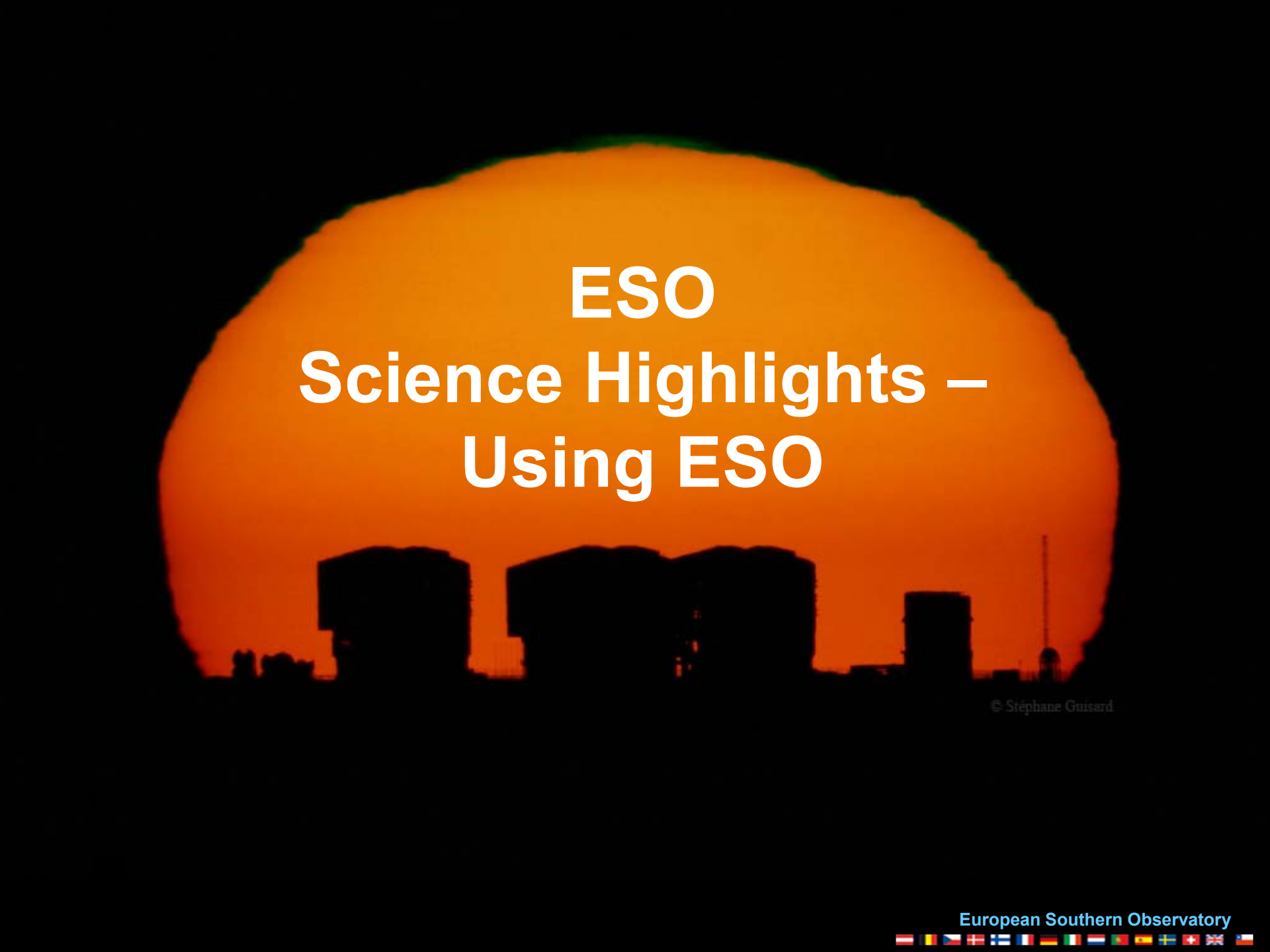
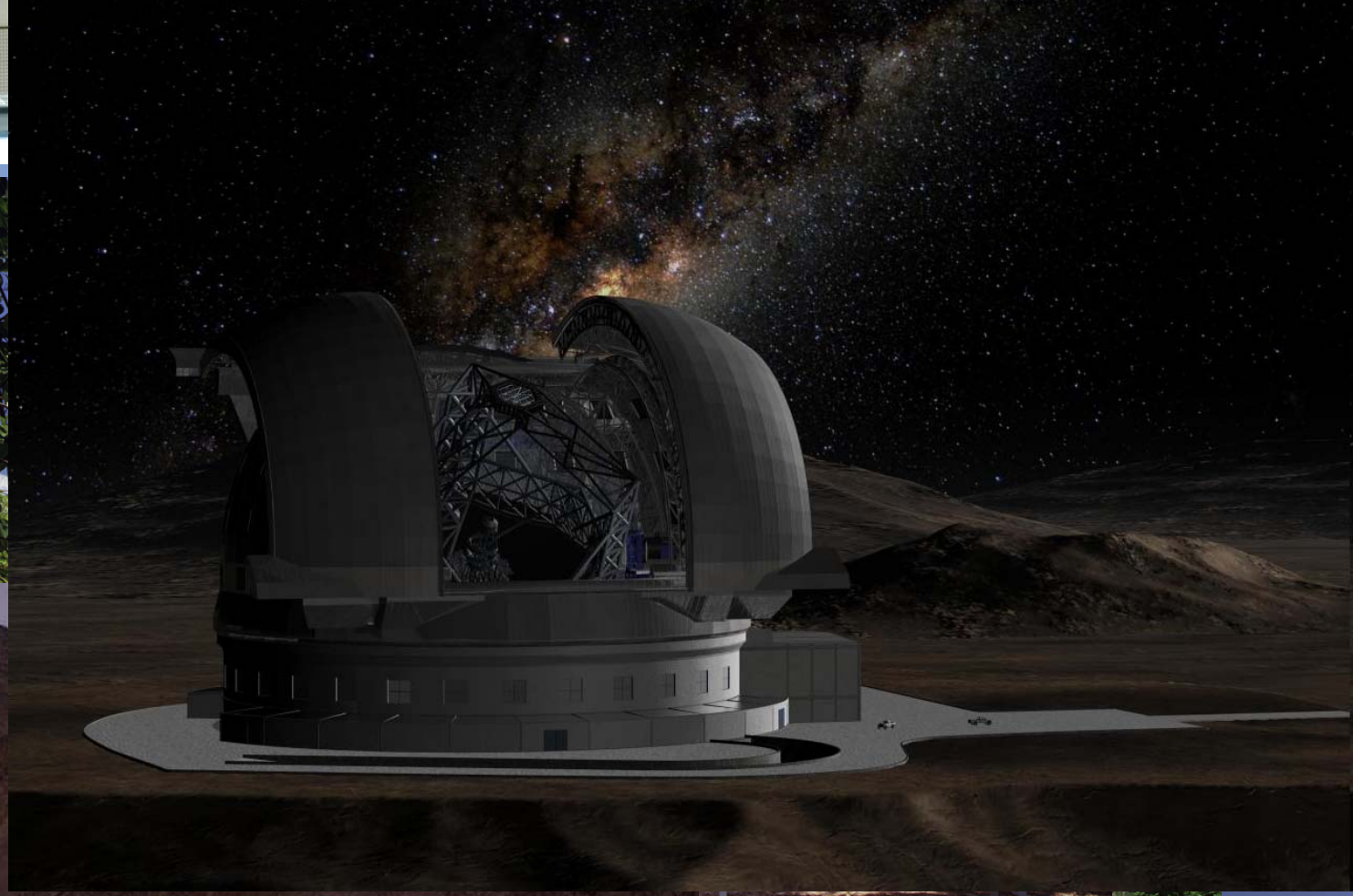

ESO
Science Highlights –
Using ESO
© Stéphane Guisard

European Southern Observatory

- Mission
  - Develop and operate world-class observing facilities for astronomical research
  - Organize collaborations in astronomy
- Intergovernmental treaty-level organization
  - Founded in 1962, by 5 countries
  - Currently 14 member states
- Observatories in Chile
  - Optical/infrared: La Silla and Paranal
  - Sub-mm: APEX and ALMA partnerships on Chajnantor
- HQ in Garching and Office in Santiago

ESO's world


ESO's sites
Garching bei München
Chajnantor
Paranal
La Silla
Santiago
Earth at Night
More information available at:
http://antwrp.gsfc.nasa.gov/apod/ap001127.html
Astronomy Picture of the Day
2000 November 27
http://antwrp.gsfc.nasa.gov/apod/astropix.html

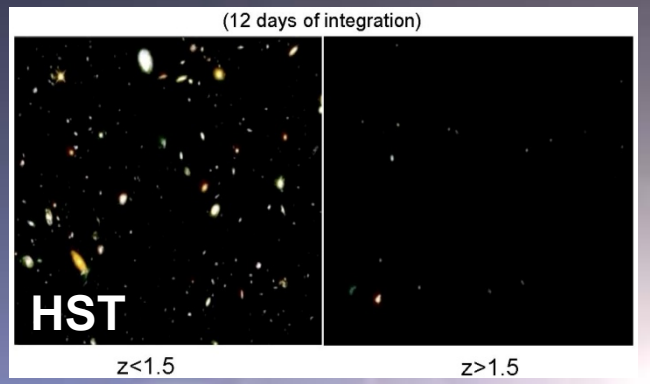


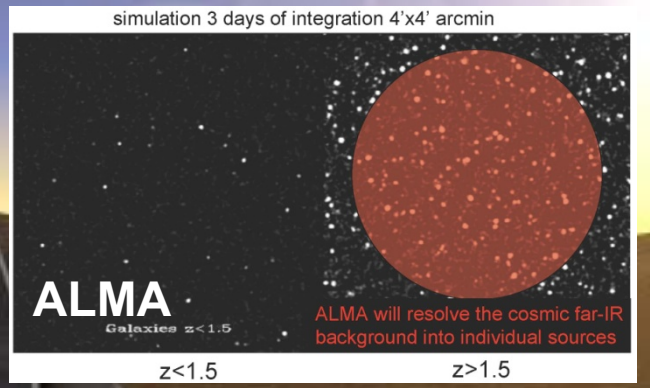
La Silla Paranal

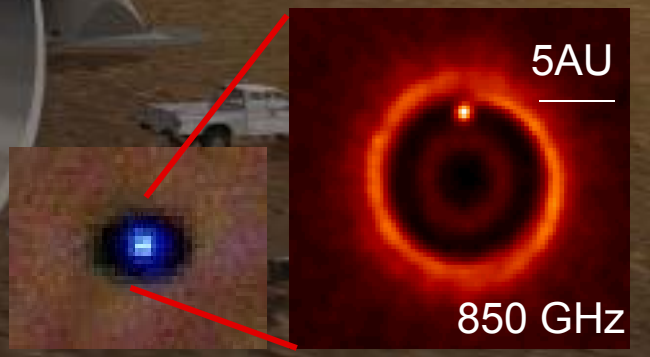
- VLT/I (Paranal)
  - Instrumentation operating, in assembly and planned
    - Covers the available optical infrared wavelengths 300nm to 20μm
    - Angular resolution from seeing limit to 50 μ-arcseconds
    - FORS2, ISAAC, UVES, FLAMES, NACO, SINFONI, CRIRES, VISIR, HAWK-I, VIMOS, X-Shooter, laser guide star facility KMOS, MUSE, SPHERE, Adaptive Optics Facility
    - MIDI, AMBER, PRIMA, GRAVITY, MATISSE
- La Silla
  - Continue operations with long-term programmes
    - HARPS, EFOSC2, SOFI, visitor instruments
- APEX
  - Covers sub-mm and mm wavelendths 0.3 to 3 mm
  - SHFI (Swedish Heterodyne Facility Instrument), LABOCA, SABOCA, APEX-SZ, CHAMP+, FLASH

