

NSLS-II SRX Beamline KB Mirror System FDR

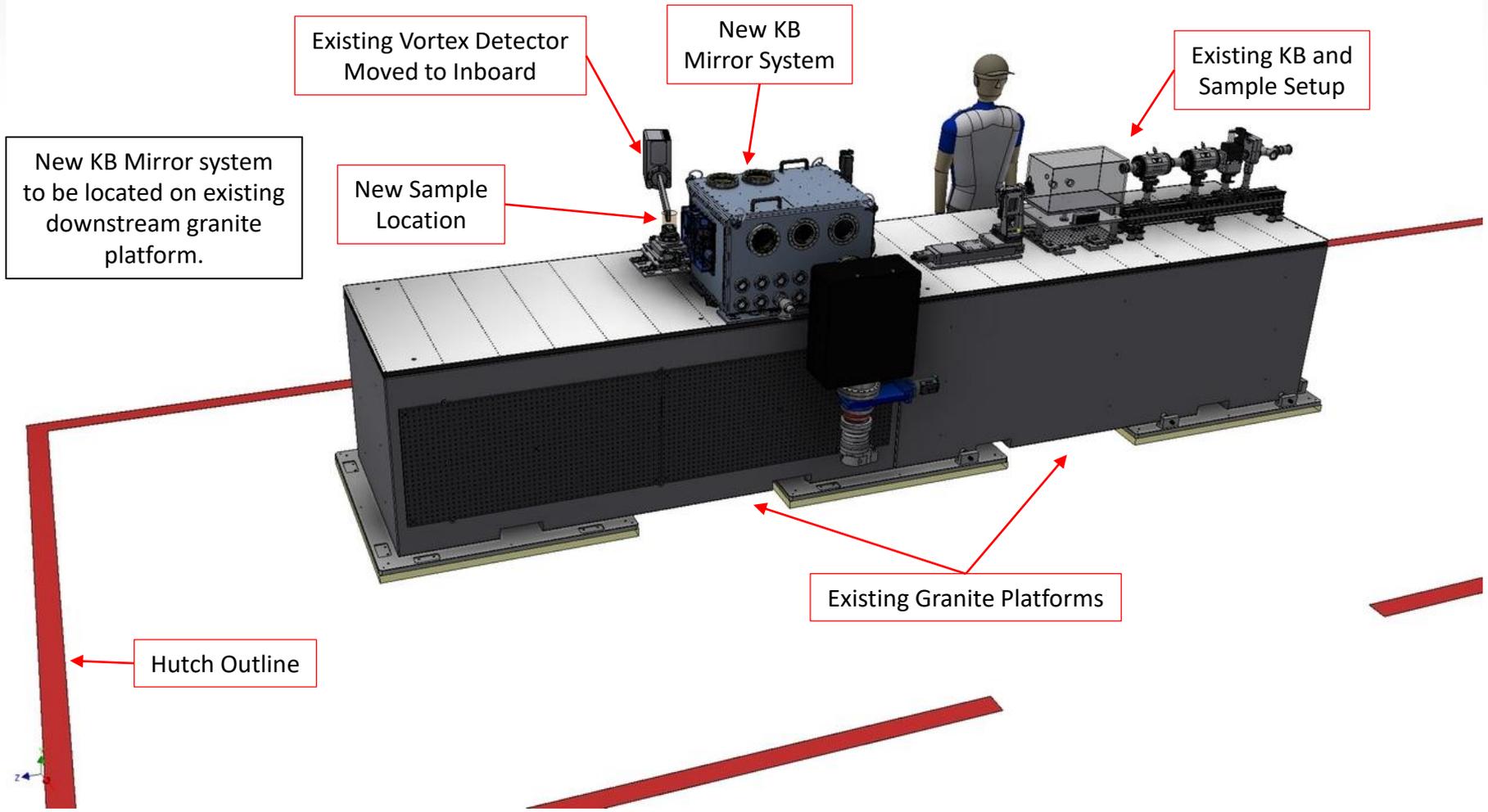
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Engineer

11 December 2018

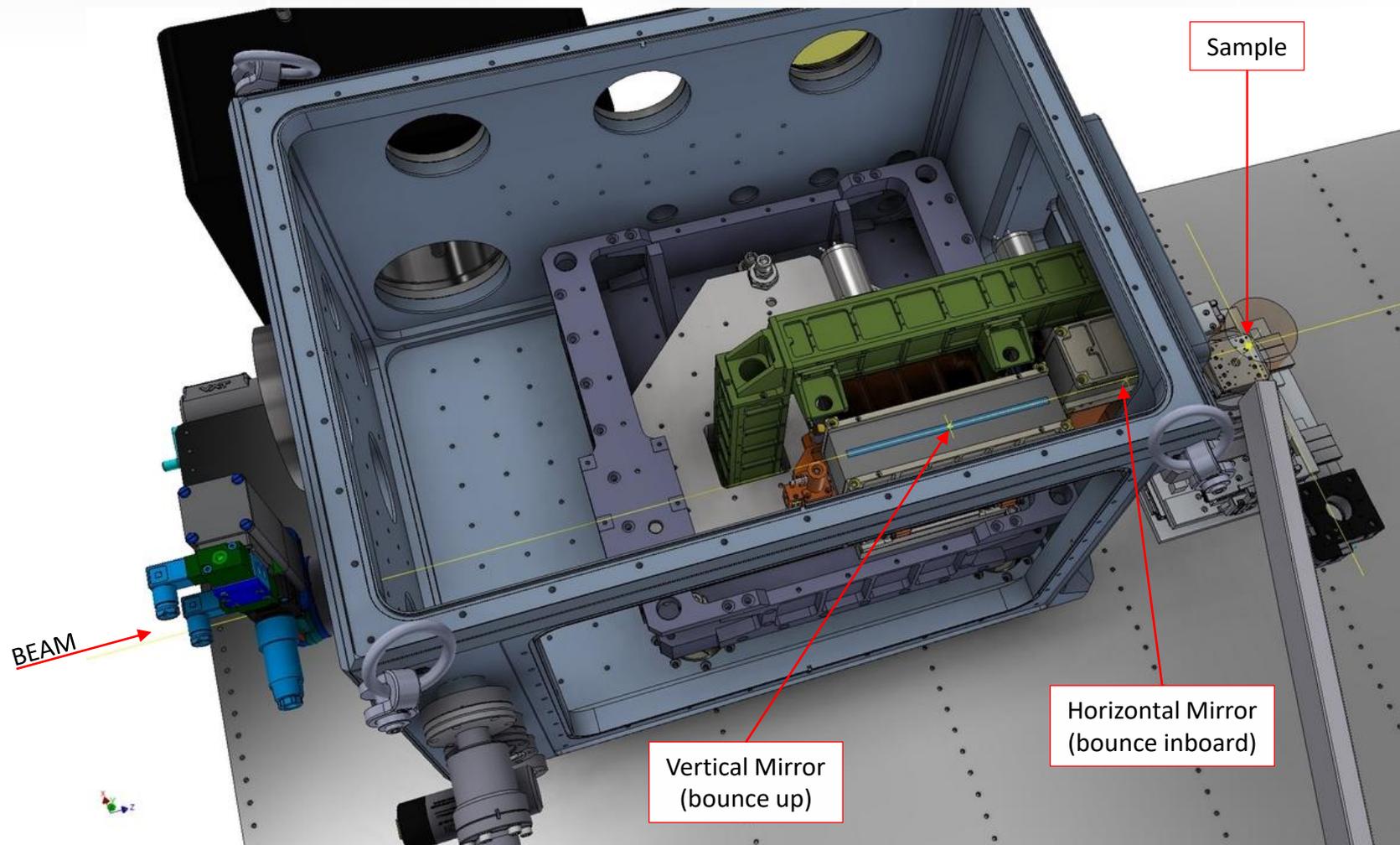
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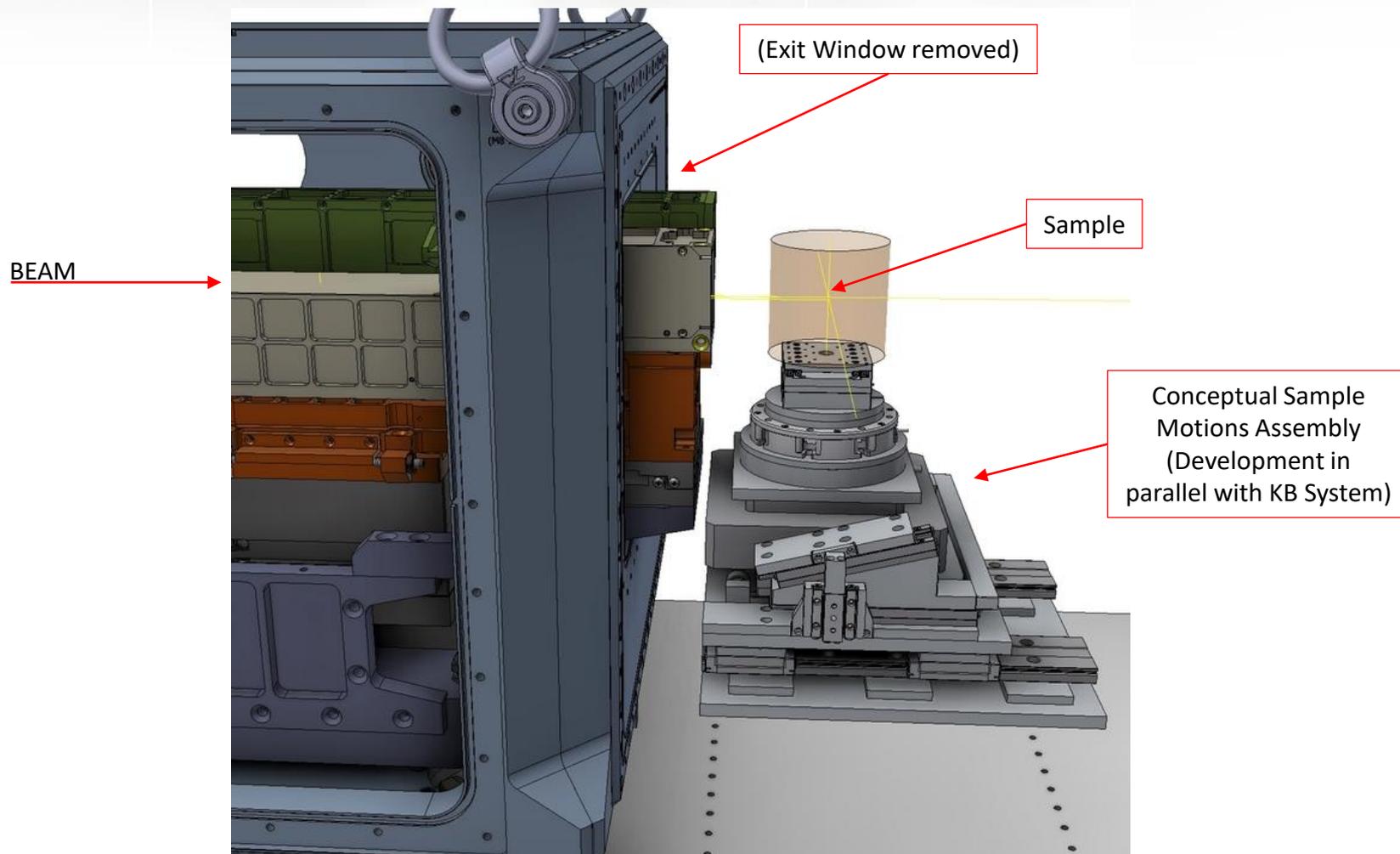
Overview



