OMEGA Principal Investigator Training
Experimental Operations

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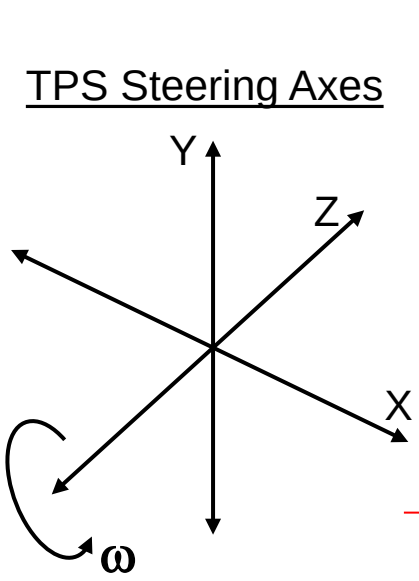
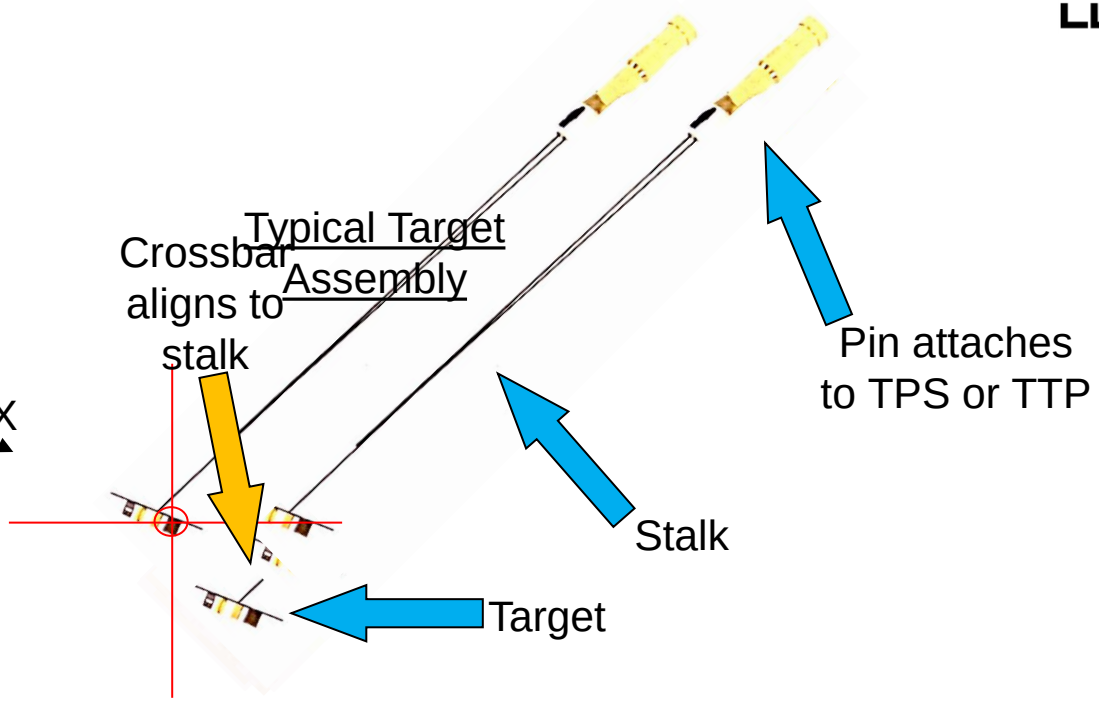
M-UD-M-002 B

Experimental Operations Group And Your Experiment

- **Target Positioning Systems Concepts and Systems**
- **Target Viewing Systems Concepts and System**
- **Target Alignment Procedures**
- **Diagnostic Support Infrastructure**
- **Diagnostic Operations – Deliverables**
- **SRF accuracy**
- **Prioritization of Diagnostics**
- **Communications**

Target Positioning Systems (TPS or TTP) hold a target and move it to the desired location using four degrees of freedom



