



CSI: THE DEVELOPMENT OF A NEW SPACE INSTRUMENT CALIBRATION FACILITY AT TNO

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TNO innovation
for life

OUTLINE

- › TNO Space heritage
- › Why is calibration needed?
- › Introduction CSI
- › Design of CSI Thermal Vacuum Chamber
- › Instrument Mechanical Manipulation System
- › Conclusion

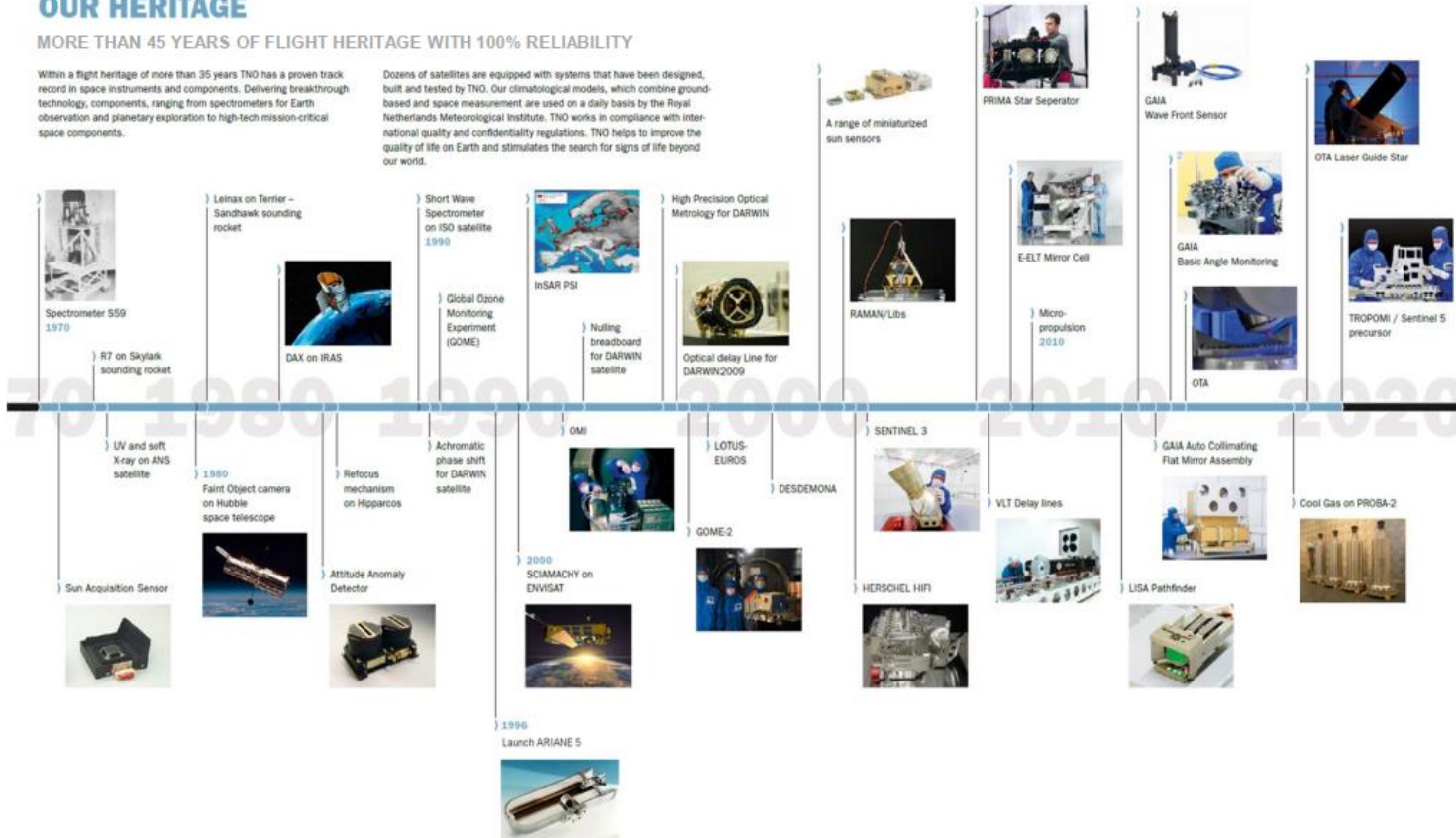
50+ YEARS OF SPACE HERITAGE

OUR HERITAGE

MORE THAN 45 YEARS OF FLIGHT HERITAGE WITH 100% RELIABILITY

Within a flight heritage of more than 35 years TNO has a proven track record in space instruments and components. Delivering breakthrough technology, components, ranging from spectrometers for Earth observation and planetary exploration to high-tech mission-critical space components.

