

GLAST Large Area Telescope:

MGSE Integration Readiness Status

Two Tower Operations

Eric Gawehn

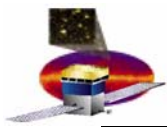
SU-SLAC

LAT I&T MGSE Dept. Manager

egawehn@slac.stanford.edu

650 – 926 – 3622 Office

650 – 796 – 2576 Cell



Agenda, MGSE Status

- **Two Tower Integration Options / Constraints**
- **Compliance to EWR 127.1 and SLAC Seismic Requirements**
 - **List of Single Failure Point (SFP) Items**
 - **SFP Risk Mitigation Methodology**
- **Drawing Maturity / Release Status**
 - **At Risk Tasks**
- **Hardware Build Status, Item by Item**
- **Schedule**

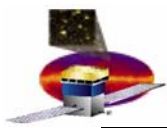


Two Tower Integration Options / Constraints

- **Two Towers in Flight Grid**
 - **Requires Proof Tested GPR and GPR to Grid Interface Brackets**
 - **Requires Proof Tested 4x4 Integration Stand**
 - **Requires Proof Test Weights and Lift Fixture to Attach Weights**
 - **At Least One PAP Should be Functional**

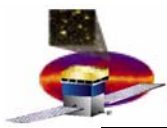
- **Two Towers in 1x4 Grid**
 - **Requires Proof Tested 1x4 Lift Fixture**
 - **Requires Proof Tested 1x4 Integration Stand (Complete)**
 - **Requires Update Design and Machining Ops to 1x4**

- **Two Towers in Single Bays, Side by Side**
 - **Requires Two TKR Interface Plates**
 - **Requires Increased Distance between Towers (~ 3" !)**



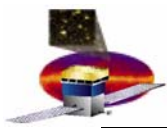
Compliance to EWR 127.1 & SLAC Seismics

- **All LAT MGSE is in complete compliance to EWR 127.1**
 - **Thorough, but Preliminary, Stress Analysis Results**
 - **Factor of Safety against yield > 3 X max design limit load**
 - **Factor of Safety against Ultimate > 5 X max design limit load**
 - **Stress Analysis Final Report Completion ~ July 16, 2004**
- **All LAT MGSE is in complete compliance to SLAC Seismic Requirements**
 - **Requires that 4x4 and 1x4 Integration Stands and Metrology Bay be bolted to the floor**
 - **Final design of hold down brackets in review by SLAC Civil Engineering**
 - **16 Man Hour effort began last Friday, June 18, 2004**
 - **No issues expected (earlier bracket design was approved)**



Single Failure Point Items

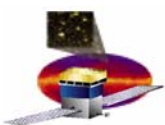
- **Center Lift Posts for 1x4 and 4x4 Z-Axis Vertical Lift Fixtures**
- **Threaded Interface Rod that Ties Crane Scale to Crane Load Block**
 - **Factor of Safety against Ultimate ~ 15.8 X**
- **Support Shafts for 4x4 and 1x4 Integration Stands**
 - **1x4 Support Shafts Have Passed Risk Mitigation Criteria**
- **Support Shaft for CAL Inversion Stand**
 - **Needs Proof Test; No issues foreseen**
- **Risk Mitigation Methodology**
 - **All SFP items are made of 15-5 PH Corrosion Resisting Steel, Cond 1100**
 - **All SFP items will be Dye Penetrant Inspected Before and After a ≥ 2 X Max Design Limit Load (MDLL) Proof Test**
 - **Process worked out for EM Series Hardware with “No Observable Flaws or Cracks” Before, or After, ≥ 2 X MDLL Proof Test**
 - **Minimum detectable flaw size was, and will be, 0.001”**



LAT MGSE Design Drawing Status

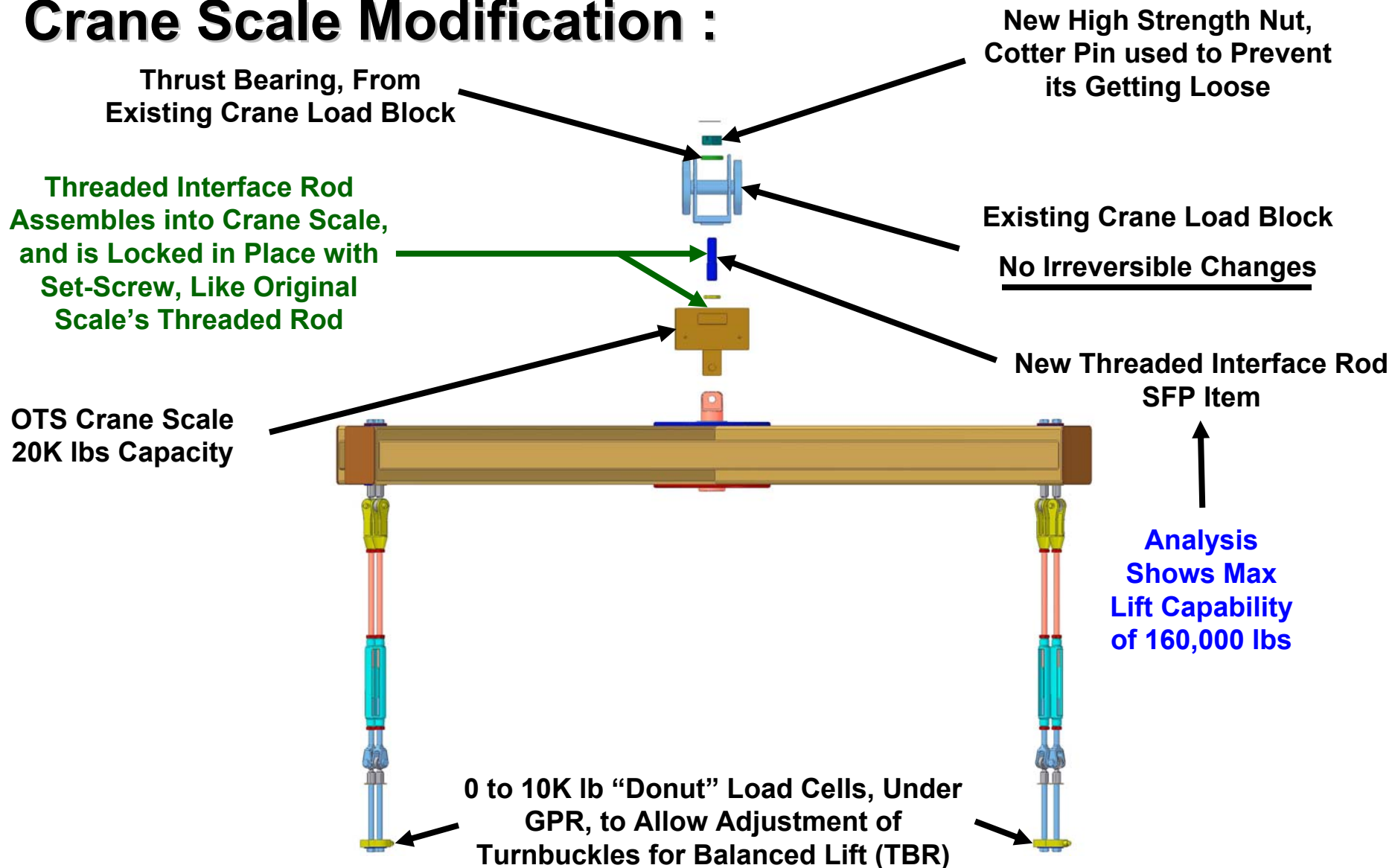
- **Total Drawing Sheet Count ~ 282***
 - **141 Drawing Sheets Released**
 - **94 drawing Sheets in Release Cycle by June 23**
 - **43 of these in “Pre-Release” Review**
 - **18 Drawing Sheets completed last year ready for release**
 - **For CAL Alignment Tool and Sight Gauges**
 - **253 Drawing Sheets virtually Released ($141 + 94 + 18 = 253$)**
 - **29 Need to be worked, but far along in most cases**
 - **1x4 Grid Update Drawing Sheet Count TBD***

*** Note: TKR Interface Plate and 1x4 Grid Update Started on June 21, 2004: Sheet Count can be estimated in about a week. Thanks to Rob Black, A Real Team Player !**



4x4 Z-Axis Vertical Lift Fixture and ...

Crane Scale Modification :





LAT - GPR Lift Point Detail

15" Remaining Lift Range With
4x4 Lift Fixture attached to LAT in
Integration Stand

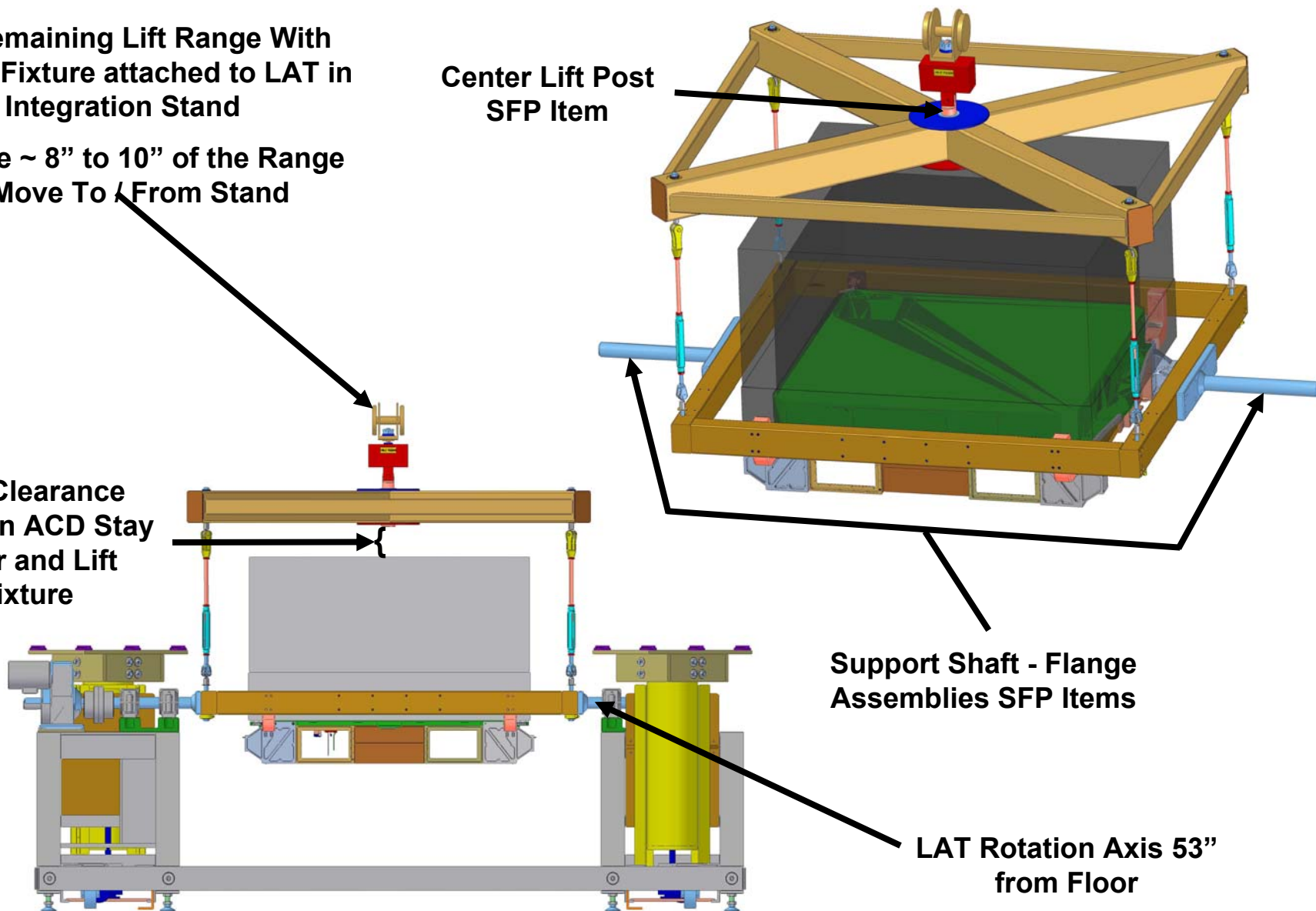
Will Use ~ 8" to 10" of the Range
to Move To / From Stand

