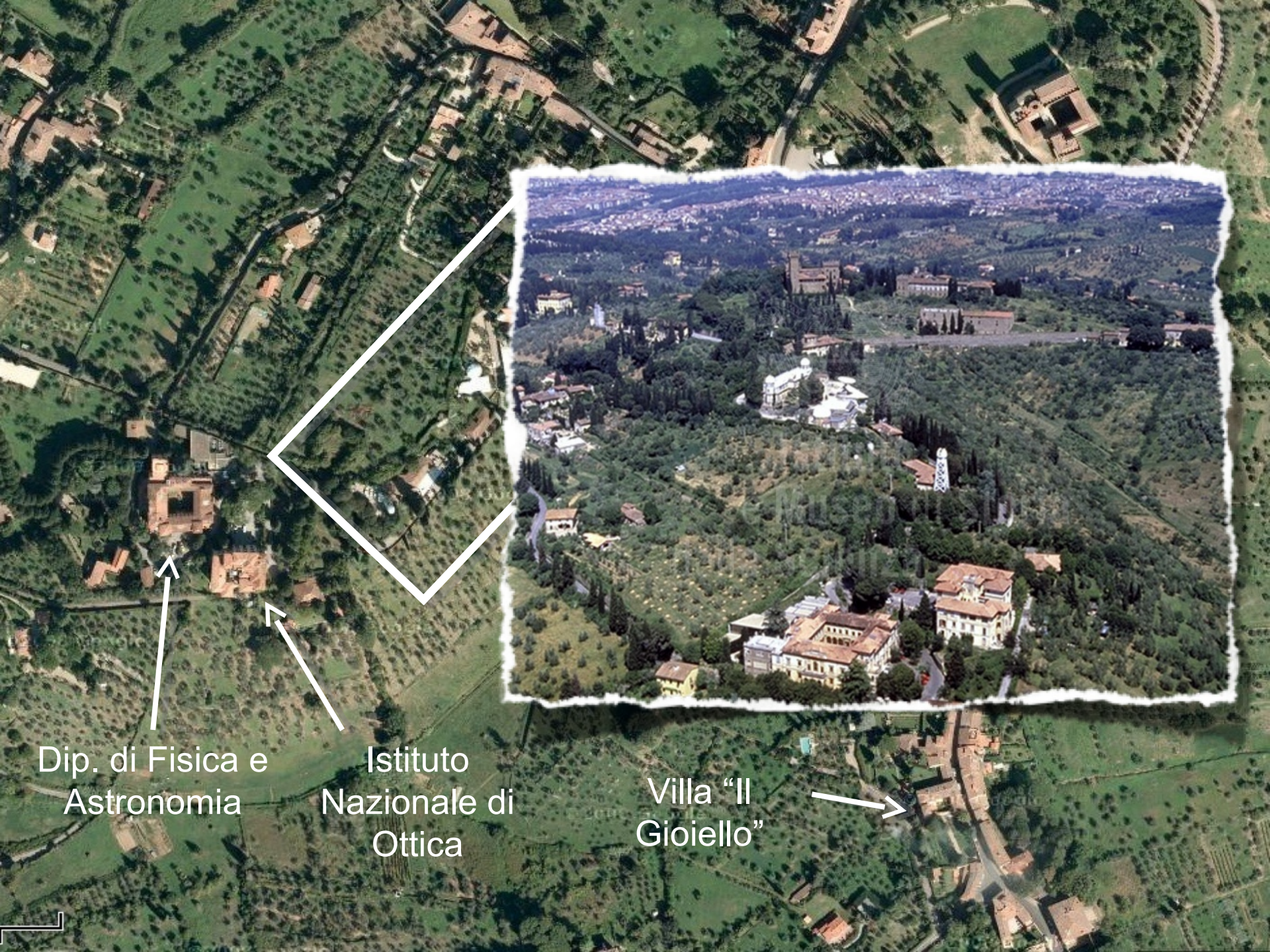
Arcetri Observatory: Astrophysics & Technology


Dip. di Fisica e Astronomia
Istituto Nazionale di Ottica
Villa “Il Gioiello”

INAF

ISTITUTO NAZIONALE
DI ASTROFISICA

NATIONAL INSTITUTE
FOR ASTROPHYSICS

- Italian Astronomic Observatories and former CNR Institutes
- 17 Institutes + TNG
- ~ 1200 employees

People

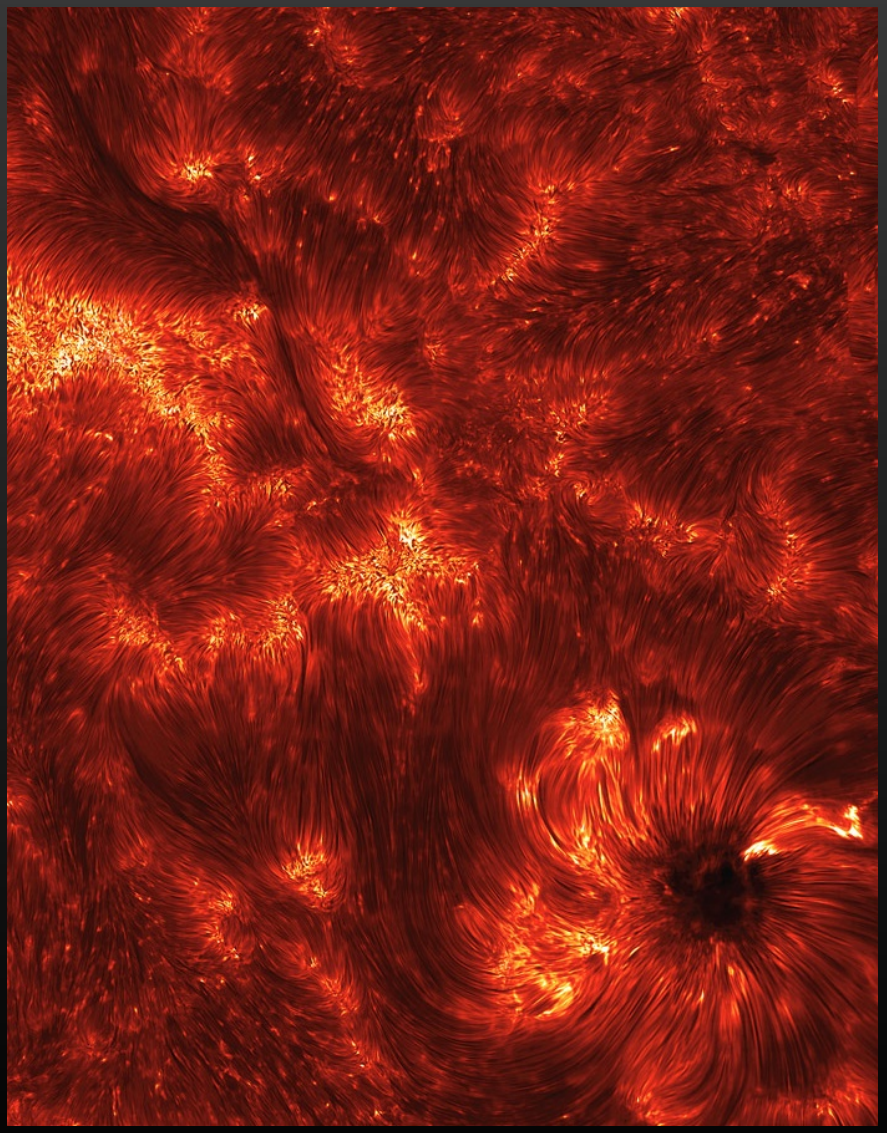
~ 120 employees:
- 60 astronomers/technology staff
- 30 technical-administrative
- 30 PhD/post-doc (15-20 calls/year)

