CONF-871179--3-Vugraphs

DE88 004175

DIAGNOSTICS FOR ATF

Ralph C. Isler
Fusion Energy Division
ORNL

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Phase IA Dec., 1987 – March, 1988

- Residual Gas Analyzer
- Vessel Thermocouples
- Coil Alignment Apparatus
- Electron Beam for Flux Surface Mapping
- Hard X-ray Monitor
- Neutron Monitors
- Instrumented Limter
- CCD Camera
- Magnetic Loops
  - Diamagnetic Loop
  - Full Rogowski Coil
  - Segmented Rogowski Coil
  - Rogowski Coils for Buss Bars
  - Voltage Loops
- 2 mm Interferometer
- H_α Detectors
  - Horizontal View
  - Vertical View
  - Limiter View
  - Gas Puff
  - Neutral Beam View
- Bolometers

Phase IB March, 1988 – July, 1988

- Spectrometers
  - Grazing Incidence
  - Vacuum Ultraviolet Czerny-Turner
  - Visible Czerny-Turner

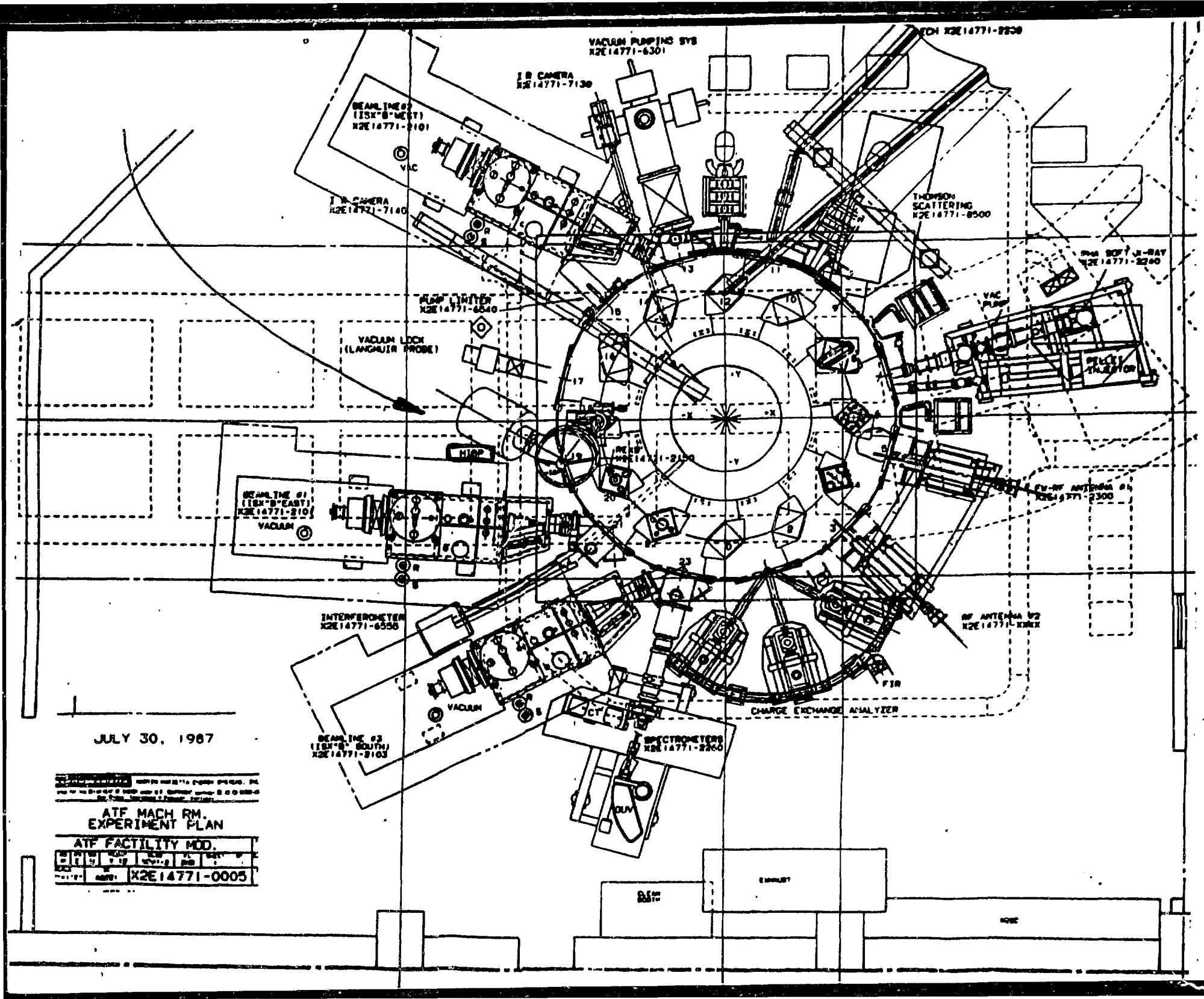
- Pulse Height Analysis System

Phase II July, 1988 – Dec., 1988

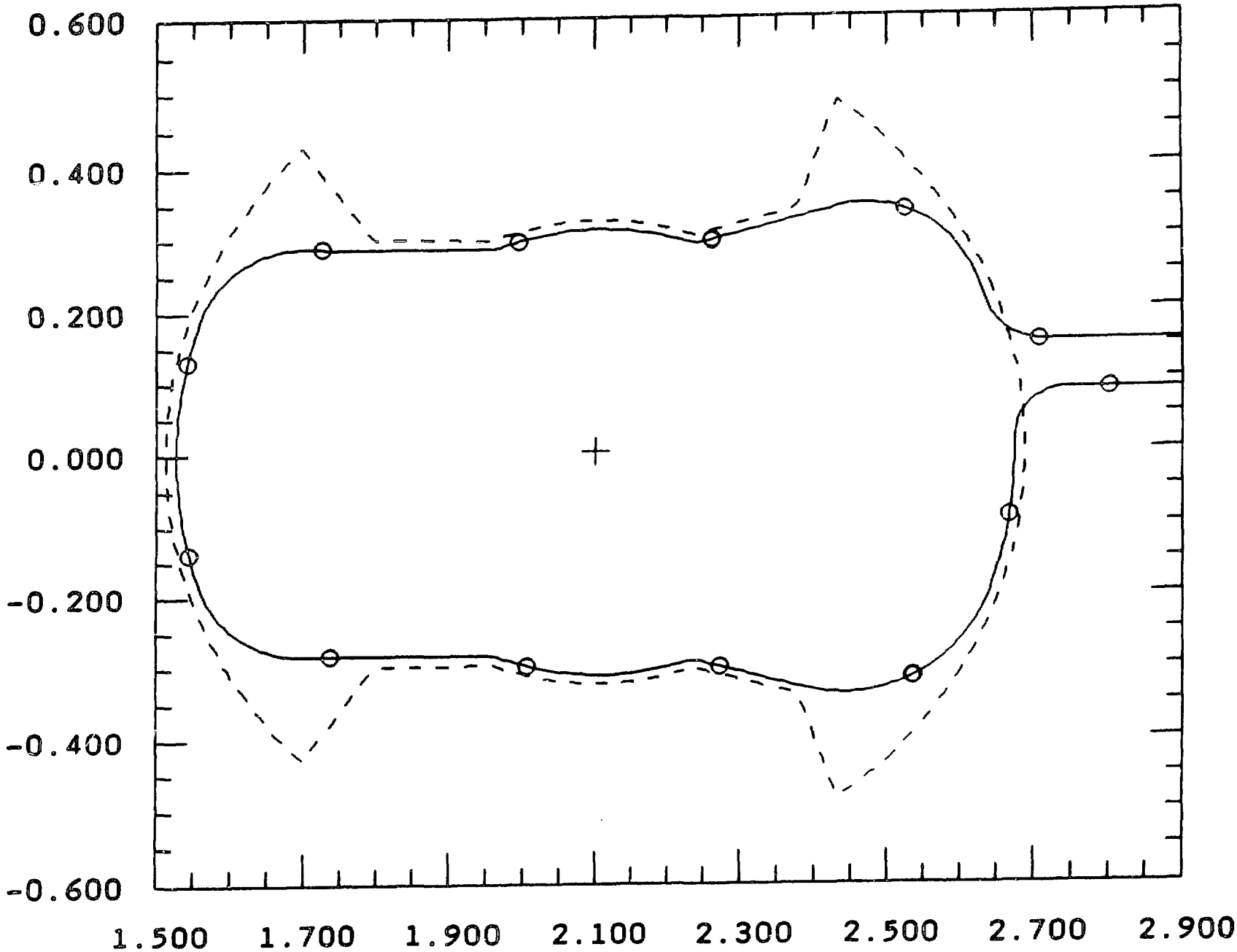
- Far Infrared Interferometer
- Thomson Scattering
- Neutral Particle Analyzer
- Visible Bremsstrahlung
- Langmuir Probe
- Infrared Camera
- Soft X-ray Array
- Mirnov Loops
- Laser Ablation
- Electron Cyclotron Emission Apparatus
- Limiter/Probe-Viewing Spectrometer