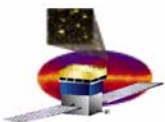
Center Lift Post
SFP Item

7.6" Clearance
Between ACD Stay
Clear and Lift
Fixture

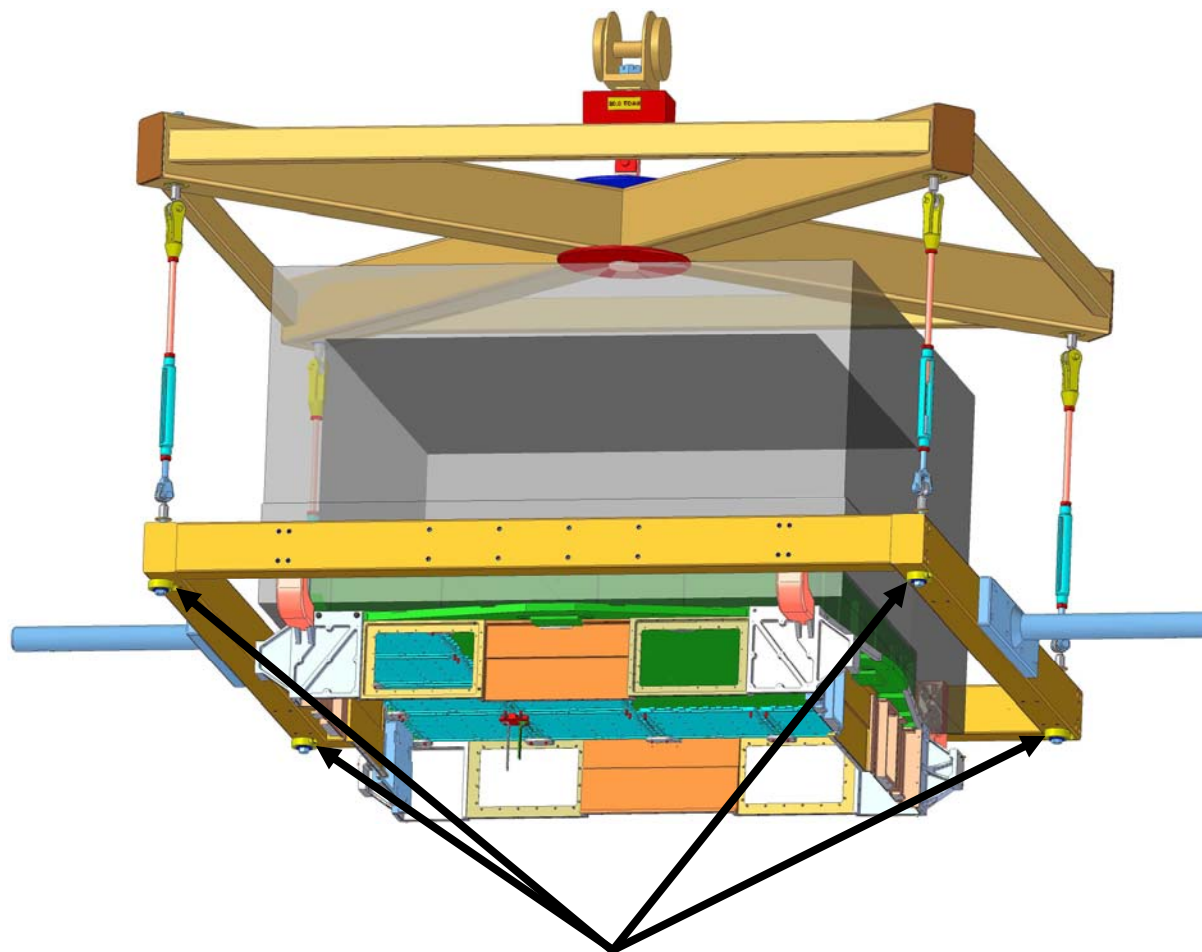
Support Shaft - Flange
Assemblies SFP Items

LAT Rotation Axis 53"
from Floor



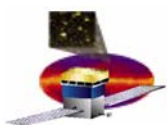


4x4 Z-Axis Vertical Lift Fixture



0 to 10K lb “Donut” Load Cells, Under
GPR, 4 Places, to Allow Adjustment of
Turn-Buckles for Balanced Lift (TBR)

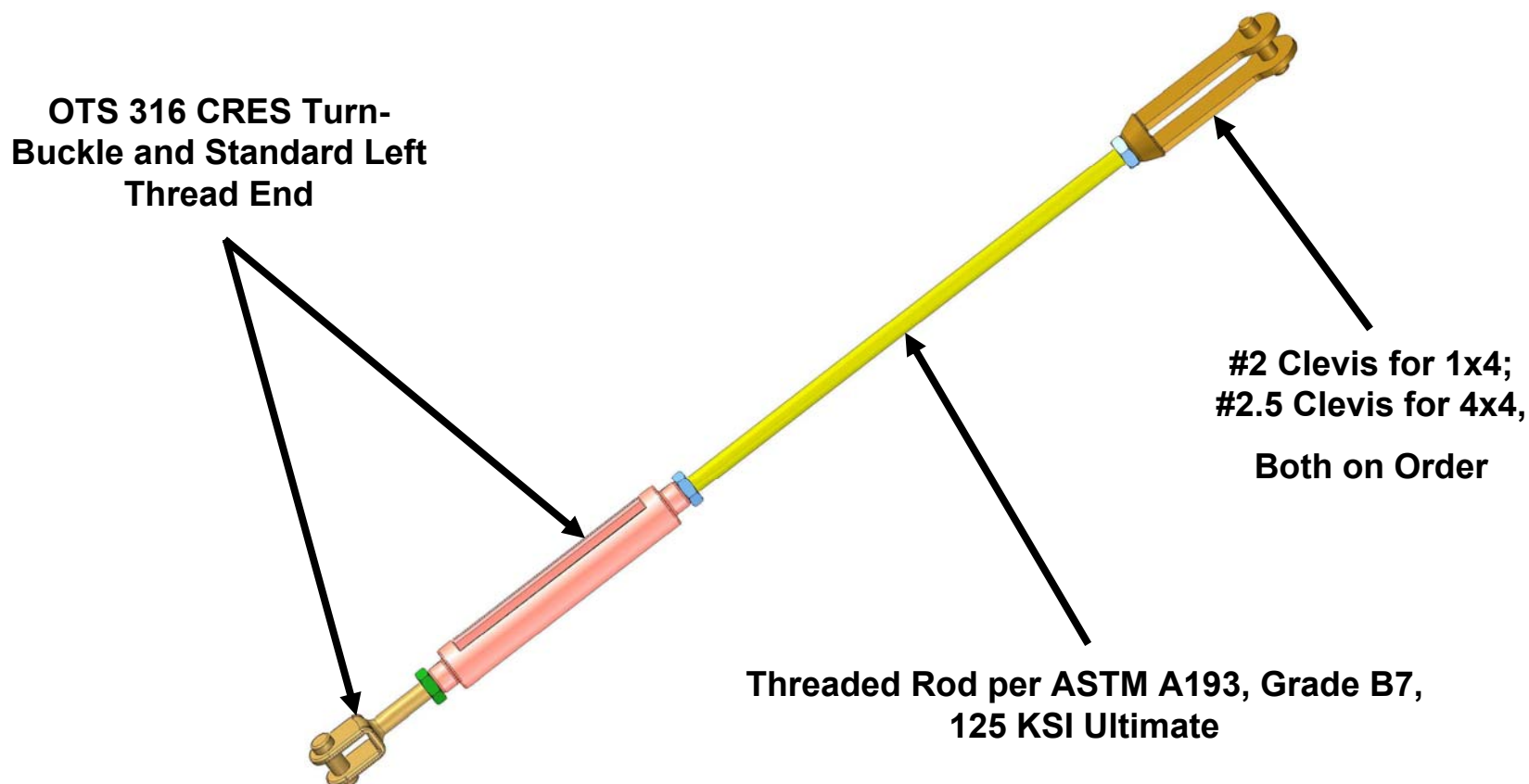
Fasteners for Top and Bottom Attach due by June 30, 2004

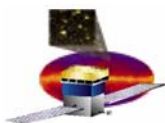


Lift Fixture Turn-Buckle Assemblies

3/4 - 10 UNC – 2A, 2B Threads for 4x4 Lift Fixture (5,200 lb Rating Each)

1/2 - 13 UNC – 2A, 2B Threads for 1x4 Lift Fixture (2,200 lb Rating Each)

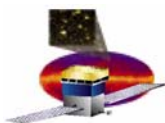




4x4 Lift Fixture Proof Test Weight Determination

MGSE Break Down:

Support Shaft – Flange Assemblies @ 120 lbs each	240 lbs
Bearings @ 40 lbs each x 4	160 lbs
Flex Coupling @ 30 lbs each x 2 for Balance	93 lbs
GPR	833 lbs
GPR to Grid Brackets @ 13.2 lbs each	53 lbs
Fasteners and Shaft Collars ~	30 lbs
Primary T-Vac Tie Beam @ 141 lbs each	282 lbs
Secondary T-Vac Tie Beam @ 48 lbs each	96 lbs
 Total MGSE to be Supported by Lift Fixture	 1,787 lbs



4x4 Lift Fixture Proof Test Weight Determination

Continued,

Total (MGSE to be Supported by Lift Fixture)	1,787 lbs
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Max LAT (@ 3,000 Kg)	6,614 lbs
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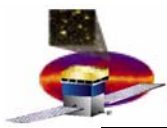
Total	8,401 lbs
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Total of Proof Test Weights = 2 x 8,401 lbs =	16,802 lbs*
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Given 3 Weights, Stacked and Bolted Together to Make Total,

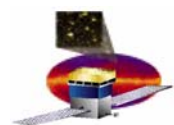
Each Weight = $16,802 \div 3 \sim 5,600$ lbs

*** Note: This Proof Test Methodology results in testing GPR to Grid Brackets to 2.5 x MDLL**



Crane Capacity Margin

Total (MGSE to be Supported by Lift Fixture)	1,787 lbs
Max LAT @ 3,000 kg (Based on Jan. 2004 Mass Properties Report)	6,614 lbs
Total	8,401 lbs
Estimated Weight of 4x4 Lift Fixture Assembly (With Turn-Buckle, Clevis and Tension Rod Assemblies)	1,460 lbs
Total of Lift with 4x4 Lift Fixture	9,861 lbs ✓
Crane Capacity Margin = 10,000 lbs – 9,861 = 139 lbs ✓	



