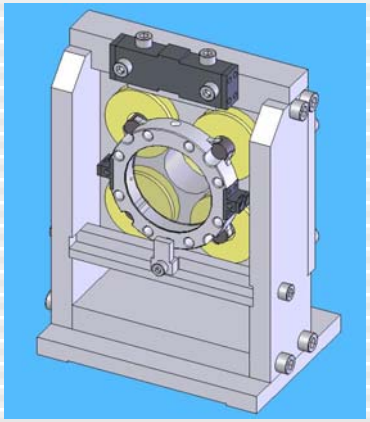
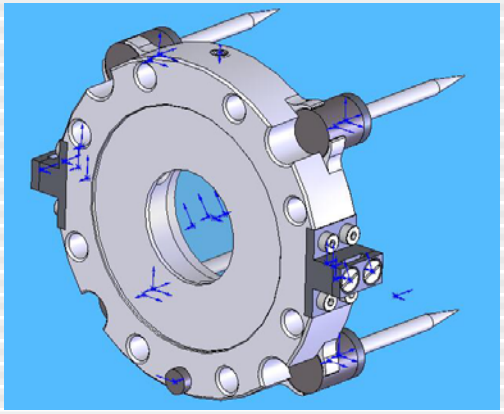




Tip-Tilt Stage

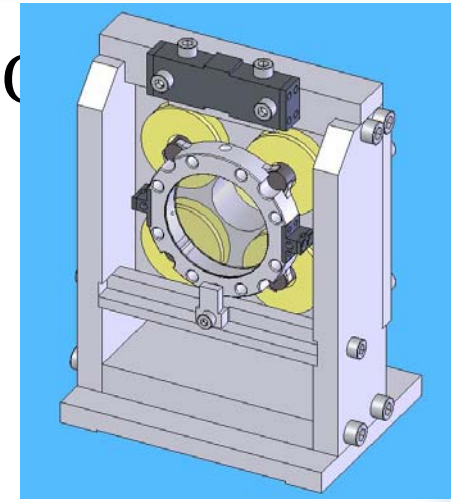
LSC/VIRGO March 2007

Centre for Gravitational Physics

Australian National University

Bram Slagmolen

What is the Tip-Tilt Stage



- A steering mirror which can dither the OMC input beam at high frequencies (1kHz - 10kHz).
- Pit/Yaw/Long actuation.
- Will hold a 2” or 1” mirror.
- Can be used for other beam steering (SPI, PD’s, etc).
- Chosen to be a simple pendulum system (e.g. modified SOS).
- Two independent wires, one on either side.

Requirements

- Dither frequency: 1 kHz.
- Dither angle: 6.8 urad (1% of .5mm cavity waist).
- Nom. Drive current: 100 mA.
- Longitudinal isolation.
- Resonant mode >2 Hz.
- Vertical bounce mode: ~343 Hz.
- Access to optical transmitted beam.
- Simple/robust unit.
- Vacuum compatible

Pit/Yaw/Long Actuation

- Using 4 new Hybrid OSEM on the face (no side OSEM).
- Using large magnets: OD10 mm x L10 mm (providing 2.05 N/A Force Coeff.).
- Nominal coil current 100 mA.
- Required force per magnet:
  - Pit: 74.3 mN
  - Yaw: 91.1 mN.
- Required OSEM force coeff.(I=100mA): 0.91 N/A
- DC angular range (pk-pk): ~14.5 mrad (I_{pk-pk}~25mA)
- Increase range by using a tapered (1:6) flag, from R_{pk-pk}=0.7 mm to R_{pk-pk}=4 mm.
- Side/Vertical resonance damped using ECD.