ALMA

- Science requirements
  - Detect CO and [CII] in Milky Way galaxy at z=3 in < 24 hr
  - Dust emission, gas kinematics in proto-planetary disks
  - Resolution to match Hubble, JWST and 8-10m with AO
  - Complement to Herschel
- Specifications
  - 66 antennas (54x12m, 12x7m)
  - 14 km max baseline (< 10mas)
  - 30-1000 GHz (10–0.3mm), up to 10 receiver bands





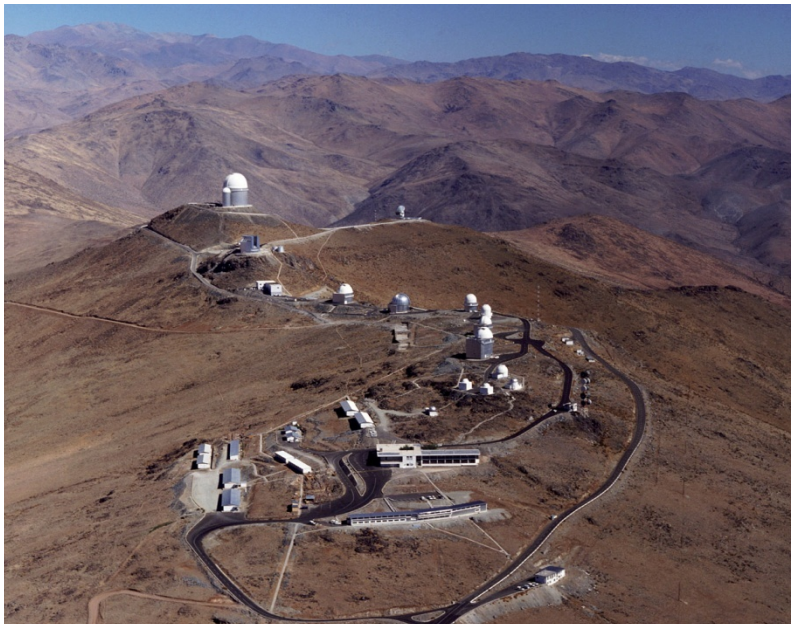


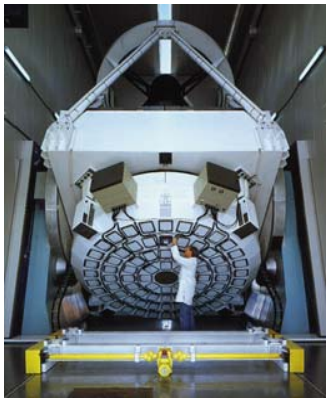
E-ELT

- Detailed design study
  - Baseline 42m primary mirror
  - Adaptive optics built-in
  - Industry strongly engaged
  - Study complete in 2010
- Project
  - Builds on *entire* expertise at ESO *and* in the member states
  - Construction 2011-2018
  - Synergy: JWST/ALMA/SKA

La Silla

- Medium-size telescopes
  - 3.6m: HARPS for exo-planet searches
  - 3.5m NTT: EFOSC2 & visitor instruments
  - 2.2m in partnership with MPG
- Small telescopes
  - Closed/funded externally





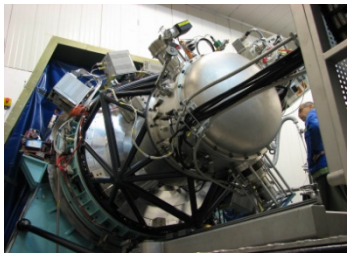
La Silla: 5 Operational Instruments

3.6m

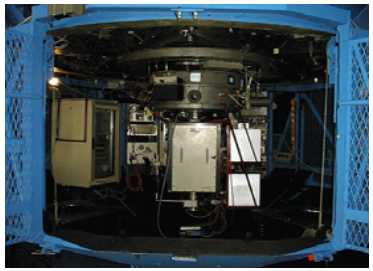
HARPS

NTT

SOFI

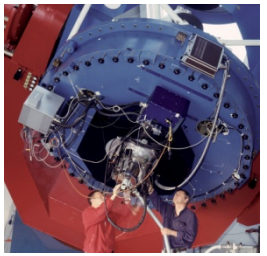


EFOSC2

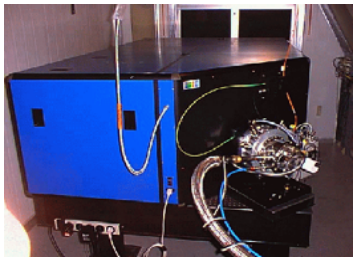


2.2m

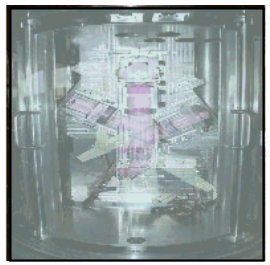
WFI



FEROS



GROND



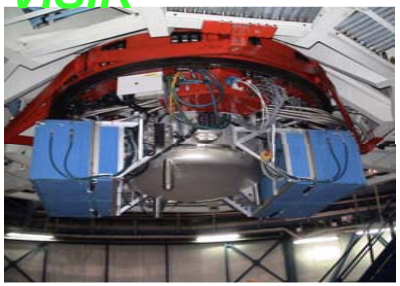
Paranal

VLT Instruments

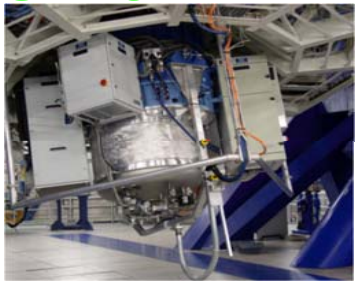
FORS2

FLAMES

VISIR



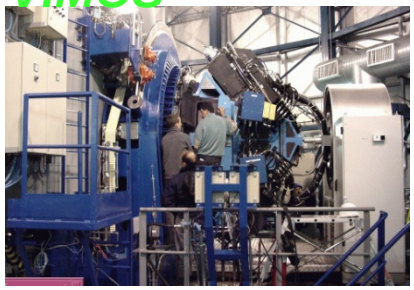
SINFONI



CRIRES

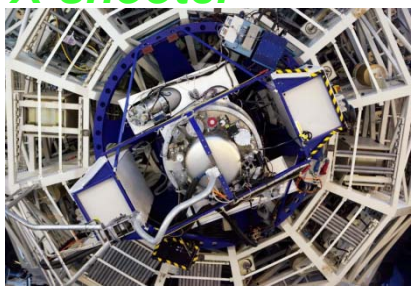
UVES

VIMOS



NACO

X-shooter



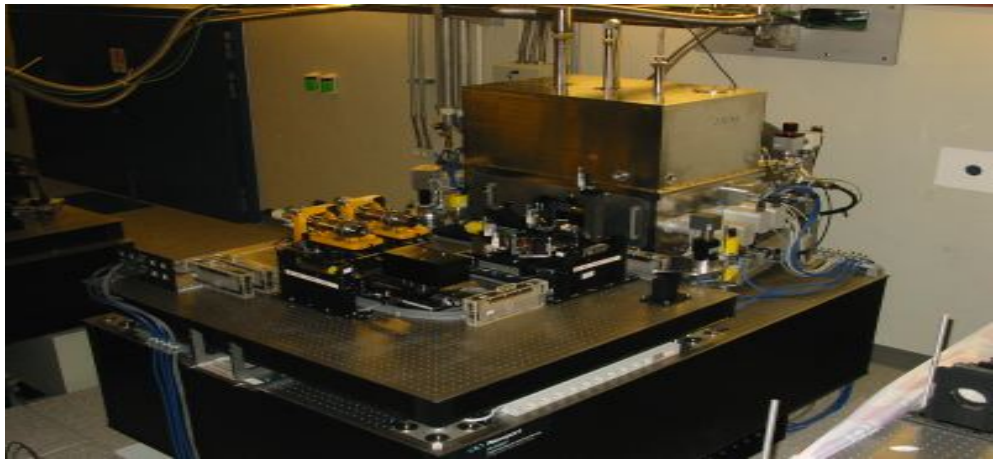
ISAAC

HAWK-I

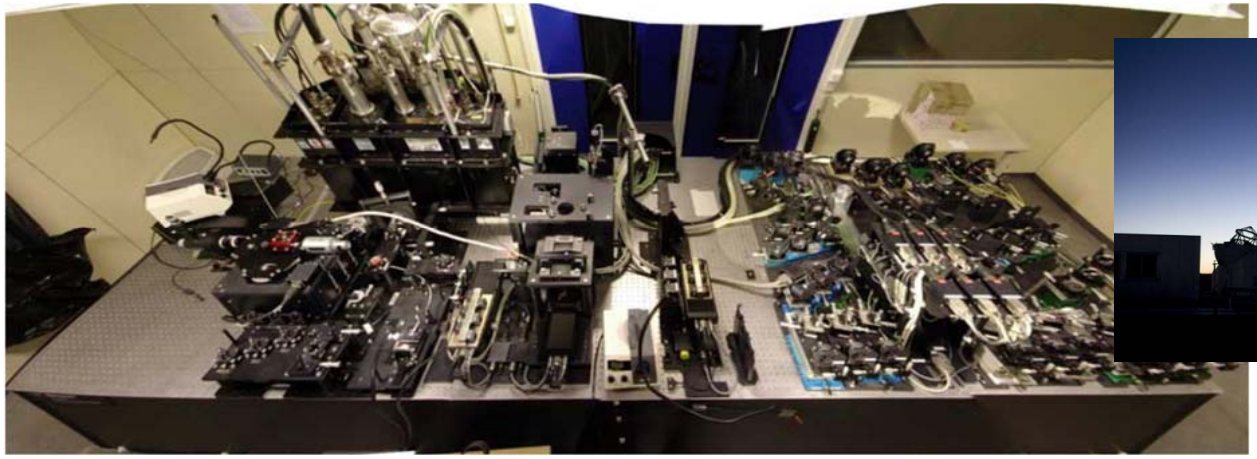
VLTI Instruments




MIDI



AMBER




Top list of ESO science

- Galactic Centre
  - Supermassive black hole
- Extrasolar planets
  - First images of exo-planets
  - Lightest known planets
- Accelerating Universe
  - Spectroscopy of distant supernovae
- Gamma-Ray Bursts/Supernovae
  - Explosion physics
  - Tracers of the distant universe

