



CUBES & WST



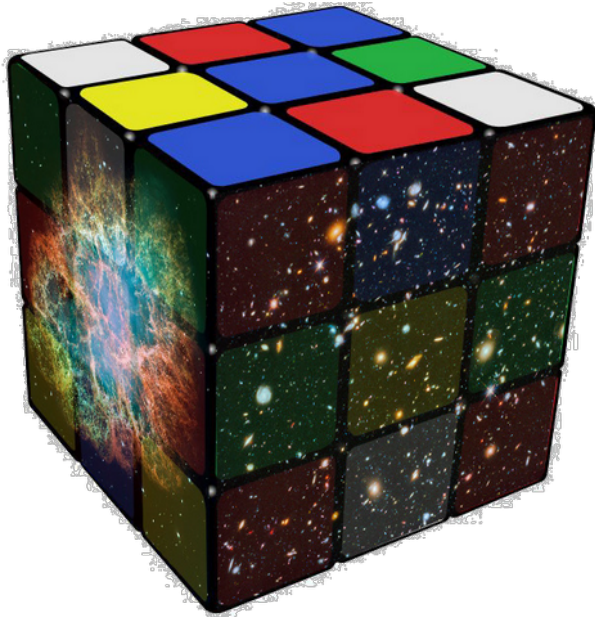
Rodolfo Smiljanic

**CAMK/PAN
Warsaw**

CAMK Annual Meeting, 31 January – 02 February (2024)



Universidade de São Paulo
Instituto de Astronomia, Geofísica e Ciências Atmosféricas



CUBES

Cassegrain U-Band Efficient Spectrograph

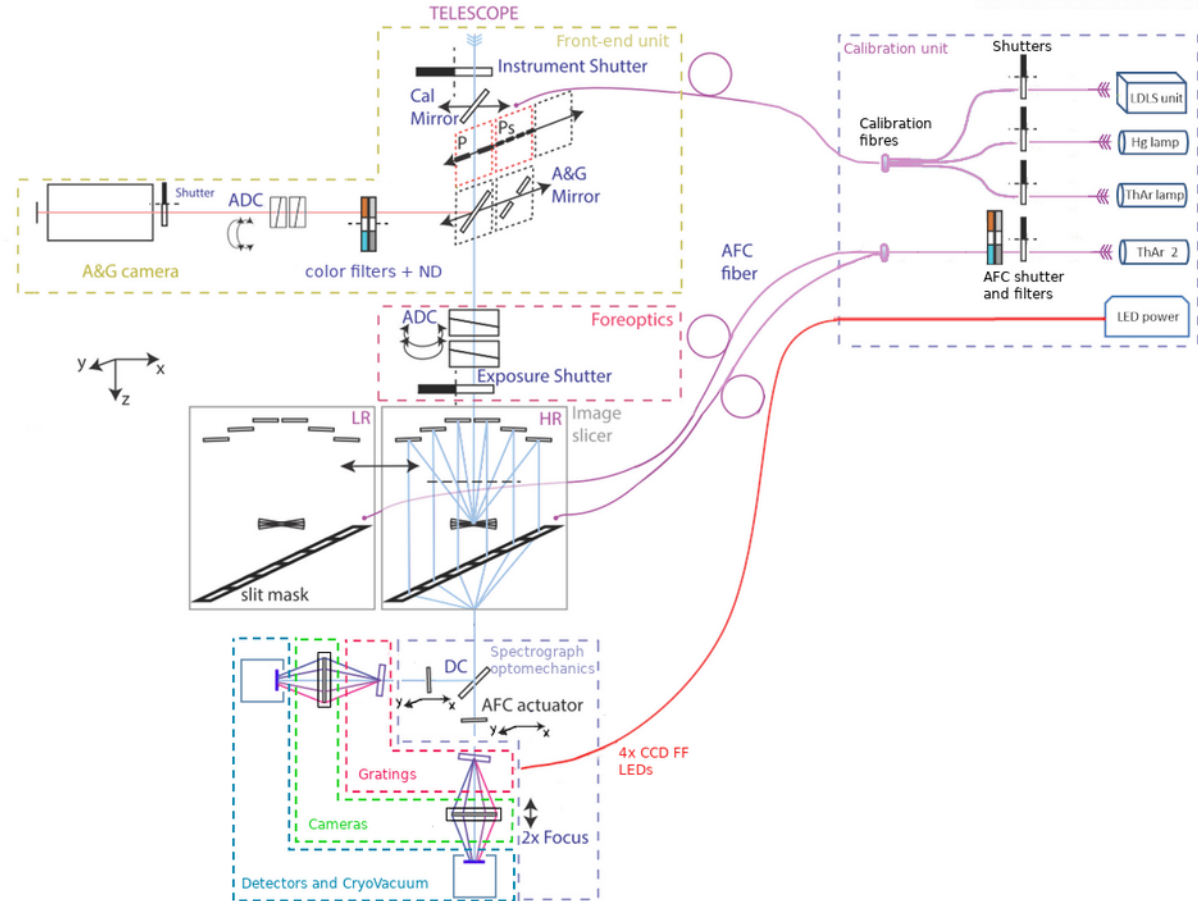




What is CUBES?