Specifications (1/2)

- Mirror assembly mass ~0.128 kg
- Mirror assembly nom. diameter: 68.2 mm
- Mirror assembly thickness: 12 mm
- Pendulum length: 55 mm
- Wire diameter: 355 um (one either side)
- d-pitch: 1.1 mm
- d-yaw (structure): 60 mm
- d-yaw (optic): 76.2 mm (3 inch)

Specifications (2/2)

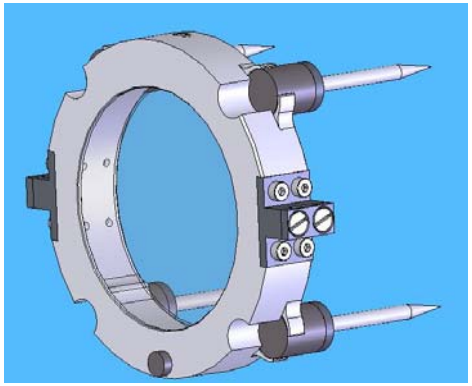
- Resonance Modes for Lightened 2” optic (using M. Barton TwoWireSimple V3 Mathematica model):
  - Longitudinal: 2.032 Hz
  - Side: 2.869 Hz
  - Pitch: 4.184 Hz
  - Yaw: 4.597 Hz
  - Vertical: 343.66 Hz
  - Roll: 500.29 Hz

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

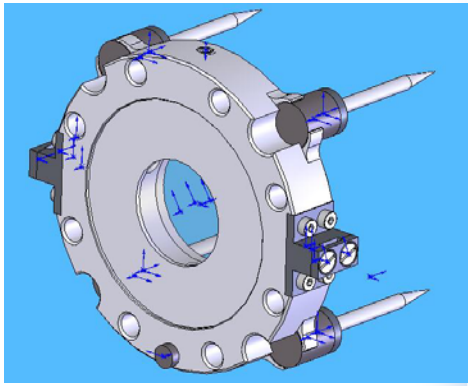
Optic Assembly

XX = Pitch
YY = Yaw

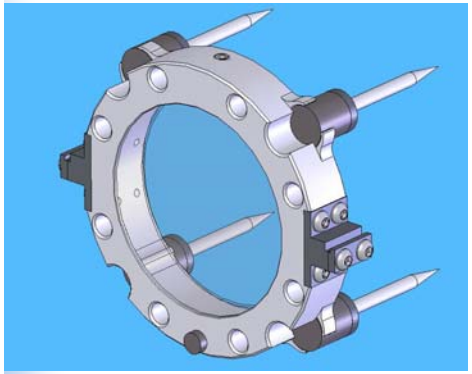
M=133 g
I_{xx}= 51.3u kg m^2
I_{yy}= 62.3u kg m^2



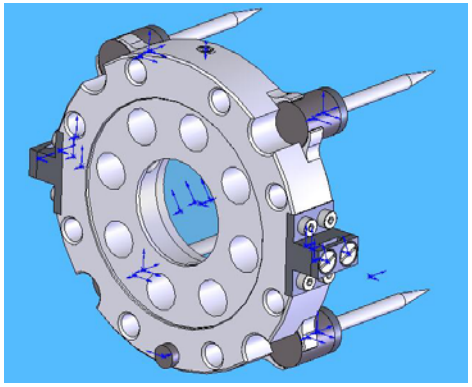
M=128 g
I_{xx}= 49.5u kg m^2
I_{yy}= 60.6u kg m^2



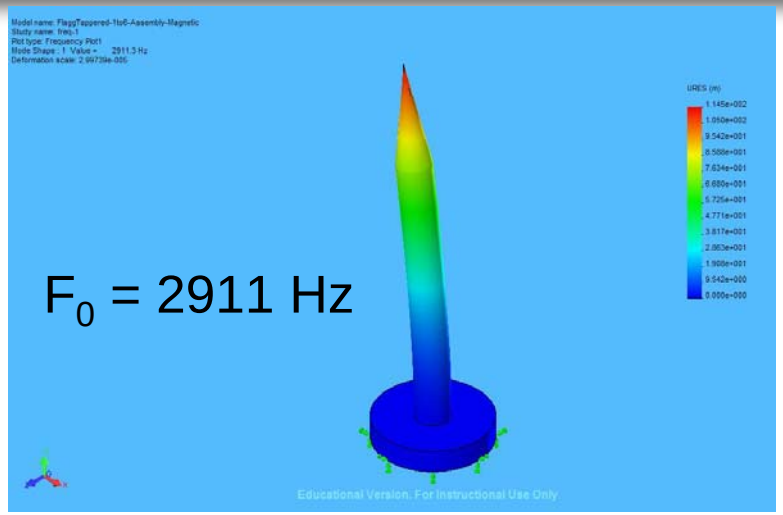
M=128 g
I_{xx}= 48.8u kg m^2
I_{yy}= 59.8u kg m^2

