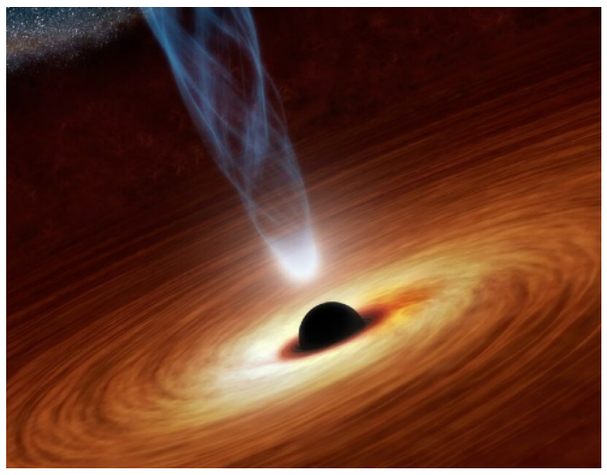
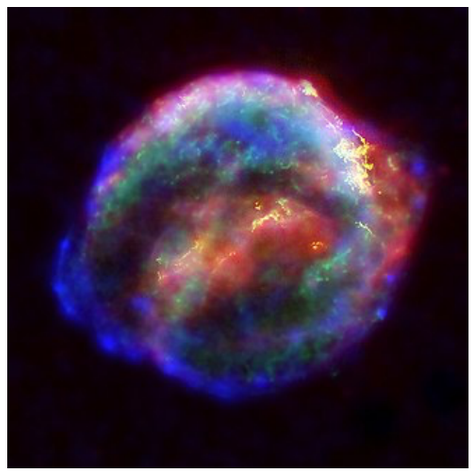
High Energy Astrophysics

Group coordinator: A. Coleiro
(alexis.coleiro@u-paris.fr)

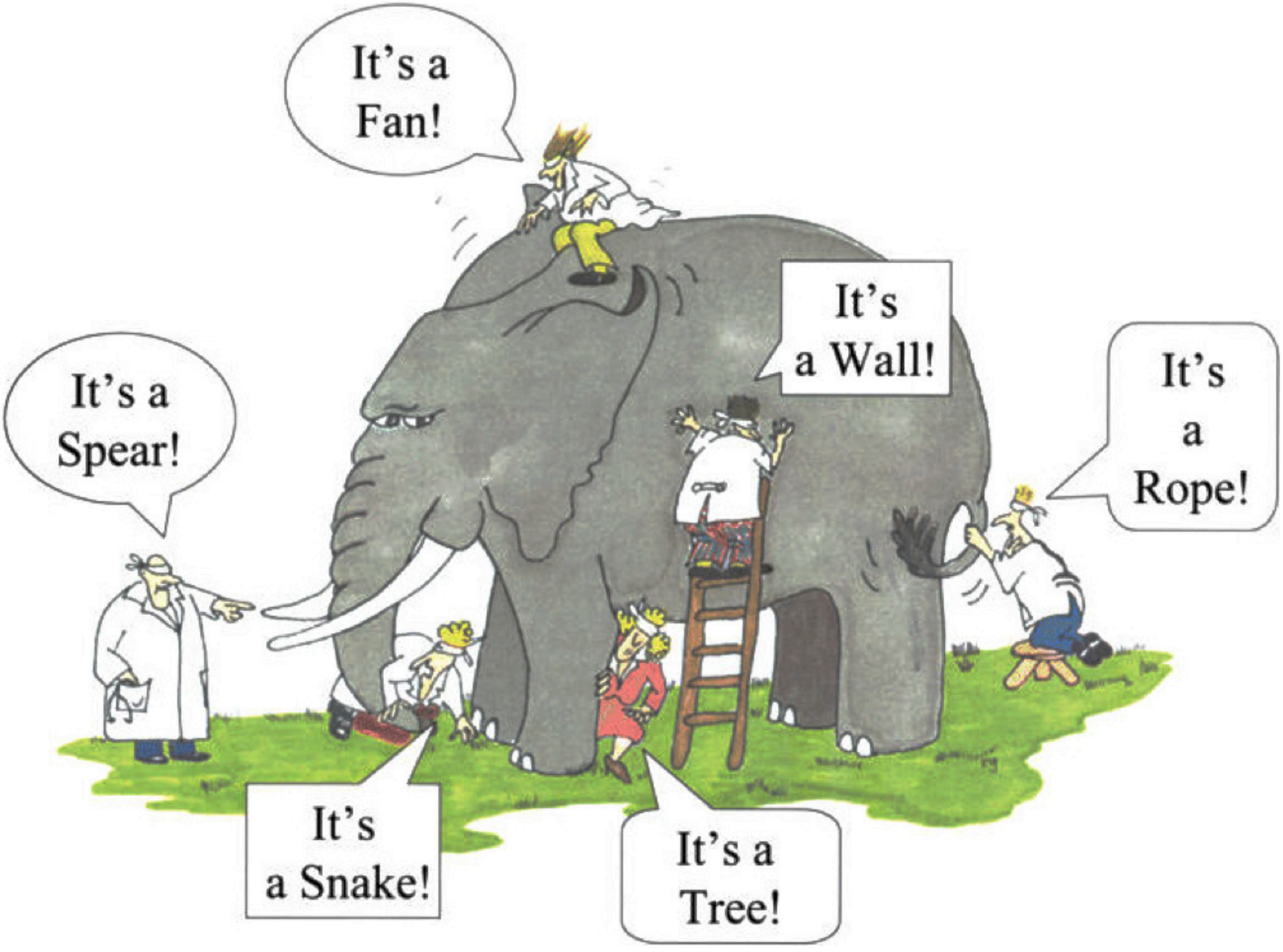
Study the high energy phenomena at play in the Universe:

- accretion and ejection processes;
- particle acceleration mechanisms;
- origin and mechanism of transient phenomena;
- nature and origin of ultra high energy cosmic ray particles