Overview (continued)

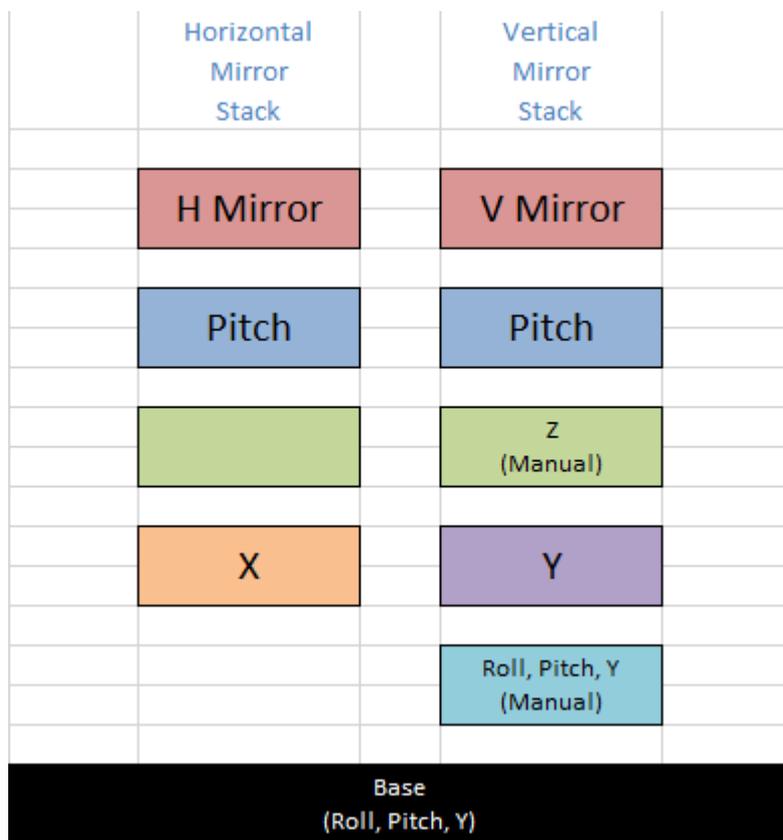


Overview (continued)