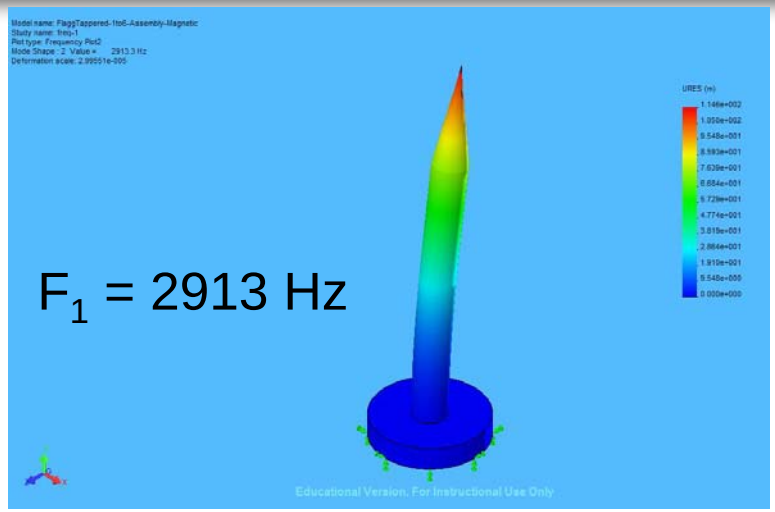


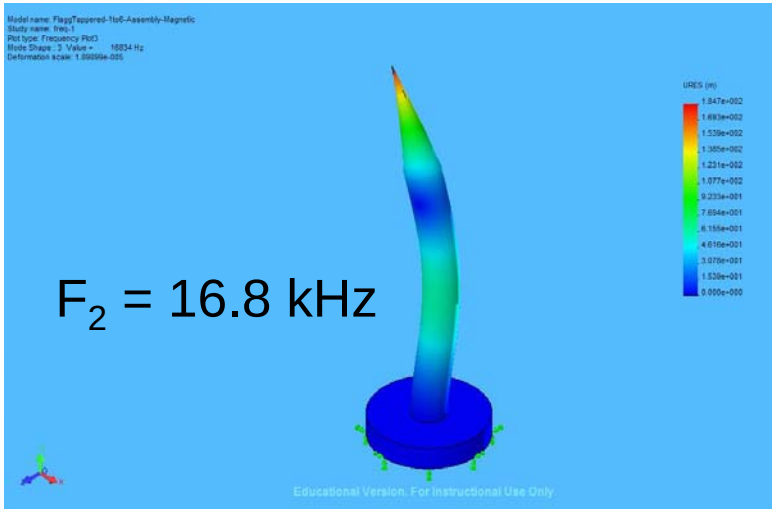
M=117 g
I_{xx}= 47.4u kg m^2
I_{yy}= 58.5u kg m^2