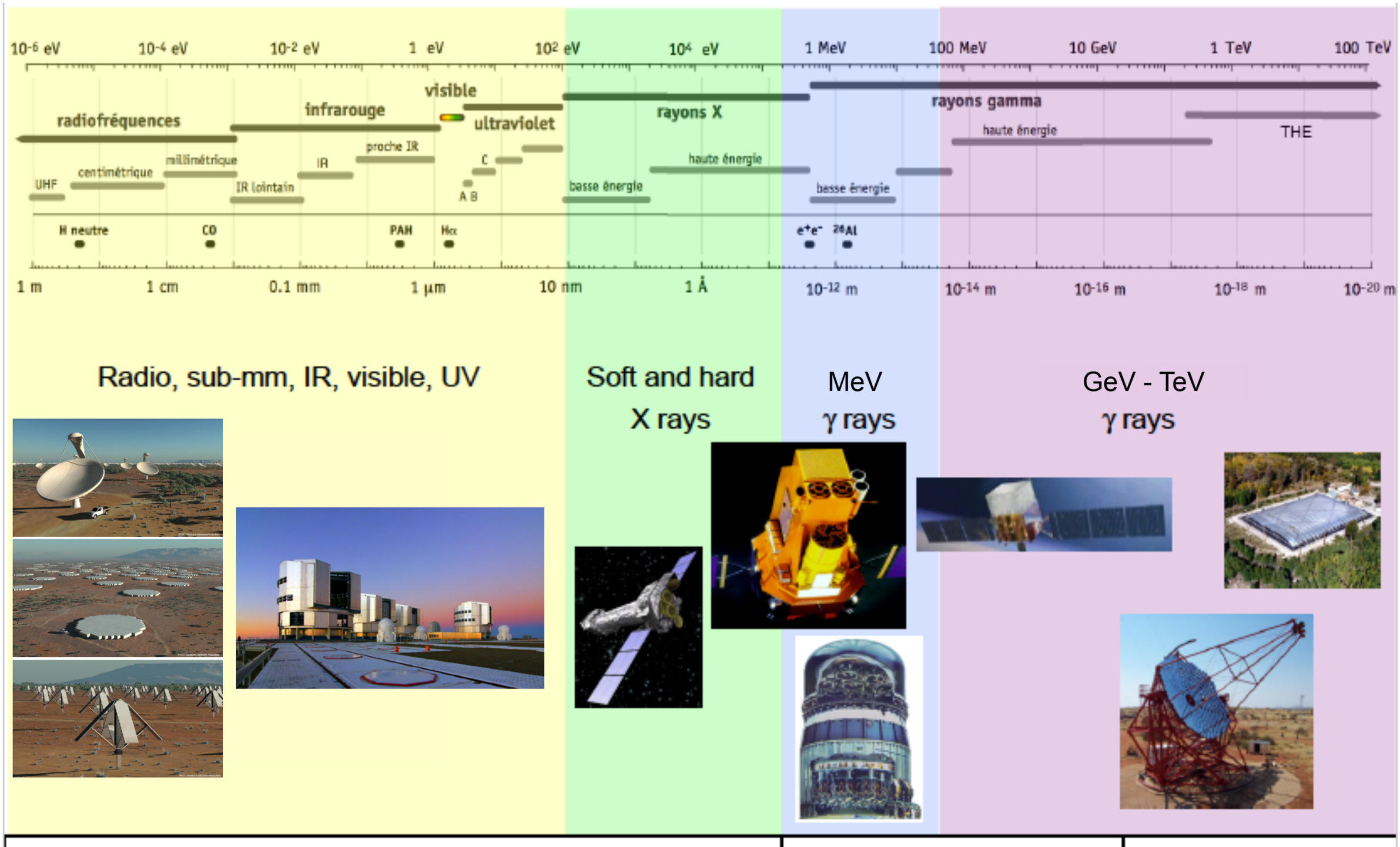
Multi-messenger / multi-wavelength approaches
Theory / phenomenology / Numerical simulations

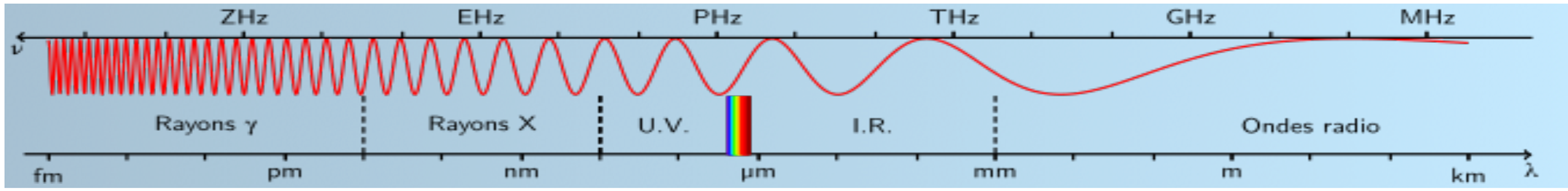



It's a Fan!
It's a Spear!
It's a Wall!
It's a Rope!
It's a Snake!
It's a Tree!

Multi-wavelength astronomy



Multi-messenger astronomy



Cosmic rays

Neutrinos

Gravitational waves

t

1600 1700 1800 1900 2000

Who we are and what do we do

25 researchers (11 CNRS, 12 Univ. Paris Cité, 3 CEA), 3 (7) postdocs, 9 PhD students

We currently run/participate to 10 projects:

- Underwater neutrino telescopes
  - ANTARES
  - KM3NeT
- Ground based gamma ray telescopes
  - HESS
  - CTA
- Space borne telescopes
  - Cosmic rays —> JEM EUSO
  - Photons —> Athena, Integral, SVOM, (CATCH, THESEUS, …)
  - Educational nano sat —> IGOSAT
- …and we do theory/phenomenology/simulations