Motions & Specifications

Motions Stack-up Schematic



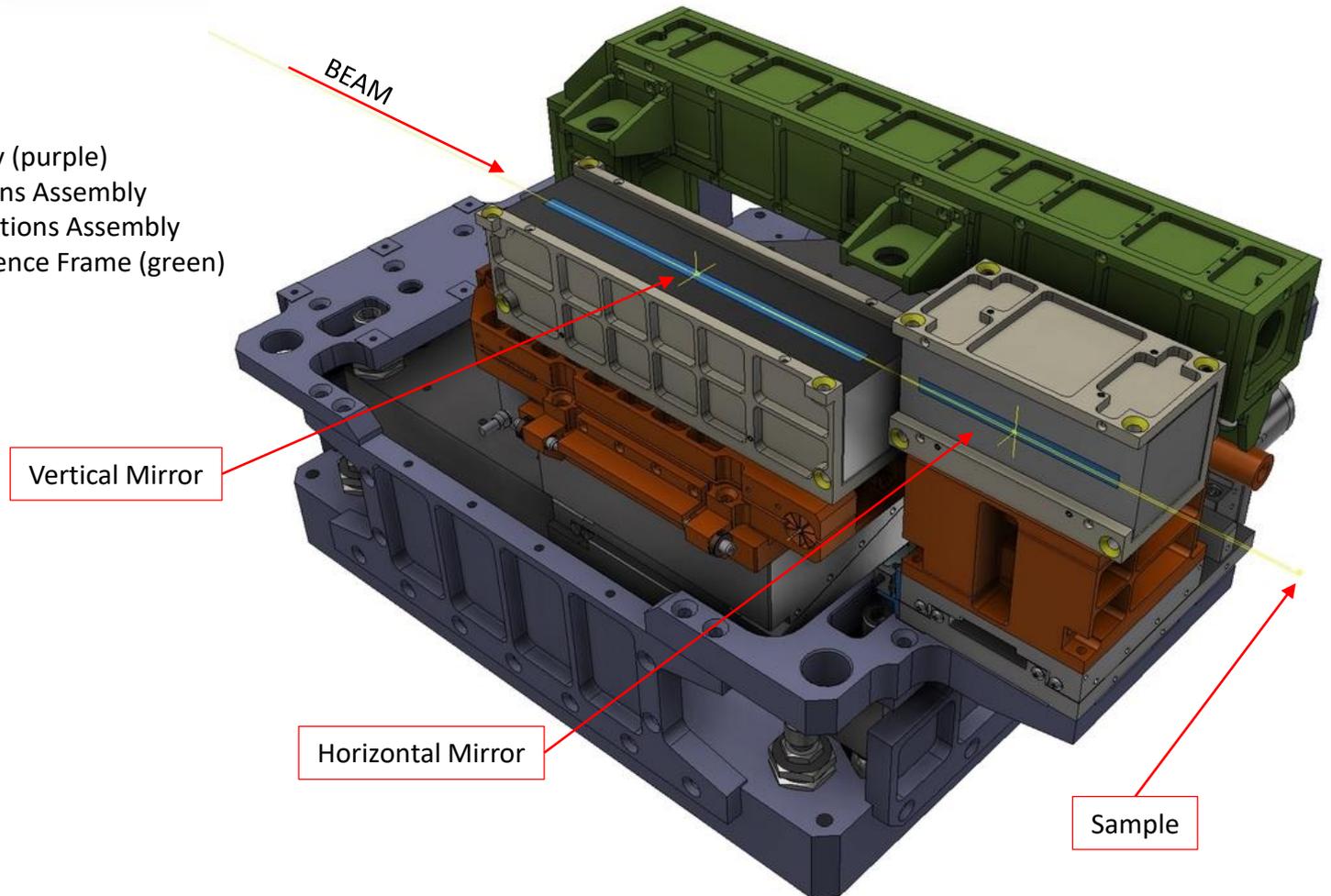
Motorized Motions Specifications

Motion	Negative Range	Positive Range	Resolution	Uni-dir Repeatability	Units
Vertical Mirror					
X					m
Y	-5.0E-3	5.0E-3	500.0E-9	500.0E-9	m
Z	-5.0E-3	5.0E-3			m
rx (pitch) coarse	-500.0E-6	4.5E-3	222.2E-9	000.0E+0	rad
rx (pitch) fine	-66.7E-6	66.7E-6	50.0E-9	50.0E-9	rad
ry (yaw)					
rz (roll)					
Horizontal Mirror					
X	-5.0E-3	5.0E-3	1.0E-6	300.0E-9	m
Y					m
Z					
rx (yaw)					
ry (pitch) coarse	-500.0E-6	4.5E-3	500.0E-9	000.0E+0	rad
ry (pitch) fine	-150.0E-6	150.0E-6	100.0E-9	100.0E-9	rad
rz (roll)					

For vertical pitch: 50 nrad step requires ~11 nm step from actuator

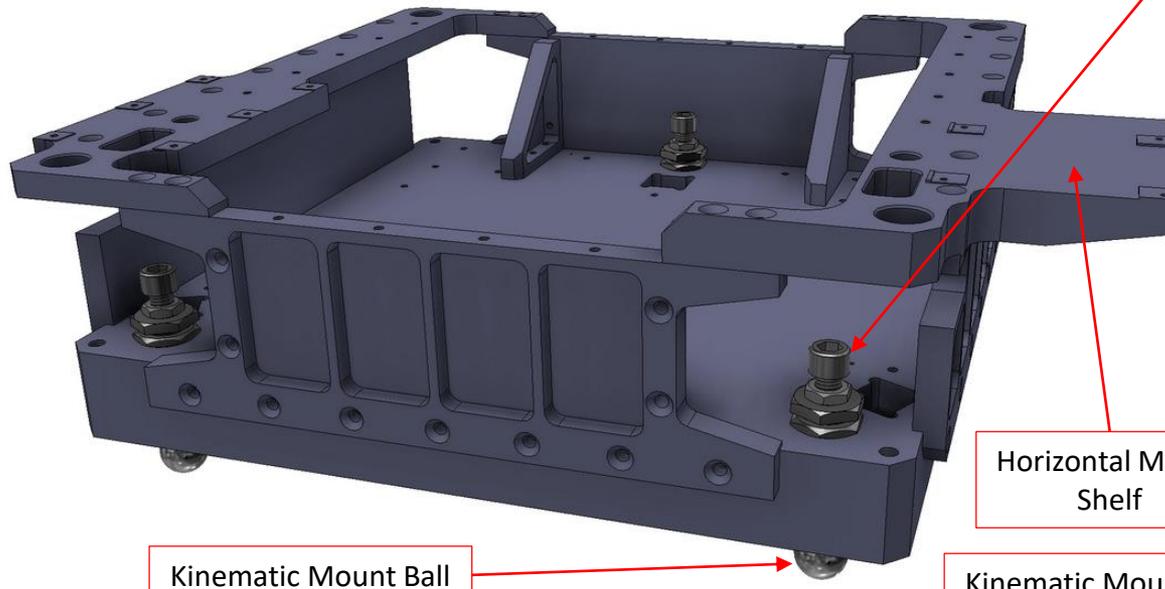
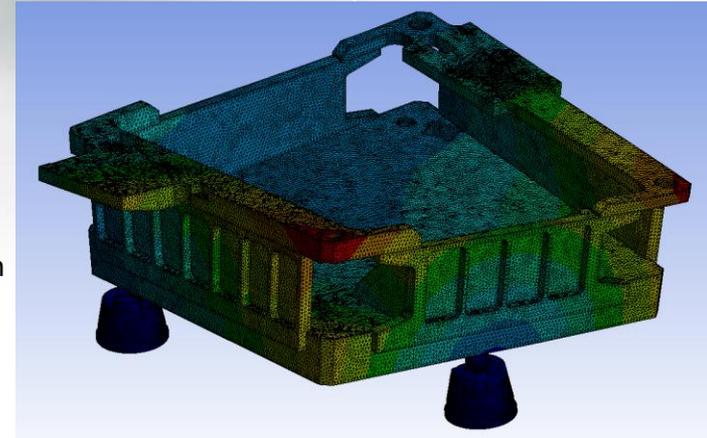
Motions Assembly

- Base Frame Assembly (purple)
- Vertical Mirror Motions Assembly
- Horizontal Mirror Motions Assembly
- Interferometer Reference Frame (green)



Base Frame Assembly

- 3-point kinematic mount
- Each kinematic ball sits in a groove with support directly to the granite platform
- Differential screw adjustment
- Fine adjustment is 0.25 mm per turn
- 300 mm ball spacing gives $\sim 800 \mu\text{rad}$ per turn (fine)
- Provides 3 “grooves” for the vertical mirror assembly kinematic mount
- Provides a “shelf” for the horizontal mirror assembly, which has 6 mrad yaw built-in (fixed)
- First vibration mode at ~ 92 Hz, second at ~ 125 Hz (with mirror motion mechanisms installed)