Phase III After Dec., 1988

- Bolometer Array
- Surface Analysis Station
- Heavy Ion Beam Probe

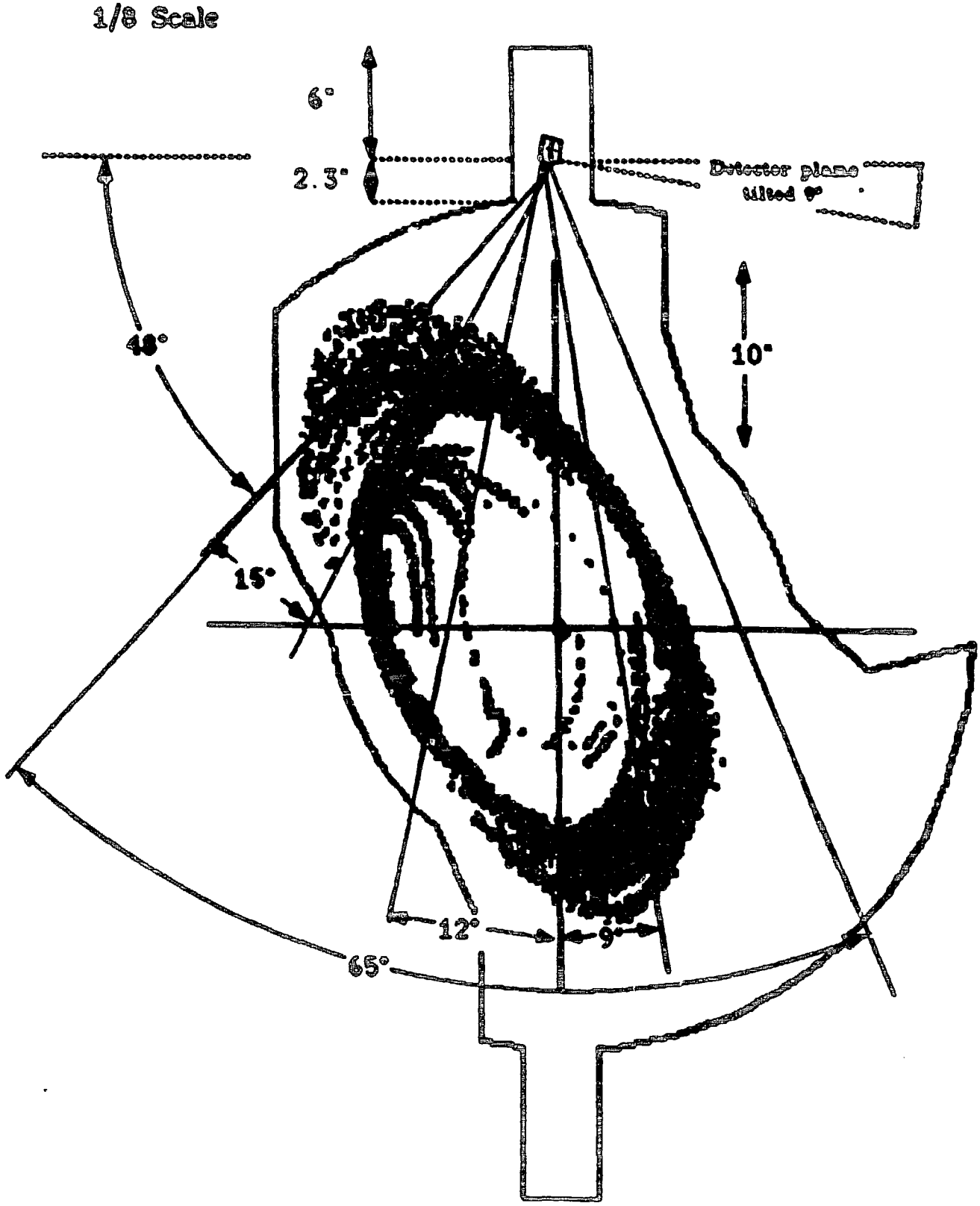

VACUUM PUMPING SYS
X2E14771-6301
I.R. CAMERA
X2E14771-7130
BEAMLINE #2
(15X"B"WEST)
X2E14771-2101
I.R. CAMERA
X2E14771-7140
THOMSON
SCATTERING
X2E14771-8500
SOFT X-RAY
X2E14771-3260
VAC PUMP
PELLET
INJECTOR
FLAP LIMITER
X2E14771-6540
VACUUM LOCK
(LANGMUIR PROBE)
HIRP
BEAMLINE #1
(15X"B"EAST)
X2E14771-2101
VACUUM
RF ANTENNA #1
X2E14771-2300
INTERFEROMETER
X2E14771-6556
RF ANTENNA #2
X2E14771-XXXX
FIR
VACUUM
CHARGE EXCHANGE ANALYZER
BEAMLINE #3
(15X"B" SOUTH)
X2E14771-2103
SPECTROMETERS
X2E14771-2200
DUMP
JULY 30, 1987
ATF MACH RM.
EXPERIMENT PLAN
ATF FACILITY MOD.
X2E14771-0005

THE ROGOWSKI COILS AND DIAMAGNETIC LOOP ARE FITTED INTO TUBES WHICH CONFORM TO THE VACUUM VESSEL WALLS. THESES TUBE CAN ALSO ACCOMODATE OPTICAL FIBERS SO THAT FARADY ROTATION OF A LASER LIGHT SOURCE CAN BE EXPLORED AS A TECHNIQUE FOR MEASURING MAGNETIC FIELDS.


0.600
0.400
0.200
0.000
-0.200
-0.400
-0.600
1.500
1.700
1.900
2.100
2.300
2.500
2.700
2.900

BOLOMETERS INSTALLED AT 7 LOCATIONS AROUND ATF INCORPORATE 3 DETECTORS EACH. THE DETECTORS ARE MASKED TO MEASURE RADIATION FROM EITHER BROAD OR NARROW ANGULAR REGIONS.

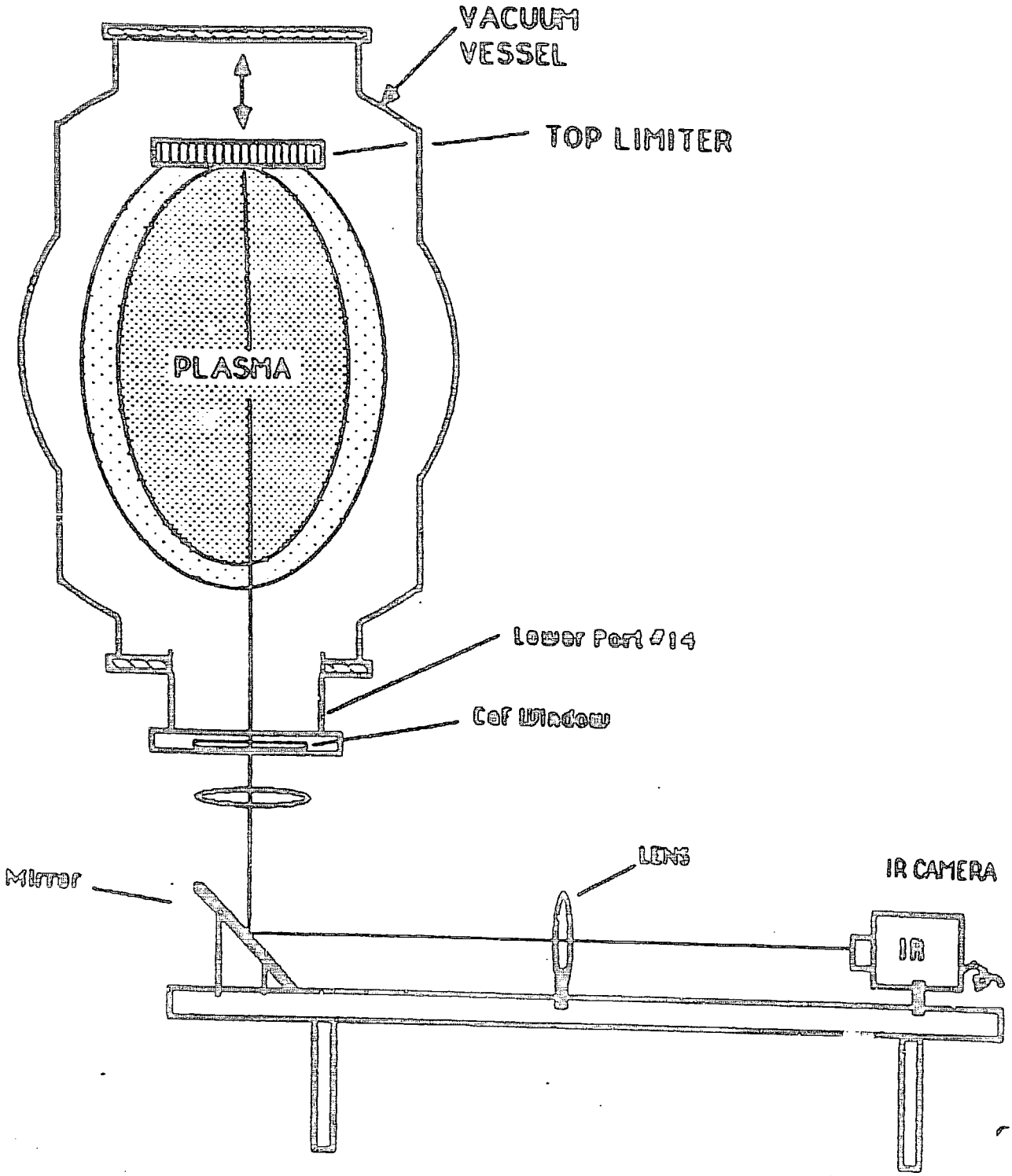
ATF Bolometer Monitor
Sector 20, $\phi = 5°$ section
10/22/86, 4:30 PM



PLASMA EDGE PARAMETERS AND PLASMA MATERIAL INTERACTIONS ARE INVESTIGATED WITH LANGMUIR PROBES, CCD CAMERAS, IR CAMERAS, AND SPECTROMETERS. A MOVEABLE, INSTRUMENTED GRAPHITE PLATE IN AN OUTER RADIAL LOCATION IS EMPLOYED TO STUDY POWER LOSSES TO THE WALLS. WE WILL CONCENTRATE ON TRYING TO DETERMINE WHETHER ENERGY IS PREFERENTIALLY TRANSPORTED THROUGH THE "STRIPES".

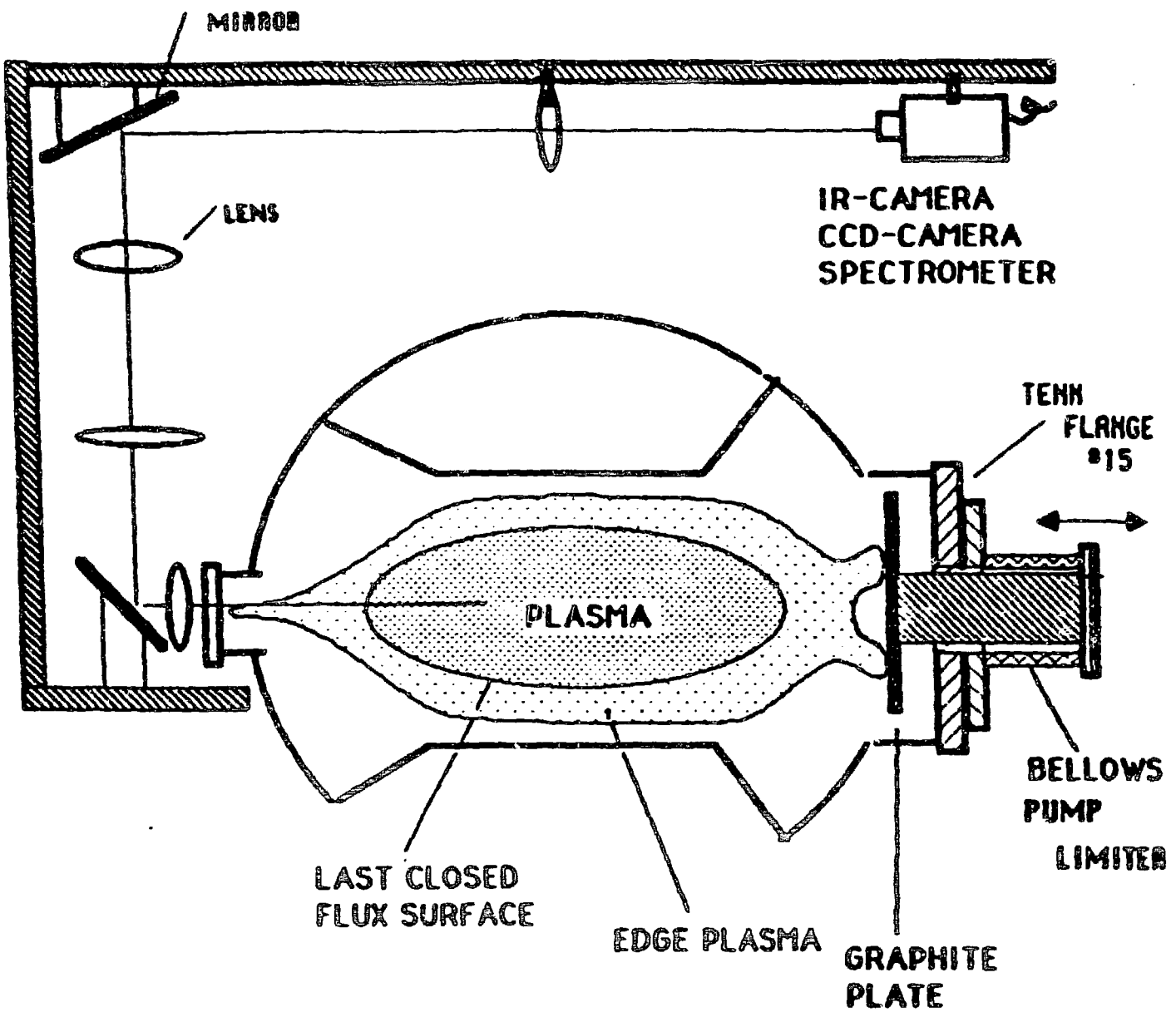
IR Camera View of ATF Instrumented Limiter

