The MIRI medium resolution spectrometer for the James Webb Space Telescope

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On behalf of the MIRI spectrometer team

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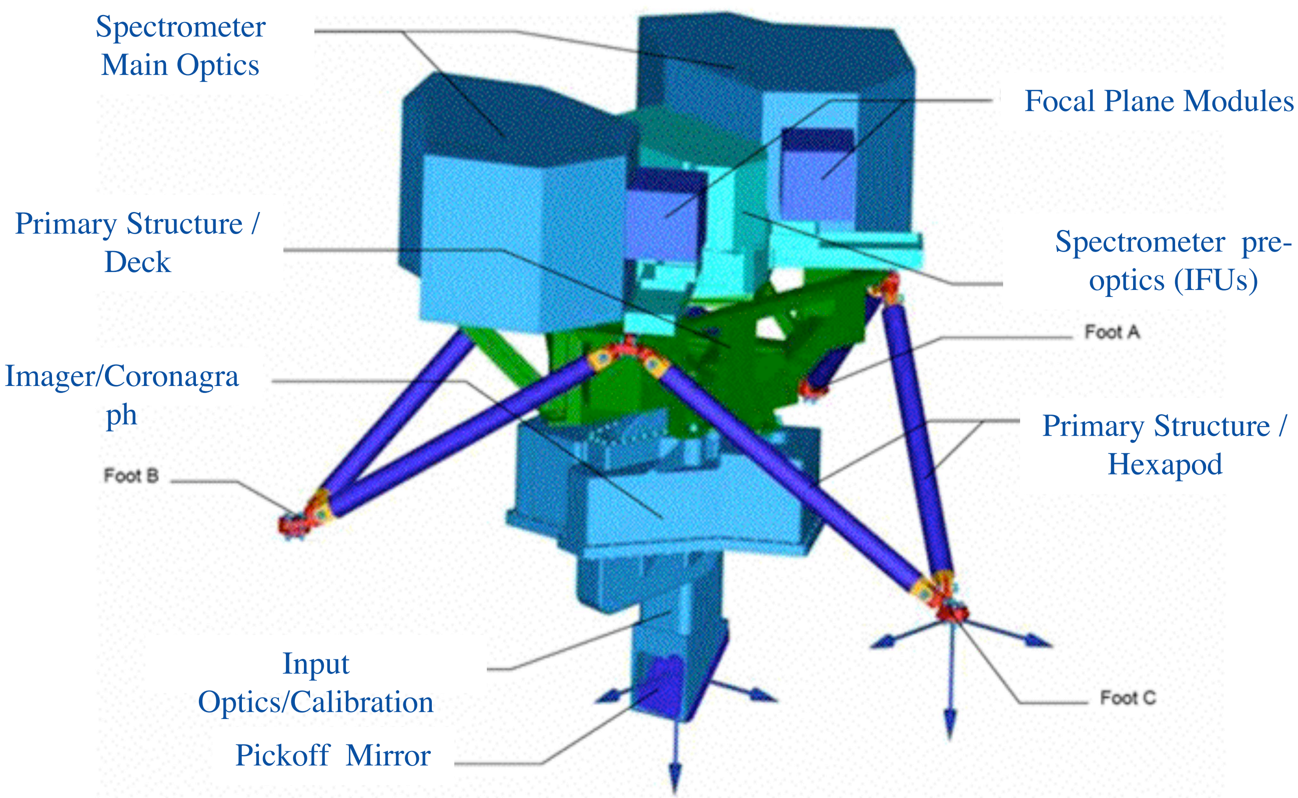
MIRI System Overview

MIRI has four functions:

- Mid-Infrared Imaging from 5 to 27μm, 0.11” pixels, 1.3’ x 1.7’ field of view
- Coronagraphic Imaging (at 10.65, 11.4, 15.5, 23 μm)
- Low Resolution Slit Spectroscopy R ~100 from 5 to 10 μm
- Medium Resolution Integral Field Spectroscopy, R ~ 3000, from 5 to 28.3μm

MIRI Optical Module – Key Design Features



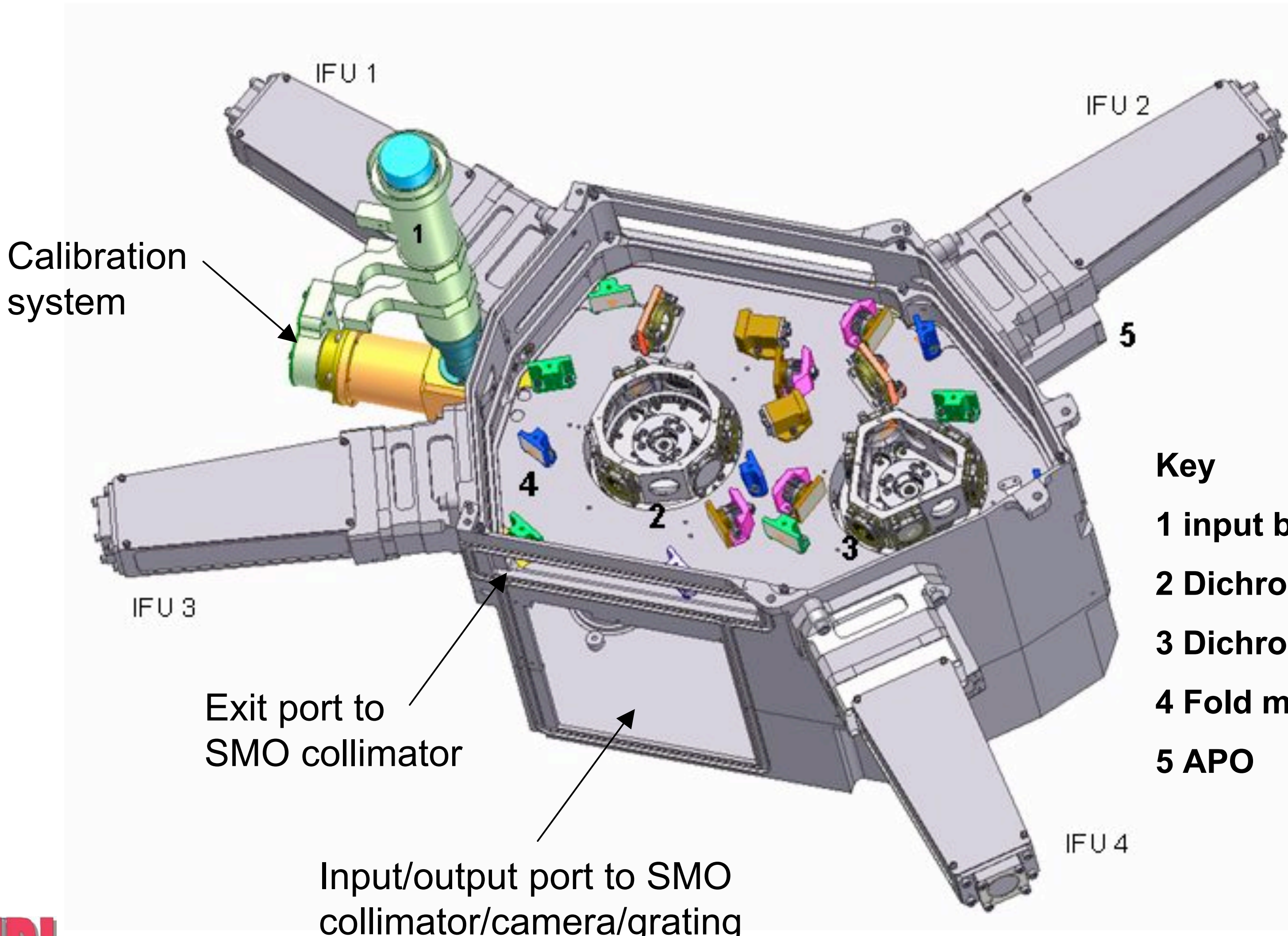
- Lightweighted, all aluminium, modular optical system
- Supported by thermally isolating carbon fibre hexapod which attaches to ISIM structure.
- Cooled to ~7K by a dedicated cryo-cooler
- Three 1kx1k SiAs detectors.
- 4 Mechanisms – 3 wheels based on ISO design (filters,dichroics, gratings) and a contamination control cover
- Light enters from the telescope via the pick-off mirror
- The fields of view of the Imager and the Medium Resolution Integral Field Spectrometer are defined and separated in an "Input optics/calibration module"
- Imager optics on one side of primary structure, spectrometer on the other

