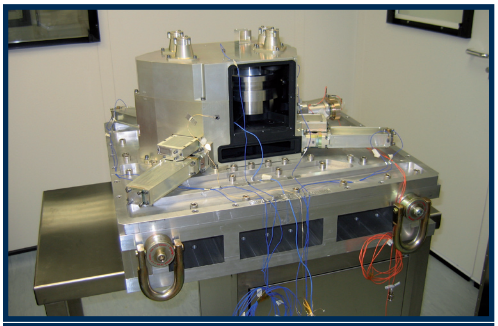
# MIRI for the James Webb Space Telescope

Science & Technology Facilities Council
UK Astronomy Technology Centre

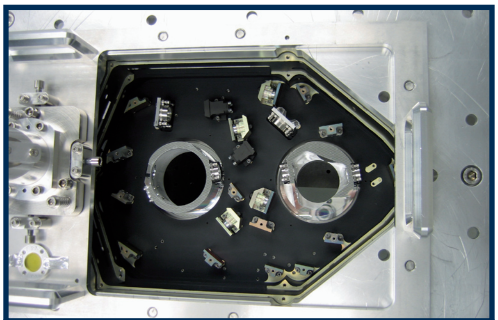
MIRI (Mid-InfraRed Instrument) is a camera and spectrometer for the James Webb Space Telescope (JWST). It will be thousands of times more sensitive than the best instruments currently available on 8m class telescopes. At 6.5m diameter, JWST will be the largest and most sensitive infrared space telescope ever flown. JWST is an international collaboration between NASA, the European Space Agency (ESA), and the Canadian Space Agency (CSA). The NASA Goddard Space Flight Center is managing the development effort and the Space Telescope Science Institute will operate JWST after launch. MIRI is being built by a large US-European partnership led in Europe by the UK ATC and in the US by JPL.



The Flight Model spectrometer pre-optics ready for thermal testing.

## James Webb Space Telescope

JWST will be a facility-class space observatory operating in the visible, near and mid-infrared, and launch is planned for 2014. It will have a hexagonal primary mirror with a collecting area of 25 square metres, passively cooled to 40K and placed in an L2 orbit to optimise IR performance. JWST will be the premier observatory of the next decade, serving thousands of astronomers worldwide. It will study every phase in the history of our Universe, ranging from the first luminous glows after the Big Bang, to the formation of solar systems capable of supporting life on planets like Earth, to the evolution of our own Solar System. JWST's instrument suite is designed for wide applicability across a broad range of scientific issues. The mission will have a minimum 5 years lifetime, with a goal of 10 years.



The Flight Model spectrometer pre-optics during optical alignment.

## MIRI Specifications

MIRI provides imaging and spectroscopy over the wavelength range 5 to 28.5 micron with10 sigma in 10,000 seconds sensitivities as noted below.

The imager provides broad-band imaging, coronagraphy and low-resolution slit spectroscopy. It has 110 milliarcsec pixels and a field of view of 75x113 arcseconds.

The coronagraph field of view is approximately 24x24 arcsecs and it is done with quarter-phase coronagraphs at 10.65, 11.4 and 15.5 microns, and a Lyot stop optimized for 23 microns. A low-resolution 5 x 0.6 arcsec slit operates over 5 to 10 microns with R ~ 100. MIRI imaging sensitivity is 700 nJy (AB=24.3) at 10.0 microns and 8.7 µJy (AB=21.6) at 21.0 microns.

The spectrometer uses an image slicer and dichroics to provide imaging spectroscopy over four simultaneous concentric fields of view ranging from 3 to 7 arcsec on a side. The spectral resolution ranges from R ~ 2400 to 3600 and the plate scale ranges between 200 to 470 milliarcsec. MIRI spectroscopic line sensitivity is 1.0 × 10-17 erg s-1 cm-2 at 9.2 microns and 5.6 × 10-17 erg s-1 cm-2 at 22.5 microns.

## UK ATC Technology

As well as leading overall the European part of MIRI, the UK ATC is responsible for designing and building the spectrometer pre-optics sub-system, which includes a set of four image slicers, as well as the spectrometer calibration system and wavelength sorting optics. The image slicers are based on those made at the UK ATC for the UIST instrument, developed further for

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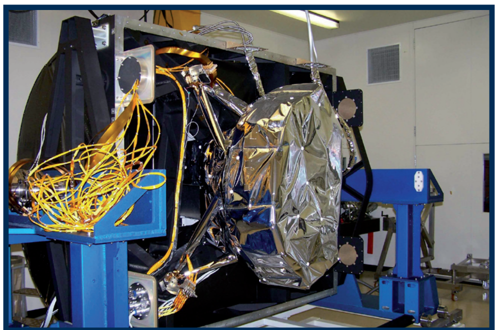


The MIRI Verification Model being prepared for the cryotest campaign at RAL.

