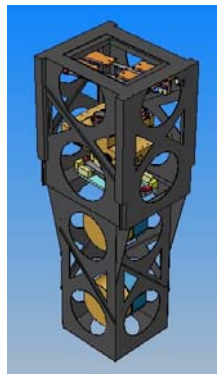
A Quad for Christmas
Calum I. Torrie

1 QUADRUPLE PENDULUM SUSPENSION



- For LASTI experiment
- 4 stages of 22, 22, 40, 40 kg
  - with full reaction chain of 22, 22, 40, 40 kg for ETM
  - (or 22, 22, 58kg, 22kg for ITM)
- Built by end December 2004

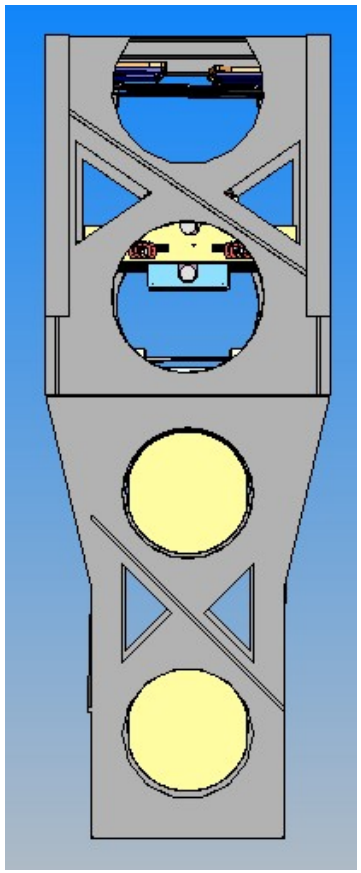
The following related work was done by: -

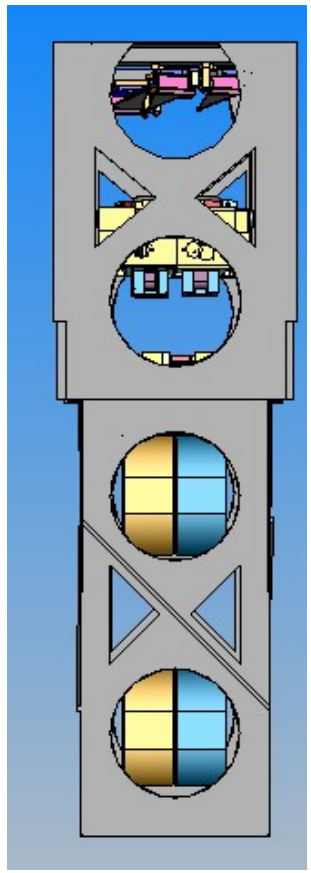
Helena Armandula, Mark Barton, Caroline Cantley, Dennis Coyne, Alastair Grant, Larry Jones, Russell Jones, Mike Plissi, Mike-Perreur-Lloyd, Norna Robertson, Janeen Romie, Ken Strain and Calum Torrie

Quad Suspension wrt concept Structure

- Mechanical stops which limit the free motion of each mass of both suspension chains must be supported by the structure.

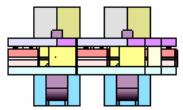
Sufficient access must be allowed for installation of upper masses, blades and fiber/ribbon welding operations (perhaps by structure removal).



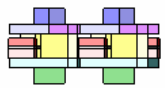


Provisions made for actuation & sensing

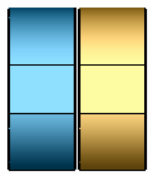
- Access for repair / replacement / adjustment of OSEMs, ECDs, ES actuators, etc. must be provided in the structural design.



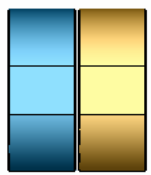
12 local control OSEMs
+ 4 ECDs (4x4 array)



