

Pollux: a European instrument concept for the Habitable Worlds Observatory



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Instrument Scientist : Luca Fossati (IWF)

What is Pollux?

Pollux is a candidate European instrumental contribution to HWO. It is a high-resolution spectrograph ($R > 70,000$) with polarimetric capabilities offering **continuous & simultaneous** coverage from the FUV (~ 100 nm) to the NIR (~ 1.9 μm).

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Coronagraph

High-contrast imaging and imaging spectroscopy

Bandpass	$\sim 200\text{--}1800$ nm
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Contrast	$\sim 1\text{e-}10$
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Vis: ~ 140 NIR: $\sim 70, 200$
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Venus Earth

High-Resolution Imager

UV/Vis and NIR imaging

Bandpass	$\sim 200\text{--}2500$ nm
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Field-of-View	3×2 arcmin
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~ 67 science filters + grism

High-precision astrometry?



UV Multi-Object Spectrograph

UV/Vis multi-object spectroscopy and FUV imaging

Bandpass	$\sim 100\text{--}1000$ nm
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Field-of-View	2×2 arcmin
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Apertures	0.2×0.1 sec
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Resolution	$500\text{--}50,000$
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An instrument from
a partner agency

POLLUX:
UV-to-NIR
high-resolution
spectrograph and
spectropolarimeter




HWO & Pollux science

Three Pollux science WGs

- Stars
- (Exo)planets
- Cosmic ecosystems

→ matching HWO science




Evolution of Elements Over Cosmic Time

Trace the rise of elements and molecules by studying of the formation, distribution, and evolution of stars.



Solar System in Its Galactic Context

Study objects at all scales in our Solar System and combine them with studies of exoplanets to shape our understanding of the full range of planet possibilities and histories.



Living Worlds

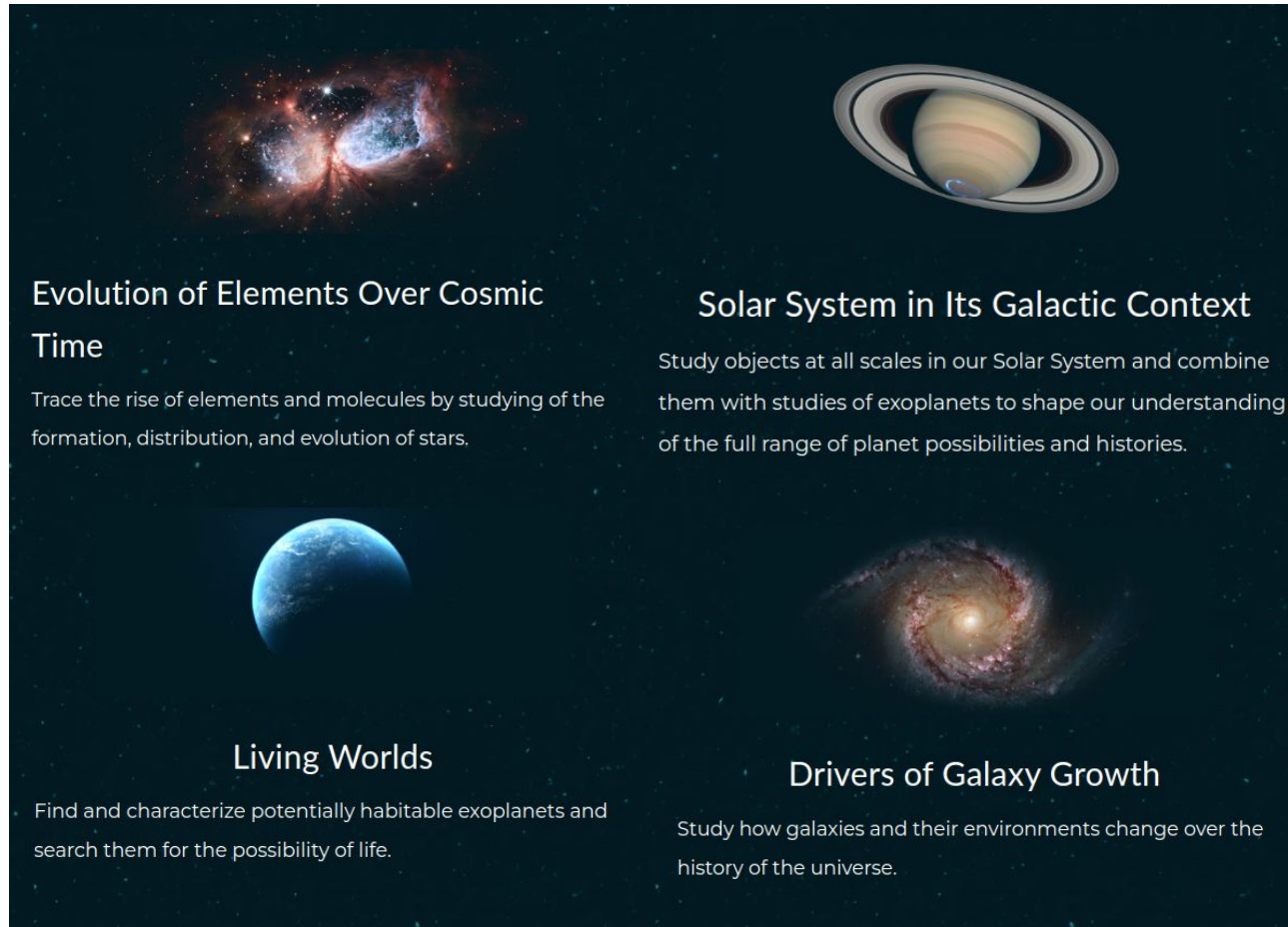
Find and characterize potentially habitable exoplanets and search them for the possibility of life.



