



PROGRAMME OF THE
EUROPEAN UNION



co-funded with



S5p-TROPOMI

Instrument status after almost five years in orbit

Airbus NL TROPOMI Post Launch Support Team

Airbus NL colleagues who contributed to TROPOMI:

Alex Deutz, Alexander van Heukelum, Andre Klaassen, Barend Ording, Bart Remmerswaal, Bernard Ouwehand, Cees J. de Haan, Charles Dodd, Daniel ten Bloemendal, Dirk Schuitman, Dirk Sloopweg, Dominique Jansen, Francis Kwidama, Frans Hommes, Gerard van Teeffelen, Hans de Kok, Hans Outshoorn, Harco Meijer, Harm Jan de Graaf, Irene van Dijk-Overvliet, Jan Doornink, Jan Frans Bös, Jan Geerse, Jelle Beetstra, Johan de Vries, Jos Dingjan, Leo C. van Lent, Lex Meijer, Marc Neefs, Marc Oort, Marc van Agthoven, Matthijs van der Kooij, Paul Verzijden, Paul Zevenbergen, Petra Toetenel, Piet Vriend, Richard Overhaart, Rob Hemmes, Rob Hoeks, Rob van Brakel, Robert Leenheer, Robert Voors, Ron Overgaauw, Sjaak Koot, Sybren de Jong, Tineke Bakker, Ton Selie, Trevor Watts



PROGRAMME OF THE
EUROPEAN UNION



co-funded with



Contents

- Instrument Heritage
- TROPOMI Technology & Industrial Team
- TROPOMI Instrument Test Program
- S5p-TROPOMI Launch and Orbit Phase
- Airbus NL Current Instrument Activities
- TROPOMI Lessons Learned



PROGRAMME OF THE
EUROPEAN UNION



co-funded with



Instrument Heritage

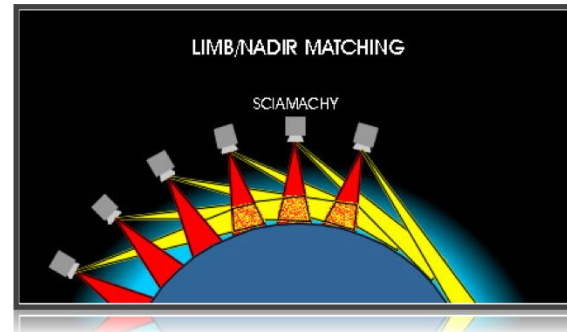


- **SCIAMACHY**

- Differential Optical Absorption Spectroscopy
- UV and SWIR channels
- Nadir, limb, occultation

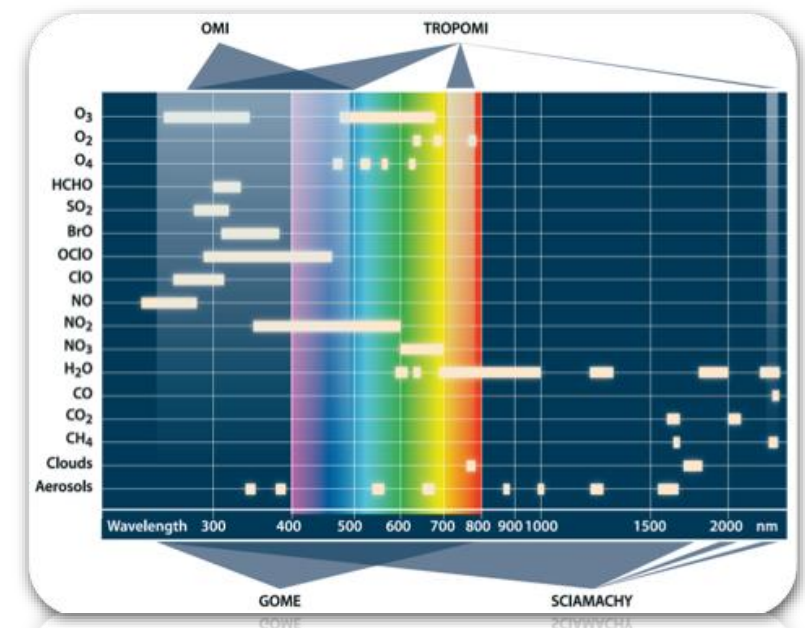
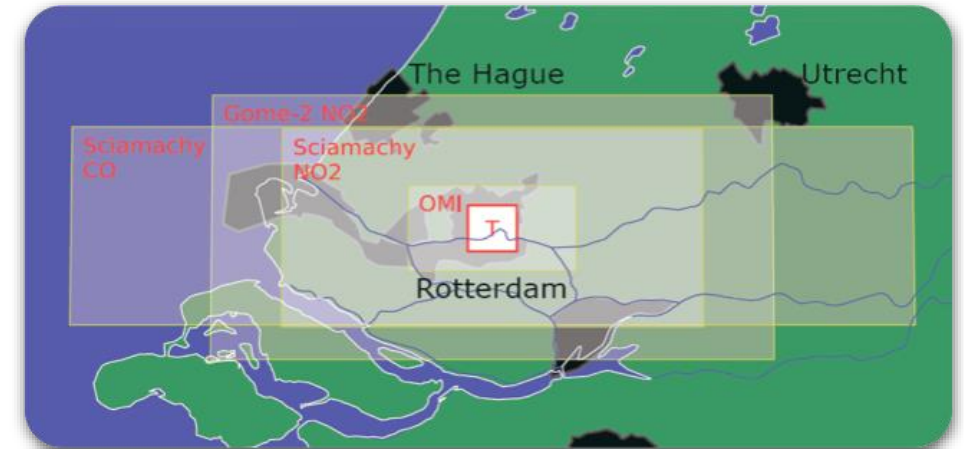
- **OMI**

- Smaller focused mission
- Conventional telescope
- UV-VIS channels
- Smaller ground pixel: 13 x 24 km²



- **TROPOMI**

- Combine and improve SCIAMACHY and OMI
- Freeform telescope mirrors
- UV, UVIS, NIR and SWIR
- 10 x improved sensitivity, ground pixel 3.5 x 7 km²