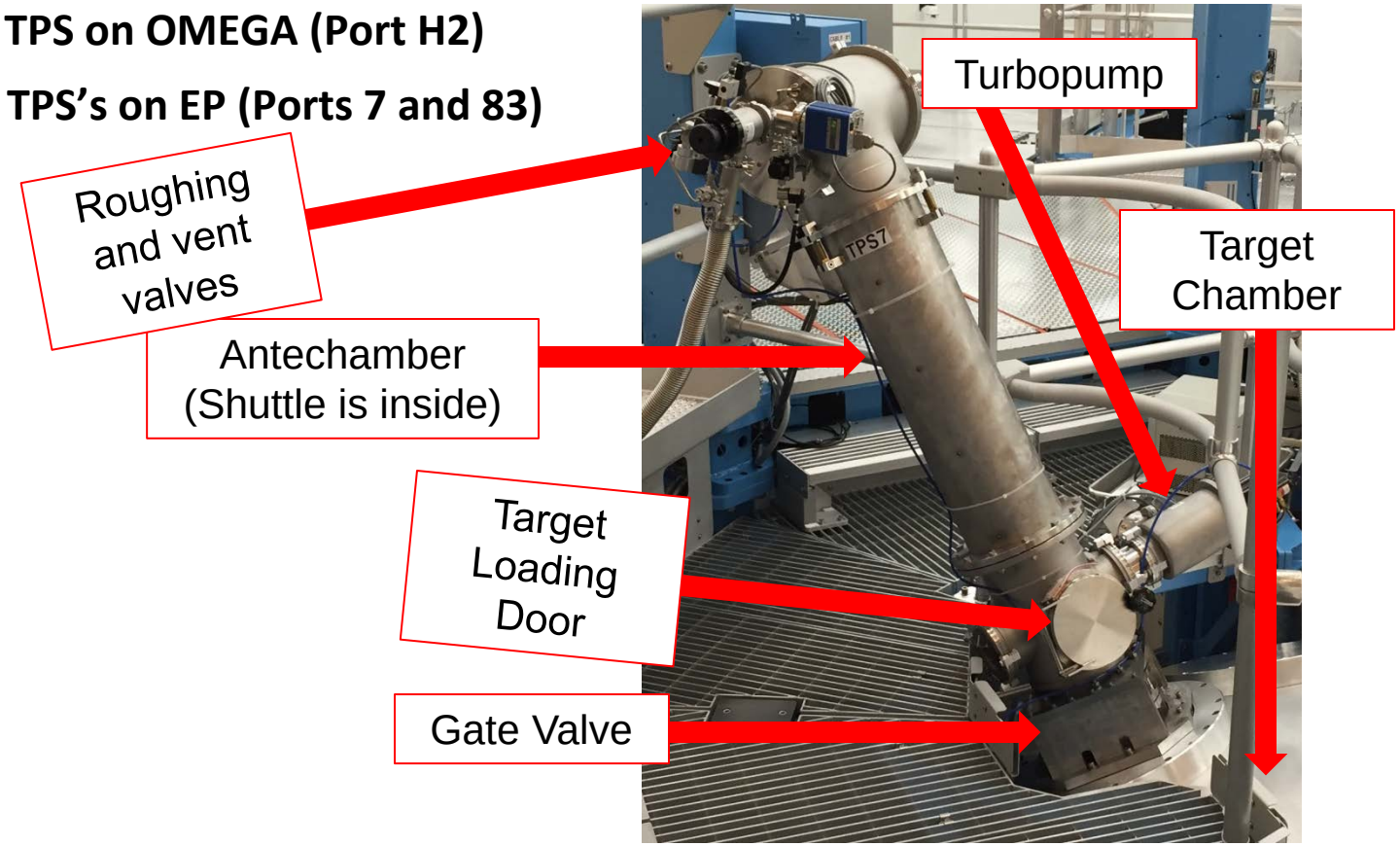


Typical Target Alignment Sequence

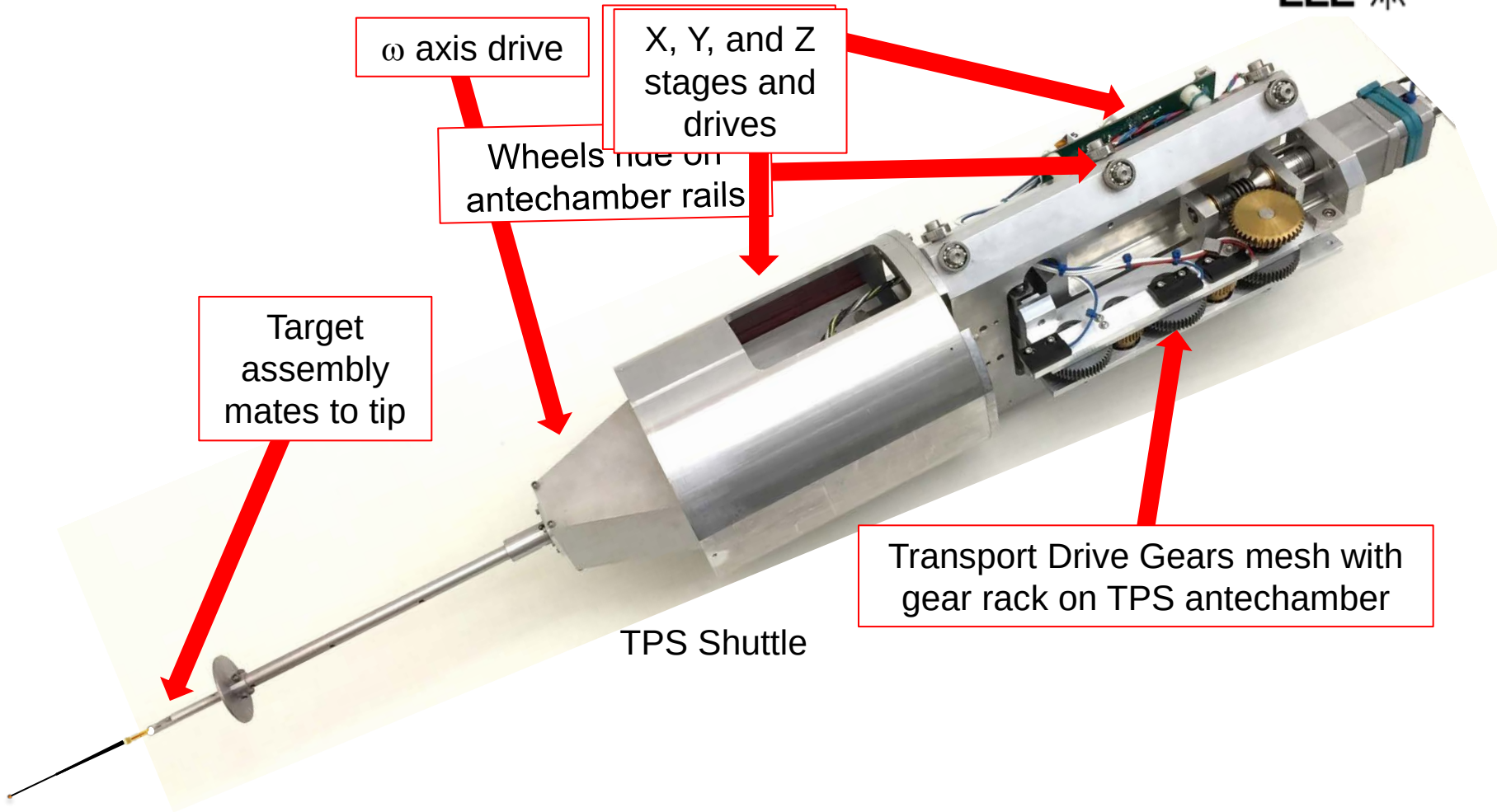
1. Rotate target using ω axis until rotational position is identified.
2. Continue rotation by calculated number of degrees to set the correct target yaw.
3. Translate target to correct position.

The fixed Target Positioning System (TPS) mounts directly to the Target Chambers

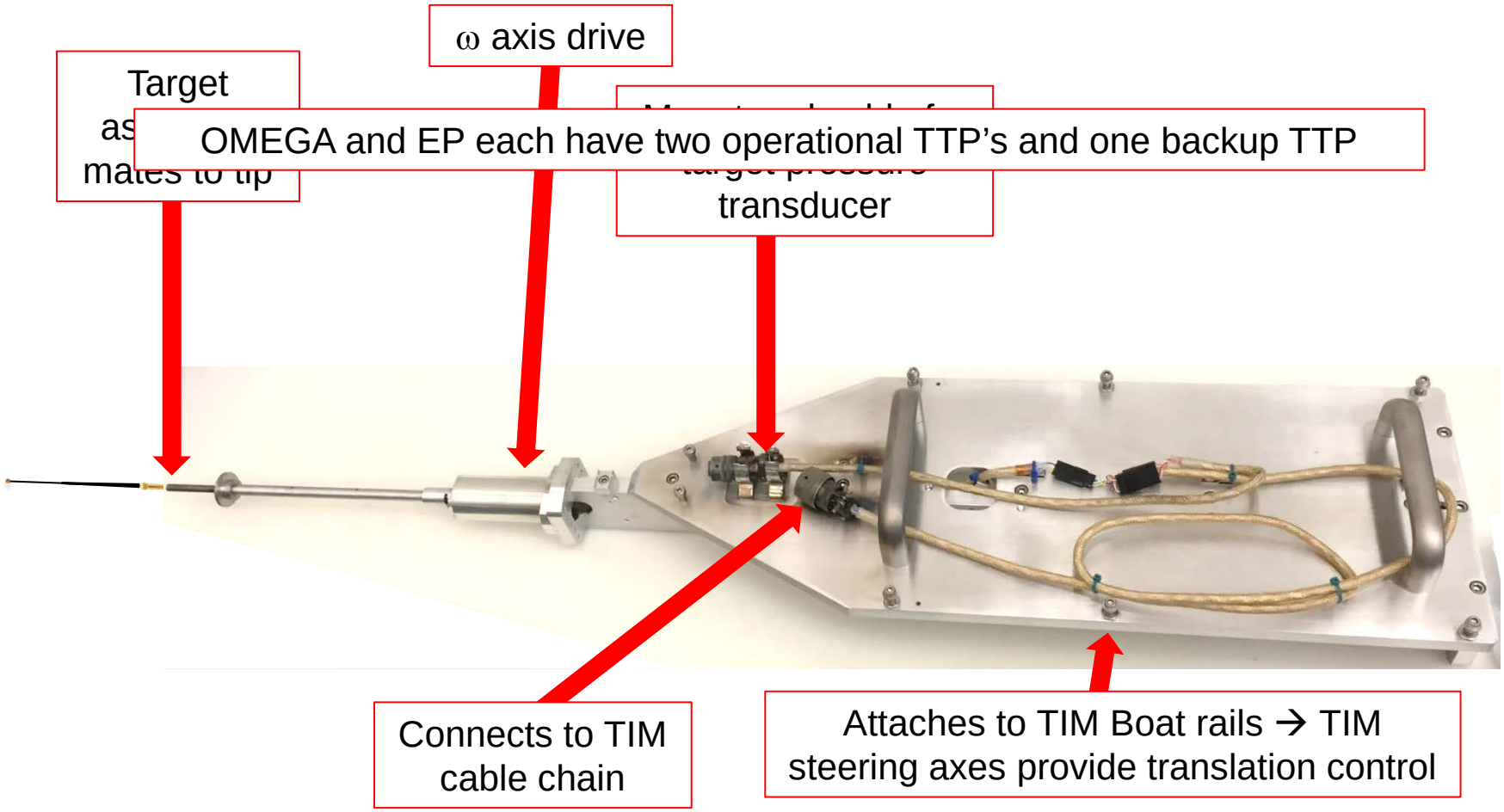
- **One TPS on OMEGA (Port H2)**
- **Two TPS's on EP (Ports 7 and 83)**



