MONALISA Update

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MONALISA

Monitoring Alignment & Stabilisation with high Accuracy

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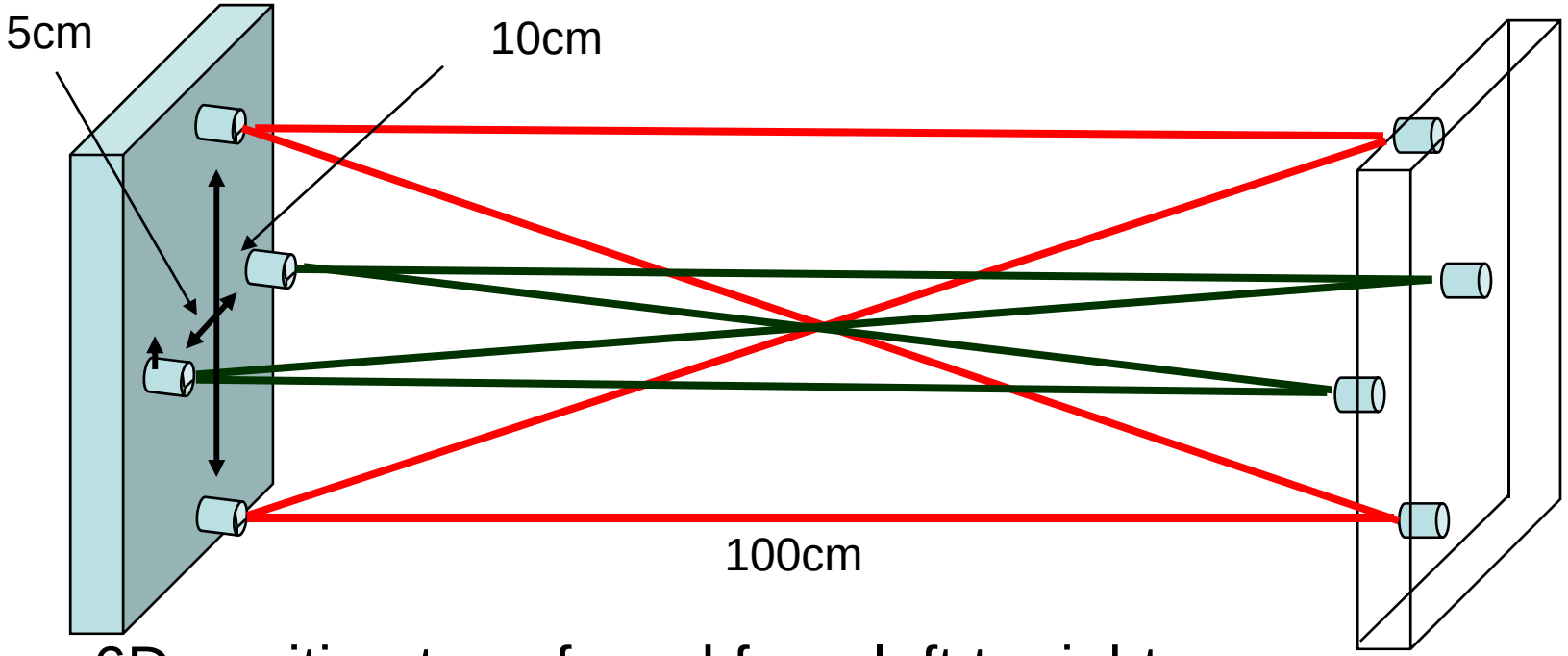
Science & Technology Facilities Council

MONALISA at ATF2

- MONALISA: measures 6D position of two objects separated by several meters with a precision of nanometres
  - Using interferometers
- ATF: Objects are QD0 and Shintake monitor
- At Oxford we have developed a distance meter with
  - better than 1 micron absolute distance resolution
  - Nanometre relative distance resolution
- Need now to develop compact straightness monitor to measure 6D position

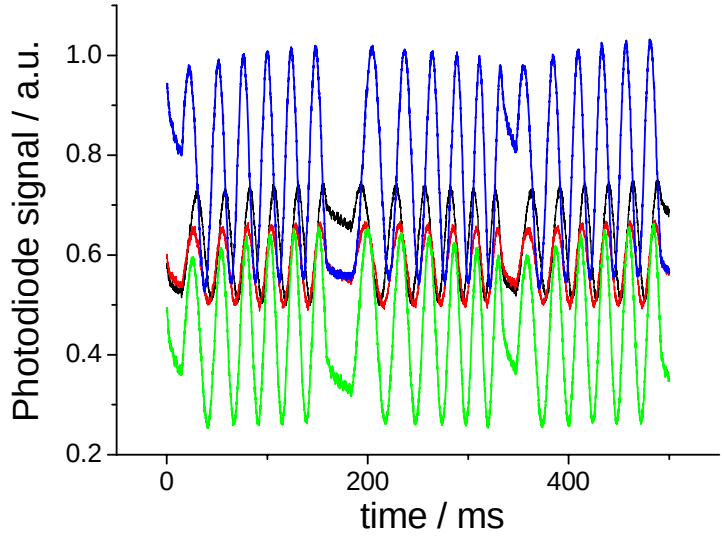
CSM (Compact Straightness Monitor)

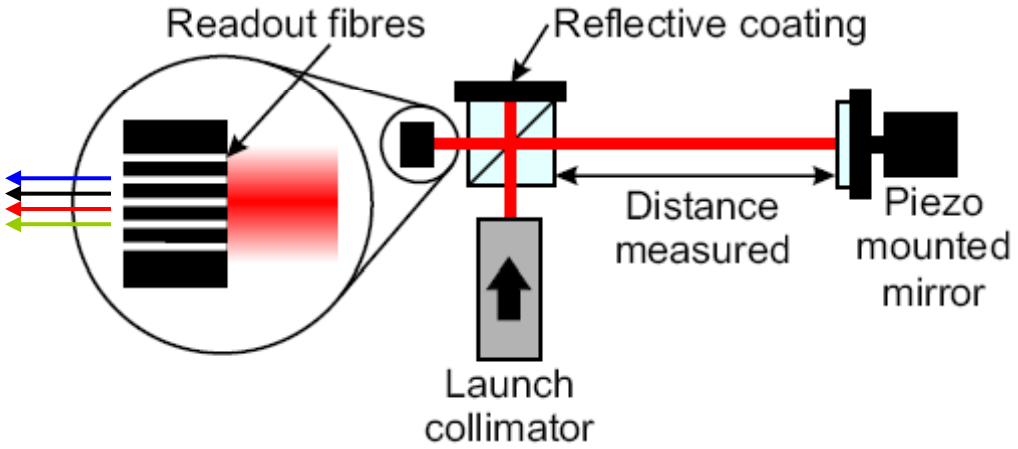


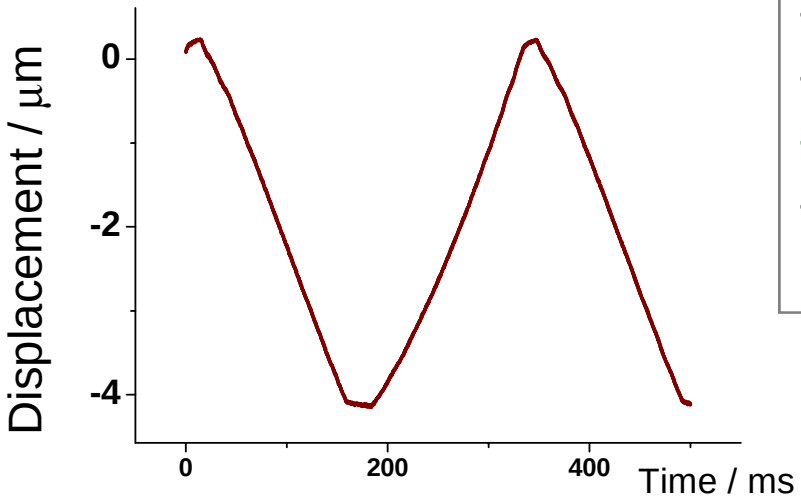
- 6D position transferred from left to right
  - breaking of symmetries is important
- Preliminary simulation results of CSM Resolution:
  - σ_y:10nm
  - distance meter resolution: 1nm
  - Positional change of optics components with respect to each other: 1nm That's the challenge.