PROGRAMME OF THE
EUROPEAN UNION



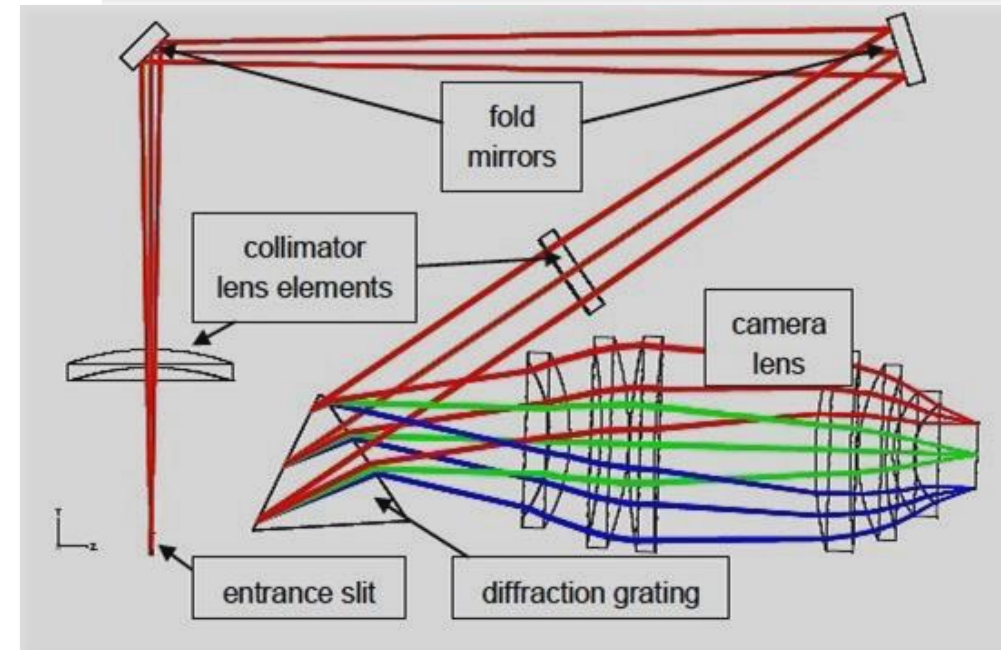
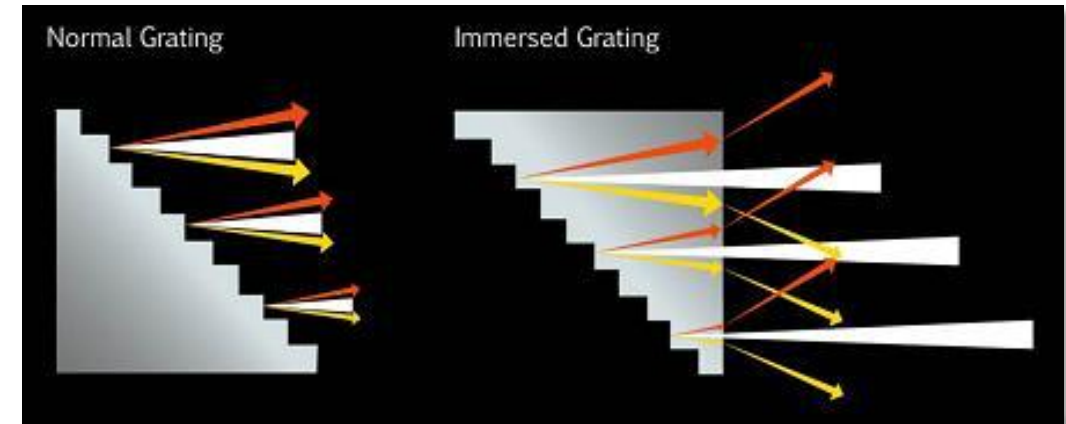
co-funded with



TROPOMI Technology & Industrial Team



- Working principle
 - Illuminate grating from inside
 - Make use of step in refractive index
- Advantages
 - Compactness
 - Increase spectral resolution
- Applied in the TROPOMI SWIR channel
 - Grating size 50 x 60 mm
 - 500 lines/mm
 - SRON/TNO development