Close cooperation with the Astronomy group of UniFi

Univ. di Firenze
Dip. Di Fisica

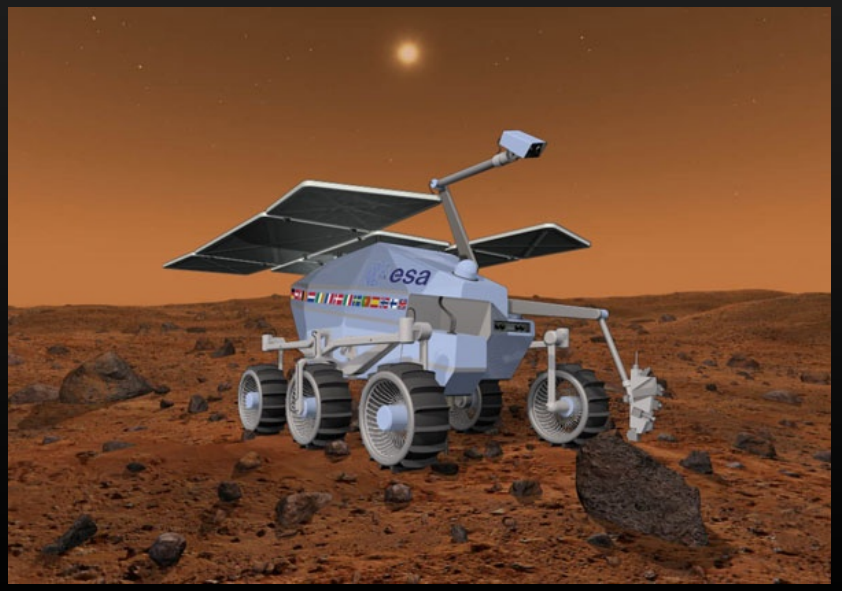
Astrophysics: Sun & Plasma Physics

- Historicaly relevant
- Both theoric and instrumental activity
  - Astrophysical plasma
  - Acoustic wave propagation and chromospheric shocks
  - Turbolence
  - Instrumentation (IBIS)



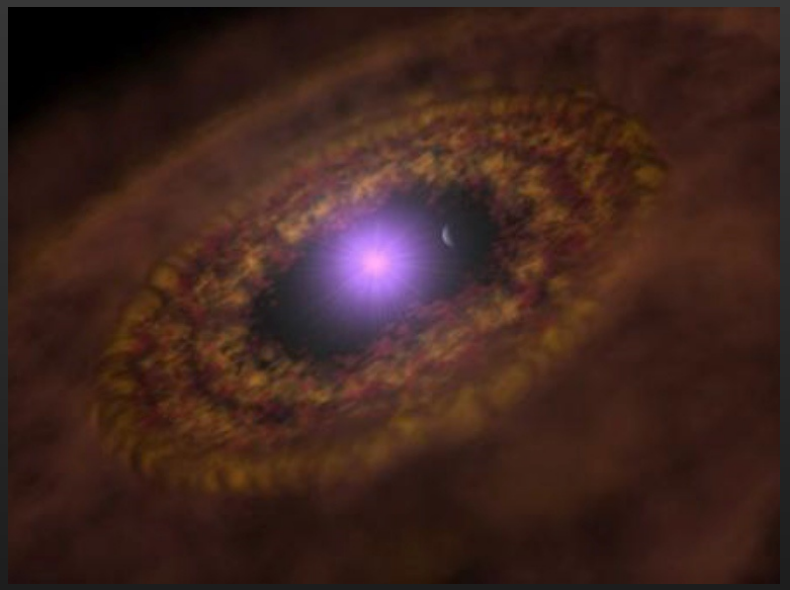
Astrophysics: Solar system & Astrobiology

- Planet formation, origin and diffusion of organics
- Comets, Asteroids
- Planetary explorations
  - Marco Polo-R: sample return mission
  - Stardust: Cometary dust
  - Exomars: Search for life on Mars (life marker chip)



Astrophysics: Star Formation

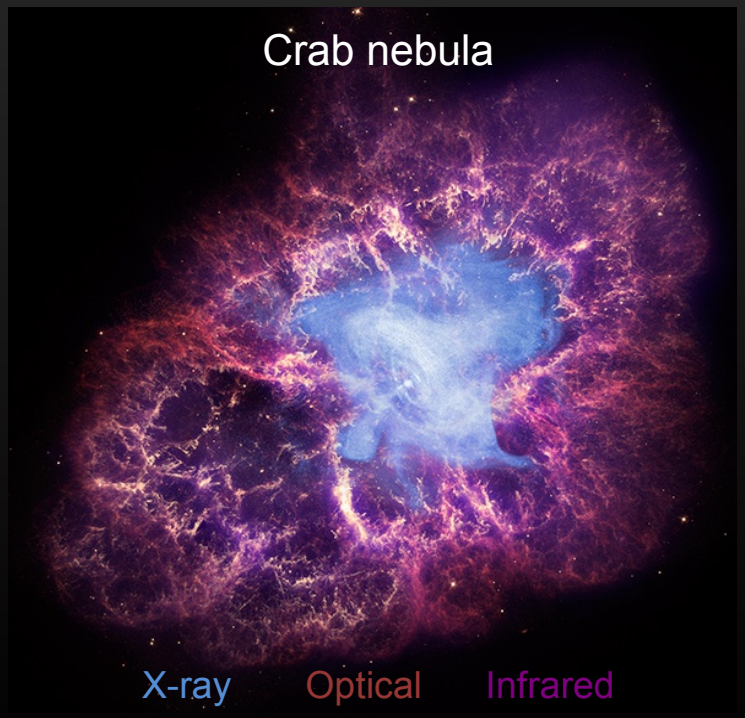
- Radio, sub-mm e infrared observations
- Chemistry of the interstellar medium
- Protostellar disks-jets