- **Cassegrain U-Band Efficient Spectrograph** (Cristiani et al. 2022a,b; Zanutta et al. 2022)
- To be installed at the 8m ESO's VLT (by 2027)
- **Consortium:** Italy (leader; PI S. Covino), Germany, UK, Brazil, Poland
- Ground near-UV (**300-405 nm**)
- High-efficiency
- Two resolutions ($R \sim 6000$, $R \sim 23000$) with two image slicers

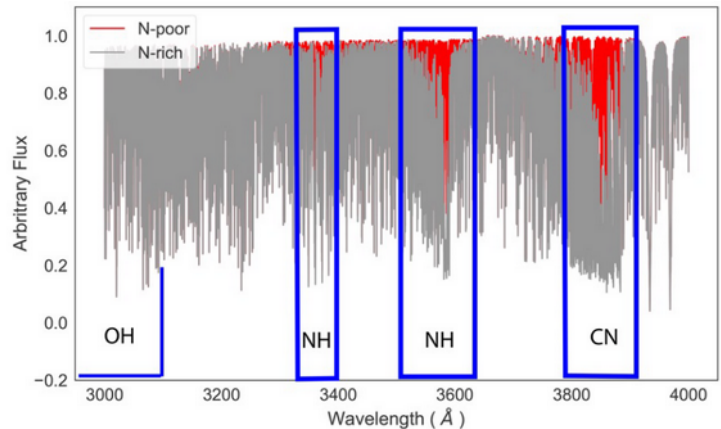




Science with CUBES



- See [CUBES special edition in Experimental Astronomy \(17 articles\)](#)
- Summary in Evans et al. (2023): Solar system, Galactic, extragalactic and transients
- Several with dedicated simulations
- Reach sources up to 3 mag fainter than currently possible at the near UV



(Evans et al. 2023)

Table 1 Summary of high-level science cases developed during the CUBES Phase A study. Entries in the third column refer to the expanded articles presented elsewhere in this Special Issue (SI)

Field	Science case	SI Contrib.
Solar System	S1: Cometary Science	[3]
	S2: Icy Satellites	...
Galactic	G1: Accretion, winds & outflows in YSOs	[4]
	G2: Exo-planet composition	...
	G3: Stellar astrophysics & exoplanets	...
	G4: Beryllium in metal-poor stars and stellar clusters	[5, 6]
	G5: Lithium production in novae	...
	G6: Metal-poor stars & light elements	[7, 8]
	G7: Neutron-capture elements	[9]
	G8: Precise metallicities of metal-poor pulsators	...
	G9: Horizontal branch stars in Galactic GCs	...
	G10: Early-type companions in binary Cepheids	...
	G11: Extragalactic massive stars	[10]
Extragalactic	E1: Primordial deuterium abundance	...
	E2: Missing baryonic mass in the high-z CGM	[11]
	E3: Cold gas at high redshift	[12]
	E4: Reionisation	...
Transients	T1: GRBs	...
	T2: Kilonovae	...
	T3: Superluminous supernovae	...



Project status



- Phase C (*Final Design*) started in 2023 (kick-off on 26th of January)
 - Fiber-link to UVES was dropped
 - Imaging mode: ADC added to the A&G path
 - Long Lead Items Review completed (Final requirements for items that have long manufacturing time; > 18 months)
 - 1 million € paid by ESO to INAF (orders for CCDs, image slicers, optics soon)
- Final Design Review (FDR) by **October 2024**



Key Milestones	Contractual Completion Date
KM.0 – Entry into force of the Consortium Agreement	T0
KM.1 – Kick-off Meeting	T0 + 1 month
KM.2 – Delivery of Prototype (grating)	T0 + 10 months
KM.3 – Preliminary Design Review (PDR)	T0 + 11 months
KM.4 – Long Lead Items Review	T0 + 17 months
KM.5 – Final Design Review (FDR)	T0 + 25 months
KM.P – Procured equipment delivered at the Consortium's premises and accepted by the Consortium	T0 + 40 months
KM.6 – Intermediate Milestone (Assembly Readiness Review)	T0 + 45 months
KM.7 – Test Readiness Review (TRR)	T0 + 57 months
KM.8 – Provisional Acceptance Europe (PAE)	T0 + 63 months
KM.9 – Intend to Accept and PTO of the Instrument	T0 + 65 months
KM.10 – Provisional Acceptance Chile (PAC)	T0 + 77 months

