

The Very Large Telescope Interferometer

–

Infrastructure und Instruments

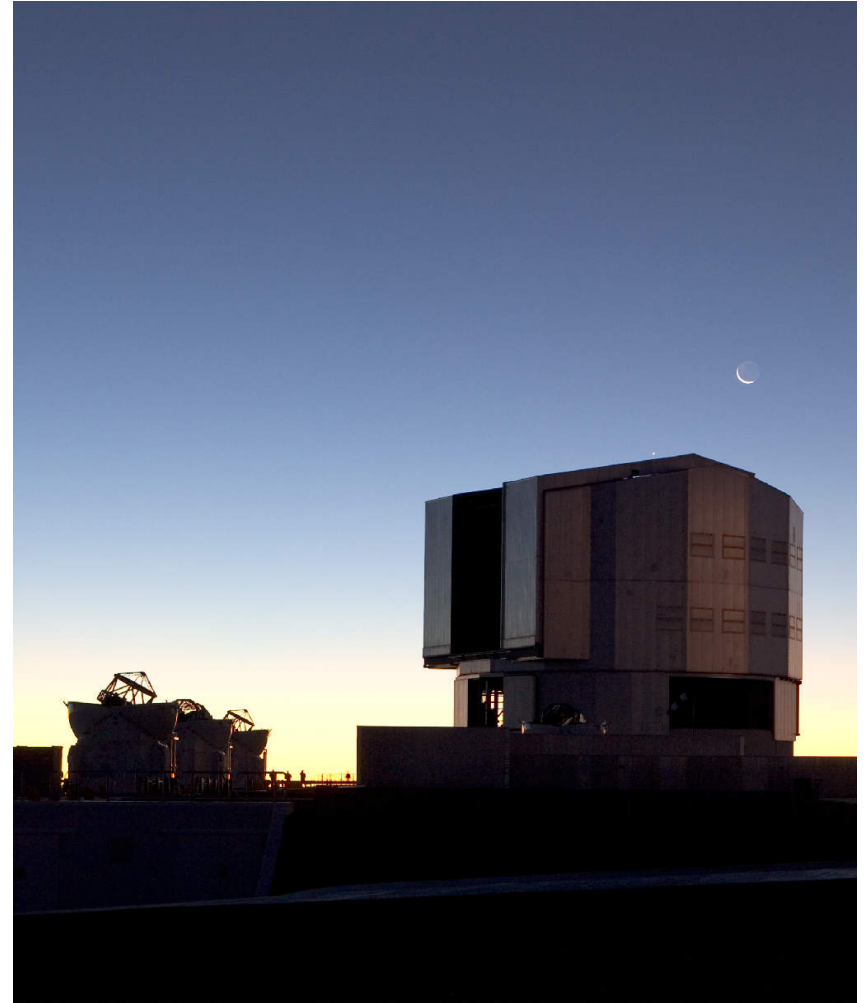
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European Southern Observatory, Chile



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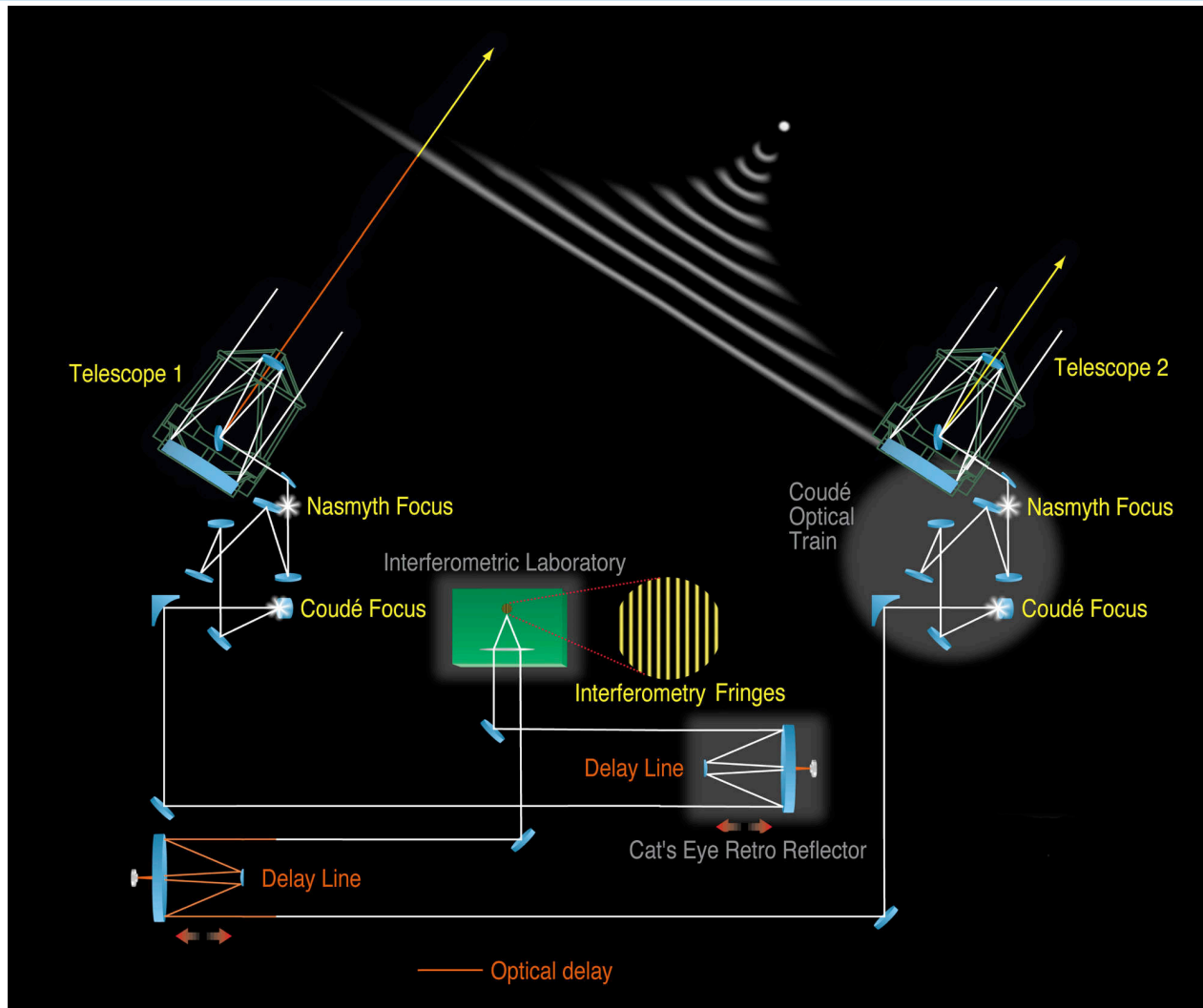


The VLTI in a nutshell

- Located on Cerro Paranal in Northern Chile
- Integral part of ESO's Very Large Telescope (VLT)
- Four fixed 8 m telescopes (UTs)
- Four movable 1.8 m telescopes (ATs)
- 6 delay lines
- Current instruments:
 - AMBER (NIR, 3 tel.),
 - PIONIER (NIR, 4 tel.)
 - GRAVITY (NIR, 4 tel.)



Infrastructure – General optical layout



Infrastructure – The Unit Telescopes



4 Unit Telescopes (UTs):

- 8.2 meter diameter
- at fixed locations
- 6 baselines: 47m to 130m
- mostly used as single dishes
- interferometry in bright time

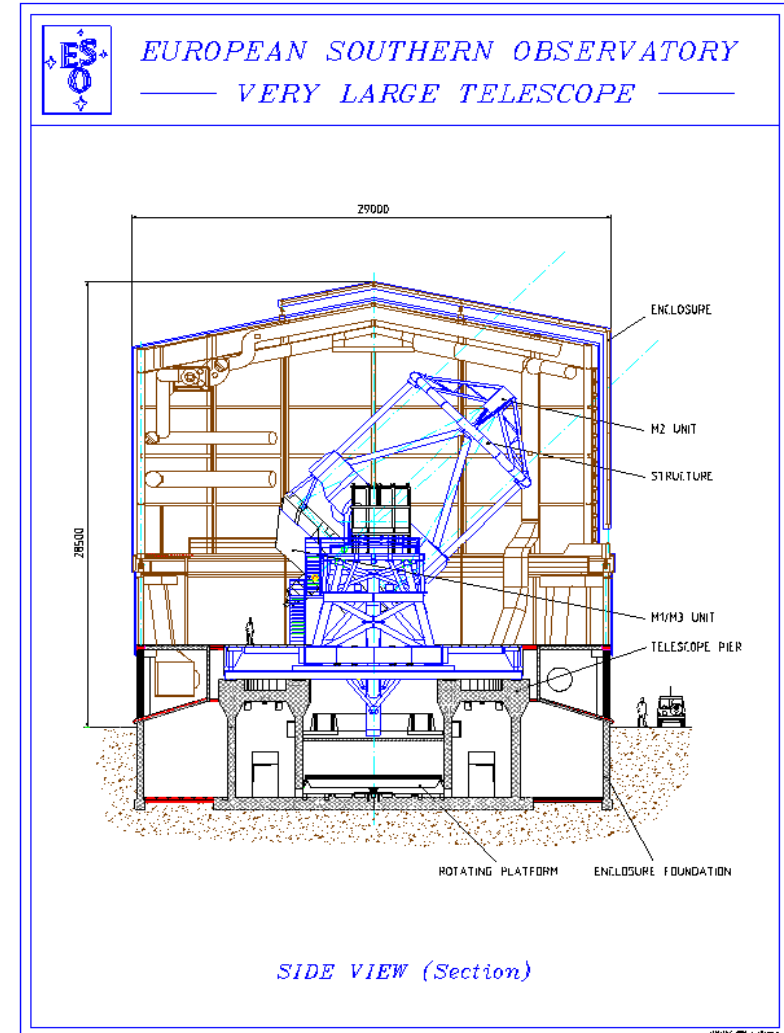


Infrastructure – The Unit Telescopes



4 Unit Telescopes (UTs):

- 8.2 meter diameter
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Multi-Application Curvature Adaptive Optics (MACAO)



