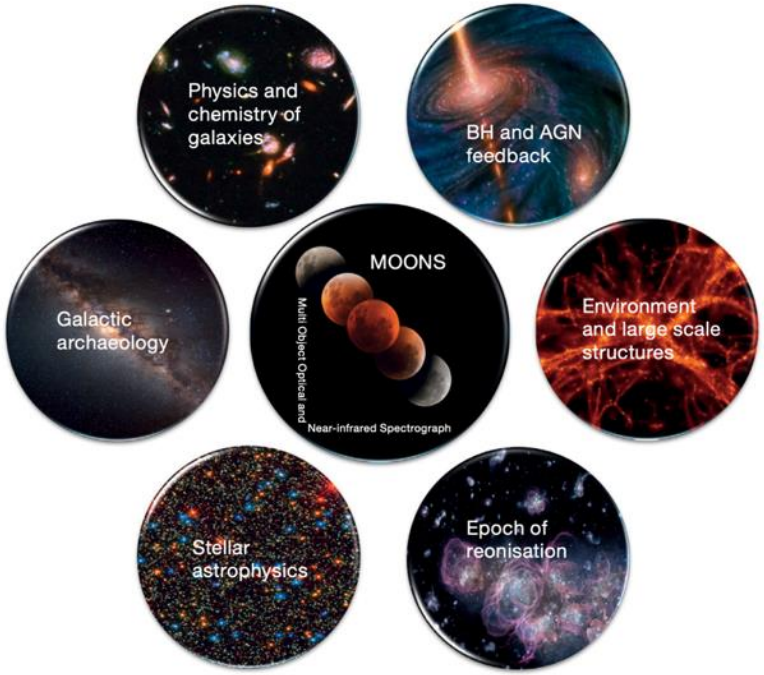
How 4MOST and MOONS will improve constraints on the dynamical masses of Local Group Galaxies

Steffen Mieske (ESO Chile), on behalf of many colleagues*

vltmoons.org



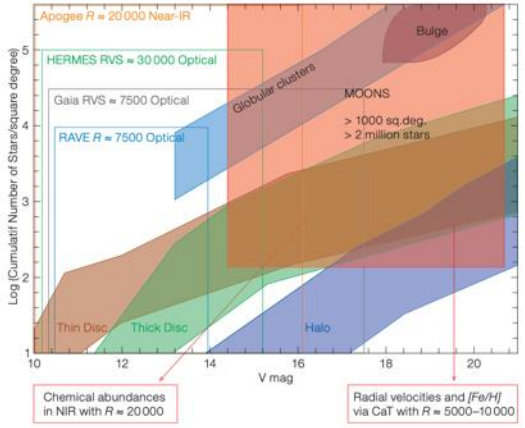
4most.eu

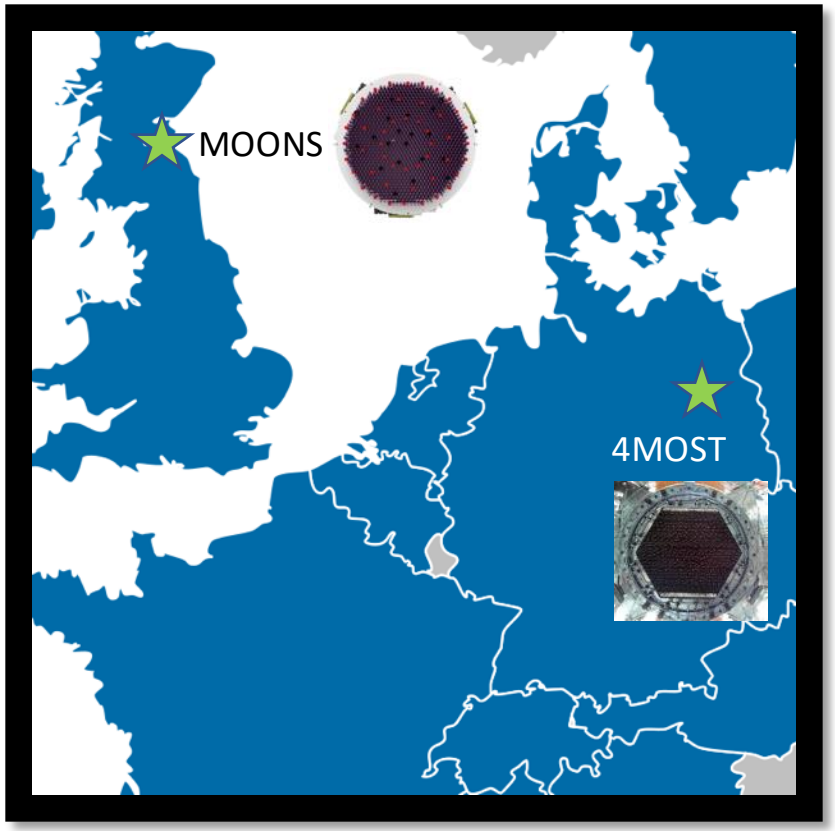
*Battaglia, Bayo, Cioni, Gonzalez, Mainieri, Mucciarelli, Schmidtobreick, Skuladottir, Szeifert

MOONS and 4MOST in a nutshell

MOONS:

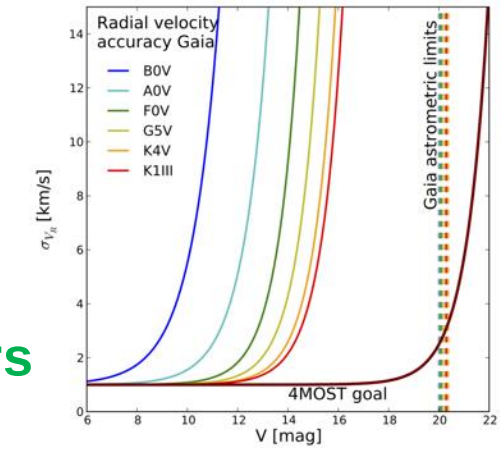
- MOS@UT1, 1000 fibers, 25’ ⌀
- 6500-18000 Å
- R~4000-20000
- **V<~21** mag for accurate v_{rad} (1hr)
- Start of operations: end of 2024
- 300 GTO nights & **open time**
- PI Cirasuolo (ESO)





4MOST:

- MOS@VISTA, 2400 fibers, 2.5º ⌀
- 3600-9500 Å
- R~4000-18500
- **V<~20** mag for accurate v_{rad} (1hr)
- Start of operations: end of 2024
- **Public surveys during first 5 years**
- PI de Jong (AIP)



