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LIGO UK

OSEM Development
UK Advanced LIGO Project

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Latest OSEM Model Located on ALUK Birmingham webpage at:

http://www.sr.bham.ac.uk/research/gravity/rh,d,2.html

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Overview

- LIGO Review Outcome (July 2004):
  - Geometric OSEM
  - Interferometric OSEM
  - Performance Requirements
- Development:
  - Sensor Development
  - Mechanical Development
  - Electronics Development
- Prototype Fabrication
  - Part Procurement
  - Mechanical Fabrication
- Next Steps:
  - Prototype Assembly
  - Vacuum Compatibility Testing
  - Prototype Testing
  - Manufacturing Study

OSEM Review Outcome

- Geometric Hybrid OSEM's:
  - **The approach of using hybrid OSEM'S plus eddy-current damping (ECD) for the quad suspensions is preferred over interferometric sensor damping.**
  - **This approach includes incorporating potential performance improvements into the hybrid OSEM sensor.**
- Interferometric Based OSEM's:
  - **Continue R&D on the interferometric sensor, as a possible back-up solution in the (unlikely) event that the Hybrid + ECD solution is later found to be inadequate.**

OSEM Review Outcome

- Required Range Performance:
  - 0.35*mm* (peak-peak) working range [1], incorporating:
    - 0.20*mm* OSEM positioning inaccuracy (adjustment resolution)
    - 0.15*mm* to cope with drifts in the suspension (thermal etc.)
  - Hybrid OSEM range has been demonstrated to be 0.7*mm* *

  ➢ **We aim for no worse than 0.7*mm* working range**

- Required Sensitivity Performance:
  - $3 \times 10^{-10} m/\sqrt{Hz}$ at 1*Hz* has been demonstrated by the Hybrid OSEM *

  ➢ **We aim for no worse than $3 \times 10^{-10} m/\sqrt{Hz}$ at 1*Hz***

* (confirmed by N. Lockerbie [2], P. Fritschel and R. Adhikari [3])

DCC References: [1] LIGO-T040110-01-K, [2] LIGO-T040106-01-K, [3] LIGO-T990089-00

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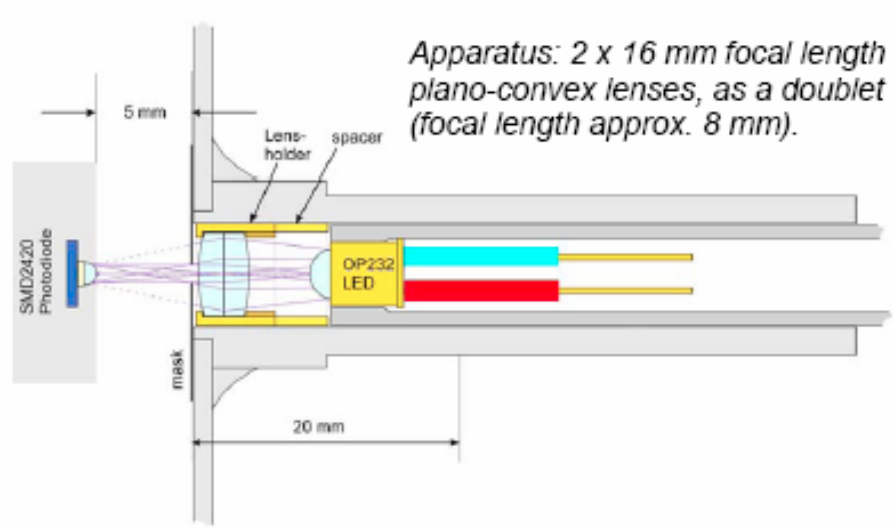
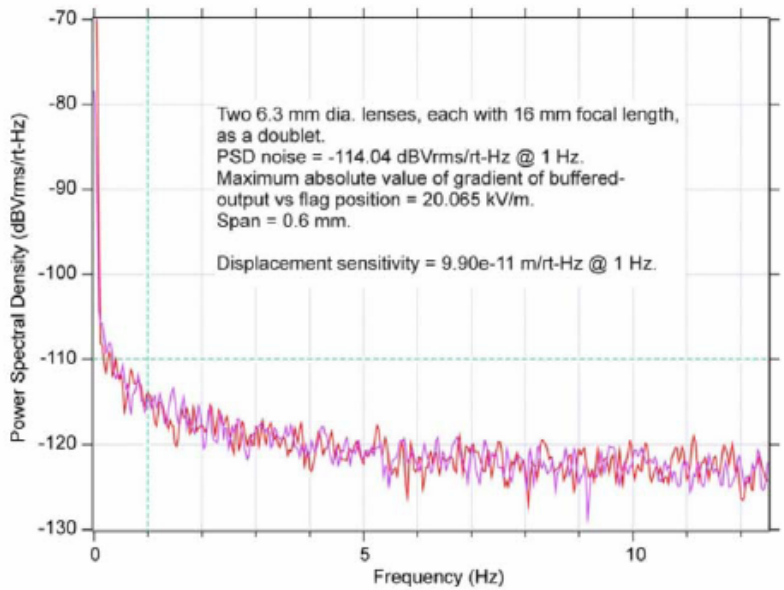
Sensor Development