4x4 Lift Fixture Proof Test Weight 1

6" Wide by 8" High by 3/8" Wall Tubing; Due to SLAC by June 30, 2004

Turn-Buckle Attach Features Added to Lift Proof Test Weights

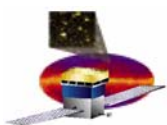
Proof Test Weights, 61" x 77.5" x 4" Thick 1019 Steel, are ~ 5,600 lbs each

Support Shaft – Flange Assemblies Not Shown for Clarity

Clevis Attach is 1" from Bottom Surface of Weight

Cg Along Z of Weight No. 1 is 4.7" Below Rotation Axis

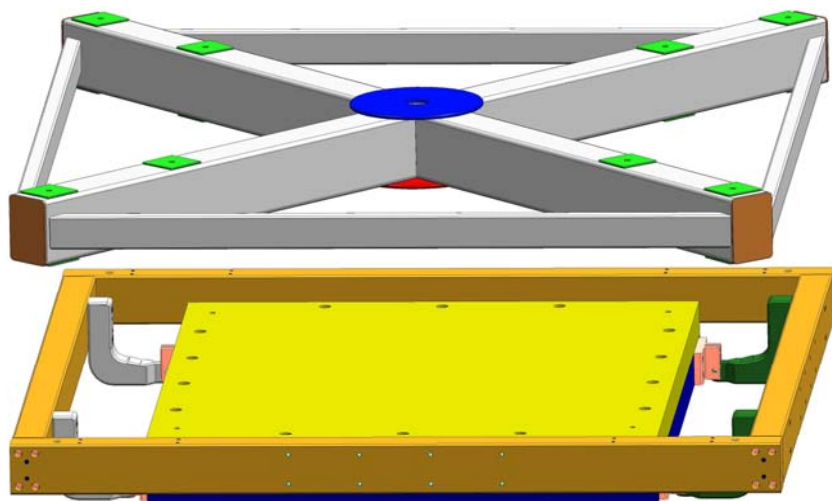
Moment: 4.7" x 5,600 lbs = 26,320 in lbs : **Do Not Attempt to Rotate on Integration Stand**



4x4 Lift Fixture Proof Test Weight 1, 2 and 1, 2, & 3

Stack Weight No. 2 on Top of
Weight No. 1

$$2 \times 5,600 \text{ lbs} = 11,200 \text{ lbs}$$



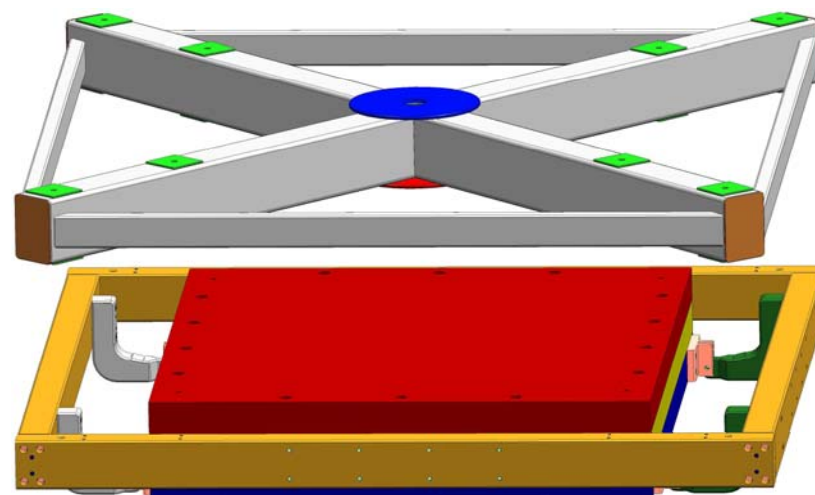
Moment Calc with 2nd Weight Stack:

$$(4.7'' + 0.7'') \times 5,600 \text{ lbs} = 30,240 \text{ in lbs}$$

Do Not Rotate

Stack Weight No. 3 on Top of Weights 1 & 2

$$3 \times 5,600 \text{ lbs} = 16,800 \text{ lbs}$$

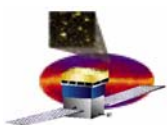


Moment Calc with 3rd Weight Stack:

$$(4.7'' + 0.7'' - 3.3'') \times 5,600 \text{ lbs} = 11,760 \text{ in lbs}$$

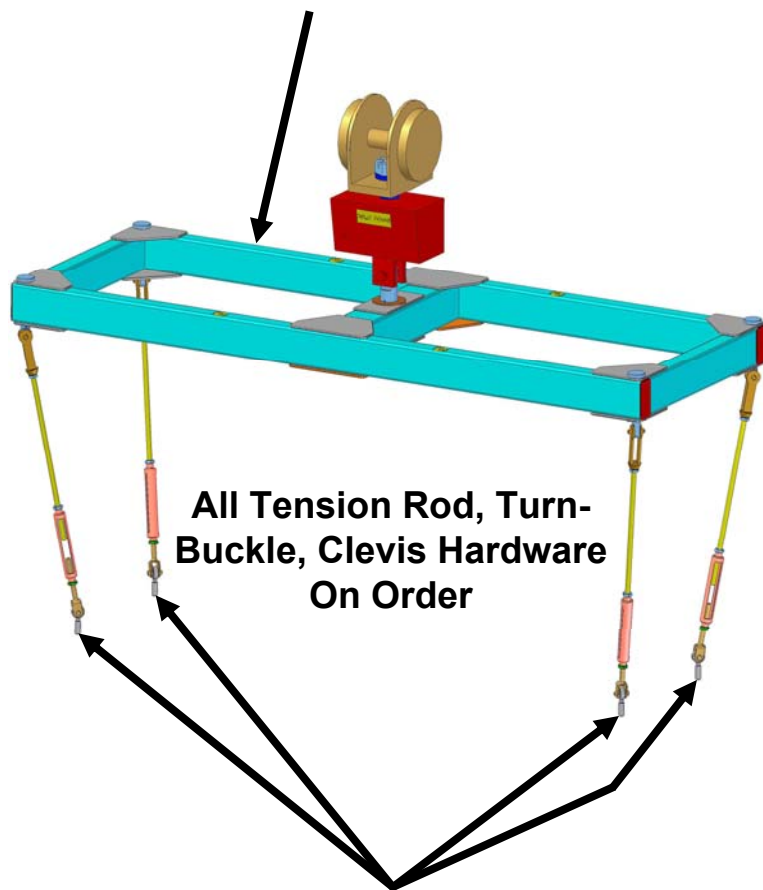
Rotate on Integration Stand with 3 Stack Weight

Capability of Rotation Drive is > 22,000 in lbs



1x4 Lift Fixture Detail

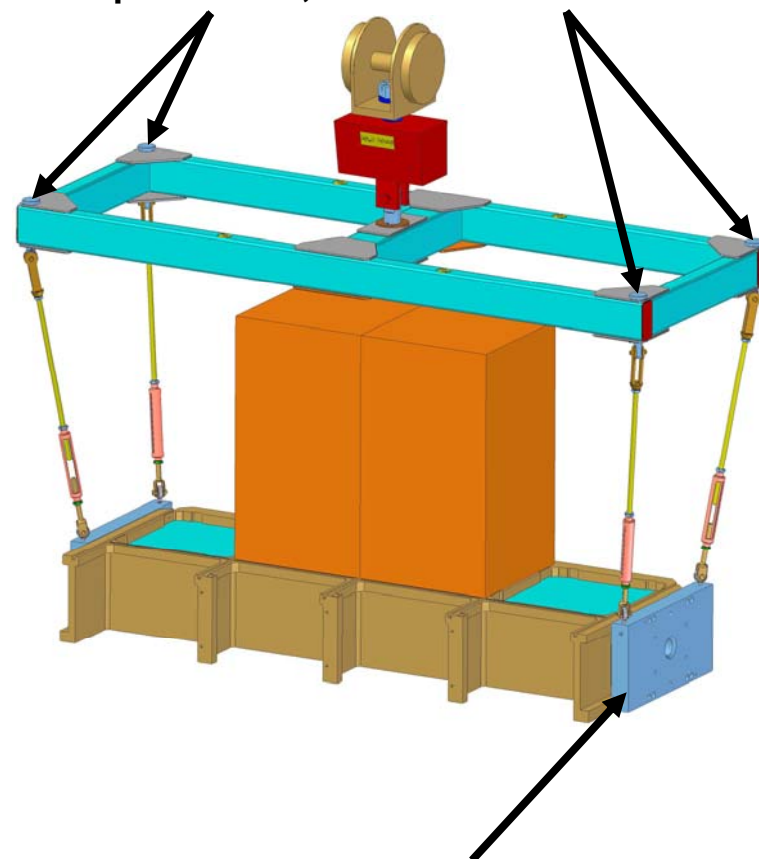
**1x4 Lift Fixture Rated for Fully Populated
1x4 Grid**



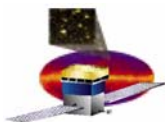
**All Tension Rod, Turn-
Buckle, Clevis Hardware
On Order**

