UCRL-ID-121566 Pt 2

Clementine Star Tracker Stellar Compass: Final Report
Part 2

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July 1995

Lawrence Livermore National Laboratory

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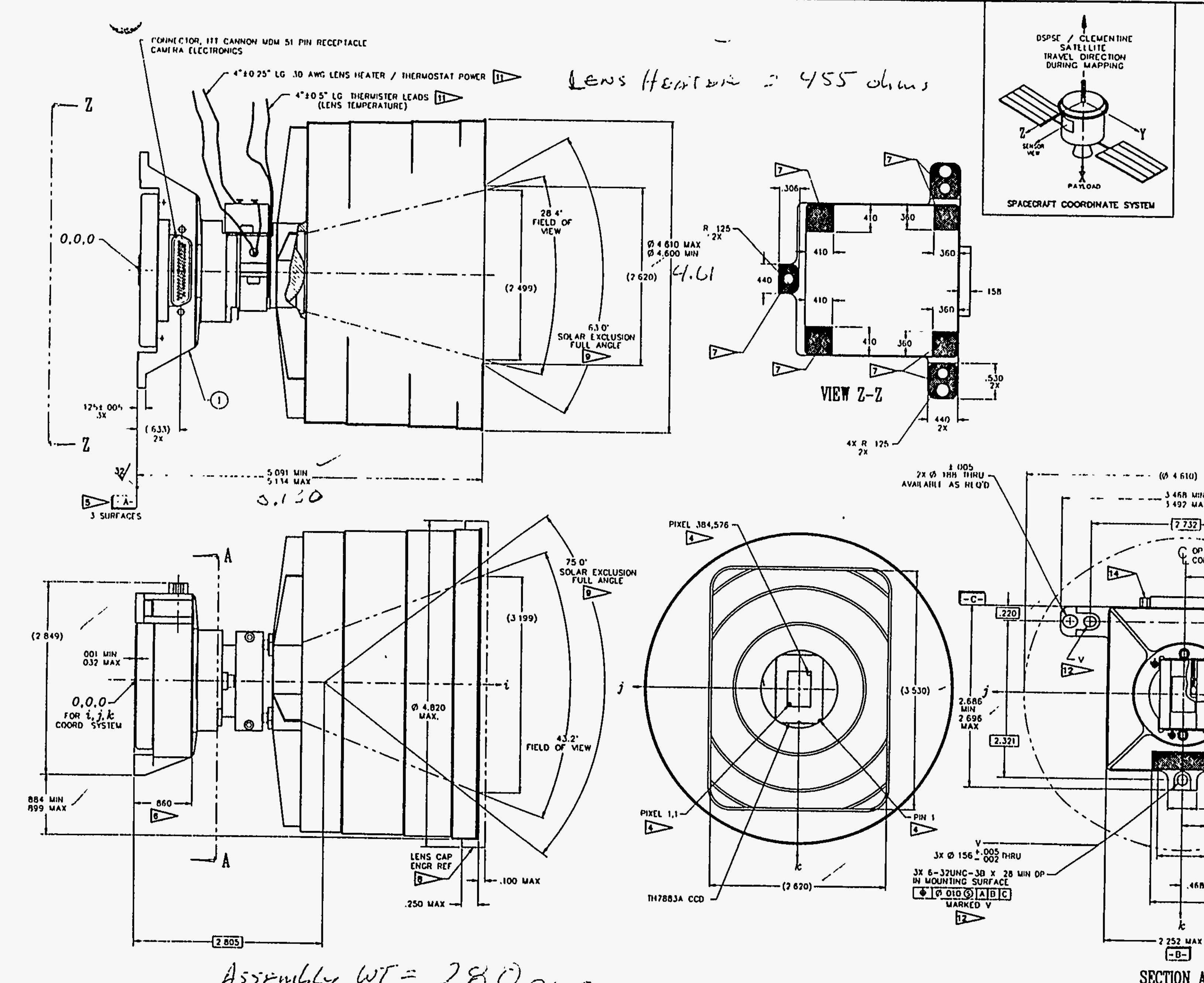
Appendix G.3.4

Assembly Procedures

at



Lens Heater = 455 ohms

4.61

5.130

Assembly WT. = 280 gms

NOTES
UNLESS OTHER' 'ECIFIED:

1. ALL DIMENSI.. ARE IN INCHES.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
3. SURFACE TEXTURE PER ANSI B46.1-1978.

4 SHOWN ENLARGED FOR CLARITY. NO SCALE.

5 MOUNTING SURFACE MATING TO SURFACE -A- SHALL BE ▱ .001 AND 32√ OR BETTER.

6 STRAP DETAILS TO BE PROVIDED BY SYSTEM INTEGRATOR WITH LLNL CONCURRENCE REQ'D. STRAP LENGTH SHALL BE MINIMIZED.

7 SURFACES SHOWN CROSS-HATCHED ARE FOR HEAT REMOVAL TO MOUNTING SURFACE.

8 LENS CAP USED FOR PARTICULATE CONTAMINATION PROTECTION. ATTACH RED TAG "REMOVE BEFORE FLIGHT".

9 MAXIMUM SOLAR EXCLUSION ANGLE DIAGONAL IS 98°

10 SCREW DEPTH NOT TO EXCEED .250 INTO HOUSING.

11 TYPE OF LEAD TERMINATION TBD

12 RECOMENDED TORQUE FOR #8-32 FASTENER WITH 120 ksi YIELD A286 GRADE MATERIAL IS 27.4±0.3 in-lbf.

13 REQUIRED TORQUE FOR #2-56 FASTENER WITH 120 ksi YIELD A286 GRADE MATERIAL IS 5.6±0.2 in-lbf.

14 REQUIRED TORQUE FOR CONNECTOR JACKSCREWS IS 1.6±0.1 in-lbf.

C	TSC					i, j & k COORDINATE SYSTEM REDEFINED
						ADDED NOTES 9 THRU 14
					E7	ADDED MIN / MAX ENVELOPE
					F3	ADDED .158 DIM
					C2	COOLING STRAP MOUNTING AREA DEFINED
					C2	NOTE #8 CHANGED
B	TSC	BT	REP		H8	LENS HEATER AND THERMISTER ADDED
B					G4	4 HEAT REMOVAL PADS ADDED TO END COVER
A	TSC	BT	REP	12/10/93	C1	NOTES 3, 4, 5, 6, & 7 CHANGED NOTE 8 ADDED
A					A1	ITEMS 2 & 3 DELETED

REF 92-106282	STAR TRACKER CAMERA ASSY. V3.1	1
NO REQD / PART / LINE STK NO	DESCRIPTION / MATERIAL	SPEC NO / ITEM

DWN PETE TRAPELLE
CHK TOM CORMAN
APVD SCOTT A. RUDDELL

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STAR TRACKER CAMERA V3.1

INTERFACE CONTROL

92-106282

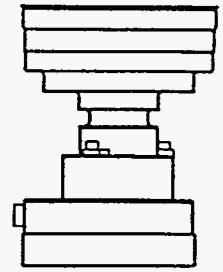
DRAWING NO AAA 92-100839-0C

ENGINEERING RELEASE

OFFICIAL USE

ST 313
6.16.97

CLEMENTINE Sensors Integration Project	ENGINEERING NOTE C1-S1-012
TITLE: Star Tracker Camera Assembly Procedure	ASSY: **Star Tracker** ORIG: Jim Dickie DATE: 7 June, 1993 APPR:



Abstract:

This document describes the assembly procedures for the Clementine Star Tracker Camera

Revision: 0A

Engineering Note
C1-S1-012

CLEMENTINE

Star Tracker Camera

Assembly Procedures

Prepared by: _______________ Date: 8 June, 1993
J. Dickie, Senior Associate

Reviewed by: _______________ Date: 9 June 1993
R. Priest, Mechanical Engineer

Reviewed by: _______________ Date: 9 June 1993
J. Lewis, Optical Engineer

Reviewed by: _______________ Date: 10 Jun 93
W. Bryson, Quality Assurance

Reviewed by: _______________ Date: 6-10-93
W. Rice, Quality Assurance

Reviewed by: _______________ Date: 10-June-93
E. Schmitt, Production

Reviewed by: _______________ Date: 10 June 1993
J. Kordas, STC Sensor Engineer

Approved by: _______________ Date: 14 Jun 93
M. Shannon, DPL Engineering

1.0 General

1.1 Scope

This document details steps required to assemble the Clementine Star Tracker Camera (STC).

1.2 Description

The STC consists of an Actel electronics PWA, a Thomson TH7883-FO2-01 B/T CCD (Flight cameras only, prototype cameras will utilize a non-B/T TH7883-F02-01 unit), mechanical hardware that encases the PWA and CCD, a mini-concentric Wide Field of View (WFOV) lens, and a light baffle. The camera is used for imaging stars to determine the position of a vehicle in space.

Assembly includes general mechanical assembly, testing to verify quality of optical couplant between the CCD and the lens fiber optic field flattener, measurement and possibly adjustment of the optical axis normal to the camera mounting surfaces, abbreviated electrical function testing prior to final staking, and final staking.

1.3 Reference Documents and Drawings

1.3.1 C1-ME-008, Clementine Sensors General Contamination Control Plan.
1.3.2 C1-S0-TBD, Clementine ESD Protection Plan.
1.3.3 C1-S1-TBD, STC Abbreviated Electronic Function Test Procedure.
1.3.4 MIL-STD-1686, Handling of ESD Sensitive Equipment.
1.3.5 MIL-STD-1246B, Product Cleanliness Levels and Contamination Control Plan.
1.3.6 C1-S0-005, Adhesives, Compounds, and Optical Couplants.
1.3.7 C1-S0-TBD, Clementine Quality Assurance Program Plan

1.4 Deviations

Procedural deviations or changes from specified procedures which do not affect the physical assembly may be made at the discretion of the responsible engineer. Deviations or changes which require any mechanical or electronic change may be made only after review and approval by a suitable Material Discrepancy Review Board as defined in the Clementine QA Program Plan.

1.5 Electro-Static Discharge Control Requirements

The STC contains electrostatic-sensitive devices which are exposed on the PWA and CCD prior to assembly closure and at the electrical interfaces after assembly closure. Therefore, it shall be handled per MIL-STD-1686 Class 1. All work shall be performed in an approved electrostatic discharge control area as defined by the Clementine Quality Assurance Group.

The STC, the test operator (using wrist straps), and related electrical test equipment shall be connected to a common ground before any electrical mating or de-mating operations, and during the use of any electrical test equipment probes. There shall be no "hot-plugging" of the test specimen with any test equipment.

- All electrostatic sensitive parts shall be stored in approved antistatic storage bags when not in use.

1.6 Cleanliness and Contamination Control Requirements

All assembly work shall be performed in a Class 100 laminar flow hood located within a Class 10,000 environment as defined in LLNL document 'Clementine Sensors General Contamination Control Plan'.

Handling of all parts shall be with clean lint-free gloves. Personnel shall wear face and hair protective smocks when handling exposed optics.

1.7 Photographs

Photographs shall be taken of the unit at major subassembly steps and of the final assembled unit. A suitable ruler shall be used to provide scale.

1.8 Disassembly Contingency

Due to the optical bonding of the CCD to the lens fiberoptic, and the time required to dissolve this bond line, there is no disassembly of an STC allowed beyond step 4.3.5, with the special exception noted in step 4.3.9. If any camera is found to be defective at any point beyond step 4.3.5, a total restart of this assembly procedure is required.

2.0 Parts List

2.1 From the kitted assembly, where applicable, record all part serial numbers for this camera into the table below.

Item	Description	Reference No.	Serial No.	Quantity
1	Camera Housing	92-106258	07	1
2	Lens Standoff	93-102550	n/a	1
3	End Cover	92-106249	02	1
4	Baffle Assembly	92-108748	n/a	1
5	WFOV Lens Assembly	92-109469	004	1
6	Actel PWA Assembly	LEA92-3128-03	04-06	1
	Includes:			
	Spacer, Tab-01	92-104616	n/a	2
	Nut, 2-56	NAS #671-C02	n/a	2
	Nut, PEM, 2-56	CRES	n/a	2
	Thermistor, Fenwal	137-562-ZXT-D02	n/a	1
7	Jackpost, Tab-08	93-101167	n/a	2
8	CCD, Thomson	TH7883-FO2-01 (Prototype Cameras)		1

9	CCD, Thomson	TH7883-FO2-01 B/T (Flight Camera Only)	7883 FO2 B/T 393-1	1
10	Pad, Circuit Board	92-104621	n/a	1
11	Pad, CCD Thermal	93-102243	n/a	1
12	Connector Bracket	92-106257	n/a	1
13	Socket head cap screw, 2-56 x .187 lg.	NAS #1352-N02-3	n/a	14
14	Socket head cap screw, 2-56 x .250 lg.	NAS #1352-N02-4	n/a	6
15	Socket head cap screw, 2-56 x .375 lg.	NAS #1352-N02-6	n/a	3
16	Socket head cap screw, 2-56 x .50 lg.	NAS #1352-N02-8	n/a	2
17	Washer, #2, Ø 0.25	NAS #620-N02	n/a	8
18	Washer, Thermal	93-102551	n/a	6
19	Thermistor, Fenwal	534-31AG04-562	n/a	1
20	Clamp, Lens Heater	93-102221	n/a	1
21	Heater, Lens, Minco	HK17402-9311	n/a	1
22	Switch, Sundstrand	974-0014-774	n/a	1
23	Tape, Reflective	Sheldahl	n/a	a/r
24	Shim, End, Upper	93-102609	n/a	2
25	Shim, End, Lower	93-102610	n/a	2

Parts logged into assembly by: K. Conway Date: 5/14/93

2.2 Required Tools

2.2.1 As part of this procedure, the following tools, with current calibration certificates, are required for assembly.

1. Torque wrench, capable of reading 0 to 10 inch-pounds minimum, with 0.1 in-lb resolution.
2. 0-1 inch Micrometer with 0.0001 inch resolution.
3. 0-1 inch Depth micrometer with 0.0001 inch resolution.

3.0 Adhesives, Couplants, Staking Compounds

3.1 For additional information on all compounds, refer to Clementine Engineering Note C1-S0-005, 'Adhesives, Compounds, and Optical Couplants'

Item	Description	Pot Life	Cure	Lot No.	Exp. Date
1	Staking Compound Hysol EA934NA	30 min.	2 hrs. @ 50°C	–	7/94
2	Optical Couplant DC 93-500	2 hrs.	24 hrs. @ 50°C	–	5/94
3	Thermal Epoxy BA-2151	30 min.	3 hrs. @ 50°C	–	7/94
4	Silver Epoxy BA-2902	30 min.	3 hrs. @ 50°C	–	12/93
5	Thermal Grease DC-340	n/a	n/a	–	–

4.0 Assembly Procedure

Initials / Date

4.1 PWA Installation Into Camera Housing

4.1.1 Remove the **Actel Camera PWA**, P/N LEA92-3067-03, from the carrier per procedure C1-S0-TBD. JWD / 5/20/93

4.1.2 Using a certified micrometer accurate to 0.0001 inches, measure the PWA thickness at the four thermal pads as shown in figure 1. Record these measurements to 4 significant figures (nominal is .046 ±.005). JWD / 5/20

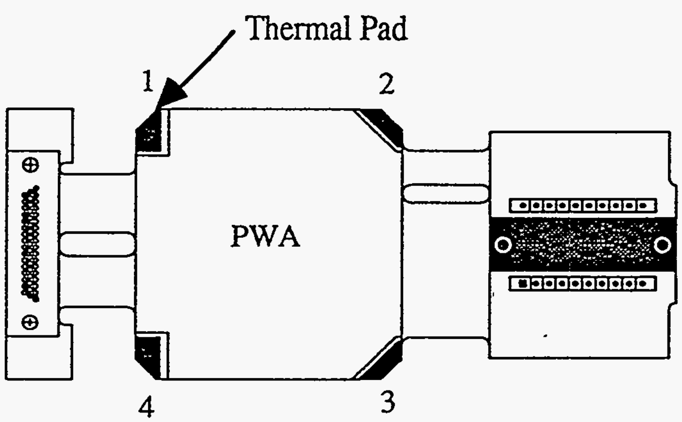


FIGURE 1

Pad Thickness

1 .0410

2 .0411

3 .0413

4 .0409

4.1.3 Place PWA in oven set to 50° C for 20 minutes. Remove PWA from oven and while still hot, bend to shape as shown in **Circuit Board ICD** drawing No. 92-104603 and figure 2. 5/20 / JWD

FLEX BOARD BENDING

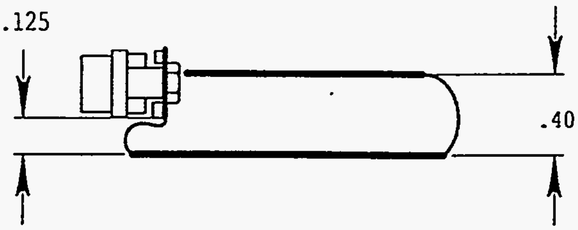
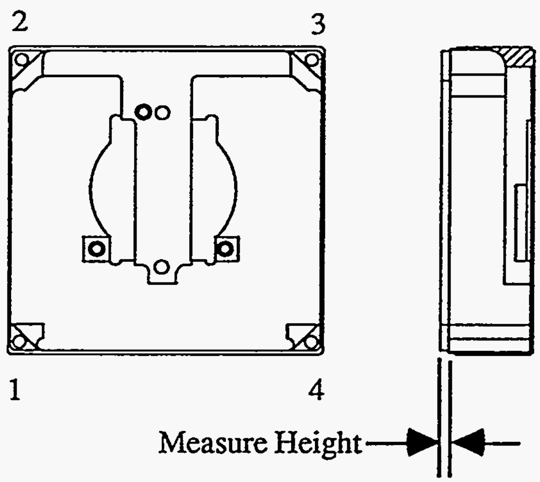


FIGURE 2

4.1.4 Using the optical comparator with the 100X objective for maximum sensitivity, measure the step height at the four corners for PWA mounting on the **Camera Housing** P/N 92-106258 as shown in Figures 3 and 5 (nominal is .050 +.000, -.005). Record these measurements to 4 significant figures. This step should be 0.0005 ±0.0001 *less* then the measured thickness of the PWA at the corresponding thermal pad areas as recorded in step 4.1.1. If correction is required, have the camera housing reprocessed, and the 2-56 threaded inserts installed before proceeding to step 4.1.5. JWD, 5/20



Step Height

1 .0472

2 .0475

3 .0472

4 .0472

FIGURE 3

4.1.5 Remove and discard the 2 screws holding the PWA connector to spacers. Install **Connector Bracket** P/N 92-106257 over connector. See figure 4. JWD, 5/21

4.1.6 Install PWA board into Camera Housing with **Circuit Board Pad** P/N 92-104621 and 2-56 washers installed between PWA assembly and housing heat sink. ***Important***, apply a thin layer (.001 in. thick, max.) of **DC-340** thermal grease to <u>both</u> sides of the circuit board pad prior to installation.
Secure connector and connector bracket with 2 each, **Jackposts** P/N 92-104607-Tab 01. Torque to 3.5 ± 0.1 in-lb.
The thermistor fits in the slot on the finger of the Camera Housing as shown in figure 4. Be careful not to pinch the thermistor leads.
Secure PWA with 2 each, 2-56 x .25 long socket head cap screws. Torque to 3.5 ± 0.1 in-lb.
Stake thermistor with **BA-2151** thermal Compound.
Stake fasteners with **EA934NA**. Cure for 3 hrs at 50 °C.

JWD 5/21/93

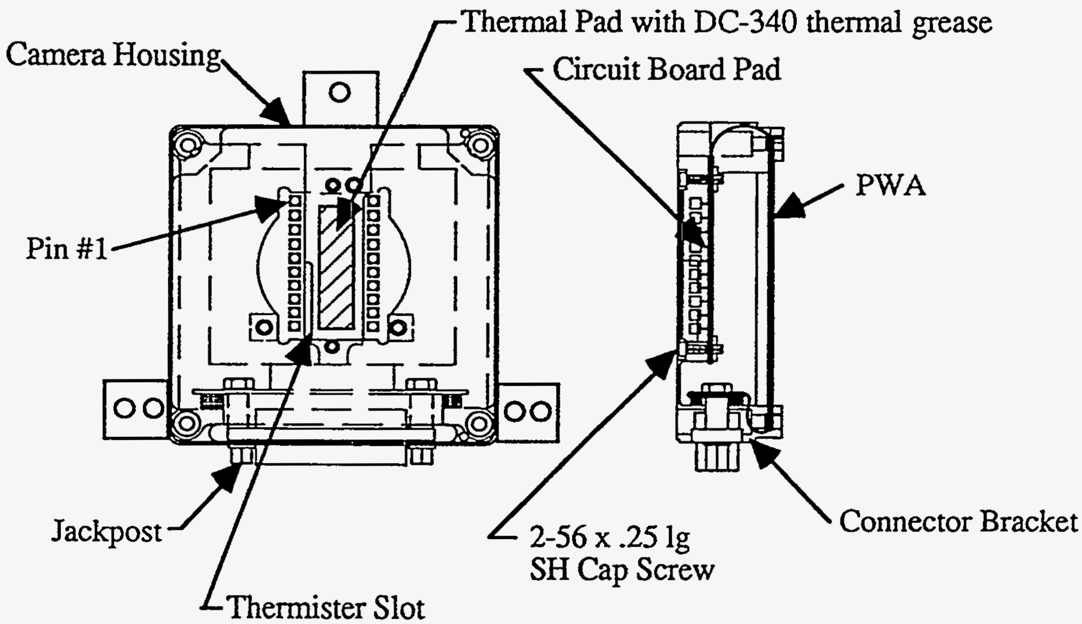


FIGURE 4

4.1.7 Apply a thin (.002 in. thick, max.) layer of BA-2902 Silver Epoxy to 4 thermal contact pads at internal corners of **End Cover** P/N 92-106249. Place **End Cover Shims**, P/N 93-102609 and 93-102610 in position on corresponding end cover pads. Cure for 3 hours at 50° C.

JWD 5/21

4.1.8 Apply a thin (.001 in. thick, max.) layer of DC-340 thermal grease to <u>both</u> sides of the four PWA thermal contact areas at corners of camera body, and the mating corners of the end cover/shim assembly.
Install end cover and secure with 4 each, 2-56 x .25 long socket head cap screws. Torque to 3.5 ± 0.1 in-lb.
<u>Do not stake fasteners at this time</u>.

JWD 5/4

4.2 CCD Installation Into Camera Housing

4.2.1 Prior to installation of CCD into camera, with extreme caution so the fiberoptic is not scratched, measure the overall thickness of the CCD to 4 significant figures using the optical comparator with the 100X objective for maximum sensitivity. Record this measurement to 4 significant figures.

CCD Thickness .3397 JWD, 5/21

4.2.2 Install **Thomson TH7883-FO2-01 CCD** (TH7883-FO2-01 B/T for flight cameras only) into PWA connector, being careful to install **CCD Thermal Pad** P/N 93-102243 between CCD and housing. ***IMPORTANT:*** be sure to apply a thin (.001 in. thick, max.) layer of DC-340 thermal grease to both surfaces of the thermal pad during installation. See figure 4. ***IMPORTANT:*** Verify location of pin #1 with socket #1 prior to installation of CCD (see fig. 4). Visually inspect assembly to verify CCD is completely and evenly seated onto thermal pad. 5/21, JWD

4.2.3 Perform abbreviated PWA board/CCD electronic functionality test per procedure C1-S1-(TBD), and verify good thermal contact between CCD and heat sink.
Record results. Pass/No Pass Pass JWD, 5/21

4.2.4 If pass, proceed with assembly section 4.3.
If no pass, stop assembly procedure until problem has been identified and corrected, and camera passes abbreviated electronics functionality test. JWD, 5/21

4.3 Lens Standoff Installation

4.3.1 Using the optical comparator with the 100X objective for maximum sensitivity, measure the step height from the lens standoff mounting ring to the thermal finger surface in the camera body. Record this measurement to 4 significant figures. See Figure 5.
Housing Step Depth .0984 JWD, 5/21

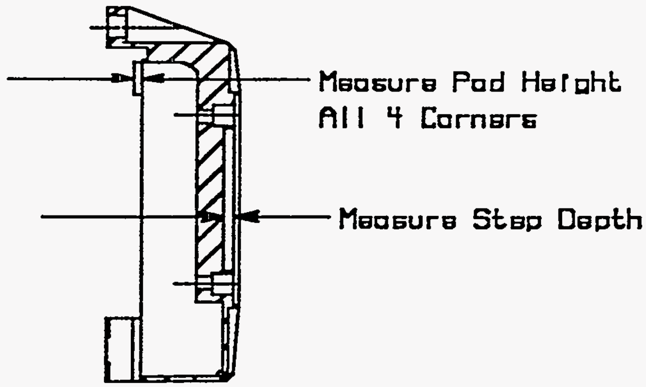


FIGURE 5

4.3.2 From the inspection data provided with **WFOV Lens** P/N 92-109469, obtain the recorded depth from the face of the fiberoptic to the three mounting tabs (nominal is 0.125). Record these measurements to 4 significant figures.

JWD, 5/22

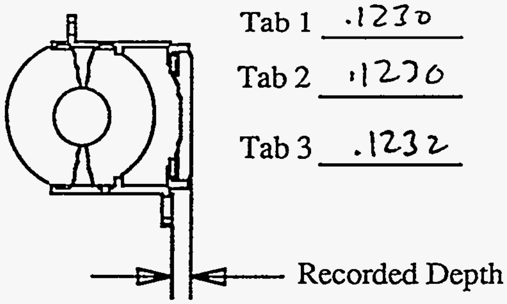
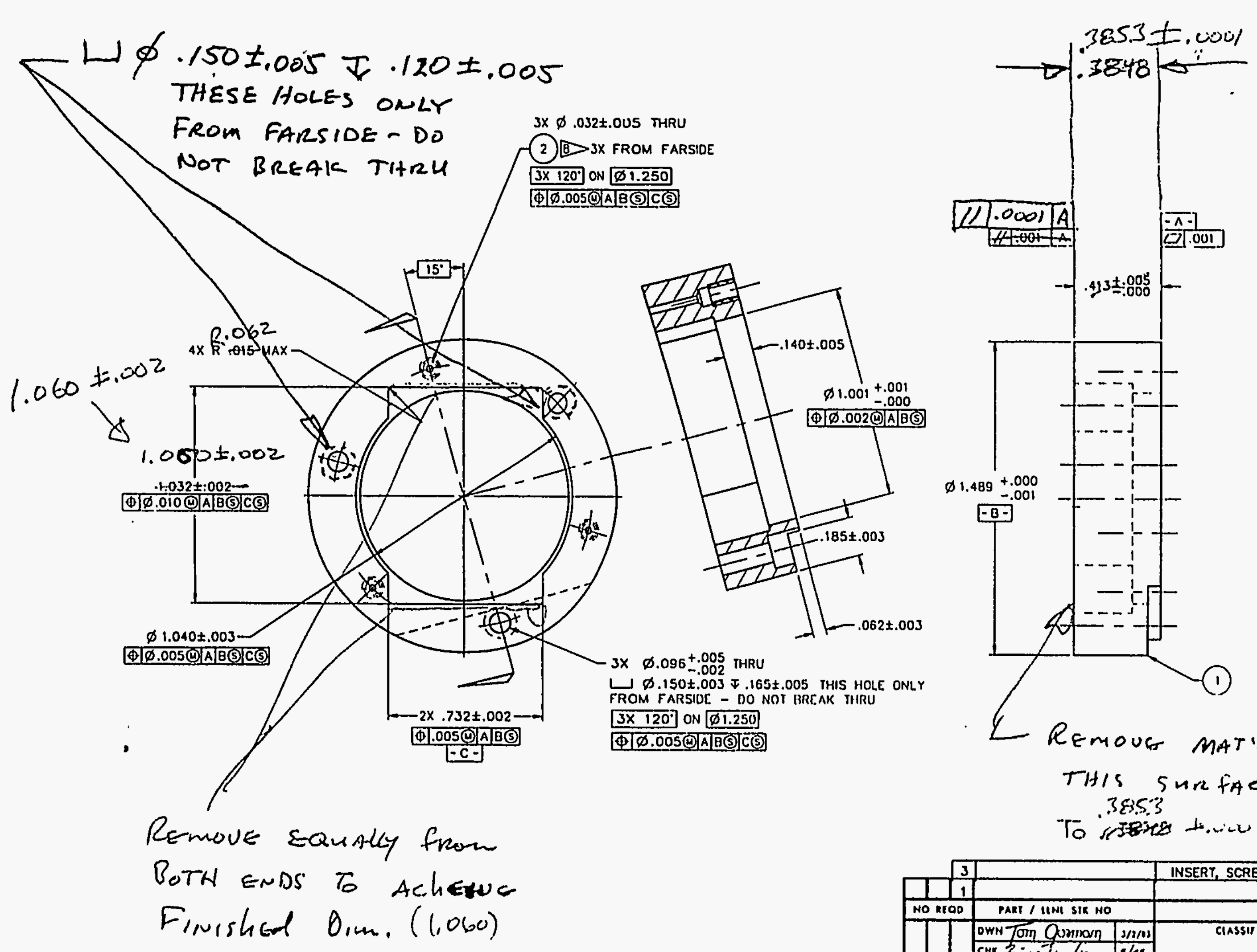


FIGURE 6

4.3.3 Calculate average depth to face of lens fiberoptic to 4 significant figures and record answer.

Average Depth .1230

JWD, 5/22



NOTES
UNLESS OTHERWISE SPECIFIED:

1. ALL DIMENSIONS ARE IN INCHES.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
3. SURFACE TEXTURE PER ANSI B46.1-1978.
4. 63√ ALL MACHINED SURFACES.
5. BREAK SHARP EDGES R.005 MAX OR CHAMFER.
6. INSIDE RADII .010 MAX.
7. CHEMICAL CONVERSION COAT PER MIL-C-5541, CLASS 3, GOLD. HANDLE PART WITH CLEAN LINT-FREE GLOVES AFTER COATING.
8. INSTALL INSERTS FROM SURFACE INDICATED PER MS33537 AFTER COATING.
9. WRAP IN CLEAN LINT-FREE MATERIAL. BAG & TAG WITH PART NO. & REV. LETTER. DO NOT MARK ON PART.

NO REQD	PART / IDENT NO	DESCRIPTION / MATERIAL	SPEC NO	ITEM
3		INSERT, SCREW LOCKING, CRES, 2-56 X .129 L	MS21209-C0215	2
1		AL ALY TYPE 6061-T651	QQ-A-250/11	1

DWN Tom Gorman 3/2/93
CHK Bill Taylor 3/93
APVD B. Price 3/93

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LAWRENCE LIVERMORE NATIONAL LABORATORY
MECHANICAL ENGINEERING DEPT
UNIVERSITY OF CALIFORNIA

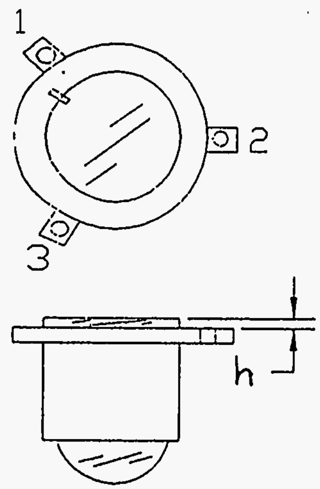
MAJOR UNIT: STAR TRACKER CAMERA ASSY, V3.1
DETAIL: LENS STANDOFF
SHOWN ON AAA 92-106282
DRAWING NO AAA 93-102550-00
SCALE .50 SHEET 1 OF 1

ENGINEERING RELEASE
APPROVED Robert E. Price Project Engineer
Date 16 Mar 1993

LTR	DWN	CHK	APVD	DATE	ZONE	CHANGE

ST-313
Flight #1

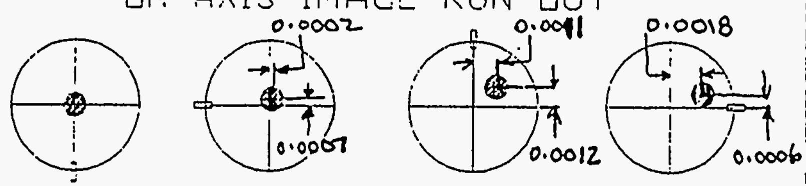
STAR TRACKER LENS ASSEMBLY (P/N 880-0001-401)
S/N: 004



PAD #	h (in)
1	0.1230
2	0.1230
3	0.1232

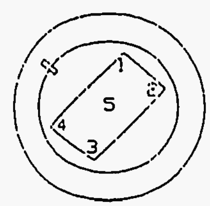
T.G.
4-1-93

ON-AXIS IMAGE RUN-OUT

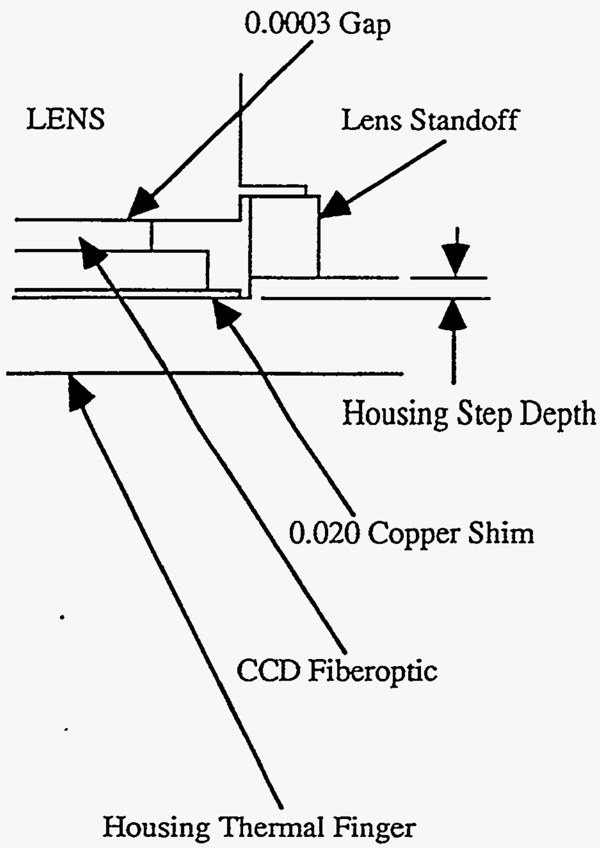


T.G. 4-1-93

IMAGE SIZE & QUALITY



FIELD PT.	IMAGE DIA.(in)	
1	0.0016	UNIFORM IMAGES
2	0.0017	
3	0.0017	
4	0.0017	
5	0.0017 to 0.0018	



Add The Following:

Lens Tab Depth	.1230
CCD Thickness	.33970
0.020 Copper Shim	0.020
0.0003 Gap	0.0003
0.001 Epoxy Fill	0.001
Sub-Total:	.4840

Subtract The Following:

Housing Step Depth	.0984
Total is Lens Standoff Thickness	.3856

FIGURE 7

4.3.7 Perform the arithmetic as shown in Figure 7. JWD / 5/22

4.3.8 Remove the lens standoff and reprocess the <u>bottom</u> surface to achieve the thickness ±0.0001, recorded from the arithmetic in Figure 7. JWD / 5/22

4.3.4 Apply a thin layer (.001 in. thick, max.) of DC-340 thermal grease to the standoff-to-camera body mechanical interface areas.
Install lens standoff to camera body with 1 each, 2-56 x .375 long and 2 each 2-56 x .50 long socket head cap screws. Torque to 3.5 ± 0.1 in-lb. JWD / 5/24

4.3.5 Using the optical comparator with the 100X objective for maximum sensitivity, measure distance from top of lens standoff to top of CCD fiberoptic at 4 positions (1-4) to verify that the fiberoptic surface is parallel to the top of the lens standoff to within 0.0001 inches as shown in figures 8 and 9, and matches the lens-to-tab depth recorded in the inspection data from the vendor +0.0003 inches. If not, reposition the CCD to correct any error. JWD / 5/24

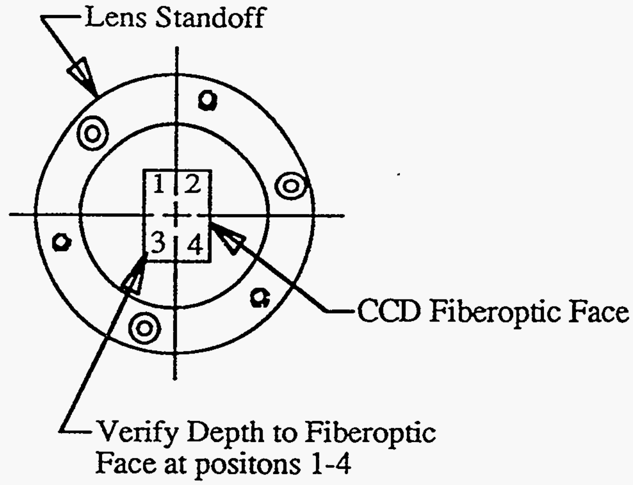


FIGURE 8

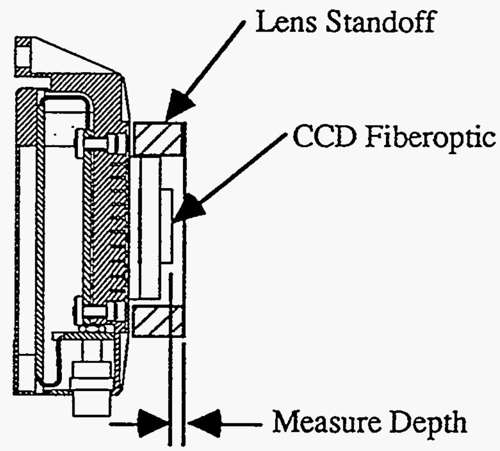


FIGURE 9

4.3.6 Stake fasteners with EA934NA Staking Compound. Cure at 60° C for 3 Hr. JWD, 5/24

4.3.7 Do not proceed to assembly section 4.4 unless there is a single time span of at least 8 hours available to complete all steps of section 4.4. JWD, 5/24

4.4 Lens Installation

4.4.1 Mix a small quantity of **DC 93-500** encapsulant and degas. Place one drop of the degassed encapsulant on top center of the CCD fiberoptic interface surface as indicated in figure 10.
Apply a thin layer (.001 in. thick, max.) of DC-340 thermal grease to the mechanical interface between the lens standoff and the WFOV lens mount tabs.
Using extreme care to avoid any contact with the thermal grease, except at the mount points, place the WFOV lens into the lens standoff.

At this point, verify the lens/CCD orientation. Visually inspect the optical interface through the lens to ensure that the encapsulant is evenly spread over the CCD/lens interface with no bubbles evident.
Secure the lens to the lens standoff with 3 each, 2-56 x .187 long socket head cap screws with #2 x Ø 0.25 CRES washers. Torque all 3 fasteners *evenly* 1/4 turn at a time to 2.9 ± 0.1 in-lb. Jun 15/24

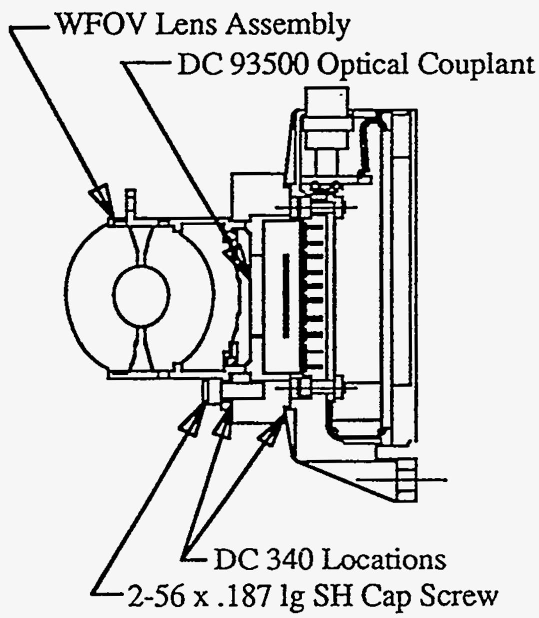


FIGURE 10

4.4.2 Within one hour of the procedures completed in step 4.4.1, perform an abbreviated camera electronic functionality test per procedure C1-S1-(TBD).
Record results. Pass/No Pass PASS
If pass, proceed to step 4.4.3
If no pass, **immediately** proceed to step 4.4.4 Jun 15/24

4.4.3 Within one hour of the test performed in step 4.4.2, perform a flat field optical test to look for bubbles and even distribution at the fiberoptic interface between the lens and CCD.
Record results. Pass/No Pass PASS
If pass, proceed to assembly section 4.5
If no pass, **immediately** proceed to step 4.4.4 Jun 15/24

4.4.4 <u>NOTE:</u> ***This step is to be taken only as an emergency measure, and only if a B/T CCD is being used.*** If the camera fails either of the tests required in steps 4.4.2 or 4.4.3, **immediately** disassemble the lens from the camera housing, remove the CCD, and carefully remove any residual couplant from all optical surfaces to ensure that both the lens and the B/T CCD can be salvaged for reuse. N/A

4.4.5 If step 4.4.4 is performed, the assembly procedure is aborted at this point and must be re-started. N/A

4.5 Baffle Installation

4.5.1 Install **Baffle Assembly** P/N 92-108748 onto the WFOV lens mounting tabs using 3 each, 2-56 x .187 long socket head cap screws and 6 each, **Thermal Isolation Washers**, P/N 93-102551. Do not torque fasteners beyond finger tight at this time. Ensure that the baffle assembly is evenly centered on the front of the WFOV lens by observing the gap between the lens and the baffle. For maximum thermal resistance, minimize metal-to-metal contact around this interface and between fasteners and mounting tabs. See Figure 11. JWD 5/25

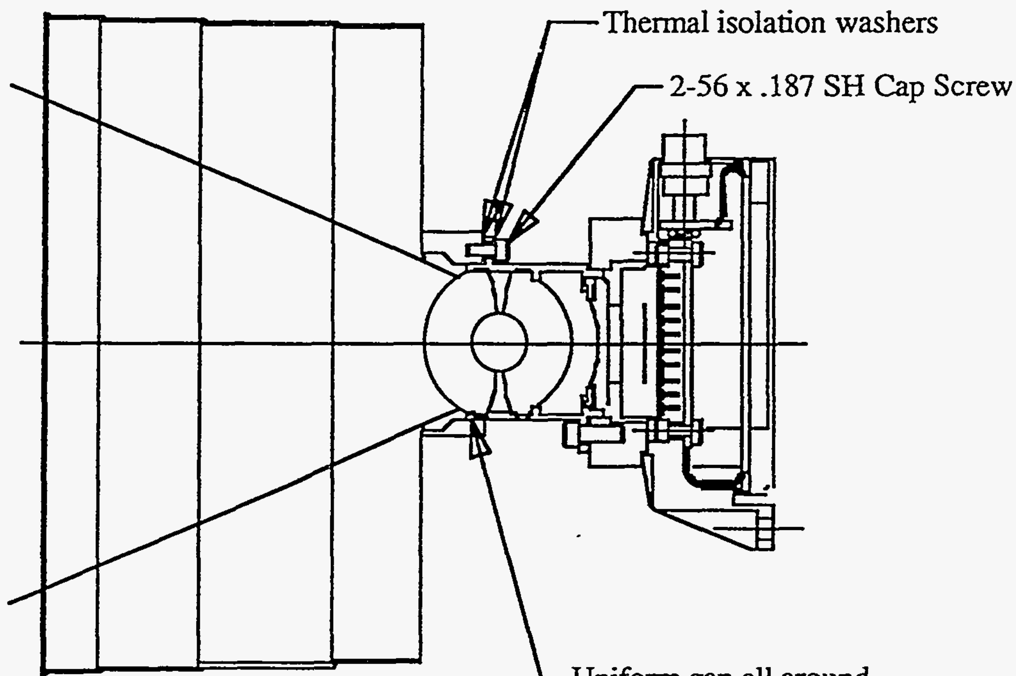


FIGURE 11

4.5.2 Perform abbreviated camera electronic functionality test per procedure C1-S1-(TBD).
Record results. Pass/No Pass PASS JWD 5/25

4.5.3 Angular orientation of the rectangular baffle cutout to the camera CCD is critical. Total angular tolerance is 0.3° rotation. Visually verify orientation as shown in Figure 12, also verify by imaging with the camera and looking for any obscuration at the corners. If baffle is within tolerance, torque fasteners to 2.0 ± 0.1 in-lb.

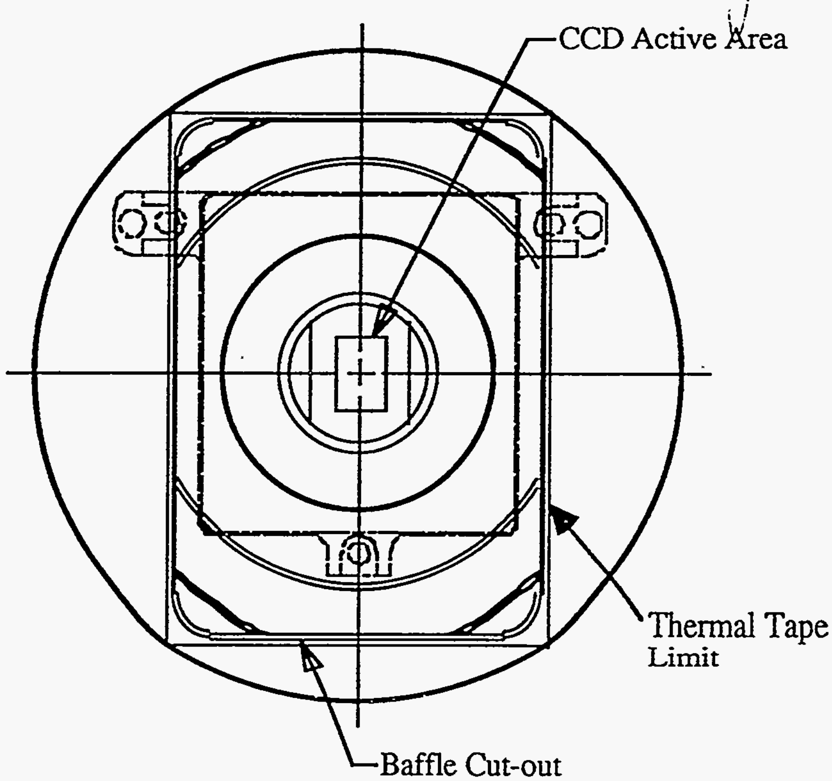


FIGURE 12

4.5.4 If camera/baffle assembly has passed all functionality tests, stake all lens, baffle, and camera end cover fasteners with EA934NA. Cure for 3 hrs. at 50 °C. Apply Sheldahl thermal tape to front of baffle vane. Trim to baffle outside diameter. **IMPORTANT:** Do not apply tape within 0.060 inches of the vane edge. See Figure 12.

4.6 Lens Heater Installation

4.6.1 Install **Lens Heater Clamp,** P/N 93-102221, and **Lens Heater Strip,** Minco P/N HK17402-9311, onto the WFOV lens barrel using 2 each, 2-56 x .187 long socket head cap screws. Be careful when routing the heater wires out of clamp to avoid damage to wires. Install temperature control switch onto lens heater clamp using 2 each, 2-56 x .187 long socket head cap screws. Place a small drop of BA-2151 thermal epoxy under center of switch prior to installation to ensure good thermal contact. Torque all fasteners to 3.5 ± 0.1 in-lb.
Stake heater wires and fasteners with EA934NA. Cure for 3 hrs at 50 °C.

JWD, 5/25

4.6.2 Bond **Thermistor,** Fenwal P/N 534-31AG04-562, to side of lens heater clamp with BA-2151 epoxy. Cure for 3 hrs. at 50 °C.

JWD, 5/25

Appendix G.3.5

Test Procedures

Appendix G.3.5.1

Calibration Data Files

```
total 58
drwxrwxr-x 28 dwd          1024 Jul  4 11:55 ./
drwxrwxr-x  7 root          512 Jun 21 12:16 ../
drwxrwxr-x  2 dwd           512 Jun 28 19:23 0C_hi_center_post_vib/
drwxrwxr-x  2 dwd           512 Jun 30 12:49 0C_hi_dark_current/
drwxrwxr-x  2 park          512 Jul  3 17:38 0C_linearity/
drwxrwxr-x  2 dwd           512 Jun 30 12:53 0C_low_dark_current/
drwxrwxr-x  2 dwd          1024 Jun 30 11:21 0C_nominal_center/
drwxrwxr-x  2 dwd          1024 Jun 30 11:27 0C_nominal_center_post_vib/
drwxrwxr-x  2 dwd           512 Jun 29 13:45 0C_nominal_dark_current/
drwxrwxr-x  2 dwd           512 Jun 30 11:23 0C_nominal_spatial_post_vib/
drwxrwxr-x  2 dwd          2048 Jun 30 11:14 0c_low_center_post_vib/
drwxrwxr-x  2 dwd           512 Jun 30 12:56 10C_nominal_dark_current/
drwxrwxr-x  2 dwd          1024 Jun 30 12:06 20C_nominal_center_post_vib/
drwxrwxr-x  2 dwd           512 Jun 30 13:37 20C_nominal_dark_current/
drwxrwxr-x  2 dwd          3072 Jun 28 12:31 Optical_Distortion/
drwxrwxr-x  2 park         1536 Jul  3 17:58 Optical_Distortion_070293/
drwxrwxr-x  2 park          512 Jul  4 12:49 Optical_Distortion_070493/
-rw-rw-r--  1 dwd          5886 Jun 10 11:33 PDRatio_061093.list
-rw-rw-r--  1 dwd          5886 Jun 17 11:46 PDRatio_061793.list
drwxrwxr-x  2 dwd           512 Jun 30 13:17 Spectral_Response/
drwxrwxr-x  2 dwd           512 Jun 29 13:49 focus/
drwxrwxr-x  2 dwd          5632 Jul  3 17:23 images/
drwxrwxr-x  2 dwd          1024 Jun 30 12:14 n10C_nominal_center_post_vib/
drwxrwxr-x  2 dwd           512 Jun 30 13:40 n10C_nominal_dark_current/
drwxrwxr-x  2 dwd          2048 Jun 30 12:44 n20C_nominal_center_post_vib/
drwxrwxr-x  2 dwd           512 Jun 30 13:44 n20C_nominal_dark_current/
drwxrwxr-x  2 dwd          7680 Jul  1 11:27 noise/
drwxrwxr-x  2 park         2048 Jul  5 10:49 noise_1/
drwxrwxr-x  2 park          512 Jul  4 12:25 on_off_test/
drwxrwxr-x  2 dwd           512 Jul  3 14:56 warm_up/
```

Star Tracker ST 313

Calibration data files: names, locations

Appendix G.3.5.2

Environmental Acceptance Test Procedures

Clementine
CCD Cameras
Environmental Acceptance Test Procedures

Camera Type: Star Tracker

S/N: ST 313

	Date	Rev.	Date	Approval
Prepared by: R. E. Priest	23 May 93			
Reviewed by: M. J. Richardson	5/24/93			
Reviewed by: J.F. Kordas	20 May 93			
Reviewed by: E. H. Schmitt	24/May/93			
Reviewed by: W. R. Bryson	24/May 93			
Approved by: M. J. Shannon	24 May 93			

University of California Lawrence Livermore National Laboratory	23 May 1993 CCD Cameras Environmental Acceptance Test Procedures	C1-ME-015 Revision 00

Table of Contents

1.0 General

1.1 Scope

This document details steps required to environmentally acceptance test the Clementine CCD cameras (Star Tracker, UV/Visible and HiRes/LIDAR Receiver). A copy of this document shall be maintained with each camera Certification Log. Data specific to that camera shall be recorded in Appendix A of this document.

1.2 Reference Documents and Drawings

Star Tracker
1.2.1 Drwg AAA92-100839, Star Tracker Camera Assy, V3.1
1.2.2 C1-S1-017, STC Abbreviated Function Test Procedures.
1.2.3 C1-S1-005, Star Tracker Camera Acceptance Level Characterization Procedures.
UV/Visible
1.2.4 Drwg AAA92-103601, UV/Visible Camera Assy, V3.1
1.2.5 C1-S2-017, UVVC Abbreviated Function Test Procedures.
1.2.6 C1-S2-002, UV/Visible Camera Acceptance Level Characterization Procedures.
HiRes/LIDAR Receiver
1.2.7 Drwg AAA92-109116, HiRes/LIDAR Receiver Camera Assy, V3.1
1.2.8 C1-S4-024, HRC Abbreviated Function Test Procedures.
1.2.9 C1-S4-005, HiRes/LIDAR Receiver Acceptance Level Characterization Procedures.
Common
1.2.10 C1-ME-008, Clementine Sensors Contamination Control Plan.
1.2.11 C1-EE-027, Clementine ESD Control Plan.
1.2.12 C1-S0-007, Clementine Quality Assurance Program Plan.
1.2.13 MIL-STD-1686, Handling of ESD Sensitive Equipment.
1.2.14 MIL-STD-1246B, Product Cleanliness Levels and Contamination Control Plan.
1.2.15 MIL-STD-1540B, Test Requirements for Space Vehicles
1.2.16 MIL-HDBK-340, Application Guidelines for MIL-STD-1540B; Test Requirements for Space Vehicles

1.3 Deviations

Procedural deviations or changes from specified procedures which do not affect the physical assembly may be made at the discretion of the responsible engineer. Deviations or changes which require any mechanical or electronic change may be made only after review and approval by a suitable Material Discrepancy Review Board as defined in the Clementine QA Program Plan.

1.4 Electro-Static Discharge Control Requirements

Each camera contains electrostatic-sensitive devices which are exposed on the electronics PWAs prior to assembly closure and at the electrical interfaces after assembly closure. Therefore, it shall be handled per MIL-STD-1686 Class 1. All work shall be performed in an approved electrostatic discharge control area as defined by the Clementine Quality Assurance Group.

The Camera, the test operator (using wrist straps), and related electrical test equipment shall be connected to a common ground before any electrical mating or de-mating operations, and during the use of any electrical test equipment probes. There shall be no "hot-plugging" of the test specimen with any test equipment.

All electrostatic sensitive parts shall be stored in approved antistatic storage bags when not in use.

1.5 Cleanliness and Contamination Control Requirements

All assembly work shall be performed in a Class 100 laminar flow hood located within a Class 10,000 environment as defined in LLNL document "Clementine Sensors General Contamination Control Plan".

Handling of all parts shall be with clean lint-free gloves. Personnel shall wear face and hair protective smocks when handling exposed optics.

1.6 Measurement Calibration and Tolerances

1.6.1 Test chambers and test equipment shall be certified to be within their current calibration periods.
1.6.2 Vibration amplitude 14.0 ± 1.4 g rms, 19.8 ± 2.0 g rms. Power spectral density spectrum ± 3 dB.
1.6.3 Temperature ± 3°C.
1.6.4 Humidity shall not be condensed on the camera at any time.

1.7 Data Collection and Reduction

Generally all data shall be recorded using an automated system (computer + software). Specific net results shall be recorded in the traveller copy of this procedure as required. Data reduction includes compiling all data into a summary table as outlined in Appendix A, and graphing mean and std dev image results vs test, and CCD temperature value vs test.

2.0 Equipment List

2.1 Test Station
2.2 Clementine Cameras Power Supply
2.3 Clementine Filter Wheel Power Supply
2.4 Clementine DC/DC Converter Power Supply
2.5 Sensor 51-pin signal cable
2.6 Sensor 15-pin filter wheel power/signal cable

3.0 Testing Procedures

3.1 Pre-Random Vibration Abbreviated Function Test

Perform Camera Abbreviated Function Test (AFT) per the referenced procedures. Obtain data and record on data sheets. Keep the original data sheets with the camera Certification Log.

3.2 Random Vibration Testing

Random vibration testing shall be performed with the camera powered off during dynamic loading. An abbreviated function test is required both before random vibration, and after all three axes of random vibration testing. Abbreviated function testing is not performed between axes tests.

The STC shall be tested to the 19.8 g rms level as specified in Fig. 3.1.

The UVVC and HRC shall be tested to the 14.0 g rms level as specified in Fig. 3.2.

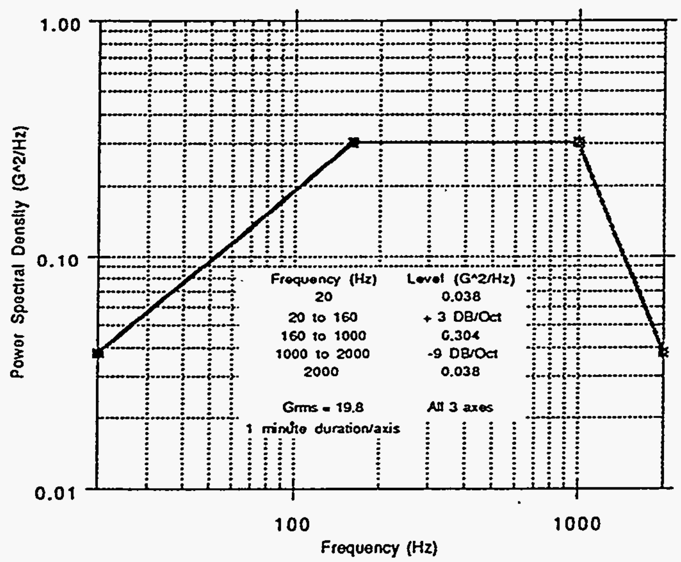


Fig. 3.1 Random Vibration Test Level for Star Tracker Camera

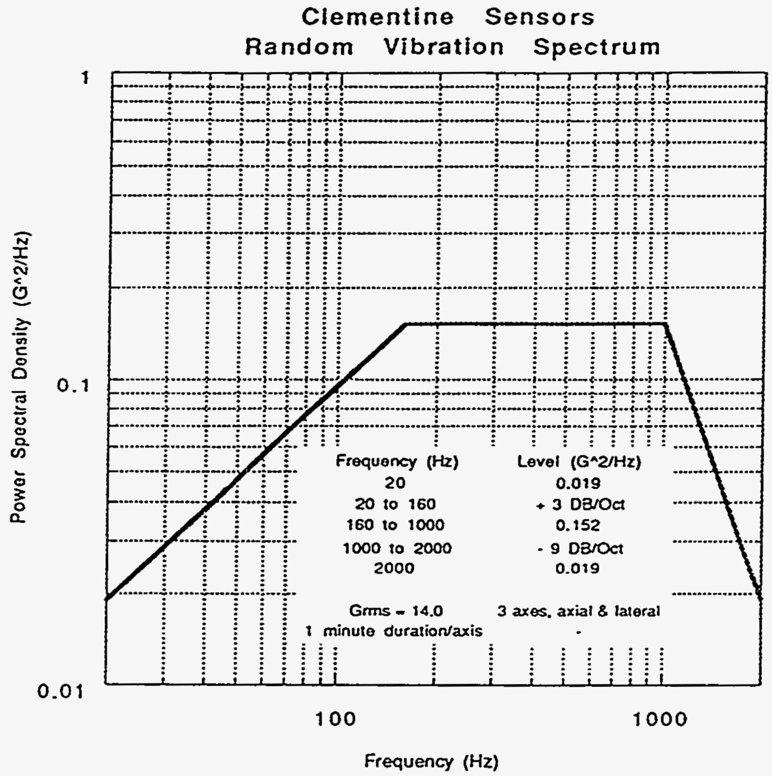


Fig. 3.2 Random Vibration Test Level
for UV/Visible and HiRes/LIDAR Cameras

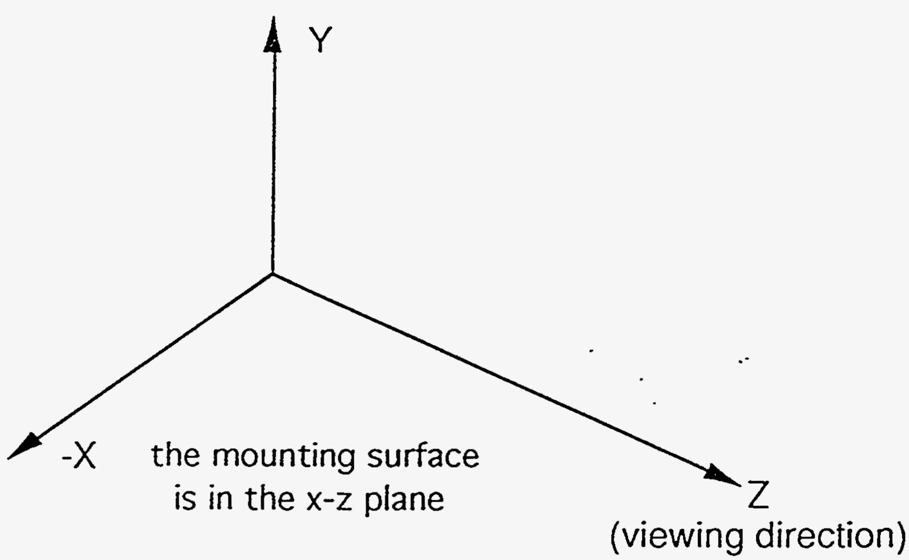


Fig. 3.3 Camera Coordinate System

3.2.1 Mount the Test Cube with a tri-axial accelerometer on the shaker head. Perform a fixture survey to determine input excitation required to achieve the PSD level specified in Fig. 3.1 or Fig. 3.2 as appropriate. Repeat the test for all three principle axes defined in Fig. 3.3. Fixture survey is required once only for the fixture.

3.2.2 X-Axis

3.2.2.1 Configure the Test Cube for x-axis testing.

3.2.2.2 Install the Camera with lens cap in place onto the Test Cube using the appropriate NAS sockethead cap screws. Torque to values shown in Table 1.

Table 1
Camera Installation Torque Specifications

Size	NAS#	Torque (in-lbf)
#4-40	NAS1352N04-x	14.7 ± 0.3
#6-32	NAS1352N06-x	27.4 ± 0.5
#8-32	NAS1352N08-x	50.7 ± 0.5

"x" designates the length of the fastener, and is selected to fit.

3.2.2.3 Remove lens cap. NOTE: the lens cap shall be off of the Camera for as short a period as practical to minimize particulate contamination.

3.2.2.4 Apply specified load for 60 second duration.

3.2.2.5 Replace the lens cap.

3.2.3 Y-Axis

3.2.3.1 Remove the Camera from the Test Cube and replace it on the Test Cube for y-axis testing.

3.2.3.2 Remove the lens cap.

3.2.3.3 Apply specified load for 60 second duration.

3.2.3.4 Replace the lens cap.

3.2.4 Z-Axis

3.2.4.1 Remove the Camera from the Test Cube and replace it on the Test Cube for z-axis testing.

3.2.4.2 Remove the lens cap.

3.2.4.3 Apply specified load for 60 second duration.

3.2.4.4 Replace the lens cap.

3.2.4.5 Remove the Camera from the Test Cube and package.

3.3 Post-Random Vibration Abbreviated Function Test

Perform Camera Abbreviated Function Test (AFT) per the referenced procedures. Obtain data and record on data sheets. Keep the original data sheets with the camera Certification Log.

3.4 Thermal Cycle Testing

The unit shall withstand thermal cycling testing that is 10°C below the min. operational limit, and 20°C above the max. operational limit. Testing shall be from -30 °C to +20 °C at ≤ 3 °C/min over six (6) cycles. Testing shall begin at room temperature, drop at the specified rate to -30 °C, increase to + 20 °C, et cetera until all six cycles are completed.

The unit shall be mounted on small aluminum plate with a light layer of DC 340 thermal silicone between the mounting feet and the plate. Cooling straps are not required for this test, except for the stepper motors on the UV/Vis and HiRes cameras. Nylon standoffs are required between the plate and the floor of the thermal chamber.

The unit shall be powered "on" during the entire thermal cycle test duration. Camera electronics shall be in the disabled state except during AFT. The filter wheel electronics shall be in the Hold mode, except during AFT.

Function testing per Camera-specific AFT Procedures shall be performed at each temperature limit, for 5 minutes near the beginning of the dwell time and for 5 minutes near the end of the dwell time. Dwell time at maximum and minimum temperature shall be 1 hour.

Read the external Fenwall thermistor with an approved DVM to monitor the Camera temperature.

NOTE: Testing may be interrupted at a 20°C temperature setting, then resumed at a later time.

3.4.1 Cycle 1, -30°C

Ramp the Camera down to -30°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.4.2 Cycle 1, +20°C

Ramp the Camera up to +20°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.4.3 Cycle 2, -30°C

Ramp the Camera down to -30°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.4.4 Cycle 2, +20°C

Ramp the Camera up to +20°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.4.5 Cycle 3, -30°C

Ramp the Camera down to -30°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.4.6 Cycle 3, +20°C

Ramp the Camera up to +20°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.4.7 Cycle 4, -30°C

Ramp the Camera down to -30°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.4.8 Cycle 4, +20°C

Ramp the Camera up to +20°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.4.9 Cycle 5, -30°C

Ramp the Camera down to -30°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.4.10 Cycle 5, +20°C

Ramp the Camera up to +20°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.4.11 Cycle 6, -30°C

Ramp the Camera down to -30°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.4.12 Cycle 6, +20°C

Ramp the Camera up to +20°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.5 Thermal Vacuum Cycling

The unit shall withstand thermal vacuum cycle testing that is 5°C below and above the min. and max. operational limits. Additionally, radiometric response shall be verified at -20°C and 0°C for correlation to calibration data acquired in a dry N_2 forced convection thermal chamber.

Testing shall be from -25 °C to +5 °C at ≤ 3 °C/min over one cycle with ambient pressure of ≤ 1 x 10^{-4} torr during the entire test. Temperature shall be provided by a controlled cold plate and cooling shroud. Testing shall begin at room temperature, drop at the specified rate to -25 °C, then increase to -20°C, then increase to 0 °C, then increase to +5°C. The temperature of the cold plate and cooling shroud shall remain the same during testing. Abbreviated function tests shall be performed at -25° and +5°C temperature limit. Abbreviated calibration measurements shall be performed per referenced calibration documents at -20°C and 0°C. Dwell time at test temperatures shall be > 2 hours.

The camera need only be powered on during the 2 hour dwell time at temperatures. Camera may be Disabled and filter wheel in Hold, except during AFT and abbreviated calibration measurements. An AFT shall be performed near the beginning, and near the end of the dwell period.

3.5.1 Configure the Camera in the thermal vacuum chamber as shown in Fig. 3.4. Note that the light source may be inside or outside the chamber as long as the irradiance is measured with a calibrated radiometer at various locations of the optical aperture of the Camera. Conditioned power and SASI interface are required. Temperature stability shall be determined by the lens thermistor.

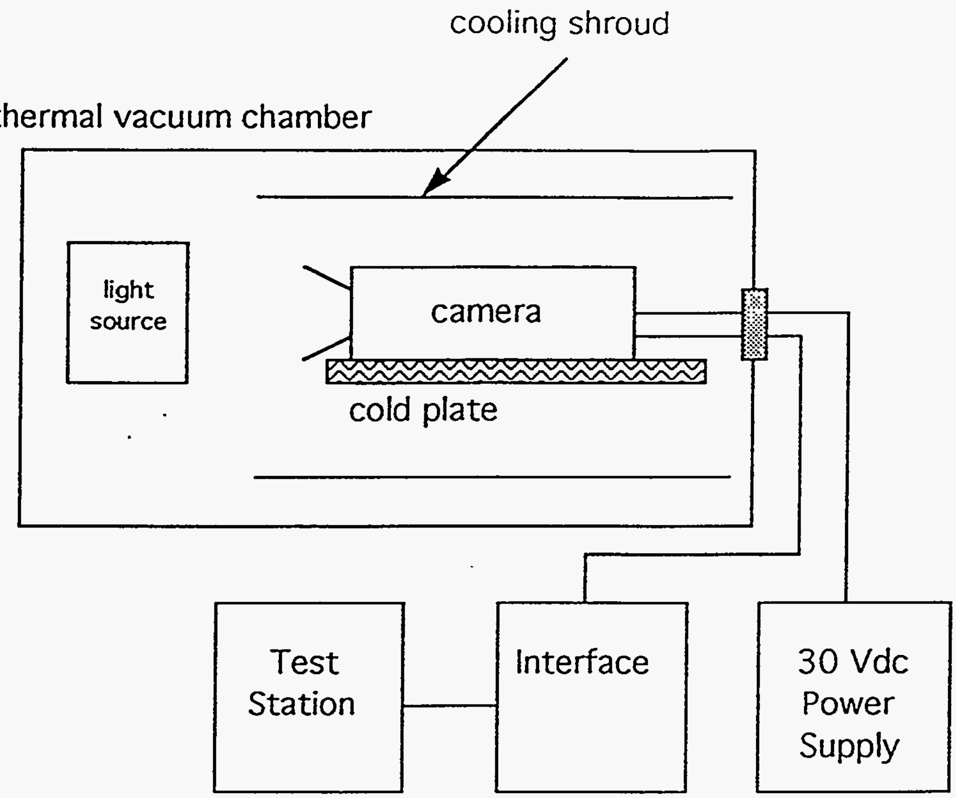


Fig. 3.4 Thermal Vacuum Test Schematic

3.5.2 Pre-TVAC Check Out

With the cold plate operating at 20°C, Perform an AFT to verify camera operation.

3.5.3 -25°C TVAC

Evacuate the chamber to < 1 x 10-4 torr.

Ramp the cold plate and shroud down to -30°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.5.4 -20°C TVAC

Ramp the cold plate and shroud up to -20°C. Perform abbreviated calibration measurements. Record all data per section 3.5, "Thermal Vacuum Cycle Testing" found in Appendix A.

Compare results with data obtained during full calibration in dry N_2. Determine if there is any statistically substantiated change in performance.

3.5.5 +0°C TVAC

Ramp the cold plate and shroud up to 0°C. Perform abbreviated calibration measurements. Record all data per section 3.5, "Thermal Vacuum Cycle Testing" found in Appendix A.

Compare results with data obtained during full calibration in dry N_2. Determine if there is any statistically substantiated change in performance.

3.5.6 +5°C TVAC

Ramp the cold plate and shroud up to +5°C at a rate < 3°C/minute. Allow temperature to stabilize within ± 3°C. Perform AFT. Wait until near the end of the dwell period, then repeat AFT.

3.5.7 Post-TVAC Testing

Turn the cold plate and shroud off and return back to ambient temperature. Vent slowly with dry nitrogen to return the chamber to one atmosphere. Perform AFT. Remove the Camera from the chamber and return back to it's storage container.

3.6 Burn-In

The unit shall accumulate, as a goal, a total of 300 cummulative hours of Camera electronics powered-on operation. Powered-on time accumulated during other tests (e.g. - thermal cycling, etc.) count toward the 300 hours. If 300 hours is satisfied by the end of all testing (environmental ATP and calibration), then additional burn-in testing is not required.

The stepper motor electronics must accumulate, as a goal, a total of 300 hours of powered-on operation. Of these 300 hours, 5 hours of stepping shall be attained with the remaining 295 hours with the electronics in the hold mode. For reference, at one filter position change per 0.35 sec stepping time, this equates to > 51,400 filter position changes.

4.0 Mechanical and Mass Properties

4.1 Review all relevant mechanical features of the unit against LLNL interface control drawing, latest applicable revision, for conformance. Mark the actual measured dimension in green on the assembly drawing included in the Camera Certification Log. Note any descrepancies.

STC drawing AAA92-100839 S/N: ST 313

UVVC drawing AAA92-103601 S/N:__________

HRC drawing AAA92-109116 S/N:__________

4.2 Weigh the Camera to the nearest gram.

Mass = 280 gms

Appendix G.3.5.2.1

Random Vibration Test Data

Appendix A - Camera Environmental Test Data Results

3.1 Pre-Random Vibration Abbreviated Function Test Unit S/N: ST 313

Test	T_∞(°C)	Tau (msec)	Gain (e-/ct)	Offset (level)	Filter (ctr wl)	mean (cts)	sigma (cts)
Pre-Rndm Vibe							

3.2 Random Vibration Testing Unit S/N: ST 313

Requirement:

14.0 ± 1.4 g rms and ≥ 60 sec duration, each axis (UV/Vis, HiRes).
19.8 ± 2.0 g rms and 60 sec duration, each axis (Star Tracker).

Axis	Measured level (g rms)	Measured duration (sec)
X	19.95	
Y	19.61	
Z	19.87	

Include data sheet for each axis in Certification Log.

3.3 Post-Random Vibration Abbreviated Function Test Unit S/N: ST 313

Test	T_∞(°C)	Tau (msec)	Gain (e-/ct)	Offset (level)	Filter (ctr wl)	mean (cts)	sigma (cts)
Post Rndm Vibe							

Appendix G.3.5.2.2
Thermal Cycle Test Data

3.4 Thermal Cycle Testing

Unit S/N:__________

Test	T_{∞} (°C)	Tau (msec)	Gain (e-/ct)	Offset (level)	Filter (ctr wl)	mean (cts)	sigma (cts)
Cycle 1, -30°C							
Cycle 1, 20°C							
Cycle 2, -30°C							
Cycle 2, 20°C							
Cycle 3, -30°C							
Cycle 3, 20°C							
Cycle 4, -30°C							
Cycle 4, 20°C							
Cycle 5, -30°C							
Cycle 5, 20°C							
Cycle 6, -30°C							
Cycle 6, 20°C							

3.5 Thermal Vacuum Cycle Testing Unit S/N:__________

TVAC Test Results

3.5.2 Pre-TVAC Abbreviated Function Test Results

Test	T_{∞}(°C)	Tau (msec)	Gain (e-/ct)	Offset (level)	Filter (ctr wl)	mean (cts)	sigma (cts)
-25°C TVAC							

3.5.3 -25°C TVAC Abbreviated Function Test Results

Test	T_{∞}(°C)	Tau (msec)	Gain (e-/ct)	Offset (level)	Filter (ctr wl)	mean (cts)	sigma (cts)
-25°C TVAC							

3.5.4 and 3.5.5 -20°C and 0°C TVAC Abbreviated Calibration Test Results

Camera Settings

Test	T_{∞} (°C)	Filter (ctr wl)	Tau (msec)	Gain (e-/ct)	Offset (level)
-20°C TVAC					
0°C TVAC					

Notes:

TVAC Calibration Results

Parameter	-20°C N_2	-20°C TVAC	0°C N_2	0°C TVAC
Pixel sensitivity, C_1 [gray levels/(nJ/cm^2-str-μm)]				
Dark level [cts] / FPA temperature during measurement [K]				
Dark current [cts] / CCD temperature during measurement [°C]				
Electronics warm-up effect [mean gray level vs time graph]				
CCD temperature vs time graph				
Lens temperature vs time graph				

3.5.6 +5°C TVAC Abbreviated Function Test Results

Test	T_∞(°C)	Tau (msec)	Gain (e-/ct)	Offset (level)	Filter (ctr wl)	mean (cts)	sigma (cts)
+5°C TVAC							

3.5.7 Post-TVAC Abbreviated Function Test Results

Test	T_∞(°C)	Tau (msec)	Gain (e-/ct)	Offset (level)	Filter (ctr wl)	mean (cts)	sigma (cts)
+5°C TVAC							

Cummulative Operation Time (Hrs)

Log Date	Camera Electronics	Filter Wheel Electronics	Stepping Time
BWA checkout	16 Hrs	NA	NA
THermal Tests	17 Hrs		
Calibration	115 Hrs		
Funct. Tests	5 Hrs		

4.1 Mechanical and Mass Properties

STC drawing AAA92-100839 S/N: ST 313

UVVC drawing AAA92-103601 S/N:____________

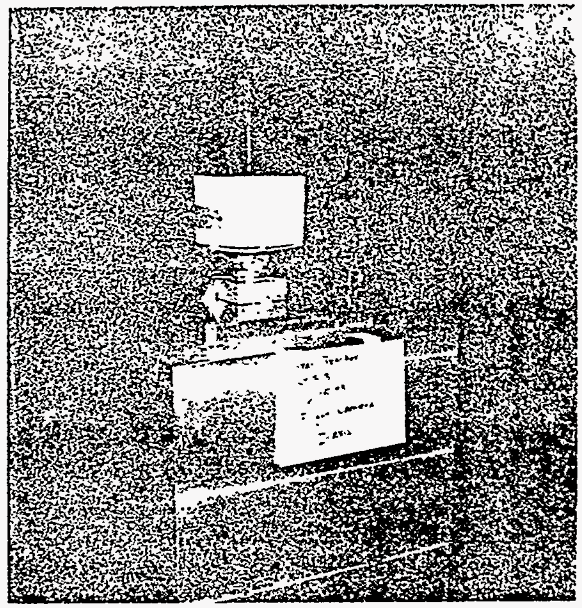
HRC drawing AAA92-109116 S/N:____________

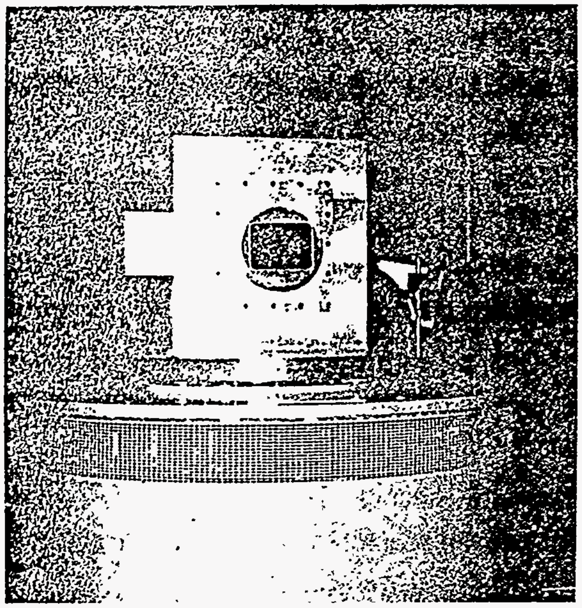
Applicable drawing revision:________

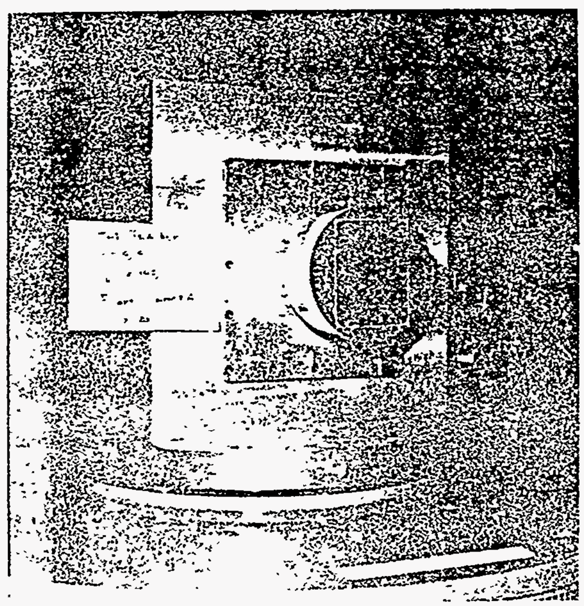
Measure relevant dimensions indicated on a copy of the referenced drawing and mark the measured value on the drawing. Keep this marked drawing with the Certification Log.

4.2 Mass

Mass = 280 grams







O GROUP [redacted] adapter Plate Torqued to 33 in.-lbs

RUN #1 STAR TRACKER [redacted]
S/T 313 [redacted] 1 MIN
6-15-93 [redacted] 19.8 GRMS
FLIGHT CAMERA [redacted] Z AXIS - Top Cub

Run #2 STAR Tracker 1 min test
ST 313 19.8 g's.
6-15-93 X-AXIS
Flight camera Side of cube

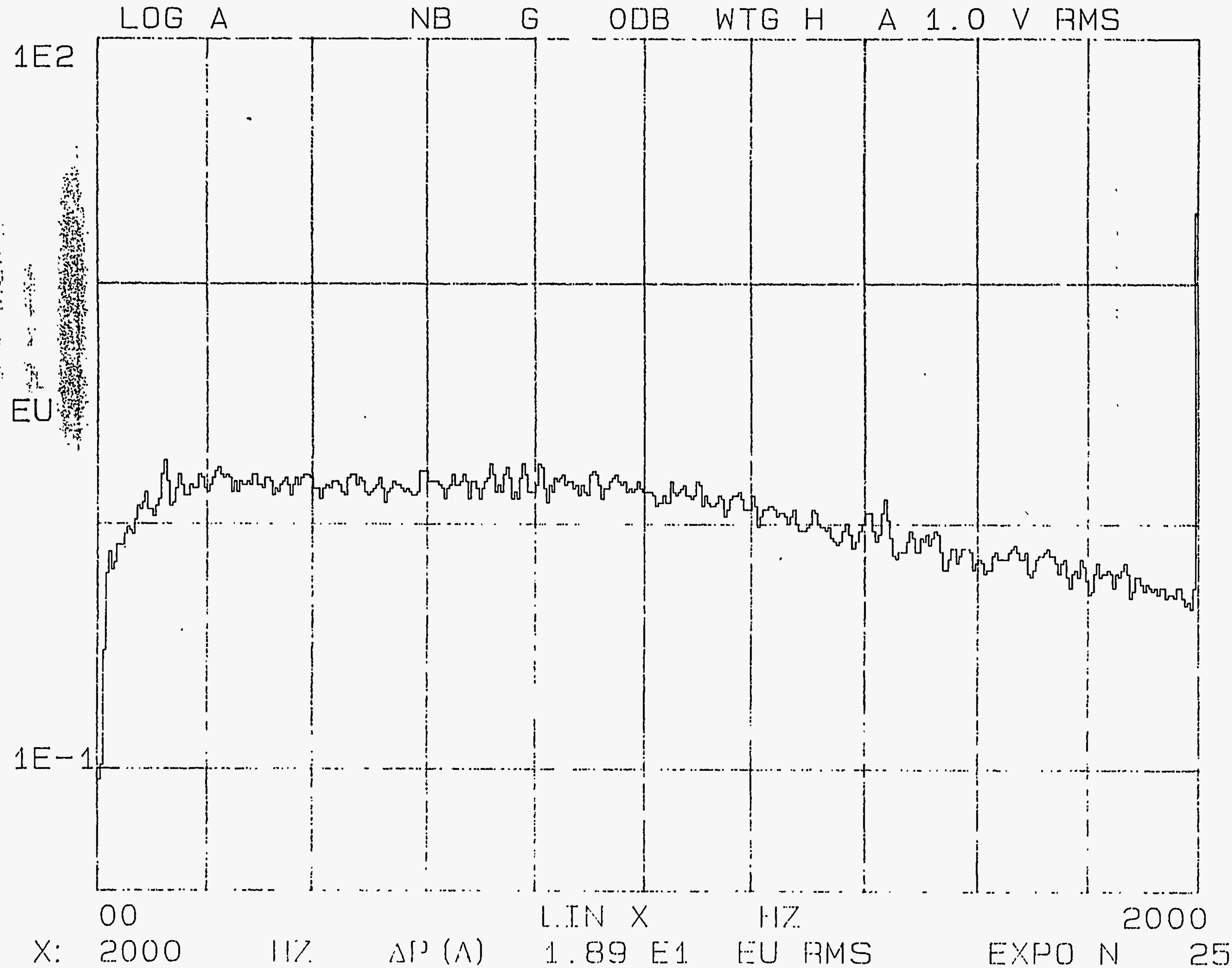
Start @

		Time	GRMS
10:40	-12 dB	15 sec	4.9
	-9 dB	15 sec	7.1
	-6 dB	15 sec	10.1
	-3 dB	10	14.6
	0 dB		19.7

RUN #3 STAR TRACKER 1 min Test
ST 313 19.8 gRMS
6-15-93 Y-AXIS
FLIGHT CAMERA side of cub

START @ 10:50

	Time	gRMS
-12 db	15	4.8
-9	10	7.2
-6	10	10.3
-3	10	14.4
0		



Run #1 Star Tracker ST 313 6/15/93 Flight Camera
Top of cube, Z-axis 19 v d. 1 min Test

Test Completed -- See Post Test

0 dB Input Grms 19.87

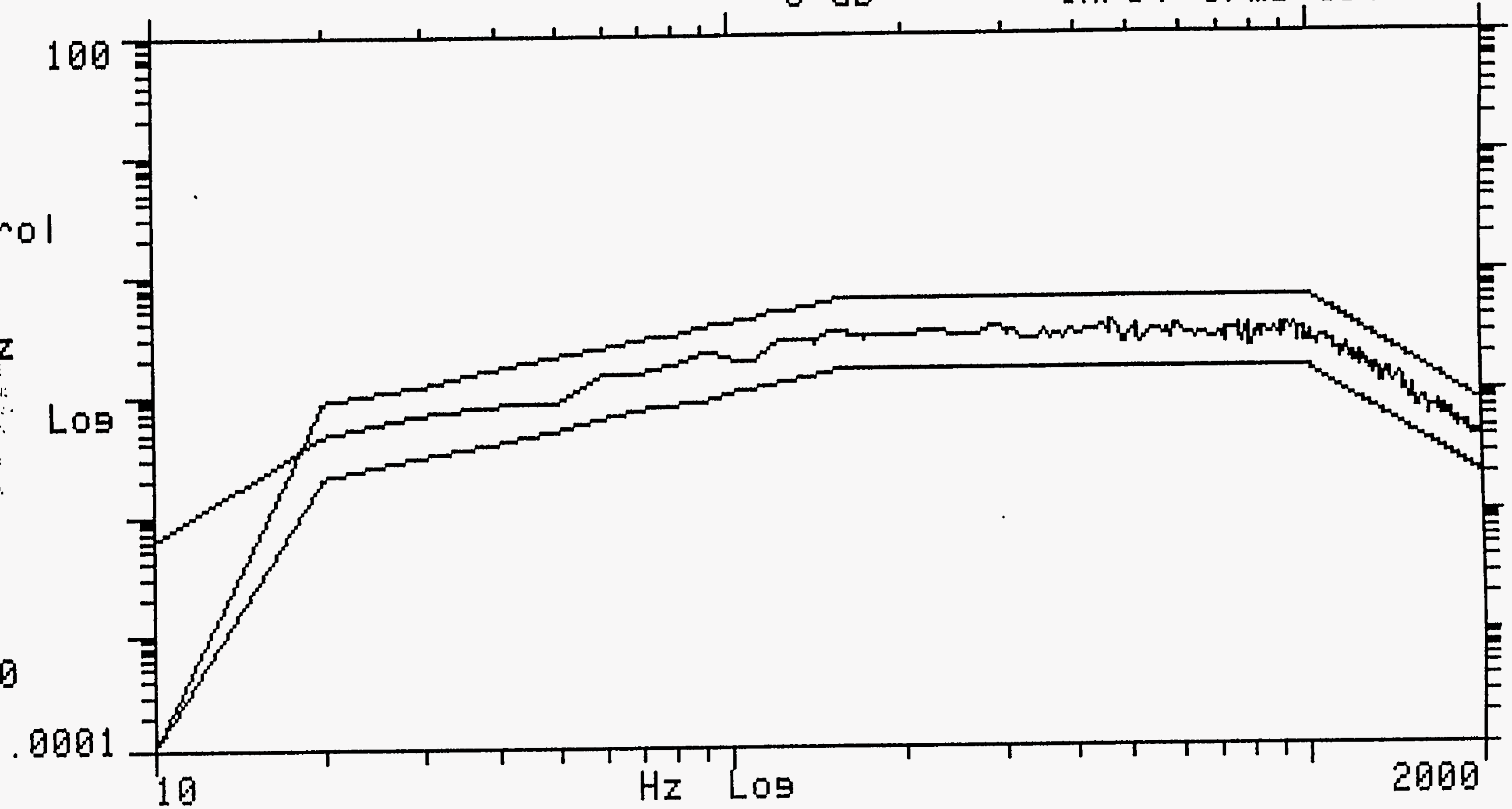
DOF
120

Control

G^2/Hz
*1

Grms
19.9

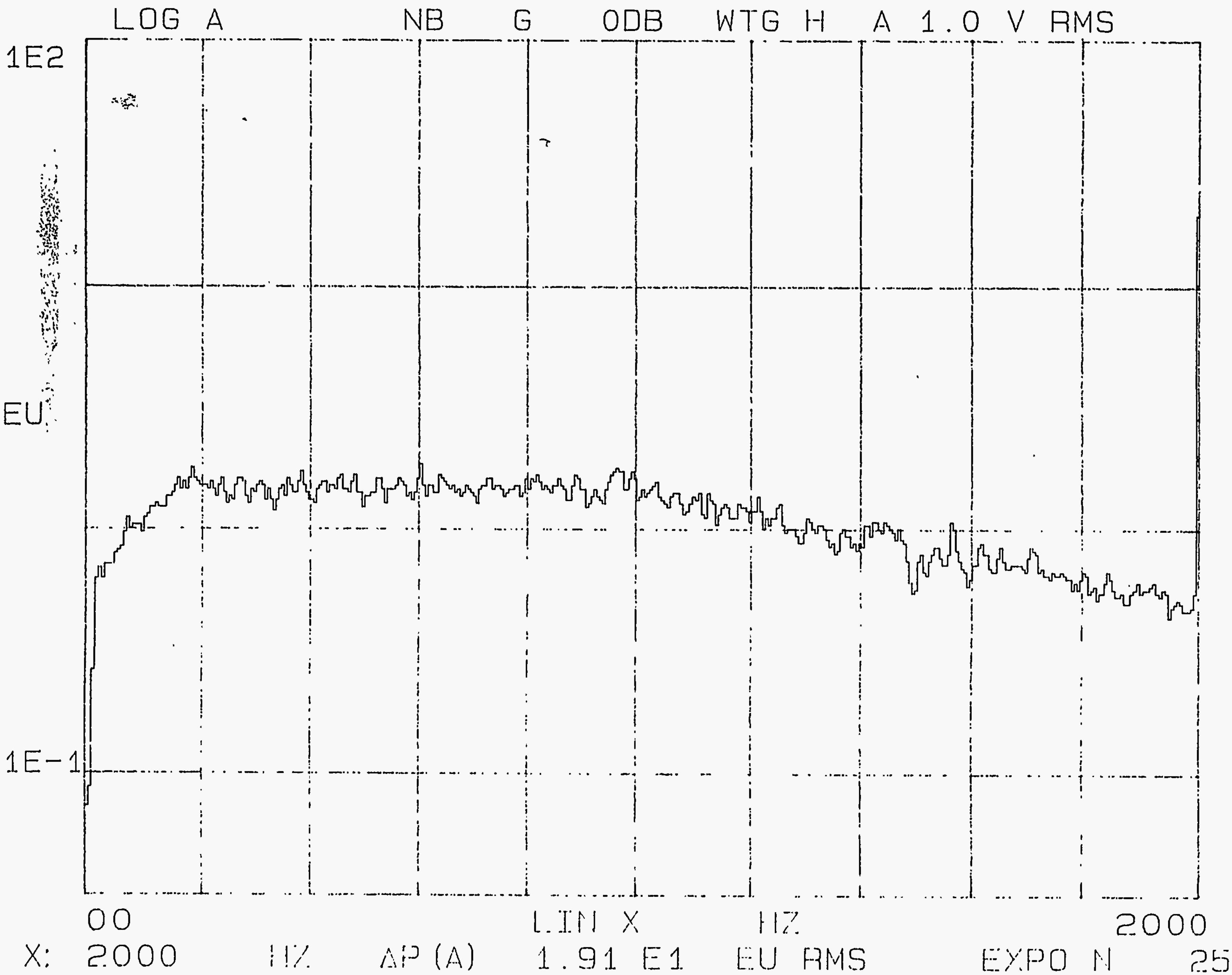
Time
0,1,0



15-Jun-93
10:15:42

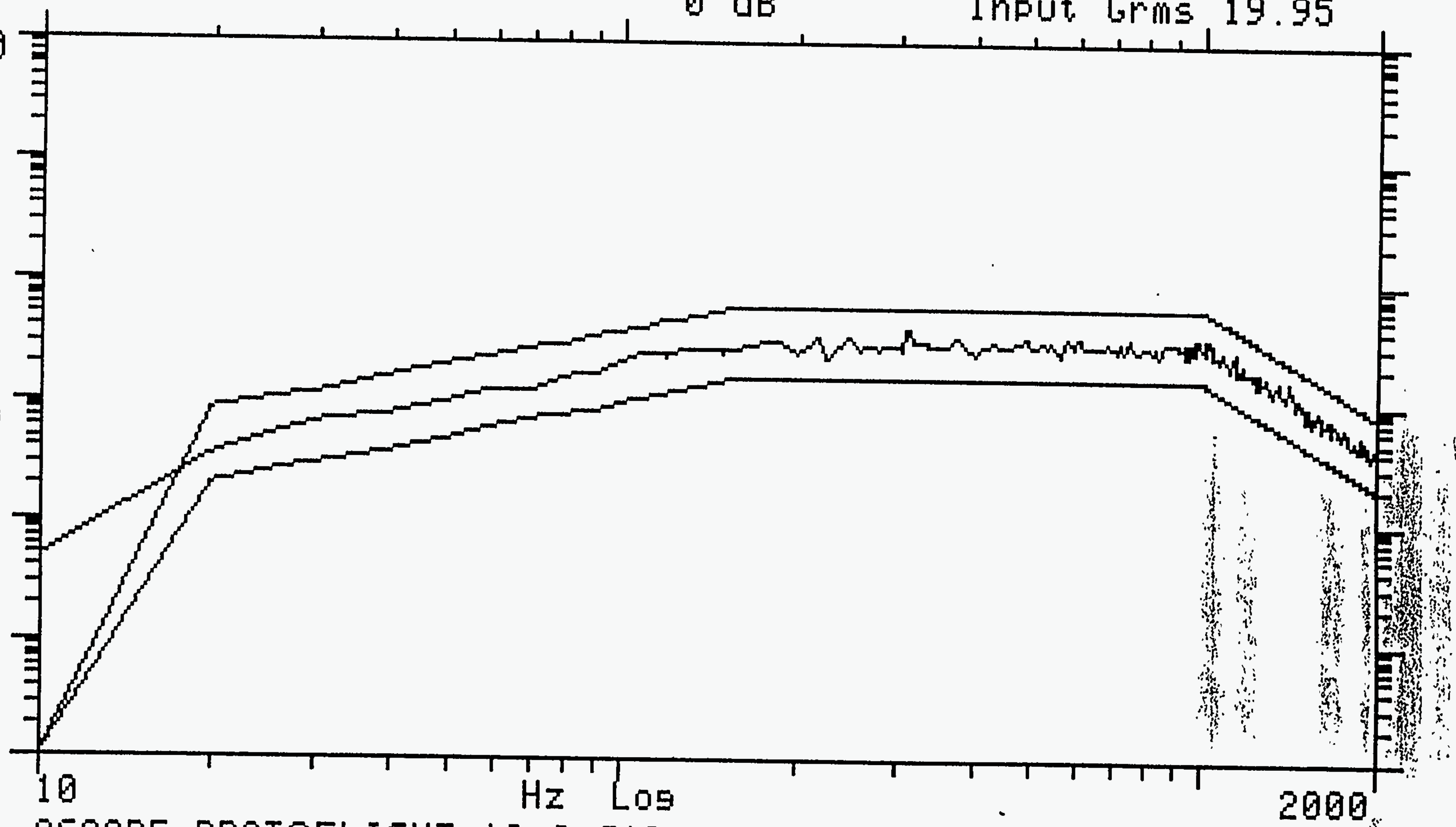
OG20PF PROTOFLIGHT 19.8 G'S

Run #1 Star Tracker ST313 w/ [illegible] flight camera.
Top of cube. Z-axis 19.8 g's 1 min Test



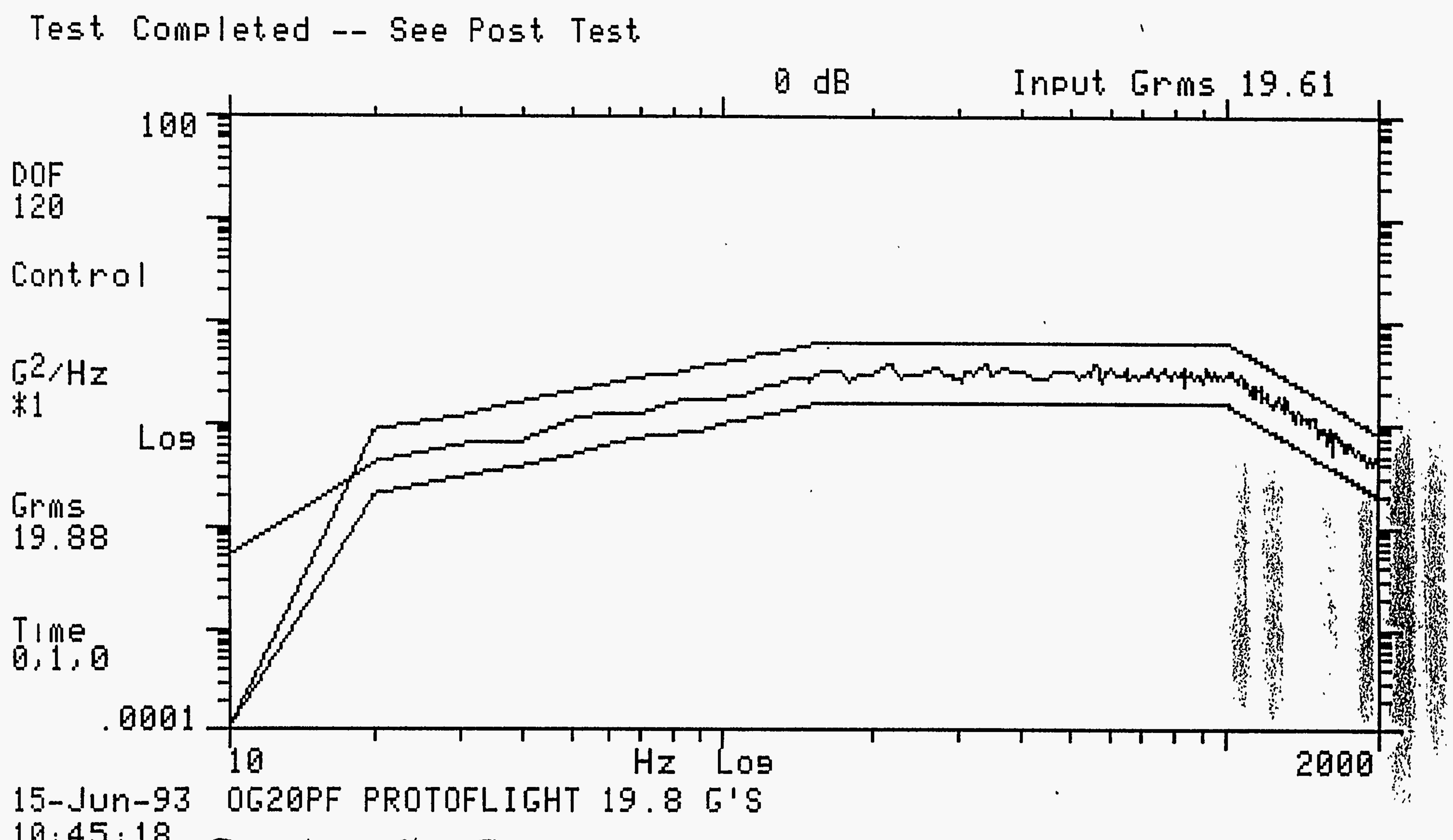
Run # 2 Star Tracker ST313 6/15/93 Flight Camera

Test Completed -- See Post Test

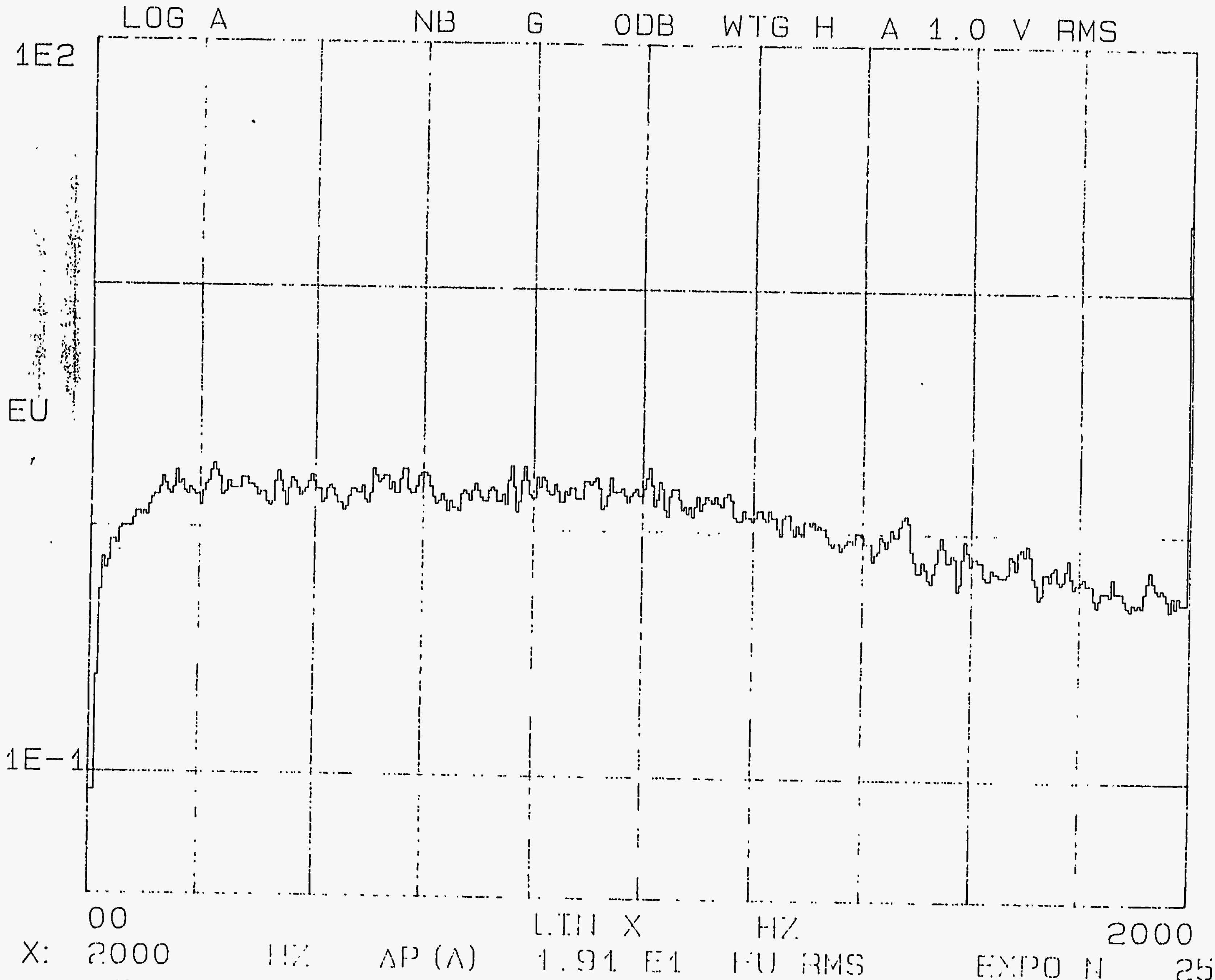


15-Jun-93 OG20PF PROTOFLIGHT 19.8 G'S
10:33:44

Run #2 StarTracker ST313 6-15-93 Flight camera
SIDE of cube X-axis 19.8 gs 1 min Test



Run# 3 StarTracker ST313 6-15-93
Flight camera. side of cube Y axis 19.8 g's 1 min. Test



LOG A NB G ODB WTG H A 1.0 V RMS
1E2
EU
1E-1
00
X: 2000 HZ AP (A) 1.91 E1 EU RMS EXPO N 25
LIN X HZ
2000

TEST REQUEST

/EAPONS TEST GROUP
/EAPONS ENGINEERING DIVISION

TEST NO: 2953-/
TEST PLAN TO FOLLOW: Yes____ No _x_
ACCOUNT NO: 7069-29
DATE: May ~~18~~, 1993
21

ITLE: Clementine Sensors

ldg: 131 Facility: UD Shaker Start Date: 4/19/93 Duration: 3 months

EFERENCES:	PART CLASS:	HAZARD:	MATERIAL	AMOUNT
O:	UNC: X	EXPLOSIVES:		
SSY PRINT#:	CRD:	RADIOACTIVE:		
SSY PRINT#:	SRD:	TOXIC:		
THER: Camera Design Document	NELA:	FLAMMABLE:		
THER:	VISUAL:	NO HAZARD:	X	

ATA ACQUISITION

RANSDUCER TYPE	NO. OF CHANNELS	RECORDING DEVICE READOUT
Control Acc. 7704-50 No response accels.	1	~~Mag. Tape~~ • SD Analyzer

REQUESTER: Jim Dickie
PHONE: 3-2351
TEST ENGINEER: Bill Ford
PHONE: 3-2849
FACILITY OPR: Lori Stoneham
PHONE: 2-8848
INSTRUMENTATION: Dave Warwas
PHONE: 4-4541

JRPOSE: To subject four different camera designs, listed below, to flight vibration (random PSD spectrum). The current spectr~~um of 19.8 G rms~~ envelope~~s~~ the response of the flight mounting platform and include~~s~~ some design margin according to O Program. See attached FIG. 1 & FIG. 2

ETAILS:

ameras: Star Tracker, UV/VIS, LIDAR and NIR -- See design document which will reside at control console.

Each camera will be vibrated AT ROOM TEMPERATURE using a one-minute ramp up to run level and a ~~two~~ 1-minute run time in each of three camera axes. ~~No thermal conditioning plans yet.~~
ONLY STAR TRACKER IS 19.8 G_{RMS} RUN LEVEL, FIG. 1, UV/VIS, LIDAR & NIR ARE 14.0 G_{RMS} RUN LEVEL, FIG. 2
Only one control channel on the "0" cube fixture will be used as input.

Verify bolt/screw torques, lock washer use, etc. on the camera system prior to vibration.

Use the same nominal torques each test at the shaker/cube and cube/camera interface and enter the above values with each test record. Mark torques on cube.

Photograph each test unit including card ID with hardware title, ~~and~~ serial number, TEST AXIS and date of test. Also include camera purpose -- prototype, flight unit, or backup.

Approved by: [signature]
Robert A. Woelffer
Weapons Test Group Leader

3-017 WSF/lcd

stribution:

ckie, Jim	Stoneham, Lori	WTG File
rd, Bill	Warwas, Dave	
moian, Ron	Woelffer, Bob	

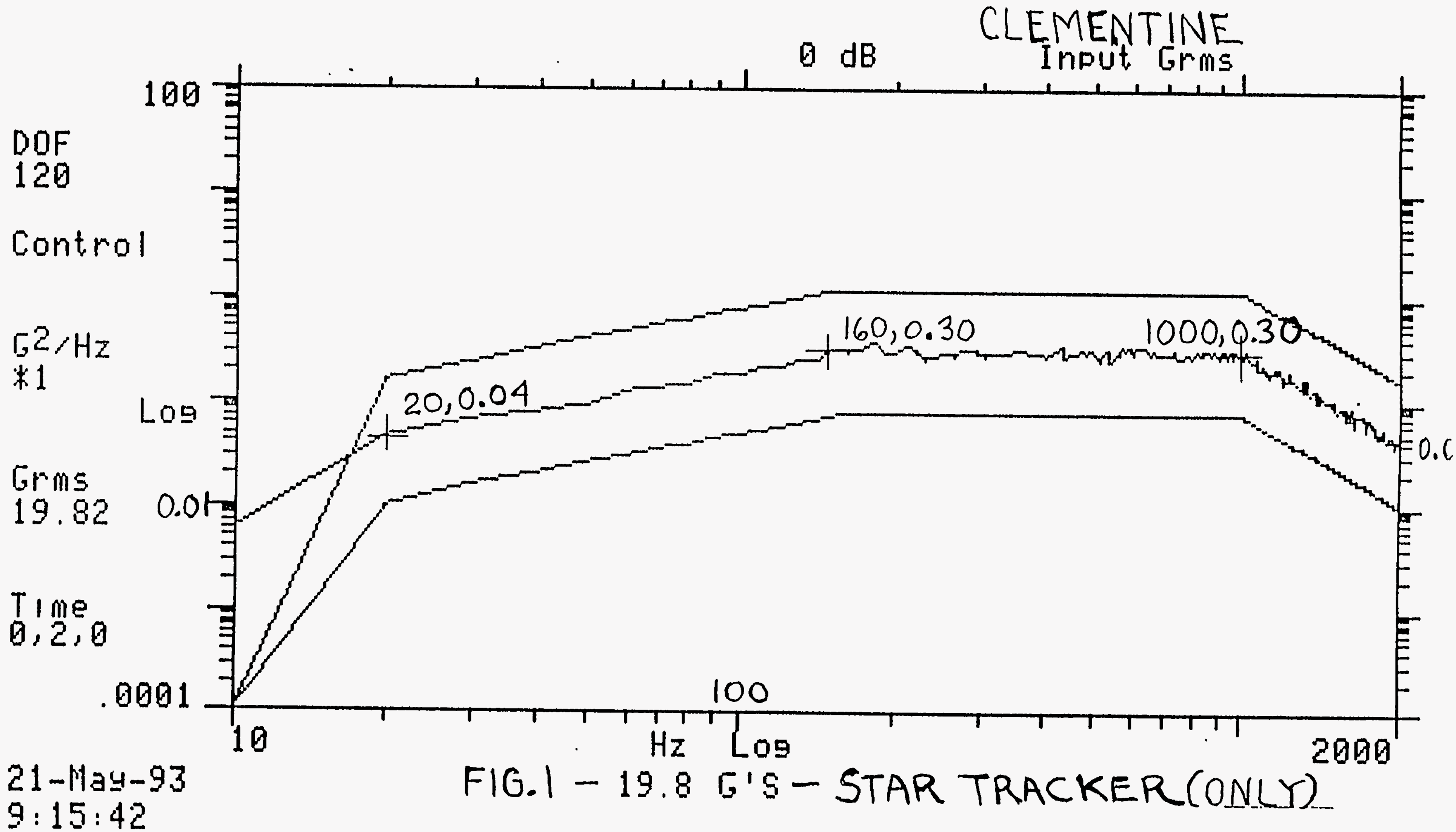


FIG.1 – 19.8 G'S – STAR TRACKER (ONLY)

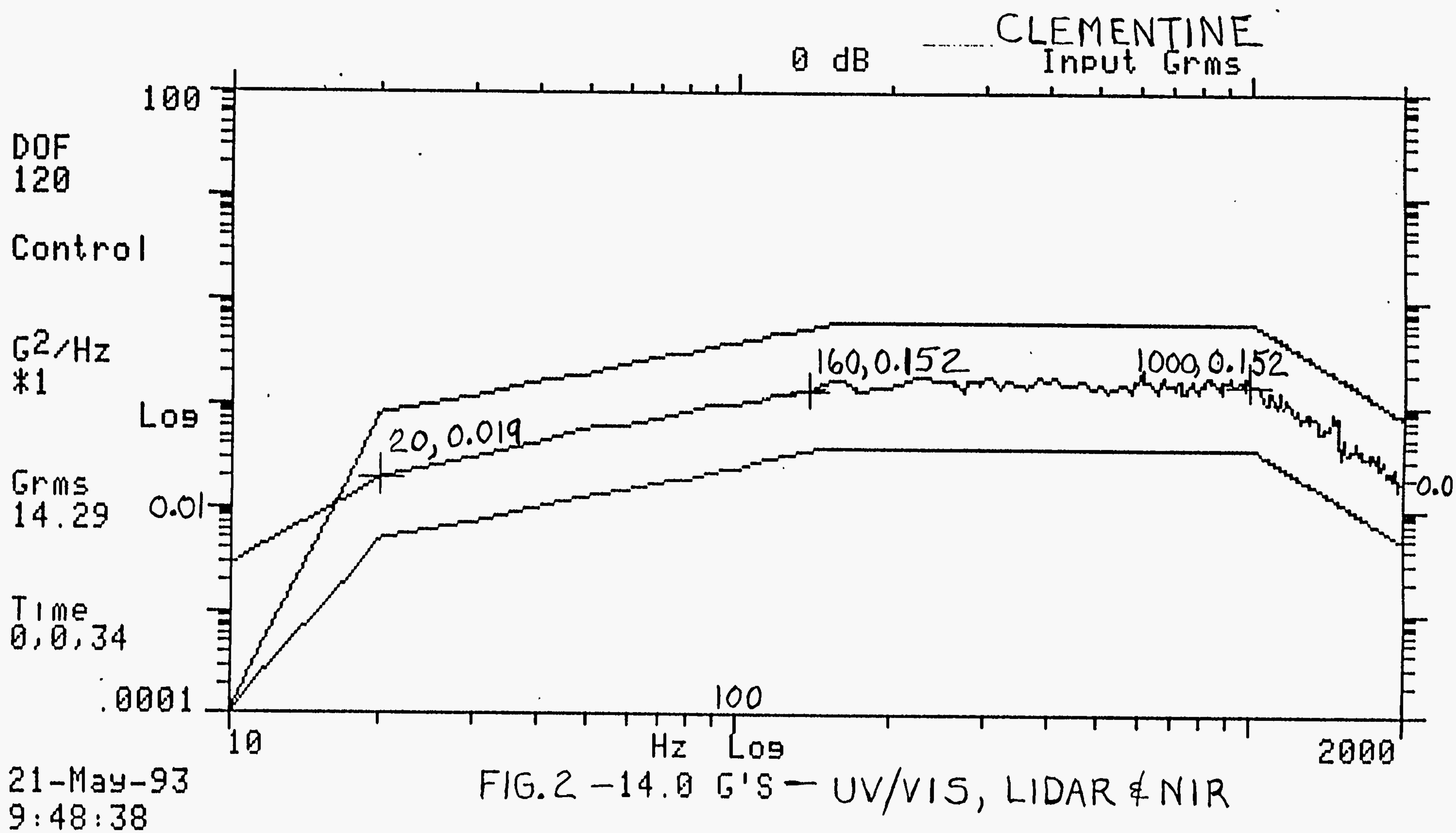


FIG. 2 -14.0 G'S — UV/VIS, LIDAR & NIR

TEST REQUEST

WEAPONS TEST GROUP
WEAPONS ENGINEERING DIVISION

TEST NO: 2953
TEST PLAN TO FOLLOW: Yes____ No x
ACCOUNT NO: 7069-29
DATE: May 18, 1993

TITLE: Clementine Sensors

Bldg: 131 Facility: UD Shaker Start Date: 4/19/93 Duration: 3 months

REFERENCES:	PART CLASS:	HAZARD:	MATERIAL	AMOUNT
J.O:	UNC: X	EXPLOSIVES:		
ASSY PRINT#:	CRD:	RADIOACTIVE:		
ASSY PRINT#:	SRD:	TOXIC:		
OTHER: Camera Design Document	NELA:	FLAMMABLE:		
OTHER:	VISUAL:	NO HAZARD:	X	

DATA ACQUISITION

TRANSDUCER TYPE	NO. OF CHANNELS	RECORDING DEVICE READOUT
• Control Acc. 7704-50 • No response accels.	1	• Mag. Tape • SD Analyzer

REQUESTER: Jim Dickie
PHONE: 3-2351
TEST ENGINEER: Bill Ford
PHONE: 3-2849
FACILITY OPR: Lori Stoneham
PHONE: 2-8848
INSTRUMENTATION: Dave Warwas
PHONE: 4-4541

PURPOSE: To subject four different camera designs, listed below, to flight vibration (random PSD spectrum). The current spectrum of 19.8 G rms envelopes the response of the flight mounting platform and includes some design margin according to O Program. See attached.

DETAILS:

Cameras: Star Tracker, UV/VIS, LIDAR and NIR -- See design document which will reside at control console.

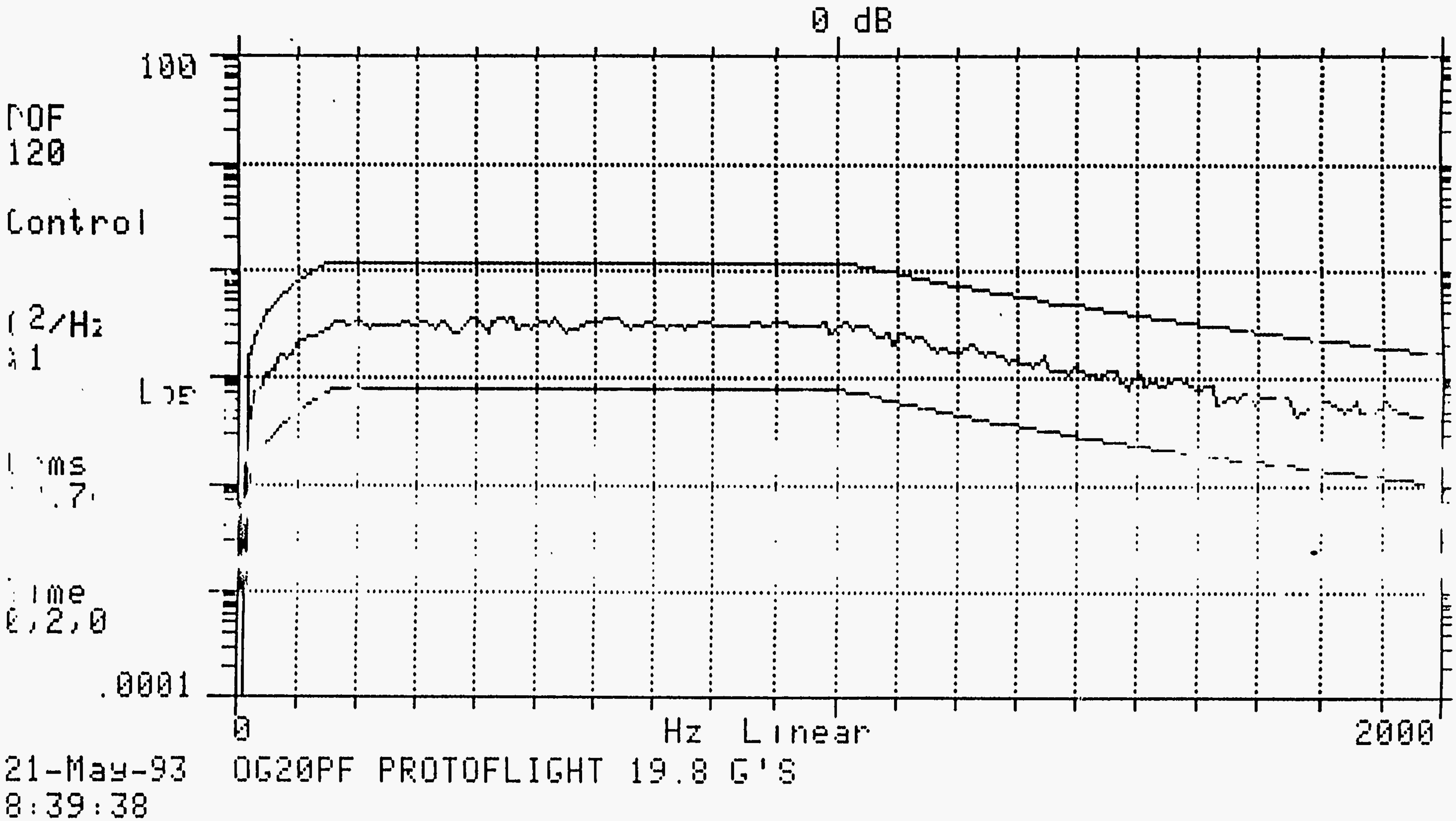
- Each camera will be vibrated using a one-minute ramp up to run level and a two-minute run time in each of three camera axes. No thermal conditioning plans yet.
- Only one control channel on the "0" cube fixture will be used as input.
- Verify bolt/screw torques, lock washer use, etc. on the camera system prior to vibration.
- Use the same nominal torques each test at the shaker/cube and cube/camera interface and enter the above values with each test record. Mark torques on cube.
- Photograph each test unit including card ID with hardware title and serial number and date of test. Also include camera purpose -- prototype, flight unit, or backup.

Approved by: R A Woelffer
Robert A. Woelffer
Weapons Test Group Leader

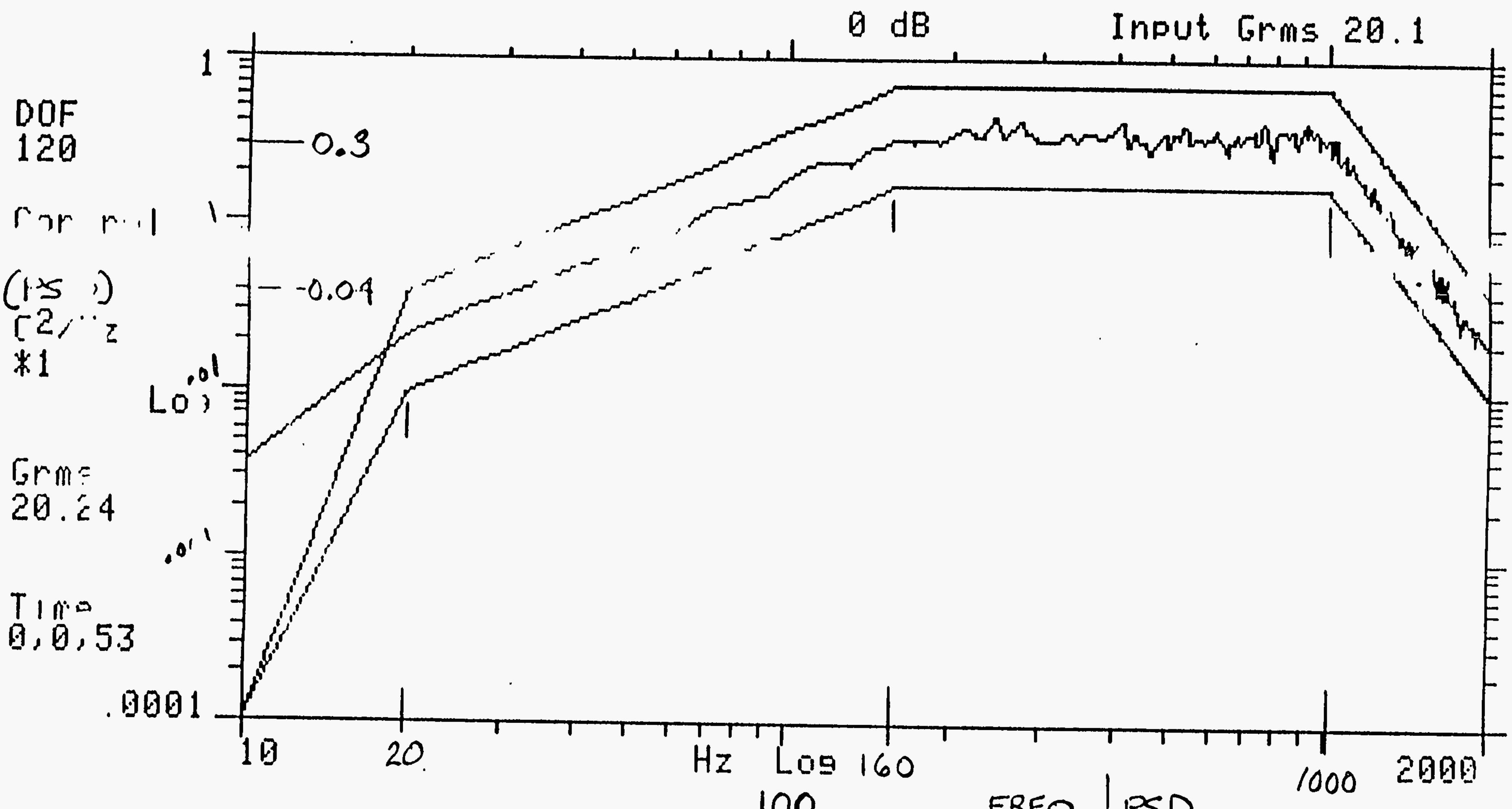
f93-017 WSF/lcd

Distribution:

Dickie, Jim	Stoneham, Lori	WTG File
Ford, Bill	Warwas, Dave	
Samoian, Ron	Woelffer, Bob	



0 dB
100
DOF
120
Control
2/Hz
1
.0001
0
Hz Linear
2000
21-May-93
8:39:38
OG20PF PROTOFLIGHT 19.8 G'S



CLEMENTINE SENSOR

FREQ.	PSD
20	0.04
160	0.30
1000	0.30
2000	0.04

GRMS=19.8

TEST REQUEST

WEAPONS TEST GROUP
WEAPONS ENGINEERING DIVISION

TEST NO: 2953
TEST PLAN TO FOLLOW: Yes___ No X
ACCOUNT NO: 7069-29
DATE: 5/18/93

TITLE: CLEMENTINE SENSORS

Bldg: 121 Facility: O.D. SHAKER Start Date: 5/19/93 Duration: 3 MOS

REFERENCES:	PART CLASS:	HAZARD:	MATERIAL	AMOUNT
ID:	UNC: X	EXPLOSIVES:		
ASSY PRINT#:	CRD:	RADIOACTIVE:		
ASSY PRINT#:	SRD:	TOXIC:		
OTHER: CAMERA DESIGN	NELA:	FLAMMABLE:		
OTHER: DOCUMENT		NO HAZARD:	X	

DATA ACQUISITION

TRANSDUCER TYPE	NO. OF CHANNELS	RECORDING DEVICE READOUT
ENTL ACC. 7704-50	1	• MAG TAPE
LOW RESPONSE ACCELS		• SD ANALYZER

REQUESTER: JIM DICKIE
PHONE: 32351
TEST ENGINEER: BILL FORD
PHONE: 32849
FACILITY OPR: LORI STONEHAM
PHONE: 28848
INSTRUMENTATION: DAVE WARWAS
PHONE: 44541

PURPOSE: TO SUBJECT FOUR DIFFERENT CAMERA DESIGNS, LISTED BELOW, TO FLIGHT VIBRATION (RANDOM PSD SPECTRUM). THE CURRENT SPECTRUM OF 19.8 GRMS ENVELOPES THE RESPONSE OF THE FLIGHT MOUNTING PLATFORM AND INCLUDES SOME DESIGN MARGIN ACCORDING TO O PROGRAM. SEE ATTACHED.

DETAILS:

CAMERAS: STAR TRACKER, UV/VIS, LIDAR & NIR — SEE DESIGN DOCUMENT WHICH WILL RESIDE AT CONTROL CONSOLE.

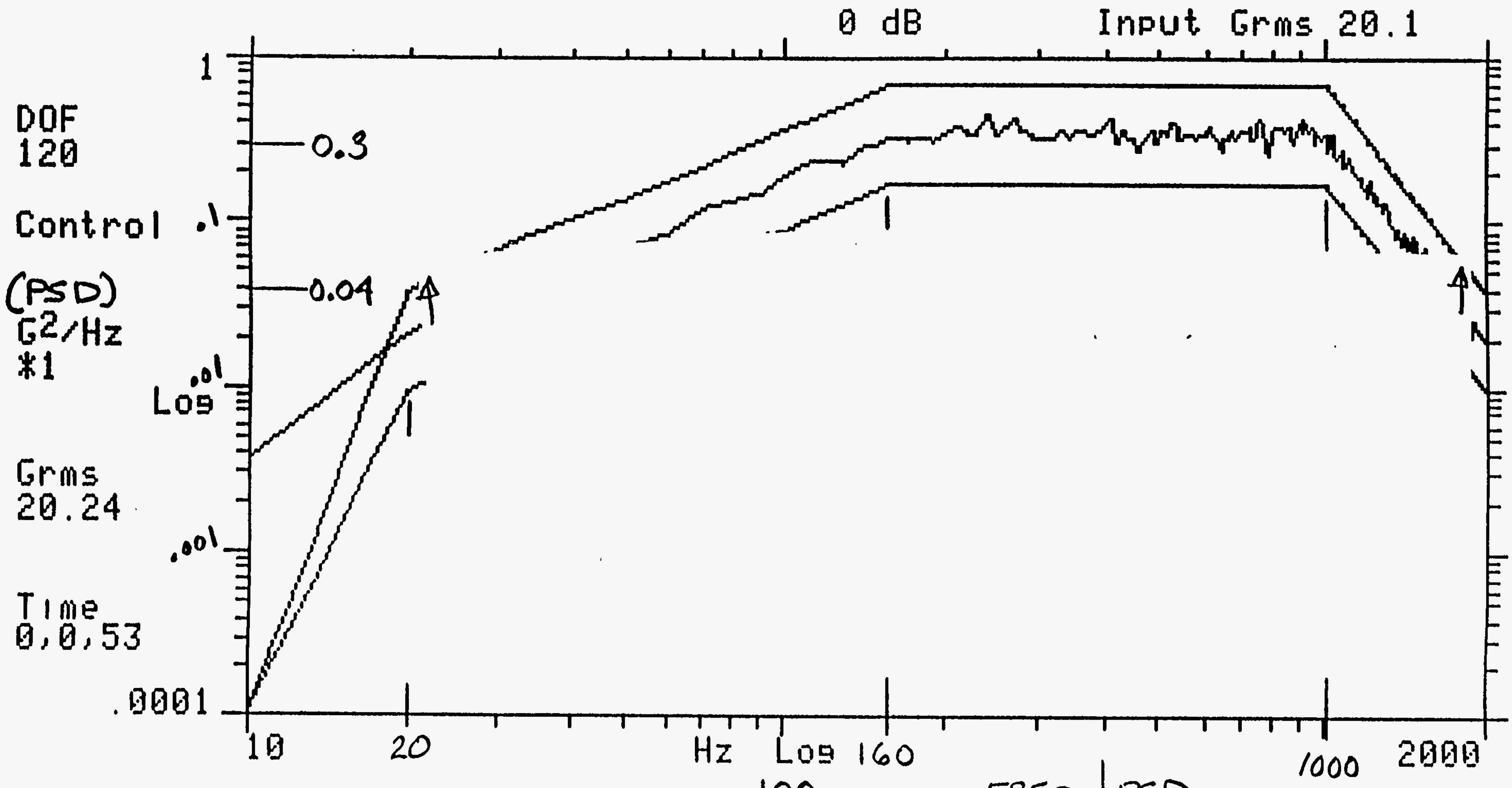
- EACH CAMERA WILL BE VIBRATED USING A 1 MINUTE RAMP UP TO RUN LEVEL & A 2 MINUTE RUN TIME IN EACH OF 3 CAMERA AXES. NO THERMAL CONDITIONING PLANS YET. ONLY 1 CONTROL CHANNEL ON THE "O" CUBE FIXTURE WILL BE USED AS INPUT.

Approved by: ______________________
Robert A. Woelffer
Weapons Test Group Leader

Distribution:

- VERIFY BOLT/SCREW TORQUES, LOCKWASHER USE, ETC. ON THE CAMERA SYSTEM PRIOR TO VIBRATION.
- USE THE SAME NOMINAL TORQUES EACH TEST AT THE SHAKER/CUBE & CUBE/CAMERA INTERFACE & ENTER THE ABOVE VALUES WITH EACH TEST RECORD. MARK TORQUES ON CUBE.

EACH TEST UNIT
• PHOTOGRAPH ^ INCLUDING CARD I.D. WITH HARDWARE TITLE & SERIAL # AND DATE OF TEST. ALSO INCLUDE CAMERA PURPOSE - PROTOTYPE, FLIGHT UNIT OR BACKUP.



CLEMENTINE SENSOR

FREQ.	PSD
20	0.04
160	0.30
1000	0.30
2000	0.04

GRMS=19.8

Appendix H

Certification Log for StarTracker A (ST 314)

StarTracker Camera

Document No. C1-AAA92-106282, Tab 02

Flight No. 2

Serial No. ST-314

May 3, 1993

Appendix H.1

Summary Technical Data

Summary Technical Data

ST 314

Parameter	Specification	Measured Value
Mass	< 483 g	285.6 g
Current at 22°C +5 Vdc analog +5 Vdc digital[1] -5 Vdc +15 Vdc -15 Vdc	 < 155 mA < 140 mA / < 410 mA < 60 mA < 140 mA < 30 mA	 107.4mA / 105mA 51mA / 292mA 41.2mA / 41.2mA 101 mA / 101mA 13.76 mA / 13.76mA
Lens Heater Resistance at 22° C (ST ONLY)	450 ± 45 Ω	454 Ω

[1] These values are with data bus disabled / data bus enabled with150 ohm termination.

INDEX

STAR TRACKER CAMERA
ST314

Appendix H.2

Board Assembly Log

Appendix H.2.1

Operations Sheet

Clementine Operations Sheet, Assembly

Part Number LEA92-3128	**Serial No.** Pioneer 04-010	**Description** Actel Startracker w/Gain and Offset Control		**Assembly Log #** AL024 **End Use** Flight
Next Assembly / Deliver To: Star Tracker Camera Sensor		**Account Number:** 7069-26	**Release To (Shop):** 1883	**Production:** **Date:**
Prepared By: K.F. Coatney Kathy Coatney	**Date:** 15 April 93	**QA:** W.R.Bryson	**Date:** 5-1-93	**Approved By:** **Date** 4-29-93

Associated Documentation:	**Notes:**
Schematic, LEA92-3128-01 Rev 0B	
Bill of Material, LEA92-3128-04 Rev 0B	
Assembly Procedure, LEA92-3128-05	
Assembly Drawing, LEA92-3128-05 Rev 0A	
Fabrication Drawing, LEA92-3128-07 Rev 0A	

Change Verification Record or Engineering Change Notice Record

Parts List or Dwg Number	Dwg Chg Letter	Eco Number	Description or Remarks	Opr	QA

Appendix H.2.2

Work Sheets

Work Sheet

Part Number:	Serial # :	Title:	Sheet:
LEA92-3128	P04-010	Pioneer Fabricated Actel Startracker Board	1

#	Operation	Date:	Oper.	Insp.
1	Inspected Board Visually - OK Lot # 6862	4/14/93		QA #2
2	Board Baked at 95C for 6 hrs in Oven	4/15/93		QA #2
	S/N # 12664-1 7:00 p.m. - 1:00 A.M			
3	Turned board over to Laura Aranda for	4/16/93		QA #2
	Assy / Solder.	4/16/93		
7.	received kit assigned to Helen Reisdorff for assembly	4-16-93	Oper #2	
8.	VERIFIED ALL RESISTORS AND CAPACITORS			
	FLUKE 3/19/93 - 3/19/95 DYNASCAN 9/3/92 - 9/3/93	4.16.93	[illegible]	
9.	TOOK RESISTANCE measurements at J1	4.16.93	[illegible]	
10.	Assy 7.0 - 7.8 Item 7	4-19.93	[illegible]	
11	Cleaned BOARD Sent To QA	4.19.93	#9	

Work Sheet

Part Number: LEA92-3128	Serial #: P04-010	Title: Pioneer Fabricated Actel Startracker Board	Sheet: 2

#	Operation	Date:	Opor.	Insp.
14	Inspected Assy/solder Oper.'s 7-11/7.0-7.8 ~~OK~~ #Q	4/19/93		QA #2
16	Baked Boards at 95C for 6 hrs in Versa Tenn II Oven S/N #126104-1	4/19/93		QA #2
17	C69 - A105 Solder disturbed? or Void	4/19/93		QA #2
18	R92 - A152 - damaged Component			
19	R131 - A119 - Contaminates	4/19/93		QA #2
20	Rework C69-A105 - Removed cap - Replaced	4/20/93	Oper #9	
21	Rework R92-A152 - Removed Resistor - Replaced	4/20/93		
22	Rework R131-A119 - Removed solder - Resoldered	4/20/93	Oper #9	
23	Assy 7.8 - Item 8 - 7.12 Item 66	4/20/93		
24	Cleaned Board - Sent to QA	4/20/93	Oper #9	
25	Inspected Rework Oper.'s 20-22	4/20/93		QA #2
26	Rework of C69, R92 + R131 - OK	4/20/93		

Work Sheet

Part Number:	Serial # :	Title:	Sheet:
LEA92-3128	P04-010	Pioneer Fabricated Actel Startracker Board	3

#	Operation	Date:	Oper.	Insp.
27	Inspected Assy/Solder Oper's 23 + 24	4/20/93		QA #2
28	Q12 - Component has Contaminates on Body	4/20/93		
29	Q13 - " " " " "			QA #2
30	Q14 - " " " " "			
31	Baked Board at 95c for 6 hrs.			QA #2
	in Oven S/N # 126604-1 / 7:00 p.m to 1:00 A.M	4/20/93		
32	Rework - Q12 - cleaned	4/21/93	H.K.	
33	Rework - Q13 - cleaned	4/21/93	H.K.	
34	Rework - Q14 - cleaned	4/21/93	H.K. Oper #9	
35	Assy 7.12, Item 67 - 7.20	4/21/93	H.K.	
36	Measured Item 78, spacers. Length of spacers .390 - .390	4/21/93	H.K.	
37.	Have not installed Item 74 - programmed chip.	4/21/93	Oper #9	
38	Assy 7.21 - 7.25 -	4/21/93	H.K.	
	J1 Bottom surface from PWB - .261 - .261		Oper #9	

Work Sheet

Part Number: LEA92-3128	Serial # : P04-010	Title: Pioneer Fabricated Actel Startracker Board			Sheet: 4
#	Operation		Date:	Oper.	Insp.
39.	Assy 7.25 - 7.28		4/21/93	Oper #	
40.	Cleaned Board - Sent to QA		4/21/93	Oper #9	
41.	Baked Board at 95 c for 6 hours in Oven		4/21/93		
	S/N # 12664-1 7:00 P.M. - 1:00 A.M.				
44	Inspected Rework Oper.'s 32-34 - OK		4/22/93		QA #2
45	Inspected Assy/Solder Oper.'s 35-40		4/22/93		QA #2
46	J1 - pin's # 33, 34 & 25 - A114 peaks.		4/22/93		
47	Rework J1-pins' 33, 34, 25 - Resoldered		4/22/93	Oper #9	
48	Cleaned Board - Sent to QA		4/22/93		
50	Inspected Rework Oper.'s 47 & 48 - OK		4/22/93		QA #2
51	Baked Board at 95 c for 6 hrs in				
	Oven S/N # 12664-1 12:00 A.M. to 6:00 p.m.		4/22/93		QA #2

Work Sheet

Part Number: LEA92-3128	Serial # : P04-010	Title: Pioneer Fabricated Actel Startracker Board	Sheet: 5

#	Operation	Date:	Oper.	Insp.
53	Waiting for U26 -	4/22/93		QA #2
54	Next Step 7.30	4/22/93		QA #2
55	Remove C4, C7 and C8 and replace with 0.1ufd, 50volt	4/29/93	JtK	
	Remove R119 and replace with 6.19K 1%. Please measure			
	and record before installation. ~~Remove R49 and replace~~ KL see #66 per JK			
	~~with 100Ω 1%~~. Remove R6 and R7.			
60	Removed C4, C7 + C8 Removed R119, R49, R6+R7	5-4-93	Oper #4	
62	Inspected Rework Oper # 60 — OK	5/4/93		QA #2
64	Installed U26	5-4-93	Oper #4	

Work Sheet

Part Number:	Serial # :	Title:	Sheet:
LEA92-3128	P04-010	Pioneer Fabricated Actel Startracker Board	6

#	Operation	Date:	Opor.	Insp.
65	Log is complete and consistant up to this point.	5 May		QA #1
66	Remove R128, temporarily tack a wire between the outermost pads of R128 and C123 as seen in Assy Procedure 7.19. ~~Temp~~ Complete operations 55, 56 and 57. Temporarily load a 1 K 1% resistor in R49 as per 7.5.1 in Assy Procedure.	5 May 93	KC	
72	Removed R128	5-5-93	Oper #3	
73	Installed jumper wire between R128 + C123			
74	Installed .1uf. 50V C4 .116 C7 .112 C8 .116 measured		Oper #3	
75	Installed (temp.) 1K measured 1003Ω R49			
76	Installed R119 6.20KΩ measured	5-5-93	Oper #3	

Work Sheet

Part Number:	Serial # :	Title:	Sheet:
LEA92-3128	P04-010	Pioneer Fabricated Actel Startracker Board	7

#	Operation	Date:	Opor.	Insp.
77	boards cleaned in freon tank, sent to QV)	5-5-93	Oper #2	
79	Inspected Rework Oper's 72-76 - OK	5/5/93		QA #2
80	Baked Boards at 95 c for 6 hrs in	5		
	S/N# 126641 Oven 7:30 p.m to 1:30 A.m	5/5/93		QA #2
			Oper #4	
83	Made + Recorded measurements under 7.32	5-6-93	D.d.	
85	Inspected Assy / operation #83 - OK	5/6/93		QA #2
86	Ready to turn over to Test - Don Arteman	5/6/93		
87	First section of test procedure finished !!	5/7/93		

Work Sheet

Part Number: LEA92-3128	Serial # : P04-010	Title: Pioneer Fabricated Actel Startracker Board	Sheet: 8

#	Operation	Date:	Oper.	Insp.
88	Remove jumper between R128 pad and C123 pad	5/7	JAK	
	~~Install~~ REmove R49 and replace with 100Ω 1%			
	Install R128 100Ω 1%.			
91	Removed jumper wire from R128 to C123	5-7-93	Oper #3	
92	Installed R128 measured 100.5Ω			
93	Removed R49 → 100.3Ω			
94	Installed R49 ~~measured~~ 100.7Ω	5-7-93	C #3	
96	INspected Rework Oper. # 91-94 - OK	5/7/93		QA #2
97	Log is consistent up to this point.	5/7/93		QA #2
99	Electronic Testing Complete. RE: Passed! MD	5/11/93	MD	
100	Returned to Q.A. for pre-conformal coat inspection	5/11/93	MD	

Work Sheet

Part Number: LEA92-3128	Serial # : P04-010	Title: Pioneer Fabricated Actel Startracker Board	Sheet: 9

#	Operation	Date:	Oper.	Insp.
102	Inspected Board pre conformal Coating application	5/11/93		QA #2
104	R 125 - A152 - damaged (chipped).	5/11/93		
105	C110 - A105 - Stressed.			QA #
106	R 124 - A115 - Flux Residue.	5/11/93		QA #2
107	R 128 - A105 - disturbed			
108	R 140 - A152 - damaged (chipped)			
109	C 32 - A152 - damaged	5/11/93		QA #2
111	Removed R125 Oper # 104	5-13-93		
112	Removed R140 Oper # 108	5-13-93	Oper #4	
113	Removed C32 Oper # 109	5-13-93		
114	Inspected Rework Removal of 111-113	5/13/93		QA #2
115	Ready for Rework opers. 104 - 113	5/13/93		

Work Sheet

Part Number: LEA92-3128	Serial # : P04-010	Title: Pioneer Fabricated Actel Startracker Board		Sheet: 10

#	Operation	Date:	Oper.	Insp.
116	(Replaced R123 (Oper #. 104	5-13-93		
117	Did Oper #105 Q110 (Resoldered)	5-13-93		
118	Did Oper # 106 (R124 Flux Residue) rework	5-13-93		
119	Did Oper # 107 (R128 disturbed) rework	5-13-93		
120	Did Oper # 108 Replaced R140	5-13-93	Oper #4	
121	Did Oper # 109 Replaced C32	5-13-93		
123	Inspected Rework Oper's 116-121- OK			
124	Board Ready for Bryson to inspect			
125	Log Complete and consistent up to 8.6	5/14/93		
127				

Work Sheet

Part Number:	Serial # :	Title:	Sheet:
LEA92-3128	P04-010	Pioneer Fabricated Actel Startracker Board	11

#	Operation	Date:	Oper.	Insp.
130	Complete assembly, 8.6 thru 8.20, clean in	14 May 93		
	freon tank prior to 8.6			
133	CLEANED IN FREON TANK	5-17-93	Oper #14 L.L.	
134	Baked Board at 95C for 6 hrs in	5/17/93		QA #2
	S/N #12664-1 Oven 6:30p.m to 12:30A.M	5/17/93		QA #2
137	Did items 8.7 thru 8.18 in Assembly Procedures	5-19-93	Oper #4	
139	Inspected ~~cco~~ oper. #137 - OK	5/20/93		QA #2
	Ready for Next Step on Thermistor	5/20/93		QA #2

Work Sheet

Part Number:	Serial # :	Title:	Sheet:
LEA92-3128	P04-010	Pioneer Fabricated Actel Startracker Board	12

#	Operation	Date:	Opor.	Insp.
142	[illegible] 8.20 & 8.21 per Assembly Procedure	5-20-93	[illegible]	
143	Inspected operations 8.6 thru 8.21	20 May 93		[illegible]
150	Assembly Complete. Ready for conformal Coat	20 May 93		[illegible]
152	Cleaned in freon tank sent to Q.A	5/20/93	Oper #12	
155	Freon cleaning is good. Next step prime for			
	Conformal Coat.	20 May 93		[illegible]
158	IMMERSEd board in Silane A174	5-21-93	JWB	
	and ISOpropyl Alcohol solution	5-21-93	JWB	

Work Sheet

Part Number:	Serial # :	Title:	Sheet:
LEA92-3128	P04-010	Pioneer Fabricated Actel Startracker Board	13

#	Operation	Date:	Oper.	Insp.
161	[illegible] Board in oven at 75°C	[illegible]	[illegible]	
162	From 1330 to 1930	[illegible]	[illegible]	
164	Placed Board in Hi-Vac chamber 2010	5-21-93	JWB	
170	Removed from Hi Vac Chamber 0910	22May93	10	
	Mask for Conformal Coat			
171	Thermistor Reading @ Room Temp 5.74K			
	Changes to 5.1K when held between fingers	22May93		
174	Did Oper #170 Masked board for Conformal Coating	5-22-93	Oper 84	

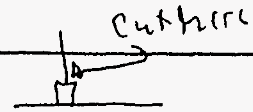
Work Sheet

Part Number: LEA92-3128	Serial # : P04-010	Title: Pioneer Fabricated Actel Startracker Board	Sheet: 14

#	Operation	Date:	Oper.	Insp.
180	Into Oven @ 60°C @ Noon S/N# 12664-1	22 May93	[illegible]	
182	Removed From oven 1800 hr	22May93	JWB	
184	Removed Board from Holder with precision Cutters	5/22/93		BB QA 82
186	Placed Board in Parylene deposition unit	5/22/93	JWB	
187	for conformal coating at 1845 hr.	5/22/93	JWB	
189	Removed Board from Parylene deposition	5-24-93	JWB	
190	unit at 0640 coating approx .0008 in	5-24-93	JWB	

Work Sheet

Part Number: LEA92-3128	Serial # : P04-010	Title: Pioneer Fabricated Actel Startracker Board	Sheet: 15

#	Operation	Date:	Oper.	Insp.
193	Cut test points flush with plastic 			
	if not already cut.	24 May 93	[illegible]	
196	Removed Masking		Oper #20	
197	Removed Test Points cut flush to		Oper #20	
198	Board as per Jim Dickie		Oper #20	
199	Removed Conformal Coating from flex		Oper #20	
	outer area's.		Oper #20	
201	Return Board to Inspection	5/24/93	Oper #20	
202	ATP Thermal Test Complete RE: OK!!	6/30/93	MD	

Appendix H.2.3

Bill of Materials

Actel Camera with Gain and Offset Control
Startracker Configuration
Rev. 00 Printed Wiring Board
Bill of Materials, Rev. 00
LEA92-3128-04

	Date	Rev.	Date	Approval
Prepared by: K. F. Coatney	30 Mar 93	0A	13 Apr 1993	
Reviewed by: W. R. Bryson	30 Mar 93	0B	16 April 93	
Reviewed by: J. F. Kordas	30-MAR-93	0C	22 Apr 93	J. Kordas
Reviewed by: M.L. Dickerson	3/31/93			
Reviewed by: E.H. Schmitt	4/2/93			
Reviewed by: M. J. Shannon	4/2/93			

University of California Lawrence Livermore National Laboratory	22 March 1993 Actel Startracker Bill of Materials	LEA92-3128-04 Revision 00

1.0 Scope

This document is the bill of materials for the Actel Camera with Gain and Offset Control for use in the Startracker, Rev 00 Printed Wiring Board, LEA92-3128-04, Rev 00.

2.0 Parts

Where a dual part number listing exists, the first number listed is a commercial part suitable for prototype work only. If the MIL-SPEC part is not available at the time flight boards are assembled, Quality assurance must OK the use of the commercial part on a part by part basis in writing.

Parts may not be substituted without the written permission of the Quality Assurance Group.

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
1	44	C1,C3,C5,C6, C15,C21, C23,C25,C26, C30,C31,C33, C34,C38,C39, C40,C42,C44, C45,C47,C48, C54,C56,C57, C58,C59,C60, C63,C64,C66, C67,C70,C91, C92,C98,C102, C103,C104,C106, C109,C112,C114, C121,C124	0.039 µF, 50V, 10%, FR=0.01%/ 1000 hr	RM1206	CDR32BX393AKUR
2	5	C2,C51,C61,C62, C122	4.7 µfd, Tant, 10V, 10%, WFR=0.01%/ 1000hr	H-CASE	CWR06FH475KC
3	1	C9	47 µfd, Tant, 20V, 10%	R-CASE	Sprague / 195D476X9020R2T

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
4	2	C10,C11	22 μfd, Tant, 15V, 10%, WFR=0.01%/ 1000hr 19.8 24.2	G-CASE	CWR06HH226KC
5	4	C12,C13,C17, C105	6.8 μfd, Tant, 10V, 10%, WFR=0.1%/ 1000hr 6.12 7.48	E-CASE	CWR06FH685KB
6	2	C20,C110	6.8 μfd, Tant, 20V, 10%, WFR=0.01%/ 1000hr 6.12 7.48	F-CASE	CWR06JH685KC
7	6	C22,C24,C29, C69,C90,C118	22 μfd, Tant, 20V, 10%, WFR=0.01%/ 1000hr 19.8 24.2	H-Case	CWR06JH226KC
8	4	C32,C52,C94, C95	10 μfd, Tant, 25V,10%, WFR=0.01%/ 1000hr 9.0 11.0	G-CASE	CWR06KH106KC
9	1	C35	0.22 μfd, 50V, 10% 0.198 0.242	RC1206	Garrett / 1206Z224M500N
10	2	C46,C93	1.0 μfd, Tant 35V, 10%, WFR=0,01%/ 1000hr 0.9 1.1	D-CASE	CWR06MH105KC
11	2	C49,C50	0.022 μfd, 100V, 10%, FR=0.01%/ 1000hr 0.0198 0.0242	RM1206	Garrett / CE223K3NR
12	1	C53	15 pf, 100V, 5%, FR=0.01%/ 1000hr 14.25 15.75	RM1206	CDR32BP150BJUR

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
13	5	C73,C74,C75, C76,C77	3300 pf, 50V, 10%, FR=0.001%/ 1000hr 2970 3630	RC0402 RC0505	Novacap / 0402B332K500N CDR11BP332AKUS
14	1	C83	0.01 µfd, 100V, 10%, FR=0.01%/ 1000hr 0.009 0.011	RM1206	CDR32BX103BKUR
15	1	C111	47 pf, 100V, 5%, FR=0.01%/ 1000 hr	RM1206 44.65 49.35	CDR32PB470BJUR
16	2	C115,C116	270 pf, 100V, 10%, FR=0.01%/ 1000hr 243 297	RM1206	CDR32BP271BKUR
17	1	D1	Diode, Switching, 50V, 200 mA MBAV74	SOT-23	Motorola / MBAV74L SN 00202
18	1	D2	Diode, Voltage Reference LM285-1.2	SOIC-8	Linear / LM285MX-1.2 SN 01502
19	1	D3	Reference, Voltage, Precision, 10V, REF-01	SOIC-8	PMI / REF01CS SN 01419
20	2	D4,D5	Diode, Schottky, 30V BAT54S	SOT-23	Phillips / BAT54S SN 03517 03516
21	9	JP4,JP6,JP7,JP9, JP11,JP13,JP14, JP15,JP16	Jumper, 0 Ω, 1%, 1/4 Watt	RM1206	D55342K07B00DOS
22	3	L1,L3,L4	Inductor, 100 µH	LQH4	MuRata Erie / LQH4N101K-TA

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
23	1	L5	Inductor, 10 µH	LQH4	MuRata Erie / LQH4N100K-TA
24	1	J1	Connector, 51 Contact, Socket	MDM51	M83513/04-G06N
25	5	Q1,Q4,Q9, Q10,Q11 S/N's 04706, 04707, 04708, 04709, 04710	Transistor, FET, SST215	SOT-143	Calogic / **No Substitute** Calogic No. SST215E
26	3	Q2,Q3,Q8 S/N's 00017, 00016, 00015	Transistor, 2N3904	SOT-23	Motorola / MMBT3904 **No Substitute**
27	3	Q12,Q13,Q14 S/N's 00917 00916 00915	Transistor, 2N7002	SOT-23	Motorola / 2N7002 **No Substitute**
28	2	R3,R66	7.5 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B7E50R
29		This space left intentionally blank			
30	2	R14,R31	243 Ω, 1%, 1/4 Watt, 100ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B243DR
31	2	R15,R32	1.82 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B1E82R

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
32	5	R16,R116,R130 R133,R136	49.9 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B49D9R
33	5	R17,R21,R49, R74,R94,R95 **TEMPORARILY LOAD R49**	1.0 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B1E00R
34	1	R18	2.49 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B2E49R
35	1	R20	2.7 KΩ, 2%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B2H70R
36	1	R24	1.62 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B1E62R
37	1	R25	9.09 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B9E09R
38	1	R26	24.3 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B24E3R

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
32	5	R16,R116,R130 R133,R136	49.9 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 49.401 50.399	RM1206	D55342K07B49D9R
33	5	R17,R21, R74,R94,R95	1.0 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 990 1,010	RM1206	D55342K07B1E00R
34	1	R18	2.49 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 2.4651 2.5149	RM1206	D55342K07B2E49R
35	1	R20	2.7 KΩ, 2%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 2,673 2,727	RM1206	D55342K07B2H70R
36	1	R24	1.62 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 1.6038 1.6362	RM1206	D55342K07B1E62R
37	1	R25	9.09 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 8.9991 9.1809	RM1206	D55342K07B9E09R
38	1	R26	24.3 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 24.057 24.543	RM1206	D55342K07B24E3R

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
39	1	R27	7.68 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B7E68R
40	2	R28,R91	0 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B00D0R
41	9	R29,R48,R101, R102,R129,R132, R135,R140,R141	10 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0,01%/ 1000hr	RM1206	D55342K07B10E0R
42	1	R30	2.15 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B2E15R
43	4	R37,R115, R49,R122,R128 **DO NOT LOAD R49 OR R128**	100 Ω, 1%, 1/4 Watt, 100 ppm, FR=0,01%/ 1000hr	RM1206	D55342K07B100DR
44	1	R38	3.01 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B3E01R
45	2	R42,R43	30 Ω, 2%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B30G0R

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
39	1	R27	7.68 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 7.6032 7.7568	RM1206	D55342K07B7E68R
40	2	R28,R91	0 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B00D0R
41	9	R29,R48,R101, R102,R129,R132, R135,R140,R141	10 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0,01%/ 1000hr 9.90 10.10	RM1206	D55342K07B10E0R
42	1	R30	2.15 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 2.1285 2.1715	RM1206	D55342K07B2E15R
43	4	R37,R115, R122,R128	100 Ω, 1%, 1/4 Watt, 100 ppm, FR=0,01%/ 1000hr 99 101	RM1206	D55342K07B100DR
44	1	R38	3.01 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 2.9799 3.0401	RM1206	D55342K07B3E01R
45	2	R42,R43	30 Ω, 2%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 29.40 30.60	RM1206	D55342K07B30G0R

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
46	2	R44,R93	1.96 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B1E96R
47	1	R46	100 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B100ER
48	1	R92	20 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B20E0R
49	4	R96,R98,R118, R120	2.61KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B2E61R
50	1	R97	301 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B301DR
51	2	R99,R119	6.19 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B6E19R
52	1	R112	511 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B511DR

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
53	1	R117	40.2 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B40D2R
54	1	R121	649 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B649DR
55	1	R124	5.1 Ω 1%, 1/8 Watt	RC1206	KOA / RM73B2B5R1JT
56	1	R125	499 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B499DR
57	1	R131	931 Ω,1%, 1/4 Watt, 100ppm, FR=0.01%/ 1000hr	RM1206	Dale / CRCW12069310FT
58	1	R134	383 Ω,1%, 1/4 Watt, 100ppm, FR=0.01%/ 1000hr	RM1206	Rohm / MCR12064420FT
59	2	R137,R49	178 Ω, 1%, 1/4 Watt, 100ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B178DR

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
60	1	R139	20.0 Ω,1%, 1/4 Watt, 100ppm, FR=0.01%/ 1000hr 19.798 20.200	RM1206	D55342K07B20D0R
61	1	T1	Sensor, Temperature 534-31AG04-562	TO-52/3	Fenwell / LTN11 Type . 534-31AG04-562
62	1	U1	Amplifier,. Operational, Clamping CLC501AJE	SOIC-8	Comlinear / CLC501AJE SN 02869
63	1	U2	Receiver, Line Quad DS34C86	SOIC-16	National / DS34C86M SN 05319
64	2	U3,U27	Amplifier, Dual, Wide Band LF353	SOIC-8	National / LF353M SN 01318 01317
65	1	U5	Controller, CCD TH7990	JLCC-44	Thomson-CSF / TH7990C S.N 14
66	4	U6,U7, U12,U25	Driver, Line, Quad DS34C87	SOIC-16	National / DS34C87M SNS 04916 04915 04914 04913
67	1	U8	Converter, Analog to Digital 8 bit MP7684	LCC-28	Micropower / MP7684ATL/883
68	4	U9,U10,U22 U23	Driver, Dual Inverting TSC4426	SOIC-8	Teledyne / TSC4426EOA SNS 05516 05515 05514 05513

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
69	2	U11,U30	Driver, Differential, Dual TSC4428	SOIC-8	Teledyne / TSC4428EOA SN's 01818 01817
70	1	U14	Amplifier, Operational, LF356	SOIC-8	National / LF356M SN 01719
71	2	U17,U18	Regulator, Voltage, Adjustable LM317	SOIC-8	National / LM317LM SN's 03704, 03705
72	1	U19 DO NOT KIT	Charged Coupled Device CCD 7860 or7863	DIP-20	Type Chosen on Camera Selection
73	1	U24	Amplifier, Operational, Clamping CLC502	SOIC-8	Comlinear, CLC502AJE SN 02952
74	1	U26 DO NOT KIT	Gate Array, Field Program, ACT1020A	JLCC-44	Actel / ACT1020A-1JQ44B
75	1	U32	Converter, Digital to Analog AD558TE/883	LCC20	Analog Devices / AD558TE/883
76	1	X1	Crystal, 20 MHz ±50ppm	CXAT	MicroCrystal / 20.000 MHz CXAT-T2
77	2	U19 Socket	Socket Strip 10 pin	SIP-10	LLNL / 5975-64700

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
78	2	N/A	Spacer	N/A	AAA92-104616-OB Tab-01
79	2	N/A	Brass CCD Mounting Nuts	N/A	AAA92-109126 REV 00
80	2	N/A	#2-56 Stainless Steel Nut	N/A	NAS671C2
81	2	N/A	Washer, Stainless Steel, #2	N/A	NAS620C-2
82	2	TP1,TP2	Test Points	N/A	LLNL / 5975-66833
83	8	C4,C7,C8,C82, C99,C100, C101,C123	0.1 µfd, 50 Volt, 10%	RC1206	Rohm / CE104K3NR-T2
84	1	L2	Inductor, 47 µH	LQH4	MuRata Erie / LQH4N470K-TA

old Rev

Actel Camera with Gain and Offset Control
Startracker Configuration
Rev. 00 Printed Wiring Board
Bill of Materials, Rev. 00
LEA92-3128-04

	Date	Rev.	Date	Approval
Prepared by: K. F. Coatney (KF Coatney)	30 Mar 93	0A	13 April 93	W. Bryson
Reviewed by: W. R. Bryson (W. Bryson)	30 Mar 93	0B	16 April 93	W. Bryson
Reviewed by: J. F. Kordas (J. F. Kordas)	30-MAR-93			
Reviewed by: M.L. Dickerson (M. Dickerson)	3/31/93			
Reviewed by: E.H. Schmitt (E.H. Schmitt)	4/2/93			
Reviewed by: M. J. Shannon	4/2/93			

University of California Lawrence Livermore National Laboratory	22 March 1993 Actel Startracker Bill of Materials	LEA92-3128-04 Revision 00

1.0 Scope

This document is the bill of materials for the Actel Camera with Gain and Offset Control for use in the Startracker, Rev 00 Printed Wiring Board, LEA92-3128-04, Rev 00.

2.0 Parts

Where a dual part number listing exists, the first number listed is a commercial part suitable for prototype work only. If the MIL-SPEC part is not available at the time flight boards are assembled, Quality assurance must OK the use of the commercial part on a part by part basis in writing.

Parts may not be substituted without the written permission of the Quality Assurance Group.

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
1	47	C1,C3,C4,C5,C6, C7,C8,C15,C21, C23,C25,C26, C30,C31,C33, C34,C38,C39, C40,C42,C44, C45,C47,C48, C54,C56,C57, C58,C59,C60, C63,C64,C66, C67,C70,C91, C92,C98,C102, C103,C104,C106, C109,C112,C114, C121,C124	0.039 µF, 50V, 10%, FR=0.01%/ 1000 hr .0351 .0429	RM1206	CDR32BX393AKUR
2	5	C2,C51,C61,C62, C122	4.7 µfd, Tant, 10V, 10%, WFR=0.01%/ 1000hr 4.23 5.17	H-CASE	CWR06FH475KC
3	1	C9	47 µfd, Tant, 20V, 10% 42.3 51.7	R-CASE	Sprague / 195D476X9020R2T

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
4	2	C10,C11	22 µfd, Tant, 15V, 10%, WFR=0.01%/ 1000hr	G-CASE	CWR06HH226KC
5	4	C12,C13,C17, C105	6.8 µfd, Tant, 10V, 10%, WFR=0.1%/ 1000hr	E-CASE	CWR06FH685KB
6	2	C20,C110	6.8 µfd, Tant, 20V, 10%, WFR=0.01%/ 1000hr	F-CASE	CWR06JH685KC
7	6	C22,C24,C29, C69,C90,C118	22 µfd, Tant, 20V, 10%, WFR=0.01%/ 1000hr	H-Case	CWR06JH226KC
8	4	C32,C52,C94, C95	10 µfd, Tant, 25V,10%, WFR=0.01%/ 1000hr	G-CASE	CWR06KH106KC
9	1	C35	0.22 µfd, 50V, 10%	RC1206	Garrett / 1206Z224M500N
10	2	C46,C93	1.0 µfd, Tant 35V, 10%, WFR=0,01%/ 1000hr	D-CASE	CWR06MH105KC
11	2	C49,C50	0.022 µfd, 100V, 10%, FR=0.01%/ 1000hr	RM1206	Garrett / CE223K3NR
12	1	C53	15 pf, 100V, 5%, FR=0.01%/ 1000hr	RM1206	CDR32BP150BJUR

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
13	5	C73,C74,C75, C76,C77	3300 pf, 50V, 10%, FR=0.001%/ 1000hr	RC0402 RC0505	Novacap / 0402B332K500N CDR11BP332AKUS
14	1	C83	0.01 µfd, 100V, 10%, FR=0.01%/ 1000hr	RM1206	CDR32BX103BKUR
15	1	C111	47 pf, 100V, 5%, FR=0.01%/ 1000 hr	RM1206	CDR32PB470BJUR
16	2	C115,C116	270 pf, 100V, 10%, FR=0.01%/ 1000hr	RM1206	CDR32BP271BKUR
17	1	D1	Diode, Switching, 50V, 200 mA MBAV74	SOT-23	Motorola / MBAV74L
18	1	D2	Diode, Voltage Reference LM285-1.2	SOIC-8	Linear / LM285MX-1.2
19	1	D3	Reference, Voltage, Precision, 10V, REF-01	SOIC-8	PMI / REF01CS
20	2	D4,D5	Diode, Schottky, 30V BAT54S	SOT-23	Phillips / BAT54S
21	9	JP4,JP6,JP7,JP9, JP11,JP13,JP14, JP15,JP16	Jumper, 0 Ω, 1%, 1/4 Watt	RM1206	D55342K07B00DOS
22	3	L1,L3,L4	Inductor, 100 µH	LQH4	MuRata Erie / LQH4N101K-TA

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
23	1	L5	Inductor, 10 µH	LQH4	MuRata Erie / LQH4N100K-TA
24	1	J1	Connector, 51 Contact, Socket	MDM51	M83513/04-G06N
25	5	Q1,Q4,Q9, Q10,Q11 SN's 04706, 04701, .04705, 04709, 04710	Transistor, FET, SST215	SOT-143	Calogic / **No Substitute** Calogic No. SST215E
26	3	Q2,Q3,Q8 SN's 00017 00016 00015	Transistor, 2N3904	SOT-23	Motorola / MMBT3904 **No Substitute**
27	3	Q12,Q13,Q14 SN's 00917 00916 00715	Transistor, 2N7002	SOT-23	Motorola / 2N7002 **No Substitute**
28	2	R3,R66	7.5 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 7.425 7.575	RM1206	D55342K07B7E50R
29	2	R6,R7	150 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 148.50 151.50	RM1206	D55342K07B150DR
30	2	R14,R31	243 Ω, 1%, 1/4 Watt, 100ppm, FR=0.01%/ 1000hr 240.57 245.43	RM1206	D55342K07B243DR
31	2	R15,R32	1.82 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 1.8018 1.8382	RM1206	D55342K07B1E82R

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
32	5	R16,R116,R130 R133,R136	49.9 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B49D9R
33	5	R17,R21, R74,R94,R95	1.0 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B1E00R
34	1	R18	2.49 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B2E49R
35	1	R20	2.7 KΩ, 2%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B2H70R
36	1	R24	1.62 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B1E62R
37	1	R25	9.09 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B9E09R
38	1	R26	24.3 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B24E3R

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
39	1	R27	7.68 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B7E68R
40	2	R28,R91	0 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B00D0R
41	9	R29,R48,R101, R102,R129,R132, R135,R140,R141	10 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0,01%/ 1000hr	RM1206	D55342K07B10E0R
42	1	R30	2.15 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B2E15R
43	4	R37,R115, R122,R128	100 Ω, 1%, 1/4 Watt, 100 ppm, FR=0,01%/ 1000hr	RM1206	D55342K07B100DR
44	1	R38	3.01 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B3E01R
45	2	R42,R43	30 Ω, 2%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B30G0R

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
46	3	R44,R93,R119	1.96 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 1.9404 1.9796	RM1206	D55342K07B1E96R
47	1	R46	100 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 98.90 101.00	RM1206	D55342K07B100ER
48	1	R92	20 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 19.80 20.20	RM1206	D55342K07B20E0R
49	4	R96,R98,R118, R120	2.61KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 2.5839 2.6361	RM1206	D55342K07B2E61R
50	1	R97	301 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 297.99 304.01	RM1206	D55342K07B301DR
51	1	R99	6.19 KΩ, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 6.1281 6.2519	RM1206	D55342K07B6E19R
52	1	R112	511 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 505.89 516.11	RM1206	D55342K07B511DR

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
53	1	R117	40.2 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 39.798 40.602	RM1206	D55342K07B40D2R
54	1	R121	649 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 642.51 655.49	RM1206	D55342K07B649DR
55	1	R124	5.1 Ω 1%, 1/8 Watt 5.049 5.151	RC1206	KOA / RM73B2B5R1JT
56	1	R125	499 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr 494.01 503.99	RM1206	D55342K07B499DR
57	1	R131	931 Ω,1%, 1/4 Watt, 100ppm, FR=0.01%/ 1000hr 921.69 940.31	RM1206	Dale / CRCW12069310FT
58	1	R134	383 Ω,1%, 1/4 Watt, 100ppm, FR=0.01%/ 1000hr 379.17 386.83	RM1206	Rohm / MCR12064420FT
59	1	R137	178 Ω, 1%, 1/4 Watt, 100ppm, FR=0.01%/ 1000hr 176.22 179.78	RM1206	D55342K07B178DR

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
60	1	R139	20.0 Ω,1%, 1/4 Watt, 100ppm, FR=0.01%/ 1000hr	RM1206	D55342K07B20D0R
61	1	T1	Sensor, Temperature 534-31AG04-562	TO-52/3	Fenwell / LTN11 Type 534-31AG04-562
62	1	U1	Amplifier,. Operational, Clamping CLC501AJE	SOIC-8	Comlinear / CLC501AJE
63	1	U2	Receiver, Line Quad DS34C86	SOIC-16	National / DS34C86M
64	2	U3,U27	Amplifier, Dual, Wide Band LF353	SOIC-8	National / LF353M
65	1	U5	Controller, CCD TH7990	JLCC-44	Thomson-CSF / TH7990C
66	4	U6,U7, U12,U25	Driver, Line, Quad DS34C87	SOIC-16	National / DS34C87M
67	1	U8	Converter, Analog to Digital 8 bit MP7684	LCC-28	Micropower / MP7684ATL/883
68	4	U9,U10,U22 U23	Driver, Dual Inverting TSC4426	SOIC-8	Teledyne / TSC4426EOA

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
69	2	U11,U30	Driver, Differential, Dual TSC4428	SOIC-8	Teledyne / TSC4428EOA
70	1	U14	Amplifier, Operational, LF356	SOIC-8	National / LF356M
71	2	U17,U18	Regulator, Voltage, Adjustable LM317	SOIC-8	National / LM317LM
72	1	U19 **DO NOT KIT**	Charged Coupled Device CCD 7860 or7863	DIP-20	Type Chosen on Camera Selection
73	1	U24	Amplifier, Operational, Clamping CLC502	SOIC-8	Comlinear, CLC502AJE
74	1	U26 **DO NOT KIT**	Gate Array, Field Program, ACT1020A	JLCC-44	Actel / ACT1020A-1JQ44B
75	1	U32	Converter, Digital to Analog AD558TE/883	LCC20	Analog Devices / AD558TE/883
76	1	X1	Crystal, 20 MHz ±50ppm	CXAT	MicroCrystal / 20.000 MHz CXAT-T2
77	2	U19 Socket	Socket Strip 10 pin	SIP-10	LLNL / 5975-64700

Item	Qty.	Designator	Description	Case	Mfg. / Part Number
78	2	N/A	Spacer	N/A	AAA92-104616-OB Tab-01
79	2	N/A	Brass CCD Mounting Nuts	N/A	AAA92-109126 REV 00
80	2	N/A	#2-56 Stainless Steel Nut	N/A	NAS671C2
81	2	N/A	Washer, Stainless Steel, #2	N/A	NAS620C-2
82	2	TP1,TP2	Test Points	N/A	LLNL / 5975-66833
83	5	C82,C99,C100, C101,C123	0.1 µfd, 50 Volt, 10%	RC1206	Rohm / CE104K3NR-T2
84	1	R49	200 Ω, 5%, 1/4 Watt, 100 ppm, FR=0,01%/ 1000hr	RM1206	D55342K07B200JR
85	1	L2	Inductor, 47 µH	LQH4	MuRata Erie / LQH4N470K-TA

Appendix H.2.4

Assembly Procedures

Assembly Procedure
for
ACTEL Camera with Gain and Offset Control, StarTracker Configuration

Address: 1

	Date:	Rev.:	Date:	Approval:
Prepared by: W. R. Bryson				
Reviewed by: M. L. Dickerson				
Reviewed by: J.F. Kordas				
Reviewed by: R. E. Priest				
Reviewed by: E.H. Schmitt				
Approved by: M.J. Shannon				

University of California Lawrence Livermore National Laboratory	13 May 93 Assembly Procedure Actel Camera with Gain and Offset Control	LEA92-3128-05 Revision 00

1.0 Scope

This document describes the assembly procedure for the Actel Camera with Gain and Offset Control, StarTracker Configuration, Rev 00 printed wiring board. This procedure has been written for hand assembly, workmanship standards shall be MIL-STD-2000.

2.0 Required and Related Documents and General Notes

2.1 Required documents:

Bill of Materials, LEA92-3128-04 Actel Camera with Gain and Offset Control, StarTracker Configuration, Rev 00 Printed Wiring Board

Assembly Drawing, LEA92-3128-03 Actel Camera with Gain and Offset Control, StarTracker Configuration, Rev 00 Printed Wiring Assembly

Adhesive Compounds and Optical Couplets, C1-S0-005

Preparation of Gold Plated Leads, C1-EE-023

Polyimide Based Printed Wiring Board Conditioning Methods, C1-EE-029

2.2 Related documents:

MIL-STD-1686A

Clementine Quality Assurance Program Plan, C1-S0-007

Clementine Sensor Suite Waiver Procedure, C1-S0-006

Clementine Failure Reporting, Analysis and Corrective Action System, C1-EE-0021

2.3 General Notes

1) All measuring devices used during the assembly of the Actel Camera board with Gain and Offset Control must be in current calibration. The calibration expiration date must be far enough in the future to allow completion of this assembly.

2) Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected or baked.

3) Clean and inspect, followed by printed wiring board bake are inserted at recommended locations. More or less components may be installed between clean and inspect points at the discretion of the QAG. It is mandatory that the printed wiring board is baked after solvent cleaning operations prior to continued solder assembly.

3.0 Visual Inspection

3.1 The printed wiring board shall have been inspected by the Quality Assurance Group (QAG) prior to loading. Record inspectors name both below and in the certification log work sheets by paragraph number.

Date: 4/14/93 (Inspection Date) QA: QA #2 (QA Stamp)

3.2 Record the manufacturer, serial number and manufactures lot code of the printed wiring board to be used in this assembly. Record both below and in the certification log work sheets by paragraph number.

Manufacturer: Pioneer Circuits Inc.

Serial #: D4-010 Lot Code: 6862

3.3 Mount the printed wiring board in an Actel Camera printed wiring board carrier.

4.0 Printed Wiring Board Bake Out

4.1 The printed wiring board shall be baked at 130 ± 5 °C for a minimum of 6 hours prior to loading, per Polyimide Based Printed Wiring Board Conditioning Methods, C1-EE-029. Prior to baking the printed wiring board, verify that the oven to be used is in current calibration and has been verified by the QAG. The start and end times along with the start and end temperatures shall be recorded. The oven temperature profile shall be recorded, using a strip chart recorder, for the duration of the bake out. Record the date, assembly, serial number, assembly step and operator on the chart and insert in the certification section of the assembly log. The make, model and serial number of the oven used for bake out shall be recorded. Record both below and in the certification log work sheets by paragraph number.

Oven Calibration and Certification Current: QA #2 (Operator or QA Stamp)

Start Time: 7:00 p.m End Time: 1:00 p.m

Start Temp: 95 °C End Temp: 95 °C

Oven Make: Versa Tenn II Oven Model: 7HJR

Oven Serial #: 12664-1

Date: 4/15/93 (Date Recorded) Operator: QA #2 (Operator or QA Stamp)

Note: Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected, tested or baked.

5.0 Parts Verification

5.1 Verify that all measuring devices to be used in 5.2 are in current calibration. Record both here and in the Assembly Log work sheets.

Equipment is in current calibration. Operator: HR. Oper #9 9/3/93
Operator or QA Stamp

FLUKE 3/19/93 - 3/19/95 DYNASCAN 9/3/92.

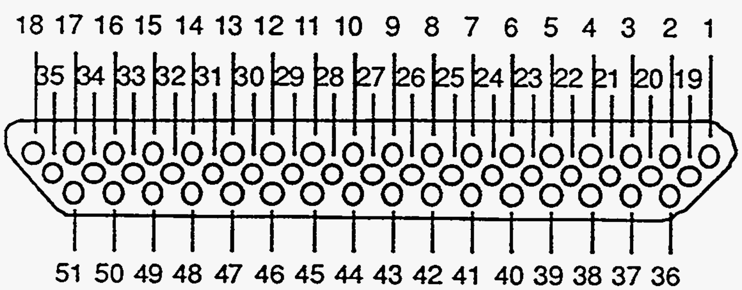
5.2 Verify that parts have been kitted per the bill of materials, LEA92-3128-04. This includes verification that all resistors and capacitors are within proper tolerance as specified in the bill of materials. Record both below and in the certification log work sheets by paragraph number.

Date: April 16, 1993
Date Verified

Operator: HR Oper #9
Operator or QA Stamp

6.0 Resistance Measurements

6.1 Resistance measurements are to be made at J1 prior to assembly. Make and record the measurements as indicated in table 1. **All readings must be greater than 10 Meg ohms, except where noted.** See figure 1 below for the location of pins in J1.



MDM 51 Contact Connector.
Face View of Socket Insert.

Figure 1.

Meter Common	Signal	Meter Signal	Signal	Actual
J1-5	AGND	J1-39	+15VDC	O.L
J1-5	AGND	J1-4	-15VDC	O.L
J1-5	AGND	J1-37	+5VDC	O.L
J1-5	AGND	J1-3	-5VDC	O.L
J1-5	AGND	J1-40	+5VIN	O.L
J1-5	AGND	J1-20	DGND	O.L
J1-20	DGND	J1-39	+15VDC	O.L
J1-20	DGND	J1-4	-15VDC	O.L
J1-20	DGND	J1-37	+5VDC	O.L
J1-20	DGND	J1-3	-5VDC	O.L
J1-20	DGND	J1-40	+5VIN	O.L
J1-39	+15VDC	J1-4	-15VDC	O.L
J1-39	+15VDC	J1-37	+5VDC	O.L
J1-39	+15VDC	J1-3	-5VDC	O.L
J1-39	+15VDC	J1-40	+5VIN	O.L
J1-4	-15VDC	J1-37	+5VDC	O.L
J1-4	-15VDC	J1-3	-5VDC	O.L
J1-4	-15VDC	J1-40	+5VIN	O.L
J1-37	+5VDC	J1-3	-5VDC	O.L
J1-37	+5VDC	J1-40	+5VIN	O.L
J1-3	-5VDC	J1-40	+5VIN	O.L

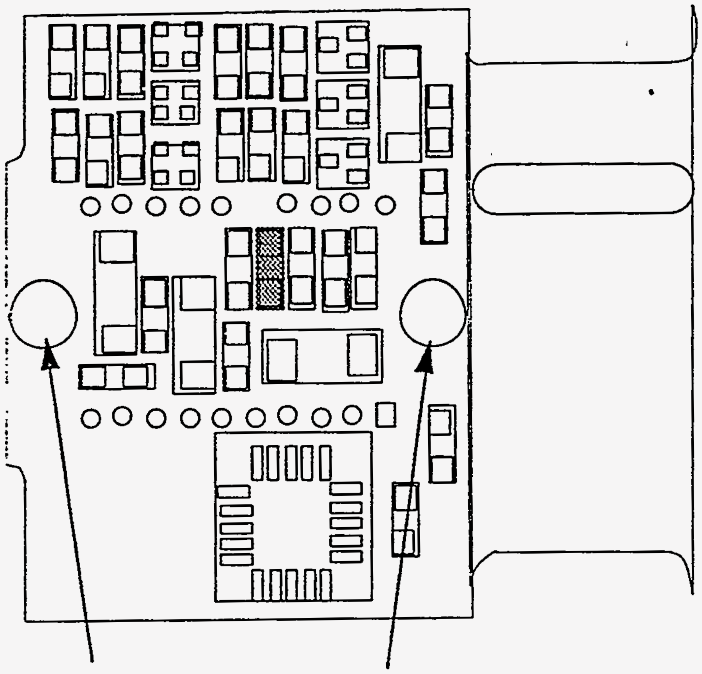
Table 1.

7.0 Detailed assembly

7.1 Installation of item 79, brass CCD mounting nuts, AAA92-109126-00.

7.1.1 Insert item 79 from the secondary side of the printed wiring board as shown in figure 2 below.

Secondary Side View



CCD Mounting Nut Locations

Figure 2.

7.1.2 Verify that the flange on the CCD nut is flush with the surface of the printed wiring board.

7.1.3 Solder the CCD mounting nuts in place.

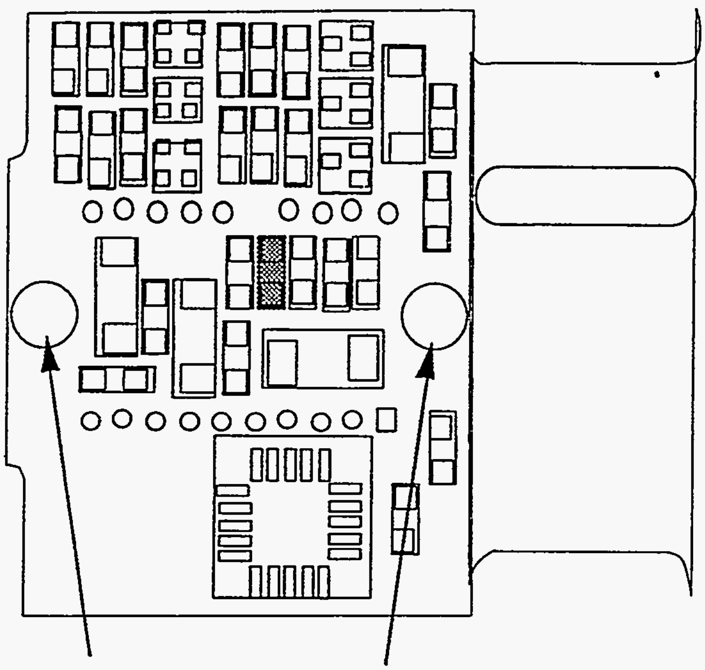
Note: Use caution to prevent solder from entering the threaded area of the CCD nut.

7.0 Detailed assembly

7.1 Installation of item 79, brass CCD mounting nuts, AAA92-109126-00.

7.1.1 Insert item 79 from the secondary side of the printed wiring board as shown in figure 2 below.

Secondary Side View



CCD Mounting Nut Locations

Figure 2.

7.1.2 Verify that the flange on the CCD nut is flush with the surface of the printed wiring board.

7.1.3 Solder the CCD mounting nuts in place.

Note: Use caution to prevent solder from entering the threaded area of the CCD nut.

7.2 Install the items listed in the table 2 below:

7.2 Install the items listed in the table 2 below:

Item	Qty	Designator	Description	Case
1	44	C1,C3,C5,C6,C15,C21, C23,C25,C26, C30,C31,C33,C34,C38, C39,C40,C42,C44,C45, C47,C48,C54,C56,C57, C58,C59,C60,C63,C64, C66,C67,C70,C91,C92, C98,C102,C103,C104, C106,C109,C112,C114, C121,C124	0.039 µF, 100V, 10%	RM1206
9	1	C35	0.22 µfd, 50V, 10%	RM1206
11	2	C49,C50	0.022 µfd, 100V, 10%	RM1206
12	1	C53	15 pf, 100V, 5%	RM1206
13	5	C73,C74,C75,C76,C77	3300 pf, 50V, 10%	RC0402 RC0505
14	1	C83	0.01 µfd, 100V, 10%	RM1206
15	1	C111	47 pf, 100V, 5%	RM1206
16	2	C115,C116	270 pf, 100V, 10%	RM1206
83	8	C4,C7,C8,C82,C99, C100, C101,C123	0.1 µfd, 50 Volt, 10%	RC1206
28	2	R3,R66	7.5 KΩ, 1%	RM1206
30	2	R14,R31	243 Ω, 1%	RM1206
31	2	R15,R32	1.82 KΩ, 1%	RM1206

Table 2.

Item	Qty	Designator	Description	Case
1	47	C1,C3,C4,C5,C6,C7,C8, C15,C21,C23,C25,C26, C30,C31,C33,C34,C38, C39,C40,C42,C44,C45, C47,C48,C54,C56,C57, C58,C59,C60,C63,C64, C66,C67,C70,C91,C92, C98,C102,C103,C104, C106,C109,C112,C114, C121,C124.	0.039 µF, 100V, 10%	RM1206
9	1	C35	0.22 µfd, 50V, 10%	RM1206
11	2	C49,C50	0.022 µfd, 100V, 10%	RM1206
12	1	C53	15 pf, 100V, 5%	RM1206
13	5	C73,C74,C75,C76,C77	3300 pf, 50V, 10%	RC0402 RC0505
14	1	C83	0.01 µfd, 100V, 10%	RM1206
15	1	C111	47 pf, 100V, 5%	RM1206
16	2	C115,C116	270 pf, 100V, 10%	RM1206
83	5	C82,C99,C100, C101,C123	0.1 µfd, 50 Volt, 10%	RC1206
28	2	R3,R66	7.5 KΩ, 1%	RM1206
29	2	R6,R7	150 Ω, 1%	RM1206
30	2	R14,R31	243 Ω, 1%	RM1206
31	2	R15,R32	1.82 KΩ, 1%	RM1206

Table 2.

7.3 Clean and inspect all solder joints per MIL-STD-2000. Rework any substandard solder joints. Record inspection both here and in the certification log worksheets.

Date: 4/19/93 (Date Inspected) QA: QA #2 (QA Stamp)

7.4 The printed wiring board shall be baked at 130 ± 5 °C for a minimum of 6 hours prior to loading, per Polyimide Based Printed Wiring Board Conditioning Methods, C1-EE-029. Prior to baking the printed wiring board, verify that the oven to be used is in current calibration and has been verified by the QAG. The start and end times along with the start and end temperatures shall be recorded. The oven temperature profile shall be recorded, using a strip chart recorder, for the duration of the bake out. Record the date, assembly, serial number, assembly step and operator on the chart and insert in the certification section of the assembly log. The make, model and serial number of the oven used for bake out shall be recorded. Record both below and in the certification log work sheets by paragraph number.

Calibration and Certification Current, Initial: QA #2 (Operator or QA Stamp)

Start Time: 7:30 p.m End Time: 1:30 A.M

Start Temp: 95 °C End Temp: 95 °C

Oven Make: VersaTemp II Oven Model: THJR

Oven Serial #: 12664-1

Date: 4/19/93 (Date Completed) Operator: QA #2 (Operator or QA Stamp)

Note: Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected, tested or baked.

7.5 Install the items listed in tables 3a and 3b below.

Item	Qty	Designator	Description	Case
32	5	R16,R116,R130, R133,R136	49.9 Ω, 1%	RM1206
33	5	R17,R21,R74,R94,R95	1.0 KΩ, 1%	RM1206
34	1	R18	2.49 KΩ, 1%	RM1206
35	1	R20	2.7 KΩ, 5%	RM1206
36	1	R24	1.62 KΩ, 1%	RM1206
37	1	R25	9.09 KΩ, 1%	RM1206
38	1	R26	24.3 KΩ, 1%	RM1206
39	1	R27	7.68 KΩ, 1%	RM1206
40	2	R28,R91	0 Ω, 1%	RM1206
41	9	R29,R48,R101,R102,R129, R132,R135,R140,R141	10 KΩ, 1%	RM1206
42	1	R30	2.15 KΩ, 1%	RM1206
43	3	R37,R115, R122	100 Ω, 1%	RM1206
44	1	R38	3.01 KΩ, 1%	RM1206
45	2	R42,R43	30 Ω, 2%	RM1206
46	2	R44,R93	1.96 KΩ, 1%	RM1206
47	1	R46	100 KΩ, 1%	RM1206
48	1	R92	20 KΩ, 1%	RM1206
49	4	R96,R98,R118,R120	2.61KΩ, 1%	RM1206
50	1	R97	301 Ω, 1%	RM1206

Table 3a.

7.5 Install the items listed in tables 3a and 3b below.

Item	Qty	Designator	Description	Case
32	5	R16,R116,R130, R133,R136	49.9 Ω, 1%	RM1206
33	5	R17,R21,R74,R94,R95	1.0 KΩ, 1%	RM1206
34	1	R18	2.49 KΩ, 1%	RM1206
35	1	R20	2.7 KΩ, 5%	RM1206
36	1	R24	1.62 KΩ, 1%	RM1206
37	1	R25	9.09 KΩ, 1%	RM1206
38	1	R26	24.3 KΩ, 1%	RM1206
39	1	R27	7.68 KΩ, 1%	RM1206
40	2	R28,R91	0 Ω, 1%	RM1206
41	9	R29,R48,R101,R102,R129, R132,R135,R140,R141	10 KΩ, 1%	RM1206
42	1	R30	2.15 KΩ, 1%	RM1206
43	4	R37,R115, R122,R128	100 Ω, 1%	RM1206
44	1	R38	3.01 KΩ, 1%	RM1206
45	2	R42,R43	30 Ω, 2%	RM1206
46	3	R44,R93,R119	1.96 KΩ, 1%	RM1206
47	1	R46	100 KΩ, 1%	RM1206
48	1	R92	20 KΩ, 1%	RM1206
49	4	R96,R98,R118,R120	2.61KΩ, 1%	RM1206
50	1	R97	301 Ω, 1%	RM1206

Table 3a.

Item	Qty	Designator	Description	Case
51	2	R99,R119	6.19 KΩ, 1%	RM1206
52	1	R112	511 Ω, 1%	RM1206
53	1	R117	40.2 Ω, 1%	RM1206
54	1	R121	649 Ω, 1%	RM1206
55	1	R124	5.1 Ω 1%	RM1206
56	1	R125	499 Ω, 1%	RM1206
57	1	R131	931 Ω, 1%	RM1206
58	1	R134	383 Ω,1%	RM1206
59	1	R137	178 Ω, 1%	RM1206
60	1	R139	20.0 Ω,1%	RM1206

Table 3b.

7.5.1 Temporarily install a 1K 1% RM1206 resistor for R49. Tack this part only do not fully solder.

7.6 Clean and inspect all solder joints per MIL-STD-2000. Rework any substandard solder joints. Record inspection both here and in the certification log worksheets.

Date: ______________________ QA: ______________________

Date Inspected QA Stamp

7.7 The printed wiring board shall be baked at 130 ± 5 °C for a minimum of 6 hours prior to loading, per Polyimide Based Printed Wiring Board Conditioning Methods, C1-EE-029. Prior to baking the printed wiring board, verify that the oven to be used is in current calibration and has been verified by the QAG. The start and end times along with the start and end temperatures shall be recorded. The oven temperature profile shall be recorded, using a strip chart recorder, for the duration of the bake out. Record the date, assembly, serial number, assembly step and operator on the chart and insert in the certification section of the assembly log. The make, model and serial number of the oven used for bake out shall be recorded. Record both below and in the certification log work sheets by paragraph number.

Item	Qty	Designator	Description	Case
51	2	R99,R119	6.19 KΩ, 1%	RM1206
52	1	R112	511 Ω, 1%	RM1206
53	1	R117	40.2 Ω, 1%	RM1206
54	1	R121	649 Ω, 1%	RM1206
55	1	R124	5.1 Ω 1%	RM1206
56	1	R125	499 Ω, 1%	RM1206
57	1	R131	931 Ω, 1%	RM1206
58	1	R134	383 Ω,1%	RM1206
59	1	R137,R49	178 Ω, 1%	RM1206
60	1	R139	20.0 Ω,1%	RM1206

Table 3b.

7.6 Clean and inspect all solder joints per MIL-STD-2000. Rework any substandard solder joints. Record inspection both here and in the certification log worksheets.

Date: 4/19/93 QA: QA
Date Inspected QA Stamp

7.7 The printed wiring board shall be baked at 130 ± 5 °C for a minimum of 6 hours prior to loading, per Polyimide Based Printed Wiring Board Conditioning Methods, C1-EE-029. Prior to baking the printed wiring board, verify that the oven to be used is in current calibration and has been verified by the QAG. The start and end times along with the start and end temperatures shall be recorded. The oven temperature profile shall be recorded, using a strip chart recorder, for the duration of the bake out. Record the date, assembly, serial number, assembly step and operator on the chart and insert in the certification section of the assembly log. The make, model and serial number of the oven used for bake out shall be recorded. Record both below and in the certification log work sheets by paragraph number.

Calibration and Certification Current, Initial: QA #2
Operator or QA Stamp

Item	Qty	Designator	Description	Case
51	1	R99	6.19 KΩ, 1%	RM1206
52	1	R112	511 Ω, 1%	RM1206
53	1	R117	40.2 Ω, 1%	RM1206
54	1	R121	649 Ω, 1%	RM1206
55	1	R124	5.1 Ω 1%	RM1206
56	1	R125	499 Ω, 1%	RM1206
57	1	R131	931 Ω, 1%	RM1206
58	1	R134	383 Ω,1%	RM1206
59	1	R137	178 Ω, 1%	RM1206
60	1	R139	20.0 Ω,1%	RM1206
84	1	R49	200 Ω, 5%	RM1206

Table 3b.

7.6 Clean and inspect all solder joints per MIL-STD-2000. Rework any substandard solder joints. Record inspection both here and in the certification log worksheets.

Date: 4 | 19 | 93 QA: QA #2
Date Inspected QA Stamp

7.7 The printed wiring board shall be baked at 130 ± 5 °C for a minimum of 6 hours prior to loading, per Polyimide Based Printed Wiring Board Conditioning Methods, C1-EE-029. Prior to baking the printed wiring board, verify that the oven to be used is in current calibration and has been verified by the QAG. The start and end times along with the start and end temperatures shall be recorded. The oven temperature profile shall be recorded, using a strip chart recorder, for the duration of the bake out. Record the date, assembly, serial number, assembly step and operator on the chart and insert in the certification section of the assembly log. The make, model and serial number of the oven used for bake out shall be recorded. Record both below and in the certification log work sheets by paragraph number.

Calibration and Certification Current, Initial: QA #2
Operator or QA Stamp

Start Time: 7:30 p.m End Time: 1:30 p.m

Start Temp: 95 °C End Temp: 95 °C

Oven Make: Versa Tem II Oven Model: THJR

Oven Serial #: 126164-1

Date: 4/19/93 Operator: QA #2
Date Completed Operator or QA Stamp

Note: Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected, tested or baked.

7.8 Install the items listed in tables 4a and 4b below.

Item	Qty	Designator	Description	Case
2	5	C2,C51,C61,C62,C122	4.7 µfd, Tant, 10V, 10%	D-CASE
3	1	C9	47 µfd, Tant, 20V, 10%	R-CASE
4	2	C10,C11	22 µfd, Tant, 15V, 10%	G-CASE
5	4	C12,C13,C17,C105	6.8 µfd, Tant, 10V, 10%	E-CASE
7	6	C22,C24,C29,C69,C90, C118	22 µfd, Tant, 20V, 10%	H-CASE
8	4	C32,C52,C94, C95	10 µfd, Tant, 25V,10%	G-CASE
10	2	C46,C93	1.0 µfd, Tant 35V, 10%	D-CASE

Table 4a.

Item	Qty	Designator	Description	Case
17	1	D1	Diode, Switching, MBAV74	SOT-23
20	2	D4,D5	Diode, Schottky, 30V BAT54S	SOT-23
26	3	Q2,Q3,Q8	Transistor, 2N3904	SOT-23
27	3	Q12,Q13,Q14	Transistor, 2N7002	SOT-23
22	3	L1,L3,L4	Inductor, 100 µH	LQH4
23	1	L5	Inductor, 10 µH	LQH4
84	1	L2	Inductor, 47 µH or 39 µH	LQH4
25	5	Q1,Q4,Q9, Q10,Q11	Transistor, FET, SST215	SOT-143
76	1	X1	Crystal, 20MHZ	CXAT

Table 4b.

7.8.1 The landing pattern for item 6 was incorrectly designed on some boards. If so, item 6 must be installed on its side. Install item 6 as listed in table 5 below.

Item	Qty	Designator	Description	Case
6	2	C20,C110	6.8 µfd, Tant, 20V, 10%	F-CASE

Table 5.

7.9 Install the jumpers indicated in table 6 below. These parts are located as shown in Figure 3 on the primary side of the printed wiring board and in Figure 4 on the secondary side of the printed wiring board.

Item	Qty	Designator	Description	Case
21	9	JP4,JP6,JP7,JP9,JP11, JP13,JP14,JP15,JP16	Jumper, 0 Ω, 1%	RM1206

Table 6.

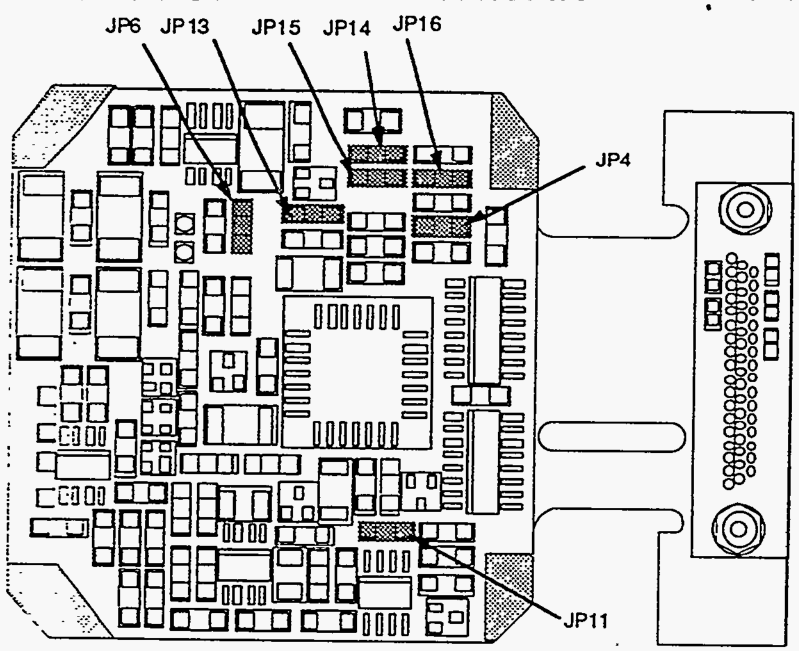


Figure 3, Primary Side View.

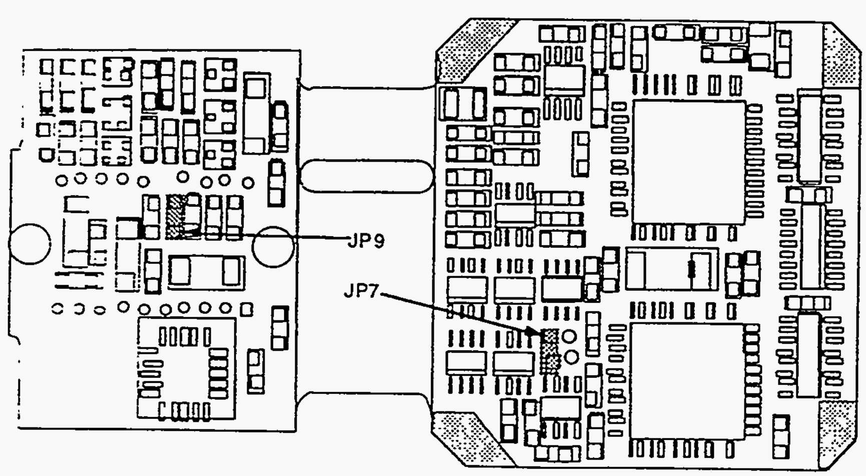


Figure 4, Secondary Side View.

7.10 Clean and inspect all solder joints per MIL-STD-2000. Rework any substandard solder joints. Record inspection both here and in the certification log worksheets.

Date: 4/20/93 (Date Inspected) QA: QA #2 (QA Stamp)

7.11 The printed wiring board shall be baked at 130 ± 5 °C for a minimum of 6 hours prior to loading, per Polyimide Based Printed Wiring Board Conditioning Methods, C1-EE-029. Prior to baking the printed wiring board, verify that the oven to be used is in current calibration and has been verified by the QAG. The start and end times along with the start and end temperatures shall be recorded. The oven temperature profile shall be recorded, using a strip chart recorder, for the duration of the bake out. Record the date, assembly, serial number, assembly step and operator on the chart and insert in the certification section of the assembly log. The make, model and serial number of the oven used for bake out shall be recorded. Record both below and in the certification log work sheets by paragraph number.

Calibration and Certification Current, Initial: QA #2 (Operator or QA Stamp)

Start Time: 7:00 p.m. End Time: 1:00 A.M.

Start Temp: 95 °C End Temp: 95 °C

Oven Make: Versa Tenn II Oven Model: THJR

Oven Serial #: 12664-1

Date: 4/20/93 (Date Completed) Operator: QA #2 (Operator or QA Stamp)

Note: Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected, tested or baked.

7.12 Install the items listed in tables 7a and 7b below.

Item	Qty	Designator	Description	Case
18	1	D2	Diode, Voltage Reference LM285-1.2	SOIC-8
19	1	D3	Reference, Voltage, Precision, 10V, REF-01	SOIC-8
62	1	U1	Amplifier,. Operational, Clamping CLC501AJE	SOIC-8
64	2	U3,U27	Amplifier, Dual, Wide Band LF353	SOIC-8
68	4	U9,U10,U22 U23	Driver, Dual Inverting TSC4426	SOIC-8
69	2	U11,U30	Driver, Differential, Dual TSC4428	SOIC-8
70	1	U14	Amplifier, Operational, LF356	SOIC-8
71	2	U17,U18	Regulator, Voltage, Adjustable LM317	SOIC-8

Table 7a.

Item	Qty	Designator	Description	Case
73	1	U24	Amplifier, Operational, CLC502	SOIC-8
63	1	U2	Receiver, Line, Quad DS34C86	SOIC-16
66	4	U6,U7, U12,U25	Driver, Line, Quad DS34C87	SOIC-16
67	1	U8	Converter, Analog to Digital 8 bit MP7684	LCC-28
75	1	U32	Converter, Digital to Analog AD558TE/883	LCC20
65	1	U5	Controller, CCD TH7990	JLCC-44

Table 7b.

7.13 Item 74, U26, an Actel ACT1020A is a programmed device. Due to its critical function in the operation of the Actel Camera it is not provided until requested. **QA verification of the Actel array is required.** Record below and in the Assembly Log work sheets the identifying information for the Actel gate array. Record the address on the front page of this document.

File Name: STI D

Check Sum: ~~Fco~~ Link File date 4/20/93

Programming Date: 3 May 93

StarTracker Address 1
#1 or #2

Device Supplied By: DPN
Name of Engineer or Technologist

QA: QA #17
QA Stamp

7.14 Install item 74, U26, ACTEL ACT1020A.

7.15 Cut pin number 16 of Item 77, socket strip for U19. **Important!** The cut must be flush with the base of the taper. See figure 5 below.

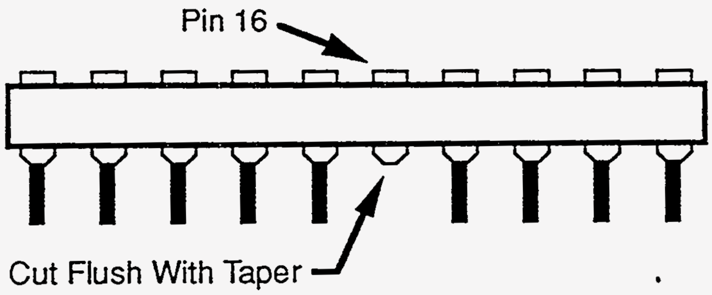


Figure 5.

7.16 Insert both strips of item 77,U19 socket, through the printed wiring board. Insert a dummy 20 pin DIP into the socket strips. Verify that the dummy DIP is completely seated in the socket strips and that the strips sit square and flat to the printed wiring board. Solder the socket strips to the printed wiring board. Remove the dummy DIP from the socket strips.

7.17 Pretin the leads of item 82 TP1 and TP2, two pin terminal strips per C1-EE-023, Preparation of Gold Plated Leads.

7.18 Install Item 82, two pin terminal strips

7.19 Temporarily tack a wire between the outermost pads of R128 and C123. See figure 6 below.

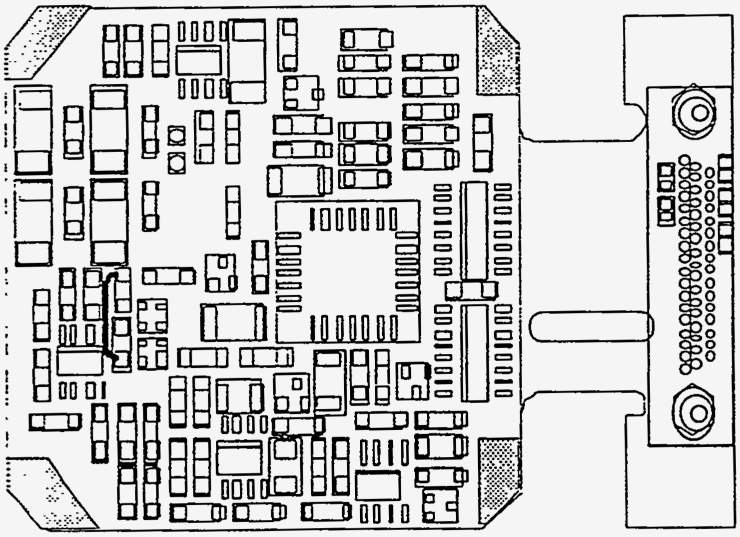


Figure 6.

7.14 Install item 74, U26, ACTEL ACT1020A.

7.15 Cut pin number 16 of Item 77, socket strip for U19. **Important!** The cut must be flush with the base of the taper. See figure 5 below.

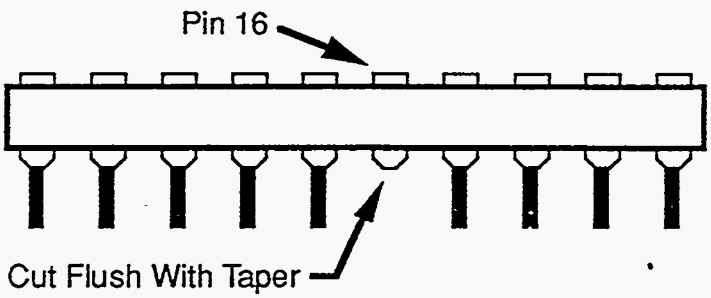


Figure 5.

7.16 Insert both strips of item 77,U19 socket, through the printed wiring board. Insert a dummy 20 pin DIP into the socket strips. Verify that the dummy DIP is completely seated in the socket strips and that the strips sit square and flat to the printed wiring board. Solder the socket strips to the printed wiring board. Remove the dummy DIP from the socket strips.

7.17 Pretin the leads of item 82 TP1 and TP2, two pin terminal strips per C1-EE-023, Preparation of Gold Plated Leads.

7.18 Install Item 82, two pin terminal strips

7.19 Pretin the leads of item 24, J1 per C1-EE-023, Preparation of Gold Plated Leads.

7.20 Measure the longest dimension of item 78, spacers, AAA92-104616-0B TAB 01. They should be 0.385 + 0.005, - 0.000 inch long. Record the measurement both here and in the assembly log work sheets.

Length of Spacers .390 .390

7.21 Assemble 2 each spacers, 2 each #2 stainless steel washers, item 81, and 2 each #2-56 stainless steel nuts, item 80, through the printed wiring board as shown in figure 6. Spacers are mounted from the primary side with nuts and washers on the secondary side. Using a calibrated tool, torque nuts to 40.0 ± 2 oz-in.

Torqued with UNCALIBRATED Tool. Torqued to 40.0 oz inches

7.20 Pretin the leads of item 24, J1 per C1-EE-023, Preparation of Gold Plated Leads.

7.21 Measure the longest dimension of item 78, spacers, AAA92-104616-0B TAB 01. They should be 0.385 + 0.005, - 0.000 inch long. Record the measurement both here and in the assembly log work sheets.

Length of Spacers .390 .390

7.22 Assemble 2 each spacers, 2 each #2 stainless steel washers, item 81, and 2 each #2-56 stainless steel nuts, item 80, through the printed wiring board as shown in figure 7. Spacers are mounted from the primary side with nuts and washers on the secondary side. Using a calibrated tool, torque nuts to 40.0 ± 2 oz-in.

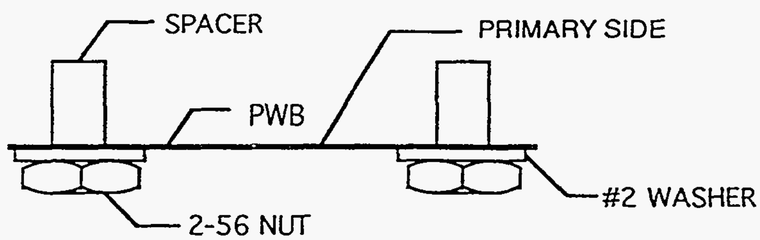


Figure 7.

7.23 Insert the leads of J1 through the printed wiring board. The connector J1 sits on top of the standoffs.

7.24 Assemble J1 to the spacers using 2 each #2-56 x .25 long. screws as shown in figure 8. Finger tighten only, do not torque.

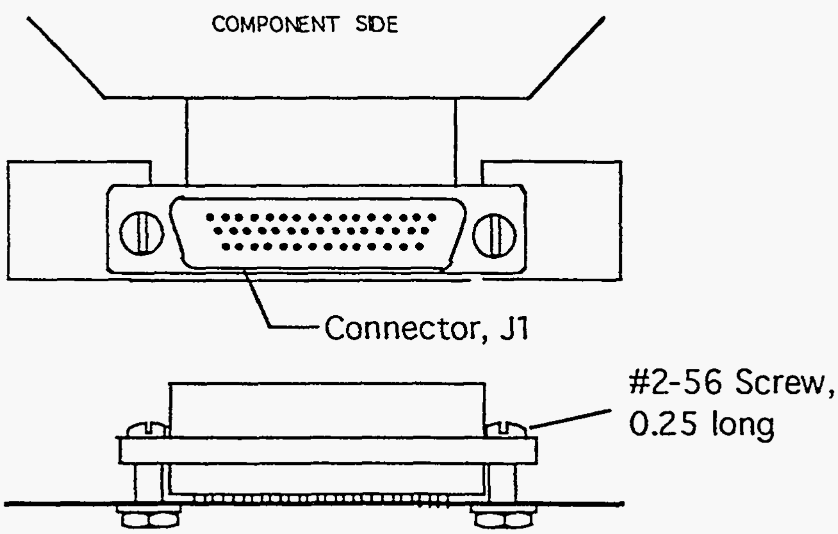


Figure 8.

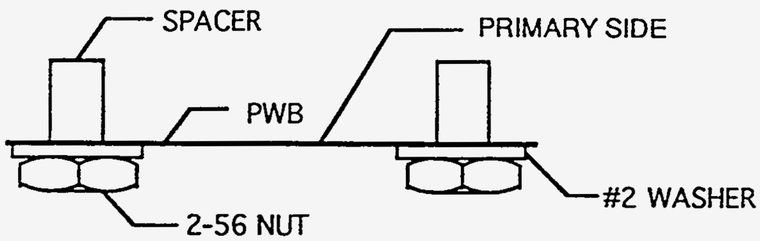


Figure 6.

7.22 Insert the leads of J1 through the printed wiring board. The connector J1 sits on top of the standoffs.

7.23 Assemble J1 to the spacers using 2 each #2-56 x .25 long. screws as shown in figure 7. Finger tighten only, do not torque.

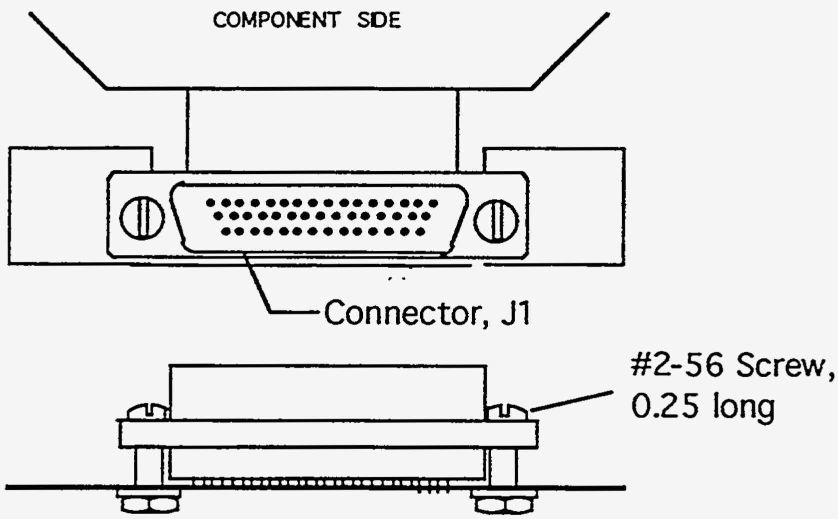


Figure 7.

7.24 Trim the leads of J1 such that they extend thru the printed wiring board by 0.020 to 0.040 inch.

7.25 Verify that the bottom surface of the flange of J1 is 0.257 ± .005 inch from the surface of the printed wiring board at both ends of the connector. Record the spacing both here and in the work sheet section of the assembly log.

J1 Bottom Surface distance from PWB: .261

J1 Bottom Surface distance from PWB: .261

Operator: H. R. Oper #9

Operator or QA Stamp

7.25 Trim the leads of J1 such that they extend thru the printed wiring board by 0.020 to 0.040 inch.

7.26 Verify that the bottom surface of the flange of J1 is 0.257 ± .005 inch from the surface of the printed wiring board at both ends of the connector. Record the spacing both here and in the work sheet section of the assembly log.

J1 Bottom Surface distance from PWB: .261 from old page 18

J1 Bottom Surface distance from PWB: .261

Operator: ______ Operator or QA Stamp

7.27 Solder the leads of J1 to the printed wiring board.

7.28 Installation of item 61, T1, thermistor will be done after completion of engineering evaluation.

7.29 Installation of items listed in table 8 below will be done after engineering evaluation.

Item	Qty	Designator	Description	Case
43	2	R49,R128	100 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/1000hr	RM1206

Table 8.

7.30 Clean and inspect all solder joints per MIL-STD-2000. Rework any substandard solder joints. Record inspection both here and in the certification log worksheets. from old page 19

Date: 7/22/93 Date Inspected QA: ______ QA Stamp

Note: Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected, tested or baked.

7.31 Install a connector saver on J1.

7.32 The printed wiring assembly now goes to engineering for evaluation.

7.26 Solder the leads of J1 to the printed wiring board.

7.27 Installation of item 61, T1, thermistor will be done after completion of engineering evaluation.

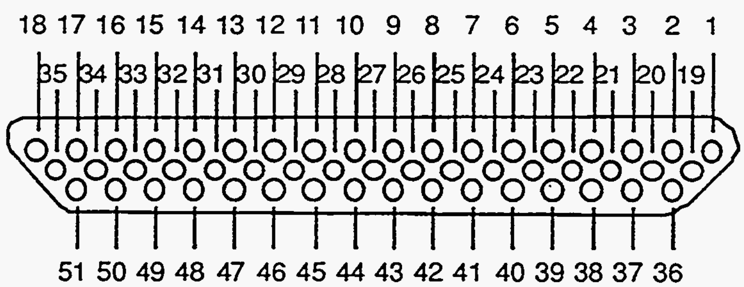
7.28 Clean and inspect all solder joints per MIL-STD-2000. Rework any substandard solder joints. Record inspection both here and ~~in the~~ certification log worksheets.

Date: 4/22/93 (Date Inspected) QA: QA #2 (QA Stamp)

Note: Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected, tested or baked.

7.29 Install a connector saver on J1.

7.30 Resistance measurements are to be made at J1 at this time. Make and record the measurements as indicated in table 8. **All readings must be greater than 1 KΩ, except where noted.** See figure 8 below for the location of pins in J1.



MDM 51 Contact Connector.
Face View of Socket Insert.

Figure 8.

8. Post Evaluation Assembly

8.1 The printed wiring board shall be baked at 130 ± 5 °C for a minimum of 6 hours prior to loading, per Polyimide Based Printed Wiring Board Conditioning Methods, C1-EE-029. Prior to baking the printed wiring board, verify that the oven to be used is in current calibration and has been verified by the QAG. The start and end times along with the start and end temperatures shall be recorded. The oven temperature profile shall be recorded, using a strip chart recorder, for the duration of the bake out. Record the date, assembly, serial number, assembly step and operator on the chart and insert in the certification section of the assembly log. The make, model and serial number of the oven used for bake out shall be recorded. Record both below and in the certification log work sheets by paragraph number.

Calibration and Certification Current, Initial: ________________ See old page 20
Operator or QA Stamp

Start Time: ________________ End Time: ________________

Start Temp: ________________ °C End Temp: ________________ °C

Oven Make: ________________ Oven Model: ________________

Oven Serial #: ________________

Date: ________________ Operator: ________________
Date Completed Operator or QA Stamp

Note: Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected, tested or baked.

8.2 Remove the jumper from outermost pads of R128 and C123 that was installed at step 7.19

8.3 Install the items listed in table 9 below.

Item	Qty	Designator	Description	Case
43	2	R49,R128	100 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/ 1000hr	RM1206

Table 9.

8. Post Evaluation Assembly

8.1 The printed wiring board shall be baked at 130 ± 5 °C for a minimum of 6 hours prior to loading, per Polyimide Based Printed Wiring Board Conditioning Methods, C1-EE-029. Prior to baking the printed wiring board, verify that the oven to be used is in current calibration and has been verified by the QAG. The start and end times along with the start and end temperatures shall be recorded. The oven temperature profile shall be recorded, using a strip chart recorder, for the duration of the bake out. Record the date, assembly, serial number, assembly step and operator on the chart and insert in the certification section of the assembly log. The make, model and serial number of the oven used for bake out shall be recorded. Record both below and in the certification log work sheets by paragraph number.

Board was not baked out. as [illegible] out. 3

Calibration and Certification Current, Initial: ____________________
Operator or QA Stamp

Start Time: ____________________ End Time: ____________________

Start Temp: ____________________ °C End Temp: ____________________ °C

Oven Make: ____________________ Oven Model: ____________________

Oven Serial #: ____________________

Date: ____________________ Operator: ____________________
Date Completed Operator or QA Stamp

Note: Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected, tested or baked.

8.2 Remove the jumper from outermost pads of R128 and C123 that was installed at step 7.19

8.3 Install the items listed in table 9 below.

Item	Qty	Designator	Description	Case
43	2	R49,R128	100 Ω, 1%, 1/4 Watt, 100 ppm, FR=0.01%/1000hr	RM1206

Table 9.

8.4 Clean and inspect all solder joints per MIL-STD-2000. Rework any substandard solder joints. Record inspection both here and in the certification log worksheets.

see old page 21

Date: 5-7-93 QA: ______________
Date Inspected QA Stamp

8.5 The printed wiring assembly now goes to engineering for additional evaluation.

8.4 Clean and inspect all solder joints per MIL-STD-2000. Rework any substandard solder joints. Record inspection both here and in the certification log worksheets. from work sheets item 96

Date: 5/7/93 QA: QA #1
Date Inspected QA Stamp

8.5 The printed wiring assembly now goes to engineering for additional evaluation.

8.6 The printed wiring board shall be baked at 130 ± 5 °C for a minimum of 6 hours prior to loading, per Polyimide Based Printed Wiring Board Conditioning Methods, C1-EE-029. Prior to baking the printed wiring board, verify that the oven to be used is in current calibration and has been verified by the QAG. The start and end times along with the start and end temperatures shall be recorded. The oven temperature profile shall be recorded, using a strip chart recorder, for the duration of the bake out. Record the date, assembly, serial number, assembly step and operator on the chart and insert in the certification section of the assembly log. The make, model and serial number of the oven used for bake out shall be recorded. Record both below and in the certification log work sheets by paragraph number.

see old page 22

Calibration and Certification Current, Initial: ____________
Operator or QA Stamp

Start Time: 6:30 p.m End Time: 12:30 a.m.

Start Temp: 95 °C End Temp: 95 °C

Oven Make: Versa Tem II Oven Model: THJR

Oven Serial #: 12664-1

Date: 5/17/93 Operator: ____________
Date Completed Operator or QA Stamp

Note: Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected, tested or baked.

8.7 Trim and form the leads of TR1 and TR2 as shown in figure 10 below.

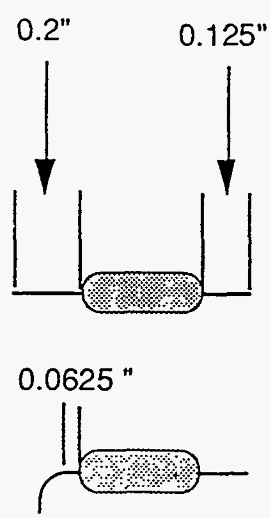


Figure 10.

8.6 The printed wiring board shall be baked at 130 ± 5 °C for a minimum of 6 hours prior to loading, per Polyimide Based Printed Wiring Board Conditioning Methods, C1-EE-029. Prior to baking the printed wiring board, verify that the oven to be used is in current calibration and has been verified by the QAG. The start and end times along with the start and end temperatures shall be recorded. The oven temperature profile shall be recorded, using a strip chart recorder, for the duration of the bake out. Record the date, assembly, serial number, assembly step and operator on the chart and insert in the certification section of the assembly log. The make, model and serial number of the oven used for bake out shall be recorded. Record both below and in the certification log work sheets by paragraph number.

Calibration and Certification Current, Initial: QA #2
Operator or QA Stamp

Start Time: ~~45~~ 6:30 PM End Time: ~~95~~ 12:30 A.M

Start Temp: 95 °C End Temp: 95 °C

Oven Make: Versa Tem II Oven Model: THJR

Oven Serial #: 12664-1

Date: 5/17/93 Operator: QA #2
Date Completed Operator or QA Stamp

Note: Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected, tested or baked.

8.7 Trim and form the leads of TR1 and TR2 as shown in figure 10 below.

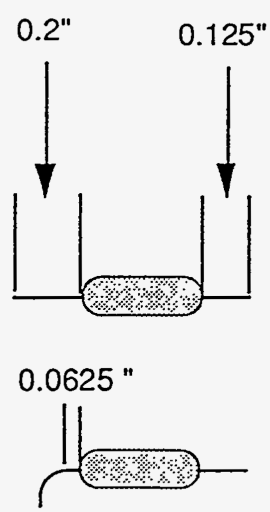


Figure 10.

8.8 Place, **do not solder at this point,** TR1 and TR2 on the secondary side of the board as shown in figure 11 below.

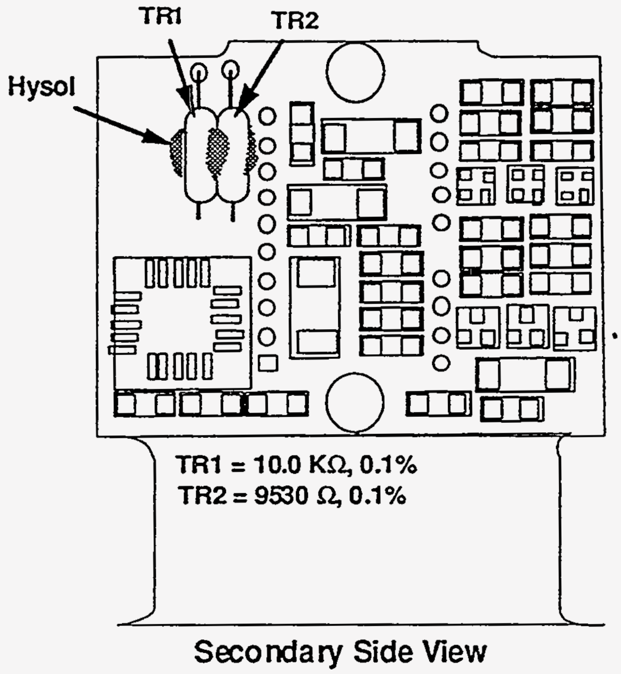


Figure 11.

8.9 Bond TR1 and TR2 to the printed wiring board as shown in figure 11 using EA 934 (reference, Eng. Note C1-S0-005). Bake for 30 minutes at 60 °C.

8.10 Identify the leads of item 61, T1, thermistor. Lead L1 is the longest lead, L4 is the shortest and L2/L3 is in between. Verify the lead identity by making resistance measurements as shown in figure 12.

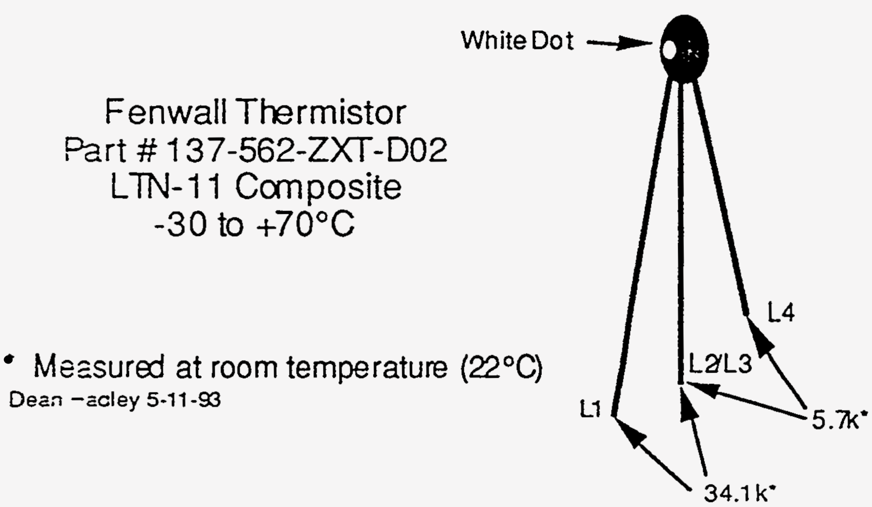


Figure 12.

8.11 Using #28 wire wrap wire insulation, insulate lead L4 and L1 to a length of 0.75 inch. Insulate leads L2/L3 to a length of 1.5 inch. Use a different color insulation for each lead.

8.12 Insert the lead for L4, from the primary side, through the hole indicated in figure 13. The lead from TR2 is also in this hole. Allow 0.75 inch of lead length between the printed wiring board and the body of the thermistor. See figure 14 for detail.

8.13 Insert the lead for L1, from the primary side, through the hole indicated in figure 13. The lead from TR1 is also in this hole. Allow 0.75 inch of lead length between the printed wiring board and the body of the thermistor. See figure 14 for detail.

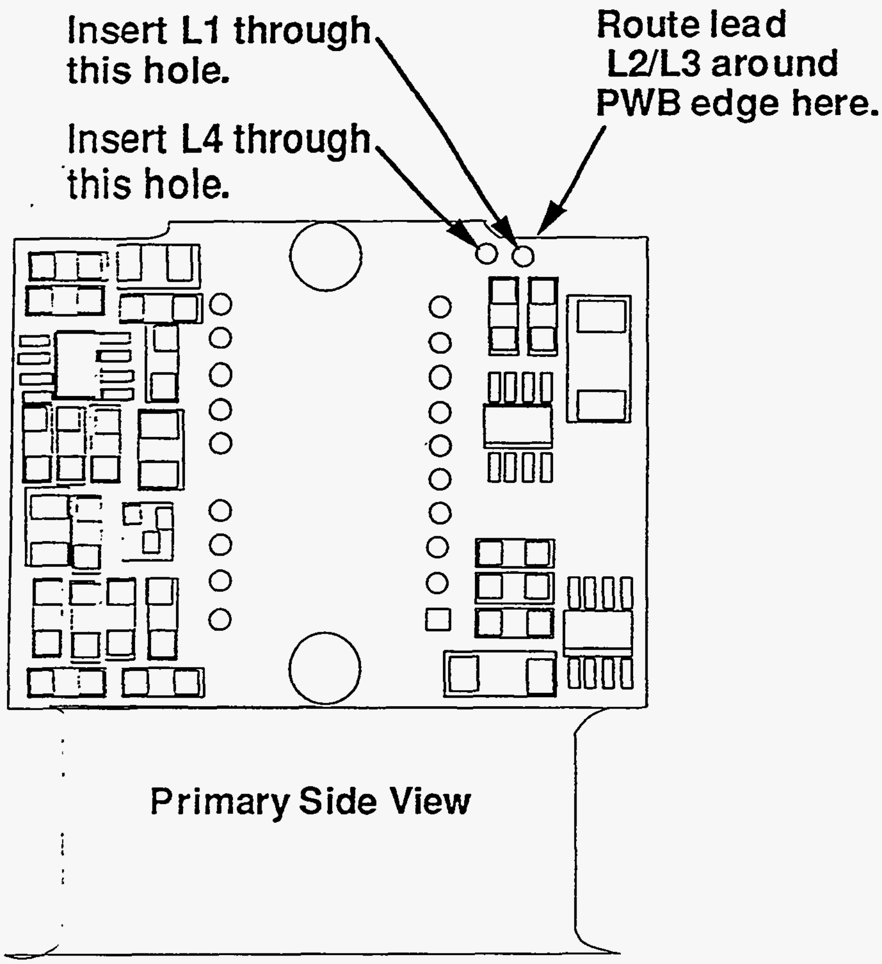


Figure 13.

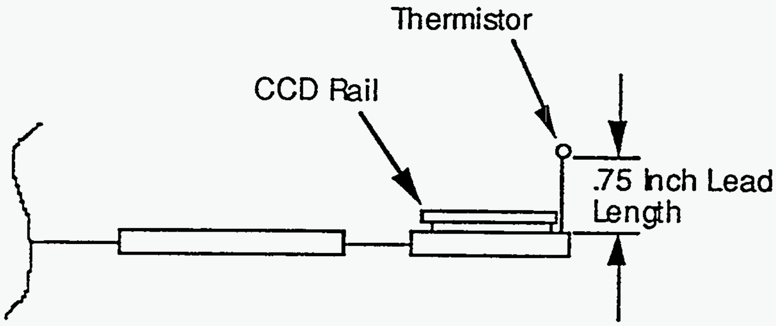


Figure 14.

8.14 Trim L4 to the correct length and solder it along with TR2. **Do not trim the lead** L1.

8.15 **Without trimming the lead,** solder L1 and TR1.

8.16 Route lead L2/L3 of T1 around the edge of the printed wiring board and to TR1 as shown in figures 13 and 15. Route lead L1 to TR2 as shown in figure 15.

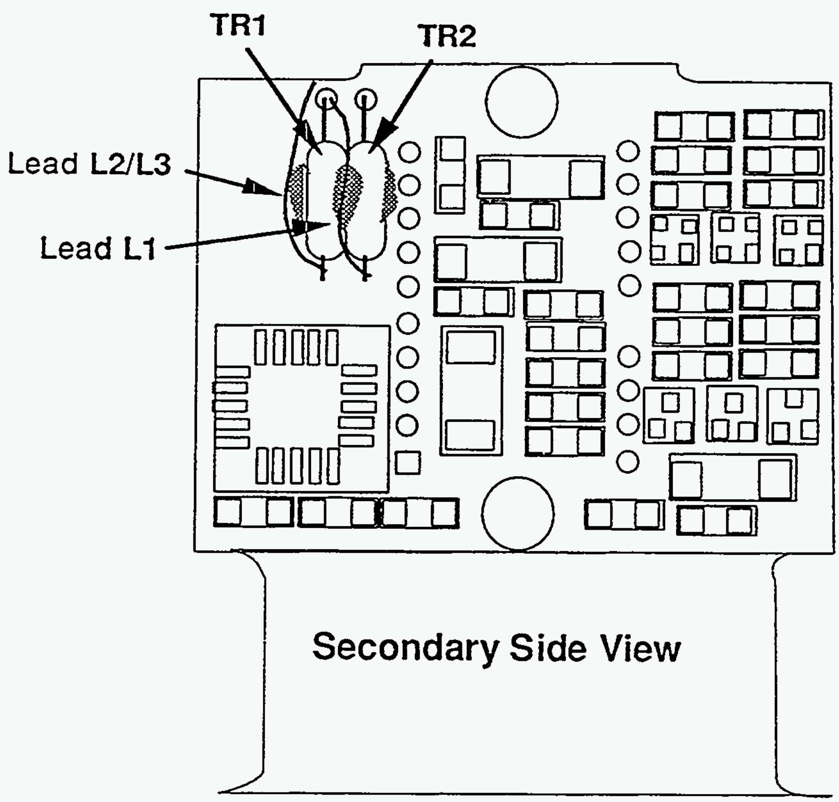


Figure 15.

8.17 Dress the thermistor wires around the end of the CCD rail as shown in figure 16 below.

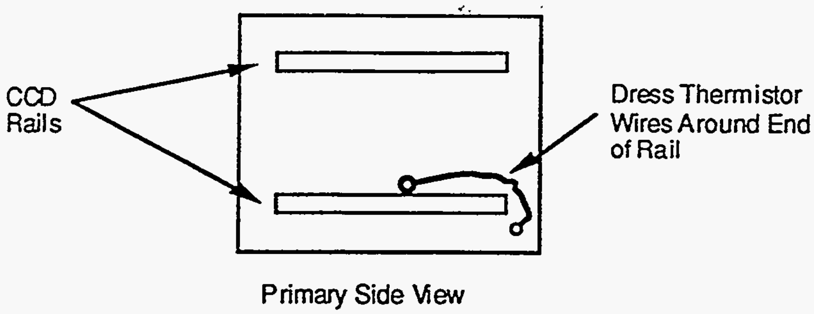


Figure 16.

8.18 Solder the leads of the thermistor to the leads of TR1 and TR2 as shown in figure 15. The leads of T1 must be wrapped at least 3 times around the lead of TR1 or TR2. Wrap the leads in the middle of the resistor lead.

8.19 Clean and inspect all solder joints per MIL-STD-2000. Rework any substandard solder joints. Record inspection both here and in the certification log worksheets.

Date: 20 May 93 QA: [QA stamp]
Date Inspected QA Stamp

8.20 Stake the thermistor wires, using EA 934 (reference, Eng. Note C1-S0-005), on the secondary side of the printed wiring board as shown in figure 17. Keep the staking on the edge of the printed wiring board as thin a practical.

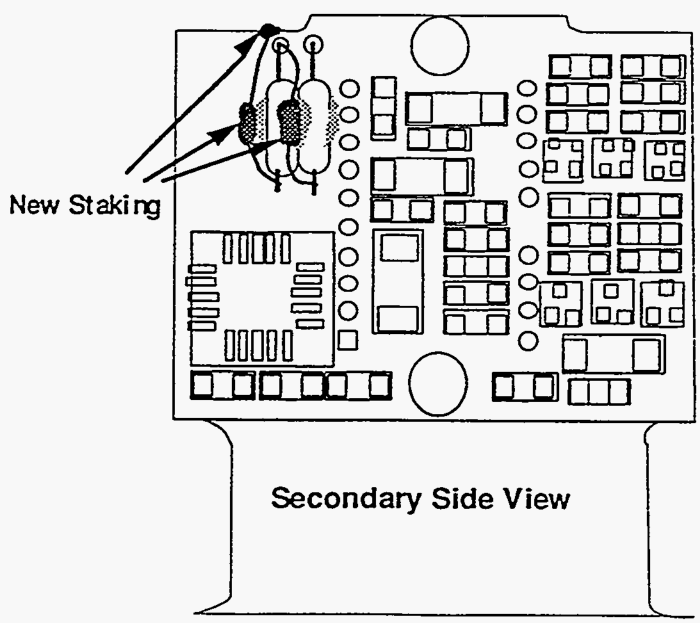


Figure 17.

8.21 Stake the connector standoff nuts and any other items indicated by Quality Assurance. Bake for 30 minutes @ 60 °C.

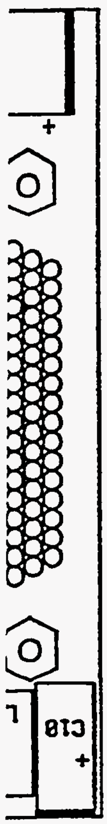
8.22 Inspect all staking operations. Record inspection both here and in the certification log worksheets.

Date: 20 May 93 (Date Inspected) QA: ______ (QA Stamp)

Note: Printed wiring boards are to be stored in an airtight, antistatic bag with a desiccant at all times the board is not being loaded, cleaned, inspected, tested or baked.

Assembly Drawings

6 MAX)



APPROVED

Project Manager

DATE

N	JARDON ENG.	04/07/93	LAWRENCE LIVERMORE NATIONAL LABORATORY
ED			
	G. ZARRAGA	04/07/93	PCB, ASSEMBLY- CAMERA (ACTEL) W/GAIN AND OFFSET CONTROL
APPROVED BY			
	J. KORDES	04/07/93	
	D. NIELSEN	04/07/93	SIZE — IDENT NO. LEA92-3128-03 — REV 0A
NEXT USING DRAWING			SCALE 2/1 — SHEET 1 OF 1

B

A

2

1

Appendix H.2.5

Certificates of Conformance

3.6 Pre-Test Operations

CAUTION
ESD SENSITIVE HARDWARE. HANDLE PER MIL-STD-1686 Class 1

X (1) Assure readiness to test, including the following items:

(a) Visual examination of the test item and its interfaces, including any special test instrumentation .

(b) Calibration is current for measuring instruments

(c) Proper edition of the procedure, and QA approval of any unincorporated redlines.

(d) Notification of QA of the time that testing will begin.

X (2) Record the "Occasion for Test" on all Data Sheets.

X (3) On the applicable data sheets, record the required information for measuring equipment to be used in the test. Verify that all such equipment bears current calibration stickers, and that calibration will not expire prior to the end of the test.

X (4) Have completed Actel Camera Array Test Board Certification C1-EE-033.

X (5) Solicit and obtain the QA Inspector's "OK to Continue."

Startracker # [illegible] C1-C10

Test Conductor Darren Weber Date 5/3/93

STID PPN 4/20/93

Functions to Be tested

1. Sasi Functions

Check bits can be set and cleared and read back.

Name: ______________________ Initials: Oper #10 Date 5/3/93

2. Double Correlated Sampling

TP14 is OL2
TP15 is ORfet
TP16 is OR

Name: ______________________ Initials: Oper #10 Date 5/3/93

3. Precision Integration mode Check and Frame Enable
{frame xfer of UV-vis arrays}

TP9 SM1
TP10 SM0
TP11 EOL
TP3 VSync {frame enable}
~~TP13~~ VTC
TP12

Name: ______________________ Initials: Oper #10 Date 5/3/93

4. Test Initialization

TP8 T2
TP7 Init

Name: ______________________ Initials: Oper #10 Date 5/3/93

DATA is to go in certification log of camera that array is going into.

3.7 TEST

Test Start Date: 5/3/93 Test Completion Date: 5/3/93

Equipment Used	S/N	Calibration In-date
TDS 540	B023760	10/1/93
Mac 2X	Doe#5251672	

Enter Name of LabView programs to Use

Name	Date Created	Date Modified
Actel Test Program	4/29/93	5/3/93

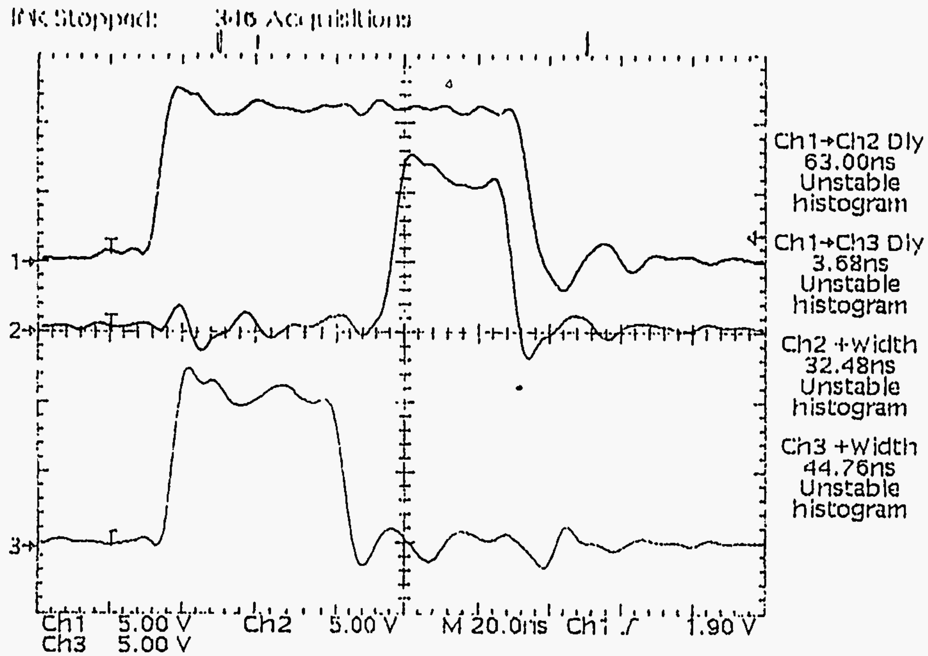
NOTES:

Test Conductors:

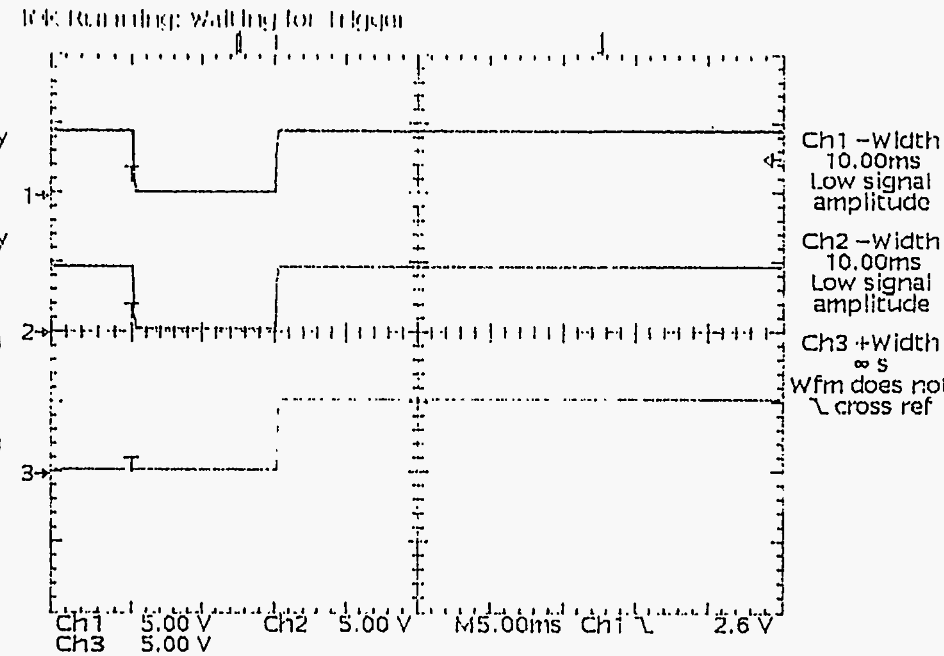
Name: [illegible] Initials: DPN Date 5/3/93

Name: ______ Initials: ____ Date ______

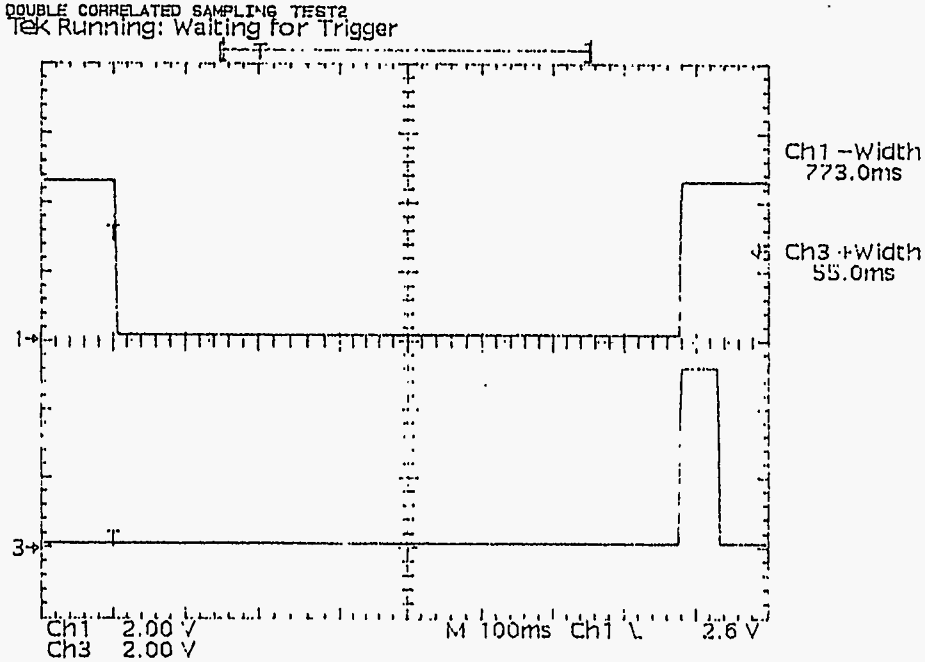
5/3/93



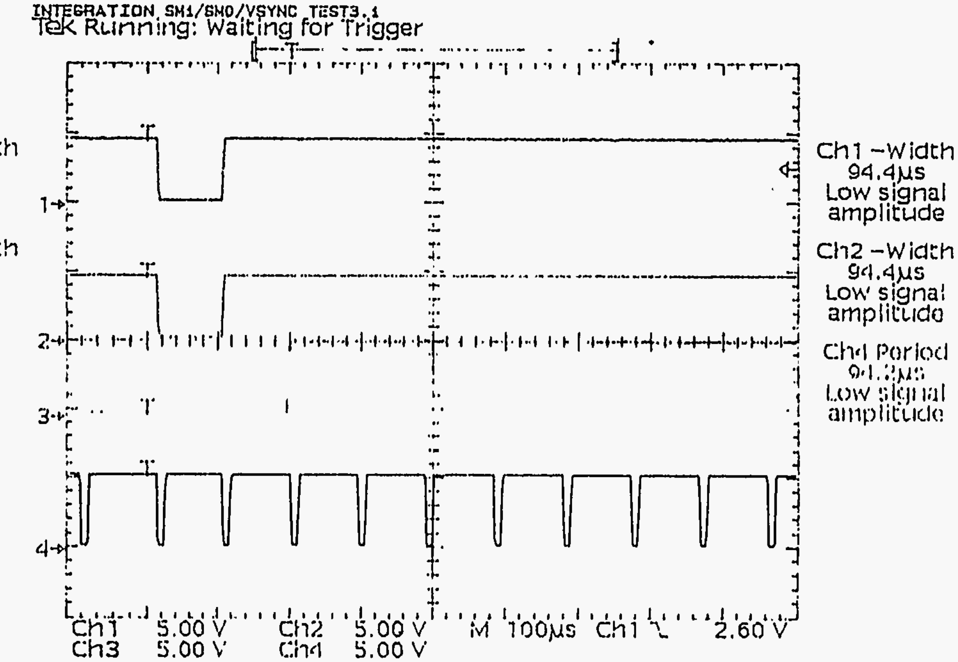
DOUBLE CORRELATED SAMPLING TEST2



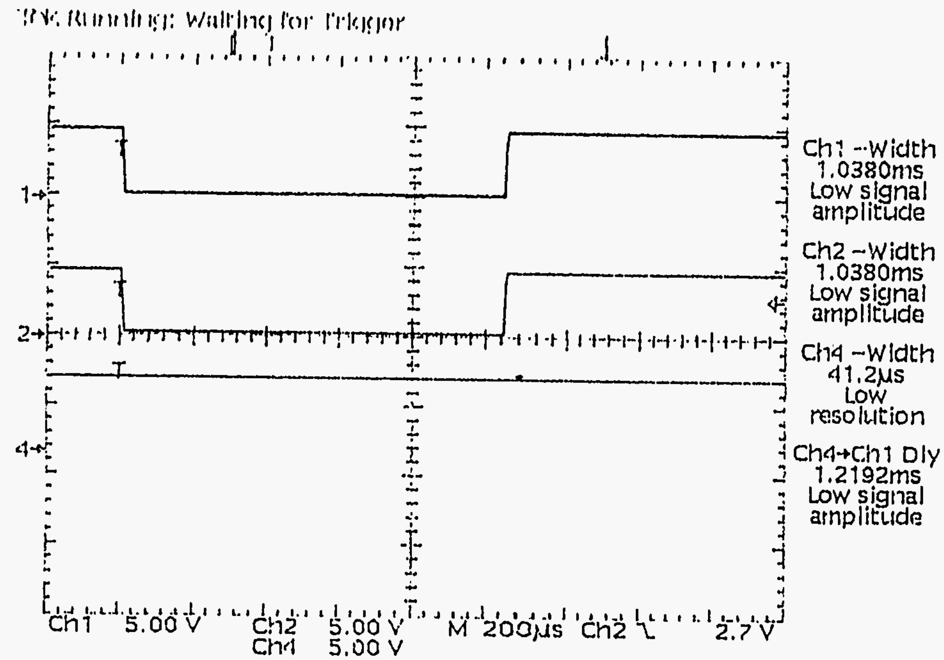
INTEGRATION SM1/SM0/VSYNC TEST3.1



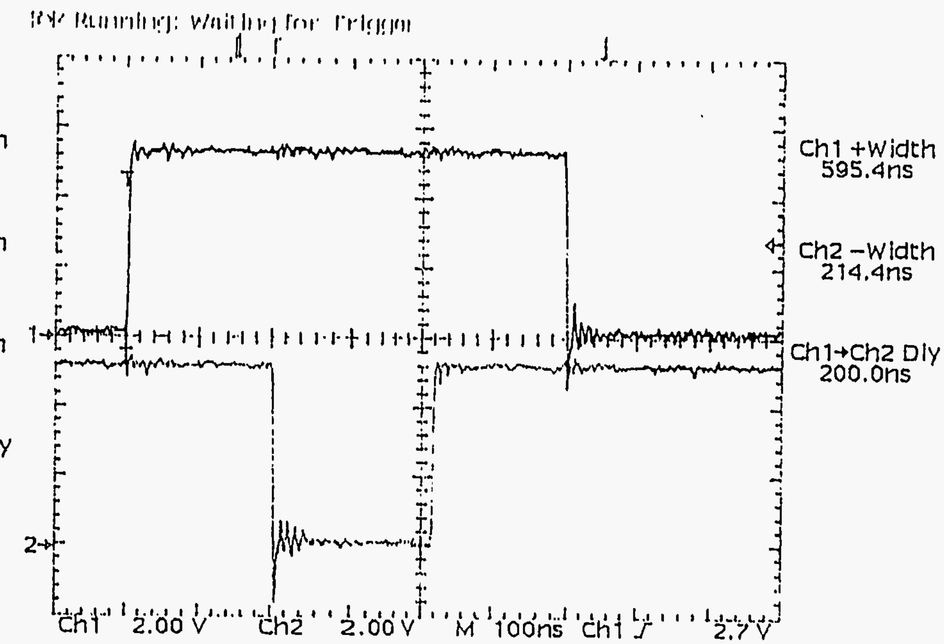
INTEGRATION SM1/VSYNC TEST3.2



INTEGRATION SM1/SM0/VSYNC/EOL TEST3.3



INTEGRATION SM1/SMO/VSYNC TEST3.4



init/t2 TEST4

ACTEL CAMERA ARRAY TEST

PROGRAM OF ARRAY AND DATE CODE
.1d
4-20-93

TESTER NAME DARRON NIELSEN

5/3/93
20:59
SASI BIT TEST 1
SASI BIT TEST 1 PASSED

5/3/93
20:59

DOUBLE CORRELATED SAMPLING TEST2
DOUBLE CORRELATED SAMPLING TEST 2 PASSED
CH1 -> CH2 DELAY
6.30E-8s
CH1 -> CH3 DELAY
3.68E-9s
CH2 +WIDTH
3.25E-8s
CH3 +WIDTH
4.48E-8s
CH1 +WIDTH
1.00E-7s

5/3/93
21:04

INTEGRATION SM1/SM0 VSYNC TEST3.1
PASSED
PARM ID 0 9
PARM ID 1 1
PARM ID 2 6A
PARM ID 3 0
PARM ID 5 1D
CH1 -WIDTH
1.00E-2s
CH2 -WIDTH

1.00E-2s
CH3 +WIDTH
9.90E37s

5/3/93
21:07

INTEGRATION SM1/VSYNC TEST3.2
PASSED
PARM ID 0 9
PARM ID 1 1
PARM ID 2 FF
PARM ID 3 1F
PARM ID 5 1D
CH1 -WIDTH
7.73E-1s
CH3 +WIDTH
5.50E-2s

5/3/93
21:09

INTEGRATION SM1/SMO/VSYNC/EOL TEST3.3
PASSED
PARM ID 0 9
PARM ID 1 1
PARM ID 2 1
PARM ID 3 0
PARM ID 5 1D
CH1 -WIDTH
9.90E37s
CH2 +WIDTH
9.90E37s
CH4 PERIOD
9.90E37s

5/3/93
21:13

INTEGRATION SM1/SM0/VSYNC TEST3.4
PASSED
PARM ID 0 9
PARM ID 1 1

PARM ID 2 B
PARM ID 3 0
PARM ID 5 1D
.H1 -WIDTH
1.04E-3s
CH2 -WIDTH
1.04E-3s
CH4 -WIDTH
4.12E-5s
/CH4 -> /CH1 delay
1.22E-3s

5/3/93
21:17

init/t2 TEST4
PASSED
CH1 -WIDTH
5.95E-7s
CH2 -WIDTH
2.14E-7s

SPRAGUE
CONCORD, NEW HAMPSHIRE

PQP# 37
7/15/92

CUSTOMER NAME Capstone Electronics DATE 1-8-93

CUSTOMER ORDER # 6X12344000 LOT#/DATE CODE A3607-1 / 9302T

CUSTOMER PART # CWR06FH475KC SPRAGUE M.O. A5397401

AMOUNT SHIPPED 275

SUMMARY OF TEST DATA
MIL-C-55365C
GROUP A INSPECTION DATA (Weibull) C

SUBGROUP I (100%)	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Weibull Life	4.7.17	100%	F/R= .0051	N/A
SUBGROUP II				
DC Leakage	4.7.4	PPM	0	0
Capacitance	4.7.5	Sampling	0	0
Dissipation Factor	4.7.6		0	0
ESR (when applicable)	4.7.10		0	0
Mechanical Exam	4.7.2		0	0
SUBGROUP III				
Visual Exam	4.7.2	13	0	0
SUBGROUP IV				
Stability at Low & High Temperature	4.7.12	13	0	0
SUBGROUP V				
Solderability **	4.7.15	13	0	0

GROUP C INSPECTION DATA

SUBGROUP I	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Vibration, High Frequency	4.7.7	12		
Thermal Shook	4.7.8			
SUBGROUP II				1
Resistance To Solder Heat	4.7.9	18		
Moisture Resistance	4.7.11			
SUBGROUP III				
Life (2000 hrs. @+125oC)	4.7.14	24		
SUBGROUP V				
Resistance to Solvents (when applicable)	4.7.16	N/A		0

NOTE: Capacitors furnished against the applicable specification and as represented by this test data meet all requirements.

Certified by: Jesse Williams
SPRAGUE
QAR FOREMAN

** N/A to gold plated termination finishes.

SPRAGUE
CONCORD, NEW HAMPSHIRE

PQP# 37
7/15/92

CUSTOMER NAME Capstone Electronics Crp DATE 12/31/92
CUSTOMER ORDER # 6X12344000 LOT#/DATE CODE A3628-1 / 9301T
CUSTOMER PART # CWR06HH226KC SPRAGUE M.O. A53974-03
AMOUNT SHIPPED 125

SUMMARY OF TEST DATA
MIL-C-55365C
GROUP A INSPECTION DATA (Weibull)

SUBGROUP I (100%)	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Weibull Life	4.7.17	100%	F/R= .0001	N/A
SUBGROUP II				
DC Leakage	4.7.4	PPM	0	0
Capacitance	4.7.5	Sampling	0	0
Dissipation Factor	4.7.6		0	0
ESR (when applicable)	4.7.10		0	0
Mechanical Exam	4.7.2		0	0
SUBGROUP III				
Visual Exam	4.7.2	13	0	0
SUBGROUP IV				
Stability at Low & High Temperature	4.7.12	13	0	0
SUBGROUP V				
Solderability **	4.7.15	13	0	0

GROUP C INSPECTION DATA

SUBGROUP I	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Vibration, High Frequency	4.7.7	12		
Thermal Shock	4.7.8			
SUBGROUP II				1
Resistance To Solder Heat	4.7.9	18		
Moisture Resistance	4.7.11			
SUBGROUP III				
Life (2000 hrs. @+125oC)	4.7.14	24		
SUBGROUP V				
Resistance to Solvents (when applicable)	4.7.16	N/A		0

NOTE: Capacitors furnished against the applicable specification and as represented by this test data meet all requirements.

Certified by: Jesse Williams
SPRAGUE
QAR FOREMAN

** N/A to gold plated termination finishes.

SPRAGUE
CONCORD, NEW HAMPSHIRE

PQP# 57
7/15/92

CUSTOMER NAME Capstone Electronics
DATE 3/4/93
CUSTOMER ORDER # 6X12344000
LOT#/DATE CODE K5873-1 / 9309T
CUSTOMER PART # CWR06FH685KC
SPRAGUE M.O. A5397402
AMOUNT SHIPPED 175

SUMMARY OF TEST DATA
MIL-C-55365C
GROUP A INSPECTION DATA (Weibull) C

SUBGROUP I (100%)	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Weibull Life	4.7.17	100%	F/R= .0004	N/A
SUBGROUP II				
DC Leakage	4.7.4	PPM	0	0
Capacitance	4.7.5	Sampling	0	0
Dissipation Factor	4.7.6		0	0
ESR (when applicable)	4.7.10		0	0
Mechanical Exam	4.7.2		0	0
SUBGROUP III				
Visual Exam	4.7.2	13	0	0
SUBGROUP IV				
Stability at Low & High Temperature	4.7.12	13	0	0
SUBGROUP V				
Solderability **	4.7.15	13	0	0

GROUP C INSPECTION DATA

SUBGROUP I				
Vibration, High Frequency	4.7.7	12		
Thermal Shock	4.7.8			
SUBGROUP II				1
Resistance To Solder Heat	4.7.9	18		
Moisture Resistance	4.7.11			
SUBGROUP III				
Life (2000 hrs. @+125oC)	4.7.14	24		
SUBGROUP V				
Resistance to Solvents (when applicable)	4.7.16	N/A		0

NOTE: Capacitors furnished against the applicable specification and as represented by this test data meet all requirements.

