



---

# Update on the HAM Large Triple Suspension (HLTS)

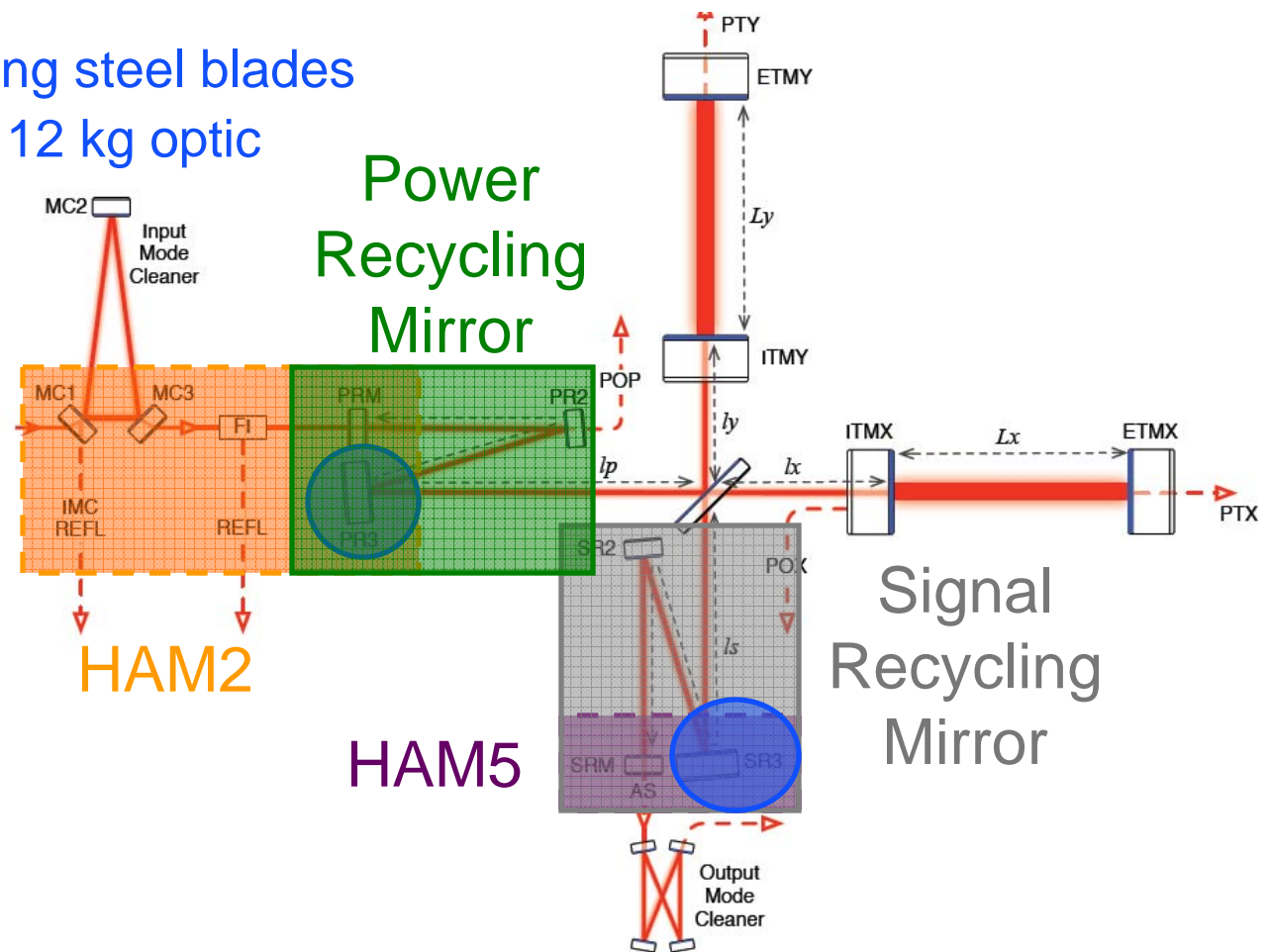
Advanced LIGO Suspensions  
LIGO-Virgo Meeting  
March 2010