- 60 elements AO system
- one system at each UT
- located at the Coudé focus
- optical light (R band)
- limiting mag.: $V \sim 17$ mag

Infrastructure – Auxiliary Telescopes



4 Auxiliary Telescopes (ATs):

- 1.8 meter diameter
- movable to different stations
- 6 baselines: 8m to 200m
- only for interferometry



Infrastructure – STRAP & NAOMI



- System for Tip/tilt Removal with Avalanche Photodiodes (STRAP):

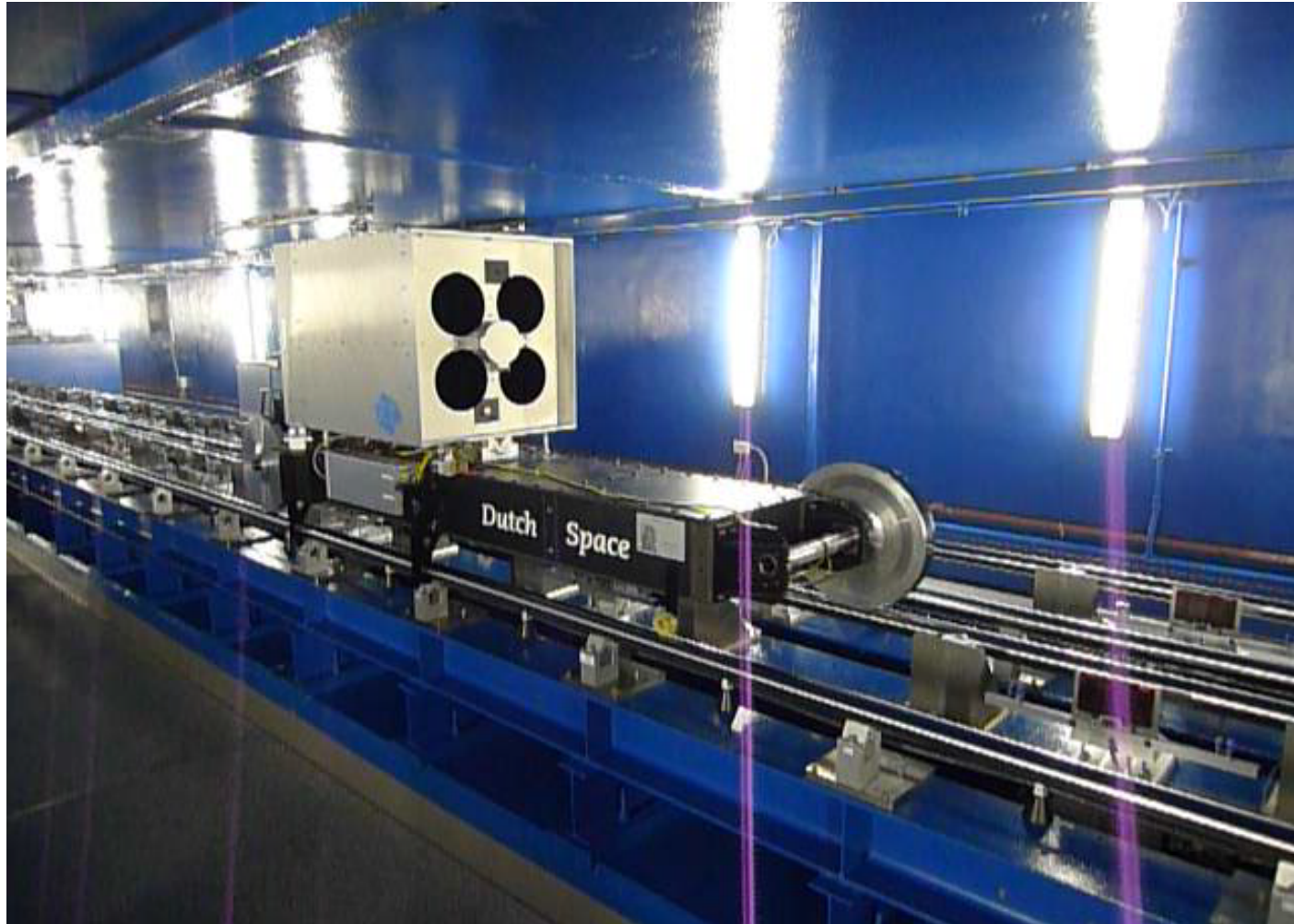
- fast, visible tip-tilt sensor
- $V < 13.5$ mag, < 57.5 arcsec.



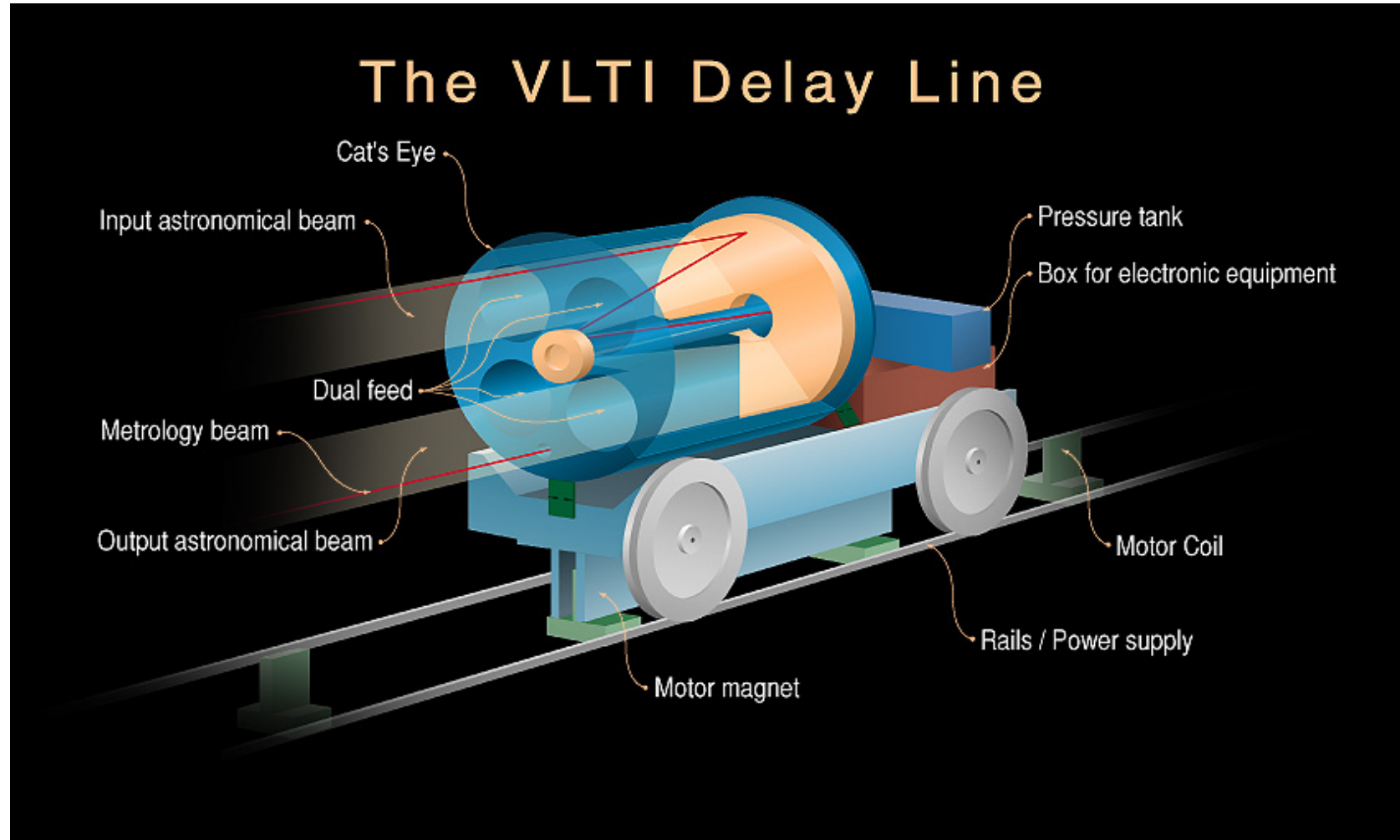
- New Adaptive Optics Module for Interferometry (NAOMI):