Certified by: Jesse Williams
SPRAGUE
QAR FOREMAN

** N/A to gold plated termination finishes.

SPRAGUE Concord, NH 03301

70 Pembroke Rd.
Concord, [illegible] 03301

SHIP DATE 03/04/93

CUSTOMER PO # [illegible]

SALES ORDER # [illegible]

CAPSTONE ELECTRONICS CORP
25 HUB DRIVE
MELVILLE, NY 11747

SHIP TO

[illegible]
[illegible] STREET
[illegible], CO [illegible]

CARTONS	WEIGHT	CHARGES

SHIP VIA		TRACKER NO.
1	1	

PARCEL SERVICE

CUSTOMER PART

SPRAGUE PART
CWR06FH685KC MIL

010E8

QTY. ORDERED	QTY. SHIPPED	QTY. BACK ORD.
175	175	

REF: QUOTE #48177
C OF C CERTS REQUIRED

SPRAGUE
CONCORD, NEW HAMPSHIRE

PQP# 57
7/15/92

CUSTOMER NAME Capstone Electronics
DATE 3/4/93
CUSTOMER ORDER # 6X12344000
LOT#/DATE CODE K5873-1 /9309T
CUSTOMER PART # CWR06FH685KC
SPRAGUE M.O. A5397462
AMOUNT SHIPPED 175

SUMMARY OF TEST DATA
MIL-C-55365C
GROUP A INSPECTION DATA (Weibull) C

SUBGROUP I (100%)	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Weibull Life	4.7.17	100% F/R=	.0004	N/A
SUBGROUP II				
DC Leakage	4.7.4	PPM	0	0
Capacitance	4.7.5	Sampling	0	0
Dissipation Factor	4.7.6		0	0
ESR (when applicable)	4.7.10		0	0
Mechanical Exam	4.7.2		0	0
SUBGROUP III				
Visual Exam	4.7.2	13	0	0
SUBGROUP IV				
Stability at Low & High Temperature	4.7.12	13	0	0
SUBGROUP V				
Solderability **	4.7.15	13	0	0

GROUP C INSPECTION DATA

	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
SUBGROUP I				
Vibration, High Frequency	4.7.7	12		
Thermal Shock	4.7.8			
SUBGROUP II				1
Resistance To Solder Heat	4.7.9	18		
Moisture Resistance	4.7.11			
SUBGROUP III				
Life (2000 hrs. @+125°C)	4.7.14	24		
SUBGROUP V				
Resistance to Solvents (when applicable)	4.7.18	N/A		0

NOTE: Capacitors furnished against the applicable specification and as represented by this test data meet all requirements.

Certified by: Jesse Williams
SPRAGUE
QAR FOREMAN

** N/A to gold plated termination finishes.

SPRAGUE
CONCORD, NEW HAMPSHIRE

PQP# 37
7/15/92

CUSTOMER NAME Capstone Electronics
DATE 1-22-93
CUSTOMER ORDER # 6X12344001
LOT#/DATE CODE K3161-1/9304
CUSTOMER PART # CWR06JH685KC
SPRAGUE M.O. A5397702
AMOUNT SHIPPED 200

SUMMARY OF TEST DATA
MIL-C-55365C
GROUP A INSPECTION DATA (Weibull) C

SUBGROUP I (100%)	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Weibull Life	4.7.17	100%	F/R= .005%	N/A
SUBGROUP II				
DC Leakage	4.7.4	PPM	0	0
Capacitance	4.7.5	Sampling	0	0
Dissipation Factor	4.7.6		0	0
ESR (when applicable)	4.7.10		0	0
Mechanical Exam	4.7.2		0	0
SUBGROUP III				
Visual Exam	4.7.2	13	0	0
SUBGROUP IV				
Stability at Low & High Temperature	4.7.12	13	0	0
SUBGROUP V				
Solderability **	4.7.15	13	0	0

GROUP C INSPECTION DATA

SUBGROUP I				
Vibration, High Frequency	4.7.7	12		
Thermal Shock	4.7.8			
SUBGROUP II				1
Resistance To Solder Heat	4.7.9	18		
Moisture Resistance	4.7.11			
SUBGROUP III				
Life (2000 hrs. @+125oC)	4.7.14	24		
SUBGROUP V				
Resistance to Solvents (when applicable)	4.7.16	N/A		0

NOTE: Capacitors furnished against the applicable specification and as represented by this test data meet all requirements.

Certified by: Jesse Williams
SPRAGUE
QAR FOREMAN

** N/A to gold plated termination finishes.

SPRAGUE 70 Pembroke Rd. Concord, NH 03301

Sprague Electric Co.
70 Pembroke Rd.
Concord, NH 03301

Pack Slip # 0089086

	CUSTOMER PO #	SALES ORDER #
SHIP DATE 01/22/93	6X12344001	953977 02 01

SOLD TO	SHIP TO
CAPSTONE ELECTRONICS CORP 25 HUB DRIVE MELVILLE, NY 11747	CAPSTONE ELECTRONICS CORP DISTRIBUTION WAREHOUSE DOCK 2 3254 FRASER STREET AURORA, CO 80011

CARTONS	WEIGHT	CHARGES	CUSTOMER PART

SHIP VIA		TRACKER NO.	SPRAGUE PART
1	1		CWR06JH685KC MIL

QTY. ORDERED	QTY. SHIPPED	QTY. BACK ORD.
UNITED PARCEL SERVICE		194D685X9020F8
200	200	

REF: QUOTE #48177
C OF C CERTS REQUIRED

SPRAQUE
CONCORD, NEW HAMPSHIRE

PQP# 37
7/15/92

CUSTOMER NAME Capstone Electronics
DATE 1-21-93
CUSTOMER ORDER # 6X12344001
LOT#/DATE CODE A3598-1 /9302T
CUSTOMER PART # CWR06JH226KC
SPRAGUE M.O. A5397701
AMOUNT SHIPPED 400

SUMMARY OF TEST DATA
MIL-C-55365C

GROUP A INSPECTION DATA (Weibull) C

SUBGROUP I (100%)	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Weibull Life	4.7.17	100%	F/R= .0005	·· N/A
SUBGROUP II				
DC Leakage	4.7.4	PPM	0	0
Capacitance	4.7.5	Sampling	0	0
Dissipation Factor	4.7.6		0	0
ESR (when applicable)	4.7.10		0	0
Mechanical Exam	4.7.2		0	0
SUBGROUP III				
Visual Exam	4.7.2	13	0	0
SUBGROUP IV				
Stability at Low & High Temperature	4.7.12	13	0	0
SUBGROUP V				
Solderability ··	4.7.15	13	0	0

GROUP C INSPECTION DATA

SUBGROUP I	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Vibration, High Frequency	4.7.7	12		
Thermal Shock	4.7.8			
SUBGROUP II				1
Resistance To Solder Heat	4.7.9	18		
Moisture Resistance	4.7.11			
SUBGROUP III				
Life (2000 hrs. @+125oC)	4.7.14	24		
SUBGROUP V				
Resistance to Solvents (when applicable)	4.7.16	N/A		0

NOTE: Capacitors furnished against the applicable specification and as represented by this test data meet all requirements.

Certified by: Jesse Williams
SPRAGUE
QAR FOREMAN

·· N/A to gold plated termination finishes.

SPRAGUE
CONCORD, NEW HAMPSHIRE

PQP# 37
7/15/92

CUSTOMER NAME Capstone Electronics DATE 1-21-93

CUSTOMER ORDER # 6X12344001 LOT#/DATE CODE A1075-1/9301T

CUSTOMER PART # CWR06JH226KC SPRAGUE M.O. A539 7701

AMOUNT SHIPPED 12

SUMMARY OF TEST DATA
MIL-C-55365C

GROUP A INSPECTION DATA (Weibull) C

SUBGROUP I (100%)	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Weibull Life	4.7.17	100%	F/R= .0004	N/A
SUBGROUP II				
DC Leakage	4.7.4	PPM	0	0
Capacitance	4.7.5	Sampling	0	0
Dissipation Factor	4.7.6		0	0
ESR (when applicable)	4.7.10		0	0
Mechanical Exam	4.7.2		0	0
SUBGROUP III				
Visual Exam	4.7.2	13	0	0
SUBGROUP IV				
Stability at Low & High Temperature	4.7.12	13	0	0
SUBGROUP V				
Solderability **	4.7.15	13	0	0

GROUP C INSPECTION DATA

SUBGROUP I	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Vibration, High Frequency	4.7.7	12		
Thermal Shock	4.7.8			
SUBGROUP II				1
Resistance To Solder Heat	4.7.9	18		
Moisture Resistance	4.7.11			
SUBGROUP III				
Life (2000 hrs. @+125oC)	4.7.14	24		
SUBGROUP V				
Resistance to Solvents (when applicable)	4.7.16	N/A		0

NOTE: Capacitors furnished against the applicable specification and as represented by this test data meet all requirements.

Certified by: Jesse Williams
SPRAGUE
QAR FOREMAN

** N/A to gold plated termination finishes.

SPRAGUE ... Pembroke Rd.
Concord, NH 03301

Sprague Electric Co.
70 Pembroke Rd.
Concord, NH 03301

Pack Slip #
008899

SHIP DATE 01/21/93

CUSTOMER PO #
AY12344001

SALES ORDER #
0E3077 01 01

SOLD TO
CAPSTONE ELECTRONICS CORP
25 HUB DRIVE
MELVILLE, NY 11747

SHIP TO
CAPSTONE ELECTRONICS CORP
DISTRIBUTION WAREHOUSE
DOCK 2
3254 FRASER STREET
AURORA, CO 80011

CARTONS	WEIGHT	CHARGES	CUSTOMER PART

SHIP VIA		TRACKER NO.	SPRAGUE PART	
1	1		CWR06JH226KC	MIL

QTY. ORDERED	QTY. SHIPPED	QTY. BACK ORD.
UNITED PARCEL SERVICE		194D226X9020H8
412	412	

REF: QUOTE #48177
C OF C CERTS REQUIRED

9302

SPRAGUE
CONCORD, NEW HAMPSHIRE

PQP# 37
7/15/92

CUSTOMER NAME Capstone Electronics

DATE 1-29-93

CUSTOMER ORDER # 6X12344001

LOT#/DATE CODE K3571-1 / 9305 V

CUSTOMER PART # CWR06KH106KC

SPRAGUE M.O. A5397703

AMOUNT SHIPPED 225

SUMMARY OF TEST DATA
MIL-C-55365C
GROUP A INSPECTION DATA (Weibull) C

SUBGROUP I (100%)	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Weibull Life	4.7.17	100% F/R= .0017		N/A
SUBGROUP II				
DC Leakage	4.7.4	PPM	0	0
Capacitance	4.7.5	Sampling	0	0
Dissipation Factor	4.7.6		0	0
ESR (when applicable)	4.7.10		0	0
Mechanical Exam	4.7.2		0	0
SUBGROUP III				
Visual Exam	4.7.2	13	0	0
SUBGROUP IV				
Stability at Low & High Temperature	4.7.12	13	0	0
SUBGROUP V				
Solderability **	4.7.15	13	0	0

GROUP C INSPECTION DATA

SUBGROUP I	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Vibration, High Frequency	4.7.7	12		
Thermal Shock	4.7.8			
SUBGROUP II				1
Resistance To Solder Heat	4.7.9	18		
Moisture Resistance	4.7.11			
SUBGROUP III				
Life (2000 hrs. @+125oC)	4.7.14	24		
SUBGROUP V				
Resistance to Solvents (when applicable)	4.7.16	N/A		0

NOTE: Capacitors furnished against the applicable specification and as represented by this test data meet all requirements.

Certified by: Jesse Williams
SPRAGUE
QAR FOREMAN

** N/A to gold plated termination finishes.

CERTIFICATE OF COMPLIANCE

SPRAGUE ELECTRIC COMPANY
Solid Tantalum Capacitor Operations
Concord, N.H.

WE CERTIFY THAT THIS MATERIAL HAS BEEN MANUFACTURED AND TESTED TO CONFORM TO THE APPLICABLE SPECIFICATIONS AND/OR DRAWING. TEST REPORTS AND/OR TEST SUMMARY SHOWING CONFORMANCE ARE ON FILE FOR EXAMINATION IF REQUIRED.

SINCERELY YOURS,

Gordon E. Kent

SPRAGUE ELECTRIC COMPANY
CAR MANAGER

WITNESSES:

Grace Williams

SPRAGUE
CONCORD, NEW HAMPSHIRE

PQP# 57
7/15/92

CUSTOMER NAME Capstone Elect.

DATE 2/18/93

CUSTOMER ORDER # 6X12344002

LOT#/DATE CODE K5077-1 / 9305U

CUSTOMER PART # CWR06MH105KC

SPRAGUE M.O. A5397802

AMOUNT SHIPPED 270

SUMMARY OF TEST DATA
MIL-C-55365C

GROUP A INSPECTION DATA (Weibull) C

SUBGROUP I (100%)	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Weibull Life	4.7.17	100%	F/R= .0017	N/A
SUBGROUP II				
DC Leakage	4.7.4	PPM	0	0
Capacitance	4.7.5	Sampling	0	0
Dissipation Factor	4.7.6		0	0
ESR (when applicable)	4.7.10		0	0
Mechanical Exam	4.7.2		0	0
SUBGROUP III				
Visual Exam	4.7.2	13	0	0
SUBGROUP IV				
Stability at Low & High Temperature	4.7.12	13	0	0
SUBGROUP V				
Solderability **	4.7.15	13	0	0

GROUP C INSPECTION DATA

SUBGROUP I	REF. PARA.	AMOUNT TESTED	AMOUNT FAILED	ALLOWED FAILURES
Vibration, High Frequency;	4.7.7	12		
Thermal Shock	4.7.8			
SUBGROUP II				1
Resistance To Solder Heat	4.7.9	18		
Moisture Resistance	4.7.11			
SUBGROUP III				
Life (2000 hrs. @+125oC)	4.7.14	24		
SUBGROUP V				
Resistance to Solvents (when applicable)	4.7.16	N/A		0

NOTE: Capacitors furnished against the applicable specification and as represented by this test data meet all requirements.

Certified by: Jesse Williams
SPRAGUE
QAR FOREMAN

** N/A to gold plated termination finishes.

CAL CAP

CALIFORNIA CAPACITOR, INC.

CERTIFICATE OF COMPLIANCE

DATE: 1/25/93

PURCHASER: LAWRENCE LIVERMORE LABS

ORDER #: B231974

ITEM: #2 500pcs. CDR32BX333AKUS

#4 500PCS. CDR32BX103BKUS

THIS IS TO CERTIFY THAT THE MATERIALS, PROCESSES AND FINISHED PARTS USED IN THE MANUFACTURE OF THESE ITEMS WERE CONTROLLED AND TESTED IN ACCORDANCE WITH THE APPLICABLE SPECIFICATIONS.

OBJECTIVE QUALITY EVIDENCE AND SUBSTANTIATIVE TEST DATA IS ON FILE FOR EXAMINATION UPON REQUEST.

TIMOTHY D. BILYK

Timothy D. Bilyk

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 1
To KATHY	From TIM
Co. LLL	Co. CAL-CAP
Dept. ENG.	Phone # (408) 262-6000
Fax # 510) 423-4986	Fax # (408) 262-0272

CAL CAP **CALIFORNIA CAPACITOR, INC.**
1579 Centre Pointe Drive • Milpitas, CA 95035-6834
(408) 252-6000

CUSTOMER P/O NUMBER	INVOICE NUMBER
B231974	100400-01

BILL TO	SHIP TO
LAWRENCE LIVERMORE LABS PO BOX 5001/ACCT. DEPT. LIVERMORE, CA. 94550	LAWRENCE LIVERMORE LABS 7000 EAST AVE/RECV DEPT LIVERMORE, CA. 94550

COMPLETE [ ] PARTIAL [X] PHONE: 5104221100 EXT.: BUYER: KAY MINKLER

AREA	CUSTOMER CODE	SALESMAN	INVOICE DATE	F.O.B.	SHIPPED VIA
A13	A23999	ATB	01/13/93	SHIP	~~FED EX PRIORITY 1~~ UPS

LINE	FACT.	PART NUMBER/DESCRIPTION	QTY. BACK ORDER	QTY SHIPPED
4	AV1	CDR32BX103BKUS .01UF 100V DXA2 PRIORITY RATING CONTRACT#W-7405-ENG-48	6	500
SPECIFICATION INFORMATION: *PKG.MUST NOT BE OPENED BY LLNL REC. CONTENTS WILL				
		TOTAL UNITS SHIPPED:		500

B231974-01
1/14/93

PACKING SLIP

ALL CLAIMS MUST BE MADE IN WRITING WITHIN FIVE DAYS AFTER RECEIPT OF GOODS
RETURN NO GOODS WITHOUT OUR PREVIOUS WRITTEN AUTHORIZATION

EEN - SHP/RCRD, YELLOW - PACKING SLIP, WHITE - SALES

REC'D. ______________

ZEUS COMPONENTS, Inc.

100 MIDLAND AVE. • PORTCHESTER, NY 10573
PH: (914) 937-7400

military distribution specialists

Certificate of Conformance

and Procurement Traceability

ATTENTION: QUALITY ASSURANCE DEPARTMENT

DATE

CUSTOMER NAME AND ADDRESS	MANUFACTURER	ASSEMBLY CODE
LAWRENCE LIVERMORE LAB ACCTG DEPT PO BOX 5001 LIVERMORE CA	KEMET	

PART NUMBER	MIL SPEC	U M	QUANTITY	MIL-S-1
CDR32BP470BJUR		EA	100	

CUSTOMER PURCHASE ORDER #

B238472

CERTIFICATION TYPE: PER MIL-S-19500 / MILR / COMMERCIAL / PER MIL-M-38510 / PER MIL STD 883 / MILC

DATE CODE

9037

RETEST

EXPIRATION

The undersigned certifies that all articles included in each shipment under the above purchase order are in accordance with said purchase order and with all requirements, specifications and drawings referenced therein; and that records of inspection and test providing objective evidence of the foregoing are on file at this facility, or at the manufacturer's plant, and are available upon request. Certification that this shipment is a part of the shipment covered by the manufacturer's documentation.

AUTHORIZED QUALITY ASSURANCE INSPECTOR

WHEN CHECKED MANUFACTURER'S CERTIFICATE ATTACHED

NOTICE REGARDING RETURN ACCEPTANCE OF MATERIAL.

ZEUS cannot accept the return of this lot or any part of this lot which does not include the original or copies of this and other documents supplied with this shipment.

REV 56-20-89

KEMET ELECTRONICS CORPORATION
HIGHWAY 385 S. E.
GREENVILLE, SOUTH CAROLINA 29606
803/963-6300 - FAX: 803/963-6322 - TELEX: 570496 - TWX: 810/287-2536

33529674

ADDRESS REPLY TO:
P. O. BOX 5928
GREENVILLE, S. C. 29606

CERTIFICATE OF COMPLIANCE

TO : ZEUS SEMICAP, INC.

REF: PURCHASE ORDER NUMBER: 749137

WE HEREBY CERTIFY THAT THE CAPACITORS SUPPLIED TO THE ABOVE NAMED COMPANY AGAINST THE REFERENCED PURCHASE ORDER WERE MANUFACTURED IN ACCORDANCE WITH THAT PURCHASE ORDER AND ALL APPLICABLE DOCUMENTS.

KEMET PART NUMBER: C1206N470J1GRH7506

CUSTOMER PART NUMBER (IF APPLICABLE): C1206N470J1GRH7506

DATE/LOT CODE(S):

MILITARY PART NUMBER (IF APPLICABLE): CDR32BP470BJUR

MILITARY INSPECTION LOT NUMBER(S) (IF APPLICABLE): 9237LH

TOTAL QUANTITY SHIPPED: 150

INVOICE NUMBER: S2U0665 LINE: 104A

DEVIATION(S)/WAIVER(S) (IF APPLICABLE): ______

CERTIFIED BY: Mary May 1-13-93
KEMET QUALITY CONTROL/DATE

7506B (10/16/91)

Certificate of Compliance

To: University of California

Lawrence Livermore Lab

7000 East Ave.

Livermore, CA 94550

Date 10-9-92-

It is hereby certified that the products (Model numbers listed below) supplied to Lawrence Livermore Lab on Purchase Order No. B227575, are in conformance with all your purchase order requirements, including applicable government, your or other specifications and drawings, to the extent specified.

The required test and/or inspection reports resulting from compliance with applicable purchase order requirements are on file and available for review by your representative or government inspectors at any reasonable time.

ANALOG DEVICES, INC.

(97 pc) Refclcs

Authorized Signature
Andrew Spisak/ Office Manager

ANALOG DEVICES, INC.
ROUTE 1 INDUSTRIAL PARK • NORWOOD, MASSACHUSETTS 02062 • TEL: 617/329-4700

11683

Certificate of Compliance

To: University of California

Lawrence Livermore Lab

7000 East Ave.

Livermore, CA 94550

Date 10-9-92

It is hereby certified that the products (Model numbers listed below) supplied to Lawrence Livermore Lab on Purchase Order No. B227575, are in conformance with all your purchase order requirements, including applicable government, your or other specifications and drawings, to the extent specified.

The required test and/or inspection reports resulting from compliance with applicable purchase order requirements are on file and available for review by your representative or government inspectors at any reasonable time.

ANALOG DEVICES, INC.

(97 pc) Refclcs

Authorized Signature

Andrew Spisak/ Office Manager

ANALOG DEVICES, INC.

ROUTE 1 INDUSTRIAL PARK • NORWOOD, MASSACHUSETTS 02062 • TEL: 617/329-4700

Certificate of Compliance

To: University of California

Lawrence Livermore Lab

7000 East Ave.

Livermore, CA 94550

Date 10-9-92

It is hereby certified that the products (Model numbers listed below) supplied to Lawrence Livermore Lab on Purchase Order No. B227575, are in conformance with all your purchase order requirements, including applicable government, your or other specifications and drawings, to the extent specified.

The required test and/or inspection reports resulting from compliance with applicable purchase order requirements are on file and available for review by your representative or government inspectors at any reasonable time.

ANALOG DEVICES, INC.

(97 pc) Refclcs

Authorized Signature

Andrew Spisak/ Office Manager

ANALOG DEVICES, INC.

ROUTE 1 INDUSTRIAL PARK • NORWOOD, MASSACHUSETTS 02062 • TEL: 617/329-4700

MIN-E-CON

Q 0011

ACCEPTANCE DATA

CUSTOMER P.O.# B243053 M.E.C. JOB# 301093

CUSTOMER PART # ______ M.E.C. PART # M83513/04-G06N

LOT SIZE 32pcs DATE CODE OR LOT # 9308

CHARACTERISTIC	SAMPLE SIZE	PASS	FAIL	INSP. BY	NOTES
VISUAL	AQL 1.0	13	0	M 6	
DIMENSIONAL	AQL 1.0	13	0	M 6	
INSULATION RES.	AQL 1.0	13	0	M TEST 2	100 V. D. C. 5000 MEG
D.W.V.	AQL 1.0	13	0	M TEST 2	600/900 VRMS
CONTACT RESISTANCE	1.0 S-4	13	0	M TEST 2	
MATING/UNMATING FORCES	1.0 S-4	13	0	M TEST 2	31 LBS. 14 OZS MAX.

DATE. 2-25-93

MIN-E-CON

Q 0011

ACCEPTANCE DATA

CUSTOMER P.O.# B 231921 M.E.C. JOB# 210070

CUSTOMER PART # — M.E.C. PART # M83513/04-G06N

LOT SIZE 30 pcs DATE CODE OR LOT # 9245

CHARACTERISTIC	SAMPLE SIZE	PASS	FAIL	INSP. BY	NOTES
VISUAL	AQL 1.0	13	0	M 6	
DIMENSIONAL	AQL 1.0	13	0	M 6	
INSULATION RES.	AQL 1.0	13	0		100 V. D. C. 5000 MEG
D.W.V.	AQL 1.0	13	0		600/900 VRMS
CONTACT RESISTANCE	1.0 S-4	13	0		
MATING/UNMATING FORCES	1.0 S-4	13	0		31 LBS. 14 OZS MAX.

DATE 11-16-90

Certificate Of Compliance

It is hereby certified that the parts furnished on this Certificate Of Compliance have been manufactured in conformance with the requirements of all applicable drawings and specifications as defined by the purchase order.

Customer Part Number ______________________

Calogic Part Number SST 215

Purchase Order Number B238535

Lot # 90-0384

Quantity 150

Wafers(s) # ______________________

calogic CORPORATION

Quality Assurance

January 21, 1993

Date

FUTURE ELECTRONICS CORP.
41 MAIN STREET E
BOLTON, MASS. 01740
TEL. (508) 779-3000

SHIP TO LAWRENCE LIVERMORE LABS
7000 EAST AVENUE
LIVERMORE, CA
94550 (415) 422-1363

UPS SHIPPER NO
MA 376-9X6
PKG ID# 815977

93/01/12 12:40:02:69 4

5104234986;# 2

CUSTOMER ORDER NUMBER					
B238487	FEDX P1	1X10N30	1	01-12-93	815977

300	C85048 T20040 554040	1	02	MOR	FREIGHT CHARGE 2N7002TR:2N7002LT1:

9242
IT 2419703

PACKING SLIP SHOULD READ
GOVERNMENT OVERNIGHT
FEDX ACCT# [illegible]
BOX #1

PACKING SLIP COMPLETE

B238487 01
Joe Casey
1-13-93

			FUTURE ELECTRONICS CORP. 41 MAIN STREET BOLTON, MA 01740	PULLED BY	CHECKED BY
I 815977	L2900001	B238487		PT S-01/11/93	

IMPORTANT [illegible]

ITEMS ON BACK ORDER ARE TEMPORARILY OUT OF STOCK AND WILL BE SHIPPED UPON RECEIPT. NO CLAIMS ALLOWED UNLESS MADE WITHIN 5 DAYS OF RECEIPT OF GOODS. 2% INTEREST PER MONTH ON PAST DUE ACCOUNTS.

PACKING S[illegible] CUSTOMER COPY

Authorized Signature

SENT BY:Xerox Telecopier 7020 ; 1-22-93 ; 8:52AM ;

PEROSTOCK, ...
520 MERCURY DRIVE
SUNNYVALE, CA ...
PH:408 730-0300 FAX: ...

UPS SHIPPER # CA 9-65-148

SHIP VIA: UPS

order referenced below has been manufactured, tested, and/or inspected in accordance with the requirements of the applicable specifications.

No metallic mercury compounds are used in the process or in the parts furnished herein. Inspections and/or tests have been performed as applicable, on both a variable and GO-NO-GO basis, utilizing equipment in accordance with the requirements of MI-STD-45662.

Documentary evidence in the form of test and/or inspection reports are on file and are available upon request.

Quality Representative

SLIP	PACK DATE	CUSTOMER PO#
24901	09-18-92	B229231

See comments below.

IP TO: UCLLNL
7000 EAST AVENUE
LIVERMORE CA 94550

BILL TO: UNIV. CAL. LAWRENCE NAT.
P. O. BOX 5001
LIVERMORE CA 94550

DATE: 09-18-92 ... INSIDE: NCG OUTSIDE: NC2 WEIGHT: 39.36 Page 1 ...

E	BIN	PART NUMBER	APN	U/M	QTY SHIPPED
		CLC5... COM	154796	EA	22
		CLC4... COM	154099	EA	22
	80903	CLC503AJE COM	154673	EA	60

ackage must not be opened by ULNNL
Receiving
Static Sensitive Products Enclosed

DISCREPANCIES MUST BE REPORTED WITHIN 5 DAYS.

Requester will verify all contents

THOMSON COMPONENTS AND TUBES CORPORATION
THOMSON MILITARY AND SPACE COMPONENTS DIVISION

40G Commerce Way
Post Office Box 540
Totowa, New Jersey 07511
Telephone 201 812-9000
FAX 201-812-9050

CERTIFICATE OF CONFORMANCE
-QSC2-

TO: LLNL DATE: 10-13-92

7000 EAST AVE, LIVERMORE, CA 94550

(CUSTOMER'S NAME AND ADDRESS)

CUSTOMER P/O: B228341

TETD ORDER CONFIRMATION: CCD1038
SHIPPING DOCUMENT: 2L0102247

DEVICE TYPE: TH7990C
LOT SIZE: ______ SHIPPED QUANTITY: 20
LOT NUMBER: ______
DATE CODE: ______ REINSPECTION DATE: ______
GENERIC SPECIFICATION: 1988 CCD DATABOOK REV: ______
DETAIL SPECIFICATION: ______ REV: ______
SCREENING CLASS: ______

REMARKS:
OLD PART NUMBER : THX33501

THE UNDERSIGNED CERTIFY THAT THE PARTS LISTED UNDER YOUR PURCHASE ORDER SHOWN ABOVE ARE PART OF THE SHIPMENT COVERED BY THE MANUFACTURER'S CERTIFICATION ATTACHED, THAT ALL PRODUCTS ARE AS DESCRIBED ON THE CERTIFICATE, AND THAT PRODUCTS HAVE BEEN HANDLED IN ACCORDANCE WITH JEDEC PUBLICATION 108 & 109 WHEN IN POSSESSION OF ABOVE VENDOR.

DATE	ESD INSPECTOR	MILITARY APPROVAL (WHEN REQUESTED)
10-14-92	[signature] INSP. #3	

NOTE: WHEN REFERRING TO THESE PARTICULAR DEVICES, PLEASE MENTION THE FOLLOWING INSPECTION NUMBER:
2D10034/2L102247.

2/5

THOMSON COMPONENTS AND TUBES CORPORATION

THOMSON MILITARY AND SPACE COMPONENTS DIVISION

40G Commerce Way
Post Office Box 540
Totowa, New Jersey 07511
Telephone 201 812-9000
FAX 201-812-9050

CERTIFICATE OF CONFORMANCE
-QSC2-

TO: LLNL DATE: 10-13-92

7000 EAST AVE, LIVERMORE, CA 94550

(CUSTOMER'S NAME AND ADDRESS)

CUSTOMER P/O: B228341

TETD ORDER CONFIRMATION: CCD1038
SHIPPING DOCUMENT: 2L0102247

DEVICE TYPE: TH7990C
LOT SIZE: SHIPPED QUANTITY: 20
LOT NUMBER:
DATE CODE: REINSPECTION DATE:
GENERIC SPECIFICATION: 1988 CCD DATABOOK REV:
DETAIL SPECIFICATION: REV:
SCREENING CLASS:

REMARKS:
OLD PART NUMBER : THX33501

THE UNDERSIGNED CERTIFY THAT THE PARTS LISTED UNDER YOUR PURCHASE ORDER SHOWN ABOVE ARE PART OF THE SHIPMENT COVERED BY THE MANUFACTURER'S CERTIFICATION ATTACHED, THAT ALL PRODUCTS ARE AS DESCRIBED ON THE CERTIFICATE, AND THAT PRODUCTS HAVE BEEN HANDLED IN ACCORDANCE WITH JEDEC PUBLICATION 108 & 109 WHEN IN POSSESSION OF ABOVE VENDOR.

DATE	ESD INSPECTOR	MILITARY APPROVAL (WHEN REQUESTED)
10-14-92	INSP. #3	

NOTE: WHEN REFERRING TO THESE PARTICULAR DEVICES, PLEASE MENTION THE FOLLOWING INSPECTION NUMBER:
2D10034/2L102247.

Micro Power Systems

CERTIFICATE OF CONFORMANCE

TO: UC Lawrence Livermore Labs.
7000 EAST AVE.
Livermore CA. 94550

DATE: Sept. 30, 1992

SALES ORDER NO: 38676

PURCHASE ORDER NO: D3390689

CUSTOMER PART NO: MP7684 ATL/883

CUSTOMER DWG NO:

LOT NO: 7688084A1-3

MPS PART NO: 7684A-TL--883

QUANTITY: 50

COUNTRY OF ORIGIN: USA

DATE CODE: 2B 9226

LAST ELECTRICAL TEST DATE: 7/28/92

SELLER CERTIFIES THAT:

1. The parts furnished against this purchase order were produced in conformance with all contractually applicable specifications.

2. Data taken to characterize the final product under the above purchase order is available for examination by duly authorized personnel.

SELLER: MICRO POWER SYSTEMS, INC.

QUALITY REPRESENTATIVE: M. Haarlan

TITLE: QA Specialist

P.O. Box 54965, 3100 Alfred Street, Santa Clara 95094-0965
Telephone: (408) 727-5350 Fax: (408) 562-3605

Micro Power Systems

CERTIFICATE OF CONFORMANCE

TO: UC Lawrence Livermore Labs
7000 East Avenue
Livermore CA. 94550

DATE: Oct. 15, 1992

SALES ORDER NO: 38676

PURCHASE ORDER NO: D3390689

CUSTOMER PART NO: MP 7684 ATL/883

CUSTOMER DWG NO:

LOT NO: 7688084A1--1

MPS PART NO: 7684A-TL--883

QUANTITY: 10

COUNTRY OF ORIGIN: U.S.A

DATE CODE: 2B 9226

LAST ELECTRICAL TEST DATE: 10/9/92

SELLER CERTIFIES THAT:

1. The parts furnished against this purchase order were produced in conformance with all contractually applicable specifications.
2. Data taken to characterize the final product under the above purchase order is available for examination by duly authorized personnel.

SELLER: MICRO POWER SYSTEMS, INC.

QUALITY REPRESENTATIVE: M. Gaertan

TITLE: QA Specialist

P.O. Box 54965, 3100 Alfred Street, Santa Clara 95094-0965
Telephone: (408) 727-5350 Fax: (408) 562-3605

DOCUMENT NUMBER: RA-304	QUALIFICATION TEST DATA FLOW TRAVELER	7684A-TL--883 MANUFACTURING PRODUCT CODE
		QA REPORT #:
		DATE:
	Micro Power Systems	LOT #: 7688084A1-3
		DATE CODE: 2B9226
TEST PER 883 CLASS B M5005	PAGE 1 OF 1	

REV	ECN #	Originator	Date
0	0585		3/26/92

FLASH CONVERTERS GROUP A TEST DATA

CUSTOMER		P.O. NUMBER	
CUST P/N		SALES ORDER	
DRAWING #			

TESTS	LTPD	DEVICES SAMPLED	ACC#	IN	OUT	REJ #	PROC
SUBGROUP 1, +25°C STATIC TESTS	2	100		100	100	0	TO-032
SUBGROUP 2, +125°C STATIC TESTS	2	100		100	100	0	TO-032
SUBGROUP 3, -55°C STATIC TESTS	2	100		100	100	0	TO-032
SUBGROUP 7, +25°C FUNCTIONAL TESTS	2	100		100	100	0	TO-032

TESTING COMPLETED AND APPROVED

MA ACCEPT 79

Quality Assurance: [signature] Date: 7-28-92

STATIC SENSITIVE PRODUCT – OBSERVE PROCESS GP-006 AT ALL TIMES

Micro Power Systems

CERTIFICATE OF CONFORMANCE

TO: UC Lawrence Livermore Labs
7000 East Avenue
Livermore CA. 94550

DATE: Oct. 15, 1992

SALES ORDER NO: 38676

PURCHASE ORDER NO: D3390689

CUSTOMER PART NO: MP 7684 ATL/883

CUSTOMER DWG NO:

LOT NO: 7688084A1-4-

MPS PART NO: 7684A-TL--883

QUANTITY: 10

COUNTRY OF ORIGIN: USA

DATE CODE: 2B 9226

LAST ELECTRICAL TEST DATE: 10/9/92

SELLER CERTIFIES THAT:

1. The parts furnished against this purchase order were produced in conformance with all contractually applicable specifications.

2. Data taken to characterize the final product under the above purchase order is available for examination by duly authorized personnel.

SELLER: MICRO POWER SYSTEMS, INC.

QUALITY REPRESENTATIVE: M. Gaerber

TITLE: QA Specialist

P.O. Box 54965, 3100 Alfred Street, Santa Clara 95094-0965
Telephone: (408) 727-5350 Fax: (408) 562-3605

B229988

Micro Power Systems

CERTIFICATE OF CONFORMANCE

TO: UC Lawrence Livermore Labs.
7000 EAST AVE.
Livermore CA. 94550

DATE: Sept. 30, 1992

SALES ORDER NO: 38676

PURCHASE ORDER NO: D3390689

CUSTOMER PART NO: MP 7684 ATL /883

CUSTOMER DWG NO:

LOT NO: 7688084 A1-3

MPS PART NO: 7684 A - TL - -883

QUANTITY: 50

COUNTRY OF ORIGIN: USA

DATE CODE: 2B 9226

LAST ELECTRICAL TEST DATE: 7/28/92

uced in conformance

/e purchase order is

P.O. Box 54965, 3100 Alfred Street, Santa Clara 95094-0965
Telephone: (408) 727-5350 Fax: (408) 562-3605

ALL AMERICAN®

a quality electronics distributor
16085 N.W. 52ND AVENUE, MIAMI, FLORIDA 33014-9317

CERTIFICATE OF CONFORMANCE

CUSTOMER NAME UNIV. CALIF LIVERMORE
AND ADDRESS LIVERMORE NAT'L LABS
7000 EAST AVENUE, RECEIVING
LIVERMORE, CA 94550

ALL AMERICAN CERTIFIES THAT THE MATERIAL SUPPLIED ON YOUR PURCHASE ORDER
B8227573 IS DESIGNED TO MEET SPECIFICATIONS PER:

1) ☐ MIL-S-19500/ 2) ☐ MIL-M-38510 3) ☐ MIL-STD-883

4) ☐ DESC DRAWING NO 5) ☑ COMMERCIAL

QUANTITY 250

PART NUMBER TC4428 EOA

MANUFACTURER TEL

DATE CODE

DATE SHIPPED 10-6-92

INSPECTION DATE

ALL AMERICAN SEMICONDUCTOR CERTIFIES THAT ALL ARTICLES INCLUDED IN EACH SHIPMENT UNDER THE ABOVE PURCHASE ORDER(S) ARE MANUFACTURED IN ACCORDANCE WITH ALL MANUFACTURER'S AND/OR APPLICABLE MILITARY SPECIFICATIONS SO DESIGNATED ON SUBJECT PURCHASE ORDER. AND FURTHER CERTIFIES THAT THIS SHIPMENT IS A PART OF THE SHIPMENT COVERED BY THE MANUFACTURER'S DOCUMENTATION. TEST REPORTS FOR MATERIAL SUPPLIED ARE ON FILE, AND ARE AVAILABLE FOR EXAMINATION AT THE POINT OF MANUFACTURE.

[signature]
QUALITY CONTROL DESIGNEE

MANUFACTURER'S CERTIFICATE ENCLOSED ☐

ALL AMERICAN®

a quality electronics distributor
16085 N.W. 52ND AVENUE, MIAMI, FLORIDA 33014-9317

CERTIFICATE OF CONFORMANCE

CUSTOMER NAME UNIV. CALIF LIVERMORE
AND ADDRESS LIVERMORE NAT'L LABS
7000 EAST AVENUE, RECEIVING
LIVERMORE, CA 94550.

ALL AMERICAN CERTIFIES THAT THE MATERIAL SUPPLIED ON YOUR PURCHASE ORDER
B B227573 IS DESIGNED TO MEET SPECIFICATIONS PER:

1) ☐ MIL-S-19500/ ______ 2) ☐ MIL-M-38510 3) ☐ MIL-STD-883

4) ☐ DESC DRAWING NO ______ 5) ☑ COMMERCIAL

QUANTITY 250

PART NUMBER TC 4426 EOA

MANUFACTURER TEL

DATE CODE ______

DATE SHIPPED 10-6-92

INSPECTION DATE ______

ALL AMERICAN SEMICONDUCTOR CERTIFIES THAT ALL ARTICLES INCLUDED IN EACH SHIPMENT UNDER THE ABOVE PURCHASE ORDER(S) ARE MANUFACTURED IN ACCORDANCE WITH ALL MANUFACTURER'S AND/OR APPLICABLE MILITARY SPECIFICATIONS SO DESIGNATED ON SUBJECT PURCHASE ORDER. AND FURTHER CERTIFIES THAT THIS SHIPMENT IS A PART OF THE SHIPMENT COVERED BY THE MANUFACTURER'S DOCUMENTATION. TEST REPORTS FOR MATERIAL SUPPLIED ARE ON FILE, AND ARE AVAILABLE FOR EXAMINATION AT THE POINT OF MANUFACTURE.

H. Whyte
QUALITY CONTROL DESIGNEE

MANUFACTURER'S CERTIFICATE ENCLOSED ☐

PENSTOCK, INC.
520 MERCURY DRIVE
SUNNYVALE, CA 94086-4018
PH:408-730-0300 FAX:408-730-4782

UPS SHIPPER # CA 9-65-148

SHIP VIA: UPS

PACKSLIP	PACK DATE	CUSTOMER PO#
P9324903	10-06-92	8229281

This is to certify that the material furnished pursuant to the pu[illegible] order referenced below has been manufactured, tested, and/or inspected accordance with the requirements of the applicable specifications.

No metallic mercury compounds are used in the process or in the pa[illegible] furnished herein. Inspections and/or tests have been performed as applicable, on both a variable and GO-NO-GO basis, utilizing equipment accordance with the requirements of MI-STD-45662.

Documentary evidence in the form of test and/or inspection reports on file and are available upon request.

10/6/92

Quality Representative

SHIP TO: UCLLNL
7000 EAST AVENUE
LIVERMORE CA 94550

BILL TO: UNIV. CAL. LAWRENCE NAT.
P. O. BOX 5001
LIVERMORE CA 94550

DER DATE: 09-18-92 ID: UCLLN-2 INSIDE: NCG OUTSIDE: NC2 WEIGHT: 4.76 Page 1 (

LINE	BIN	PART NUMBER	APN	U/M	QTY SHIPPED
003		CLC502AJE COM	154710	EA	4

B229281-03

10/7/92

DISCREPANCIES MUST BE REPORTED WITHIN 5 DAYS.

. .NYVALE, CA 94086-4018
PH:408-730-0300 FAX:408-730-4782

UPS SHIPPER # CA 9-65-148

SHIP VIA: UPS

PACKSLIP	PACK DATE	CUSTOMER PO#
P9324902	10-01-92	B229281

order referenced has been manufactured, tested, and/or inspected in accordance with the requirements of the applicable specifications.

No metallic mercury compounds are used in the process or in the parts furnished herein. Inspections and/or tests have been performed as applicable, on both a variable and GO-NO-GO basis, utilizing equipment in accordance with the requirements of MI-STD-45662.

Documentary evidence in the form of test and/or inspection reports are on file and are available upon request.

10/1

Quality Representative

SHIP TO: UCLLNL
7000 EAST AVENUE
LIVERMORE CA 94550

BILL TO: UNIV. CAL. LAWRENCE NAT.
P. O. BOX 5001
LIVERMORE CA 94550

ORDER DATE: 09-18-92 ID: UCLLN-2 INSIDE: NCG OUTSIDE: NC2 WEIGHT 21.06 Page. 1 of-1

LINE	BIN	PART NUMBER	APN	U/M	QTY SHIPPED
003		CLC502AJE COM	154710 B/O=4	EA	56

B229281.02
10/5/92

Certificate of Compliance

ANALOG DEVICES, INC.
3 TECHNOLOGY WAY • NORWOOD, MASSACHUSETTS 02062 • TEL 617/329-4700

SOLD TO
UNIVERSITY OF CALIFORNIA
LAWRENCE LIVERMORE LABORATORY
ACCOUNTING OFFICE
P O BOX 5001

LIVERMORE
CA 94551 1015 YS

UNIV OF CALIFORNIA
LAWRENCE LIVERMORE LAB
7000 EAST AVE

LIVERMORE
CA 94550 1015 YS
B243191

*REPRI

CUSTOMER PURCHASE ORDER NO.
B243191

DATE OF ORDER
02/17/93

PRINT DATE
02/19/93

DATE CODES AS REQUIRED	SALES CATALOG NUMBER	DESCRIPTION	QTY. SHIP
COMPLIANT TO PAR 1.2.1 OF MIL-STD-883 — QTY: 40, CODE: 9135A; 883	3 AD558TE/883B	IC, MONO 8-BIT D/A CONVER	40

It is hereby certified that the products (Model numbers listed above) supplied on the above referenced purchase order, are in conformance with all purchase order requirements, including applicable government, or other specifications and drawings, to the extent specified. All 883 product is compliant to paragraph 1.2.1 of MIL- STD-883.
The required test and traceability documentation resulting from compliance with applicable requirements are on file and available for review by your representative or government inspectors at any reasonable time.

JTHORIZED ANALOG DEVICES QUALITY CONTROL REPRESENTATIVE ____

Certificate of Compliance

ANALOG DEVICES, INC.

3 TECHNOLOGY WAY • NORWOOD, MASSACHUSETTS 02062 • TEL: 617/329-4700

SOLD TO

UNIVERSITY OF CALIFORNIA
LAWRENCE LIVERMORE LABORATORY
ACCOUNTING OFFICE
P O BOX 5001

LIVERMORE
CA 94551 1015 YS

CUSTOMER PURCHASE ORDER NO.
B22754

DATE OF ORDER
09/18/92

PRINT DATE
09/21/92

DATE CODES AS REQUIRED	SALES CATALOG NUMBER	DESCRIPTION	QTY. SHIP
COMPLIANT TO PAR.1.2.1. OF MIL-STD-883 — 883; QTY 45, CODE 9040 13; RE	AD558TE/883B	IC, MONO 8-BIT D/A CONVER	45

It is hereby certified that the products (Model numbers listed above) supplied on the above referenced purchase order, are in conformance with all purchase order requirements, including applicable government, or other specifications and drawings, to the extent specified. All 883 product is compliant to paragraph 1.2.1 of MIL- STD-883.
The required test and traceability documentation resulting from compliance with applicable requirements are on file and available for review by your representative or government inspectors at any reasonable time.

THORIZED ANALOG DEVICES QUALITY CONTROL REPRESENTATIVE

ANALOG DEVICES

MIL-STD 883 ATTRIBUTES TEST DATA

Customer	Special/Generic	QC Lot #
	AD558TE/883B	F141072/01

Date Code	Prepared By	QC Lot Size	Ship Qty.
9040A	E. Johnston	81 pcs.	

VISUAL/MECHANICAL/ELECTRICAL SCREENING

Method	Screen Mil-Std 883; Method 5004	Cond.	Gross	Net	Rej/Other	Date	Comments
2010	INTERNAL VISUAL	B	476	476	0	10/6/90	
1008	STABILIZATION BAKE	C	476	476	—	10/8/90	
1010	TEMPERATURE CYCLE	C	476	476	—	10/8/90	
2001	CONSTANT ACCELERATION	E	476	476	—	10/9/90	Y_1 axis
1014	HERMETICITY FINE LEAK	A	476	472	4	10/9/90	
1014	HERMETICITY GROSS LEAK	C	472	472	0	10/9/90	
	PRE BURN-IN ELECTRICAL		459	447	12	10/22/90	
1015	BURN IN		447	447	—	10/22/90 10/29/90	160 hours, +125°C
	POST BURN-IN ELECTRICAL	25°C	447	445	2	10/29/90	P D A = 5%; P D = .45%
		25°C	445	369	76	11/5/90	Per ADS Data Sheet
		Tmin-Tmax	369	358	11	11/6/90	
2009	EXTERNAL VISUAL		100	81	19	11/21/90	

QUALITY CONFORMANCE INSPECTION

Method	Screen		Cond.	Gross	Net	Rej/Other	Date	Comments
5005	GROUP A INSPECTION		LTPD 2	116	116	0	11/6/90	Per ADS Data Sheet
5005	GROUP B INSPECTION							
2016	Subgroup 1	N/A	S.S. = 2	-	-	-	-	
2015	Subgroup 2		S.S. = 4	4	4	0	11/20/90	
2003	Subgroup 3		LTPD 10	3	3	0	11/21/90	22 leads
2014	Subgroup 4	N/A	S.S. = 1	-	-	-	↓	
2011	Subgroup 5		LTPD 15	4	4	0	11/26/90	15 wires
1018	Subgroup 6	N/A	—	—	—	—	—	
1014	Subgroup 7	N/A	LTPD 5	-	-	-	-	
3015	Subgroup 8	N/A	—	—	—	—	—	

Approved By Edward W Cannon Date 12/1/90

ADS 186 Rev. C

ANALOG DEVICES

MIL-STD 883 ATTRIBUTES TEST DATA

Customer	Special/Generic	QC Lot #
	+0558TE/883B	F20C105-01

Date Code	Prepared By	QC Lot Size	Ship Qty.
913517	S. Kasthurawa	213 pcs	

VISUAL / MECHANICAL / ELECTRICAL SCREENING

Method	Screen Mil-Std 883; Method 5004	Cond.	Gross	Net	Rej./Other	Date	Comments
2010	INTERNAL VISUAL	B	487	487	–	8/27/91	
1008	STABILIZATION BAKE	C	487	487	–	8/31/91	
1010	TEMPERATURE CYCLE	C	487	487	–	9/01/91	
2001	CONSTANT ACCELERATION	E	487	487	–	9/01/91	Y_1 axis
1014	HERMETICITY FINE LEAK	A	487	484	3	9/02/91	
1014	HERMETICITY GROSS LEAK	C	484	484	–	9/02/91	
	PRE BURN-IN ELECTRICAL		476	475	1	10/31/91	
1015	BURN IN		475	475	–	11-01-91 / 11-08-91	160 hours, +125°C
	POST BURN-IN ELECTRICAL	25°C	475	475	–	11-8-91	P D A = 5%; P D = [illegible]
		25°C	464	433	31	11-18-91	
		T_{MIN} T_{MAX}	433	383	50	11-18-91	Per ADS Data Sheet
2009	EXTERNAL VISUAL		218	217	1	8/26/92	

QUALITY CONFORMANCE INSPECTION

Method	Screen	Cond.	Gross	Net	Rej./Other	Date	Comments
5005	GROUP A INSPECTION	LTPD 2	116	116	–	11-18-91	Per ADS Data Sheet
			116	116	–	11-18-91	
			116	116	–	11-19-91	
5005	GROUP B INSPECTION						
2016	Subgroup 1 N/A	S.S. = 2	–	–	–	–	
2015	Subgroup 2	S.S. = 4	4	4	–	8/24/92	
2003	Subgroup 3	LTPD 10	3	3	–	11/26/91	22 Leads
2014	Subgroup 4 N/A	S.S. = 1	–	–	–	–	
2011	Subgroup 5	LTPD 15	4	4	–	11/26/91	15 WIRES
1018	Subgroup 6 N/A	–	–	–	–	–	
1014	Subgroup 7 N/A	LTPD 5	–	–	–	–	
3015	Subgroup 8 N/A	–	–	–	–	–	

Approved By [illegible signature] Date 9/1/92

MC Quality Level 1

Micro Crystal
Div. of ETA
2540 Grenchen
Switzerland

QUALITY CONFORMANCE INSPECTION MIL-C-3098 G

CUSTOMER Uni of California	PO.No. B243124
TYPE CXAT-T2	PCS 25
LOT No.: CQ001176	
FREQUENCY 20.0 MHz [kHz]	FREQ.TOLERANCE ± 50 [ppm]
LOAD CAPACITANCE CL 20 [pF]	SHUNT CAPACITANCE Co 3.20 [pF]
SERIES RESISTANCE R 1 0.050 [k Ω]	OPERAT.TEMP.RANGE -55° ÷ +125°C
DRIVE LEVEL MAX [μ W]	MARKING MC 20.000 MT
MEASURING EQUIPMENT No. QC-Tester II	OSCILLATOR No. 999

	Insp.Level / AQL	n – c MIL STD 105D	n – c eff EFFECTIVE	$\bar{X}$ ARITHM. MEAN	S STAND. DEV.
SERIES RESISTANCE R 1 [k Ω]	2 / 0.65	100%	25-0	0.015	0.004
SERIES CAPACITANCE C 1 [f F]	2 / 0.65	100%	25-0	9.84	0.24
FREQUENCY DEVIAT. $\Delta f/f$ [ppm]	2 / 0.65	100%	25-0	8.4	7.3
VISUAL	2 / 1.0	100%	25-0		
TURNOVER POINT [°C]	S4 / 0.65	100%	25-0	48.01	7.82
TEMP.COEFFICIENT α [$°C^{-1}$]	S4 / 0.65	100%	25-0	$-.162 \cdot 10^{-6}$	$.109 \cdot 10^{-6}$
TEMP.COEFFICIENT β [$°C^{-2}$]	S4 / 0.65				
OPERATING TEMP.RANGE	S4 / 0.65	100%	25-0		

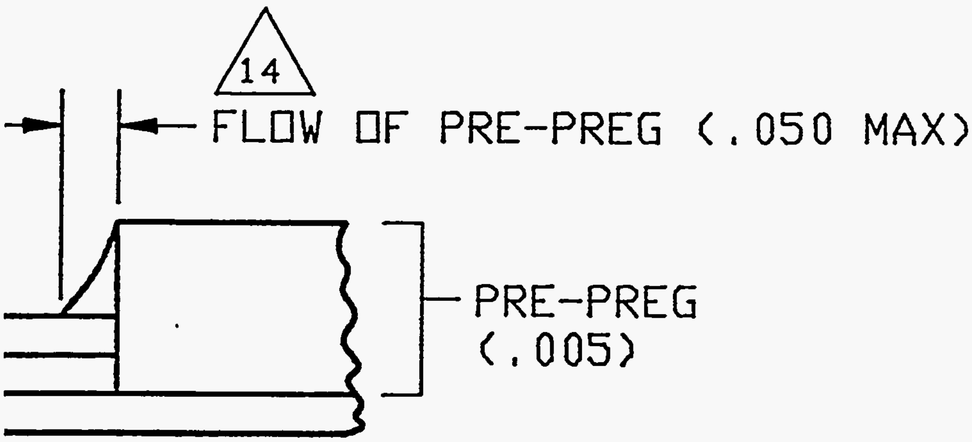
QUALITY FACTOR 57704	AGING [/ 85°C] Δ f/f [ppm]
DATE : 18. Februar 93 QC: [signature]	QA: [signature]

Appendix H.2.6

Artwork

LAYER 10
SHEET 10 (SECONDARY SIDE)

E-E



SECTION F-F

APPROVED

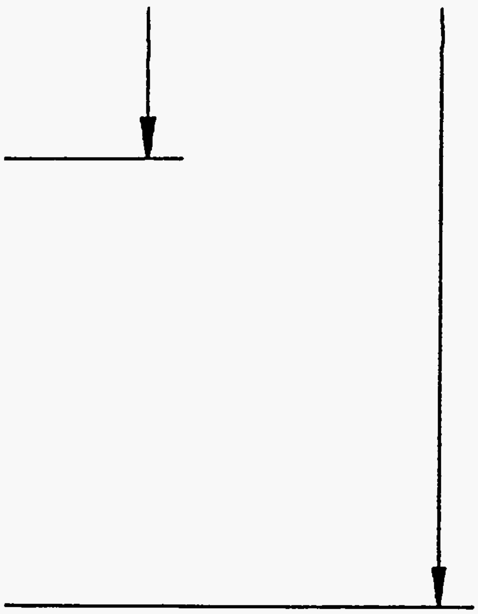
JARDON ENG.	4/07/93	LAWRENCE LIVERMORE NATIONAL LABORATORY	
B. ZARAGOZA	4/07/93	P.C.B CAMERA (ACTEL) W/AGAIN AND OFFSET CONTROL	
APPROVED BY			
J. KOFORS	4/07/93		
D. NIELSEN	4/07/93	SIZE / IDENT NO. LEA92-3128-07	REV 0A
EXT USING DRAWING		SCALE / SHEET 1 OF 2	

B

A

2

1



B

ENGINEERING [illegible]

APPROVED

Project [illegible]

DATE

A

	SIZE	IDENT NO.		REV
		LEA92-3128-07		0A
SCALE	2/1		SHEET 2 OF 2	

2 1

Appendix H.2.7

Electronic Test Data

Appendix H.2.7.1

Electronic Test Procedure:
Actel Camera, PWA with Gain and Offset Control

Electronic Test Procedure

Actel Camera, PWA
with Gain and Offset Control

SN# 04 - 010

(ST1 configured)

	Date	Rev.	Date	Approval
PREPARED BY: MERCEDES L. DICKERSON	5/6/93			
REVIEWED BY: DARRON P. NIELSEN	5/6/93			
REVIEWED BY: WILLIAM R. BRYSON				
REVIEWED BY: JOSEPH F. KORDAS	5-6-93			
REVIEWED BY: MICHEAL J. SHANNON	5/6/93			

University of California Lawrence Livermore National Laboratory	Actel Camera, PWA with Gain and Offset Control Electronic Test Procedure	LEA92-3128-06 Revision 00

Table of Contents

Table of Contents cont.

1. Scope.

This document specifies equipment and procedures required to verify the electrical performance of the ACTEL Camera Printed Wiring Assembly (LEA92-3128-02) in the startracker configuration.

Oscilloscope camera photos and graphs should be attached to the test procedure. Other printer data should be placed in a document protector and inserted in this certification log.

Section 16 describes those tests that are required after conformal coating.

2. Required Documents and Test Equipment.

2.1 Required Documents:

Actel Camera PWB Schematic, LEA92-3128-01-0C OR LEA92-3128-11-0C
Actel Camera PWB Assembly Drawing, LEA92-3128-03
SUN DatacubeTest Station
A Short Guide to Running hspcube , C1-S1-002

2.2 Required Test Equipment:

SUN DatacubeTest Station
includes: Protomax Interface
S1/S2 Data Interface Power Supply, AIT EE-0090-10
Engineering TH7883 CCD for test purposes
Digital voltmeter such as Fluke model 77
AM 503 Current Probe (2ea) powered by a TM502A Power Supply
Tektronix 2465B Analog Oscilloscope with P6106A probes (4ea)
Oscilloscope recording camera
Tektronix TDS540 Digital Oscilloscope
Hewlett Packard Desk Jet 500 Printer
HP 4194 Impedance Gain-Phase Analyzer, with probe and RG 58 cabling
Tektronix HC100 color plotter
Philips PM 3585, 200 MHz Logic Analyzer
TV Optoliner Model K-4000 (with neutral density (ND) filters) and Lamphead
HeNe Laser, 1mW at 632.8nm (with ND filters)
Surface mount testing probes,
Tektronix 20-pin and 44-pin SMQK1 PLCC
Actel Camera board carrier mount, to prevent carrier/pc card flexing
PC board holder/clamp
Video Copier Processor Tektronix Model HC02
Environmental chamber
Timer
Black cloth or an opaque cover for the CCD
Packing Foam
Breakout Connector, 51 contact miniD

The above listed test equipment MUST have calibration dates within one year of test integration. Calibration records should also be available for inspection.

Any fabricated testing hardware, such as the 51-pin breakout connector,MUST have quality assurance tagging and records stating such.

3. Conditions and Requirements

3.1 Precautions

(1) Responsibility for Safety. All personnel are responsible for maintaining a safe work environment. The Test Conductor or cognizant operator shall assure that appropriate safe practices are implemented during these operations, and that operations are performed in a proper order.

(2) ESDS Equipment. The test specimen contains electrostatic- sensitive devices which are exposed at the electrical interfaces. Therefore, it shall be handled per MIL-STD-1686 Class 1. The test specimen, the test operator (using wrist straps), and related electrical test equipment shall be connected to a common ground before any electrical mating or de-mating operations, and during the use of any electrical test equipment probes. There shall be no "hot-plugging" of the test specimen with any test equipment.

(3)Examine Connectors. Before mating any flight connector, examine the connector and the connector with which it is to be mated, to assure that there are no interferences at the pin interface. **Connector savers will be used at all times.**

3.4 Cleanliness and Environment

(1) Standard laboratory conditions of atmospheric temperature, pressure, and humidity are acceptable for the testing defined herein.

(2) Normal housekeeping standards will be required. If appropriate, the unit may be cleaned prior to installation into the next assembly, or prior to return to storage.

3.5 Quality Assurance (QA) Provisions

QA provisions operative during activities defined in this procedure shall be as specified in the project's QA Plan. This section identifies the interfaces between QA and test personnel. QA and test personnel are jointly responsible for the effectiveness of these interfaces in implementing the QA provisions.

(1) QA shall be notified, in advance, of performance of any activities described in this procedure. A QA Inspector may monitor those activities as is deemed necessary or appropriate, in accordance with the project QA Plan. The inspector shall verify that the proper revision of this procedure is used, and that the required Certification Log is in proper order. QA will then give the "OK to Test" prior to the start of test activities.

(2) The QA Inspector shall verify: that calibration is current for all measuring equipment used in these operations, and will not expire prior to completion of these operations; that applicable project-specific electrical support test equipment (STE) has been properly certified and tagged; and that applicable lifting and handling STE has been properly proof tested and tagged.

Quality Assurance (QA) Provisions (continuation)

(3) The QA Inspector may assist in assuring that the precautionary and environmental requirements stated in 3.1 and 3.2 are met. He shall also, at his discretion, assist in the inspection of test setups prior to application of power to a test specimen, and prior to any mechanism-assisted lifts or moves.

(4) Upon the occurrence of a test anomaly (any event that deviates from the planned procedures, exceeds normal variations, or generates unexpected data), operation of the test article shall be stopped immediately. All other test conditions and parameters shall be maintained (except as those conditions may pose an immediate hazard). The QA Inspector shall be notified that a test anomaly has occurred.

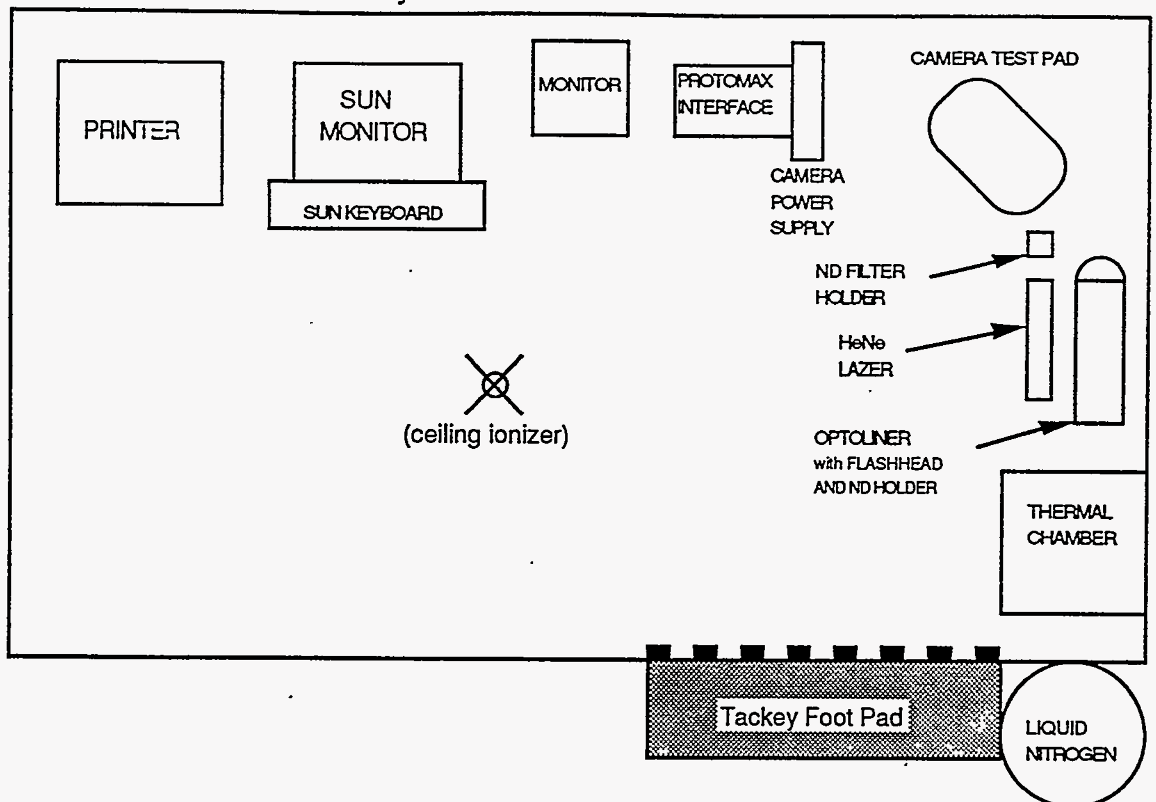
(5) The QA Inspector or Test Conductor (with QA concurrence) shall note each test anomaly on the Failure Reporting And Corrective Action System (FRACAS). The Inspector and the Test Conductor shall review the anomaly. Minor troubleshooting may be done to determine the cause of the anomaly; however, no disassembly or other actions that present a risk to the test article shall be allowed. If the anomaly is found to result from human error or test equipment problems that have not affected the test article, corrective action shall be taken and testing may continue. All troubleshooting steps and results shall be recorded on the FRACAS. The Test Conductor shall supervise any troubleshooting or retesting required in resolving test anomalies.

(6) If a test anomaly cannot be resolved as described above, the Project Engineer shall be notified. If the action indicates that a rework or repair may be required, the anomaly and troubleshooting results shall be noted in the Action Item List (AIL) portion of the Certification Log, Fracus report and a Material Discrepancy Report (MDR) shall be initiated (if required) and processed as prescribed in the QA Plan.

(7) The QA Inspector shall stamp log entries as appropriate, attesting to the proper completion of these operations as previously approved in this procedure document.

3. SUN DatacubeTest Station

The LLNL SUN Test Station layout looks like this:



The work station area must be electro-statically protected and approved.

A Short Guide to Running hspcube, C1-S1-002, by Ray Aley, Hye-Sook Park, and Eric Parker explains the Sun3 Computer-Datacube workstation and the software imaging options for the Startracker (S1), UV-Visible (S2), and Lidar (S4) modes.

5. Printed Wiring Assembly Specificity

5.1 Inspection

Inspect the carrier mounted Actel board for any conflict with the configuration table, assembly drawing or obvious fabrication flaws. Inspect the action item list of the certification log for any anomalies. **NOTE!! The camera board should remain attached to the carrier mount until ultimately bent and housed.!!**

SN# 04-C10 Inspection completed By DRA (initials) Date 5/6/93

5.2 Power Plane Resistance Measurements

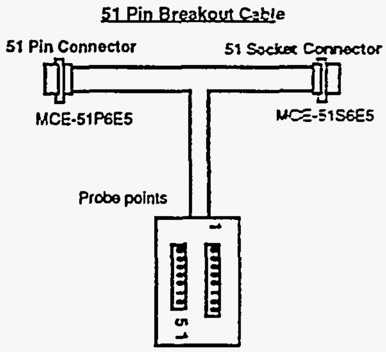
Measure power plane resistances at **J1**. **NOTE: N0 cable attached!**

pin# DVM(common)	vs	pin# DVM(signal)	expected Ω	measured Ω
5 (AGND)	-	39 (+15VDC)	≥2MΩ	>2M Ω
	-	4 (-15VDC)	≥2MΩ	>2M Ω
	-	37 (+5VDC)	≈479Ω	470 Ω
	-	38 (+5VDC)	≈479Ω	470 Ω
	-	3 (-5VDC)	≈1.54kΩ	1.54K Ω
	-	40 (+5VIN)	≈2.9kΩ	4.36K Ω
20 (DGND)	-	5	≈.2Ω	.3 Ω
	-	39	>2MΩ	>2M Ω
	-	37	≈468Ω	470 Ω
	-	38	≈468Ω	470 Ω
	-	3	≈1.5kΩ	1.54K Ω
	-	40	≈3KΩ	4.37 Ω
39 (+15VDC)	-	4	≥11KΩ	12K Ω
	-	37	≥2MΩ	>2M Ω
	-	38	≥2MΩ	>2M Ω
	-	3	≥2MΩ	>2M Ω
	-	40	≥2MΩ	>2M Ω
4 (-15VDC)	-	37	>2MΩ	>2M Ω
	-	38	>2MΩ	>2M Ω
	-	3	>2MΩ	>2M Ω
	-	40	>2MΩ	>2M Ω
37 (+5VDC)	-	38	≈.3Ω	.2 Ω
		3	≈2kΩ	2K Ω
	-	40	>3KΩ	4.84KΩ
3 (-5VDC)	-	40	≈4.5kΩ	5.41K Ω

5.3 Power Plane Voltage Measurements

Using a flight certified breakout connector, verify power voltages at camera connector **before** attaching it to the camera board. Complete the table below, then turn off the power. Use J1-pin 20 for DVM ground.

P.S. #3



J1 pin #	Expected V	Measured V
39	+15V	+15.38
4	-15V	-15.28
37,38	+5VDC	+5.15
3	-5V	-5.40
40	+5VAIN	+5.15

Cable voltages satisfied, now measure the power plane voltages. Connect camera side of the breakout connector to the camera board. Once the breakout is attached to the camera board, leave it in place throughout the testing procedure to save the board's connector.

Power up the camera board and record the voltages between single point ground (SPG) or TP1 and indicated voltage points:

PRIMARY SIDE

+5.0V

U12-pin 16 5.02 v

U25-pin 16 5.02 v

+5.0VA

+C11 4.91 v

U8-pins 7,15, 18,21,23, 26 4.90 v

U1-pin 7 4.90 v

U24-pin 7 4.90 v

D4-pin 2 4.90 v

SECONDARY SIDE

+C10 5.02 v

U2-pins 4, 9, 15,16 5.02 v

U26-pins 3, 14, 16, 25, 35 5.02 v

U5-pin 22 5.02 v

U6-pin 16 5.02 v

U7-pin 16 5.02 v

U32-pin14 4.90 v

PRIMARY SIDE		SECONDARY SIDE	
-5.0VA			
-C12	-5.31 v	Q9-pin 4	-5.30 v
U1-pin 4	-5.31 v	Q10-pin 4	-5.30 v
U24-pin 4	-5.31 v	Q11-pin 4	-5.30 v
Q1-pin 4	-5.31 v		
Q4-pins 4	-5.31 v		
+15.0V			
Q2-pin 3	15.18 v	+C9	15.17 v
U17-pin 1	15.23 v	U18-pin 1	15.24 v
U14-pin 7	15.18 v	U27-pin 8	15.17 v
		U3-pin 8	15.17 v
		D3-pin 2	15.17 v
-15.0V			
U14-pin 4	-15.27 v	-C52	-15.28 v
		U3-pin 4	-15.28 v
		U27-pin 4	-15.28 v

5.4 CCD Bias Voltage Measurements

S1—	≈0v Vss		
S2 & S4—	≈-3.0v Vss		
U19-pins 1, 10 and 17	0 v	U3-pin 1	0 v
S1—	≈1.5v Vgs		
S2 &S4—	≈2.5v Vgs		
U19-pin 20	1.5 v		
≈13.0v Vdr			
U19-pin 18	13.13 v	U3-pin 7	13.12 v
≈15.0v Vdd			
U19-pins 5, and15	15.18 v		

PRIMARY SIDE		SECONDARY SIDE	

5.5 Reference Voltage Measurements

10.0V ref		D3-pin 6	9.98 v	
0.1V DARK REF		+C93	.908 v	0.099 DRA 5/7/93
		U27-pin 3	.908 v	0.099 DRA 5/7/93

10.7VA clocking ref (ØL1, ØR, ØRFET)

U17-pin 3	10.83 v
U11- pin 6	10.82 v
U30-pin 6	10.83 v

10.7VB clocking ref (P, ØP)

U18-pin 3	10.67 v
U9-pin 6	10.67 v
U10-pin 6	10.67 v
U22-pin 6	10.67 v
U23-pin 6	10.67 v

Analog to digital (A/D) converter reference voltages:
≈2.5V A/D ref

	expected volts		measured volts	
		U27-pin 5	2.492 v	DRA
U8-pin 6	≈0.620v		.617 v	
U8-pin 22	≈1.245v		1.244 v	
U8-pin 9	≈1.875v		1.873 v	
U8-pin 17	≈2.500v		2.492 v	

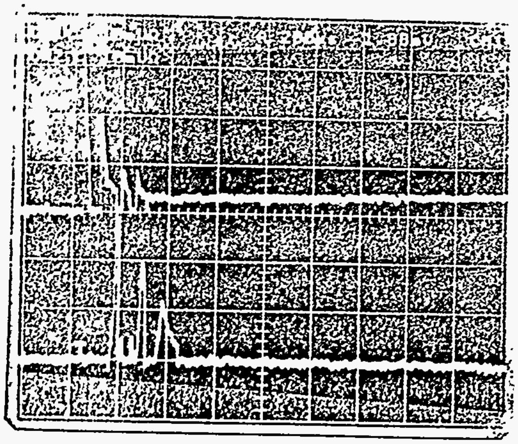
5.6 Video Clamping Voltage Measurements

	expected volts	measured volts	
U1-pin 8	≈2.0v	3.43 v	OKAY
U24-pin 8	≈3.5v	3.43 v	
U1-pin 5	≈-1.0v	-1.048 v	
U24-pin 5	≈-0.5v	-.545 v	

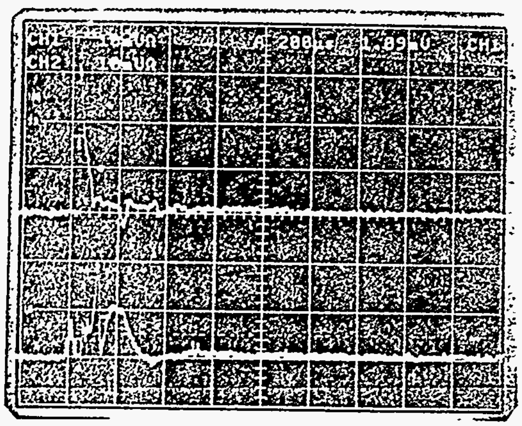
Turn off the test fixture.

5/12/93 CURRENT MEASUREMENTS

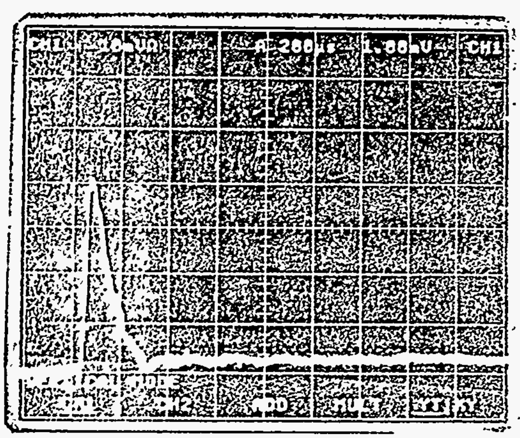
STI SN #04-10



±15V



±5V



+5VAIN

5.7 DC Steady State Current Measurements:

These measurements require an oscilloscope and the AM503 Current Probe powered by a TM502A.

Operation of the AM 503 requires that the **oscilloscope be set at 10mV/div** and that the **probe be in the locked position.**

Isolate and label the camera wiring harness with respect to the individual power voltages. **Note!!** There are two +5VDC wires#37&38 so isolate these wires together.

Power up the camera board. Using the appropriate menu based on the camera board's configuration (Startracker) **disable** the Video bus. Consult *A Short Guide to Running hspcube*, C1-S1-002 for the necessary SASI or SUN keyboard commands.

With the Probe and Oscilloscope functional, attach the current probe around each input voltage wire and in the case of the +5VDC the wire pair, each time acquiring and recording the oscilloscope display. Note the units/div used at the AM503 so that the current can be calculated.

Consult *A Short Guide to Running hspcube*, C1-S1-002 for the necessary SASI command to **enable** the Video bus. Repeat the current measurements. Each time acquiring and recording the oscilloscope display and recording the units/div used at the AM503 so that the current can be calculated.

Calculate the currents under each Video bus state and complete the table below.

Voltages	AM503 units/div	Calculated Current Video Bus Disabled	Calculated Current Video Bus Enabled
+15V	20ma	101	101
-15V	2ma	13.76	13.76
+5VDC	10mA/50mA	50.5mA	~~300~~ 292 mA
-5V	10mA	~~42.7~~ 41.2 mA	~~42.7~~ 41.2 mA
+5VAIN	20mA	107.4	105

DRA 8-9-93

SN# 04-010 By DRA (initials) Date 8-9-93 (passed)

REMEMBER to attach your recorded documentation to this test procedure!
(A document protector is advised)

5.8 Offset Digital-to-Analog (D/A) Verification

To verify data transfer and D/A output voltage, a Fluke 77 or voltmeter is needed.

Within the appropriate menu select and send the indicated offset data via the SASI. Measure the output voltage of U32, AD558TE pins 19, 20. Record the results in the table below.

IMPORTANT: All readings <u>must</u> meet indicated tolerances!

Decimal Data Input	Expected Voltage	Measured Voltage Out
00	0.0V±10mV	.051
01	80mV±10mV	.080
02	160mV±10mV	.160
04	320mV±10mV	.320
08	640mV±10mV	.640
16	1.28V±10mV	1.280
20	1.61V±10mV	1.599
26	2.09V±10mV	2.079
31	2.49V±10mV	2.479

SN# 04-010 By MD/DA (initials) Date 5/7/93 (passed)

5.9 Gain Selection Verification

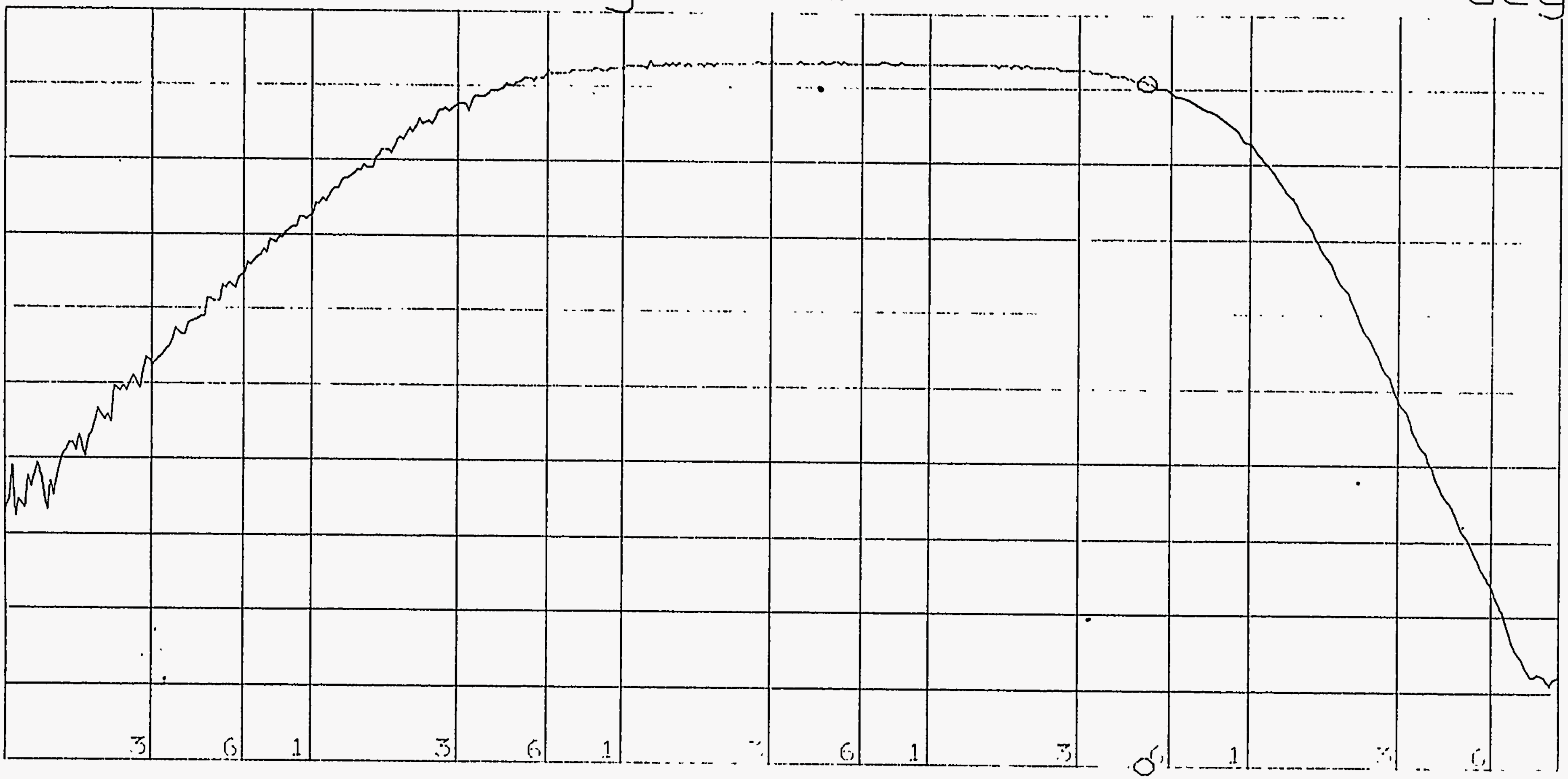
To verify proper data transfer of gain setting, use a Fluke 77 voltmeter.

Within the appropriate menu select and send the indicated gain data via the SASI. Measure the voltage at Q11,Q10 and Q9 gates. Record the results in the table below.

	msb		lsb
S1 INPUT	75e/bit Q11	150e/bit Q10	350e/bit Q9
0	0v	0v	0v
1	0v	0v	15v
2	0v	15v	0v
3	0v	15v	15v
4	15v	0v	0v
5	15v	0v	15v
6	15v	15v	0v
7	15v	15v	15v

SN# 04-10 By [initials] Date 5/6/93
initials passed

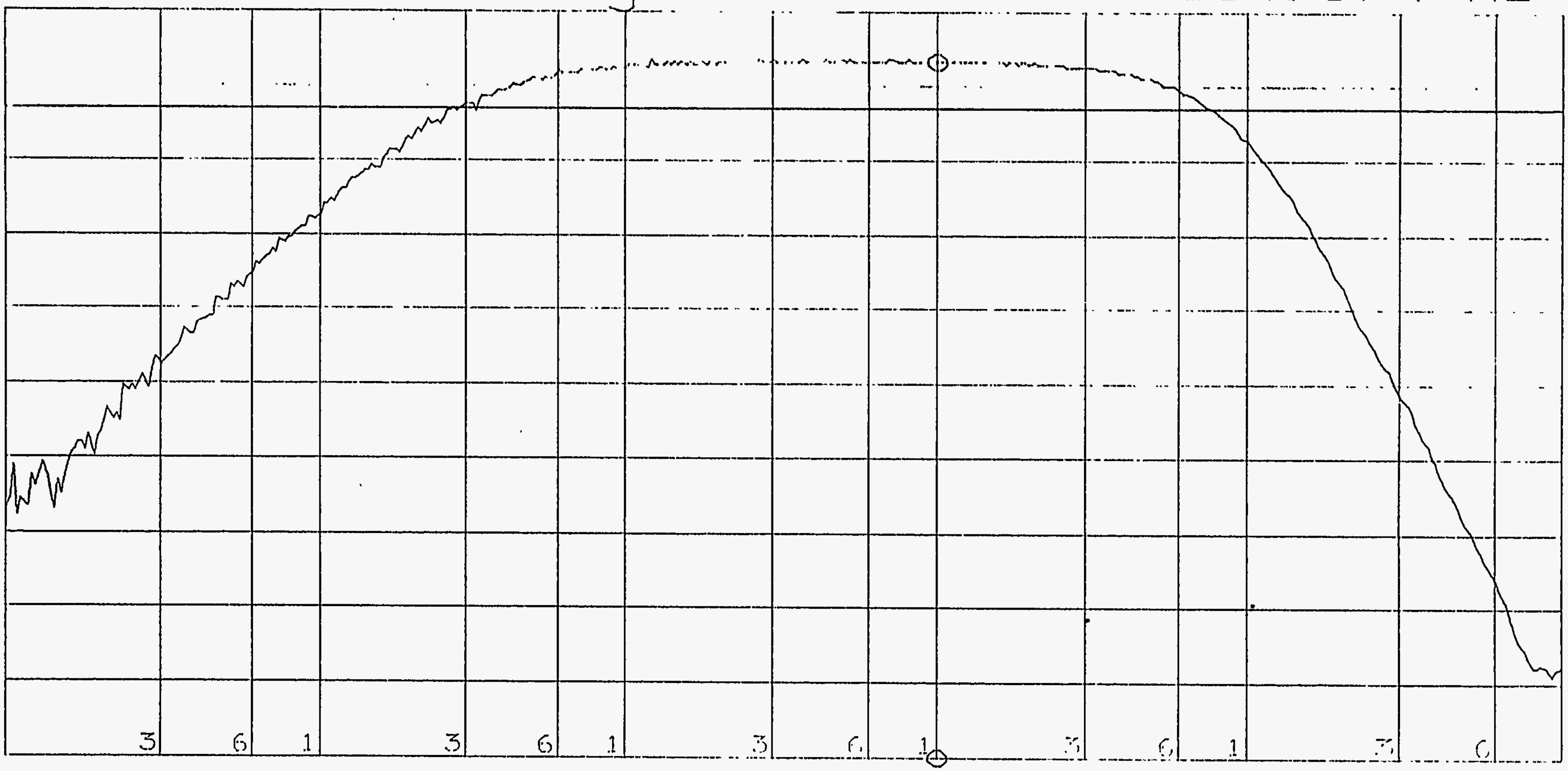
A: T/R (dB) B: θ   o MKR   5 011 872.336 Hz
A MAX   40.00   dB   GAIN   35.3489   dB
B MAX   180.0   deg PHASE   deg



A/DIV   5.000   dB   START   1 000.000 Hz
B MIN -180.0   deg STOP 100 000 000.000 Hz
OSC=   15.0 DBM

SI #04-010 (FIRST CONFIGURATION) U8 pin 28
75e/bit
5/6/93

A: T/R (dB) B: θ			ΔCRS_A	-3.08711	dB
A MAX	40.00	dB	LEFT	29 402.592	Hz
B MAX	180.0	deg	RIGHT	7 675 064.374	Hz



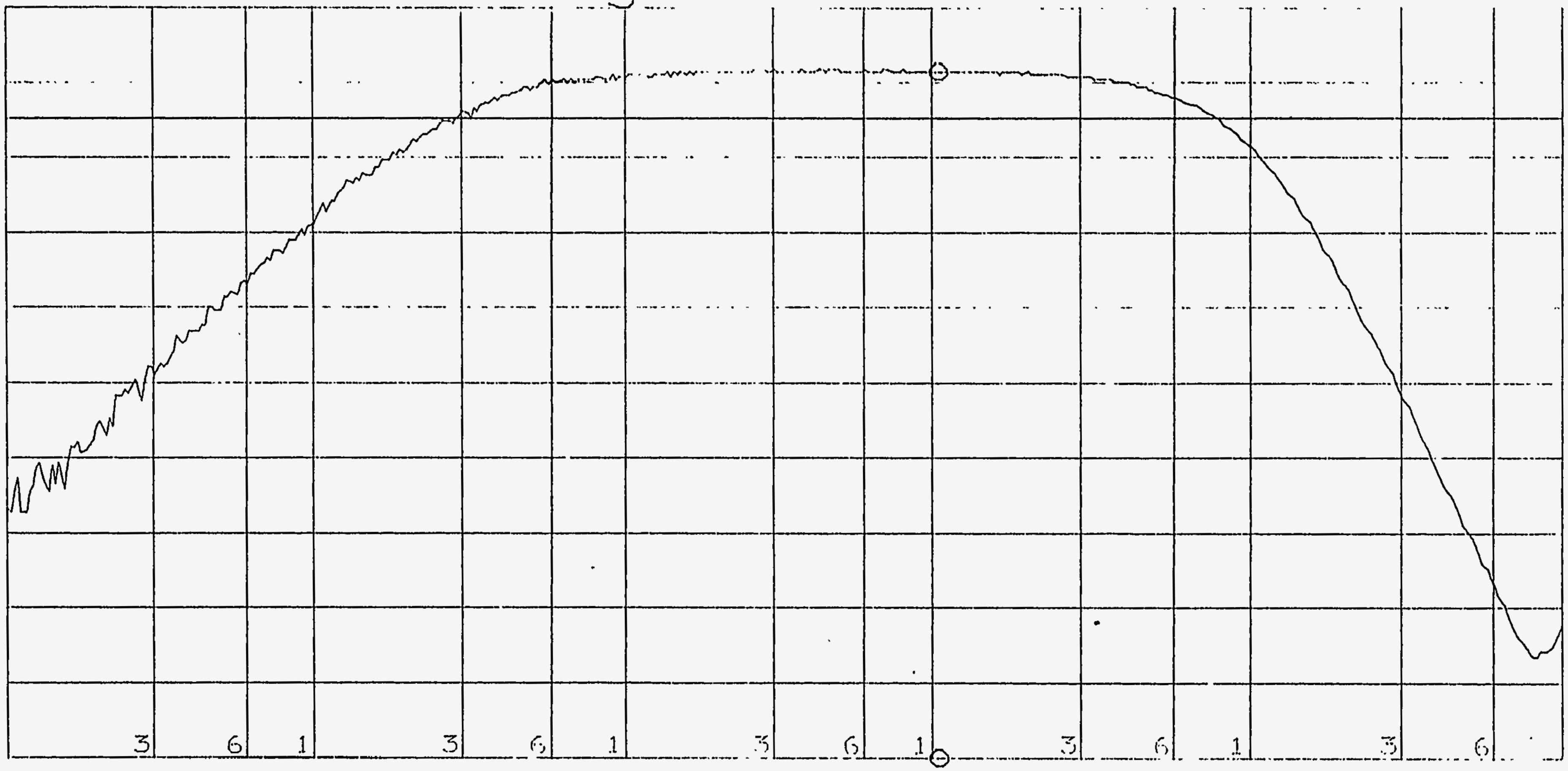
A/DIV	5.000	dB	START	1 000.000	Hz
B MIN	-180.0	deg	STOP	100 000 000.000	Hz
OSC=	-45.0 DBM				

SI #04-010 (FIRST CONFIGURATION) U8 pin 28

75e/bit

5/6/93

A: T/R (dB) B: θ   ΔCRS_A   -3.03824 dB
A MAX 35.00 dB   LEFT   29 250.465 Hz
B MAX 180.0 deg   RIGHT   7 883 591.014 Hz



A/DIV 5.000 dB   START   1 000.000 Hz
B MIN -180.0 deg   STOP 100 000 000.000 Hz
OSC= -45.0 DBM

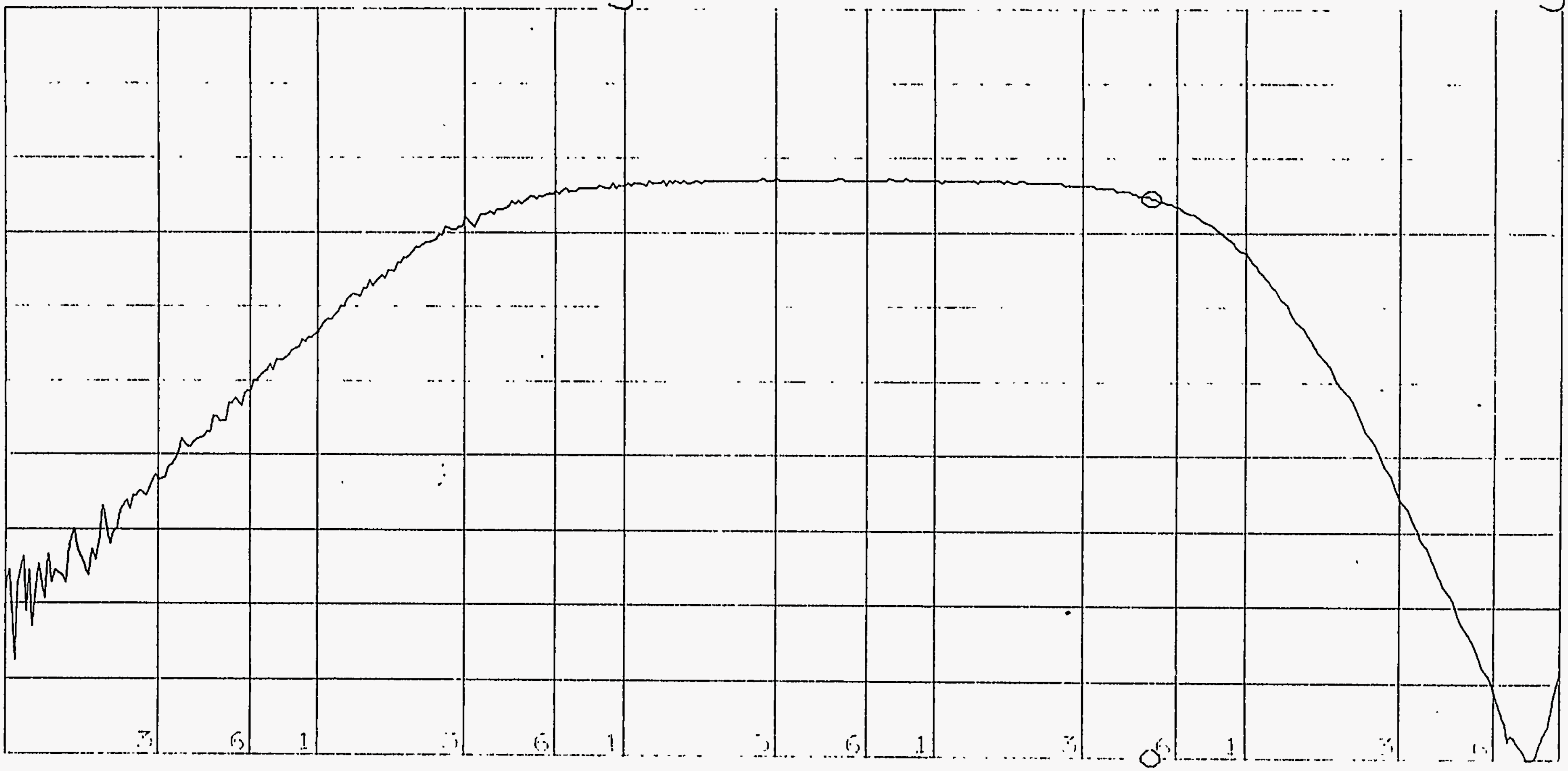
51 #04-010 (FIRST CONFIGURATION) UB pin 28
150 e/bit   5/6/93

A: T/R (dB) B: θ　　O MKR　5 011 872.336 Hz
A MAX 35.00 dB　GAIN　29.5394 dB
B MAX 180.0 deg　PHASE　deg

A/DIV 5.000 dB　START　1 000.000 Hz
B MIN −180.0 deg　STOP　100 000 000.000 Hz
OSC= −45.0 DBM

SI #04-010 (FIRST CONFIGURATION)　4B pin 28
150e/bit　5/6/93

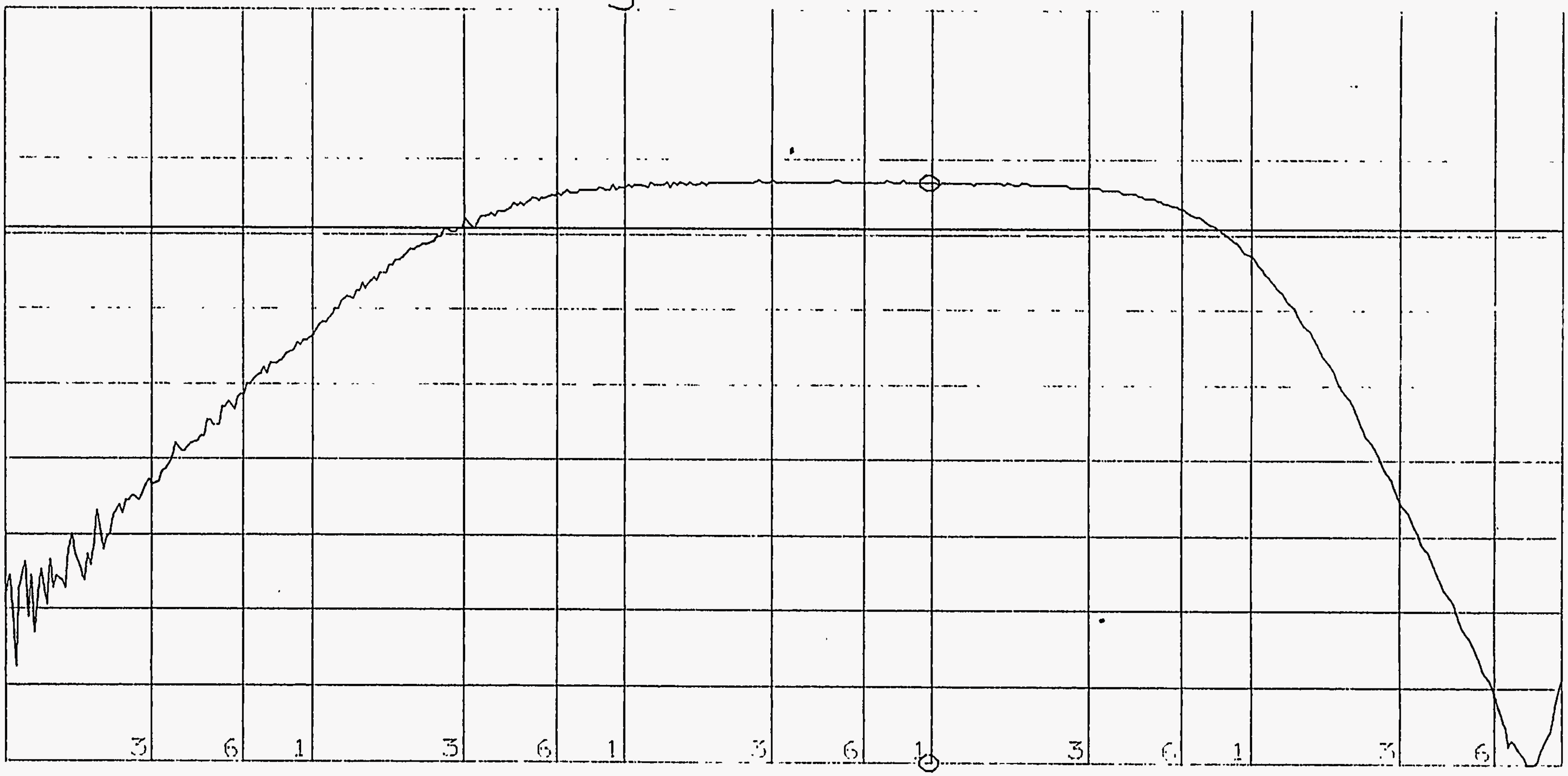
A: T/R (dB) B: θ　　O MKR　5 011 872.336 Hz
A MAX 35.00 dB　GAIN　22.2864 dB
B MAX 180.0 deg PHASE　deg



A/DIV 5.000 dB　START　1 000.000 Hz
B MIN -180.0 deg　STOP 100 000 000.000 Hz
OSC= -45.0 DBM

51 #04-010 (FIRST CONFIGURATION)　UB-pin 28
350 e/bit 5/6/93

A: T/R (dB) B: θ   ΔCRS_A   -3.06407 dB
A MAX 35.00 dB   LEFT   29 668.084 Hz
B MAX 180.0 deg   RIGHT   7 878 807.165 Hz



A/DIV 5.000 dB   START   1 000.000 Hz
B MIN -180.0 deg   STOP 100 000 000.000 Hz
OSC= -45.0 DBM

S1 #04-010 (FIRST CONFIGURATION)   U8 pin 28
350 e/bit   5/6/93

6.0 Video Amplifier Gain Verifications.

The video gain measurements require use of the HP4194 Impedance Gain/Phase Analyzer.

6.1 Test Board Configuration

Configure the board under test as follows:

Replace R49 with a 1.0 Kohm 1% resistor.

Remove R128 and connect R128's outermost pad with C123's outermost pad. This grounds Q1 and Q4 gates.

Disable the 20MHz oscillator by connecting U5 pins 5 and 23 together.,

6.2 HP4194 Analyzer Configuration and Connection.

Configure the HP4194 Analyzer as follows:

Gain/Phase measurement,
A Scale linear and AutoScale,
Log Sweep, 1 KHz to 100 MHz,
Oscillator Level equal to -45 dBm.

Insert a 1 Kohm resistor from U19 pin 18 to U19 pin 16. Attach the HP4194 oscillator output to U19 pin 16 and its ground to the ground test point.

6.3 Gain and 3dB Bandwith Acquisition.

Measure and store the reference level. Then measure the gain at 5MHz and 3dB frequency at U8 pin 28 for all three gain settings. Record the measured values in the following table and attach the data plots in a document protector.

Gain Setting	Expected Gain dB	Measured Gain dB	Expected 3dB bandwidth(MHz)	Measured 3dB bandwidth(MHz)
4	35.5±0.5	35.38	7.5±0.5	7.675 MHz
2	29.5± 0.5	29.5	7.5±0.5	7.883 MHz
1	22.2±0.5	22.28	7.5±0.5	7.878

SN# 04-10 By MD (initials) Date 5/6/93 (passed)

7. Clocking Measurements with CCD installed

Verify that U19 pin 16 is not shorted to ground.
Measured 4.3 M Ω (>1MΩ)

Insert the appropriate prototype TH7883 CCD into location U19.

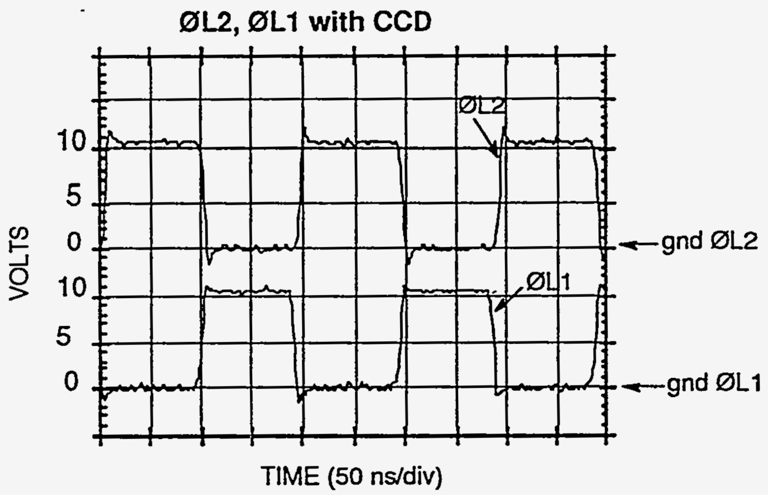
Carefully Check CCD Orientation!!

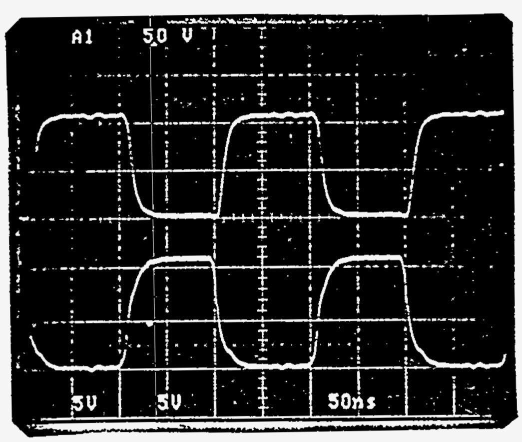
7.1 Acquire and record the ØL2 and ØL1 clocks:

Make these scope probe connection:

Probe	Location
Channel 1	U19 pin 2
Channel 2	U19 pin 3

Change the scope horizontal sweep frequency to **50ns** per division.

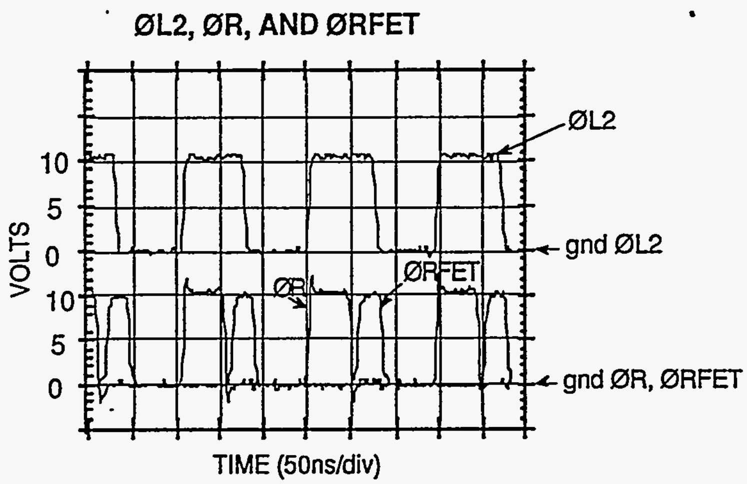


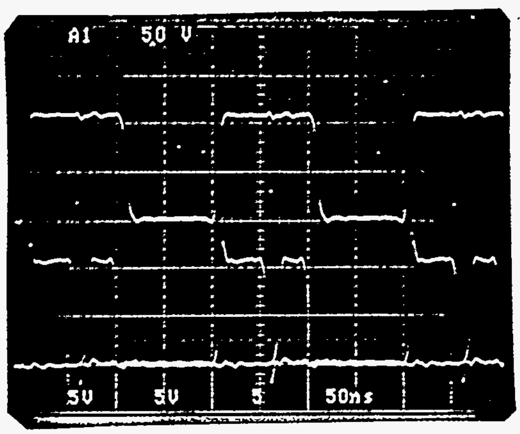


7.2. Acquire and record the ØL2, ØR, and ØRFET clocks:

Move the scope ØR, and ØRFET probe to these locations:

Probe	Location
Channel 2	U19 pin 19
Channel 3	R128 Q1 gate side





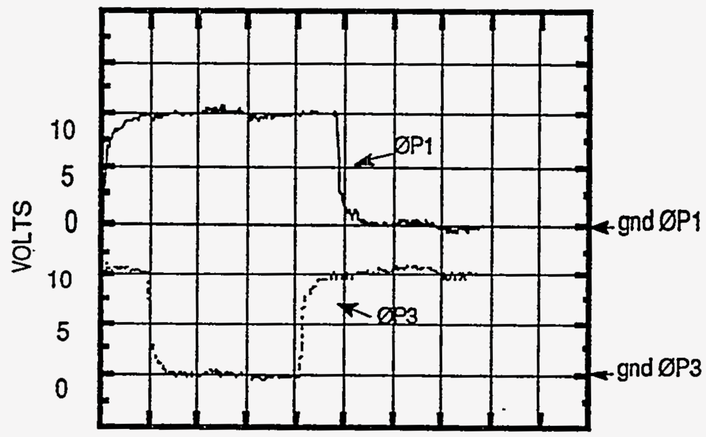
7.3 Acquire and record the ØP1, and ØP3 clocks:

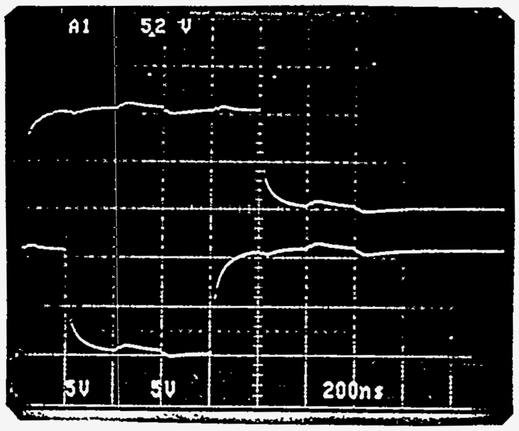
Move the scope probes to these locations:

Probe	Location
Channel 1	U19 pin 14
Channel 2	U19 pin 13

Shift the horizontal sweep frequency to **200ns** per division.

ØP1, ØP3 with CCD



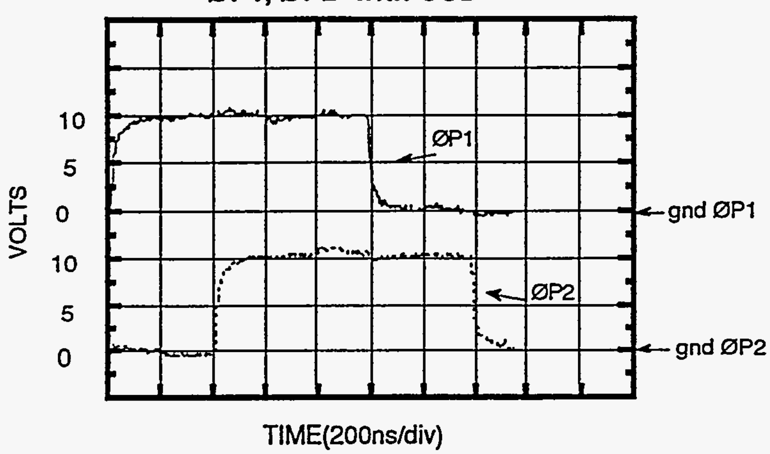


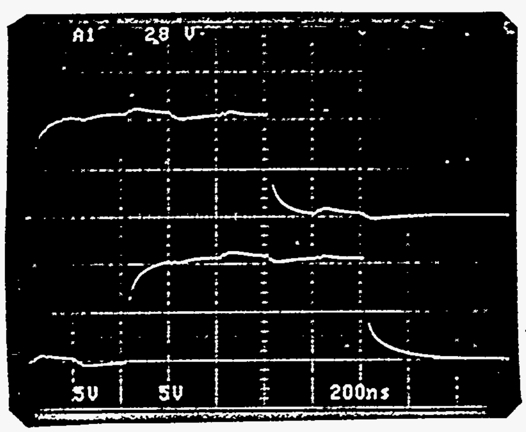
7.4 Acquire and record the ØP1, and ØP2 clocks:

Move the scope probe to this location:

Probe	Location
Channel 2	U19 pin 12

ØP1, ØP2 with CCD

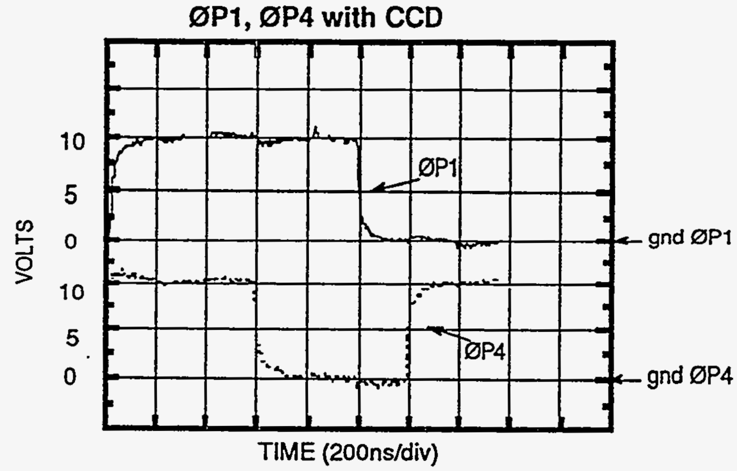


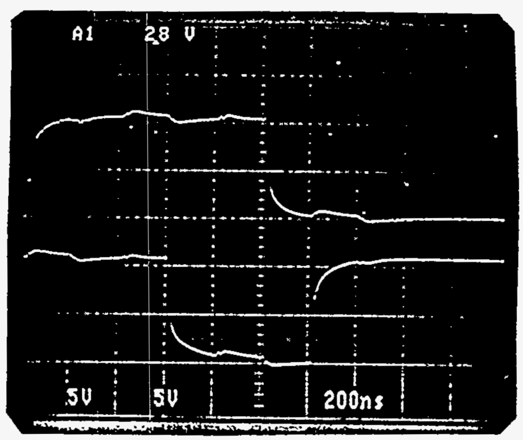


7.5 Acquire and record the ØP1, and ØP4 clocks:

Move the scope probe to the location indicated:

Probe	Location
Channel 2	U19 pin 11

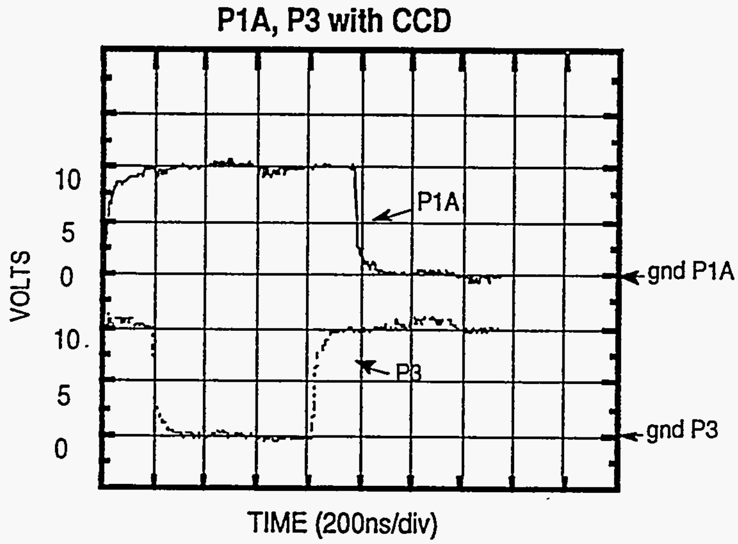


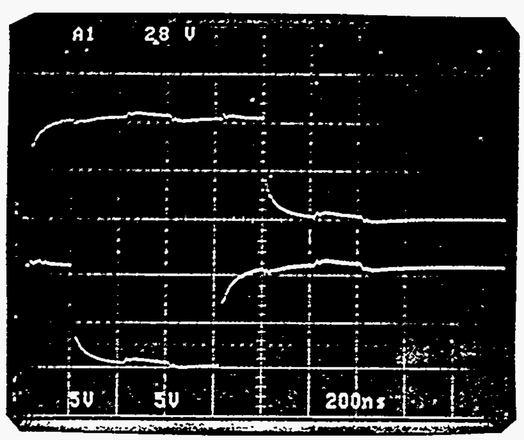


7.6 Acquire and record the P1A, and P3 clocks:

Move the scope probes to these locations:

Probe	Location
Channel 1	U19 pin 9
Channel 1	U19 pin 8

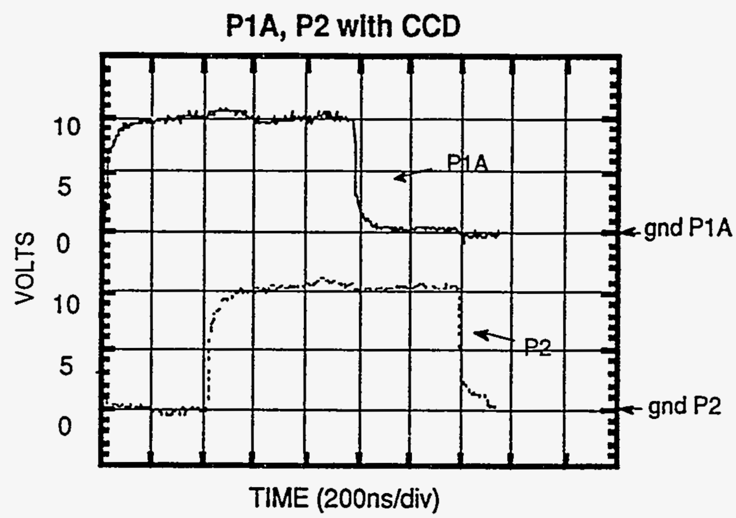


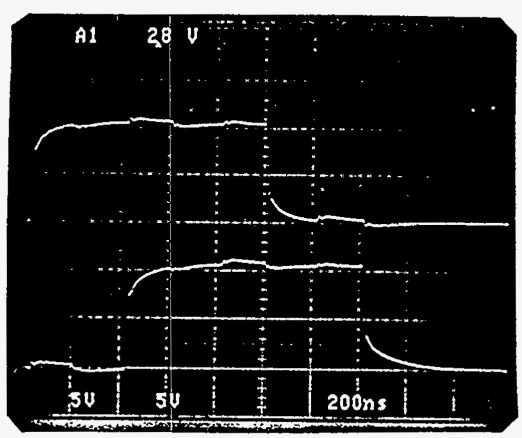


7.7 Acquire and record the P1A, and P2 clocks:

Move the scope probe to this location:

Probe	Location
Channel 2	U19 pin 7



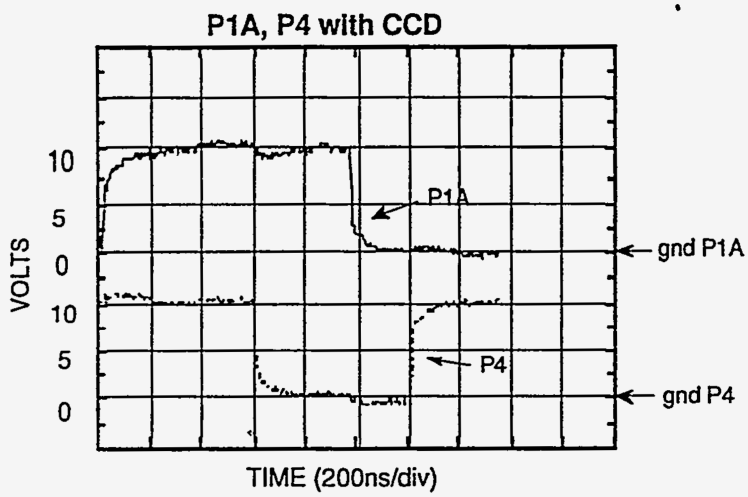


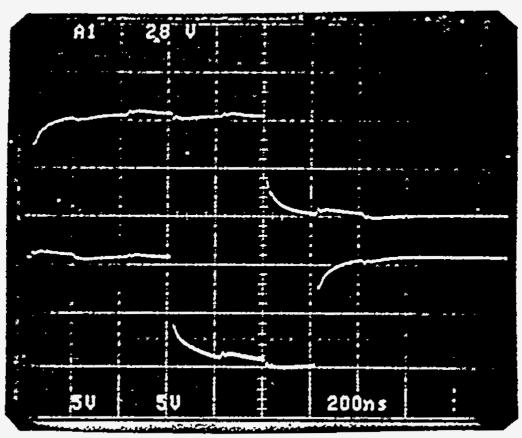
)

7.8 Acquire and record the P1A, and P4 clocks:

Move the scope probe to this location:.

Probe	Location
Channel 2	U19 pin 6



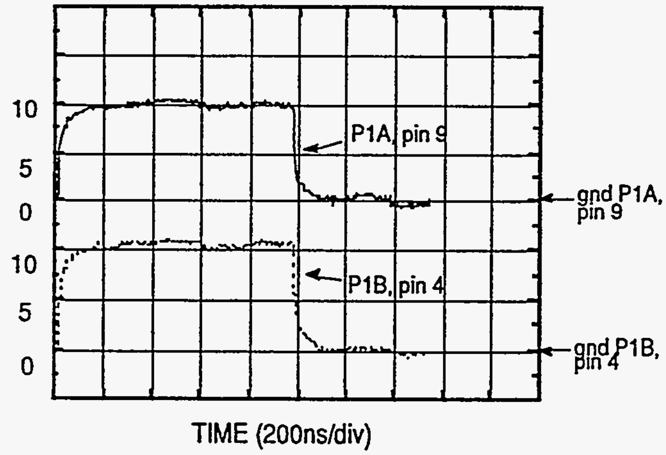


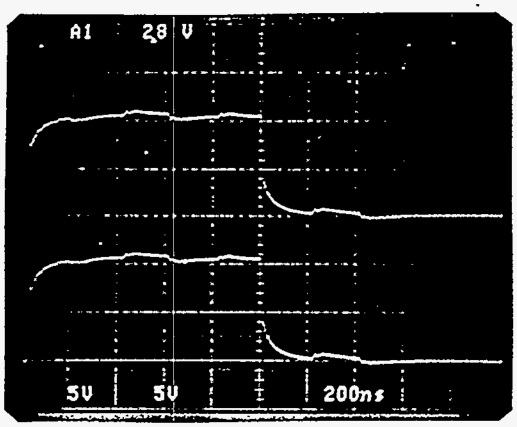
7.9 Acquire and record the P1A, and P1B clocks:

Move the scope probe to this location:

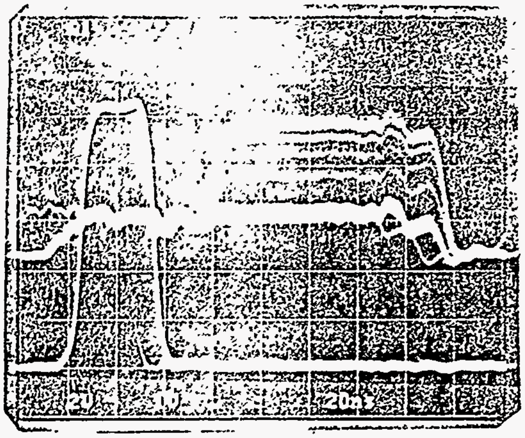
Probe	Location
Channel 2	U19 pin 4

P1A, P1B with CCD

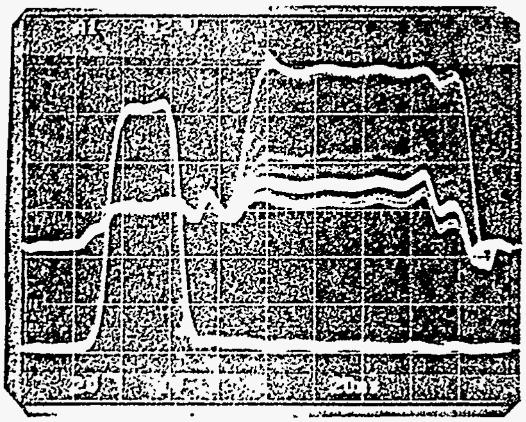




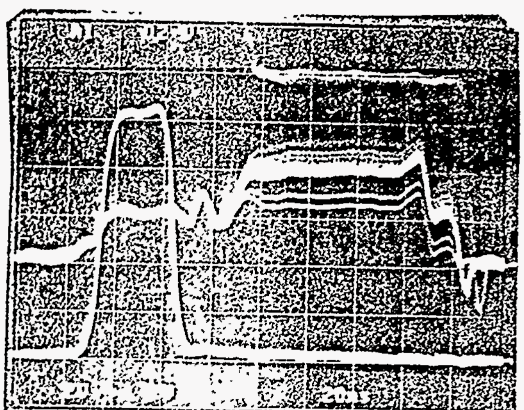
#04-12



350e/in



150 e/unit



75 e/in

8. Double Correlated Sampling Functionality Verification

This measurement requires the use of a Tektronix 2465B—or like—oscilloscope.

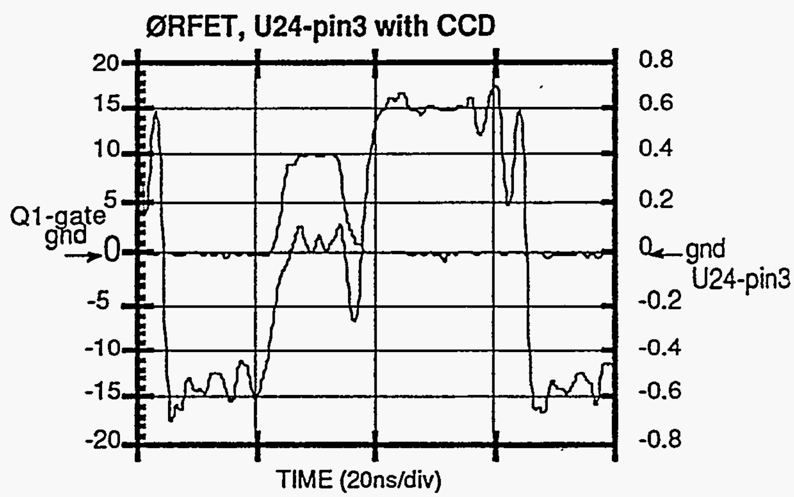
Verify the gain of the camera is 150e/bit via the SASI.

Make these scope probe connection:

Probe	Location
Channel 2	U24 pin 3
Channel 3	R128 Q1 gate side

Adjust the time base to **20ns** per division.

Acquire and record the Q1 or ØRFET vs Video signals:



Make the same measurement at 350e/bit and 1000e/bit.

Note: During the Q1 or ØRFET pulse, the video signal should be ≈0v or ground. At high gains, the sensor may require cool down by non-operation and/or an opaque covering to acquire this measurement.

9. Analog to Digital (A/D) Converter Clock vs U24-pin 6 & U8-pin 28

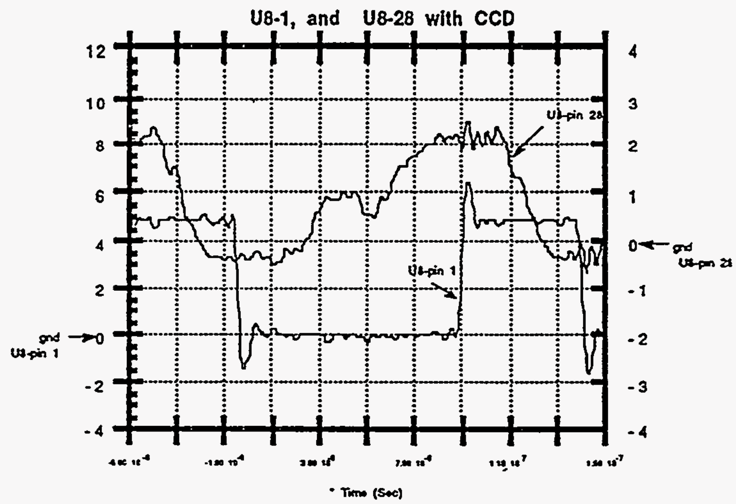
This measurement requires the Tektronix 2465B analog—or like—oscilloscope.

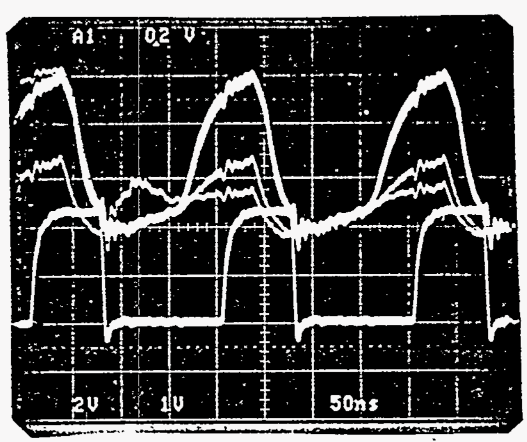
Set the scope to trigger on channel 1.

Set the horizontal sweep to **50ns**/division.

Move the scope probes to these locations:

Probe	Location	Vertical Gain
Channel 1	U8 pin 1	2 V/division
Channel 2	U8 pin 28	500 mV/division



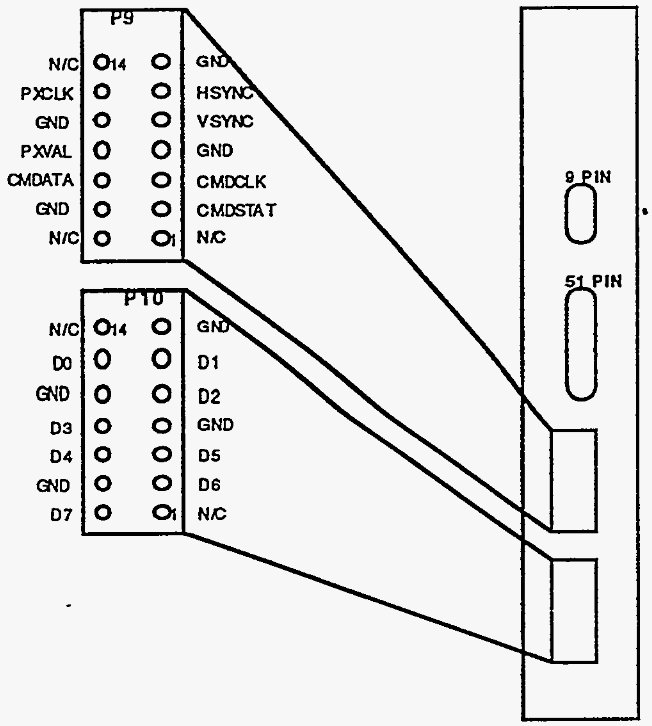


10. Video Interface Timing Confirmation

This test requires the use of the Phillips PM 3585 Logic Analyzer.

10.1 Logic Analyzer Setup

Move the analyzer pod probes to the following locations at the Datacube interface card connectors designated as P9 and P10:



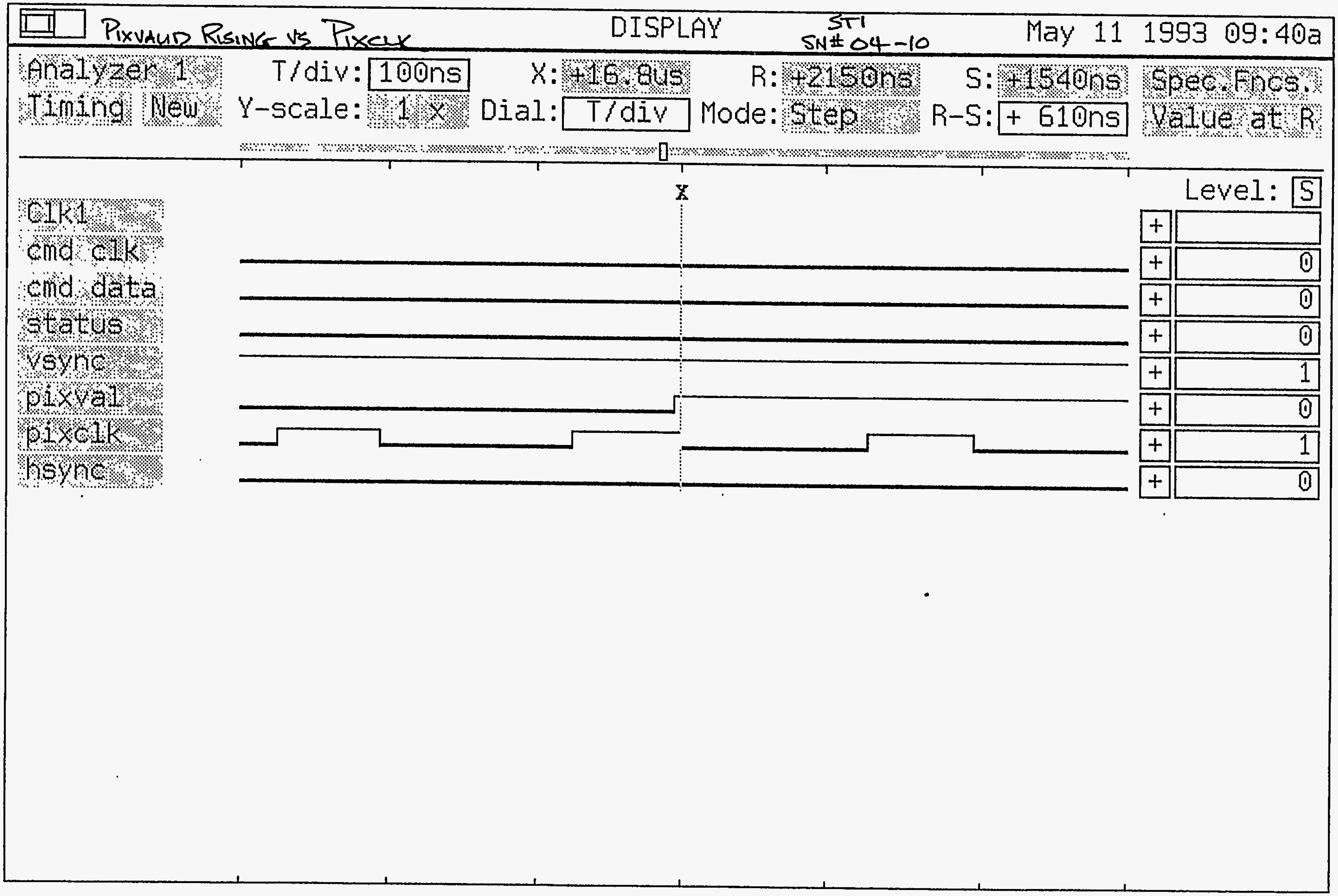
channel 1-CMDCLK
channel 2-CMDDATA
channel 3-CMDSTAT
channel 4-VSYNC
channel 5- PIXVAL
channel 6-PIXCLK
channel 7-HSYNC
channel 9-16-DATA BUS

Attach the pod ground to any of the GND pins indicated.

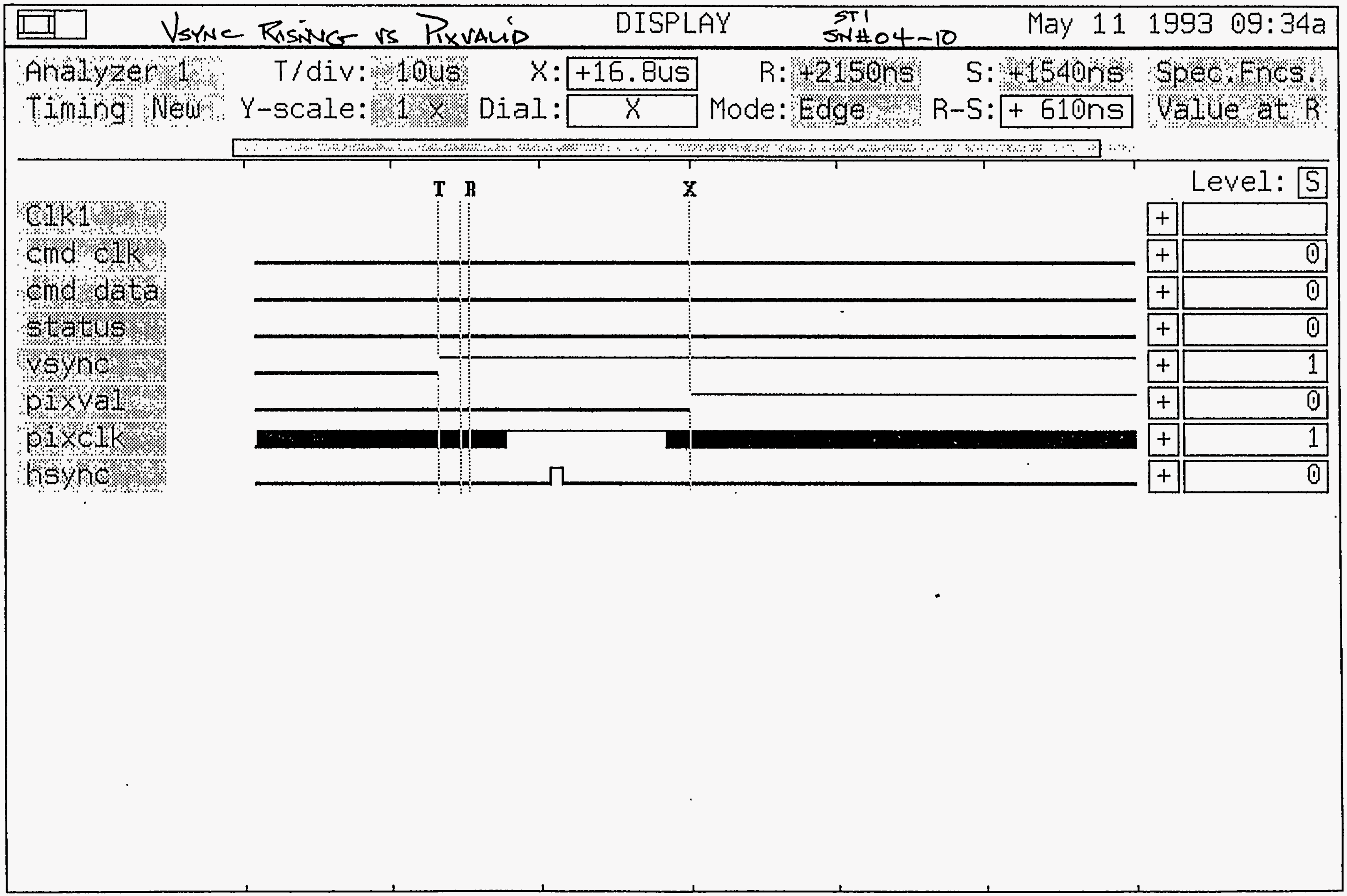
10.2 Timing acquisitions:

Pixclk vs Data
Vsync vs Pixvalid (condensed and expanded at the beginning of line & frame)
(condensed and expanded at the end of line & frame)
SASI Command (this is CMDDATA while a SASI is sent from the SUN keyboard)
Rising and falling edges at Vsync vs Pixclk
Rising and falling edges at Pixval vs Pixclk

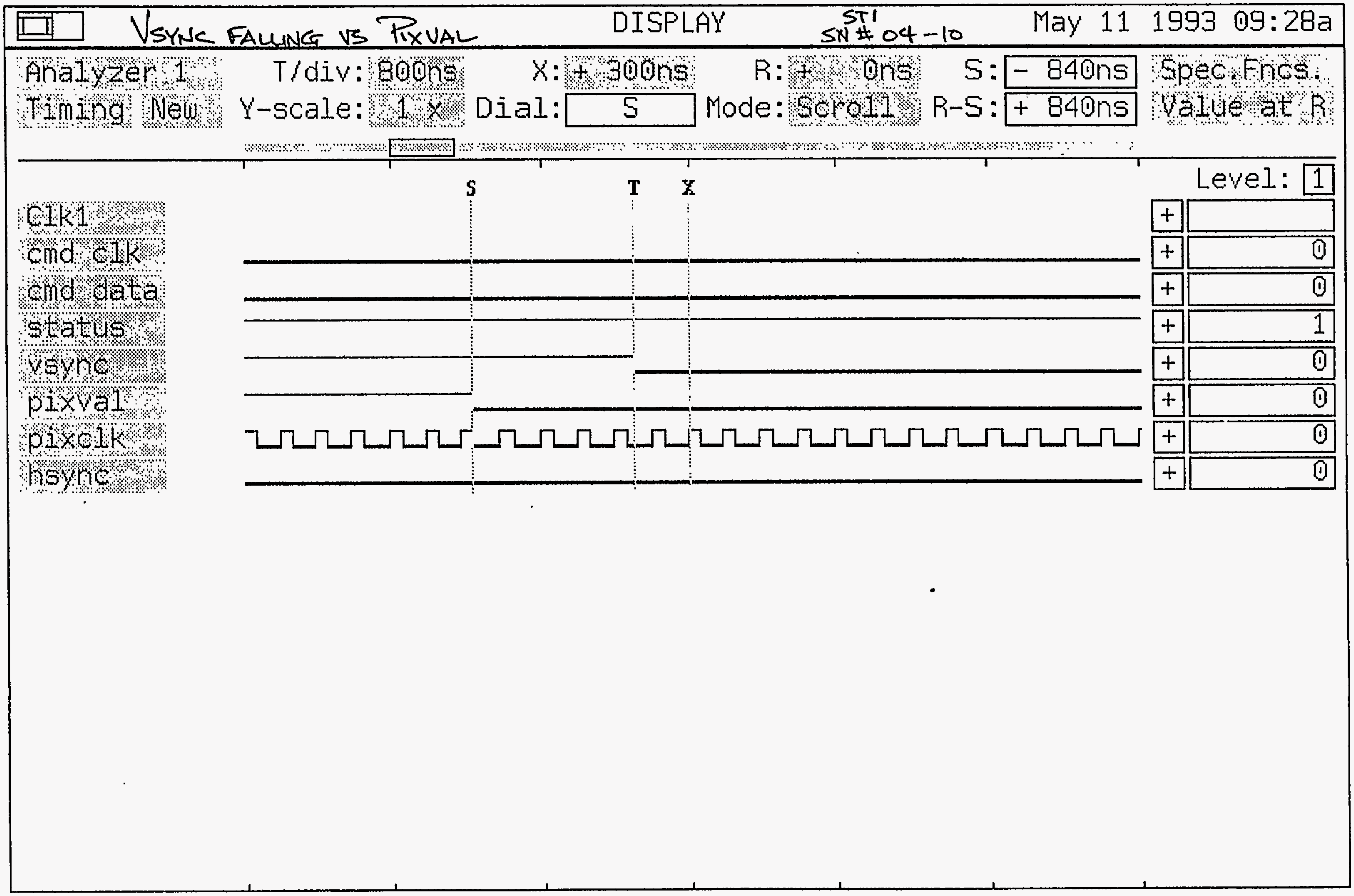
REMEMBER to attach your recorded documentation to this test procedure!
(A document protector is advised)



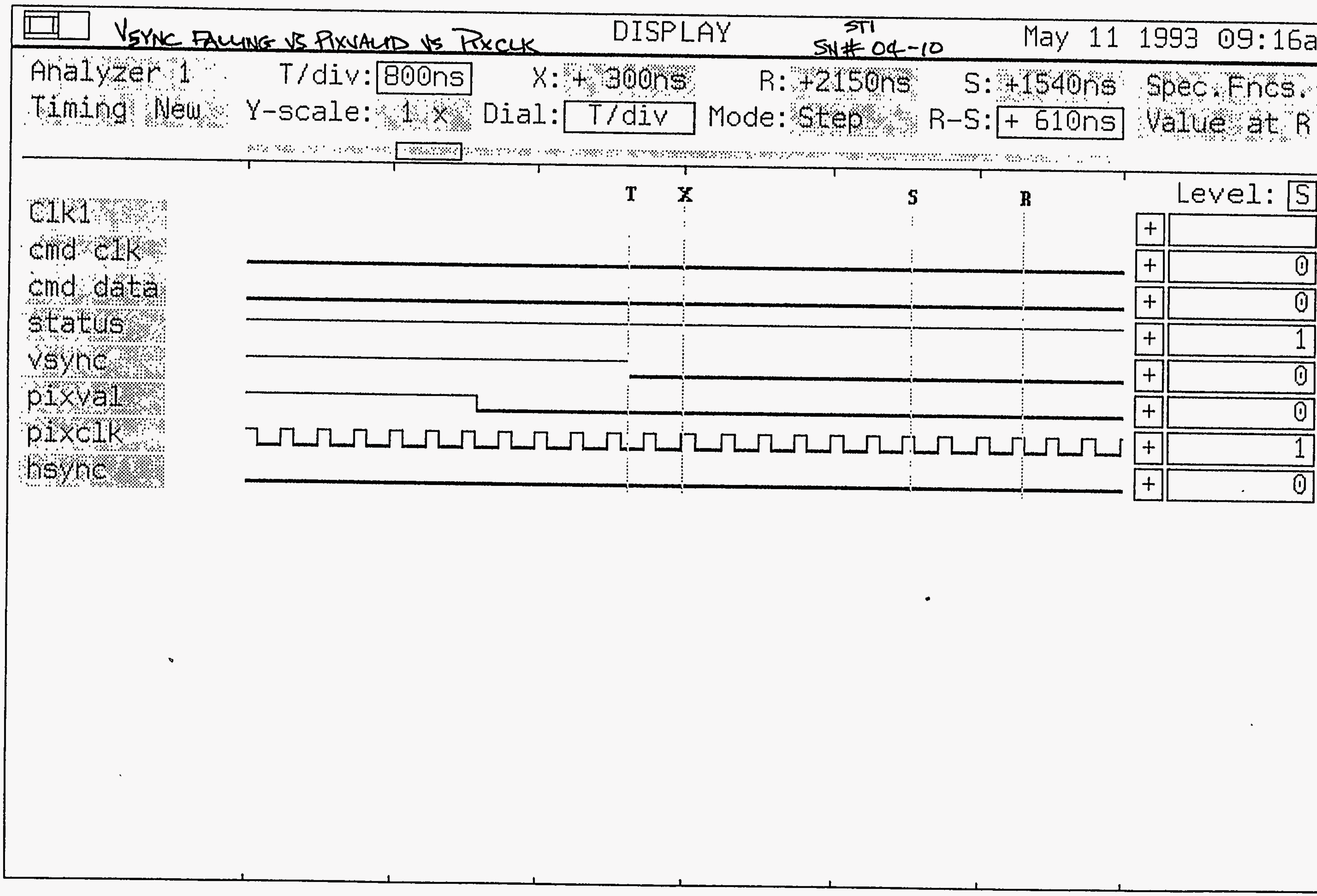
Philips PM3580/PM3585



Philips PM3580/PM3585

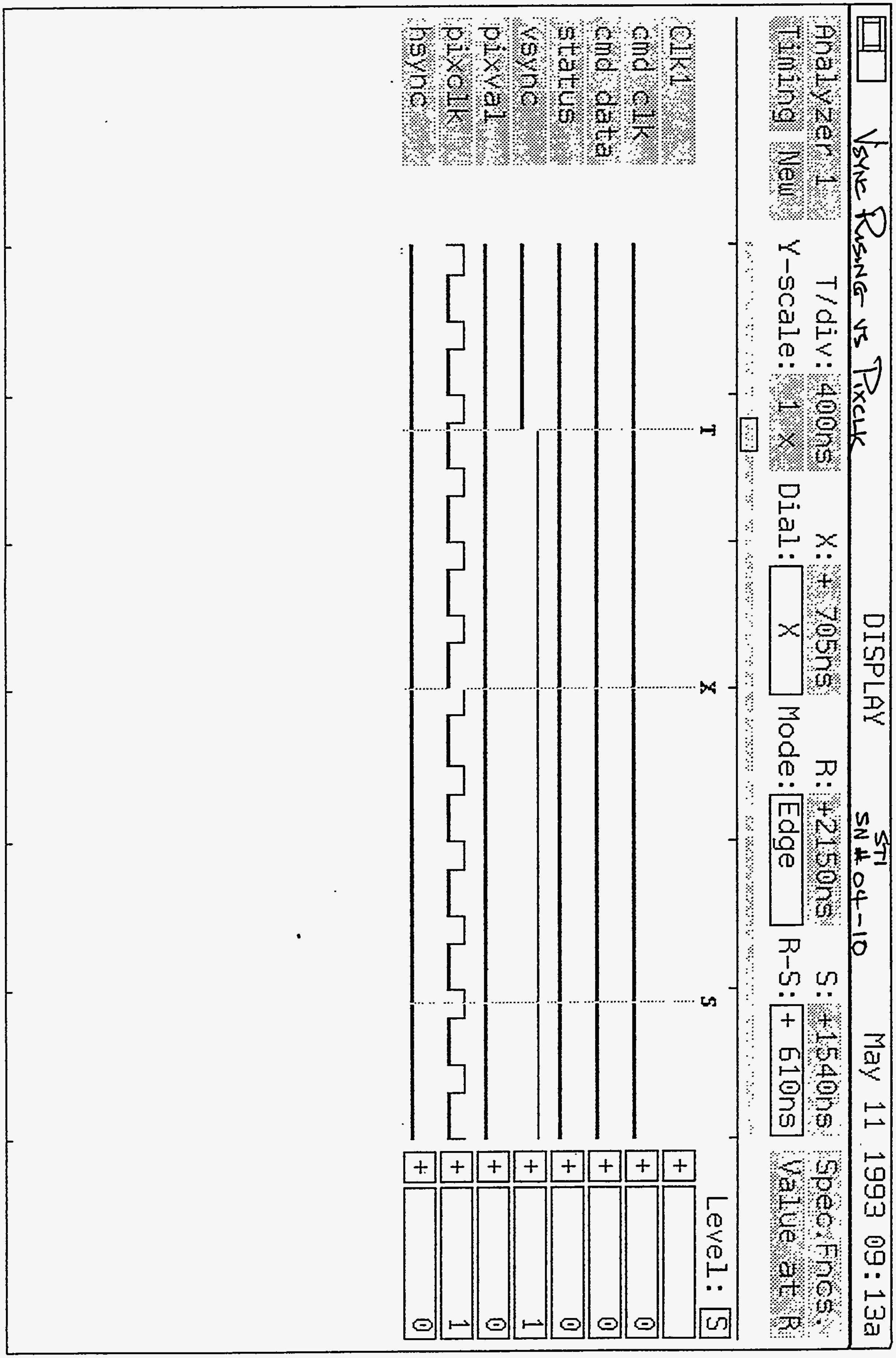


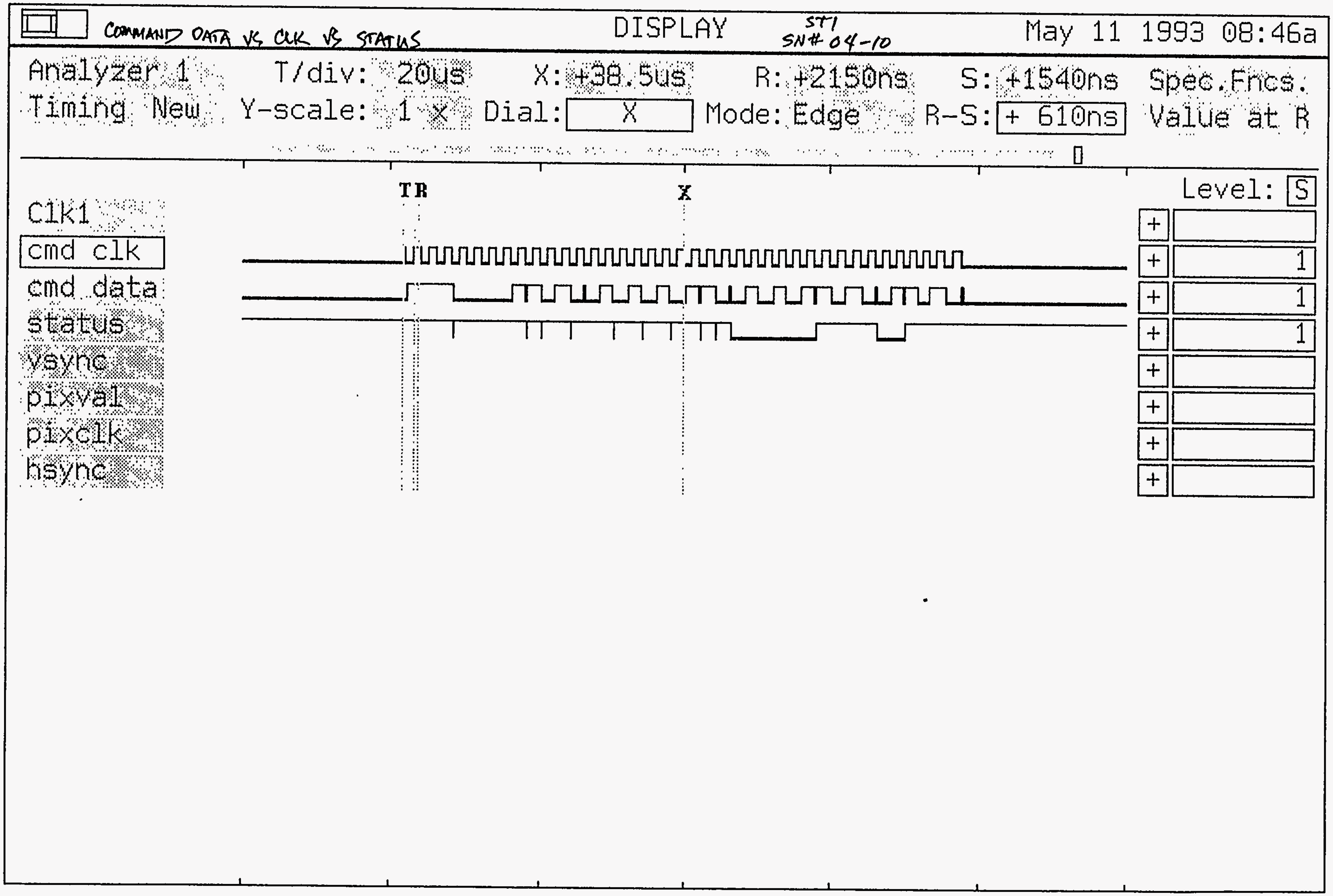
Philips PM3580/PM3585



Philips PM3580/PM3585

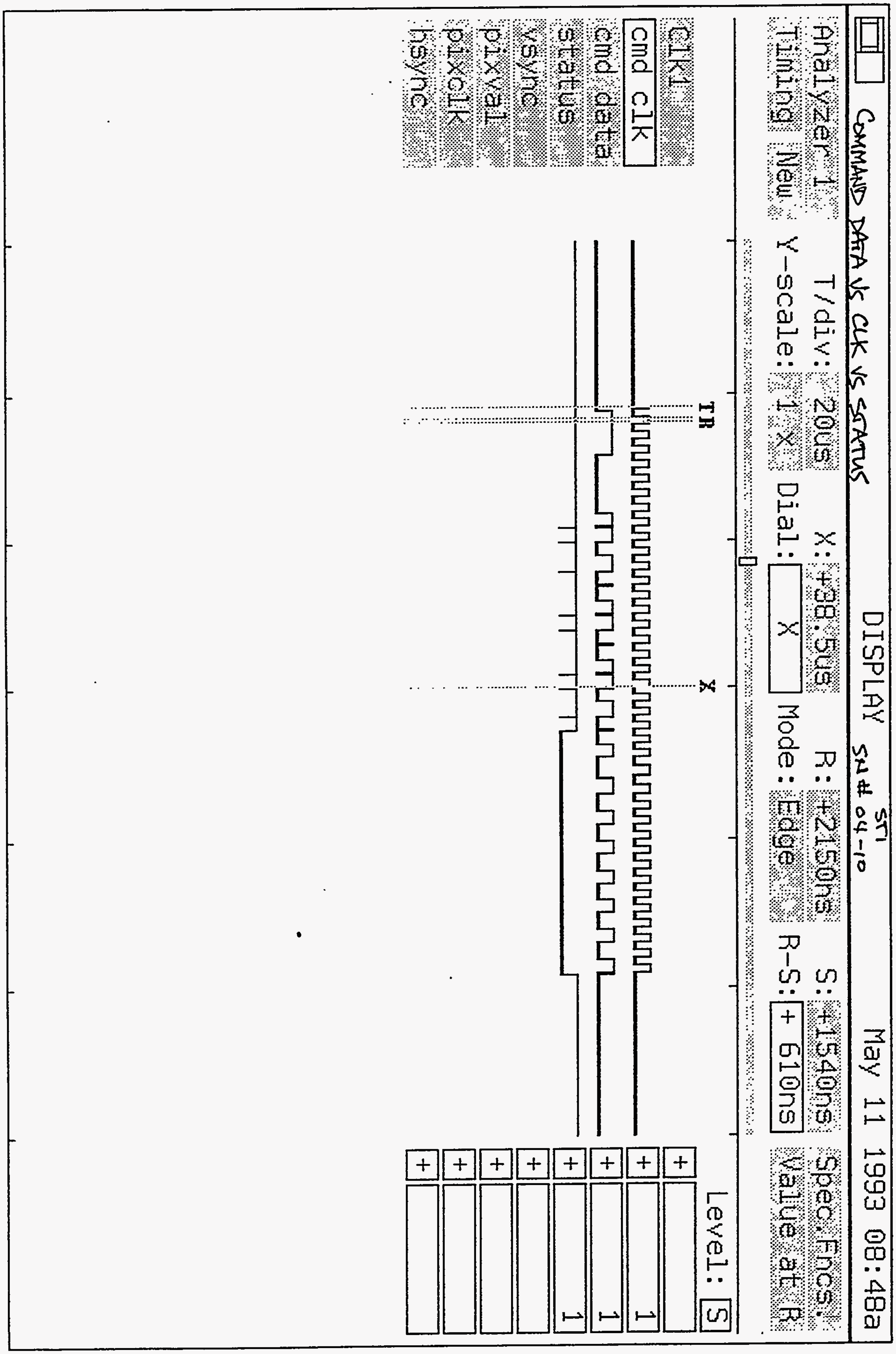
Philips PM3580/PM3585

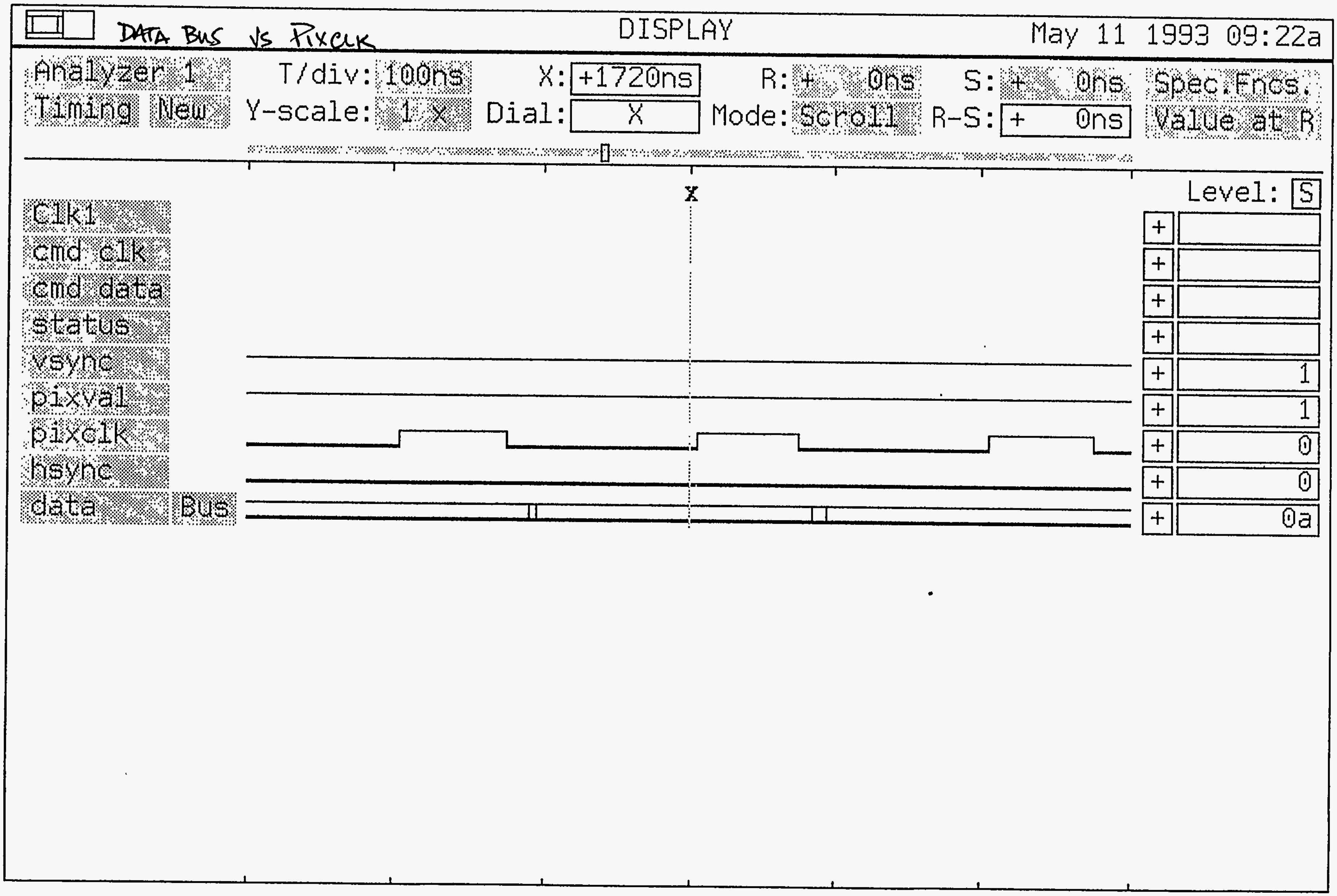




Philips PM3580/PM3585

Philips PM3580/PM3585



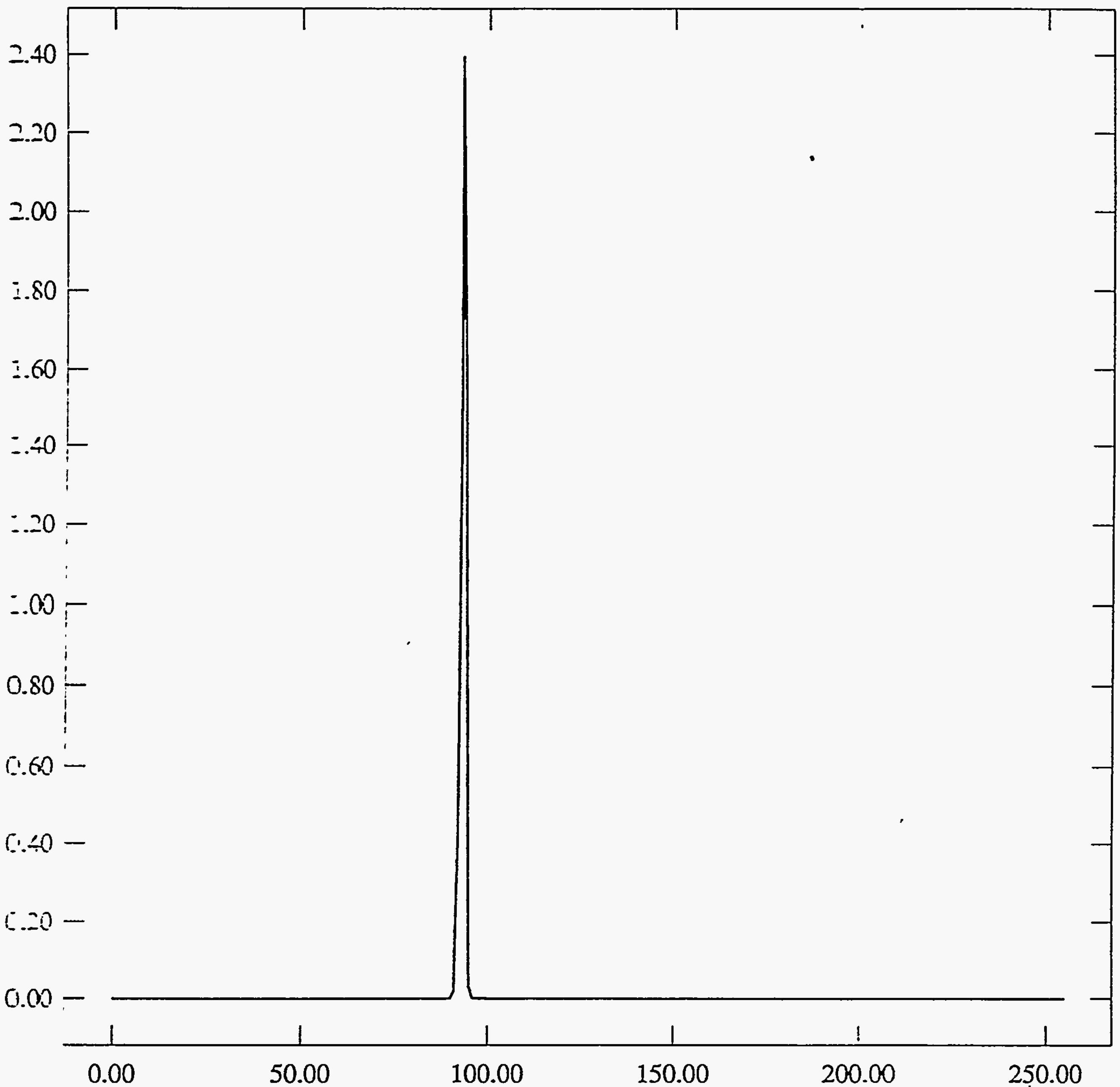


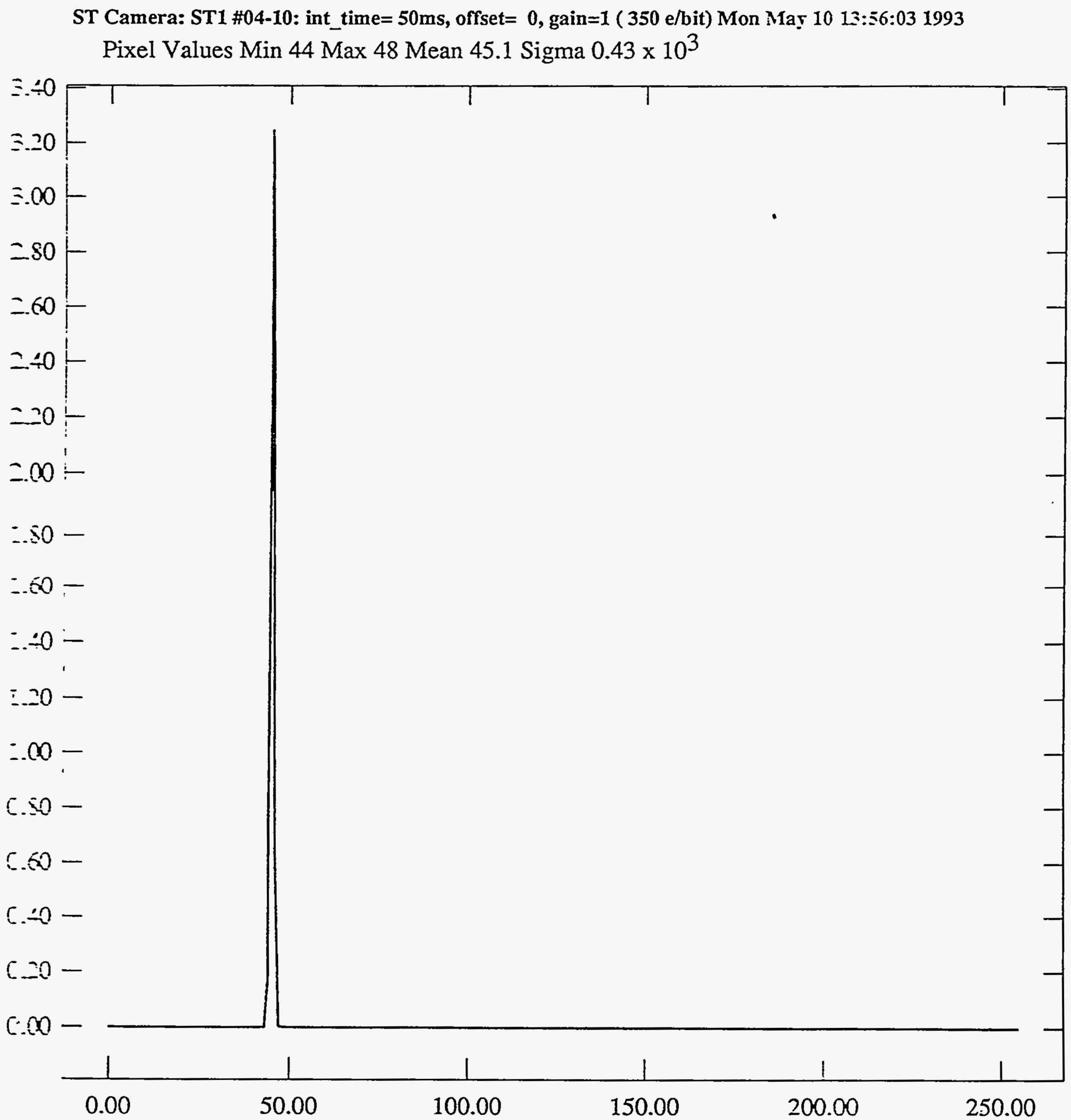
Philips PM3580/PM3585

PRETHERMAL W/ F = [illegible]

ST Camera: ST1 #04-10: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Mon May 10 13:56:45 1993

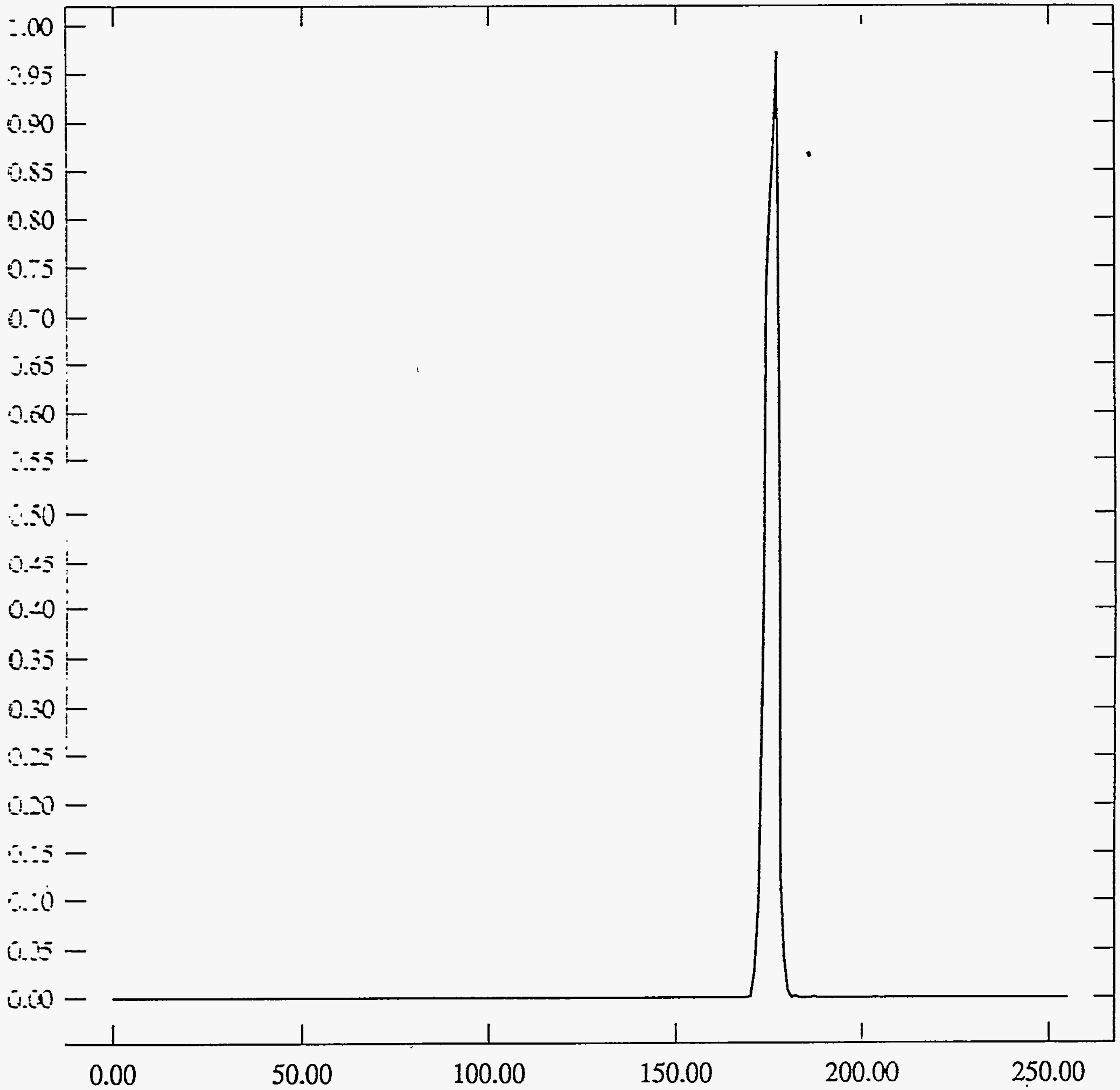
Pixel Values Min 91 Max 99 Mean 93.2 Sigma 0.65 x 10^3




ST Camera: ST1 #04-10: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Mon May 10 13:56:03 1993
Pixel Values Min 44 Max 48 Mean 45.1 Sigma 0.43 x 10^3
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1 #04-10: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Mon May 10 13:57:21 1993

Pixel Values Min 170 Max 187 Mean 175.4 Sigma 1.55 x 10^3



11. Dark Noise Measurements.

This measurement requires only the SUN Datacube Test Station and its image processing capabilities and an opaque covering.

Remove all test probes and place an opaque cover over the test CCD. turn the camera on and collect the dark frames as quickly as possible and record histograms.

Verify the gain of the camera is 4(75e/bit) and the integration time is 50msec and offset is 0 via the SASI.
Make the same measurement at gain level 2(150e/bit) and 1(350e/bit).

Fill in the Mu/Sigma values in the table below:

Gain (e/Bit)	Expected Average Black Level	Measured Average Black Level	Expected Histogram Sigma	Measured Histogram Sigma
4(75e/bit)	160		1.2	
2(150e/bit)	~~750~~		0.7	
1(350e/bit)	32	45.1	0.5	.43 ~~[illegible]~~ OK MD

SN# 04-06 By MD (initials) Date 5/10/02 (passed)

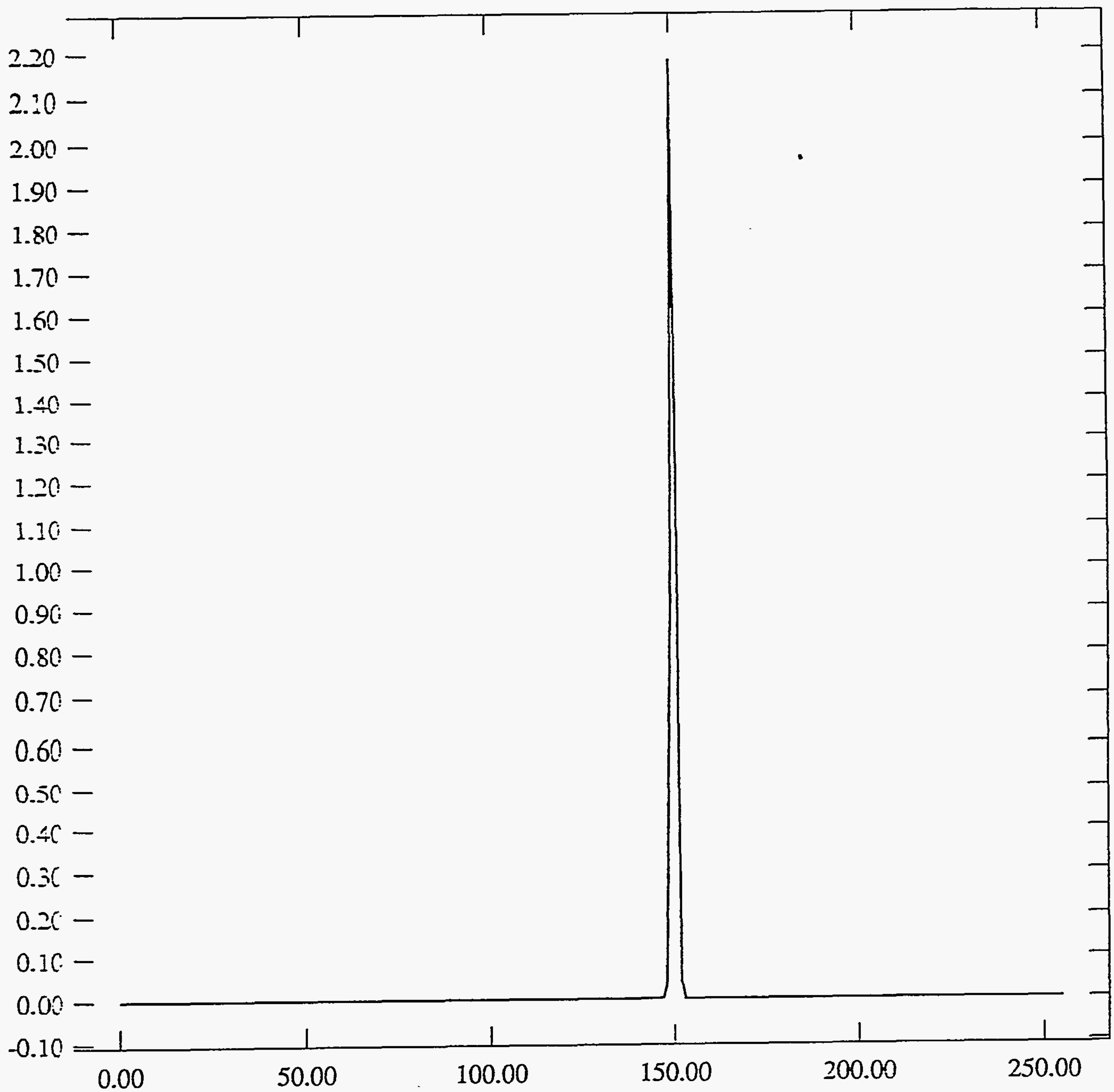
Turn off the test fixture.

REMEMBER to attach your recorded documentation to this test procedure!
(A document protector is advised)

	TEMP (degrees C)	50ms/mu	50ms/sigma	100ms/mu	100ms/sigma	200ms/mu	200ms/sigma	NOTES:
1								
2	-20	150.00	0.72	150.10	0.72	150.40	0.72	5/10/93
3	-10	148.20	0.78	148.70	0.71	149.90	0.70	Flight F.0. CCD#1
4	0	147.70	0.84	149.10	0.66	152.10	0.94	
5	10	149.80	0.70	154.00	1.17	163.10	1.16	75e/bit
6	20	159.00	0.99	169.60	1.33	190.70	2.26	R49=100Ω
7	30	185.10	1.26	211.60	2.44			

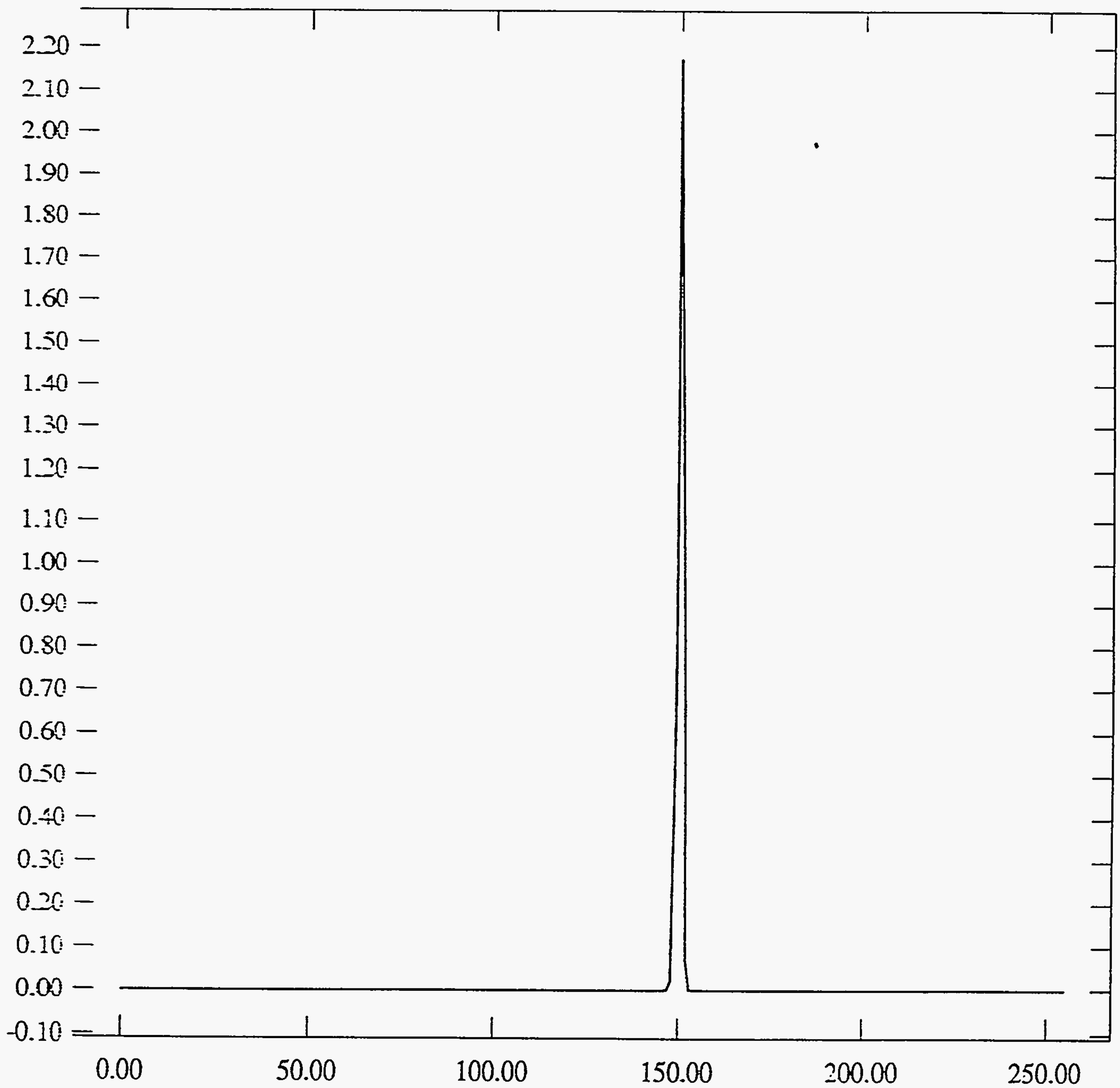
ST Camera: ST1#04-10 -20C: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Mon May 10 15:48:16 1993

Pixel Values Min 147 Max 152 Mean 150.0 Sigma 0.72 x 10^3



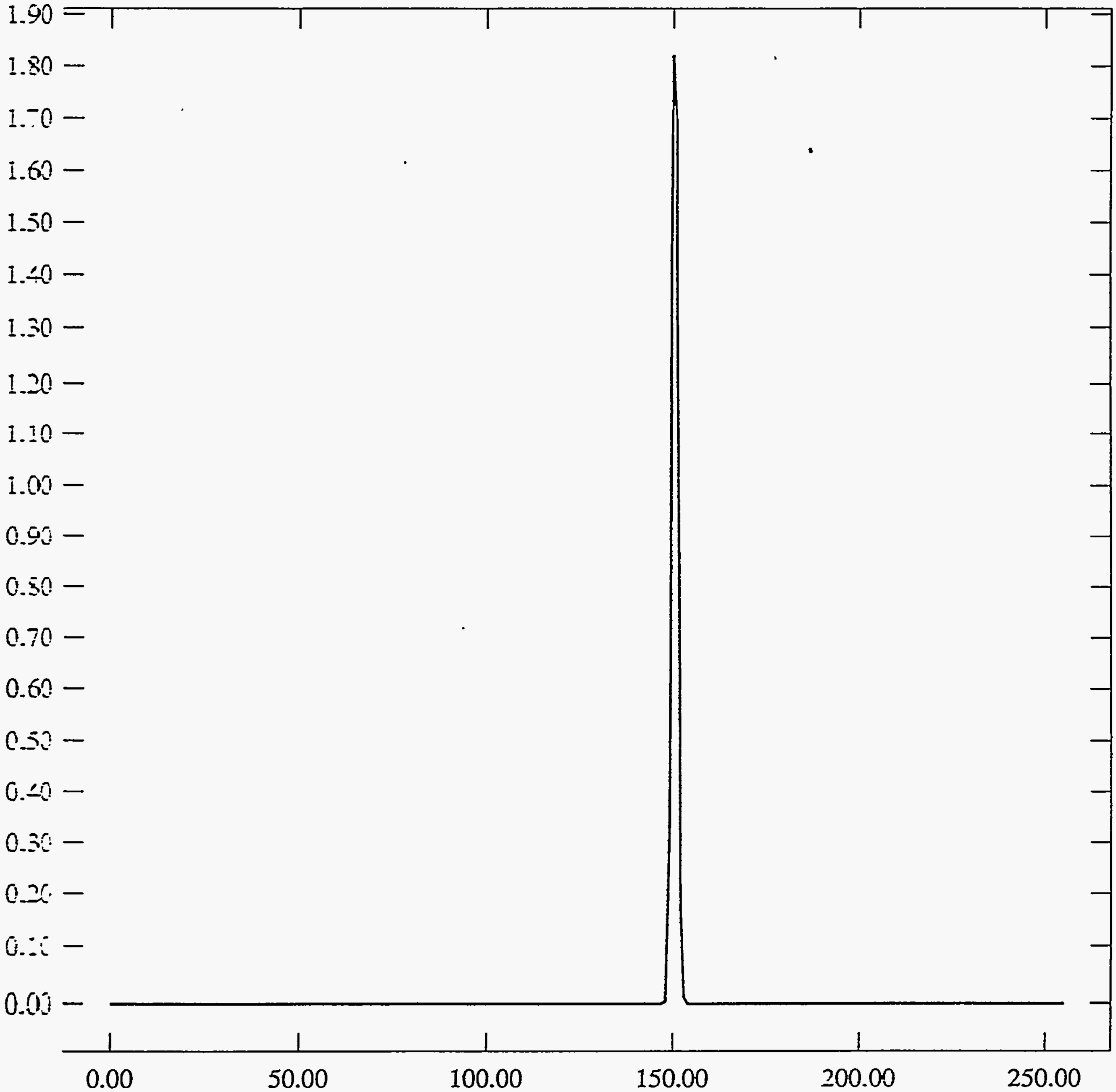
ST Camera: ST1#04-10 -20C: int_time=100ms, offset= 0, gain=4 (75 e/bit) Mon May 10 15:48:46 1993

Pixel Values Min 147 Max 153 Mean 150.1 Sigma 0.72 x 10^3



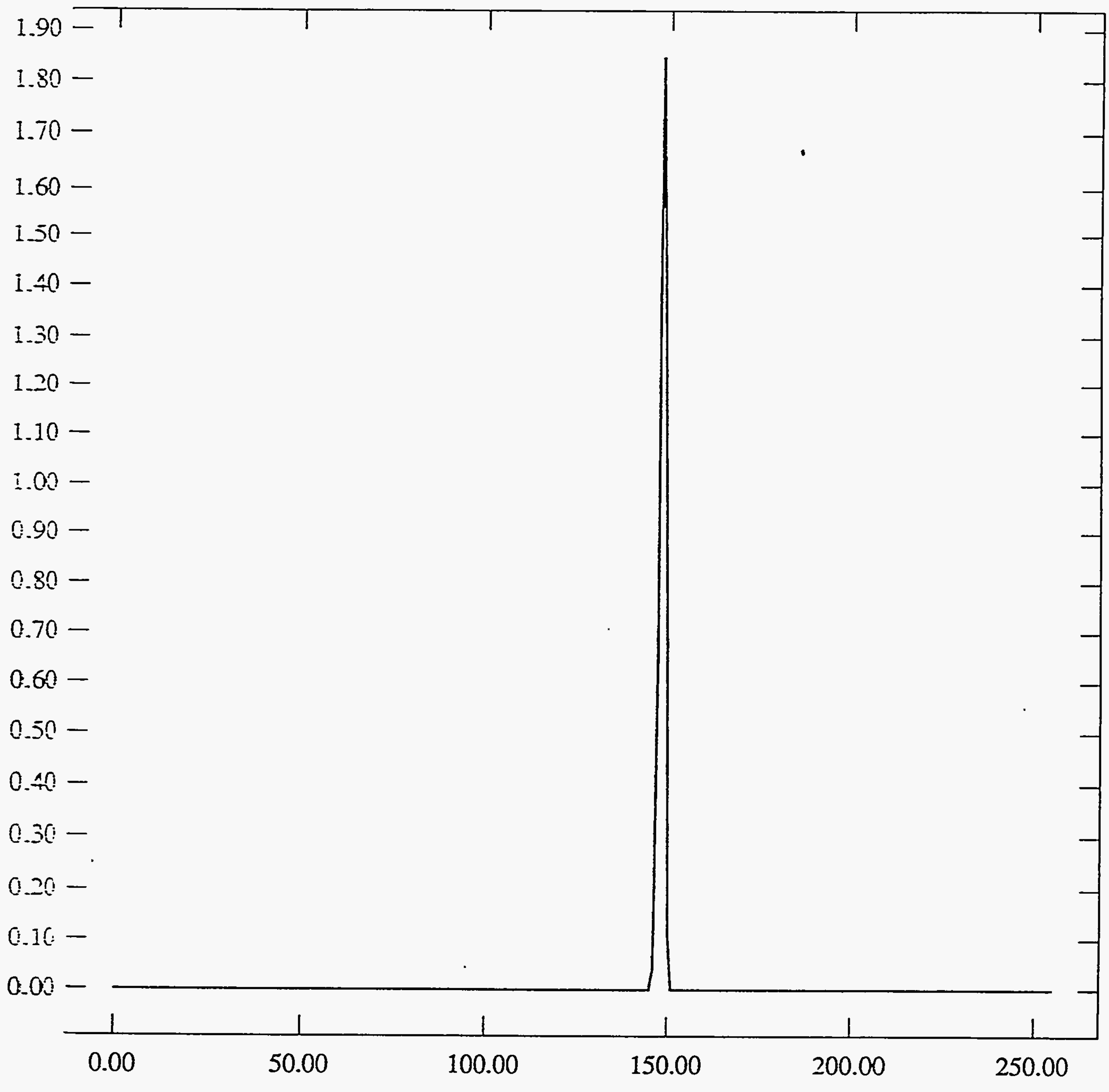
ST Camera: ST1#04-10 -20C: int_time=200ms, offset= 0, gain=4 (75 e/bit) Mon May 10 15:49:18 1993

Pixel Values Min 148 Max 153 Mean 150.4 Sigma 0.72 x 10^3



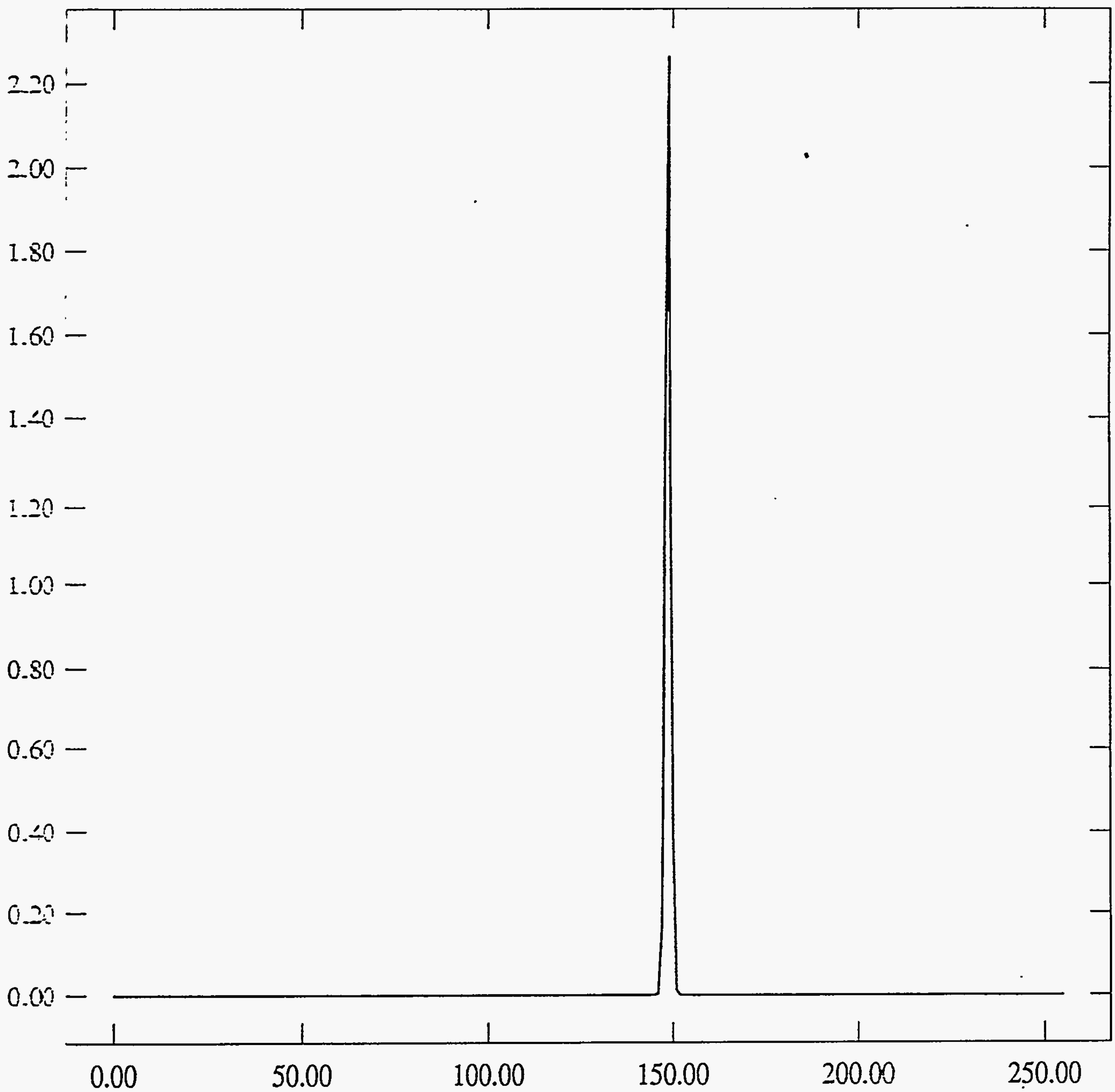
ST Camera: ST1#04-10 -10C: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Mon May 10 16:12:44 1993

Pixel Values Min 146 Max 150 Mean 148.2 Sigma 0.78 x 10^3



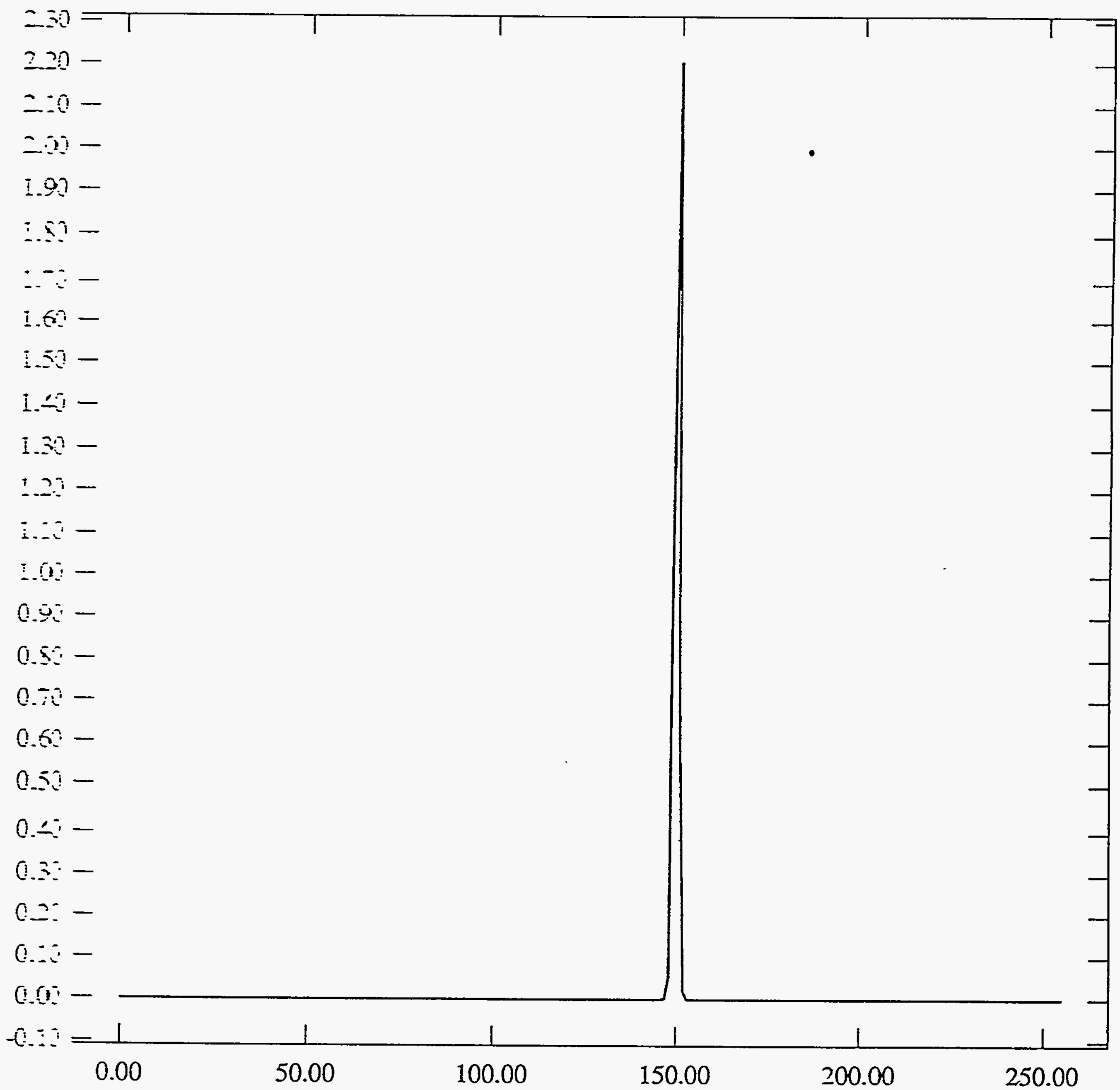
ST Camera: ST1#04-10 -10C: int_time=100ms, offset= 0, gain=4 (75 e/bit) Mon May 10 16:13:24 1993

Pixel Values Min 146 Max 151 Mean 148.7 Sigma 0.71 x 10^3



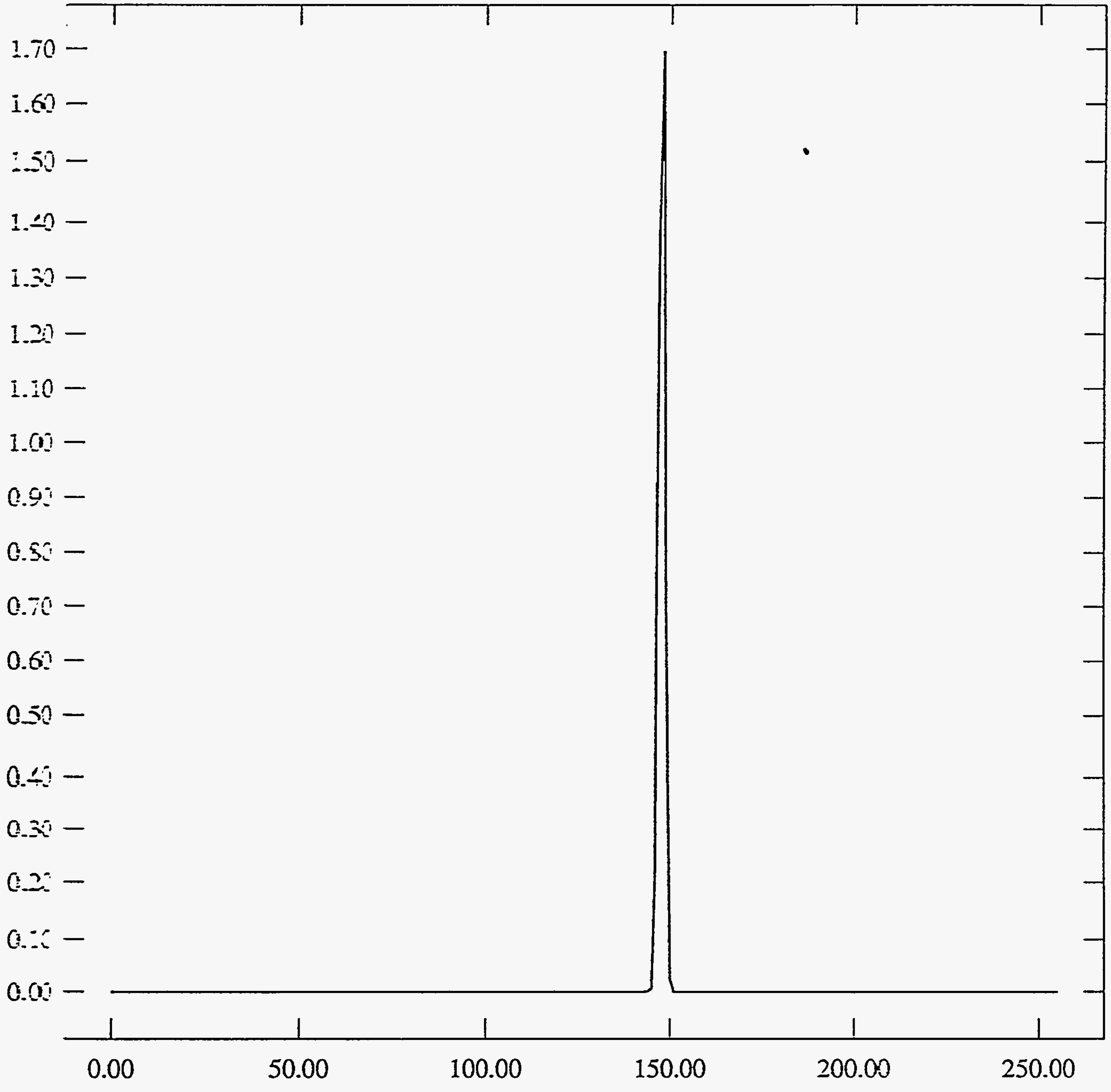
ST Camera: ST1#04-10 -10C: int_time=200ms, offset= 0, gain=4 (75 e/bit) Mon May 10 16:14:04 1993

Pixel Values Min 147 Max 152 Mean 149.9 Sigma 0.70 x 10^3



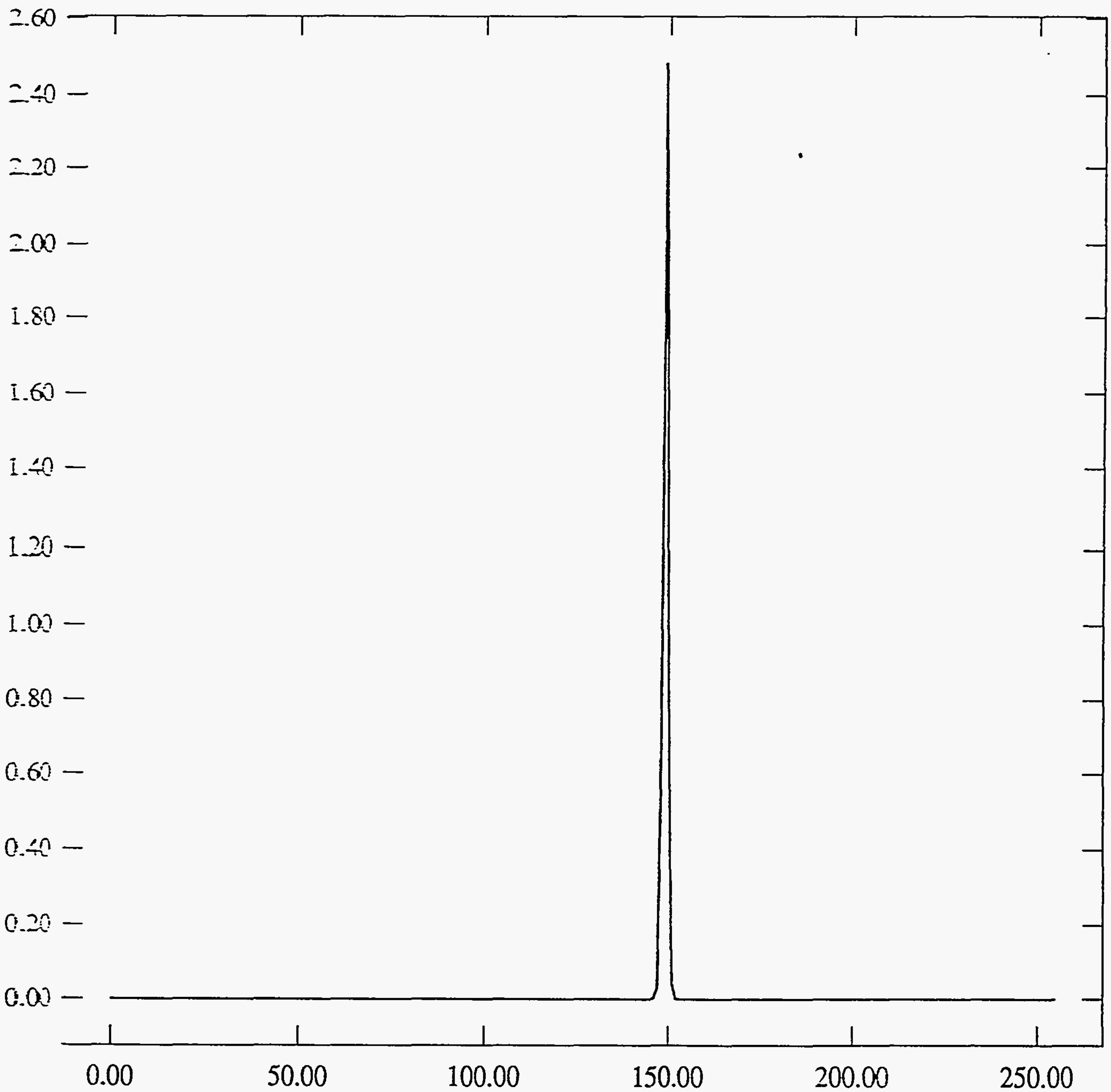
ST Camera: ST1#04-10 0C: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Mon May 10 16:43:29 1993

Pixel Values Min 144 Max 150 Mean 147.7 Sigma 0.84 x 10^3



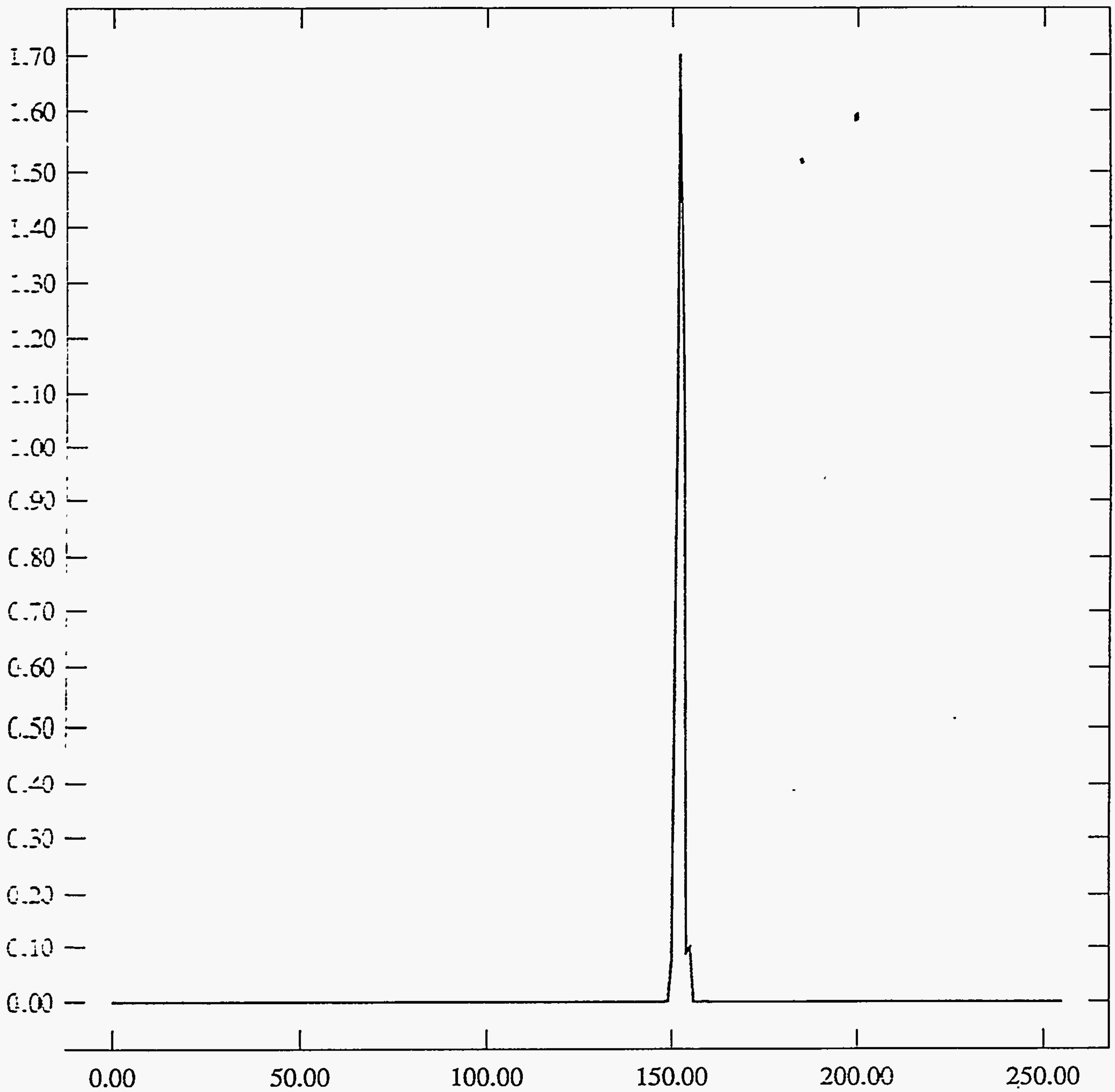
ST Camera: ST1#04-10 0C: int_time=100ms, offset= 0, gain=4 (75 e/bit) Mon May 10 16:44:01 1993

Pixel Values Min 146 Max 152 Mean 149.1 Sigma 0.66 x 10^3



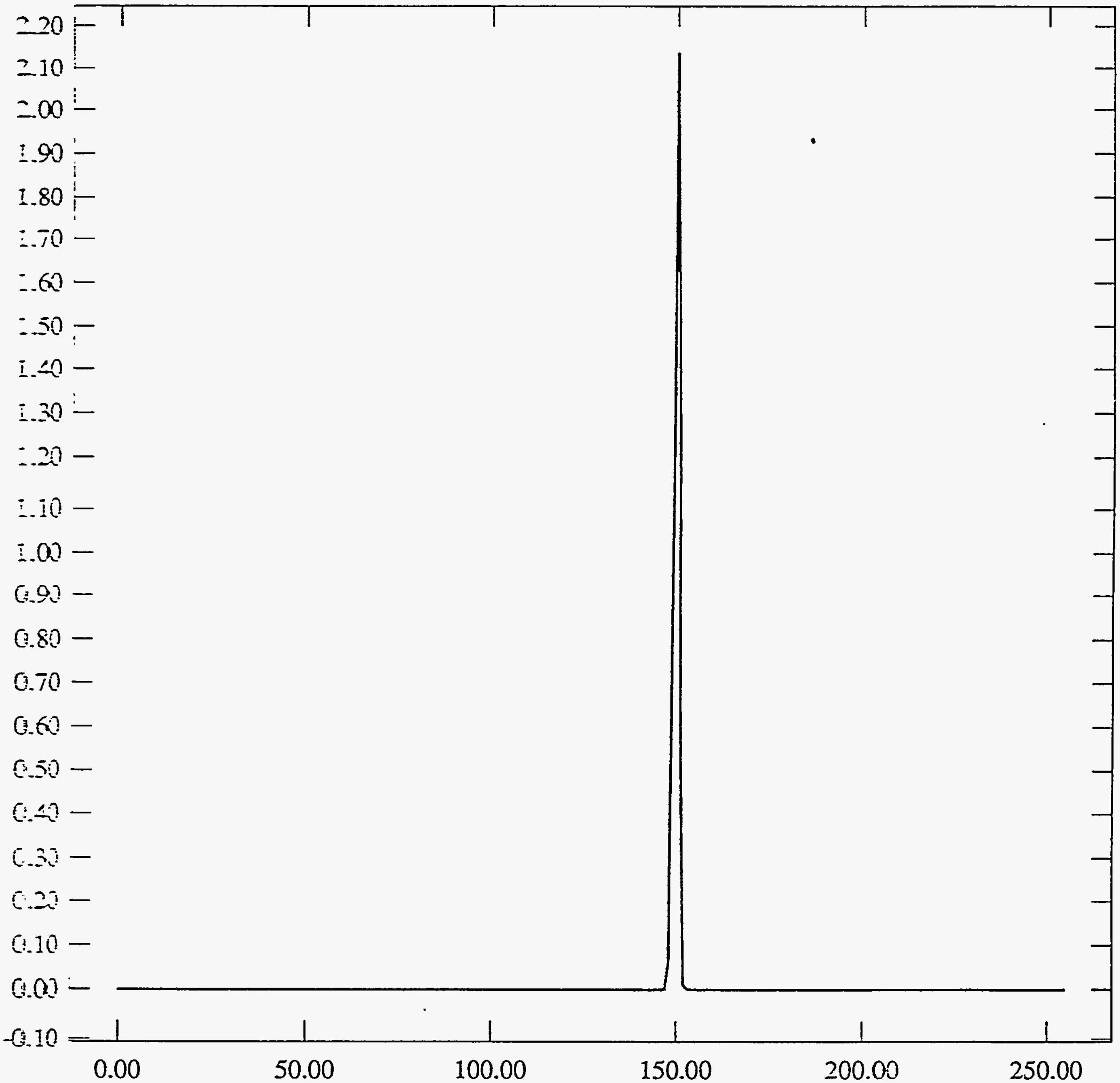
ST Camera: ST1#04-10 0C: int_time=200ms, offset= 0, gain=4 (75 e/bit) Mon May 10 16:44:32 1993

Pixel Values Min 149 Max 159 Mean 152.1 Sigma 0.94 x 10^3



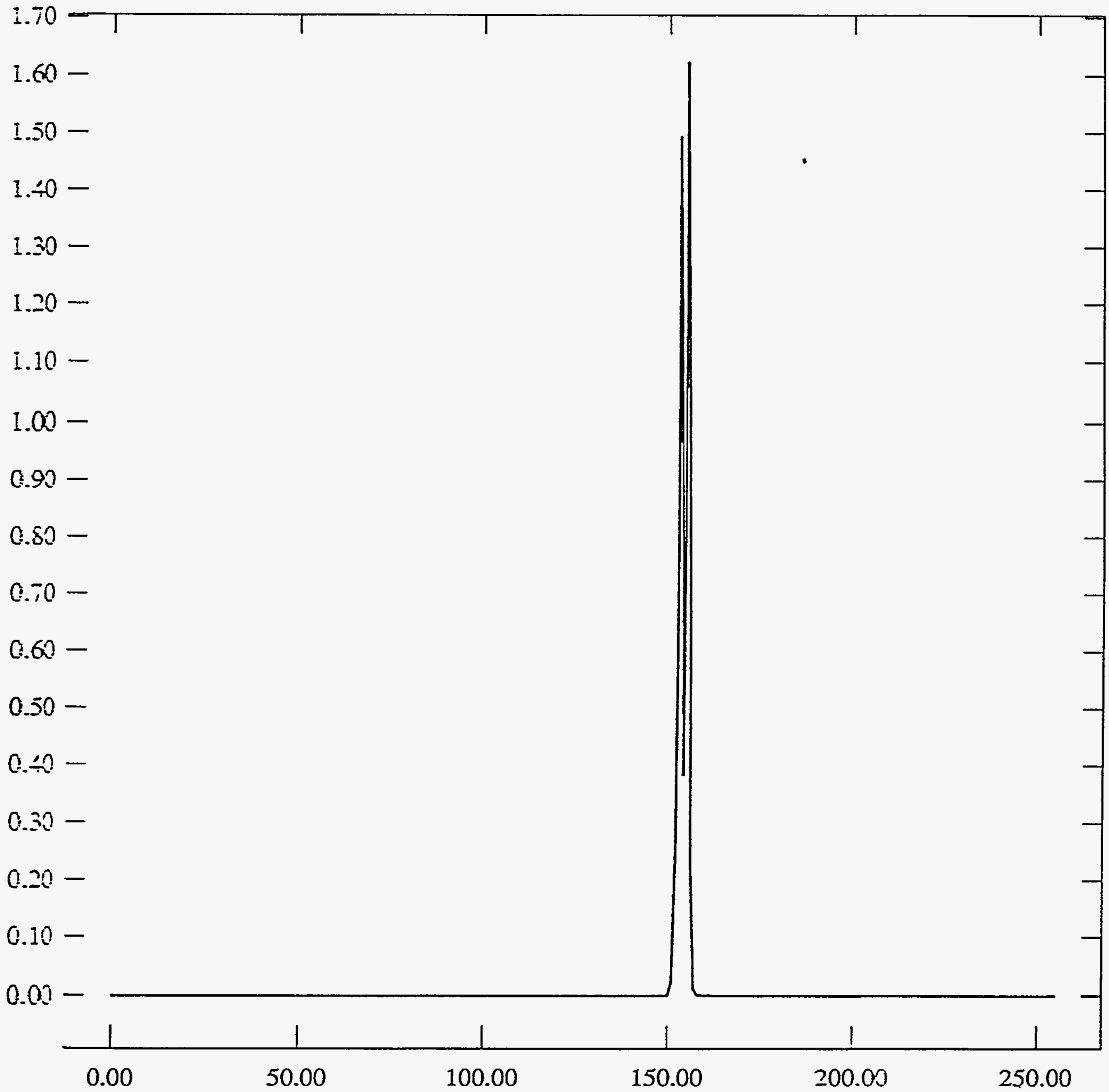
ST Camera: ST1#04-10 10C: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Mon May 10 17:06:57 1993

Pixel Values Min 147 Max 153 Mean 149.8 Sigma 0.70 x 10^3



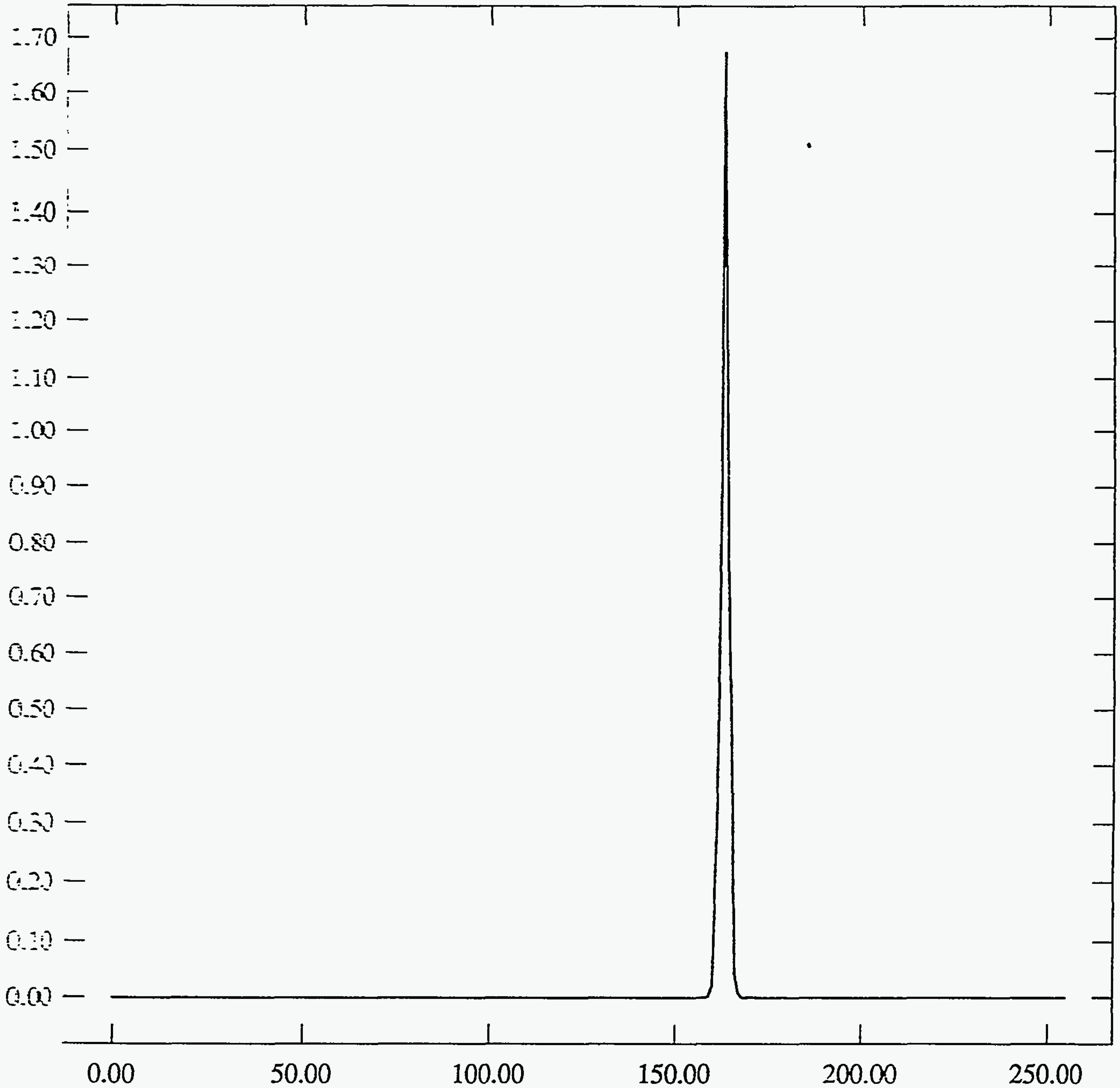
ST Camera: ST1#04-10 10C: int_time=100ms, offset= 0, gain=4 (75 e/bit) Mon May 10 17:08:39 1993

Pixel Values Min 151 Max 161 Mean 154.0 Sigma 1.17 x 10^3



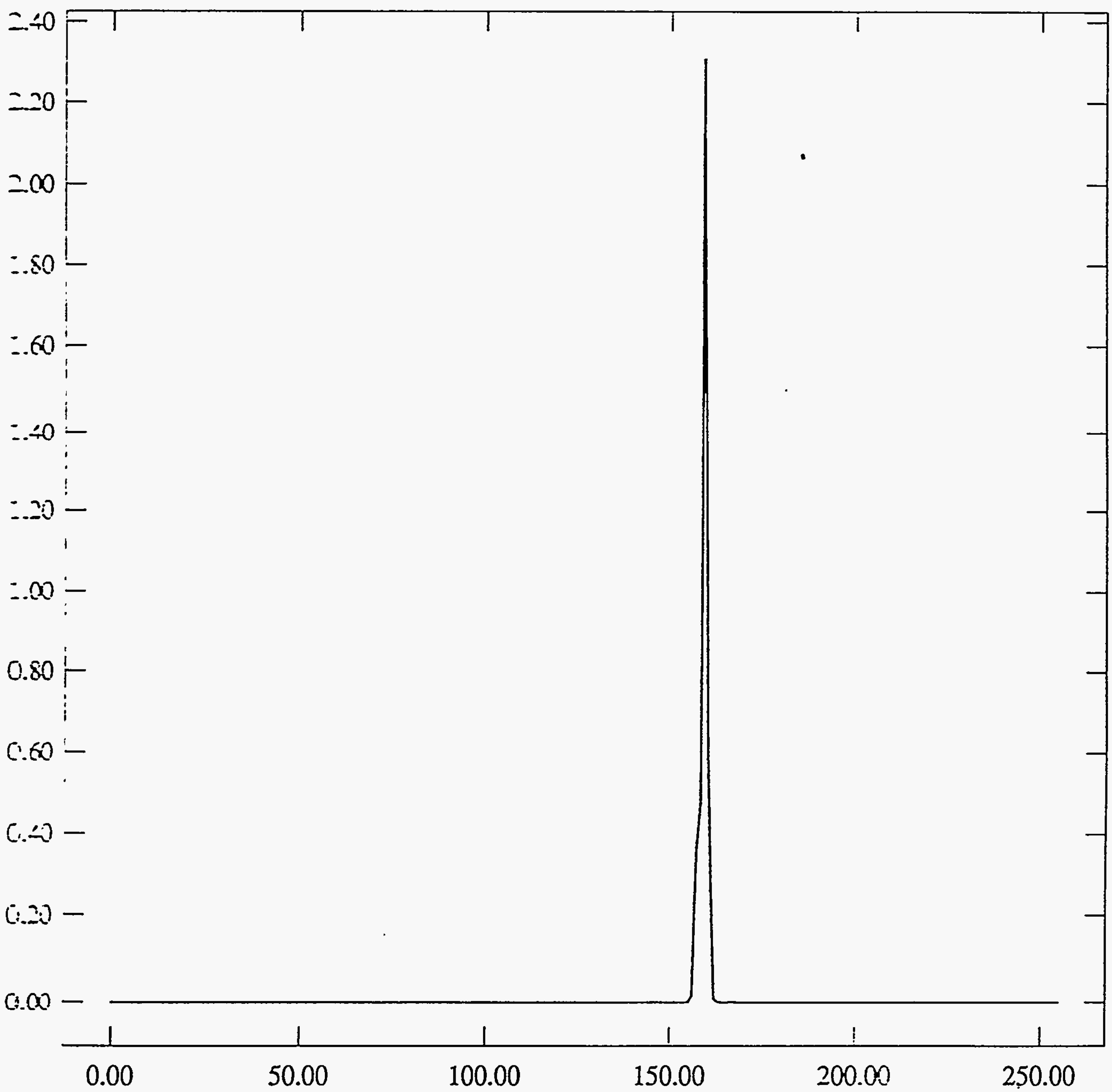
ST Camera: ST1#04-10 10C: int_time=200ms, offset= 0, gain=4 (75 e/bit) Mon May 10 17:11:04 1993

Pixel Values Min 159 Max 179 Mean 163.1 Sigma 1.16 x 10^3



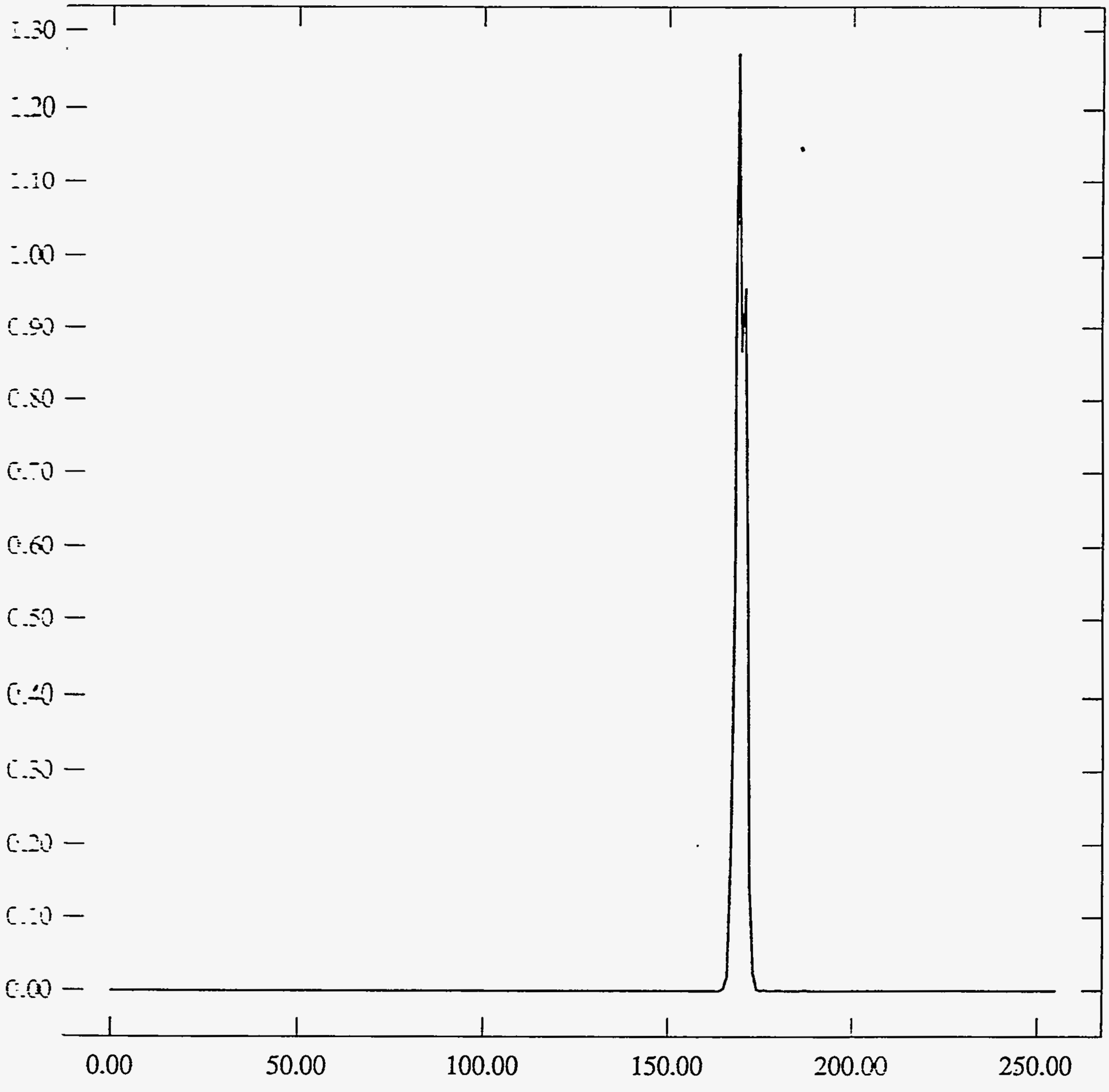
ST Camera: ST1#04-10 20C: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Mon May 10 17:25:21 1993

Pixel Values Min 156 Max 167 Mean 159.0 Sigma 0.99 x 10^3



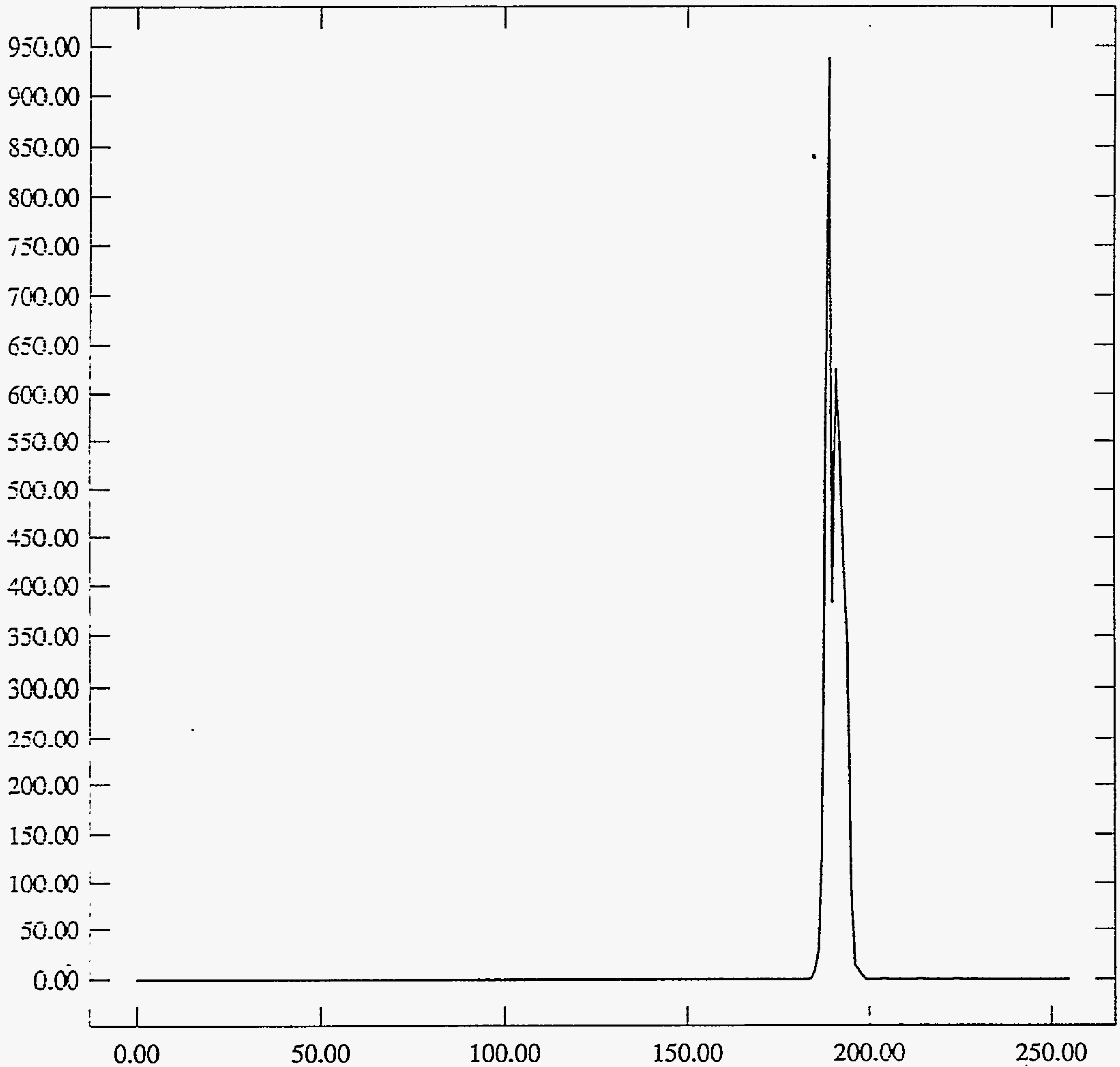
ST Camera: ST1#04-10 20C: int_time=100ms, offset= 0, gain=4 (75 e/bit) Mon May 10 17:25:53 1993

Pixel Values Min 165 Max 187 Mean 169.6 Sigma 1.33 x 10^3



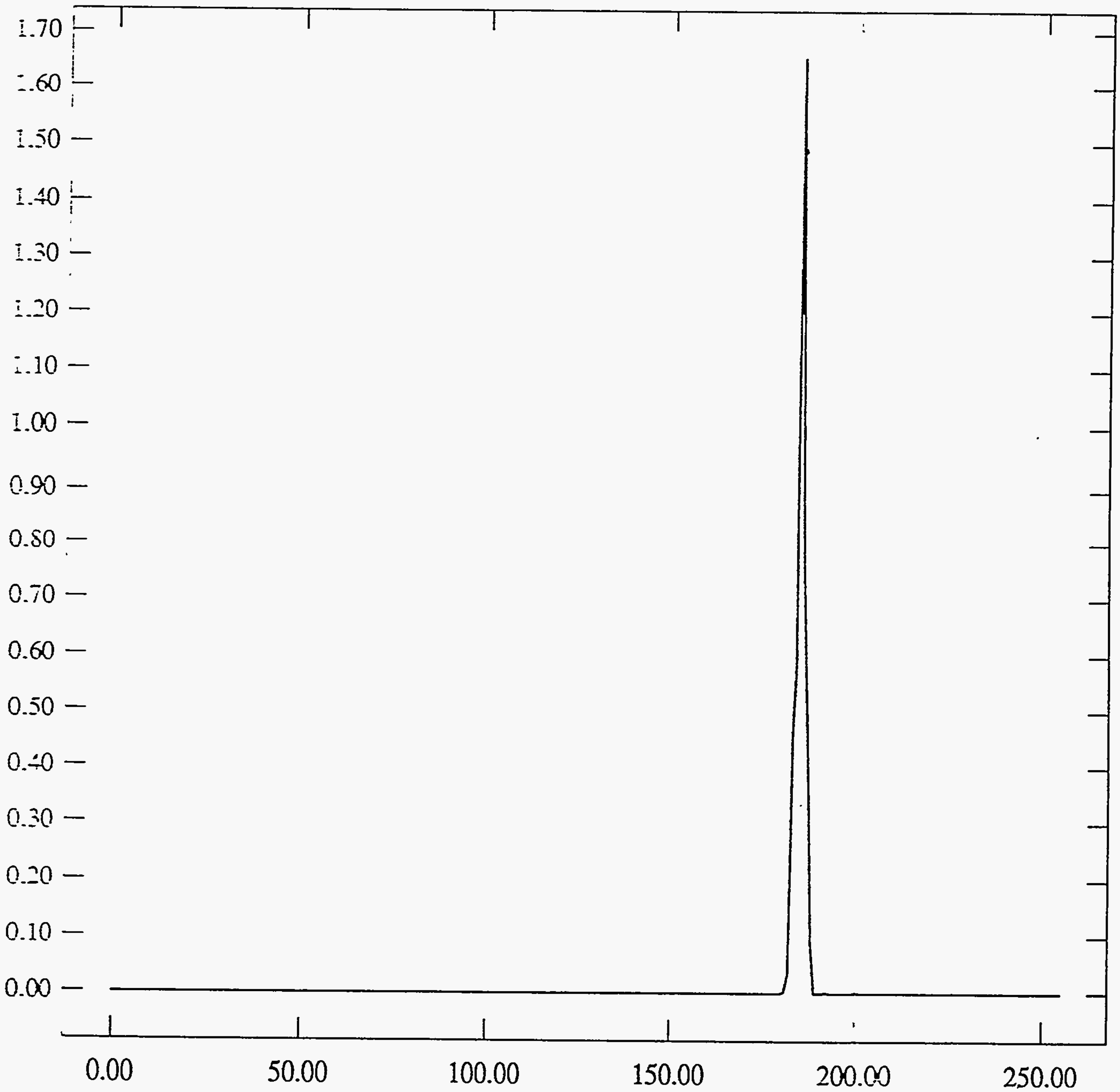
ST Camera: ST1#04-10 20C: int_time=200ms, offset= 0, gain=4 (75 e/bit) Mon May 10 17:26:31 1993

Pixel Values Min 184 Max 224 Mean 190.7 Sigma 2.26



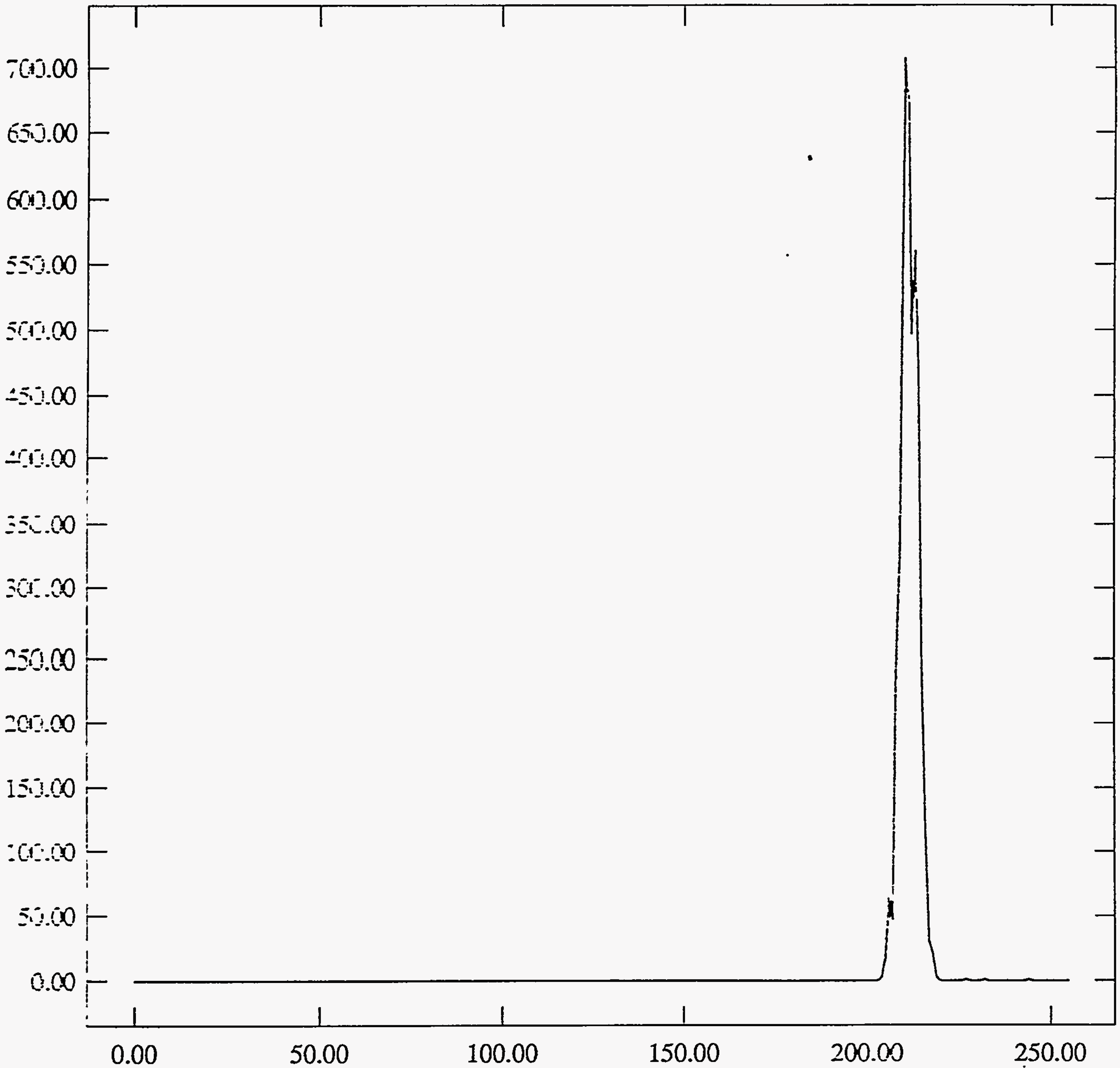
ST Camera: ST1#04-10 30C: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Mon May 10 17:58:33 1993

Pixel Values Min 181 Max 200 Mean 185.1 Sigma 1.26 x 10^3



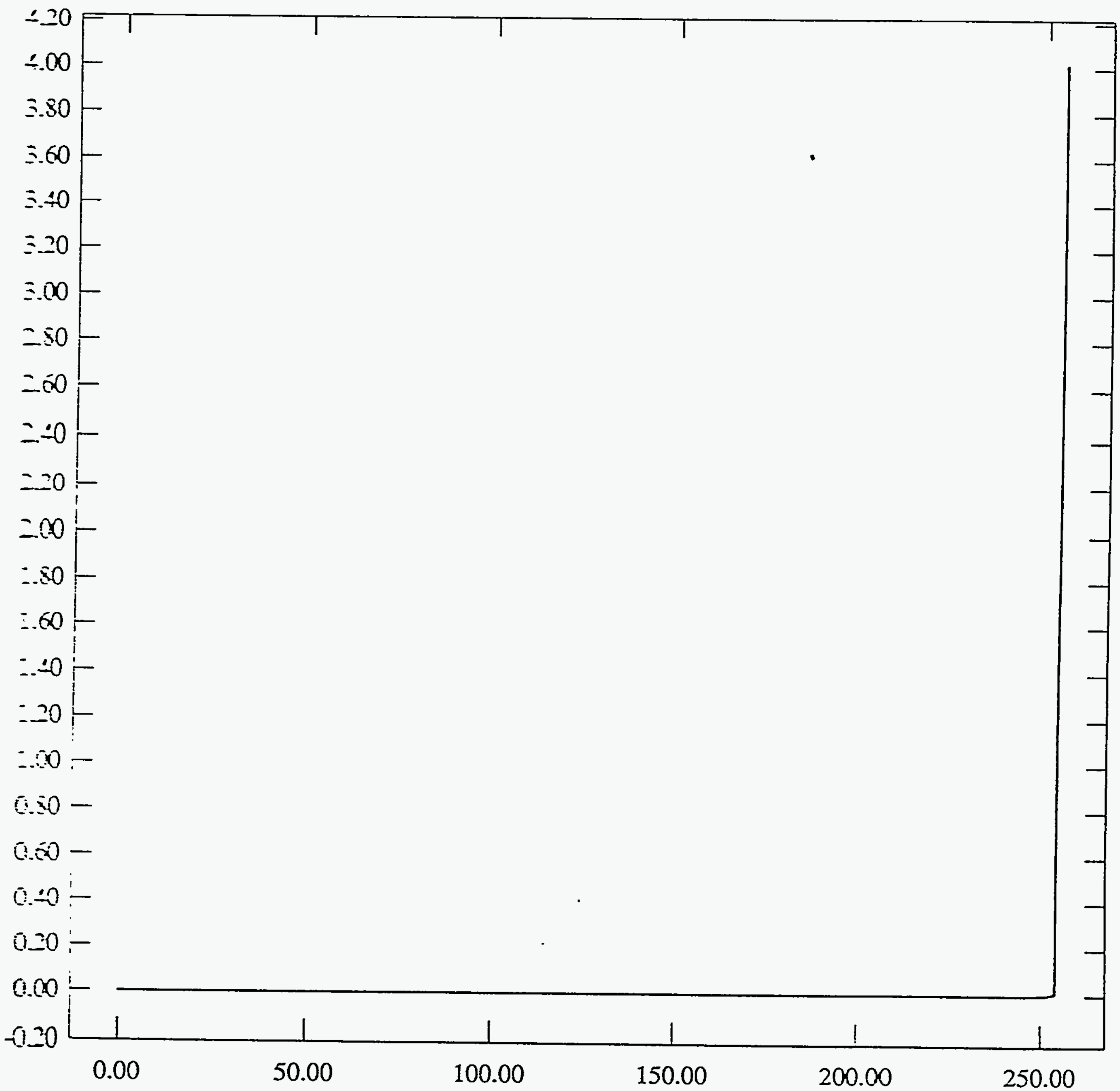
ST Camera: ST1#04-10 30C: int_time=100ms, offset= 0, gain=4 (75 e/bit) Mon May 10 17:59:20 1993

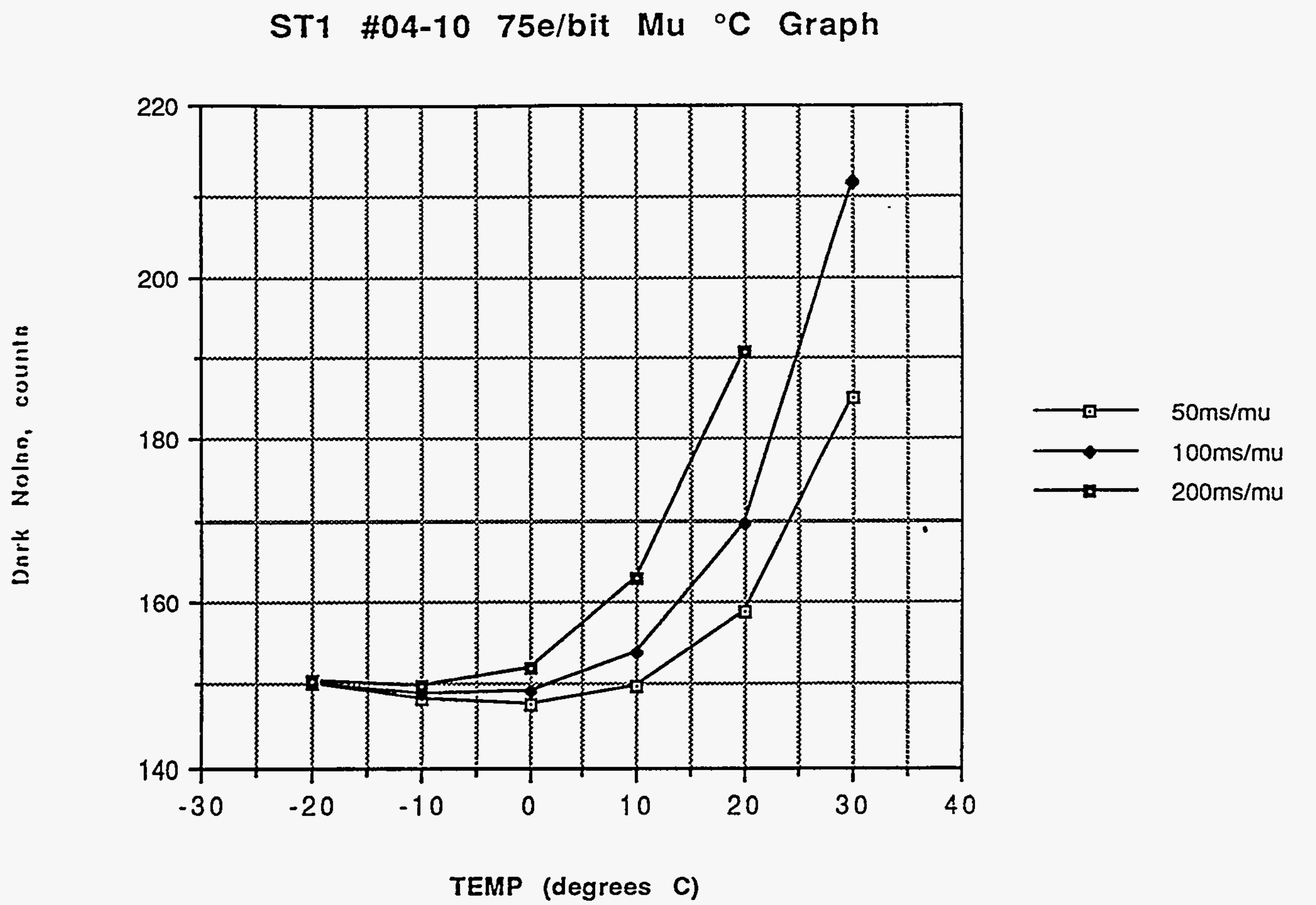
Pixel Values Min 204 Max 244 Mean 211.6 Sigma 2.44



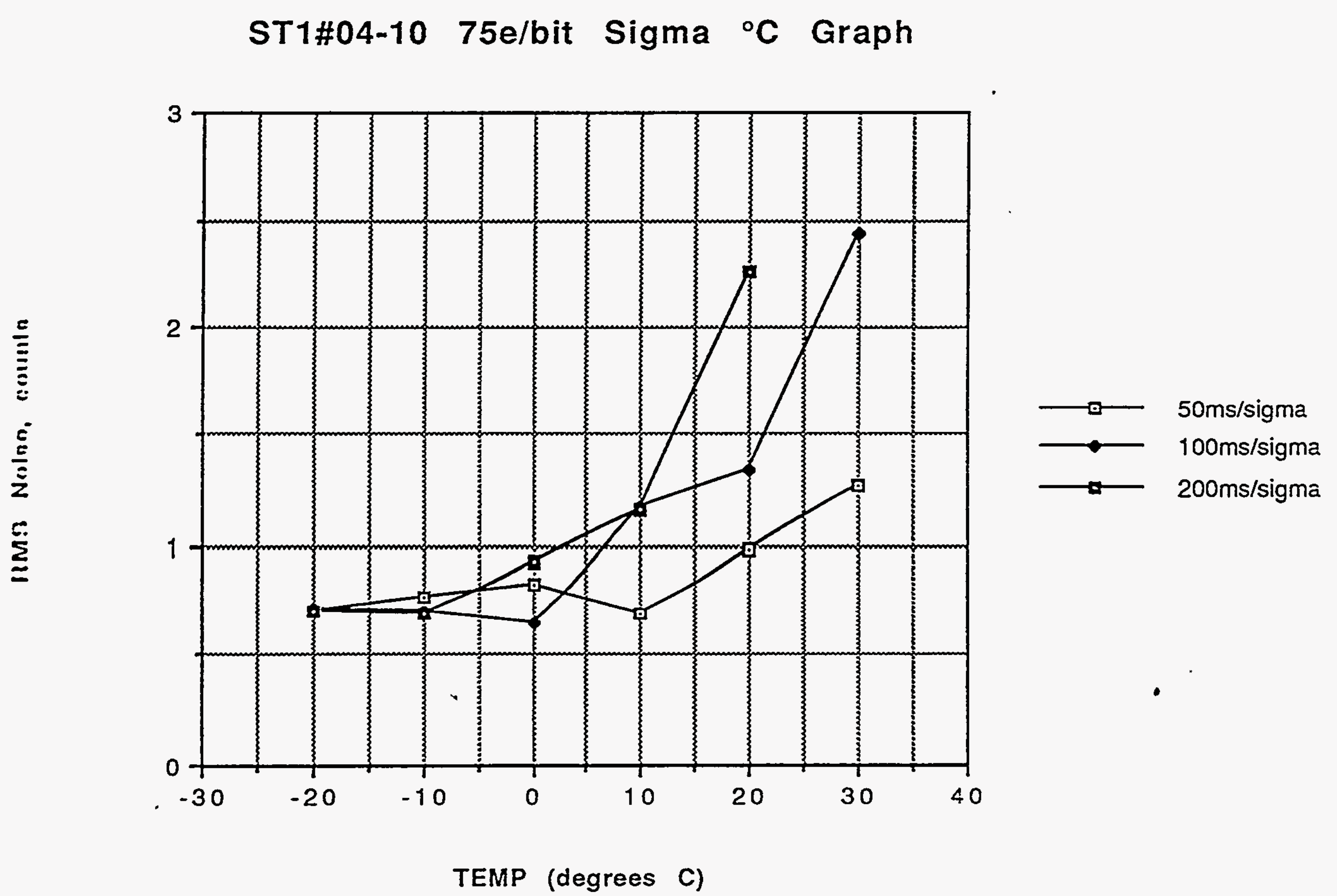
ST Camera: ST1#04-10 30C: int_time=200ms, offset= 0, gain=4 (75 e/bit) Mon May 10 18:00:09 1993

Pixel Values Min 250 Max 255 Mean 255.0 Sigma 0.15 x 10^3





ST1 #04-10 75e/bit Mu °C Graph
Dark Noise, counts
220
200
180
160
140
-30
-20
-10
0
10
20
30
40
TEMP (degrees C)
50ms/mu
100ms/mu
200ms/mu



ST1#04-10 75e/bit Sigma °C Graph
RMS Noise, counts
3
2
1
0
-30
-20
-10
0
10
20
30
40
TEMP (degrees C)
50ms/sigma
100ms/sigma
200ms/sigma

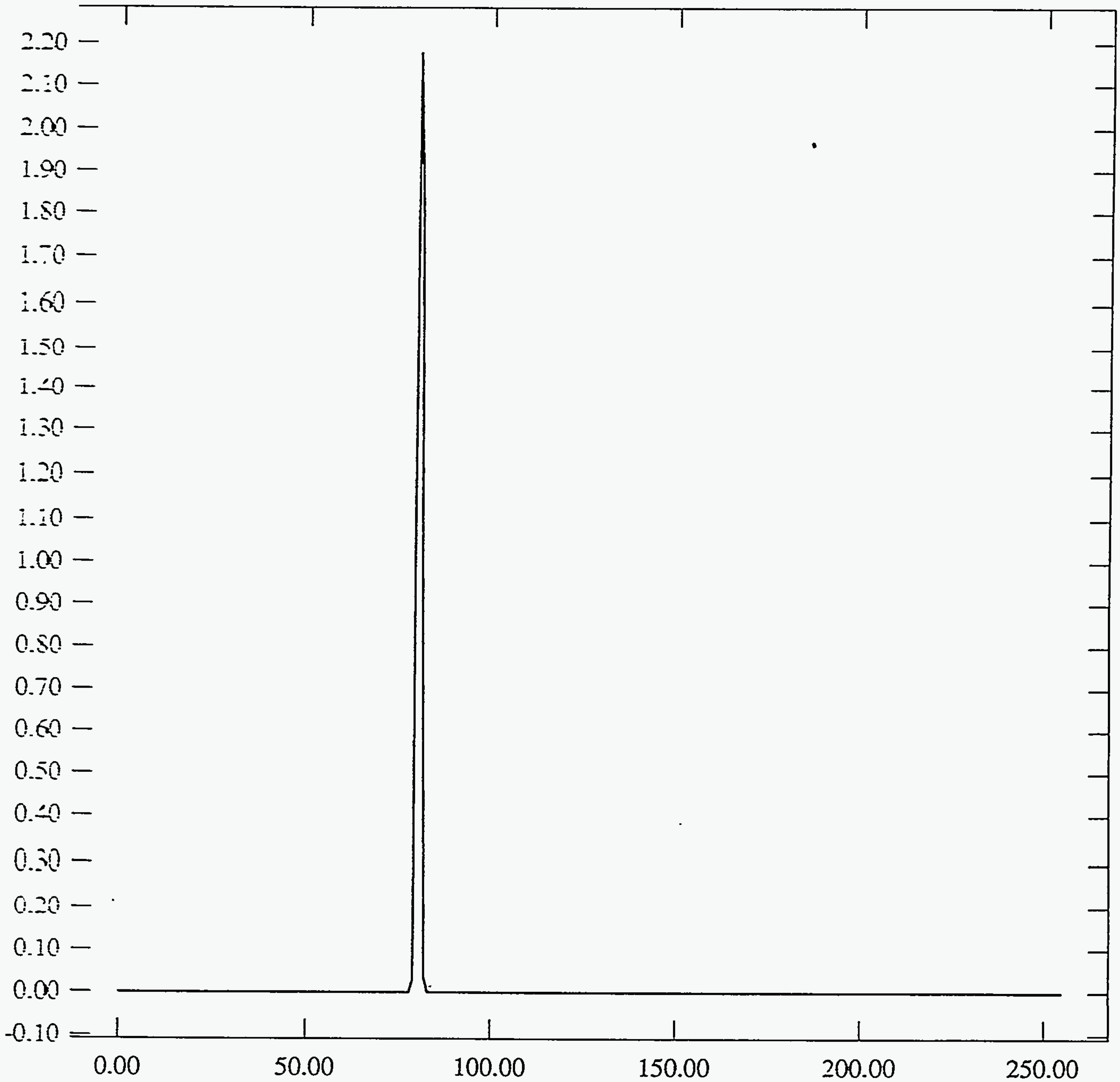
ST1#04-10\CDT\150e

Tue, May 11, 1993 4:49 PM

	TEMP (degrees C)	60ms/mu	60ms/sigma	100ms/mu	100ms/sigma	200ms/mu	200ms/sigma	NOTES:
1								
2	-20	80.60	0.63	80.50	0.52	80.70	0.51	5/10/93
3	-10	79.70	0.59	79.90	0.51	80.40	0.52	Flight F.0. CCD#1
4	0	79.40	0.66	80.00	0.45	81.50	0.55	
5	10	80.50	0.52	82.40	0.55	86.90	0.70	150e/bit
6	20	84.90	0.55	89.90	0.78	100.80	1.13	R49=100Ω
7	30	97.90	0.85	111.50	1.23	138.40	2.14	

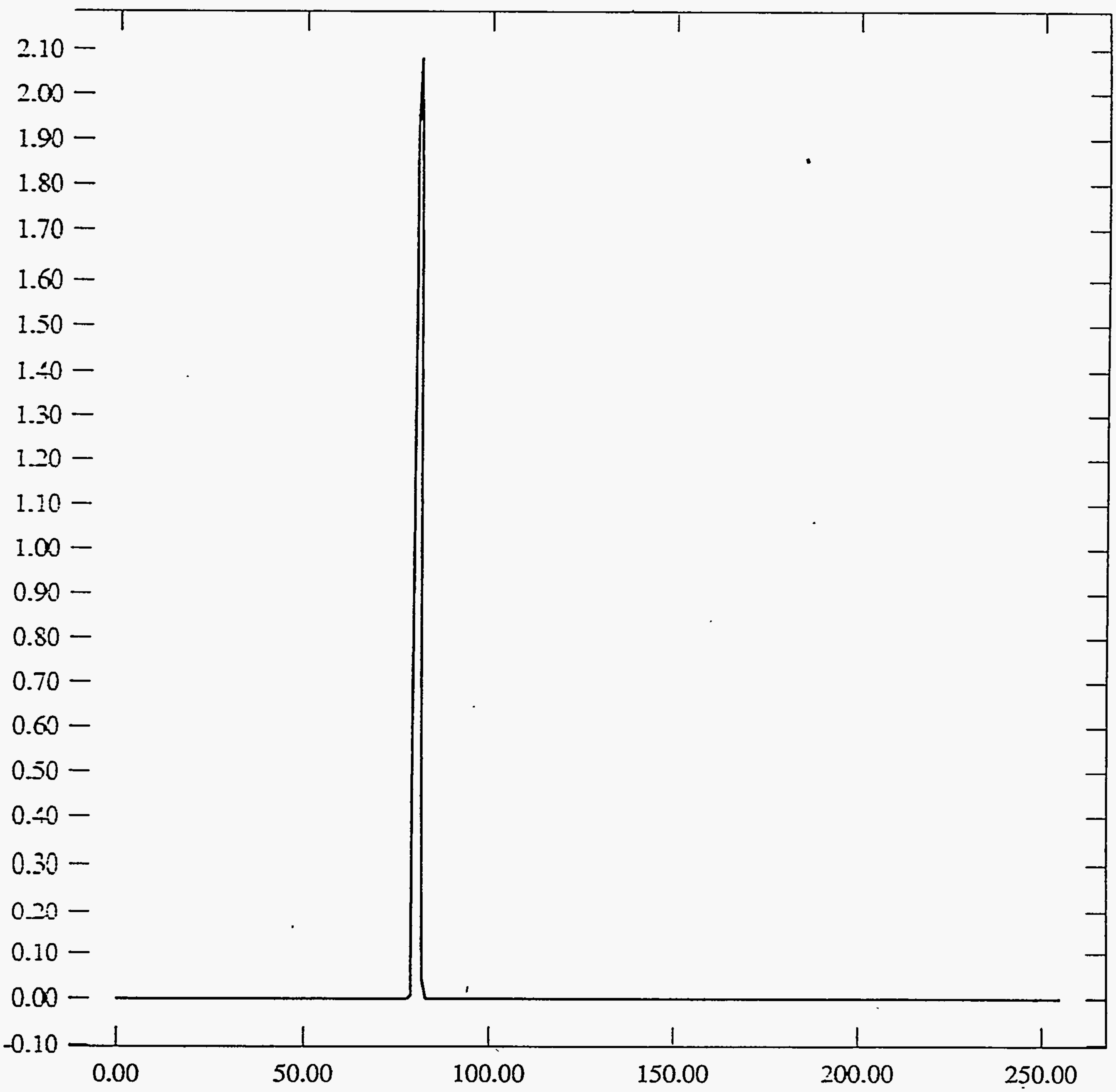
ST Camera: ST1#04-10 -20C: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Mon May 10 15:46:30 1993

