AO Enclosure Crane
Conceptual Review

What will be covered?

- Requirements
- Stack Up
- Instrument Locations and Max Load
- Detailed Reviews of 3 Design Concepts
  - Bridge Crane
  - Free Standing Articulating Jib Crane
  - Ceiling Mounted Articulating Jib Crane
- My Ranking (and why)
- Next Steps
- Feedback

Requirements Overview

Notes:

- Red indicates conflict between requirements

	A	B	C	D	E
1	Stakeholder	Requirement Type	Sub-Requirements	Importance (1-5)	Conflict (Row)
2		Capability			
3	Deno (SCALES)		780 lb Min Working Load Limit (5000 lb target)	5	9
4	Deno (SCALES)		Must be able to lift an object a min 5" (maximize, target 31")	5	13
5	Eduardo		Create a mount or resting space for SCALES lid (NO SUSPENDED LOAD)	3	
6	Caltech (FEI)		Create a mount or resting space for FEI cryostat (NO SUSPENDED LOAD)	3	
7	Marc		Maximize Coverage of Crane Reach	2	11
8	Eduardo		To be used in K1 and K2 AO Enclosures	2	
9	Scott (PyWFS)		Make crane easy to move/take down and store (maximize AO space)	2	3, 24
10		Spatial Constraints			
11	Consensus		Must mount to structural steel of AO Platform	5	7
12	Consensus		Distance from hook to the floor (vertical) must be at least 100"	5	13
13	Consensus		Must be no taller than the AO enclosure ceiling (137")	5	12
14	Jacques		Must not block access to elevated ring (full access to AO bench)	4	
15	Eduardo		Any exterior legs/posts must not block access to AO roof ladder	1	
16	Truman		Must not occlude wall instrument/panel access	1	
17	Truman		Must not obstruct double doors/instrument cart rails	1	
18		Power			
19	Consensus		All electric elements limited to 110V AC	3	
20		Future-Proofing			
21	Consensus		Compatible Hook Functionality (Swivel vs Fixed, size, etc.)	3	
22	Consensus		COTS parts as possible (ie. Kundel)	2	
23	Erin P., Max Davis	Human and Instrument Safety			
24	Consensus		Safety Factor (3 yield, 5 ult)	5	9
25	Consensus		Cannot Overload AO Platform (consider both crane and load)	5	
26	Marc		Design in a way to avoid crashing load or crane elements into instruments	5	
27	Eduardo		Integrate a hard stopping mechanism/capacity (load break) (limit drift)	4	
28	Marc		Clean Operation (no leaking fluids) (drip pan?)	3	
29		Budget			
30	Consensus		Budget unspecified (Target <$20k)	1	
31		Material			
32	Marc		No component should give off too much heat (<50W)	1	
33		OSHA			
34	OSHA		Access for annual maintenance/inspection	5	

Key Requirements

	A	B	C	D	E
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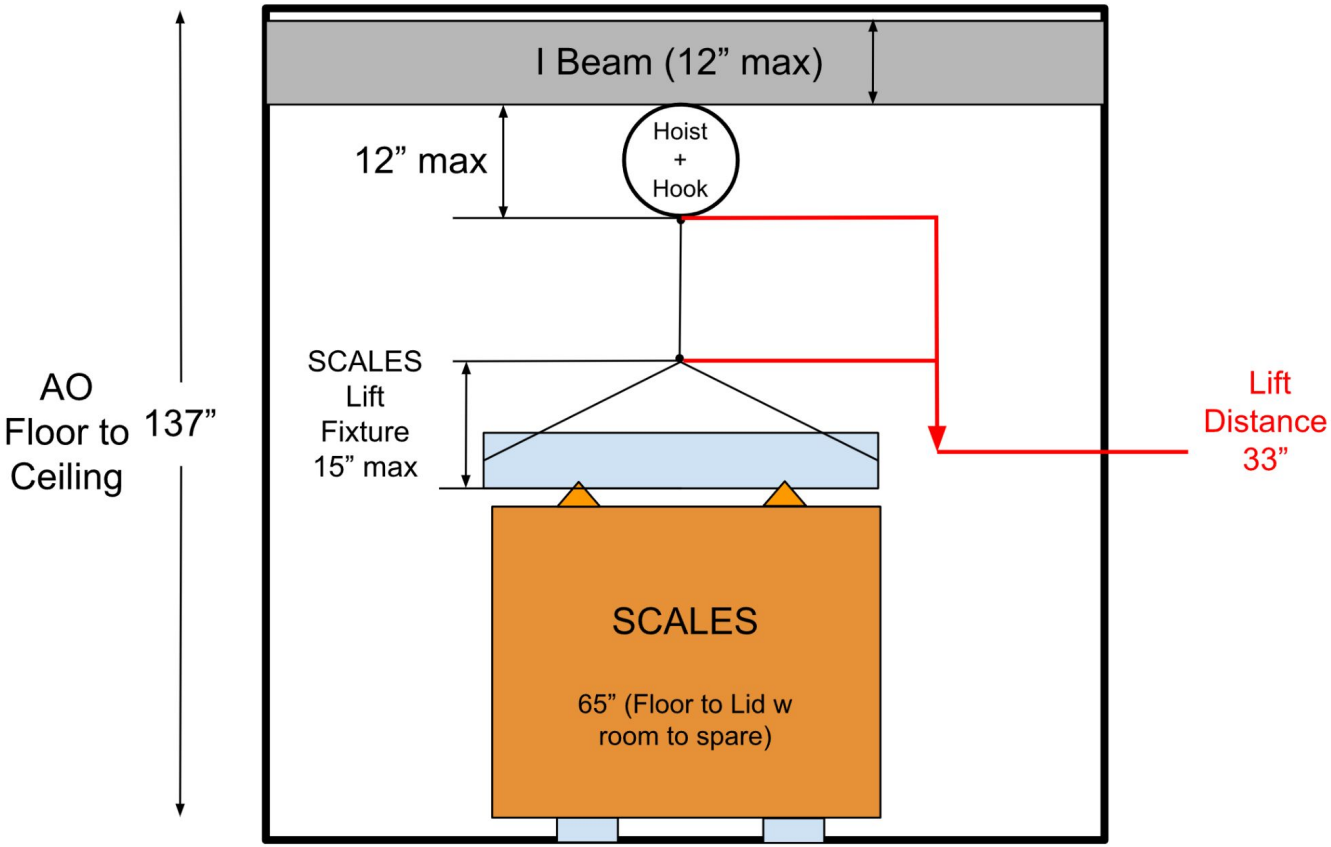
34	OSHA		Access for annual maintenance/inspection	5	