4 global control actuators

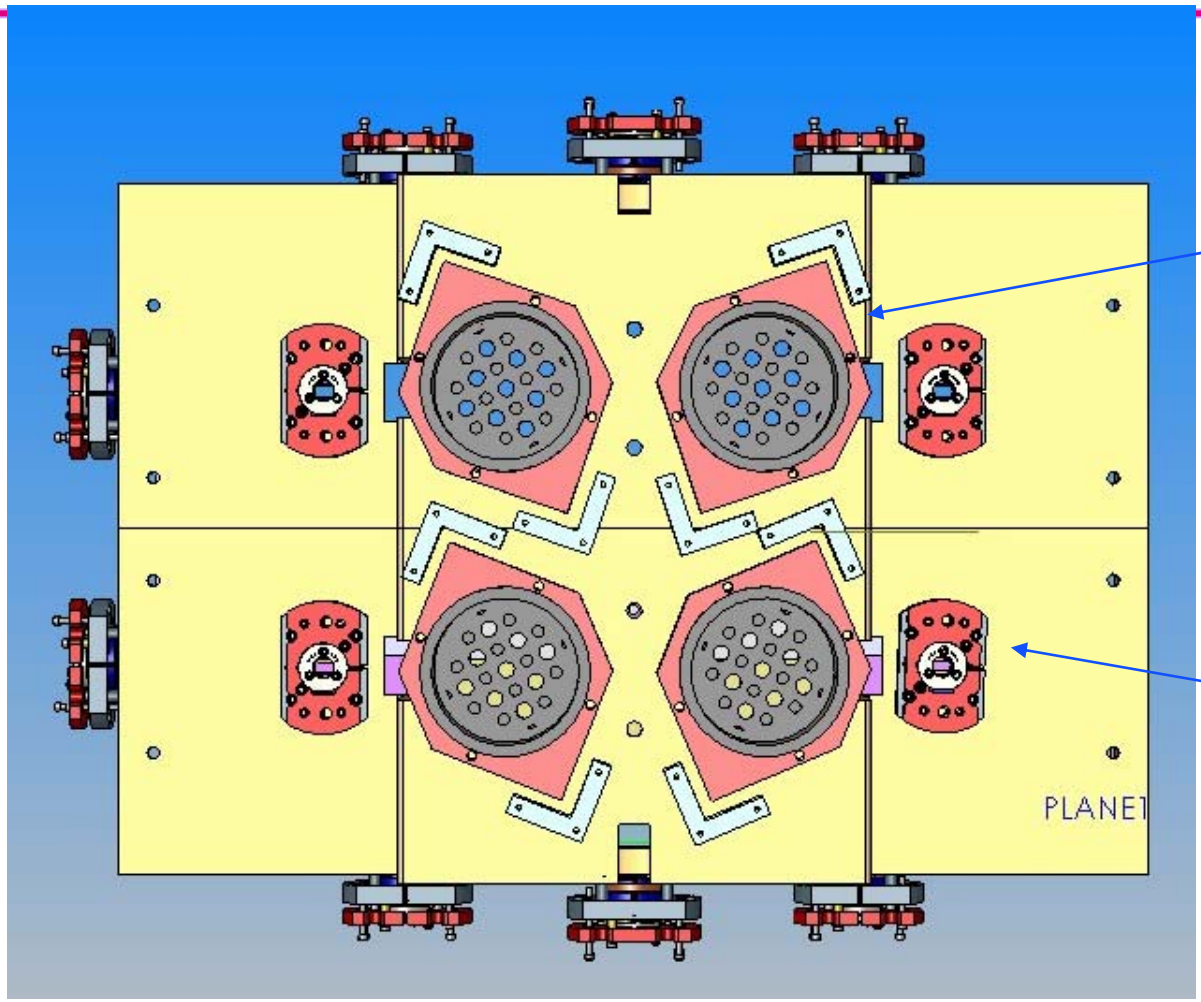


4 global control actuators



Electro-static actuation

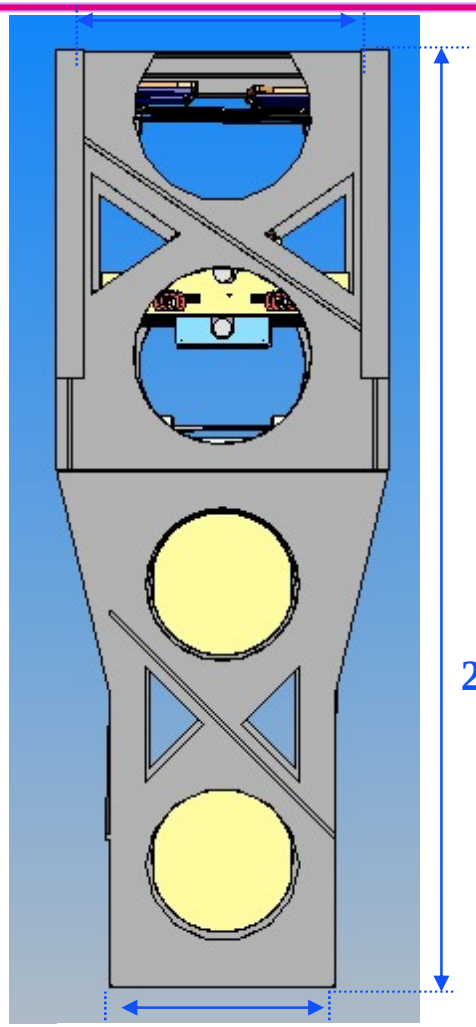
L.C. OSEMS and ECDs: - Plane view of both top masses

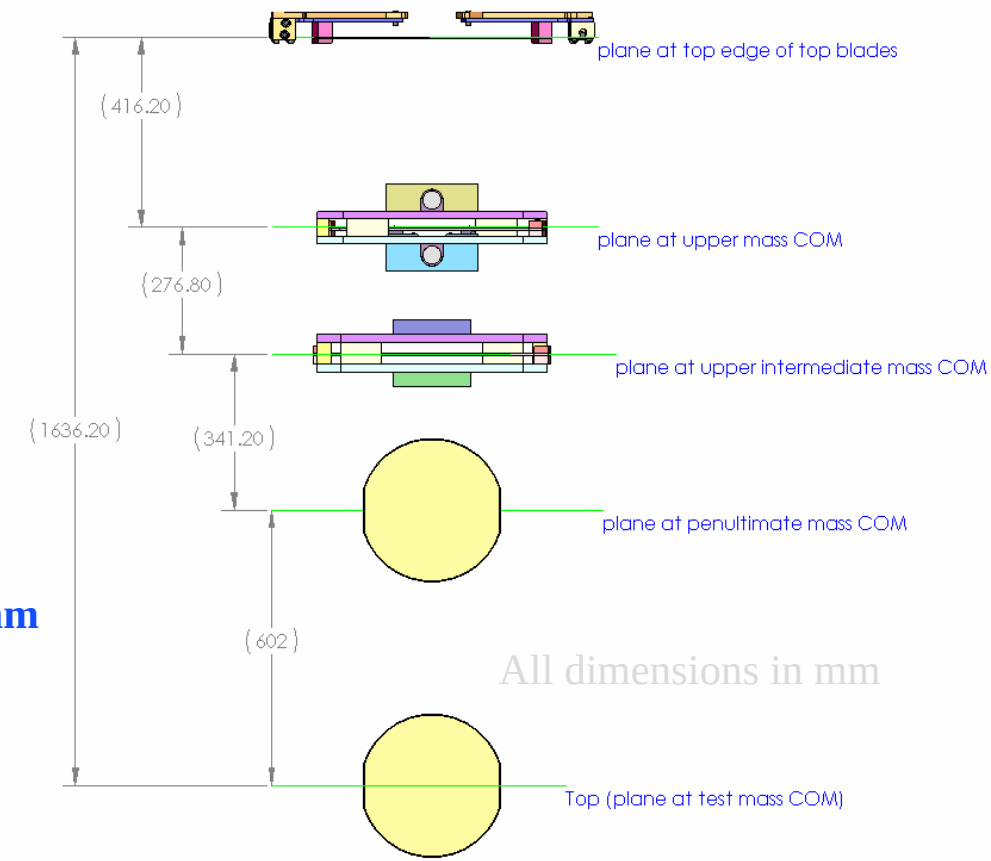


2 4x4 arrays per suspension (acting in the vertical direction)

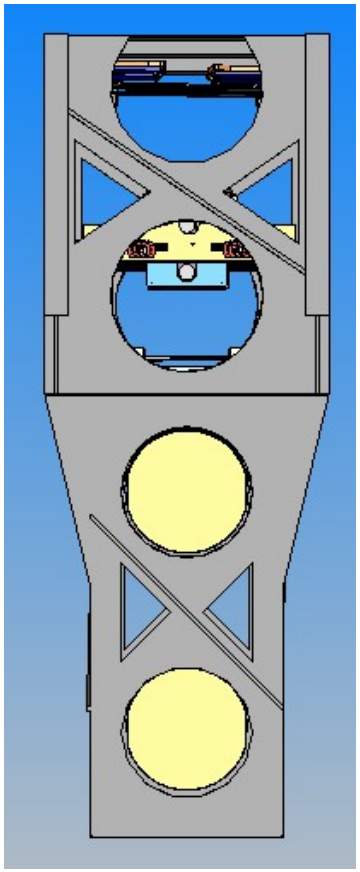
6 local control osems per suspension (supplied by Glasgow)