Sector #14



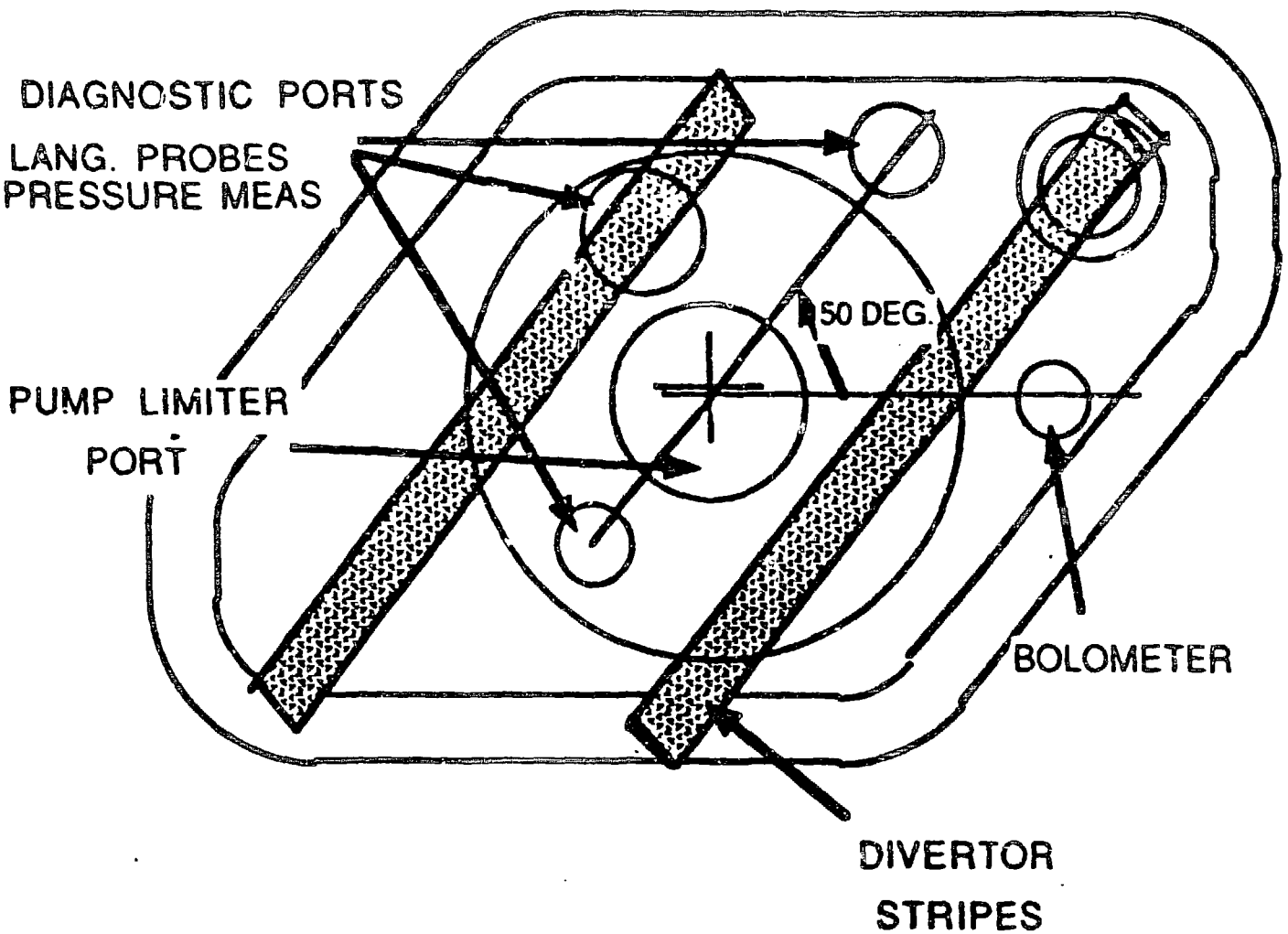
DLH 3/19/87

DIVERTOR CONFIGURATION EXPERIMENT ON ATF



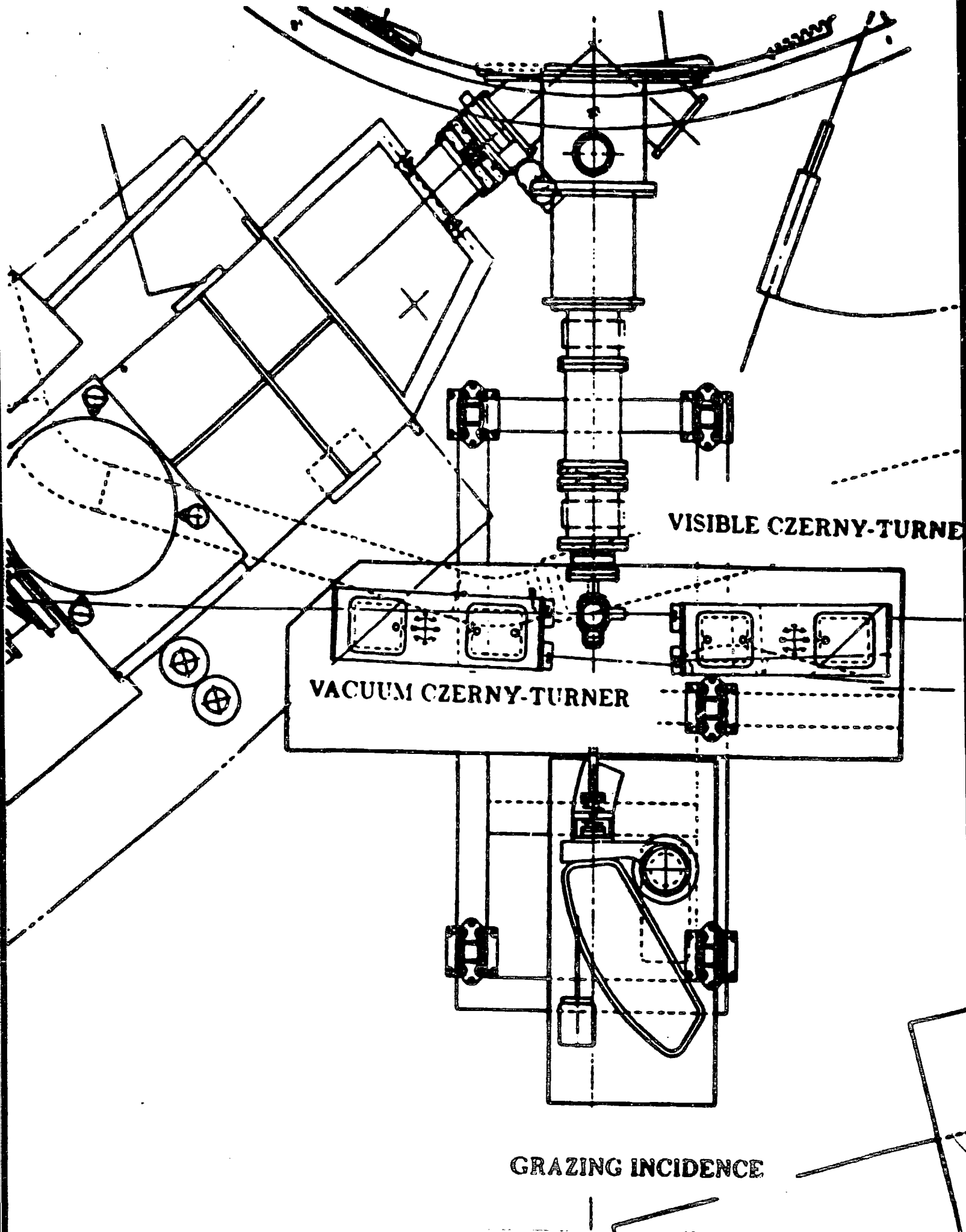
DLH 4/9/87

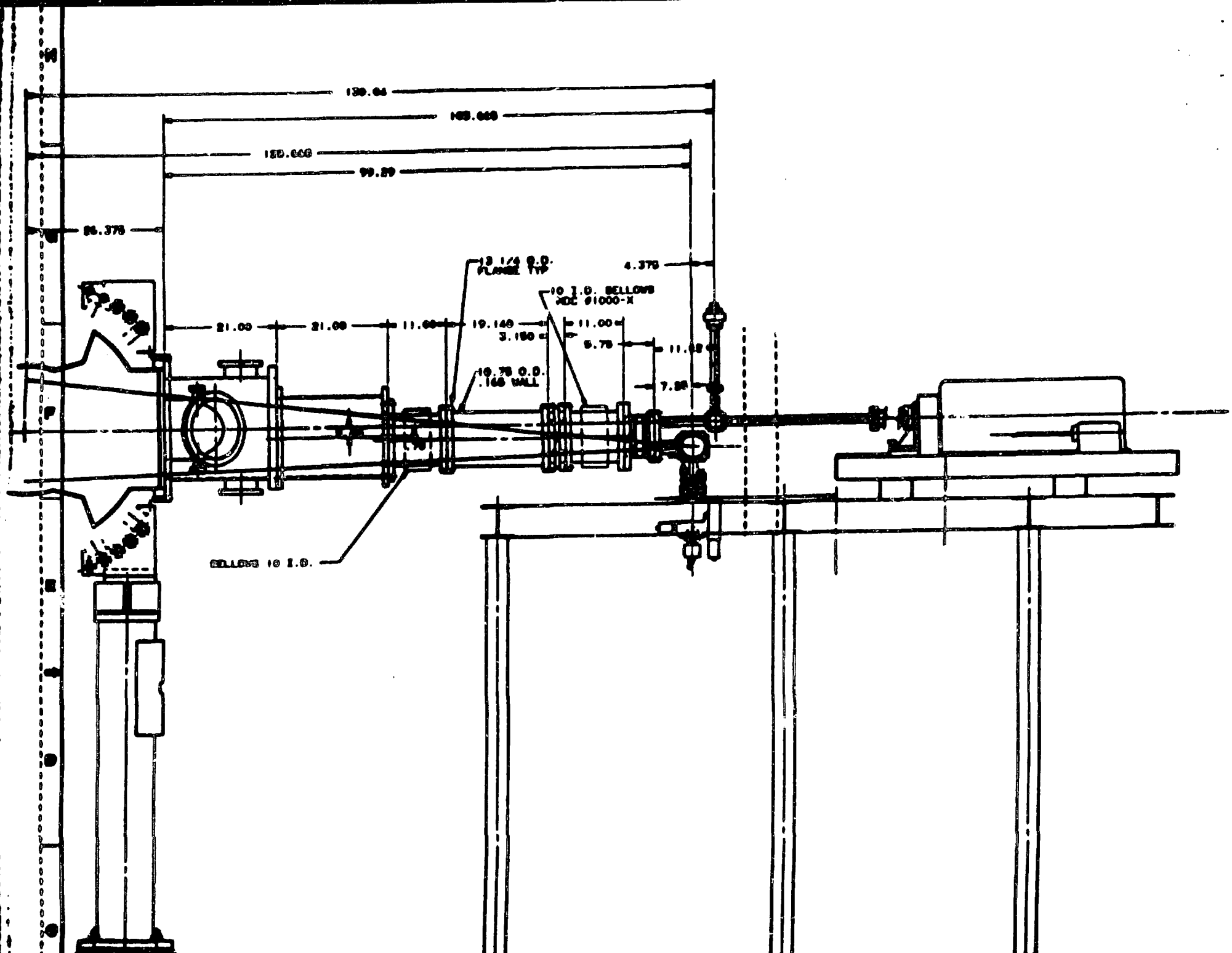
TENN PORT #15

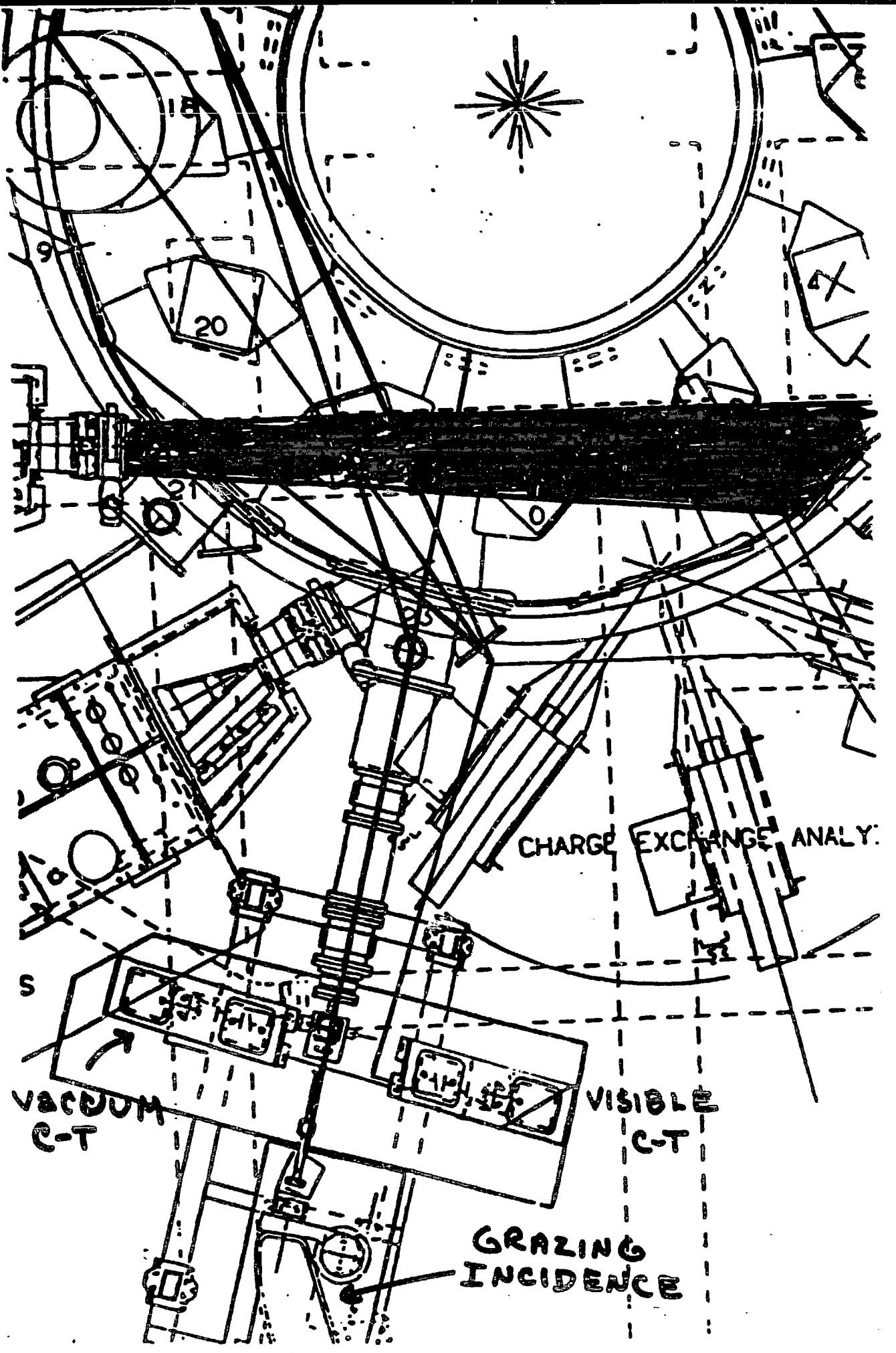


EDGE DIAGNOSTICS AND PUMP LIMITER

FOUR SPECTROMETERS ARE PLANNED FOR ATF. THE SPECTRAL REGION FROM 20 Å TO 8000 Å CAN BE UTILIZED FOR INVESTIGATING IMPURITY PRODUCTION AND CONFINEMENT. IN ADDITION, TWO OF THE INSTRUMENTS ARE ALSO SUITABLE FOR MEASURING ION TEMPERATURES AND PLASMA ROTATION FROM DOPPLER WIDTHS AND SHIFTS.

