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LLNL-TR-400648

ITAS Final Design Review

J. Celeste, S. Compton, P. Datte, G. Holtmeier, M. Latta, T. Lee, J. Moody, K. Piston, R. Robinson

January 22, 2008

Disclaimer

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

The National Ignition Facility

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10- 20- 06

*Retired

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TAS Contributors

- Electrical Design – Phil Datte, Willie Lew, Ken Piston
- Optical Design – Milt Latta, Ron Robinson
- Mechanical Design – Gregg Holtmeier, Tony Lee, Imants Reinbachs, Frank Snell, George Miller, Glenn Jones, Frank Snell, Pete Swort, Mike Vitalich, Greg Repose
- Physics – Jim Murray, Dan Kalantar, Erlan Bliss, Marilyn Schneider
- Integration – John Celeste
- Project Management – John Celeste, Phil Datte
- IPRB – Richard Knight

Agenda

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- Agenda
- Level 1 action Items from PDR
- Fundamental Requirements Review
- Introduction
- Stake Holders
- Overview of Operations
- CCD Selection
- Mechanical design Final
- Electrical design
  - Illumination
  - CCD Synchronization
- Interfaces
- Optical Status
  - CCRS, Cryo,ICCS, FODI, T& H, TASPOS
- Transportation/Handling
- Review of Calibration Station & Process
- Technical Risks & Mitigation
- Key Schedule dates
- Budget Summary

PDR Action Items

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- ITAS PDR Action Items
  - 6 Level one, 15 Level two, 6 Level three
  - 6 Level One:
    - ✓ ARC Interface
    - Neutron Activation: Issue being worked
    - ✓ Radiative heat transfer on to TAS & Cryo
    - ✓ ICCS key dates for TAS, and software deliverables
    - ✓ ICCS Analysis of image processing requirements
    - ✓ Light sensitivity of Dome (KG3) & CCD combination for 375nm and 351nm

Overview of ITAS

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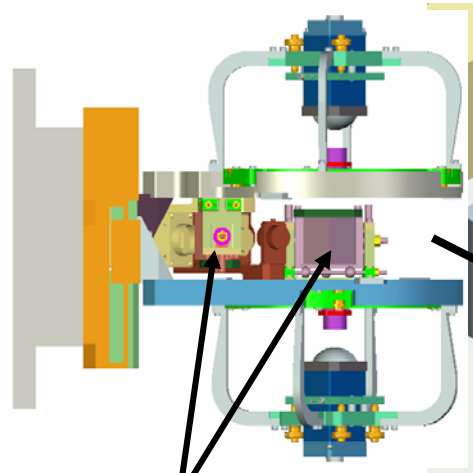
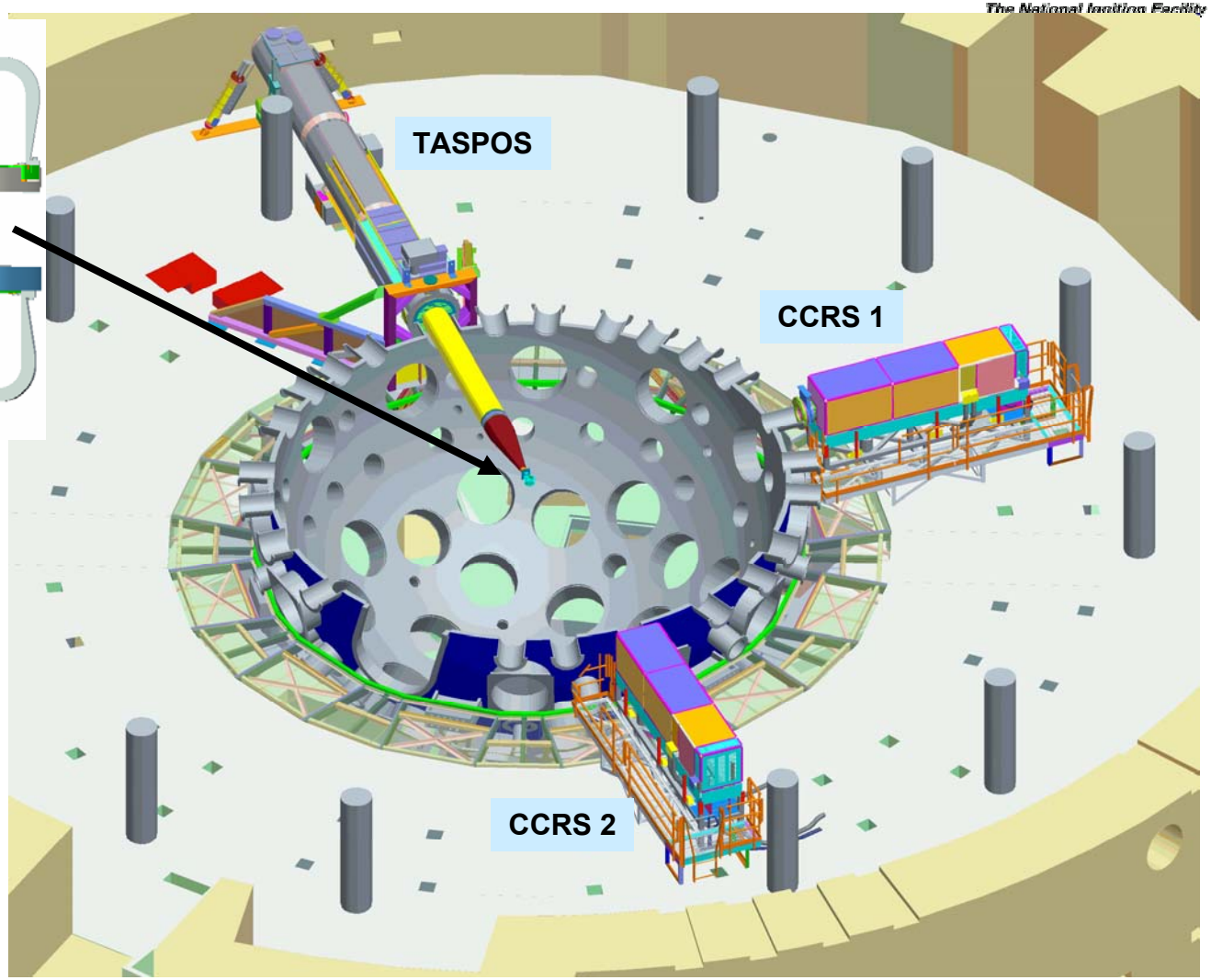
- Overview of ITAS
  - ITAS Alignment System level
  - Position Reference System
  - Stake Holders
  - Concept of Operation
  - Key Requirements
  - Up Grades
  - Known Design Issues
  - RAM Plan
  - Overview Summary

TAS is inserted with TASPOS and aligned with CCRS 1 and 2 using TAS prisms

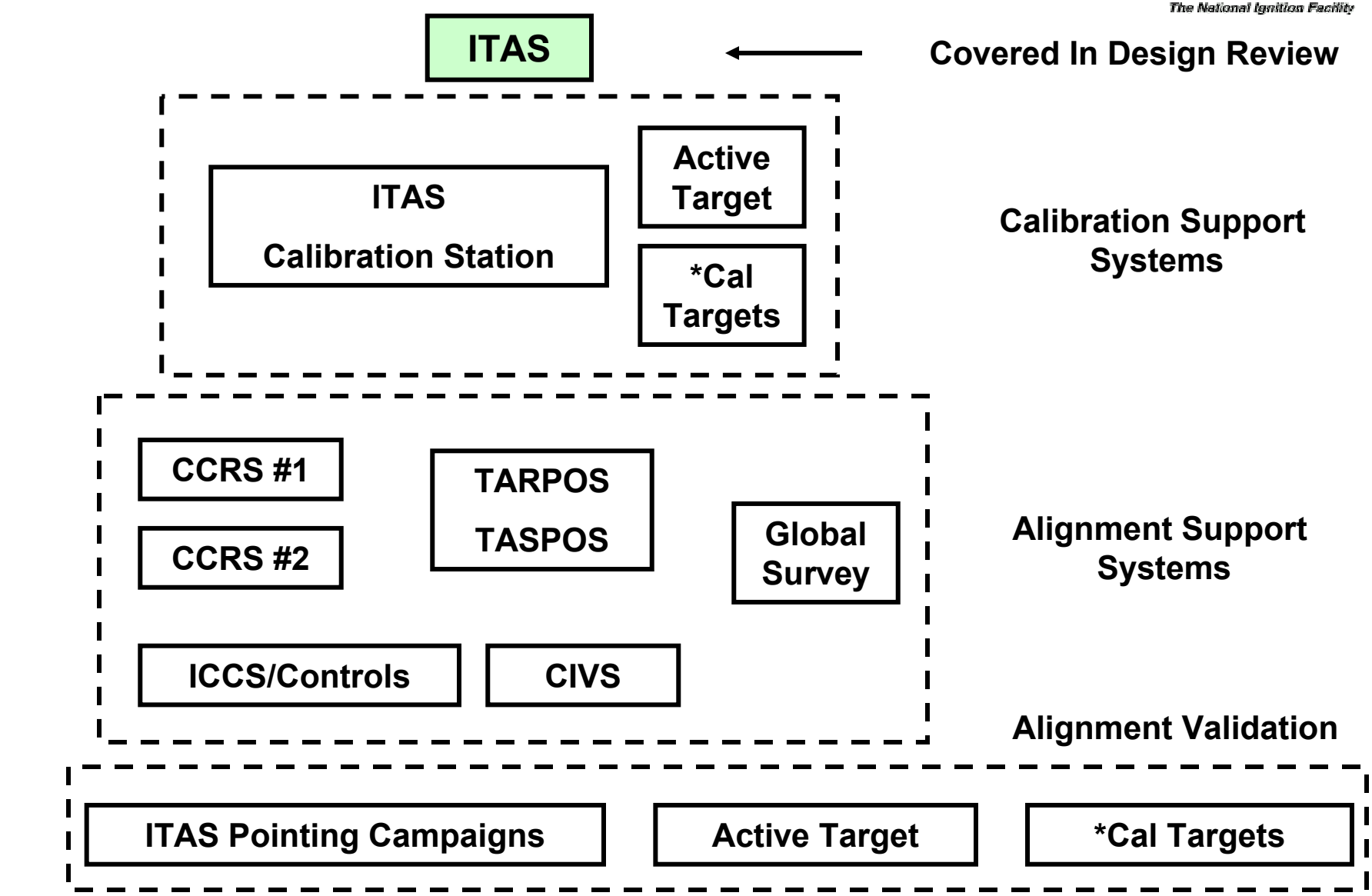


TAS Prisms



Position Reference System

ITAS Alignment Systems



TAS Stakeholders

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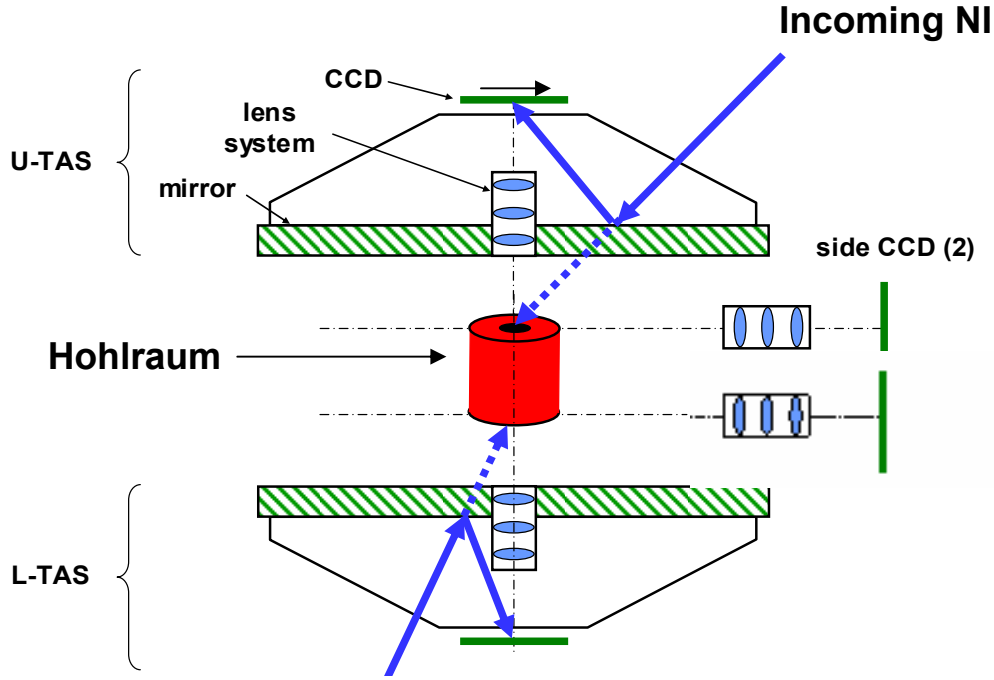
• Auto Alignment	W. Ferguson
• Cryo	T. Malsbury, K. Skulina
• Ignition Target	S. Haan
• Beam Alignment	S. Burkhart, B. Van Wonterghem
• System Engineering	D. Kalantar, B. Young, M. Schneider, P. Wegner
• ICCS, Video	J. Krammen, B. Fishler, M. Miller, Allan Casey
• Target Area Integration	J. Celeste
• TASPOS	G. Holtmeier

TAS Concept of Operation



ITAS must perform 2 functions:

1. **Align Targets** (using upper, lower, & side cameras)
2. **Align Beams** (using mirror reflection to upper and lower cameras)

Both functions can be performed efficiently with the present design concept without having to insert another device

ITAS/CCRS Fundamental Requirements (Review)

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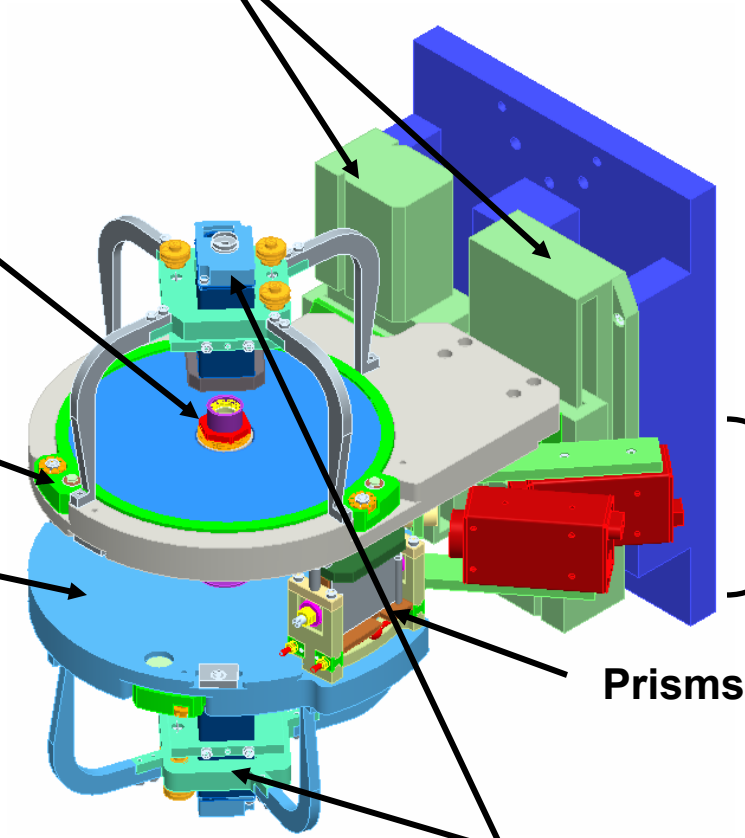
- CCRS & ITAS shall provide the capability to align the target vertical axis relative to the target chamber vertical axis to within 4 mrad
- CCRS & ITAS shall provide the capability to align the NIF beams to targets such that the rms error of each beam from its specified LEH aim point is 50 microns (rms) or less
- CCRS & ITAS shall provide the capability to align the NIF beams to targets such that the mean value of the beams centroid is within 15 microns (rms) of the upper/lower LEH aim points on the target
- CCRS & ITAS shall meet these requirements over a region within 5 cm radius of nominal target chamber center

ITAS- Key Components



ITAS Known Design Issues

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- Adjustments needed on the Side Cameras, not in current design
- Review adjustment for the upper/lower centering imaging lens, it is hard to get the resolution
- CIVS synchronization with TAS video & lighting undefined
- Illumination panels, vendor problems may go to glass
- Vacuum compatibility with video cameras, baseline vacuum check failed
- Vacuum compatibility associated with off the shelf cable harness, need testing

ITAS Upgrades

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- New requirements established for ITAS
- New digital CCD (Basler 4.4 μm square pixel, 12 bit dynamic range)
- New mechanical designs providing adjustments
- New Additional side CCD
- New Programmable/directional lighting, single wavelength (630 nm)
- New Provisions for handling ITAS
- Radiation activation modeling in progress to establish risk mitigation
- Cable holds for proper cable routing, cable routing
- Proper connectors at TAS/TASPOS interface

TAS RAM Plan

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- ITAS reliability = 99.74% (probability of meeting no-yield shot reqts)
- ITAS availability = 99.28% (unavailable during unplanned maint. only)
- ITAS maintainability fits within NIF scheduled maintenance of 69 days/yr
- For NIF yield shots, ITAS is expected to eventually suffer catastrophic detector damage due to neutron radiation. It will then be swapped with spare ITAS, cameras replaced and recalibrated off-line.
- Planned 2 replacement ITAS units available at all times and an adjacent ITAS calibration lab in the Target Diagnostic Bldg.
- At least 1 pre-calibrated ITAS will be available and capable of installation within a 2 hour time period.
- In-situ performance validation will be performed using the ITAS "active target".