Quad Suspension Layout wrt Structure

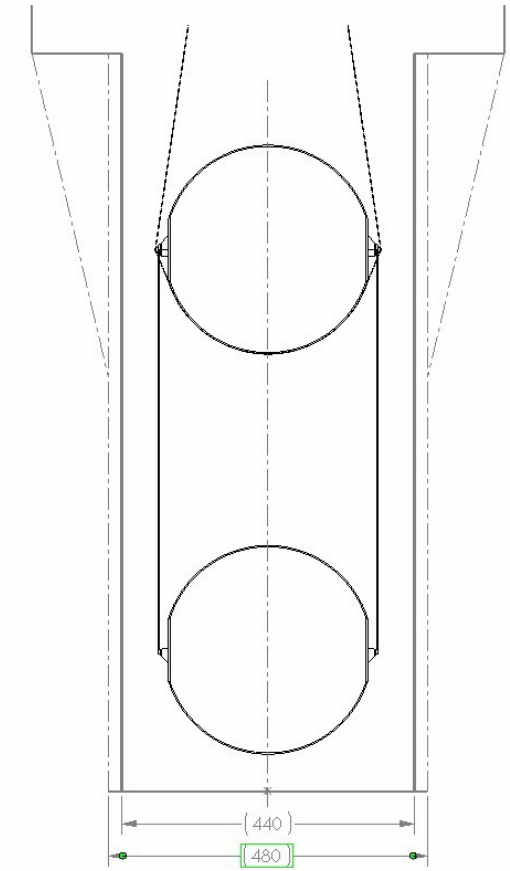


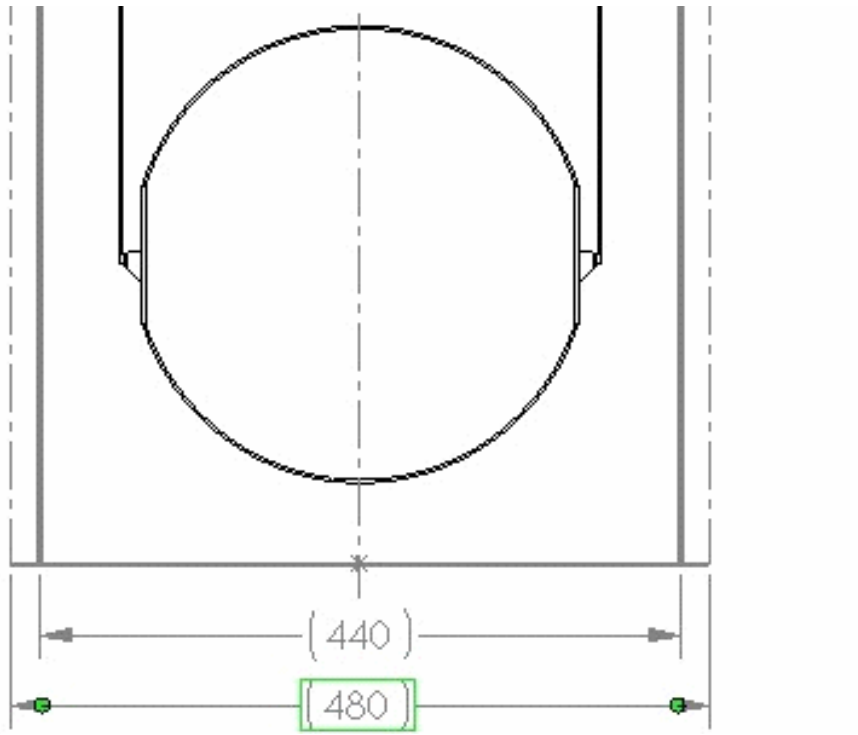


Lower Layout of the ETM



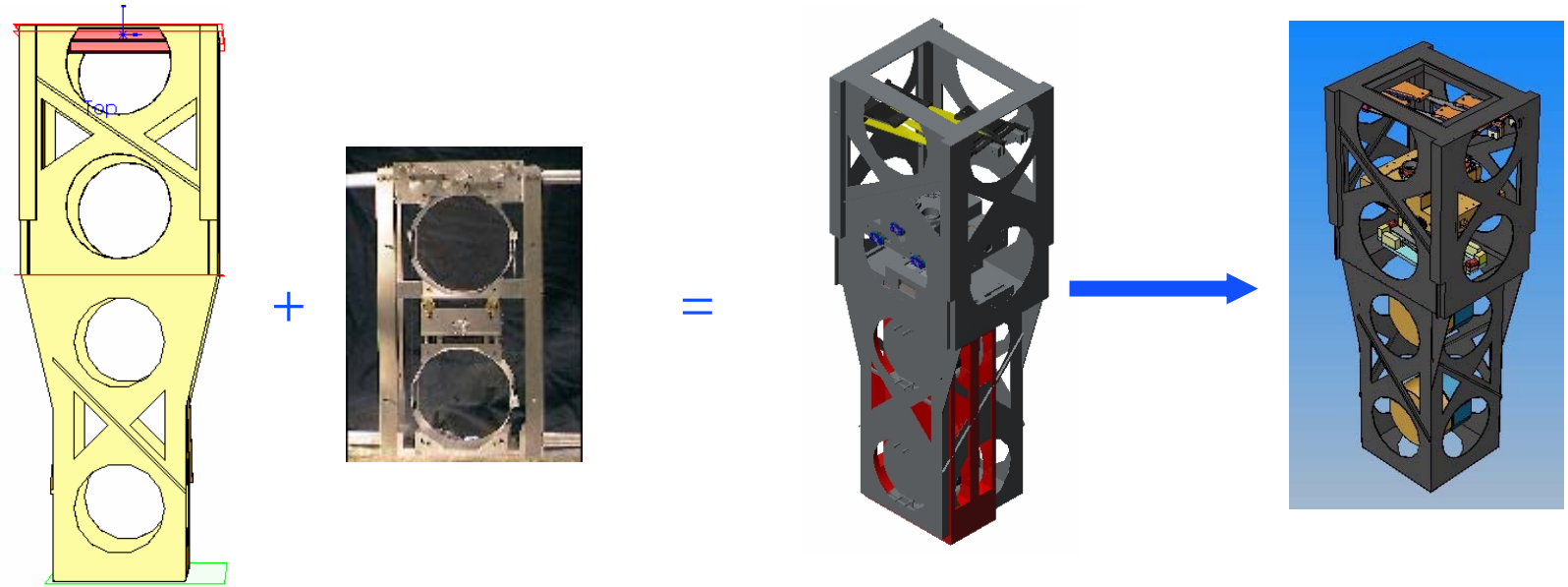
All dimensions in mm



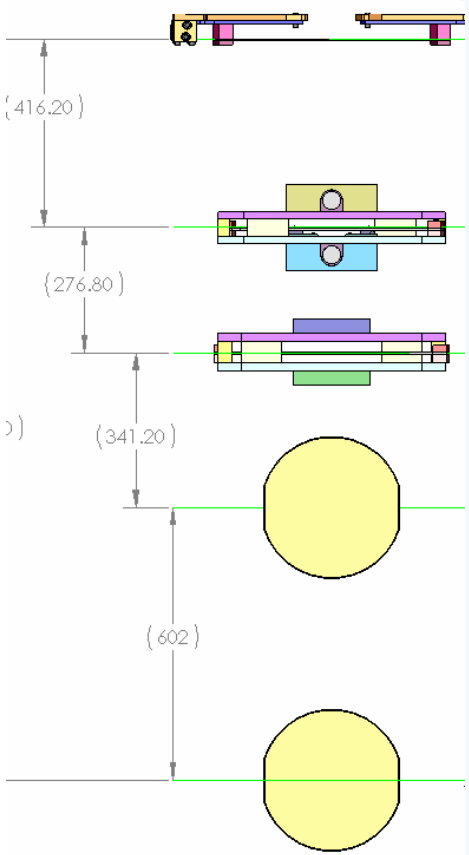


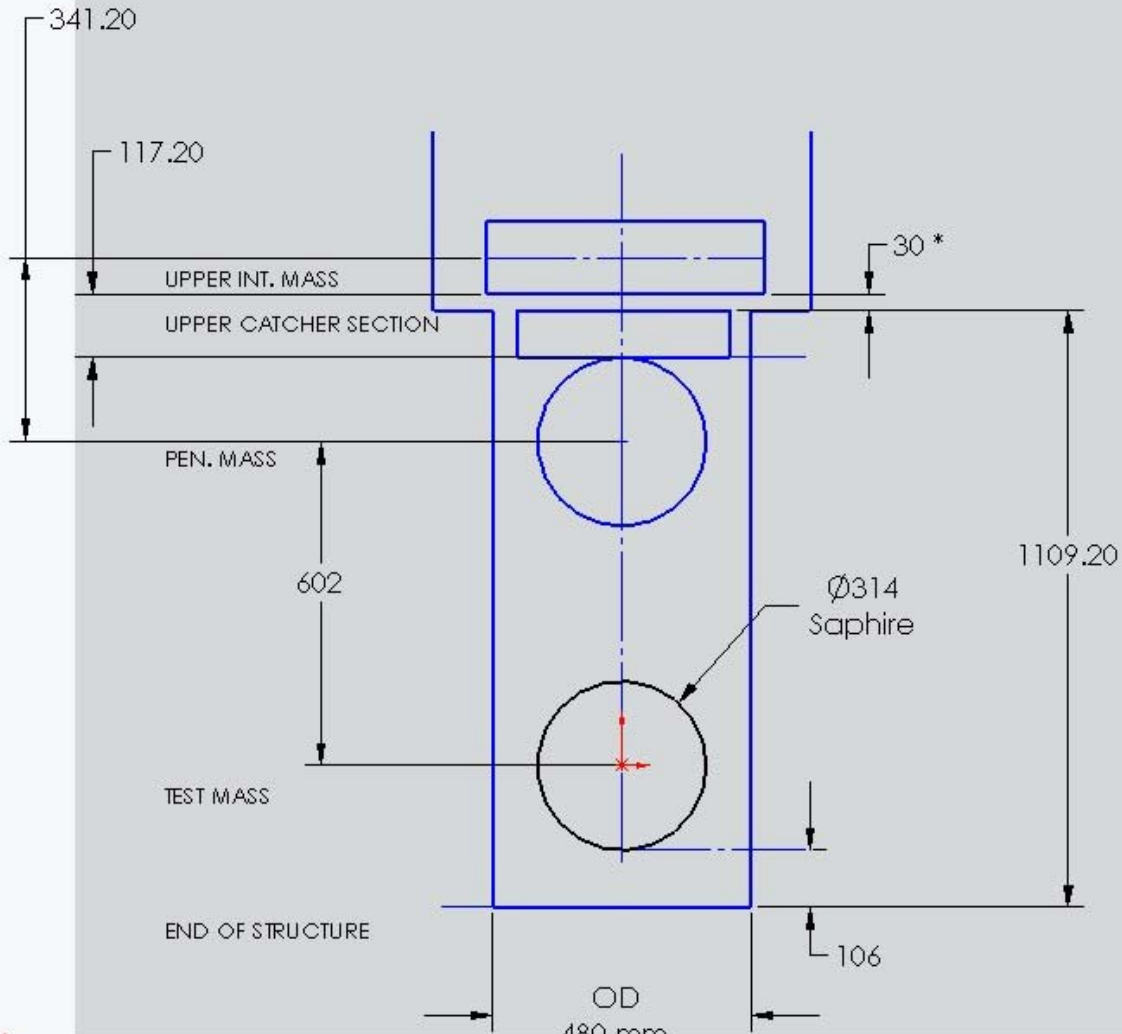
Catcher wrt Structure

- The lower part of the structure must allow for (accommodate) the "catcher", or test mass fixture for installing and welding fibers.