[Derek Bridges](#) representing Advanced LIGO  
Suspensions team

<http://ilog.ligo-wa.caltech.edu:7285/advligo/Suspensions>

# HLTS – Why and Where

- HAM Large Triple Suspension (HLTS)
  - Triple pendulum
  - 2 stages of maraging steel blades
  - 265 mm diameter, 12 kg optic





# HLTS History

---

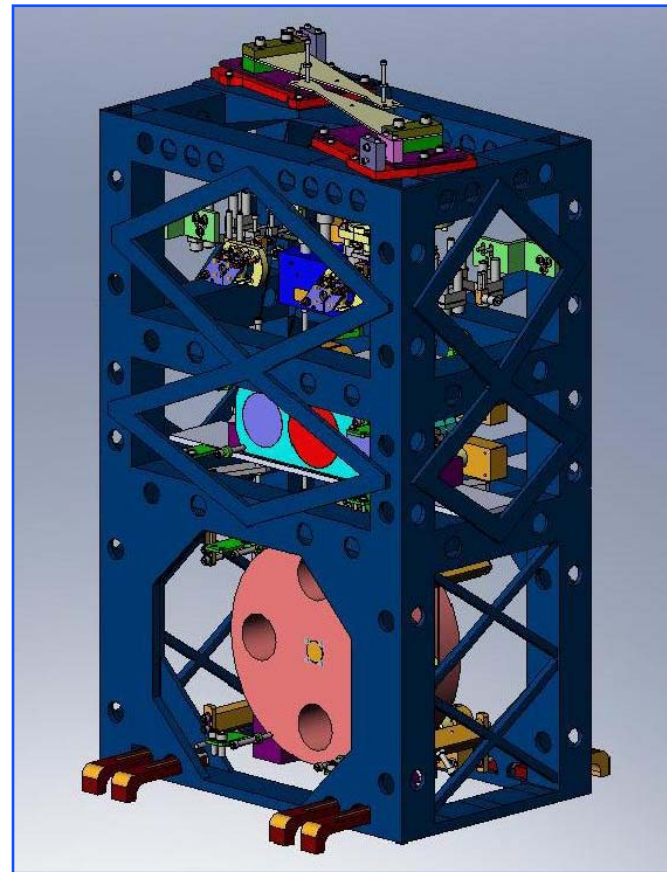
- Original design conducted in 2002-2003
  - Recycling Mirror (RM) envisioned as one optic as in iLIGO/eLIGO
  - Prototype not built due to lack of funding
- Design work restarted in mid-2007
- Feb. 2008: Stable Recycling Cavities
  - 3 optics each for Power and Signal Recycling Mirrors (1 large, 2 small)
  - RM Suspension became HLTS (PR3/SR3)
  - IMC (Input Mode Cleaner) Suspension became HSTS (HAM Small Triple Suspension) (IMC, PRM/SRM, PR2/SR2)
- Nov. 2008 – Jan. 2009: HLTS/HSTS Preliminary Design Review
- HLTS Final Design Review imminent