ITAS Design Improvement Summary

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- Improved upper and lower stage design with fewer constraints
- Decoupled imaging lens and mirror to simplify calibration procedure
- Added X-Y lens adjustment to eliminate offset between upper and lower images
- Tip/tilt mirror adjustment independent of other adjustments in web assembly
- Mirror mounted at OD instead of ID for stability
- Prism adjustment added to allow accurate positioning of TAS center point
- Additional side camera eliminates need for fiducial and simplifies CCRS images
- Camera mount redesigned to allow for a larger CCD
- CCDs digital, higher resolution (4.4 μm pixels)

TAS design is divided into subassemblies allowing offline component testing to validate concepts

ITAS Mechanical Design

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- Designers – Tony Lee, Glenn Jones, Imants Reinbachs, Frank Snell, Pete Swort, Mike Vitalich, Greg Repose
- What's covered?
  - Camera Support Structure (Web)
  - Beam Clearance
  - Camera Mounting
  - Mirror and Imaging Lens Mounting
  - Transport and Handling
- What was addressed at the 5/18/06 CDR?
  - Mirror Adjustment
  - Stage Design
  - Prism Mount
  - Imaging Lens Adjustment

Prototypes of these 7 items have been built.

Results will be discussed.

Imaging Lens is supported by Mirror Support

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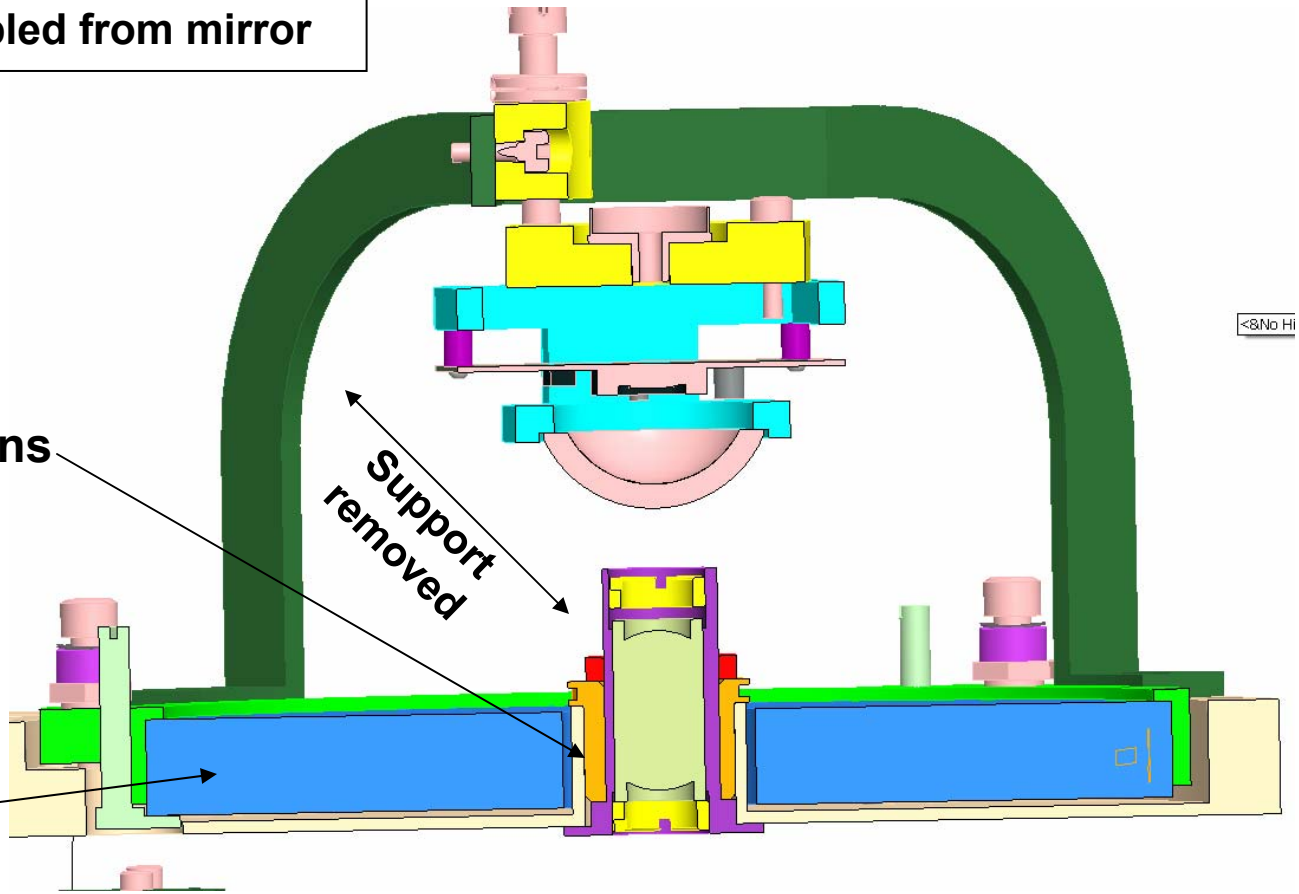
- Image lens is not supported by camera web as it was for TAS2
- Improves beam clearance at critical area near lens
- Image lens is decoupled from mirror



Camera Support Web is Redesigned

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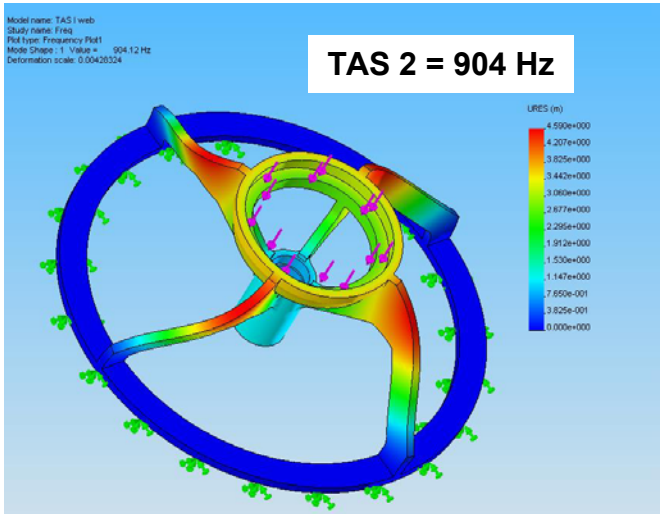
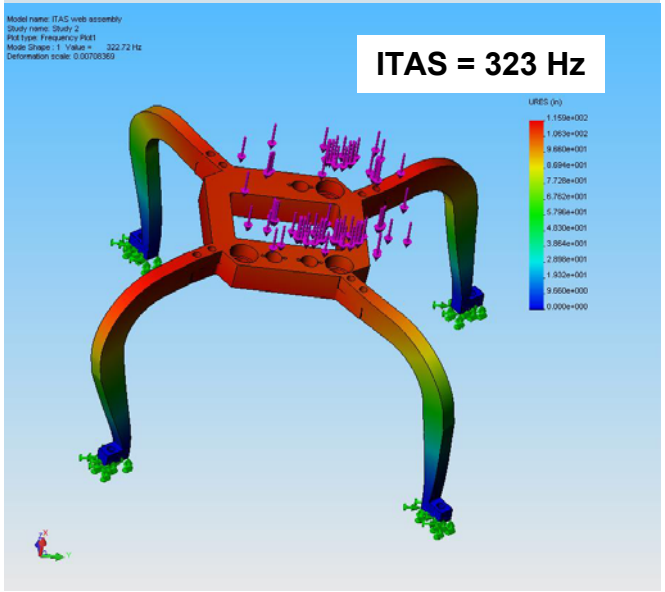
- Redesigned to obtain required beam clearances
- Cosmos FEA was performed
- Views are of 1st mode shape and fundamental frequency
- TASPOS boom fundamental freq. is <10 Hz and is stable to about 1 μm RMS P-P
- ITAS support is a stiff design and will not resonate with boom



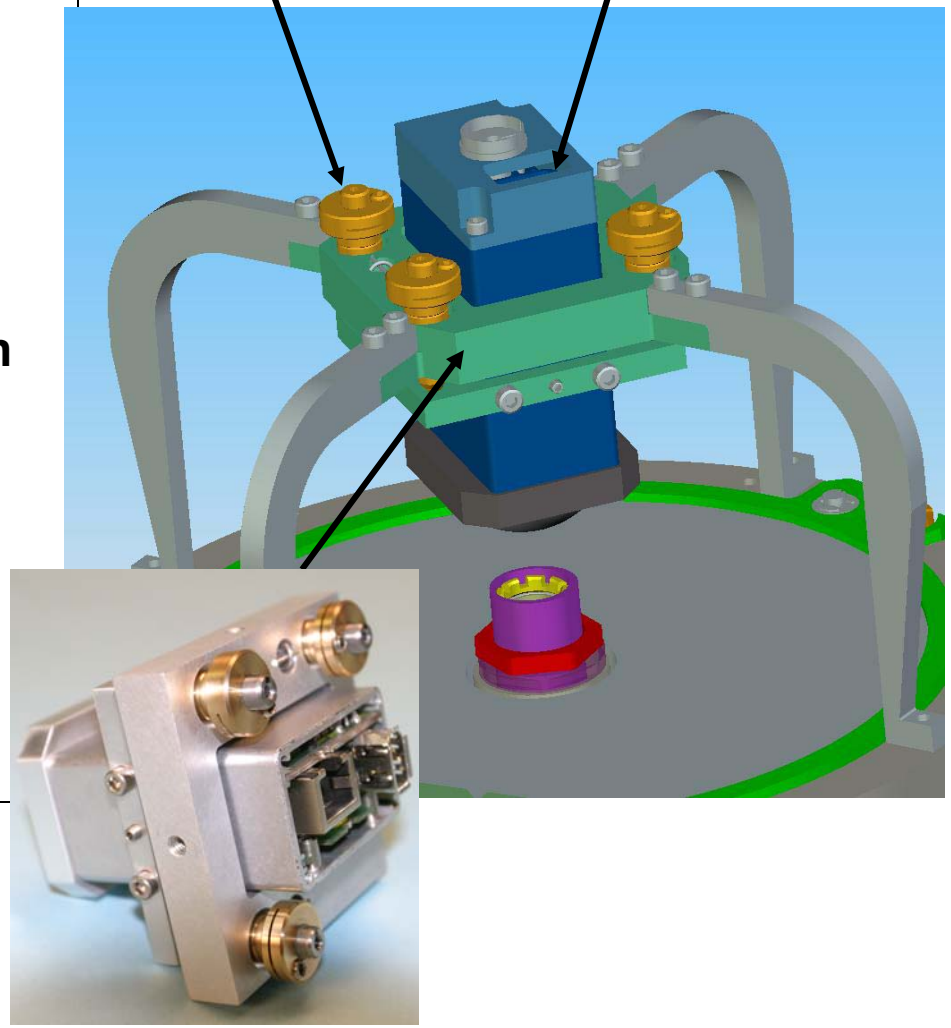


I-TAS Support Features

- Symmetrical shape for rotational and thermal stability
- Easy camera replacement
- Provides access to Imaging lens
- Simpler fabrication
- Reduced cost

Upper/lower camera mount has been redesigned

- Must accommodate new camera
- Replaced Newport stage with Newport micro actuators
- Provides tip/tilt and elevation
- Lateral translation of camera not required (rough positioning provided)
- TAS2 stage had 12 μrad resolution per vendor
- New actuators 27% better based upon thread pitch
- Measured < 89 μrad on actuator adjustment (test set up limited)
- +/-1.4 mrad requirement



Mirror Support Performs Several Functions

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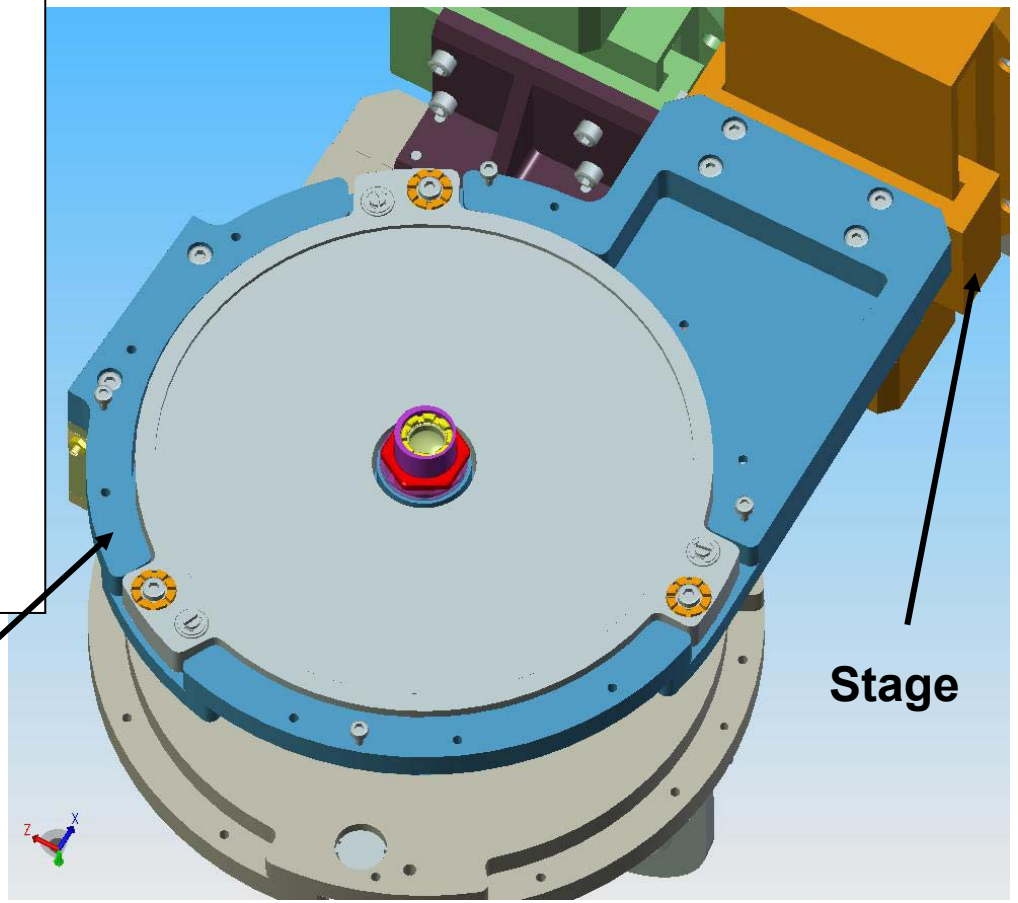
- Solid bottom eliminates need for additional 2ω beam block
- Supports side camera
- Provide tip/tilt base for mirror
- Supports image lens
- Mounts directly to slider



Primary Mirror Assembly has been tested

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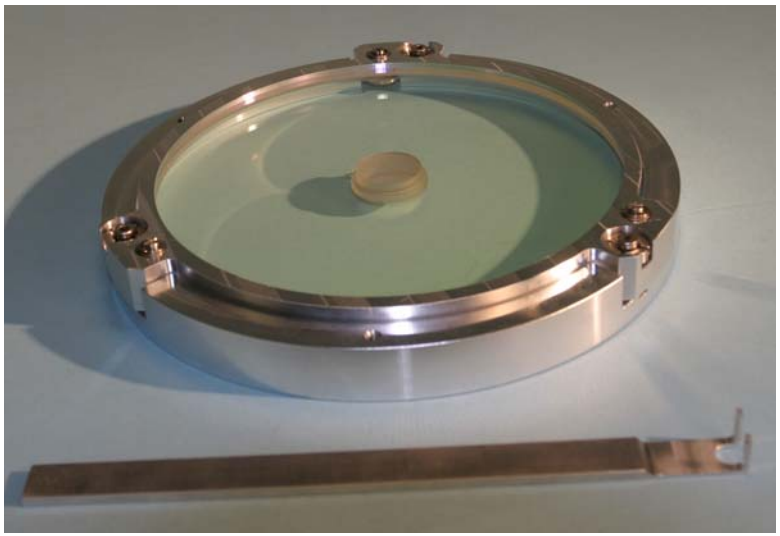
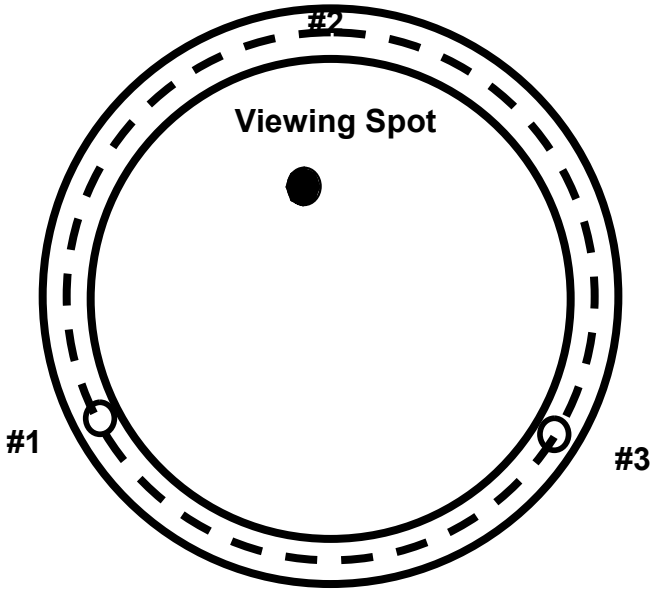
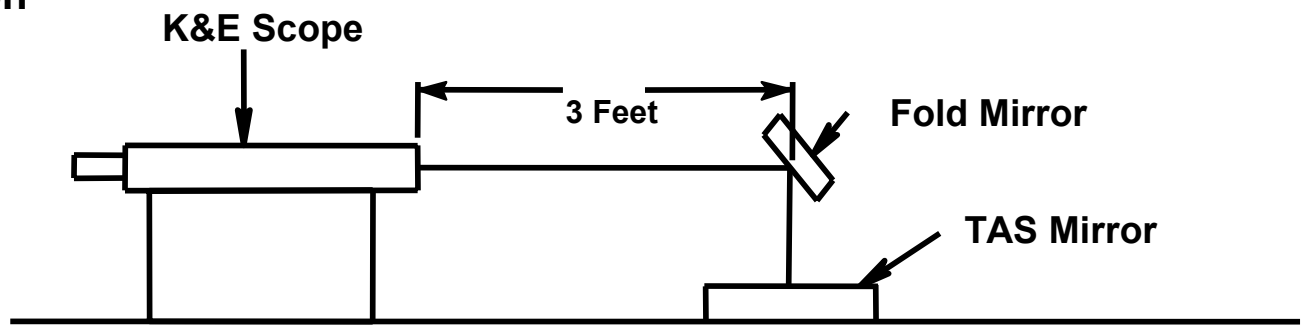