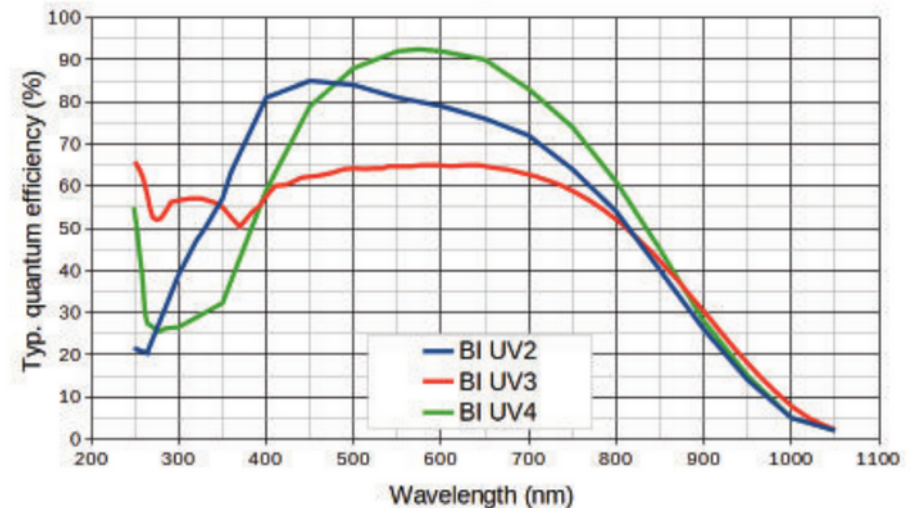


Polish participation

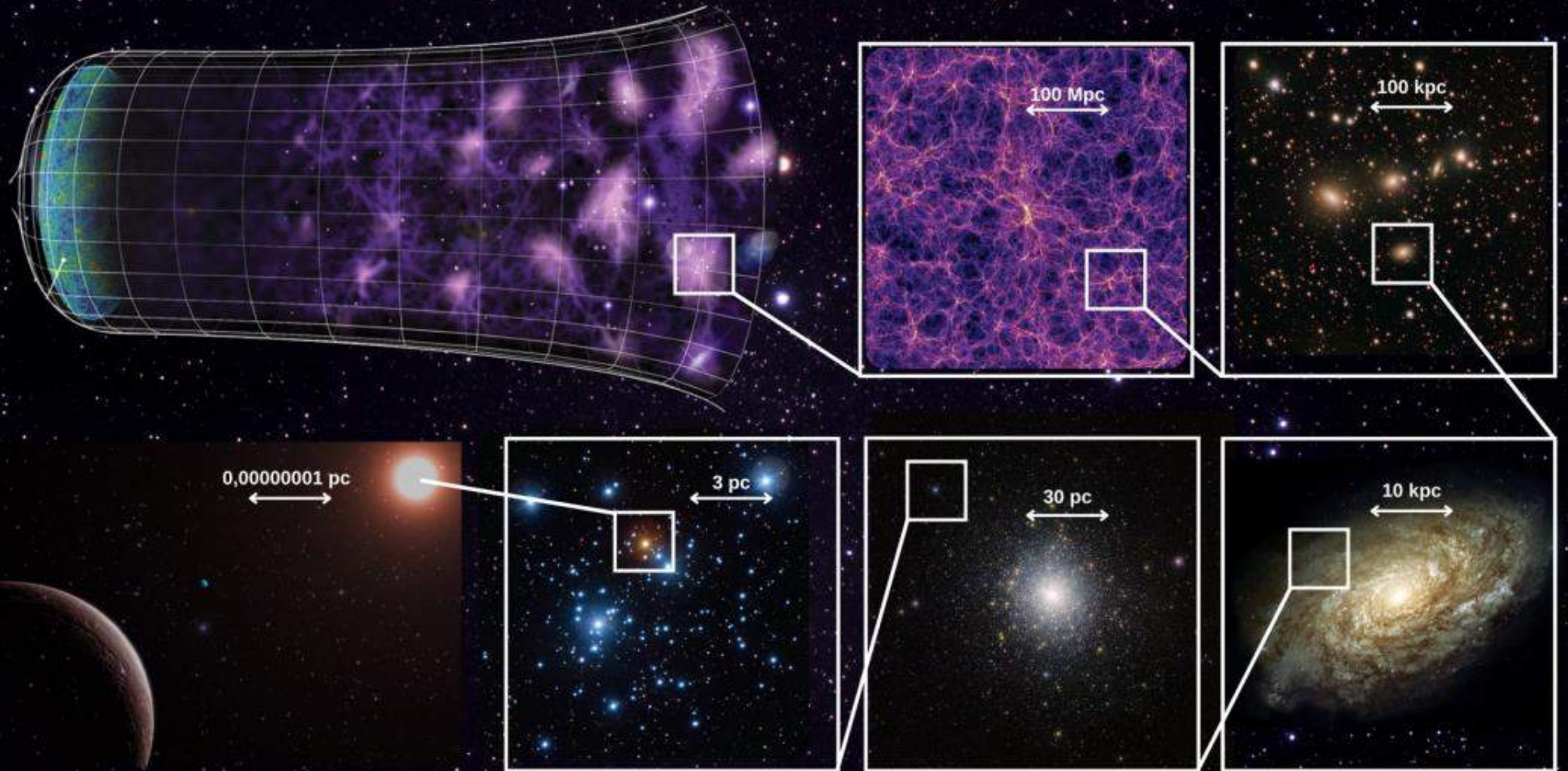


- Contribution at **5.7%** of staff effort and cost
- R. Smiljanic: co-PI at Executive Board
- **OPUS/LAP NCN grant approved** (collaboration with Heidelberg University):
 - Purchase of Acquisition & Guiding camera
 - Characterization of A&G (with Heidelberg)
 - Development of imaging mode simulator & imaging mode data reduction SW
 - One post-doc to work on science simulations
 - ➔ Simulate spectrophotometry of metal-poor stars with CUBES
- Participation in the 90 GTO nights to be awarded to the consortium (span 3-5 years)

ELSE-I 1k x 1k BI UV3 – Axiom Optics:



Wide-field Spectroscopic Telescope





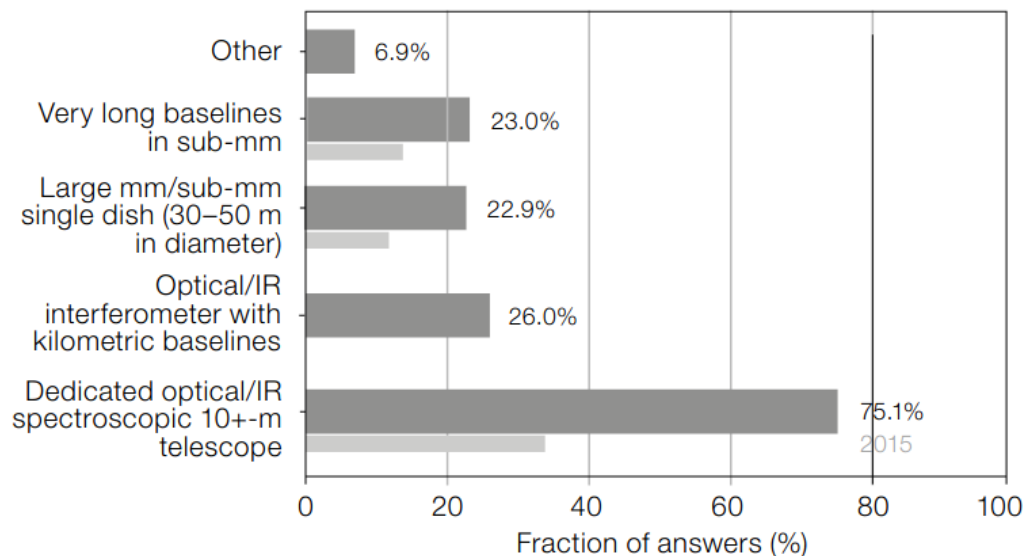
What is the WST

<https://www.wstetlescope.com/>



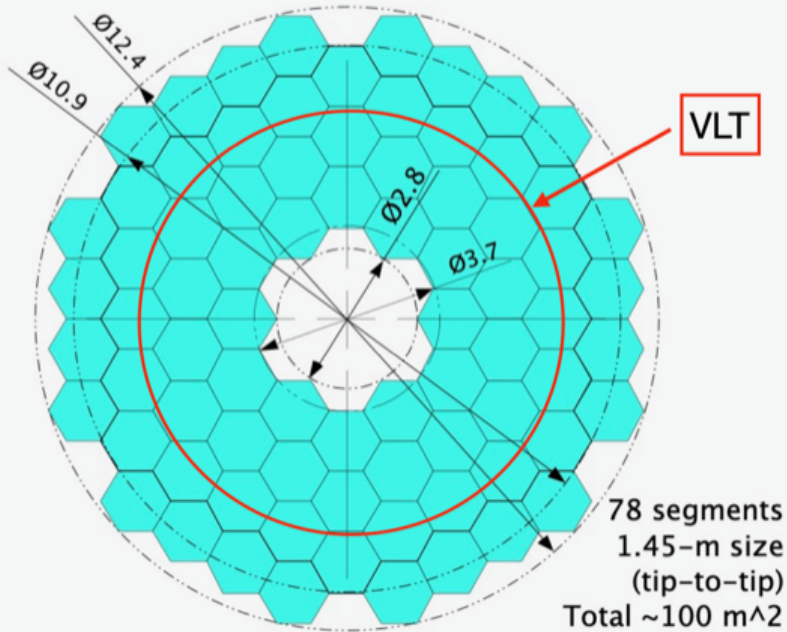
- Wide-field Spectroscopic Telescope (WST)
- A 10-m class ground-based telescope dedicated to multi-object spectroscopy
 - **Project for the future: > 2035**
- In October 2021, a consortium of 18 Institutes was formed (from Europe and Australia, including also ESO)
- Horizon Europe proposal in April 2022:
 - Three-years study to prepare a conceptual design
 - Proposal was formally approved but not funded...
- **Now preparing for new call: deadline March 12, 2024**

Which of these possible facilities do your future research objectives require?



(Merand et al. 2021)