- 4×4 element low-order Shack-Hartmann system
- arrival 2016 / 2017

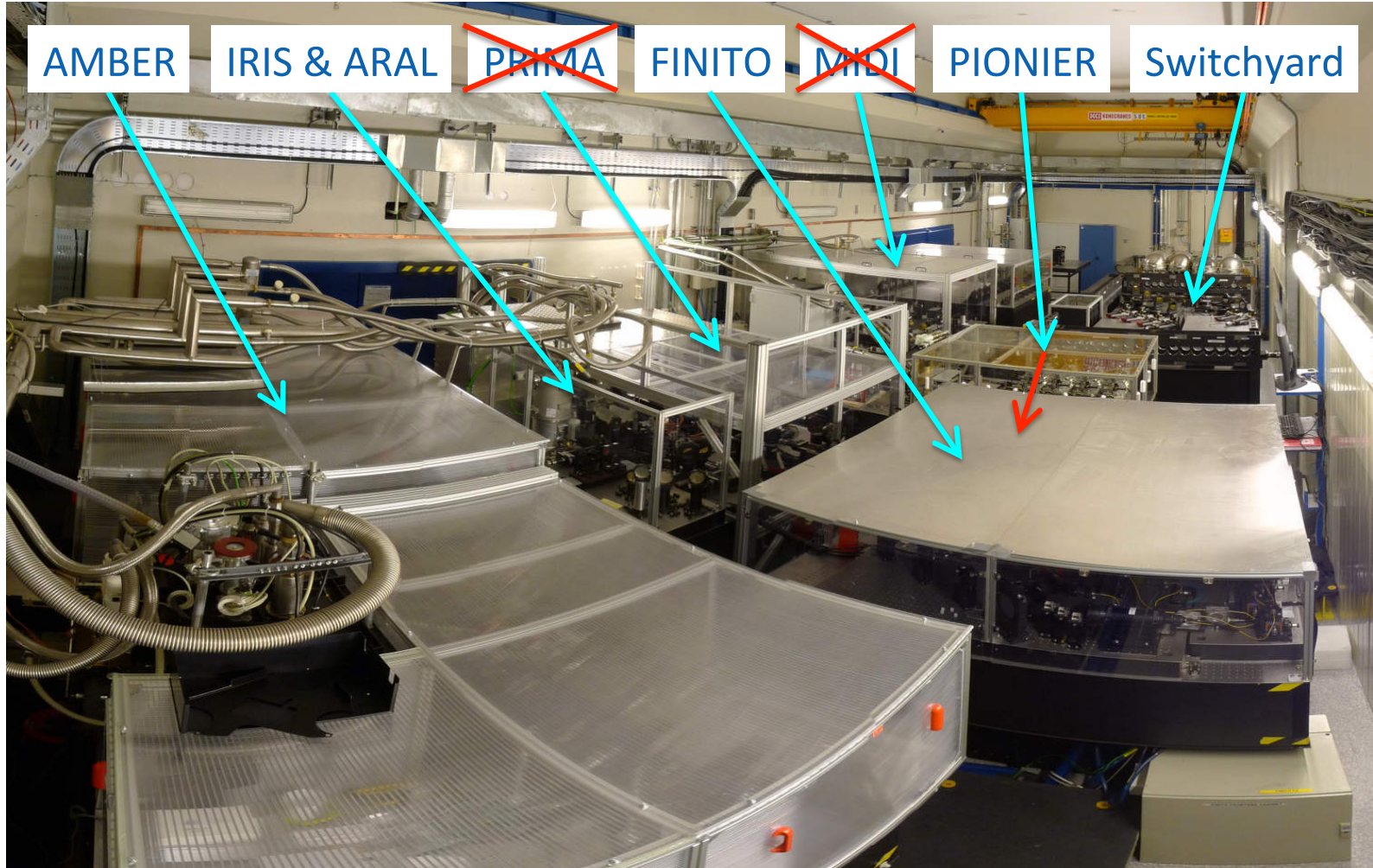
Infrastructure – Delay Lines



Infrastructure – Delay Lines



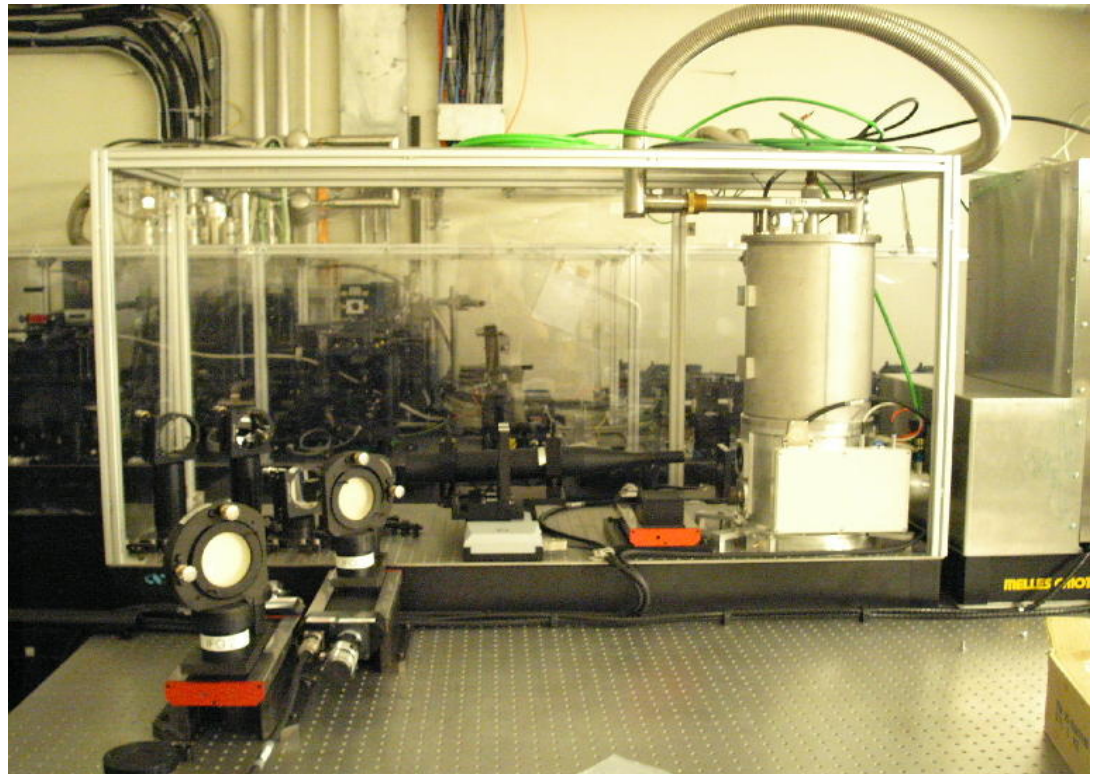
Infrastructure – Interferometric Laboratory



Infrastructure – IRIS & ARAL



- IRIS: tip/tilt sensor in the lab
- ARAL: alignment unit



IRIS in the
VLT lab

Infrastructure – FINITO



Fringe-tracking Instrument of Nice and Torino (FINITO):

- On-axis fringe tracker
- H-band, three beams
- Limit: H = 8 mag (UTs)
H = 5 mag (ATs)