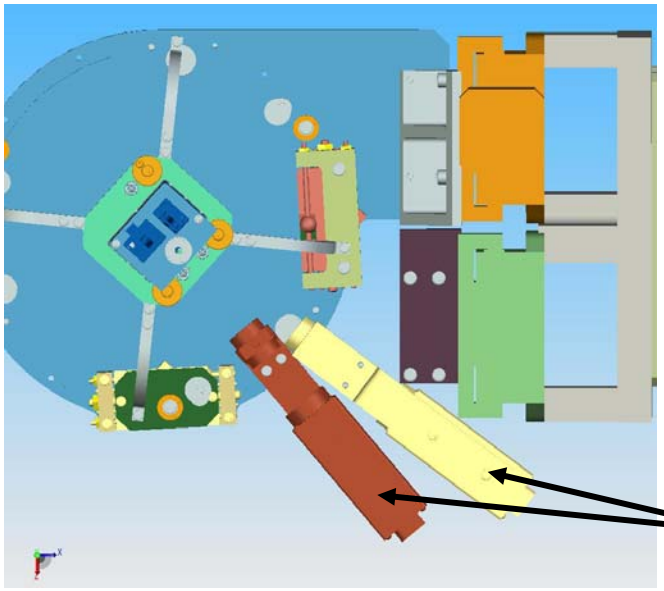
- 90 μrad tip/tilt resolution (+/-1.4 mrad req.)
- Allows mirrors to be aligned relative to each other
- Spring loaded allows mirror to be flipped



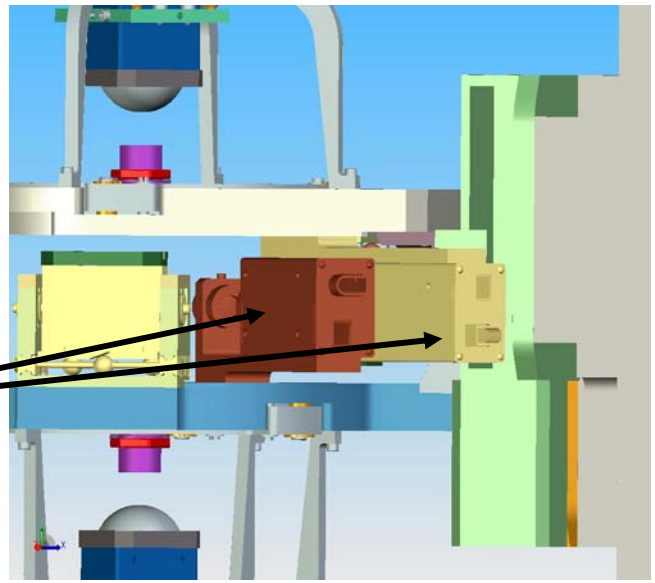
Primary Mirror and Tooling

Side Cameras are Coupled to Mirror Support

- ITAS has 2 side cameras
- 1 camera mounted on each mirror support
- Camera moves with stage
- Pointed at TCC



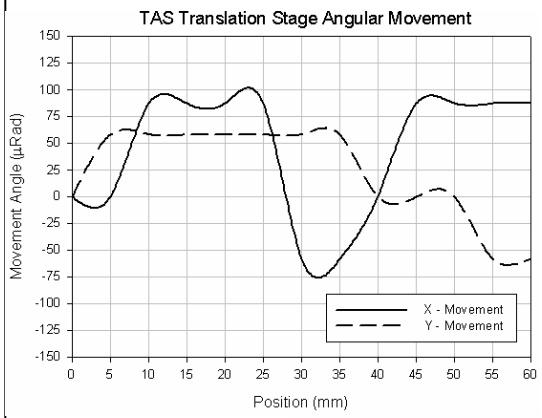
Side Cameras

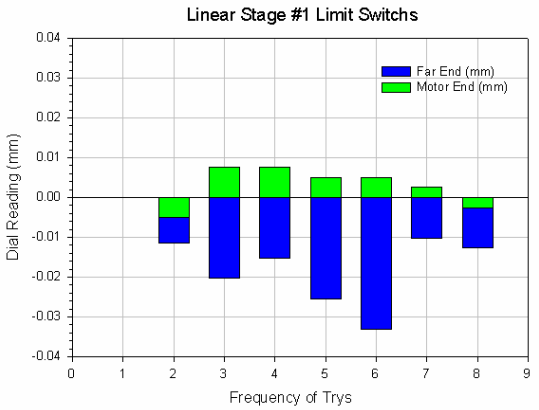


Side Cameras

Stage Tested Offline

- **Resolution**
  - **Measured 2.5 μm, no micro stepping**
  - **0.4 μm mfg spec. (+/-4 μm req.)**
- **Linear Runout**
  - **Measured 2.5 μm for full length of travel**
  - **Mfg states bidirectional repeatability is +/-0.5 μm**
- **Angular Tilt**
  - **100 μrad with 3 ft-lb moment (300 μrad req.)**
  - **5 ft-lb max moment load per mfg spec**

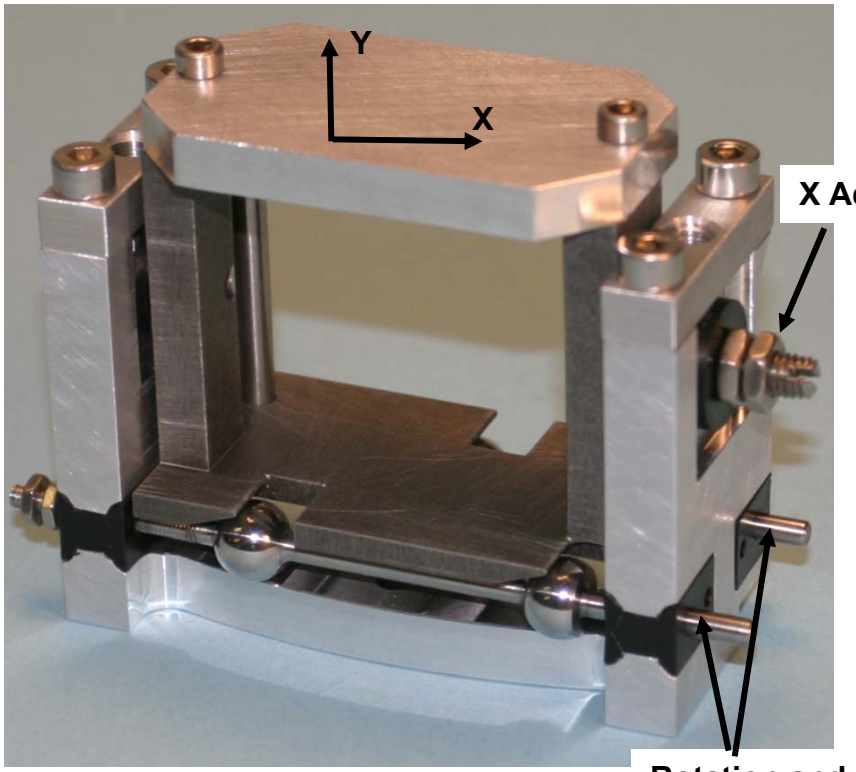


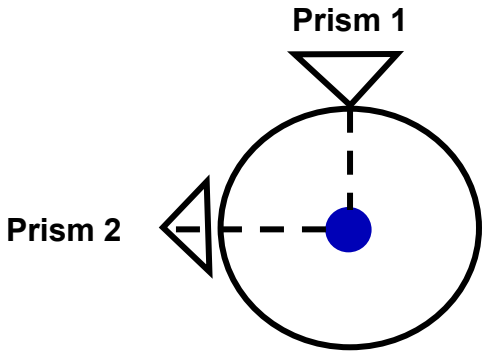


- **Newmark Systems NLS4**
- **1-6 torr rated**
- **NIF approved Krytox lubrication**
- **Tefzel wired limit switches available**
- **Investigating Tefzel wired motors**

Prism Mount has been tested offline

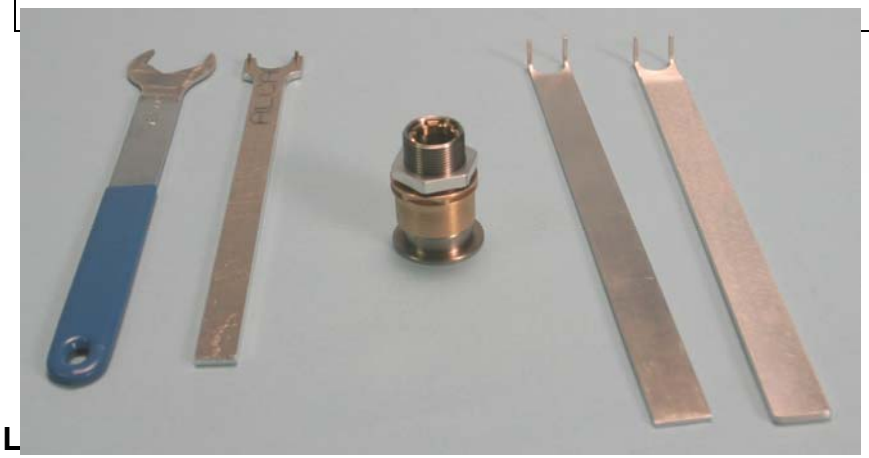
- Allows accurate positioning of ITAS center point
- 3 degrees of freedom
  - Rotation about X-axis
    - 15 μrad measured resolution with 1/8 turn (+/-100 μrad req.)
    - 10 deg travel calculated
  - Vertical Y
    - 12.5 μm resolution with ¼ turn (scope limited, +/-10μm req.)
    - 3mm travel calculated
  - Horizontal X
    - 12.5 μm resolution with 1/16 turn (scope limited, +/-50μm req.)
    - 2 mm travel calculated



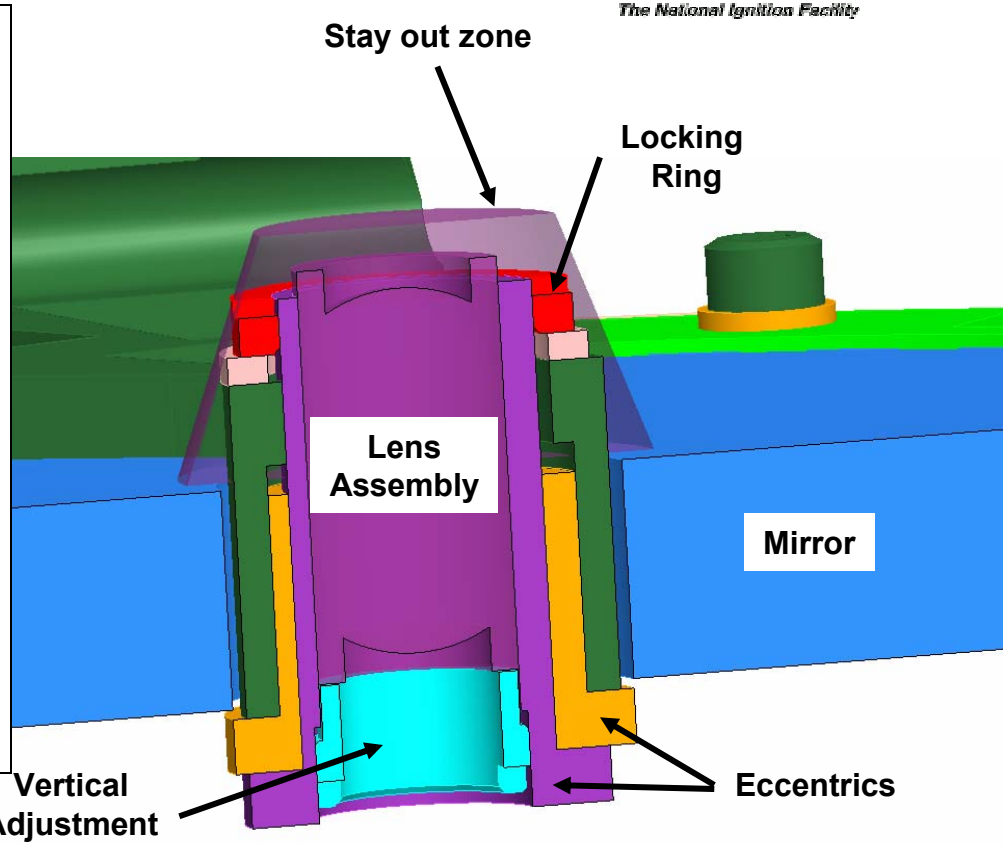


Imaging Lens Mount will Provide X-Y Adjustment

- Used to adjust target image relative to beam image
- Eliminates offset between upper and lower camera images
- Supported by center web
- Lens floats w.r.t. mirror ID
- X-Y adjustments in mirror plane by eccentrics with +/-1 mm travel
- Vertical focus adjustment by threaded barrel assembly



Adjustment Tooling



Upper & Lower Lens Test

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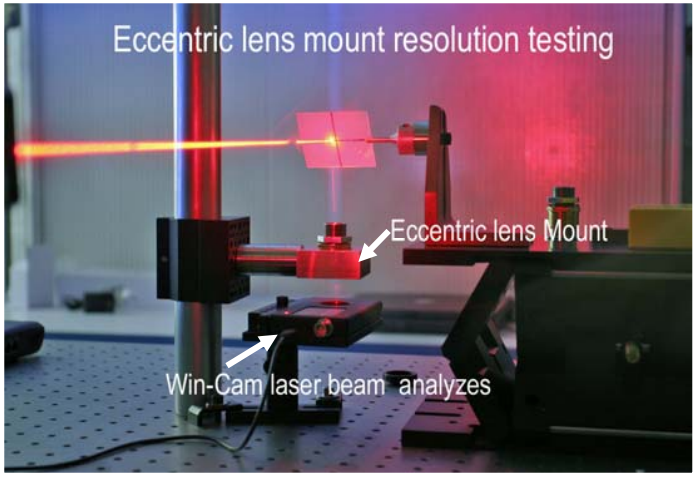
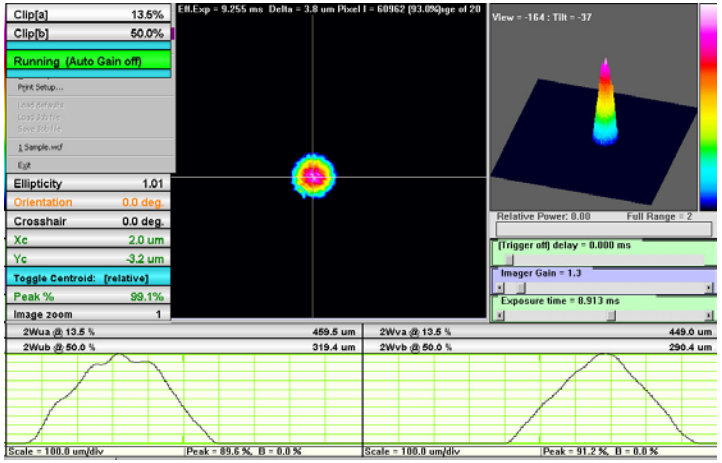


Concentric Lens Test Setup



- Software
  - Live Centroiding
  - Relative motion monitoring
  - Averaging

Lens test showed able to move off center and recover back to original position to less than 1 pixel (4.4 Microns), Need live update capability in software.