Drivers of Galaxy Growth

Study how galaxies and their environments change over the history of the universe.

HWO & Pollux science



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Pollux aligns with ESA
(Voyage 2050), NASA (2020
Decadal), and AstroNet
priorities

Pollux STARS science WG

What impact have magnetic fields on the formation of stars and of their planets?

Link magnetic fields and accretion/ejection flows in protostars to test the magnetospheric accretion scenario

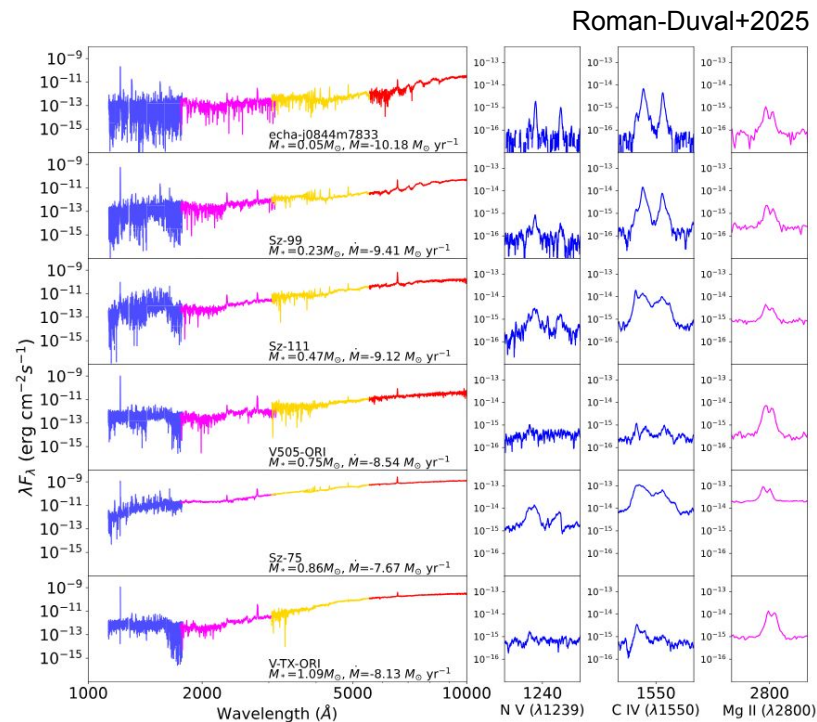
Measurables

- Stellar magnetic field topology and strength
- Mass accretion rate and geometry
- Thermal structure of the accretion shock
- Outflow components, ejection rates and geometry
- Thermal structure of the magnetosphere and magnetospheric flows
- Thermal & dynamical structure of the disk/magnetosphere interface