Instruments - Overview



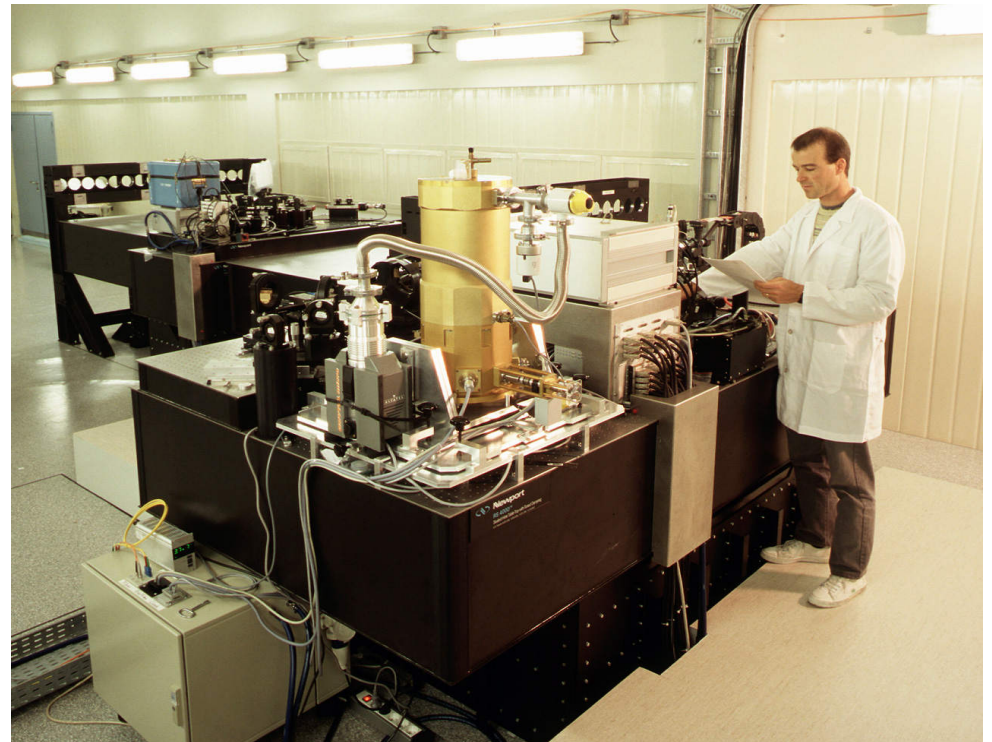
Name	Beams	Wavelength (Band)	Spectral Resolution	Years
VINCI	2	2.0 – 2.4 μm (K)	none	2001 – 2004
MIDI	2	8 – 12 μm (N)	30 & 230	2002 – 2015
PRIMA	2	2.0 – 2.4 μm (K)	none	2008 – 2015
AMBER	3	1.1 – 2.4 μm (J, H, K)	35, 1500 & 12000	since 2004
PIONIER	4	1.5 – 1.8 μm (H)	none, 15 & 40	since 2010
GRAVITY	4	2.0 – 2.4 μm (K)	22, 500 & 4500	from 2015
MATISSE	4	3 – 13 μm (L, M, N)	30 to 1000	from 2016

Instruments – VINCI



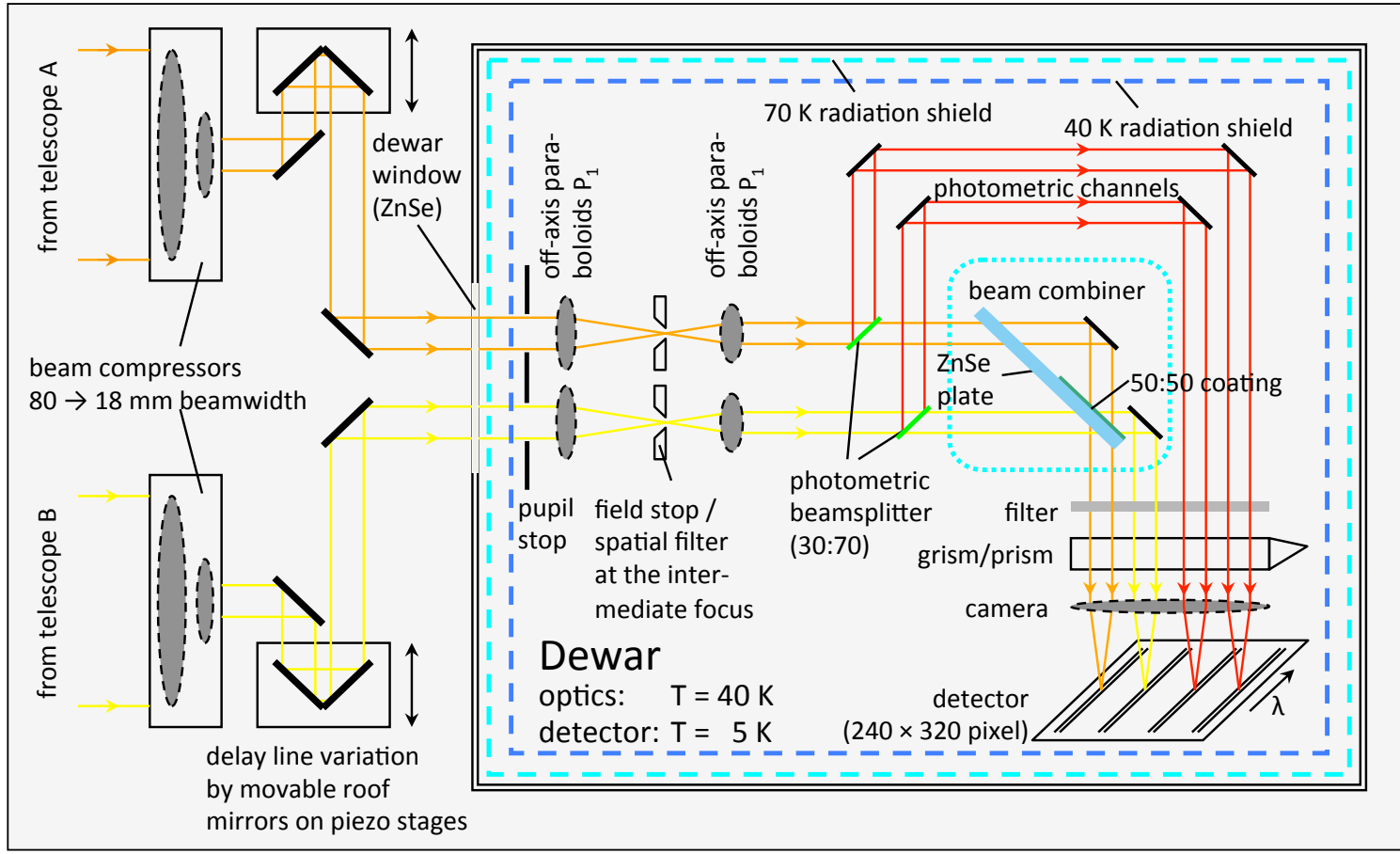
VINCI was the VLTI commissioning instrument:

- integrated optics
- 2 beams
- K band



VINCI in the
VLTI lab, 2001

MID-infrared Interferometric instrument (MIDI)



Instruments – MIDI

- Sensitivity: 0.2 Jy (UTs), 4 Jy (ATs)
- N-band (8 to 13 μm) dispersed fringes:
 - NaCl prism ($R = \lambda / \delta\lambda \sim 30$)
 - Grism ($R = \lambda / \delta\lambda \sim 230$)