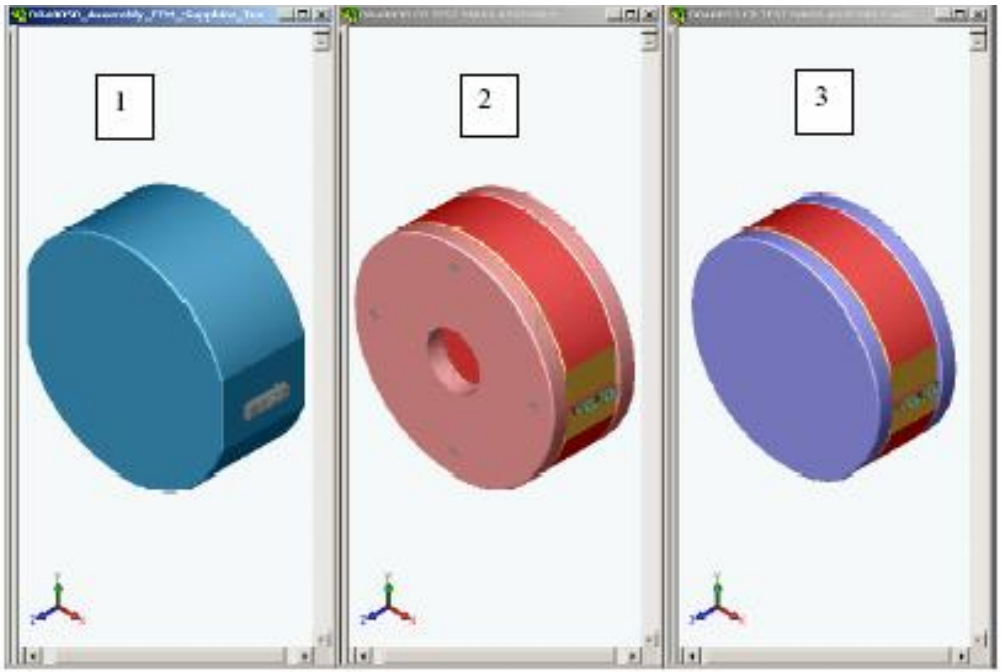
Upper catcher wrt suspenion





LIGO-G040095-01

Test Mass Assembly



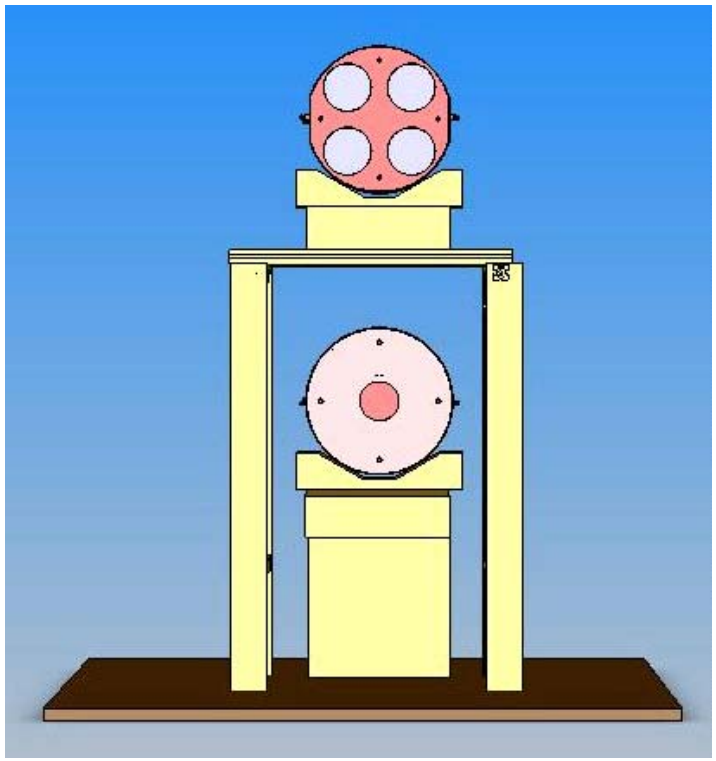
Sapphire

Al+S/Steel
+Alum faces

Al + S/Steel
+ Glass faces

Single and Double Pendulum prototypes

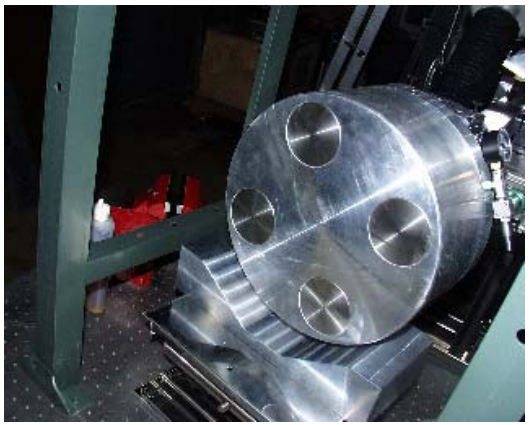
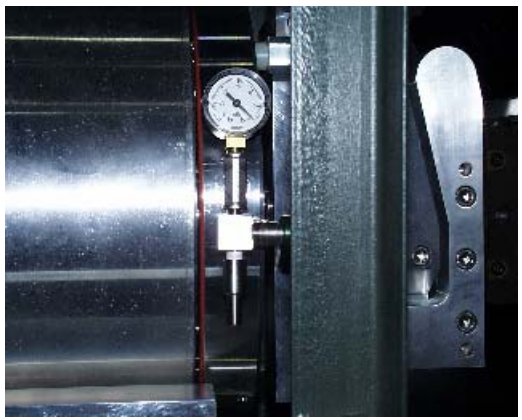
Single



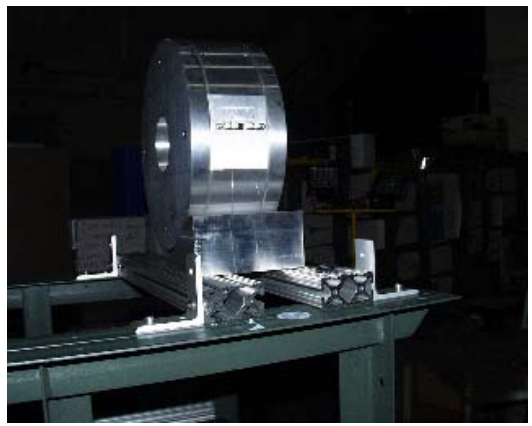
March 2004

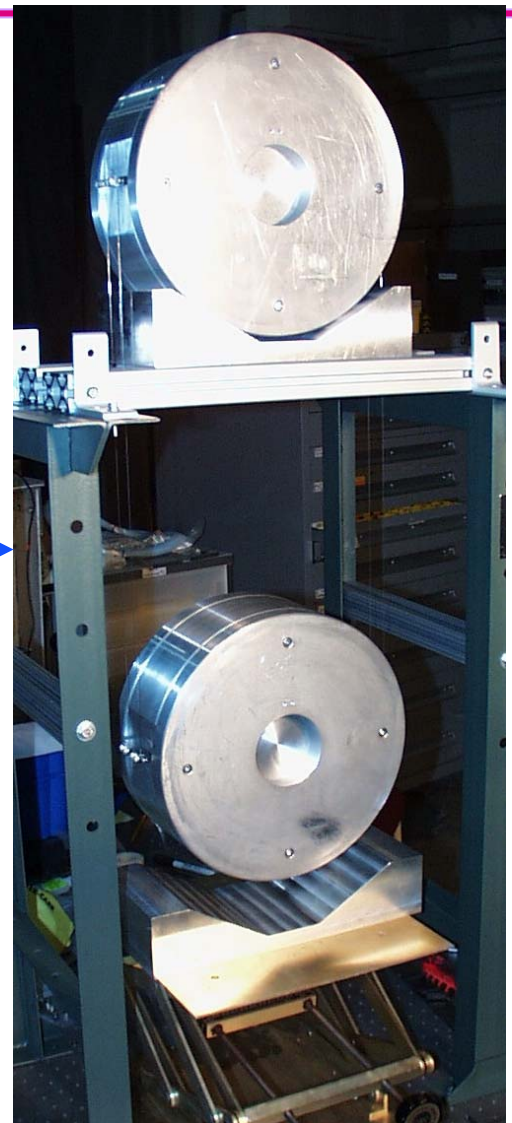
Single Pendulum – Helena's Ergonomic arm