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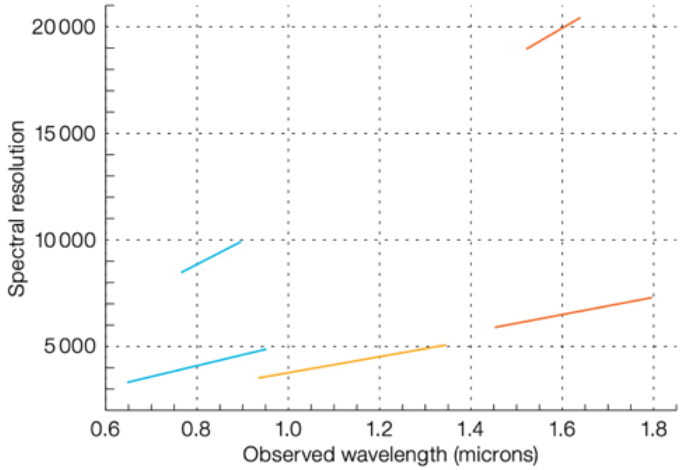
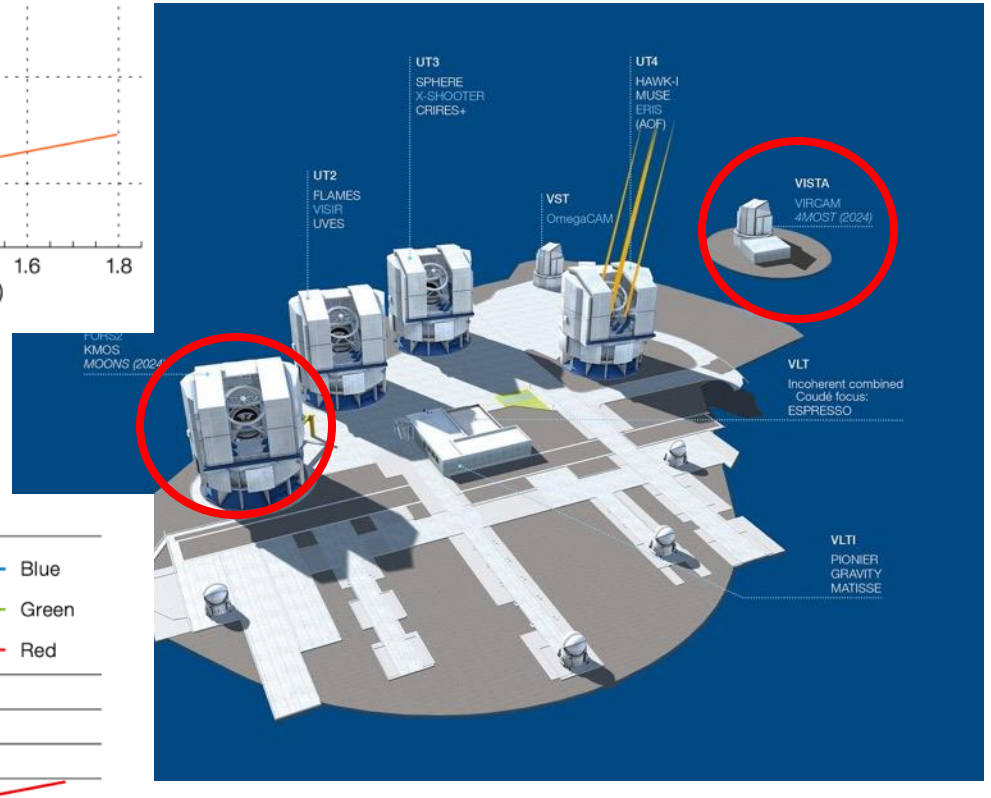


ESO Paranal



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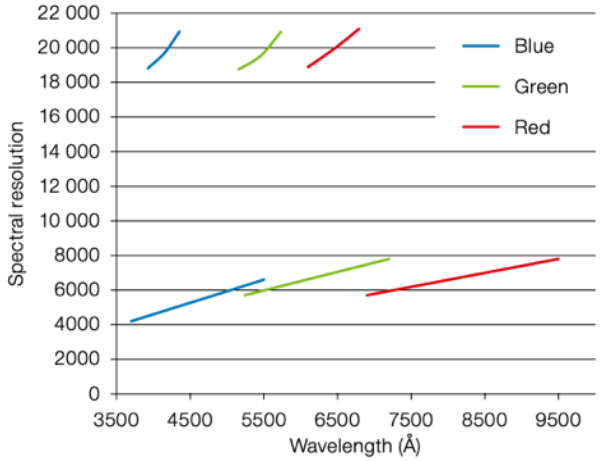


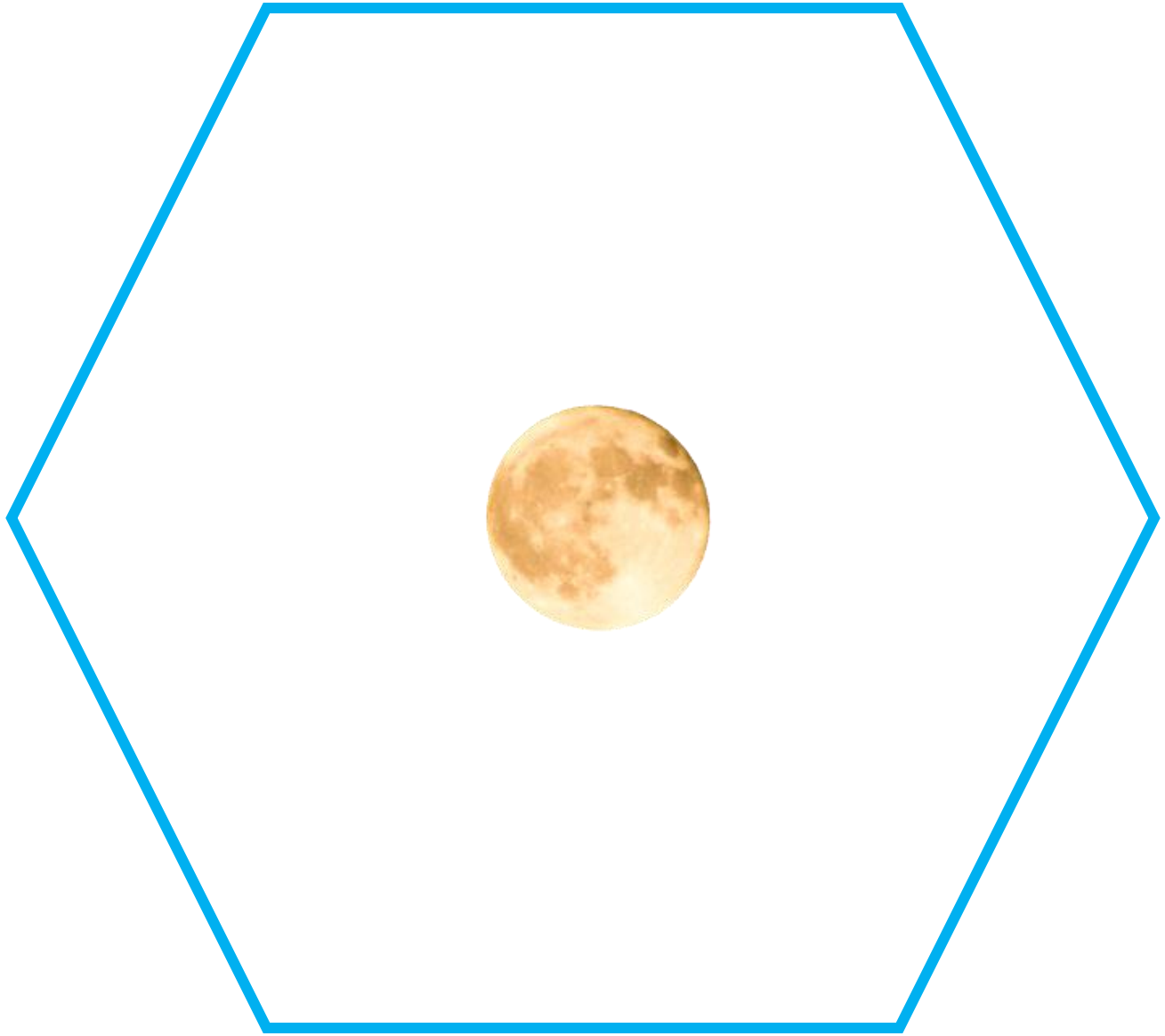
MOONS FOV 25’ ⌀
(full VLT FOV)

