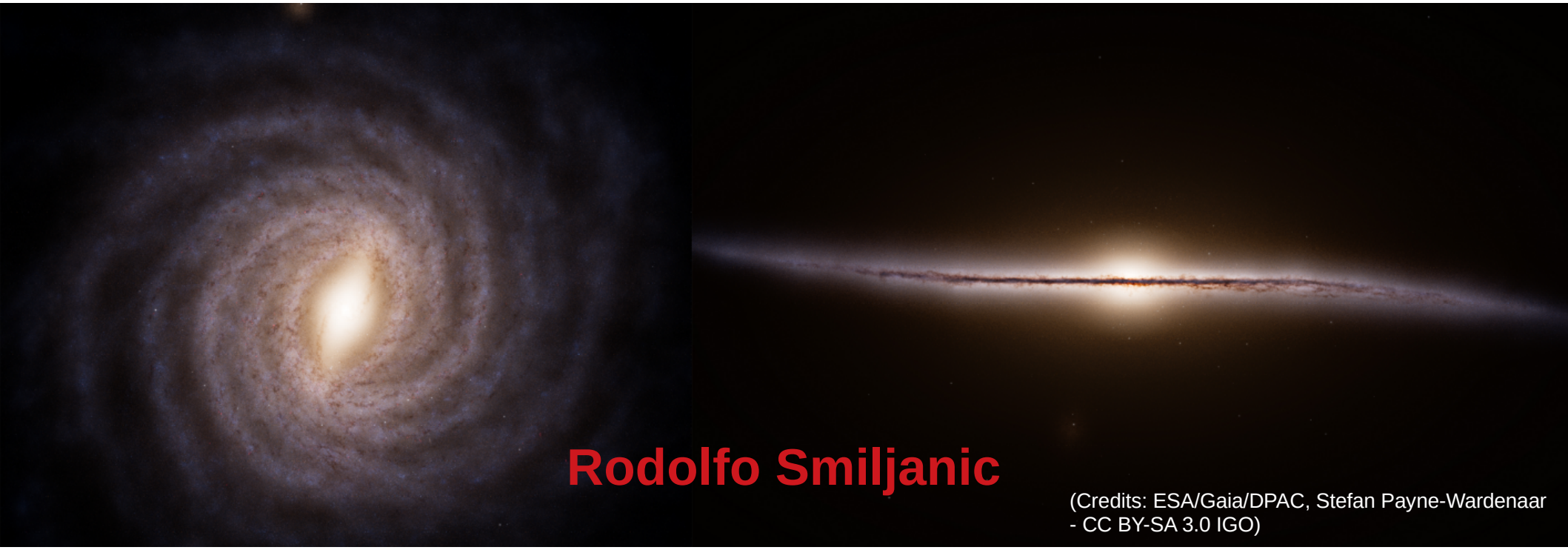
CUBES, WST & Gaia

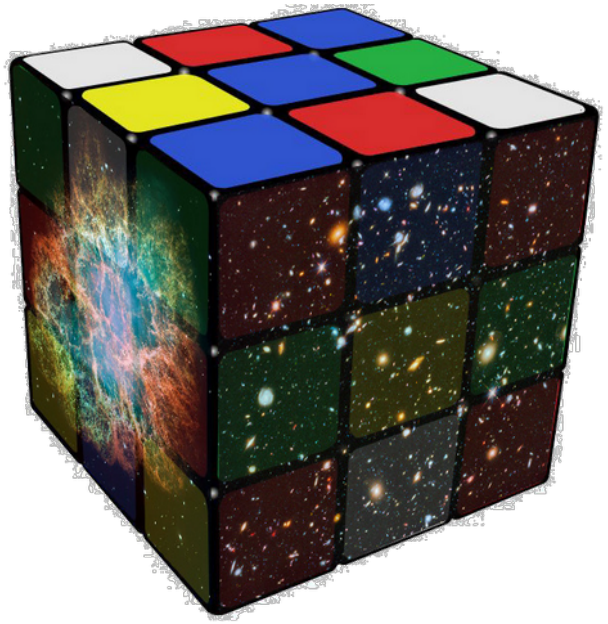


Rodolfo Smiljanic

CAMK/PAN
Warsaw

(Credits: ESA/Gaia/DPAC, Stefan Payne-Wardenaar - CC BY-SA 3.0 IGO)