**1/2 - 20 UNF – 2A Spherical Tie Rods
In House**

**Solid Shaft Tie Rods Required to Meet Structural
Requirements; Raw Materials in House**

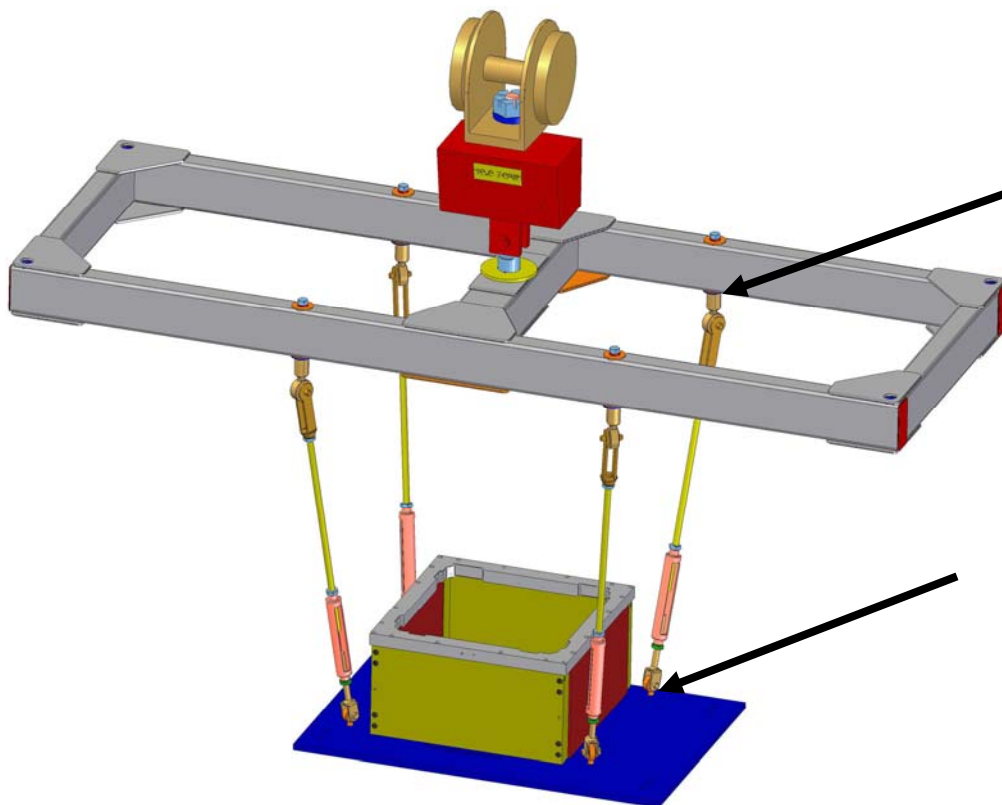


**1x4 Grid to Support Shaft – Flange
Interface Plates are Ready for Match
Location**

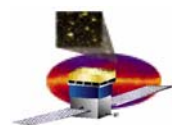


EM Single Bay Lift Detail

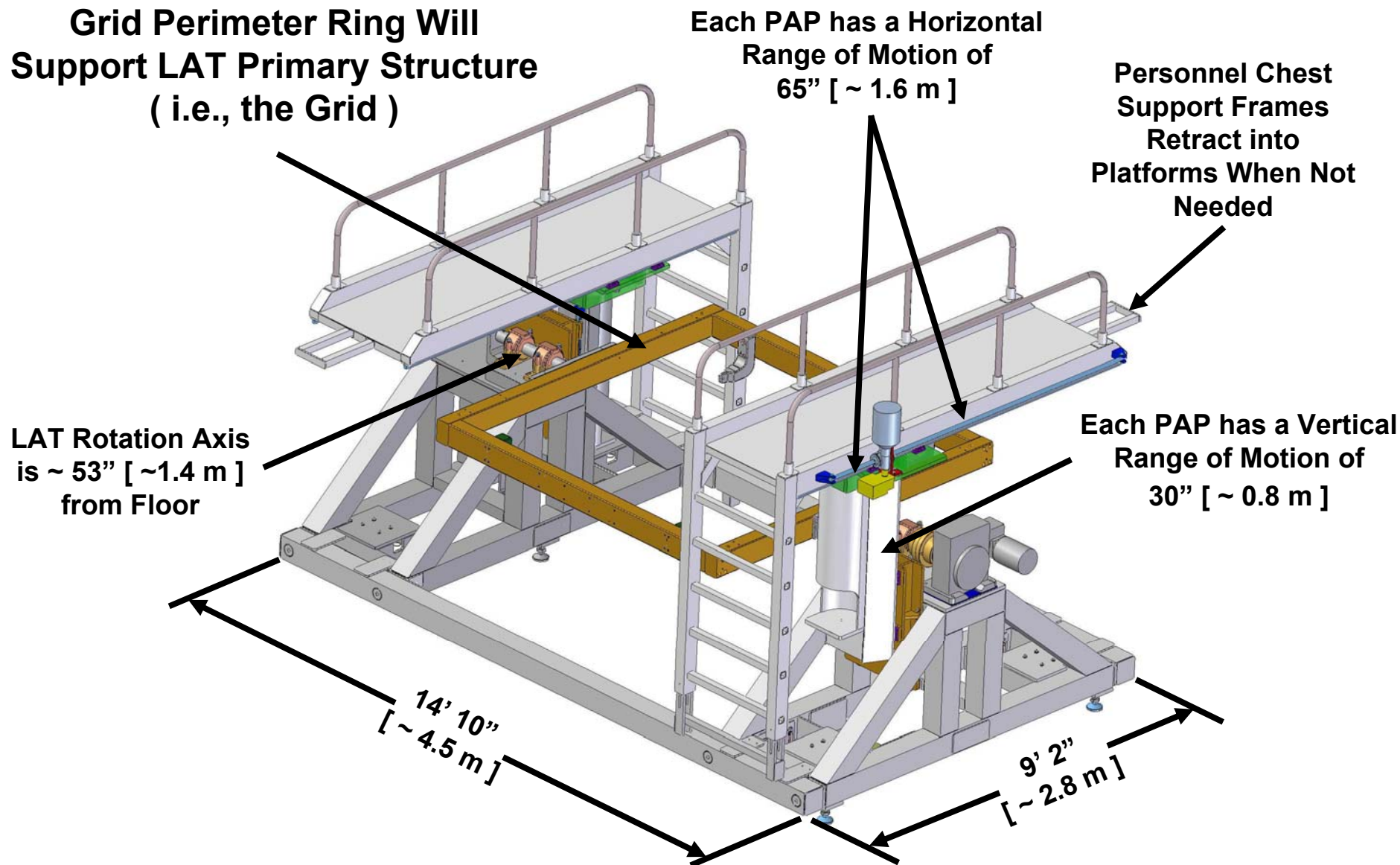
EM SB Uses 1x4 Lift Frame with Spherical Tie Rod End “Kit” to Attach to 1x4 Tension Rods from Frame to EM SB

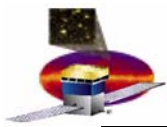


Spherical Tie Rod Receptacles in EM SB Plate are In House



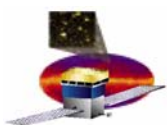
LAT 4x4 Integration Stand, ISO View





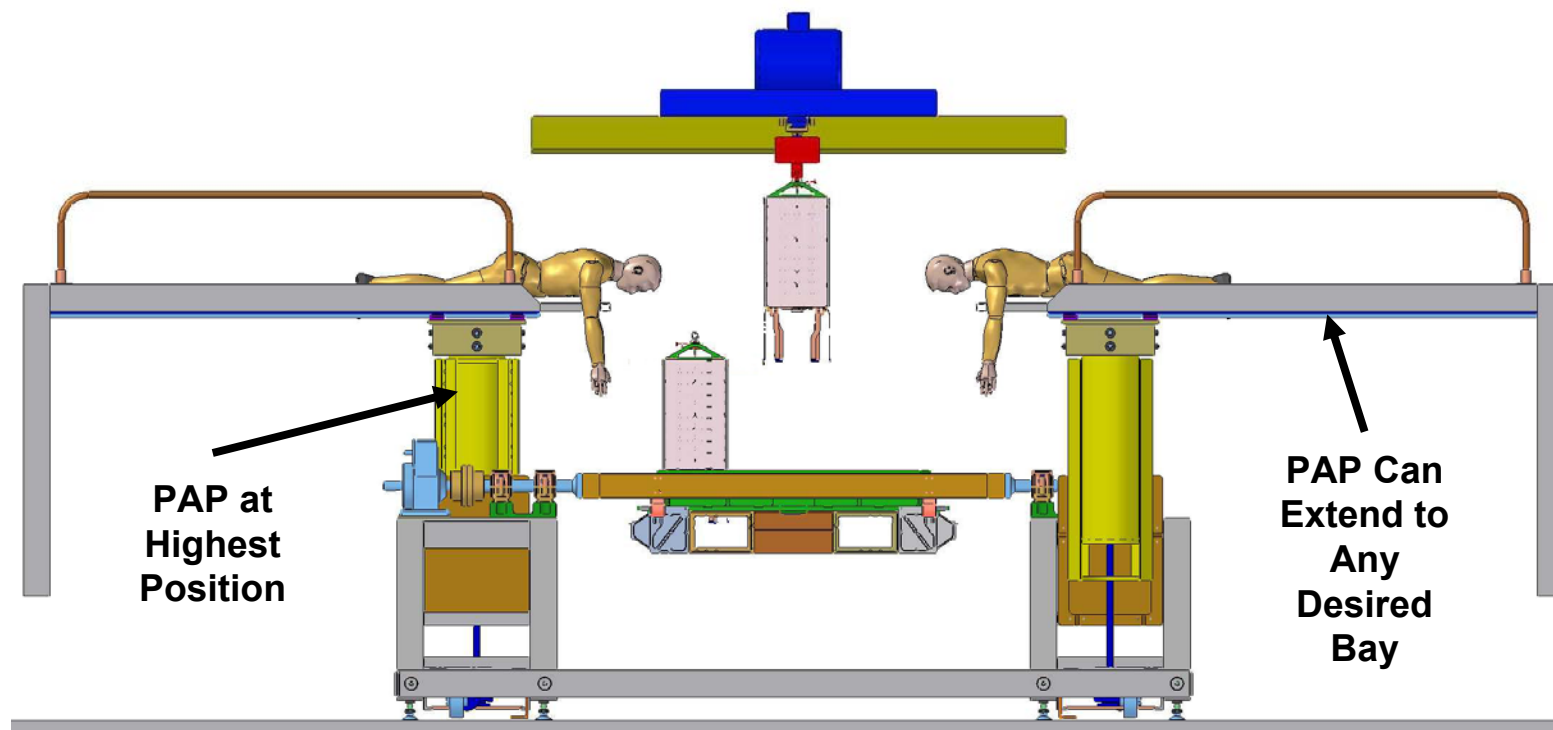
Personnel Access Platform Controls Summary

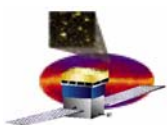
- Only one PAP to be moved at a time
- Prior to any move, at least three people will verify and sign “Safe to Move” step in procedure (Two Technicians and Test Conductor)
- Tools required for operations on PAP would be placed in TBD tool / hardware basket prior to move near flight hardware
 - Tools / items in excess of 100 grams will have lanyards, where practical
 - CAL attach to Grid – Only 4 to 8 Fasteners, then retract PAPs, rotate away from LAT, lower, then Stow / Park
 - LAT rotated to comfortable position for installation of remaining CAL to Grid interface fasteners (to Minimize Drop Hazards)