MIRI spectrometer scientific requirements

- **Wavelength range 5 – 28 microns**
- **Field of view not less than 3.5 x 3.5 arc-seconds squared**
- **Spatial sampling to match FWHM of JWST PSF**
- **Spectral resolving power**
  - 5_m < λ < 10μm R > 2400
  - 10_m < λ < 15μm R > 1600
  - 15_m < λ < 28μm R > 800
- **Image quality: 80% EED @ 8μm < 1.1 x 80% EED of an unaberrated JWST – translated to an RMS wavefront error specification for the sub-systems**
- **Detector format: Two 1024 x 1024 SiAs arrays with 25μm pixels**

Optical path through MIRI spectrometer

Spectrometer pre-optics (SPO) layout



Key

1 input baffle tube

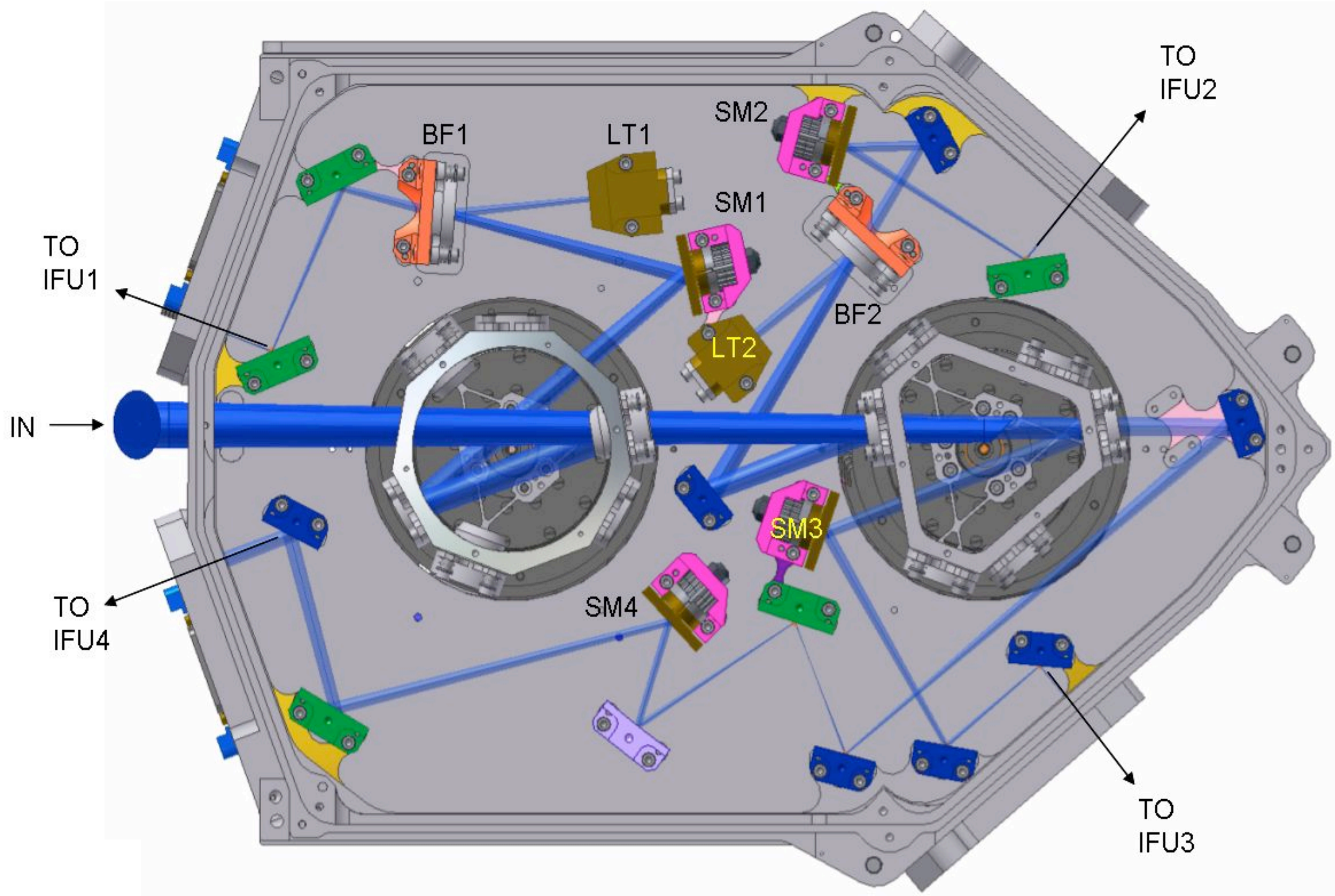
2 Dichroic wheel A

3 Dichroic wheel B