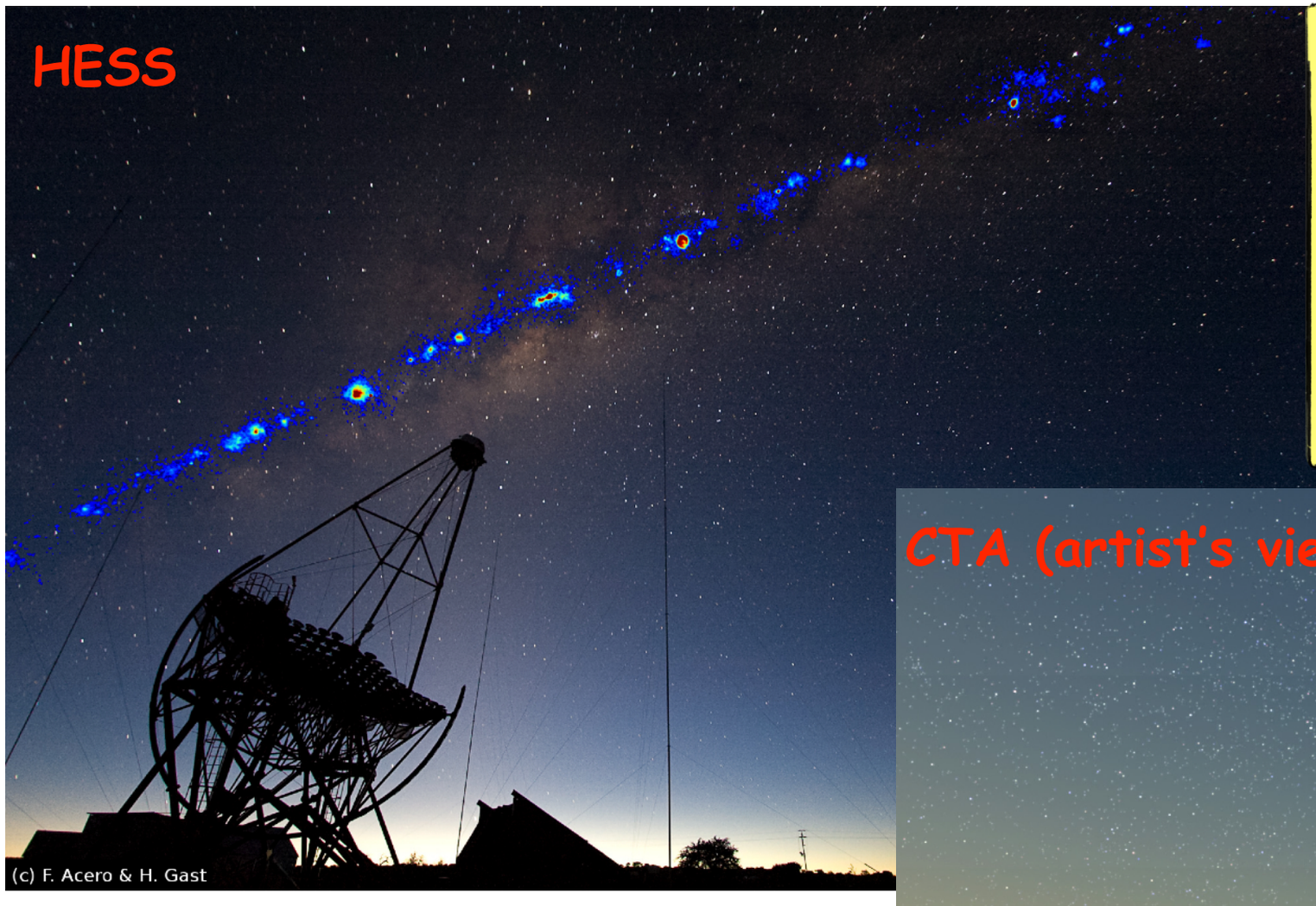
Ground based instruments



19 team members

2 projects

Ground based instruments: the HESS/CTA team



Exploring the very-high-energy gamma-ray sky (E > GeV) (understand particle acceleration)

