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TAKING THE PULSE OF OUR PLANET FROM SPACE

EUMETSAT ECMWF EUSPA

The Copernicus Sentinel-4 Mission for Atmospheric Composition

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Idustrial consortium lead by Airbus, Science teams lead by DLR

25 May 2022

Copernicus Missions for Atmospheric Composition

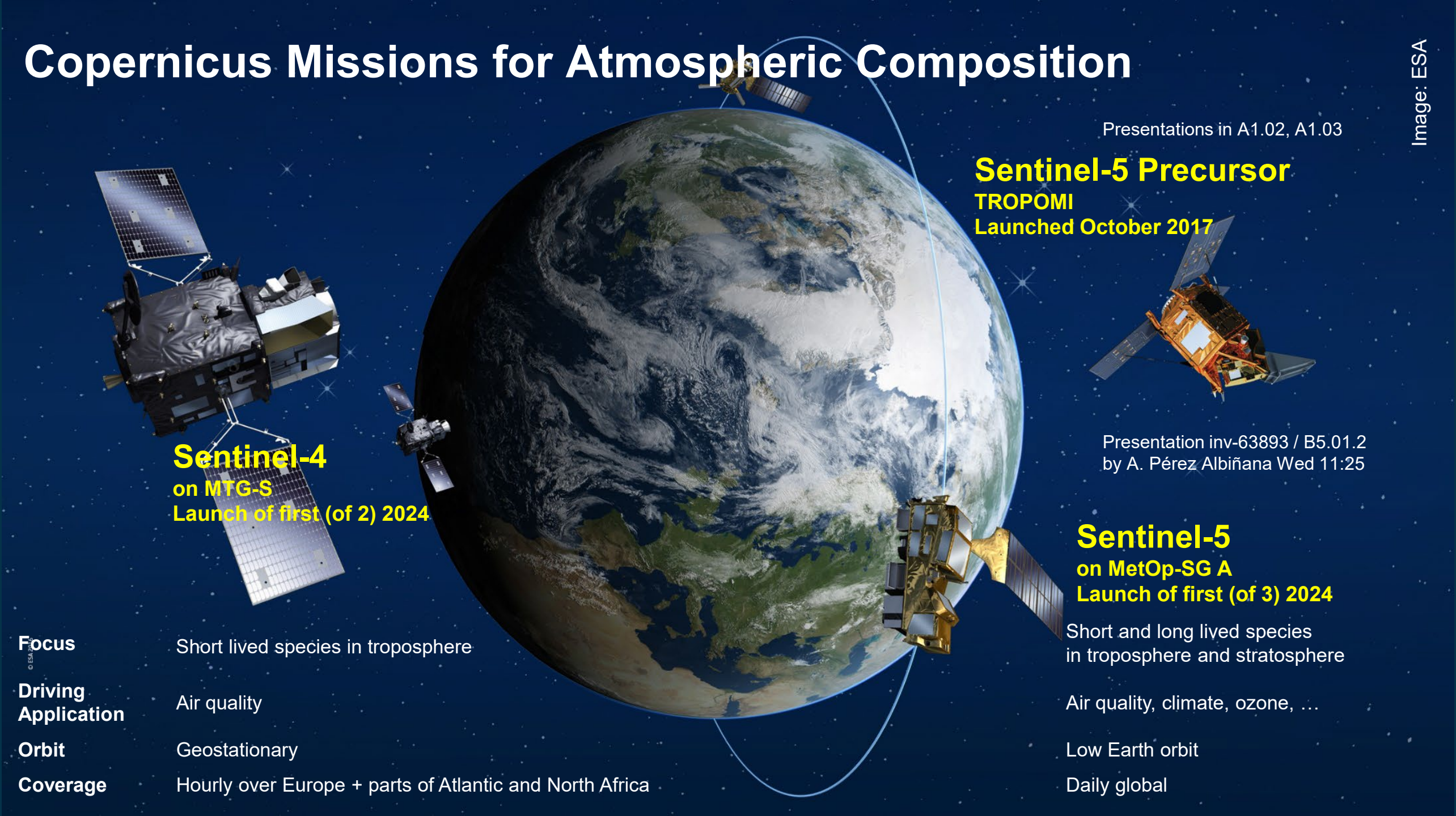


Image: ESA

Presentations in A1.02, A1.03

Sentinel-5 Precursor
TROPOMI
Launched October 2017

Presentation inv-63893 / B5.01.2
by A. Pérez Albiñana Wed 11:25

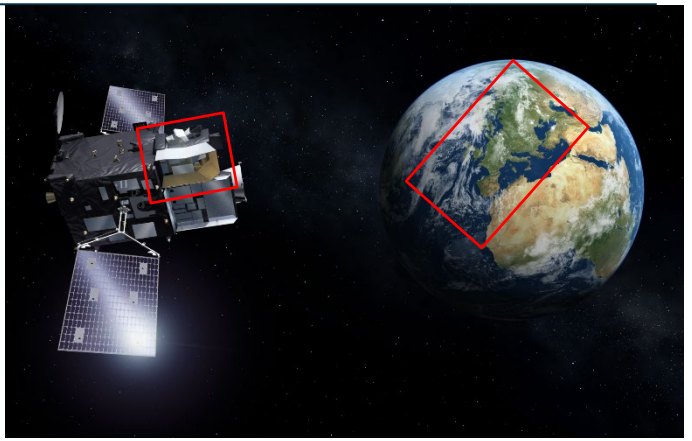
Sentinel-4
on MTG-S
Launch of first (of 2) 2024

Sentinel-5
on MetOp-SG A
Launch of first (of 3) 2024

	Sentinel-4	Sentinel-5
Focus	Short lived species in troposphere	Short and long lived species in troposphere and stratosphere
Driving Application	Air quality	Air quality, climate, ozone, …
Orbit	Geostationary	Low Earth orbit
Coverage	Hourly over Europe + parts of Atlantic and North Africa	Daily global

