An Overview of External Pre-Isolation (EPI)

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Outline

Key Ideas for the External Pre-Isolator

Geometry of a solution

Review of a single DOF isolation and alignment system

Differences between 1 and 6 degrees of freedom

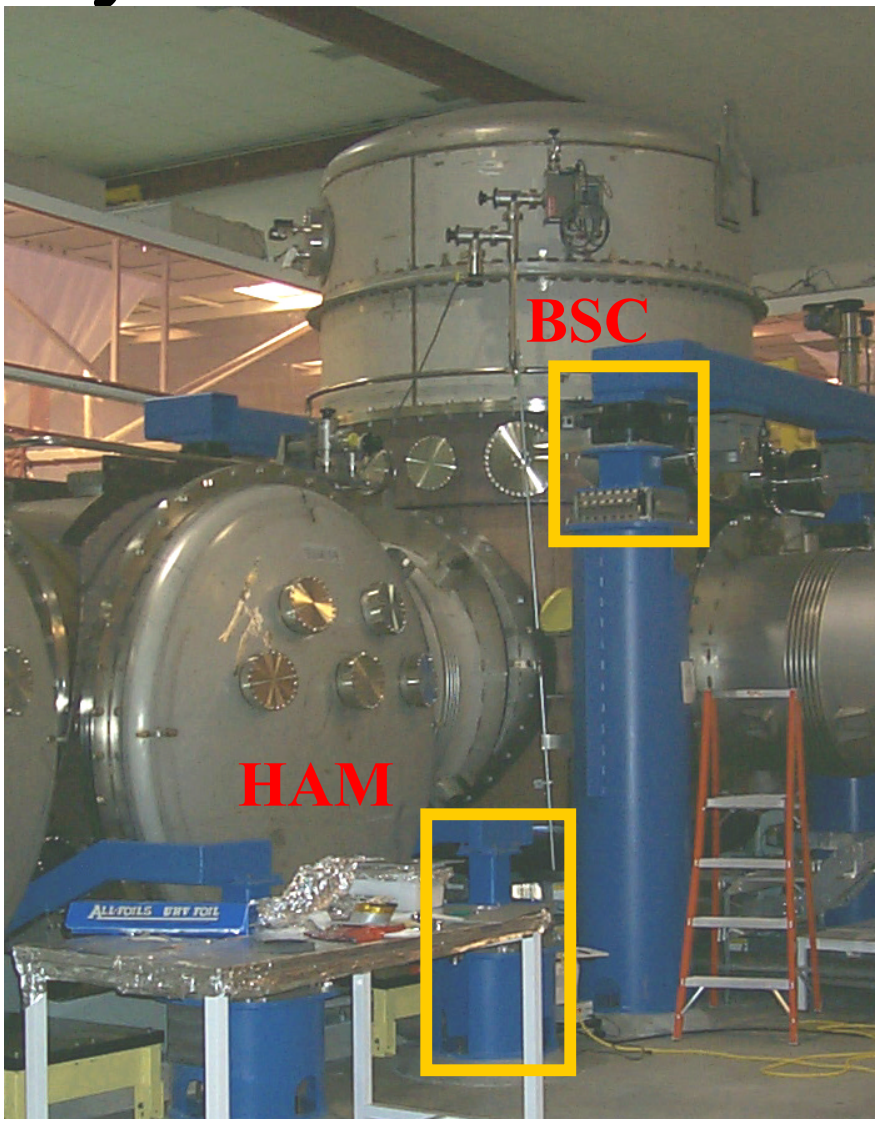
Installation of two systems at LASTI

Key ideas of the External Pre-Isolators (EPI)