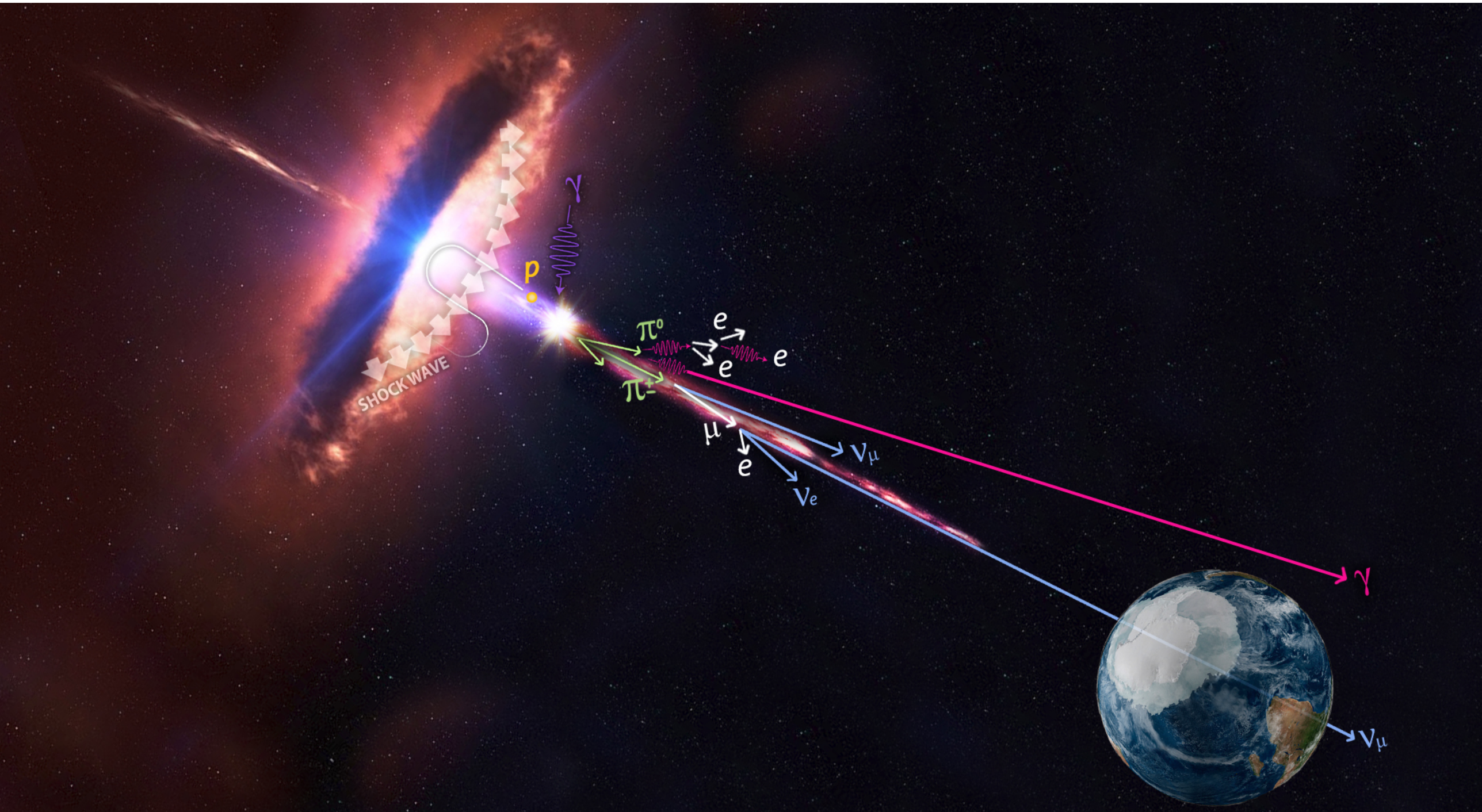


15 team members
2 projects

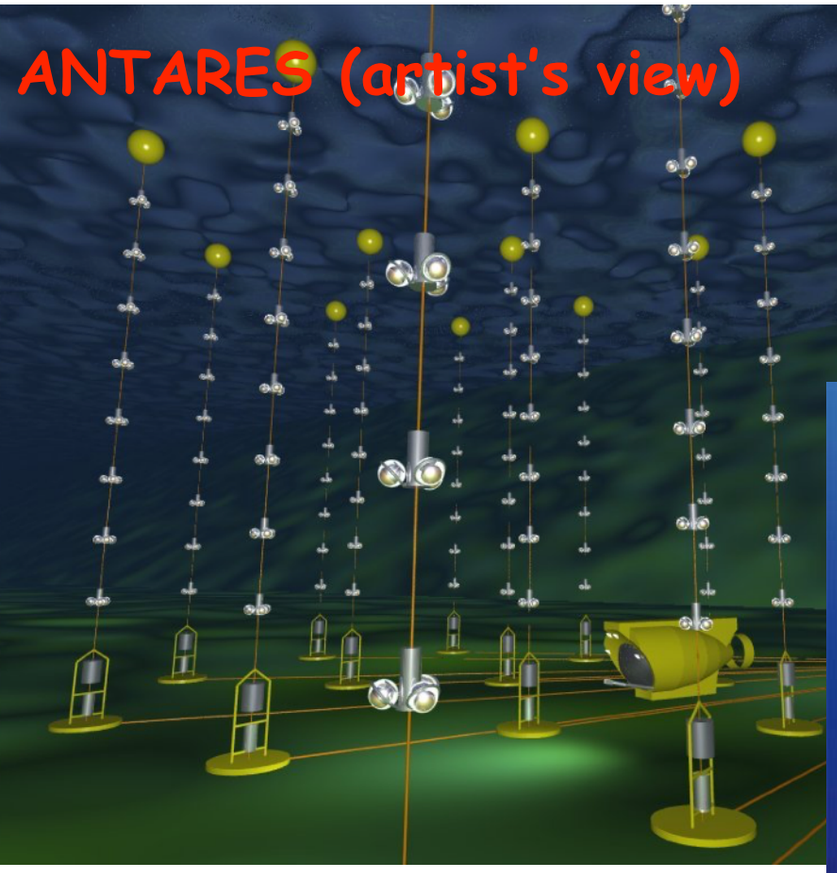


Underwater instruments

Underwater instruments: the ANTARES/KM3NeT team

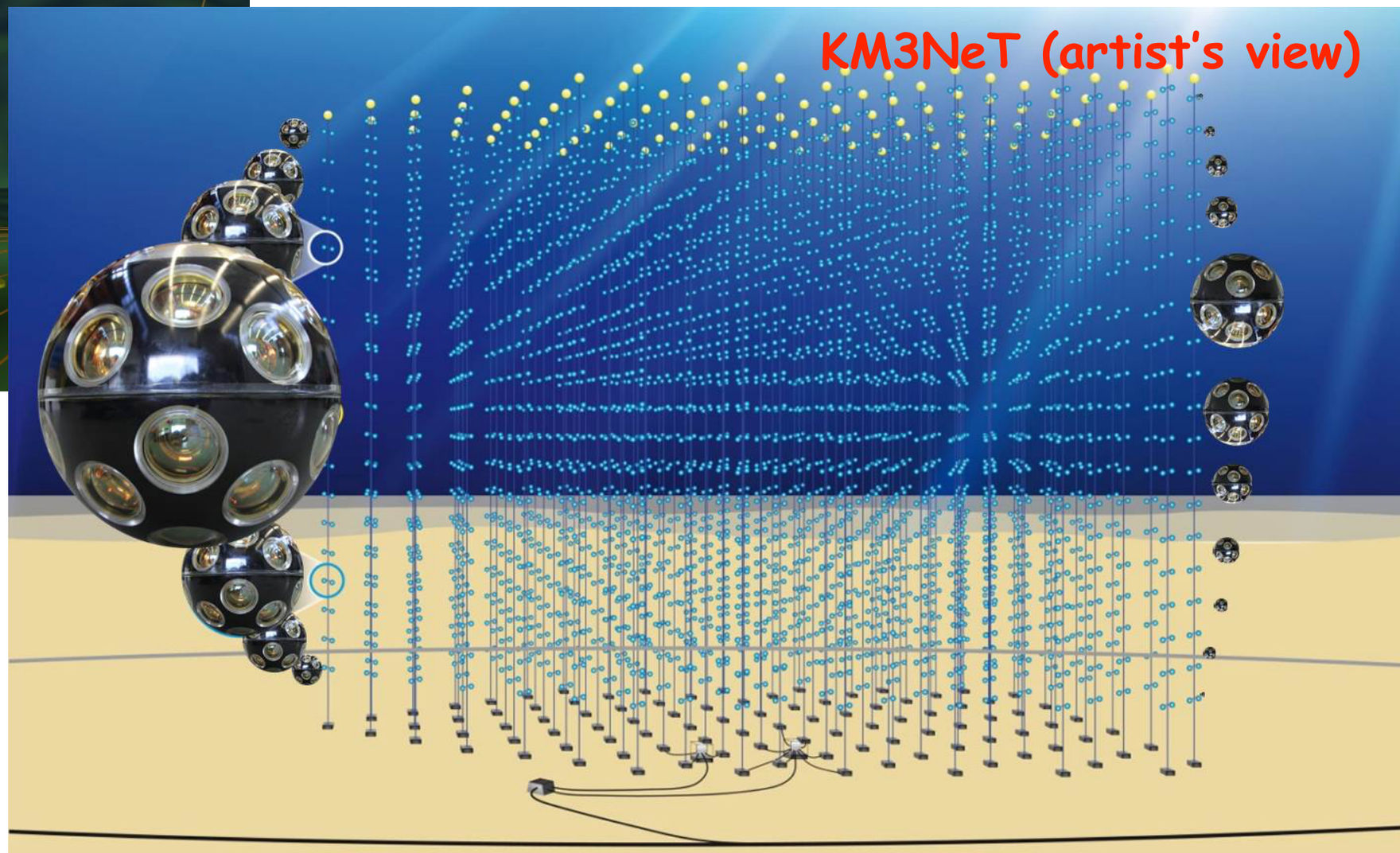


Underwater instruments: the ANTARES/KM3NeT team



Searching for very-high-energy astrophysical neutrinos

⇒ understand the origin of high-energy cosmic rays





Space borne instruments

Space borne instruments

Six space projects:

- Educational nano sat
  - IGOSAT
- Cosmic ray studies
  - JEM-EUSO
- Photon detectors
  - INTEGRAL (the past…)
  - SVOM (…the present…)
  - CATCH (future)
  - THESEUS (future)
  - ATHENA (future…)

Cosmic ray observations from space: JEM EUSO

Detection of the highest energy cosmic rays (>10^{19} eV)