Fornax dSph*

Sculptor dSph*

*ESO DSS2

4MOST FOV 2.5º ⌀
(VISTA telescope)



Science programs with MOONS

100 GTO nights Galactic Surveys

- 70 nights bulge
- 30 nights MW satellites (MCs, Sgr, streams)

200 GTO nights Galaxy evolution

+ Open time

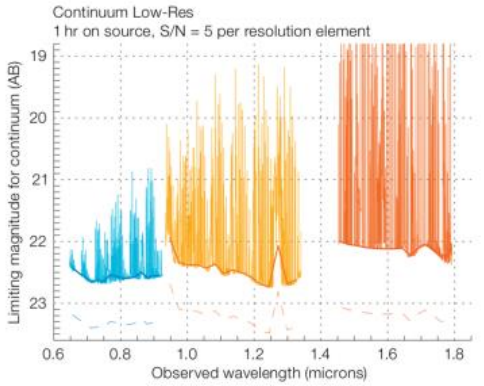
First Call for Proposals (CfP) expected **2024**

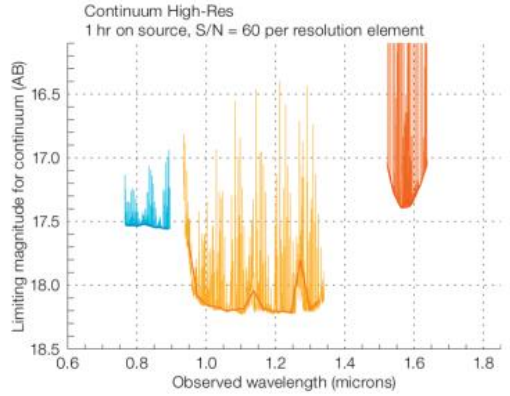
MOONS Galactic GTO program (100 nights)

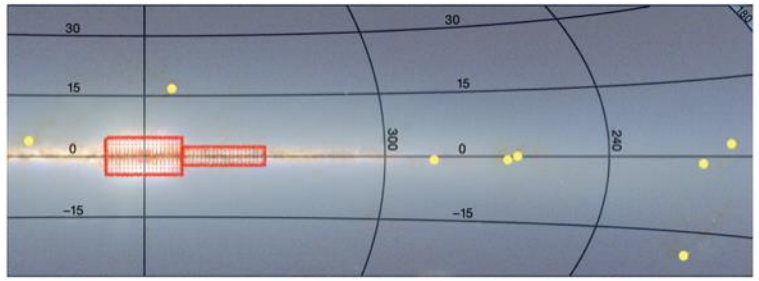
REDdened Milky WAY (REDWAY) survey and
Milky Way Satellites Survey
PI: González

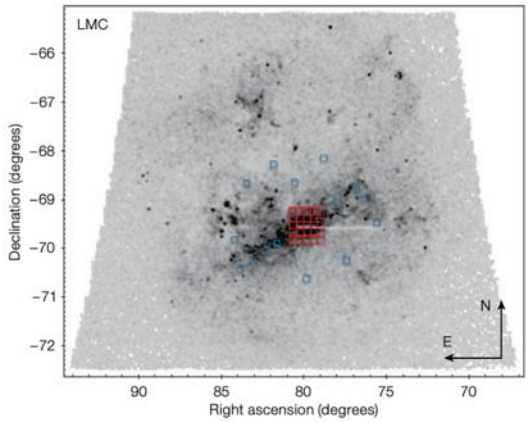
Goals:

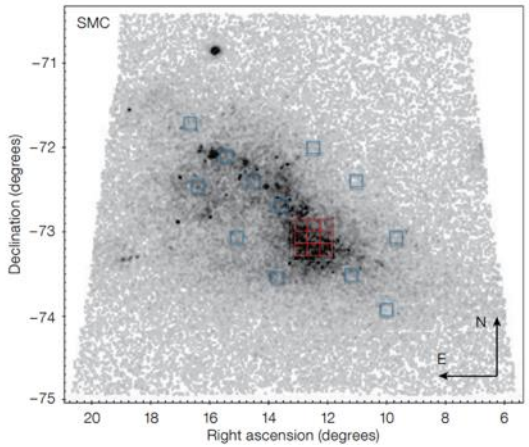
- Sample the chemodynamics of the stellar populations in the Galaxy's inner 3 kpc
- Sample the stellar populations in the central regions of the Magellanic clouds and in the Sagittarius galaxy and streams











Science programs with 4MOST

Galactic surveys:

Split in community (30% of time) and consortium (70% of time) public surveys

Stellar Clusters in 4MOST
Survey PI: Sara Lucatello (Osservatorio Astronomico di Padova)

White Dwarf Binary survey (WDB)
Survey PIs: Odette Toloza (Universidad Técnica Federico Santa María) and Alberto Rebassa (Universitat Politècnica de Catalunya)

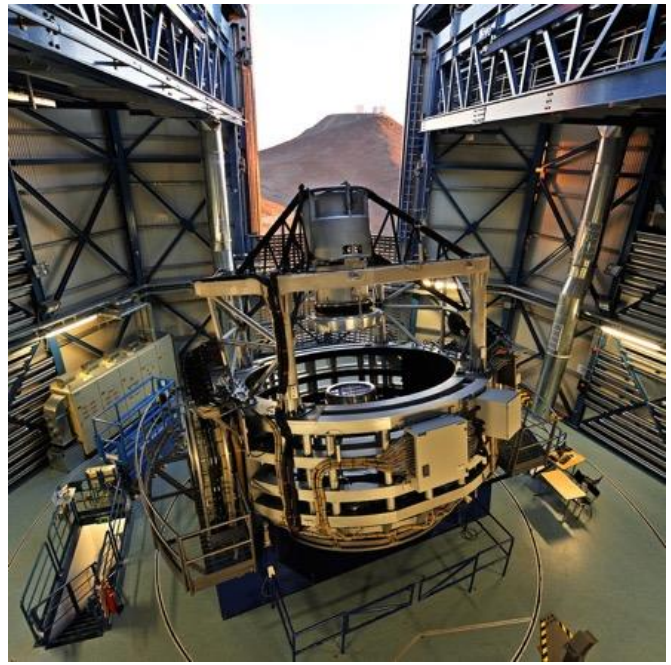
4MOST Survey of Young Stars (4SYS)
Survey PI: Germano Sacco (Osservatorio Astrofisico di Arcetri)