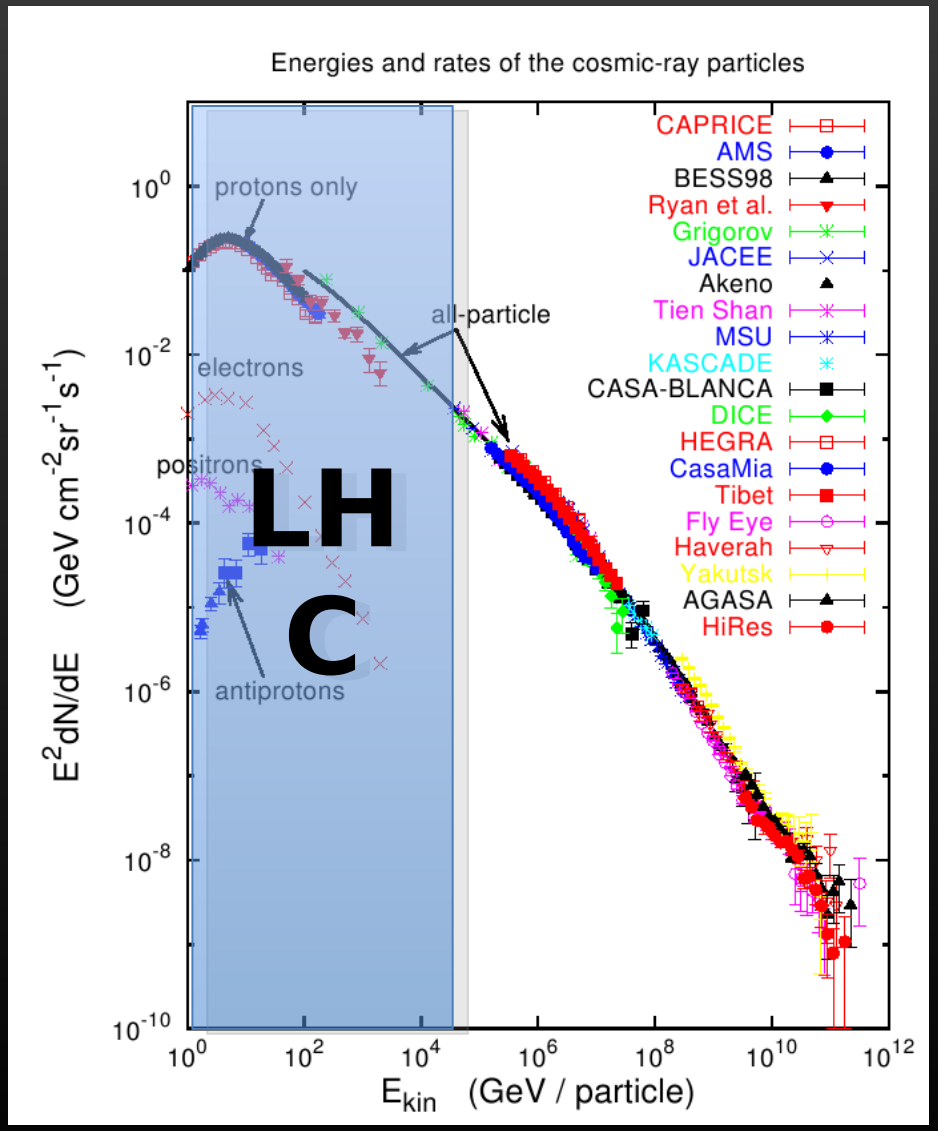


Astrophysics: High Energies

Theoric studies on:

- Cosmic rays acceleration
- Supernovae remnants
- Neutron stars
- pulsars





Astrophysics: Galaxies

- Coalescence of cosmologic dark matter halos
- Origin of stars inside dark matter halos
- Diffuse matter (gas, dust, metals)
- Supernovae

