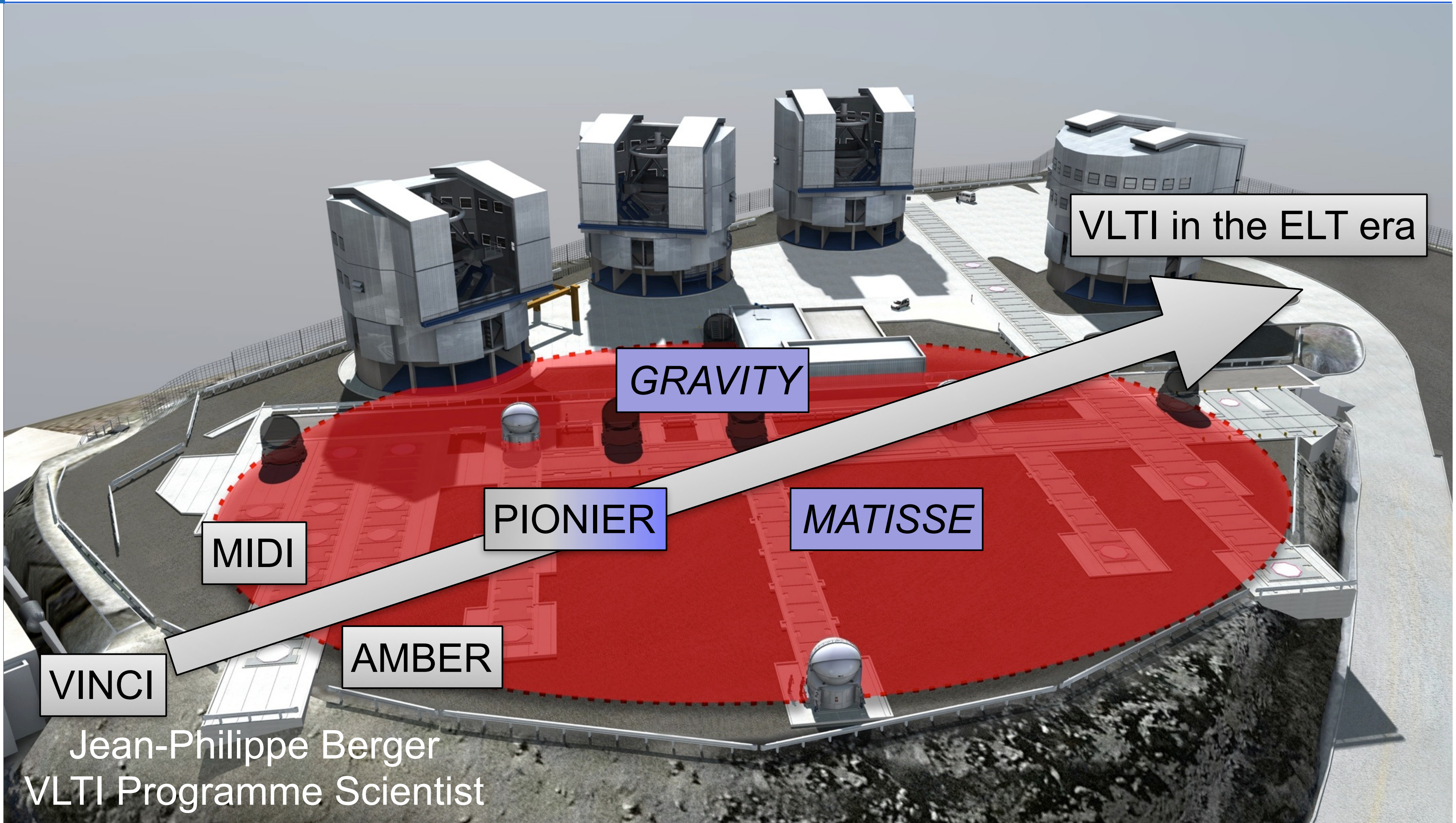
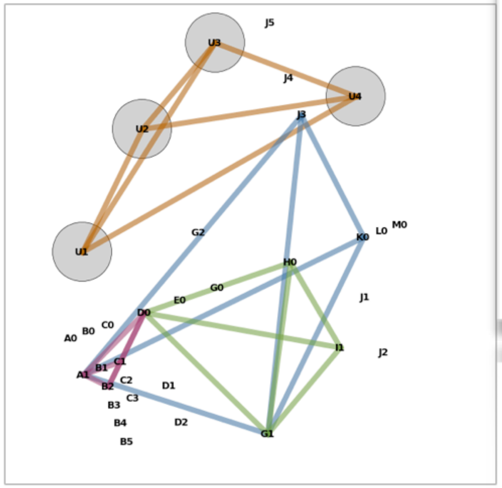
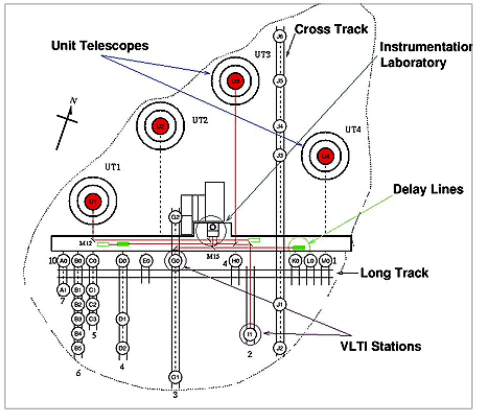
VLTI in the next decade

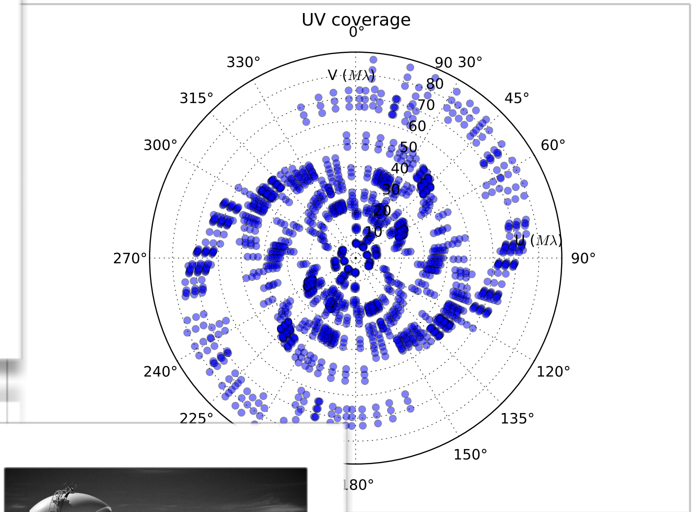


THE VLTI

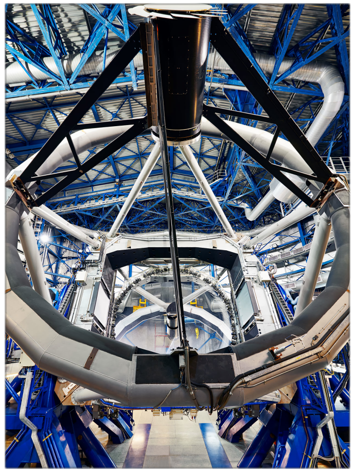
A sophisticated infrastructure

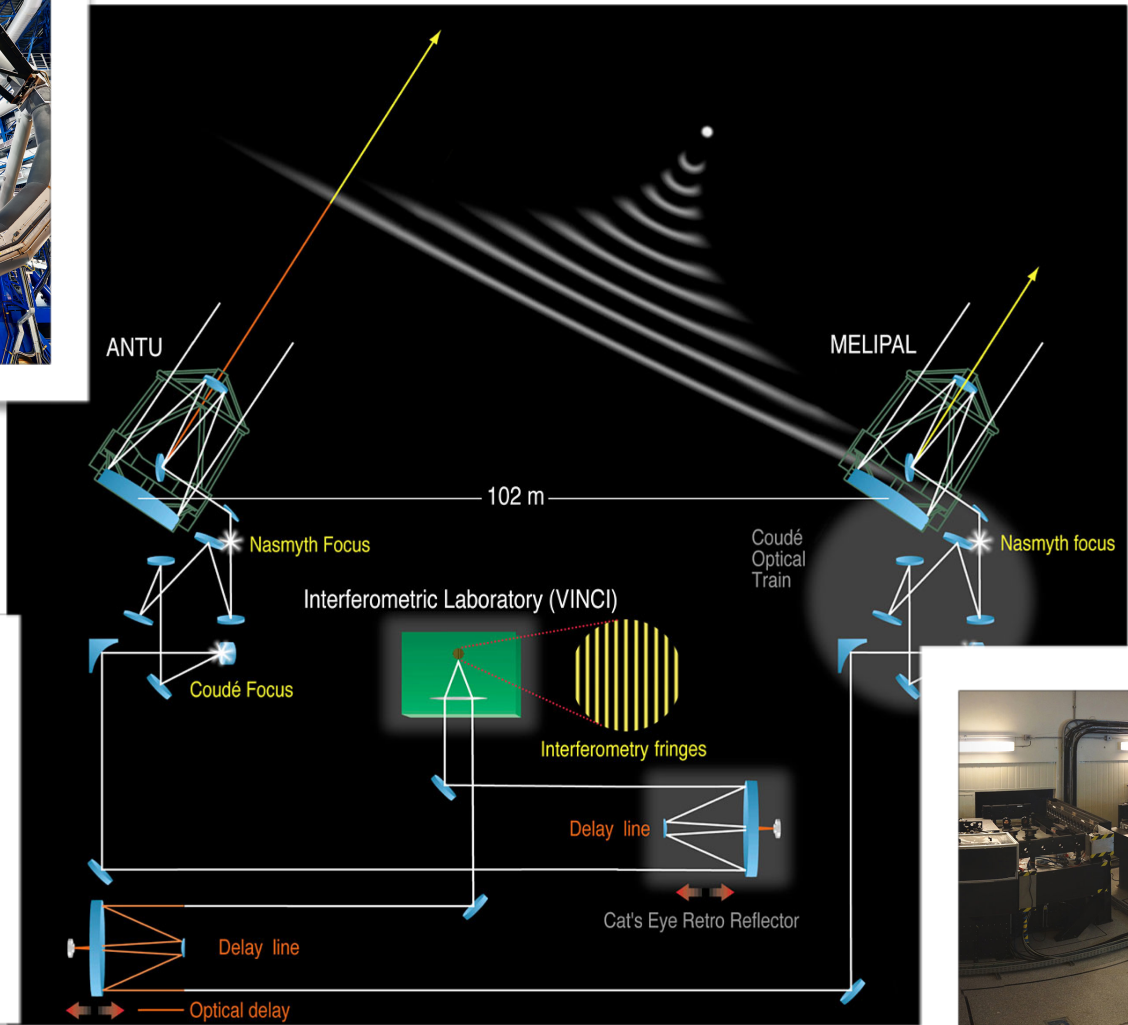


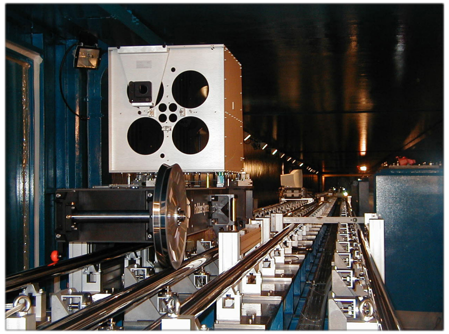


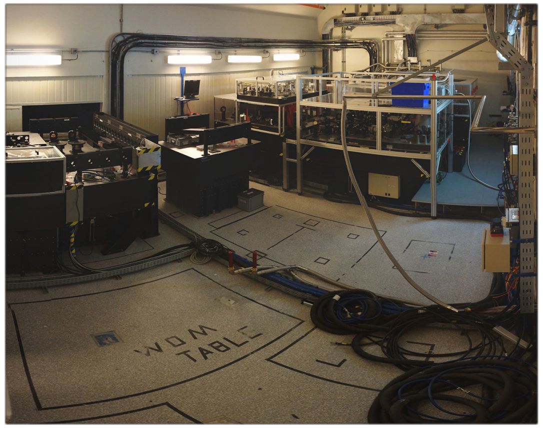


A sophisticated infrastructure









An extended team

many names not here but crucial support

Directorate of Operations

Paranal

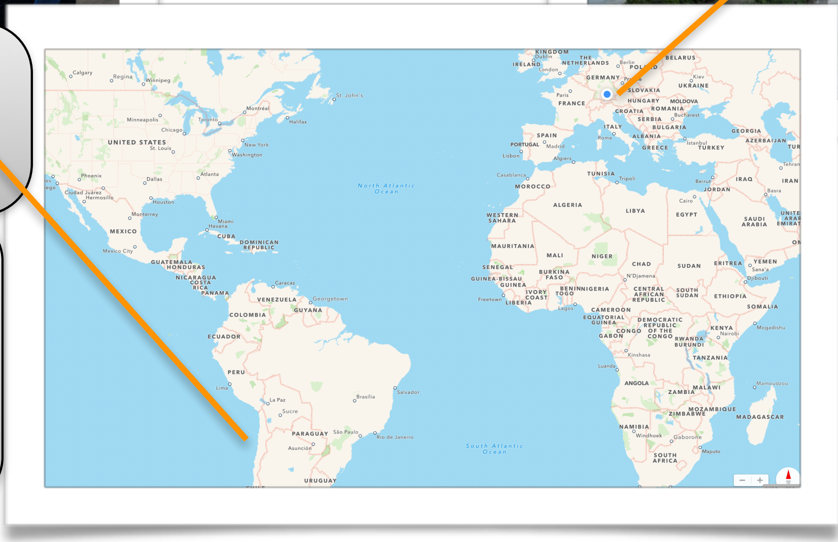
Department of instrumentation/ mechanics/electronics

VLTI System Engineering
N. Schuler, P. Bourget, S. Poupar, J. Alonso …

SCIOPS
A. Mérand
W.-J. de Wit, A. Pino + 8 staff (astronomers + TIO) + 2 post-doc

Quality control & pipeline
I. Percheron
A. Gabasch
E. Garcia + DMO division

Garching



User Support
C. Hummel
M. Wittkowski

Directorate of Engineering

VLTI engineers
F. Delplancke
T. Phan Duc
L. Andolfato
R. Abuter
S. Engner
C. Schmid
+ Many others

Directorate of Programs

GRAVITY/MATISSE I Scientist + PM + SE
M. Schöller, L. Jochum, P. Bristow, A. Glindemann

VLTI Infrastructure PM
F. Gonte

VLTI scientist:
J. Woillez

VLTI is almost ready for 2nd generation

European Southern Observatory

ESO –

Public | Science | User Portal | Intranet | Subscribe | Contact | Site

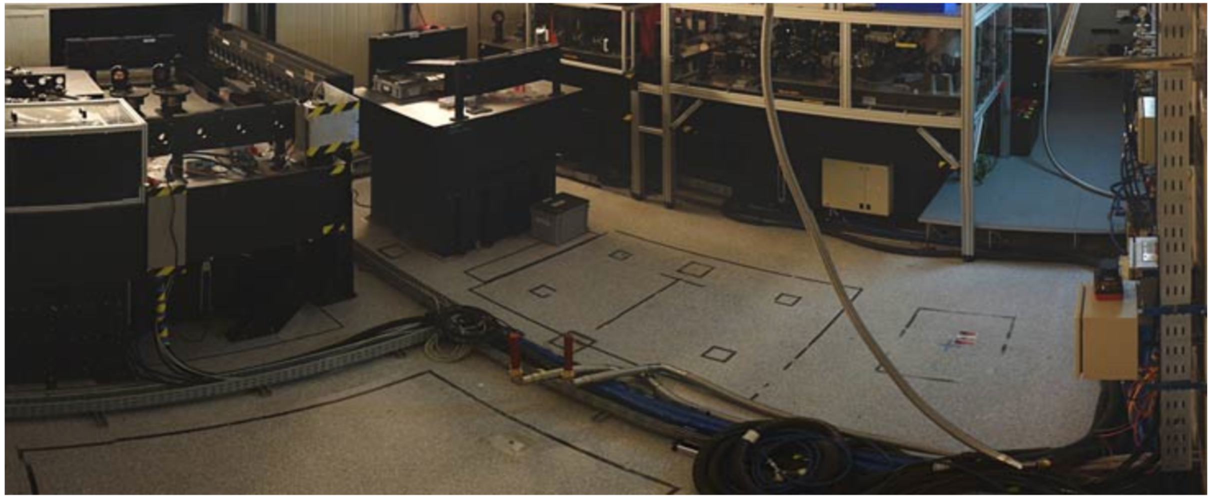
ESO Intranet

- Safety at ESO
- Contact
- Internal News
- Most Useful to Know
- Calendar and Information Systems
- Human Resources Information
- Information Technology Services
- Science Matters
- Directorates and more
- Programmes and more
- International Staff Association
- Social Activities

int15271 — Internal Announcement

First milestone in VLTI recommissioning: Second Light!

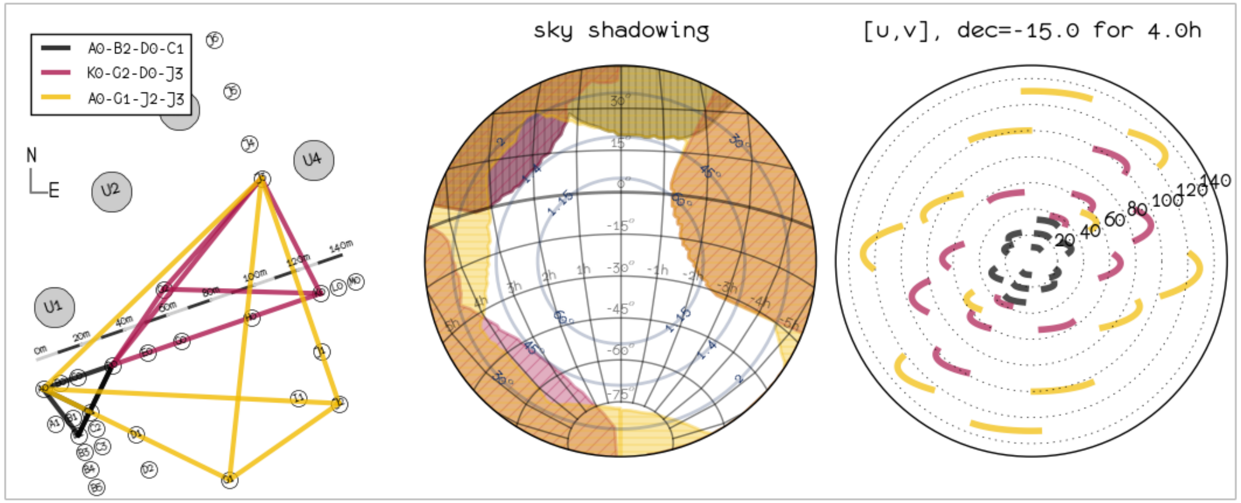
10 September 2015



Click to Enlarge

We are very happy to report that, on the nights of 23–24 and 24–25 August 2015, we obtained fringes again on AMBER/FINITO, and PIONIER — the current instruments of the VLT Interferometer (VLTI). Why is this important? Because this recommissioning follows six months in which the VLTI has been off the sky for extensive upgrades.