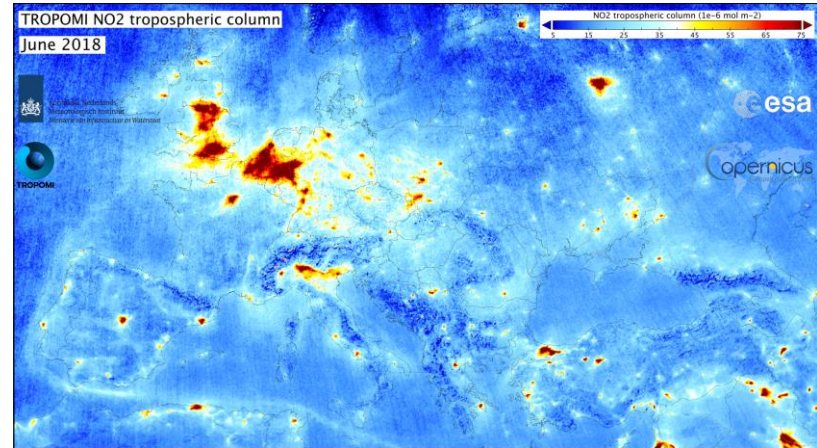
Dozens of satellites are equipped with systems that have been designed, built and tested by TNO. Our climatological models, which combine ground-based and space measurement are used on a daily basis by the Royal Netherlands Meteorological Institute. TNO works in compliance with international quality and confidentiality regulations. TNO helps to improve the quality of life on Earth and stimulates the search for signs of life beyond our world.



RECENT TNO HERITAGE IN THE SPACE DOMAIN



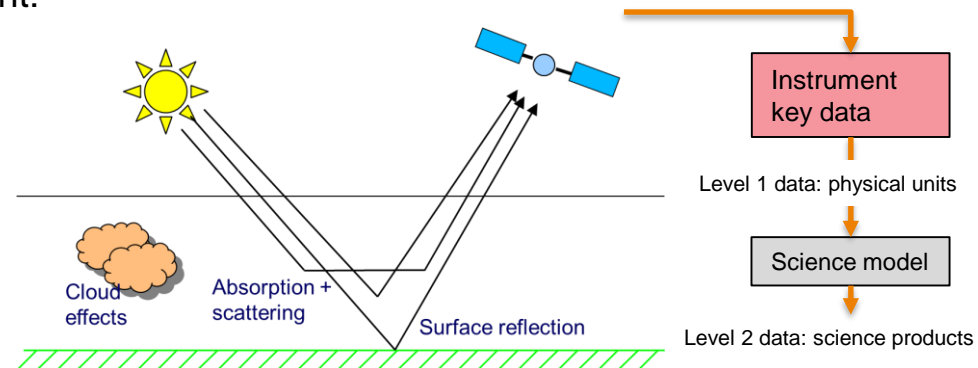
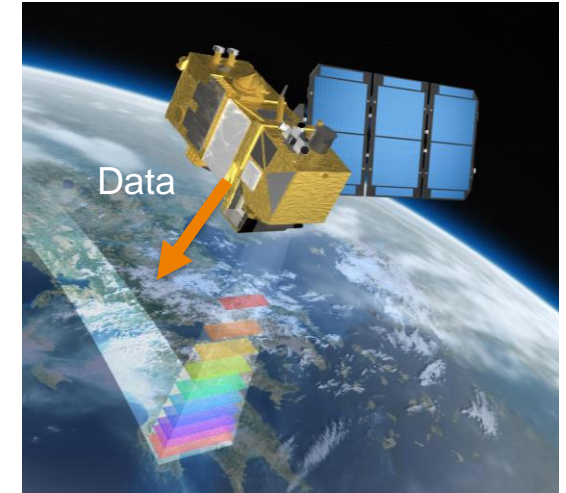
TROPOMI on Sentinel 5P