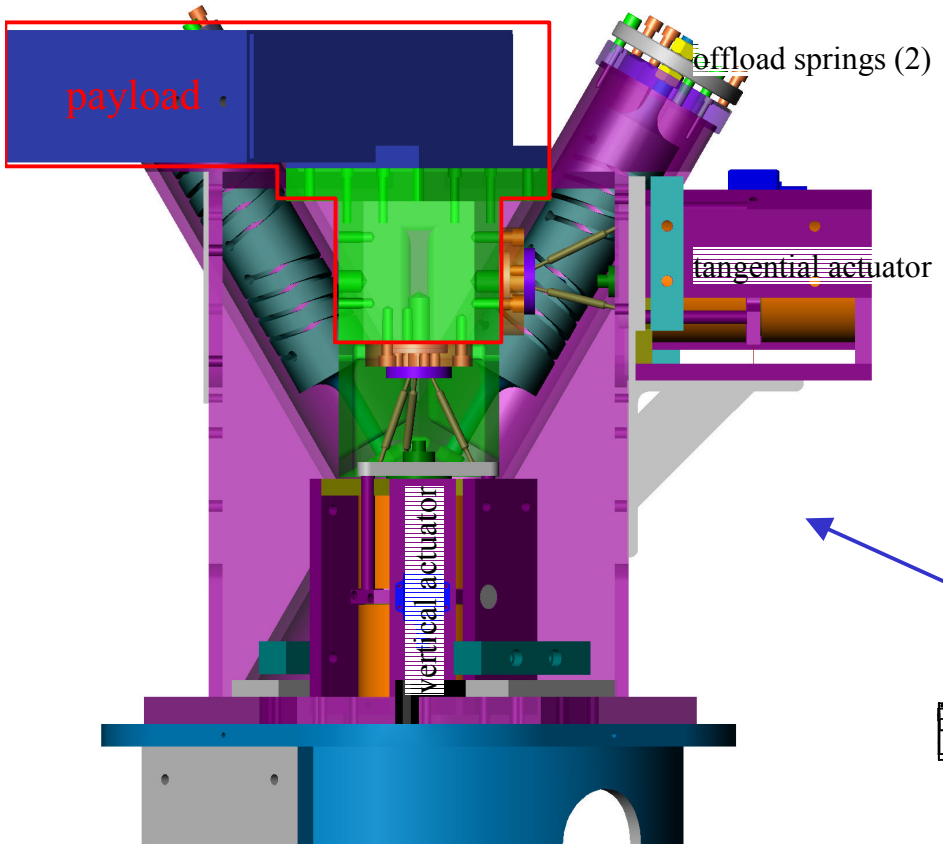
- Control the support table (base of the passive stack) in all 6 DOF
- Use active feedback to control the support table
  - Displacement sensors at low frequencies
  - Inertial sensors at high frequencies (sometimes)
  - Blend between high and low is ~0.5 Hz to 1.0 Hz
- Correct the displacement sensors with ground motion sensors
- Isolate all three translational DOFs from microseism to ~ 10 Hz
- Achieve necessary performance from .15 Hz to 3 Hz
- Achieve performance with minimal disruption to the interferometer

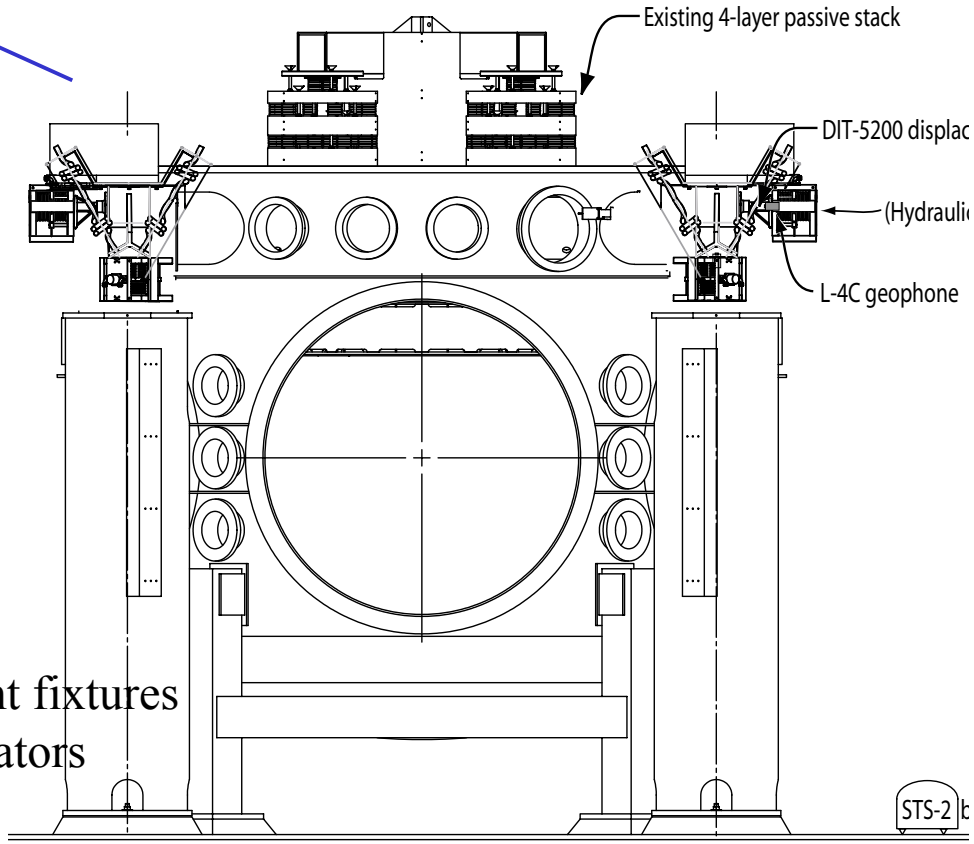
Placement of an External Isolation System