# HLTS Continued Design (2007)

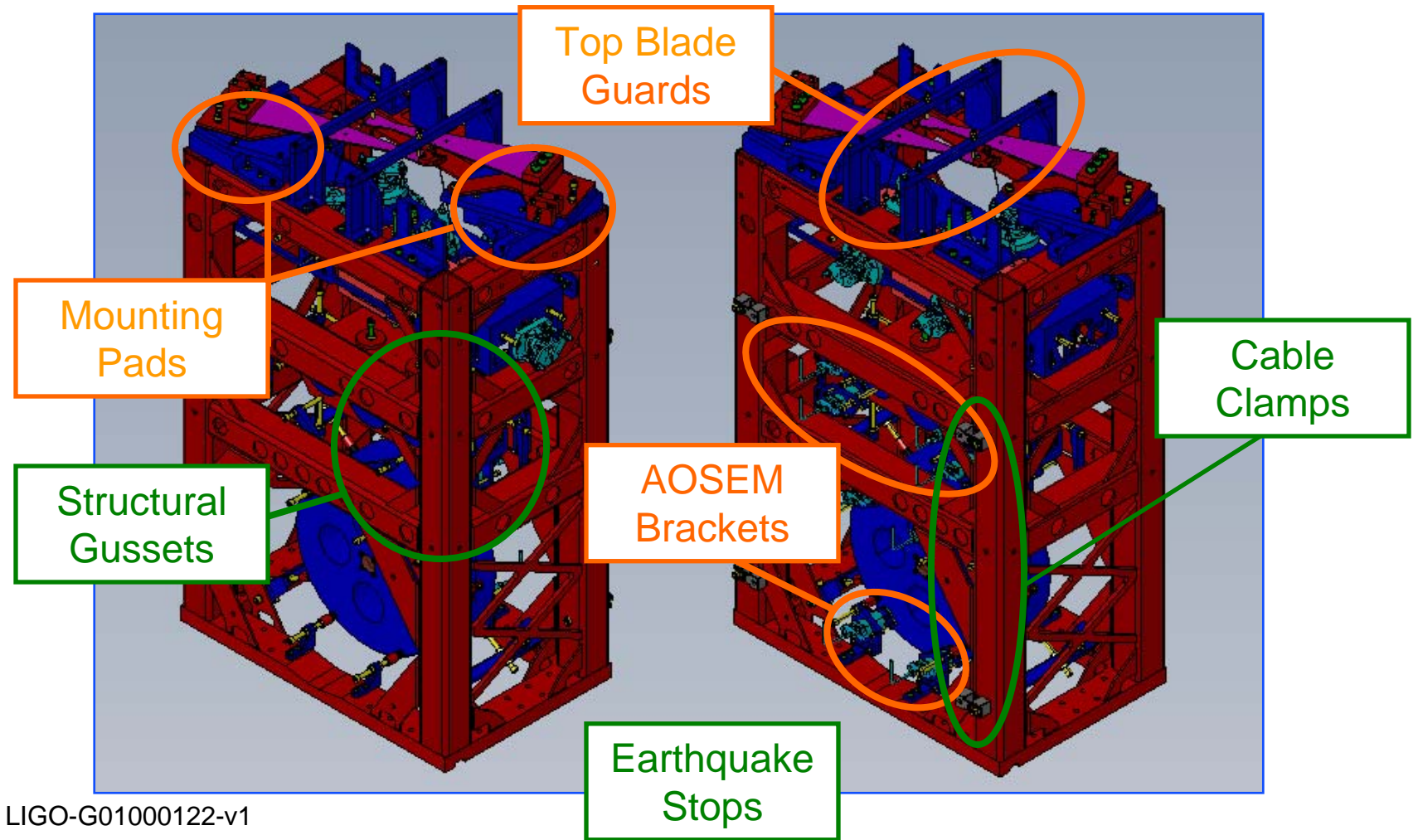
---

- Metal, rectangular Intermediate Mass
- Center and side adjusters on Intermediate Mass
- Bottom Mass suspended on steel wires, not silica fibers
- No flats on Bottom Mass
- Bolted-on struts to stiffen structure





# HLTS Prototype Features



LIGO-G01000122-v1



# HLTS Prototype Structure

---

- Prototype structure uses self-clinching nuts (60X)
  - Threaded fastener that cold-welds when press-fit onto a plate
  - Thin-walled structural tubing prevents using threaded holes
- Seeking approval for self-clinching nuts in production