CAMK Annual Meeting, 22-23 January, 2025

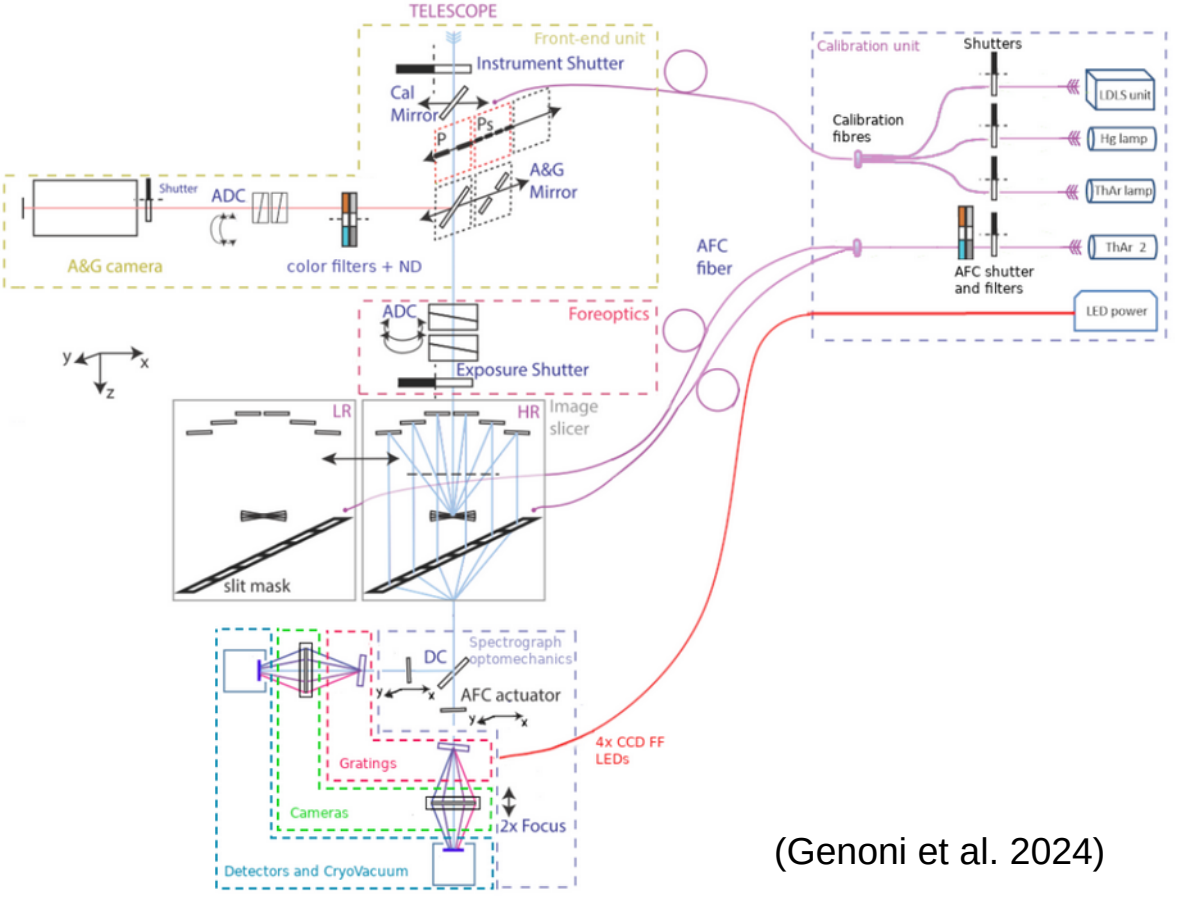


CUBES

Cassegrain U-Band Efficient Spectrograph

What is CUBES?