- Install an isolation and alignment system without opening the chambers.
- Replace the coarse and fine actuators which are currently between the pier and the cross beam weldment (which hold the support tubes and support table)
- New system will act to hold support table still in the presence of ground motion



Placement of the Actuators and Offload Springs





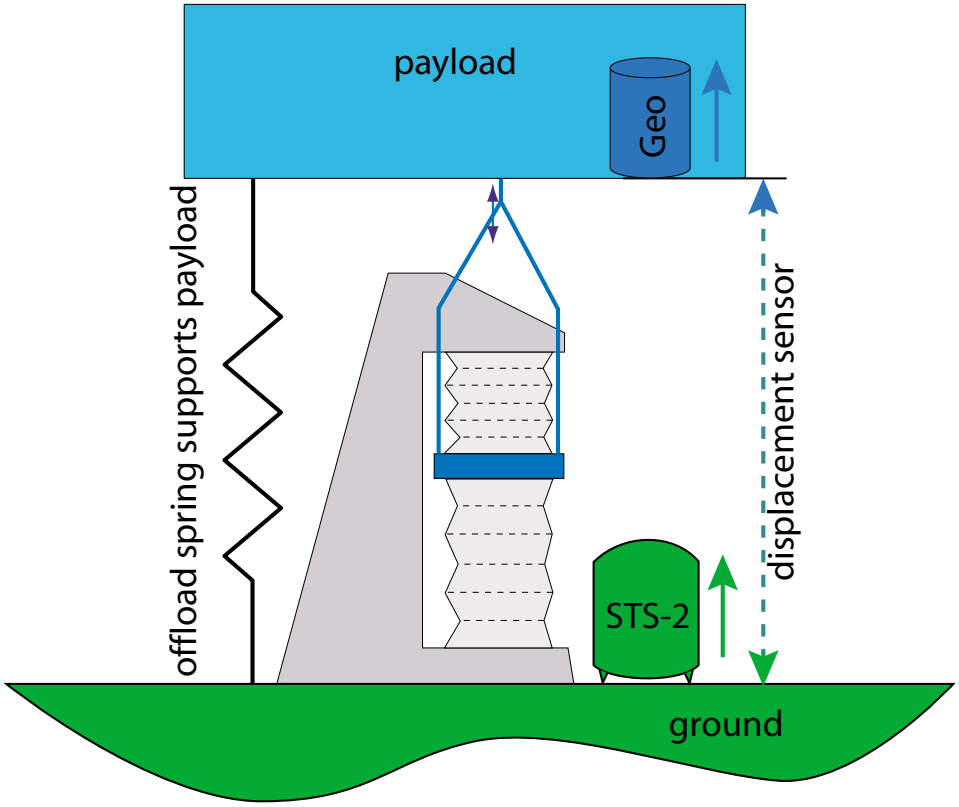
Drawings courtesy of Ken Mason

All the pier-top components are mounted into a frame

Frame holds:

- 1 vertical and 1 tangential actuator,
  (isolation and alignment in 6 DOF)
- Pair of offload springs and initial alignment fixtures
- Sensors which are not included in the actuators