Pixel Values Min 79 Max 82 Mean 80.5 Sigma 0.53 x 10^3



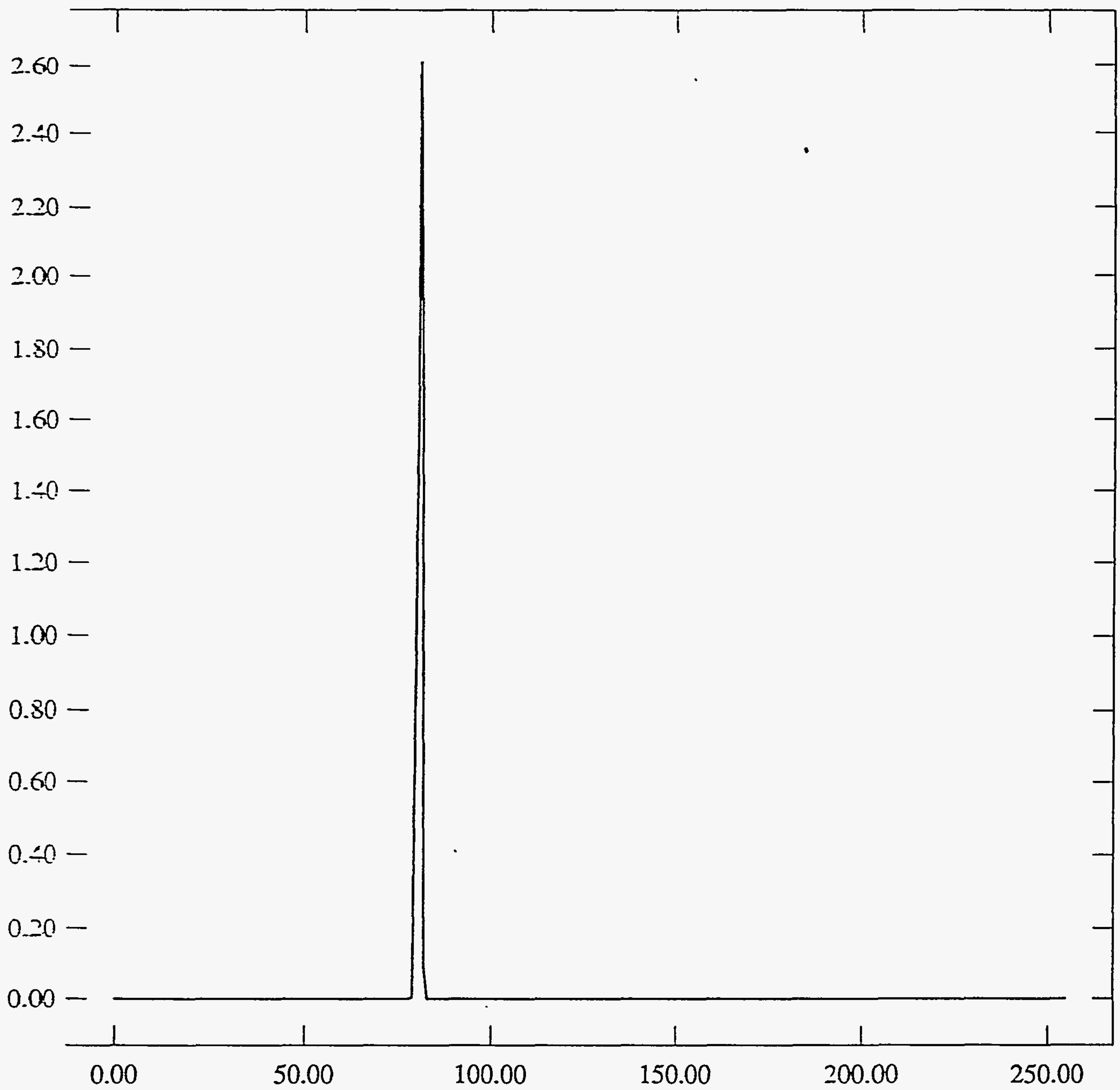
ST Camera: ST1#04-10 -20C: int_time=100ms, offset= 0, gain=2 (150 e/bit) Mon May 10 15:47:07 1993

Pixel Values Min 79 Max 82 Mean 80.5 Sigma 0.52 x 10^3

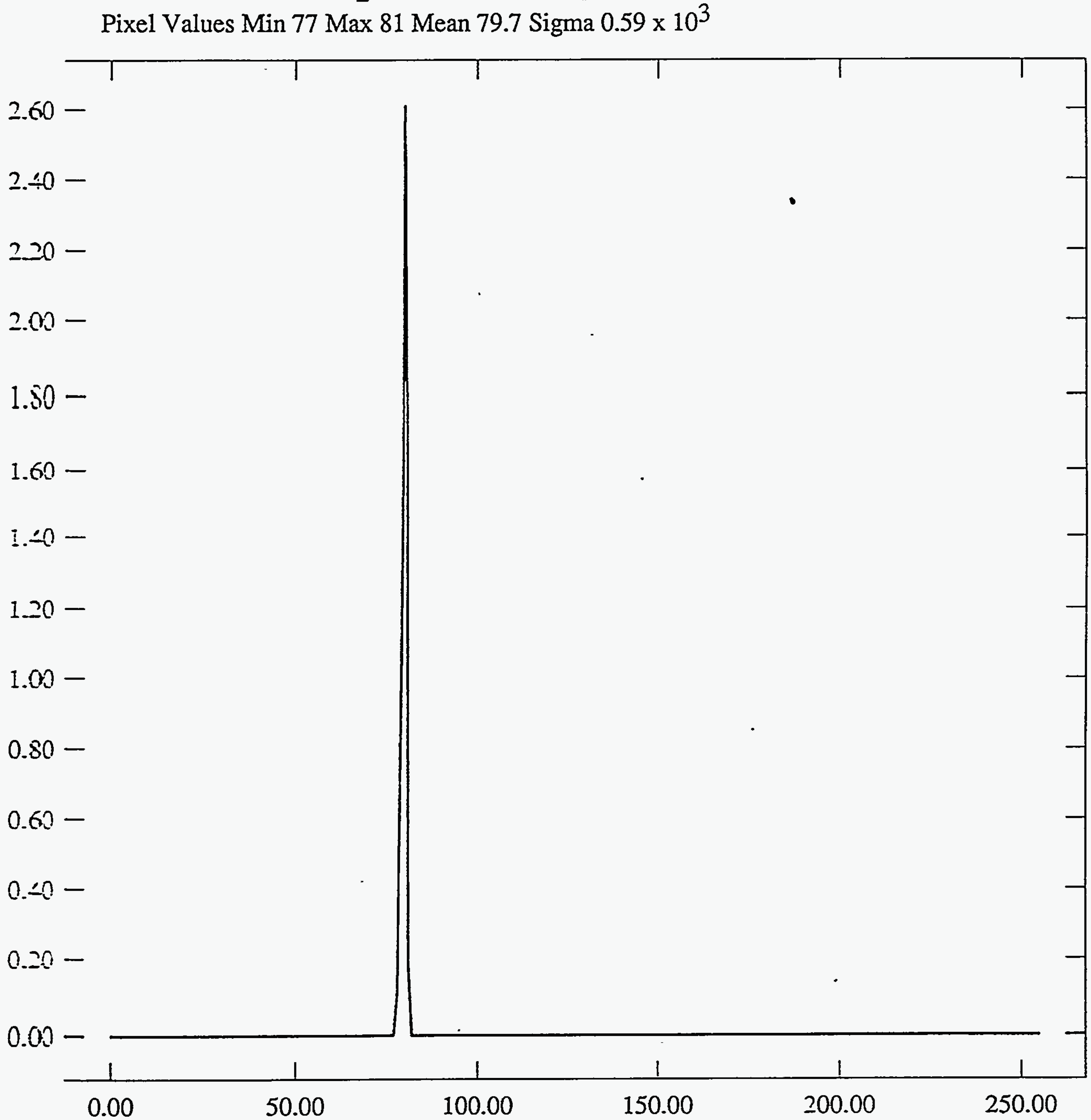


ST Camera: ST1#04-10 -20C: int_time=200ms, offset= 0, gain=2 (150 e/bit) Mon May 10 15:47:44 1993

Pixel Values Min 79 Max 82 Mean 80.7 Sigma 0.51 x 10^3

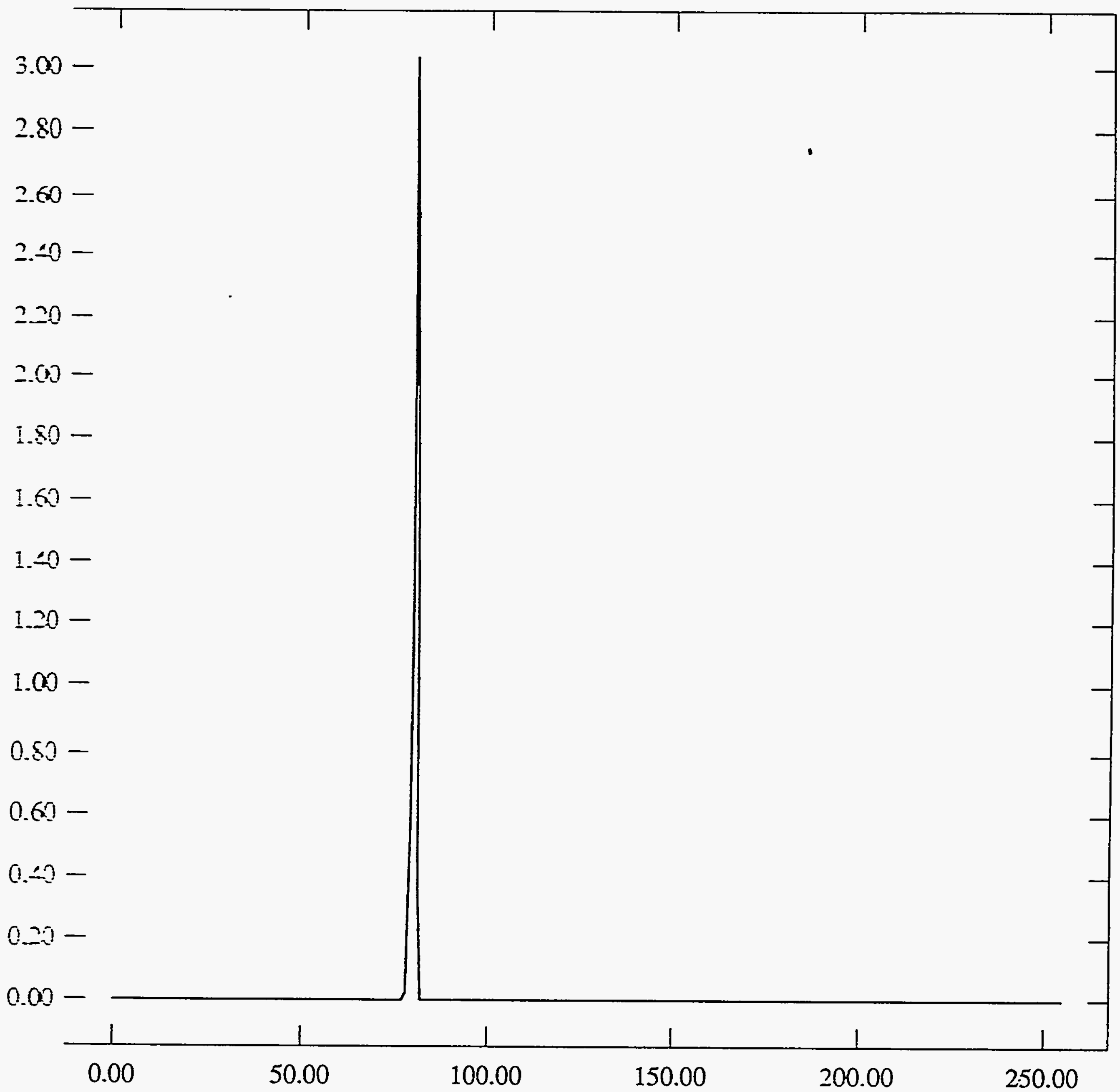


ST Camera: ST1#04-10 -10C: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Mon May 10 16:11:10 1993



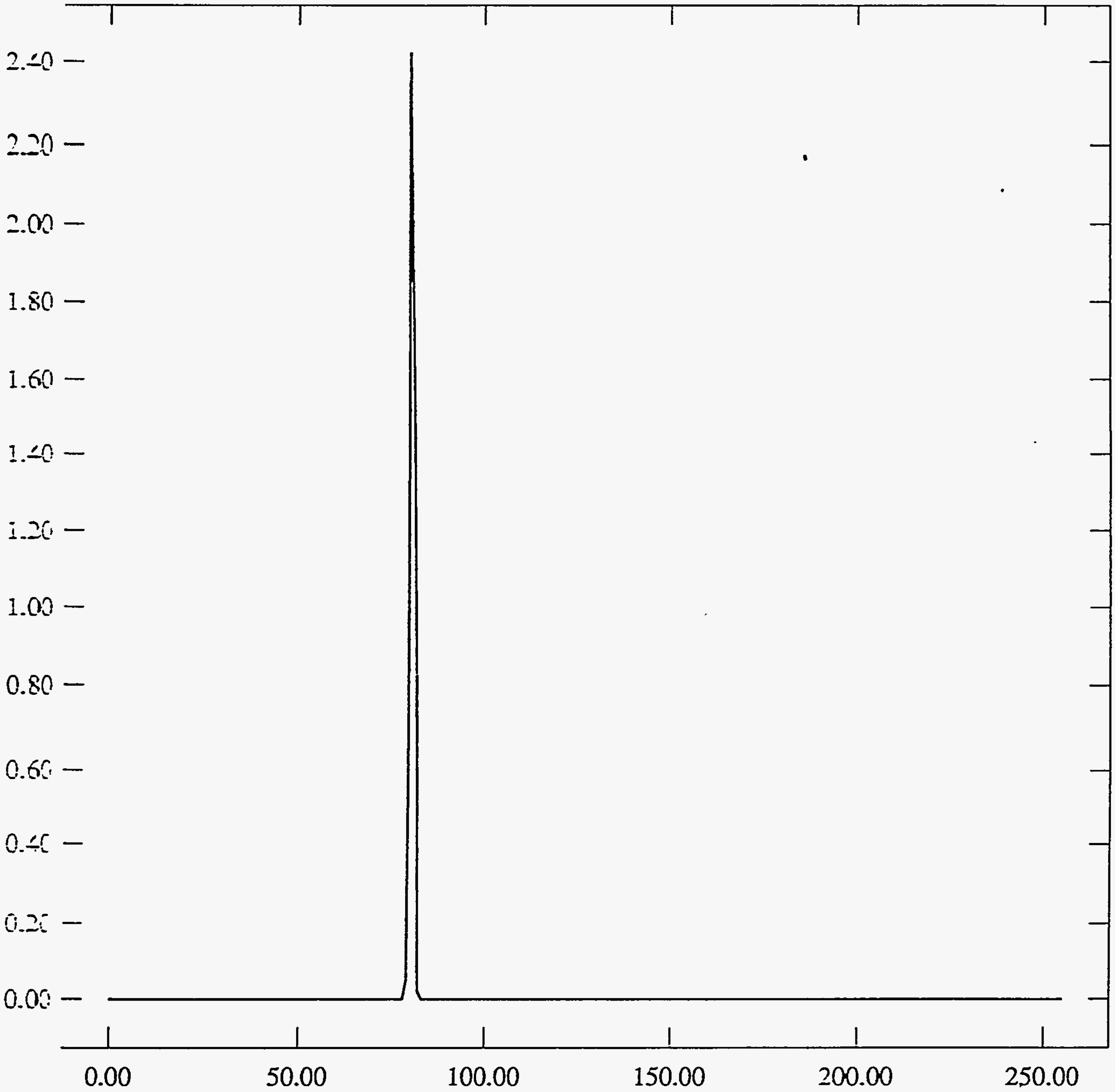
ST Camera: ST1#04-10 -10C: int_time=100ms, offset= 0, gain=2 (150 e/bit) Mon May 10 16:11:40 1993

Pixel Values Min 78 Max 81 Mean 79.9 Sigma 0.51 x 10^3



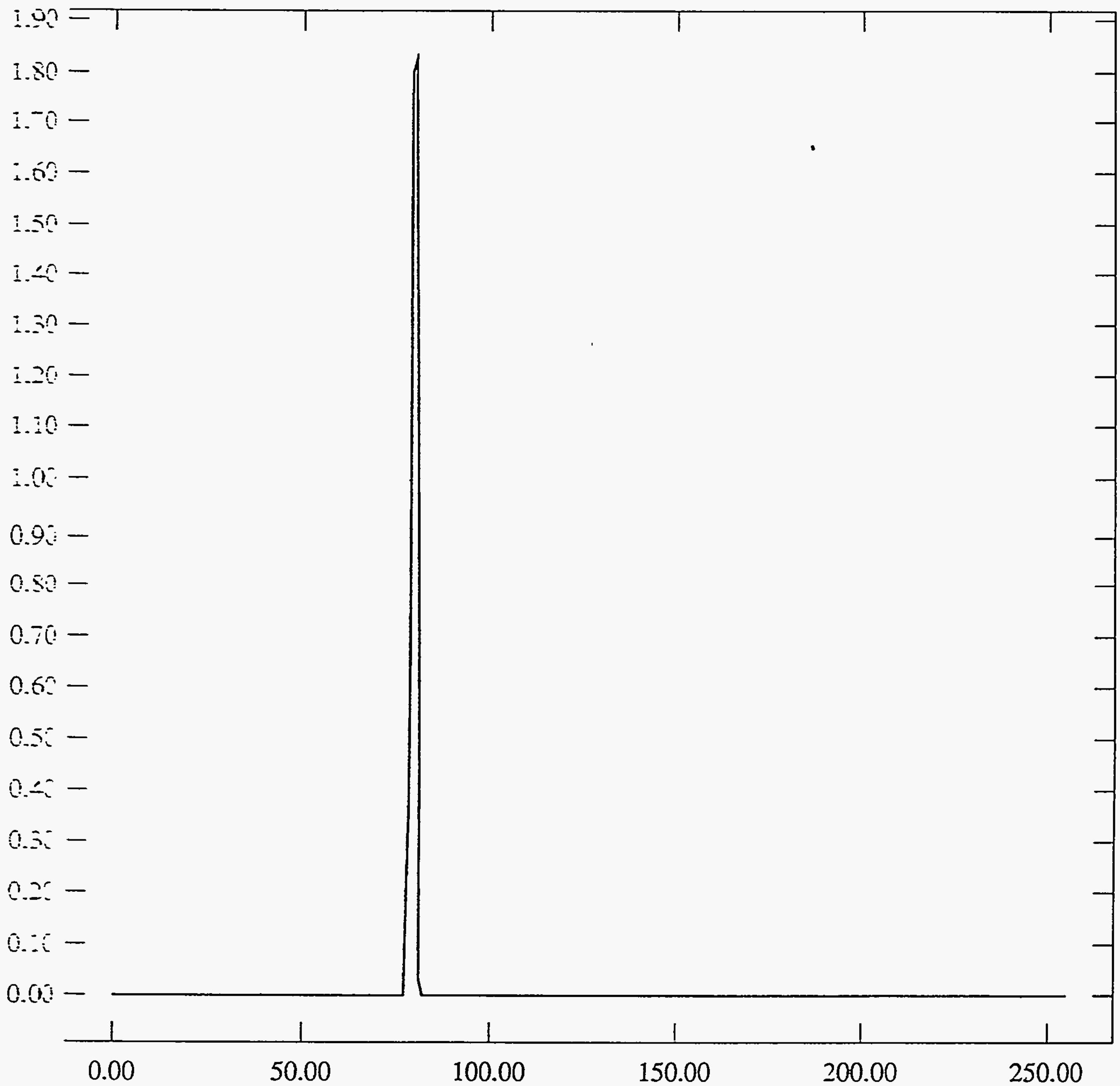
ST Camera: ST1#04-10 -10C: int_time=200ms, offset= 0, gain=2 (150 e/bit) Mon May 10 16:12:11 1993

Pixel Values Min 79 Max 82 Mean 80.4 Sigma 0.52 x 10^3



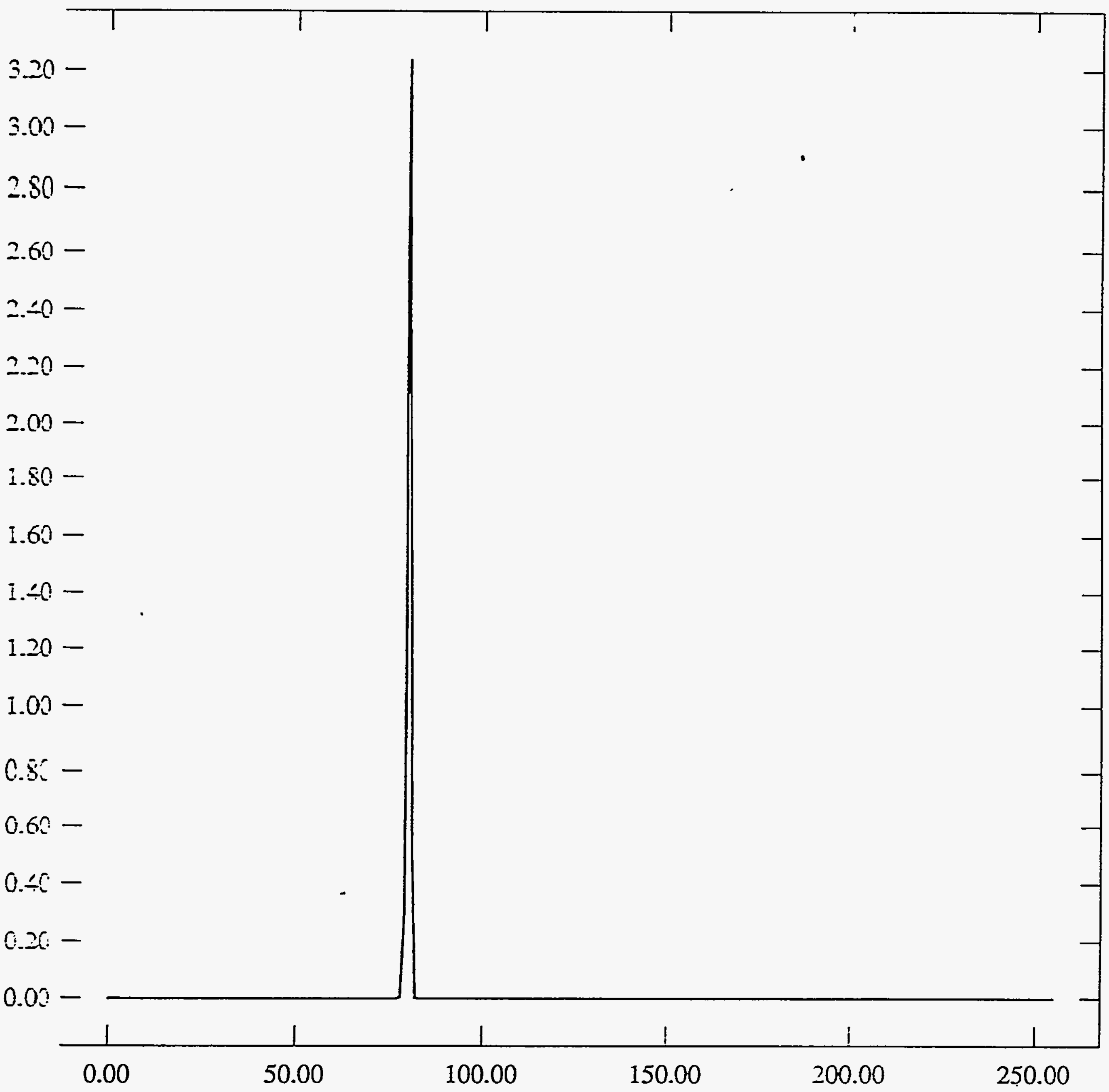
ST Camera: ST1#04-10 0C: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Mon May 10 16:41:23 1993

Pixel Values Min 78 Max 81 Mean 79.4 Sigma 0.66 x 10^3

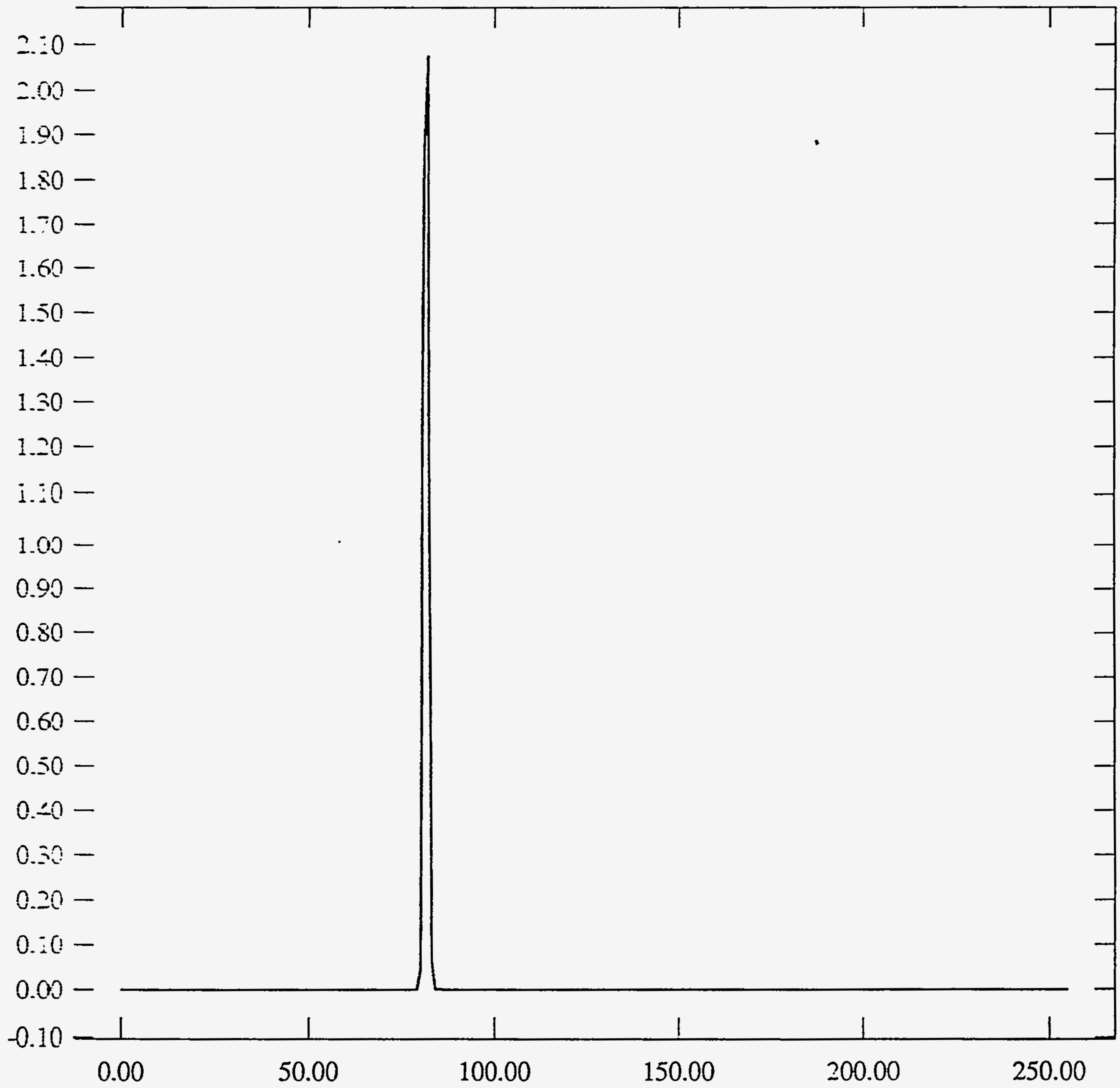


ST Camera: ST1#04-10 0C: int_time=100ms, offset= 0, gain=2 (150 e/bit) Mon May 10 16:42:04 1993

Pixel Values Min 78 Max 82 Mean 80.0 Sigma 0.45 x 10^3

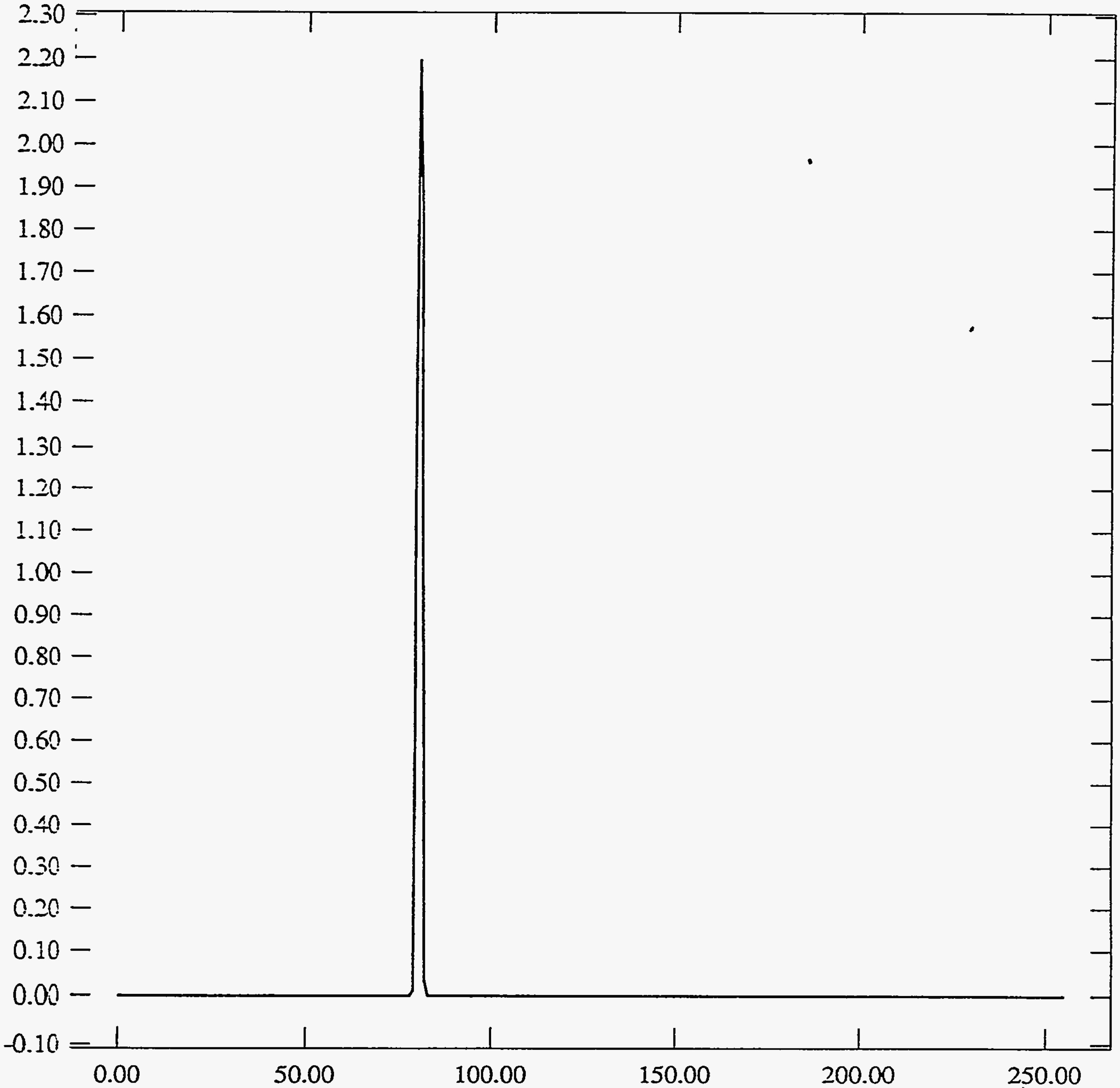


ST Camera: ST1#04-10 0C: int_time=200ms, offset= 0, gain=2 (150 e/bit) Mon May 10 16:42:49 1993
Pixel Values Min 80 Max 85 Mean 81.5 Sigma 0.55 x 10^3



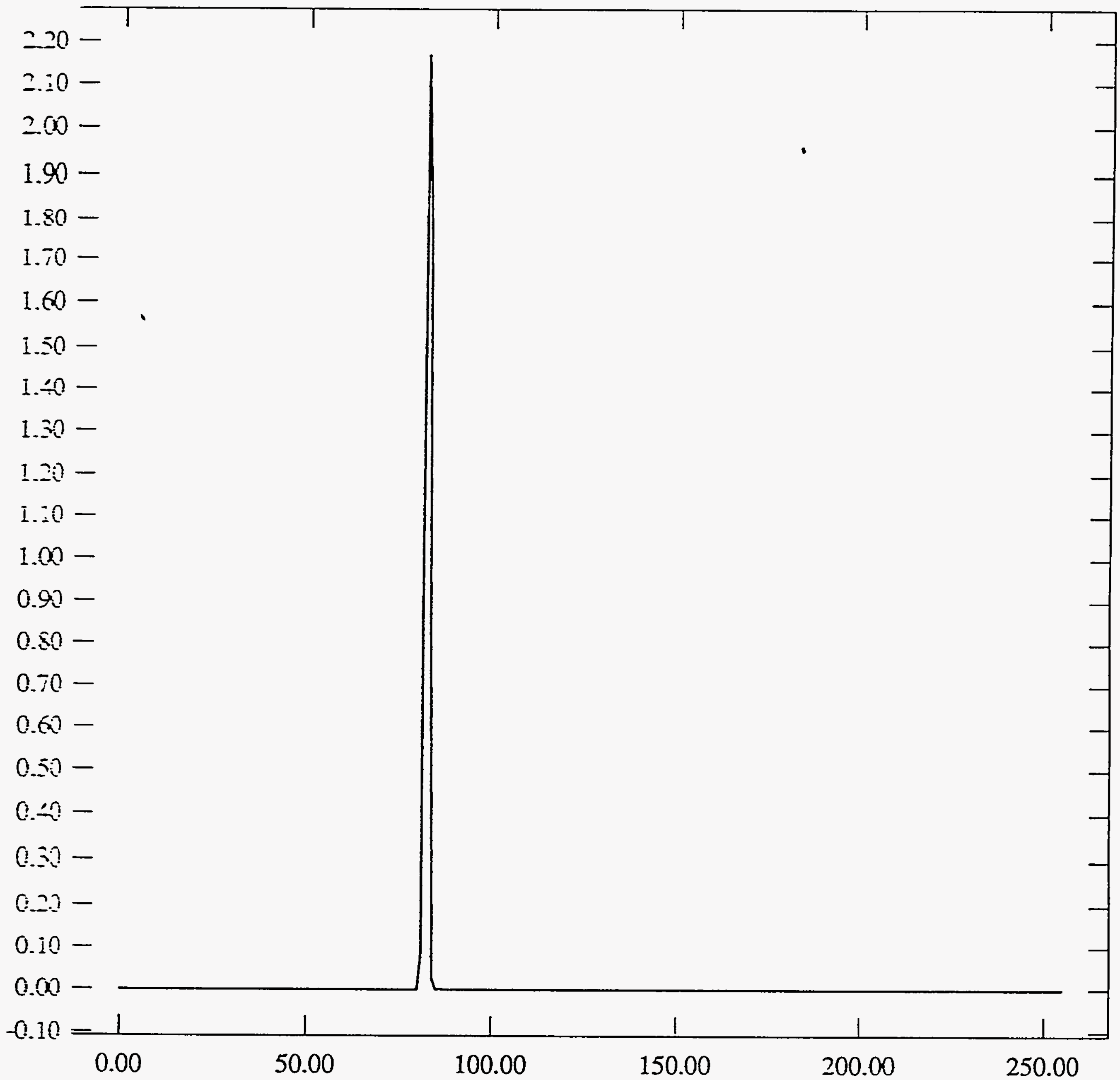
ST Camera: ST1#04-10 10C: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Mon May 10 17:04:43 1993

Pixel Values Min 79 Max 82 Mean 80.5 Sigma 0.52 x 10^3



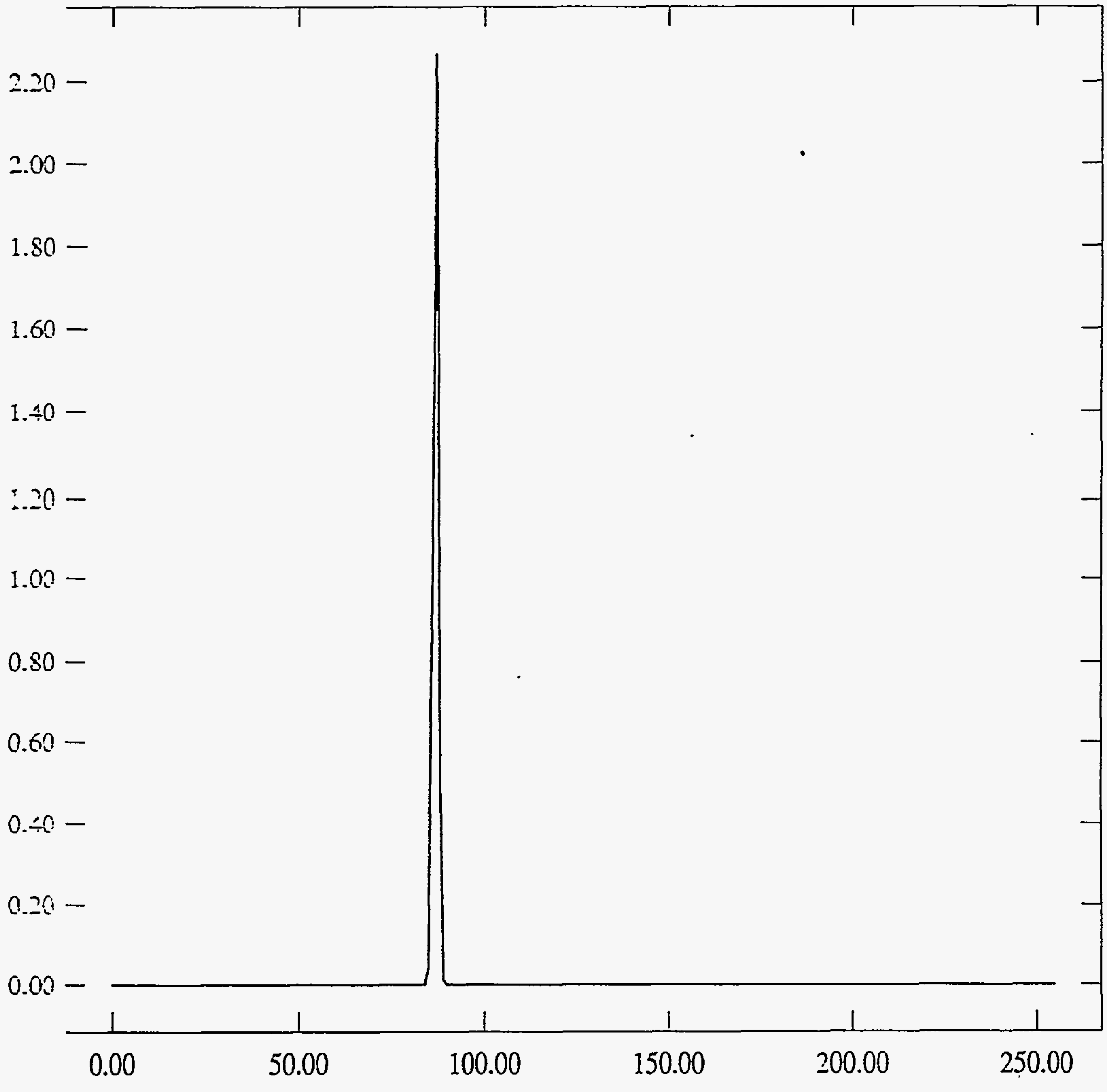
ST Camera: ST1#04-10 10C: int_time=100ms, offset= 0, gain=2 (150 e/bit) Mon May 10 17:05:13 1993

Pixel Values Min 81 Max 86 Mean 82.4 Sigma 0.55 x 10^3



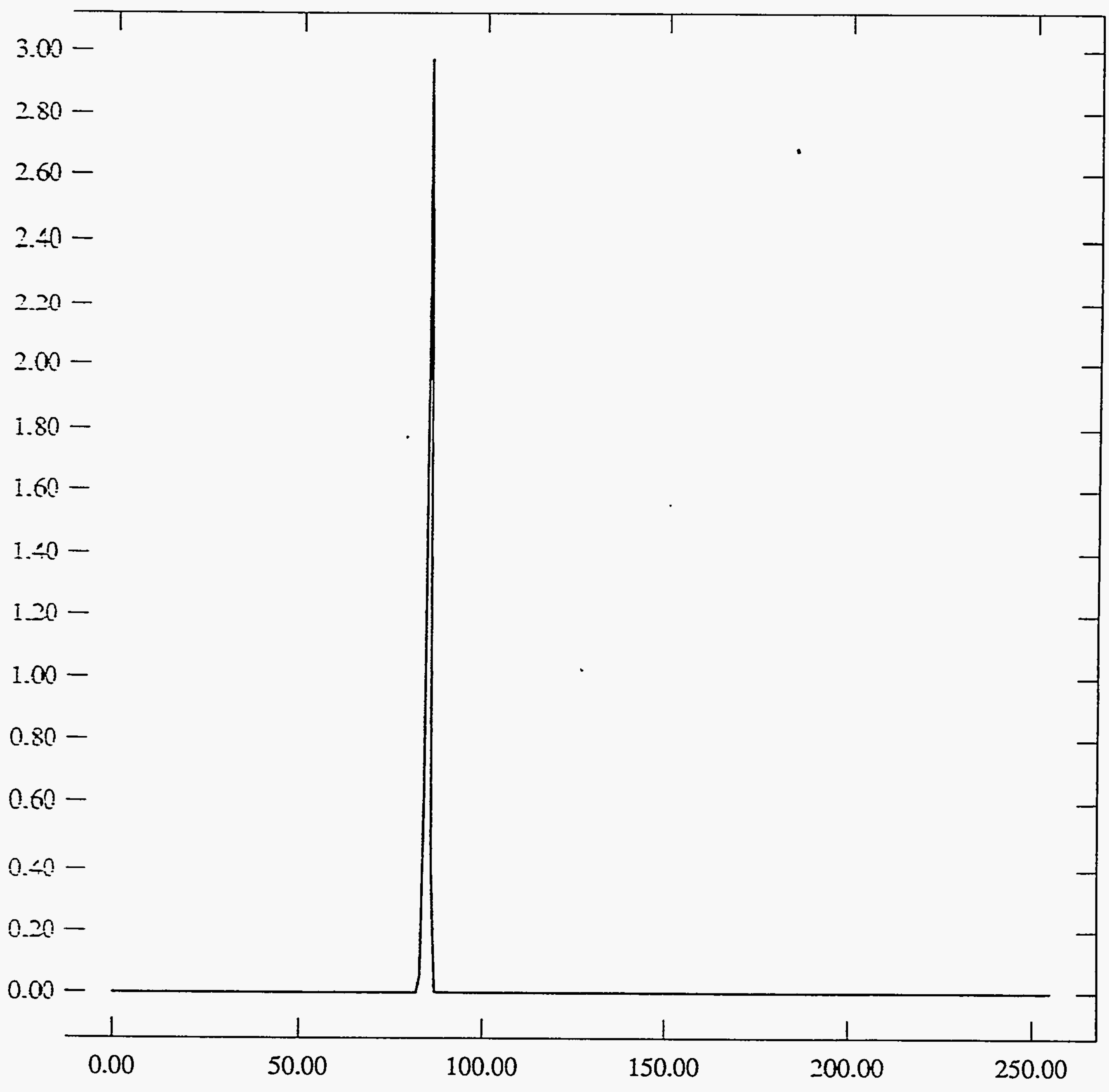
ST Camera: ST1#04-10 10C: int_time=200ms, offset= 0, gain=2 (150 e/bit) Mon May 10 17:06:24 1993

Pixel Values Min 85 Max 95 Mean 86.9 Sigma 0.70 x 10^3



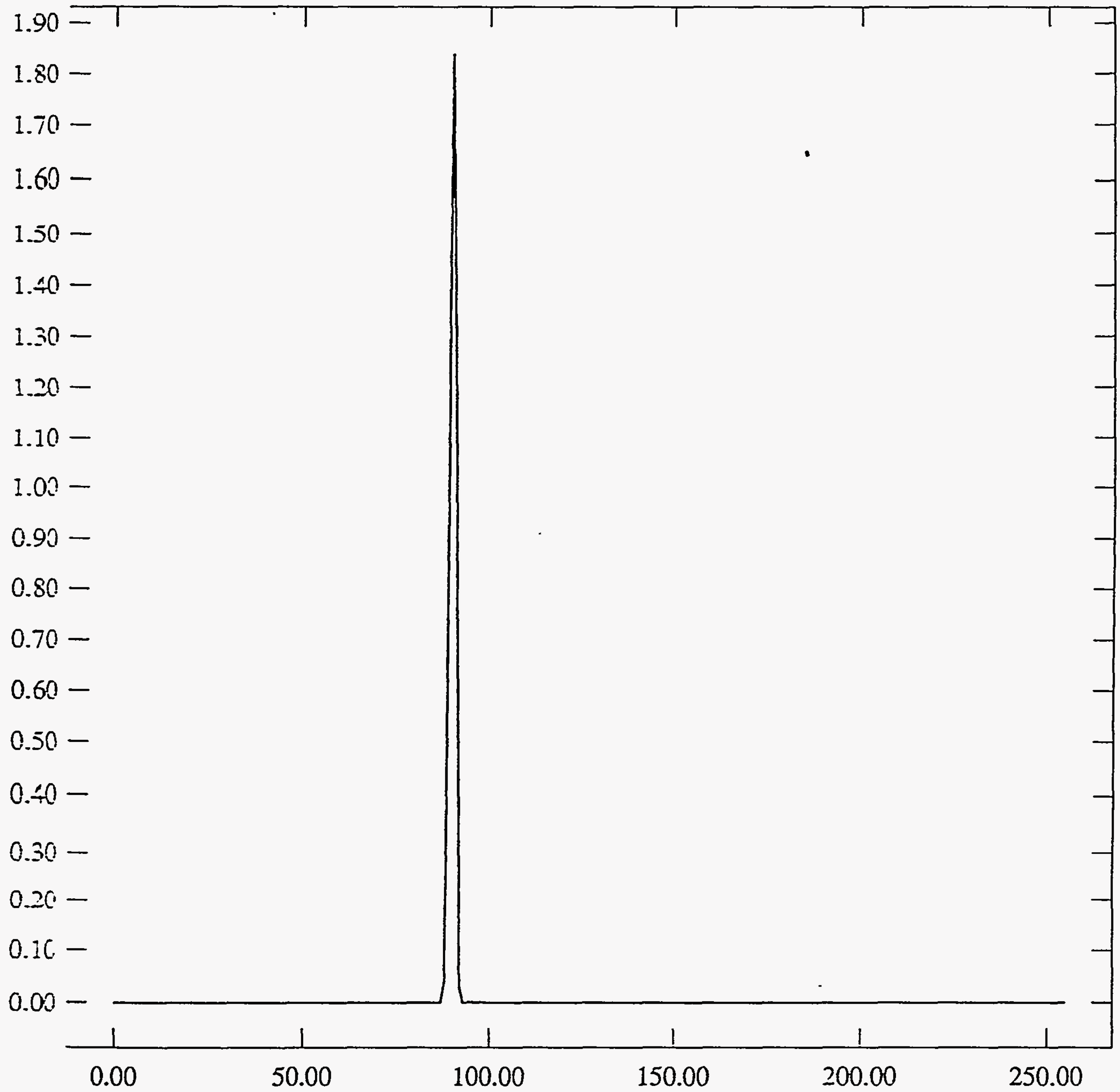
ST Camera: ST1#04-10 20C: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Mon May 10 17:23:53 1993

Pixel Values Min 83 Max 89 Mean 84.9 Sigma 0.55 x 10^3



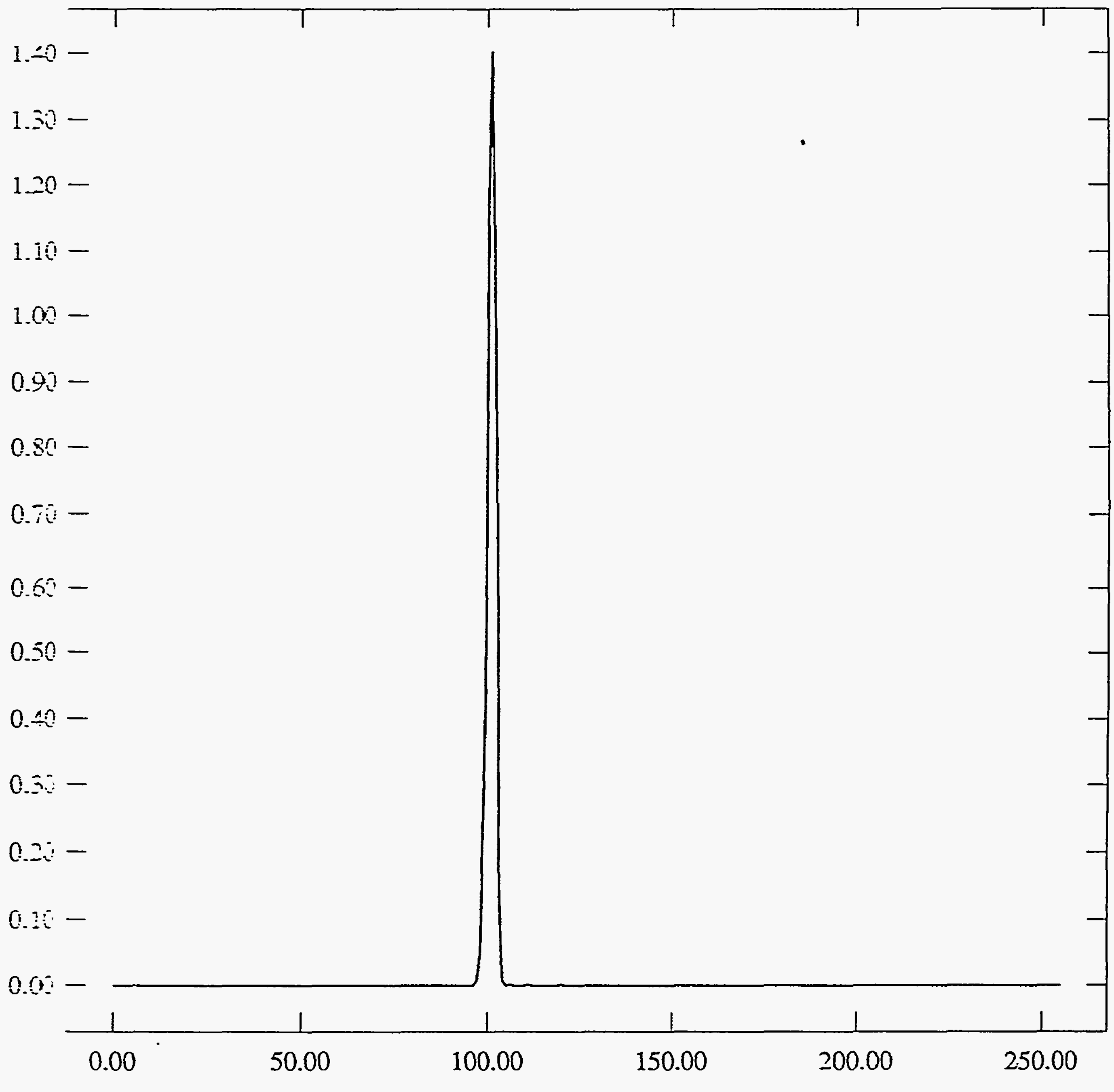
ST Camera: ST1#04-10 20C: int_time=100ms, offset= 0, gain=2 (150 e/bit) Mon May 10 17:24:21 1993

Pixel Values Min 88 Max 98 Mean 89.9 Sigma 0.78 x 10^3



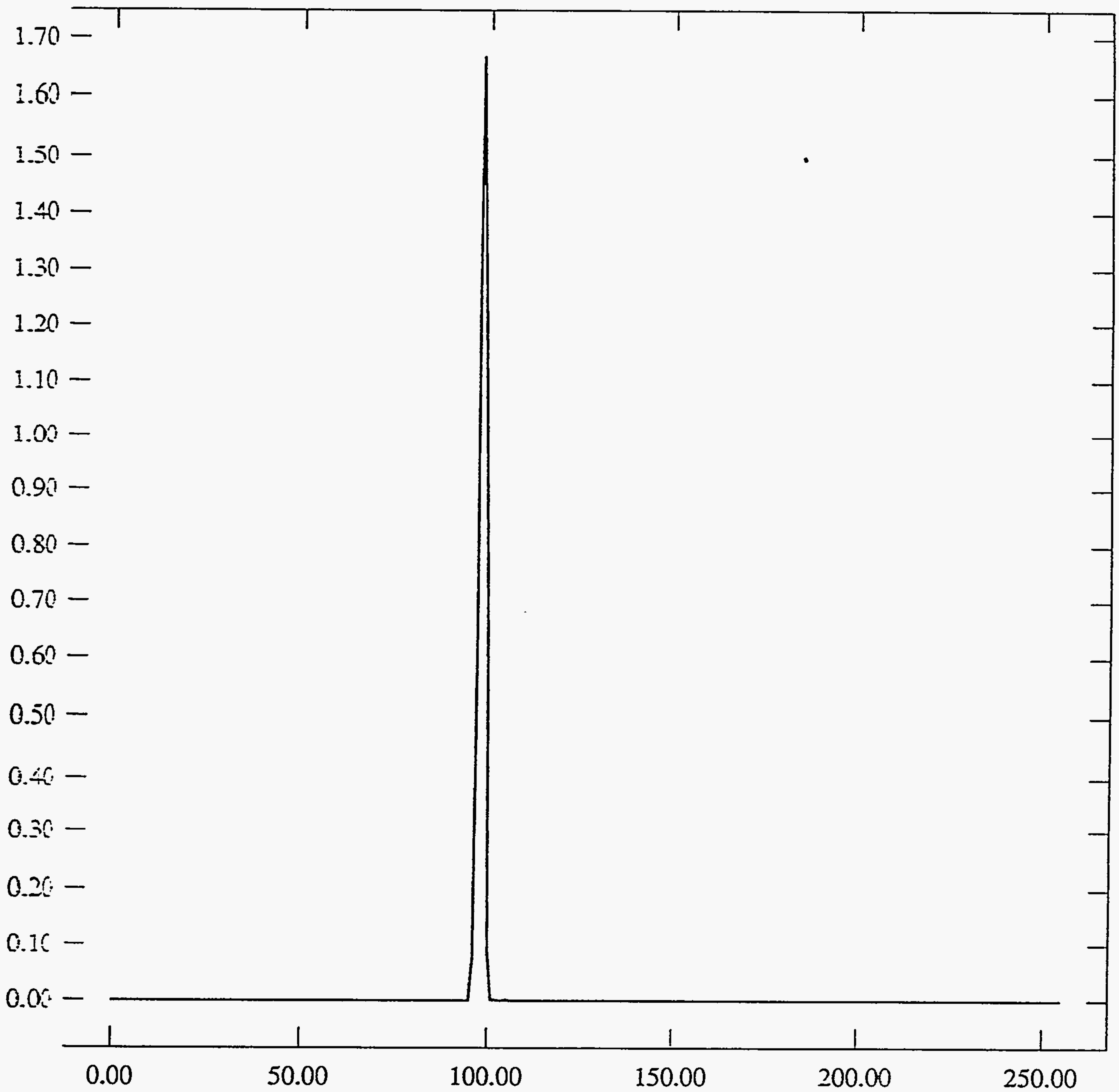
ST Camera: ST1#04-10 20C: int_time=200ms, offset= 0, gain=2 (150 e/bit) Mon May 10 17:24:52 1993

Pixel Values Min 97 Max 120 Mean 100.8 Sigma 1.13 x 10^3



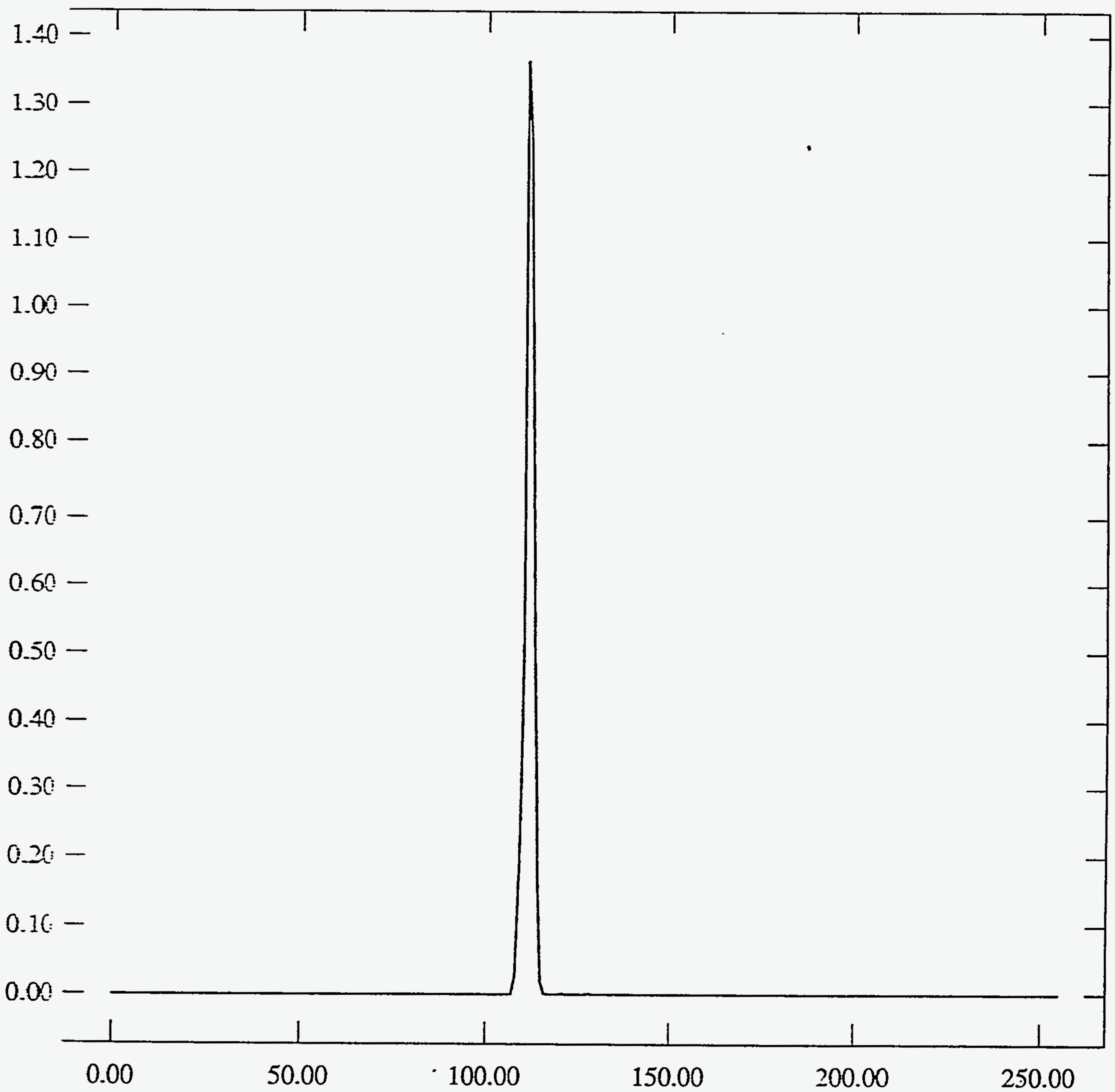
ST Camera: ST1#04-10 30C: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Mon May 10 17:56:00 1993

Pixel Values Min 96 Max 105 Mean 97.9 Sigma 0.85 x 10^3



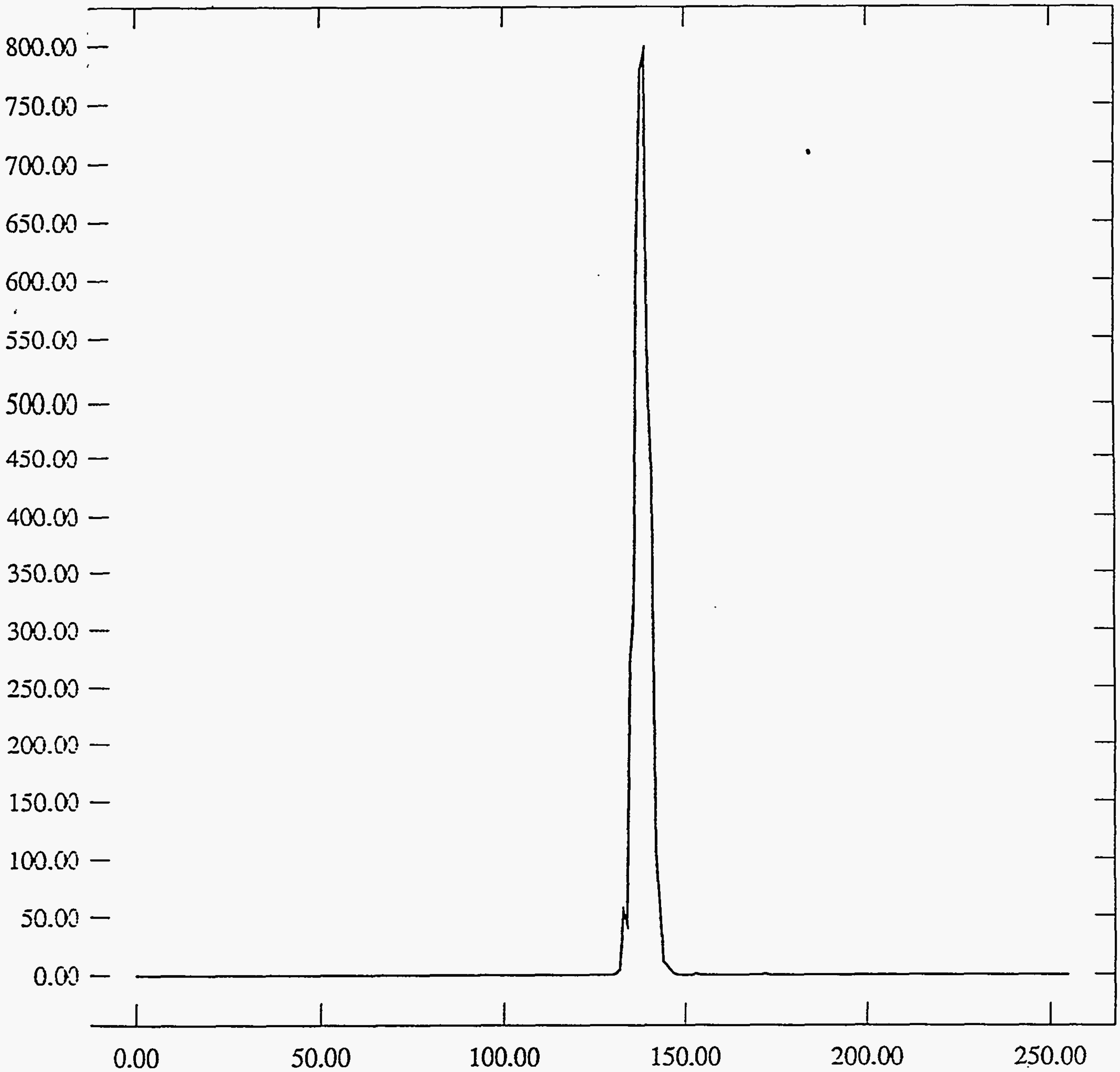
ST Camera: ST1#04-10 30C: int_time=100ms, offset= 0, gain=2 (150 e/bit) Mon May 10 17:57:16 1993

Pixel Values Min 108 Max 128 Mean 111.5 Sigma 1.23 x 10^3

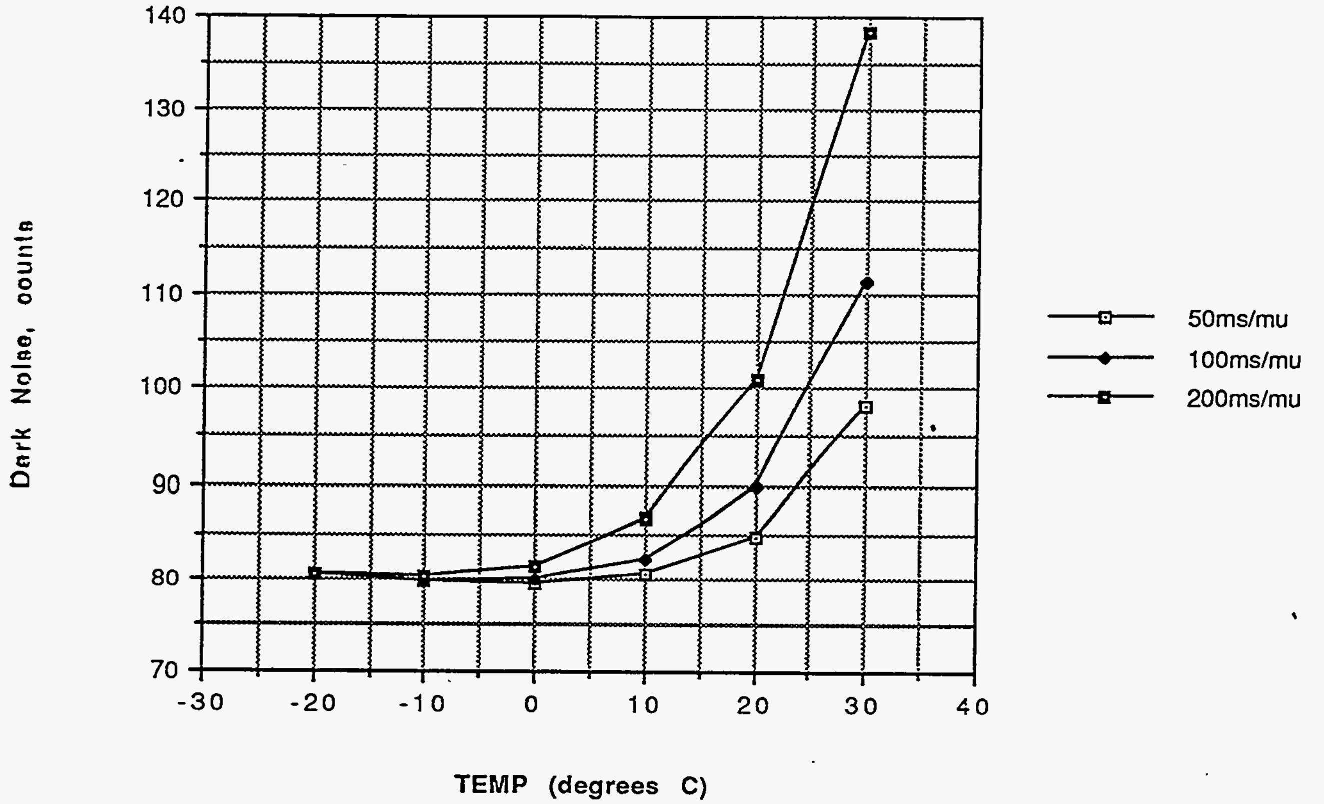


ST Camera: ST1#04-10 30C: int_time=200ms, offset= 0, gain=2 (150 e/bit) Mon May 10 17:58:02 1993

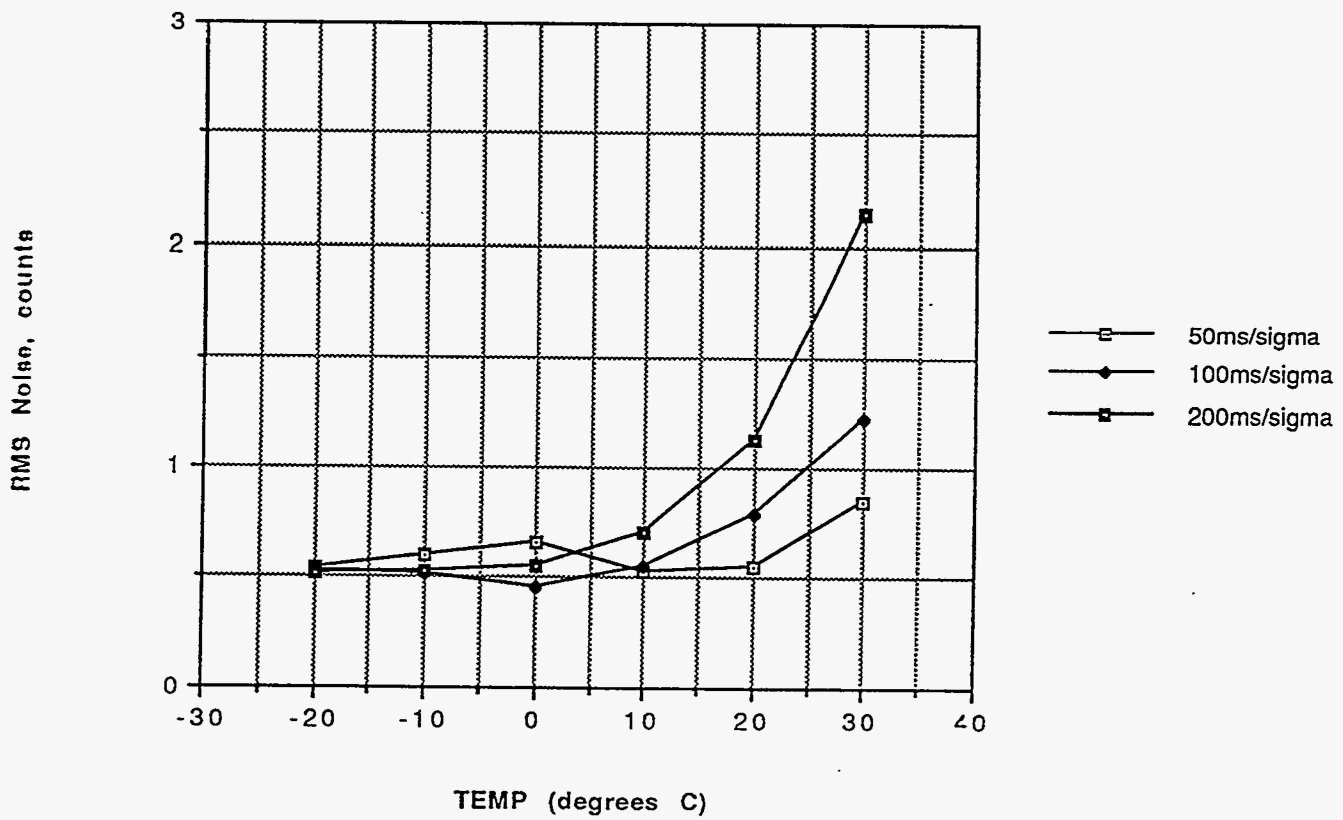
Pixel Values Min 131 Max 172 Mean 138.4 Sigma 2.14



ST1 #04-10 150e/bit Mu °C Graph



ST1 #04-10 150e/bit Sigma °C Graph



12. Thermal Test

This test requires the SUN Datacube and its image processing capabilities, an environmental chamber with limit rate controls, and a timer.

Carefully Insert The Flight CCD
Into The Test Board.
Check Its Orientation

12.1. Thermal Test Setup

Secure the carrier mounted Actel board in a PC board holder and place the holder in the environmental chamber. Care should be taken so that the board does not short to chamber walls.

Attach the camera cable harness to the Actel board via a feed-through hole. Wrap a piece of foam around the cable harness. Squeeze the wrapped harness into the feed-through so that the hole is sealed and there is no strain on the inside/outside cabling.

Place an opaque cover over the CCD.

Power-up and confirm a functioning camera/acquisition system by capturing a frame. At room temperature this should resemble the dark measurement histogram acquired in SECTION 11.

Turn-off the camera board under test

Seal the environmental chamber.

Set chamber temperature ramp rate at 2° C/min.

Set chamber temperature deviation limit to 2° C.

Set chamber soak time to 20 minutes.

Start the thermal sequence at -20°C or at a °C determined by your requester.

12.2 Thermal Measurement Acquisition

The Guide to running hspcube, C1-S1-002 explains a Fast 9 image capture. This program module automatically grabs a 50ms, 100ms and 200ms integration time images at all three gains. It then does a histogram of those images using a region of interest specified by the user.

Repeat Fast 9 completing your needed temperature range.

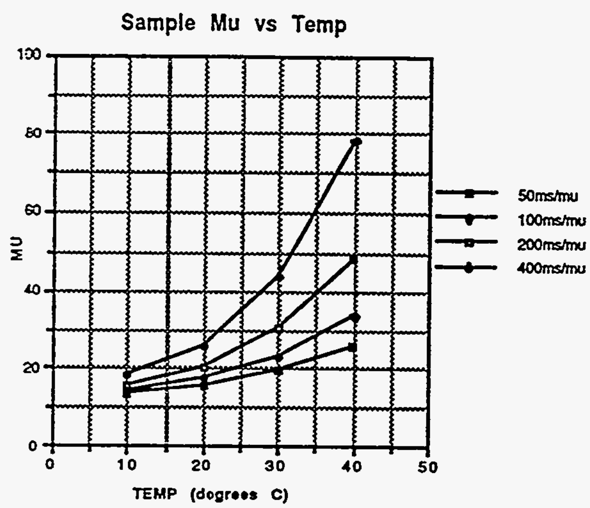
Fill in the Table below.

	50ms	50ms	100ms	100ms	200ms	200ms
Temp	Mu	Sigma	Mu	Sigma	Mu	Sigma
-20° C						
-10° C						
0° C						
10° C						
20° C						
30° C						

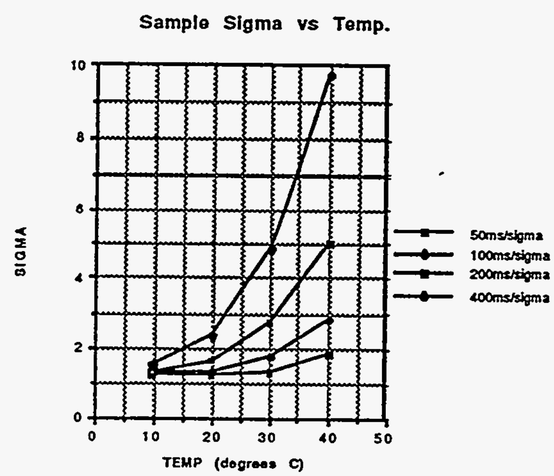
12.3 Thermal Data and Graphs

Graphing techniques will vary with software. However, if you use Cricketgraph, use the "line" graph format.

Plot Mu vs Temperature as below:



Plot Sigma vs Temperature like this:



SN# C4 - 10 By ~~ JMD ~~ initials Date 5/10/93 passed

Remember to attach graphs and associated data to test procedure!
(a document protector is advised)

13. Flat Field Linearity Test

This test requires the use of the SUN Datacube and its image processing capabilities, a TV Optoliner Model K-4000 with neutral density(ND) filters ranging from 0.8 to 2.8, and a resolution chart for focusing.

13.1. Linearity Test Setup

Using alcohol and Q-tips clean the installed CCD.

Verify a properly connected camera acquisition system by acquiring an image. Always use a connector saver.

Turn on the test fixture.

Put the SUN Datacube in the Acquire mode, see *Guide to Running hspcube*—C1-S1-002.

Install a total 0.8ND filter and test pattern in the T.V. Optoliner.

Adjust the camera board so that the test pattern image is centered and focused on the CCD.

NOTE: Once focused, neither the camera nor the optoliner can be moved. Allow the T.V. Optoliner and camera to warm up under continuous operation for ≈1 hour before proceeding. Keeping the camera's environmental temperature constant and allowing a long warm up requires only one background histogram for linearity computation.

Remove the test pattern and replace with a flat field image.

With 0.8 ND filtering installed in the optoliner, adjust the T.V. Optoliner lamp voltage so that you get a Mu count between 235 and 250.

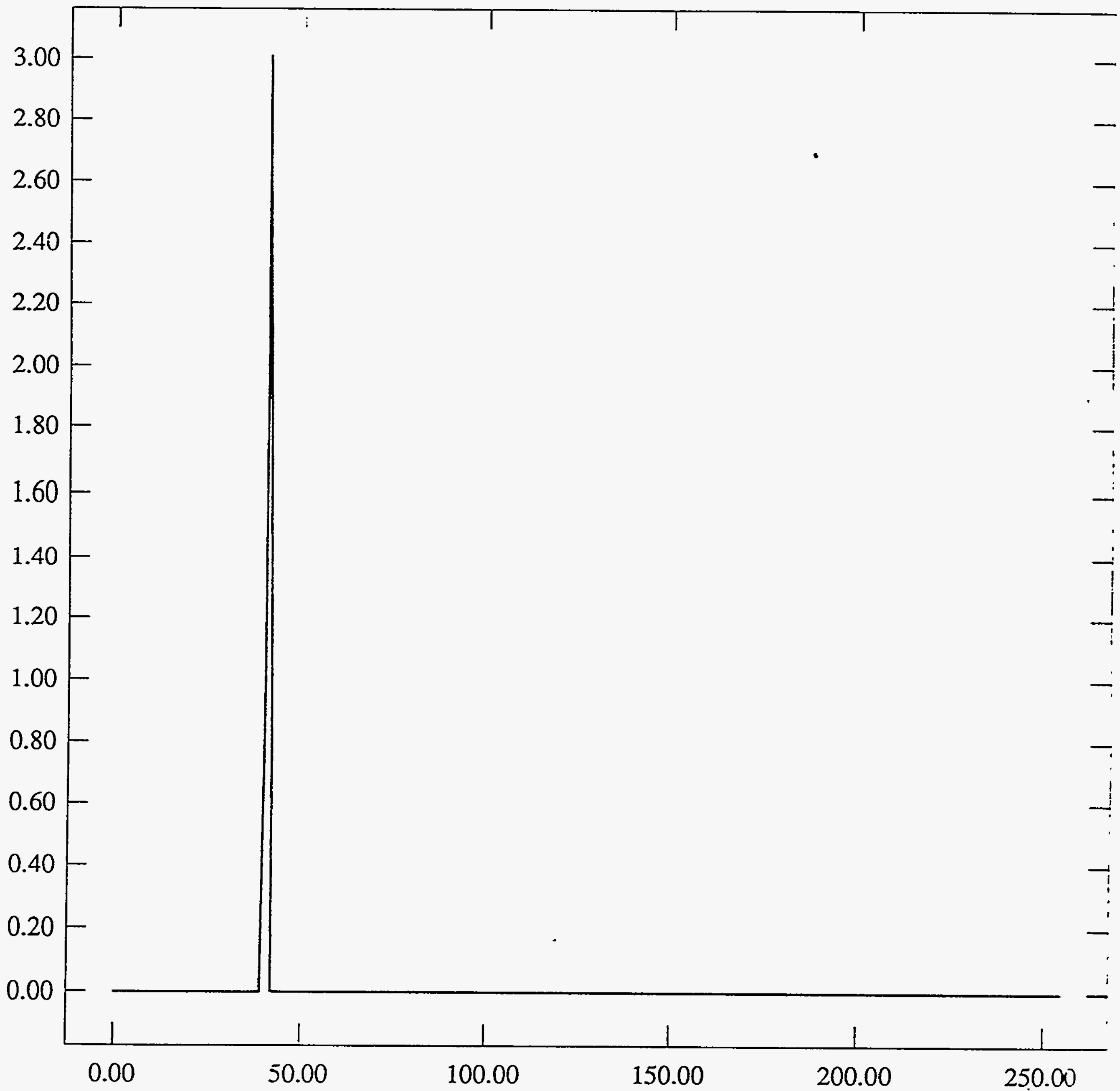
13.2 Linearity Measurement Acquisition

Use the SUN Datacube "Acquire and build histogram Sequence " to capture a frame and process a defined region of interest. Then obtain its histogram.

	TEMP (degrees C)	50ms/mu	50ms/sigma	100ms/mu	100ms/sigma	200ms/mu	200ms/sigma	NOTES:
1								
2	-20	40.70	0.44	40.80	0.42	40.80	0.41	5/10/93
3	-10	40.00	0.36	40.00	0.35	40.30	0.47	Flight F.0. CCD#1
4	0	39.40	0.50	39.80	0.42	40.60	0.50	
5	10	40.00	0.36	40.90	0.27	42.70	0.48	350e/bit
6	20	41.70	0.46	43.80	0.43	48.50	0.58	R40-100Ω
7	30	47.40	0.55	52.90	0.64	64.10	1.09	

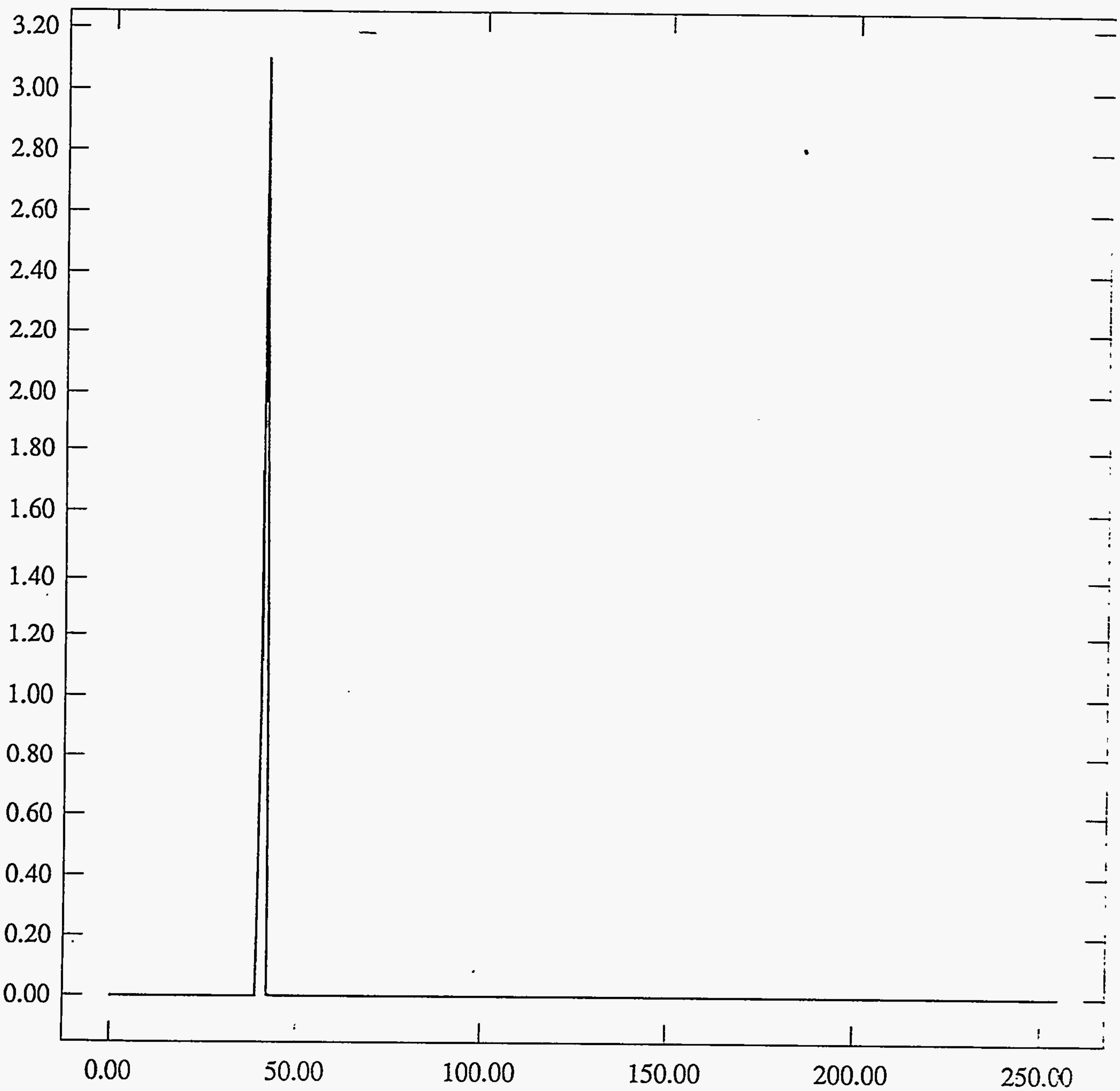
ST Camera: ST1#04-10 -20C: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Mon May 10 15:44:43 1993

Pixel Values Min 40 Max 42 Mean 40.7 Sigma 0.44 x 10^3



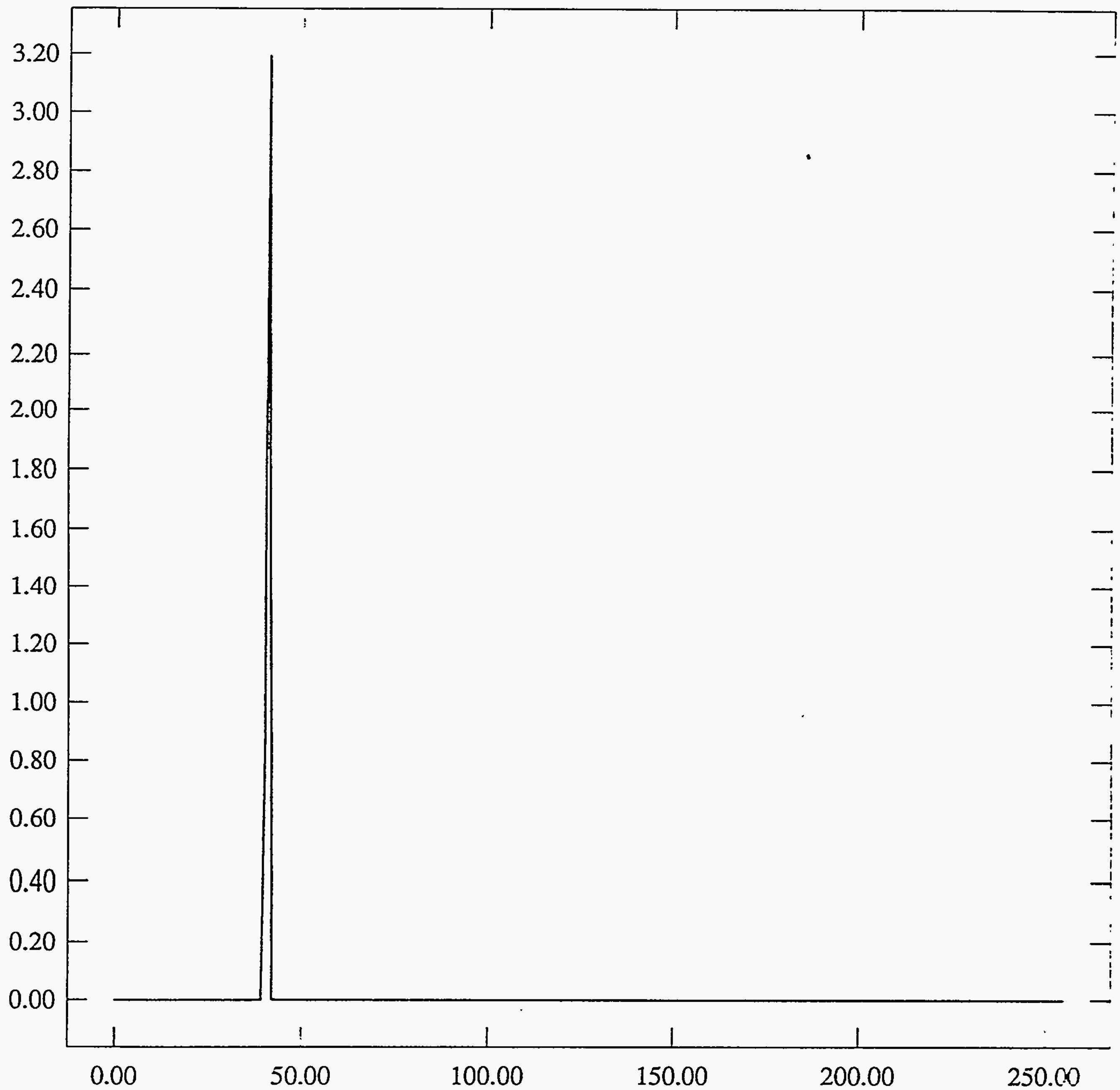
ST Camera: ST1#04-10 -20C: int_time=100ms, offset= 0, gain=1 (350 e/bit) Mon May 10 15:45:24 1993

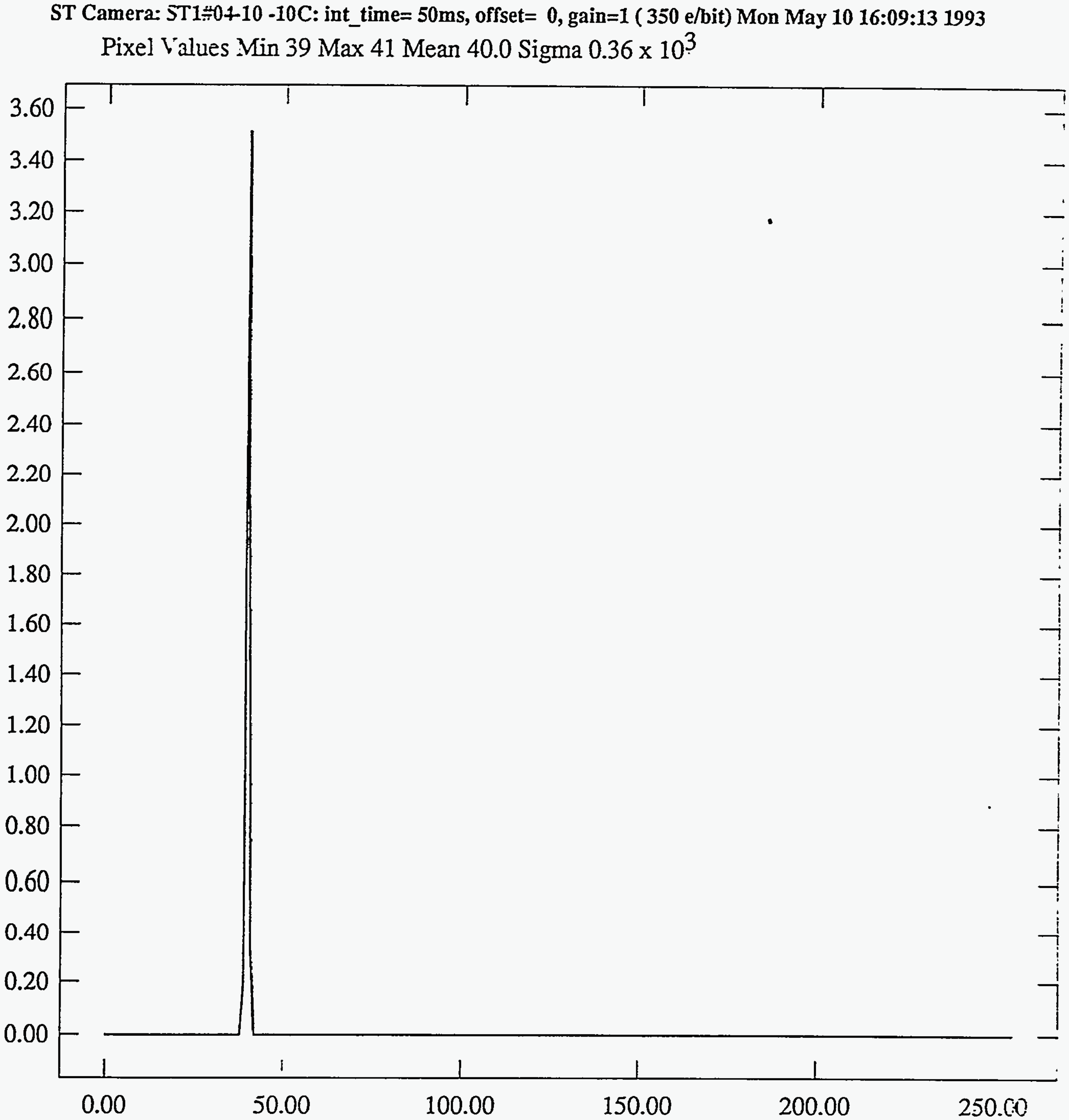
Pixel Values Min 40 Max 42 Mean 40.8 Sigma 0.42 x 10^3



ST Camera: ST1#04-10 -20C: int_time=200ms, offset= 0, gain=1 (350 e/bit) Mon May 10 15:45:58 1993

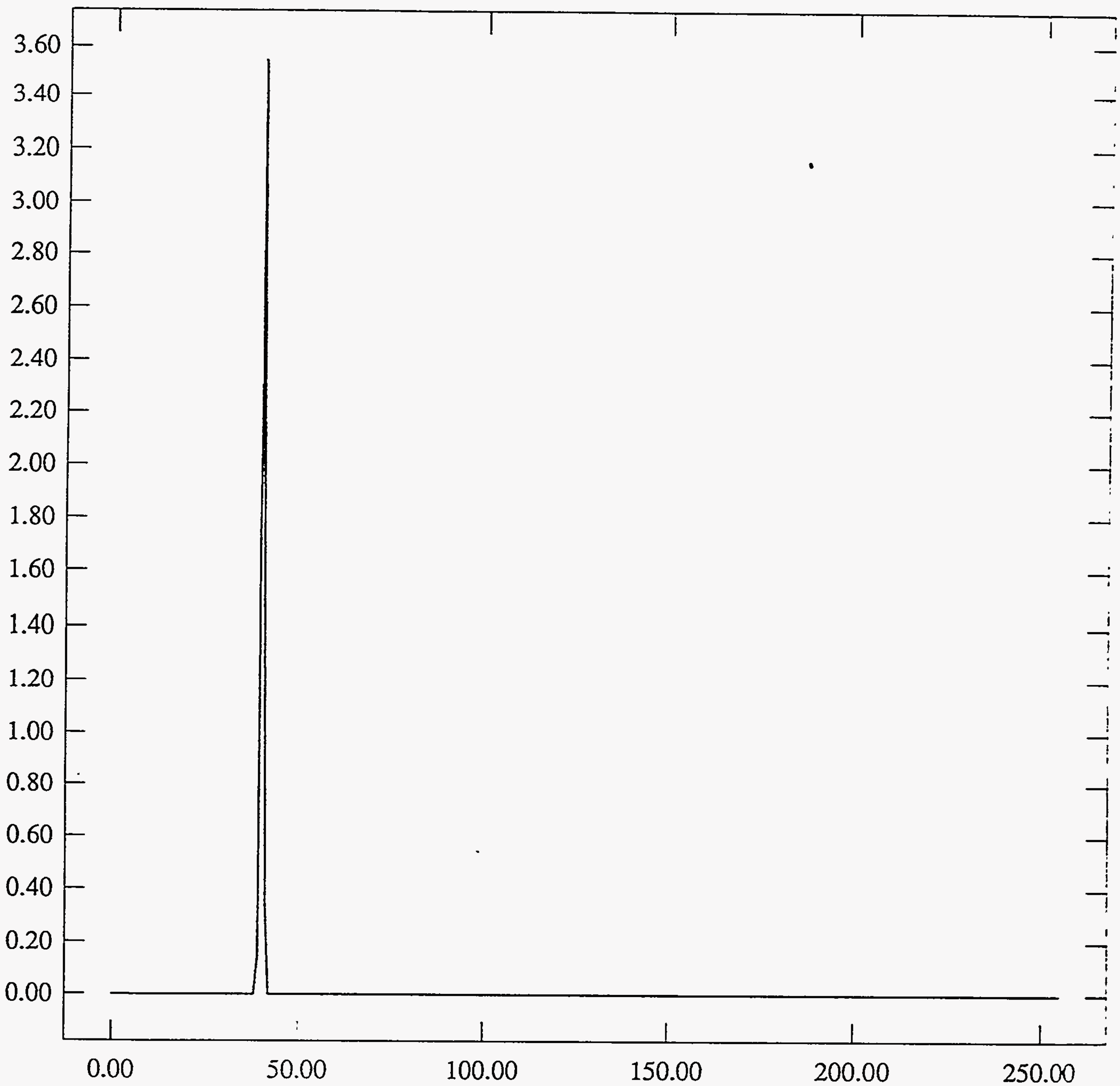
Pixel Values Min 40 Max 42 Mean 40.8 Sigma 0.41 x 10^3




ST Camera: ST1#04-10 -10C: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Mon May 10 16:09:13 1993
Pixel Values Min 39 Max 41 Mean 40.0 Sigma 0.36 x 10^3
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

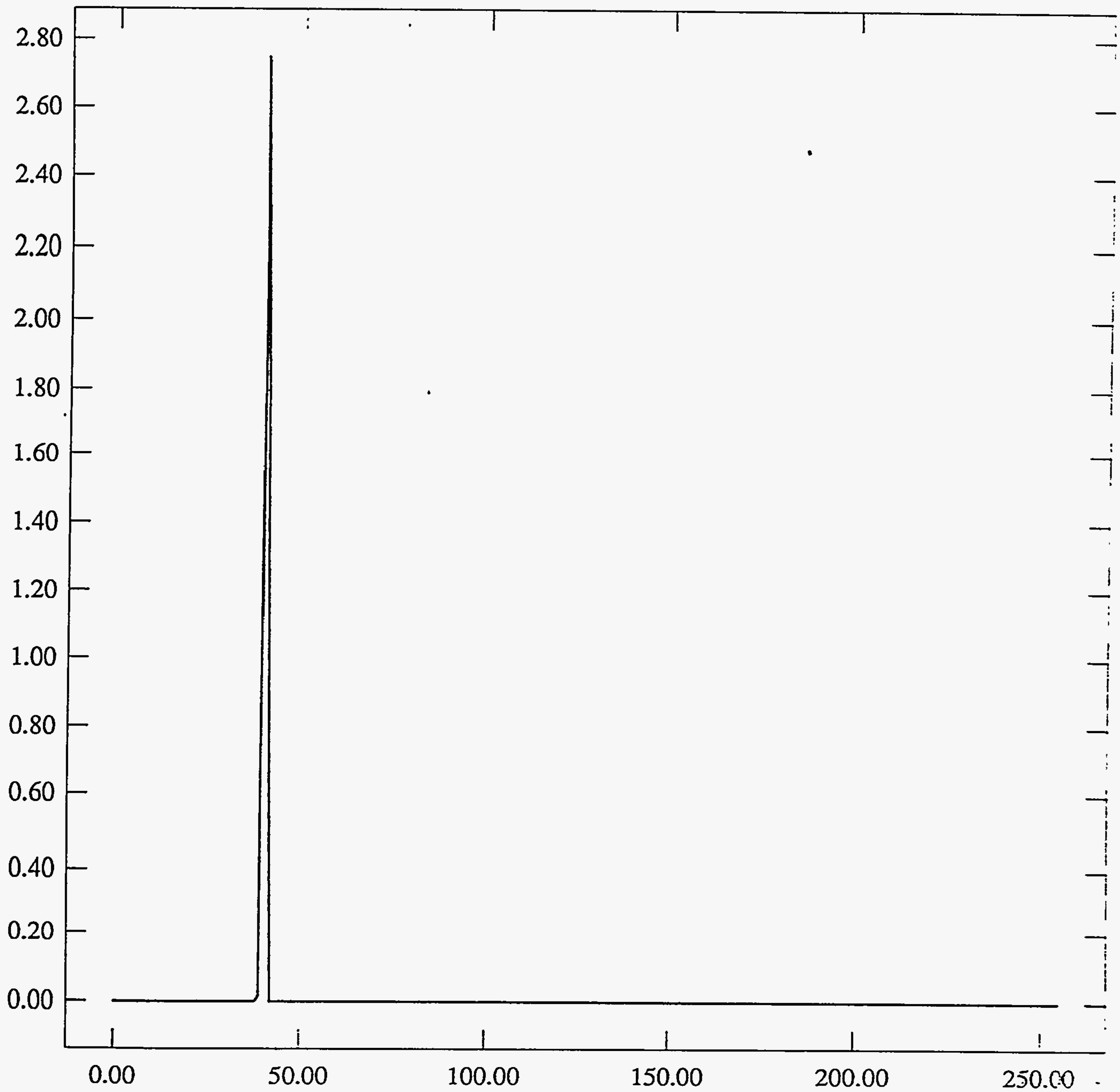
ST Camera: ST1#04-10 -10C: int_time=100ms, offset= 0, gain=1 (350 e/bit) Mon May 10 16:10:09 1993

Pixel Values Min 39 Max 41 Mean 40.0 Sigma 0.35 x 10^3



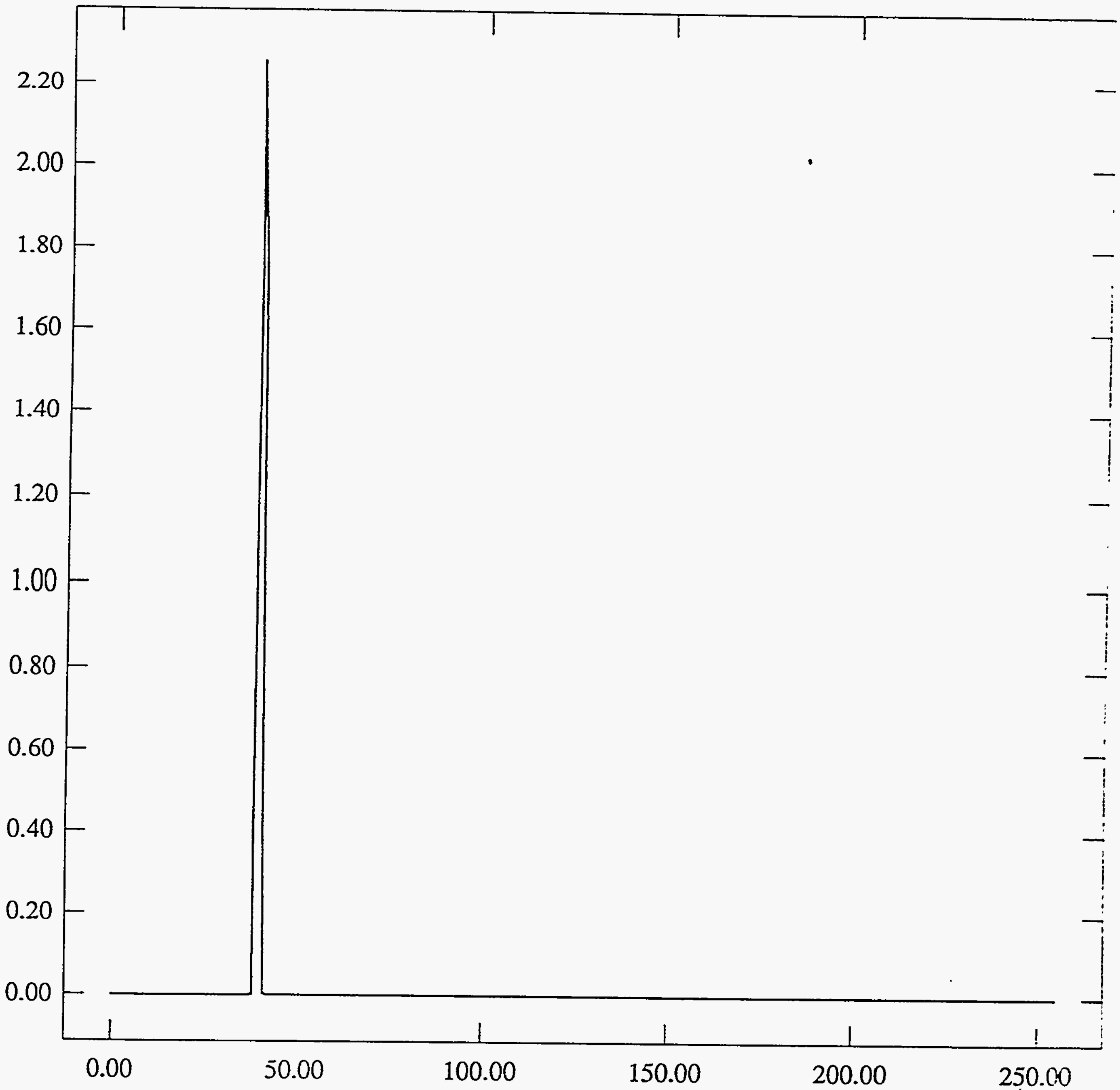
ST Camera: ST1#04-10 -10C: int_time=200ms, offset= 0, gain=1 (350 e/bit) Mon May 10 16:10:41 1993

Pixel Values Min 39 Max 41 Mean 40.3 Sigma 0.47 x 10^3



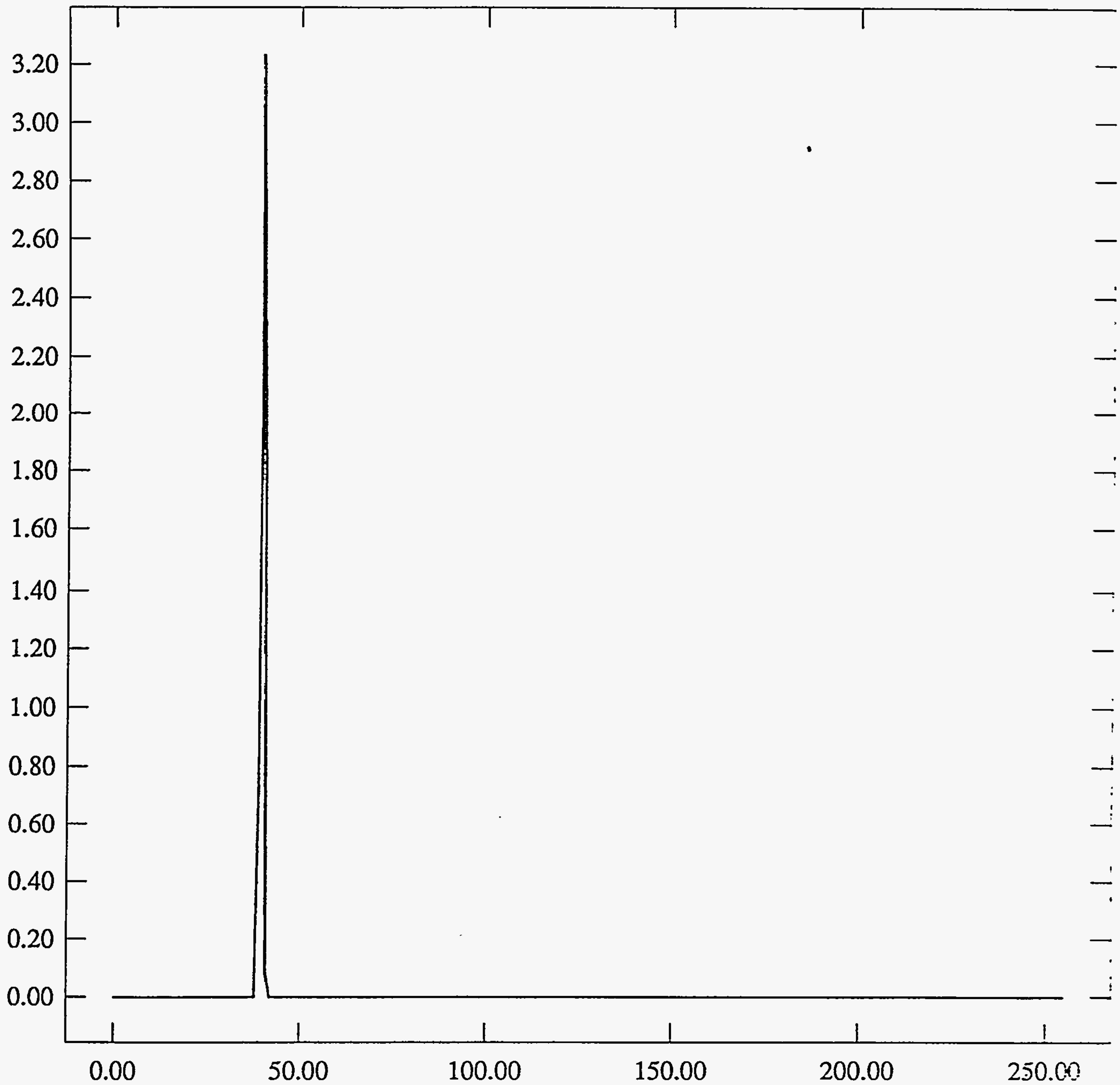
ST Camera: ST1#04-10 0C: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Mon May 10 16:39:37 1993

Pixel Values Min 38 Max 41 Mean 39.4 Sigma 0.50 x 10^3



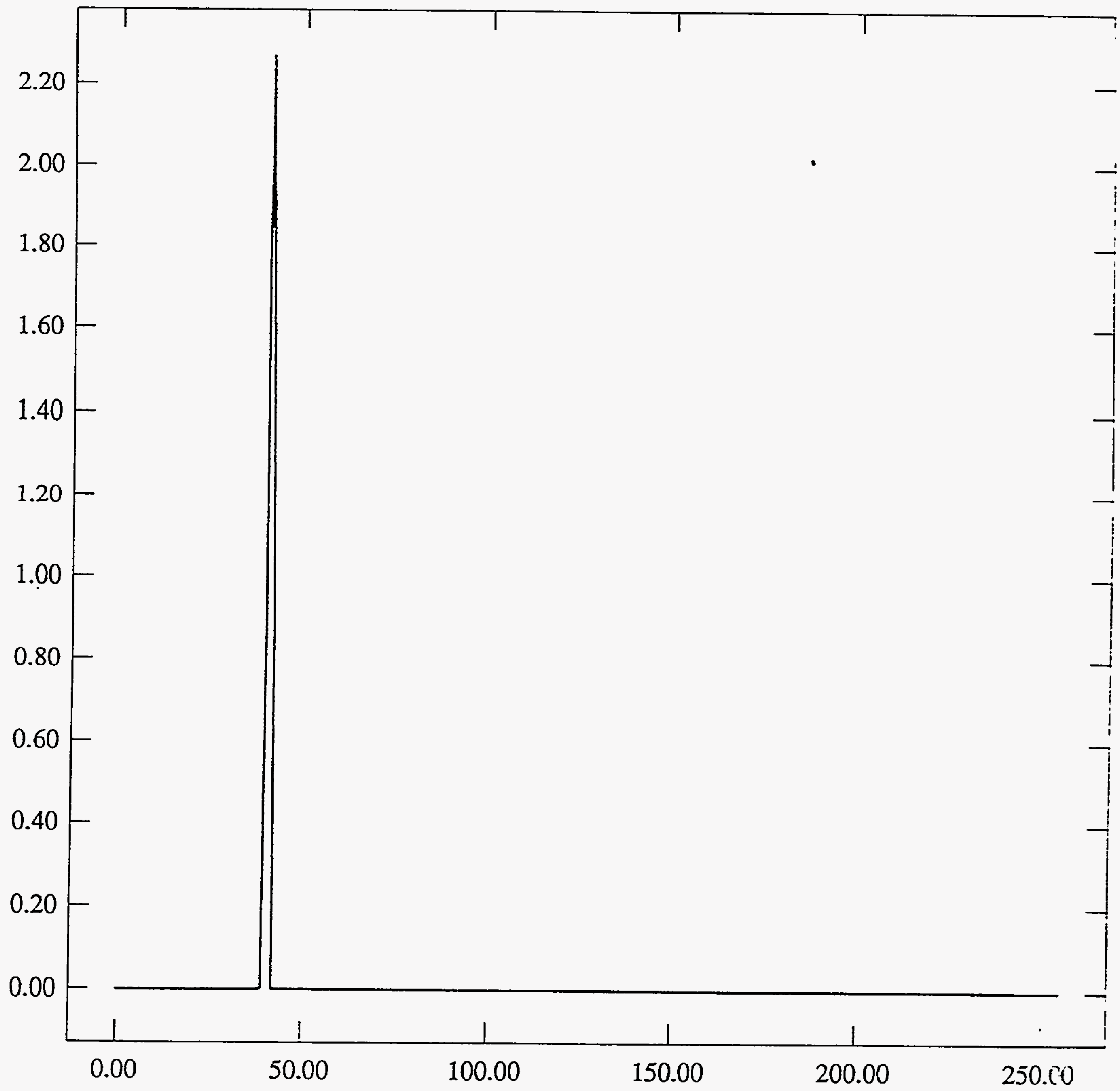
ST Camera: ST1#04-10 0C: int_time=100ms, offset= 0, gain=1 (350 e/bit) Mon May 10 16:40:21 1993

Pixel Values Min 39 Max 41 Mean 39.8 Sigma 0.42 x 10^3



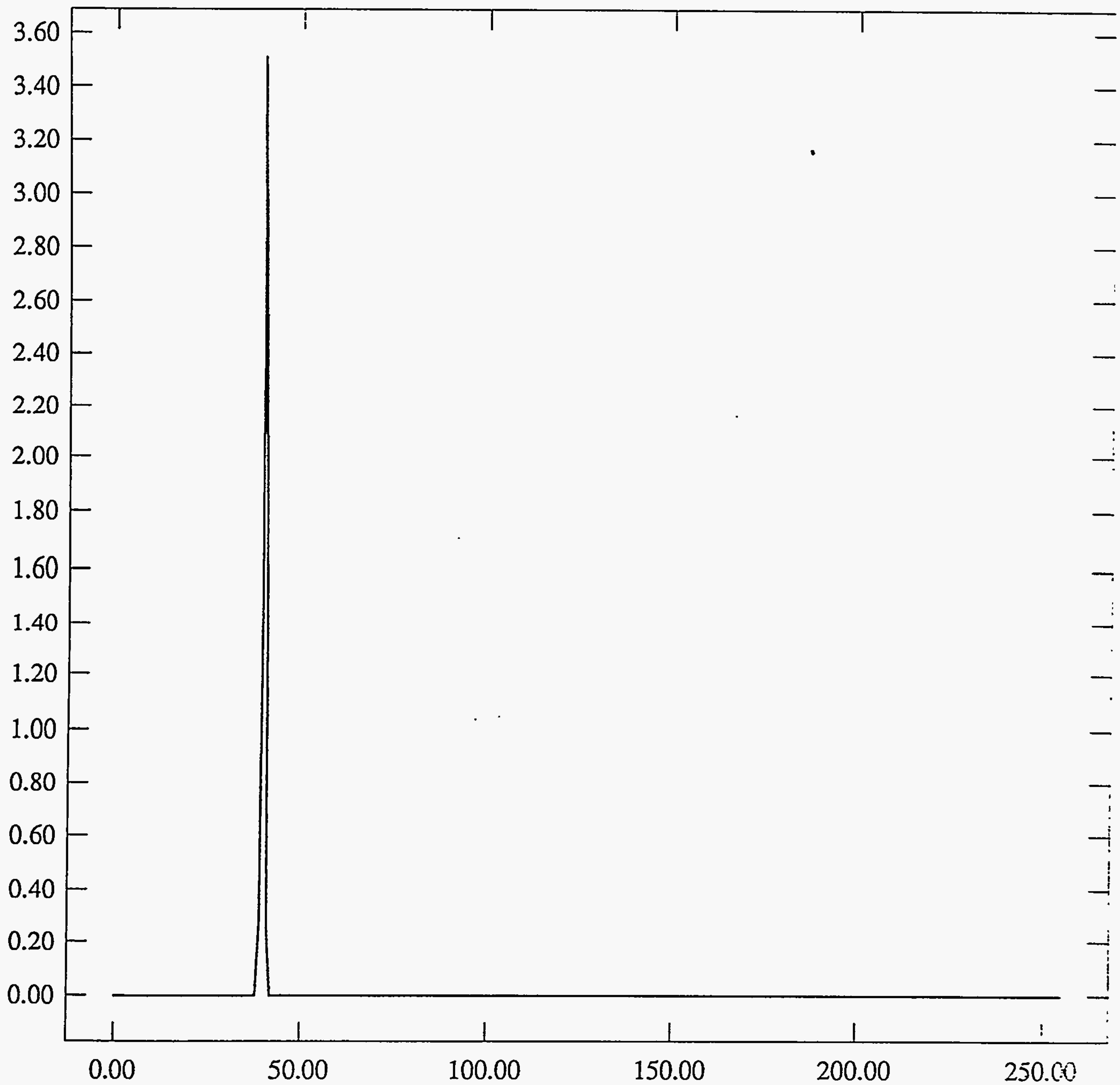
ST Camera: ST1#04-10 0C: int_time=200ms, offset= 0, gain=1 (350 e/bit) Mon May 10 16:40:55 1993

Pixel Values Min 39 Max 42 Mean 40.6 Sigma 0.50 x 10^3



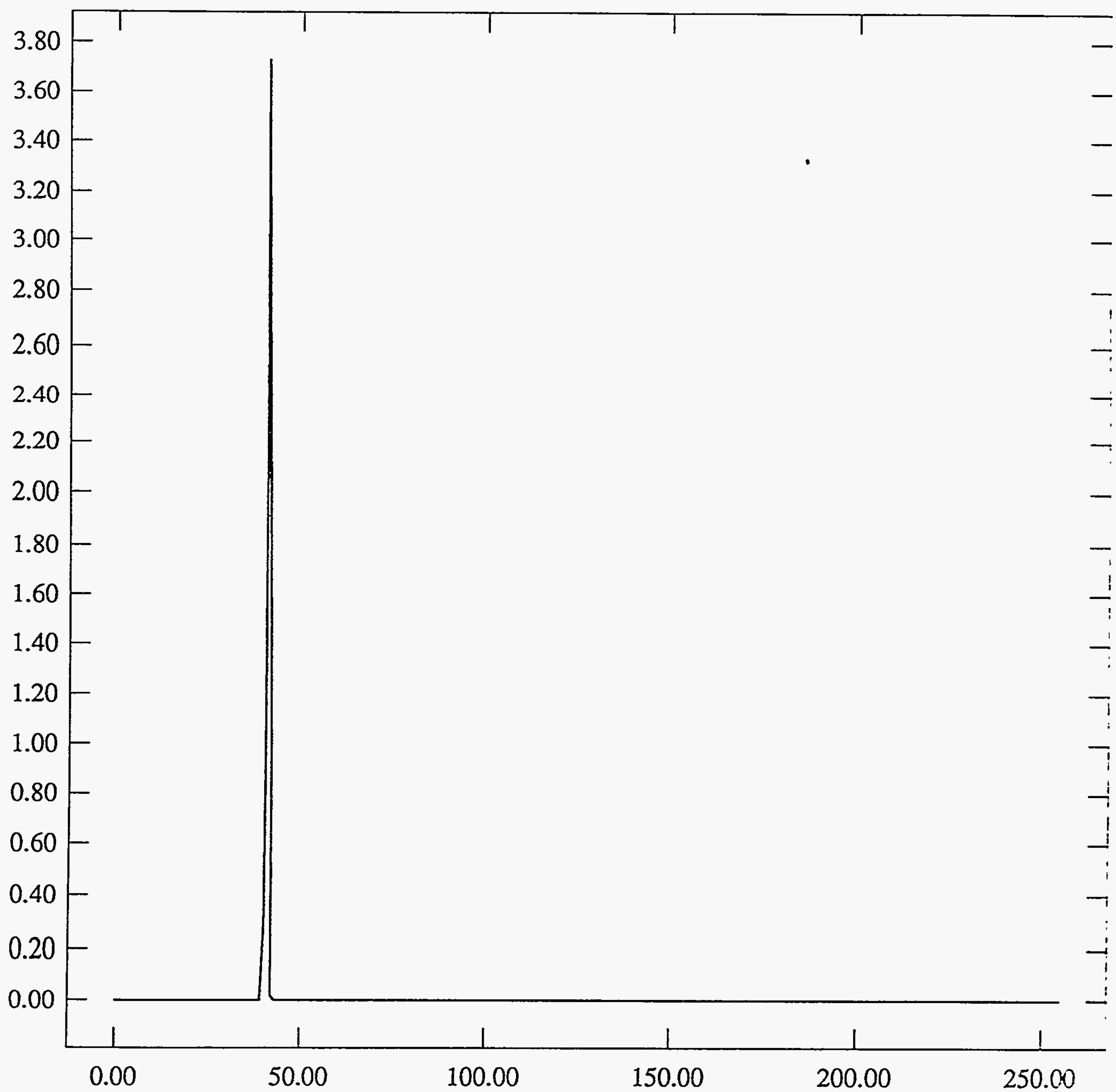
ST Camera: ST1#04-10 10C: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Mon May 10 17:02:58 1993

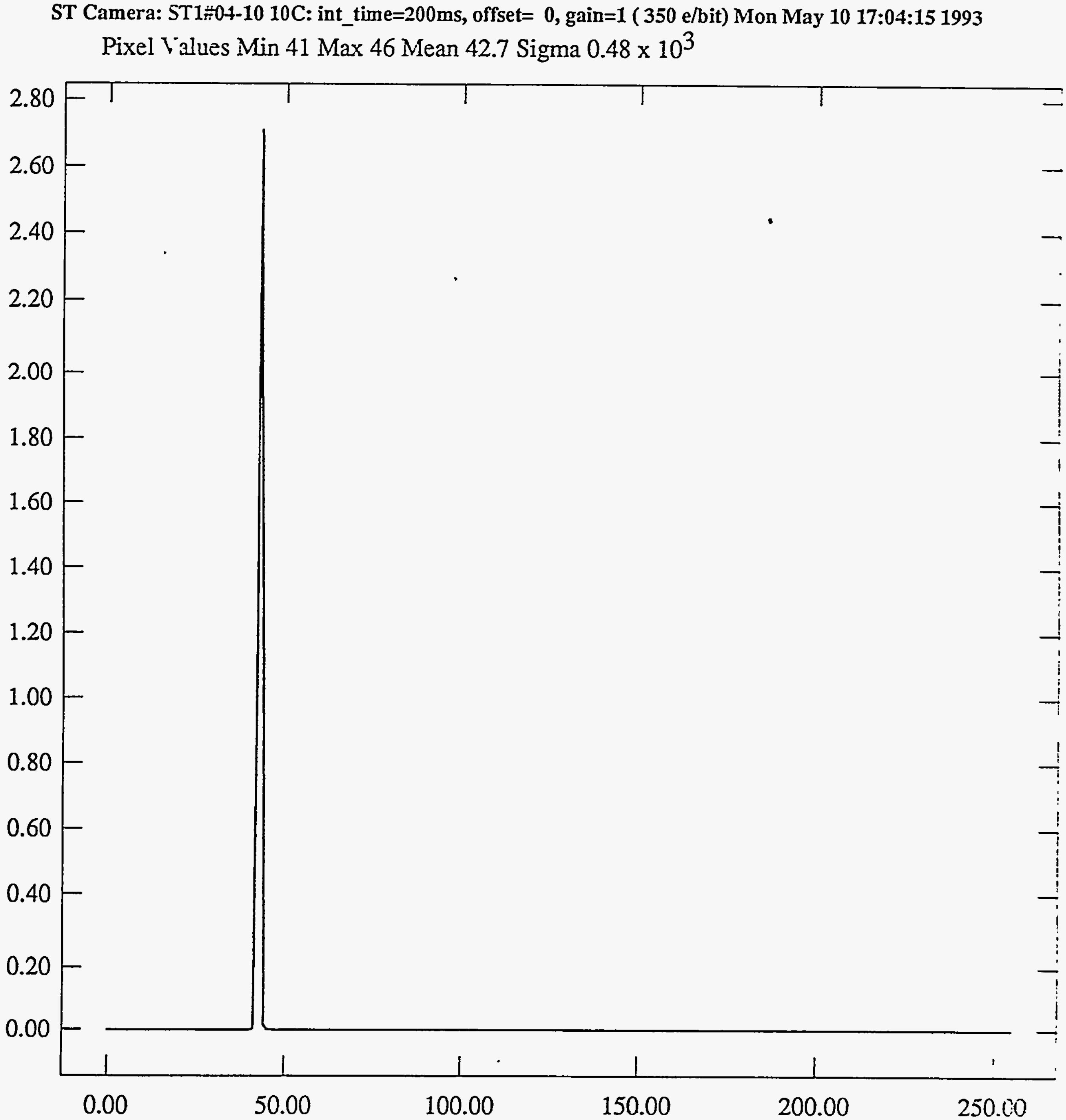
Pixel Values Min 39 Max 41 Mean 40.0 Sigma 0.36 x 10^3



ST Camera: ST1#04-10 10C: int_time=100ms, offset= 0, gain=1 (350 e/bit) Mon May 10 17:03:28 1993

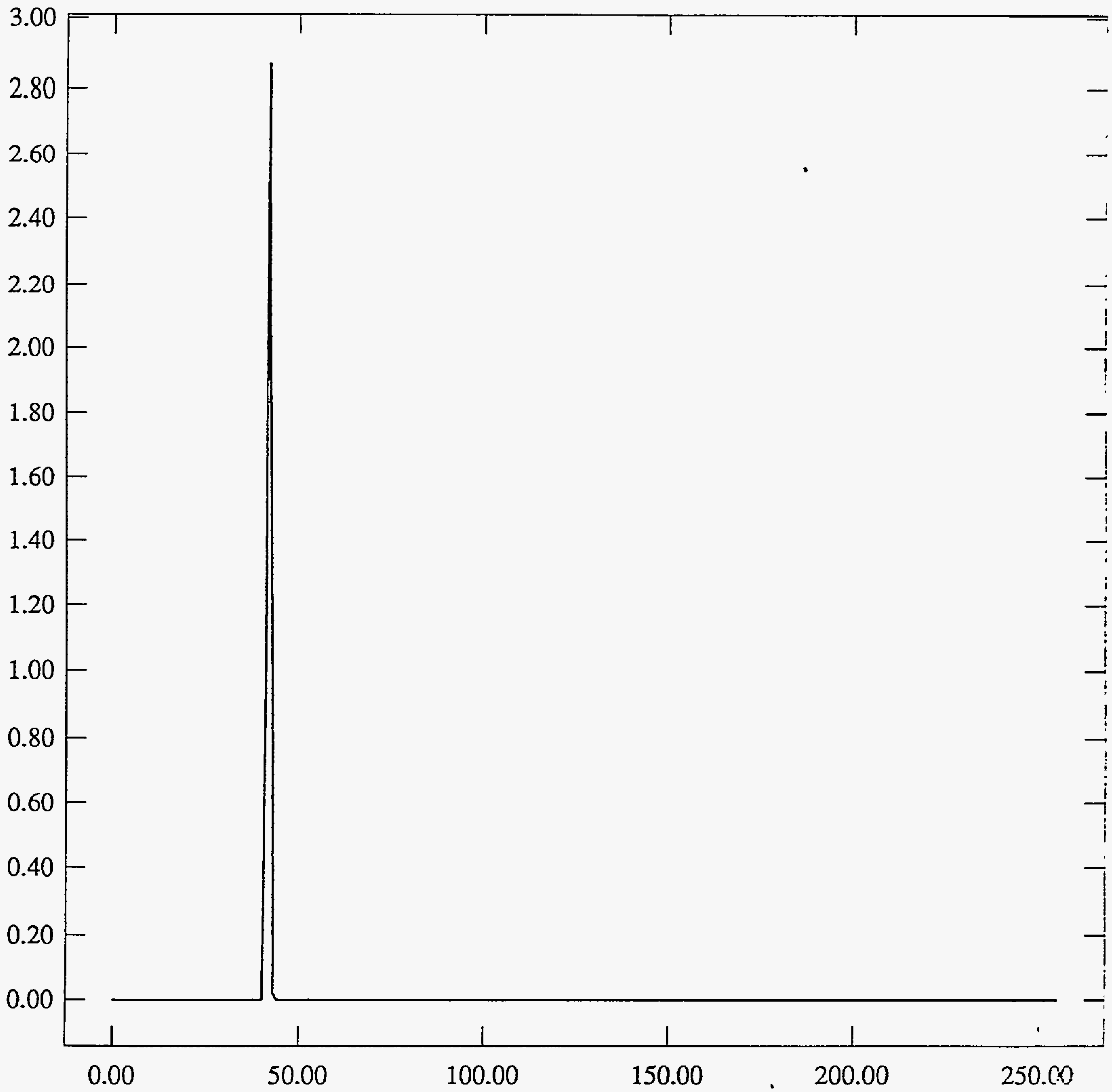
Pixel Values Min 40 Max 42 Mean 40.9 Sigma 0.27 x 10^3




ST Camera: ST1#04-10 10C: int_time=200ms, offset= 0, gain=1 (350 e/bit) Mon May 10 17:04:15 1993
Pixel Values Min 41 Max 46 Mean 42.7 Sigma 0.48 x 10^3
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

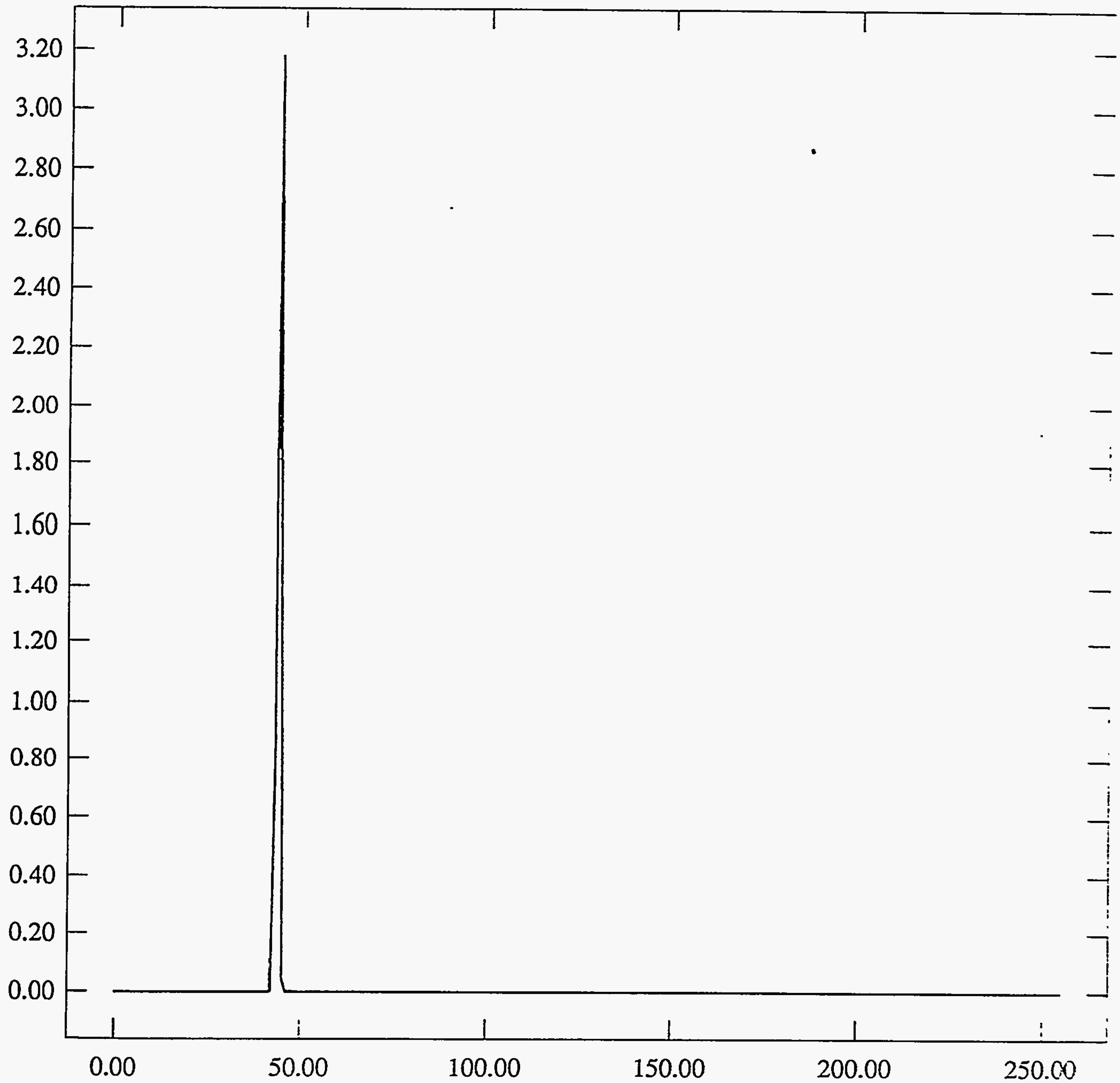
ST Camera: ST1#04-10 20C: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Mon May 10 17:22:15 1993

Pixel Values Min 41 Max 43 Mean 41.7 Sigma 0.46 x 10^3

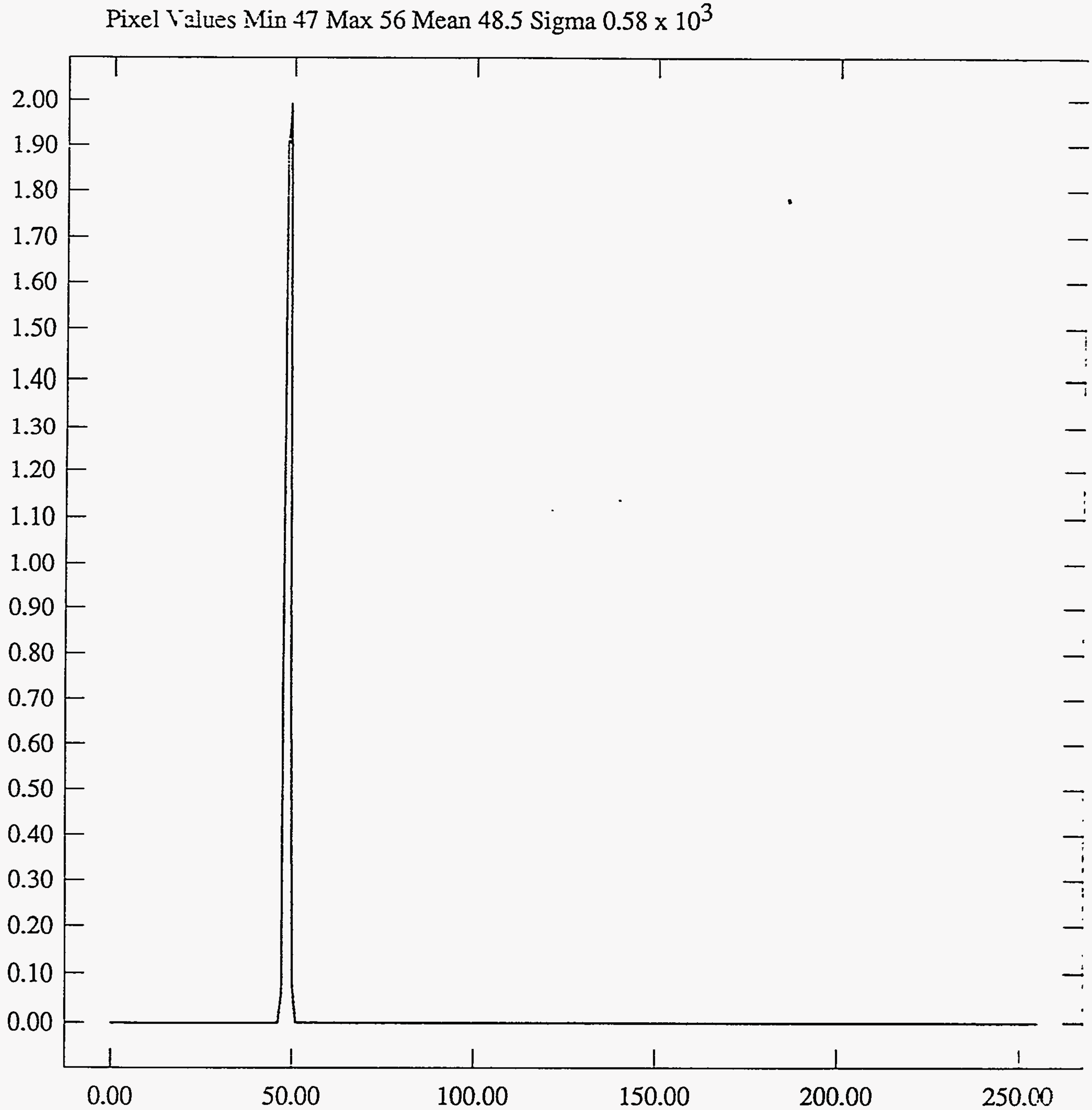


ST Camera: ST1#04-10 20C: int_time=100ms, offset= 0, gain=1 (350 e/bit) Mon May 10 17:22:46 1993

Pixel Values Min 43 Max 48 Mean 43.8 Sigma 0.43 x 10^3

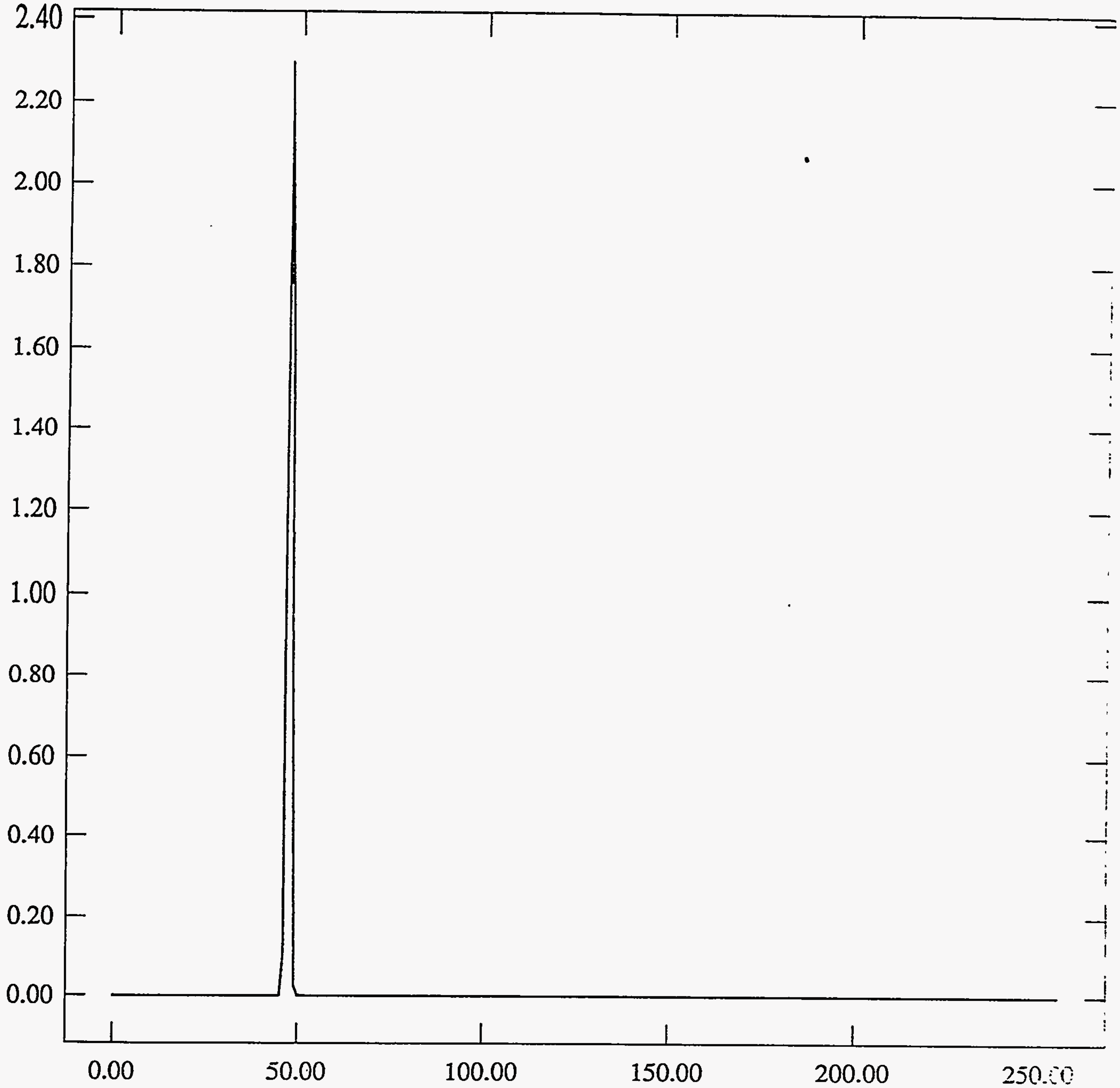


ST Camera: ST1#04-10 20C: int_time=200ms, offset= 0, gain=1 (350 e/bit) Mon May 10 17:23:23 1993



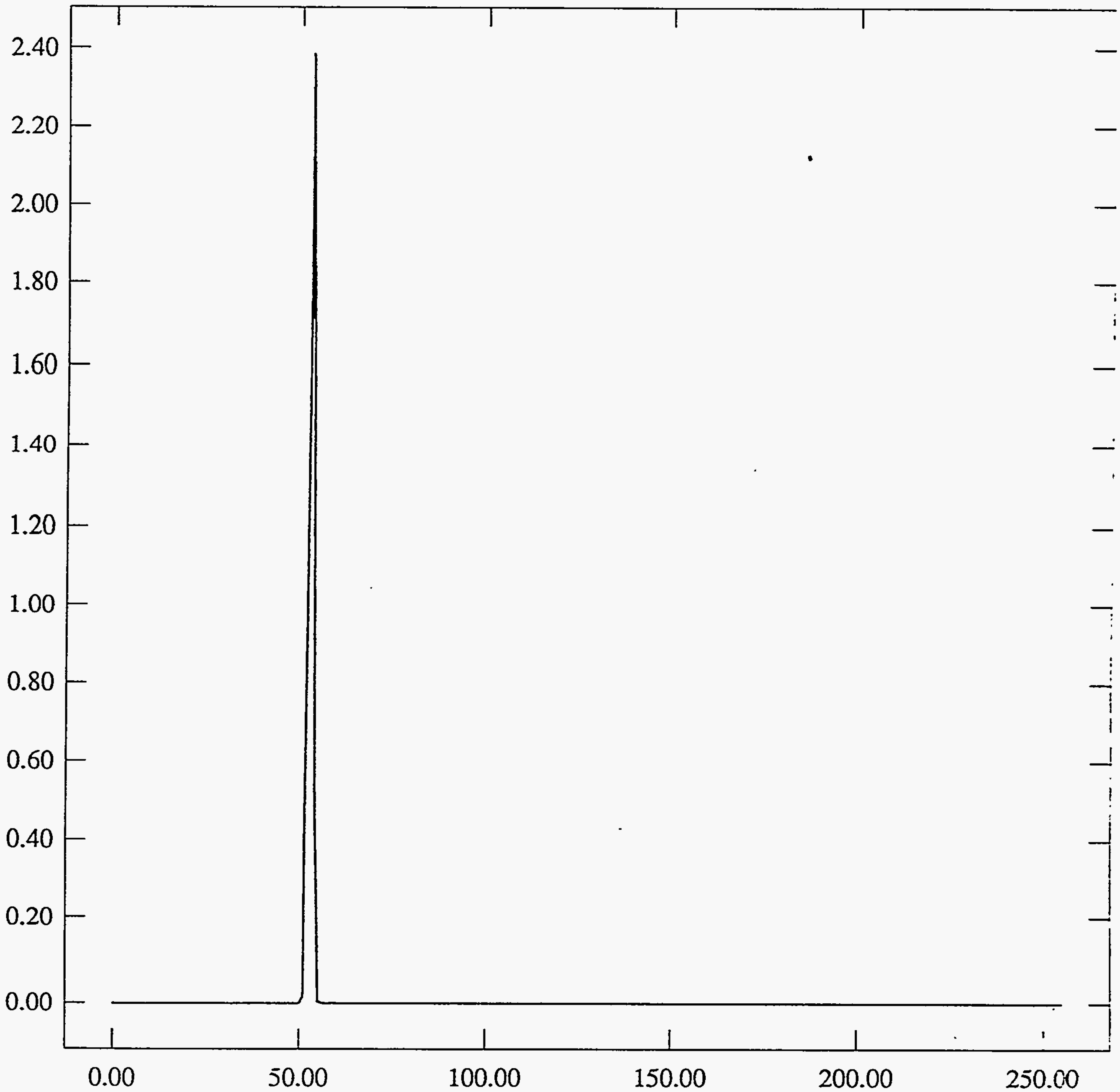
ST Camera: ST1#04-10 30C: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Mon May 10 17:53:32 1993

Pixel Values Min 46 Max 51 Mean 47.4 Sigma 0.55 x 10^3



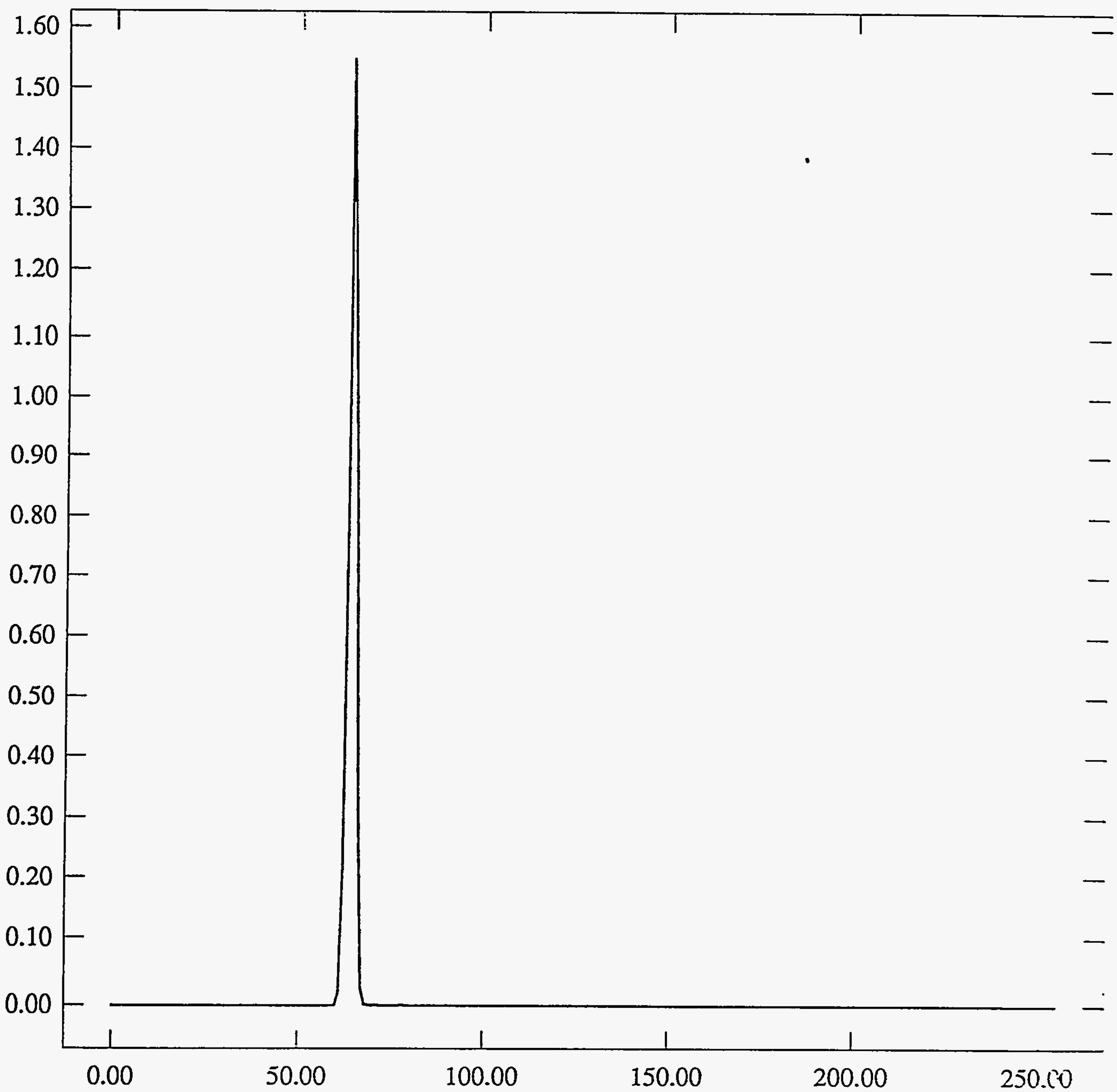
ST Camera: ST1#04-10 30C: int_time=100ms, offset= 0, gain=1 (350 e/bit) Mon May 10 17:54:46 1993

Pixel Values Min 51 Max 59 Mean 52.9 Sigma 0.64 x 10^3

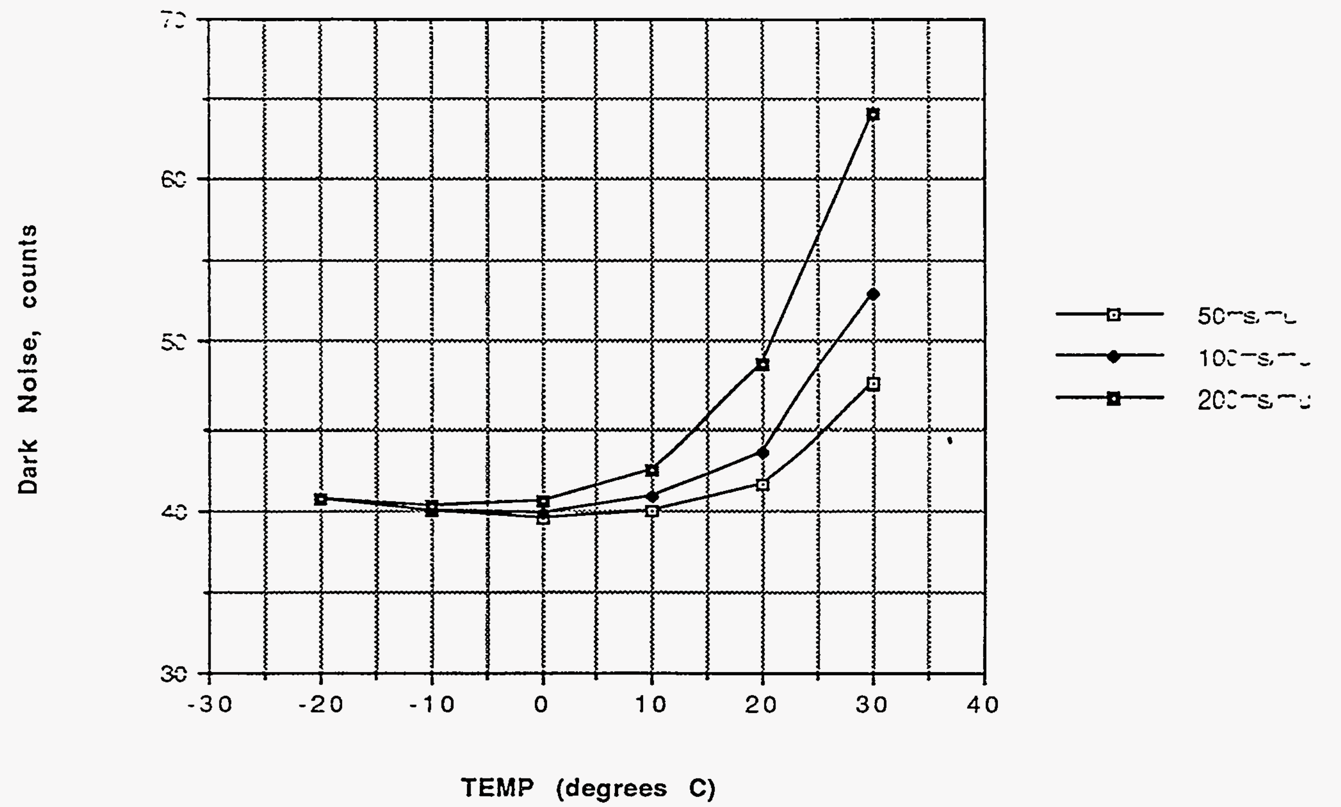


ST Camera: ST1#04-10 30C: int_time=200ms, offset= 0, gain=1 (350 e/bit) Mon May 10 17:55:23 1993

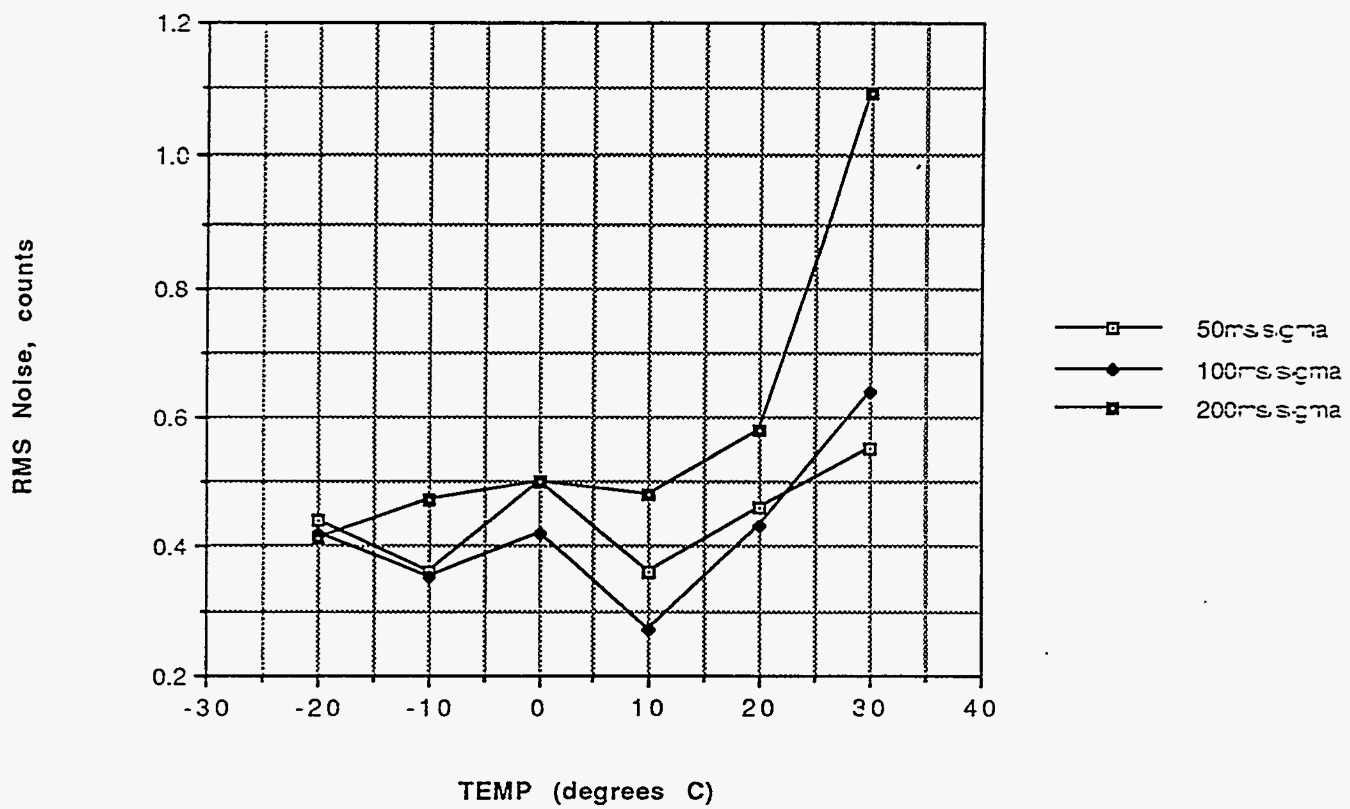
Pixel Values Min 61 Max 78 Mean 64.1 Sigma 1.09 x 10^3



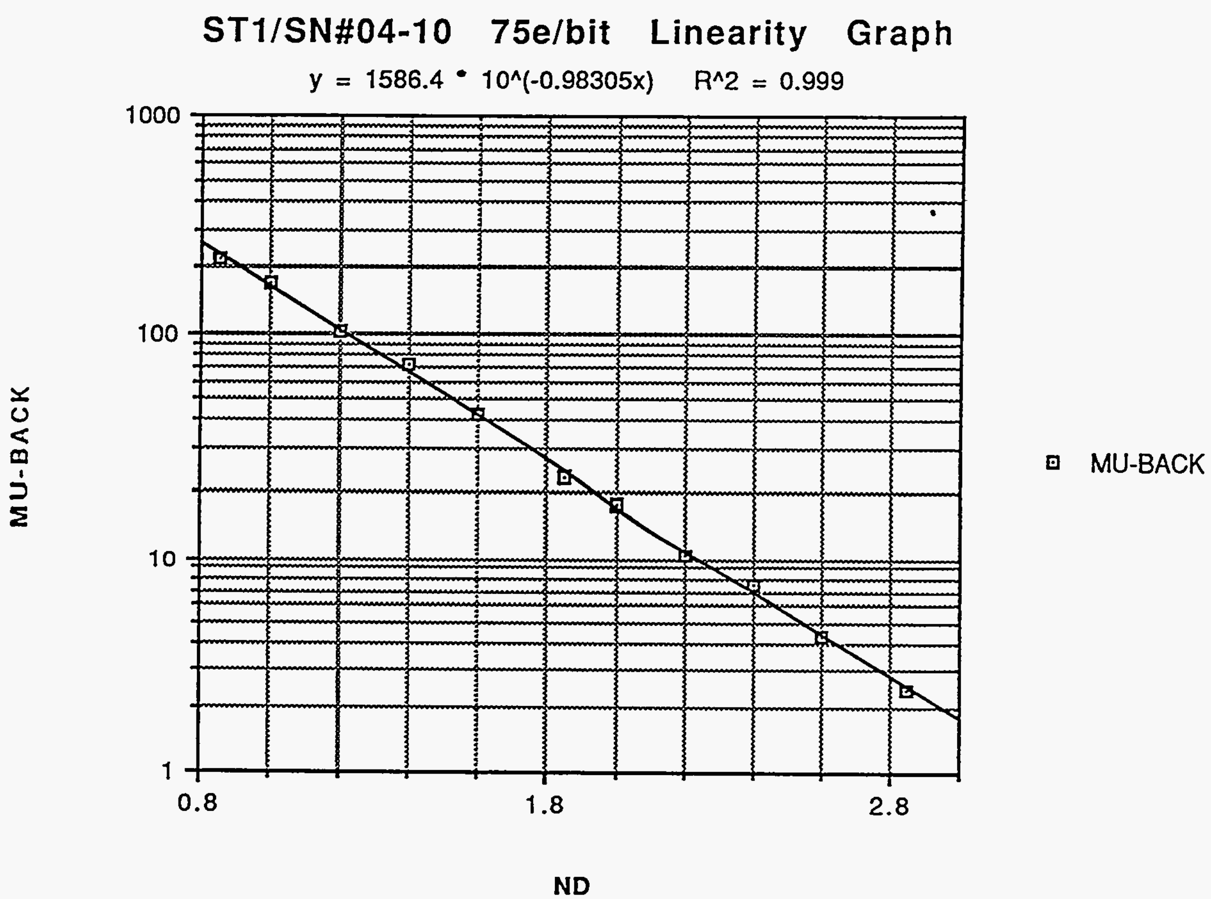
ST1#04-10 350e/bit Mu °C Graph



ST1#04-10 350e/bit Sigma °C Graph



STI #04-10
5/10/93
preliminary
Focus


ST1/SN#04-10 75e/bit Linearity Graph
y = 1586.4 * 10^(-0.98305x) R^2 = 0.999
1000
100
10
1
0.8
1.8
2.8
ND
MU-BACK
MU-BACK

ST1/SN#04-10/75e/LNDT Wed, May 12, 1993 9:24 AM

	ND	MU	BACK	MU-BACK	Colu	NOTES:
1						
2	0.85	243.32	27.02	216.30		5/10/93
3	1.00	199.12	27.02	172.10		ST1 SN#04-10
4	1.20	131.29	27.02	104.27		11.3v
5	1.40	98.63	27.02	71.61		
6	1.60	69.54	27.02	42.52		SUNDATACUBE
7	1.85	50.17	27.49	22.68		offset=24
8	2.00	45.03	27.49	17.54		75e/bit
9	2.20	37.94	27.49	10.45		P.S.#5008
10	2.40	34.96	27.49	7.47		HEAD#4163
11	2.60	31.86	27.49	4.37		
12	2.85	29.93	27.49	2.44		

13.3 Linearity Data Collection.

Select the first gain setting.

Begin by taking a background level. Use an ND of 8.0 for background. Adjust the Offset so that the black level is equal to 20 counts and readjust the lamp voltage so that the average is equal to 240 - 250 counts with an ND of 0.85.

Starting with 0.8 ND, increment the ND filter value with 0.2 steps until MU almost equals the background. Acquire, build histogram, and record mu/sigma information for each ND value. Repeat this sequence for all 3 Gain settings.

Turn off power.

Sample data table:

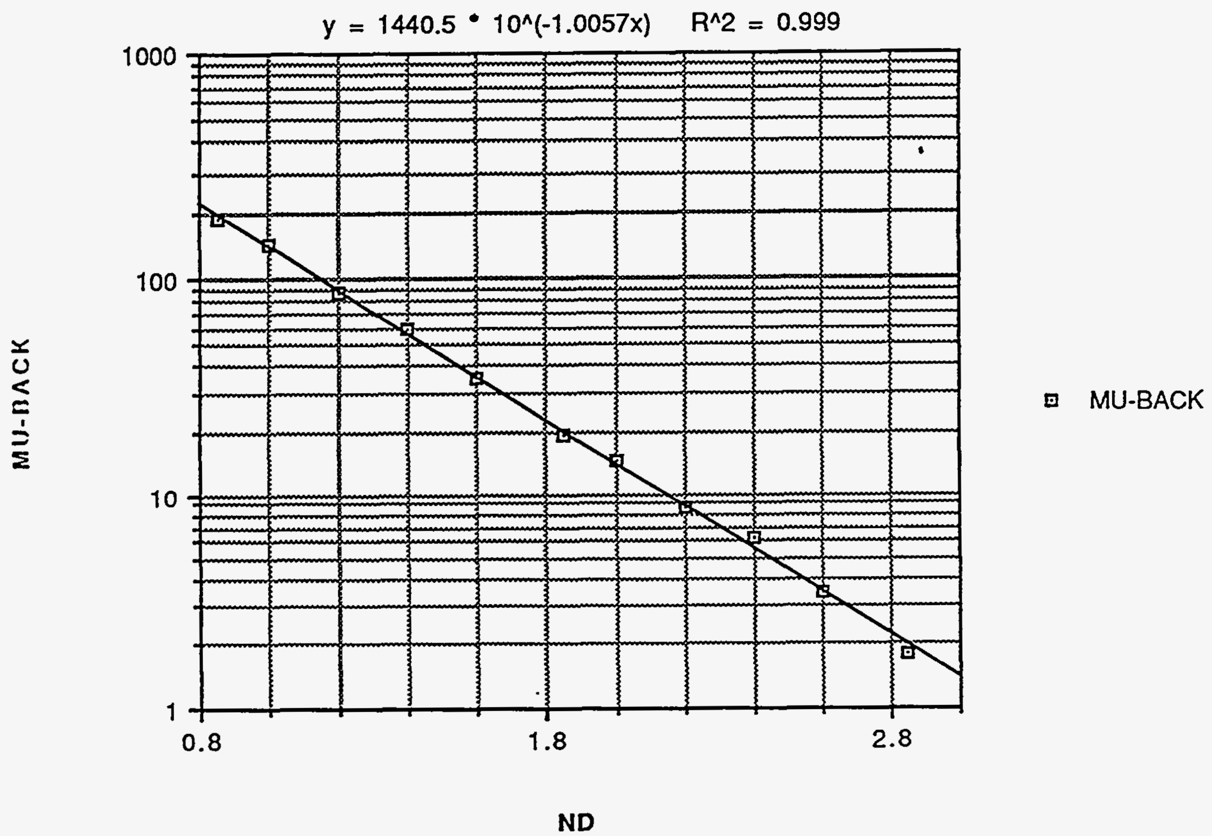
ND	Mu	Backgnd	Mu-Back
0.85	249	82	167
1.0	211	82	129
1.2	159	82	77
1.4	136	82	54
1.6	113	82	31
1.85	99	82	17
2.0	95	82	13
2.2	90	82	8
2.4	87	82	5
2.6	85	82	3
2.85	84	82	2

Actual data table for gain of 4 75L

SN# 04-10 Date 5/10/93
Offset 24 ..P.S.Volt 11.3x

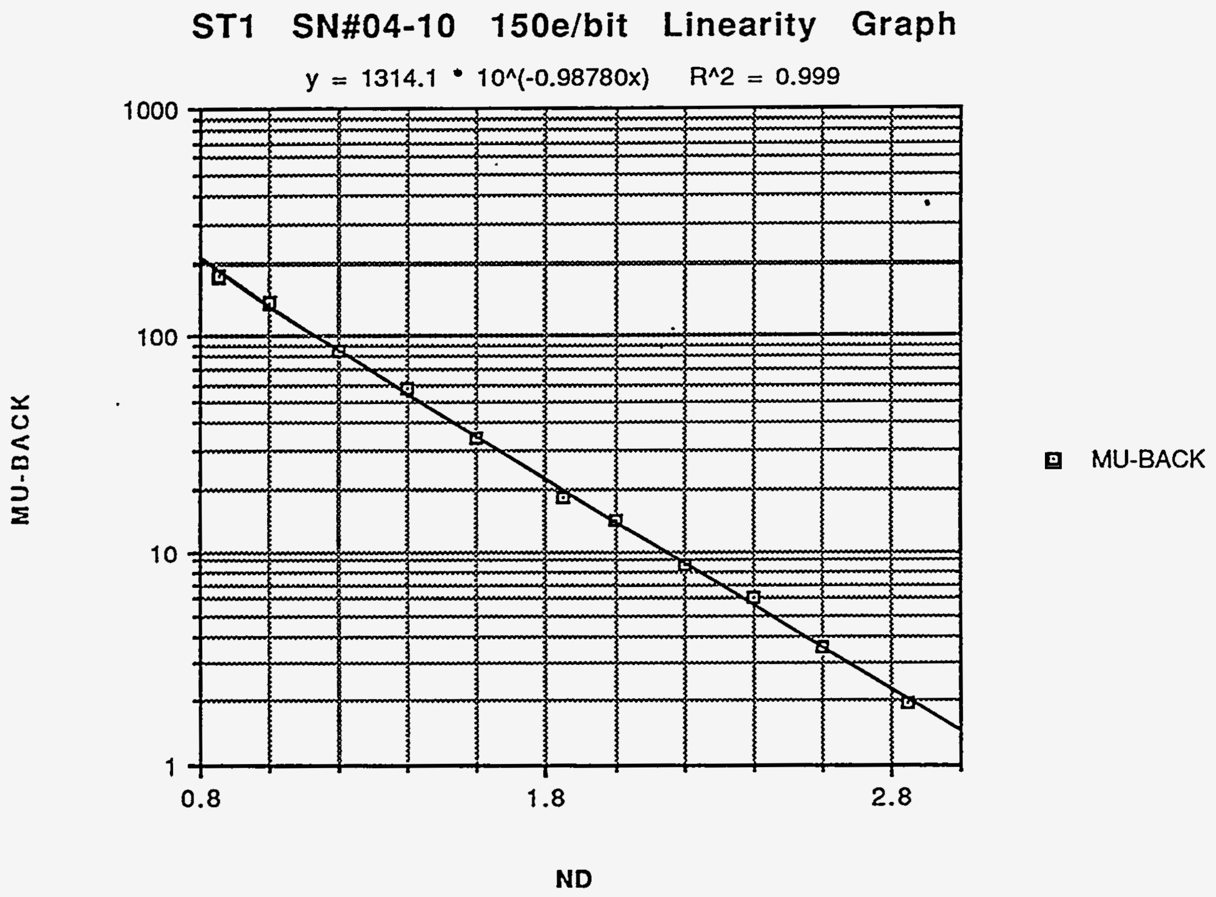
ND	Mu	Backgnd	Mu-Back
0.85	243.32	27.02	
1.0	199.12		
1.2	131.29		
1.4	98.63		
1.6	69.54		
1.85	50.17	27.49	
2.0	45.03		
2.2	37.94		
2.4	34.96		
2.6	31.86		
2.85	29.93		

ST1 SN#04-10 350e/bit Linearity Graph



ST1/SN#04-10/350e/LNDT Wed, May 12, 1993 11:40 AM

	ND	MU	BACK	MU-BACK	NOTES:
1					
2	0.85	217.72	27.54	190.18	5/10/93
3	1.00	173.06	27.54	145.52	ST1 SN#04-10
4	1.20	115.02	27.54	87.48	14.0v
5	1.40	87.86	27.54	60.32	
6	1.60	62.51	27.56	34.95	SUNDATACUBE
7	1.85	46.55	27.56	18.99	offset=3
8	2.00	42.09	27.56	14.53	350e/bit
9	2.20	36.24	27.56	8.68	P.S.#5008
10	2.40	33.81	27.56	6.25	HEAD#4163
11	2.60	31.02	27.56	3.46	
12	2.85	29.37	27.56	1.81	


ST1 SN#04-10 150e/bit Linearity Graph
y = 1314.1 * 10^(-0.98780x) R^2 = 0.999
1000
100
10
1
0.8
1.8
2.8
MU-BACK
ND
MU-BACK

	ND	MU	BACK	MU-BACK	Colu	NOTES:
1						
2	0.85	206.23	23.44	182.79		5/10/93
3	1.00	163.21	23.44	139.77		ST1 SN#04-10
4	1.20	107.88	23.44	84.44		12.0v
5	1.40	81.89	23.44	58.45		
6	1.60	57.39	23.44	33.95		SUNDATACUBE
7	1.85	41.67	23.44	18.23		offset=11
8	2.00	37.58	23.44	14.14		150e/bit
9	2.20	32.00	23.47	8.53		P.S.#5008
10	2.40	29.56	23.47	6.09		HEAD#4163
11	2.60	27.00	23.47	3.53		
12	2.85	25.43	23.47	1.96		

Actual data table for gain of 2 150e

SN# 04-10 Date 5/10/93
Offset 11 ..P.S.Volt 12.V

ND	Mu	Backgnd	Mu-Back
0.85	206.23	23.44	
1.0	163.21		
1.2	107.88		
1.4	81.89		
1.6	57.39		
1.85	41.67		
2.0	37.58	23.47	
2.2	32.00		
2.4	29.56		
2.6	27.00		
2.85	25.43		

Actual data table for gain of 1 350e

SN# 04-10 Date 5/10/93
Offset 3 ..P.S.Volt 14.V

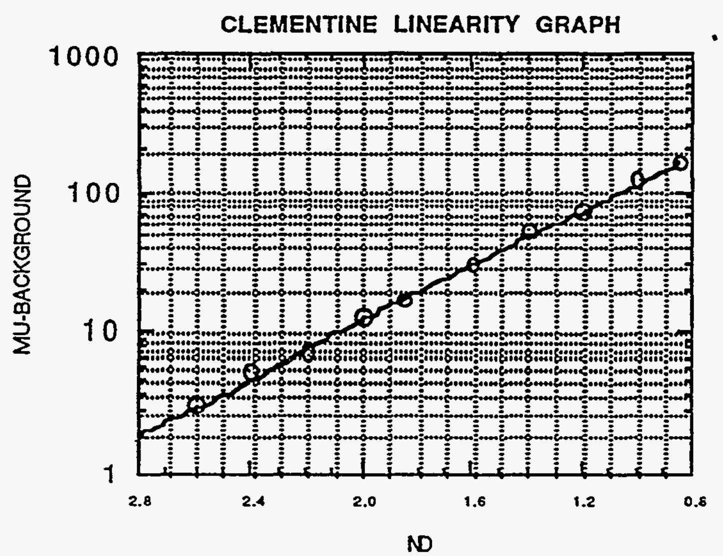
ND	Mu	Backgnd	Mu-Back
0.85	217.72	27.54	
1.0	173.06		
1.2	115.02		
1.4	87.86		
1.6	62.51	27.56	
1.85	46.55		
2.0	42.09		
2.2	36.24		
2.4	33.81		
2.6	31.02		
2.85	29.37		

13.4 Linearity Data Processing

Graphing techniques will vary with software. If you use Cricketgraph, select the "scatter" graph format. Note: Y axis = Mu-Back; X axis = ND.

Choose a logarithmic Y axis and an exponential curve fit.

Here is a flat field linearity graph using Cricketgraph:



Confirm your linear results:

SN# 04-70 By MD/DA (initials) Date 5/10/93 (passed)

REMEMBER to include your recorded documentation in the test procedure!
(a document protector is advised)

14. Offset Linearity Test

This test requires the use of the SUN Datacube and its image processing capabilities, a TV Optoliner Model K-4000 with neutral density(ND) filters ranging up to 1.8, and a resolution chart for focusing.

14.1. Offset Linearity Test Setup

Using alcohol and Q-tips, clean the installed CCD.

Verify a properly connected camera acquisition system.

Power up the test fixture.

Put the frame grabber in the grab mode.

Install a total 0.8 Neutral Density (ND) filter and test pattern in the T.V. Optoliner.

Adjust the camera board so that the test pattern image is focused on the CCD.

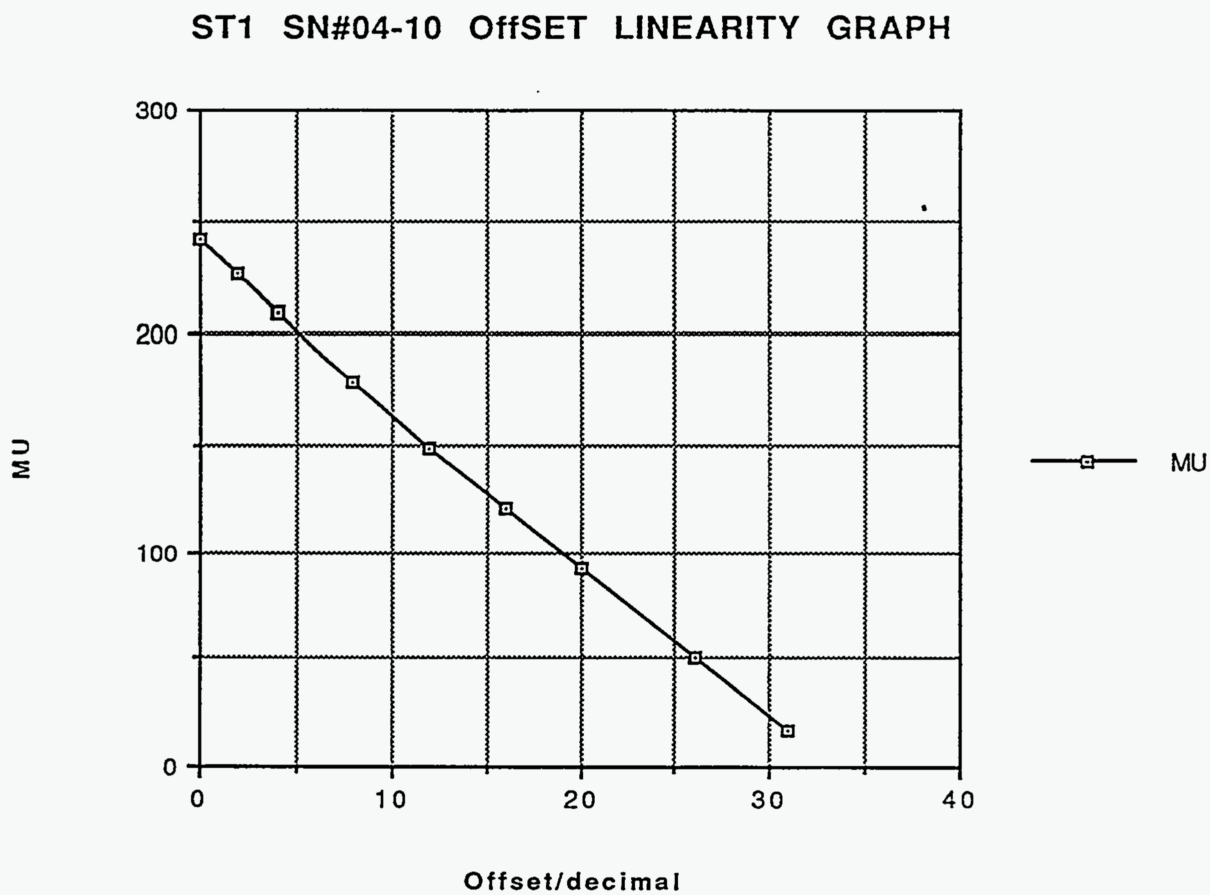
NOTE: With the focal plane now established, neither the camera nor the optoliner can be moved.

Remove test pattern for a flat field image.Set the board gain to gain setting of 2.

Remove all ND (ND = 0.0) and input a HEX offset of 00.

Adjust the T.V. Optoliner lamp voltage so that you get a *MU* of ≈250 counts.

Allow the T.V. Optoliner and camera to warm up under continuous operation for ≈1 hour before proceeding. Keeping the camera's environmental temperature constant and allowing a long warm up requires only one background histogram for linearity computation.


ST1 SN#04-10 OffSET LINEARITY GRAPH
300
200
100
0
0
10
20
30
40
MU
Offset/decimal
MU

	Offset/decimal	MU	Colum	Column 4
1				
2	0	241.41		5/10/93
3	2	225.41		ST1 SN#04-10
4	4	209.25		P. S. = 14.0v
5	8	178.47		CCD#8846
6	12	149.11		SUNDATACUBE
7	16	121.53		
8	20	92.65		350e/bit
9	26	50.91		P.S.#5008
10	31	17.35		HEAD#4163

14.2 Offset Linearity Measurement Acquisition

Use the SUN Datacube " Acquire and build histogram Sequence " to capture a frame and process a defined region of interest and to analyze for mu/sigma histograms.

14.3 Offset Linearity Data and Graph

Begin by taking a background level. Use an ND of 8.0 for background.

Input the offset values listed in the table below recording a histogram of the defined region of interest each time.

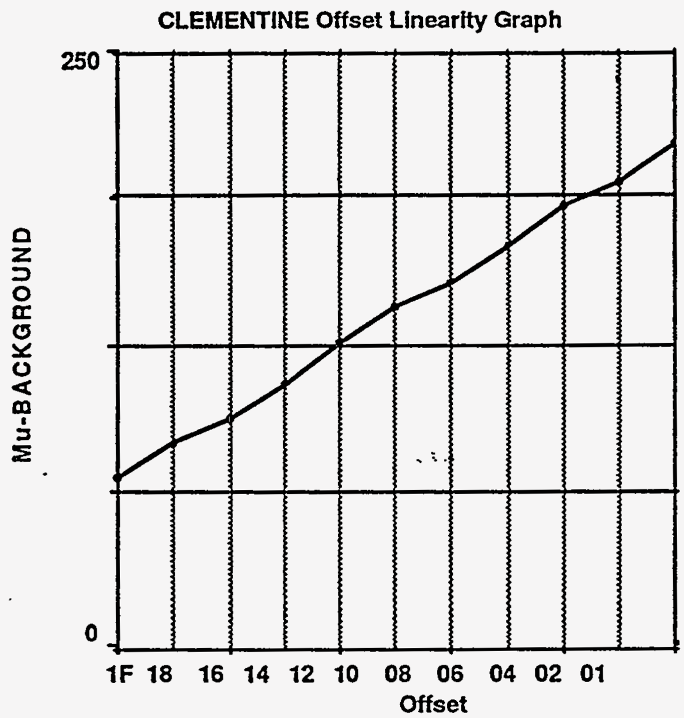
Power down the test fixture.

Offset	Mu	Backgnd	Mu-Back
00	241.41	52.12	
02	225.41		
04	209.25		
08	178.47		
12	149.11		
16	121.53		
20	92.65		
26	50.91		
31	17.35		

Graphing techniques will vary with software. If you use Cricketgraph, select the "scatter" graph format. Plot MU-BACKGROUND vs OFFSET

Choose a linear Y axis and linear curve fit.

Here is an offset linearity graph using Cricketgraph:

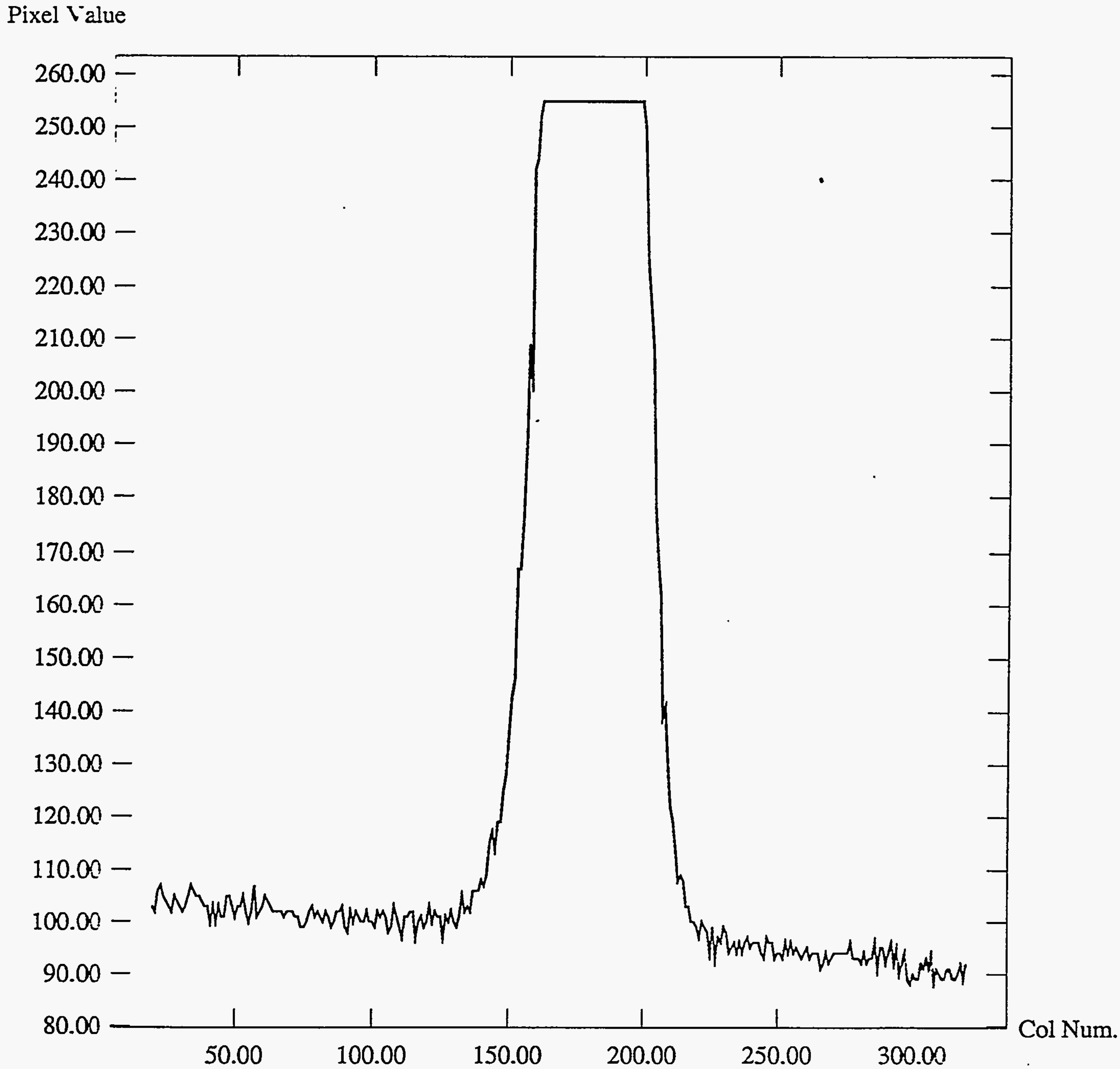


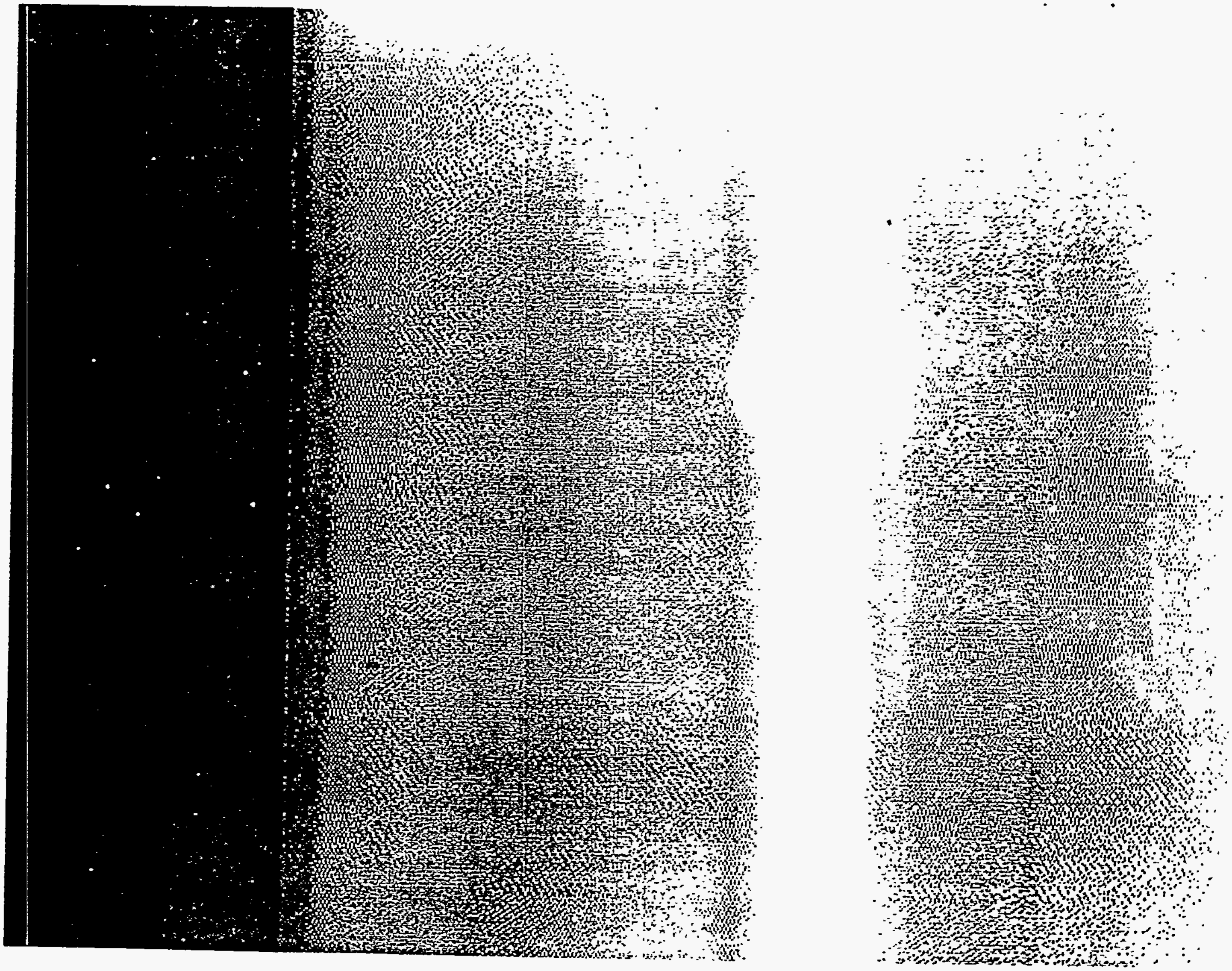
SN# 04-10 By MD/DA Date 5/10/93

initials passed

REMEMBER to include your recorded documentation in the test procedure!
(a document protector is advised)

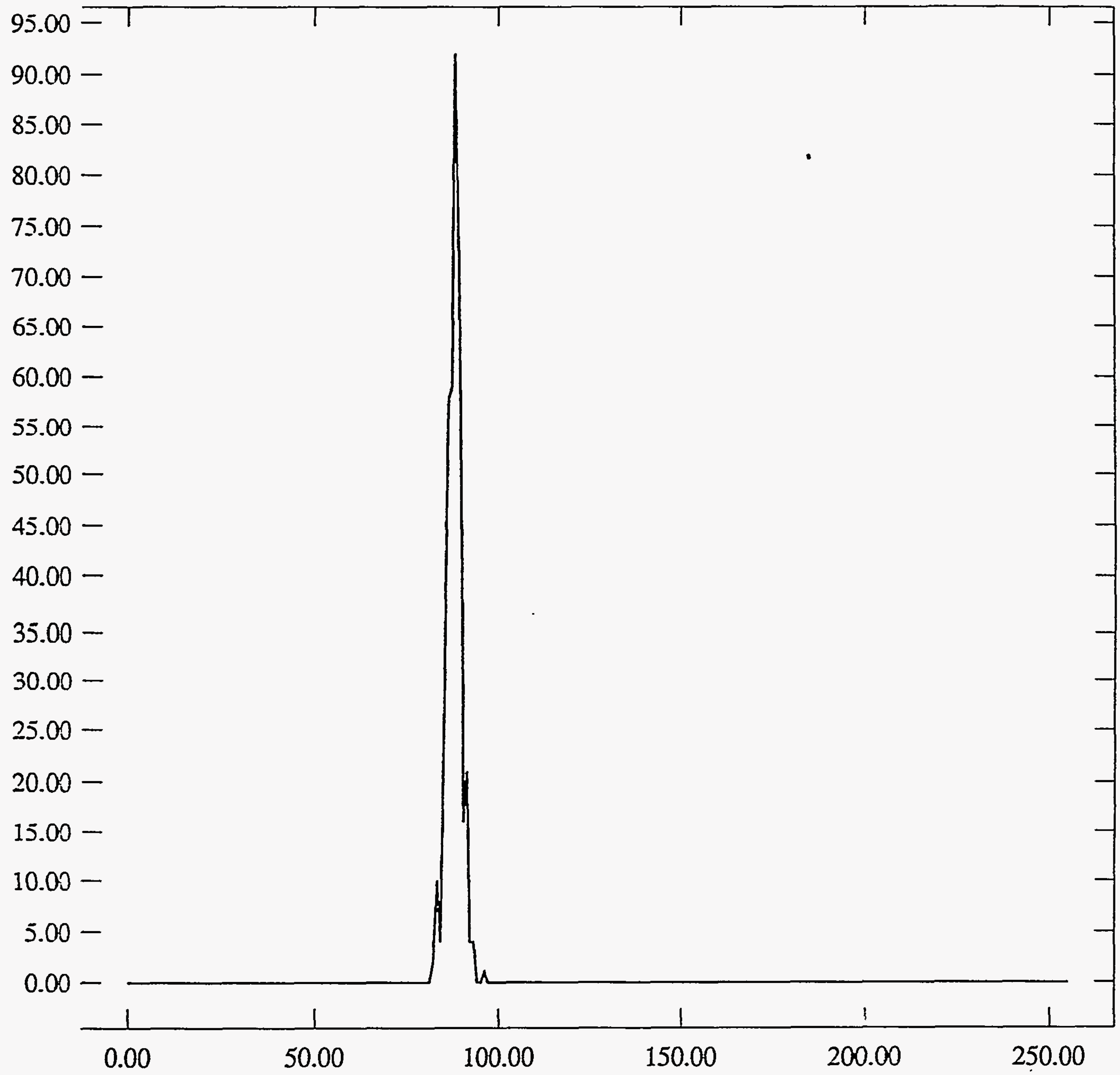
ST1 #04-10 LASER TEST 5/11/93





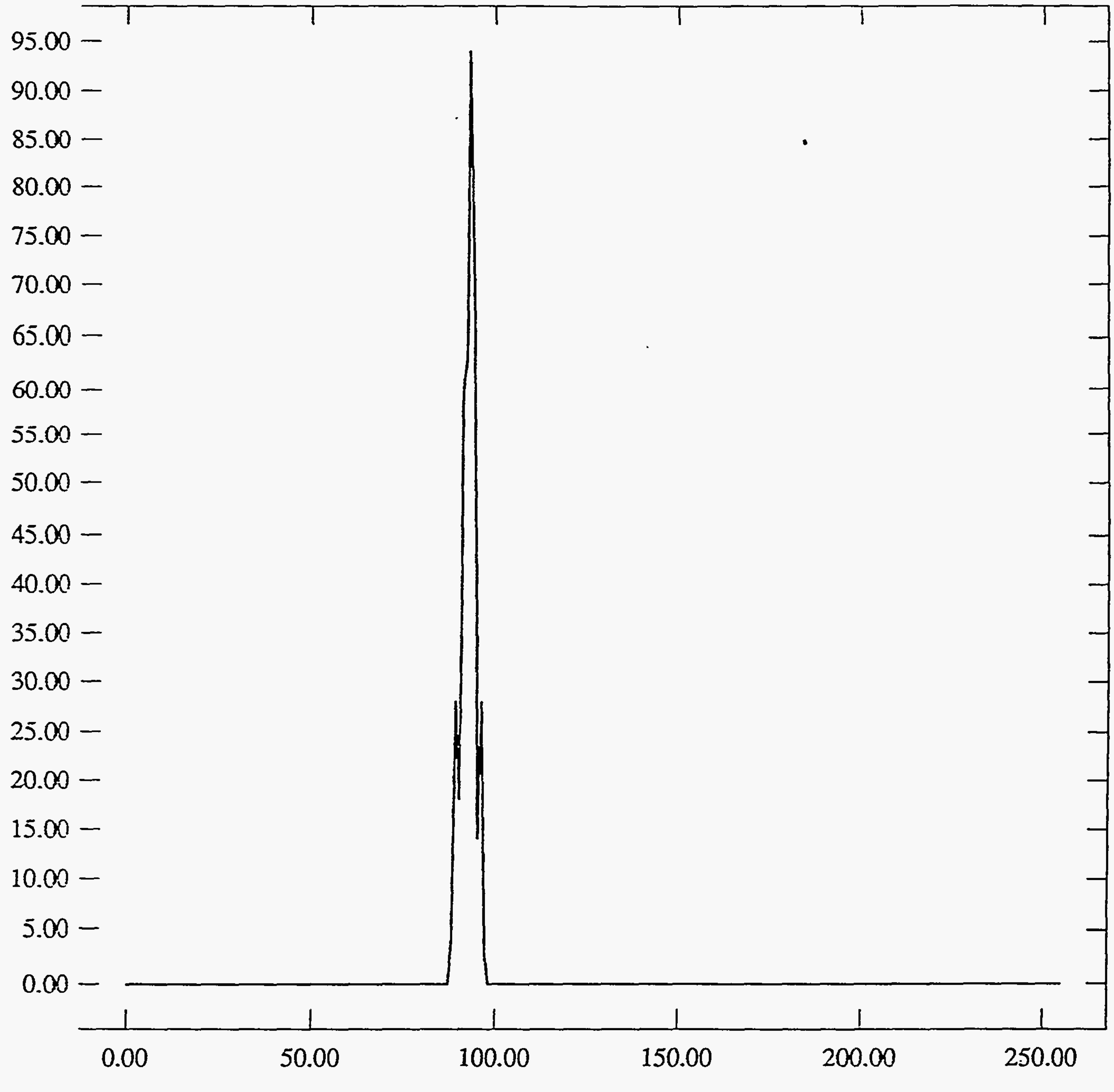
ST Camera: right side: int_time= 50ms, offset= 31, gain=2 (150 e/bit) Tue May 11 10:31:24 1993

Pixel Values Min 82 Max 96 Mean 87.6 Sigma 1.99

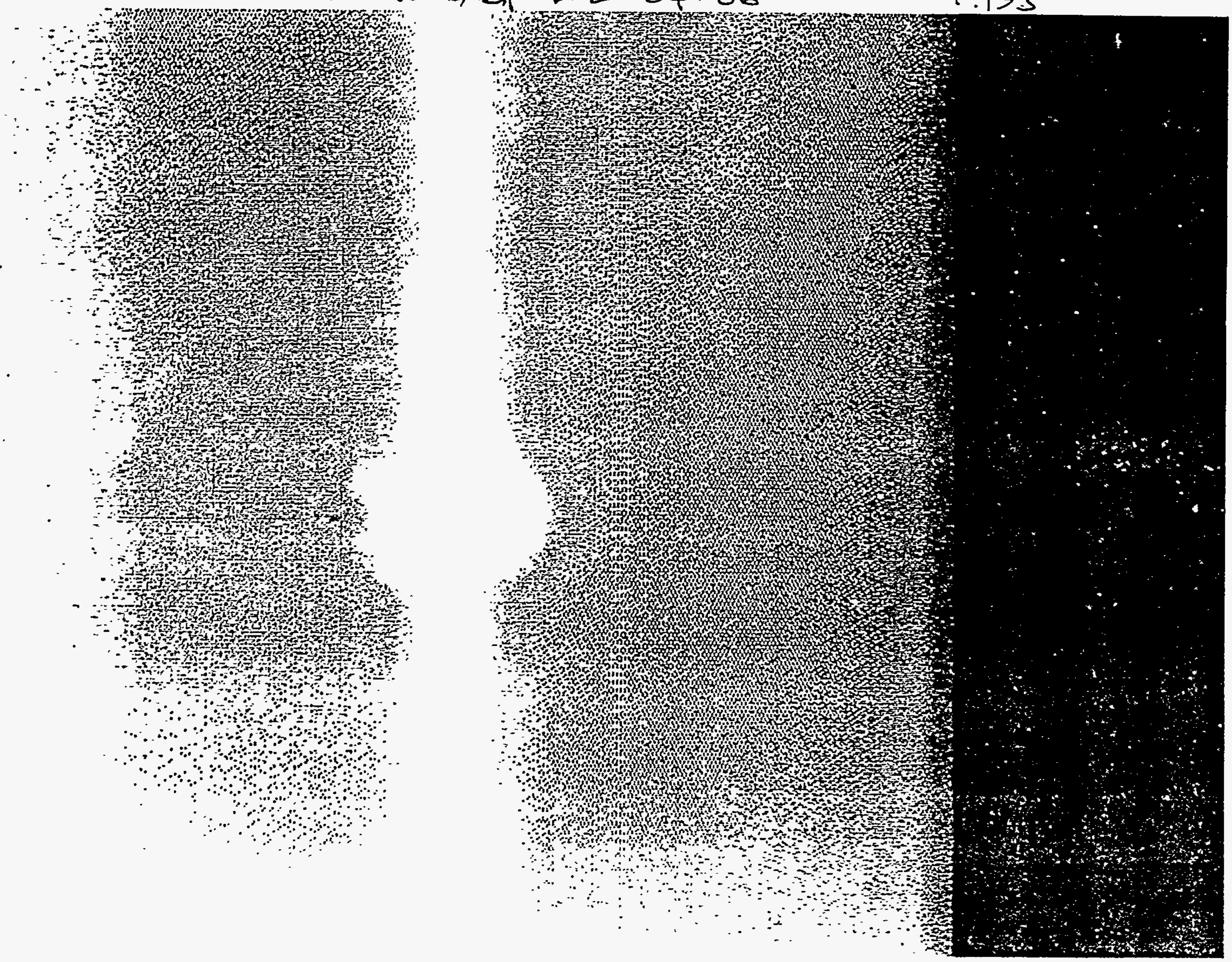


ST Camera: Left side: int_time= 50ms, offset= 31, gain=2 (150 e/bit) Tue May 11 10:30:21 1993

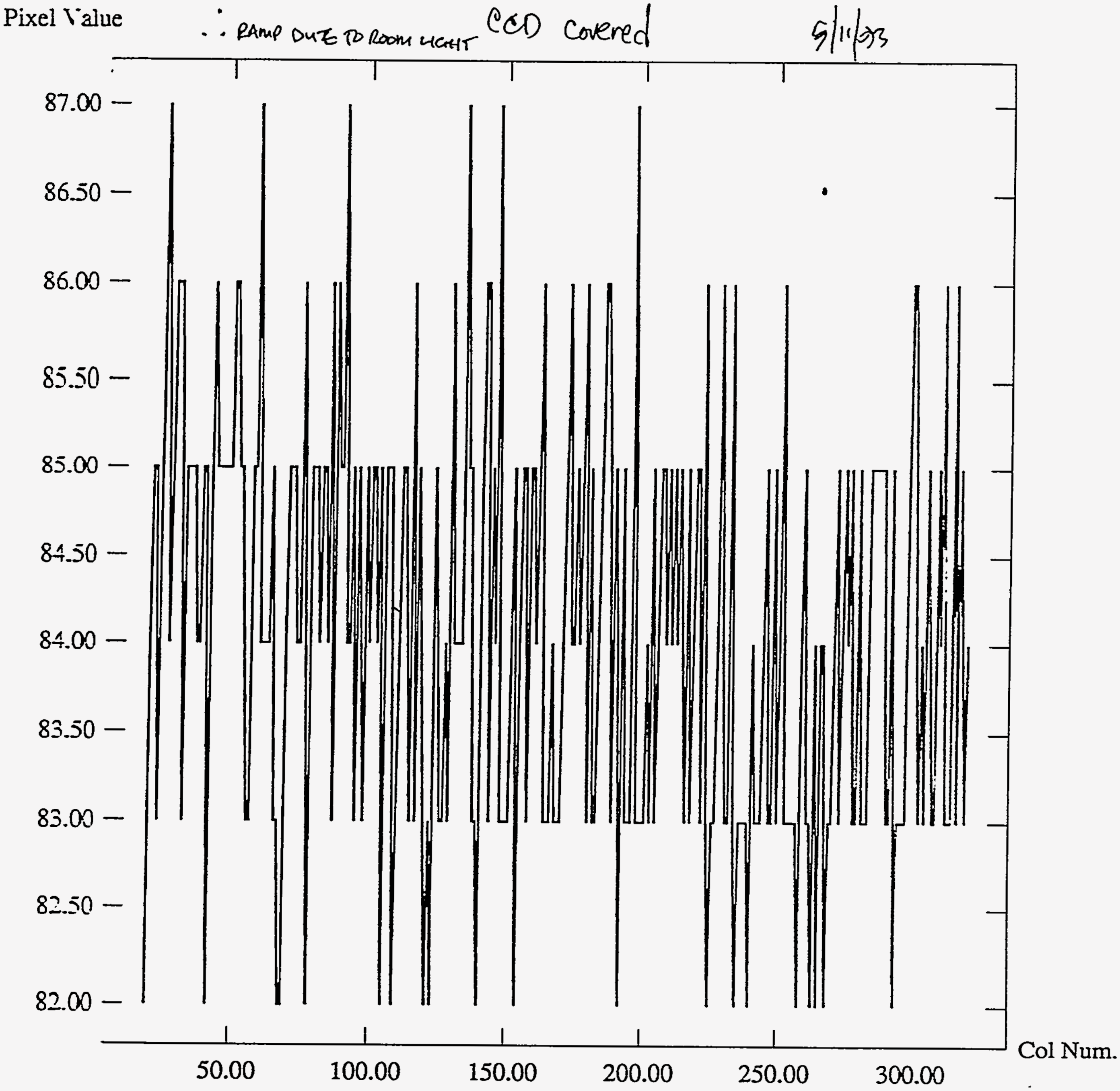
Pixel Values Min 88 Max 97 Mean 92.5 Sigma 1.89



6ND 150e/bit ST2 04-06 5/4/93

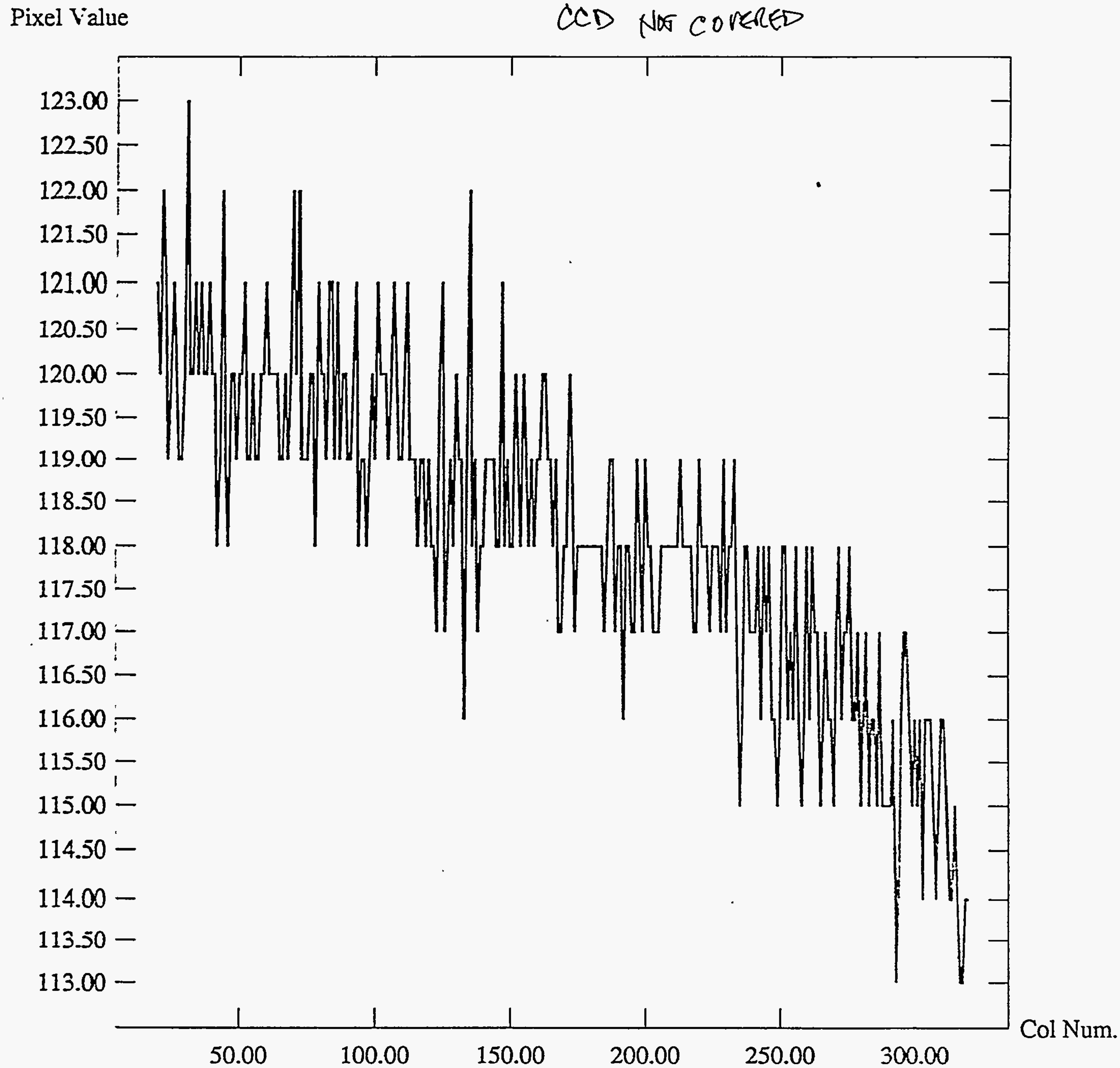


Row Lineout Row 239

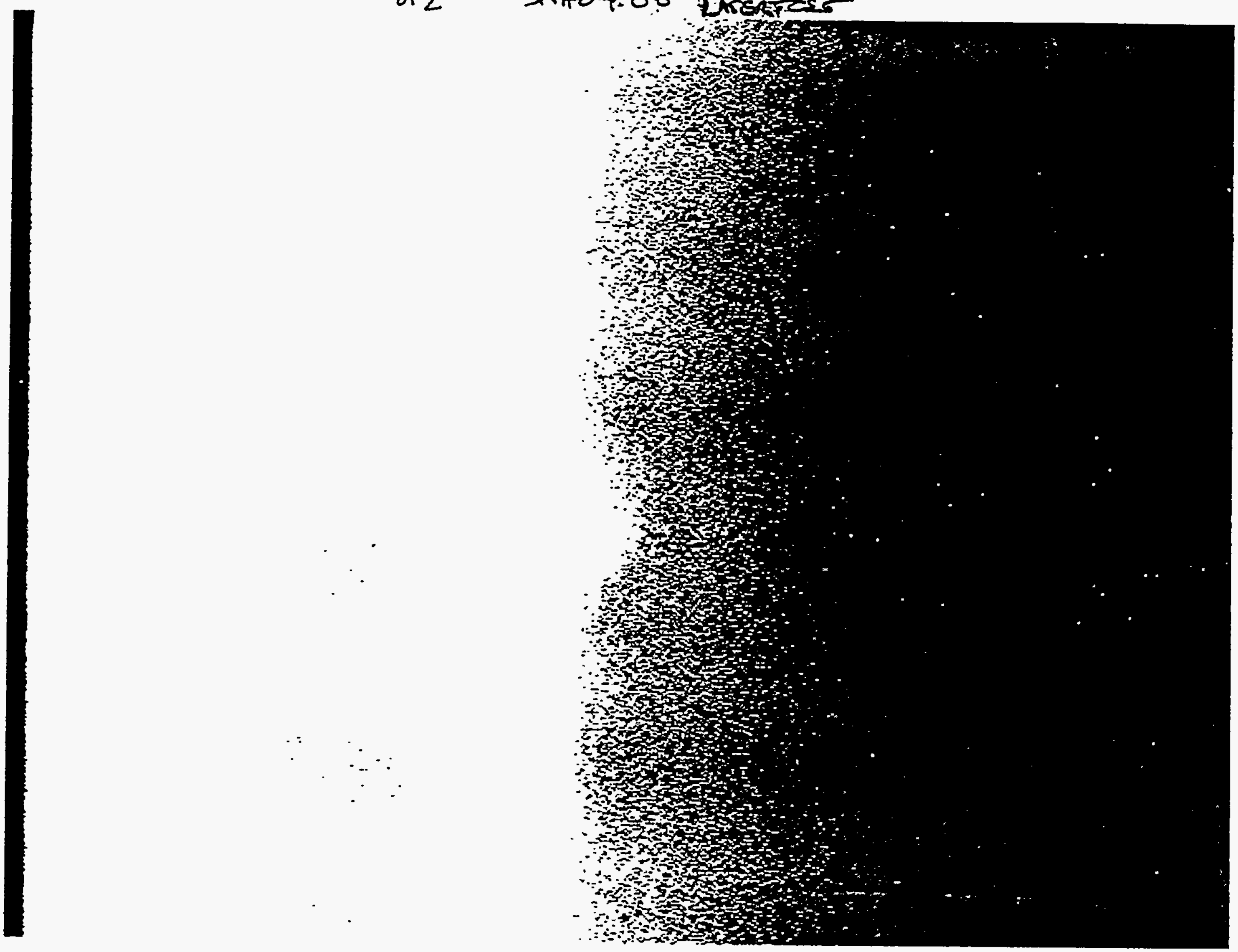


Row Lineout Row 239

CCD NOT COVERED



5T2 SN#04.06 [illegible]



15. Laser Test

This test requires the use of the SUN Datacube and its image processing capabilities, a HeNe Laser, 1mW at 632.8nm appropriate ND filters ranging from 2.0 to 6.0 or combinations equaling such.

Verify a working camera system.

Turn off camera power.

Position a HeNe Laser on the approximate center of the CCD.

Place an optical ND filter holder in the path of the laser beam.

Power the camera.

Place the SUN Datacube in the Acquire mode.

Do a Print Pixel—see *Guide to Running hspcube, C1*-S1-002—to check pixel values of illuminated area.

Install sufficient optical ND to reduce the intensity of the laser light to the saturation level of the CCD or 255 counts.

Do a Get Row Lineout plot—see *Guide to Running hspcube*,C1-S1-002—through the illuminate area.

Note: There should be no oscillations or tailing around the saturated spot.

Use the video copier to record the non-oscillating saturated laser spot image.

SN# 04-16 By 5-11-93 (initials) Date WMZ (passed)

REMEMBER to include your recorded documentation in the test procedure!
(a document protector is advised)

16. Tests Required after Conformal Coating

Archive/record a post conformal coat:

1) Dark Noise Measurement (Section 11).

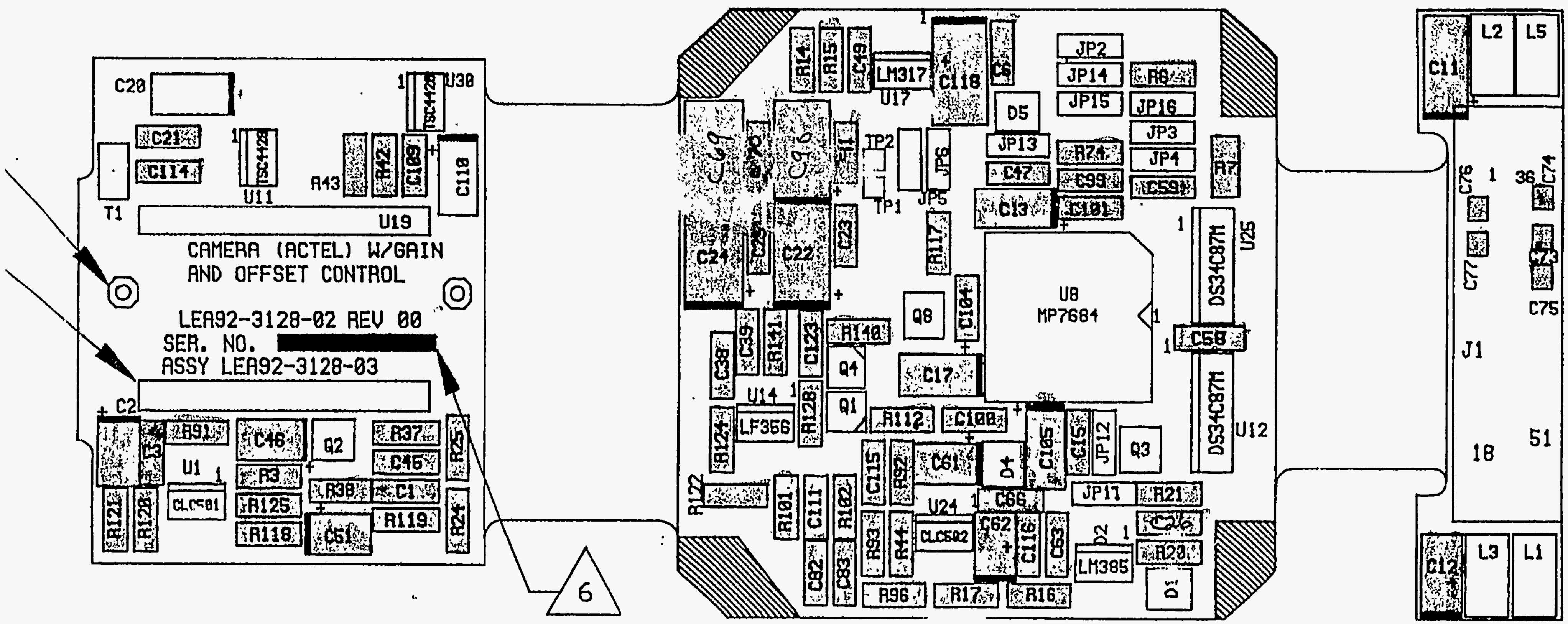
2) A focused test pattern image using the TV Optoliner.

SN#____________ By__________ Date____________
initials passed

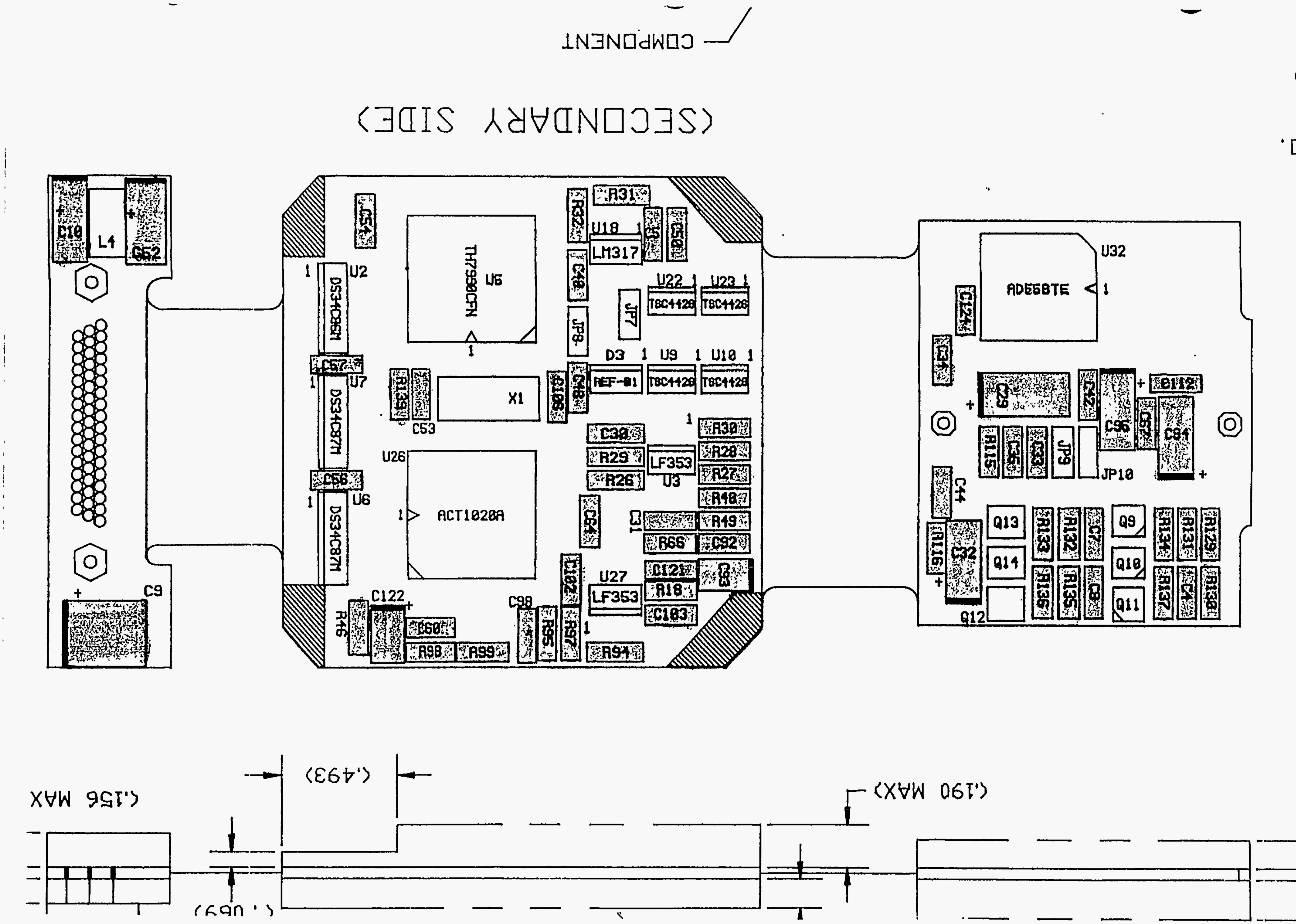
REMEMBER to include your recorded documentation in the test procedure!
(a document protector is advised)

04-010

REV



(PRIMARY SIDE)



COMPONENT
(SECONDARY SIDE)
(.156 MAX
(.069)
(.493)
(.190 MAX)
TH7990CFN
ACT1020A
AD668TE
LM317
LF353

Appendix H.3

Mechanical Assembly Log

Appendix H.3.1

Operations Sheet

Clementine Operations Sheet, Certification

Part Number C1-AAA92-106282 TAB02	**Serial No.** ST314	**Description** Star Tracker Camera, V3.1	**Certification Log #** CL008 **End Use** Flight
Next Assembly / Deliver To: None		**Account Number:** 7069-20	**Release To (Shop):** Jim Dickie 1882B
Production: [illegible] **Date:** 05-MAY-93			
Prepared By: Kathy Coatney Kathy Coatney	**Date:** 3 May 93	**QA:** W.R. Bryson	**Date:**
Approved By: **Date**			

Associated Documentation:	**Notes:**
Assembly Log,	
Document Tree, C1-AAA92-106282 Tab 02-00	
Assembly Procedure, C1-S1-012	
Assembly Drawing, AAA92-106277-00	
Test Procedure,	

Change Verification Record or Engineering Change Notice Record

Parts List or Dwg Number	Dwg Chg Letter	Eco Number	Description or Remarks	Opr	QA

Appendix H.3.2

Work Sheets

Work Sheet

Part Number: C1-AAA92-106282 Tab 02	Serial # : ST314	Title: Star Tracker Camera, V3.1	Sheet: 01

#	Operation	Date:	Oper.	Insp.
1	Measured CCD, Housing, Lens standoff		JD	
2	Machined Standoff to .3860 ± .0001		JD	
3	Machined corner pads on Housing		JD	
4	Parts Re-conversion Coated.		JD	
5	Installed PWA 04-010 into Housing	6/17/93	JWD	
6	~~Performed Abr~~ installed CCD 7883F02 B/T	6/18/93	JWD	
7	Performed Abreviated Test per procedure			
	C1-EE-036 All O.K. (D. Nielsen)	6/18/93	JWD	
	in T-1879 'Black' Rm OUT 10:55 IN 11:20	6/18	JWD	
8	Bonded Lens to CCD with DC 93-500	6/18	JWD	
9	Flat-Field image O.K. no Bubbles	6/18	JWD	
10	Cure at 40°C – 24 Hrs	6/19	JWD	
11	Installed SPIRE Baffle (glued) marked			
	"PROTO" staked w/ Hysol EA934 NA	6/26	JWD	

Work Sheet

Part Number: C1-AAA92-106282 Tab 02	Serial # : ST314	Title: Star Tracker Camera, V3.1	Sheet: 02

#	Operation	Date:	Oper.	Insp.
12	INSTALLED LENS HEATER, CLAMP, THERMAL SWITCH AND THERMISTOR. STAKED WITH HYSOL EA934NA	6/26/93	JWD	
13	Soldered Heater leads to thermostat.	28Jun93	RL	
14	Dressed Thermistor leads	28Jun93	RL	
15	Inspected operation 13 and 14	28Jun93		QA
16	Staked heater wires	28Jun93	QA	
17	ATP THERMAL TEST COMPLETE RE: O.K.	7/1/93	8 180	
18	SHAKE TEST IN ~~B~~ 131 High Bay Dynamics Lab 3-AXIS, 1 MIN EA. @ 19.8 GRMS	1/July/93	JWD	

Work Sheet

Part Number: C1-AAA92-106282 Tab 02	Serial # : ST314	Title: Star Tracker Camera, V3.1	Sheet: 03

#	Operation	Date:	Oper.	Insp.
18(CONT)	OUT of Bag AT 10:10 A.M. CLASS 10,000			
	IN BAG AT 10:40 A.M	1 July '93	JWD	
19	SHAKE TESTS PASS O.K.		JWD	
20	To M. Dickenson in 1879 "BLACK" Rm			
	for Abbreviated Functionality TEST	1 July '93	JWD	
22	Abbreviated Functionality Test = OK!!	1/7/93	Oper. 8	
24	Out of Bag 8:45	2/7/93	MD	
25	In Bag 9:28	2/7/93	MD	
26	Out of Bag 9:40	2/7/93	MD	
27	Lens Heater °C cycle X1 Re: it works!	2/7/93	MD	
28	In Bag : 12:35	2/7/93	MD	

Work Sheet

Part Number: C1-AAA92-106282 Tab 02	Serial # : ST314	Title: Star Tracker Camera, V3.1	Sheet: 04

#	Operation	Date:	Oper.	Insp.
29	Assembly weight (SPIRE Baffle) 285.6 gms	8/9/93	JWD	
30	Heater, Lens, Resistance 454 ohms	8/9/93	JWD	
31	Thermistor at Rm. Temp. 5.66 Kohm	8/9/93	JWD	
32	Attached Berg pin sockets to thermistor and			
	heater.	9Aug93	WRB	

Appendix H.3.3
Bill of Materials

Clementine
Configuration Management

S1
Star Tracker Camera

Document Tree #:	C1-AAA92-106282 TAB02-00
Title:	Star Tracker Camera Assy, V3.1
Next Higher Tree:	None

Comments:
Star Tracker Camera C1-AAA92-106282 Tab02 uses a ST2A Camera Board

Serial Number:	
File Name:	
Software/Op. System:	Excel 4.0/Macintosh

Prepared by:	[signature]	Date:	3/17/93	E.E. Apvd.	[signature]	Date:	4/22/93
Prod. Chk.	[signature]	Date:	4/2/93	M.E. Apvd.	[signature]	Date:	4/7/93
E.E. Chk.	[signature]	Date:	4-15-93	Q.A. Apvd.	[signature]	Date:	3-May 93
M.E. Chk.	[signature]	Date:	4/2/93	Engr. Rlsd		Date:	

REVISION HISTORY

Level	00										
Date											

STAR TRACKER CAMERA

5/26/93

LEVEL 1	2	3	4	5	6	Prefix	Document Title	Document Number: Foreign	Document Number: LLNL	Rev	S/N	Status
	X					S1	**STAR TRACKER CAMERA ASSY, V3.1**		AAA92-106282	00		
	X					S1	CAMERA ASSEMBLY PROCEDURE		C1-S1-012	00		
		X				S1	ISOLATOR SHIM		AAA93-102551	00		
		X				S1	THERMAL SHIM		AAA93-102241	00		
	X					S1	INTERFACE CONTROL		AAA92-100839	0B		
		X				S1	CCD, THOMSON	TH7883F02-01B/T				FLIGHT
		X				S1	CCD, THOMSON	TH7883F02-01	7883F0P393			PROTO
	X					S1	ENVELOPE CONTROL		AAA92-100838	00		
	X					S1	OPTICAL PRESCRIPTION	OCA 17073	NONE			
		X				S1	LENS ASSEMBLY	880-0001-401-0C	AAA92-109469	0C		
			X			S1	FACEPLATE, FIBER OPTIC	880-1004-001-0B	AAA92-109466	0B		PURCHASED ITEM
			X			S1	ELEMENTS ASSEMBLED	880-0002-101-0C	AAA92-109462	0C		
				X		S1	ELEMENT NO. 1	880-1000-001-0B	AAA92-109463	0B		
				X		S1	ELEMENT NO. 2	880-1001-401-0F	AAA92-109464	0F		
				X		S1	ELEMENT NO. 3	880-1002-001-0B	AAA92-109465	0B		
			X			S1	FOCUS SPACER	880-1006-001-00	AAA92-109468	00		
			X			S1	HOUSING	880-1005-001-0D	AAA92-109467	0D		
			X			S1	CLAMP, LENS HEATER		AAA93-102221	00		
		X				S1	**BAFFLE ASSY**	880-0004-001-0B	AAA92-108748	0B		
			X			S1	BASE, BAFFLE	880-1080-001-0B	AAA92-108749	0B		
1	2	3	4	5	6							

DOCUMENT TREE NUMBER: C1-AAA92-106282 TAB02

LEVEL 1	2	3	4	5	6	Prefix	Document Title	Document Number Foreign	LLNL	Rev	S/N	Status
			X			S1	COVER		AAA93-102598	00		
			X			S1	VANE NO. 1	880-1021-001	AAA92-108747	00		
			X			S1	VANE NO. 2	880-1022-001	AAA92-108746	00		
			X			S1	VANE NO. 3	880-1023-001	AAA92-108745	00		
			X			S1	VANE NO. 4	880-1024-001	AAA92-108744	00		
		X				S1	**CAMERA ASSY**		AAA92-106277	00		
			X			S1	CAMERA HOUSING		AAA92-106258	0C		
			X			S1	BUSHING, JACKPOST, MDM CONN.		AAA93-101167 TAB08	00		
			X			S1	CIRCUIT BOARD PAD	800-3068	AAA92-104621	00		
			X			S1	END COVER		AAA92-106249	0A		
			X			S1	SHIM, LOWER, END COVER		AAA93-102610	00		
			X			S1	SHIM, UPPER, END COVER		AAA93-102609	0A		
			X			S1	CONNECTOR BRACKET		AAA92-106257	0A		
			X			S1	PAD, CCD THERMAL		AAA93-102243	00		
			X			S1	ICD, CAMERA		AAA92-104603	0E		
			X			S1	ST2A CAMERA ASSY, w. GAIN & OFFSET CONT.		LEA92-3128-13	0A		IN FILE
			X			S1	SCHEMATIC, CAMERA, ST2A		LEA92-3128-11	0B		IN FILE
				X		S1	ARTWORK		LEA92-3128-02	00		IN FILE
				X		S1	BILL OF MATERIALS		LEA92-3128-04	0C		IN FILE
1	2	3	4	5	6							

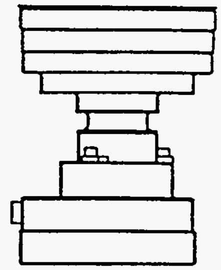
DOCUMENT TREE NUMBER: C1-AAA92-106282 TAB02

LEVEL							Document Title	Document Number				
1	2	3	4	5	6	Prefix		Foreign	LLNL	Rev	S/N	Status
					X	S1	SPACER (CONN. STANDOFF)		AAA92-104616-TAB01	0C		
					X	S1	MTG. HARDWARE	800-3043	AAA92-104607-TAB01	00		
					X	S1	NUT, PCB RETAINER		AAA92-109126	0A		
				X		S1	ASSEMBLY PROCEDURE		LEA92-3128-05	0B		IN FILE
				X		S1	TEST PROCEDURE		LEA92-3128-16	00		N/A
				X		S1	FAB DRAWING		LEA92-3128-07	0A		IN FILE
				X		S1	ARRAY DOCUMENTATION-U26		LEA92-3128-18	00		NOT SIGNED
			X			S1	THERMISTER, FENWALL	137-562-ZXT-D02				
			X			S1	LENS STANDOFF		AAA93-102550	0A		
1	2	3	4	5	6							

Appendix H.3.4

Assembly Procedures

CLEMENTINE Sensors Integration Project	**ENGINEERING NOTE** C1-S1-012
TITLE: Star Tracker Camera Assembly Procedure	ASSY: **Star Tracker** ORIG: Jim Dickie DATE: 7 June, 1993 APPR:



Abstract:

This document describes the assembly procedures for the Clementine Star Tracker Camera

Revision: 0A

Engineering Note
C1-S1-012

CLEMENTINE

Star Tracker Camera

Assembly Procedures

Prepared by: ________________ Date: 8 June, 1993
J. Dickie, Senior Associate

Reviewed by: ________________ Date: 9 June 1993
R. Priest, Mechanical Engineer

Reviewed by: ________________ Date: 9 June 1993
J. Lewis, Optical Engineer

Reviewed by: ________________ Date: 10 Jun 93
W. Bryson, Quality Assurance

Reviewed by: ________________ Date: 6-10-93
W. Rice, Quality Assurance

Reviewed by: ________________ Date: 10-June-93
E. Schmitt, Production

Reviewed by: ________________ Date: 10 June 1993
J. Kordas, STC Sensor Engineer

Approved by: ________________ Date: 14 Jun 93
M. Shannon, DPL Engineering

1.0 General

1.1 Scope

This document details steps required to assemble the Clementine Star Tracker Camera (STC).

1.2 Description

The STC consists of an Actel electronics PWA, a Thomson TH7883-FO2-01 B/T CCD (Flight cameras only, prototype cameras will utilize a non-B/T TH7883-F02-01 unit), mechanical hardware that encases the PWA and CCD, a mini-concentric Wide Field of View (WFOV) lens, and a light baffle. The camera is used for imaging stars to determine the position of a vehicle in space.

Assembly includes general mechanical assembly, testing to verify quality of optical couplant between the CCD and the lens fiber optic field flattener, measurement and possibly adjustment of the optical axis normal to the camera mounting surfaces, abbreviated electrical function testing prior to final staking, and final staking.

1.3 Reference Documents and Drawings

1.3.1 C1-ME-008, Clementine Sensors General Contamination Control Plan.
1.3.2 C1-S0-TBD, Clementine ESD Protection Plan.
1.3.3 C1-S1-TBD, STC Abbreviated Electronic Function Test Procedure.
1.3.4 MIL-STD-1686, Handling of ESD Sensitive Equipment.
1.3.5 MIL-STD-1246B, Product Cleanliness Levels and Contamination Control Plan.
1.3.6 C1-S0-005, Adhesives, Compounds, and Optical Couplants.
1.3.7 C1-S0-TBD, Clementine Quality Assurance Program Plan

1.4 Deviations

Procedural deviations or changes from specified procedures which do not affect the physical assembly may be made at the discretion of the responsible engineer. Deviations or changes which require any mechanical or electronic change may be made only after review and approval by a suitable Material Discrepancy Review Board as defined in the Clementine QA Program Plan.

1.5 Electro-Static Discharge Control Requirements

The STC contains electrostatic-sensitive devices which are exposed on the PWA and CCD prior to assembly closure and at the electrical interfaces after assembly closure. Therefore, it shall be handled per MIL-STD-1686 Class 1. All work shall be performed in an approved electrostatic discharge control area as defined by the Clementine Quality Assurance Group.

The STC, the test operator (using wrist straps), and related electrical test equipment shall be connected to a common ground before any electrical mating or de-mating operations, and during the use of any electrical test equipment probes. There shall be no "hot-plugging" of the test specimen with any test equipment.

All electrostatic sensitive parts shall be stored in approved antistatic storage bags when not in use.

1.6 Cleanliness and Contamination Control Requirements

All assembly work shall be performed in a Class 100 laminar flow hood located within a Class 10,000 environment as defined in LLNL document 'Clementine Sensors General Contamination Control Plan'.

Handling of all parts shall be with clean lint-free gloves. Personnel shall wear face and hair protective smocks when handling exposed optics.

1.7 Photographs

Photographs shall be taken of the unit at major subassembly steps and of the final assembled unit. A suitable ruler shall be used to provide scale.

1.8 Disassembly Contingency

Due to the optical bonding of the CCD to the lens fiberoptic, and the time required to dissolve this bond line, there is no disassembly of an STC allowed beyond step 4.3.5, with the special exception noted in step 4.3.9. If any camera is found to be defective at any point beyond step 4.3.5, a total restart of this assembly procedure is required.

2.0 Parts List

2.1 From the kitted assembly, where applicable, record all part serial numbers for this camera into the table below.

Item	Description	Reference No.	Serial No.	Quantity
1	Camera Housing	92-106258	04	1
2	Lens Standoff	93-102550	314	1
3	End Cover	92-106249	04	1
4	Baffle Assembly	92-108748		1
5	WFOV Lens Assembly	92-109469	006	1
6	Actel PWA Assembly	LEA92-3128-03	04-010	1
	Includes:			
	Spacer, Tab-01	92-104616	n/a	2
	Nut, 2-56	NAS #671-C02	n/a	2
	Nut, PEM, 2-56	CRES	n/a	2
	Thermistor, Fenwal	137-562-ZXT-D02	n/a	1
7	Jackpost, Tab-08	93-101167	n/a	2
8	CCD, Thomson	TH7883-FO2-01 (Prototype Cameras)	N/A	1

9	CCD, Thomson	TH7883-FO2-01 B/T (Flight Camera Only)	7883F02B/T 393-3	1
10	Pad, Circuit Board	92-104621	n/a	1
11	Pad, CCD Thermal	93-102243	n/a	1
12	Connector Bracket	92-106257	n/a	1
13	Socket head cap screw, 2-56 x .187 lg.	NAS #1352-N02-3	n/a	14
14	Socket head cap screw, 2-56 x .250 lg.	NAS #1352-N02-4	n/a	6
15	Socket head cap screw, 2-56 x .375 lg.	NAS #1352-N02-6	n/a	3
16	Socket head cap screw, 2-56 x .50 lg.	NAS #1352-N02-8	n/a	2
17	Washer, #2, Ø 0.25	NAS #620-N02	n/a	8
18	Washer, Thermal	93-102551	n/a	6
19	Thermistor, Fenwal	534-31AG04-562	n/a	1
20	Clamp, Lens Heater	93-102221	n/a	1
21	Heater, Lens, Minco	HK17402-9311	n/a	1
22	Switch, Sundstrand	974-0014-774	n/a	1
23	Tape, Reflective	Sheldahl	n/a	a/r
24	Shim, End, Upper	93-102609	n/a	2
25	Shim, End, Lower	93-102610	n/a	2

Parts logged into assembly by: K Kortney Date: 6/93

2.2 Required Tools

2.2.1 As part of this procedure, the following tools, with current calibration certificates, are required for assembly.

1. Torque wrench, capable of reading 0 to 10 inch-pounds minimum, with 0.1 in-lb resolution.
2. 0-1 inch Micrometer with 0.0001 inch resolution.
3. 0-1 inch Depth micrometer with 0.0001 inch resolution.

3.0 Adhesives, Couplants, Staking Compounds

3.1 For additional information on all compounds, refer to Clementine Engineering Note C1-S0-005, 'Adhesives, Compounds, and Optical Couplants'

Item	Description	Pot Life	Cure	Lot No.	Exp. Date
1	Staking Compound Hysol EA934NA	30 min.	2 hrs. @ 50°C		7/94
2	Optical Couplant DC 93-500	2 hrs.	24 hrs. @ 50°C		5/94
3	Thermal Epoxy BA-2151	30 min.	3 hrs. @ 50°C		5/94
4	Silver Epoxy BA-2902	30 min.	3 hrs. @ 50°C		12/93
5	Thermal Grease DC-340	n/a	n/a	—	—

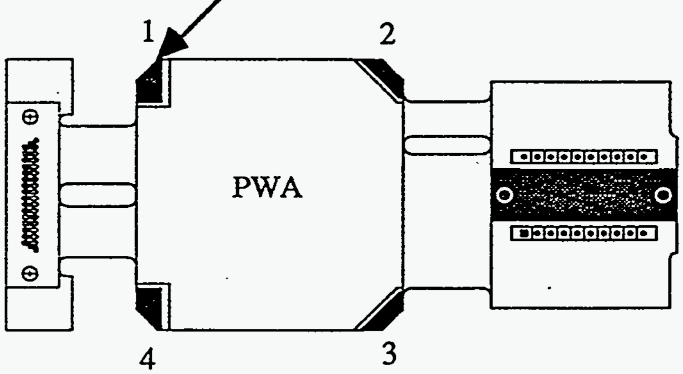
4.0 Assembly Procedure

Initials / Date

4.1 PWA Installation Into Camera Housing

4.1.1 Remove the **Actel Camera PWA**, P/N LEA92-3067-03, from the carrier per procedure C1-S0-TBD. 6/93 / JD

4.1.2 Using a certified micrometer accurate to 0.0001 inches, measure the PWA thickness at the four thermal pads as shown in figure 1. Record these measurements to 4 significant figures (nominal is .046 ±.005). 6/93 / JD



Pad Thickness

1 .0421

2 .0423

3 .0424 ✓

4 .0422

FIGURE 1

4.1.3 Place PWA in oven set to 50° C for 20 minutes. Remove PWA from oven and while still hot, bend to shape as shown in **Circuit Board ICD** drawing No. 92-104603 and figure 2. 6/93 / JD

FLEX BOARD BENDING

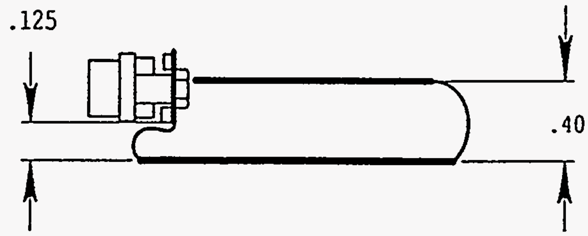
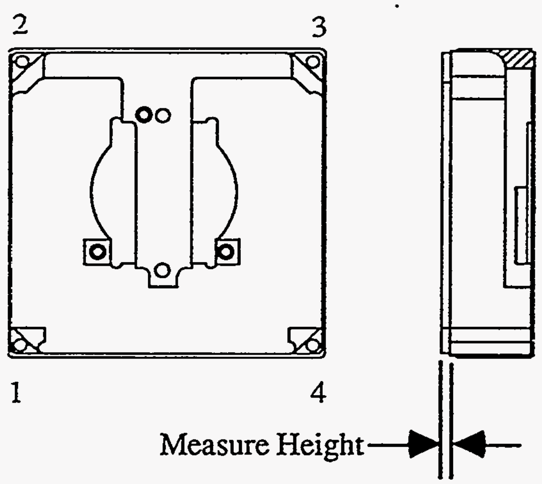


FIGURE 2

4.1.4 Using the optical comparator with the 100X objective for maximum sensitivity, measure the step height at the four corners for PWA mounting on the **Camera Housing** P/N 92-106258 as shown in Figures 3 and 5 (nominal is .050 +.000, -.005). Record these measurements to 4 significant figures. This step should be 0.0005 ±0.0001 *less* then the measured thickness of the PWA at the corresponding thermal pad areas as recorded in step 4.1.1. If correction is required, have the camera housing reprocessed, and the 2-56 threaded inserts installed before proceeding to step 4.1.5. 6/3 / JWD



Step Height

1 .0476

2 .0470

3 .0467

4 .0470

FIGURE 3

4.1.5 Remove and discard the 2 screws holding the PWA connector to spacers. Install **Connector Bracket** P/N 92-106257 over connector. See figure 4. 6/17 / JWD

4.1.6 Install PWA board into Camera Housing with **Circuit Board Pad** P/N 92-104621 and 2-56 washers installed between PWA assembly and housing heat sink. ***Important***, apply a thin layer (.001 in. thick, max.) of **DC-340** thermal grease to both sides of the circuit board pad prior to installation.
Secure connector and connector bracket with 2 each, **Jackposts** P/N 92-104607-Tab 01. Torque to 3.5 ± 0.1 in-lb.
The thermistor fits in the slot on the finger of the Camera Housing as shown in figure 4. Be careful not to pinch the thermistor leads.
Secure PWA with 2 each, 2-56 x .25 long socket head cap screws. Torque to 3.5 ± 0.1 in-lb.
Stake thermistor with **BA-2151** thermal Compound.
Stake fasteners with **EA934NA**. Cure for 3 hrs at 50 °C. 6/17 / JWD

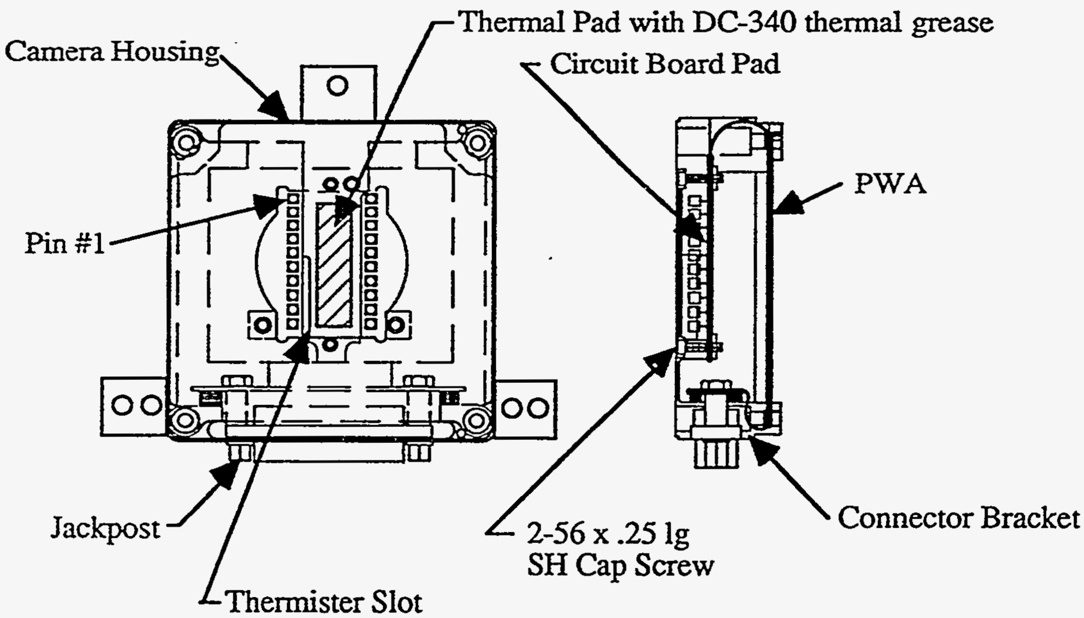


FIGURE 4

4.1.7 Apply a thin (.002 in. thick, max.) layer of BA-2902 Silver Epoxy to 4 thermal contact pads at internal corners of **End Cover** P/N 92-106249. Place **End Cover Shims,** P/N 93-102609 and 93-102610 in position on corresponding end cover pads. Cure for 3 hours at 50° C. 6/8 / JWD

4.1.8 Apply a thin (.001 in. thick, max.) layer of DC-340 thermal grease to both sides of the four PWA thermal contact areas at corners of camera body, and the mating corners of the end cover/shim assembly.
Install end cover and secure with 4 each, 2-56 x .25 long socket head cap screws. Torque to 3.5 ± 0.1 in-lb.
Do not stake fasteners at this time. 6/17 / JWD

4.2 CCD Installation Into Camera Housing

4.2.1 Prior to installation of CCD into camera, with extreme caution so the fiberoptic is not scratched, measure the overall thickness of the CCD to 4 significant figures using the optical comparator with the 100X objective for maximum sensitivity. Record this measurement to 4 significant figures.

CCD Thickness .3393 — 6/3 / JD

4.2.2 Install **Thomson TH7883-FO2-01 CCD** (TH7883-FO2-01 B/T for flight cameras only) into PWA connector, being careful to install **CCD Thermal Pad** P/N 93-102243 between CCD and housing. ***IMPORTANT:*** be sure to apply a thin (.001 in. thick, max.) layer of DC-340 thermal grease to both surfaces of the thermal pad during installation. See figure 4. ***IMPORTANT:*** Verify location of pin #1 with socket #1 prior to installation of CCD (see fig. 4). Visually inspect assembly to verify CCD is completely and evenly seated onto thermal pad. — 6/18 / JWD

4.2.3 Perform abbreviated PWA board/CCD electronic functionality test per procedure C1-S1-(TBD), and verify good thermal contact between CCD and heat sink.
Record results. Pass/No Pass Pass — 6/18 / JWD

4.2.4 If pass, proceed with assembly section 4.3.
If no pass, stop assembly procedure until problem has been identified and corrected, and camera passes abbreviated electronics functionality test. — 6/18 / JWD

4.3 Lens Standoff Installation

4.3.1 Using the optical comparator with the 100X objective for maximum sensitivity, measure the step height from the lens standoff mounting ring to the thermal finger surface in the camera body. Record this measurement to 4 significant figures. See Figure 5.

Housing Step Depth .0970 — 6/3 / JWD

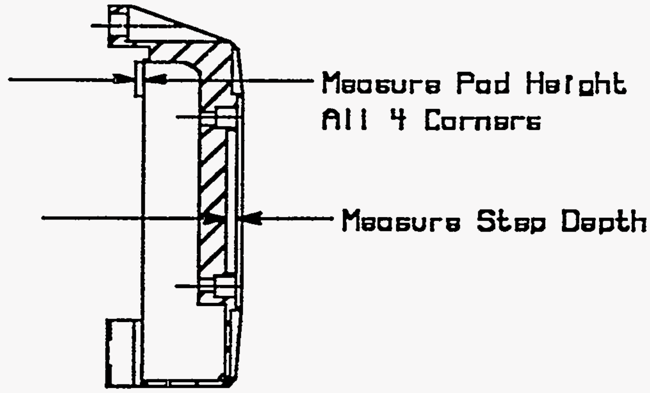
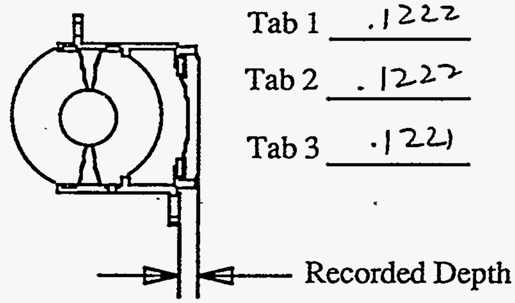


FIGURE 5

4.3.2 From the inspection data provided with **WFOV Lens** P/N 92-109469, obtain the recorded depth from the face of the fiberoptic to the three mounting tabs (nominal is 0.125). Record these measurements to 4 significant figures. 6/3 /JWD



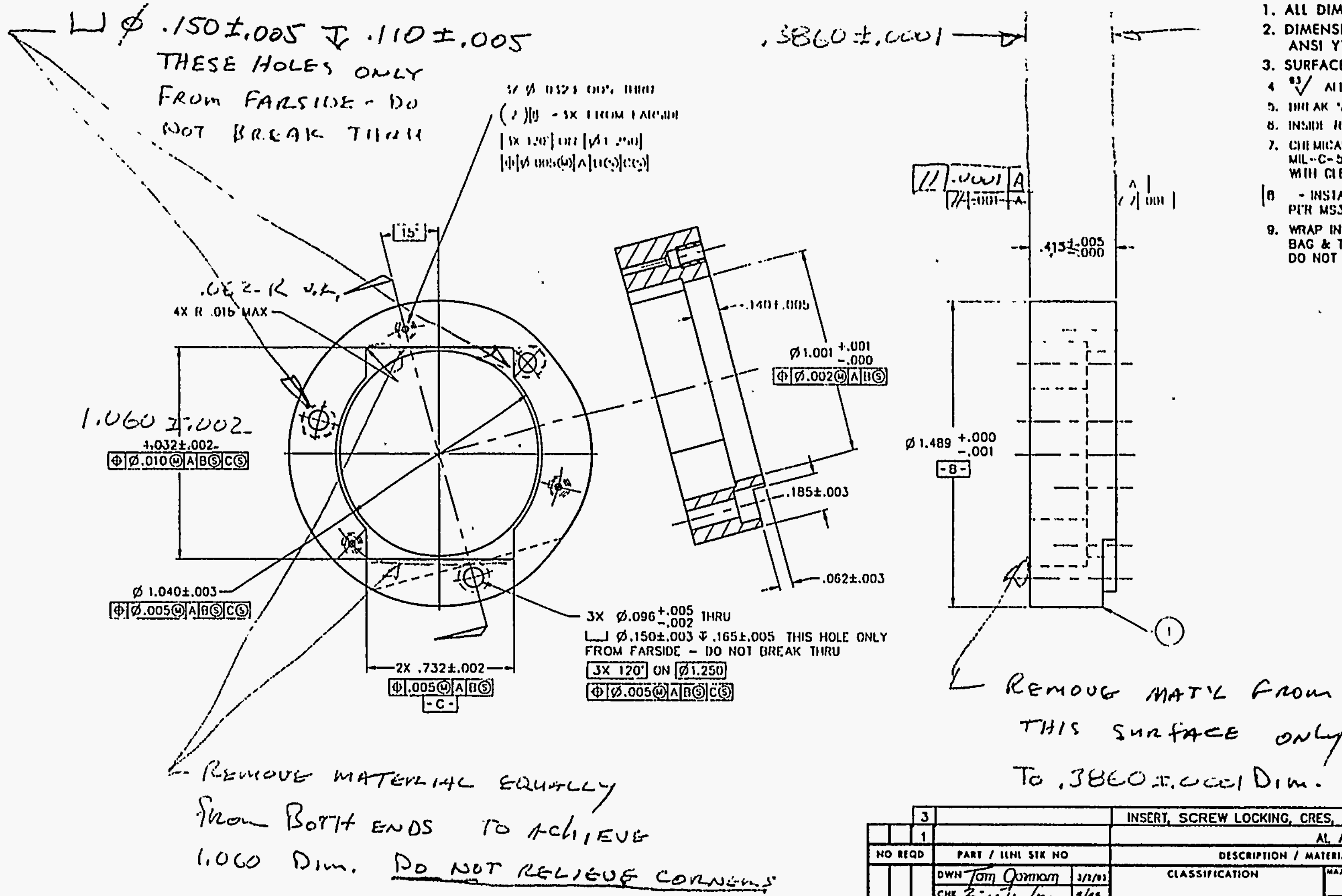
Tab 1 .1222

Tab 2 .1222

Tab 3 .1221

FIGURE 6

4.3.3 Calculate average depth to face of lens fiberoptic to 4 significant figures and record answer.
Average Depth .1222 6/3 /JWD



NOTES
UNLESS OTHERWISE SPECIFIED:

1. ALL DIMENSIONS ARE IN INCHES.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
3. SURFACE TEXTURE PER ANSI B46.1-1978.
4. 63√ ALL MACHINED SURFACES.
5. BREAK SHARP EDGES .005 MAX OR CHAMFER
6. INSIDE RADII .010 MAX
7. CHEMICAL CONVERSION COAT PER MIL-C-5541, CLASS 3, GOLD. HANDLE PART WITH CLEAN LINT-FREE GLOVES AFTER COATING.
8. - INSTALL INSERTS FROM SURFACE INDICATED PER MS33537 AFTER COATING
9. WRAP IN CLEAN LINT-FREE MATERIAL. BAG & TAG WITH PART NO. & REV. LETTER. DO NOT MARK ON PART.

NO REQD	PART / IDENT STK NO	DESCRIPTION / MATERIAL	SPEC NO	ITEM
3		INSERT, SCREW LOCKING, CRES, 2-56 X .129 L	MS21209-C0215	2
1		AL ALY TYPE 6061-T651	QQ-A-250/11	1

DWN Tom Gorman 3/2/93
CHK Bill Taylor 3/93
APVD 3/93

CLASSIFICATION

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LAWRENCE LIVERMORE NATIONAL LABORATORY
MECHANICAL ENGINEERING DEPT
UNIVERSITY OF CALIFORNIA

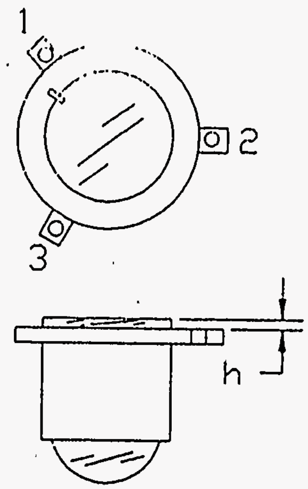
MAJOR UNIT: STAR TRACKER CAMERA ASSY, V3.1
SUBASSY:
DETAIL: LENS STANDOFF
SHOWN ON AAA 92-106202
DRAWING NO: AAA 93 102550 00

ENGINEERING RELEASE
APPROVED
Project Engineer
Date 16 Mar 1993

S7-314
Flight #2

STAR TRACKER LENS ASSEMBLY
S/N: 005 (P/N 880-0001-401)

4-5-93
T.G.