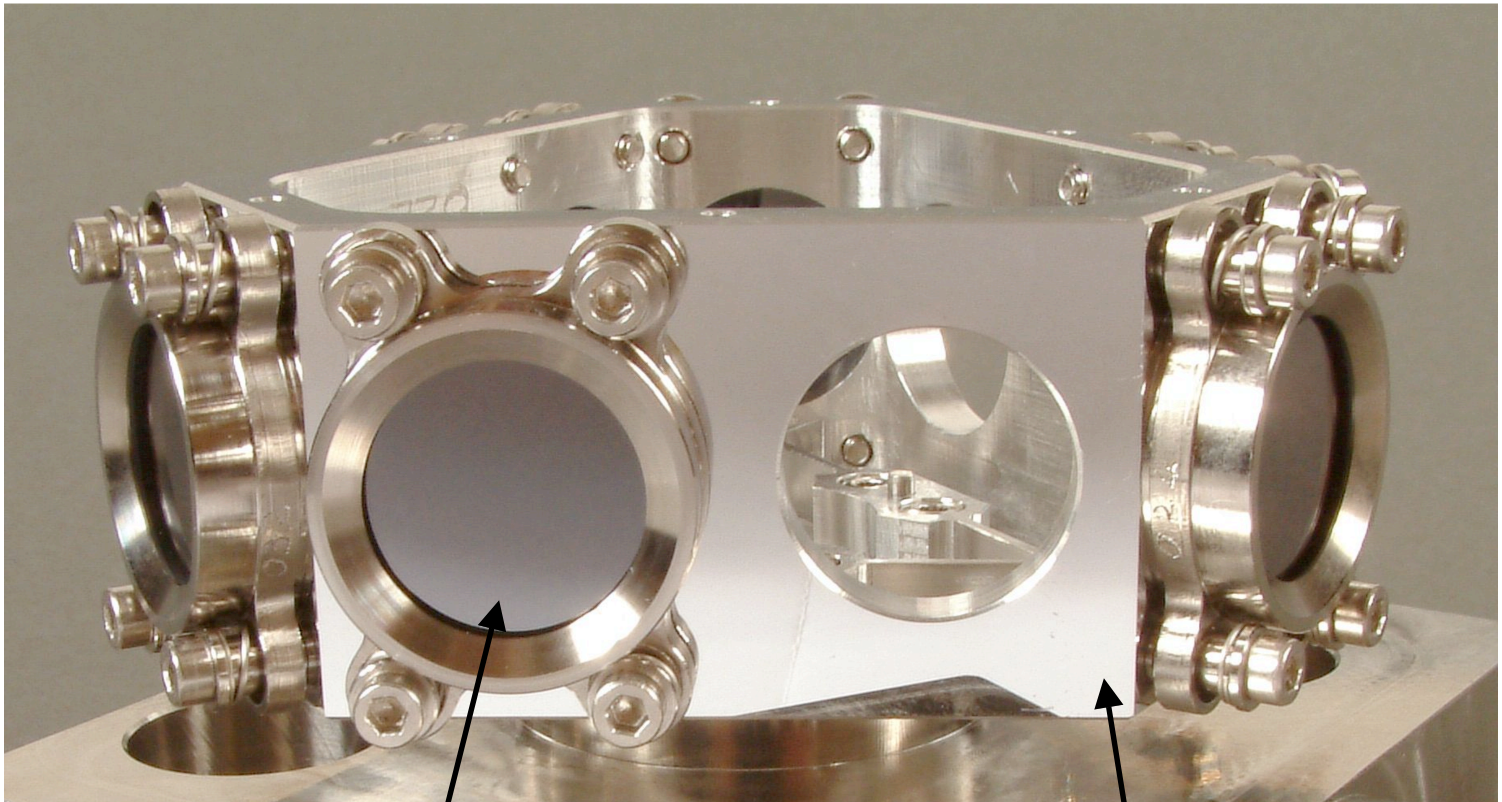
4 Fold mirror

5 APO

SPO – layout of dichroic level



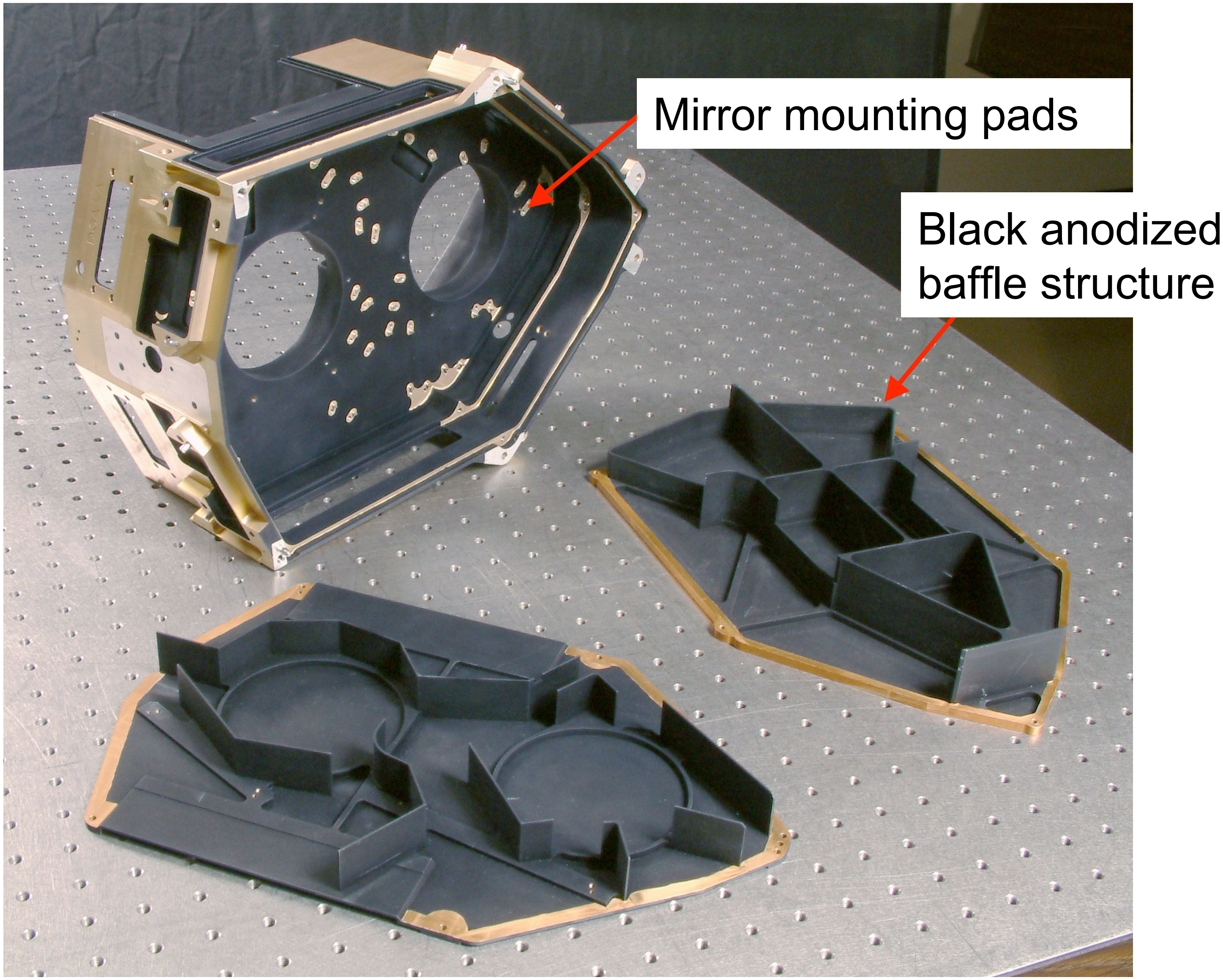
SPO – dichroic wheel assembly EQM



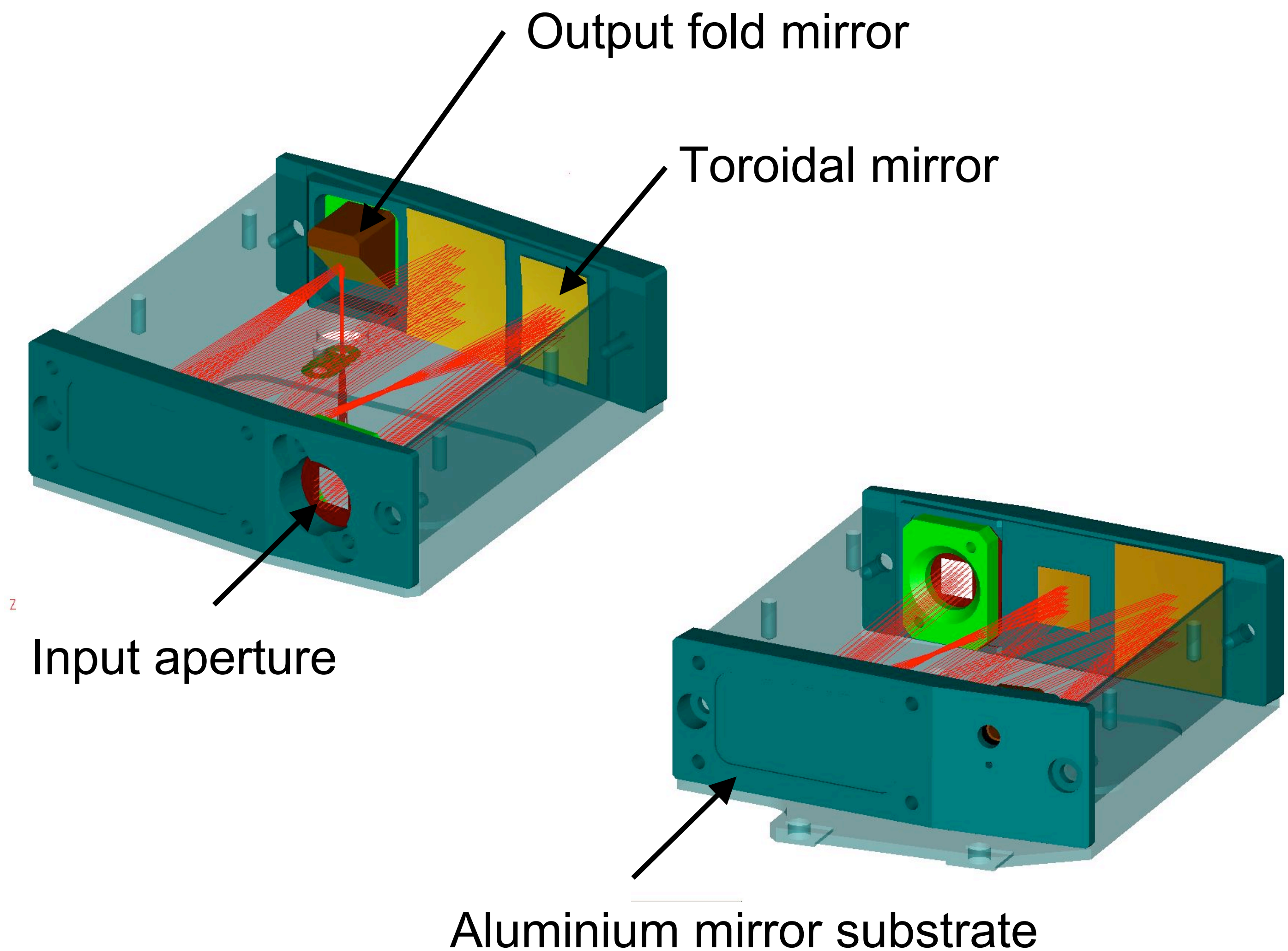
CdTe filter

Diamond machined aluminium wheel

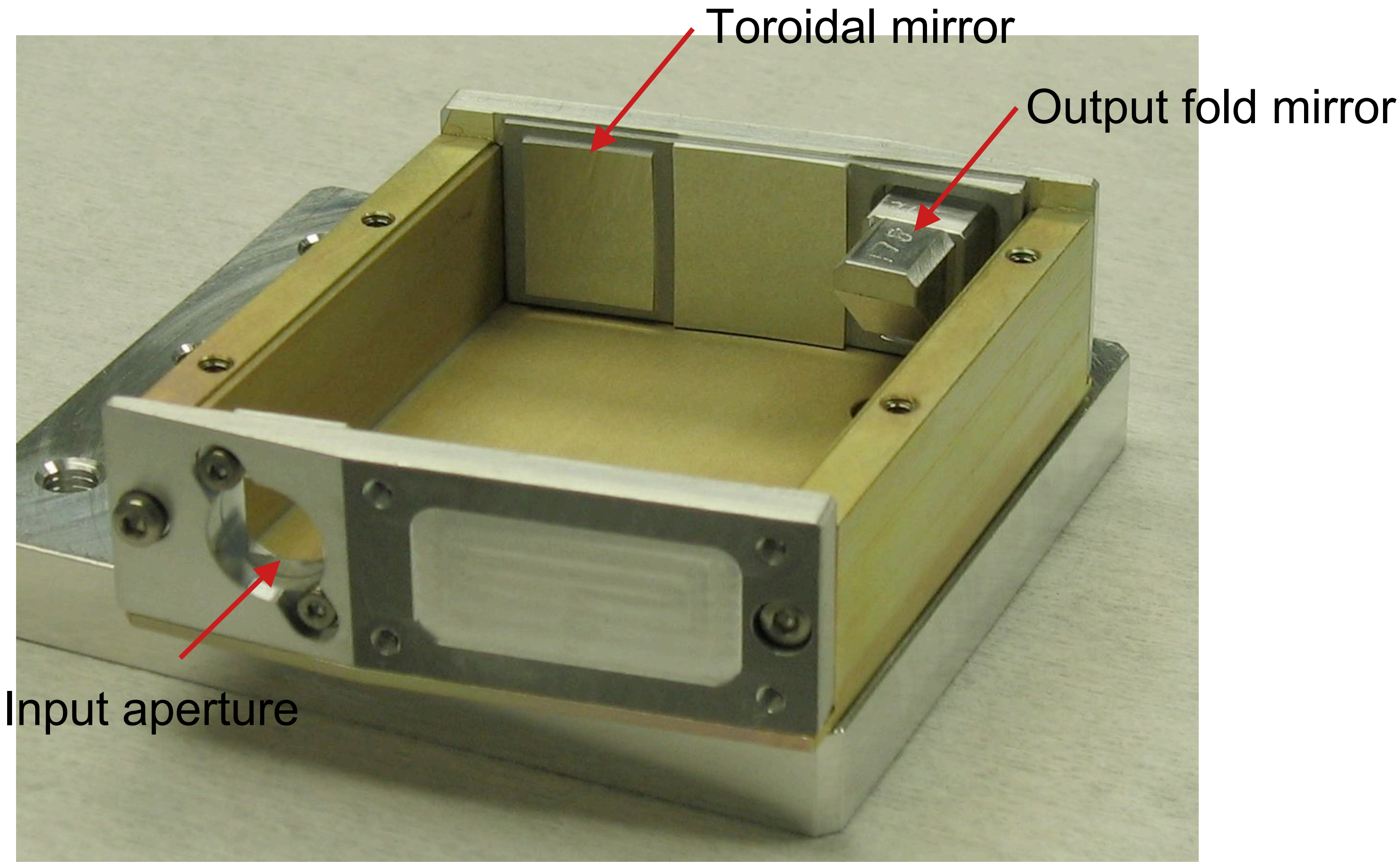
SPO – verification model chassis hardware