Personnel Access Platform TKR

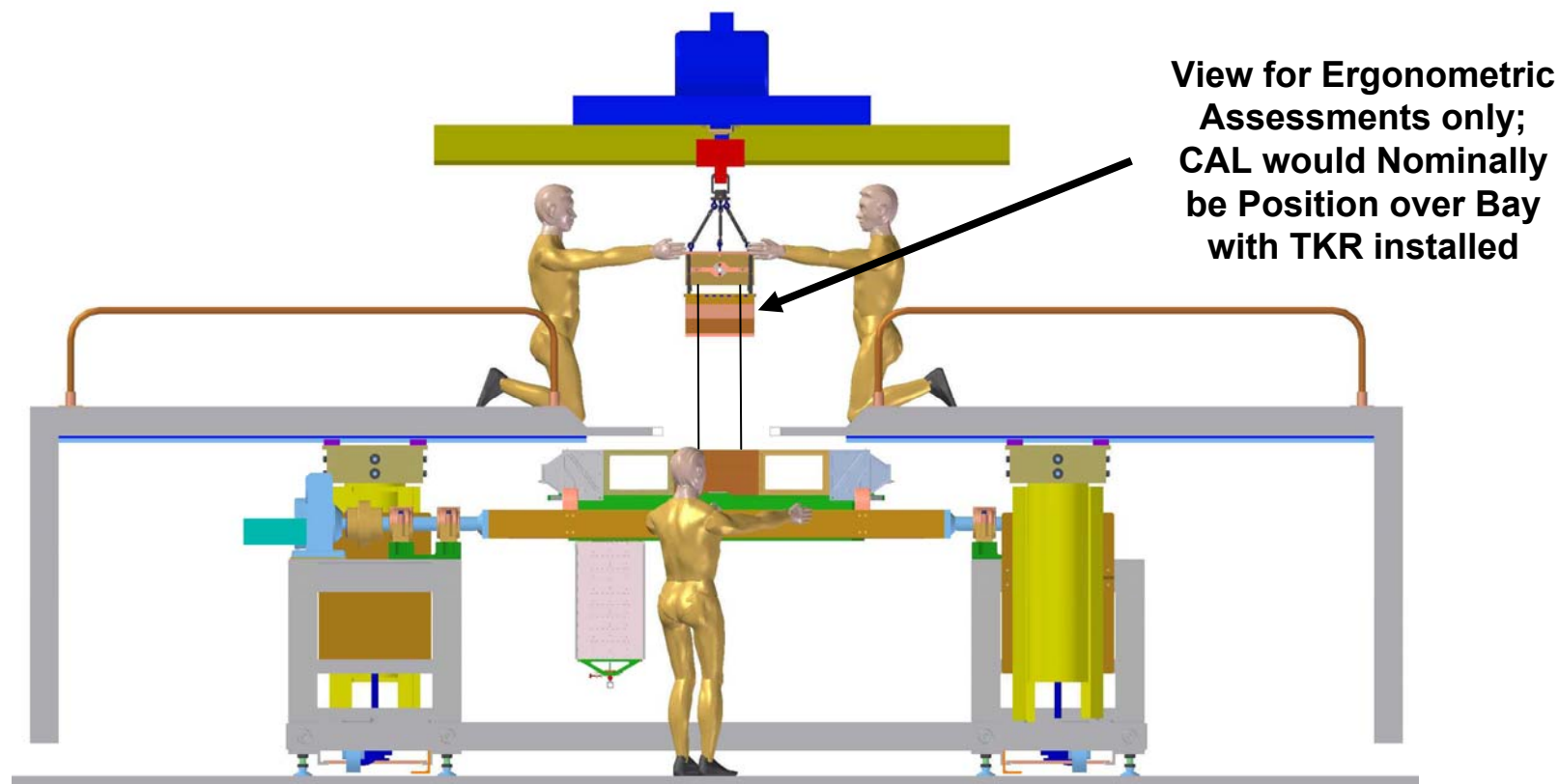
- PAP provides ready access to allow crew to Attach or Remove TKR Lift Fixture from any bay position
- TKR cables will need to be dressed to their -Z end to allow TKR motion up and over other installed TKRs

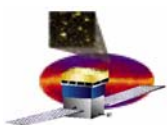




Personnel Access Platform CAL

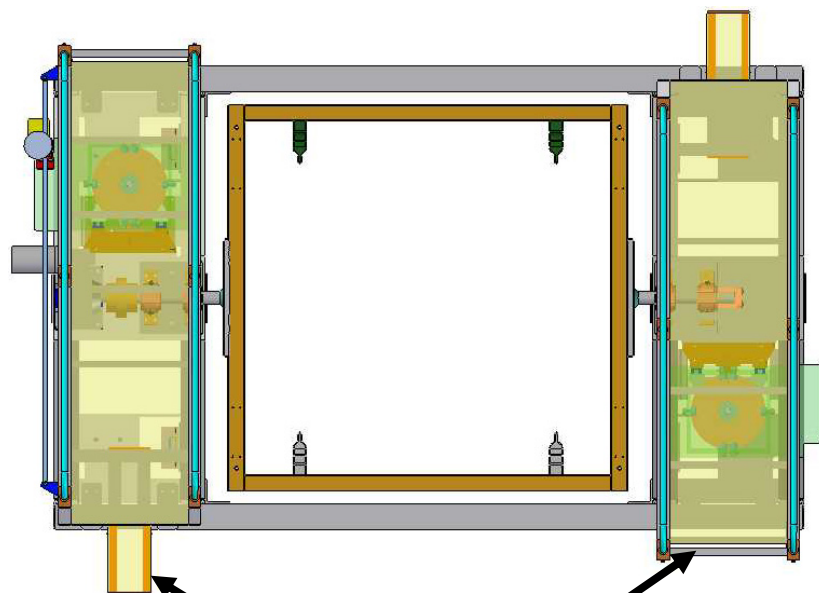
- A technician will install CAL Alignment Rods
- Two technicians on PAPs are required to obtain precise alignment of CAL Alignment Tool with respect to CAL Alignment Rods





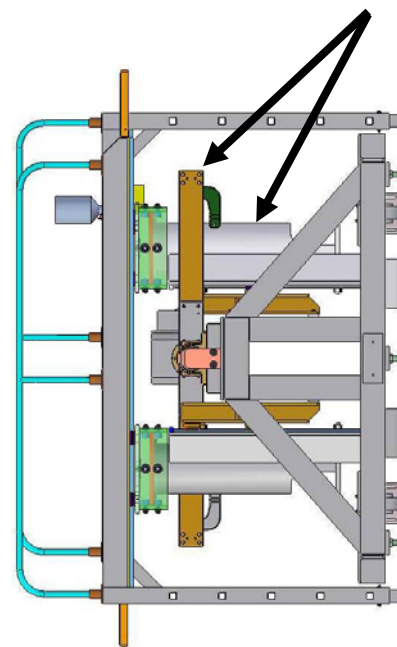
PAP Movement Sequence

**Each PAP Motion is Operated “Individually”
by a Technician on the Ground. Two
“Spotters” Will Provide Feedback to PAP
“Driver” to Assist Impact Avoidance**

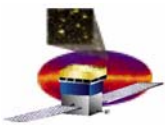


PAPs Shown in Parked Position

**Limit Switches prevent
power from being
supplied to PAP Drives
Unless LAT is Level
within $\pm 1^\circ$ (TBC)**



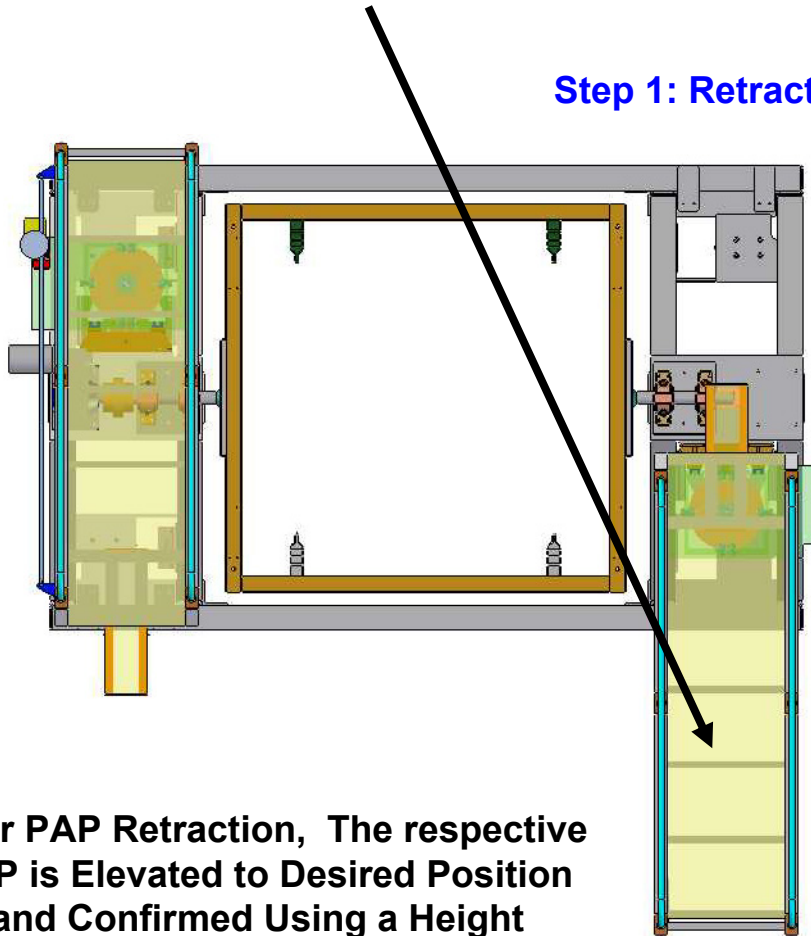
**Only One Drive will Receive
Power at a Time**



PAP Movement Sequence, Continued

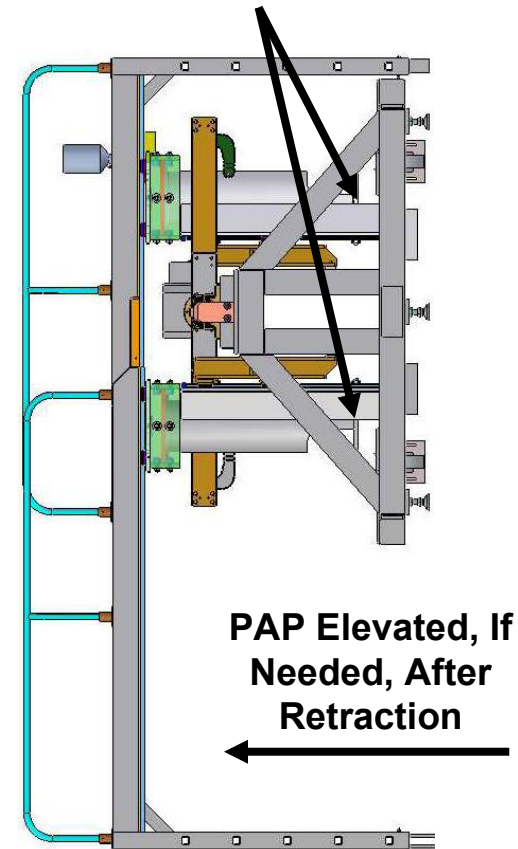
If LAT is Level, One PAP can be Retracted
from Parked Position at a Time

Step 1: Retract a PAP



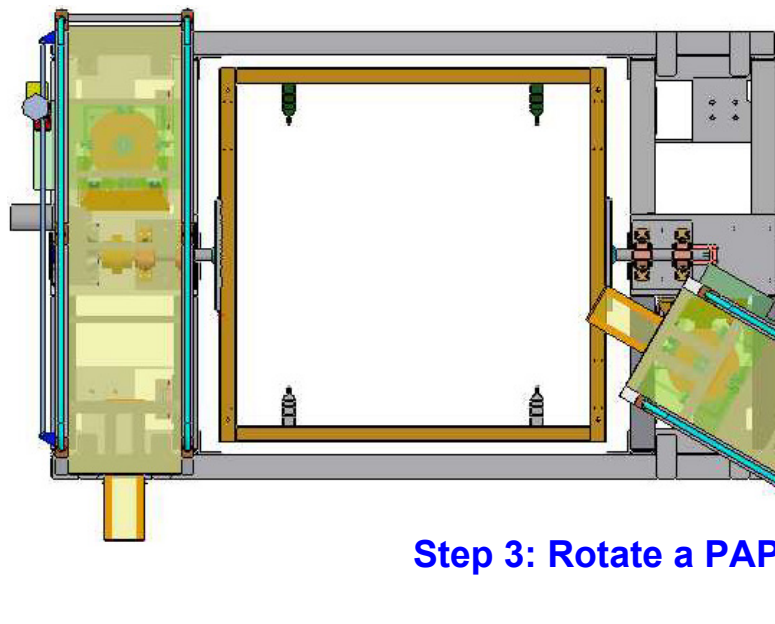
After PAP Retraction, The respective
PAP is Elevated to Desired Position
and Confirmed Using a Height
Validation "Yard Stick"