These are the absolute “must have” requirements for the design

Stack Up

Rough Estimate:

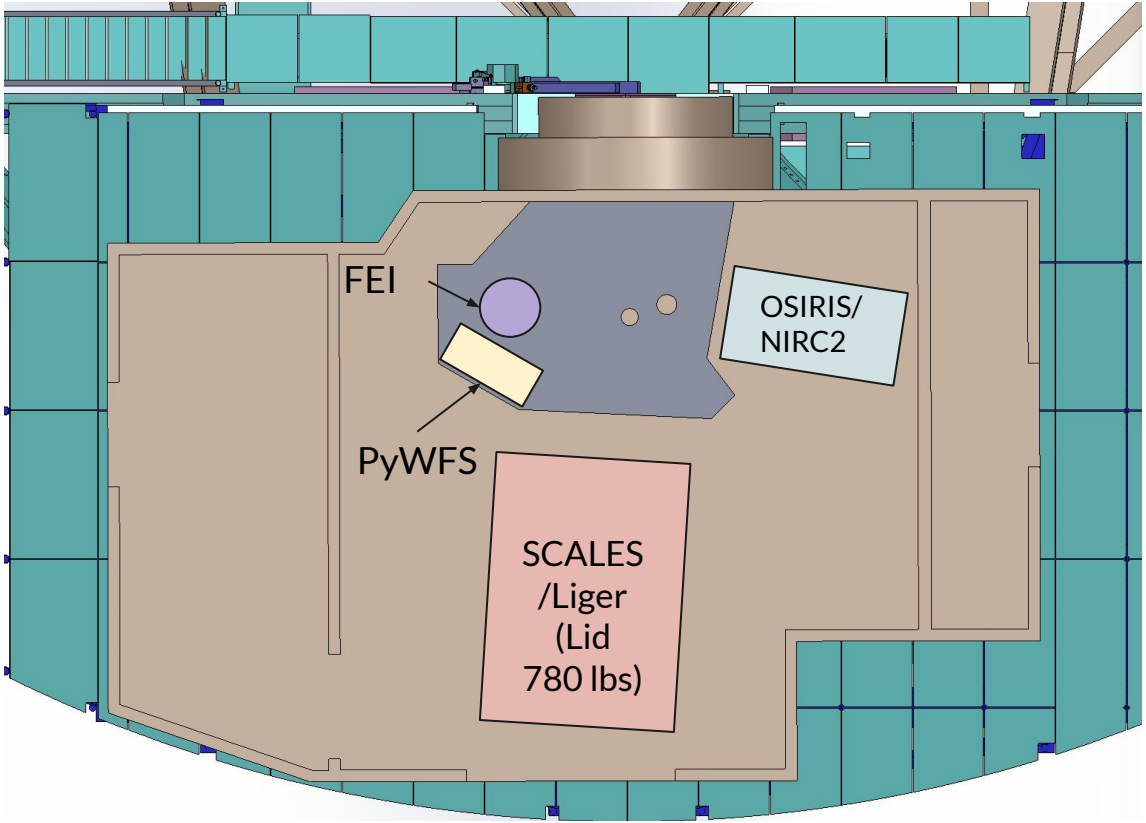
- All figures subject to change
- SCALES lift fixture being designed currently by UC Davis instrument team



Instrument Locations and Max Load

Note:

Liger and HISPEC omitted for clarity/positions undefined



For each concept, I will discuss…

- Concept Overview and General Specs
- Optimal Mounting Locations
- Estimated Coverage
- Installation
- Additional Considerations

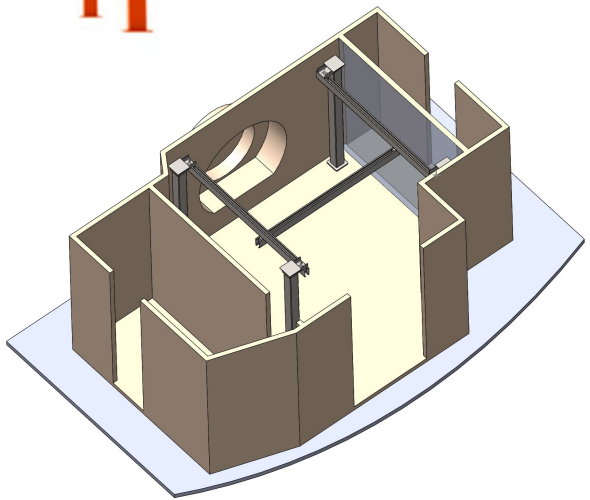
Concept #1
Bridge Crane

Possible Vendors: Kundel, CM (Unified)

Load Capacity = 1 ton

Standard Coverage (Kundel) = 12’X12’