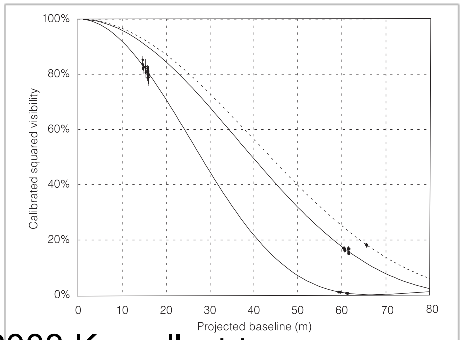
The VLTI back in business



ACHIEVEMENTS IN THE LAST DECADE

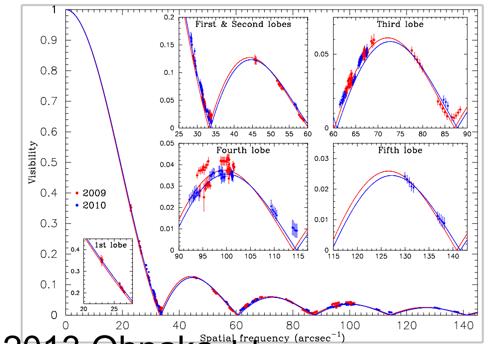
Exquisite constraints on stellar surfaces

VINCI



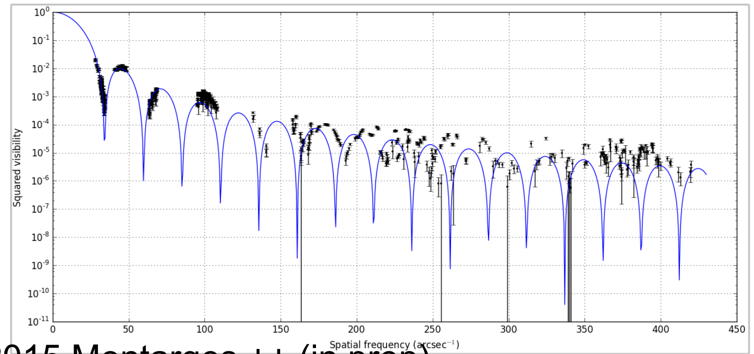
2003 Kervella ++

AMBER



2013 Ohnaka ++

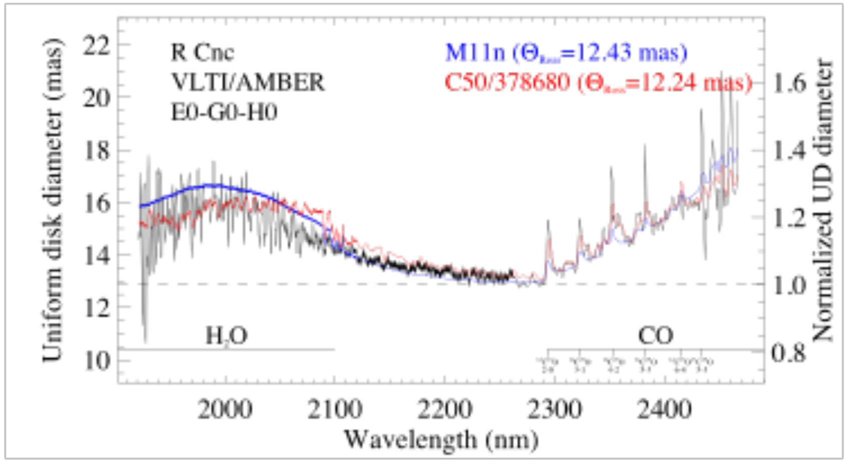
PIONIER



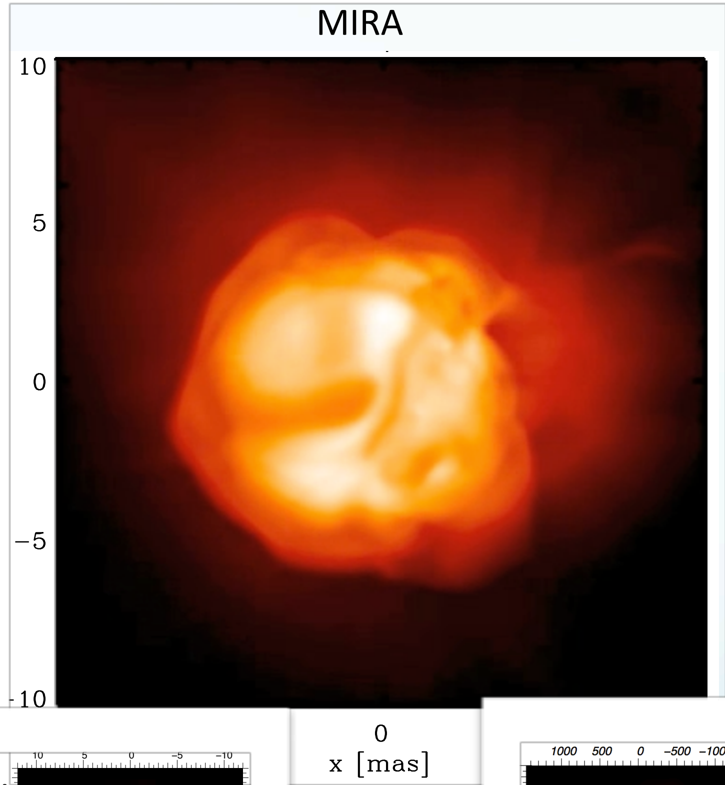
2015 Montarges ++ (in prep)

Spectro interferometry was enabled

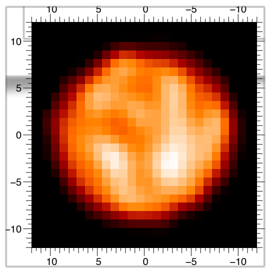
AMBER, Wittkowski 2011++

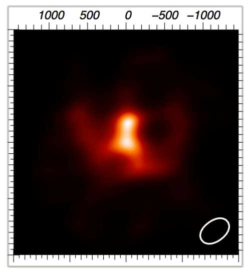


2014 Chiavassa



2015, Paladini in prep

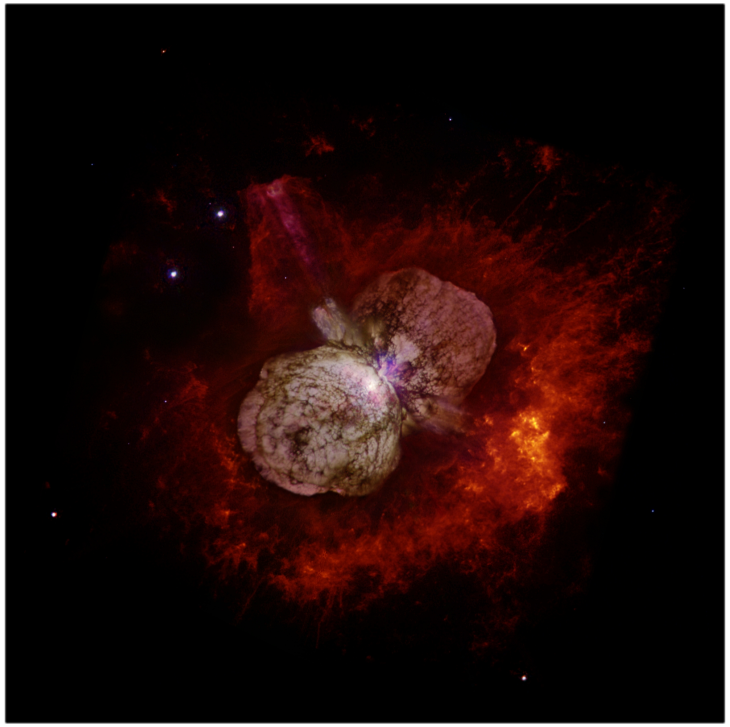




Molecular layer spatio-temporal structure exposed

Spectro interferometry was enabled

Weigelt et al. 2007



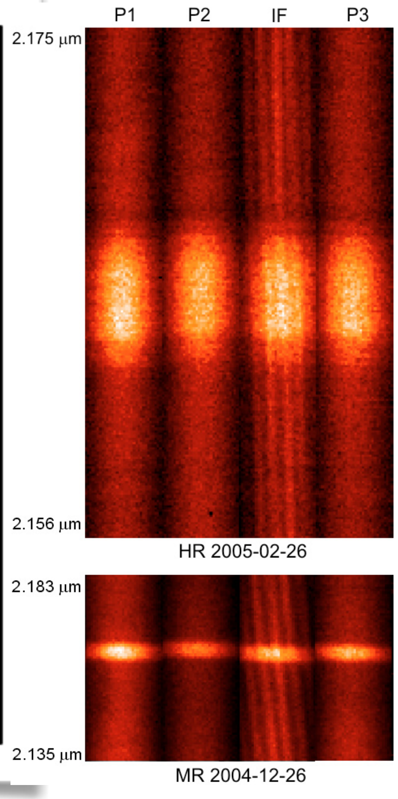
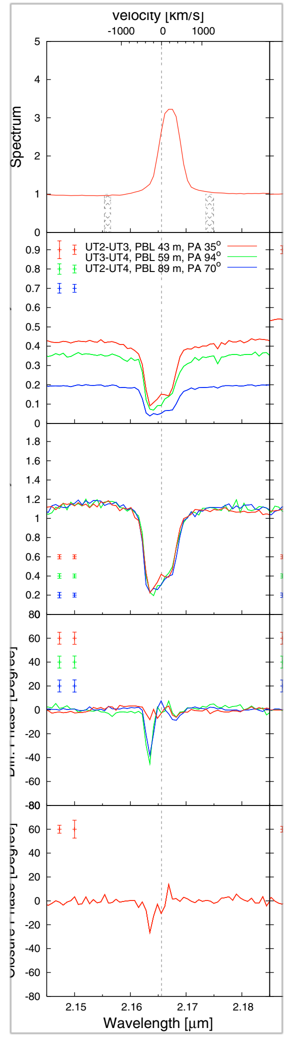


Fig. 1. Spectrally dispersed AMBER/VLTI Michelson interferograms of η Car. The two panels show the spectrally dispersed fringe signal (IF) as well as the photometric calibration signals from the three telescopes (P1–P3) in high (HR, *upper panel*) and medium spectral resolution mode (MR, *lower panel*). In both panels, the bright regions are associated with the Doppler-broadened Brγ emission line.



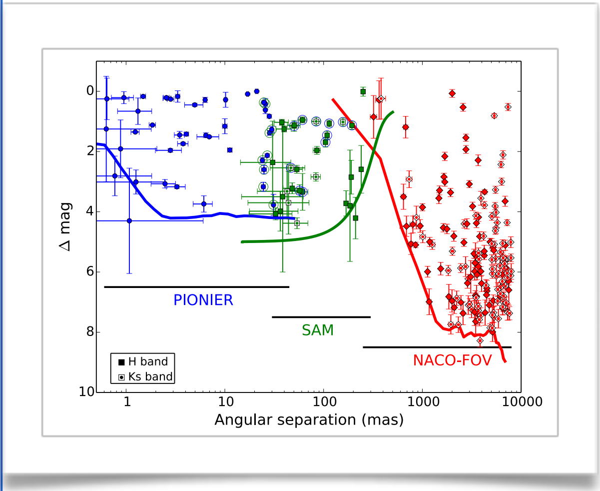
Discovering the engine at the hear of the Eta Carina nebula

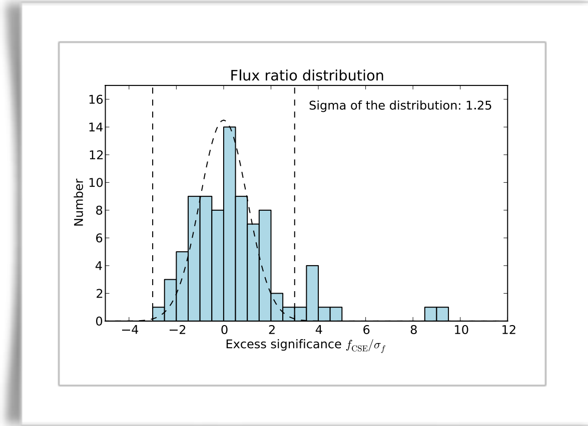
Efficiency has enabled surveys with N>100 objects