Freeform telescope mirror



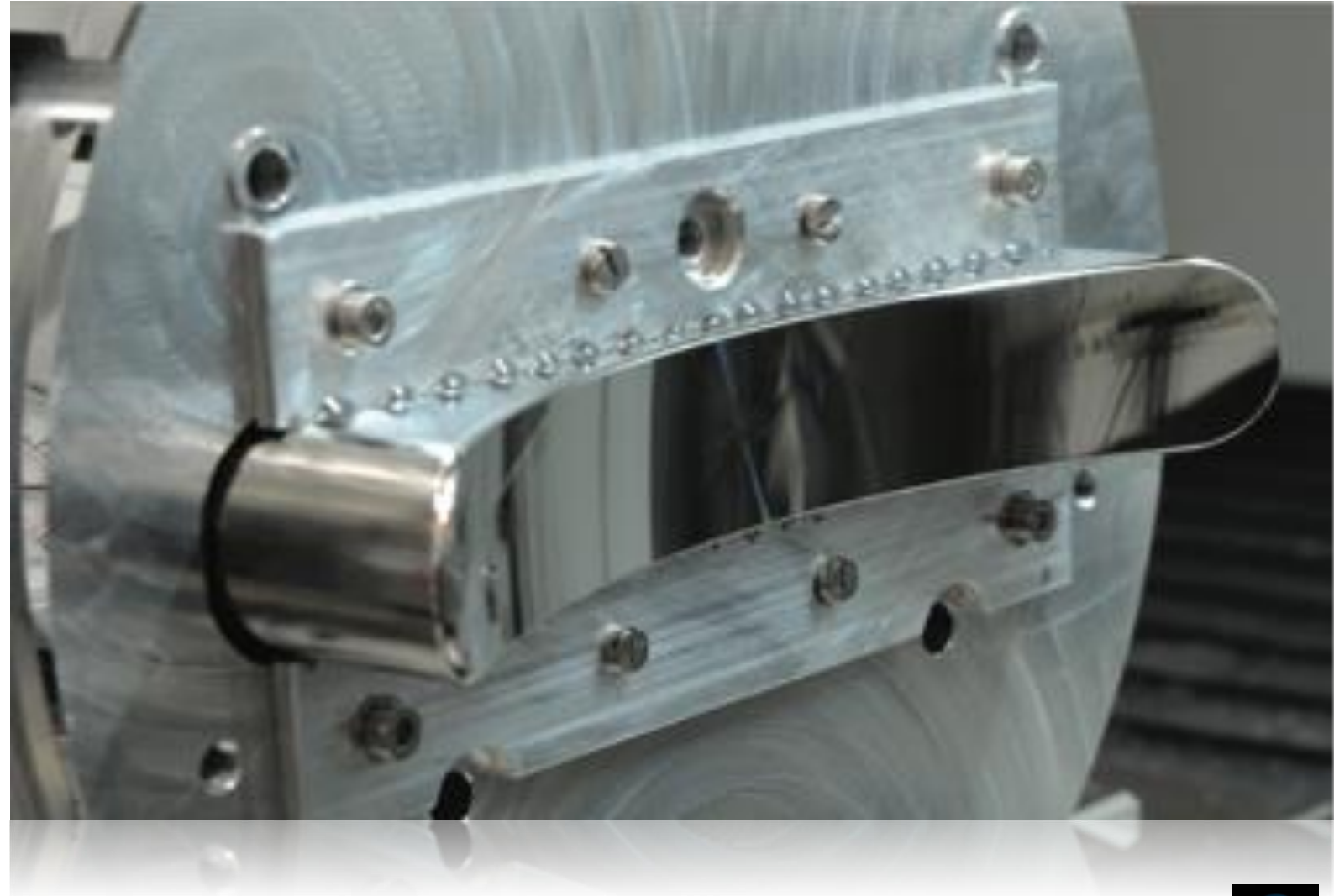
PROGRAMME OF THE
EUROPEAN UNION

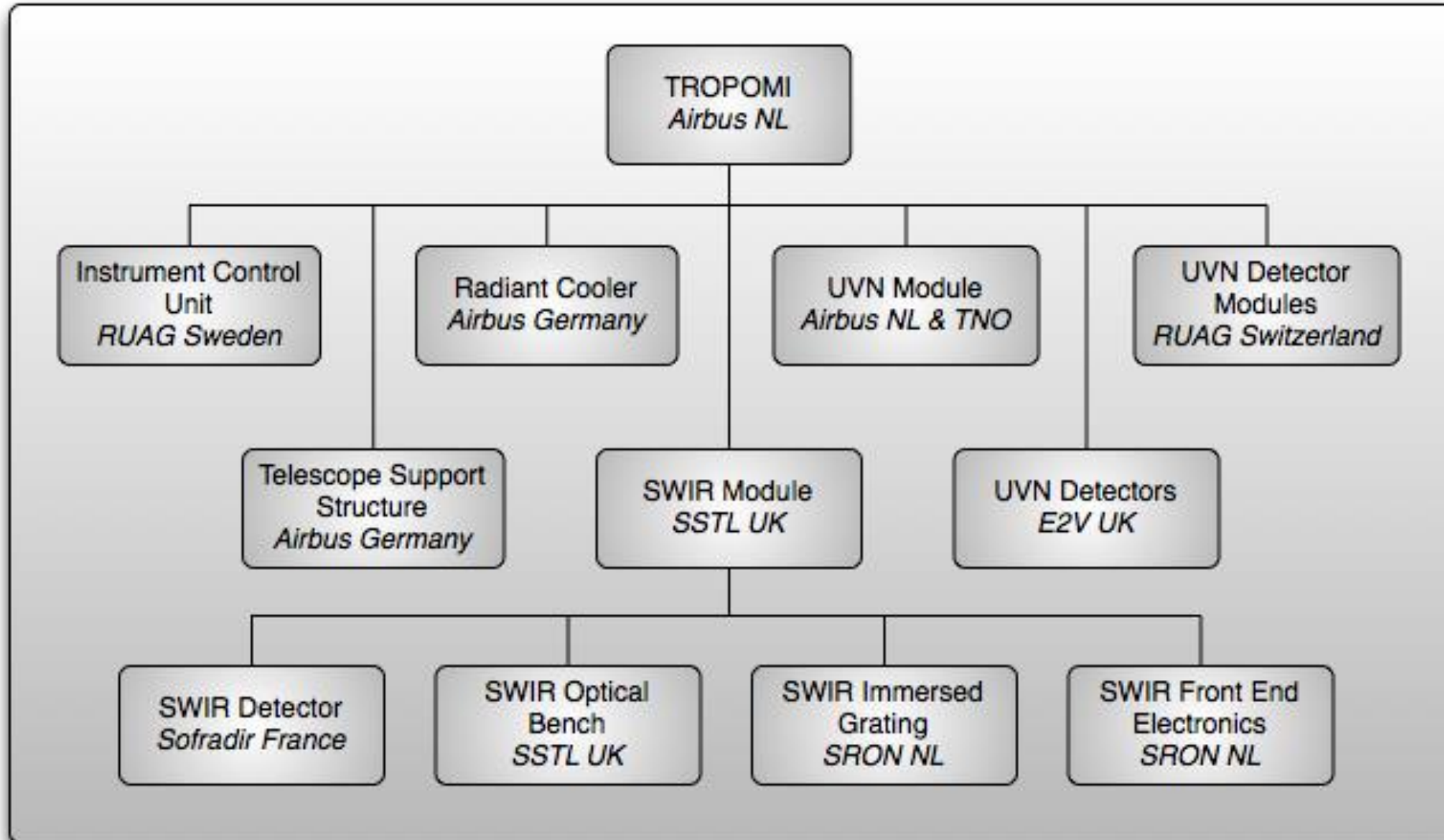


co-funded with



- Toroidal shape
- Anamorphic telescope
- 0.02° resolution
- Sub-km spot size
- TNO development







