Agenda

- EO Overview
- Earth Explorer
- Copernicus + Meteorological
- Small and Nano Sats
- Technology vision
- CMIN-22

Small satellite – and ESA EOP lines

Revisit time ⬇ | **Affordable Constellations** | **Miniaturisation**

Scout missions:

- demonstrate novel Earth Observation techniques in Earth science and related non-commercial applications (open data policy);

InCubed (Investing in Industrial Innovation) **Programme & missions**:

- to invest in European industrial competitiveness → commercial driven
- **co-funded scheme** with 3 clear procurement steps
- wide scope : development of (sat, ground system) and also end-to-end missions;

Φ-sat missions:

- to develop missions for fast demonstration of EO new technique
- to showcase innovative/disruptive technologies such as on-board AI
- Open data policy

Scouts

PB-EO decision (18-19 Feb 2021)
(after running 4 feasibility studies: 2 for implementation)

3 yrs development + Launch in 2024 + ≥ 1 year operation

Industrial ~ 25 M€
RfP issued

ESP-MACCS

3 x 12U Cubesats
Earth System processes

Instrument by RAL-Space

- RfQ released in March 2021
- KO: June-July

Industrial ~ 25 M€
In dialogue phase – April IPC

HydroGNSS

1 x 45 kg Sat with GNSS-R
Biomass, soil moisture, ice

SSTL technology

- 28-April IPC
- Release of RfQ – June 2021
- KO : Nov.2021

Two good examples of CEOI technology – adopted by ESA missions

Risk Retirement activities (only)
In dialogue phase → PP to June IPC

NanoMagSat

OpenCosmos P/F

3 x 16U Cubesat
Nano magnetic field

TANGO

2 x 16U Cubesat
Anthropogenic greenhouse

Scout round-2 : ITT soon enough to select before CMIN-22:

- TBD number for feasibility study
- Some of those for implementation - others continue maturation ?

Scouts for implementation– CEOI & ESA

ESP-MACCS

Earth System Processes Monitored in the Atmosphere by a Constellation of Cube Sats.

Understand processes in the Upper Troposphere and Stratosphere (UTS) – based on Sun Occultation

Three x 12U Cubesats with
3x HIROS (Heterodyne TIR Spectrometers)
+ HSDI (VIS NIR Hyperspectral Solar Disk Imager)

Instrument by RAL Space (UK)

HydroGNSS

GNSS-R to measure biomass, soil moisture and permafrost.
Also (as for TDS-1): sea wind speeds.

Novelties wrt TDS-1:
Dual Pol. + GPS/Galileo + dual freq. (L1/E1-L5/E5) + coherent channel.
45 kg SSTL-21 platform with upgraded GNSS-R FPGA receiver

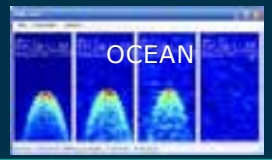
Technology from SSTL (UK)

Two good examples of synergy of CEOI technology pre-developments and adoption in ESA programmes

ESA also complemented TDS-1 (with SSTL and NOC) and to GNSS-R Science part

Courtesy of SSTL

TDS-1 PRIMARY : Ocean
→ **sea wind speed**
(incoherent reflection)



NOC (UK)

but, interesting findings: in **LAND** and **ICE**
(coherent → specular reflection)
➔ enabler of HydroGNSS