Launched in 2017

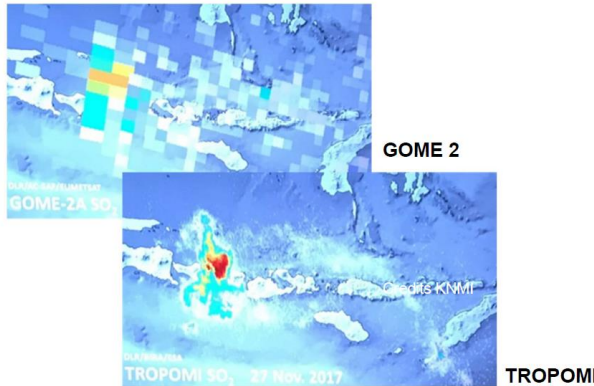
WHY IS CALIBRATION NEEDED

- › The received data on earth would have two unknowns if there were no calibration
 - › Earth
 - › Instrument
- › Instruments need **calibration** on the generated output, this requires a realistic space environment:
 - › Temperature
 - › Pressure
 - › And known (optical) input conditions

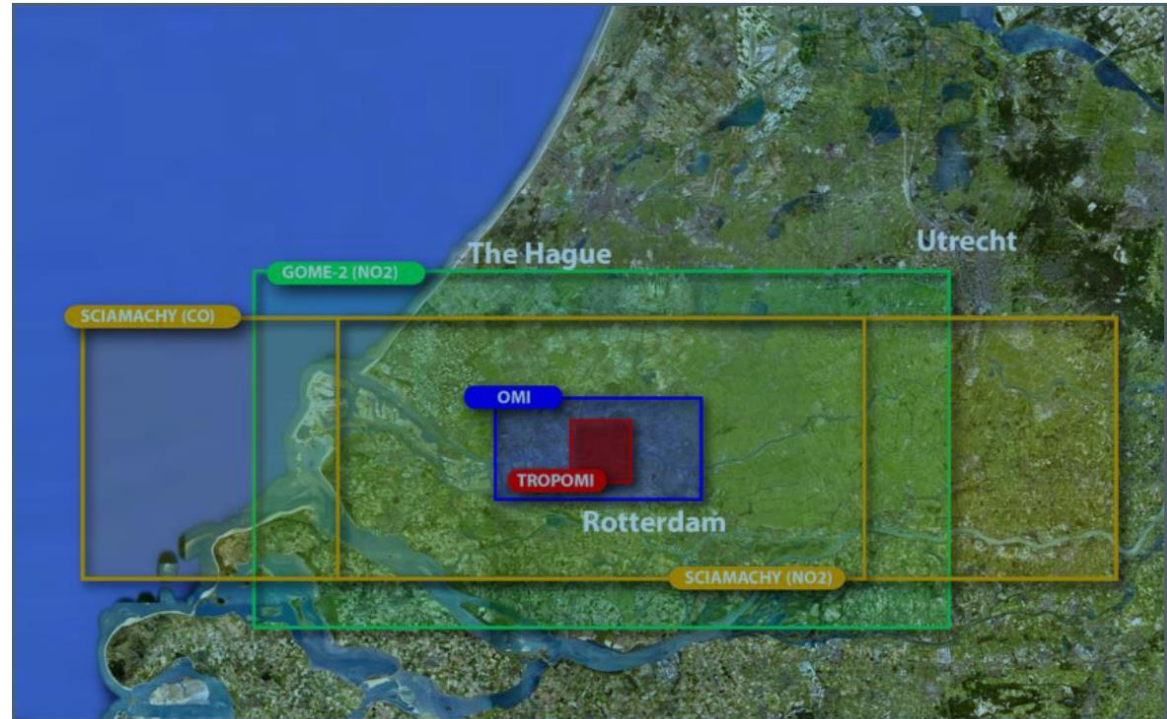


TRENDS IN SPACE INSTRUMENTS

- › Better ground resolution
- › Constellations of multiple instruments
- › Dedicated missions