SPO – Anamorphic Pre-Optics (APO)



APO verification model hardware



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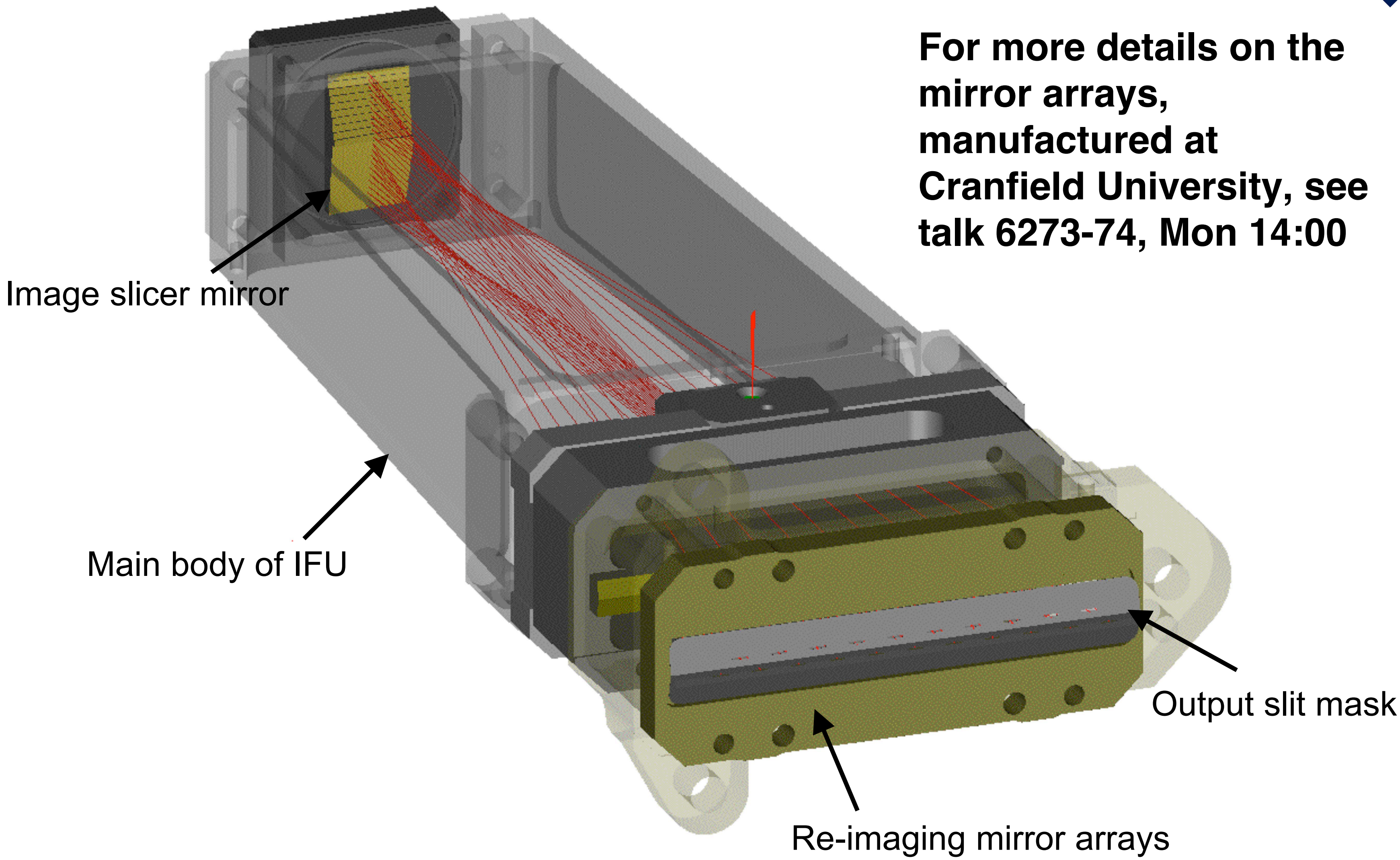
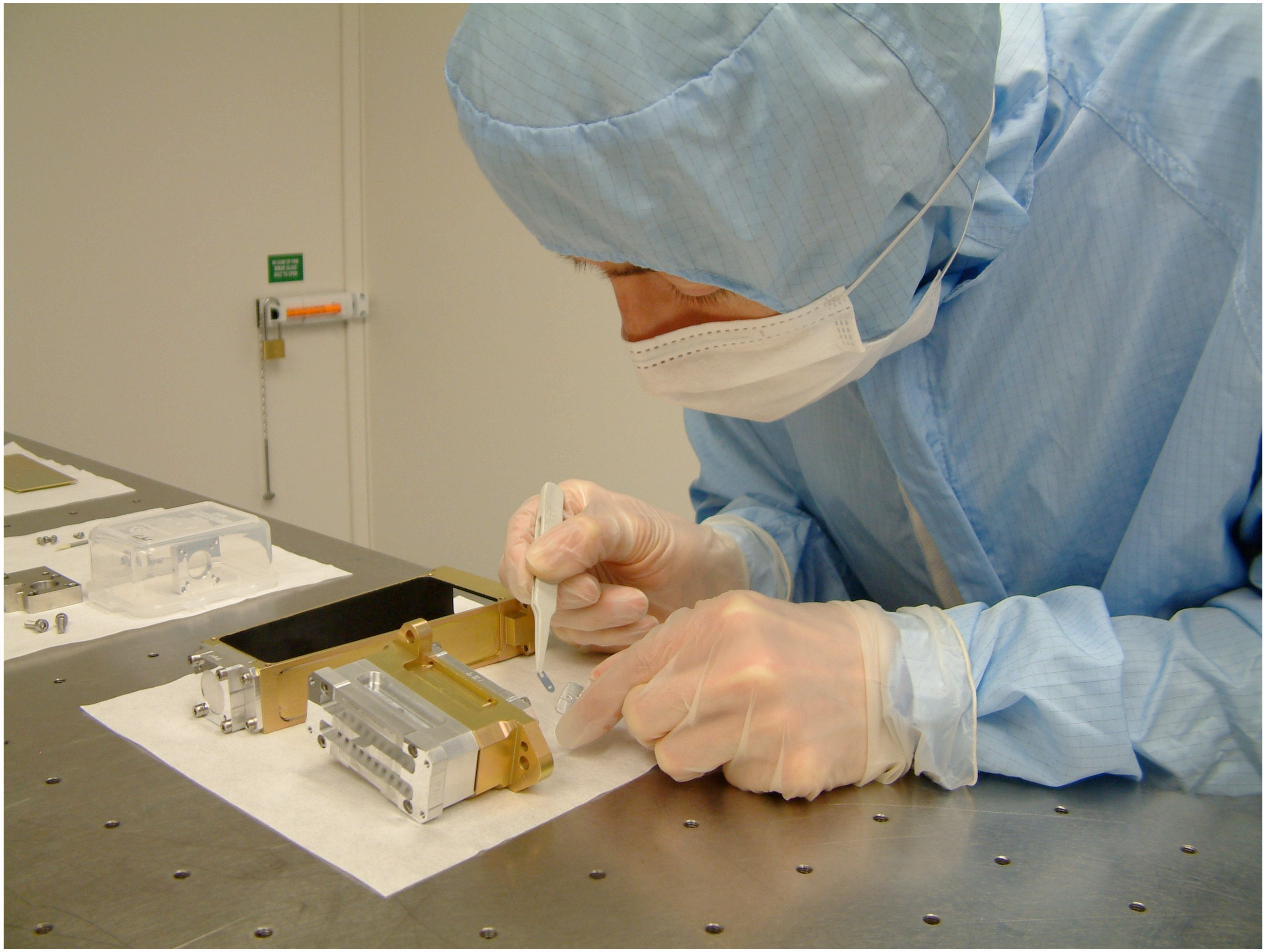
SPO – Integral Field Unit