Upper & Lower Lens Test, Continued

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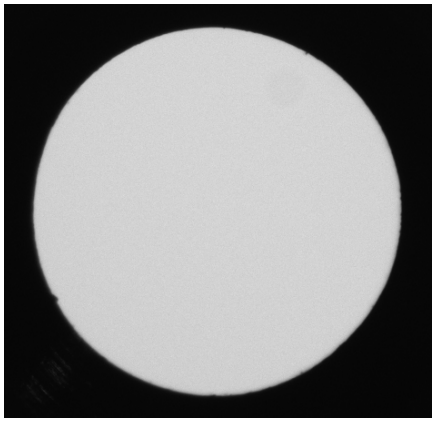
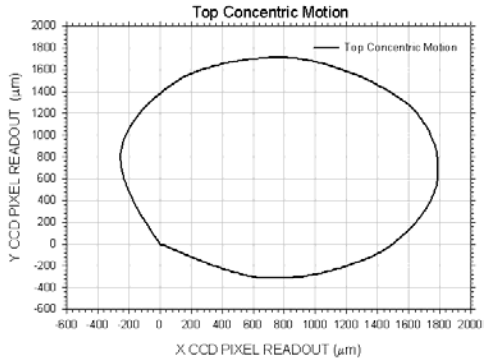


Single Image Processing

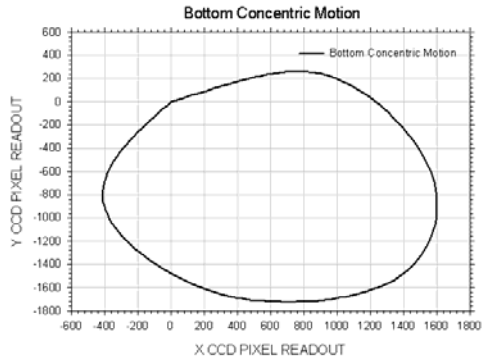
360 Rotation Image Processing

Image Processing of the TAS Upper/Lower Lens Adjustment

Center of Mass Plot of Spot Position



Inner Cylinder



Outer Cylinder

Capable of Adjustment
Need better control

Lens System Setup & Tests

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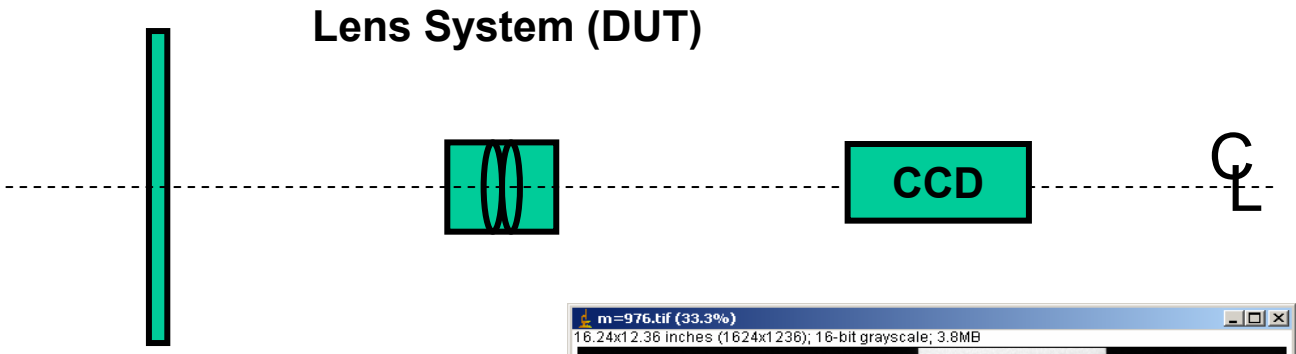
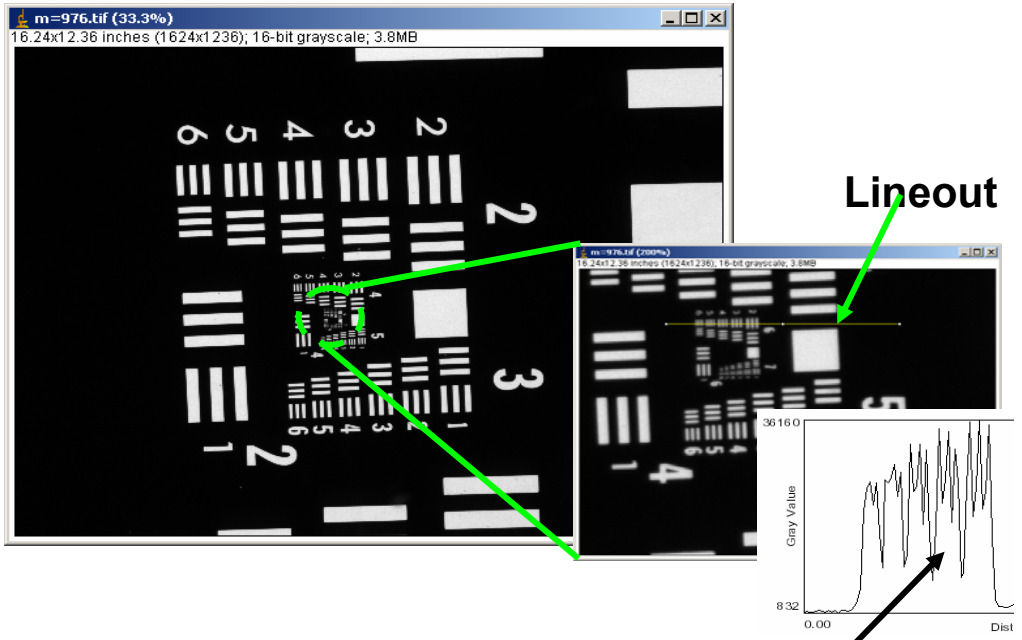
All Lens Systems Tested, and Verified



Airforce Target



Imaging Test Results

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Optical System	Aperture (mm)				Magnification (M)	Resolution (lp/mm)	
	4	6	8	10	Design (0.667)	Design (67 lp/mm) @ 30% MTF	
Lens #1	X				0.672	45.3	
(90x60)-Upper		X			0.656	50.8	
			X		0.672	80.6	√
				X	0.656	80.6	
Lens #2	X				0.656	57	
(75x50)-Lower		X			0.656	57	
			X		0.656	80.6	√
				X	0.656	71.8	
					Design (1.00)	Design (100 lp/mm) @ 30% MTF	
Lens #3	N/A				1.00	114	
Upper/Lower							√

Prototype Sub Assemblies Testing

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- Performance verification on the following subsystems:
  - Translation stage* √
  - Prism mounts √
  - Mirror mount √
  - Primary lens mount* √
  - Side lens mount √
  - CCD response vs angle √
  - Illumination panel* √

* Needs reviewing & possible modifications

Stay Out Zone Review

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- Stay Out Zones
  - Beam Interference with ITAS
  - ITAS with TASPOS
  - Open area inside ITAS

ITAS Beam Clearance

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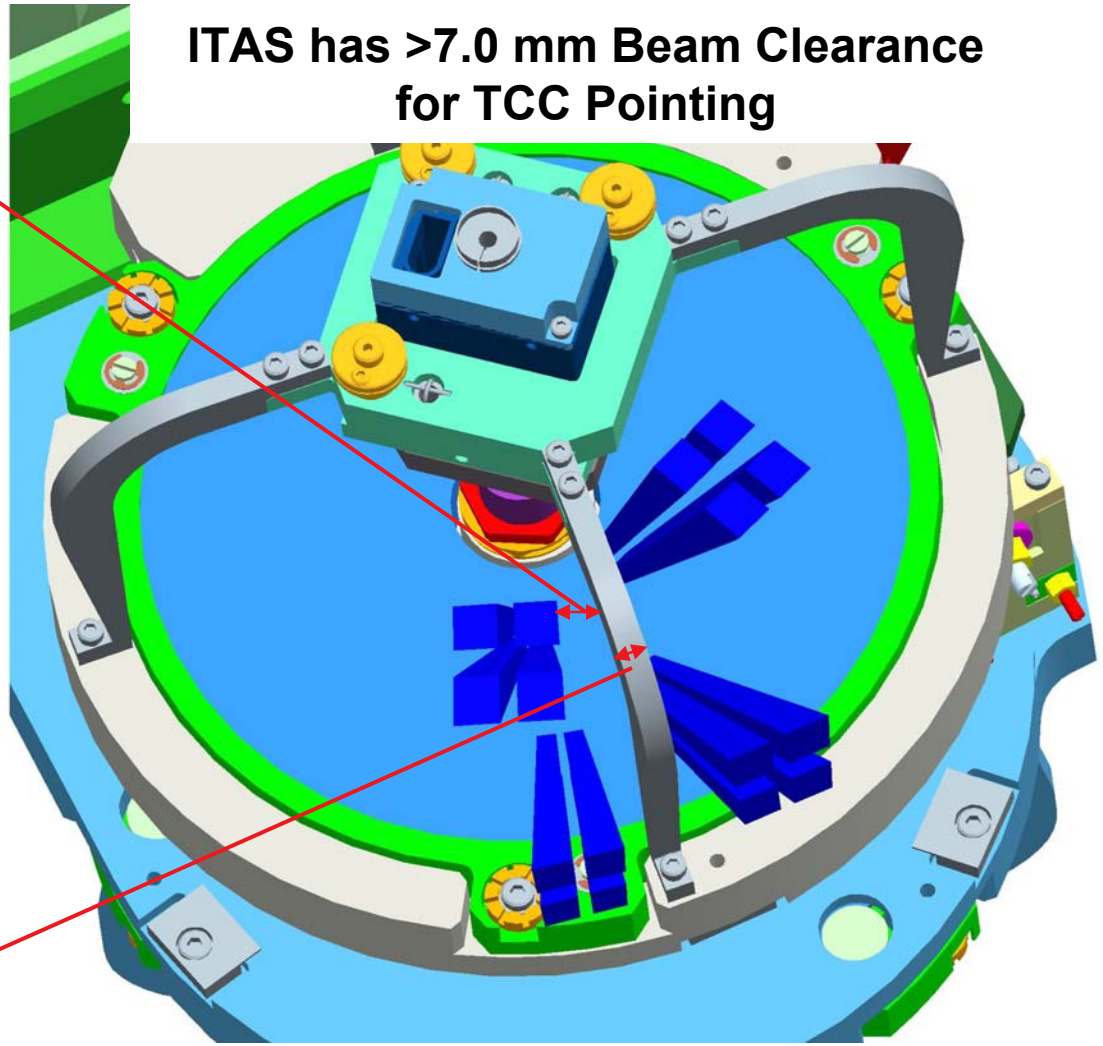
- TAS2 web clips offset beams
- Fundamental issue driving TAS redesign
- 3mm Beam offset required
- 4mm clearance with beam offset

Beam Clearance

ITAS has >7.0 mm Beam Clearance for TCC Pointing



6mm Thick Web

ITAS can interfere with chamber port

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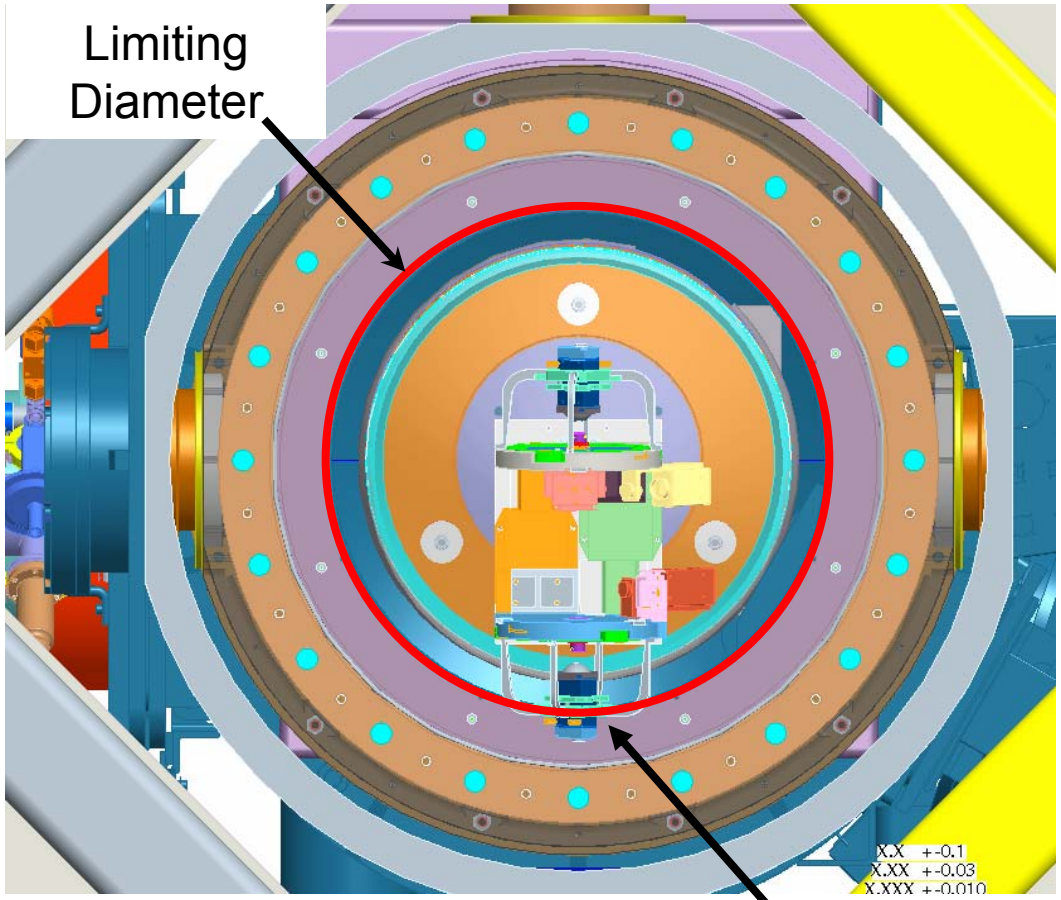
No interference if:

Mirrors are closed to nominal position

Or

Nod is centered



Mirrors Fully Open
3 Degrees Nod

Interference

Stay Out Zone Inside ITAS

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- Need picture here showing tuna can stayout zone

ITAS Electrical Design

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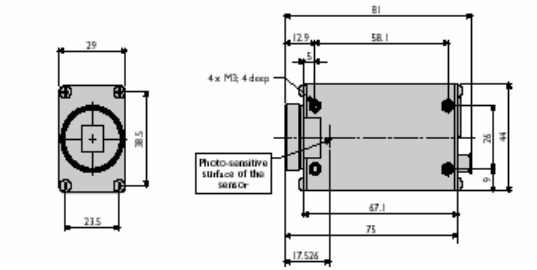
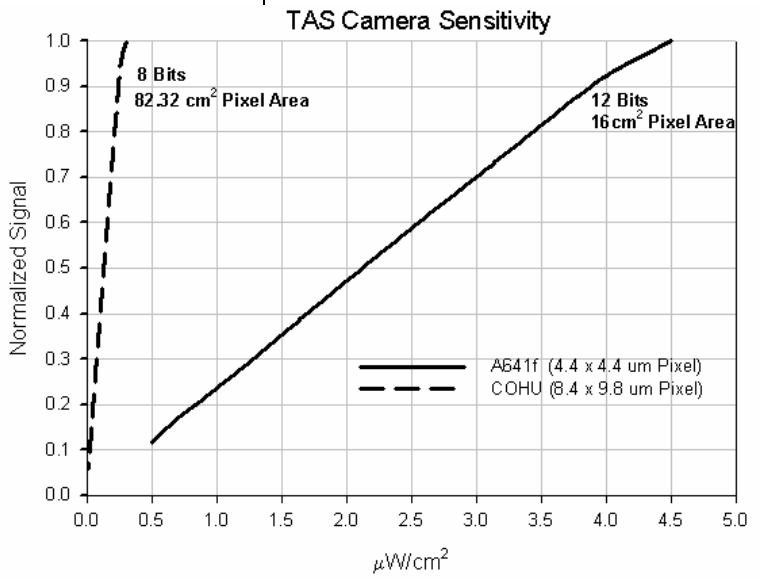
- CCD Evaluation
- Illumination
- Video Synchronization
- ITAS Cable Model

CCD Basler 641f

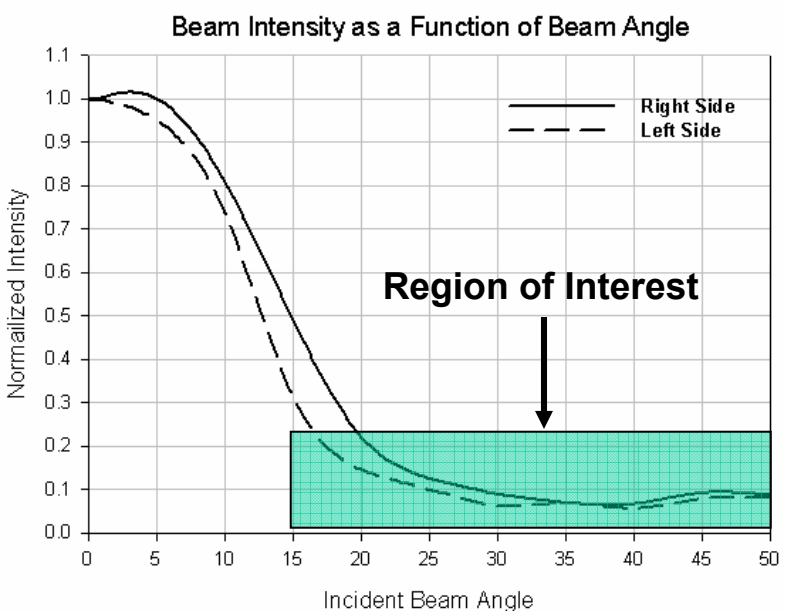
- Basler CCD type A641f, NIF# - NXXXX-XXXX
- Firewire IEEE- 1394a capability (connectors not adequate)
- Pixel size 4.4 μm square
- ½ format, (1624 x 1236) pixels, 2Meg Pixels
- No cover glass
- No Lens
- Trigger capability
- Synchronization capability
- Vacuum tested, report – Baseline Failed