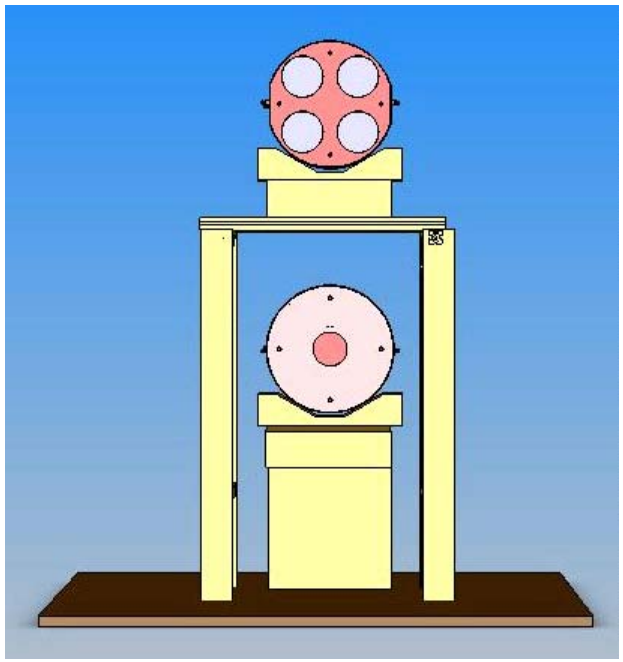

Single Pendulum – 40kg on 4 wires





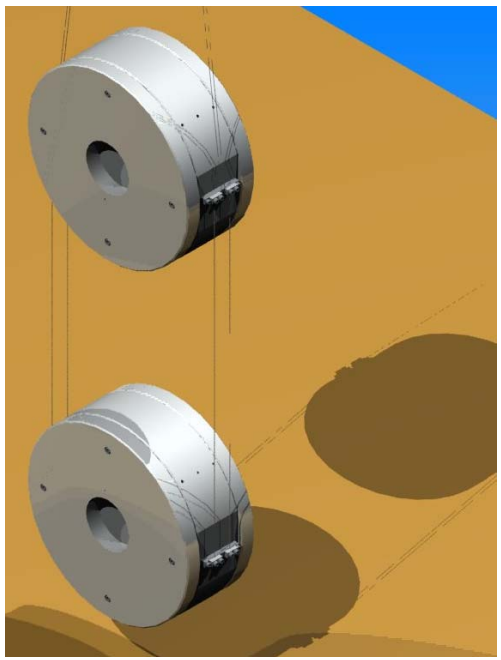
Single and Double Pendulum prototypes

Single



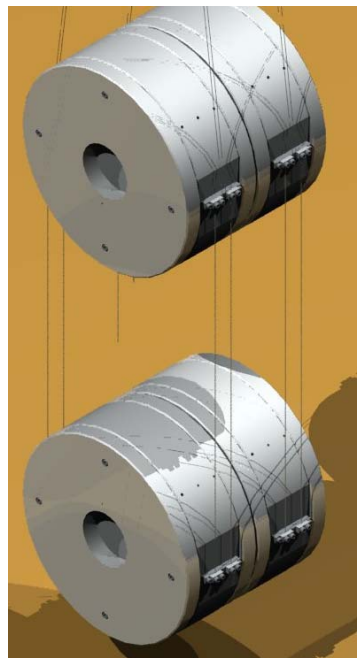
March 2004

Double



April 2004

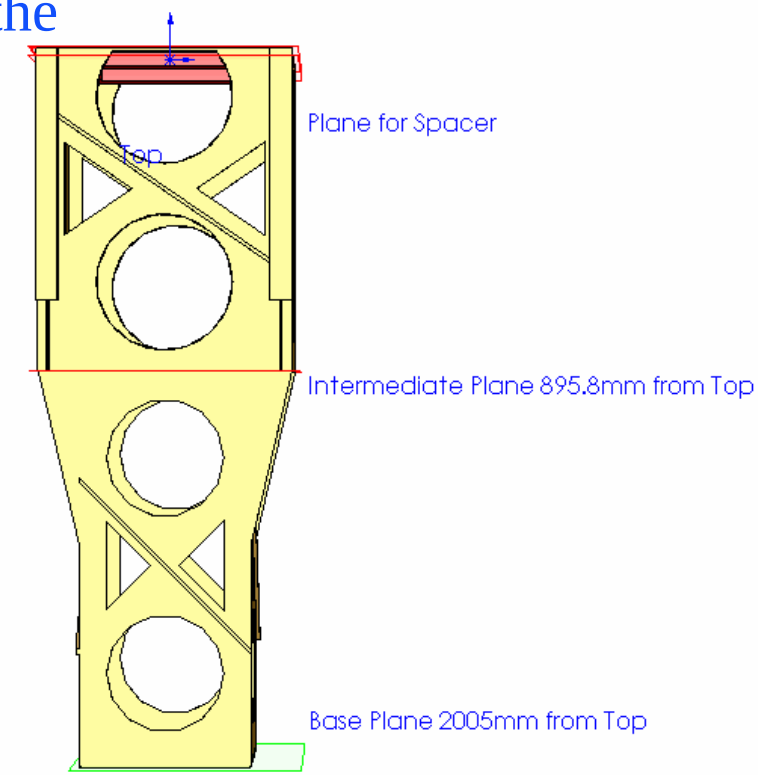
with reaction chain



May 2004

Quad Concept Structure

- The lower part must be separable from the upper part, to facilitate repair/removal of the fibers and optics.
- Features for a lifting fixture must be designed into the lower part of the structure (or interact with the catcher)