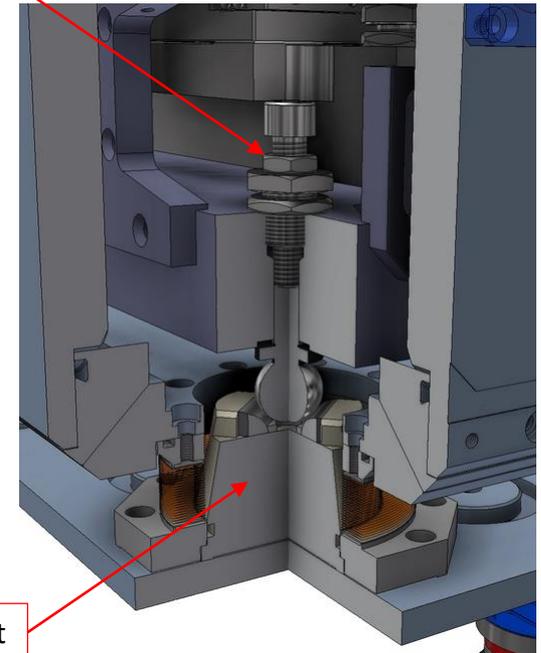


Differential Screw Adjuster

Horizontal Mirror Shelf

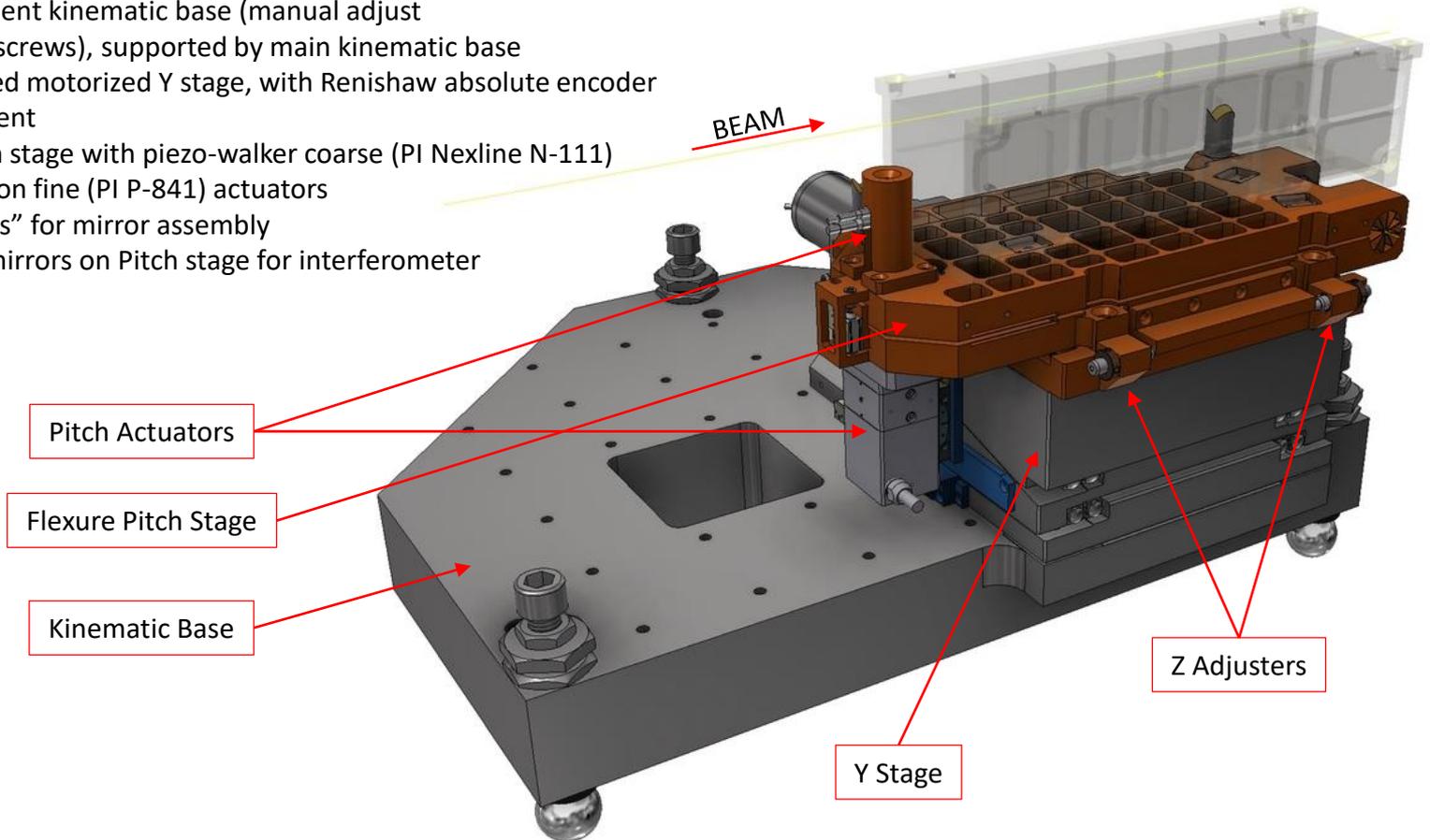
Kinematic Mount Ball

Kinematic Mount Post



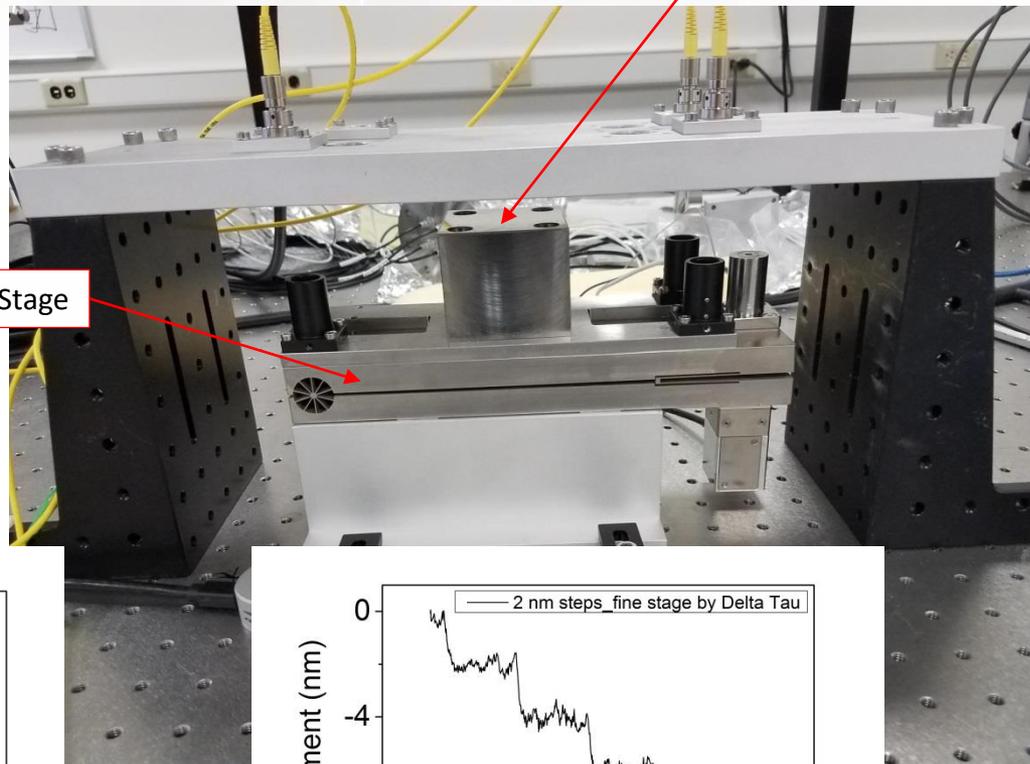
Vertical Mirror Motions Assembly

- Y/pitch/roll alignment kinematic base (manual adjust using differential screws), supported by main kinematic base
- Kohzu wedge-based motorized Y stage, with Renishaw absolute encoder
- Manual Z adjustment
- Flexure-pivot Pitch stage with piezo-walker coarse (PI Nexline N-111) and piezo-expansion fine (PI P-841) actuators
- Kinematic “grooves” for mirror assembly
- 2x retroreflector mirrors on Pitch stage for interferometer

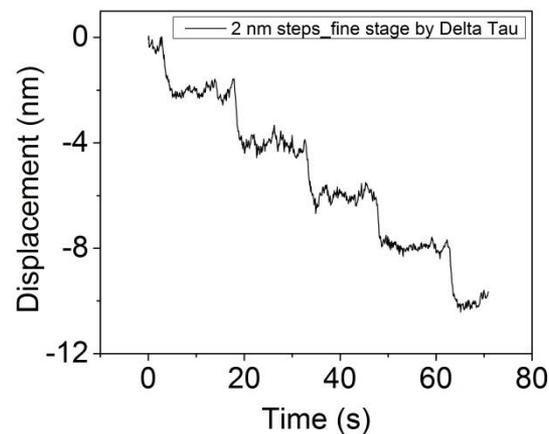
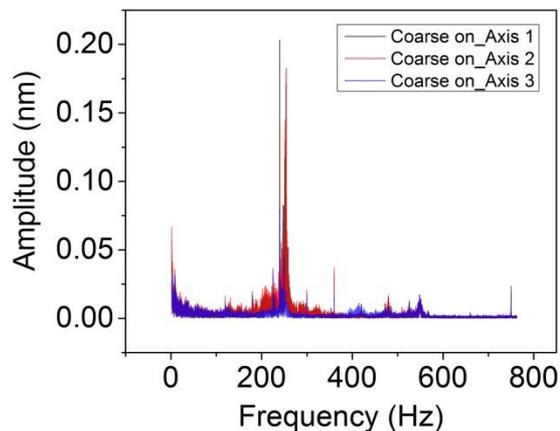


Vertical Pitch Flexure Testing

- Testing done in Metrology Lab in 703
- Two flexure designs tested
- Each was tested for various step sizes, repeatability, and stability, also resonant frequencies measured
- Design shown was selected for use
- Horizontal Pitch stage uses similar design