Unique Pollux contribution

Simultaneous observation of accretion and magnetic field diagnostics

WG led by Ana Ines Gomez de Castro (Spain)



Pollux (EXO)PLANETS science WG

1. Solar system science

- Impact of energetic particle precipitation (aurorae) on the atmospheres of giant solar system planets
- Charge exchange in comets

2. Exoplanet atmospheric characterisation and escape

- Detection of atomic and molecular species (from UV to NIR)
- Impact of photochemistry on upper and lower atmospheres
- No tellurics, retain continuum information, and molecules in NUV
- From habitable-zone rocky planets to close-in giant planets

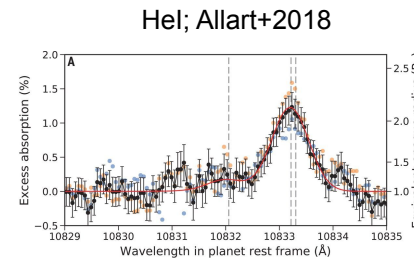
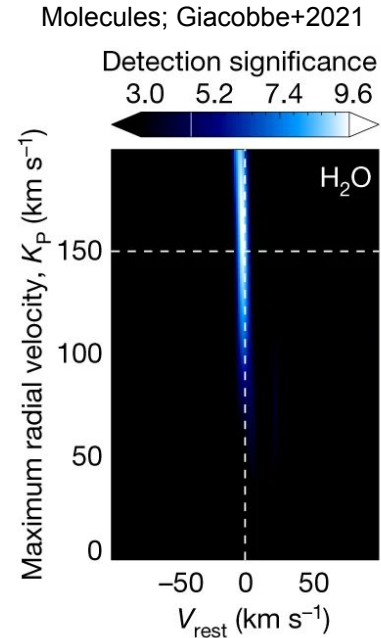
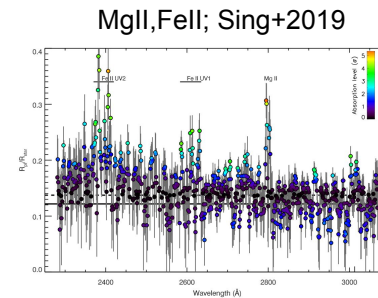
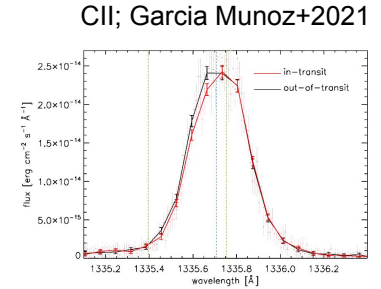
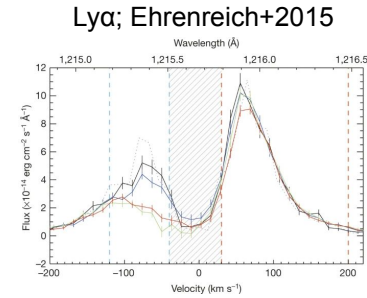
3. Star-planet interactions

- Star-planet magnetic connection
- Exoplanetary magnetic fields

4. Rocky planet composition

- Sputtered surface material from close-in rocky planets
- Characterisation of metals in the atmospheres of DZ white dwarfs

WG led by Luca Fossati (Austria) → ??