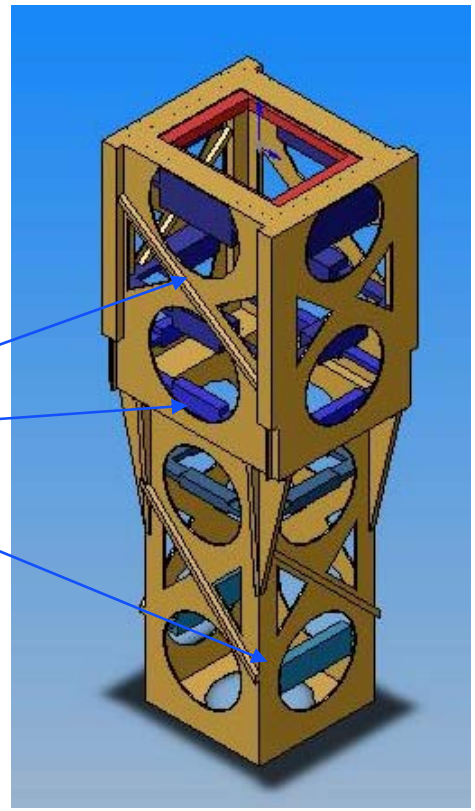


Modeling the Structures

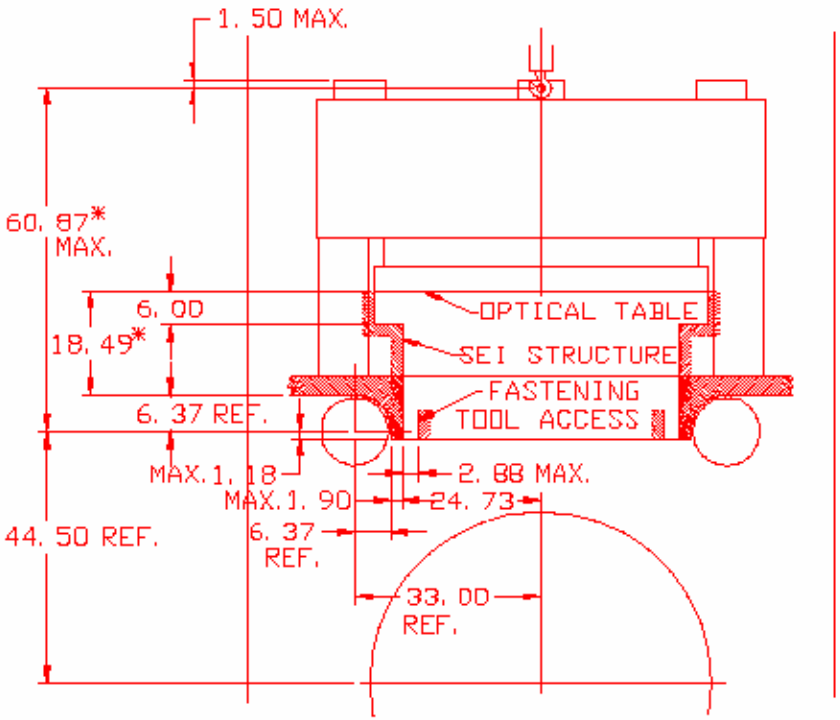
- Frequency Analysis of the Quadruple Pendulum Structure
  - REF: LIGO-T030044-03, by Dennis Coyne
- Preliminary Frequency Analysis of the HAM Structures
  - REF: LIGO-T030278-04, by CIT and SUS team
    - o Compares 3 configurations of existing MC structure
    - o FEA in ANSYS Classic (and IDEAS and Algor)
      - Confidence in FEA approach
      - Number of stiffening concepts

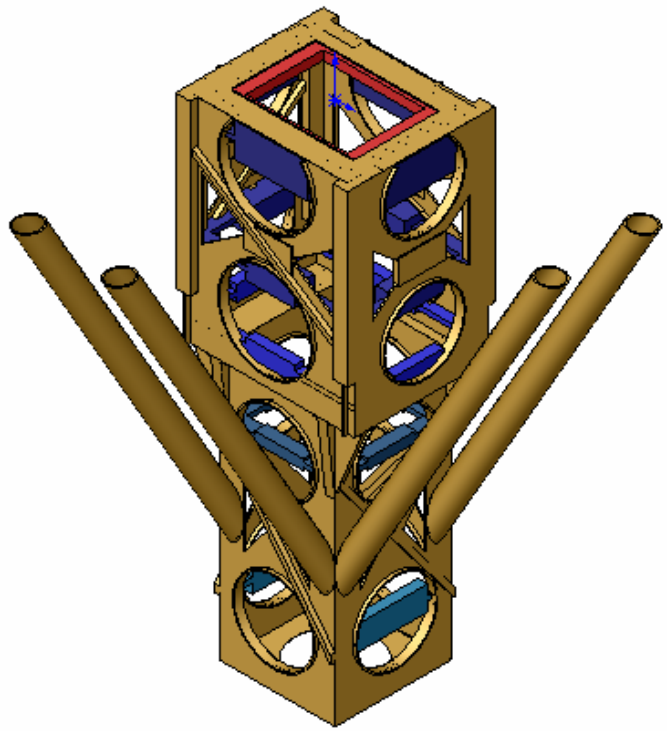
Modeling the Structures

- Process used developed from work referenced on previous slide
  - ANSYS Workbench
- multiple configurations of the structure (40-100kg)
  - all include 60-70 kg of non-structural mass REF: LIGO-T030137



Quad wrt BSC Tank and SEI System





* DESIGN SHALL BE CAPABLE OF HAVING THESE HEIGHTS REDUCED BY UP TO 3. 94", BY A SIMPLE RE-DESIGN.

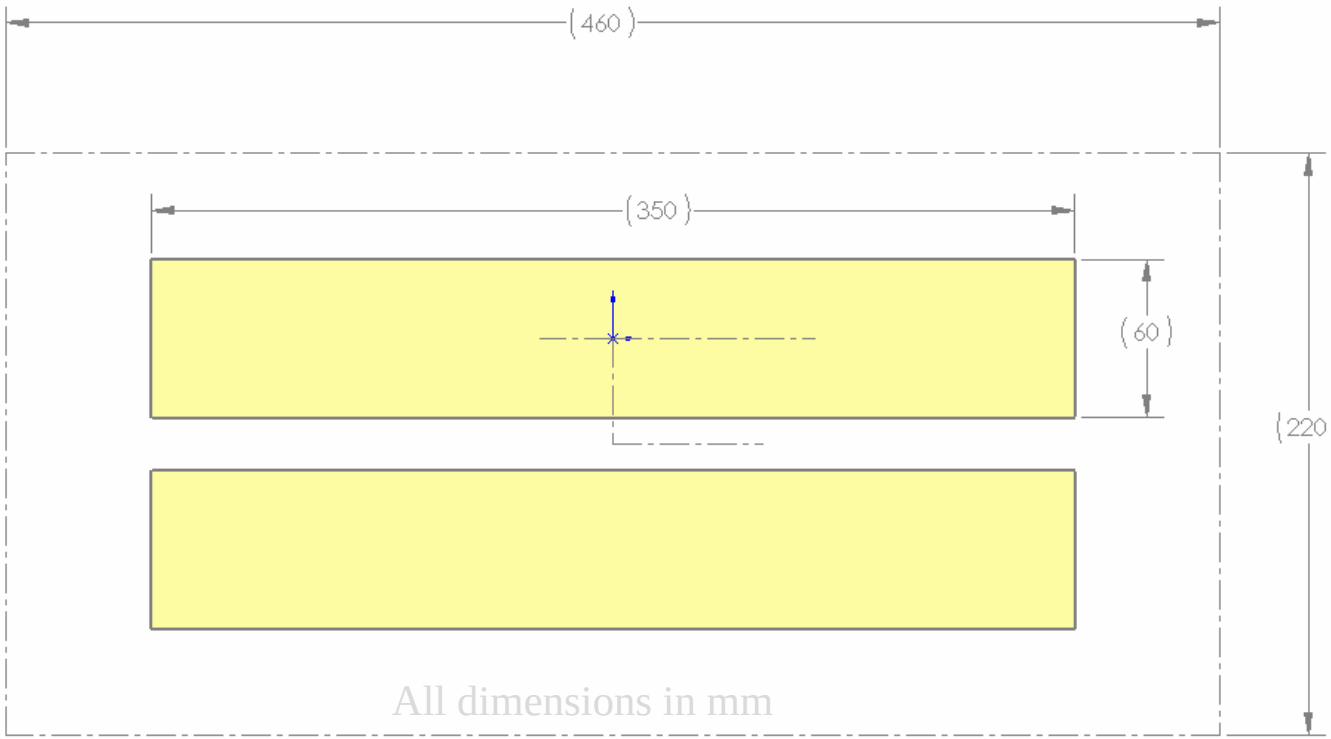
ALL DIMENSIONS ARE IN INCHES

D030100-01
ADVLIGO SEI BSC OPT
TABLE & STRUCTURE L
L JONES 5/2/03

Functional requirements of the structure

• The lower part must be separable from the upper part, to facilitate repair/removal of the fibers and optics. Features for a lifting fixture must be designed into the lower part (could be separate from the lower part).
• The lower part must allow for (accommodate) the "catcher", or test mass fixture for installing and welding fibers.
• Mechanical stops which limit the free motion of each mass of both suspension chains must be supported by the structure.
• Sufficient access must be allowed for installation of upper masses, blades and fiber/ribbon welding operations (perhaps by structure removal).
• Access for repair/replacement/adjustment of OSEMs, ECDs, ES actuators, etc. must be provided in the structural design.
• Access for cleaning the optic in situ must be accommodated by the structure.
• Wire routing & securing provision must be designed into the structure for all sensing and actuation, as well as for a ring heater for the thermal compensation plate (for the ITM suspensions).