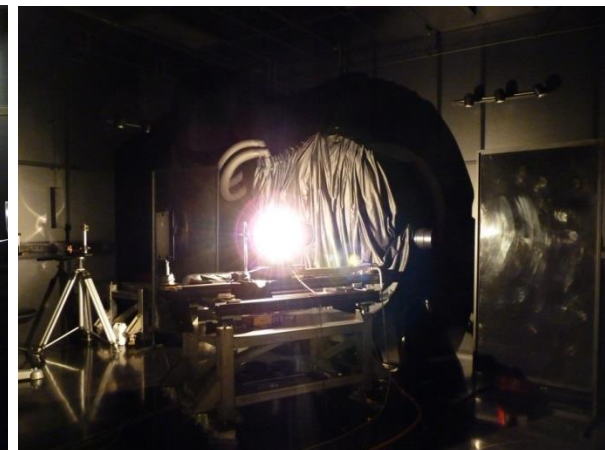
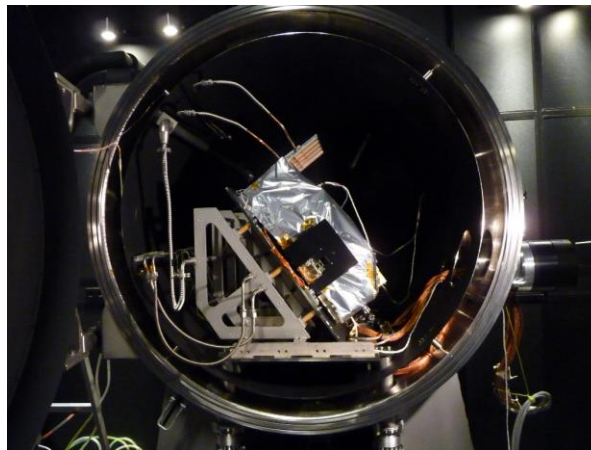
Credits KNMI Volcano Agung in Bali, Indonesia