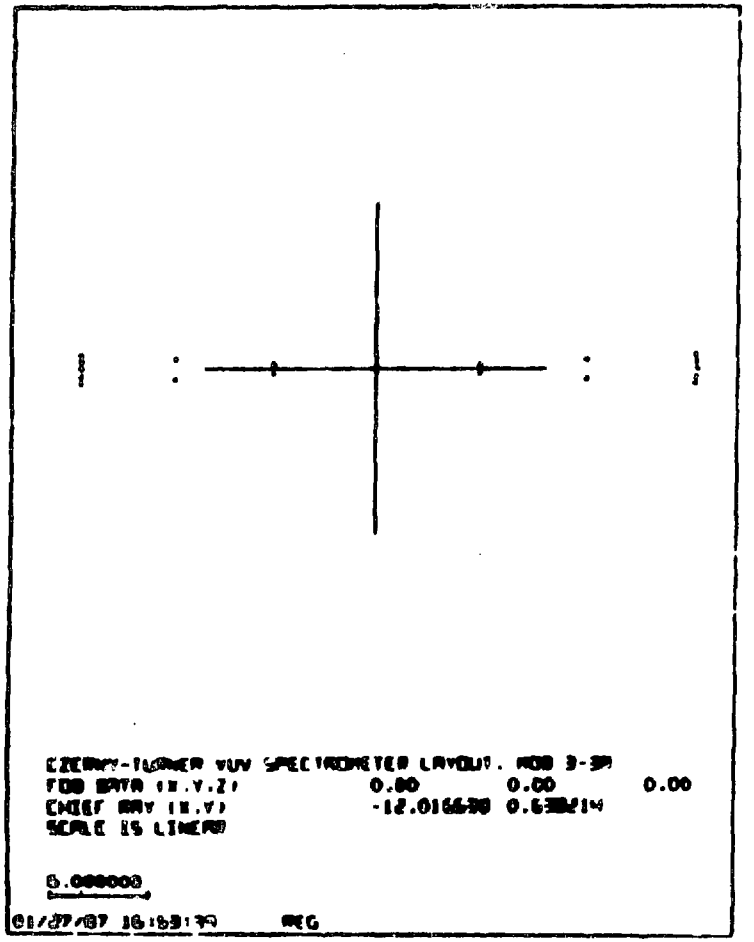

VISIBLE CZERNY-TURNE
VACUUM CZERNY-TURNER
GRAZING INCIDENCE


139.06
105.000
150.000
99.89
86.375
4.375
21.00
21.00
11.00
19.140
3.190
11.00
5.75
11.62
7.88
10 I.D. BELLOWS
MDC #1000-X
10.75 O.D.
.165 WALL
BELLOWS 10 I.D.

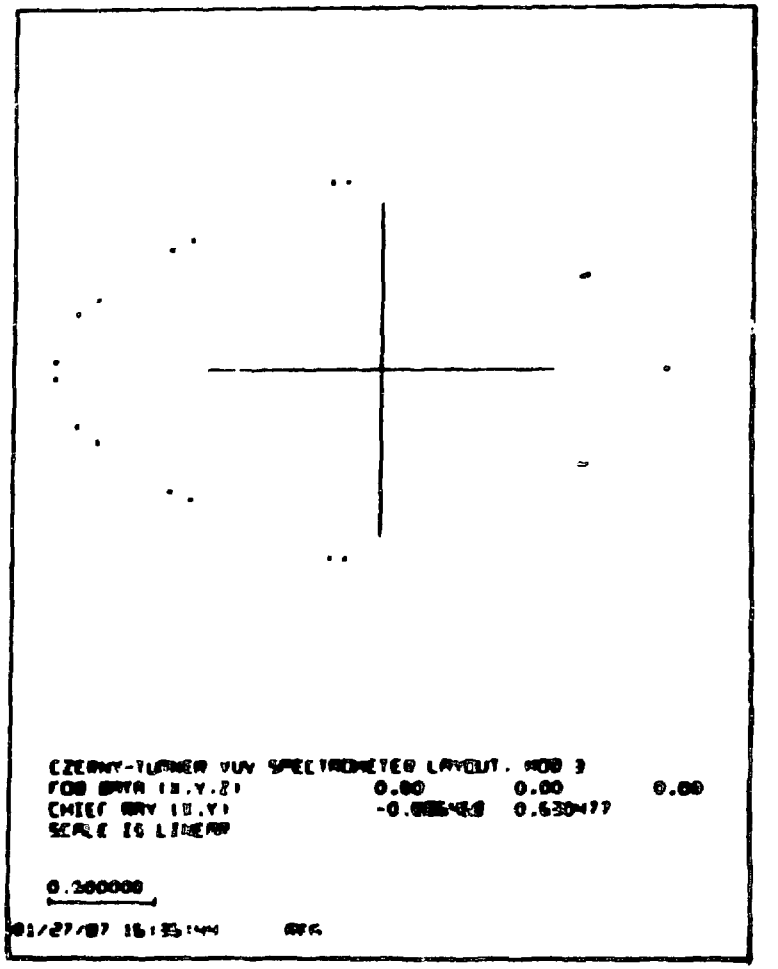

20
CHARGE EXCHANGE ANALY
VACUUM C-T
VISIBLE C-T
GRAZING INCIDENCE

Puncture Plots Showing Spatial Resolution of the Czerny-Turner System in a Vertical Plane at R_0.

