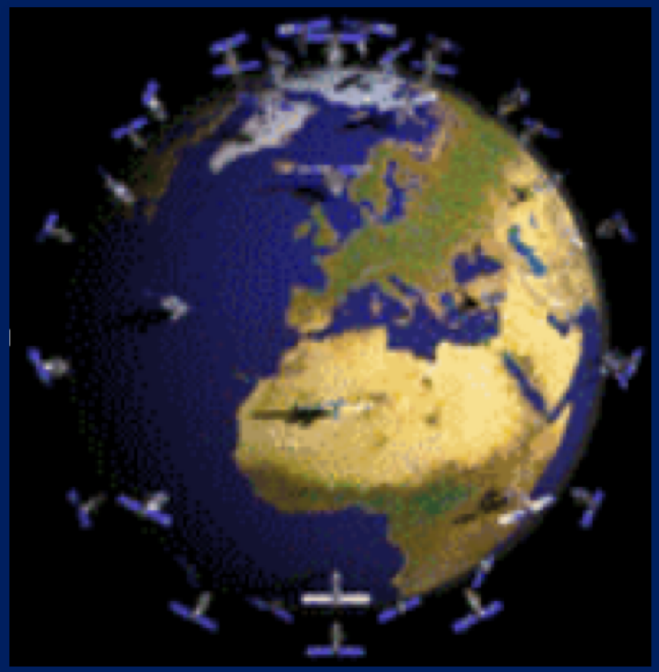
Agenzia Spaziale Italiana

The HERMES Pathfinder mission: ASI programme overview

Simonetta Puccetti



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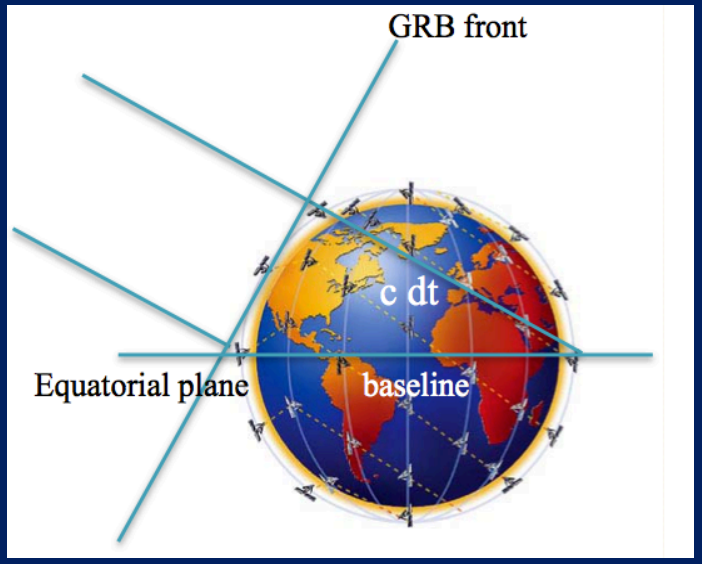
HERMES-SP/TP 1ST SCIENTIFIC WORKSHOP 18-19 NOV 2020

Mission Concept by L.Burderi and F. Fiore

HERMES will be an all-sky monitor to catch bright high-energy transients (e.g., Gamma-Ray Bursts possible counterpart of GWs), composed of a constellation of hundreds of nanosatellites spatially distributed in low Earth orbits and hosting X-ray detectors operating in a very broad energy band, from a few keV to a few hundred keV.



HERMES will allow accurate localization of Gamma-Ray Bursts by the measurement of the delays between GRB signal arrival times on at least 3 satellites

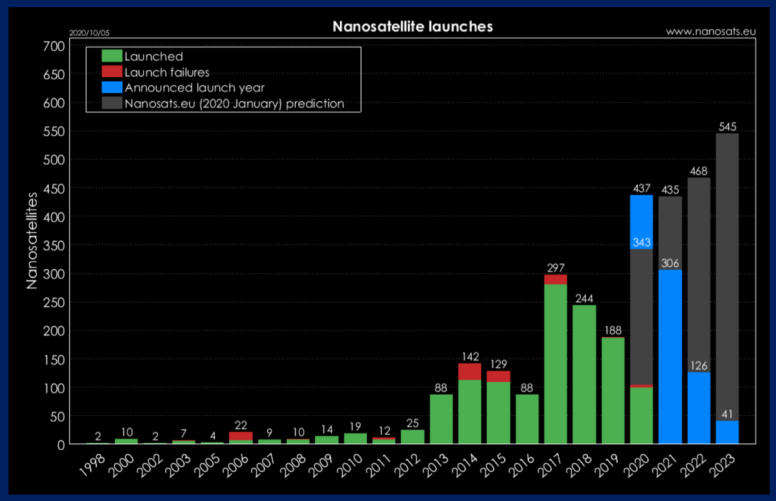
HERMES main science:

- Prompt localization of counterparts of GW and neutrino events
- GRB fine temporal structure ⇒ GRB inner engine physics
- Test quantum space-time scenarios by measuring the delay time between GRB photons of different energy (see e.g., Amelino-Camelia + 1998, Amelino-Camelia et al. 2013)

Astronomy with cubesats: the new frontier

Cubesat using COTS have limited costs , quick development (few years to be compared with > 10 years for traditional telescopes) and modularity.

The global space economy is growing rapidly in the area of small satellites, including large constellations, of low-cost but high-performance spacecrafts.



Cubesat for science (astronomy, planetology,….)

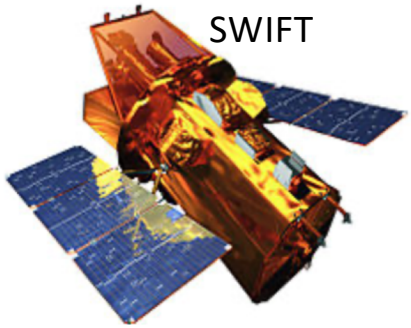
- Hermes
- Argomoon
- Liciacube
- Astrobio
- Burstcube
- Glowbug
- BlackCAT
- Camelot
- Compol
- Sharjah-Sat-1
- CubeSpec
- Skyhopper
- …….
- ….

Cubesats can be complementary to the traditional telescopes for specific scientific targets.

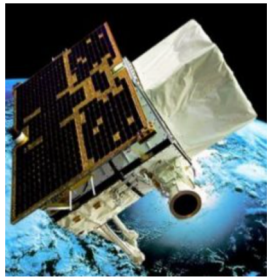
Why HERMES in the 20's?

Since 2002:

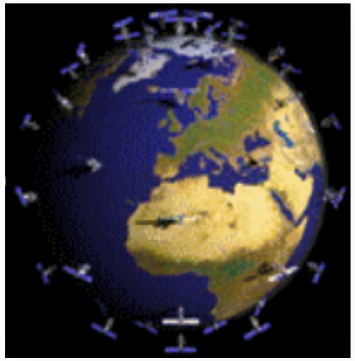

FERMI


SWIFT


INTEGRAL

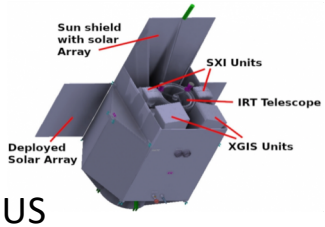

AGILE

In the 20's:
HERMES GRB all sky monitor =>

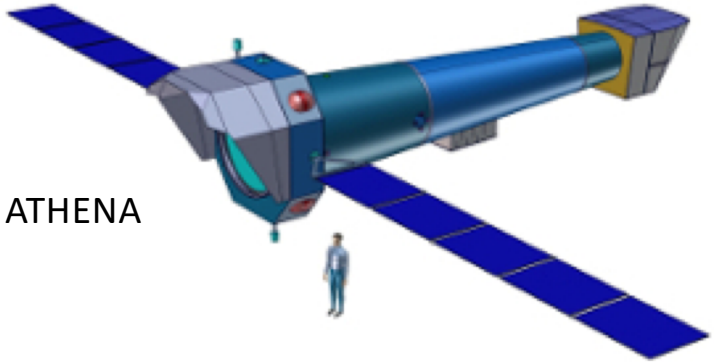


1 HERMES module:
3U cubesat (1U payload)
Field of View: 2 steradians
Energy band: 2 keV – 20 MeV
Energy resolution: 15% at 30 keV
effective area 50-60 cm^2

Launch > 2032



THESEUS


ATHENA

…….
……
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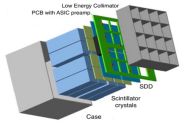
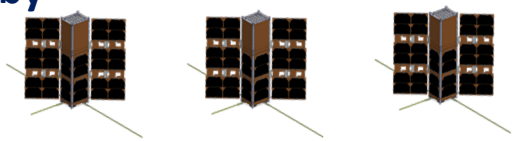
HERMES PATHFINDER:

and many others....