- Sensor Performance Study *(N. Lockerbie):*
  - 0.6*mm* (peak-peak) working range
  - Sensitivity $1 \times 10^{-10} m/\sqrt{Hz}$ at 1*Hz*





  - September 2004: Includes additional emitter lens + mask configuration (*as shown above*)
  - Current Test Configuration: Includes additional emitter <u>&</u> <u>receiver</u> lens + mask configuration *(to aid commonality of sensor components part design)*

Sensor Development

- Sensor Components:
  - Honeywell Surface-Mount Emitter (SME2470) Replaced with Optek leaded device (OP232)

TO-46 Package

Hermetically Sealed

Kovar

(n.b. anode-to-case)

  - Honeywell Surface-Mount Receiver (SMD2420) Replaced with Centronics leaded device (BPX65)

TO-18 Package

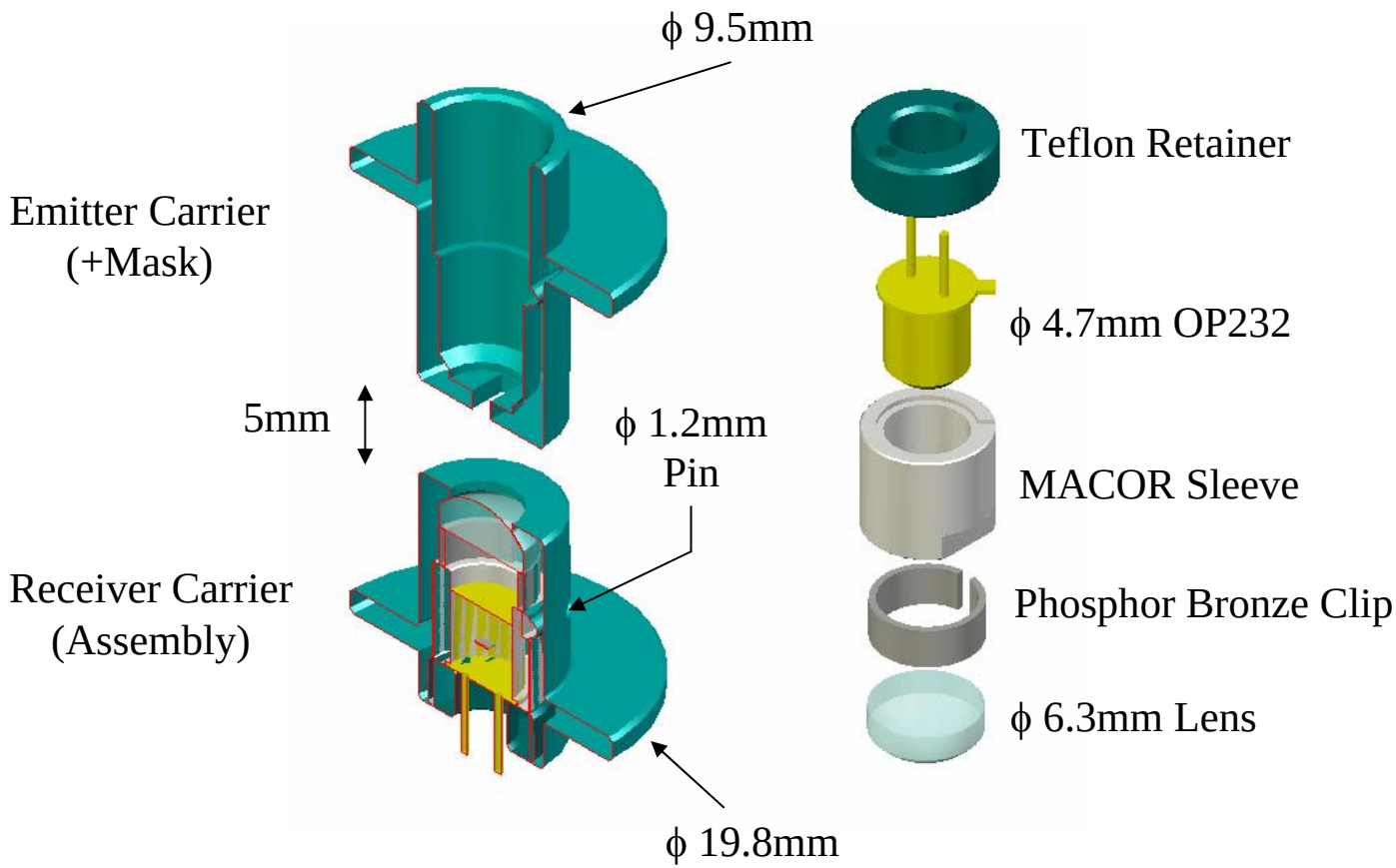
Hermetically Sealed

Steel

(n.b. cathode-to-case)