CURRENT FACILITY AT TNO

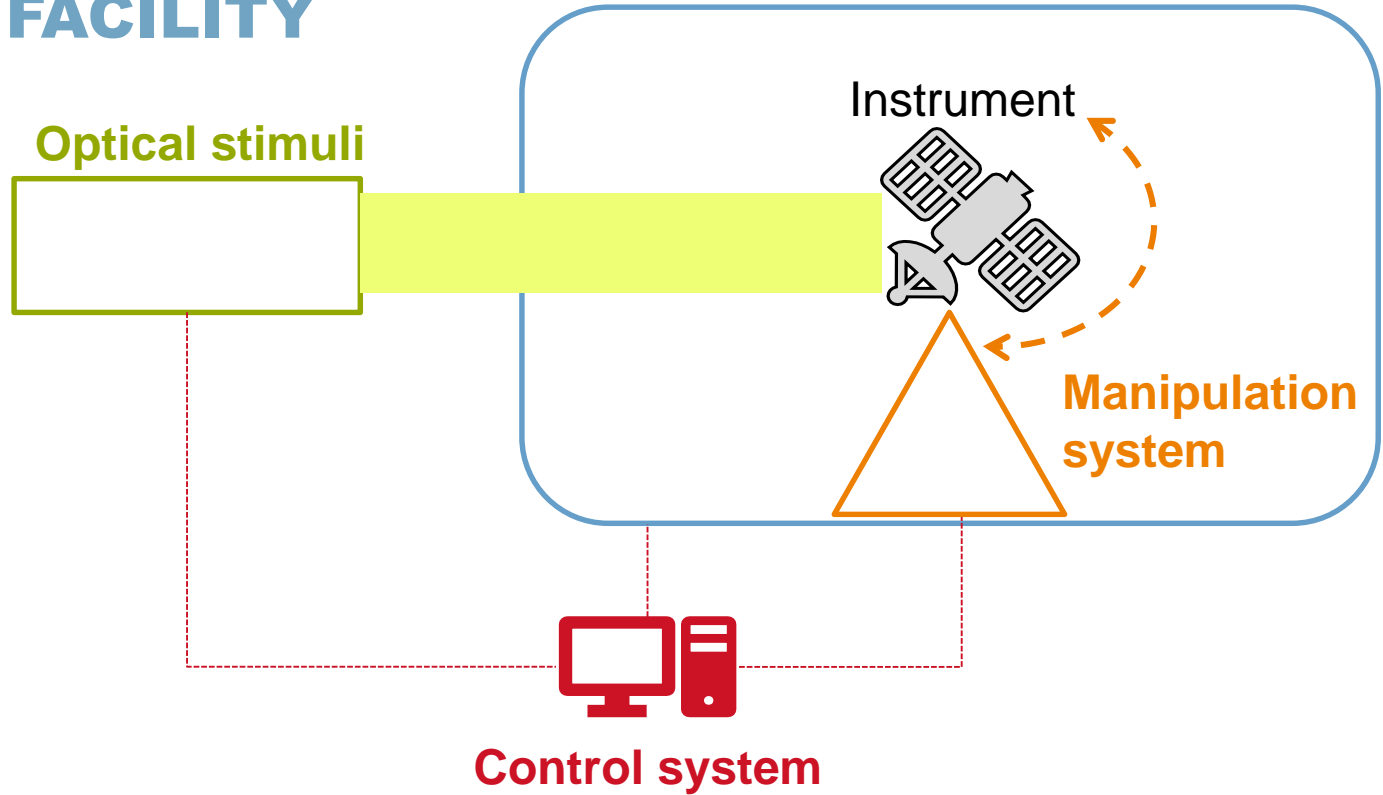


- › Vacuum Calibration Facility (VCF)
- › TVC in a dark clean room
- › Diameter shroud 1,5 meter, length 2 meter



CSI FACILITY

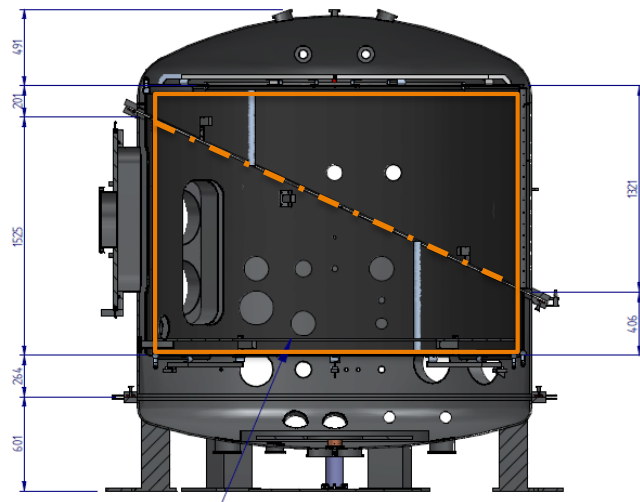
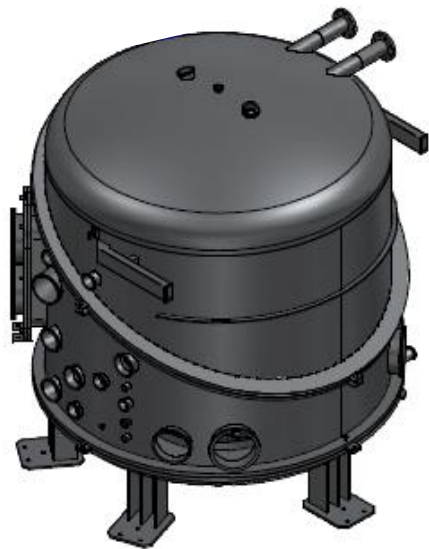
Thermal Vacuum Chamber