4MOST Gaia RRLyrae Survey (4GRoundS)
Survey PI: Rodrigo Ibata (Université de Strasbourg)

Spectroscopic Discovery of Binaries with Dormant Black Holes
Survey PIs: Michał Pawlak (Uniwersytetu Jagiellońskiego w Krakowie) and Tsevi Mazeh (Tel Aviv University)

4MOST survey of dwarf galaxies and their stellar streams: Small but fundamental (4DWARFS)
Survey PI: Ása Skúladóttir (Università degli Studi di Firenze)

Community
Galactic



Milky Way Halo Low Resolution Survey
Survey PIs: Else Starkenburg (Rijksunversiteit Groningen), Clare Worley (University of Cambridge)

Milky Way Halo High Resolution Survey
Survey PI: Norbert Christlieb (Universität Heidelberg)

Milky Way Bulge and Disk Low Resolution Survey (4MIDABLE-LR)
Survey PIs: Cristina Chiappini (Leibniz-Institut für Astrophysik Potsdam), Ivan Minchev (Leibniz-Institut für Astrophysik Potsdam)

Milky Way Bulge and Disk High Resolution Survey (4MIDABLE-HR)
Survey PIs: Thomas Bensby (Lunds universitet), Maria Bergemann (Max-Planck-Institut für Astronomie)

The Thousands and One Magellanic Clouds fields Low and High Resolution Survey (1001MC)
Survey PI: Maria-Rosa Cioni (Leibniz-Institut für Astrophysik Potsdam)

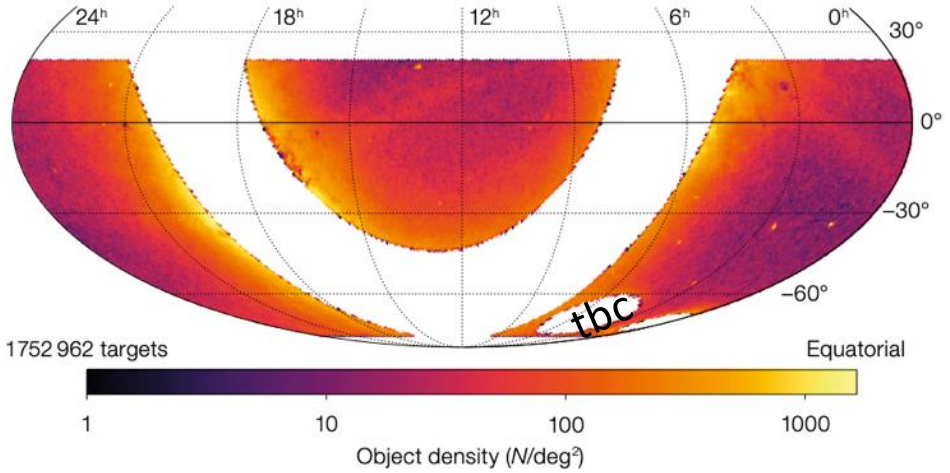
Consortium
Galactic

4most.eu

4MOST surveys aimed at constraining dynamical masses of LG galaxies

4MOST Consortium Survey 1: The Milky-Way Halo Low-Resolution Survey
PIs: Starkenburg & Worley. https://doi.eso.org/10.18727/0722-6691/5120

Goals:
- Determine density profile, shape and characteristic parameters of the DM halo of the Milky Way, including testing alternative theories of gravity such as MOND.
- Measurement of perturbations induced by clumps on the spatial and kinematic properties of cold streams, leading to constraints on the mass spectrum of perturbers and the nature of DM
- Quantifying the amount of kinematic substructure as a function of distance and location on the sky



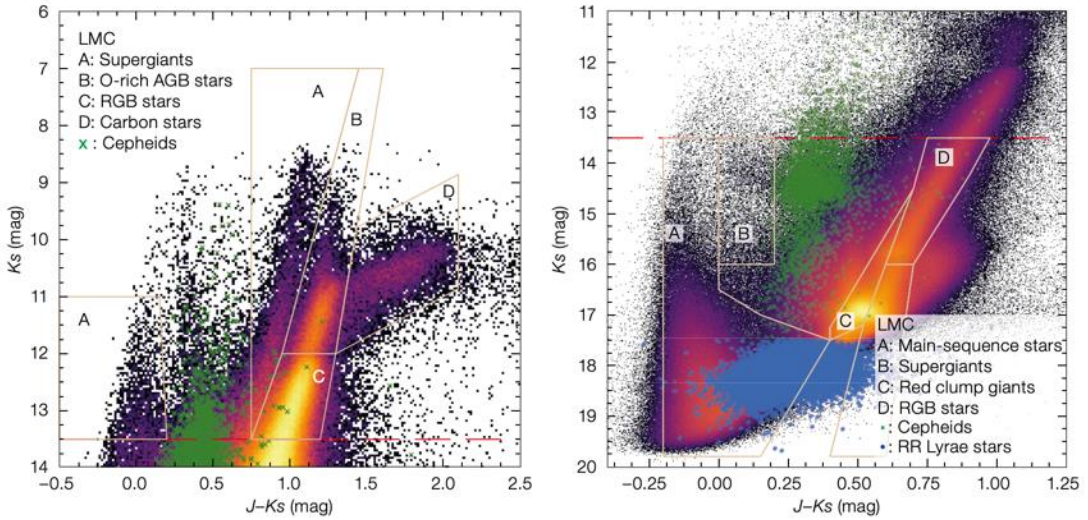
4MOST surveys aimed at constraining dynamical masses of LG galaxies

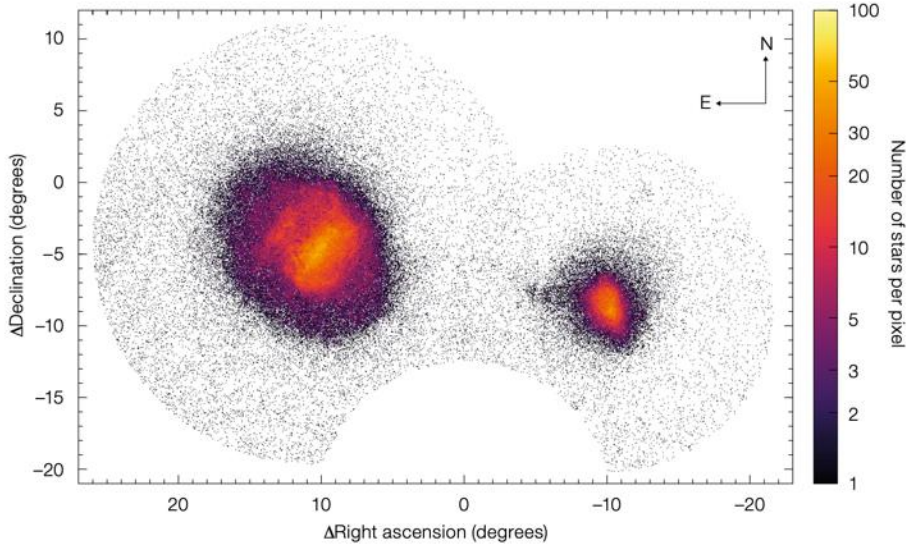
4MOST Consortium Survey 5: The Thousand and One Magellanic Cloud Fields Low- and High-resolution Survey (1001MC)