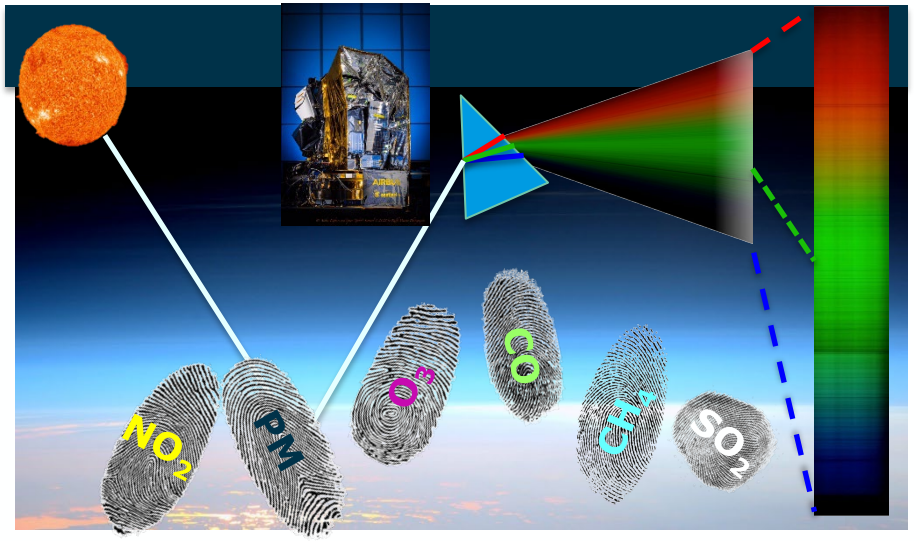
Sentinel-4 Mission

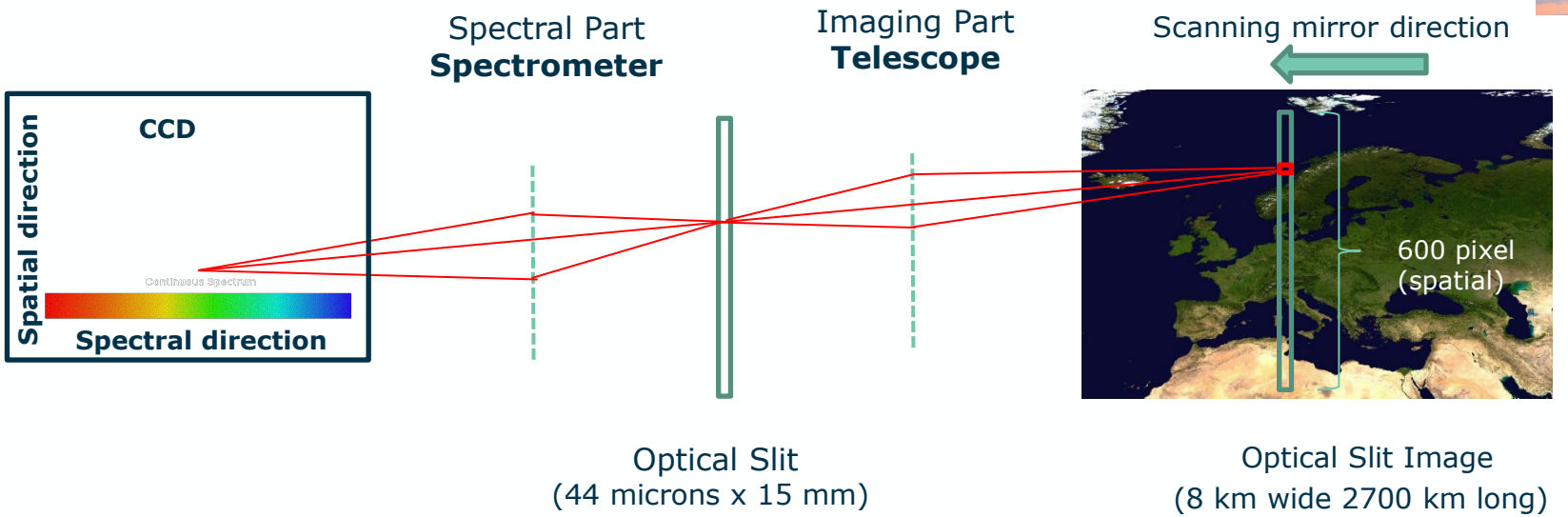
- Objective: monitor operationally atmospheric composition over Europe with hourly revisit → Copernicus Atmosphere Monitoring Service
- Imaging spectrometer on geostationary orbit
- UV, Visible and Near IR wavelength bands (305-500 nm; 750 – 775 nm)
- Observations of O_3, NO_2, SO_2, HCHO, CHOCHO, aerosol with 8 km spatial sampling
- Embarked on Meteosat Third Generation Sounder satellites (MTG-S)
- 2 instruments (PFM, FM2) on 2 satellites, 7.5 years lifetime each
- Built by ESA, prime contractor Airbus (DE)