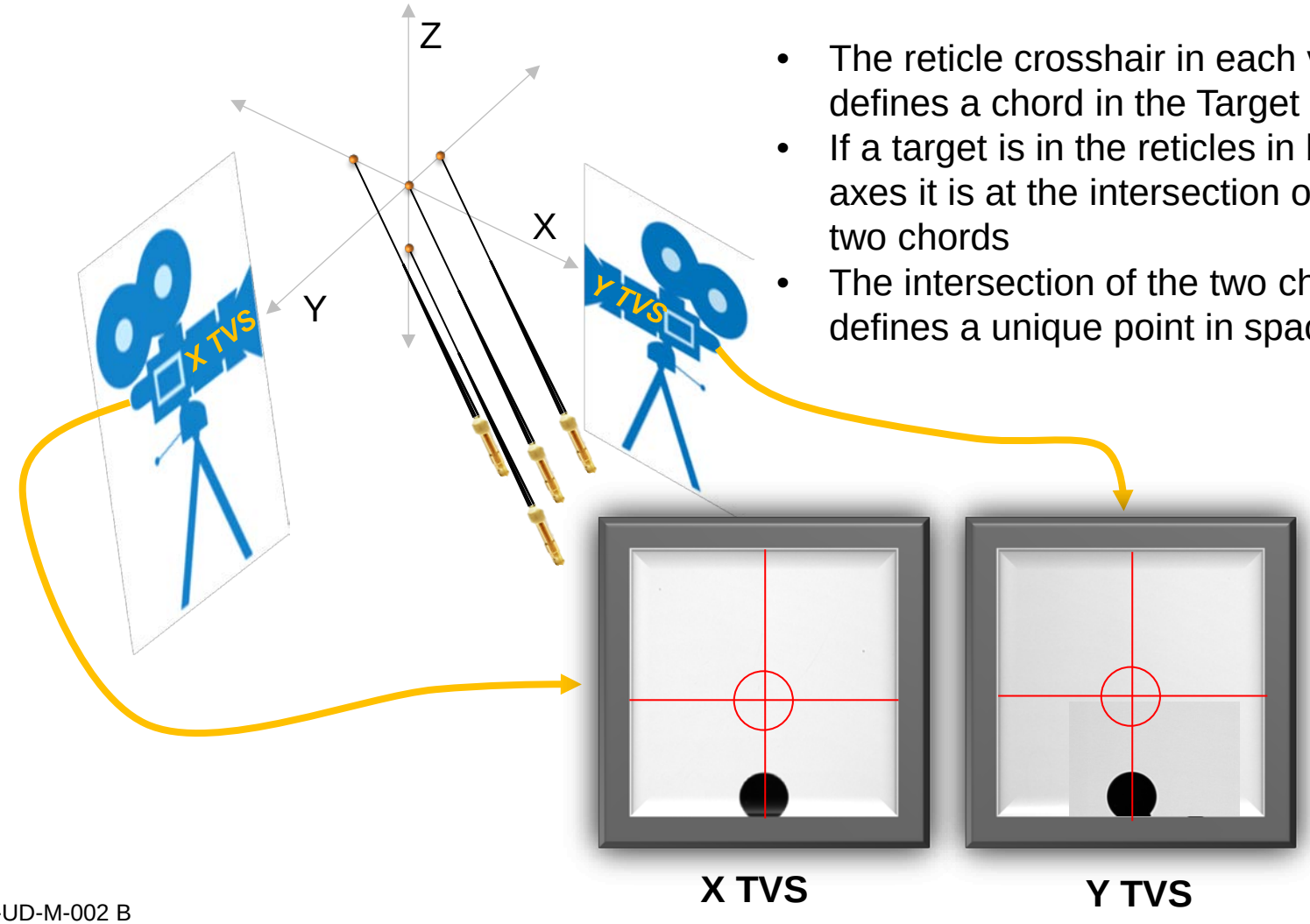
The TPS Shuttle rides inside the TPS antechamber weldment and supports the target



The TIM Target Positioner (TTP) mounts in a TIM and uses the TIM steering axes for target translation



Points in 3-D space can be located using two camera views that are perpendicular to each other



- The reticle crosshair in each view defines a chord in the Target Chamber
- If a target is in the reticles in both TVS axes it is at the intersection of those two chords
- The intersection of the two chords defines a unique point in space

The OMEGA and EP Target Viewing Systems (TVS) are *shadowgraphs*

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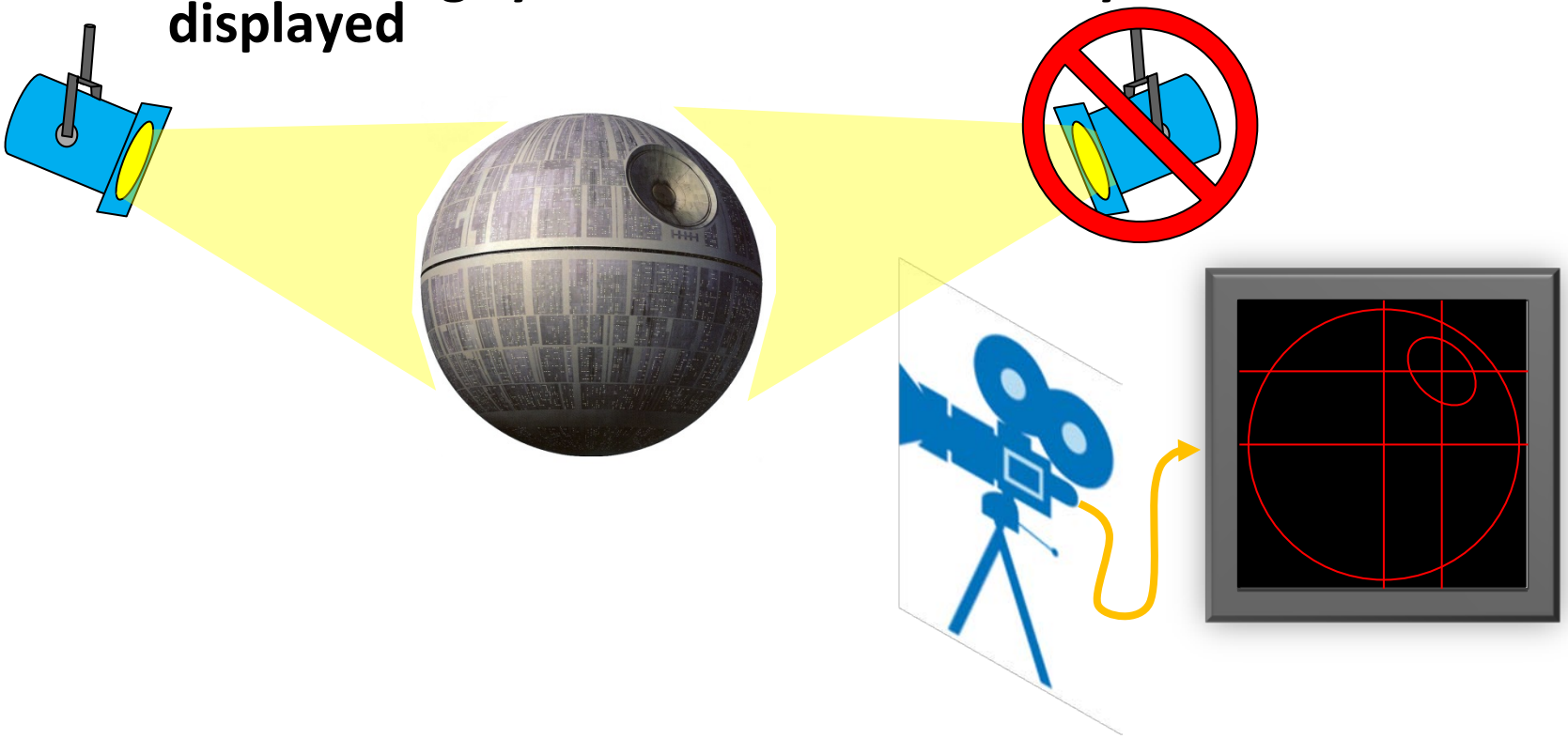
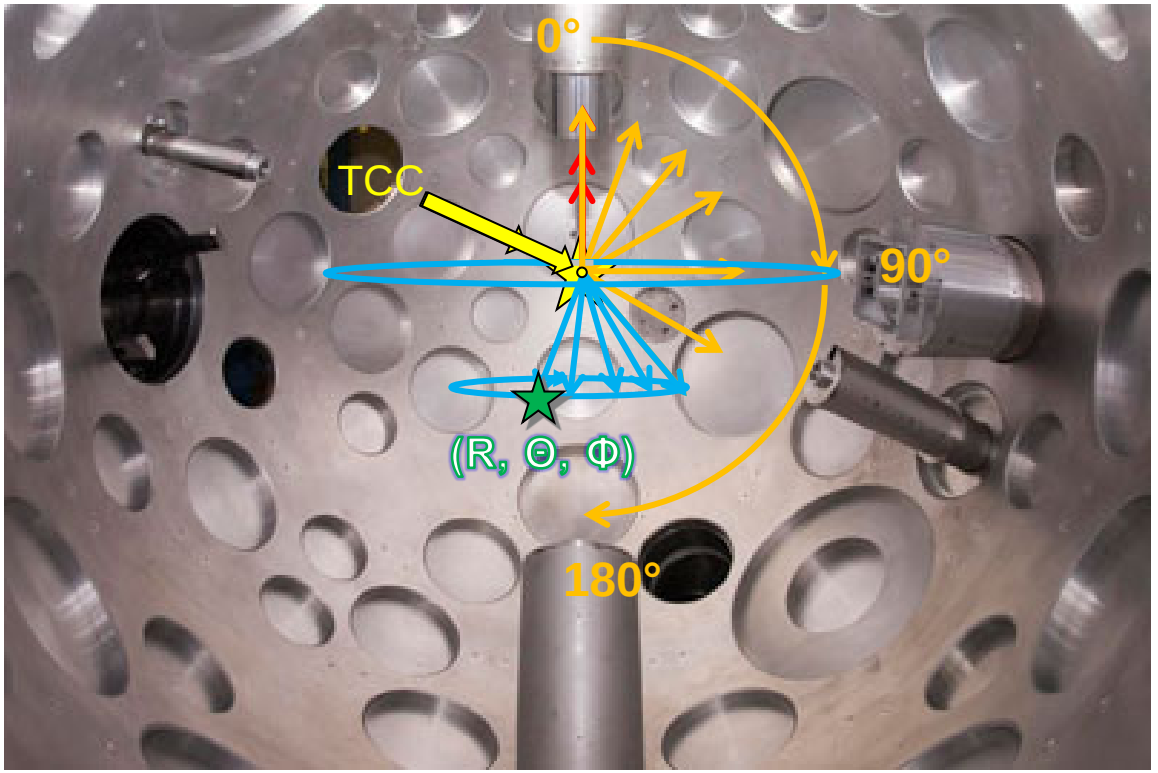
- **Could see surface detail if front sided illumination was available**
- **Our viewing systems are backlit – only a silhouette is displayed**