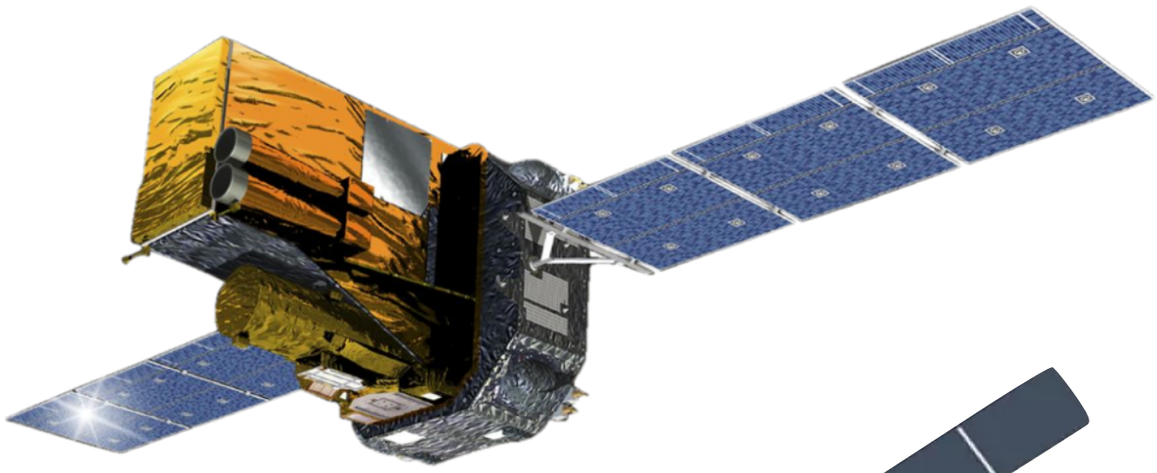


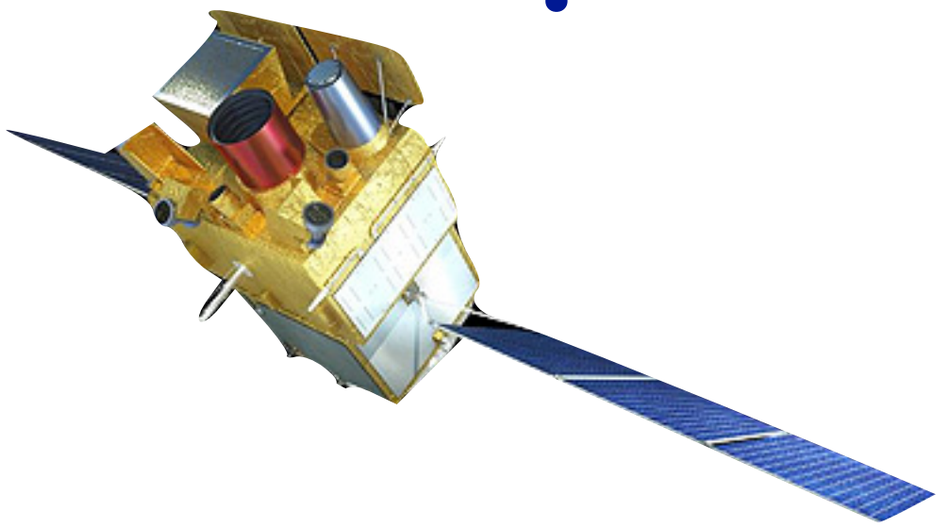
HIGHLIGHTS

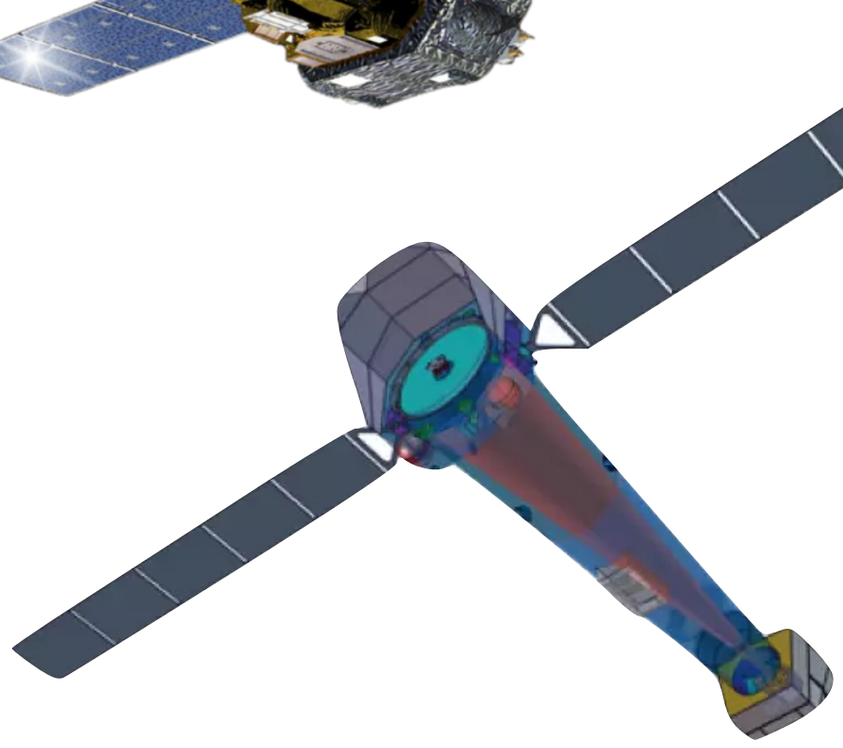
MINI-EUSO on the ISS since 2019 and operative since then.

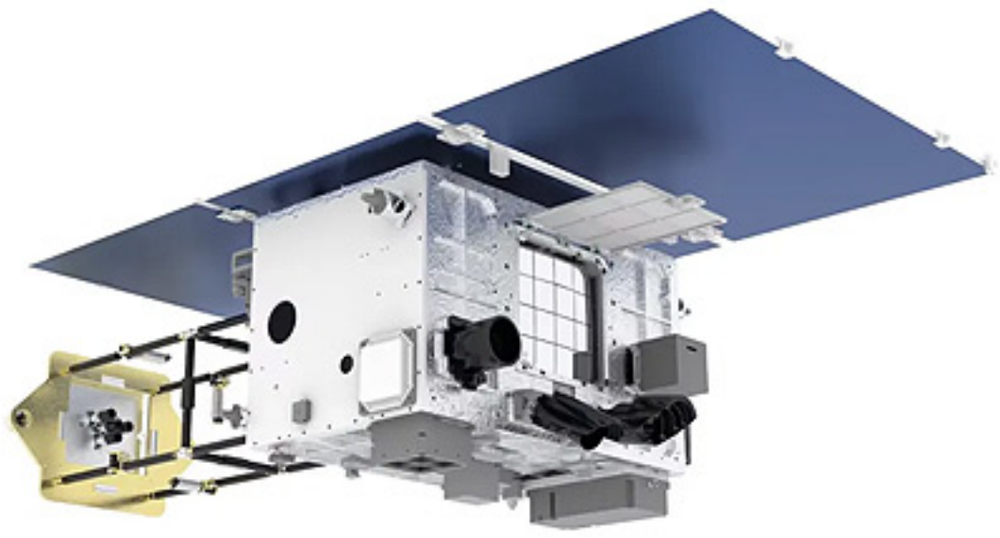
- PI/Spokesperson @APC
- WP leadership
  - Detection Units (Elementary Cells - ECs)
  - Calibration focal surface
- Technical activities
  - Integration of the focal plane from EUSO-SPB2 (NASA long duration balloon flight in 2023)
  - ECs used for EUSO-SPB2 and will be used for POEMMA (NASA)