Hard Mechanical
Stops will be
Adjusted for CAL
Access Operations



Step 2: Elevate PAP to Work Height as Required

PAP Movement Sequence, Continued



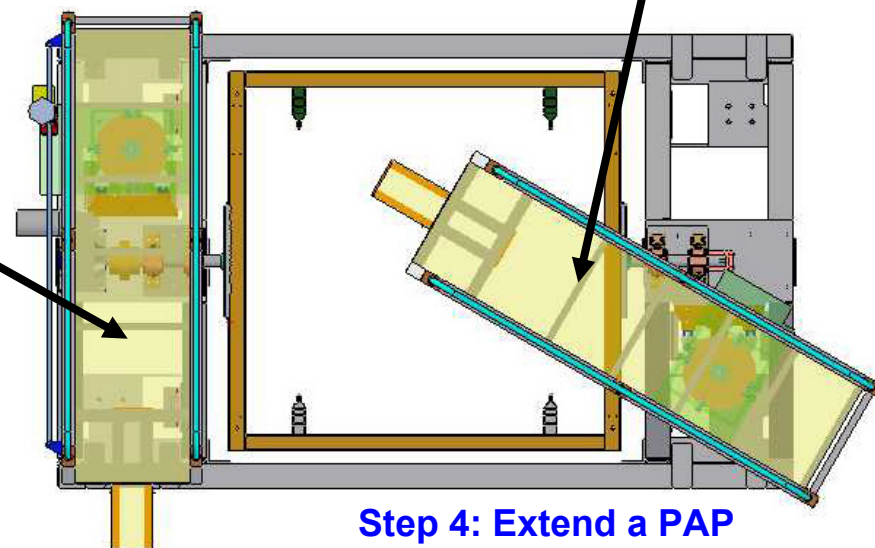
Step 3: Rotate a PAP

After Correct PAP Height is Verified, the PAP is Rotated to Align with Desired Bay for Planned Operations

After PAP Rotation is Complete, PAP is Slowly Extended to Desired Bay

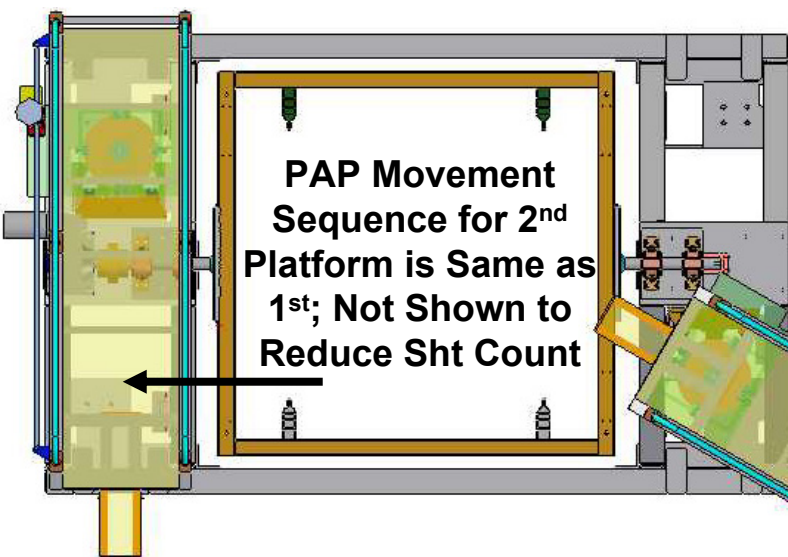
Movement of 2nd PAP Occurs After Completion of 1st PAP, and in the Same Manner

Again, Power is Only Available to One Drive at a Time !