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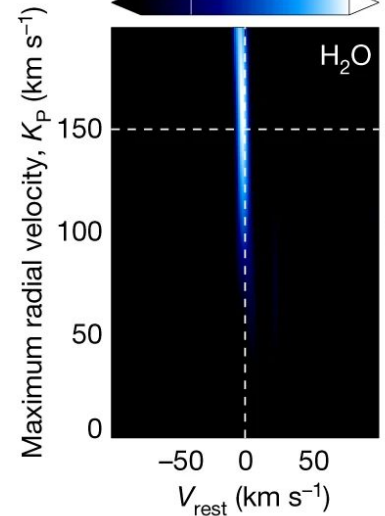
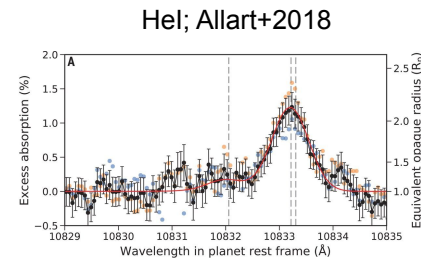
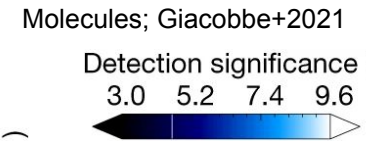
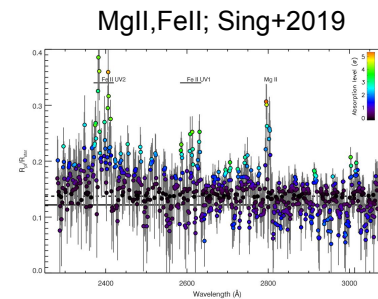
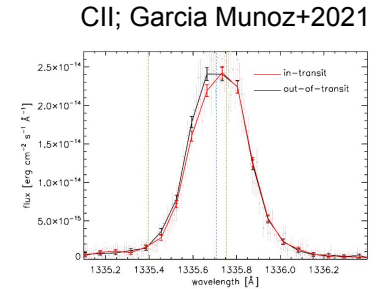
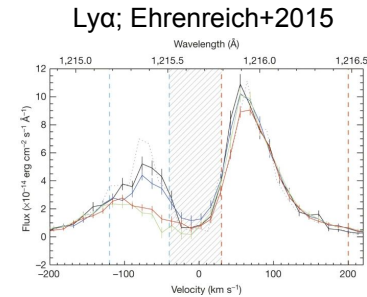
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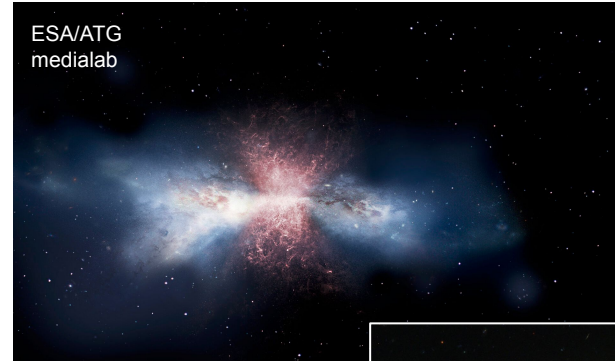
WG led by Luca Fossati (Austria) →



Pollux COSMIC ECOSYSTEMS science WG

1. Interstellar, Circumgalactic and Intergalactic Media

- Polarization by diffusion and absorption in gas and dust
- Magnetic fields and structuring of the medium
- Interactions between galaxies and their environment
- Dust chemistry



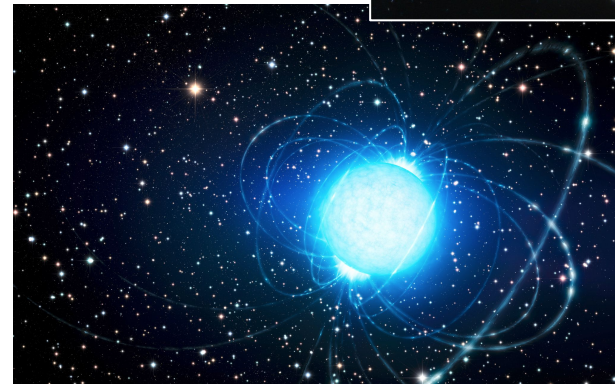
2. Quiescent, active and interacting galaxies

- Dynamics of galactic disks and halos
- Physics of accretion and general relativity
- Feedback from AGN (jets, winds) and starbursts
- Interaction between galaxies and impact on their evolution



3. Local and cosmological probes (e.g. first stars, high-Z galaxies, pulsars/magnetars, SNe, GRBs)

- Traces of reionization and first objects
- Polarization of fossil radiation and distant galaxies
- Constraints on dark matter and dark energy
- Cosmic gravitational lensing



WG led by Frédéric Marin (France)