Locations in the Target Chambers are described by spherical coordinates

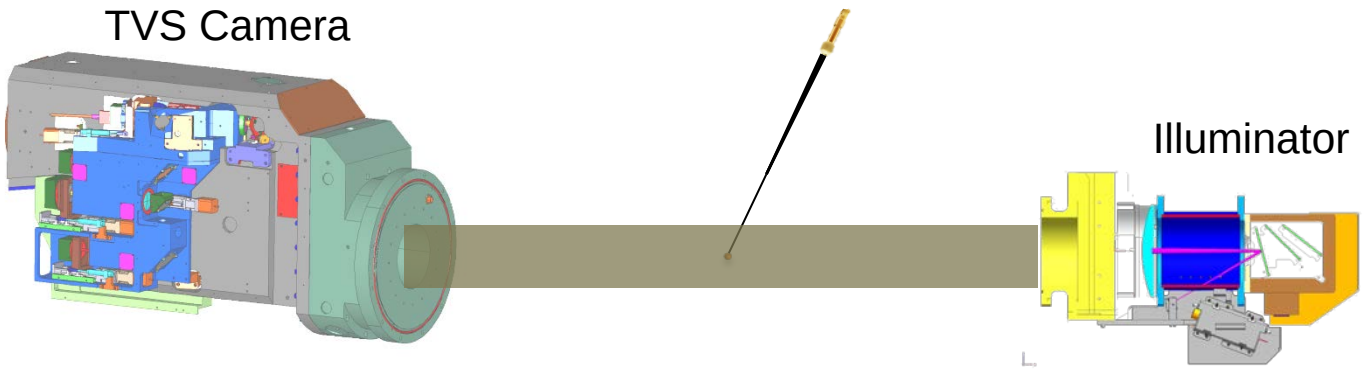
- Three coordinates
  - (R, Θ, Φ)
- Origin at Target Chamber Center (TCC)
- R = distance from TCC
- Θ – declination from straight up
  - Never >180° !
- Φ – azimuth (angle around the equator)
  - North = 0°
  - Increases CCW looking down on TC



Each (R, Θ, Φ) identifies a unique location in 3-D space

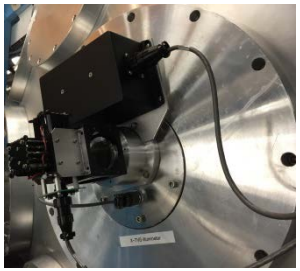
Each (R, Θ, Φ) maps to a unique X TVS / Y TVS reticle pair

Each OMEGA Target Viewing System (TVS) axis has 4 channels and on-shot capability



- Target is imaged by a reflective telescope
- Images are sent to 4 camera channels
- Each camera channel is filtered for its own illuminator color
- Each camera acquires only when its illuminator is firing
- All optics are outside TC vacuum except the vacuum window
- TVS cameras acquire images up until shot time
- Spatially combines the output pulses from 4 different color, sequentially firing LED's
- Supports independent control of illumination intensity for each camera channel
- Pulsed illumination lowers thermal load on the target
- LED's are fired at non-overlapping times to eliminate cross talk
- Output beam is collimated to ~50 mm diameter

EP Target Viewing System (TVS) has two channels but does not have on-shot capability



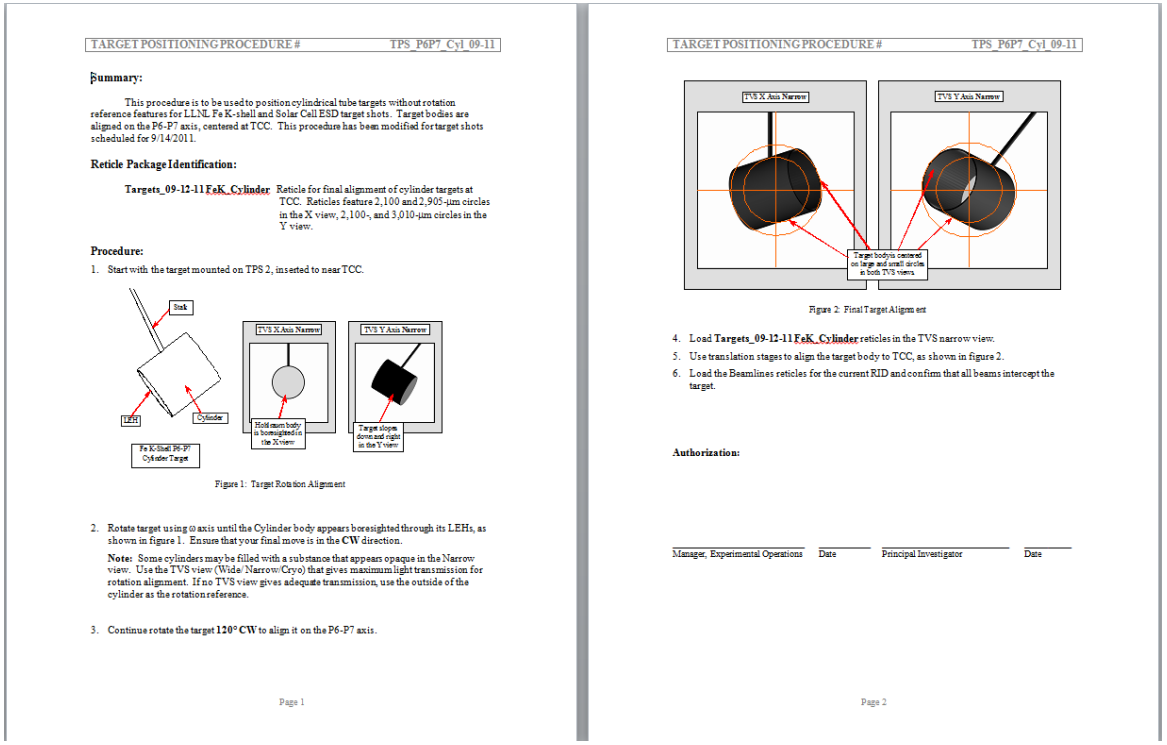
- Illuminators have 2 pulsed-LED's
- Imaging is by a refractive telescope
- 2 camera channels per axis
- Shutters must be closed before CHARGE to protect lenses near TCC

Target Alignment Protocol

1. **Target is designed with alignment features**
2. **Plan to align procedure is developed by Experimental Operations (XOPS) and the PI**
   - **Use VisRad model to communicate target specifics**
   - **Procedure (written by XOPS) is negotiated to meet requirements of LLE and the PI**
     - Each procedure has a unique name
     - Each procedure is used only once, although subsequent campaigns may use archived procedures as a basis
   - **Procedure is approved and countersigned by both the PI and LLE**
   - **Procedure name is added to SRF Target specification sheets by XOPS**
3. **Operators use the procedure to align the target**
4. **PI must approve final position of each target prior to shot**

Target positioning procedures meet the requirements of both the PI and the facility

- Unique for each target configuration
- Jointly developed by LLE and PI
- Published by LLE
- PI and LLE must sign off on each procedure
- Revised and reviewed for each shot day



TARGET POSITIONING PROCEDURE # TPS_P6P7_Cyl_09-11

Summary:

This procedure is to be used to position cylindrical tube targets without rotation reference features for LLNL Fe K-shell and Solar Cell ESD target shots. Target bodies are aligned on the P6-P7 axis, centered at TCC. This procedure has been modified for target shots scheduled for 9/14/2011.