PROGRAMME OF THE
EUROPEAN UNION



co-funded with



TROPOMI Instrument Test Program



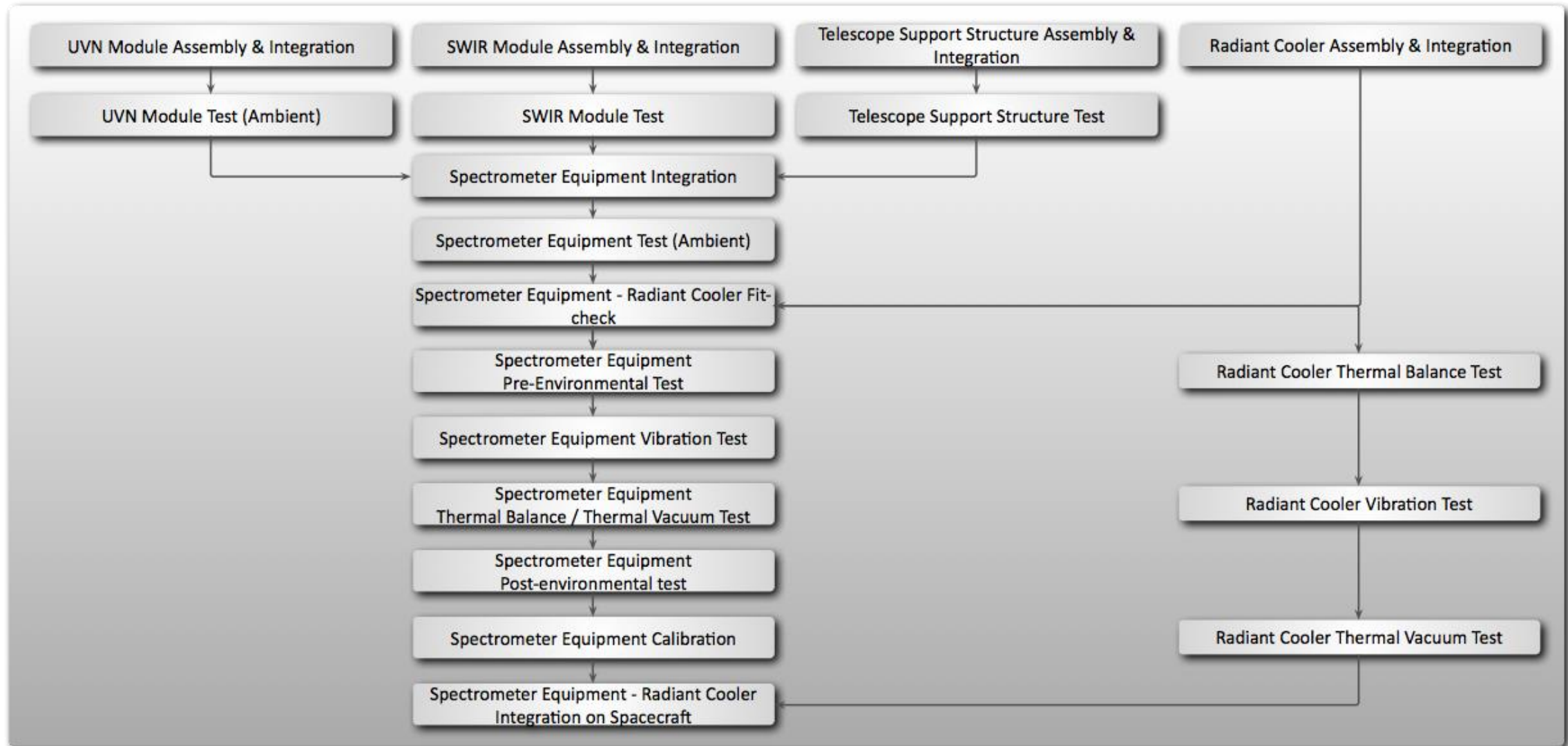
TROPOMI Instrument Level Test Program



PROGRAMME OF THE EUROPEAN UNION



co-funded with



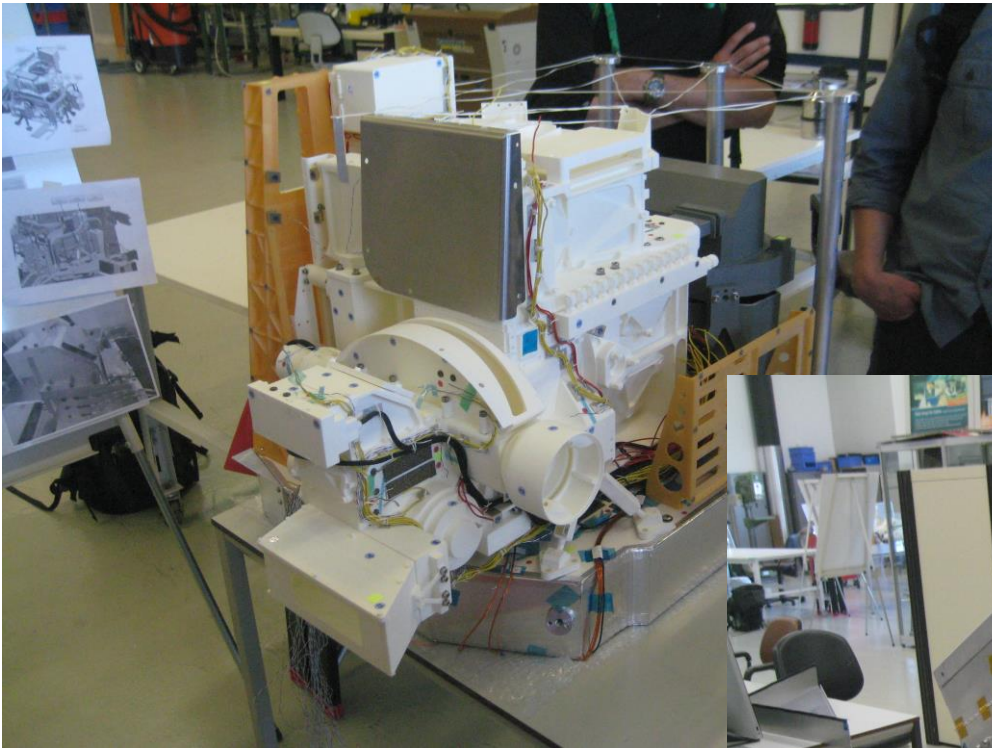
Early Instrument Level Test Models Already Starting in 2012