Multiwavelength observations

X-ray

Optical

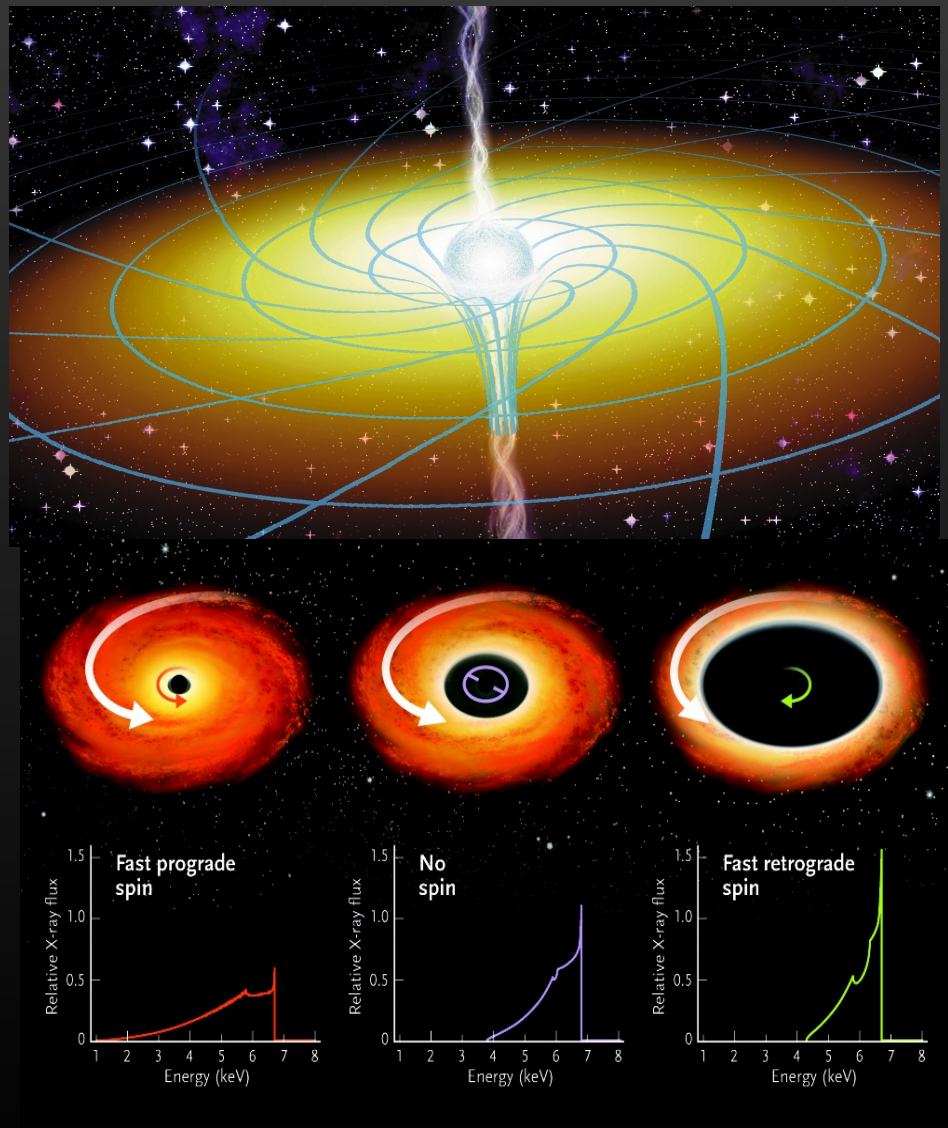
Hα

Infrared

Astrophysics: Active Galactic Nuclei

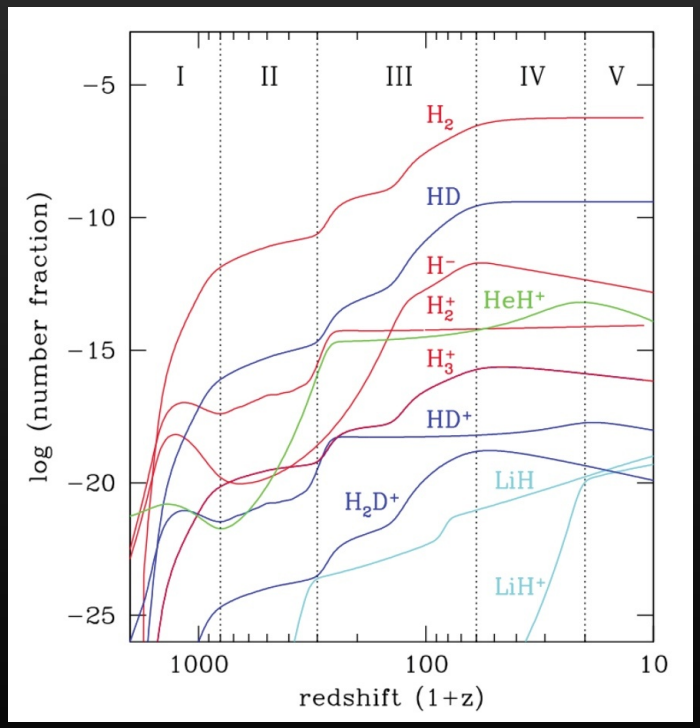
- Supermassive (10^7-10^9 Msun) BH in galactic centers - Quasars

- Co-evolution galaxies-BH
- GR test in strong field regime

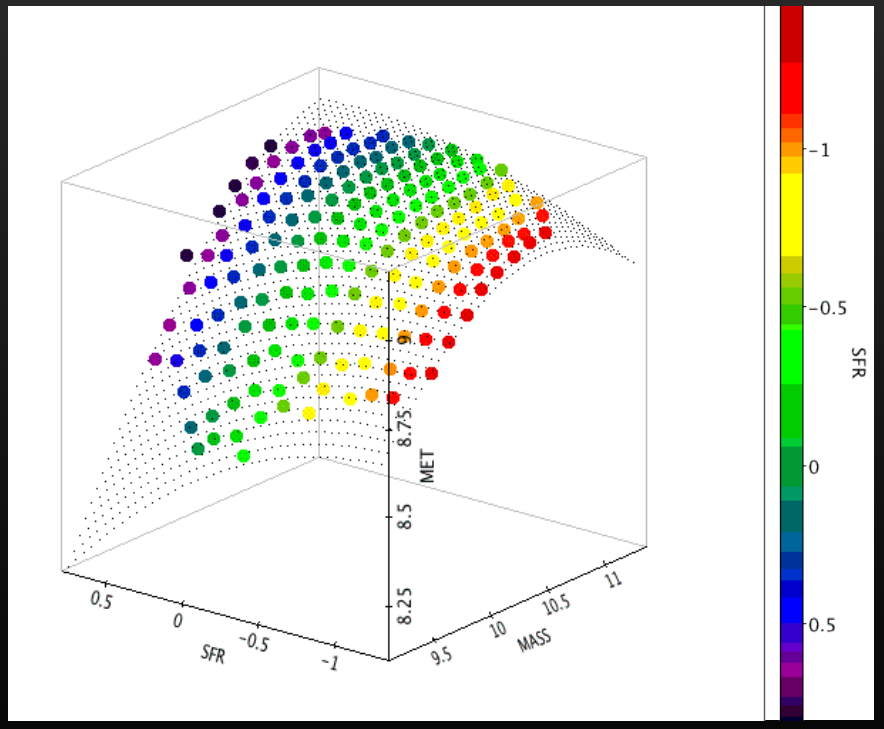


Elements formation-evolution

- Matal abundances: cosmology and star formation history



Molecules in cosmology



Chemical elements in galaxies

LBT: Large binocular telescope

2 x 8.4m
New generation:
1.Adaptive optics
2.Interferometry

4 partners:
1.INAF – I
2.Max-Planck – D
3.Arizona – USA
4.RC – USA

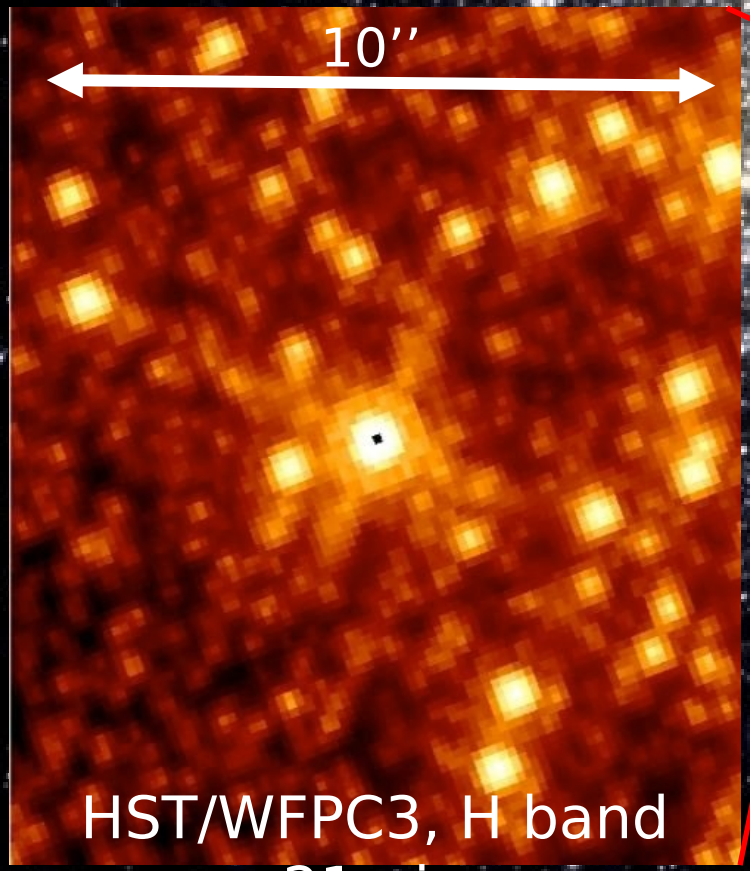
12 store height

Mount Graham (Arizona)