Multi-fibre read out (compact launch)

FFI: Fixed Frequency Interferometry (OPD 400mm)







- Fixed frequency laser (FFI)
- Compact Launch: 25x25x15mm
- Test *shown here* with moving mirror
- The “real” setup will use retro-reflector
  - easier for setup!

Multi-fibre read out (compact launch)

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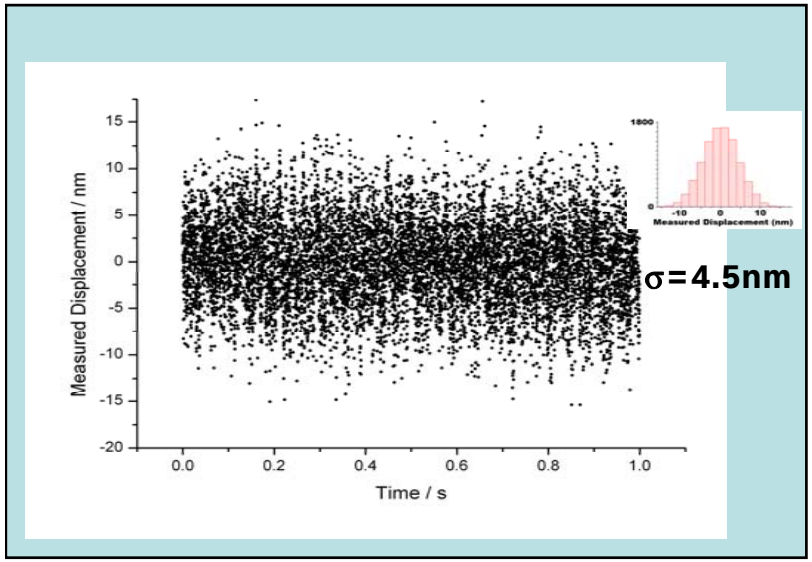
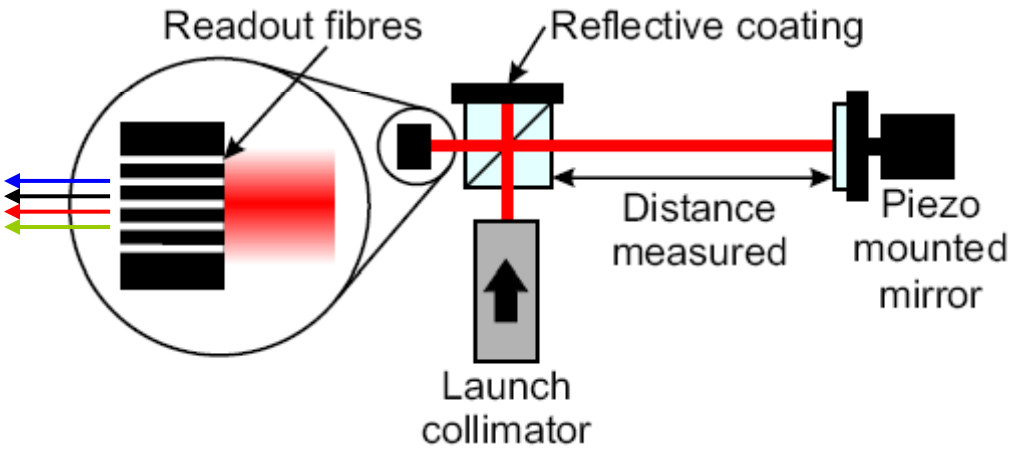
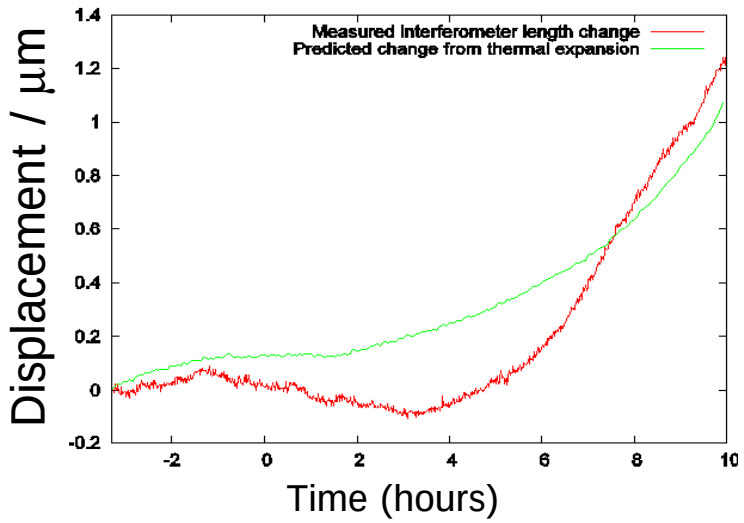