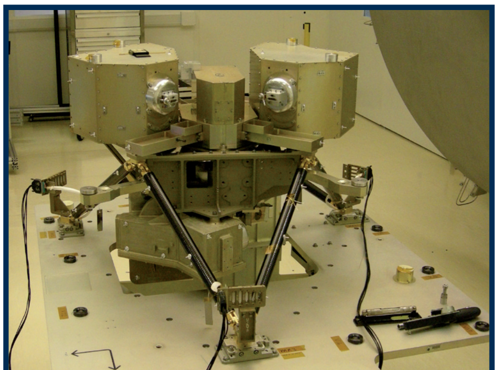
use in space and at MIRI's much longer wavelengths.

## JWST and MIRI Timeline

2008: The MIRI Verification Model, a flight-like copy of the instrument design was built and tested. This successfully demonstrated all the procedures for building the instrument, for testing and calibrations as well as the scientific performance of the spectrometer, imager and coronagraphs.

2009: Delivery of all the flight model sub-systems, including the UK ATC's spectrometer pre-optics to RAL for assembly into the flight MIRI Instrument.

2009: Delivery of the MIRI Structural-Thermal model (MIRI STM), shown in the picture below



The MIRI Structural-Thermal Model.

undergoing alignment measurements at RAL, to Goddard. Thermal and vibration testing of the MIRI STM there will provide accurate data for the environments MIRI must be shown to be capable of withstanding.

2010: Delivery of the flight MIRI to the Goddard for testing along with the other JWST instruments prior to integration with the telescope.

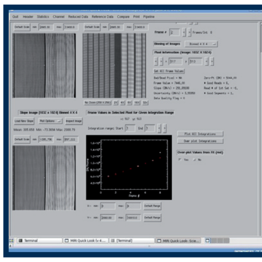
2012: Integration of the instruments and telescope, followed by end-end testing before integration with the spacecraft begins.

2013: Cycle 1 call for General Observer Proposals, to be carried out in the first year of the mission, will be issued by STScI.

2014: Launch.

## The MIRI Team

MIRI draws on the expertise of the following organizations: Ames Research Center, USA; Astrium, Ltd., U.K; ASTRON, Netherlands Foundation for Research in Astronomy; CEA Service d'Astrophysique, Saclay, France; Centre Spatial de Liége, Belgium; Consejo Superior de Investigacones Científicas, Spain; Cranfield Univ, UK; Danish Space Research Institute; Dublin Institute for Advanced Studies, Ireland; ETKA, Belgium; ESTEC, Netherlands; Institute d'Astrophysique Spatiale, France; Instituto Nacional de Técnica Aerospacial, Spain; ETH, 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; Onsala Space Observatory, Sweden Physikalishes Institut, Bern, Switzerland; Raytheon Vision Systems, USA; Rutherford Appleton Laboratory (RAL), UK; Space Telescope Science Institute, USA;



VM test spectra being displayed using the DHAS quicklook tool.

Toegepast-Natuurwetenschappelijk Ondeszoek (TNO-TPD), Netherlands; UK Astronomy Technology Centre (UK ATC); 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; Univ. of Reading, UK; Utah State Univ. USA; Zeiss, Germany

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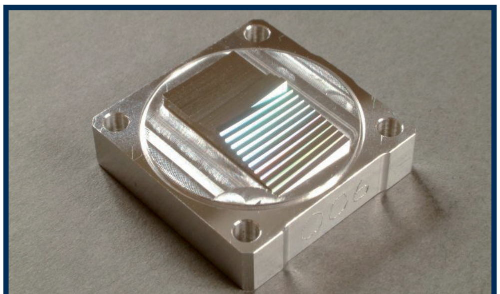
For more information about JWST and all the instruments, see Gardner et al. 2006, Space Science Reviews, 123, 485. You can register for the mission newsletter email distribution at https://lists.nasa.gov/mailman/listinfo/gsfc-jwst-update or download them from http://www.jwst.nasa.gov



One of the four image slicer mirrors.