- Co-funded by ESA and European Commission in Copernicus Programme
- Instrument operation, data processing and dissemination by EUMETSAT
- PFM instrument integrated; on-ground calibration and characterization starts now
  FM2: under integration
- Launch of first MTG-S satellite foreseen in 2024



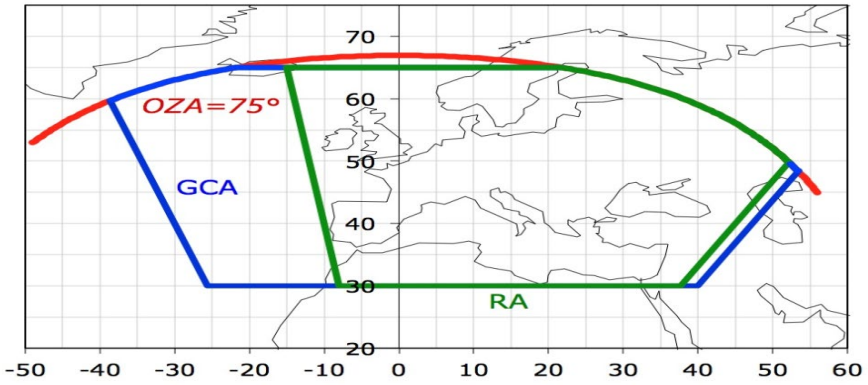
Sentinel-4 Instrument Concept

- Detection of Earth atmosphere absorption spectra by trace gases by measuring Solar Irradiance and Earth backscattered Radiance
- Telescope ➔ slit ➔ collimator ➔ disperser ➔ camera ➔ detector
- FOV: N/S: 3.85° ; E/W: 11.2° ; hourly coverage of Europe
- Spatial sampling: 8.0 x 8 km from Geo orbit