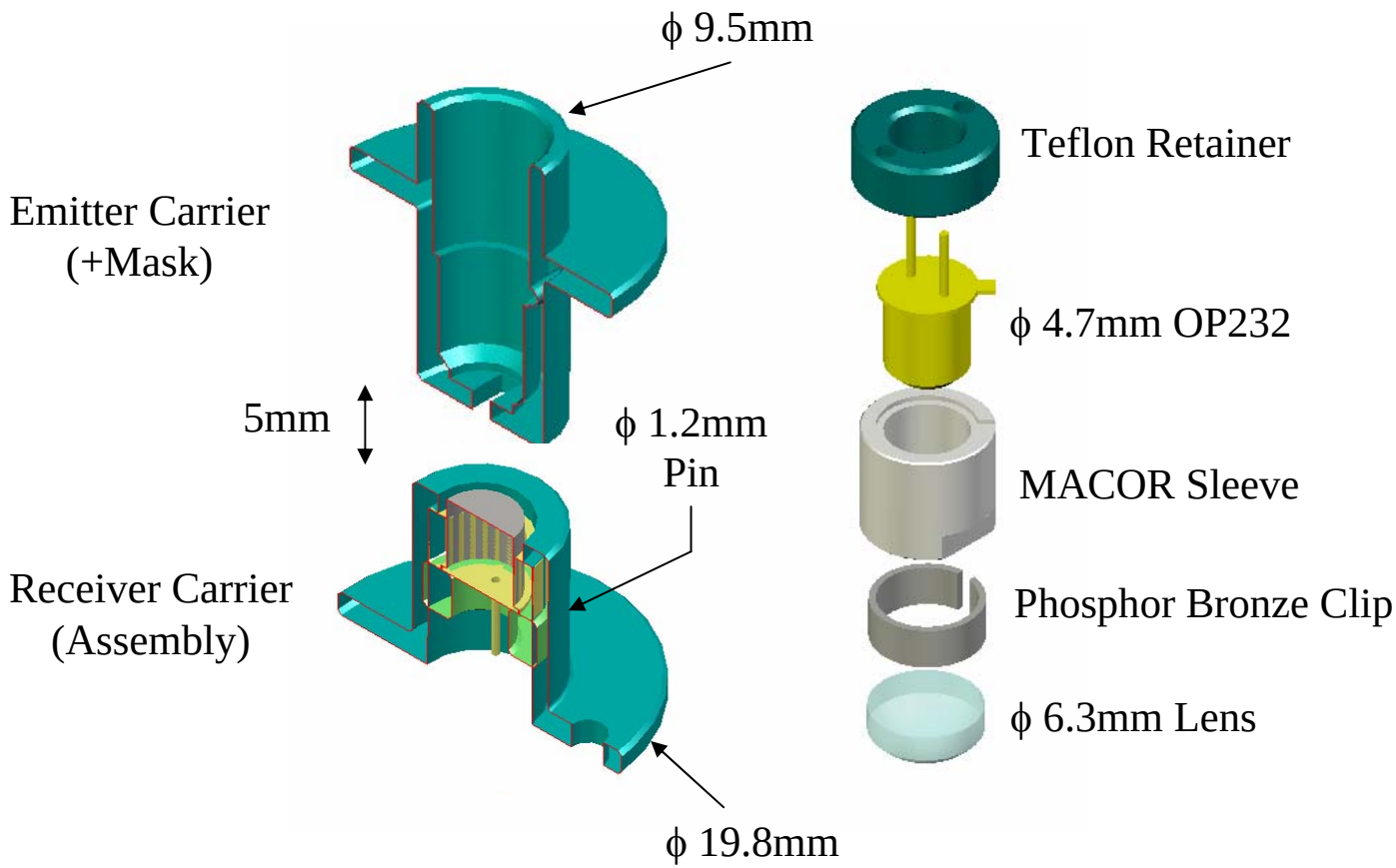
Mechanical Development

- Sensor Assembly (Duel Lens Approach):



Mechanical Development

- Sensor Assembly (Single Lens Approach):