PAD #	h (in)
1	0.1222
2	0.1222
3	0.1221

ON-AXIS IMAGE RUN-OUT

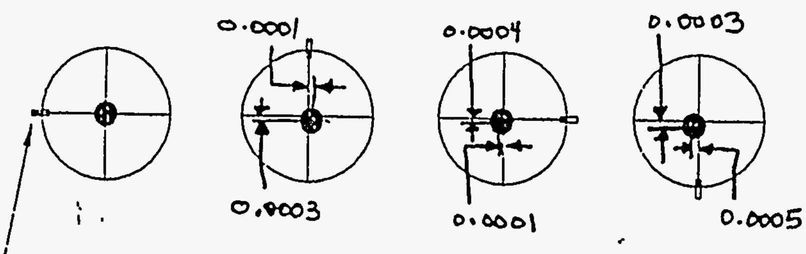
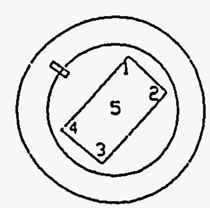
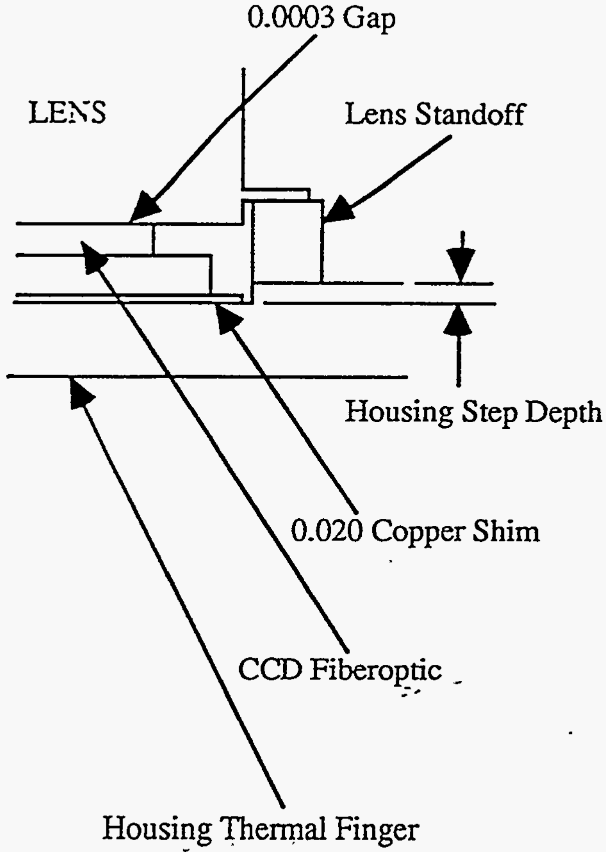


IMAGE SIZE & QUALITY



FIELD PT.	IMAGE DIA.(in)
1	0.0017
2	0.0017
3	0.0018
4	0.0018
5	0.0017 to 0.0018



Add The Following:

Lens Tab Depth	.1222
CCD Thickness	.3393
0.020 Copper Shim	0.020
0.0003 Gap	0.0003
0.001 Epoxy Fill	0.001
Sub-Total:	.4830

Subtract The Following:

Housing Step Depth	.0970
Total is Lens Standoff Thickness	.3860

FIGURE 7

4.3.7 Perform the arithmetic as shown in Figure 7. 6/3 / JWD

4.3.8 Remove the lens standoff and reprocess the <u>bottom</u> surface to achieve the thickness ±0.0001, recorded from the arithmetic in Figure 7. 6/3 / JWD

4.3.4 Apply a thin layer (.001 in. thick, max.) of DC-340 thermal grease to the standoff-to-camera body mechanical interface areas.
Install lens standoff to camera body with 1 each, 2-56 x .375 long and 2 each 2-56 x .50 long socket head cap screws. Torque to 3.5 ± 0.1 in-lb. 6/17 / JWD

4.3.5 Using the optical comparator with the 100X objective for maximum sensitivity, measure distance from top of lens standoff to top of CCD fiberoptic at 4 positions (1-4) to verify that the fiberoptic surface is parallel to the top of the lens standoff to within 0.0001 inches as shown in figures 8 and 9, and matches the lens-to-tab depth recorded in the inspection data from the vendor +0.0003 inches. If not, reposition the CCD to correct any error. 6/17 / JWD

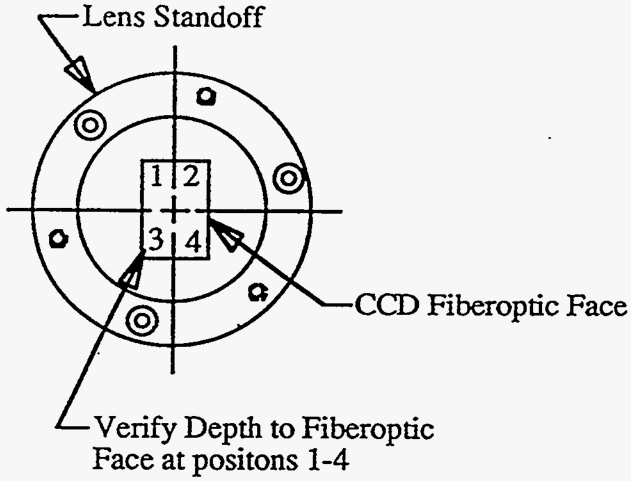


FIGURE 8

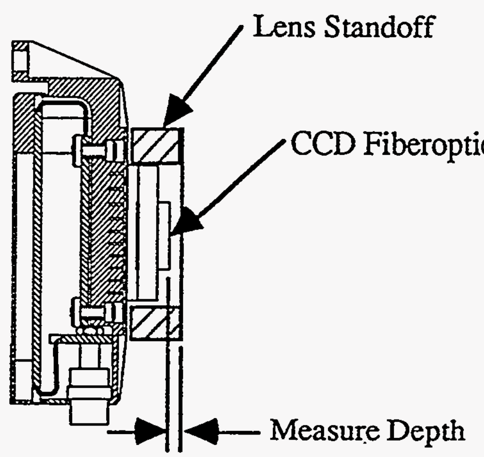


FIGURE 9

4.3.6 Stake fasteners with EA934NA Staking Compound. Cure at 60° C for 3 Hr. 6/18 / JWD

4.3.7 Do not proceed to assembly section 4.4 unless there is a single time span of at least 8 hours available to complete all steps of section 4.4. 6/17 / JWD

4.4 Lens Installation

4.4.1 Mix a small quantity of **DC 93-500** encapsulant and degas. Place one drop of the degassed encapsulant on top center of the CCD fiberoptic interface surface as indicated in figure 10.
Apply a thin layer (.001 in. thick, max.) of DC-340 thermal grease to the mechanical interface between the lens standoff and the WFOV lens mount tabs.
Using extreme care to avoid any contact with the thermal grease, except at the mount points, place the WFOV lens into the lens standoff.

At this point, verify the lens/CCD orientation. Visually inspect the optical interface through the lens to ensure that the encapsulant is evenly spread over the CCD/lens interface with no bubbles evident.
Secure the lens to the lens standoff with 3 each, 2-56 x .187 long socket head cap screws with #2 x Ø 0.25 CRES washers. Torque all 3 fasteners *evenly* 1/4 turn at a time to 2.9 ± 0.1 in-lb. 6/18 / JWD

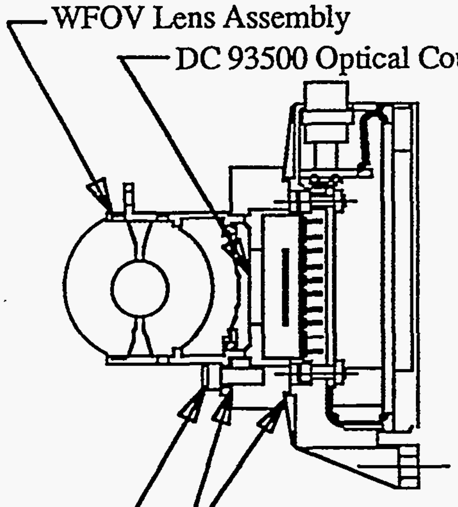


FIGURE 10

4.4.2 Within one hour of the procedures completed in step 4.4.1, perform an abbreviated camera electronic functionality test per procedure C1-S1-(TBD).
Record results. Pass/No Pass PASS
If pass, proceed to step 4.4.3
If no pass, **immediately** proceed to step 4.4.4 6/18 / JWD

4.4.3 Within one hour of the test performed in step 4.4.2, perform a flat field optical test to look for bubbles and even distribution at the fiberoptic interface between the lens and CCD.
Record results. Pass/No Pass PASS
If pass, proceed to assembly section 4.5
If no pass, **immediately** proceed to step 4.4.4 6/18 / JWD

4.4.4 NOTE: ***This step is to be taken only as an emergency measure, and only if a B/T CCD is being used.*** If the camera fails either of the tests required in steps 4.4.2 or 4.4.3, **immediately** disassemble the lens from the camera housing, remove the CCD, and carefully remove any residual couplant from all optical surfaces to ensure that both the lens and the B/T CCD can be salvaged for reuse. N/A / JWD

4.4.5 If step 4.4.4 is performed, the assembly procedure is aborted at this point and must be re-started. N/A / JWD

4.5 Baffle Installation

4.5.1 Install **Baffle Assembly** P/N 92-108748 onto the WFOV lens mounting tabs using 3 each, 2-56 x .187 long socket head cap screws and 6 each, **Thermal Isolation Washers**, P/N 93-102551. Do not torque fasteners beyond finger tight at this time. Ensure that the baffle assembly is evenly centered on the front of the WFOV lens by observing the gap between the lens and the baffle. For maximum thermal resistance, minimize metal-to-metal contact around this interface and between fasteners and mounting tabs. See Figure 11. 6/18 / JWD

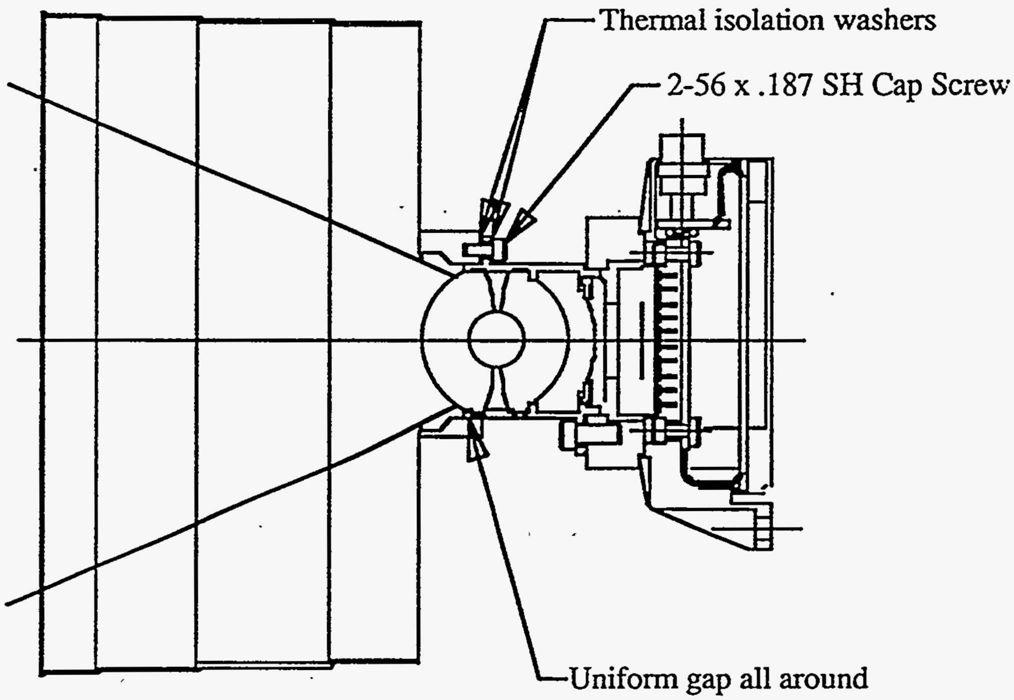


FIGURE 11

4.5.2 Perform abbreviated camera electronic functionality test per procedure C1-S1-(TBD).
Record results. Pass/No Pass PASS 6/18 / JWD

4.5.3 Angular orientation of the rectangular baffle cutout to the camera CCD is critical. Total angular tolerance is 0.3° rotation. Visually verify orientation as shown in Figure 12, also verify by imaging with the camera and looking for any obscuration at the corners. If baffle is within tolerance, torque fasteners to 2.0 ± 0.1 in-lb. 6/20 / JWD

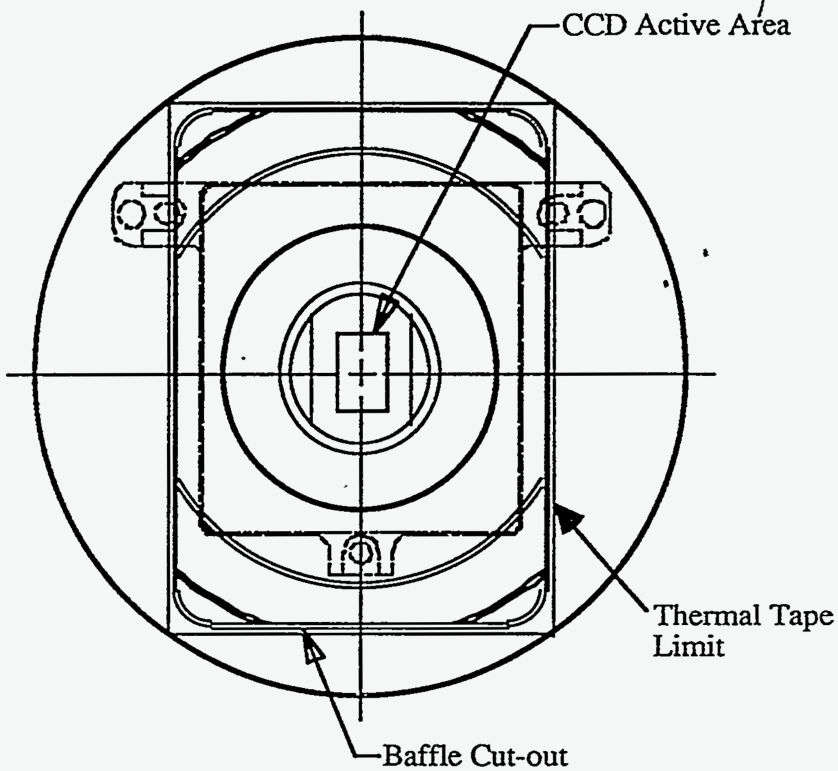


FIGURE 12

4.5.4 If camera/baffle assembly has passed all functionality tests, stake all lens, baffle, and camera end cover fasteners with EA934NA. Cure for 3 hrs. at 50 °C. Apply Sheldahl thermal tape to front of baffle vane. Trim to baffle outside diameter. **IMPORTANT:** Do not apply tape within 0.060 inches of the vane edge. See Figure 12. 6/20 / JWD

4.6 Lens Heater Installation

4.6.1 Install **Lens Heater Clamp**, P/N 93-102221, and **Lens Heater Strip,** Minco P/N HK17402-9311, onto the WFOV lens barrel using 2 each, 2-56 x .187 long socket head cap screws. Be careful when routing the heater wires out of clamp to avoid damage to wires. Install temperature control switch onto lens heater clamp using 2 each, 2-56 x .187 long socket head cap screws. Place a small drop of BA-2151 thermal epoxy under center of switch prior to installation to ensure good thermal contact. Torque all fasteners to 3.5 ± 0.1 in-lb.
Stake heater wires and fasteners with EA934NA. Cure for 3 hrs at 50 °C. 6/20 / JWD

4.6.2 Bond **Thermistor,** Fenwal P/N 534-31AG04-562, to side of lens heater clamp with BA-2151 epoxy. Cure for 3 hrs. at 50 °C. 6/20 / JWD

Appendix H.3.5

Test Procedures

Abbreviated Functional Test Procedure for Sub and Fully Housed Clementine Camera, PWAs with Gain and Offset Control

6/18/93

SJ 314
PRIOR TO LENS BOND
CCD INSTALLED / NO LENS

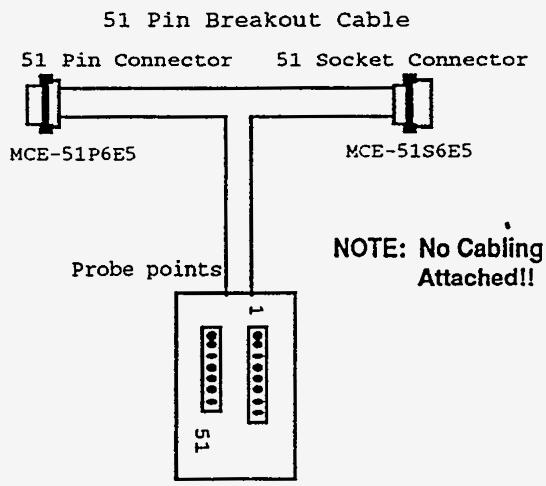
THIS IS A ST-1 CAMERA!

	Date	Rev.	Date	Approval
PREPARED BY: MERCEDES L. DICKERSON				
REVIEWED BY: DARRON P. NIELSEN (signature: Darron Nielsen)	6-17-93			
REVIEWED BY: WILLIAM R. BRYSON	17 June 93			
REVIEWED BY: JOSEPH F. KORDAS (signature: J. F. Kordas)	6-17-93			
REVIEWED BY: MICHAEL J. SHANNON	6/17/93			

University of California Lawrence Livermore National Laboratory	Abbreviated Functional Test Procedure for Sub and Fully Housed Clementine Camera, PWAs with Gain and Offset Control	C1-EE-036 Revision 0A

1. Sub and Final Assémbly Resistance and Voltage Specificity prior to Power-up

Inspect the camera for connector saver and shorting plug. If one or both of these are not present obtain them. A 51-contact breakout should be attached to the connector saver to perform this test. The 51-contact shorting plug should be attached to the connector saver for transport or storage once this test is complete.
Using a flight certified breakout connector—



—Verify these resistances:

pin# DVM(common)	vs	pin# DVM(signal)	expected	measured Ω
5 (AGND)	-	39 (+15VDC)	>400Ω	494 Ω
	-	4 (-15VDC)	>12KΩ	12.7 KΩ
	-	37 (+5VDC)	>400Ω	473 Ω
	-	38 (+5VDC)	>400Ω	473 Ω
	-	3 (-5VDC)	>1kΩ	1.5K Ω
	-	40 (+5VIN)	>4kΩ	4.3KΩ
20 (DGND)	-	5	≤1Ω	0 Ω
	-	39	>400Ω	493 Ω
	-	37	>400Ω	473 Ω
	-	38	>400Ω	473 Ω
	-	3	>1kΩ	1.5KΩ
	-	40	>4KΩ	4.3KΩ
39 (+15VDC)	-	4	>11KΩ	12.2KΩ
	-	37	~~>10KΩ~~	959 Ω
	-	38	~~>10KΩ~~	959 Ω
	-	3	~~>13KΩ~~	2.0KΩ
	-	40	~~>15KΩ~~	4.8KΩ

4 (-15VDC)	-	37	>12KΩ	13.7KΩ
	-	38	>12KΩ	13.7KΩ
	-	3	>13KΩ	14.8KΩ
	-	40	>13KΩ	17.6KΩ
37 (+5VDC)	-	38	≤1Ω	0 Ω
	-	3	>2kΩ	2K Ω
	-	40	>4KΩ	4.9KΩ
3 (-5VDC)	-	40	>5kΩ	5.9KΩ
2 (CGND)	-	51	≤1Ω	0 Ω
	-	36	∞	✓ Ω
	-	5	∞	✓ Ω
	-	37	∞	✓ Ω
	-	39	∞	✓ Ω
	-	40	∞	✓ Ω
	-	4	∞	✓ Ω
	-	3	∞	✓ Ω

Using a flight certified breakout connector, verify power voltages at cable connector—camera end—**before** attaching it to the camera board. Use J1-pin 20 for multimeter ground and complete the following table.

J1 pin #	Expected V	Measured V
39	+15V	+15.3
4	-15V	-15.3
37,38	+5VDC	+5.1
3	-5V	-5.4
40	+5VAIN	+5.1

Turn off the power. Specificity verified, the camera and cabling are ready for power-up.

SN# ST 314 By JWD Date 6/18/93
04-010 initials passed.

6/18/93 JWD
OUT of Bag 10:55 A
RTN To Bag 11:20 A

FUNCTIONALITY TEST PRIOR
TO LENS BONDING

2. Room Temperature Dark Measurement Data

Connect a quality assured data acquisition system and cabling with the resistance verified camera to be tested.

Acquire dark images at all three gain values—1,2, and 4—using a 50ms integration time and 0 offset.

Turn off power.

Using the same region of interest for each acquired image, process a histogram resulting in MU and SIGMA values. These values should correspond to those taken at ≈20°C during the Thermal Test. Therefore, review the 50ms data for all three gains at 20°C. NOTE: This assumes the thermal test was performed with the same CCD now housed.

SN# ST 314 04-010 By DPN / JWD initials Date 6/18/93 passed

3. Imaging Verification

With adequate lensing, capture an image with the Startracker or UV-Vis camera and verify that it does image.

Place an image-on-clear or text-on-clear transparency against the Lidar intensifier and gate the intensifier appropriately to capture a Lidar image.

SN# ST 314 04-010 By JWD initials Date 6/18/93 passed

REMEMBER to attach your recorded documentation to this test procedure!
(A document protector is advised)

Appendix H.3.5.1

Calibration Data Files

```
total 57
drwxrwxr-x 25 calibrat     1024 Aug  3 16:00 ./
drwxrwxrwx  5 root          512 Aug  4 19:52 ../
drwxrwxr-x  2 calibrat     2048 Aug  1 14:31 0C_hi/
drwxrwxr-x  2 calibrat      512 Aug  1 14:38 0C_hi_dark_current/
drwxrwxr-x  2 calibrat     2048 Aug  1 15:02 0C_low/
drwxrwxr-x  2 calibrat      512 Aug  1 15:07 0C_low_dark_current/
drwxrwxr-x  2 calibrat     2048 Aug  1 15:15 0C_nominal/
drwxrwxr-x  2 calibrat      512 Aug  1 15:18 0C_nominal_dark_current/
drwxrwxr-x  2 calibrat      512 Aug  1 15:22 10C_nominal_dark_current/
drwxrwxr-x  2 calibrat     2560 Aug  1 15:32 20C_nominal/
drwxrwxr-x  2 calibrat     2560 Aug  2 09:35 20C_nominal2/
drwxrwxr-x  2 calibrat     1024 Aug  1 17:17 20C_nominal_dark_current/
drwxrwxr-x  2 calibrat      512 Jul 27 19:19 Hot_Pixels/
drwxrwxr-x  2 calibrat      512 Jul 27 19:19 Optical_Distortion/
-rw-r--r--  1 calibrat      681 Jul 27 20:30 ST314.crd
drwxrwxr-x  2 calibrat      512 Jul 27 19:19 Spectral_Response/
drwxrwxr-x  2 calibrat      512 Jul 31 11:37 electronic_warm_up/
drwxrwxr-x  2 calibrat     1024 Jul 28 16:56 focus/
drwxrwxr-x  2 calibrat      512 Jul 28 16:57 image/
drwxrwxr-x  2 calibrat     2048 Aug  1 16:27 n10C_nominal/
drwxrwxr-x  2 calibrat      512 Aug  1 17:21 n10C_nominal_dark_current/
drwxrwxr-x  2 calibrat     2048 Aug  1 16:37 n20C_nominal/
drwxrwxr-x  2 calibrat      512 Aug  1 17:25 n20C_nominal_dark_current/
drwxrwxr-x  2 calibrat    23040 Aug  4 15:54 noise/
drwxrwxr-x  2 calibrat     1024 Jul 28 16:54 optical_distortion/
drwxrwxr-x  2 calibrat      512 Aug  3 16:01 test/
```

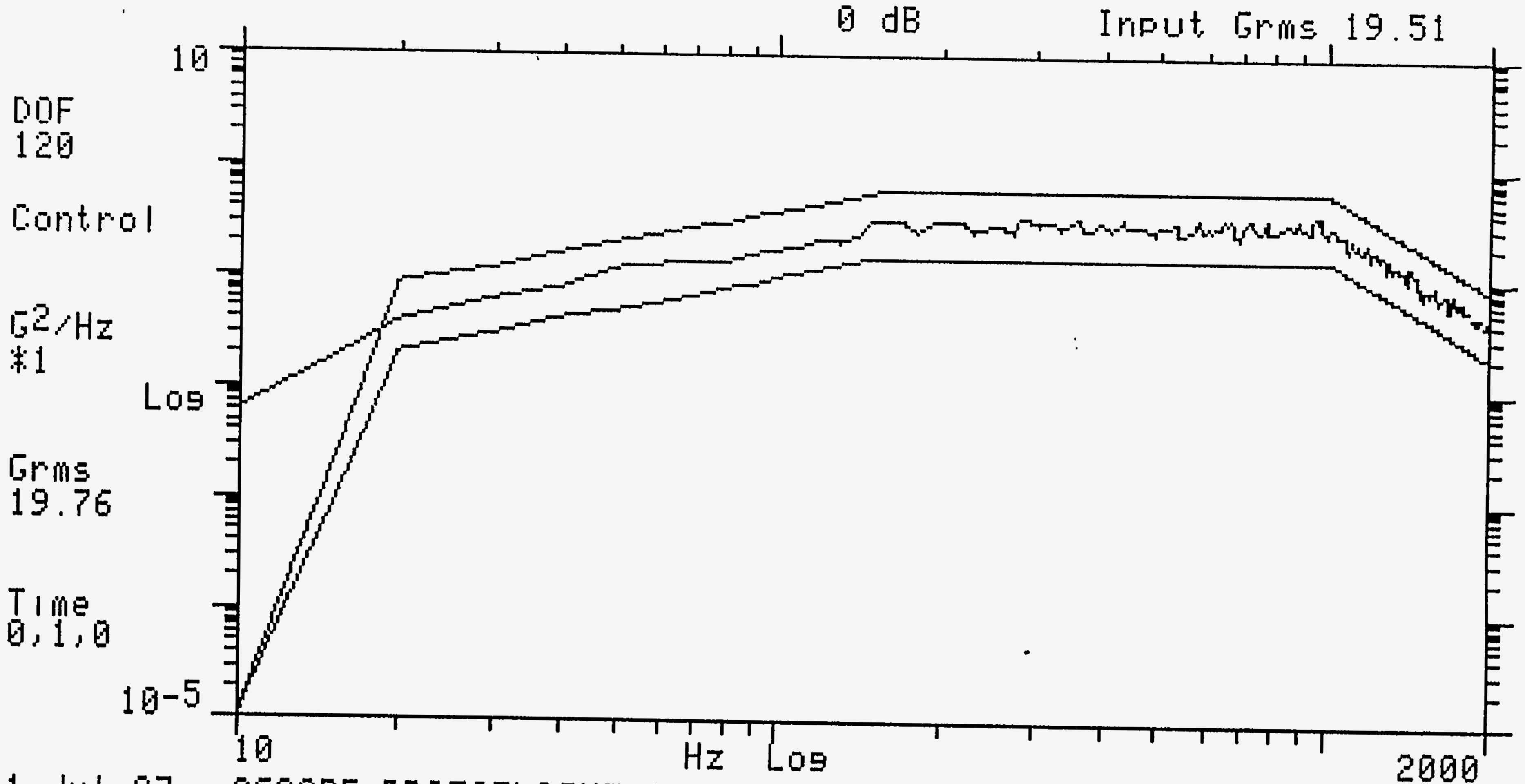
Appendix H.3.5.2

Environmental Acceptance Test Procedures

Appendix H.3.5.2.1

Random Vibration Test Data

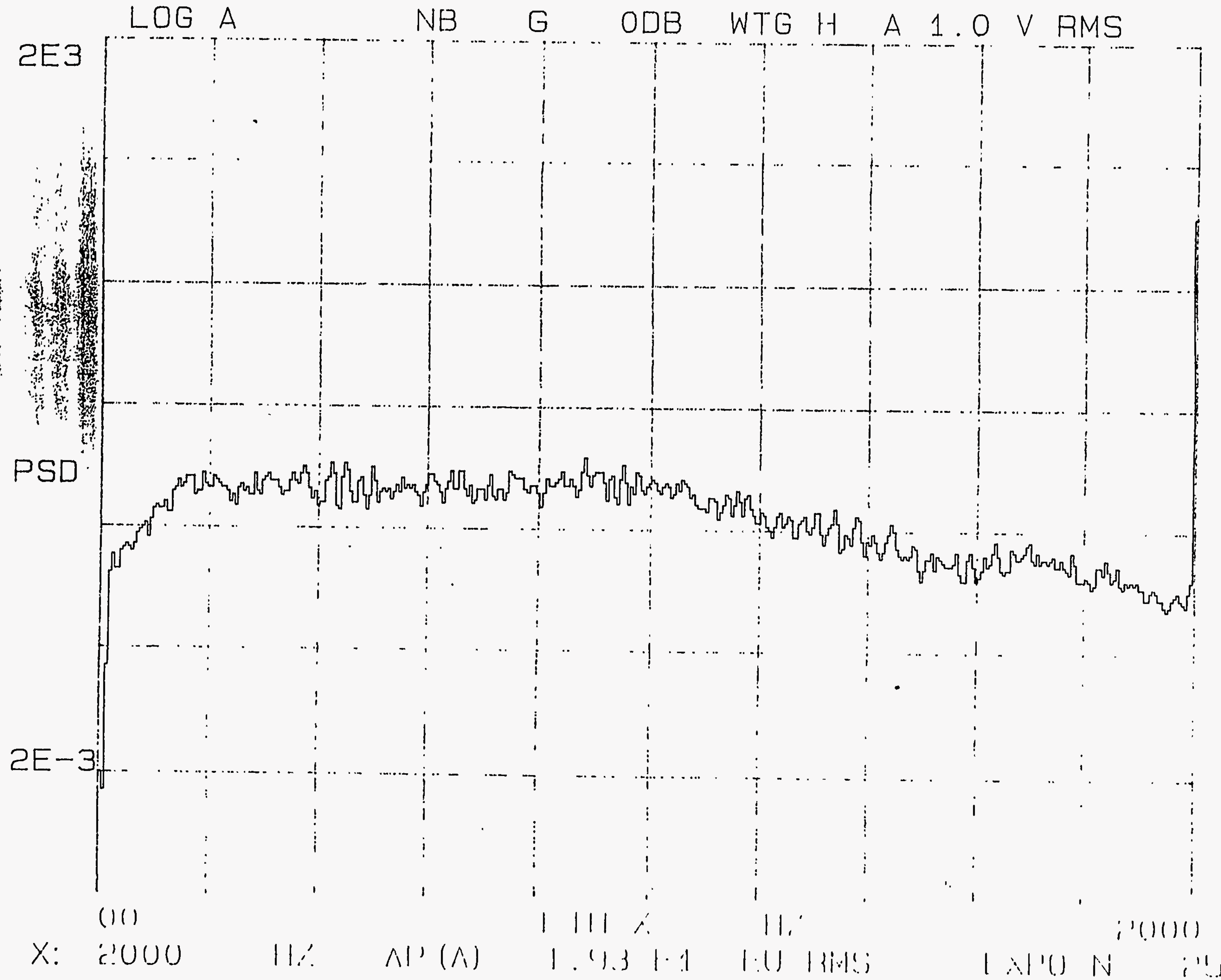
Test Completed -- See Post Test

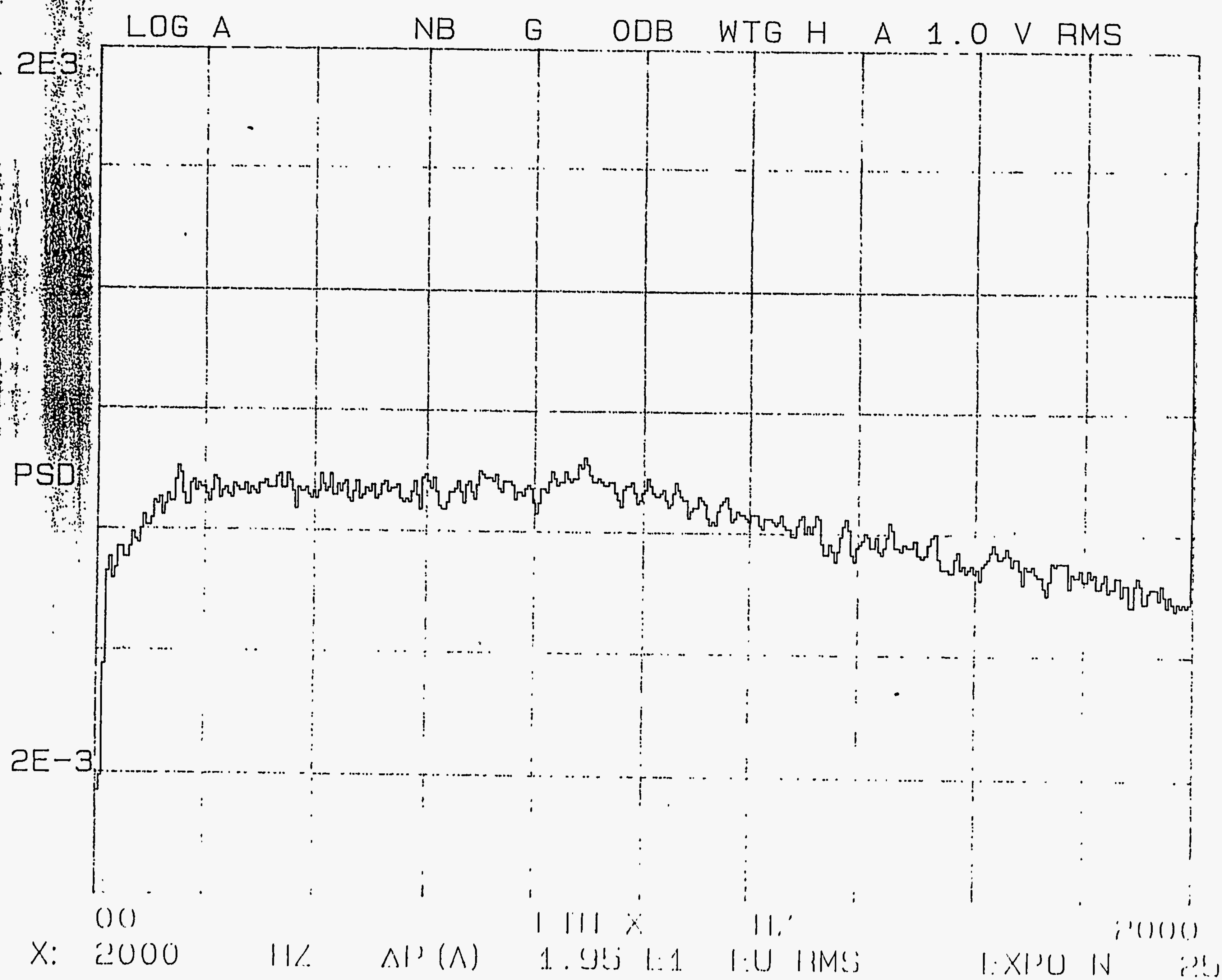


1-Jul-93 OG20PF PROTOFLIGHT 19.8 G'S
10:12:0

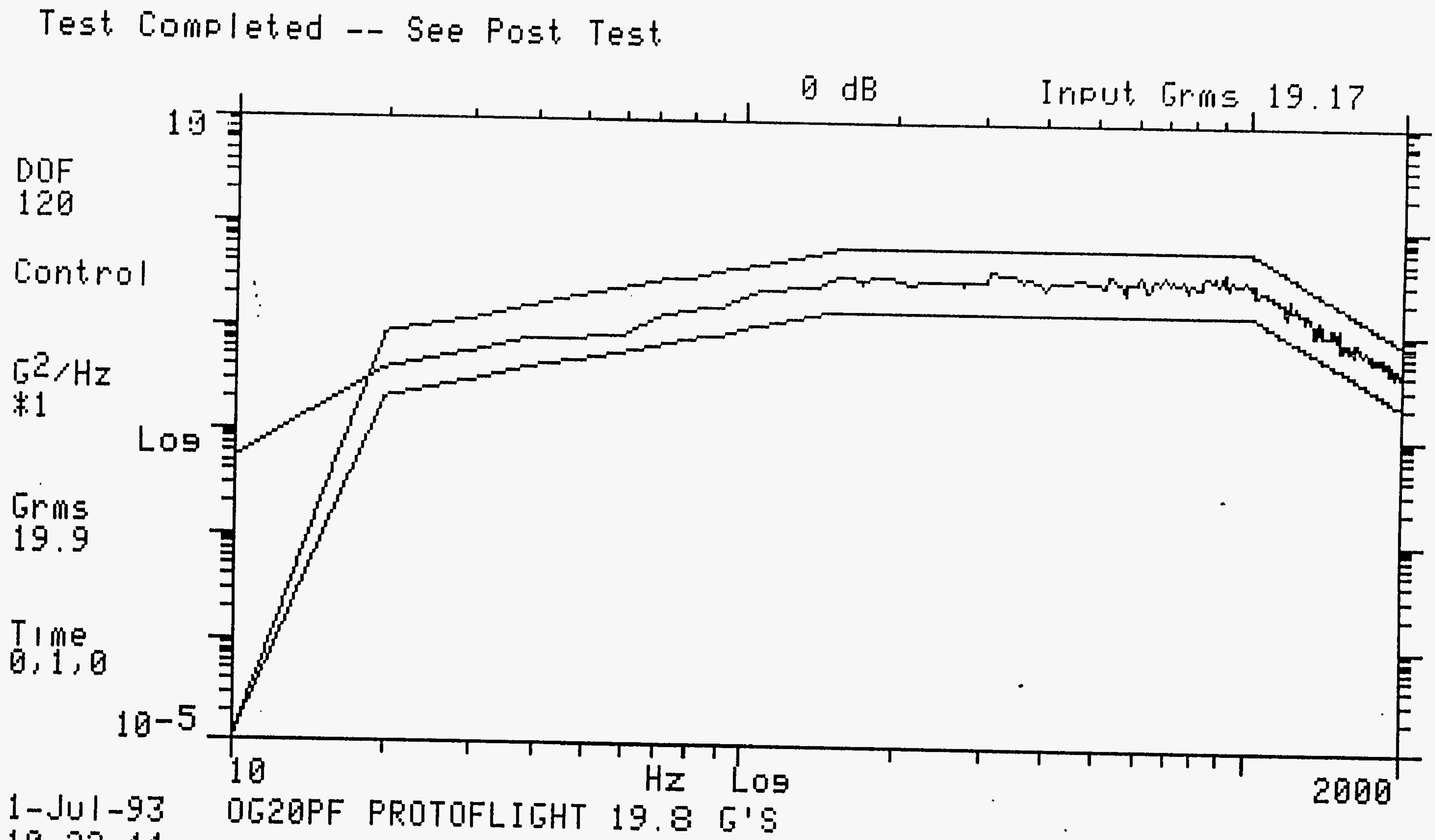
STAR TRACKER ST 314
Z AXIS

STARTRACKER 314
Z-AXIS 1 MIN.

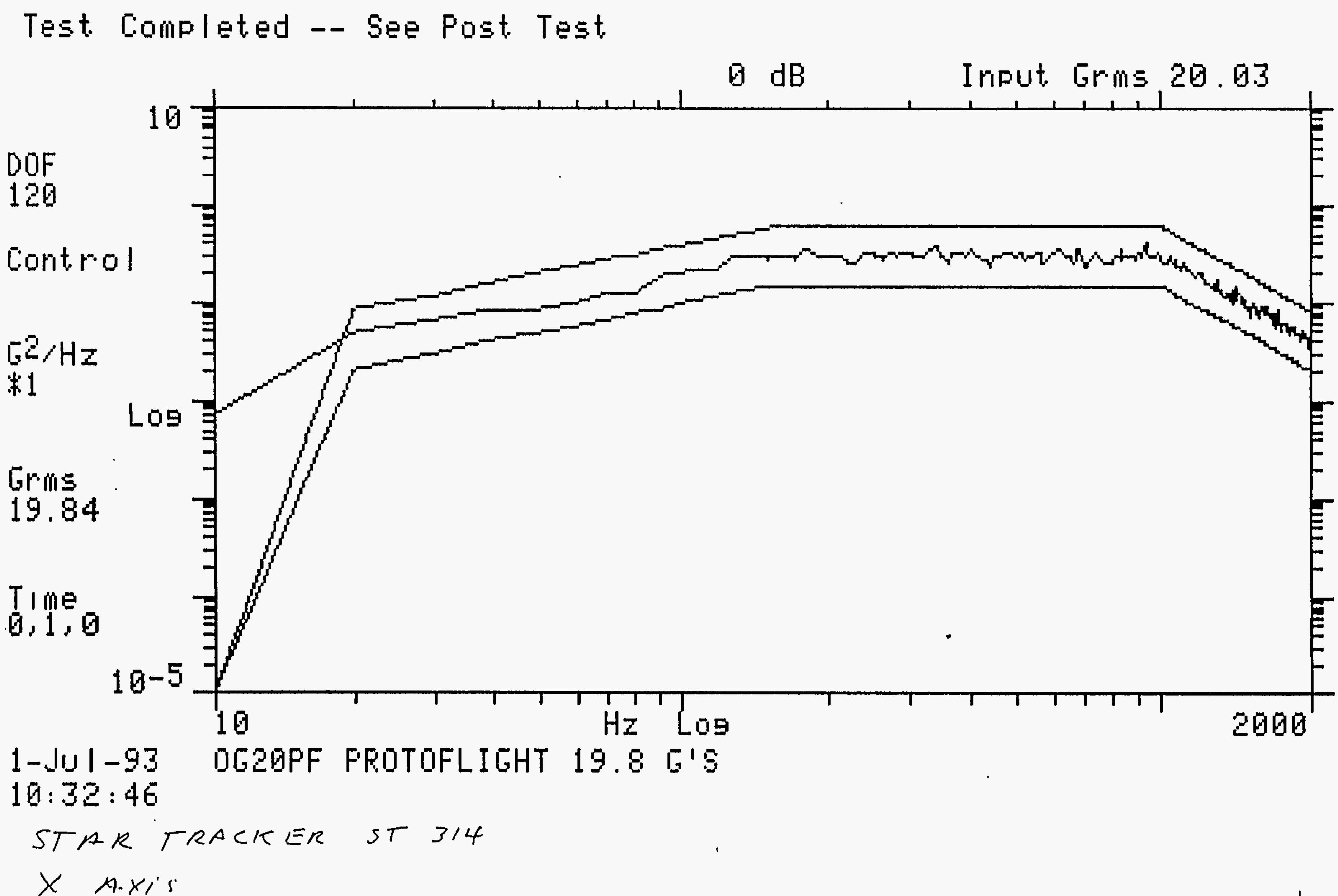


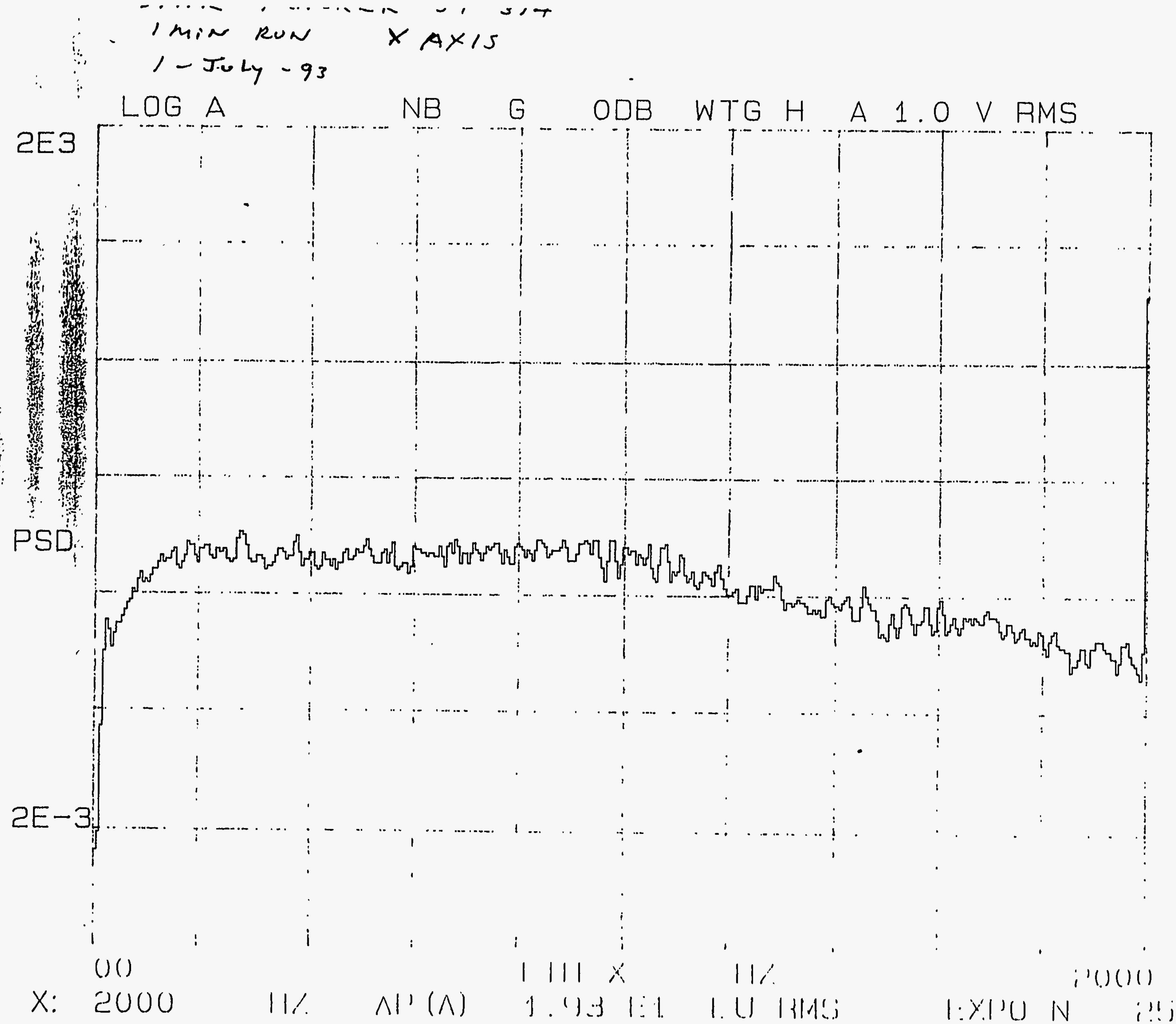


LOG A NB G ODB WTG H A 1.0 V RMS
2E3
PSD
2E-3
00
X: 2000 HZ AP (A) 1.95 E1 EU RMS
2000
EXPO N 25

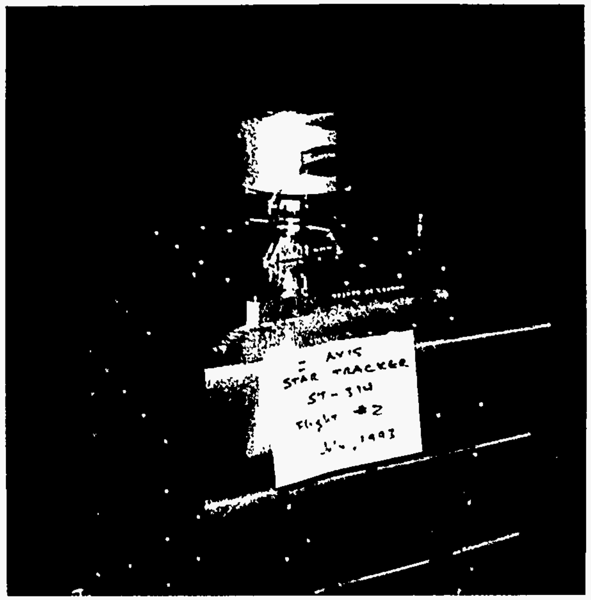


STARTRACKER 3/4
Y-AXIS


Test Completed -- See Post Test
0 dB
Input Grms 20.03
10
DOF
120
Control
G2/Hz
*1
Log
Grms
19.84
Time
0,1,0
10-5
10
Hz Log
2000
1-Jul-93
10:32:46
OG20PF PROTOFLIGHT 19.8 G'S
STAR TRACKER ST 314
X AXIS


1MIN RUN X AXIS
1-July-93
LOG A NB G ODB WTG H A 1.0 V RMS
2E3
PSD
2E-3
00
X: 2000 HZ AP(A)
HZ
2000
EXPO N

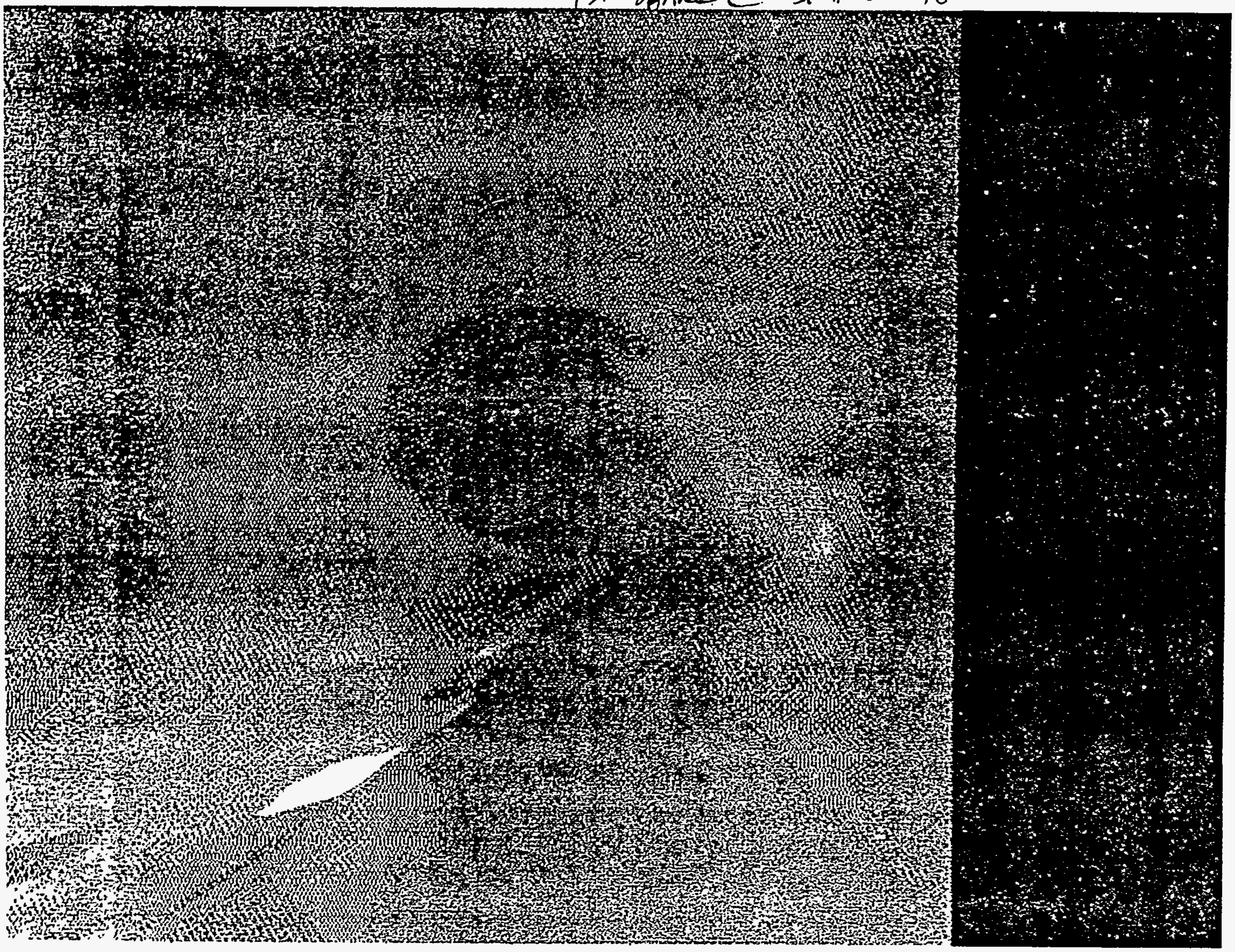

X Axis
STAR TRACKER
ST-314
Flight #2
July, 1993

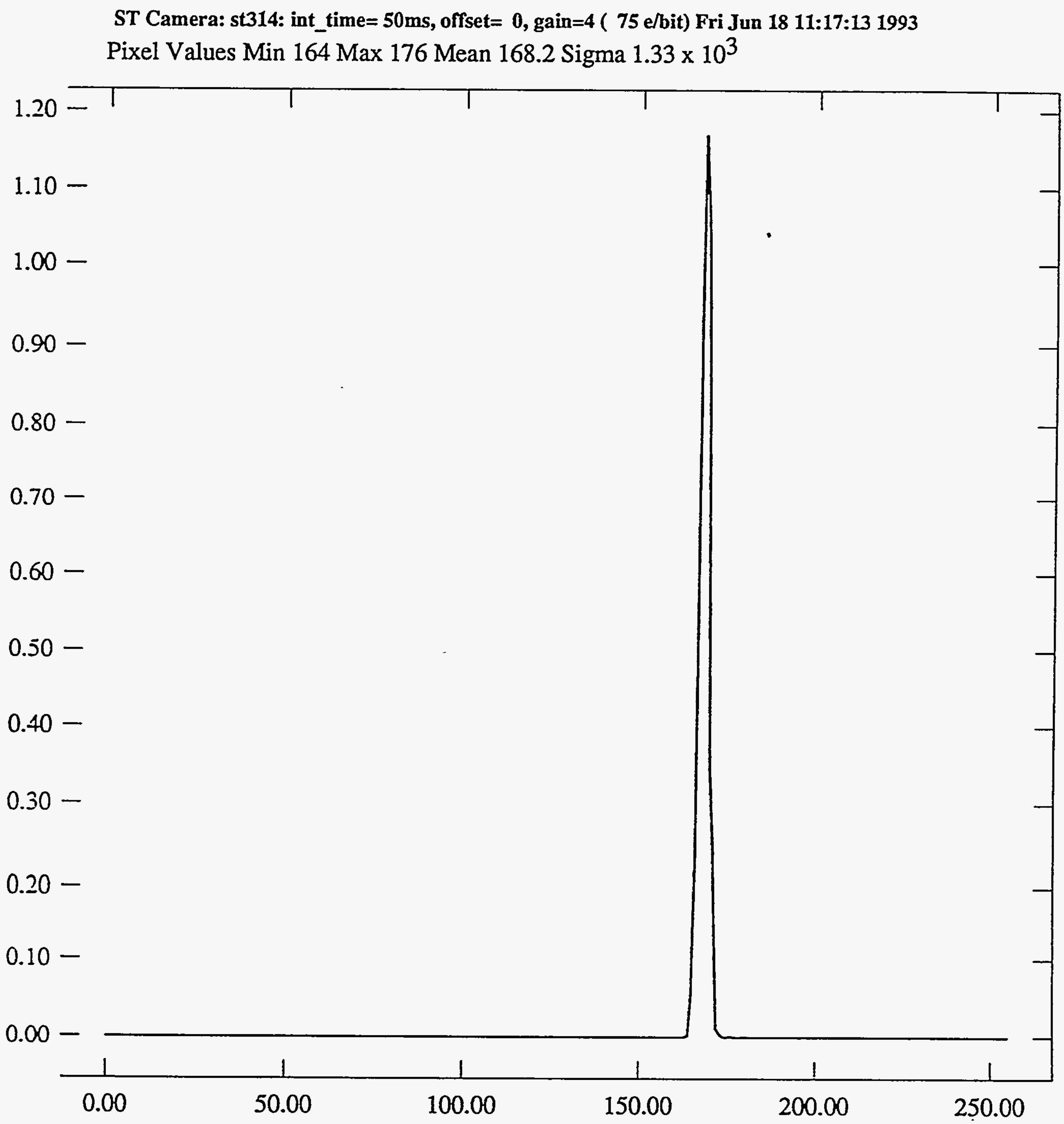

Z Axis
STAR TRACKER
ST-314
Flight #2
July, 1993


Y Axis
STAR TRACKER
ST-314
Flight #2

7.193

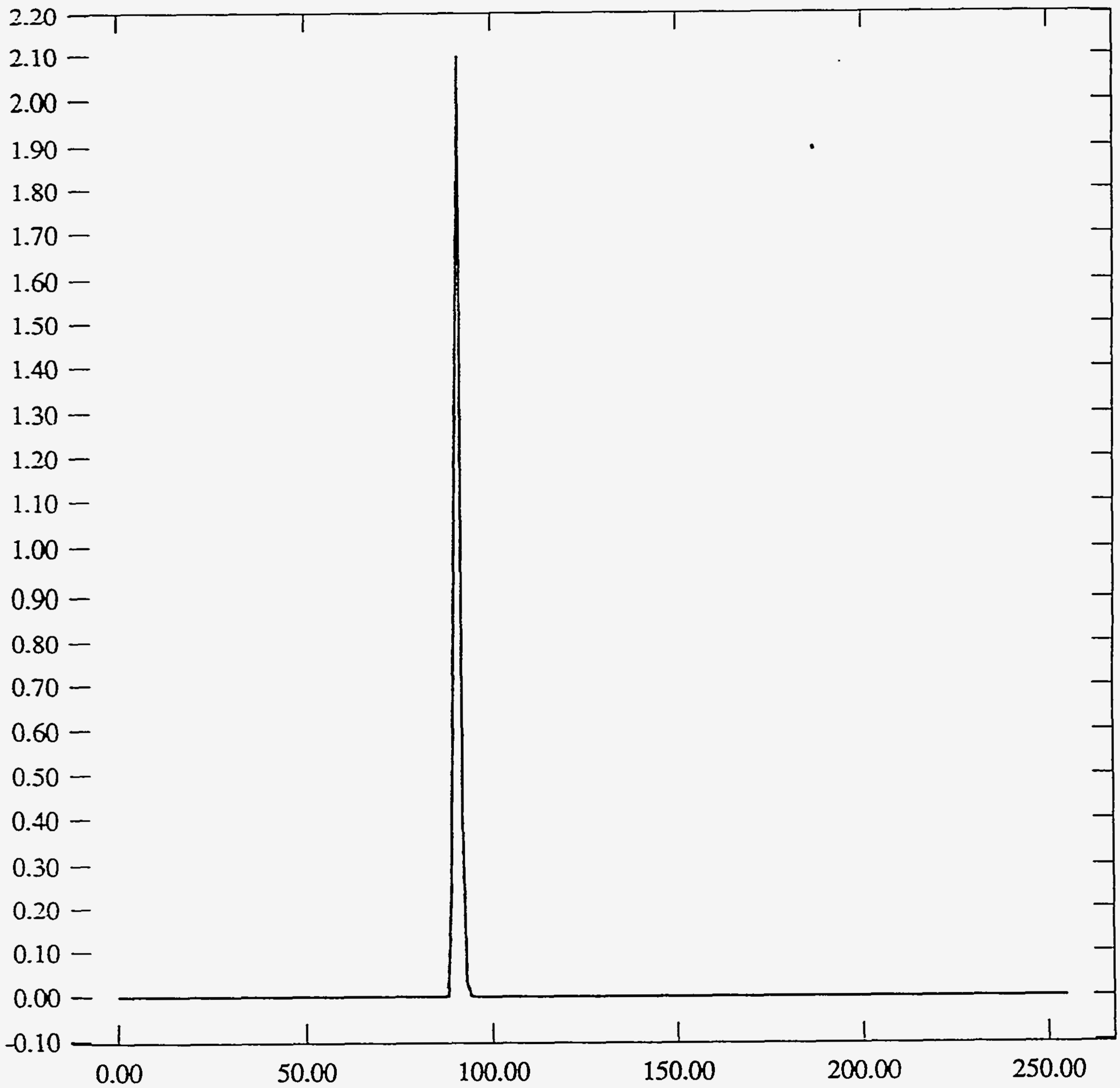
PST SHAKE 2 SN# 0CL 10

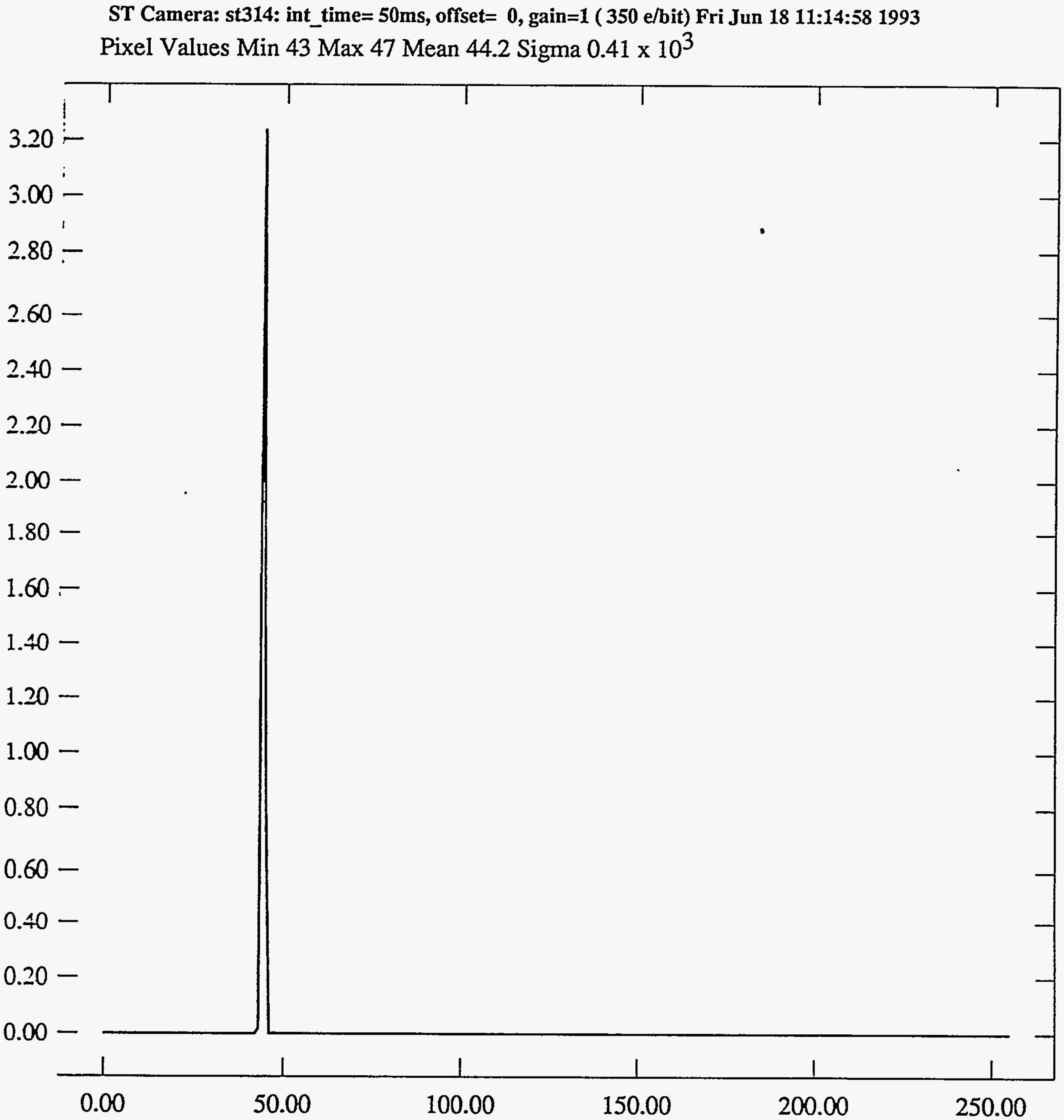



ST Camera: st314: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Fri Jun 18 11:17:13 1993
Pixel Values Min 164 Max 176 Mean 168.2 Sigma 1.33 x 10^3
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: st314: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Fri Jun 18 11:15:54 1993

Pixel Values Min 88 Max 94 Mean 90.7 Sigma 0.78 x 10^3





ST Camera: st314: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Fri Jun 18 11:14:58 1993
Pixel Values Min 43 Max 47 Mean 44.2 Sigma 0.41 x 10^3
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

Abbreviated Functional Test Procedure for Sub and Fully Housed Clementine Camera, PWAs with Gain and Offset Control

7.1.93

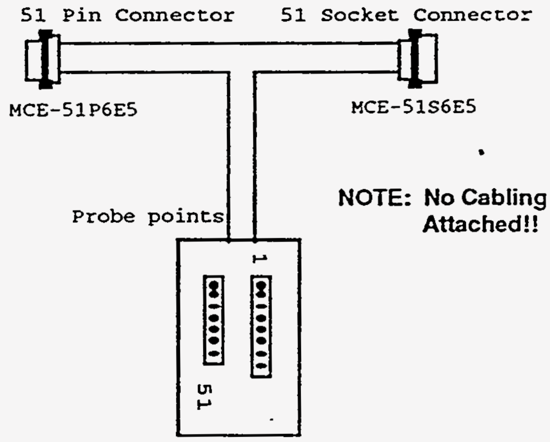
	Date	Rev.	Date	Approval
PREPARED BY: MERCEDES L. DICKERSON				
REVIEWED BY: DARRON P. NIELSEN	6-17-93			
REVIEWED BY: WILLIAM R. BRYSON	17 Jun 93			
REVIEWED BY: JOSEPH F. KORDAS	6-17-93			
REVIEWED BY: MICHAEL J. SHANNON	6/17/93			

University of California Lawrence Livermore National Laboratory	Abbreviated Functional Test Procedure for Sub and Fully Housed Clementine Camera, PWAs with Gain and Offset Control	C1-EE-036 Revision 0A

1. Sub and Final Assembly Resistance and Voltage Specificity prior to Power-up

Inspect the camera for connector saver and shorting plug. If one or both of these are not present obtain ther
A 51-contact breakout should be attached to the connector saver to perform this test. The 51-contact shortii
plug should be attached to the connector saver for transport or storage once this test is complete.
Using a flight certified breakout connector—

51 Pin Breakout Cable



—Verify these resistances:

pin# DVM(common)	vs	pin# DVM(signal)	expected	measured Ω
5 (AGND)	-	39 (+15VDC)	>400Ω	481 Ω
	-	4 (-15VDC)	>12KΩ	12K Ω
	-	37 (+5VDC)	>400Ω	469 Ω
	-	38 (+5VDC)	>400Ω	469 Ω
	-	3 (-5VDC)	>1kΩ	1.54KΩ
	-	40 (+5VIN)	>4kΩ	4.37KΩ
20 (DGND)	-	5	≤1Ω	.3 Ω
	-	39	>400Ω	481 Ω
	-	37	>400Ω	469 Ω
	-	38	>400Ω	469 Ω
	-	3	>1kΩ	1.54K Ω
	-	40	>4KΩ	4.37KΩ
39 (+15VDC)	-	4	>11KΩ	11.9K Ω
	-	37	>10KΩ	946 Ω
	-	38	>10KΩ	946 Ω
	-	3	>13KΩ	2.0K Ω
	-	40	>15KΩ	4.8K Ω

4 (-15VDC)	-	37	>12KΩ	13.53kΩ
	-	38	>12KΩ	13.53K Ω
	-	3	>13KΩ	14.61KΩ
	-	40	>13KΩ	17.42k Ω
37 (+5VDC)	-	38	≤1Ω	.3 Ω
	-	3	>2kΩ	2K Ω
	-	40	>4KΩ	4.85KΩ
3 (-5VDC)	-	40	>5kΩ	5.92KΩ
2 (CGND)	-	51	≤1Ω	.3 Ω
	-	36	∞	∞ Ω
	-	5	∞	∞ Ω
	-	37	∞	∞ Ω
	-	39	∞	∞ Ω
	-	40	∞	∞ Ω
	-	4	∞	∞ Ω
	-	3	∞	∞ Ω

Using a flight certified breakout connector, verify power voltages at cable connector—camera end—**before** attaching it to the camera board. Use J1-pin 20 for multimeter ground and complete the following table.

J1 pin #	Expected V	Measured V
39	+15V	15.31
4	-15V	-15.79
37,38	+5VDC	5.11
3	-5V	-5.4
40	+5VAIN	5.11

Turn off the power. Specificity verified, the camera and cabling are ready for power-up.

SN# 04-10 By ________ Date 7-1-93
initials passed

2. Room Temperature Dark Measurement Data

Connect a quality assured data acquisition system and cabling with the resistance verified camera to be tested.

Acquire dark images at all three gain values—1,2, and 4—using a 50ms integration time and 0 offset.

Turn off power.

Using the same region of interest for each acquired image, process a histogram resulting in MU and SIGMA values. These values should correspond to those taken at ≈20°C during the Thermal Test. Therefore, review the 50ms data for all three gains at 20°C. NOTE: This assumes the thermal test was performed with the same CCD now housed.

SN# 04-10 By # 8 QC81 (initials) Date 7·1·91 (passed)

3. Imaging Verification

With adequate lensing, capture an image with the Startracker or UV-Vis camera and verify that it does image.

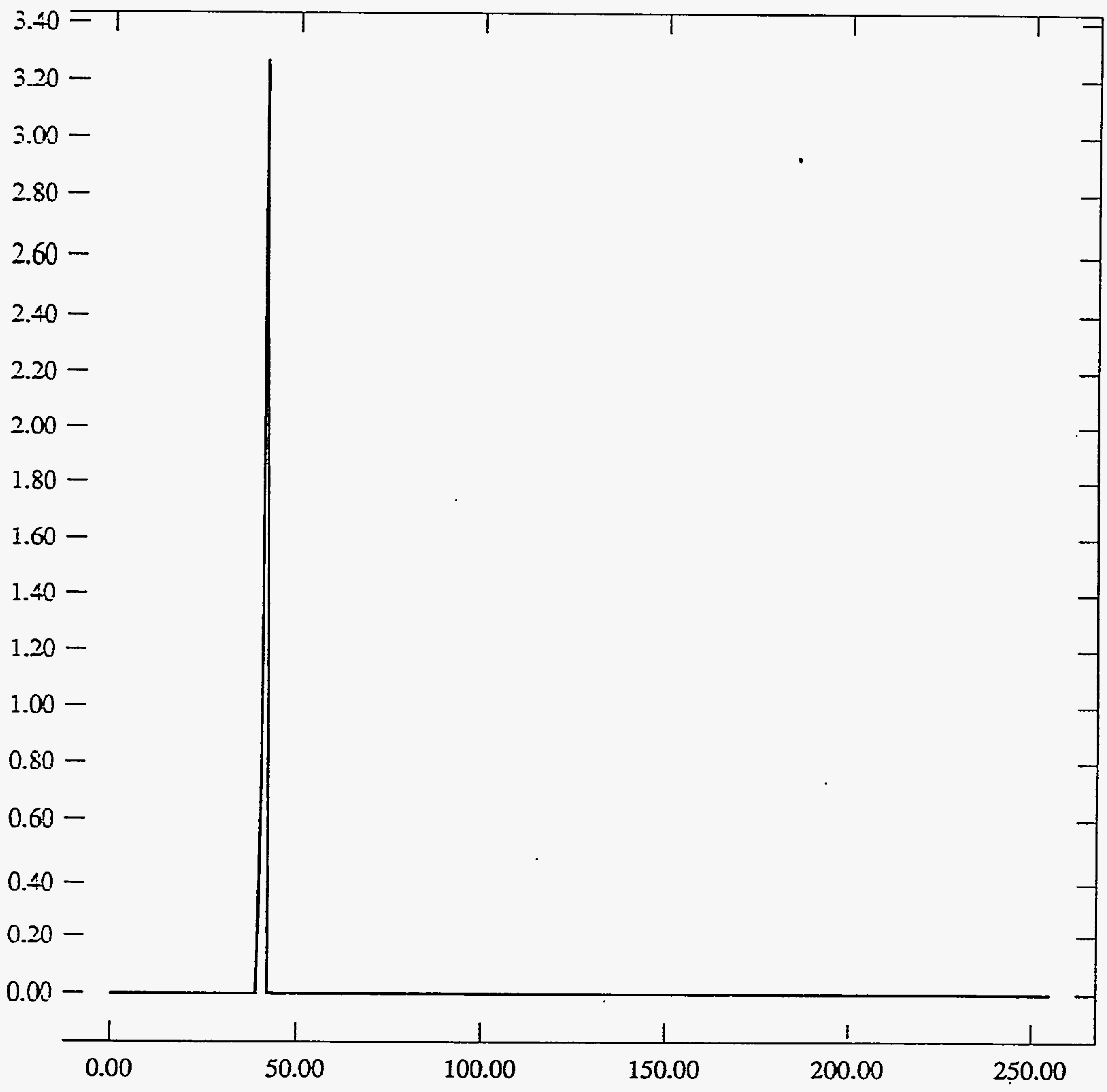
Place an image-on-clear or text-on-clear transparency against the Lidar intensifier and gate the intensifier appropriately to capture a Lidar image.

SN# 04-10 By # 8 QC81 (initials) Date 7·1·91 (passed)

REMEMBER to attach your recorded documentation to this test procedure!
(A document protector is advised)

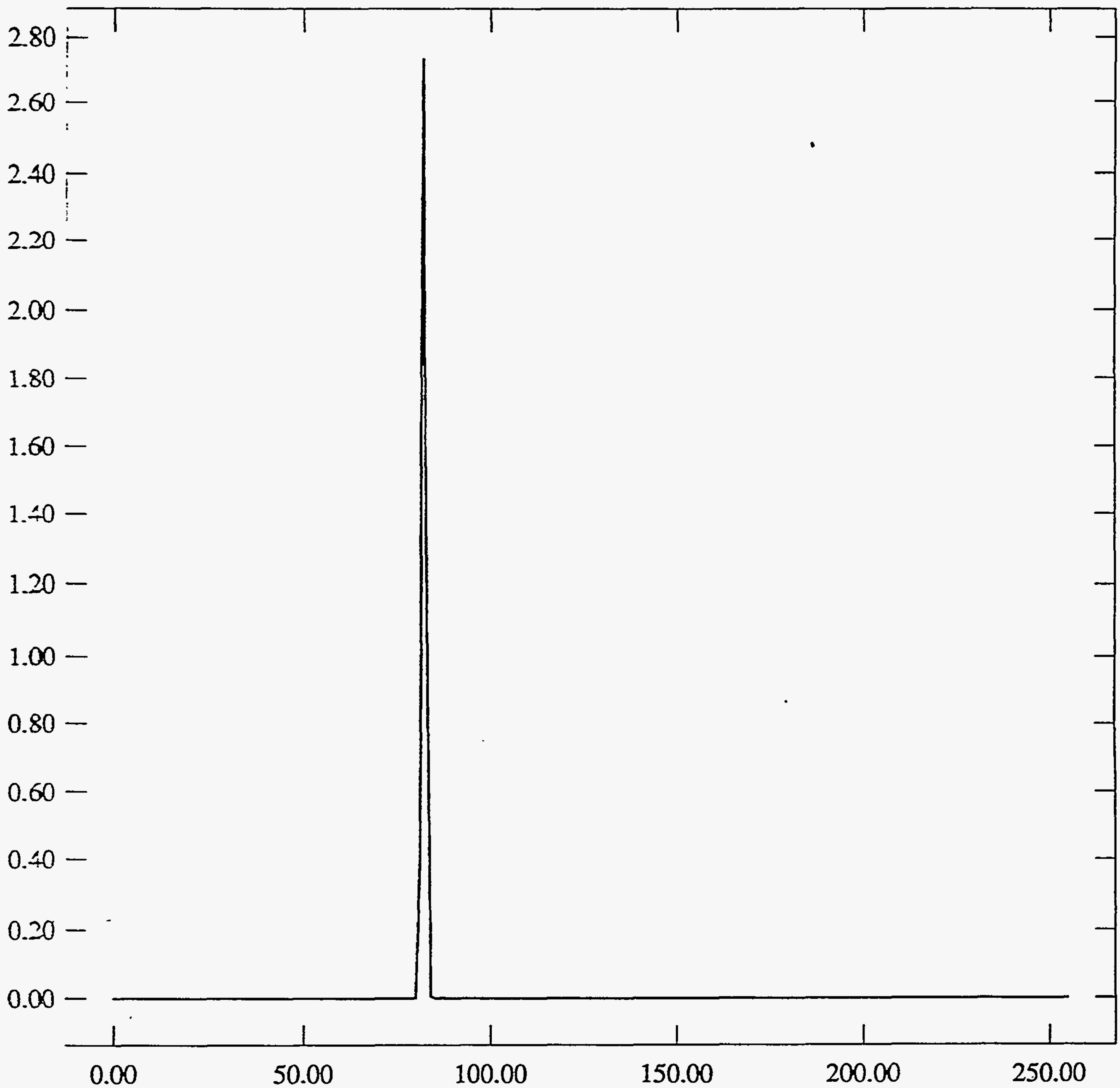
ST Camera: ST1#04-10pstshk2: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Thu Jul 1 14:25:18 1993

Pixel Values Min 40 Max 43 Mean 40.8 Sigma 0.39 x 10^3



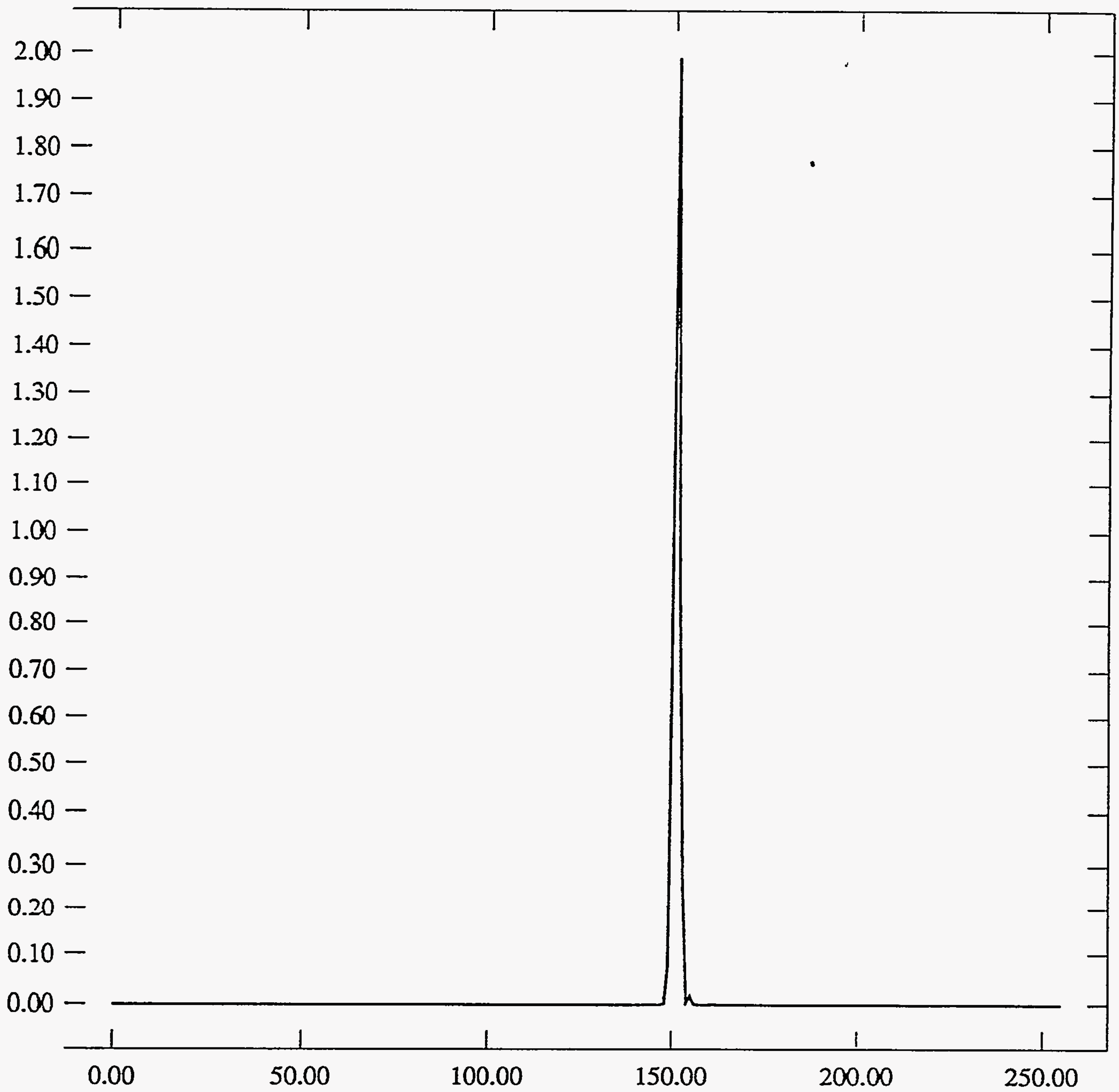
ST Camera: ST1#04-10pstshk2: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Thu Jul 1 14:25:45 1993

Pixel Values Min 80 Max 87 Mean 82.1 Sigma 0.57 x 10^3



ST Camera: ST1#04-10pstshk2: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Thu Jul 1 14:26:06 1993

Pixel Values Min 148 Max 161 Mean 151.1 Sigma 0.91 x 10^3

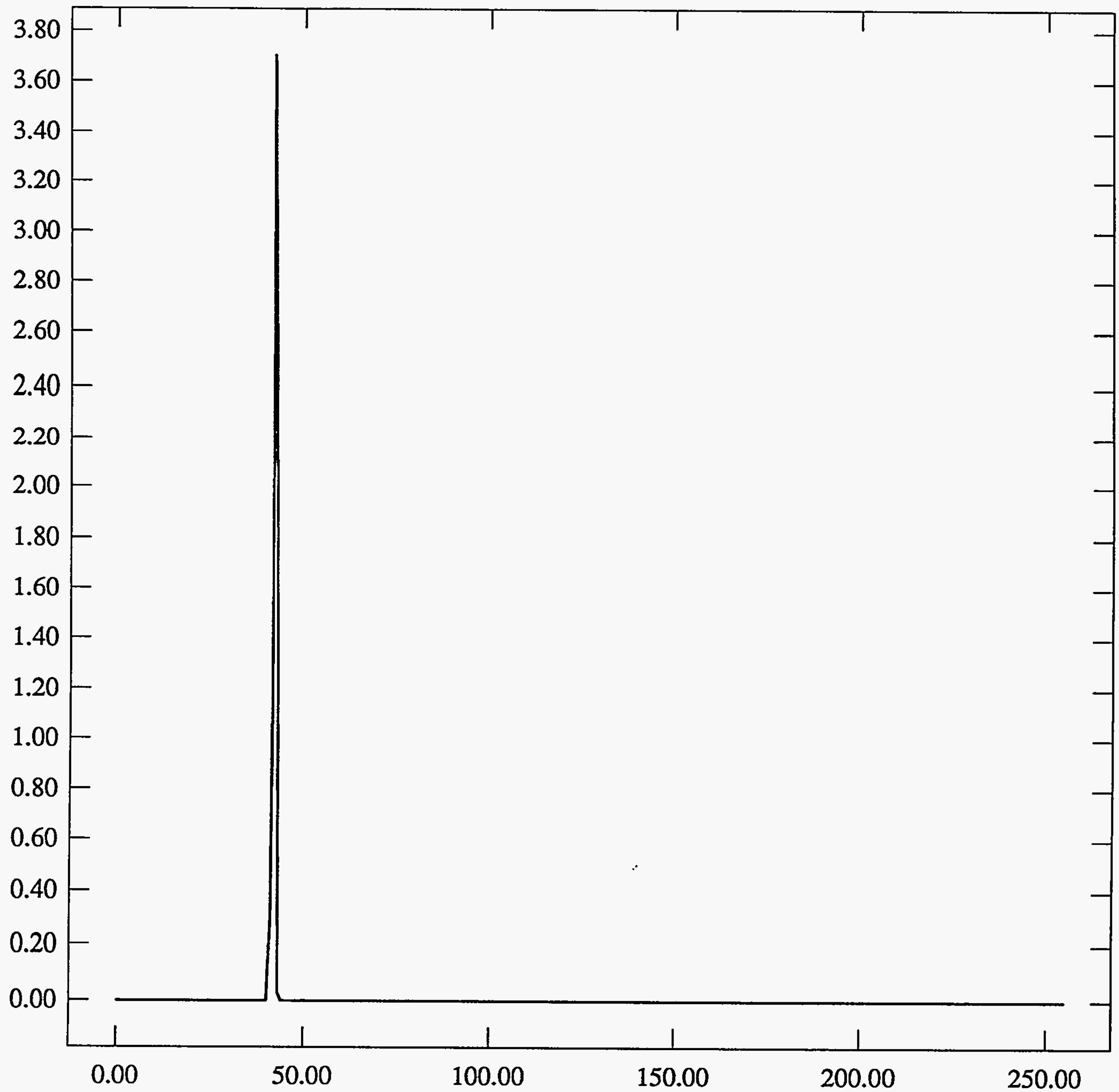


Appendix H.3.5.2.2
Thermal Cycle Test Data

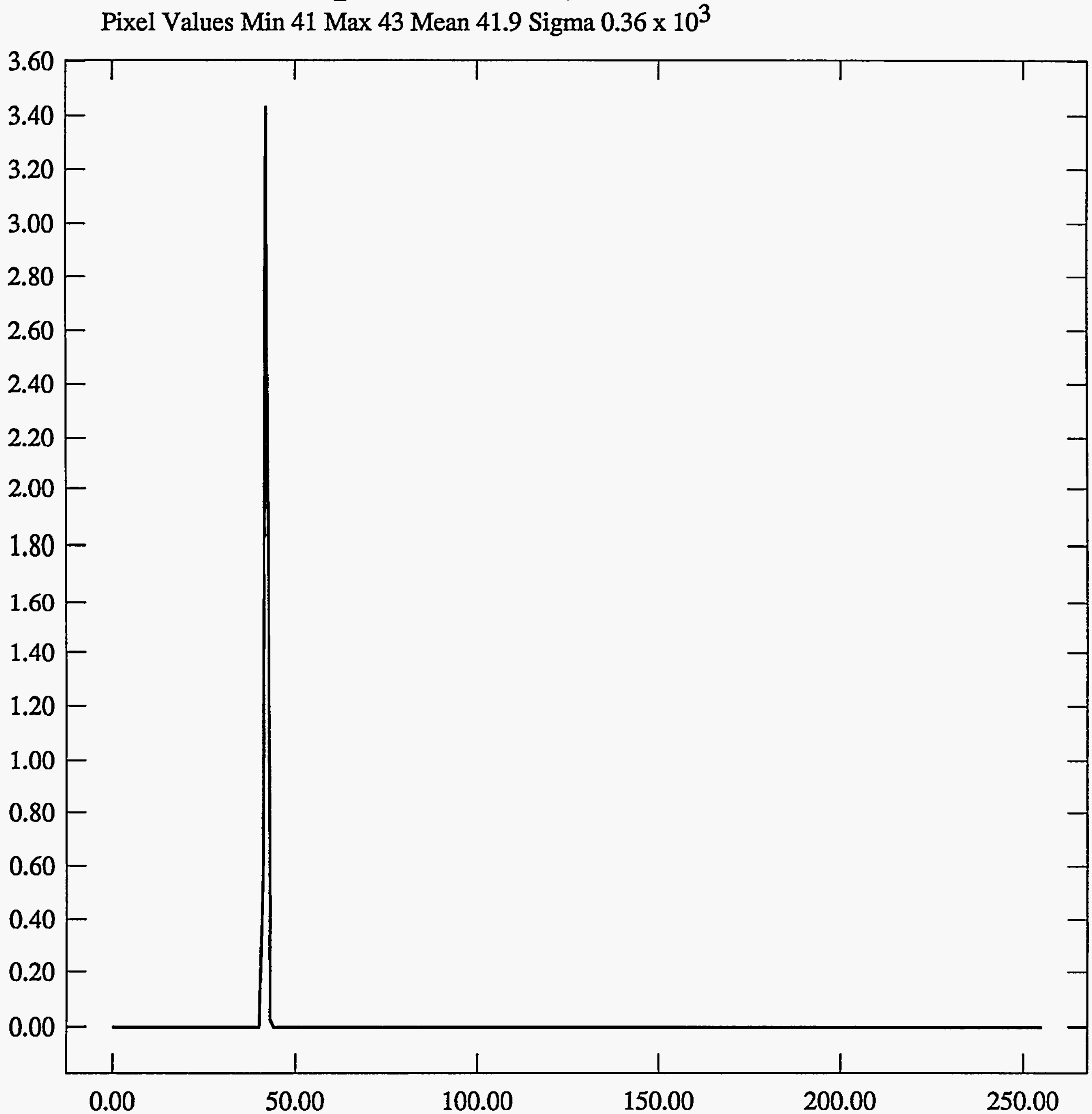
INITIAL AMBIENT °C +15MIN

ST Camera: ST1#04-10 : int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 05:17:12 1993

Pixel Values Min 41 Max 43 Mean 41.9 Sigma 0.28 x 10^3

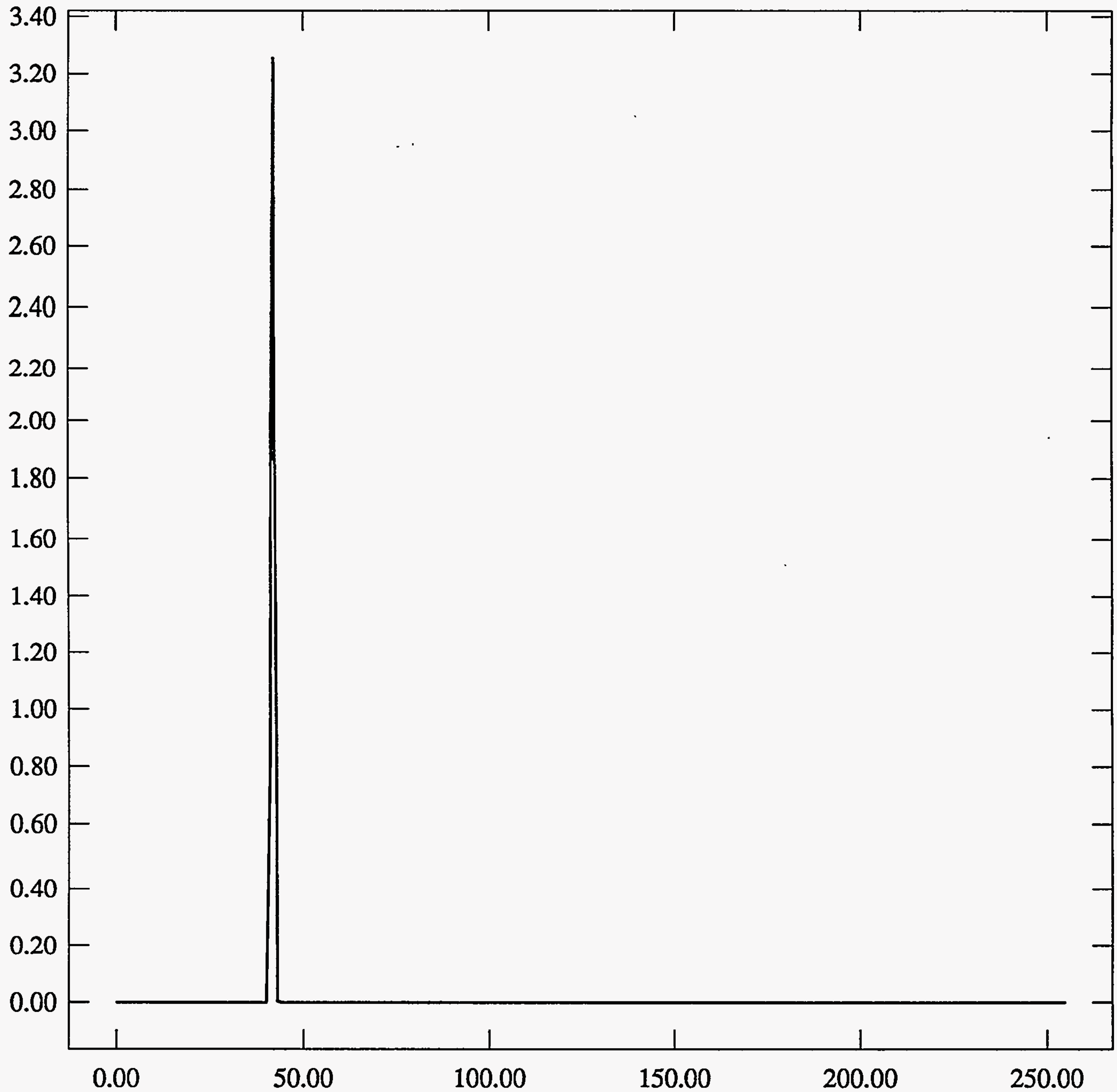


ST Camera: ST1#04-10 : int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 05:17:54 1993



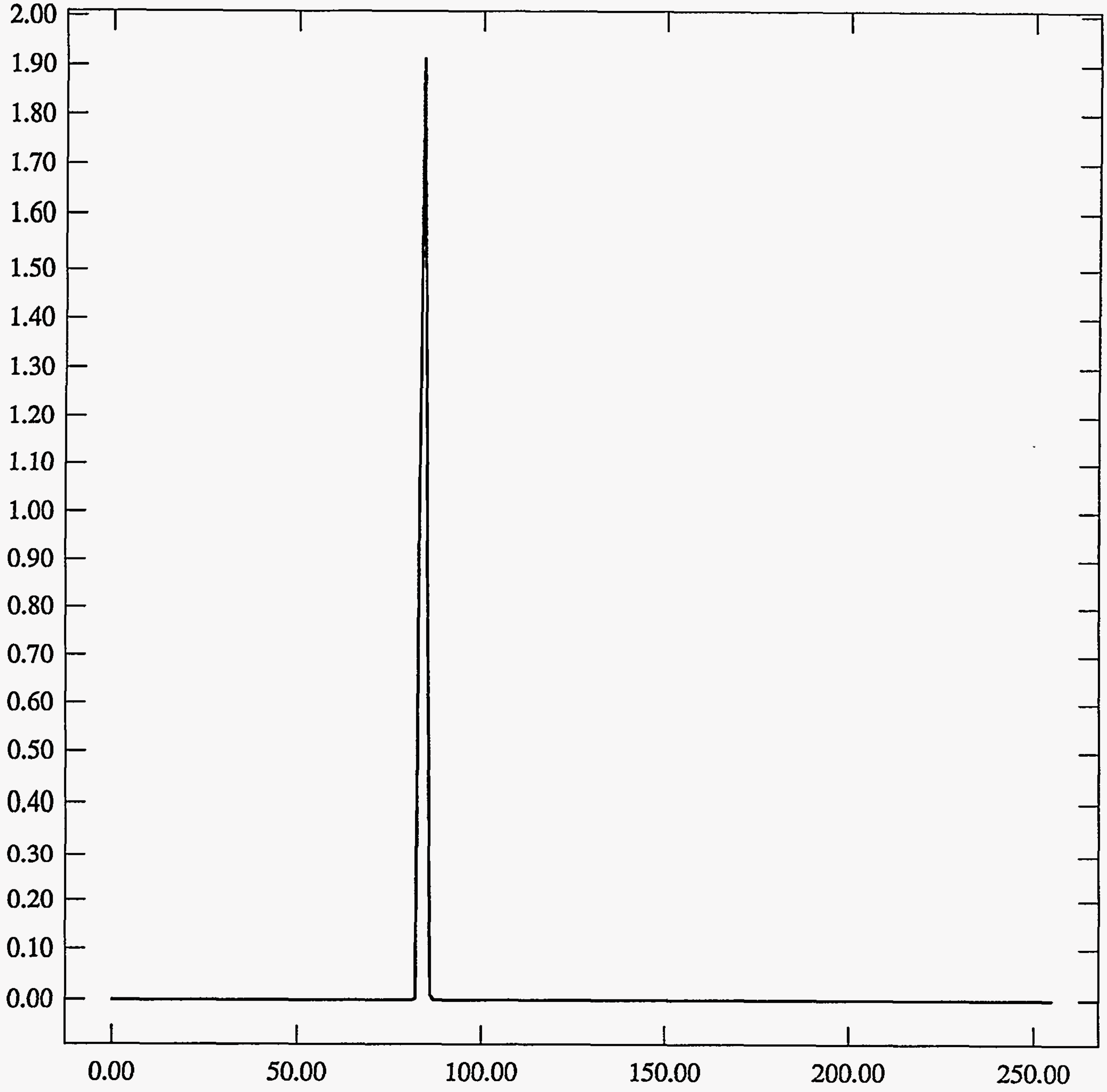
ST Camera: ST1#04-10: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 05:18:34 1993

Pixel Values Min 41 Max 43 Mean 41.8 Sigma 0.40 x 10^3



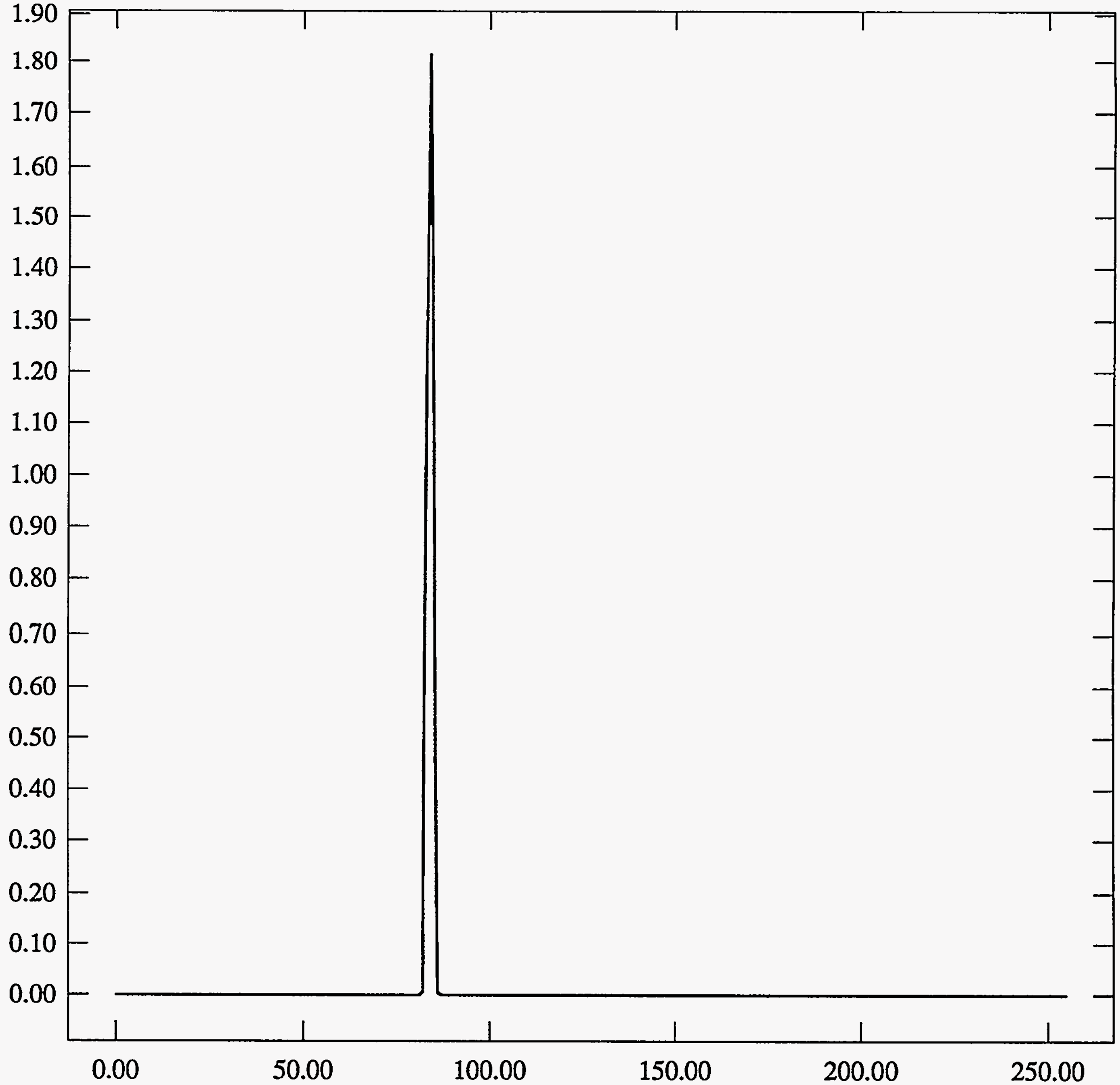
ST Camera: ST1#04-10: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 05:19:02 1993

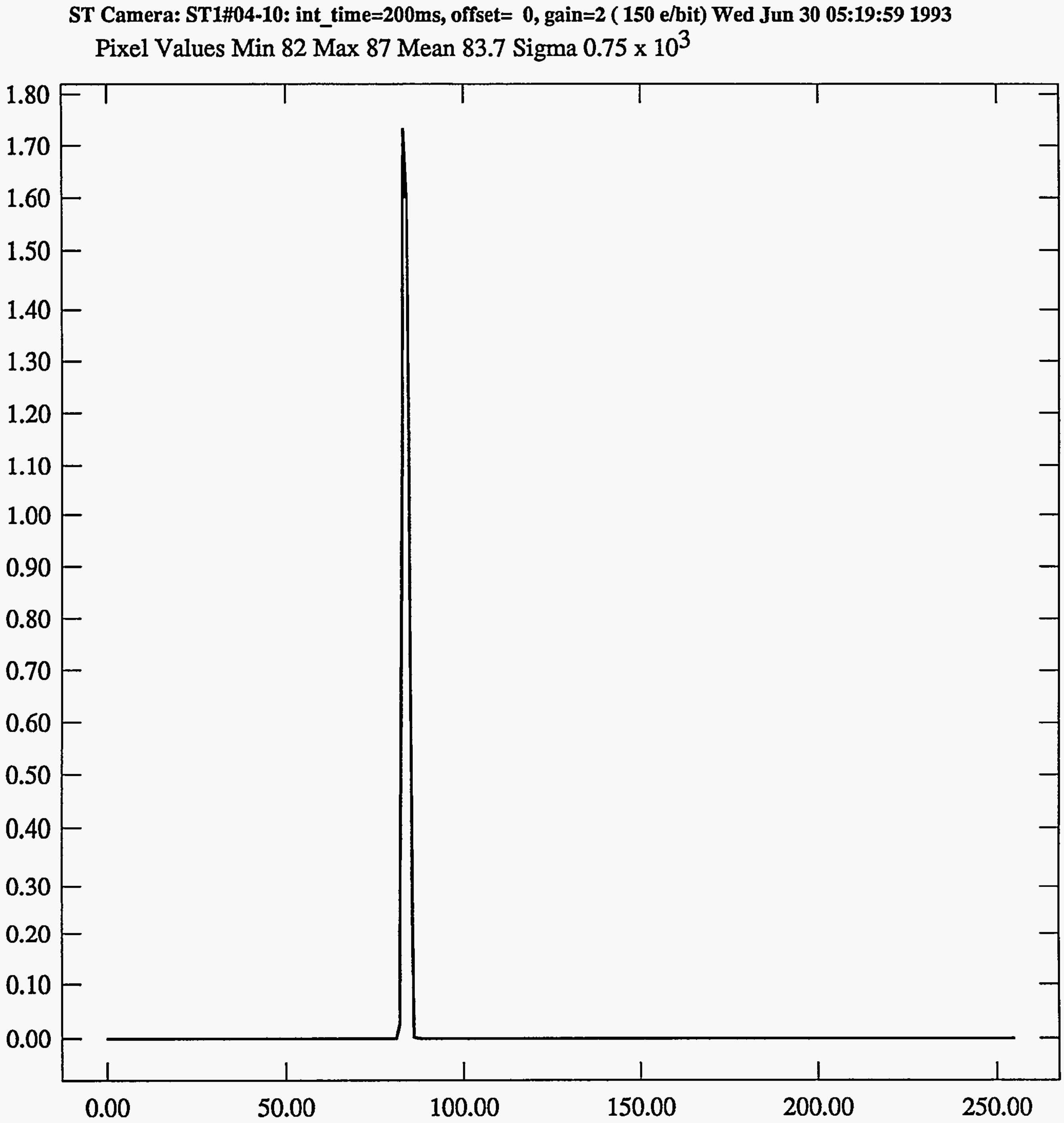
Pixel Values Min 82 Max 86 Mean 84.1 Sigma 0.73 x 10^3

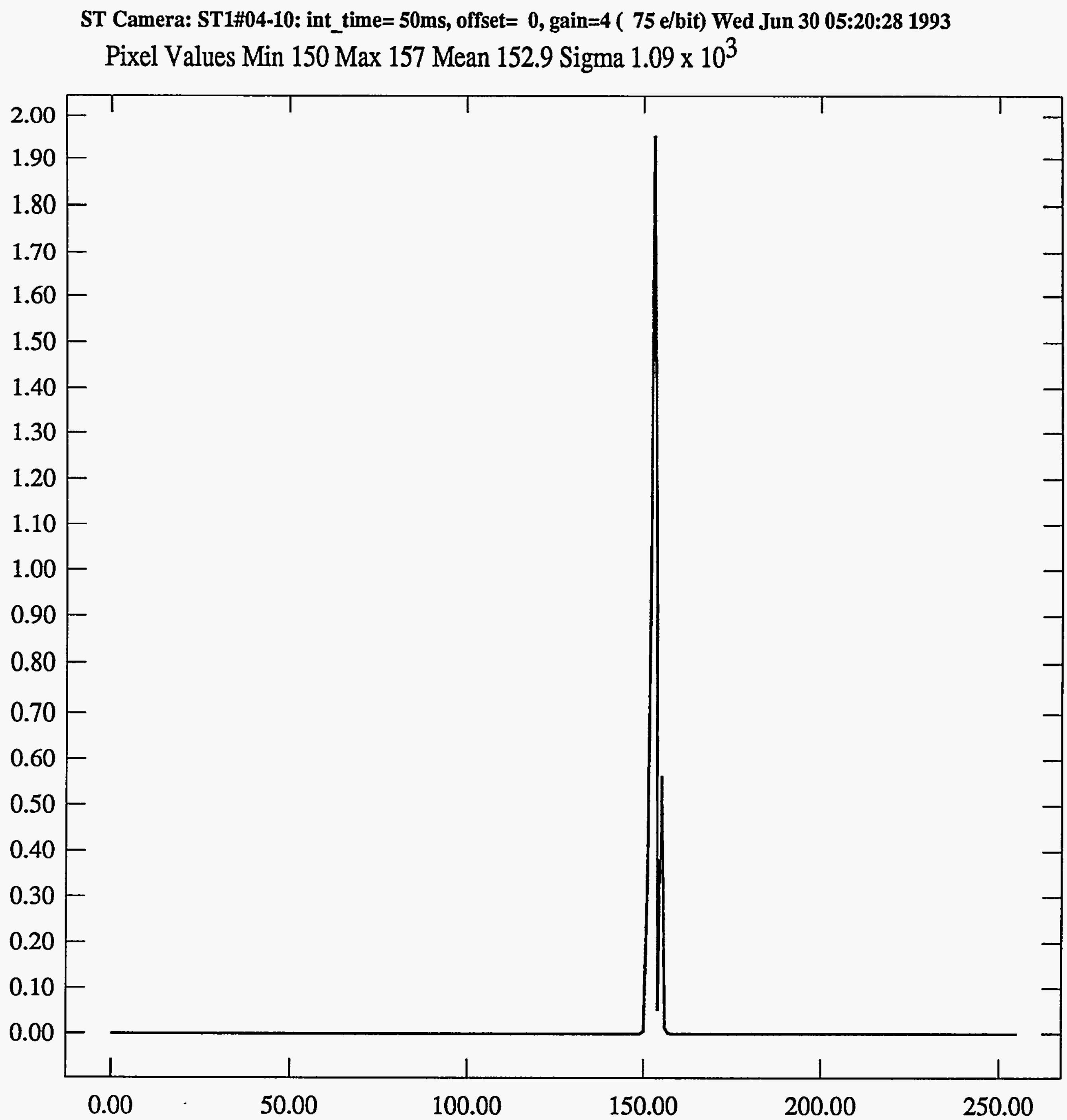


ST Camera: ST1#04-10: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 05:19:32 1993

Pixel Values Min 82 Max 86 Mean 83.9 Sigma 0.75 x 10^3

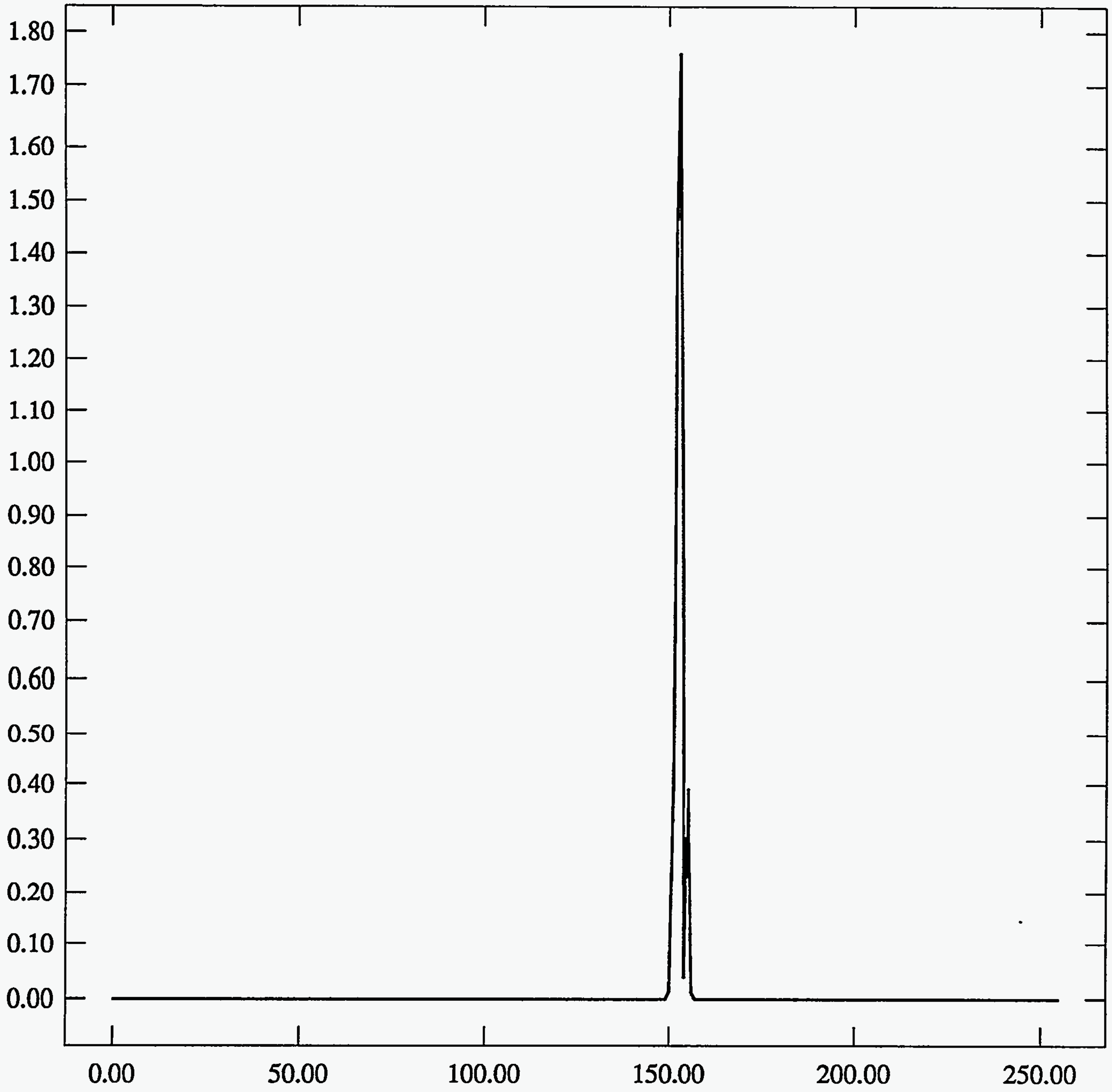



ST Camera: ST1#04-10: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 05:19:59 1993
Pixel Values Min 82 Max 87 Mean 83.7 Sigma 0.75 x 10^3
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
50.00
100.00
150.00
200.00
250.00

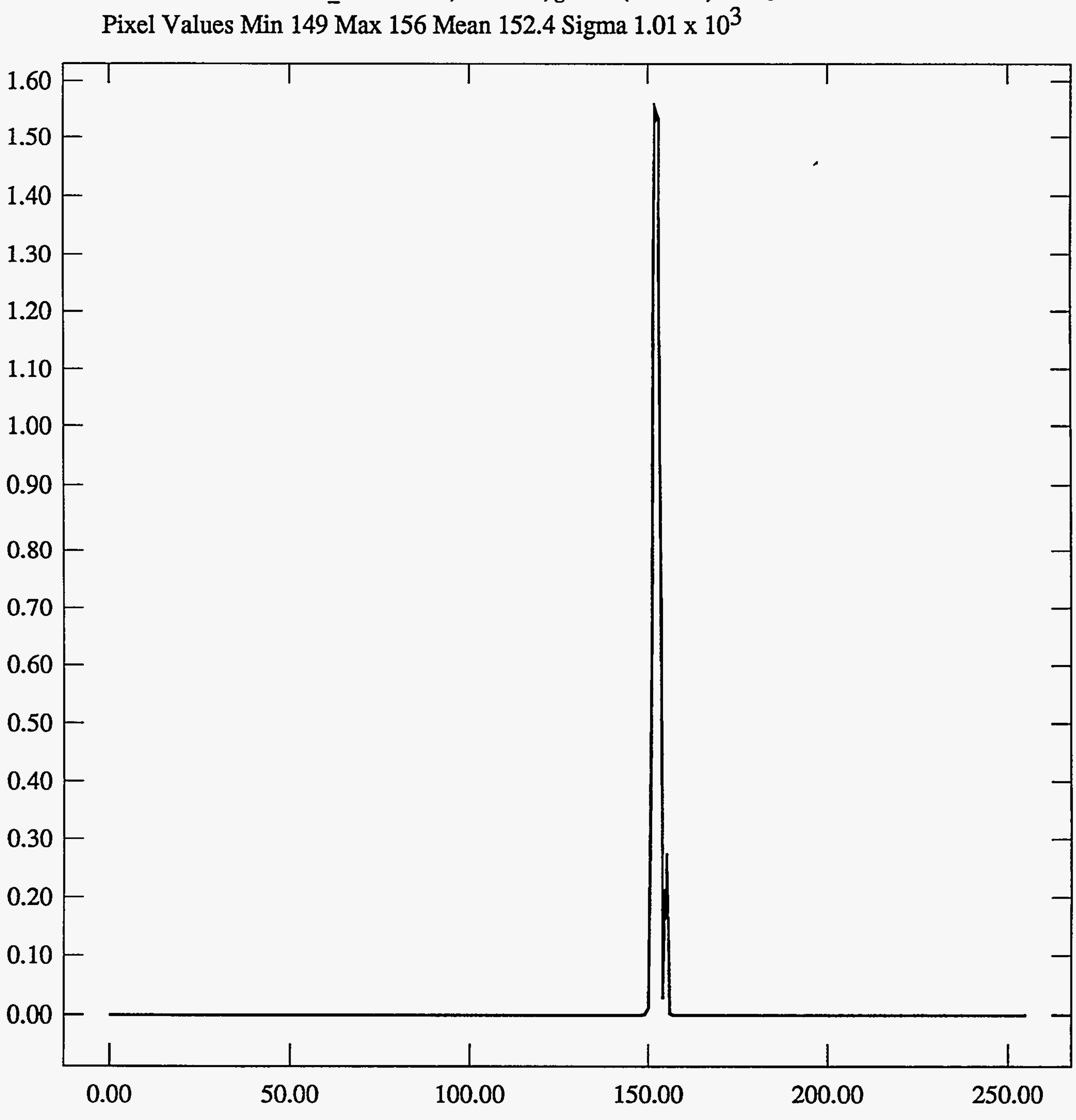

ST Camera: ST1#04-10: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 05:20:28 1993
Pixel Values Min 150 Max 157 Mean 152.9 Sigma 1.09 x 10^3
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1#04-10: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 05:21:00 1993

Pixel Values Min 150 Max 156 Mean 152.7 Sigma 1.04 x 10^3

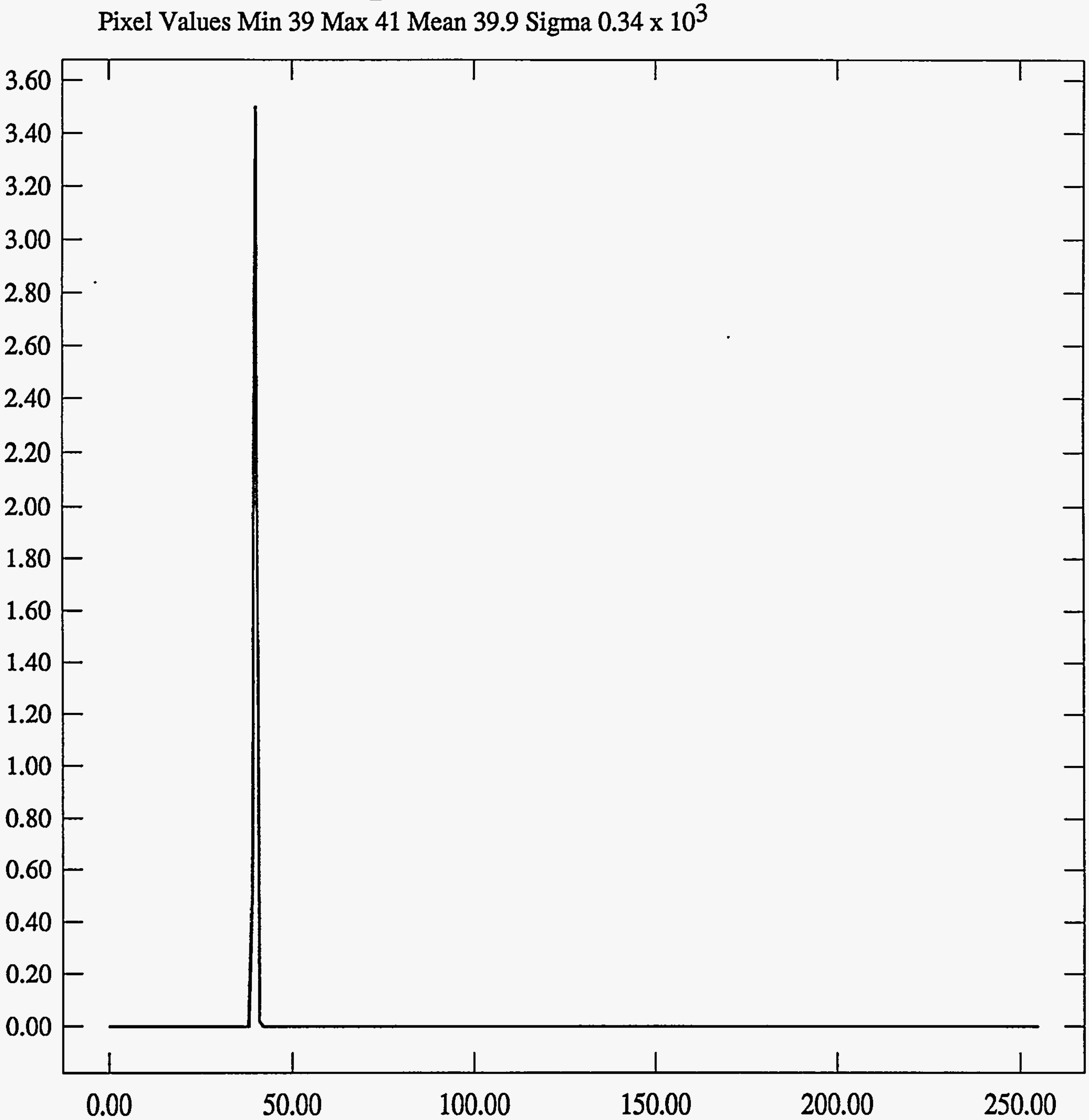


ST Camera: ST1#04-10: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 05:21:47 1993



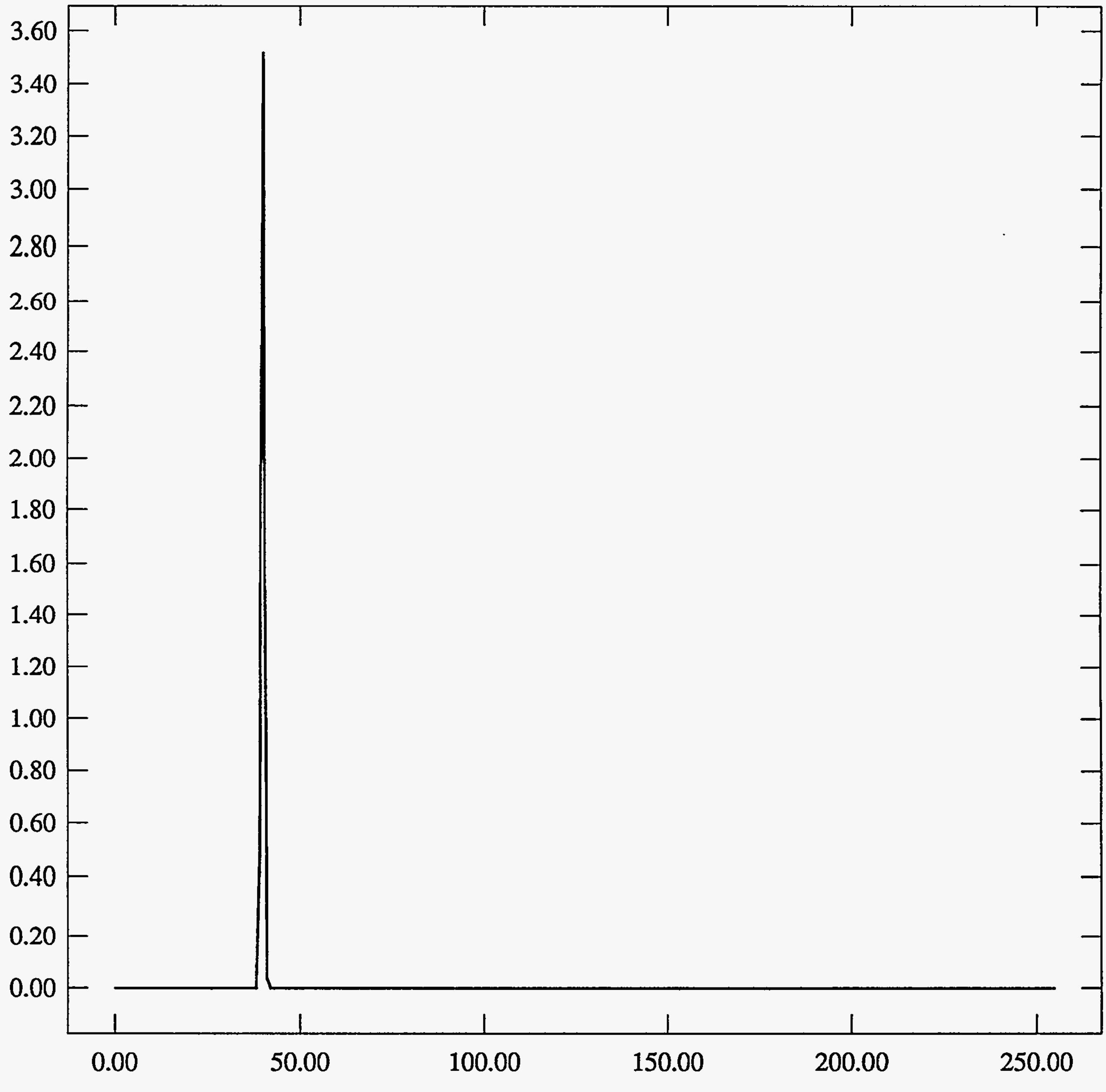
#1 -30 @ 15 MIN

ST Camera: ST1#04-10 -30C #1: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 06:03:25 1993



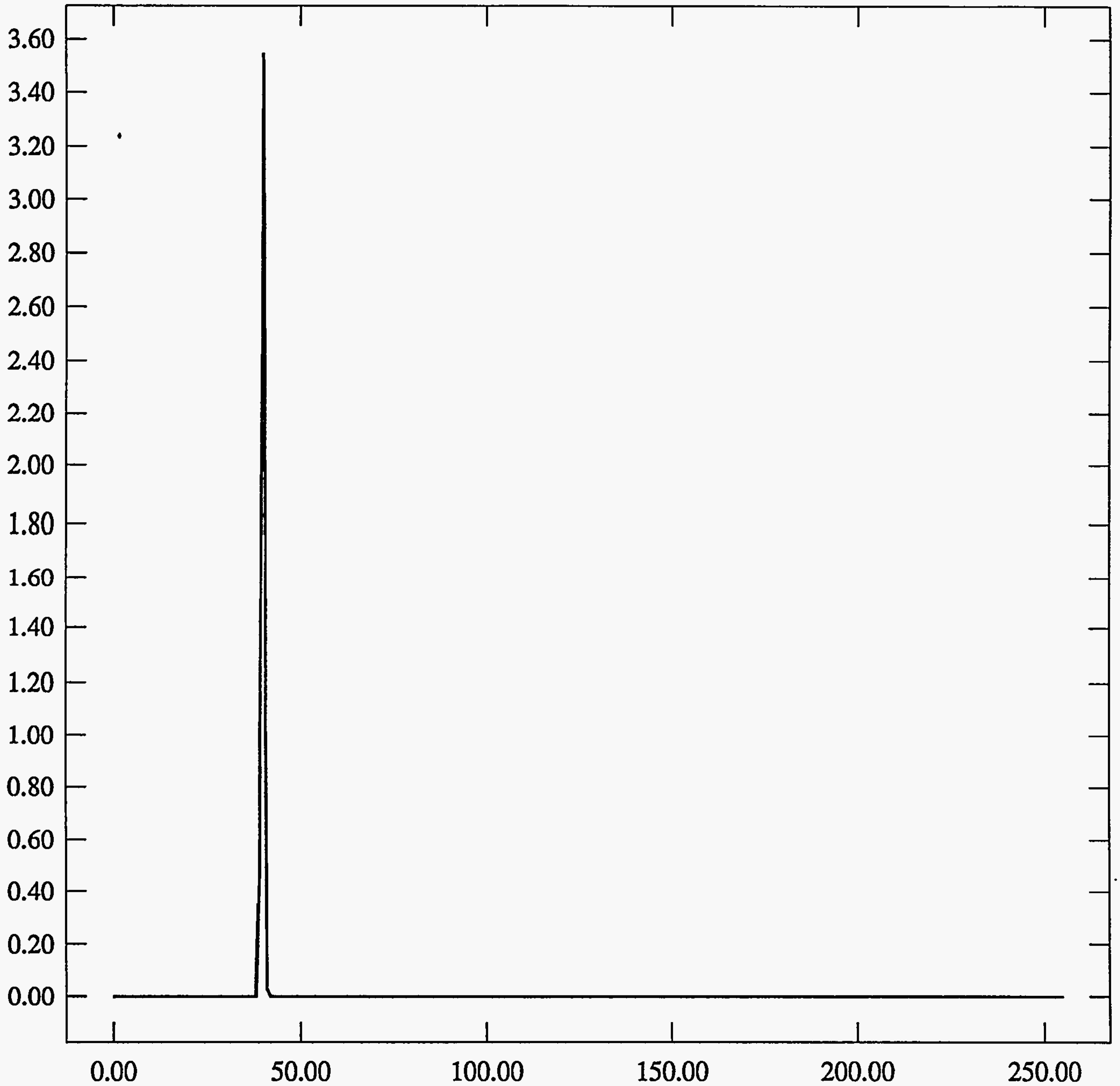
ST Camera: ST1#04-10 -30C #1: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 06:04:38 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.34 x 10^3



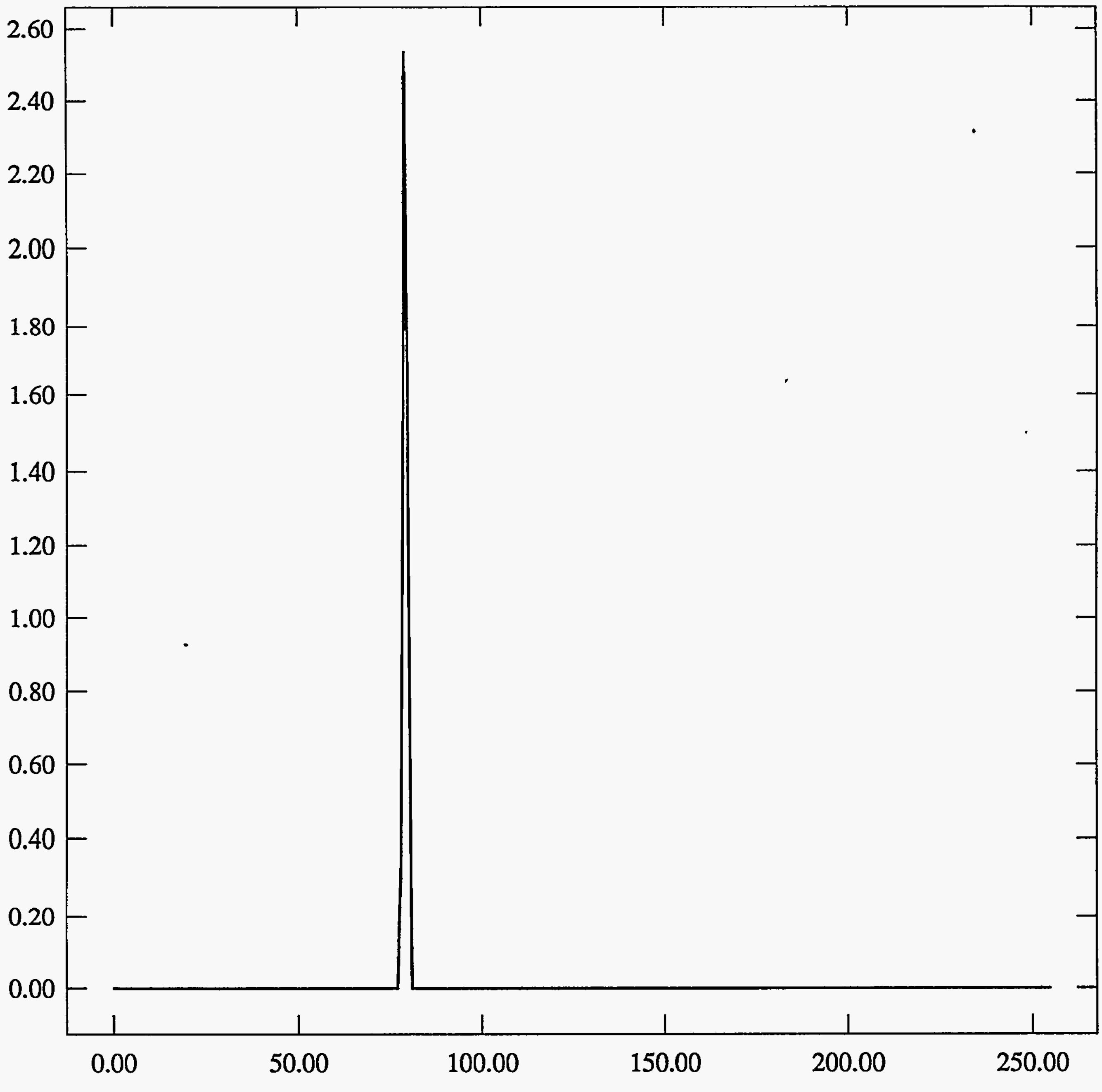
ST Camera: ST1#04-10 -30C #1: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 06:05:23 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.33 x 10^3



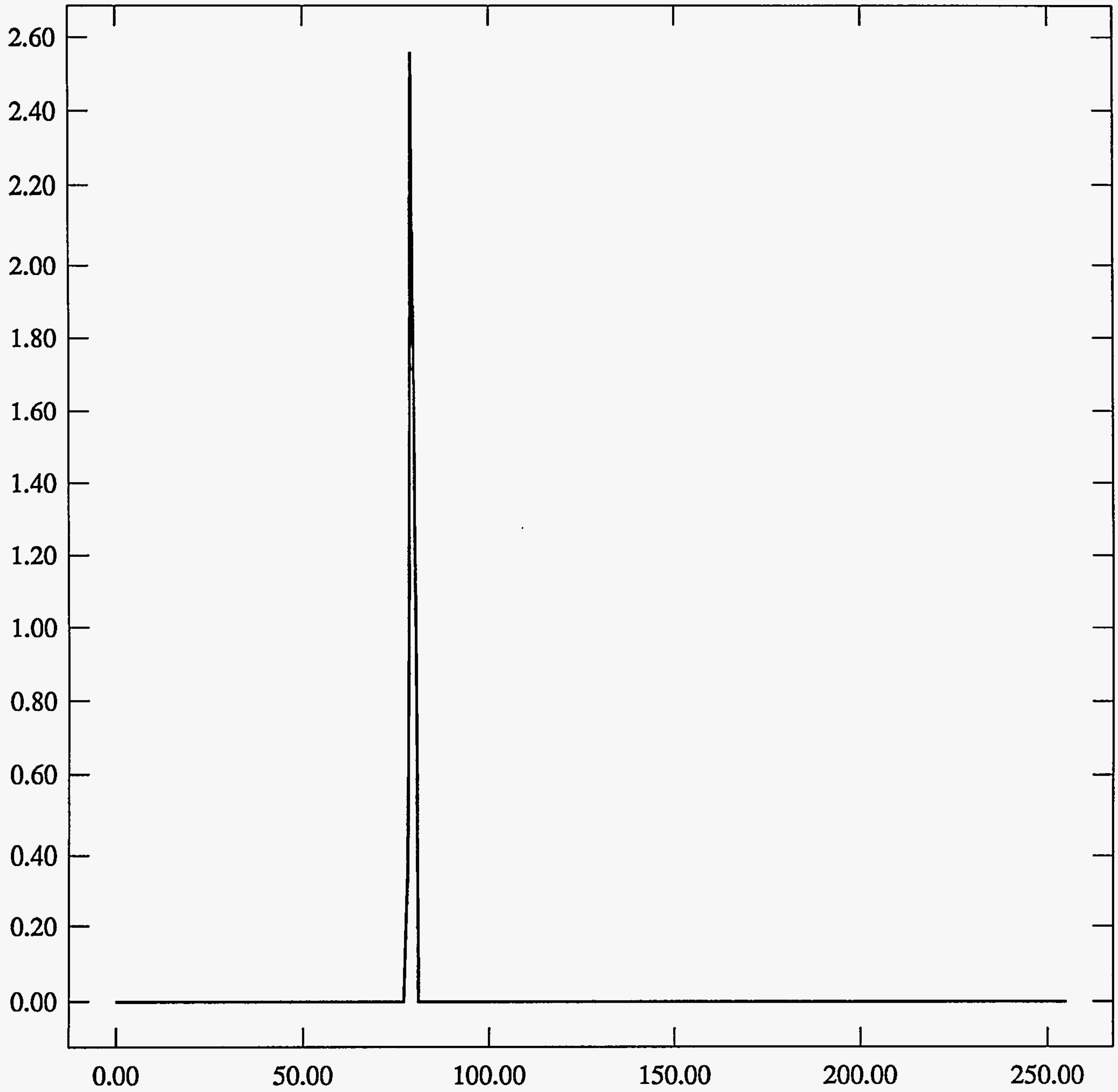
ST Camera: ST1#04-10 -30C #1: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 06:06:27 1993

Pixel Values Min 78 Max 80 Mean 79.2 Sigma 0.58 x 10^3



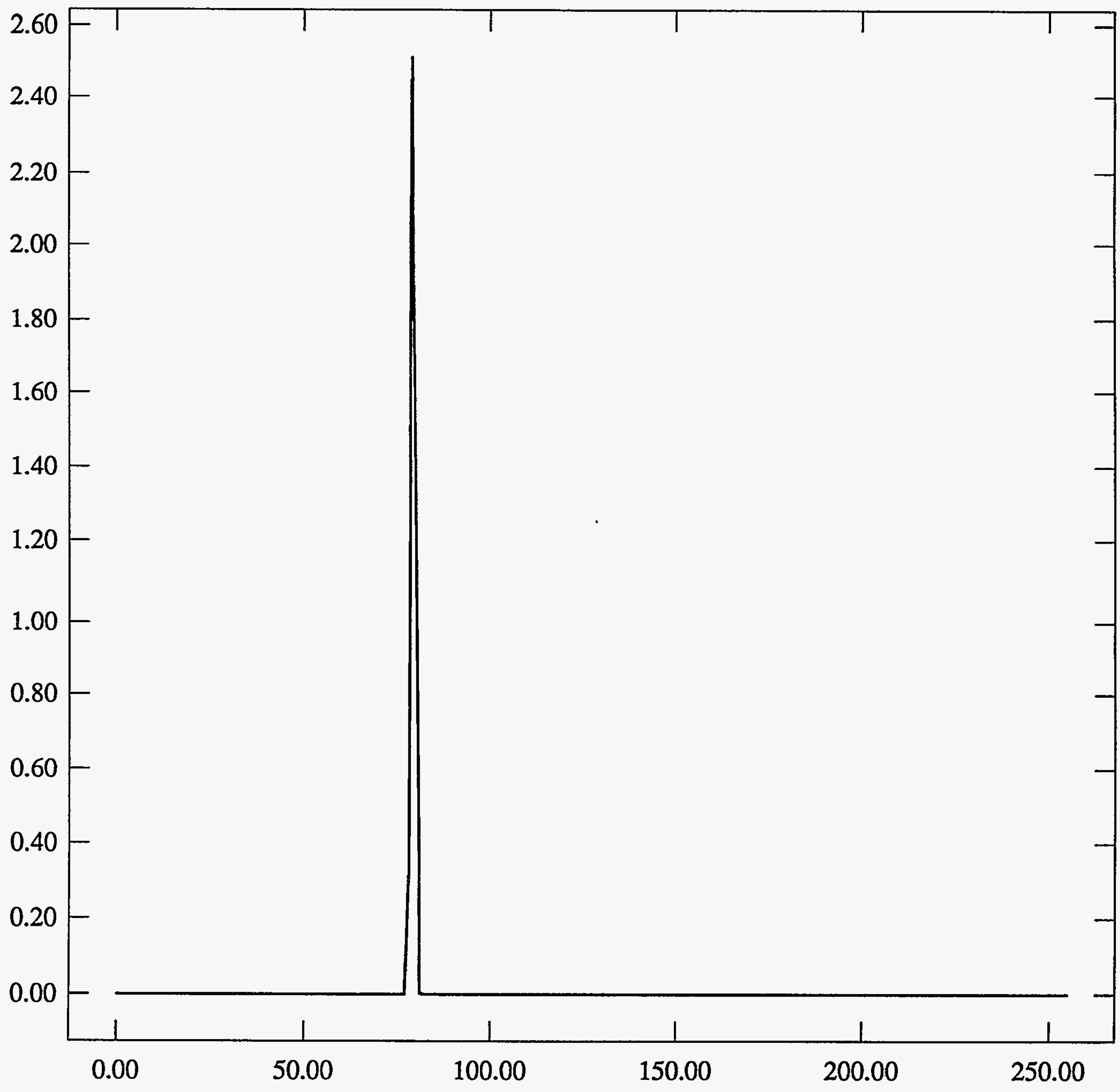
ST Camera: ST1#04-10 -30C #1: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 06:06:54 1993

Pixel Values Min 78 Max 80 Mean 79.2 Sigma 0.57 x 10^3



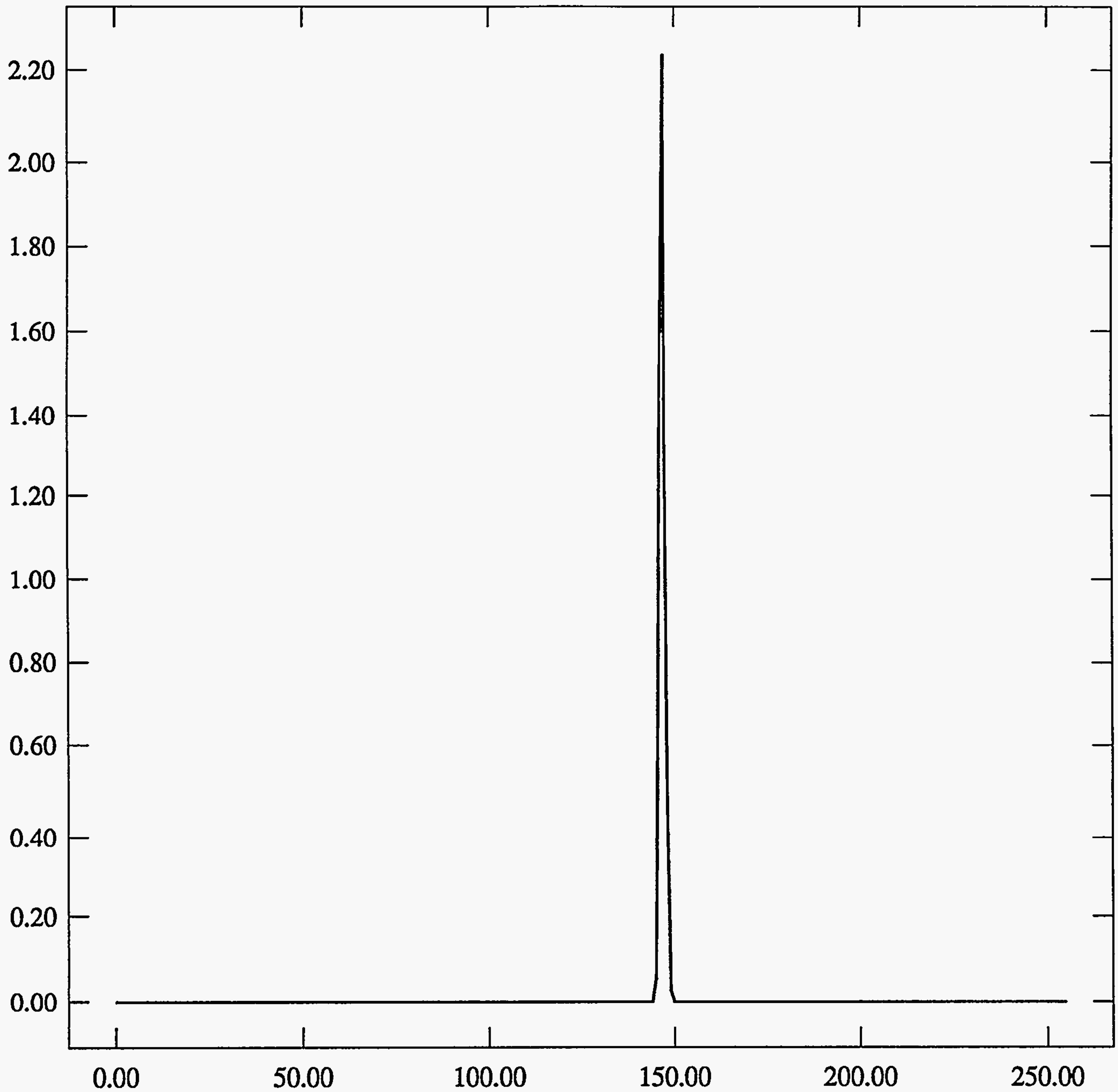
ST Camera: ST1#04-10 -30C #1: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 06:08:14 1993

Pixel Values Min 78 Max 81 Mean 79.2 Sigma 0.58 x 10^3



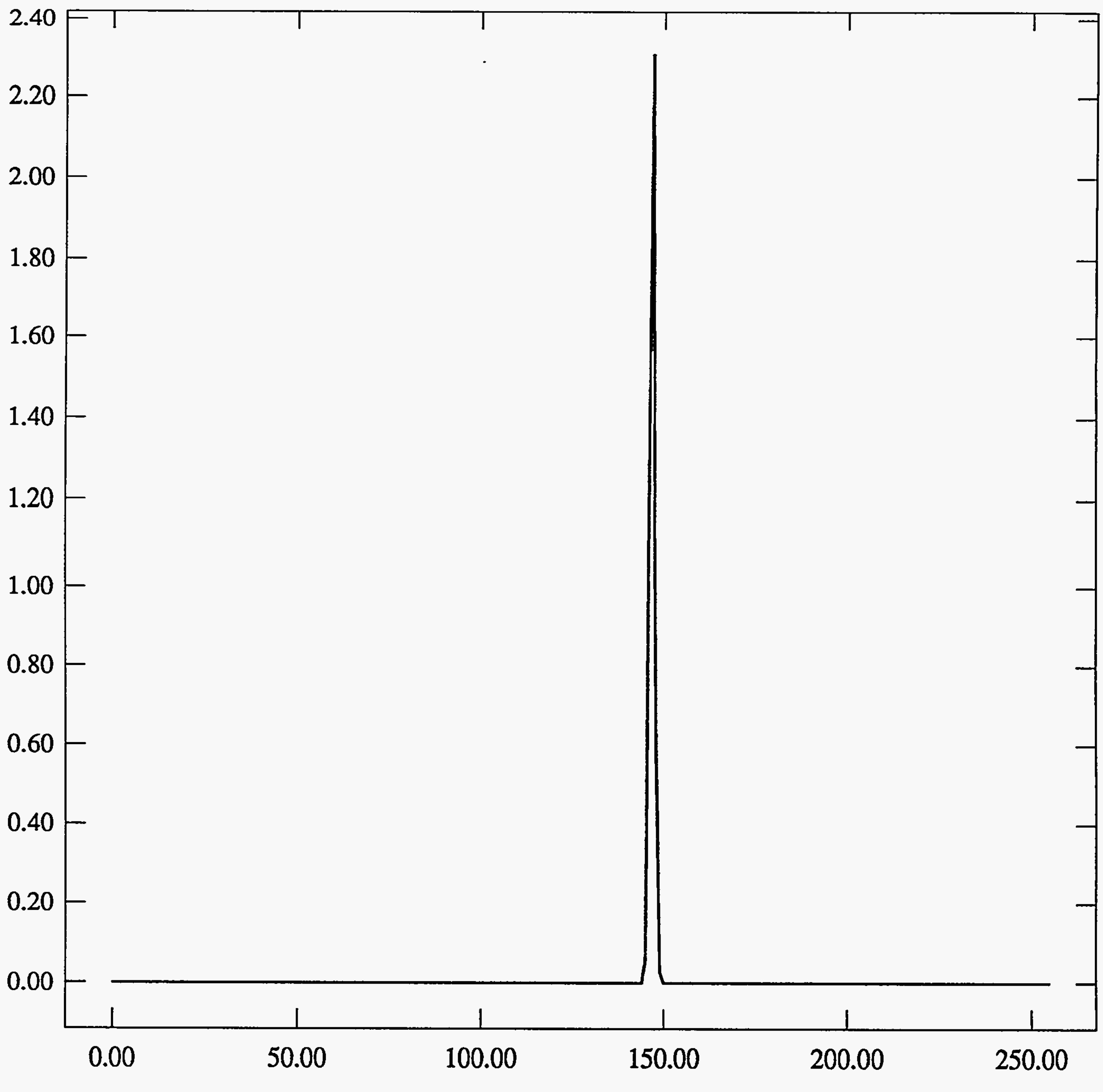
ST Camera: ST1#04-10 -30C #1: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 06:08:38 1993

Pixel Values Min 145 Max 149 Mean 146.8 Sigma 0.69 x 10^3



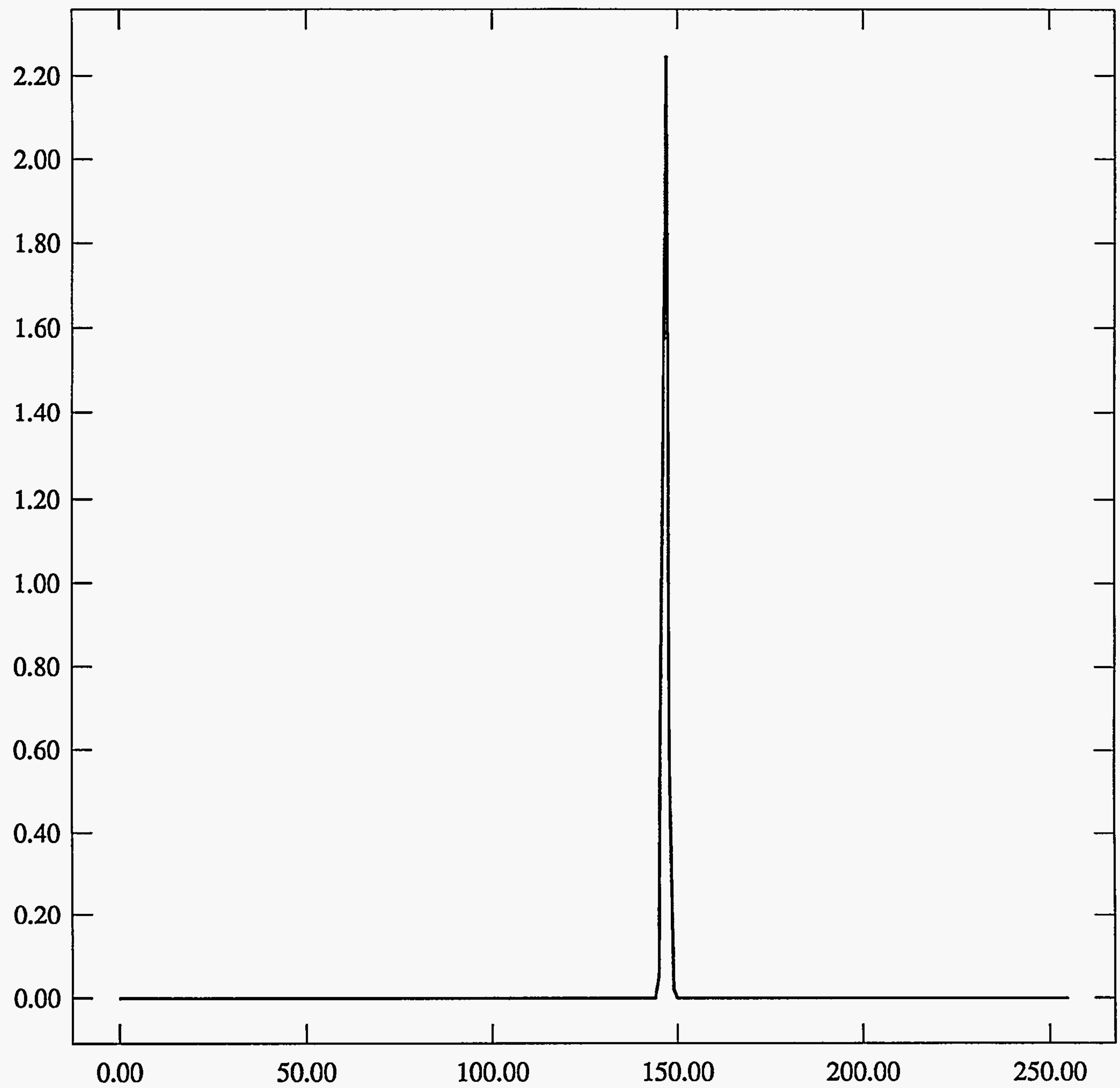
ST Camera: ST1#04-10 -30C #1: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 06:09:12 1993

Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.69 x 10^3



ST Camera: ST1#04-10 -30C #1: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 06:09:43 1993

Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.69 x 10^3

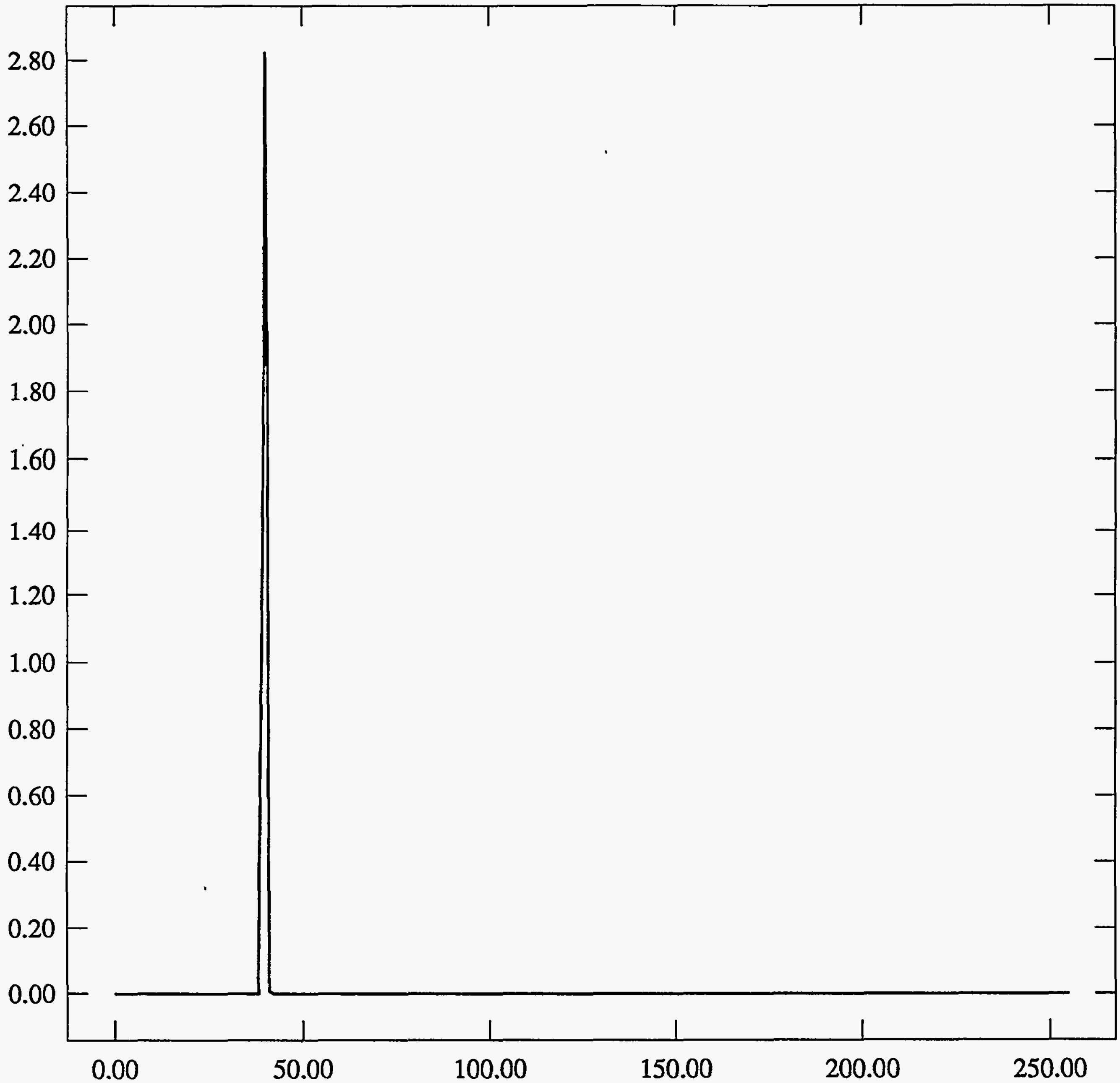


#1 - 30

END OF CYCLE.

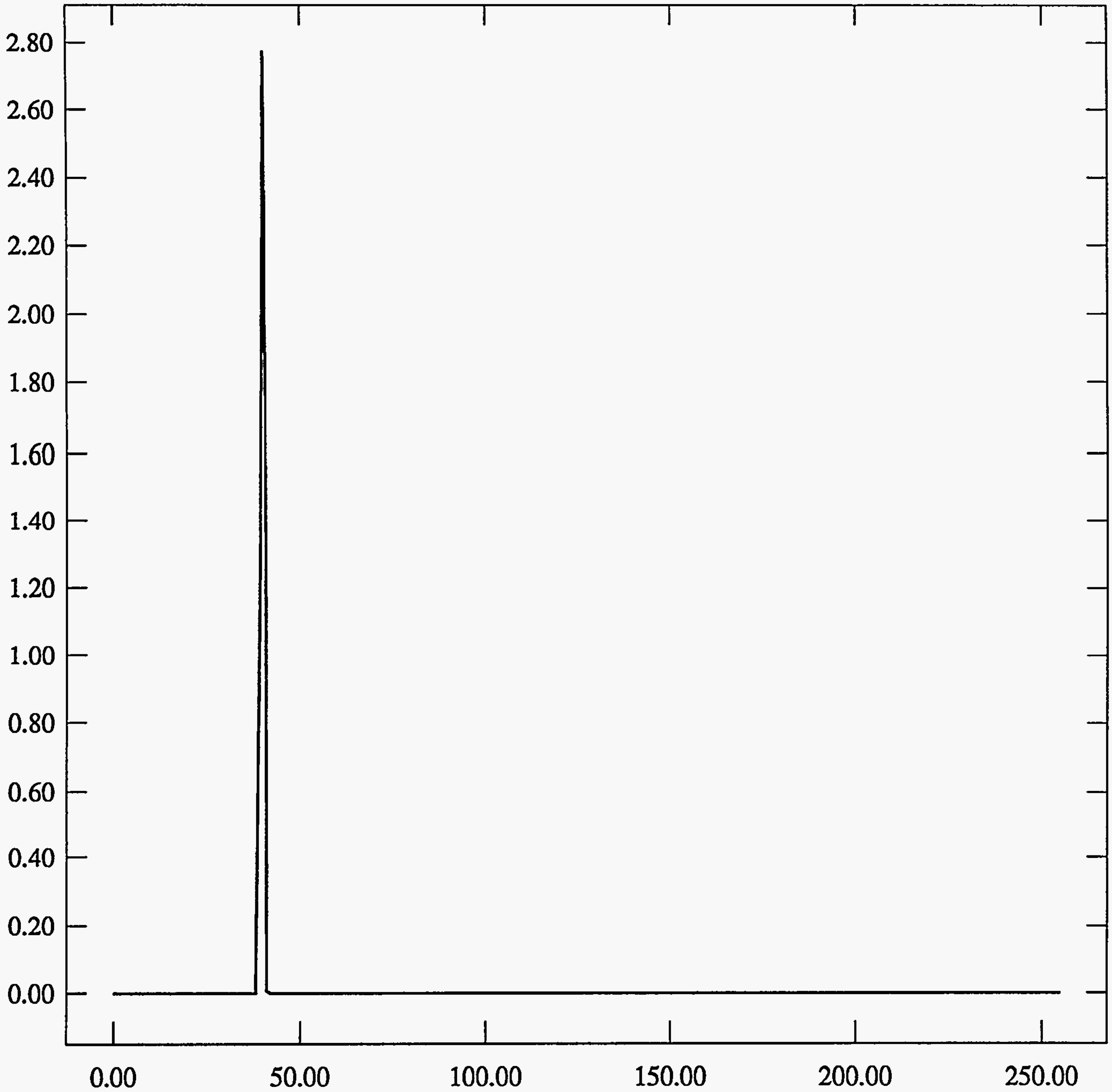
ST Camera: ST1#04-10 -30C #1: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 06:48:28 1993

Pixel Values Min 39 Max 41 Mean 39.7 Sigma 0.46 x 10^3



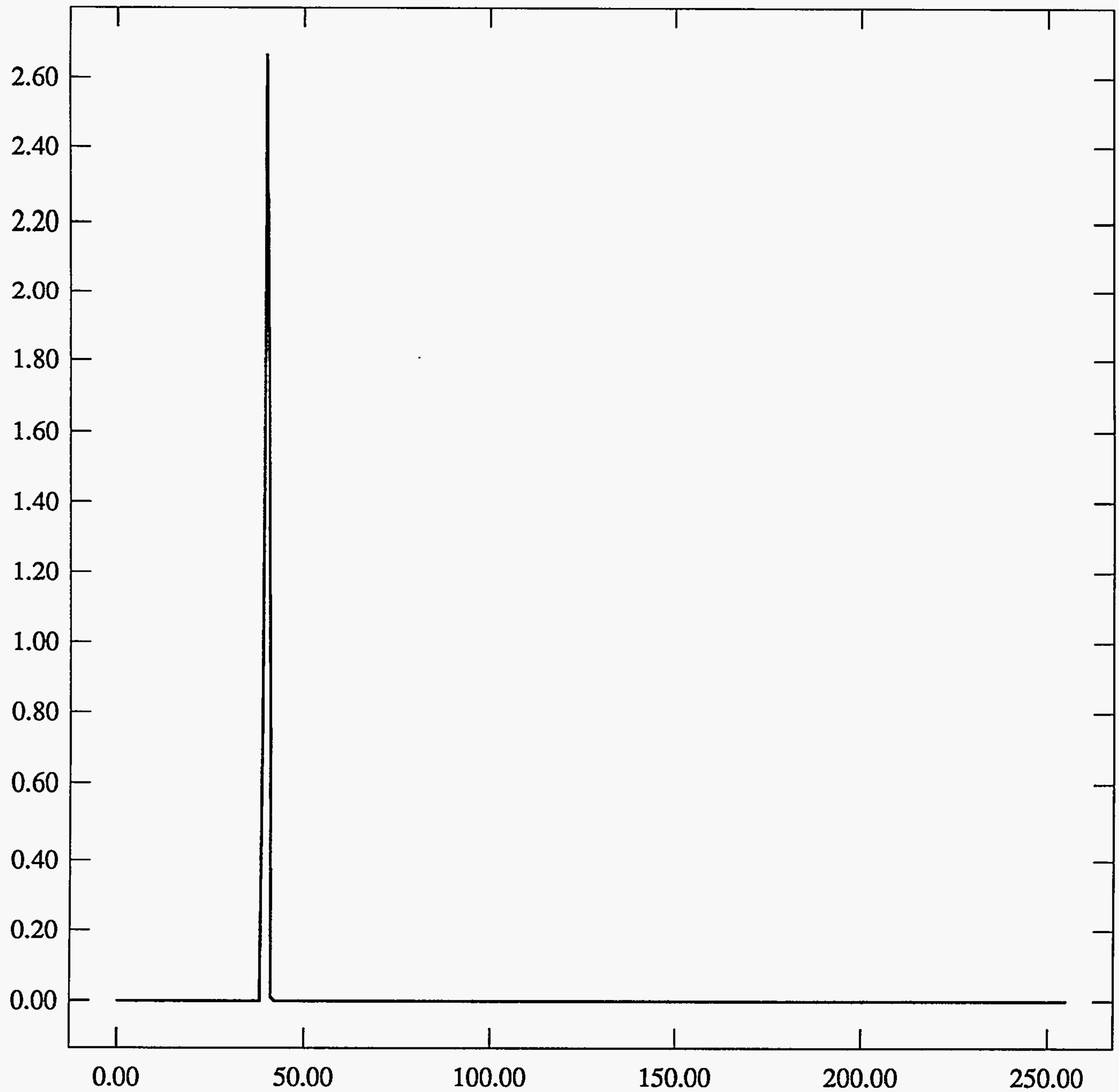
ST Camera: ST1#04-10 -30C #1: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 06:48:50 1993

Pixel Values Min 39 Max 41 Mean 39.7 Sigma 0.47 x 10^3



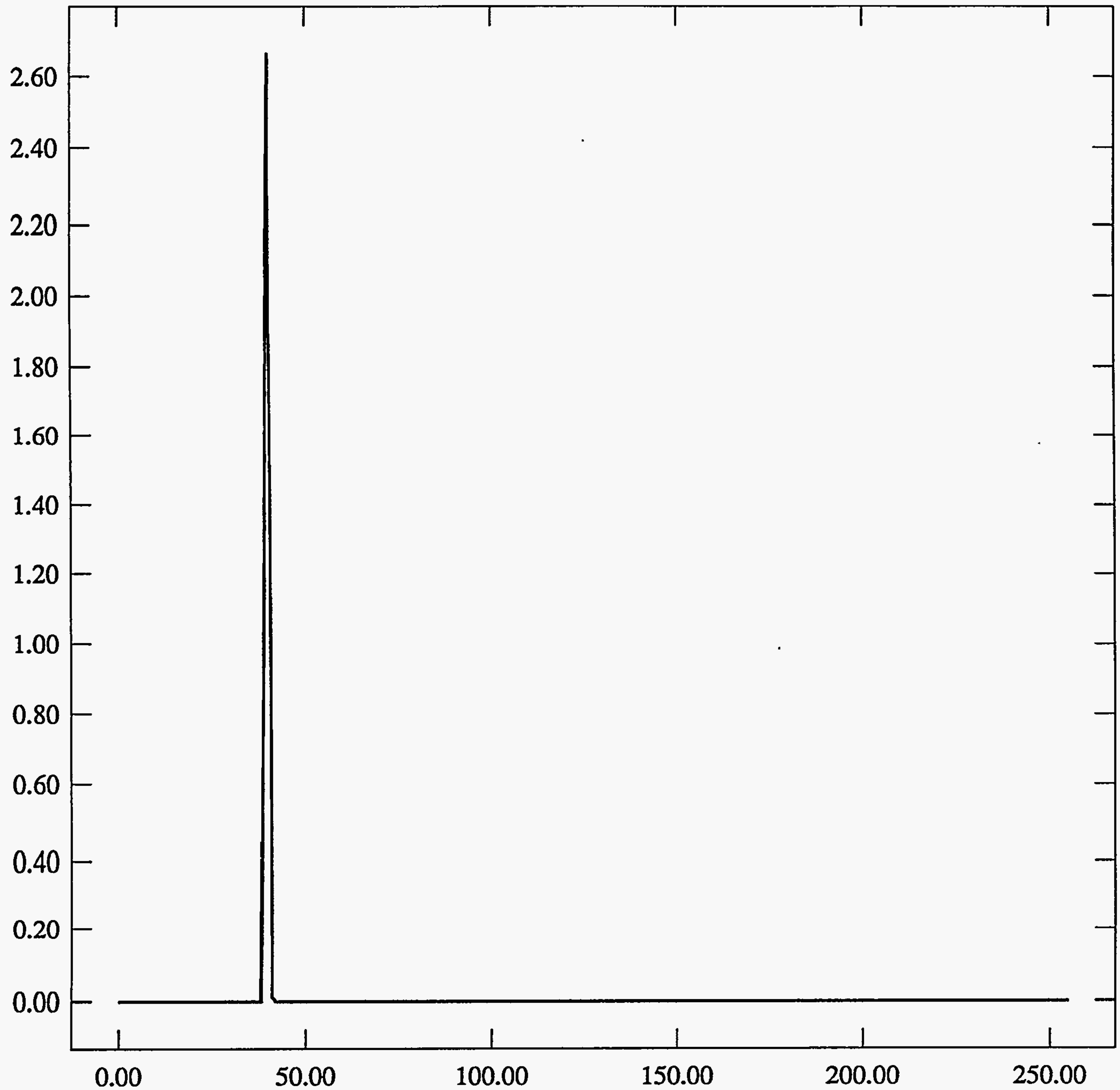
ST Camera: ST1#04-10 -30C #1: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 06:49:31 1993

Pixel Values Min 39 Max 41 Mean 39.7 Sigma 0.48 x 10^3



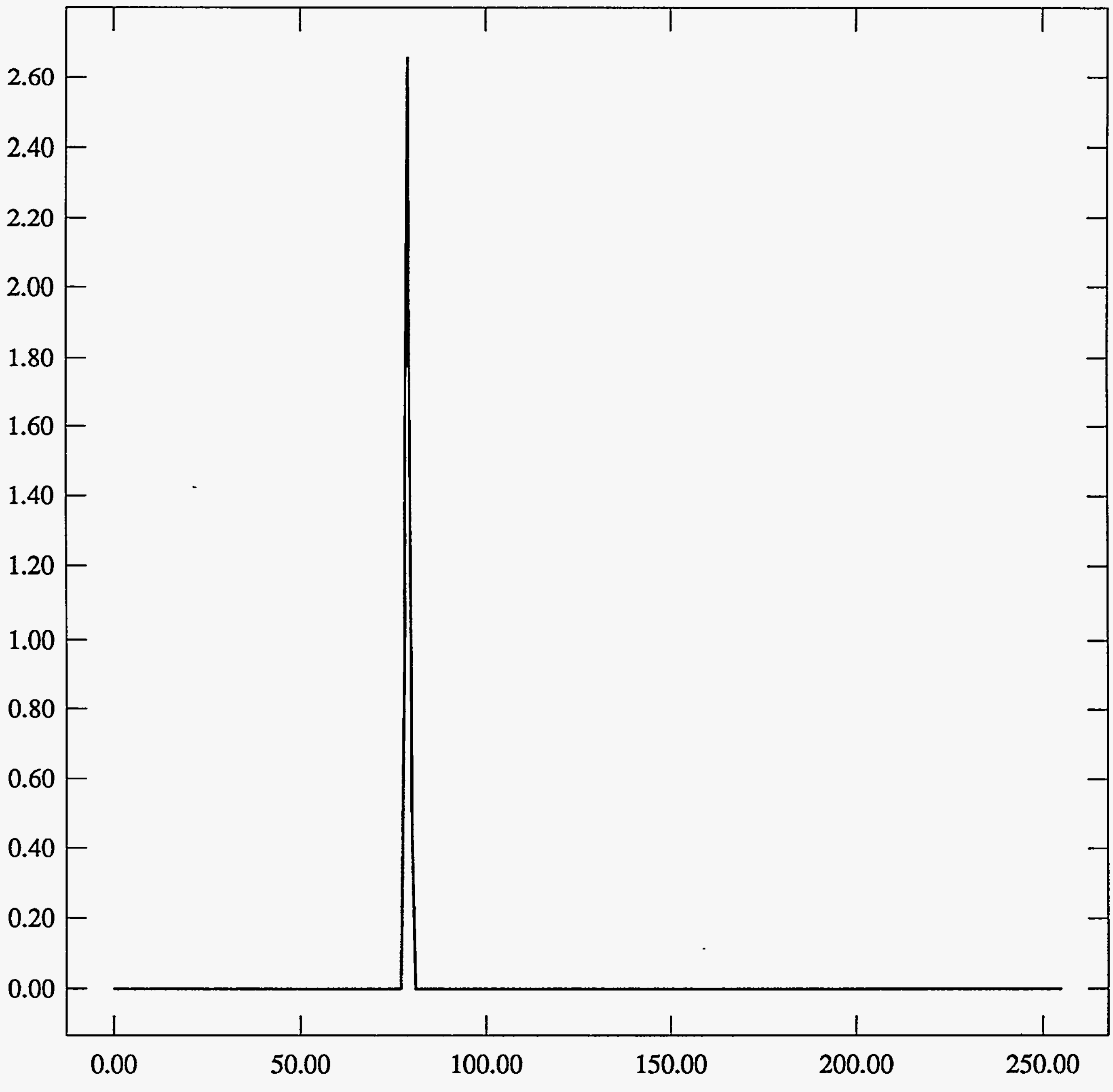
ST Camera: ST1#04-10 -30C #1: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 06:49:31 1993

Pixel Values Min 39 Max 41 Mean 39.7 Sigma 0.48 x 10^3



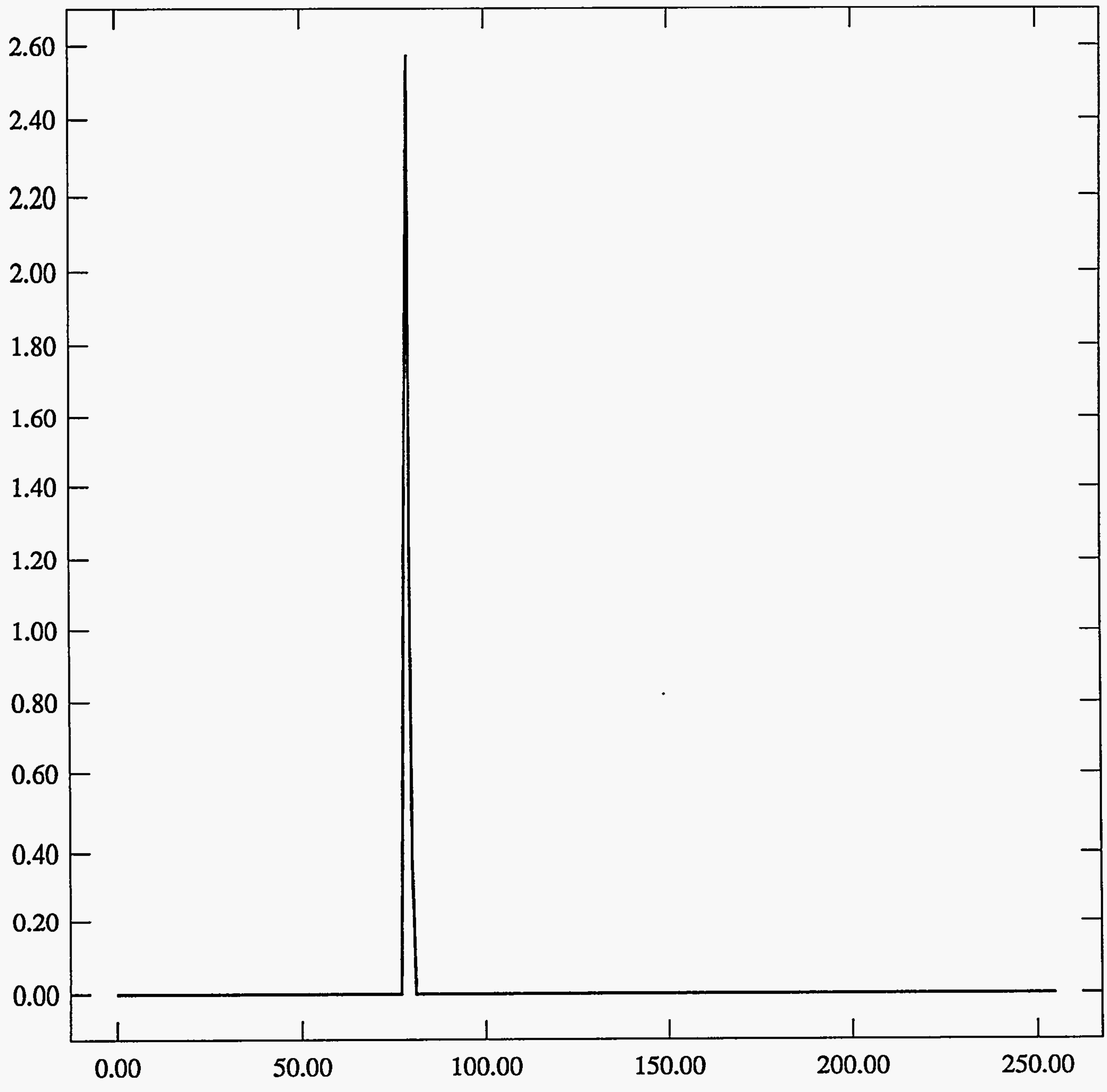
ST Camera: ST1#04-10 -30C #1: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 06:50:08 1993

Pixel Values Min 77 Max 80 Mean 78.9 Sigma 0.57 x 10^3



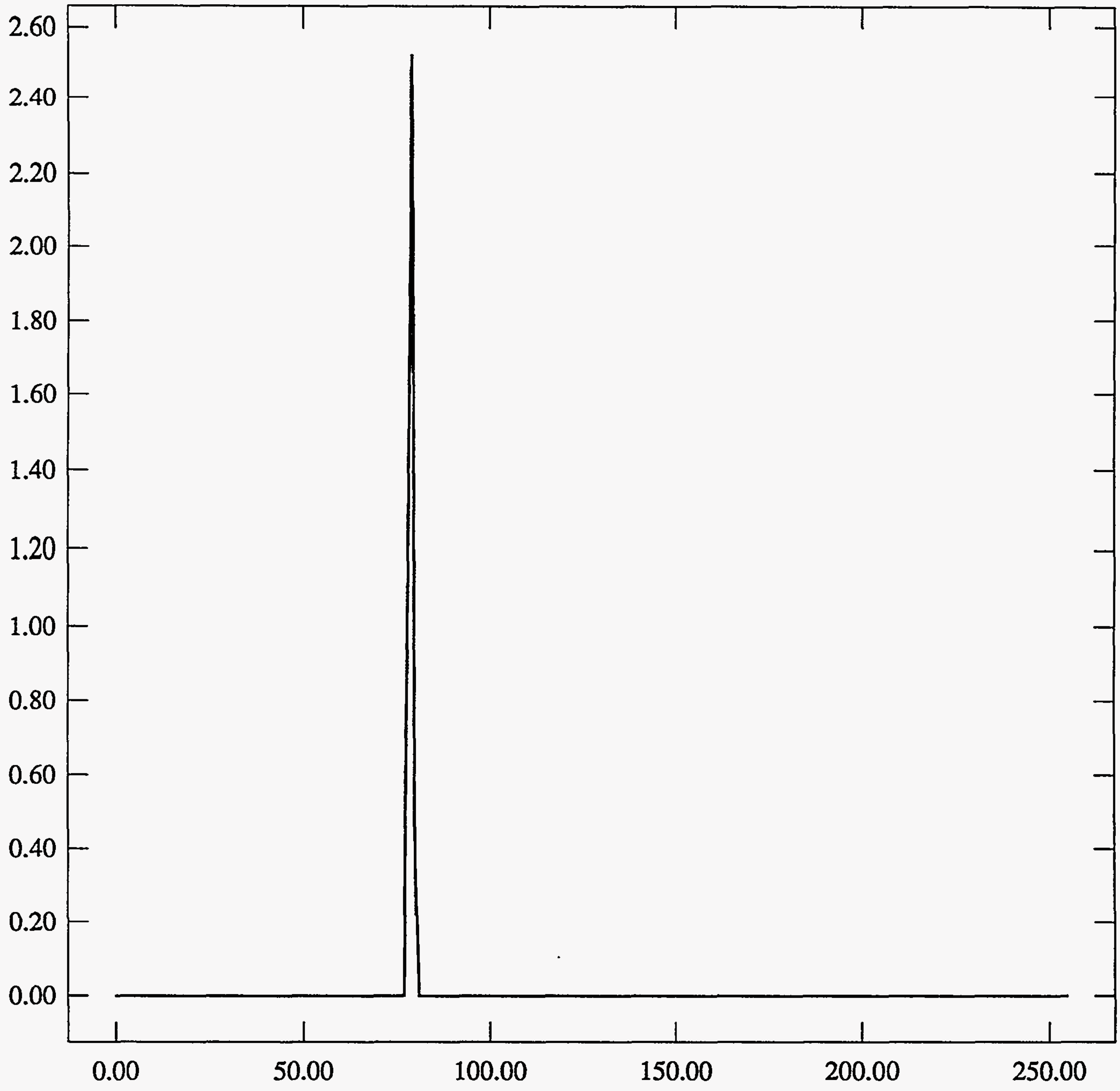
ST Camera: ST1#04-10 -30C #1: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 06:51:06 1993

Pixel Values Min 78 Max 80 Mean 78.8 Sigma 0.58 x 10^3



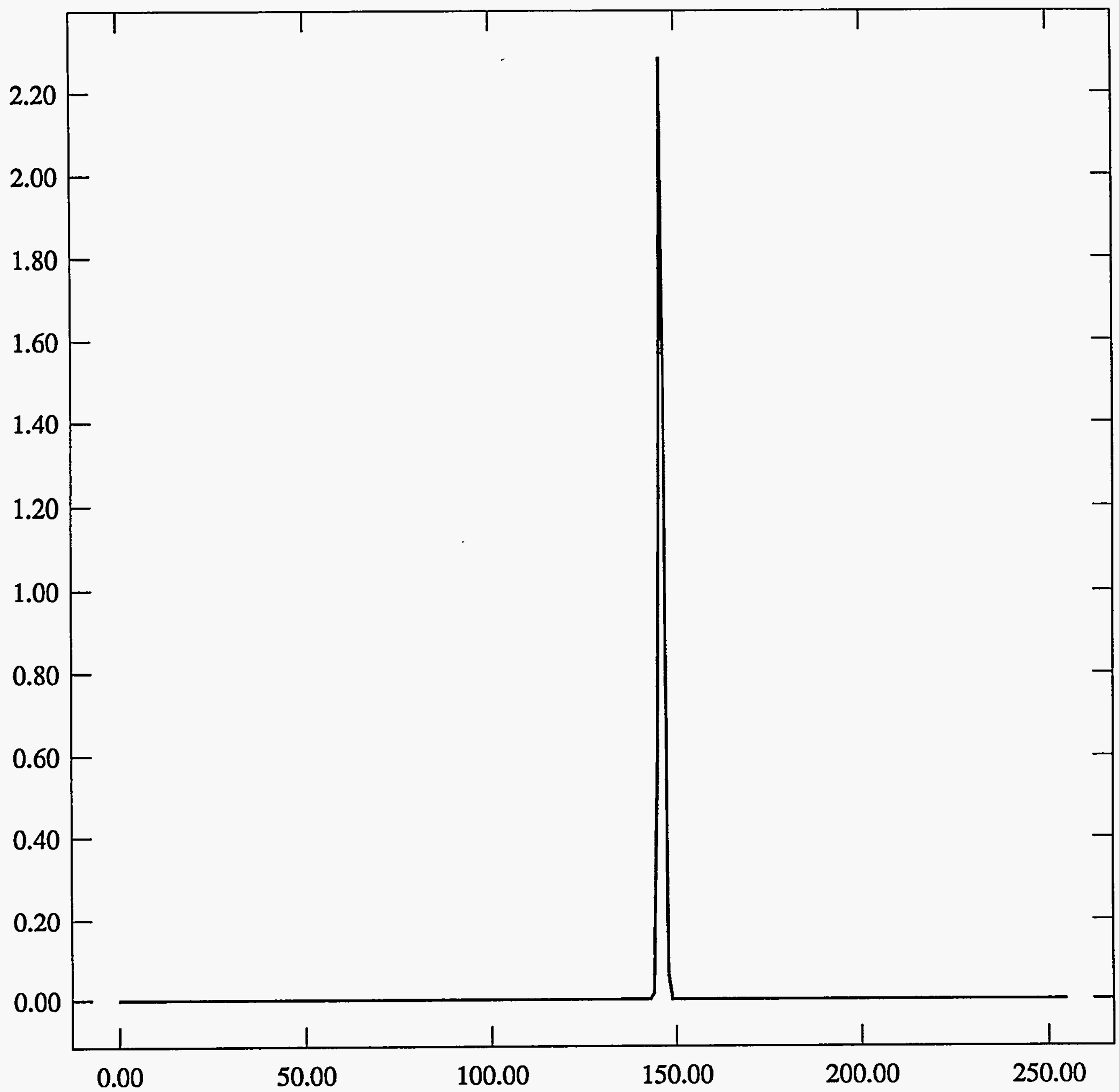
ST Camera: ST1#04-10 -30C #1: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 06:51:36 1993

Pixel Values Min 77 Max 80 Mean 78.8 Sigma 0.58 x 10^3



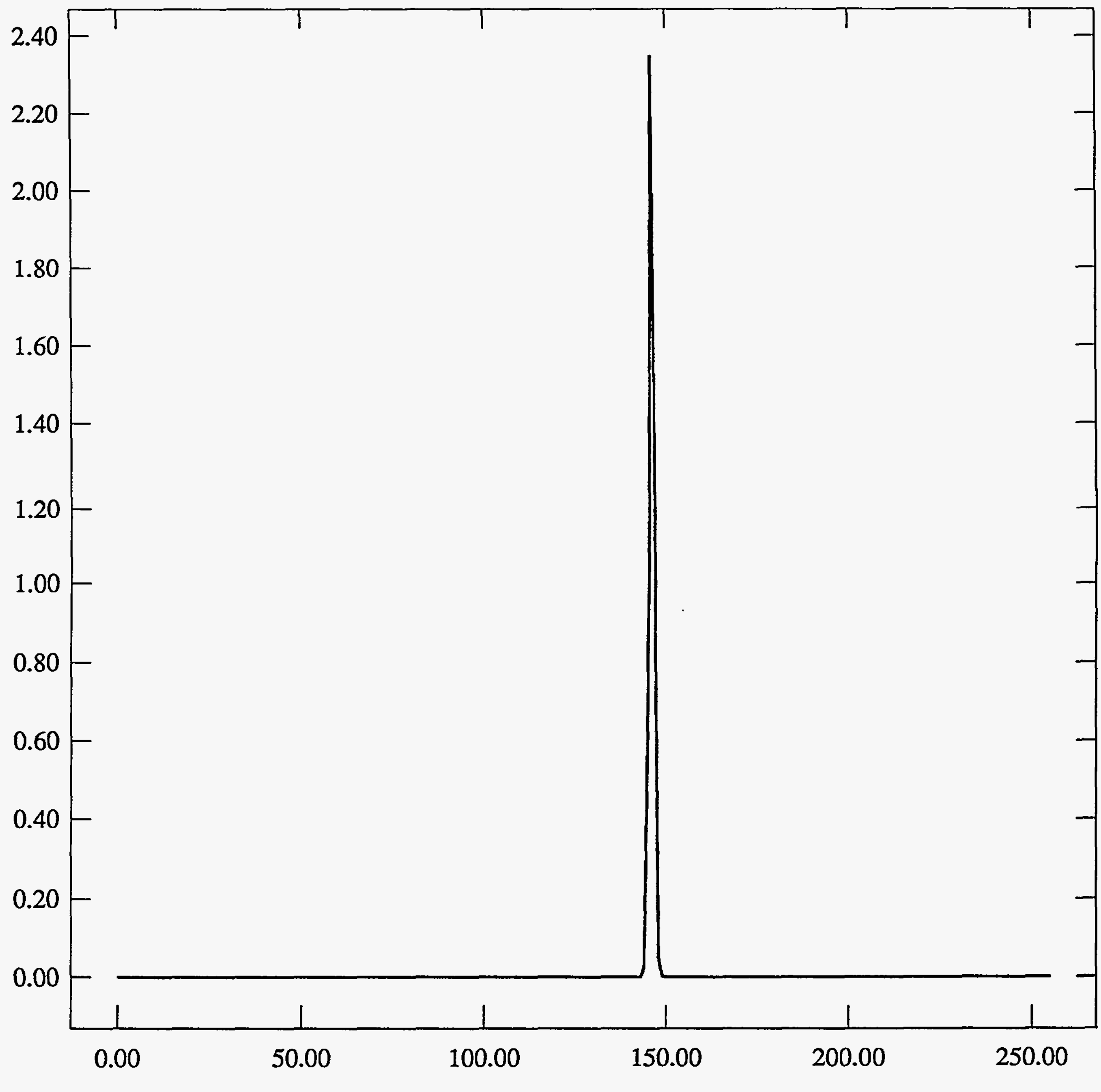
ST Camera: ST1#04-10 -30C #1: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 06:52:09 1993

Pixel Values Min 144 Max 148 Mean 146.2 Sigma 0.68 x 10^3



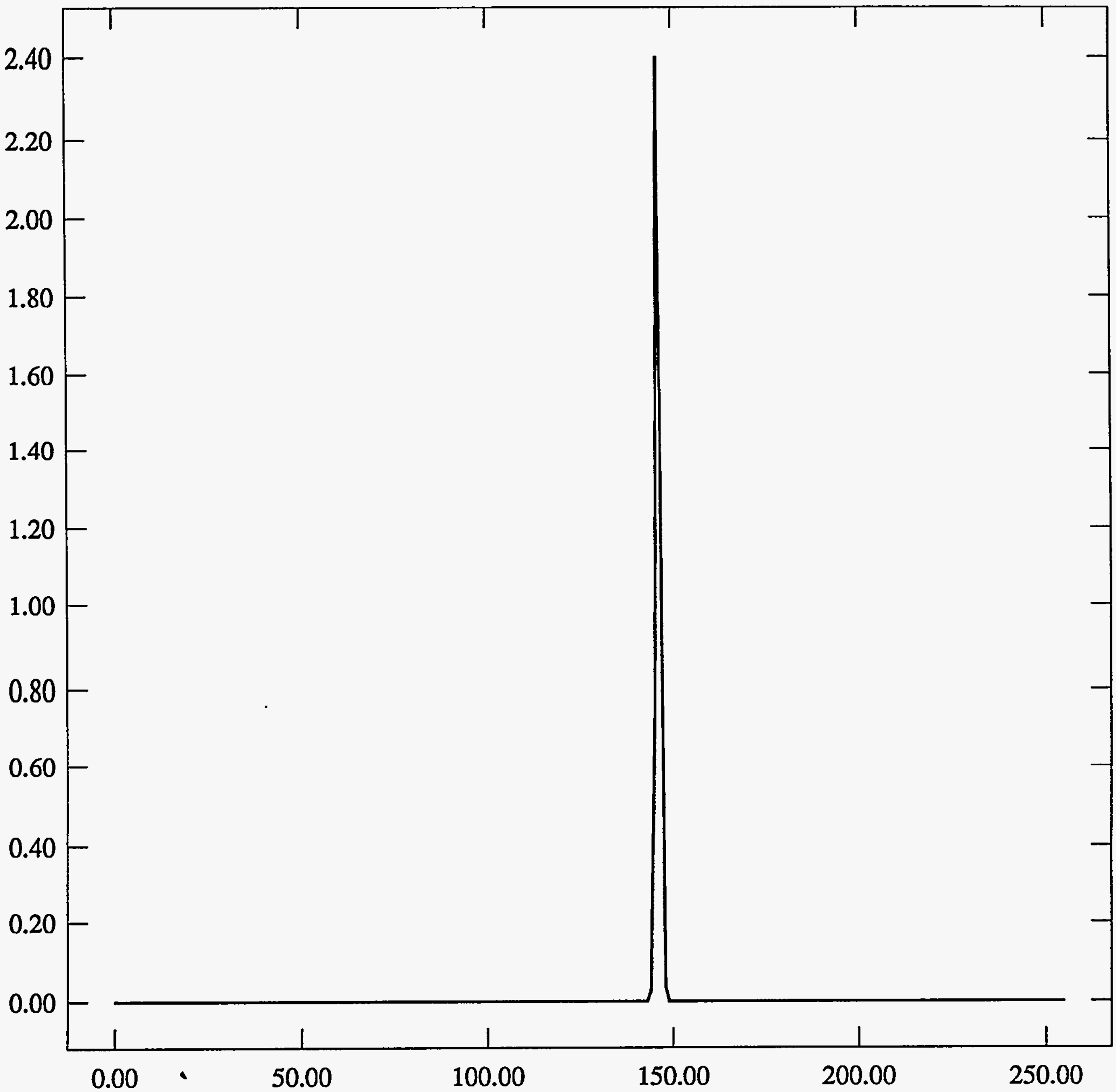
ST Camera: ST1#04-10 -30C #1: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 06:52:40 1993

Pixel Values Min 144 Max 149 Mean 146.1 Sigma 0.68 x 10^3



ST Camera: ST1#04-10 -30C #1: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 06:53:17 1993

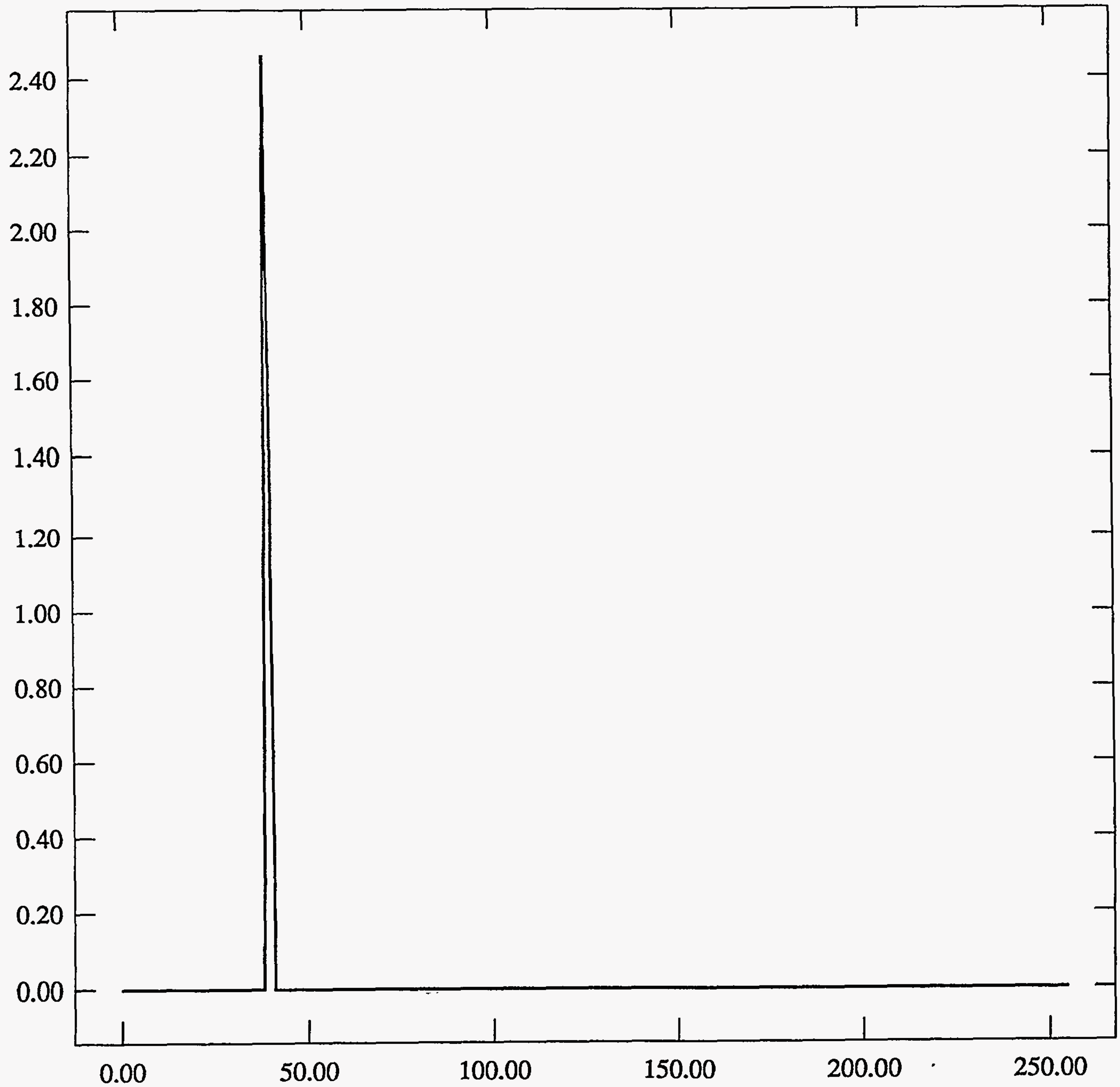
Pixel Values Min 144 Max 148 Mean 146.0 Sigma 0.67 x 10^3

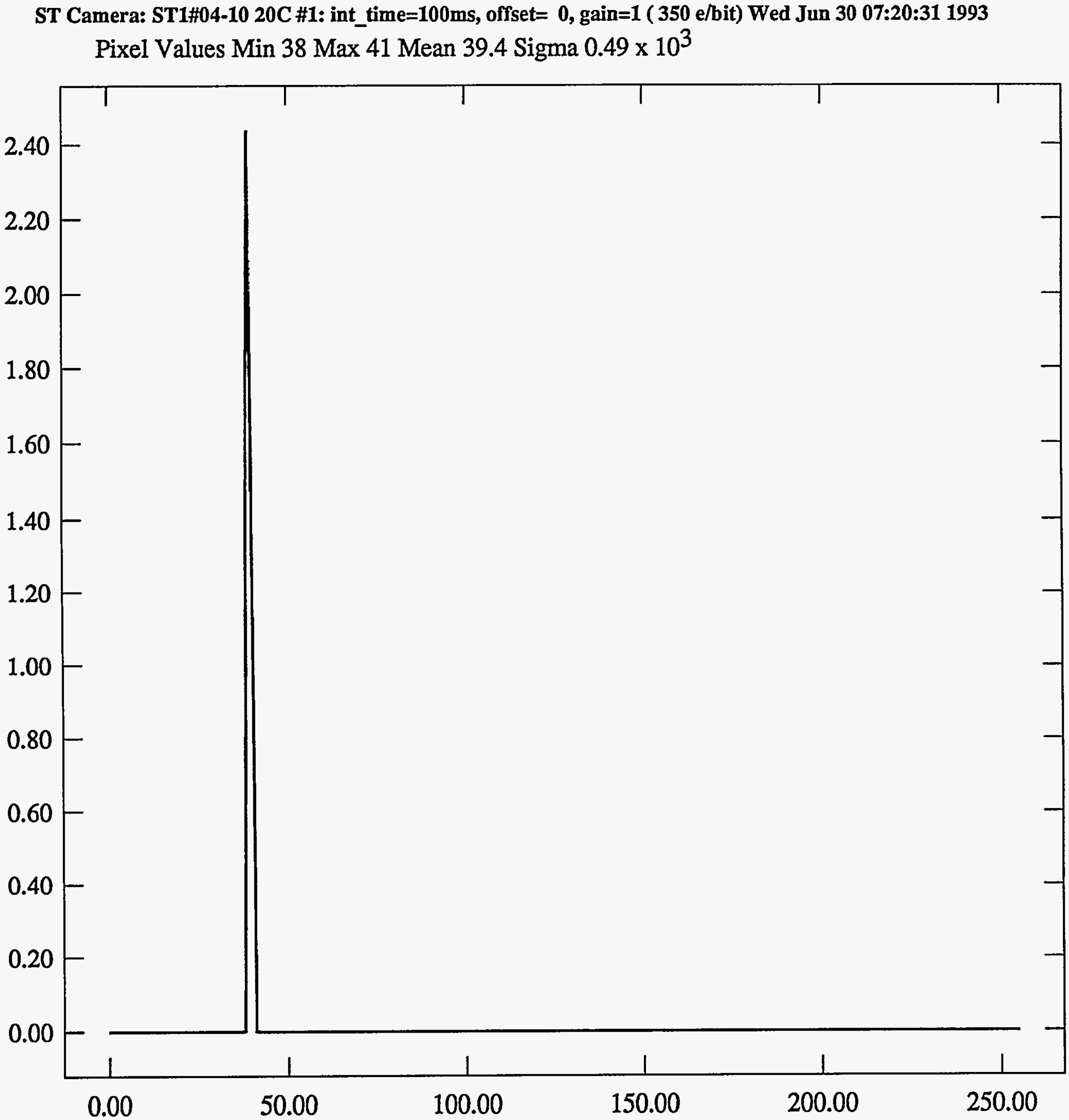


#1 20°C +15MIN

ST Camera: ST1#04-10 20C #1: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 07:19:50 1993

Pixel Values Min 39 Max 40 Mean 39.4 Sigma 0.49 x 10^3

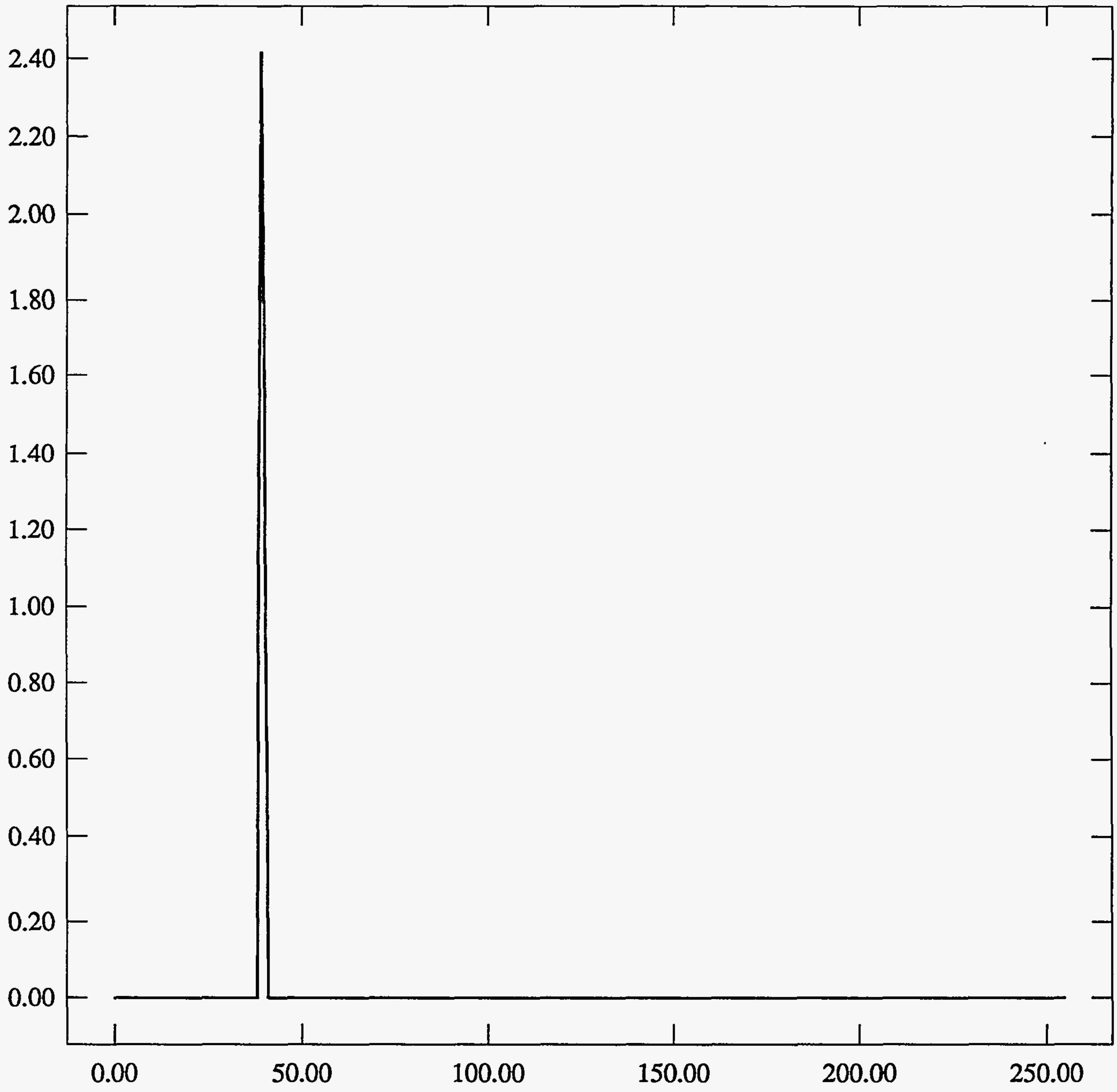




ST Camera: ST1#04-10 20C #1: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 07:20:31 1993
Pixel Values Min 38 Max 41 Mean 39.4 Sigma 0.49 x 10^3
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

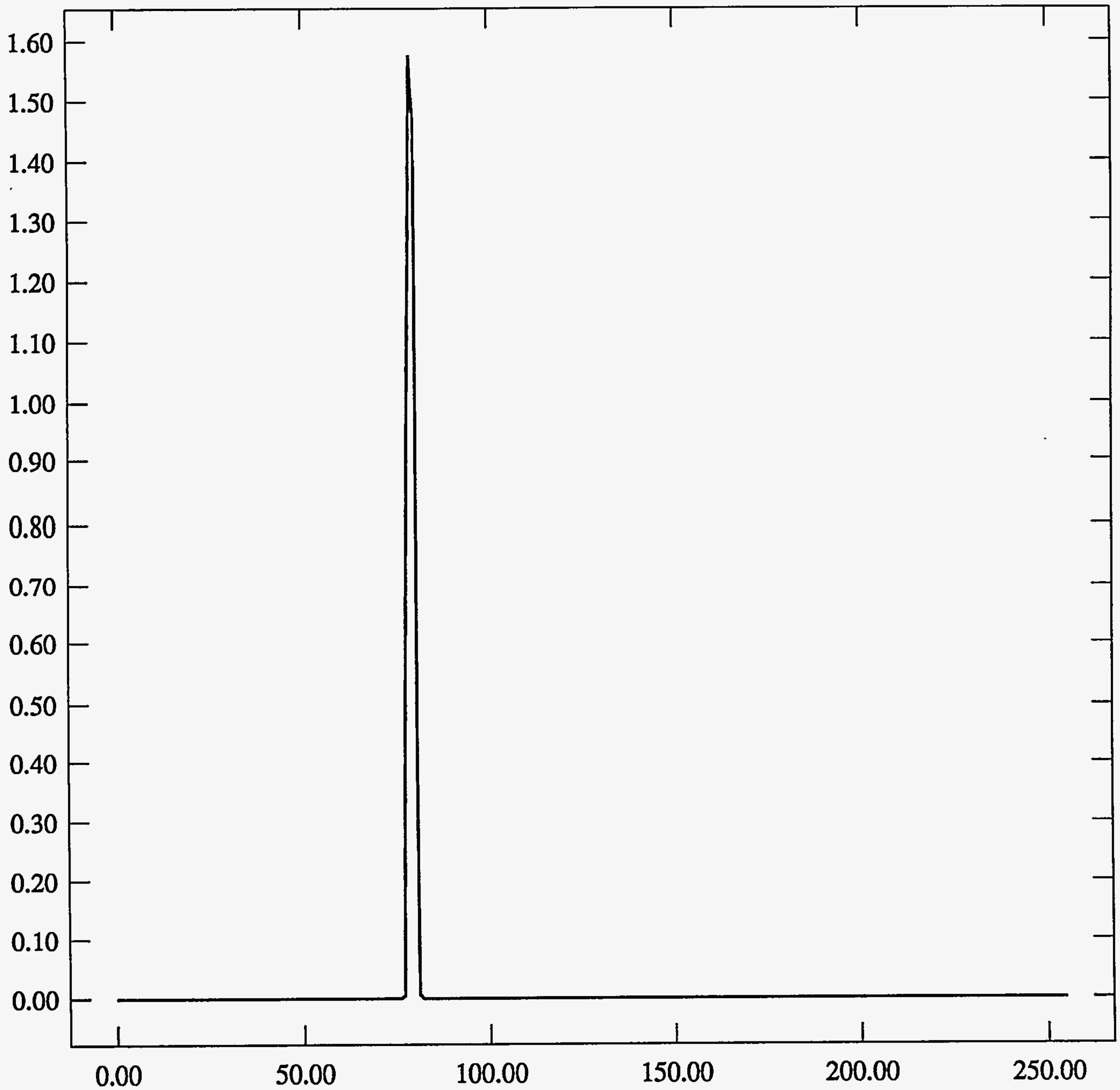
ST Camera: ST1#04-10 20C #1: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 07:21:00 1993

Pixel Values Min 39 Max 41 Mean 39.4 Sigma 0.49 x 10^3



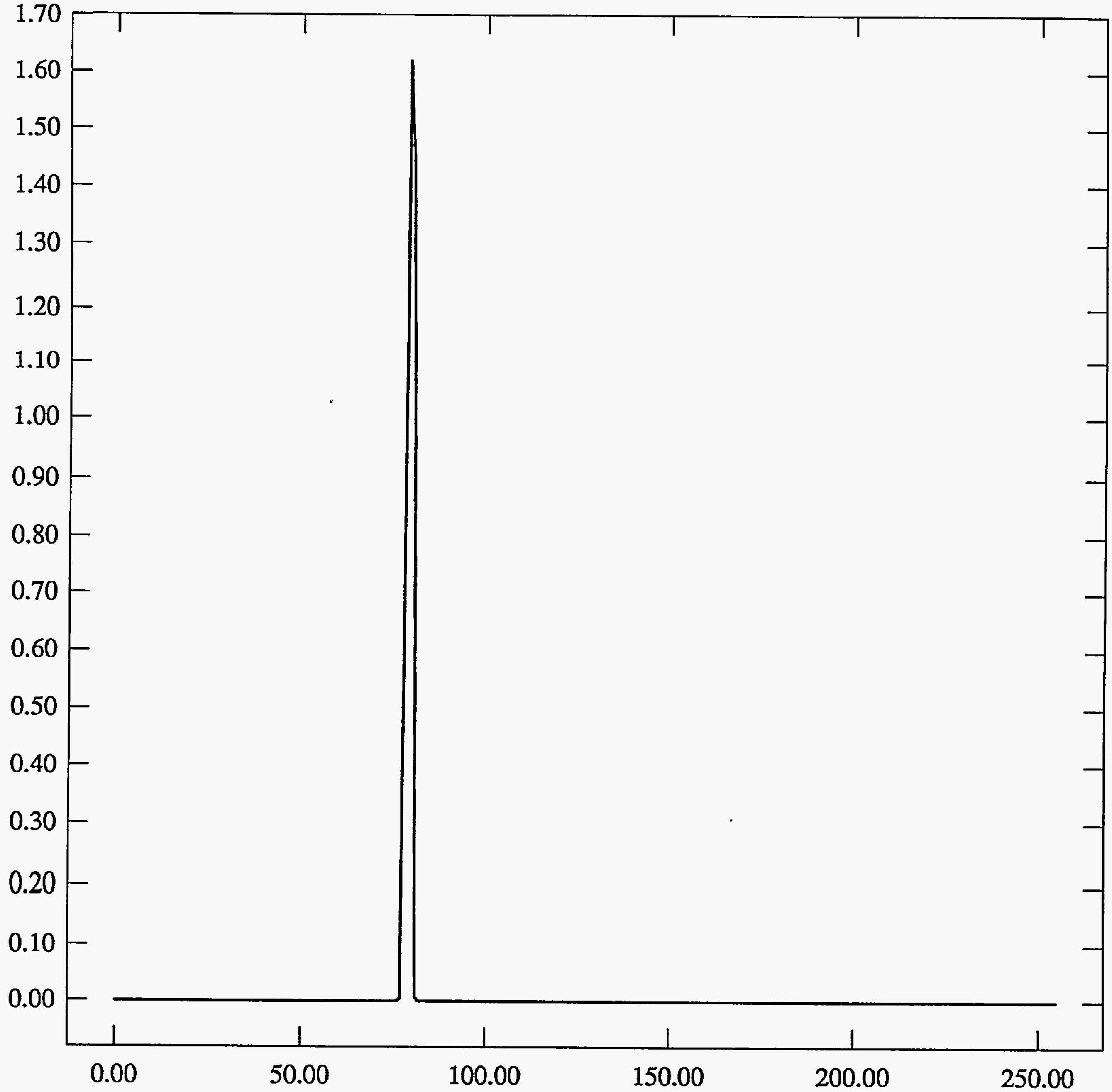
ST Camera: ST1#04-10 20C #1: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 07:21:50 1993

Pixel Values Min 77 Max 81 Mean 79.1 Sigma 0.78 x 10^3



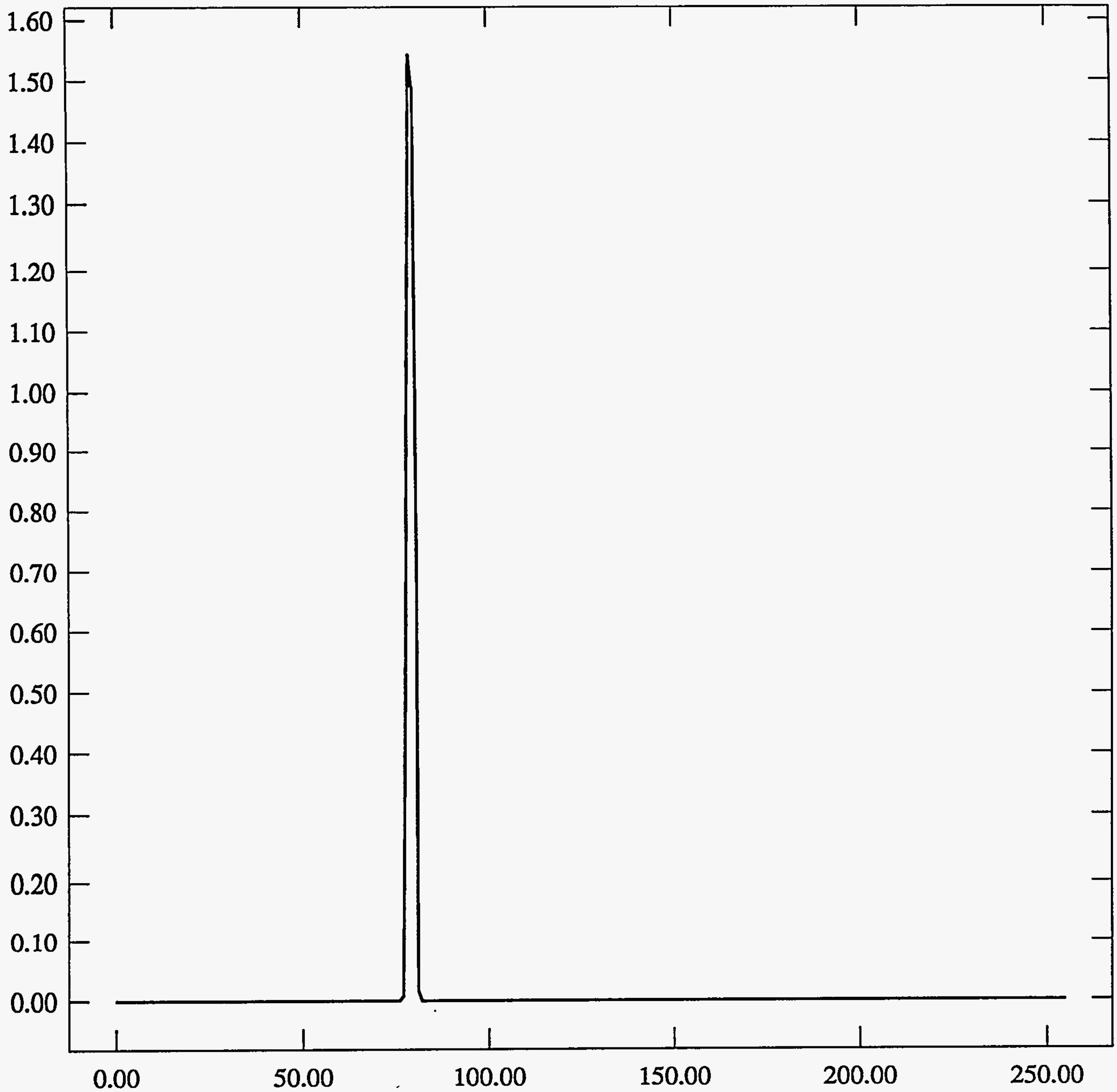
ST Camera: ST1#04-10 20C #1: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 07:22:45 1993

Pixel Values Min 77 Max 81 Mean 79.1 Sigma 0.77 x 10^3



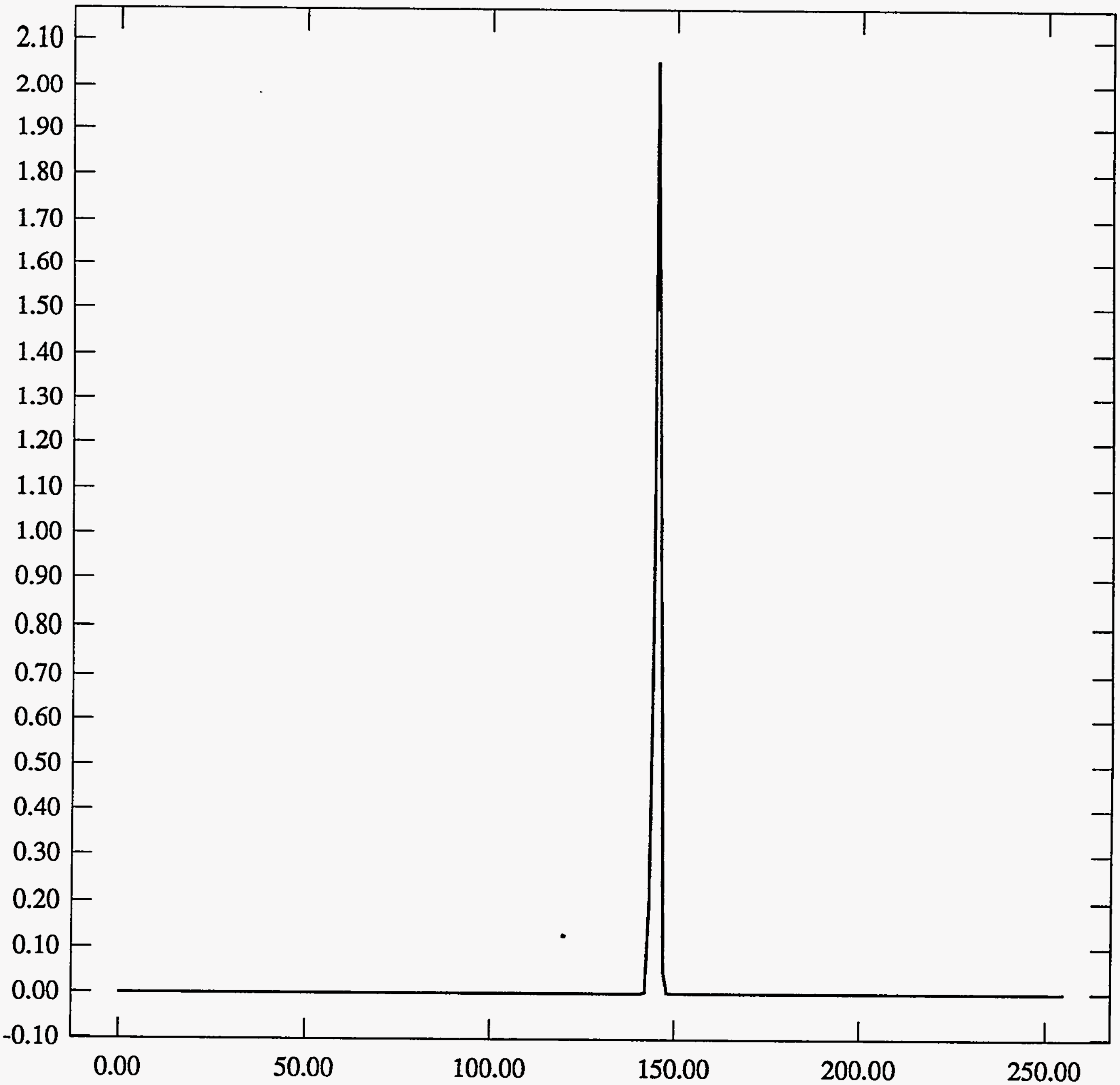
ST Camera: ST1#04-10 20C #1: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 07:23:07 1993

Pixel Values Min 77 Max 81 Mean 79.1 Sigma 0.79 x 10^3



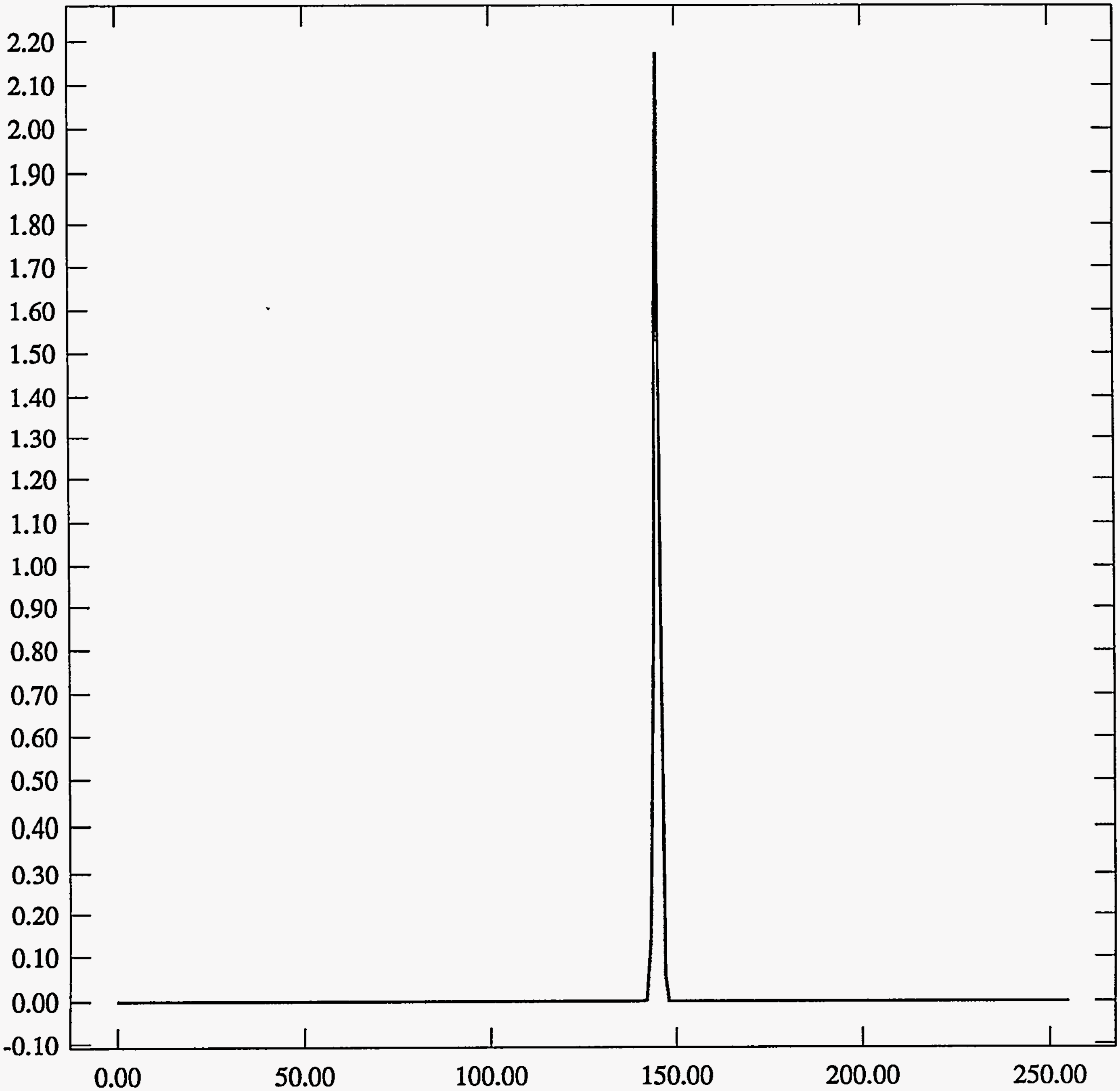
ST Camera: ST1#04-10 20C #1: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 07:23:33 1993

Pixel Values Min 142 Max 148 Mean 144.9 Sigma 0.82 x 10^3



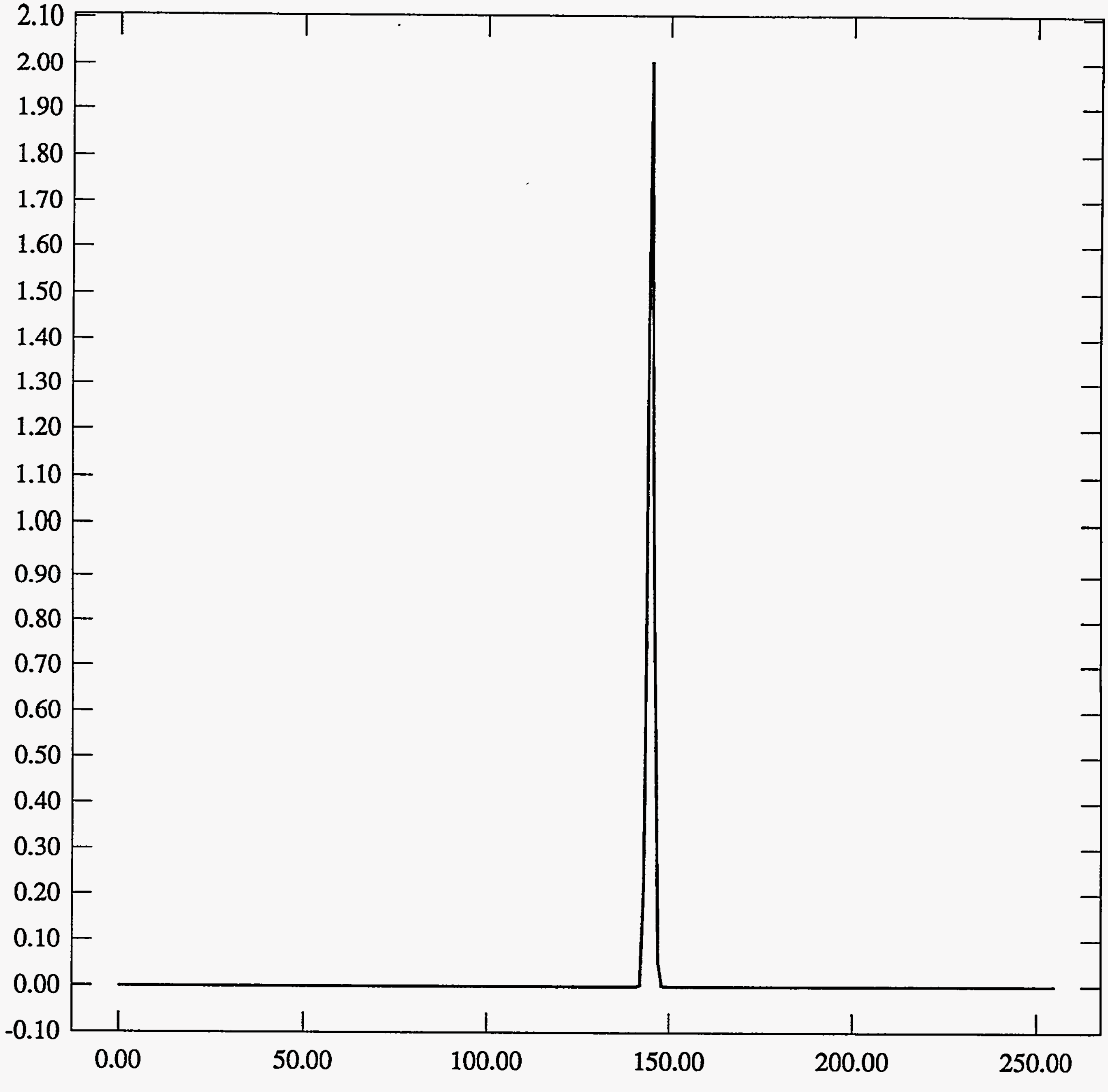
ST Camera: ST1#04-10 20C #1: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 07:24:02 1993

Pixel Values Min 142 Max 147 Mean 144.9 Sigma 0.78 x 10^3



ST Camera: ST1#04-10 20C #1: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 07:24:32 1993

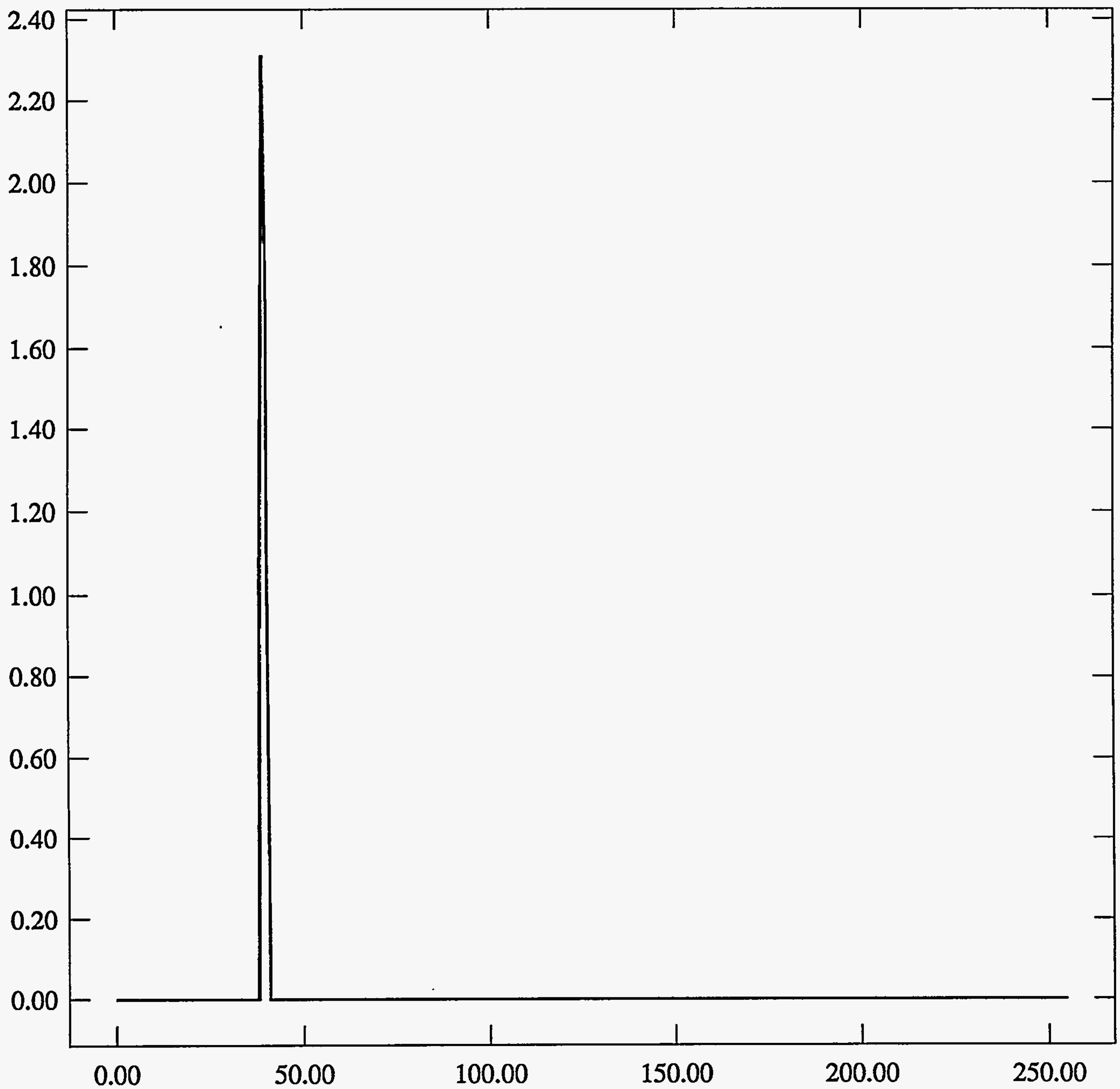
Pixel Values Min 142 Max 148 Mean 144.8 Sigma 0.83 x 10^3



#1 20 @ end of cycle

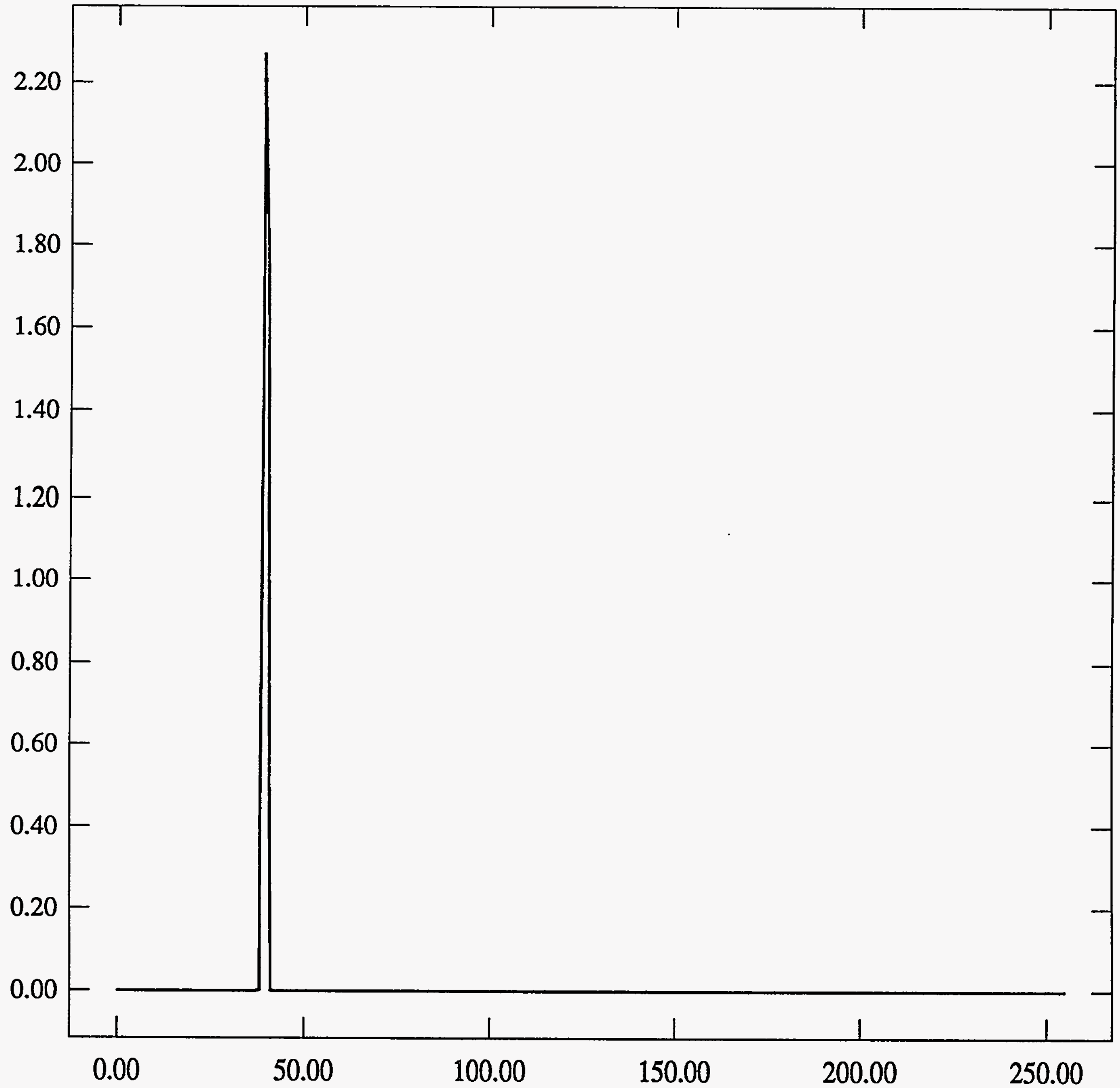
ST Camera: ST1#04-10 20C #1: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 07:59:47 1993

Pixel Values Min 39 Max 40 Mean 39.4 Sigma 0.49 x 10^3



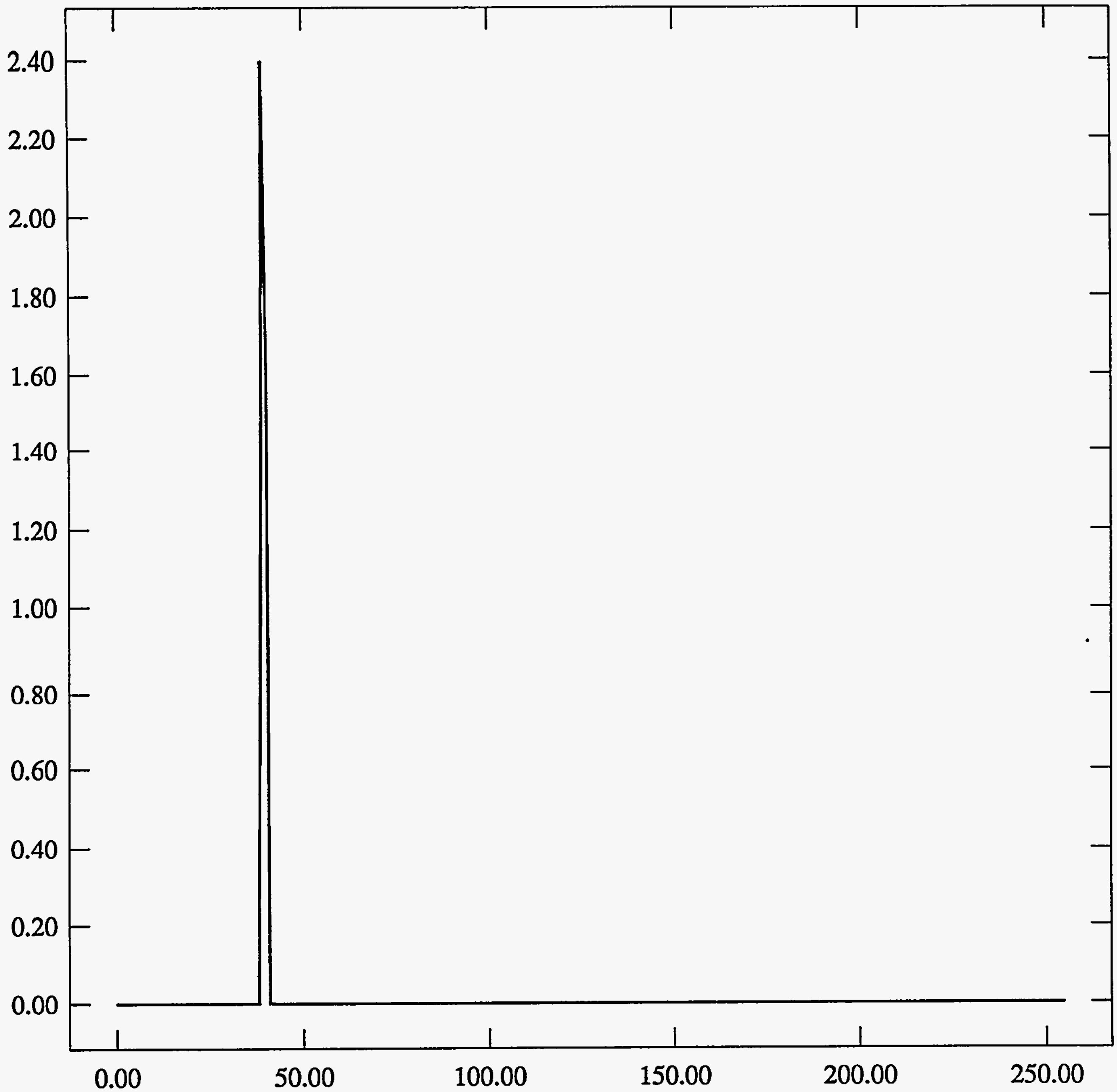
ST Camera: ST1#04-10 20C #1: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 08:00:06 1993

Pixel Values Min 38 Max 41 Mean 39.4 Sigma 0.50 x 10^3



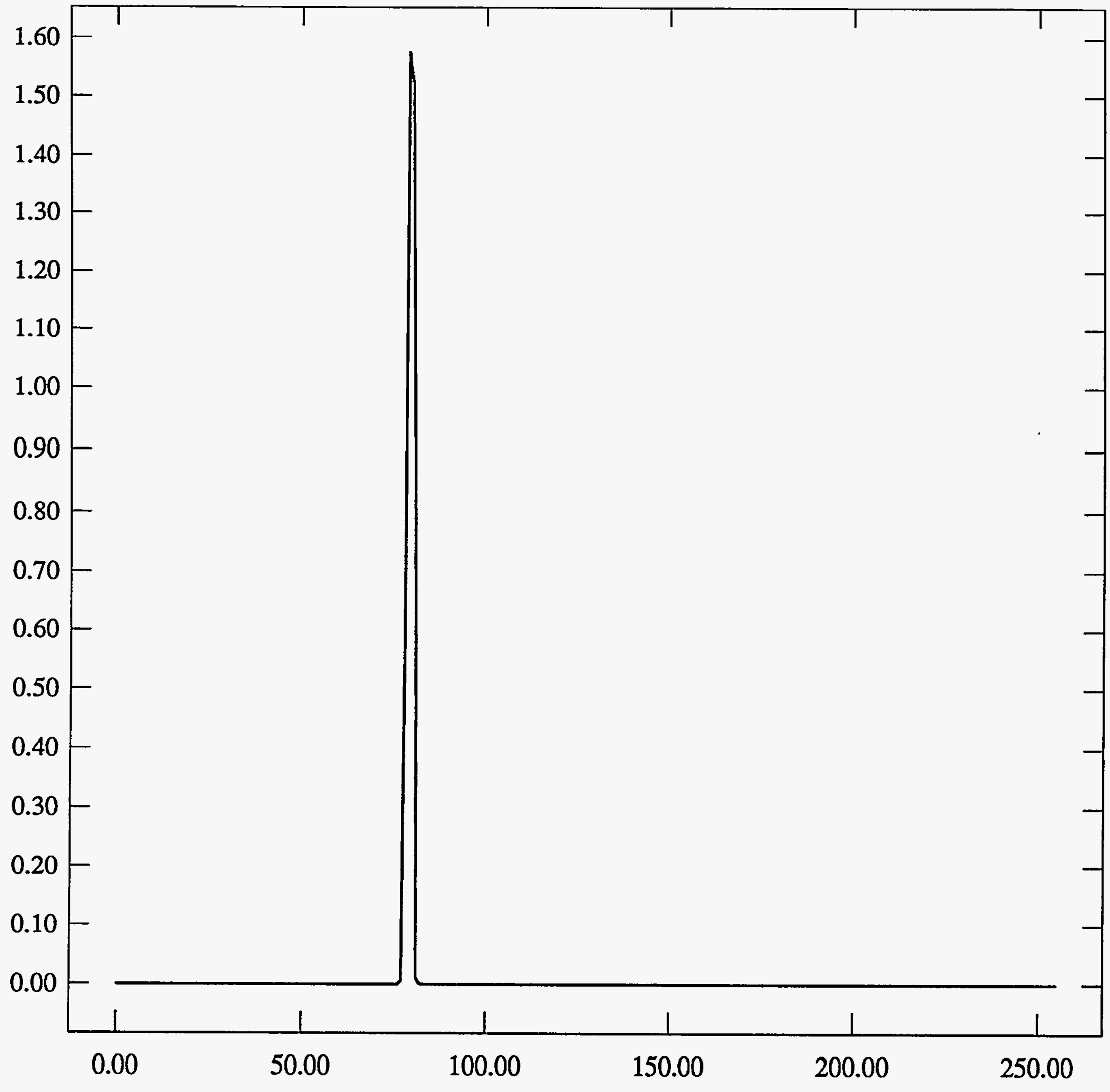
ST Camera: ST1#04-10 20C #1: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 08:00:42 1993

Pixel Values Min 39 Max 41 Mean 39.4 Sigma 0.49 x 10^3



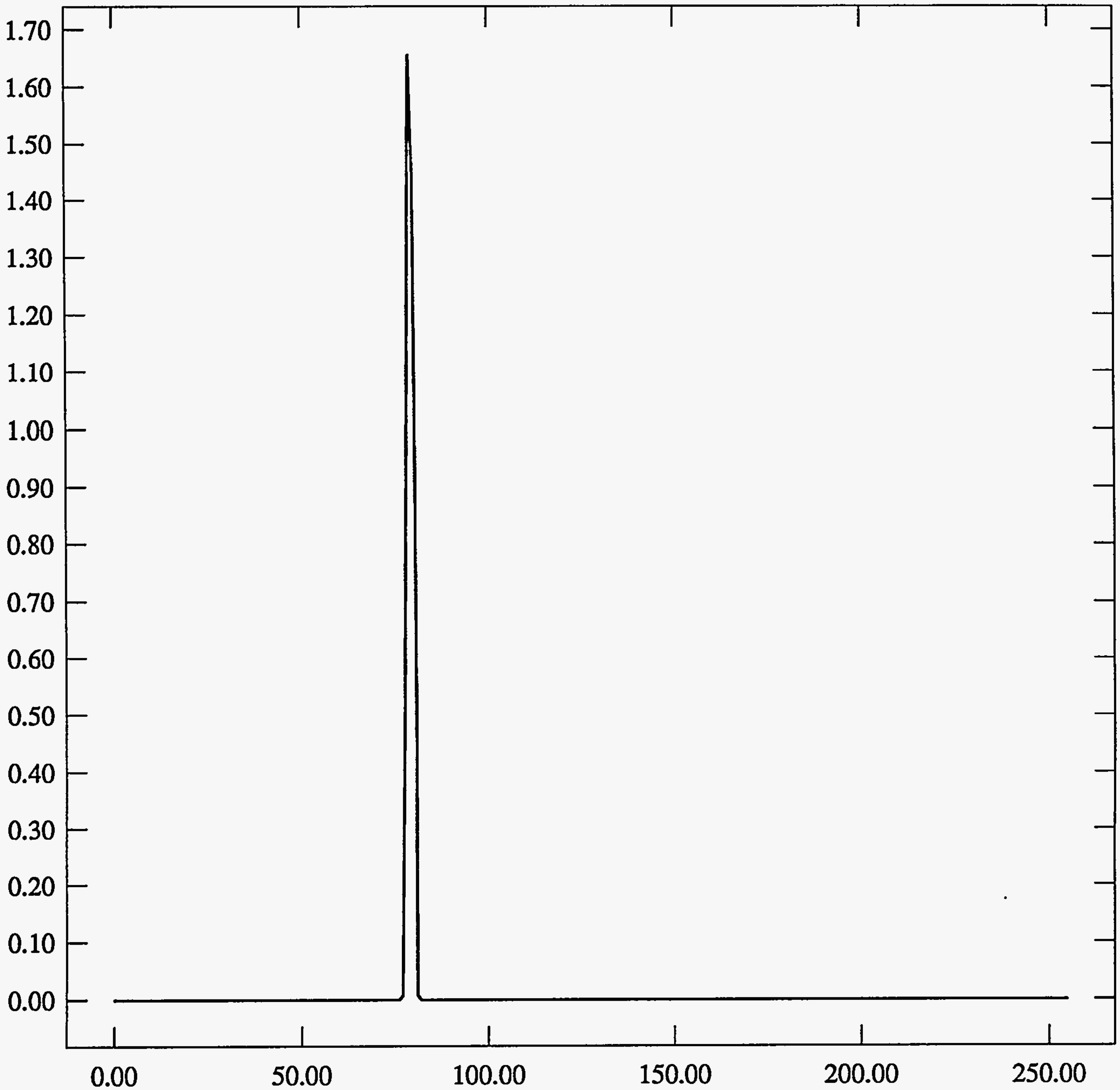
ST Camera: ST1#04-10 20C #1: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 08:01:52 1993

Pixel Values Min 77 Max 82 Mean 79.2 Sigma 0.78 x 10^3



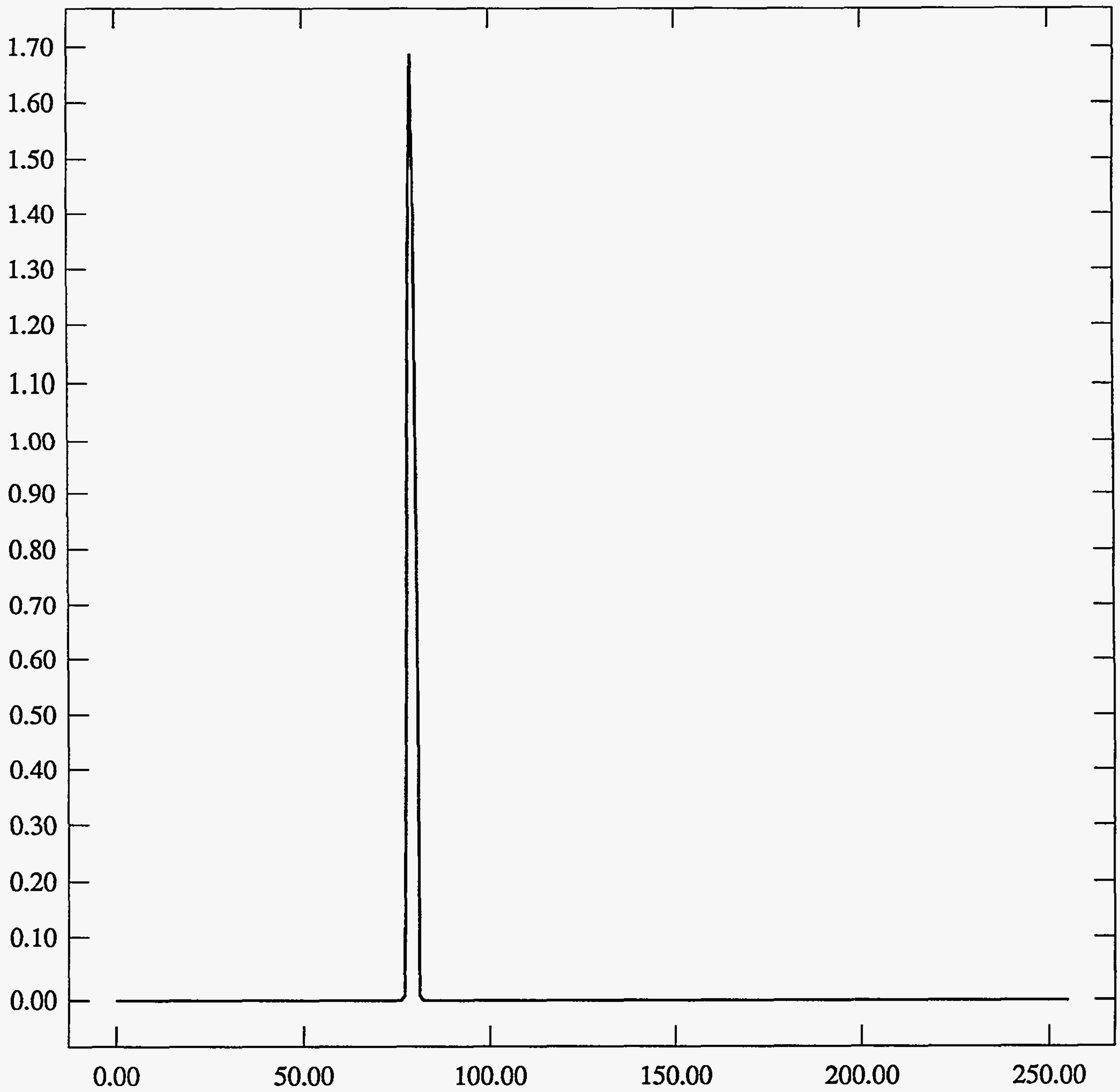
ST Camera: ST1#04-10 20C #1: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 08:02:59 1993

Pixel Values Min 77 Max 81 Mean 79.1 Sigma 0.76 x 10^3



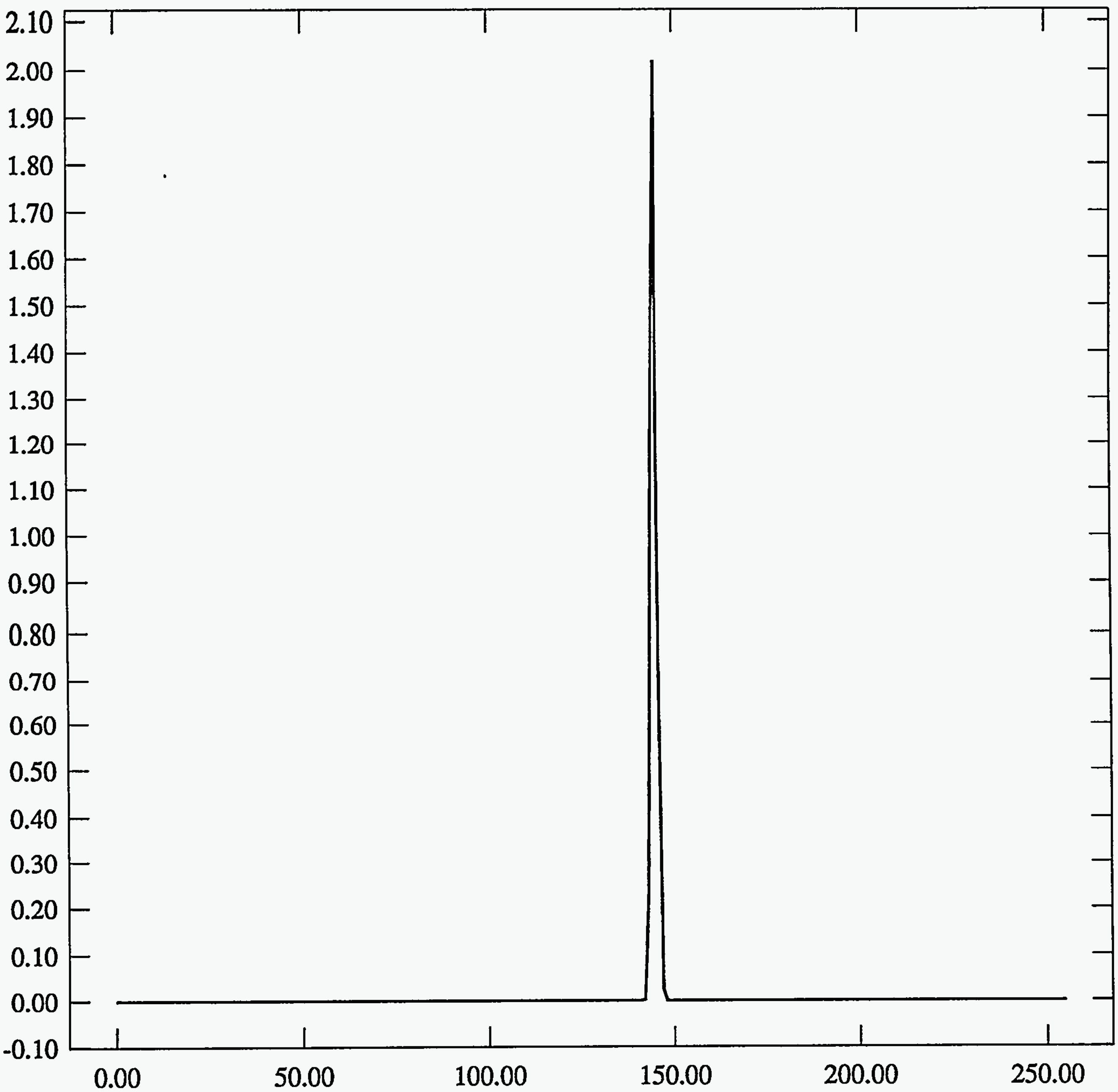
ST Camera: ST1#04-10 20C #1: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 08:03:27 1993

Pixel Values Min 77 Max 81 Mean 79.1 Sigma 0.76 x 10^3



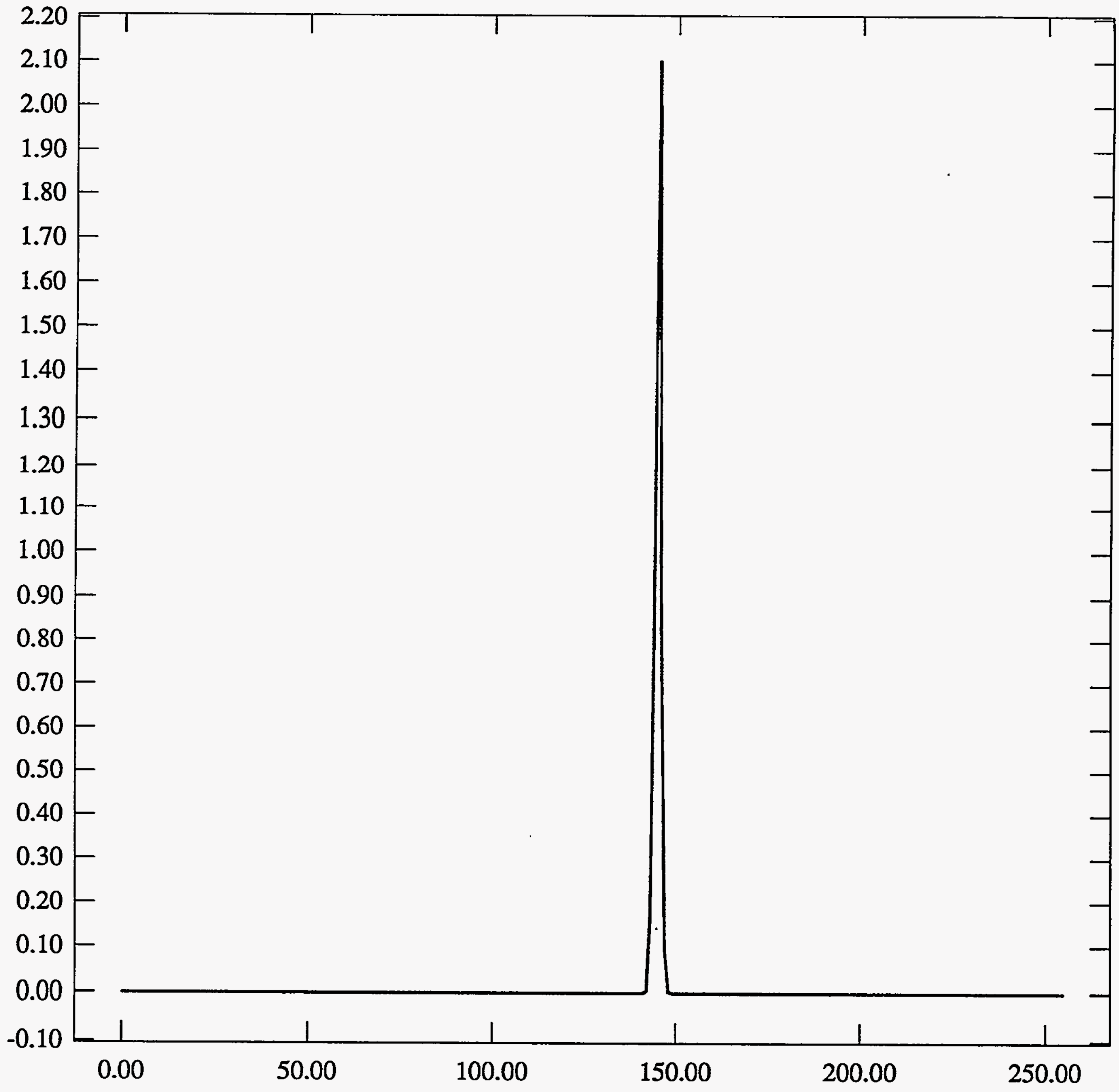
ST Camera: ST1#04-10 20C #1: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 08:03:52 1993

Pixel Values Min 142 Max 147 Mean 144.8 Sigma 0.80 x 10^3

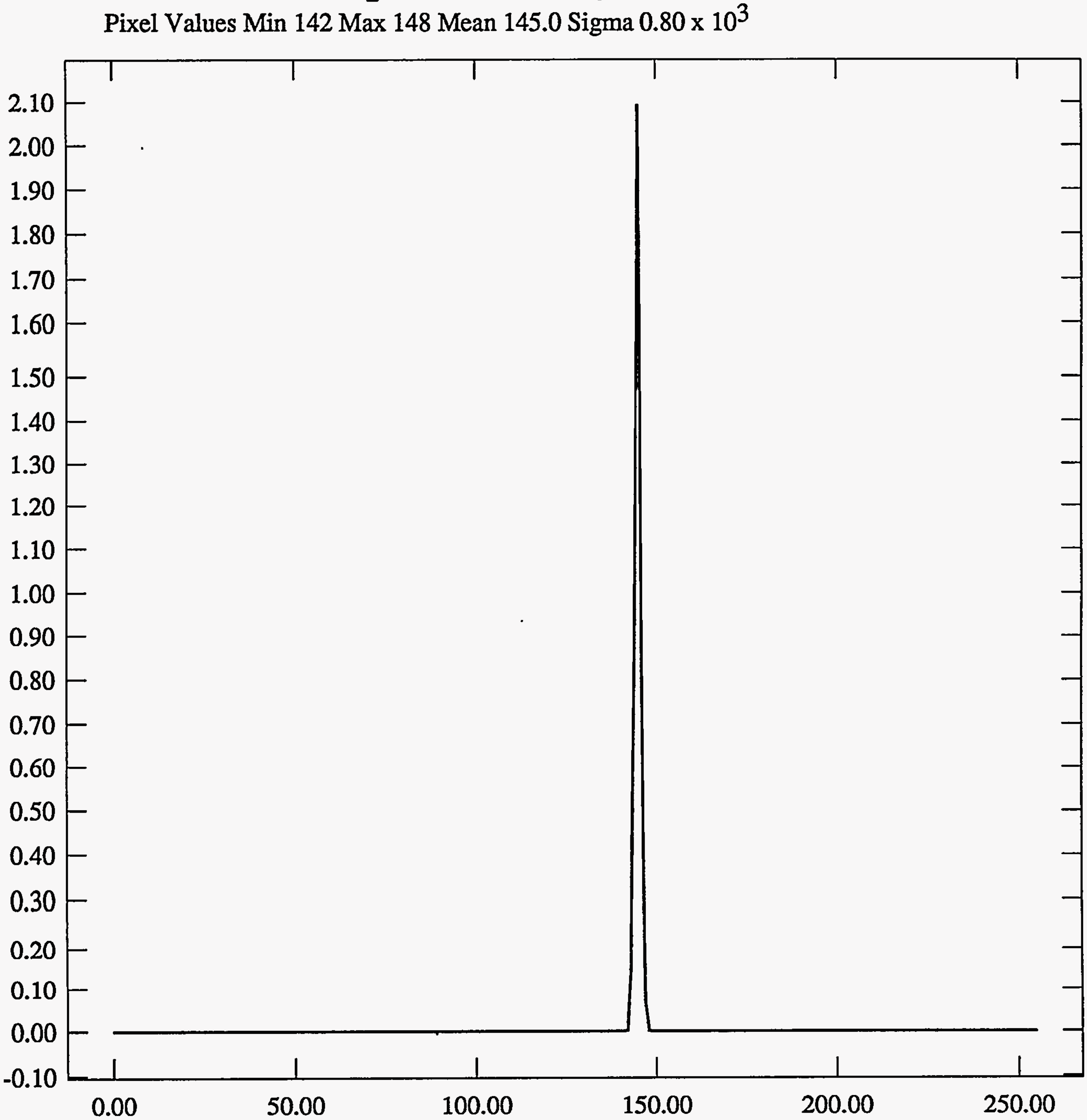


ST Camera: ST1#04-10 20C #1: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 08:04:29 1993