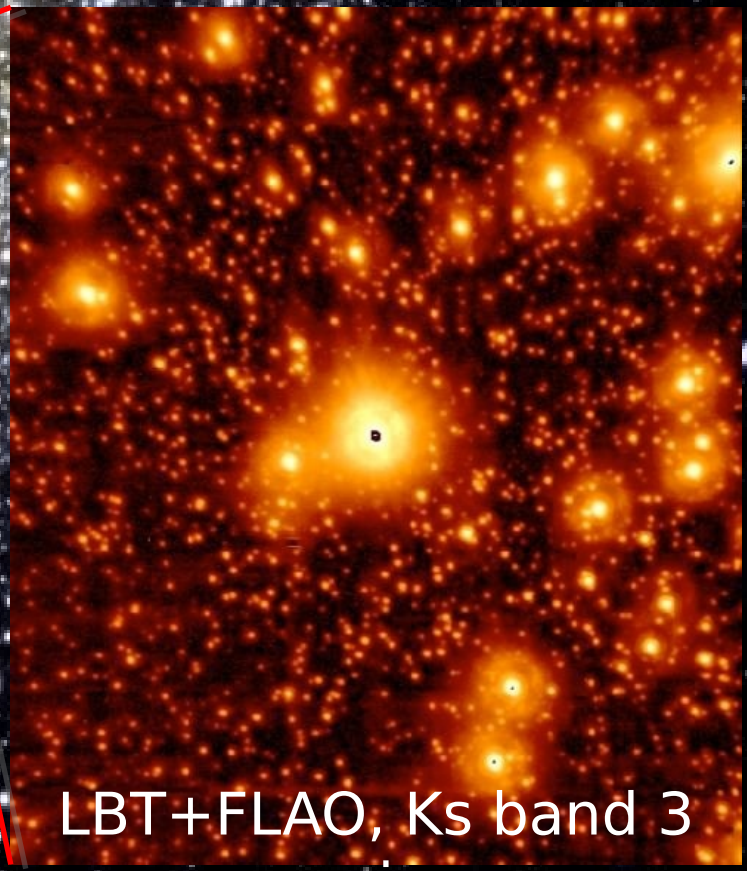
Arcetri: Adaptive optic systems

- Deformable mirrors (674 actuators, 1kHz)
- Wavefront sensor
- Laser guide star system