Spherical Mirror Only



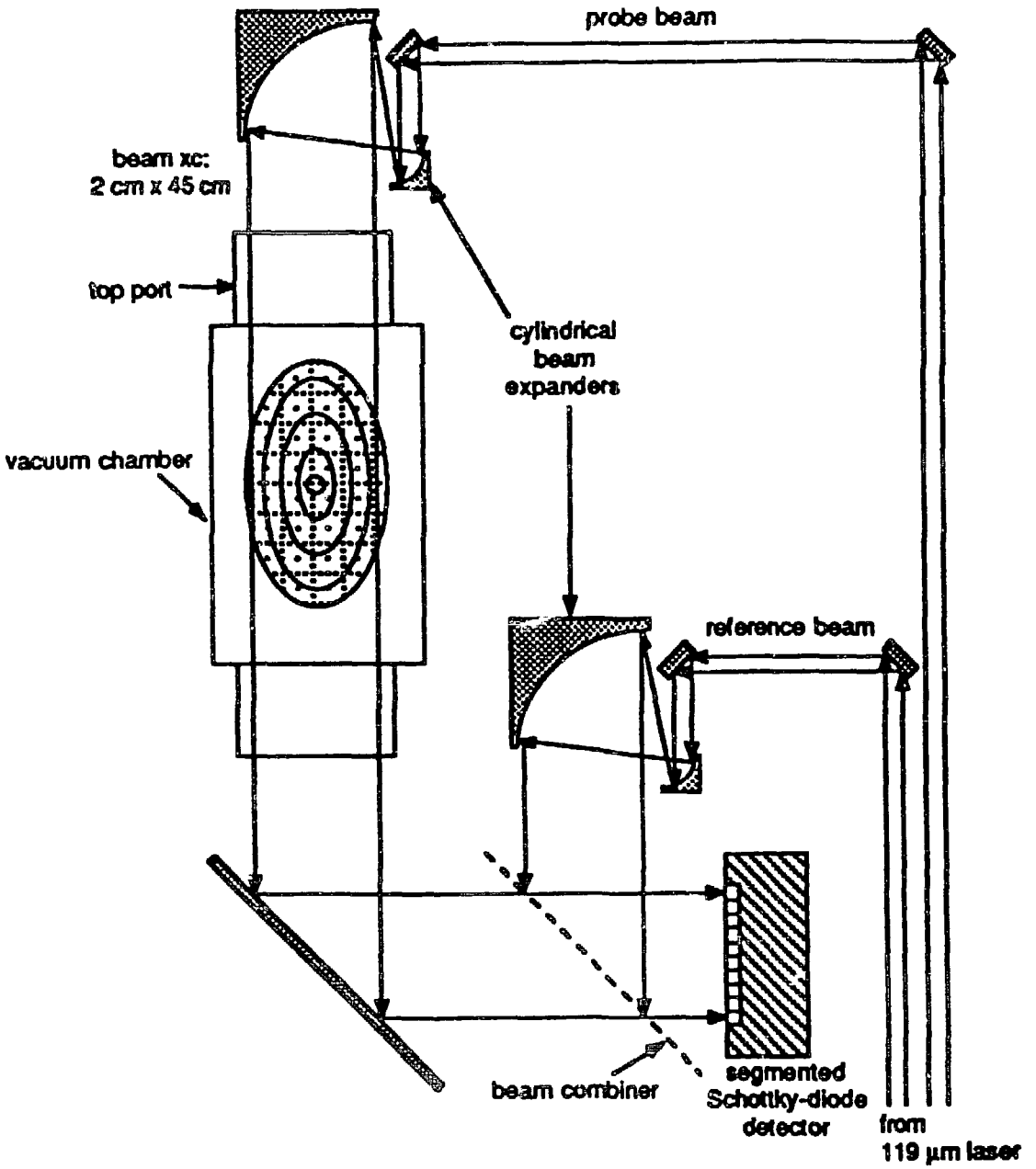
Spherical Mirror + Cylindrical Mirror



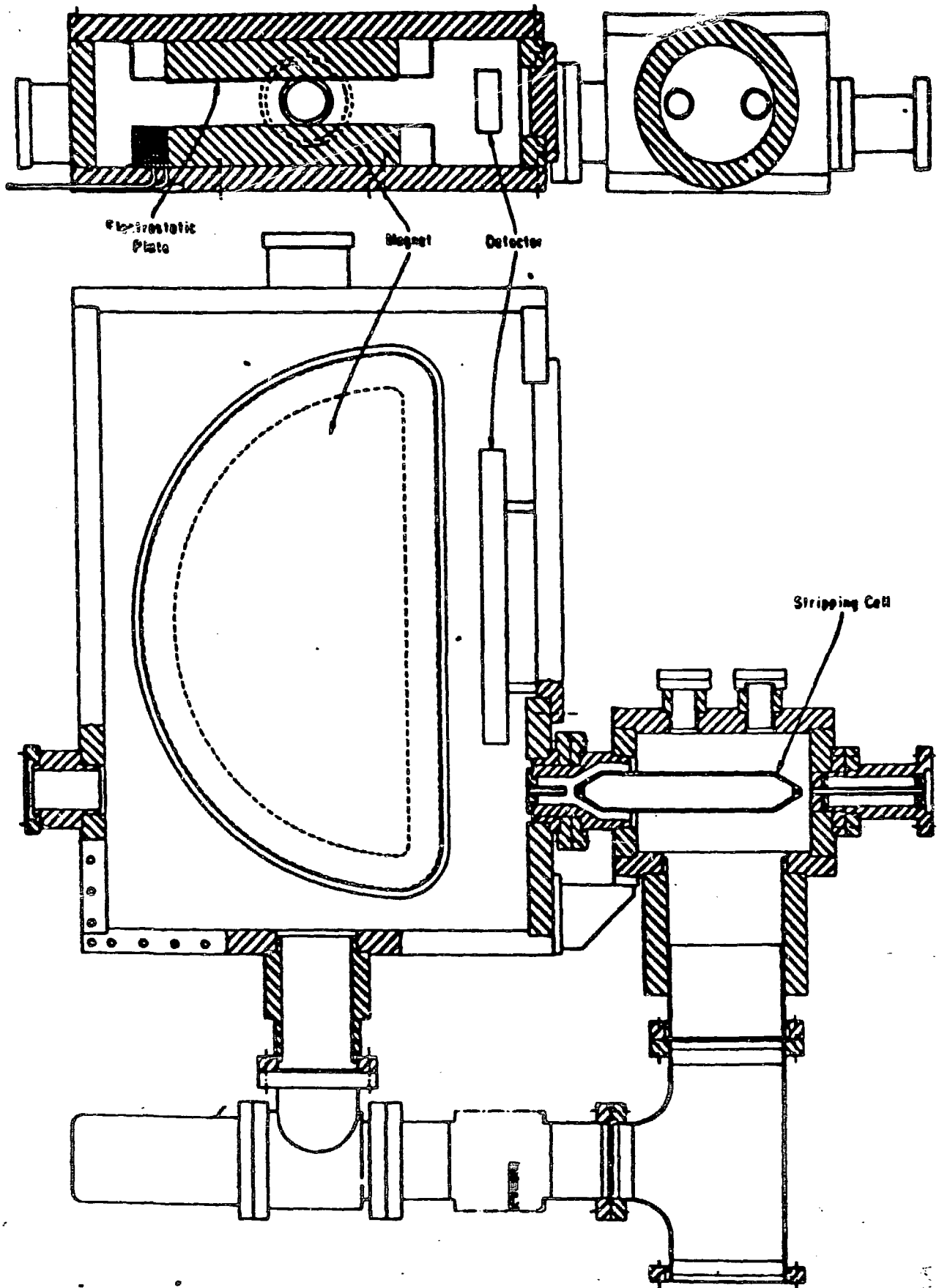
A 15 CHANNEL METHYL ALCOHOL LASER OPERATING AT 119 μm with 1W STEADY STATE OUTPUT IS USED FOR ELECTRON DENSITY MEASUREMENTS. THIS DEVICE INCORPORATES A NOVEL MIRROR SYSTEM TO EXPAND THE LASER BEAM SO THAT FULL PLASMA COVERAGE IS OBTAINED.