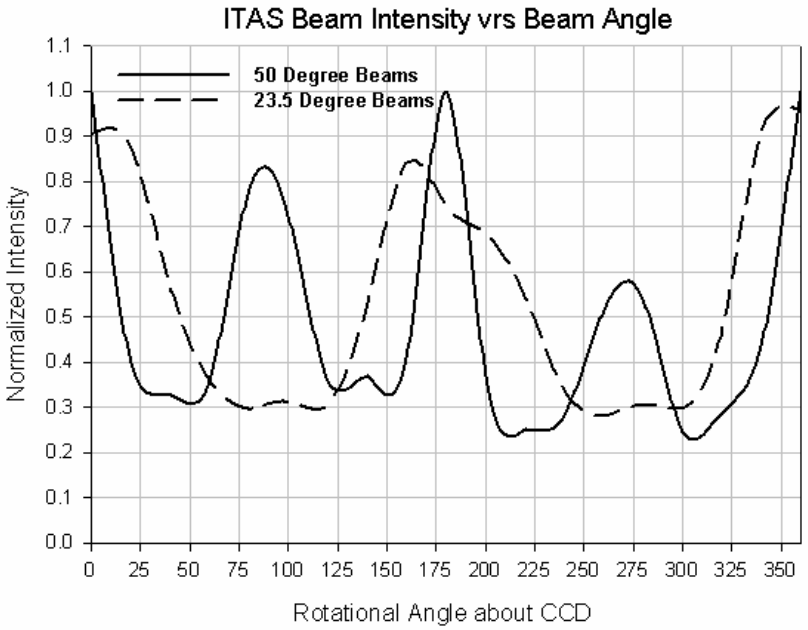




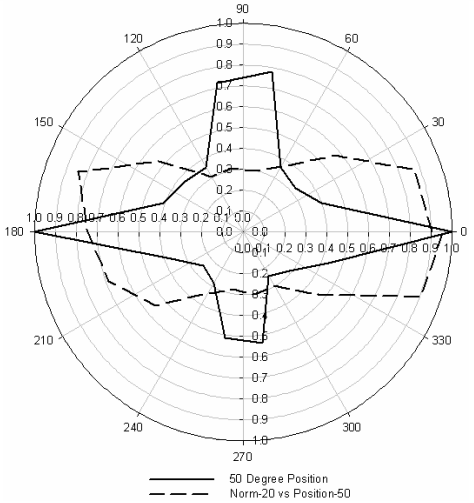
No Lens was used during measurement

CCD Response vs Beam Angle





CCD Beam Angle Test
Incident Angle & Rotational Angle



Issue: Need strategy to handle different beam intensities

TAS Illuminator System Features

The National Ignition Facility

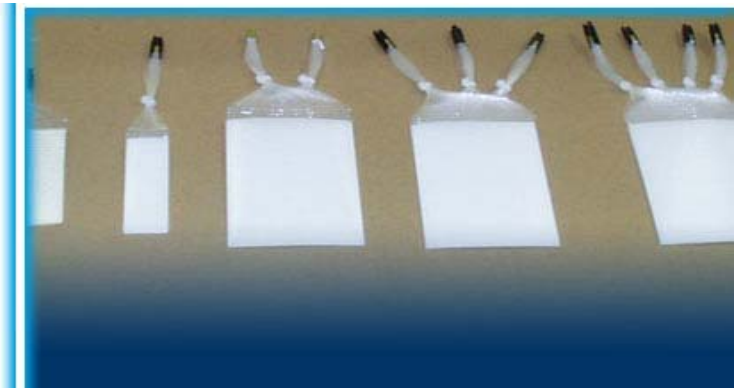
•The new ITAS Illumination System will include the following features:

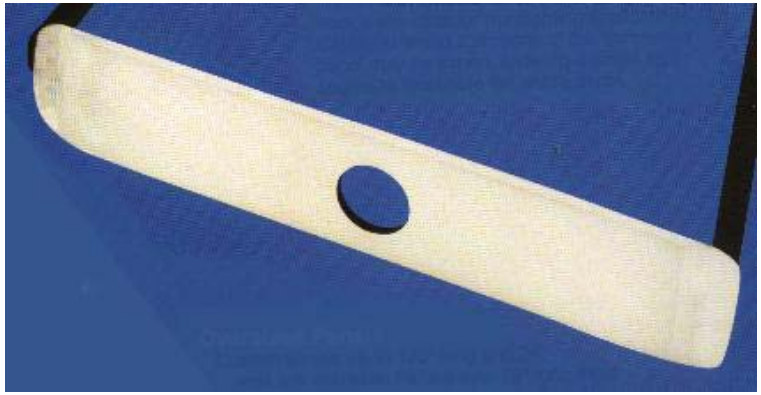
- **Programmability - The system will be controllable through the ICCS network from the control room or any ICCS workstation.**
- **Directional Lighting – Low angle "spot lights" will be placed around the perimeters of the upper and lower panel illuminators. These will be individually controllable. (630nm)**
- **Synchronization – The illumination system will be optionally pulsed to the camera frame rate for Cryo target implementation.**
- **Offline Characterization Storage – The Illumination chassis will provide storage media to allow archival of illuminator set points for various targets.**
- **Manual control via chassis front panel.**

Flat Panel Diffuse Ambient Lighting

The National Ignition Facility

- Fiber optic panel with LED lighting. The LED's are placed a fixed distance from the panel and are operated from a low voltage source.
- The fiber optic panel same dimensions are the same as primary mirror area.
- Measurements show good efficiency with no noise interference. (Needs to be vacuum qualified.)





Panels with cutouts for camera lenses are ideal for front lighting applications. Cables entering from both ends of the illuminated panel can be joined, allowing a single light source to illuminate the entire panel.

Illumination Panel

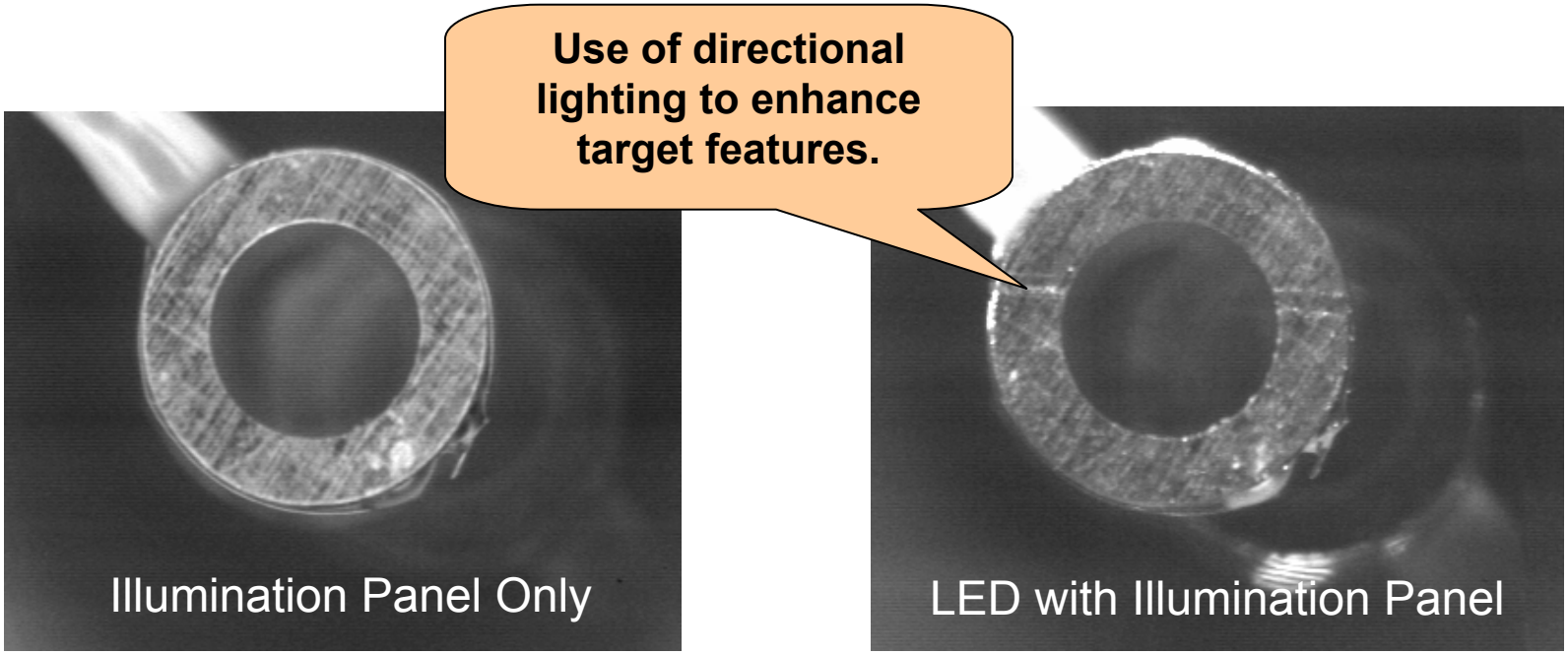
The National Ignition Facility

- Need more data here

Low Angle Directional Lighting

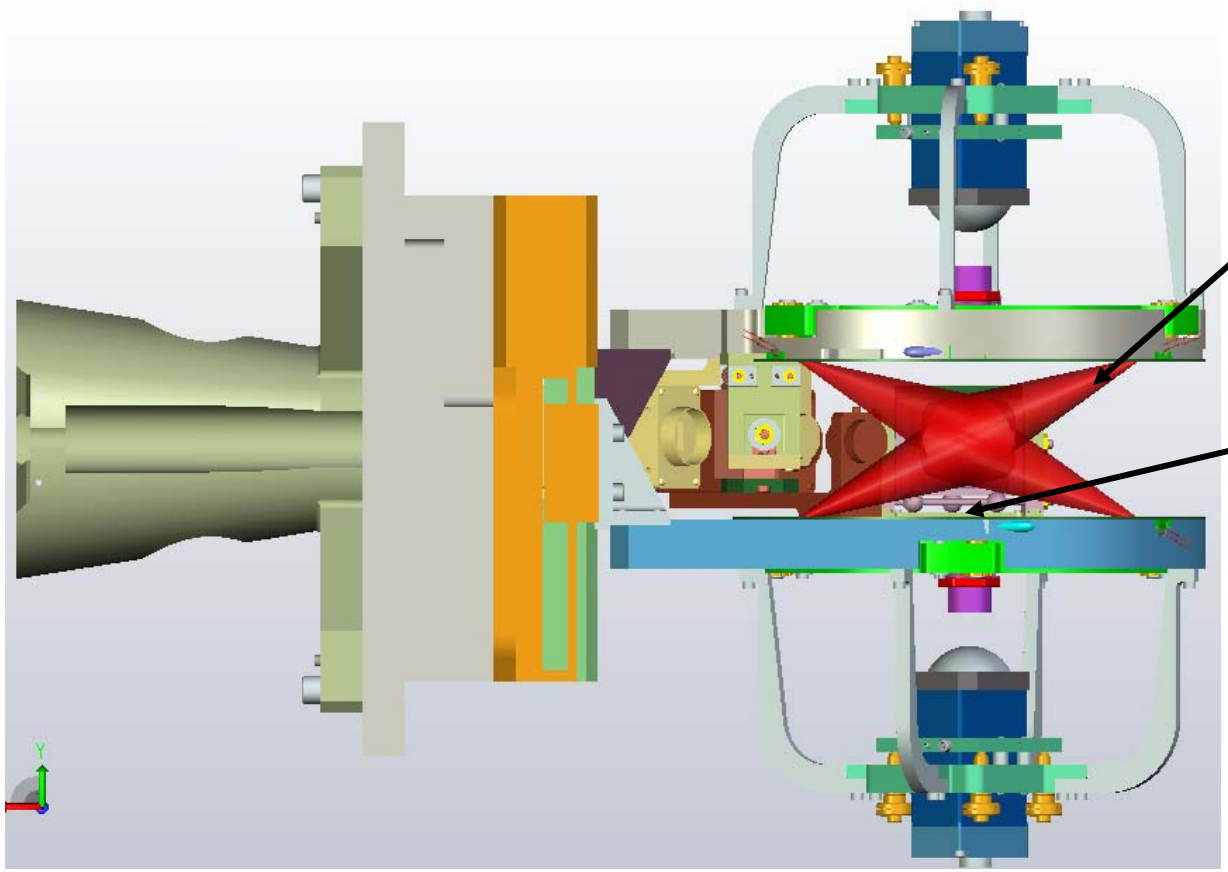
The National Ignition Facility

- Used for off axis targets or for viewing target markings.
- Eight “spot lights” placed in the upper & lower mirror housing.
- Lights will be controllable through ICCS.
- Spot lights will not be used during hohlraum cryo targets.



ITAS Illumination Design

The National Ignition Facility

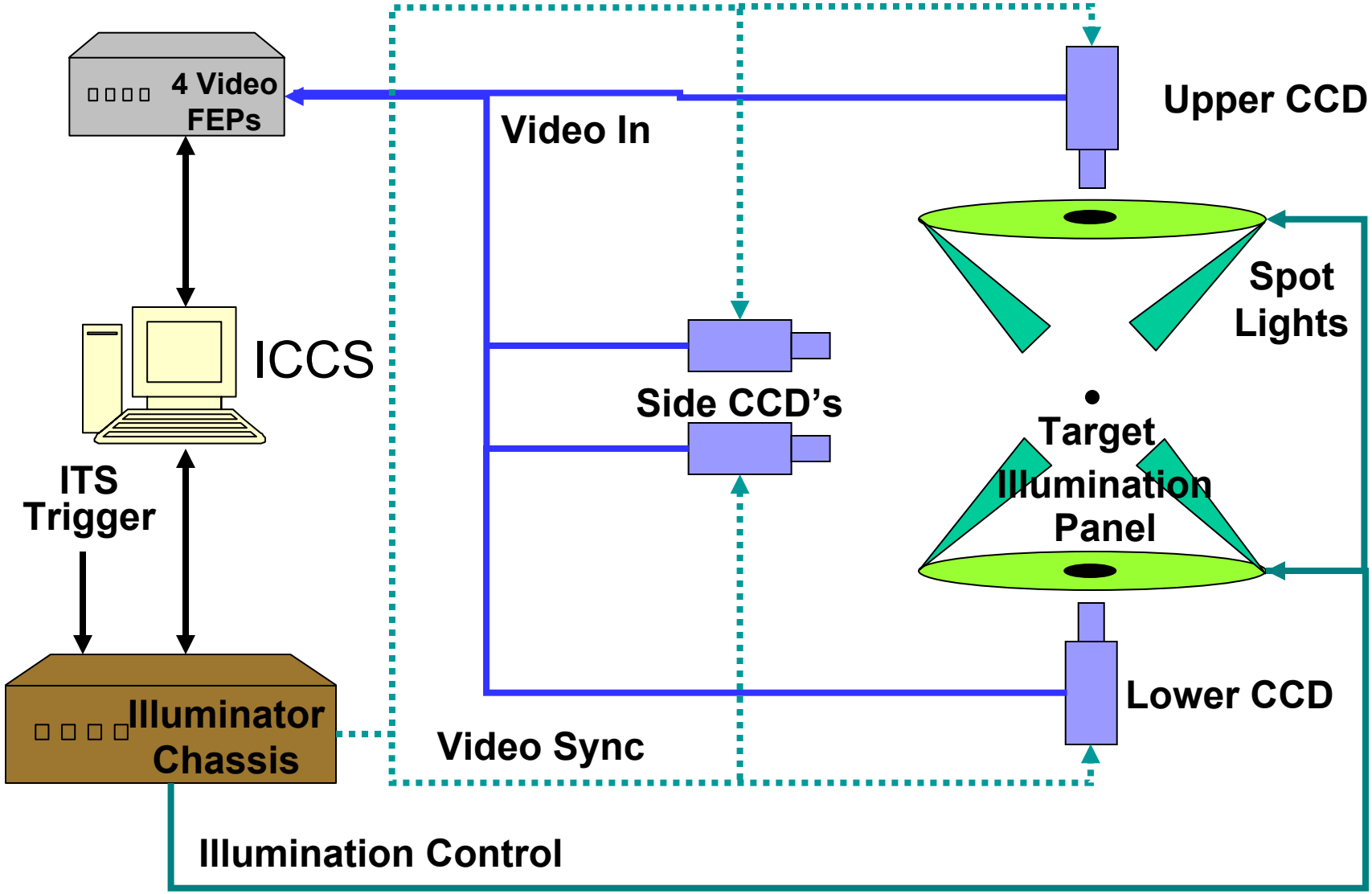


LED Direction Lighting Upper and Lower

LED Ambient Lighting Upper and Lower

Illumination Intensity is Programmable and Synchronized with Video

Illumination System Functional Design



Video Synchronization

The National Ignition Facility

- Video modes
  - Shot capture
    - Used for rod shots
  - Trigger mode 5 Hz frame rate
    - Used for movement viewing
  - Trigger Mode 1 Hz
    - Illumination Setup for rod shots
- Video Synchronization & Illumination
  - Programmable dwell time
  - Programmable integration time
  - DC operation

Example CCD Video Measurement, with Lens

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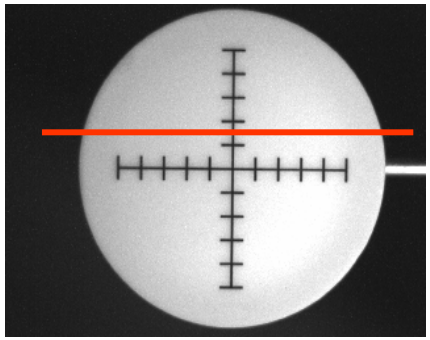
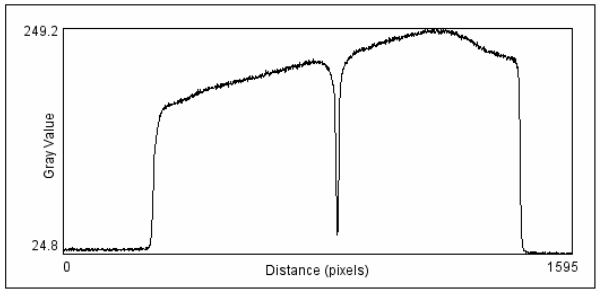
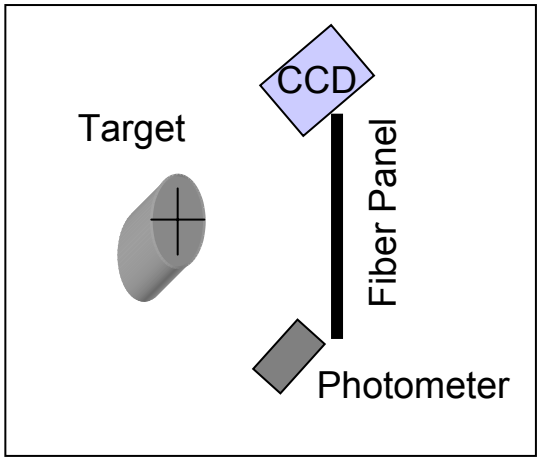
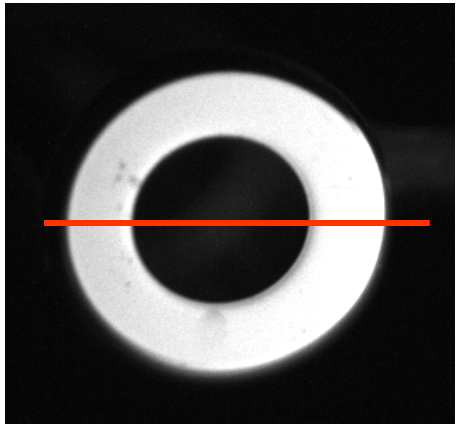