Adaptive optics



HST/WFPC3, H band
21min



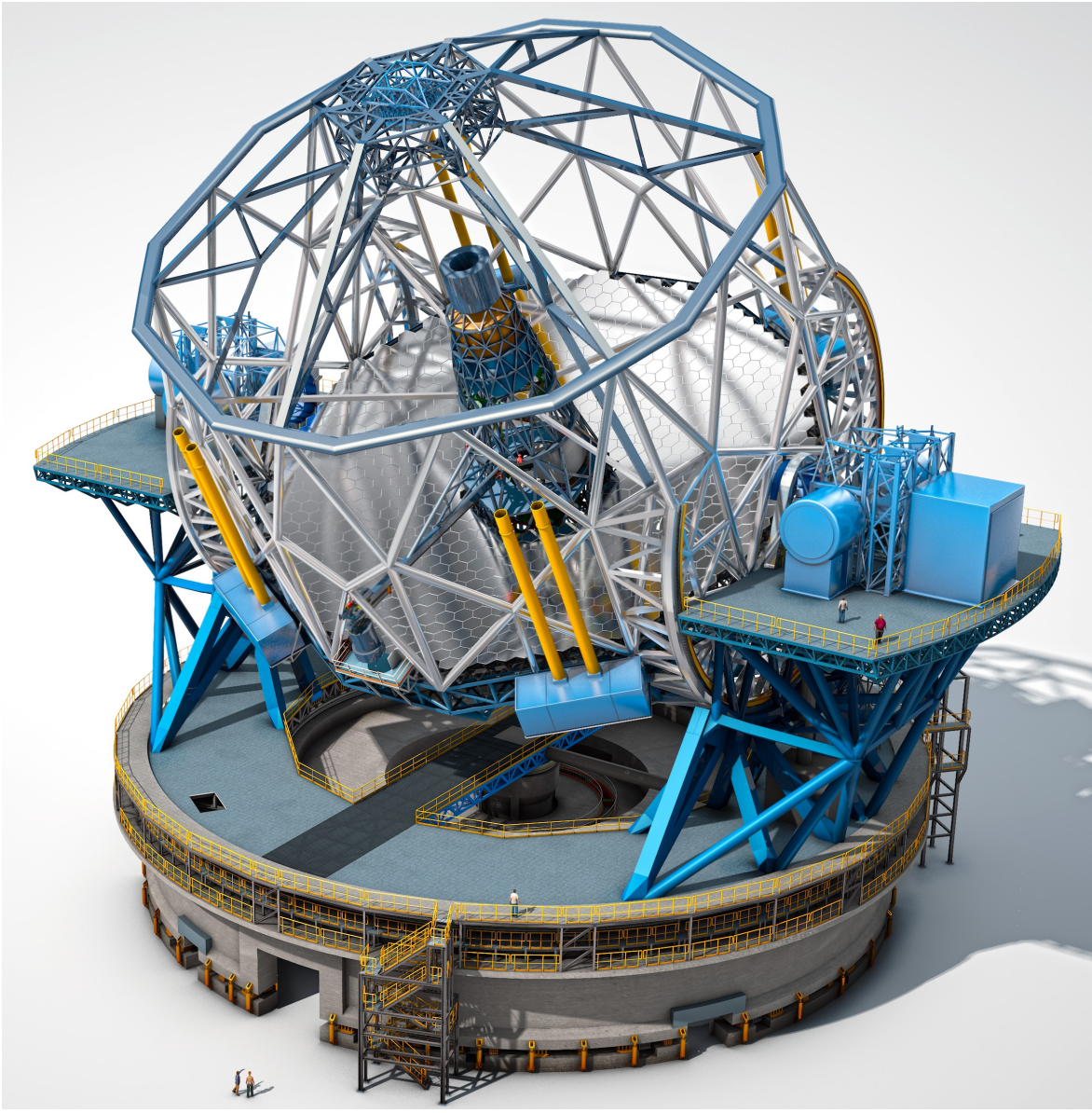
LBT+FLAO, Ks band 3
min

E-ELT:
European extremely-Large Telescope

39m

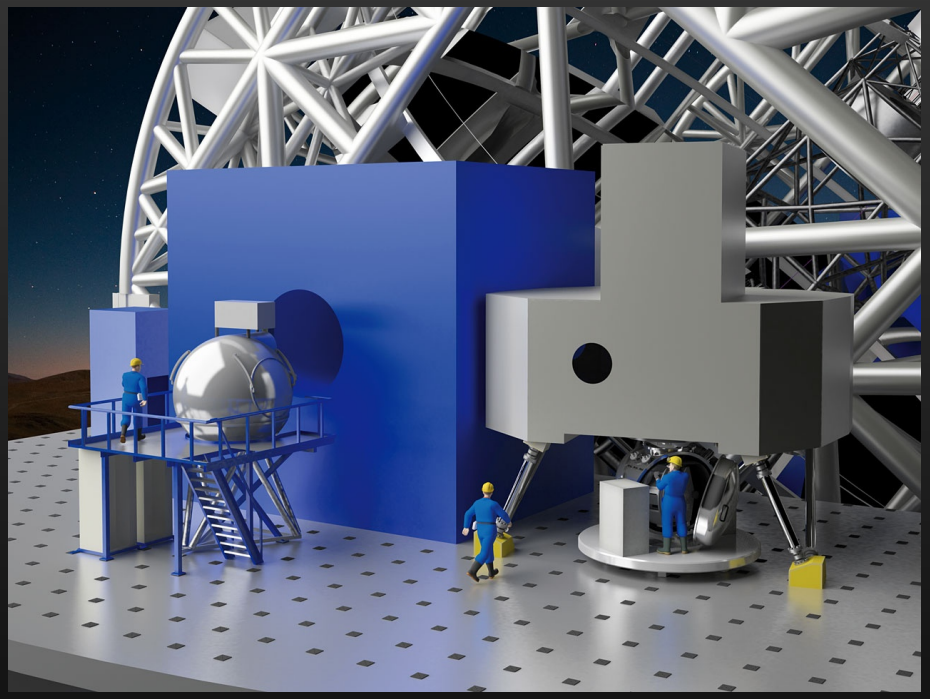
1.Large collecting area

2.Large angular resolution



ELT Instrumentation

1. ELT-IFU (integral-field spectrograph + LTAO+GLAO
2. ELT-CAM (high-resolution camera) + MAORY (adaptive-optics module)
3. ELT-VISIR (mid-IR istrument) + SCAO
4. ELT-HIRES (high-resolution 400-2500nm spectrograph) + SCAO
5. ELT-MOS (multi-object spectrograph) + GLAO
6. ELT-PCS (spectrograph for exoplanet atmospheres) + XAO



Radioastronomy group: Astrophysics

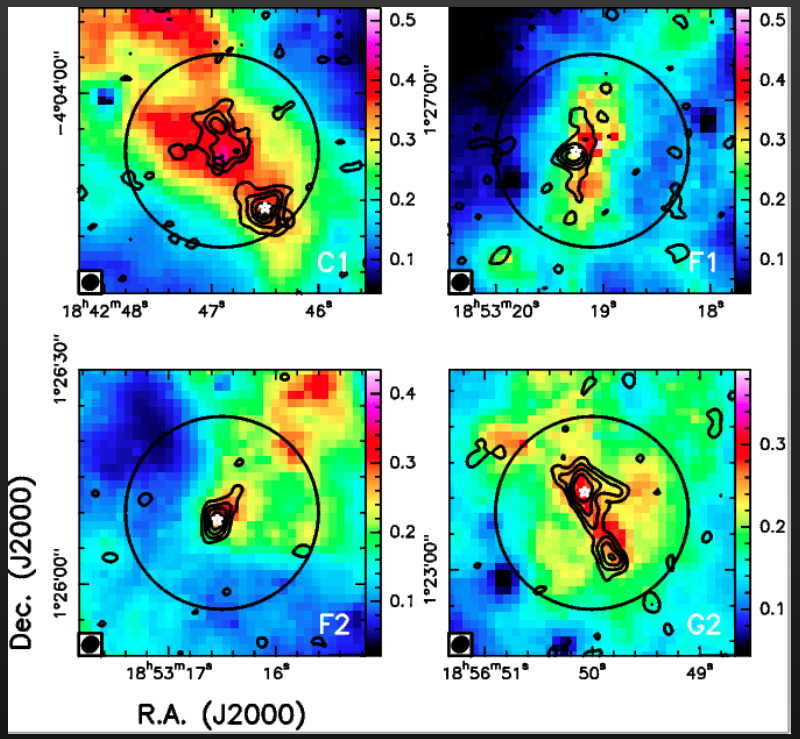
- Observative: several groups observe and use radio data
  - Galactic: physics and chemistry of molecular clouds; low- and high-mass star formation
  - Extragalactic: atomic and/or molecular gas in nearby galaxies and low-metallicity starbursts