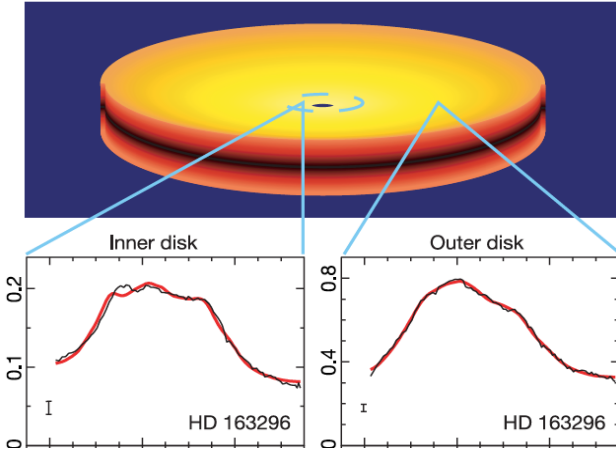
MIDI in the
VLT lab



Grism (left) and
prism (right) of MIDI

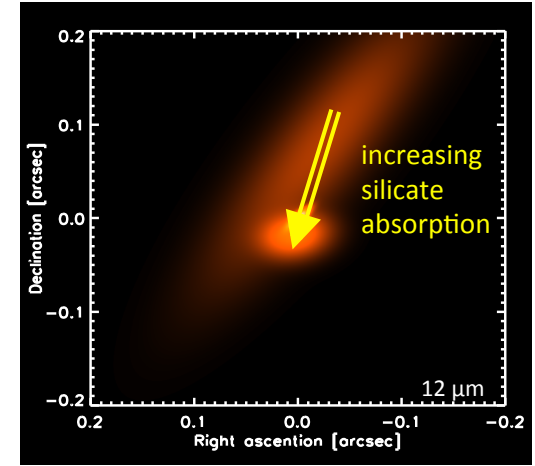
Instruments – MIDI science

Herbig Ae/Be

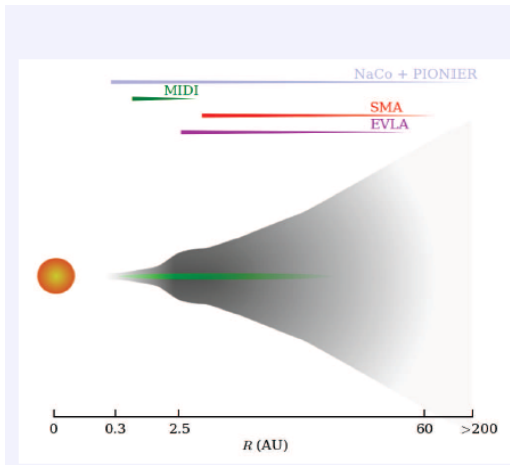


van Boekel et al. 2004

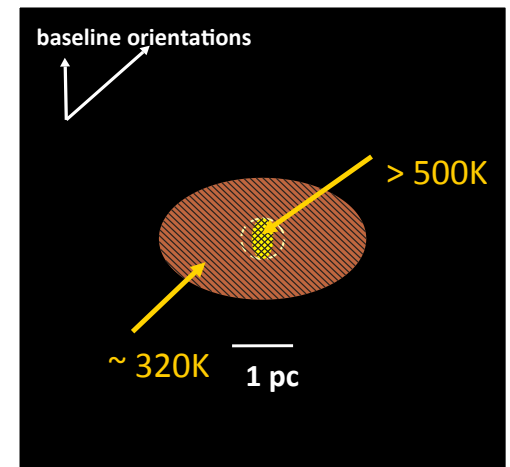
AGN



T Tauri stars

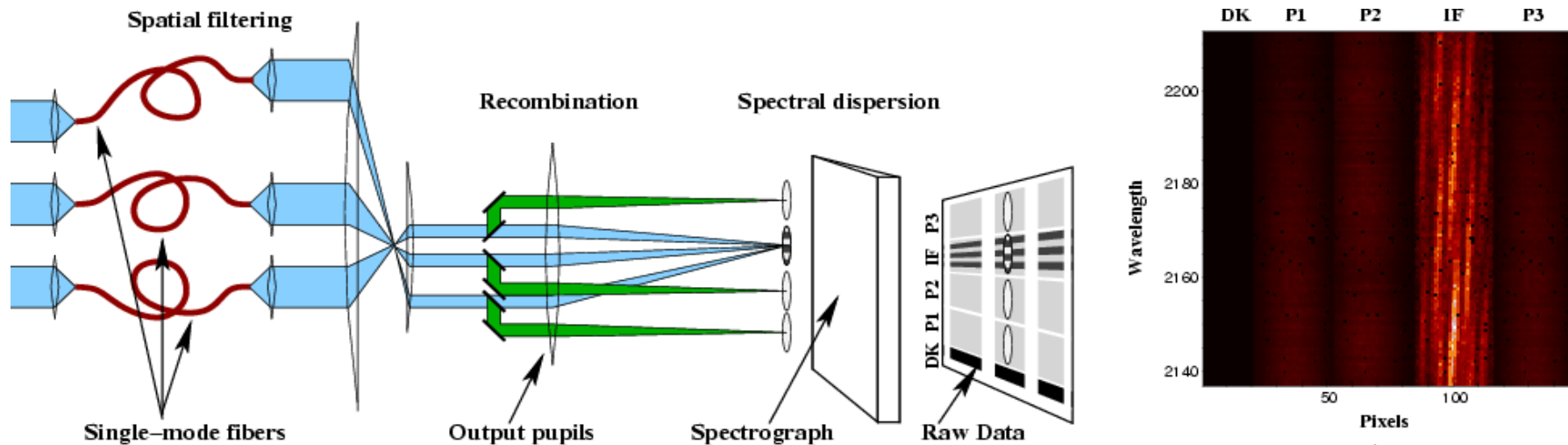


TW Hya
Menu et al. 2014



Jaffe et al 2004, López Gonzaga et al 2014

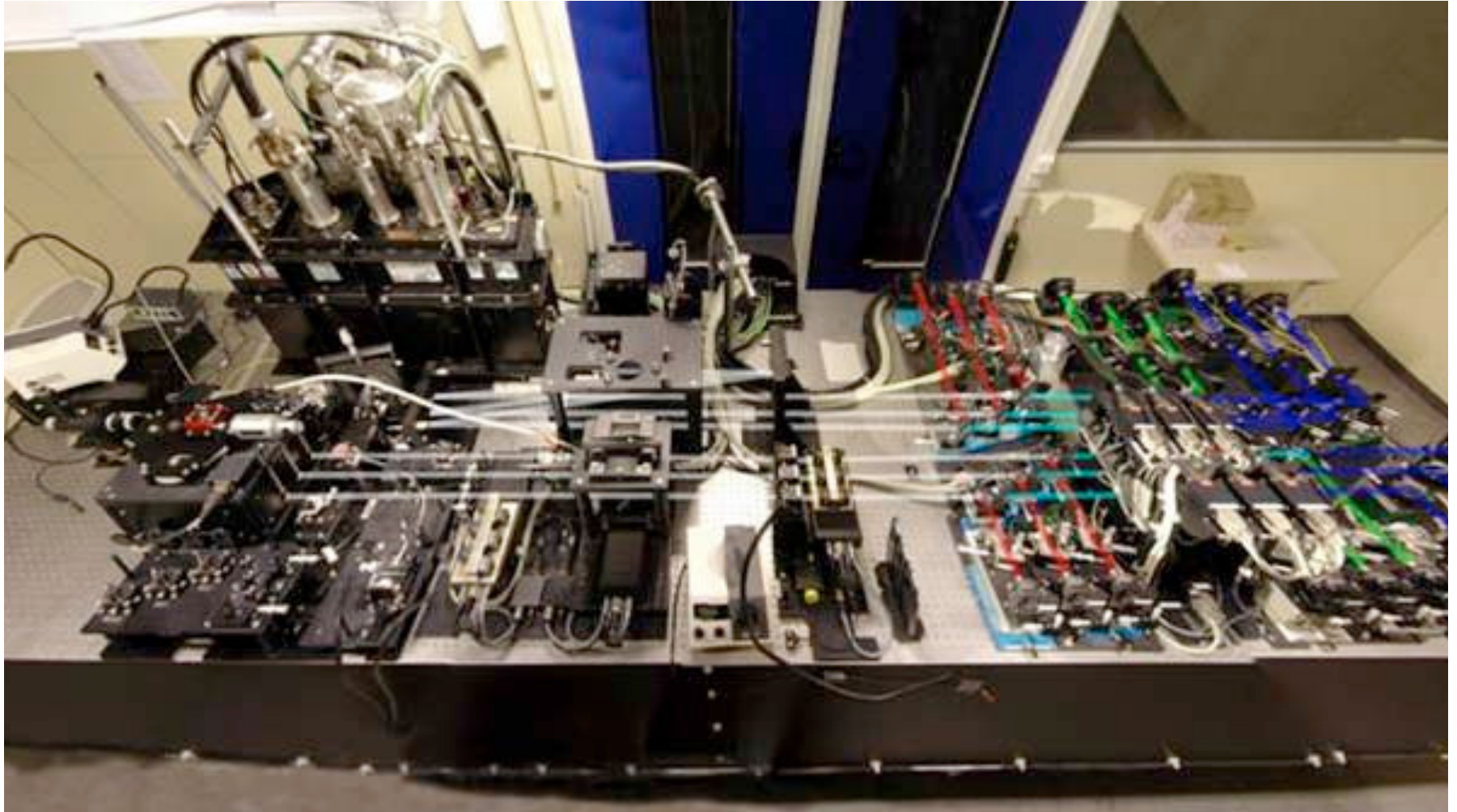
Instruments – AMBER



Astronomical Multiple BEAm Recombiner (AMBER):

- image plane interferometer
- 3 telescopes: 3 baselines & closure phases
- Spectral resolution $R = 35, 1500 \text{ \& } 12000$ (unique)
- Limit at $K \sim 11$ mag (UTs)
- (J), H, K band (i.e. NIR)