ATF Multichannel FIR Inteferometer

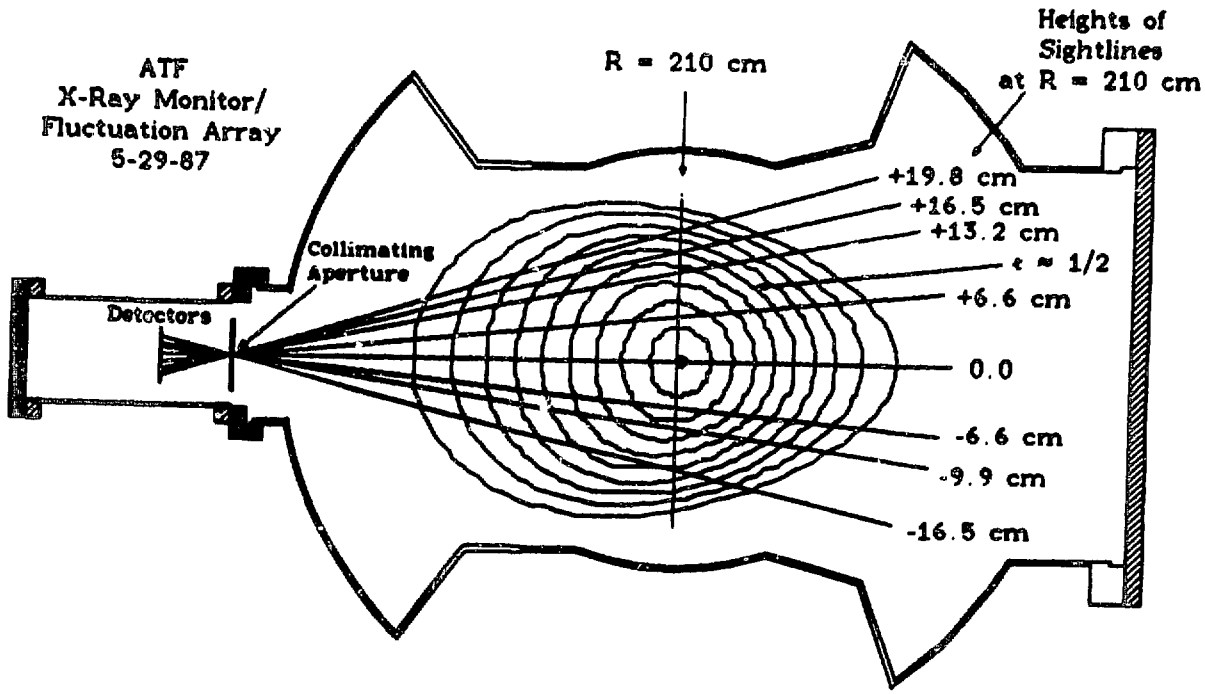
15 channels, radial resolution = 3 cm

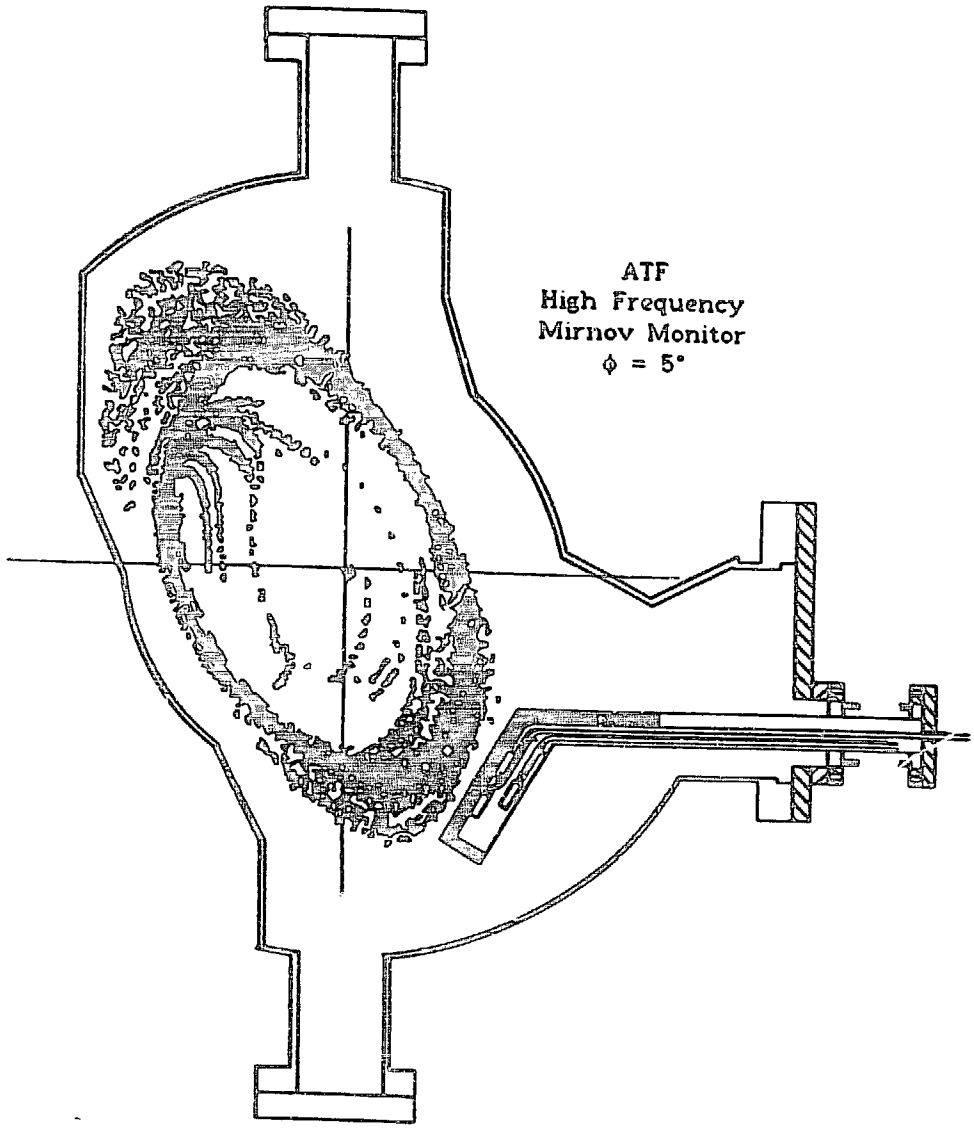


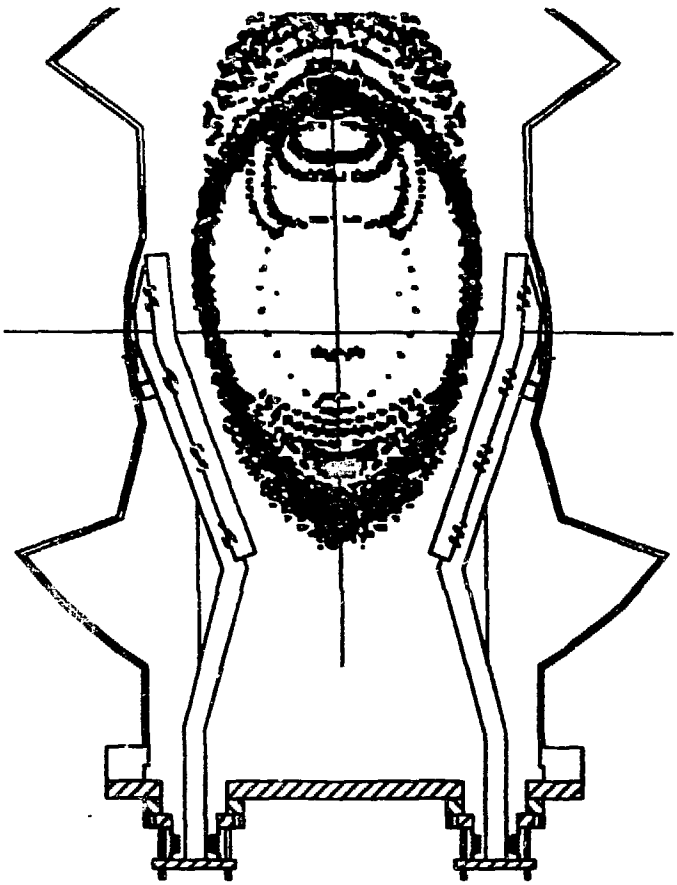
THE NEUTRAL PARTICLE ANALYZER WILL INITIALLY BE INSTALLED WITH A FIXED RADIAL VIEW. LATER, IT WILL BE MOUNTED ON A MOVEABLE STAND WHICH WILL ALLOW BOTH POLOIDAL AND TOROIDAL SCANNING OF APPROXIMATELY $\pm 45°$.


Electrostatic
Plate
Magnet
Detector
Stripping Cell

FLUCTUATIONS ARE STUDIED BY SOFT X-RAY ARRAYS AND BY HIGH AND LOW FREQUENCY MIRNOV COILS. LANGMUIR PROBE DATA AT THE PLASMA EDGE AND HEAVY-ION BEAM PROBE SIGNALS FROM THE CENTER ARE ALSO EXPECTED TO PROVIDE INFORMATION ABOUT FLUCTUATIONS OF DENSITY AND ELECTRIC FIELDS.


ATF
X-Ray Monitor/
Fluctuation Array
5-29-87
R = 210 cm
Heights of
Sightlines
at R = 210 cm
+19.8 cm
+16.5 cm
+13.2 cm
ε ≈ 1/2
+6.6 cm
0.0
-6.6 cm
-9.9 cm
-16.5 cm
Collimating
Aperture
Detectors