Fully customizable coverage

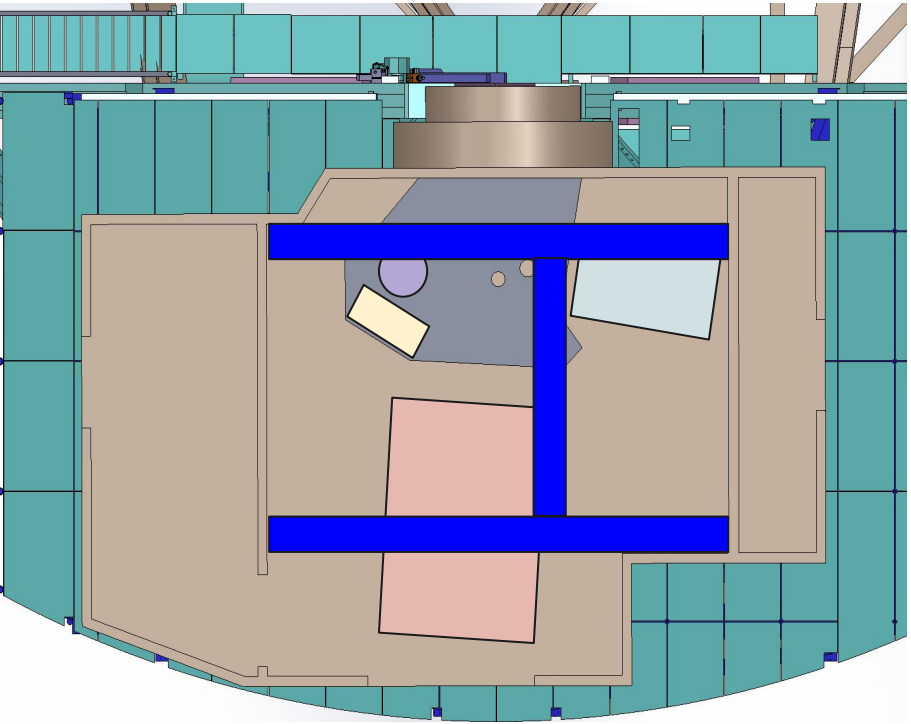


Optimal Mounting Locations

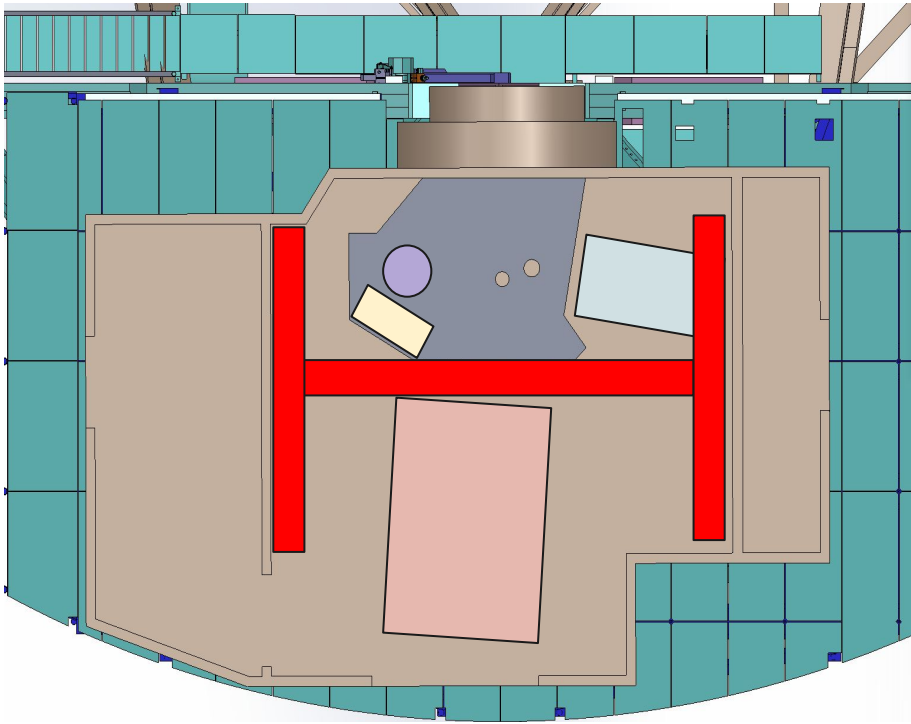
Mounting Considerations:

- Posts **MUST** be mounted to structural steel (or supported by steel through mounting)
- Interior posts require alteration of AO floor
- Exterior posts require alteration of AO walls