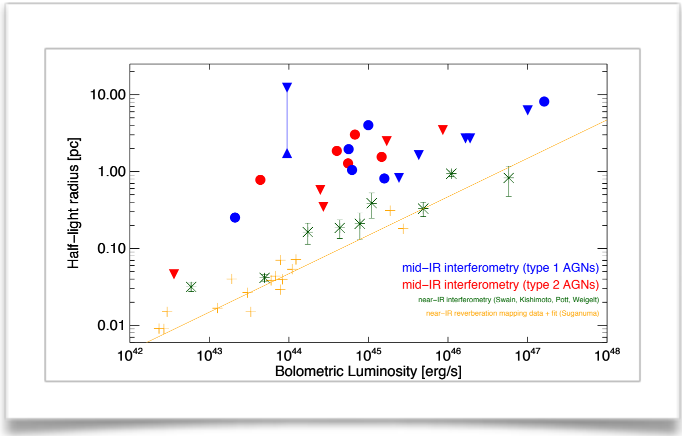
Binarity among massive stars

Mid-IR sublimation front in AGN's core

2014 Ertel ++







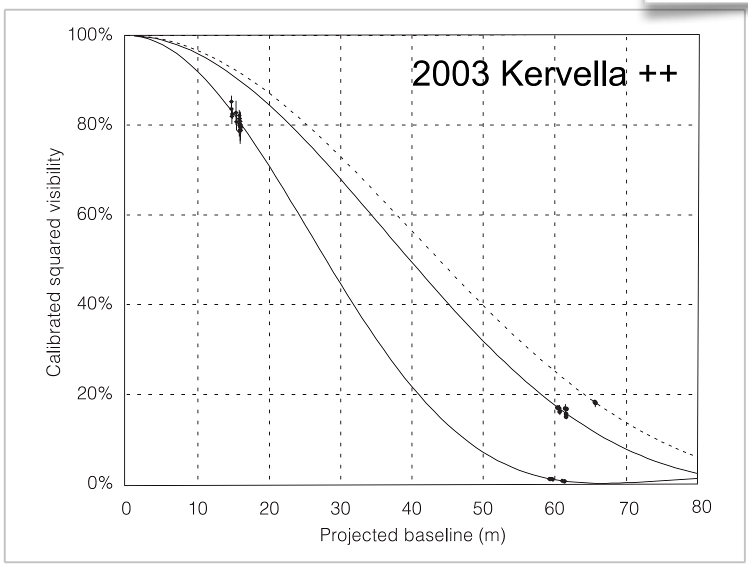
2014 Sana ++

Exozodiacal dust

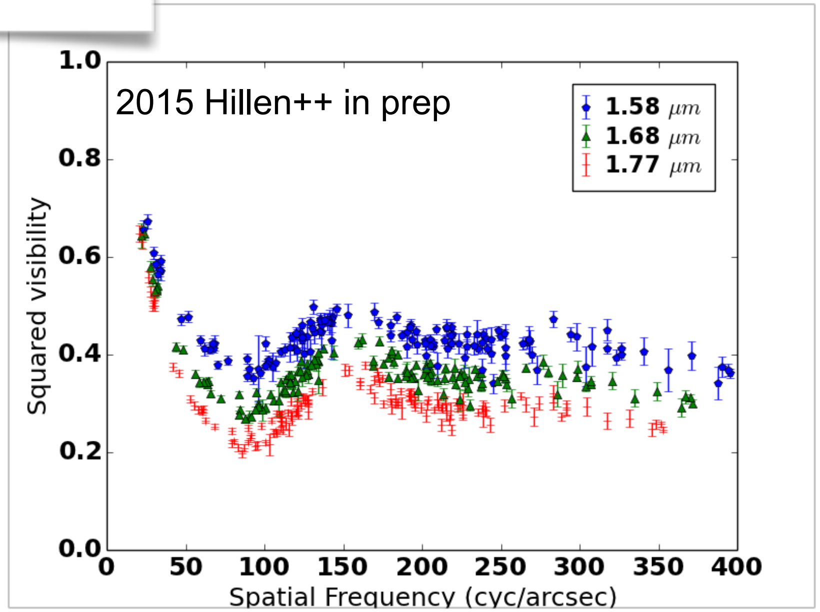
2013 Burtscher++

Optical interferometry went from snapshot to imaging

SNAPSHOT

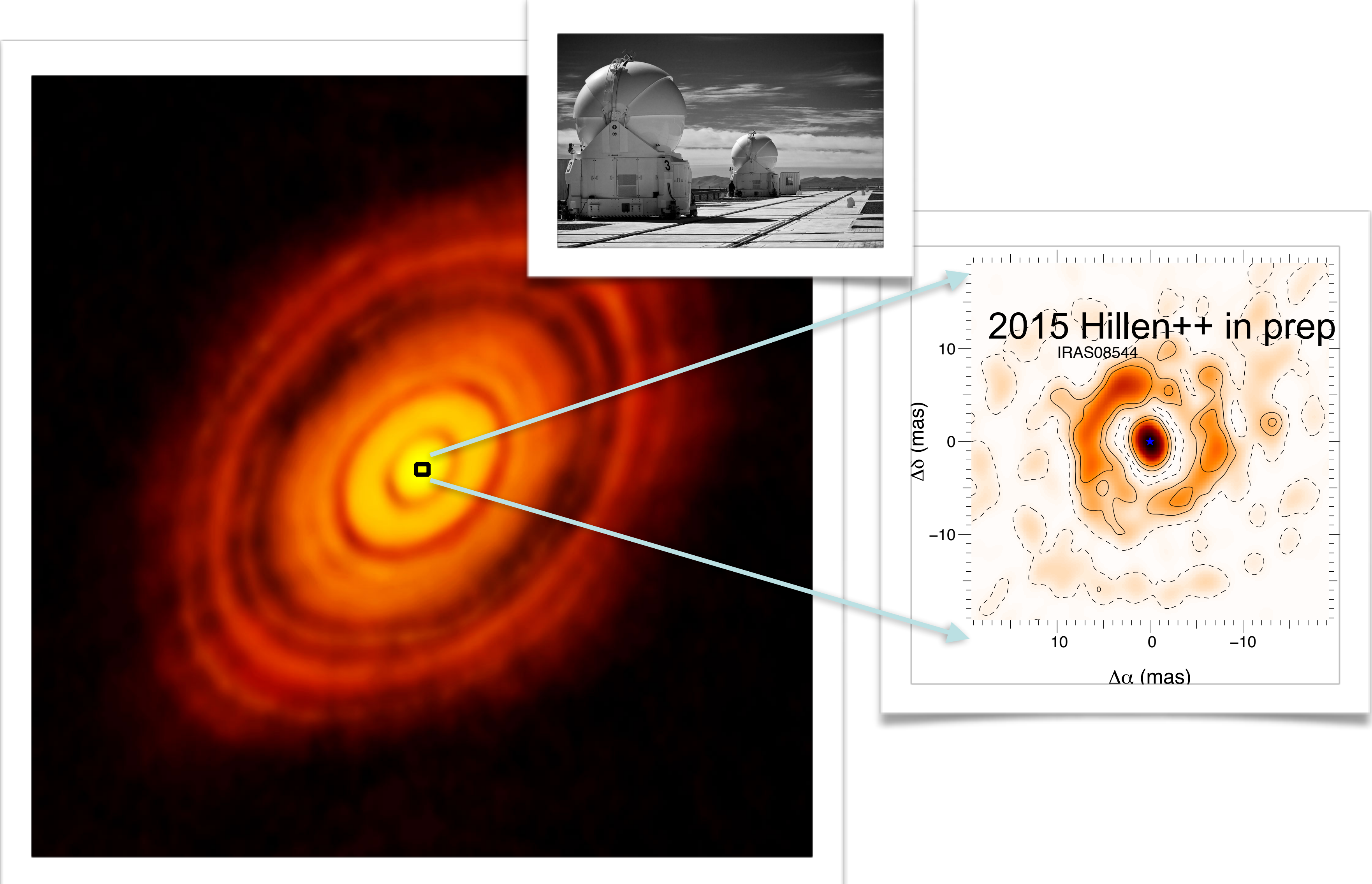


IMAGING



BUT … uv coverage still a limitation

Optical interferometry went from snapshot to imaging



CAUTION: not the same object

Optical interferometry went from snapshot to imaging

2015 Paladini ++

MIRAs

Rapid rotators

2007 Monnier ++
2009 Zhao ++
20111 Che ++

2010 Kloppenborg ++

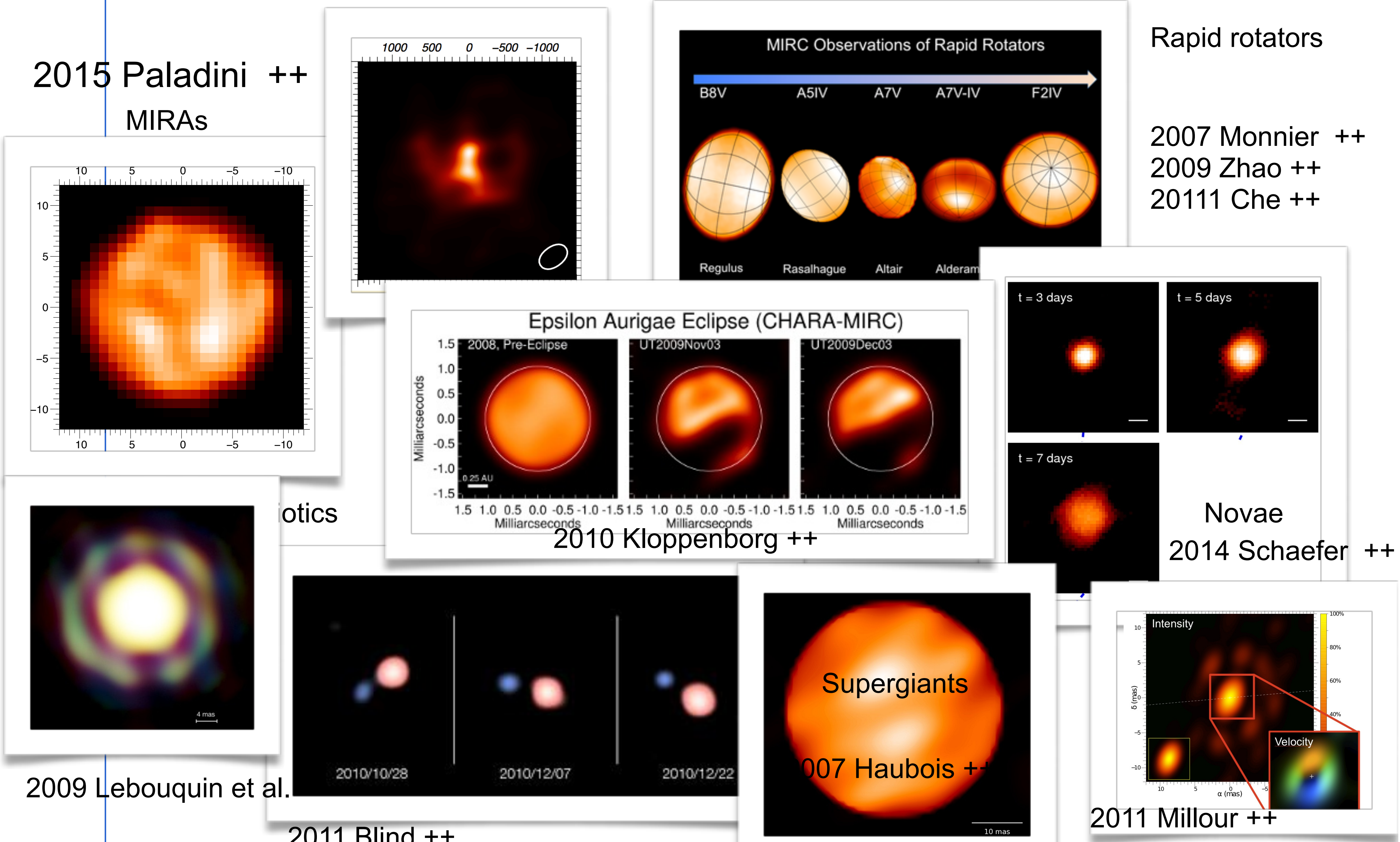
Novae
2014 Schaefer ++

2009 Lebouquin et al.

2011 Blind ++

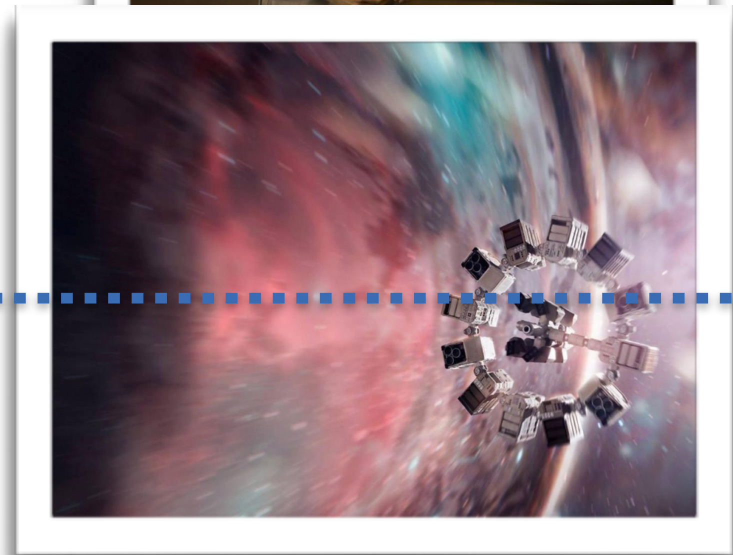
Supergiants
007 Haubois ++

2011 Millour ++



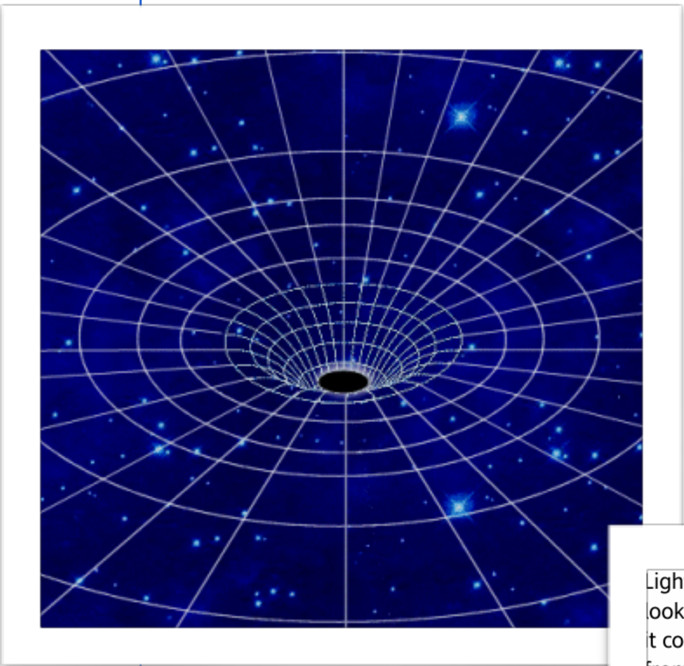
GRAVITY

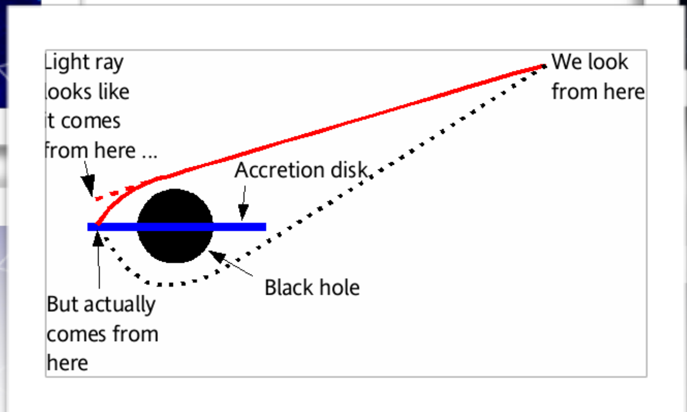
The spooky action of a black hole



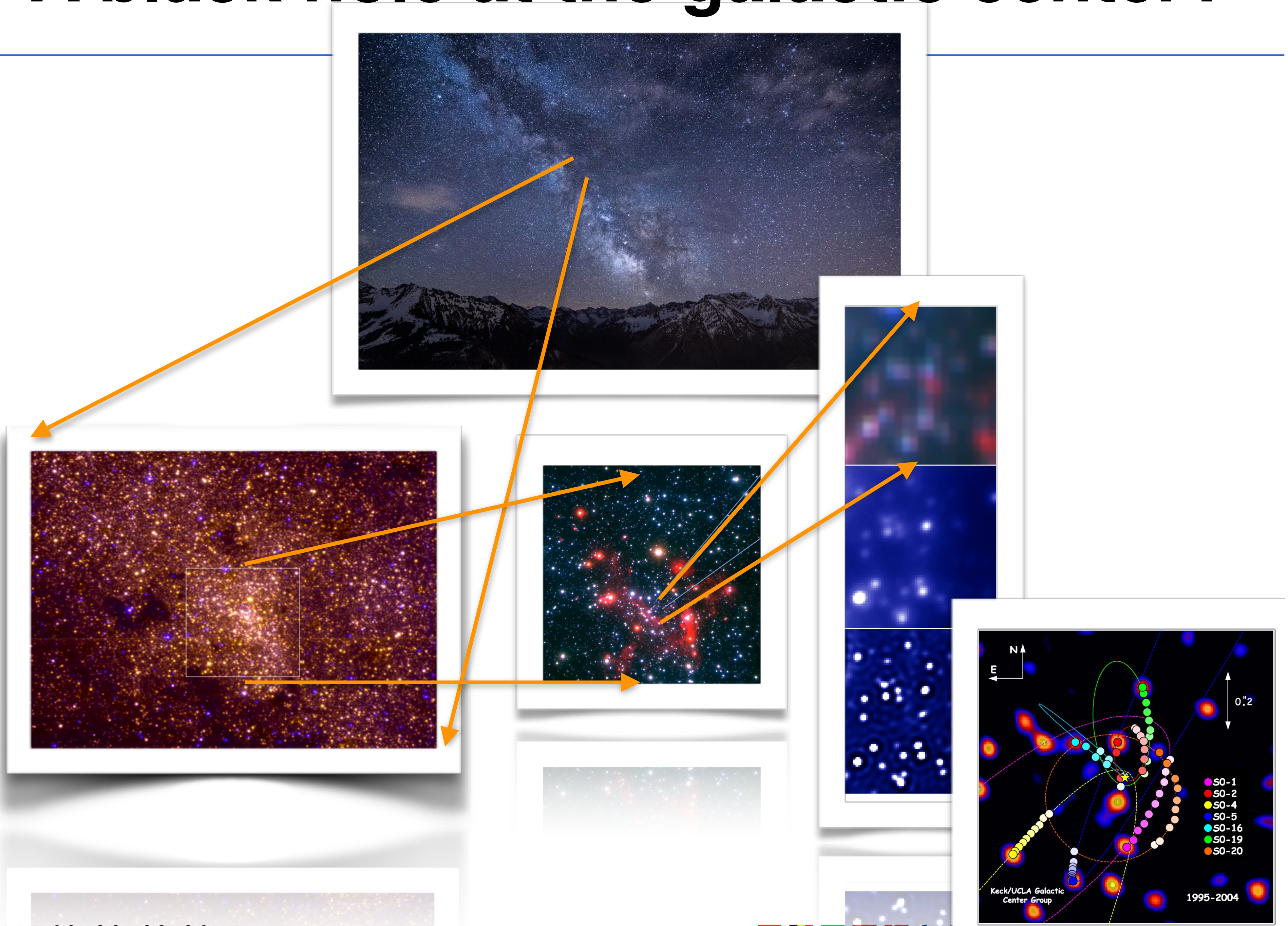
Warner Bros: “Interstellar”

Studying a black hole from close is the ultimate way to validate Einstein's GR

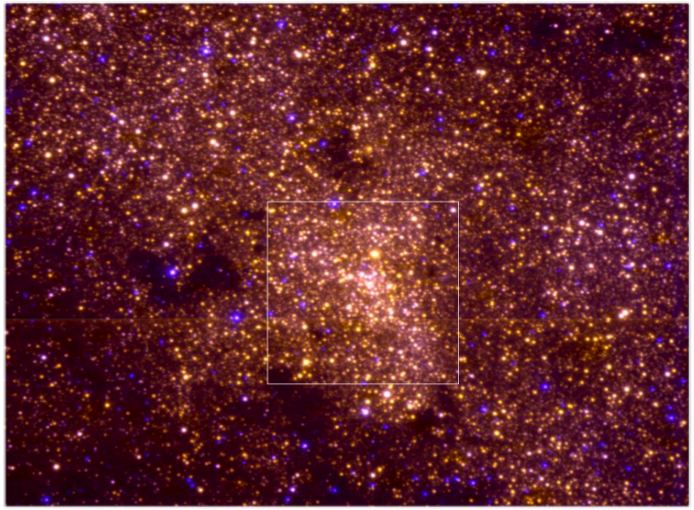


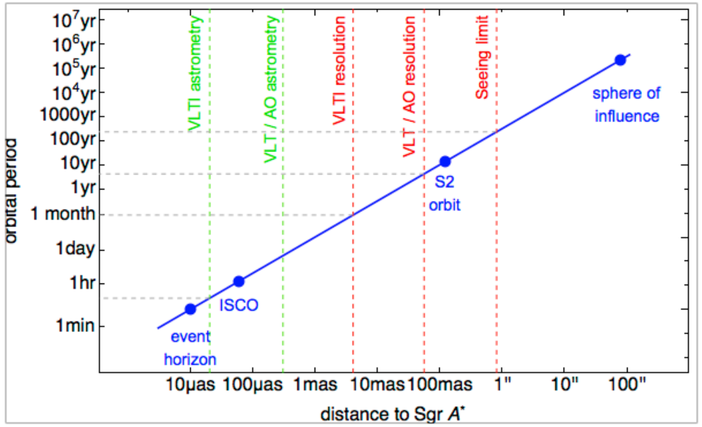


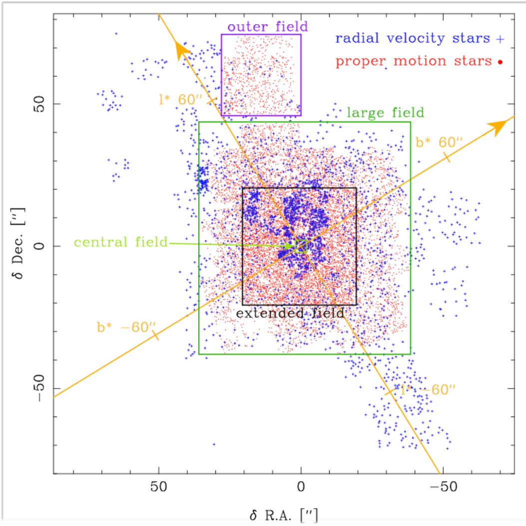
A black hole at the galactic center?



The closest we get the stronger the influence: need high angular resolution

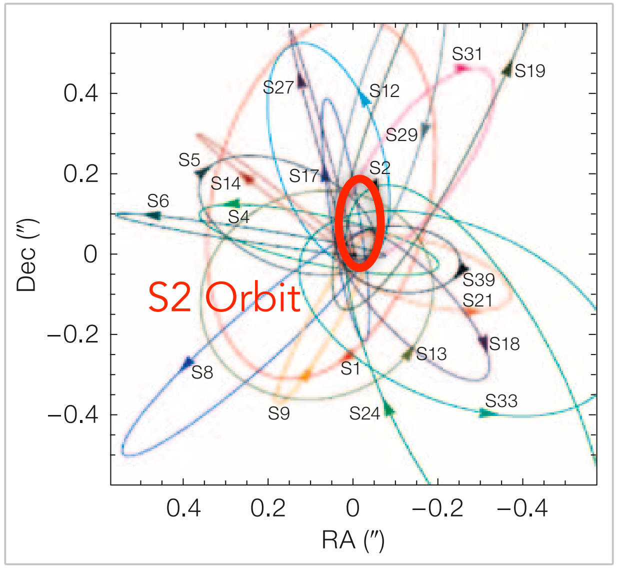






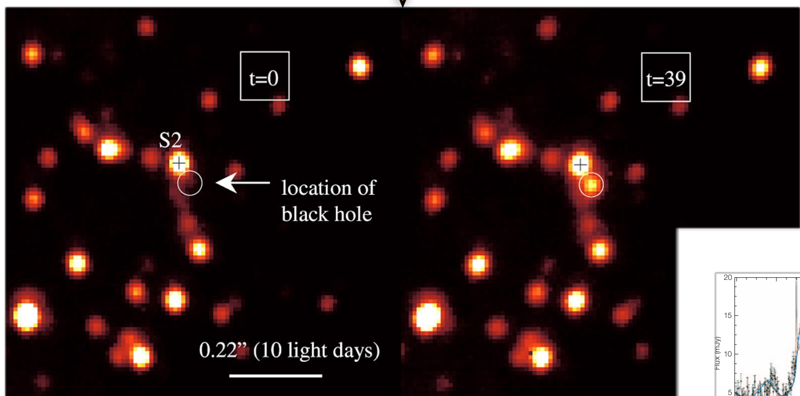
Words at the botto...