Preliminary TLR

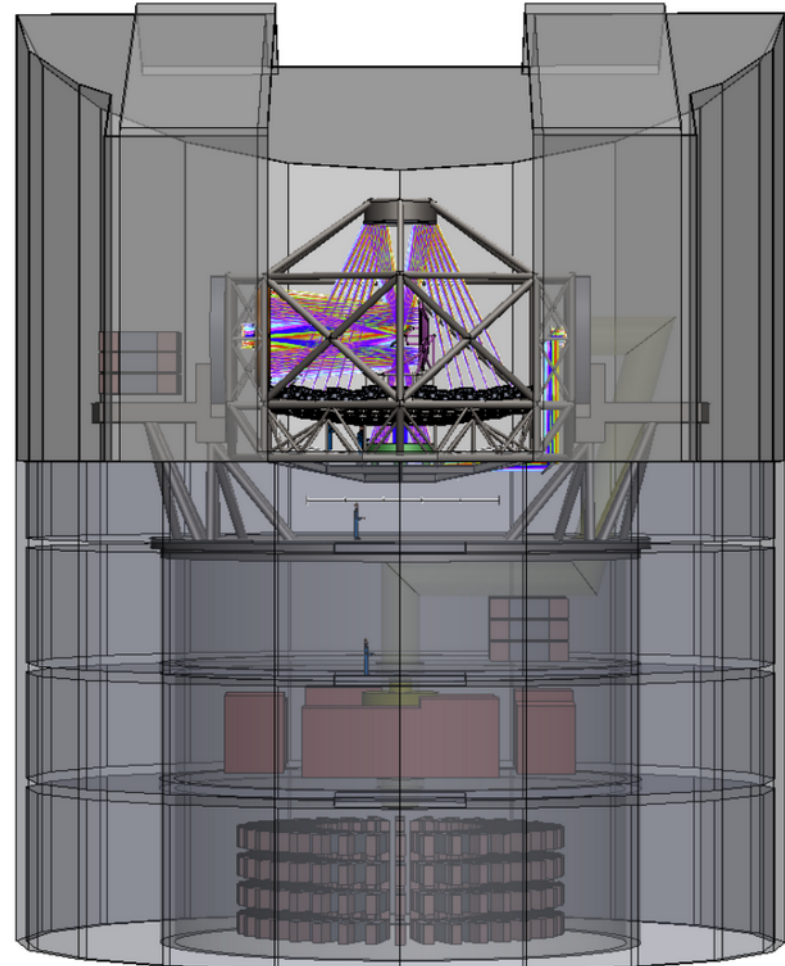


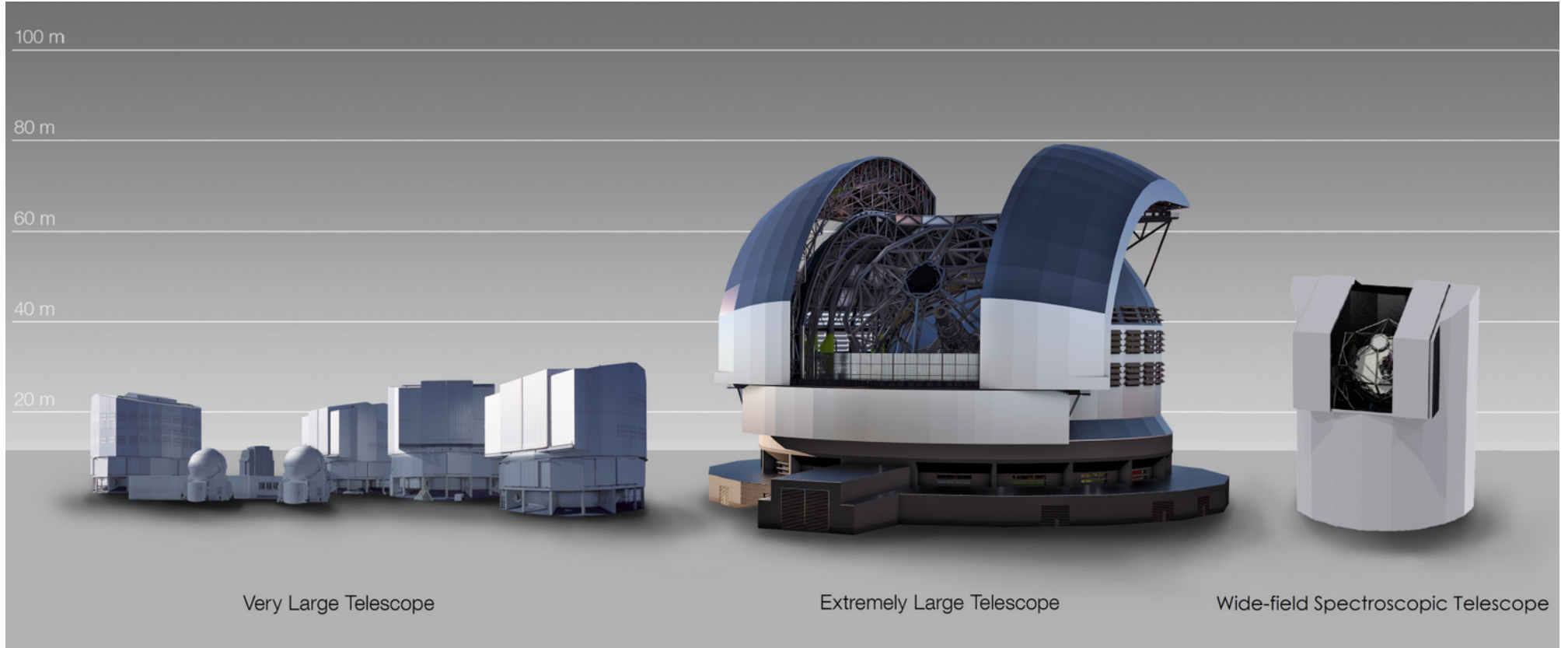
Re-use ELT segments

Telescope Aperture	12 m, seeing limited
Telescope FoV	2.5 - 5 deg ²
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 arcmin ²
IFS Resolution	3,000-5,000
IFS Spec Range	370-970 nm
IFS Mosaic	9x9 arcmin ²
MOS & IFS simultaneous operation	

IR extension to a later stage

- VLT style dome: 50m tall, 40m diameter
- The IFS units on the ground floor; high-resolution spectrographs on the 1st floor; low-resolution spectrographs on the 2nd floor (or on a Nasmyth platform)
- Site selection (around Paranal): visits to the La Montura and La Chira; past seeing statistics of Ventarrones
- Sustainability strategy being developed
- **32m ESO ELT is now > 50% complete**
 - **ESO will start in 2024 studies to define the next big facility**