- 10 staff, 2 associate (retired), 2 post doc

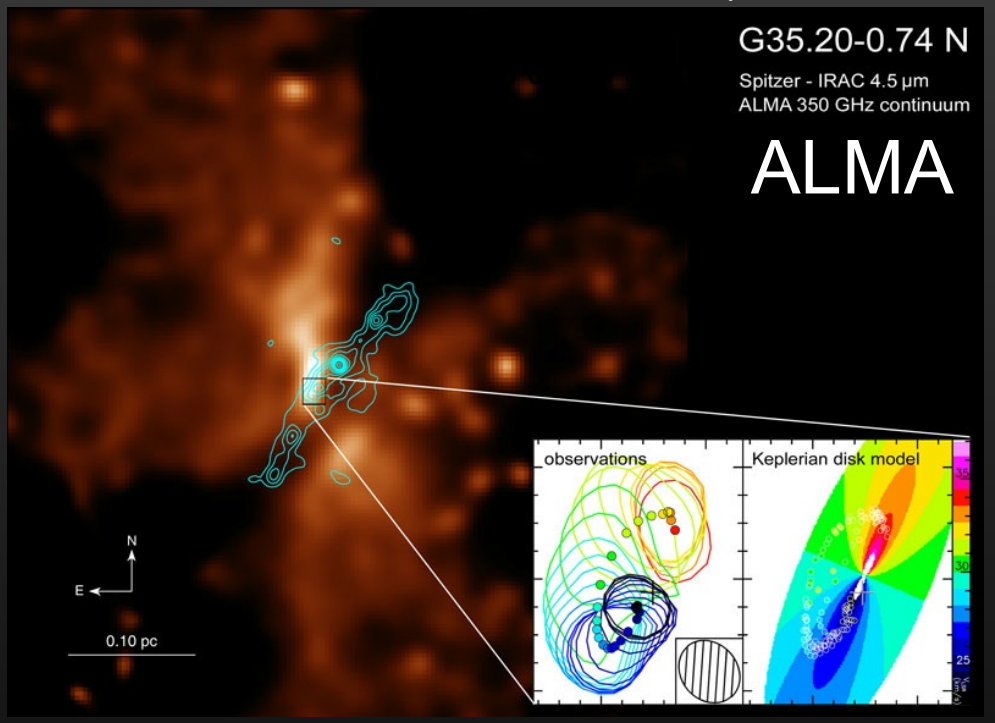
Main findings

- IR-dark clouds: detection of bound pre-stellar cores
- Structure/kinematics of jets and disks in low-mass YSOs
- Detection of Keplerian disks around high-mass YSOs
- Chemistry of dense gas: chemical clocks (deuteration, depletion) and pre-biotic molecules (e.g. detection of glycoaldehyde)
- Parallax measurements and Galactic disk structure and kinematics
- Cool dust detection in extreme low-metallicity starbursts
- Detection of weak outflows from low-luminosity AGN

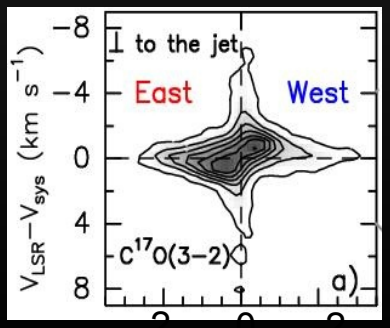
ALMA finds massive, deuterated (prestellar) cores in IRDCs to be bound (Tan + Fontani 2013)

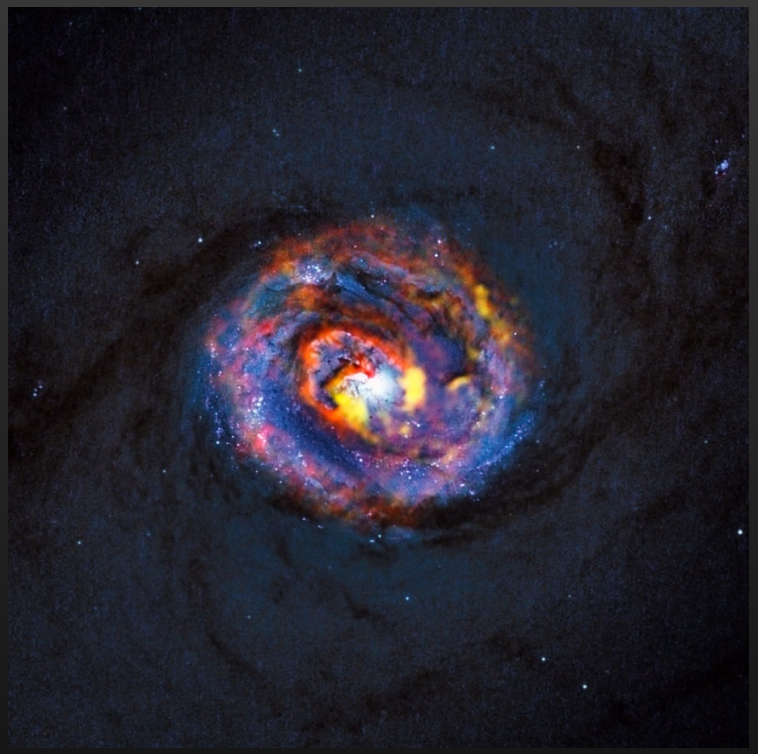


ALMA finds Keplerian disk around high-mass (18 M_o) YSO (Sánchez-Monge, Cesaroni, Beltrán, et al. 2013)



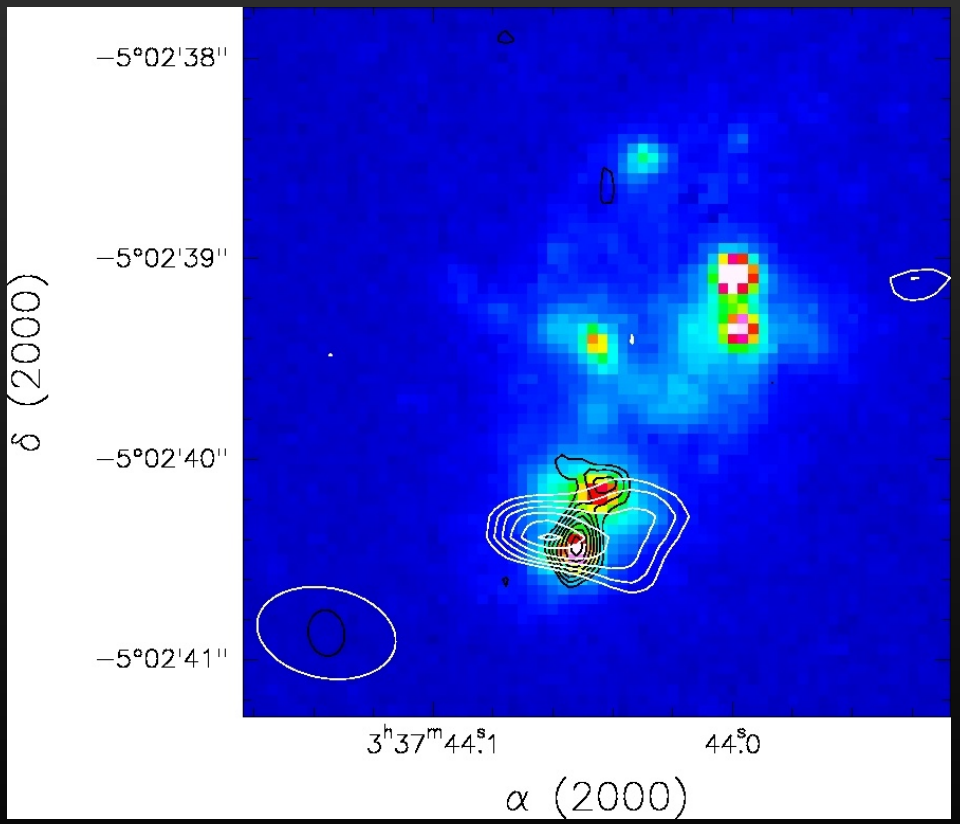
ALMA study of jet and Keplerian disk in low-mass YSO (Codella et al. 2014)





NGC 1433: ALMA reveals the weakest outflow ever discovered in a low-luminosity AGN (Combes, Garcia-Burillo, Casasola, Hunt et al. 2013).

SBS 0335-052: ALMA localizes cool dust in a metal-poor starburst, overthrowing previous estimates of dust-to-gas mass ratios at low metallicity (Hunt et al. 2014).