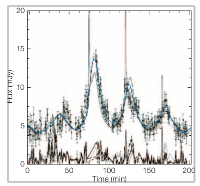
ESO telescopes & instruments and the galactic center: a success story

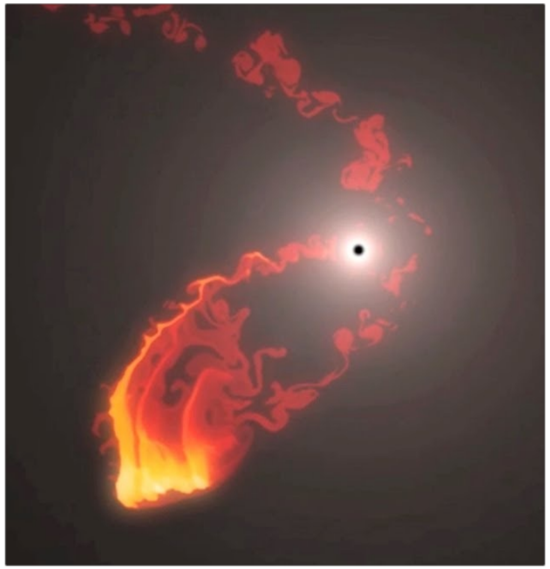


Measuring the mass through orbits

Detection of a mysterious flare

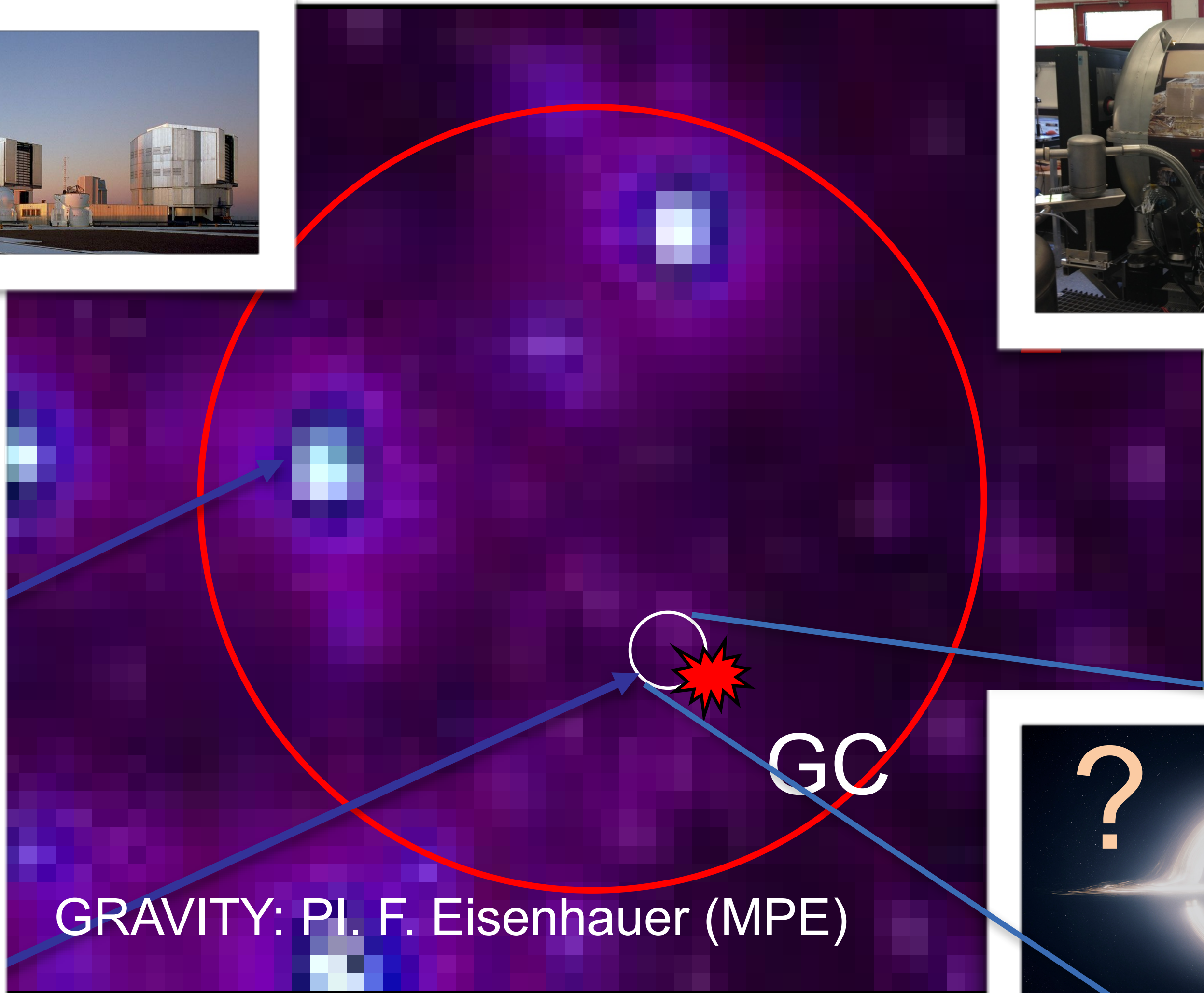




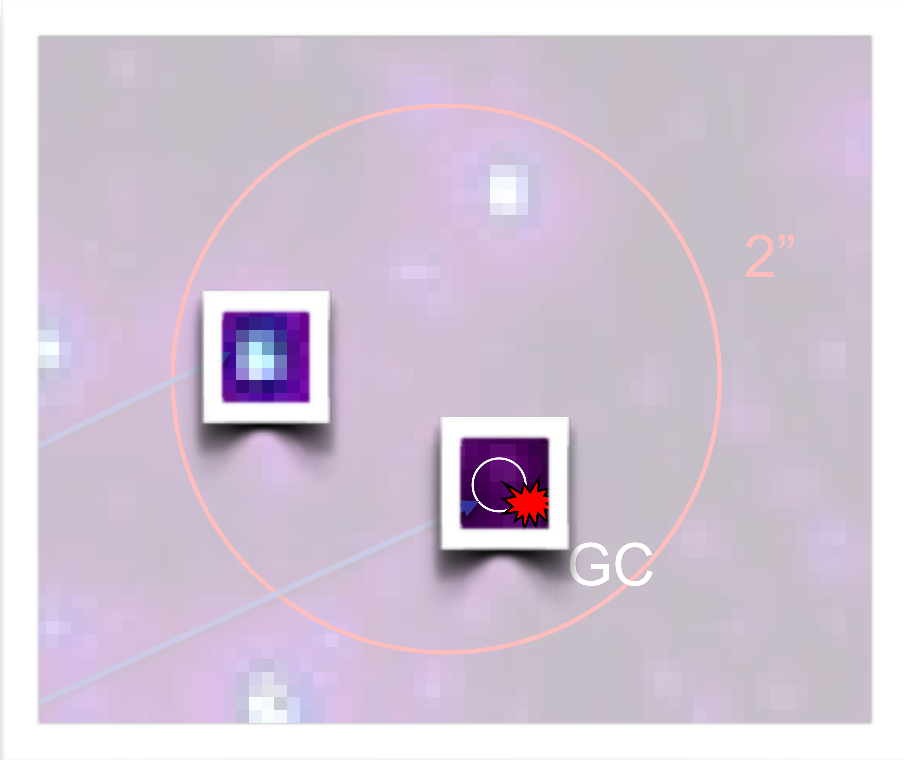


Fatal cloud disruption

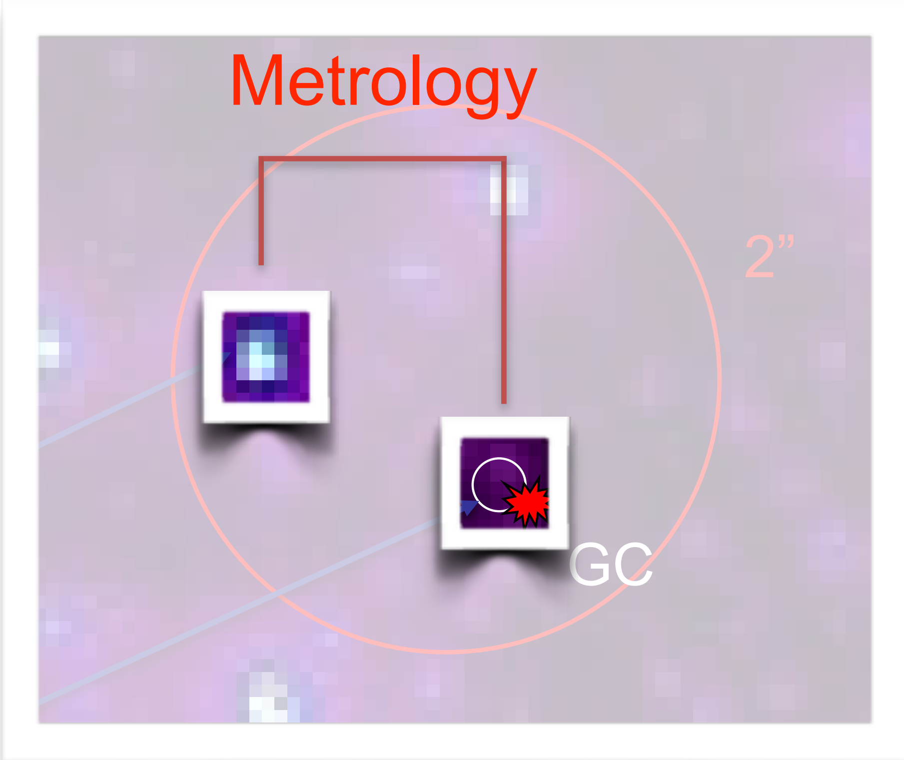
GRAVITY: pushing the frontiers of our knowledge in black-holes and fundamental physics.



Gravity observes two objects at the same time

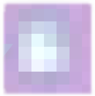


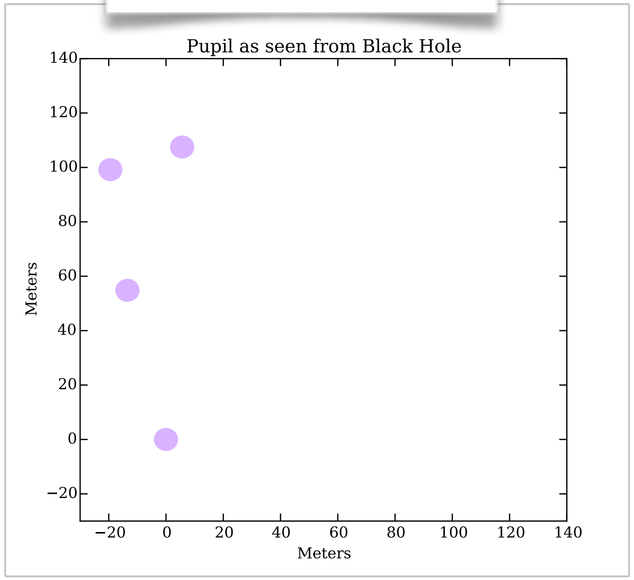
A VLT-end-to end metrology allows astrometry between two objects