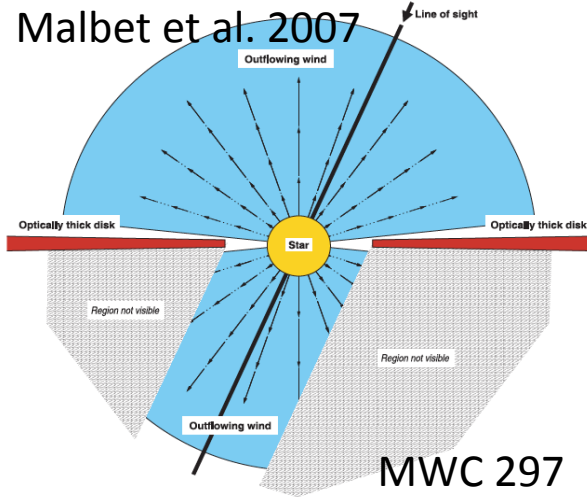
Instruments – AMBER



Instruments – AMBER science



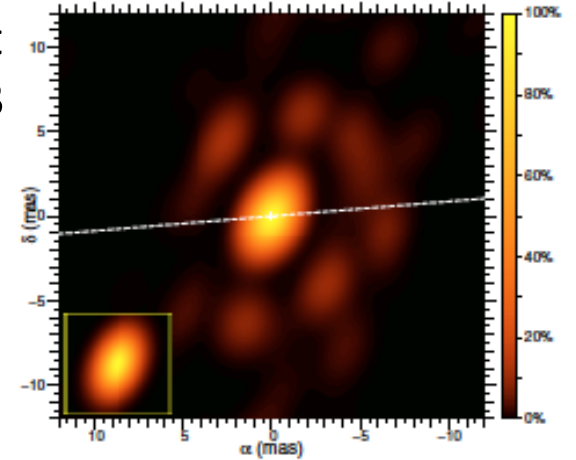
Malbet et al. 2007



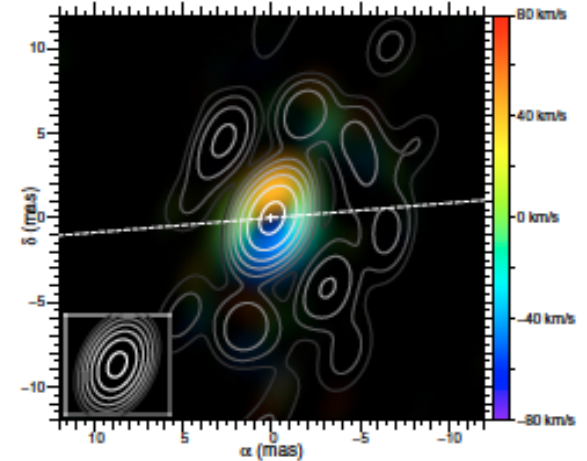
Young
Stellar
Objects

A[e] supergiant
HD 62623

OBSERVATION



Millour et al. 2011



Mira
Stars

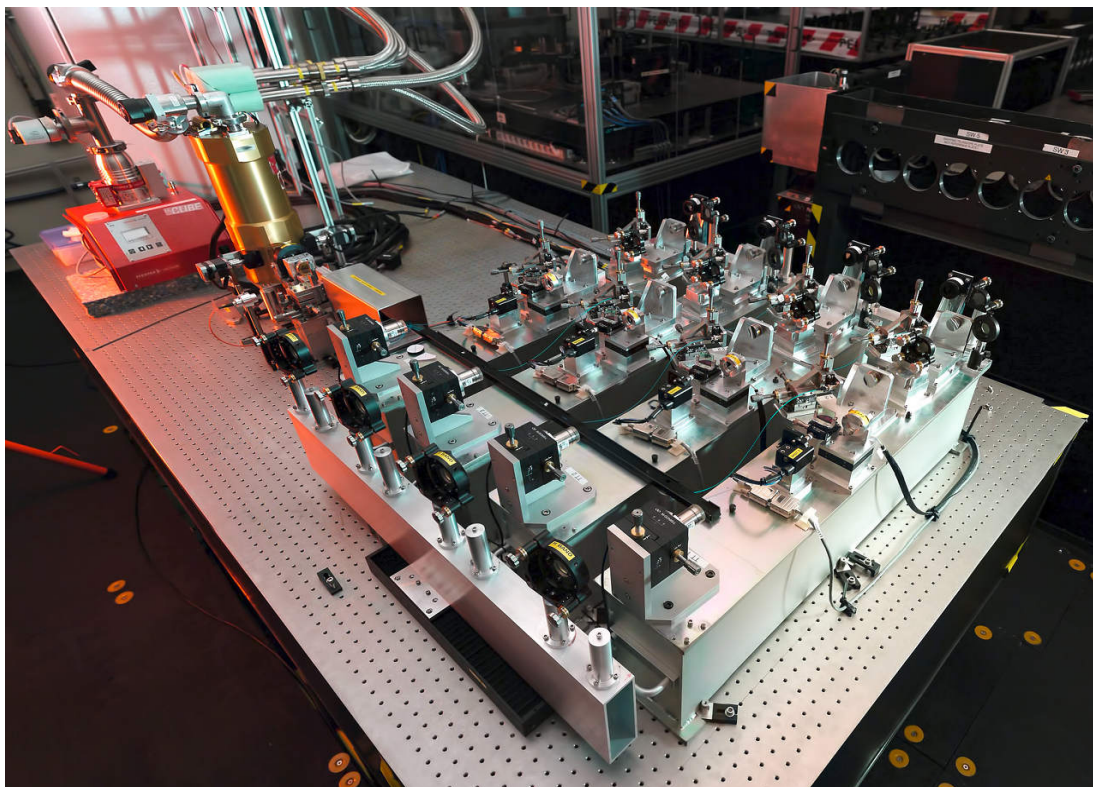
Le Bouquion et al. 2009

Tau Lep

Instruments – PIONIER

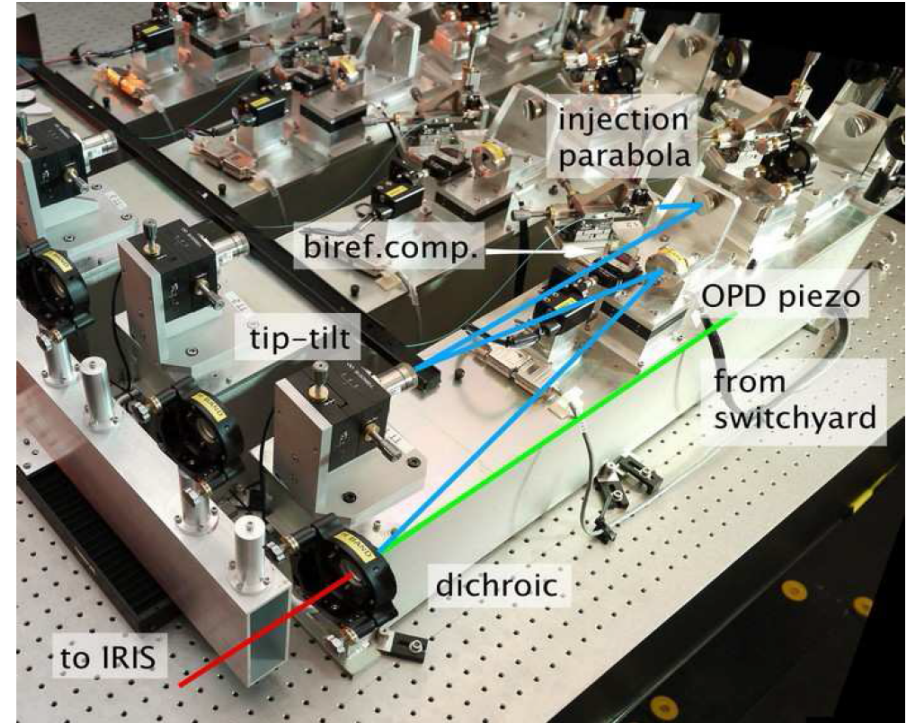
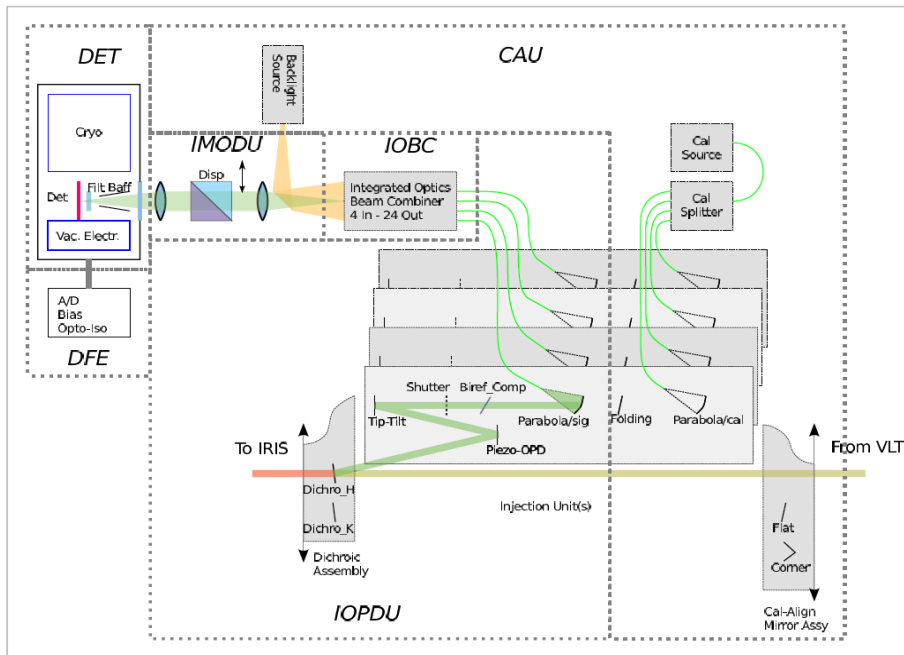
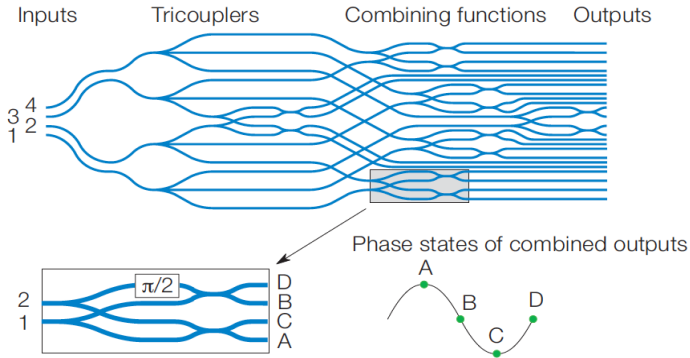


- PIONIER is an integrated optics 4T beam combiner:
 - 6 baselines and 3 closure phases \Rightarrow imaging
 - H-band ($1.7 \mu\text{m}$)
 - 1, 3 or 7 spectral channels
 - up to $H \sim 8$ mag.