Plot showing resonant frequency of flexure

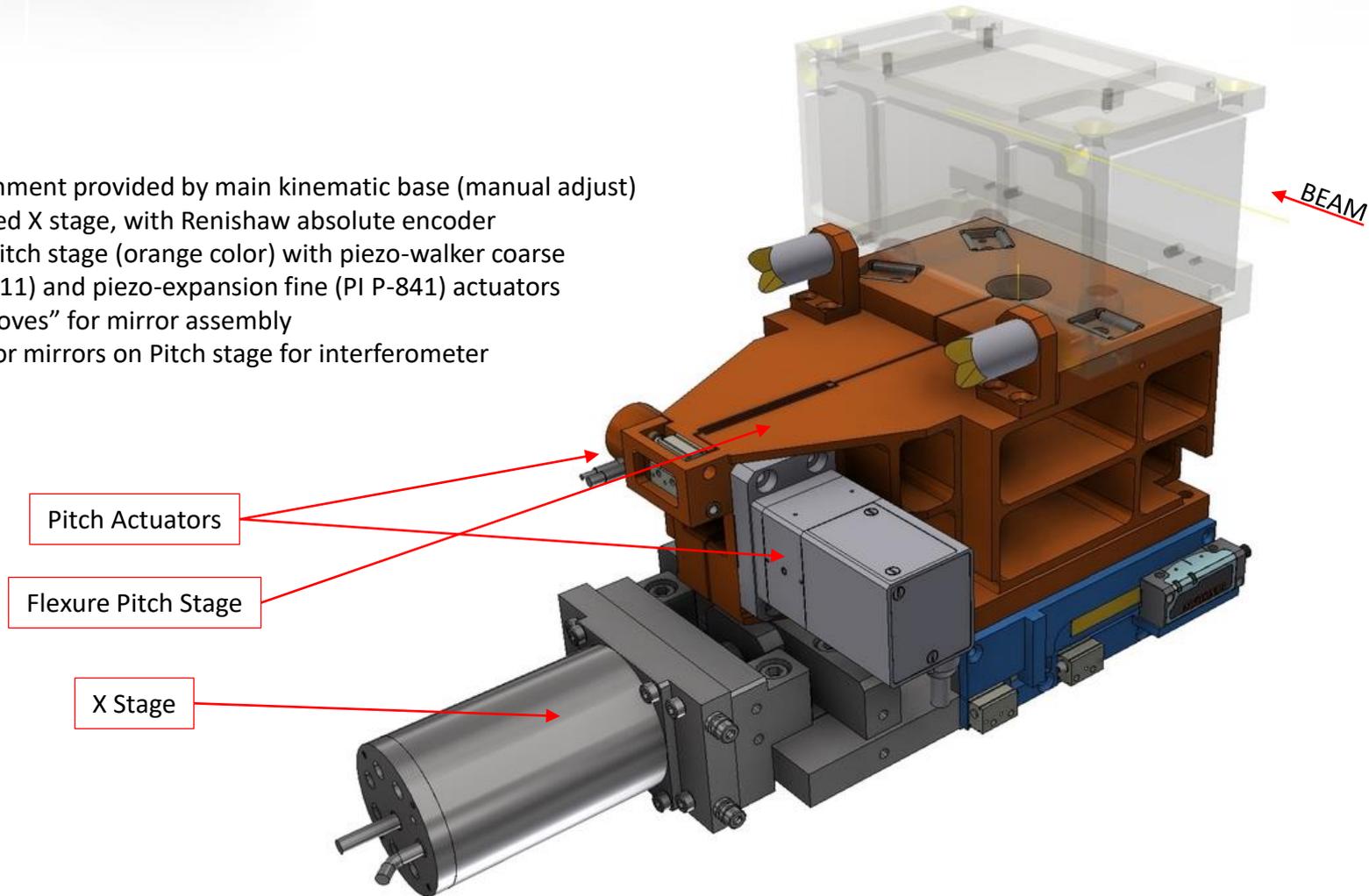


Plot showing 2 nm steps in under closed-loop control

Photo and plots: Weihe Xu

Horizontal Mirror Motions Assembly

- Y/roll/yaw alignment provided by main kinematic base (manual adjust)
- Kohzu motorized X stage, with Renishaw absolute encoder
- Flexure-pivot Pitch stage (orange color) with piezo-walker coarse (PI Nexline N-111) and piezo-expansion fine (PI P-841) actuators
- Kinematic “grooves” for mirror assembly
- 2x retroreflector mirrors on Pitch stage for interferometer

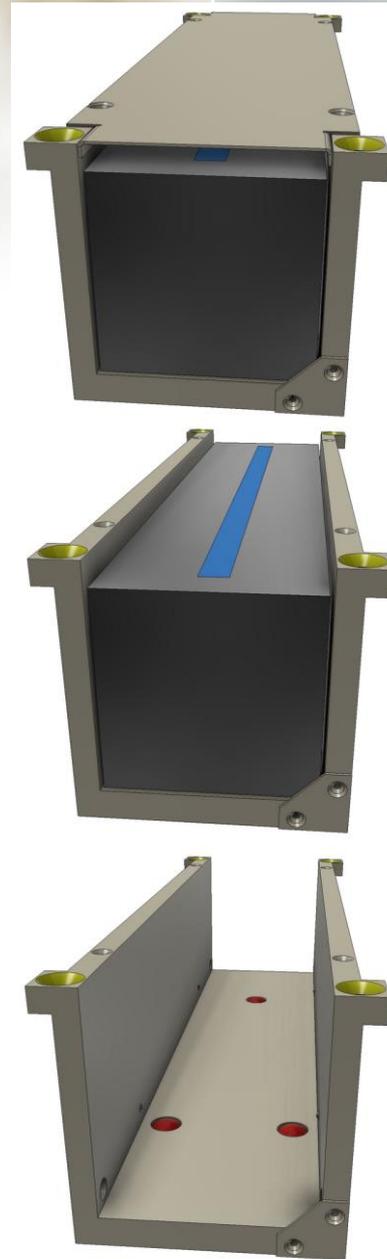


Mirrors

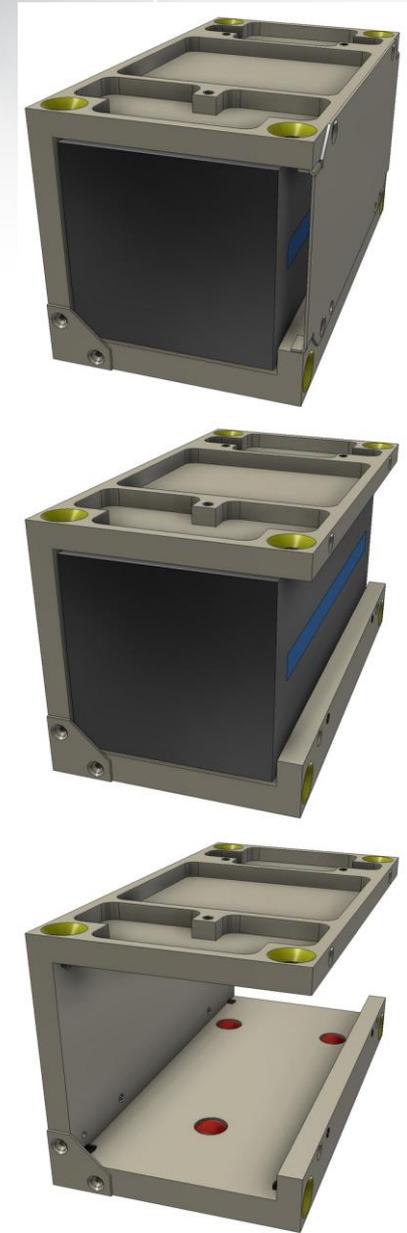
- Mirrors are “fixed-figure” elliptical-cylindrical (no bending).
- Mirrors “permanently” mounted into a frame which provides alignment, support, protection, and fiducial points.
- Frame provides a kinematic mount for mirror. Balls pass through the frame to the “grooves” on the Pitch stage below.
- Frame provides soft-point set screws for securing and aligning the mirror into the frame.
- Cover can be removed for metrology. Can be installed during handling, transport, in operation, etc.

Parameter	100L HFM	200L VFM	Units
Mirror Shape	Elliptical cylinder	Elliptical cylinder	----
Clear aperture length	>100	>200	mm
Clear aperture width	>7	>7	mm
Mirror Length	120	220	mm
Mirror Width	50	50	mm
Mirror Thickness	50	50	mm
Substrate material	Single crystal Si	Single crystal Si	----
Roughness (at 50x)	<0.3	<0.3	nm rms
Tangential slope error	<0.05	<0.07	urad rms
Tangential shape error	-	<0.8	nm rms
p(source to mirror center)	15156.6 *	65630 *	mm
q(mirror center to focal point)	125 *	295 *	mm
theta(incidence angle)	3	3	mrad
Radius in sagittal direction	>20	>20	km
Coating	Rh 30nm	Rh 30nm	----