- **Cassegrain U-Band Efficient Spectrograph** (Genoni et al. 2024)
- Ground near-UV **(300-405 nm)**
- High-efficiency
- Two resolutions (R~6000, R~23 000) with two image slicers
- To be installed at the 8m ESO's VLT (**by 2029**)
- **Consortium:** Italy (leader; PI S. Covino), Germany, UK, Brazil, Poland **+ New member: Slovenia**



(Genoni et al. 2024)

Project during 2024

- CUBES Science Meeting (17-19 January), Naples, Italy
  - Working group on ozone absorption (monitoring on-going with ESO)
- CUBES Team at SPIE Astronomical Telescopes + Instrumentation, 2024, Yokohama, Japan:
  - 6 contributions (3 as co-I)
- Major tenders started (or soon): CCDs, image slicers, grating, spectrograph optics
- Final Design Review (FDR) on **Oct. 2024**
  - Three critical action items pending to be finished by April
- Phase D kick-off: February / March 2025

Milestone	Schedule
Entry into force of the CA	~~15 Feb. 2022~~
KOM with ESO	~~24 Mar. 2022~~
PDR	~~30 Nov. - 1 Dec. 2022~~
Detector LLI Review	~~6 Jul. 2023~~
Optics LLI Review	~~16 Nov. 2023~~
FDR	~~24-25 Oct. 2024~~
PAE	Feb. 2029
PAC	May 2030

Our participation

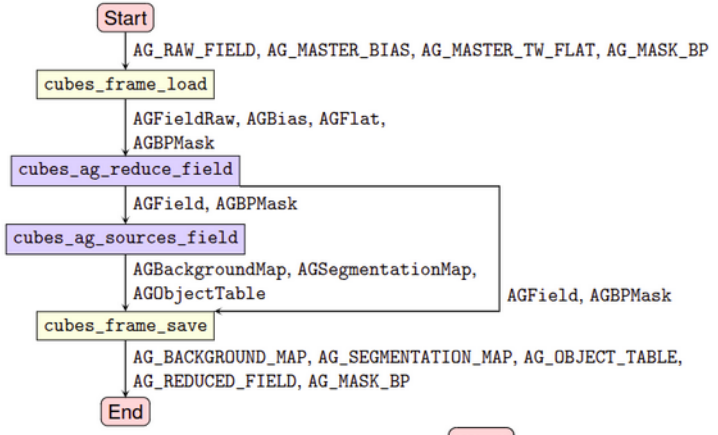
- Software contributions:

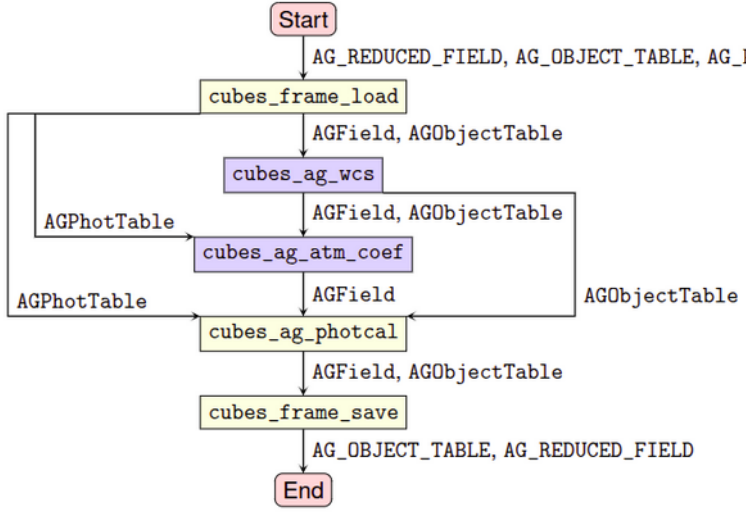
  1) Design data reduction pipeline for the photometry mode

  2) Design specifications for the observation preparation software

- One new post-doc hired to work on science simulations (Deepak, since Sep. 2024; see his presentation tomorrow)