PROGRAMME OF THE
EUROPEAN UNION

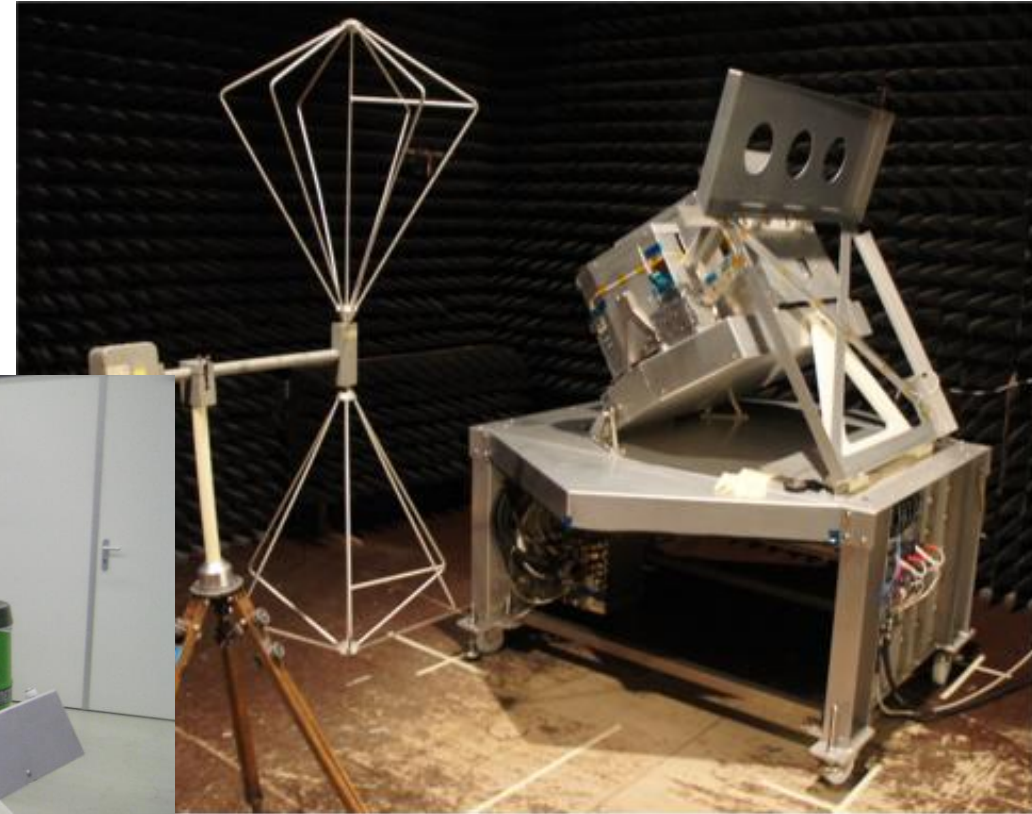


co-funded with



3D Printed Mockup

- Harness routing
- MLI blanket fit checks



Electrical Confidence Model (EFM)

- Early operations tests
- Early EMC test
- Still in use for procedure validation

Fit Check of Cooler and Instrument – August 8th, 2014



PROGRAMME OF THE
EUROPEAN UNION



co-funded with



Sentinel-5P Mission: 5 years anniversary 10 - 14 October 2022 Taormina, Italy

AIRBUS



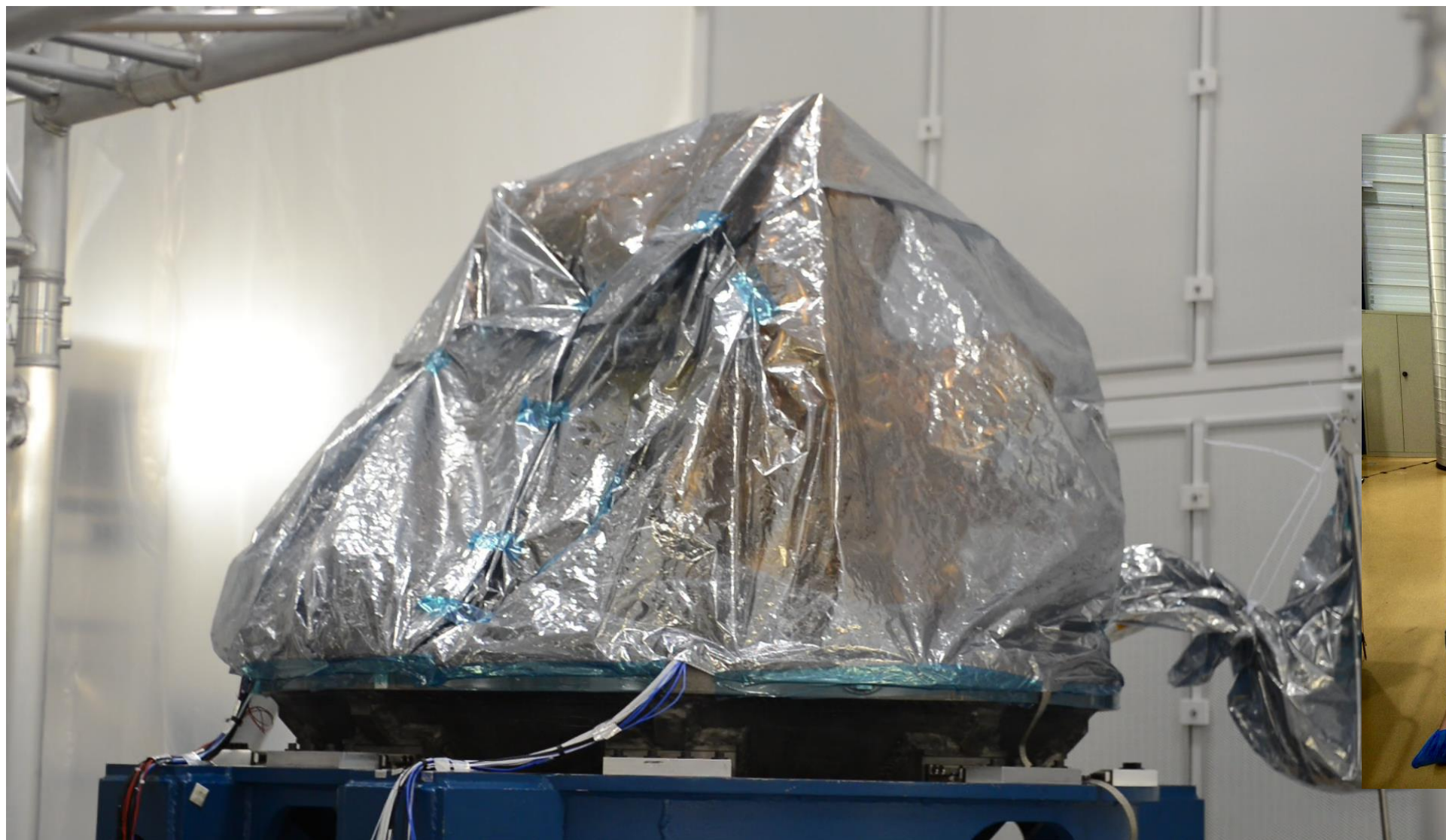
Instrument Vibration Test - September 14th, 2014