PI: Cioni http://www.eso.org/sci/publications/messenger/archive/no.175-mar19/messenger-no175-54-57.pdf

Goals:

- Identify chemical and kinematical patterns in the Magellanic Clouds, and their interrelations
- Establish how star formation history and dynamical evolution of the MCs are linked to those patterns
- Quantify metallicity dependence of key distance indicators
- Study physical and wind properties of massive stars





4MOST surveys aimed at constraining dynamical masses of LG galaxies

4MOST Community survey 4: Gaia RRLyrae Survey
PI Ibata

Goals:
- Reveal the six-dimensional structure of the outer MW
- Derive non-parametric measure of the MW's dark matter distribution in 3D

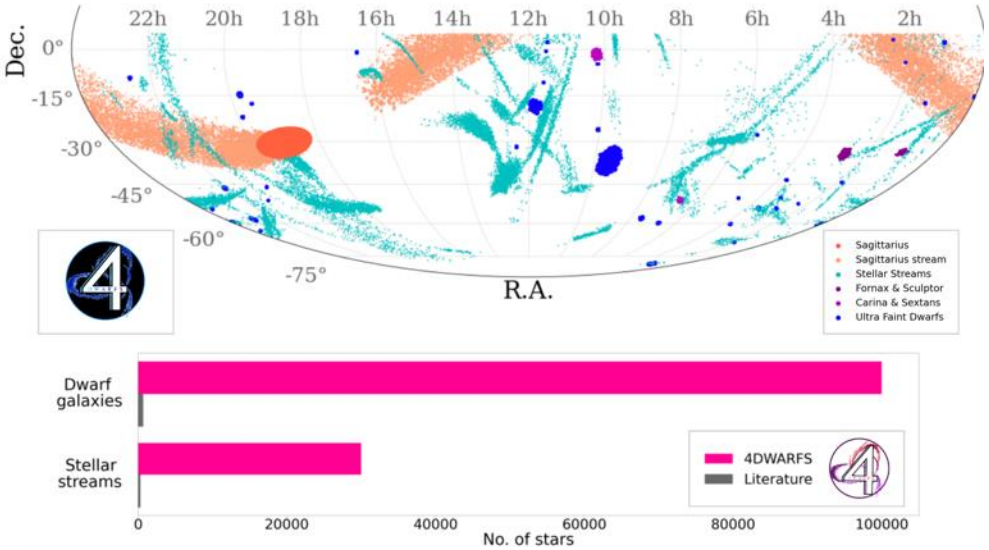
→ Increase by 2 orders of magnitude the number of RRLyrae with measured v_{rad}

4MOST surveys aimed at constraining dynamical masses of LG galaxies

4MOST Community survey 6: [Survey of dwarf galaxies and their stellar streams: small but fundamental (4DWARFS)](#). PI Skuladottir

Goals:

- Constrain dynamical masses
- Identify and study kinematical substructures
- Derive chemo-chrono-dynamical mapping
- Constrain binary distribution from repeat observations



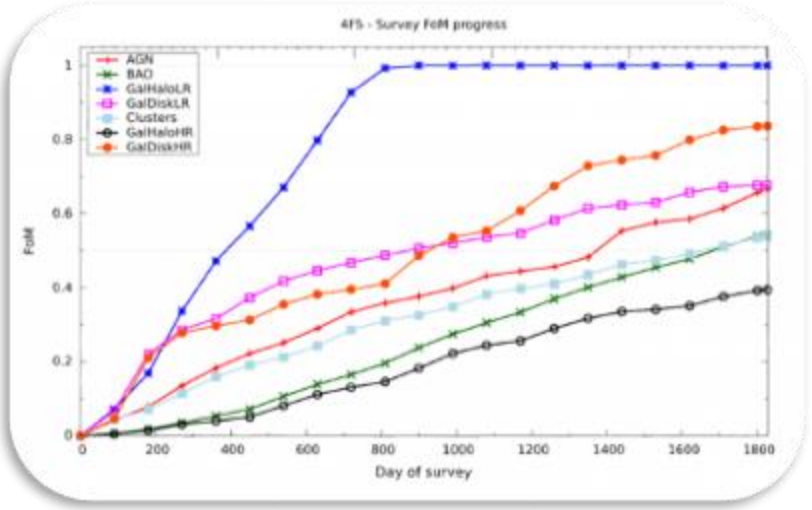
→ 130000 target stars in total

Community data access

4MOST @ VISTA: data products from surveys

The first five years of operations, 4MOST will execute exclusively Public Surveys that have already been selected, see also previous slides.

- **raw data become public immediately** (but no public pipeline available)
- **data products to be released on a ~yearly basis** (spectra, physical parameters, catalogues)
- **MW halo survey could be the first one to be completed**



Preliminary!! – https://www.4most.eu/cms/operations/surveysimulations/

Community data access

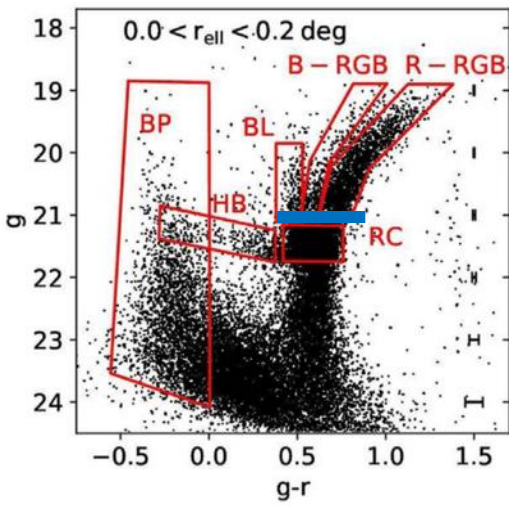
MOONS @ UT1: open time proposals

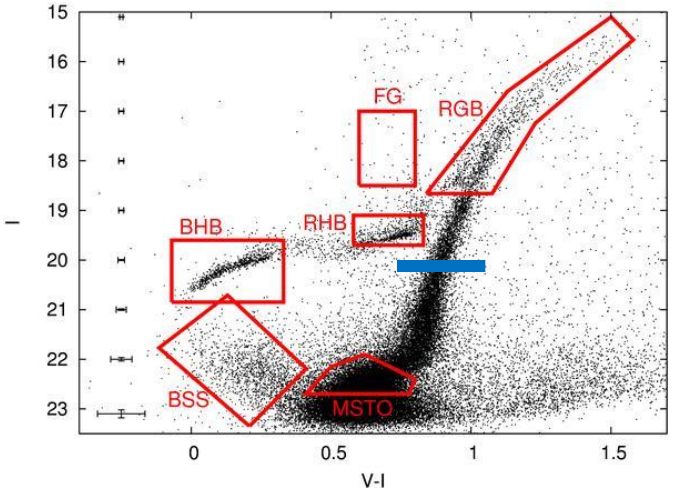
- Offered for observations by end of 2024 via regular CfP
- A public data reduction pipeline will be available