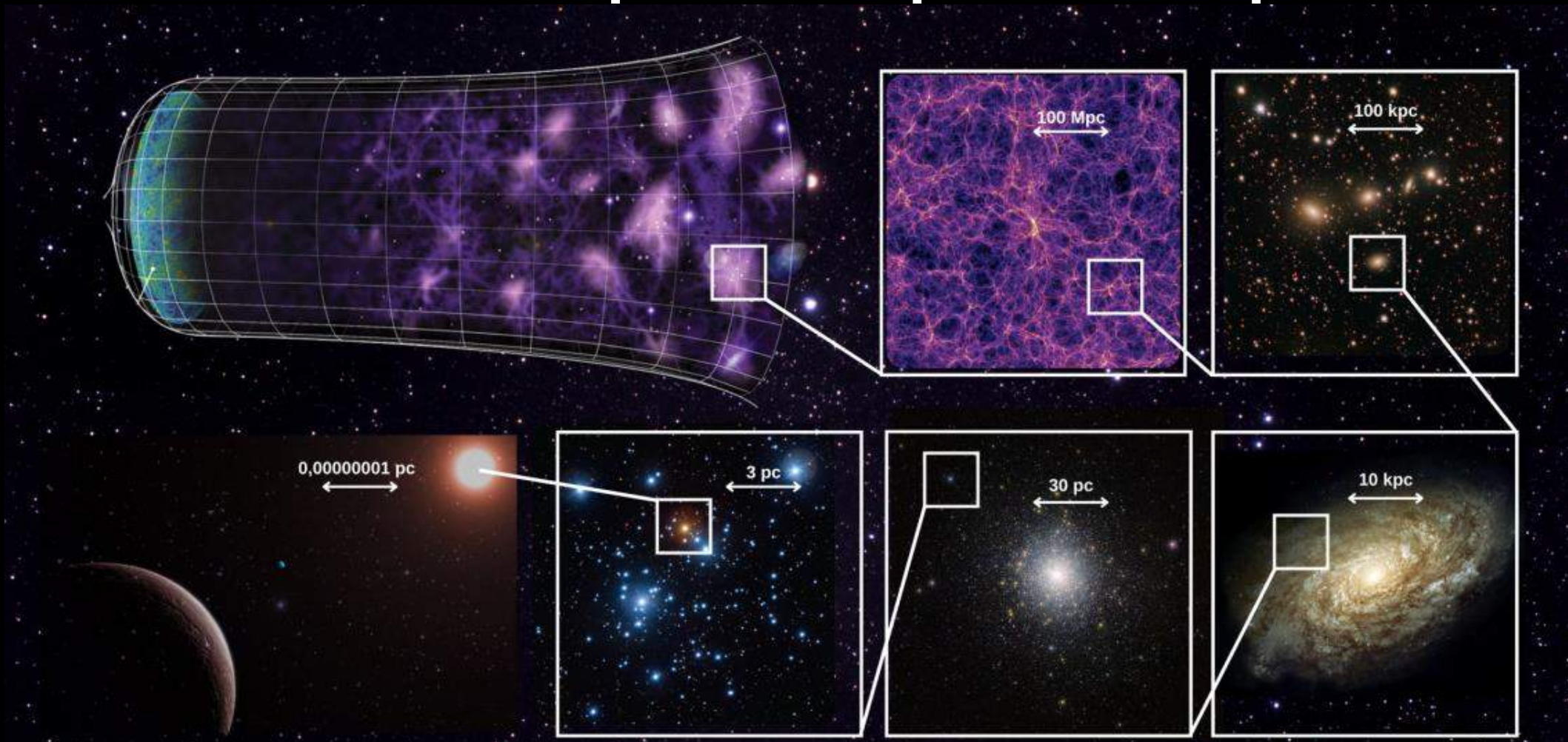
- Within **OPUS/LAP NCN grant (2024-2027):**
  - ➔ Purchase of Acquisition & Guiding camera (ELSE-I 1k x 1k BI UV3; Axiom Optics)
  - ➔ Characterization of A&G (with Heidelberg)
  - ➔ Development of imaging mode simulator & imaging mode data reduction SW





(Data Reduction Library Specifications)

Wide-field Spectroscopic Telescope

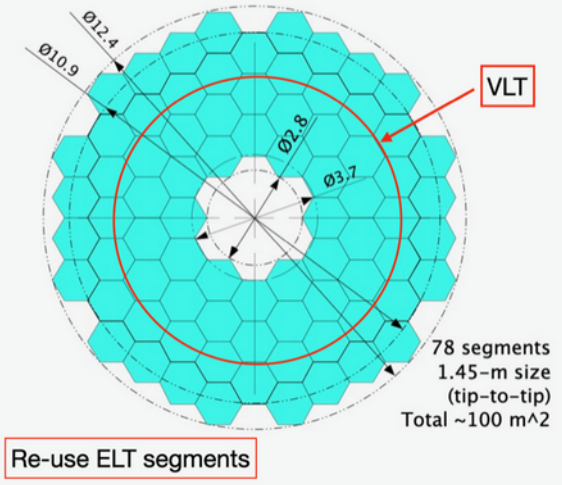


What is the WST?