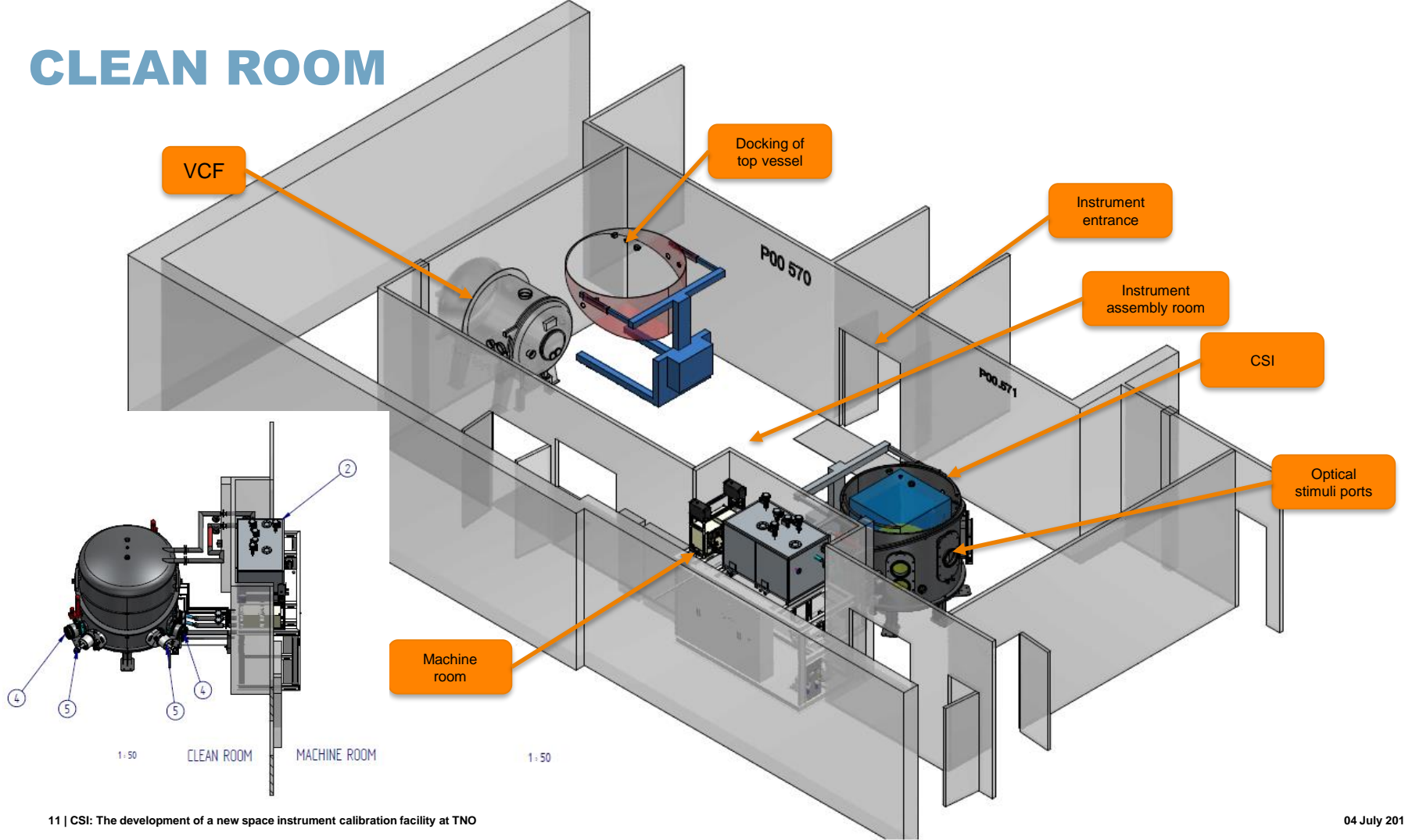
CSI: THERMAL VACUUM SYSTEM

- › Thermal Vacuum Chamber
 - › Size: vertical cylinder of 2.7 m diameter and 2.5 m height
 - › Shroud covering the full volume of the vessel
 - › temperature range: -80 °C to + 80 °C
 - › temperature rate of change: up to 3 °C/min
 - › Two independent cold plate systems (or inner shroud)
 - › temperature range: -173 °C to + 80 °C
 - › Anticipated temperature stability of the instrument: <0.2 °C
 - › Bake-out temperature: >100 °C
 - › Ultimate pressure chamber: < 1x10⁻⁷ mbar
 - › Cleanliness: cold trap, RGA, and QCM



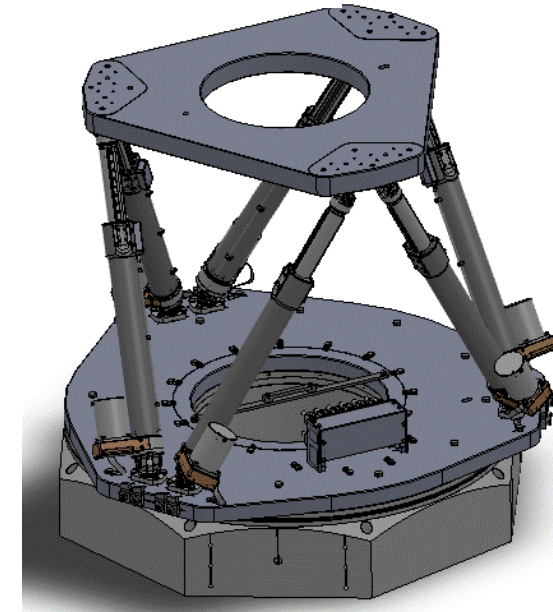
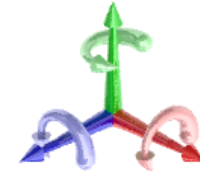


