ALL-METAL CONTROLS PROTOTYPE QUADRUPLE PENDULUM SUSPENSION

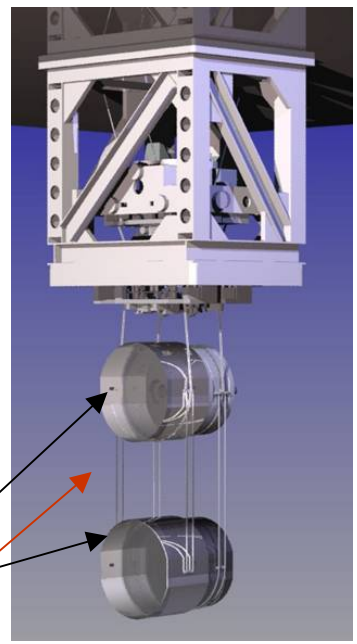
Calum I. Torrie (given by Caroline A. Cantley)

on behalf of the entire team involved in the work associated with the all-metal controls prototype pendulum suspension for Advanced LIGO

LSC MEETING HANFORD MARCH 2006

Suspension Design for Advanced LIGO

- Four stage pendulum with three stages of cantilever blade springs for enhanced vertical isolation
- Minimise noise from control:
  - damping at top mass
  - use of reaction pendulum
- Target suspension noise level for main optics (test masses): 10^{-19} m/√ Hz at 10 Hz
- Reduce thermal noise:
  - 40 kg silica mirror suspended on silica ribbons
- Involves two prototypes
  - Controls prototype – all metal (US with UK)
  - Noise prototype – with silica final stage (UK with US)



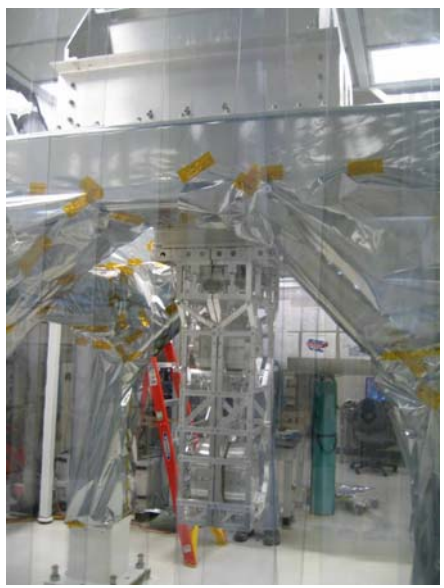
All-Metal Controls Prototype Quadruple Pendulum Suspension

- team from Caltech, Glasgow, MIT, RAL & Stanford
- aim is to check
  - mechanical design
  - control aspects
  - installation & alignment procedures
- construction and initial testing performed at Caltech
- suspension delivered to LASTI in February 2006
  - construction and assembly complete
  - tests on the suspension with support structure underway
- first installation fixtures to be delivered in April 2006
- suspension will be moved into BSC chamber (on solid stack) mid-April 2006

C. Torrie's talk in SWG breakout session

Quad Controls Prototype @ LASTI

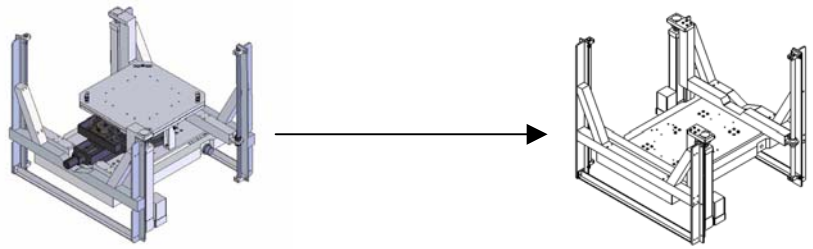
- Quad assembled and suspended on solid stack, mounted on test stand, in February 2006
- Relative alignment of the two chains to 0.3 mrad in pitch & yaw
- Prior to installation the suspension structure will be aligned on the solid stack using the auto-collimator



Quad Controls Prototype @ LASTI

Installation Fixtures (alignment tooling)

- For Quad controls prototype



  - Lift table (mechanised)
  - Custom X, Y, Pitch, Rotation table
    - 300 lbs
    - Tested under 2000lb load

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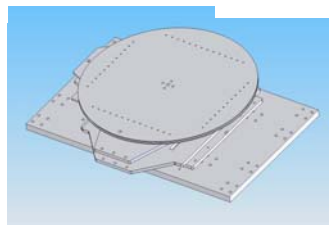
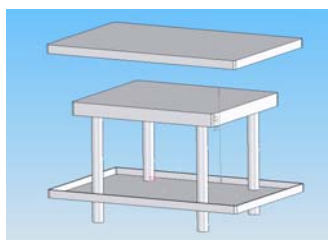


  - Mobile vertical table (lighter alternative)
    - 300 lbs
    - Tested under 2000lb load



  - Articulated arm concept

2nd QUAD structure

- Equivalent structure with “dummy” non-suspended mass
- Installed on technology demonstrator at Stanford
- Will be shipped to UK for further noise prototype development
  - optimisation
  - tuning of monolithic stage assembly procedures

  - Refer to B. Lantz talk at the SEI/SWG breakout session

What's Next

- Controls prototype quad suspension tests @ LASTI
  - damping, transfer function, mode frequencies
  - alignment & transfer to beam splitter chamber (BSC) on solid stack
  - installed onto seismic table – combined testing
- Continued development of installation tooling
- Other work
  - Final design of input mode cleaner suspension for noise prototype production
  - Conceptual design of double pendulum pick off mirror suspension
  - Output mode cleaner suspension design