https://www.wstelescope.com/

- Wide-field Spectroscopic Telescope (WST)
- Consortium formed in 2021 (19 institutes in Europe + Australia)
- A 12-m ground-based telescope dedicated to multi-object spectroscopy
  - ➔ **ESO Expanding Horizons call: next big project for the future: >2040**
- Any professional astronomer is welcome to join the extended science team (see link)

Preliminary TLR

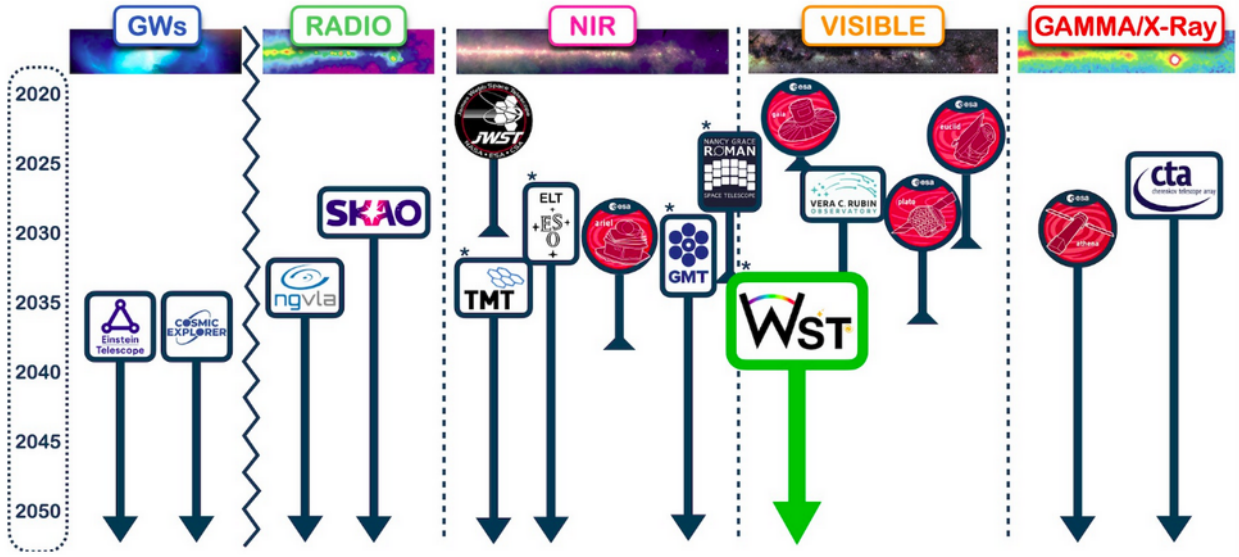


Telescope Aperture	12 m, seeing limited
Telescope FoV	2.5 - 5 deg²
MOS LR Multiplex	20,000
MOS LR Resolution	2,000-7,000
MOS LR Spec Range	370 (350) - 970 nm
MOS HR Multiplex	2,000
MOS HR Resolution	20,000-40,000
MOS HR Spec Range	3-4 regions in 350-970 nm
IFS FoV	3x3 arcmin²
IFS Resolution	3,000-5,000
IFS Spec Range	370-970 nm
IFS Mosaic	9x9 arcmin²
MOS & IFS simultaneous operation	

IR extension to a later stage

Project in 2024

- WST Team at SPIE Astronomical Telescopes + Instrumentation, 2024, Yokohama, Japan
  - ➔ 2 contributions (1 as co-I)
- WST Science White Paper; Manieri et al. 2024, arXiv:2403.05398 (194 pages)
  - ➔ Cosmology; Extragalactic; Resolved stellar populations; Galactic and stellar; Time domain
- **Horizon Europe proposal approved in 2024 (~ 3M €):**
  - ➔ Three-years study to prepare a conceptual design (Feb. 2025)
  - ➔ One postdoc to join CAMK (half-time work on WST)



(Manieri et al. 2024)