PROGRAMME OF THE
EUROPEAN UNION



co-funded with



Sentinel-5P Mission: 5 years anniversary 10 - 14 October 2022 Taormina, Italy

AIRBUS



Opening Radiant Cooler Door in Vacuum – November 15th, 2014



PROGRAMME OF THE
EUROPEAN UNION



co-funded with



Airbus D TROPOMI team

Sentinel-5P Mission: 5 years anniversary 10 - 14 October 2022 Taormina, Italy

AIRBUS



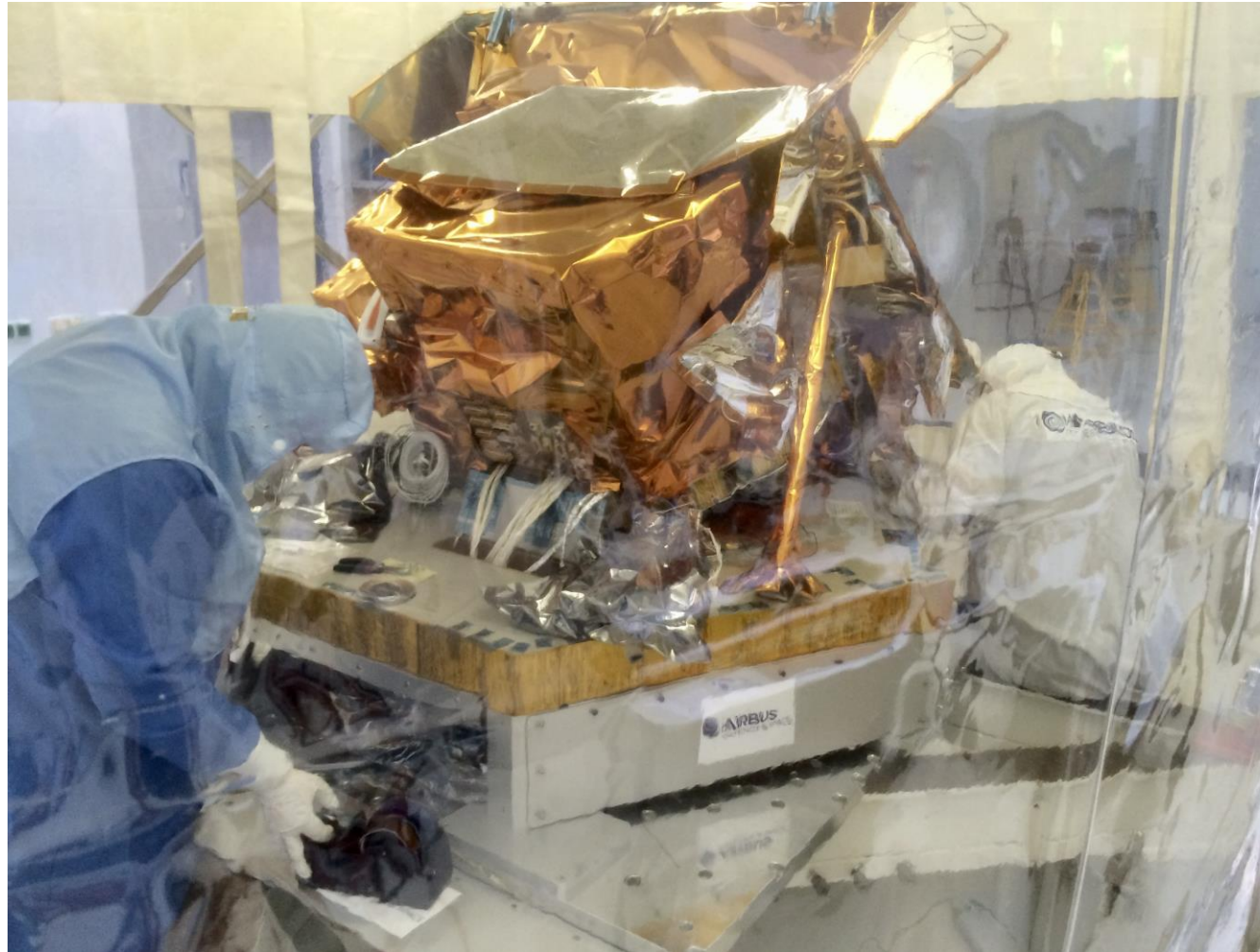
Preparation Acoustic Test – November 24th, 2014



PROGRAMME OF THE
EUROPEAN UNION



co-funded with



TROPOMI Instrument Module and Radiant Cooler jointly acoustically tested on representative Spacecraft panel

Sentinel-5P Mission: 5 years anniversary 10 - 14 October 2022 Taormina, Italy

AIRBUS



TROPOMI Integrated on S5p at Airbus UK



PROGRAMME OF THE
EUROPEAN UNION



co-funded with



Sentinel-5P Mission: 5 years anniversary 10 - 14 October 2022 Taormina, Italy

AIRBUS



Dress Rehearsal Cooler Door Opening August 24th 2017



PROGRAMME OF THE
EUROPEAN UNION

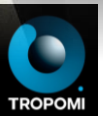


co-funded with



Sentinel-5P Mission: 5 years anniversary 10 - 14 October 2022 Taormina, Italy

AIRBUS



TROPOMI Schedule



PROGRAMME OF THE
EUROPEAN UNION



co-funded with



<i>Milestone / Activity</i>	<i>Date / Period</i>
Preliminary Design Review (PDR)	May 2011
Subsystem PDRs	2 nd half of 2011
Subsystem CDRs	2 nd half of 2012
Critical Design Review (CDR)	February 2013
Assembly	March-July 2014
Environmental Test	August-December 2014
Calibration	January – May 2015
Instrument Delivery	May 2015
S5p Integration And Test	May – December 2015
NIR Out Of Band Straylight Test	November 2016 – January 2017
Launch-EOP Dress Rehearsals	August 2017
Launch	October 13 th , 2017