Vertical Mirror

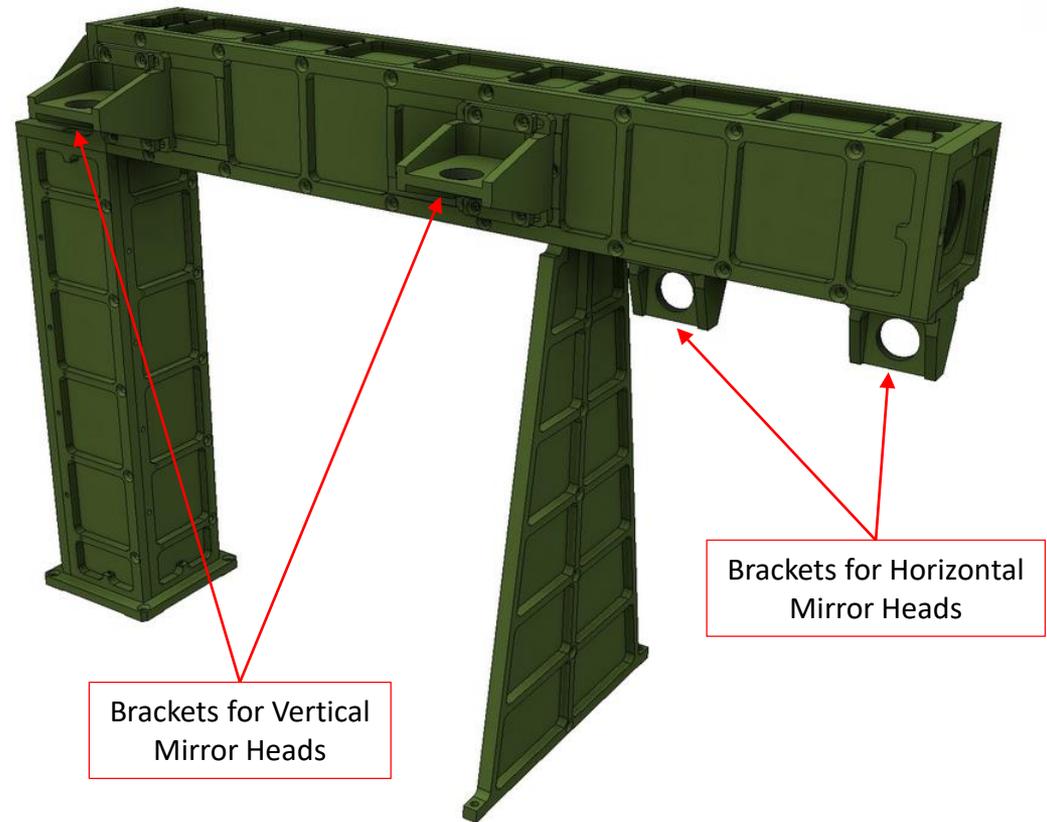
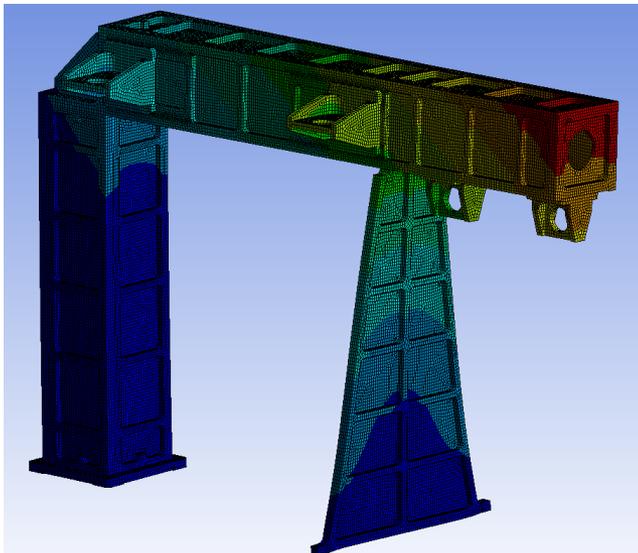


Horizontal Mirror



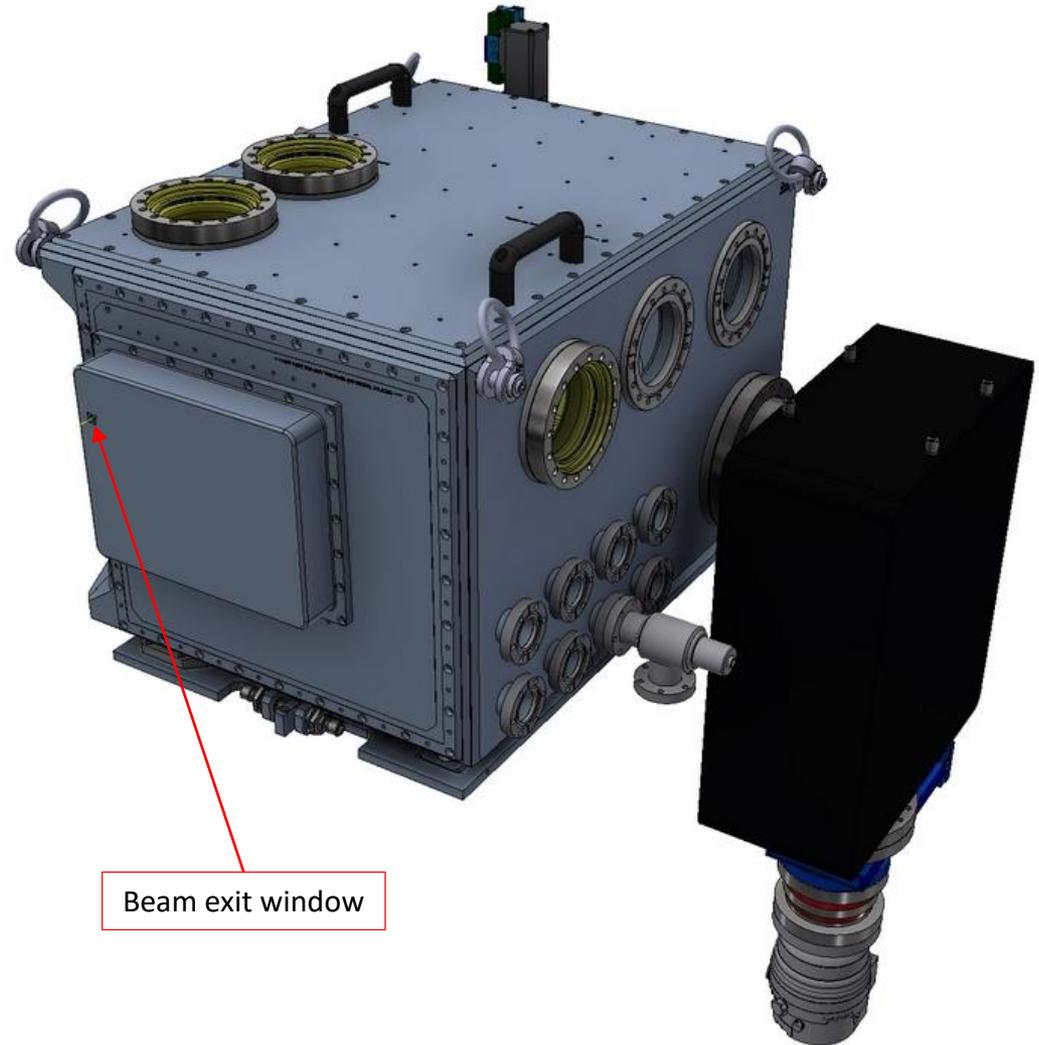
Interferometer Reference Frame

- Supported on Base Frame Assembly
- Invar box-beam construction
- Supports two interferometer heads for each mirror
- Allows monitoring/control of the pitch for each mirror
- First vibration mode at ~ 400 Hz
- Design to continue to increase stiffness