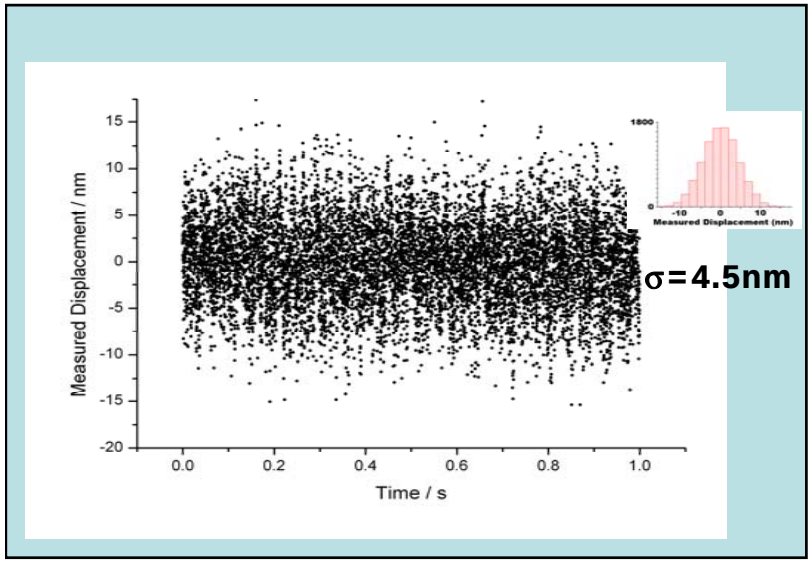


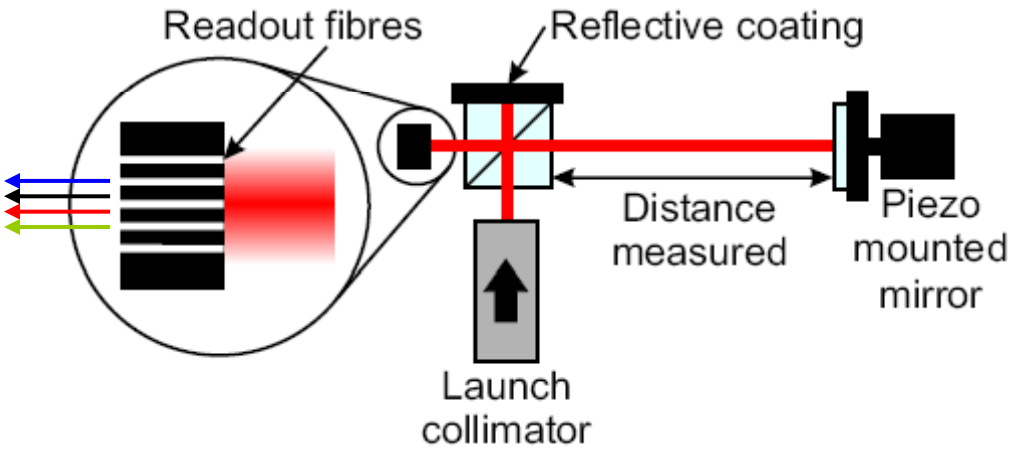


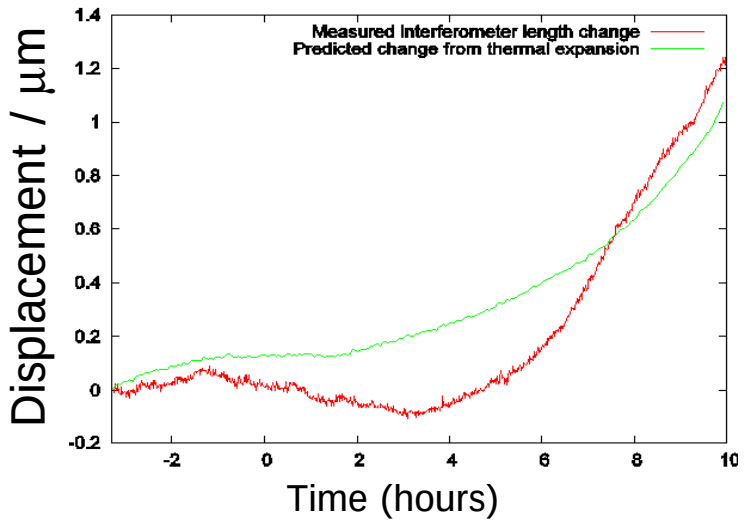
- Fixed frequency laser (FFI)
- Compact Launch: 25x25x15mm
- Test *shown here* with moving mirror
- First stationary mirror test :
  - resolution 5 nm demonstrated
  - to be improved with vaccuum
  - and laser frequency stabilisation

Multi-fibre read out (compact launch)

FFI: Fixed Frequency Interferometry (OPD 400mm)





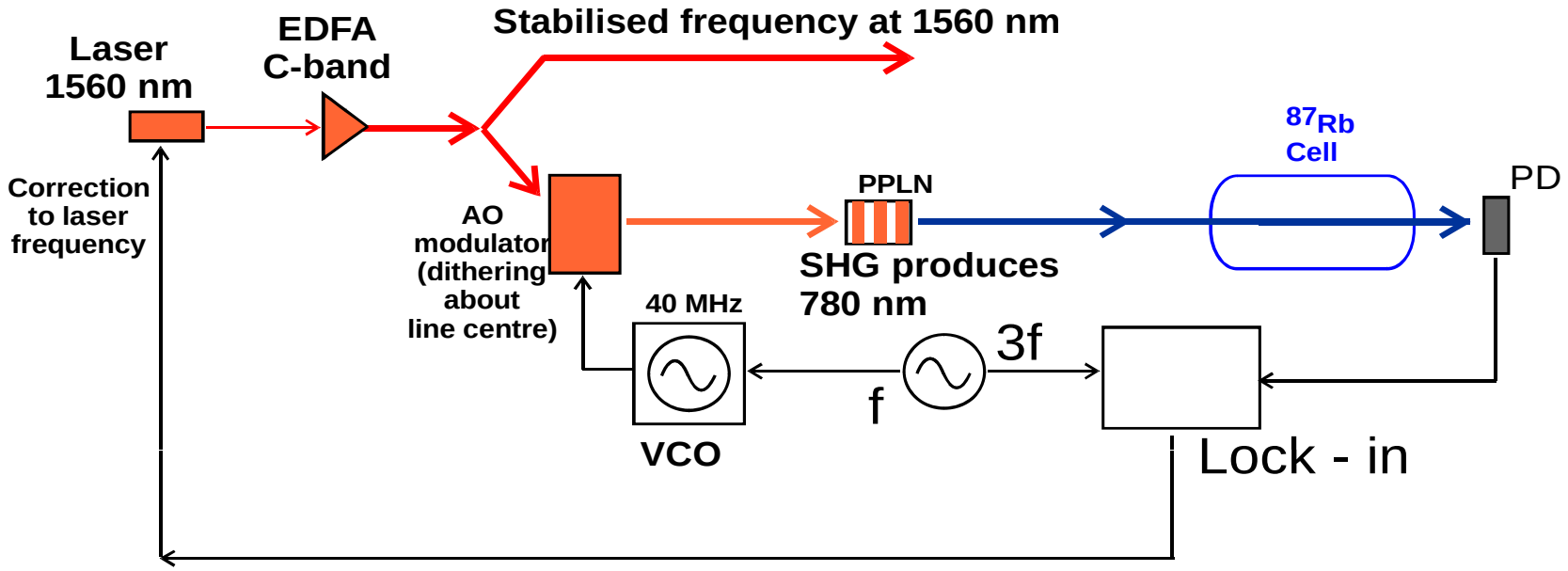


- Fixed frequency laser (FFI)
- Compact Launch: 25x25x15mm
- Test *shown here* with moving mirror
- First stationary mirror test :
  - resolution 5 nm demonstrated
  - to be improved with vaccuum
  - and laser frequency stabilisation

Frequency stabilisation

Frequency standard: ^{87}Rb D_2 line at 780 nm

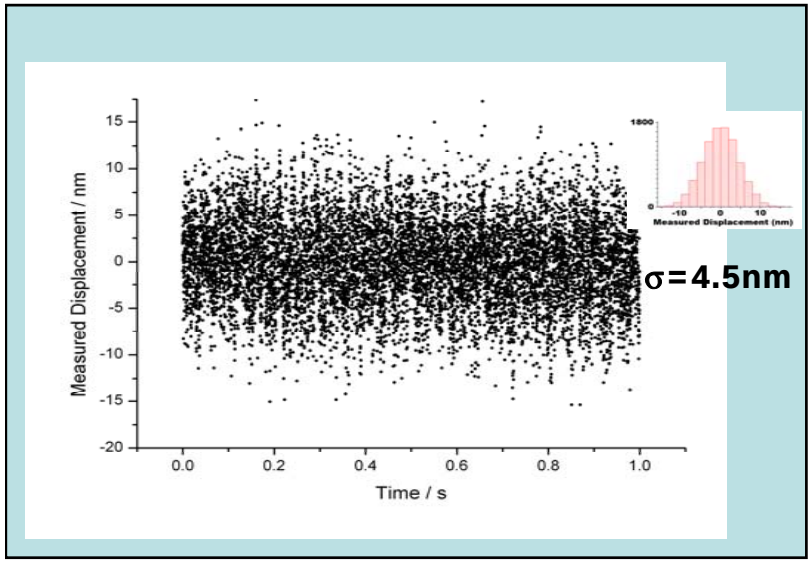
Simplified Schematic:

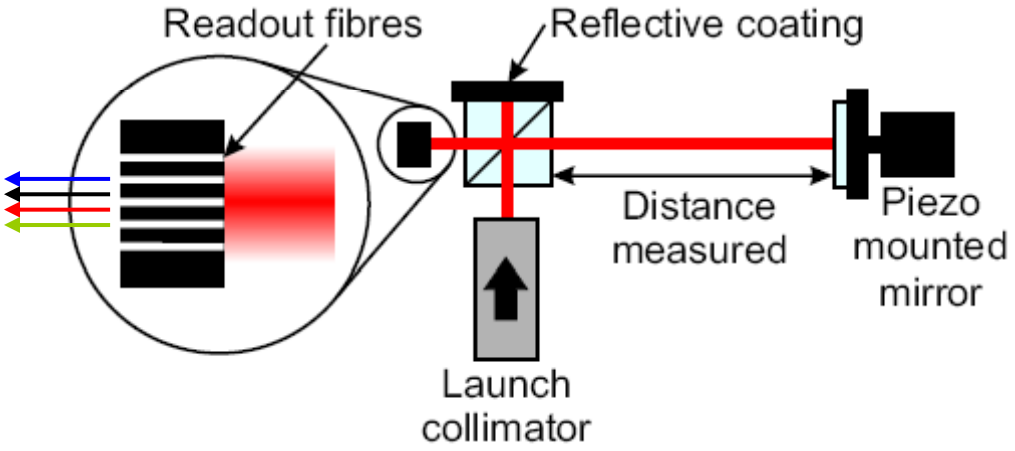


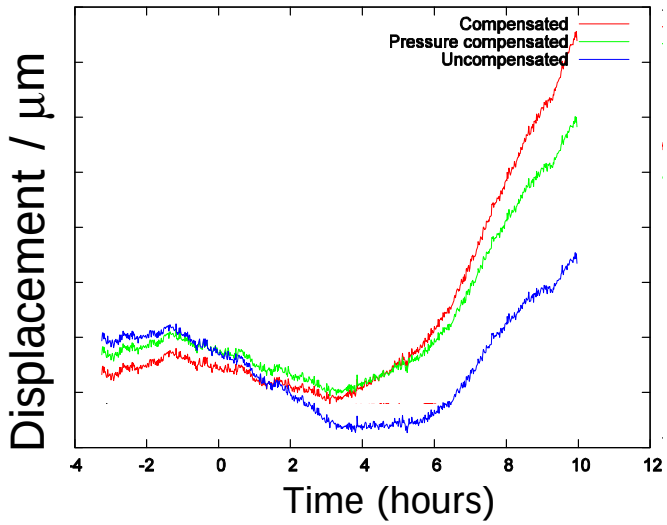
- Need 20 kHz stability for 1nm over distances of 10m.
- NPL done ~kHz.

Multi-fibre read out (compact launch)

FFI: Fixed Frequency Interferometry (OPD 400mm)



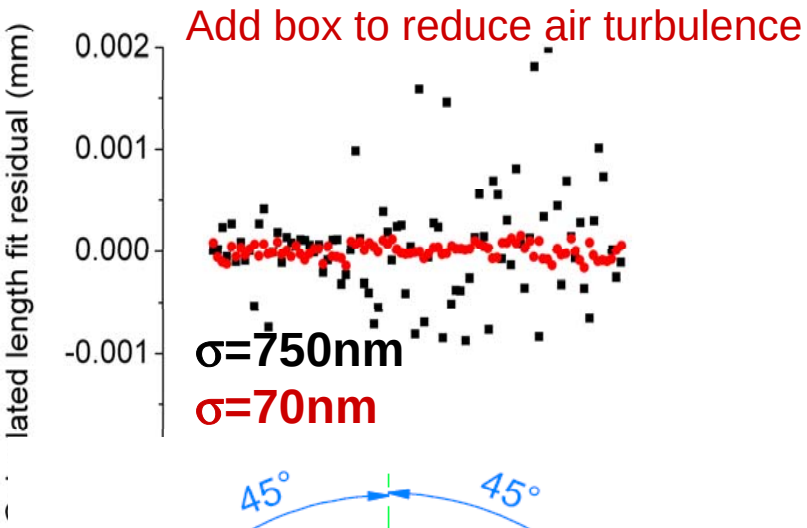


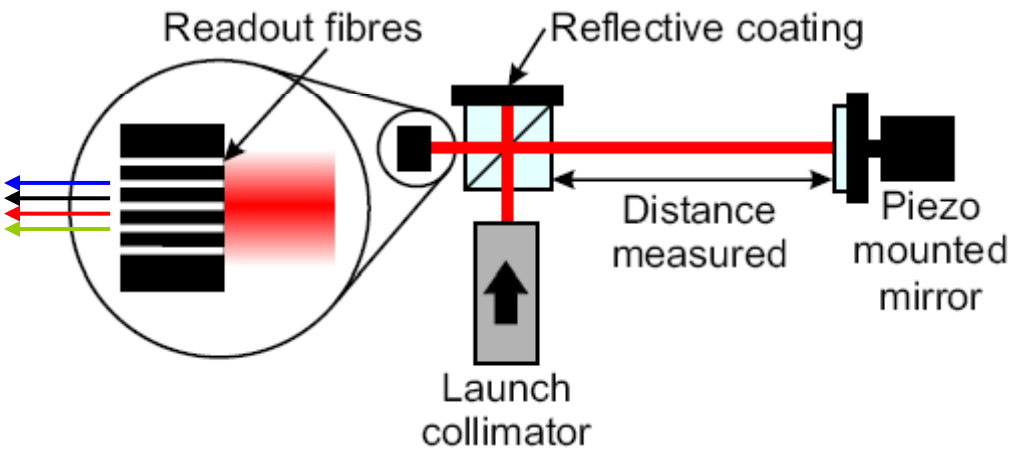


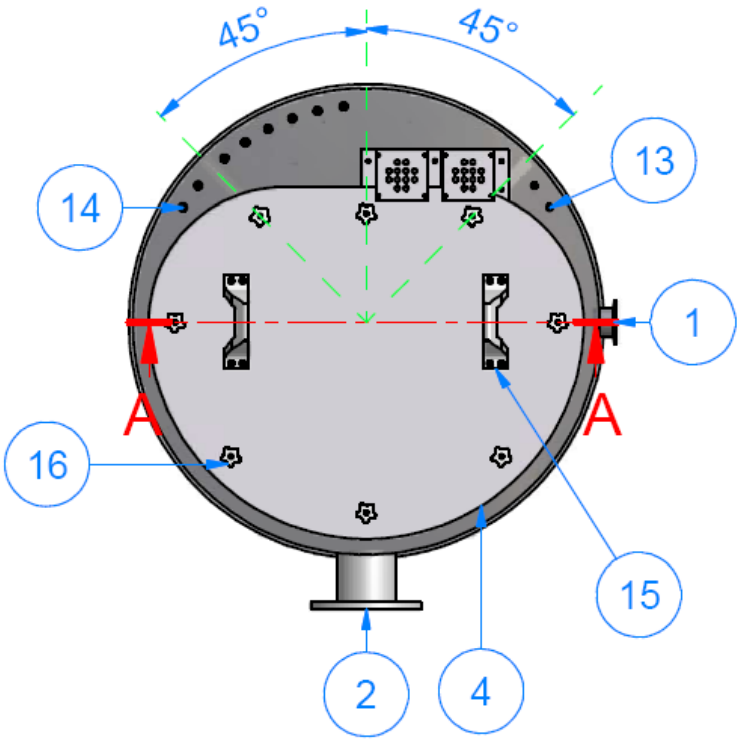
- Fixed frequency laser (FFI)
- **Compact Launch: 25x25x15mm**
- Test *shown here* with moving mirror
- First stationary mirror test :
  - resolution 5 nm demonstrated
  - to be improved with vaccuum
  - and laser frequency stabilisation
  - temperature and pressure dependence look reasonable

Multi-fibre read out (compact launch)

FSI:Frequency Scanning Interferometry (OPD 400mm)







- Same interferometer can be used for FSI
- Better resolution by just covering interferometer with box
  - expect to do even better in vacuum!