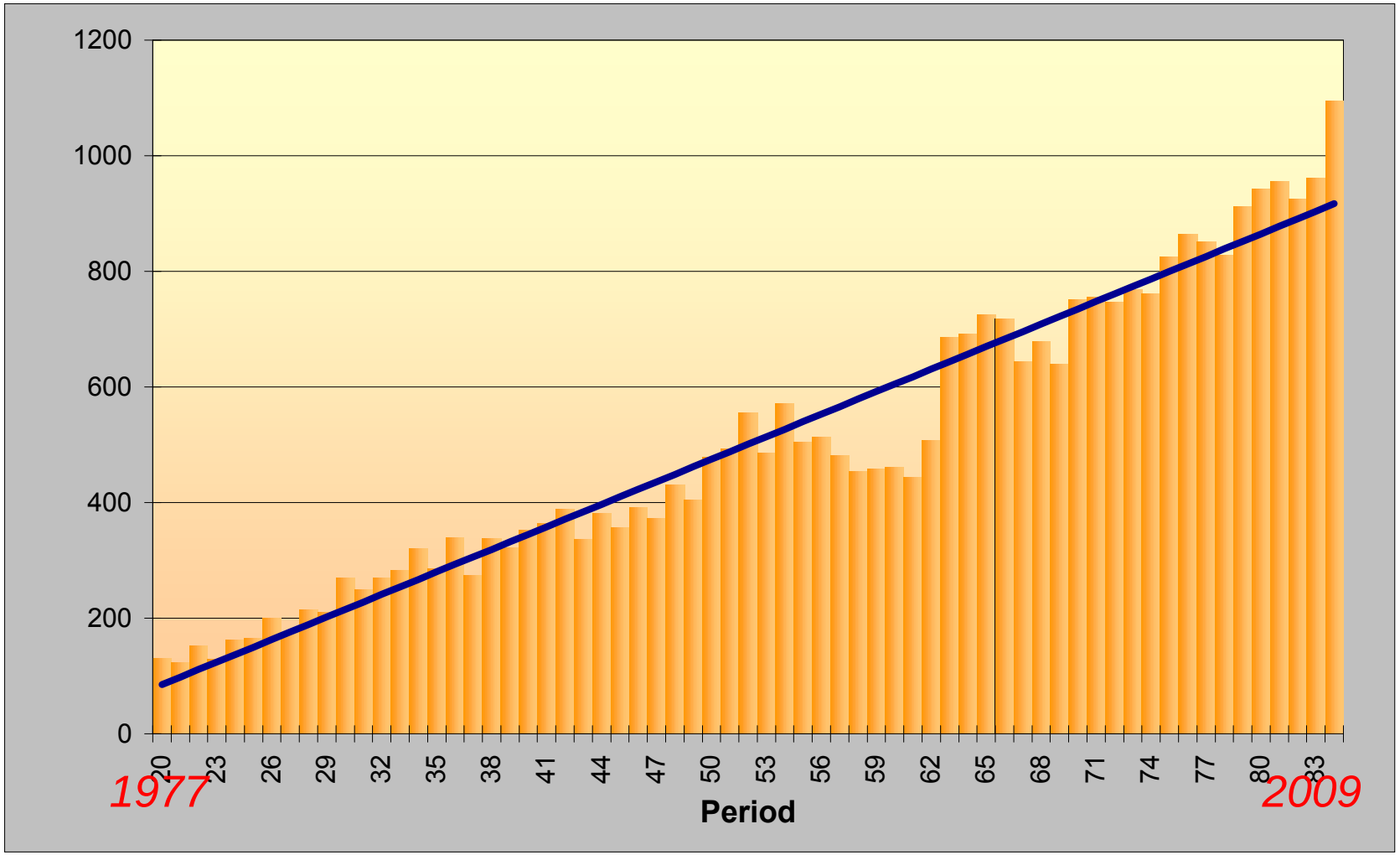
Other top science from ESO

- Metal-poor stars
  - Tracing the chemical enrichment
  - Finding the oldest known stars
- Stellar populations in nearby galaxies
  - Measuring stars beyond the Local Group
- Massive galaxies in the distant Universe
  - Puzzles in galaxy formation
- Varying physical constants?
  - Measure the fine-structure constant over time
- Testing the cosmological model
  - Cosmic background temperature

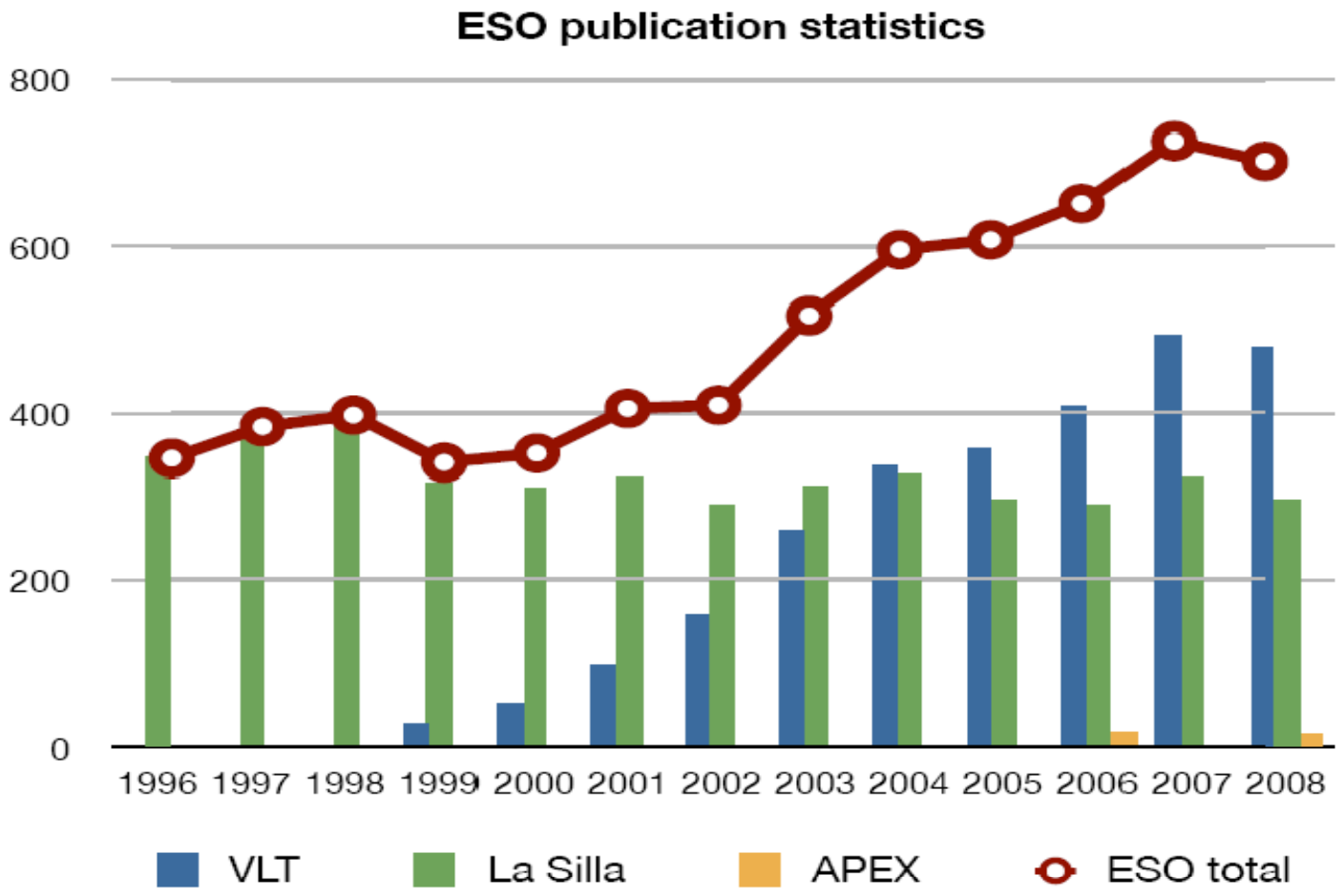
More top science

- Detecting and imaging the torus around AGN
- Measure the geometric shape of stars
- Determine the size of stars
  - E.g. Cepheids to calibrate the period-luminosity relation
- Star formation
  - Debris disks, chemistry in circumstellar disks
- Measure the structure of the Milky Way
  - Local spiral arm
  - Bulge, disk and halo, run-away stars
- Solar System objects
  - Comets, asteroids, weather on Titan