Sentinel-5P Mission: 5 years anniversary 10 - 14 October 2022 Taormina, Italy

AIRBUS





PROGRAMME OF THE
EUROPEAN UNION



co-funded with



S5p-TROPOMI Launch & In-Orbit Phase





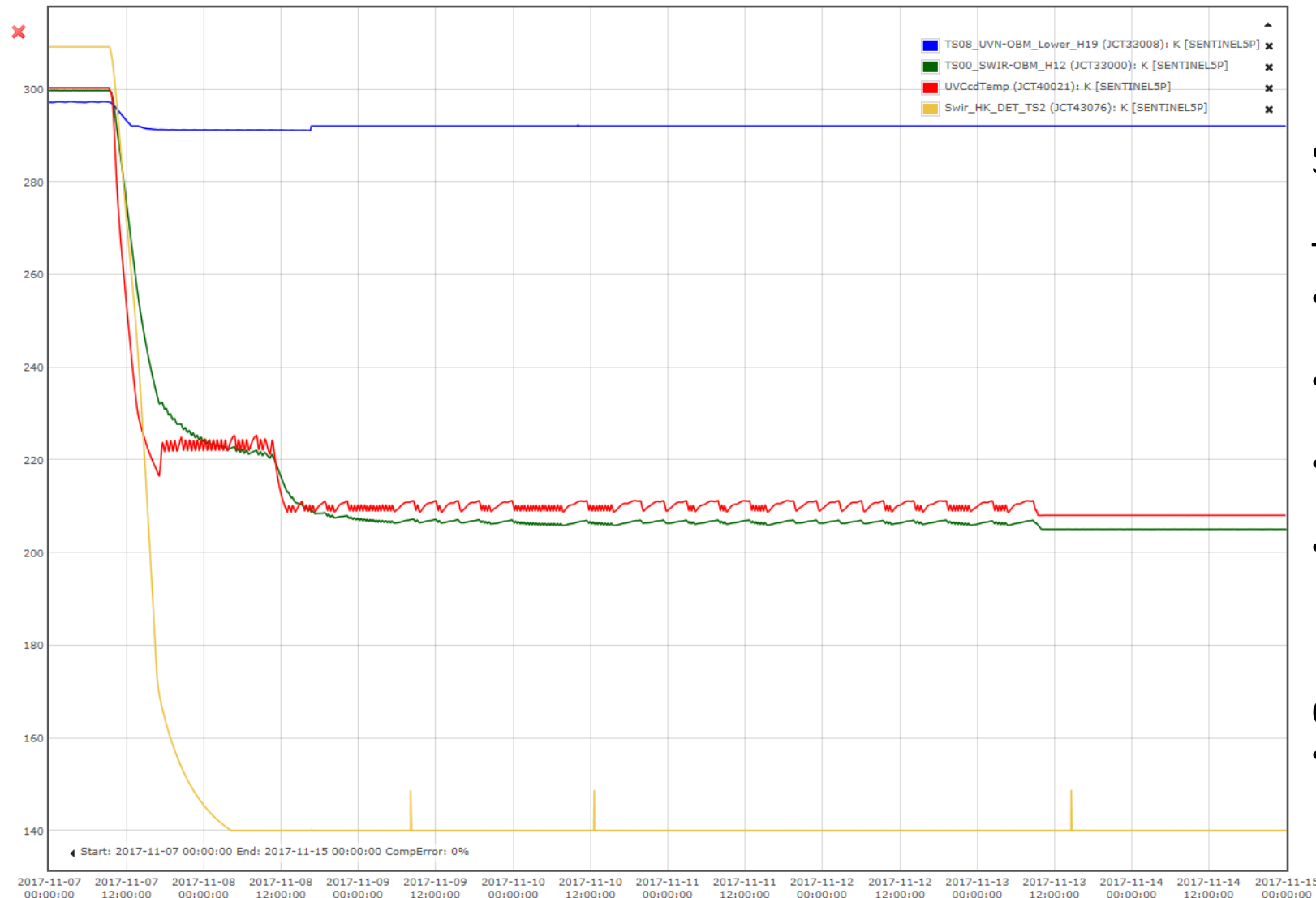
Instrument Cool Down – November 7th – 14th, 2017



PROGRAMME OF THE
EUROPEAN UNION



co-funded with



Status after almost four years in orbit

Thermal

- In-orbit temperatures equal to on-ground calibration temperatures
- In-orbit temperature stabilities are well within specifications
- No changes to the settings since the end of commissioning
- Small hiccups occur during
 - Orbital Correction Manoeuvres
 - Collision Avoidance Manoeuvres

Operations

- Minor changes to operational baseline

- Life Limited Items
 - White Light Source (WLS)
 - Folding Mirror Mechanism (FMM)
 - Diffusor Mechanism (DIFM)
 - EEPROM write cycles and maintenance planning
- Status
 - Mechanisms
 - No signs of degradation
 - White Light Source
 - 0.8% power decrease in 4 years
- Way forward
 - Continue monitoring
- Thermal Headroom Evolution
 - Initial degradation tends to stabilise
- Keep Ground Support Equipment operational



The Airbus NL TROPOMI Post Launch Support Team

UVN Detectors Temperature Control



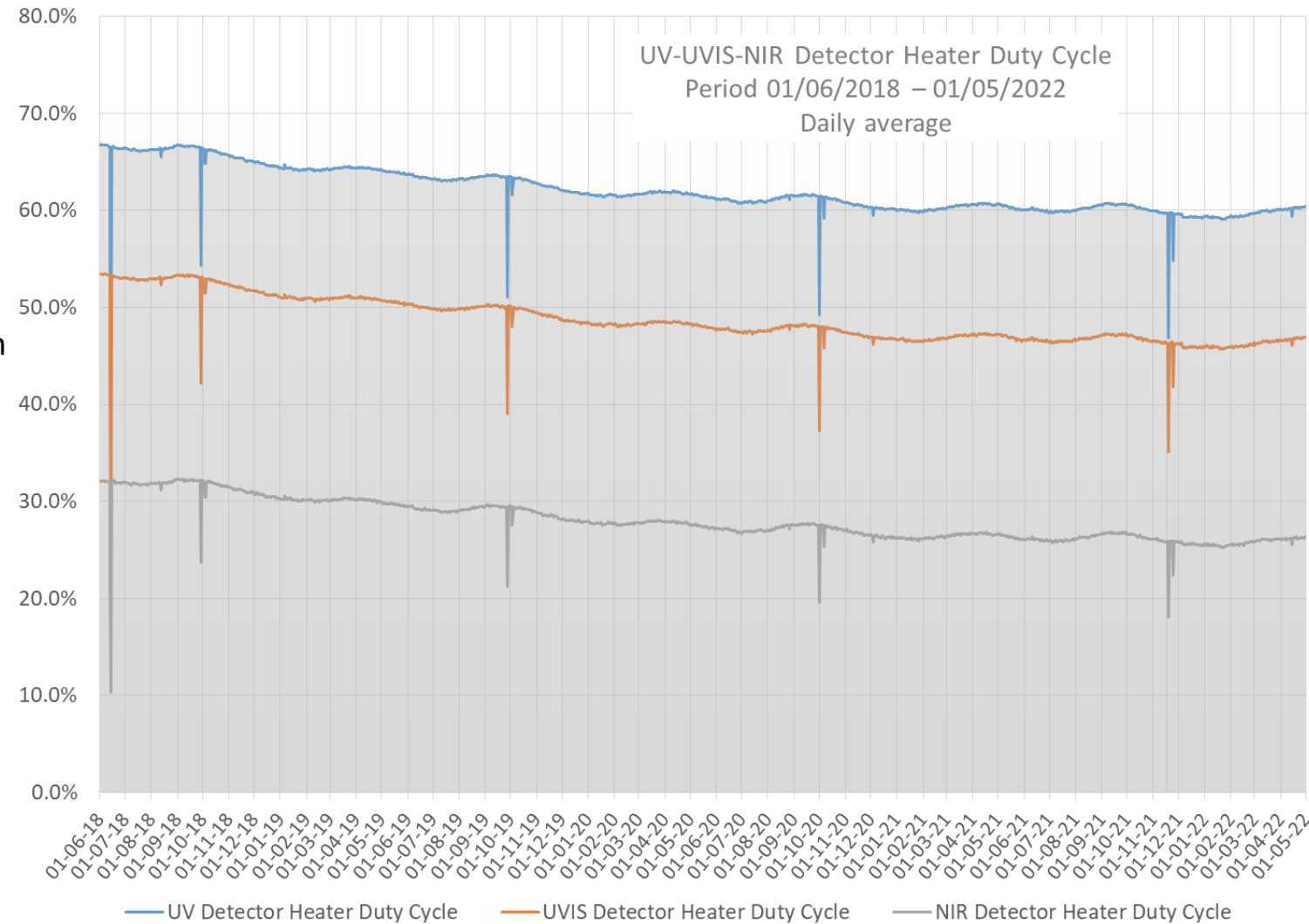
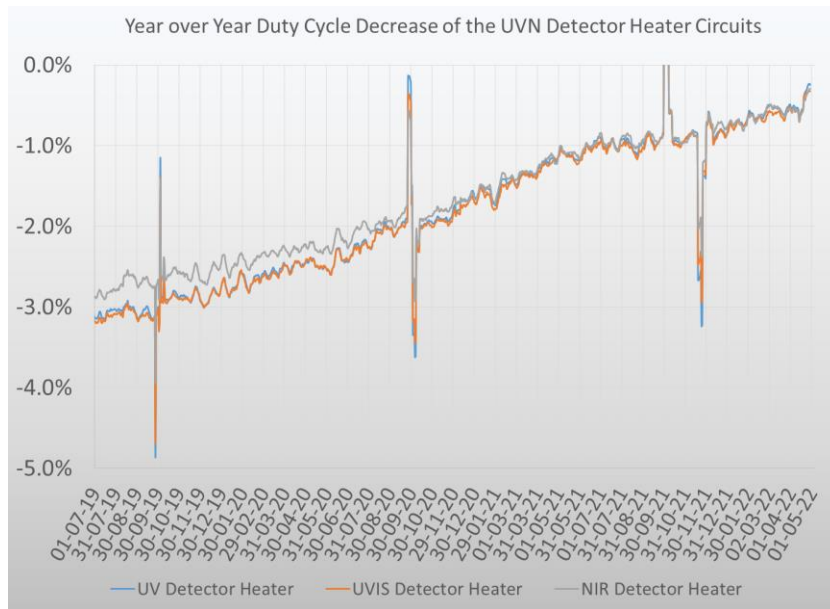
PROGRAMME OF THE EUROPEAN UNION