Radioastronomy group: Technology

Expertise:

- Passive EM optics: feeds, OMT, superconducting filters
- Cryogenics: optical properties of large windows
- Digital signal processing (FPGA-GPU): digital receivers, spectrometers, correlators, pulsar processing
- Spectrum management: Italian liaision for RAS with the National Administration, CRAF Member for INAF

Projects

- Large telescopes: ALMA, SKA
- European Framework programs: Radionet
- Italian telescopes: Medicina, Noto, SRT

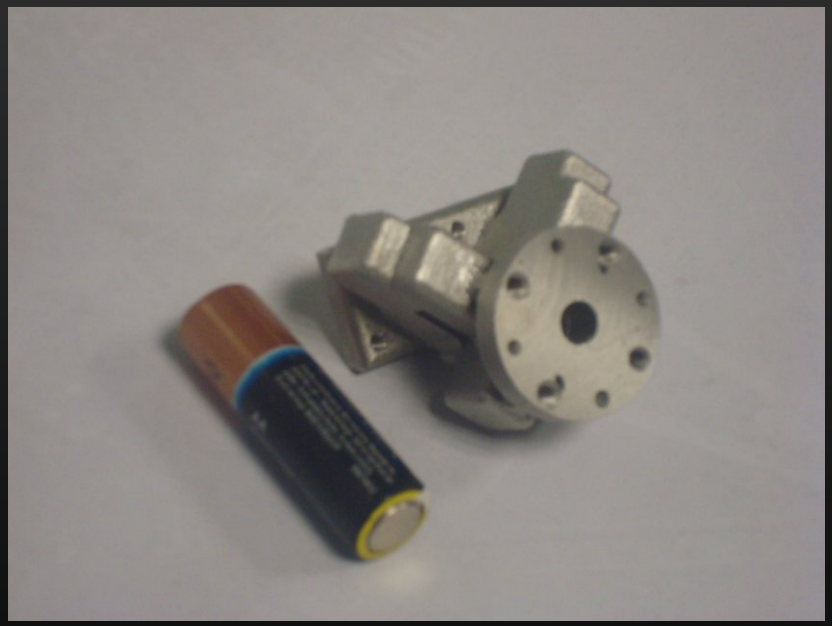
Staff

4 research staff, 2 Post-doc

1 technical position, full time, + 4 part time

ASI
Technologies for Space Missions

Front-end devices at Q-band

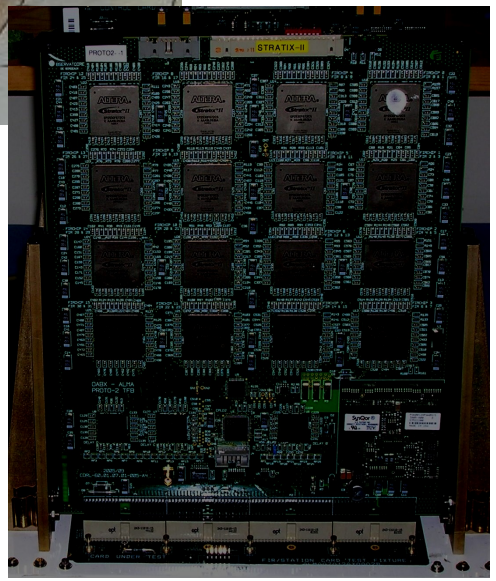


Aluminum Platelet (left) and 3D Laser Synthering (top) OMTs

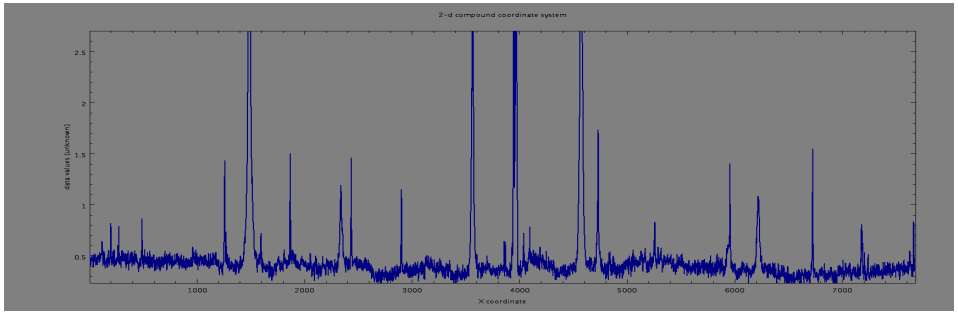
Filterbank to adapt 2 GHz ALMA IF BW to 62 MHz correlator BW

- Zero cost upgrade of previous correlator design
- 32 fold increase in spectral resolution
- Possibility of mixed resolution modes

ALMA correlator



Tunable Filterbank board



ALMA first light spectrum of OriA at 240 GHz

EM analysis and experimental validation of Low Frequency Aperture Arrays

INAF - Arcetri

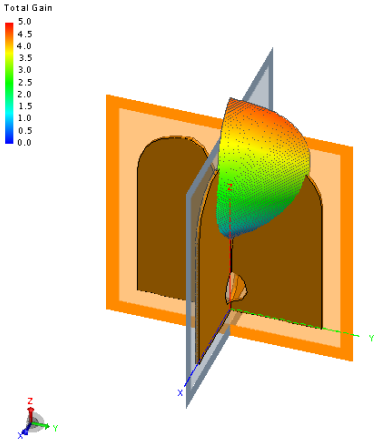
POLITECNICO DI TORINO

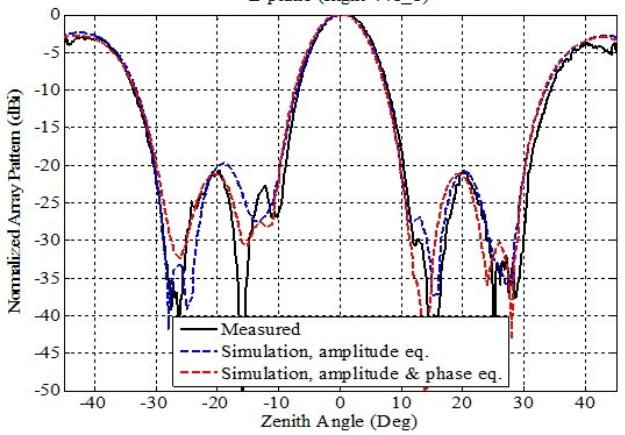
INAF ira

National Research Council of Italy

IEIIT

Institute of Electronics, Computer and Telecommunication Engineering





Frequency channelizer for FX correlators

Frequency channelization both in the LFAA beamformer and in the correlators

2^{18} channels: Two stage channelization

Filter design and optimization

Effects of quantization