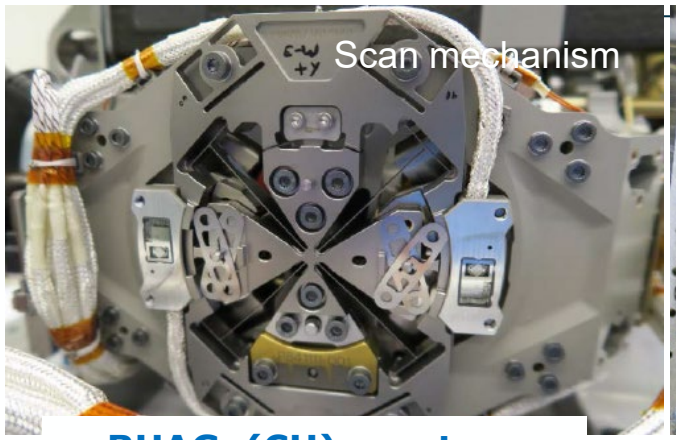


GCA = Geographic Coverage Area
RA = Reference Area

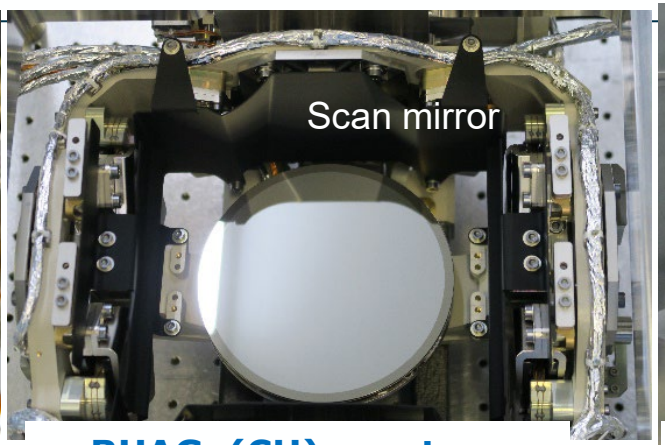


600 spectra / slit-image in 6.4 sec ➔ > 560 slits/ hr (4500 km) ➔ > 330.000 spectra / hr