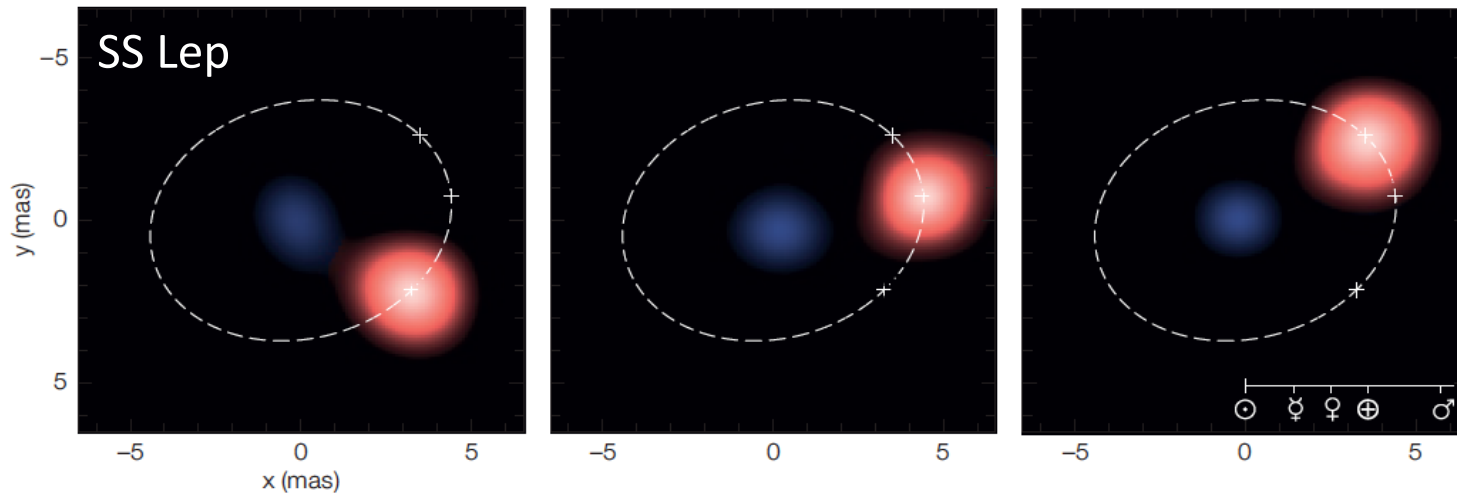


PIONIER in the
VLTI lab

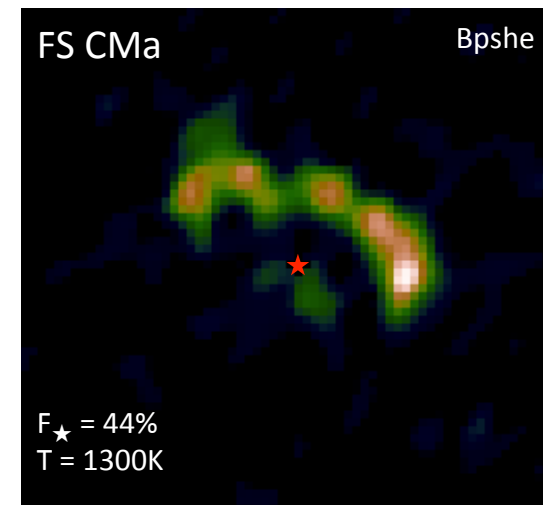
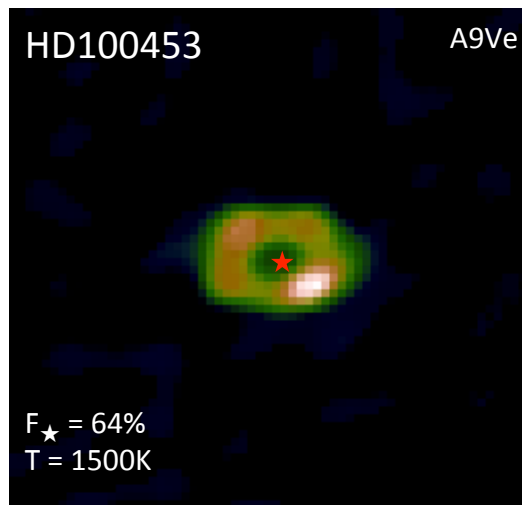
Instruments – PIONIER



Instruments – PIONIER science



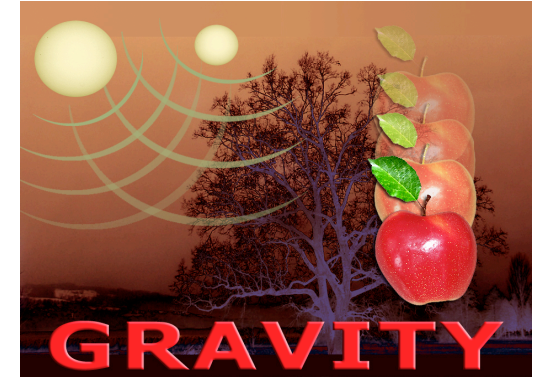
Kluska et al. 2014



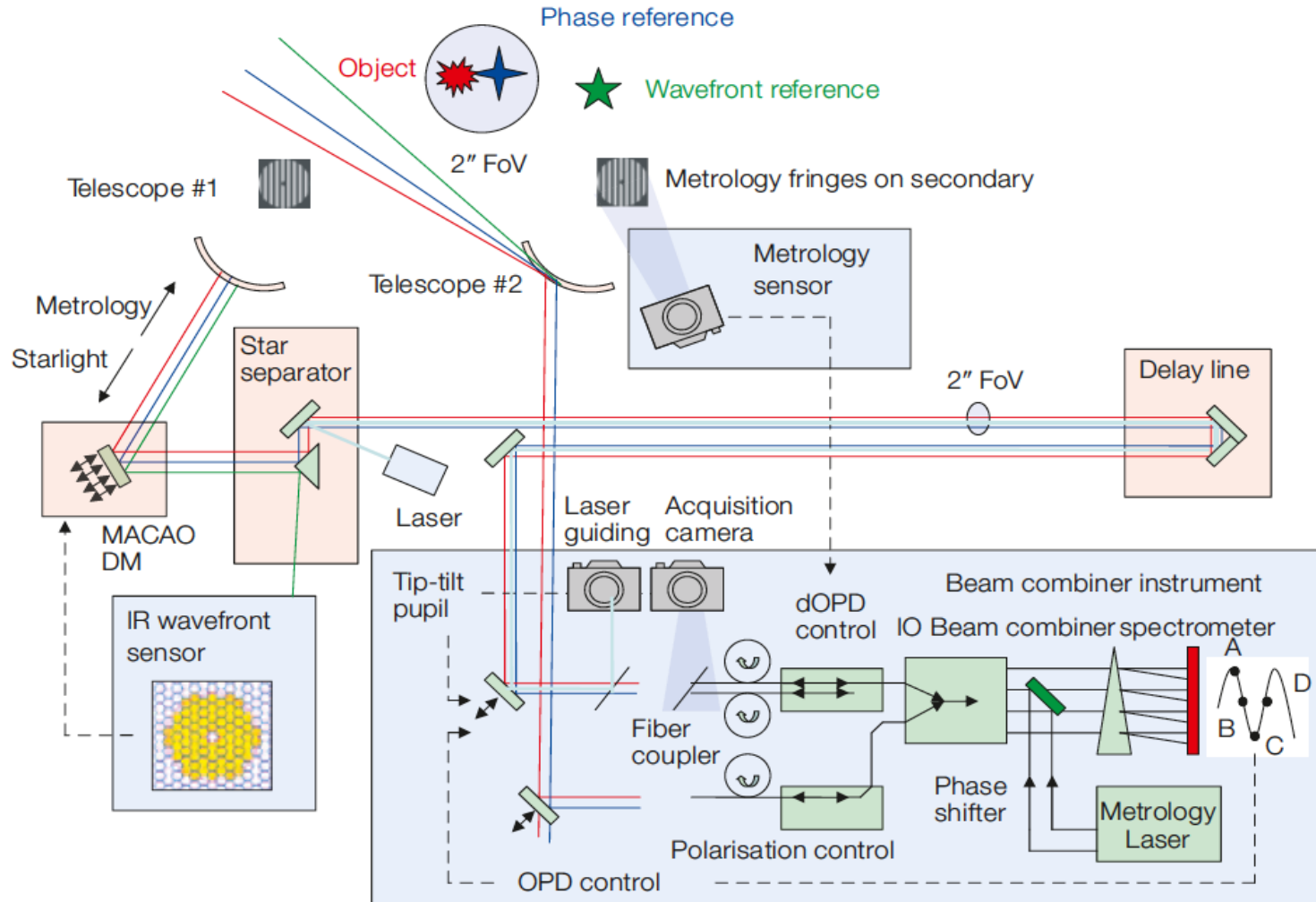
GRAVITY



- 4T beam combiner
- narrow-angle astrometry ($10 \mu\text{as}$)
- phase-referenced imaging
- K-band ($2.2 \mu\text{m}$)
- Spectro-interferometry: R 22, 500 and 4500