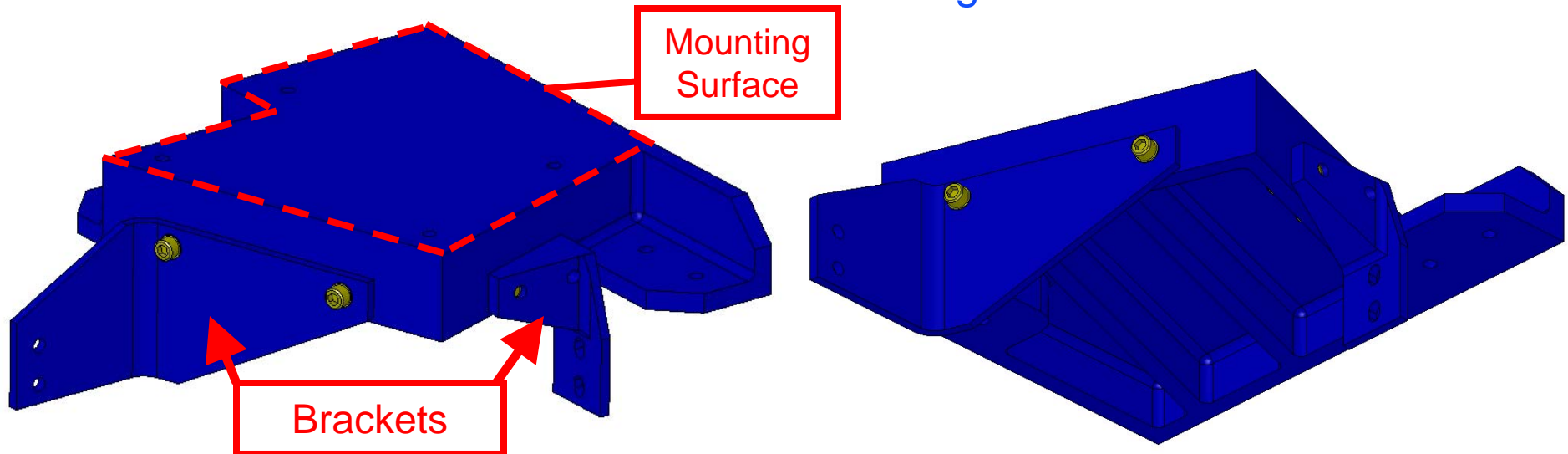
Caltech Test



LLO Test

# HLTS Prototype Structure

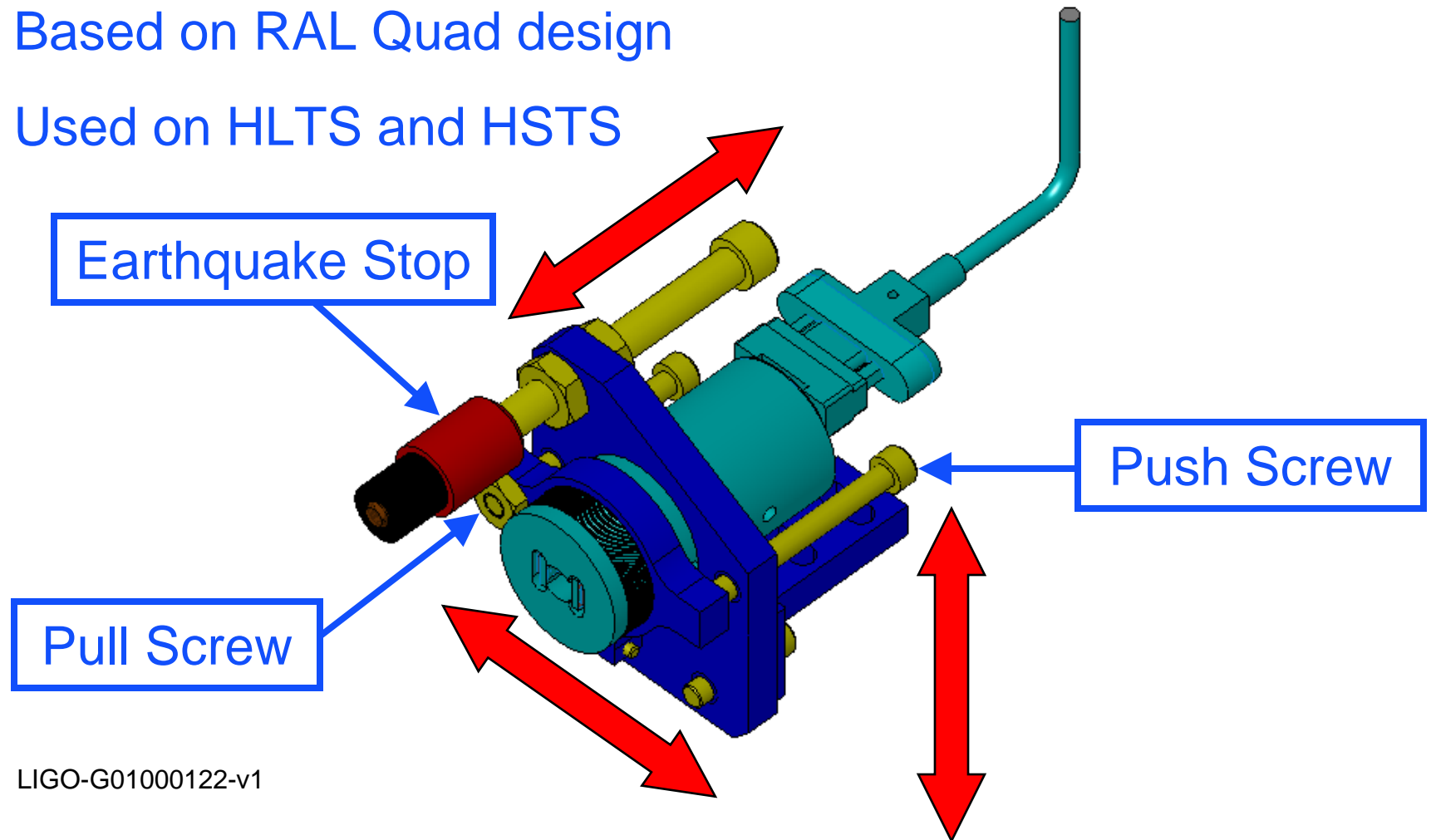
- Mounting Pads
  - Three simple parts from one complex part
  - Designed to be cut down to achieve proper optic height
    - Accounts for variations in welding of structure