For more details on the mirror arrays, manufactured at Cranfield University, see talk 6273-74, Mon 14:00

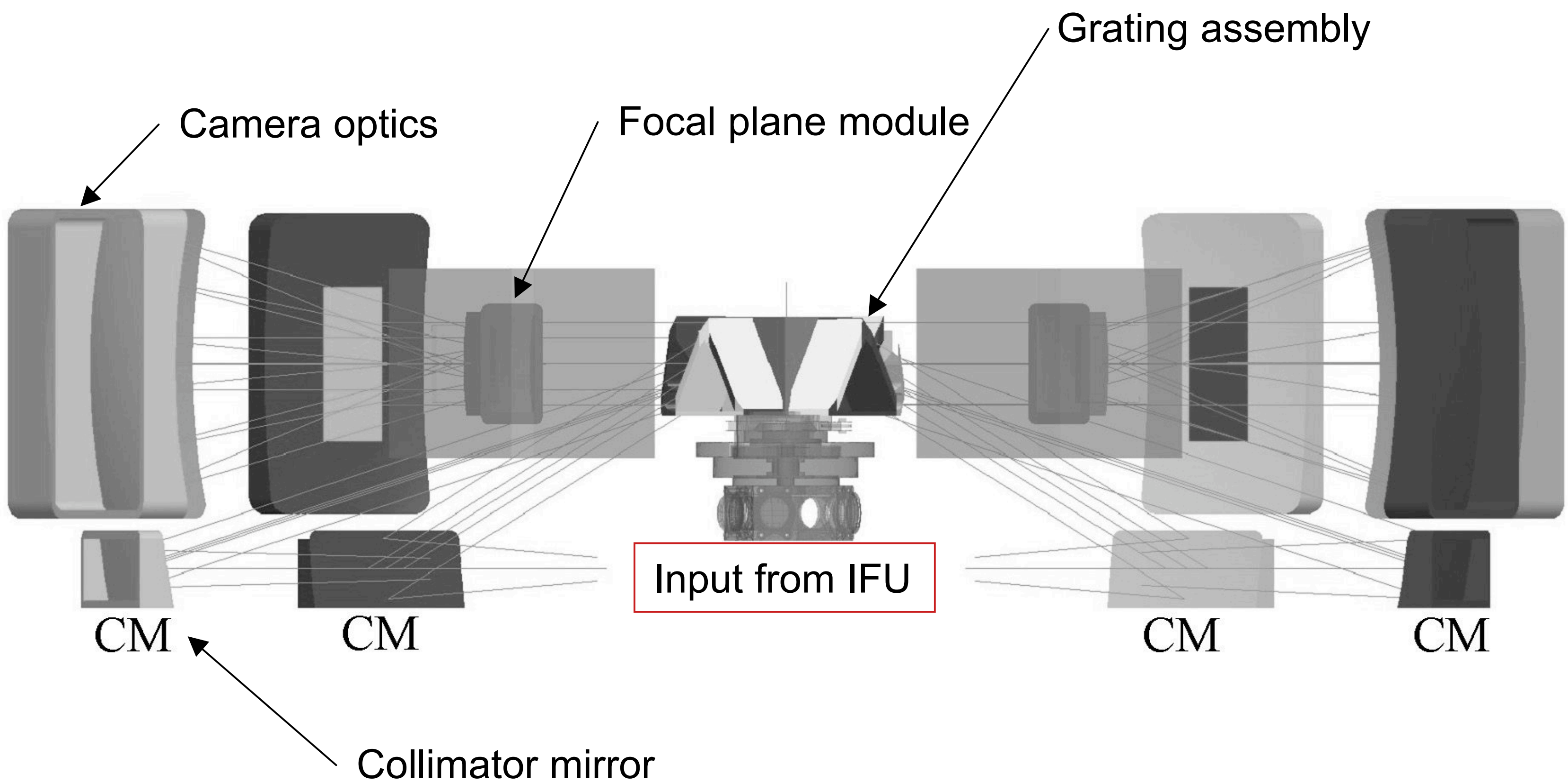


IFU assembly



Assembly carried out in class 100 clean room

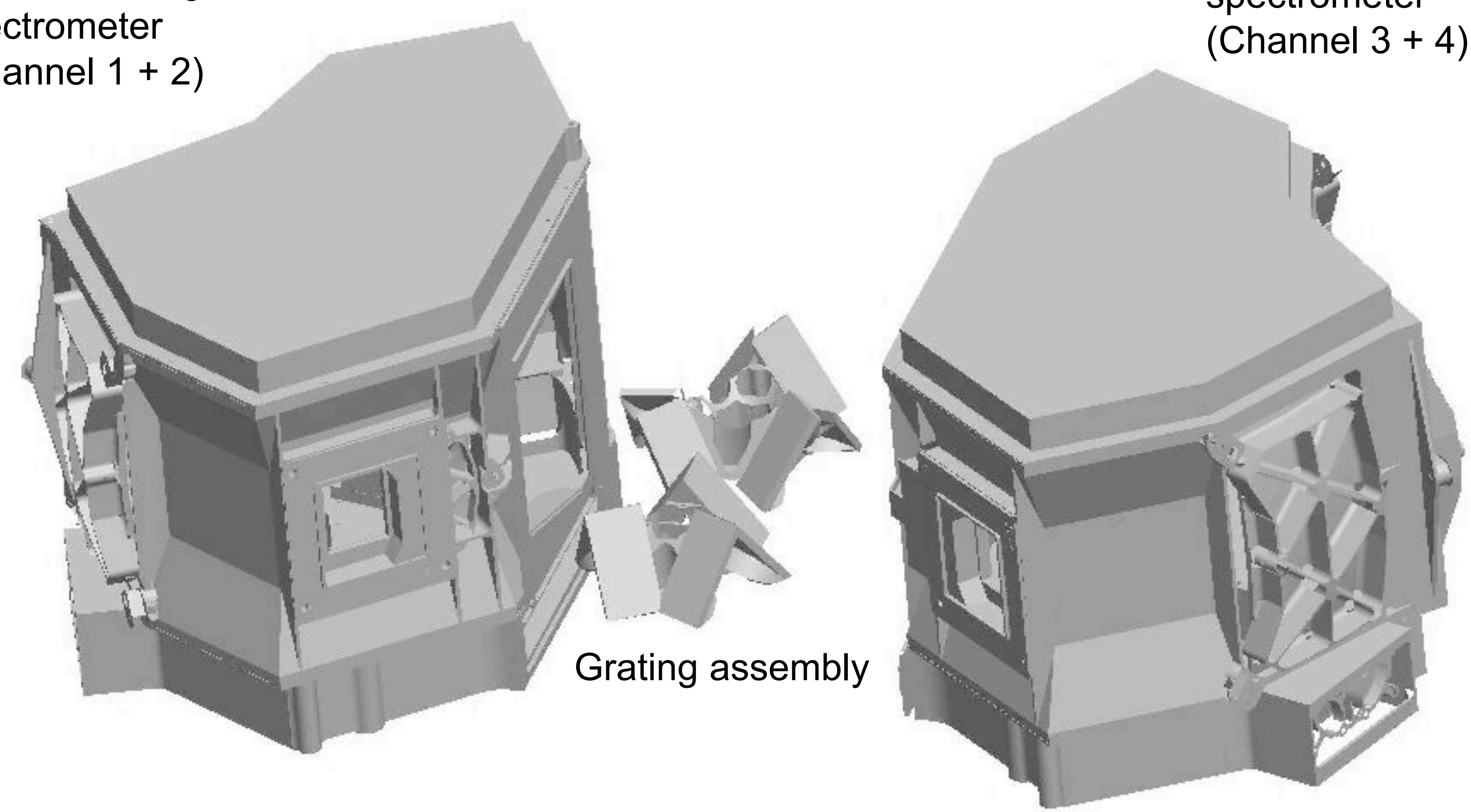
SMO – opto-mechanical layout



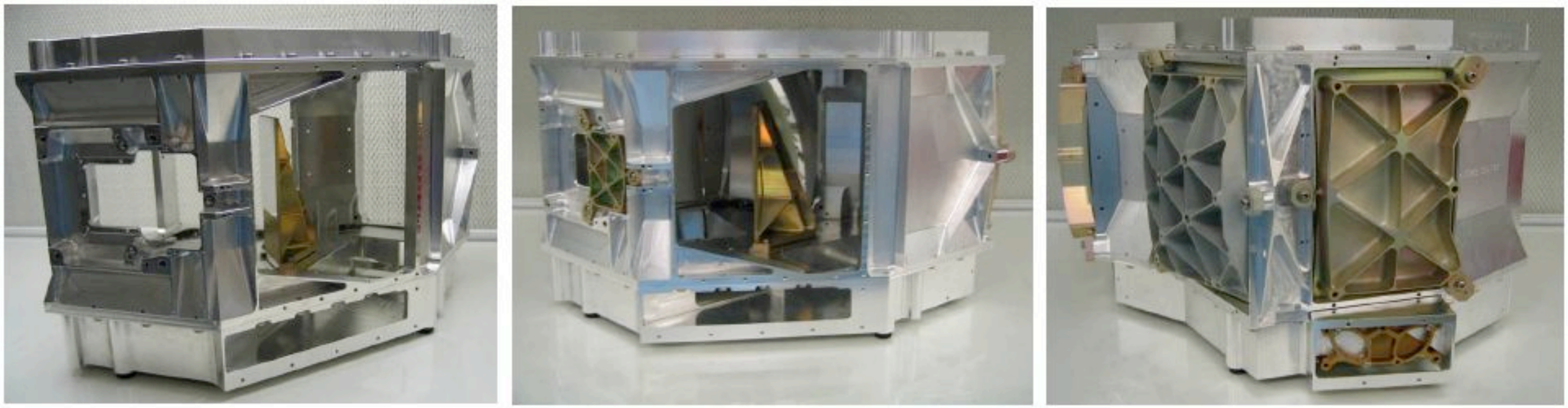
SMO – optical layout of camera optics

SMO – grating wheel mechanical hardware

SMO – mechanical structure



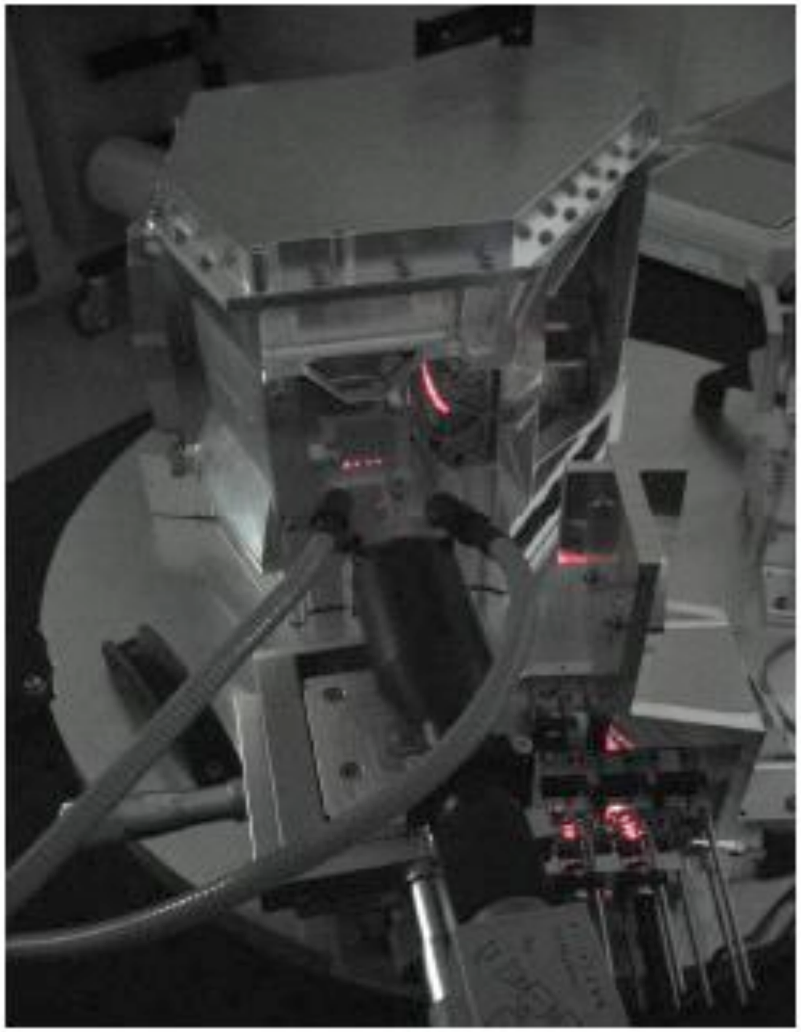
SMO – qualification model assembly



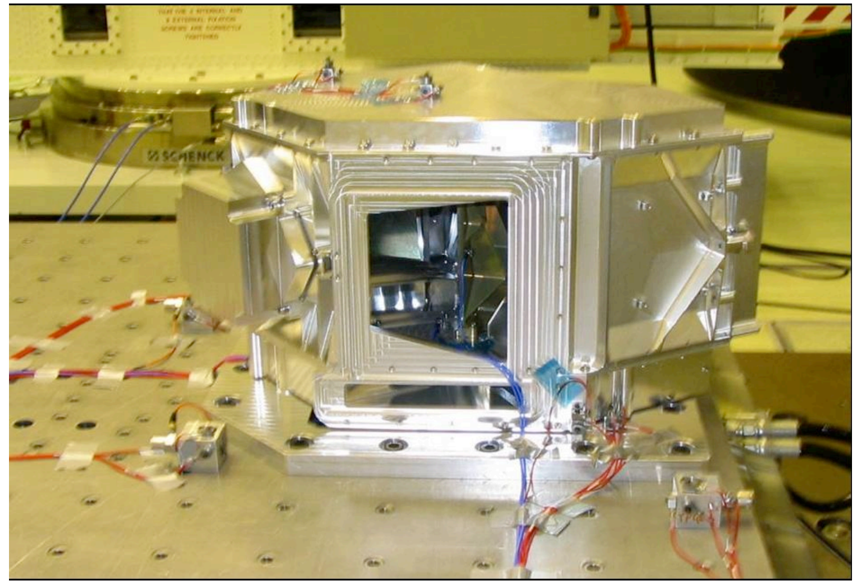
QM is

- Manufactured
- Assembled
- Verified regarded alignment
- Vibration tested
- Verified regarding alignment

SMO – QM Alignment inspection



SMO – QM vibration test

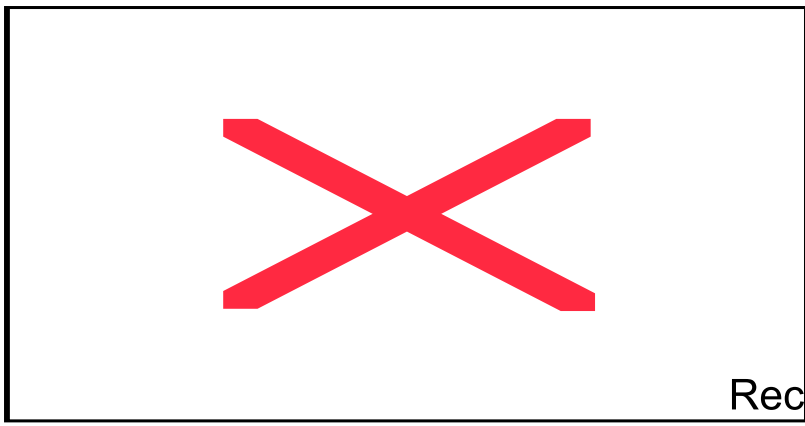


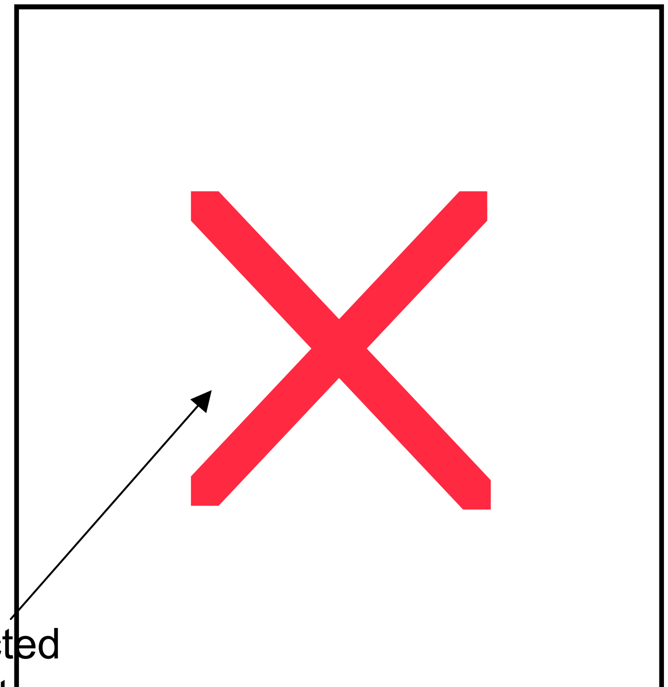
Vibration Test

Modelled performance for channel 2 at 8 μm

Full end to end optical system analysis done using physical optics propagation tool in zemax

Central slice





Reconstructed image meets specifications on FWHM and EED