Pixel Values Min 142 Max 148 Mean 145.0 Sigma 0.83 x 10^3



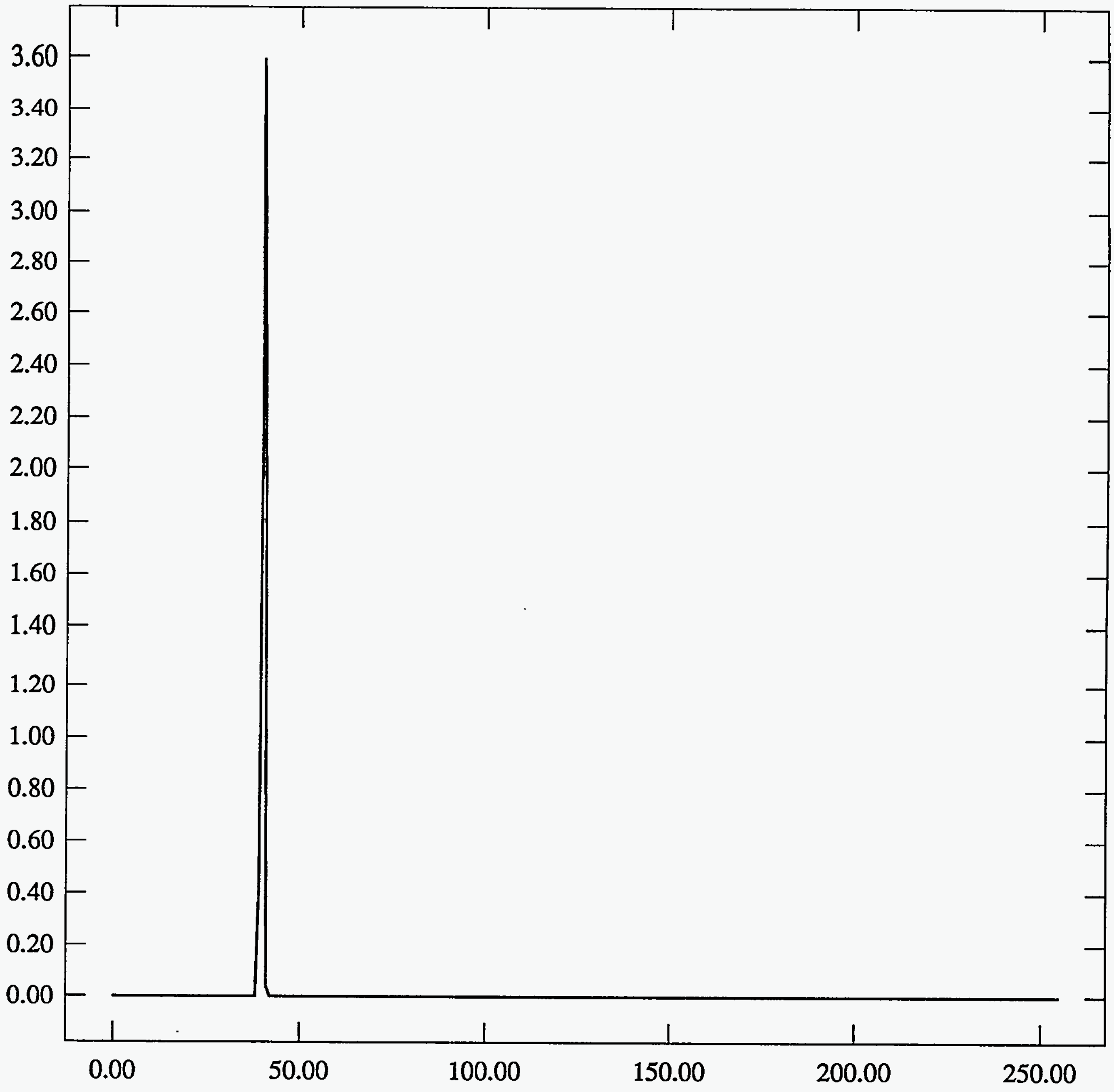
ST Camera: ST1#04-10 20C #1: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 08:05:10 1993



#2 -30 15MIN

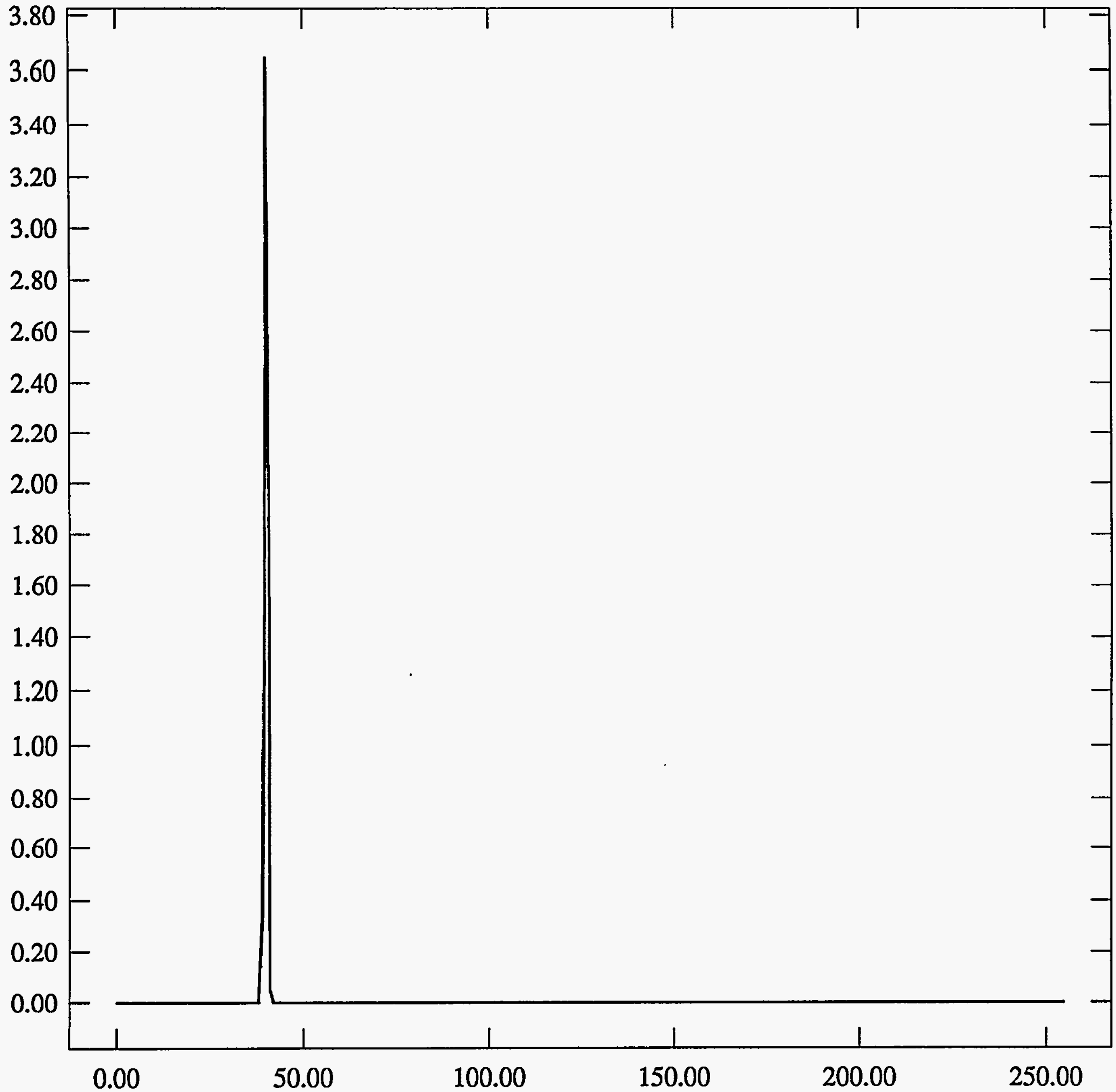
ST Camera: ST1#04-10 -30C #2: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 08:36:01 1993

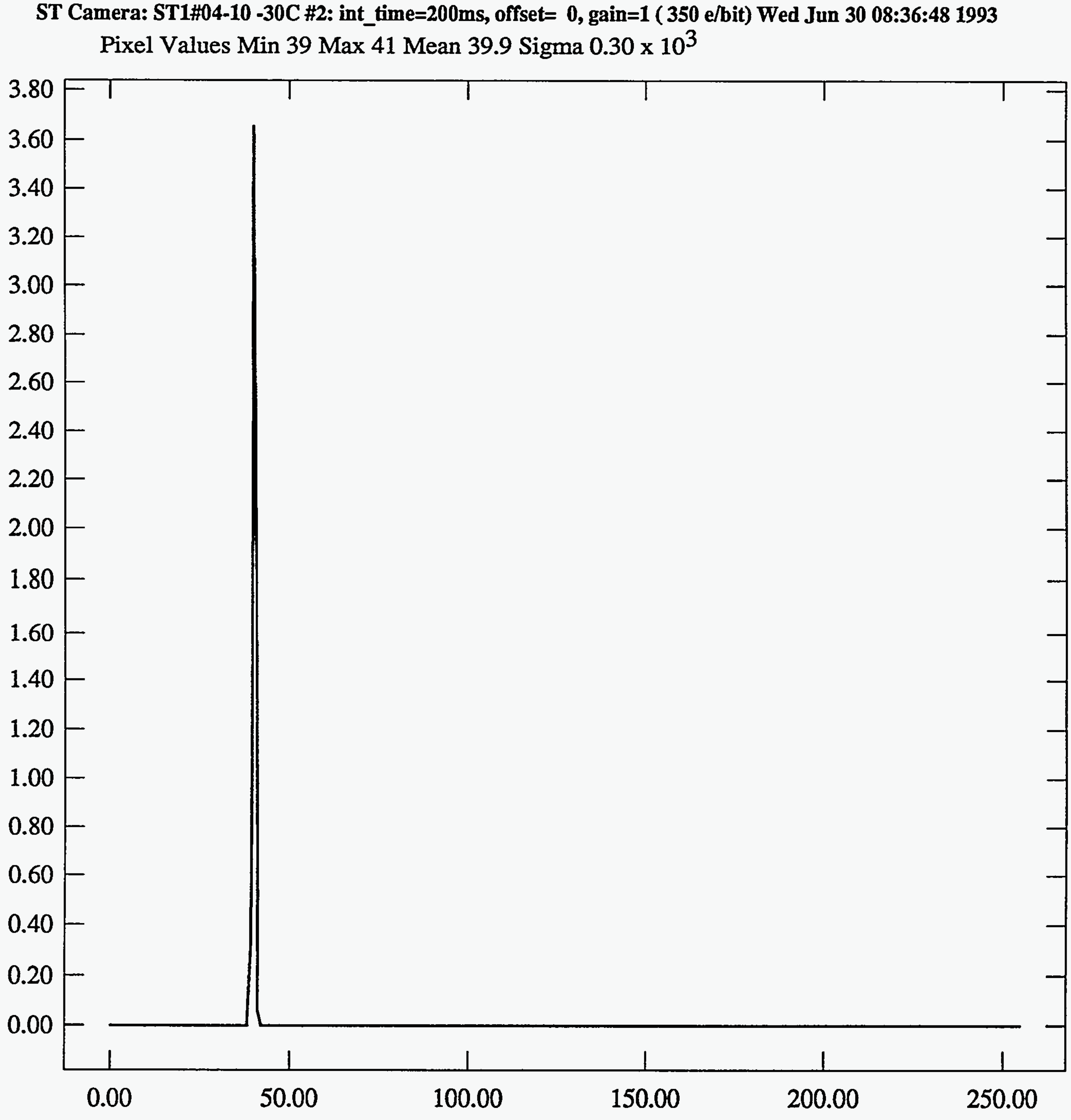
Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.32 x 10^3



ST Camera: ST1#04-10 -30C #2: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 08:36:26 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.30 x 10^3

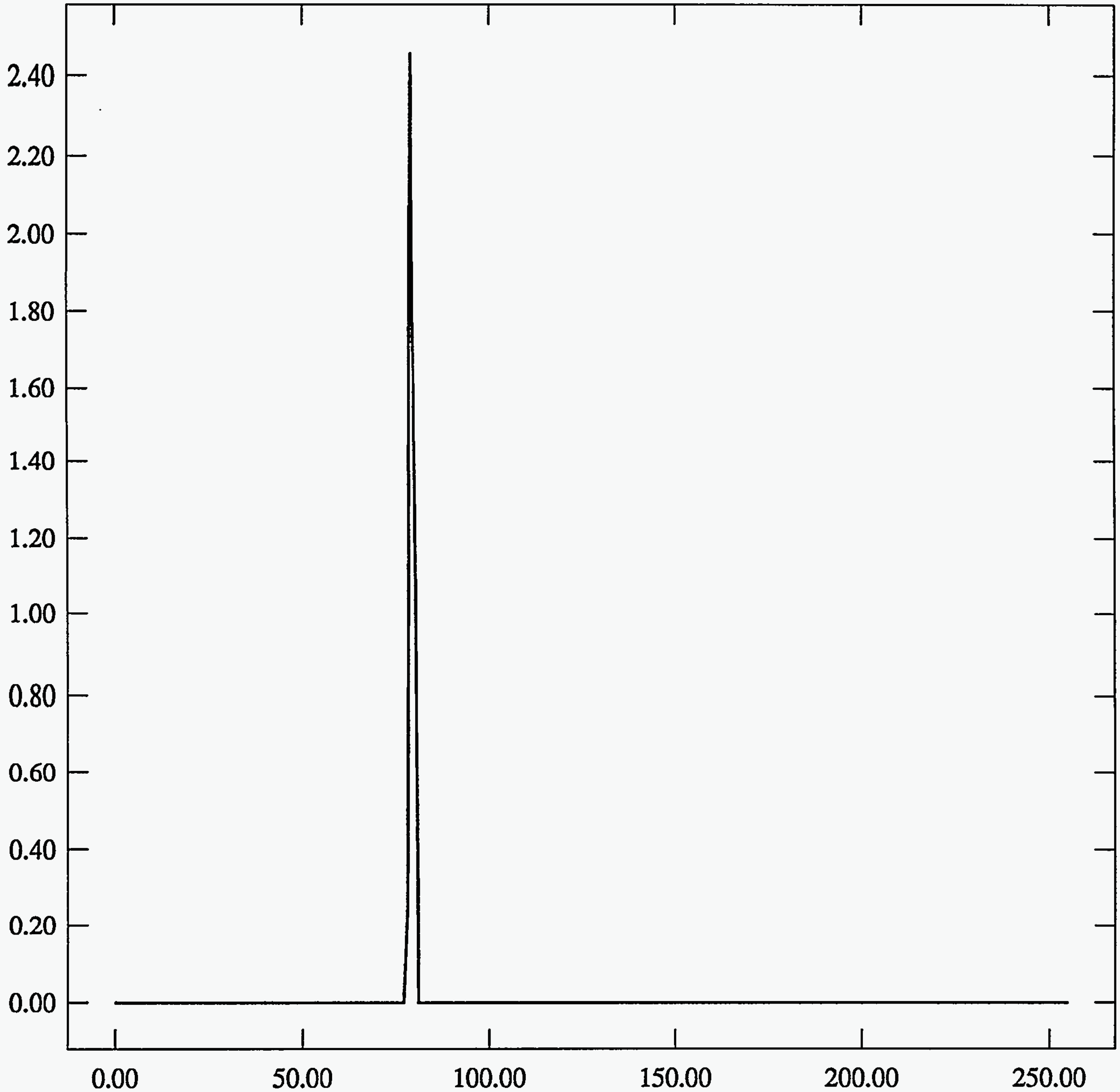




ST Camera: ST1#04-10 -30C #2: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 08:36:48 1993
Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.30 x 10^3
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

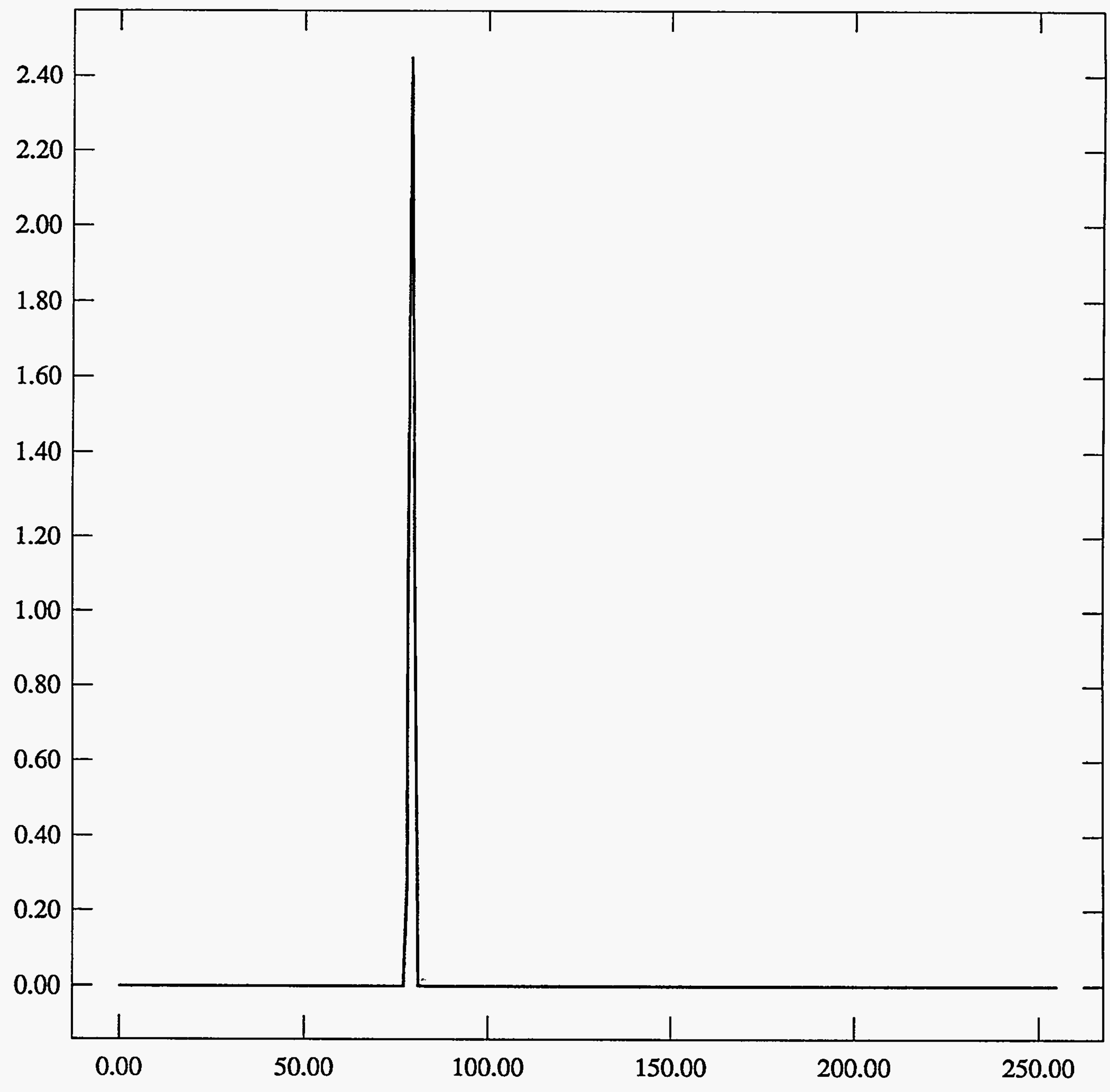
ST Camera: ST1#04-10 -30C #2: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 08:37:19 1993

Pixel Values Min 78 Max 80 Mean 79.3 Sigma 0.57 x 10^3



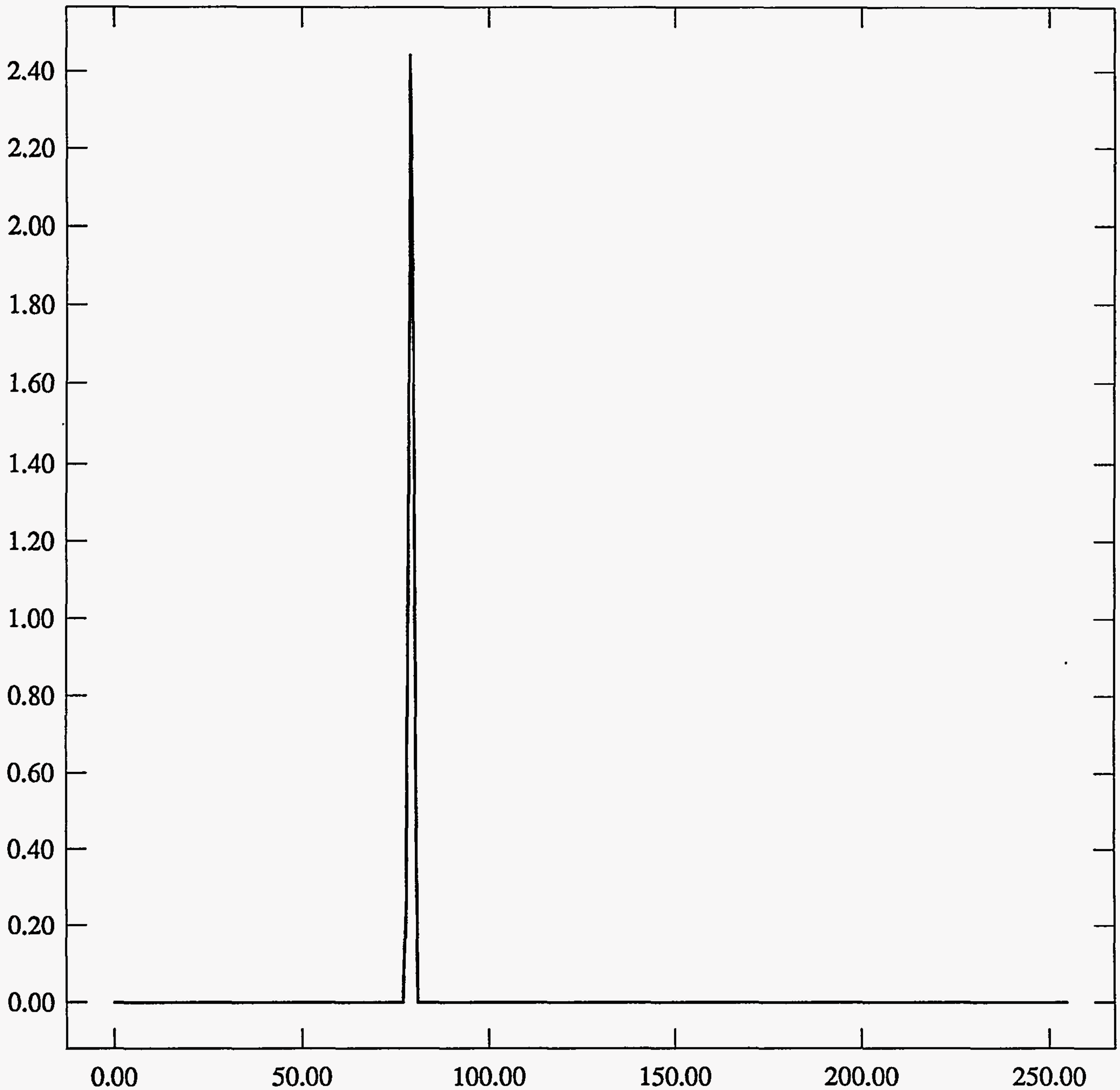
ST Camera: ST1#04-10 -30C #2: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 08:38:02 1993

Pixel Values Min 78 Max 81 Mean 79.3 Sigma 0.57 x 10^3



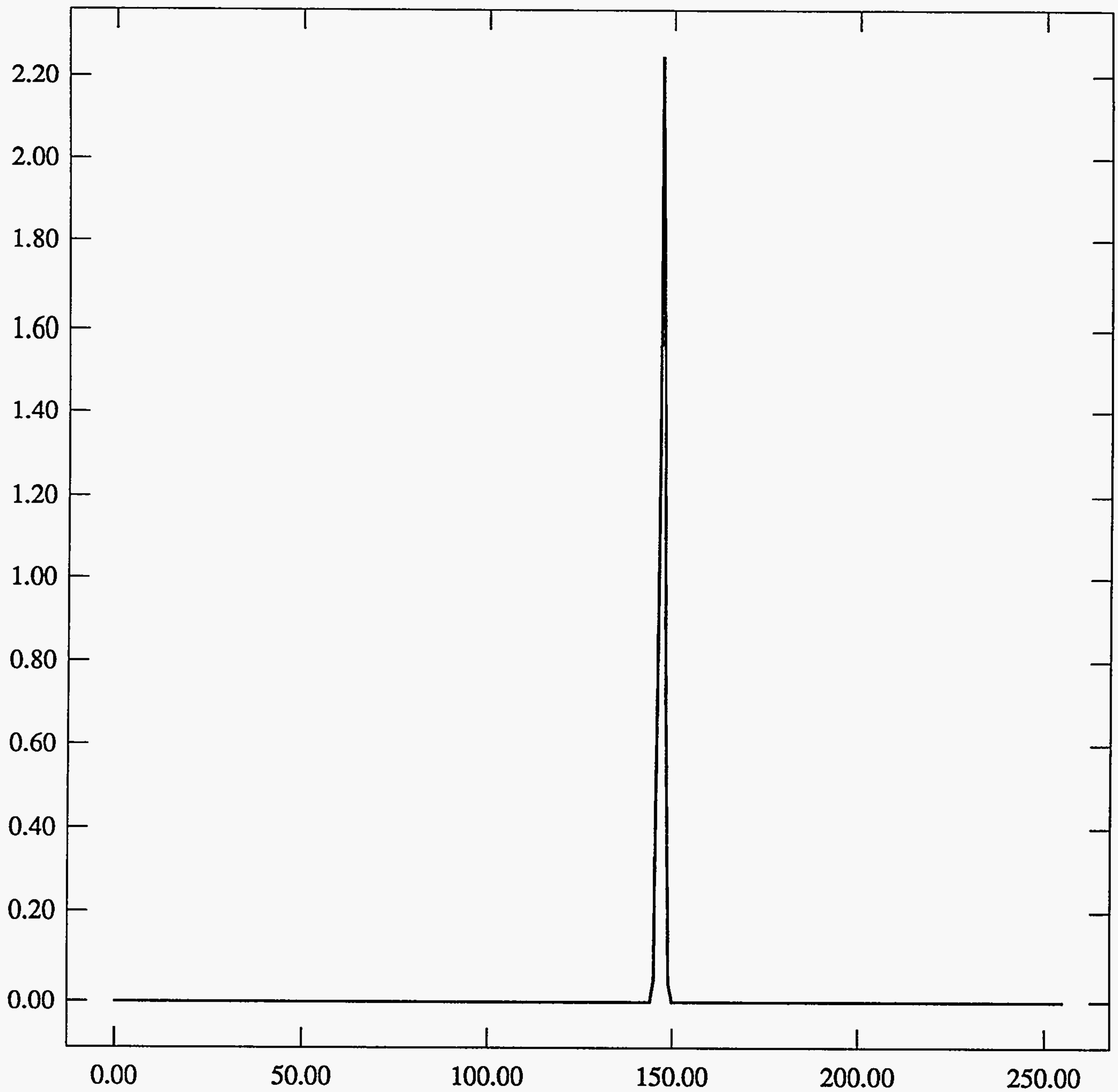
ST Camera: ST1#04-10 -30C #2: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 08:38:36 1993

Pixel Values Min 78 Max 80 Mean 79.3 Sigma 0.57 x 10^3



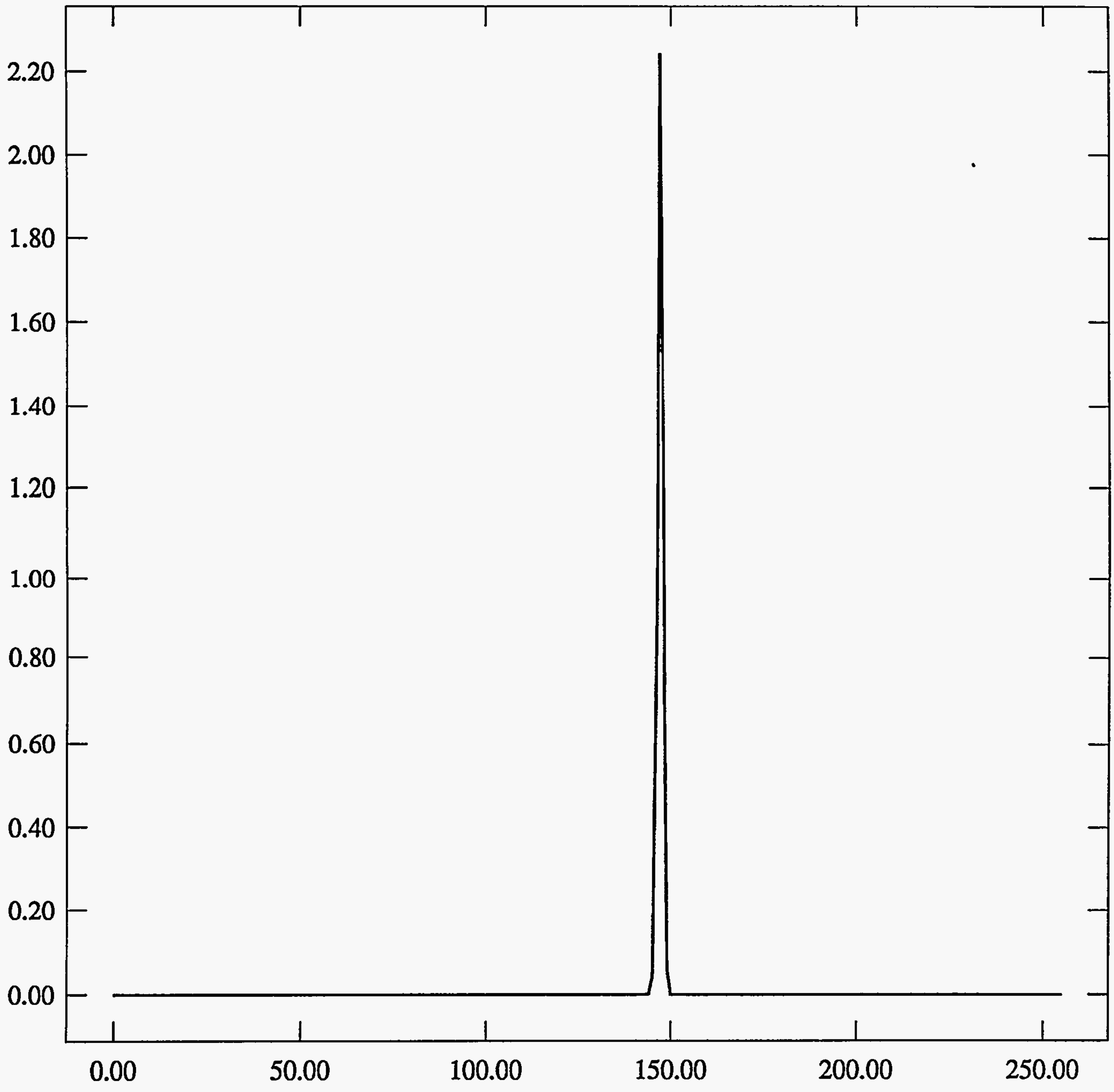
ST Camera: ST1#04-10 -30C #2: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 08:39:45 1993

Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.72 x 10^3



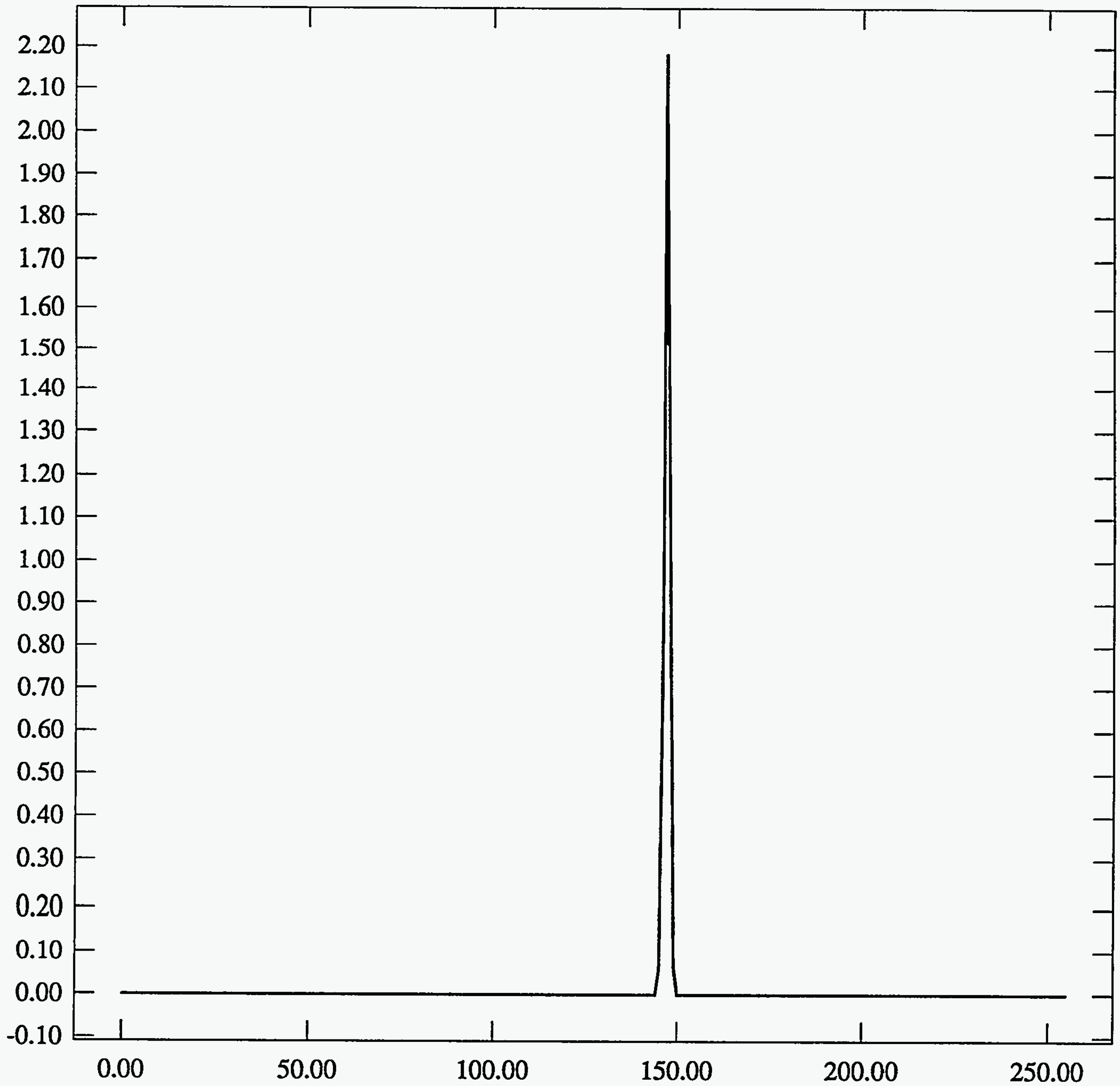
ST Camera: ST1#04-10 -30C #2: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 08:40:38 1993

Pixel Values Min 144 Max 149 Mean 146.9 Sigma 0.72 x 10^3



ST Camera: ST1#04-10 -30C #2: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 08:41:48 1993

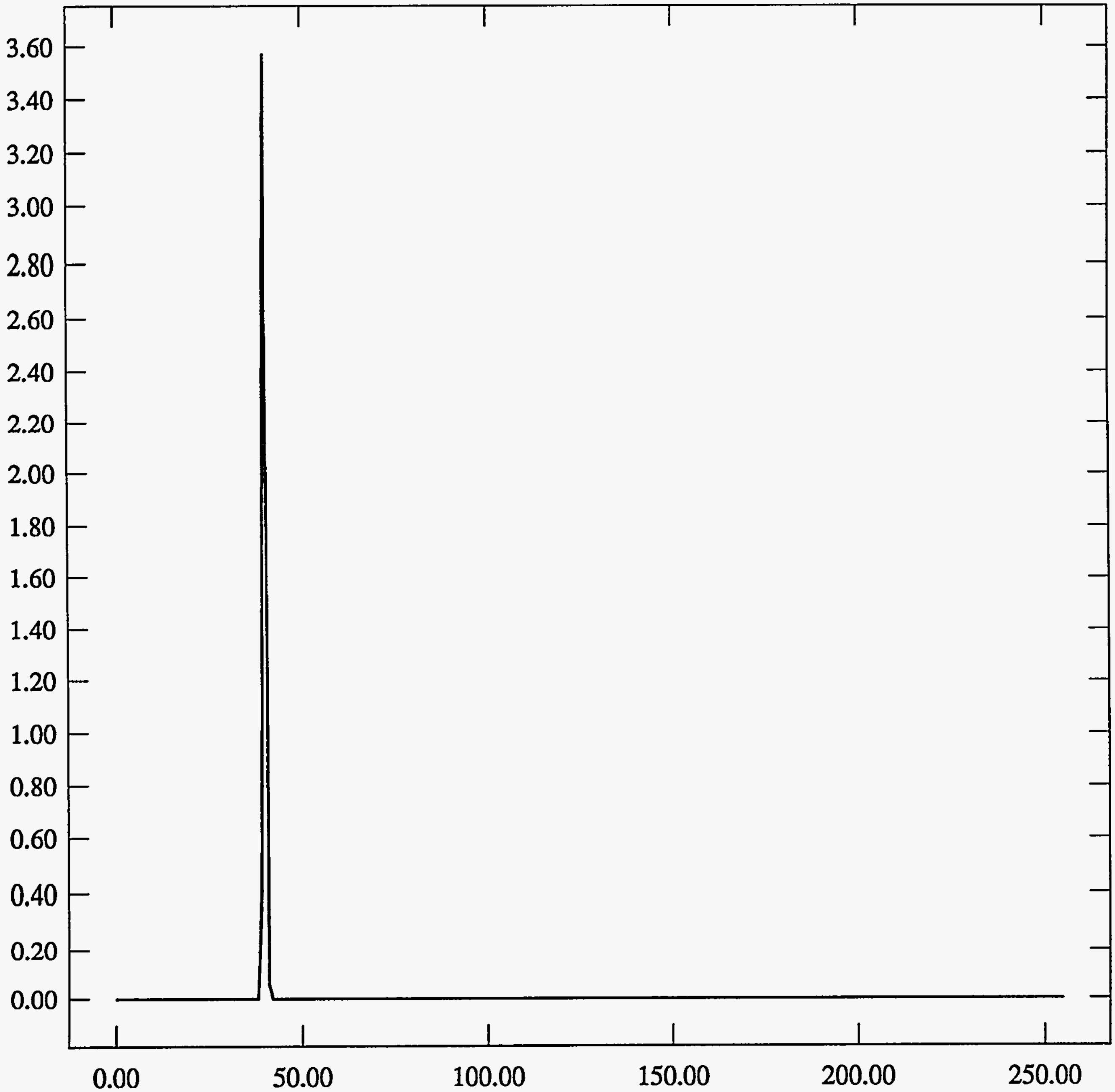
Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.74 x 10^3



#2 -30 END

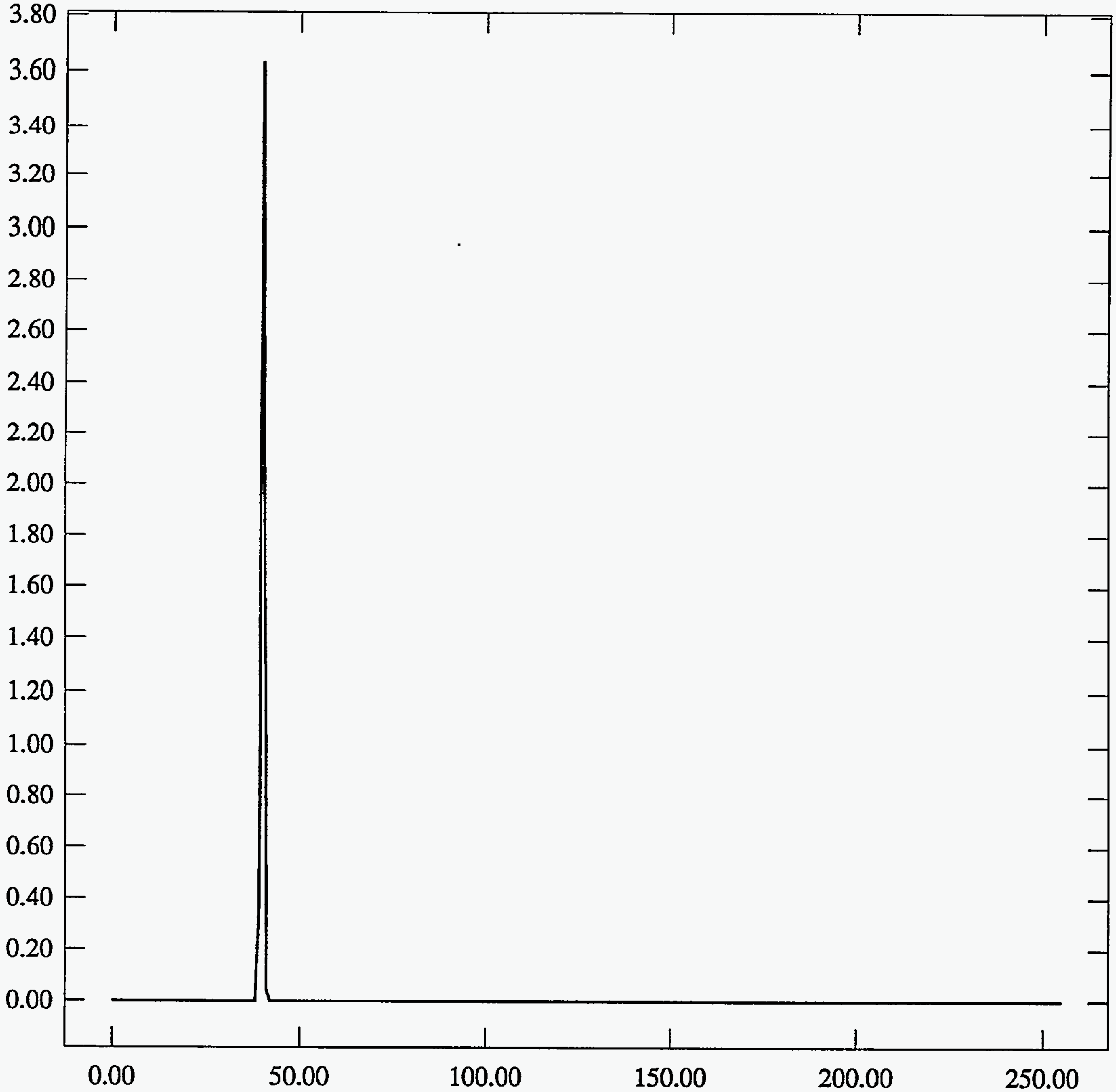
ST Camera: ST1#04-10 -30C #2: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 09:17:47 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.33 x 10^3



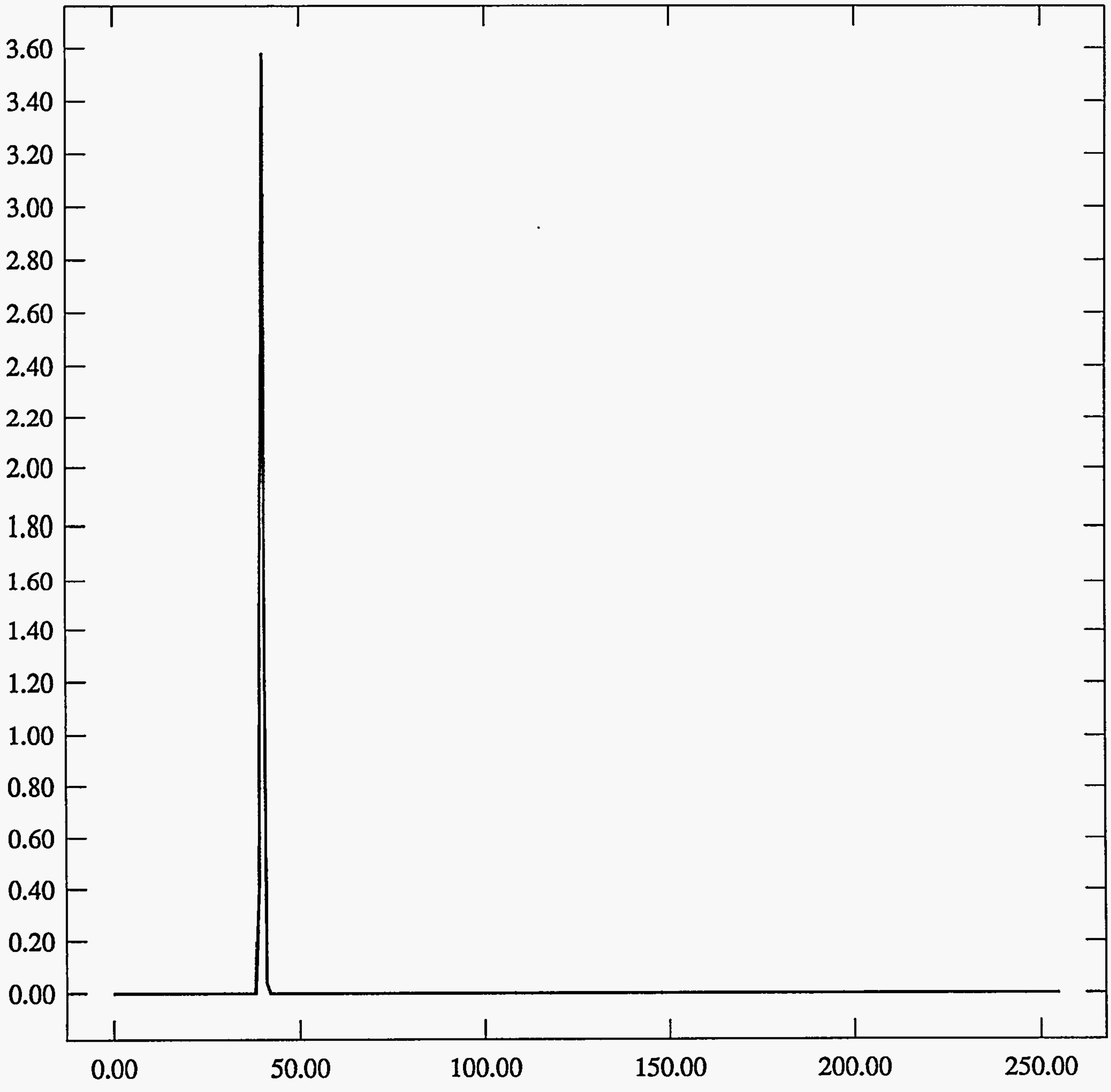
ST Camera: ST1#04-10 -30C #2: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 09:18:08 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.31 x 10^3



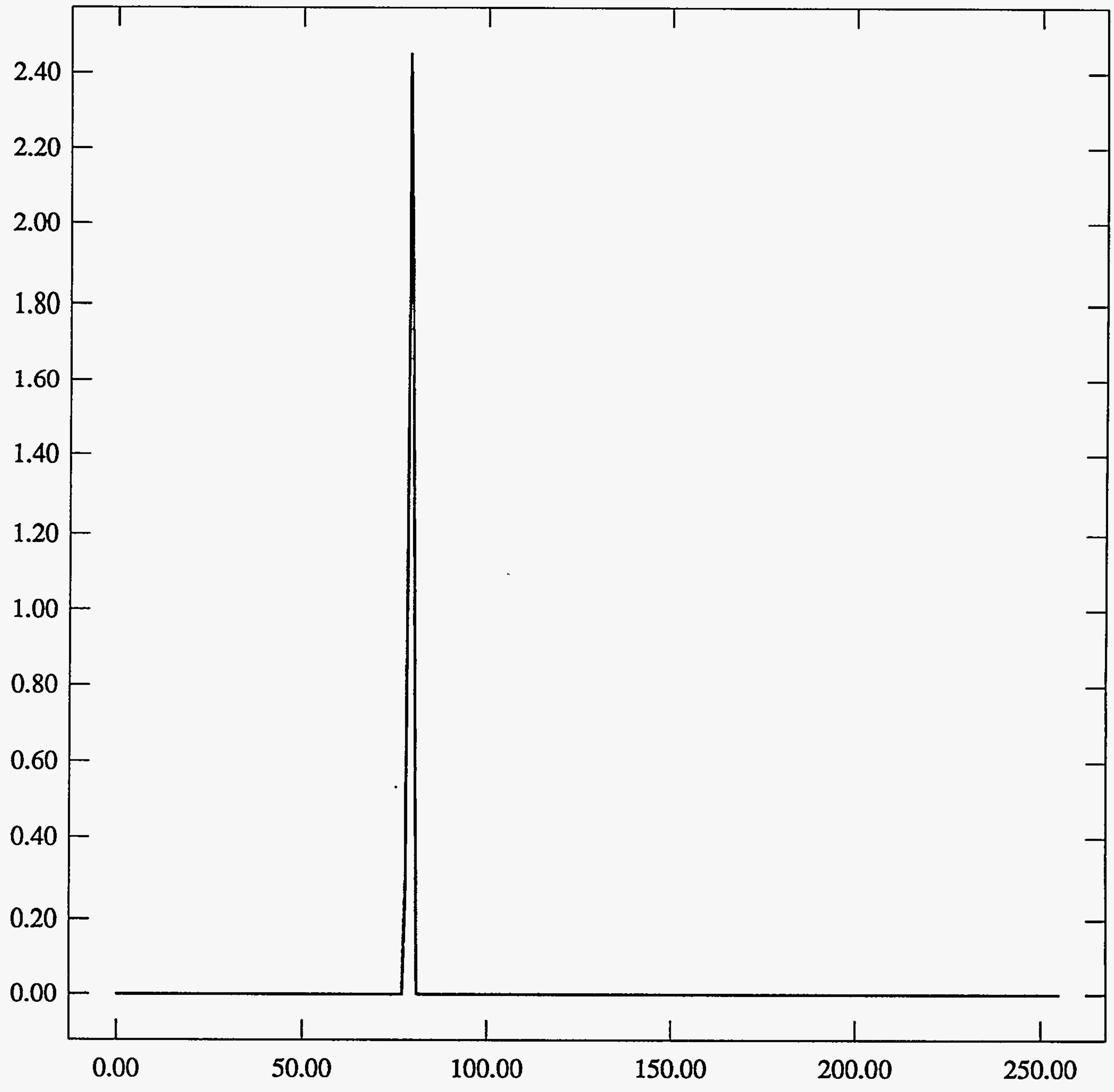
ST Camera: ST1#04-10 -30C #2: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 09:18:37 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.32 x 10^3



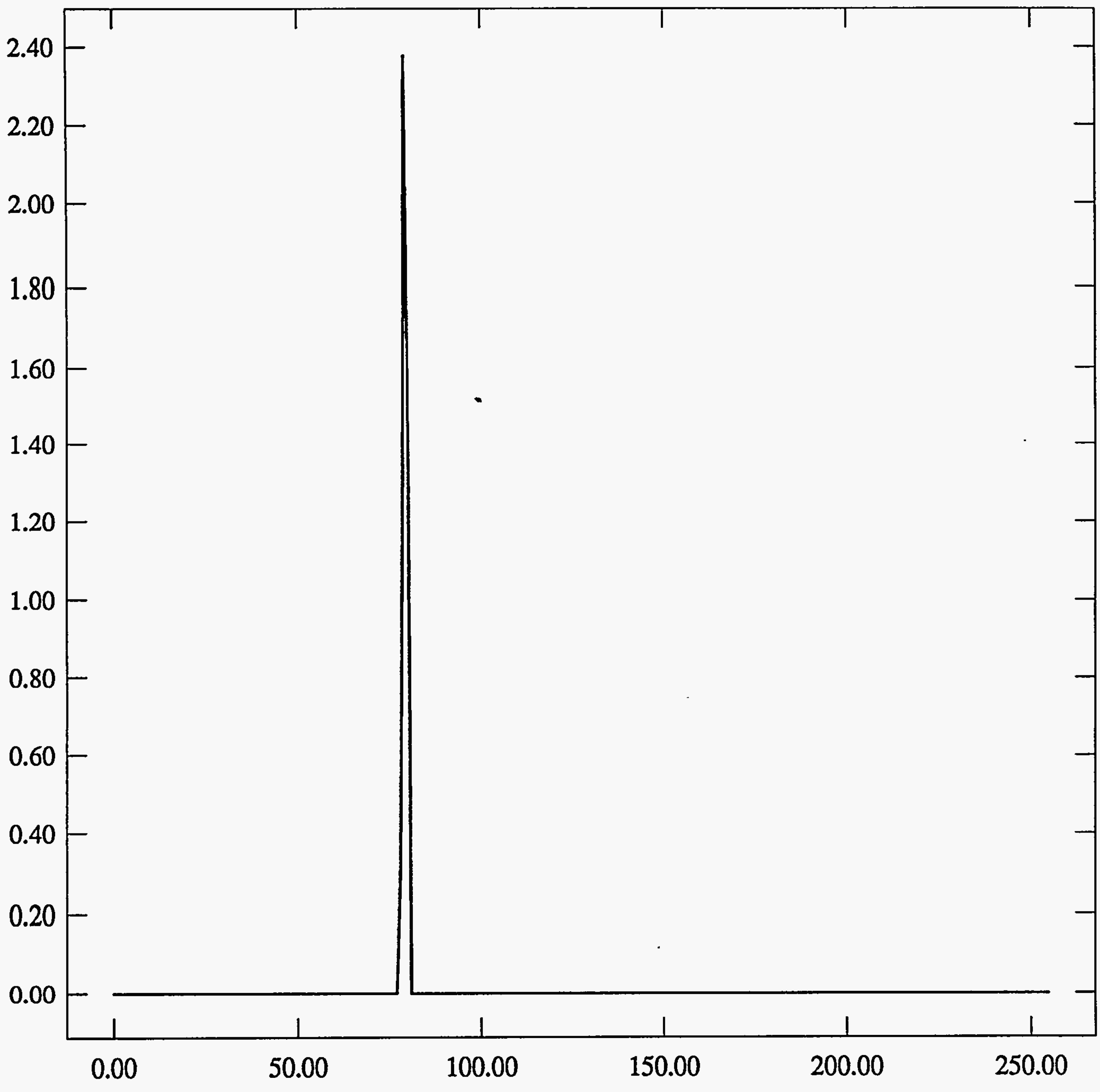
ST Camera: ST1#04-10 -30C #2: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 09:18:58 1993

Pixel Values Min 78 Max 81 Mean 79.2 Sigma 0.58 x 10^3



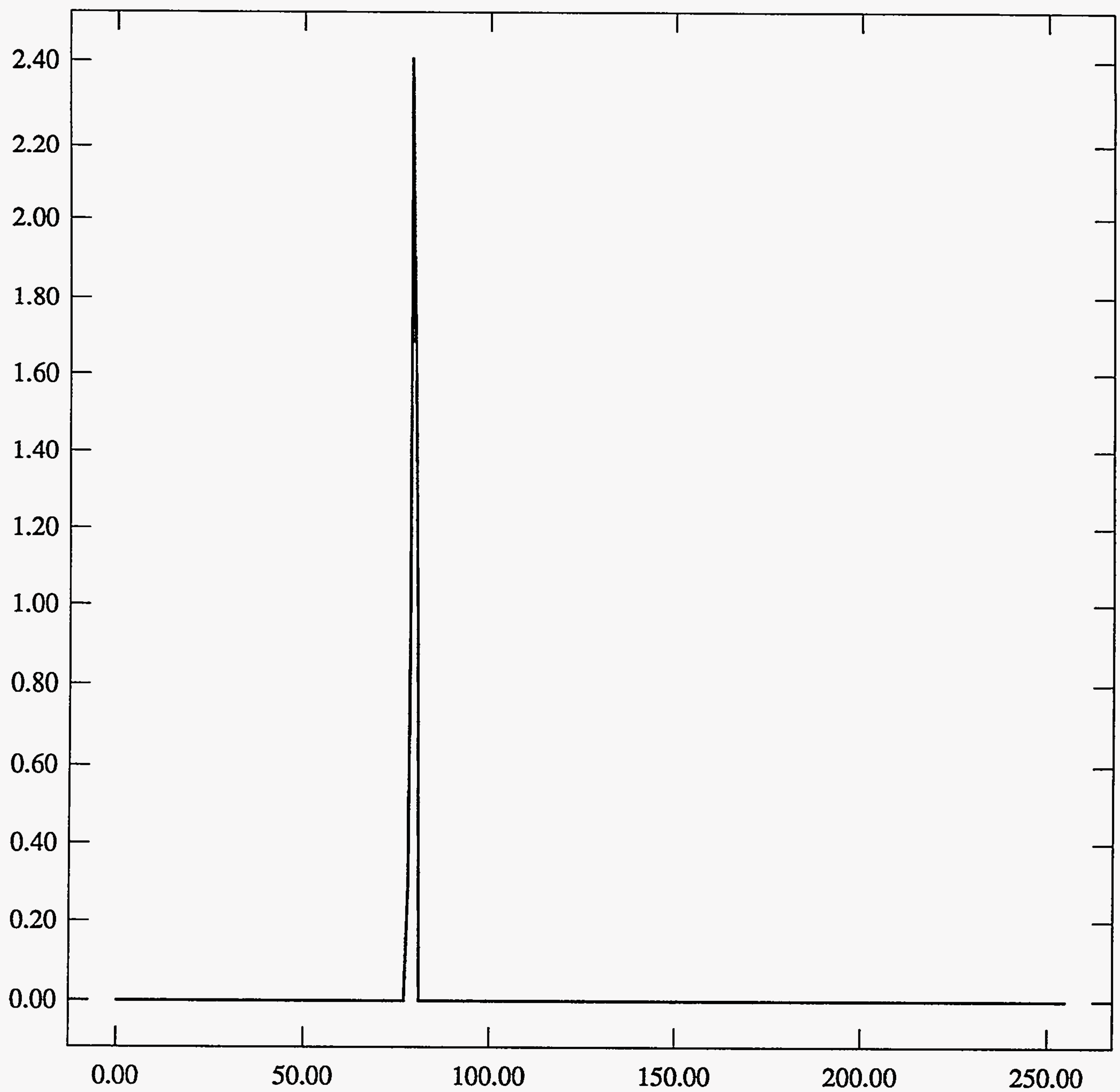
ST Camera: ST1#04-10 -30C #2: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 09:19:20 1993

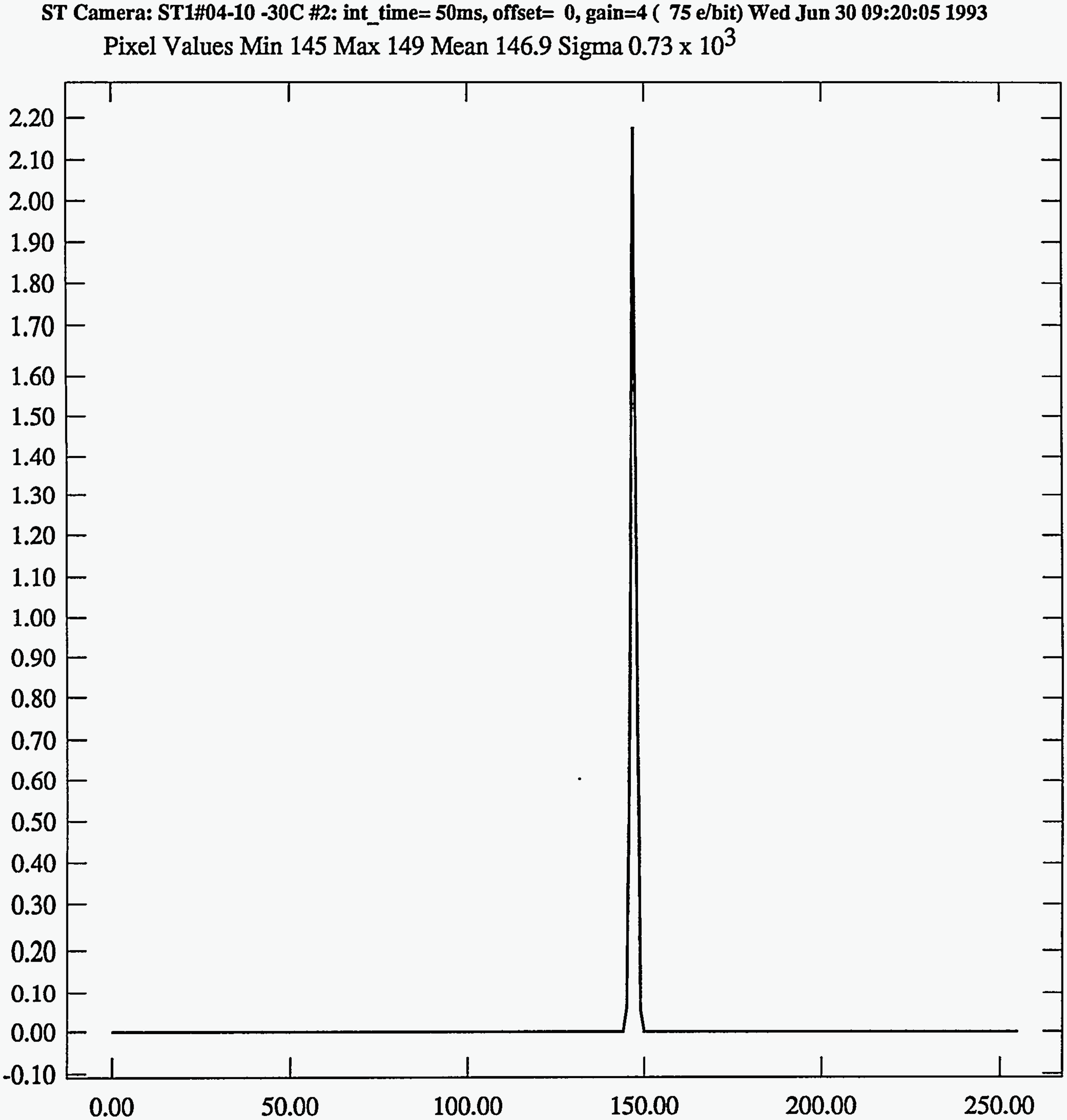
Pixel Values Min 78 Max 80 Mean 79.3 Sigma 0.59 x 10^3



ST Camera: ST1#04-10 -30C #2: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 09:19:45 1993

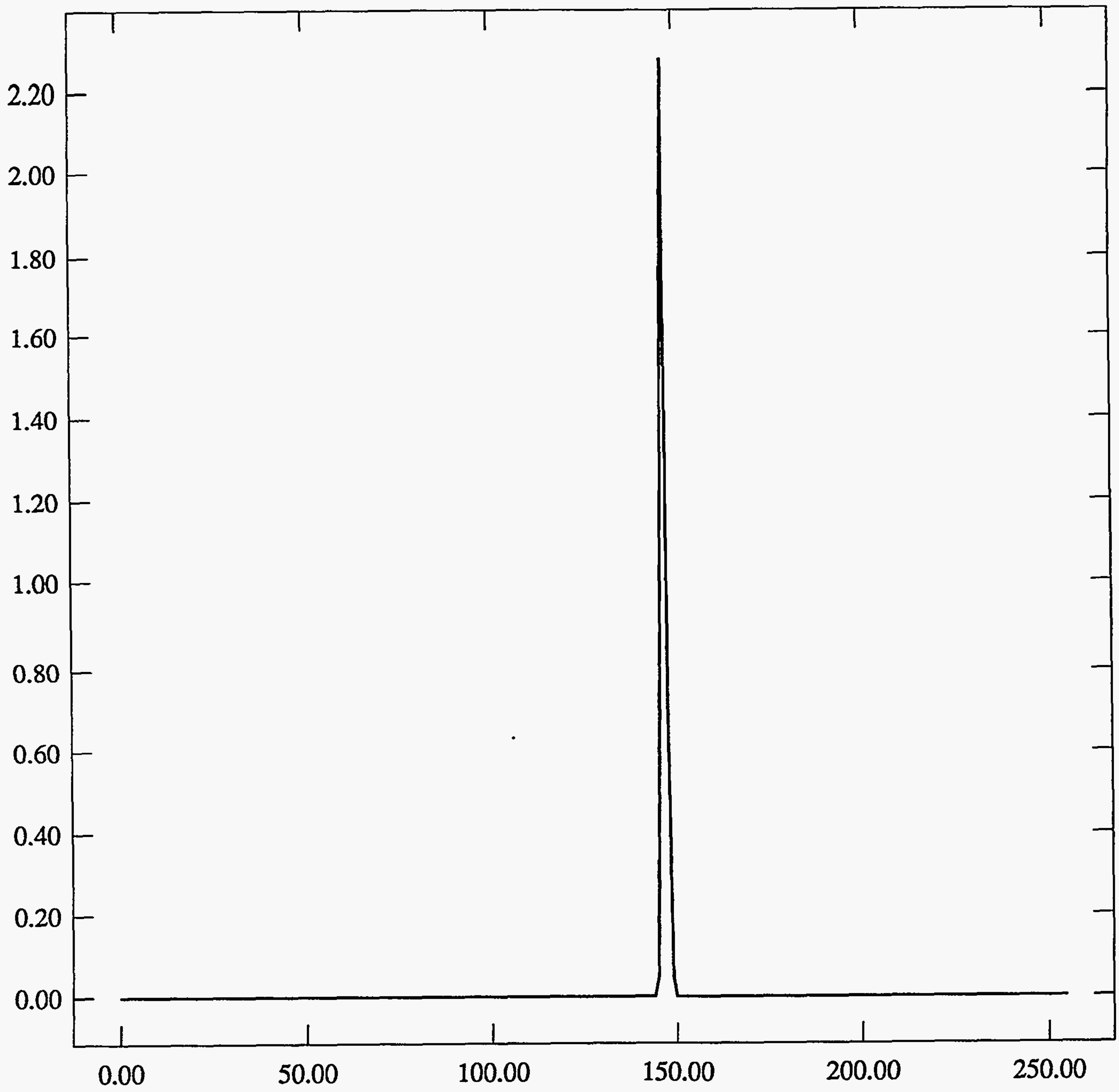
Pixel Values Min 78 Max 80 Mean 79.3 Sigma 0.58 x 10^3




ST Camera: ST1#04-10 -30C #2: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 09:20:05 1993
Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.73 x 10^3
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.00
50.00
100.00
150.00
200.00
250.00

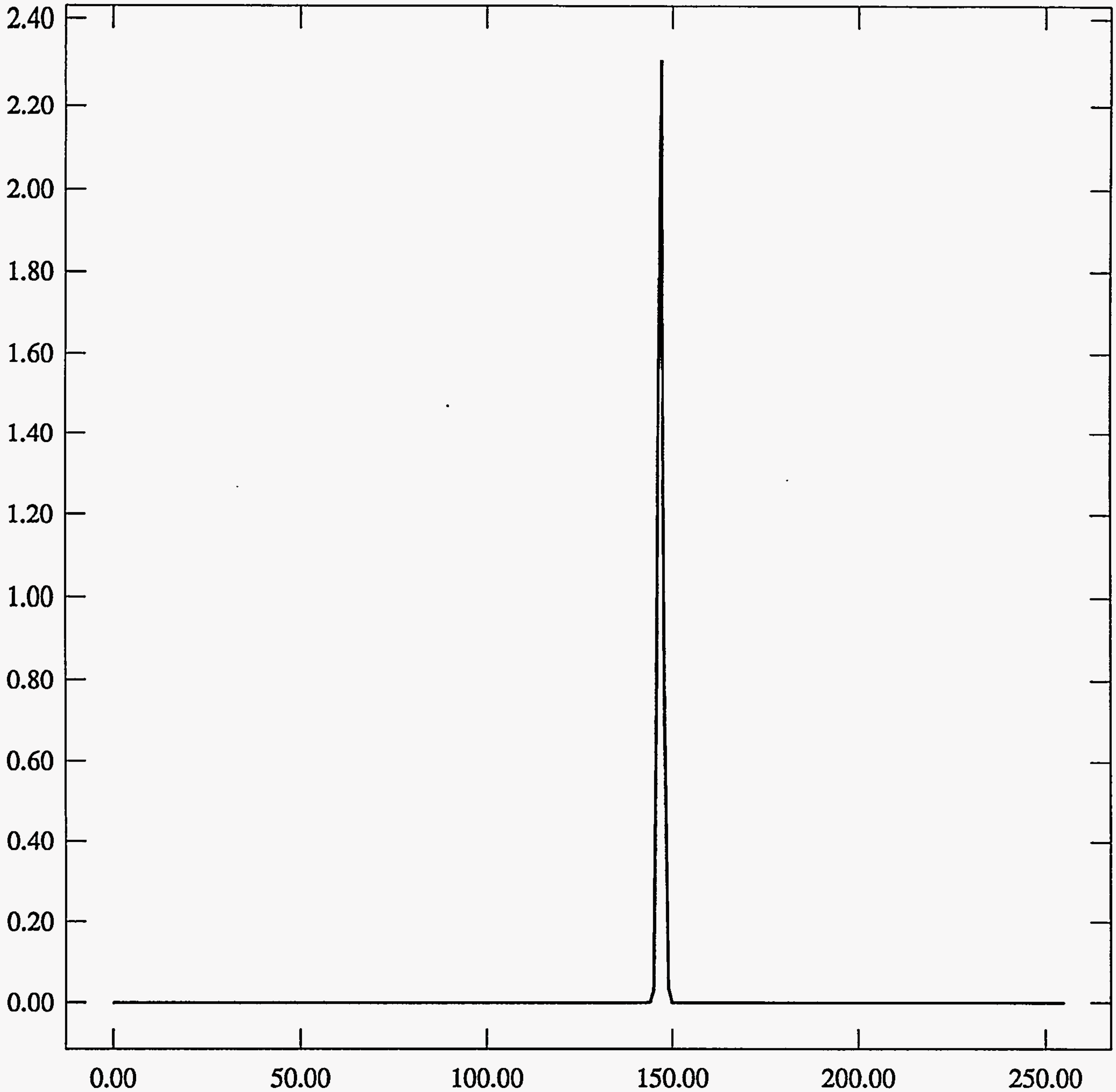
ST Camera: ST1#04-10 -30C #2: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 09:20:30 1993

Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.71 x 10^3



ST Camera: ST1#04-10 -30C #2: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 09:20:57 1993

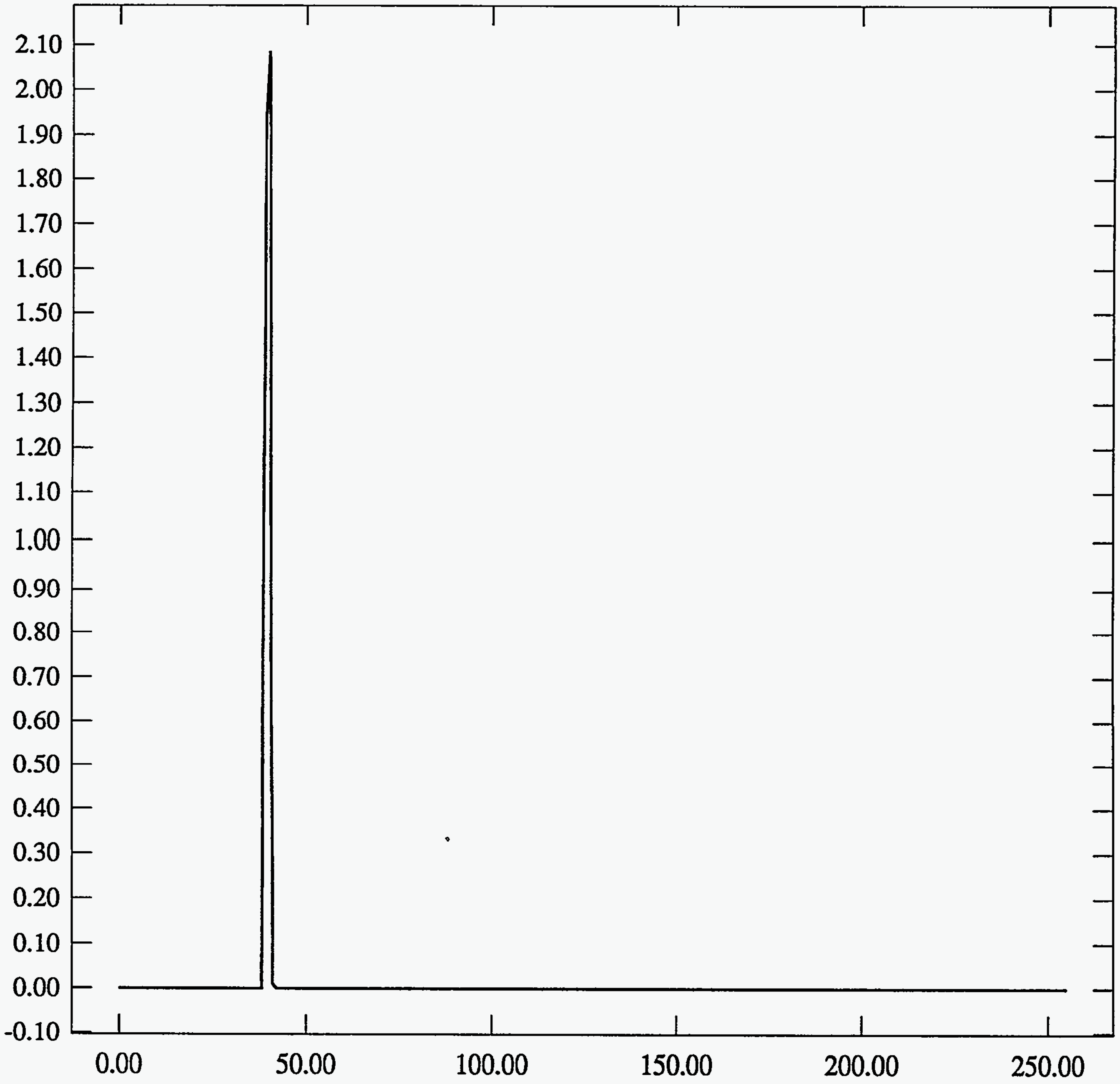
Pixel Values Min 144 Max 149 Mean 146.9 Sigma 0.69 x 10^3



#2 20C 15min

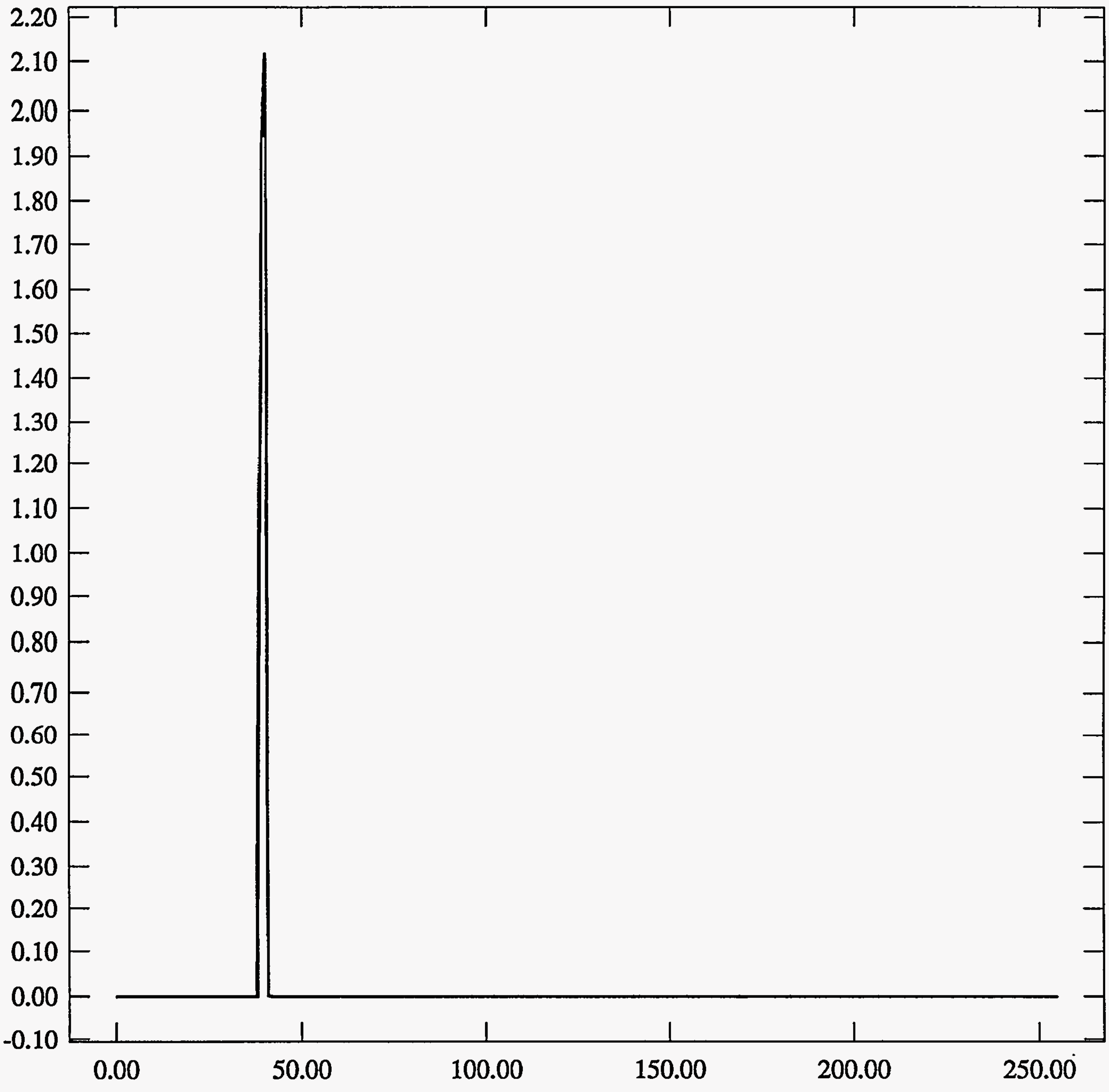
ST Camera: ST1#04-10 20C #2: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 09:52:21 1993

Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3



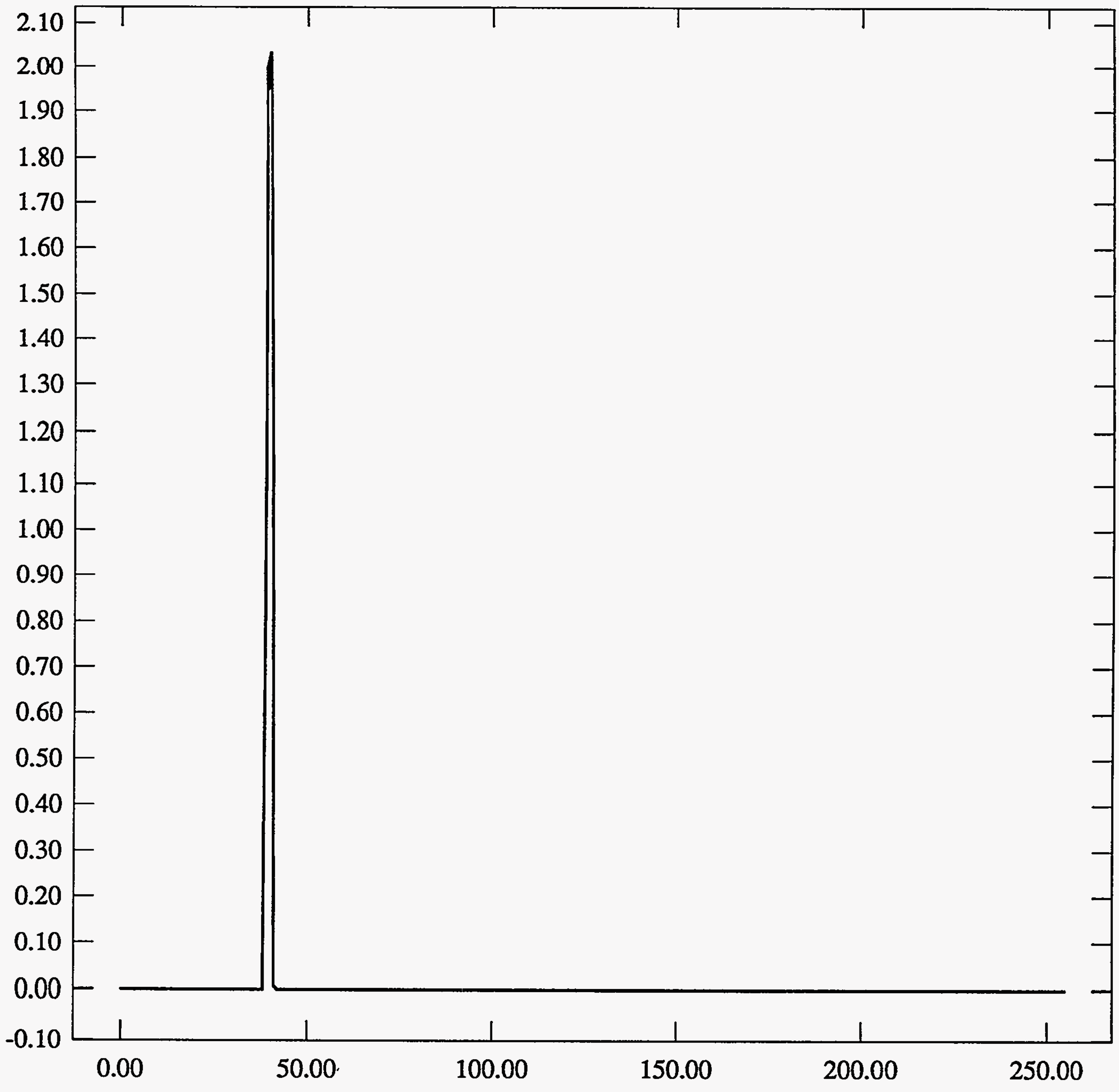
ST Camera: ST1#04-10 20C #2: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 09:52:37 1993

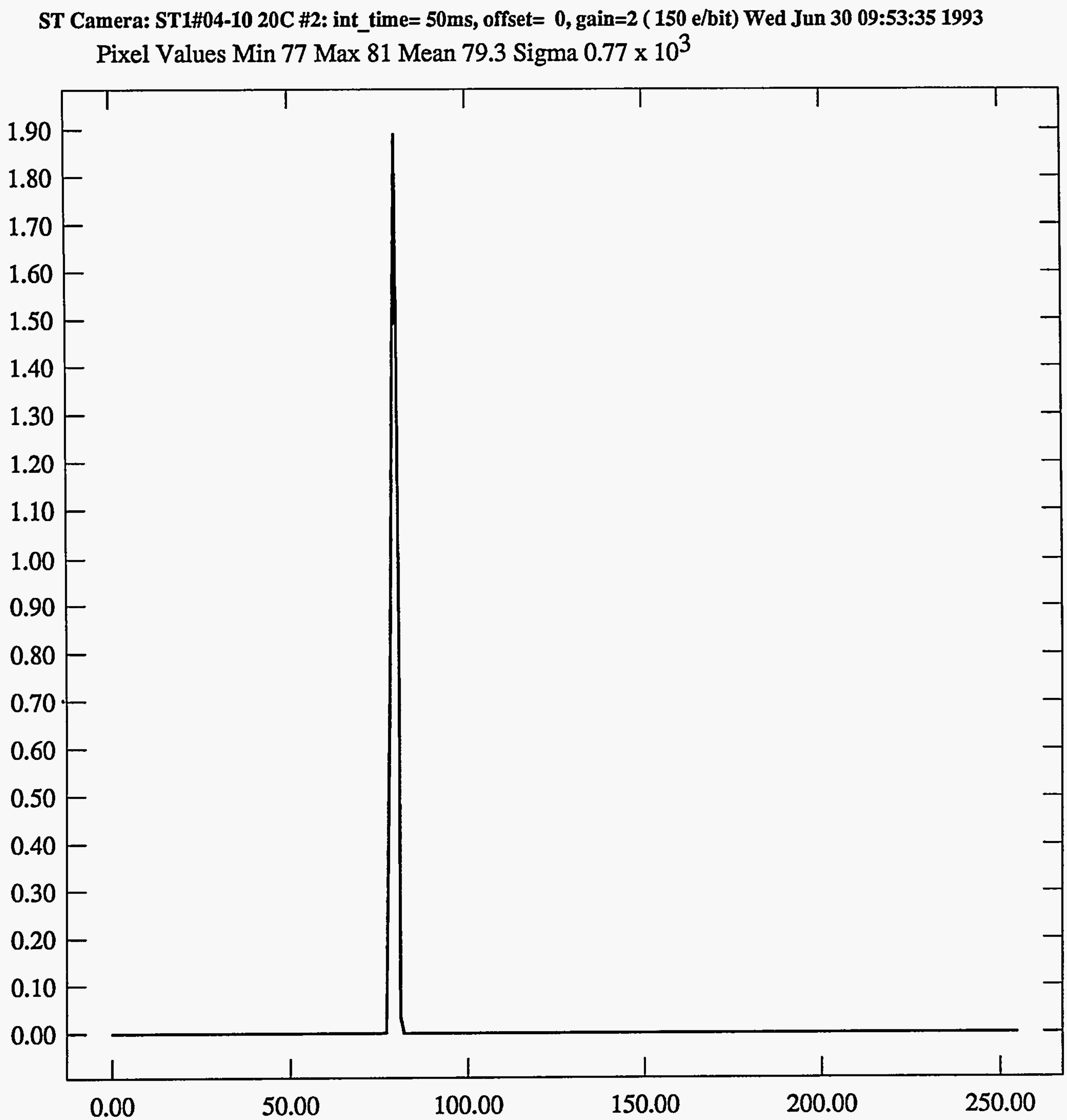
Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3



ST Camera: ST1#04-10 20C #2: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 09:52:56 1993

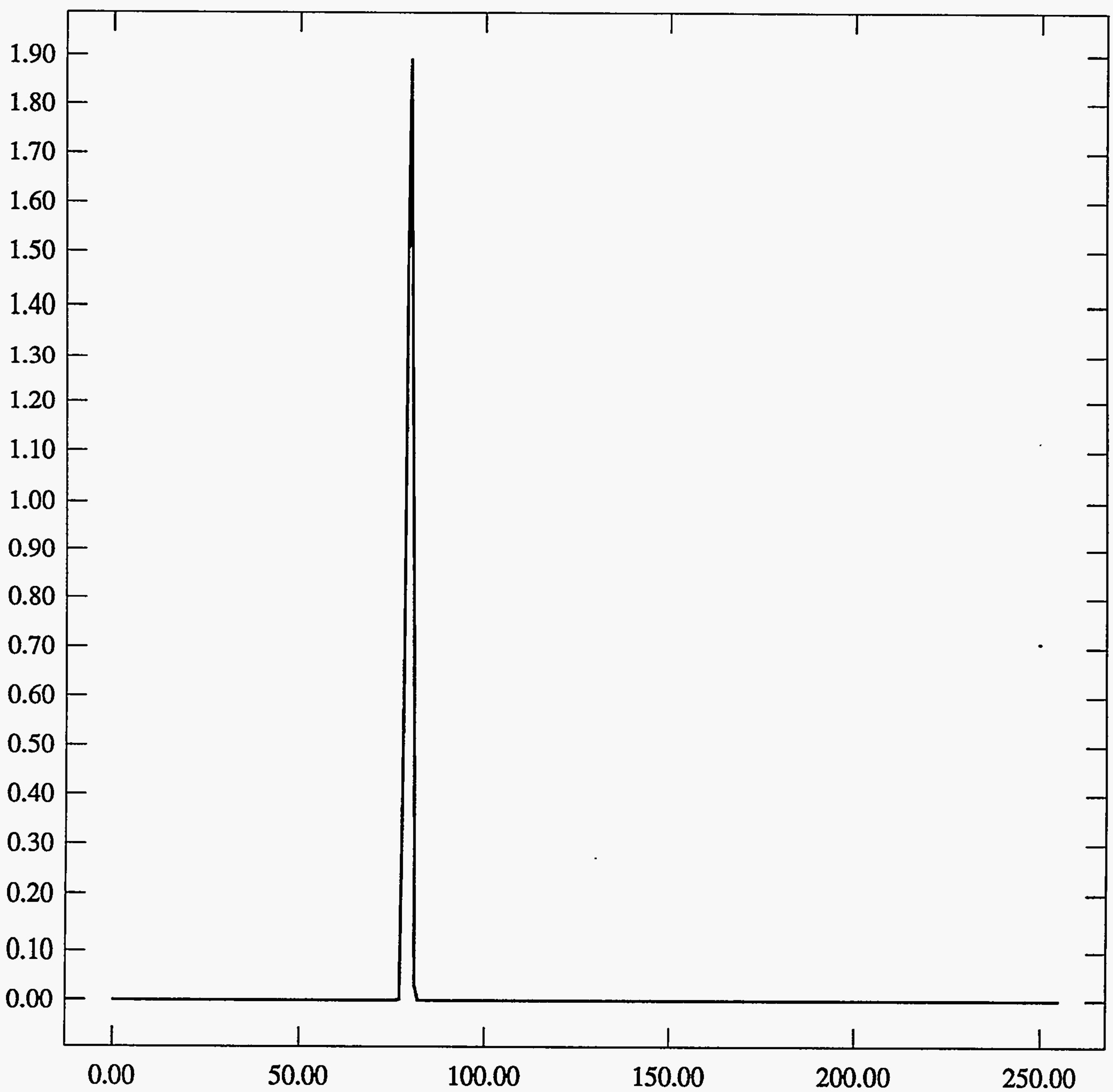
Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3



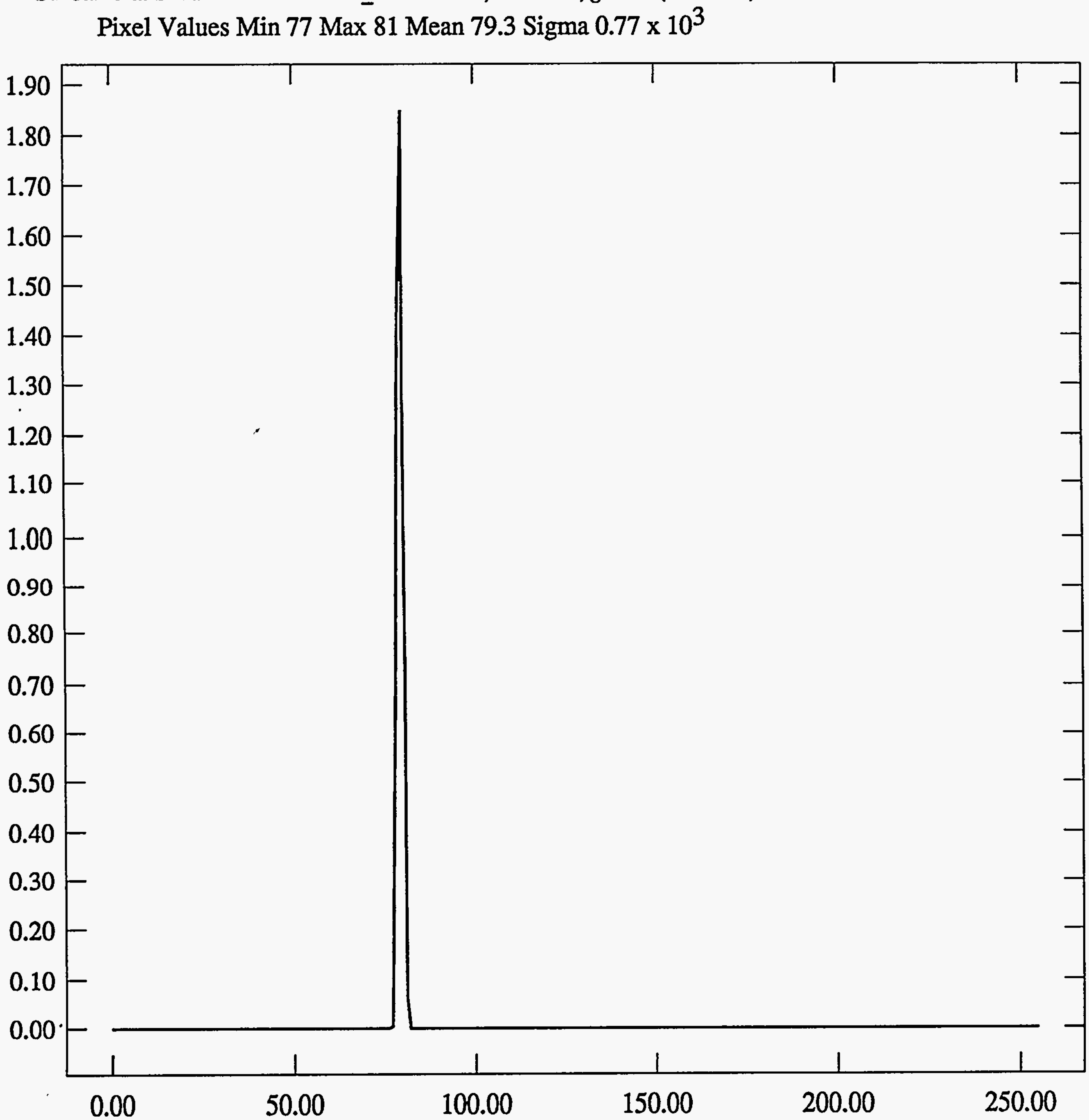

ST Camera: ST1#04-10 20C #2: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 09:53:35 1993
Pixel Values Min 77 Max 81 Mean 79.3 Sigma 0.77 x 10^3
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1#04-10 20C #2: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 09:53:54 1993

Pixel Values Min 77 Max 81 Mean 79.3 Sigma 0.76 x 10^3

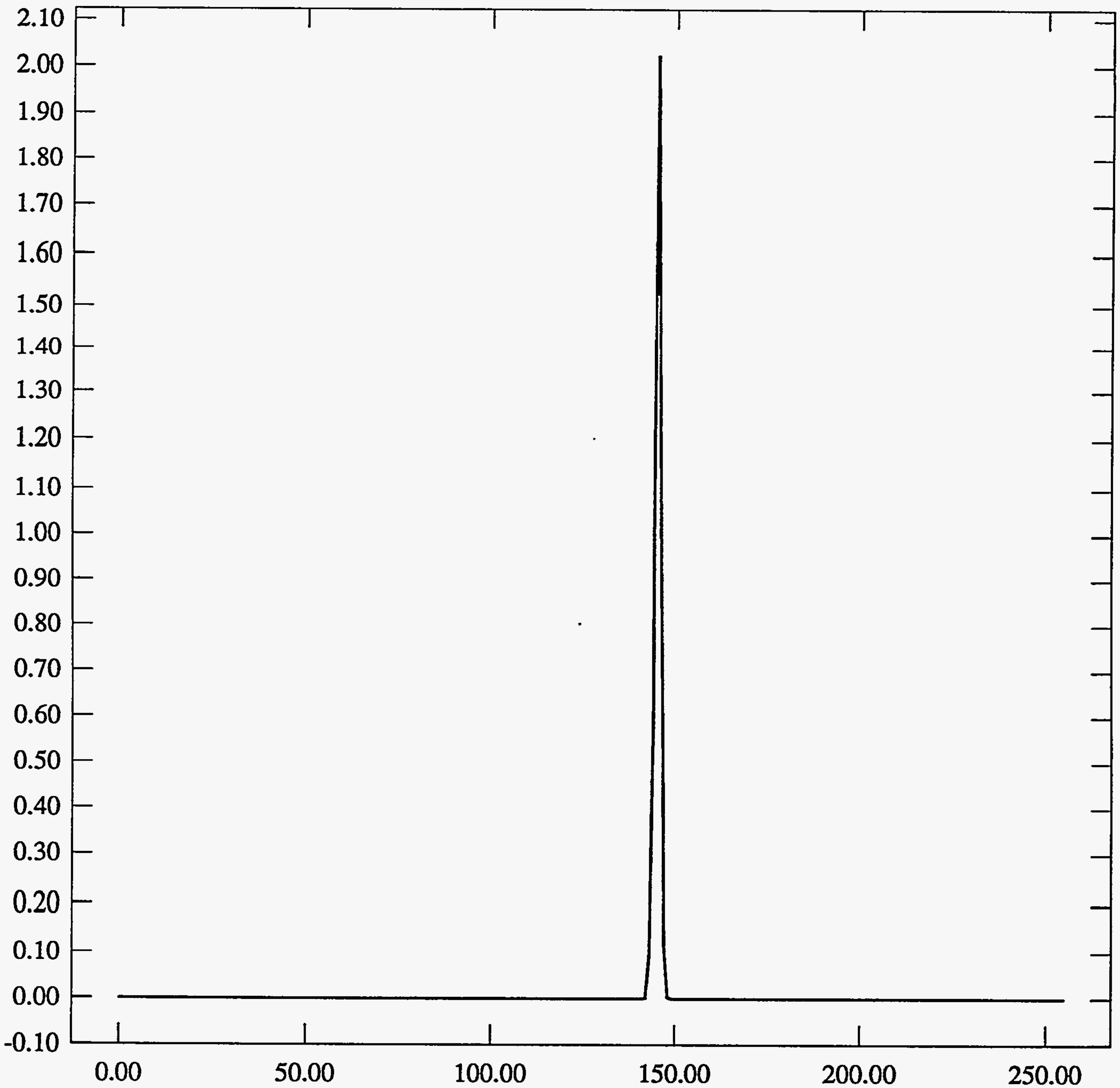


ST Camera: ST1#04-10 20C #2: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 09:54:15 1993



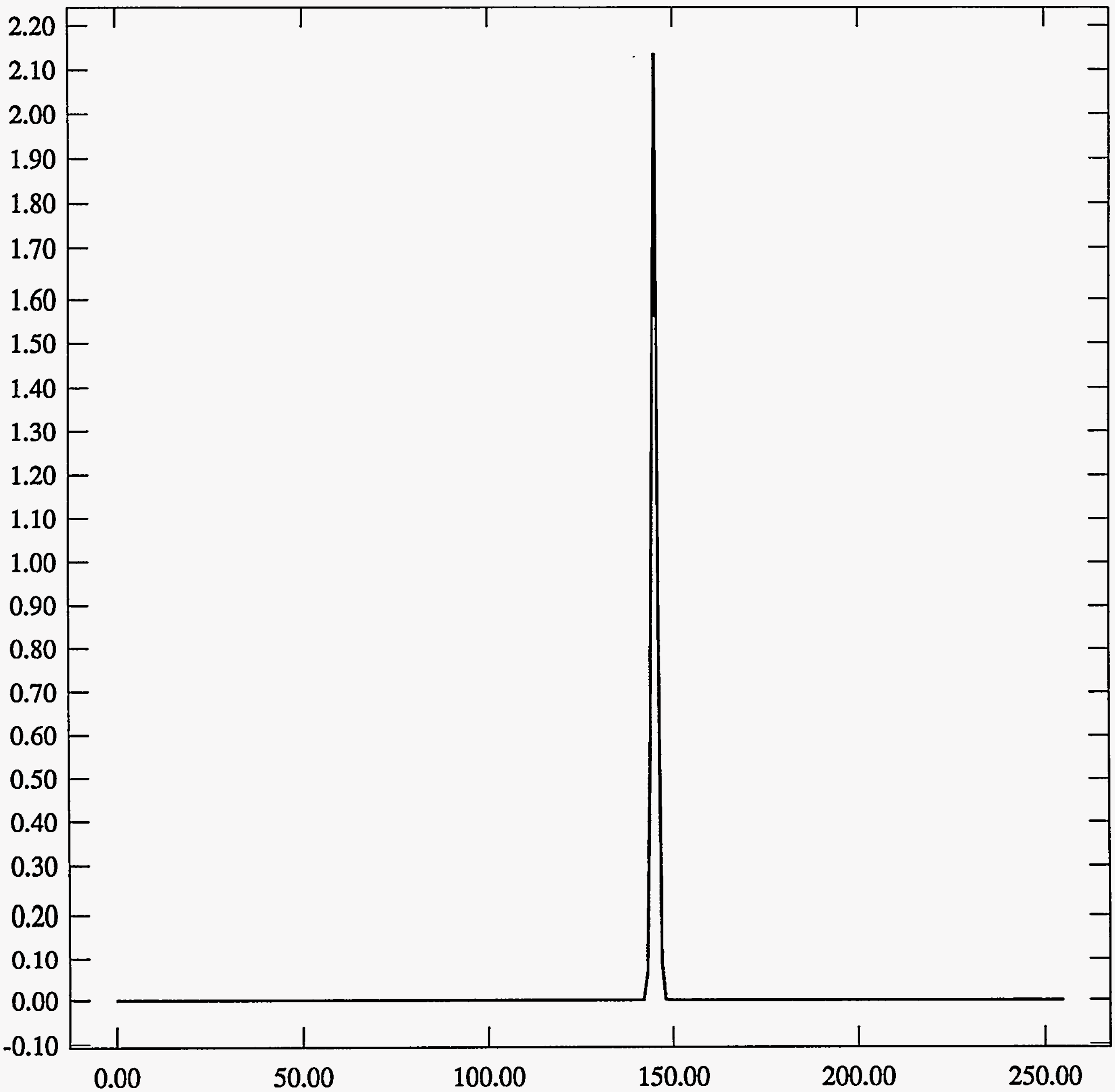
ST Camera: ST1#04-10 20C #2: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 09:54:36 1993

Pixel Values Min 142 Max 148 Mean 145.2 Sigma 0.80 x 10^3



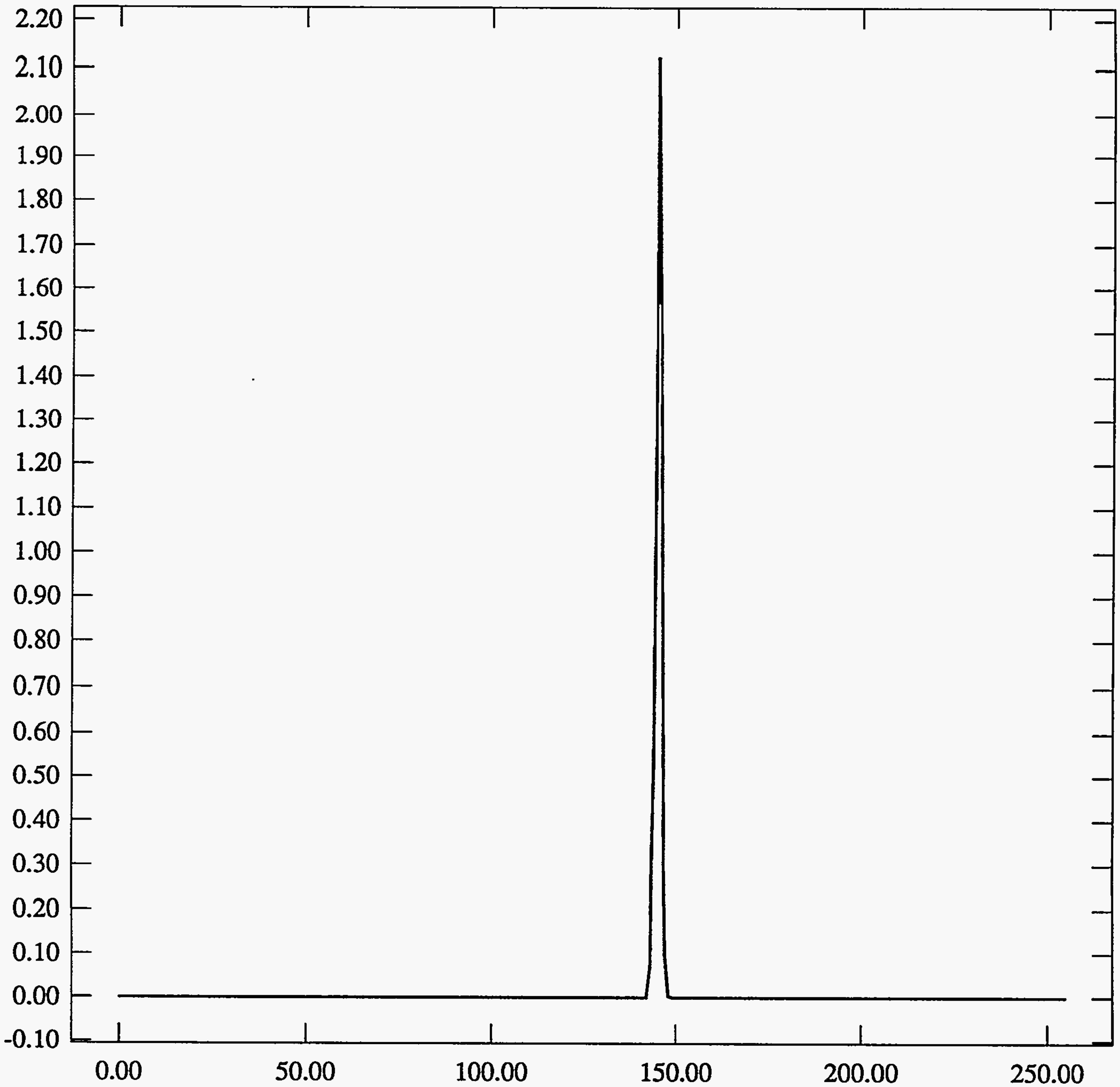
ST Camera: ST1#04-10 20C #2: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 09:55:00 1993

Pixel Values Min 143 Max 148 Mean 145.2 Sigma 0.75 x 10^3



ST Camera: ST1#04-10 20C #2: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 09:55:21 1993

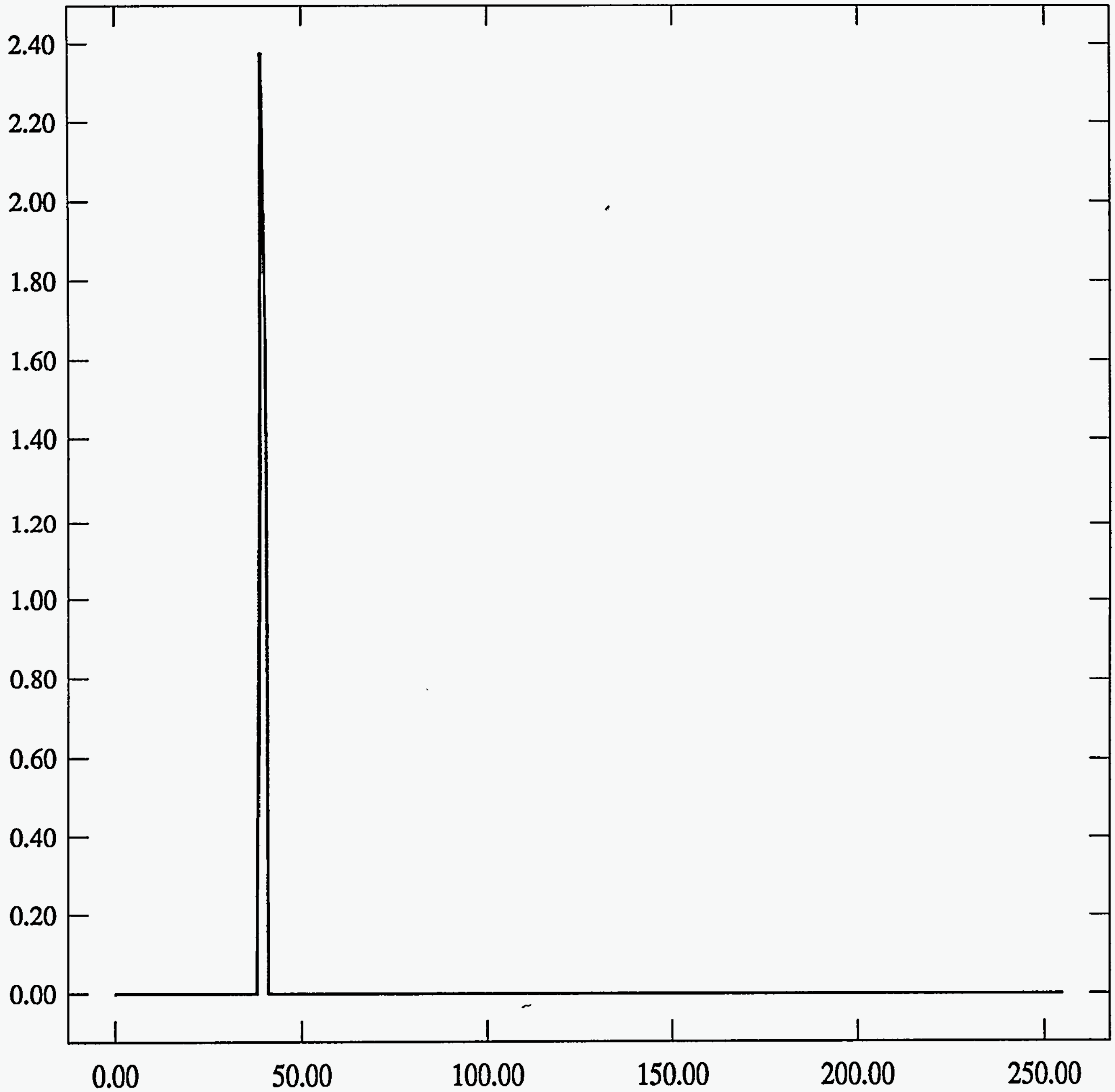
Pixel Values Min 143 Max 148 Mean 145.2 Sigma 0.76 x 10^3



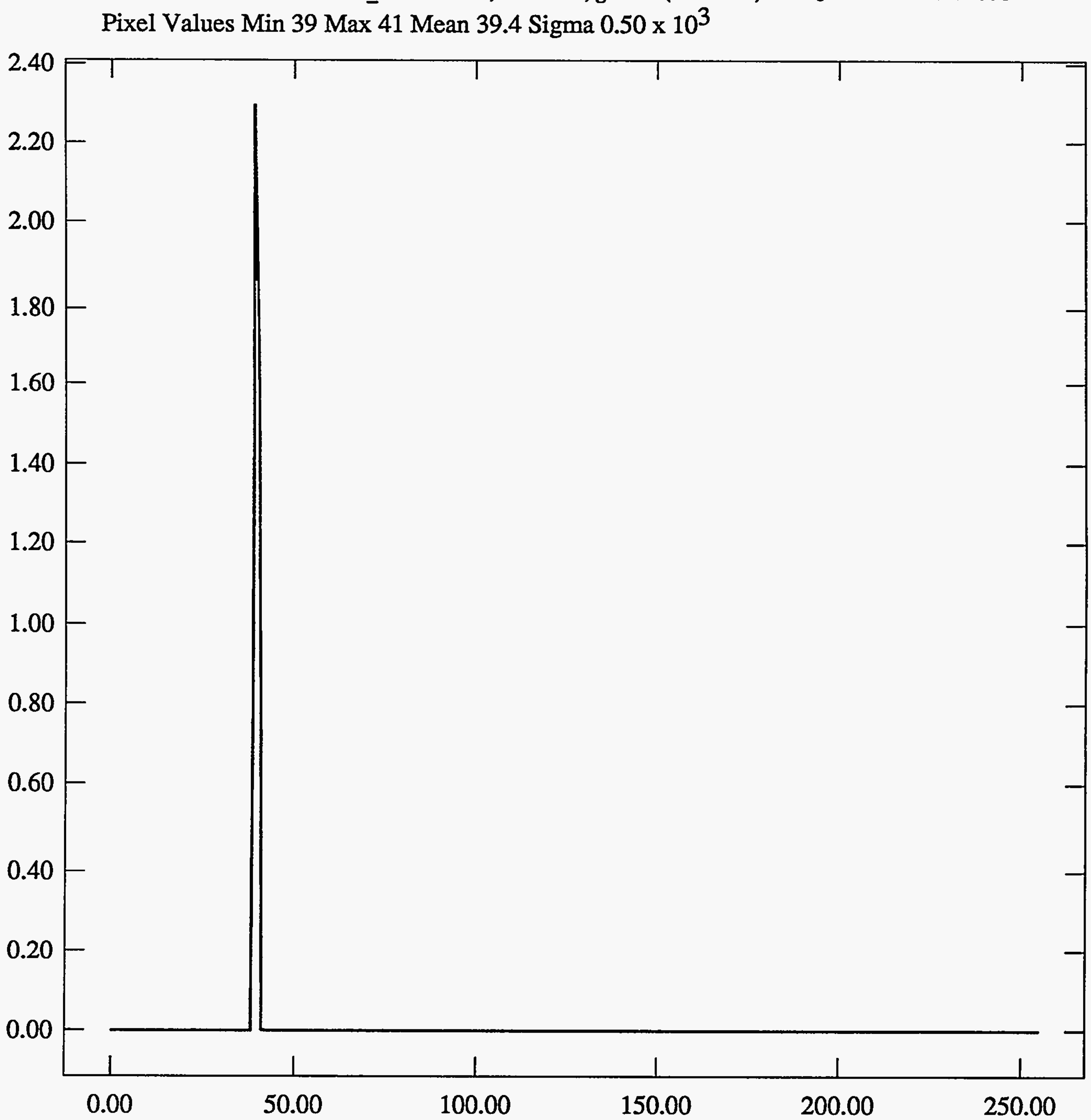
#2ϕ 20C END OF CYCLE

ST Camera: ST1#04-10 20C #2: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 10:33:49 1993

Pixel Values Min 39 Max 41 Mean 39.4 Sigma 0.49 x 10^3

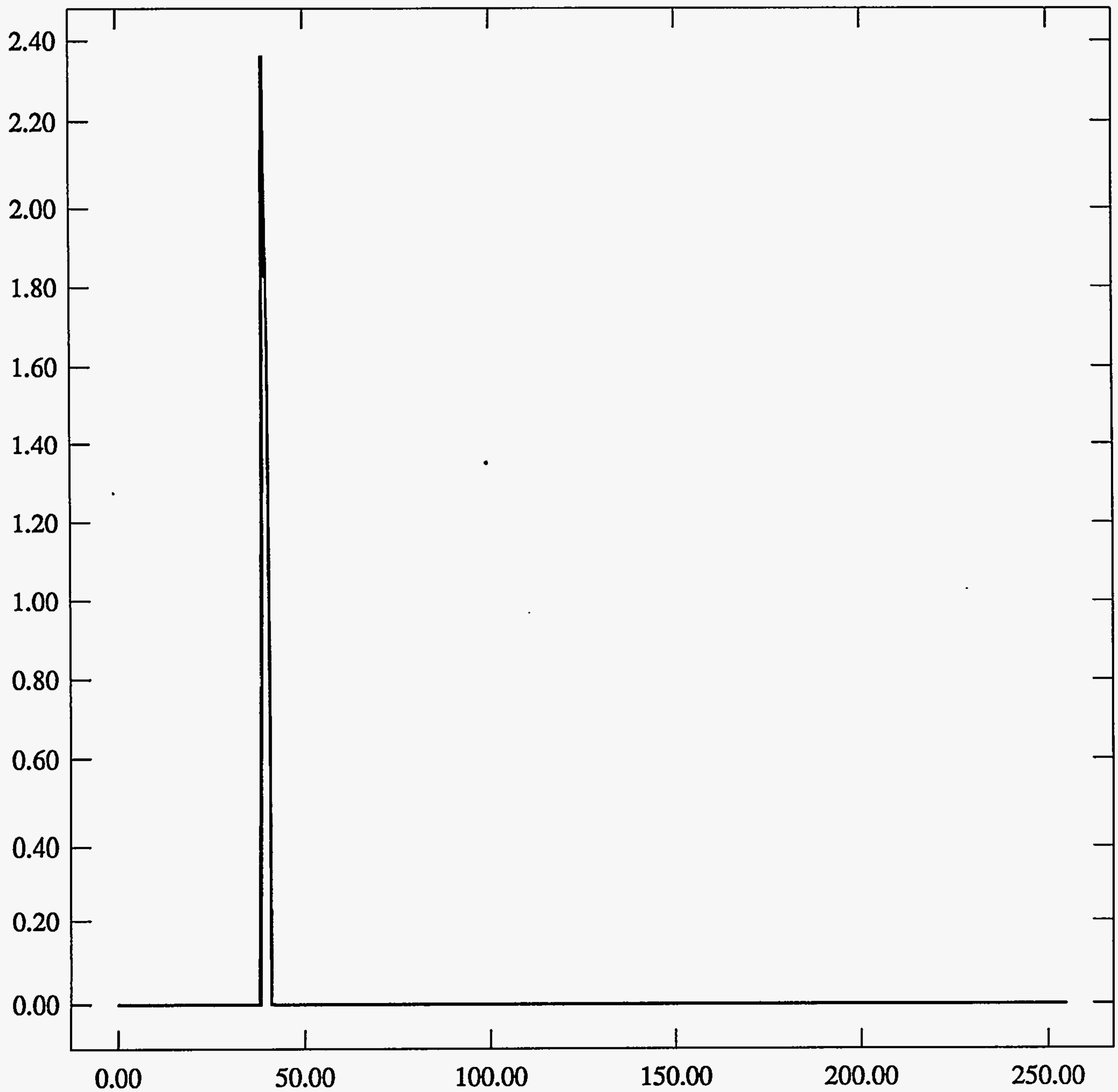


ST Camera: ST1#04-10 20C #2: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 10:34:06 1993



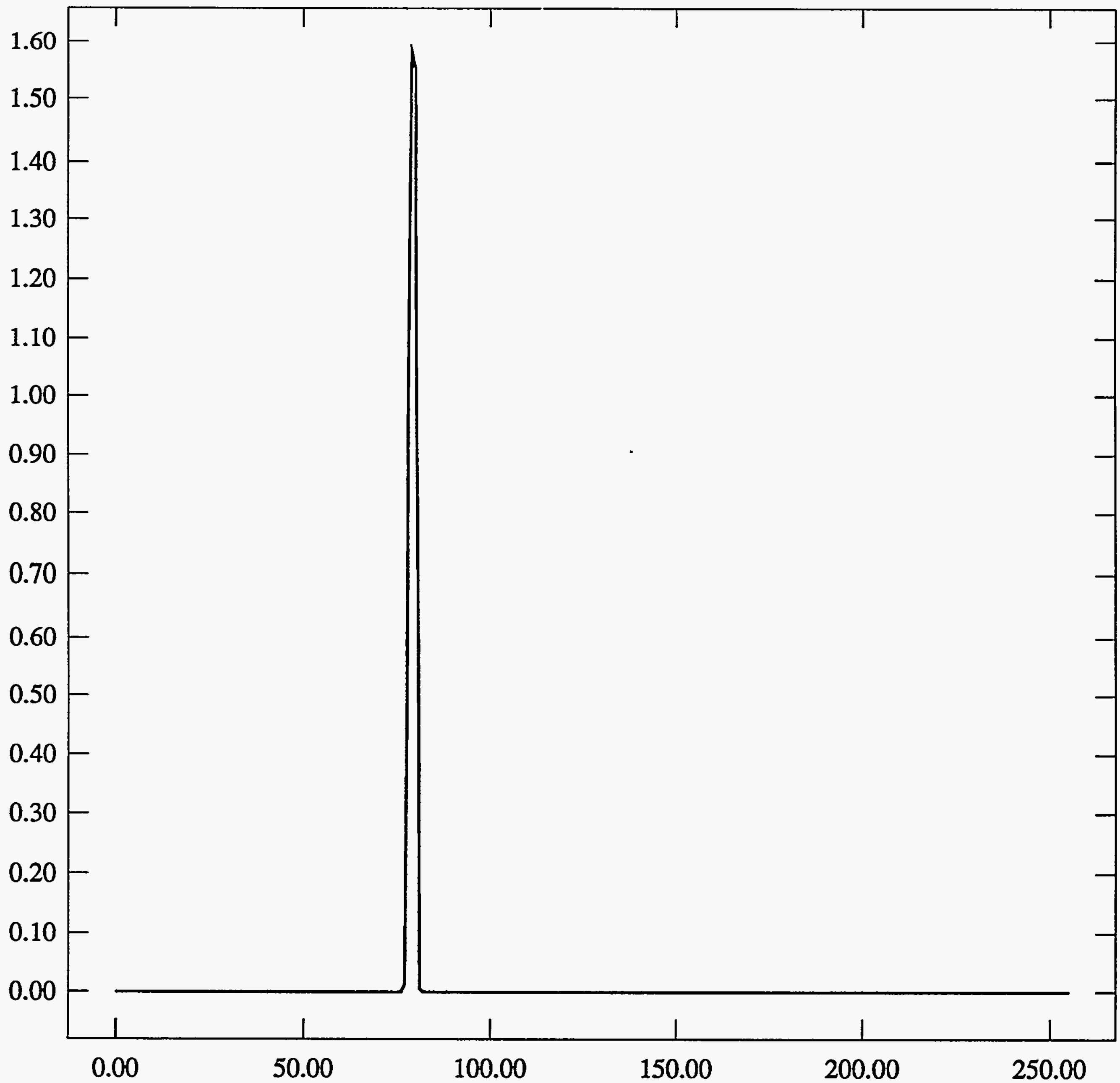
ST Camera: ST1#04-10 20C #2: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 10:34:23 1993

Pixel Values Min 39 Max 41 Mean 39.4 Sigma 0.49 x 10^3



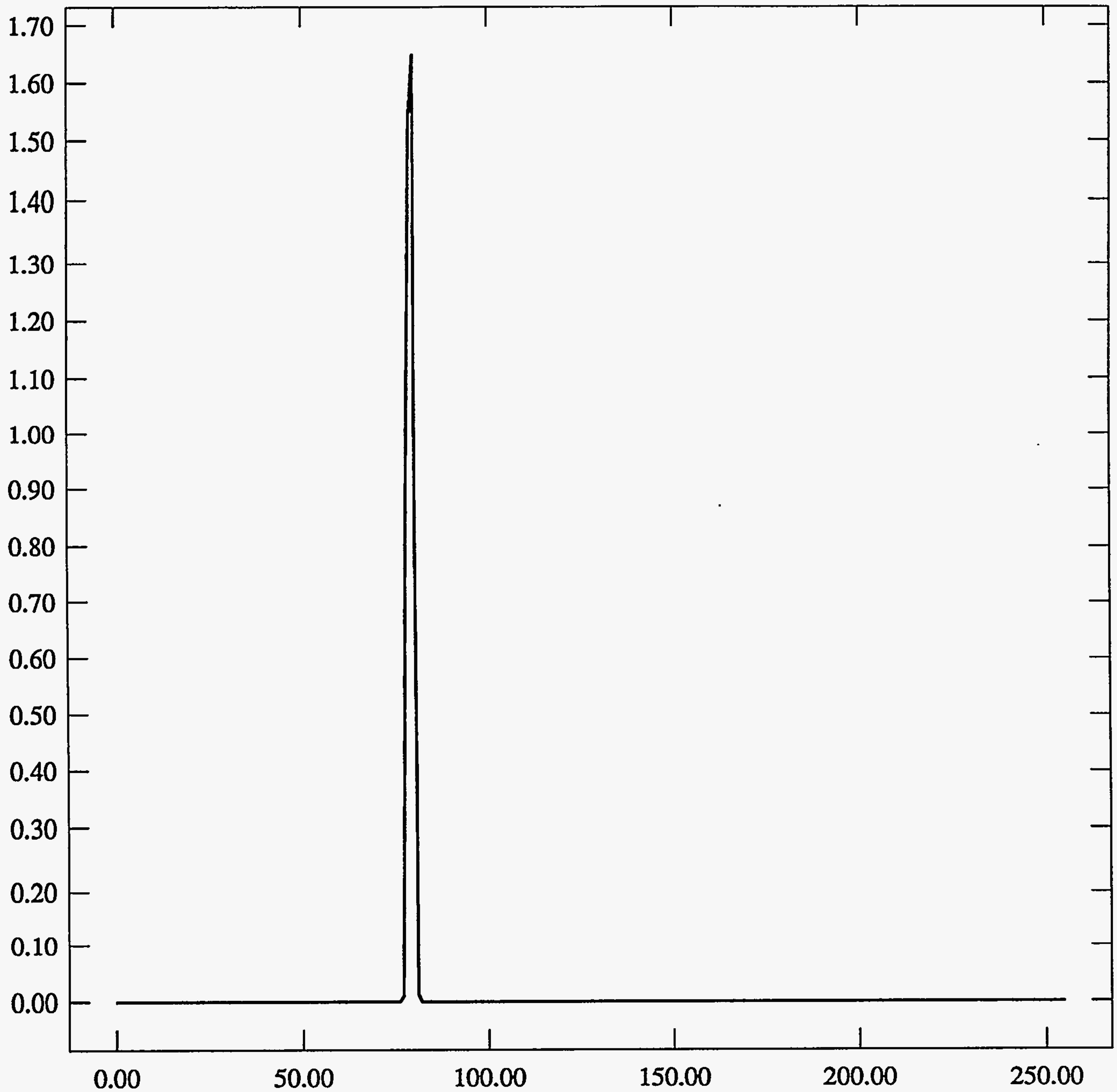
ST Camera: ST1#04-10 20C #2: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 10:34:49 1993

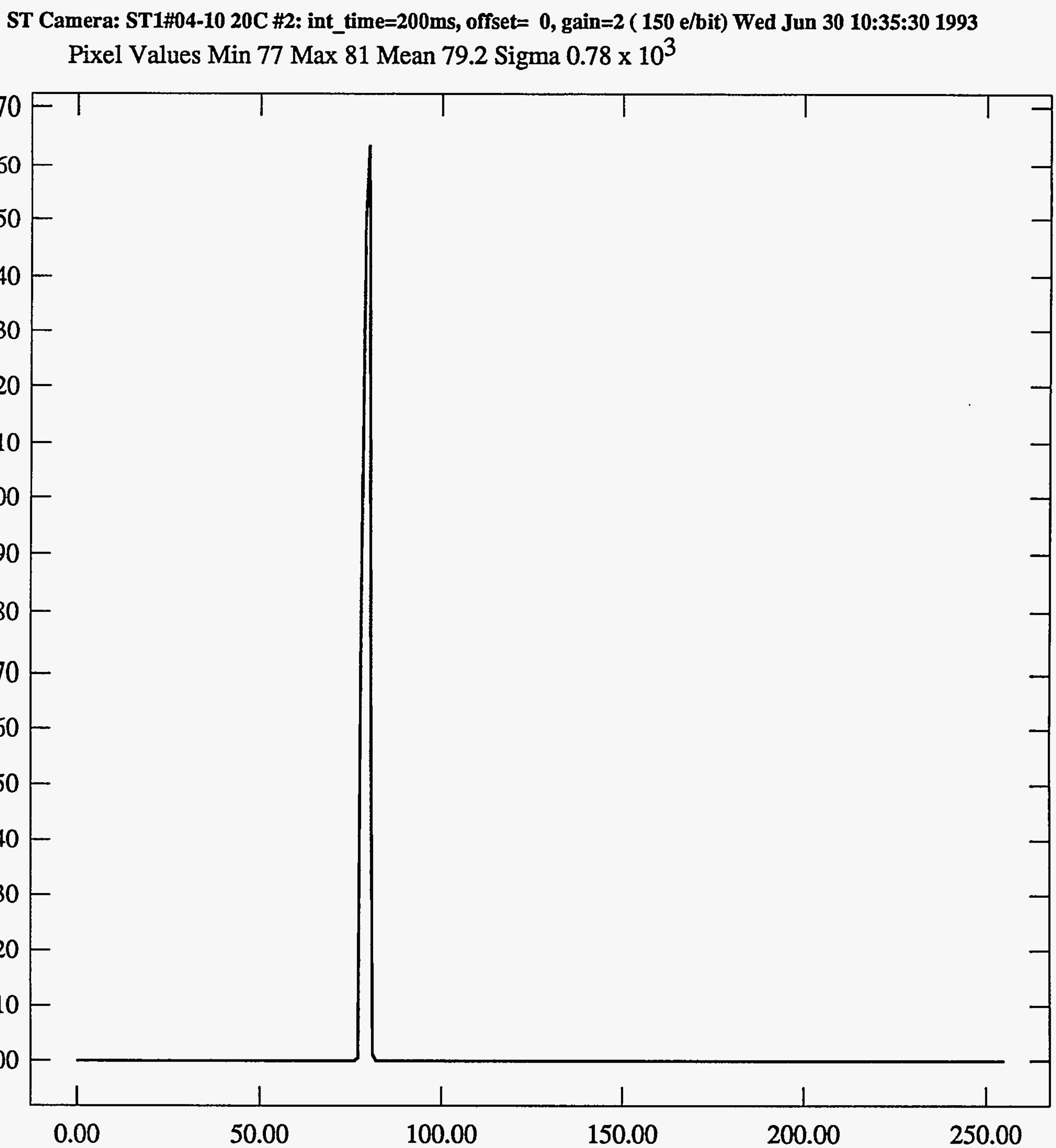
Pixel Values Min 77 Max 81 Mean 79.2 Sigma 0.77 x 10^3



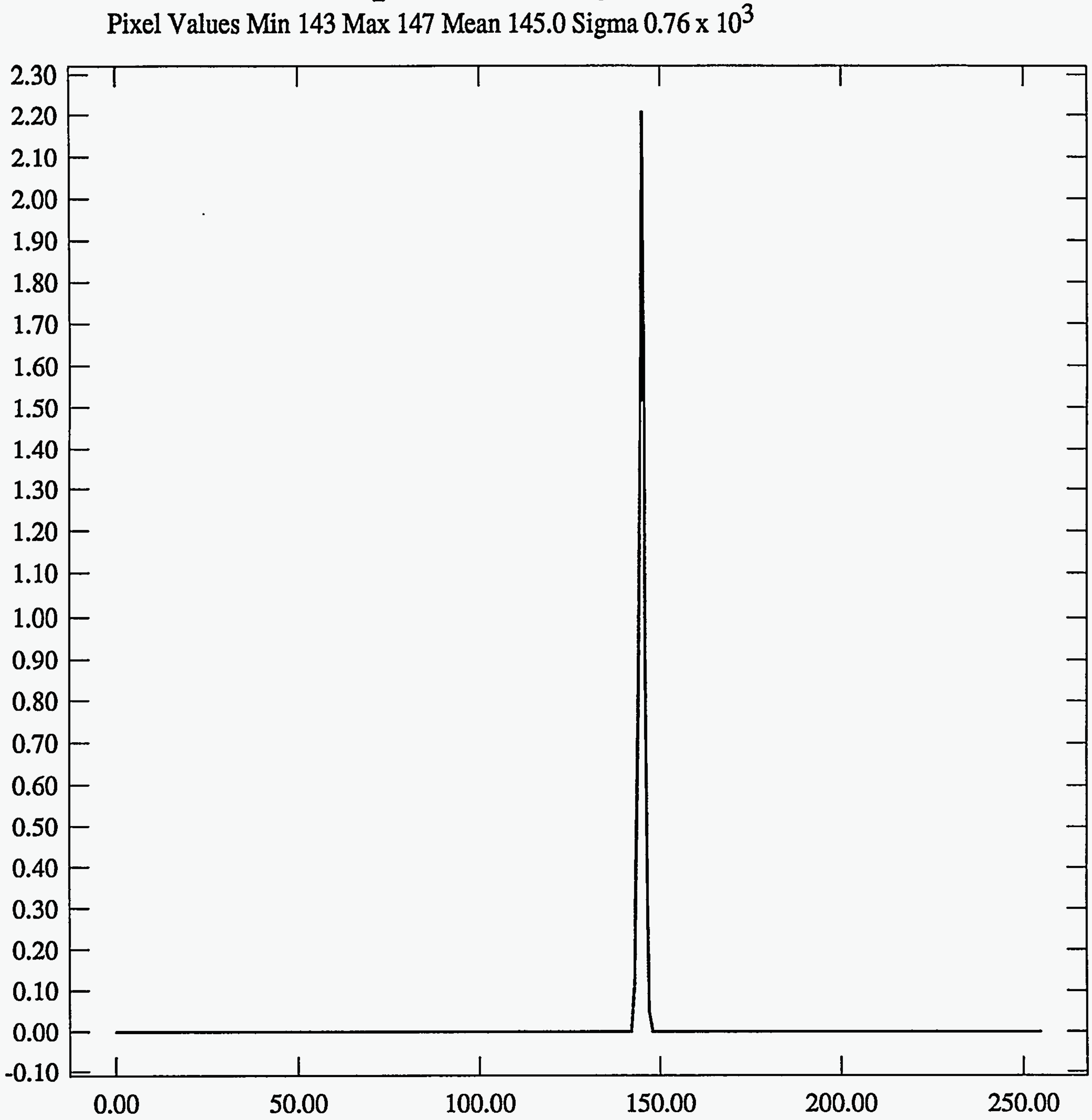
ST Camera: ST1#04-10 20C #2: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 10:35:13 1993

Pixel Values Min 77 Max 81 Mean 79.2 Sigma 0.77 x 10^3



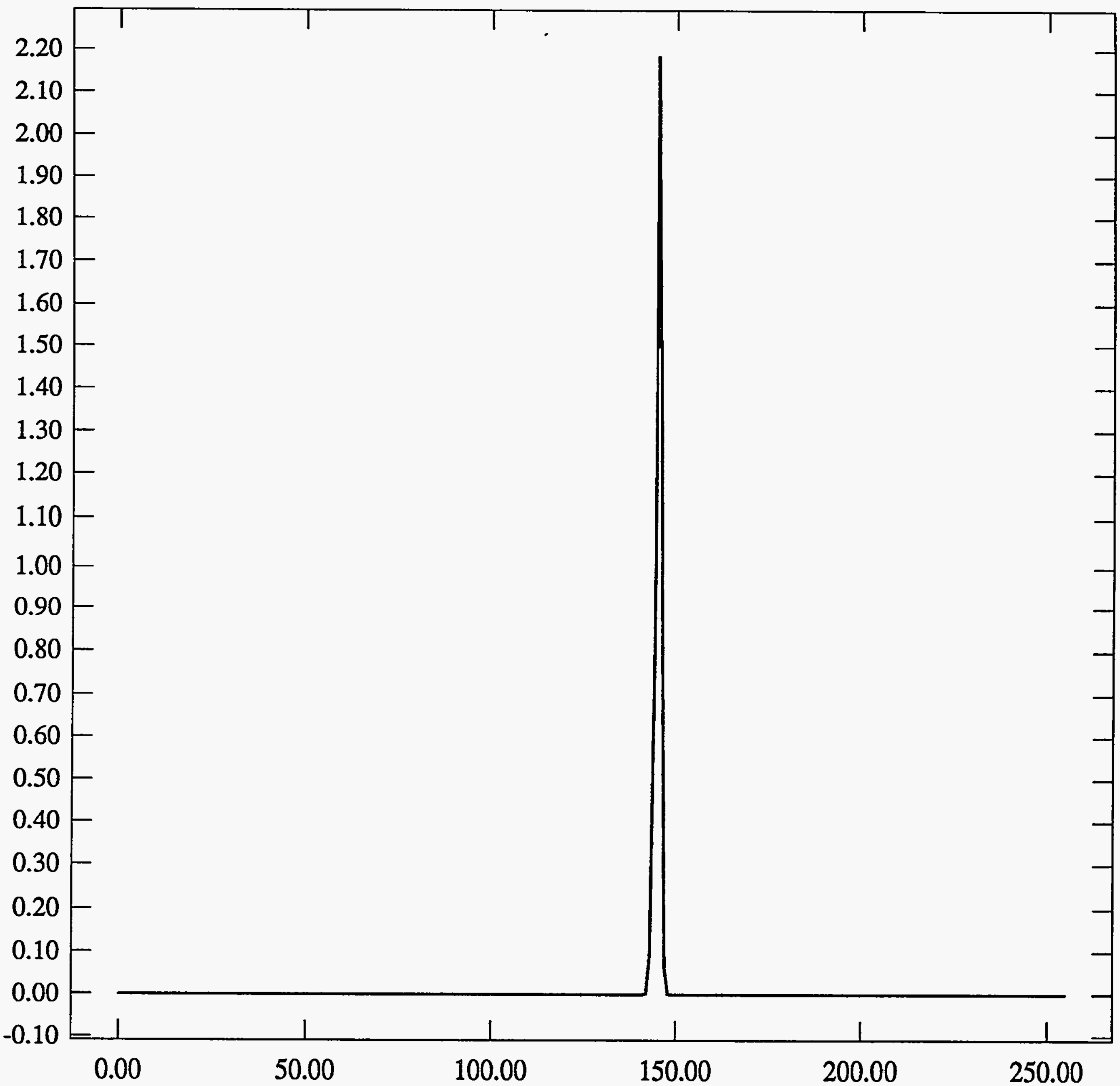

ST Camera: ST1#04-10 20C #2: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 10:35:30 1993
Pixel Values Min 77 Max 81 Mean 79.2 Sigma 0.78 x 10^3
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1#04-10 20C #2: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 10:35:52 1993



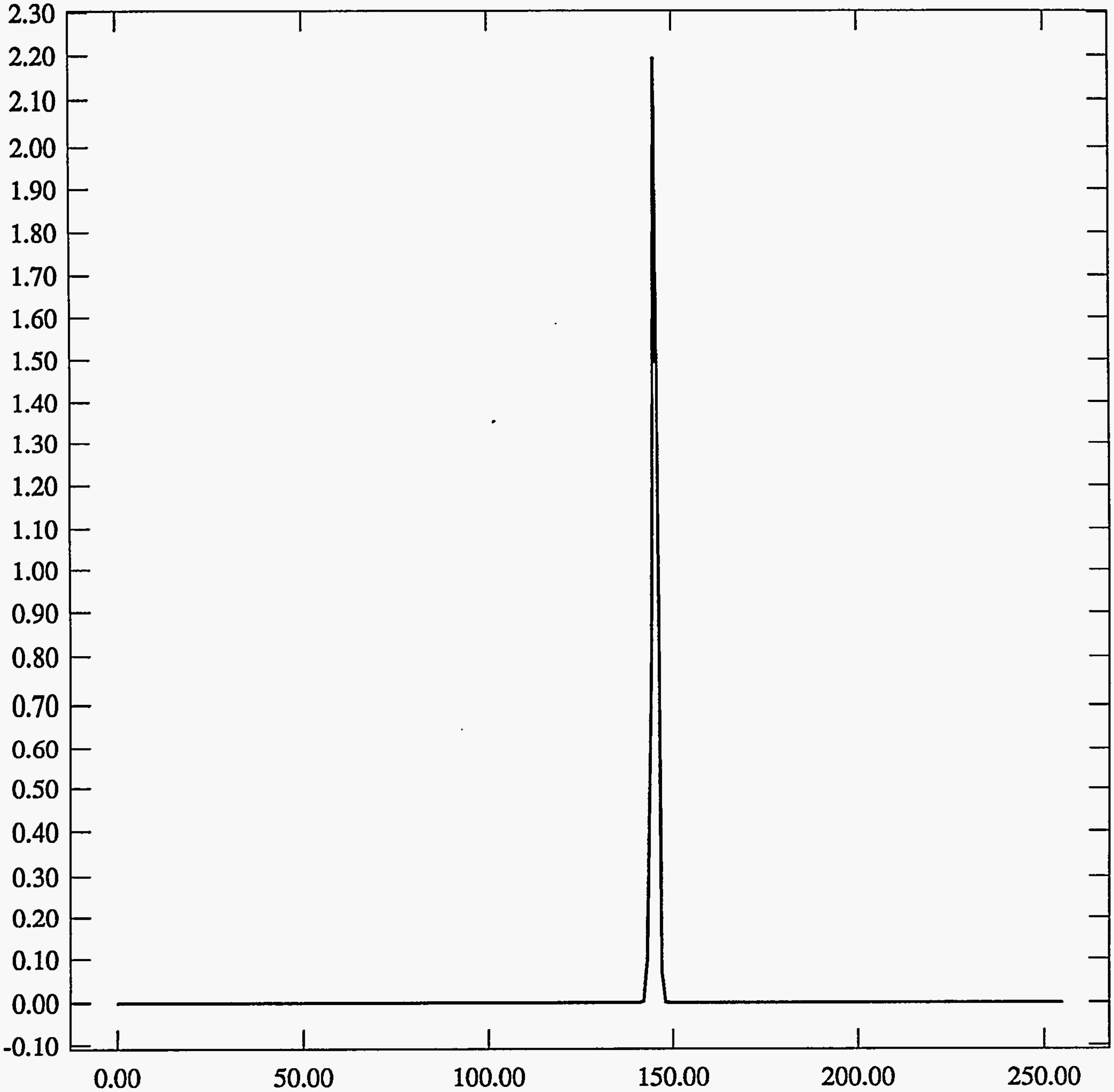
ST Camera: ST1#04-10 20C #2: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 10:36:11 1993

Pixel Values Min 142 Max 148 Mean 145.0 Sigma 0.76 x 10^3



ST Camera: ST1#04-10 20C #2: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 10:36:28 1993

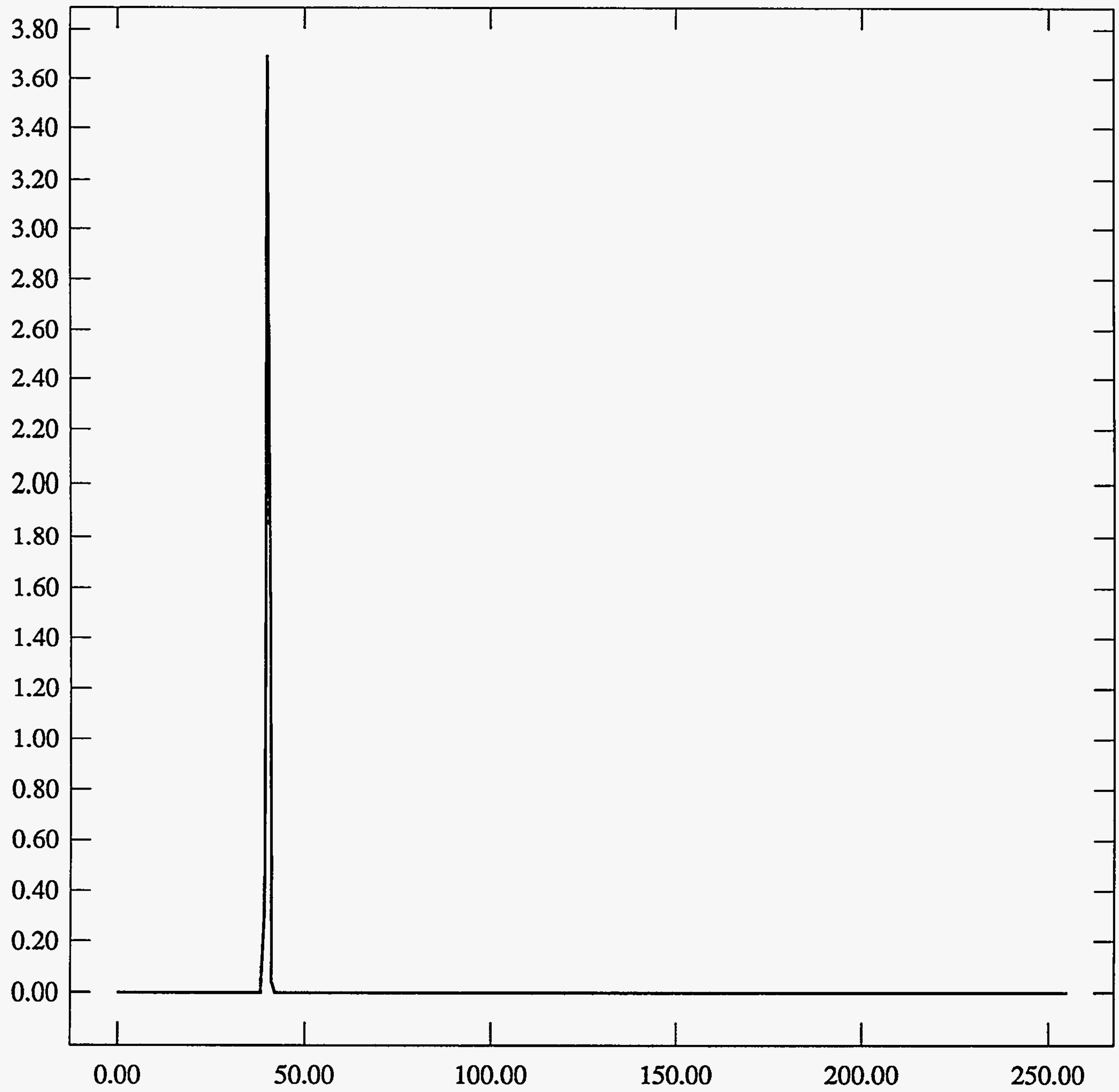
Pixel Values Min 142 Max 148 Mean 145.0 Sigma 0.77 x 10^3



#3 -30C 15min

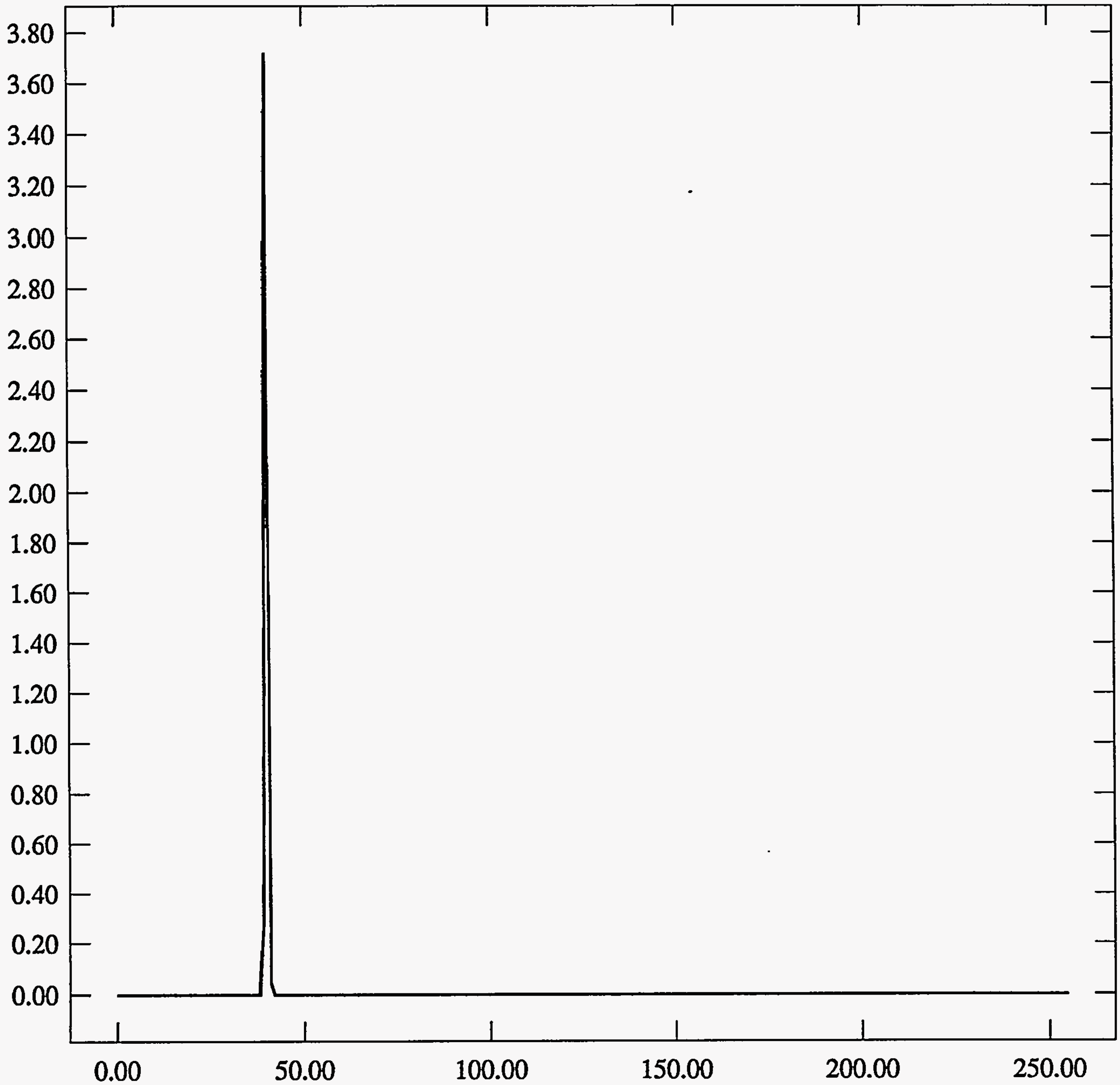
ST Camera: ST1#04-10 -30C #3: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 11:09:37 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.28 x 10^3



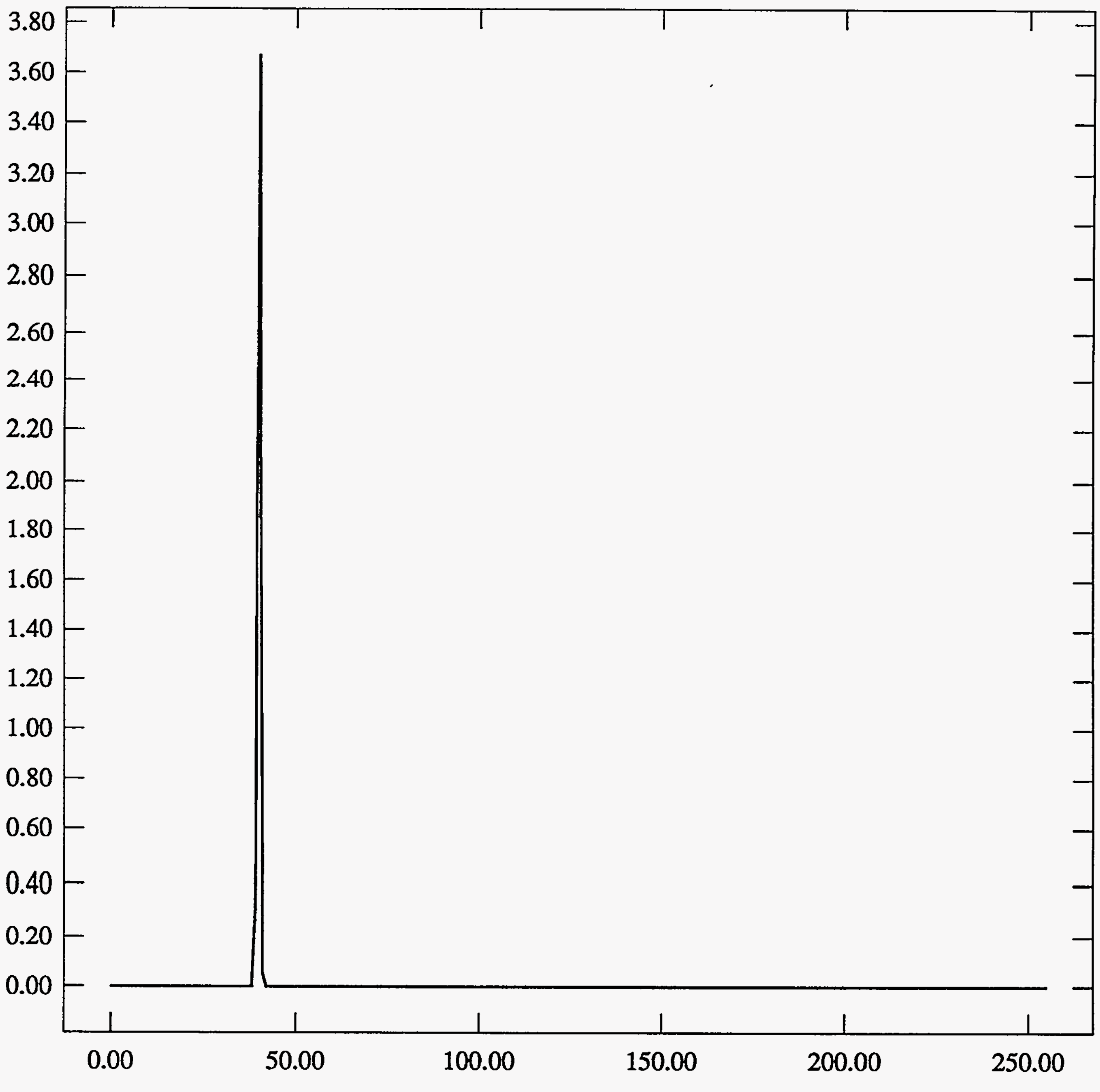
ST Camera: ST1#04-10 -30C #3: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 11:09:54 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.28 x 10^3



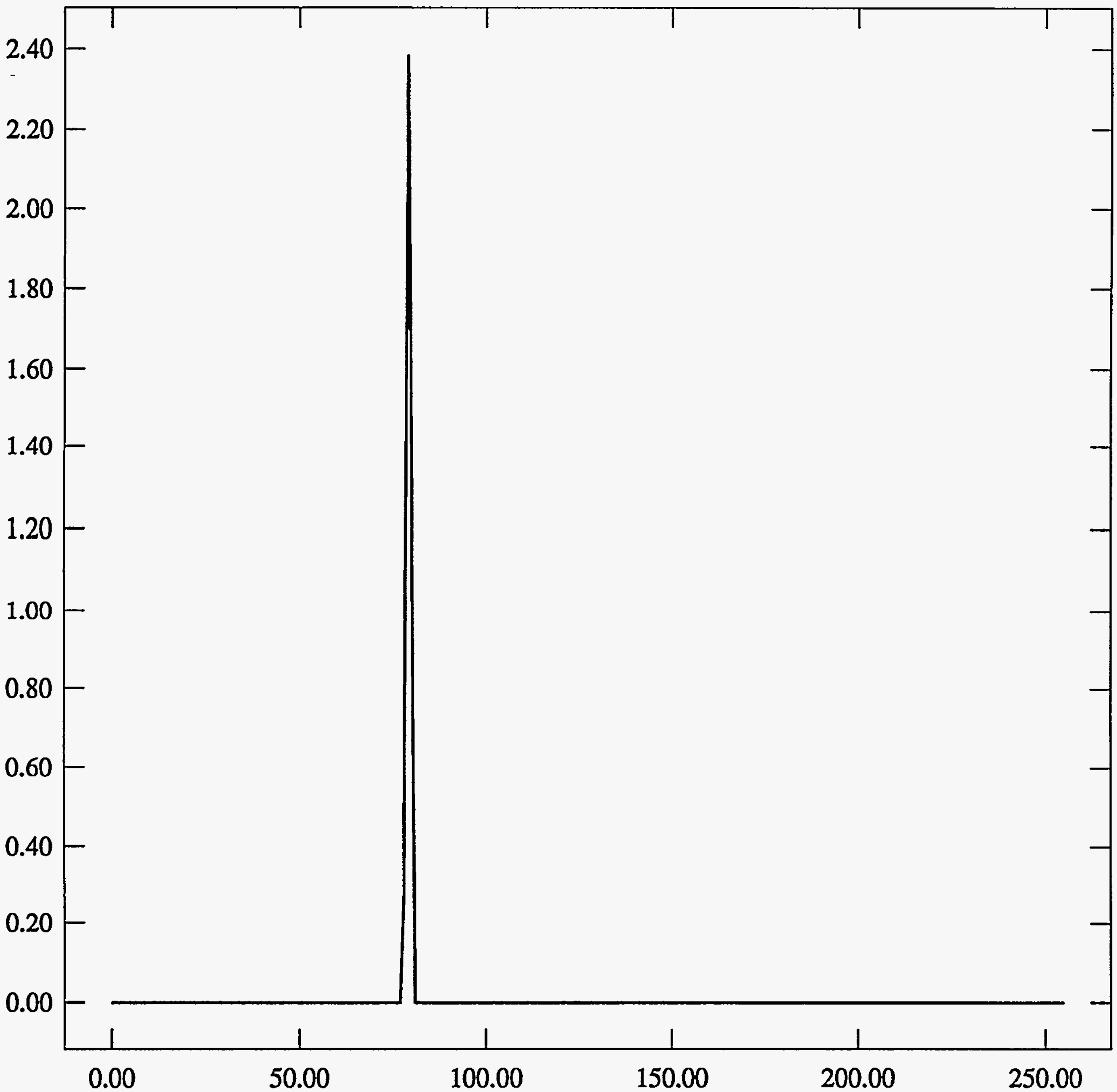
ST Camera: ST1#04-10 -30C #3: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 11:10:10 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.29 x 10^3



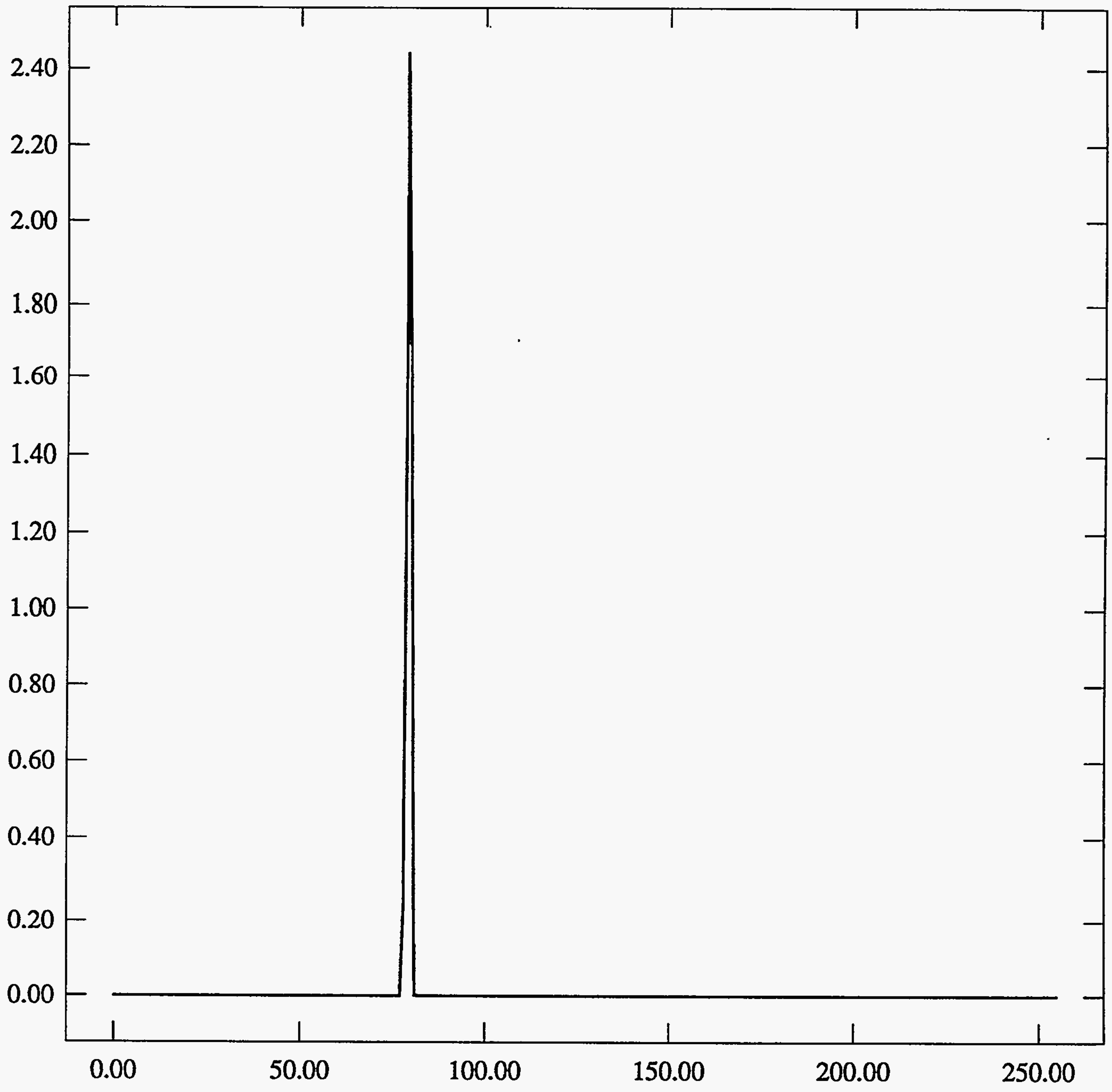
ST Camera: ST1#04-10 -30C #3: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 11:10:30 1993

Pixel Values Min 78 Max 81 Mean 79.3 Sigma 0.58 x 10^3



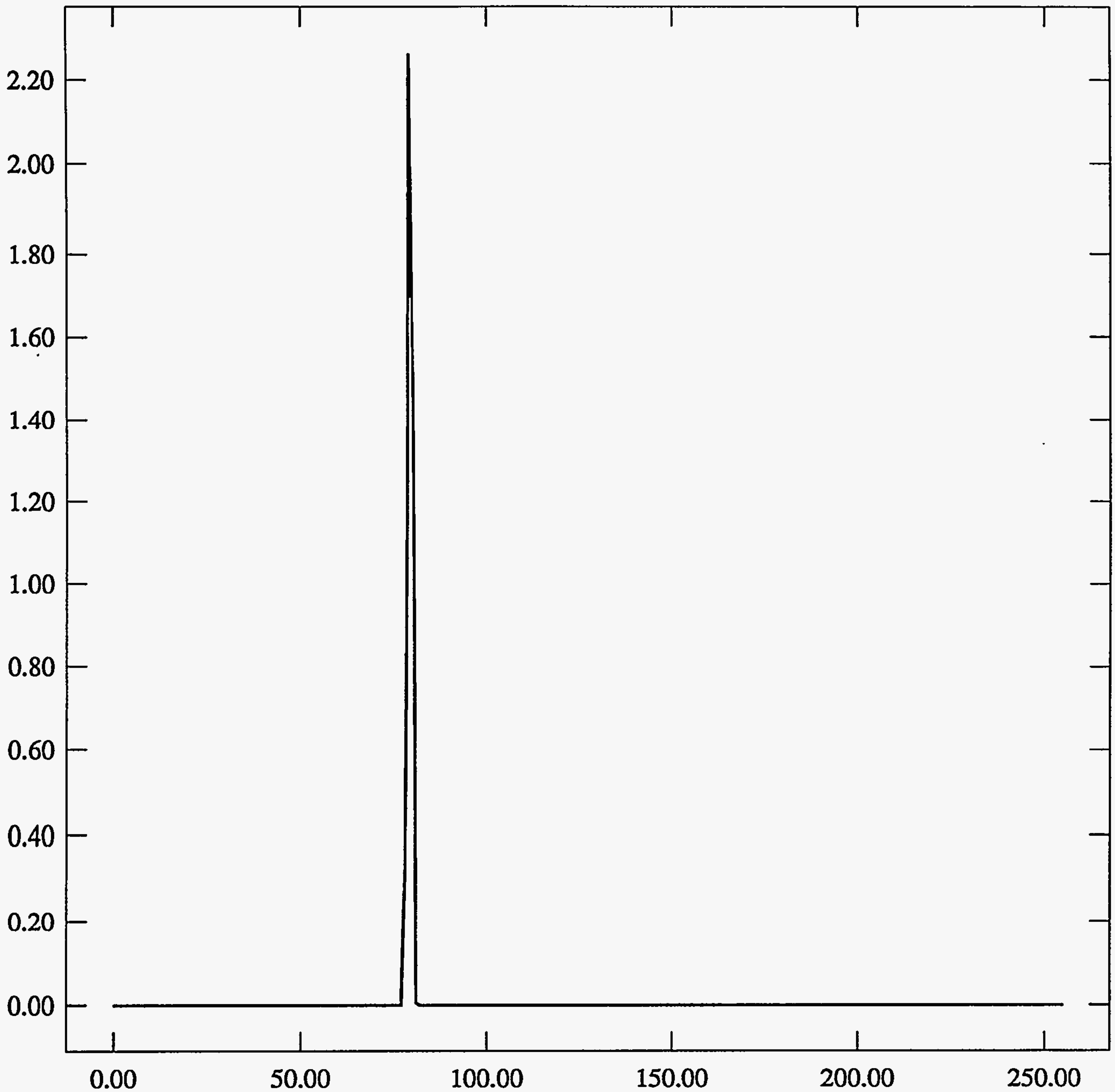
ST Camera: ST1#04-10 -30C #3: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 11:10:54 1993

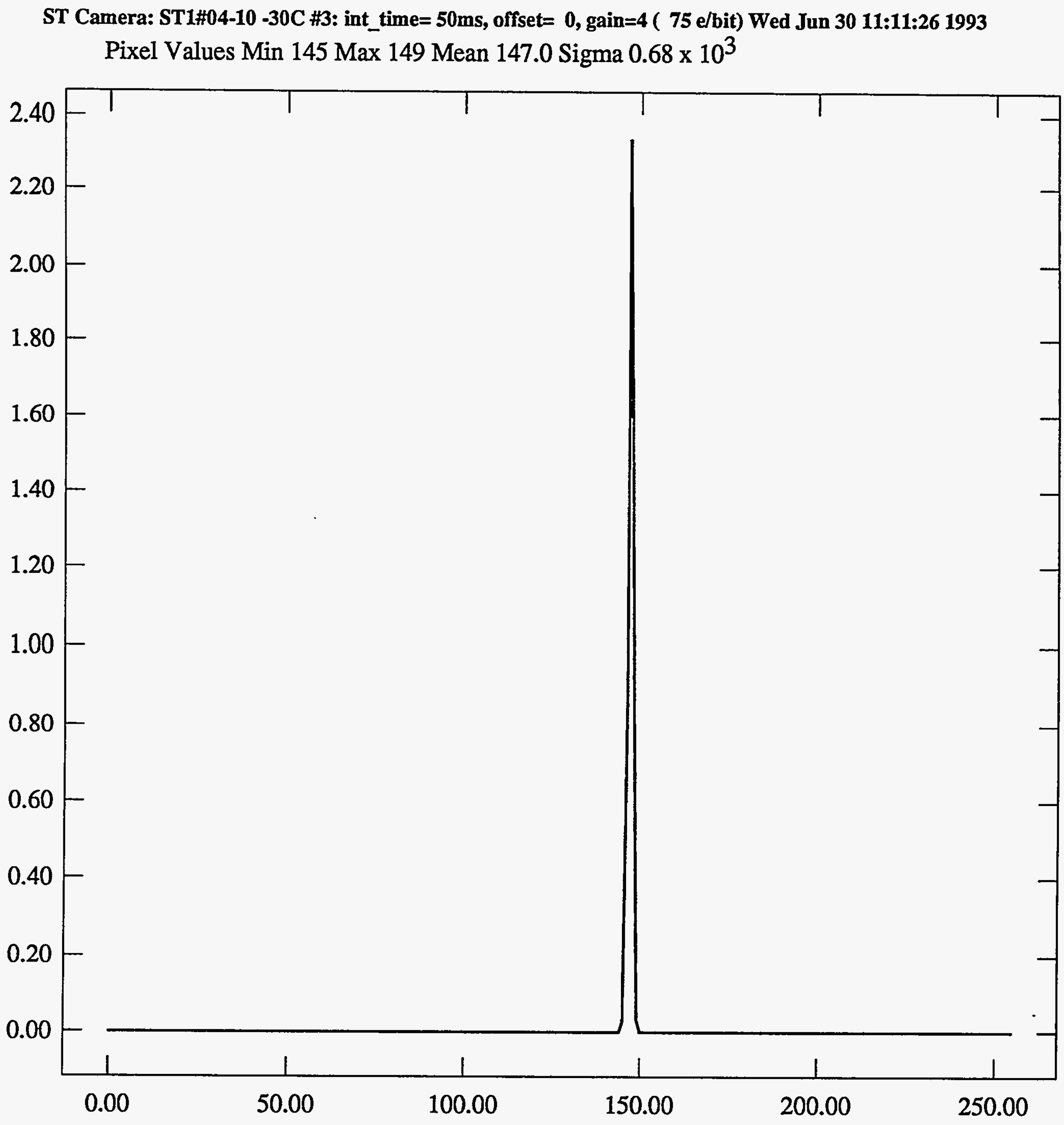
Pixel Values Min 78 Max 81 Mean 79.3 Sigma 0.57 x 10^3



ST Camera: ST1#04-10 -30C #3: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 11:11:10 1993

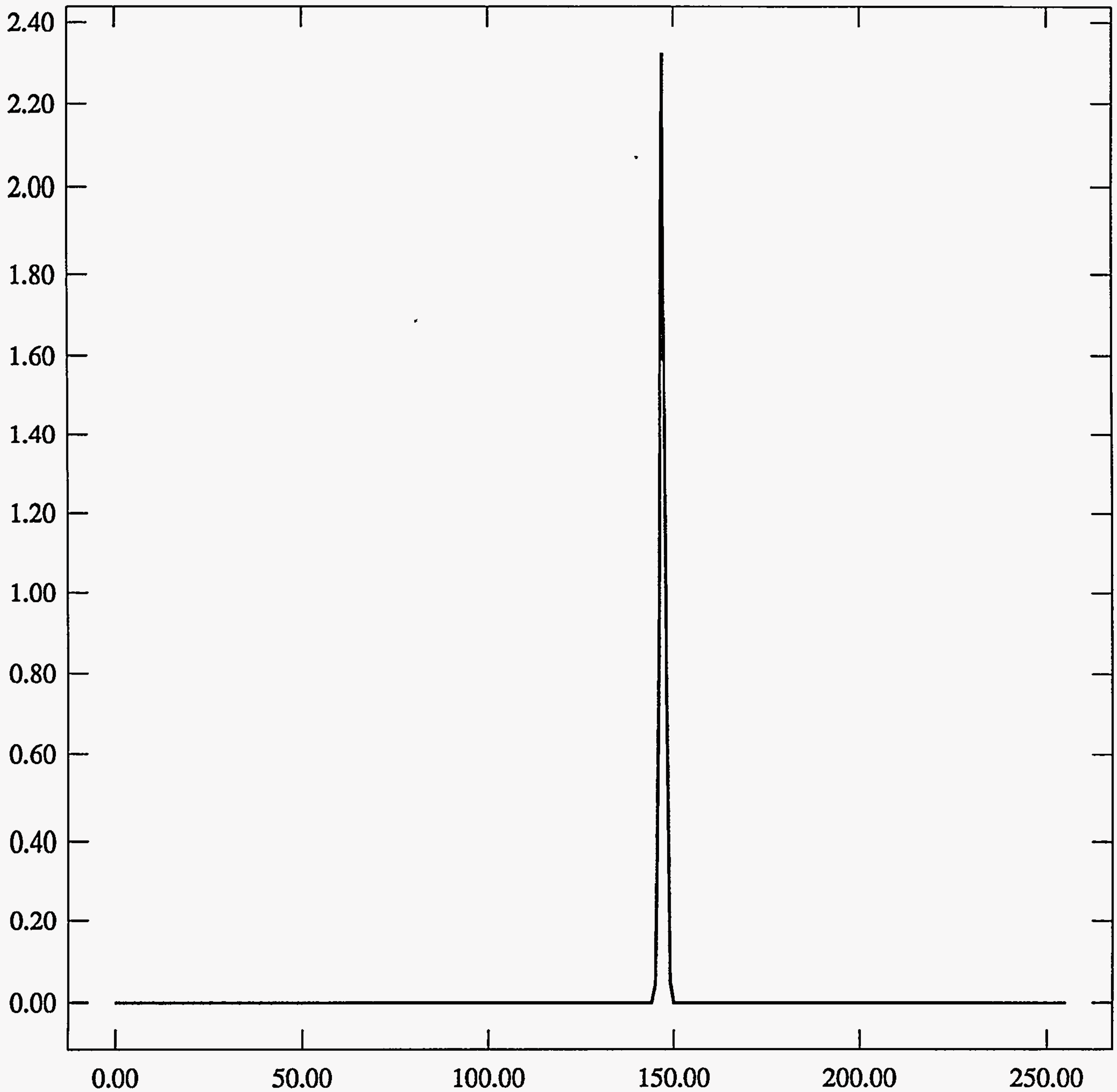
Pixel Values Min 78 Max 81 Mean 79.3 Sigma 0.61 x 10^3




ST Camera: ST1#04-10 -30C #3: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 11:11:26 1993
Pixel Values Min 145 Max 149 Mean 147.0 Sigma 0.68 x 10^3
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

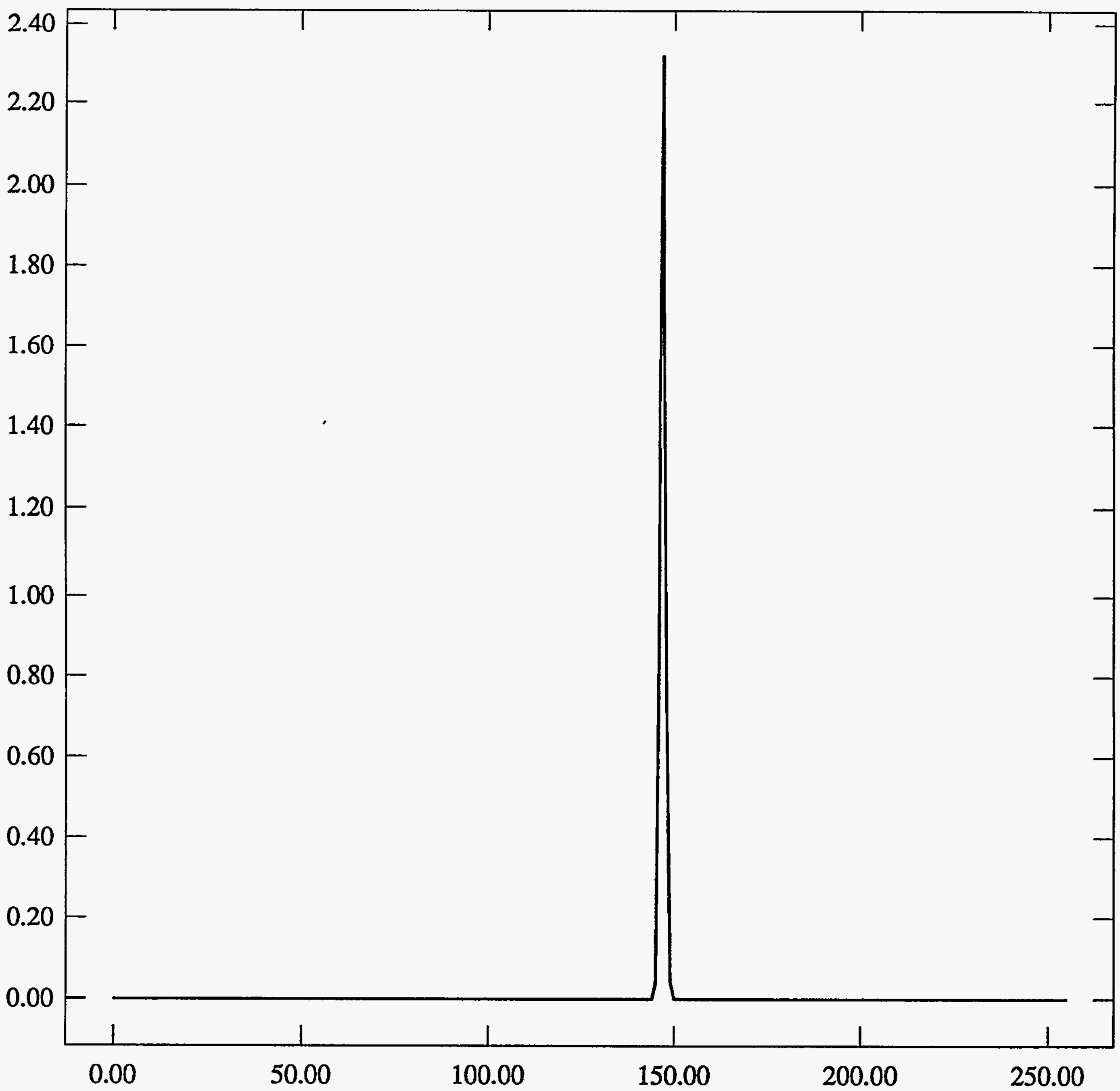
ST Camera: ST1#04-10 -30C #3: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 11:11:43 1993

Pixel Values Min 145 Max 149 Mean 147.0 Sigma 0.70 x 10^3



ST Camera: ST1#04-10 -30C #3: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 11:12:01 1993

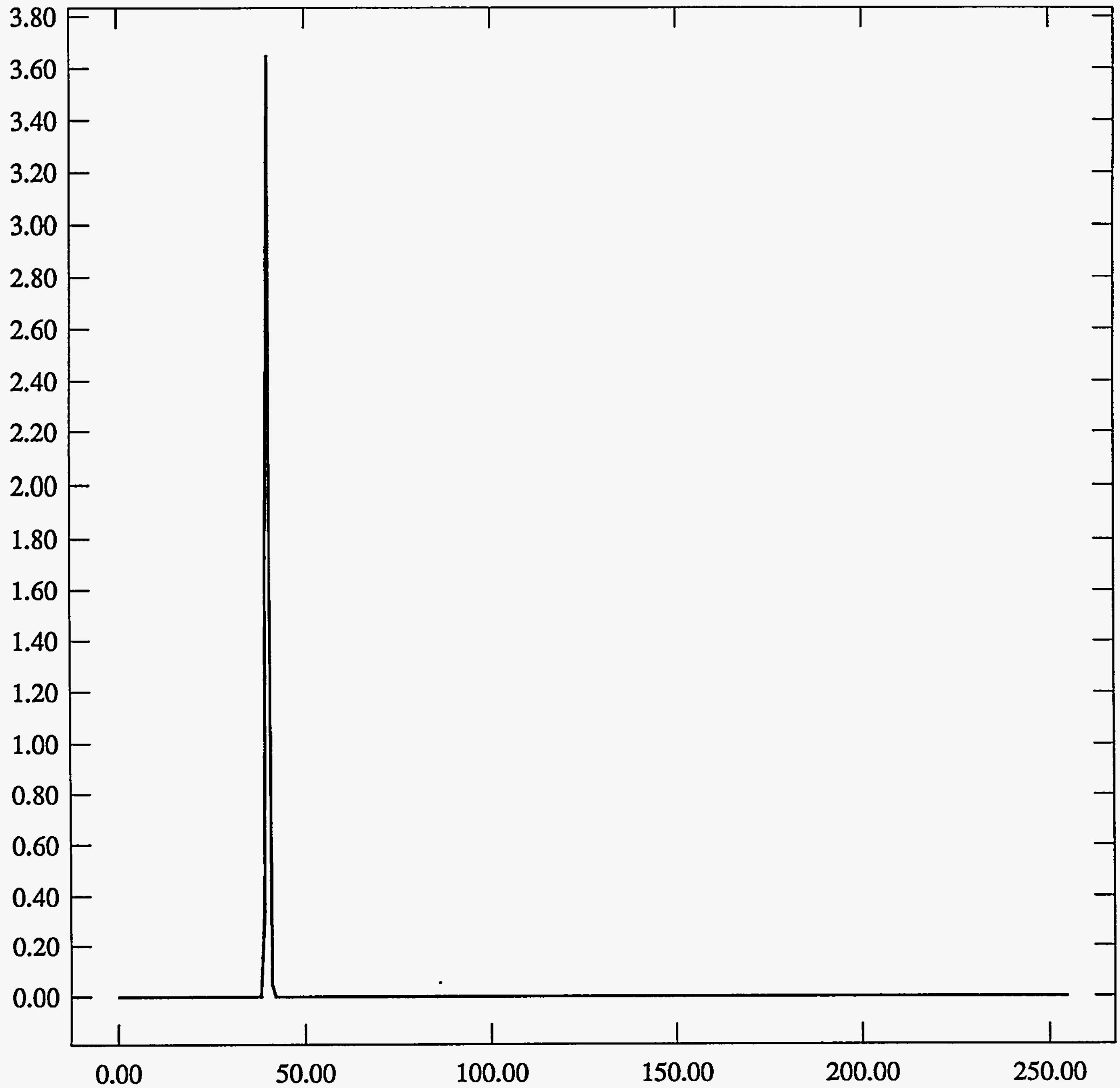
Pixel Values Min 145 Max 150 Mean 147.0 Sigma 0.70 x 10^3

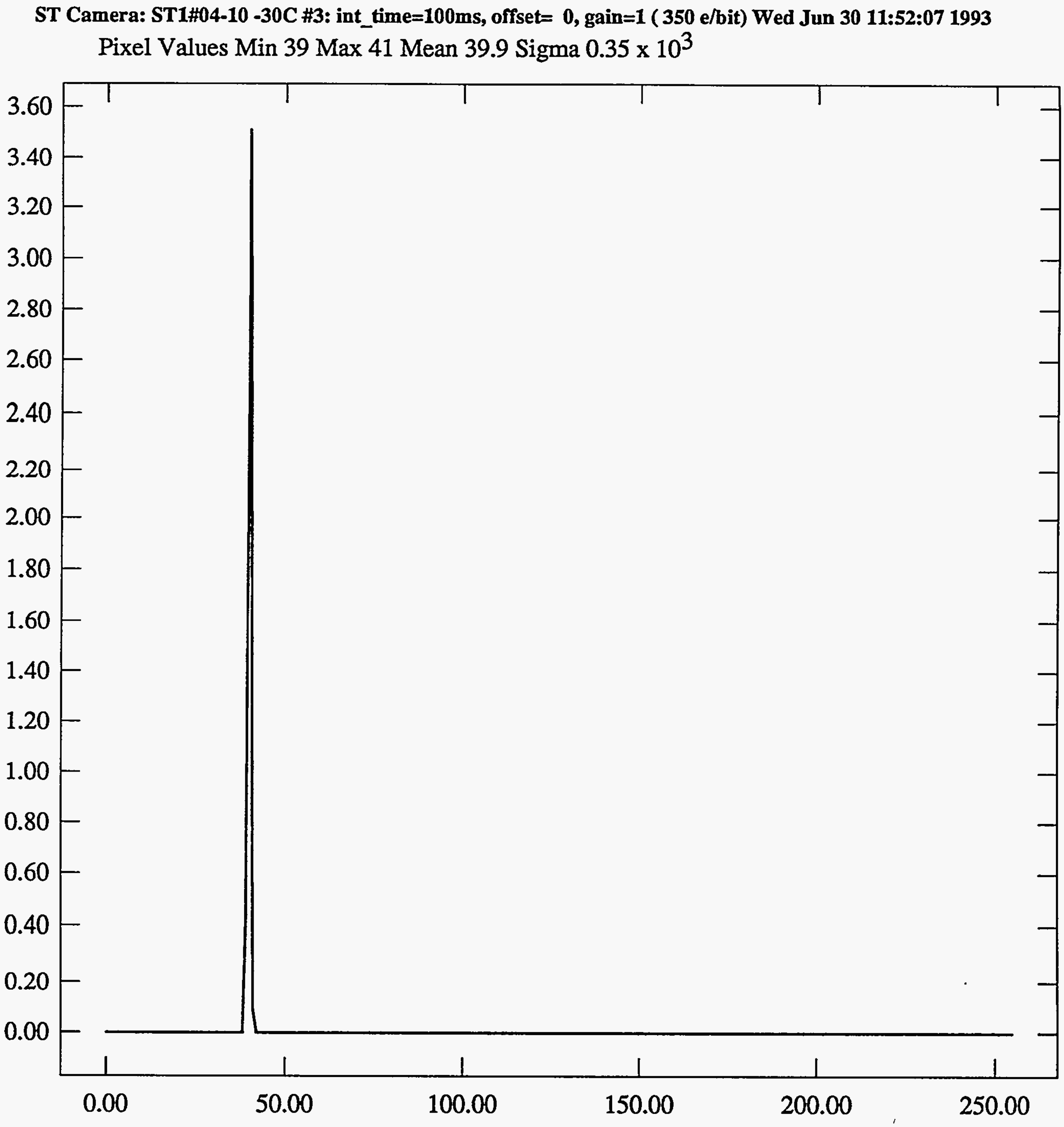


#3 -30 END

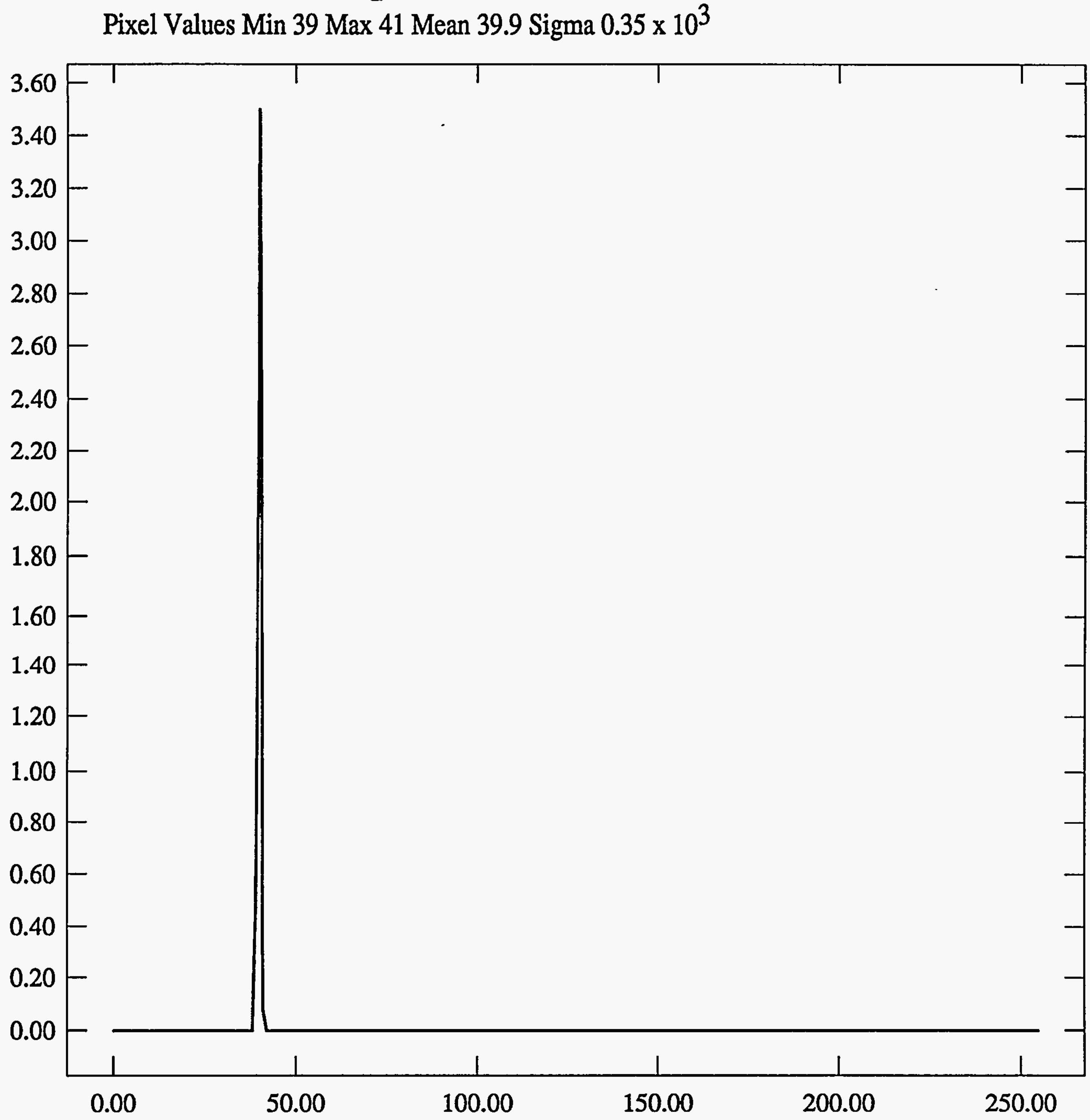
ST Camera: ST1#04-10 -30C #3: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 11:51:38 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.30 x 10^3



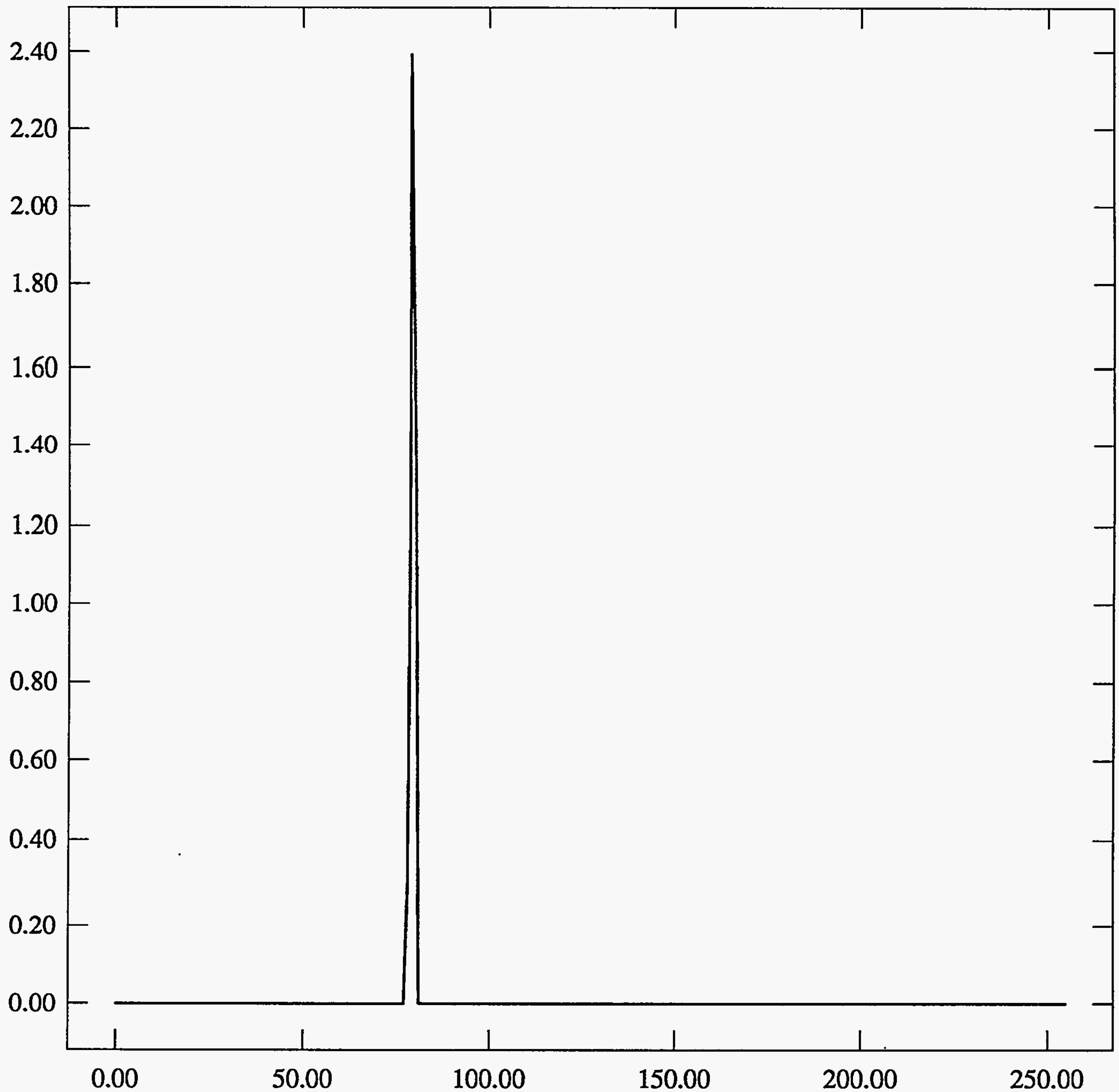

ST Camera: ST1#04-10 -30C #3: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 11:52:07 1993
Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.35 x 10^3
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1#04-10 -30C #3: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 11:52:27 1993



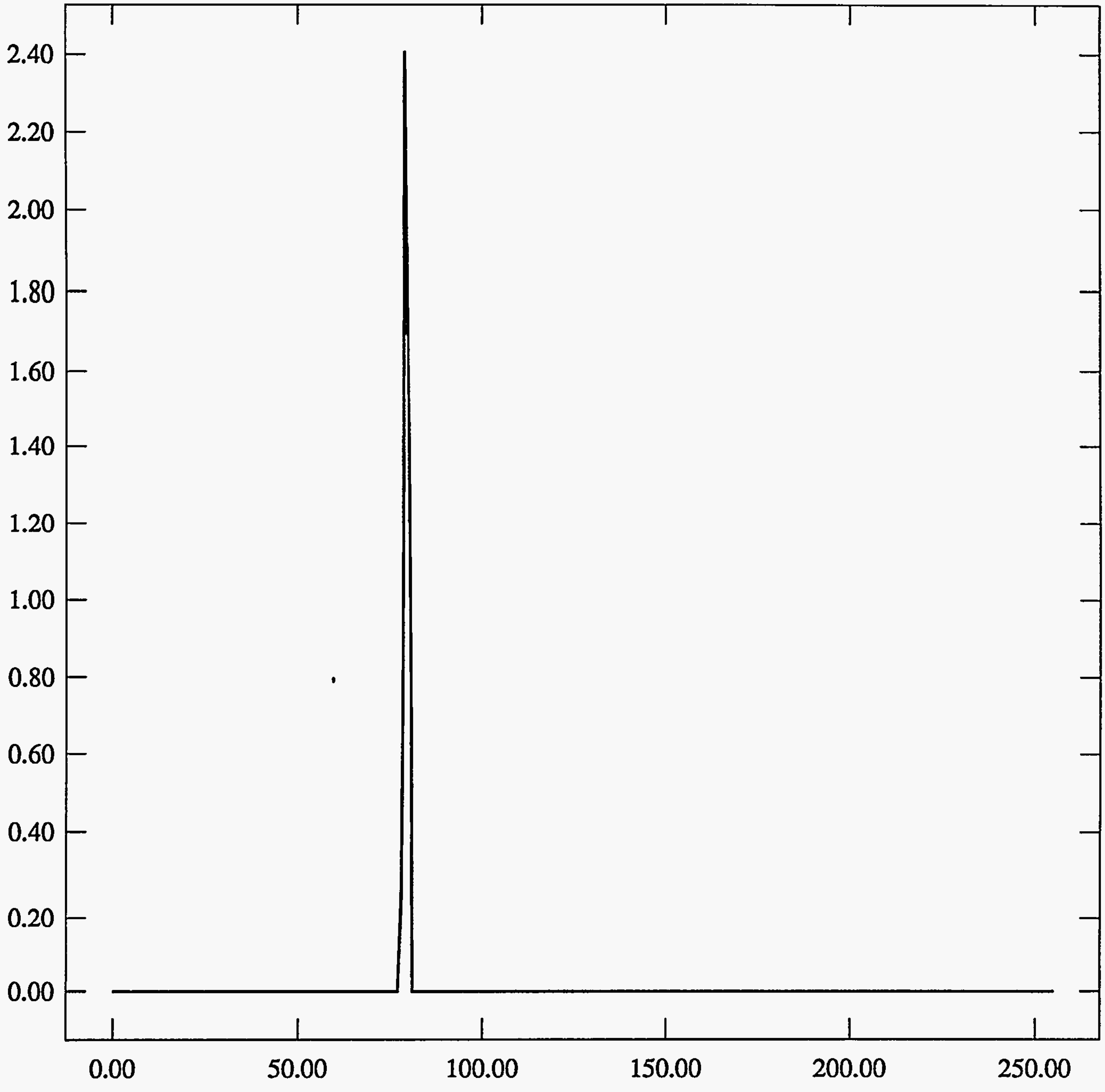
ST Camera: ST1#04-10 -30C #3: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 11:52:42 1993

Pixel Values Min 78 Max 81 Mean 79.3 Sigma 0.58 x 10^3



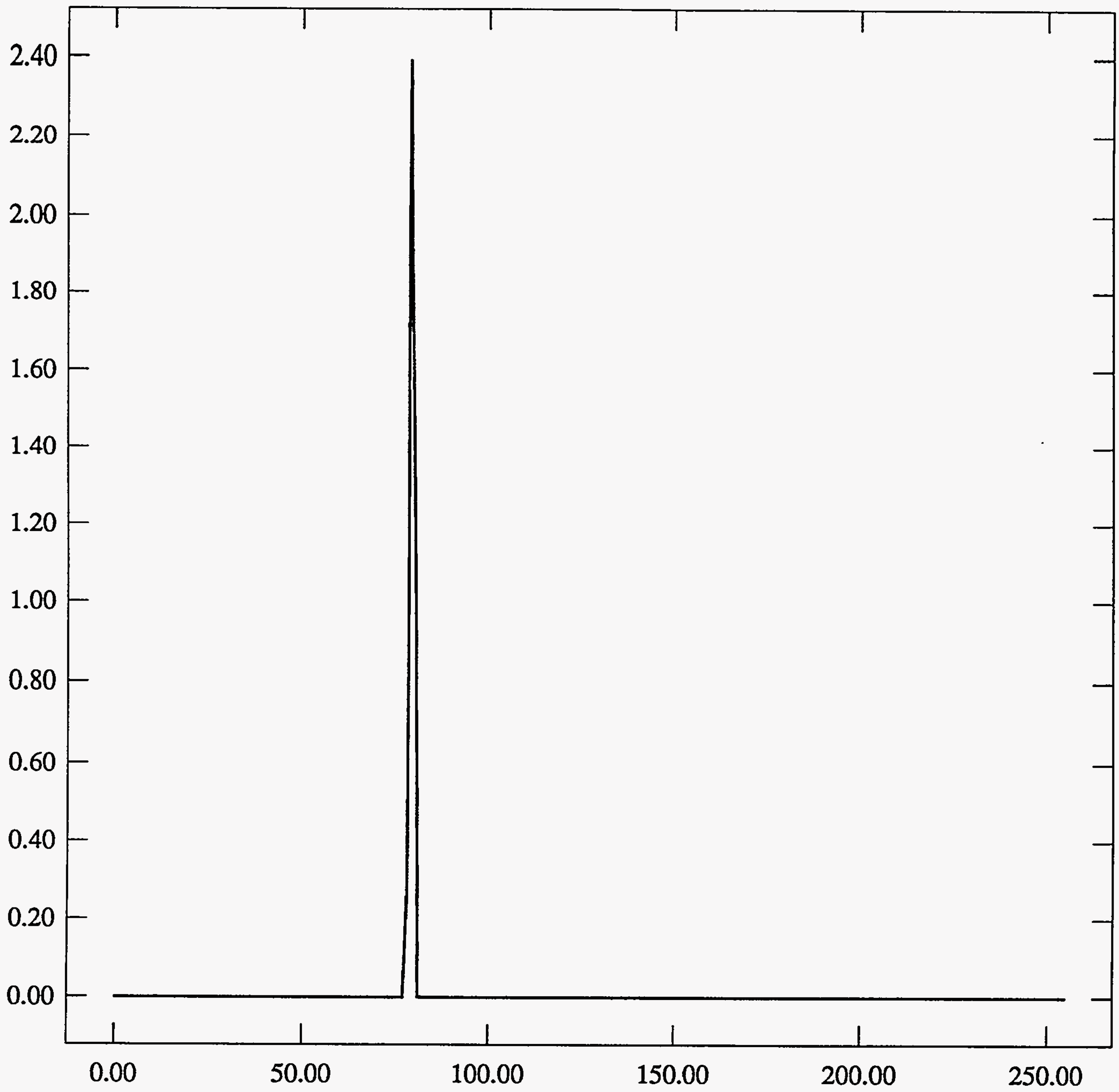
ST Camera: ST1#04-10 -30C #3: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 11:53:11 1993

Pixel Values Min 78 Max 80 Mean 79.3 Sigma 0.58 x 10^3

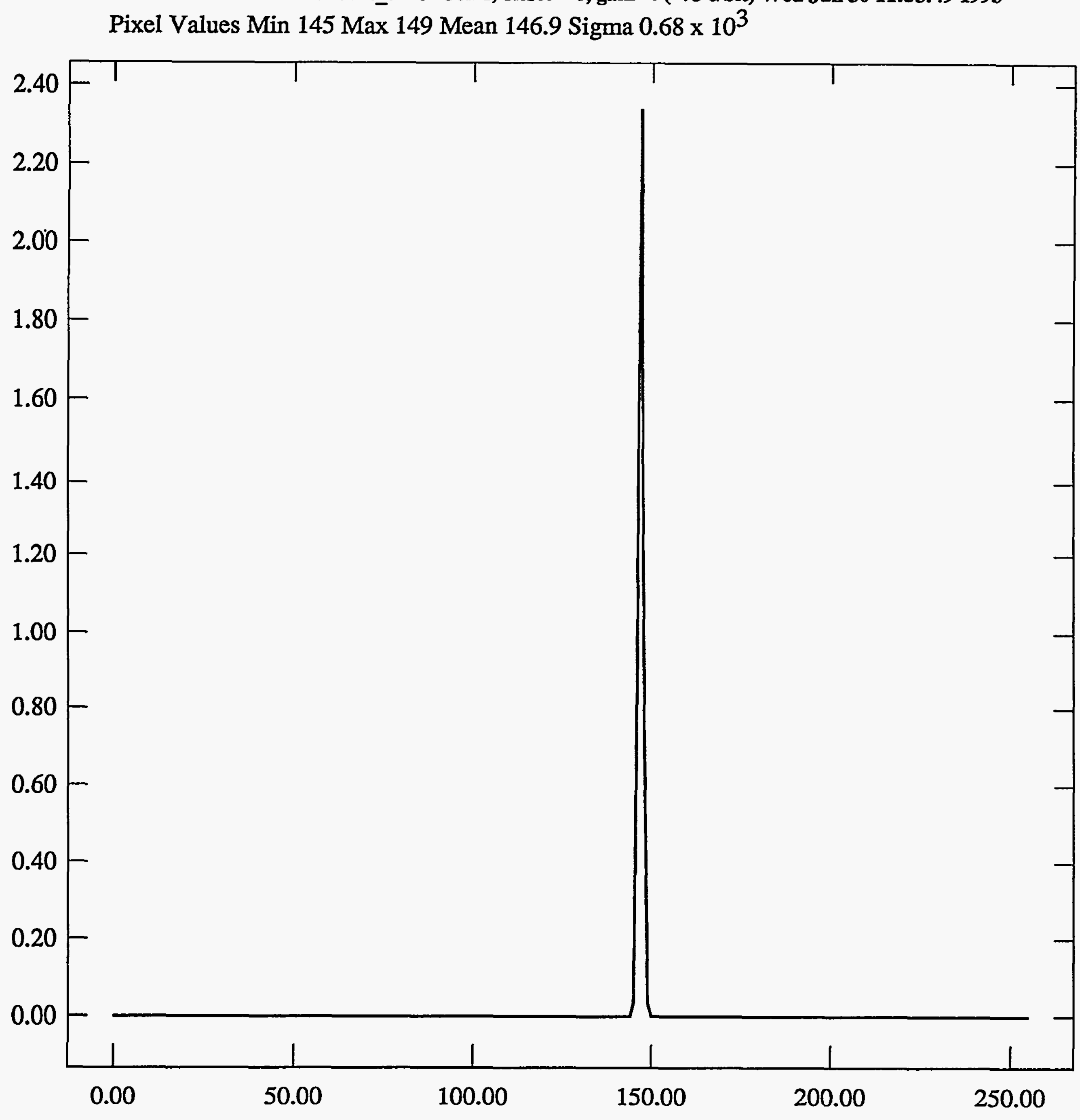


ST Camera: ST1#04-10 -30C #3: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 11:53:28 1993

Pixel Values Min 78 Max 81 Mean 79.3 Sigma 0.58 x 10^3

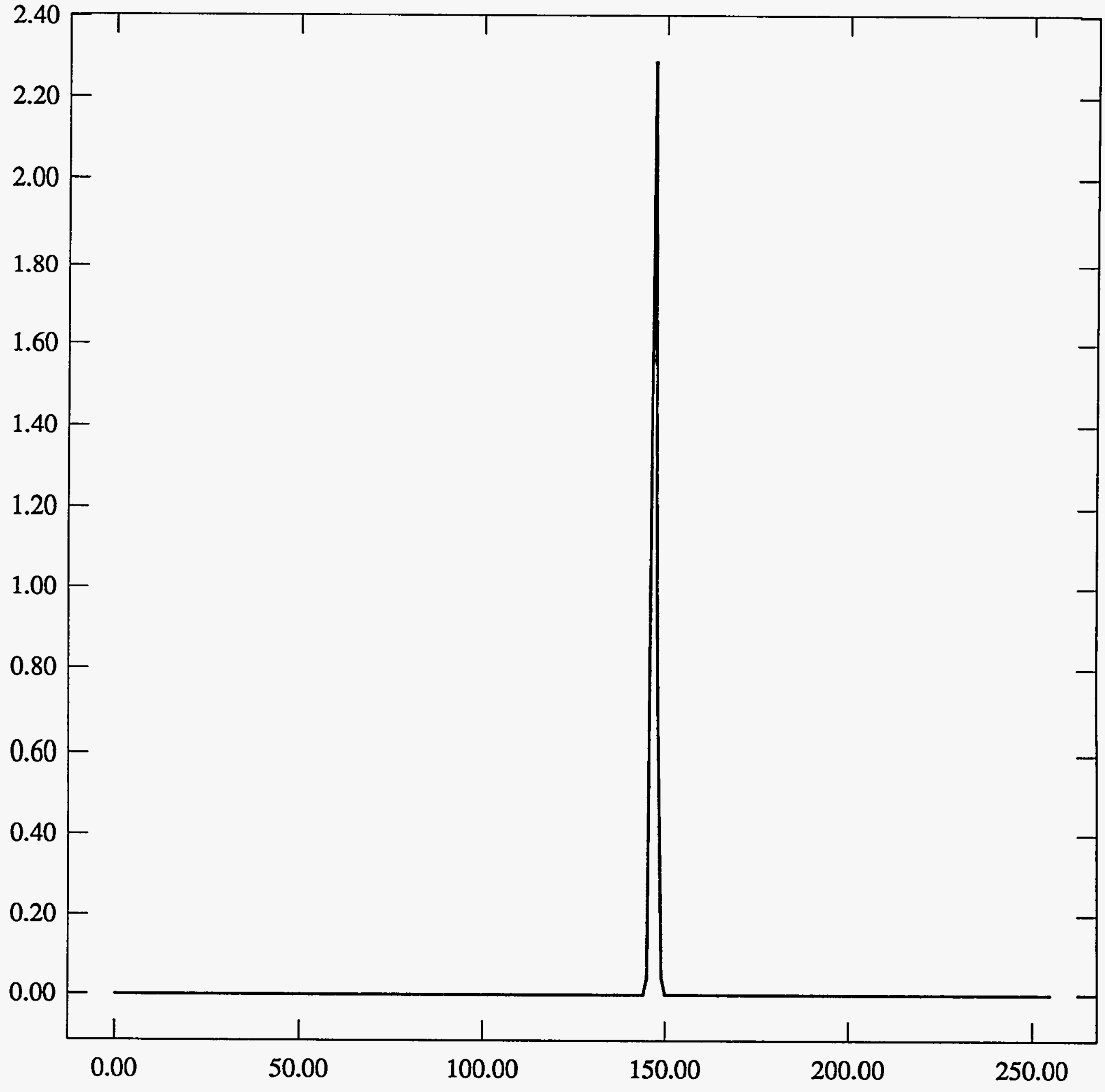


ST Camera: ST1#04-10 -30C #3: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 11:53:49 1993



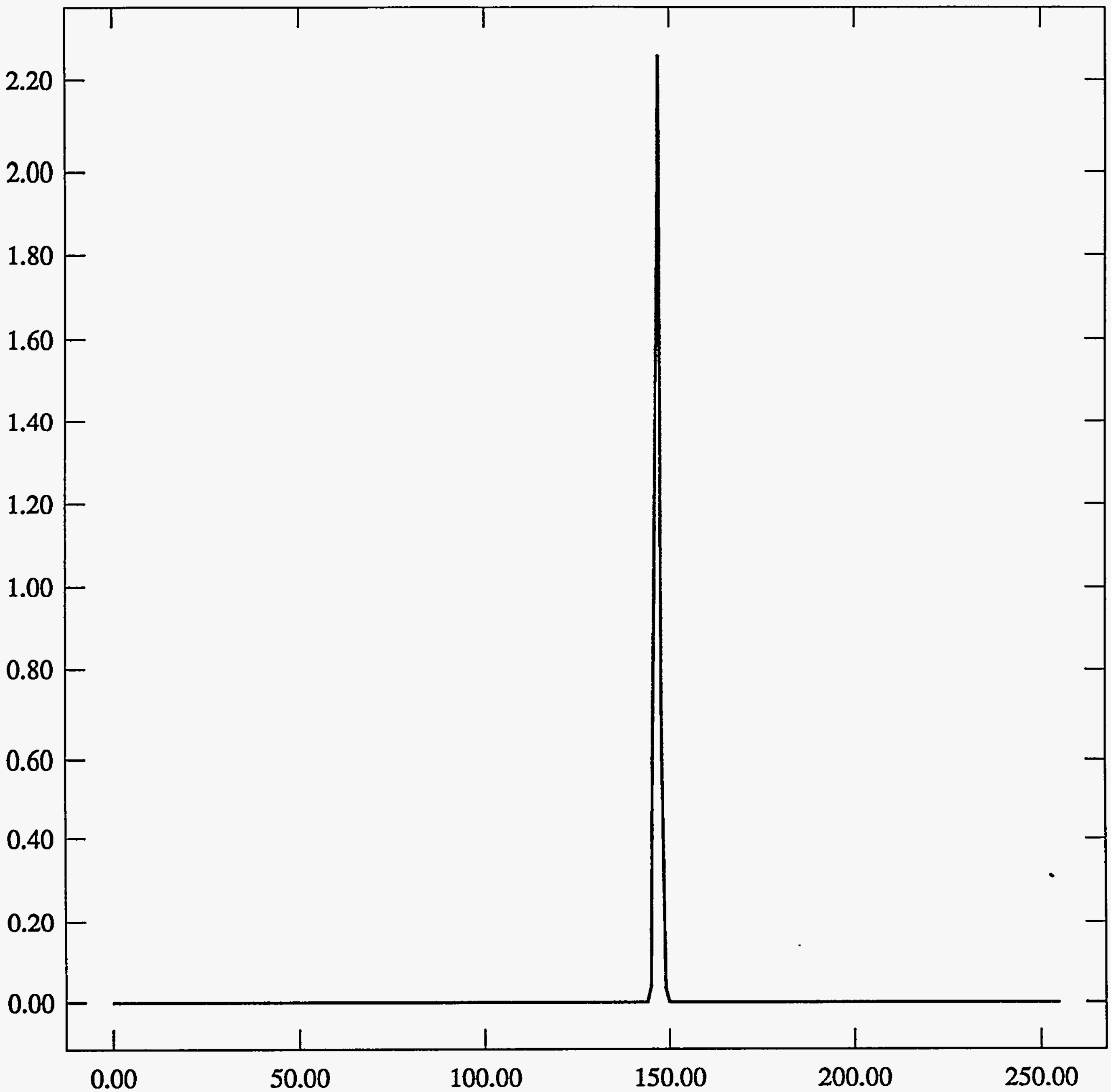
ST Camera: ST1#04-10 -30C #3: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 11:54:11 1993

Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.70 x 10^3



ST Camera: ST1#04-10 -30C #3: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 11:54:29 1993

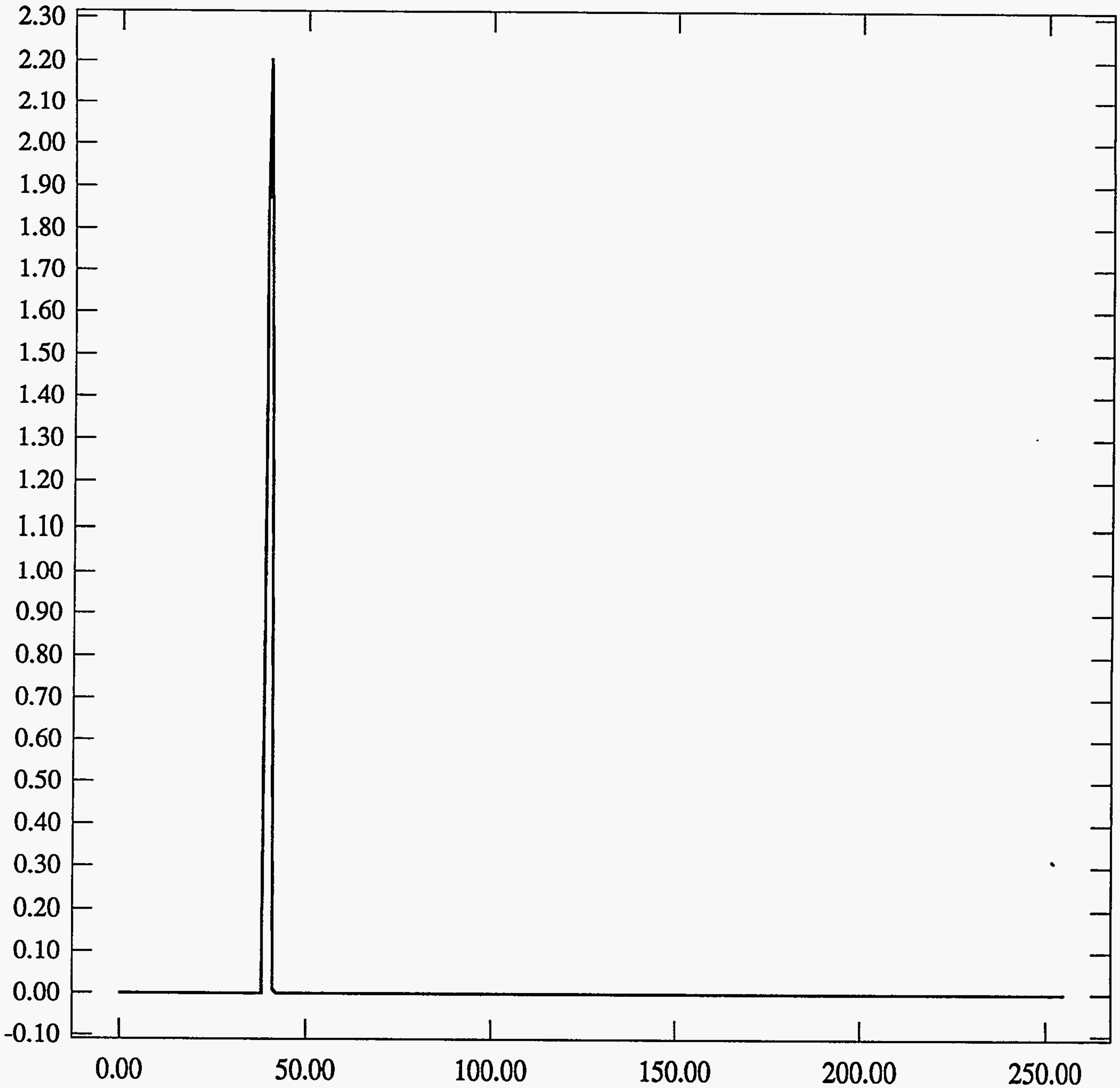
Pixel Values Min 145 Max 150 Mean 146.9 Sigma 0.70 x 10^3



#3 20C 15mins

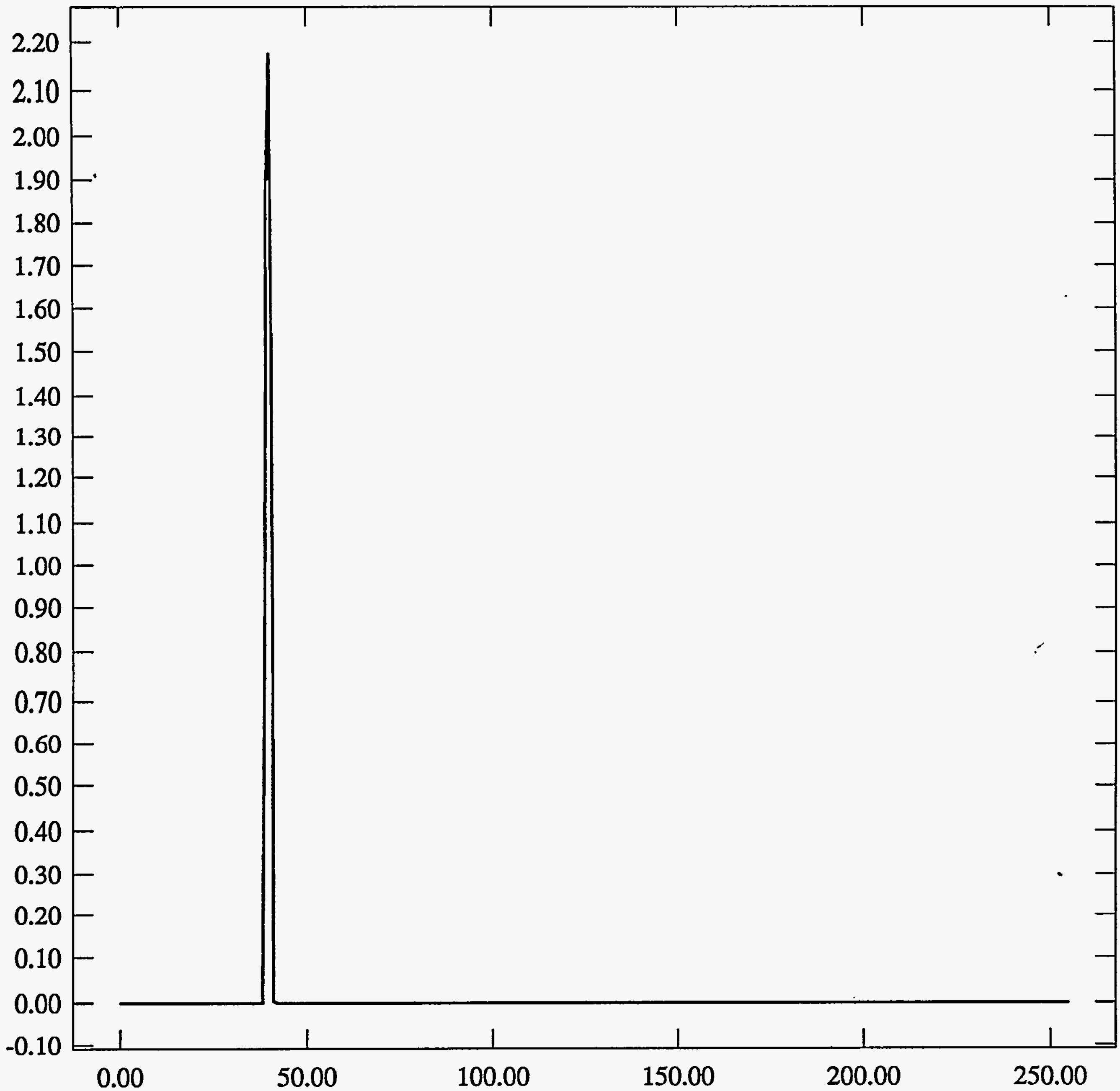
ST Camera: ST1#04-10 20C #3: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 12:25:32 1993

Pixel Values Min 39 Max 41 Mean 39.6 Sigma 0.50 x 10^3

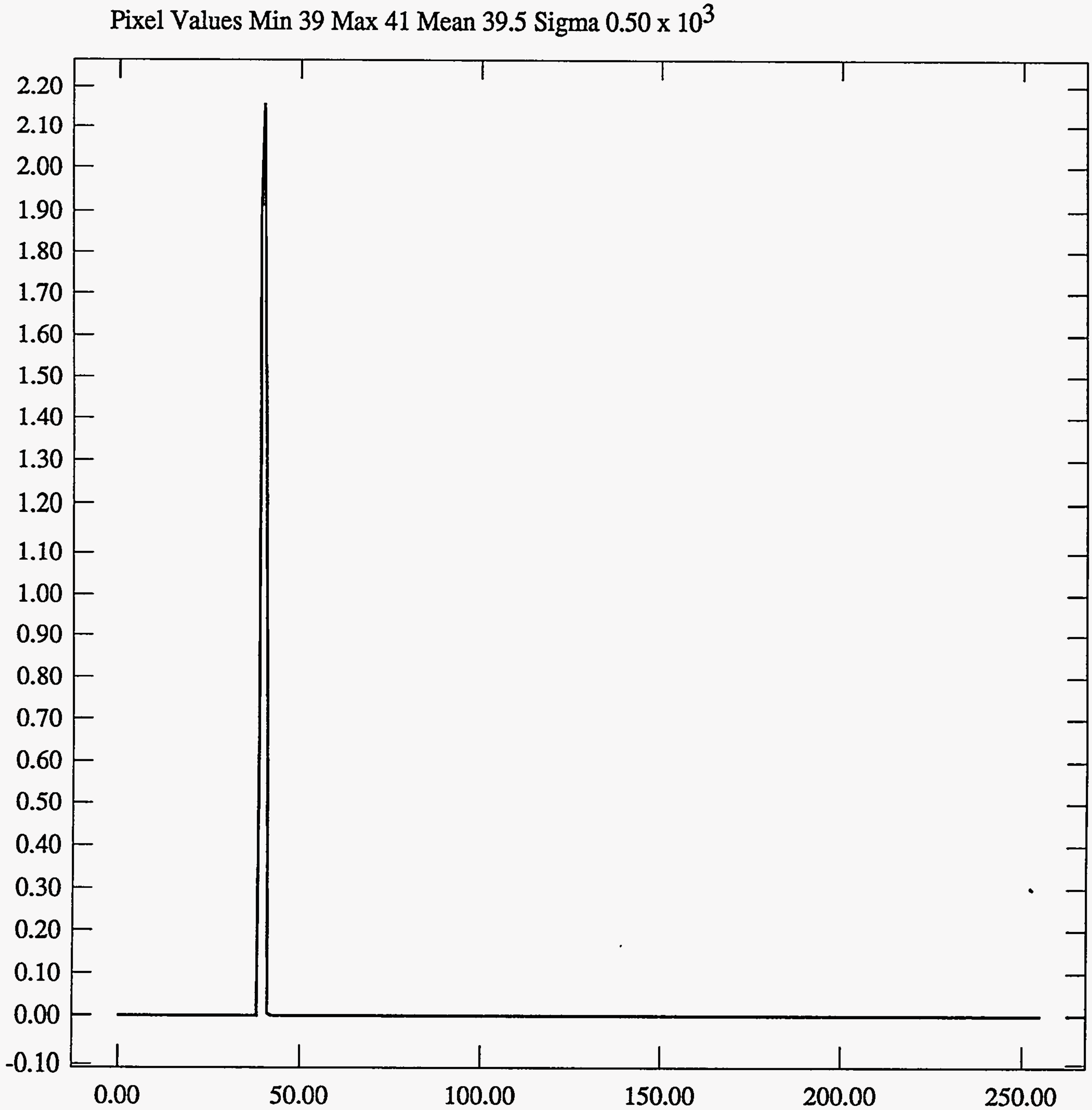


ST Camera: ST1#04-10 20C #3: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 12:25:47 1993

Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3

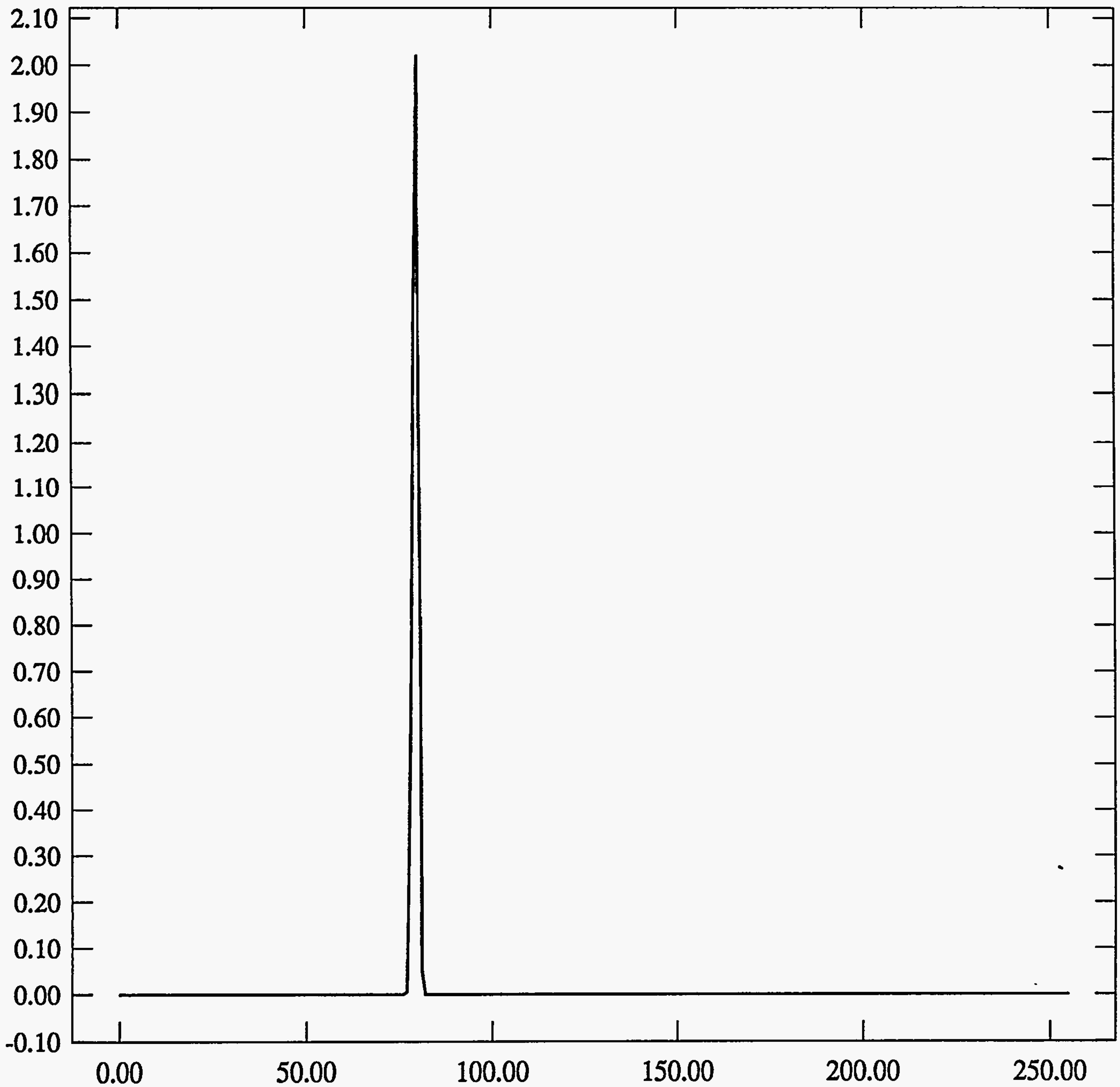


ST Camera: ST1#04-10 20C #3: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 12:26:05 1993

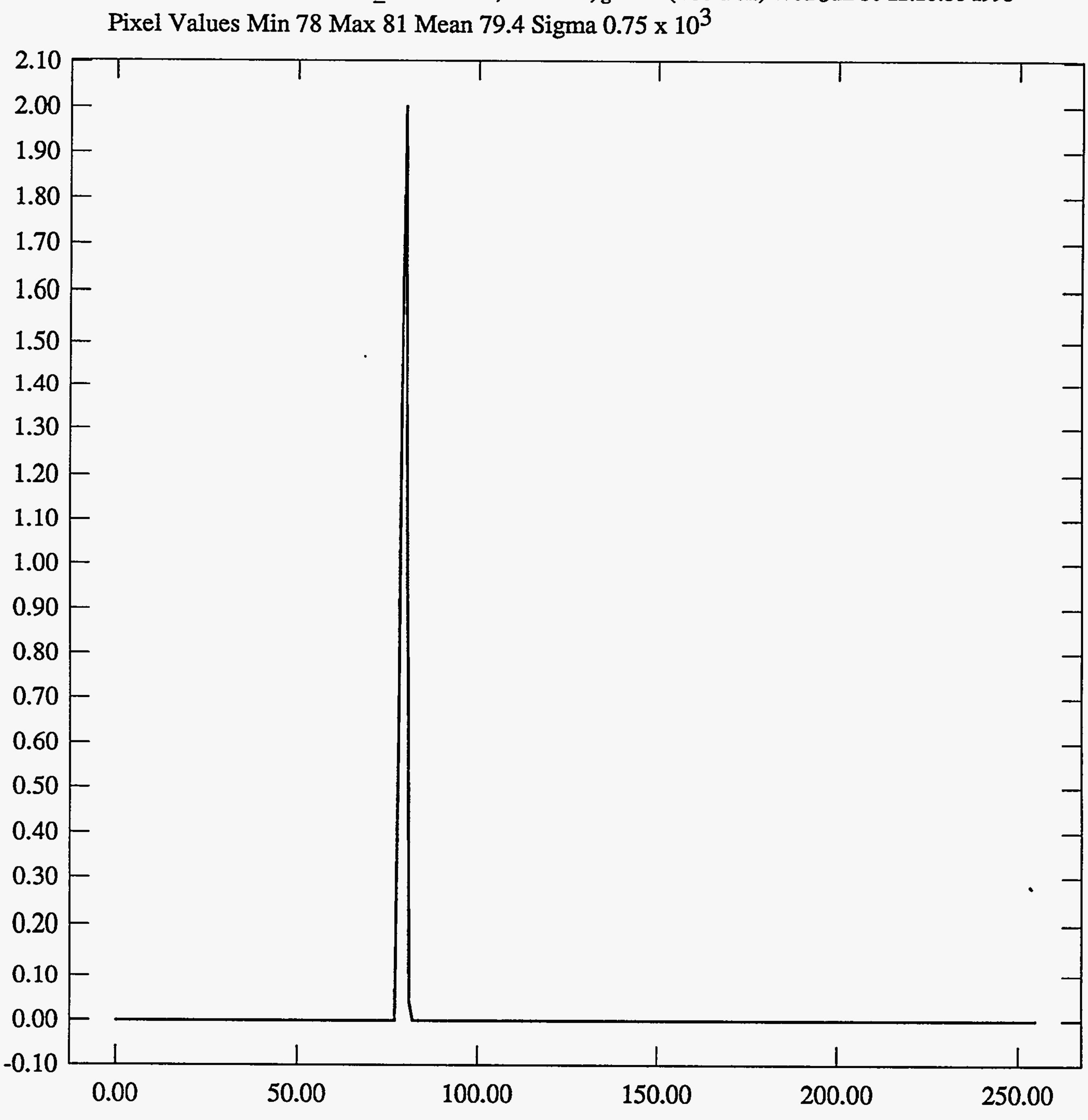


ST Camera: ST1#04-10 20C #3: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 12:26:23 1993

Pixel Values Min 77 Max 81 Mean 79.4 Sigma 0.75 x 10^3

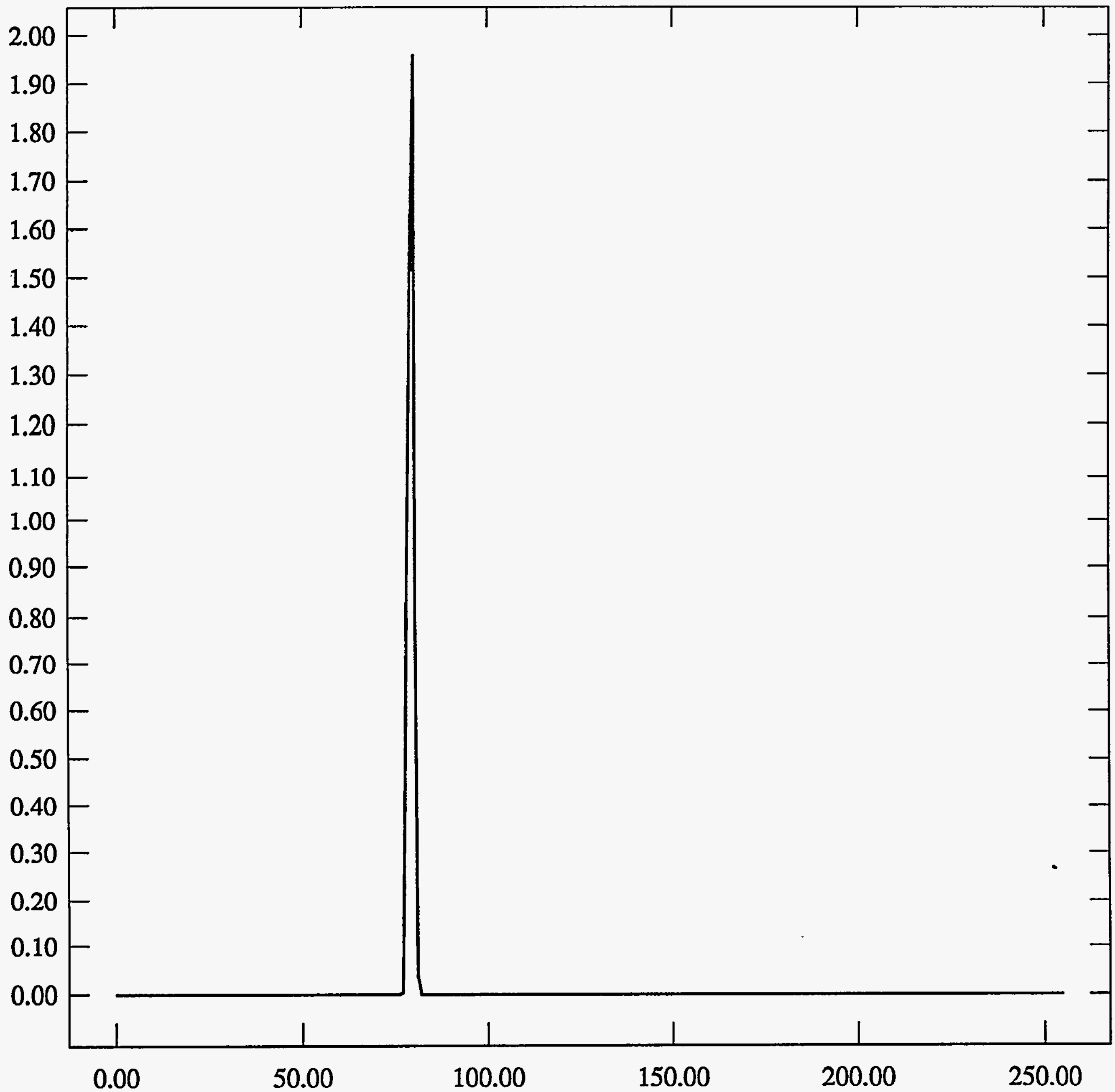


ST Camera: ST1#04-10 20C #3: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 12:26:38 1993



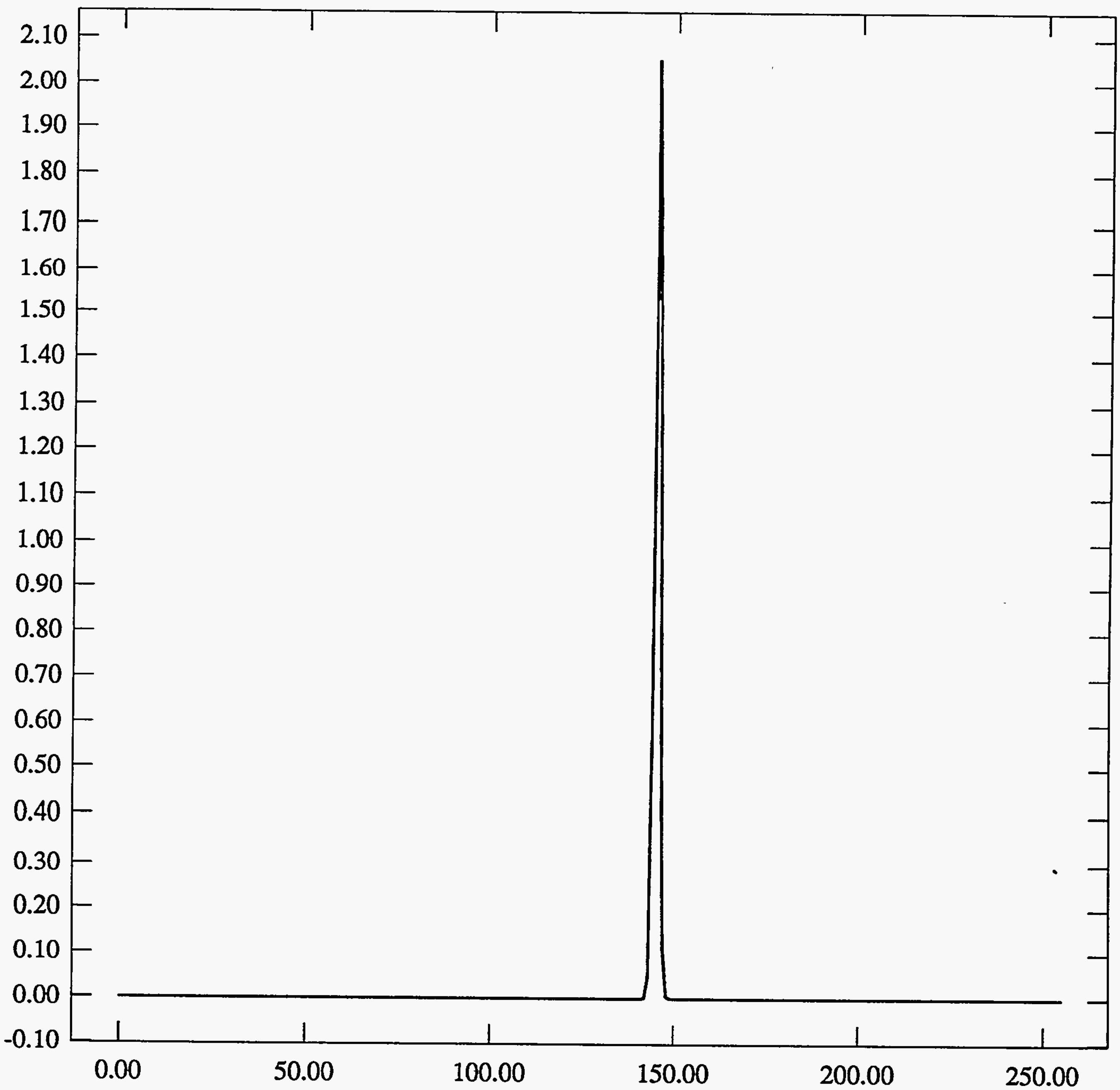
ST Camera: ST1#04-10 20C #3: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 12:26:54 1993

Pixel Values Min 77 Max 81 Mean 79.3 Sigma 0.75 x 10^3



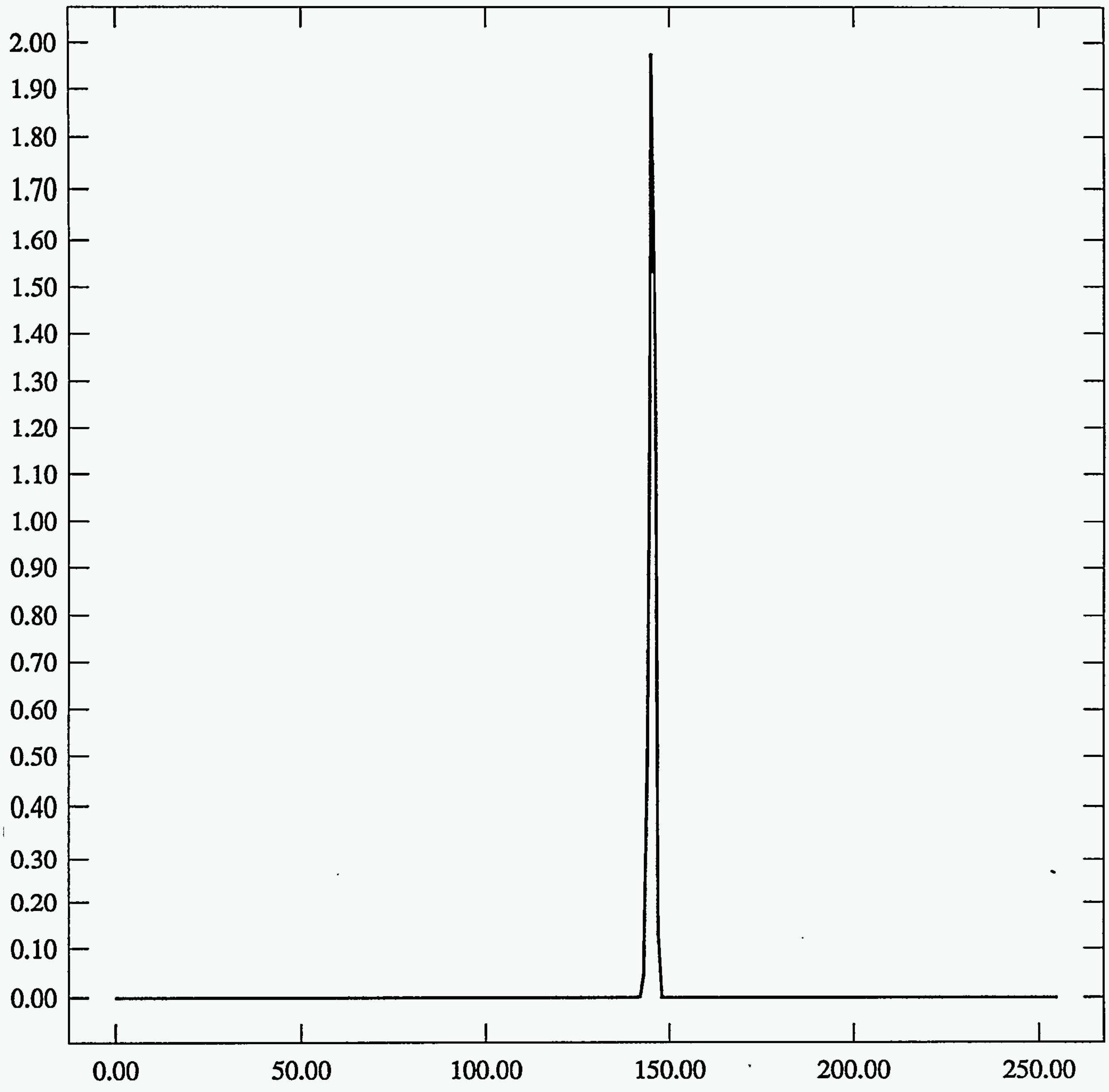
ST Camera: ST1#04-10 20C #3: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 12:27:12 1993

Pixel Values Min 142 Max 148 Mean 145.2 Sigma 0.76 x 10^3



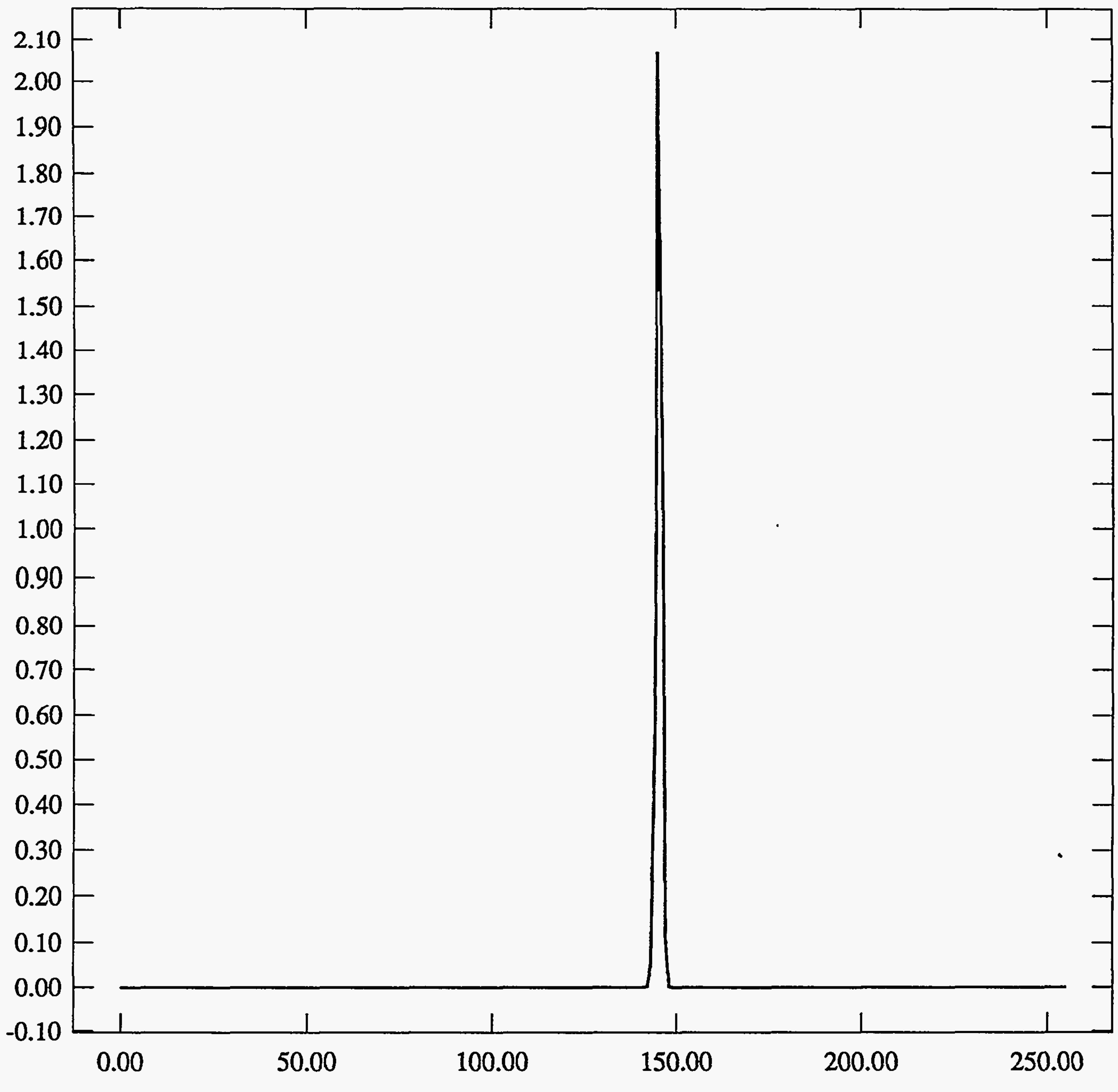
ST Camera: ST1#04-10 20C #3: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 12:27:32 1993

Pixel Values Min 142 Max 147 Mean 145.3 Sigma 0.76 x 10^3



ST Camera: ST1#04-10 20C #3: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 12:27:49 1993

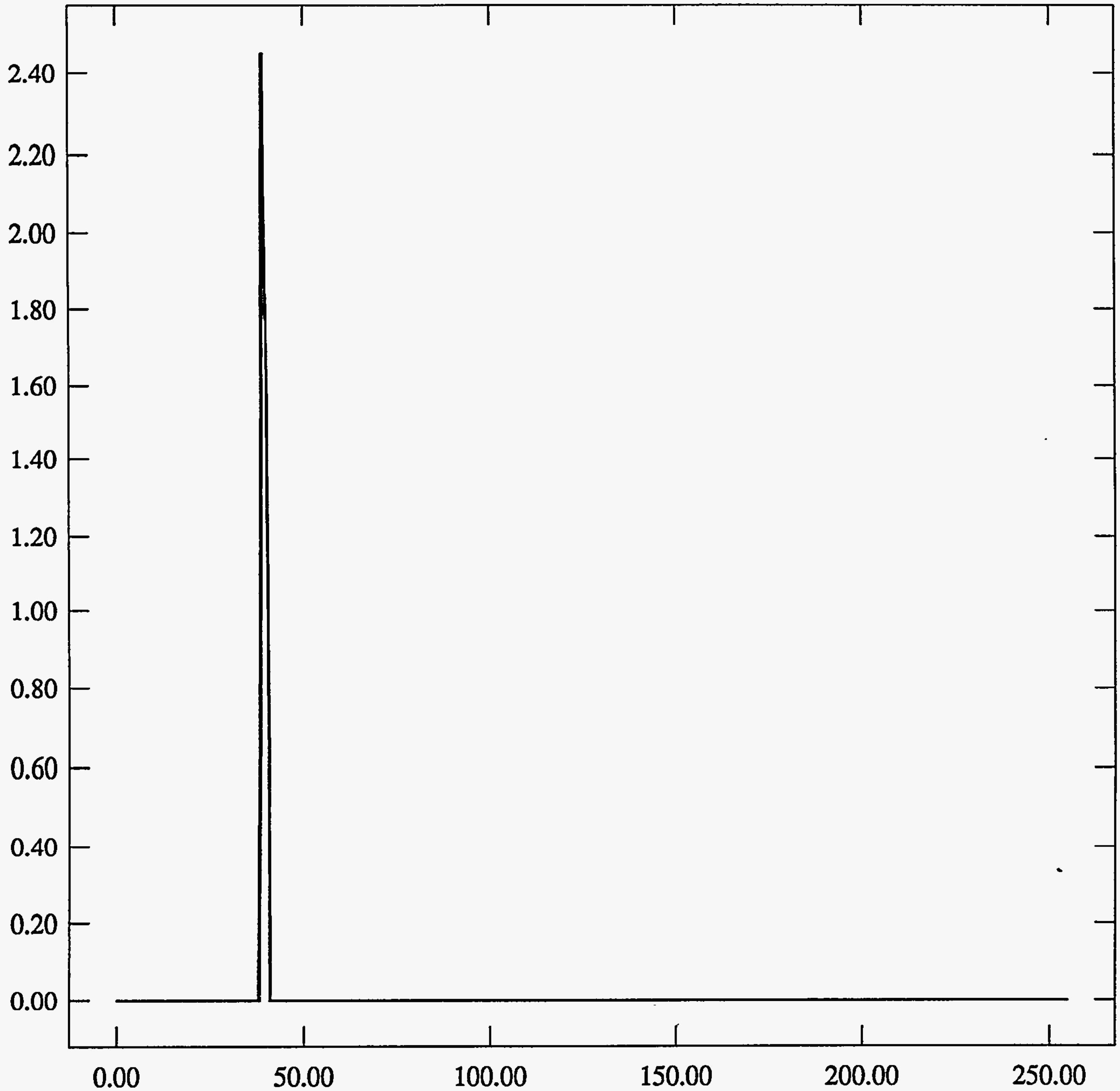
Pixel Values Min 142 Max 148 Mean 145.2 Sigma 0.76 x 10^3



3 20°C End

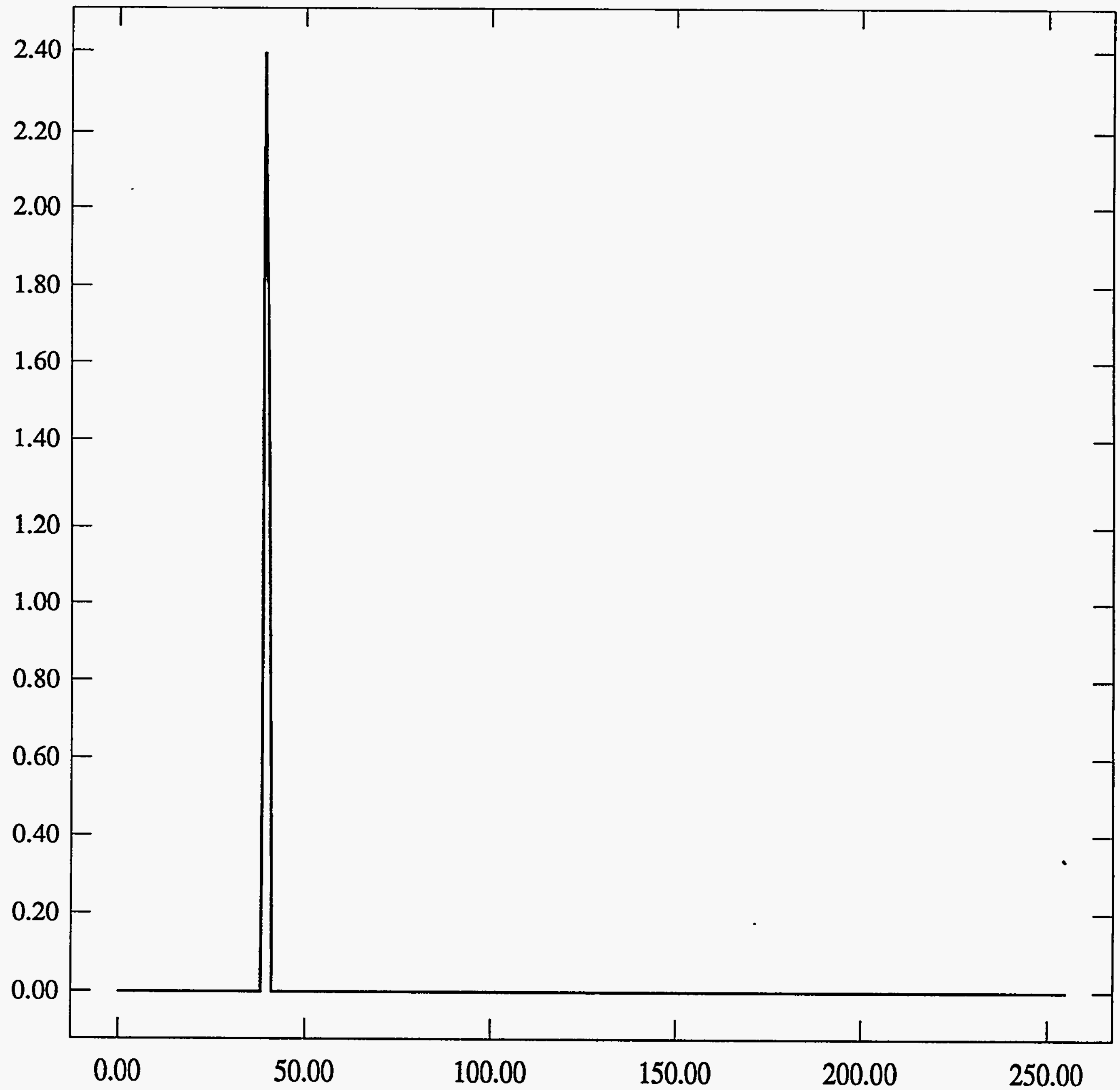
ST Camera: ST1#04-10 20C #3: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 13:04:43 1993

Pixel Values Min 39 Max 40 Mean 39.4 Sigma 0.49 x 10^3



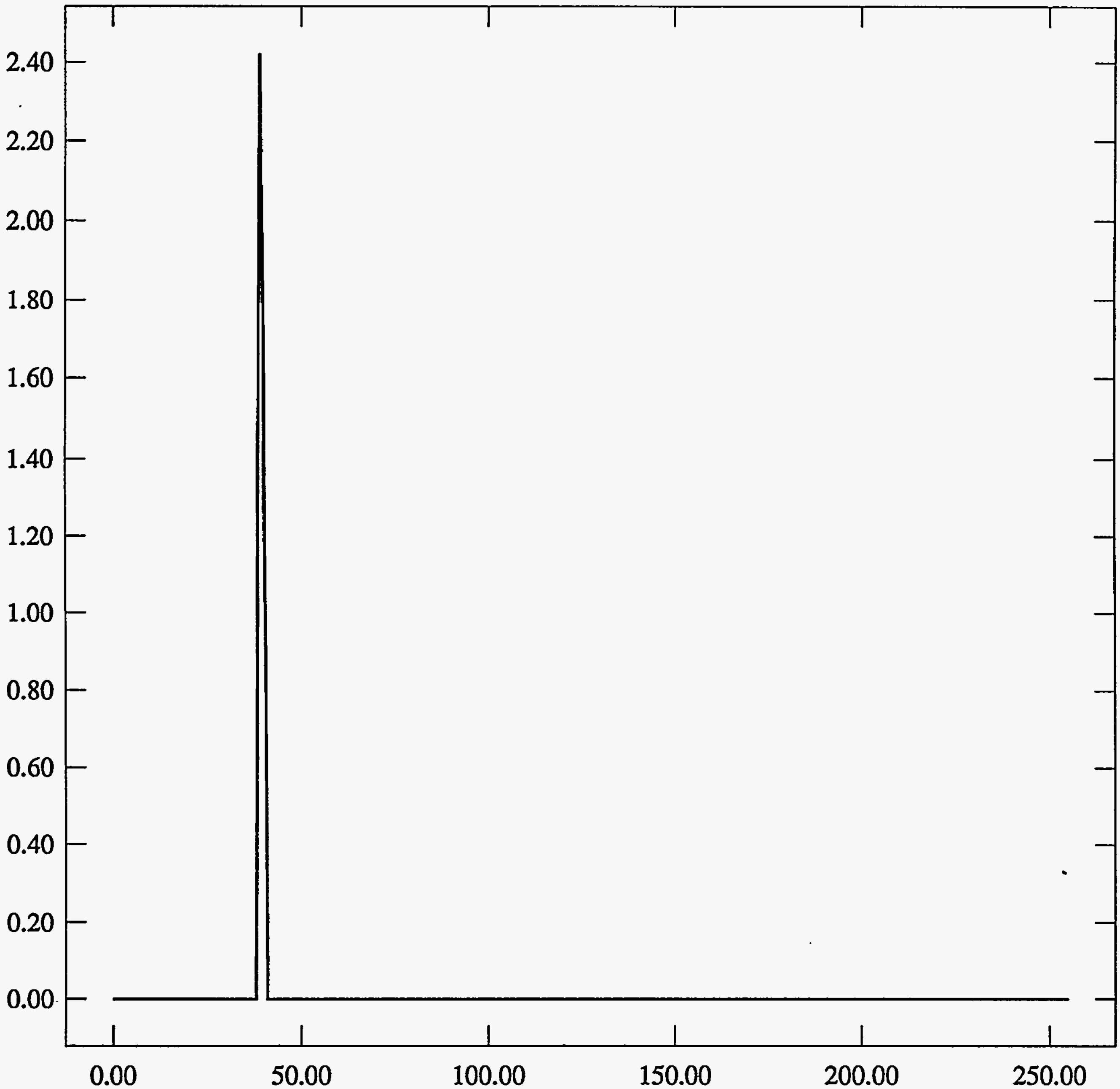
ST Camera: ST1#04-10 20C #3: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 13:05:49 1993

Pixel Values Min 39 Max 40 Mean 39.4 Sigma 0.49 x 10^3

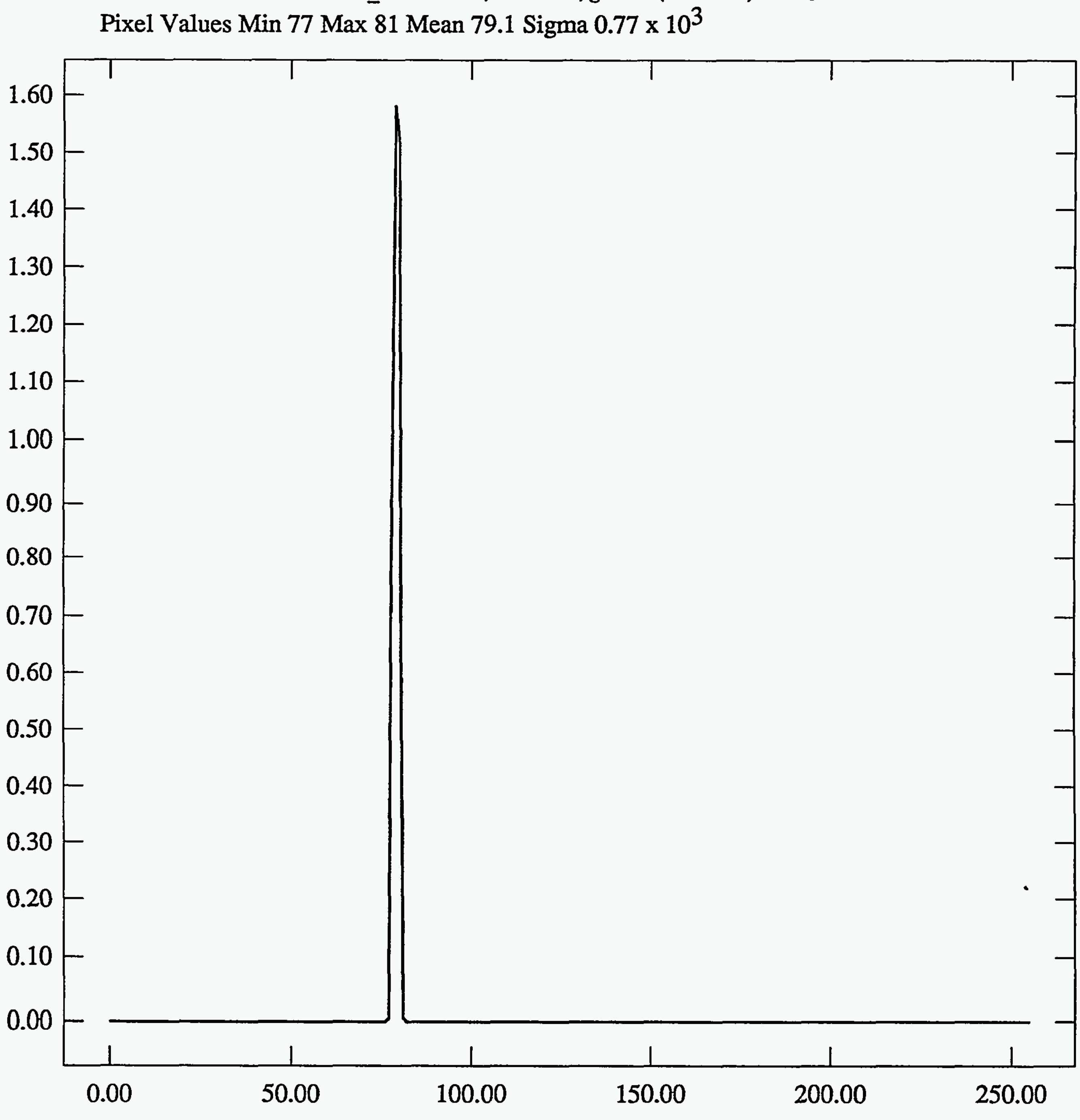


ST Camera: ST1#04-10 20C #3: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 13:06:29 1993

Pixel Values Min 39 Max 40 Mean 39.4 Sigma 0.49 x 10^3

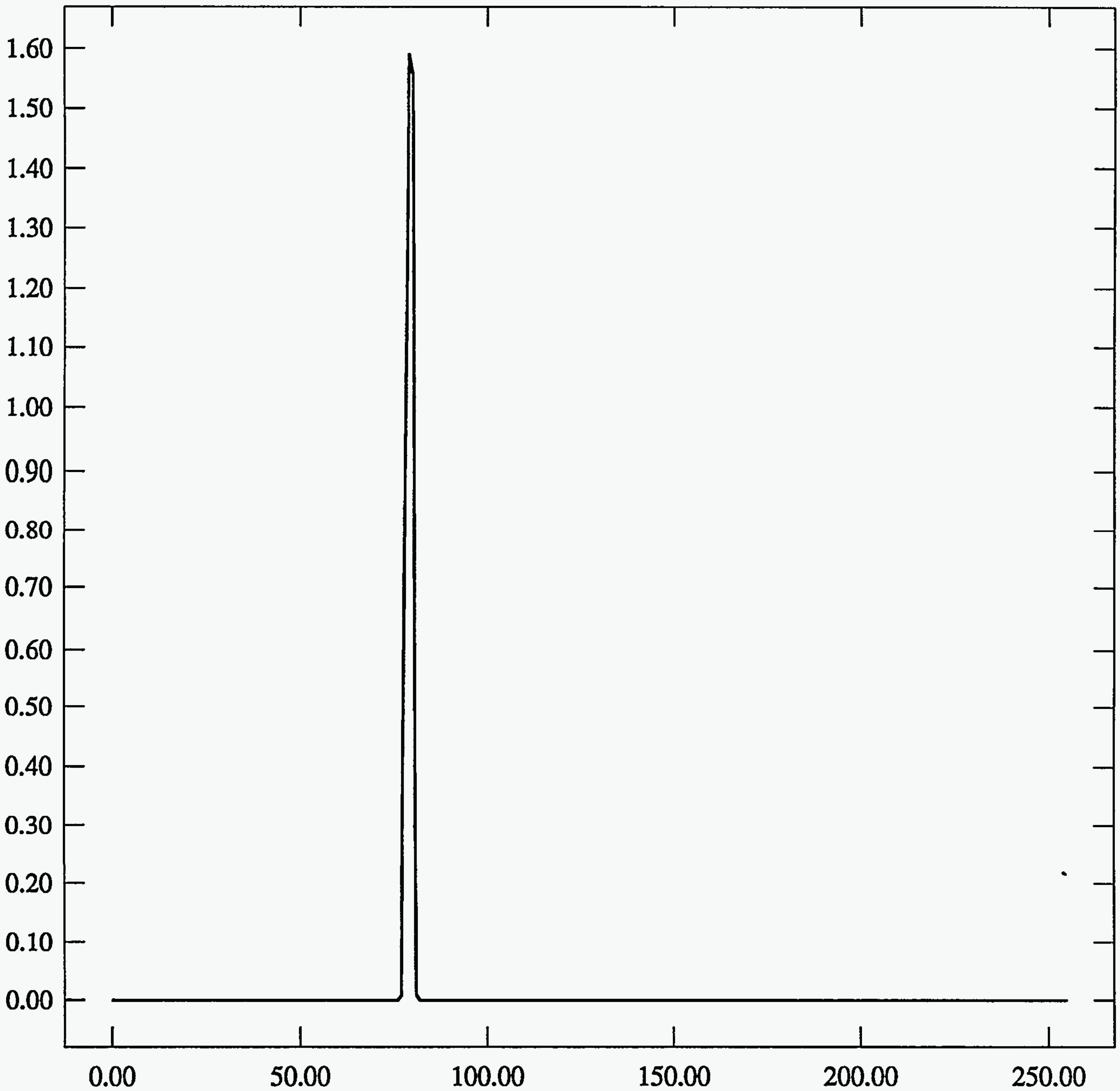


ST Camera: ST1#04-10 20C #3: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 13:07:11 1993



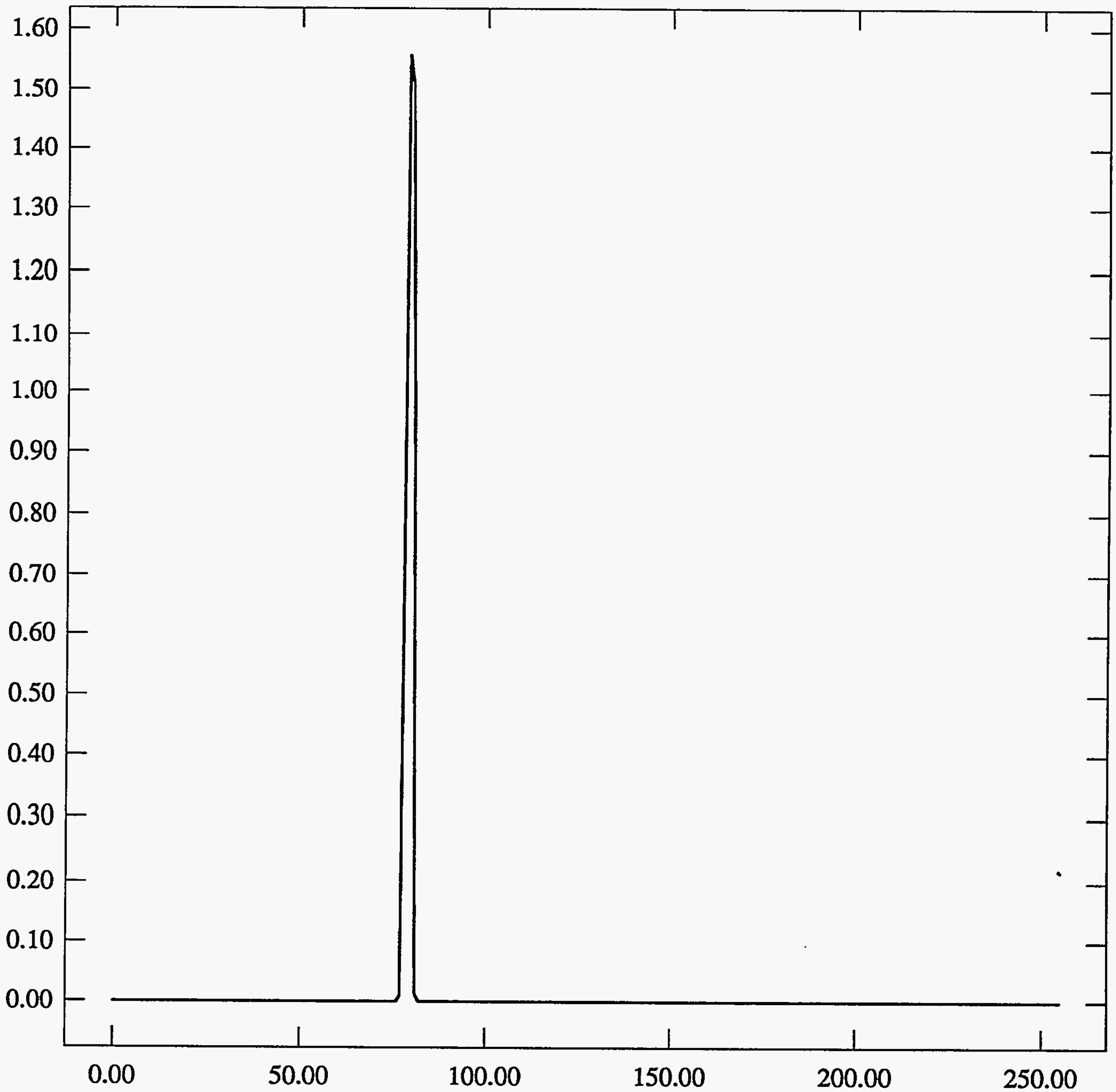
ST Camera: ST1#04-10 20C #3: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 13:07:49 1993

Pixel Values Min 77 Max 81 Mean 79.2 Sigma 0.77 x 10^3



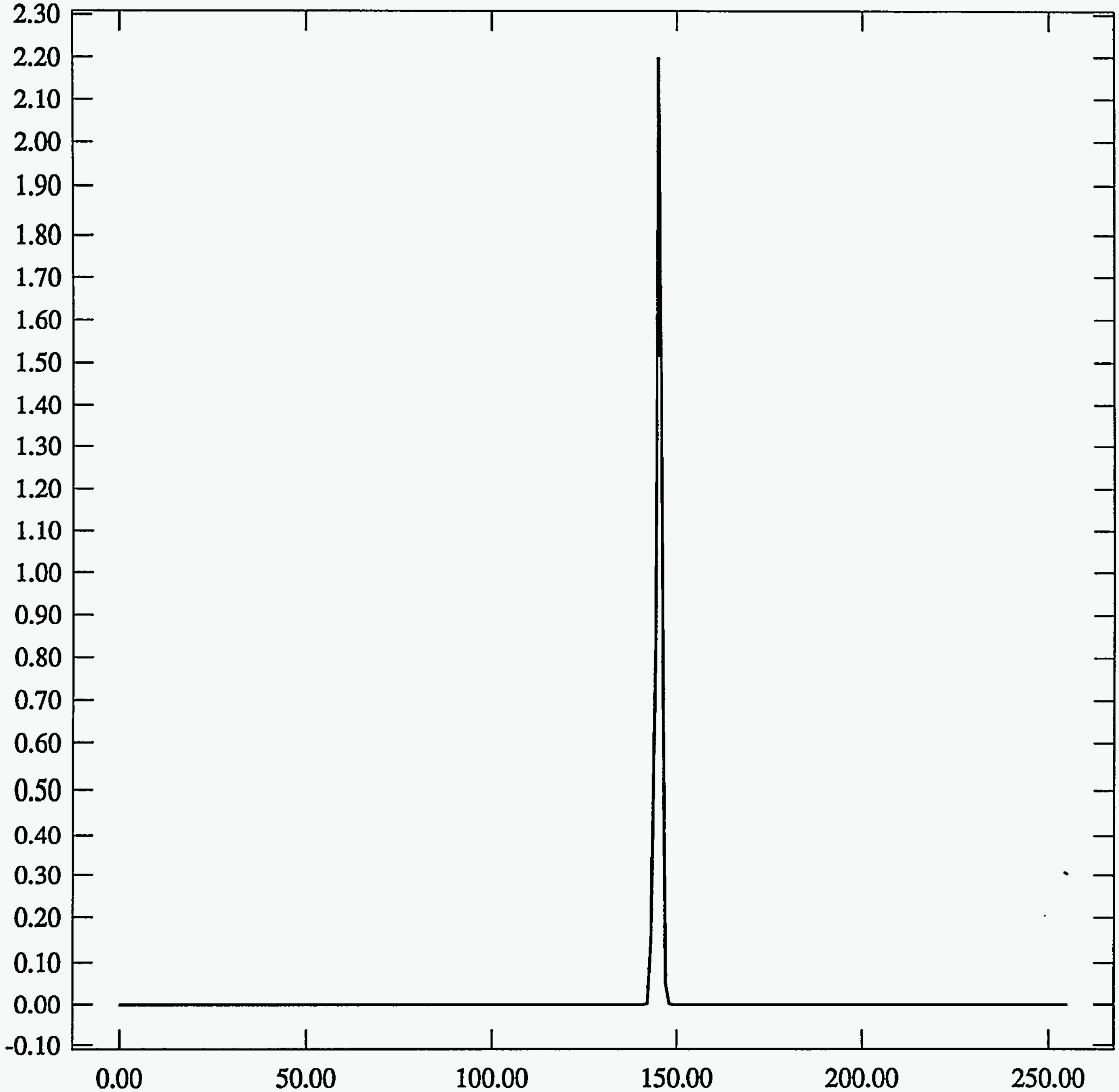
ST Camera: ST1#04-10 20C #3: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 13:08:31 1993

Pixel Values Min 77 Max 81 Mean 79.1 Sigma 0.78 x 10^3



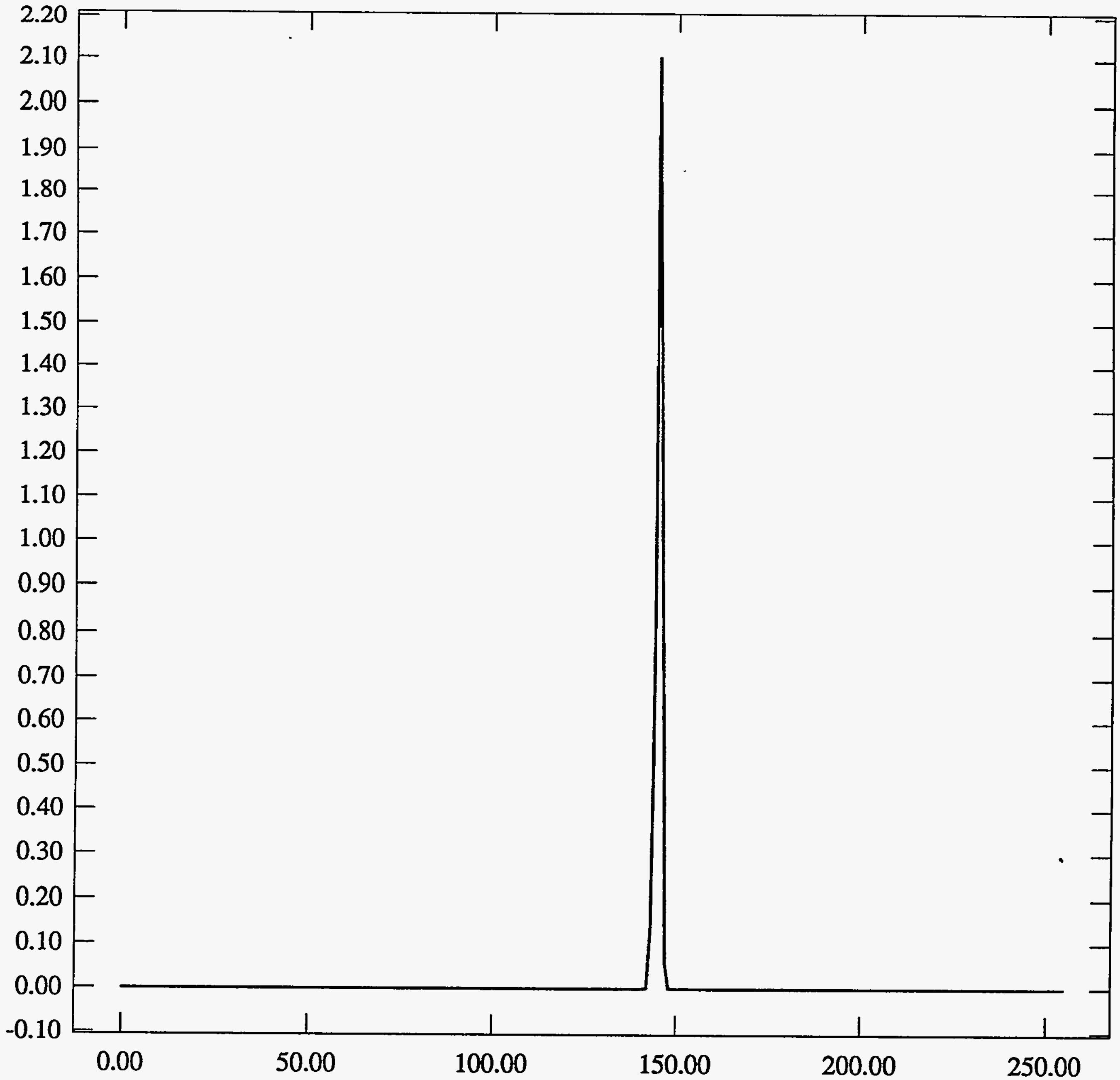
ST Camera: ST1#04-10 20C #3: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 13:09:18 1993

Pixel Values Min 142 Max 148 Mean 145.0 Sigma 0.79 x 10^3



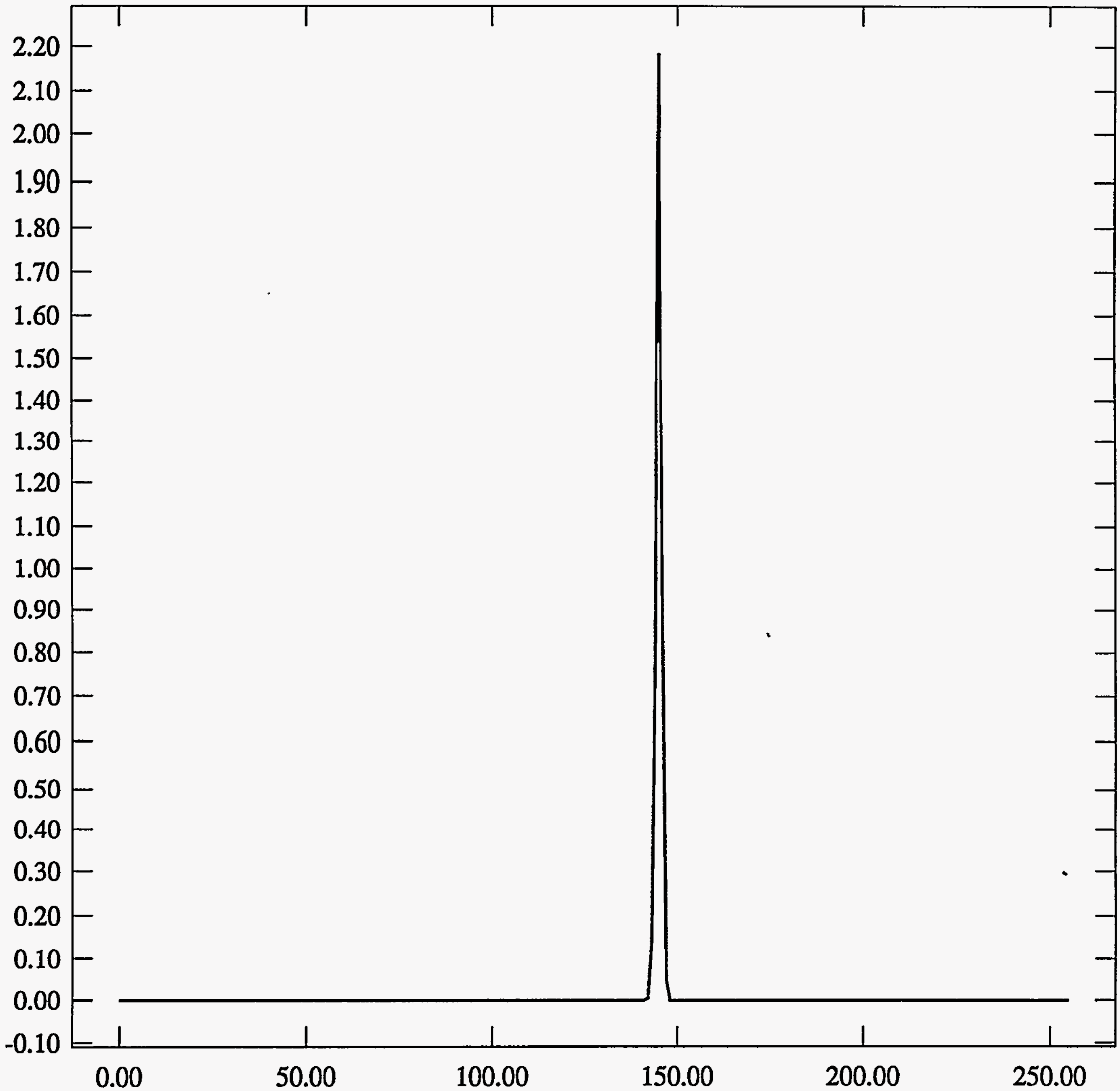
ST Camera: ST1#04-10 20C #3: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 13:10:01 1993

Pixel Values Min 142 Max 148 Mean 145.0 Sigma 0.79 x 10^3



ST Camera: ST1#04-10 20C #3: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 13:10:42 1993

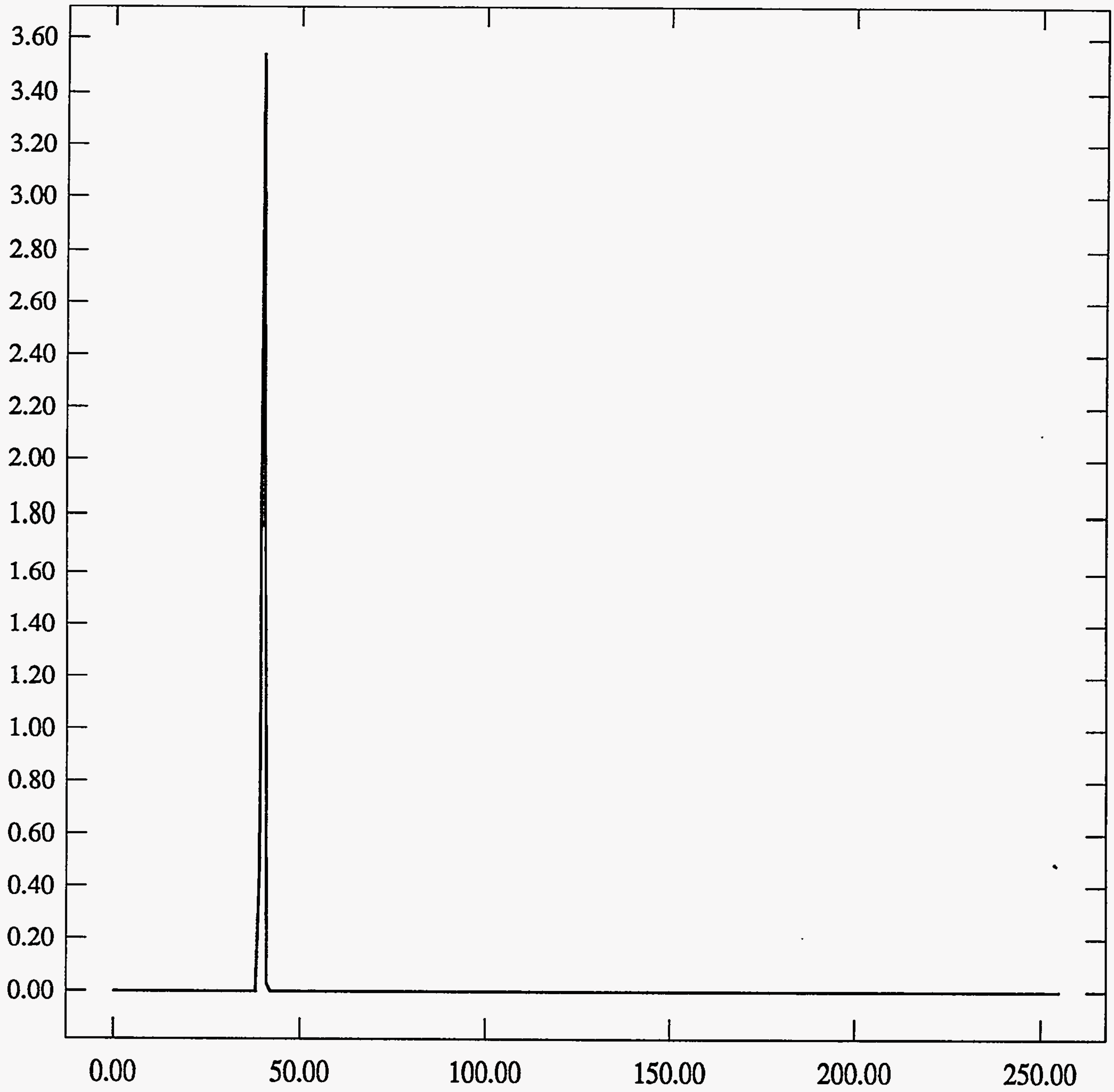
Pixel Values Min 142 Max 147 Mean 144.9 Sigma 0.78 x 10^3



#4 -30°C
15m

ST Camera: ST1#04-10 -30C #4: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 13:46:20 1993

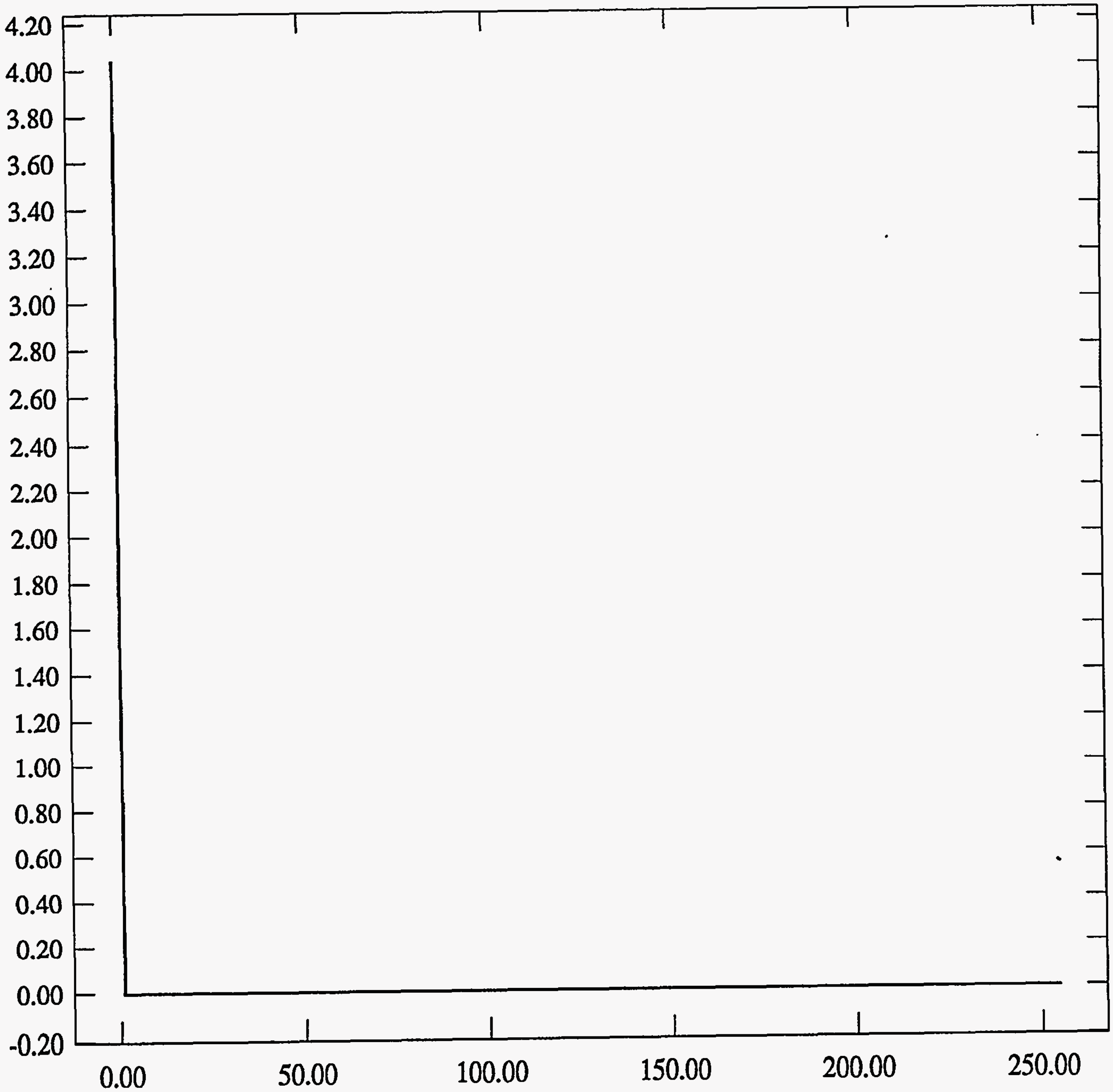
Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.33 x 10^3



?

