



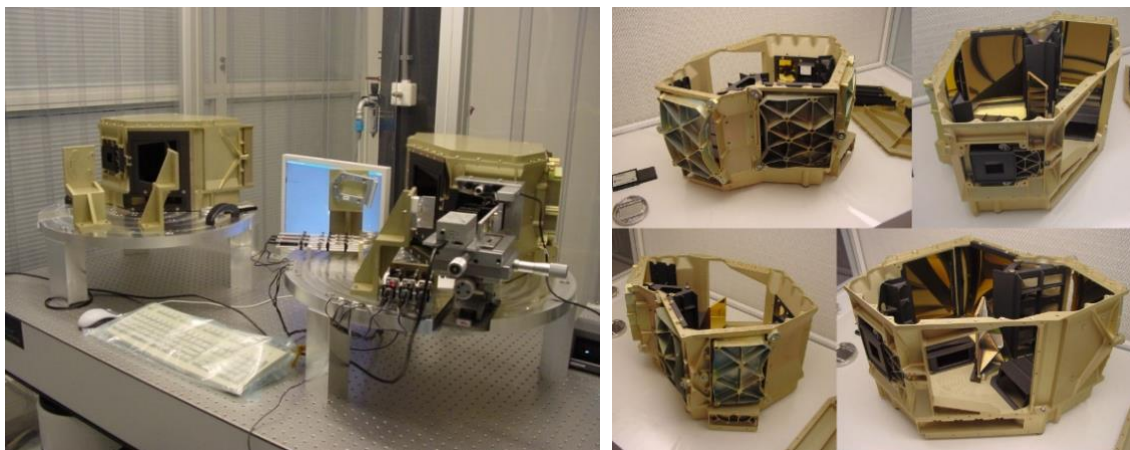
## NOVA and JWST-MIRI

The James Webb Space Telescope (Webb in short), launched on Christmas Day 2021, is the new NASA/ESA flagship. Webb is designed to answer fundamental questions about the distant and near universe, from the formation of the first stars and galaxies to the hunt for and exploration of new worlds. Webb is the most ambitious and complex space mission ever built, pushing the boundaries of human knowledge.

### MIRI

One of the four instruments onboard Webb is the Mid InfraRed Instrument (MIRI), which was designed and built in a 50%-50% partnership between Europe and the US. Europe was responsible for the hardware of the instrument, while the US supplied the detectors and cryogenic cooling system. The Netherlands developed and built the heart of the medium-resolution spectrometer (MRS).

MIRI consists of a camera and a spectrometer and detects light in the mid-infrared region of the electromagnetic spectrum, with wavelengths longer (redder) than our eyes can detect. MIRI covers the wavelength range from 5 to 28 microns, even longer than the other instruments on Webb. With its sensitive detectors, MIRI will be able to see the red-shifted light from distant galaxies, penetrate the dusty environments of newly formed stars and planets, and investigate the composition of the atmospheres of exoplanets.



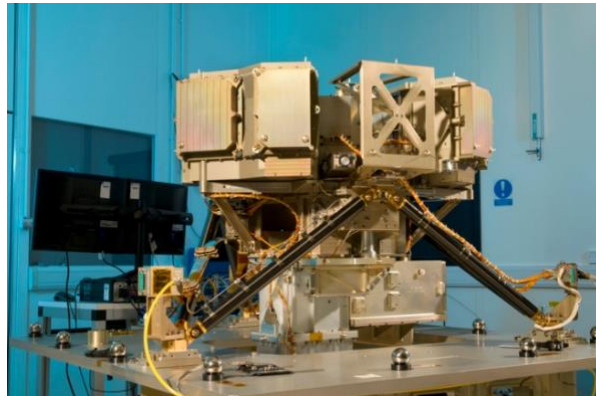
*MIRI-MRS- components in the NOVA Optical-Infrared-lab in Dwingeloo 2006-2008. (Credit: NOVA)*

Once cooled to -267 degrees Celsius, MIRI's sensitivity is two to three times greater than any previous instrument in this wavelength range, and its images will also be an order of magnitude sharper. See: <https://blogs.nasa.gov/webb/2022/05/09/miris-sharper-view-hints-at-new-possibilities-for-science/>

## Consortium

MIRI consists of several special modules built by the European Consortium, a collaboration of nationally funded European institutions led by the United Kingdom (PI: Gillian Wright). The Dutch contribution was led by co-PI Ewine van Dishoeck (Leiden). The Netherlands was responsible for the design, construction and testing of the heart of MIRI, the main optics of the medium-resolution spectrometer (MRS).

The spectrometer is able to acquire spectra at more than 100 positions simultaneously due to a new design of the Integral Field Unit. To efficiently cover the entire wavelength range in just three observation settings, the MRS uses four channels simultaneously. See: <https://www.youtube.com/watch?v=8TQYUdtEfV8>



*Left: The main optics of the MIRI-spectrometer in the clean room in Dwingeloo, with Menno de Haan. (Credit: NOVA).  
Right: The complete MIRI-instrument after integration in the United Kingdom. (Credit: STFC)*

## O/IR-group

The Optical Infrared Group (O/IR) of the Netherlands Research School for Astronomy (NOVA) was responsible for the Dutch hardware contribution to MIRI. The NOVA-O/IR group is located in Dwingeloo. ASTRON and TNO were subcontractors and SRON also made a number of contributions.

The work started in 2002 and was financed by NOVA and the Dutch research funder NWO. Optical and mechanical designers collaborated intensively in the first phase to arrive at the very compact and seemingly simple layout of the complex MRS instrument. It earned engineer Gabby Aitink-Kroes the European Engineer PowerWoman award at the Hannover Messe in 2014. Nearly 50 companies contributed to the MRS. The Dutch-built hardware was delivered to the UK in 2008 to be integrated, tested and calibrated with the rest of MIRI. The complete MIRI instrument was delivered to NASA in 2012.

## Integration, calibration and testing

MIRI was then integrated and calibrated along with the other three instruments on Webb, at Goddard Space Flight Center in 2015-2016, and thereafter coupled and tested with the telescope in the cryo-chamber (the refurbished Apollo mission test chamber) at Johnson Space Flight Center in Houston in 2017. The telescope and its instruments were then transported to Northrup Grumman in Los Angeles to be integrated with the sunshield, and finally shipped to ESA's launch site in Kourou, French Guiana, in the fall of 2021.

The Dutch MIRI team participated in all phases of the design, construction, calibration and testing of the MRS. Since its delivery in 2012, the team has mainly focused on the calibration and commissioning of the spectrometer, including the development of high-level algorithms and scripts for the reduction and analysis of the MIRI-IFU data, in collaboration with several partners.

Dutch astronomers at all NOVA institutes (Universities of Amsterdam, Groningen, Leiden and Nijmegen) have received guaranteed observation time through this investment and are among the first to observe with the telescope to reap the scientific harvest.



*Left: Part of the Dutch MIRI team at the 2012 handover of MIRI to NASA in London. From right to left: Jan-Willem Pel (head of the MRS optical design), Sandra Eggens-Eeltink (technician), Gabby Aitink-Kroes (engineer), Ramon Navarro (head of NOVA Optical Infrared lab). (Credit: NOVA)*

*Right: The project leaders of the Dutch part of MIRI with the 1:1 JWST scale model, in Dublin in 2007. From left to right: Rieks Jager (Dutch project manager), Ewine van Dishoeck (MIRI co-PI for the Netherlands), Bernhard Brandl (deputy co-PI for the Netherlands). (Credit: NOVA)*