Pollux high-resolution spectrograph and spectropolarimeter

FUV to NIR: Circular + linear polarisation (I,Q,U,V)

Five echelle spectrographs, each equipped with a dedicated polarimeter

Observing modes

- Point source spectropolarimetry: FUV (100-123 nm)
- Simultaneous spectroscopy: FMUV to NIR (101 to 1888 nm)
- Simultaneous spectropolarimetry: FMUV to NIR (120.5 to 1888 nm)
- Point source Spectroscopy (FMUV to NIR) or Slit Spectroscopy (FMUV and NUV)



	FUV	FMUV	NUV	OPT	NIR
Wavelength Range (nm)	100-123	101-236	234-472	472-944	944-1888
Spectral Resolution	> 100k	>75k	>100k	>100k	>100k
Point source <u>spectropolarimetry</u>	Yes	Yes 120.5-236 nm	Yes	Yes	Yes
Point source spectroscopy	No	Yes	Yes	Yes	Yes
Slit spectroscopy	No	Yes	Yes	No	No

Pollux high-resolution spectrograph and spectropolarimeter

Almost none of the instrumental characteristics in the table below are “written in stone”

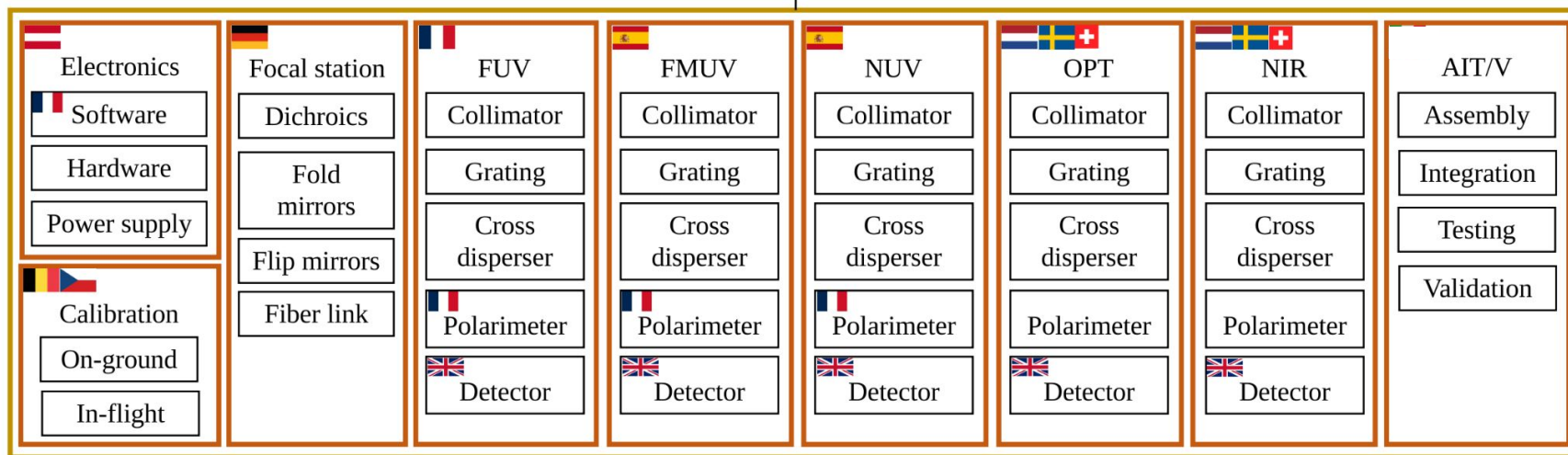
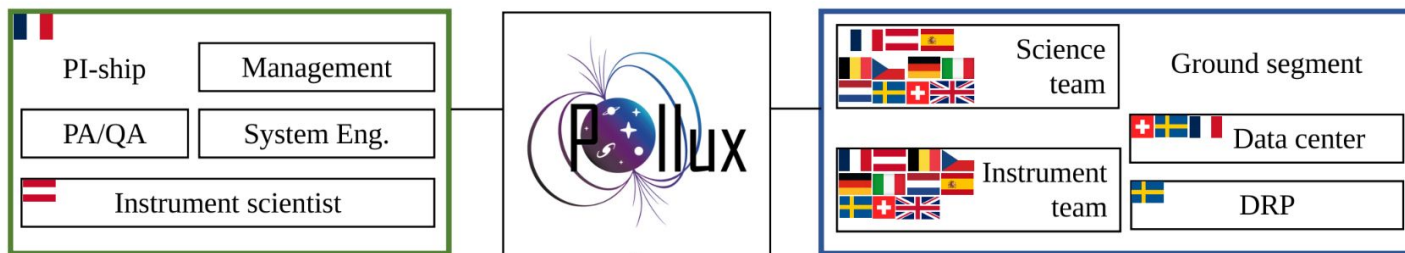
We are looking for new science cases to help us design the best possible instrument; e.g. we just started a study aiming at adding a medium-resolution (20-30 k) mode