Proposal submission

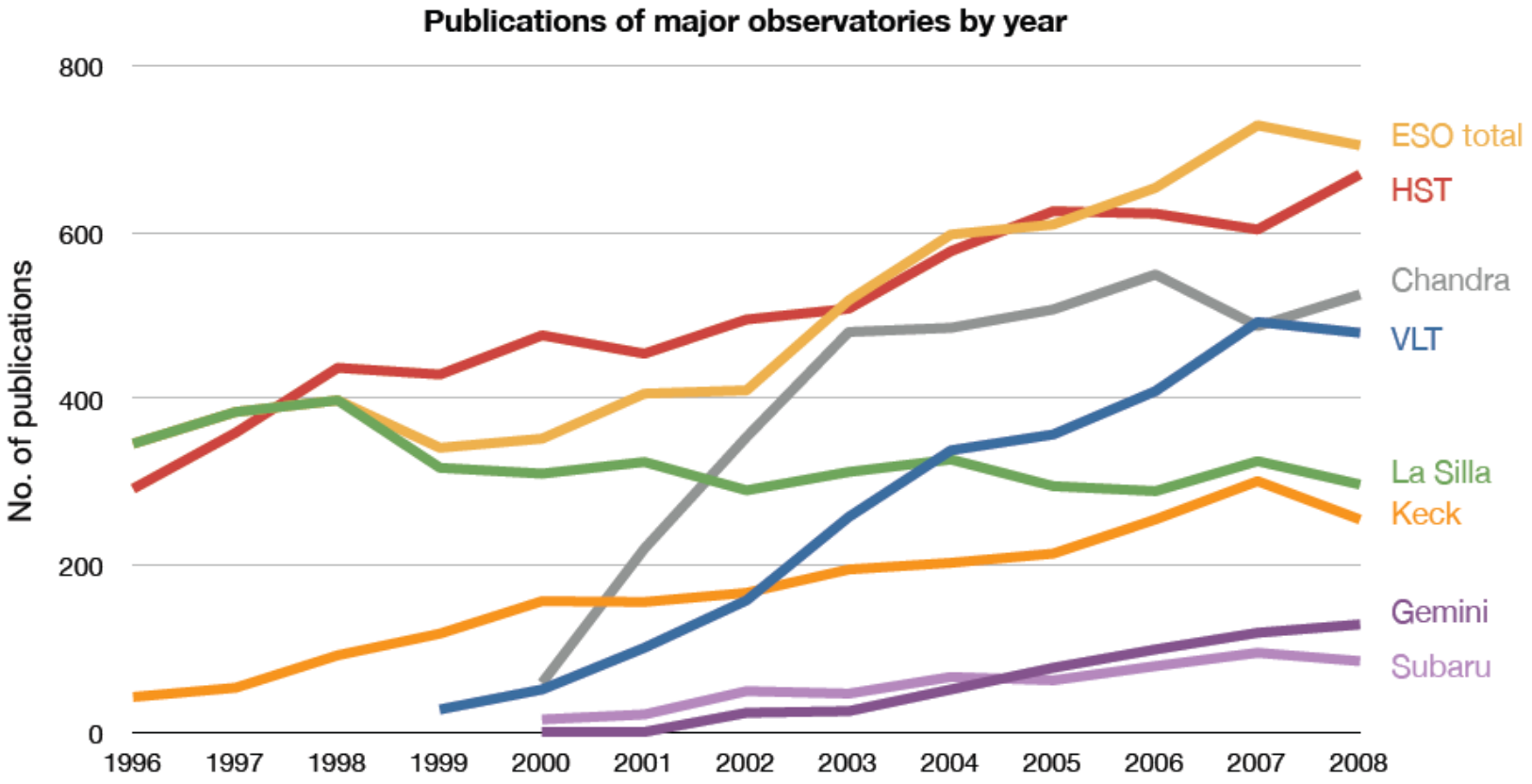


ESO Publication Statistics



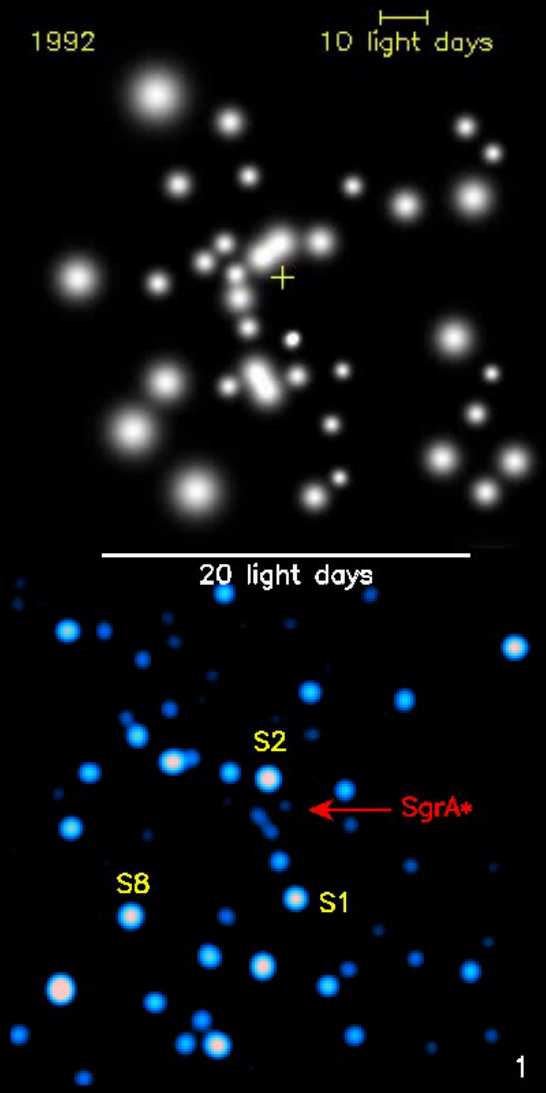
available at http://www.eso.org/sci/libraries/edocs/ESO/ESOstats.pdf

ESO and other Observatories



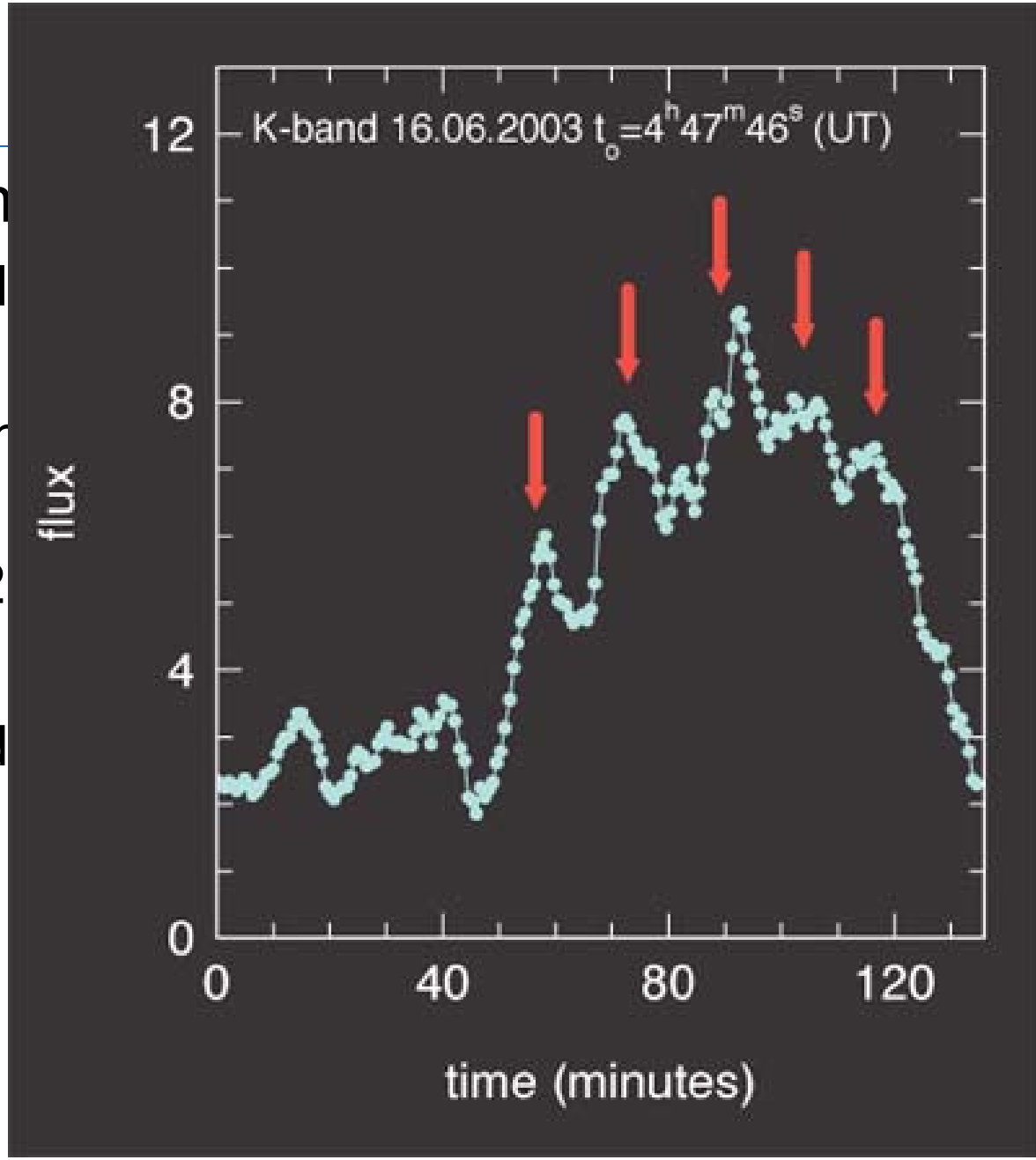
Black hole at the Galactic Centre

- Mass determination through stellar orbits
- Structure around the black hole revealed through flashes
- Coordinated studies with other wavelengths
- Multi-year study
  - use of AO instruments (SHARP on NTT, ISAAC NACO, SINFONI on VLT)



Flashes

- Variable IR em
  - Detection of H also flares
  - consistent with of Sgr A*
  - Discovery in 2
  - Flare duration
  - substructure d



The ESO exo-planet machinery

- HARPS at 3.6m telescope
  - best radial velocity machine at a 4m telescope (supported by UVES on VLT)
  - extremely stable spectrograph
  - fast pipeline → nearly immediate results
- NACO
  - adaptive optics system on an 8m telescope
- VLTI
  - highest spatial resolution for follow-up observations of known systems
- NACO/SINFONI/FORS2
  - transit measurements
  - atmospheres of exo-planets

ESO results on exo-planets

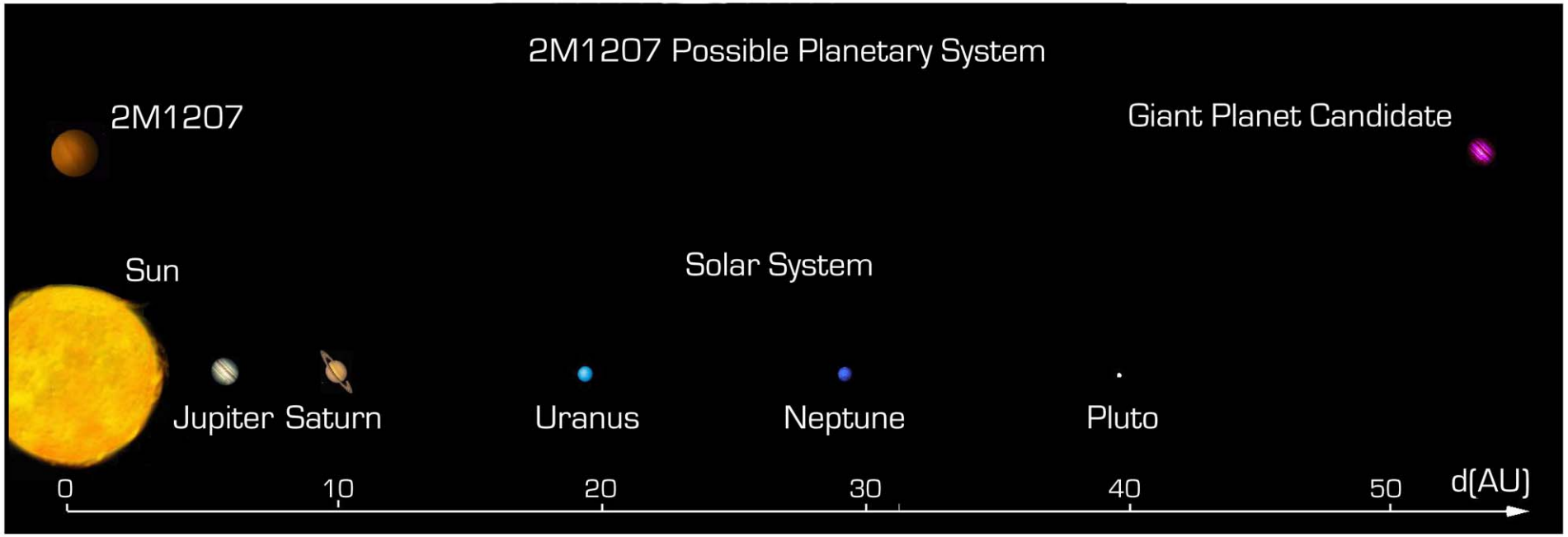
- Most radial velocity detections through HARPS
  - lowest-mass planets known so far
    - rocky planets, earth-mass planets
  - planetary systems
- First direct image of a planet
  - around a brown dwarf
  - now innermost planet directly images (β Pic)
- Combination with transits
  - characterization of planets
    - mass, density, temperatures

A planet with 1.9$M_\oplus$ and one in the habitable zone

- Gliese 581

First image of an exo-planet

- Red object near a brown dwarf
  - NACO observations (with the IR wavefront sensor) of a brown dwarf (2MASSWJ1207334-393254)
  - Brown dwarf with ~25 M_{Jup} at 70 pc in the