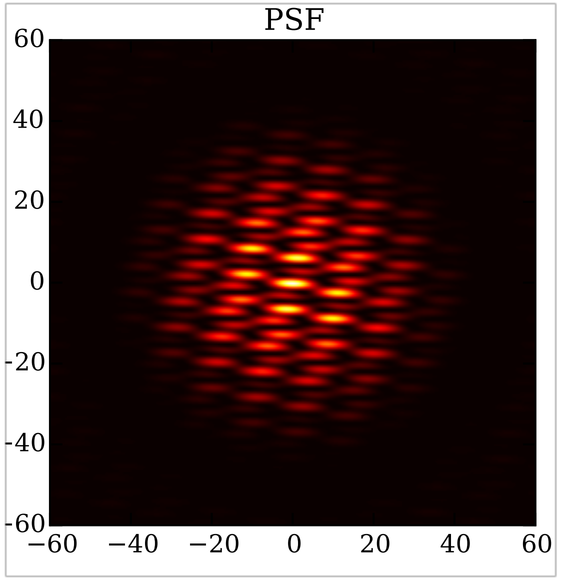


GRAVITY-Imaging

Metrology

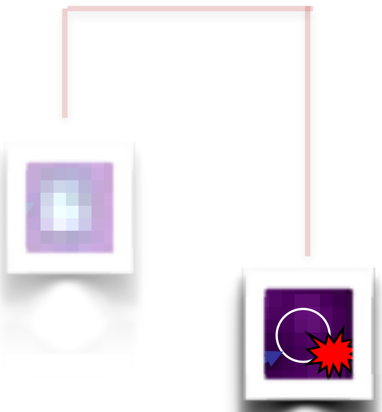


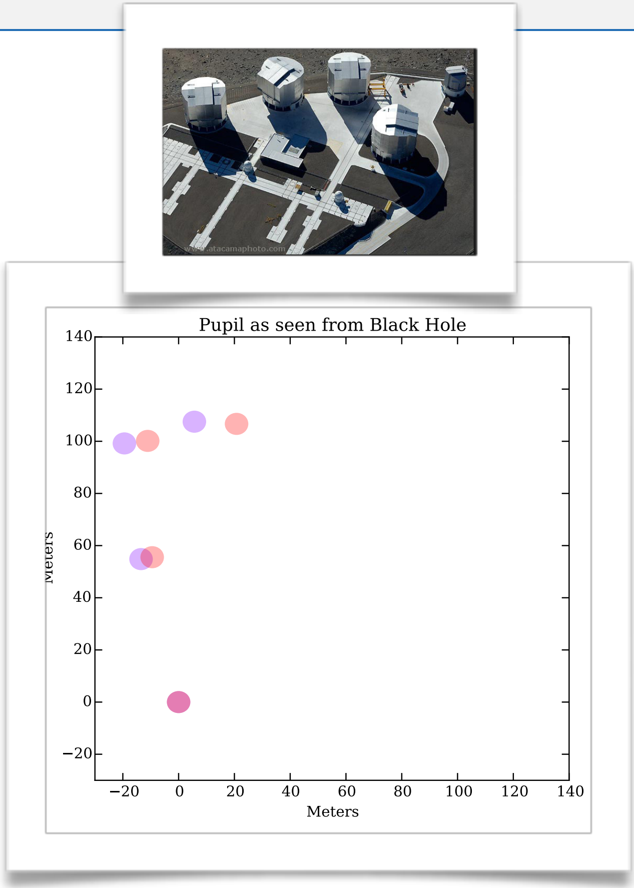


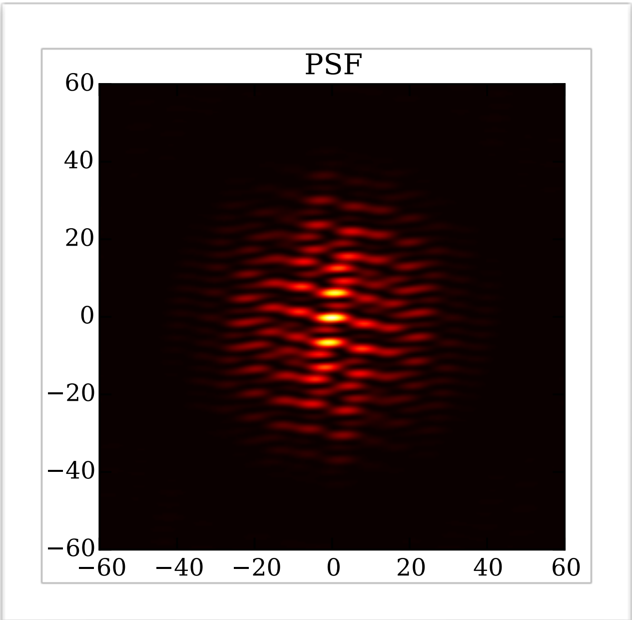


GRAVITY-Imaging

Metrology

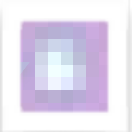


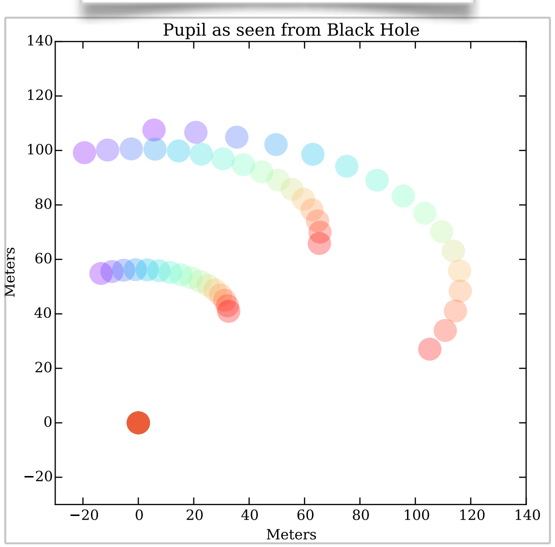


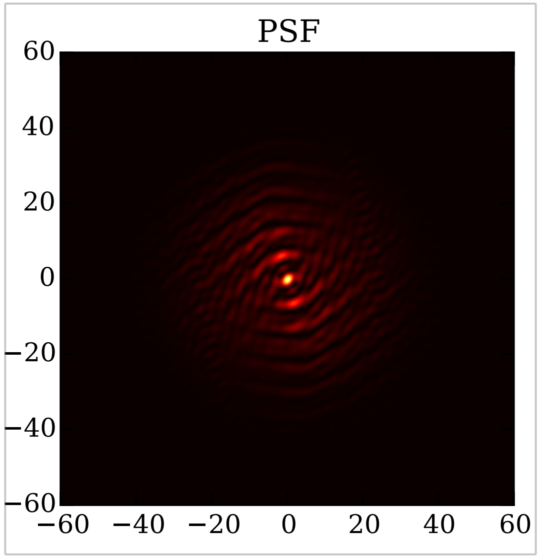


GRAVITY-Imaging

Metrology



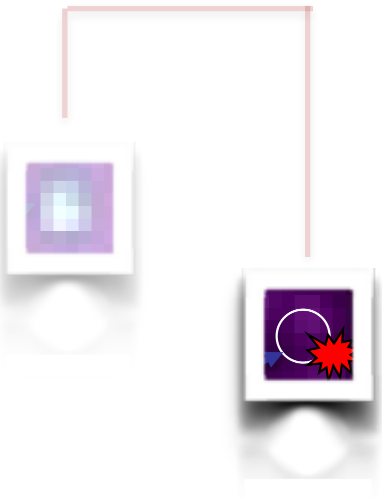


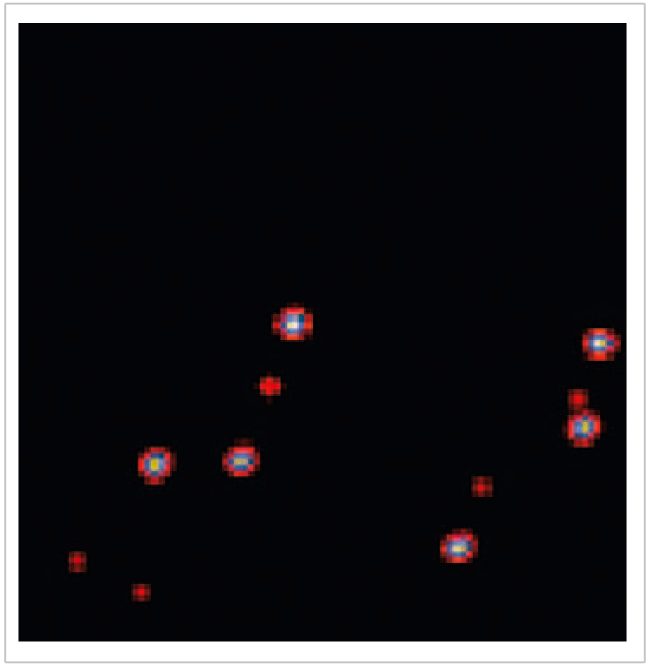


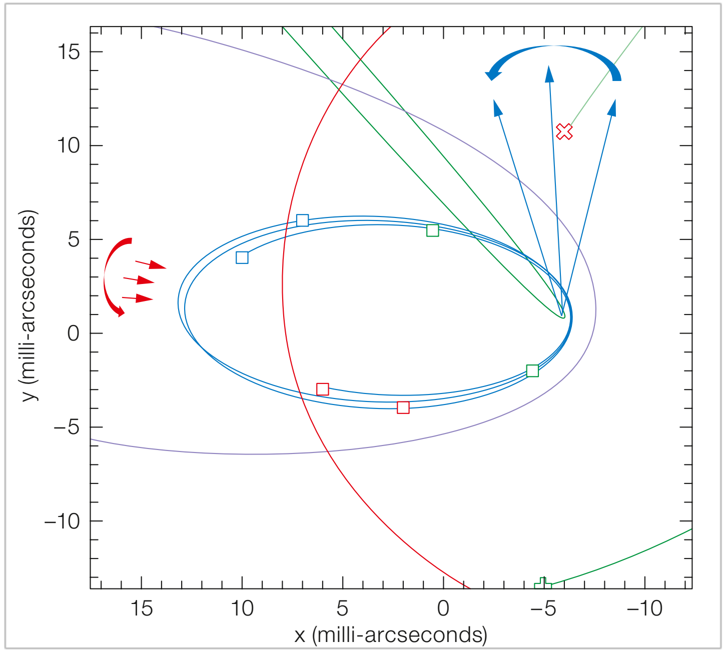
Explaining the young stars paradox

Metrology

GRAVITY-Imaging

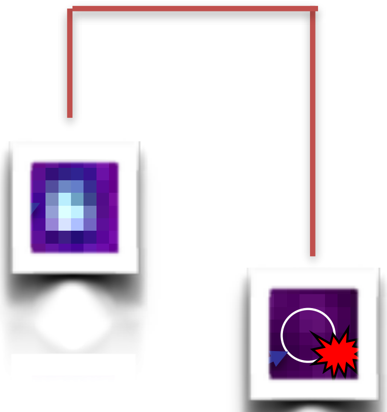




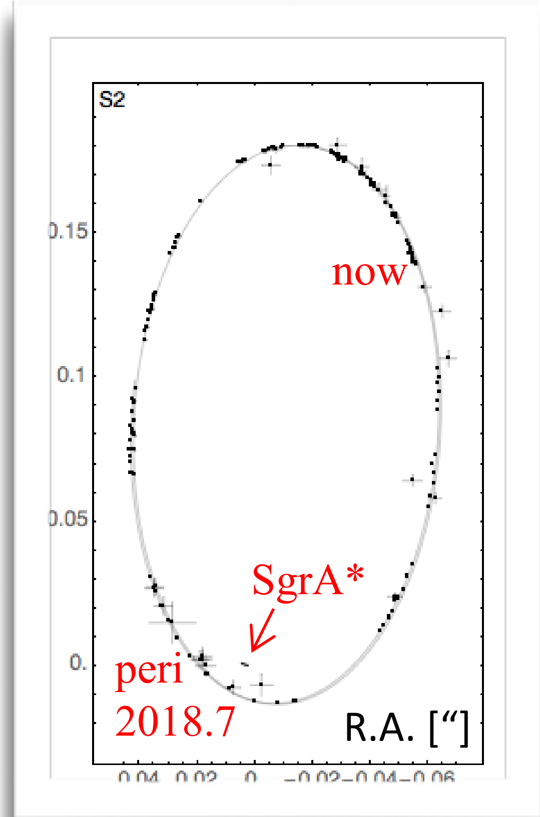


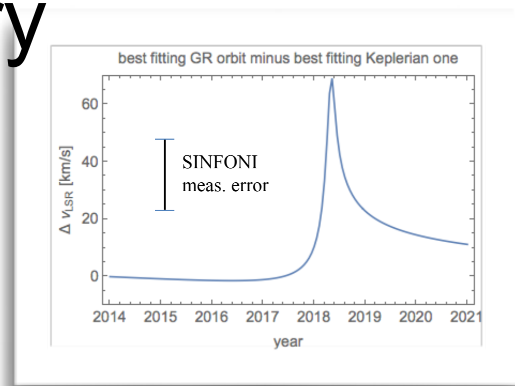
The black-hole should leave its signature in the orbits of the stars passing close-by

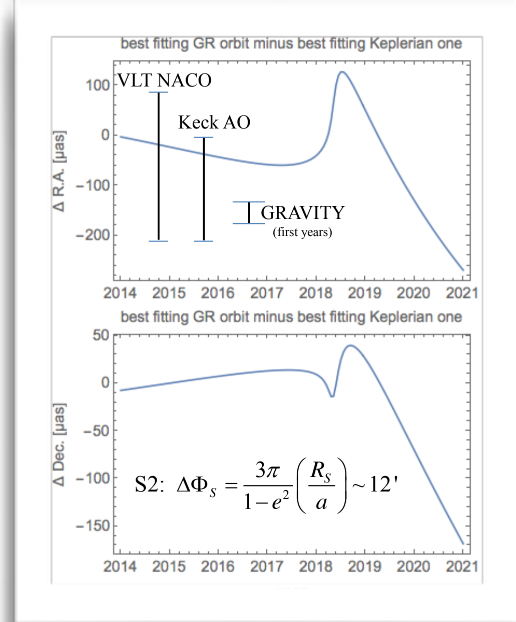
Metrology



GRAVITY-Astrometry



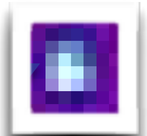


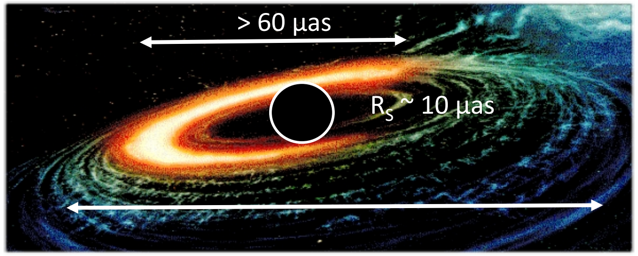


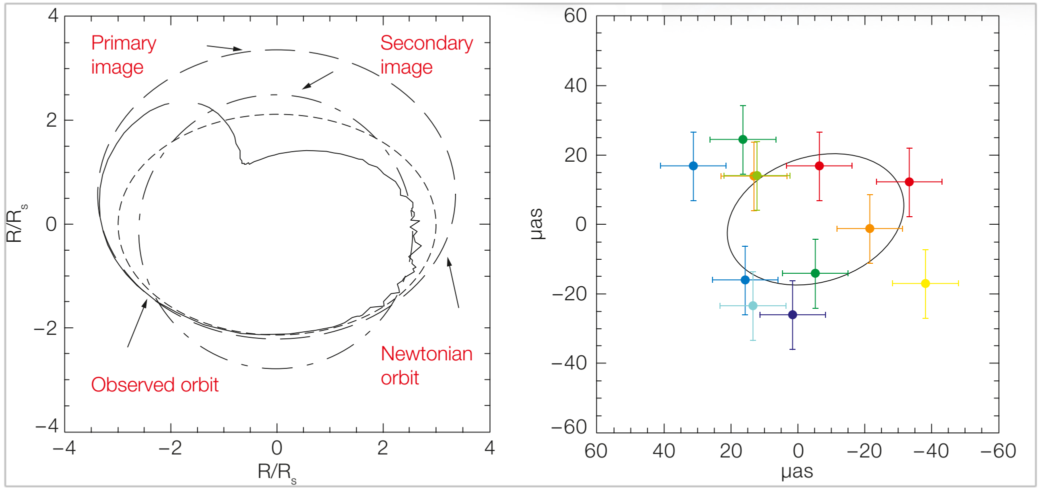
The peculiar case of S2

Unveiling the nature of the flare

Metrology

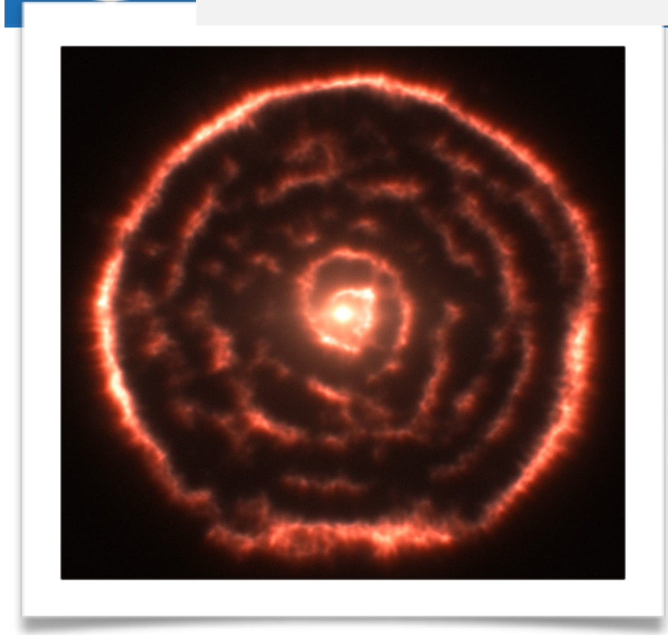




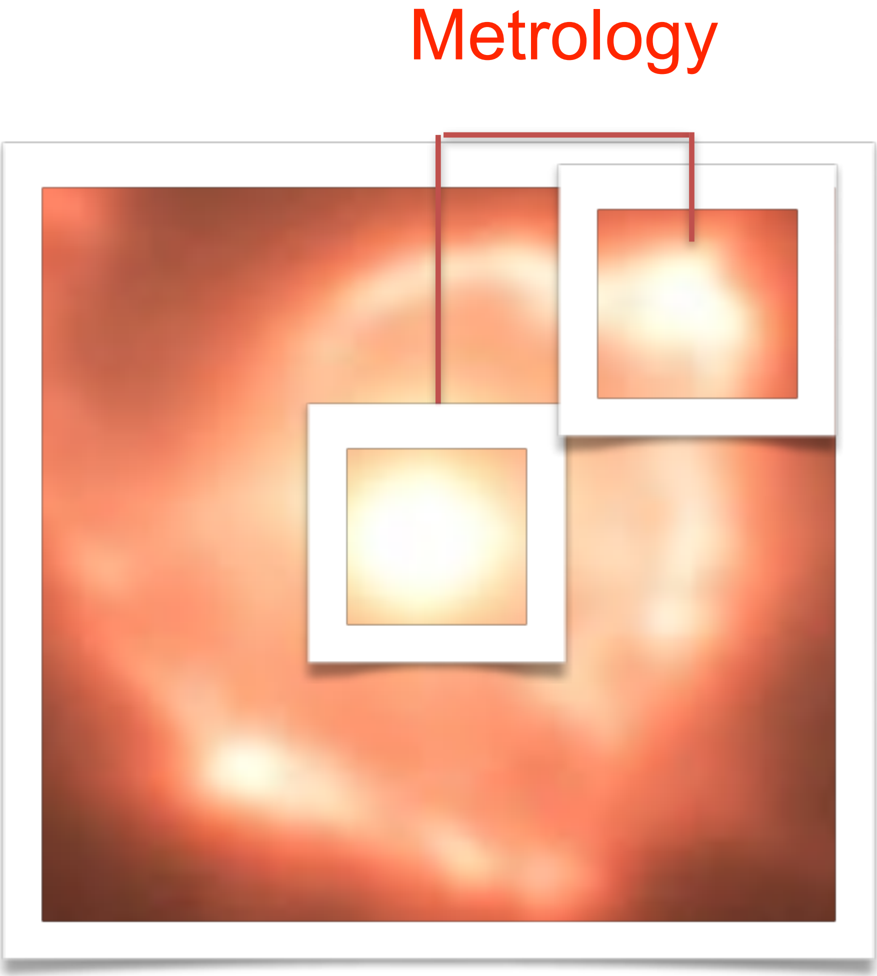


Words at the bottom

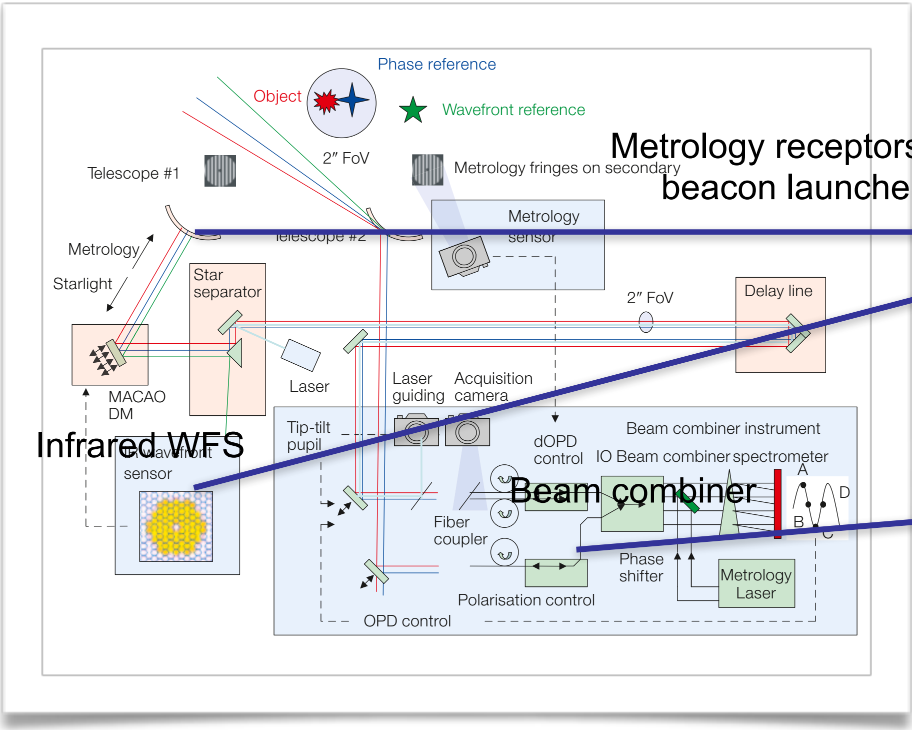
The possibility of mosaicing



Maercker ++ 2012



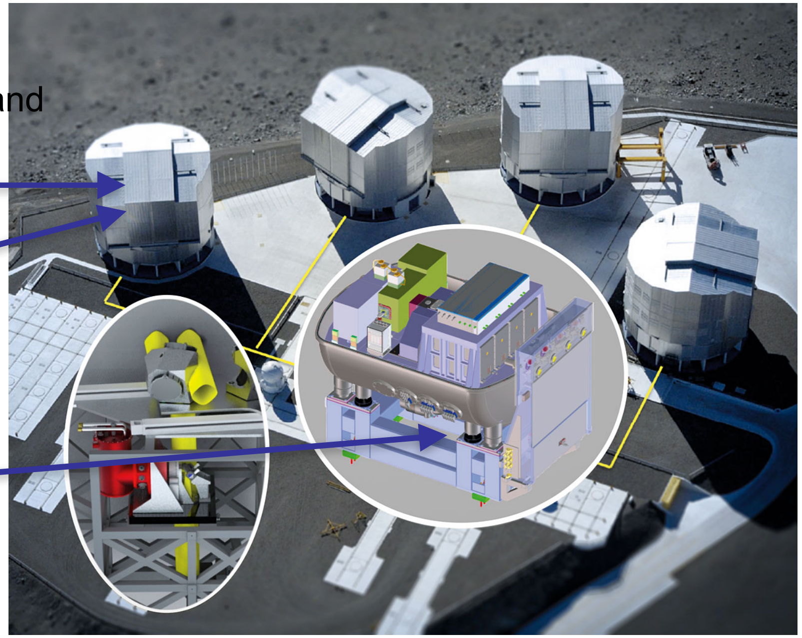
GRAVITY: a profound impact on the infrastructure