Reticle Package Identification:

Targets_09-12-11FeK_Cylinder Reticle for final alignment of cylinder targets at TCC. Reticles feature 2,100 and 2,905-μm circles in the X view, 2,100-, and 3,010-μm circles in the Y view.

Procedure:

1. Start with the target mounted on TPS 2, inserted to near TCC.

Figure 1: Target Rotation Alignment

2. Rotate target using ω axis until the Cylinder body appears boresighted through its LEHs, as shown in figure 1. Ensure that your final move is in the **CW** direction.

   Note: Some cylinders may be filled with a substance that appears opaque in the Narrow view. Use the TVS view (Wide/Narrow/Cryo) that gives maximum light transmission for rotation alignment. If no TVS view gives adequate transmission, use the outside of the cylinder as the rotation reference.

3. Continue rotate the target **120° CW** to align it on the P6-P7 axis.

Page 1

TARGET POSITIONING PROCEDURE # TPS_P6P7_Cyl_09-11

Figure 2: Final Target Alignment

4. Load **Targets_09-12-11FeK_Cylinder** reticles in the TVS narrow view.
5. Use translation stages to align the target body to TCC, as shown in figure 2.
6. Load the Beamlines reticles for the current RID and confirm that all beams intercept the target.

Authorization:

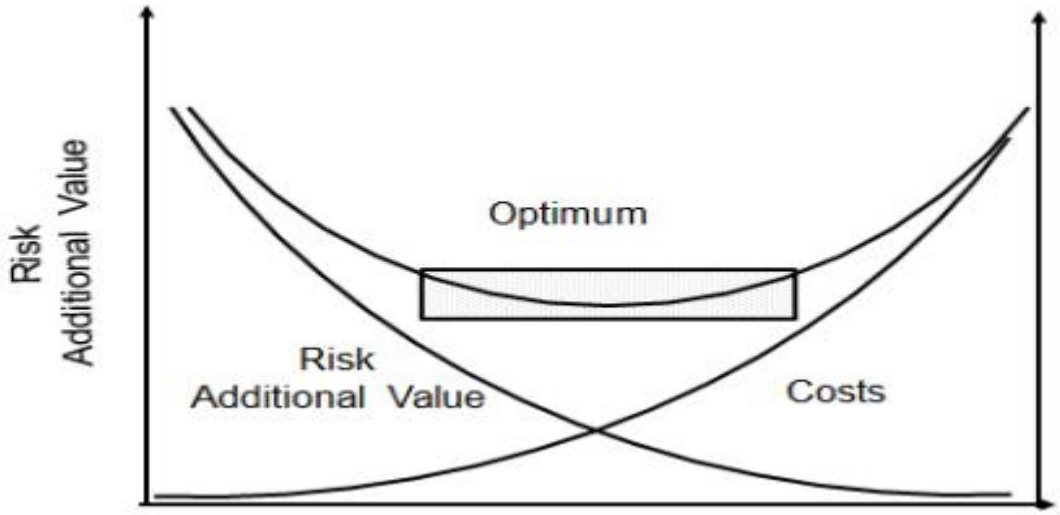
Manager, Experimental Operations Date Principal Investigator Date

Page 2

Target Positioning Deliverables

When	Principle Investigator	LLE (Experimental Operations)
> 2 weeks to shot day	• VisRad file • Other info on target location and geometry • Consult with LLE on alignment plan	• Consults with PI on target alignment method and features • Generate draft positioning procedure
2 days prior to shot day	Detailed Target Metrology data	Target Metrology Data Verification
1 day prior to shot day	Sign-off on positioning procedure	• Publish positioning procedure • Sign-off on positioning procedure • Assign procedures to shot in SRF • Generate TVS reticles • Brief crew on procedure
Day of Shot	Verify/approve positioning of each target	• Position each target • Verify / approve positioning of each target

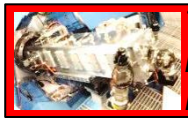
Your choice of target approval method is part of your strategy to balance shot rate and risk mitigation



Delegate

Witness final positon only

Witness all steps



XOPS operates and maintains a variety of infrastructure to support target diagnostic operation

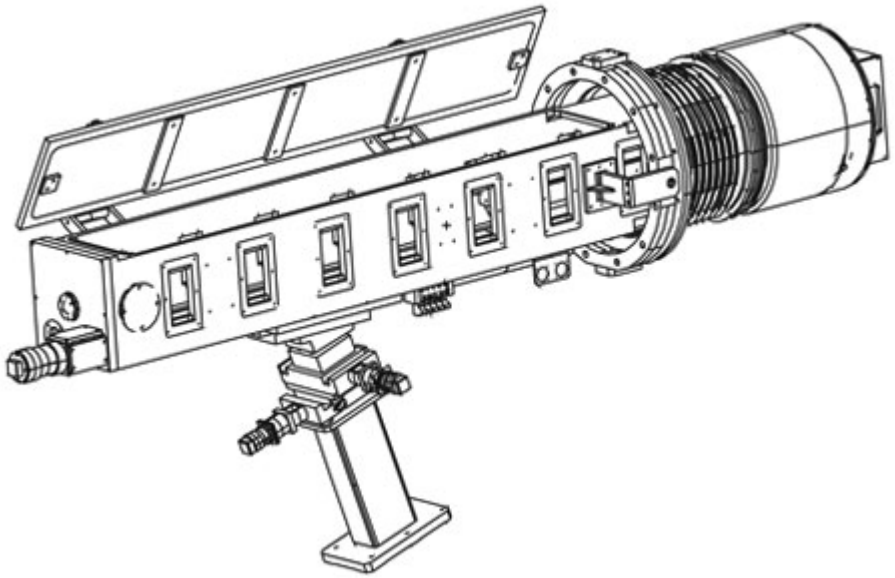
UR LLE

- Mechanical support
  - Target Chamber ports
  - Ten Inch Manipulators
  - Target Area Structures
- Controls, cooling systems, and power management
- Triggers and timing monitor systems