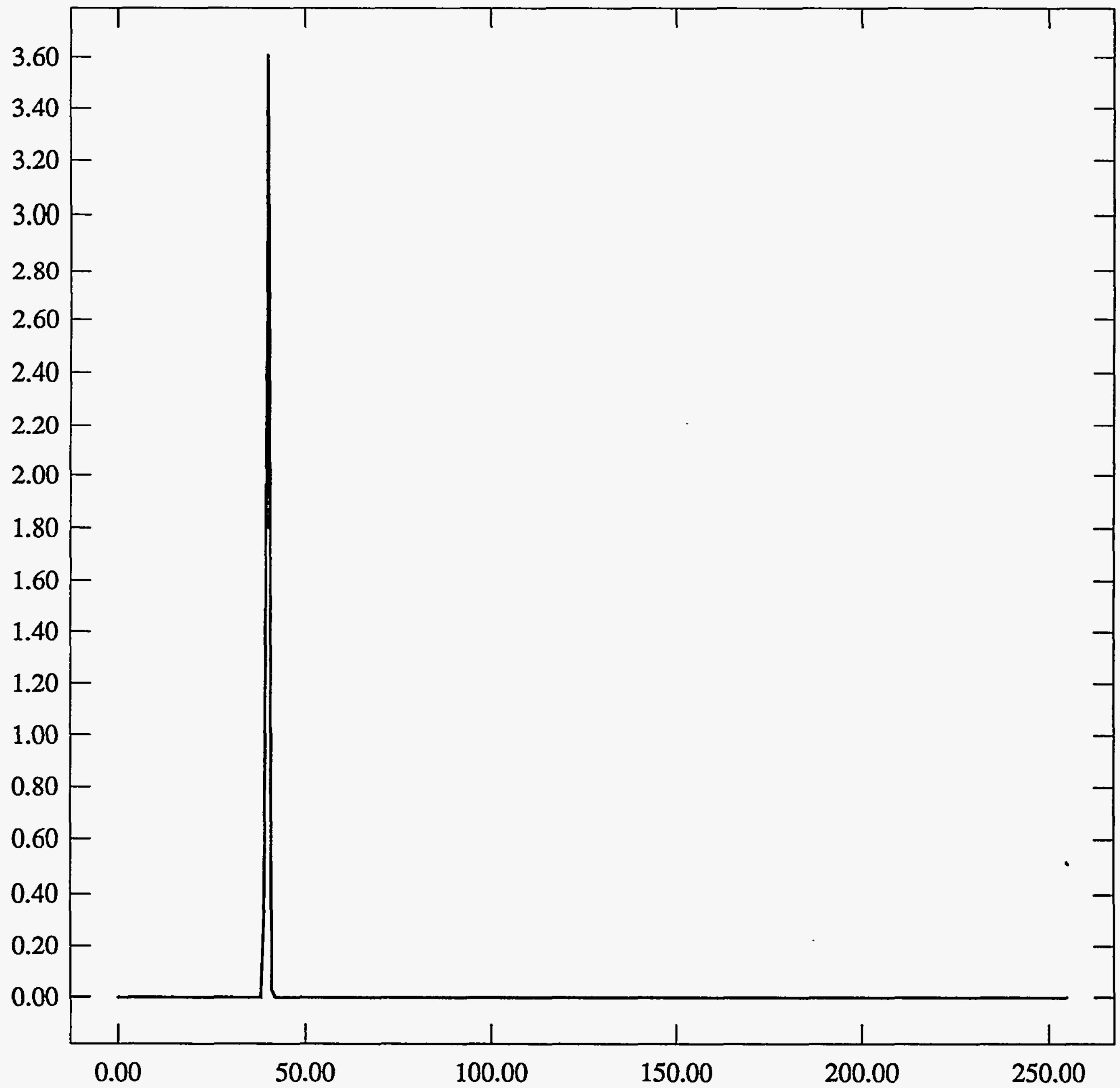
ST Camera: ST1#04-10 -30C #4: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 13:47:07 1993

Pixel Values Min 0 Max 0 Mean 0.0 Sigma 0.00 x 10^3



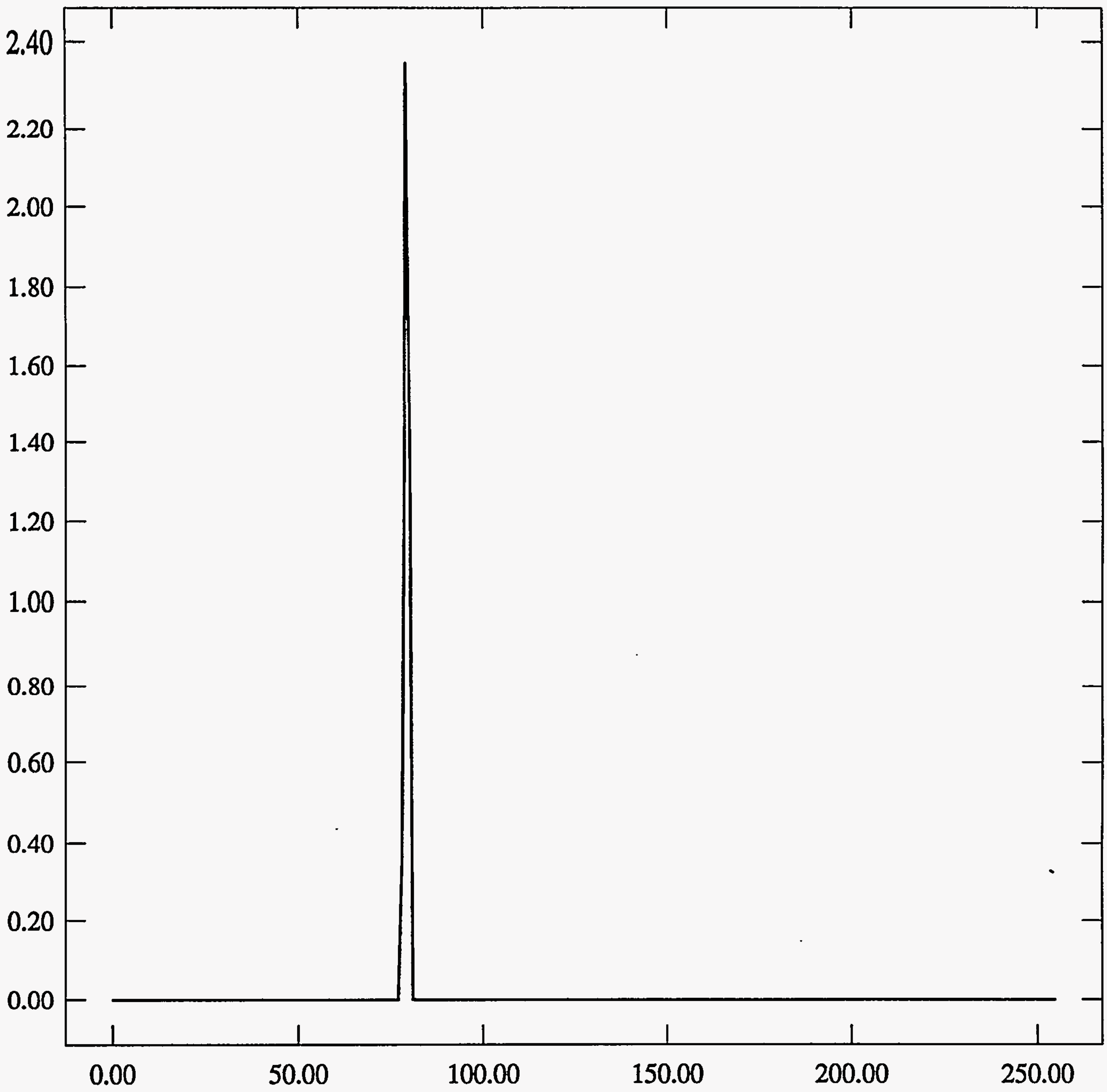
ST Camera: ST1#04-10 -30C #4: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 13:47:53 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.31 x 10^3



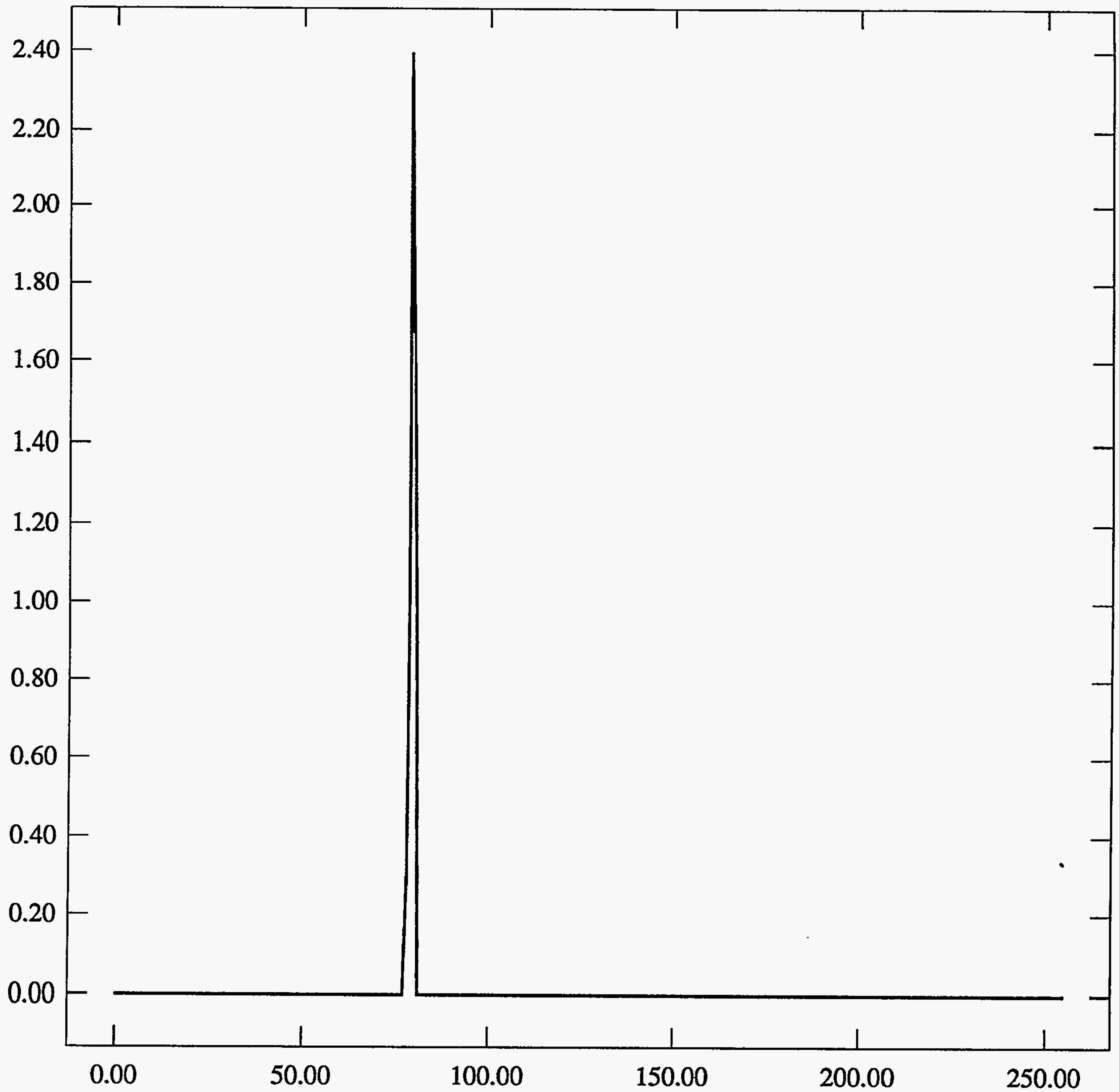
ST Camera: ST1#04-10 -30C #4: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 13:48:39 1993

Pixel Values Min 78 Max 81 Mean 79.2 Sigma 0.60 x 10^3



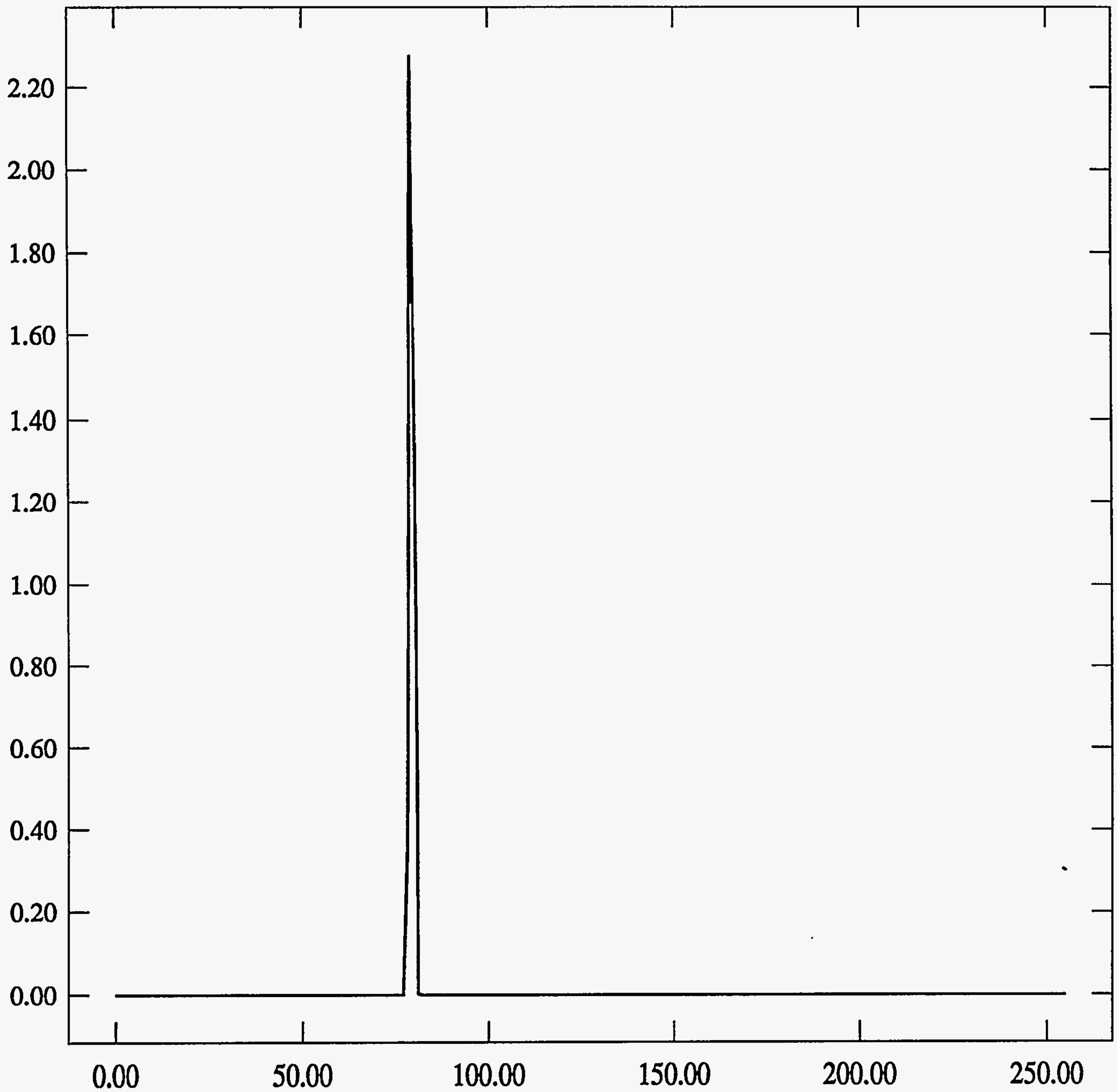
ST Camera: ST1#04-10 -30C #4: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 13:49:14 1993

Pixel Values Min 78 Max 80 Mean 79.3 Sigma 0.58 x 10^3



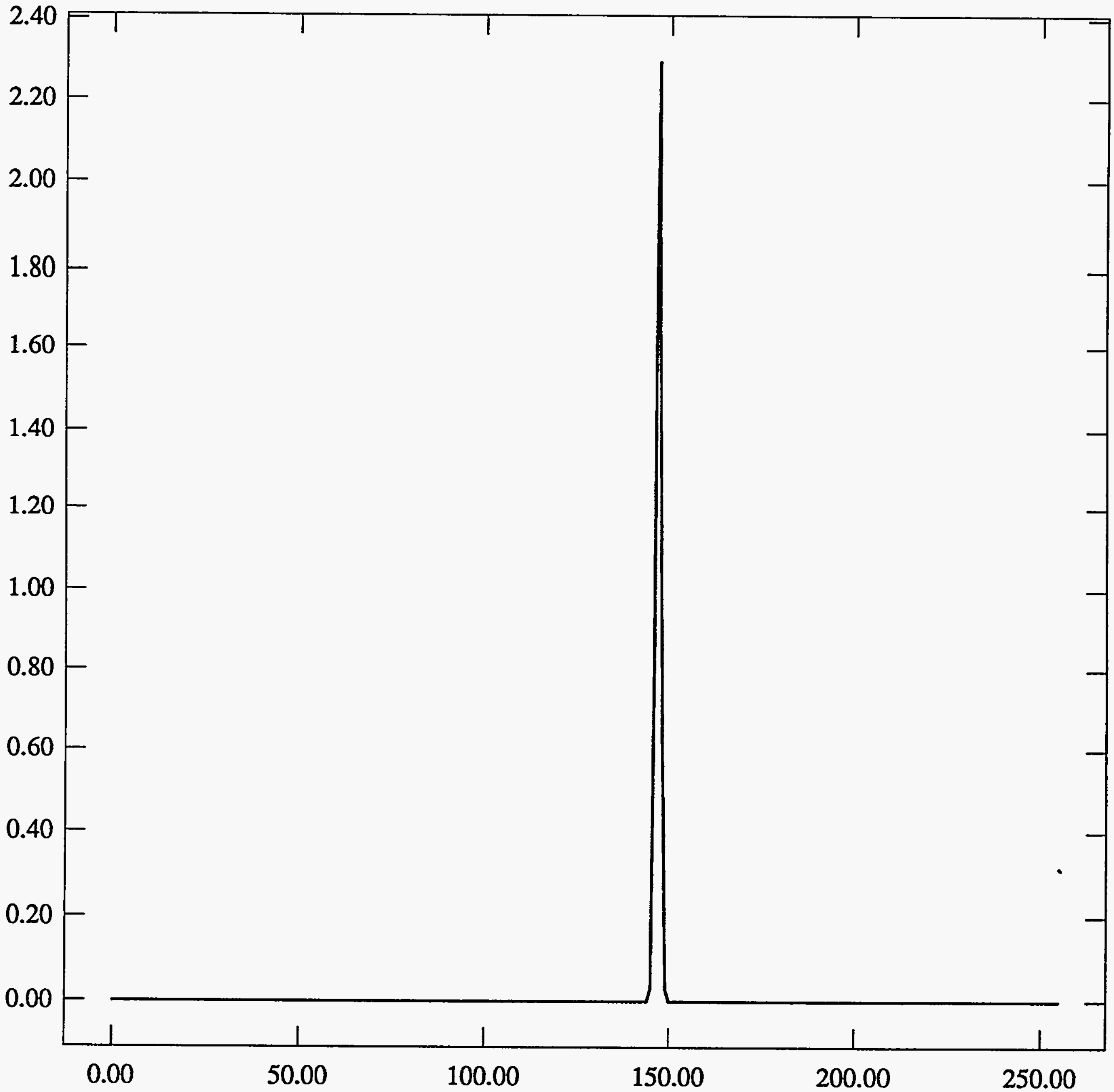
ST Camera: ST1#04-10 -30C #4: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 13:50:01 1993

Pixel Values Min 78 Max 81 Mean 79.3 Sigma 0.61 x 10^3



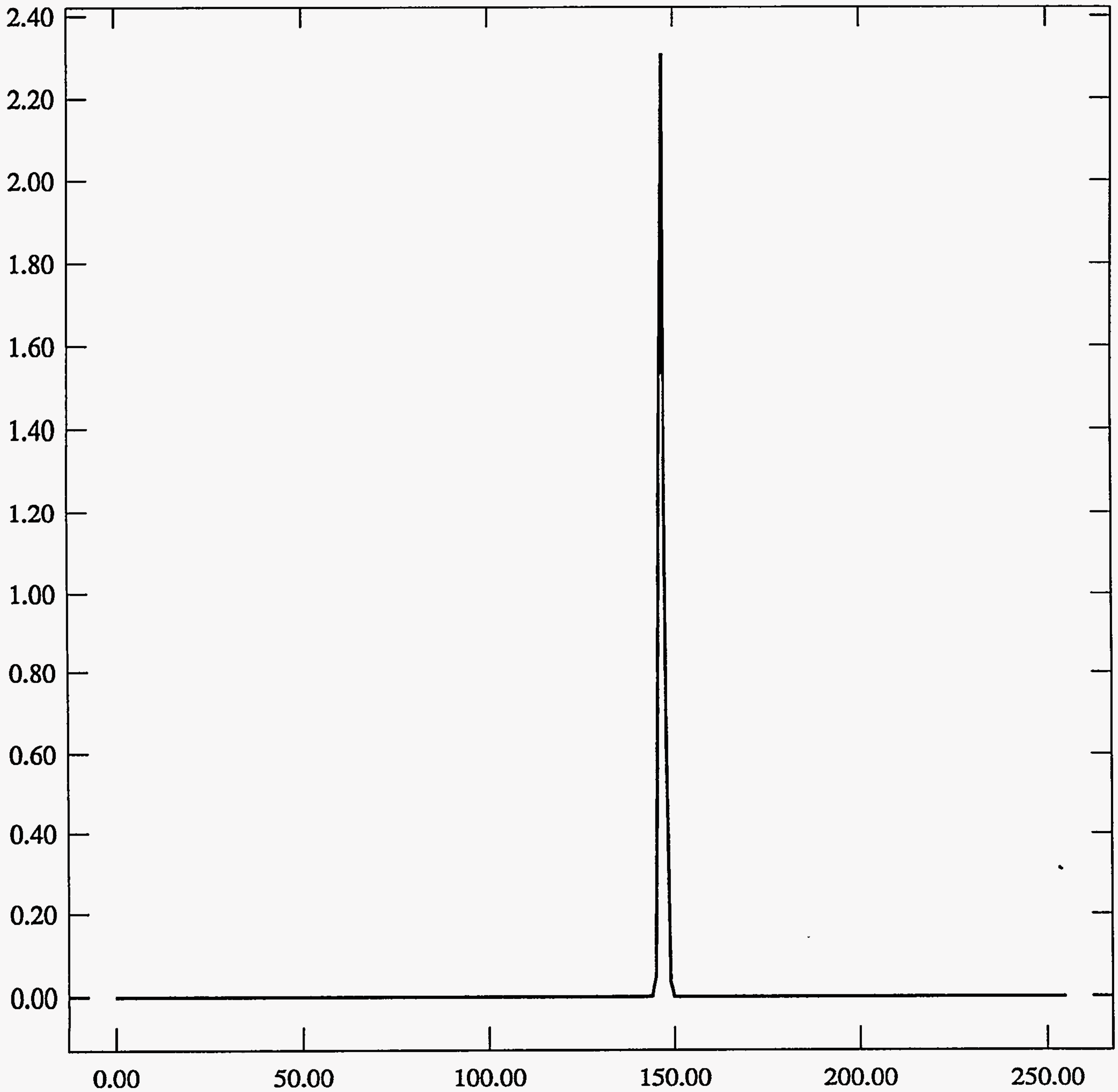
ST Camera: ST1#04-10 -30C #4: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 13:50:43 1993

Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.69 x 10^3



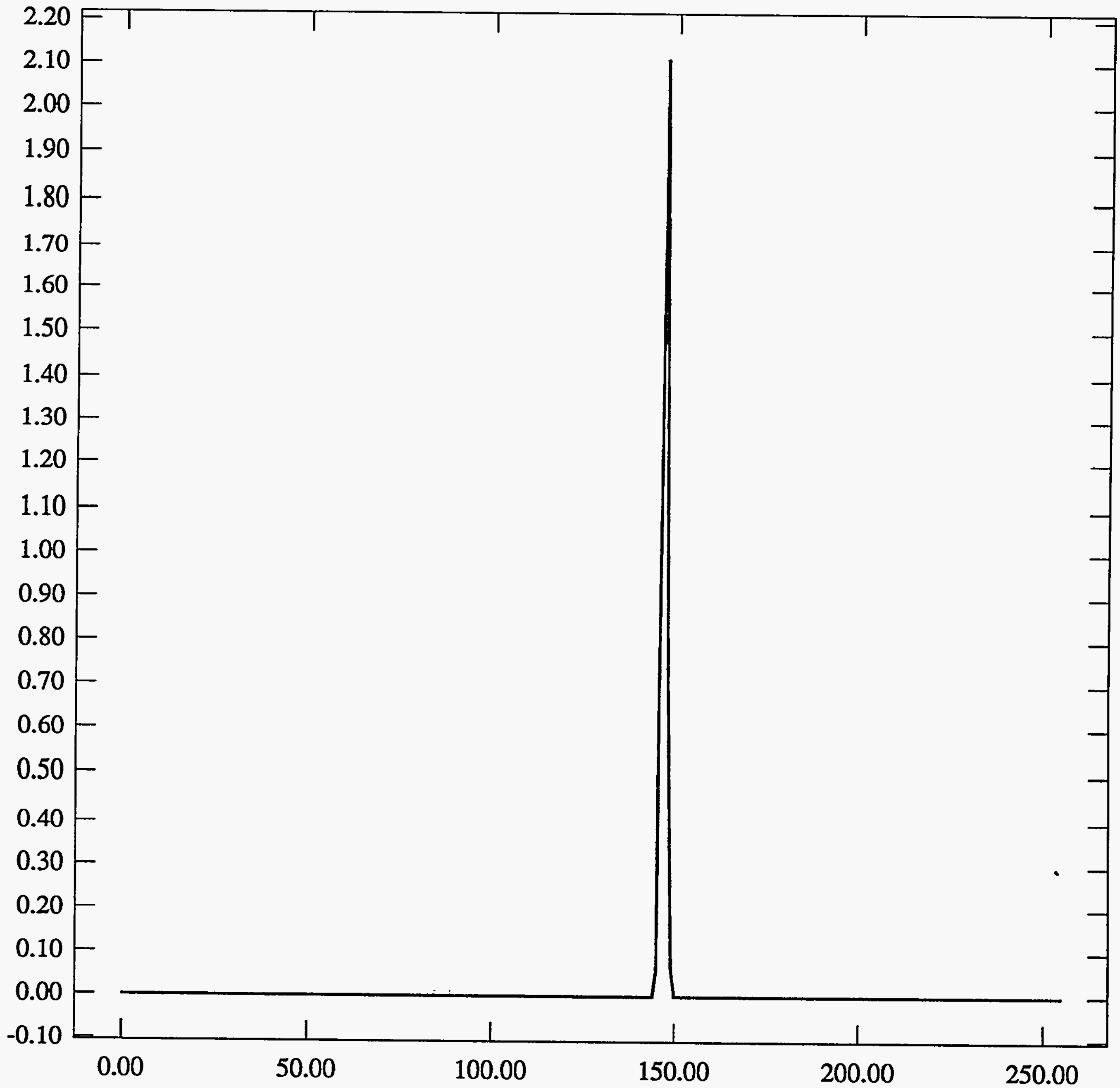
ST Camera: ST1#04-10 -30C #4: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 13:51:26 1993

Pixel Values Min 144 Max 149 Mean 146.9 Sigma 0.69 x 10^3



ST Camera: ST1#04-10 -30C #4: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 13:52:17 1993

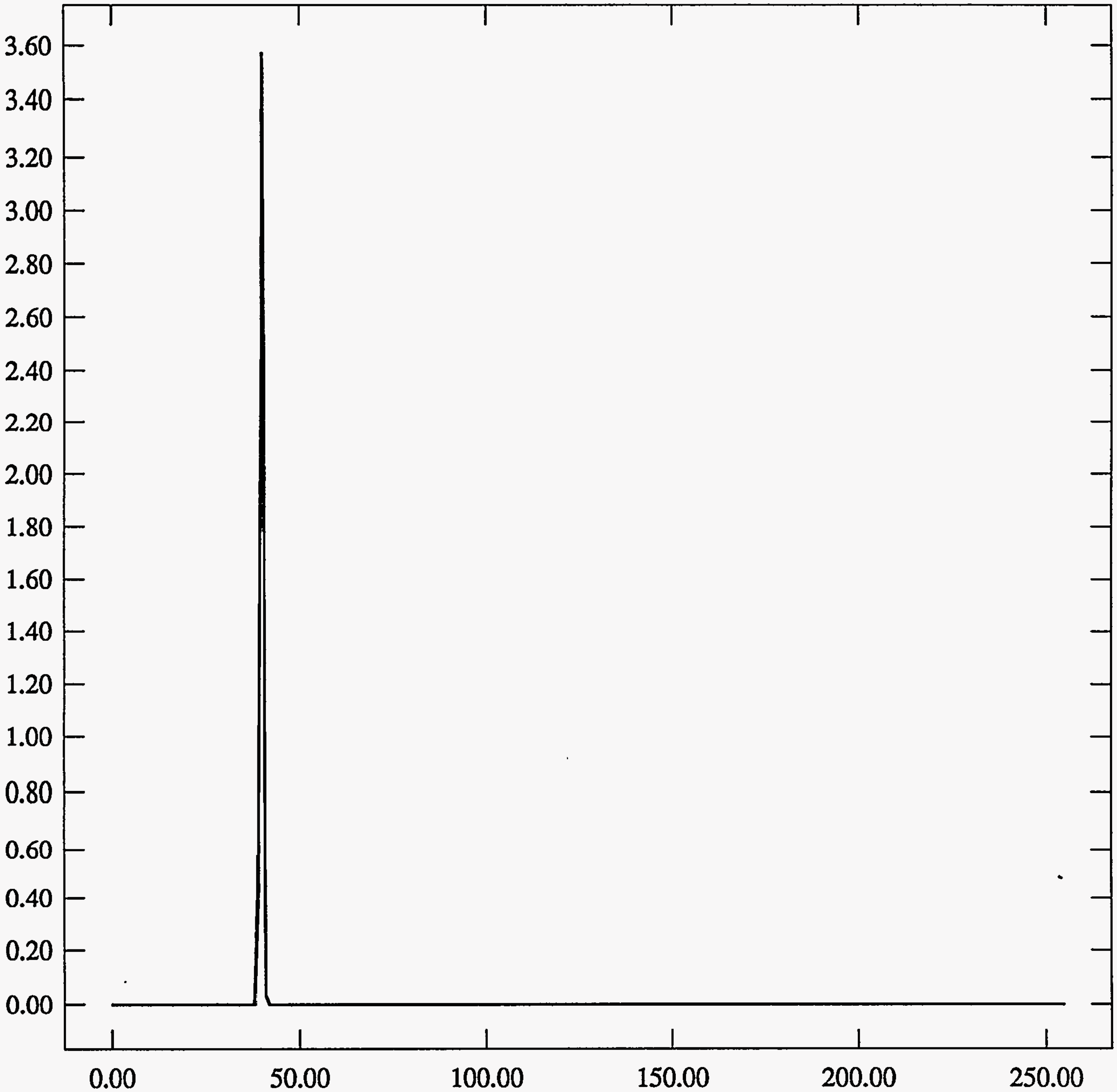
Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.75 x 10^3



#4 -30°C END

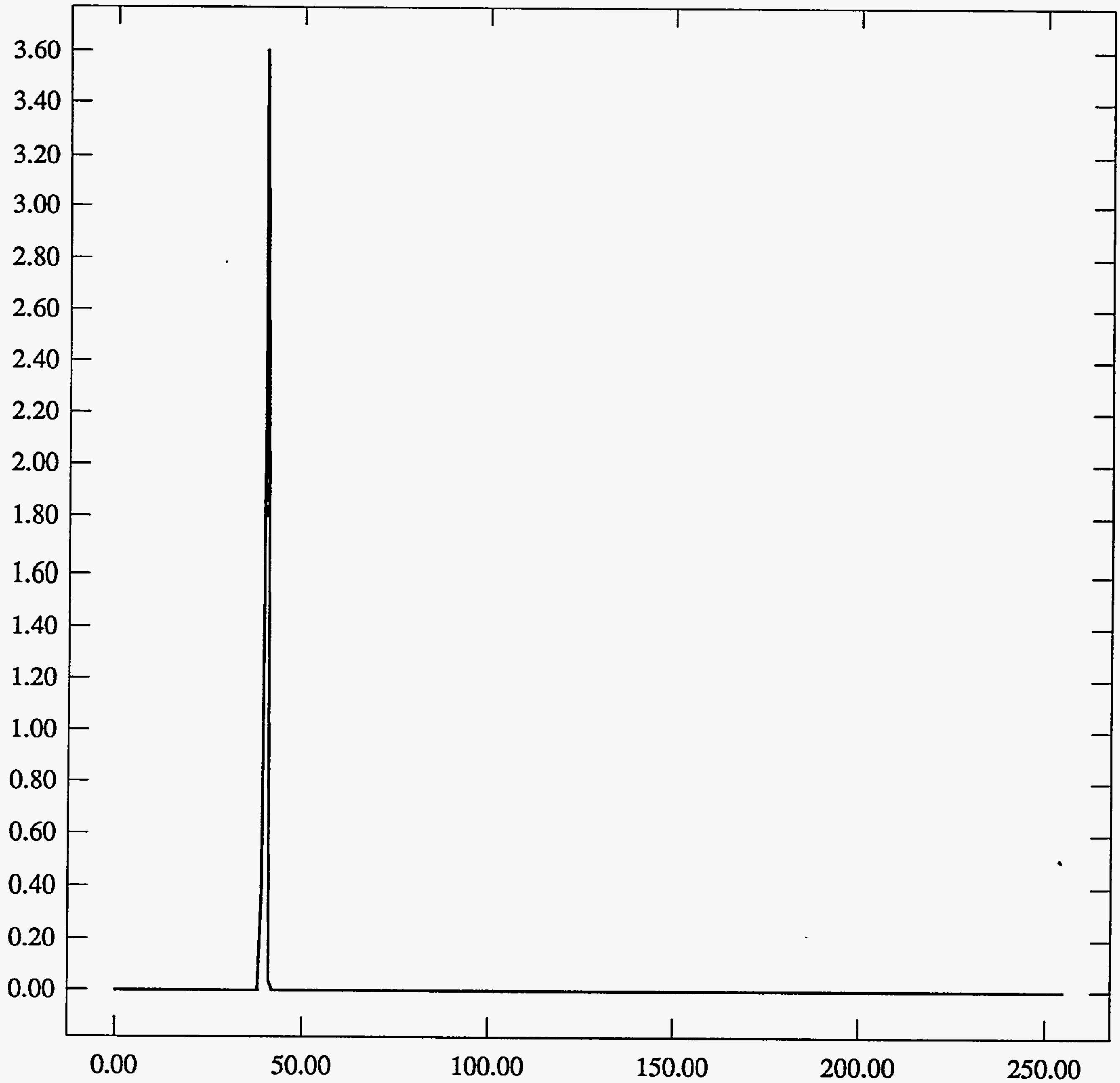
ST Camera: ST1#04-10 -30C #4: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 14:21:11 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.33 x 10^3



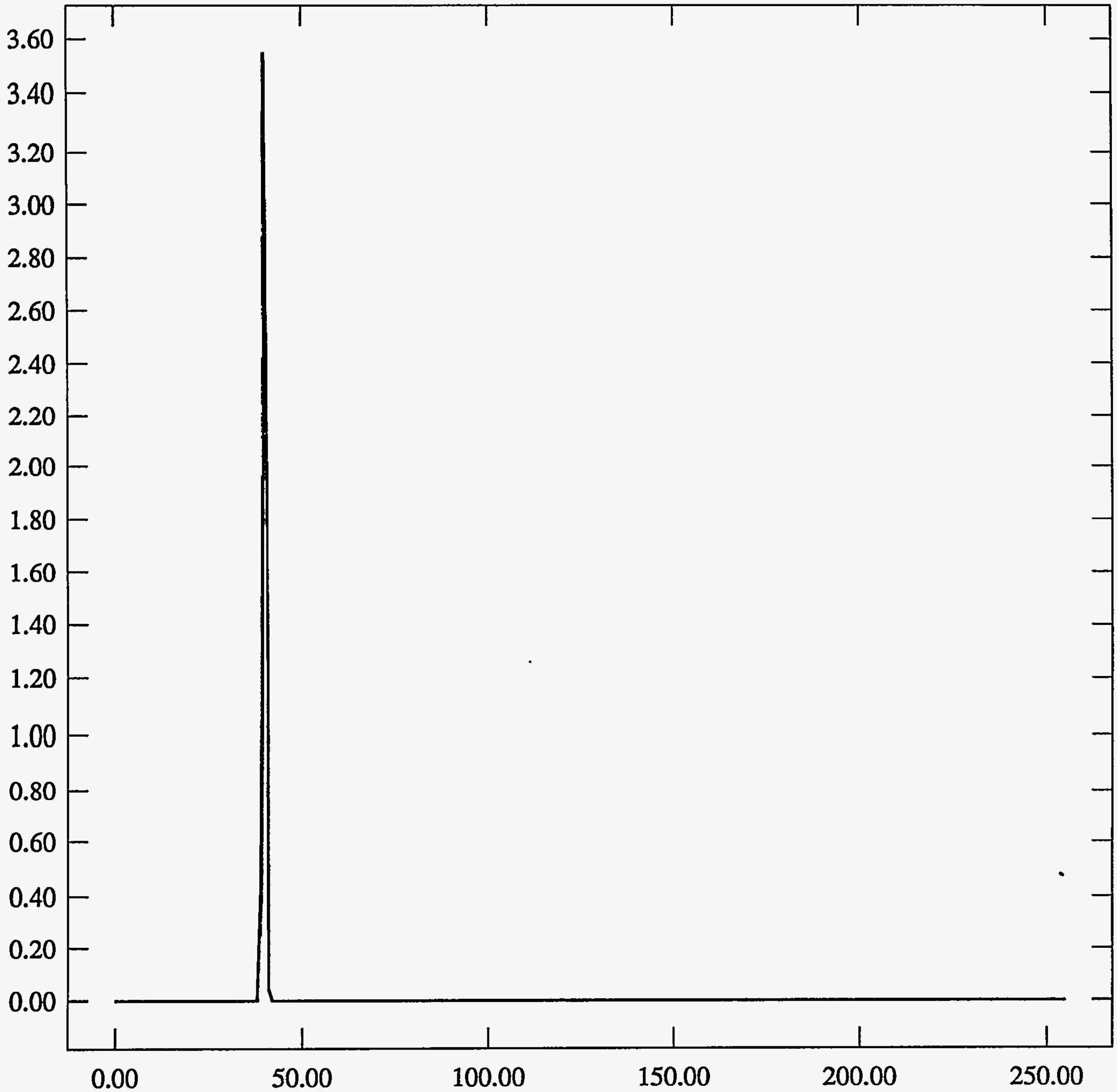
ST Camera: ST1#04-10 -30C #4: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 14:21:53 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.32 x 10^3



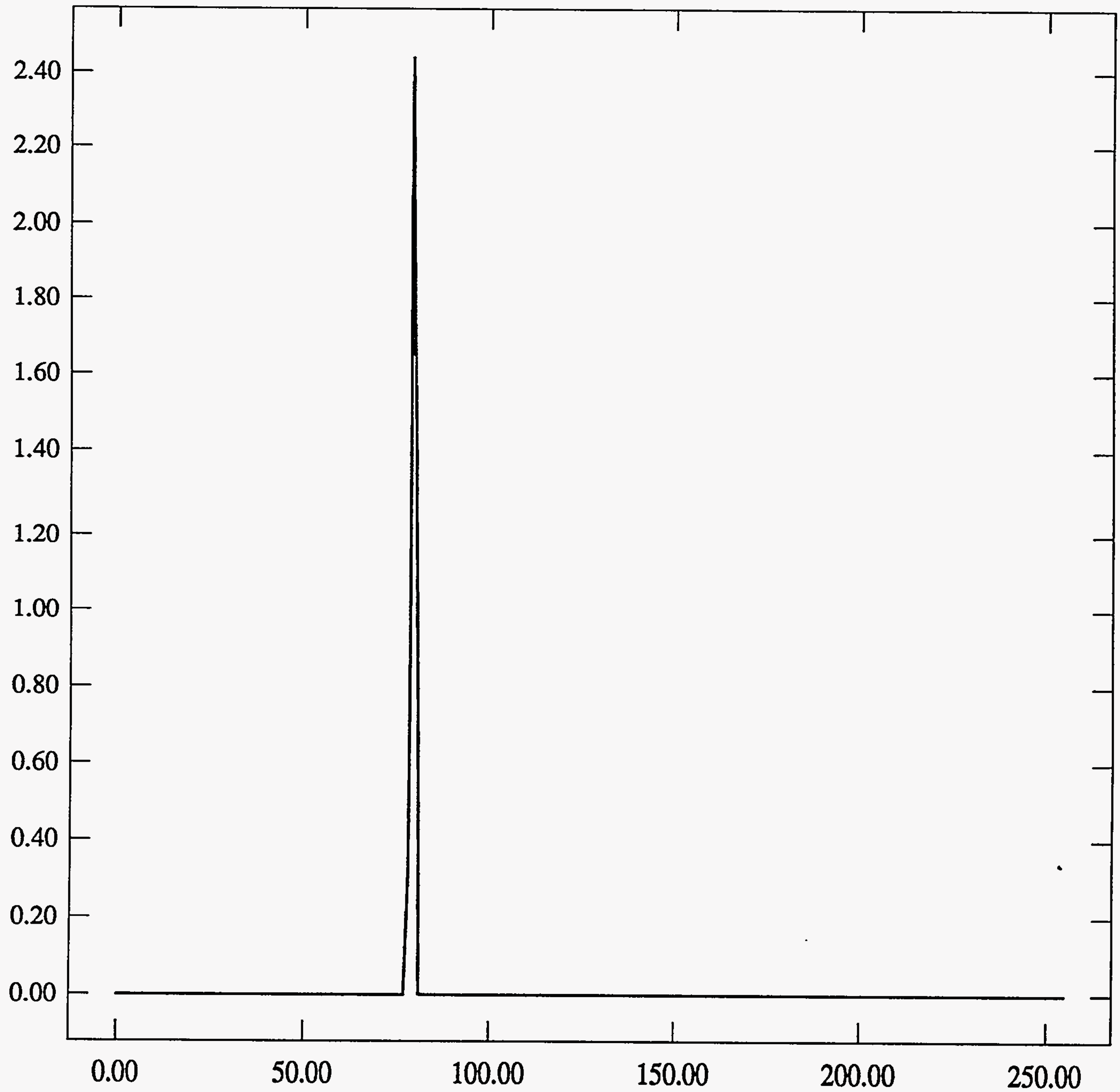
ST Camera: ST1#04-10 -30C #4: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 14:22:48 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.33 x 10^3



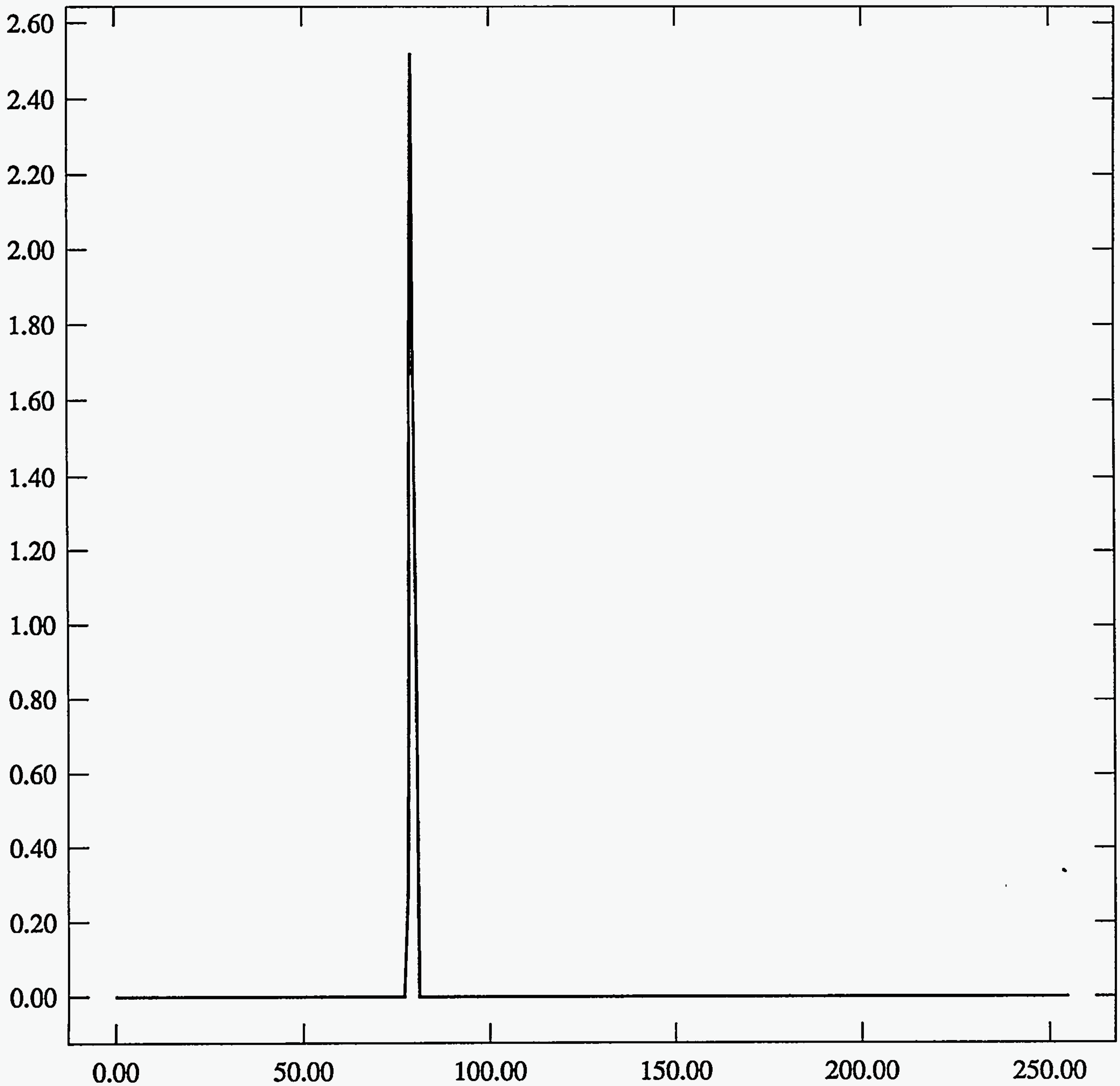
ST Camera: ST1#04-10 -30C #4: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 14:23:04 1993

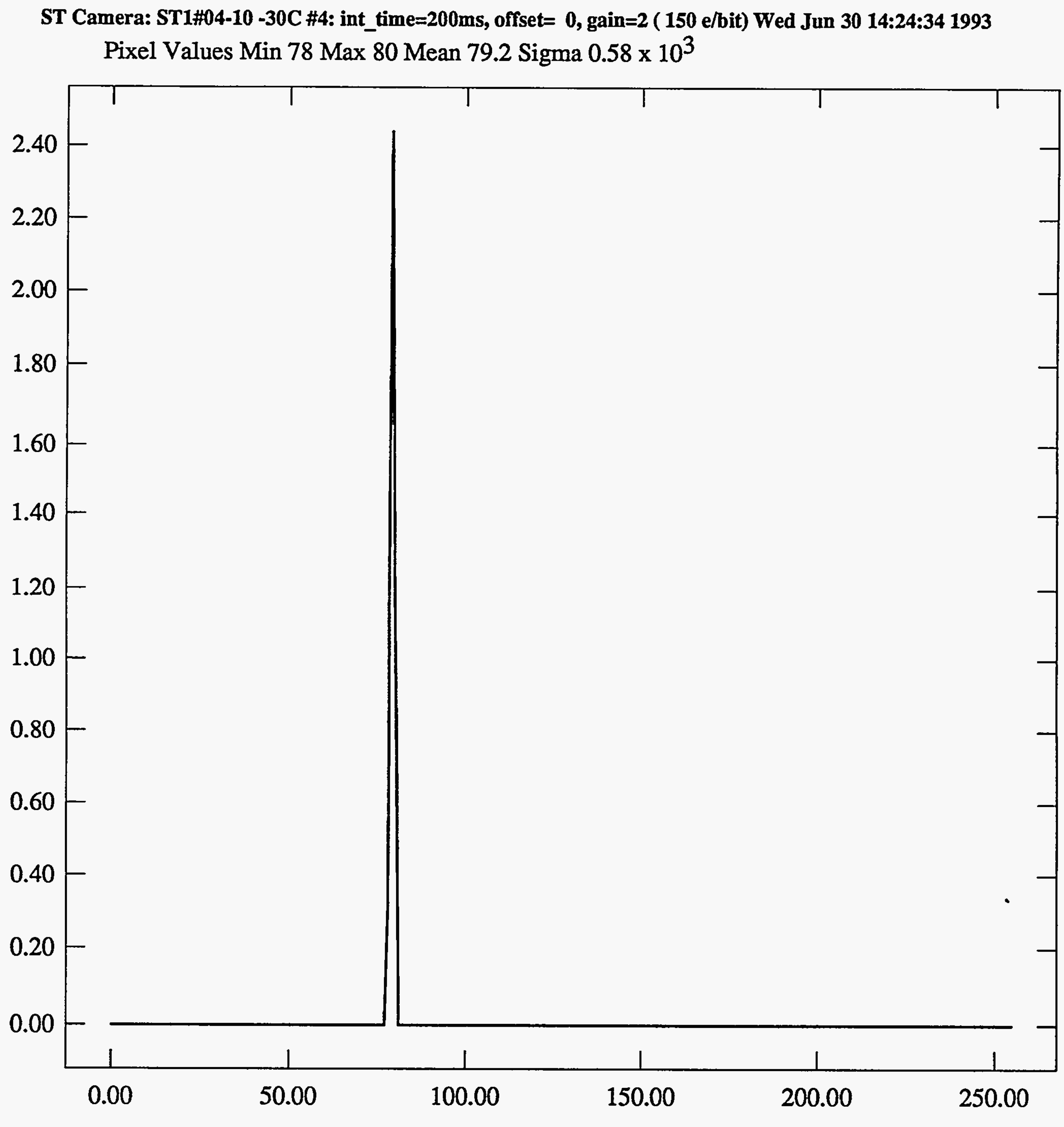
Pixel Values Min 78 Max 81 Mean 79.2 Sigma 0.58 x 10^3



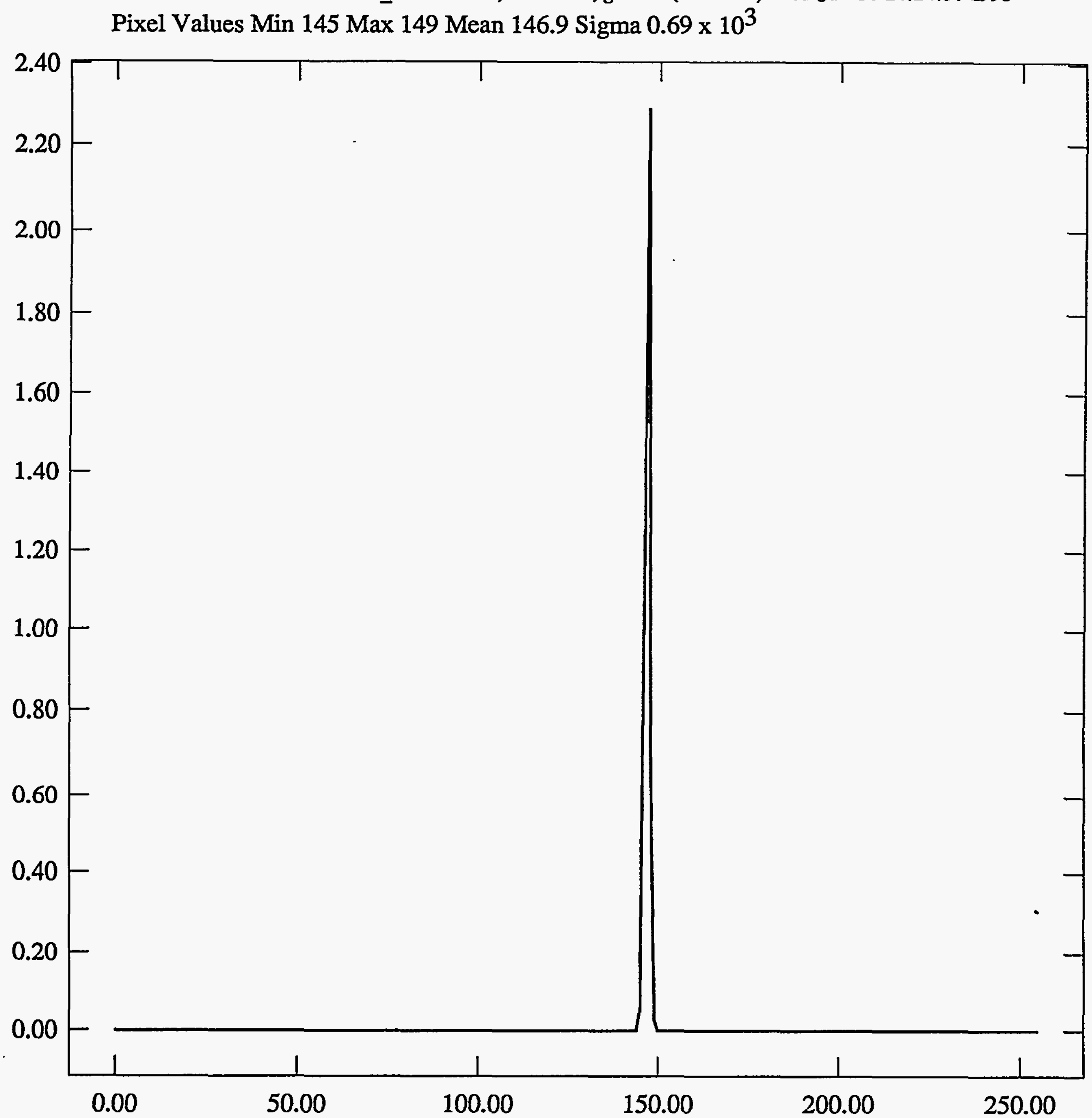
ST Camera: ST1#04-10 -30C #4: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 14:23:30 1993

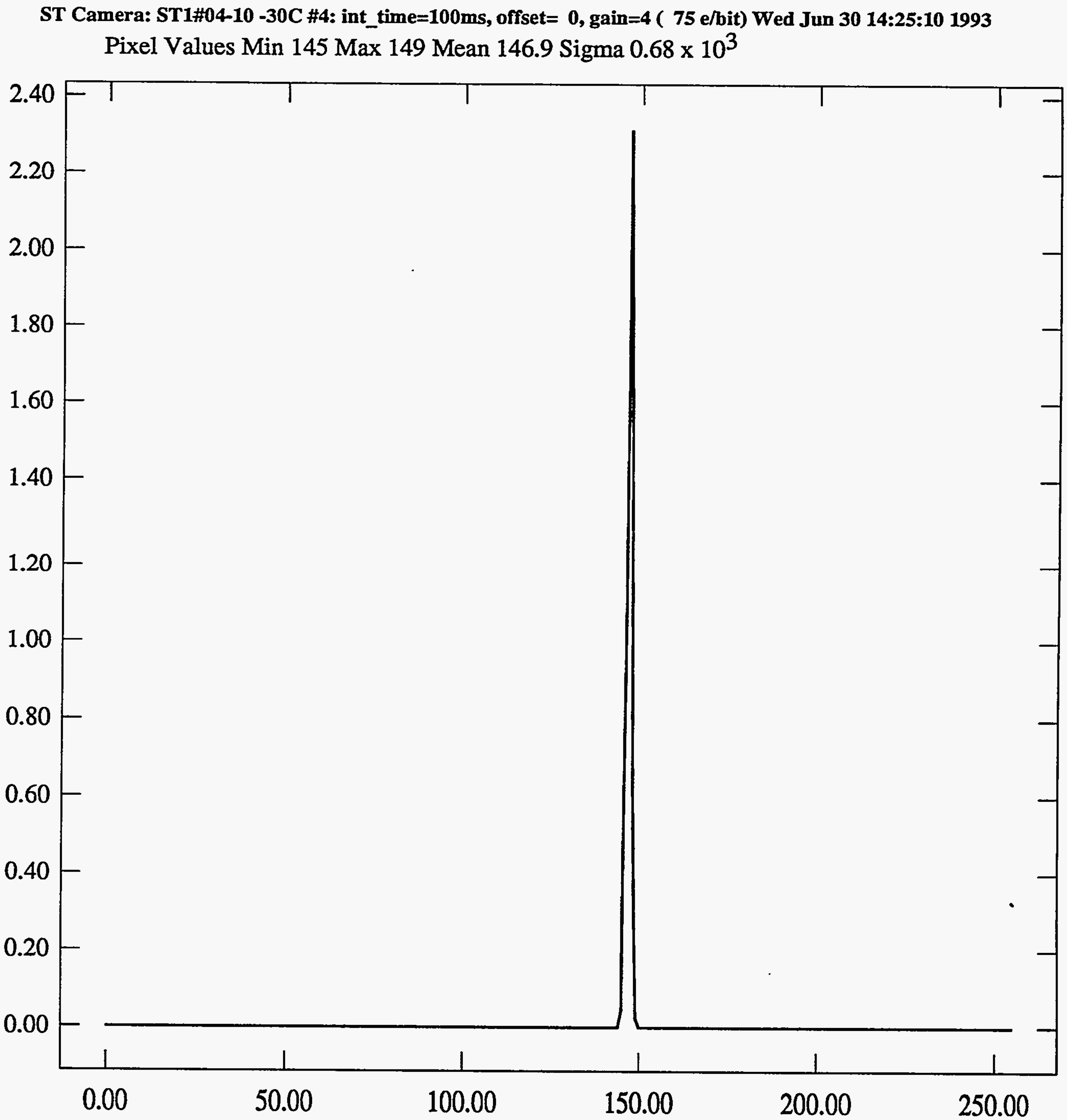
Pixel Values Min 78 Max 80 Mean 79.2 Sigma 0.57 x 10^3




ST Camera: ST1#04-10 -30C #4: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 14:24:34 1993
Pixel Values Min 78 Max 80 Mean 79.2 Sigma 0.58 x 10^3
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1#04-10 -30C #4: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 14:24:50 1993

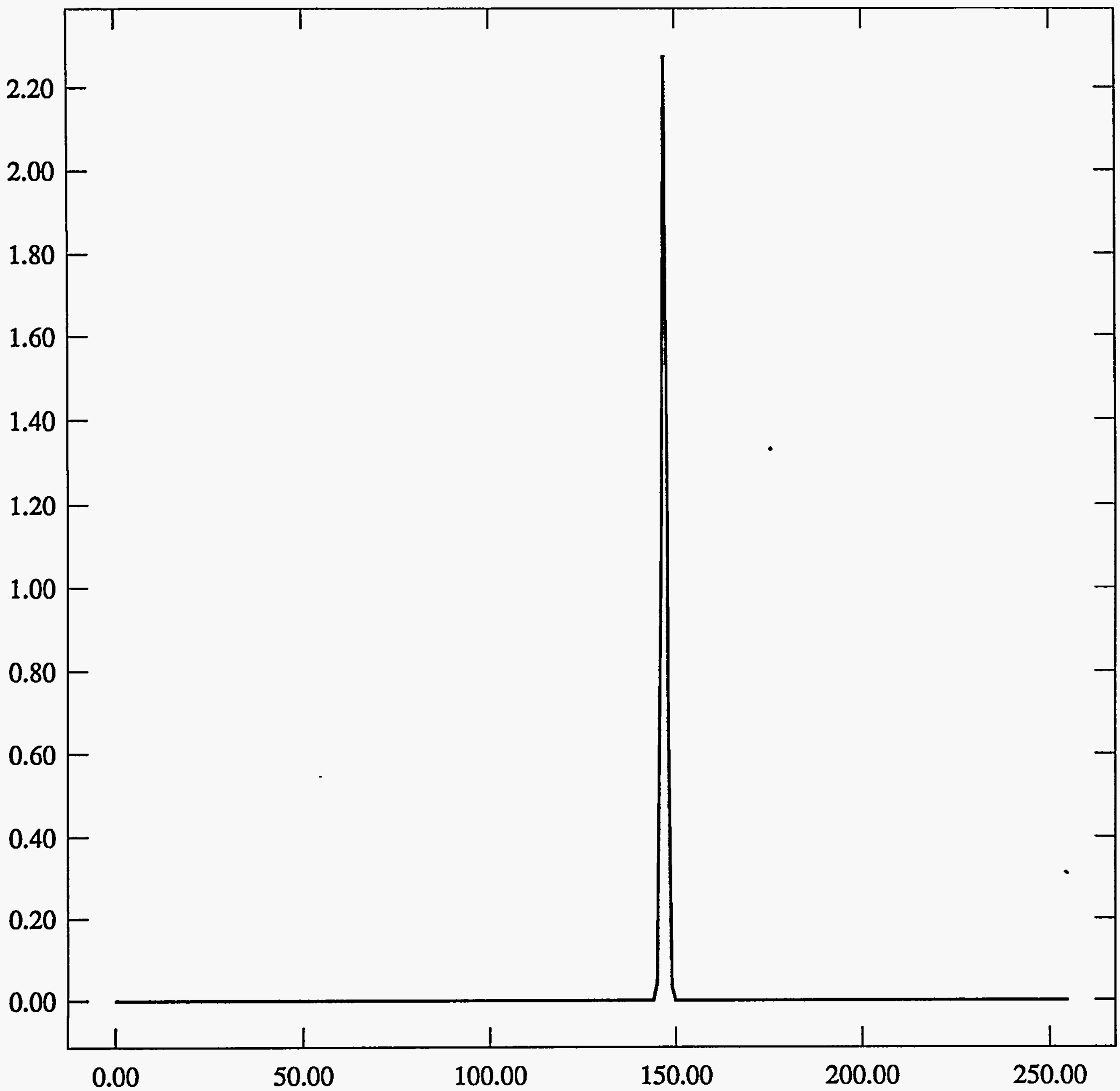




ST Camera: ST1#04-10 -30C #4: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 14:25:10 1993
Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.68 x 10^3
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1#04-10 -30C #4: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 14:25:27 1993

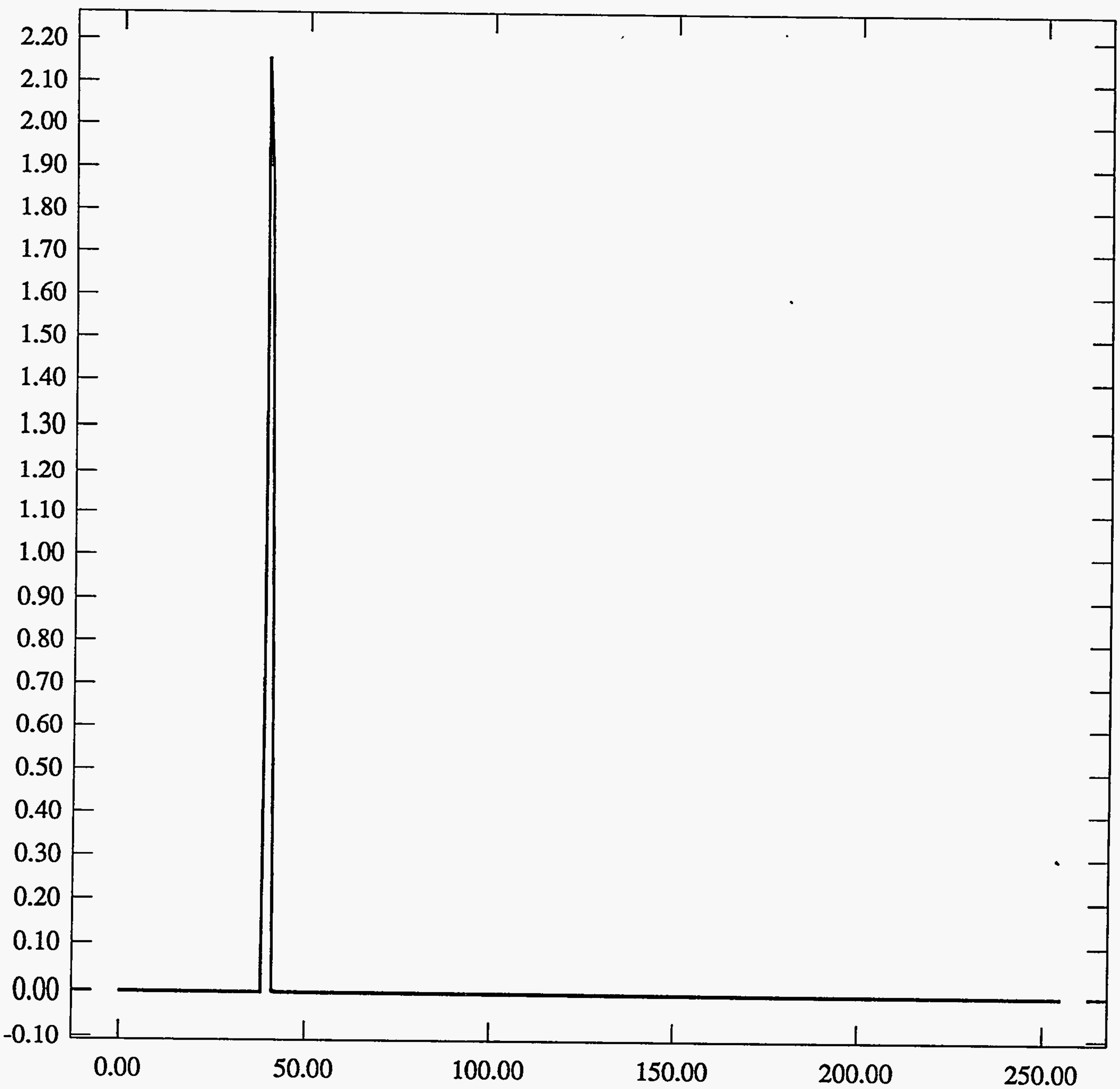
Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.70 x 10^3



#4 20C 15min

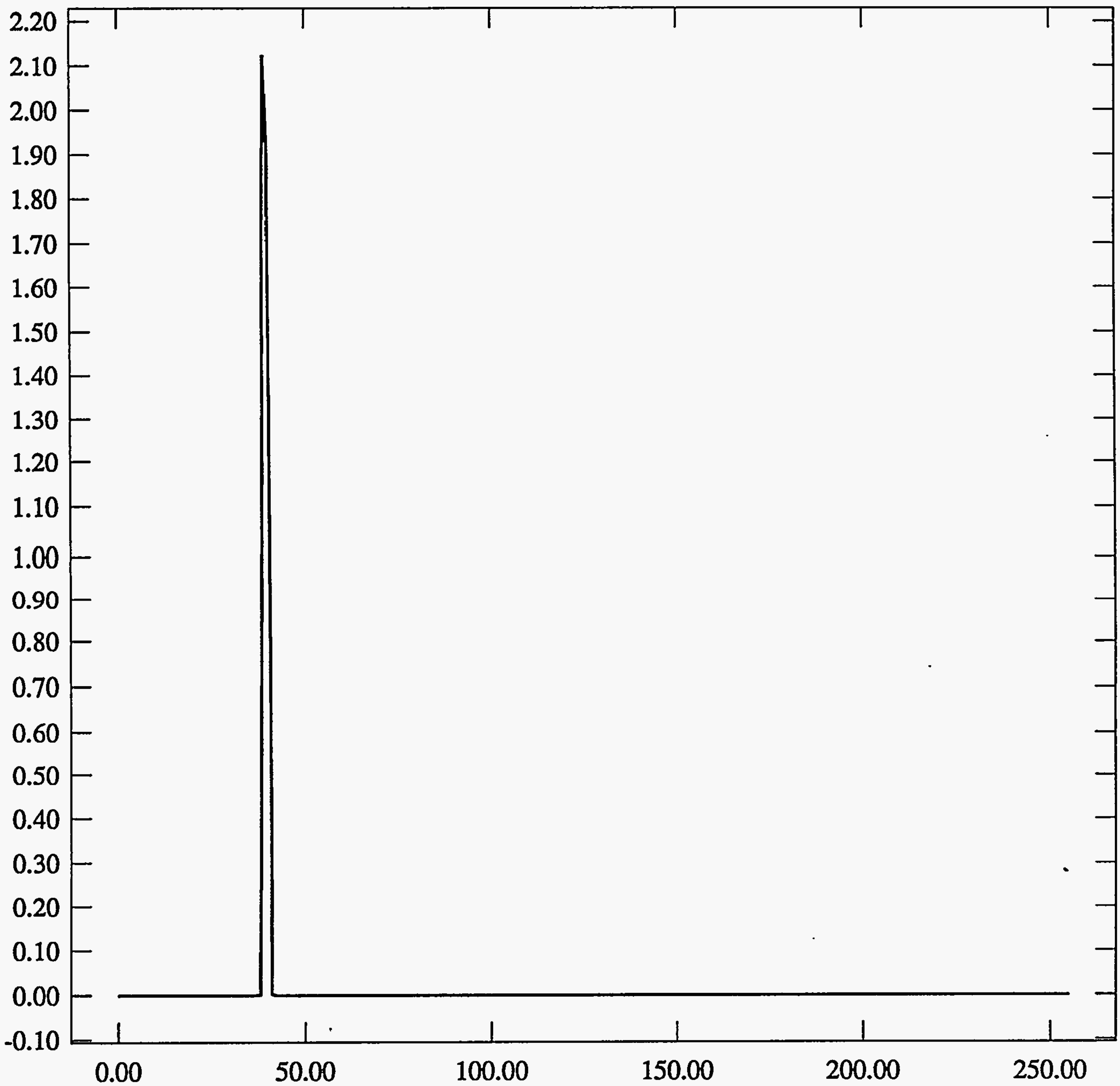
ST Camera: ST1#04-10 20C #4: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 15:01:35 1993

Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3



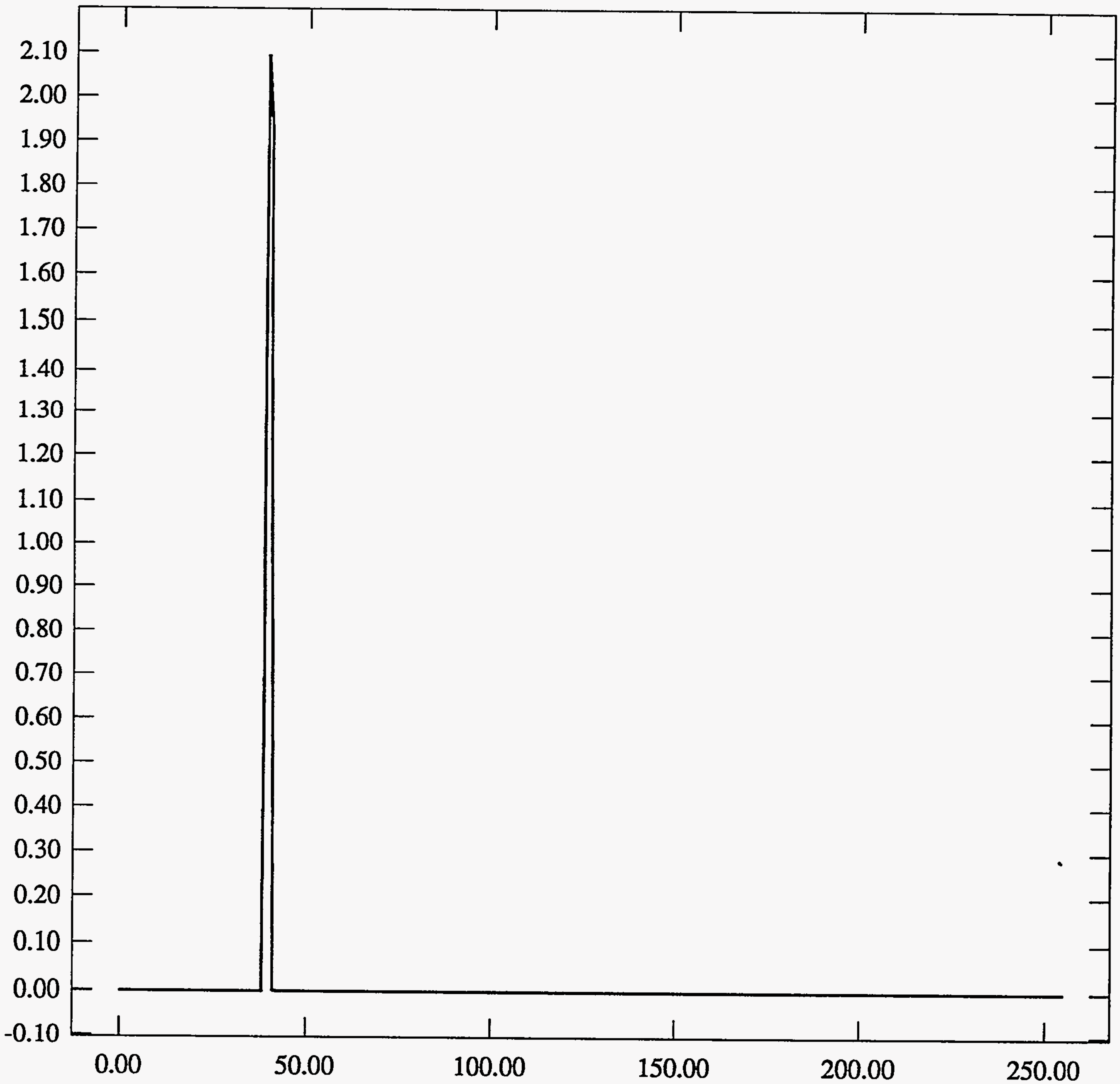
ST Camera: ST1#04-10 20C #4: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 15:01:48 1993

Pixel Values Min 38 Max 41 Mean 39.5 Sigma 0.50 x 10^3



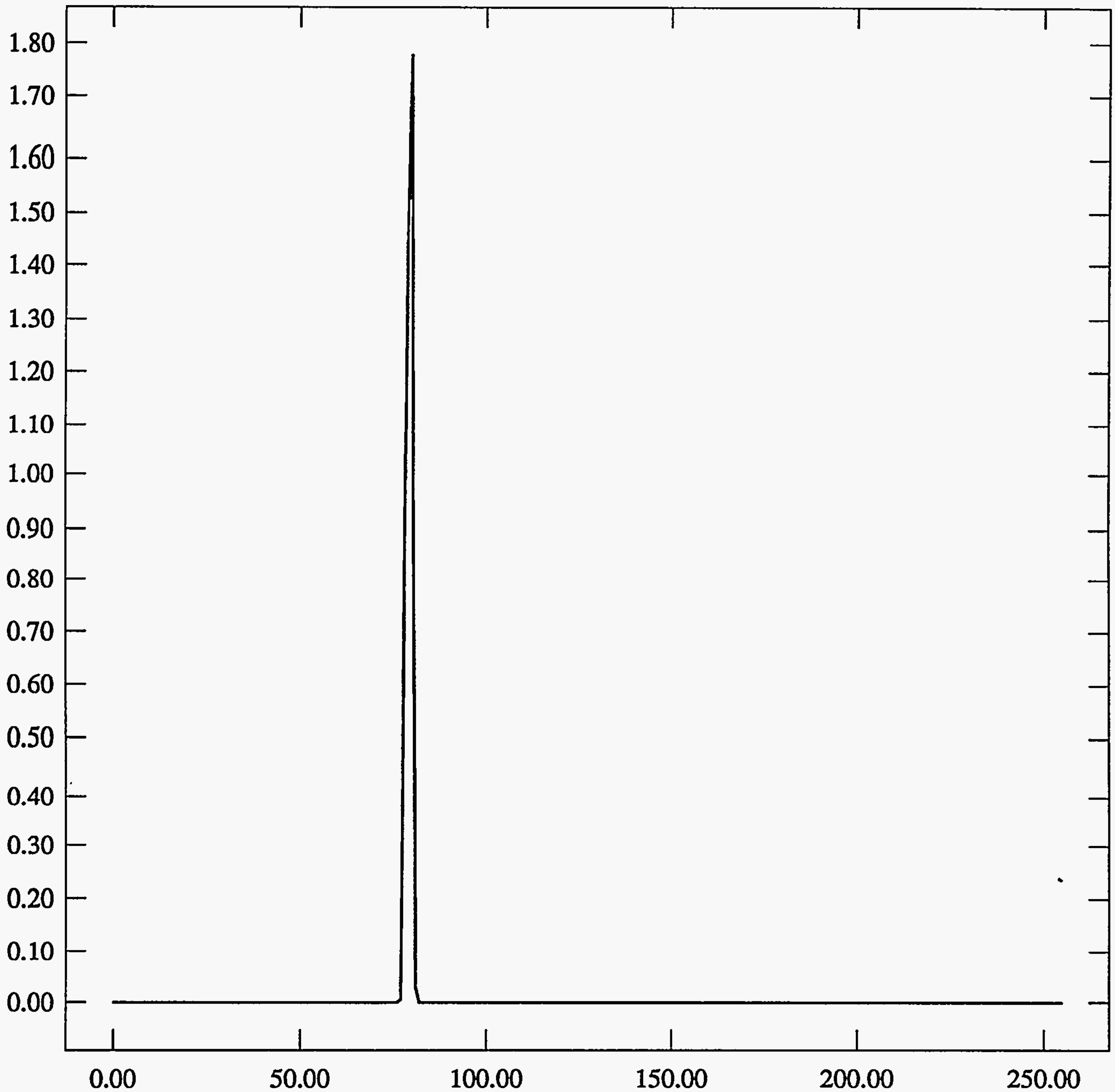
ST Camera: ST1#04-10 20C #4: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 15:01:59 1993

Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3



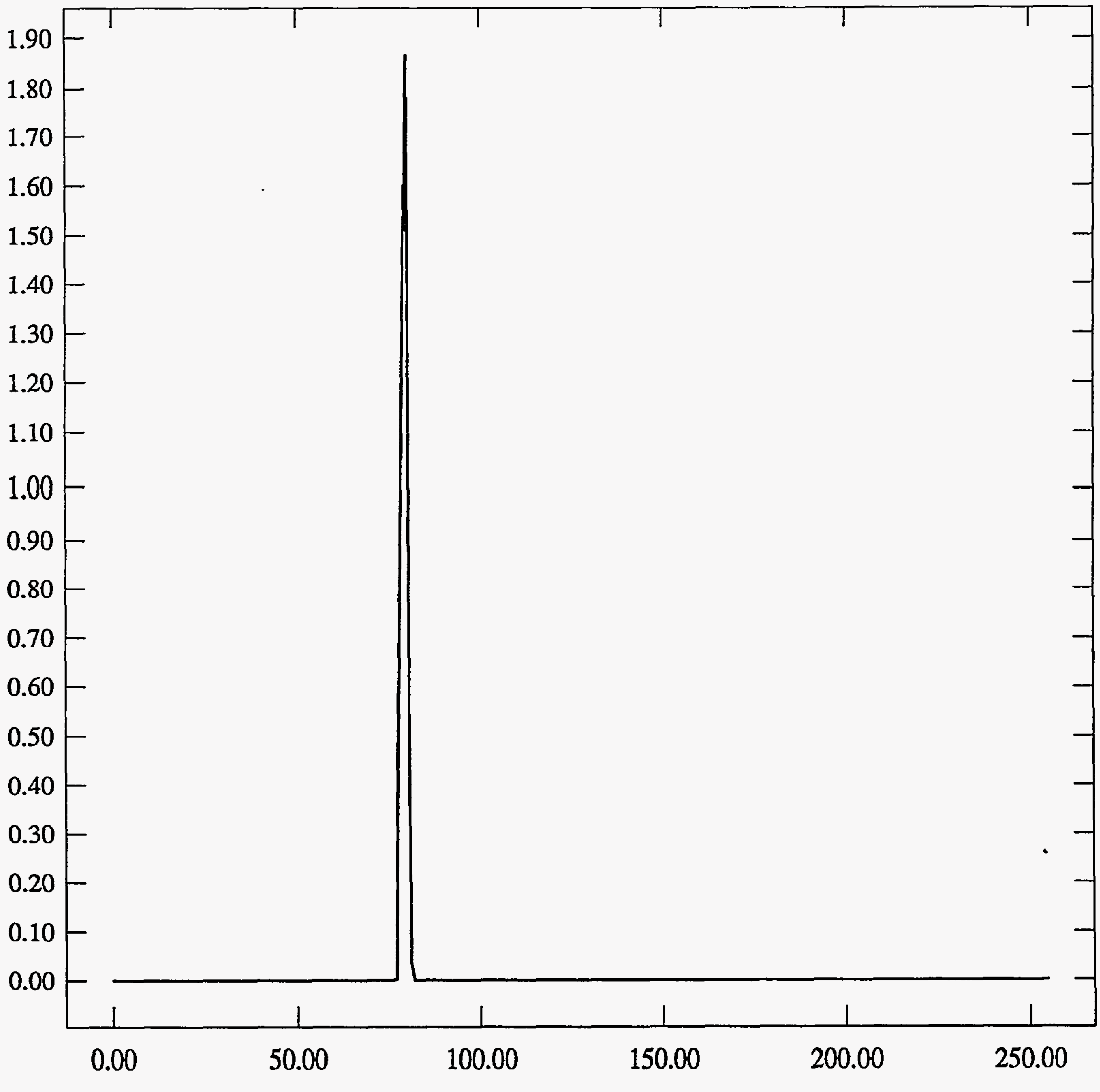
ST Camera: ST1#04-10 20C #4: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 15:02:16 1993

Pixel Values Min 77 Max 81 Mean 79.3 Sigma 0.77 x 10^3



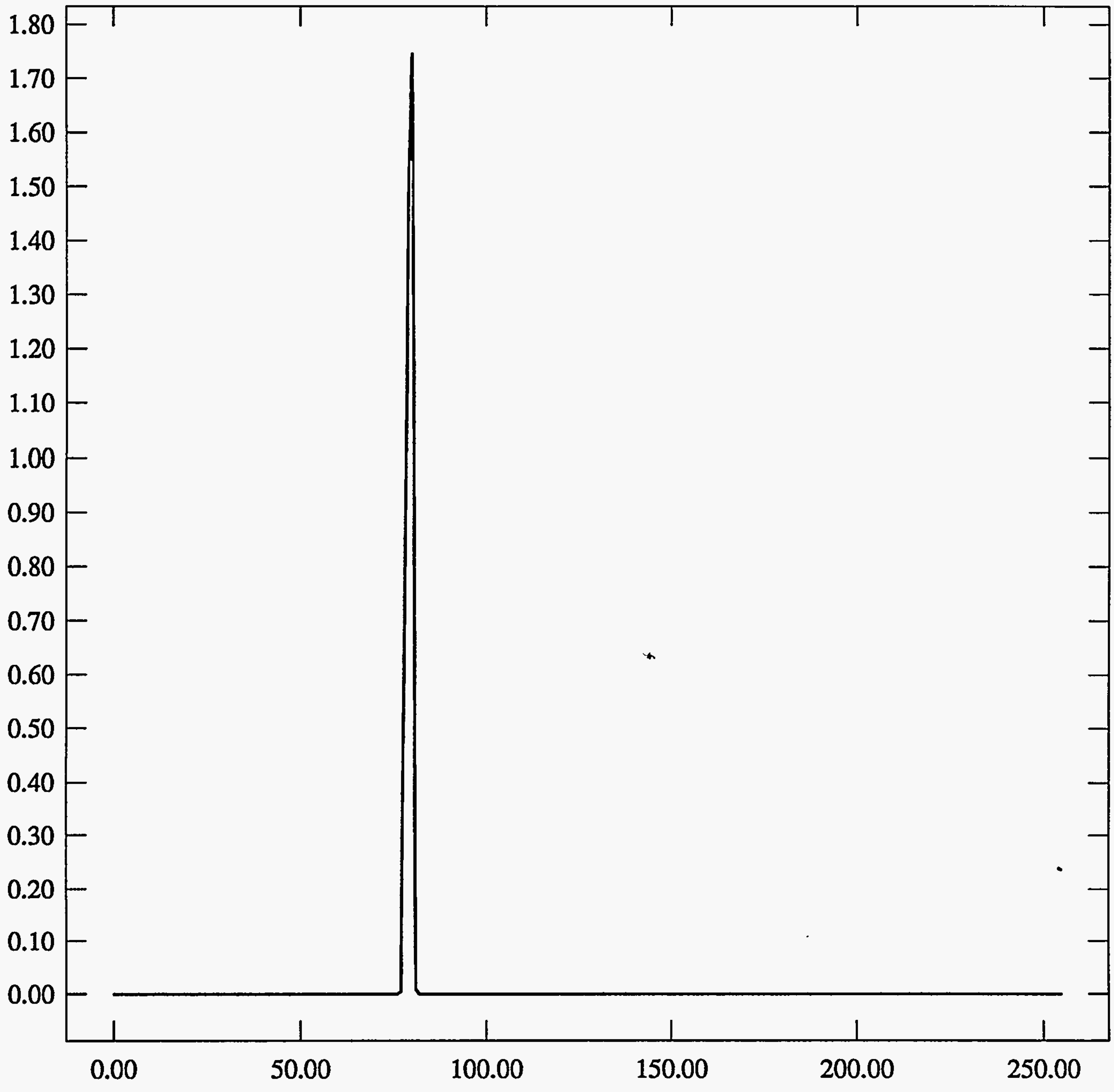
ST Camera: ST1#04-10 20C #4: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 15:02:32 1993

Pixel Values Min 77 Max 81 Mean 79.3 Sigma 0.76 x 10^3



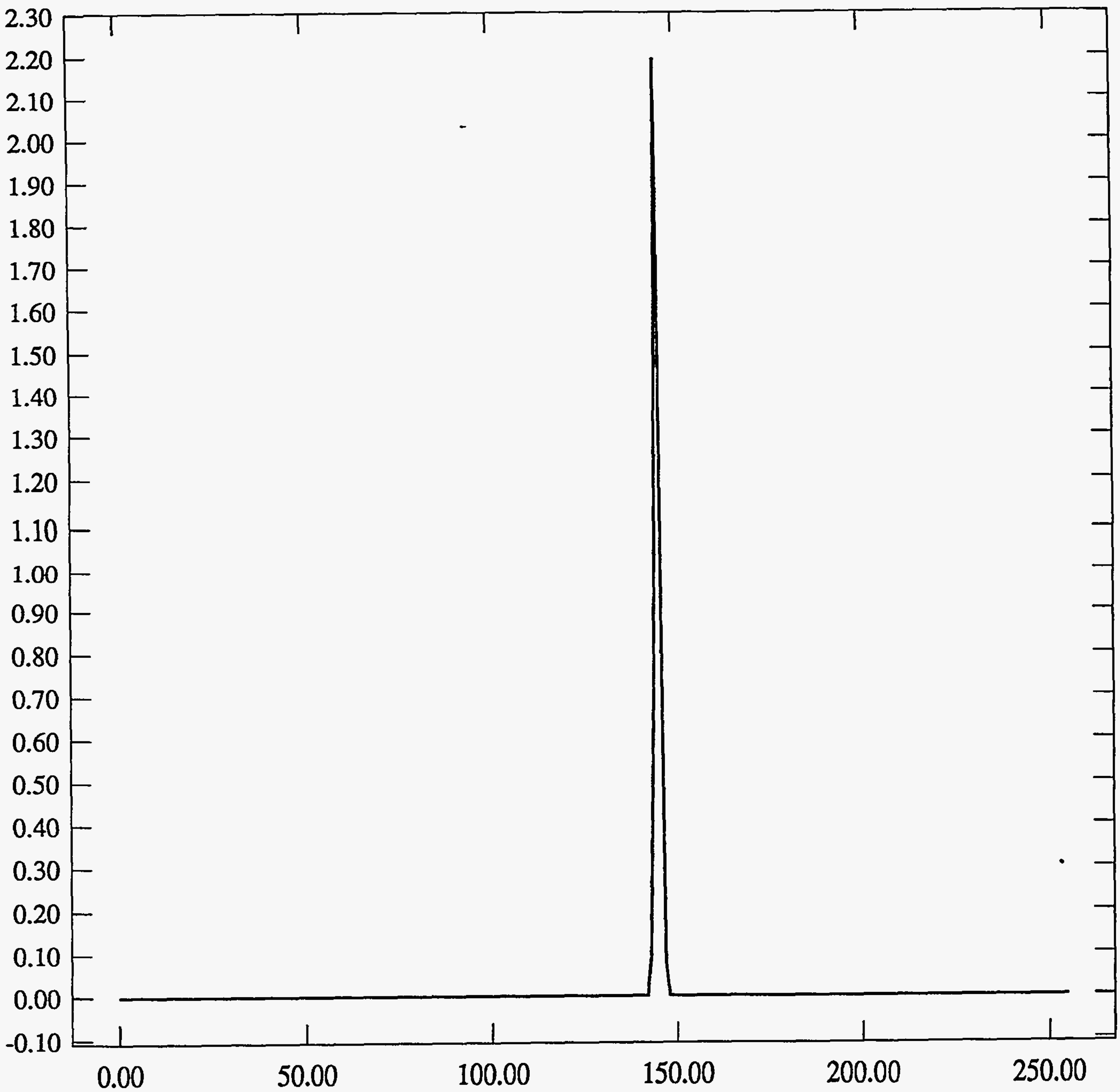
ST Camera: ST1#04-10 20C #4: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 15:02:44 1993

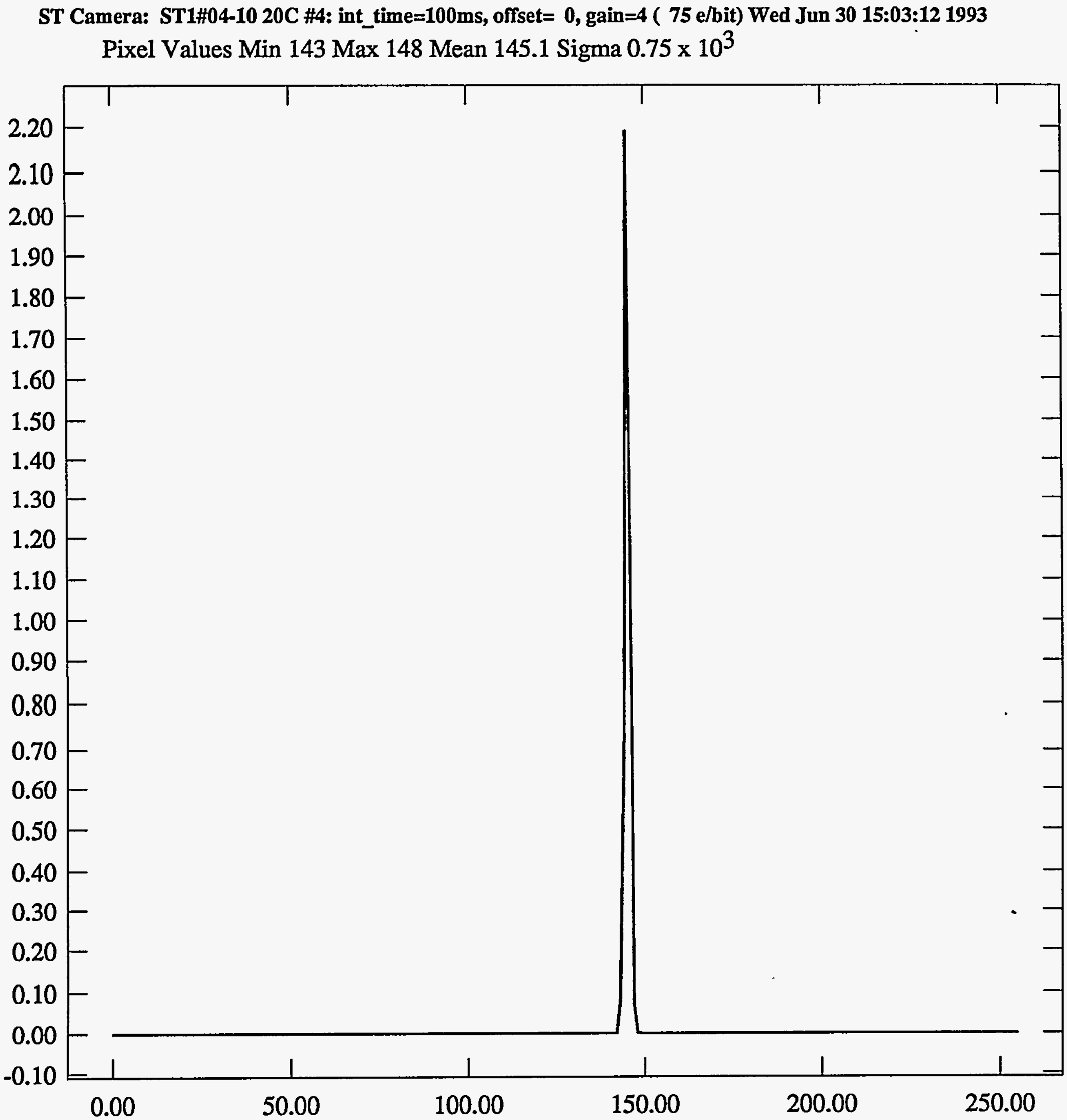
Pixel Values Min 77 Max 81 Mean 79.2 Sigma 0.76 x 10^3



ST Camera: ST1#04-10 20C #4: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 15:03:00 1993

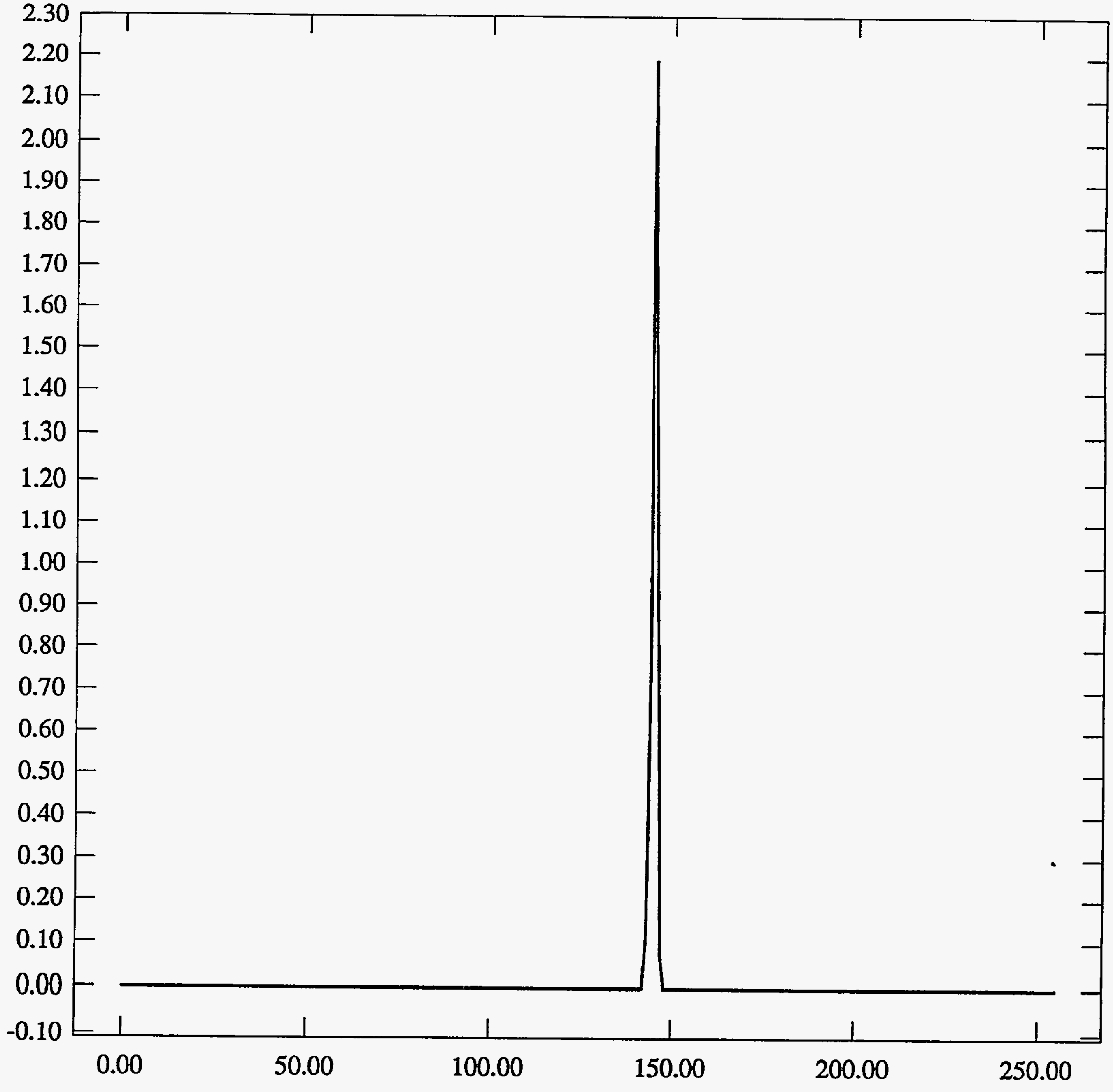
Pixel Values Min 143 Max 148 Mean 145.1 Sigma 0.77 x 10^3




ST Camera: ST1#04-10 20C #4: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 15:03:12 1993
Pixel Values Min 143 Max 148 Mean 145.1 Sigma 0.75 x 10^3
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1#04-10 20C #4: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 15:03:24 1993

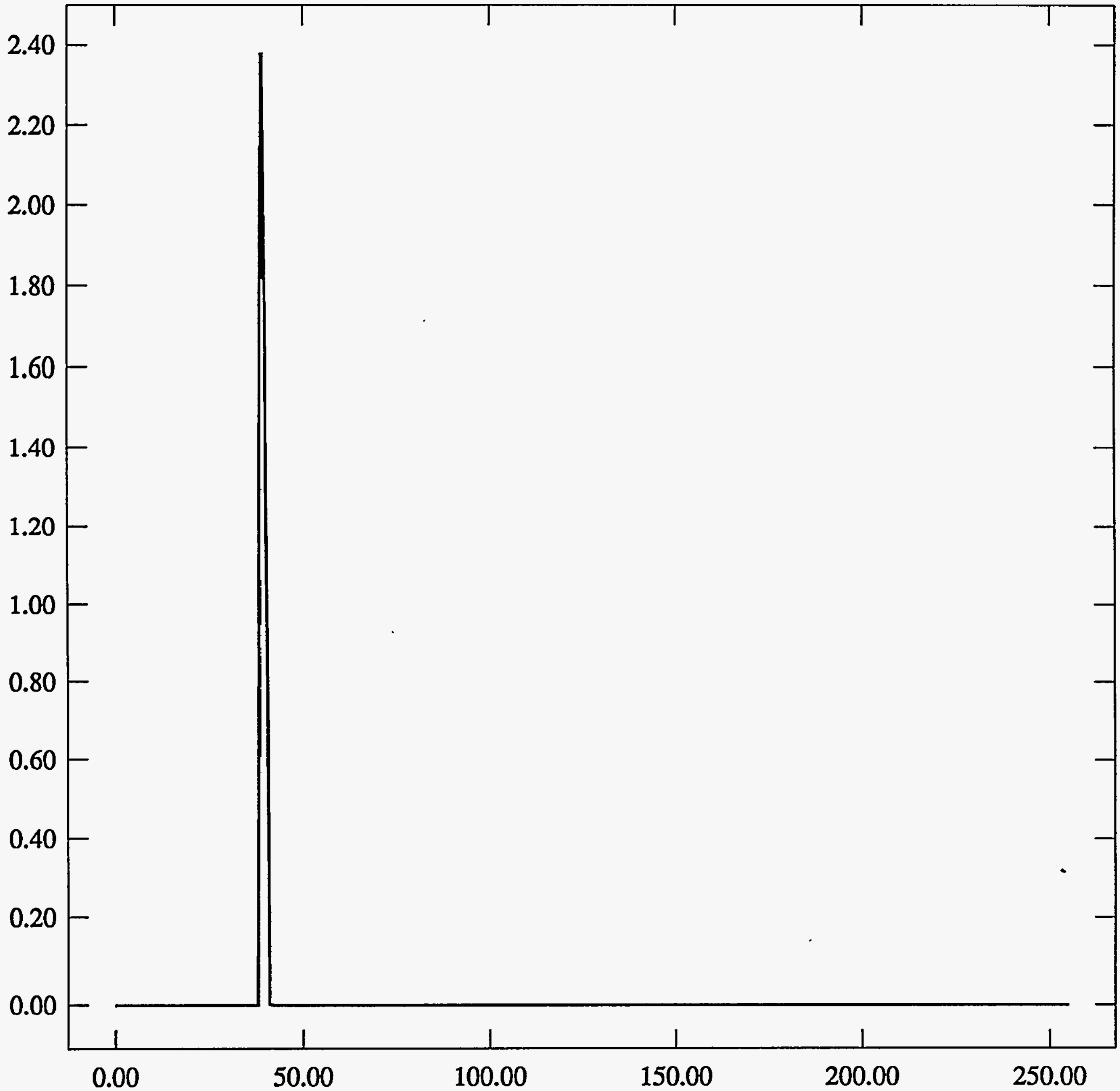
Pixel Values Min 142 Max 147 Mean 145.0 Sigma 0.77 x 10^3



#4 20C END OF CYCLE

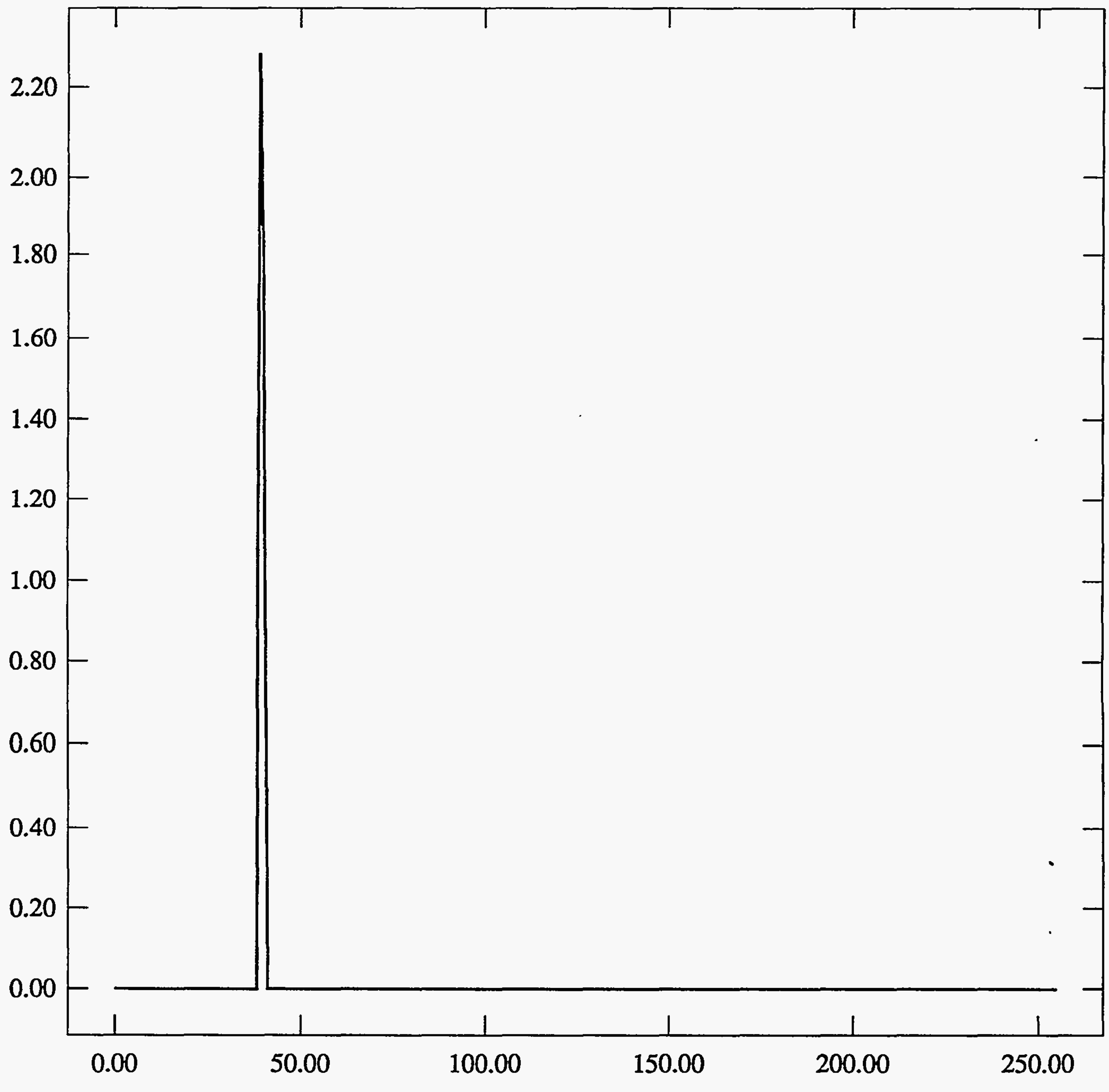
ST Camera: ST1#04-10 20C #4: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 15:41:02 1993

Pixel Values Min 39 Max 41 Mean 39.4 Sigma 0.49 x 10^3



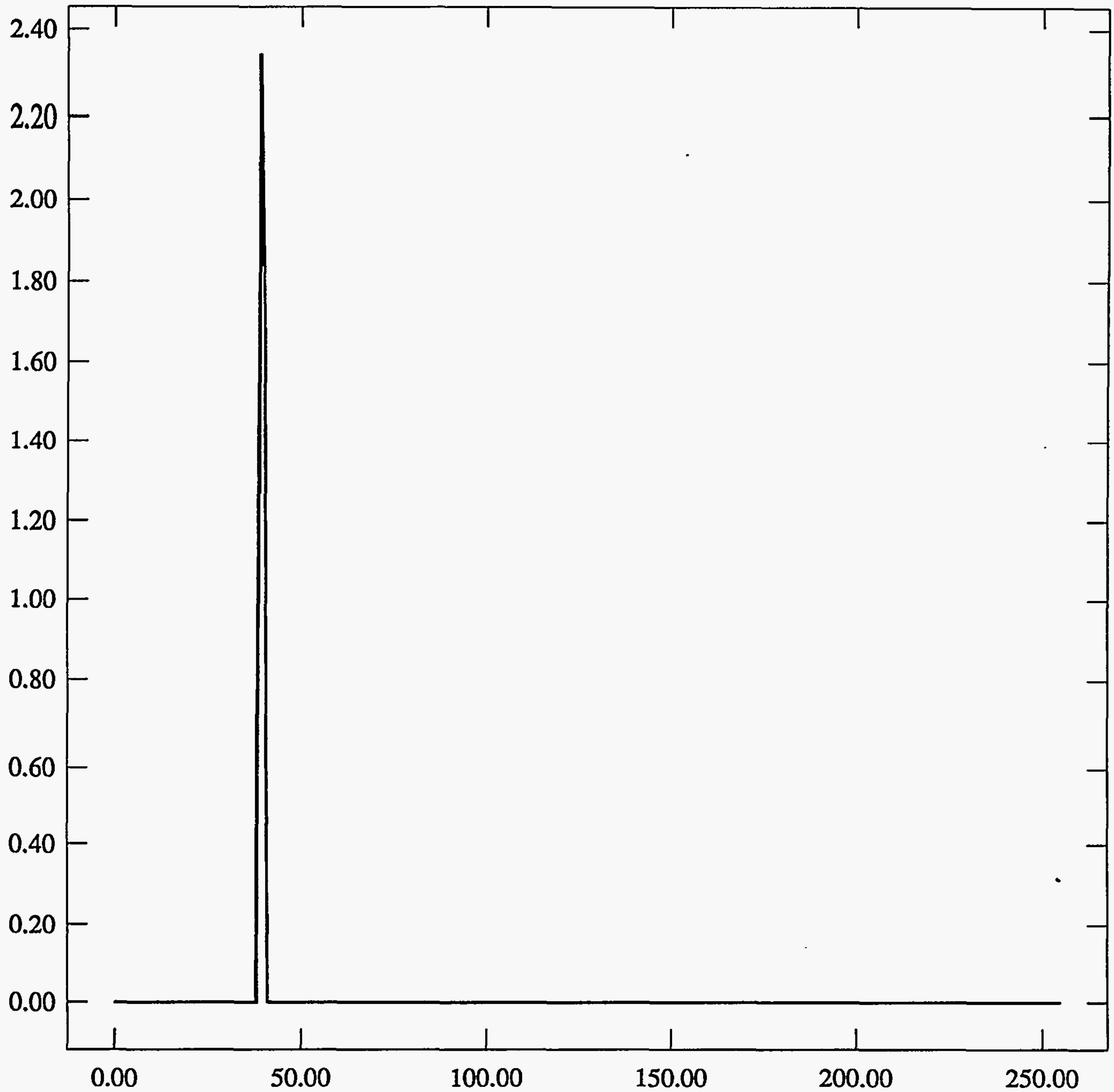
ST Camera: ST1#04-10 20C #4: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 15:41:35 1993

Pixel Values Min 39 Max 40 Mean 39.4 Sigma 0.50 x 10^3



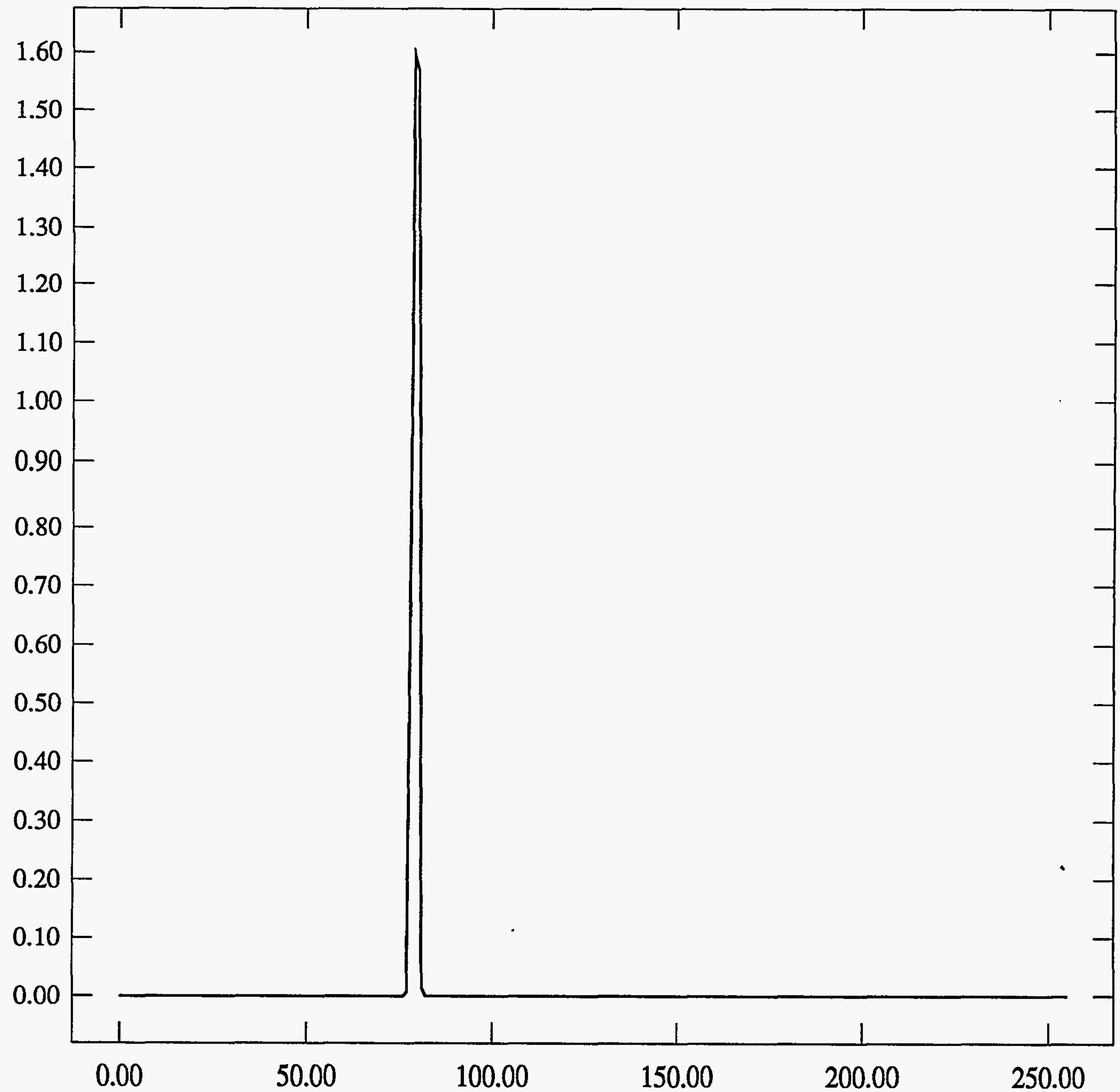
ST Camera: ST1#04-10 20C #4: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 15:41:46 1993

Pixel Values Min 39 Max 41 Mean 39.4 Sigma 0.49 x 10^3



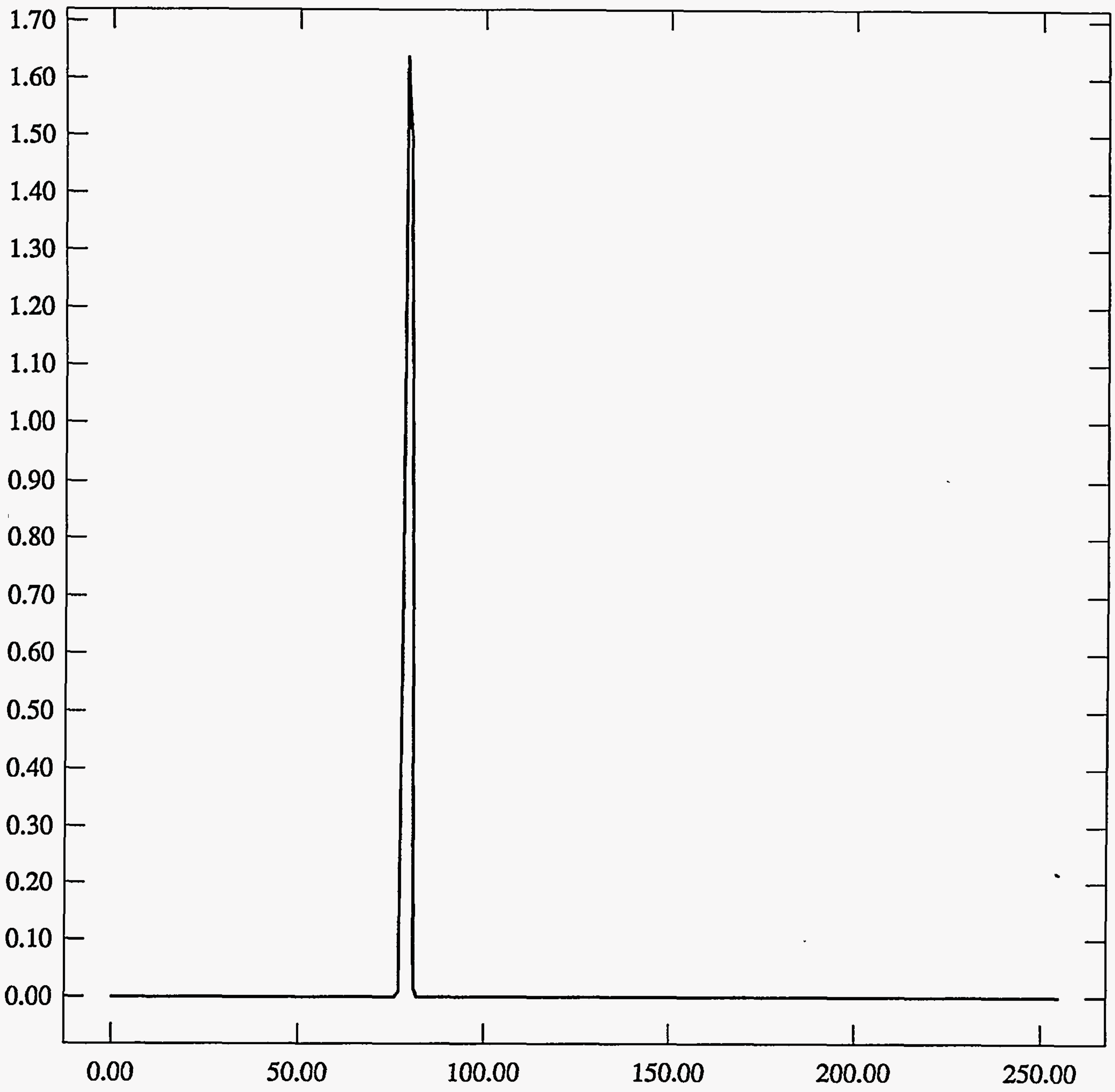
ST Camera: ST1#04-10 20C #4: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 15:42:01 1993

Pixel Values Min 77 Max 81 Mean 79.2 Sigma 0.77 x 10^3



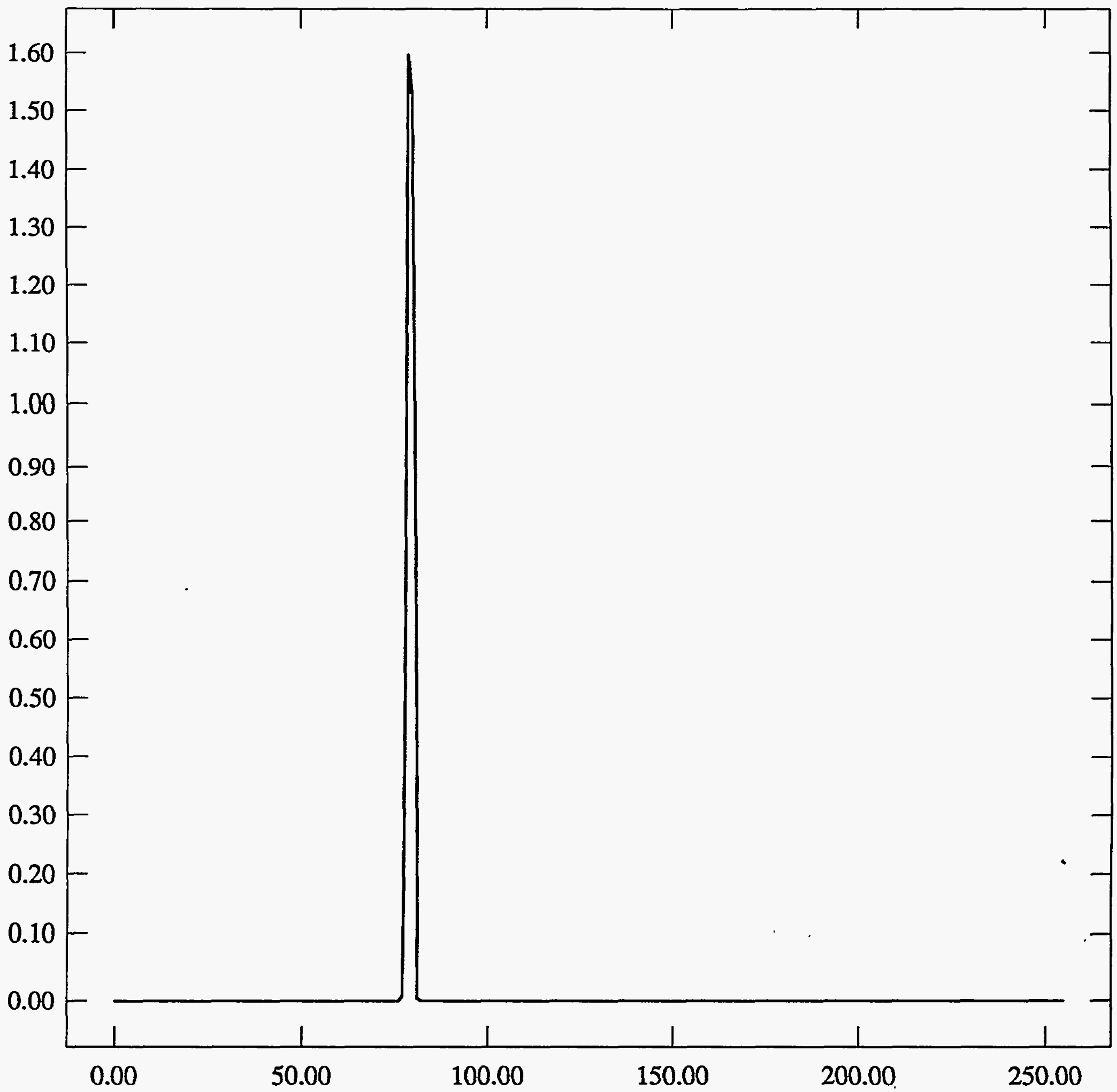
ST Camera: ST1#04-10 20C #4: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 15:42:16 1993

Pixel Values Min 77 Max 81 Mean 79.1 Sigma 0.77 x 10^3



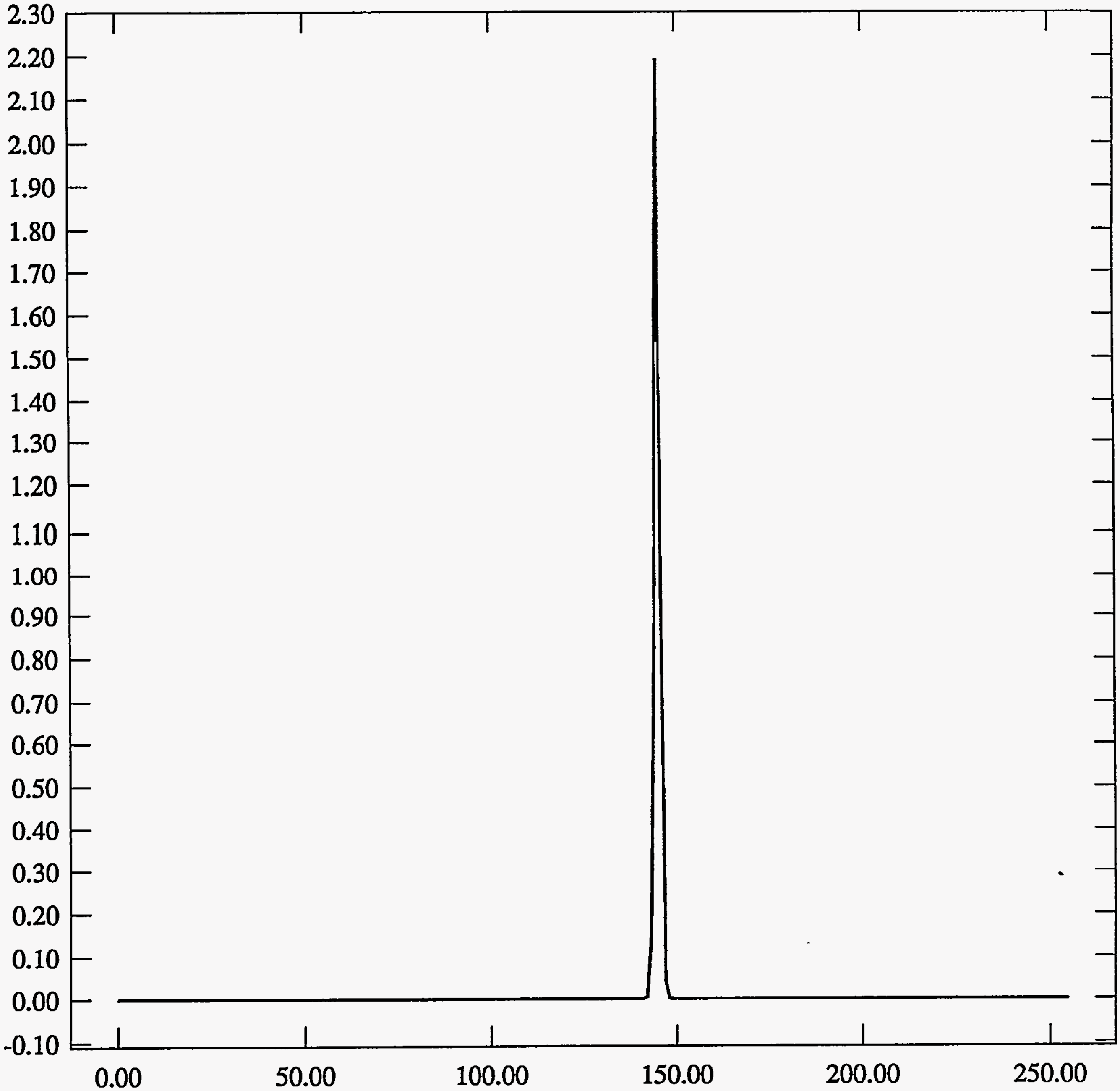
ST Camera: ST1#04-10 20C #4: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 15:42:30 1993

Pixel Values Min 77 Max 81 Mean 79.2 Sigma 0.77 x 10^3



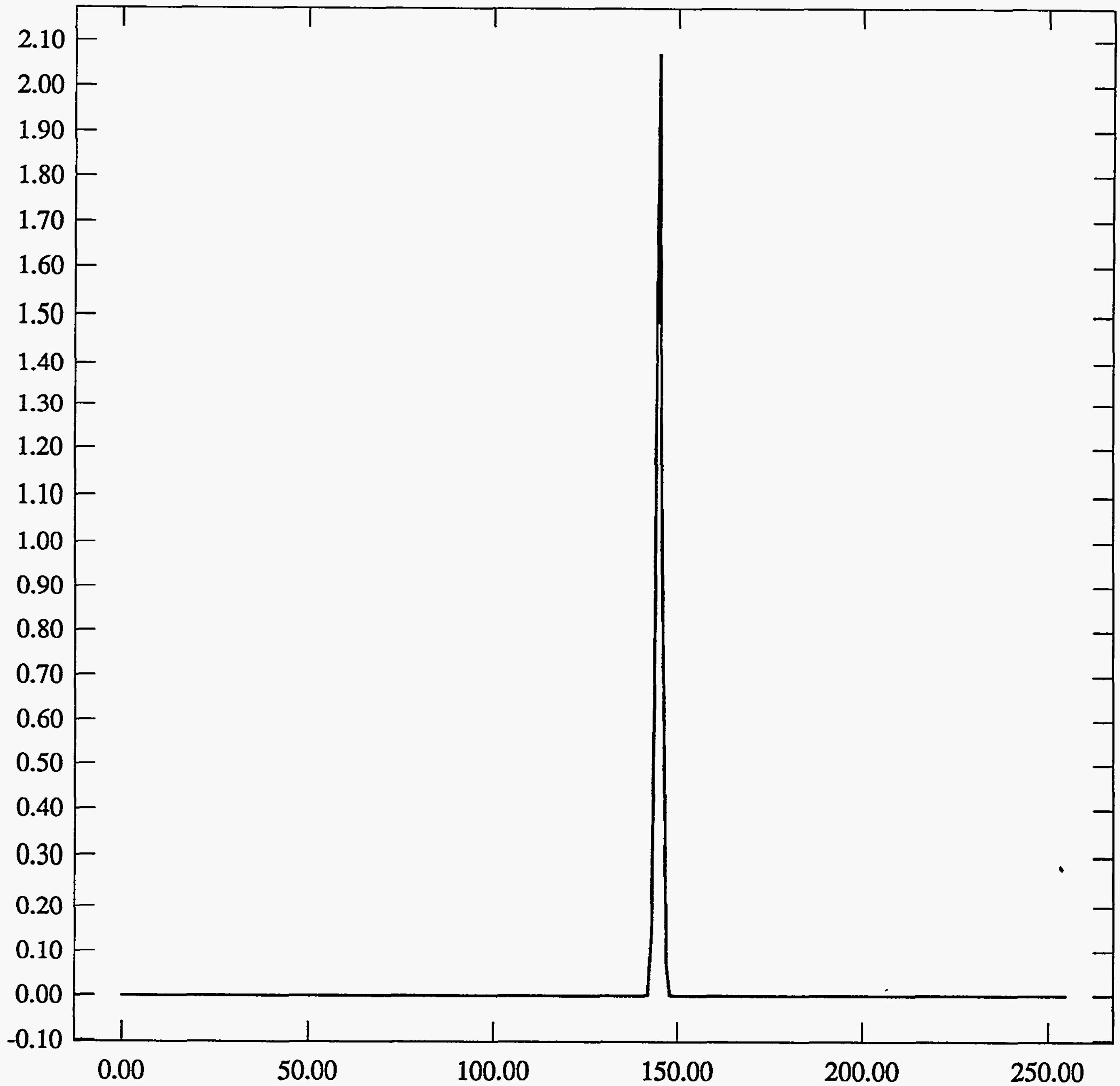
ST Camera: ST1#04-10 20C #4: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 15:42:43 1993

Pixel Values Min 142 Max 148 Mean 144.9 Sigma 0.77 x 10^3



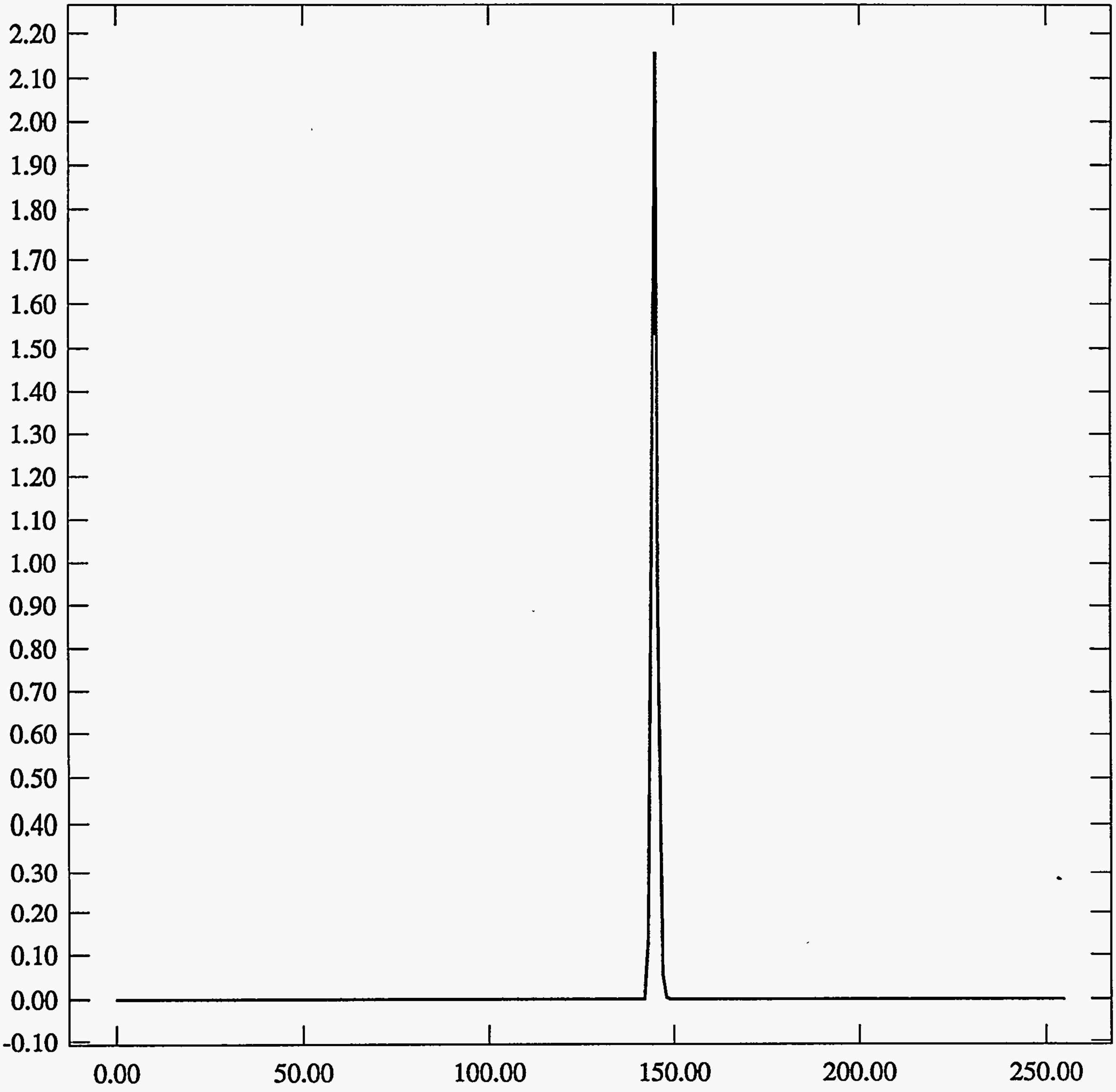
ST Camera: ST1#04-10 20C #4: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 15:42:57 1993

Pixel Values Min 142 Max 148 Mean 145.0 Sigma 0.81 x 10^3



ST Camera: ST1#04-10 20C #4: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 15:43:15 1993

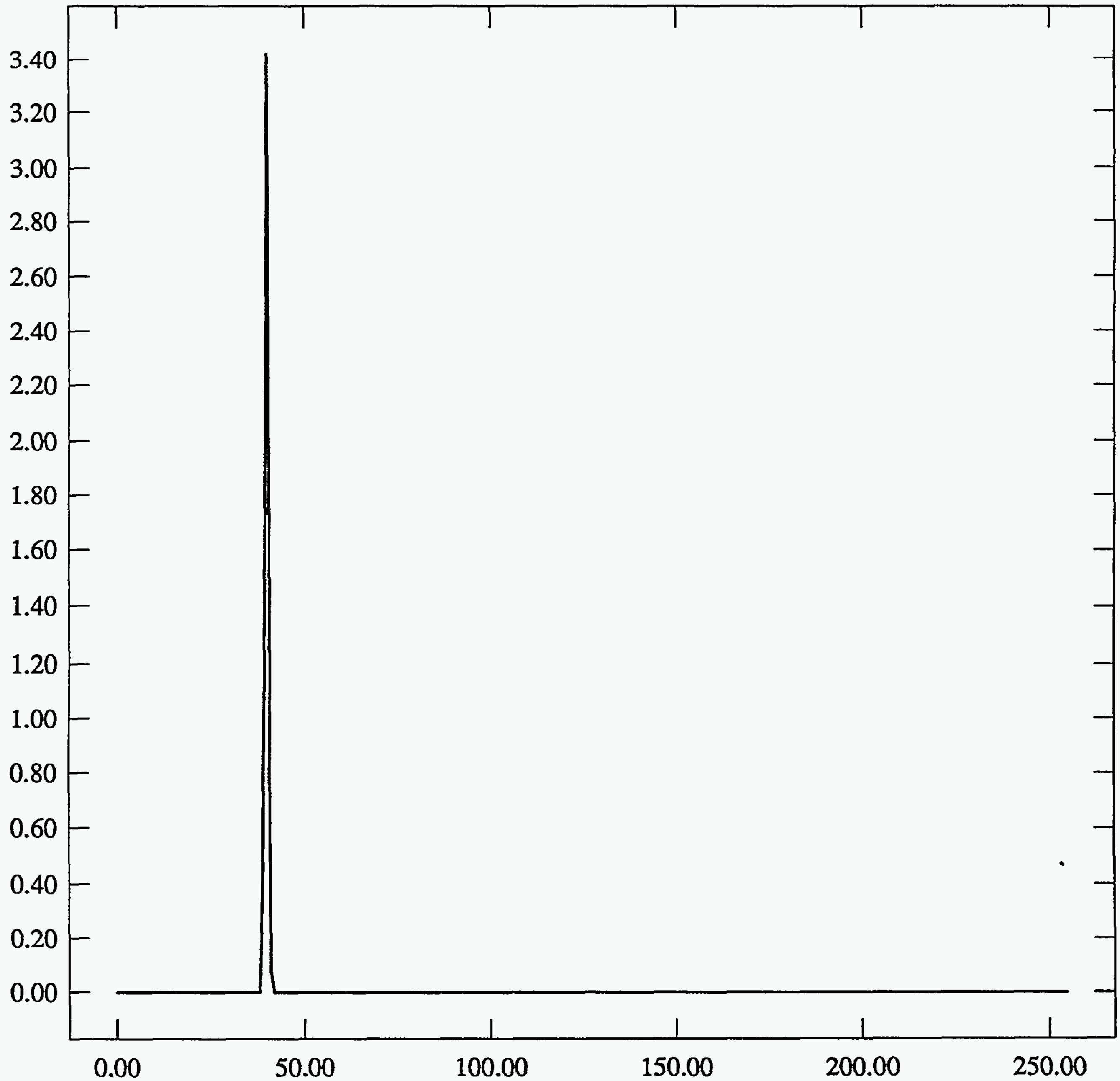
Pixel Values Min 143 Max 148 Mean 144.9 Sigma 0.78 x 10^3



#5 -30C 15 mins

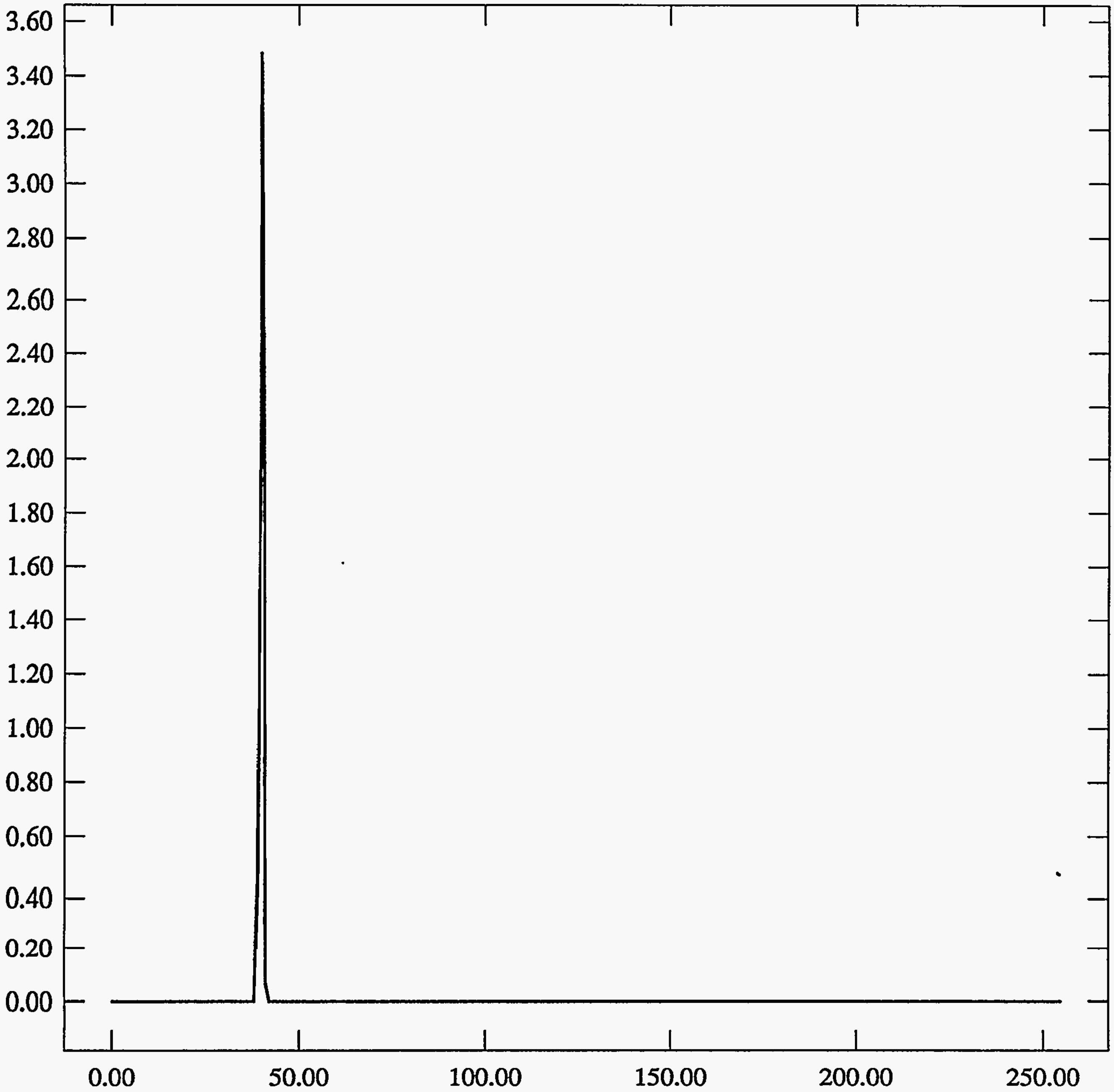
ST Camera: ST1#04-10 -30C #5: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 16:18:50 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.37 x 10^3



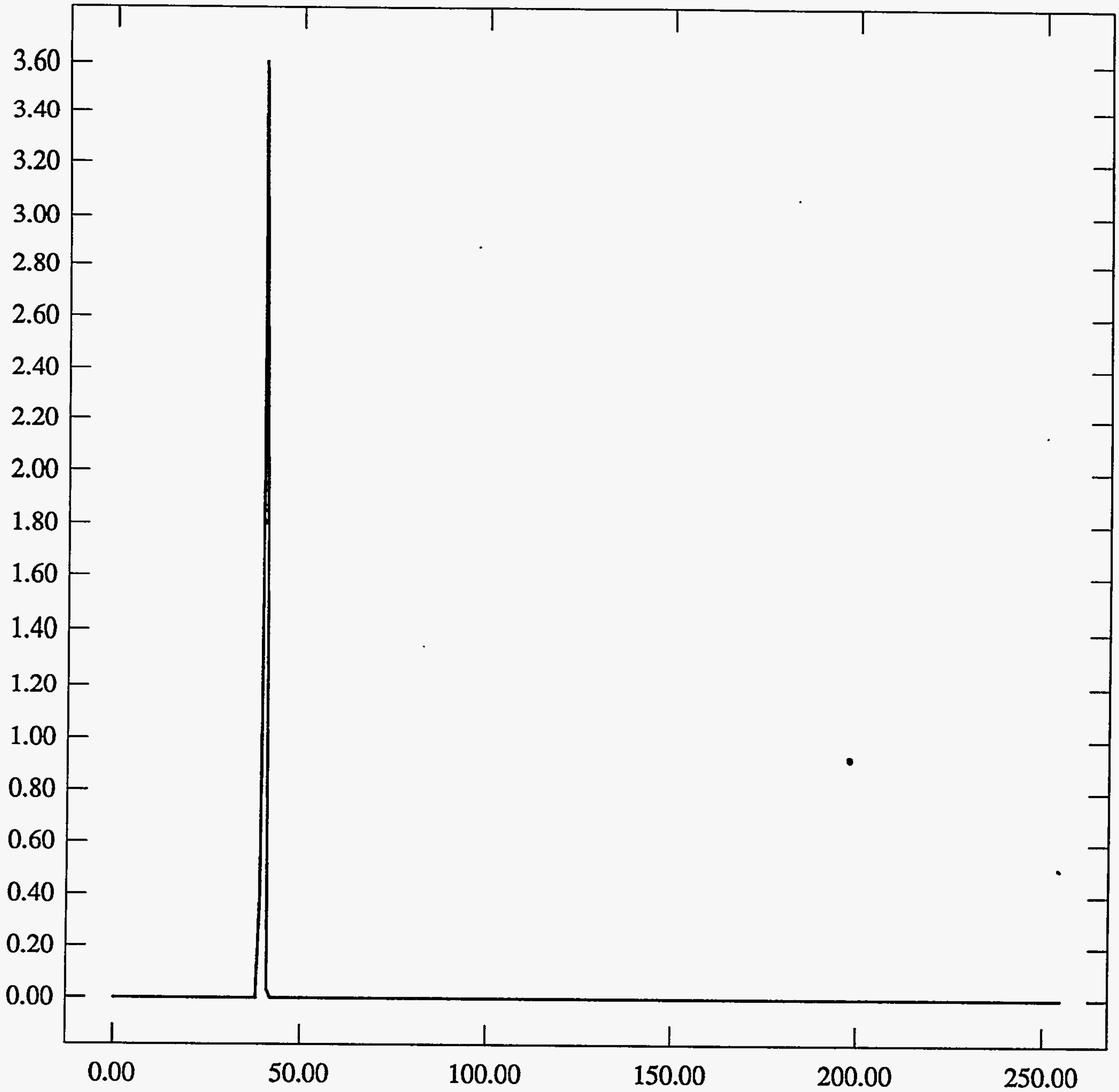
ST Camera: ST1#04-10 -30C #5: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 16:19:06 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.36 x 10^3

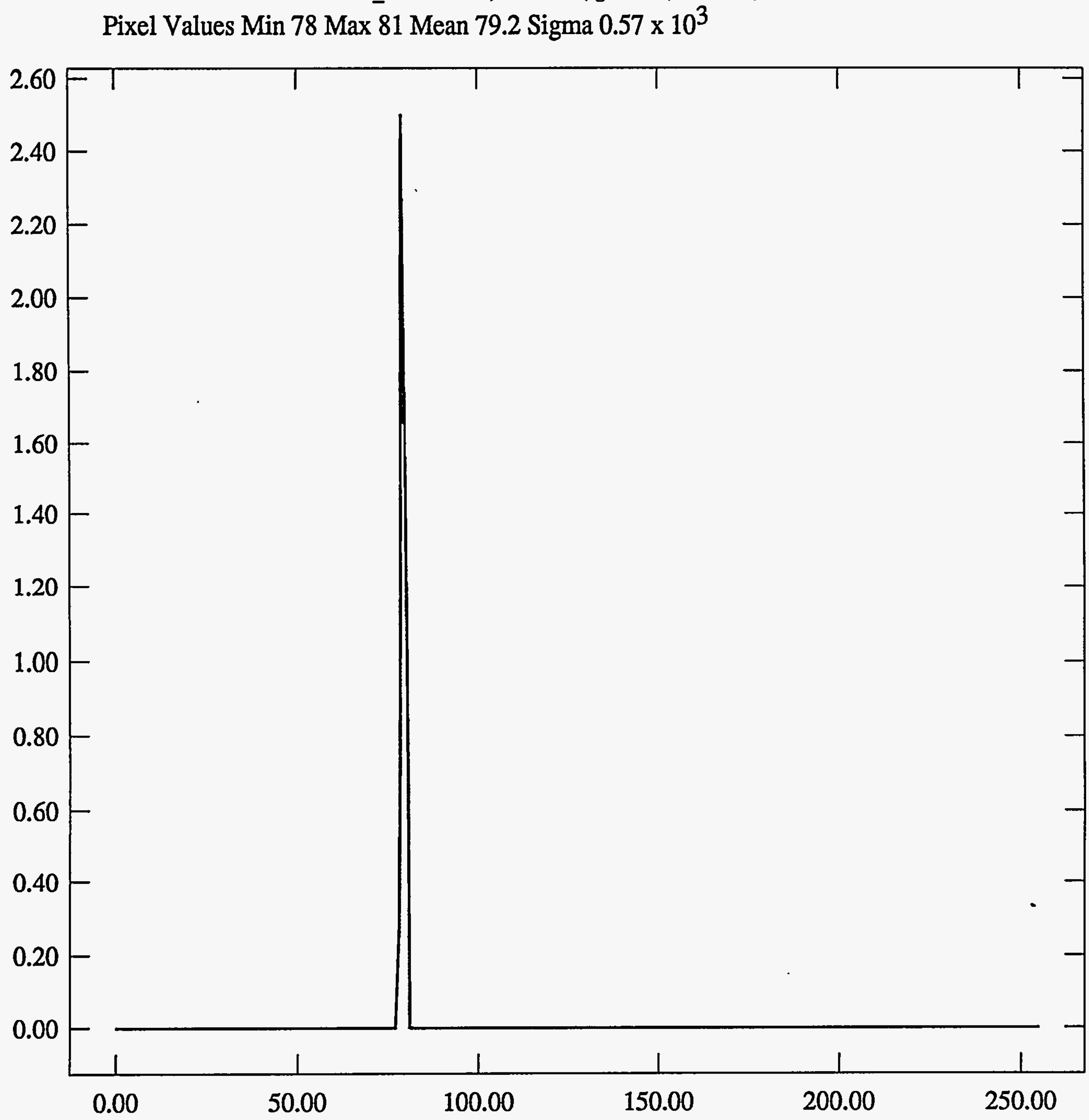


ST Camera: ST1#04-10 -30C #5: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 16:19:17 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.31 x 10^3

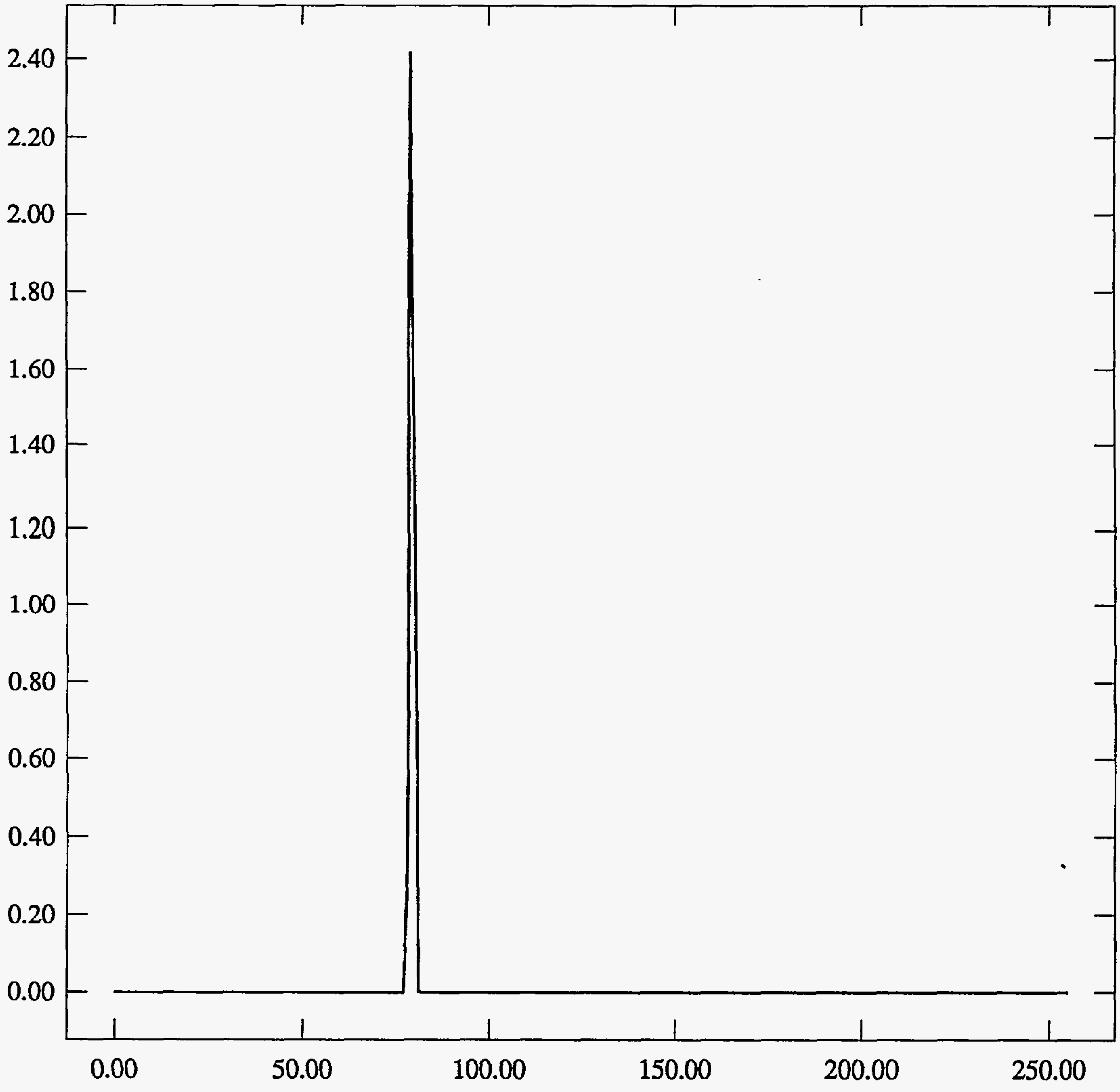


ST Camera: ST1#04-10 -30C #5: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 16:19:32 1993



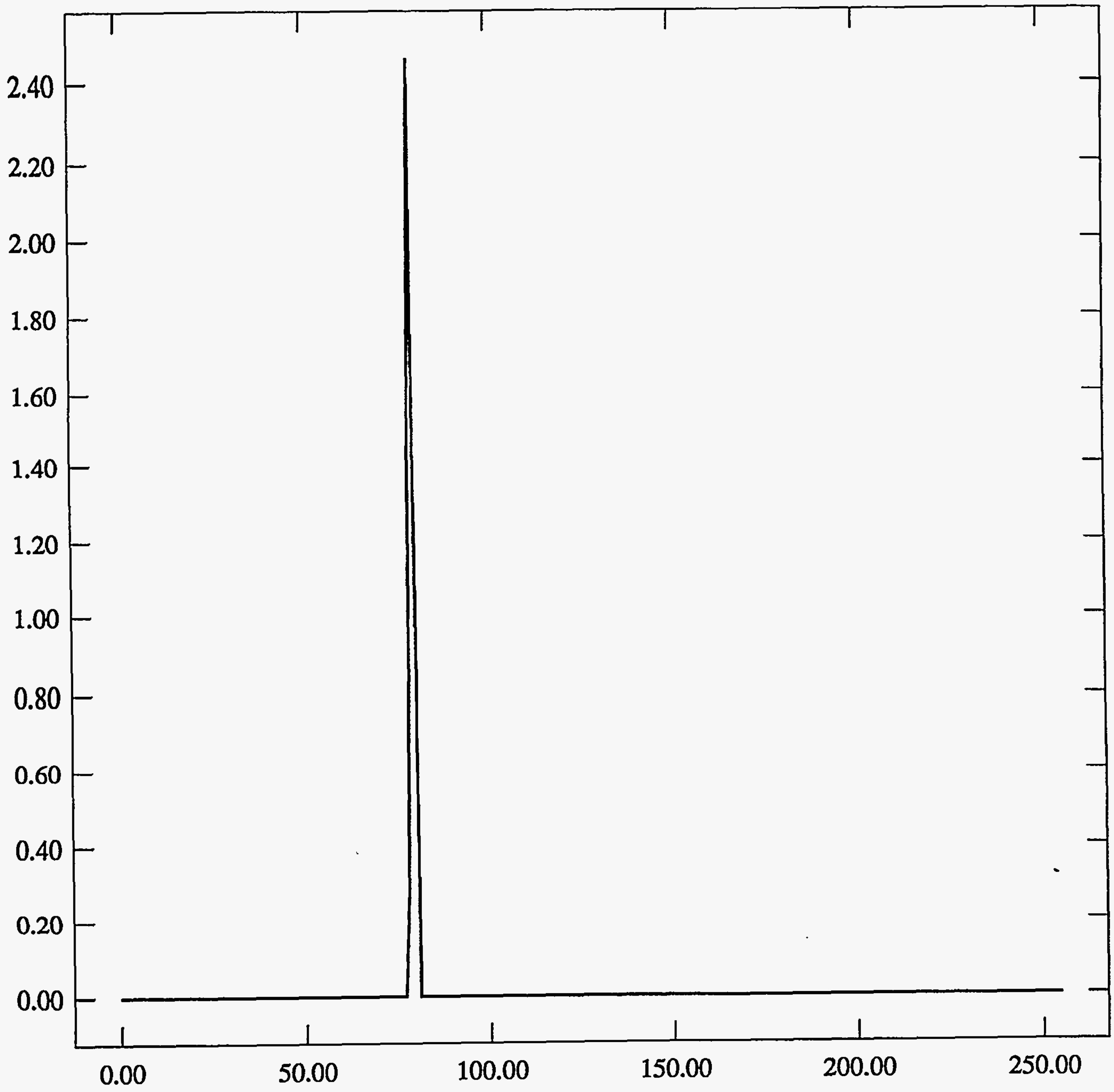
ST Camera: ST1#04-10 -30C #5: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 16:19:47 1993

Pixel Values Min 78 Max 81 Mean 79.2 Sigma 0.59 x 10^3



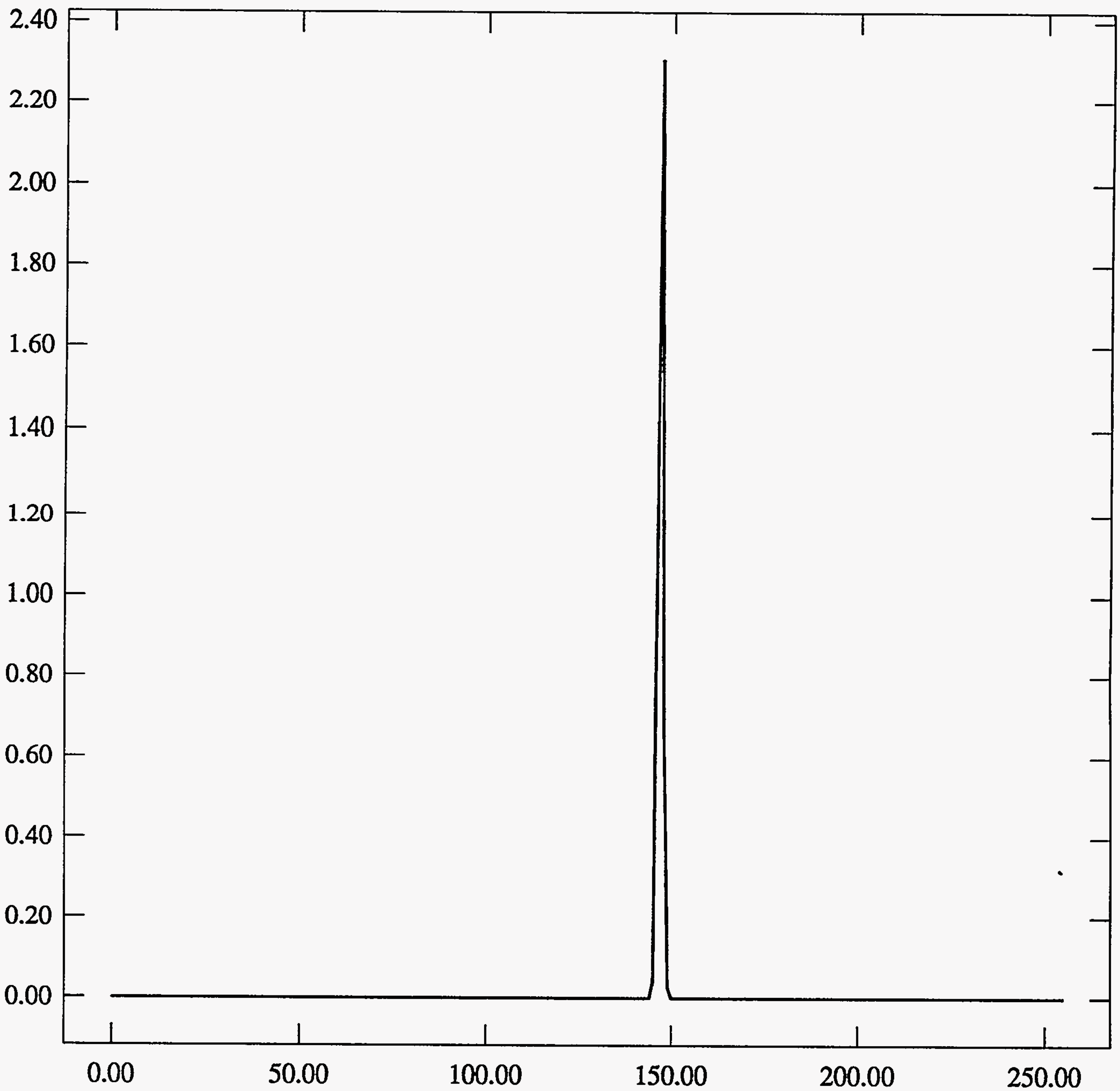
ST Camera: ST1#04-10 -30C #5: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 16:20:04 1993

Pixel Values Min 78 Max 80 Mean 79.3 Sigma 0.57 x 10^3



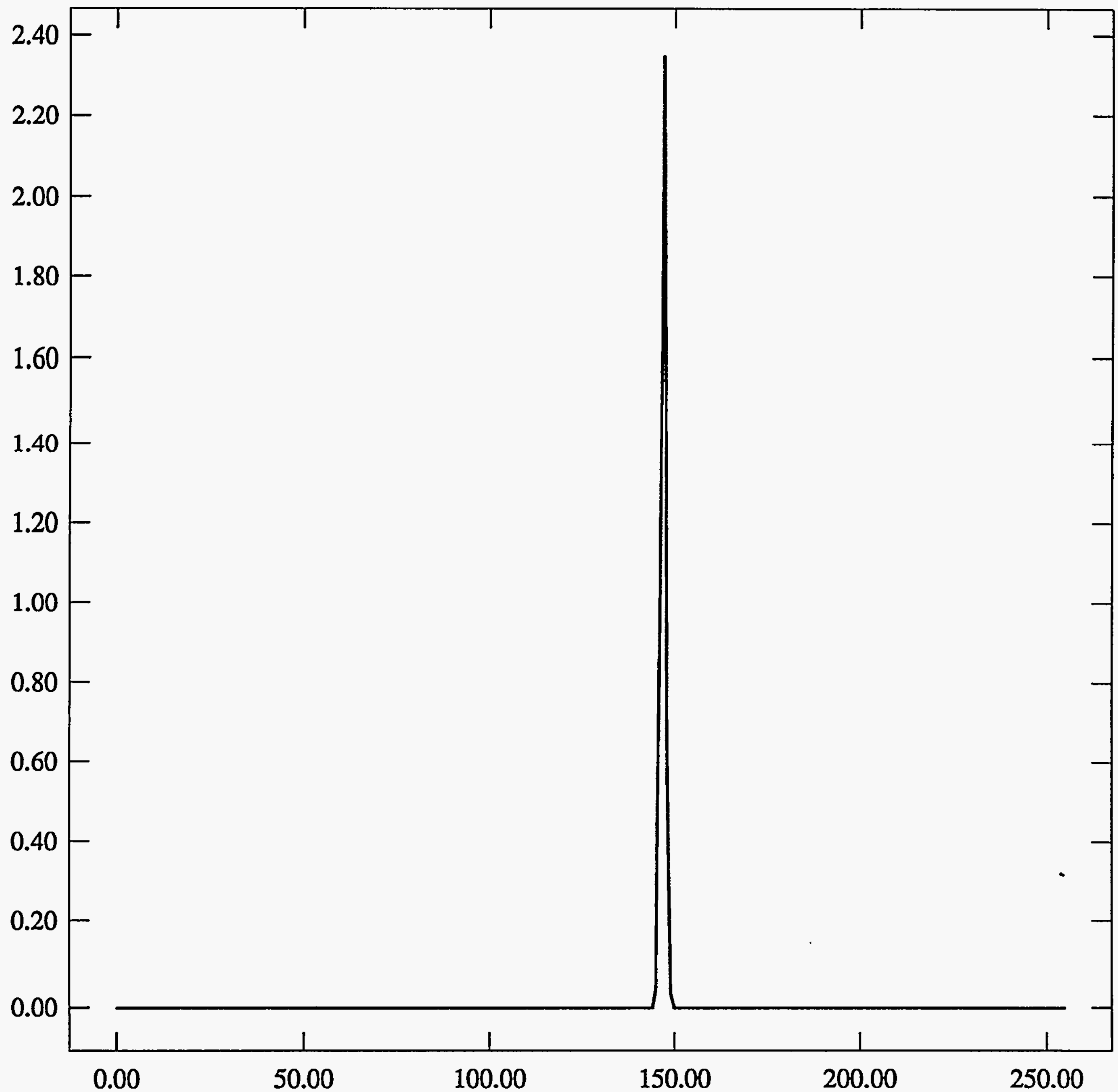
ST Camera: ST1#04-10 -30C #5: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 16:20:16 1993

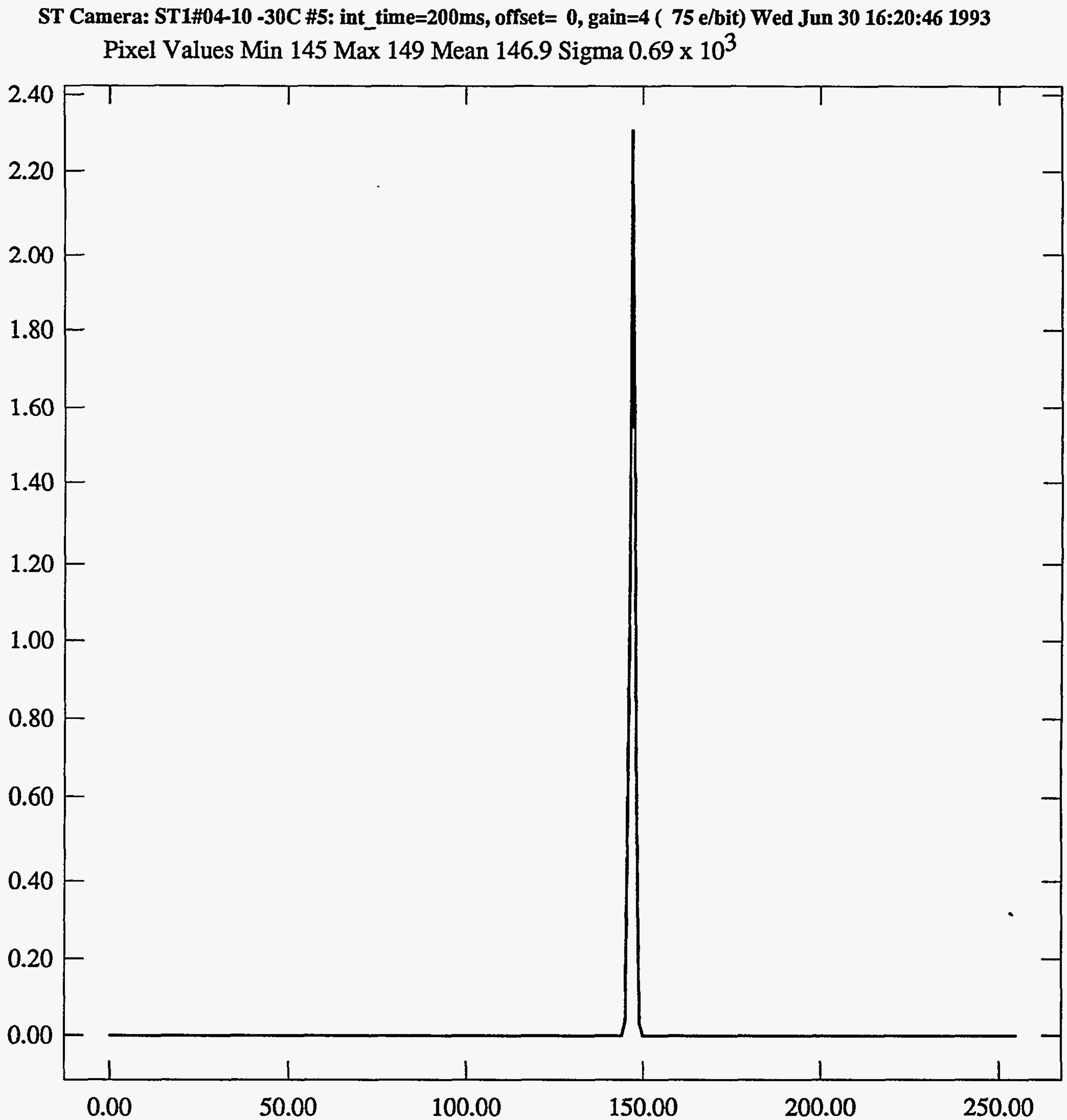
Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.69 x 10^3



ST Camera: ST1#04-10 -30C #5: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 16:20:31 1993

Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.69 x 10^3

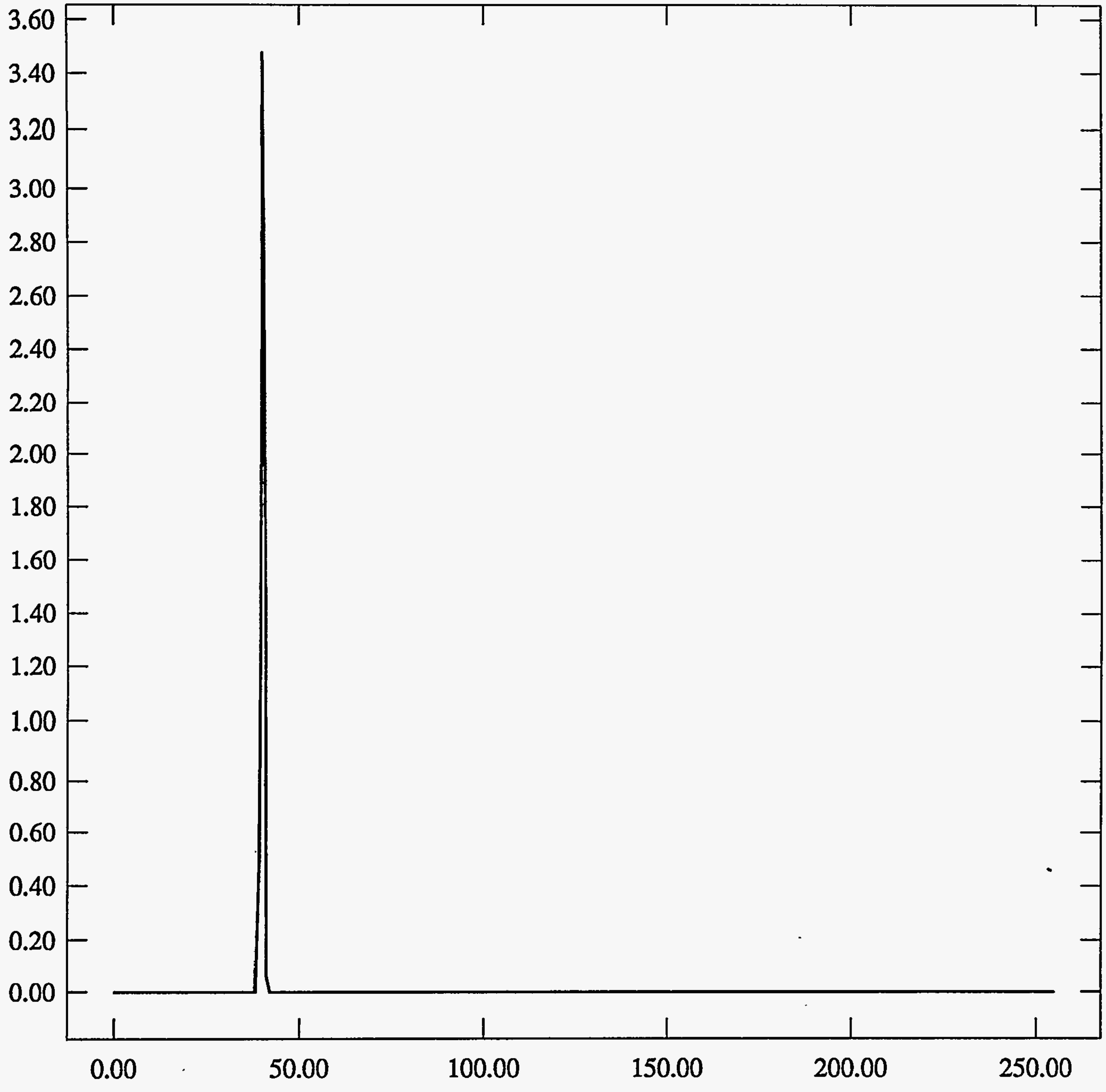



ST Camera: ST1#04-10 -30C #5: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 16:20:46 1993
Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.69 x 10^3
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

#5 -30C END

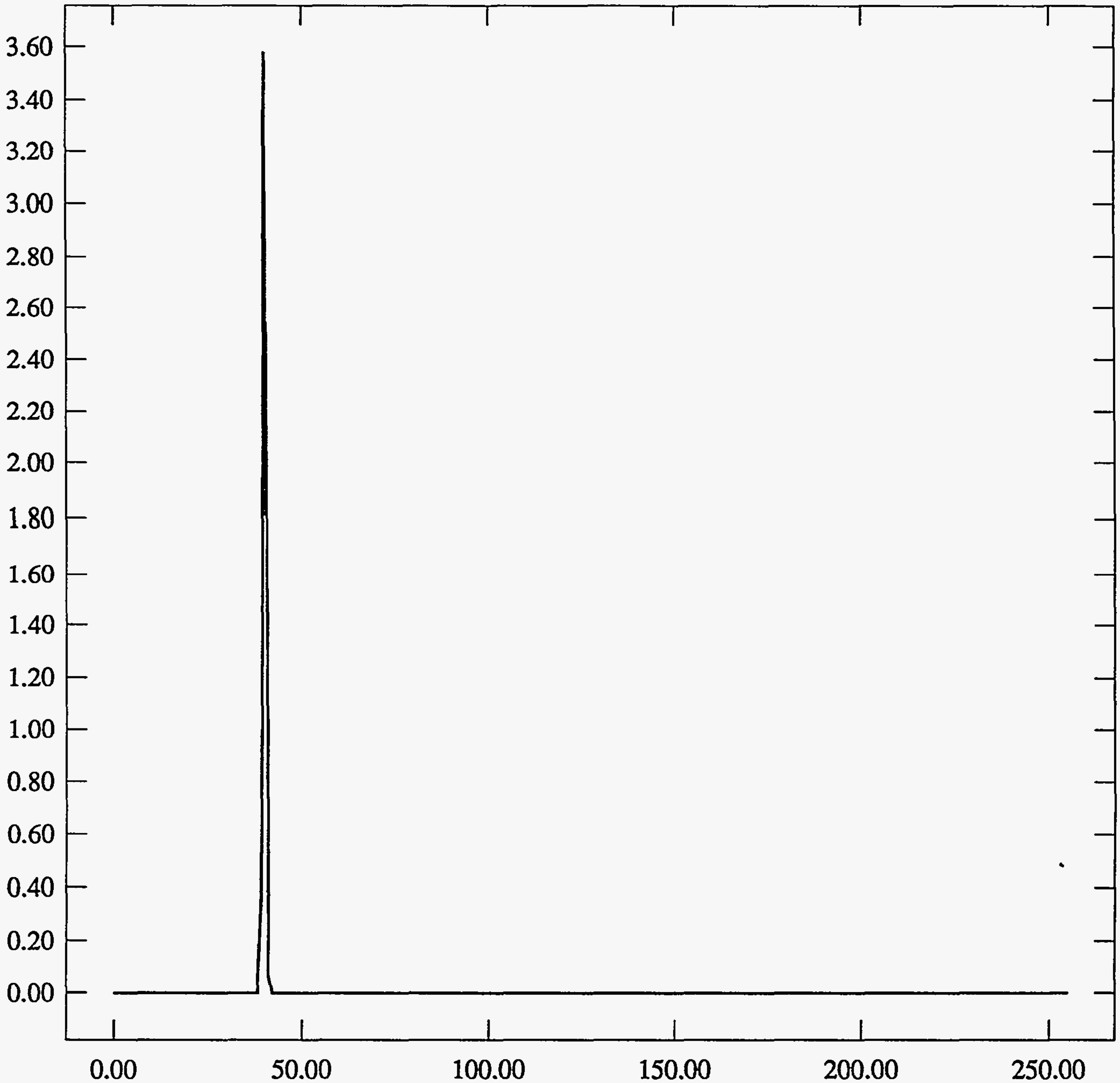
ST Camera: ST1#04-10 -30C #5: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 16:55:59 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.36 x 10^3

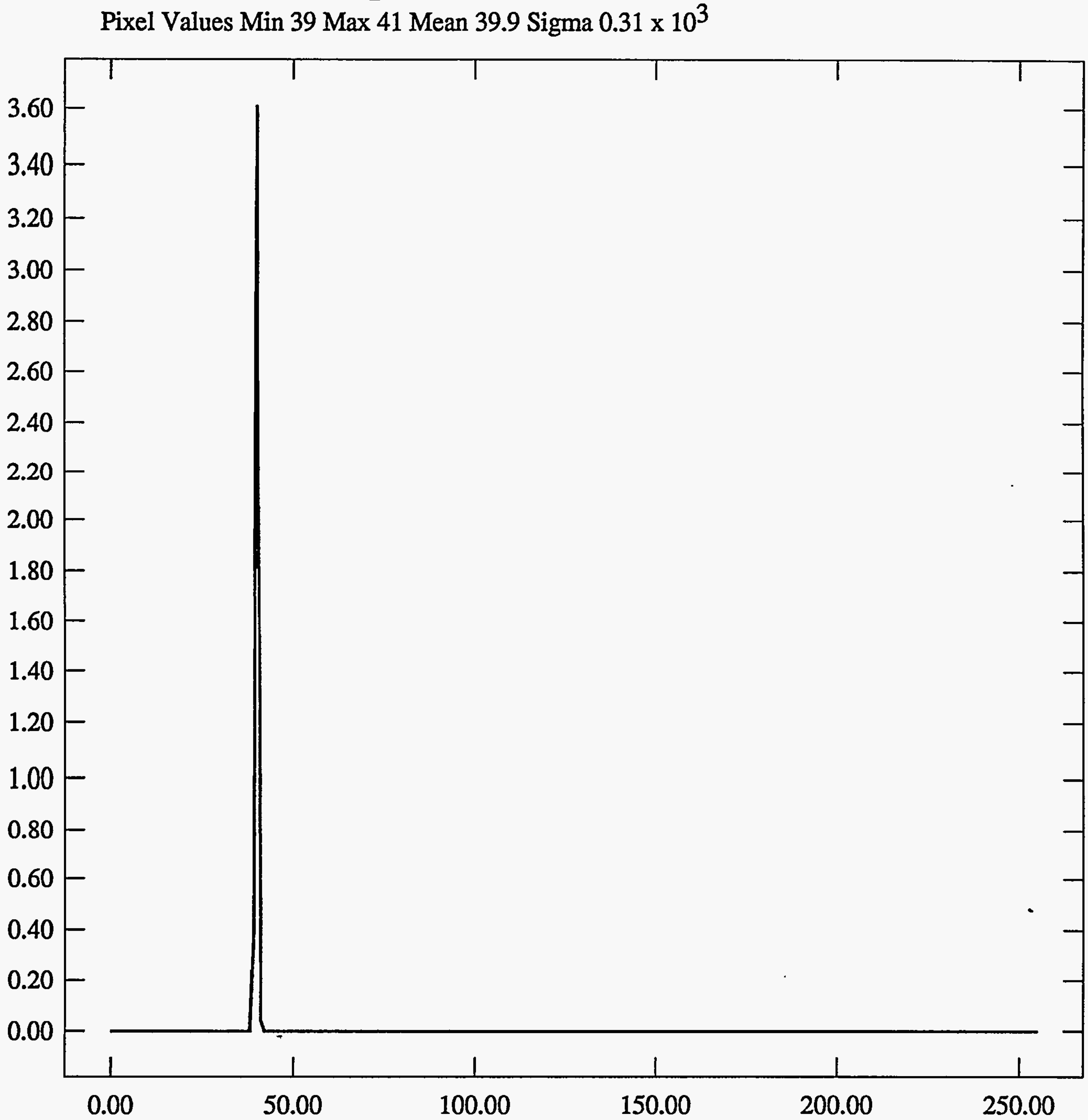


ST Camera: ST1#04-10 -30C #5: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 16:56:13 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.33 x 10^3

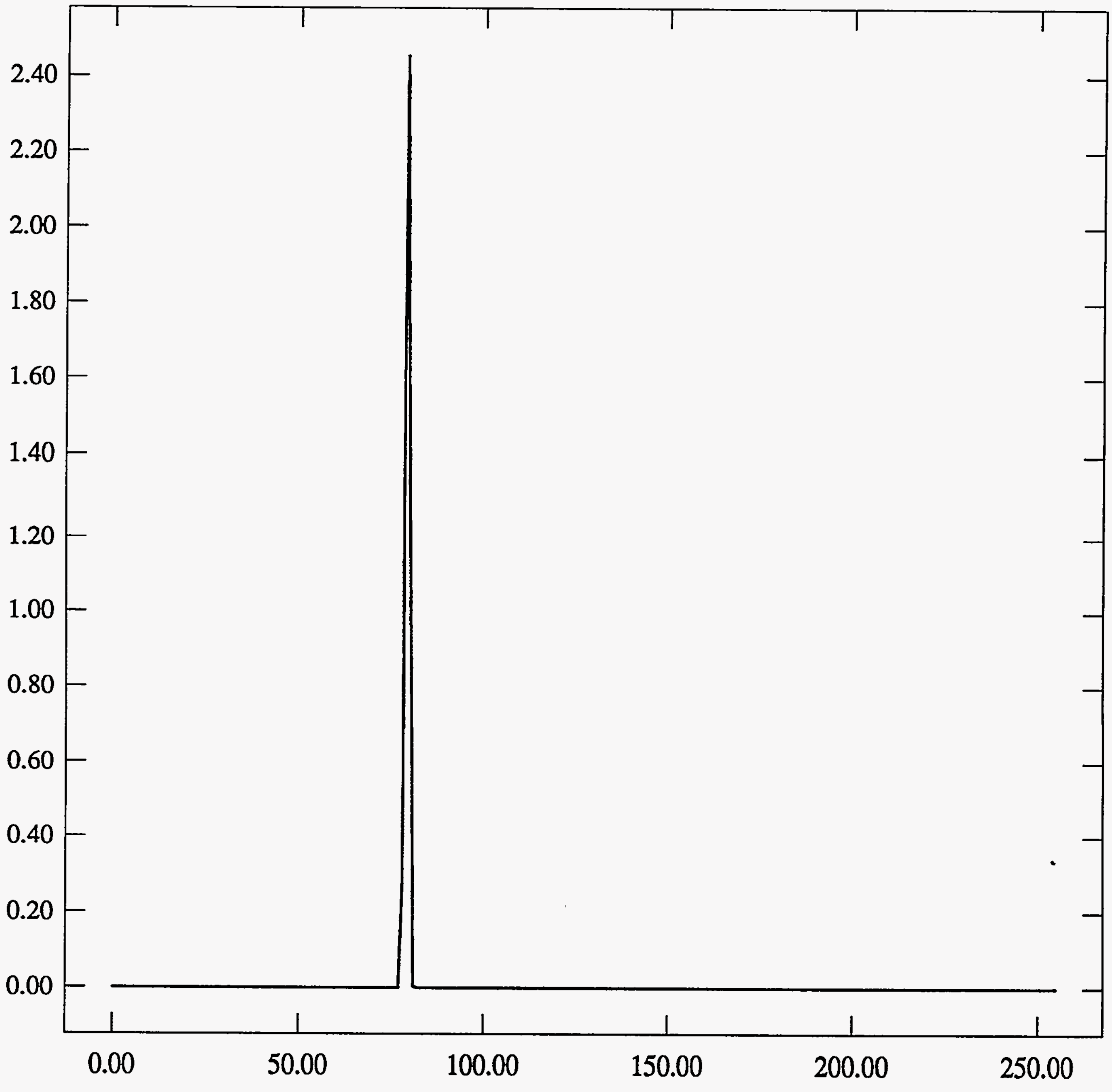


ST Camera: ST1#04-10 -30C #5: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 16:56:25 1993



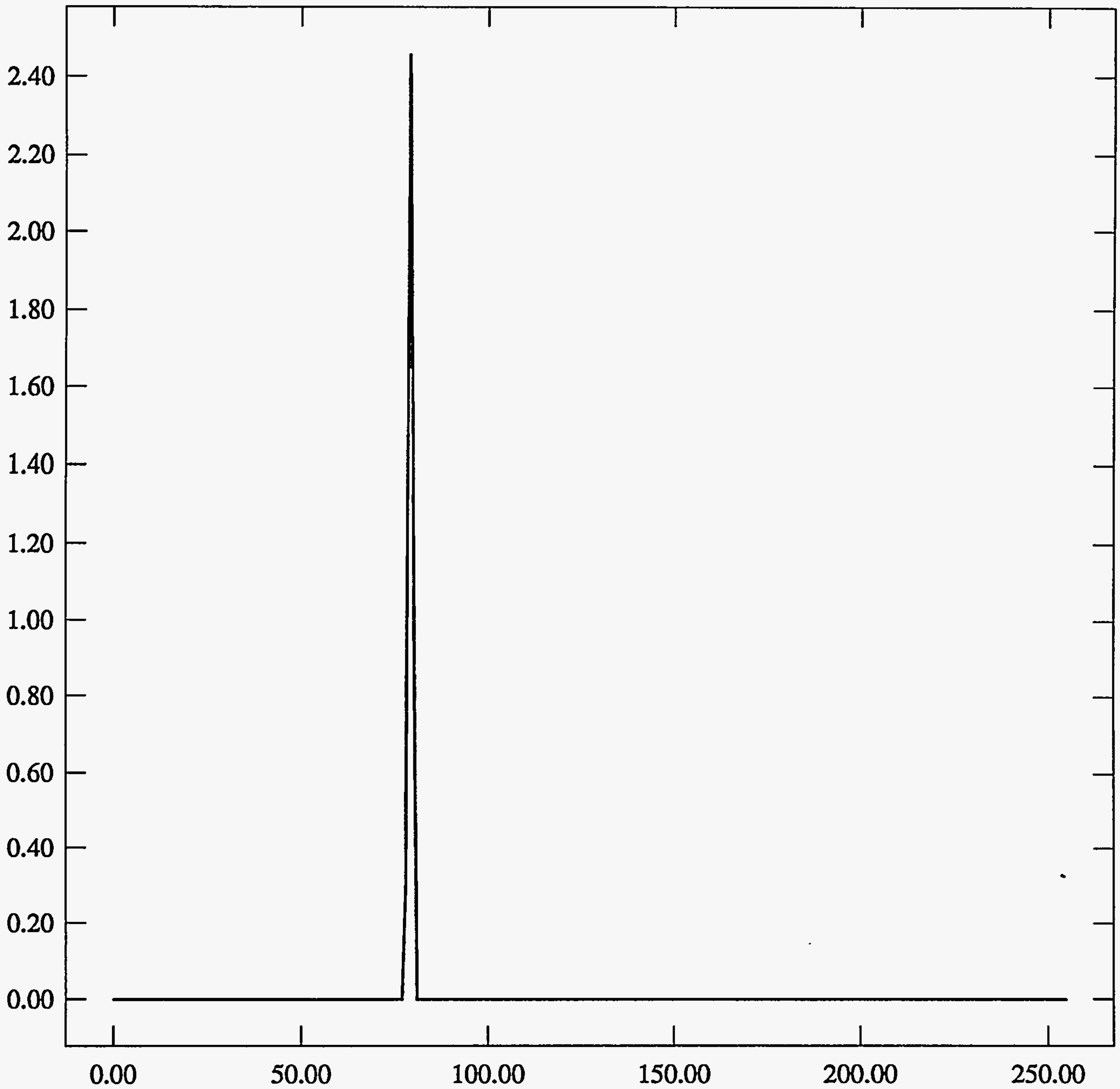
ST Camera: ST1#04-10 -30C #5: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 16:56:39 1993

Pixel Values Min 78 Max 81 Mean 79.3 Sigma 0.58 x 10^3



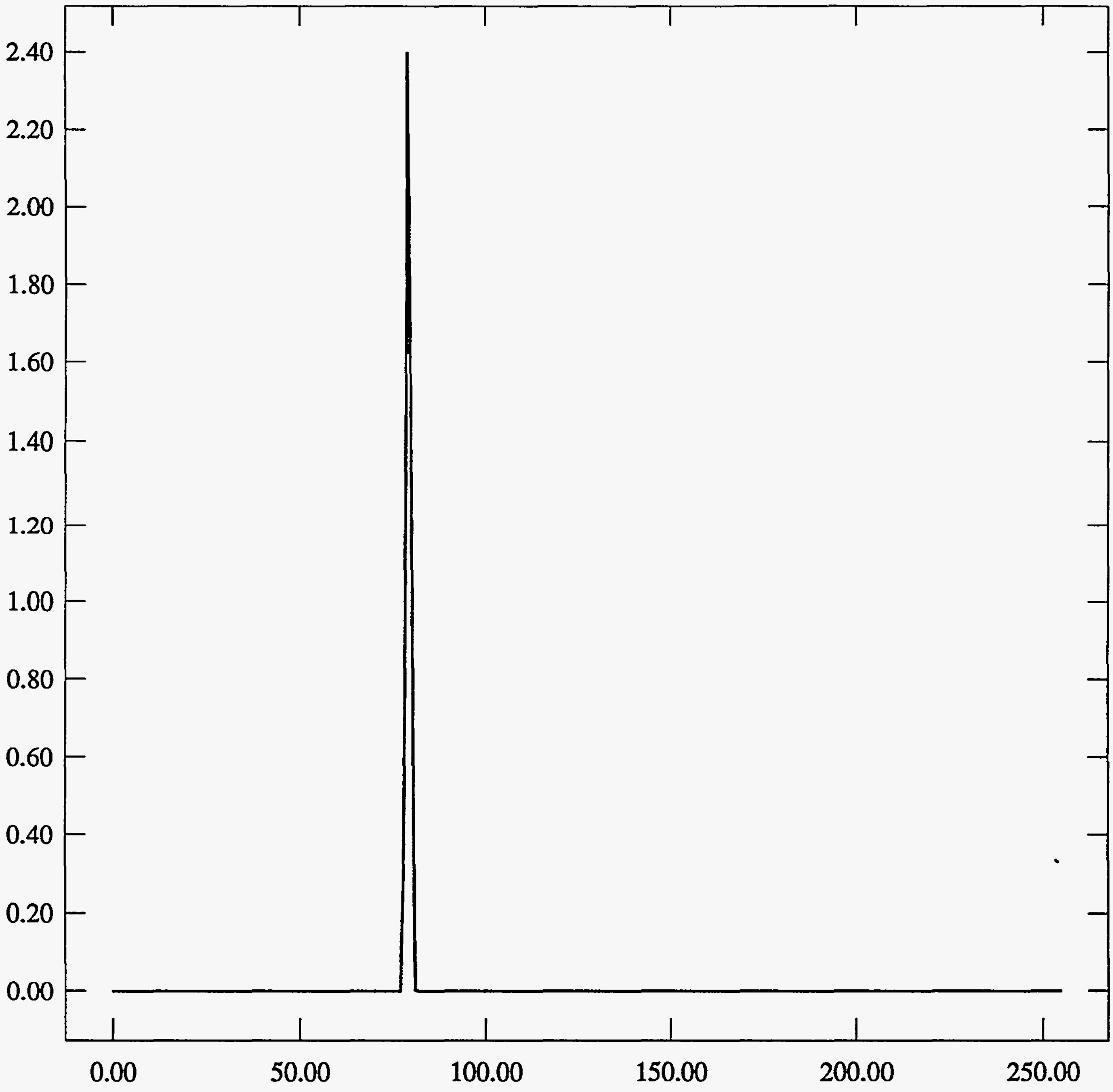
ST Camera: ST1#04-10 -30C #5: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 16:56:54 1993

Pixel Values Min 78 Max 80 Mean 79.2 Sigma 0.58 x 10^3



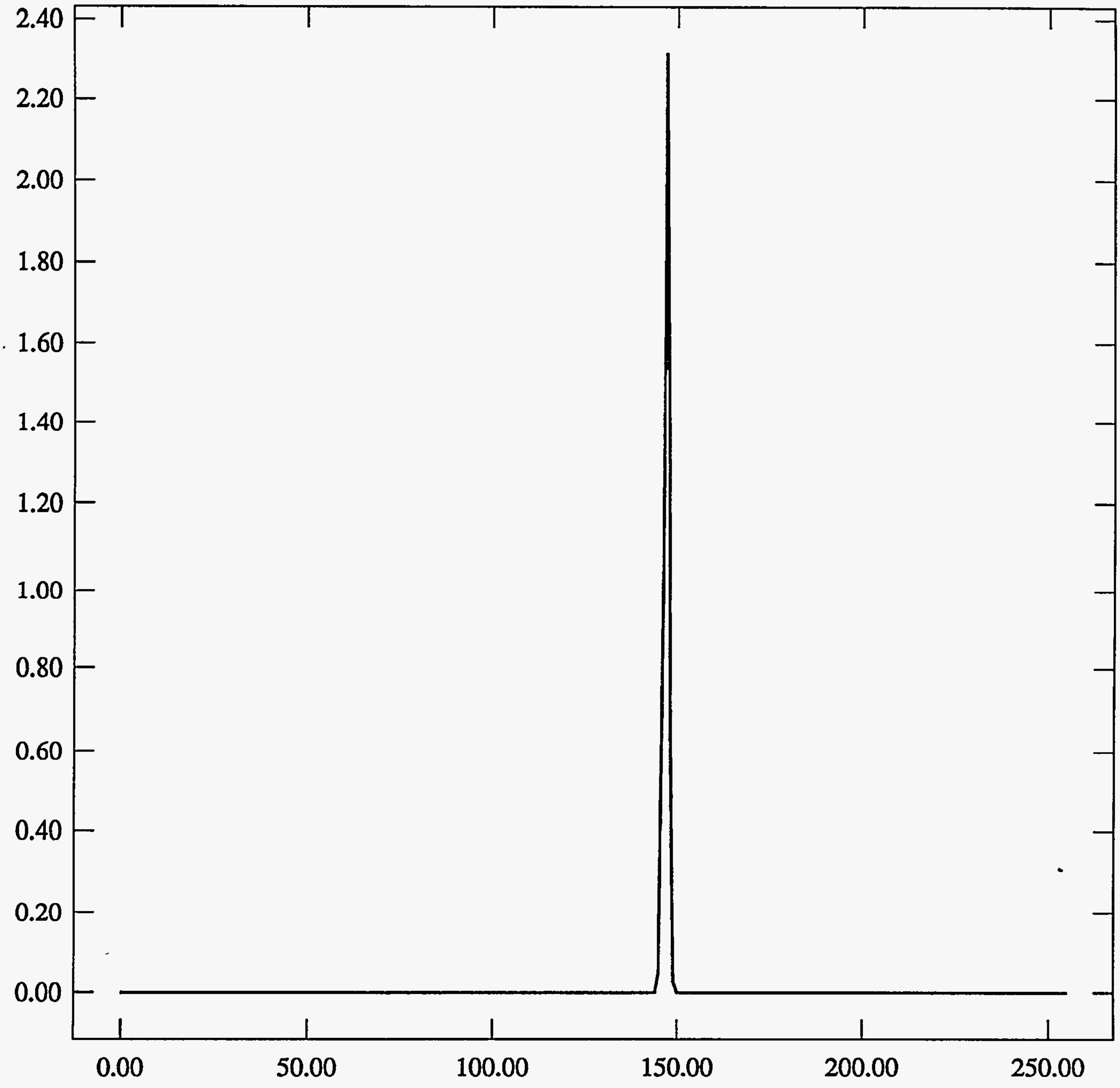
ST Camera: ST1#04-10 -30C #5: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 16:57:13 1993

Pixel Values Min 78 Max 81 Mean 79.2 Sigma 0.60 x 10^3



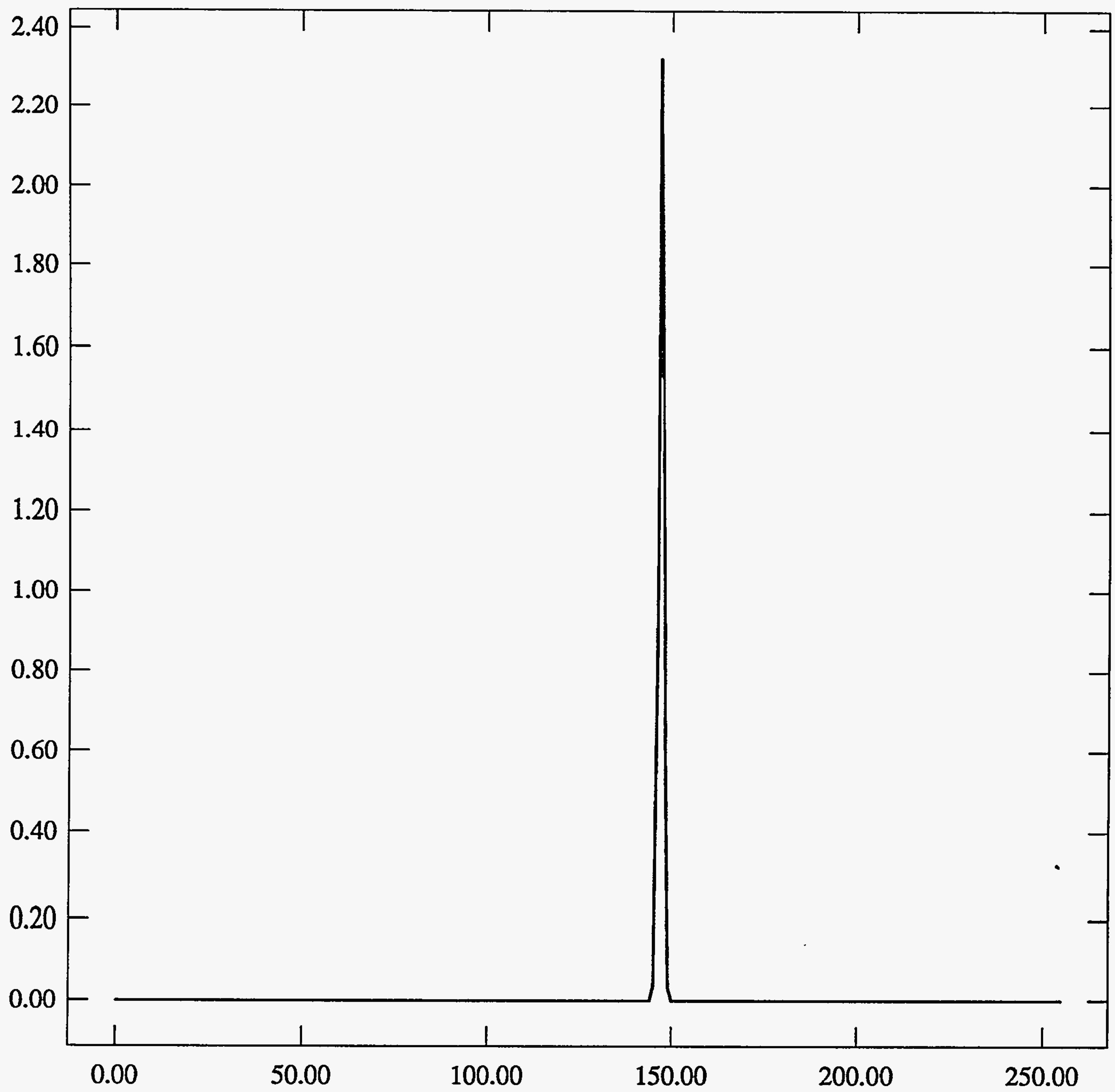
ST Camera: ST1#04-10 -30C #5: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 16:57:29 1993

Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.69 x 10^3



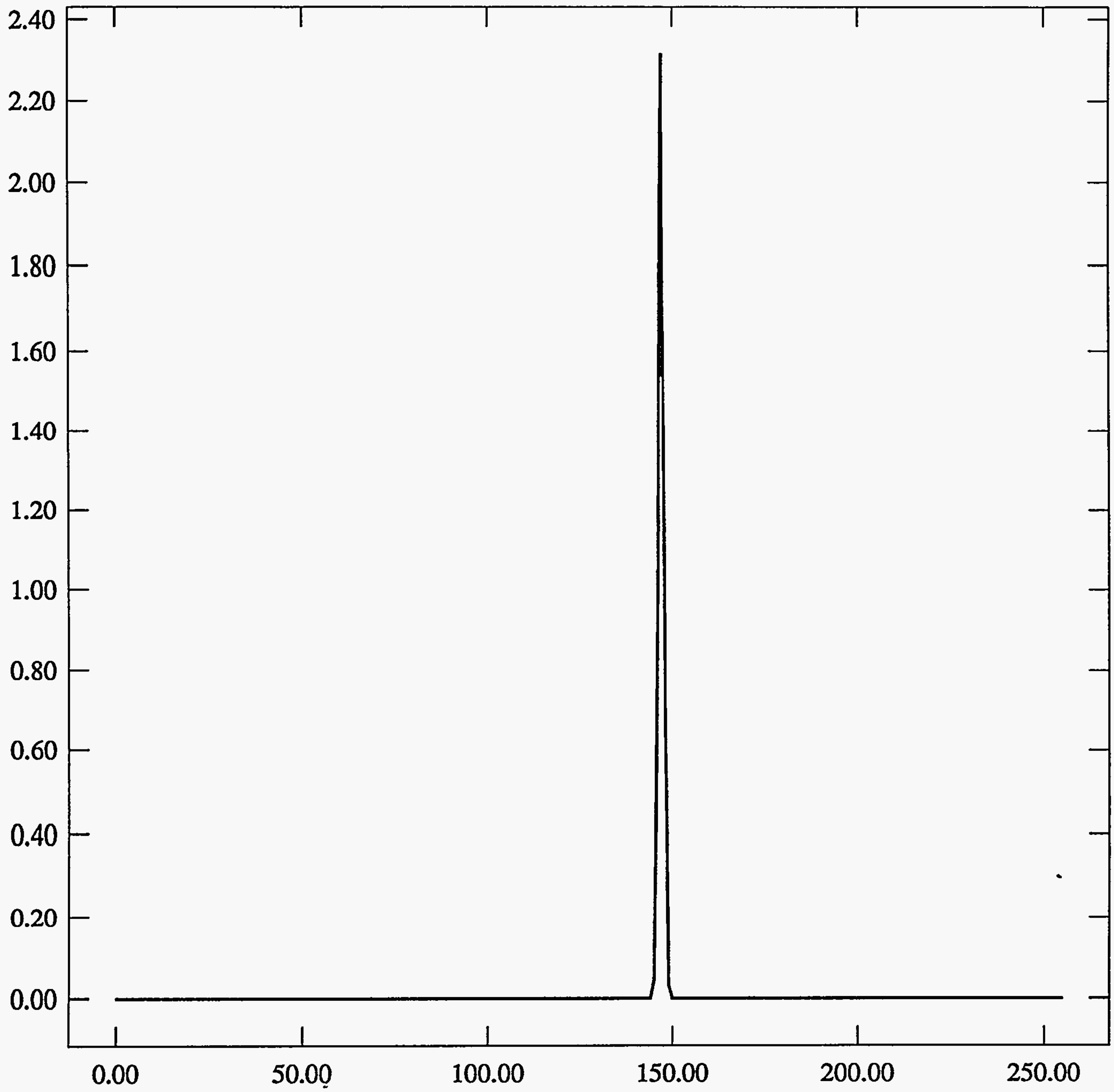
ST Camera: ST1#04-10 -30C #5: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 16:57:42 1993

Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.68 x 10^3



ST Camera: ST1#04-10 -30C #5: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 16:57:53 1993

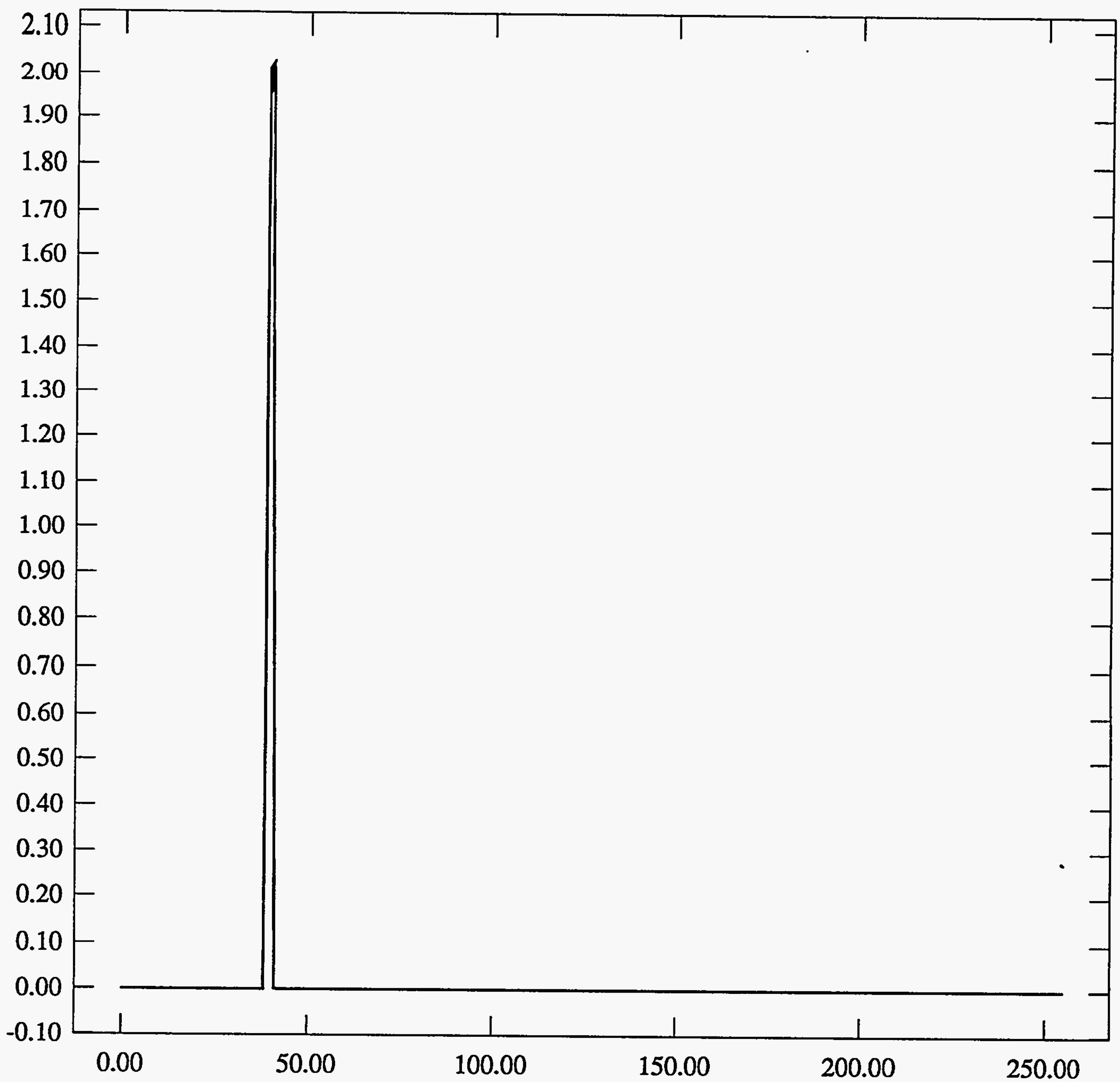
Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.69 x 10^3

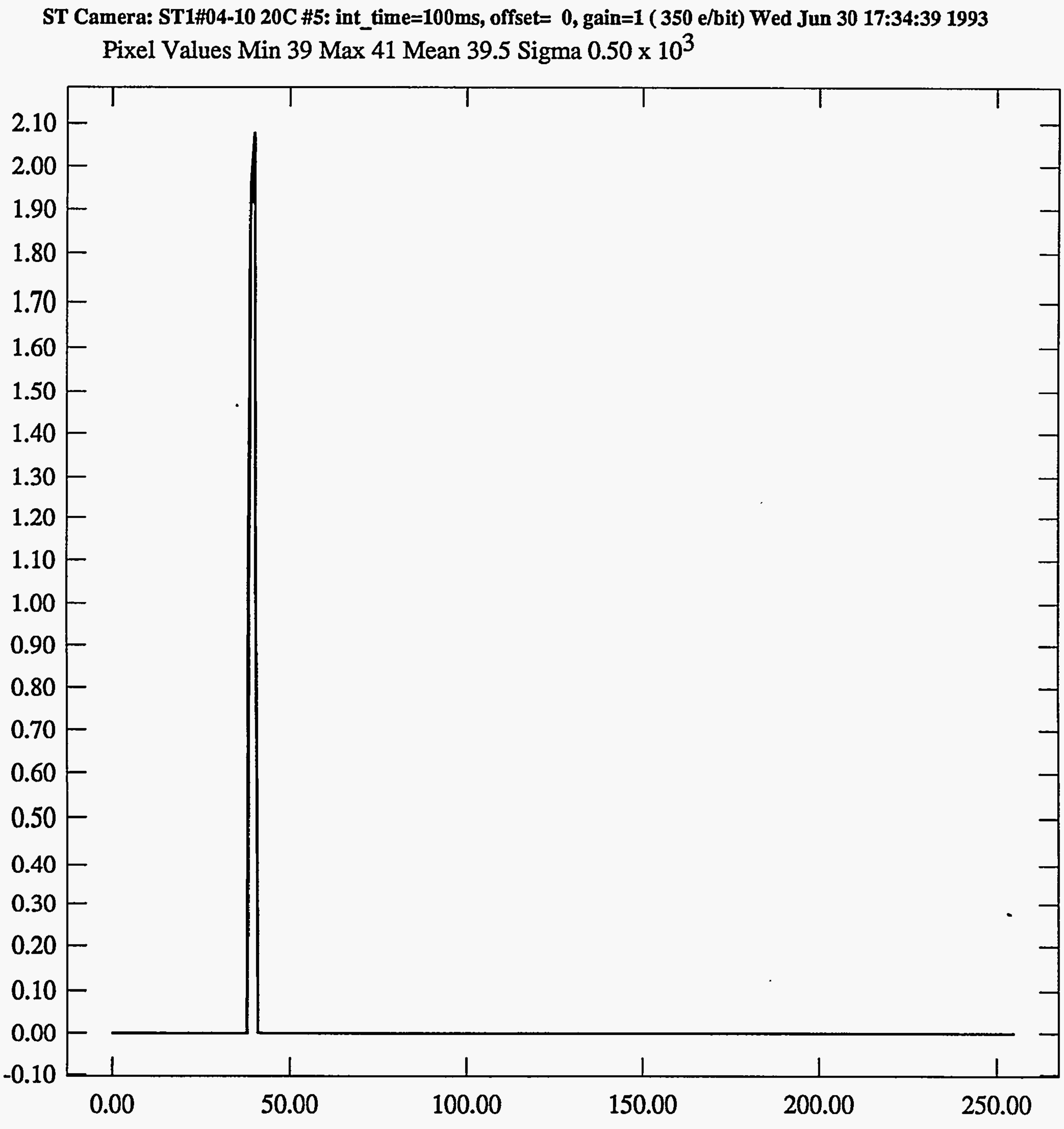


#5 20C 15min

ST Camera: ST1#04-10 20C #5: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 17:34:21 1993

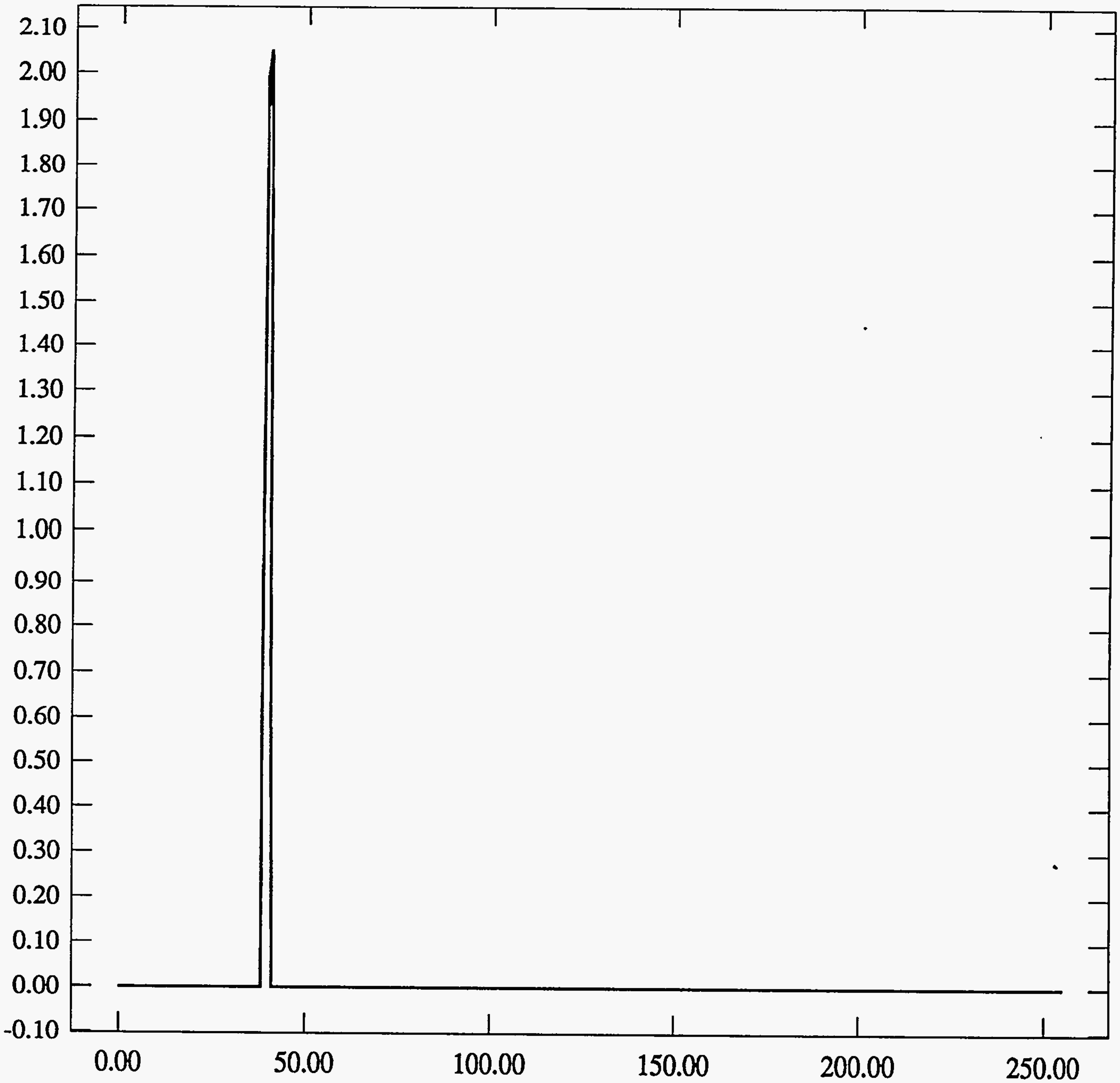
Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3

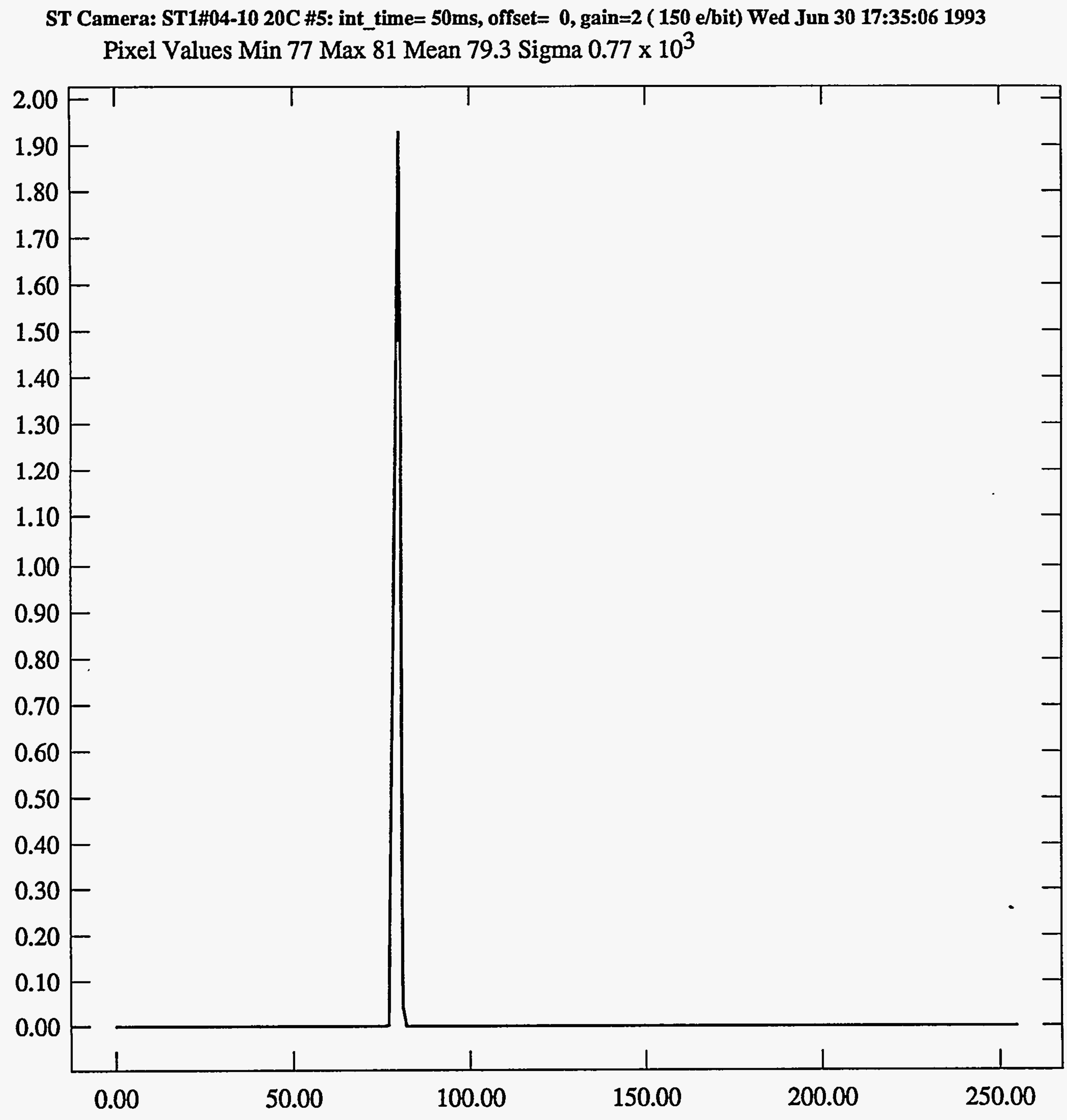



ST Camera: ST1#04-10 20C #5: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 17:34:39 1993
Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1#04-10 20C #5: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 17:34:50 1993

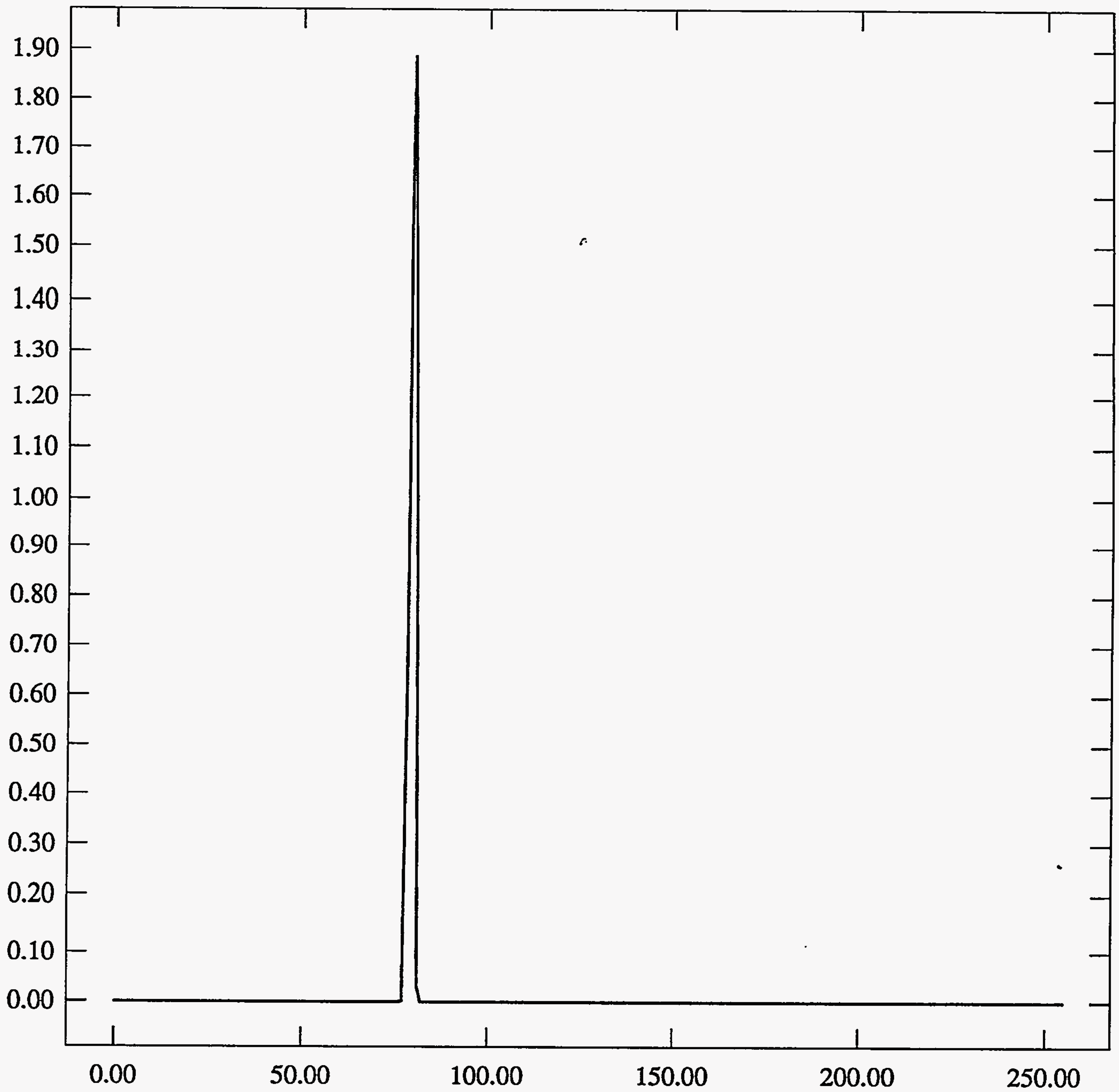
Pixel Values Min 39 Max 40 Mean 39.5 Sigma 0.50 x 10^3




ST Camera: ST1#04-10 20C #5: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 17:35:06 1993
Pixel Values Min 77 Max 81 Mean 79.3 Sigma 0.77 x 10^3
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
50.00
100.00
150.00
200.00
250.00

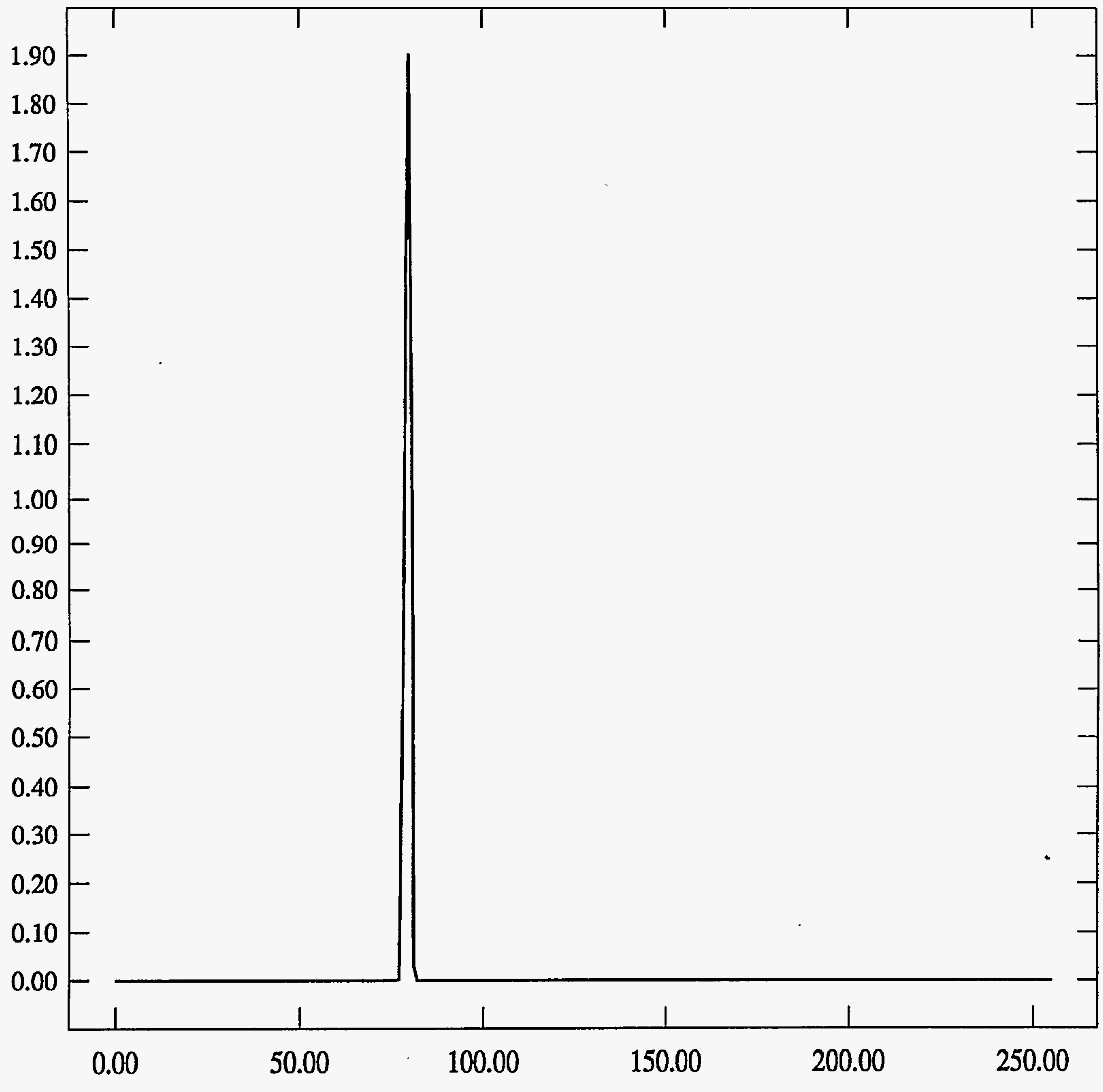
ST Camera: ST1#04-10 20C #5: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 17:35:16 1993