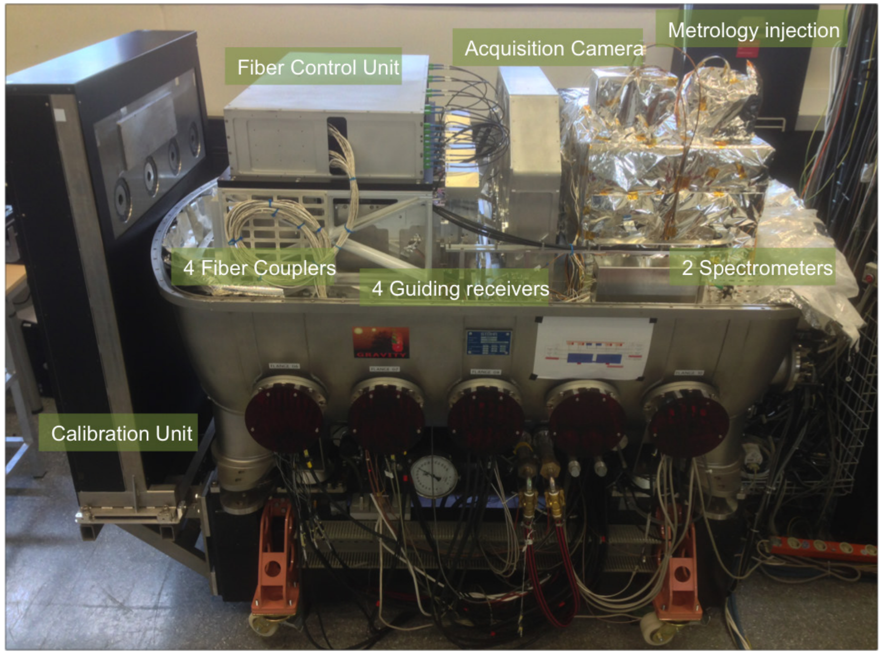
Infrared WFS

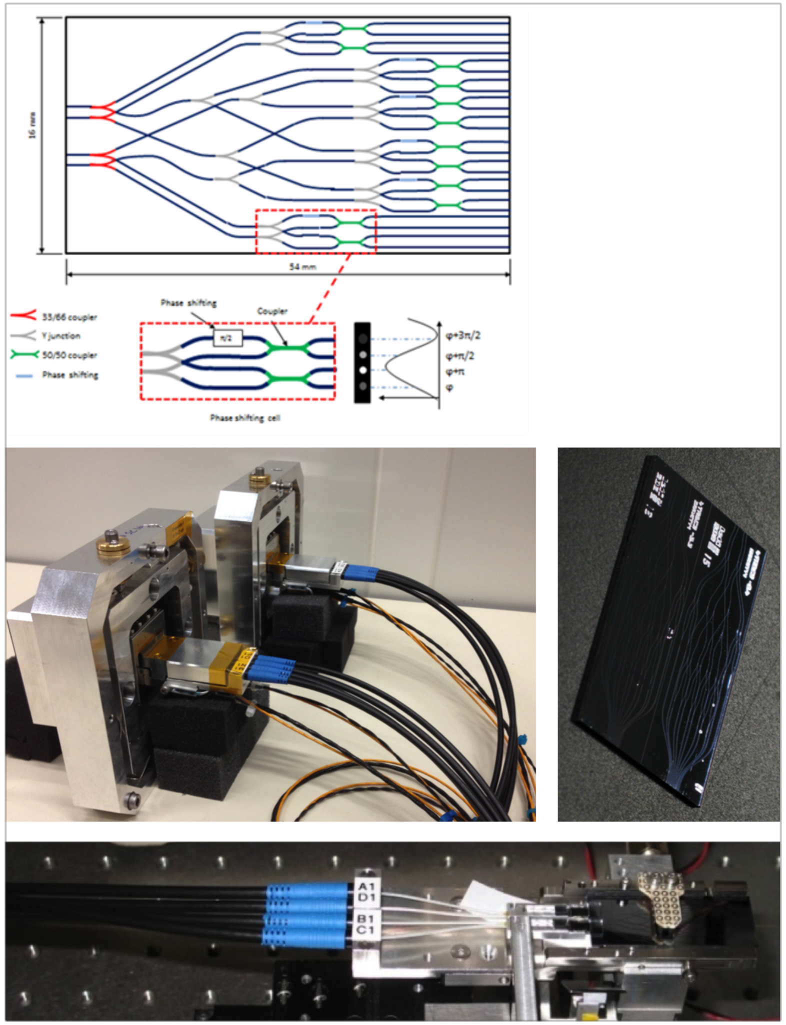
Metrology receptors and beacon launchers

Beam combiner

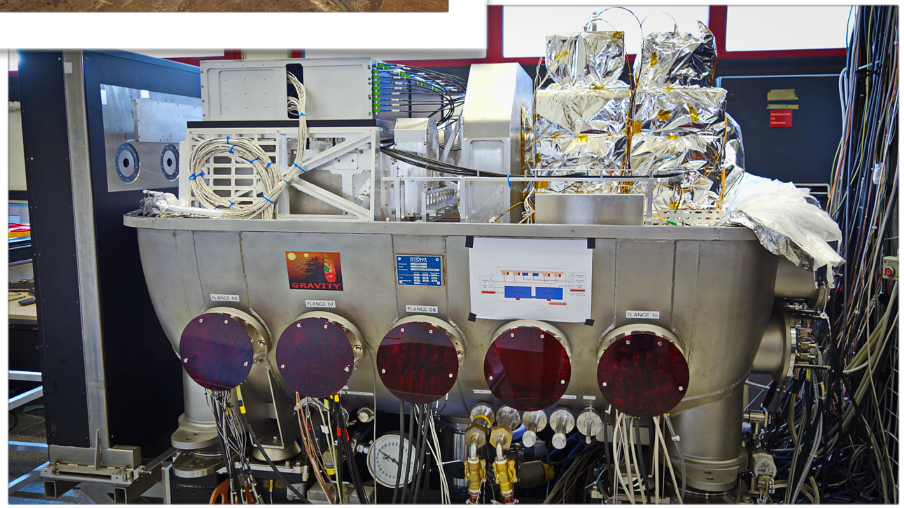


GRAVITY a photonics tech based experiment





GRAVITY in the NIH



- In the VLTI lab: october 2015
- First on-sky light: november 2015

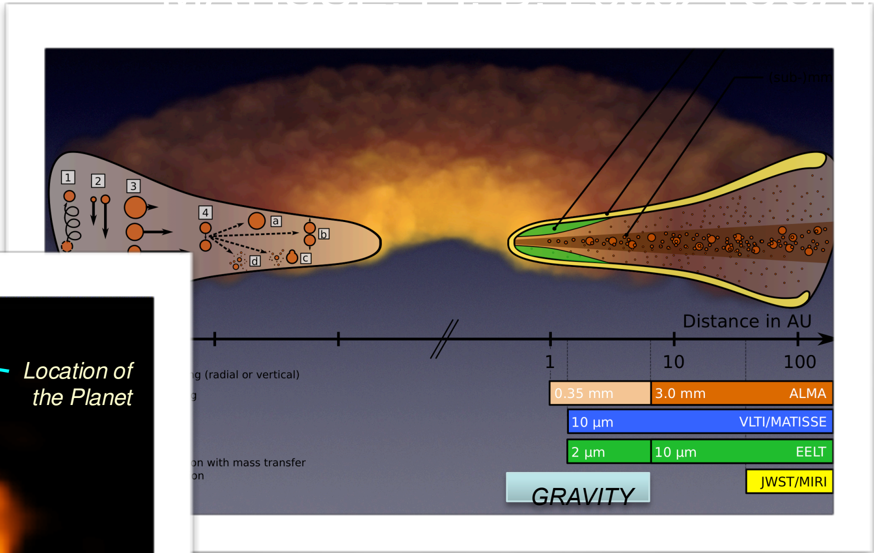
MATISSE

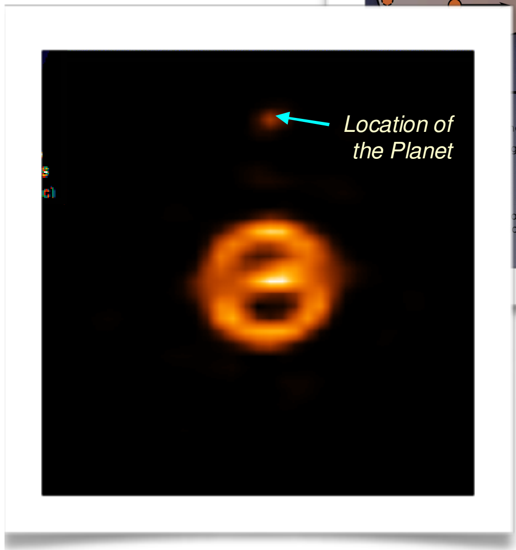
MATISSE

4 Telescopes: L, M, N
R ~ 4000

PI: B. Lopez (OCA)
2018

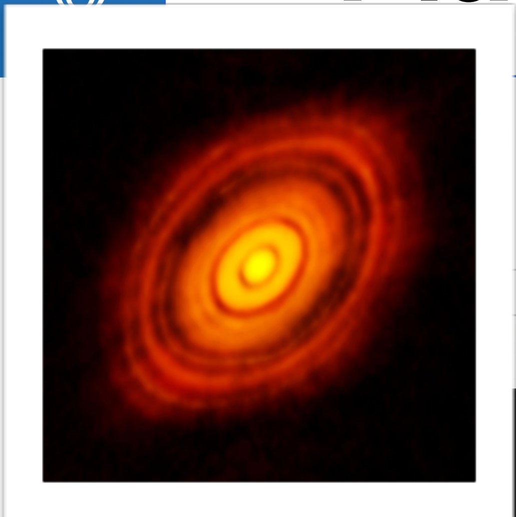
In operation:
2018



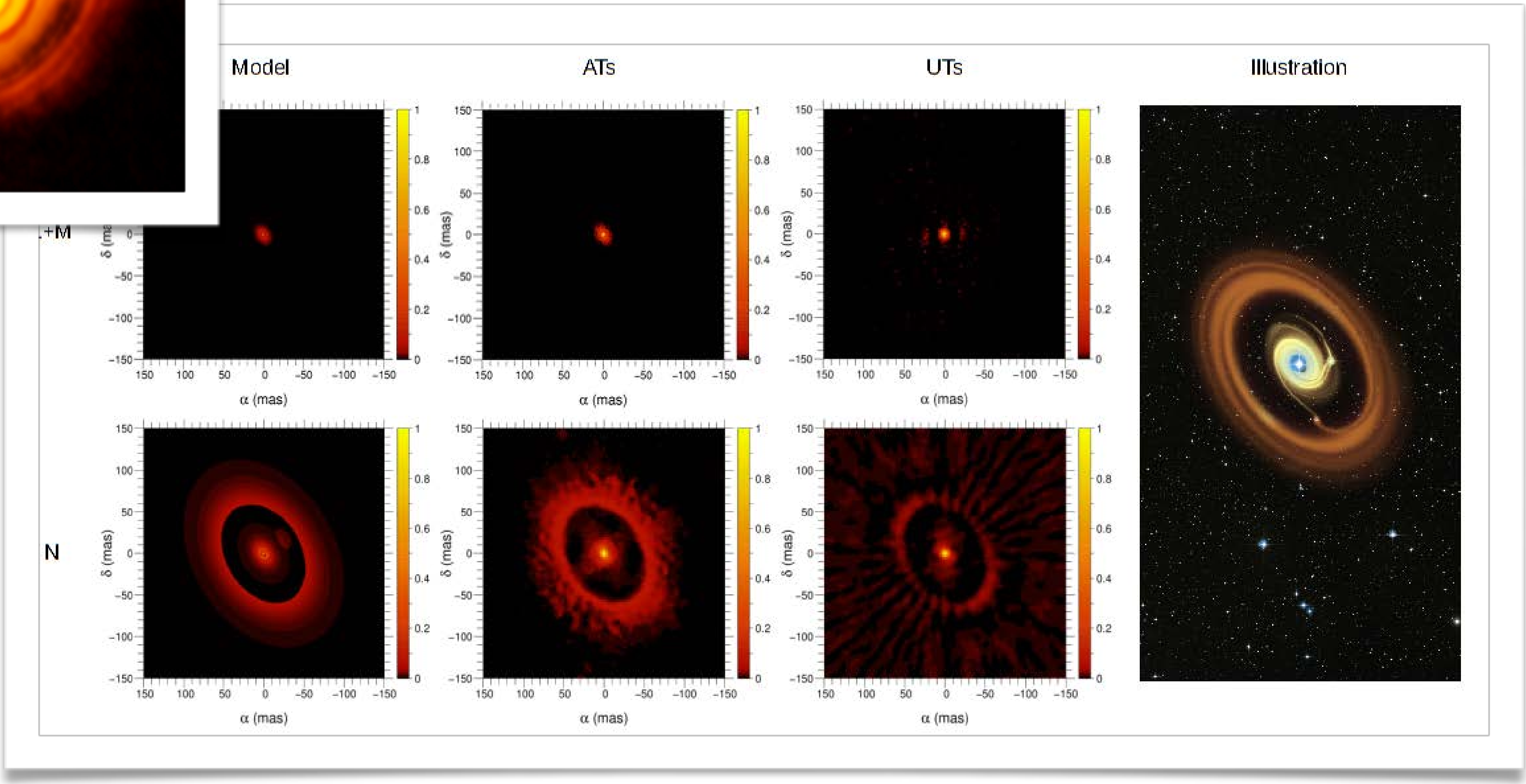


- Observing planet formation processes at the astronomical unit scale
- Mapping Active Galactic Nuclei central parsecs
- The formation of massive stars
- Dust and winds from evolved stars

Planet formation at AU scale



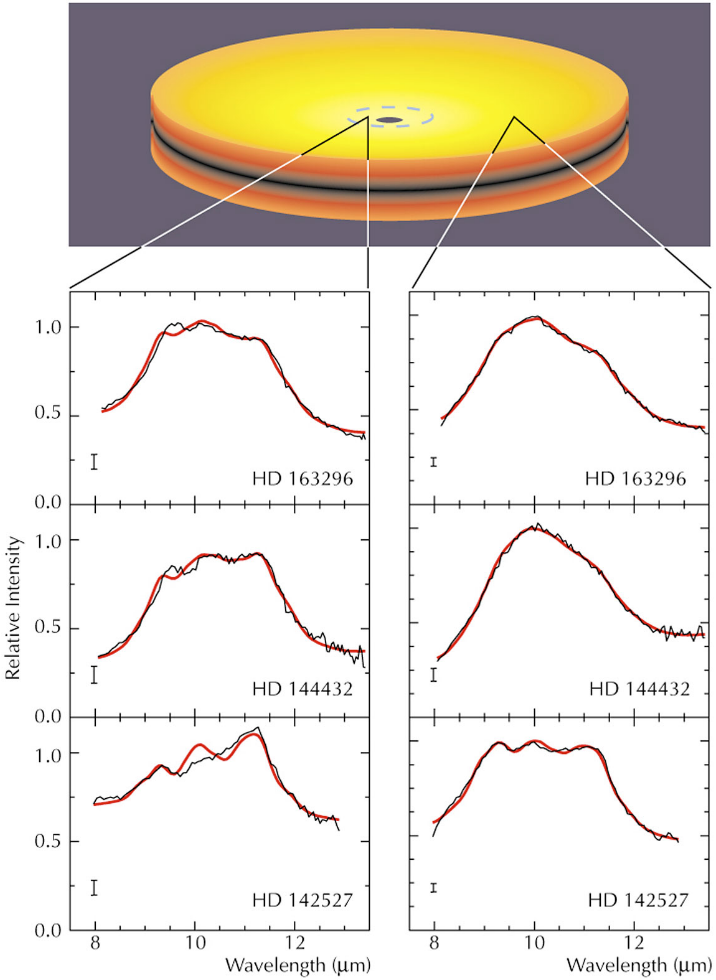
ALMA Partnership 2015



Lopez et al. 2014

Spectroscopy in mid-IR

van Boekel et al. 2004

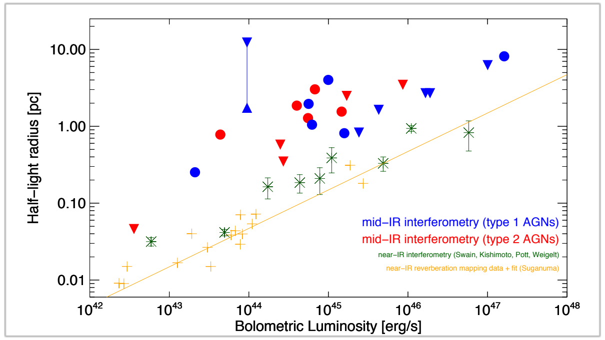


Components	Wavelengths
H_2O (ice)	3.14µm
H_2O (gas)	2.8 – 4.0µm
H recombination lines	4.05µm (Brα), 4.65µm (Pfβ)
Polycyclic Aromatic Hydrocarbons	3.3 – 3.4 µm
Nano-diamonds	3.52 µm
CO fundamental transition series	4.6 – 4.78 µm
CO (ice)	4.6 – 4.7 µm
Amorphous silicates, Crystalline silicates (olivines and pyroxenes), PAHs, fine structure lines (e.g. [NeII])	8 – 13 µm

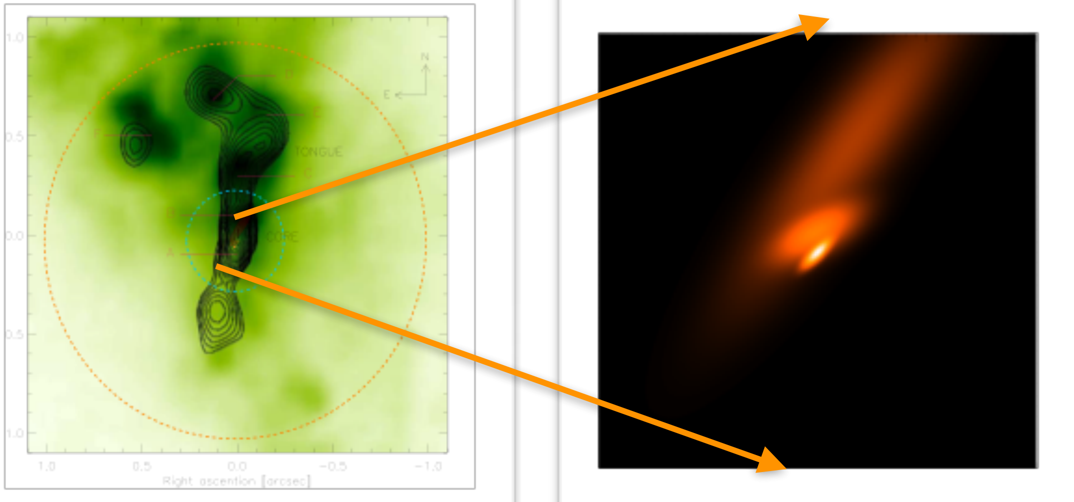
Lopez et al. 2014

Active galactic nuclei

2013 Burtscher++



Lopez-Gonzaga et al. 2014

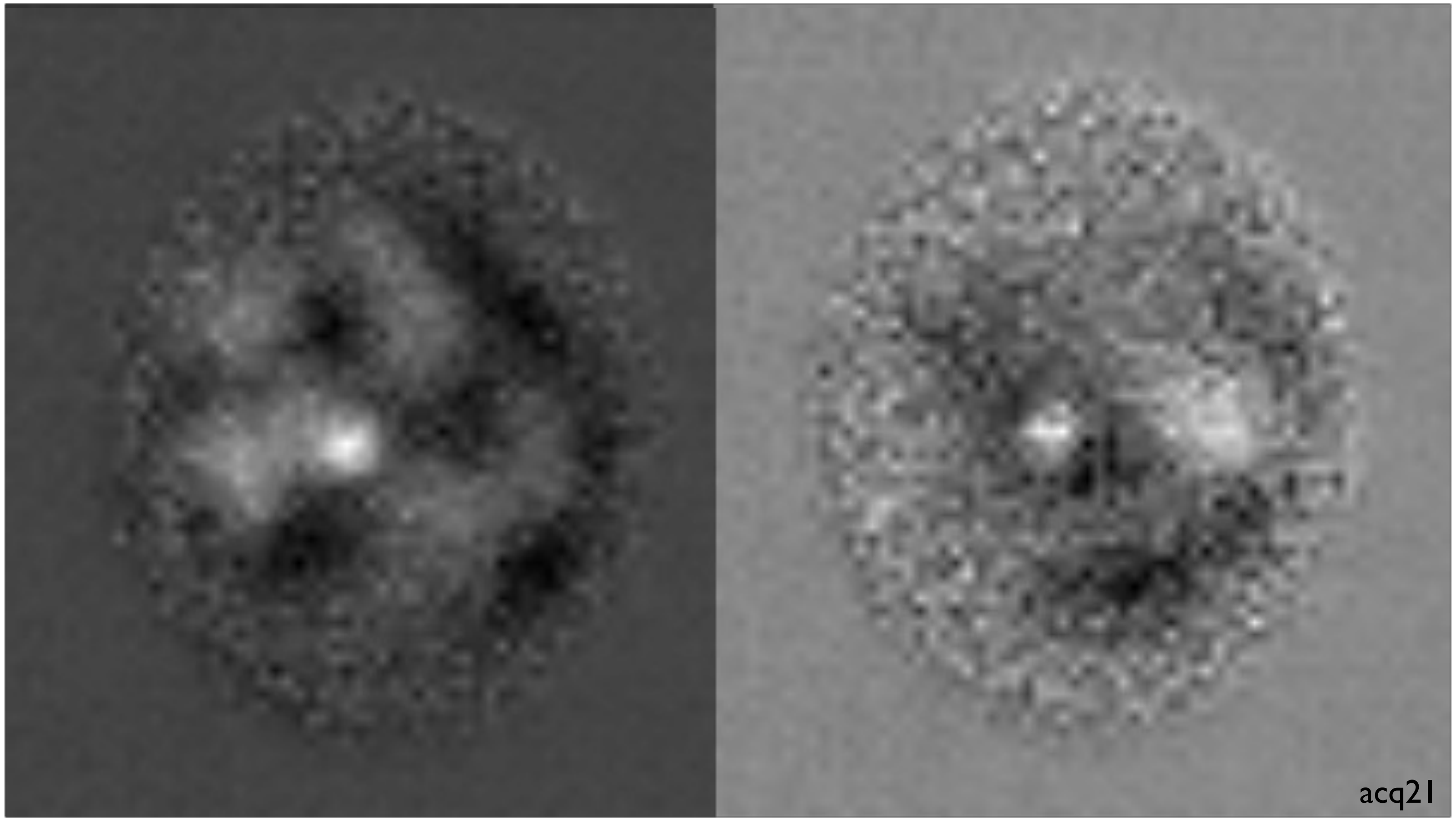


Understand the complexity of the inner parsecs (e.g near-nucleus/nucleus symetries)