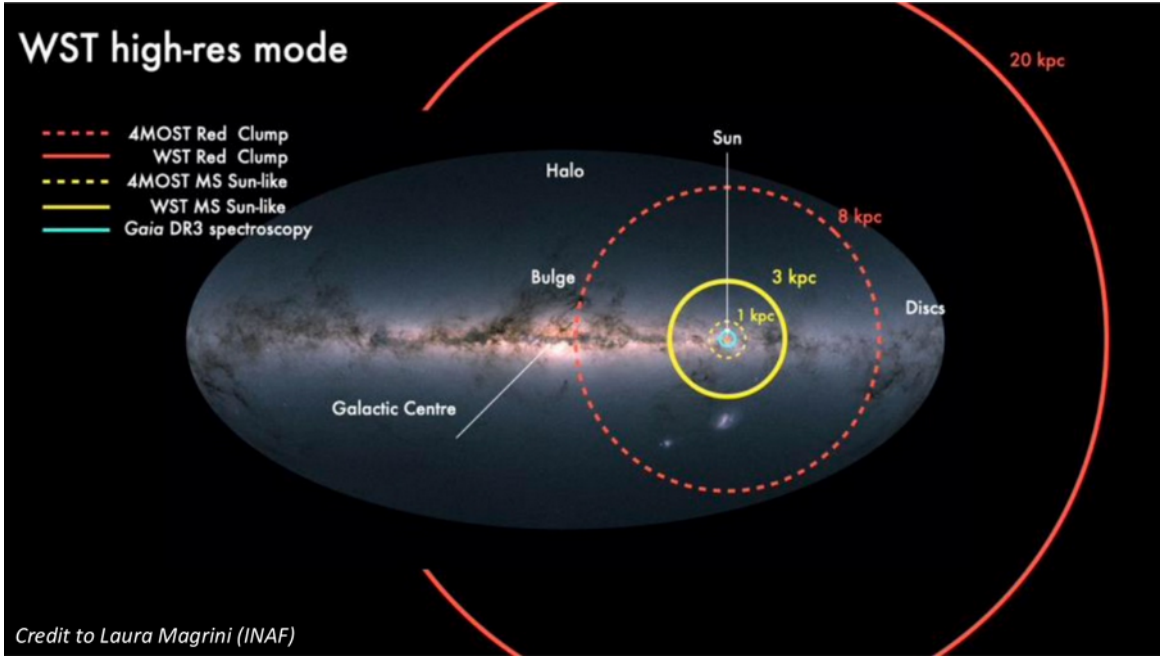
Exoplanet, Stellar and Galactic Science

- Four main topics:
  - Origins of the elements
  - Origins of the Milky Way system
  - Origins of stars and planets
  - Stellar evolution
- Except for Gaia-ESO and PFS @ Subaru, all surveys use 4m telescopes
- Except for Gaia-ESO (~7000 stars) and GALAH, all survey spectra with R < 20k