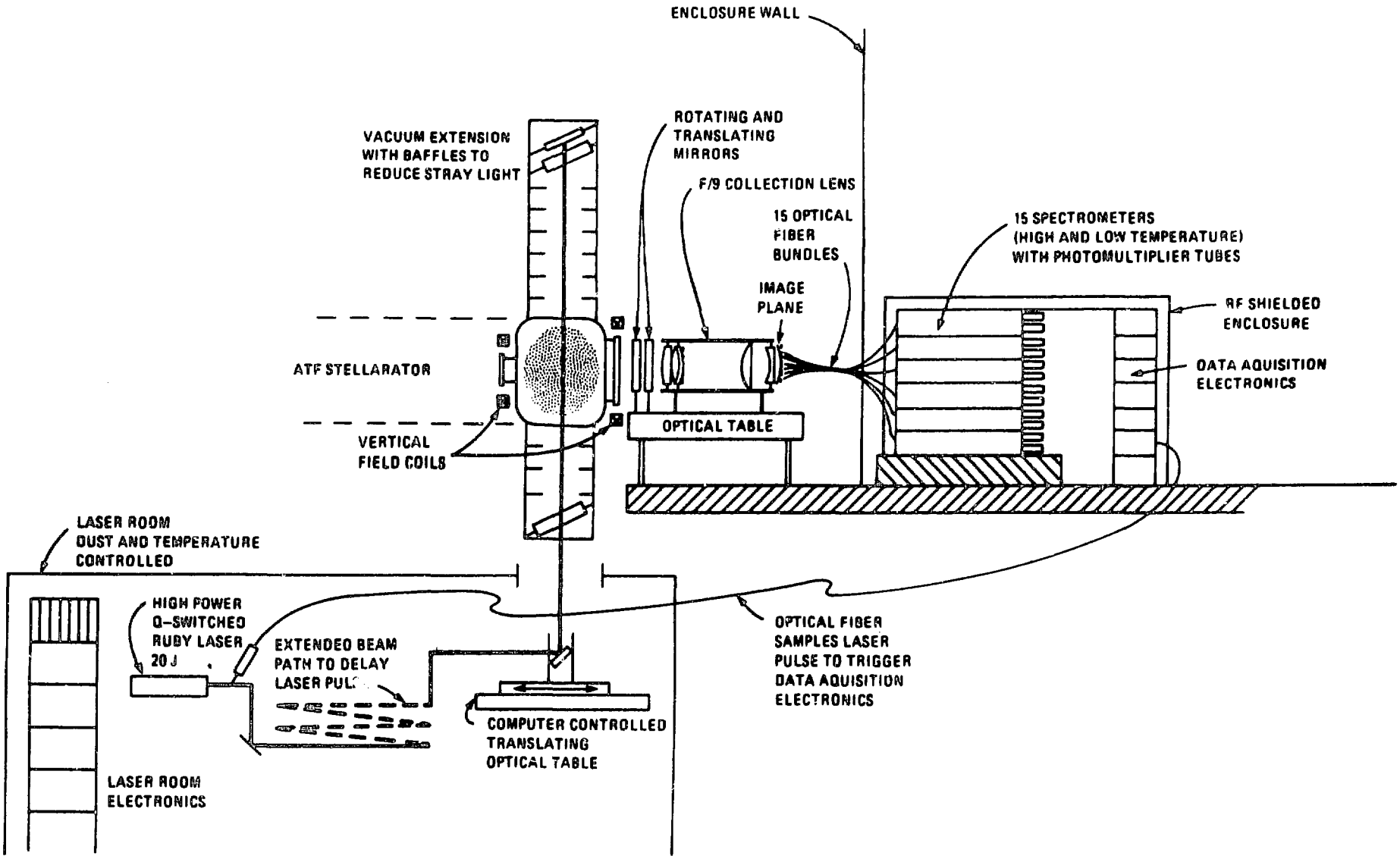

ATF
High Frequency
Mirnov Monitor
ϕ = 5°

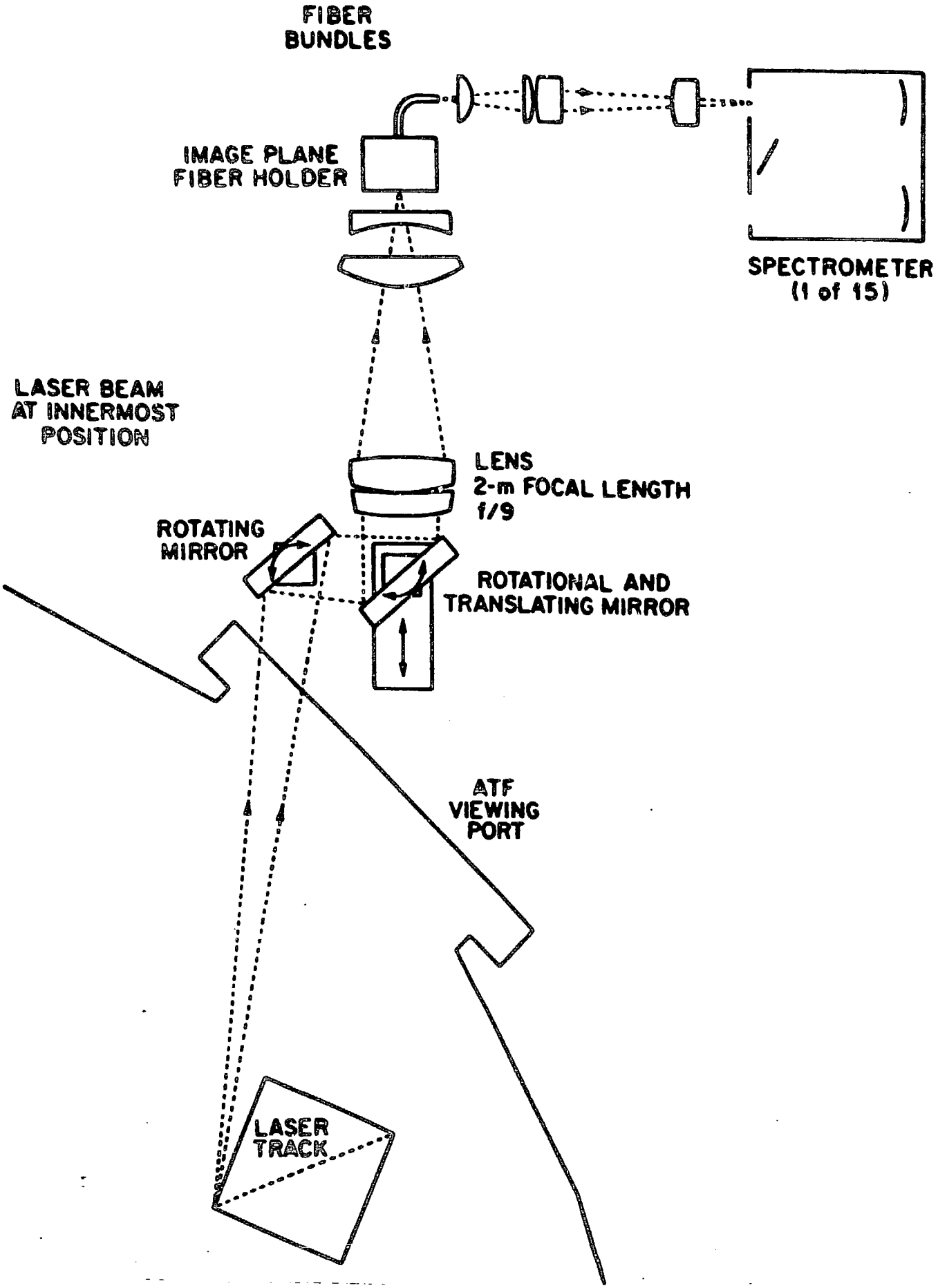


THE THOMSON SCATTERING SYSTEM USES A 20 JOULE Q-SWITCHED RUBY LASER AND IS CAPABLE OF MAKING MEASURMENTS AT 15 SPATIAL POINTS AT ONE TIME DURING A DISCHARGE. THE BEAM CAN BE SCANNED RADIALLY TO GIVE 2-DIMENSIONAL INFORMATION. AN UPGRADE TO A YAG LASER IS POSSIBLE SO THAT SEVERAL PROFILES MAY BE OBTAINED DURING A SHOT.

ATF SYSTEM OUTLINE

ORNL-DWG 86-2630R FED




FIBER
BUNDLES
IMAGE PLANE
FIBER HOLDER
SPECTROMETER
(1 of 15)
LASER BEAM
AT INNERMOST
POSITION
LENS
2-m FOCAL LENGTH
f/9
ROTATING
MIRROR
ROTATIONAL AND
TRANSLATING MIRROR
ATF
VIEWING
PORT
LASER
TRACK

COLLECTION OPTICS FIELD OF VIEW

ORNL-DWG 86-2094 FE

ECE Measurements

The frequency range of 67-114 GHz is covered by the combination of three recievers, with 1 GHz resolution.

The focused viewing beam is directed vertically and has a width of 6-7 cm in center of the plasma. In this view, mod-B contours are symmetric with respect to flux surfaces.

For B=.95 T,

Second harmonic is severely restricted by cutoff density.

Instead, use third harmonic, X-mode:

Cutoff censity = 5.2×10^{13} cm-3
Optically thick only near center, where dB/dz => 0, which corresponds to 79.5 GHz.
16 channel reciever covers 67-83 GHz.

Expect to get Te(0) versus time from the emission peak near 79 GHz.

For B = 1.9 T

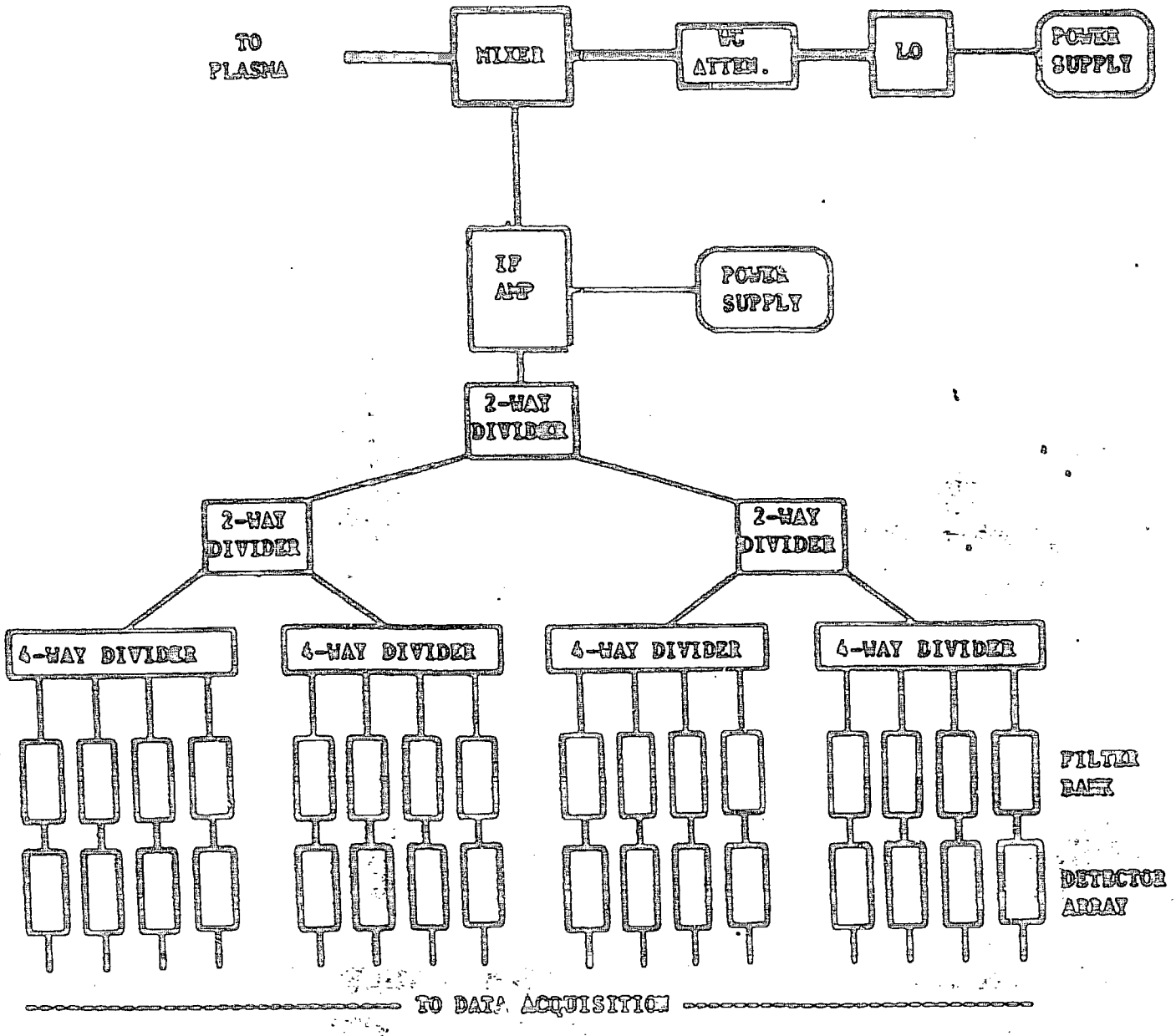
Second harmonic, X-mode.

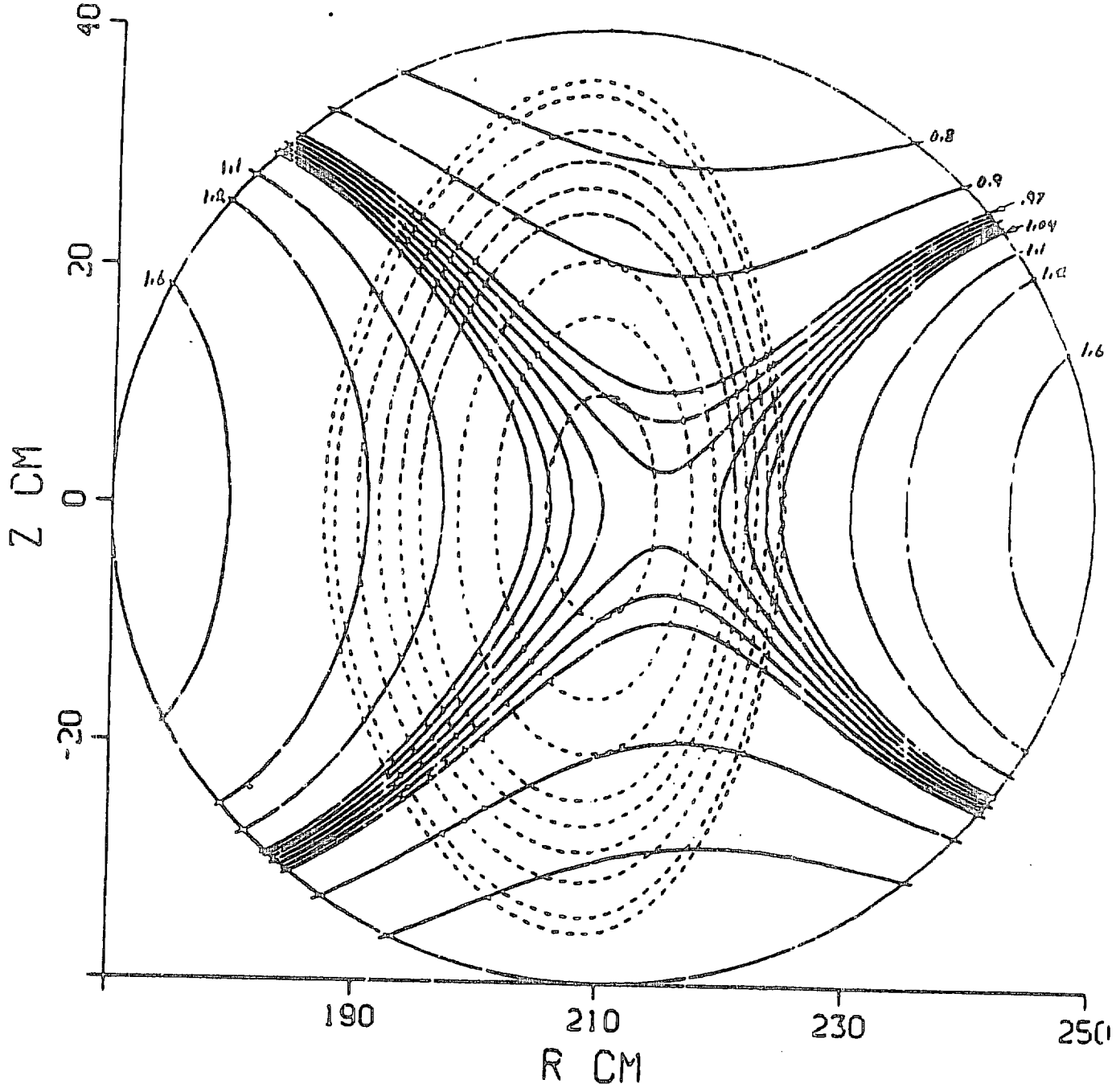
Cutoff density = 7.0×10^{13} cm-3
Optically thick over much of profile, covered by two recievers, 82-98 and 98-114 GHz.

Expect to get some Te(r) profile information.