Estimated Coverage



Orientation #1



Orientation #2

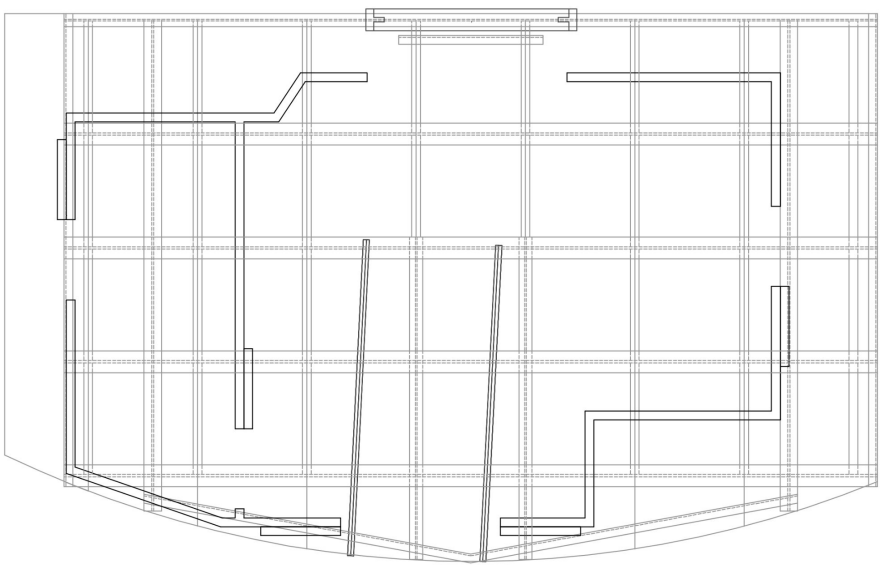
Installation

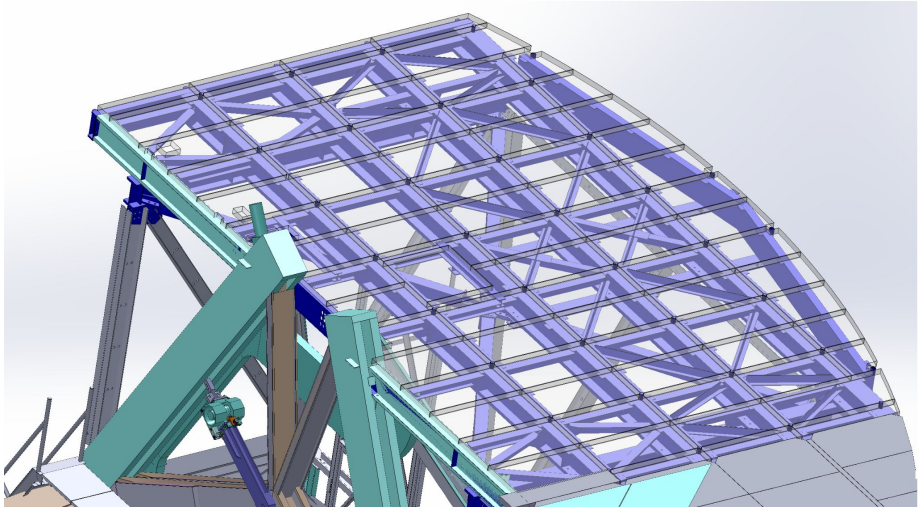
Post Installation:

- 4 through bolts per post
  - Mounted to I beams (preferably thinner vertical beams)
  - Structural beams are welded together to form I beam profile
    - Will require further analysis (Jason)
  - No alteration to crane required for mounting

Crane Assembly:

- Must be assembled on site (on summit in AO)
- Estimated installation time = ~6 hours for 2 technicians
  - Not including platform/AO wall alteration





Additional Considerations

Wall Mounted Devices:

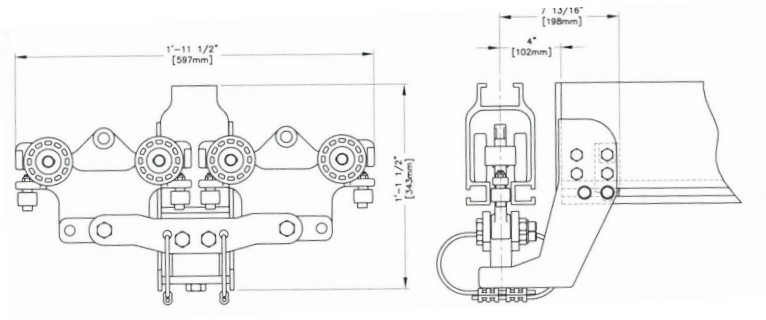
- Possibility for relocation of one or more support instruments mounted on enclosure walls
  - Air filters will be easier to move
  - Cable trays/waterfall are much more difficult if not impossible to relocate
  - All will add time for technicians at summit (>2 hours)
  - Railways have a reported displacement due to deformation of 3” to the left and right of the beam itself
    - “Boot” seal may be required for flexibility in wall penetration

Floor Alterations:

- Interior posts will require cutting through floor inside AO
  - Chip/debris concerns for clean room

Stackup:

- Standard model takes up 24” of vertical space above hoist
- Customization can reduce crane body stack up to 13.5”
  - “Same Plane Bridge” (pictured to the right)
    - CM (Unified) version

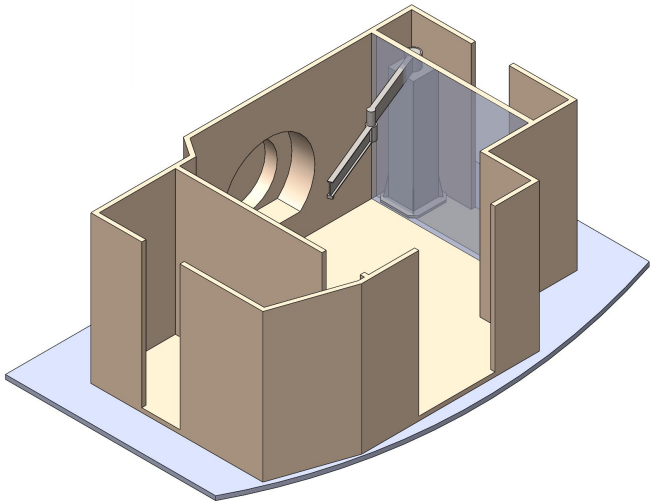


Concept #2
Free Standing Articulating Jib Crane

Possible Vendors: Columbus McKinnon (Unified)