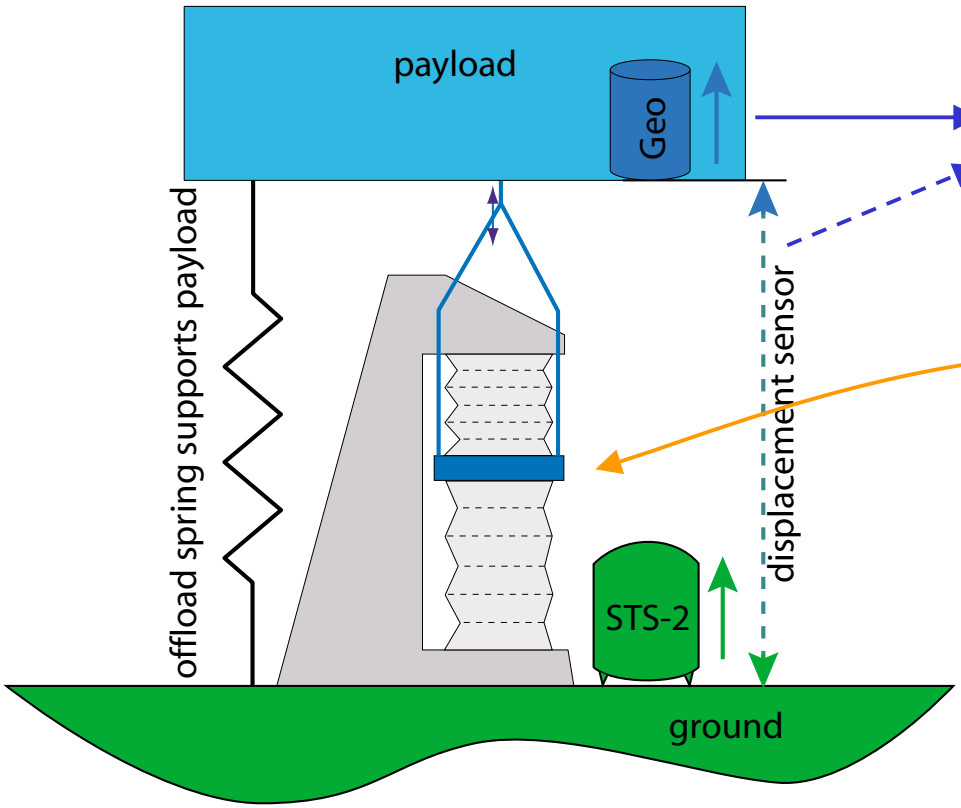
How to maintain Alignment, and have Isolation from the Ground

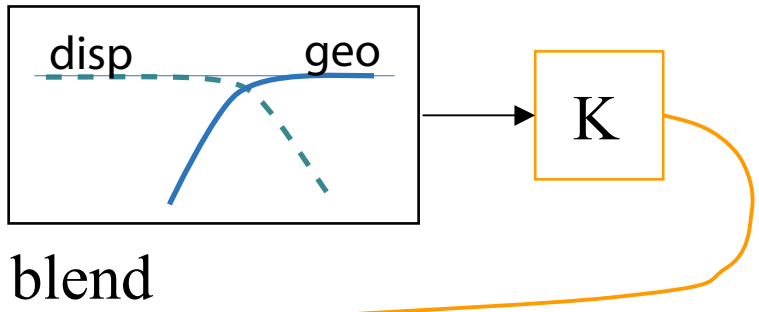


Simple model for 1 DOF has:

- Payload to be isolated from the
- Ground
- Offload springs to support the load and set the static alignment
- Feedback displacement sensor
- Feedback inertial sensor
- Actuator
- Translational DOFs have ground motion sensors