Kinematical studies of LG dwarfs under-represented in GTO

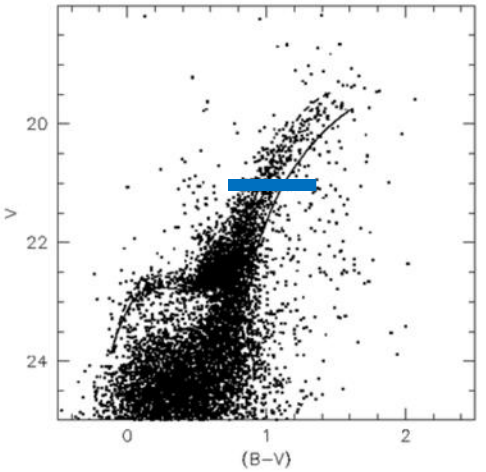
- Very good stability of MOONS line-spread function
  - MOONS to reach 0.5 km/s in HR, ~2 km/s in LR (σ of LG dwarfs 4-10 km/s)
  - Limiting mag V~21 for S/N=20 in LR (1 mag deeper than GAIA astrometry)

Fornax dSph
(Wang+ 2019)





Sculptor dSph
(de Boer+ 2011)



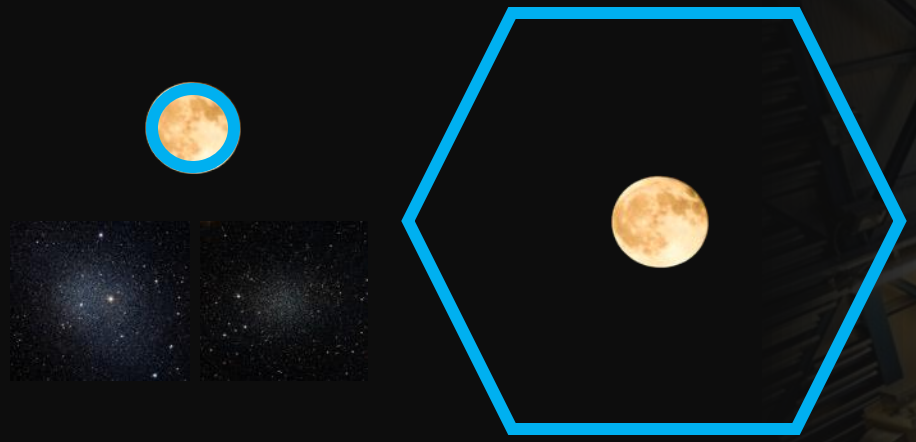
Leo dSph
(Saviane+ 2000)

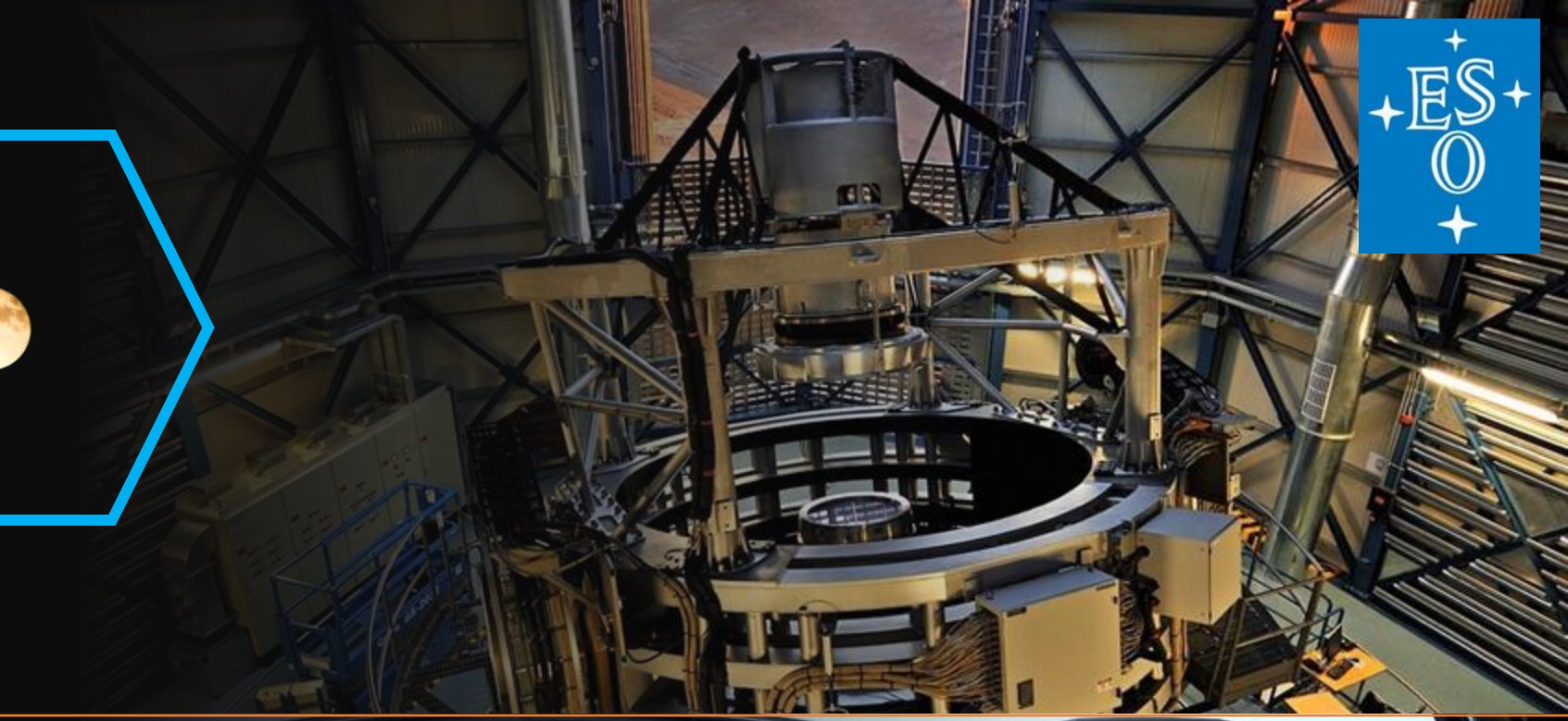
Science questions in the field of this conference that MOONS and 4MOST will help to address