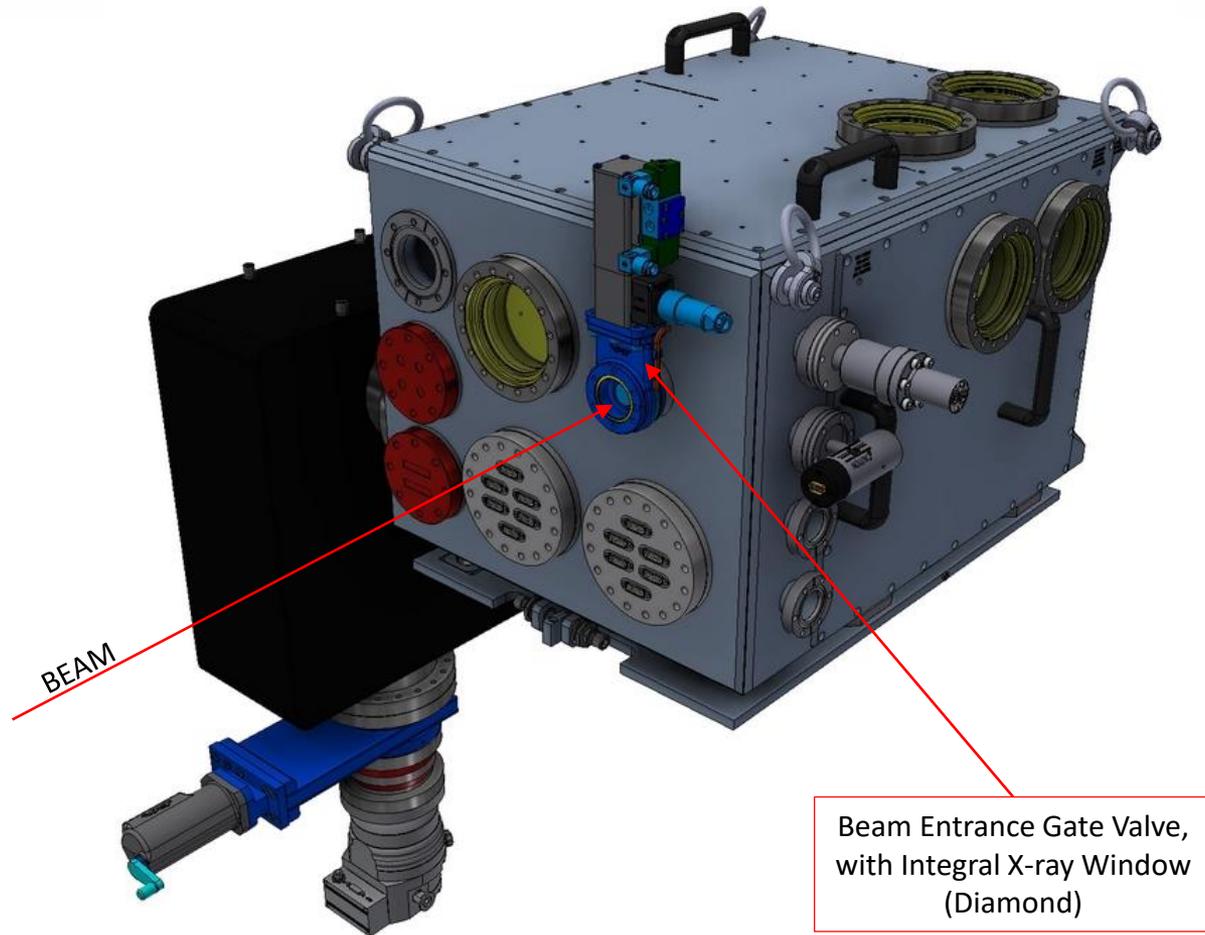


Vacuum Chamber

- High-vacuum ($1e-8$ Torr) design
- Welded stainless steel construction
- Three fixed faces (bottom, upstream, outboard)
- Three removable panels (top, inboard downstream), Viton O-ring seals
- Removable exit window “bump-out” cover
- Base plate provides X, Y, Pitch, Roll, and Yaw alignment (all manual)
- Provisions for hoist rings
- Ion pump, with port for turbo pump (if needed)
- Ports for viewing, vacuum gauges, pump-out valve, electrical feedthroughs, spares, etc
- Bellow feedthroughs for motion mechanism support posts
- More ports for lighting to be added

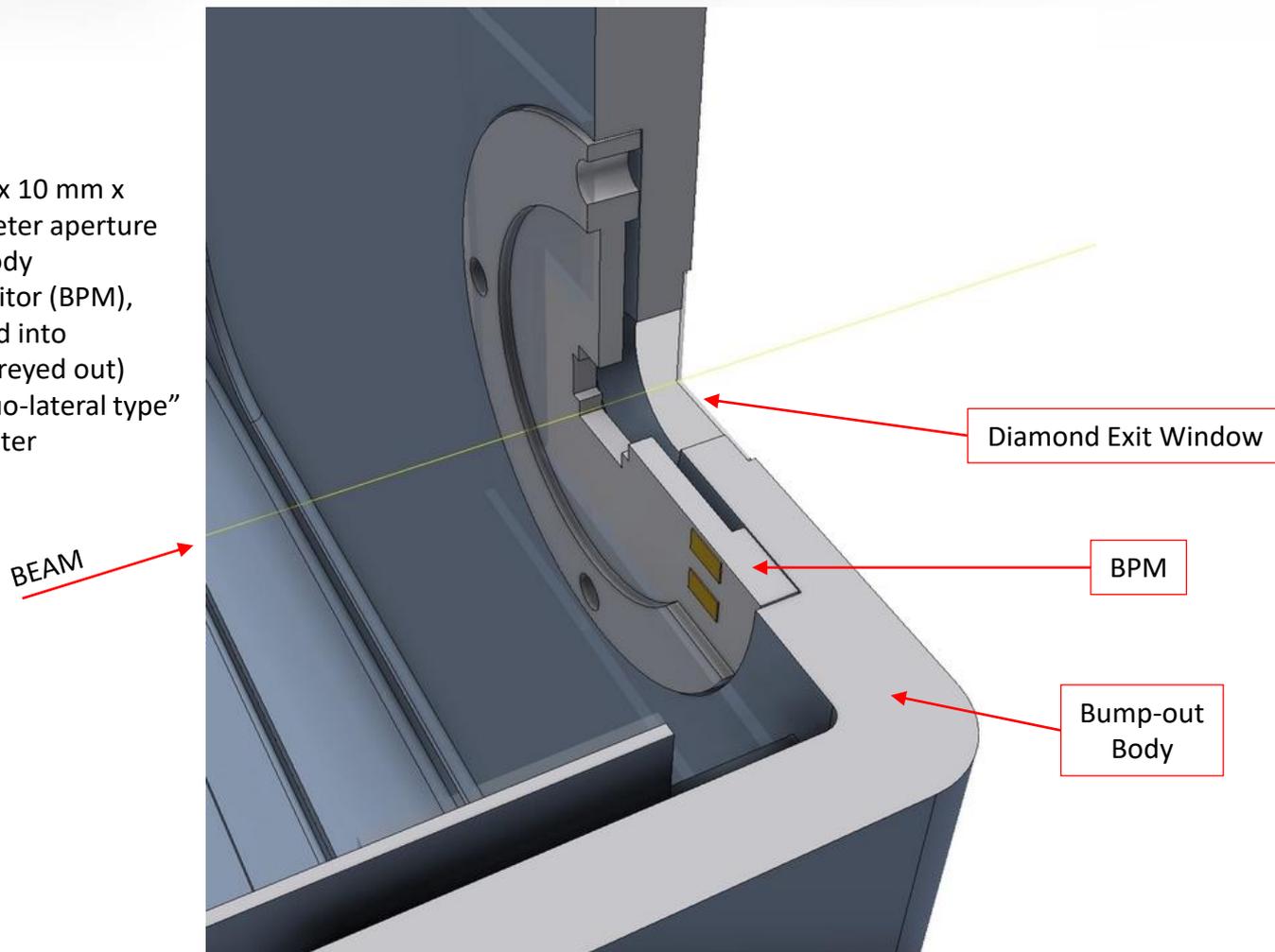
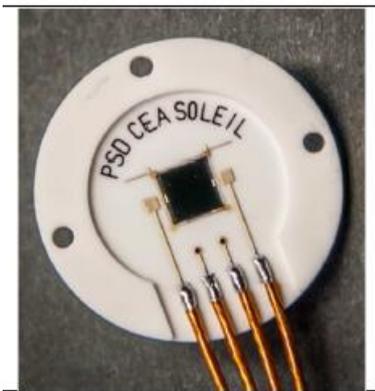


Vacuum Chamber (continued)