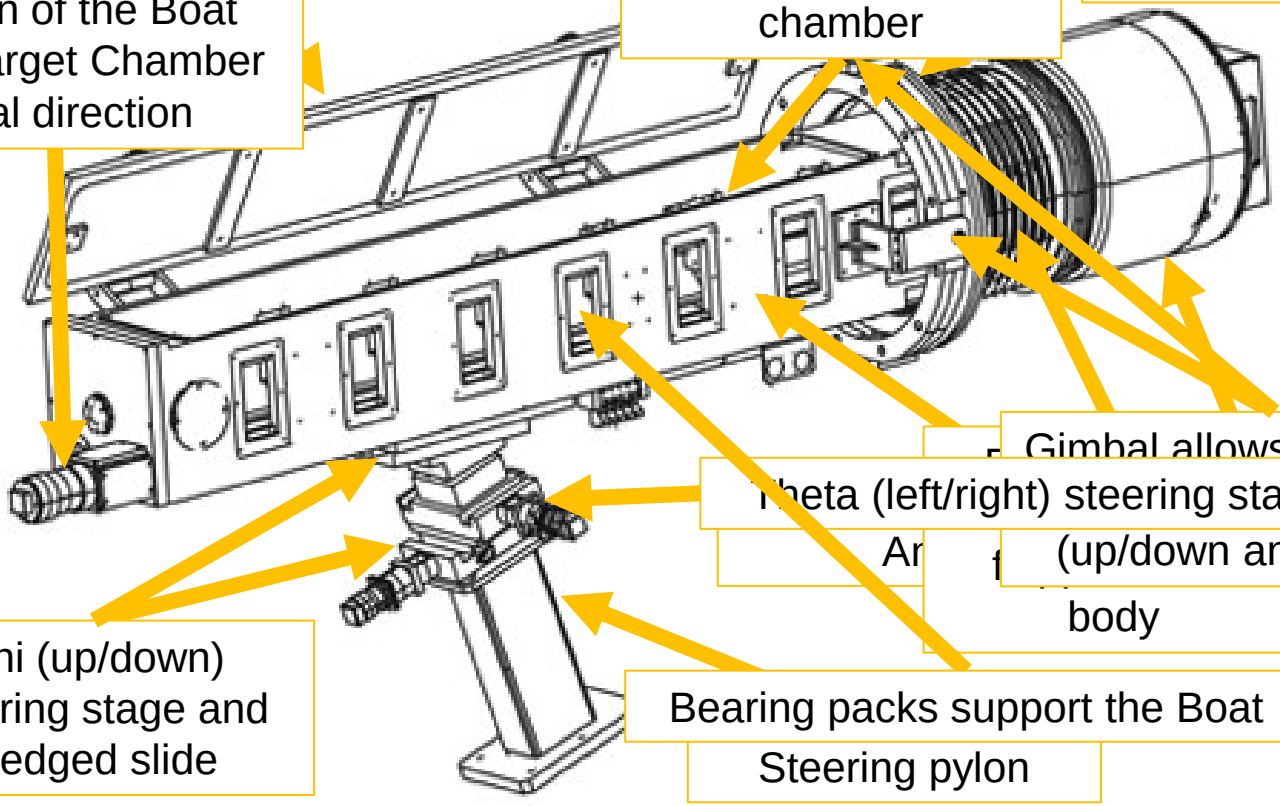
The Ten Inch Manipulator (TIM) is host to over 100 different currently operational diagnostic types

A TIM can provide:

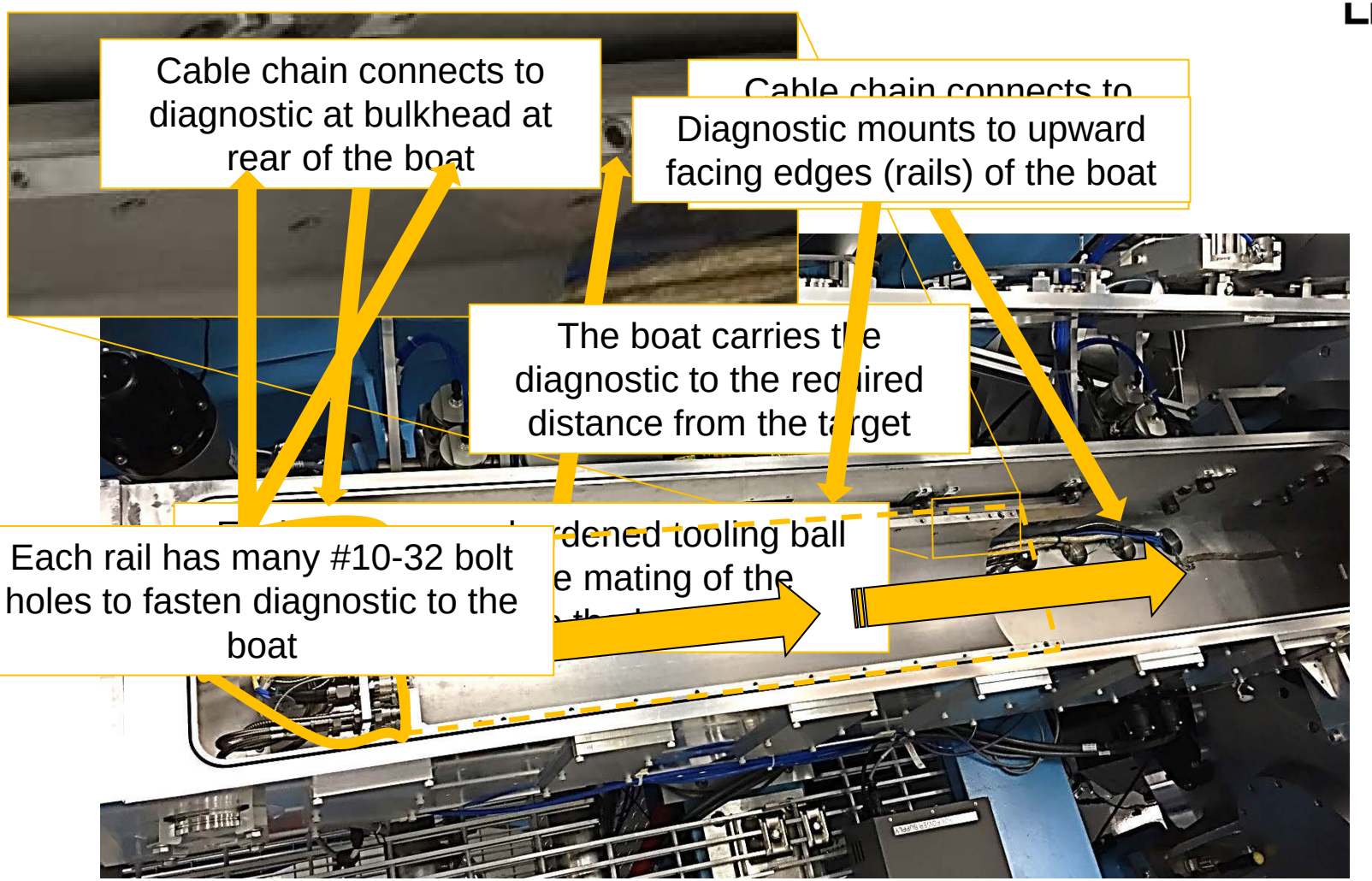
- Mechanical support
- Three axis alignment to the target
- Antechamber (airlock) to the Target Chamber
- Electrical power
- Trigger
- Timing Monitor
- Timing fiducial
- Communications
- Control
- Cooling