Diffuse Target, 0.500 μW/cm²

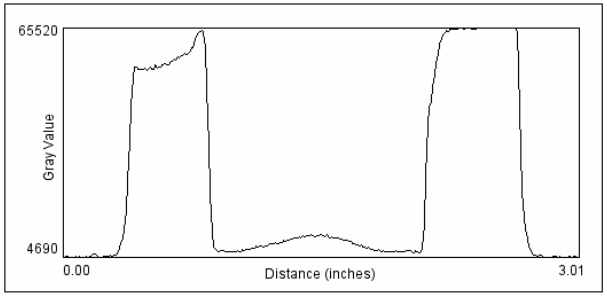


Line Out, 8 Bits, High Gain

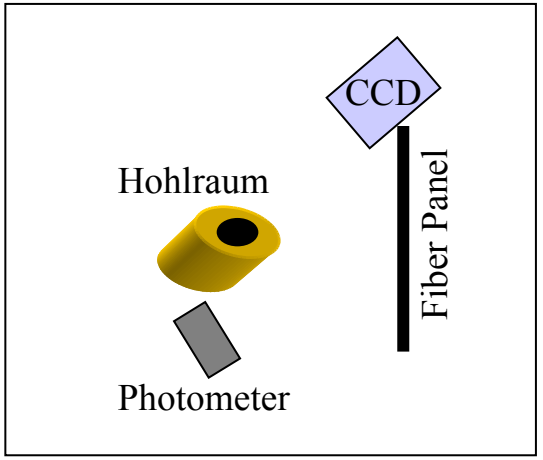




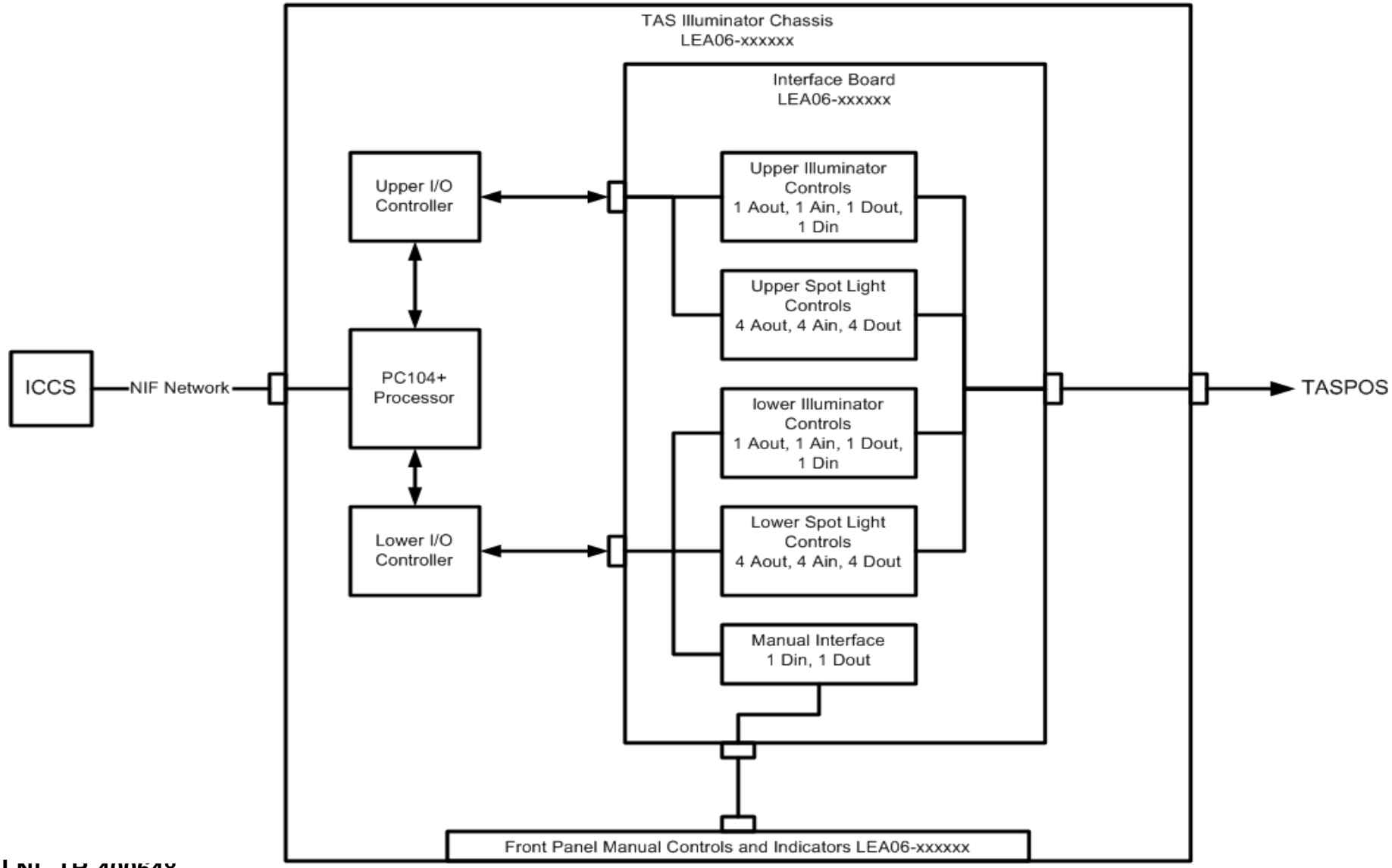
Gold Target, 0.600 μW/cm²



Line Out, 12 Bits, High Gain

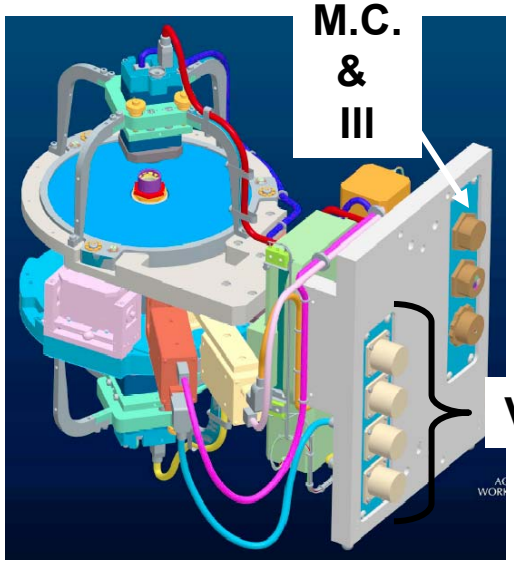


Illuminator Chassis Design

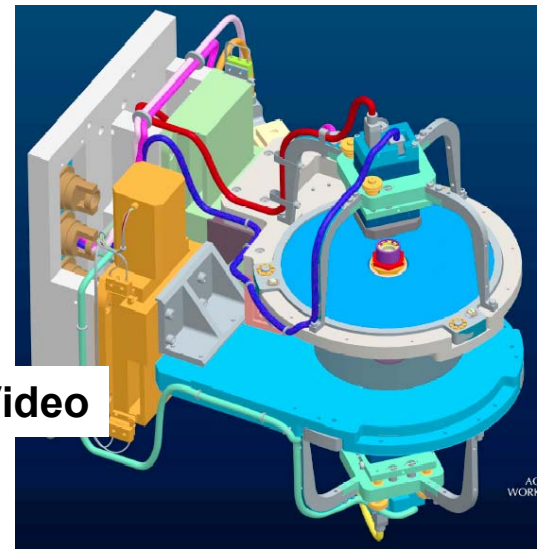


ITAS Electrical Cabling

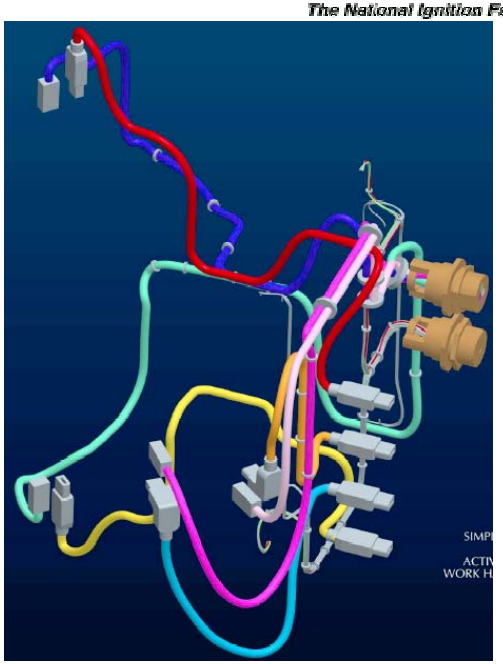
The National Ignition Facility



Back View



Front View



Skeleton View

- Electrical Routing
  - Motor Control
  - Video
  - Illumination

Drawing Status

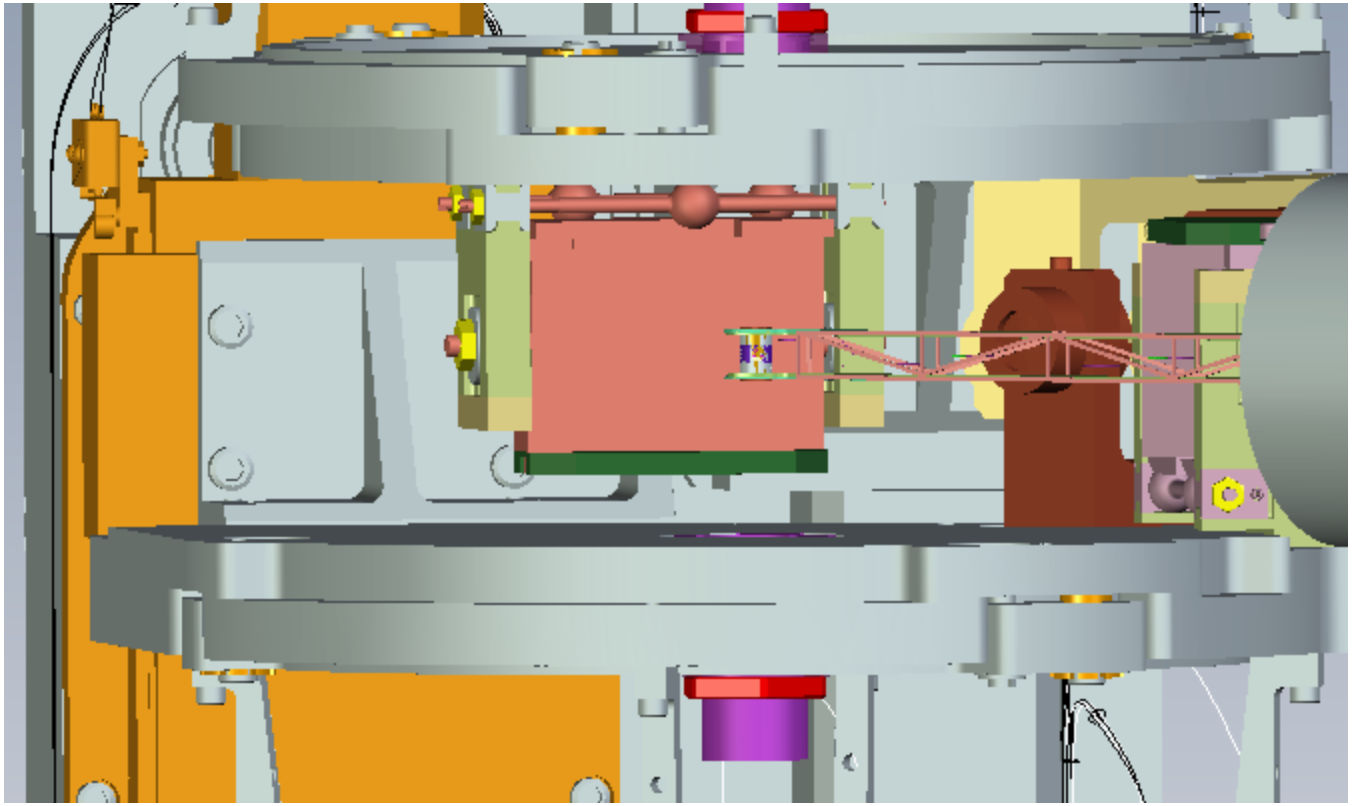
The National Ignition Facility

	Total	In ECMS	Released
ITAS Mechanical Assembly & Optical	96	87	2
ITAS Electrical Assembly	8	8	
Transport and Handling	TBD		
Calibration Station	TBD		

Cryo-ITIC Interface

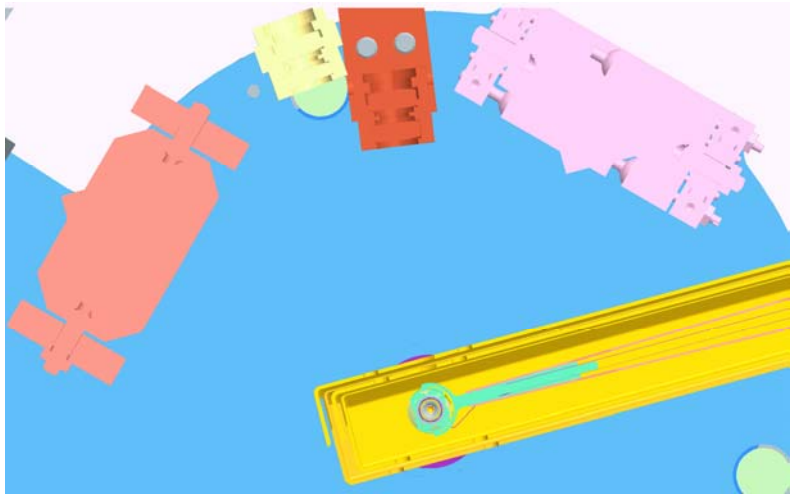
Cryo-ITAS Interface

The National Ignition Facility

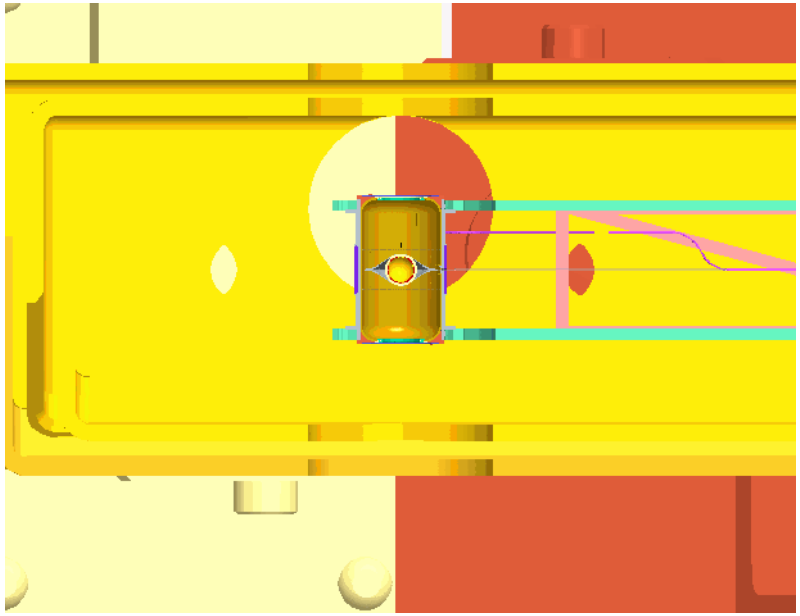


Hohlraum Inside ITAS

Cryo ITIC Hohlraum Interface



Upper/Lower Cryo Hohlraum View



Side view cryo Hohlraum
One side camera view only

Cryo Temperature Model

The National Ignition Facility

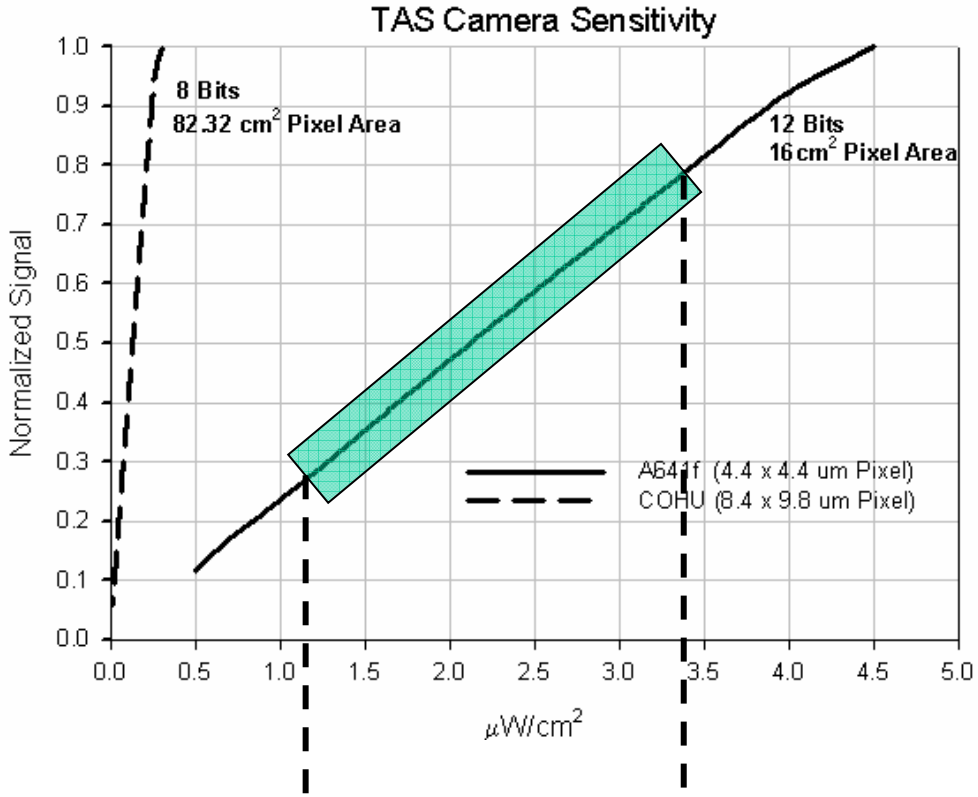
Max Power on Cryo Target
0.13 mW/cm^2, NIF-XXXX