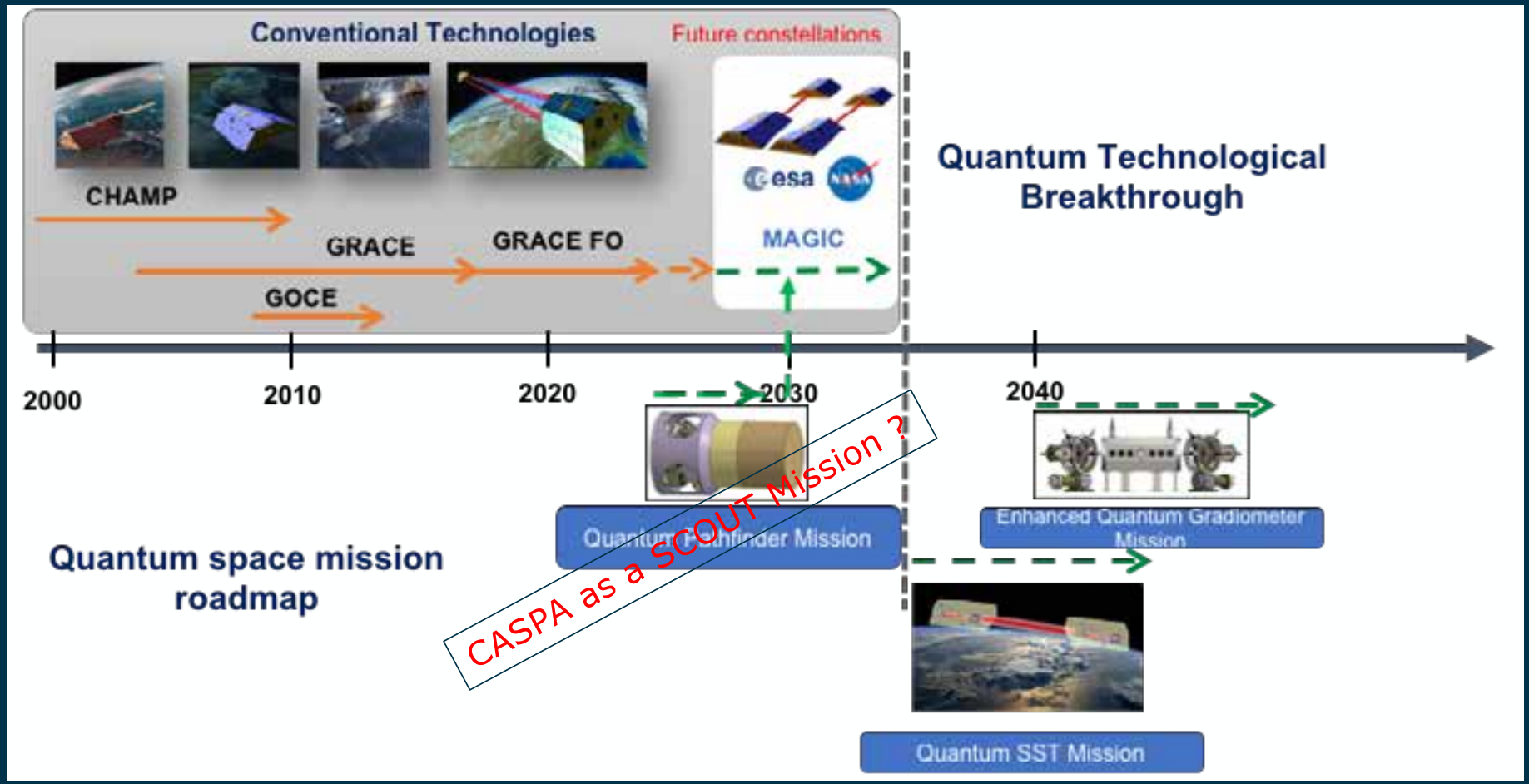
Many

HydroGNSS novelties wrt TDS-1:

- LAND – ICE primary + Ocean (as in TDS-1) secondary
- Very similar GNSS-R instrument as TDS-1 + additions
  - Dual Polarisation
  - GPS/Galileo
  - dual freq. (L1/E1-L5/E5)
  - Incoherent + 1-coherent channel.

Concepts for future missions: first outlook

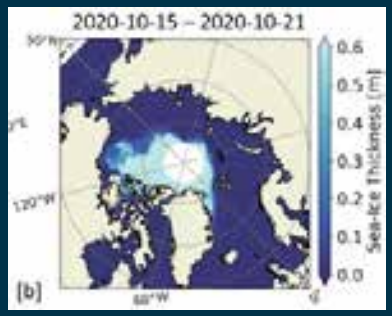
(as presented on 30th March to CEOI)



Phi-Sat-1 / 2 and …

UPC (ES), winner of **Copernicus Master Challenge**

- **FFSCAT Launched on 03-Sep-2020** with Vega PoC SSMS - VV16
- 2x 6U CubeSats: (also ISL RF and Optical)
  - Sat.A) with GNSS-R + L-band radiometer
  - Sat .B) with HyperScout-2 + AI-ML for Cloud Detection (**Φ-Sat-1 experiment**)