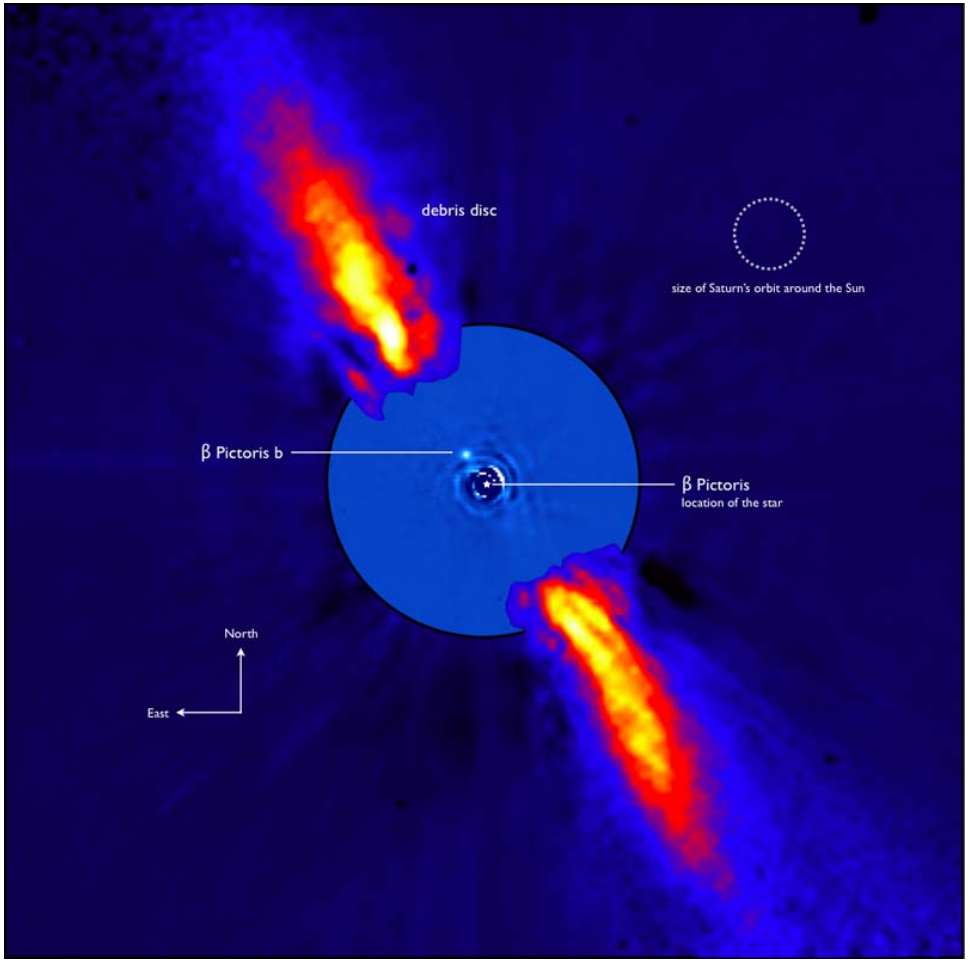


λ (μm)

Chauvin et al., A&A, 425, L29

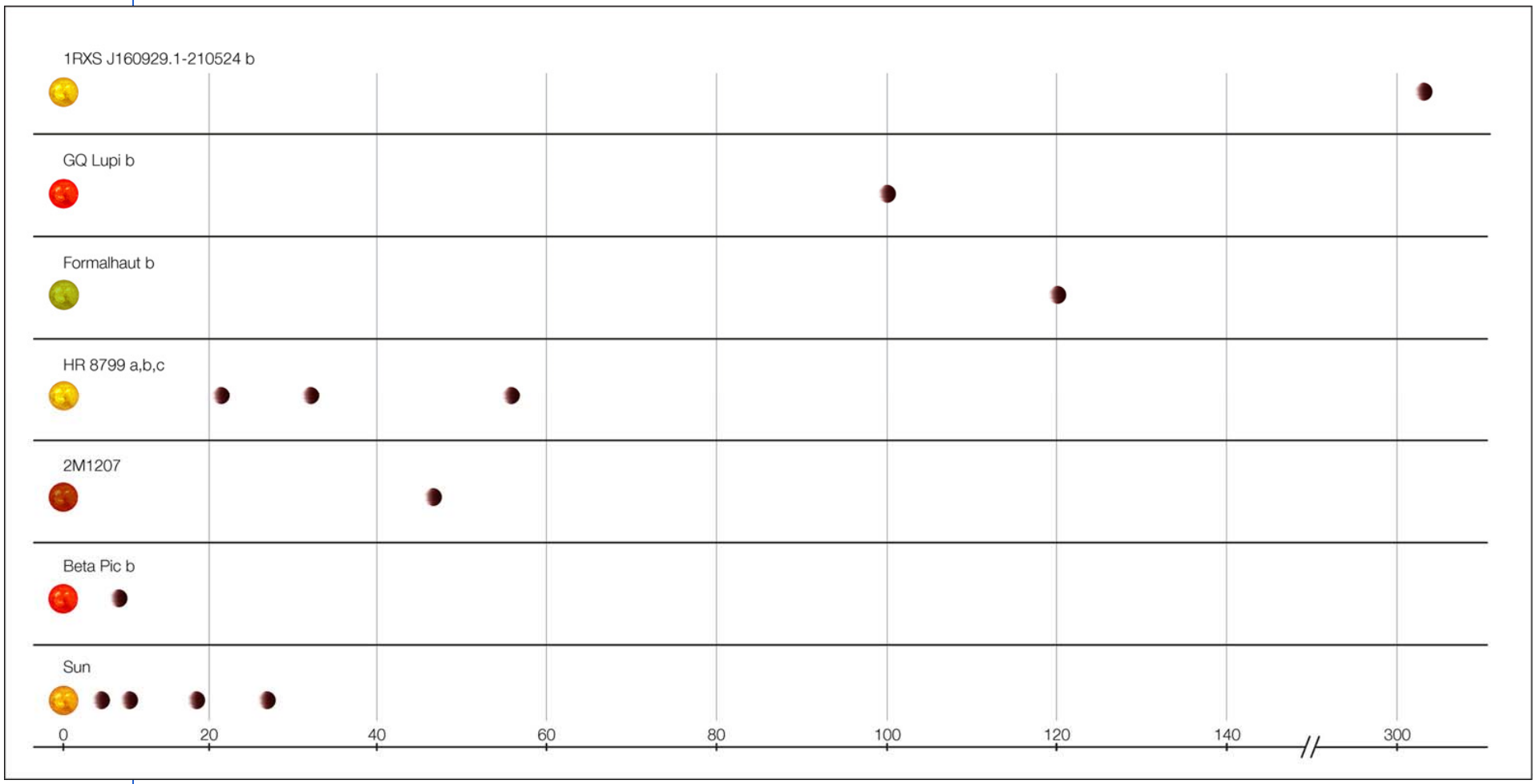
β Pic planet

- Planet within the massive dust disk
- Orbit only a few AU
- NACO imaging



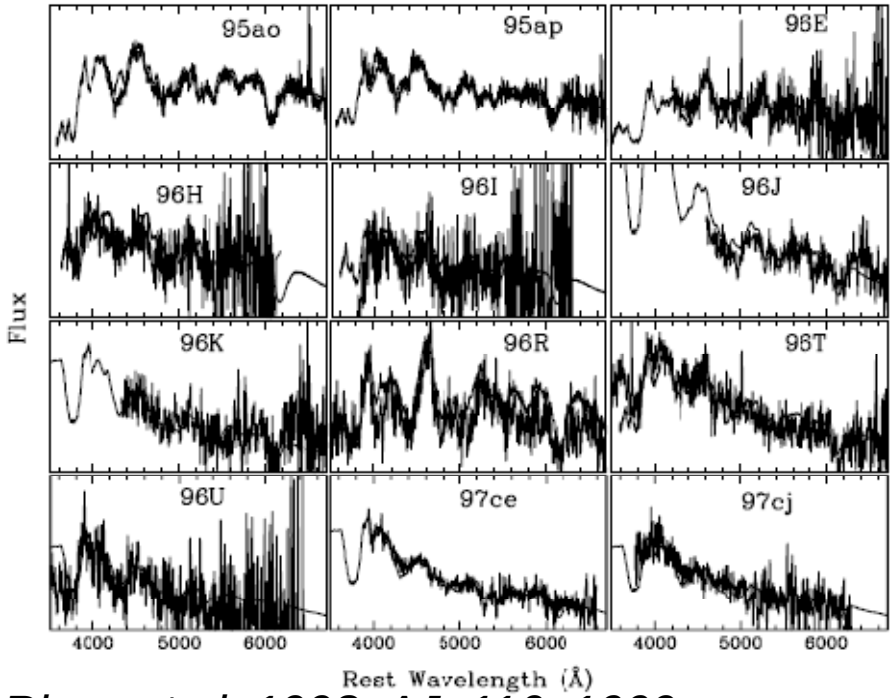
Lagrange et al. 2009, A&A, 493, L21

Imaged planets

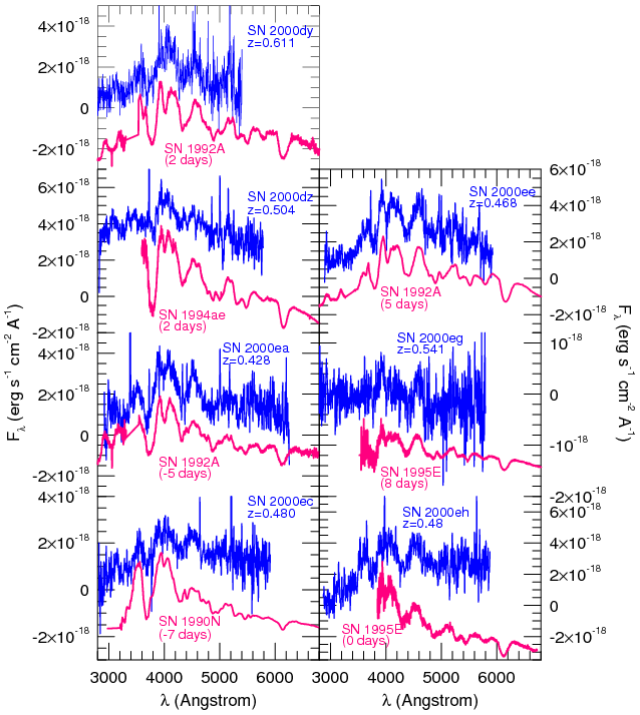


Accelerating Universe

- Contribution of most of the early photometry and spectroscopy of High-z SN Search Team
  - difference between a 4m and a 8m telescope