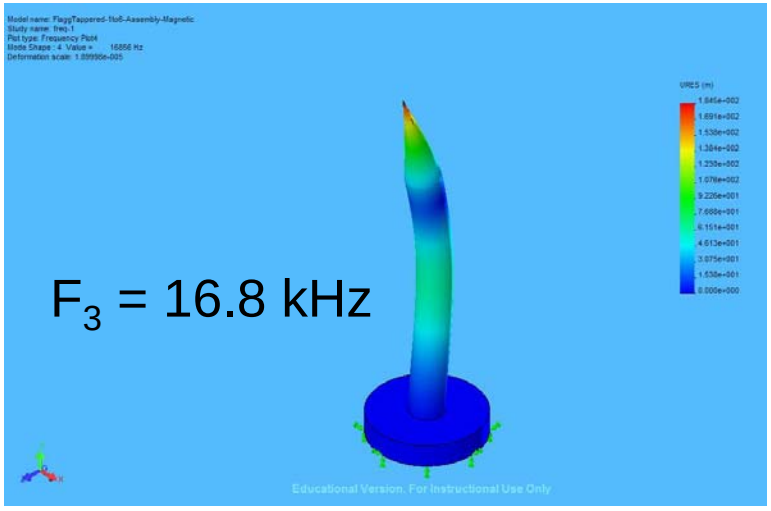


OSEM Flag Modes

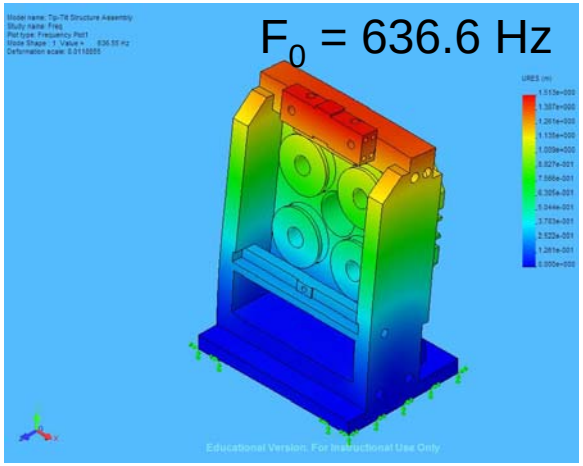


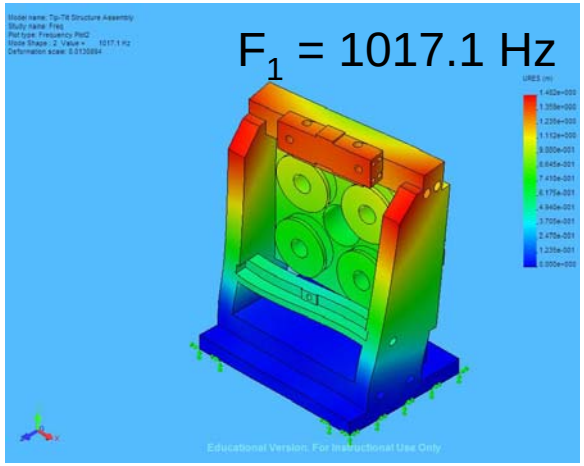


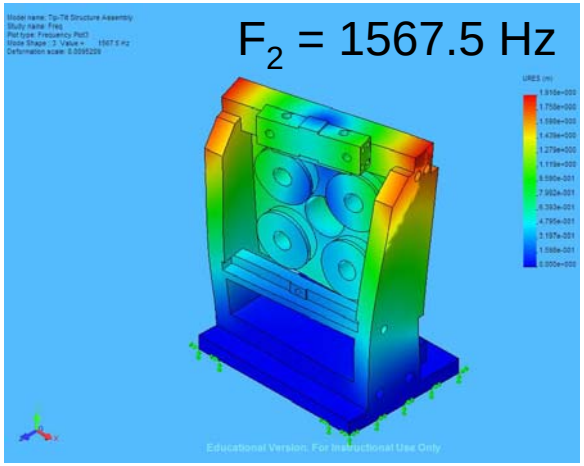