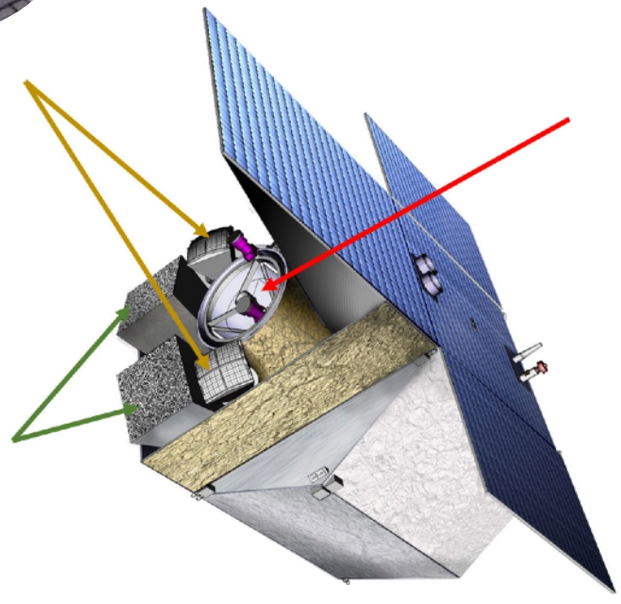
Space-based telescopes







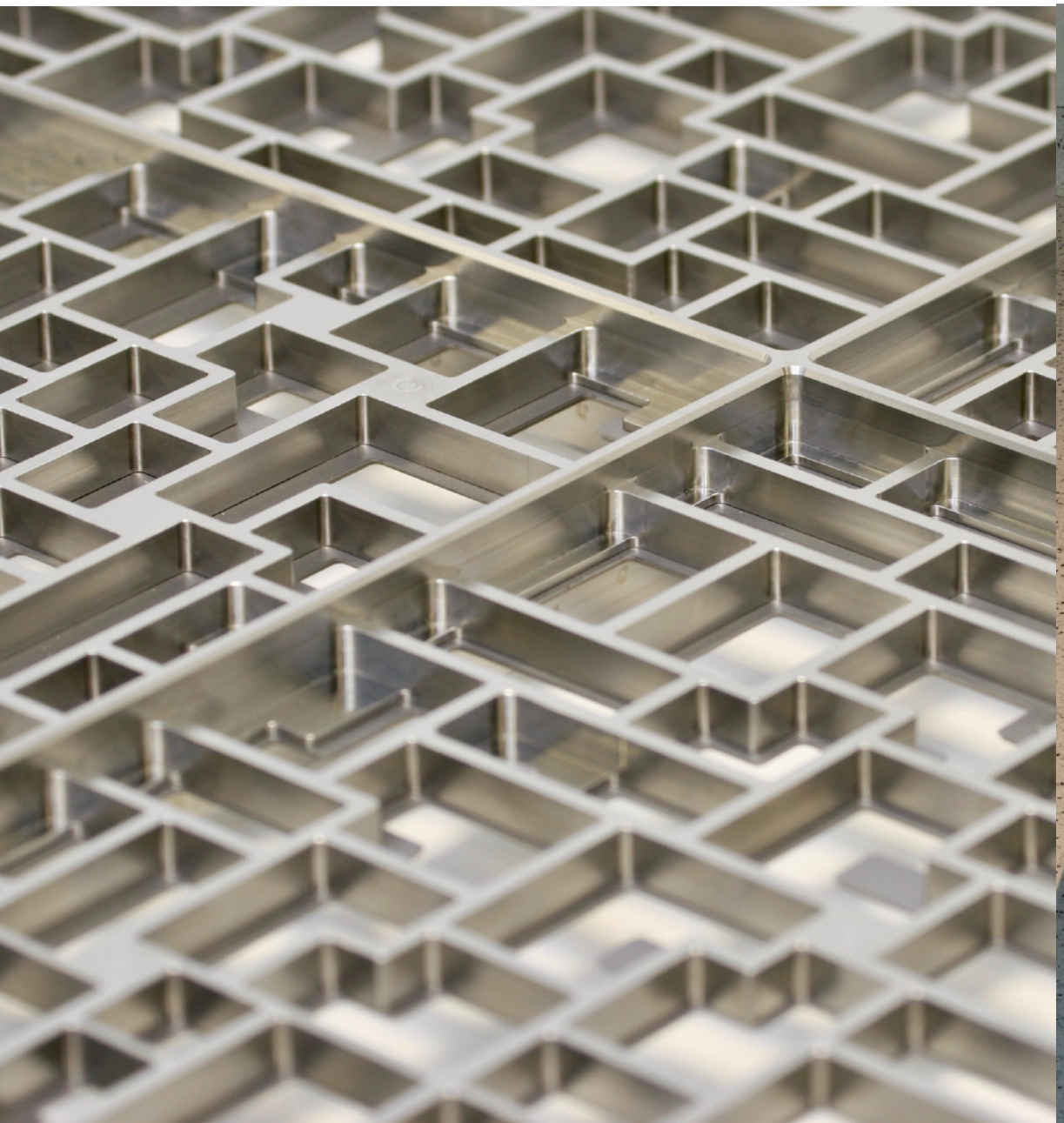


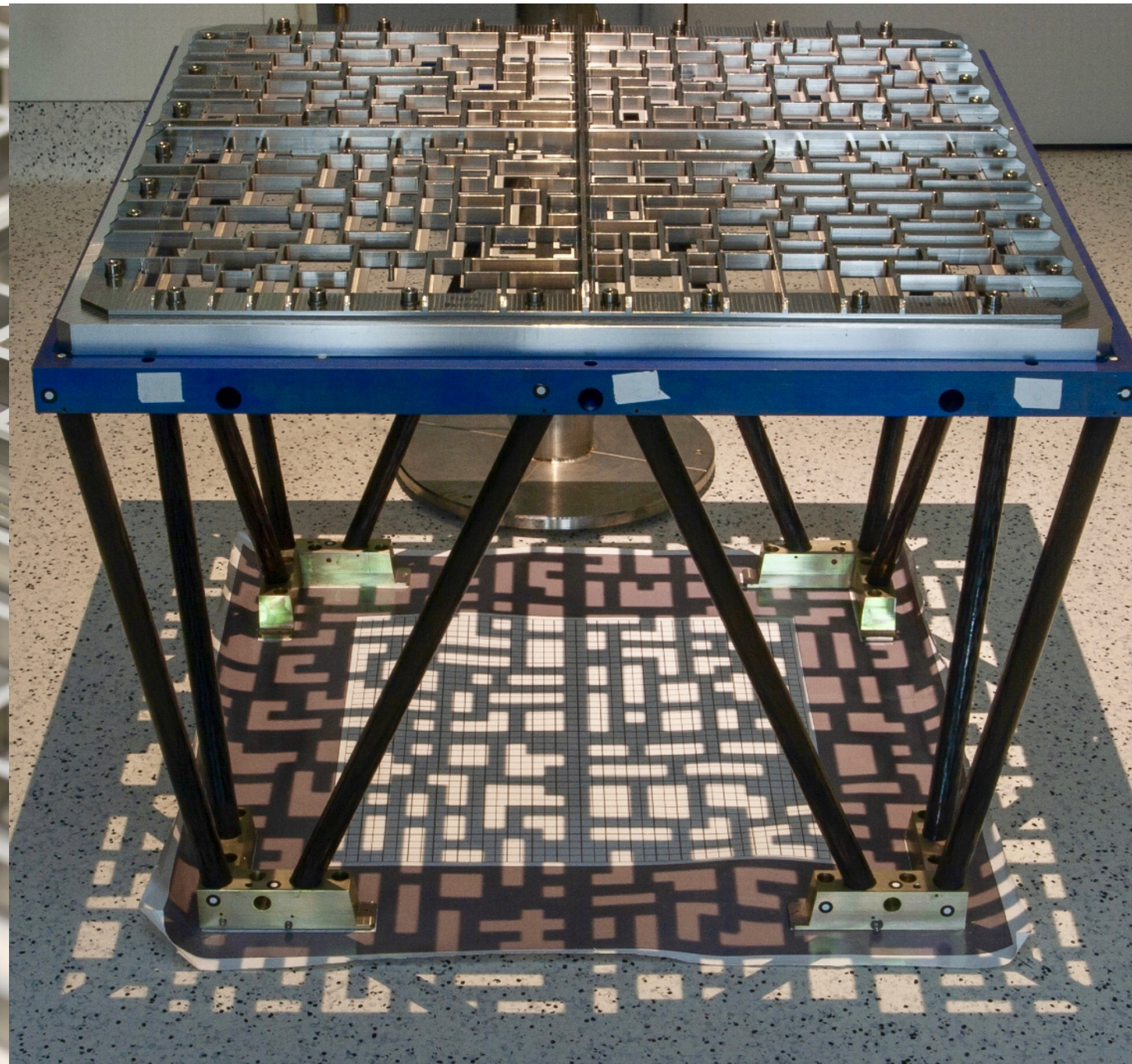


Space borne instruments highlight: SVOM coded mask delivered

ECLAIRs — main wide field of view instrument onboard SVOM

Hard x-rays (4 – 150 keV) —> first **self supporting coded mask** to be sent in space