Cryo Target Temp:
- **Hohlraum Temperature**
  - **T ~ 16-20 K**
- **Inside shield wall**
  - **T ~ 60K**
- **Outside shield wall**
  - **T~ 298K**

Cryo Target Material:
- **Gold, Aluminum**

Total Illumination Power < 130 μW/cm^2

Illumination of TAS on Cryo

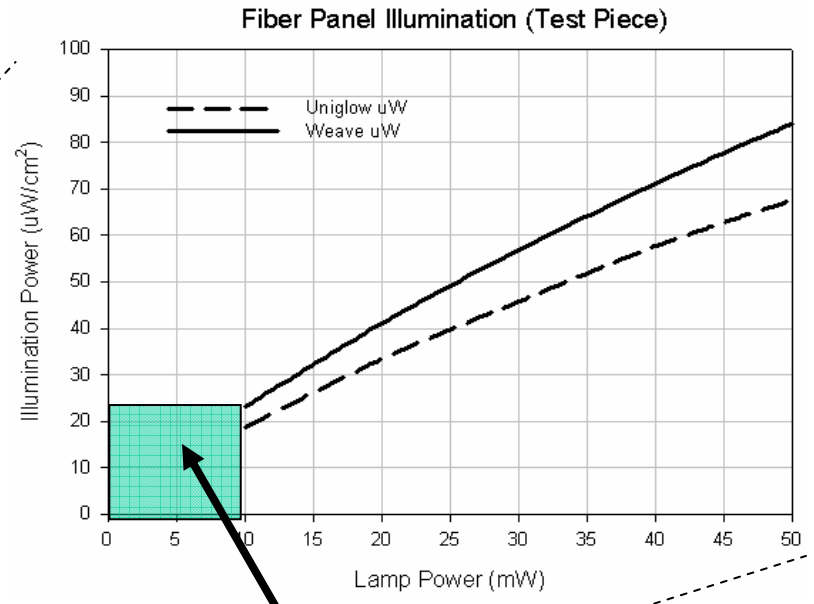


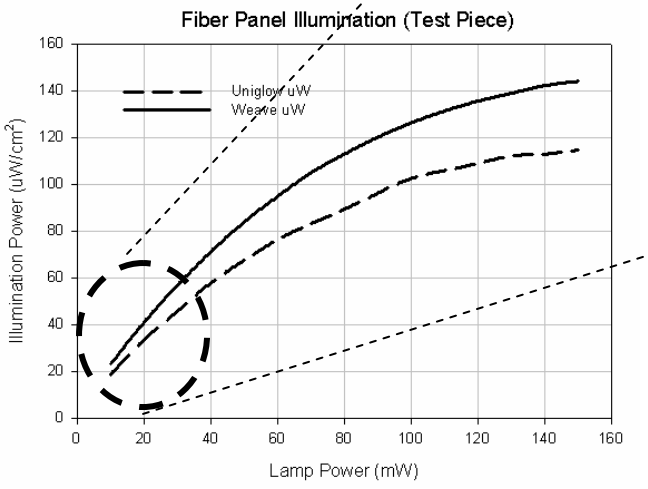
Nominal Operating Range

- **Camera Operates: 2.5 μW/cm²**
  - **No Lenses (worst case)**
- **2 Illumination Systems: 5 μW/cm²**
- **Goal is power < 130 μW/cm²**
- **Margin is (130/5) or X26**

TAS Illumination is ok for Cryo-Operation

Illumination Power Nominal Levels





TAS Illumination Operations based on current CCD measurements, white light

Margin for different target reflectivity

ICCS Support, Video, CCD

The National Ignition Facility

- ICCS Activities
  - Video
  - GUI
  - Broadview

ICCS Support, Video, CCD

The National Ignition Facility

- ICCS software development to support IQ is limited to digital video support
  - Digital Video FEP and video maintenance panel to support the Basler A641f (SCR 17750)
- A641f support is scheduled for 5.4.0 release, scheduled for B581 release on Jan 29, 2007

ICCS Video, continued

The National Ignition Facility

- Full range of Basler A641f features will be supported by the digital video FEP:
  - Max image resolution of [1624 x 1236] - 12 bits
  - Frames per second limited to 14 FPS at [1624 x 1236] x 8.
  - Gain:
    - 1.0 (0dB) – 2.43 (7.71dB) @ 16bit
    - 1.0 (0dB) – 19.8 (25.9 dB) @ 8bit
  - Programmable exposure time:
    - 15μs – 5.0sec
  - Programmable Duty cycle
  - During synchronization the exposure time is adjustable

- All digital video FEP image processing functionality (decimation, rotation, flips, etc.) shall be available

ICCS Broad View Updates Required

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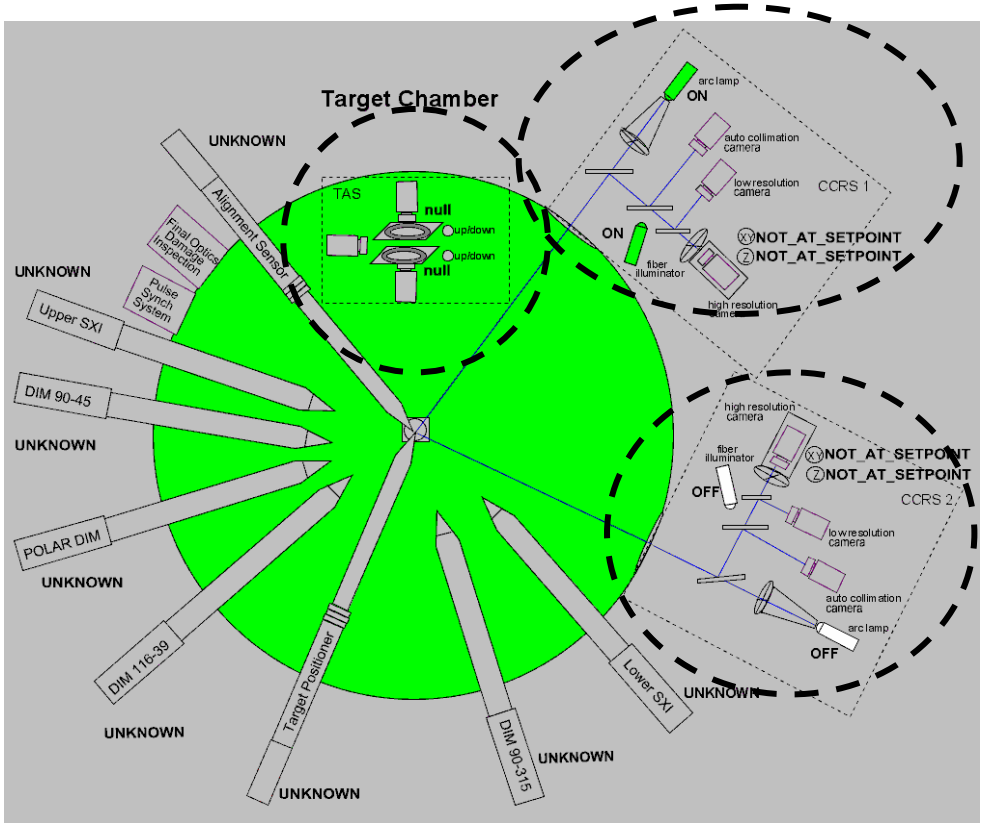


Broadview Needs Updates

- **New TAXONS**
- **New Broadview Panels**
  - **ITAS**
  - **CCRS #1**
  - **CCRS #2**
  - **Active Target**
- **Work In Progress, Allen Casey**

ICCS Broad View Concepts

The National Ignition Facility

Need updates here if any...

Optical System Status

TAS Optical Systems

The National Ignition Facility

- Target Viewing System
  - Top/Bottom Systems use F=30 mm lens at 1.0 magnification
  - Side camera systems (2) use double achromat system at 0.67 magnification, Side Lens 1 is different focal length from Side Lens 2
- Beam Viewing System
  - NIF alignment beams reflected from mirror placed exactly mid-way between target and detector planes
  - Dome made of KG3 filter material absorbs 1ω radiation protecting CCD during rod shots
  - Beam offset for off-axis aim points requires lookup table correction produced by dome
- Prism Reference Systems
  - Two prisms used to align TAS to TCC using CCRS
  - Each prism provides X,Y and 1 tilt angle reference

ITAS Optical Systems, Continued

The National Ignition Facility

- ITAS OCD AAA03–200803-AA (1 Drawings, 6 sheets)
  - Is in the process of being updated
    - Adding additional Side Camera (75/50) & (90/60)
    - Updating the new version of the side lens system (achromatic doublet)
    - Updated the new version of the upper/lower imaging lens
  - Mirrors, domes, prisms complete and on order
  - No filter glass required

ITAS Supporting System

The National Ignition Facility

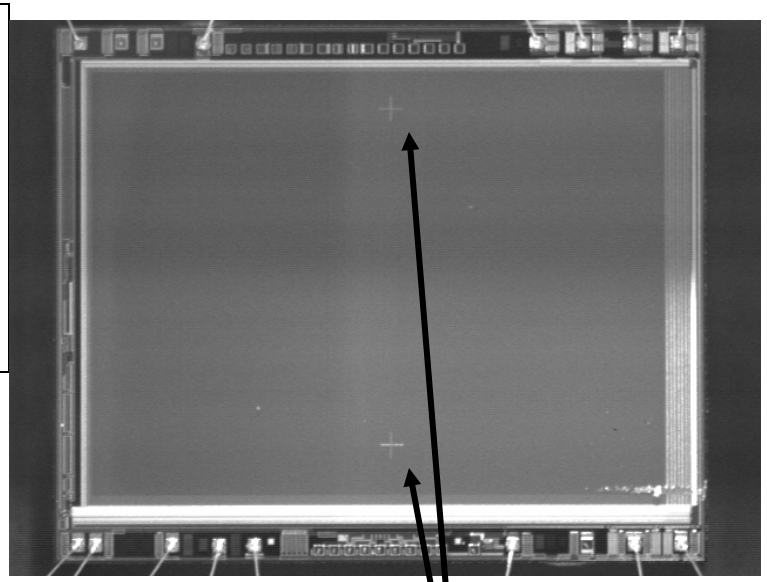
- ITAS Supporting System
  - Active Target Status
  - Calibration Station Status
  - Transportation & Handling Status

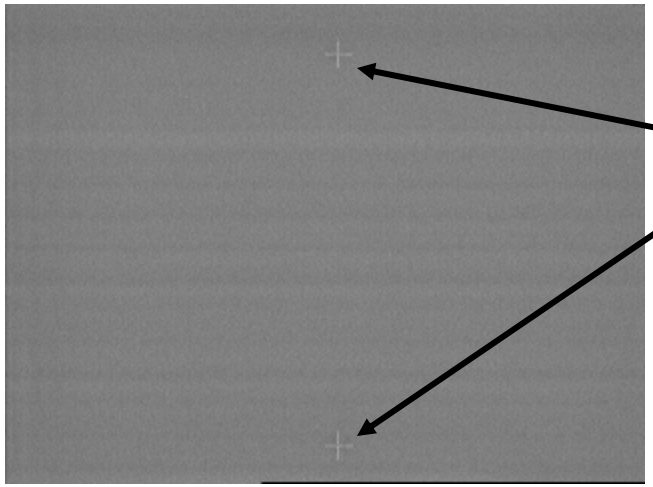
Active Target Fiducials

The National Ignition Facility

Production techniques:

1. Excimer laser excises microlenses on CCD
   - Lack of contrast
   - Danger of damage to CCD chip
2. Other Methods needs to be explored, work in progress





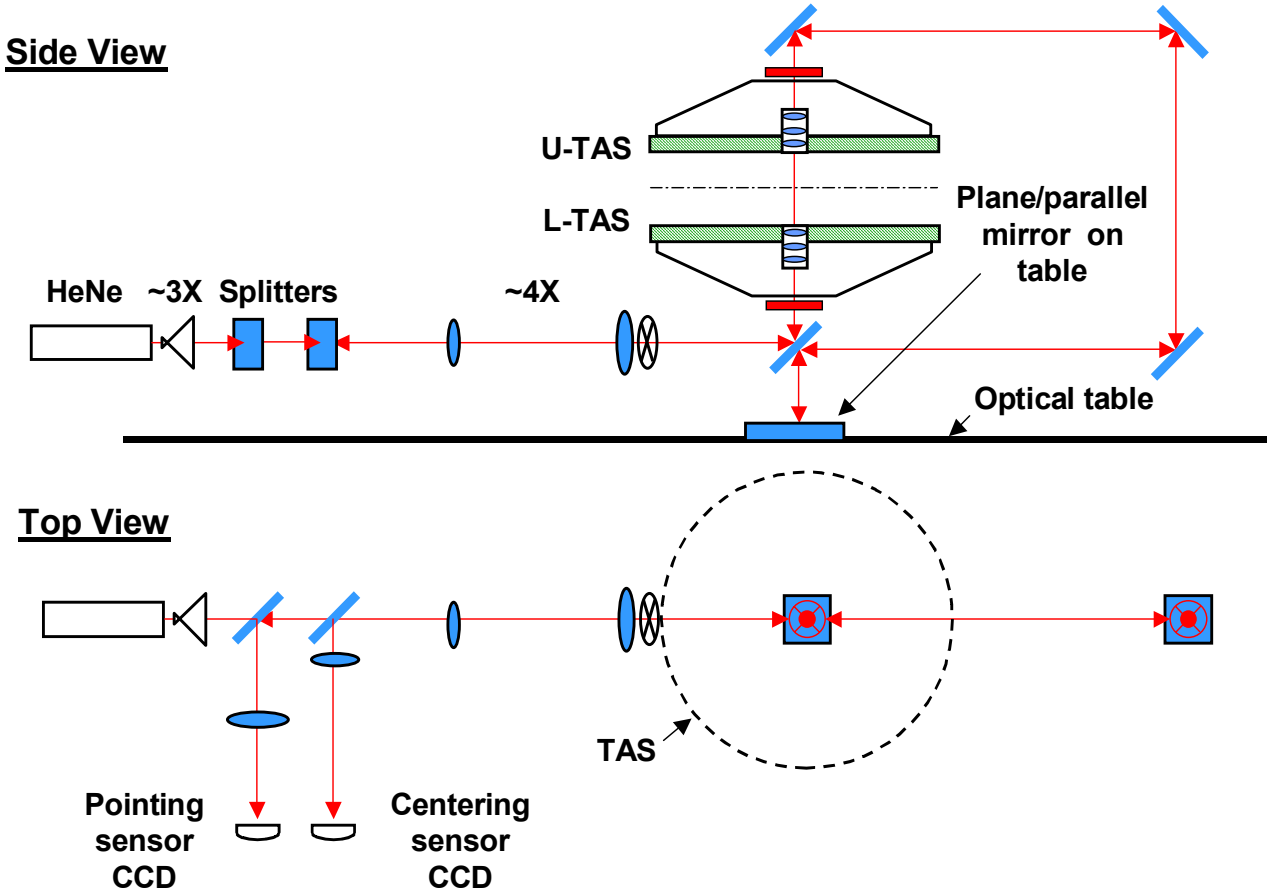
Internal and external images of CCD with microlenses removed by laser removal technique

Active Target Status

The National Ignition Facility

1. Laser forward transfer – not effective
2. New direction required, activity in progress

TAS Calibration Station



Calibration Station Status

The National Ignition Facility

- Dedicated, separate room for ITAS calibration
- B391/RB130 interim location (~1 ½ years)
- TD room on 17'6" in B581 permanent location

Requirements

- Angular
  - Replicate CCRS #1 & CCRS #2 within 1.0mrad
  - Orthogonality within 0.25 mrad
  - Simulated NIF beams at 30 and 50 degrees with 1 degree
  - Vertical axis stable with 0.1 mrad
  - HeNe beams aligned to surrogate CCRS within 0.5 mrad
  - Insertion mechanism angular repeatability with 0.2 mrad
  - Target angular orientation within 5 mrad

Calibration Station Status, Continued

The National Ignition Facility

Requirements

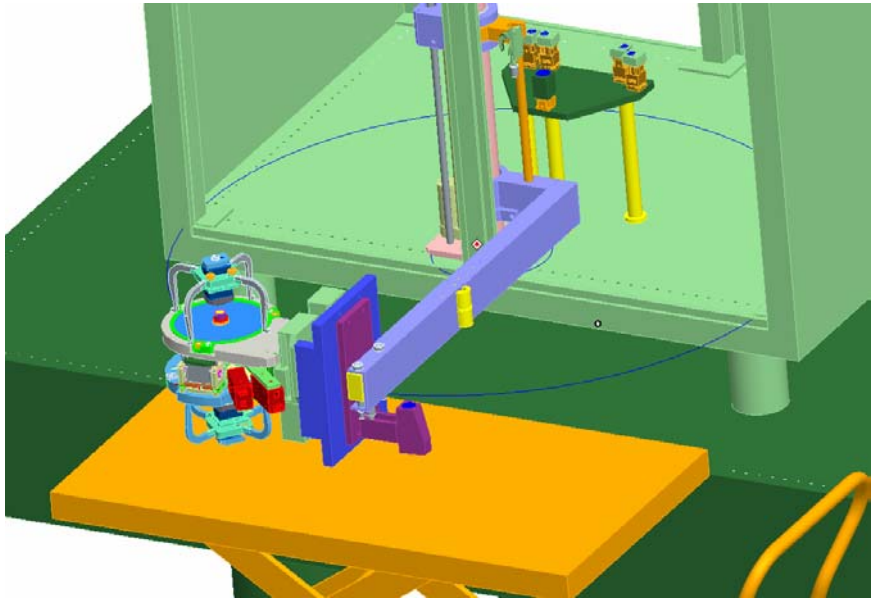
- **Position**
  - **Vertical overlap of CCRS within 10 microns**
  - **Locate prism fiducials within 100 microns**
  - **Repeatability determined beam centroid with 5 microns**
  - **HeNe beams overlab at mid-plane within 50 microns**
  - **Insertion mechanism repeatable within 20 microns**
  - **ITAS adjustments to coordinate references to within 10 microns (x,y,z) and 0.1 mrad to HeNe reference axis**
  - **Calibration station shall provide a minimum of 4 simulated NIF beam lines that can be located at arbitrary azimuthal angles with nominal equal spacing.**
  - **Calibration station shall accommodate the 4 simulated beam lines at the same polar angle.**