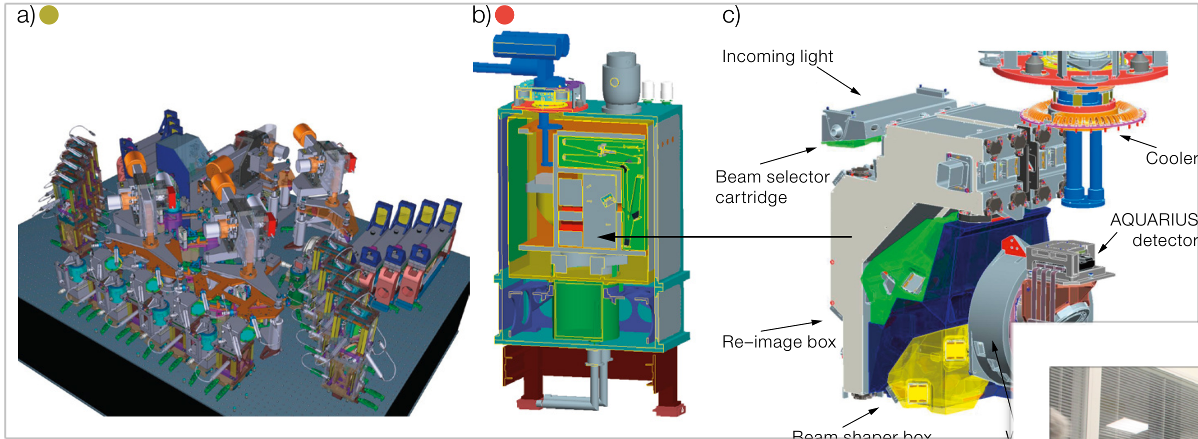
MATISSE + (GRAVITY):

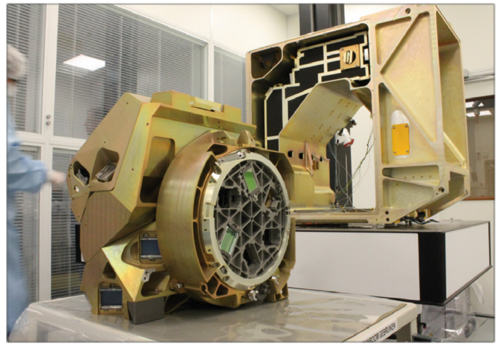
- Test unified model
- Confirm S2 (MIDI) have strong bipolar dust emission.
- Why S1 diverse (MIDI)
- How UV/X flux are intercepted (energy balance)?
- Exploit L bands lines (C0, Br alpha): turbulence/shocks – ionisation radiation
- Connecting the 100 pc – 10 pc scales (inflows/outflows)
- Structure of BLR (Br alpha, Br gamma)
- Mineralogy (dust processing) - Polarimetry

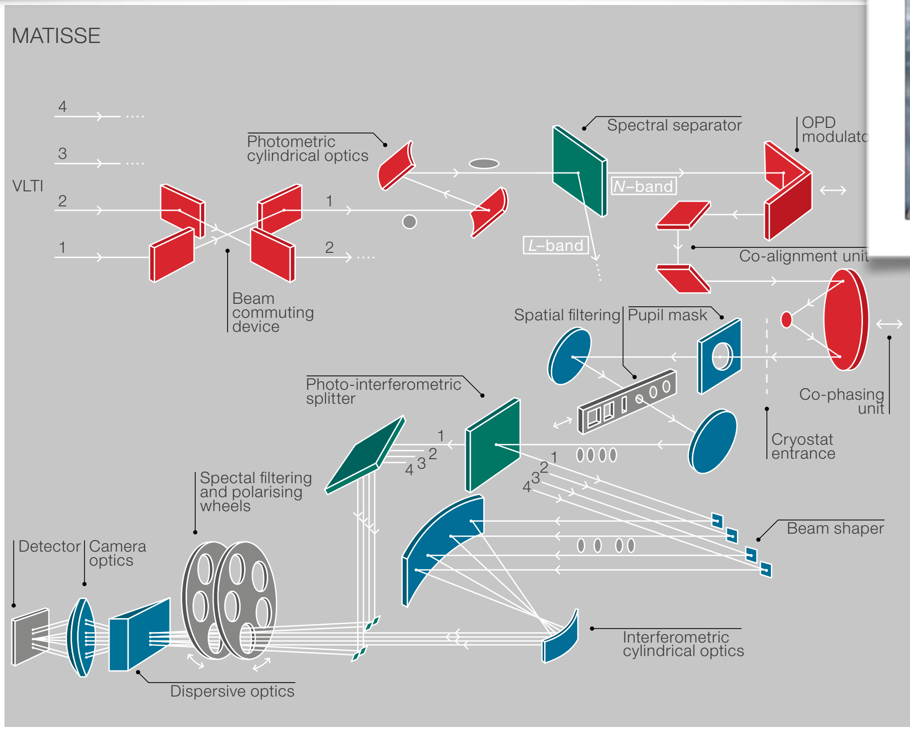
The challenge of mid-IR observations

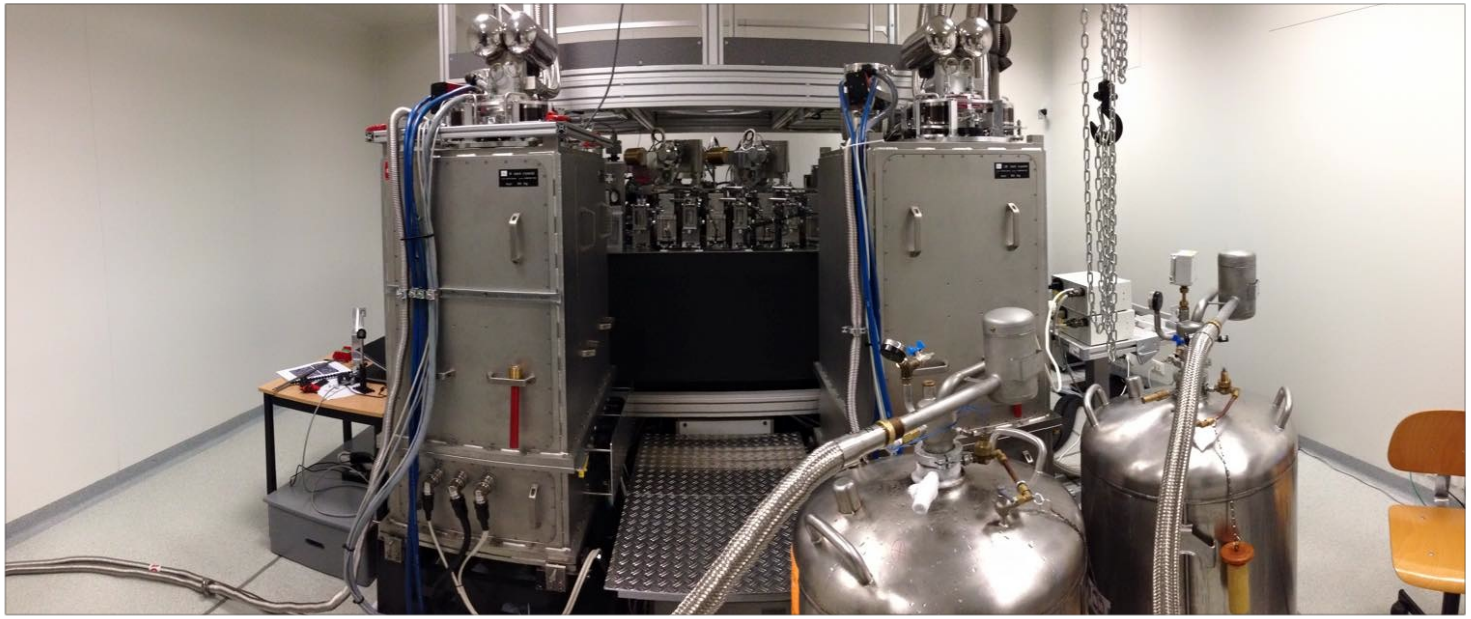


The challenge of combining four mid-infrared beams

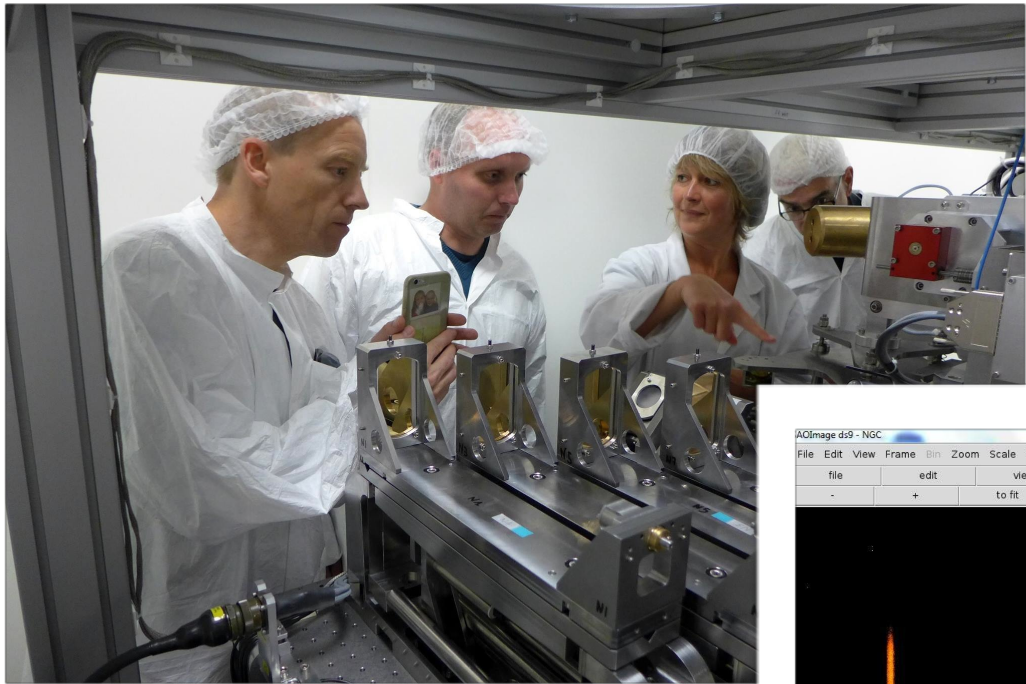


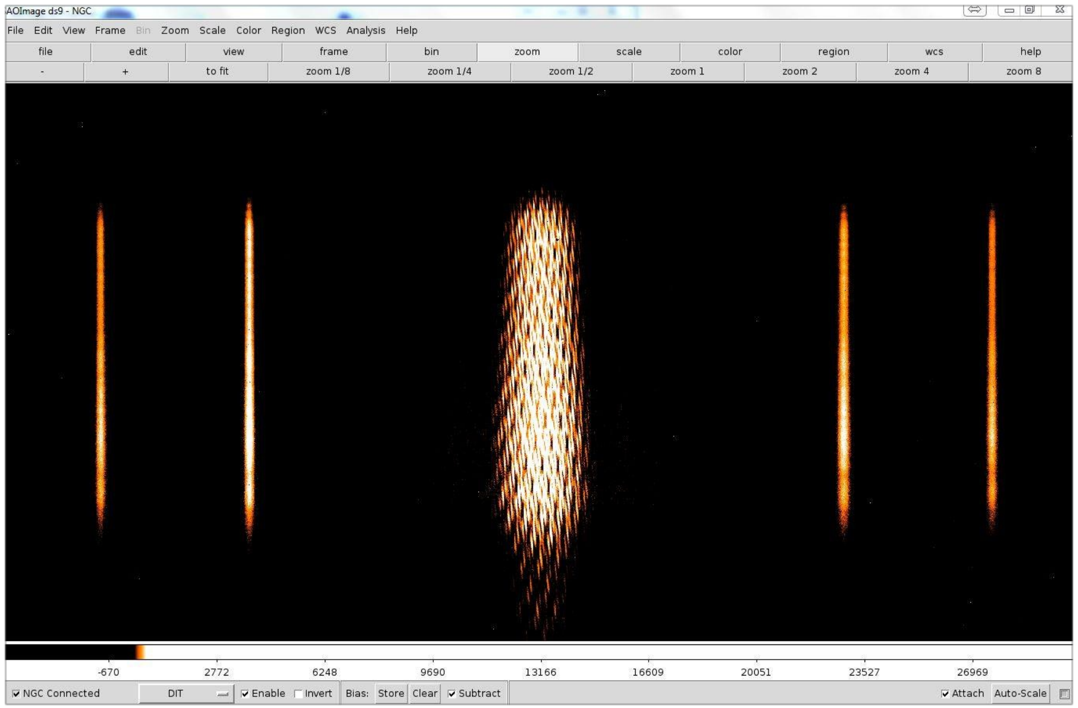






First 4T fringes

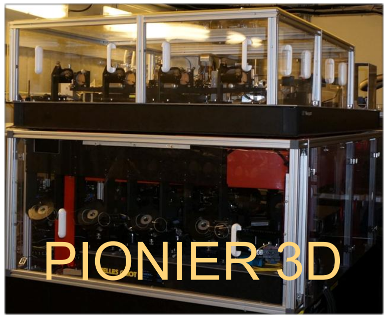


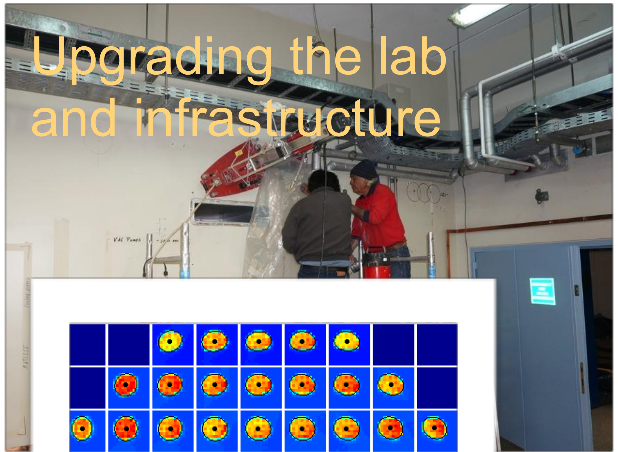


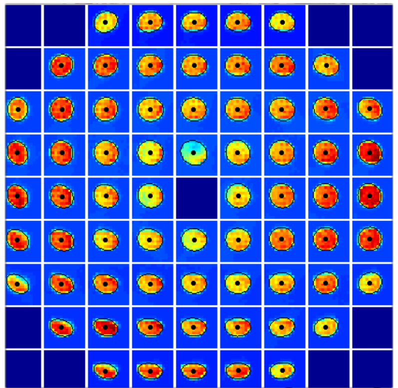
The lab is ready

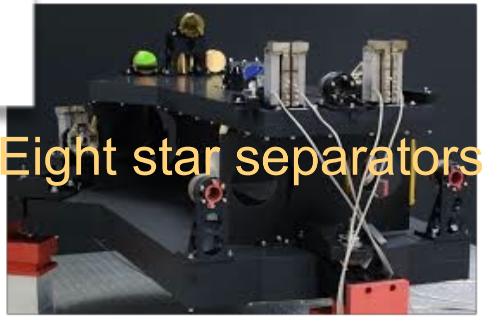
CHALLENGES FOR THE NEXT DECADE

Upgrade the infrastructure
Make it performant (AO + phasing)