Pixel Values Min 77 Max 81 Mean 79.3 Sigma 0.74 x 10^3



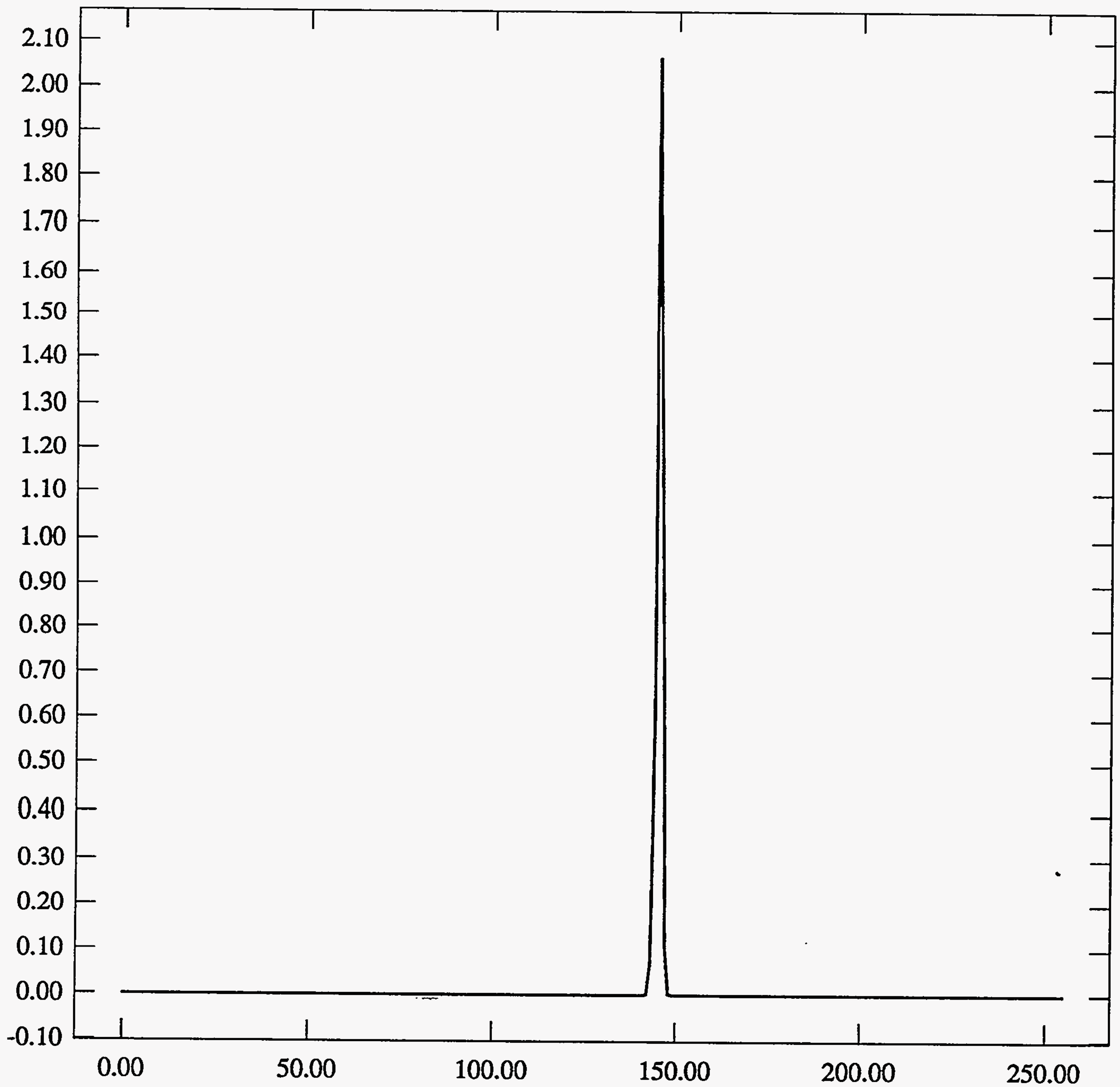
ST Camera: ST1#04-10 20C #5: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 17:35:30 1993

Pixel Values Min 77 Max 81 Mean 79.3 Sigma 0.75 x 10^3



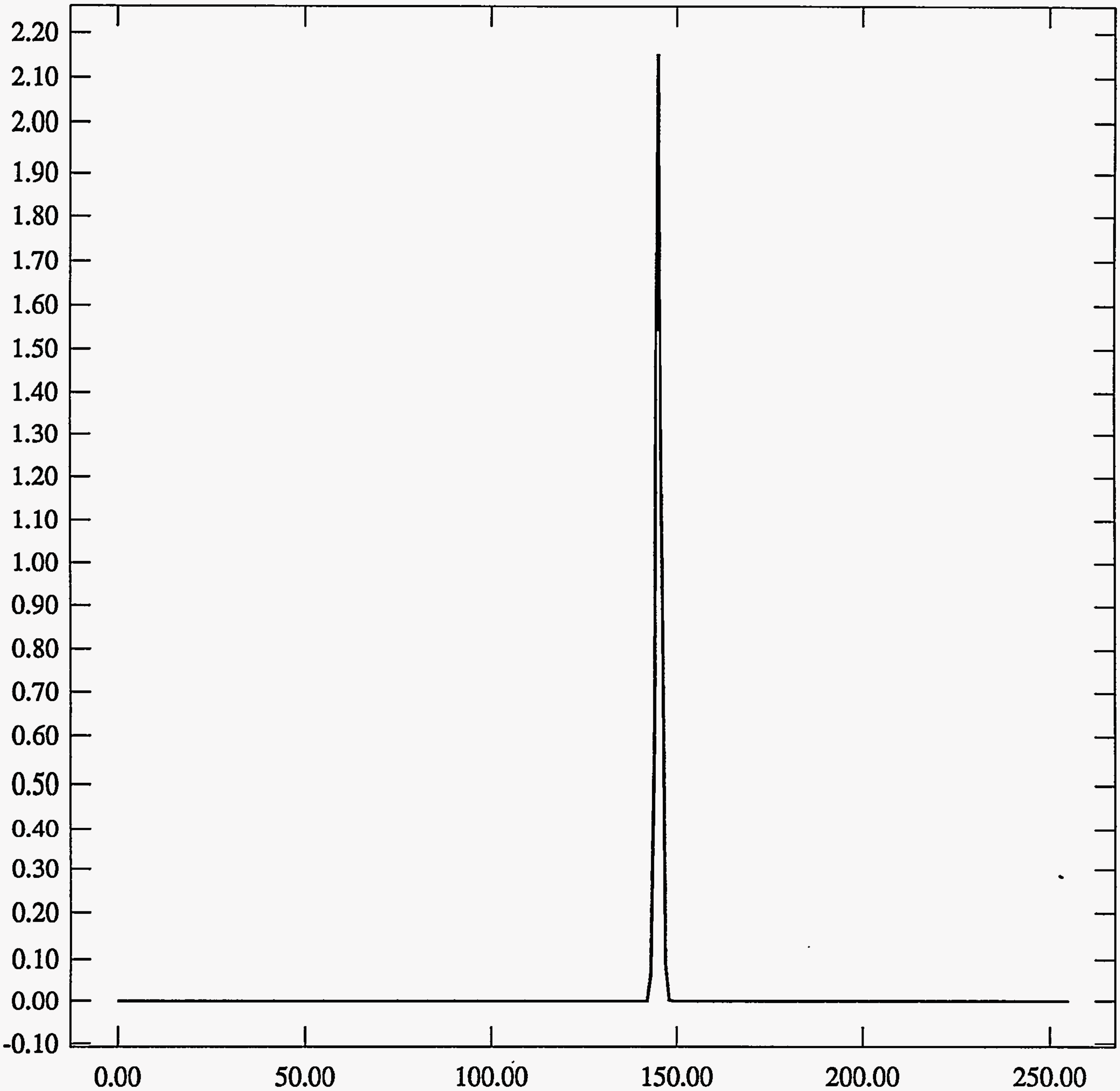
ST Camera: ST1#04-10 20C #5: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 17:35:46 1993

Pixel Values Min 142 Max 148 Mean 145.1 Sigma 0.78 x 10^3



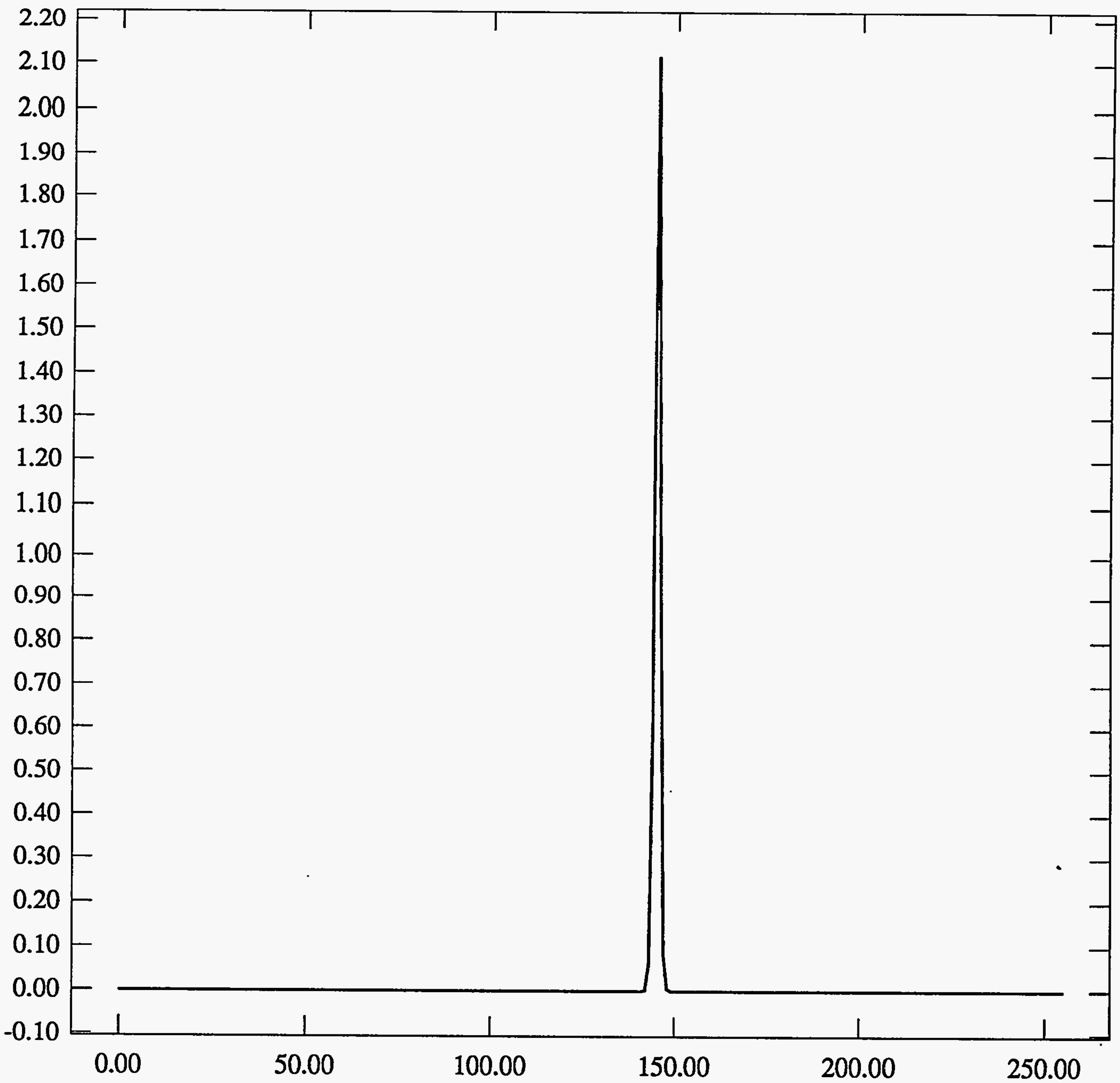
ST Camera: ST1#04-10 20C #5: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 17:36:01 1993

Pixel Values Min 143 Max 148 Mean 145.1 Sigma 0.75 x 10^3



ST Camera: ST1#04-10 20C #5: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 17:36:24 1993

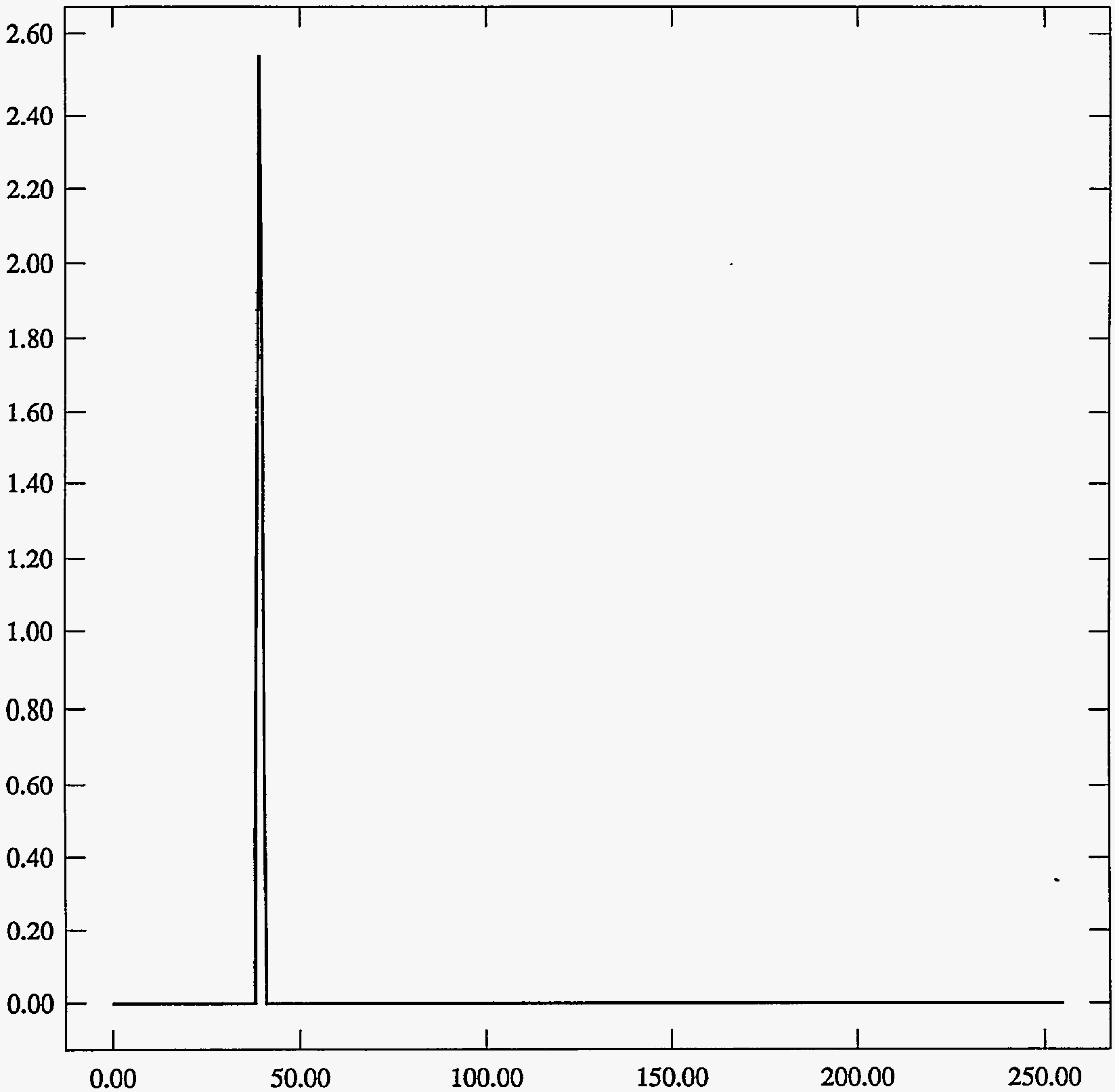
Pixel Values Min 142 Max 148 Mean 145.2 Sigma 0.76 x 10^3



#5 20C and dicycle

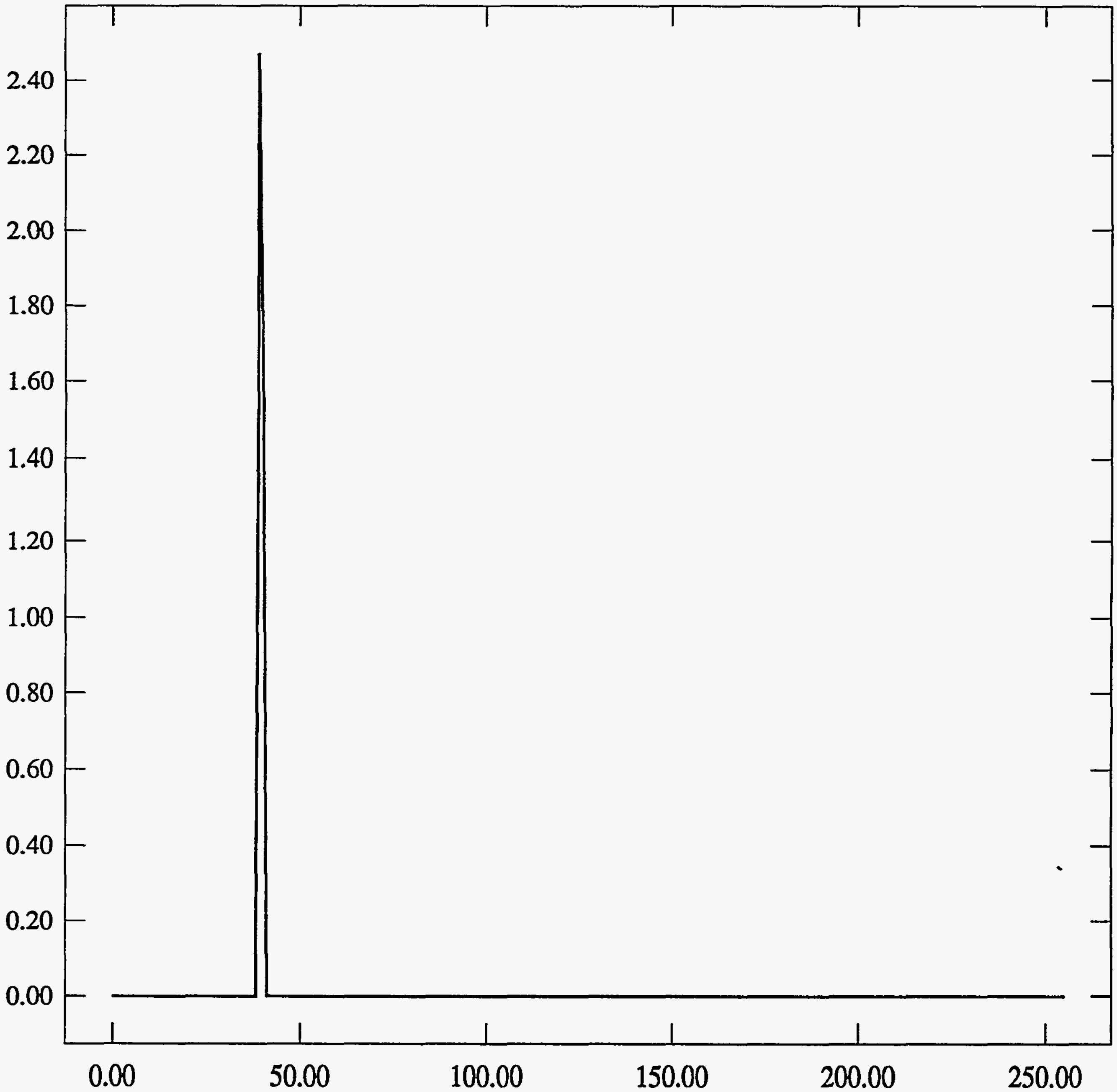
ST Camera: ST1#04-10 20C #5: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 18:14:31 1993

Pixel Values Min 39 Max 40 Mean 39.4 Sigma 0.48 x 10^3



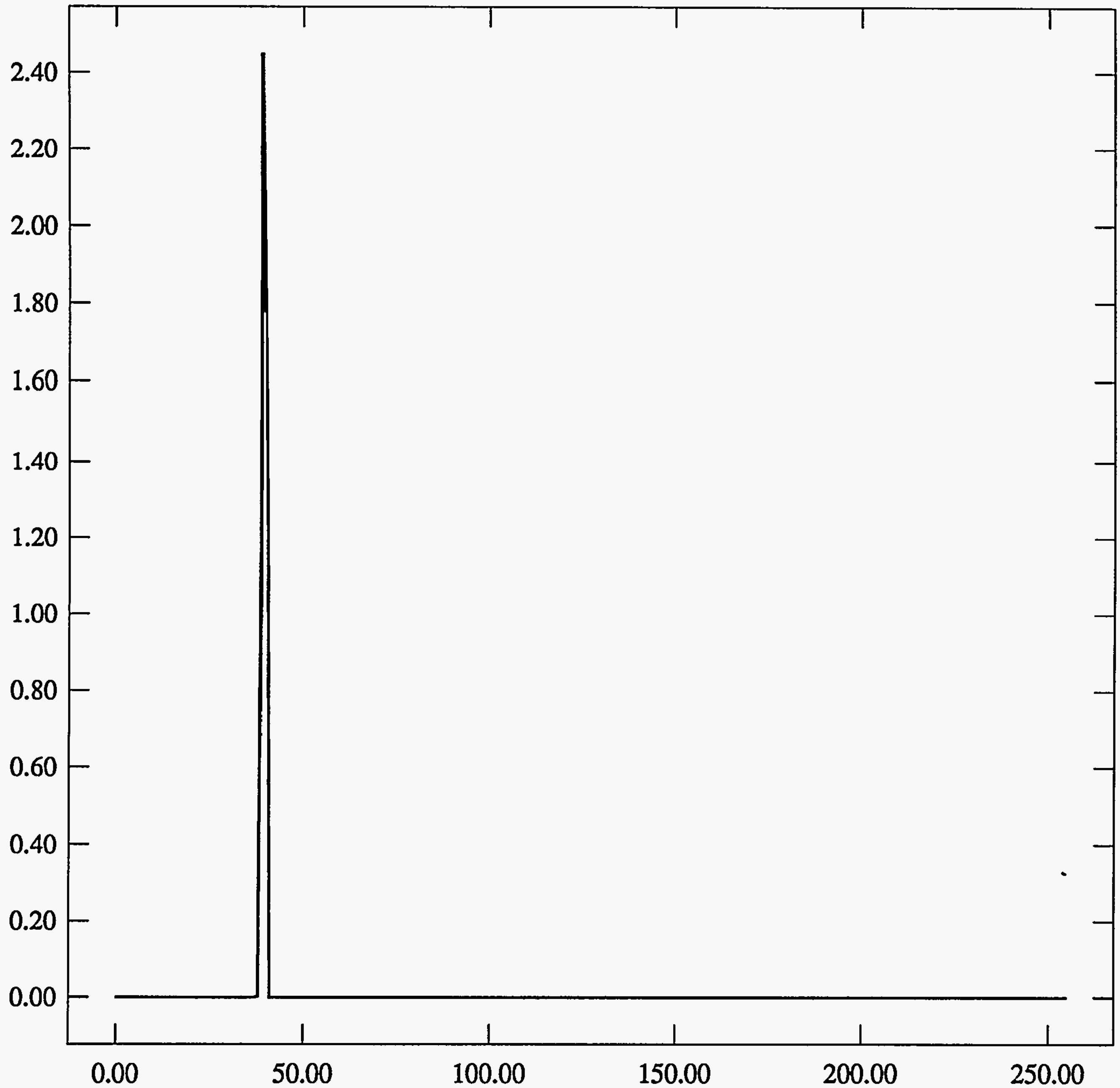
ST Camera: ST1#04-10 20C #5: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 18:14:43 1993

Pixel Values Min 39 Max 41 Mean 39.4 Sigma 0.49 x 10^3



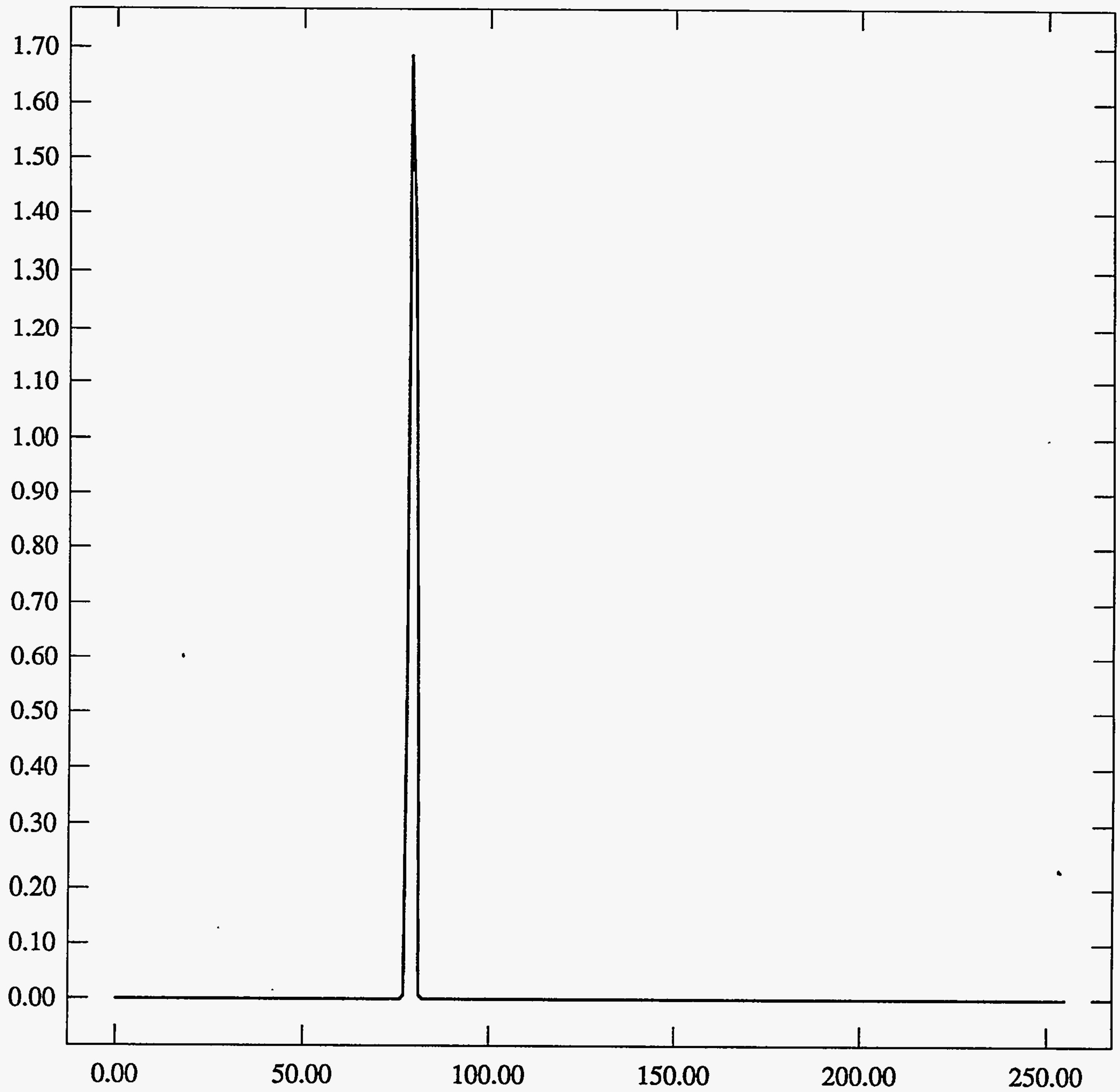
ST Camera: ST1#04-10 20C #5: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 18:14:55 1993

Pixel Values Min 38 Max 40 Mean 39.4 Sigma 0.49 x 10^3



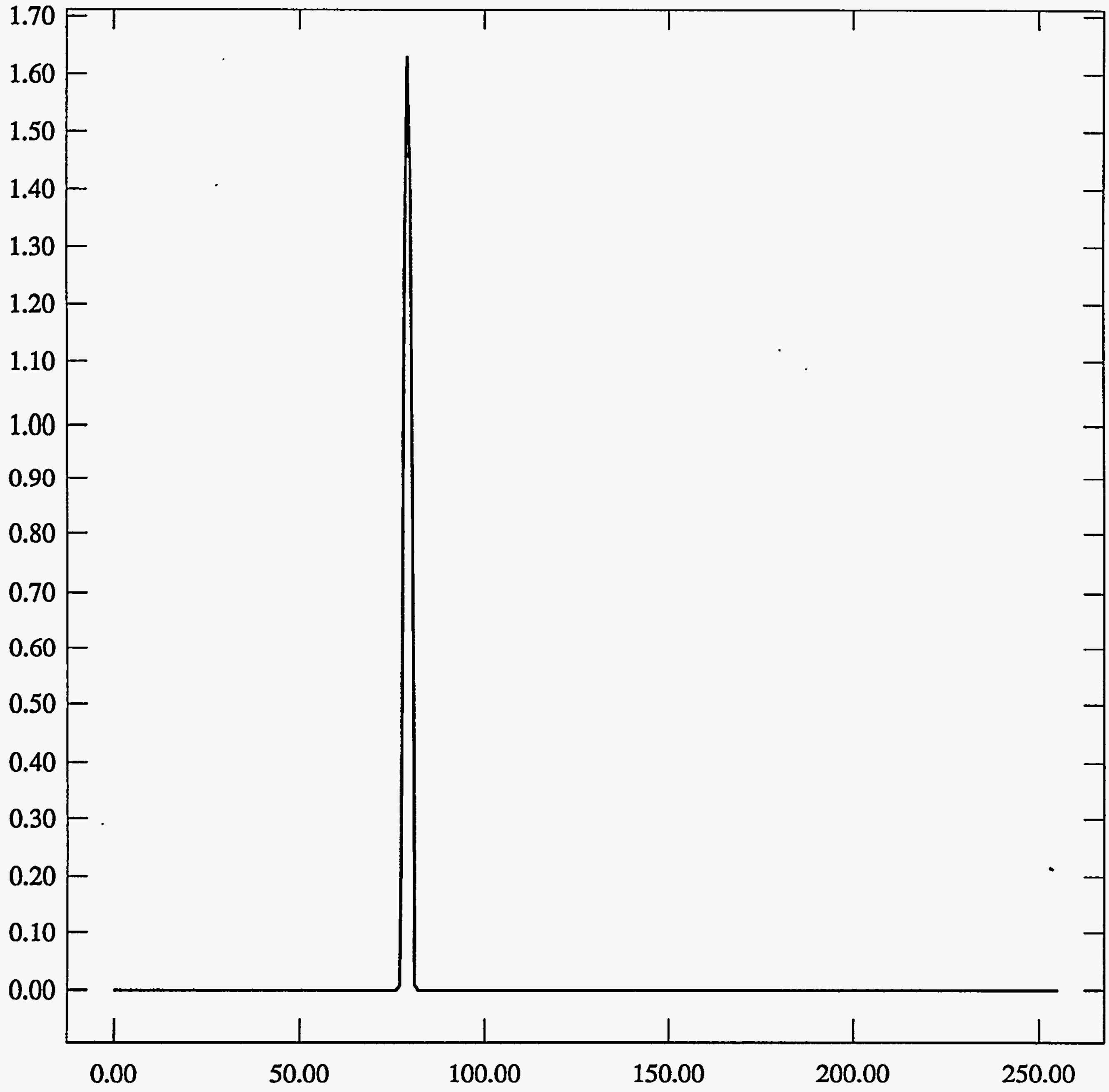
ST Camera: ST1#04-10 20C #5: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 18:15:07 1993

Pixel Values Min 77 Max 81 Mean 79.1 Sigma 0.76 x 10^3



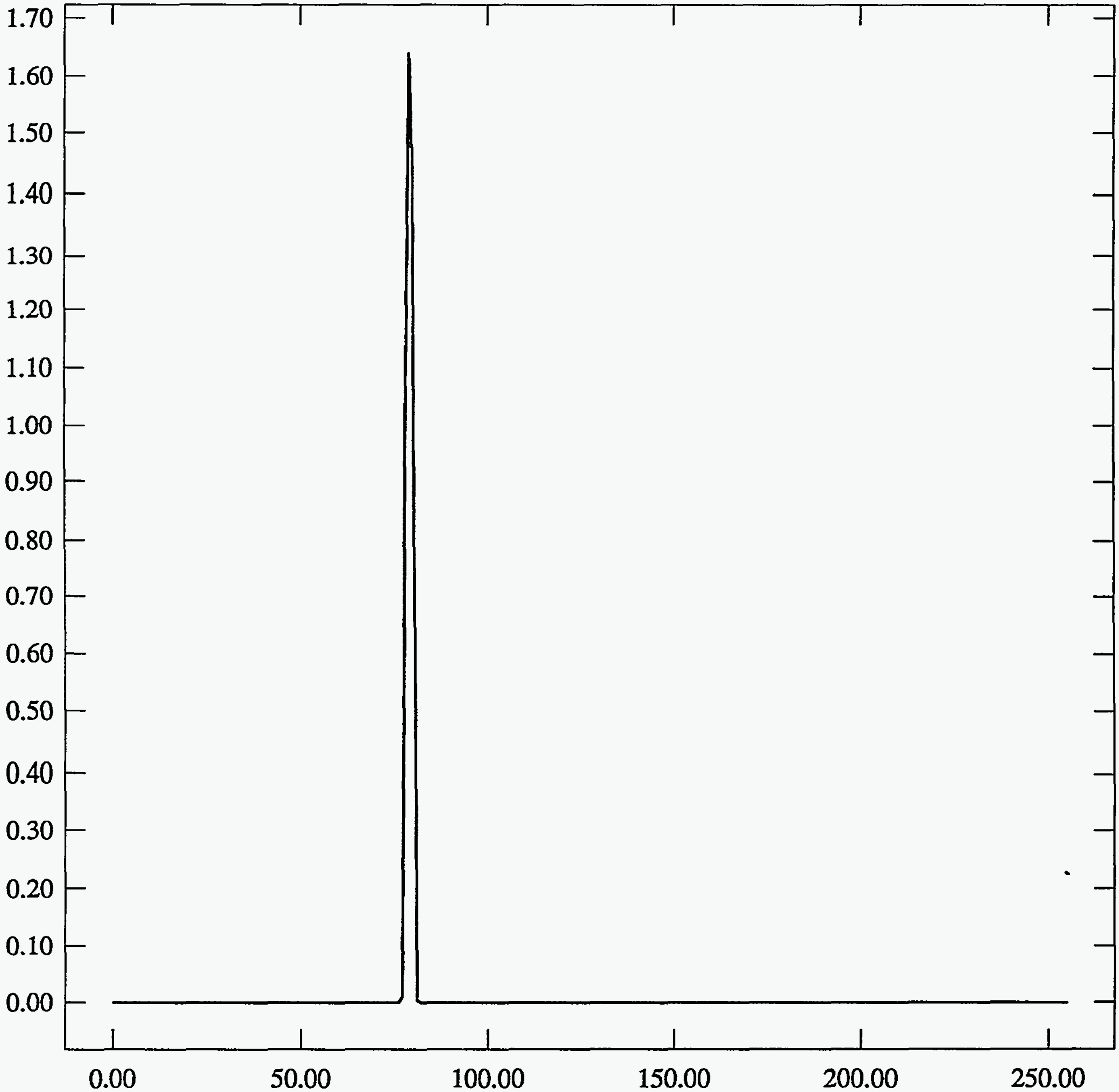
ST Camera: ST1#04-10 20C #5: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 18:15:20 1993

Pixel Values Min 77 Max 81 Mean 79.1 Sigma 0.78 x 10^3



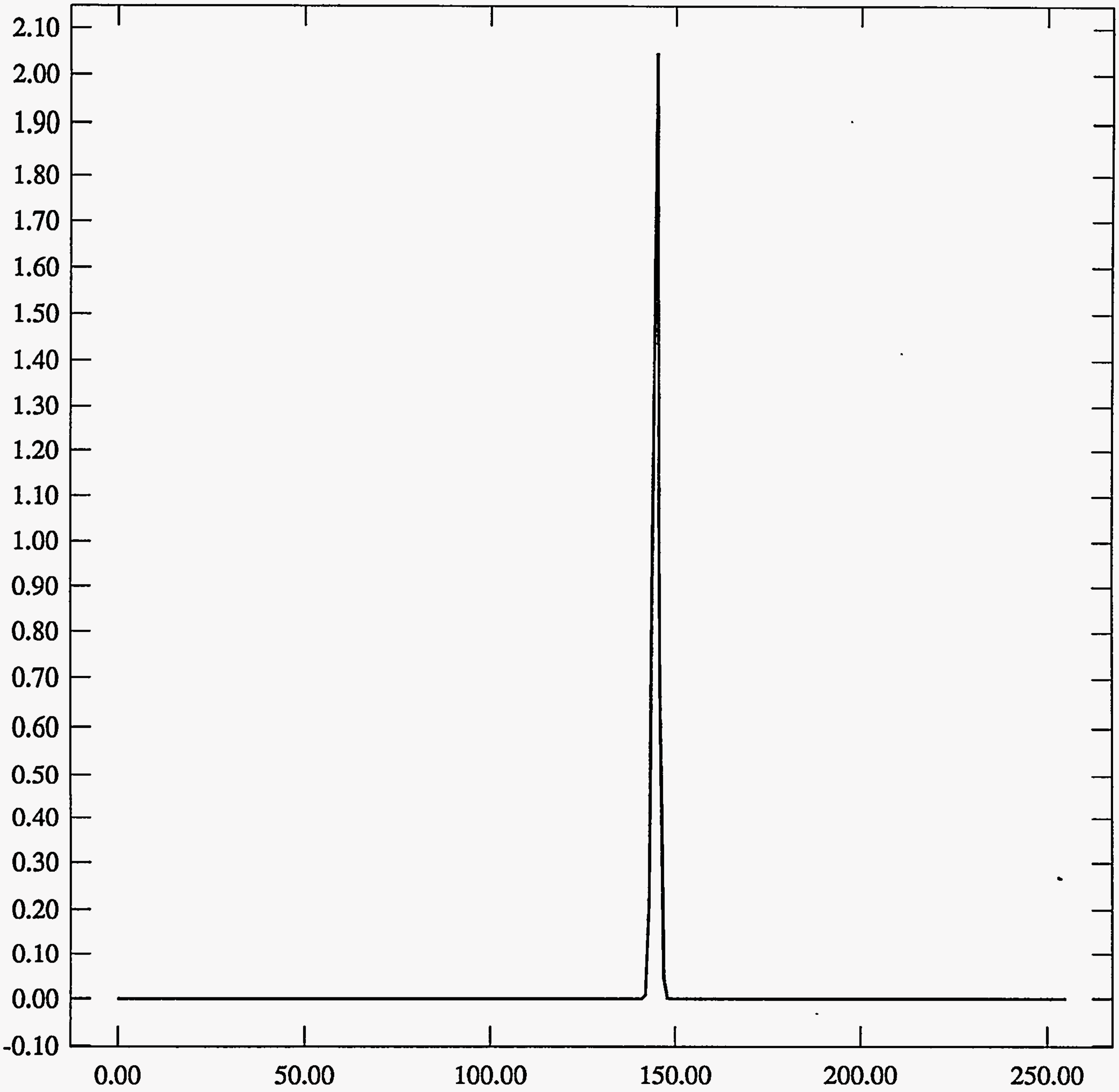
ST Camera: ST1#04-10 20C #5: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 18:15:31 1993

Pixel Values Min 77 Max 81 Mean 79.1 Sigma 0.77 x 10^3



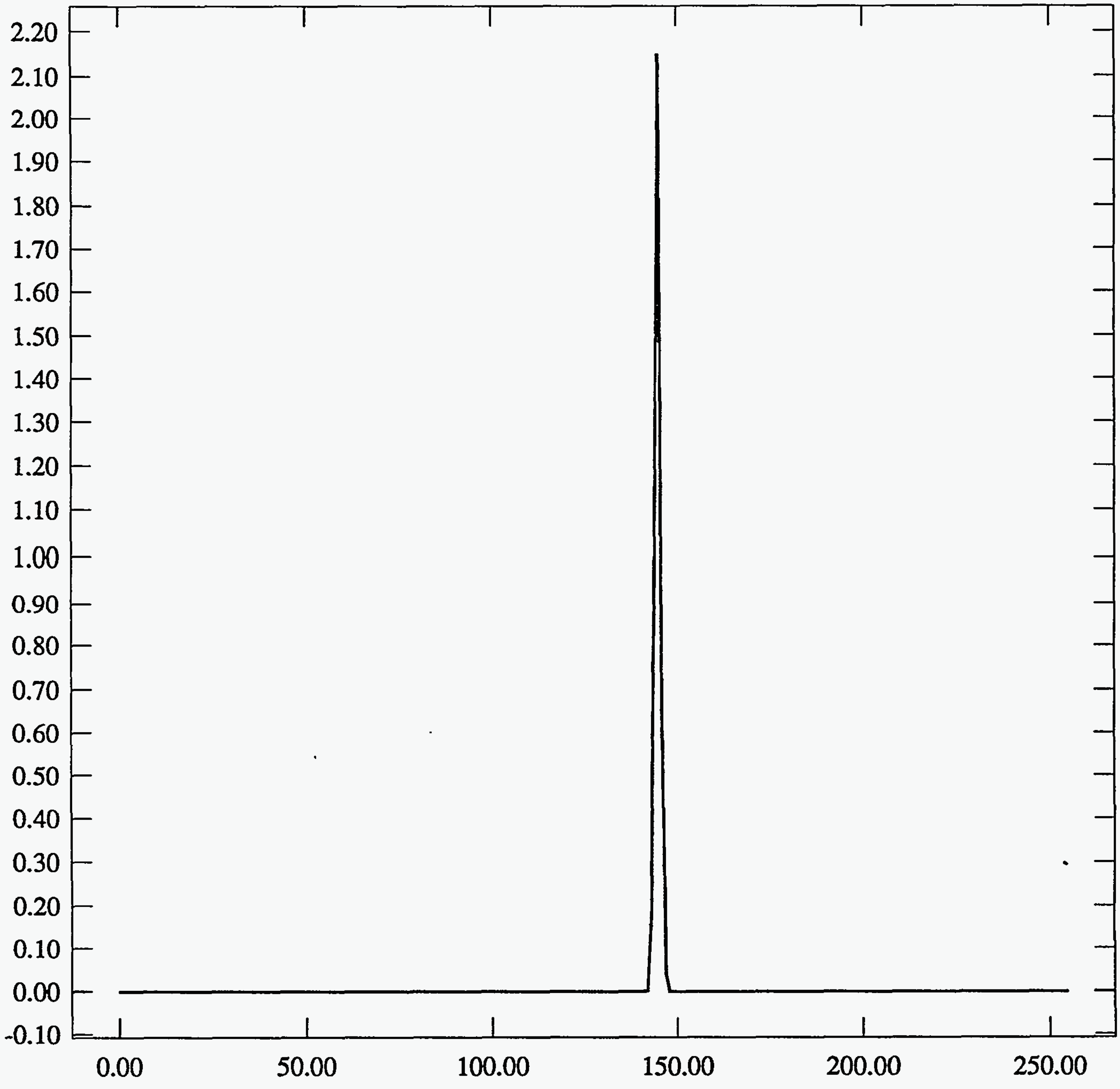
ST Camera: ST1#04-10 20C #5: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 18:15:43 1993

Pixel Values Min 142 Max 148 Mean 144.8 Sigma 0.82 x 10^3



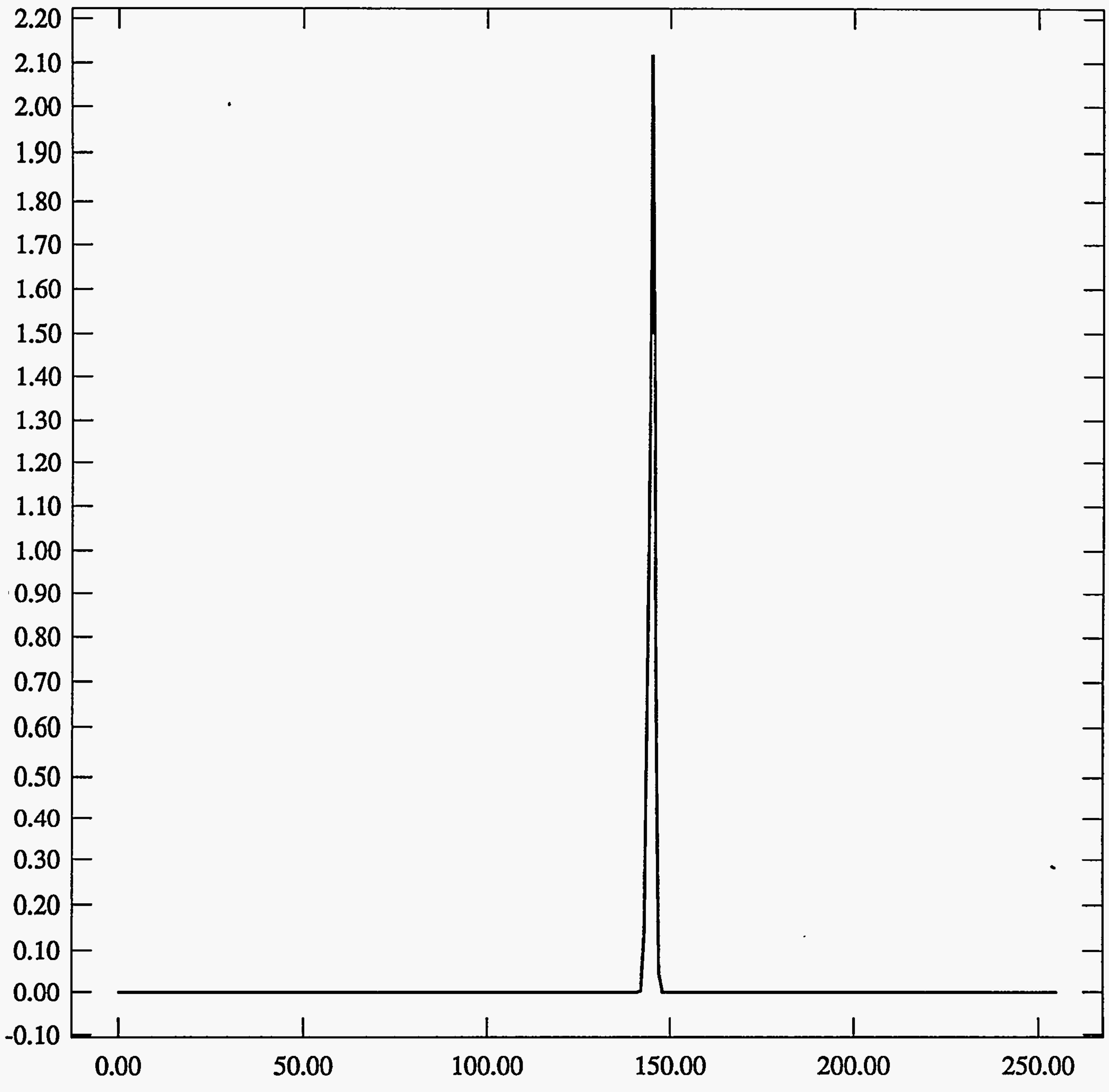
ST Camera: ST1#04-10 20C #5: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 18:15:57 1993

Pixel Values Min 142 Max 147 Mean 144.9 Sigma 0.78 x 10^3



ST Camera: ST1#04-10 20C #5: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 18:16:15 1993

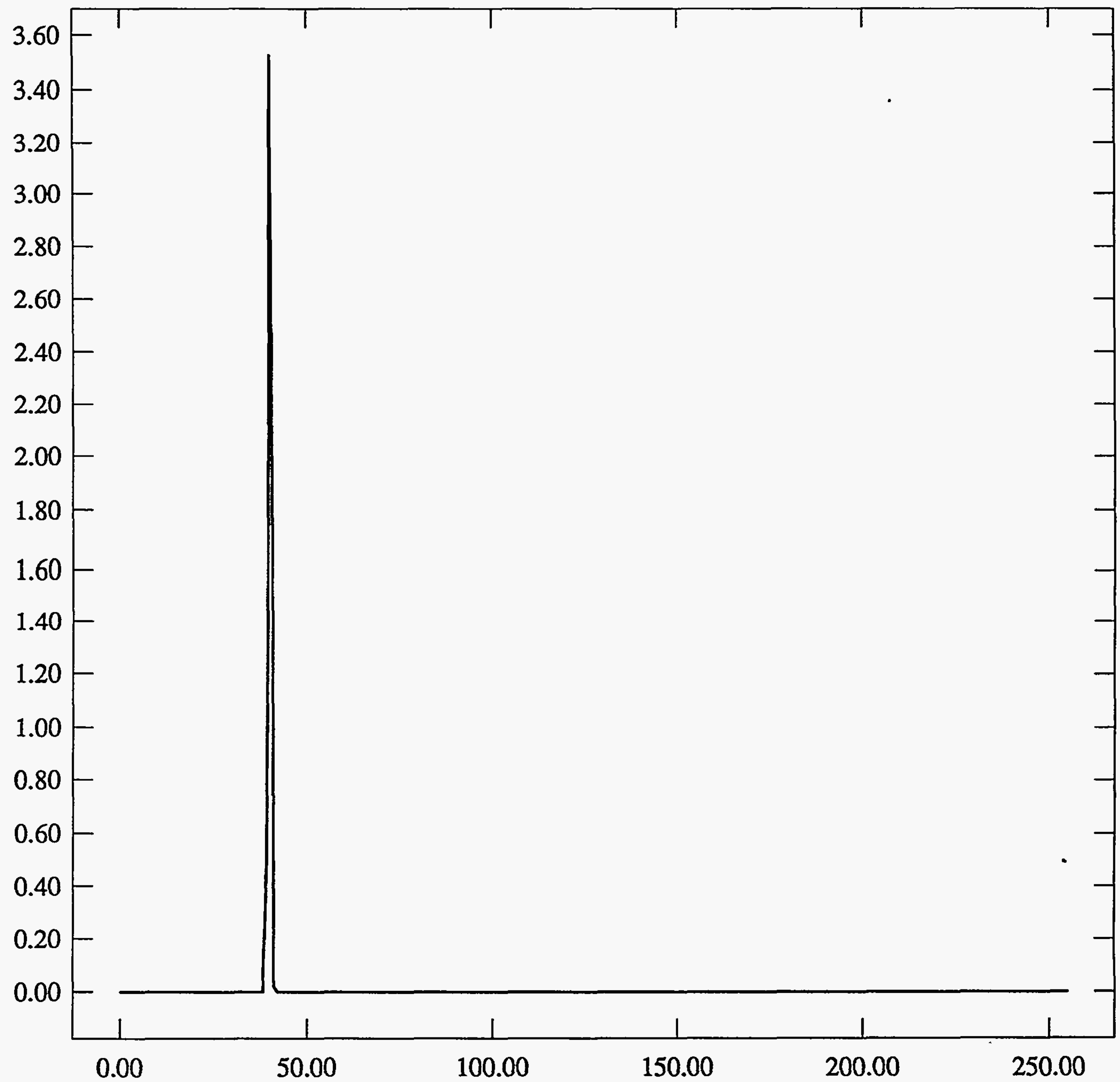
Pixel Values Min 142 Max 147 Mean 144.9 Sigma 0.78 x 10^3



#6 · 30C 15mins

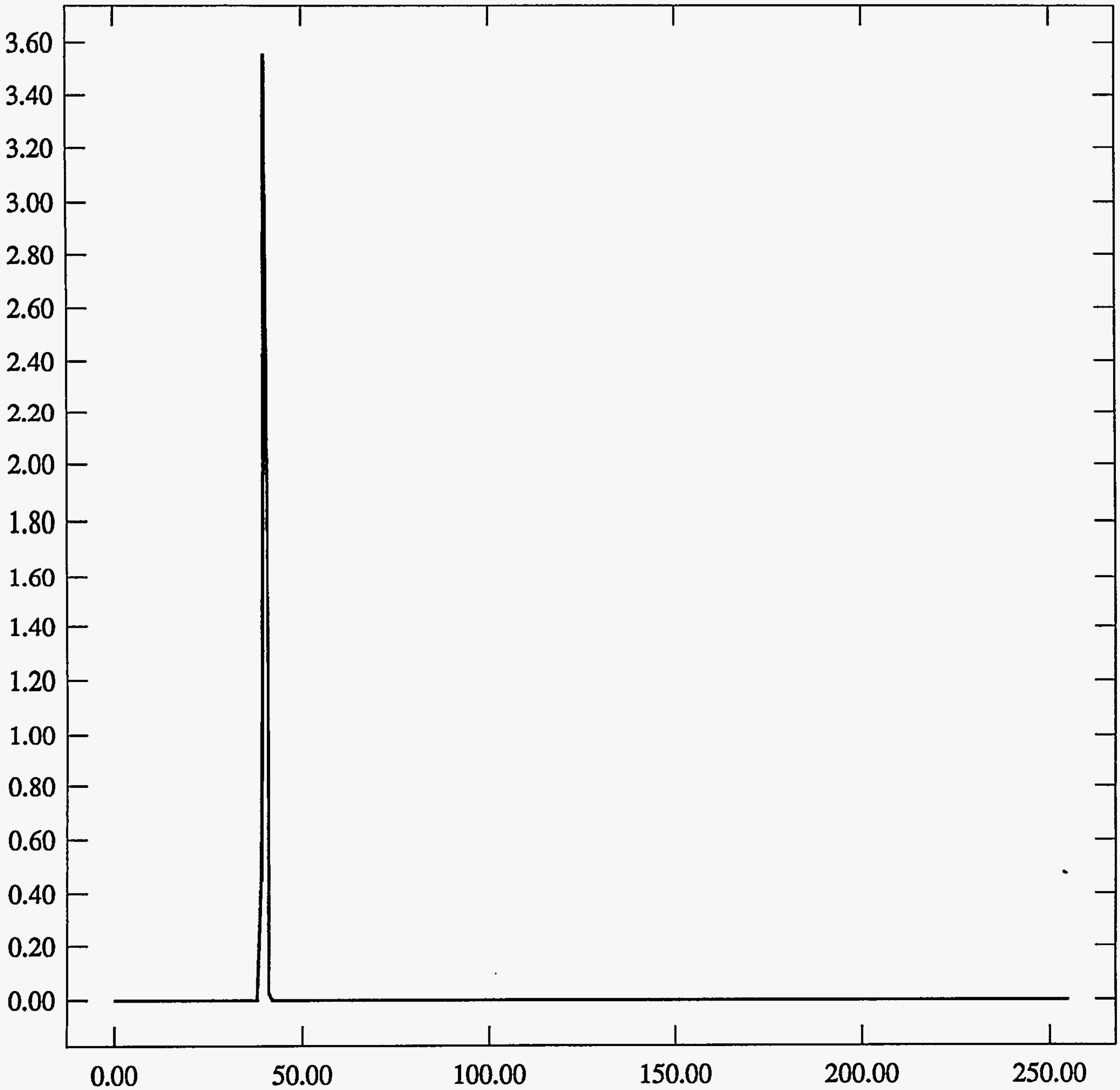
ST Camera: ST1#04-10 -30C #6: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 18:53:50 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.34 x 10^3



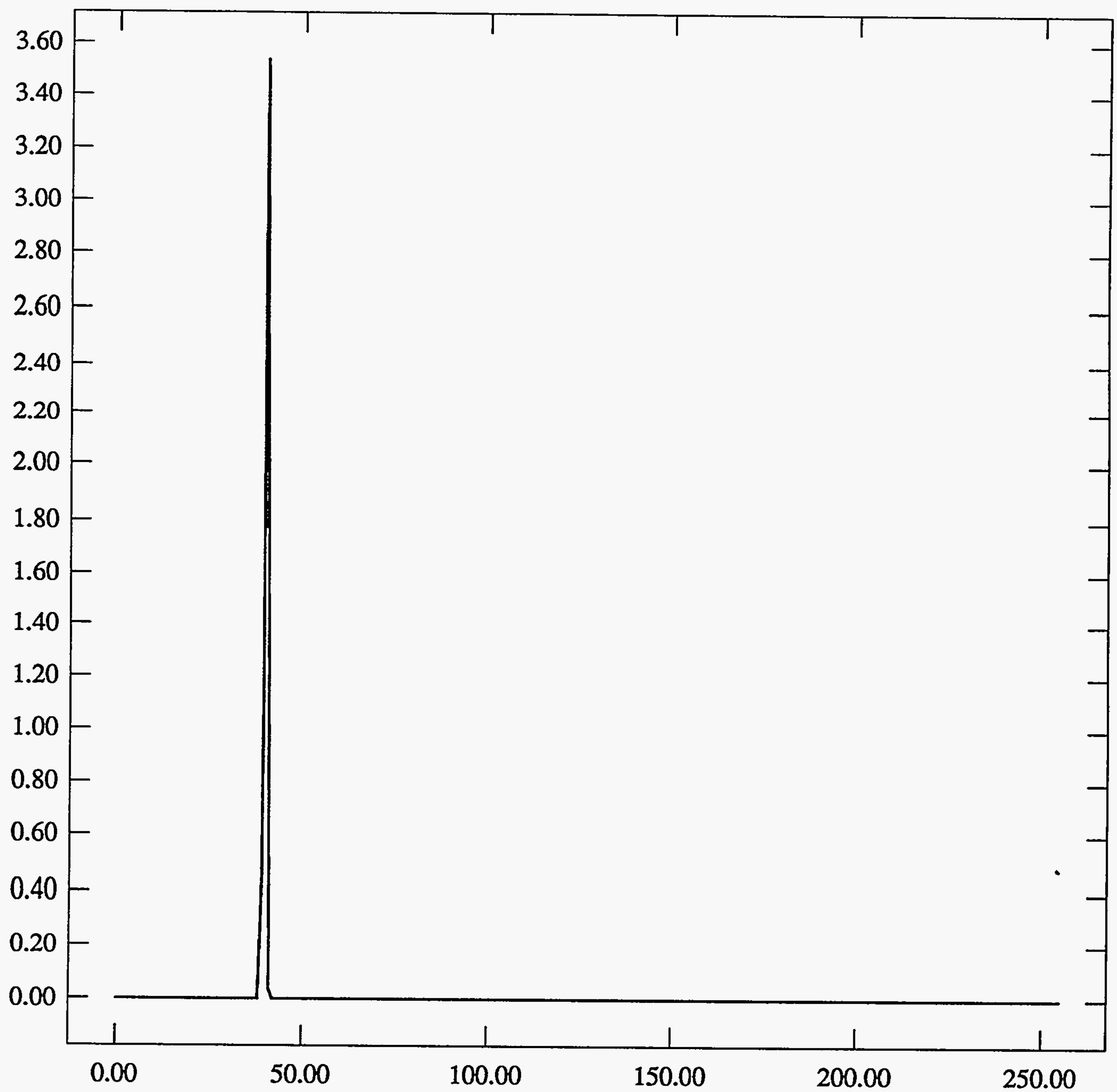
ST Camera: ST1#04-10 -30C #6: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 18:54:07 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.33 x 10^3



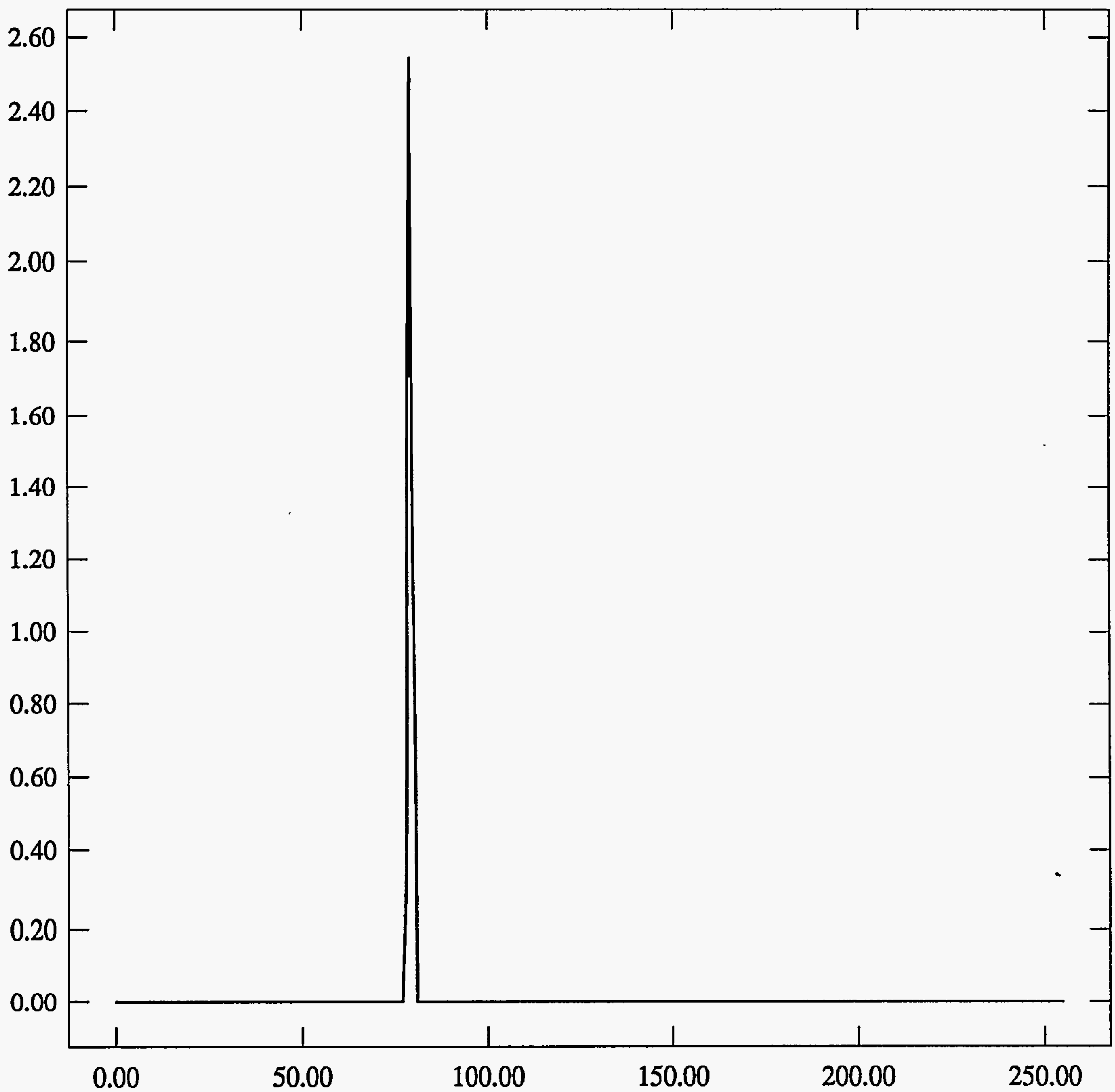
ST Camera: ST1#04-10 -30C #6: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 18:54:20 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.34 x 10^3



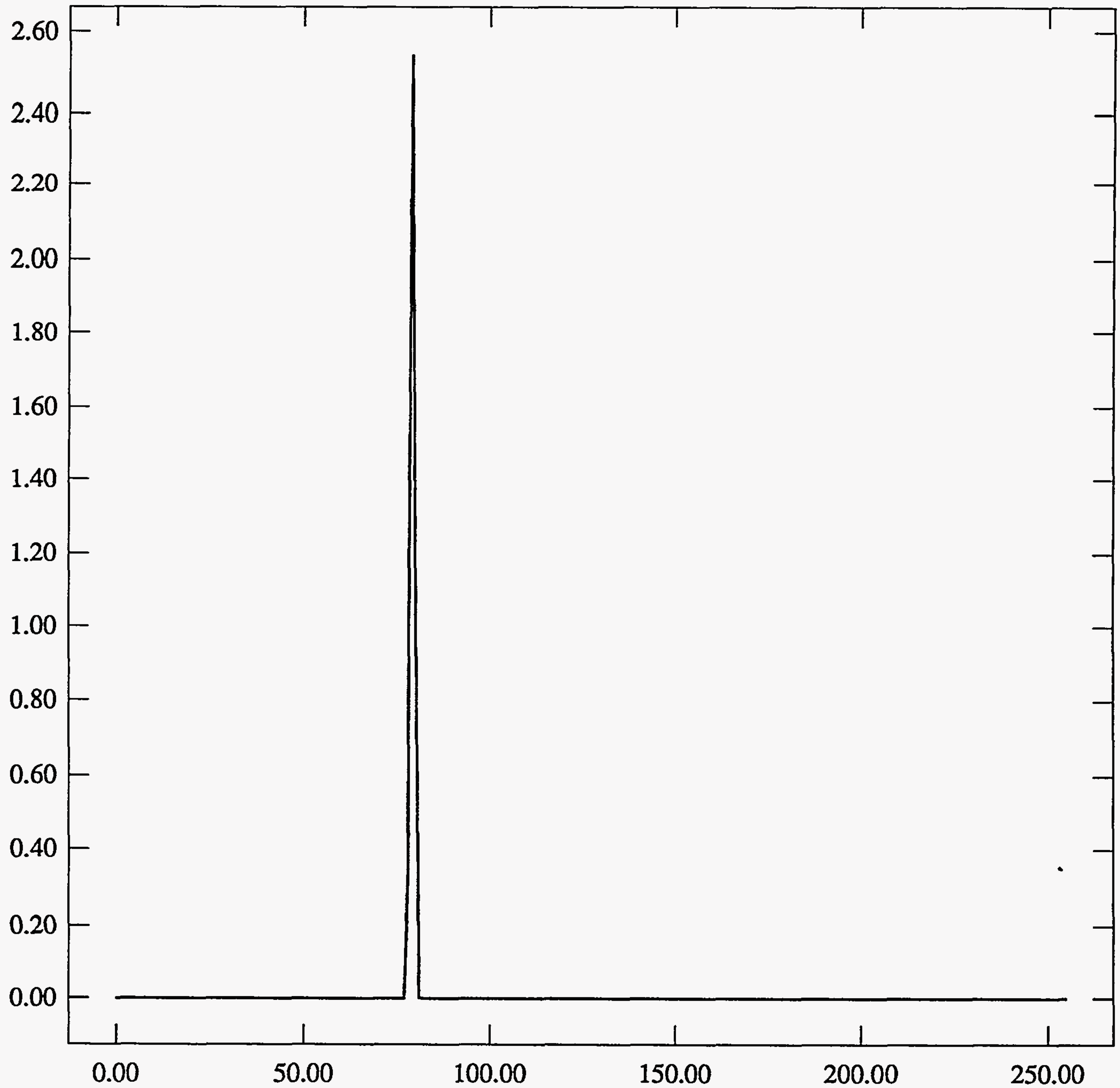
ST Camera: ST1#04-10 -30C #6: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 18:54:34 1993

Pixel Values Min 78 Max 80 Mean 79.2 Sigma 0.57 x 10^3



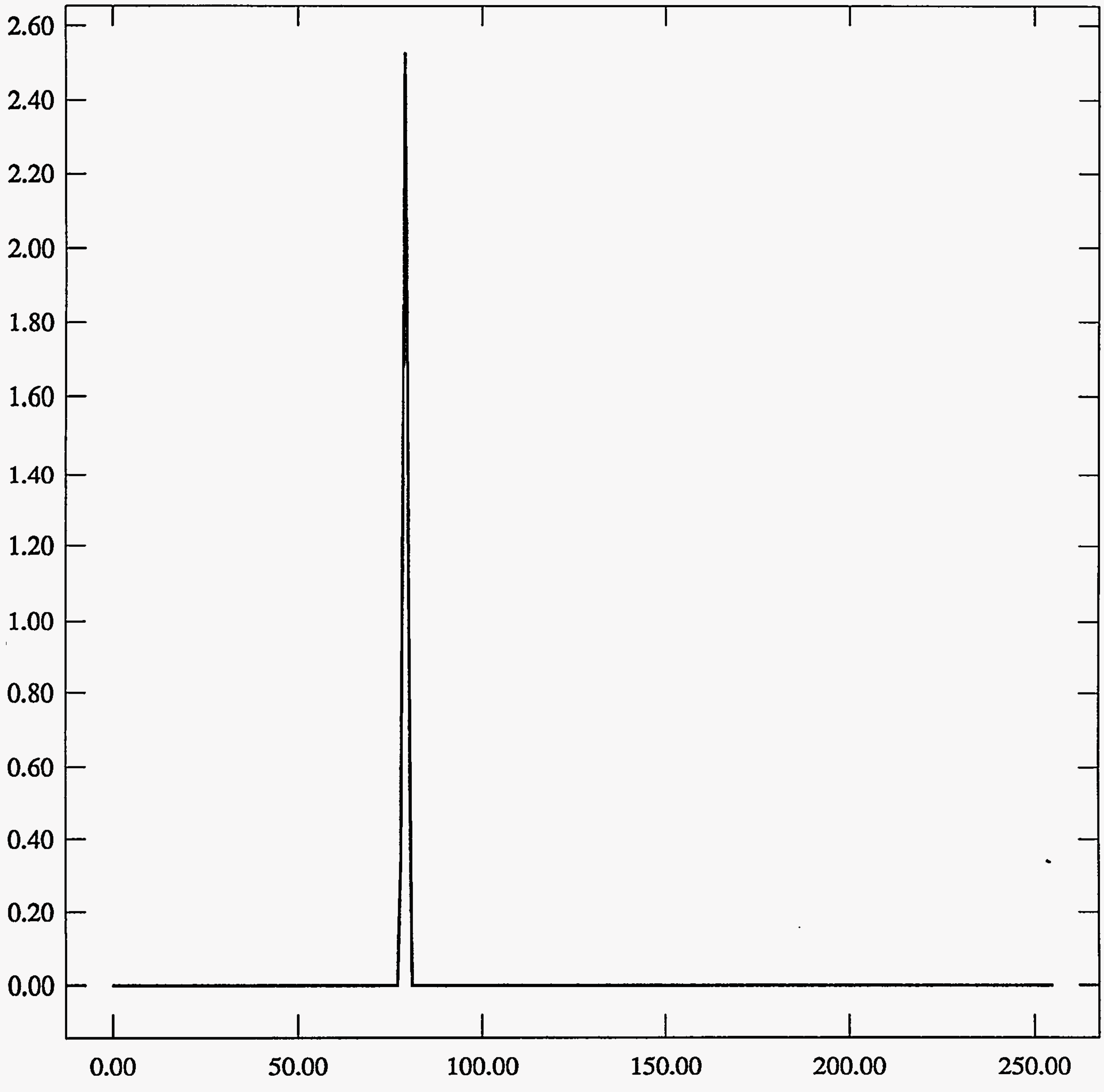
ST Camera: ST1#04-10 -30C #6: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 18:54:46 1993

Pixel Values Min 78 Max 81 Mean 79.2 Sigma 0.58 x 10^3

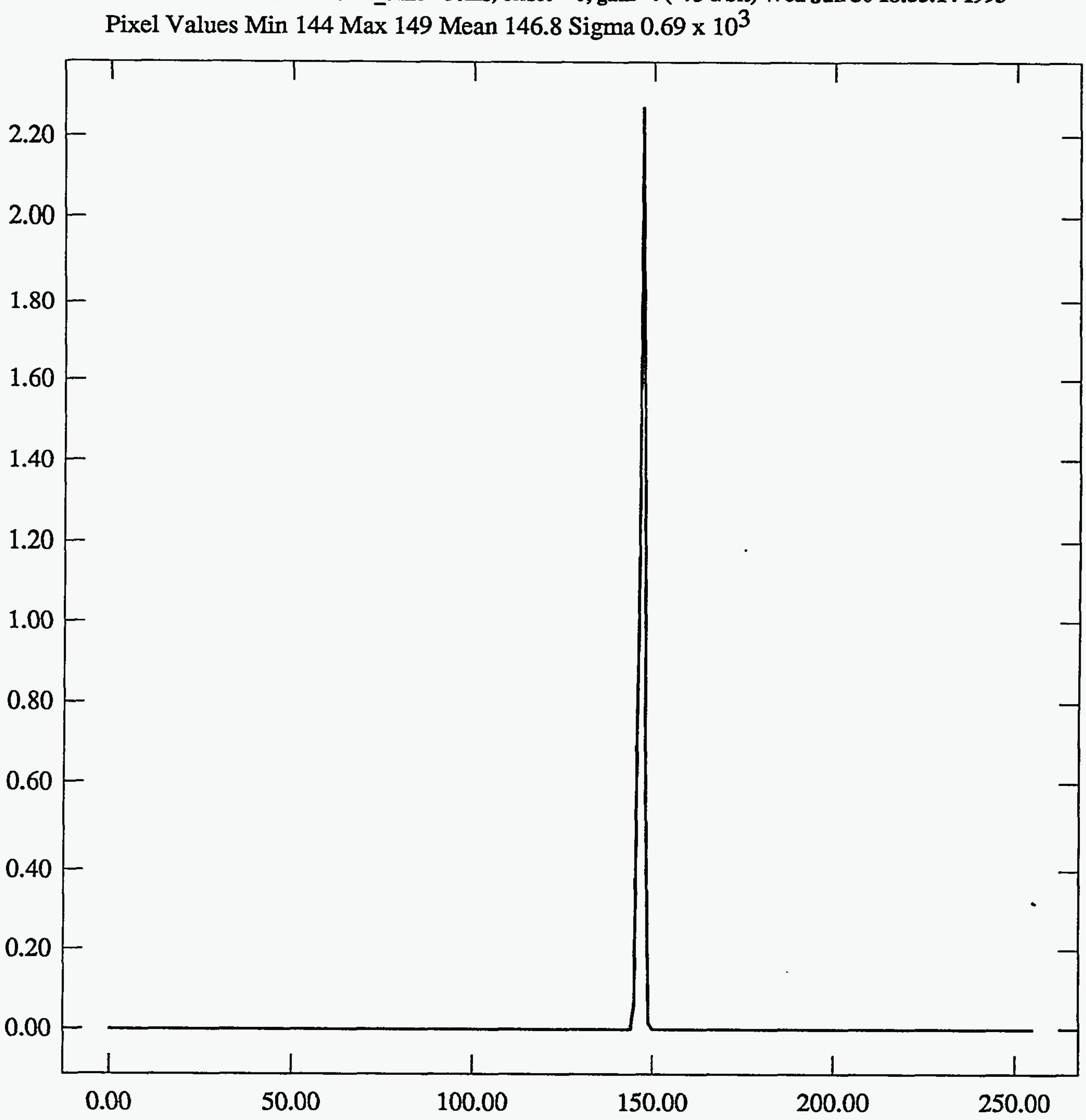


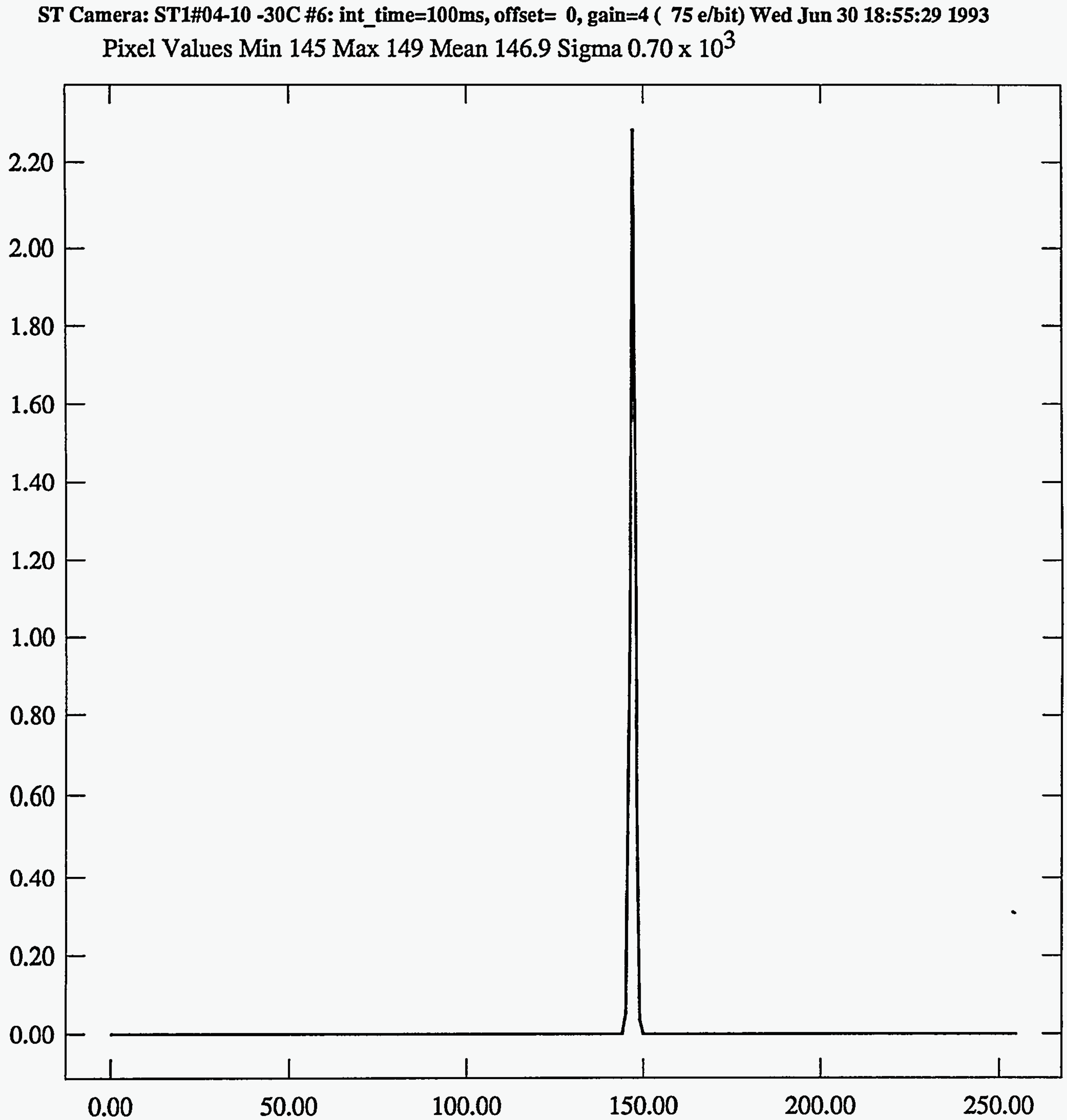
ST Camera: ST1#04-10 -30C #6: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 18:55:02 1993

Pixel Values Min 78 Max 80 Mean 79.2 Sigma 0.58 x 10^3



ST Camera: ST1#04-10 -30C #6: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 18:55:14 1993

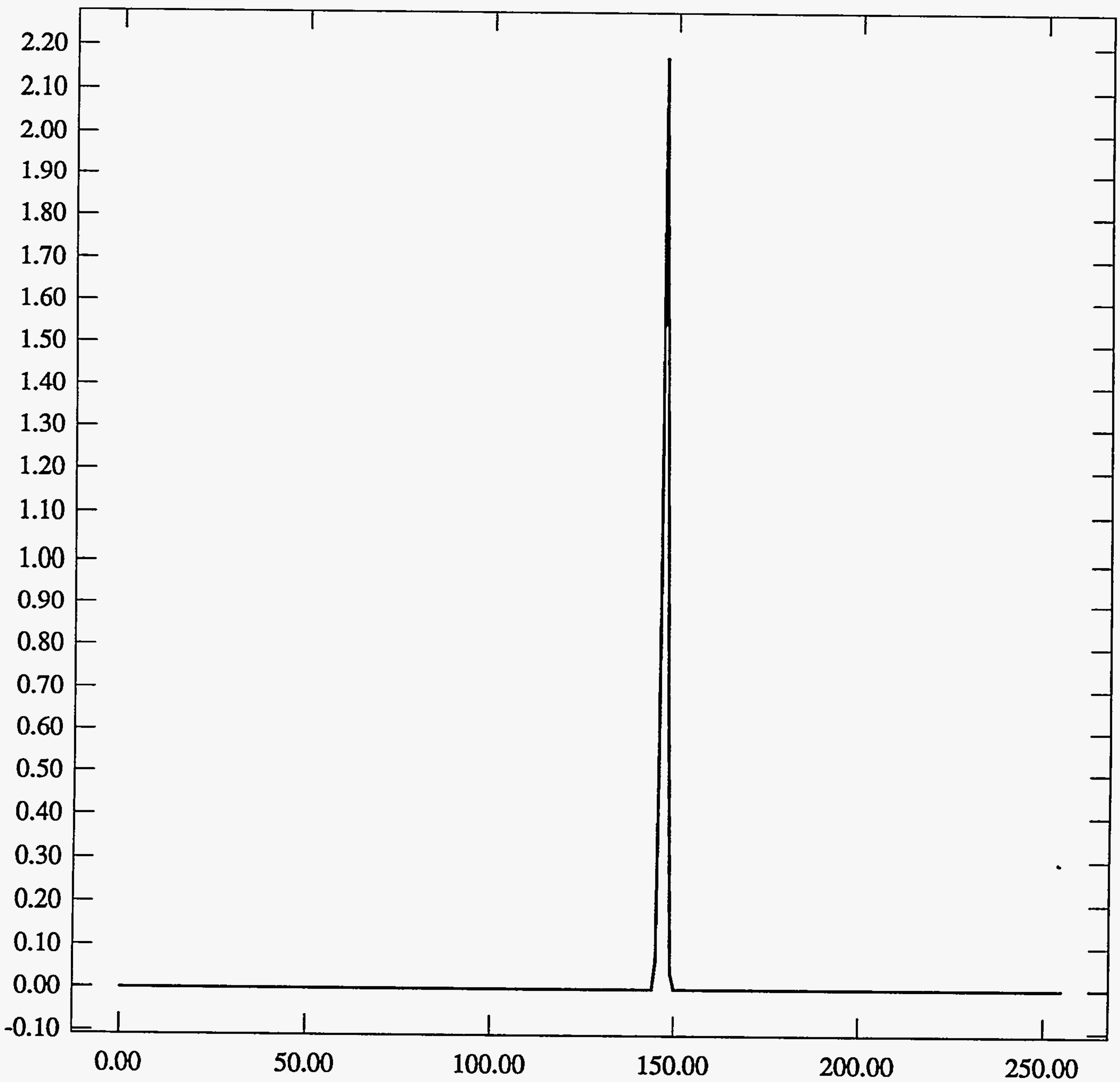




ST Camera: ST1#04-10 -30C #6: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 18:55:29 1993
Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.70 x 10^3
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1#04-10 -30C #6: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 18:55:42 1993

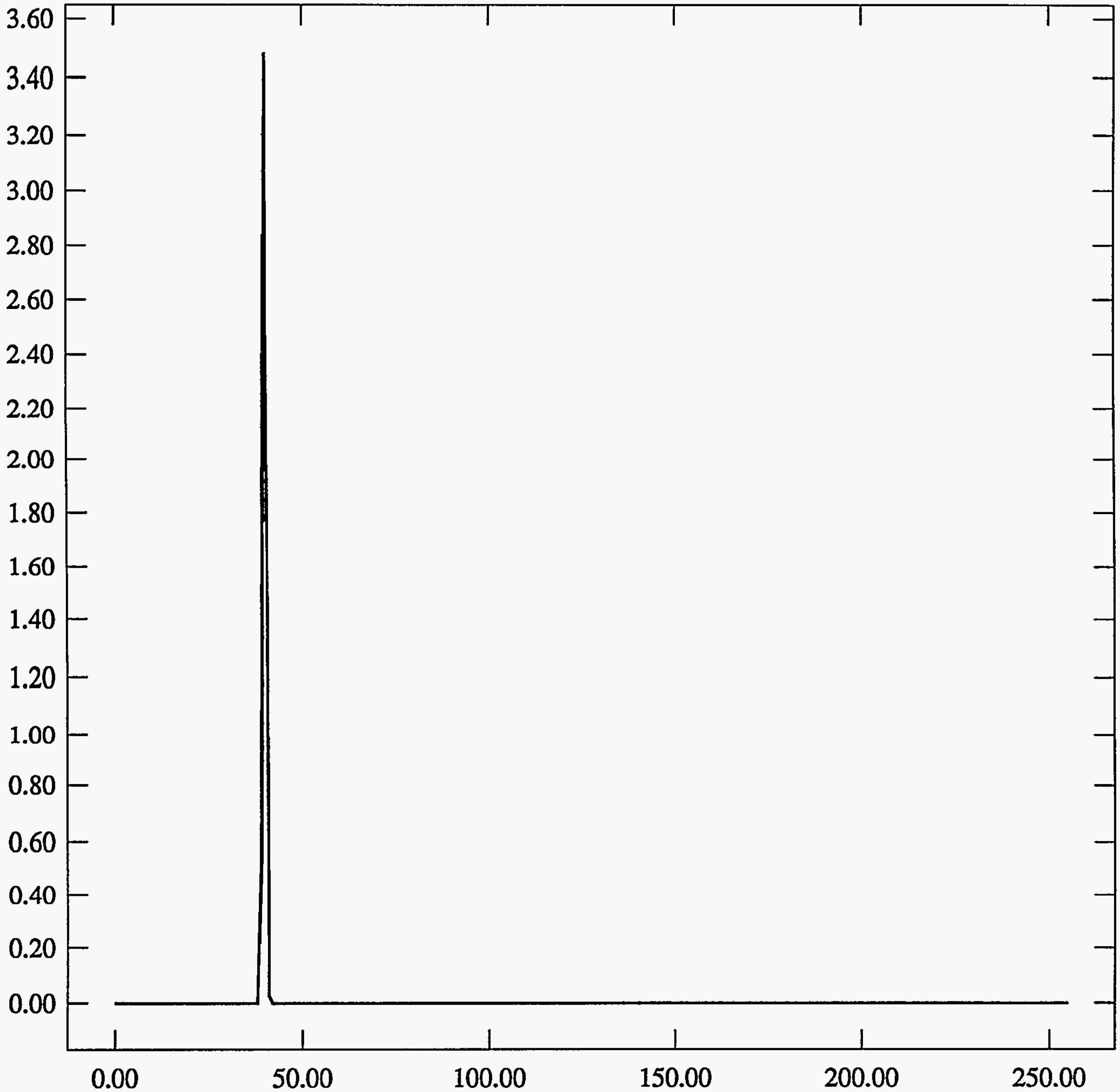
Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.72 x 10^3



#6 -30C END

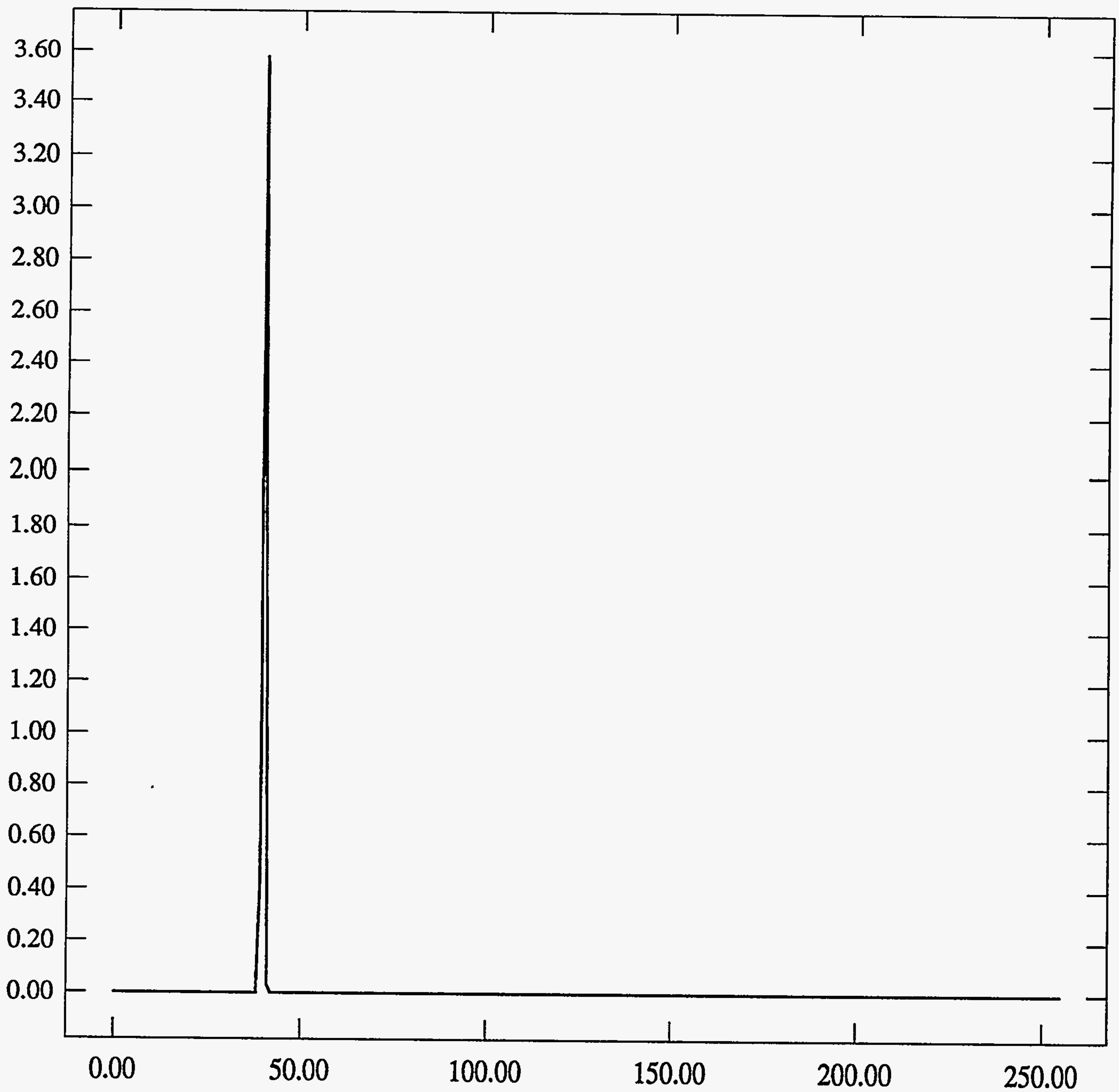
ST Camera: ST1#04-10 -30C #6: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 19:33:02 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.35 x 10^3



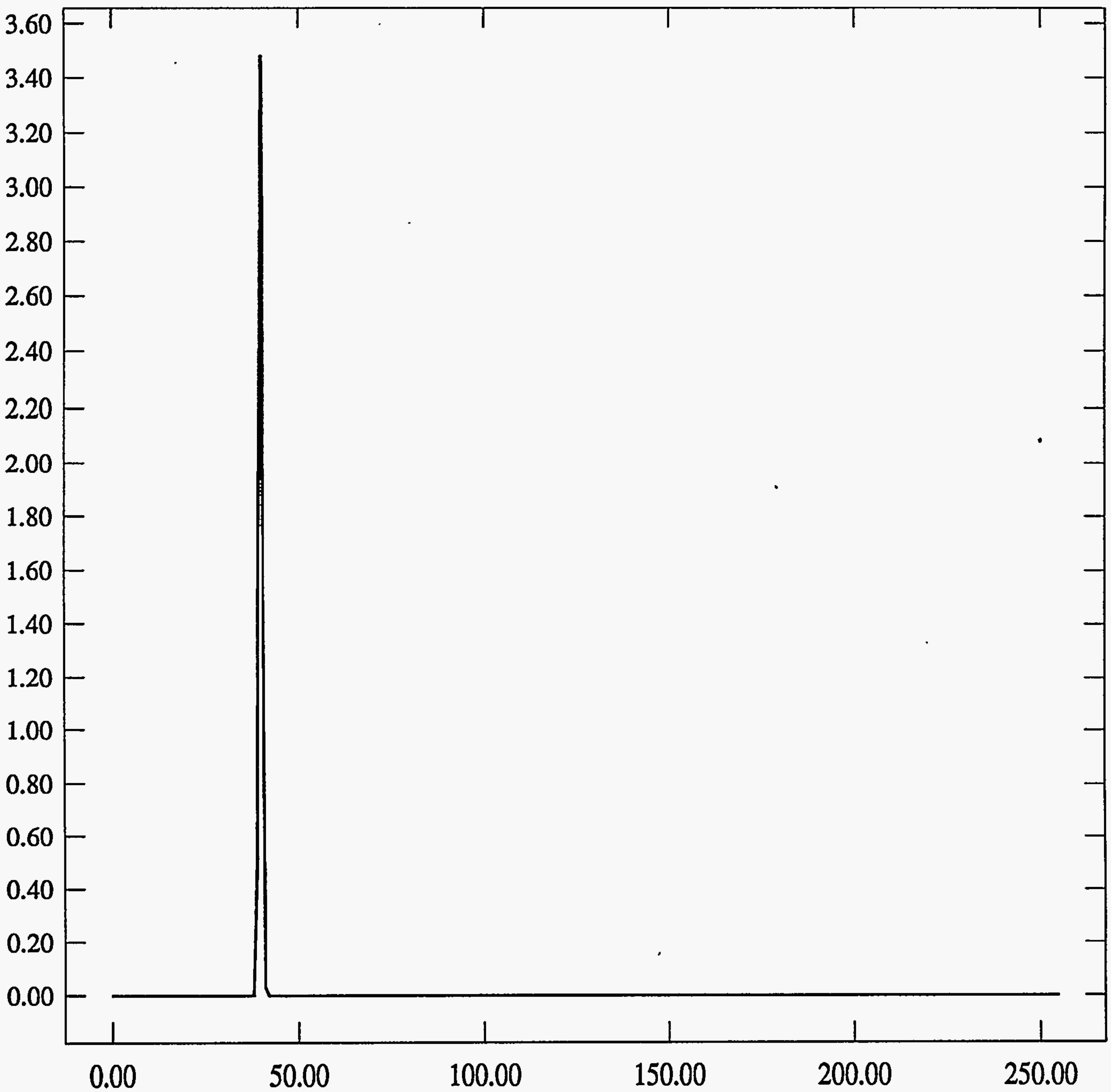
ST Camera: ST1#04-10 -30C #6: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 19:33:14 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.32 x 10^3



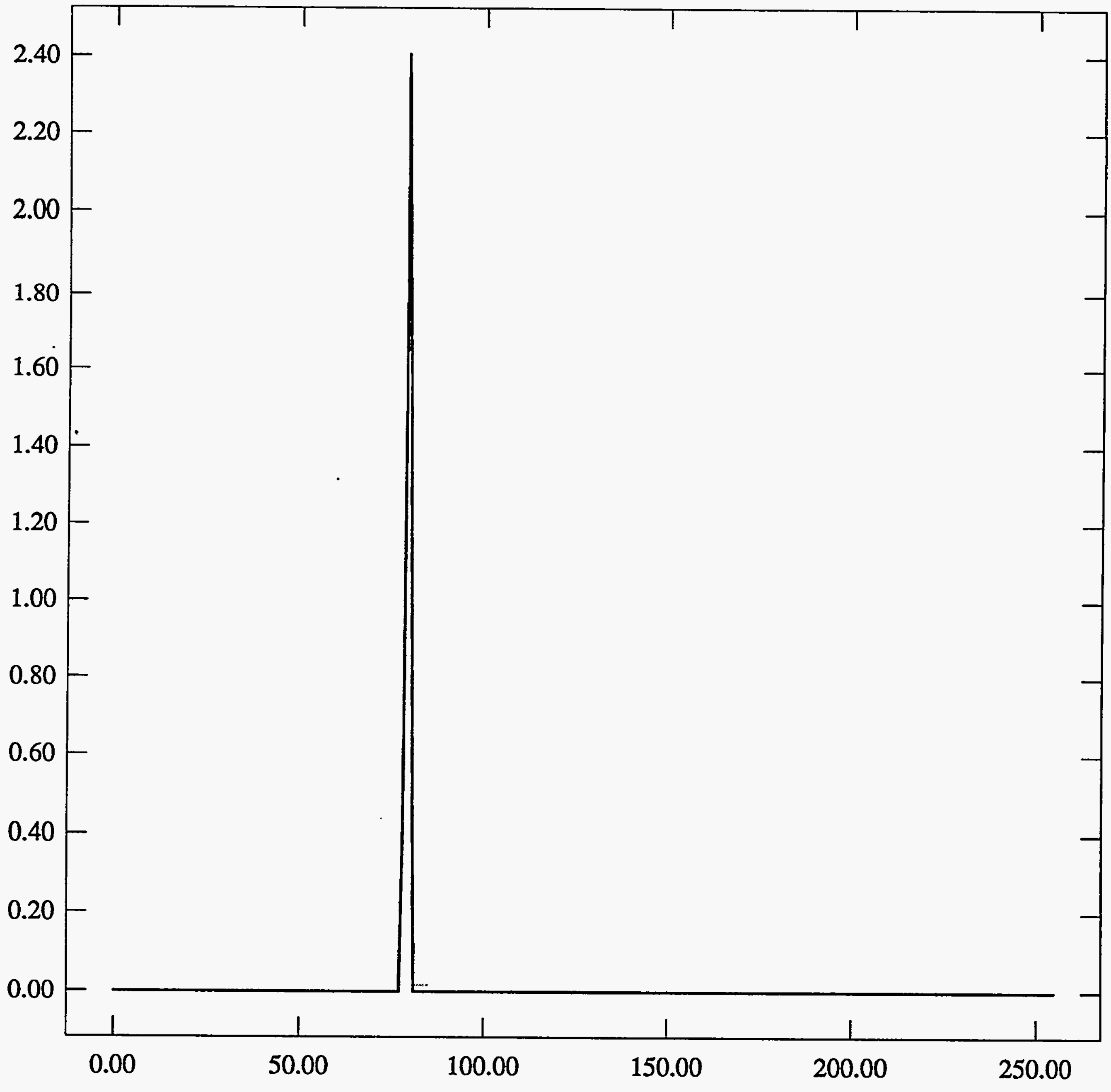
ST Camera: ST1#04-10 -30C #6: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 19:33:24 1993

Pixel Values Min 39 Max 41 Mean 39.9 Sigma 0.35 x 10^3

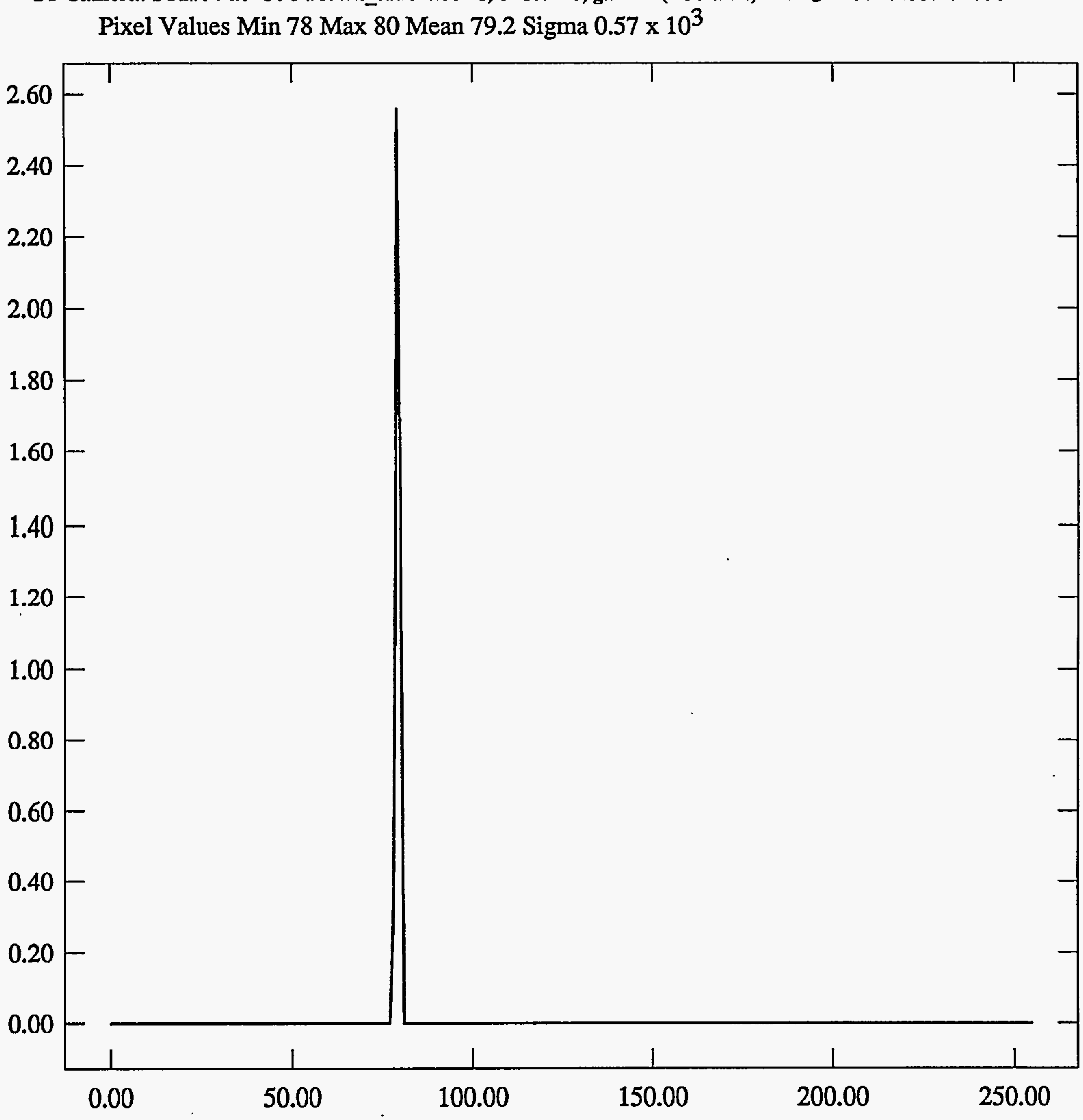


ST Camera: ST1#04-10 -30C #6: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 19:33:36 1993

Pixel Values Min 78 Max 80 Mean 79.2 Sigma 0.60 x 10^3

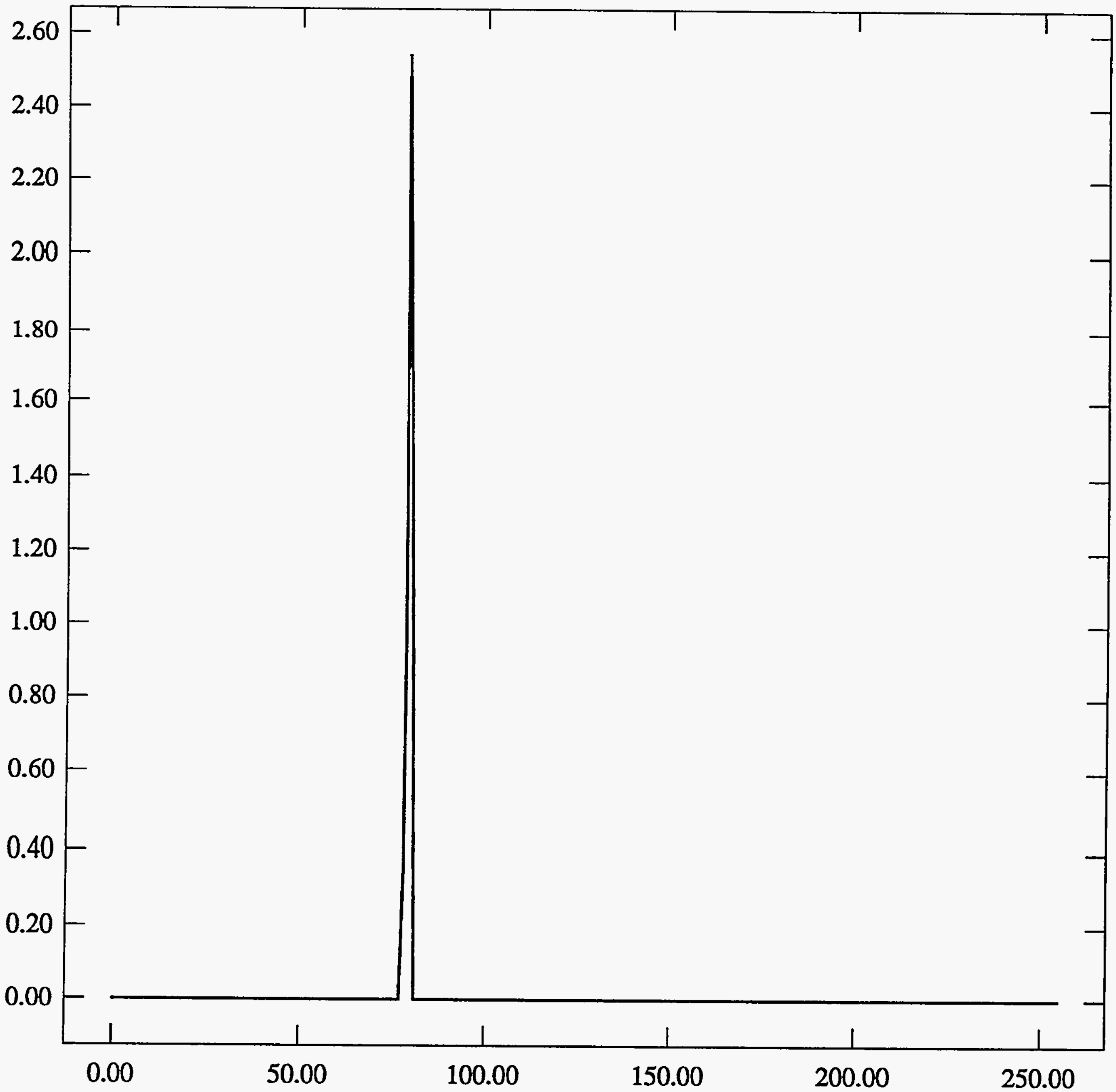


ST Camera: ST1#04-10 -30C #6: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 19:33:48 1993



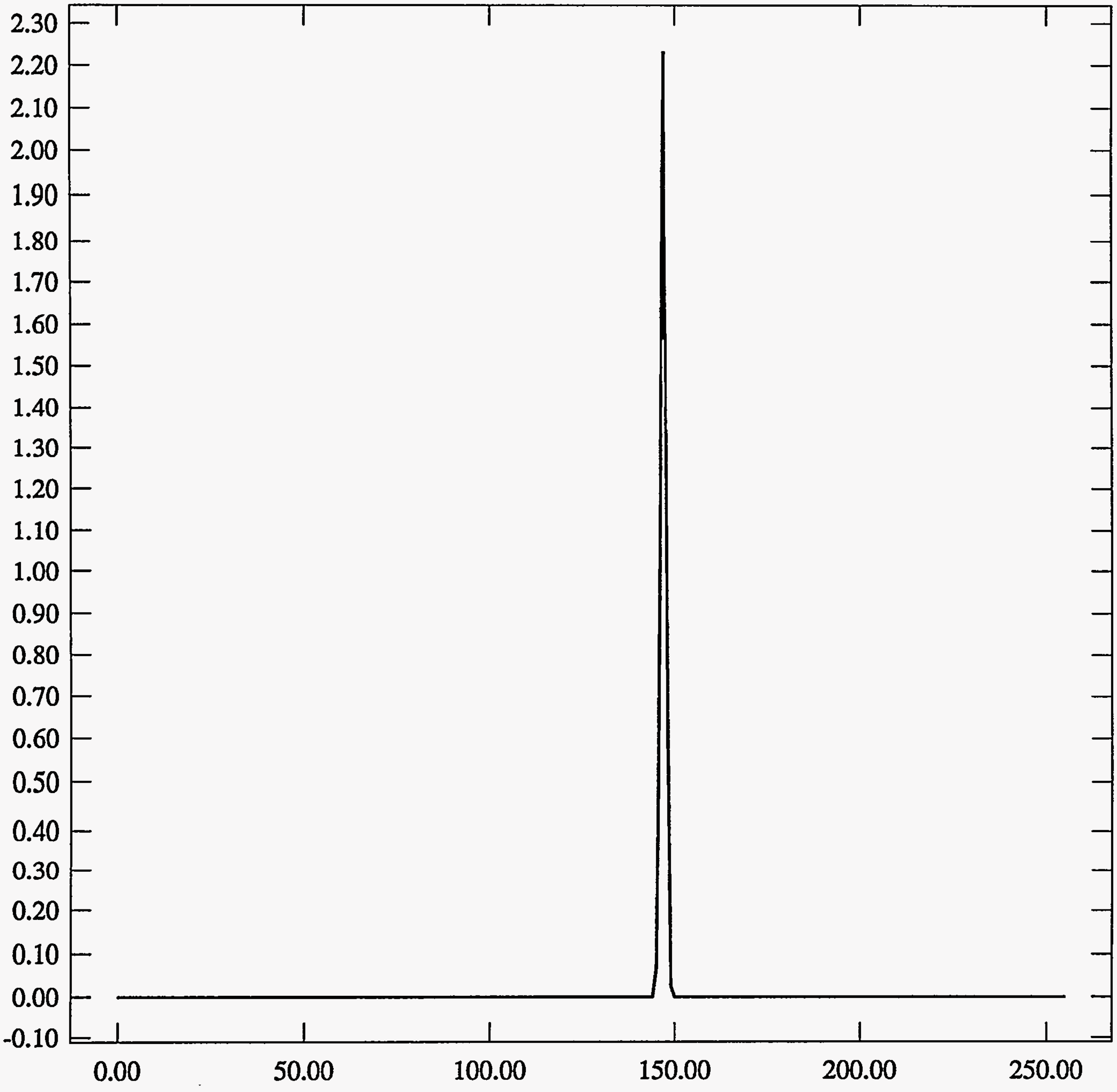
ST Camera: ST1#04-10 -30C #6: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 19:33:59 1993

Pixel Values Min 78 Max 80 Mean 79.2 Sigma 0.58 x 10^3



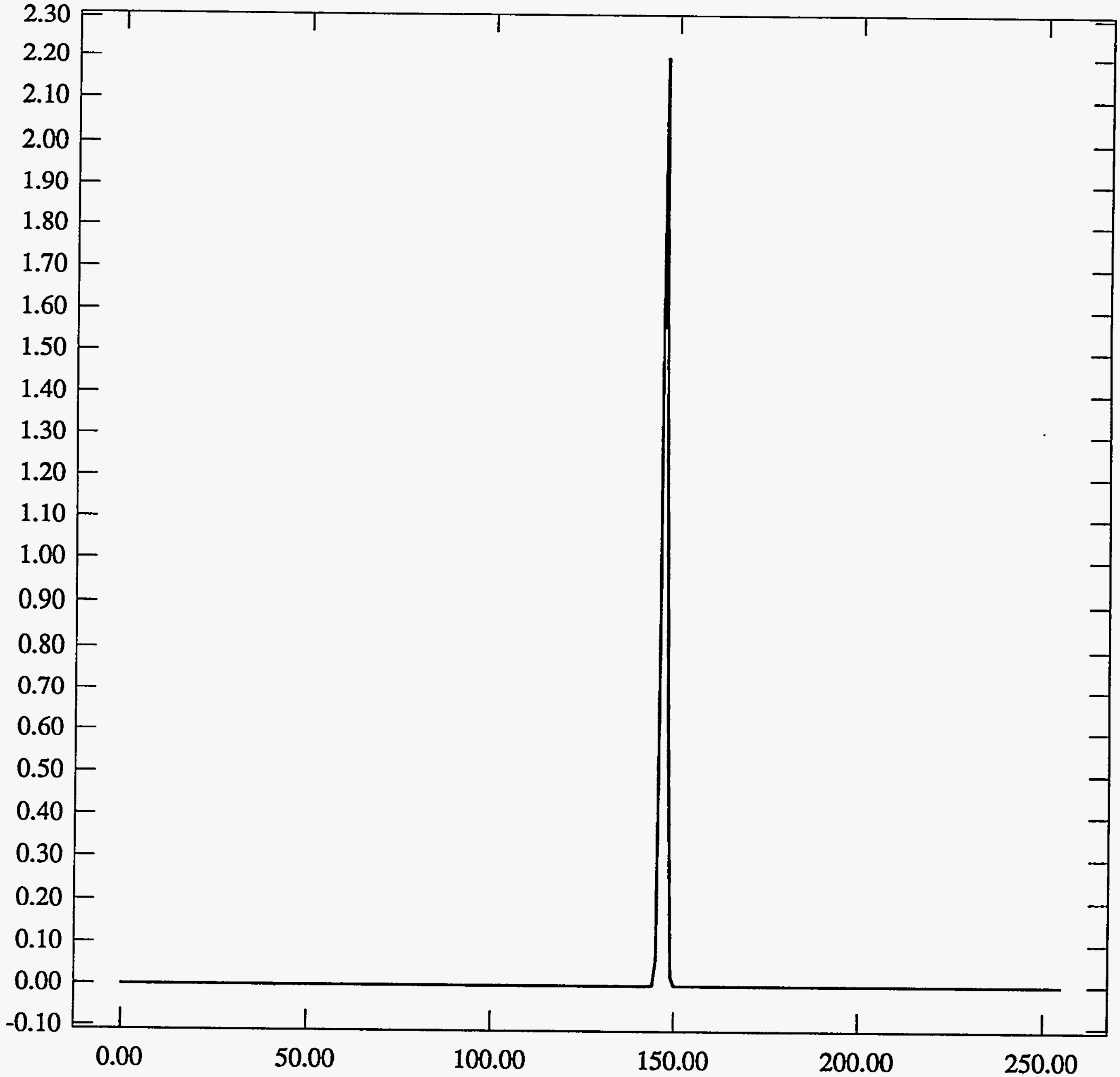
ST Camera: ST1#04-10 -30C #6: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 19:34:10 1993

Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.70 x 10^3



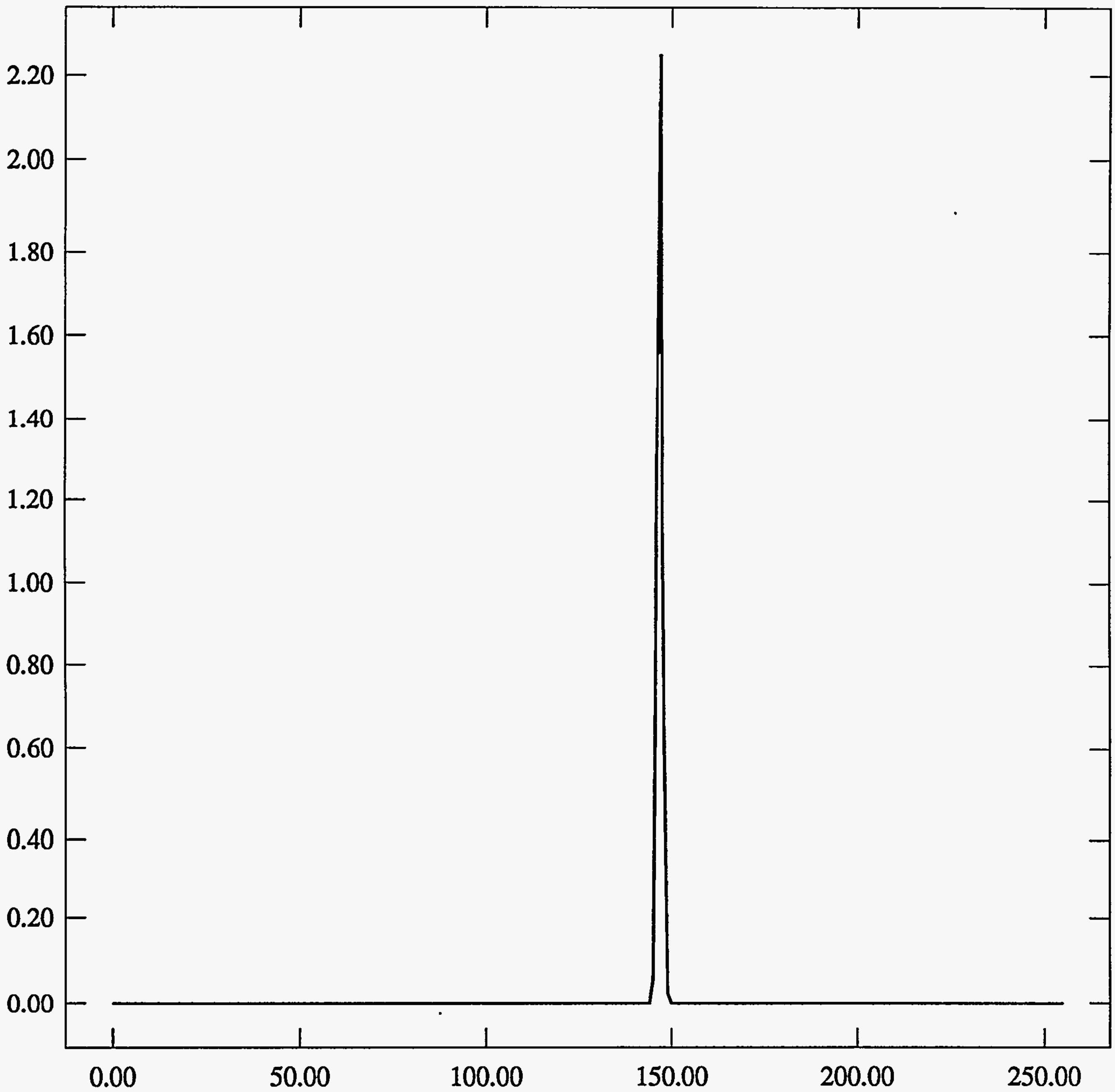
ST Camera: ST1#04-10 -30C #6: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 19:34:22 1993

Pixel Values Min 144 Max 149 Mean 146.9 Sigma 0.71 x 10^3



ST Camera: ST1#04-10 -30C #6: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 19:34:34 1993

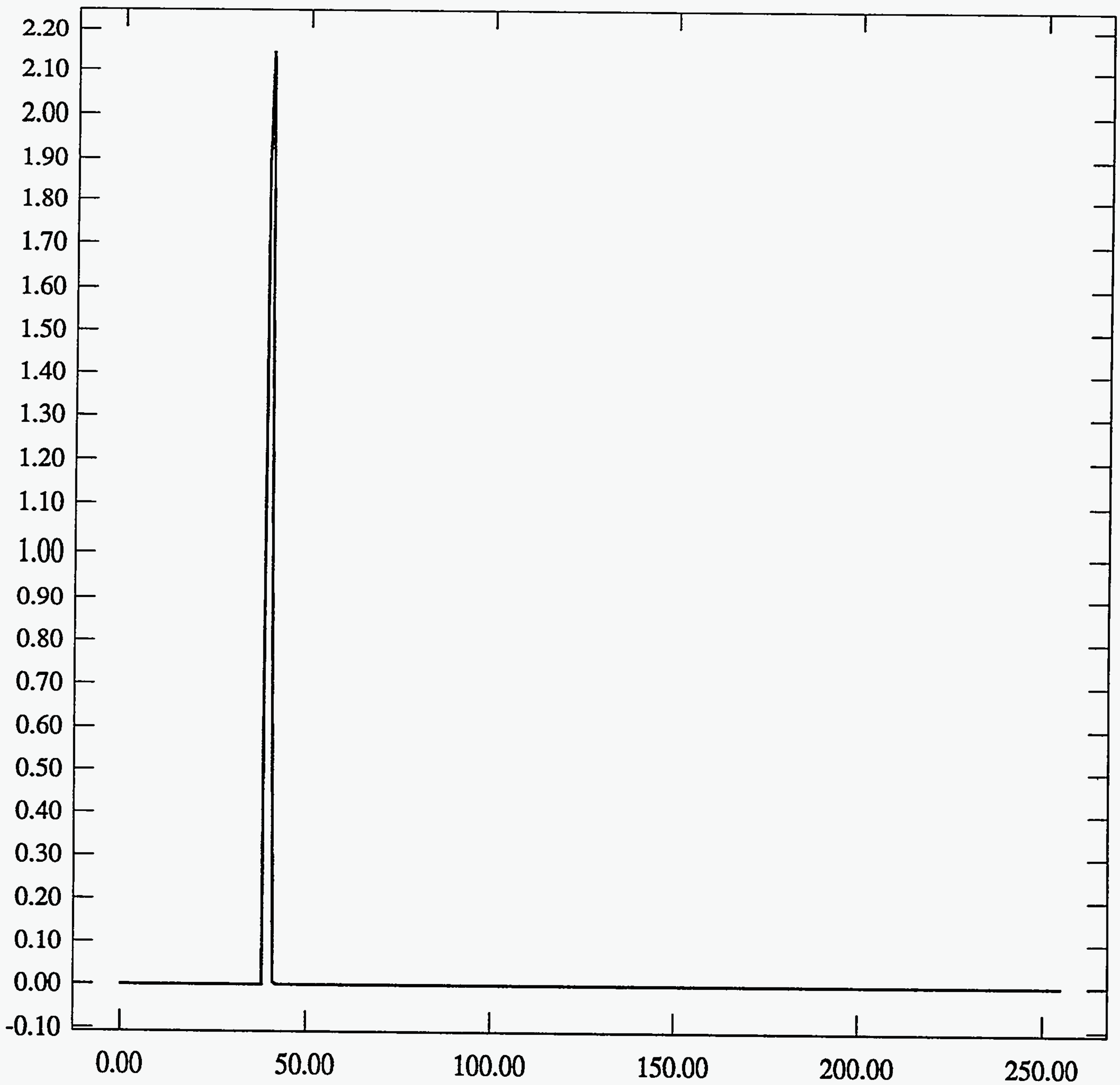
Pixel Values Min 145 Max 149 Mean 146.9 Sigma 0.70 x 10^3



#6 20C 15min

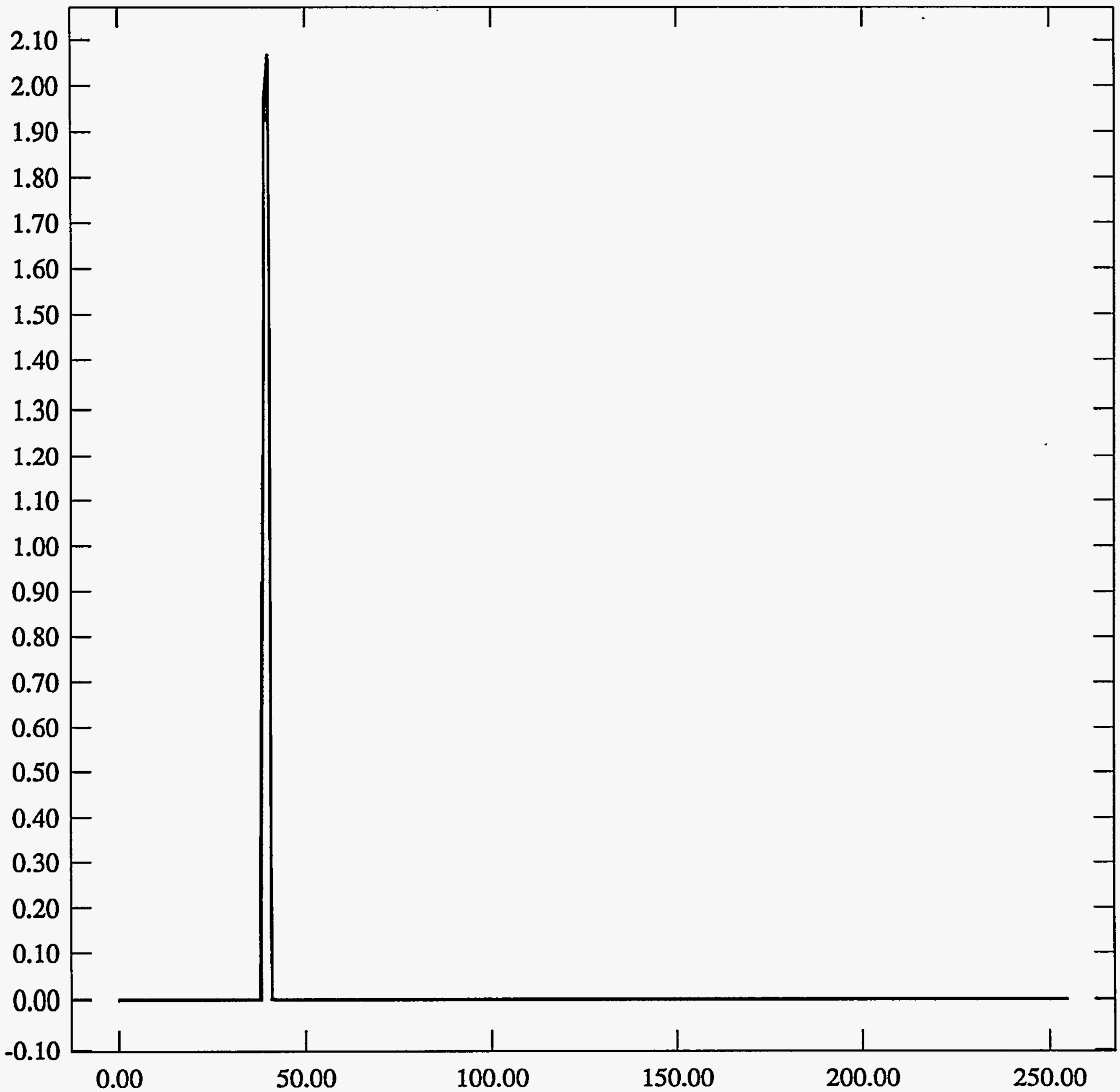
ST Camera: ST1#04-10 20C #6: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 20:07:25 1993

Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3



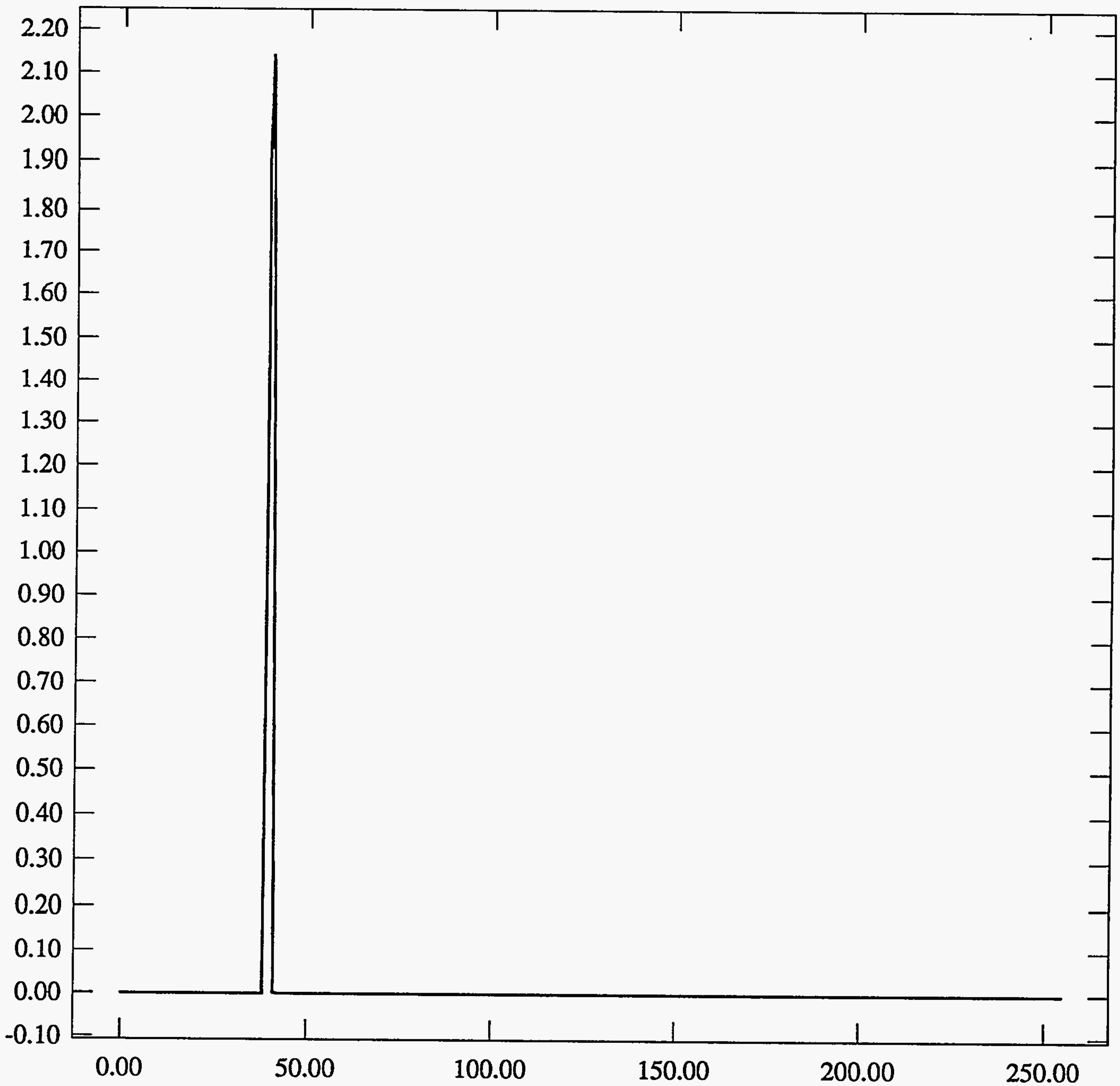
ST Camera: ST1#04-10 20C #6: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 20:07:42 1993

Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3



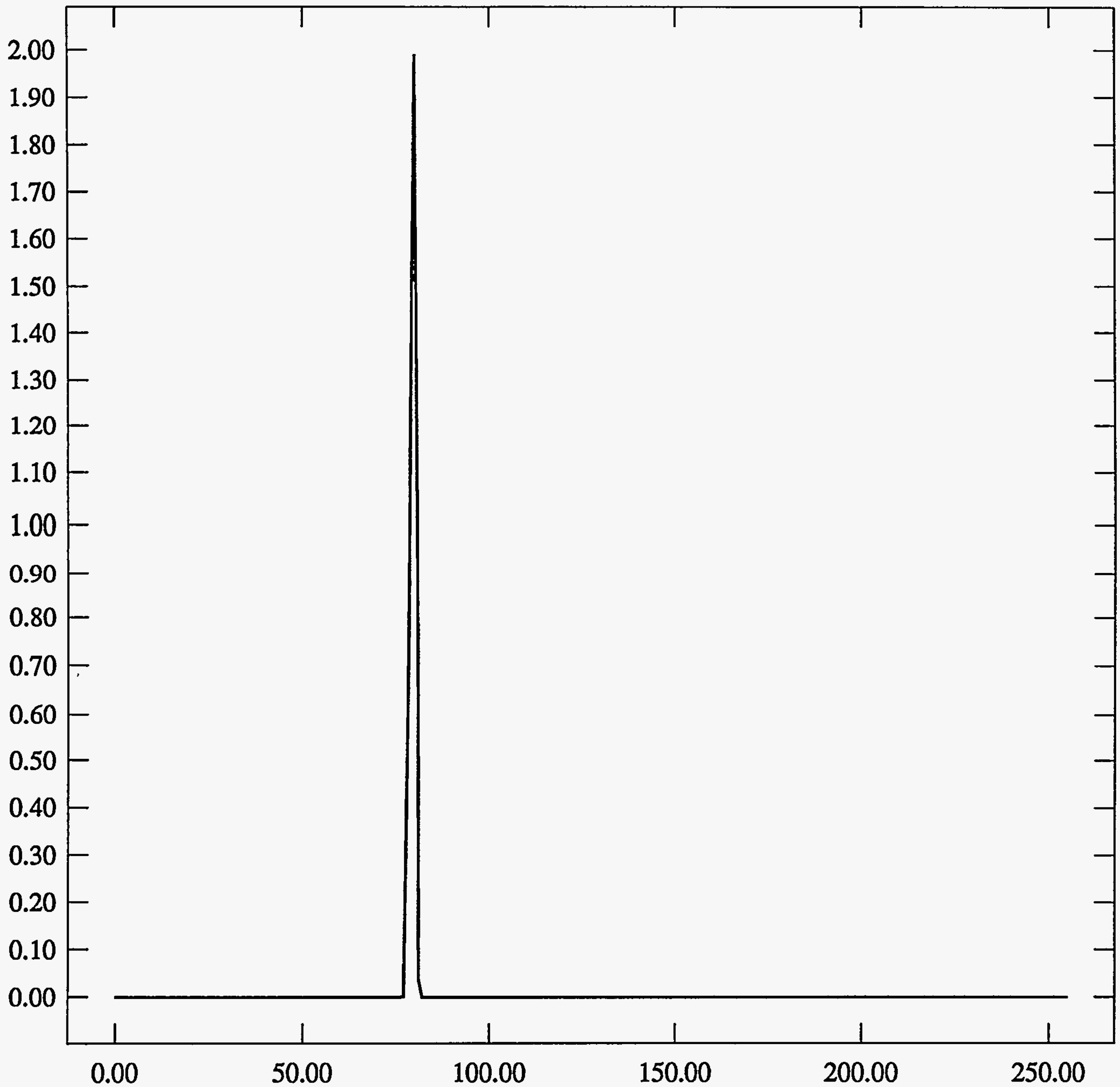
ST Camera: ST1#04-10 20C #6: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 20:07:54 1993

Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3



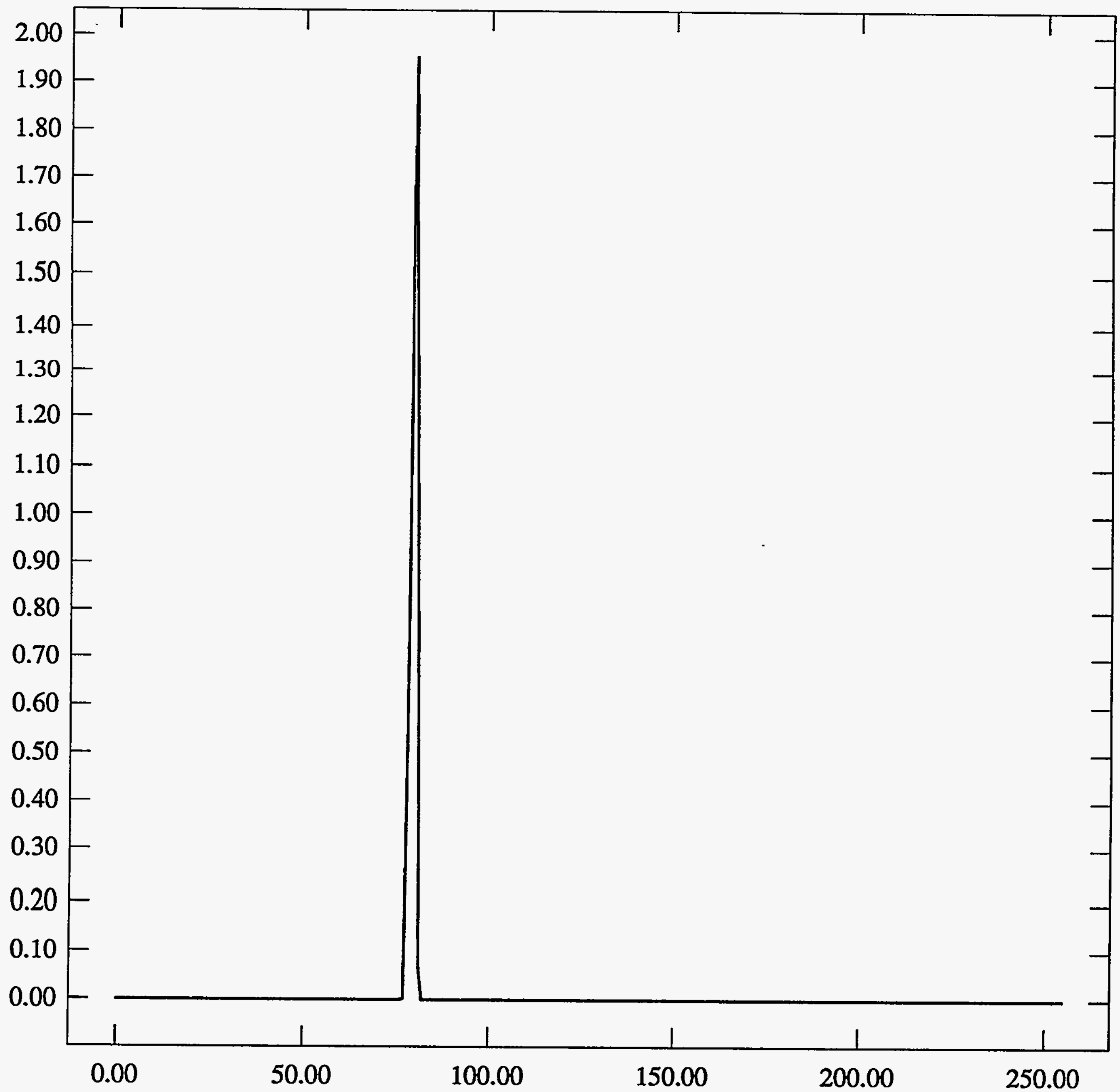
ST Camera: ST1#04-10 20C #6: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 20:08:10 1993

Pixel Values Min 77 Max 81 Mean 79.4 Sigma 0.74 x 10^3

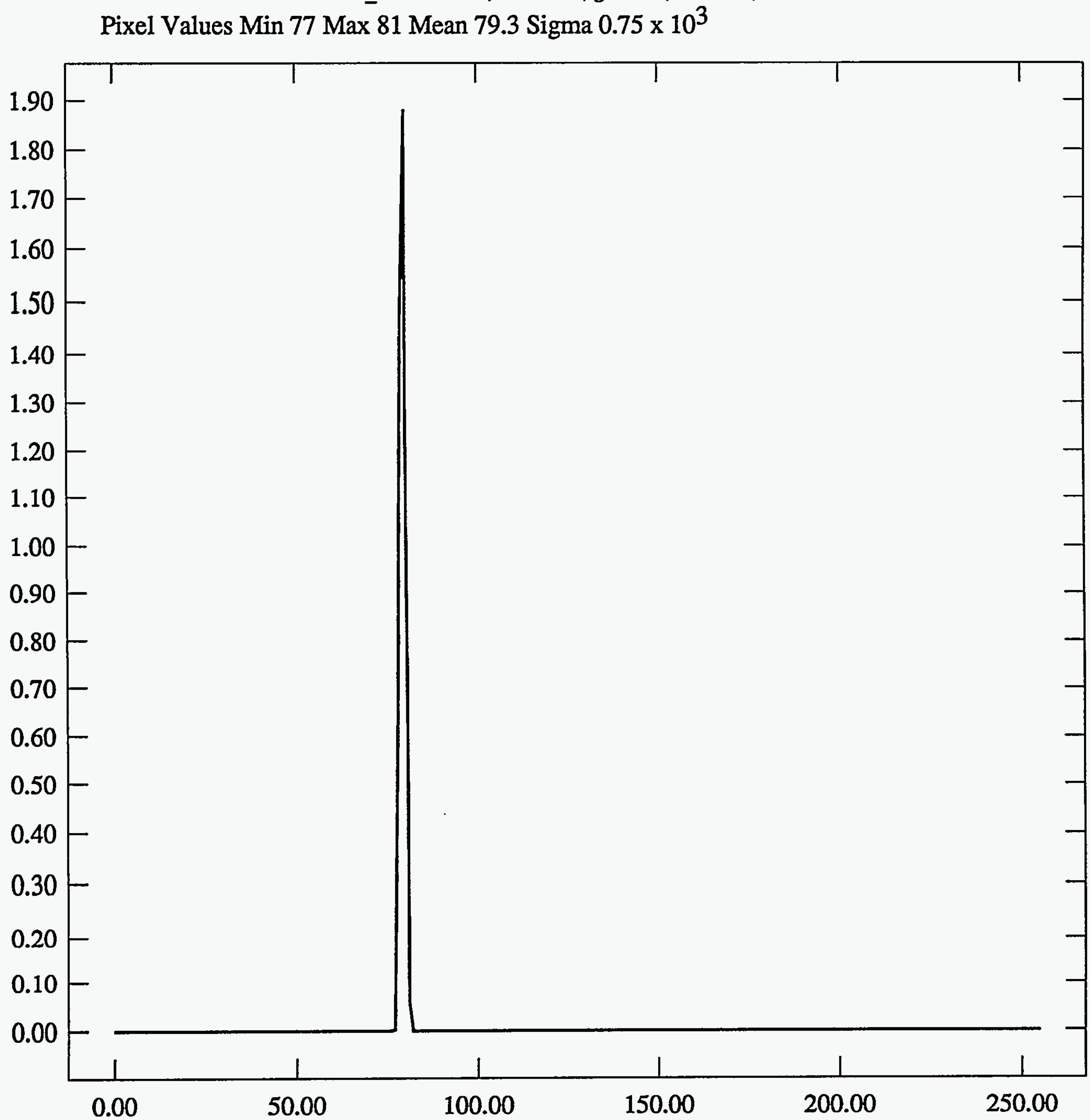


ST Camera: ST1#04-10 20C #6: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 20:08:21 1993

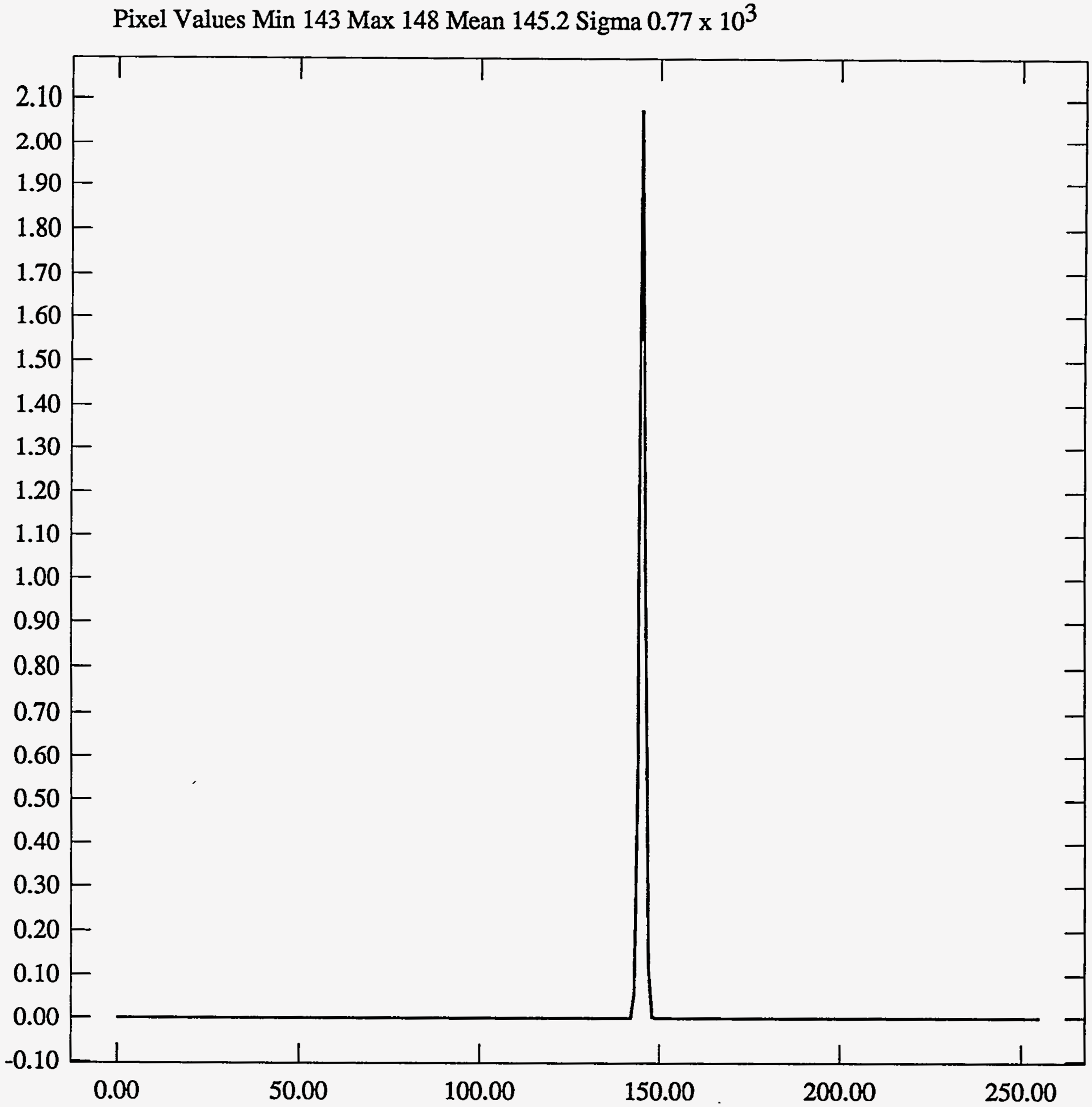
Pixel Values Min 77 Max 81 Mean 79.4 Sigma 0.77 x 10^3



ST Camera: ST1#04-10 20C #6: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 20:08:41 1993

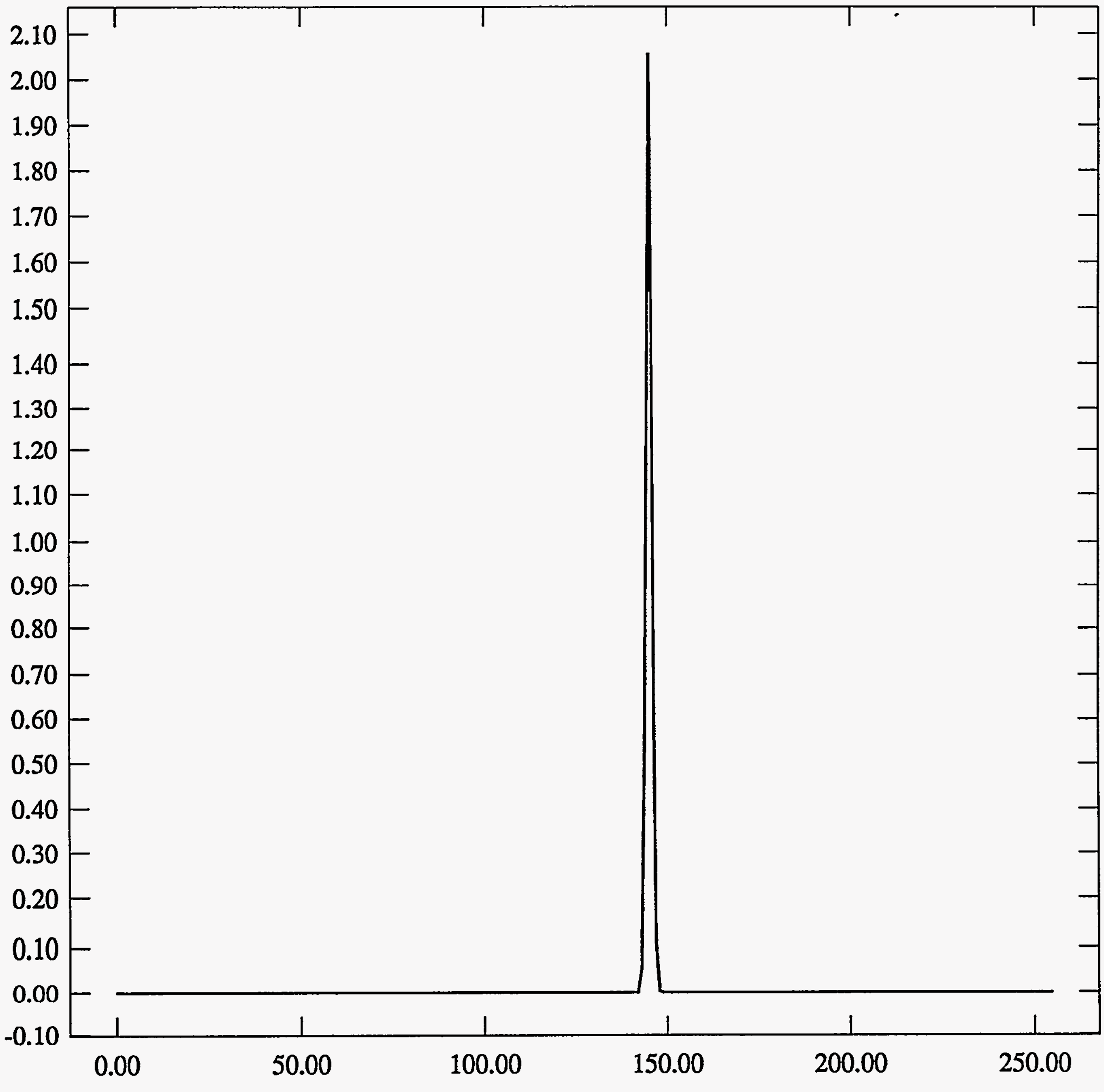


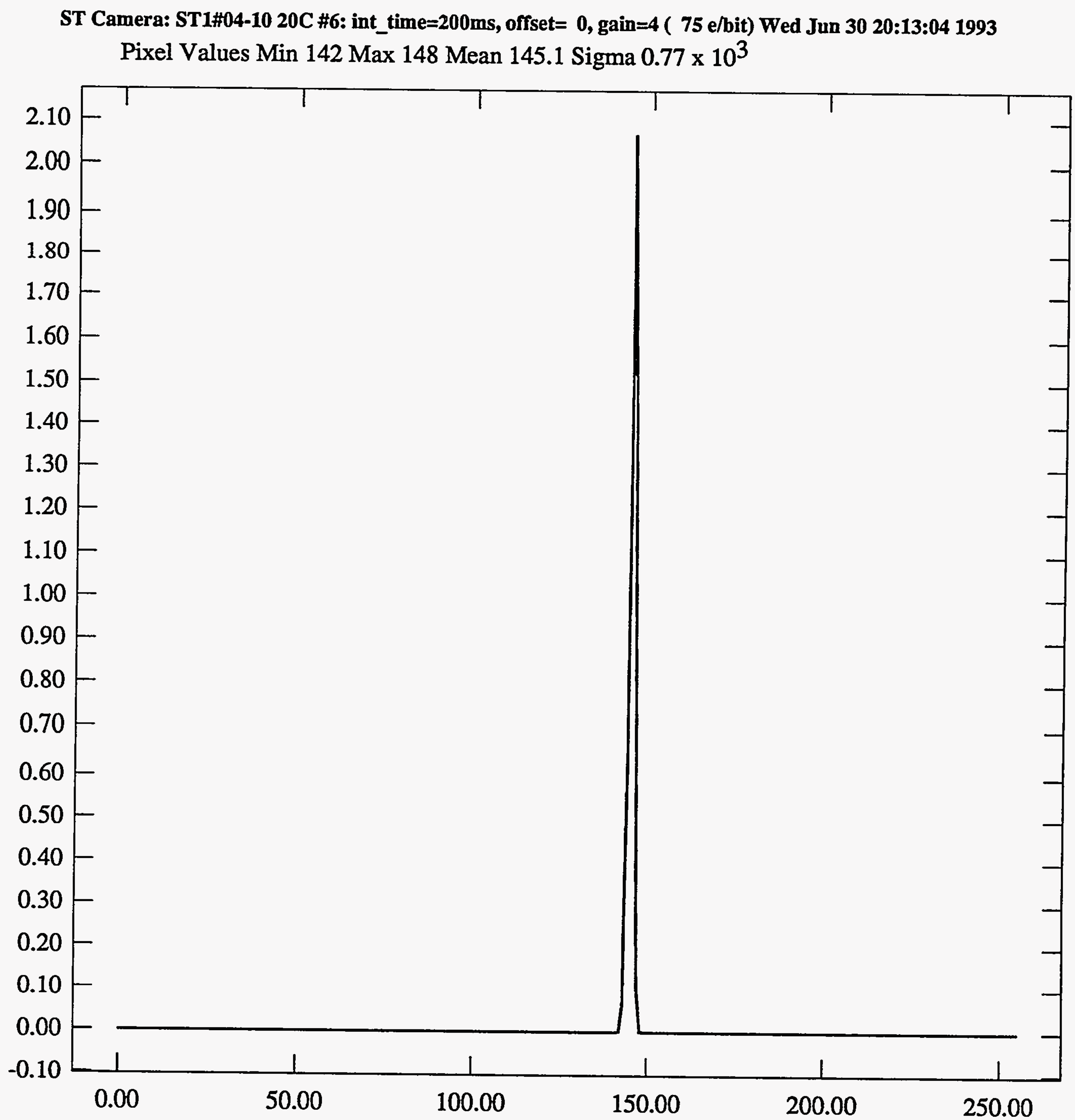
ST Camera: ST1#04-10 20C #6: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 20:08:59 1993



ST Camera: ST1#04-10 20C #6: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 20:09:11 1993

Pixel Values Min 143 Max 148 Mean 145.2 Sigma 0.76 x 10^3

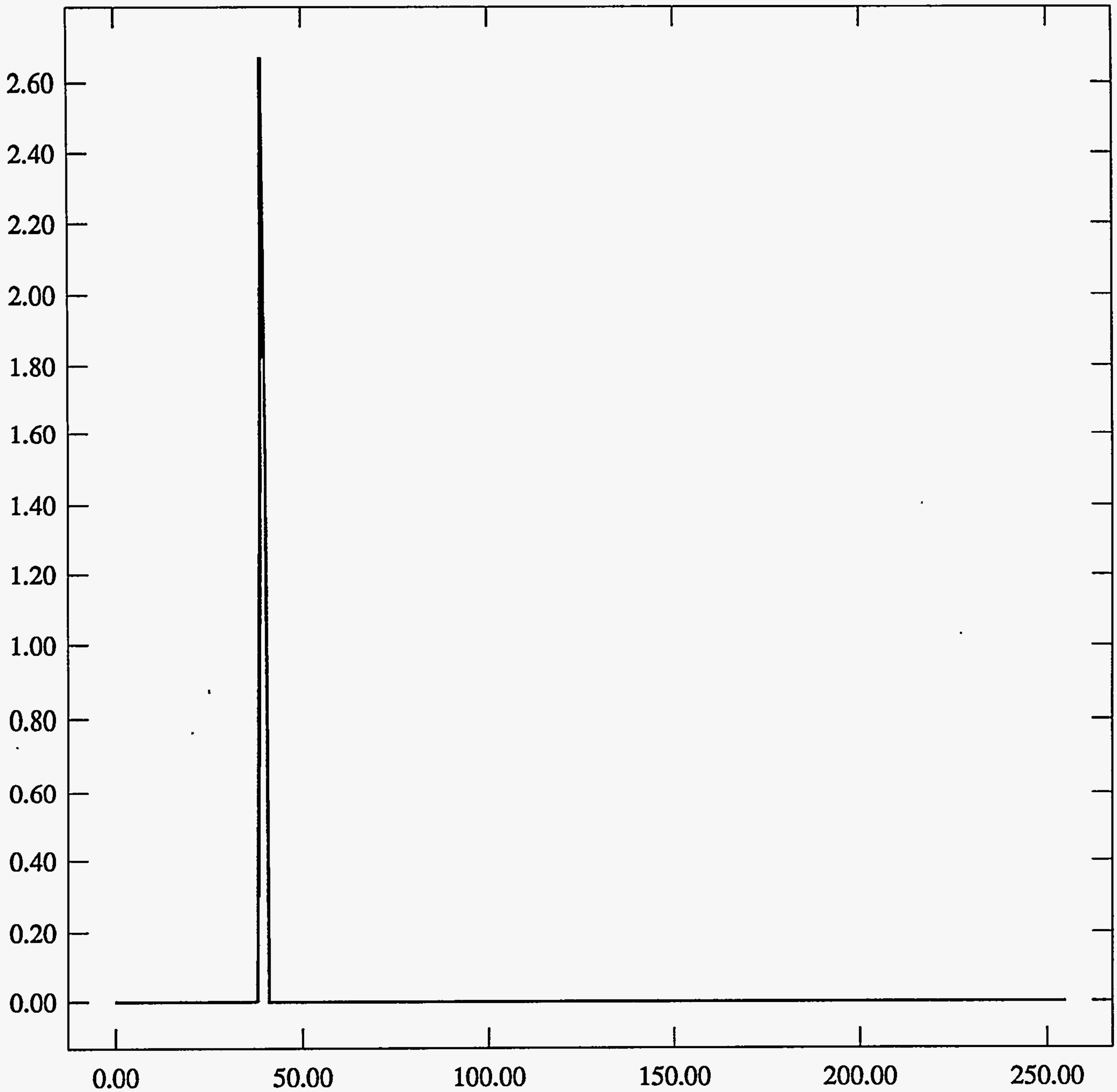



ST Camera: ST1#04-10 20C #6: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 20:13:04 1993
Pixel Values Min 142 Max 148 Mean 145.1 Sigma 0.77 x 10^3
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.00
50.00
100.00
150.00
200.00
250.00

#6 +20 END OF CYCLE

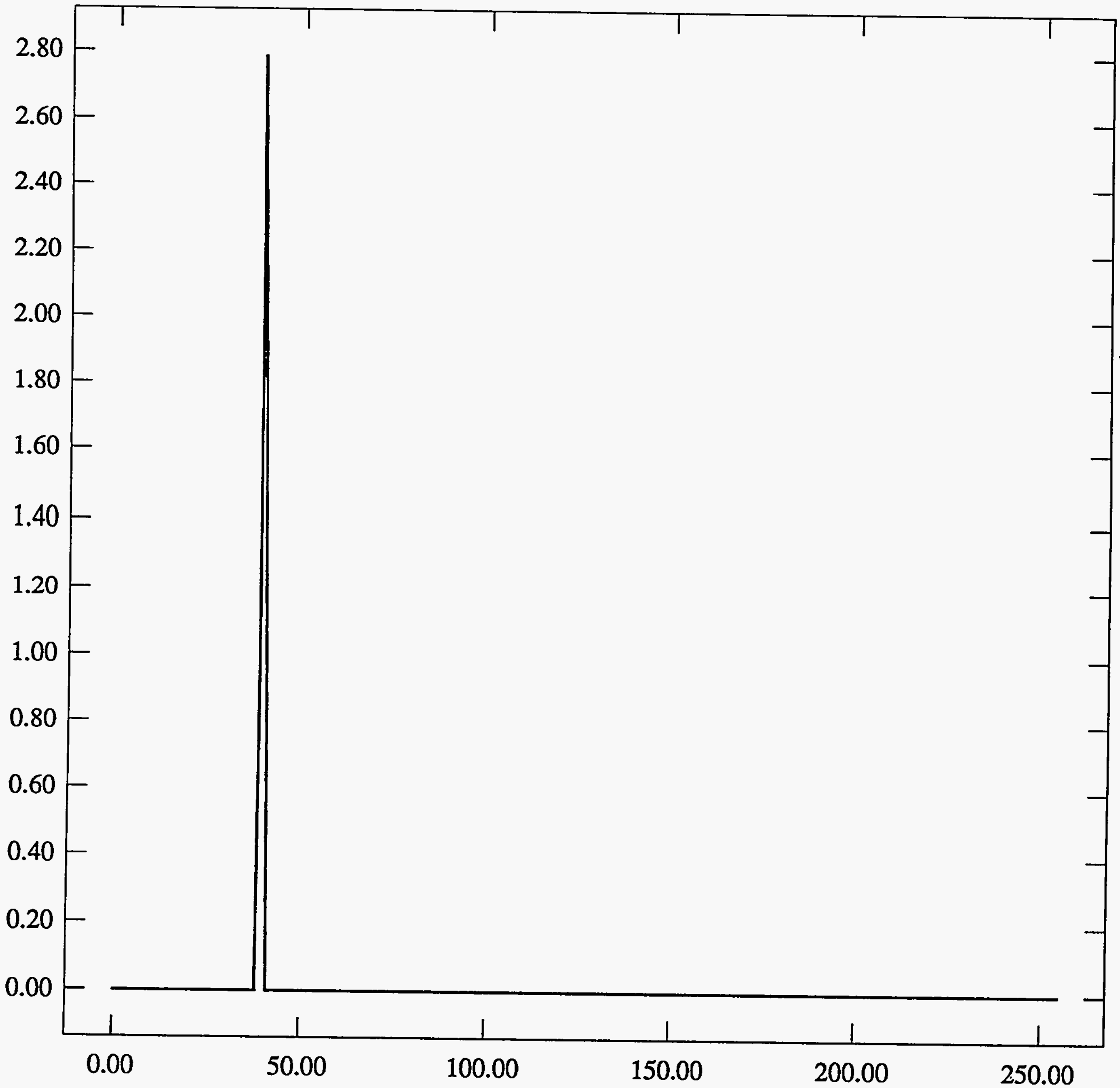
ST Camera: ST1#04-10 20C #6: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 20:48:11 1993

Pixel Values Min 38 Max 40 Mean 39.3 Sigma 0.47 x 10^3



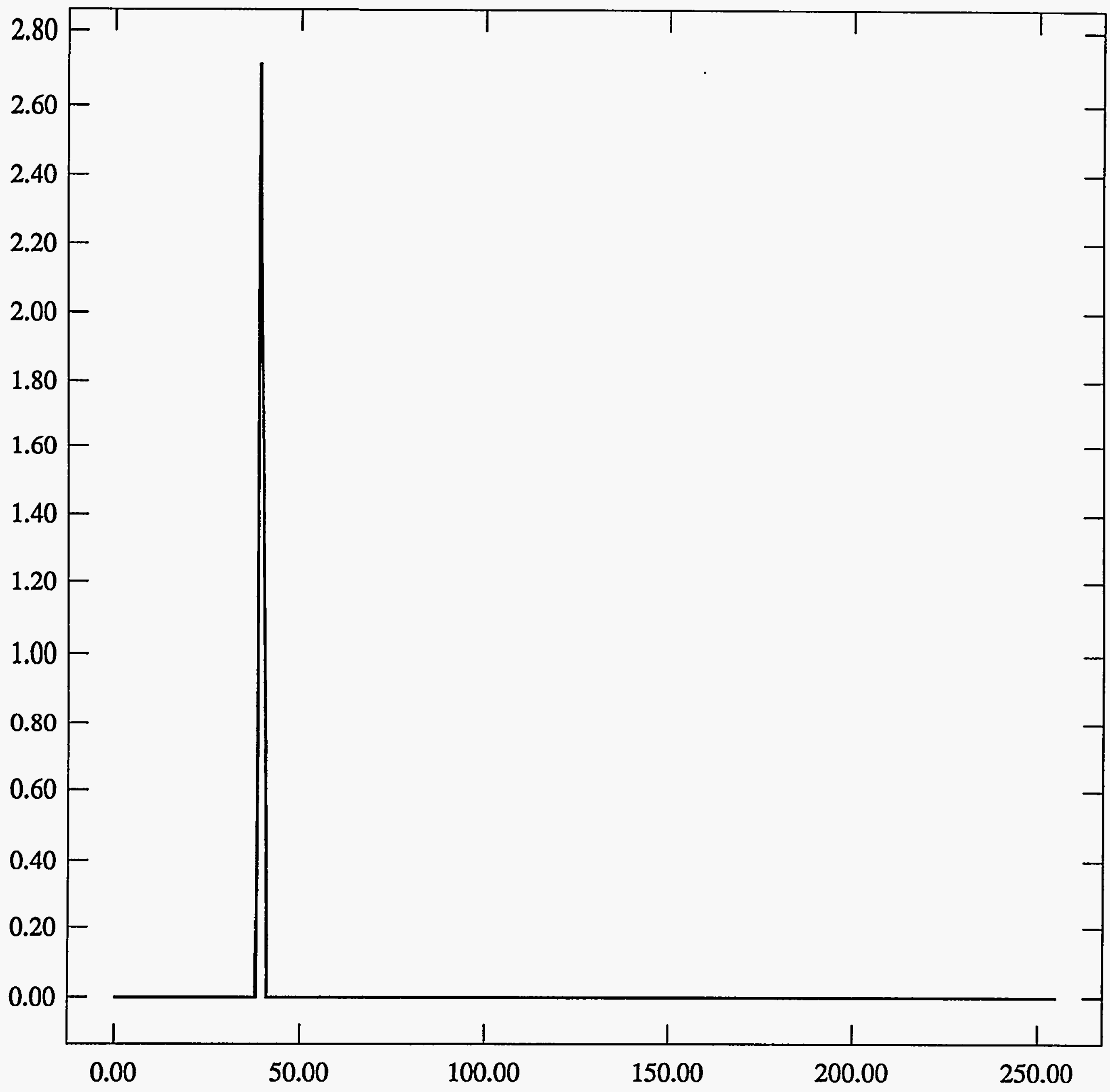
ST Camera: ST1#04-10 20C #6: int_time=100ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 20:48:24 1993

Pixel Values Min 39 Max 40 Mean 39.3 Sigma 0.46 x 10^3



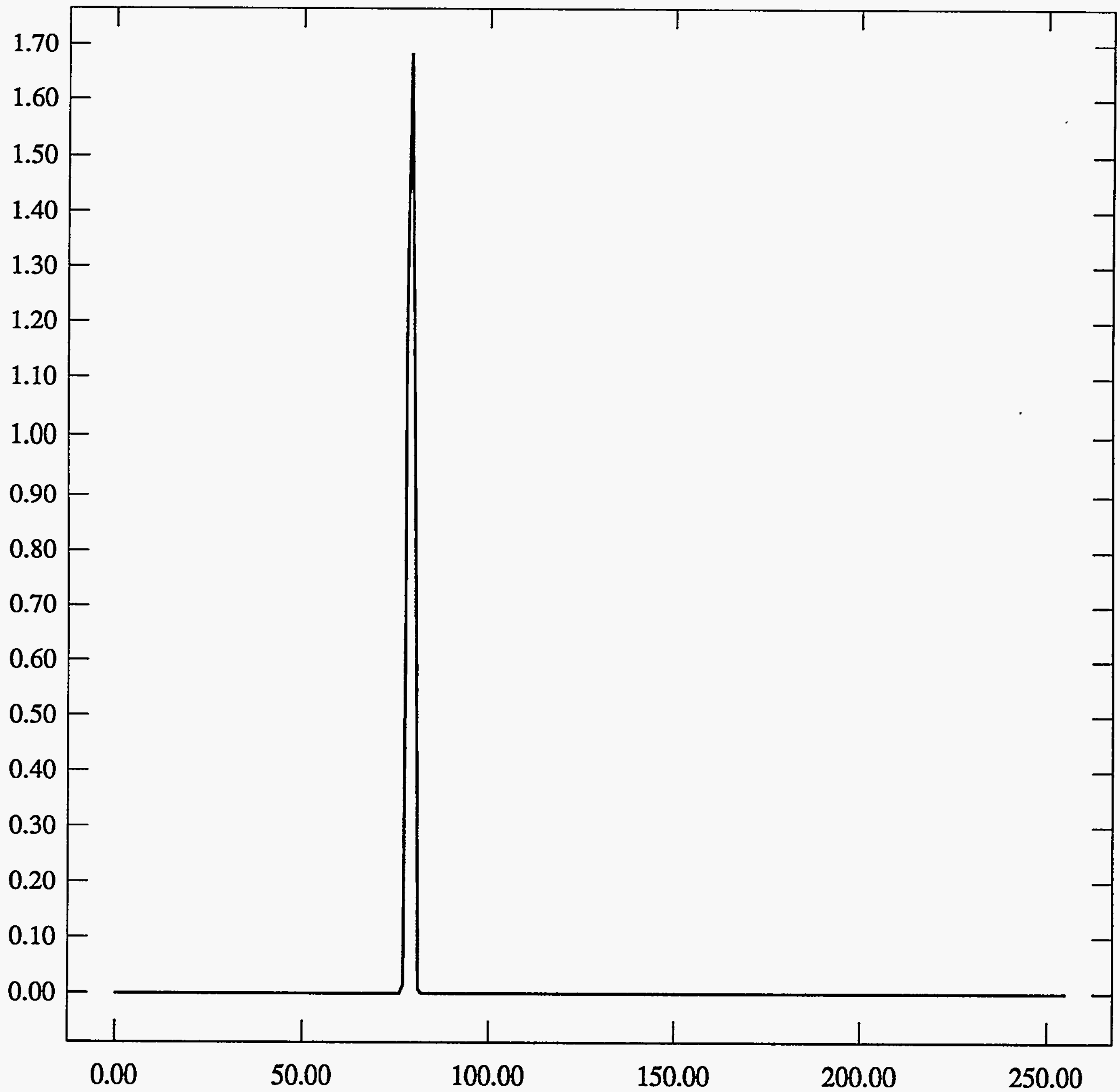
ST Camera: ST1#04-10 20C #6: int_time=200ms, offset= 0, gain=1 (350 e/bit) Wed Jun 30 20:48:35 1993

Pixel Values Min 39 Max 40 Mean 39.3 Sigma 0.47 x 10^3



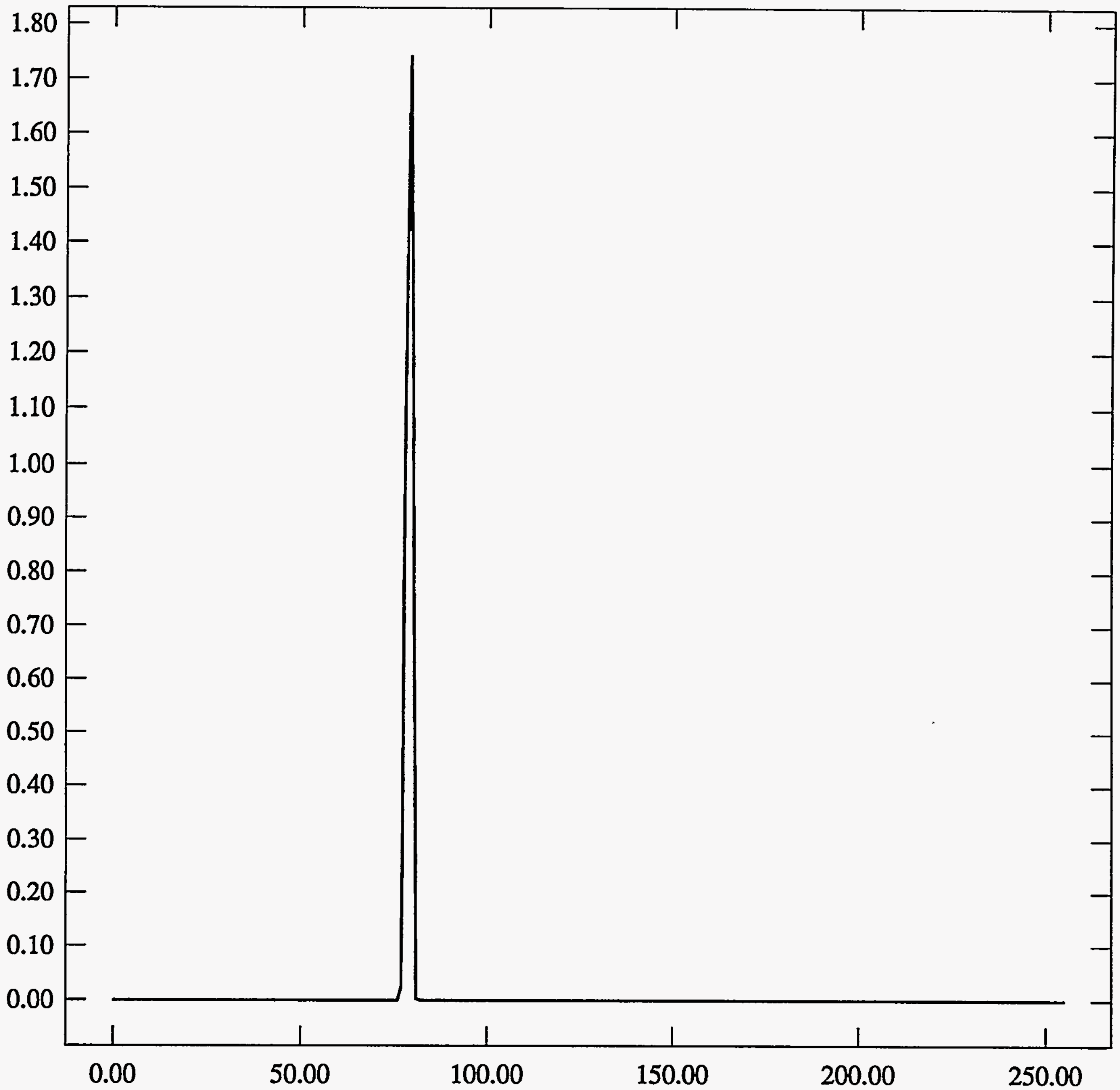
ST Camera: ST1#04-10 20C #6: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 20:48:47 1993

Pixel Values Min 77 Max 81 Mean 79.0 Sigma 0.77 x 10^3



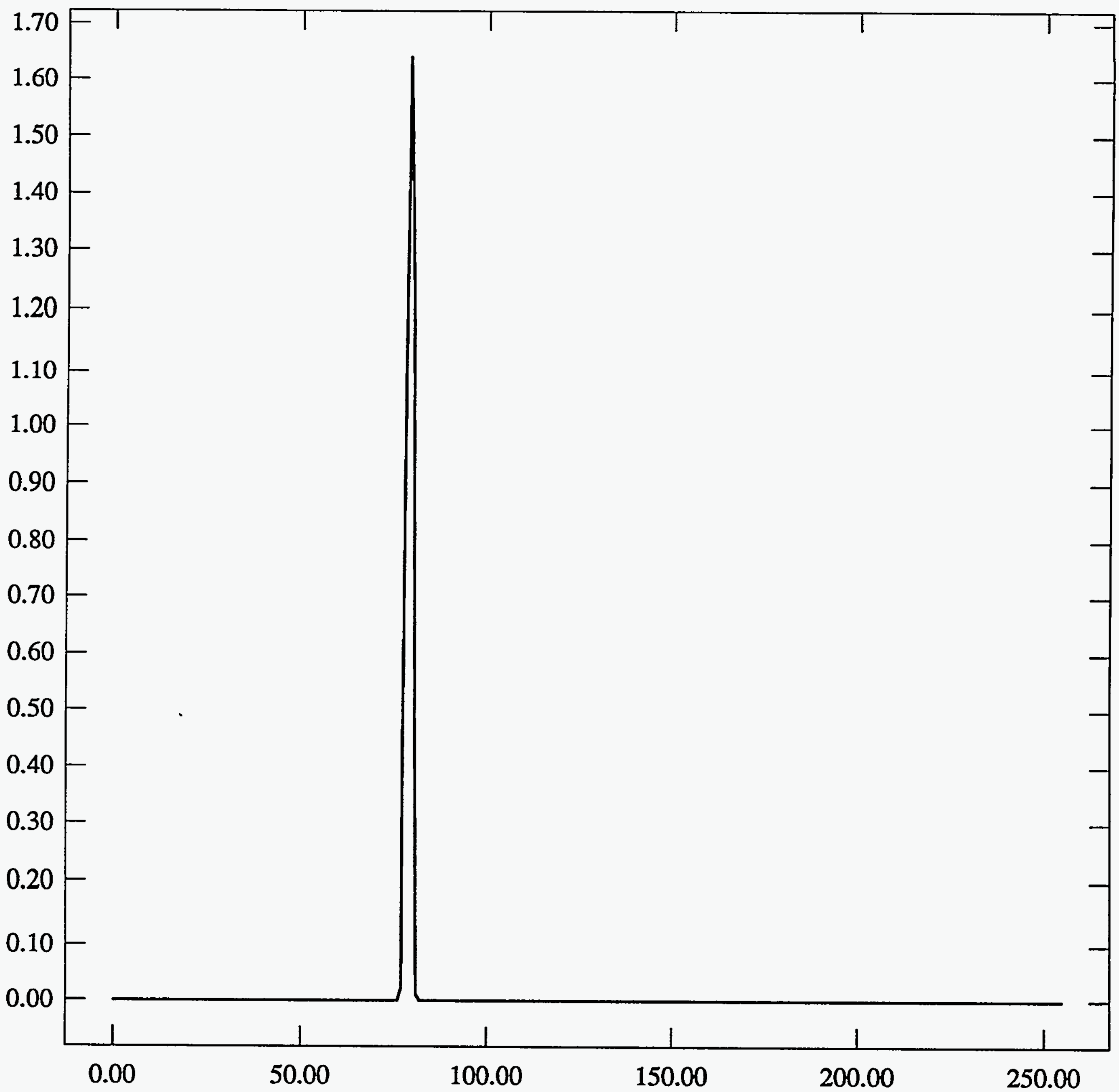
ST Camera: ST1#04-10 20C #6: int_time=100ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 20:48:59 1993

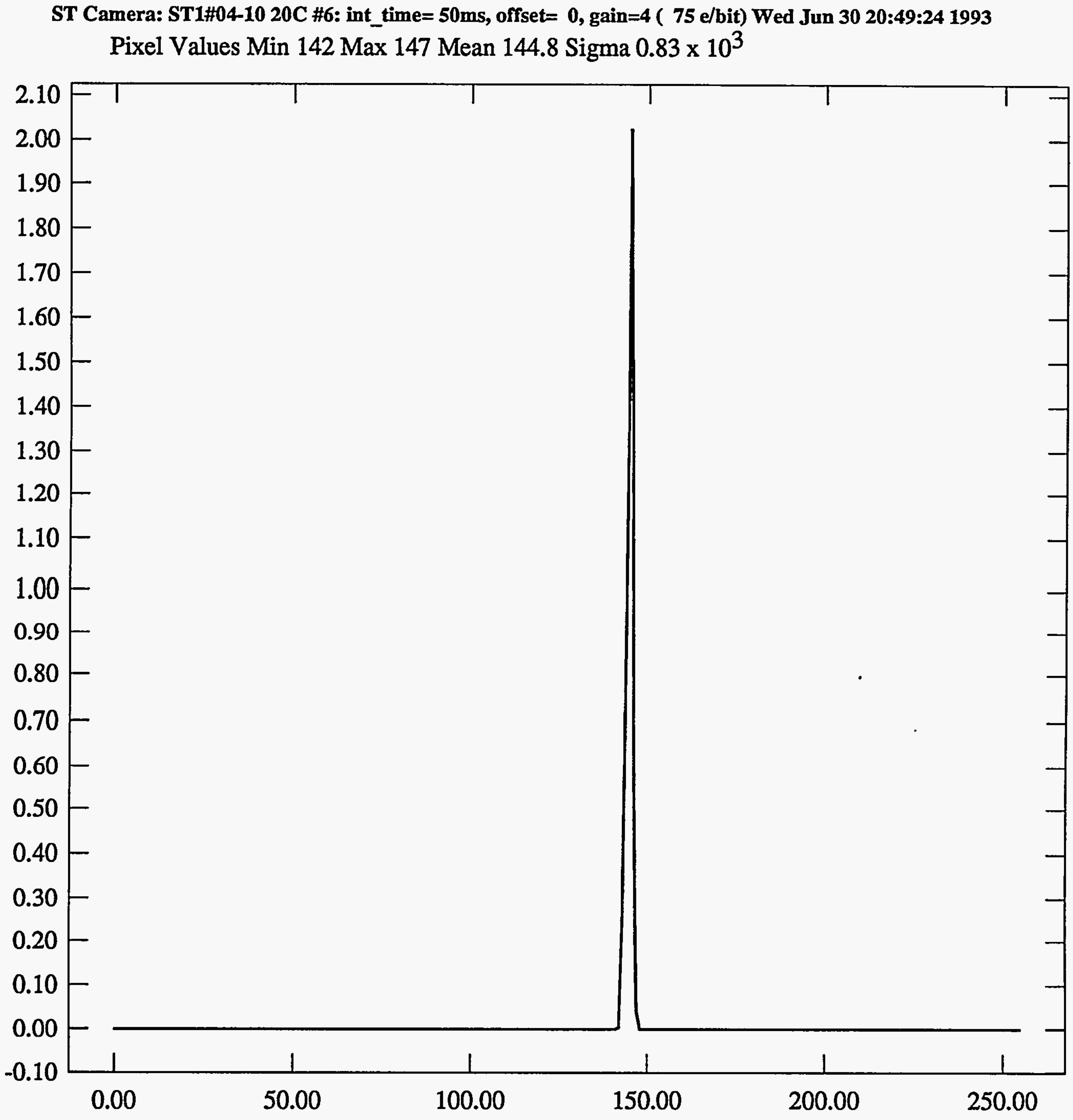
Pixel Values Min 77 Max 81 Mean 79.0 Sigma 0.77 x 10^3



ST Camera: ST1#04-10 20C #6: int_time=200ms, offset= 0, gain=2 (150 e/bit) Wed Jun 30 20:49:11 1993

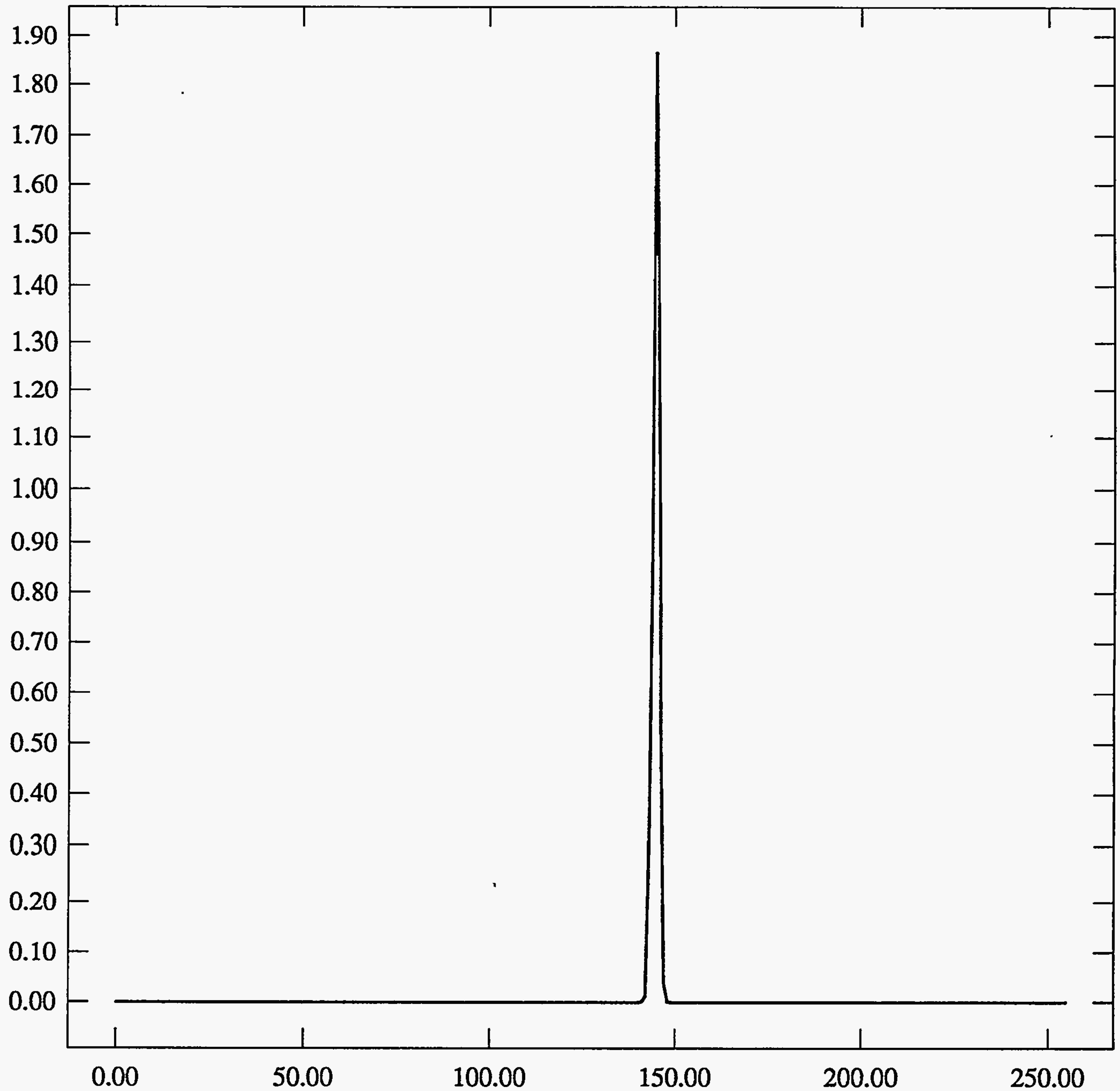
Pixel Values Min 77 Max 81 Mean 79.0 Sigma 0.79 x 10^3




ST Camera: ST1#04-10 20C #6: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 20:49:24 1993
Pixel Values Min 142 Max 147 Mean 144.8 Sigma 0.83 x 10^3
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.00
50.00
100.00
150.00
200.00
250.00

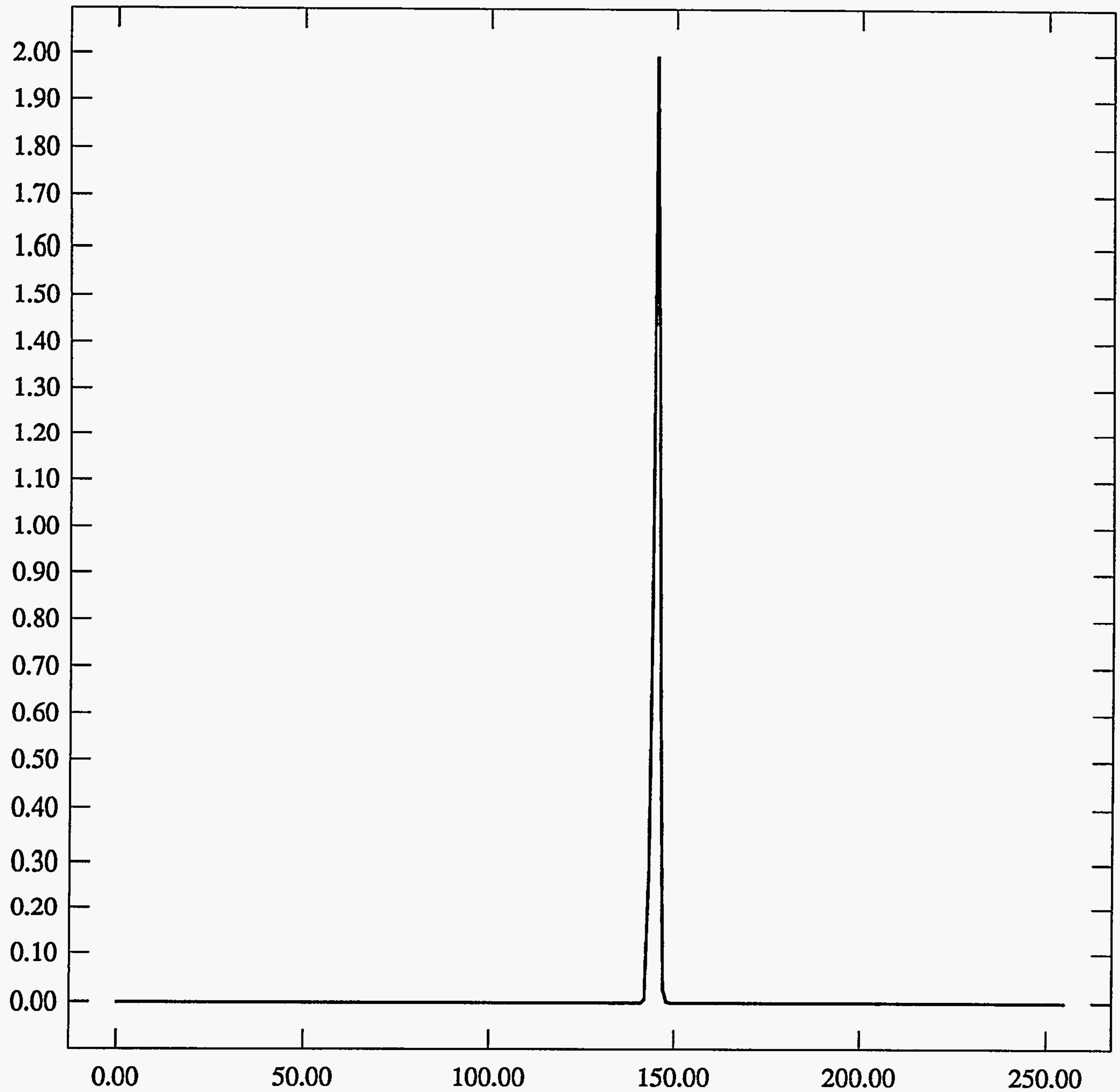
ST Camera: ST1#04-10 20C #6: int_time=100ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 20:49:36 1993

Pixel Values Min 141 Max 148 Mean 144.7 Sigma 0.86 x 10^3



ST Camera: ST1#04-10 20C #6: int_time=200ms, offset= 0, gain=4 (75 e/bit) Wed Jun 30 20:49:49 1993

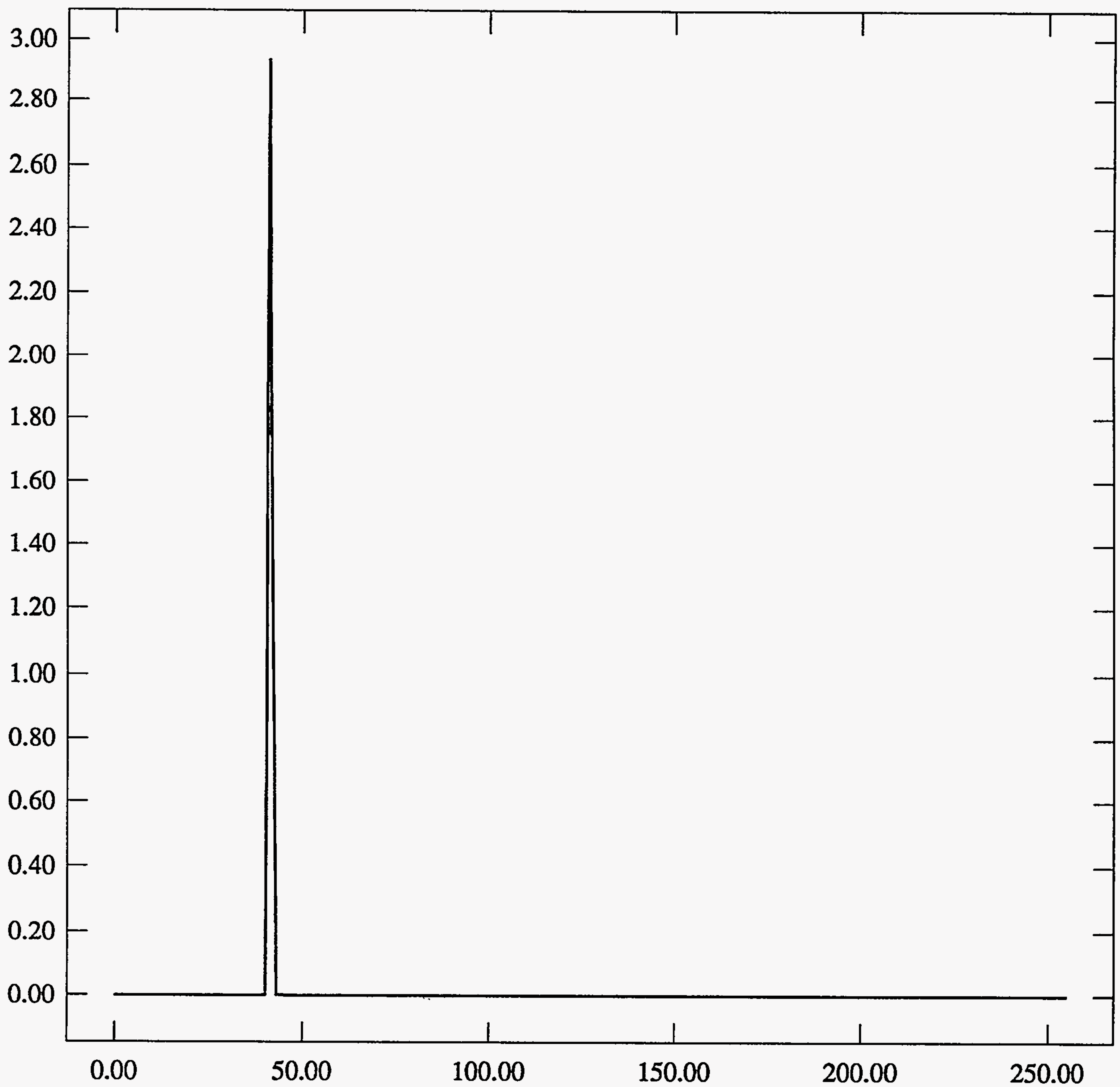
Pixel Values Min 142 Max 148 Mean 144.7 Sigma 0.83 x 10^3



LENS HEATER 20°C END OF CYC

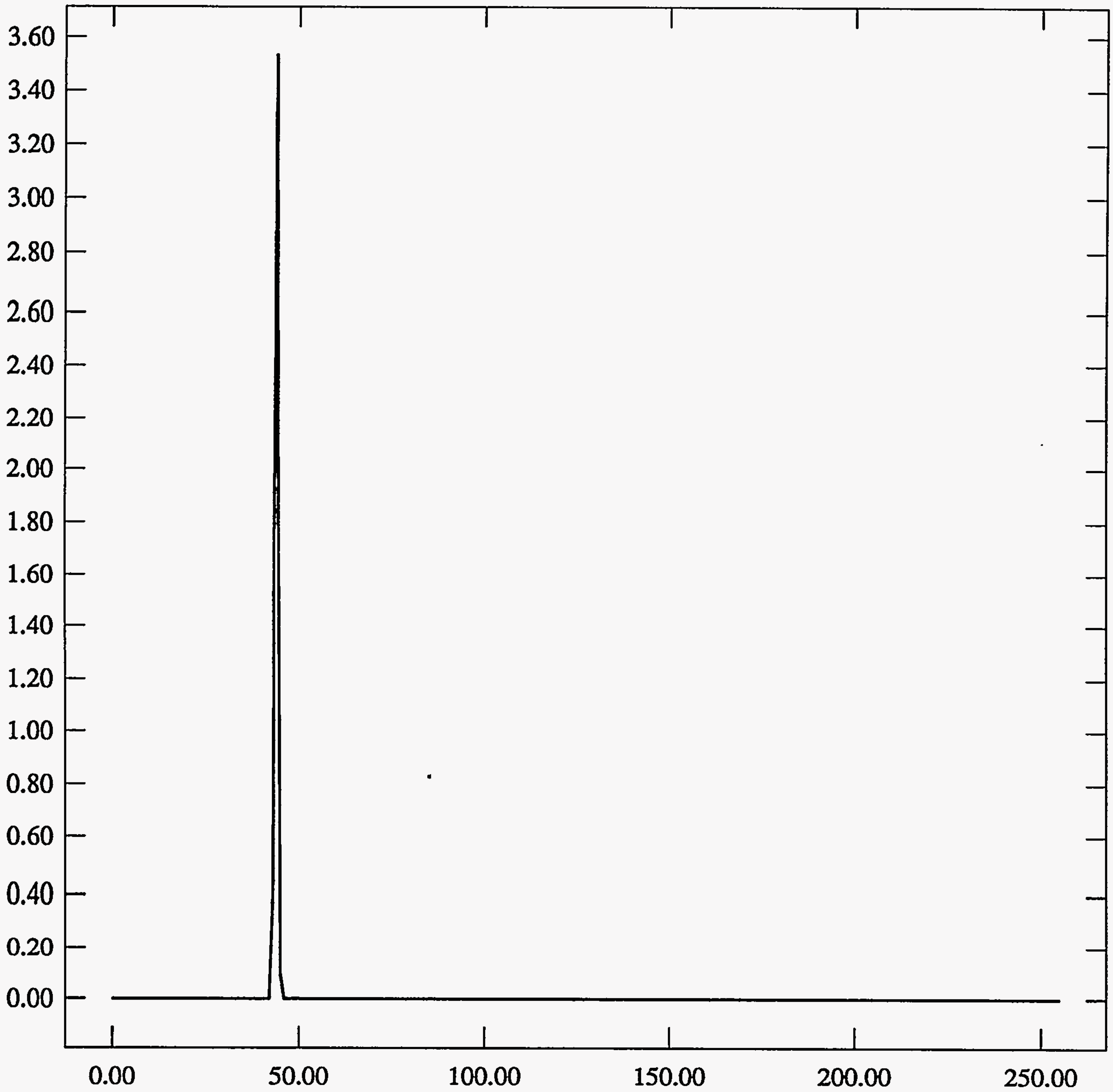
ST Camera: ST1#4-10 20C: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 12:22:44 1993

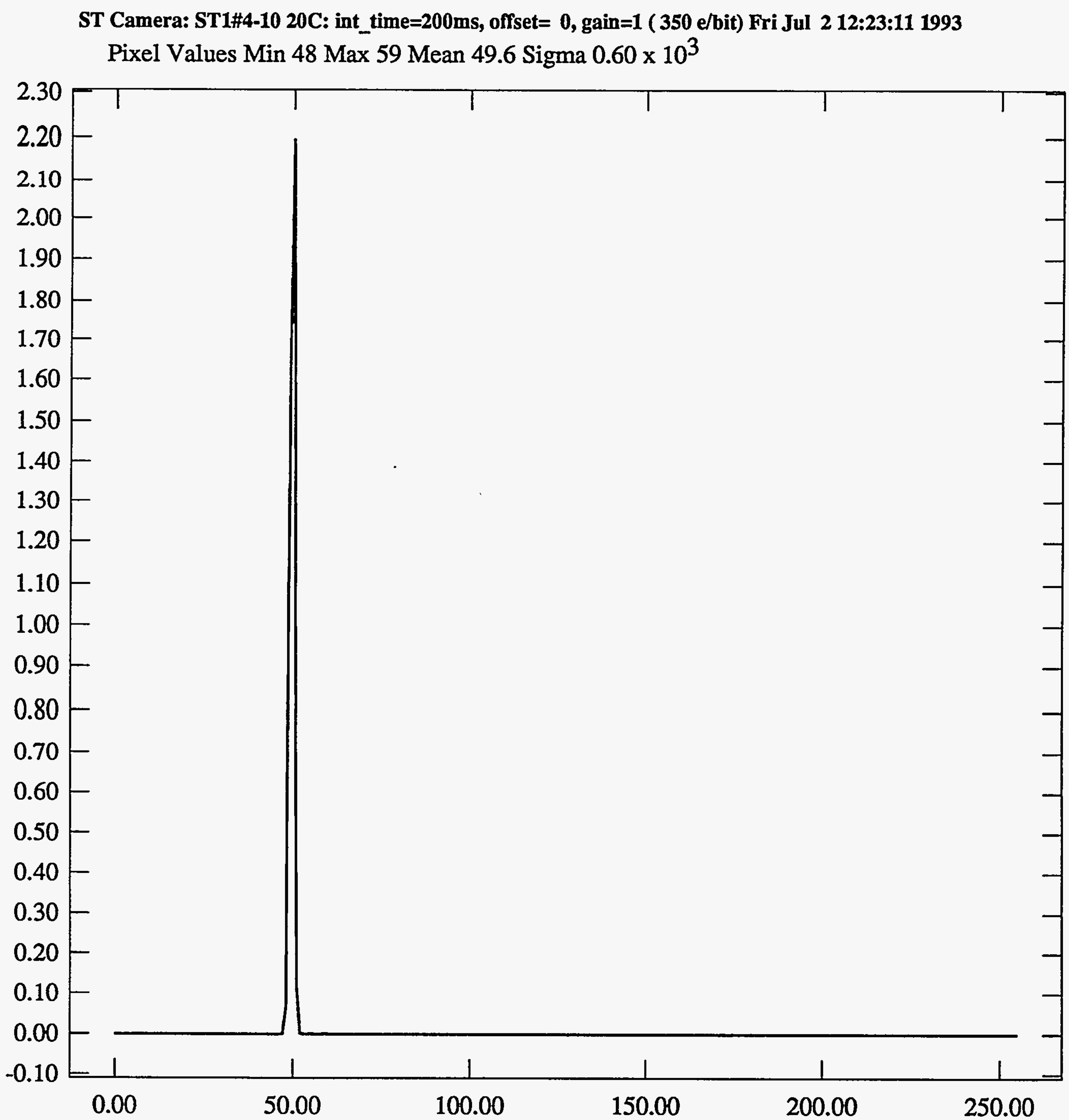
Pixel Values Min 40 Max 44 Mean 41.3 Sigma 0.45 x 10^3



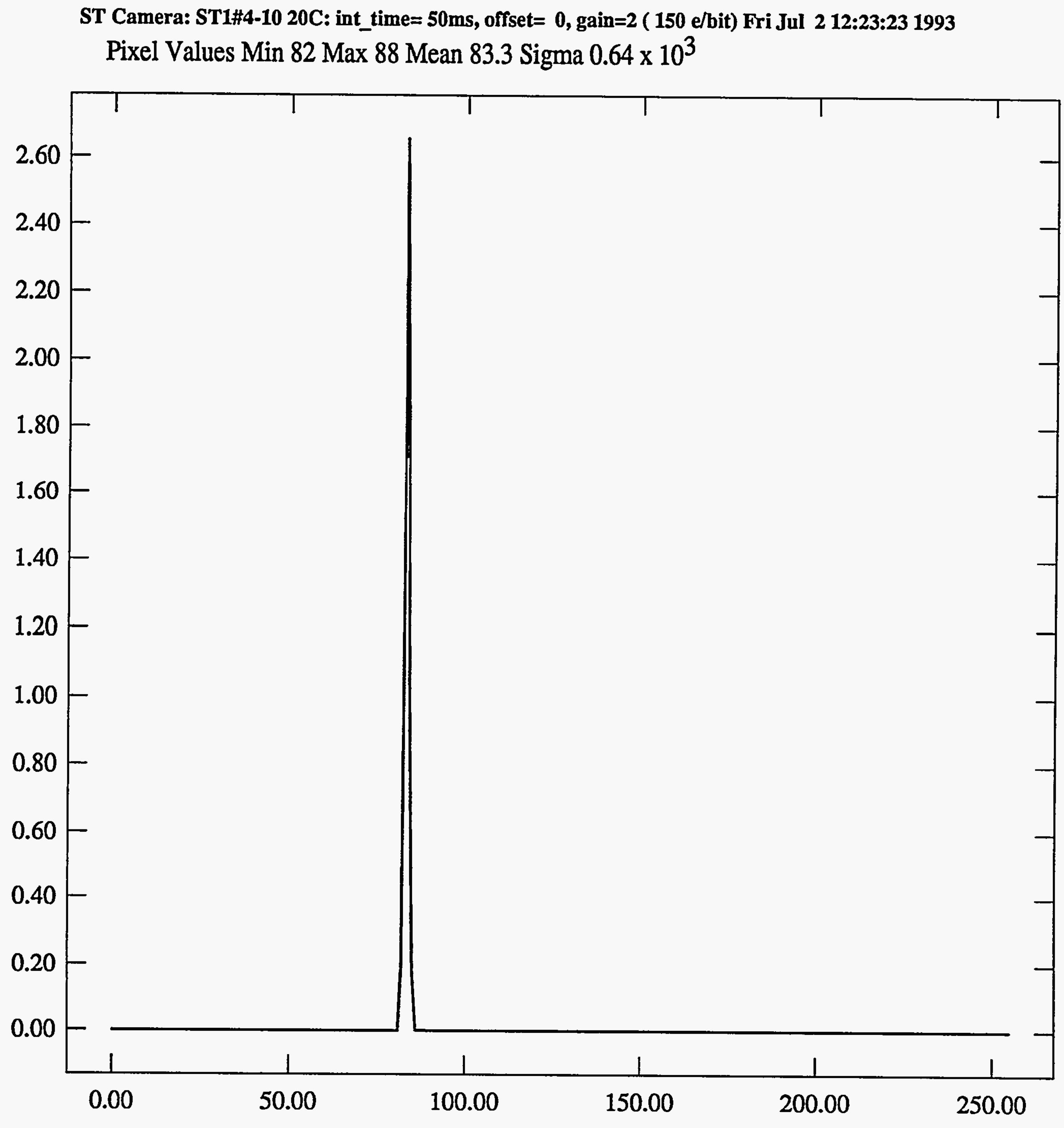
ST Camera: ST1#4-10 20C: int_time=100ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 12:22:58 1993

Pixel Values Min 43 Max 49 Mean 43.9 Sigma 0.35 x 10^3



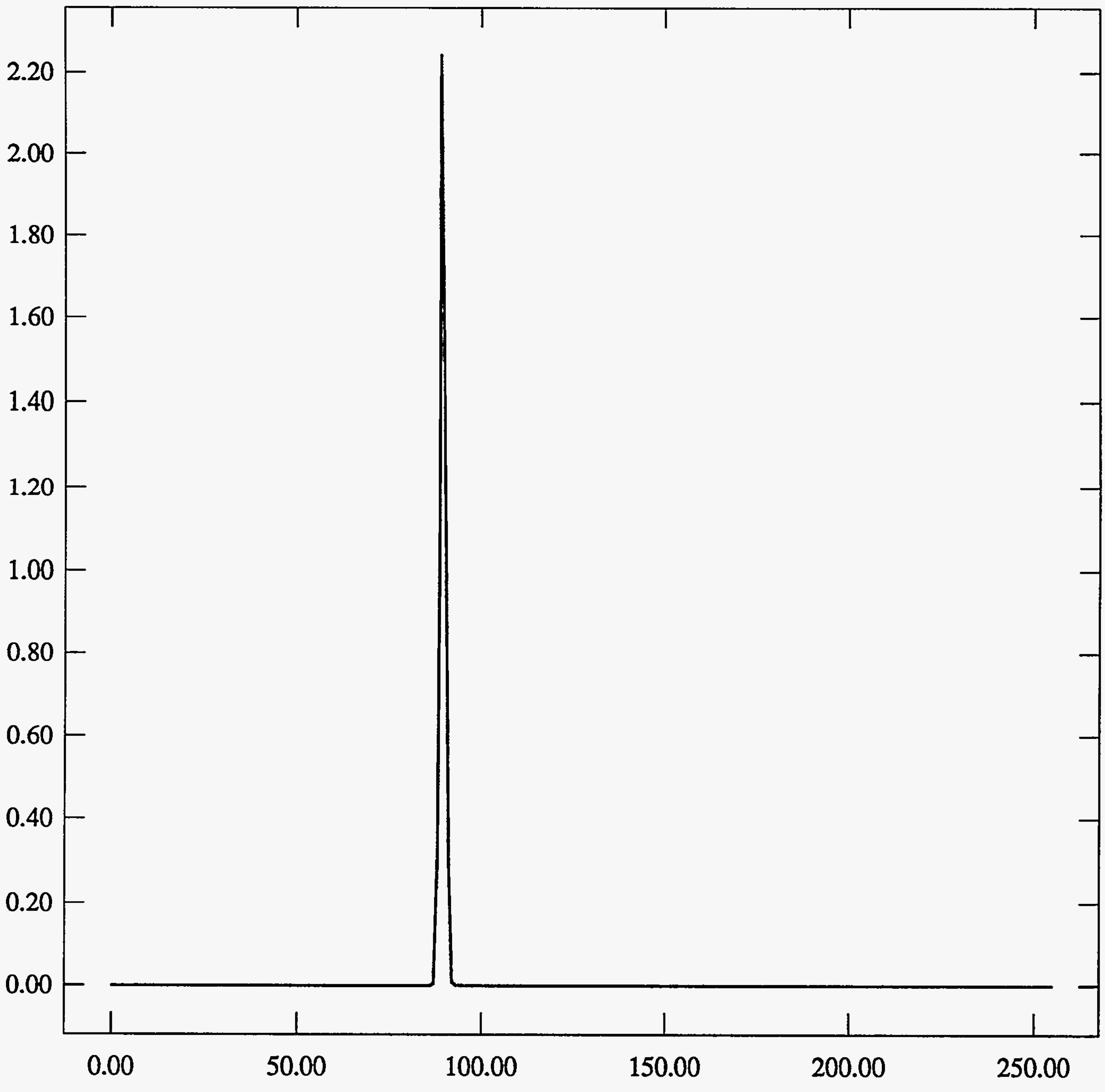


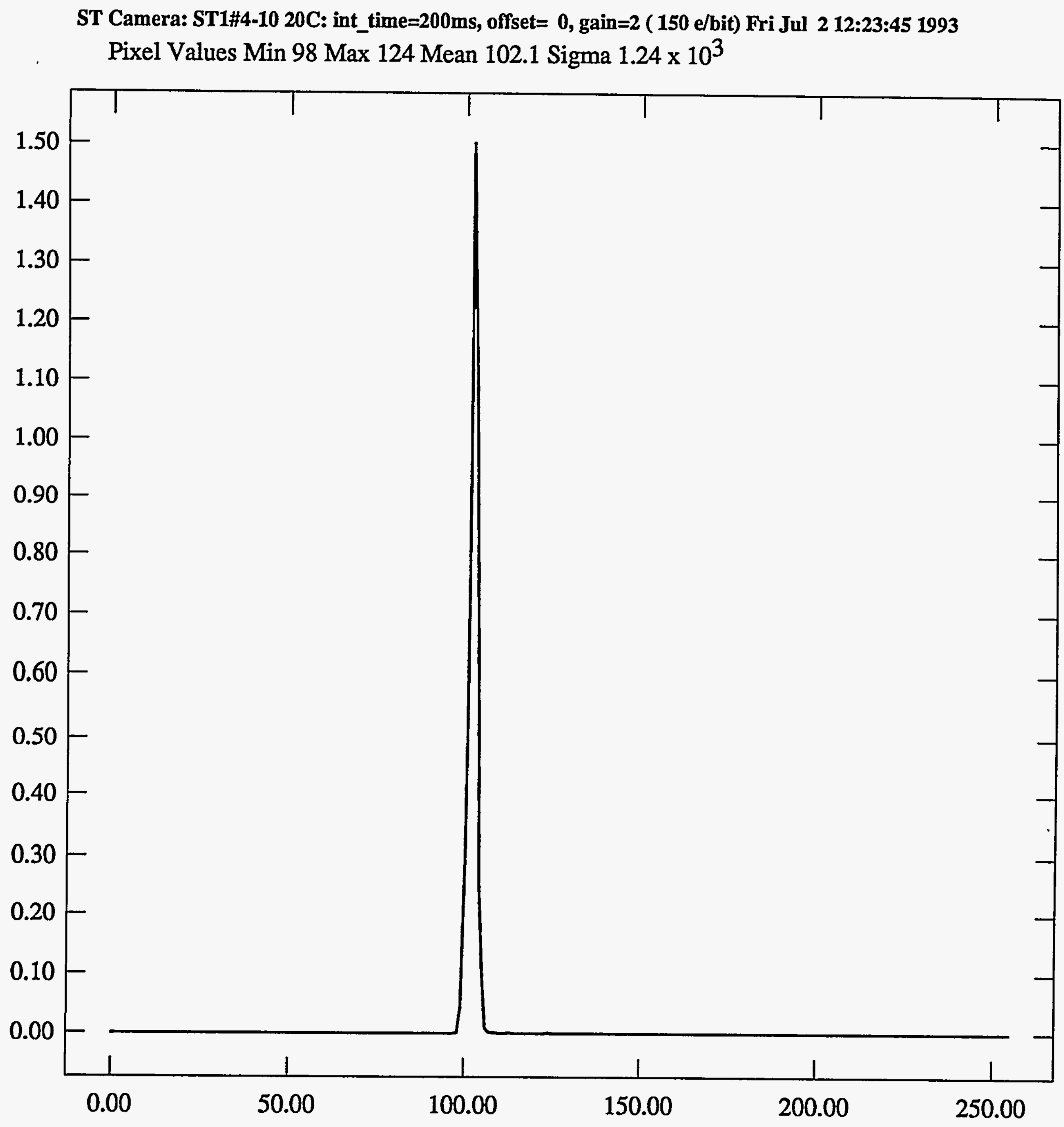
ST Camera: ST1#4-10 20C: int_time=200ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 12:23:11 1993
Pixel Values Min 48 Max 59 Mean 49.6 Sigma 0.60 x 10^3
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.00
50.00
100.00
150.00
200.00
250.00


ST Camera: ST1#4-10 20C: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 12:23:23 1993
Pixel Values Min 82 Max 88 Mean 83.3 Sigma 0.64 x 10^3
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1#4-10 20C: int_time=100ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 12:23:33 1993

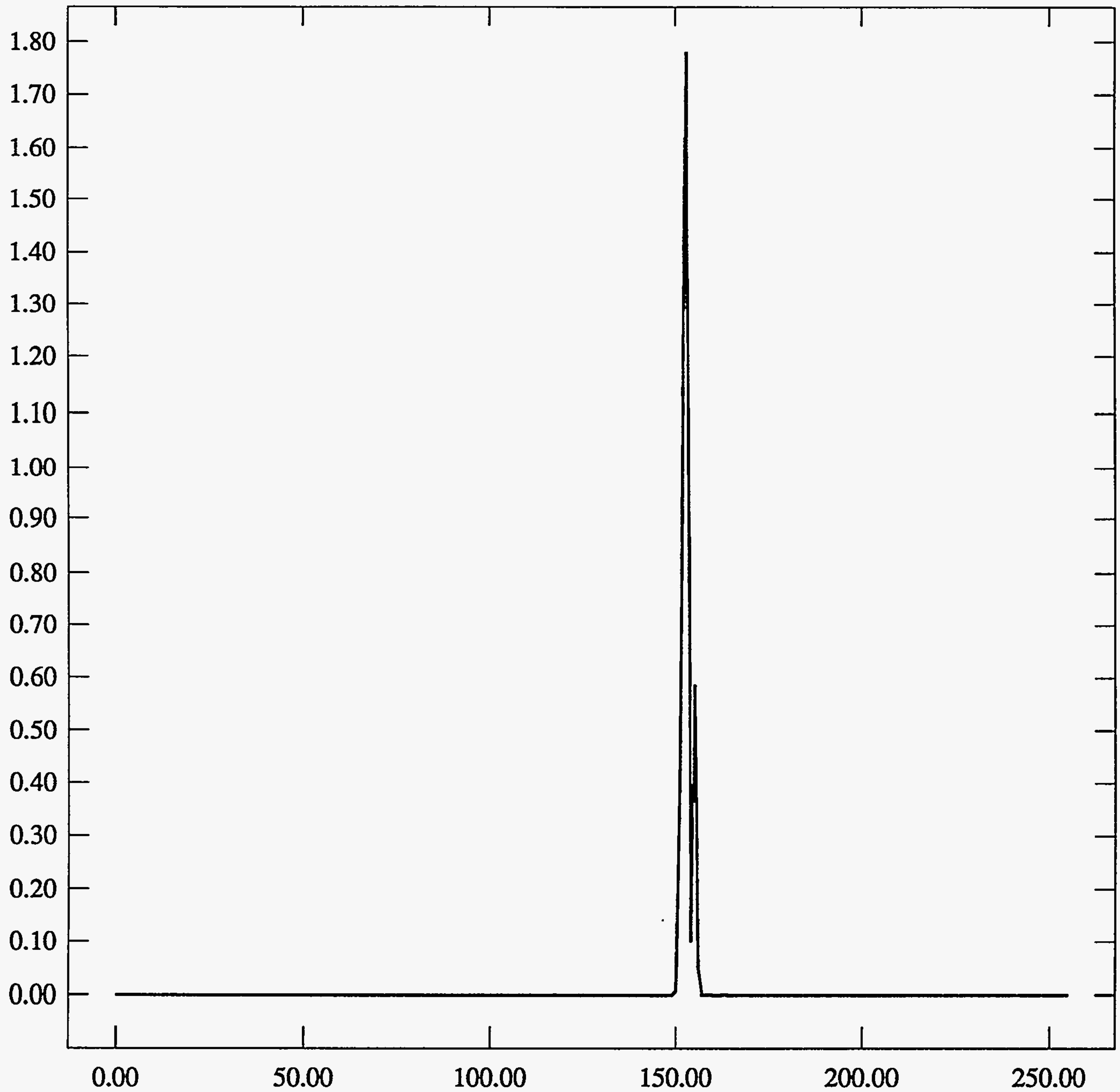
Pixel Values Min 87 Max 99 Mean 89.4 Sigma 0.77 x 10^3




ST Camera: ST1#4-10 20C: int_time=200ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 12:23:45 1993
Pixel Values Min 98 Max 124 Mean 102.1 Sigma 1.24 x 10^3
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
50.00
100.00
150.00
200.00
250.00

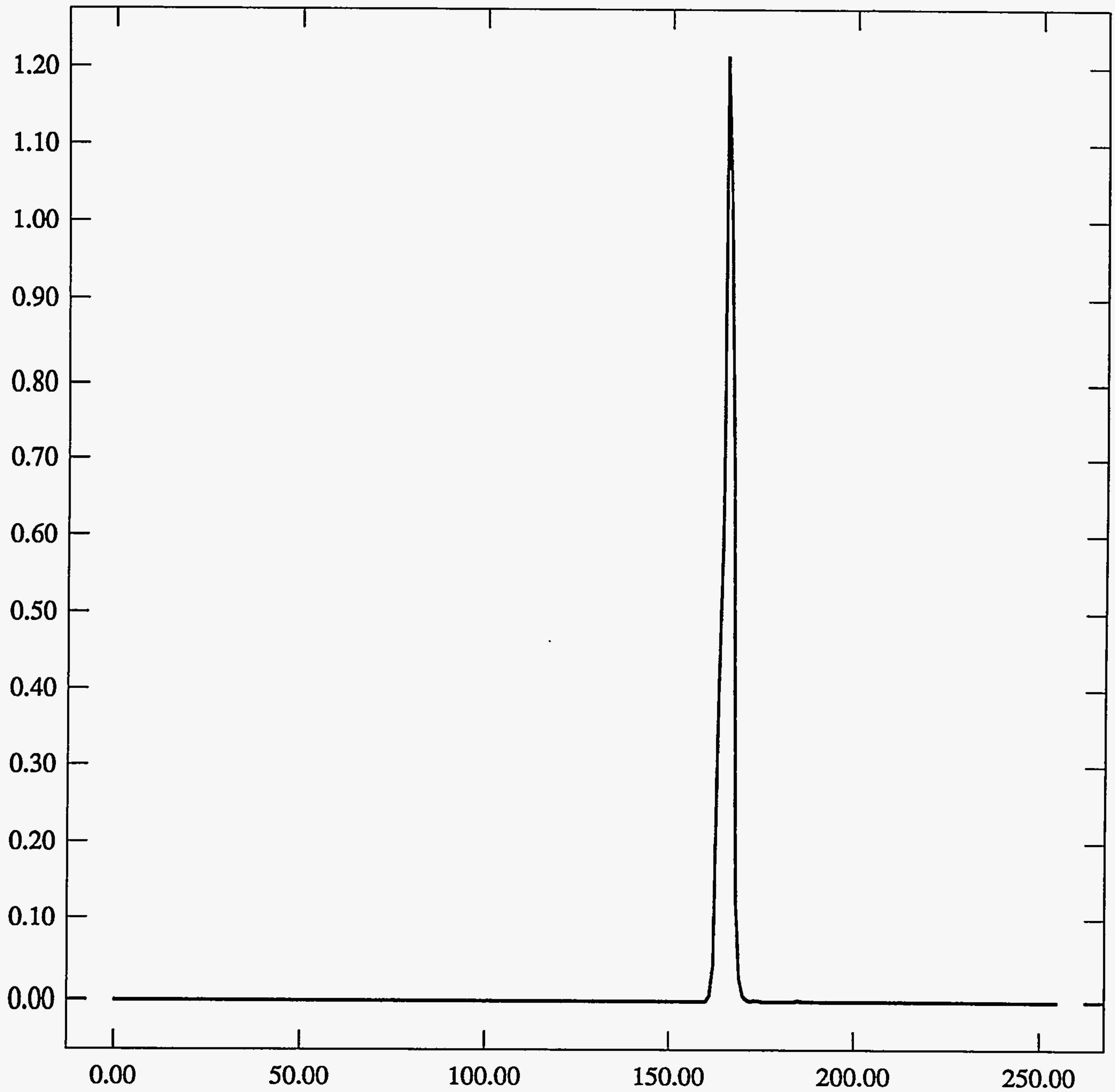
ST Camera: ST1#4-10 20C: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 12:24:01 1993

Pixel Values Min 150 Max 163 Mean 152.9 Sigma 1.19 x 10^3



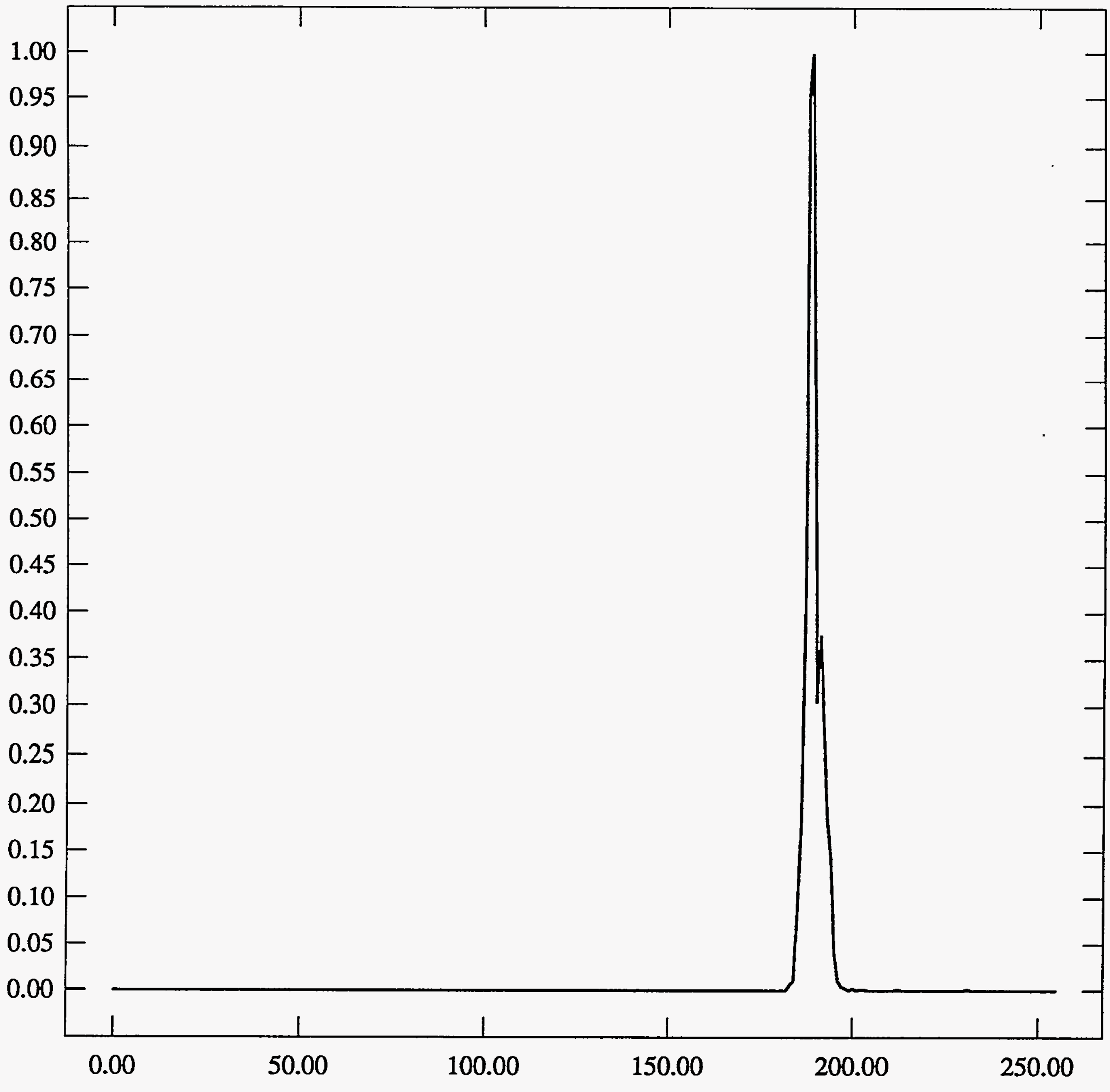
ST Camera: ST1#4-10 20C: int_time=100ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 12:24:12 1993

Pixel Values Min 161 Max 185 Mean 165.3 Sigma 1.40 x 10^3



ST Camera: ST1#4-10 20C: int_time=200ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 12:24:25 1993

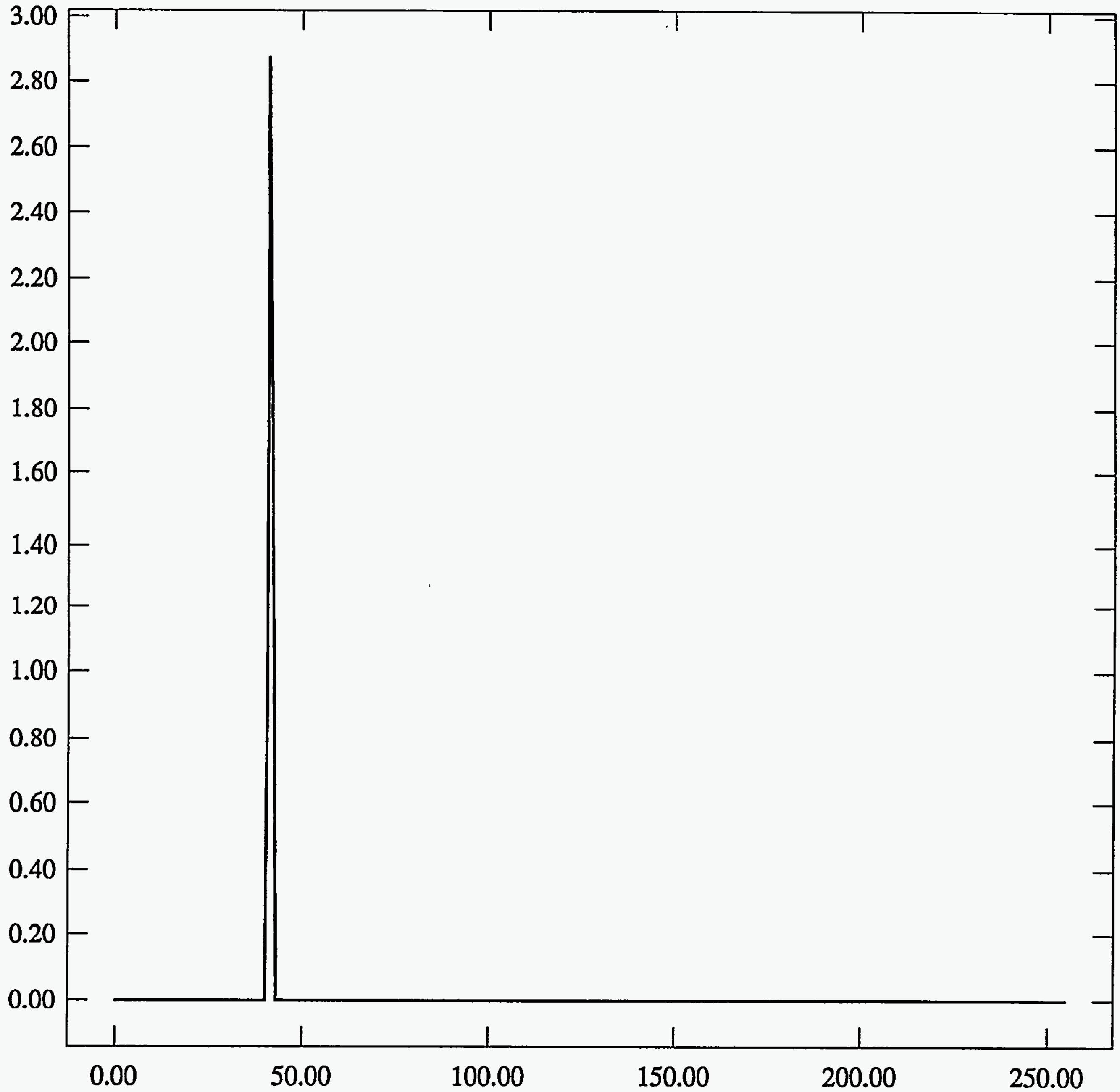
Pixel Values Min 183 Max 231 Mean 189.2 Sigma 2.34 x 10^3



LENS HEATER
20C 15 min

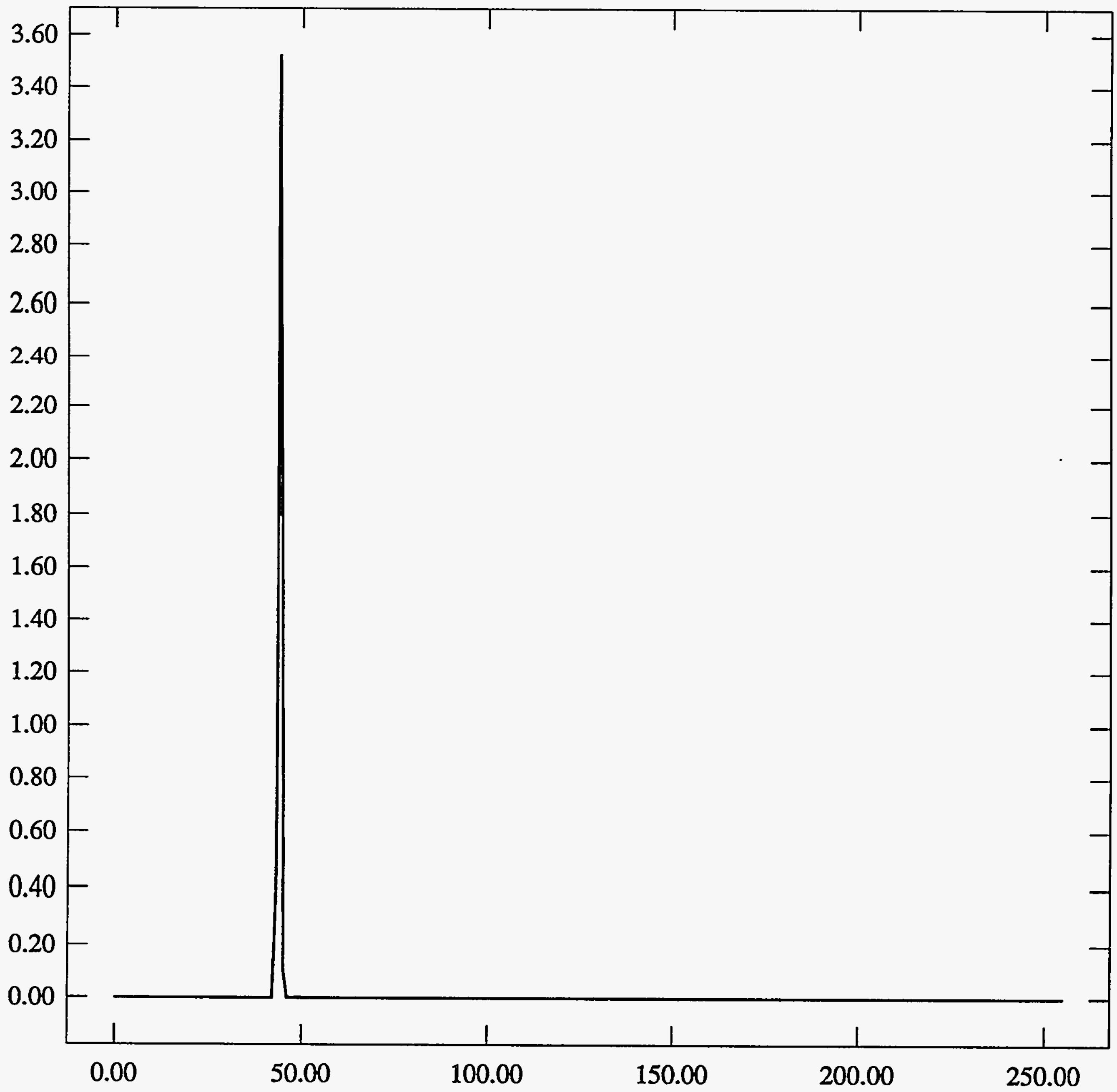
ST Camera: ST1#4-10 20C: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 11:42:15 1993

Pixel Values Min 41 Max 44 Mean 41.3 Sigma 0.45 x 10^3



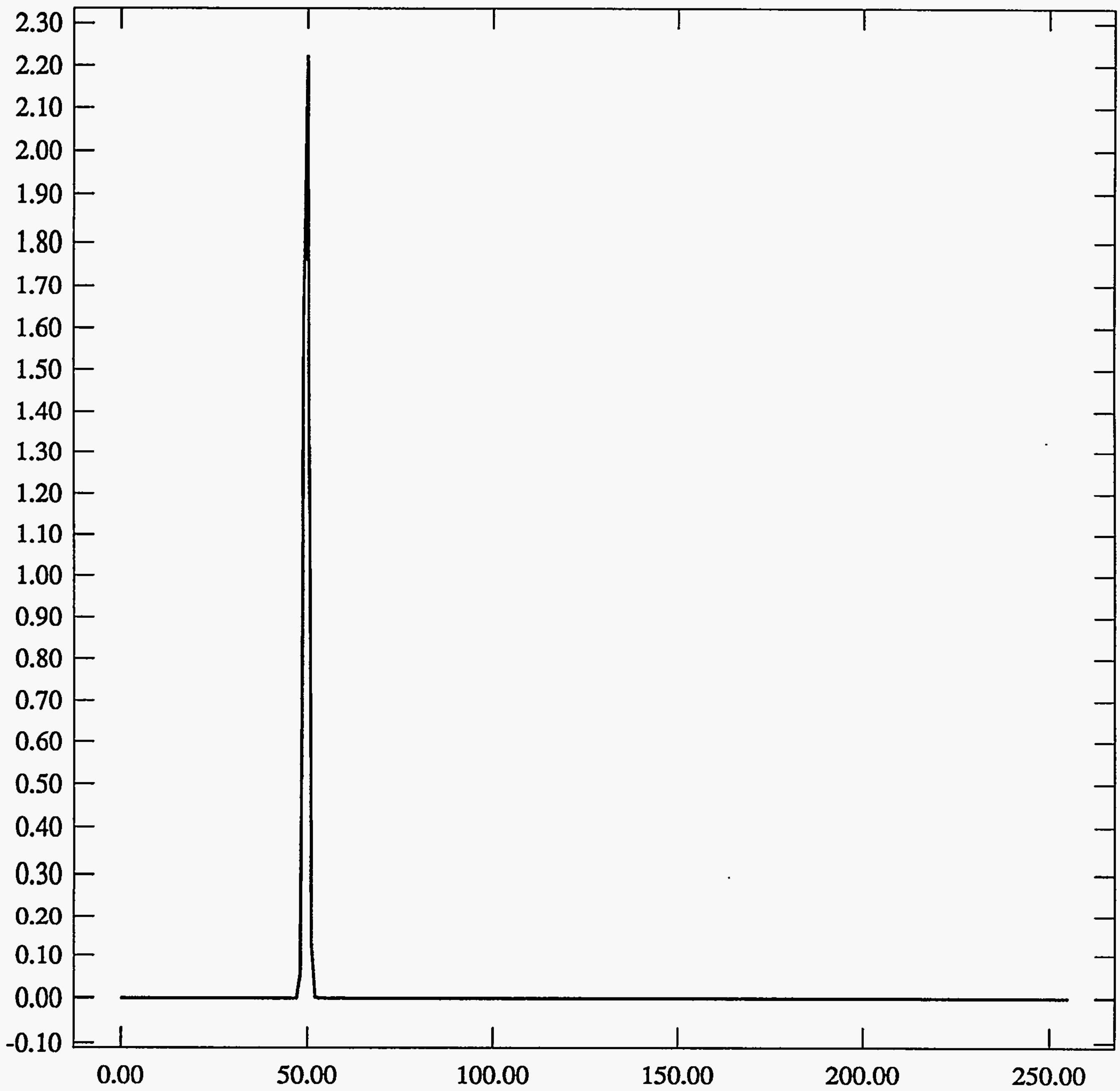
ST Camera: ST1#4-10 20C: int_time=100ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 11:42:29 1993

Pixel Values Min 43 Max 49 Mean 43.9 Sigma 0.36 x 10^3



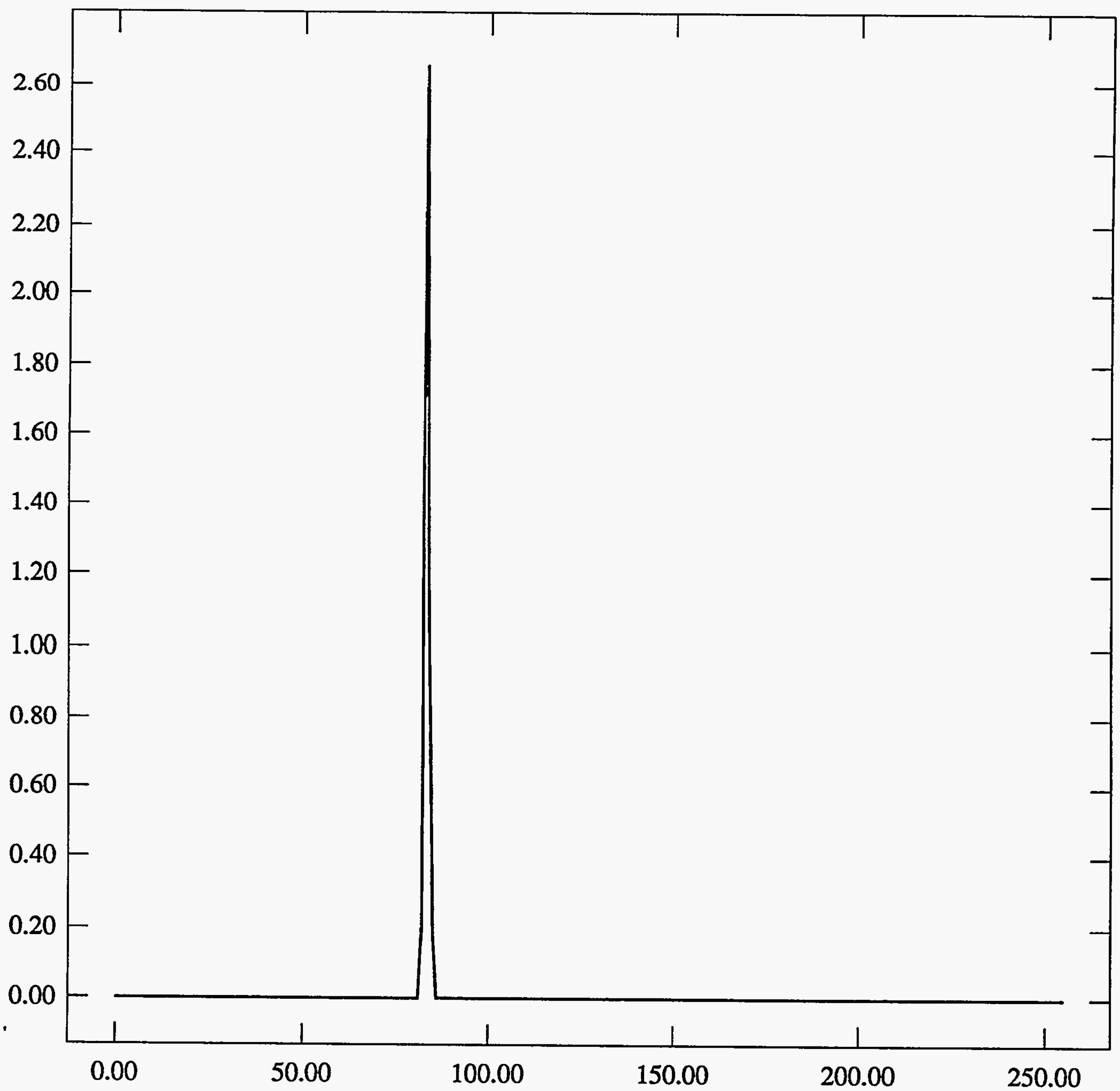
ST Camera: ST1#4-10 20C: int_time=200ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 11:42:41 1993

Pixel Values Min 48 Max 59 Mean 49.6 Sigma 0.60 x 10^3



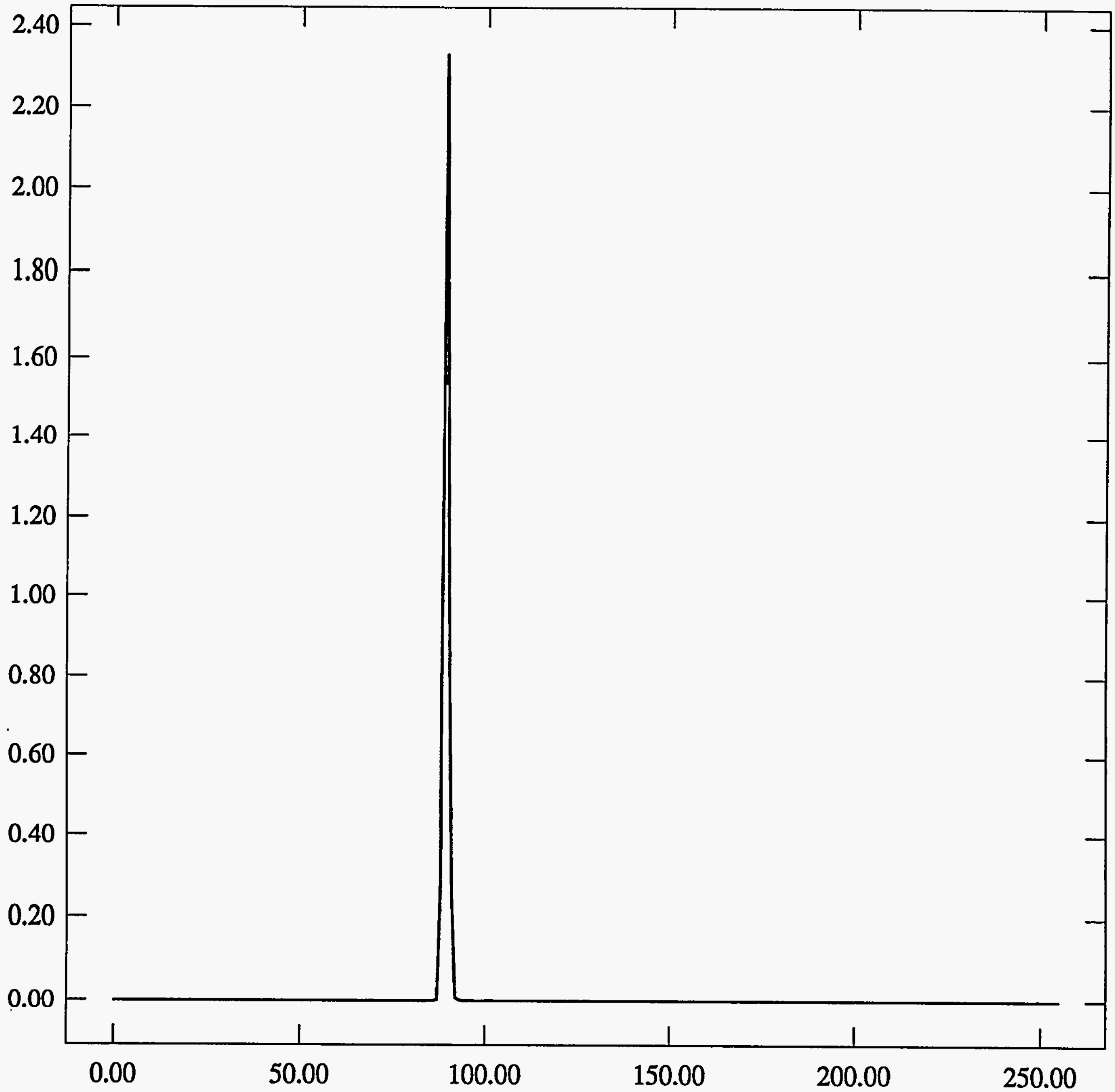
ST Camera: ST1#4-10 20C: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 11:43:02 1993

Pixel Values Min 82 Max 89 Mean 83.3 Sigma 0.64 x 10^3



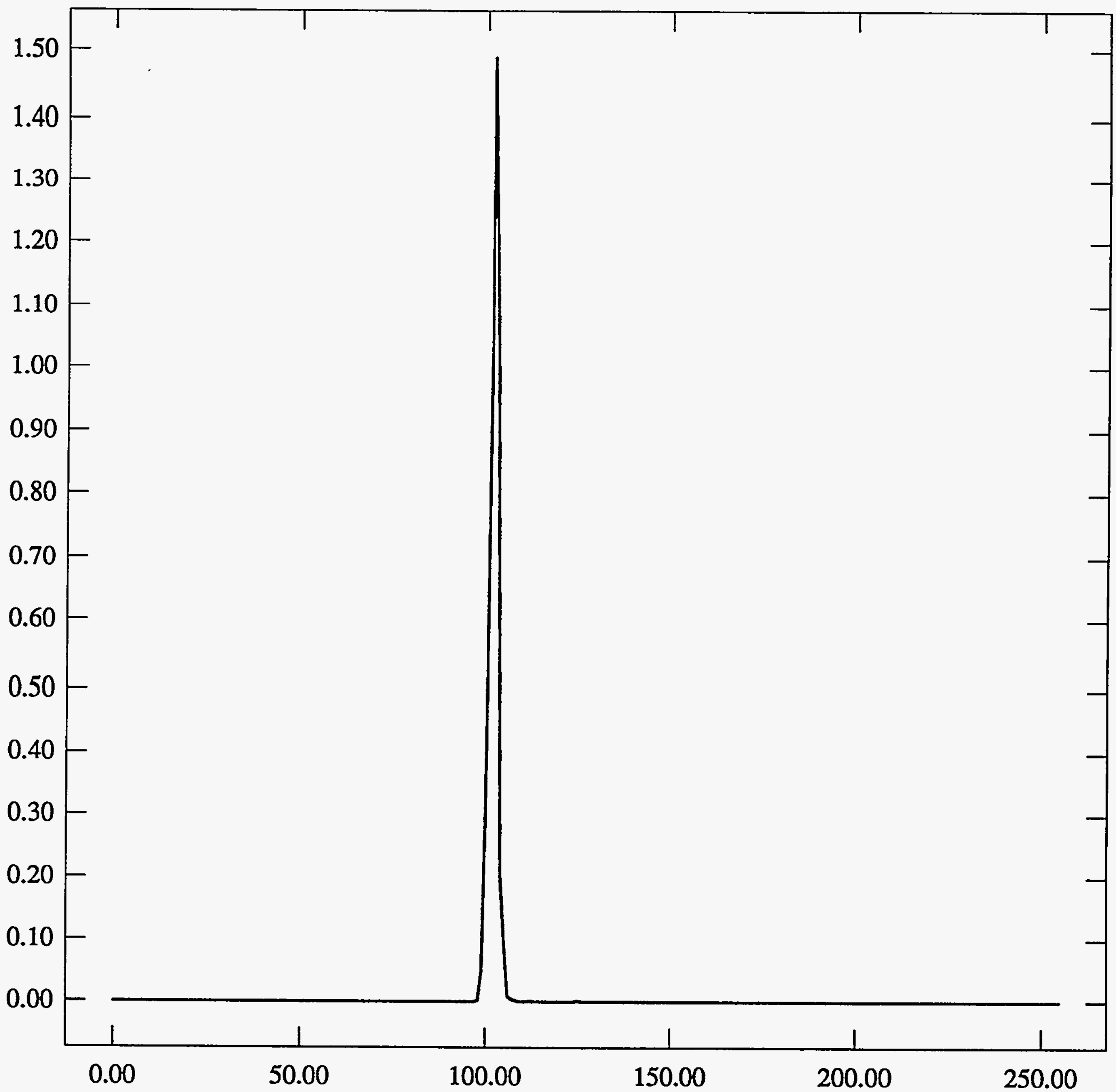
ST Camera: ST1#4-10 20C: int_time=100ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 11:43:13 1993

Pixel Values Min 87 Max 101 Mean 89.4 Sigma 0.75 x 10^3



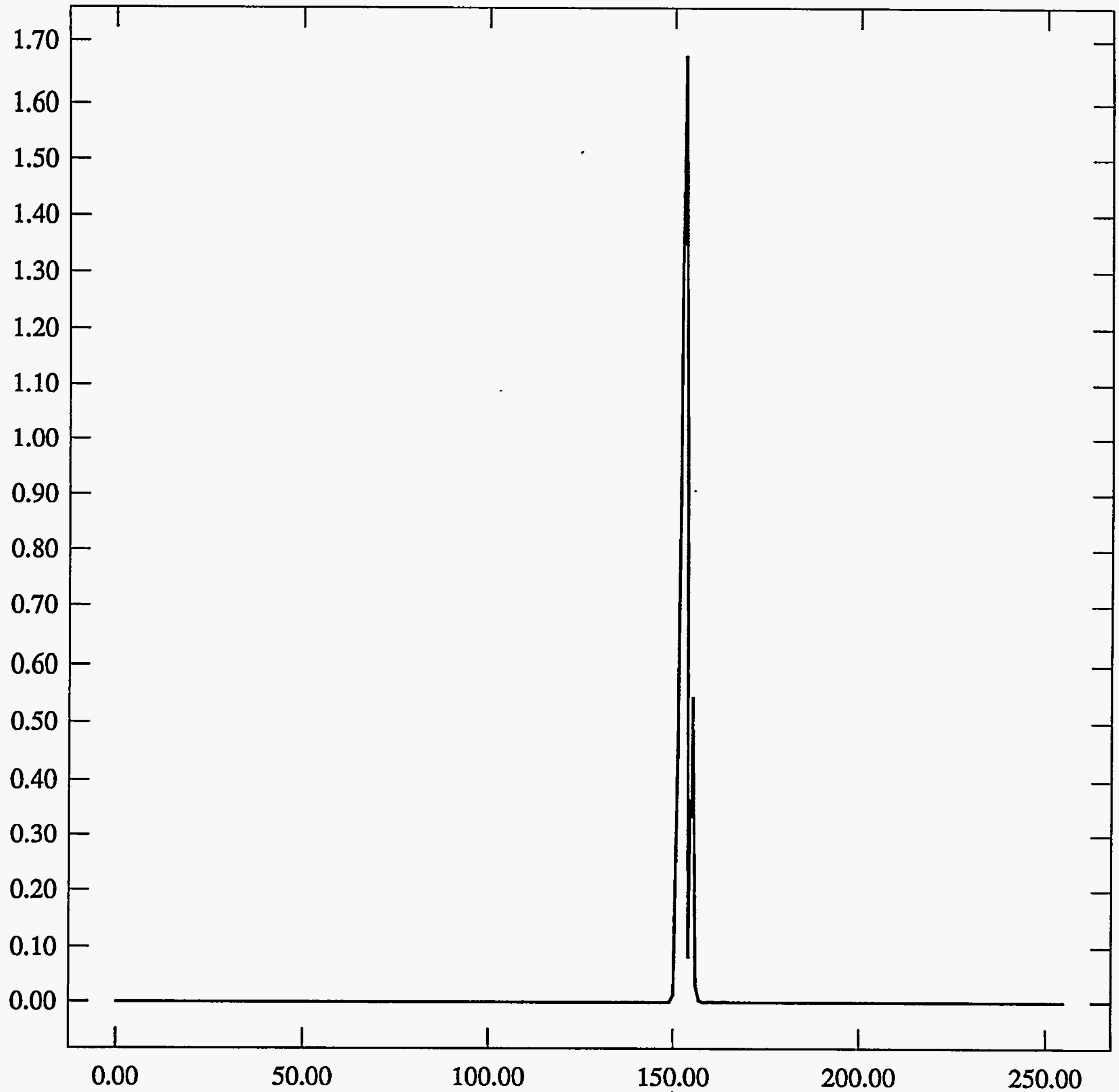
ST Camera: ST1#4-10 20C: int_time=200ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 11:43:22 1993

Pixel Values Min 98 Max 125 Mean 102.1 Sigma 1.24 x 10^3



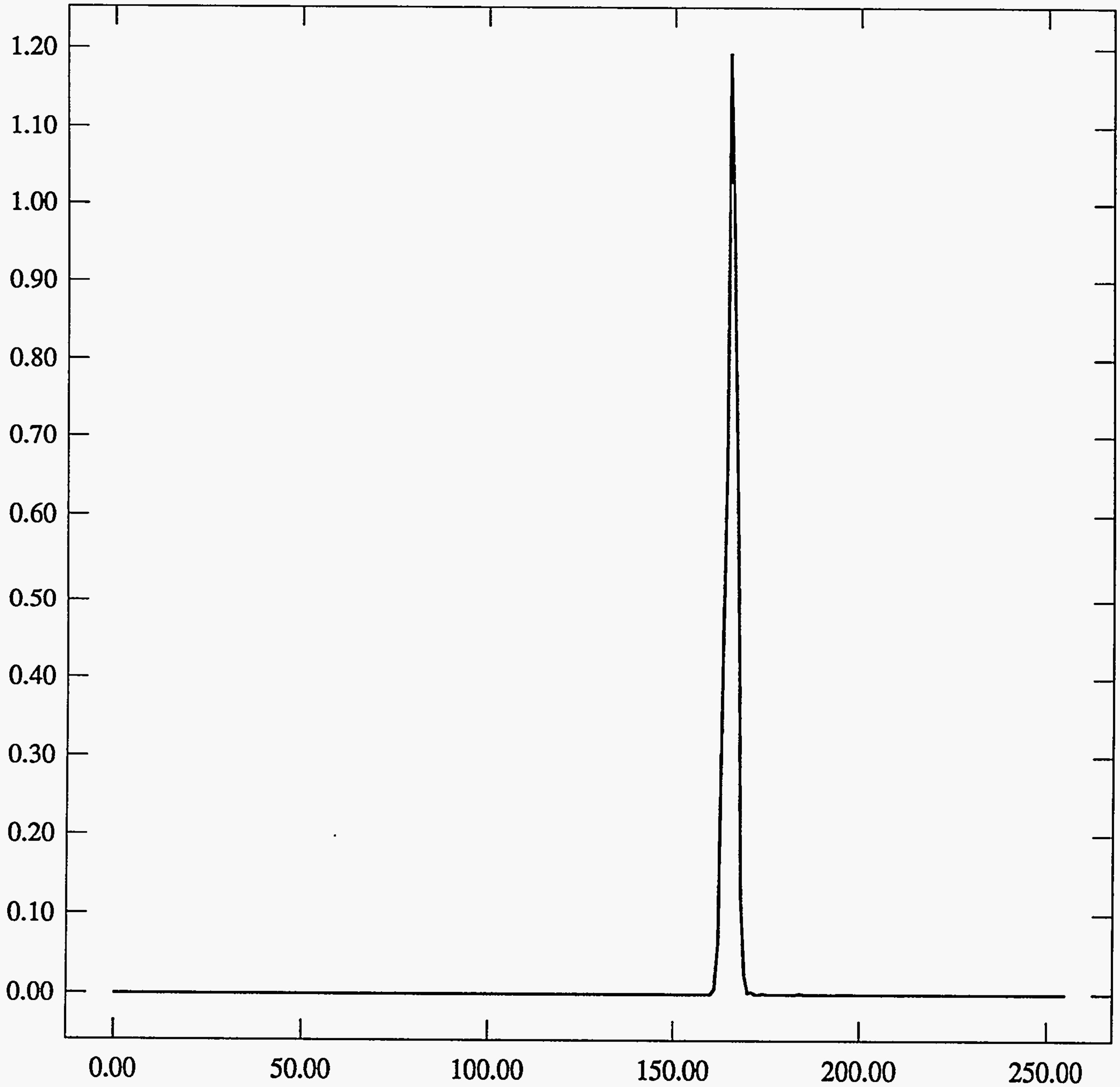
ST Camera: ST1#4-10 20C: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 11:43:35 1993

Pixel Values Min 150 Max 164 Mean 152.8 Sigma 1.19 x 10^3



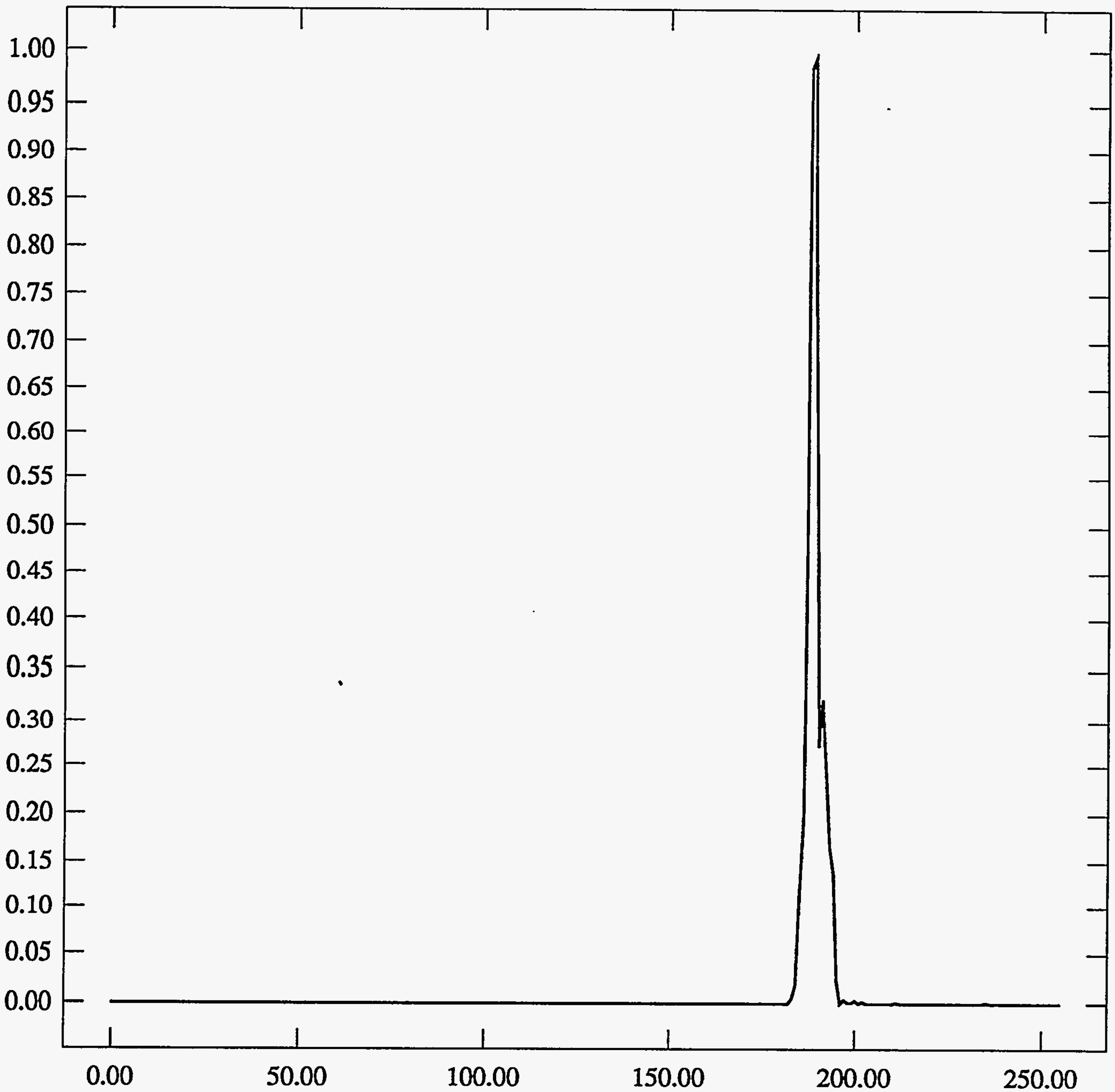
ST Camera: ST1#4-10 20C: int_time=100ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 11:43:46 1993