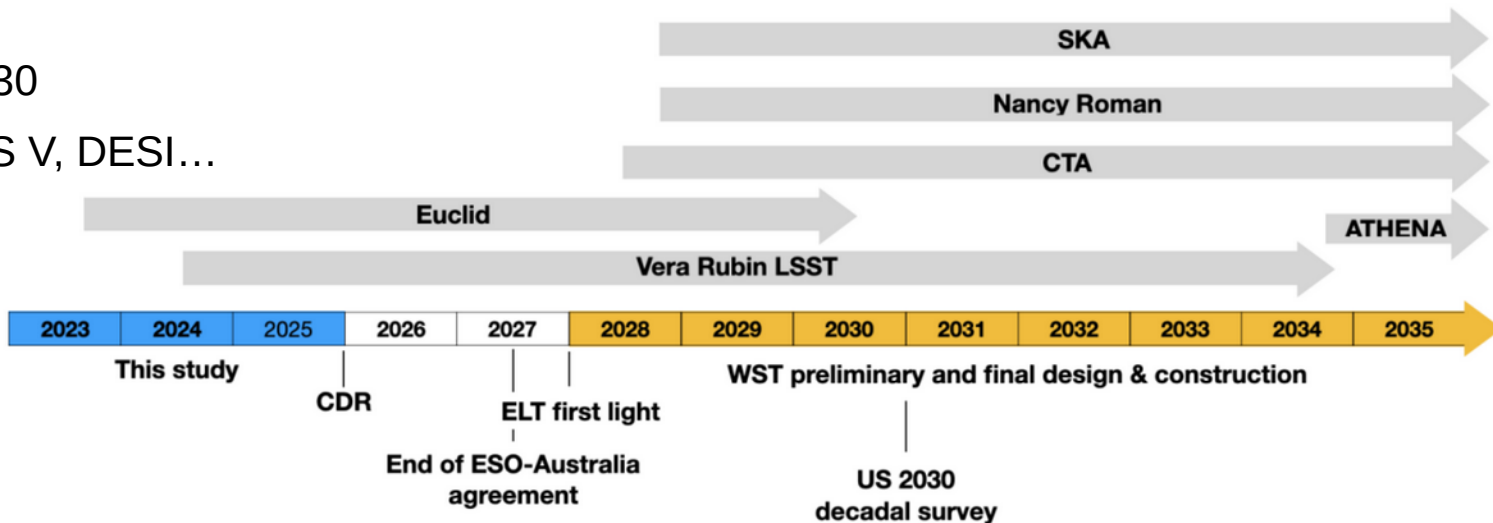


- Participation in the Science Team is welcome, regardless of affiliation
- Science White Paper: arXiv by end of February
- **What is the transformational science that can only be addressed by a 12-metre telescope fully dedicated to multi-object spectroscopy in >2035?**

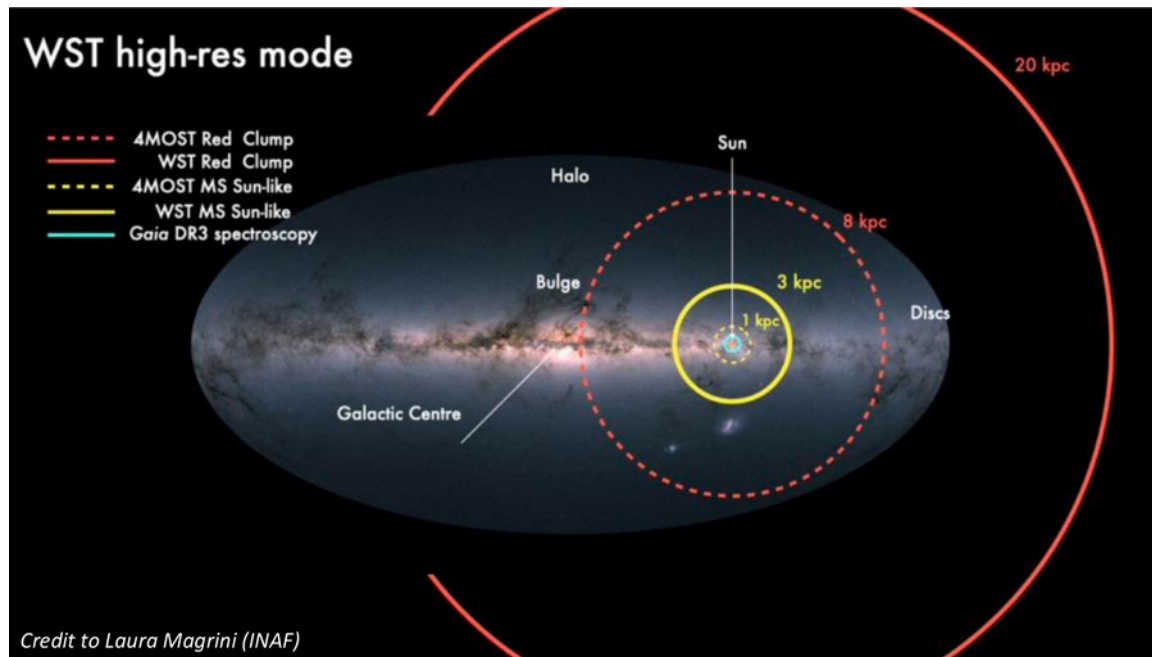
WP2 - Science

- 2.1 Cosmology
- 2.2 Extragalactic
- 2.3 Galactic
- 2.4 Time-domain

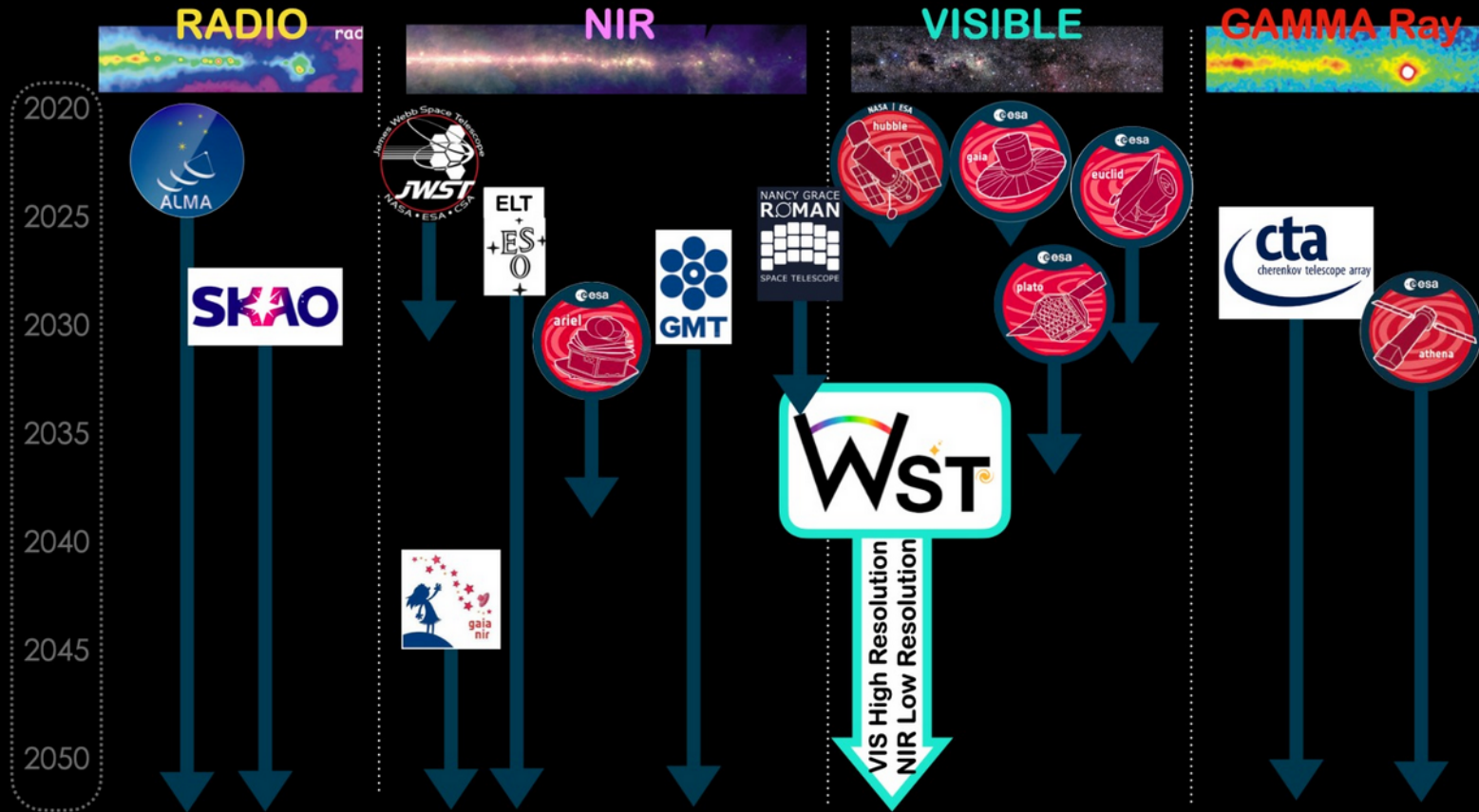
- Gaia DR5 by end of 2030
- 4MOST, WEAVE, SDDS V, DESI...
- ELTs > 5-10 years