Sentinel-4 FM Subsystems

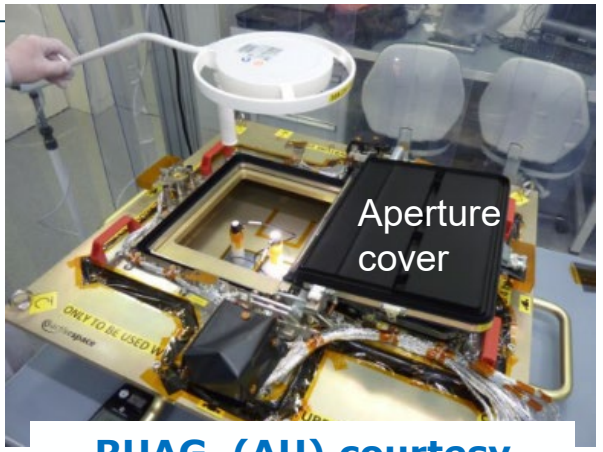


RUAG (CH) courtesy

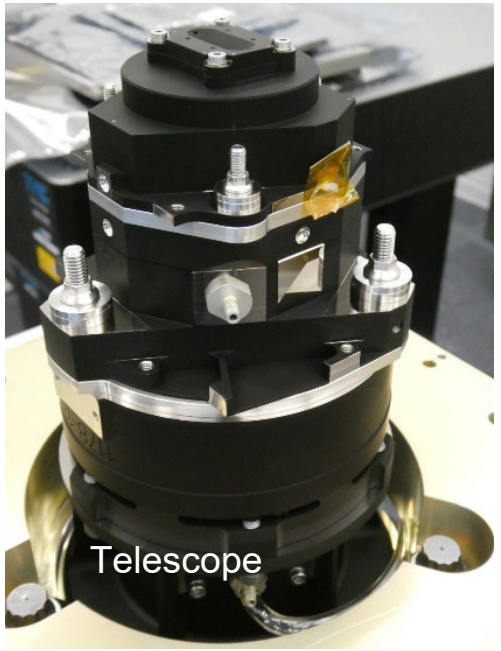


RUAG (CH) courtesy

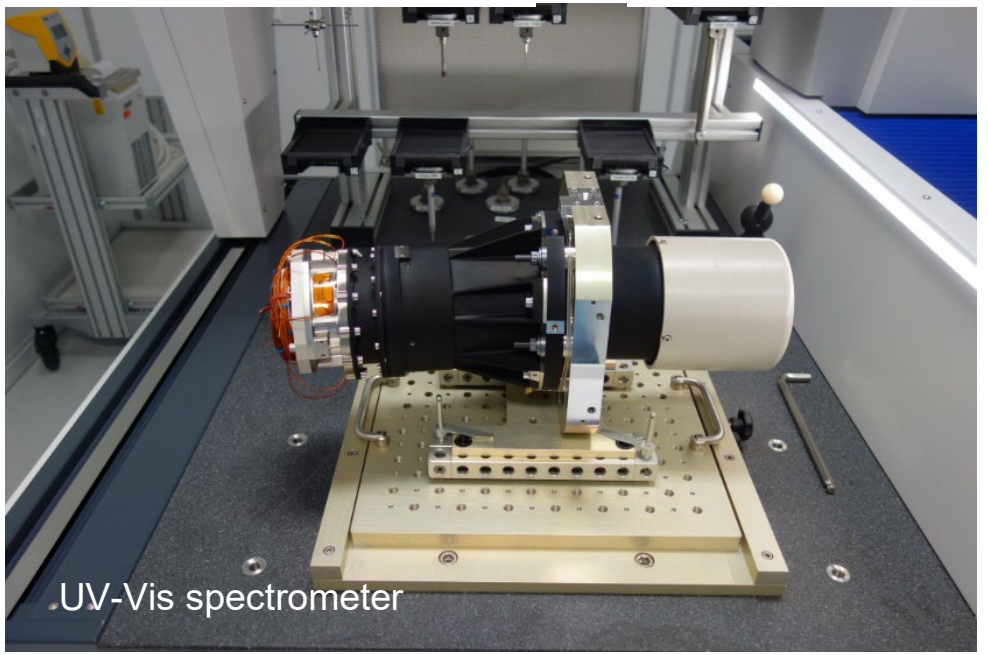
CSL (BE) courtesy



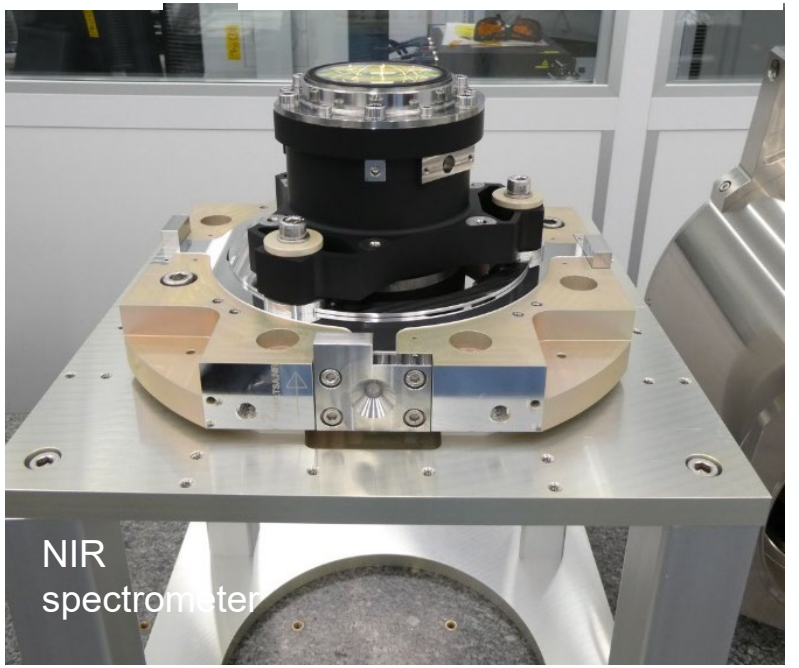
RUAG (AU) courtesy



Jena Optronik (DE) courtesy

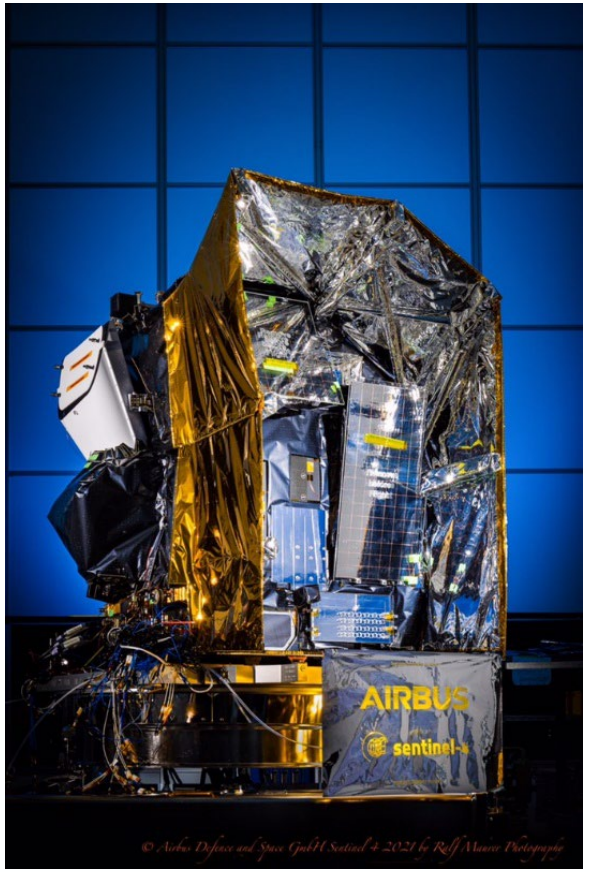


Jena Optronik (DE) courtesy

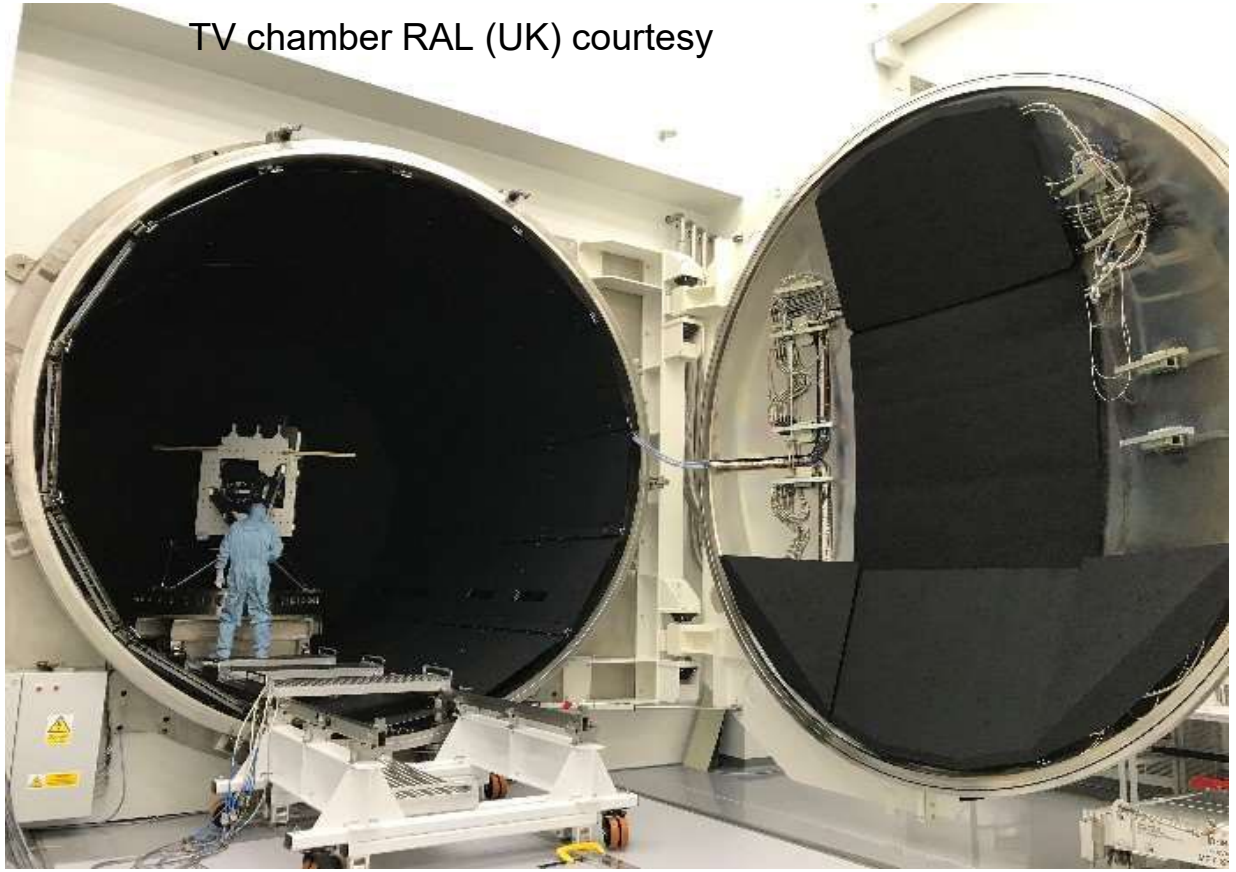


Jena Optronik (DE) courtesy

Sentinel-4 Proto Flight Model ready for On-ground Calibration and Characterization



TV chamber RAL (UK) courtesy



Copernicus Sentinel-4 Level-2

- Level-2 products cover atmospheric constituents that drive air quality
  - Trace gases: O_3 (tropospheric and total column), NO_2, HCHO, CHOCHO, SO_2
  - Aerosol optical depth, aerosol layer height, UV absorbing index
  - Auxiliary products for handling clouds and surface reflectance, facilitating synergy with FCI, ..

- Operational Processor (L2OP) developed by a consortium led by DLR under responsibility of ESA
  - Verified on synthetic data, testing on data from geostationary GEMS ongoing
  - Uncertainty budget established per product