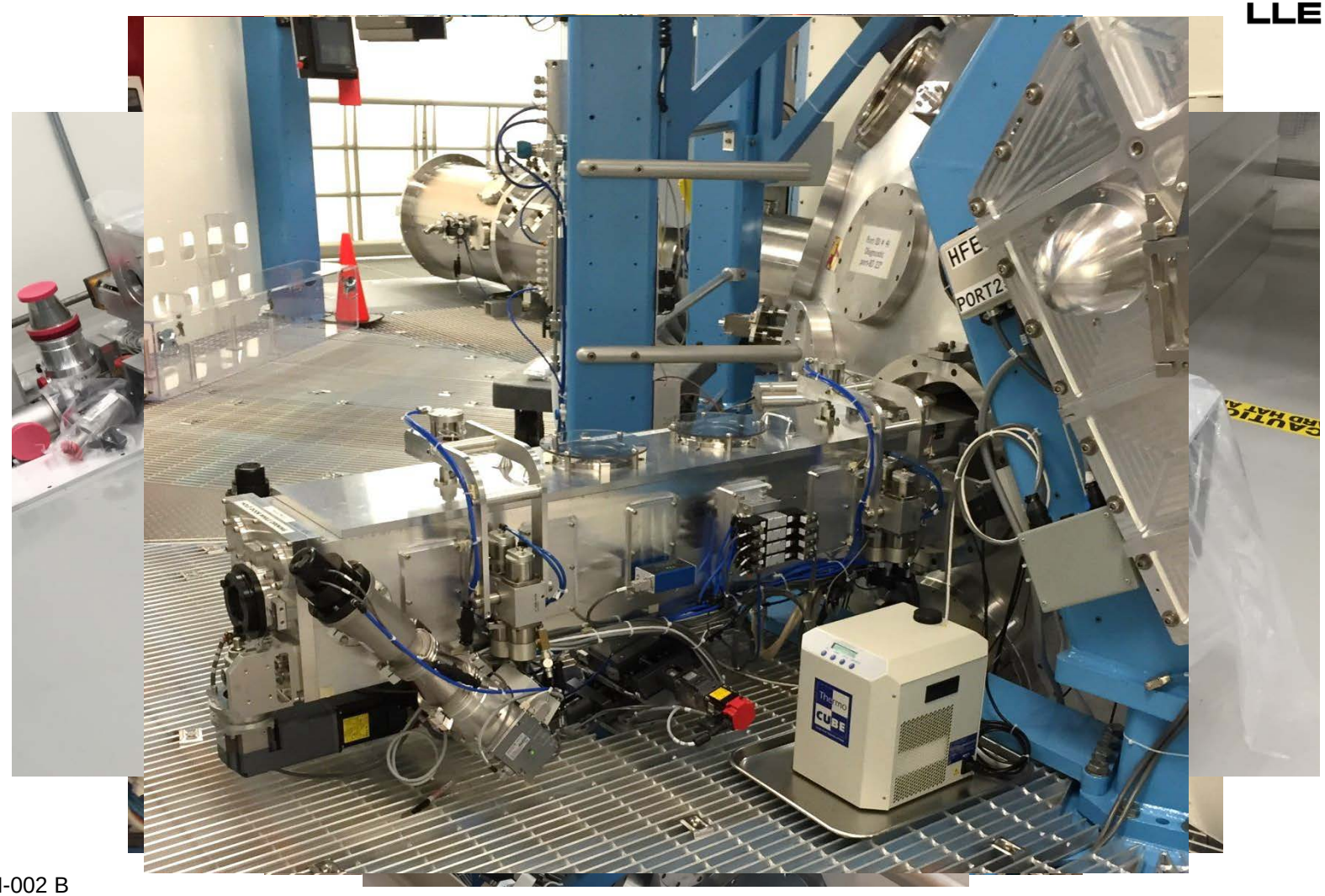
Major components of the TIM



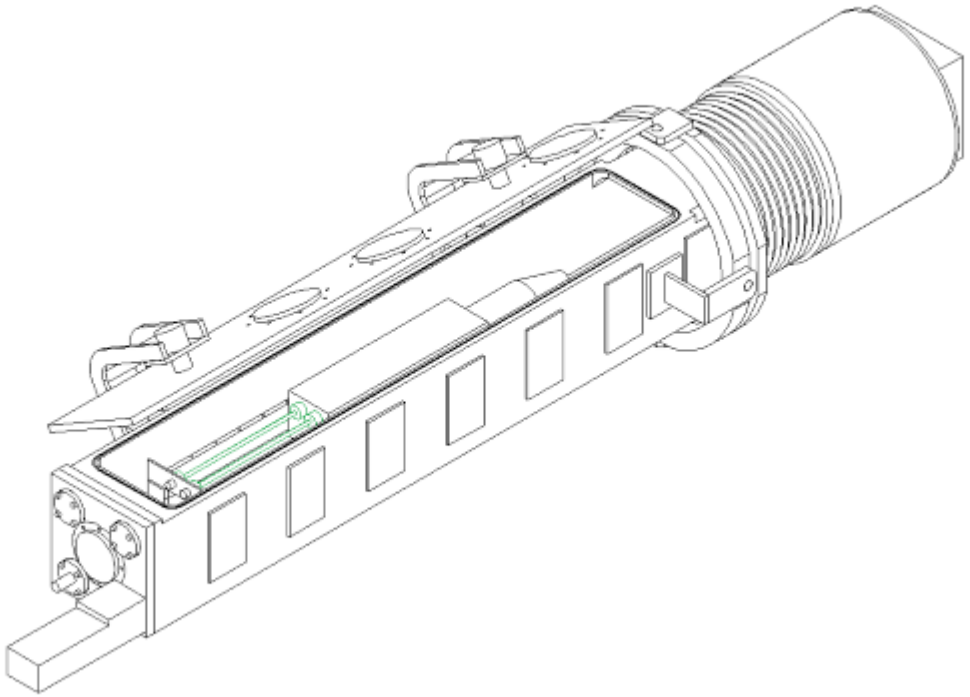
Diagnostics mount to the TIM boat, which provides utilities and mechanical support



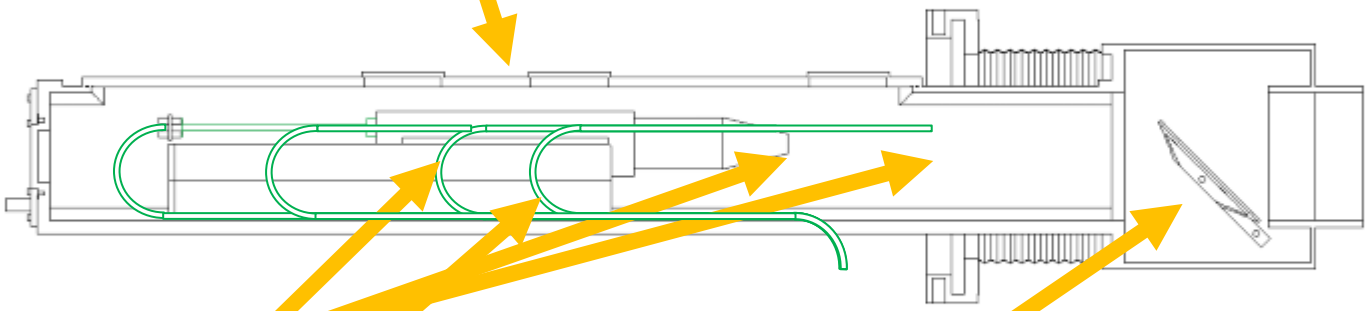
Six TIM's are deployed on OMEGA (1-6) and five TIM's (10-14) are deployed on EP



The diagnostic loads into the TIM boat through the top door while the Target Chamber is at vacuum



The TIM antechamber is pumped to TC pressure and the T-axis is used to position the diagnostic at the correct distance to TCC



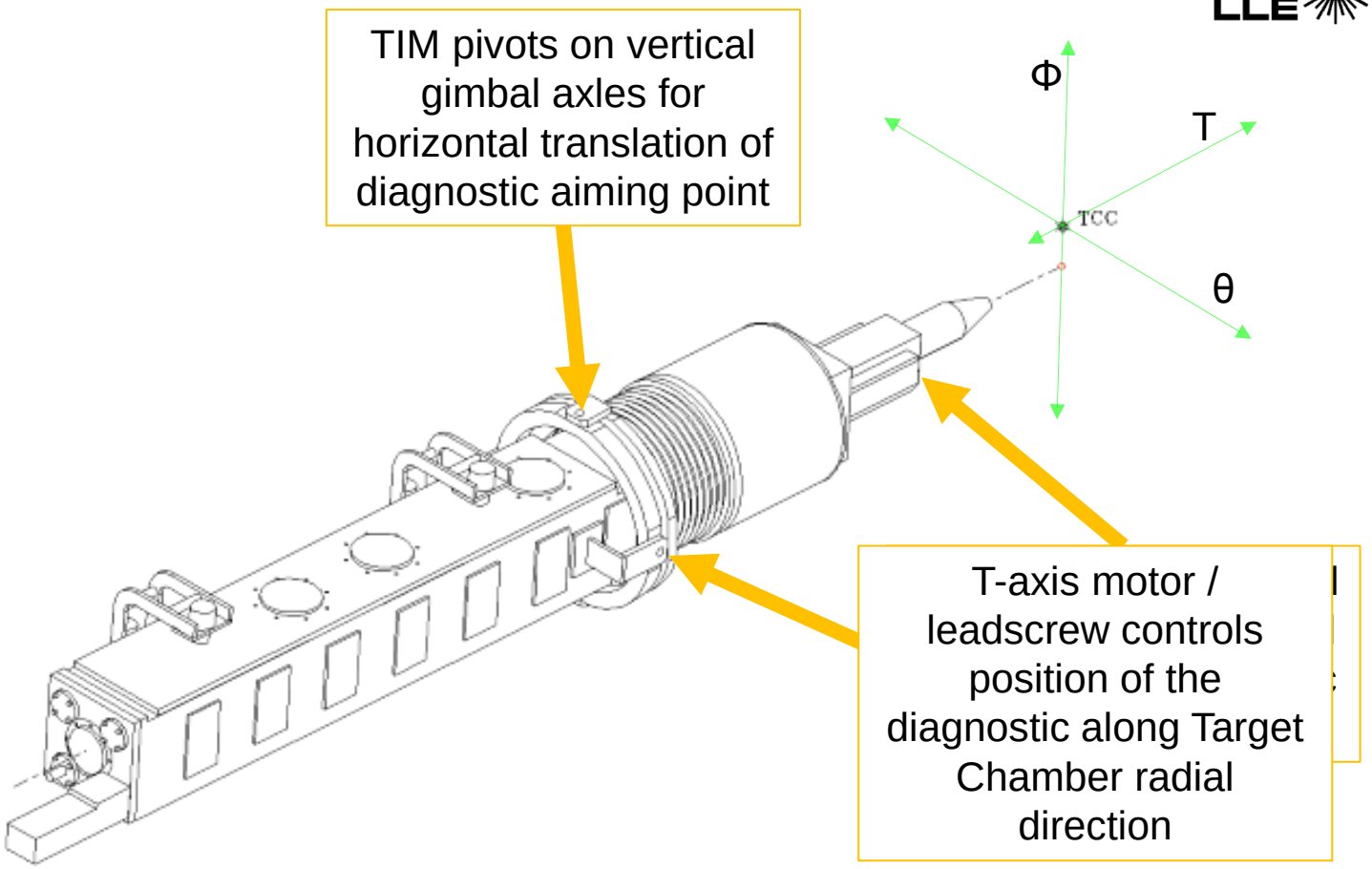
TIM antechamber is pumped to same pressure as the Target Chamber