LiCAS Reference Interferometers

- Frequency Scanning Interferometry
  - long line reference interferometers show world leading resolution
  - Using single non-stepped readout

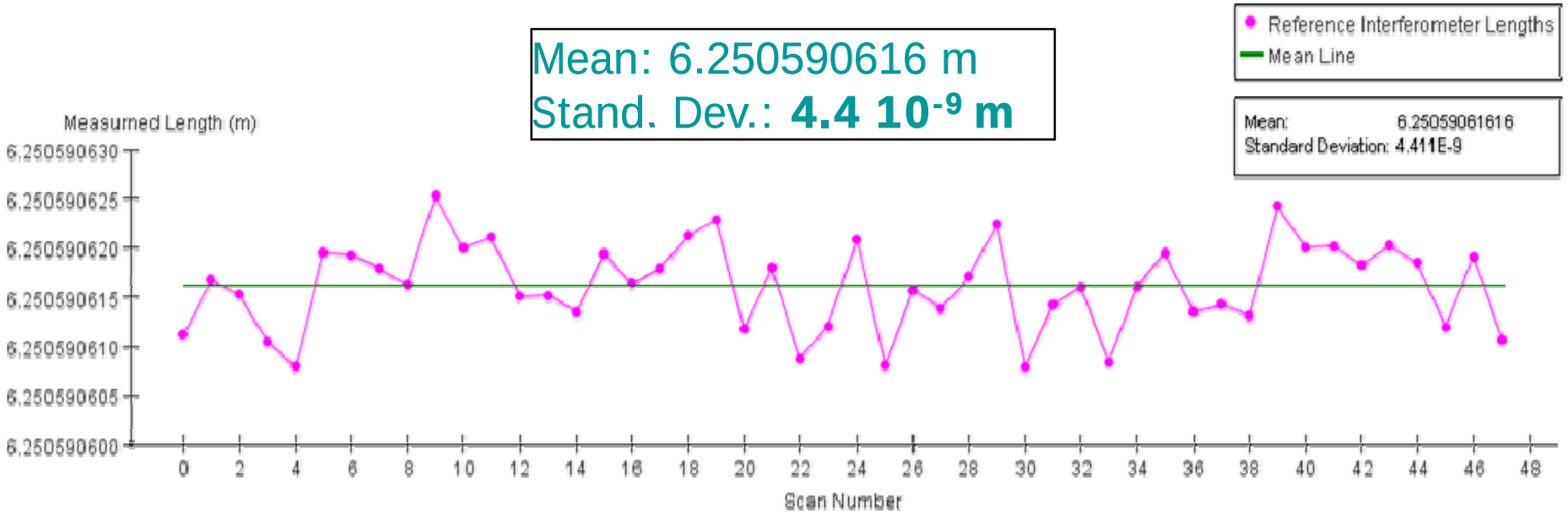


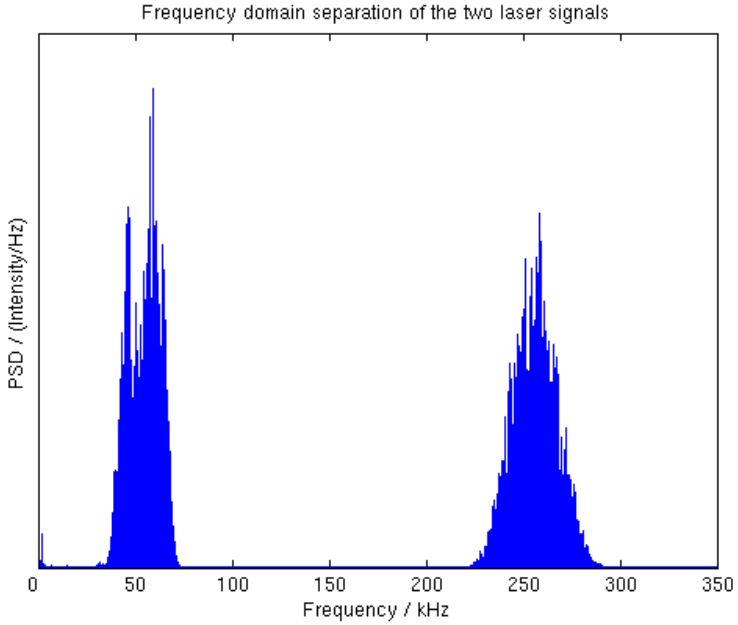
Fig. 2 Repeatability of FSI Ref. Interf. measurements

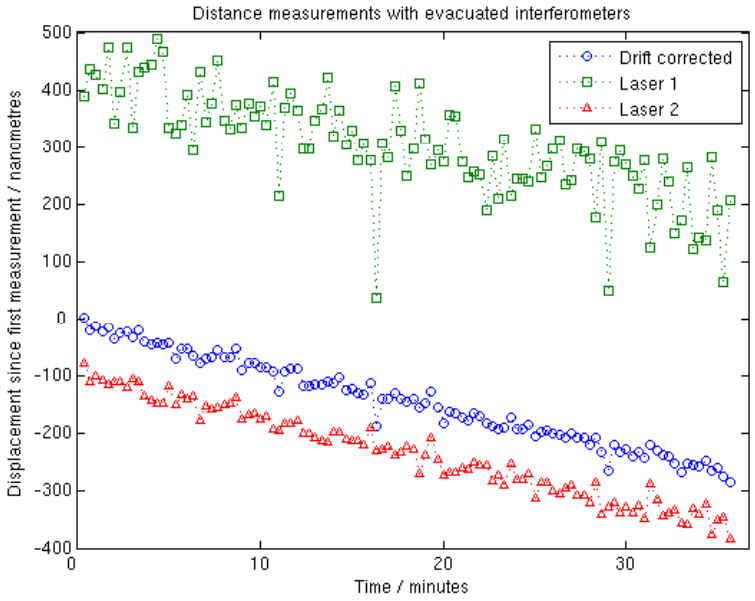
Dual Laser FSI

- Known Fundamental limitation on Resolution: Drift errors during scan (~1s)
- Solution: Use two lasers scanning in opposite direction.
  - Second laser being purchased as I speak.
  - Some test data taken during tryout.
- Modulate two lasers with different frequencies – demodulate with electronics
- Use different tuning speeds resulting in different FSI frequencies

Opposite tuning Lasers

- Using two evacuated LiCAS reference interferometers: 6.25m OPD.
  - Separation easy
  - Resolution improves