- May be able to delete brackets based on TF results

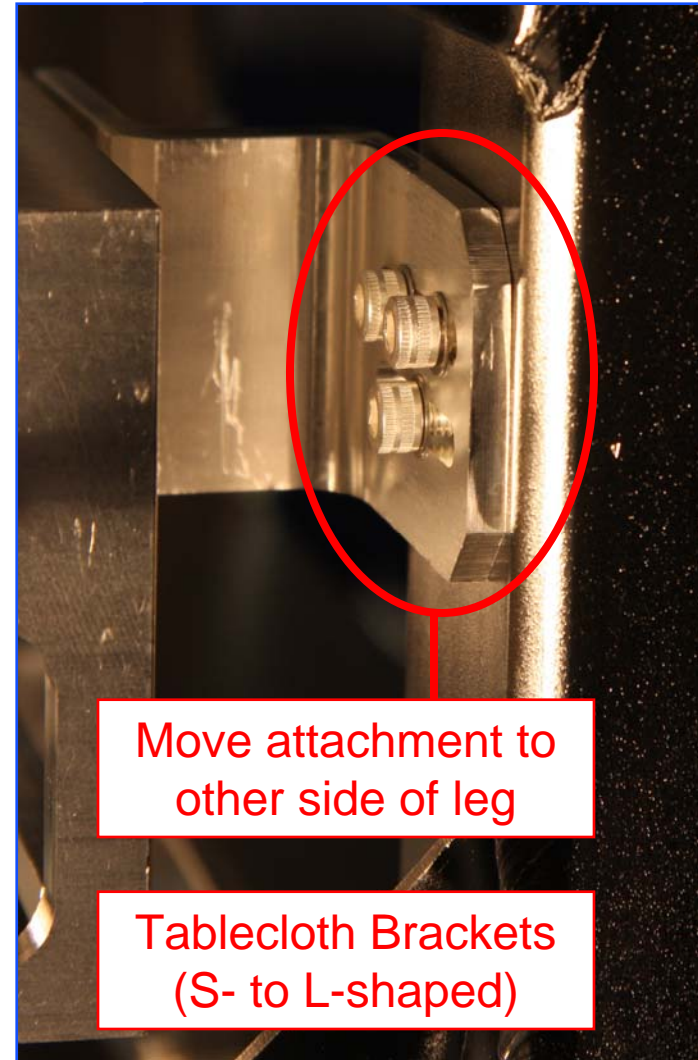
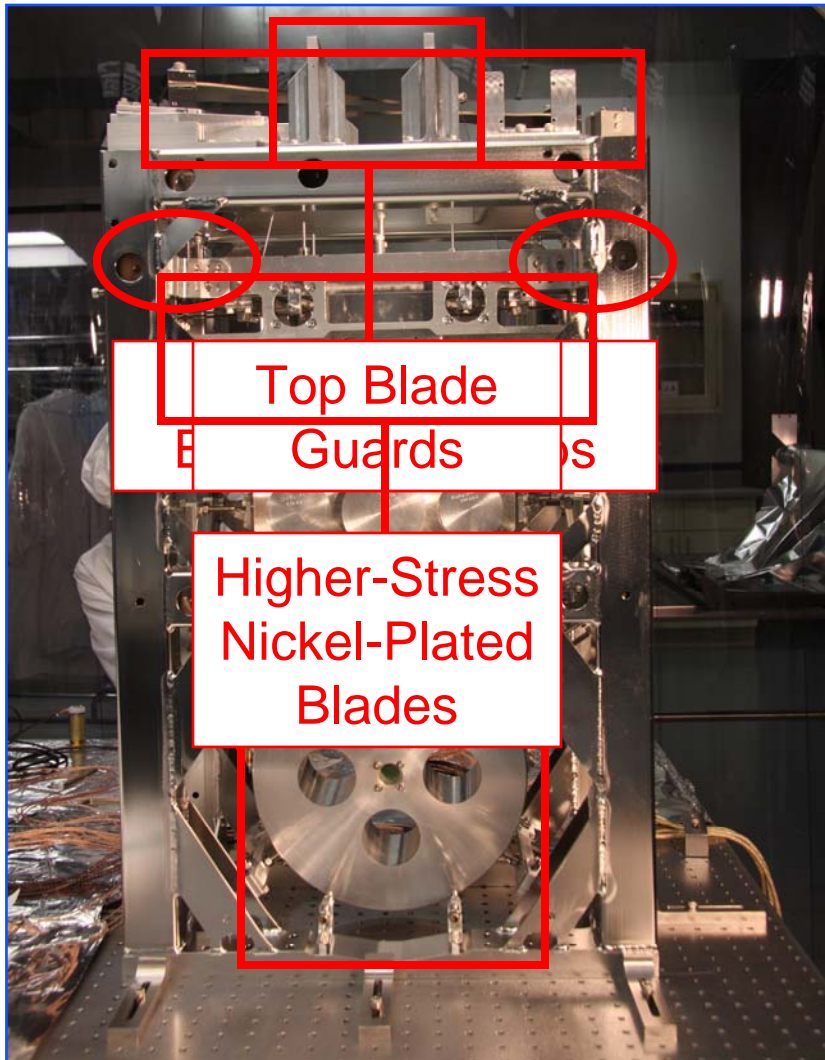
# AOSEM Brackets