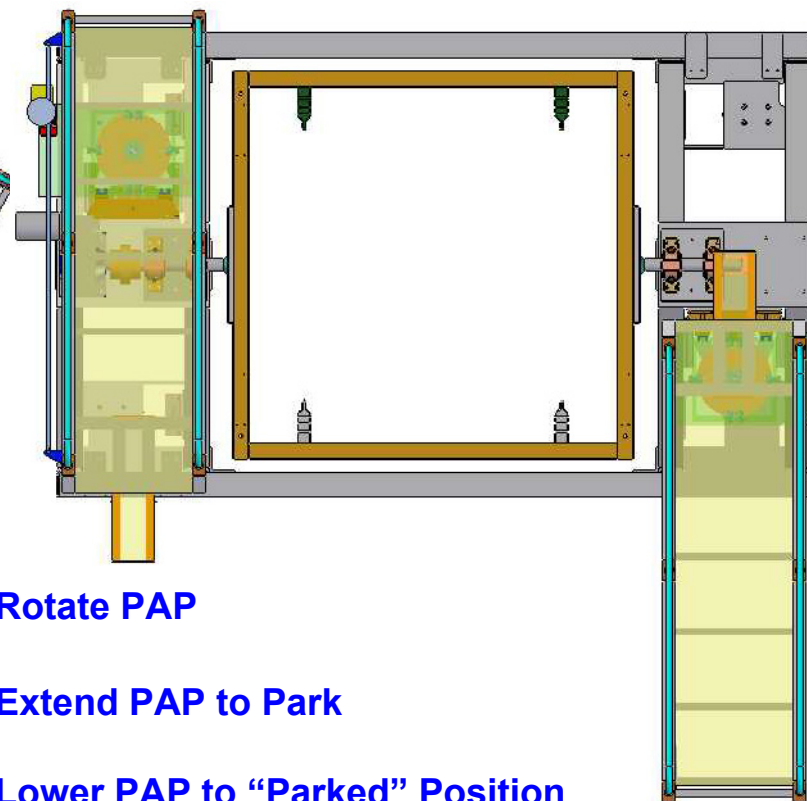
Step 4: Extend a PAP

PAP Movement Sequence, Continued



After Bay Operations Complete, PAP is Retracted

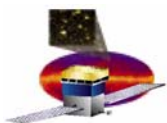
Step 5: Retract PAP



Step 6: Rotate PAP

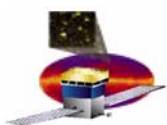
Step 7: Extend PAP to Park

Step 8: Lower PAP to "Parked" Position

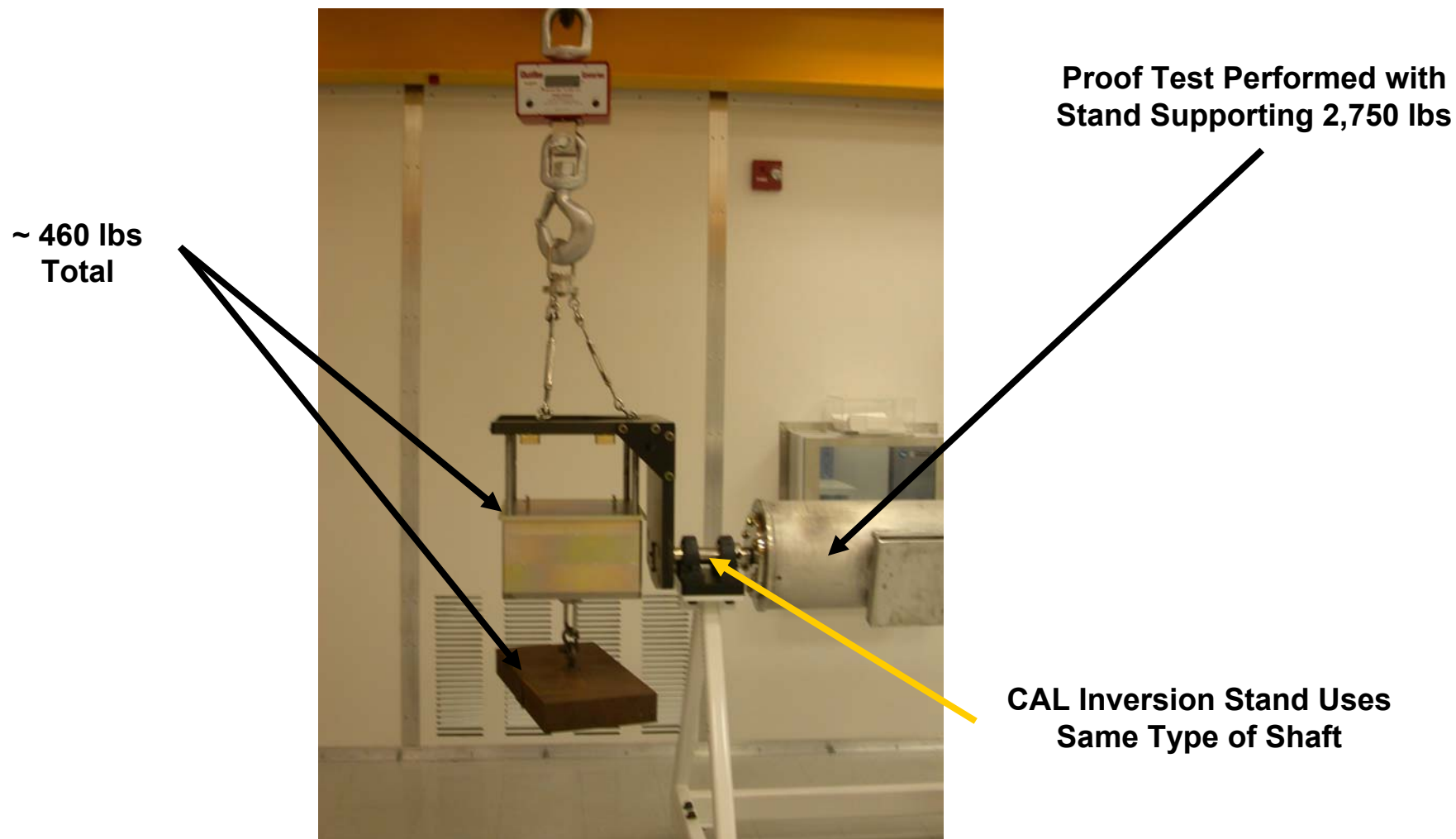


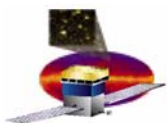
1x4 Integration Stand Proof Test





CAL Inversion Interface Proof Test Complete

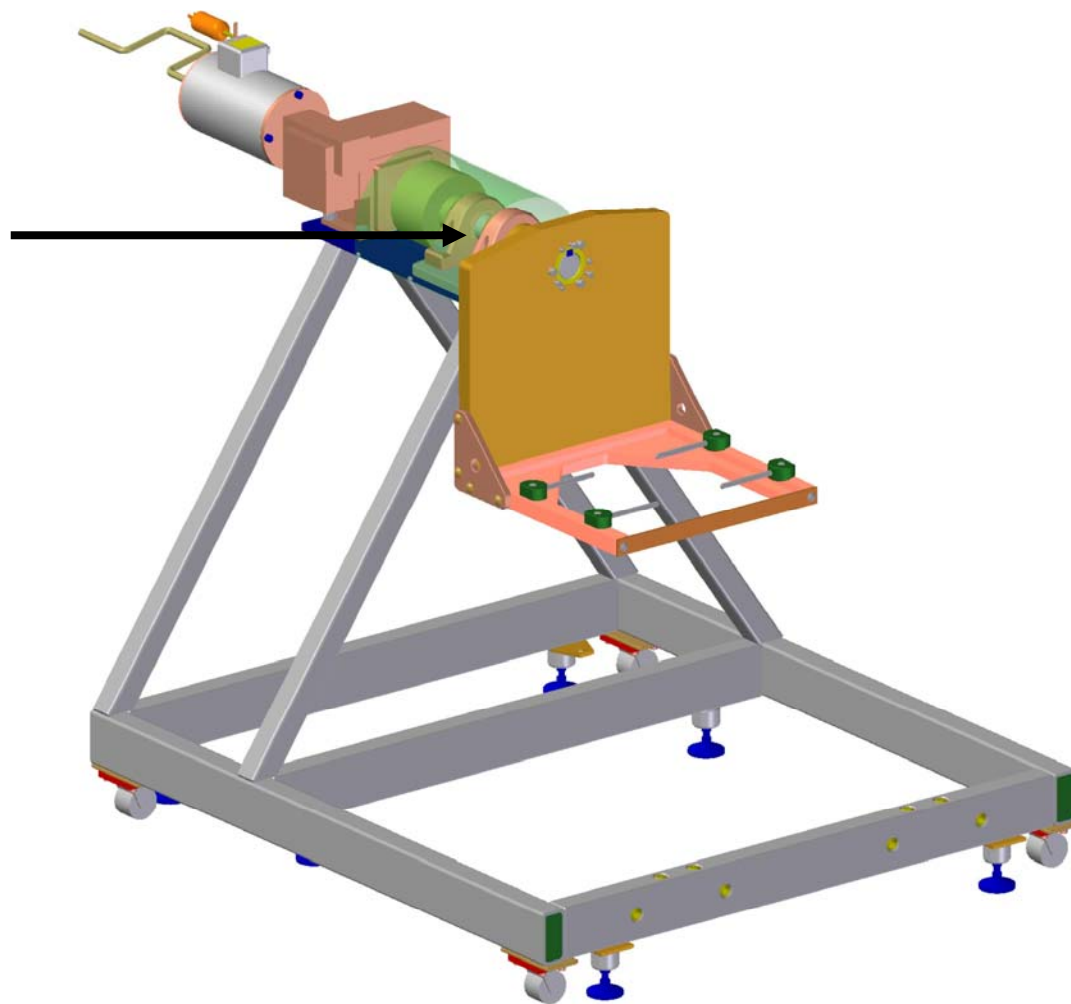


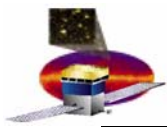


CAL Inversion Stand Status

**Support Shaft Requires Proof Test in
This Configuration**

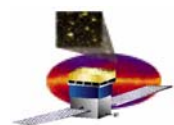
Shaft Now Available for Proof Test





CAL Ops

- **CAL –Z Up Lift Fixture Has Been Proof Tested**
 - **Need QA Concurrence for Proof Test Certification Labels**
 - **Waiting for QA Concurrence for 2 to 3 months (Help !)**
- **CAL Alignment Rods**
 - **At Center-less Grinding Shop**
 - **Need Final Attach to CAL Interface**
- **CAL Alignment Tool**
 - **Ready to Go**
 - **All previous interferences were minor and have been corrected**
 - **CAL Group Agree to Extend Length of Their Handling Fixture Posts by 0.5”;** This Solved minor interference between Engagement Fingers and Bottom Most (i.e., -Z Direction) Flange on TEM PS.
 - **Should try Tool with 3rd Stack E-Box to Ensure Clearance Exists**



Metrology Bay Status

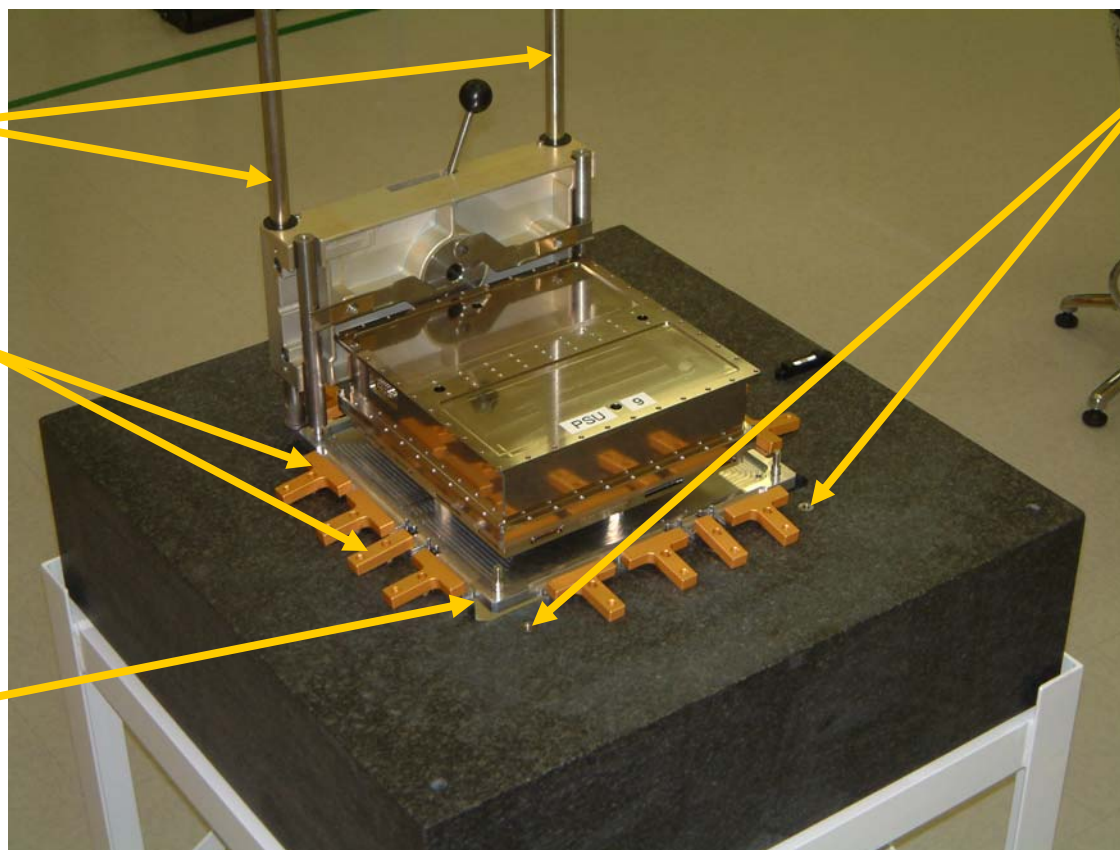
- Metrology Bay is Complete; Fastener Hardware for CAL Base Plate Clamps due by COB Wed. June 23, 2004
- Operations Training Still to Go

Alignment Rods
Modified to Fit
MB

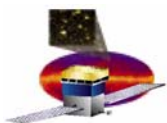
One Set of Extra
Clamps In House

Bay Opening
Too Large by
0.012" on a
Side; NCR to
Process

Will
Recommend
"Use As Is"