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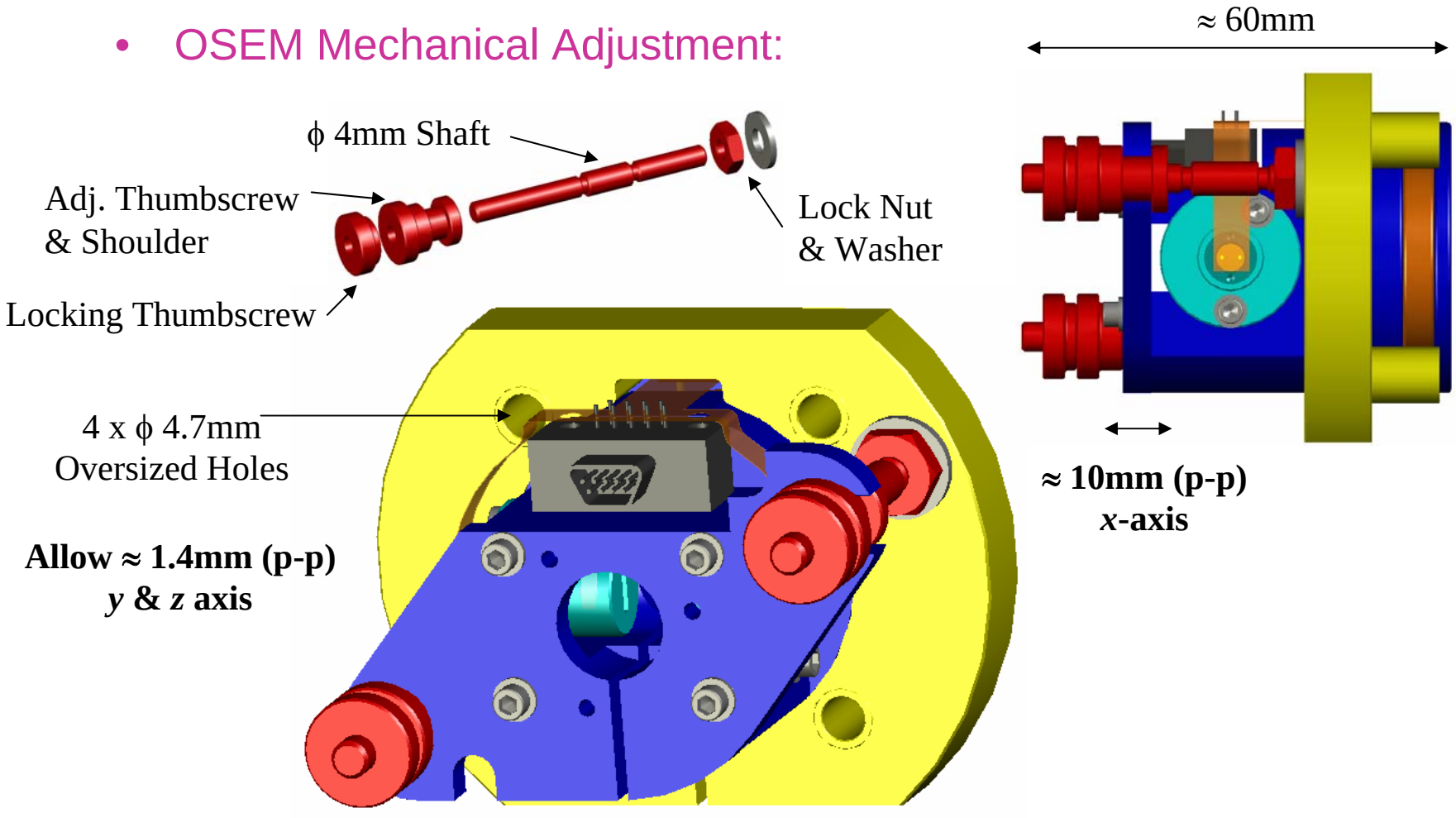
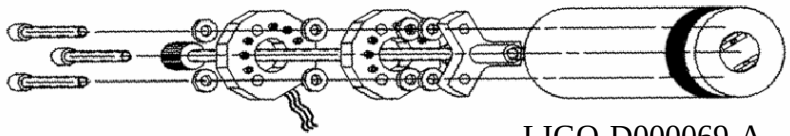
Mechanical Development

- OSEM Mechanical Adjustment:



Mechanical Development

- Pitch Adjustment Magnet (PAM) Screw Retro-Fit Implementation:



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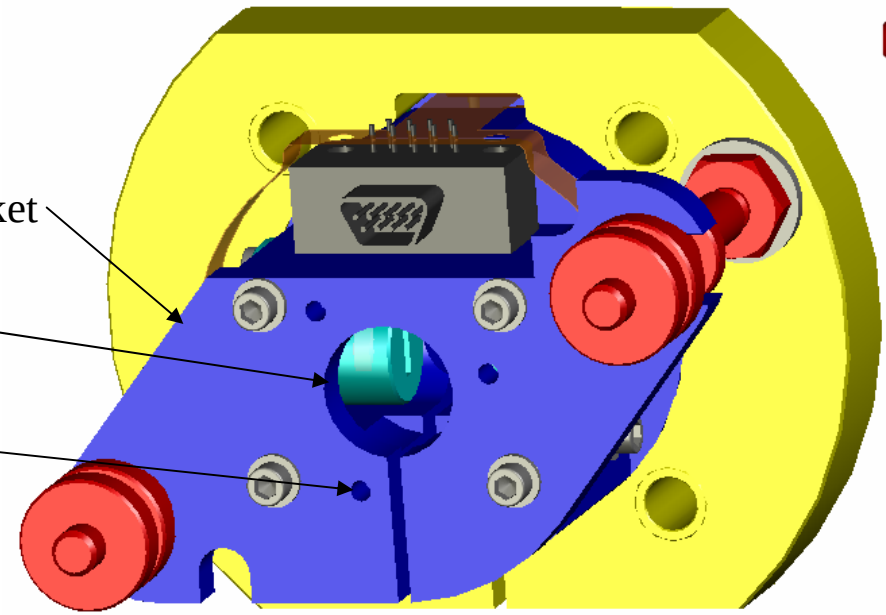
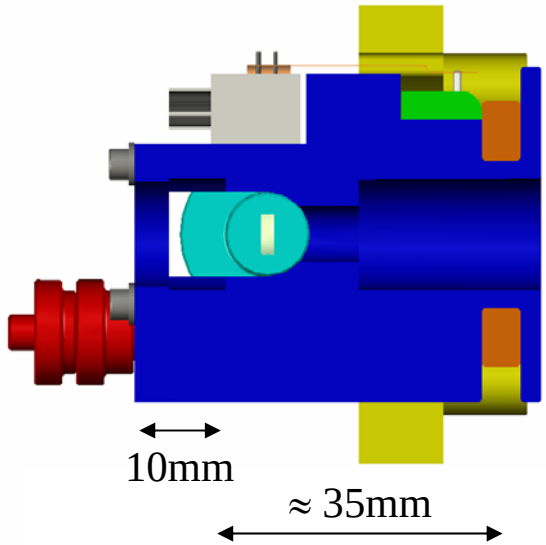