- Based on RAL Quad design
- Used on HLTS and HSTS





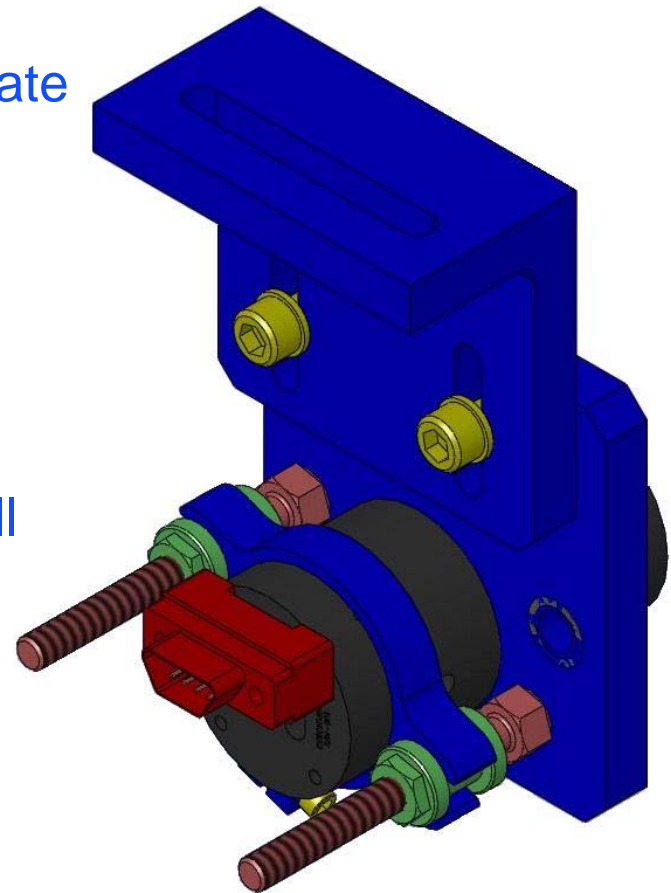
# HLTS Changes for Production



# Revised AOSEM Brackets

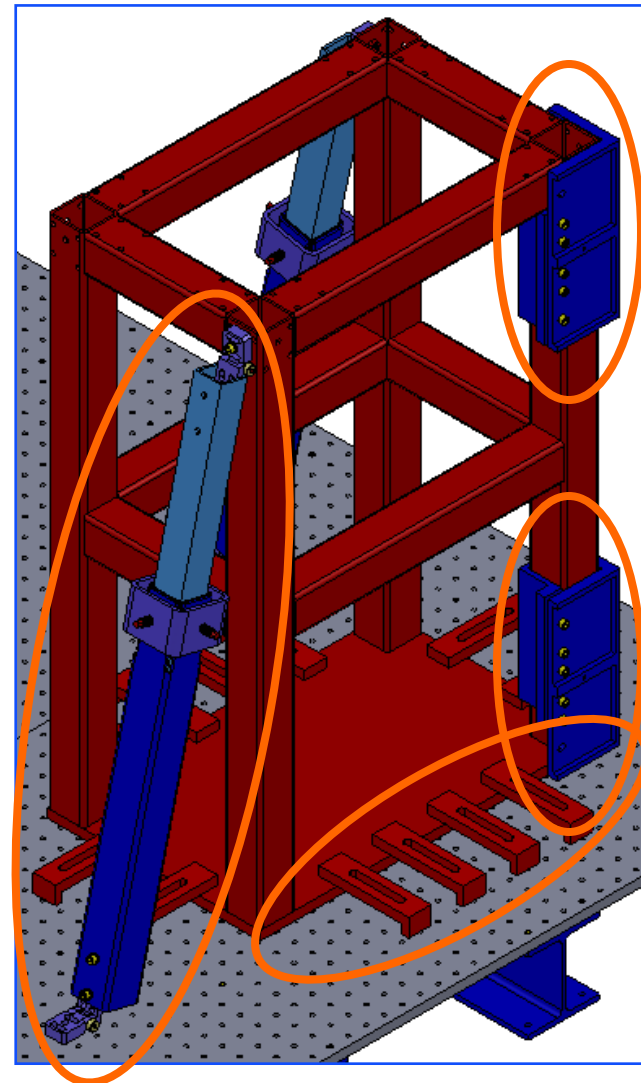
---

- First AOSEM brackets found to be inadequate
  - Push screw “walks” on collar surface
  - Uneven push and pull
- Redesign based on BOSEM (Birmingham OSEM) adjuster
  - PEEK captive nuts with fine-threaded screws make both screws push and pull



# Interfaces with SYS, SEI

- Clamps to hold HLTS to optical table
- Spacers to adjust optic height
- Damping required to simplify SEI control system
  - Corner Pads with Viton
  - Damping Struts
- HAM Installation Arm
  - Used to install HLTS, HSTS into HAM chamber
- Holes provided in structure for interfaces





# HLTS Electronics

- Triples Test Stand
  - Test stand will be used for all HAM SUS assembly/checkout tests
  - HLTS prototype testing being done with 6 BOSEMs, 4 LIGO 1 OSEMs, 4 prototype AOSEMs (improved LIGO I OSEMs)
  - Damping has been demonstrated
  - Transfer function, damping tests delayed due to framebuilder, front-end problems
- Development of a document relating electronics to mechanical system (Brett Shapiro, MIT)

LIGO-G01000122-v1



# HLTS In-Chamber Placement

- HAM2 – most crowded chamber in aLIGO
  - LLO install first – Feb 2011
- HAM ISI installed
- Proposed SUS installation:
  - HLTS (PR3) installed first
  - HSTS (IMC1, IMC3, PRM) and other optics installed around HLTS
- HAM5 contains 1 HLTS (SR3) and 1 HSTS (SRM)