Multiwavelength observations

HIGHLIGHTS

Main lines of research:

- X-ray and multi-wavelength observation of the Galactic centre
- Studies of binary systems/compact objects
- Multi-wavelength study of SNRs/PWNae



Theory, simulations…



8 team members

4 main lines of research

Theory, phenomenology, simulations…

HIGHLIGHTS

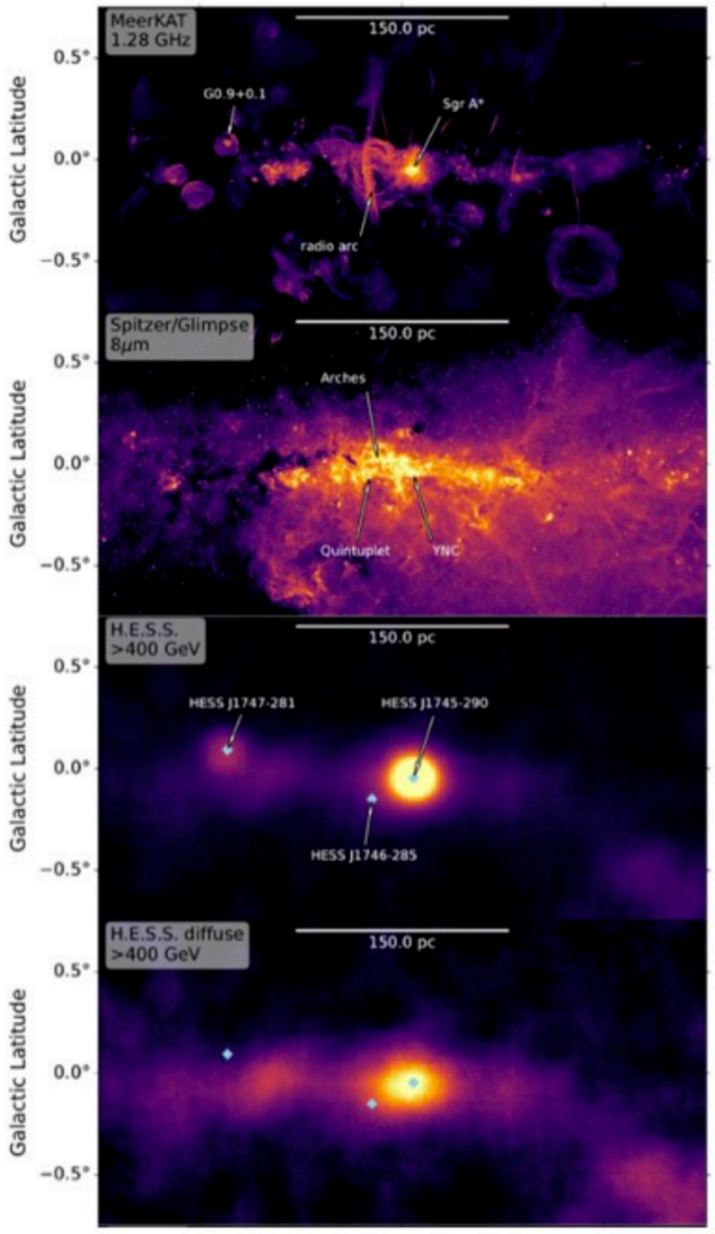
Research activities in:

- Galactic cosmic rays
- Ultra High Energy Cosmic Rays
- AGNs modelling
- Numerical simulations

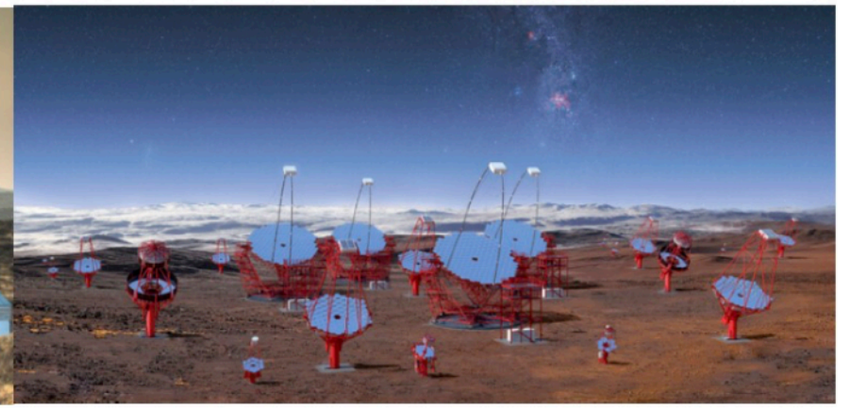
Internship Opportunity (M2)

Régis TERRIER : rterrier@apc.in2p3.fr
Anne LEMIERE : alemiere@apc.in2p3.fr

Three-dimensional Modelling of the Galactic Centre: From molecular gas to gamma-ray emission, Constraints from H.E.S.S. and Prospects for CTAO







SCIENTIFIC CONTEXT

Diffuse gamma-ray emission observed by H.E.S.S. probes cosmic-ray interactions with the dense molecular gas of the Galactic Centre. Its interpretation remains limited by uncertainties in the 3D distribution of the gas.

INTERNSHIP OBJECTIVES

- **Modelling: Build a 3D molecular gas distribution in the Central Molecular Zone (CMZ).**
- **Data analysis: Model gamma-ray emission for different cosmic-ray scenarios and constrain them using H.E.S.S. observations with Python and Gammapy.**
- **CTAO prospects: Simulate future observations to assess their potential to constrain the 3D location of molecular clouds and cosmic-ray propagation.**

High-Energy Neutrino–Blazar Associations using modern Machine Learning approaches

Pourvu: Non

Formations

Stage

Niveau demandé

M2

Year

2026

Services/Groupes

Astrophysique à Haute Energie

Responsable

Yvonne Becherini

Email du responsable

yvonne.becherini@apc.in2p3.fr