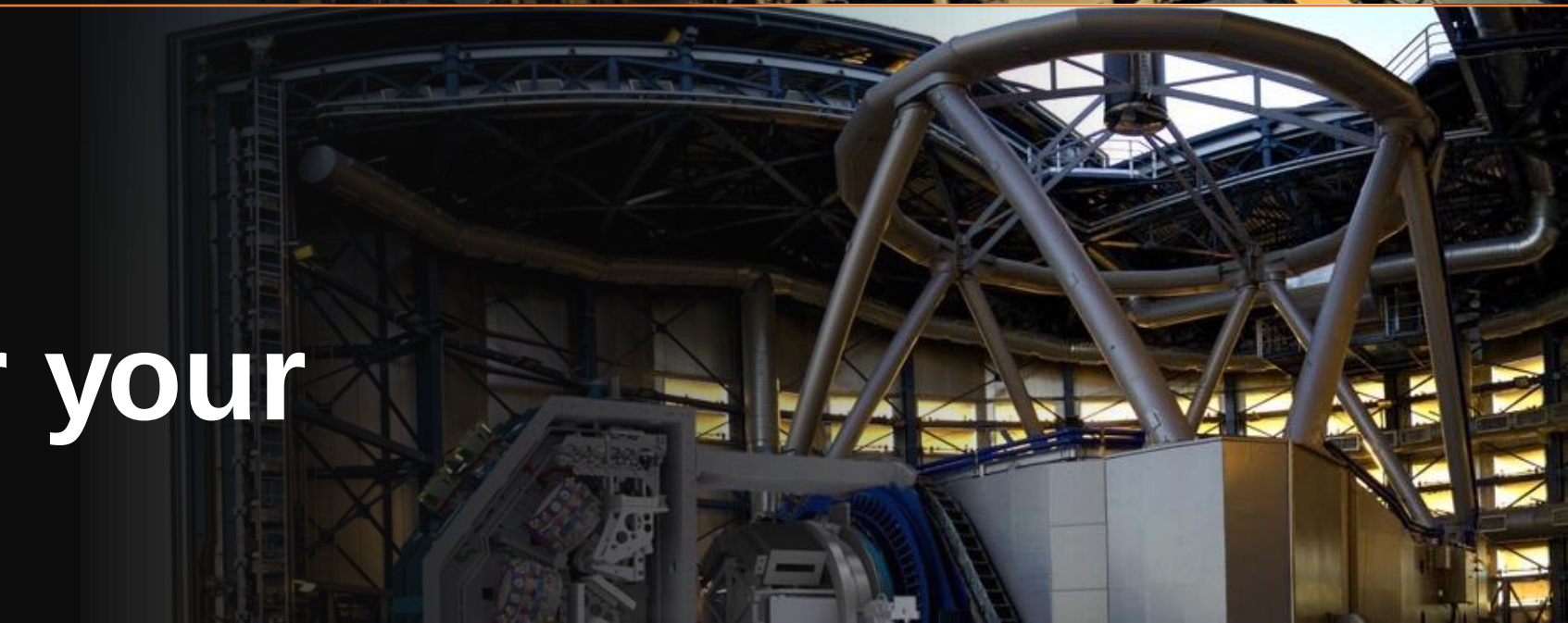
- **Constrain the gravitational potential and dark matter halo of the Milky Way, test alternative gravity theories**
  - 4MOST community survey 4GROUNDS (Ibata), 4MOST consortium survey 1 (Starkenburg)

- **Identify and characterize kinematical and chemical sub-structures of LG dwarf galaxies**
  - 4MOST community survey 4DWARFS (Skuladottir), 4MOST consortium survey 1001MC (Cioni)
  - MOONS GTO: MCs & SgrDwarf (González)
  - **Opportunity for MOONS open time on LG dwarfs!**