The National Ignition Facility

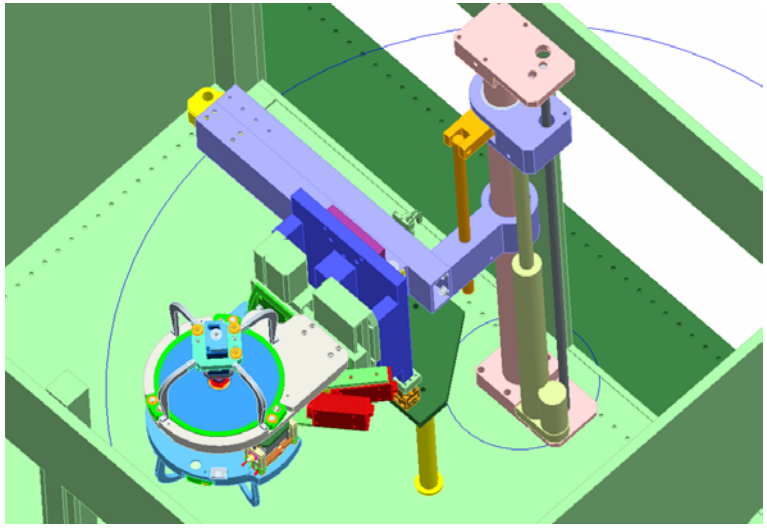
Transportation & Handling

Similar lifting fixture will be used at Cal Station

The National Ignition Facility



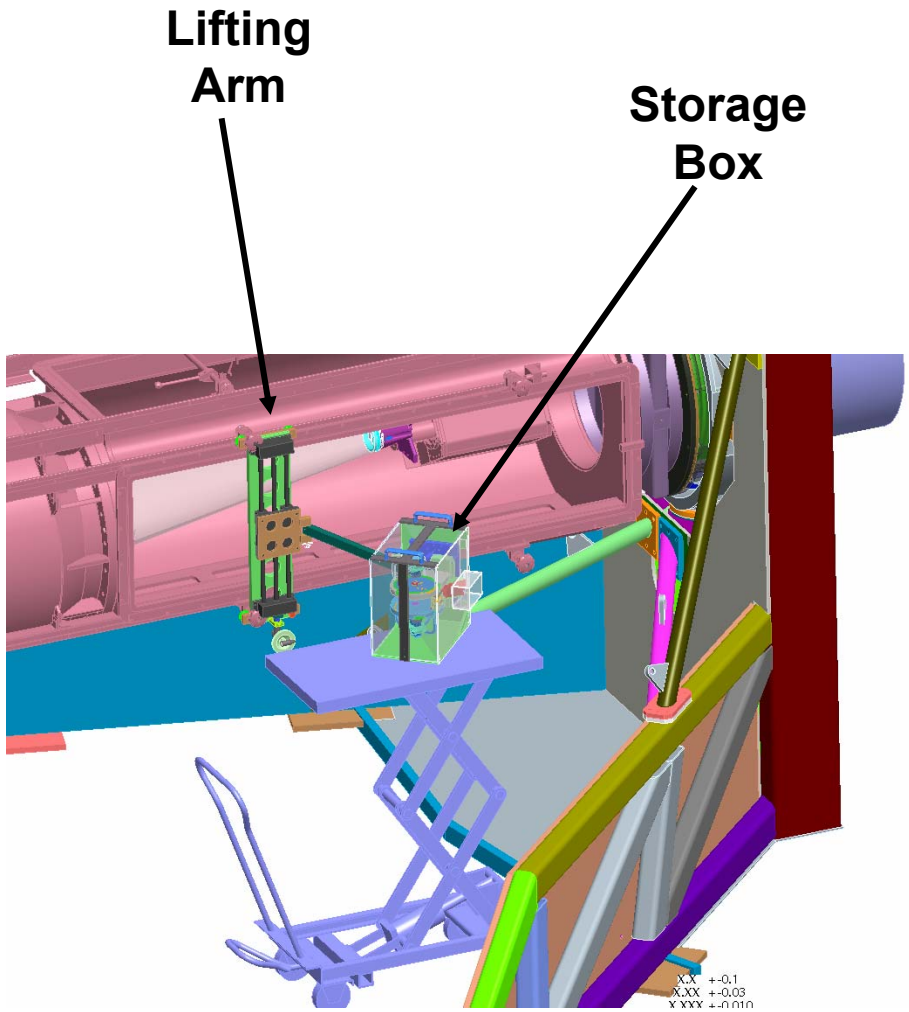
Outside the Cal Station



Inside the Cal Station

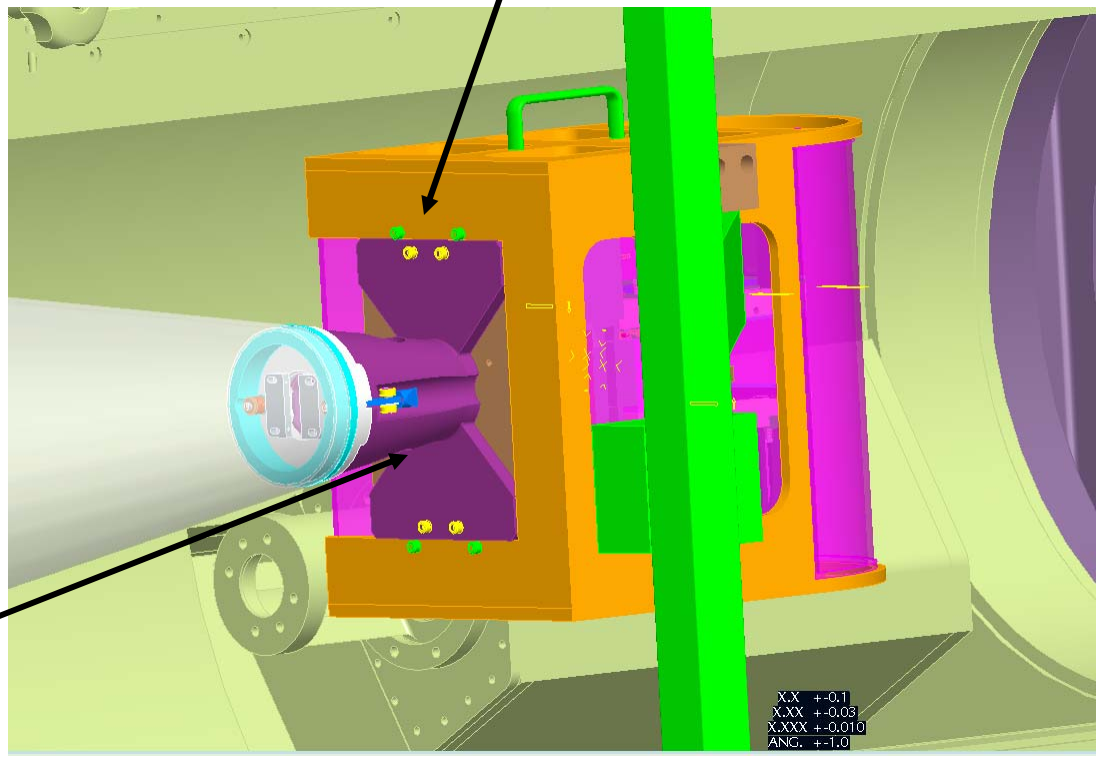
ITAS will be handled by a new lifting fixture

- ITAS is mounted in a portable storage box
- Removable lifting arm attaches to side TASPOS door rails
- ITAS is lifted from cart and swung into place by lifting arm
- ITAS attached to cone and box is removed



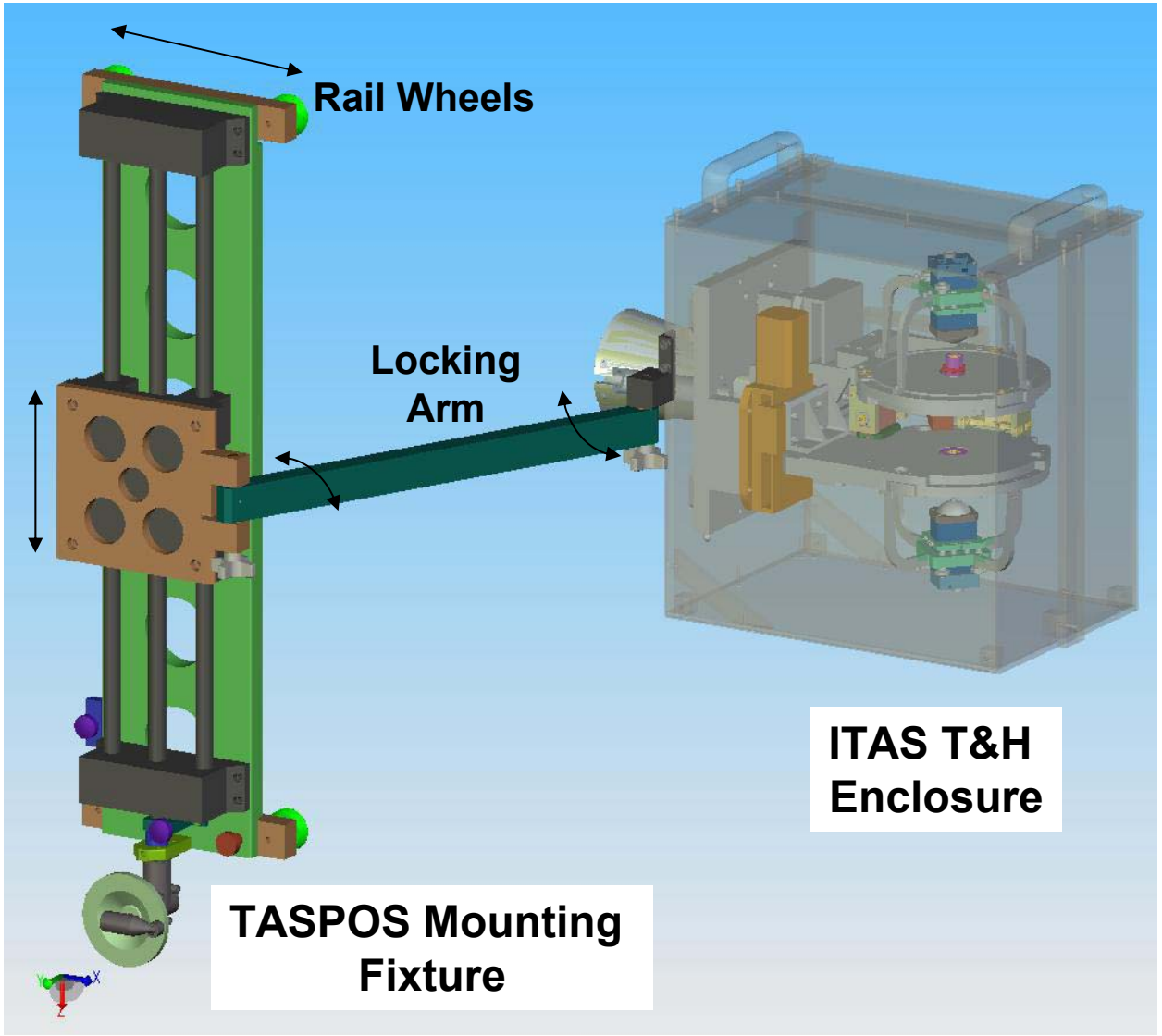
ITAS Mounting Plate Provides Handoff to Cone

- 2 sets of holes on rear of ITAS mounting plate provides handoff
- Outer set attaches ITAS to storage box
- Inner set attaches ITAS to TASPOS cone
- 2 alignment pins will located ITAS to cone

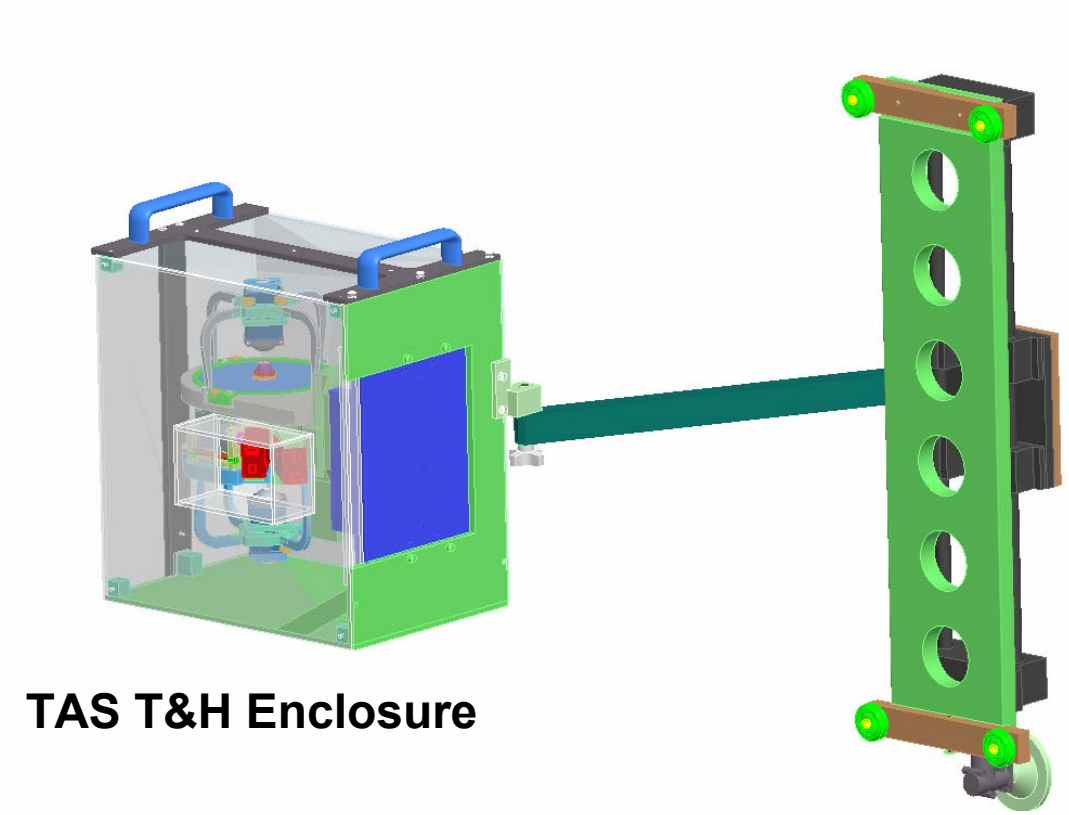


T&H Tool used to Install/Remove into TASPOS

- Rotates at both ends of locking arm
- Elevation adjusted by vertical rail with hand crank
- Linear motion along boom axis by door rails



T&H Tool Install/Remove into TASPOS



TAS T&H Enclosure

TASPOS Mounting Fixture

Technical Risks & Mitigation

The National Ignition Facility

- Transportation & Handling
  - Transportation enclosure
  - Clean environment
  - Assembled to TASPOS w/ enclosure intact
  - Designed hold points
- EMP
  - Use of “Standard Grounding & Shielding Practices” (NIF - 0008324)
  - Power down system before a shot (not needed during a shot)
  - TAS enclosed in TASPOS before shot (provides E&M shielding due to Faraday cage effect)
- Radiation
  - Neutron testing of CCD/CMOS detectors shows cameras will have finite lifetime (Al Throop)
  - ITAS not powered during shot
  - Additional shielding at TASPOS, system is being reviewed.
  - Bad pixels can be dealt with through signal processing
  - Spare ITAS w/ fresh cameras to cover catastrophic failure available

Technical Risks & Mitigation (2)

The National Ignition Facility

- Heat Load onto Cryo Targets
  - Pulsed ITAS illumination source synchronized to video
  - Intensity adjustable illumination capability
  - Dwell time adjustable
- Calibration Validation
  - Active target to validate calibration in situ in Target Chamber
- Reduced Hohlraum Alignment Risk
  - Additional side camera (1 for upper ITAS, 1 for lower ITAS)
    - Second side camera not used for Cryo targets.
  - Active target validation
  - Offline target validation on calibration station provides stored settings of illumination, etc. for shot cycle
  - Additional lighting for better contrast during alignment

Key Schedule Dates

The National Ignition Facility

• Preliminary Design Review	Complete
• Proto Assy. Tests Complete	9/1
• Final Design Review	week of 10/20
• Cal Station Qualified	80% Complete
• Cal Station Review	12/15
• Active Target Qualified	12/15
• All Procurements delivered	12/15
• Fab and Calibration start	1/15
• TAS calibrated/ready to ship	1/30/07
• IQ	2/15
• OQ	3/1
• First NIF use	~ 5/1

ITAS Summary

The National Ignition Facility

- **Risk Areas**
  - **Vacuum compatible issues**
  - **Vendor issues with illumination**
  - **Intensity variability vs Angle**
  - **Activation Modeling may show other issues for future operation**
  - **Overall stability may need to be verified**