Join the consortium to support the definition of the instrument characteristics

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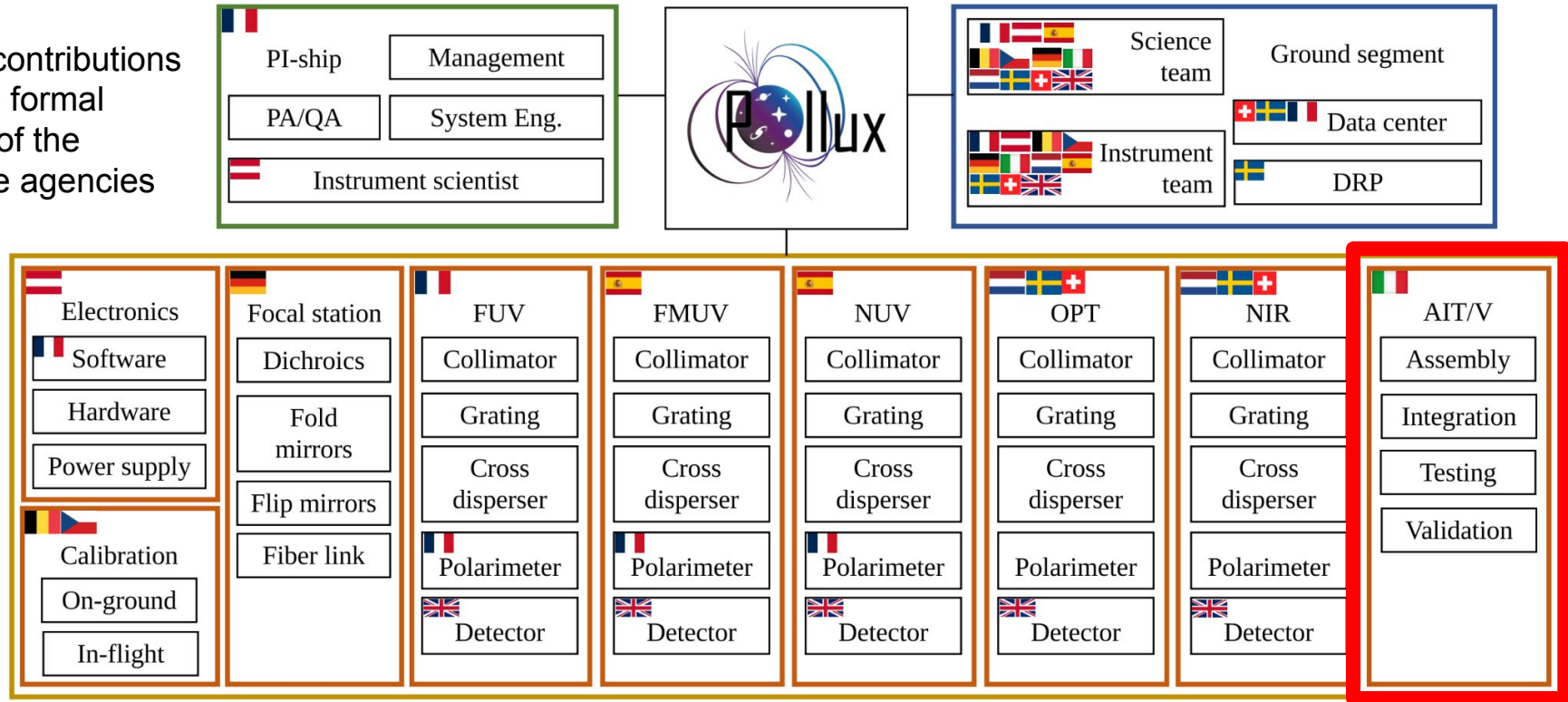
Currently projected European consortium