  - V1 near completion (2 parts delivered, last one expected 3Q2022), V2 after PFM on-ground calibration, V3 after PFM in-orbit verification

- Will be integrated into MTG
  L2 Processing Facility (L2PF) by EUMETSAT

Approach to Calibration and Validation

- Sentinel-4 and Sentinel-5 Cal/Val Plan
  - Jointly prepared by ESA and EUMETSAT
  - Covers both Sentinel-4 and Sentinel-5
  - Formulates Cal/Val objectives and requirements
  - Sets frame for Announcement of Opportunity Call

- Announcement of Opportunity Call
  - Trigger & coordinate nationally funded Cal/Val activities, in particular campaigns
  - Jointly prepared by ESA and EUMETSAT
  - Released at ~1.5 years before launch
  - One combined Call for Sentinel-4 and Sentinel-5 (if launches are not too far apart)

- Level-2 Cal/Val Activities
  - Start once consolidated Level-1b becomes available
  - Bulk of activities after completion of Satellite In-Orbit Verification

Copernicus Sentinel-4 and Sentinel-5 Data

- Free, full, and open access
  - Copernicus Sentinel Data Policy & EU Regulations
- Processed up to Level-2 in EUMETSAT's MTG and EPS-SG ground segments
- Dissemination of Level-2 products in near real-time via EUMETCast
- Access to Level-1b and Level-2 products via EUMETSAT Data Centre
- Cloud-based access to data and processing tools
  - Copernicus Data and Information Access Services (DIAS)
  - Enable users to build applications and process large datasets easily

Copernicus Sentinel-4 and Sentinel-5 Data Users

Presentation A1.02.1
by A. Inness Mo 13:30

- Copernicus Atmosphere Monitoring Service (CAMS)
  - Monitor and forecast atmospheric composition
  - Provide input to local air quality services (e.g. mobile phone apps)
  - Monitor and forecast ozone and erythemal dose rates (UV index)
  - Support monitoring of compliance with European directives on air quality and emissions
  - Support policy makers to assess effectiveness of measures to reduce pollution
- Copernicus Climate Change Service (C3S)
  - Monitor WMO Essential Climate Variables: CH_4, O_3, aerosol, and precursors (NO_2, SO_2, HCHO, CO)
  - Detect and characterise ECV related emissions
  - Support policy makers to assess effectiveness of adaptation and mitigation measures
- Volcanic Ash Advisory Centres (VAAC)
  - support air traffic controllers
- Science community
  - Study the atmosphere: composition trends, patterns, events, processes, …
  - Improve atmospheric composition models
- … and more