- **Characterise properties of stellar streams**



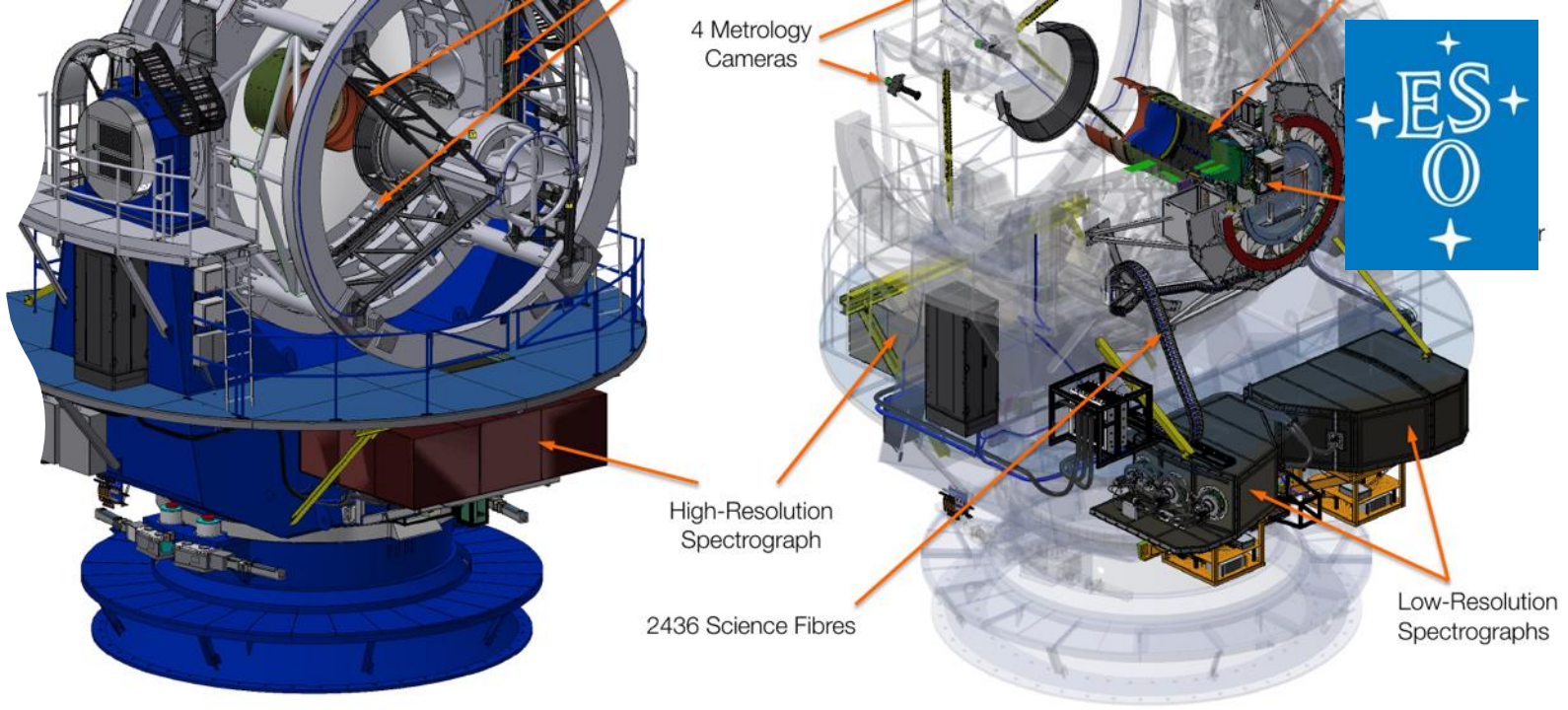


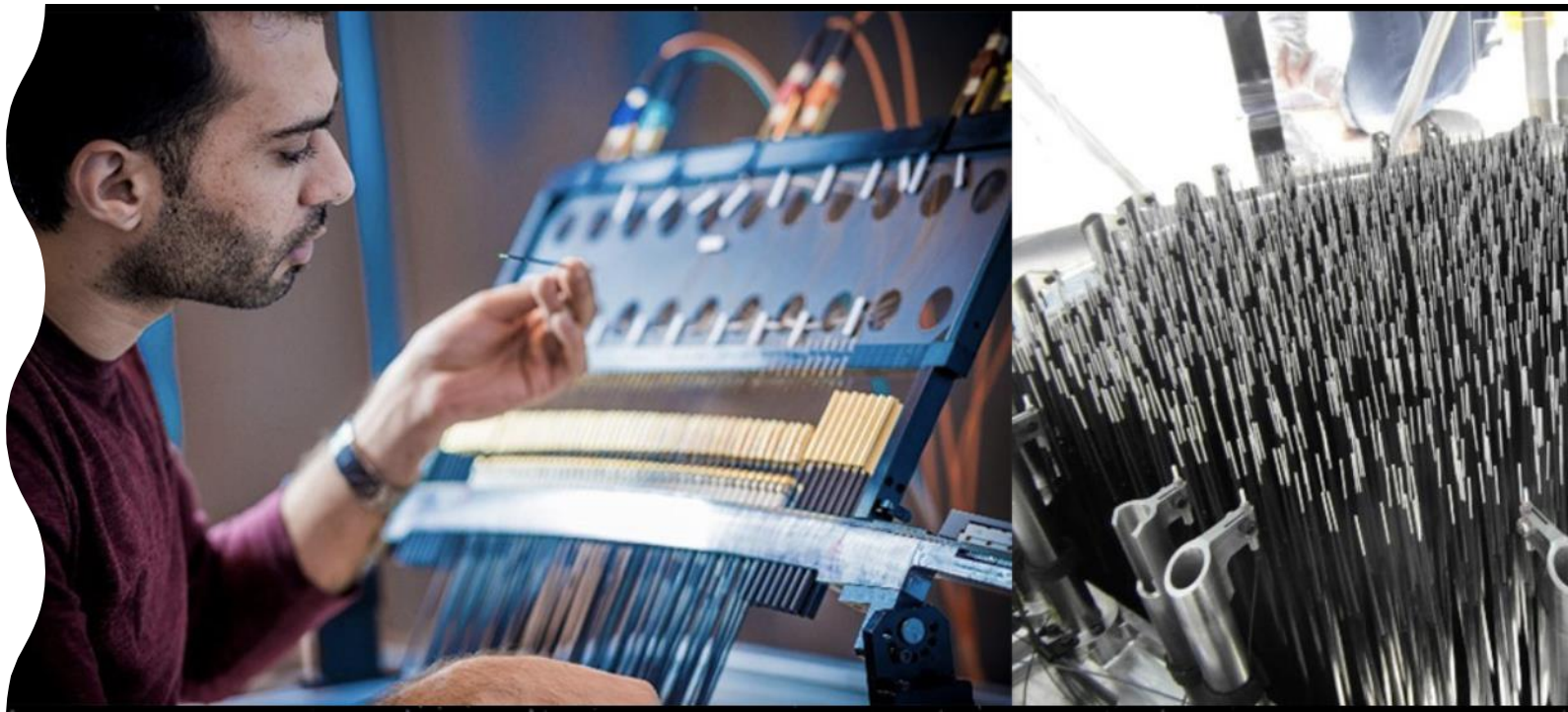


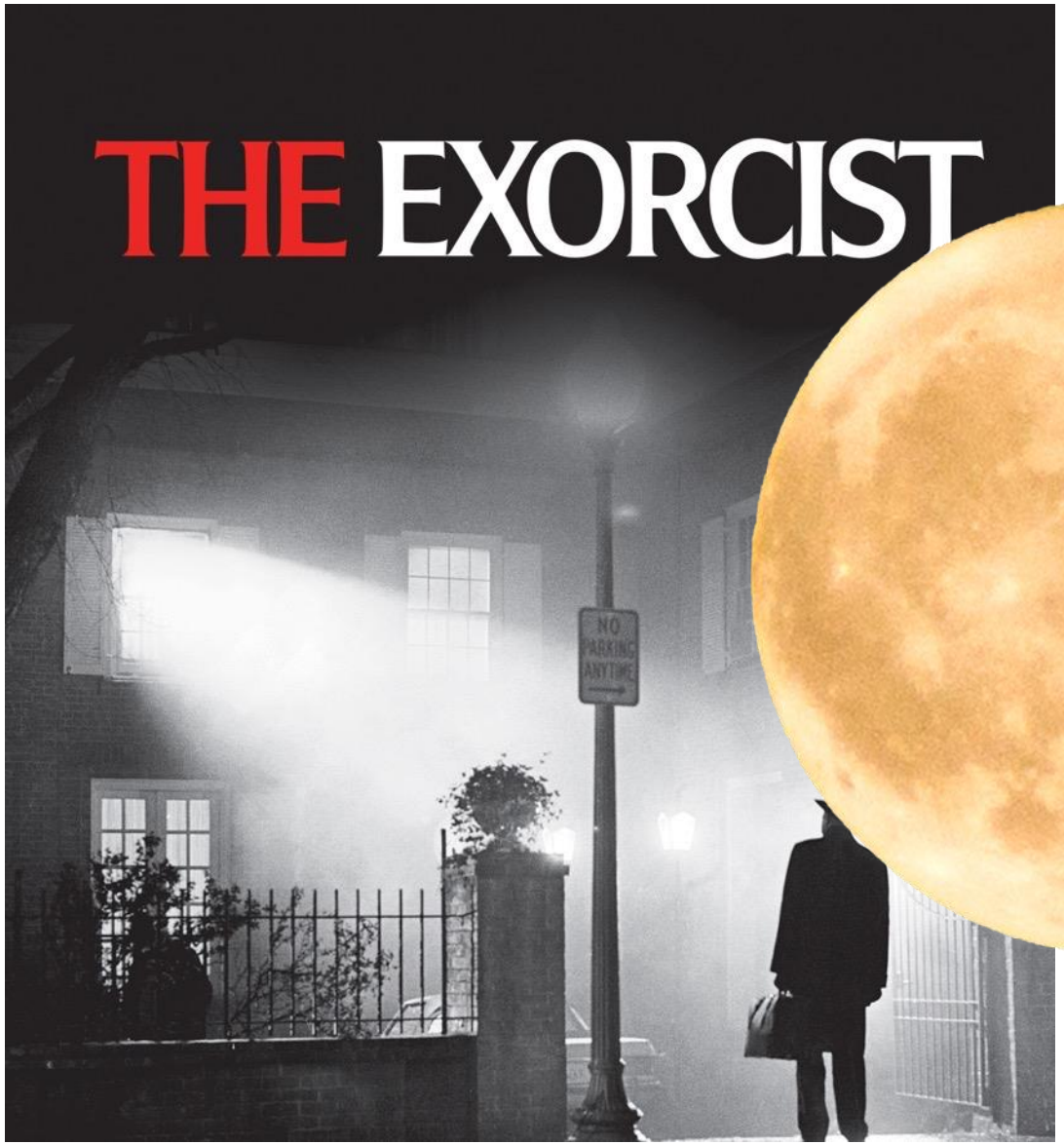
Thanks for your attention

4MOST operations model

- Data for different surveys are taken simultaneously in each exposure
- Instrument consortium takes a service role for the community during the preparation of Observing Blocks and data processing
- Shared responsibility ESO & consortium






THE EXORCIST
NO PARKING ANYTIME