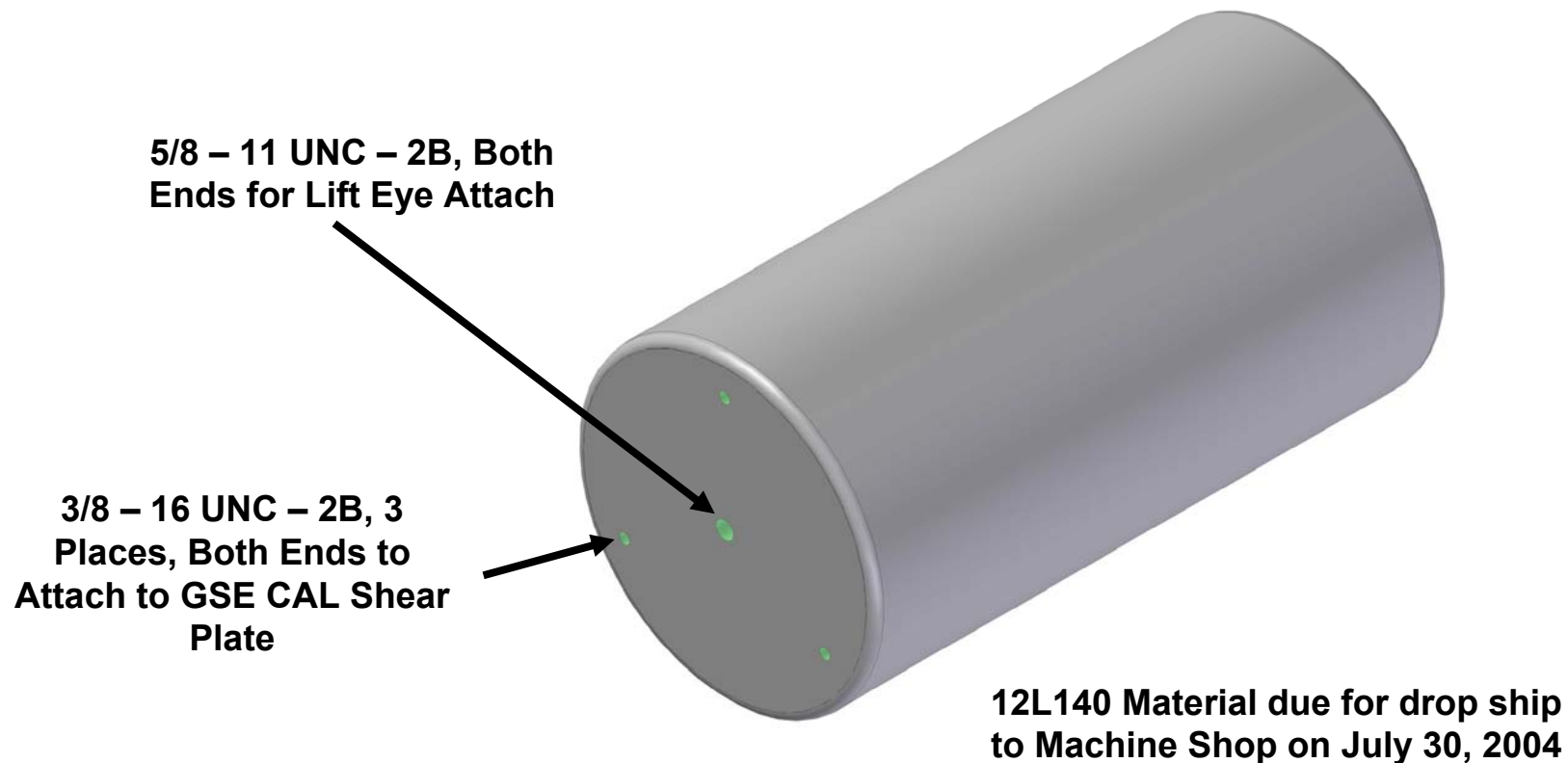


Extra Set of
Alignment Rod
Receptacles in
Case 1st Set Gets
Damaged

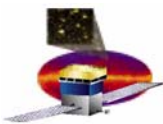


Tower Mass Simulator

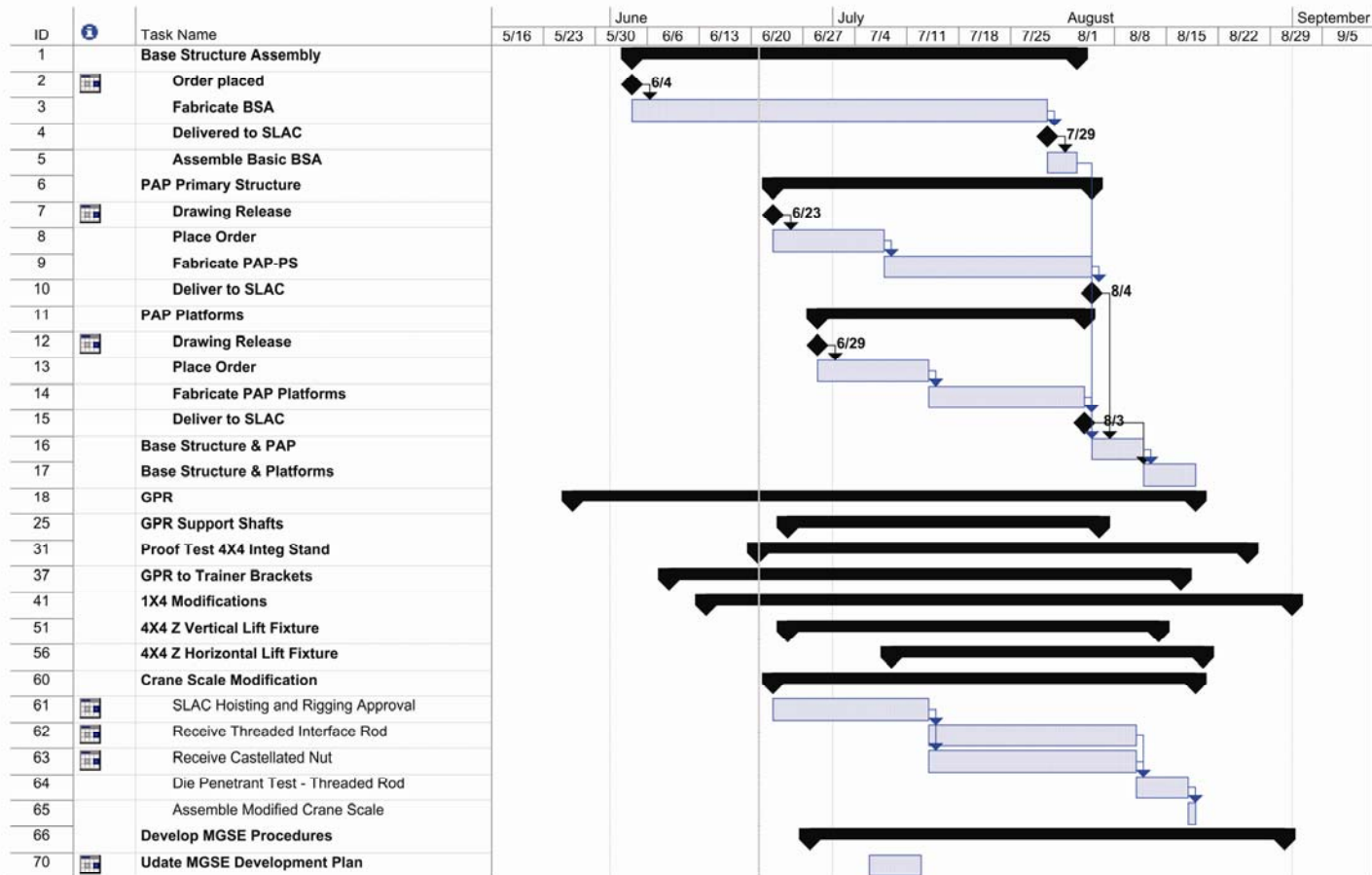
Solid Steel, 9" Diameter by 15" Long, Electro-less Nickel Plated* after machining



***Note: Nickel Plating is much lower cost than Powder Coat**



Schedule



Project: MGSE
Date: Mon 6/21/04

Task

Split

Progress

Milestone

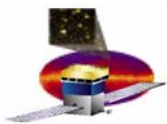
Summary

Project Summary

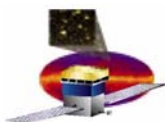
External Tasks

External Milestone

Deadline



Back Up Charts



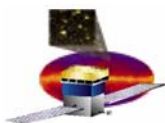
LAT MGSE Drawing Maturity / Release Status

E. Gawehn

June 22, 2004

LAT MGSE Status Tracking Matrix

LAT I&T MGSE Item	Stress Analysis		Design - Drafting			Procurement		Assembly		Ready / Comments
	Status	Report	Modeled	Detailed	Released	Ordered	In-House	Status	Proof Test	
4x4 Integration Stand										136 ish Dwgs Total
4x4 Rotation / Support Stand	√	Jul 16	√	√	√ May 06	85%	Jun 23 ?			44 Dwg Sheets Released
PAP Primary Structure		Jul 16	√	√	June 24	70%	Jul 15			43 Dwg Shts
PAP Platform Detail Assy		Jul 16	100%	50%	June 29					41 ish Dwg Shts
Grid Perimeter Ring - Brackets	√	Jul 16	√	√	May 27		Aug 06			Vendor Surveys June 24
Support Shaft - Flange Assemblies	√	Jul 16	√	√	Jun 23	50%	Jul 28			4 Dwgs Ready for Release
Z Axis Up Lift Fixture		Jul 16	√	√						16 Dwgs Ready for Release
Z Axis Up Lift Spreader	√		√	√	Jun 23		Jul 28			
Z Axis Up Tension Rod Assemblies			√	√	Jun 23	98%	Jun 29			
Z Axis Horizontal Lift Fixture		Jul 16								12 Dwg Shts
Z Axis Horizontal Lift Spreader	√		√	98%	Jul 08		At SLAC			Ready for DCN by Jul 08
Z Axis Horizontal Shackles	√		√	√		30%	At SLAC			1019 Mat'l Apr'd by Stress
Crane Scale Height Modification	√	Jul 16	√	√	May 27	30%	Jul 23	6 Dwgs		Order Turn On Jun 25 ?
4x4 MGSE Proof Test Assemblies		Jul 16	90%	10%	TBD		Jun 29	9 Dwgs		Need Stress Rvw / Appvl
CAL -Z Up Lift Fixture	√		√	√	√	√	√	√	√	Complete, 4 dwgs
CAL Alignment Tools	√		√	√	18 Dwg	√	√		n/a	Complete
CAL Alignment Rods	√		√	√		90%		2 dwgs		Machining 50% Complete
CAL Inversion Stand / Interface	√		√	√	√	√	√	14 Dwg	√	Final Shaft Needs Heat Treat
E-Box Shimming										
Metrology Bay with Stand	n/a		√	√	√	√		9 Dwg	n/a	Ready by Jun 22 (Need NCR)
Clamps, Align Rods, Lift Eyes, etc	n/a		√	√	√	√	√		n/a	Clamps complete



LAT MGSE Drawing Maturity / Release Status

E. Gawehn

June 22, 2004

LAT MGSE Status Tracking Matrix

LAT I&T MGSE Item	Stress Analysis		Design - Drafting			Procurement		Assembly		Ready / Comments
	Status	Report	Modeled	Detailed	Released	Ordered	In-House	Status	Proof Test	
TWR Mass Simulators	√	Jul 16	√	√	May 27		Aug 20		n/a	Raw Mat'l Arrives Jul 30
EM-2 Single Bay (TKR Interface Plate)	√	n/a	90%	10%					n/a	2 Dwgs
1x4 Lift Fixture		Jul 16			Jun 04					16 Dwgs Ready for Release
1x4 Lift Spreader	√		√	√			Jul 28			
1x4 Tension Rod Assemblies			√	√		85%	Jun 22			Need Clevis Only
1x4 Grid Update 1x4 Grid Machining	√	Jul 16				TBD				Design Start Jun 17 Vendor Selection in Parallel
1x4 Integration Stand	EG		√	√	√	√	√	58 Shts	√	Awaits 1x4 Grid final Check
1x4 Integ Stand Proof Test Weight			√	√	√	√	√	11 Shts	√	Use for 1x4 Lift Fixture too

Total Drawing Sheet Count 282. 141 Drawing Sheets have been released.

94 Dwg Sheets in Release Cycle by Jun 23

18 Drawings, completed last year are ready for release cycle (CAL Alignment Tool and Sight Gages)

Overall Drawing Status Summary:

253 Dwg Shts virtually complete (141 + 94 + 18 = 253); 29 need to be worked, but are far along in most cases

1x4 Grid Update TBD Dwg Shts



Acronyms

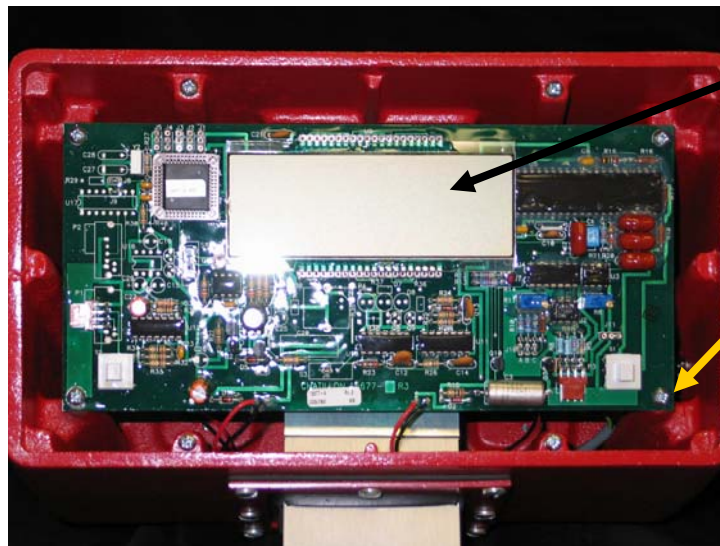
- **ACD** **Anti-Coincidence Detector**
- **ASTM** **American Society of Testing & Materials**
- **CAL** **Calorimeter**
- **EWR** **East West Range Safety Requirements**
- **GPR** **Grid Perimeter Ring**
- **LAT** **Large Area Telescope**
- **MDLL** **Maximum Design Limit Load**
- **MGSE** **Mechanical Ground Support Equipment**
- **Ops** **Operations**
- **OTS** **Off - The - Shelf**
- **PAP** **Personnel Access Platform**
- **PH** **Precipitation Hardened**
- **SFP** **Single Failure Point**
- **SU SLAC** **Stanford University's Stanford Linear Accelerator Center**
- **TBR** **To Be Resolved**
- **TEM** **Tower Electronics Module**
- **TKR** **Tracker**
- **T-Vac** **Thermal Vacuum (Test)**



Crane Scale Photos



OTS 0 to 20,000 lb Crane Scale



Remove Circuit Card; 4 Screws, 1 at each Corner

New Threaded Rod Is Installed Here

Set Screw to Lock Threaded Rod in Place