Riess et al. 1998, AJ, 116, 1009



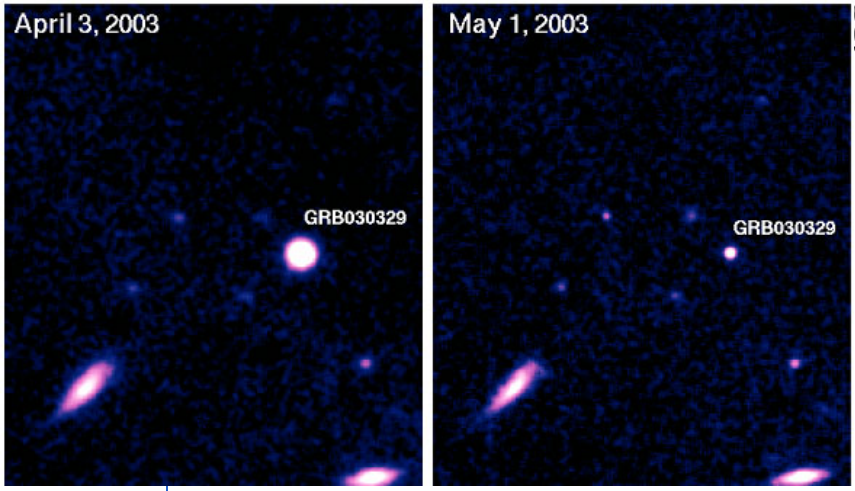
Leibundgut & Sollerman 2001

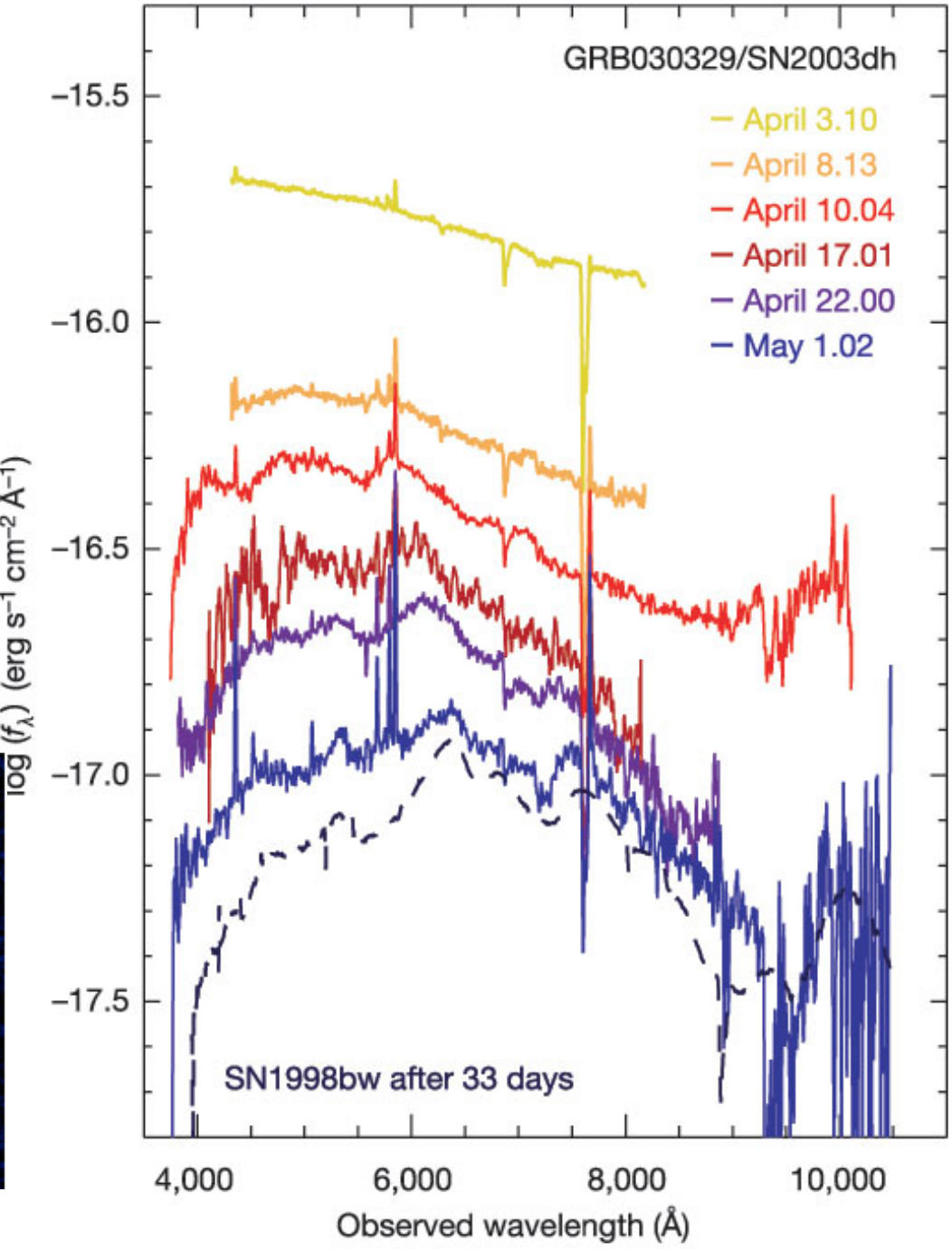
Gamma-Ray Bursts

- Identification relied on optical data
  - redshifts, explosion energies, explosion physics
- Cosmological probes
  - the most distant observable stars
  - light houses to measure the intergalactic medium
  - tracers of chemical enrichment?
- Very short duration
  - required special instrumentation and software to observe adequately

SN/GI

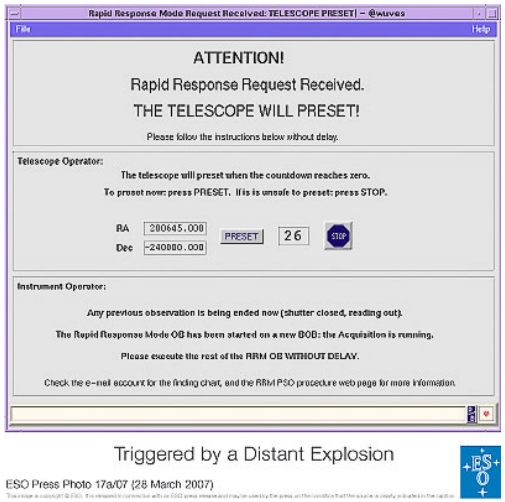
- Spectral signatur
  Gamma-Ray Bur
- GRB 030329/SN
  GRB 980425/SN
  UVES spectrum fou
  known GRB – "cc
  FORS1 and 2 obse
  3 until May 1)





Rapid Response Mode (RRM)

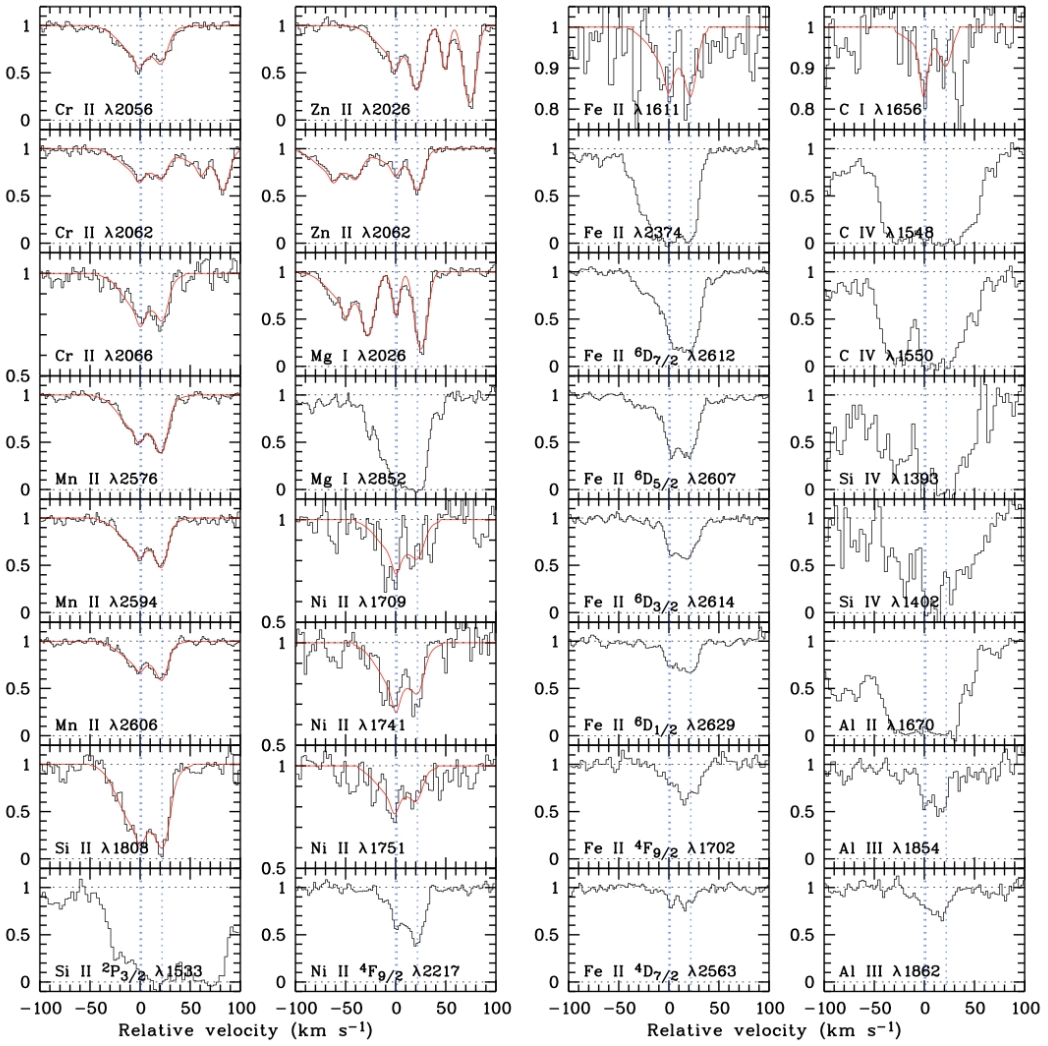
UVES observations of GRB 060418
10 minutes
after the initial Swift trigger



Triggered by a Distant Explosion

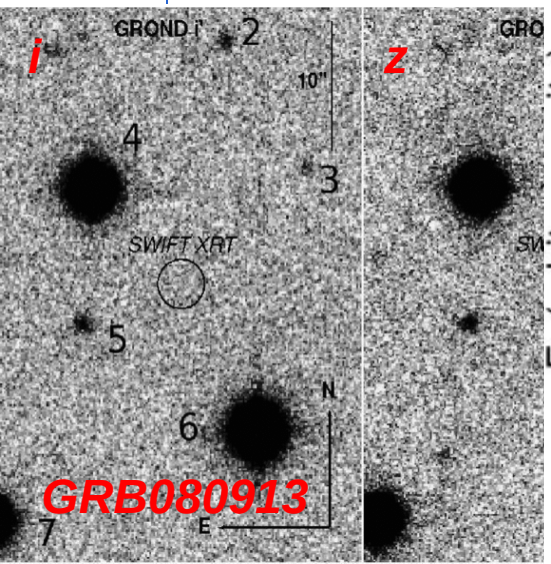
ESO Press Photo 17a/07 (28 March 2007)