Max Load Capacity = 1000 lbs

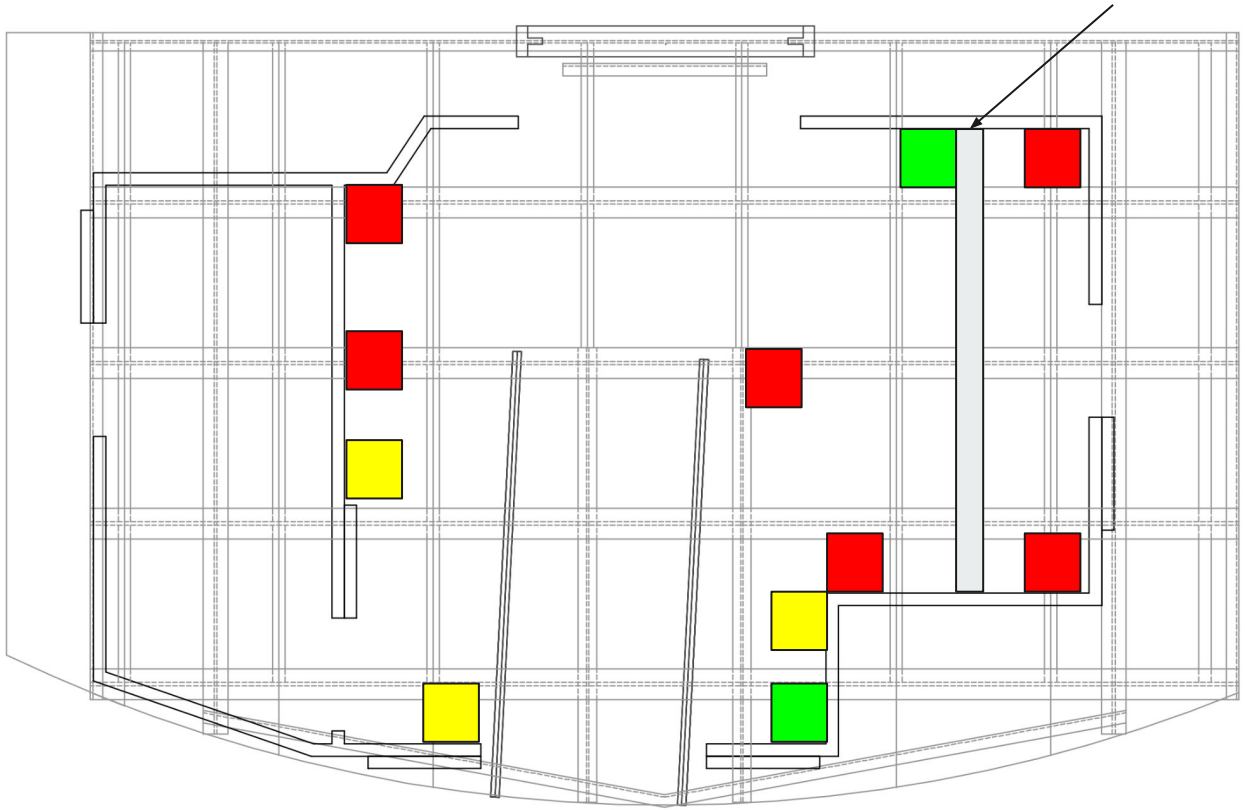
Max Extended Boom Span = 14’



Possible Mounting Locations

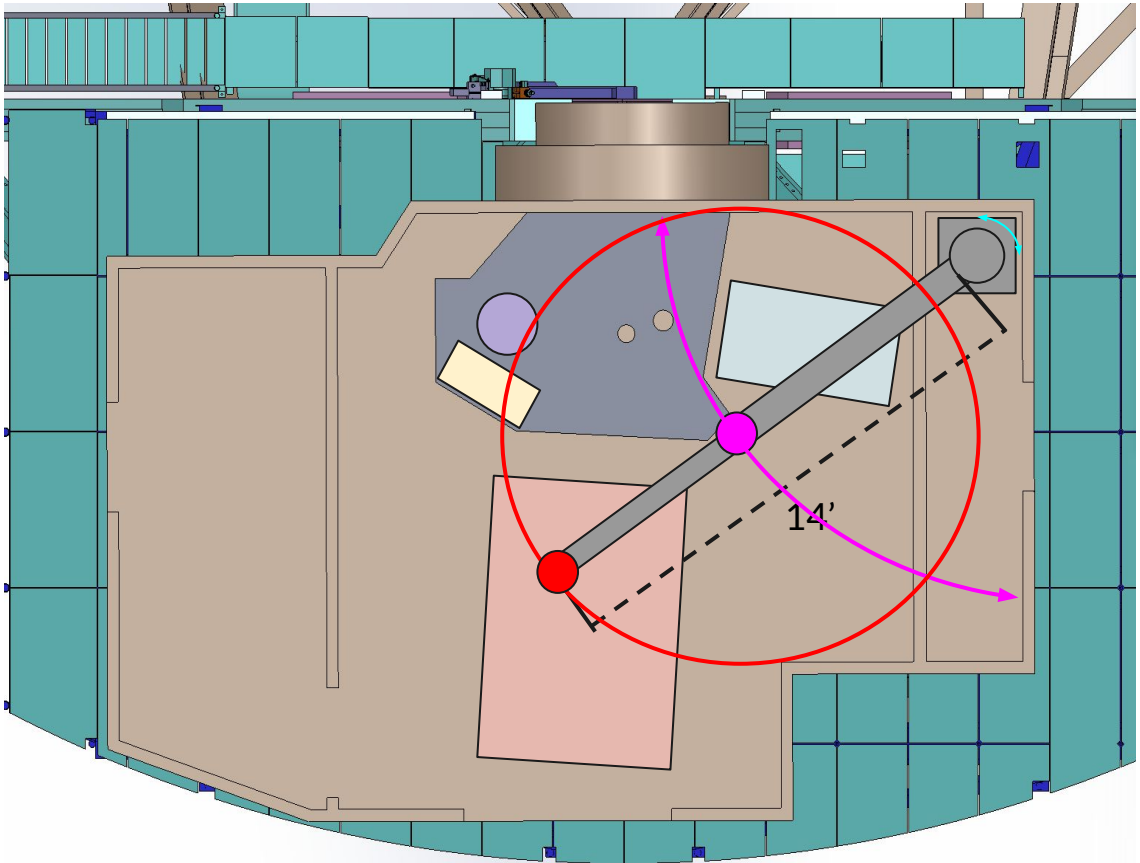
Mounting Considerations:

- Post **MUST** be mounted to structural steel or share a mounting fixture
- Worst Case, Better Case, Best Case for space saving



Estimated Coverage

- Worst case coverage shown
  - Other positions offer complete coverage of main AO enclosure area
- Pivot points will include hard stops and rotary locks
- Trolley available for exterior beam
  - 3 DOF
  - Optimal Load Path