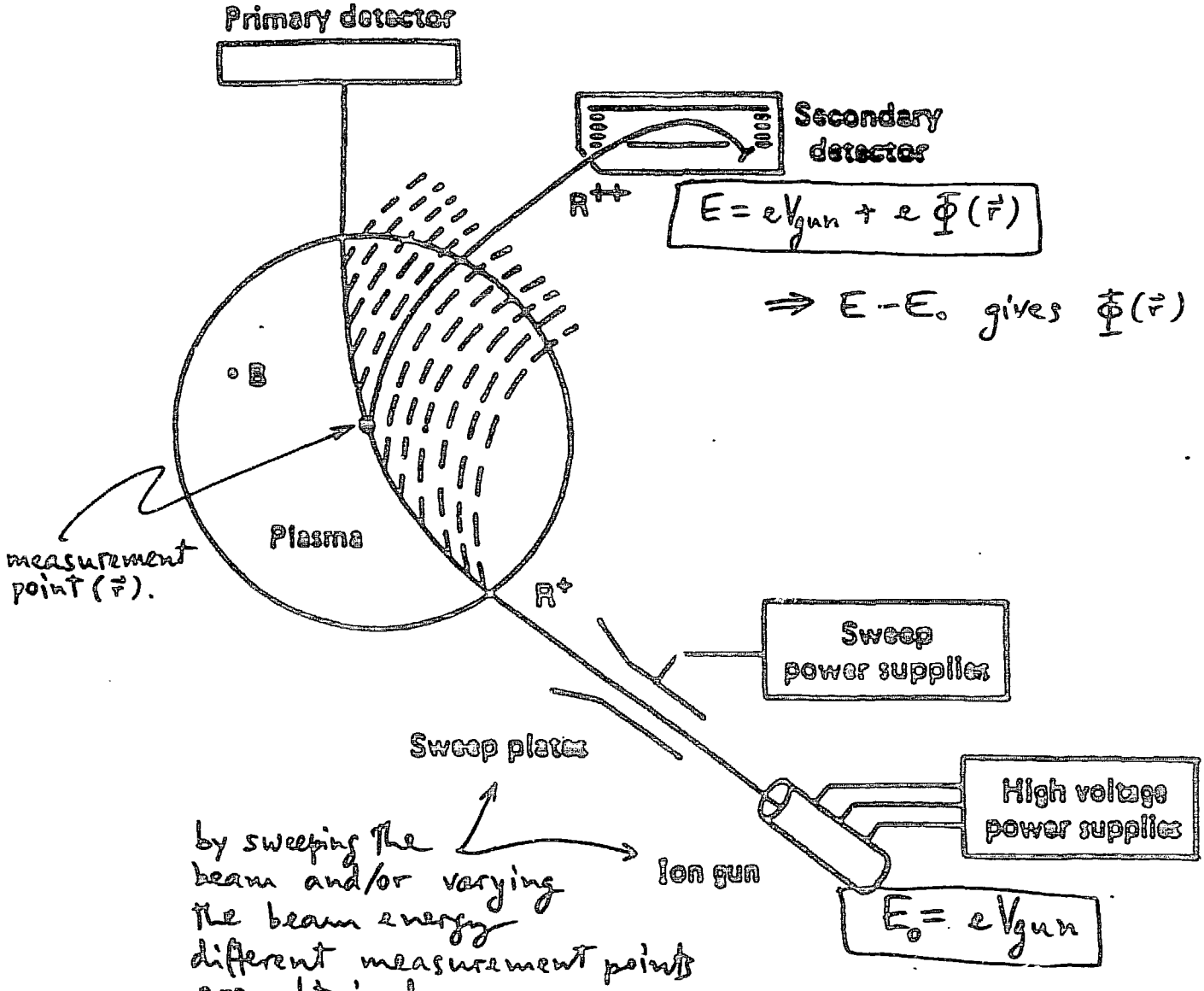
Initially, only the 67-83 and 98-114 GHz recievers will be available.

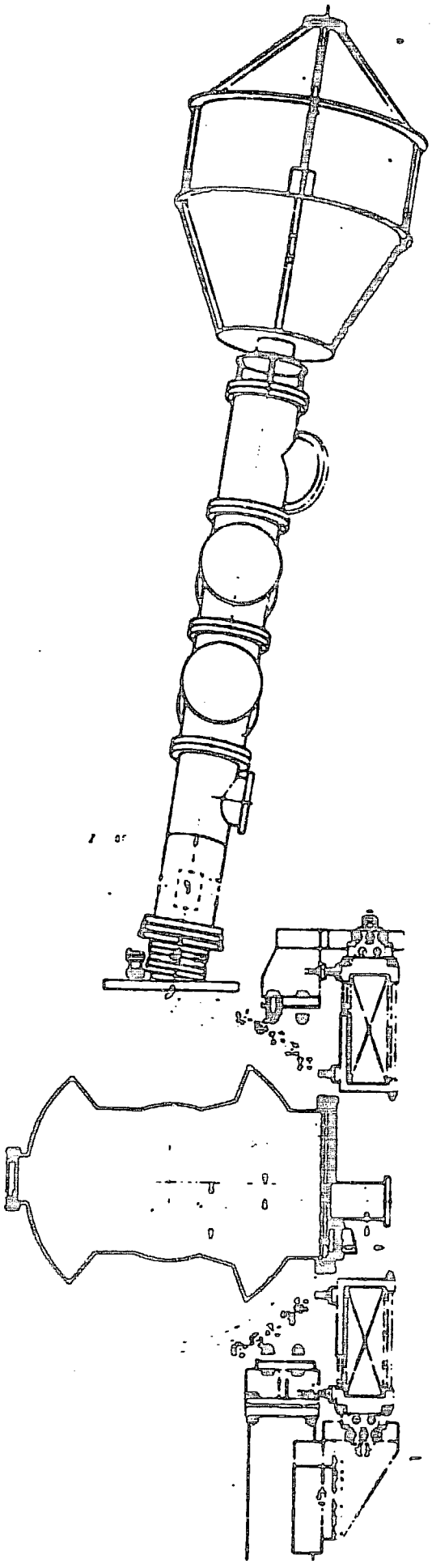
16 CHANNEL FILTER BANK



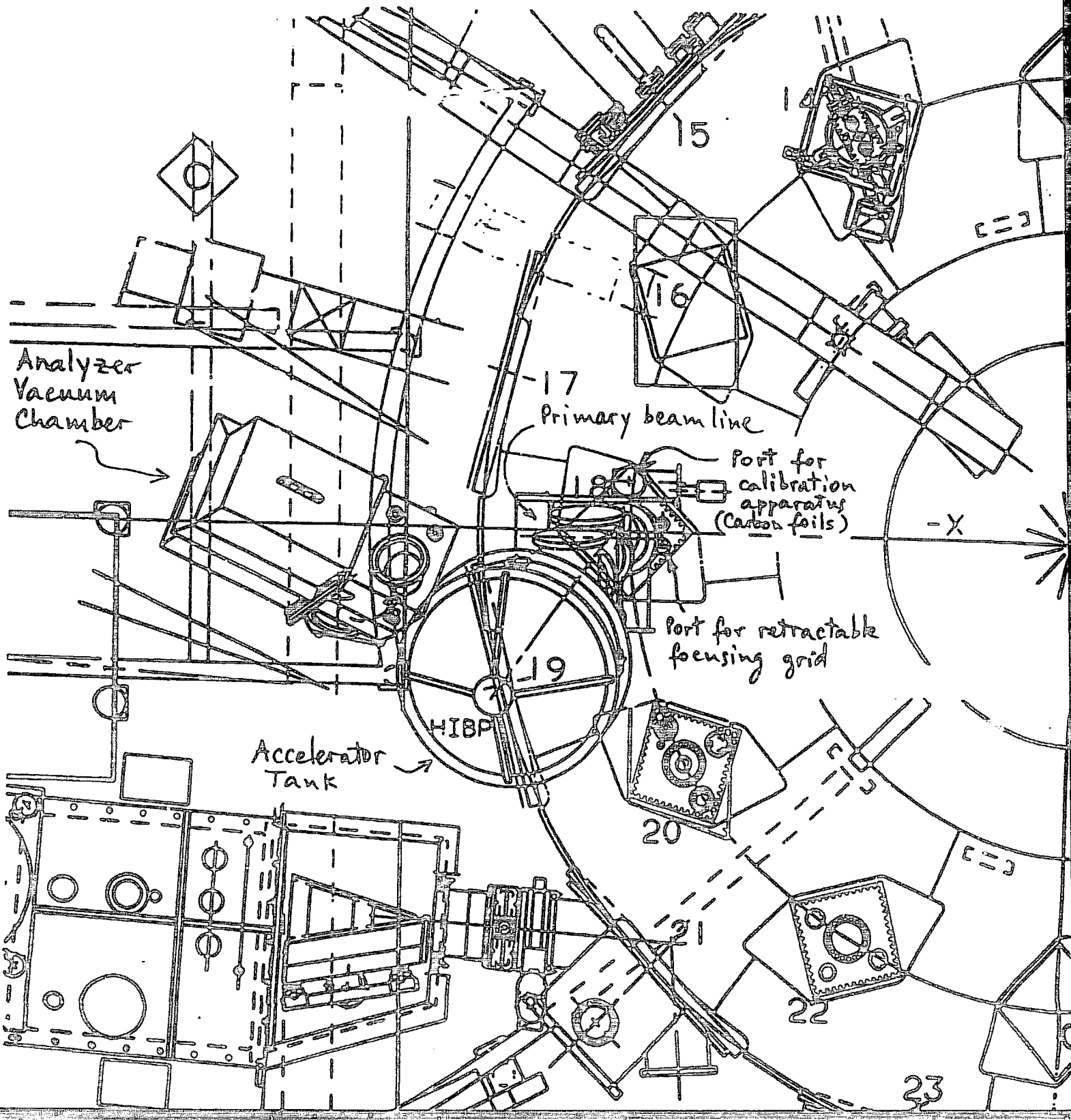

40
20
0
-20
Z CM
190
210
230
250
R CM
0.8
0.9
.97
1.04
1.1
1.6
1.1
1.6

PHYSICAL PRINCIPLE OF THE DIAGNOSTIC TECHNIQUE





ATF/HIBP Layout



EXPECTATIONS FOR MEASUREMENT CAPABILITIES

Phase IA (ECH only)

- Flux Surface Integrity
- $\overline{n}_e$

  $\left.\right\} \tau_p^*, \tau_p$
- Hydrogen Influx
- Radiated Power (global)
- Plasma Currents
- Plasma Configuration
- Power to Limiters
- Edge parameters from Probes in Limiters

EXPECTATIONS FOR MEASUREMENT CAPABILITIES

Phase IB (ECH + NBI)

- β (diamagnetic)
- T_e (PHA) } τ_E^*
- Beam power into plasma
- T_e (PHA) } τ_E
- T_i (NPA, spectroscopy) } E_r
- Poloidal, toroidal rotation
- Impurity composition

EXPECTATIONS FOR MEASUREMENT CAPABILITIES

Phase II (ECH + NBI +ICRH)

- T_e profiles (TS) } χ_e, χ_i, β (kinetic)
- n_e profiles (TS, FIR)
- Power Accountability
- T_e(t) (ECE)
- Fluctuation information (Mirnov loops, SXR, etc.)
- Impurity confinement times
- Details of impurity production
- Z_{eff}

Phase III

- fast ion distributions (NPA)
- E_r (HIBP)
- Local fluctuations (HIBP)
- P_{rad}(r)