T-axis drive moves diagnostic to

Diagnostic is always connected to outside world via cable chain

Flapper valve opens the TIM antechamber to the Target Chamber

The diagnostics is aligned using the TIM's three steering axes



Diagnostic Deliverables

When	Principle Investigator	LLE (Experimental Operations)
> 3 months to shot day	• Declare any new diagnostics or modifications to existing diagnostics • Create and maintain accurate SRFs for preparation	• Track and support qualification of new diagnostics • Review SRFs and consult on instrument / experiment plan
0-1 week prior to shot	• Final review of plan at 2 week and 1 week reviews • All SRFs accurate and complete • SRF auditor checks verified	• Final review of SRFs, auditor, and overall plan • Make logistics arrangements • Coordinate Instrument Specialists, PIs and facility assets
Day of Shot	• Consult with LLE on diagnostic details as necessary • Review data and advise changes	• Operate diagnostics • Make requested changes to diagnostic sections of SRF • Implement requested changes to diagnostics • Review data, consult with PI, implement changes • Deliver physical data to PI as necessary

The Shot Request Form (SRF) is your contract with Experimental Operations Group

- **Feasibility assessment and long term preparations are based on SRF's submitted at the 3-month proposal stage**
- **Final preparation for shots is performed to meet requirements set in final SRF's as available at 00:00 on the Friday prior to your shot week**
- **Unintended specifications on SRF's are likely to be propagated to the actual shot implementation**

Complete and accurate Shot Request Forms are necessary to efficient conduct of shot operations

Conflicts are identified by evaluating SRF data using the SRF Auditor and the Shared Diagnostic Usage Report

OMEGA SRF Audit Results (Help)

Report for 13-Mar-2014

For RID 46830

pien XRFC-5 is selected for use in the EP facility on the same day that XRFC-5 is selected for use in the Omega facility.

???? Secondary Diagnostic XRFC-5 does not have a setup sheet.

For RID 46832

???? XRFC-5 in TIM 6 may interfere with off axis beams 57, 62

For RID 46847

No errors were detected.

Omega/EP Shared (conflicting) Diagnostic Usage report from 10-Mar-2014 to 14-Mar-2014

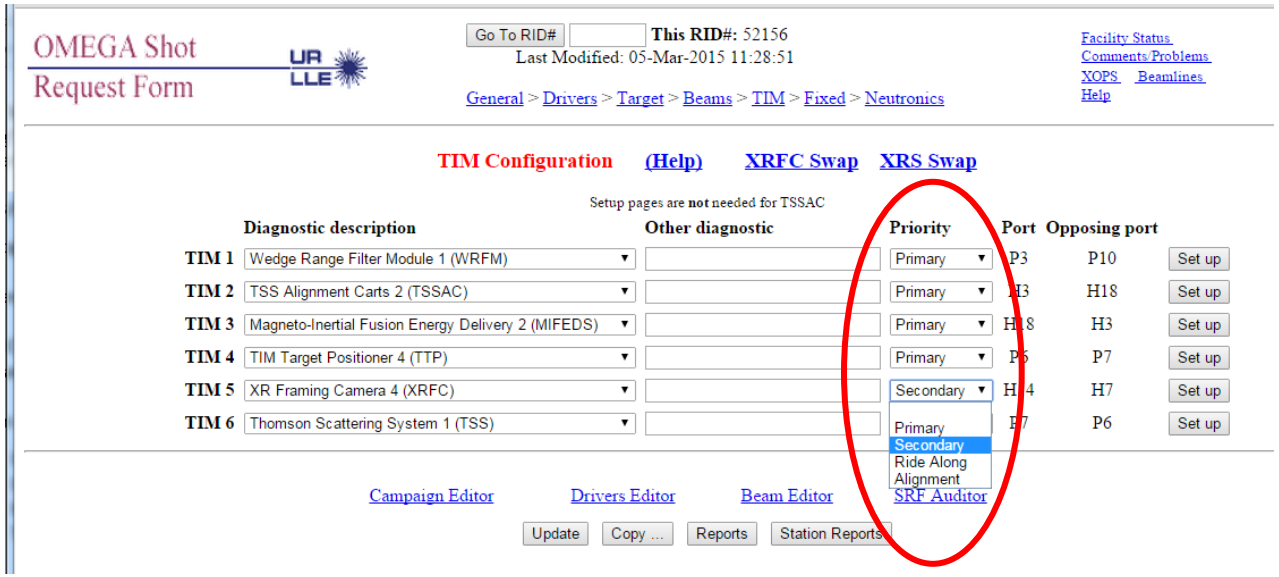
Generated Fri Jan 10 10:10:10 2014

Key
- Direct Conflict
- Used in EP after usage in Omega
- Used in EP the week after usage in Omega
- To be used in Omega after usage in EP

Date	OMEGA	EP
11-Mar-2014	XRS-2 (CRYO shot) XRS-2 (ISE)	XRFC-3 (GatlingGun-14A) XRFC-5 (GatlingGun-14A) uDMX-1 (GatlingGun-14A)
12-Mar-2014	ASBO_tel-REFR (XRDEOS-14C) PXRDIP-1 (XRDEOS-14C) XRS-1 (XRDEOS-14C)	SSC-A (MAGLIFEP-14A) XRFC-1 (MAGLIFEP-14A)
13-Mar-2014	OATEL-1 (LiDEOS_14B) XRFC-4 (LiDEOS_14B) XRFC-5 (LiDEOS_14B)	HERIE/BMXS-1 (GatlingGun-13A) XRFC-3 (GatlingGun-13A) XRFC-5 (GatlingGun-13A) uDMX-1 (GatlingGun-13A)

- **The SRF Auditor Checks for Global inconsistencies**
- **The Shared Diagnostic Usage Report shows request conflicts for diagnostics that are used in both OMEGA and OMEGA EP**

Prioritizing diagnostics (primary, secondary, or ride-along) is an important element in your strategy to maximize your results



Priority	Fault at Start of Charge	Fault during Charge
Primary	Hold until operational	Abort shot
Secondary	Hold until operational	Continue shot
Ride-Along	Continue shot	Continue shot
Alignment	N/A	N/A

The Experimental System Operator (ESO) is your interface to Omega Experimental Systems on shot day

- Target alignment
- Diagnostic operations
- Changes to diagnostic sections of SRF
- Implementation of changes to diagnostics

On Shot Day

- **Clear lines of communication are necessary**
  - **Establish a single point of contact from the scientific group to communicate diagnostic changes to the Experimental System Operator (ESO)**
  - **Insist on a read-back for verification of all verbal instructions to the ESO**
  - **Use written instructions for diagnostic changes when possible**
  - **All diagnostics SRF changes are performed at your request by the ESO**
  - **All target SRF changes are performed at your request by the Shot Director**
- **You must be available in the control room immediately prior to the shot**
- **Good planning and communication will improve our results**