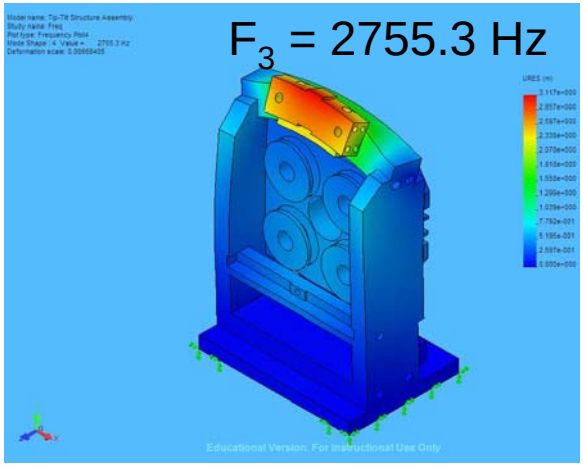


Structure Modes







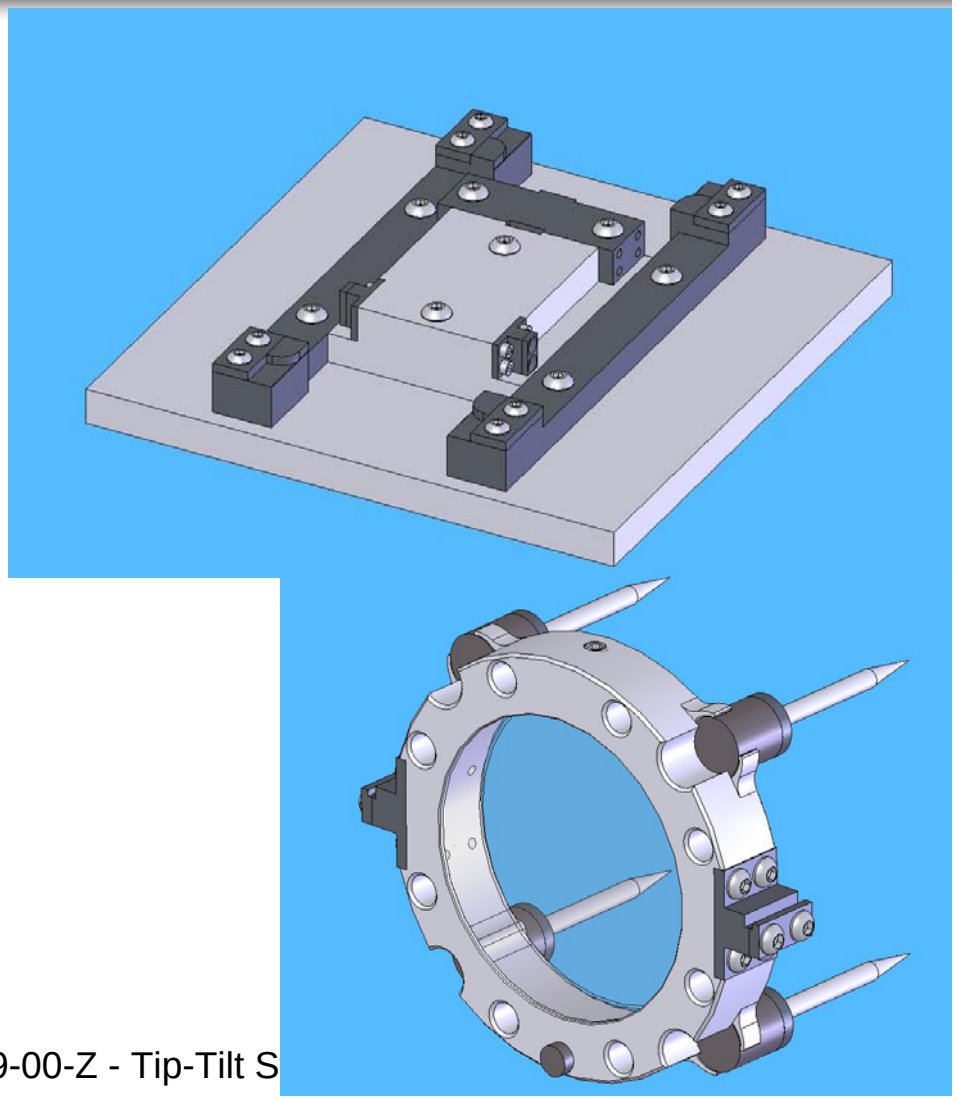


Mode1 Movie

QuickTime™ and a
Cinepak decompressor
are needed to see this picture.