Beamsplitter layout



NOTE

Lower Footprint

Previously-

516 mm x

280 mm

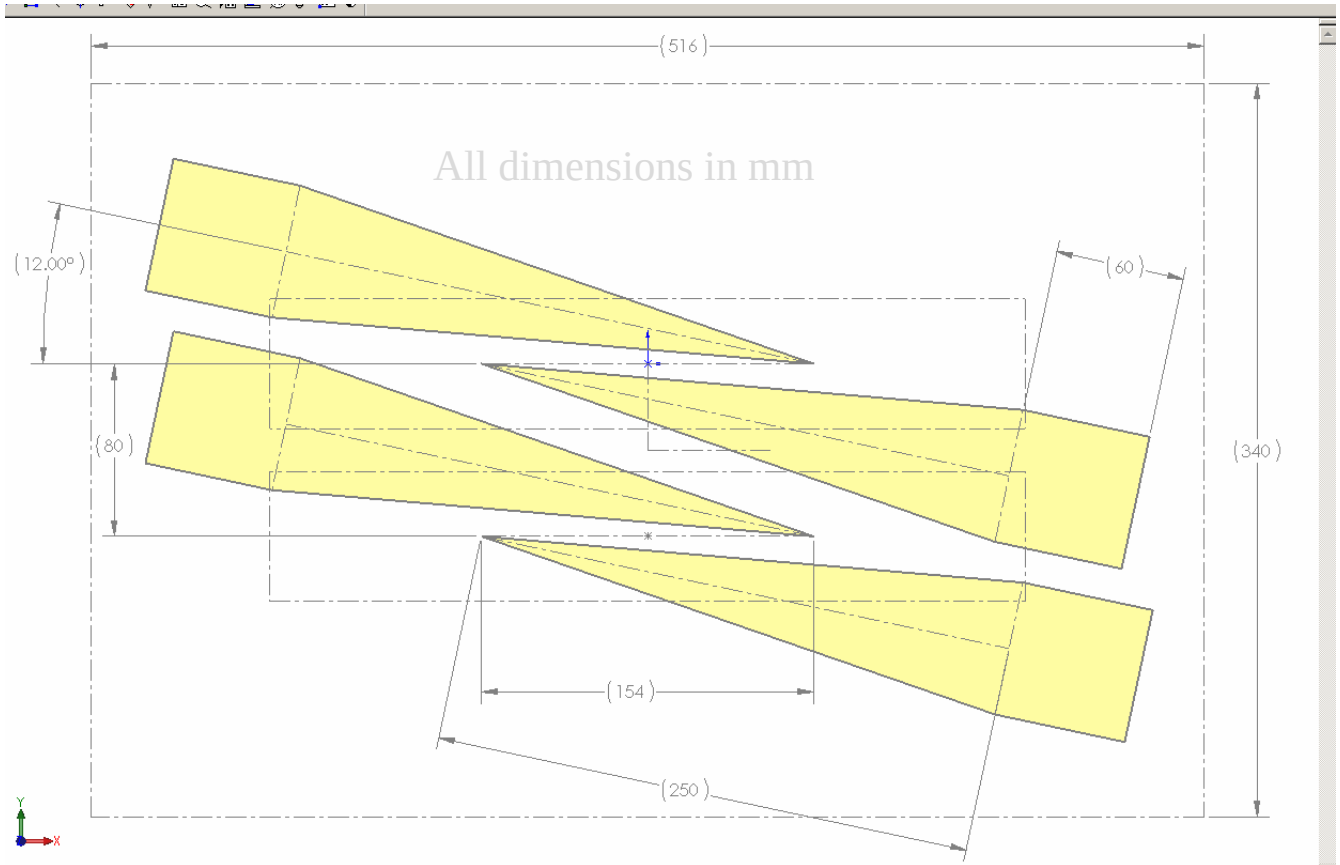
Proposing-

460 mm x

220 mm

PLAN VIEW PENULTIMATE MASSES + LOWER FOOTPRINT

Beamsplitter layout



PLAN VIEW OF TOP BLADES + UPPER FOOTPRINT

NOTE

Upper Footprint

Previously-

730 mm x

350 mm

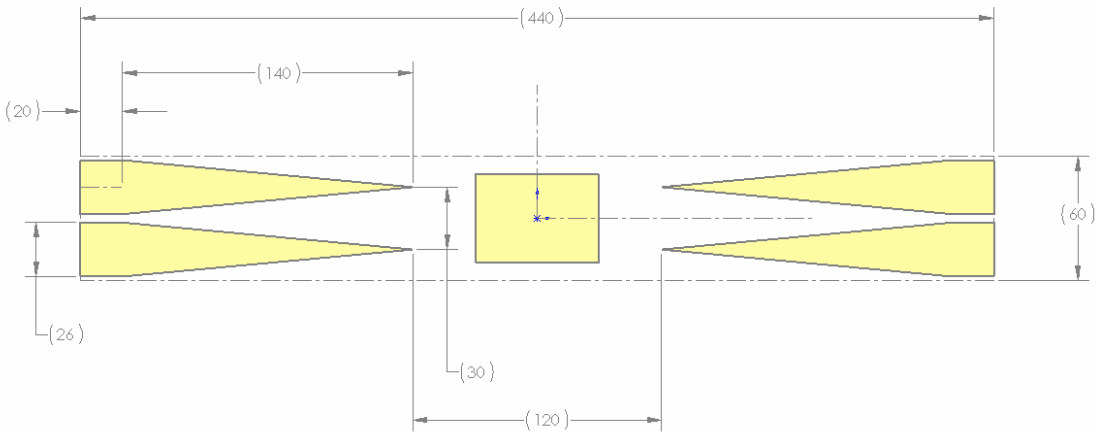
Proposing-

516 mm x

340 mm