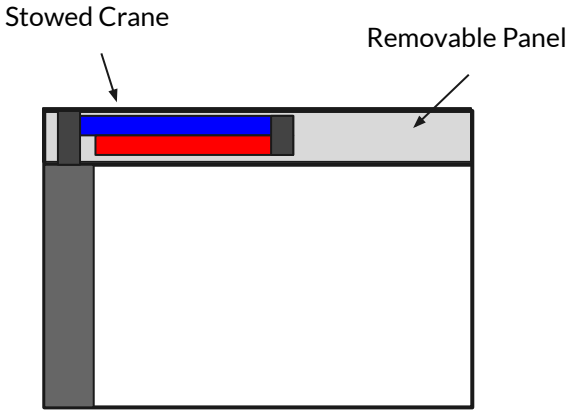
Installation

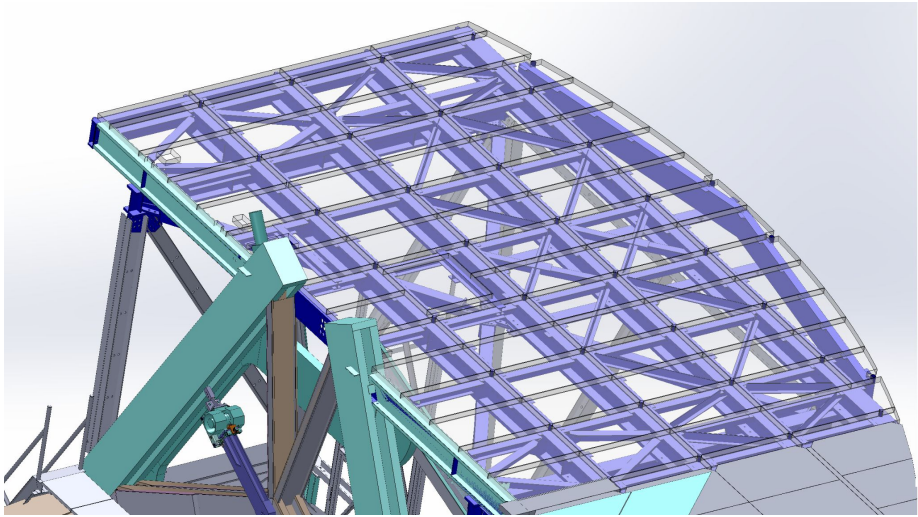
Post Installation:

- 4+ through bolts depending on FEA and most efficient load path
- Preferably supported by a wider I beam
  - Present load sharing must be analyzed
- AO floor **AND** platform grate must be cut to access I beams
  - Chip/debris inside AO during operation
- Gowning area wall/plastic curtain may to be altered
  - Only if certain mounting location(s) are used
  - Removable panel (shown top right)

Mounting Fixture:

- Will be designed and analyzed by yours truly (primarily)
  - Takes design time away from actual crane
- Creates more load for I beams
  - Rough concept models have max weight of ~500 lbs
- Must be load rated (cantilever moment)
  - ASME/OSHA guidelines will apply
    - May require outside expertise (civil/structural)





Additional Considerations

Weight of Parts:

- Shipped as several large parts
  - Some assembly on site (>1 hour)
  - Parts may be heavy enough to require dome crane
    - Can be lowered onto instrument cart and wheeled in (~2 hours)

Wall Mounted Devices:

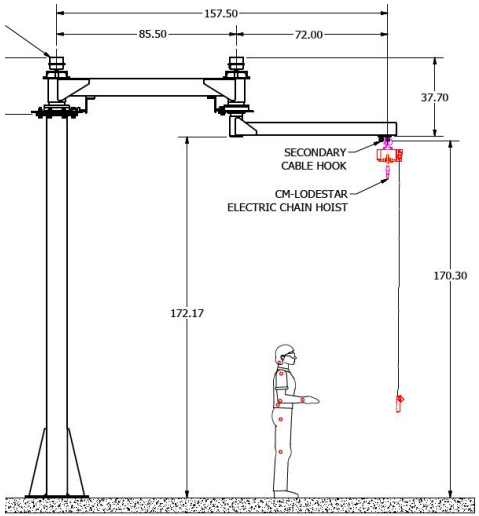
- Possibility for relocation of one or more support instruments mounted on enclosure walls
  - Air filters will be easier to move
  - Cable trays/waterfall are much more difficult if not impossible to relocate
  - All will add time for technicians at summit

Stackup:

- Possible to have exterior arm above interior arm to maximize headroom
  - exterior arm stackup = 13”
- Addition of trolley adds to stackup (~3”)

Cantilever Load:

- Non-optimal load path
- Load capacity vs. coverage trade-off

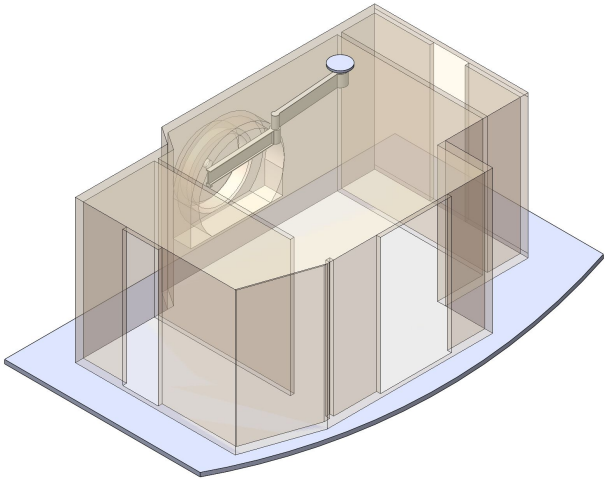


Concept #3
Ceiling Mounted Articulating Jib Crane

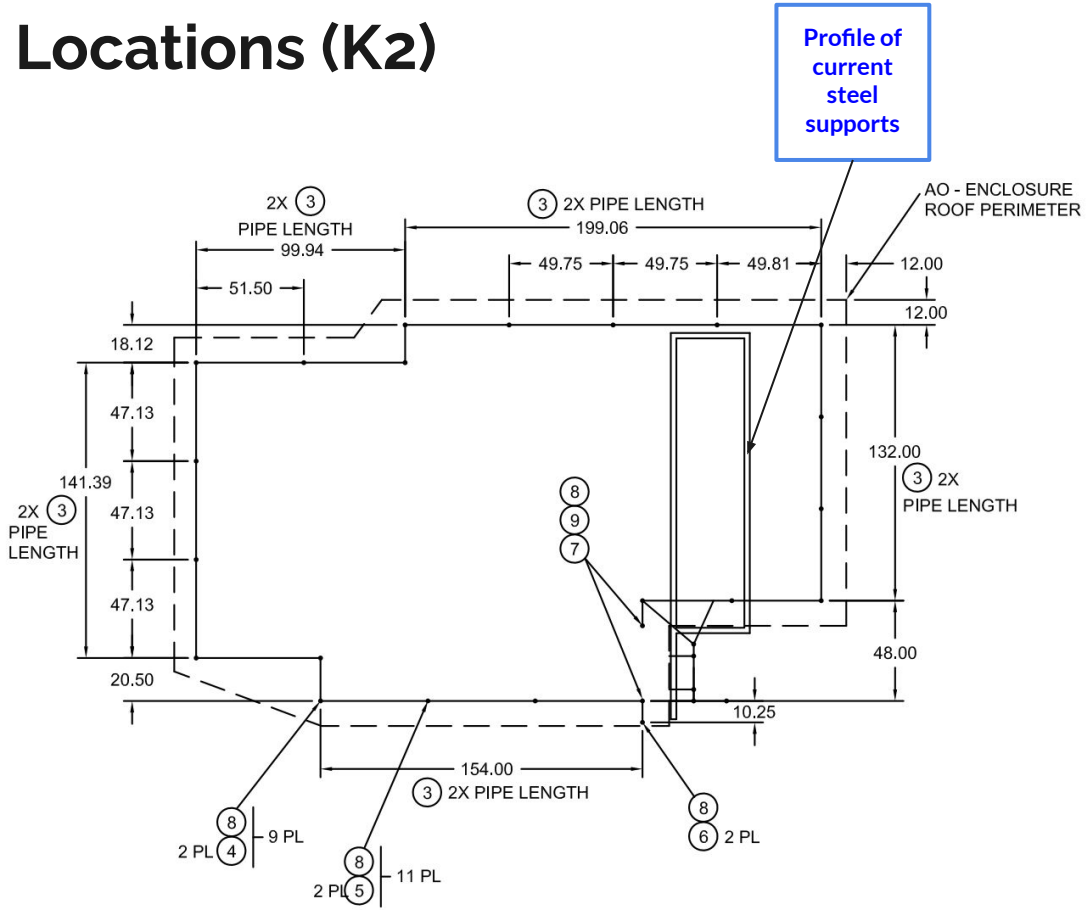
Possible Vendors: Spanco

Max Load Capacity = 2000 lbs

Max Extended Boom Span = 16’

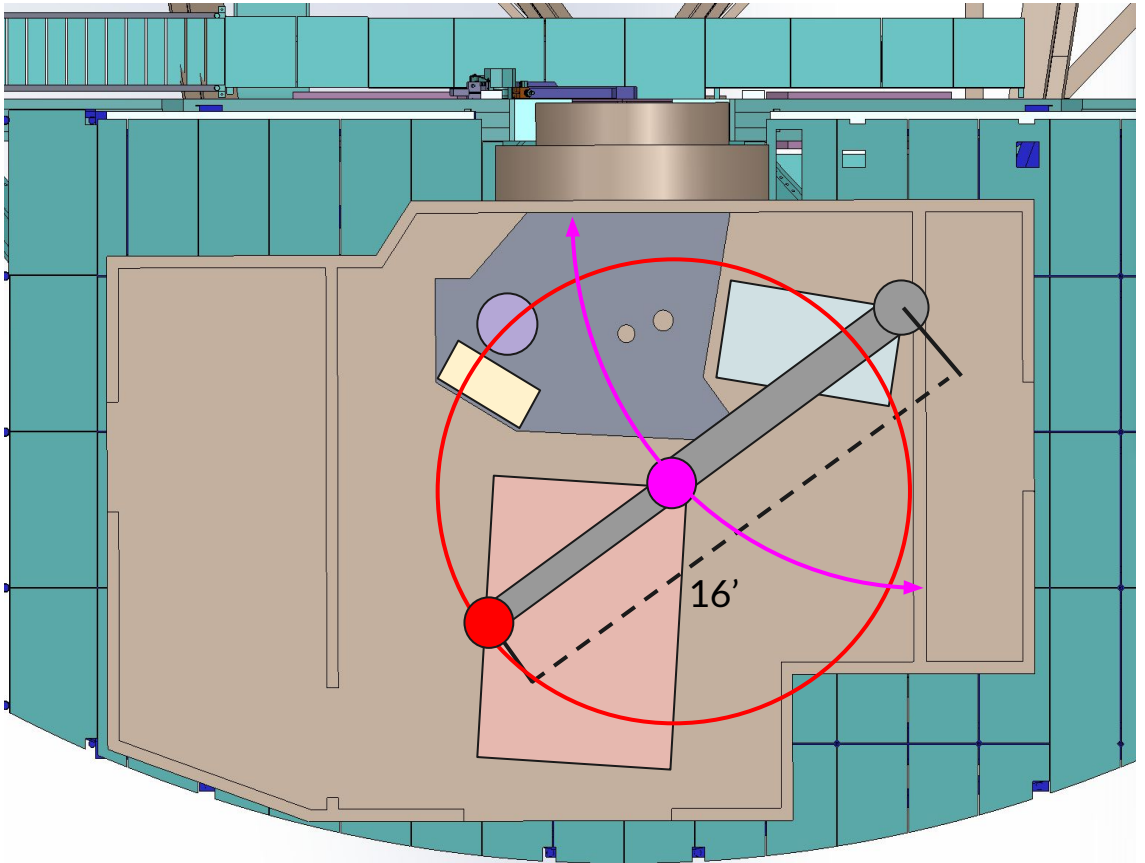


Possible Mounting Locations (K2)