co-funded with



- UV, UVIS and NIR detector temperature control
- Temperature stabilised at 208 K
- Stability < 35 mK pp
- Heater duty cycle needs to stay > 0
- Initial duty cycle decrease rate tends to slow down



Sentinel-5P Mission: 5 years anniversary 10 - 14 October 2022 Taormina, Italy





PROGRAMME OF THE
EUROPEAN UNION



co-funded with



Airbus NL Current Instrument Activities

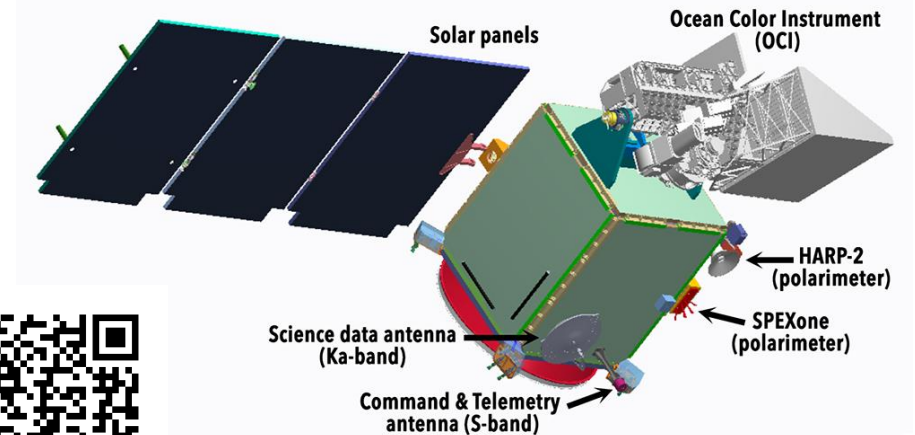
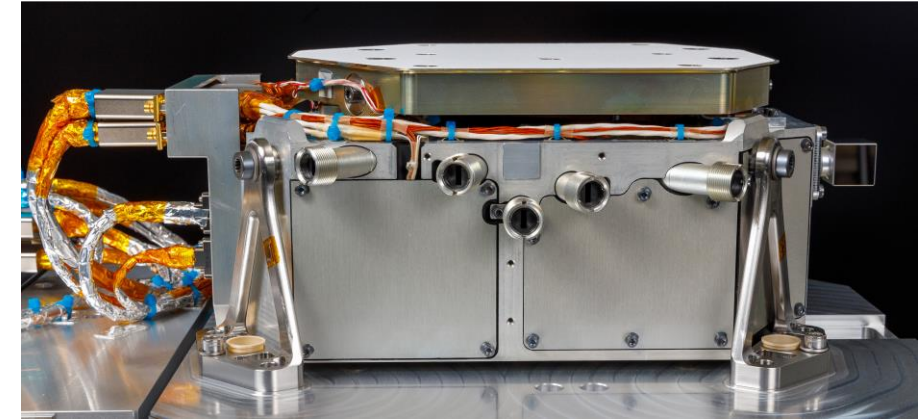


- SPEXone for NASA-PACE

- Maps linear polarization state onto spectrum
- Using passive optical (FreeForm) components
- Focus on aerosol measurements
- Mass 9 kg, size 370x280x150 mm³
- Integrated Q1/2022 on PACE spacecraft
- Launch scheduled for Q1/2024
- Joint development SRON/Airbus with support of TNO
- Funded by NL government, SRON and Airbus

Derived from SPEXone: Noctua family

- Different versions for Aerosols, CH₄, NO₂ and more to come
- Both swath and staring capabilities
- Suitable for space- and airborne platforms
- Re-use instrument components and infrastructure



Plankton, Aerosol, Cloud, ocean Ecosystem SpaceCraft
Credit: NASA/GSFC





PROGRAMME OF THE
EUROPEAN UNION



co-funded with






TROPOMI Lessons Learned






- Technical

- Avoiding complex interfaces 
- Emphasis on cleanliness control 
 - Rigourously maintaining a clean assembly/integration environment
 - Purging with GN2 until launch
 - 3 weeks decontamination period after launch
- Excellent performing proven space craft platform 

- Organisational

- Appointing a Joint Project Team has turned out to be an excellent approach 
 - Direct involvement
 - Speeds up project decisions
 - Problem solving attitude
 - Emphasis on schedule adherence

- Direct project involvement of science end-users 



PROGRAMME OF THE
EUROPEAN UNION



co-funded with



Thank you