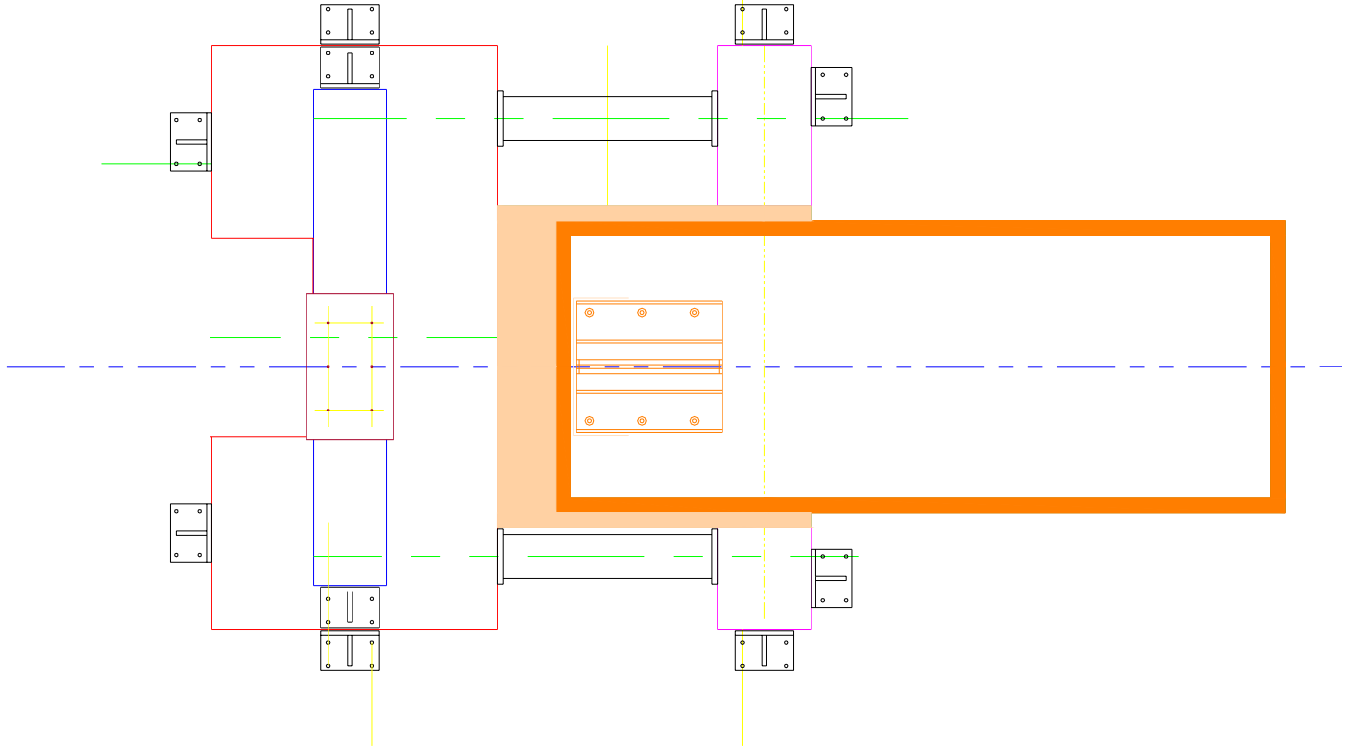




Progress

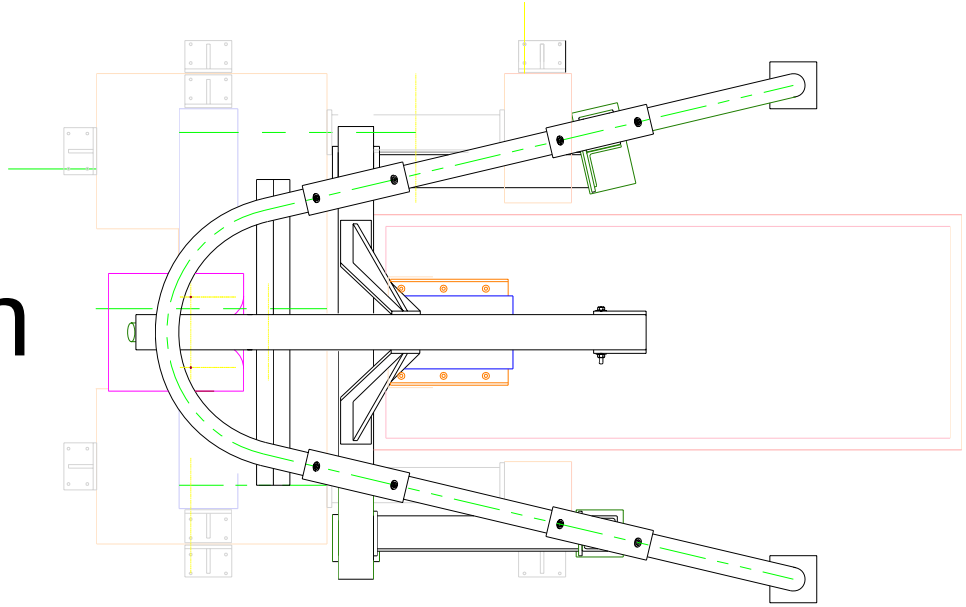
- Hardware
  - Built novel Interferometer designs
  - Pioneered new phase measurement techniques
  - Vacuum vessel to demonstrate nm precision currently being vacuum tested
  - Tested compact launch optics
- Software
  - Developed novel phase analysis technique
  - Collaborated with LiCAS on OO analysis package
  - Developed binary file format for data handling
    - users MonAliSA, LiCAS and ATLAS (FSI)...
    - Available in Java, C and LabVIEW

Shintake Monitor and Optical Table for Final Doublet Support so far

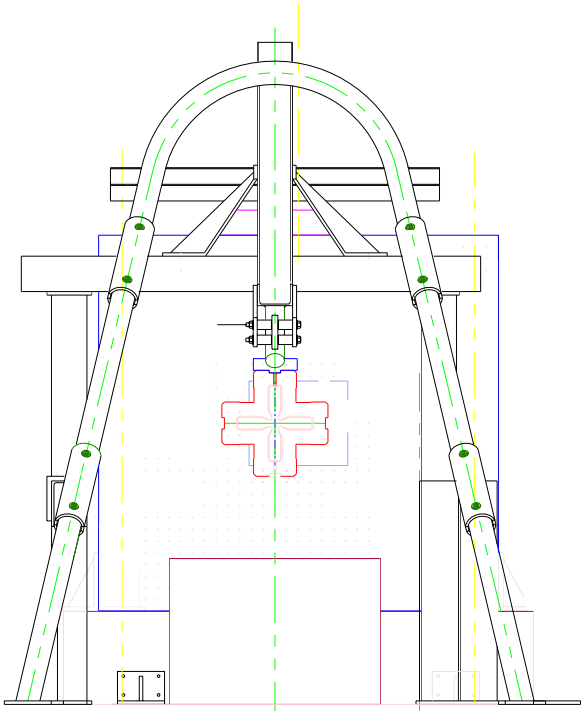


- Find MONLISA support structure:
  - Not attached to present support structures
  - Rigid to not induce unwanted vibration
  - Fit into overall footprint