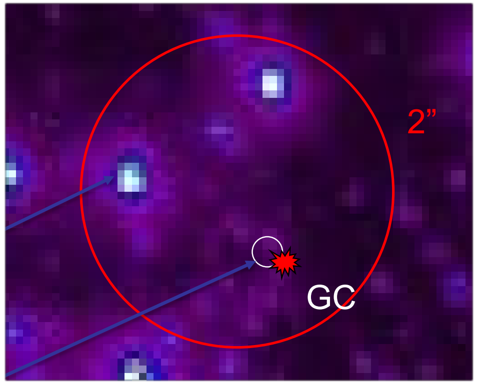




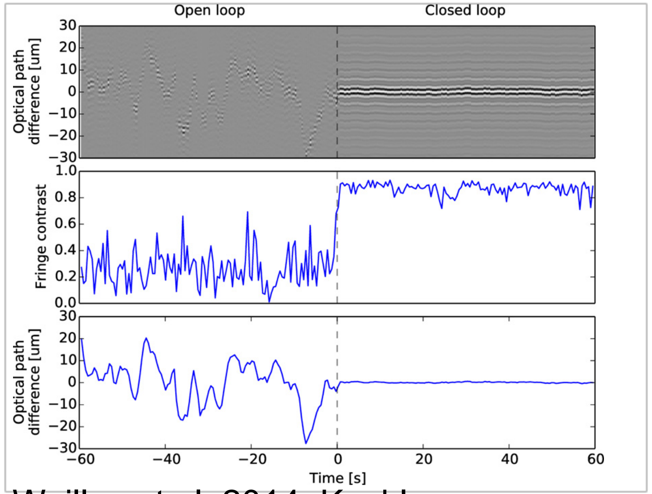

Contribution to CIAO



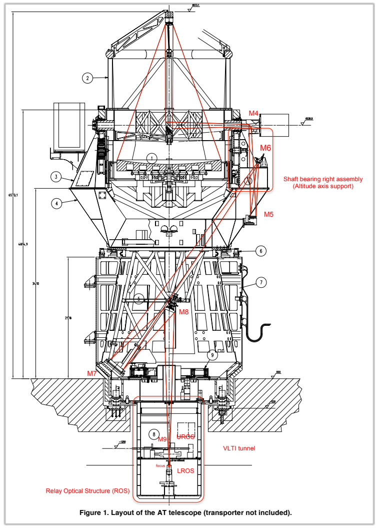
Improve performance



NAOMI: Adaptive optics for the VLTI
CIAO: IR WFS for UTs



Woillez et al. 2014, Keckl

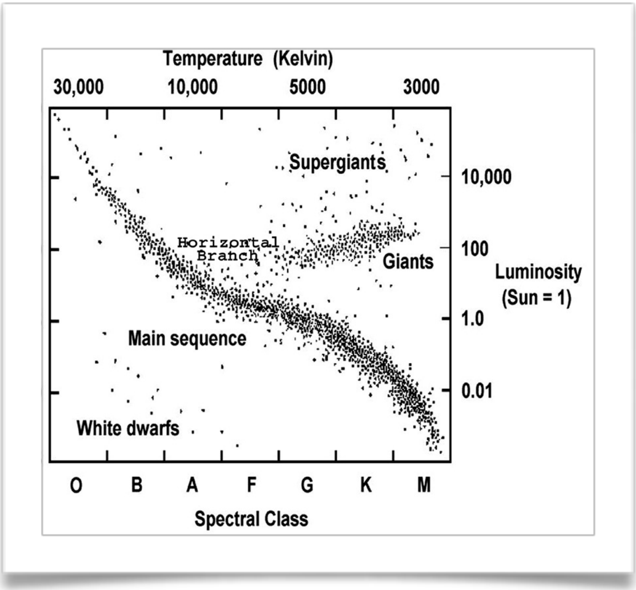


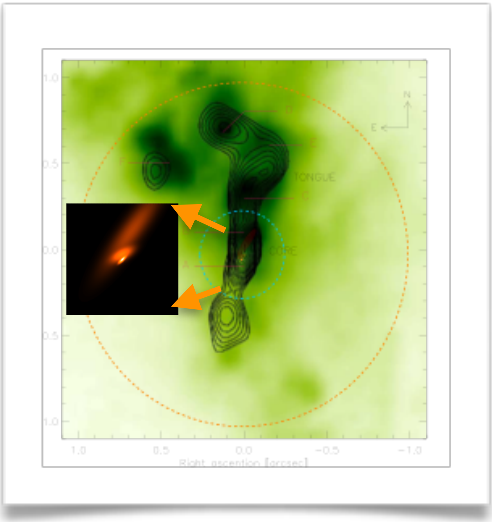
ENABLE Astrometry/ Phase referencing
Gravity

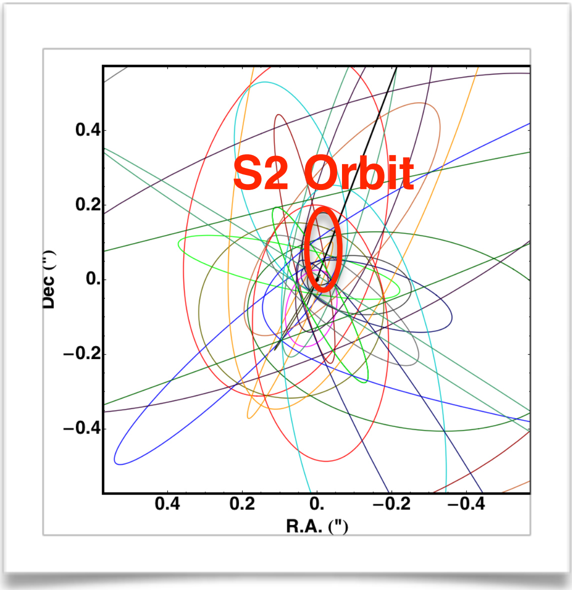
PHASING the array:
GRAVITY for MATISSE phase the array

The scientific ambition is multiple

Understand the structure of AGN nuclei





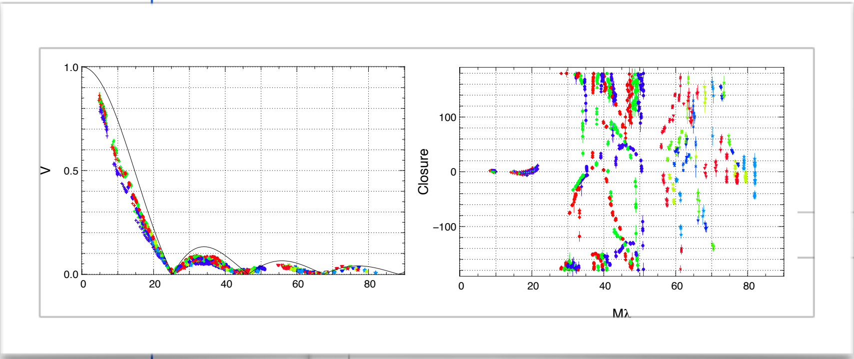


Understand how stars (single or binary) evolve and interact with their environment

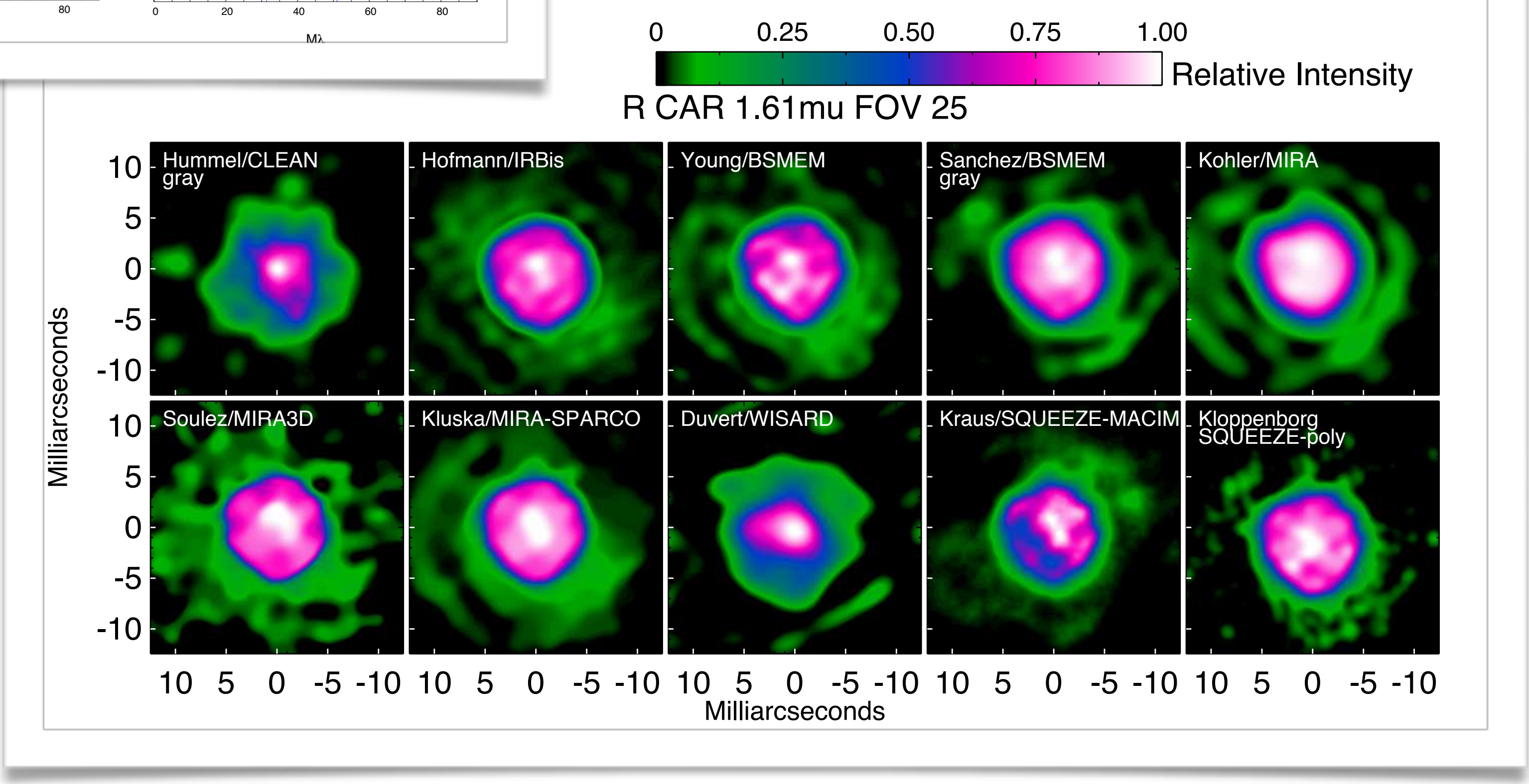
Understand GRAVITY

Combination of surveys, detailed imaging & astrometric campaigns

Consolidate image reconstruction

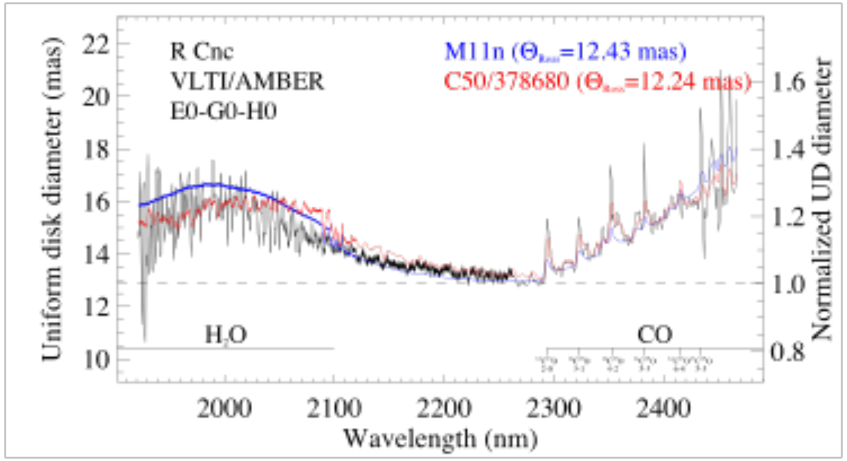


Beauty contest

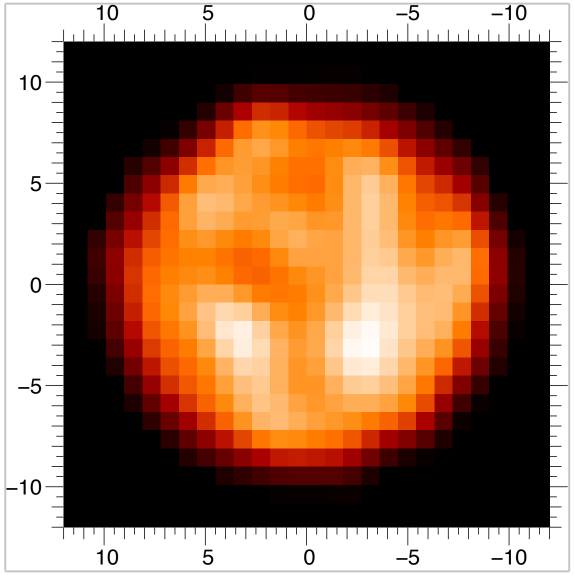


Monnier++ 2014

Combine spectral resolution and imaging



Wittkowski++ 2011

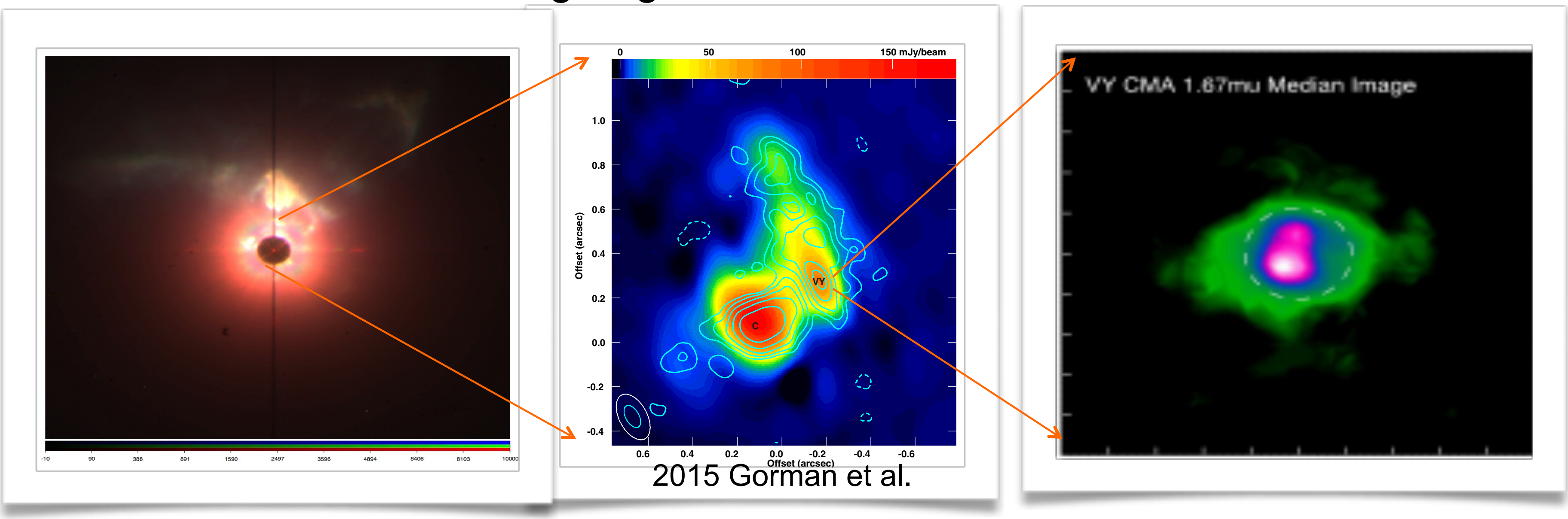


Paladini in prep

Expand the user base and join synergies

Develop VLTI expertise centers: Provide VLTI users with support in preparing their proposals, reducing their data and reconstructing images

Ongoing discussion with JMMC

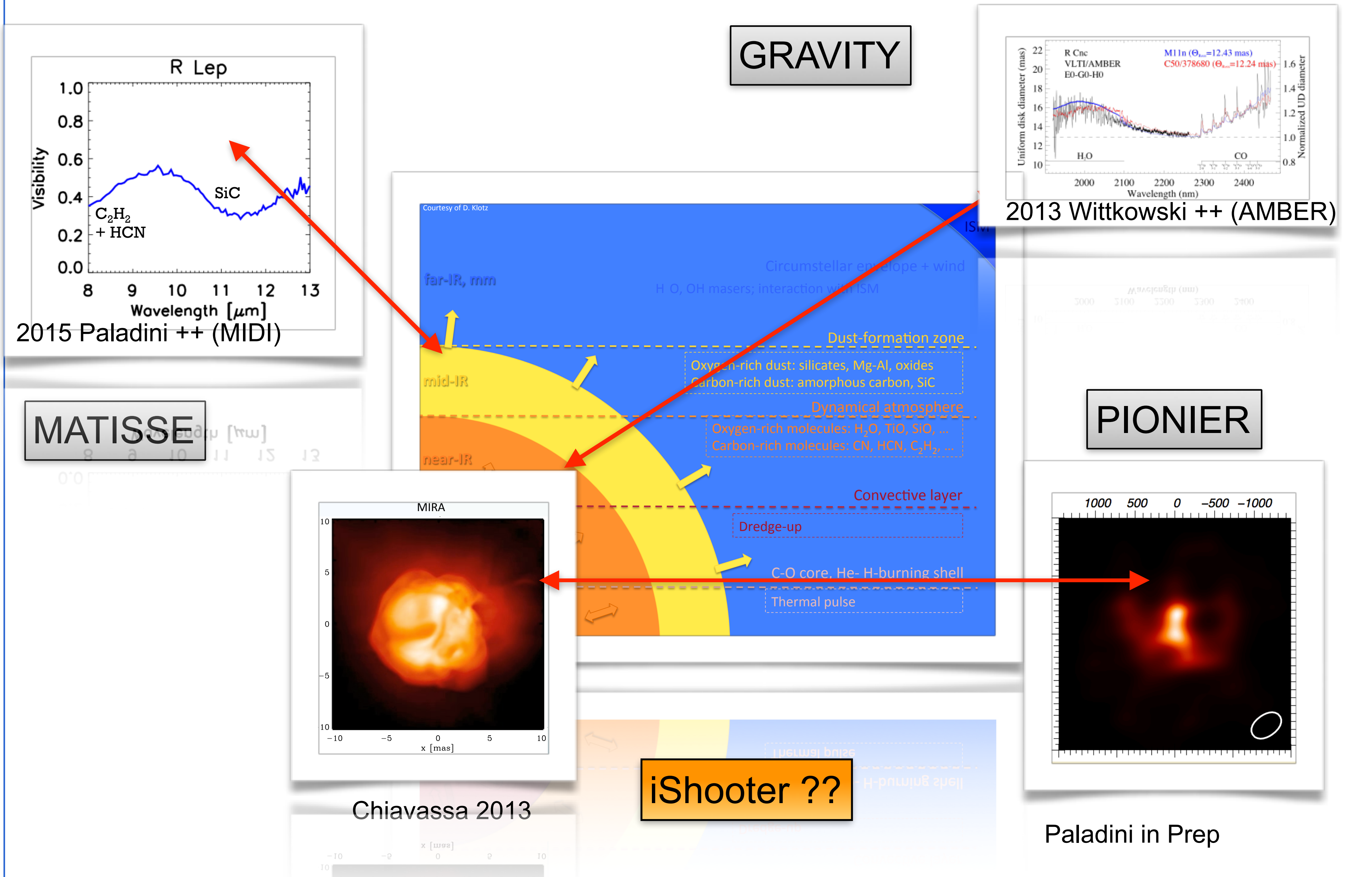


SPHERE

ALMA

PIONIER

Couple imaging and spectroscopy and use **simultaneously** the VLTI instruments



TAKE AWAY MESSAGE

WRAP UP

- VLTI is a robust facility open to all astronomers
- Important infrastructure effort ongoing
- Overall performance is a major challenge
- Survey, spectro-imaging and astrometry programs will have to live together: an operational challenge
- GRAVITY and MATISSE offer a considerable increase in scientific capability but they will be a challenge
- Imaging capability enhanced but still requires
- We are busy for the next decade !