How to maintain Alignment, and have Isolation from the Ground

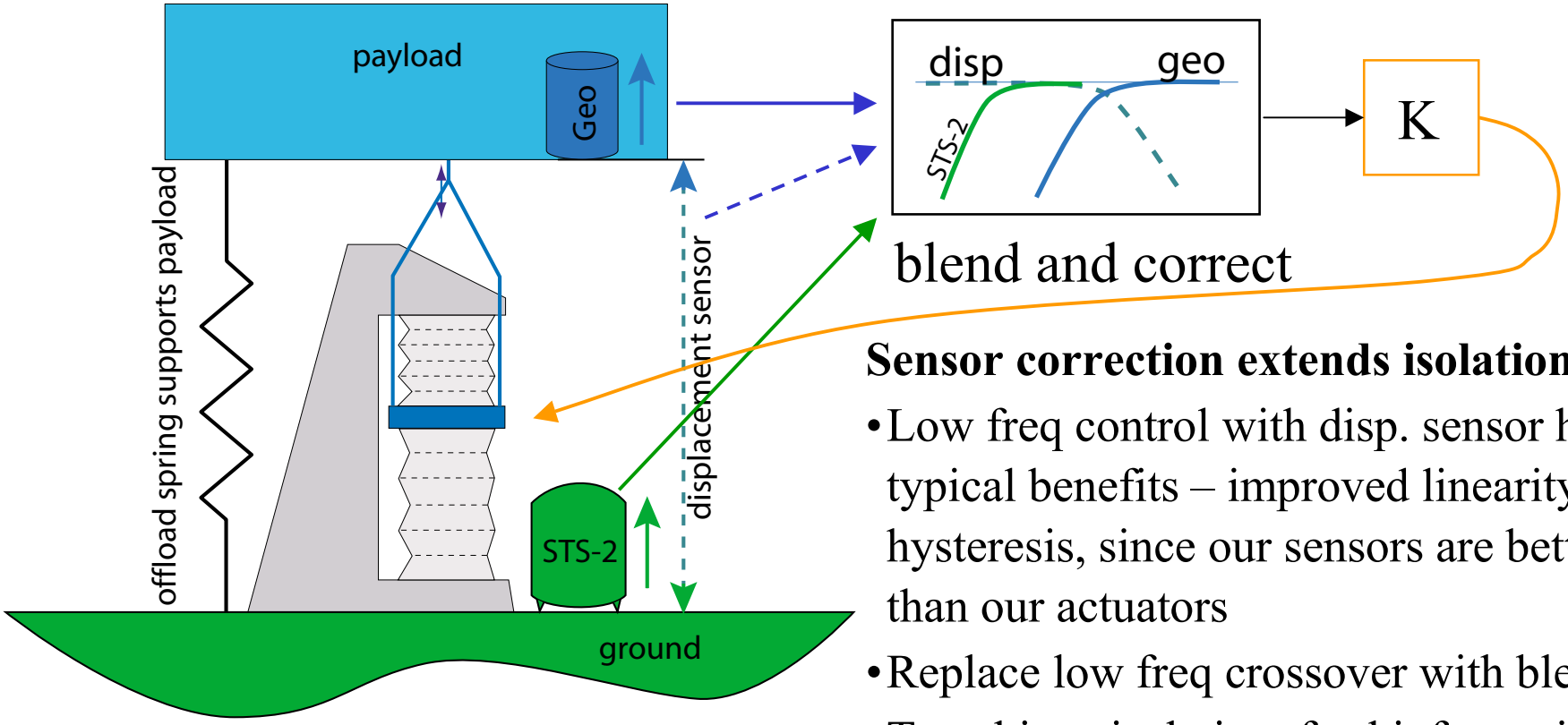




To make a control loop:

- Blend displacement and inertial sensors (super sensor)
- Add control, drive actuator
- Below blend freq it's a positioning system (command alignment to DC)
- Above blend freq it's an isolation system from ground motion
- Always resists external payload forces

How to maintain Alignment, and have Isolation from the Ground



Sensor correction extends isolation:

- Low freq control with disp. sensor has typical benefits – improved linearity, hysteresis, since our sensors are better than our actuators
- Replace low freq crossover with blend
- To achieve isolation, feed information from STS-2 to correct the displacement sensor.

Implementation in 6 DOF

- Piers at the four corners can be used for 6 DOF system with vertical and tangential actuators, sensors, and offload springs.
- Offload springs form a V to give better load handling.
- At low frequencies, translations are different than rotations because (based on PEPI results) slab translations cause more problems that slab rotations.
- At low freq (microseism to a few Hz) isolate against translations, and actively lock payload rotations to slab rotations.