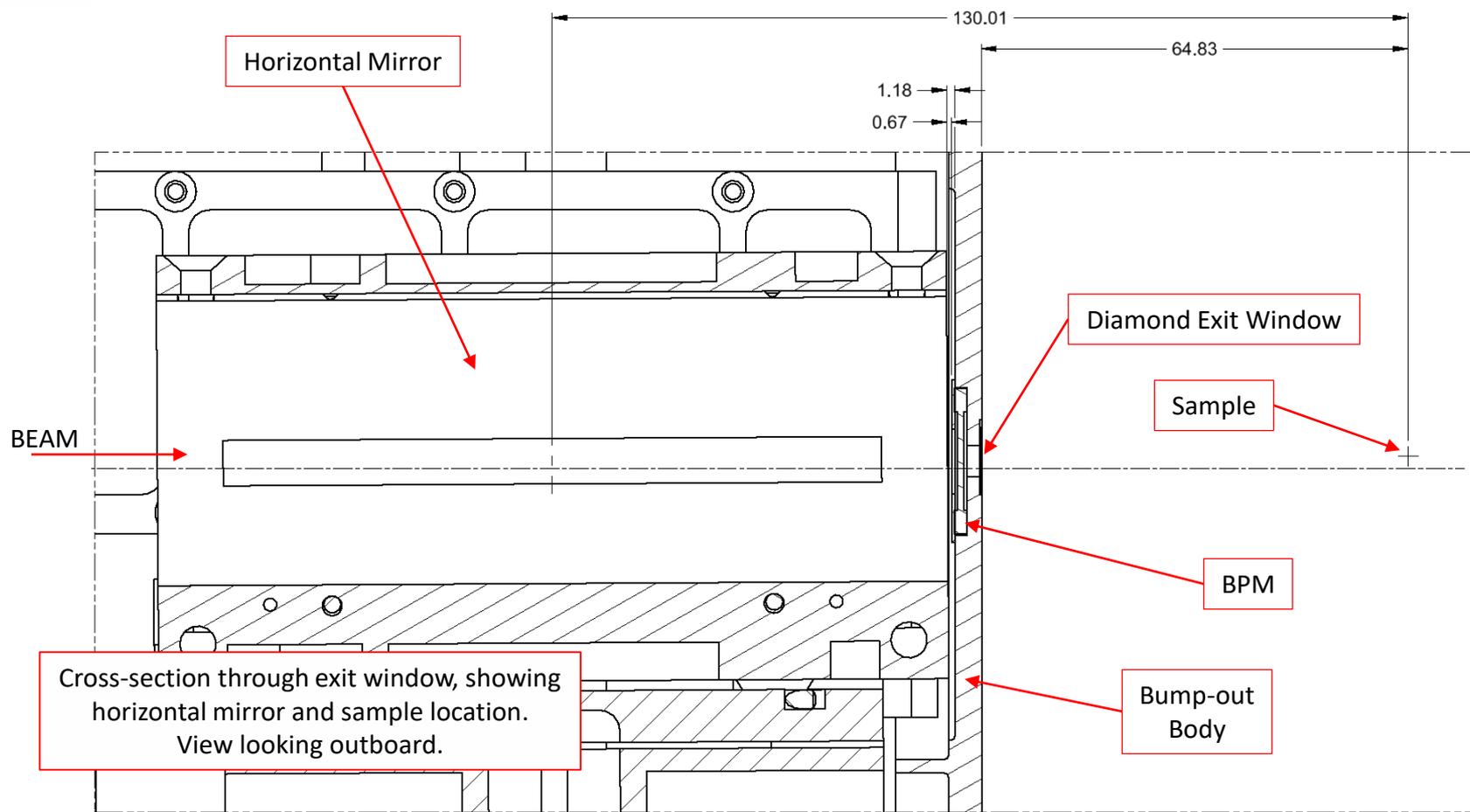


Vacuum Chamber, Exit Window

- Diamond exit window, 10 mm x 10 mm x 200 um thickness, 7 mm diameter aperture
- Window glued to bump-out body
- In-vacuum beam position monitor (BPM), aligned to beam by recess, held into place with clamping bracket (greyed out)
- BPM is “resistive electrodes duo-lateral type” from CAE/Soleil, 23 mm diameter

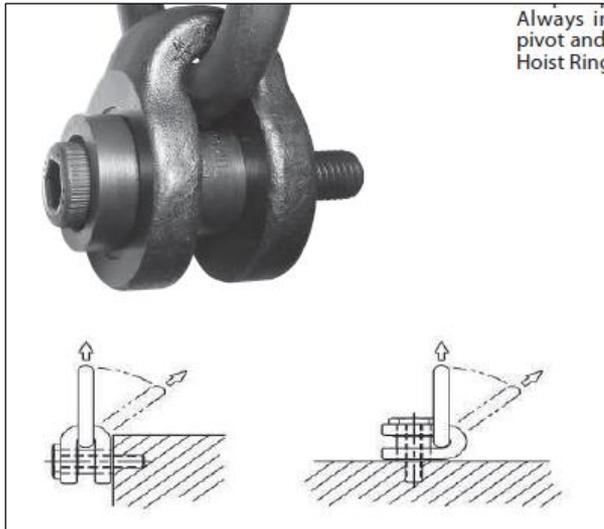


Vacuum Chamber, Exit Window (continued)



ESH, Lifting, Vacuum Chamber

- Chamber has four lift points
- One on each corner, with permanent label
- M8 tapped hole into the welded frame
- CarrLane CLM-36710-SPHR side-pull hoist rings
- Chamber empty weight is 450 kg (1000 lbs)
- Hoist ring rating is 400 kg (880 lbs) each
- Removable panels need hutch crane to lift (top panel is about 60 kg (132 lbs))
- Each removable panel has two tapped holes for lifting
- Each removable panel provided with handles for guiding during lift

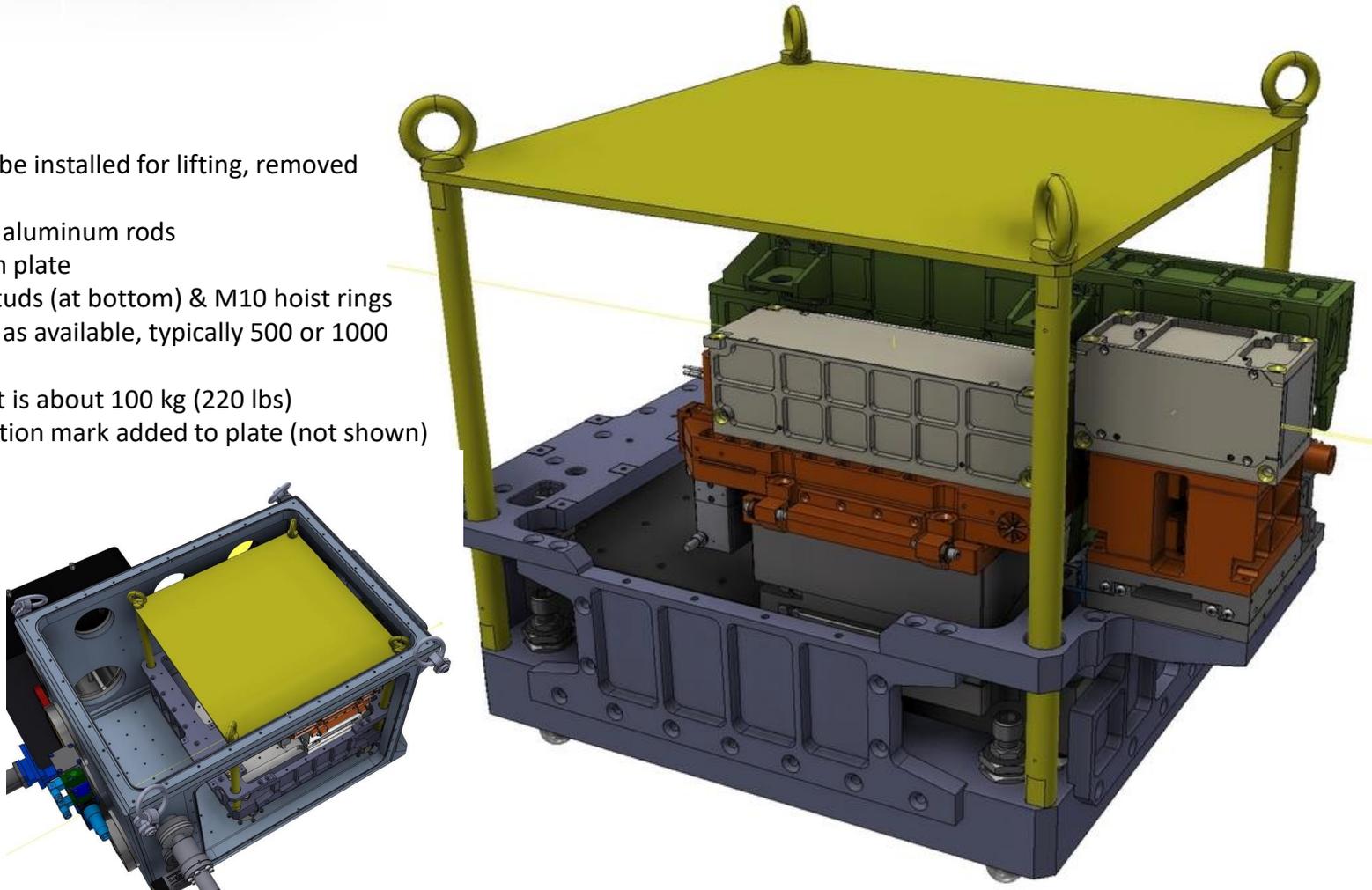


From CarrLane Catalog



ESH, Lifting, Motions Assembly

- Lifting Frame to be installed for lifting, removed after use.
- $\frac{3}{4}$ inch diameter aluminum rods
- $\frac{1}{4}$ inch aluminum plate
- M10 threaded studs (at bottom) & M10 hoist rings (Fixed or swivel, as available, typically 500 or 1000 lbs rating each.)
- Assembly weight is about 100 kg (220 lbs)
- CoG and orientation mark added to plate (not shown)



ESH, Other

- No gases or liquids fed into the chamber
- ?

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