National contributions
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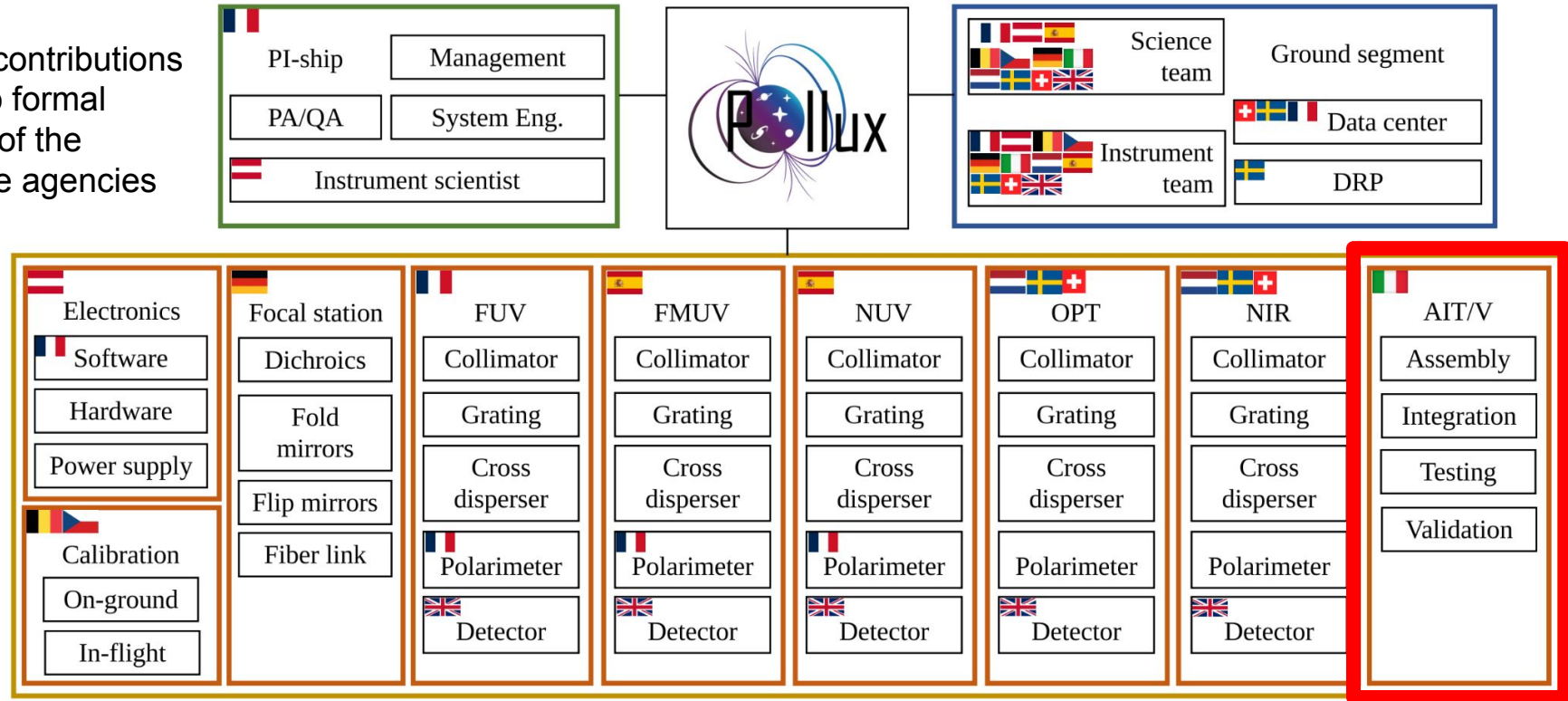
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To get in touch with the Pollux Project Office: pollux.po@lam.fr

If you are interested in getting involved



Pollux current baseline instrumental layout