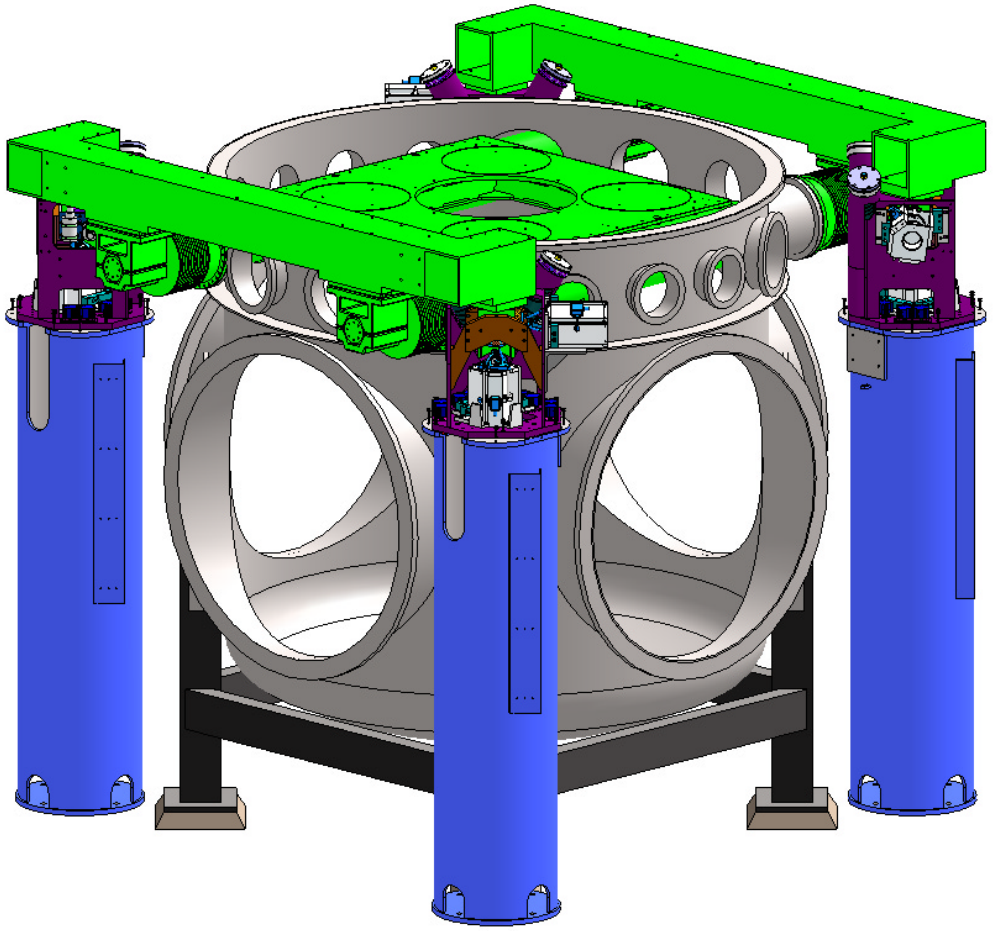
Implementation in 6 DOF

Piers support the payload (blue)

EPI system frame (purple) atop the pier

EPI controls the support table (green)

Stack (not shown) sits on the support table



Recently…

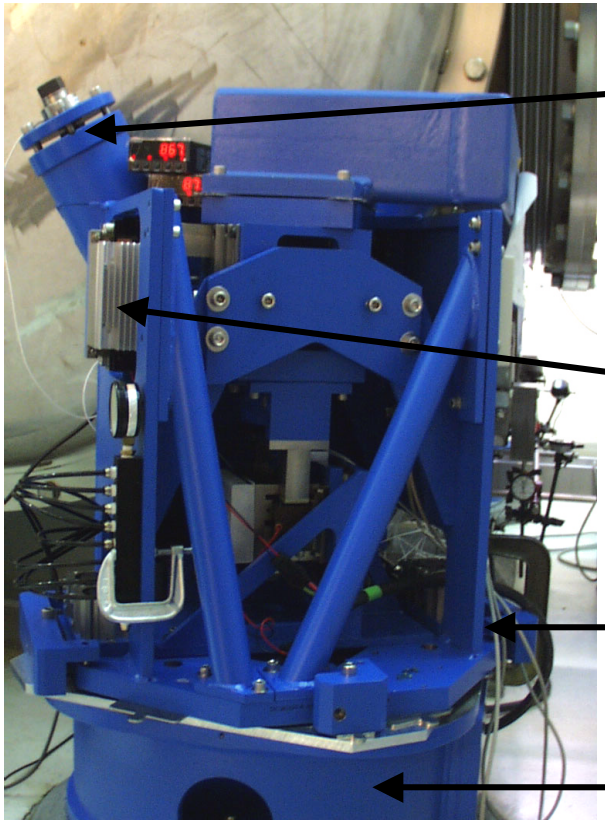
There are now 2 full systems installed at LASTI.

Baseline is a system with hydraulic actuators now installed on the LASTI BSC.

Backup system uses electromagnetic actuators now installed on a HAM chamber.