Pixel Values Min 161 Max 184 Mean 165.2 Sigma 1.44 x 10^3



ST Camera: ST1#4-10 20C: int_time=200ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 11:43:57 1993

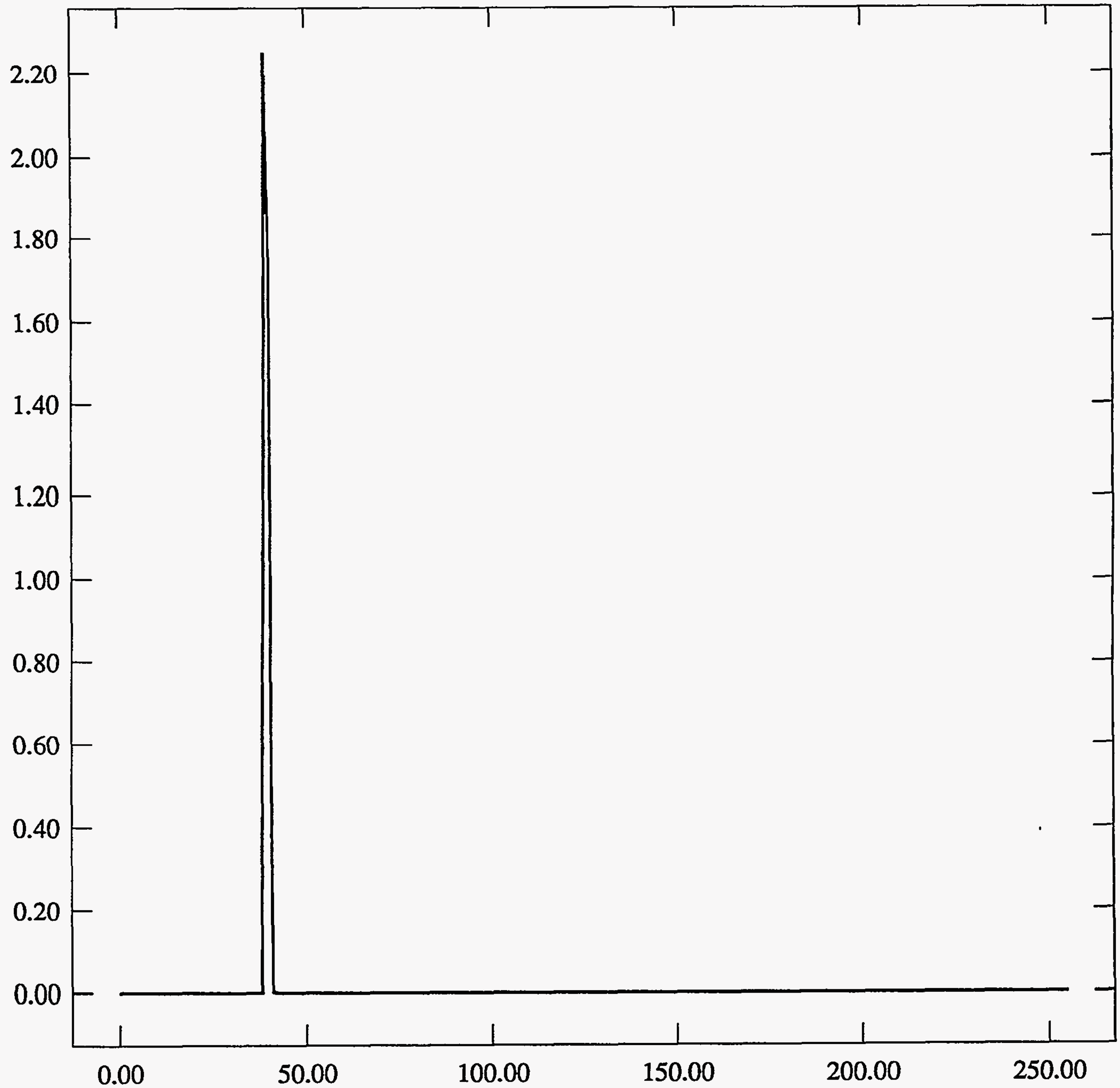
Pixel Values Min 183 Max 235 Mean 189.0 Sigma 2.33 x 10^3

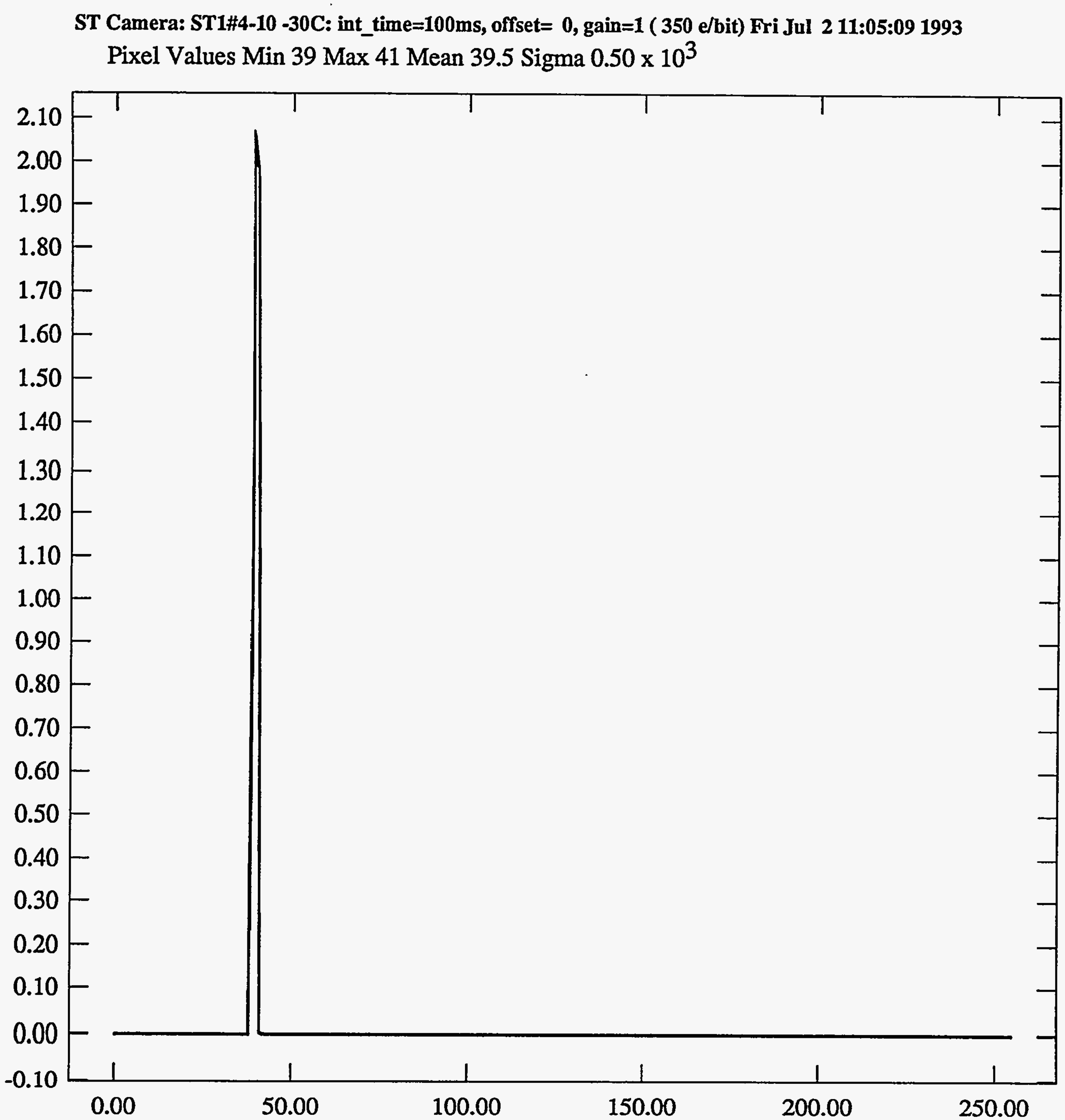


LENS HEATER -30°C. end

ST Camera: ST1#4-10 -30C: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 11:04:57 1993

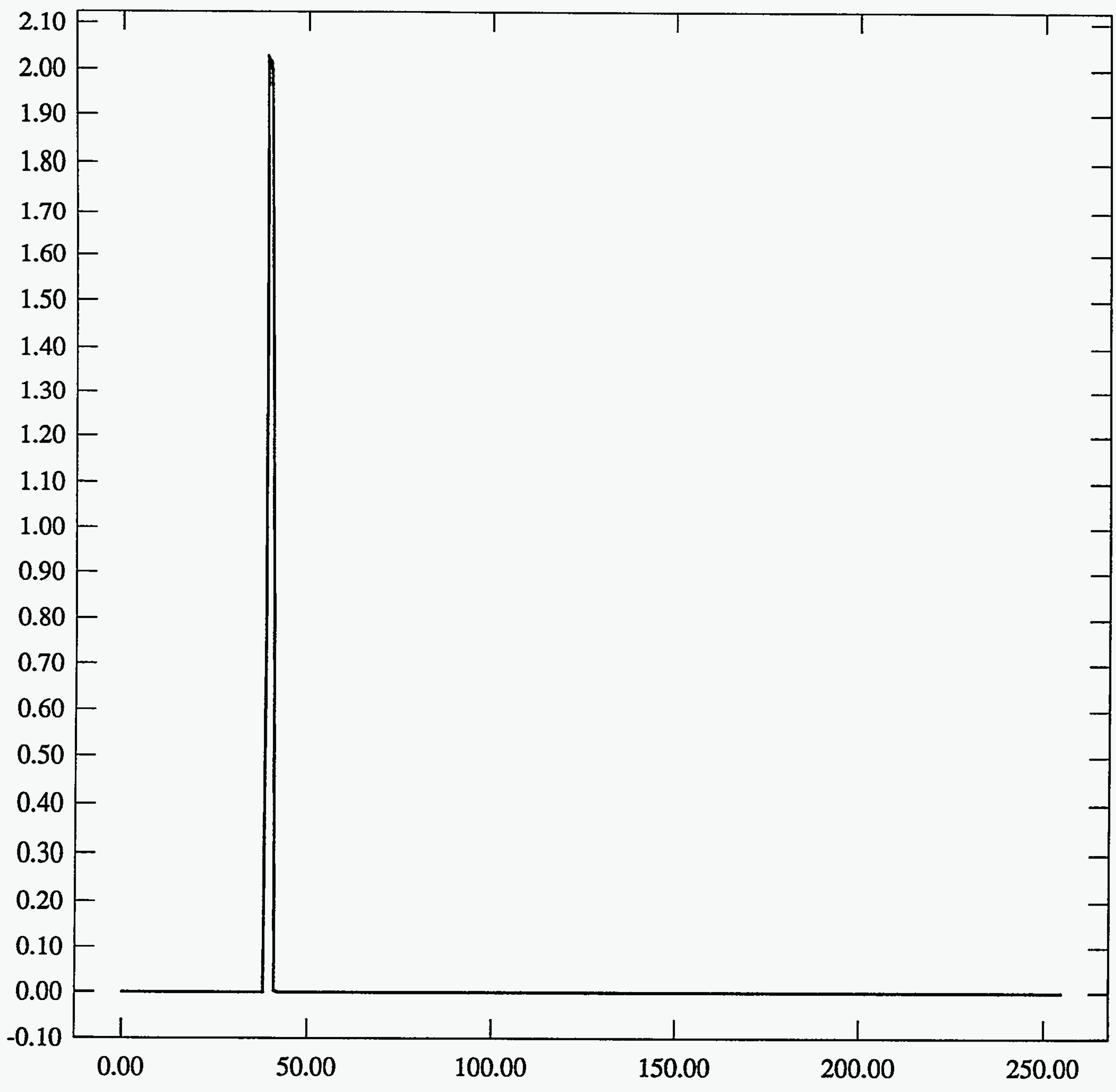
Pixel Values Min 39 Max 41 Mean 39.4 Sigma 0.50 x 10^3




ST Camera: ST1#4-10 -30C: int_time=100ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 11:05:09 1993
Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.00
50.00
100.00
150.00
200.00
250.00

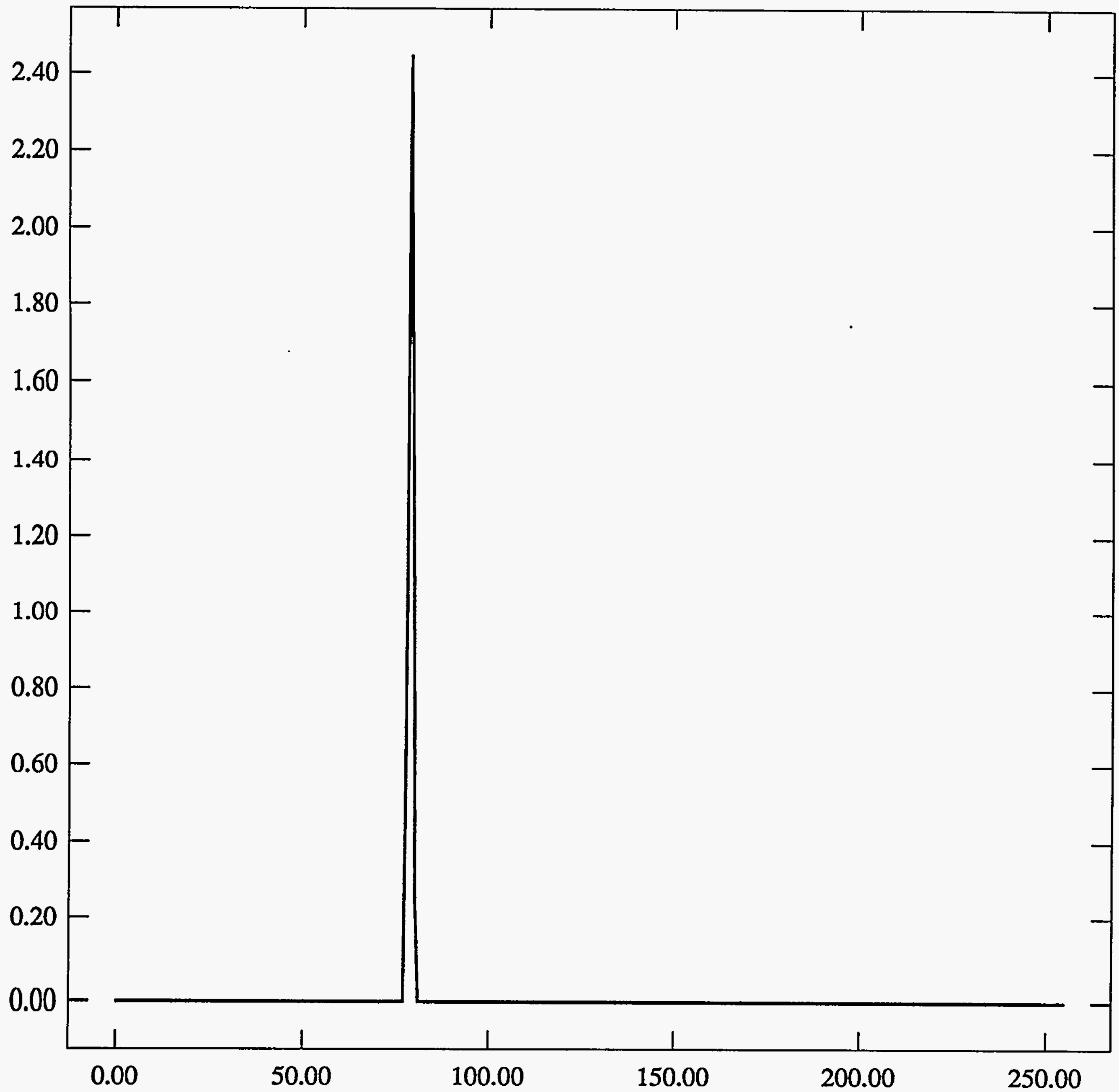
ST Camera: ST1#4-10 -30C: int_time=200ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 11:05:50 1993

Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3



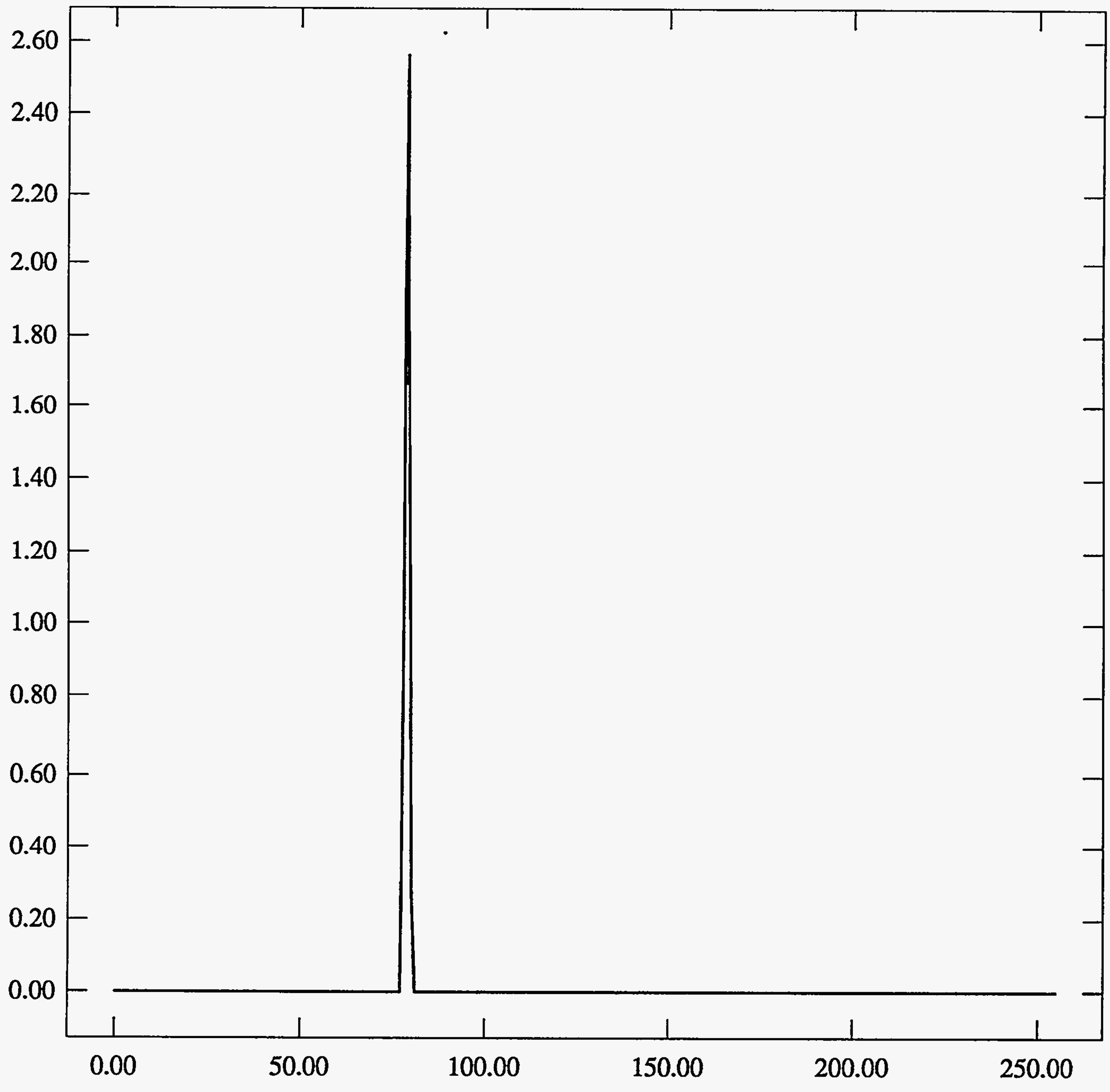
ST Camera: ST1#4-10 -30C: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 11:06:03 1993

Pixel Values Min 77 Max 80 Mean 78.7 Sigma 0.57 x 10^3



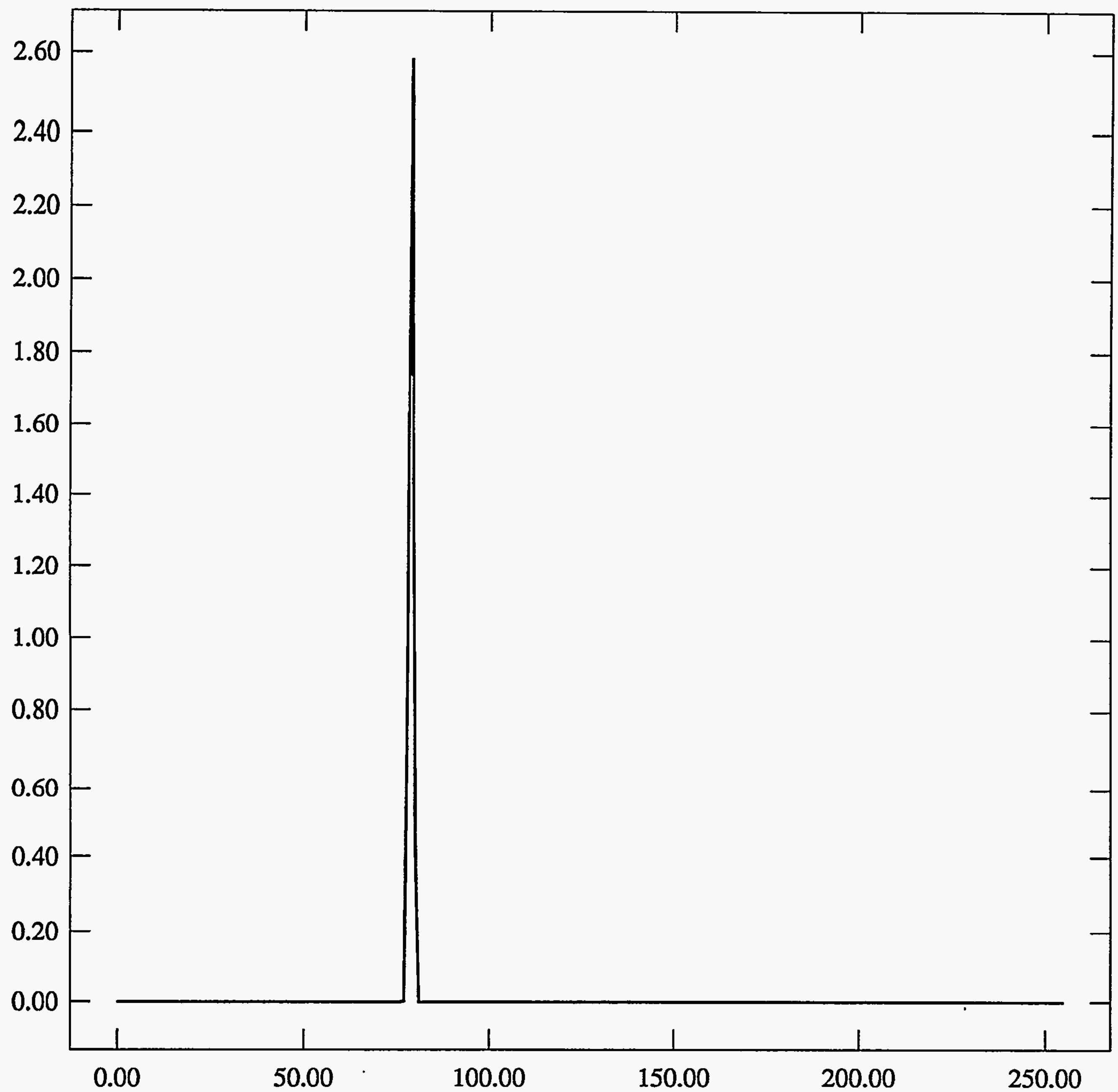
ST Camera: ST1#4-10 -30C: int_time=100ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 11:06:15 1993

Pixel Values Min 78 Max 80 Mean 78.8 Sigma 0.56 x 10^3



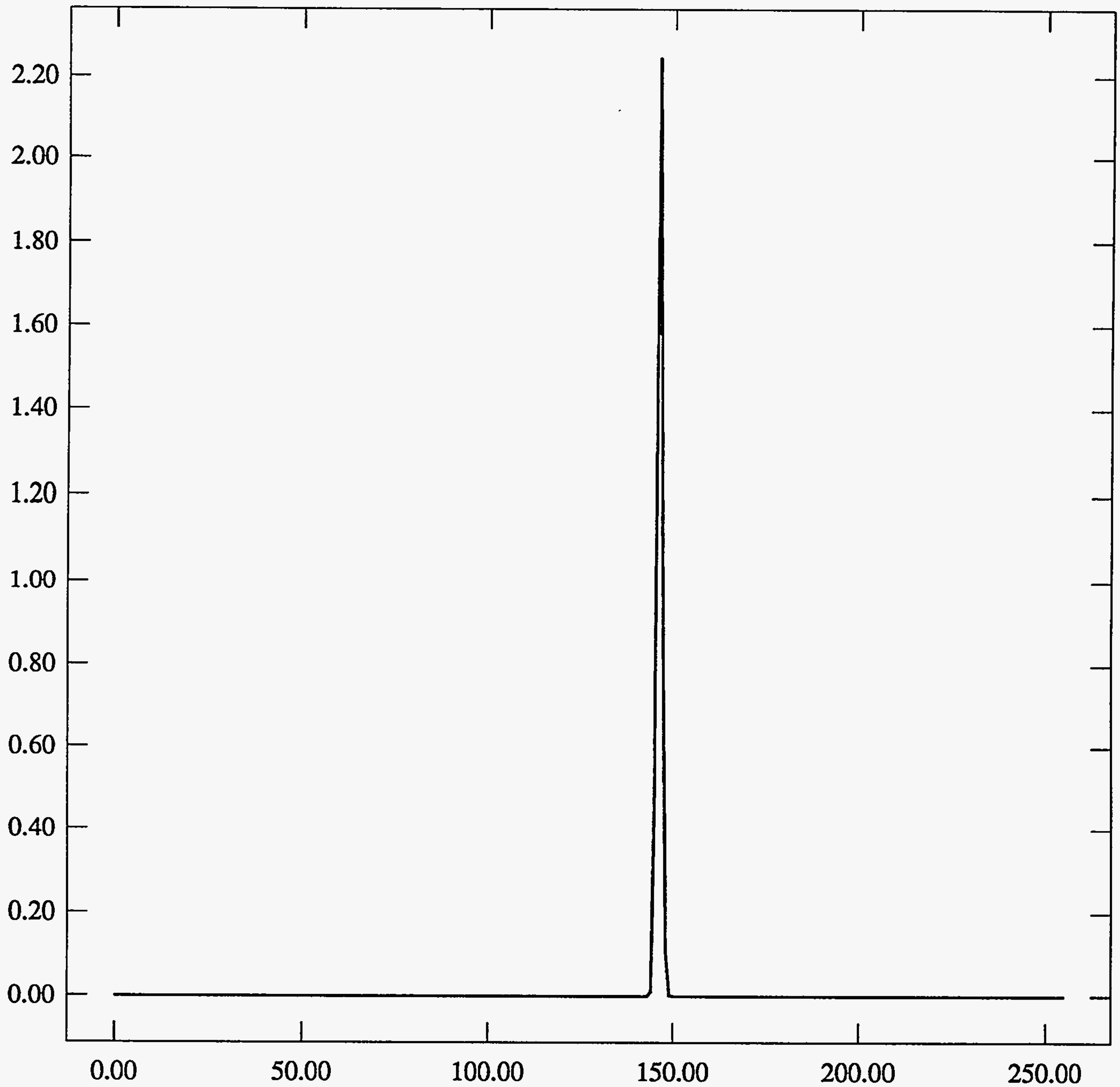
ST Camera: ST1#4-10 -30C: int_time=200ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 11:06:28 1993

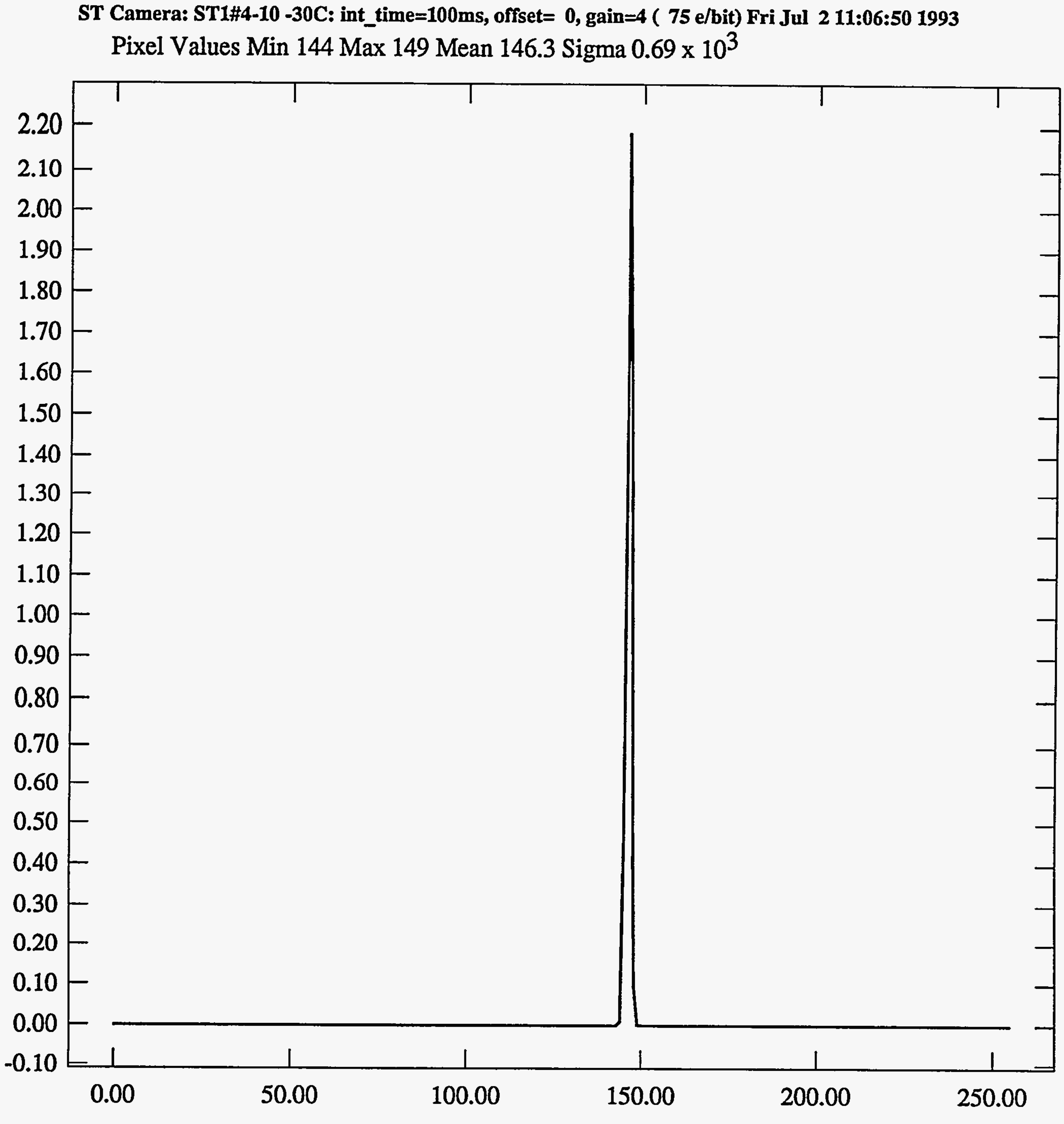
Pixel Values Min 77 Max 80 Mean 78.9 Sigma 0.59 x 10^3



ST Camera: ST1#4-10 -30C: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 11:06:39 1993

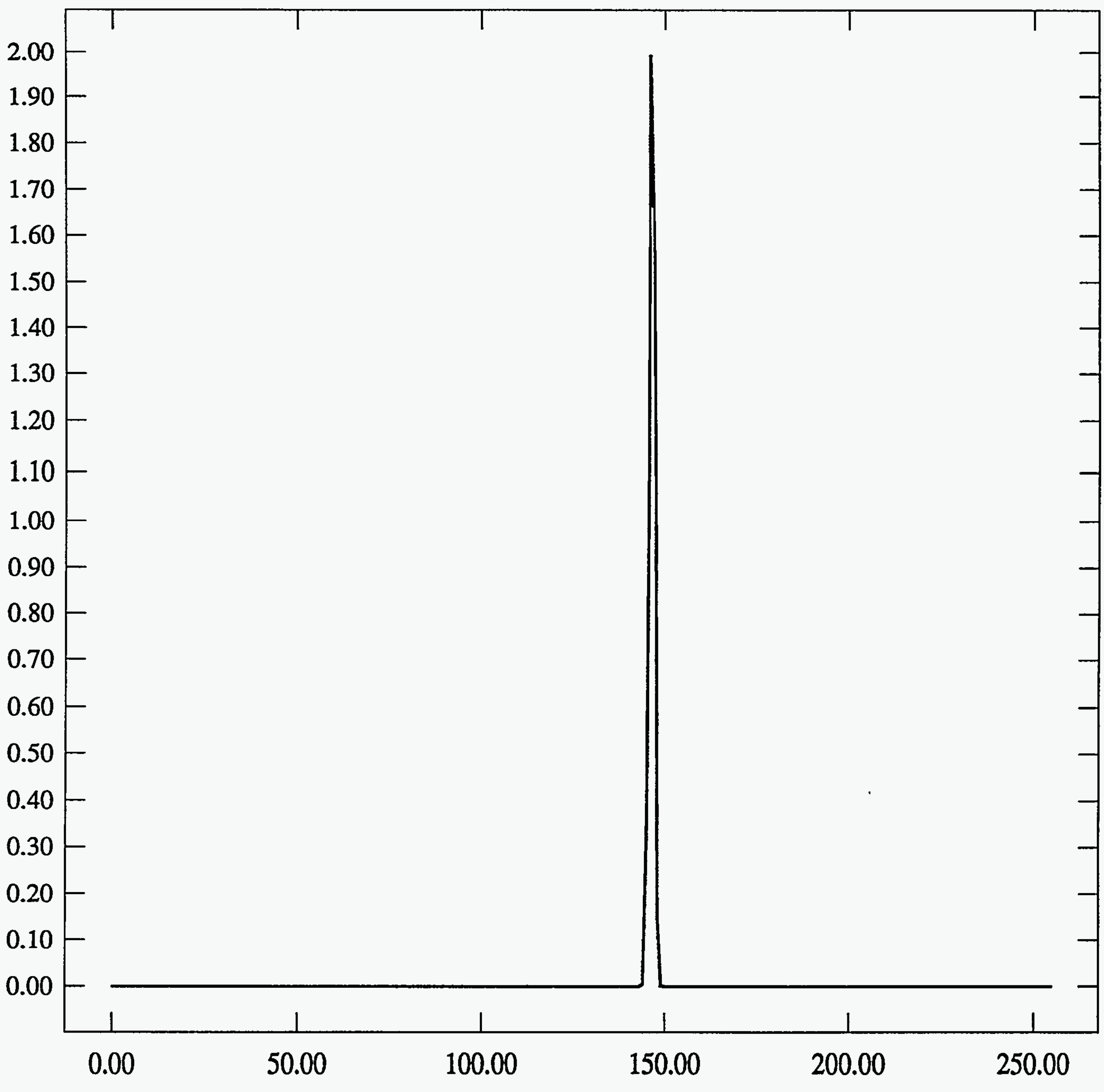
Pixel Values Min 144 Max 149 Mean 146.2 Sigma 0.70 x 10^3




ST Camera: ST1#4-10 -30C: int_time=100ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 11:06:50 1993
Pixel Values Min 144 Max 149 Mean 146.3 Sigma 0.69 x 10^3
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.00
50.00
100.00
150.00
200.00
250.00

ST Camera: ST1#4-10 -30C: int_time=200ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 11:07:05 1993

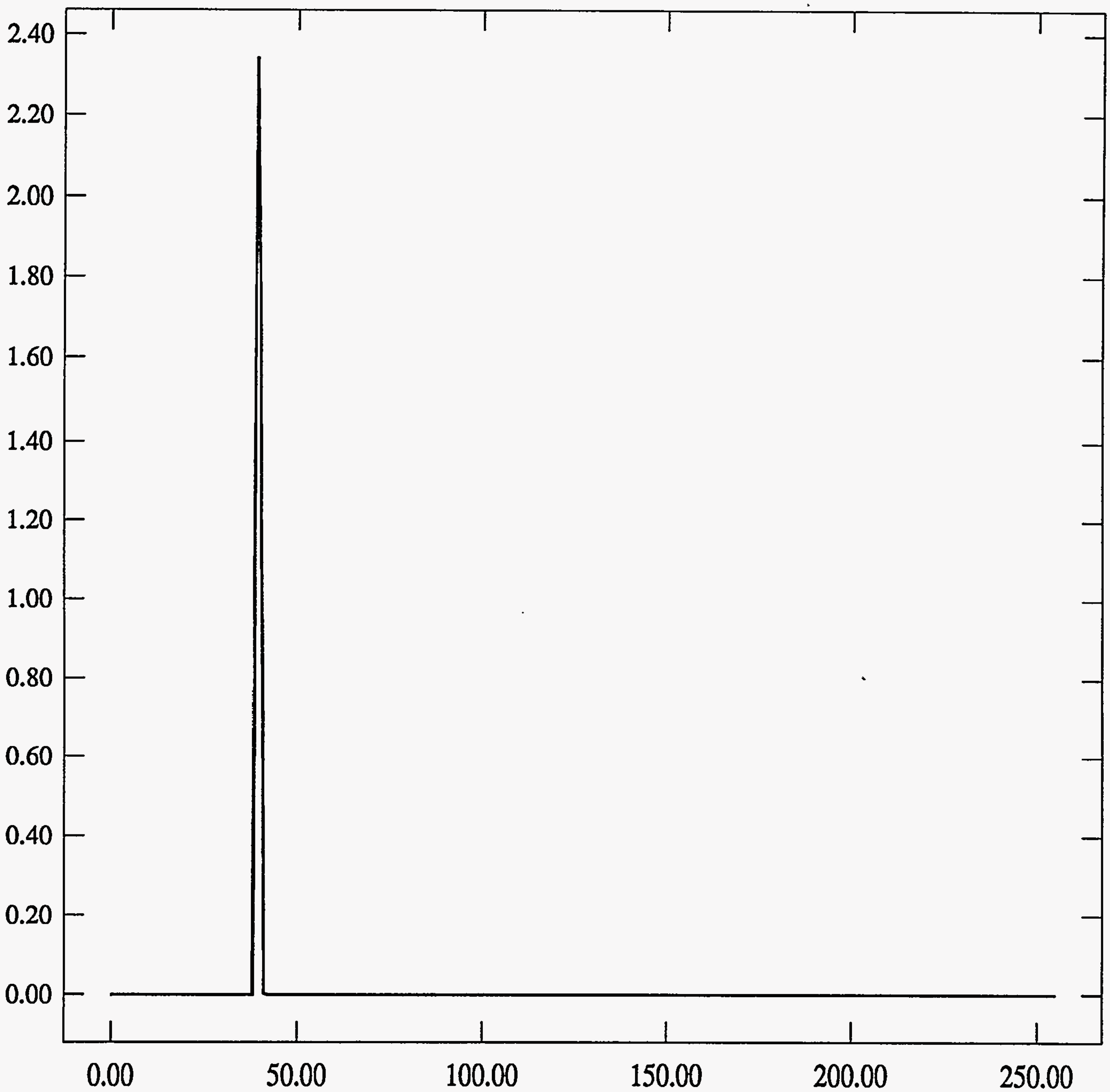
Pixel Values Min 144 Max 149 Mean 146.4 Sigma 0.70 x 10^3

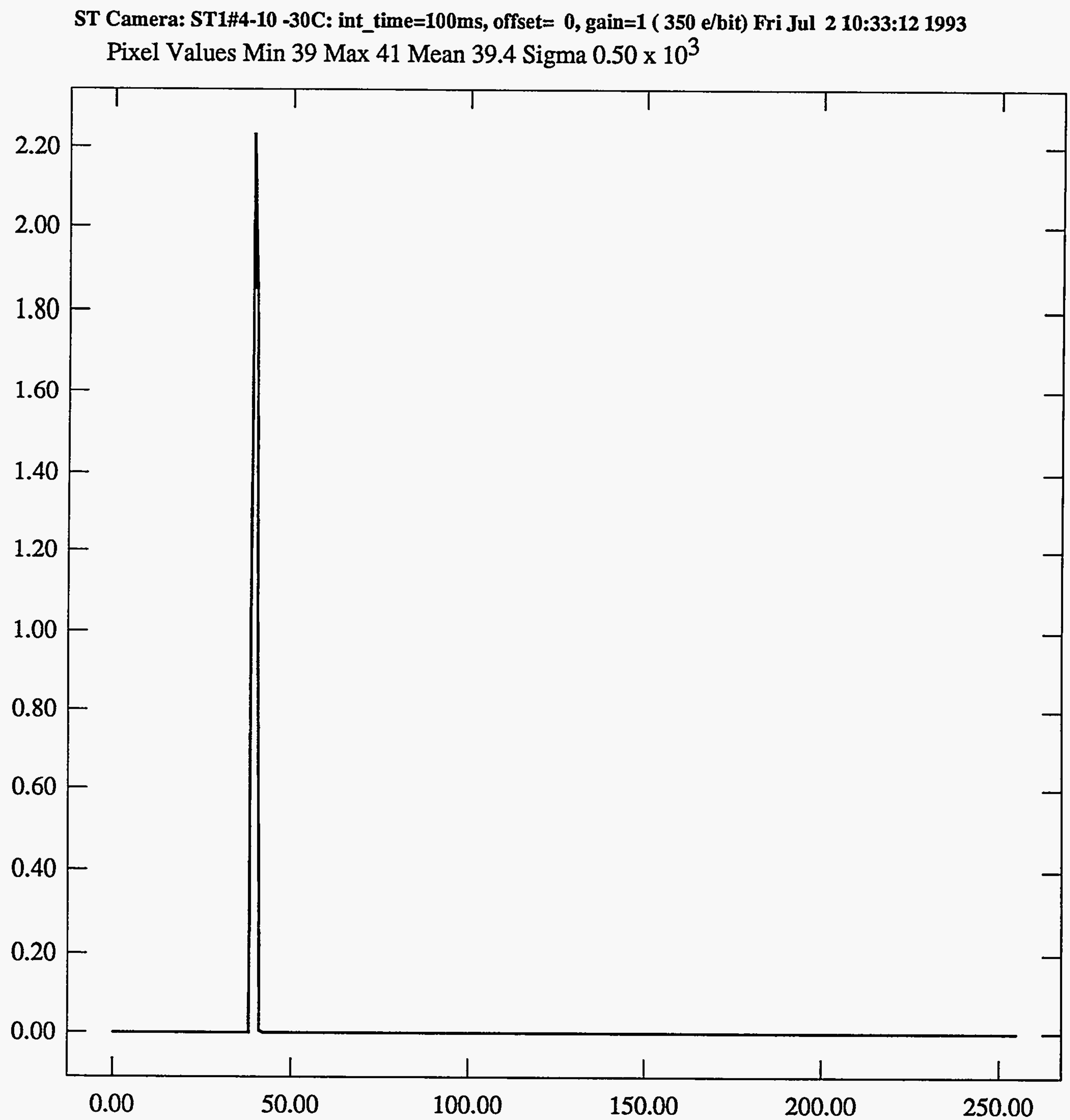


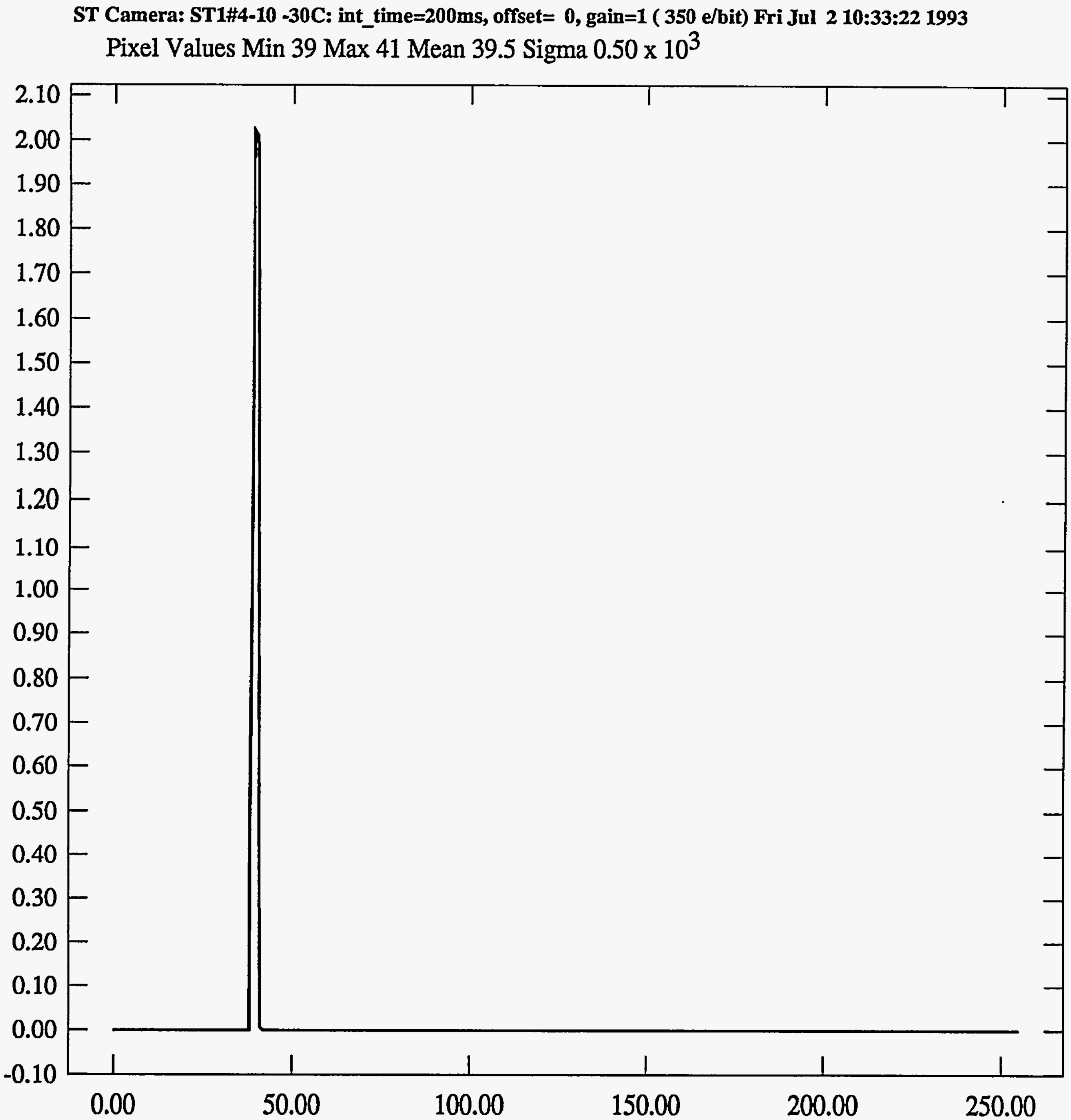
LENS HEATER ~ 30° 20 mins

ST Camera: ST1#4-10 -30C: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 10:32:59 1993

Pixel Values Min 39 Max 41 Mean 39.4 Sigma 0.50 x 10^3

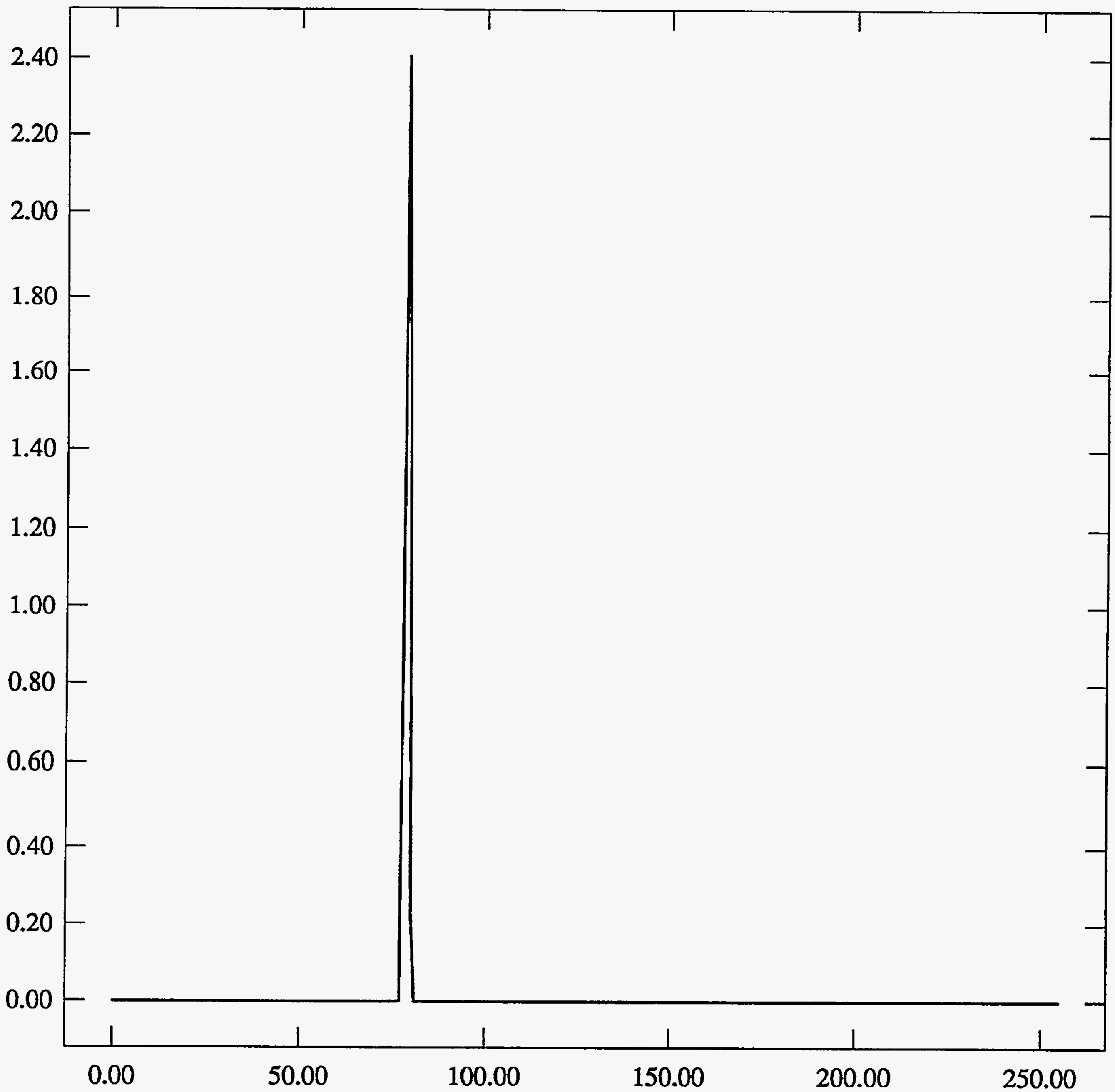



ST Camera: ST1#4-10 -30C: int_time=100ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 10:33:12 1993
Pixel Values Min 39 Max 41 Mean 39.4 Sigma 0.50 x 10^3
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00


ST Camera: ST1#4-10 -30C: int_time=200ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 10:33:22 1993
Pixel Values Min 39 Max 41 Mean 39.5 Sigma 0.50 x 10^3
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.00
50.00
100.00
150.00
200.00
250.00

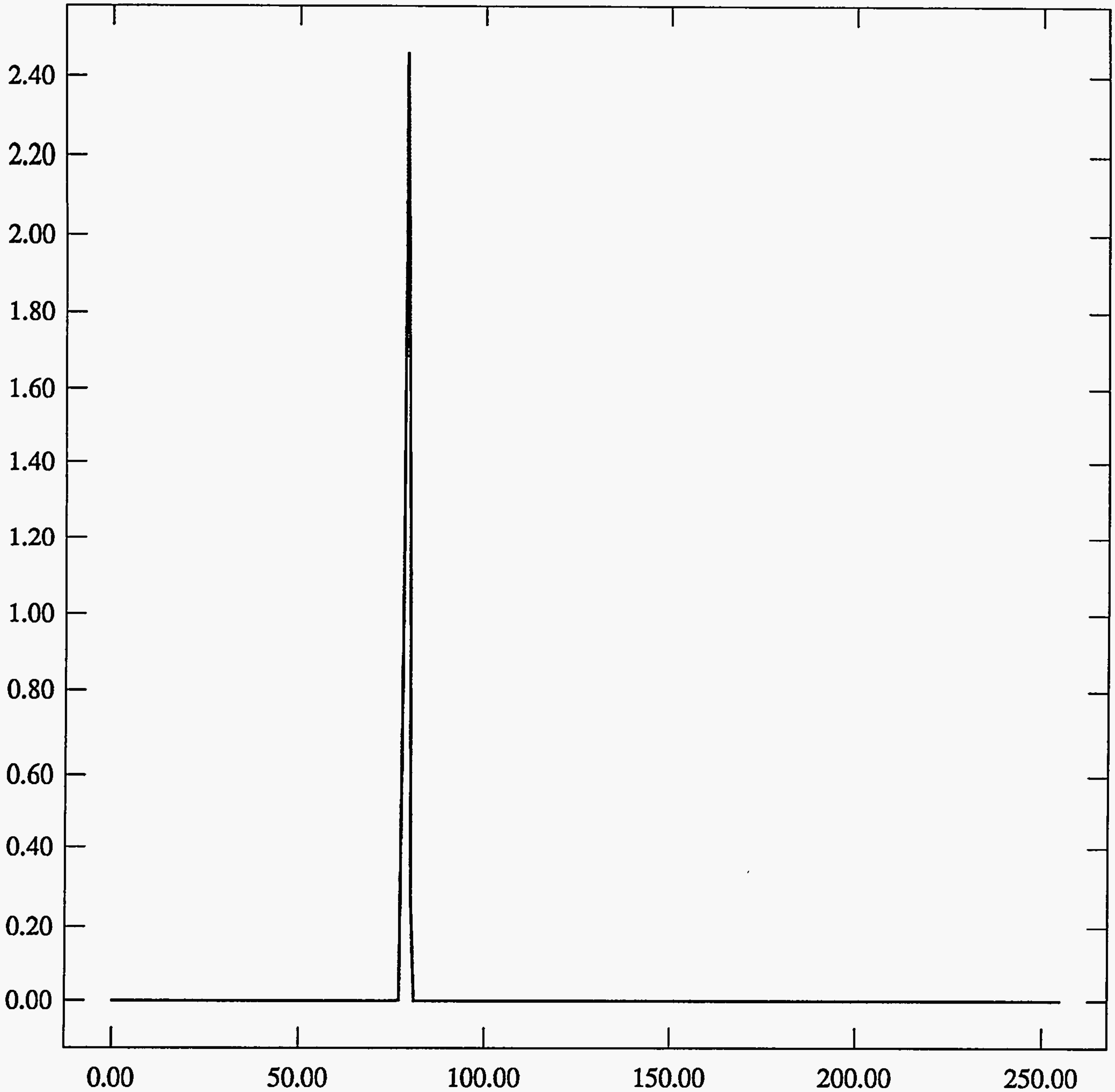
ST Camera: ST1#4-10 -30C: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 10:33:37 1993

Pixel Values Min 77 Max 80 Mean 78.7 Sigma 0.57 x 10^3



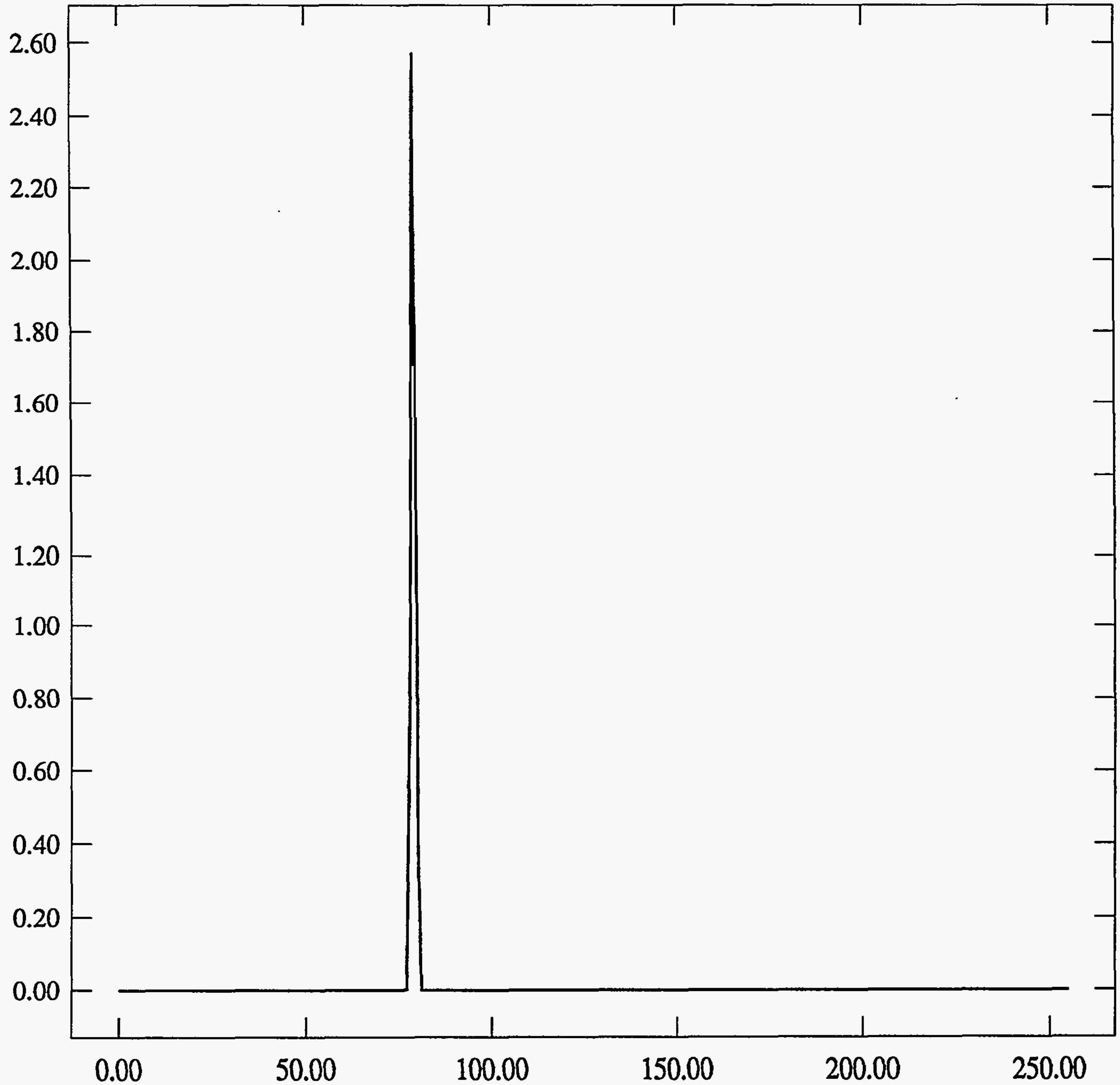
ST Camera: ST1#4-10 -30C: int_time=100ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 10:33:58 1993

Pixel Values Min 77 Max 80 Mean 78.7 Sigma 0.57 x 10^3



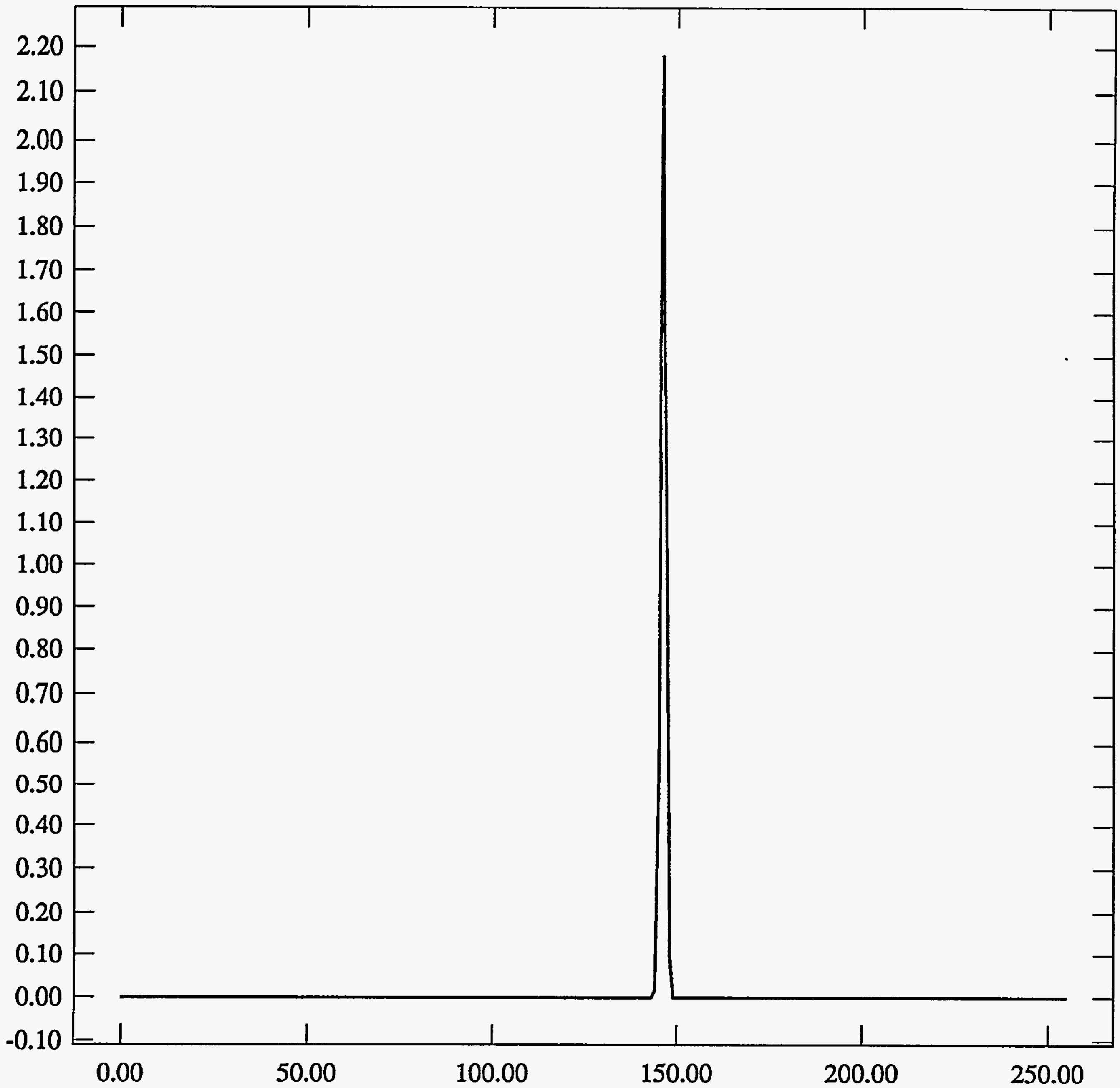
ST Camera: ST1#4-10 -30C: int_time=200ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 10:34:11 1993

Pixel Values Min 77 Max 80 Mean 78.8 Sigma 0.58 x 10^3



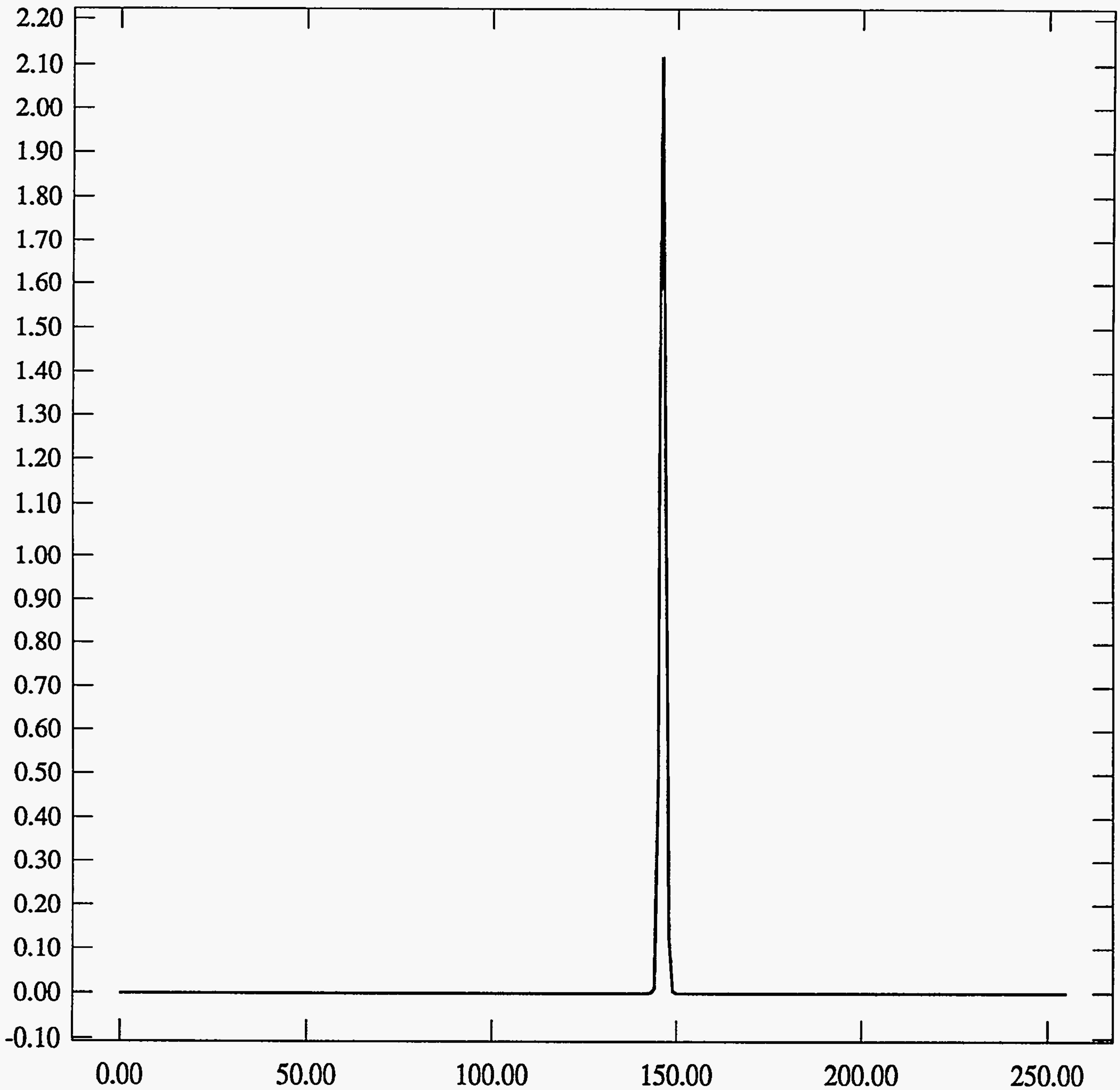
ST Camera: ST1#4-10 -30C: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 10:34:29 1993

Pixel Values Min 144 Max 148 Mean 146.2 Sigma 0.72 x 10^3



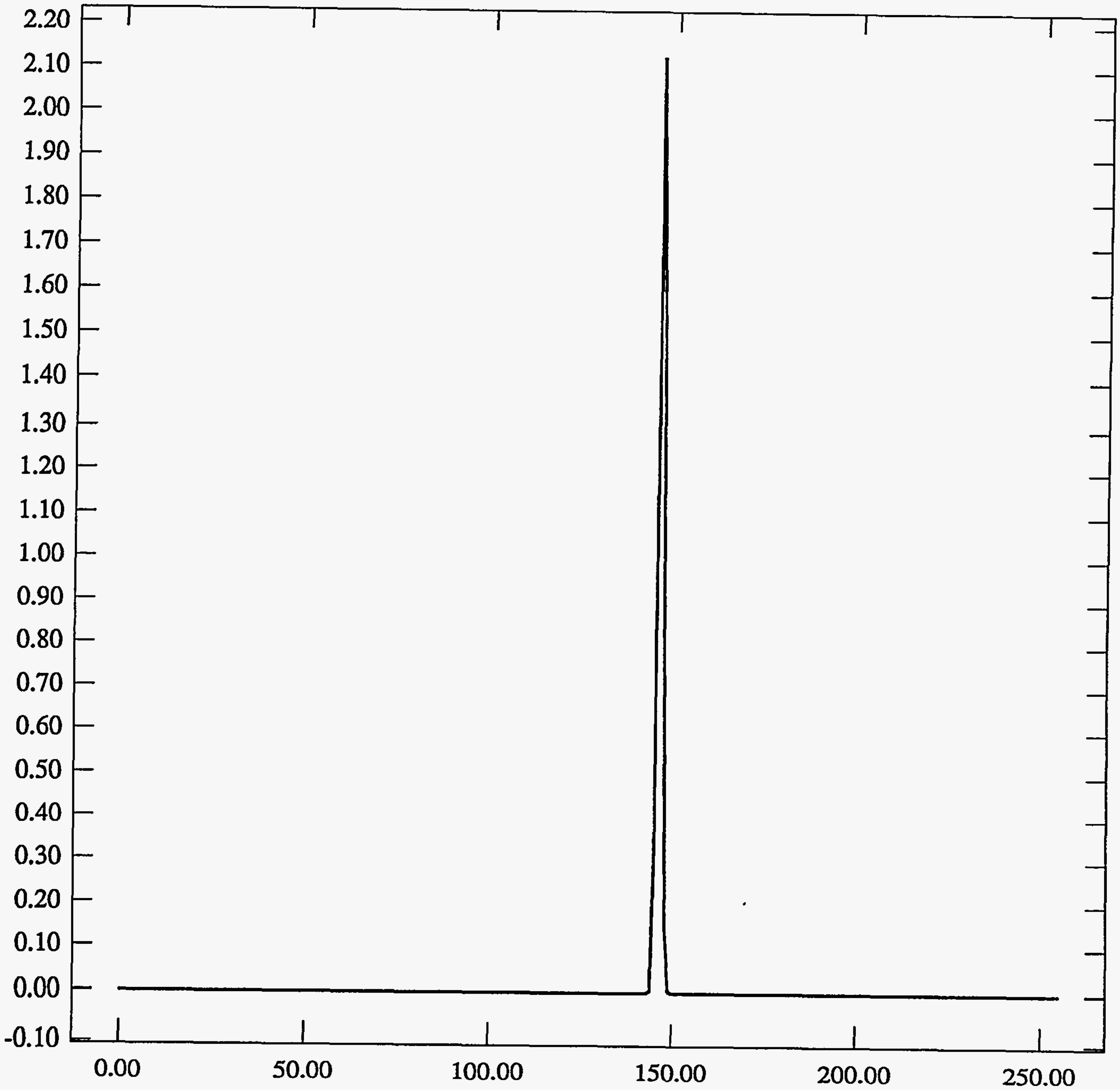
ST Camera: ST1#4-10 -30C: int_time=100ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 10:34:42 1993

Pixel Values Min 143 Max 149 Mean 146.3 Sigma 0.72 x 10^3



ST Camera: ST1#4-10 -30C: int_time=200ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 10:34:56 1993

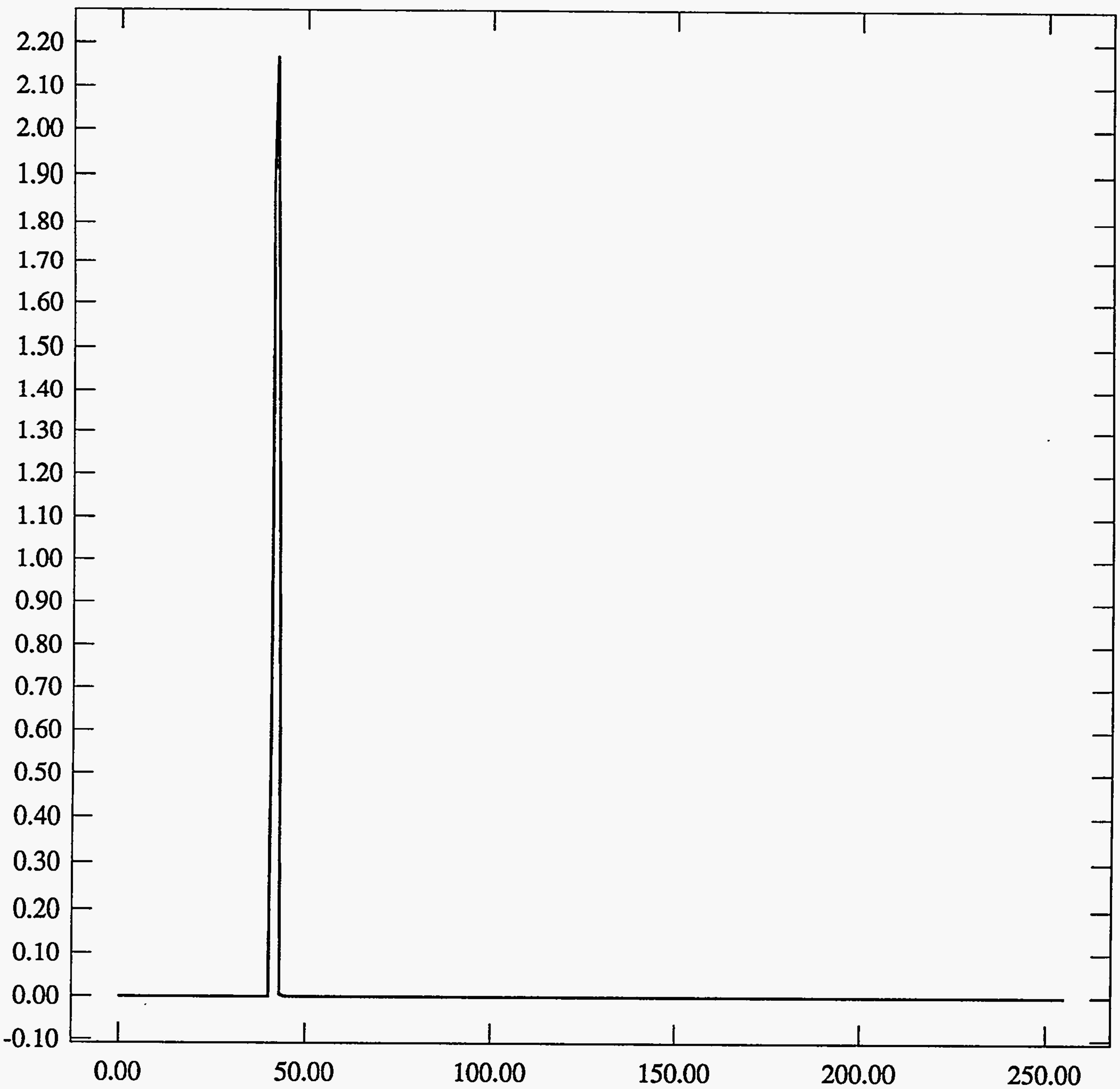
Pixel Values Min 144 Max 149 Mean 146.3 Sigma 0.69 x 10^3



INITIAL TEST

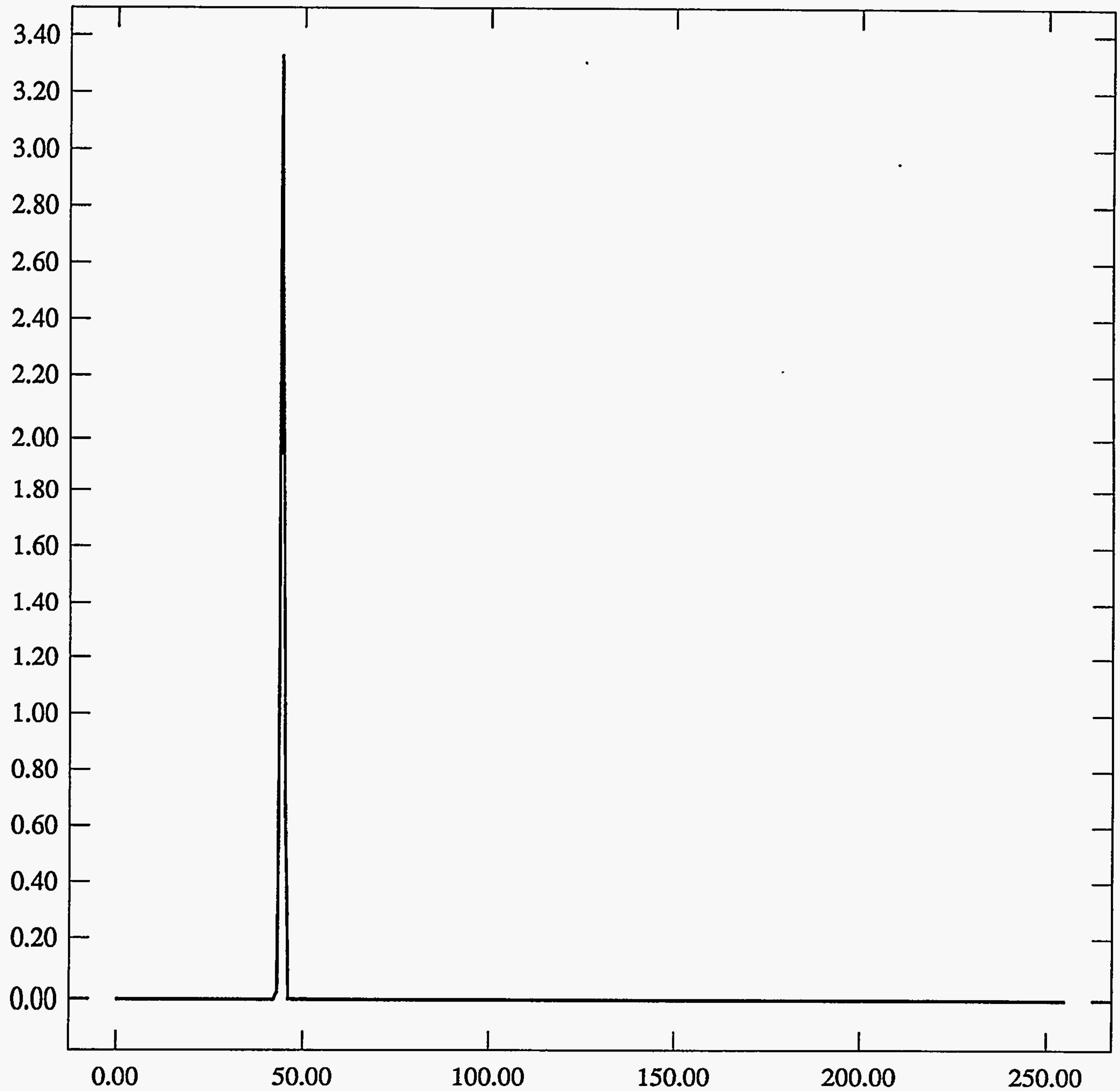
ST Camera: ST1#4-10htrtst: int_time= 50ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 09:50:09 1993

Pixel Values Min 41 Max 44 Mean 41.5 Sigma 0.50 x 10^3



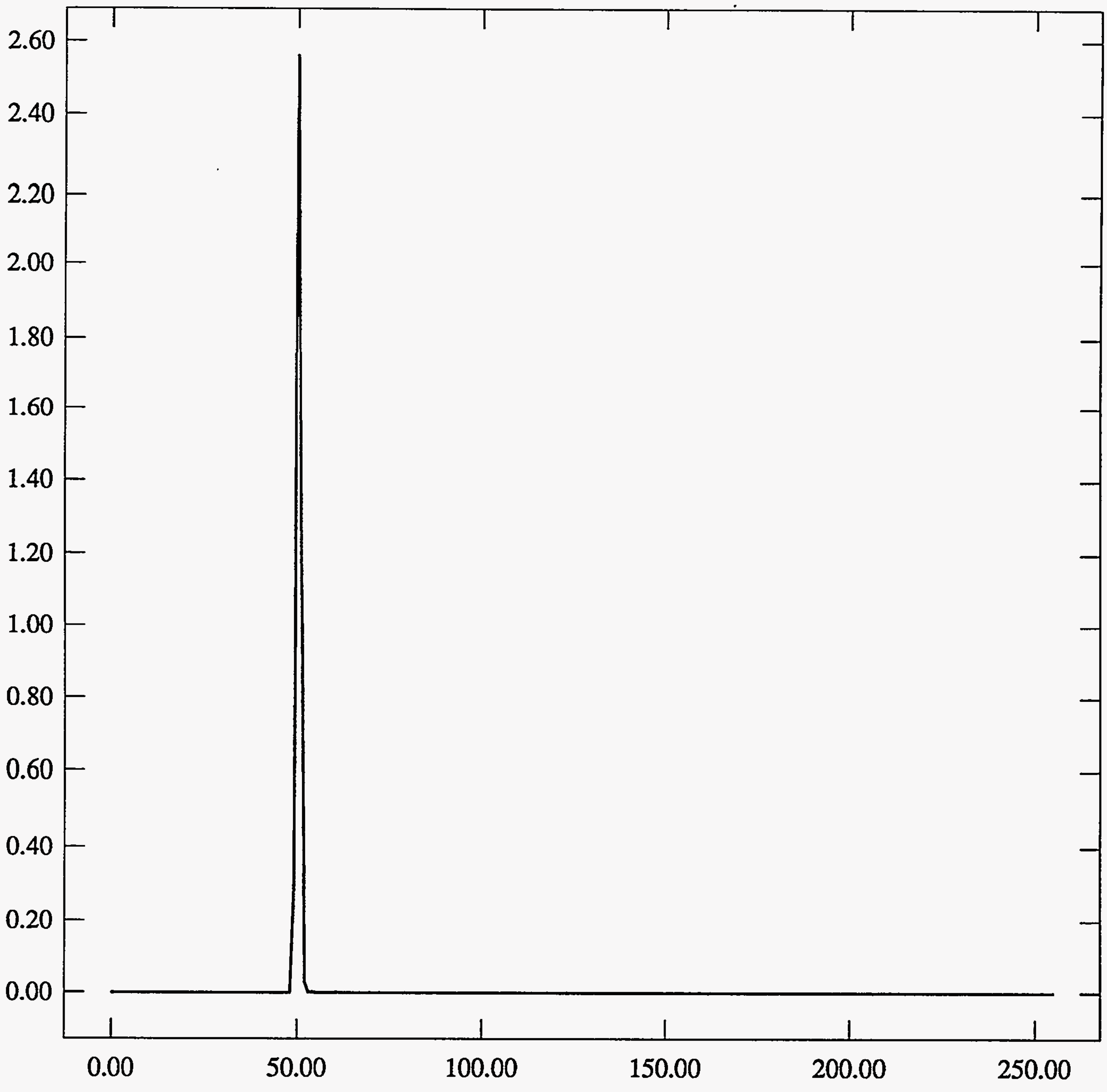
ST Camera: ST1#4-10htrtst: int_time=100ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 09:50:22 1993

Pixel Values Min 43 Max 50 Mean 44.2 Sigma 0.40 x 10^3



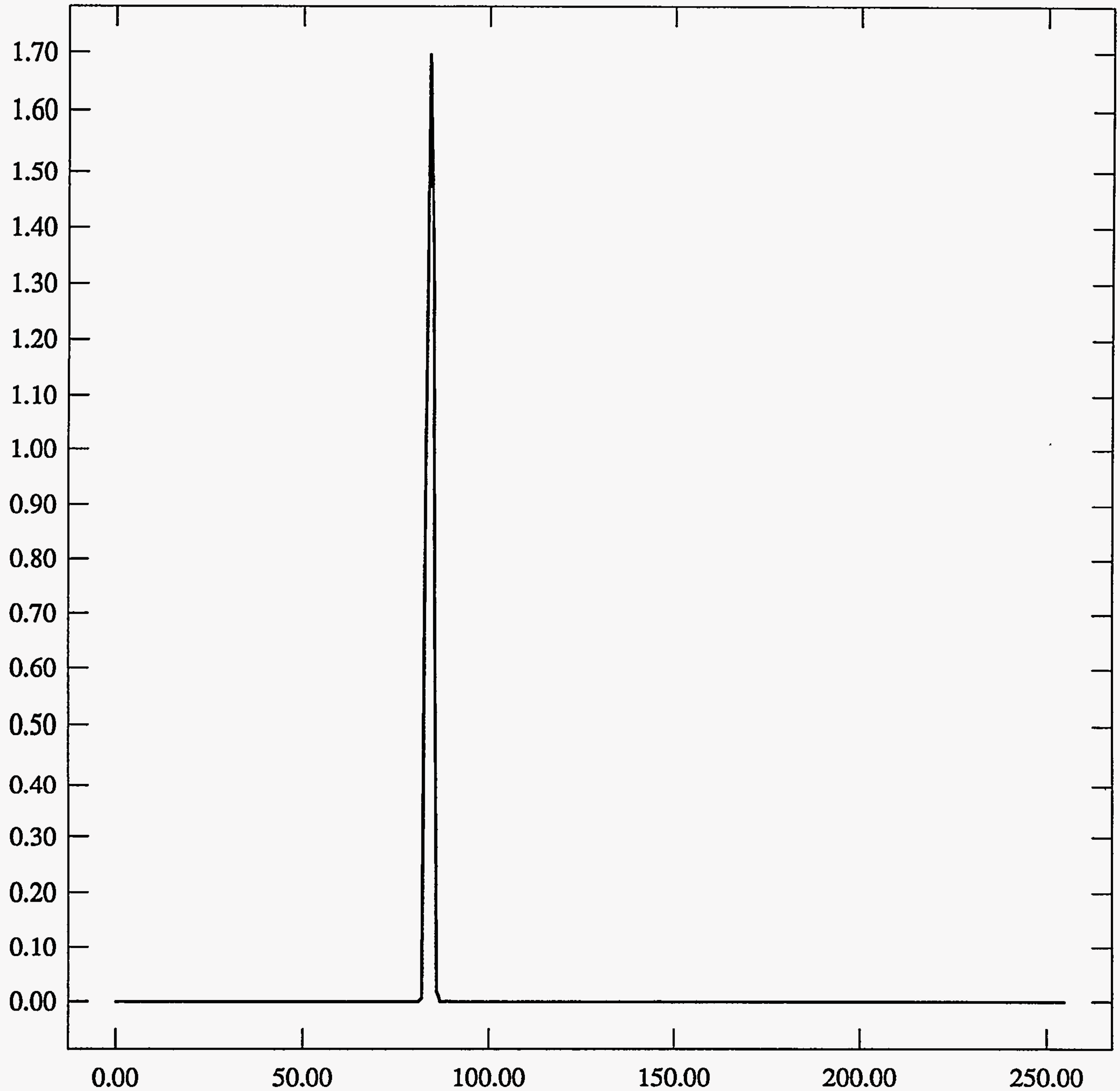
ST Camera: ST1#4-10htrtst: int_time=200ms, offset= 0, gain=1 (350 e/bit) Fri Jul 2 09:50:33 1993

Pixel Values Min 49 Max 61 Mean 50.2 Sigma 0.61 x 10^3



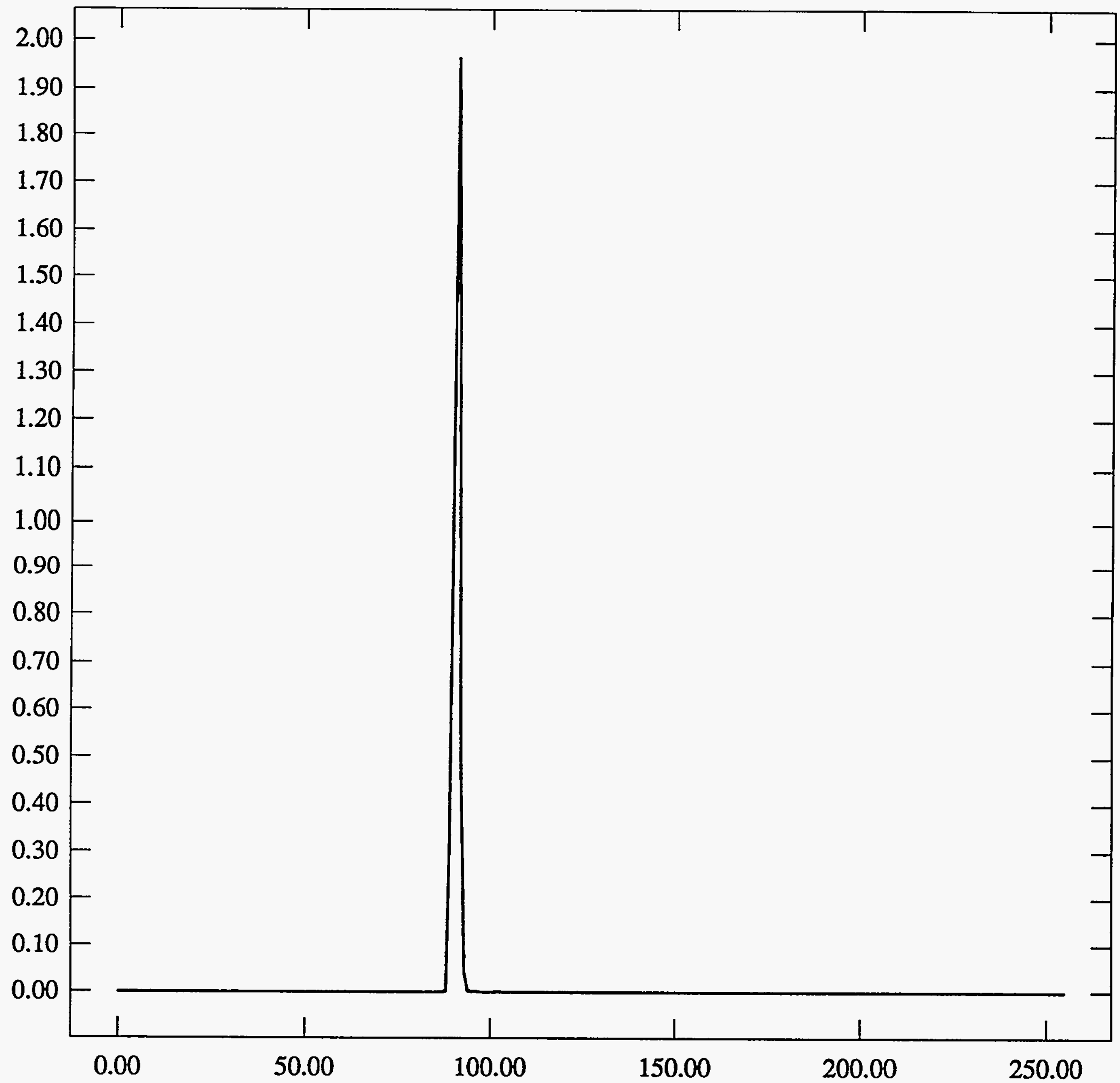
ST Camera: ST1#4-10htrtst: int_time= 50ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 09:50:44 1993

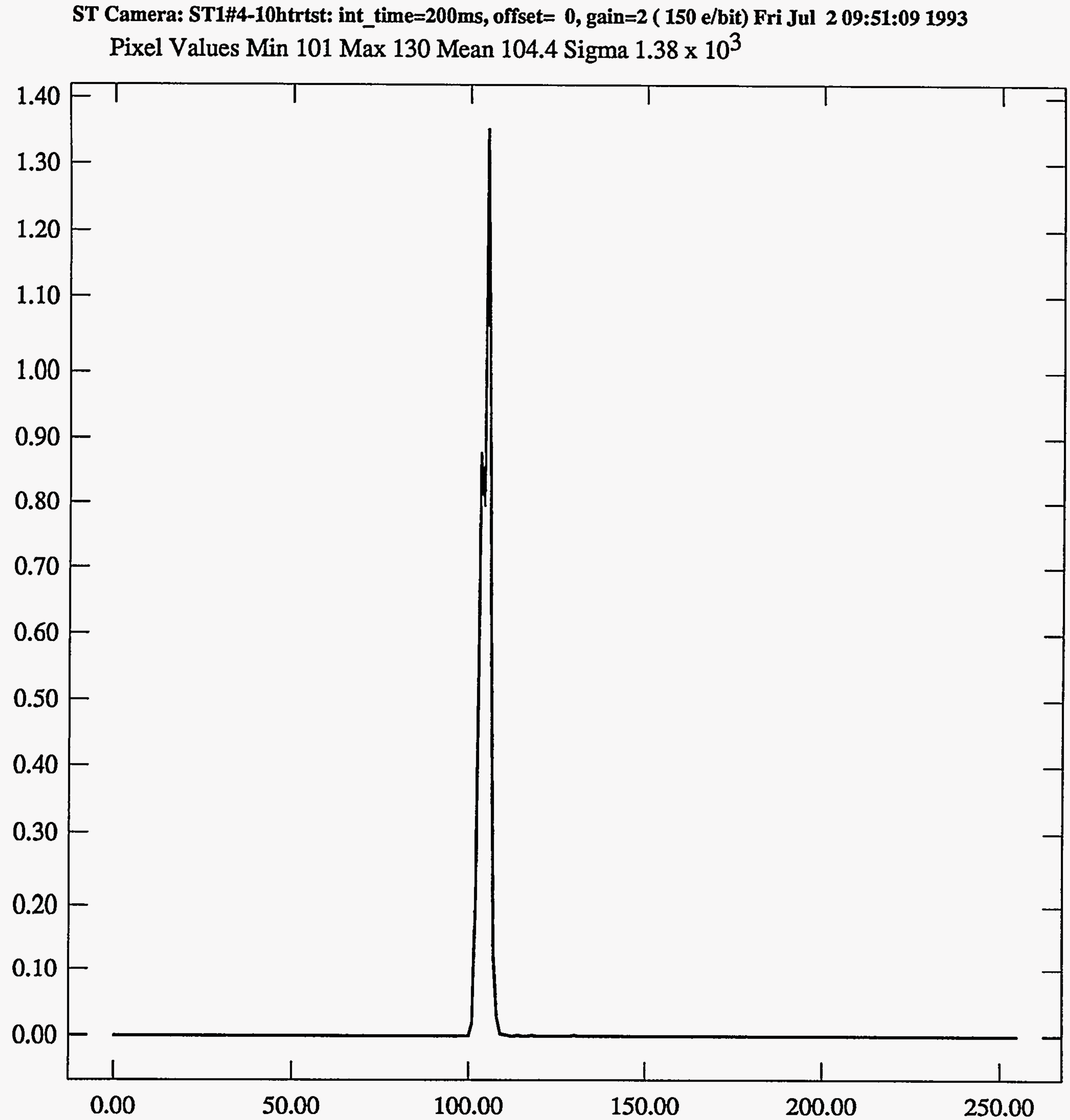
Pixel Values Min 82 Max 89 Mean 84.1 Sigma 0.77 x 10^3



ST Camera: ST1#4-10htrtst: int_time=100ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 09:50:57 1993

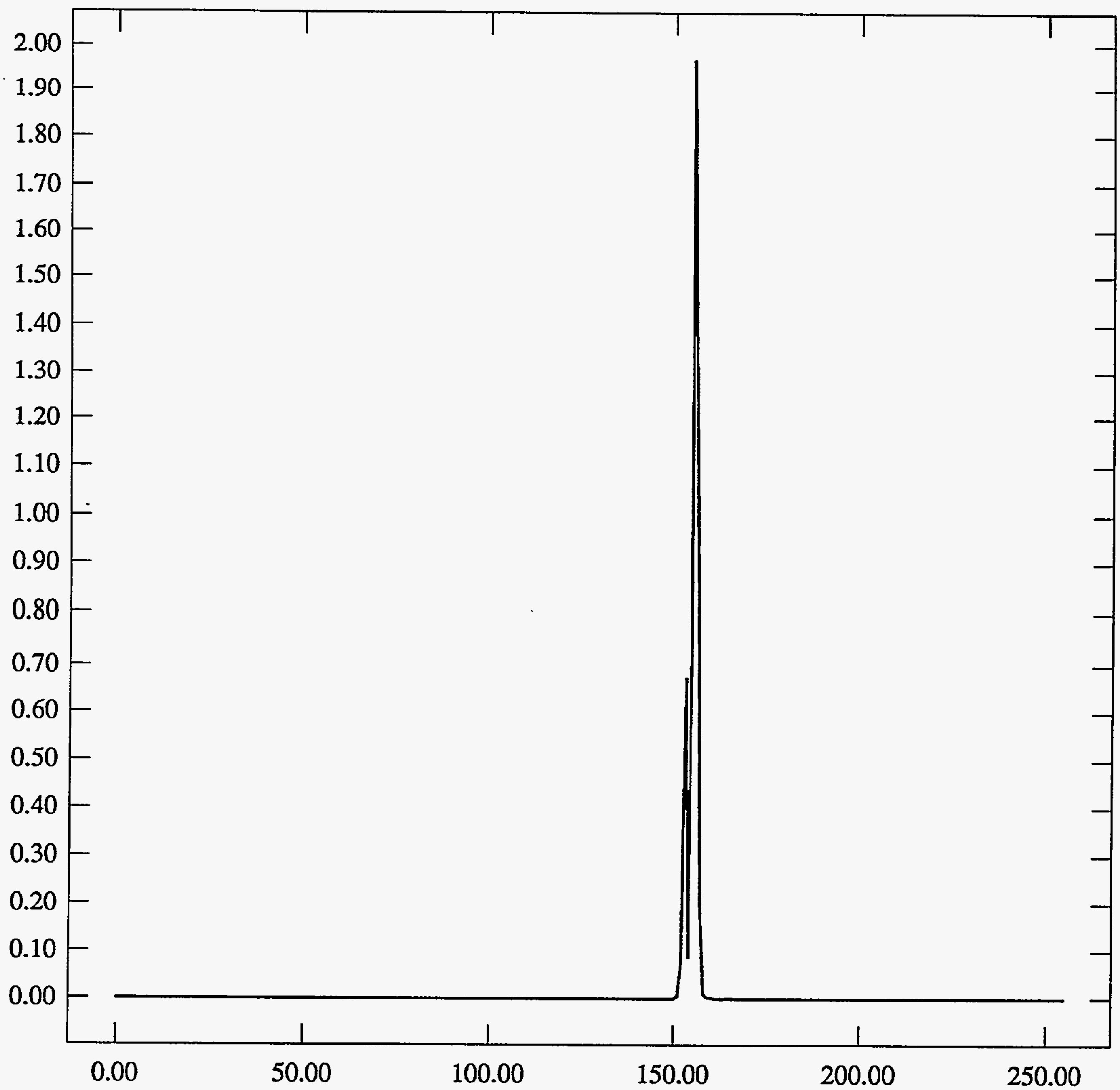
Pixel Values Min 88 Max 102 Mean 90.7 Sigma 0.86 x 10^3




ST Camera: ST1#4-10htrtst: int_time=200ms, offset= 0, gain=2 (150 e/bit) Fri Jul 2 09:51:09 1993
Pixel Values Min 101 Max 130 Mean 104.4 Sigma 1.38 x 10^3
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
50.00
100.00
150.00
200.00
250.00

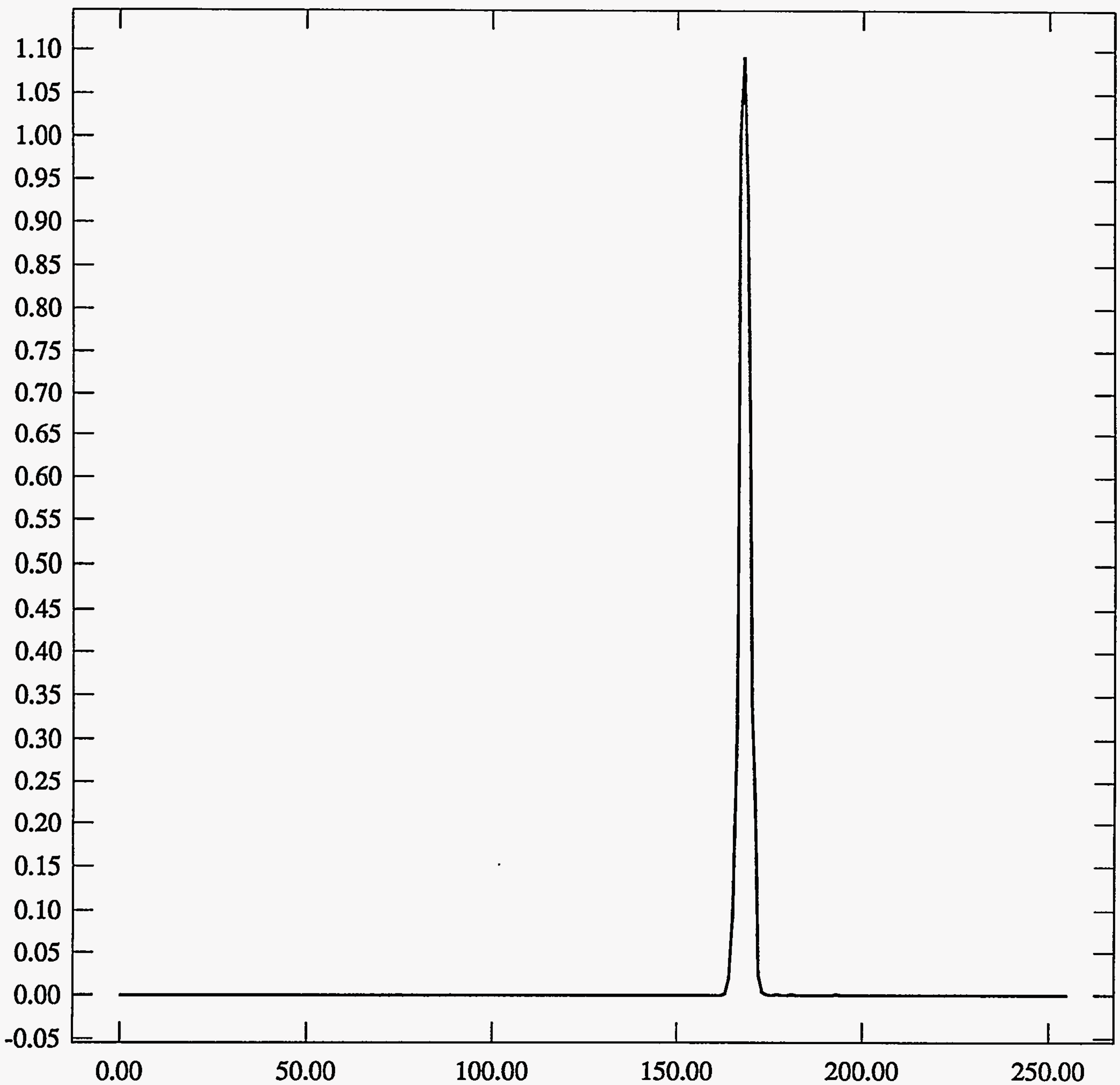
ST Camera: ST1#4-10htrtst: int_time= 50ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 09:51:26 1993

Pixel Values Min 151 Max 165 Mean 155.0 Sigma 1.18 x 10^3



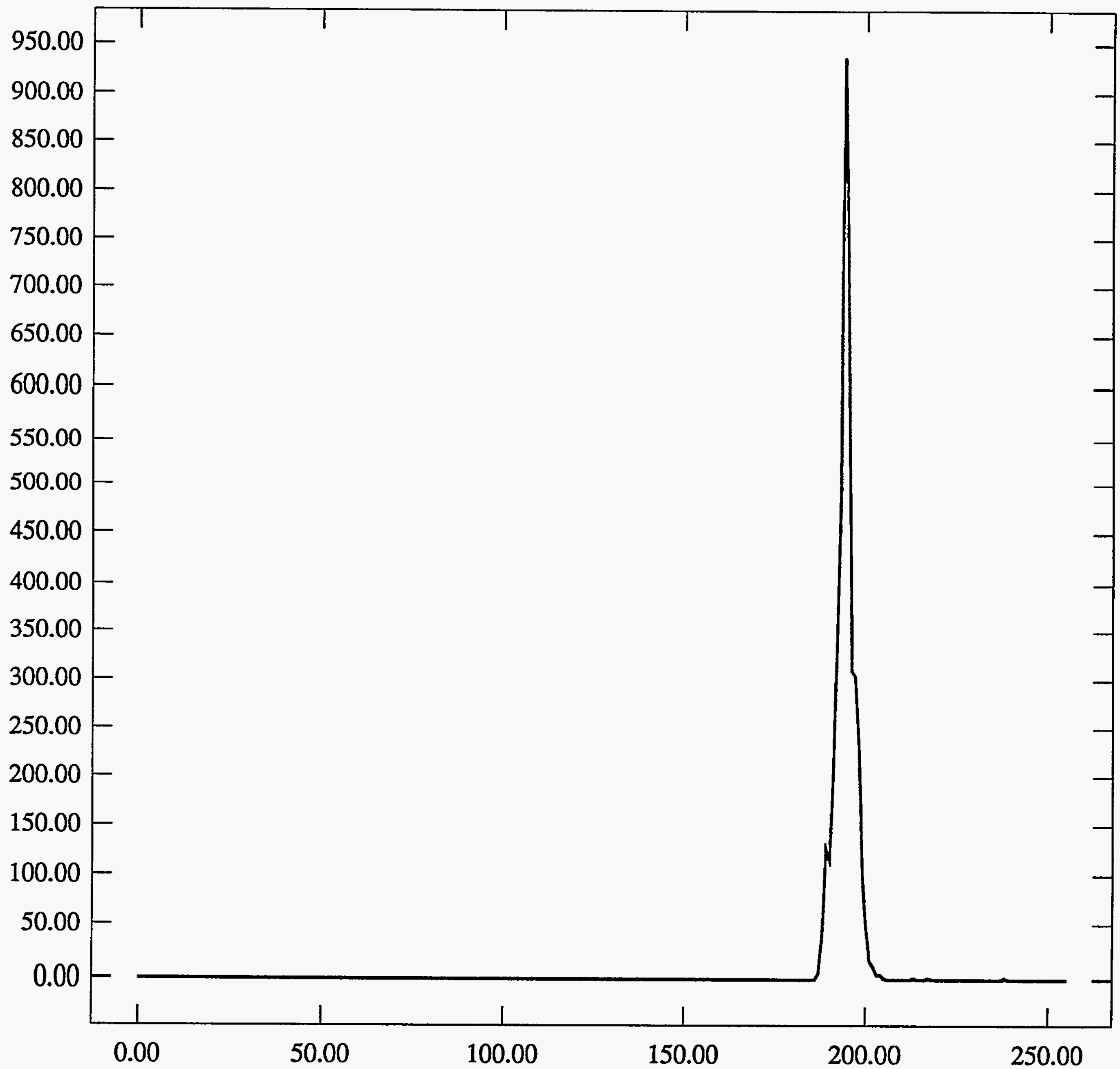
ST Camera: ST1#4-10htrtst: int_time=100ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 09:51:42 1993

Pixel Values Min 163 Max 193 Mean 168.1 Sigma 1.50 x 10^3



ST Camera: ST1#4-10htrtst: int_time=200ms, offset= 0, gain=4 (75 e/bit) Fri Jul 2 09:51:58 1993

Pixel Values Min 187 Max 238 Mean 194.3 Sigma 2.62



Appendix I
Miscellaneous

Appendix I.1

Clementine Sensor Test Acceptance Procedure for ST 313

Clementine

Sensor Test Acceptance Procedure

Submit Comments to:

Robert F. Hills
Lawrence Livermore National Laboratory
510.423.7344 Office
hills1@llnl.gov EMAIL

RECORD OF CHANGES

Revision Letter	Date	Title or Brief Description	Entered by
Draft	7 July 1993	Working Draft	RFH
Draft-A	13 July 1993	Modified to expand test procedure steps	RFH
Draft-B	15 July 1993	Modified for corrections and additional steps	RFH
Draft-C	27 July	Modified for corrections and additional steps	RFH

Sensor ID: ST 313 **Date Verified:** 8-2-93

Verification Eng/Tech : NRS / DPN

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1 Overview

1.1. Scope

This document is the LLNL Clementine sensor acceptance test procedure for the DSPSE spacecraft. It defines the optical, mechanical, thermal, electrical, and software tests necessary to verify the functionality of the sensors for the Clementine Sensor Integration Project at NRL

The subsystems associated with the sensor data acquisition verification process are shown in Figure 1.1.

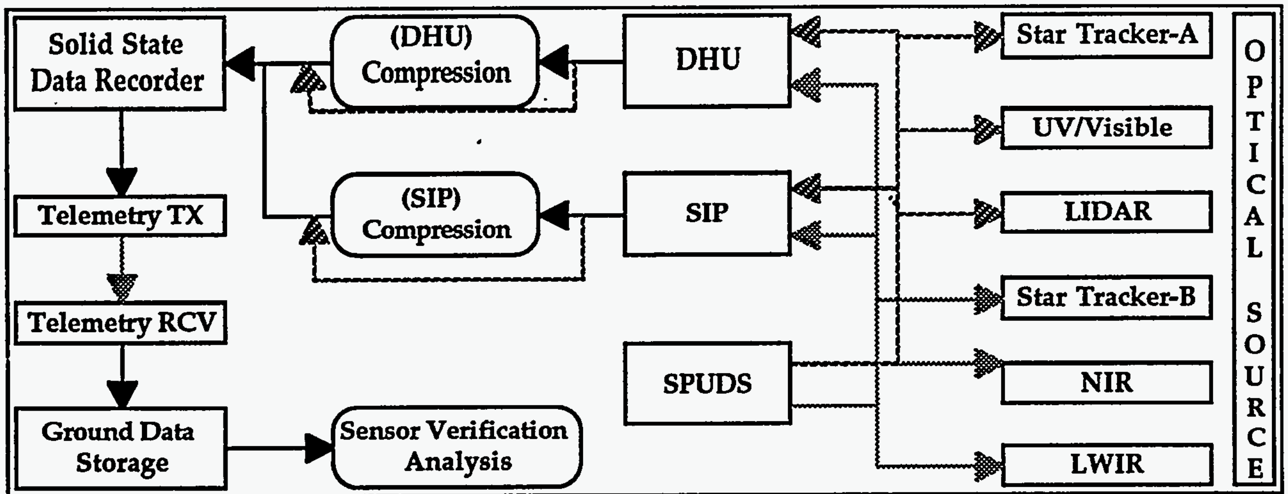

Figure 1.1 Sensor Test & Verification Subsystems

LLNL will provide a Pre-Integration Sensor Acceptance Testing, verification, and a debug platform using interfaces which imitates the S/C interface. The LLNL Setup is shown in Figure 1.2

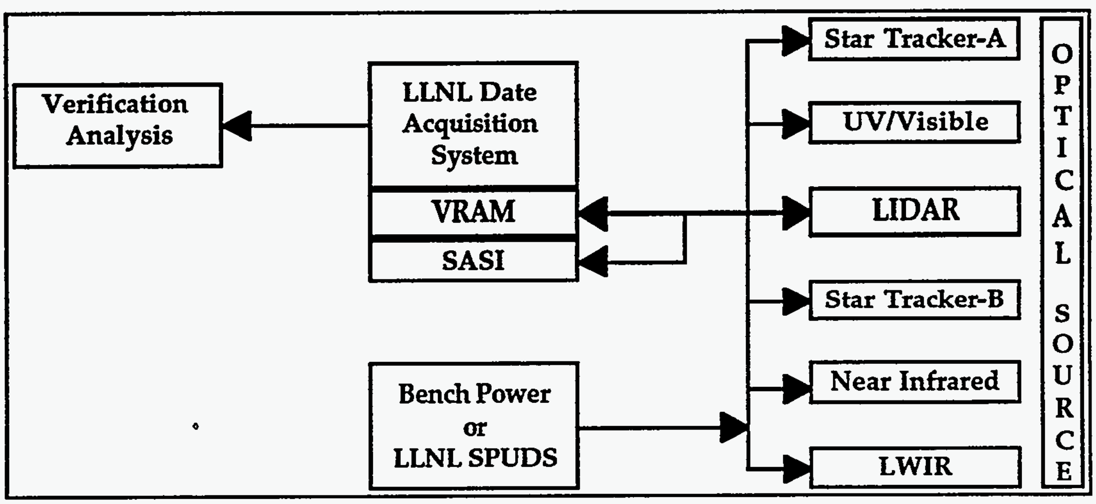

Figure 1.2 Pre-Spacecraft-Integration Sensor Verification Model

1.2. Verification Modes

Two verification modes are defined for this verification plan. These are 1) Functional verification and 2) Performance Verification.

Functional verification is defined as an application of a test at nominal spacecraft conditions; i.e. voltages and ambient (room) temperatures. These environmental parameters must be maintained within the acceptable ranges for all components included in the test and are summarized below.

Performance verification is defined as an application of a test at the full range of space conditions; i.e. Max-min voltages and temperatures. These environmental parameters must be maintained within the acceptable ranges for all components included in the test and are summarized below.

Each verification test in this plan will include the operational parameters (for temperature, voltages, etc.) that are necessary for the above listed verification modes.

1.2.1. Verification Tests

The followings tests will be performed on each sensor:

- Sensor Physical Examination (LLNL)
- Filter Positioner (LLNL)
- Electrical Wave-form (LLNL)
- SASI Command Set (LLNL)
- Dark Field (LLNL)
- Image Field Analysis (LLNL)
- Flat Field (LLNL)

The Naval Research Laboratory will need to provide the additional tests listed below to complete the test suite for the sensors at NRL.

- Radiometric Sensitivity (NRL)
- Point Spread Function (NRL)
- SIP-DHU-Sensor Interface (NRL)
- Sensor Timeout (NRL)
- Image Compression/Decompression (NRL)
- Boresight Alignment (NRL)
- Sensor Data Telemetry (NRL)
- Sensor Software Algorithms (NRL)

Each of the procedures allows a comparison to the calibrations performed at LLNL. A comparison of the results of the sensor verification tests and the LLNL calibrations will be made.

1.3. Documents

1.3.1. LLNL Documents

Interface Control Documents

C1-S4-008	LIDAR High Resolution Camera/Range Receiver
C1-S4-011	LIDAR Laser Transmitter Assembly
C1-S2-008	UV/Visible Camera
C1-S1-010	Star Tracker Camera
C1-S3-008	Near Infrared Camera
C1-S3A-006	Long wave Infrared Camera

Performance Specifications

TBD	LIDAR High Resolution Camera/Range Receiver
TBD	LIDAR Laser Transmitter Assembly
TBD	UV/Visible Camera
TBD	Star Tracker Camera
TBD	Near Infrared Camera
TBD	Long wave Infrared Camera

1.4. Environments & Handling Procedures

1.4.1. Anti Static Environment

The sensors are electrostatic sensitive devices and will be handled in a manner so as to prevent damage due to static charge. This will include the grounding of the operator (grounded wrist band), camera, working surface, and conductive floor mats to a common point. The sensors will be sealed in a anti-static bag before leaving the anti-static environment and will be packed in its aluminum case when being transported.

1.4.2. Contamination

All sensors must be maintained within a contamination environment specified in their ICD's. The Sensor usage and environment must be logged in order to maintain the proper level of contamination prior to flight. Analysis of exposure levels and usage will be periodically verified.

To prevent dust from accumulating on the optics, a mask and lint-free gloves shall be worn when in close proximity to the uncovered sensor. The sensor lens and baffle shall be covered at all times when the camera is not in use.

1.4.3. Temperature

Temperature limitations placed upon the sensors are in terms of the Base Plate temperature, CCD temperature and the lens temperature. The base plate temperature limits are specified to protect the electronic and mechanical parts from thermal damage. The CCD temperature limits are primarily concerned with achieving required CCD performance. The lens temperature limits are concerned with the performance of the STC optics and the protecting them from thermal damage. The various temperature limits are described below:

1- Operational-In-Spec – This is the temperature range which is required in order to achieve sensor performance requirements.

2- Operation-Out-Spec – This is the temperature range which is required in order to prevent damage to the sensor while maintaining a functional state. Damage and/or a reduction in reliability can occur to a sensor because the electronic junction temperatures are outside operating limits. This temperature limit will prevent the worst case electronic component from exceeding its maximum, derated, junction temperature. Maximum junction temperatures are derated according to thermal design and reliability requirements.

During all tests the CCD, base plate , and where appropriate, lens temperatures must be monitored on a continuous basis. If the node temperature exceeds the specifications listed in the sensor ICD, then the test must be terminated until all temperature conditions return with the specified limits.

Table x.x.x Sensor temperature range Summary

Requirements (°C)	StarTracker		UV-VIS		NIR		LWIR		HiRes		Laser		Suite	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Base Plate:														
Operational In-Spec	-20	2	-20	2									-20	2
Operational Out-Spec	-20	10	-20	25									-20	10
Non-Operating	-40	70	-35	50									-35	50
CCD:														
Operational In-Spec	-20	10	-20	10									-20	10
Operational Out-Spec	-20	60	-20	25									-20	25
Non-Operating	-40	85	-40	50									-40	50
Lens:														
Operational In-Spec	-20	40	-20	40									-20	40
Operational Out-Spec	-30	70	-30	50									-30	50
Non-Operating	-30	70	-30	50									-30	50

1.4.4. Humidity

The environment in which the tests are to take place shall be maintained at a relative humidity between 40 and 70%. At no time shall condensation occur.

2 Physical Verification

Operator: DPN/LRS Date: 8-2-93

2.1. Applicable Sensors:

- [x] StarTracker 313
- [ ] UV-VIS
- [ ] HiRes
- [ ] Laser Transmitter
- [ ] NIR
- [ ] LWIR

2.2. Data Storage Locations:

Images: NONE
Temp : NONE

2.3. Purpose:

Upon arrival of each sensor at NRL, a physical examination will be performed to check for any damage that may have occurred during shipping. This will include verification of the serial number and a visual check of the structure, optics, baffles, and all connectors.

2.4. Test Environment & Procedure

- [x] Verify that the sensor Certification Log has an exposure log in the front of the book, and that it has been started.
- [x] Verify that the sensor Certification Log has work sheets to log all sensor activities and has been started.
- [x] Unpack the sensor using the "Sensor Activity Log Sheet LLNL-SAL 0624 (Enter Number here) , "Preparation & Grounding" section. Note on the LLNL-SAL that other sections are skipped due to the nature of the verification test.
- [x] Log the execution of the "LLNL Physical Examination Test" in the sensor certification log.

Log or verify the following:

- [x] Verify that the sensor has the proper sensor identification and LLNL property tag. (NO ID)
- [x] Verify that Sensor shorting plugs are present.
- [x] Verify the presence of connector savers on all sensor connectors.
- [x] Verify that the sensor has a baffle cover and that it is labeled to its sensor
- [x] Note any loose screws, broken staking, or other physical damage.
- [x] Note the condition of the optics and any contamination found.
- [x] Verify that the sensor has flying leads for the lens temperature, and lens heater and that ther is no apparent damage.

- ❑ Store the sensor using the "Sensor Activity Log Sheet (LLNL-SAL), "Securing the Sensor" section.
- ❑ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

2.5. Performance Analysis & Reporting Criterion

No post processed data reduction is necessary for this test. The report shall contain a detailed description of the results of the examination steps outlined in the test procedure.

3 Filter Positioner Test

Operator: DRW/NRS Date: 8-2-93

3.1. Applicable Sensors:

☑ StarTracker 313 ☐ UV-VIS ☐ HiRes
☐ Laser Transmitter ☐ NIR ☐ LWIR

3.2. Data Storage Locations:

Images: NONE
Data: /dspse/<Sensor>/filterPos/date/<sensorname.filtertest>
Temp : /dspse/<Sensor>/filterPos/date/temperature_log_data

3.3. Purpose:

Verify the step operation and position status of the sensor's filter wheel.

3.4. Test Environment & Procedure

Star Tracker

☑ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)

☐ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> - LLNL-SAL-xxxxx.temp.
Example: UV311-LLNL-SAL-0016.temp

☐ Log the execution of the "LLNL Filter Positioner Test" in the sensor certification log.

☐ Step, settle and read the filter on the sensor using the filter position driver software "filterStepTest" for 1000 revolutions of the filter wheel.

☐ When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.

The software will verify that the filterwheel stops at the correct position each time by comparing the SASI command expected position (software state machine) and the position obtained by sending a SASI request for filter position command.

☐ Note Any exceptions in the test

☐ Store the sensor using/completing the "Sensor Activity Log Sheet (LLNL-SAL)

☐ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

3.5. Performance Analysis & Reporting Criterion

Note any software exeception that were generated (due to mis synchronization of the software state machine and the physical hardware).

Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.

4 Electrical Waveform Verification Test

Operator: ________________ Date: ____________________

4.1. Applicable Sensors

- ☑ StarTracker 313
- ☐ UV-VIS ____________
- ☐ HiRes ____________
- ☐ Laser Transmitter ____________
- ☐ NIR ____________
- ☐ LWIR ____________

4.2. Data Storage Locations

~~Images:~~ ~~NONE~~ ST313-LLNL-SAL.0024

Temp: /dsps~~e/<SensorID>/waveform/date/temperature_log_data~~

4.3. Purpose

Verify the sensor logical waveform tranisitions, timings, switching characteristics in a single [OPTIONAL: or multiple] sensor bus environment.

Verify that the sensor powers up with its bus drivers tri-stated.

4.4. Test Environment & Procedure

- ☑ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)
- ☑ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> -'LLNL-SAL-~~xxxxx~~ 0024.temp.
  Example: UV311-LLNL-SAL-0016.temp
- ☑ Log the execution of the "LLNL Electrical Waveform Test" in the sensor certification log.
- ☑ Run this test at ambient conditions, monitor and logging temperature profiles of the CCD and baseplate temperature.

Use the Lecroy Oscilloscope and set the following Parameters.

- ☑ Lecroy Function E: is ON and set to Math function: (Channel1 - Channel2)
  Place the raw data differential output (channel1) on the top of the screen, and the (Channel1 - channel2) subtraction on the bottom of the screen.
- ☑ Calibrate the probes to a flat response on the Scope calbiration point. Then Remove any bias from the probes for the channel-1 - Channel 2) subtraction function.
- ☑ Run the program "tv" on the Sun system.

Using an integration time of 100ms obtain plots of each of the following differential driver outputs at the MDM-51 Breakout Box:

Signal	MDM-51 DiffSig Pin#	MDM-51 DiffSig.N Pin#	Vram U#Pin #	Time /Div	Volage/Div
Hsync	12	11	U11 P3	20 µSec	5.0
Vsync	45	28	U11 P13	10 mSec	5.0
Pixclk	18	35	U11 P11	50 nSec	5.0
Pixval	10	27	U11 P5	50 µSec	5.0
D0	17	34	U16 P13	500 nSec	5.0
D1	50	33	U16 P11	500 nSec	5.0
D2	16	15	U16 P5	500 nSec	5.0
D3	49	32	U16 P3	500 nSec	5.0
D4	14	31	U17 P13	500 nSec	5.0
D5	48	47	U17 P11	500 nSec	5.0
D6	13	30	U17 P5	500 nSec	5.0
D7	46	29	U17 P3	500 nSec	5.0
CmdClk	9	26	U22 P1	10 µSec	5.0
CmdStat	42	25	U22 P7	5 µSec	5.0
CmdDat	43	44	U6 P5	10 µSec	5.0

MDM-51 Pin #20 is Ground for the Differential Signals
Vram Pins: U11-XX and U17-YY are grounds for the single Ended Signals.

- Verify log and plot the the Pixel Clock Rate.
  Pixel Clock Rate: 5 MHz
- Verify, log and plot the line time for the sensor based on the High-State of Pixval.
  Line Time: 76.5 µS
- Verify, log and plot the interline time for the sensor based on the Low-state of Pixval.
  Interline Time: 18.2 µS
- Verify log and plot the Imge Frame Readout Time based on the High-State of Vsync.
  Frame Time: 54.7 mS

For an integration time of:

- StarTracker :100mSec
- Nir: 100 mSec
- HiRes :100mSec
- LWIR :100mSec
- UV-VIS : 100mSec

Generate a detailed logic timing diagram (using the HP Data Analyzer)

- Beginning of the Frame Transfer
- End-Of-Frame Transfer
- Sasi Command Transaction, showing CMDCLK, CMDSTAT, CMDDAT

- When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.

- ❑ Note Any exceptions in the test

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- ❑ Store the sensor using/completing the "Sensor Activity Log Sheet (LLNL-SAL)
- ❑ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

4.5. Performance Analysis & Reporting Criterion

Plot both Logic Timing Transitions, and Waveform Transitions for the Data acquired in the test procedure.

Verify that the both the timing and Waveform Transitions meet ICD specifications.

Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.

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5. SASI Command-Primitive Test

Operator: ______________ Date: ________________

5.1. Applicable Sensors:

❑ StarTracker ______________ ❑ UV-VIS ________________ ❑ HiRes ________________
❑ Laser Transmitter _________ ❑ NIR __________________ ❑ LWIR ________________

5.2. Data Storage Locations:

Images: NONE
Temp : /dspse/<Sensor>/sasiCmd/date/temperature_log_data

5.3. Purpose:

Test the sensors parameter memory against valid and invalid SASI commands. This test will use computer software to run through all the possible permutations of SASI commands, and verify that the parameter memory state is properly modified by proper SASI commands, and not modified by illegal commands.

The Test will also ensure that a sensor will not come on the bus if an illegal command is sent while the sensor's drivers are tri-stated.

5.4. Test Environment & Procedure

- ❑ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)
  Log the execution of the "LLNL Physical Examination Test" in the sensor certification log.
  Use a class 1000 or better environment if possible.
- ❑ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> - LLNL-SAL-xxxxx.temp.
  Example: UV311-LLNL-SAL-0016.temp
- ❑ When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.
- ❑ Store the sensor using/completing the "Sensor Activity Log Sheet (LLNL-SAL)
  Use aclass 1000 or better environment if possible.
- ❑ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.
- ❑ Note Any exceptions in the test

5.5. Performance Analysis & Reporting Criterion

Sofware should report the status of both good and bad SASI commands, reporting any anomolies that were generated while testing all possible data inputs to the sensor.

Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.

6 Dark Field Uniformity Test

Operator: DPN Date: 8-2-93

6.1. Applicable Sensors:

❑ StarTracker ST 313 ❑ UV-VIS ❑ HiRes
❑ Laser Transmitter ❑ NIR ❑ LWIR

6.2. Data Storage Locations:

Images: /dspse/<Sensor>/darkField/date/<sensorname.imagenumber>
Temp: /dspse/<Sensor>/darkField/date/temperature_log_data

6.3. Purpose:

The dark field images recorded will be used to measure the dark current and dark current uniformity at a known temperature. These values will be used to verify the dark field sensitivity to integration time and the fixed pattern noise as measured at LLNL.

6.4. Test Environment & Procedure

This test is performed in at ambient temperature [OPTIONAL: with a cooled base-plate], recording dark field images and the temperature environment at which they were obtained.

☒ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)
Log the execution of the "LLNL Dark Field Uniformity Test" in the sensor certification log.

☒ Power the sensor and allow the sensor to come to thermal equilibrium for 15 minutes.

☒ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> - LLNL-SAL-xxxxx.temp.
Example: UV311-LLNL-SAL-0016.temp

Take 5 dark fields images with the appropriate source for the listed integration times:

Sensor	Integration Times	Offset	Gain	Source	Intensifier Gain	Filterwheel Position
StarTracker	☒ 50 ☒ 100 ☒ 200 ☒ 250	0	75 ~~, 150, 350~~	Dark Cloth	N/A	
UV-VIS	❑ 50 ❑ 100 ❑ 200 ❑ 250	0	150 ~~, 350, 1000~~	Dark Cloth	N/A	
HiRes	❑ 50 ❑ 100 ❑ 200 ❑ 250	0	150	Dark Cloth	0	
NIR				300, 350° Baseplate		
LWIR						

[OPTIONAL: For LLNL CCD sensor take images at each of a 5, 10, 15° C baseplate temperatures]

- ☐ Make a README.IMAGES in the image directory (/dspse/sensor/darkField/date) file to describe the images taken in the sequence. Include the following line for each sensor:_
  Filename Integration time=xxx Gain=xxx Offset=xxx

- ☐ Record the temperature conditions of the following: Ambient temperature, sensor baseplate temperature, CCD temperature, lens temperature, relative humdity.
  CCD 29°C Len 26 C

- ☐ When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.

- ☐ Store the sensor using/completing the "Sensor Activity Log Sheet (LLNL-SAL)
  Use aclass 1000 or better environment if possible.

- ☐ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

- ☐ Note Any exceptions in the test

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6.5. Performance Analysis & Reporting Criterion

The Dark Field Uniformity Report Shall contain the following:

- ☐ Histogram showing the distribution of the image field pixel values, notated with temperatures.

- ☐ Plot showing the integration time VS (Averaged) Dark Current for both a entire frame and defined regeion. (mean, StdDev, Var)

- ☐ [Optional] Plot showing the (averaged) dark current VS temperature

- ☐ Compare the Dark current wiht LLNL calibration Summary Report

Plot an Image Field showing the Fixed Pattern noise of the summation of each Integration times images (10-20each).

Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.

7. Image Field Analysis Test

Operator: DPN Date: 8-2-93

7.1. Applicable Sensors:

☒ StarTracker ST 313 ☐ UV-VIS ☐ HiRes
☐ Laser Transmitter ☐ NIR ☐ LWIR

7.2. Data Storage Locations:

Images: /dspse/<Sensor>/imageField/date/<sensorname.imagenumber>
Temp : /dspse/<Sensor>/imageField/date/temperature_log_data

7.3. Purpose:

Acquire and store a re-creatable image field for analysis.

7.4. Test Environment & Procedure

☒ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)
Log the execution of the "LLNL Image Field Analysis Test" in the sensor certification log. Use a class 1000 or better environment if possible.

☒ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> - LLNL-SAL-xxxxx.temp.
Example: UV311-LLNL-SAL-0016.temp

For Each Filter Position

Using a StarField Generator, or Opto- Image

Vary Integration time and Gain to produce peak pixel of ~220 digital counts

Sensor	Integration Times	Offset	Gain	Source	Intensifier Gain	Filter Position
StarTracker	☒ 100 ☒ 200 ☒ 300	0 0 0	75 150 350	Cassiopeia Source ~~Dark Cloth~~ ~~Dark Cloth~~	N/A	N/A
UV-VIS	☐ 50 ☐ 100 ☐ 200	0 0 0		Dark Cloth Dark Cloth Dark Cloth		
HiRes	☐ 50 ☐ 200 ☐ 250	0 0 0		Dark Cloth Dark Cloth Dark Cloth		
NIR				300° 350°		
LWIR				300°		

☐ When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.

- ❑ Store the sensor using/completing the "Sensor Activity Log Sheet (LLNL-SAL)
- ❑ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.
- ❑ Note Any exceptions in the test

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7.5. Performance Analysis & Reporting Criterion

- ❑ Generate PSF for Point Source at a Pixel near the center of the Field of View and 4 points evenly spaced off axis.
- ❑ Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.

8. Flat Field Test [Optional]

Operator: ______________ Date: ________________

8.1. Applicable Sensors:

❑ StarTracker	❑ UV-VIS	❑ HiRes	❑ Laser Transmitter
❑ NIR	❑ LWIR		

8.2. Data Storage Locations:

Images: /dspse/<Sensor>/flatField/date/<sensorname.imagenumber>
Temp: /dspse/<Sensor>/flatField/date/temperature_log_data

8.3. Purpose

A verification of the LLNL absolute radiometric calibration will be performed on the sensors with an accuracy of TBD. A Labsphere Uniform Source System will be used to provide a calibrated (NIST traceable) radiance for a wavelength range of 0.4 to 2.3 mm. This source will be used for all visible sensors and the NIR sensor. For the LWIR and upper wavelength filters of the NIR, the extended blackbody source will be used. The source will be placed near the sensor to ensure the source fills the entire sensor field of view. A radiometric analysis will be performed as follows: For each filter setting, gain setting, and a set of appropriate integration time two images will be acquired and stored:

8.4. Test Environment & Procedure

- ❑ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)
  Log the execution of the "LLNL Flat Field Test" in the sensor certification log.
  Use a class 1000 or better environment if possible.

- ❑ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> - LLNL-SAL-xxxxx.temp.
  Example: UV311-LLNL-SAL-0016.temp

- ❑ Do SOMETHING!!!

- ❑ Store the sensor using/completing the "Sensor Activity Log Sheet (LLNL-SAL)

- ❑ When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.

- ❑ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

- [ ] Note Any exceptions in the test

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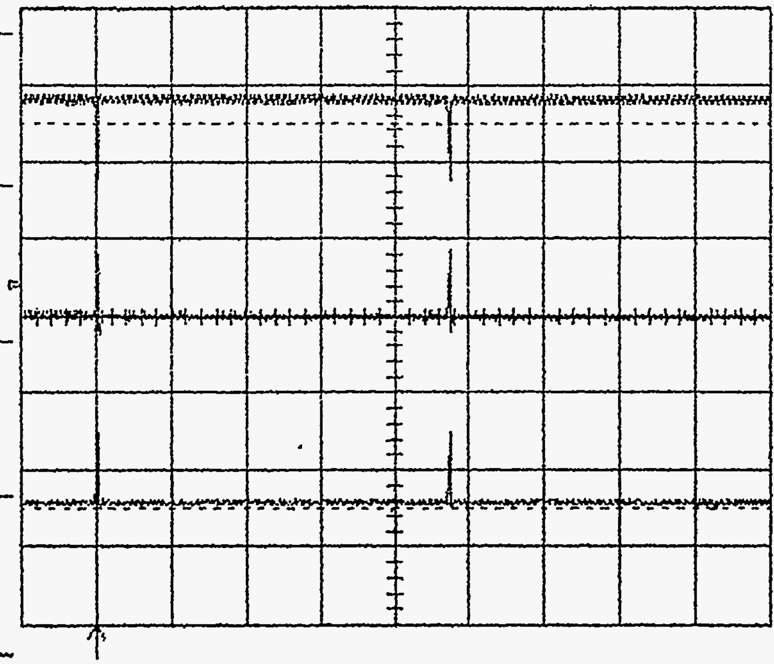
8.5. Performance Analysis & Reporting Criterion

- [ ] Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.

2-Aug-93
13:33:21

Main Menu



1 - 2
20 µs 10 V

Chan 1
20 µs 5 V

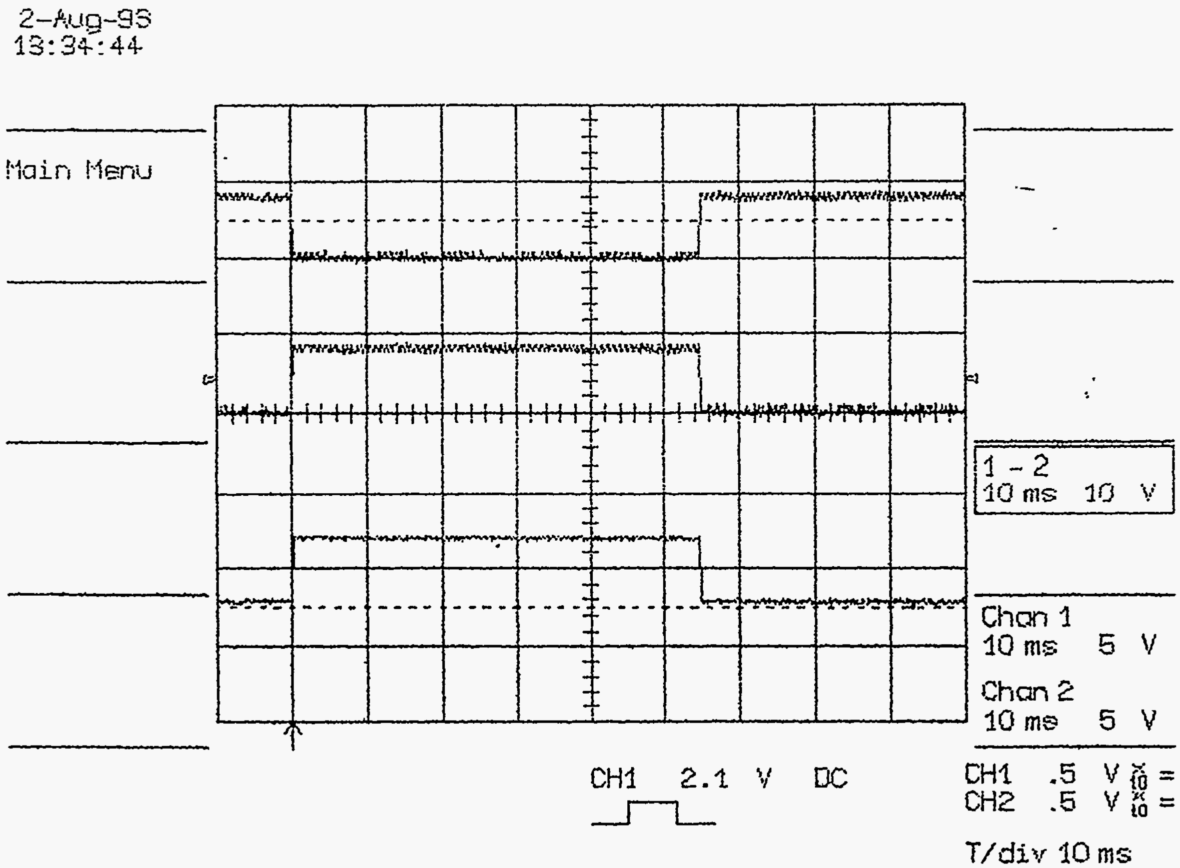
Chan 2
20 µs 5 V

CH1 2.1 V DC

CH1 .5 V x10 =
CH2 .5 V x10 =

T/div 20 µs

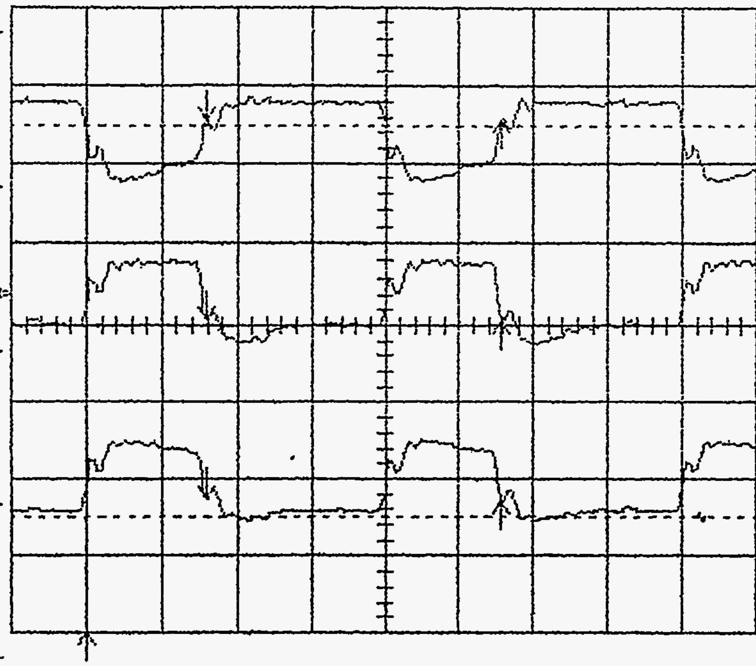
H sync


2-Aug-95
13:34:44
Main Menu
1 - 2
10 ms 10 V
Chan 1
10 ms 5 V
Chan 2
10 ms 5 V
CH1 2.1 V DC
CH1 .5 V x10 =
CH2 .5 V x10 =
T/div 10 ms

Vsync

2-Aug-93
13:37:43

Main Menu



1 - 2
-0.17 V

Chan 1
-0.08 V

Chan 2
0.09 V

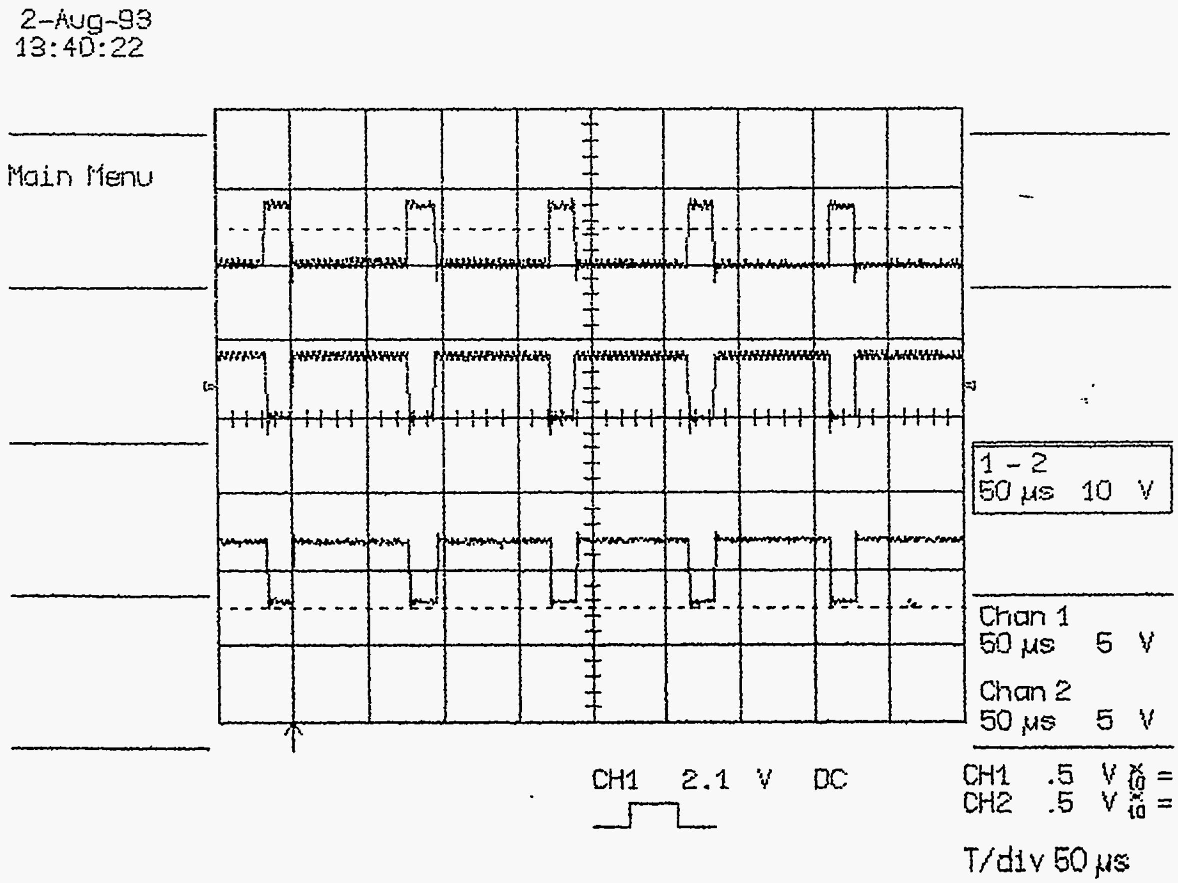
Δt 199.75 ns
1/Δt 5.0063 MHz

CH1 2.1 V DC

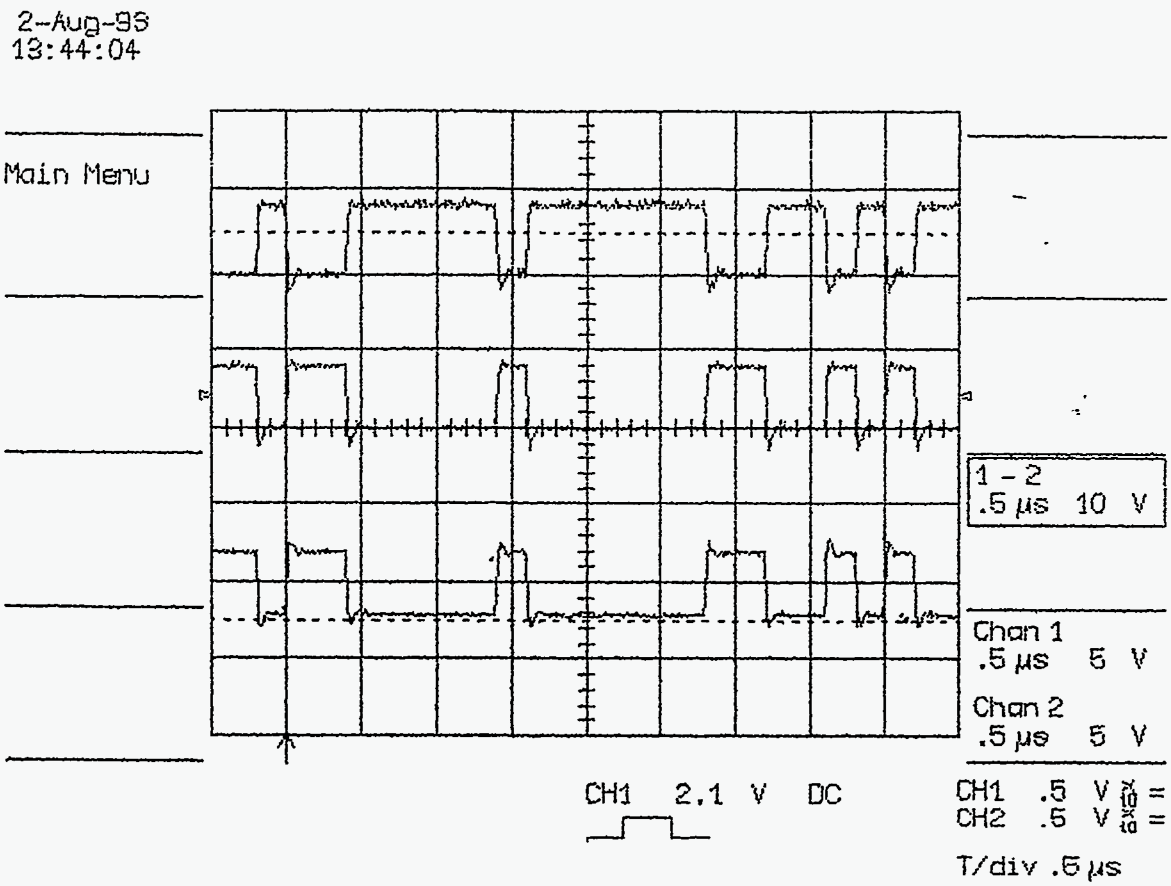
CH1 .5 V x10 =
CH2 .5 V x10 =

T/div 60 ns

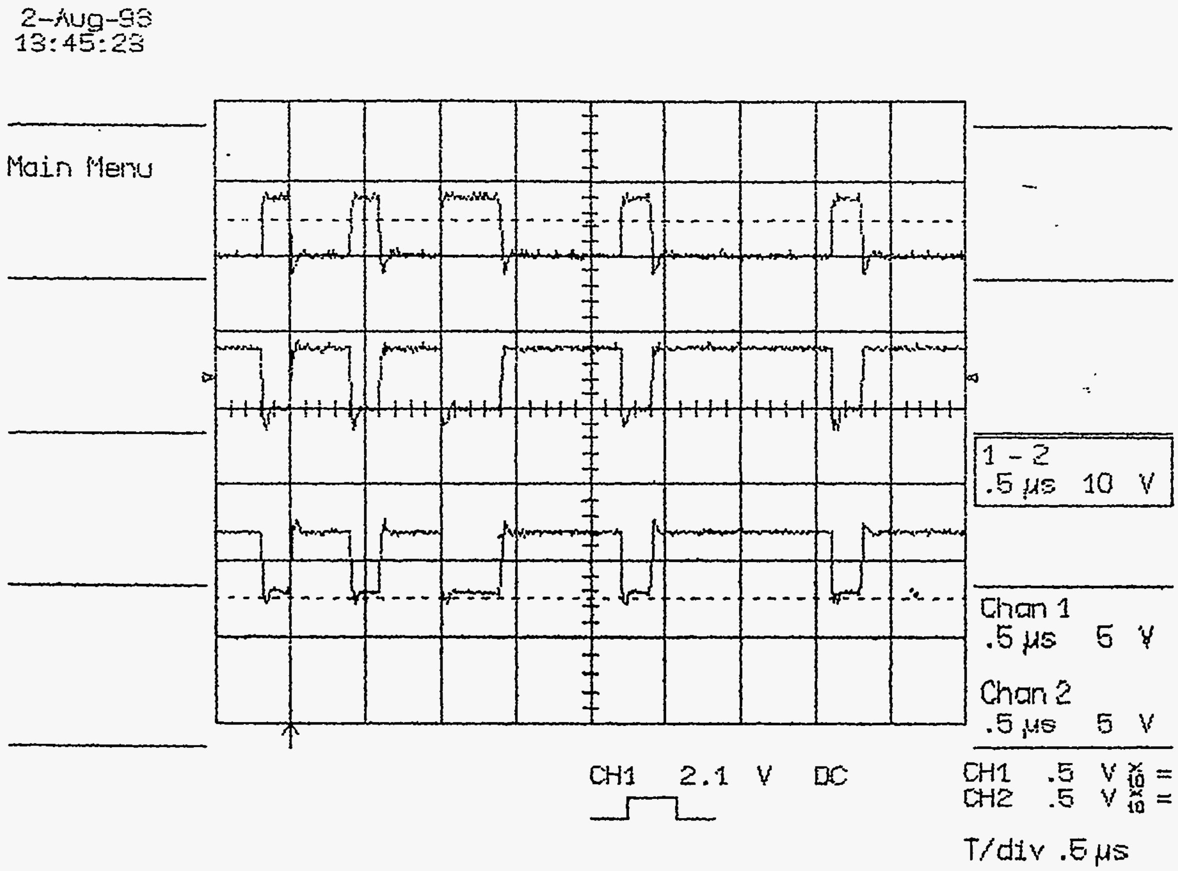
Pixelk


2-Aug-93
13:40:22
Main Menu
1 - 2
50 µs 10 V
Chan 1
50 µs 5 V
Chan 2
50 µs 5 V
CH1 2.1 V DC
CH1 .5 V X10 =
CH2 .5 V X10 =
T/div 50 µs

Pix Val


2-Aug-95
13:44:04
Main Menu
1 - 2
.5 µs 10 V
Chan 1
.5 µs 5 V
Chan 2
.5 µs 5 V
CH1 2.1 V DC
CH1 .5 V x10 =
CH2 .5 V x10 =
T/div .5 µs

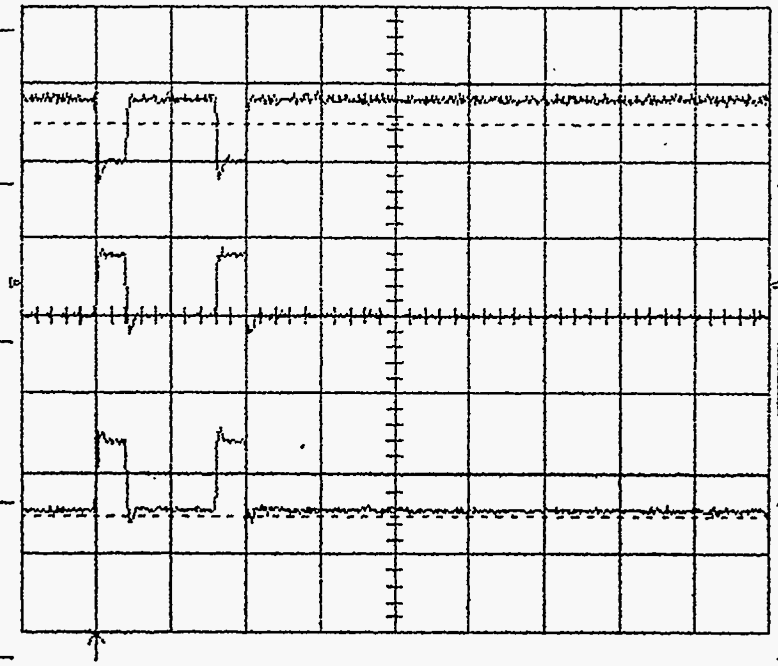
DØ


2-Aug-93
13:45:23
Main Menu
1 - 2
.5 µs 10 V
Chan 1
.5 µs 5 V
Chan 2
.5 µs 5 V
CH1 2.1 V DC
CH1 .5 V x10 =
CH2 .5 V x10 =
T/div .5 µs

D1

2-Aug-95
13:47:27

Main Menu



1 - 2
.5 µs 10 V

Chan 1
.5 µs 5 V

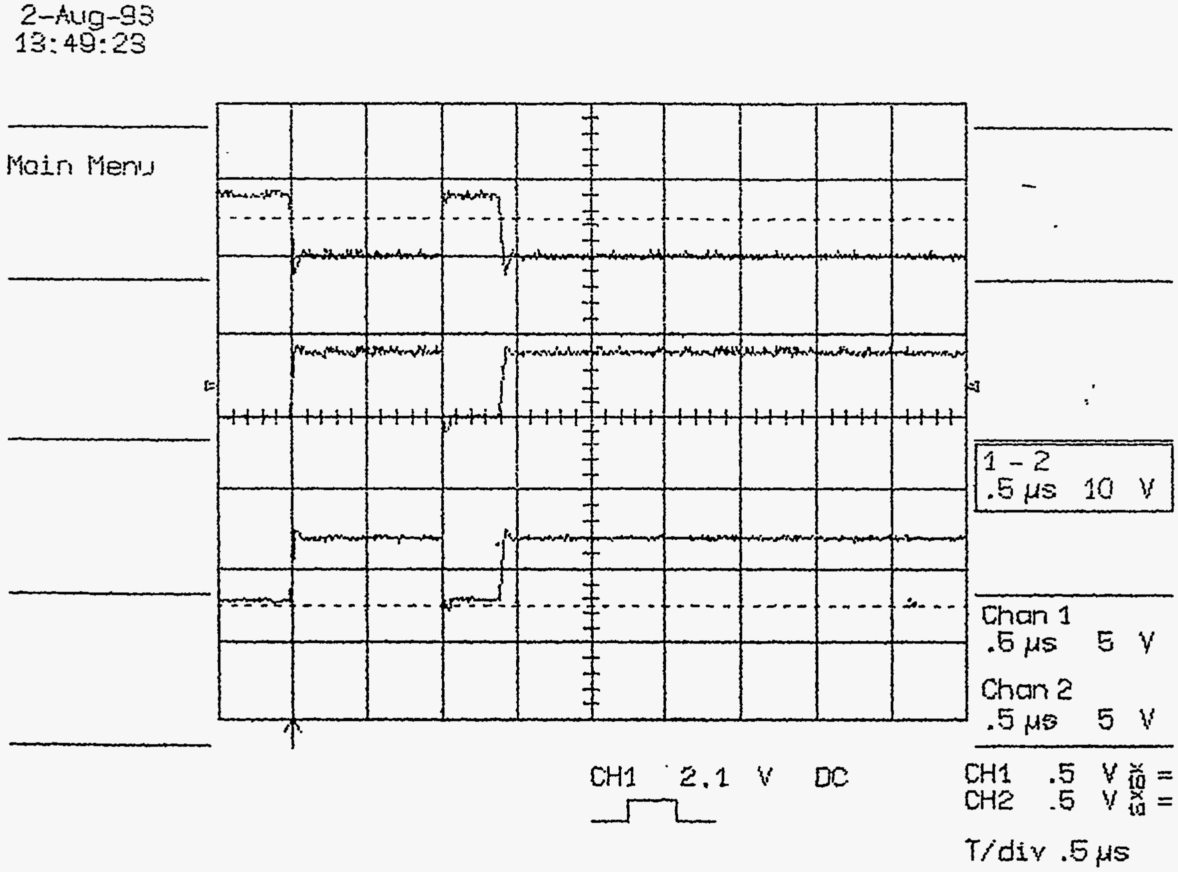
Chan 2
.5 µs 5 V

CH1 2.1 V DC

CH1 .5 V x10 =
CH2 .5 V x10 =

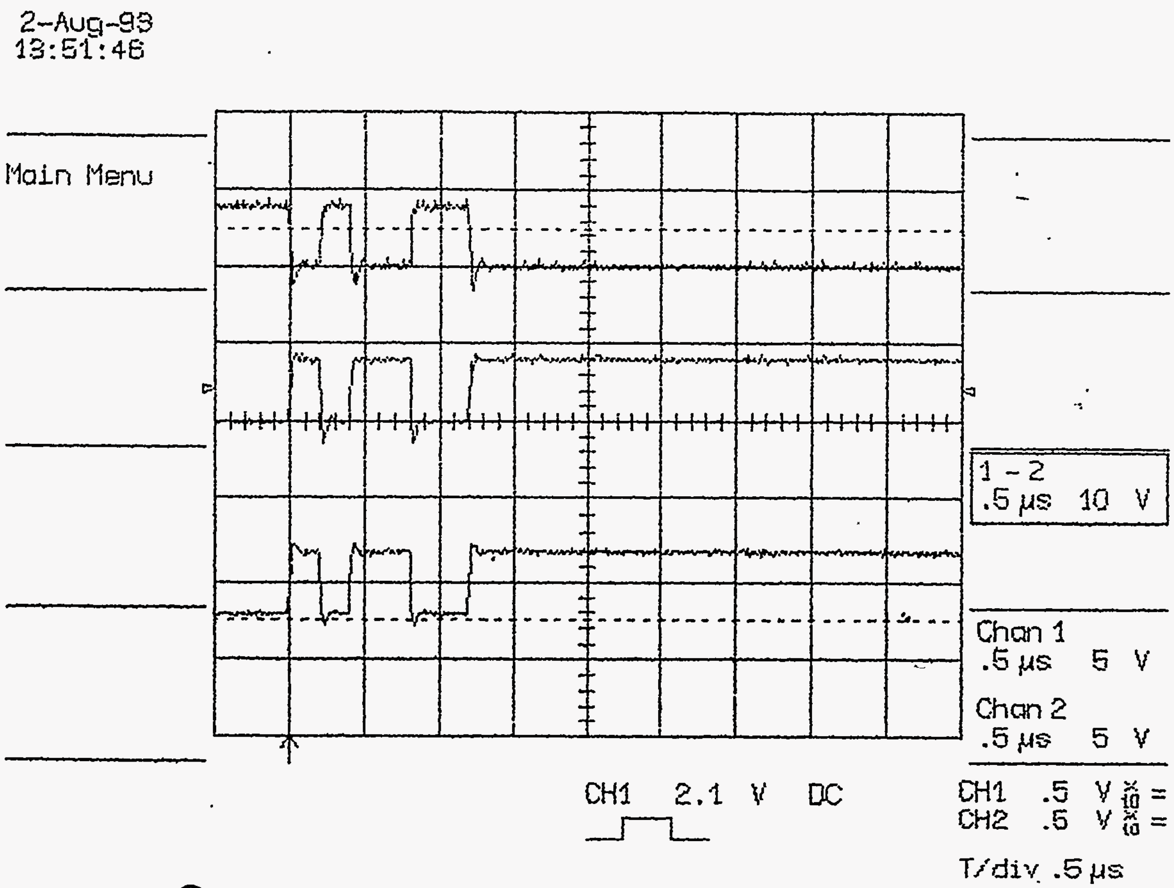
T/div .5 µs

D2



2-Aug-93
13:49:23
Main Menu
1 - 2
.5 µs 10 V
Chan 1
.5 µs 5 V
Chan 2
.5 µs 5 V
CH1 2.1 V DC
CH1 .5 V
CH2 .5 V
T/div .5 µs

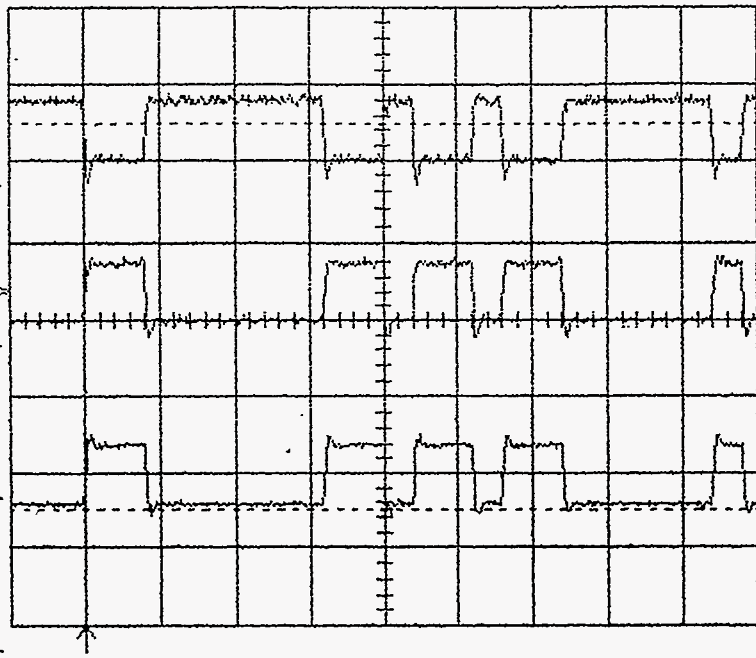
D3


2-Aug-99
13:51:46
Main Menu
1 - 2
.5 µs 10 V
Chan 1
.5 µs 5 V
Chan 2
.5 µs 5 V
CH1 2.1 V DC
CH1 .5 V x10 =
CH2 .5 V x10 =
T/div .5 µs

D4

2-Aug-93
13:52:51

Main Menu



1 - 2
.5 µs 10 V

Chan 1
.5 µs 5 V

Chan 2
.5 µs 5 V

CH1 2.1 V DC

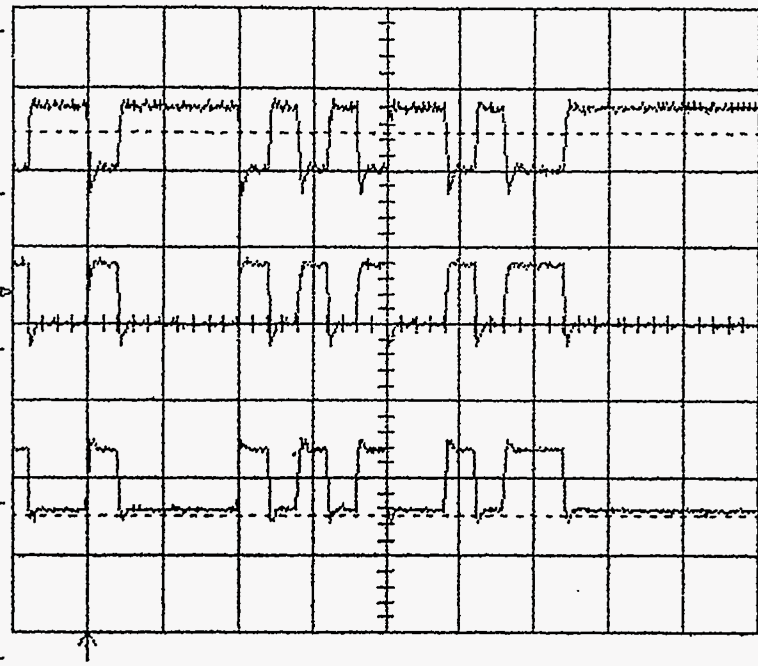
CH1 .5 V x10 =
CH2 .5 V x10 =

T/div .5 µs

D5

2-Aug-93
13:53:46

Main Menu



1 - 2
.5 µs 10 V

Chan 1
.5 µs 5 V

Chan 2
.5 µs 5 V

CH1 2.1 V DC

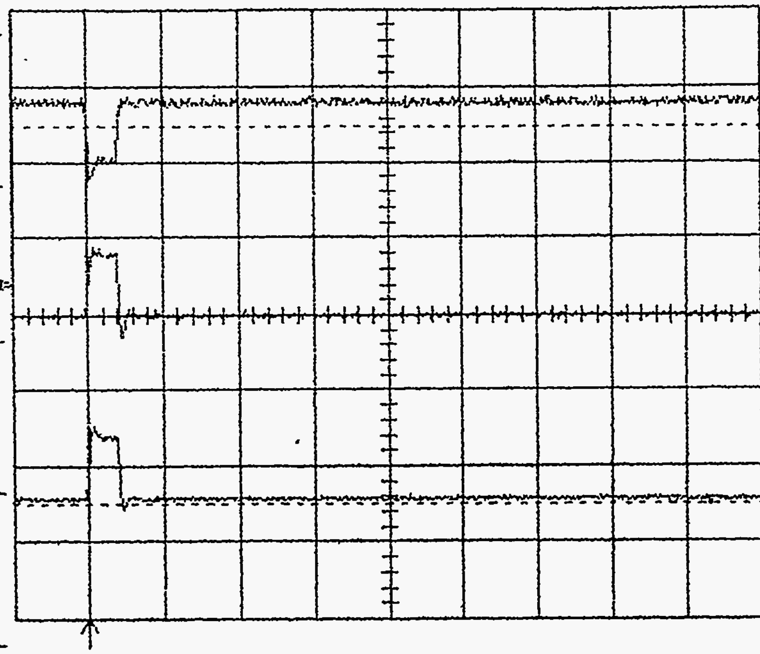
CH1 .5 V $\times$10 =
CH2 .5 V $\times$10 =

T/div .5 µs

P6

2-Aug-93
13:57:20

Main Menu



1 - 2
.5 µs 10 V

Chan 1
.5 µs 5 V

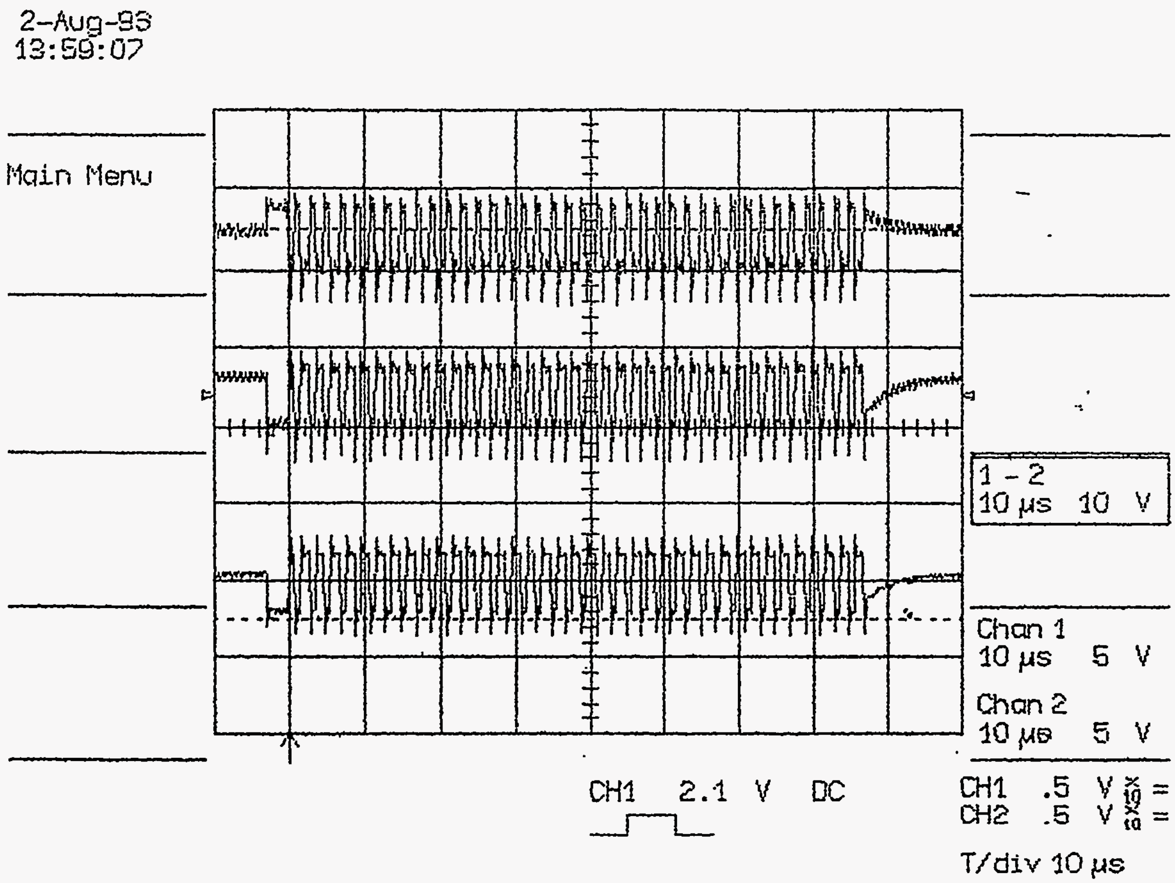
Chan 2
.5 µs 5 V

CH1 2.1 V DC

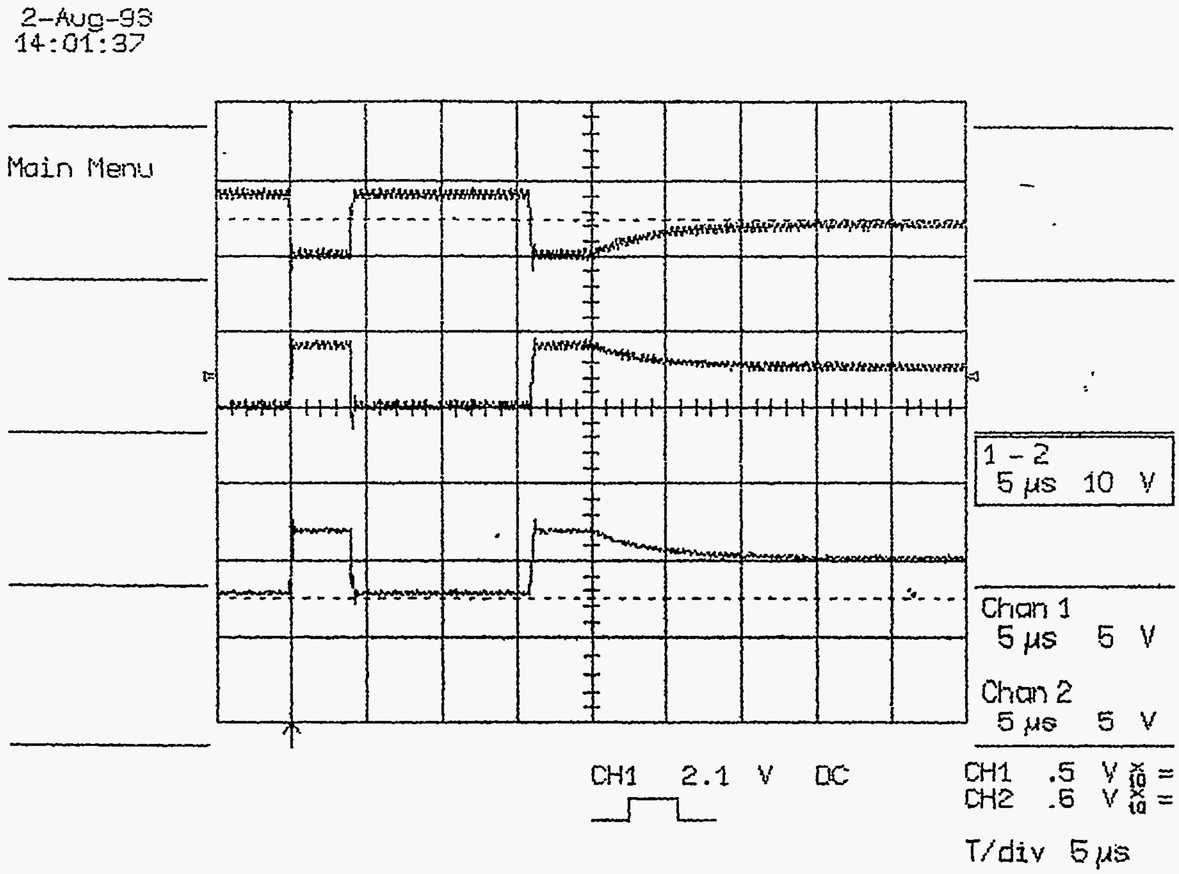
CH1 .5 V x10 =
CH2 .5 V x10 =

T/div .5 µs

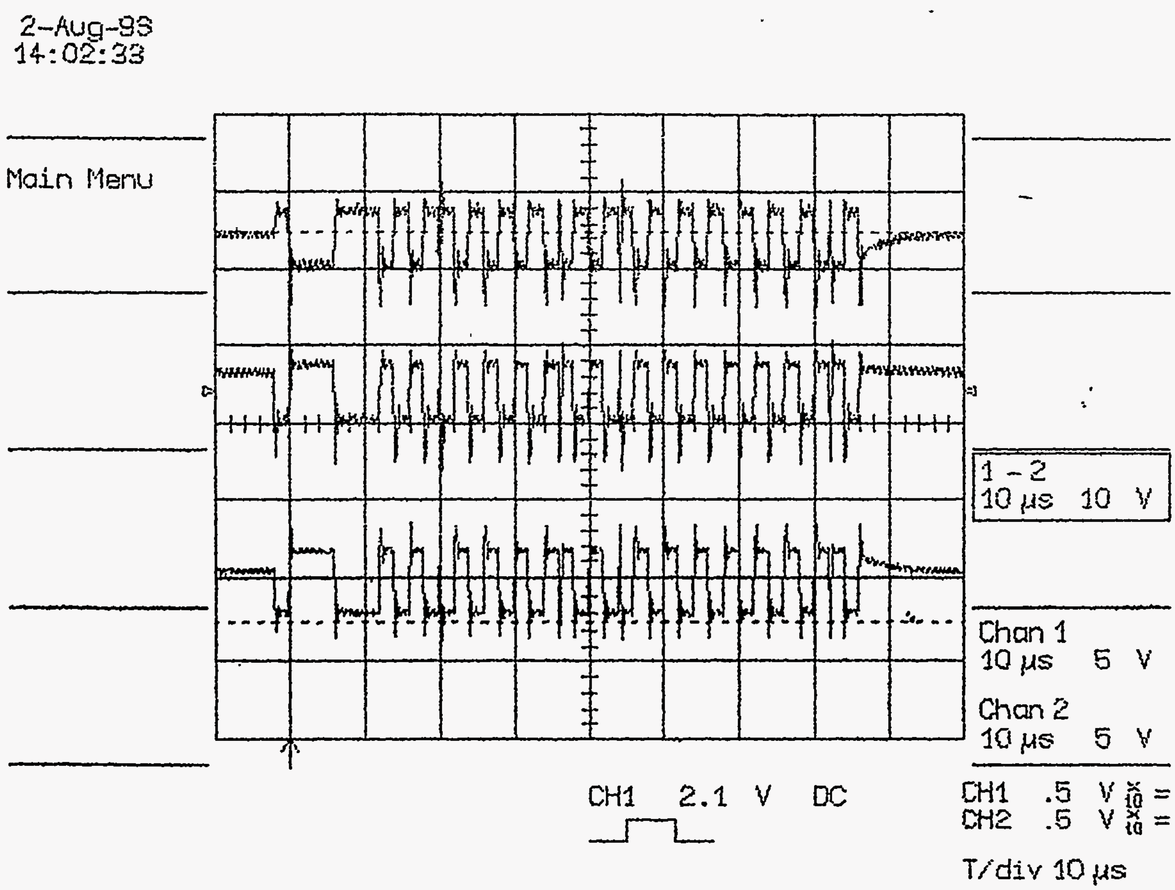
D7


2-Aug-95
13:59:07
Main Menu
1 - 2
10 µs 10 V
Chan 1
10 µs 5 V
Chan 2
10 µs 5 V
CH1 2.1 V DC
CH1 .5 V x10 =
CH2 .5 V x10 =
T/div 10 µs

CMD clk


2-Aug-93
14:01:37
Main Menu
1 - 2
5 µs 10 V
Chan 1
5 µs 5 V
Chan 2
5 µs 5 V
CH1 2.1 V DC
CH1 .5 V x10 =
CH2 .6 V x10 =
T/div 5 µs

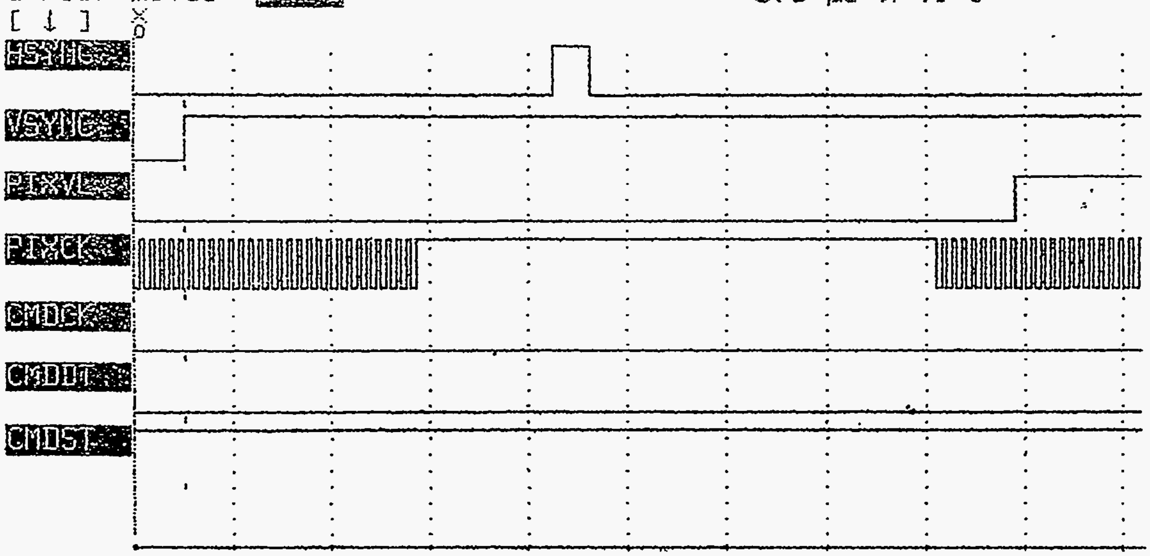
cmd stat


2-Aug-93
14:02:33
Main Menu
1 - 2
10 µs 10 V
Chan 1
10 µs 5 V
Chan 2
10 µs 5 V
CH1 2.1 V DC
CH1 .5 V x10 =
CH2 .5 V x10 =
T/div 10 µs

CMD DAT

Timing Waveform Diagram_________Continuous trace in process_____

Sample Period [20 ns]   2.000 µs/div
Magnification [1X]   20.00 ns/clk
Magnify about [illegible]   1.040 µs x to time trig
Cursor moves [illegible]   0.0 µs x to o -

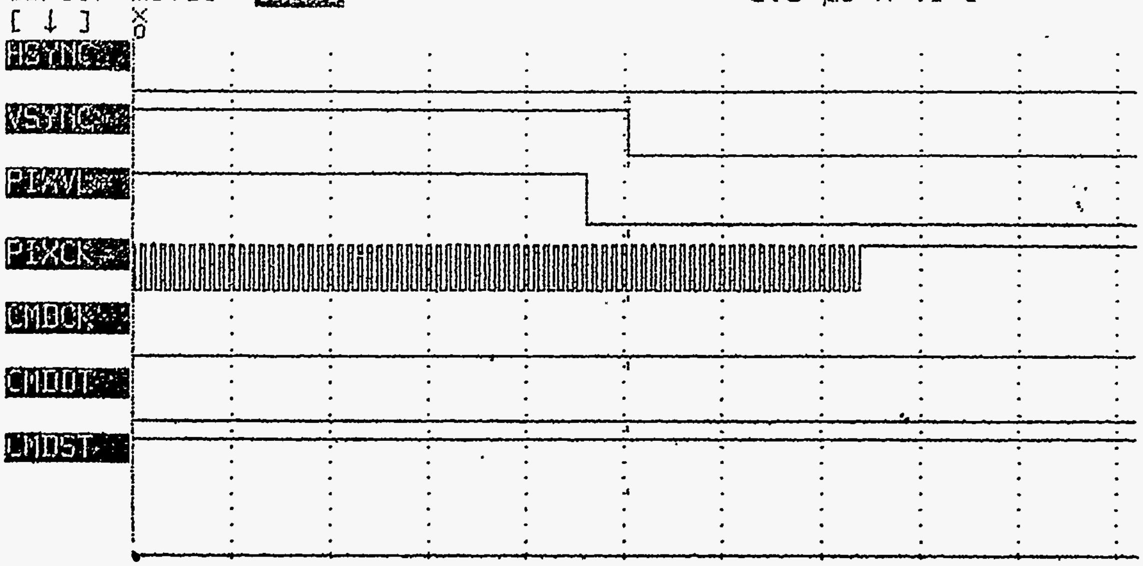


Beginning of Frame

Timing Waveform Diagram_________Continuous trace in process_____

Sample Period [20 ns]
Magnification [1X]
Magnify about [illegible]
Cursor moves [illegible]
[↓]

2.000 µs/div
20.00 ns/clk
10.08 µs x to time trig
0.0 µs x to o –

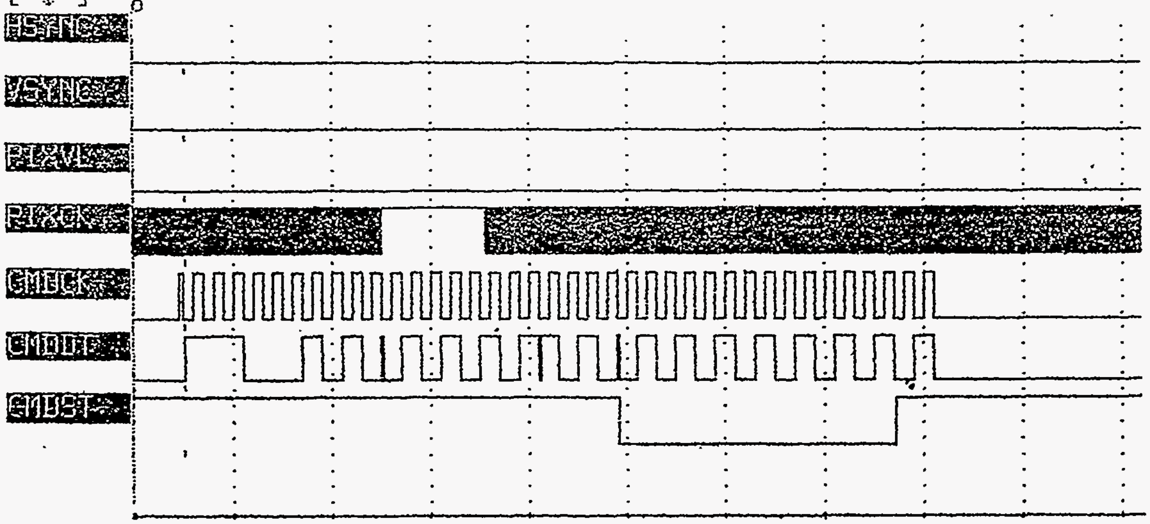


End of Frame

Timing Waveform Diagram_________Continuous trace in process_____

Sample Period [100 ns] 10.00 µs/div
Magnification [1X] 100.0 ns/clk
Magnify about [illegible] 5.200 µs x to time trig
Cursor moves [illegible] 0.0 µs x to o

[↓] x o



Sasi CMD

Appendix I.2

Clementine Sensor Test Acceptance Procedure for ST 314

Clementine
Sensor Test Acceptance Procedure

Submit Comments to:

Robert F. Hills
Lawrence Livermore National Laboratory
510.423.7344 Office
hills1@llnl.gov EMAIL

RECORD OF CHANGES

Revision Letter	Date	Title or Brief Description	Entered by
Draft	7 July 1993	Working Draft	RFH
Draft-A	13 July 1993	Modified to expand test procedure steps	RFH
Draft-B	15 July 1993	Modified for corrections and additional steps	RFH
Draft-C	27 July	Modified for corrections and additional steps	RFH
OA	10 August 1993	Modified to add steps for IR sensors	RFH

Sensor ID: ST 314 **Date Verified:** 8/12/93

Verification Eng/Tech : Nielsen

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1 Overview

1.1. Scope

This document is the LLNL Clementine sensor acceptance test procedure for the DSPSE spacecraft. It defines the optical, mechanical, thermal, electrical, and software tests necessary to verify the functionality of the sensors for the Clementine Sensor Integration Project at NRL

The subsystems associated with the sensor data acquisition verification process are shown in Figure 1.1.

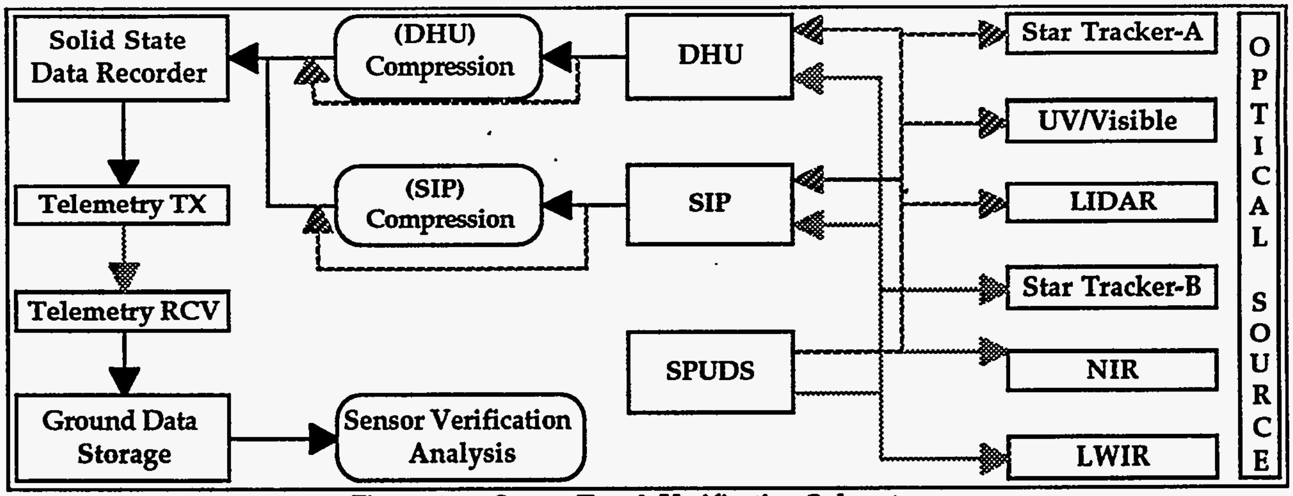

Figure 1.1 Sensor Test & Verification Subsystems

LLNL will provide a Pre-Integration Sensor Acceptance Testing, verification, and a debug platform using interfaces which imitates the S/C interface. The LLNL Setup is shown in Figure 1.2

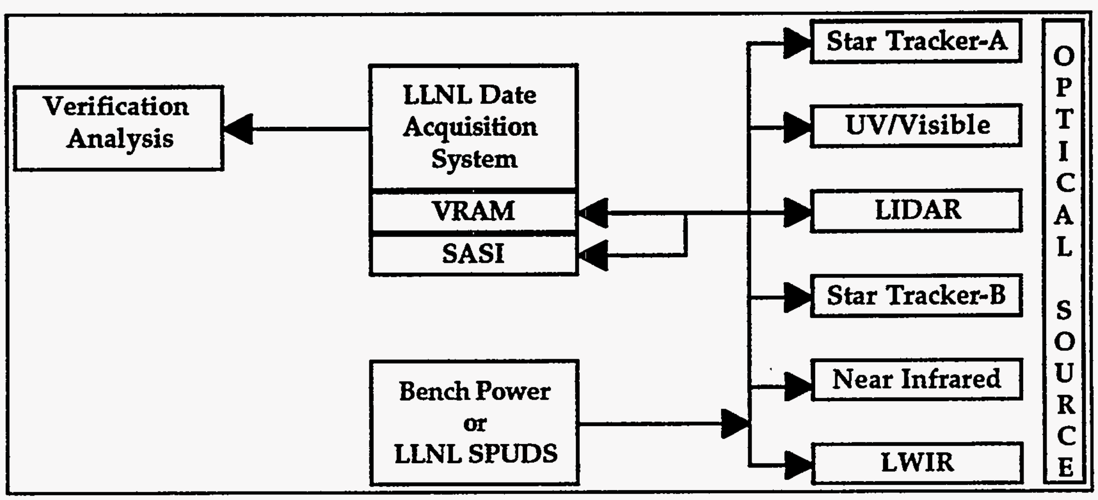

Figure 1.2 Pre-Spacecraft-Integration Sensor Verification Model

1.2. Verification Modes

Two verification modes are defined for this verification plan. These are 1) Functional verification and 2) Performance Verification.

Functional verification is defined as an application of a test at nominal spacecraft conditions; i.e. voltages and ambient (room) temperatures. These environmental parameters must be maintained within the acceptable ranges for all components included in the test and are summarized below.

Performance verification is defined as an application of a test at the full range of space conditions; i.e. Max-min voltages and temperatures. These environmental parameters must be maintained within the acceptable ranges for all components included in the test and are summarized below.

Each verification test in this plan will include the operational parameters (for temperature, voltages, etc.) that are necessary for the above listed verification modes.

1.2.1. Verification Tests

The followings tests will be performed on each sensor:

- Sensor Physical Examination (LLNL)
- Filter Positioner (LLNL)
- Electrical Wave-form (LLNL)
- SASI Command Set (LLNL)
- Dark Field (LLNL)
- Image Field Analysis (LLNL)
- Flat Field (LLNL)

The Naval Research Laboratory will need to provide the additional tests listed below to complete the test suite for the sensors at NRL.

- Radiometric Sensitivity (NRL)
- Point Spread Function (NRL)
- SIP-DHU-Sensor Interface (NRL)
- Sensor Timeout (NRL)
- Image Compression/Decompression (NRL)
- Boresight Alignment (NRL)
- Sensor Data Telemetry (NRL)
- Sensor Software Algorithms (NRL)

Each of the procedures allows a comparison to the calibrations performed at LLNL. A comparison of the results of the sensor verification tests and the LLNL calibrations will be made.

1.3. Documents

1.3.1. LLNL Documents

Interface Control Documents

C1-S4-008	LIDAR High Resolution Camera/Range Receiver
C1-S4-011	LIDAR Laser Transmitter Assembly
C1-S2-008	UV/Visible Camera
C1-S1-010	Star Tracker Camera
C1-S3-008	Near Infrared Camera
C1-S3A-006	Long wave Infrared Camera

Performance Specifications

TBD	LIDAR High Resolution Camera/Range Receiver
TBD	LIDAR Laser Transmitter Assembly
TBD	UV/Visible Camera
TBD	Star Tracker Camera
TBD	Near Infrared Camera
TBD	Long wave Infrared Camera

1.4. Environments & Handling Procedures

1.4.1. Anti Static Environment

The sensors are electrostatic sensitive devices and will be handled in a manner so as to prevent damage due to static charge. This will include the grounding of the operator (grounded wrist band), camera, working surface, and conductive floor mats to a common point. The sensors will be sealed in a anti-static bag before leaving the anti-static environment and will be packed in its aluminum case when being transported.

1.4.2. Contamination

All sensors must be maintained within a contamination environment specified in their ICD's. The Sensor usage and environment must be logged in order to maintain the proper level of contamination prior to flight. Analysis of exposure levels and usage will be periodically verified.

To prevent dust from accumulating on the optics, a mask and lint-free gloves shall be worn when in close proximity to the uncovered sensor. The sensor lens and baffle shall be covered at all times when the camera is not in use.

1.4.3. Temperature

Temperature limitations placed upon the sensors are in terms of the Base Plate temperature, CCD temperature and the lens temperature. The base plate temperature limits are specified to protect the electronic and mechanical parts from thermal damage. The CCD temperature limits are primarily concerned with achieving required CCD performance. The lens temperature limits are concerned with the performance of the STC optics and the protecting them from thermal damage. The various temperature limits are described below:

1- Operational-In-Spec – This is the temperature range which is required in order to achieve sensor performance requirements.

2- Operation-Out-Spec – This is the temperature range which is required in order to prevent damage to the sensor while maintaining a functional state. Damage and/or a reduction in reliability can occur to a sensor because the electronic junction temperatures are outside operating limits. This temperature limit will prevent the worst case electronic component from exceeding its maximum, derated, junction temperature. Maximum junction temperatures are derated according to thermal design and reliability requirements.

During all tests the CCD, base plate , and where appropriate, lens temperatures must be monitored on a continuous basis. If the node temperature exceeds the specifications listed in the sensor ICD, then the test must be terminated until all temperature conditions return with the specified limits.

Table x.x.x Sensor temperature range Summary

Requirements (°C)	StarTracker		UV-VIS		NIR		LWIR		HiRes		Laser		Suite	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Base Plate:														
Operational In-Spec	-20	2	-20	2									-20	2
Operational Out-Spec	-20	10	-20	25									-20	10
Non-Operating	-40	70	-35	50									-35	50
CCD:														
Operational In-Spec	-20	10	-20	10									-20	10
Operational Out-Spec	-20	60	-20	25									-20	25
Non-Operating	-40	85	-40	50									-40	50
Lens:														
Operational In-Spec	-20	40	-20	40									-20	40
Operational Out-Spec	-30	70	-30	50									-30	50
Non-Operating	-30	70	-30	50									-30	50

1.4.4. Humidity

The environment in which the tests are to take place shall be maintained at a relative humidity between 40 and 70%. At no time shall condensation occur.

2 Physical Verification

Operator: Nielsen Date: 8/12/93 Activity Sheet: LLNL-SAL-0029

2.1. Applicable Sensors:

❑ StarTracker ST 314 ❑ UV-VIS ___ ❑ HiRes ___
❑ Laser Transmitter ___ ❑ NIR ___ ❑ LWIR ___

2.2. Data Storage Locations:

Images: NONE
Temp: NONE

2.3. Purpose:

Upon arrival of each sensor at NRL, a physical examination will be performed to check for any damage that may have occurred during shipping. This will include verification of the serial number and a visual check of the structure, optics, baffles, and all connectors.

2.4. Test Environment & Procedure

☒ Verify that the sensor Certification Log has an exposure log in the front of the book, and that it has been started.

☒ Verify that the sensor Certification Log has work sheets to log all sensor activities and has been started.

☒ Unpack the sensor using the Sensor Activity Log Sheet, "Preparation & Grounding" section.

☒ Log the execution of the "LLNL Physical Examination Test" in the sensor certification log.

Log or verify the following:

☒ Verify that the sensor has the proper sensor identification and LLNL property tag.

☒ Verify that sensor shorting plugs are present.

☒ Verify the presence of connector savers on all sensor connectors.

☒ Verify that the sensor has a baffle cover and that it is labeled to its sensor

☒ Note any loose screws, broken staking, or other physical damage.

☒ Note the condition of the optics and any contamination found.

☒ Verify that the sensor has flying leads for the lens temperature, and lens heater and that ther^e^ is no apparent damage. Sp.

- ☐ Store the sensor using the "Sensor Activity Log Sheet (LLNL-SAL) , "Securing the Sensor" section or continue to next test. ☐ Stored Sensor | ☒ Continued Testing.

- ☐ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

2.5. Performance Analysis & Reporting Criterion

No post processed data reduction is necessary for this test. The report shall contain a detailed description of the results of the examination steps outlined in the test procedure.

3 Filter Positioner Test

Operator: ______________ Date: ________________ Activity Sheet: LLNL-SAL-______

3.1. Applicable Sensors:

❑ StarTracker ______	❑ UV-VIS ______	❑ HiRes ______
❑ Laser Transmitter	❑ NIR ______	❑ LWIR

3.2. Data Storage Locations:

Images: NONE
Data: /dspse/<Sensor>/filterPos/date(YYMMDD)/<filtertest>
Temp: MAC:<SensorID>-LLNL-SAL-XXXX.temp.FPT

3.3. Purpose:

Verify the step operation and position status of the sensor's filter wheel.

3.4. Test Environment & Procedure

- ❑ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)
- ❑ Log the execution of the "LLNL Filter Positioner Test" in the sensor certification log.
- ❑ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> - LLNL-SAL-xxxxx.temp. FPT
  Example: UV311-LLNL-SAL-0016.temp.
- ❑ Step, settle and read the filter on the sensor using the filter position driver software "filterStepTest" for 1000 steps of the filter wheel. Do both Clockwise (CW) and CounterClockWise (CCW)

```
filterStepTest -s <Sensor> -f CW -d 250 -n 1000
filterStepTest -s <Sensor> -f CCW -d 250 -n 1000
```

- ❑ When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.

The software will verify that the filterwheel stops at the correct position each time by comparing the SASI command expected position (software state machine) and the position obtained by sending a SASI request for filter position command.

❑ Note Any exceptions in the test

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❑ Store the sensor using the "Sensor Activity Log Sheet (LLNL-SAL) , "Securing the Sensor" section or continue to next test. ❑ Stored Sensor | ❑ Continued Testing.

❑ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

3.5. Performance Analysis & Reporting Criterion

Note any software exeception that were generated (due to mis synchronization of the software state machine and the physical hardware).

Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.

4 Electrical Waveform Verification Test

Operator: Dr Nielsen Date: 8/12/93 Activity Sheet: LLNL-SAL-______

4.1. Applicable Sensors

❑ StarTracker ST 314	❑ UV-VIS______	❑ HiRes______
❑ Laser Transmiter	❑ NIR______	❑ LWIR______

4.2. Data Storage Locations

Images: NONE
Temp : MAC:<SensorID>-LLNL-SAL-XXXX.temp.EWVT

4.3. Purpose

Verify the sensor logical waveform tranisitions, timings, switching characteristics in a single [OPTIONAL: or multiple] sensor bus environment.

Verify that the sensor powers up with its bus drivers tri-stated.

4.4. Test Environment & Procedure

❑ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)

❑ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> - LLNL-SAL-xxxxx.temp.
Example: UV311-LLNL-SAL-0016.temp

☒ Log the execution of the "LLNL Electrical Waveform Test" in the sensor certification log.

☒ Run this test at ambient conditions, monitor and logging temperature profiles of the CCD and baseplate temperature.

Use the Lecroy Oscilloscope and set the following Parameters.

☒ Lecroy Function E: is ON and set to Math function: (Channel1 - Channel2)
Place the raw data differential output (channel1) on the top of the screen, and the (Channel1 - channel2) subtraction on the bottom of the screen.

☒ Calibrate the probes to a flat response on the Scope calbiration point. Then Remove any bias from the probes for the channel-1 - Channel 2) subtraction function.

☒ Run the program "tv" on the Sun system.

For an integration time of:

☒ StarTracker : 100mSec ☐ HiRes : 100mSec ☐ UV-VIS : 100mSec
☐ Nir: 11 mSec ☐ LWIR : 5.76

Obtain plots of each of the following differential driver outputs at the MDM-51 Breakout Box:

Signal	MDM-51 DiffSig Pin#	MDM-51 DiffSig.N Pin#	Vram U# Pin #	Time/Div (St, UVVIS, Hires)	Time /Div (NIR/LWIR)	Volage/Div
☒ Hsync	12	11	U11 P3	20 µSec	20 µSec	5.0
☒ Vsync	45	28	U11 P13	10 mSec	10 mS ec	5.0
☒ Pixclk	18	35	U11 P11	50 nSec	200 ns	5.0
☒ Pixval	10	27	U11 P5	50 µSec	50 µSec	5.0
☒ D0	17	34	U16 P13	500 nSec	500 nSec	5.0
☒ D1	50	33	U16 P11	500 nSec	500 nSec	5.0
☒ D2	16	15	U16 P5	500 nSec	500 nSec	5.0
☒ D3	49	32	U16 P3	500 nSec	500 nSec	5.0
☒ D4	14	31	U17 P13	500 nSec	500 nSec	5.0
☒ D5	48	47	U17 P11	500 nSec	500 nSec	5.0
☒ D6	13	30	U17 P5	500 nSec	500 nSec	5.0
☒ D7	46	29	U17 P3	500 nSec	500 nSec	5.0
☒ CmdClk	9	26	U22 P1	10 µSec	10 µSec	5.0
☒ CmdStat	42	25	U22 P7	5 µSec	5 µSec	5.0
☒ CmdDat	43	44	U6 P5	10 µSec	10 µSec	5.0

MDM-51 Pin #20 is Ground for the Differential Signals
Vram Pins: U11-XX and U17-YY are grounds for the single Ended Signals.

☐ Verify log and plot the the Pixel Clock Rate.
Pixel Clock Rate: 5 MHz

☒ Verify, log and plot the line time for the sensor based on the High-State of Pixval.
Line Time: 79.1µS

☒ Verify, log and plot the interline time for the sensor based on the Low-state of Pixval.
Interline Time: 17.µS

☒ Verify log and plot the Imge Frame Readout Time based on the High-State of Vsync.
Frame Time: 54.65 ms

Generate a detailed logic timing diagram (using the HP Data Analyzer)
☒ Beginning of the Frame Transfer
☒ End-Of-Frame Transfer
☒ Sasi Command Transaction, showing CMDCLK, CMDSTAT, CMDDAT

☐ When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.

- [ ] Note Any exceptions in the test

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- [ ] Store the sensor using the "Sensor Activity Log Sheet (LLNL-SAL) , "Securing the Sensor" section or continue to next test. ❑ Stored Sensor | ❑ Continued Testing.

- [ ] When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

4.5. Performance Analysis & Reporting Criterion

Plot both Logic Timing Transitions, and Waveform Transitions for the Data acquired in the test procedure.

Verify that the both the timing and Waveform Transitions meet ICD specifications.

Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.

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5 SASI Command-Primitive Test

Operator: ______________ Date: ________________ Activity Sheet: LLNL-SAL-______

5.1. Applicable Sensors:

❑ StarTracker ______________ ❑ UV-VIS ________________ ❑ HiRes ________________
❑ Laser Transmitter ________ ❑ NIR ________________ ❑ LWIR ________________

5.2. Data Storage Locations:

Images: NONE
Temp: MAC:<SensorID>-LLNL-SAL-XXXX.temp.SCPT

5.3. Purpose:

Test the sensors parameter memory against valid and invalid SASI commands. This test will use computer software to run through all the possible permutations of SASI commands, and verify that the parameter memory state is properly modified by proper SASI commands, and not modified by illegal commands.

The Test will also ensure that a sensor will not come on the bus if an illegal command is sent while the sensor's drivers are tri-stated.

5.4. Test Environment & Procedure

❑ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)
Log the execution of the "LLNL Physical Examination Test" in the sensor certification log.

❑ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> - LLNL-SAL-xxxxx.temp.
Example: UV311-LLNL-SAL-0016.temp

❑ When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.

❑ Store the sensor using the "Sensor Activity Log Sheet (LLNL-SAL), "Securing the Sensor" section or continue to next test. ❑ Stored Sensor | ❑ Continued Testing.

❑ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

❑ Note Any exceptions in the test

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5.5. Performance Analysis & Reporting Criterion

Sofware should report the status of both good and bad SASI commands, reporting any anomolies that were generated while testing all possible data inputs to the sensor.

Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.

6 Dark Field Uniformity Test

Operator: ~~ST3~~ Nielsen Date: 8/13/93 Activity Sheet: LLNL-SAL-0230

6.1. Applicable Sensors:

☐ StarTracker 5B14	☐ UV-VIS ______	☐ HiRes ______
☐ Laser Transmitter ______	☐ NIR ______	☐ LWIR ______

6.2. Data Storage Locations:

Images: /dspse/<Sensor>/darkField/date/<sensorname.imagenumber>
Temp : MAC:<SensorID>-LLNL-SAL-XXXX.temp.DFUT

6.3. Purpose:

The dark field images recorded will be used to measure the dark current and dark current uniformity at a known temperature. These values will be used to verify the dark field sensitivity to integration time and the fixed pattern noise as measured at LLNL.

6.4. Test Environment & Procedure

This test is performed in at ambient temperature [OPTIONAL: with a cooled base-plate], recording dark field images and the temperature environment at which they were obtained.

☑ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)
Log the execution of the "LLNL Dark Field Uniformity Test" in the sensor certification log.

☑ Power the sensor and allow the sensor to come to thermal equilibrium for 15 minutes.

☒ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> - LLNL-SAL-xxxxx.temp.
Example: UV311-LLNL-SAL-0016.temp

Acquire Images at the settings listed below:

Sensor	Integration Times	Offset	Video Gain	#Images	Source	Intensifier Gain	Filter Position
StarTracker	☑ 50	0	75	5	Cover & DarkCloth	N/A	N/A
	☑ 100	0	75	5	Cover & DarkCloth	N/A	N/A
	☑ 200	0	75	5	Cover & DarkCloth	N/A	N/A
	☑ 250	0	75	5	Cover & DarkCloth	N/A	N/A
UV-VIS	☐ 50	0	150	5	Cover & DarkCloth	N/A	
	☐ 100	0	150	5	Cover & DarkCloth	N/A	
	☐ 200	0	150	5	Cover & DarkCloth	N/A	
	☐ 250	0	150	5	Cover & DarkCloth	N/A	
HiRes	☐ 50	0	150	5	Cover & DarkCloth	0	3
	☐ 100	0	150	5	Cover & DarkCloth	0	3
	☐ 200	0	150	5	Cover & DarkCloth	0	3
	☐ 250	0	150	5	Cover & DarkCloth	0	3

NIR	❑ 11 ms	N/A	N/A	5	300° C Soder Iron	N/A	
	❑ 33 ms	N/A	N/A	5	350° C Soder Iron	N/A	
	❑ 57 ms	N/A	N/A	5			
	❑ 100 ms	N/A	N/A	5			
LWIR	❑ 0.18 ms	N/A	N/A	5	Black Body 35° C	N/A	N/A
	❑ 1.44 ms	N/A	N/A	5	BlackBody 77° C	N/A	N/A
	❑ 2.88 ms	N/A	N/A	5			N/A
	❑ 5.76 ms	N/A	N/A	5			N/A

[OPTIONAL: For LLNL CCD sensor take images at each of a 5, 10, 15° C baseplate temperatures]

☑ Make a README.IMAGES in the image directory (/dspse/sensor/darkField/date) file to describe the images taken in the sequence. Include the following line for each sensor:
Filename Integration time=xxx Gain=xxx Offset=xxx

☑ Record the temperature conditions of the following: Ambient temperature, sensor baseplate temperature, CCD temperature, lens temperature, relative humdity.
CCD 27 °C lens 26 °C

❑ When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.

☑ Store the sensor using the "Sensor Activity Log Sheet (LLNL-SAL), "Securing the Sensor" section or continue to next test. ❑ Stored Sensor | ☑ Continued Testing.

❑ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

❑ Note Any exceptions in the test

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6.5. Performance Analysis & Reporting Criterion

The Dark Field Uniformity Report Shall contain the following:

❑ Histogram showing the distribution of the image field pixel values, notated with temperatures.

❑ Plot showing the integration time VS (Averaged) Dark Current for both a entire frame and defined regeion. (mean, StdDev, Var)

❑ [Optional] Plot showing the (averaged) dark current VS temperature

❑ Compare the Dark current wiht LLNL calibration Summary Report

Plot an Image Field showing the Fixed Pattern noise of the summation of each Integration times images (10-20each).

Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.

7 Image Field Analysis Test

Operator: Nielsen Date: 8/13/93 Activity Sheet:-LLNL-SAL-0030

7.1. Applicable Sensors:

❑ StarTracker S314 ❑ UV-VIS ______ ❑ HiRes ______
❑ Laser Transmitter ______ ❑ NIR ______ ❑ LWIR ______

7.2. Data Storage Locations:

Images: /dspse/<Sensor>/imageField/date/<sensorname.imagenumber>
Temp: MAC:<SensorID>-LLNL-SAL-XXXX.temp.IFAT

7.3. Purpose:

Acquire and store a re-creatable image field for analysis.

7.4. Test Environment & Procedure

❑ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)

❑ Log the execution of the "LLNL Image Field Analysis Test" in the sensor certification log.

❑ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> - LLNL-SAL-xxxxx.temp.
Example: UV311-LLNL-SAL-0016.temp

Vary Integration time and Gain to produce peak pixel of ~220 digital counts

Sensor	Integration Time (ms)	Offset	Video Gain	# Images	Source	Intensifier Gain	Filter Position
StarTracker	❑ 100	0	75	5	Cassiopeia	N/A	N/A
	❑ 200	0	150	5	Cassiopeia		
	❑ 300	0	350	5	Cassiopeia		
UV-VIS	❑ 50	0		5	Dark Cloth		
	❑ 100	0		5	Dark Cloth		
	❑ 200	0		5	Dark Cloth		
HiRes	❑ 10	0		5	RefStar*	190	2
	❑ 25	0		5	RefStar*	190	2
	❑ 50	0		5	RefStar*	190	2
	❑ 10	0		5	RefStar*	190	4
	❑ 25	0		5	RefStar*	190	4
	❑ 50	0		5	RefStar*	190	4
NIR				5	300°		
				5	350°		
LWIR				5	300°		

* Ref star is the Cassiopeia Constellation StarSimulator Reference star with 3.9K-Ohm resistor in series with the power supply.

- ☑ When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.

- ☑ Store the sensor using the "Sensor Activity Log Sheet (LLNL-SAL), "Securing the Sensor" section or continue to next test. ☑ Stored Sensor | ☑ Continued Testing.

- ☐ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

- ☐ Note Any exceptions in the test

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7.5. Performance Analysis & Reporting Criterion

- ☐ Generate PSF for Point Source at a Pixel near the center of the Field of View and 4 points evenly spaced off axis.

- ☐ Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.

8 Flat Field Test [Optional]

Operator: ______________ Date: ________________ Activity Sheet:~LLNL-SAL-______

8.1. Applicable Sensors:

❑ StarTracker ______________	❑ UV-VIS ________________	❑ HiRes ________________
❑ Laser Transmitter ________	❑ NIR ________________	❑ LWIR ________________

8.2. Data Storage Locations:

Images: /dspse/<Sensor>/flatField/date/<sensorname.imagenumber>
Temp : MAC:<SensorID>-LLNL-SAL-XXXX.temp.FFT

8.3. Purpose

A verification of the LLNL absolute radiometric calibration will be performed on the sensors with an accuracy of TBD. A Labsphere Uniform Source System will be used to provide a calibrated (NIST traceable) radiance for a wavelength range of 0.4 to 2.3 mm. This source will be used for all visible sensors and the NIR sensor. For the LWIR and upper wavelength filters of the NIR, the extended blackbody source will be used. The source will be placed near the sensor to ensure the source fills the entire sensor field of view. A radiometric analysis will be performed as follows: For each filter setting, gain setting, and a set of appropriate integration time two images will be acquired and stored:

8.4. Test Environment & Procedure

❑ Unpack the sensor using the "Sensor Activity Log Sheet (LLNL-SAL)
Log the execution of the "LLNL Flat Field Test" in the sensor certification log.

❑ At Power-On, Start the Fluke Temperature Data Logger bu pushing the "Start Log" button on the Macintosh interface. Save the file as: <sensorID> - LLNL-SAL-xxxxx.temp.
Example: UV311-LLNL-SAL-0016.temp

❑ Do SOMETHING!!!

❑ Store the sensor using the "Sensor Activity Log Sheet (LLNL-SAL) , "Securing the Sensor" section or continue to next test. ❑ Stored Sensor | ❑ Continued Testing.

❑ When testing has been completed, turn the power to the sensor off and close the temperature data log file on the macintosh.

❑ When the test is successfully completed, Update the LLNL Sensor Acceptance Testing Summary Sheet.

- ☐ Note Any exceptions in the test

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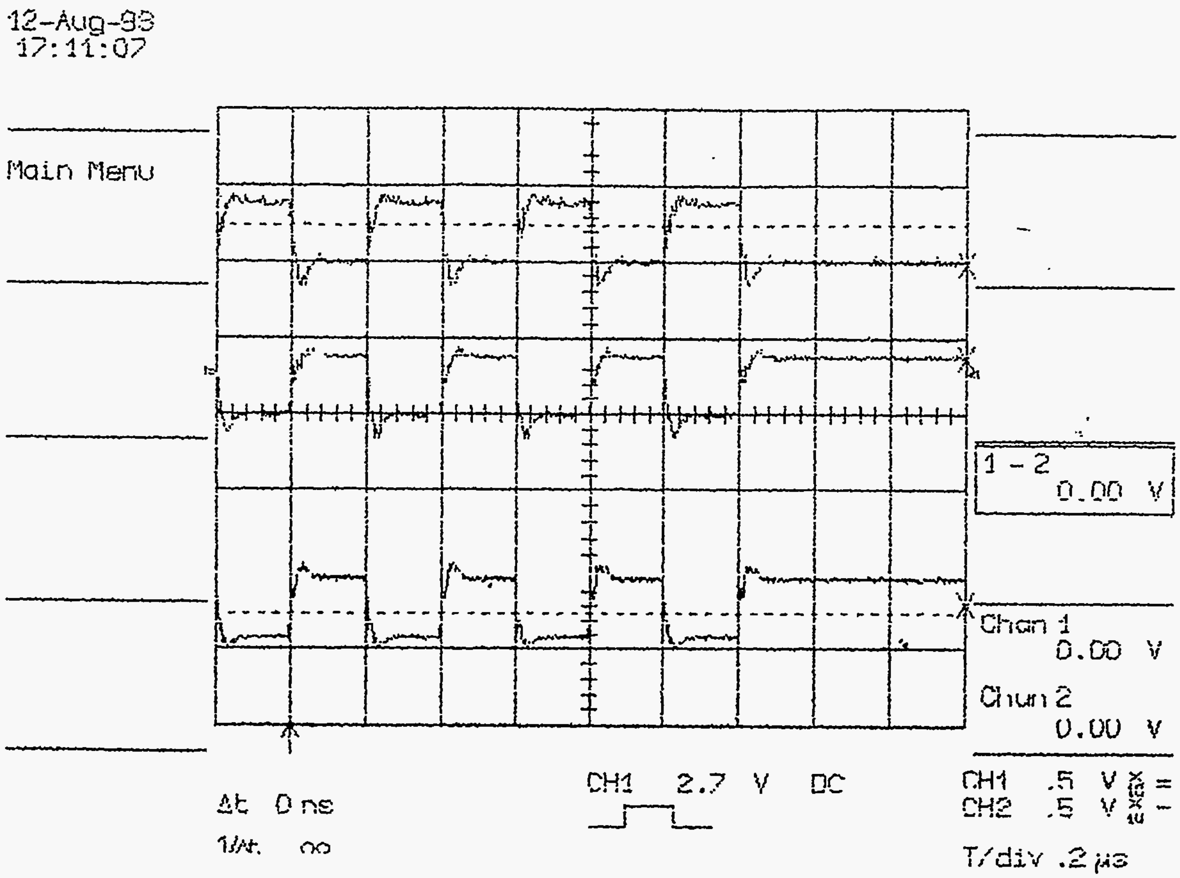
8.5. Performance Analysis & Reporting Criterion

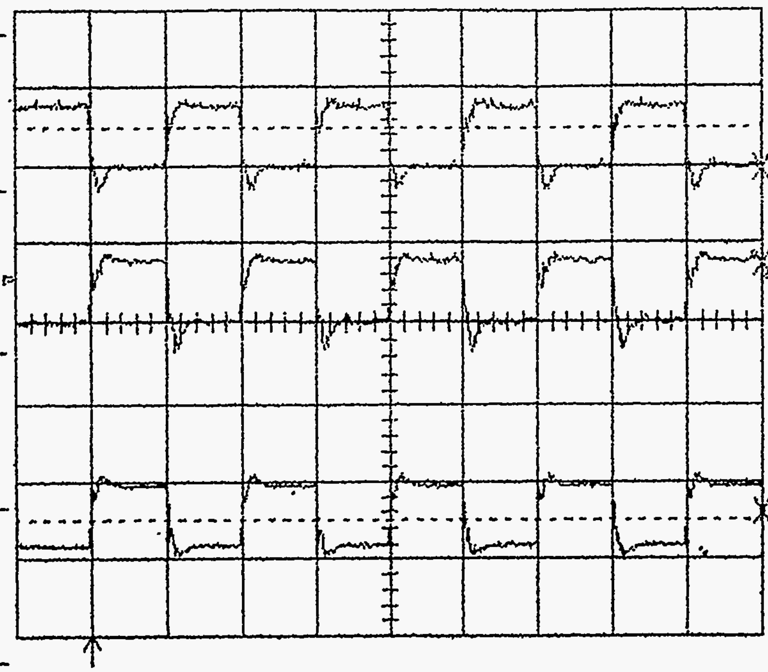
- ☐ Plot temperature vs time of the sensor CCD, and baseplate starting at power-on, notated with room temperature.


12-Aug-93
17:11:07
Main Menu
1 - 2
0.00 V
Chan 1
0.00 V
Chan 2
0.00 V
Δt 0 ns
1/Δt ∞
CH1 2.7 V DC
CH1 .5 V
CH2 .5 V
T/div .2 μs

D7

12-Aug-99
17:10:10

Main Menu



1 - 2
0.00 V

Chan 1
0.00 V

Chan 2
0.00 V

Δt 0 ns
1/Δt ∞

CH1 2.7 V DC

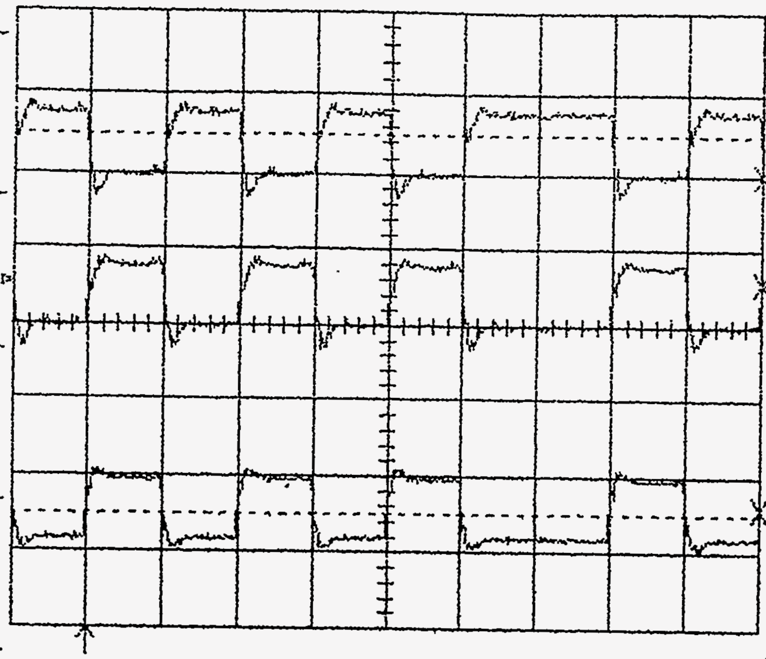
CH1 .5 V x10 =
CH2 .5 V x10 =

T/div .2 μs

D6

12-Aug-93
17:09:15

Main Menu



1 - 2
0.00 V

Chan 1
0.00 V

Chan 2
0.00 V

Δt 0 ns
1/Δt ∞

CH1 2.7 V DC

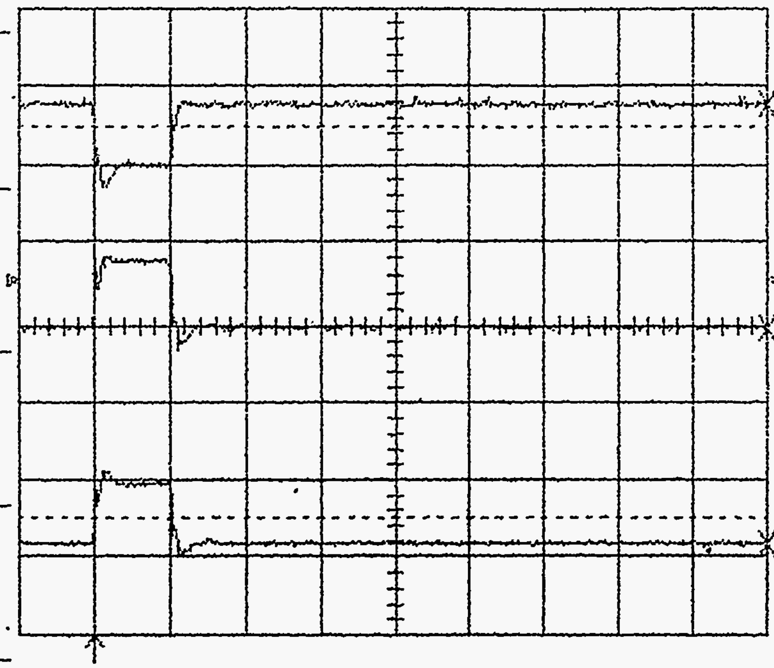
CH1 .5 V =
CH2 .5 V =

T/div .2 µs

D 5

12-Aug-95
17:07:53

Main Menu



1 - 2
0.00 V

Chan 1
0.00 V

Chan 2
0.00 V

Δt 0 ns

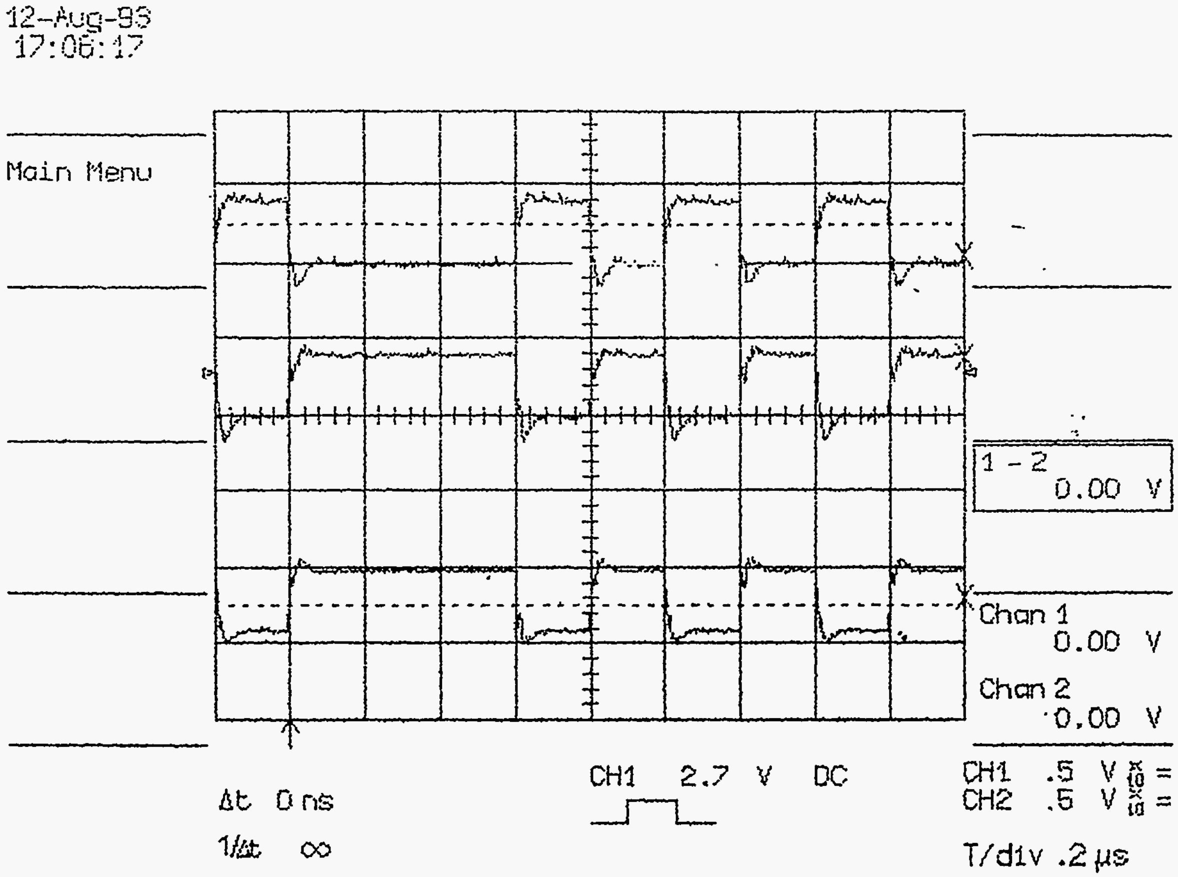
1/Δt ∞

CH1 2.7 V DC

CH1 .5 V x10 =
CH2 .5 V x10 =

T/div .2 μs

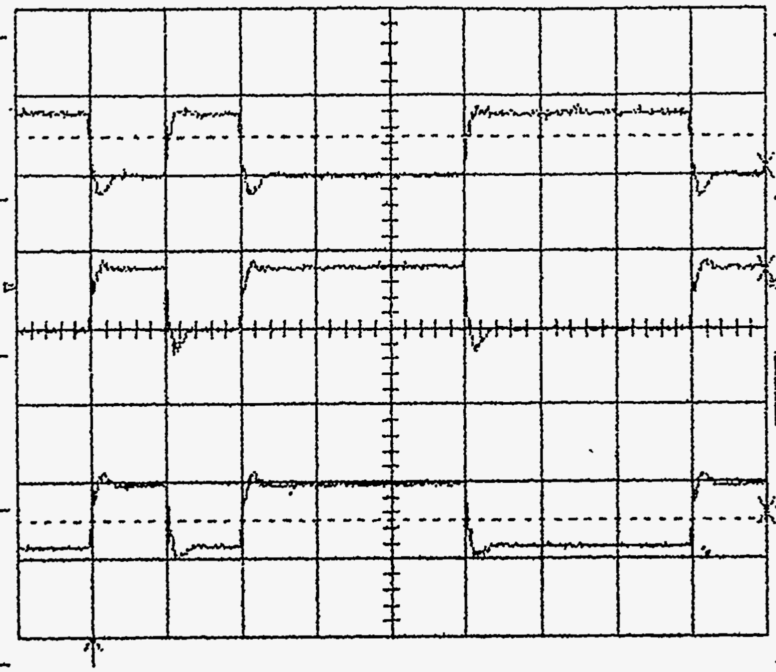
D 4


12-Aug-93
17:06:17
Main Menu
1 - 2
0.00 V
Chan 1
0.00 V
Chan 2
0.00 V
Δt 0 ns
1/Δt ∞
CH1 2.7 V DC
CH1 .5 V
CH2 .5 V
T/div .2 µs

D3

12-Aug-93
17:05:25

Main Menu



1 - 2
0.00 V

Chan 1
0.00 V

Chan 2
0.00 V

Δt 0 ns

1/Δt ∞

CH1 2.7 V DC

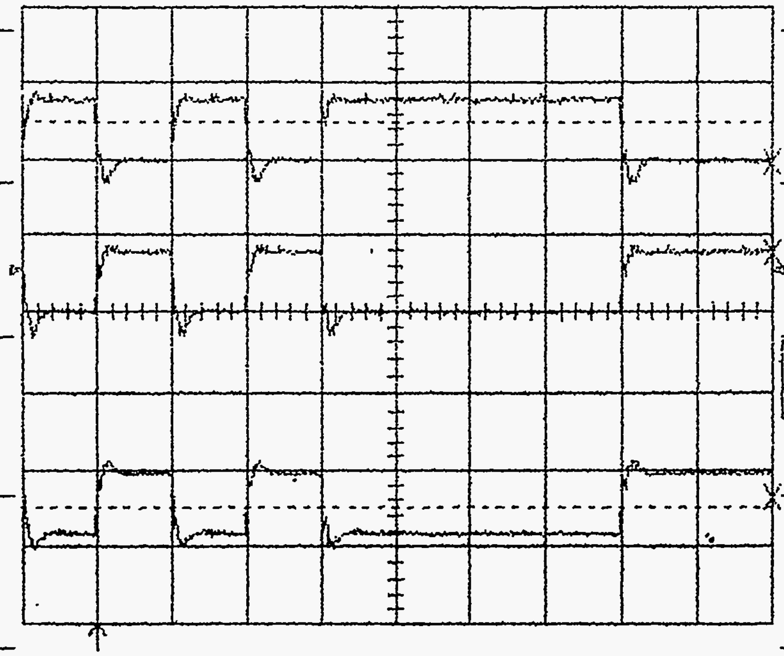
CH1 .5 V x10 =
CH2 .5 V x10 =

T/div .2 µs

D2

12-Aug-93
17:04:21

Main Menu



1 - 2
0.00 V

Chan 1
0.00 V

Chan 2
0.00 V

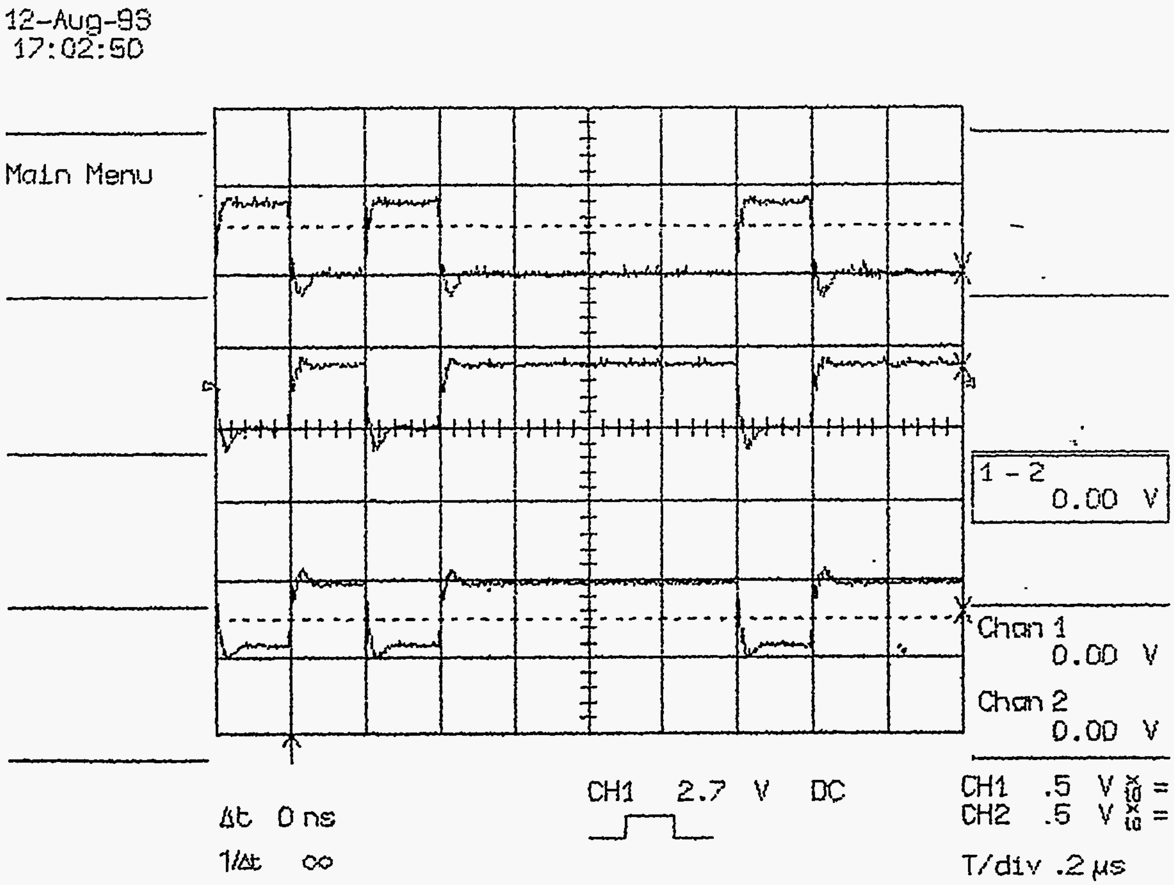
Δt 0 ns
1/Δt ∞

CH1 2.7 V DC

CH1 .5 V x10 =
CH2 .5 V x10 =

T/div .2 μs

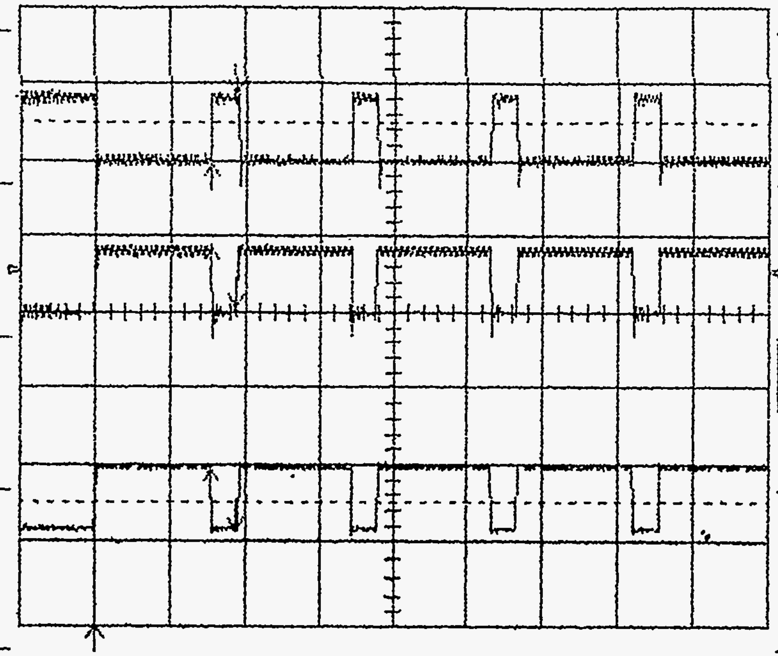
D1


12-Aug-93
17:02:50
Main Menu
1 - 2
0.00 V
Chan 1
0.00 V
Chan 2
0.00 V
Δt 0 ns
1/Δt ∞
CH1 2.7 V DC
CH1 .5 V
CH2 .5 V
T/div .2 μs

D 0

12-Aug-98
17:00:35

Main Menu



1 - 2
7.97 V

Chan 1
3.91 V

Chan 2
-4.53 V

Δt -17.10 μs
1/Δt -58.48 kHz

CH1 2.7 V DC

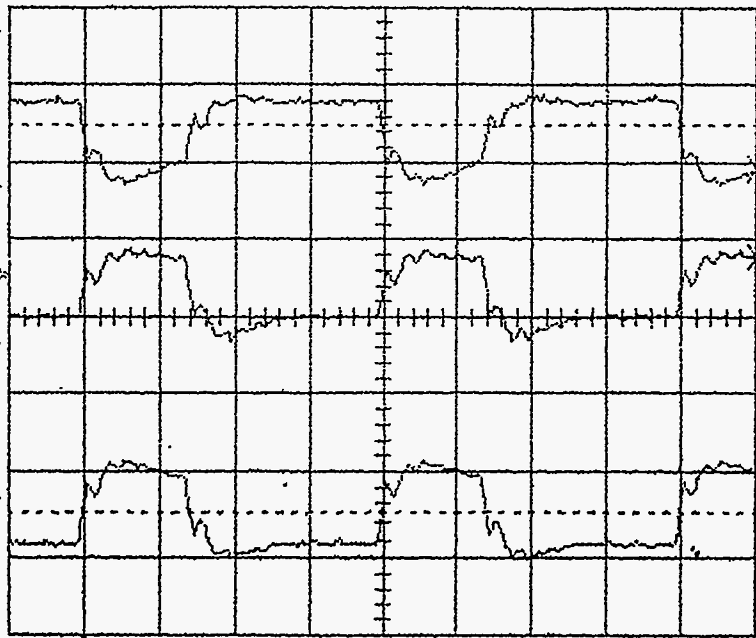
CH1 .5 V x10 =
CH2 .5 V x10 =

T/div 50 μs

Pix Val

12-Aug-93
16:57:53

Main Menu



1 - 2

Chan 1
0.00 V

Chan 2
0.00 V

Δt 0.00 ns

1/Δt ∞

CH1 2.7 V DC

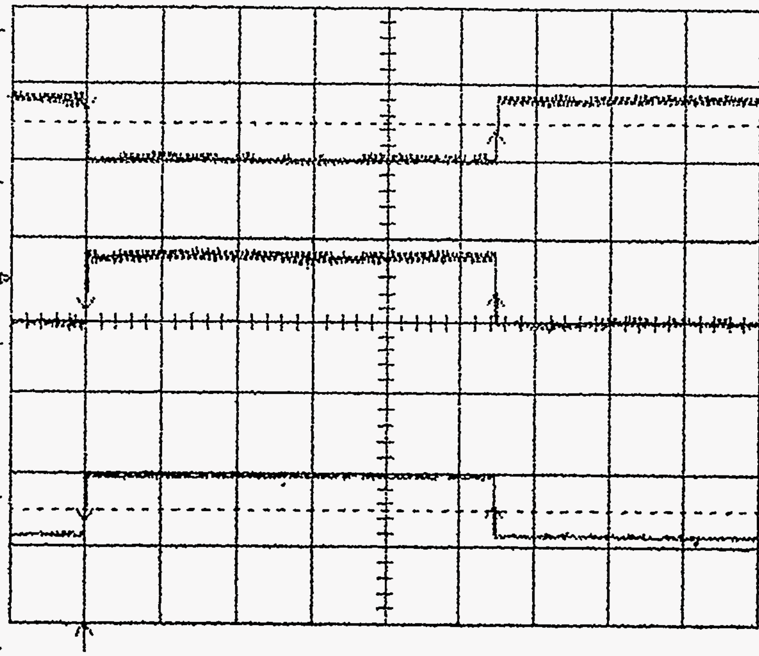
CH1 .5 V x10 =
CH2 .5 V x10 =

T/div 50 ns

Pixclk

12-Aug-93
16:56:39

Main Menu



1 - 2
2.29 V

Chan 1
1.93 V

Chan 2
-1.21 V

Δt 54.65 ms
1/Δt 18.298 Hz

CH1 2.7 V DC

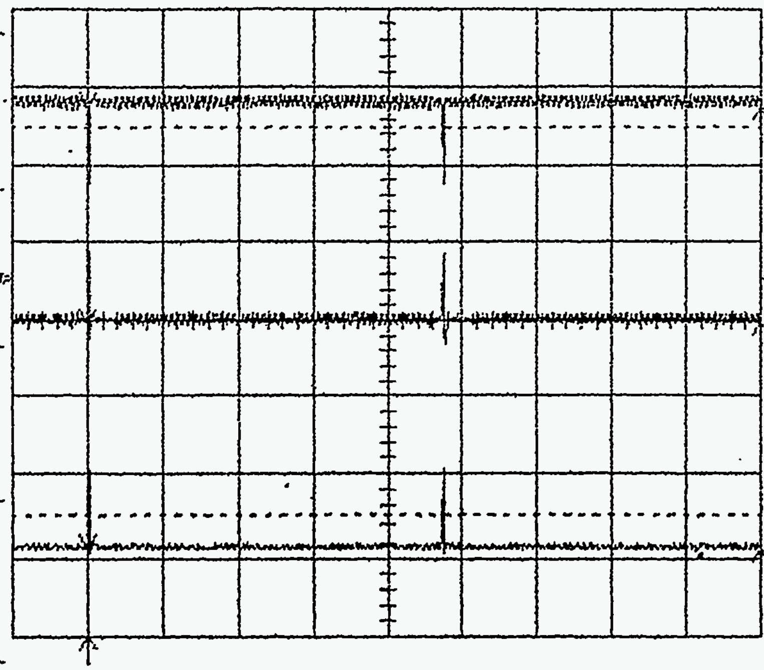
CH1 .5 V x10 =
CH2 .5 V x10 =

T/div 10 ms

Vsync

12-Aug-98
16:55:08

Main Menu



1 - 2
0.00 V

Chan 1
-0.00 V

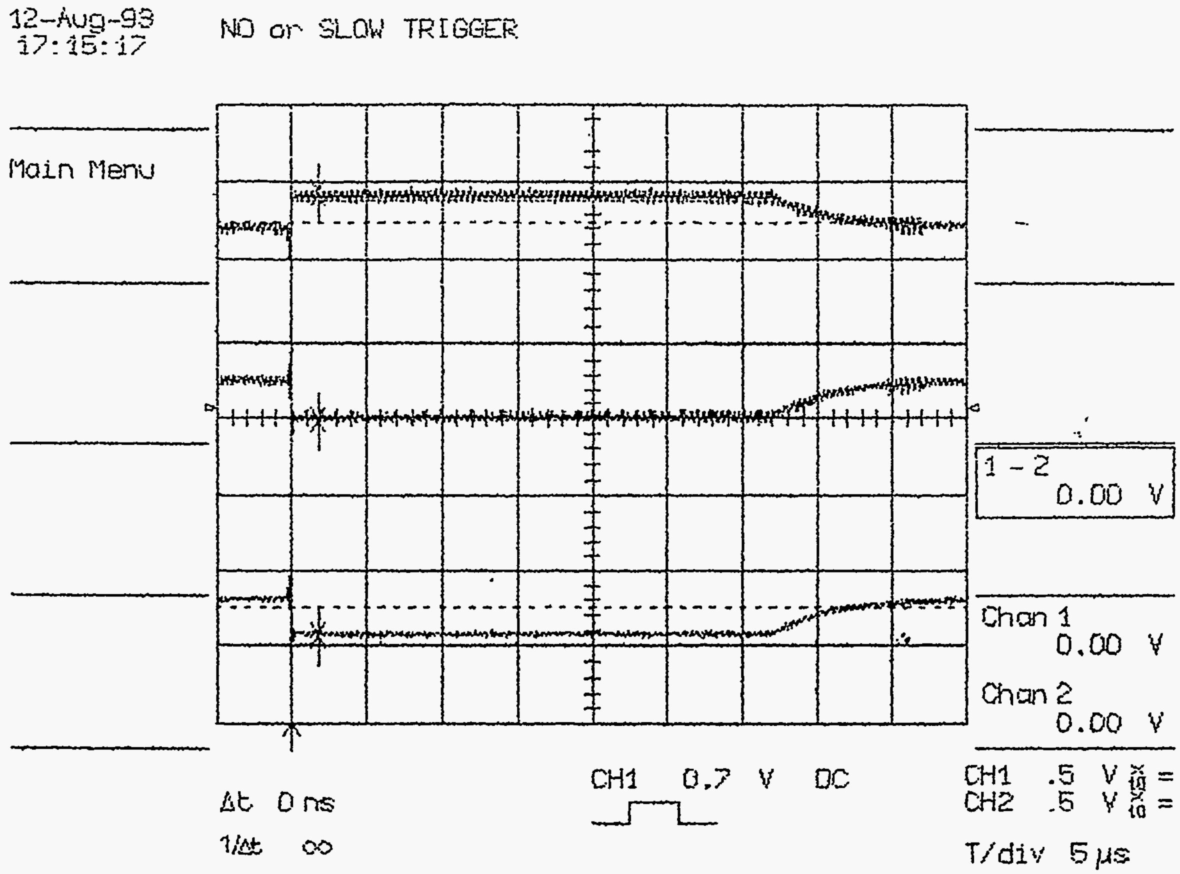
Chan 2
-0.16 V

Δt 180.0 µs
1/Δt 5.556 kHz

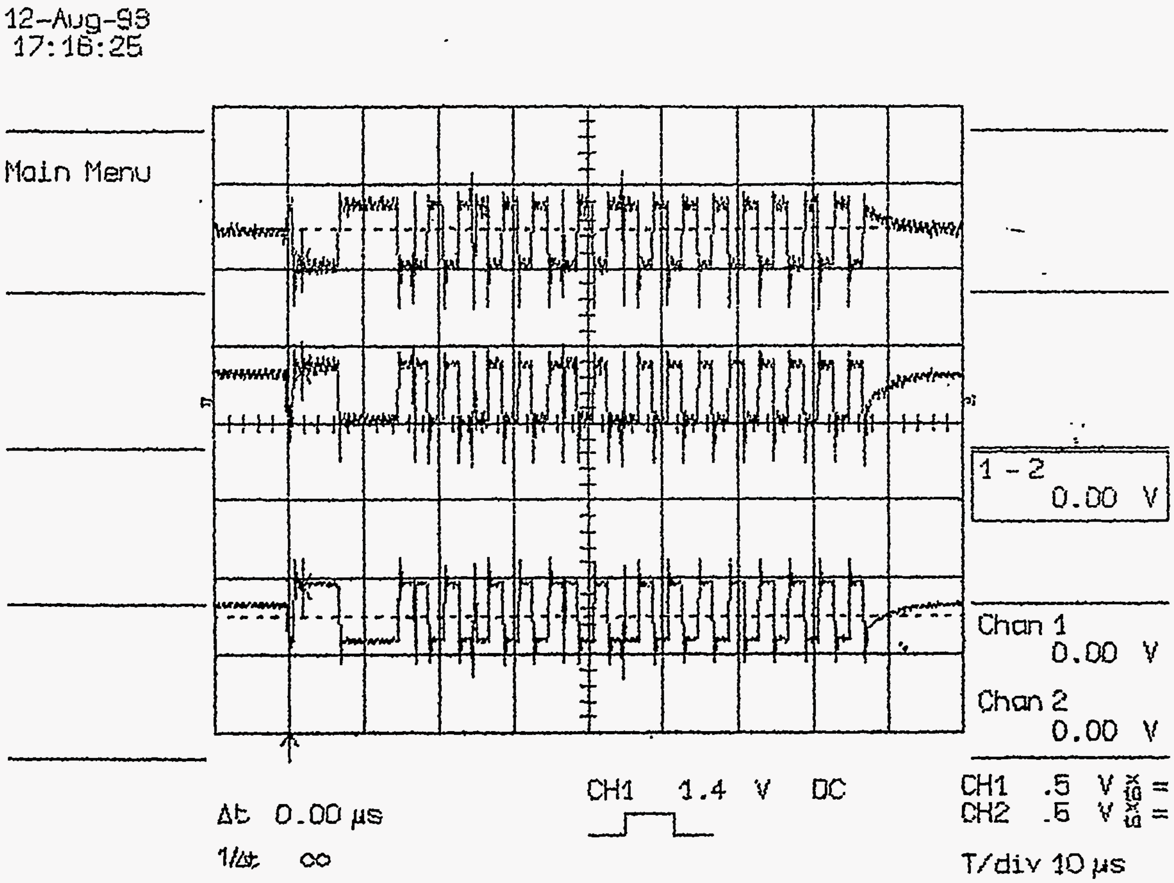
CH1 2.7 V DC

CH1 .5 V $\frac{x}{10}$ =
CH2 .5 V $\frac{x}{10}$ =
T/div 20 µs

H sync

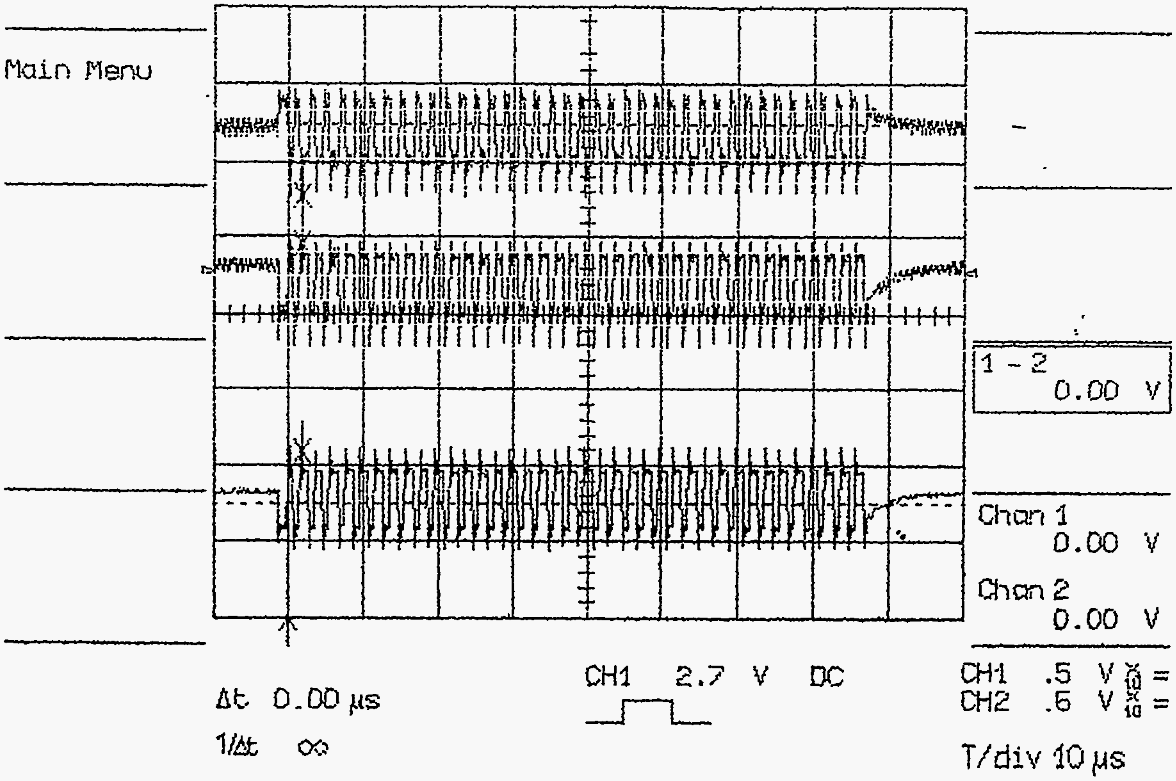

12-Aug-93
17:15:17
NO or SLOW TRIGGER
Main Menu
1 - 2
0.00 V
Chan 1
0.00 V
Chan 2
0.00 V
Δt 0 ns
1/Δt ∞
CH1 0.7 V DC
CH1 .5 V
CH2 .5 V
T/div 5 μs

SASI Status


12-Aug-93
17:16:25
Main Menu
1 - 2
0.00 V
Chan 1
0.00 V
Chan 2
0.00 V
Δt 0.00 µs
1/Δt ∞
CH1 1.4 V DC
CH1 .5 V
CH2 .5 V
T/div 10 µs

SASI Data

12-Aug-93
17:13:29

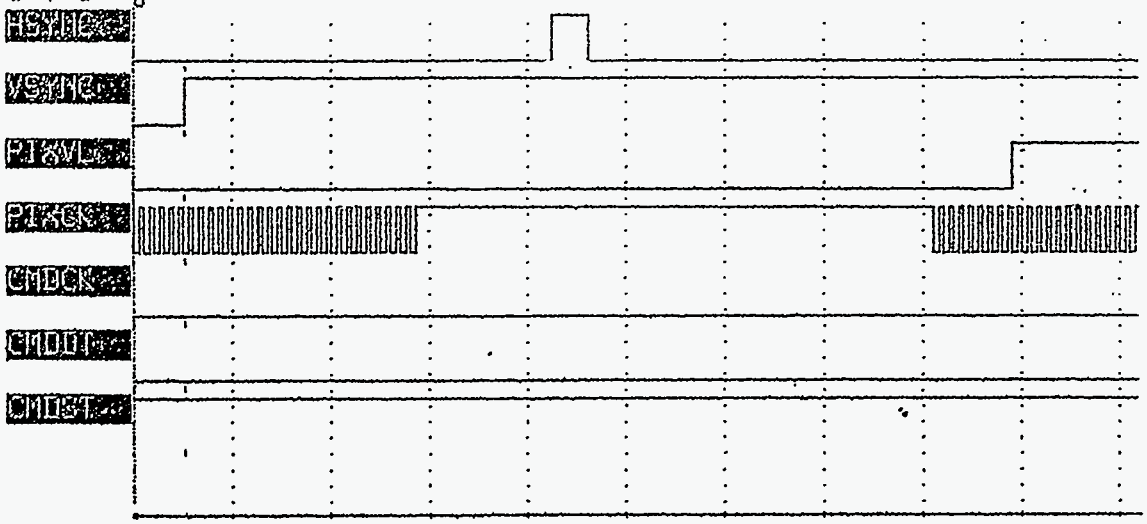


SASI CLK

Timing Waveform Diagram_________Continuous trace in process_____

Sample Period [20 ns] 2.000 µs/div
Magnification [1X] 20.00 ns/clk
Magnify about [X] 1.040 µs x to time trig
Cursor moves [X] 0.0 µs x to o

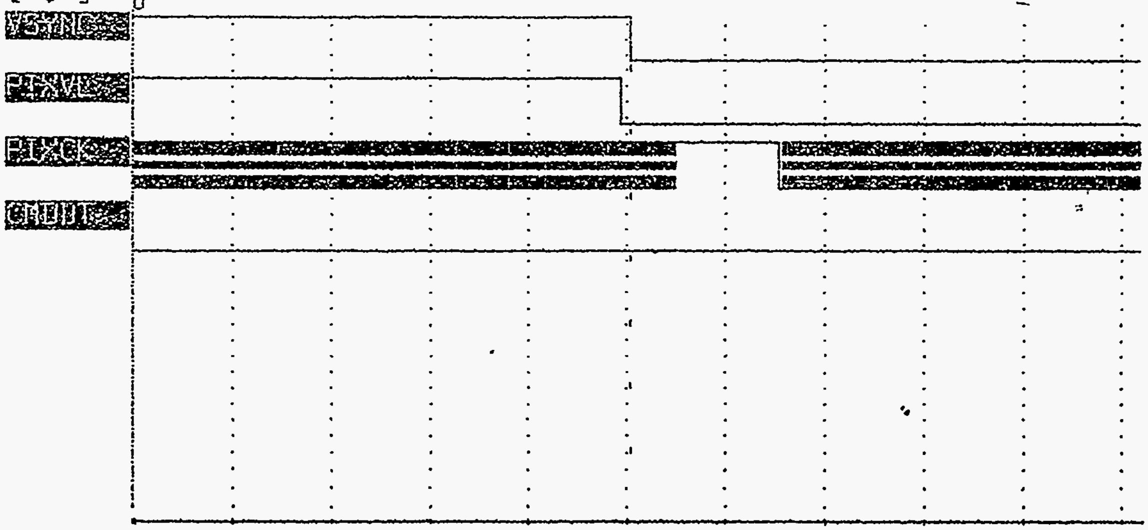
[↓] X o



Beginning

Timing Waveform Diagram----------Continuous trace in progress-----

Sample Period [100 ns]   10.00 µs/div
Magnification [X1]   100.0 ns/clk
Magnify about [illegible]   50.40 µs x to time trig
Cursor moves [illegible]   0.0 µs x to o
[↓] x o

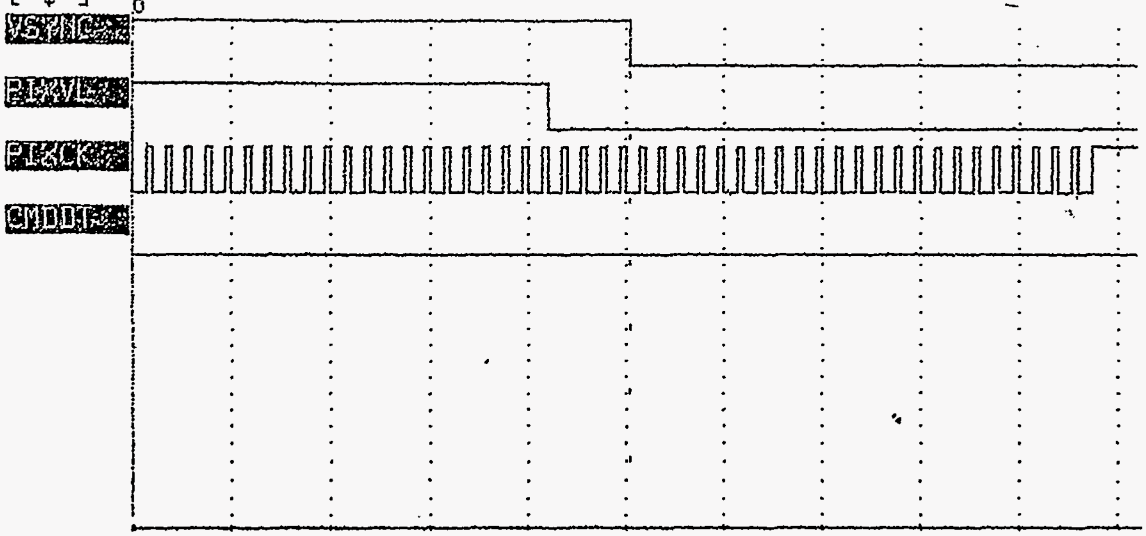


End of Frame

Timing Waveform Diagram_________Continuous trace in process_____

Sample Period [10 ns] 1.000 μs/div
Magnification [1X] 10.00 ns/clk
Magnify about [illegible] 5.040 μs x to time trig
Cursor moves [illegible] 0.0 μs x to o

[↓] x o

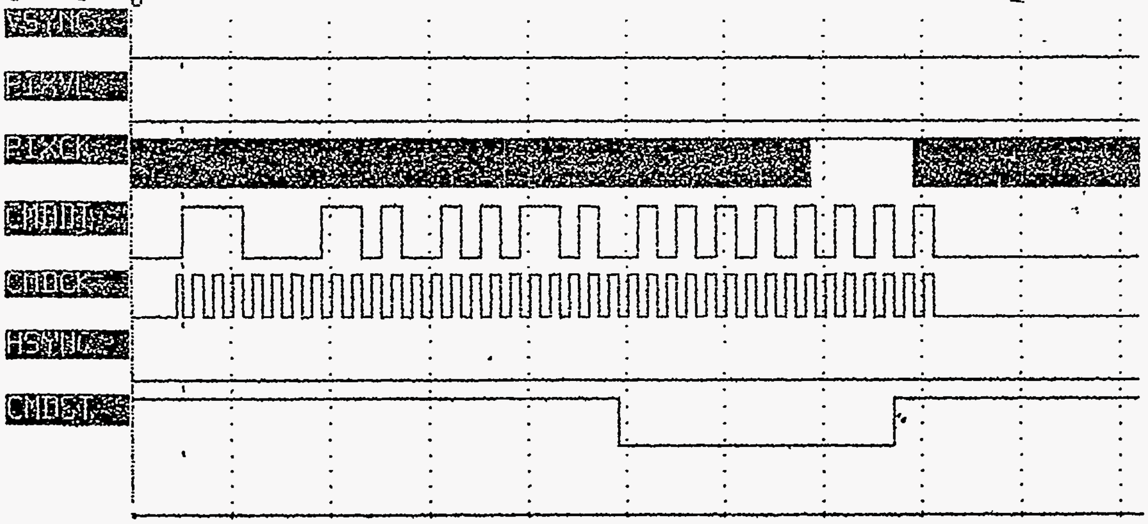


End of Frame

Timing Waveform Diagram_________Continuous trace in process_____

Sample Period [100 ns] 10.00 µs/div
Magnification [illegible] 100.0 ns/clk
Magnify about [illegible] 5.200 µs x to time trig
Cursor moves [illegible] 0.0 µs x to o

[↓] x o



SASI