- Three main topics:
 - Origins of the elements
 - Origins of the Milky Way system
 - Origins of stars and planets
- 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

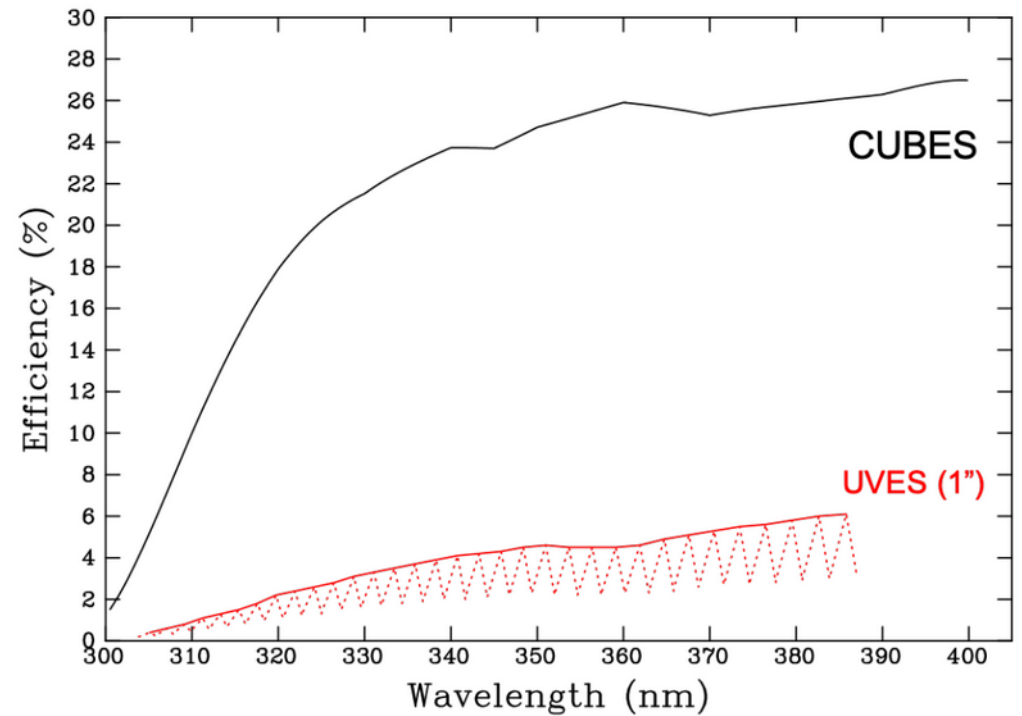
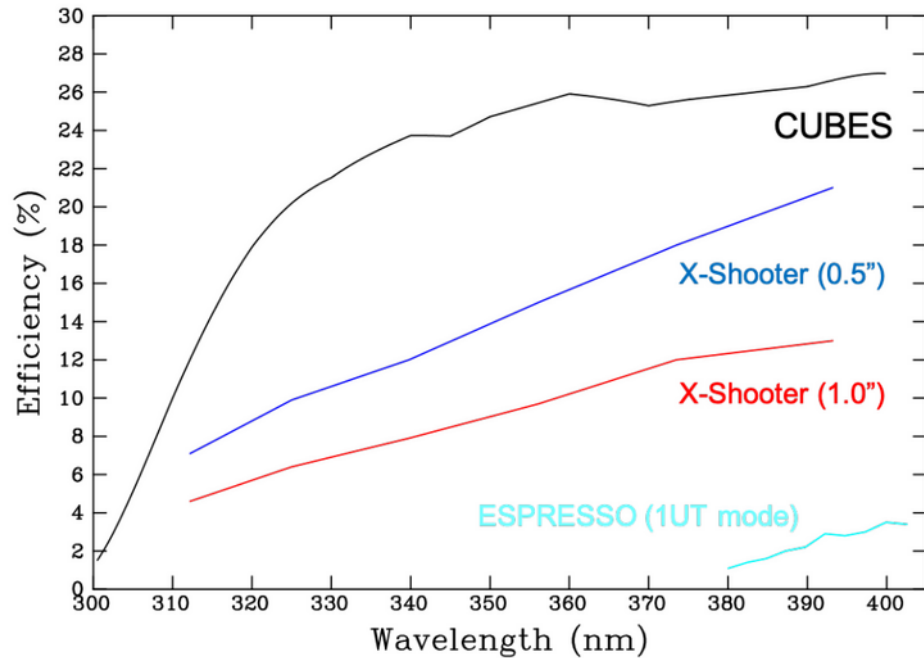