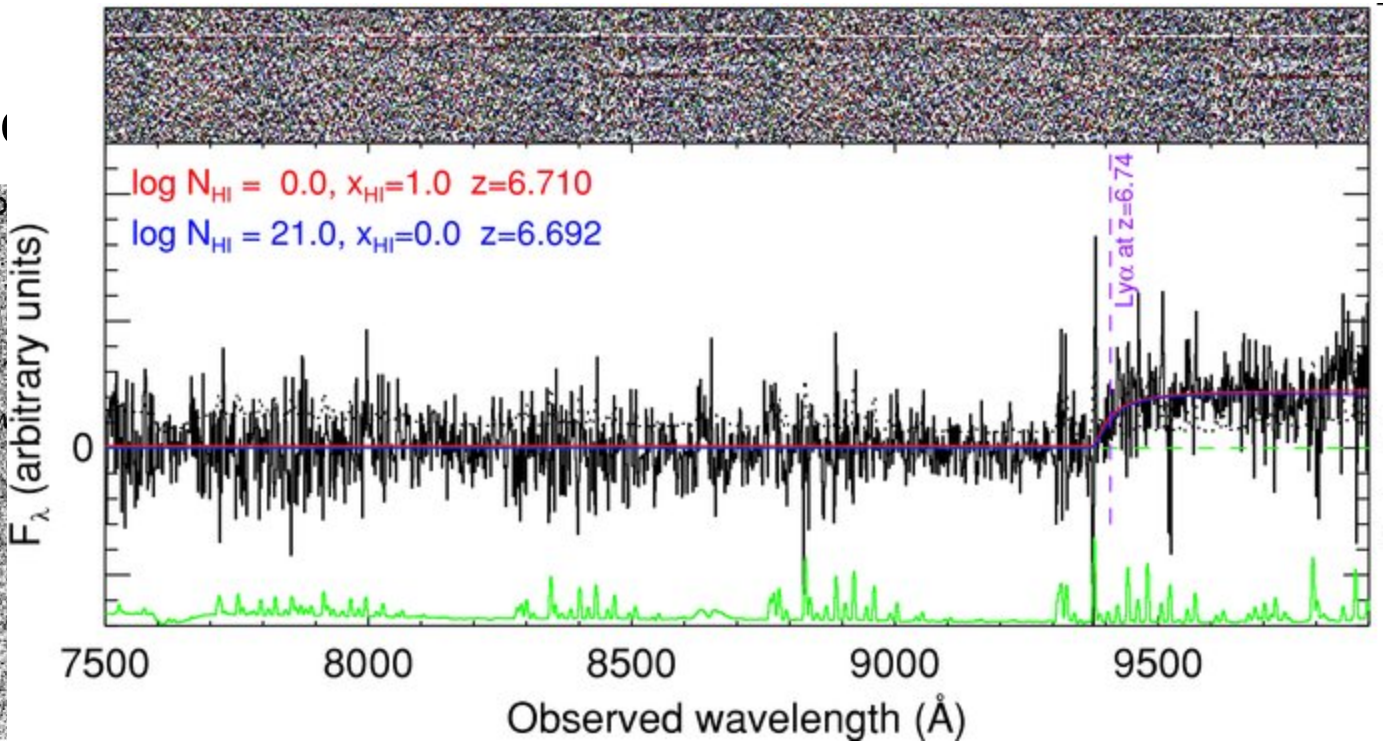
Many metal line systems at 3 redshifts.
[Zn/Fe] >> QSO abs.



Gamma-Ray Bursts

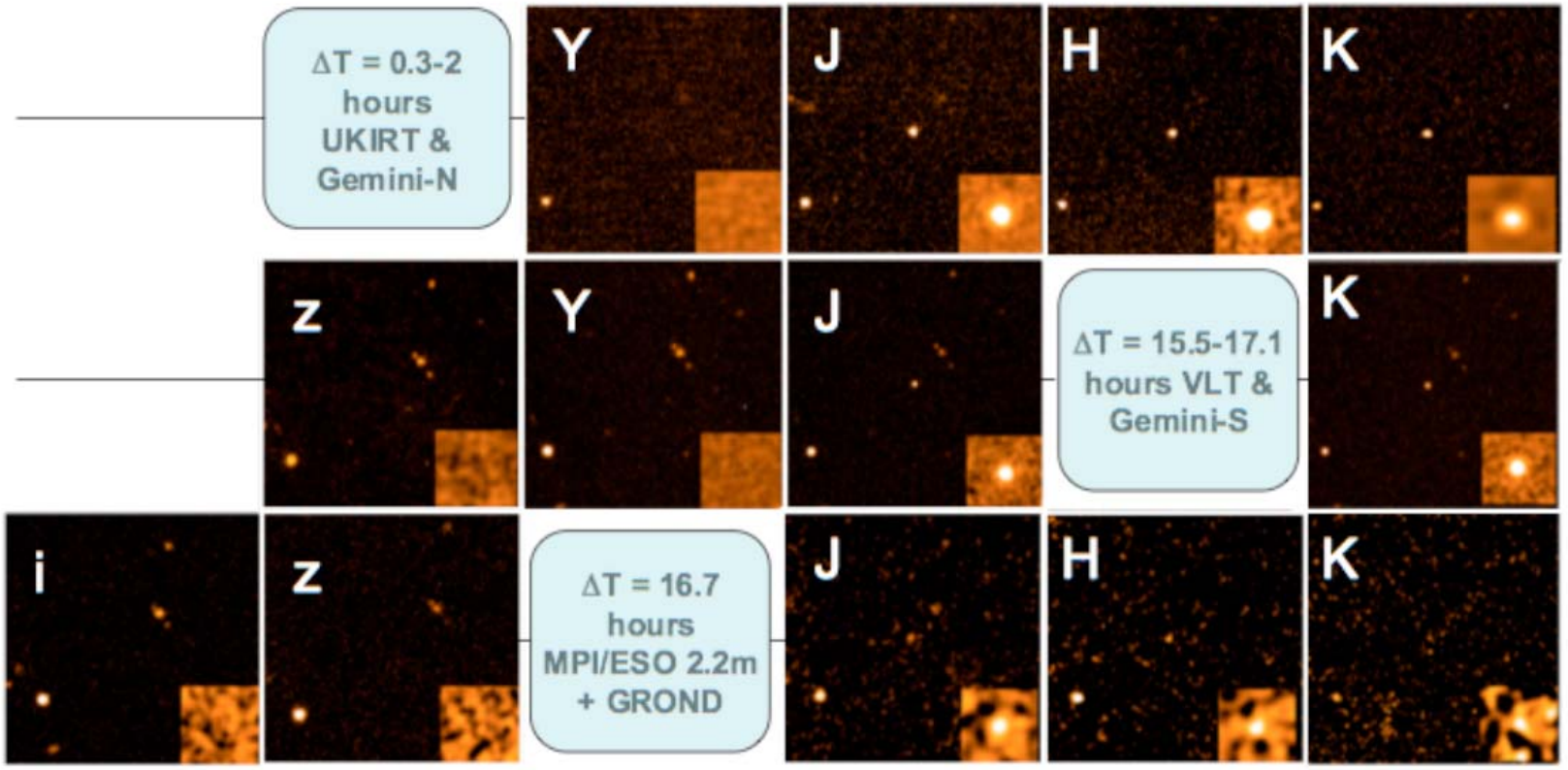
- Most distant stellar objects ever observed
  - redshifts 6.7 and 8.2 (tentative)
  - lookback time of nearly 12.5 billion years (or 95% of the age of the universe)
- VLT equipped with rapid response mode
  - allows detecti





Most distant stellar object yet observed – GRB 090423

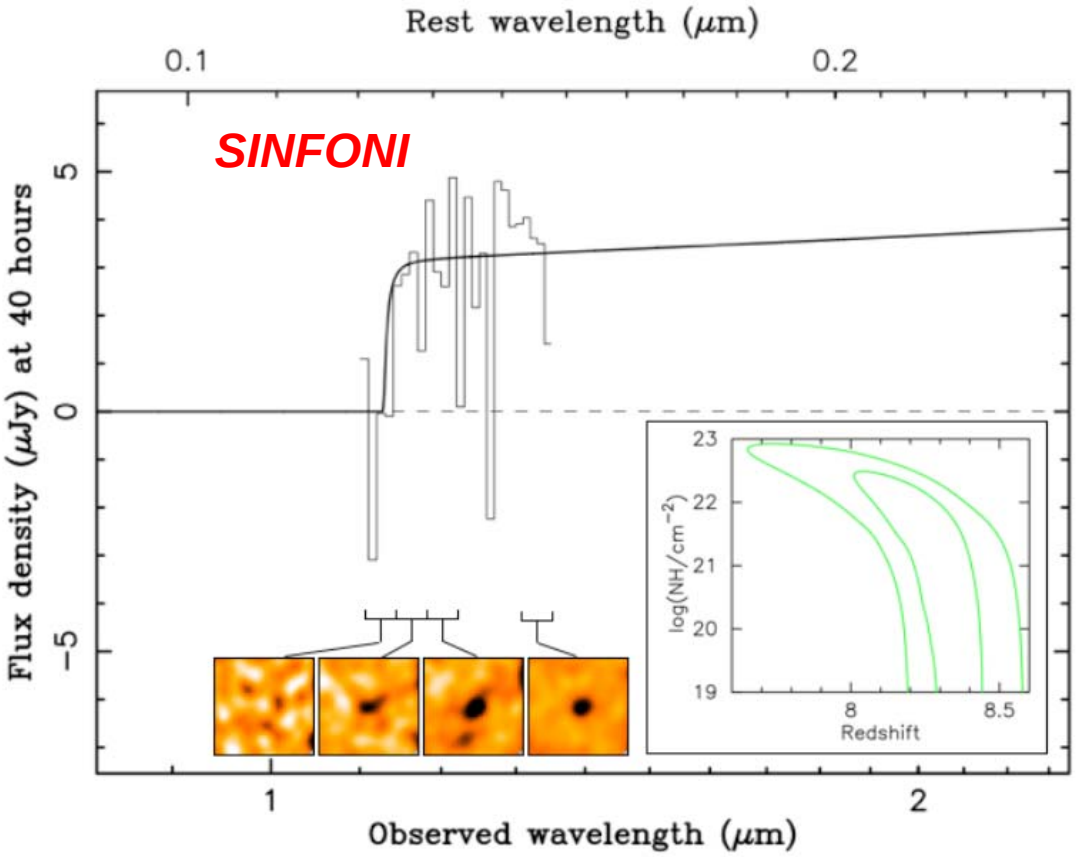
- Optical drop-out, bright in the near-infrared
- Rapid decline