Two types of actuators under test at LASTI

MEPI on HAM



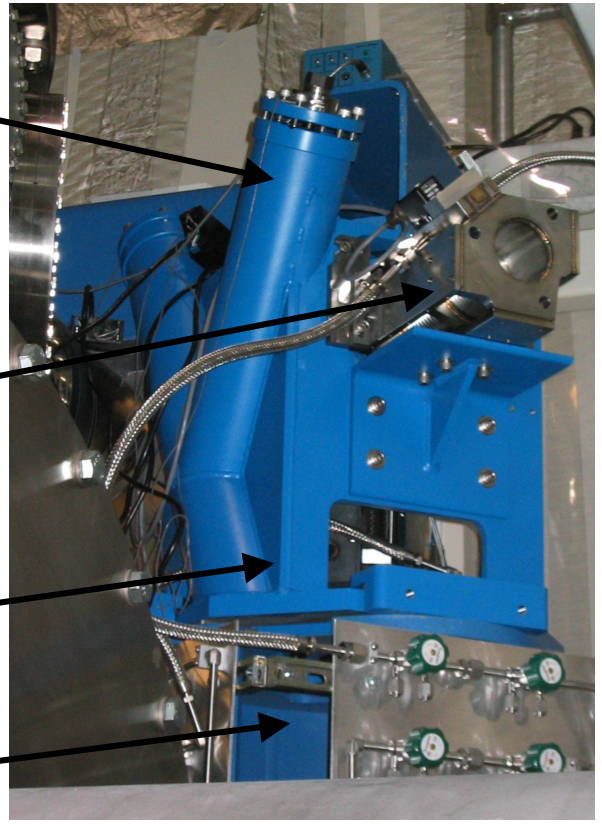
springs

horizontal actuators

frames

piers

HEPI on BSC

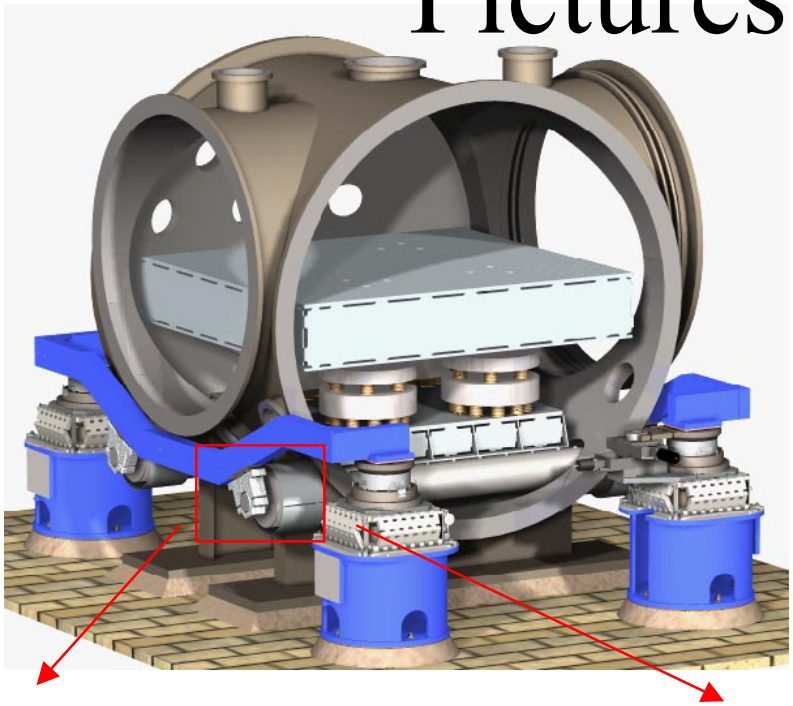


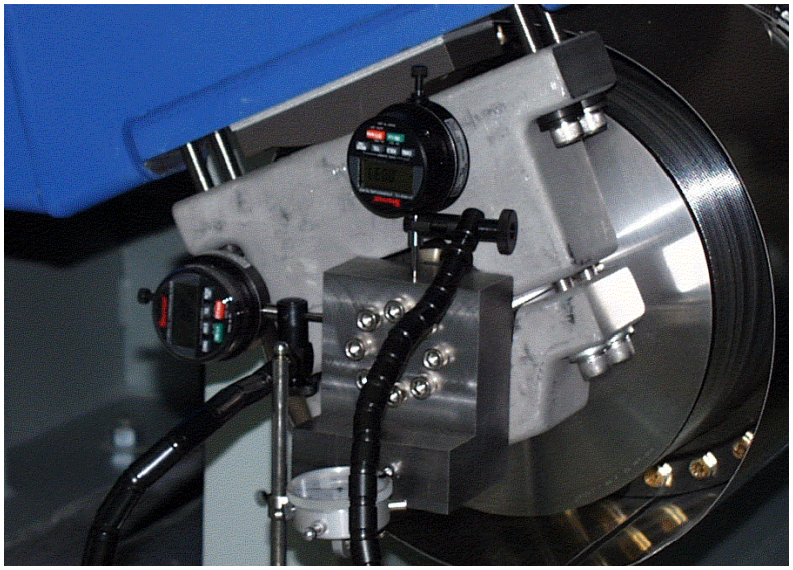
Installation

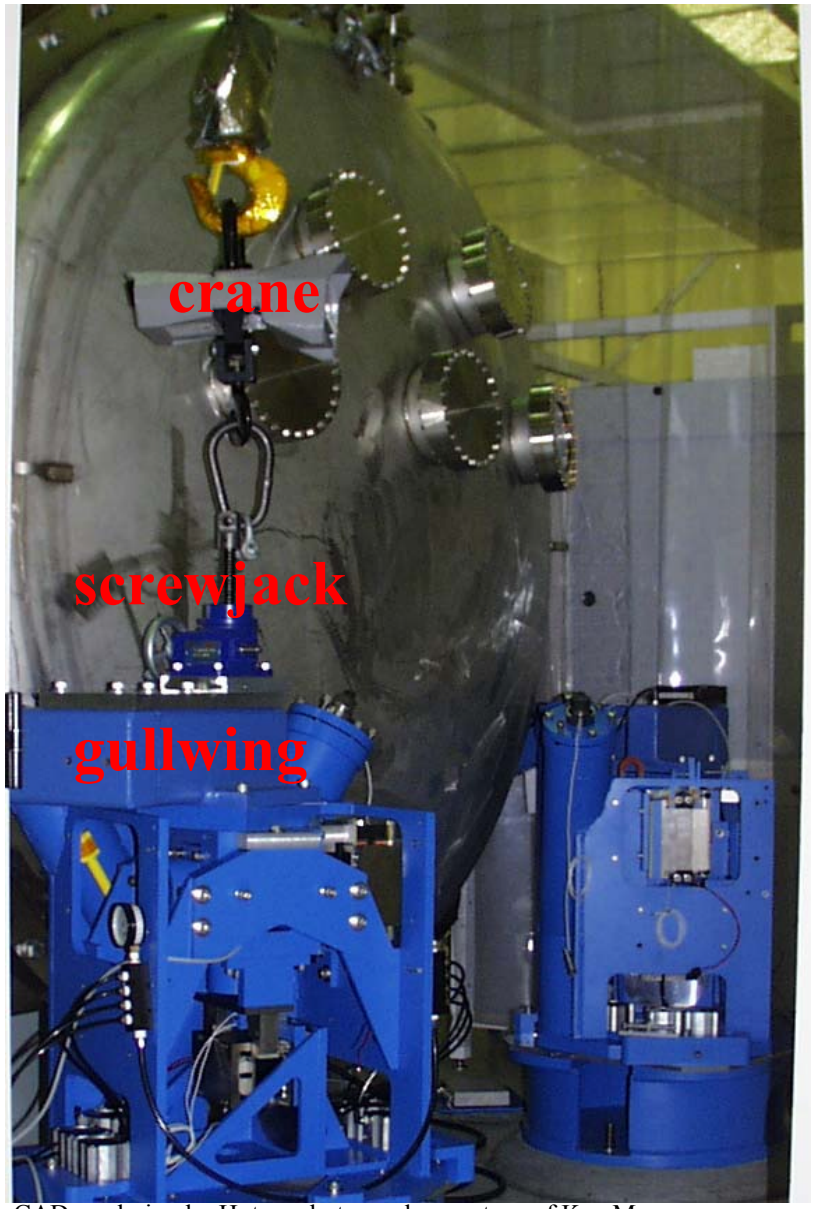
Do not open the vacuum chambers.
Do not disturb the alignment of the installed optics.
Do not drop the baby.

1. Instrument the position of the support table
2. For each corner, lift the crossbeam weldment (.010”) with the crane and manual screwjack
   a) Lower the scissor jack
   b) Remove the old coarse and fine actuators
   c) Install the new frame and actuators
   d) Align the frame, align the payload, align the sensors & actuators
3. With all 4 new corners installed, iterate the alignment with the offload springs and coarse actuation system. (.001”)

Pictures of HAM Installation







CAD rendering by Hytec, photographs courtesy of Ken Mason

Summary

What I covered:

1. We are using an External Pre-Isolator because it can be installed with minimal disruption to the interferometer
2. The geometry of EPI should allow alignment in 6 DOF, and low frequency isolation in translation.
3. Described the way we blend and correct sensors to get alignment and isolation

Still to come:

1. Brian will talk about the HEPI control and performance.
2. Rich Mittleman will talk about the MEPI control and performance.