Sea ice thickness : www.mdpi.com/2072-4292/13/7/1366
Soil Moisture : www.mdpi.com/2072-4292/13/5/994
www.mdpi.com/2072-4292/13/1/121
ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9044708

Φ-sat-2: 4m feasibility + 12 m development → launch 2022 + 1 yr ops

- 16 proposals were evaluated (2.74 M€ budget)
- **Open Cosmos (UK) winner**, with partners - KO done (Feb. 2021)
  - See presentation on AI-techniques on 21-April

Φ-sat-3 : Call and selection before CMIN-2022

Φ-week
11-15 Oct. 2021
https://philab.phi.esa.int/%cf%86-week-2021-save-the-date/

InCubed– Ongoing upstream activities

mantis

Mission and Agile Nanosatellite for Terrestrial Imagery Services

Led by
Open Cosmos
+ Satlantis

Specific focus on energy sector
3m GSD (SR)

12U Cubesat with
VIS-NIR Push broom Multispectral 4 bands Dual Telescope - Onboard Super Resolution and Cloud Detection

incubed.phi.esa.int/portfolio/mantis

SAT4EO

Led by
Deimos + SSTL
+ E2VTeledyne

AOCS and Instrument for
Very High Resolution imagery from state of the art small satellite platform

Detector mostly developed under CEOI

VHR System, 0.6 m native GSD with Super Resolution capabilities (0.3 m), Enhanced AOCS

100-200 Kg S/C AOCS Suite – Compact VIS-NIR VHR Telescope (new Sensor Development) – Dedicated Exploitation Platform

incubed.phi.esa.int/portfolio/sat4eoce/

Others coming: e.g. Hyperfield with Reaktor (FI)

Agenda

- Earth Explorer
- Copernicus
- Meteorological
- Small and Nano Sats
- ESA EOP Technology vision
- CMIN-22

EO Technology vision : It is part of ESA's Technology Strategy

Higher performance / cost ratio

- **New Measurements/instruments** (enabler)
  - **Higher spatial, temporal, radiometric** resolution
- Lower recurring cost
  - **Platform Standardisation** & multi source suppliers
  - **Spin-in** techno: e.g. COTS ; Lifetime & flexibility (FPGAs)
- **Big Data** (AI enabler) & Data continuity

Miniaturisation and constellations

- More **autonomous** platform & operations & synchronisation
- **Distributed** Ground Segment