Tanvir et al., Nature submitted

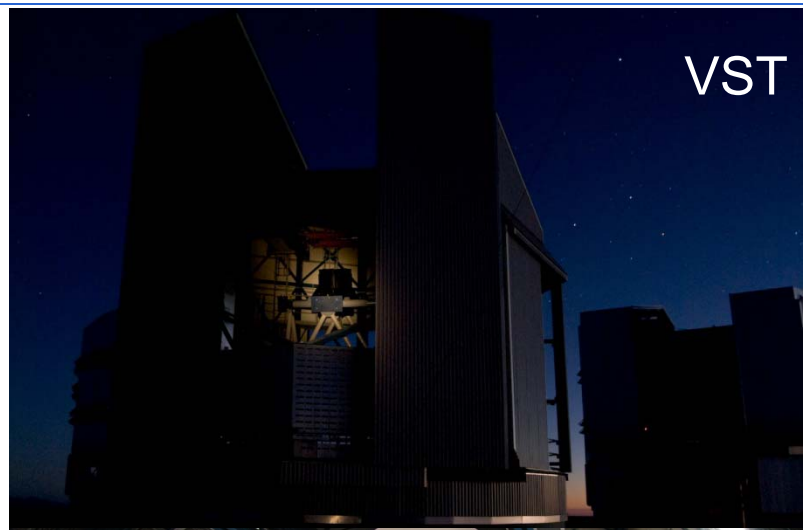
GRB 090423

- Spectroscopy 17 hours after outburst
- Lyman break indicates a redshift of z≈8.2



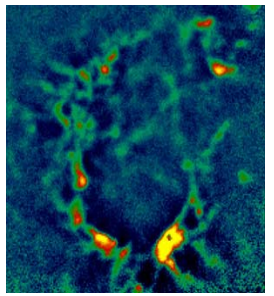
The Survey Telescopes

- Under construction
  - VST 2.6m for optical
  - VISTA 4.1m for infrared
  - Completion in late 2009
- Science
  - Multi-year program of large public surveys
  - Coordinated by ESO
  - Develops European survey capability



Chajnantor

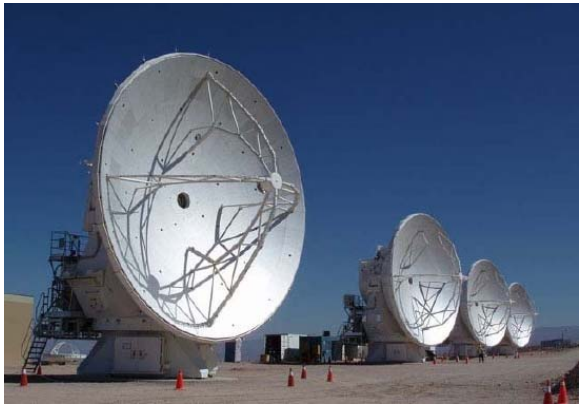
- APEX
  - 12m sub-millimeter antenna, operated by ESO @ Sequitor
  - MPG (50%), Sweden (23%) and ESO (27%)
- ALMA
  - Transformational science
  - 66 antennas at 5050m
  - Operations support at 2950m
  - Global partnership with North America East Asia & Chile



Chajnantor

- Three facility and three `PI` instruments on APEX
- Watch out for ALMA
  - early science in 2011
  - be prepared

ALMA 2009



ALMA 2013

Proposing for ESO time

- Call for proposals is open

Structure of the ESO OPC

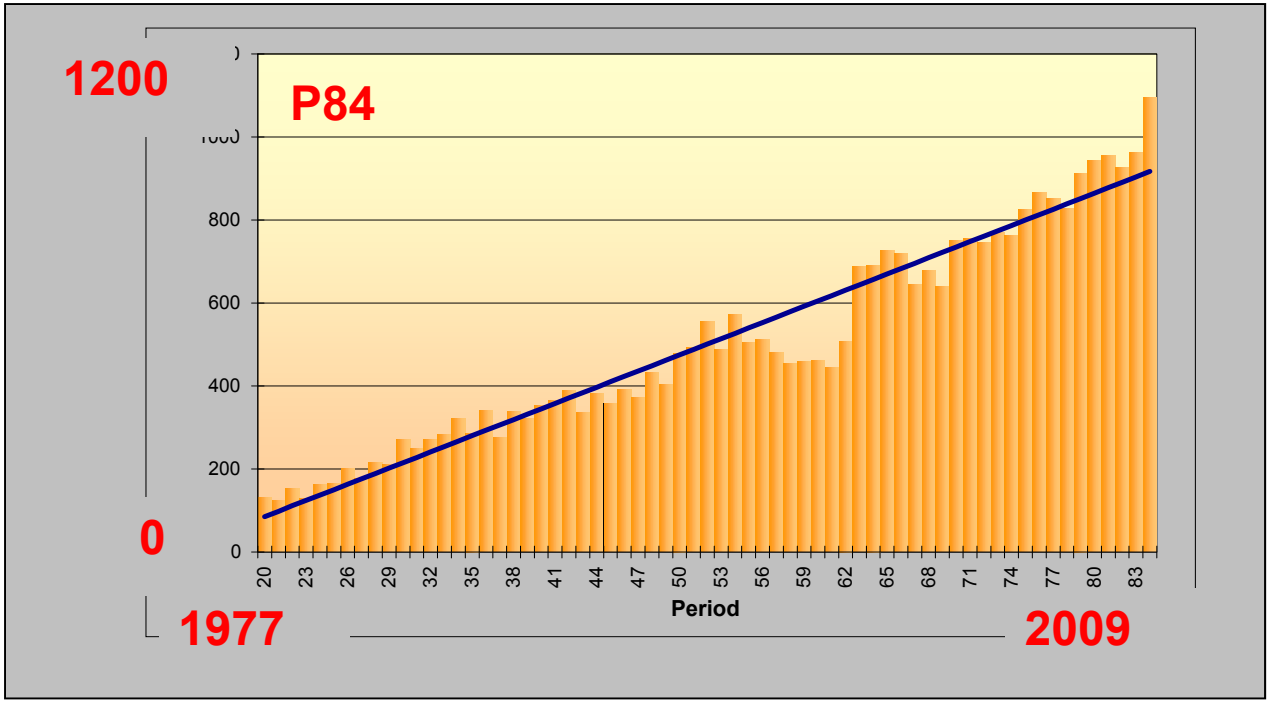
- Observing Programmes Committee
  - 4 scientific categories
    - Cosmology (A)
    - Galaxies and Active Galactic Nuclei (B)
    - Interstellar Medium, Star Formation and Planetary Systems (C)
    - Stellar Evolution (D)
  - 13 panels
    - 3 for category A
    - 2 for category B
    - 4 each for categories C and D

Proposal types

- 5 proposal types all handled by OPC
  - normal programmes
  - short programmes
  - large programmes
  - Coordinated VLT/XMM projects
  - Target of Opportunity
  - calibration programmes
    - all considered by the OPC
- Director Discretionary Time
    - submission any time
    - decided by ESO Director General

ESO proposals

- Nearly 1000 proposals submitted
  - P83 – 962 proposals
    - 58 proposals with Spanish PI (6.0%)
  - P84 – 1095 proposals submitted
    - 69 proposals with Spanish PI (6.3%)



ESO proposals

- Pressure factor typically high
  - typical oversubscription for ESO telescopes is >3
    - often reaching 5 and in certain periods/RA ranges 8 or higher
  - Large Programmes have an acceptance rate of about 20% or less
  - Pressure on ToO proposals is extremely high
    - GRBs, supernovae, novae, stellar occultations by TNOs, microlensing,

High pressures

- Some right ascensions are already in high demand

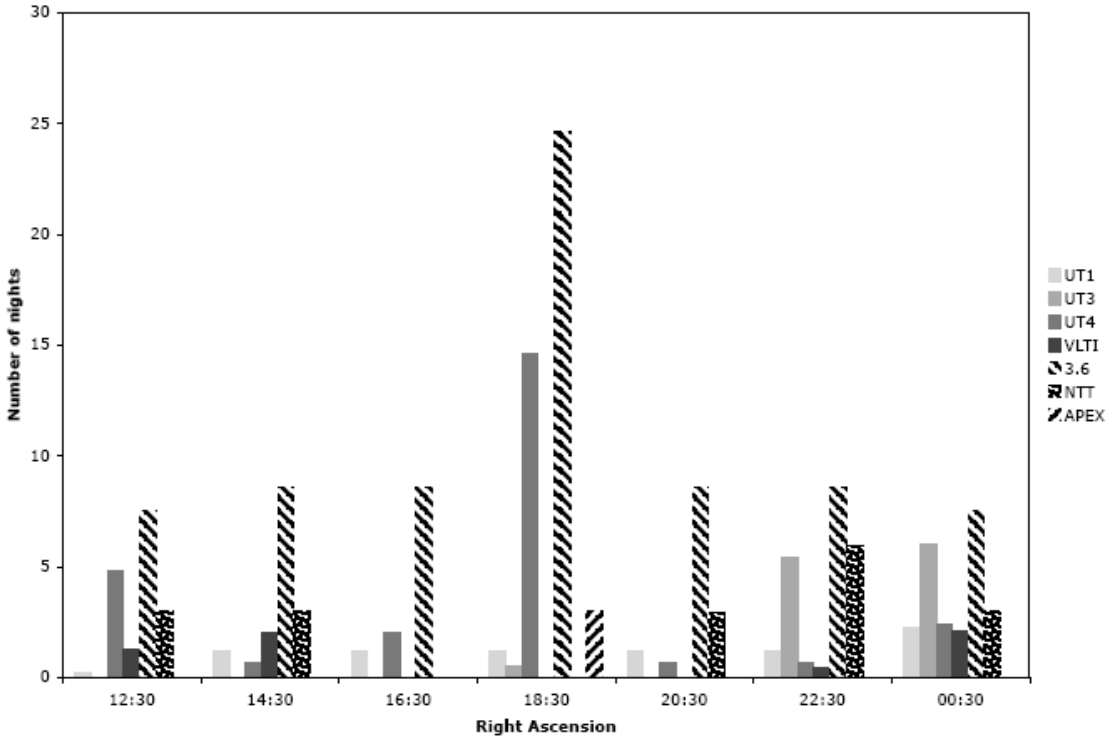


Figure 3: Expected time allocation (in nights) for ongoing Large Programmes in Period 85. The RA bins are defined as for Figs. 1 and 2.

Call for Proposals

- Important document
  - contains a lot of relevant information
  - especially important for first-time users
  - contains many useful links to instrumentation and other useful information
  - binding document, if proposal is approved

Call for Proposals

- Everybody must read

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What makes a proposal successful?

- Exciting science
  - providing a clear progress in our understanding of some phenomenon
- A neat idea
  - unusual method, new idea, new approach, unique observation or experiment
- Clear language
  - presentation of an exciting story, which is interesting for many people
  - cover all questions somebody may have
  - information to the point

What makes a proposal successful?

- A consistent story
  - the proposal is complete and provides all information
  - quantitative arguments for the amount of time requested
- Good Luck!

ESO Archive

- The ESO data archive
  - is a rich source of excellent data
  - abstracts of previous proposals available
  - data public one year after they have been delivered to the PI
  - great way to compete with your competitor, if they got observing time
  - easy retrieval and selection of calibration data

Get involved

- Participate in OPC
- Participate in other ESO activities
  - get to know the organisation better
  - active interactions with ESO people
- Have a lively scientific exchange with the (European) astronomical community
  - conferences, workshops
  - regularly publish your results

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ESO's goals for next five years

- Best science from La Silla Paranal Observatory
  - Second generation instruments (VLT/VLTI)
  - Key surveys with VST and VISTA
  - Long-term programs for unique science on La Silla
  - Prepare for ALMA science with APEX
- Deliver ALMA on time and budget
- Design world-leading E-ELT, and secure funding for construction and operations