Estimated Coverage

- Hoist fixed to end of exterior arm (2 DOF)
  - Attempting to contact Spanco for customization
- Hard stops will prevent crashing into walls
- Hoist compatibility currently unkown



Installation

K2:

- Structural steel already exists for NIRC 2 “cover lifting device”
  - >6 through bolts
    - Mounted into hollow steel beams
- Shipped as several large parts
  - Some assembly on site (~1 hour)
  - Parts may be heavy enough to require dome crane
    - Can be lowered onto instrument cart and wheeled in (~2 hours)
      - Avoids need for removal of AO enclosure

K1:

- Structural steel frame from K2 will need to be replicated
  - Will add significant design time just for structure
  - Will also require comprehensive onsite measurement and FEA to validate load capacity
  - Must follow ASME/OSHA guidelines (load test?)
  - Structure installation may take a whole day (~6 hours) and at least 2 technicians (likely more)
- Alterations to AO Enclosure
  - Hole in K1 AO roof for mounting

Additional Considerations

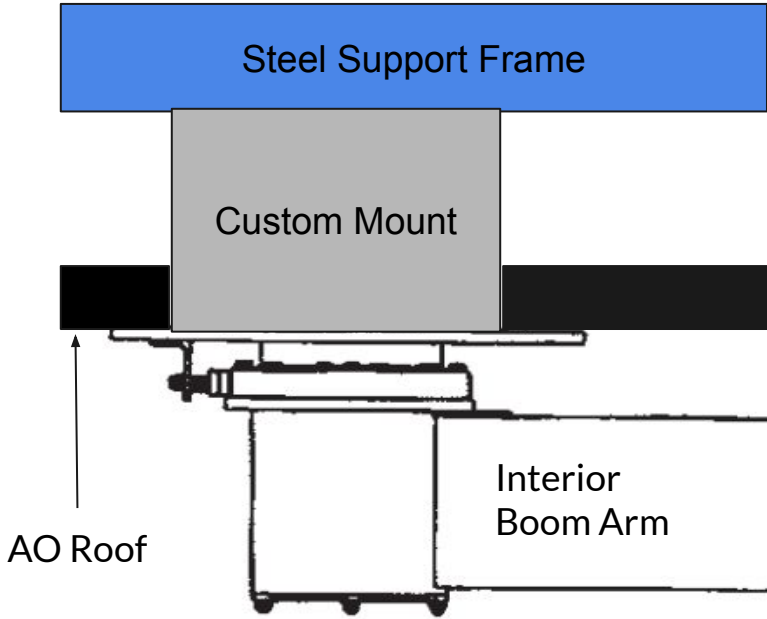
Mounting Fixture:

- Will be designed and analyzed by yours truly (primarily)
  - Takes design time away from actual crane
- Creates more load for I beams
  - Rough concept models have max weight of ~500 lbs
- Must be load rated (cantilever moment)
  - ASME/OSHA guidelines will apply
    - May require outside expertise (civil)

Stack up:

- Exterior arm cannot be mounted on top of interior
  - Guaranteed 24” minimum stack up (before hoist)

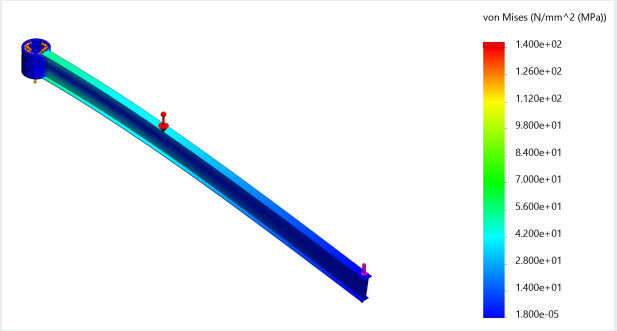
This design may prevent removal of AO Enclosure for dome crane access

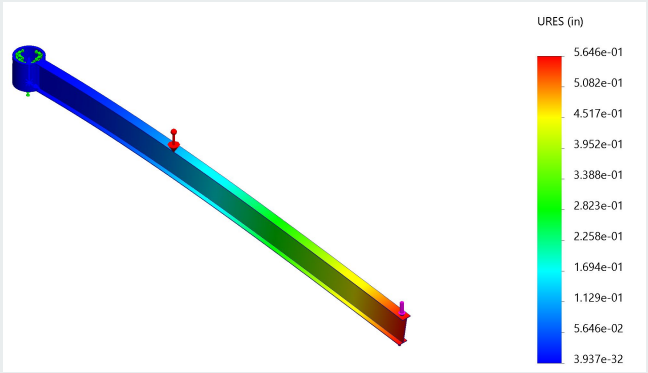


My Ranking

1. Bridge Crane
2. Free Standing Articulating Jib Crane
3. Ceiling Mounted Articulating Jib Crane

Next Steps...





- EC?
- CAD Design (dependent on concept chosen)
- Working with Jason on AO platform FEA
    - Investigate structural stability of “welded I-beams”
- Communication with vendors on best practices
    - Load testing/rating
- FEA (backed up by MathCAD)
- Reviewing ASME/OSHA guidelines
- Load testing and FEA for any mounting fixture
- FMEA
    - Mounting fixture
    - Seismic event analysis

Feedback:

What do you think about the proposed concepts?

What concepts/factors have I failed to consider?

Any and All feedback is greatly appreciated…

Thank you for your time!