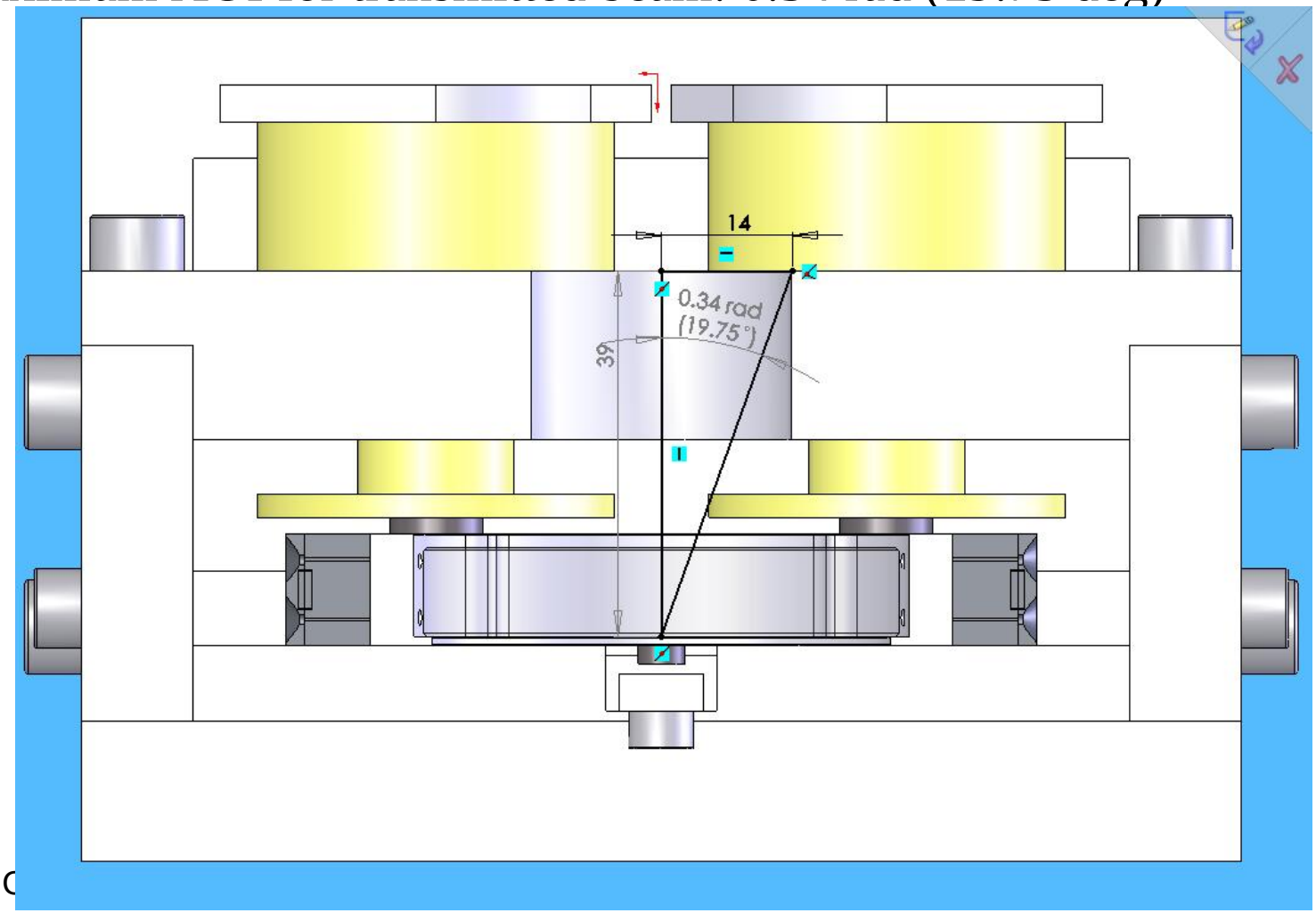
Suspension Wire Assembly Jig

- Suspension wire diameter is 355um.
- COM of the optic assembly is 1.726 mm towards the ‘back’.
- Using a Jig to locate the wire as close to the COM as possible.
- May need to nudge the WireClamp when balancing the optic assembly.