CLEAN ROOM



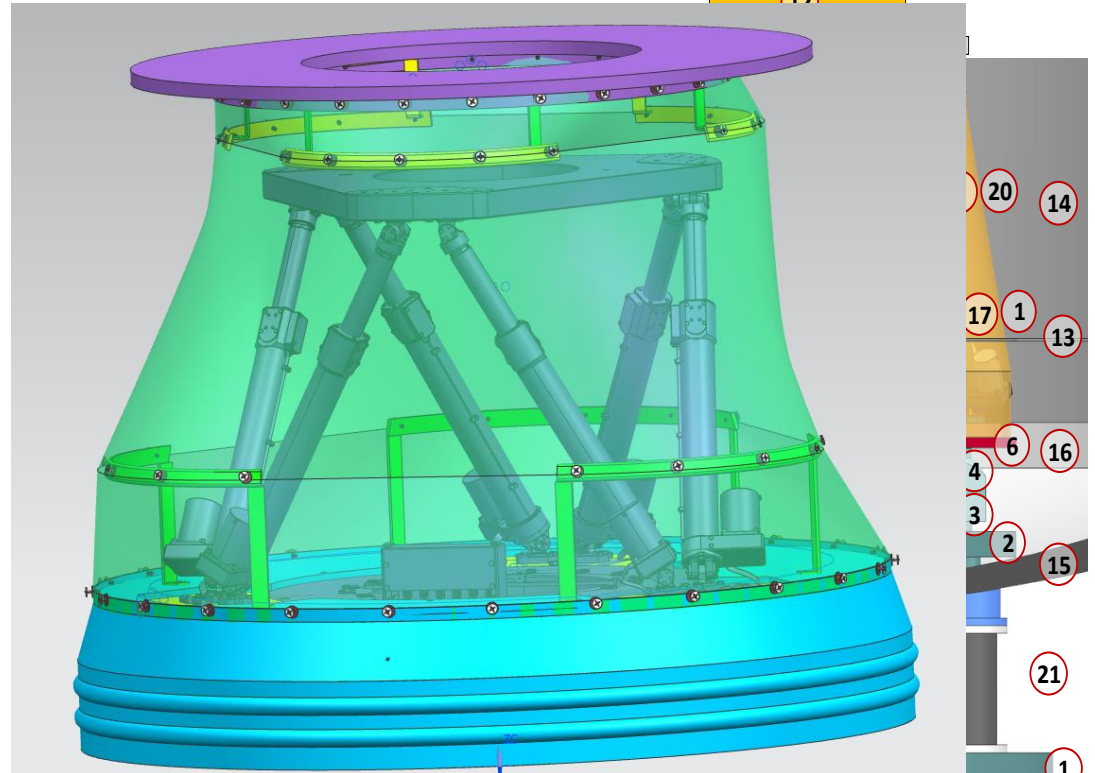
MECHANICAL MANIPULATION SYSTEM

- › Rotation stage and Hexapod in vacuum
- › Maximum mass 300 kg
- › Rotation stage:
 - › Instrument rotation: +/- 175°
- › Hexapod:
 - › Translation and rotation in 6 DOF
 - › Maximum tilt is >15°
- › Instrument pointing accuracy: < 0.001°



THERMAL CONSTRAINTS MANIPULATION SYSTEM

- › TVC temperature range -80°C to $+100^{\circ}\text{C}$ during bake-out
- › Hexapod and rotation table operation window $+10^{\circ}$ to $+50^{\circ}\text{C}$
- › Hexapod and rotation table survival temperature $+10^{\circ}\text{C}$ to $+100^{\circ}\text{C}$



CONCLUSION

- › TNO has a long heritage in the development of optical earth observation instruments, calibration units and calibrations
- › TNO is investing in a new calibration system to remain a frontrunner in the space domain
- › CDR for both the TVC and Manipulation system are scheduled for July 2019
- › CSI fully integrated and functional 1st of January 2021

A nighttime photograph of a city street. In the foreground, a modern, curved pedestrian bridge with a metal mesh railing is illuminated from below. The background shows a city street with light trails from moving vehicles, including a prominent green light trail. Buildings with lit windows are visible on both sides of the street.

› **THANK YOU FOR YOUR
ATTENTION**

Take a look:
[TNO.NL/TNO-INSIGHTS](https://www.tno.nl/tno-insights)

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