Thank you for your attention





CUBES efficiency



The Gaia Mission

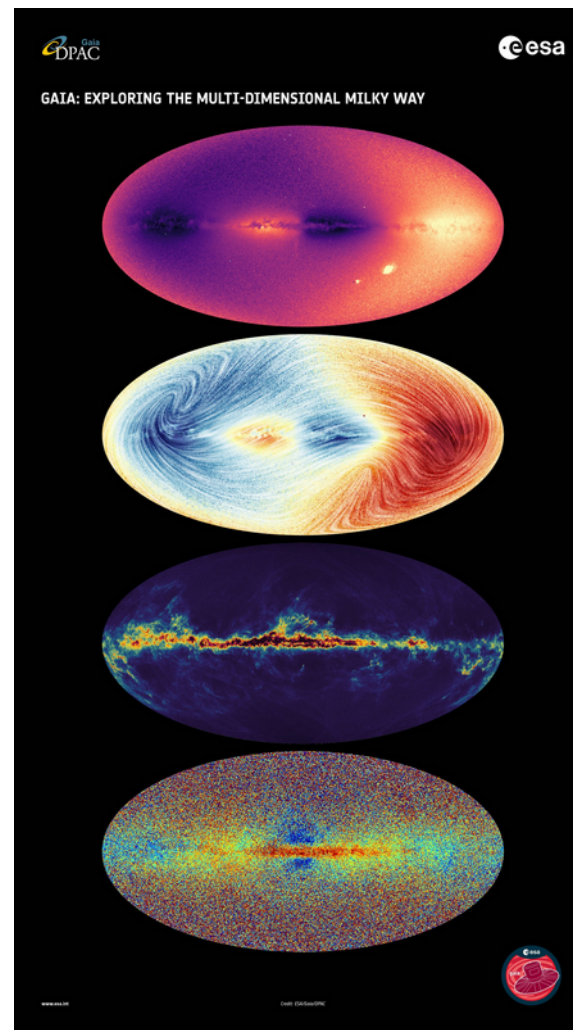




Gaia Science Team



- Nominated to join the **Gaia Science Team** (GST) from November 2022 (for 3 years, renewable)
- Milestones:
 - **Gaia Focused Product Release: October 2023**
 - Gaia end of life: early 2025
 - Gaia DR4 (based on 66 months of data) not before the end of 2025
 - Gaia DR5 (all data) not before end of 2030

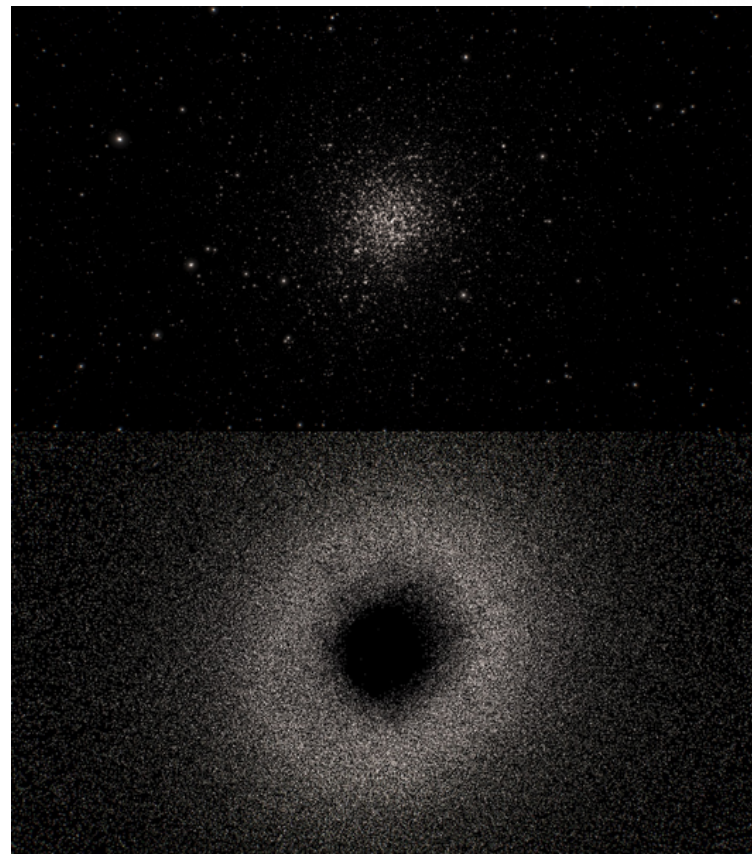




Gaia FPR



- 1) Astrometry and photometry from engineering images taken in the Omega Centauri region (+ 526 000 new sources)
- 2) 4.8 million sources around 3.8 million quasar candidates: 381 gravitational lens candidates
- 3) 9600 Long Period Variables with radial velocity time series
- 4) Detection of diffuse interstellar bands in 235 000 sources from stacked spectra
- 5) Orbits for 156 000 solar system objects + epoch astrometry based on 66 months of data



(New sources in the core of ω Cen)

Thank you for your attention