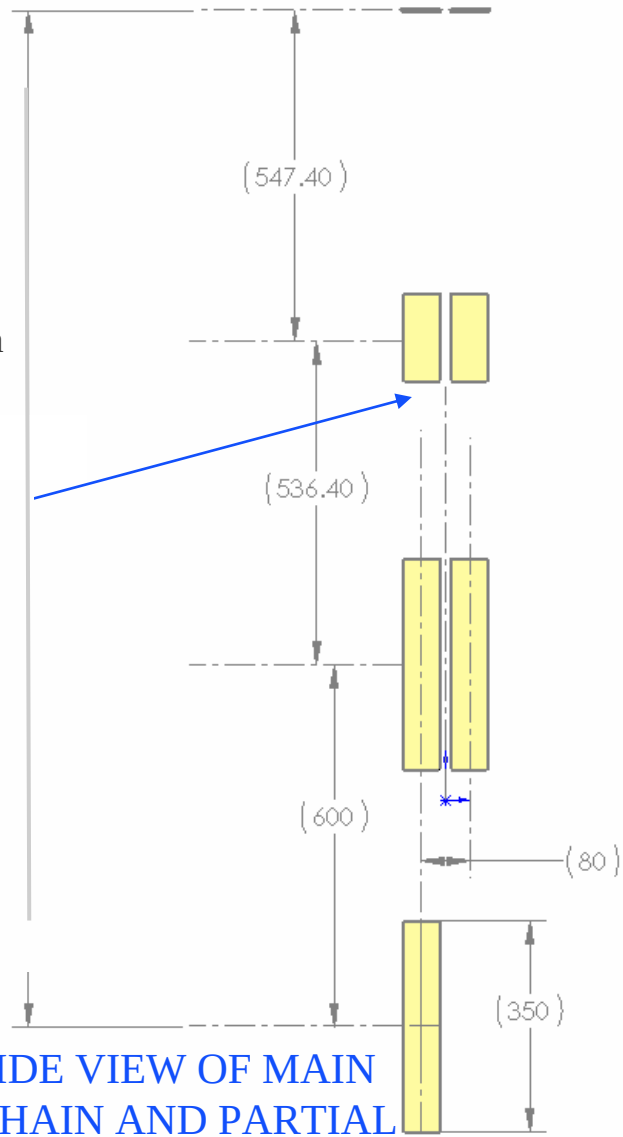
Beamsplitter layout

All dimensions in mm



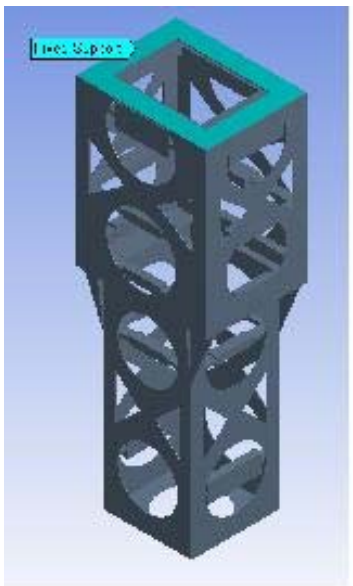
PLAN VIEW OF UPPER MASS

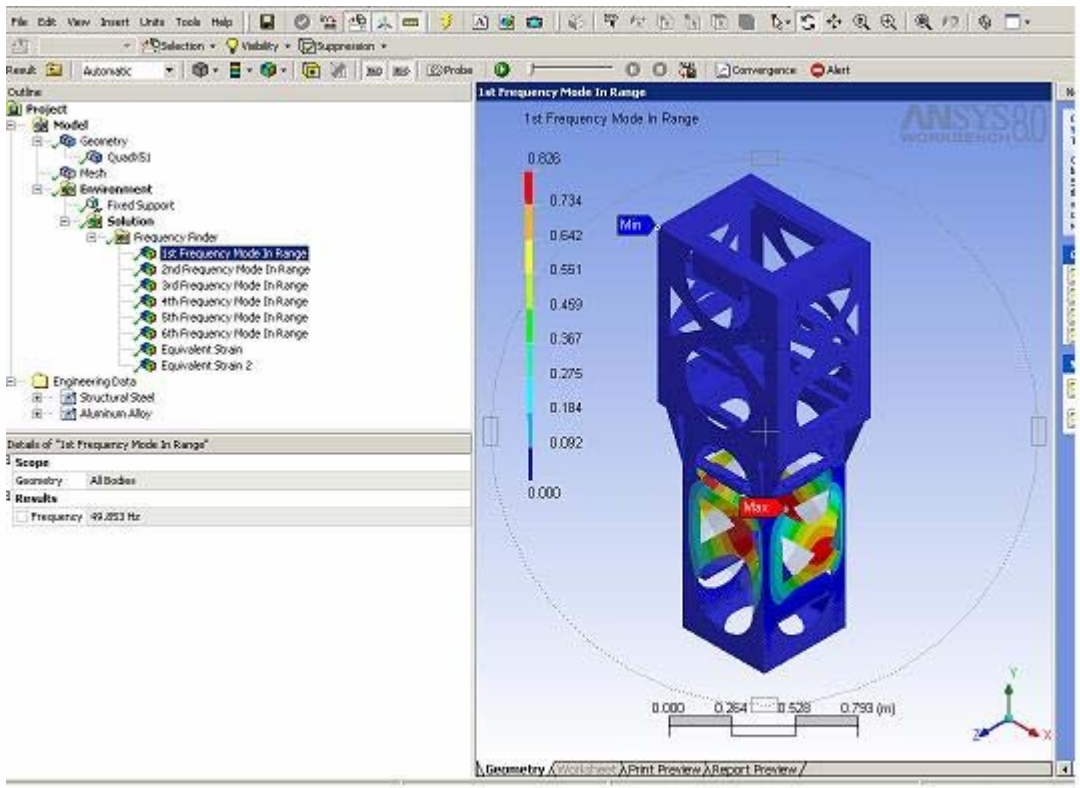
1684mm



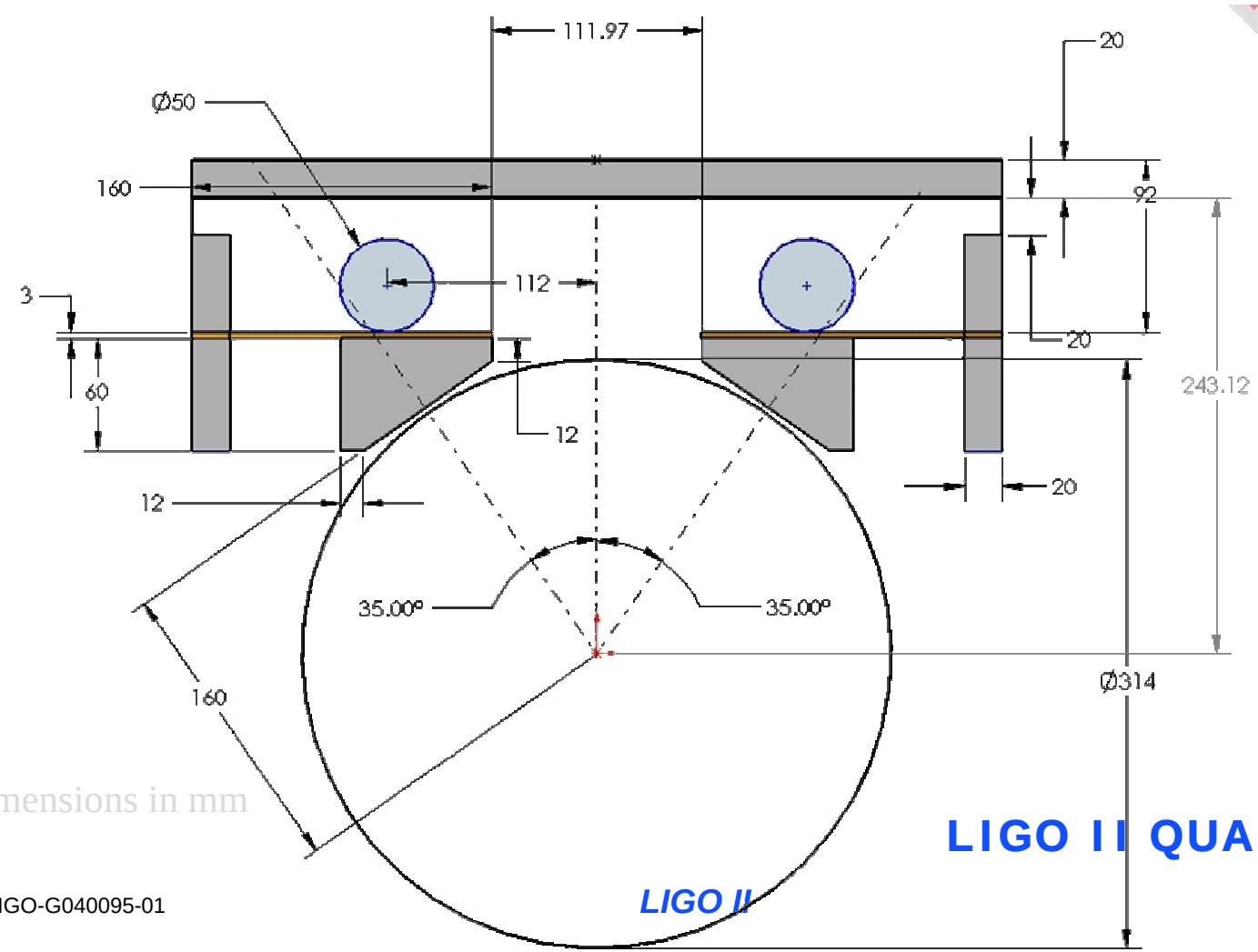
SIDE VIEW OF MAIN CHAIN AND PARTIAL REACTION CHAIN

Modeling the Structures





Upper catcher wrt suspenion



All dimensions in mm

LIGO II QUAD LAYOUT