Specsim - MIRI spectrometer simulator described in Lorente et al. 6274-55

Summary and status

- **Opto-mechanical design complete. Both SPO and SMO have completed CDR**
- **Verification model hardware**
  - SPO components have been received
  - SMO CMs are ready
  - SMO M1-1, M1-2 and M3 are ready to be gold-coated
  - SMO VM Gratings on track for a June 2006 delivery
- **Most of sub-system testing now complete**
- **Assembly of Verification Model in progress**
- **Delivery of spectrometer sub-systems to Rutherford Appleton Laboratory for integration and test into MIRI VM will be later this year**

MIRI draws on the expertise of the following organizations:

Ames Research Center, USA; Astron, Netherlands Foundation for Research in Astronomy; CEA Service d'Astrophysique, Saclay, France; Centre Spatial de Liége, Belgium; Consejo Superior de Investigacones Científicas, Spain; Danish Space Research Institute; Dublin Institute for Advanced Studies, Ireland; EADS Astrium, Ltd.U.K, European Space Agency, Netherlands; Institute d'Astrophysique Spatiale, France; Instituto Nacional de Técnica Aerospacial, Spain; Institute of Astronomy, Zurich, Switzerland; Jet Propulsion Laboratory, USA; Laboratoire d'Astrophysique de Marseille (LAM), France; Lockheed Advanced Technology Center, USA; Max-Planck-Insitut für Astronomie (MPIA), Heidelberg, Germany; Observatoire de Paris, France; Observatory of Geneva, Switzerland; Paul Scherrer Institut, Switzerland; Physikalishes Institut, Bern, Switzerland; Raytheon Vision Systems, USA; Rutherford Appleton Lavoratory (RAL), UK; Space Telescope Science Institute, USA; Toegepast-Natuurwetenschappelijk Ondeszoek (TNO-TPD), Netherlands; U.K. Astronomy Technology Centre (UK-ATC); University College, London, UK; Univ. of Amsterdam, Netherlands; Univ. of Arizona, USA; Univ. of Cardiff, UK; Univ. of Cologne, Germany; Univ. of Groningen, Netherlands; Univ. of Leicester, UK; Univ. of Leiden, Netherlands; Univ. of Leuven, Belgium; Univ. of Stockholm, Sweden, Utah State Univ. USA

SPO – VM dichroic wheel assemblies