➔ Reach fainter and more distant sources

➔ Explore chemical elements missed by other surveys

➔ Reach higher precision in the abundances

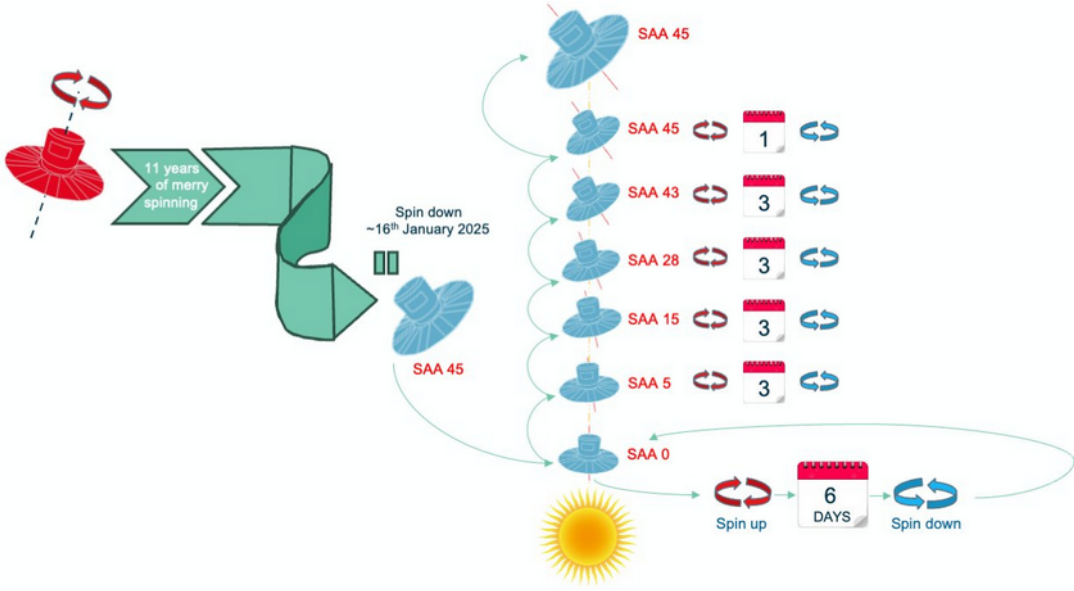


The Gaia Mission

CAMK Annual Meeting, 22 January 2025

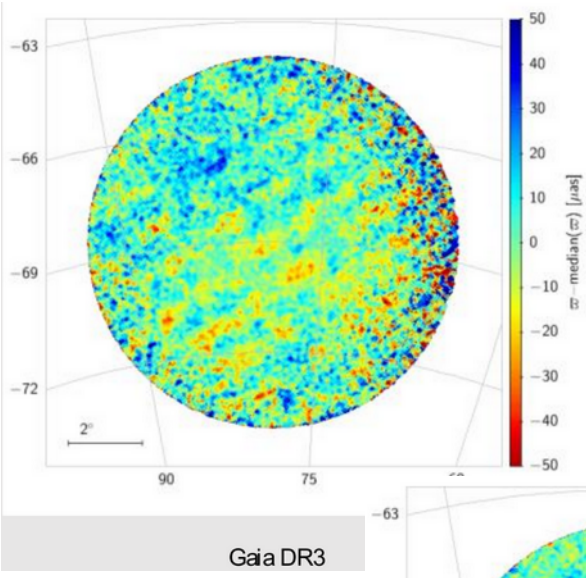
Gaia End of Observations

- **Not the end of the mission!**
- Cold gas (used to control the precise spinning of the spacecraft) ends in February 2025
- Science observations ended in 15 January, 2025 (after 10.5 years of observations)
  - ➔ 2551x10^9 astrometric, 512x10^9 photometric, 50x10^9 spectroscopic CCD measurements (Oct. 2024)
- Start a series of technologies tests
- Gaia passivation: **27th of March**
- Sent to an orbit with <1% chance to come back to Earth in 100 years

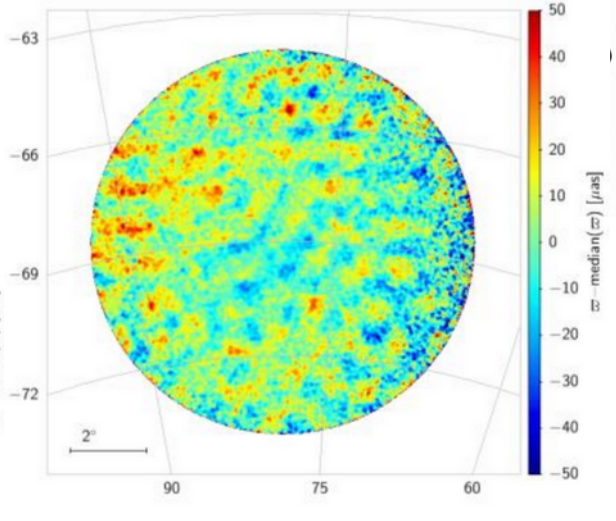


Gaia DR4 and DR5

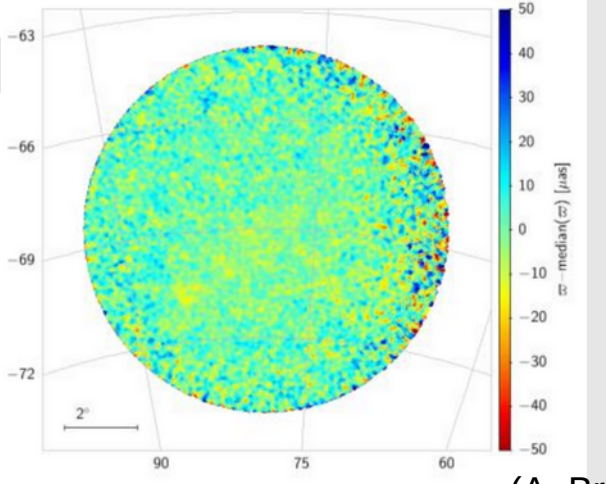
- **Gaia DR4 is not more of the same**
  - ➔ Not before mid-2026
  - ➔ Based on 5.5 years of data
  - ➔ Full catalogues of epoch data
  - ➔ Improvements wrt DR3
- Gaia DR5: Legacy archive
  - ➔ Not before end-2030
  - ➔ Full mission (10.5 years)
  - ➔ Some data of internal databases and possibly software
  - ➔ Maintain expertise for next astrometric mission (Gaia-NIR? > 2040)