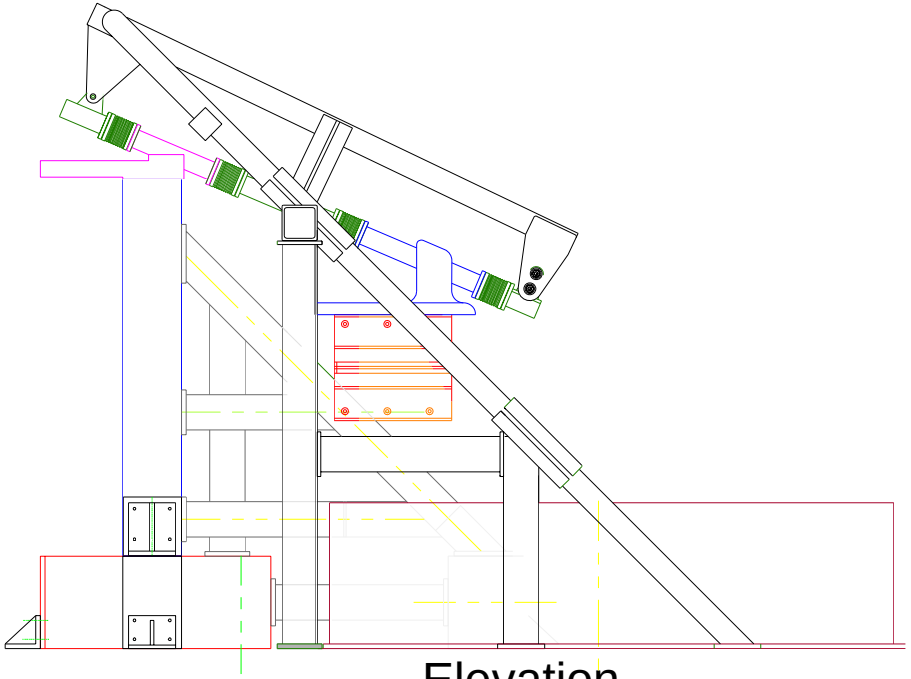
Overview of Current Design



Plan View

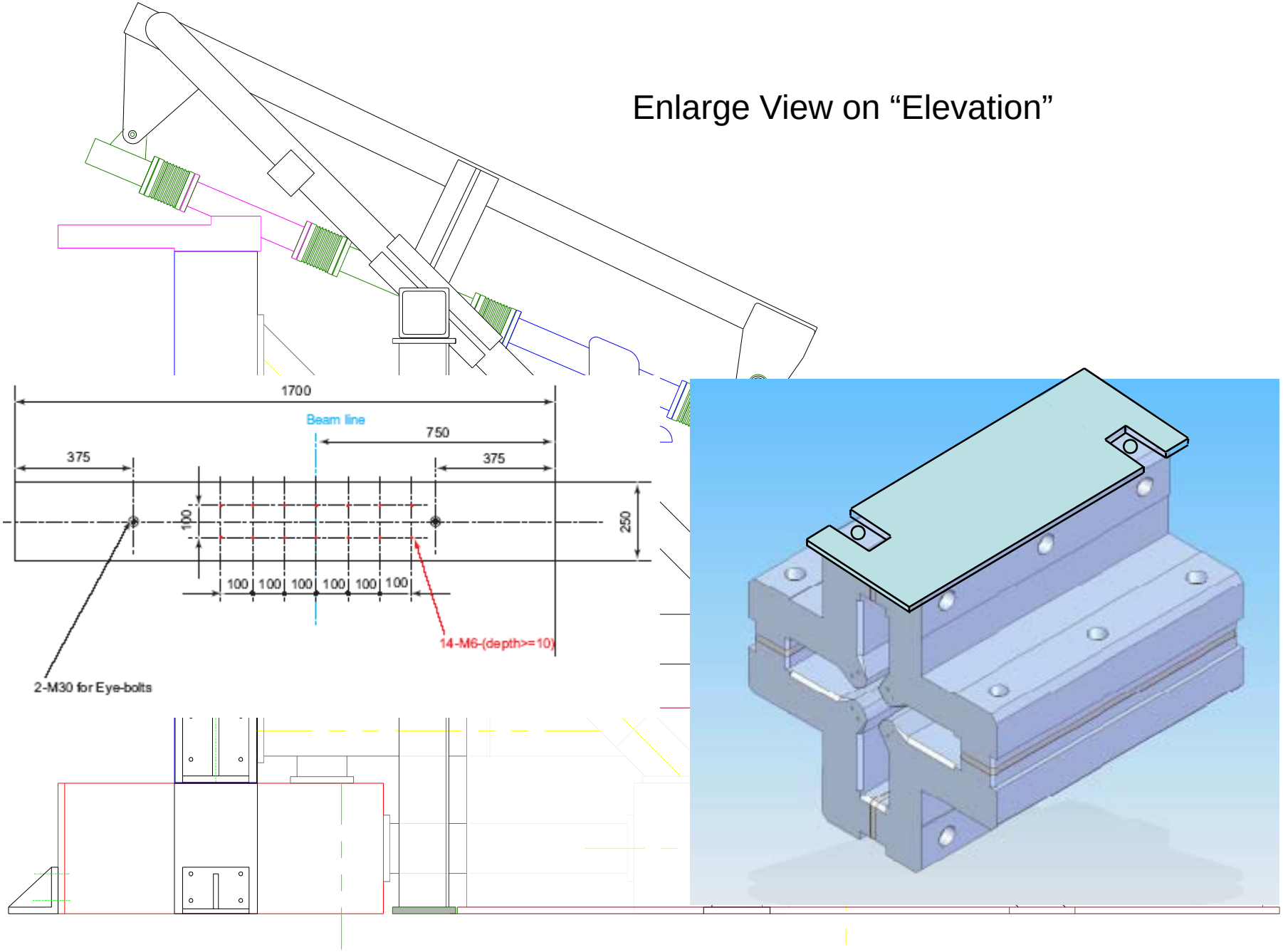


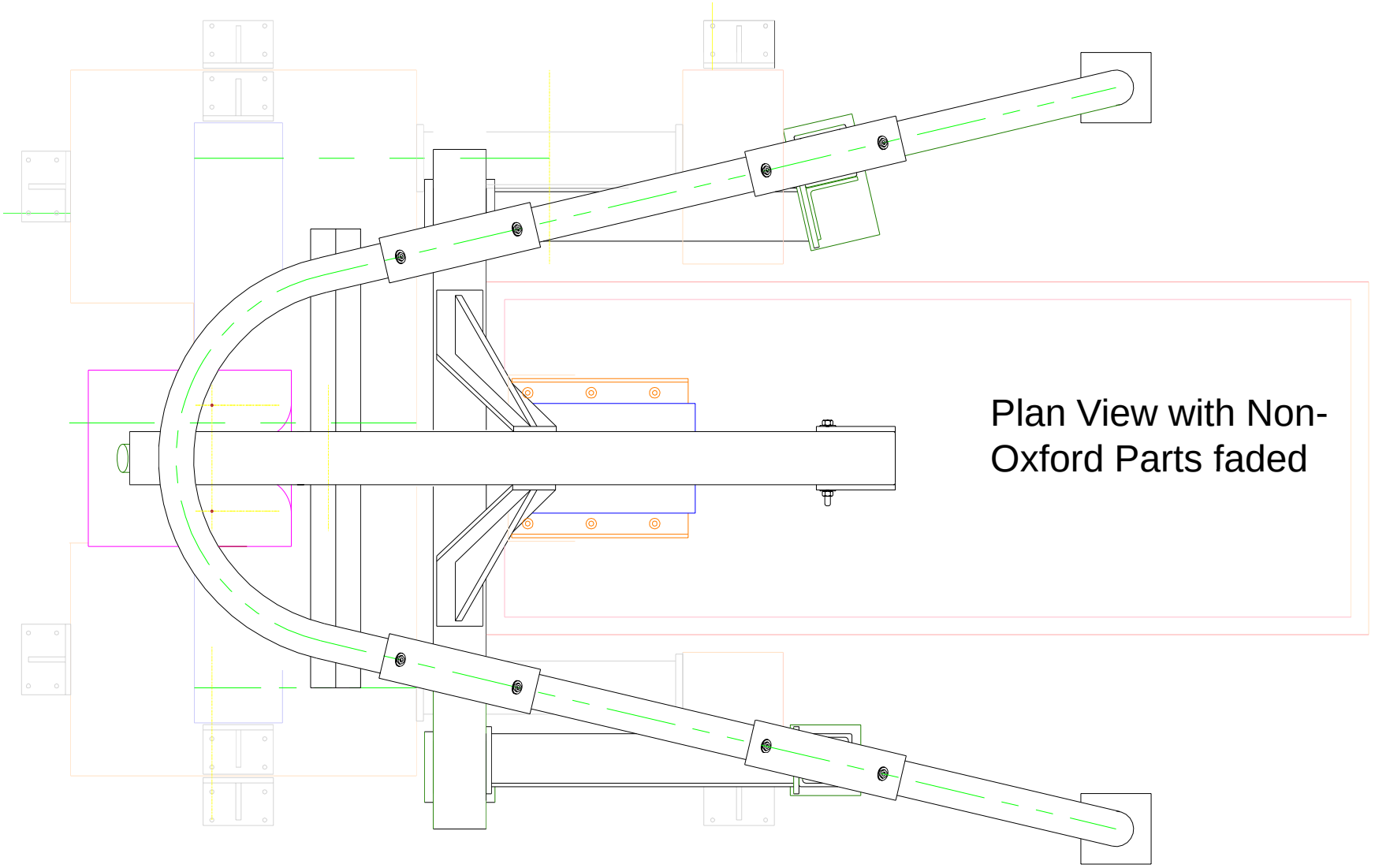
End View



Elevation

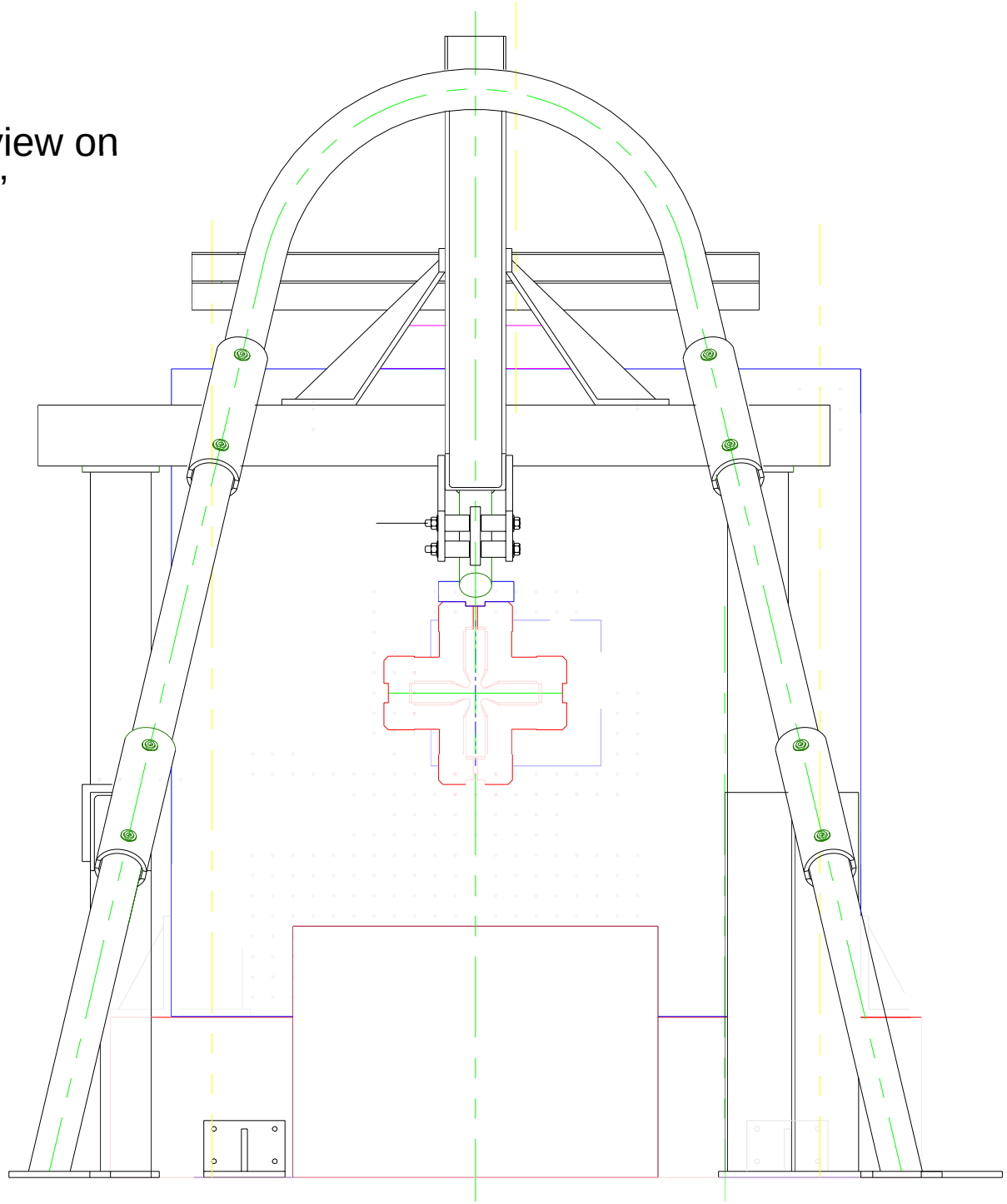
Enlarge View on “Elevation”

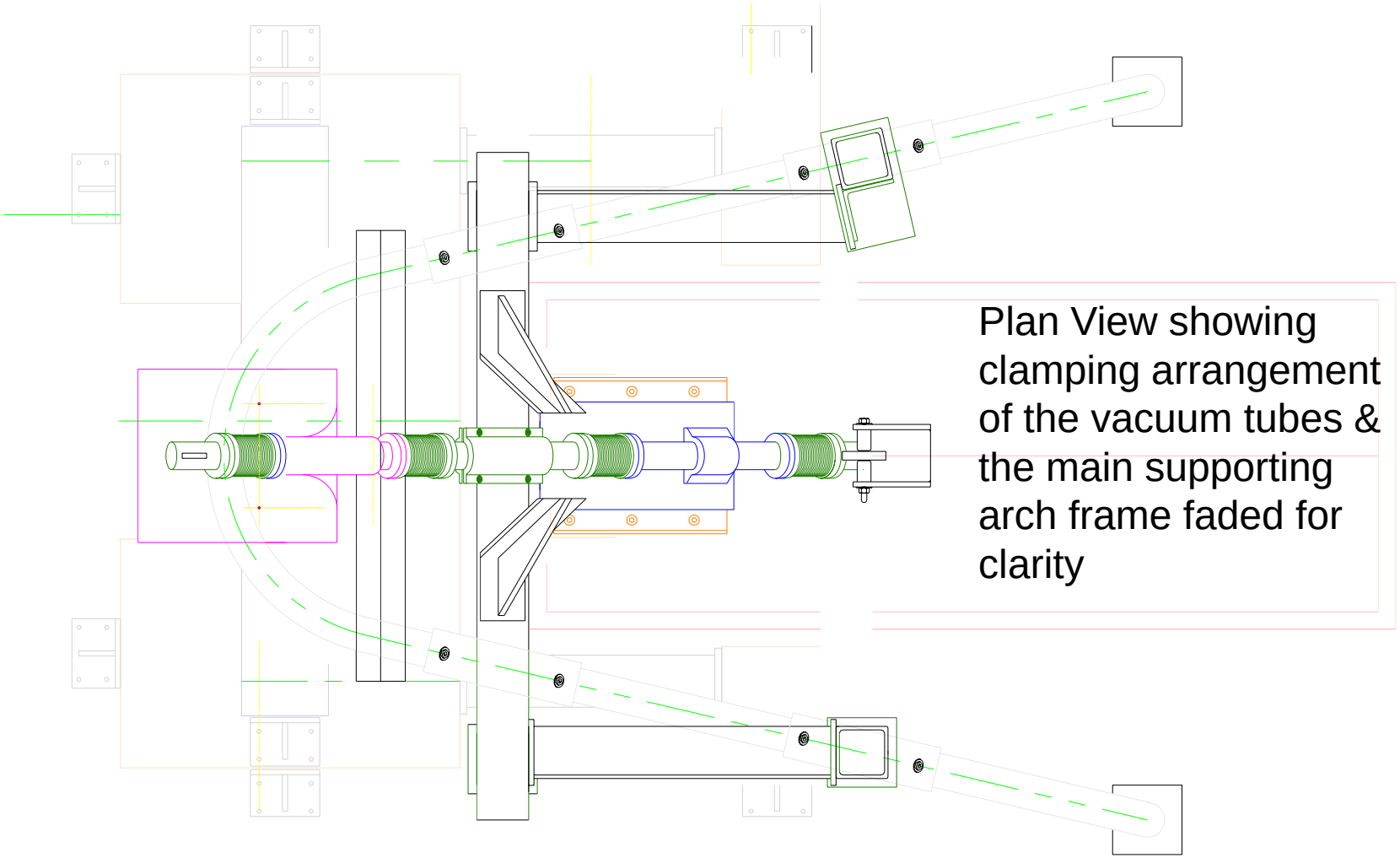




Plan View with Non-Oxford Parts faded

Enlarged view on
“End View”





Plan View showing clamping arrangement of the vacuum tubes & the main supporting arch frame faded for clarity

Conclusion

- CSM design started
- Vacuum test vessel ready.
- Promising results on both FFI and FSI front
- Frequency Stabilization Concept finished
- Converging towards practical mounting structure.