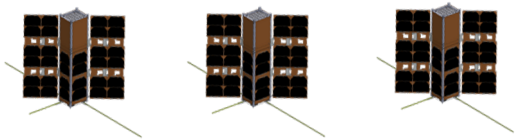
- **HERMES 2014 R&D proposal to ASI PI L. Burderi**:
  - ➢first development of the detector



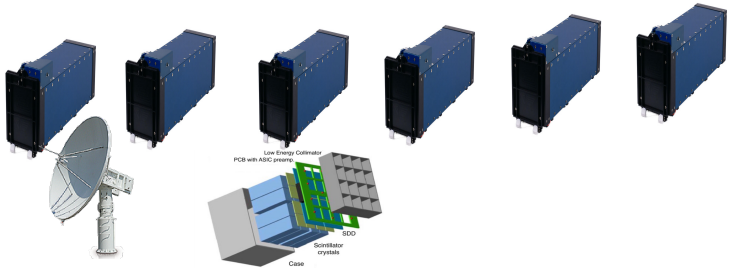
- **HERMES Technology Pathfinder (HTP): grant 2015 'premiale' MIUR lead by ASI**
  - ➢Agreement ASI-INAF: 3 unit payload
  - ➢Agreement ASI-PoliMI: 3 unit service module



- **HERMES Scientific Pathfinder (HSP): grant UE – H2020 lead by F.Fiore**
  - ➢Consortium INAF-PoliMI-others: 3 unit payload + 3 unit service module+ design MOC and SOC



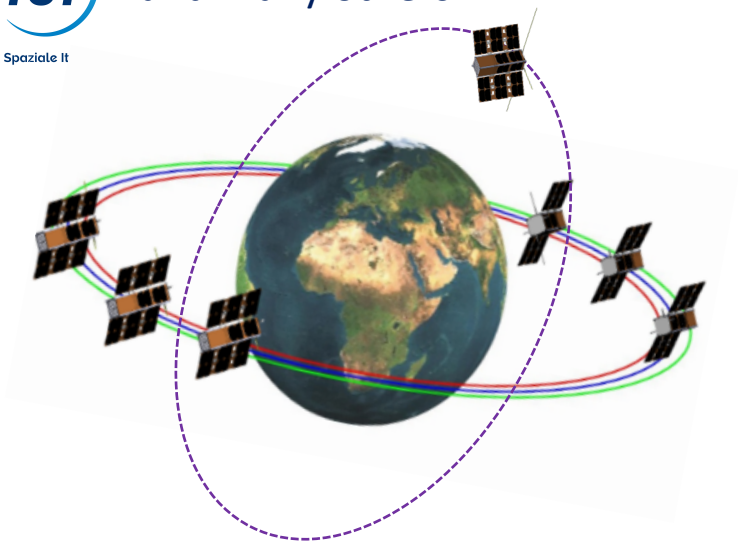
- **HERMES Advanced Scientific Pathfinder (HASP): grant 2018 'premiale' ASI**
  - ➢Agreements ASI-INAF and ASI-PoliMI:
    - ✓ 1 unit payload (on board payload+antenna+transponder of SC SPIRIT (ASA))
    - ✓ 6 dispenser
    - ✓1 antenna to be installed at the BSC in Malindi
    - ✓Ground Segment



- **Launch in charge of ASI**: **2022**

HERMES PATHFINDER:

and many others....



HERMES TP+SP: 6 modules

- Nominal orbital parameters:

Orbit Type	Equatorial circular
Altitude*	500 ÷ 550 km LEO
Orbital Inclination*	0 ÷ 20 degrees
Orbital Period*	~ 1,5 hour

- Satellite envelope: 3U standard
- **No propulsion** →
- Mission lifetime: 2+ years

HERMES evaluates accurate GRB sky positions applying triangulation method=> The lack of propulsion requires a dedicated mission analysis to optimize the area simultaneously covered by at least 3 satellites minimizing the maneuvers.

SPIRIT (see M. Trenti's talk)

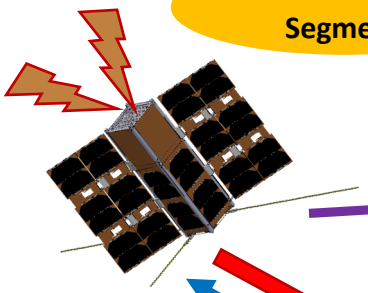
- 1 payload HERMES on board
- LEO, SSO orbit
- Launch date 2022

→

- Test of the payload in non equatorial orbit
- Improvement of the localization sensitivity thanks to satellites in different orbital planes.