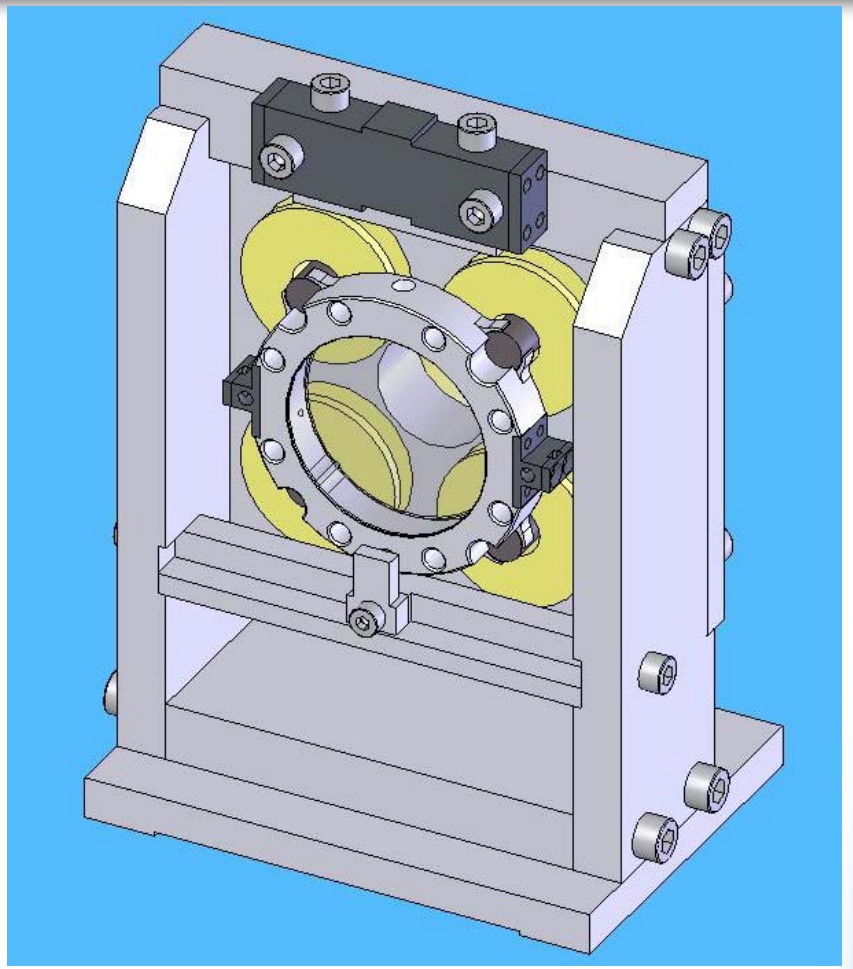
Transmitted Beam AOI

- Maximum AOI for transmitted beam: 0.34 rad (19.75 deg)



Design

- Suspension wire clamped using a separate jig.
- Large magnets clamped (can be glued).
- Pitch adjust by nudging the ‘InnerWireClamp’, similar to iLIGO SOS.
- Most parts made from aluminium (darker parts S/S in figure).
- See drawings at



http://ilog.ligo-wa.caltech.edu:7285/advligo/Tip-Tilt_Mechanical_Design

To Do / Schedule

1. Beam dumping for larger AOI (scatter prevention). (June)
2. Assemble one and measure the normal modes. (March/April)
3. Built local control. (April)
4. Test the dither technique. (May)
5. Measure P/Y cross coupling. (May/June)
6. Shipment of Tip-Tilt to CIT/MIT. (July)