Gaia DR3



DR3 code applied to DR4 data

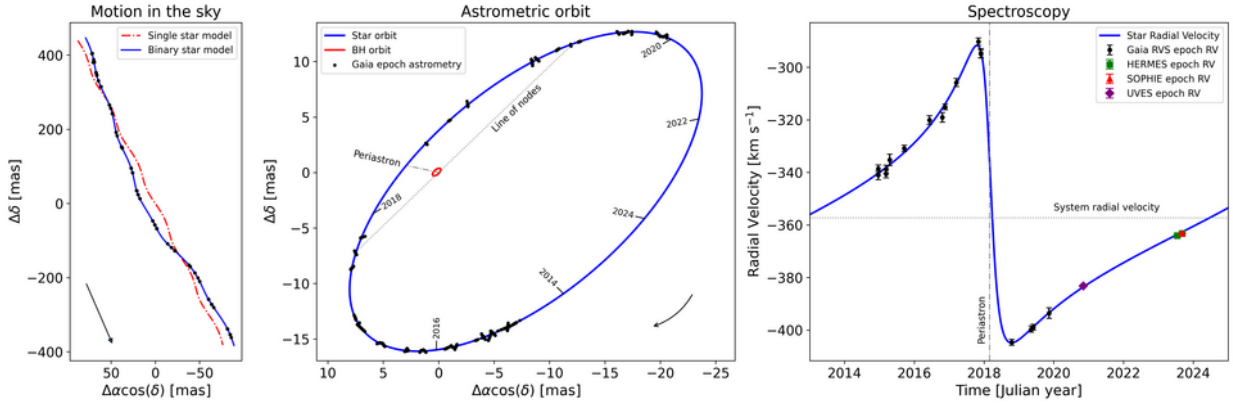


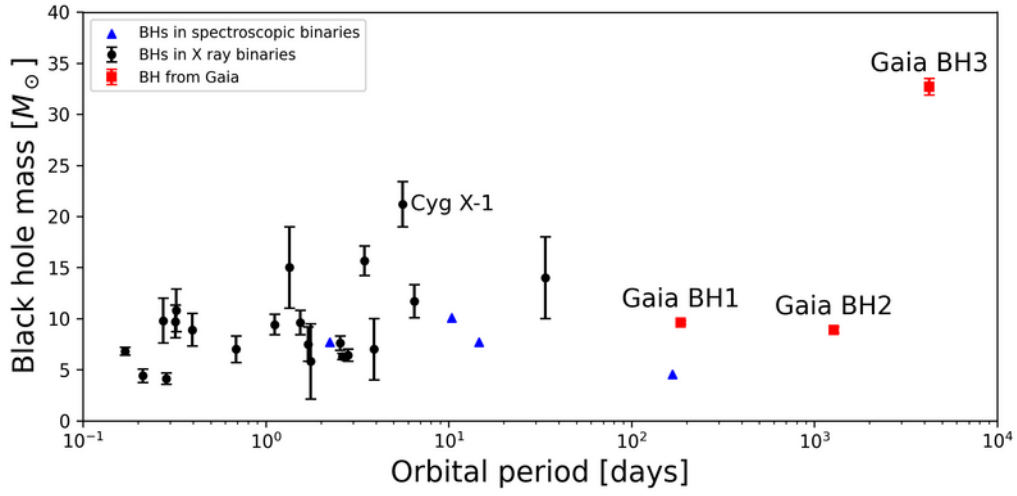
Gaia DR4: after extensive optimization of calibration

(A. Brown, EAS2024)

Gaia Black Hole 3

- **Gaia BH3** (Gaia collaboration et al. 2024)
  - ➔ Outlier found during processing for Gaia Data Release 4
- Great example of the use of epoch data (astrometric + photometric)
- 32.7 Msun object orbiting a metal-poor halo star every 5.5 years





(Credits: ESA/Gaia/DPAC - CC BY-SA 3.0 IGO.)

Thank you for your attention