HERMES Pathfinder Architecture

(Operations Concept)



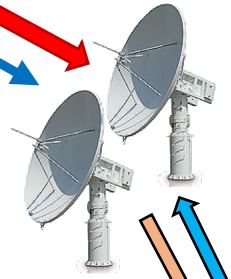
HERMES Flight Segment

Scientific TRIGGER

IRIDIUM costellation

Science Data & TM

TC/TM & Backup Science



GS Network (Kenya-Australia)

HERMES MOC in Italy

Science Data & TM

TC

HERMES SOC located at the ASI SPACE SCIENCE DATA CENTER (SSDC)

Science Operations concept:

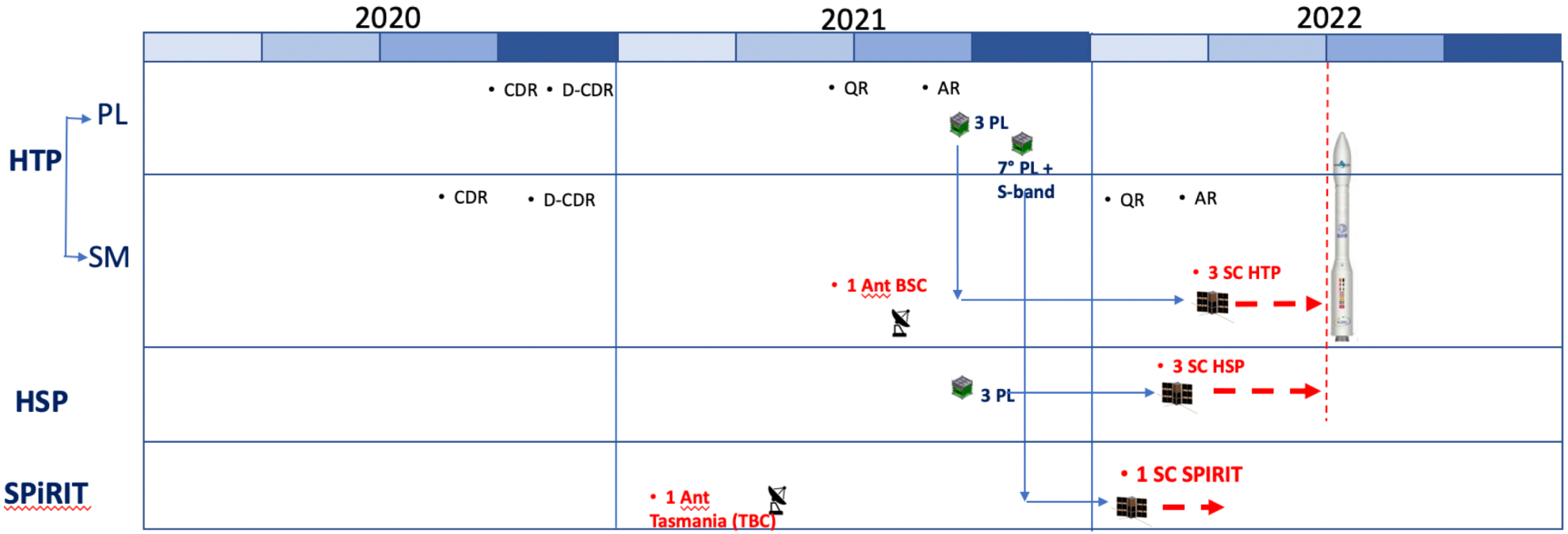
- Continuous **acquisition of deep space background** is performed by each satellite and downloaded periodically to GS.
- In case of **GRB detection** a TRIGGER (allarm + GRB raw location) is immediately sent to SOC through the IRIDIUM network (max delay < 30 min)

HERMES PATHFINDER

and many others....

ASI strategy:

- standard procedures used for traditional telescopes => reduced risk
- standard milestone reviews: CDR of the service module closed in November, CDR of the payload near to be closed.
- 2022: 6 flight modules HERMES + 1 payload HERMES-SPIRIT ready for launch



HERMES PATHFINDER: perspectives

The pathfinder will prove the **feasibility** of the experiment and the on-flight data/telemetry will allow to **optimize** the future HERMES constellation made up of hundreds of nanosatellites.

We expect:

- hardware improvement (payload and service module)
- on board software optimizzation (e.g., trigger algorithm)
- background characterization
- study of possible systematic effects (e.g., on the position reconstruction)
- ……

but also:

GRB detections, localization, time variability analysis… → **science!**