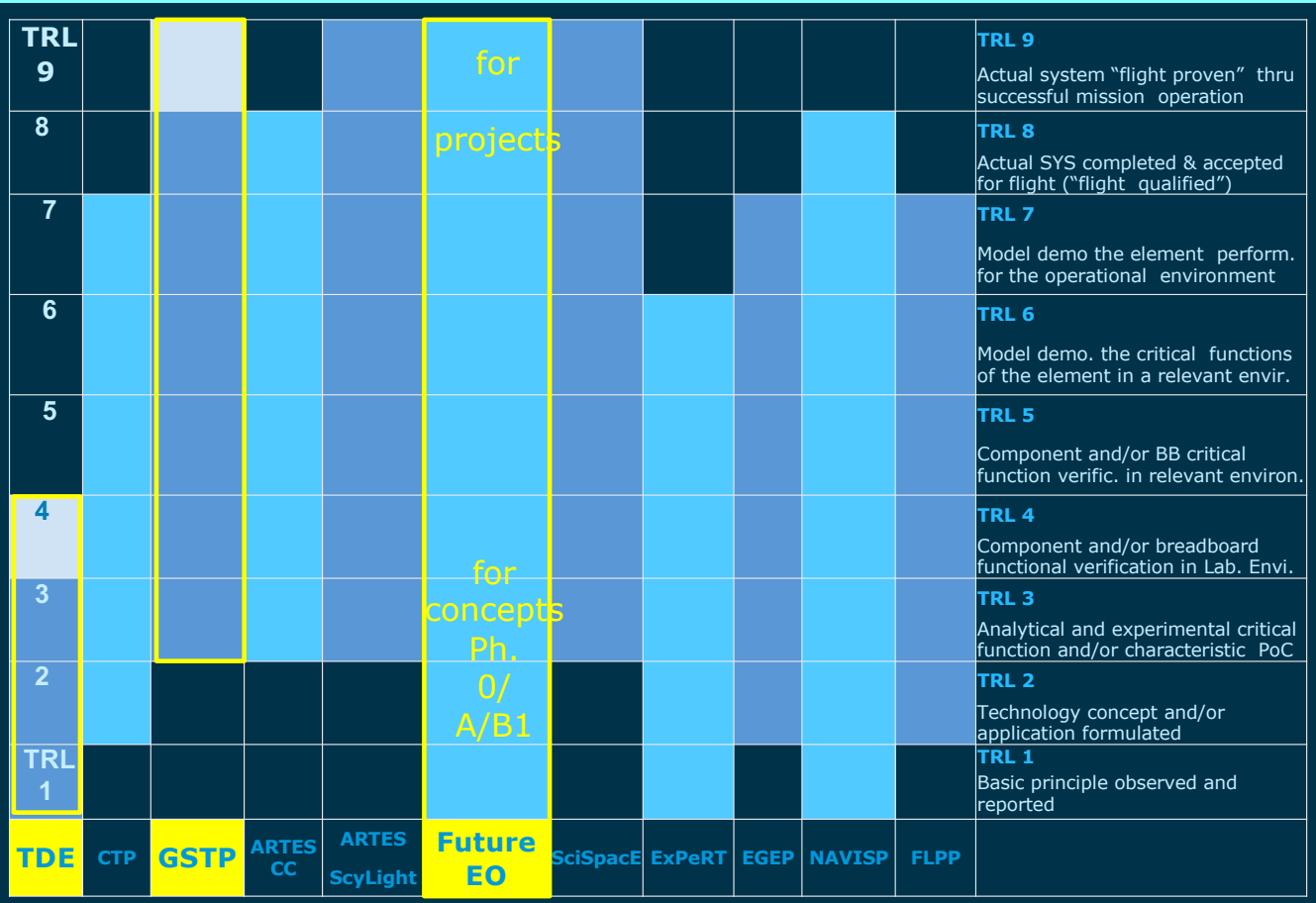
Not limited to LEO: also HEO & GEO orbits relevant for EO.

EOP in ESA TECHNOLOGY PROGRAMME LANDSCAPE

EOP Technology under 3 programmes:

- **TDE** (former TRP): up to TRL 3-4
- **GSTP** : higher TRLs
- **EOEP/FutureEO** : all TRLs

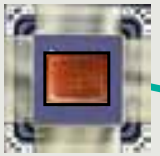
EOEP : Earth Observation **Envelope** Programme



Successful model

Advanced GPS-Galileo ASIC (AGGA-4)

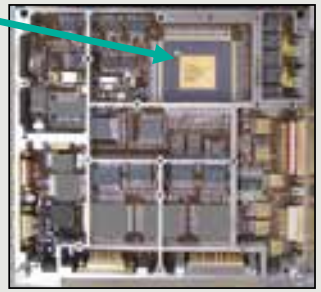
EOEP funding → **ASIC** (**enabler**)



*by **Airbus, ATMEL, RUAG***

(~6 Million gates with 180 nm process)

GSTP funding → **GNSS Receivers**



Many Programs adopting AGGA-4:

- MetOp-SG (P/F & RO inst.), S1c/d, S2c/d, S3c/d, **S6**, Proba-3, Neosat, Biomass, Flex, LSTM, CRISTAL, CO2M, …
- CSO, SARah, + Comp.Adv Sat. 500 (S Korea), **Mohammed VI**
- Vega-C

26 GHz (K-band)data downlink (up to 10 Gb/s)

- **EOEP** funding **System studies** (**enabler**)
- **EOEP, GSTP, TRP, ARTES,** for development for **OB / OG** Antennas, OB Tx / OG Rx), Propagation, …

Tesat

Gbit/s Transmitter

Konsberg

Antenna

20 cm

Programs adopting the 26 GHz band:

- MetOp-SG, MTG, EDRS, Euclid ➔ HPCM Sentinels
- military (not disclosed)