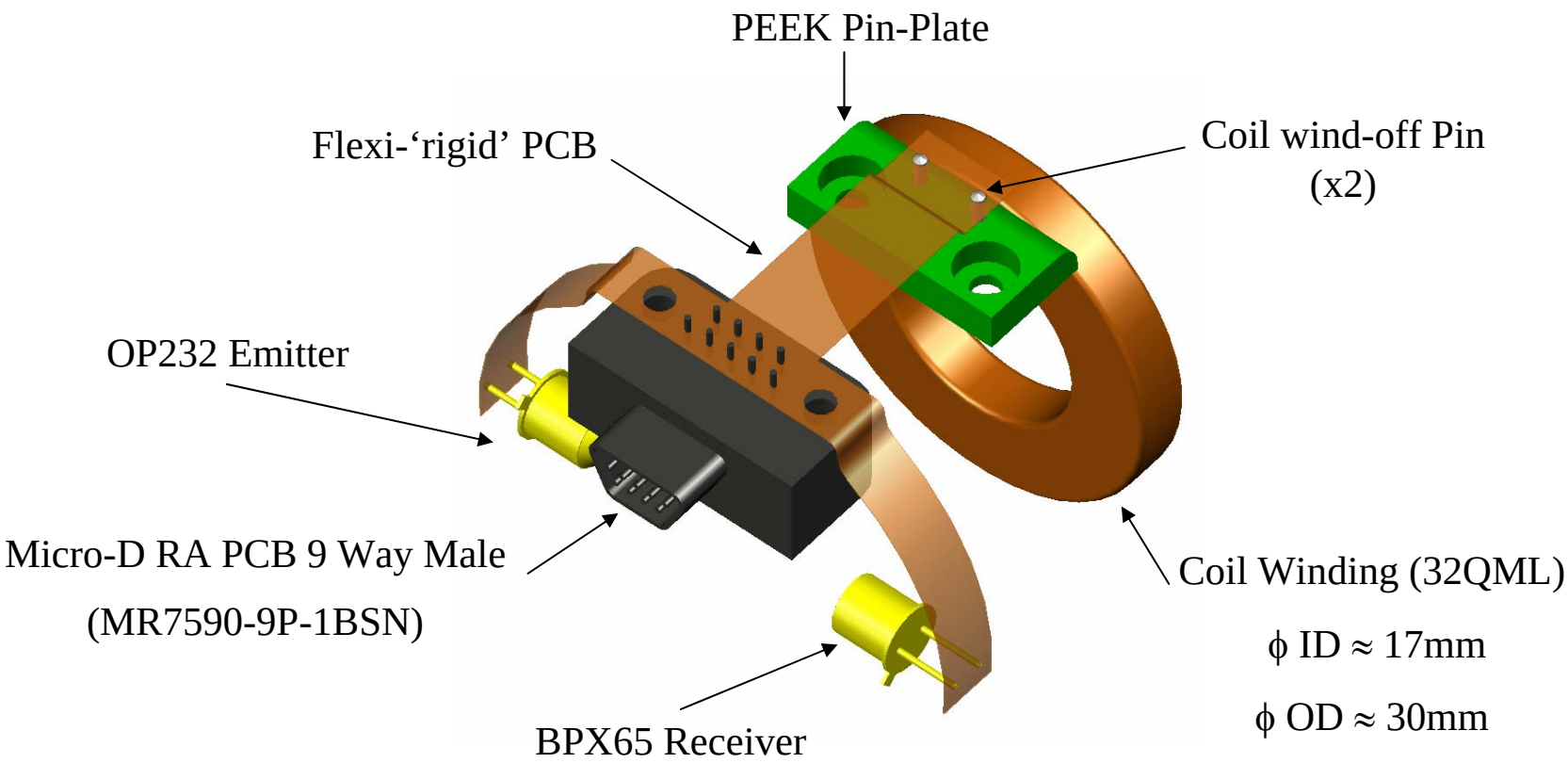


Initial LIGO Design: 10mm separation between magnets

Modified Hybrid OSEM Design: 35mm separation between magnets

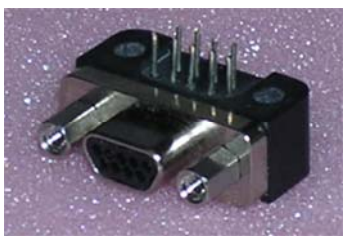
Electronics Development

- Inter-Connect Development:



Prototype Fabrication

- Part-Procurement (for UHV testing & prototyping):
  - 32QML coil winding wire (MWS Wire Ind. CA)
    - Currently utilised for controls prototypes
  - Flexi-rigid circuits designed & fabricated (Lyncolec, UK)
    - (approx 24 required for vacuum compatibility testing)
  - OSEM micro-D connector procurement underway (GlenAir, UK)
    - 30 units (approx 24 required for vacuum compatibility testing)
  - Pigtail micro-D mating connector procurement underway (GlenAir, UK)
    - 30 units (approx 24 required for vacuum compatibility testing)
  - ➢ Identification of production issues:
    - Inked / Labeled parts (e.g. Connectors & Flexi-rigid)



RA OSEM Male

LCP Insulator Insert

STR Pigtail Female

Flexi-circuit & connector

Prototype Fabrication

- Mechanical Fabrication (local contractor):
  - Coil-former, Clamp, Bracket, and Adjustment assembly have been recently fabricated (6061 Aluminium & Titanium parts)
  - Sensor assembly has been omitted at this stage
    - Gauge performance of ‘alternative’ adjustment method
    - Next task is to design and issue the drawings for the single lens sensor configuration and fabricate the parts (2-3 Weeks)





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Next Steps

- OSEM Prototypes (Immediate Tasks):
  - Cleaning of fabricated parts
  - Some assembly of OSEM parts is required
  - Identification of any production issues
    - Fit at adjustment shoulder interface
- Prototype Device Testing (1-2 Months):
  - Noise performance of sensor
  - Sensor variability in transfer function
  - Vacuum compatibility testing
  - Thermal considerations
- Noise-Prototype Production (2-4 Months):
  - Update drawings according to Drawing Guideline Doc
  - Manufacturing Study (*no in-house production*)
  - Ready for PDR

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Interferometric OSEM R&D