GRAVITY - design



GRAVITY – science goals



- Galactic Centre:
 - True nature of the SgrA* flares
 - Spin and inclination of Black Hole
 - Solve the “Paradox of Youth”
 - Tests of fundamental physics
- Active Galactic Nuclei: Torus and BLR
- Intermediate mass black holes
- X-ray binaries
- Masses of the massive stars and brown dwarfs
- Planet formation in circumstellar discs



- Multi AperTure mid-Infrared SpectroScopic Experiment
- 4T beam combiner
- L, M and N-band (3 to 13 μm)
- spectro-interferometry: $R \sim 30$ to 1000



- new spectral windows (L & M band)
- image reconstruction in the thermal infrared



Observatoire
de la COTE d'AZUR



ASTRON

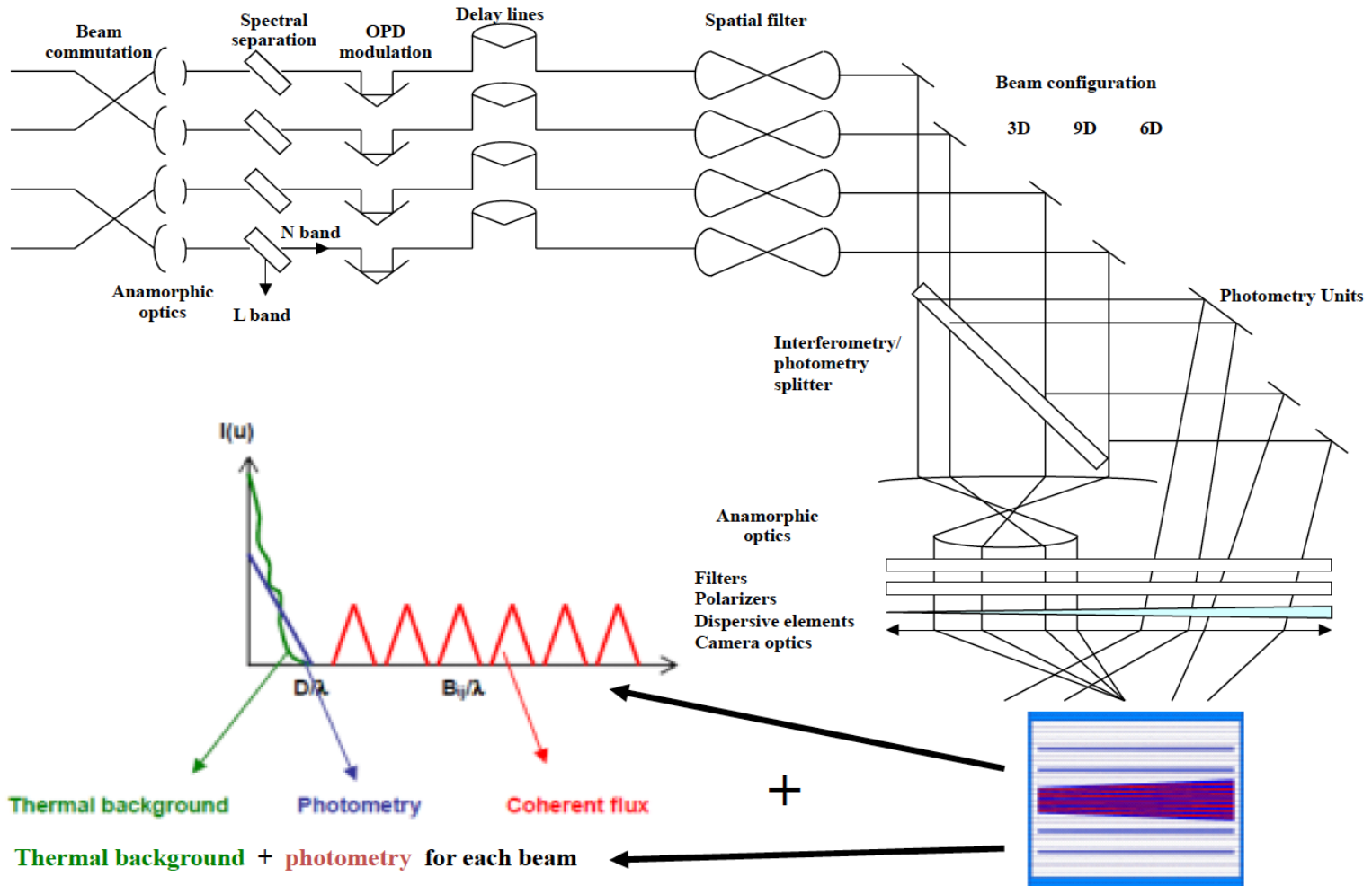
Max-Planck-Institut
für
Radioastronomie

CAU
Christian-Albrechts-Universität zu Kiel

universität
wien



MATISSE - design



MATISSE - operations



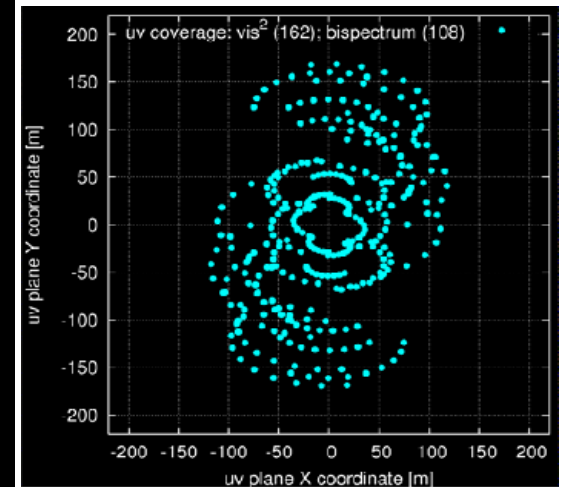
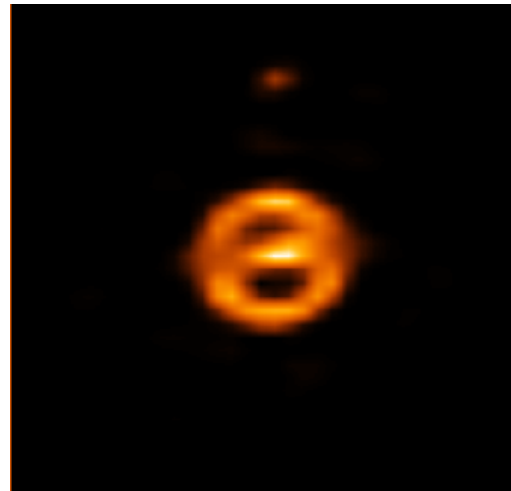
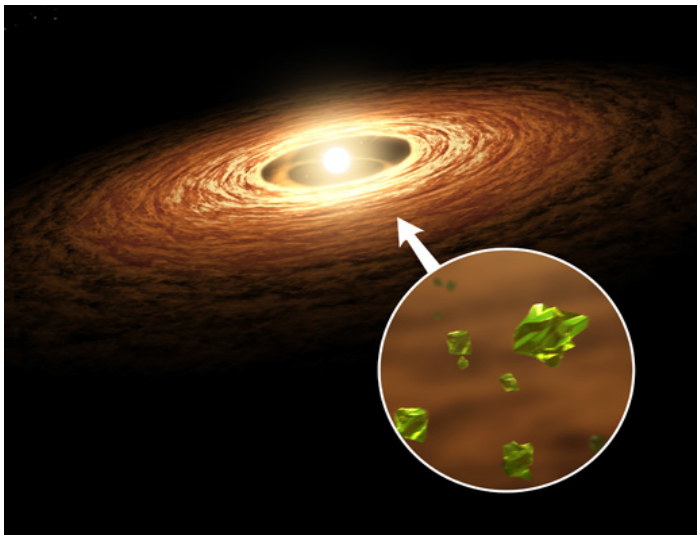
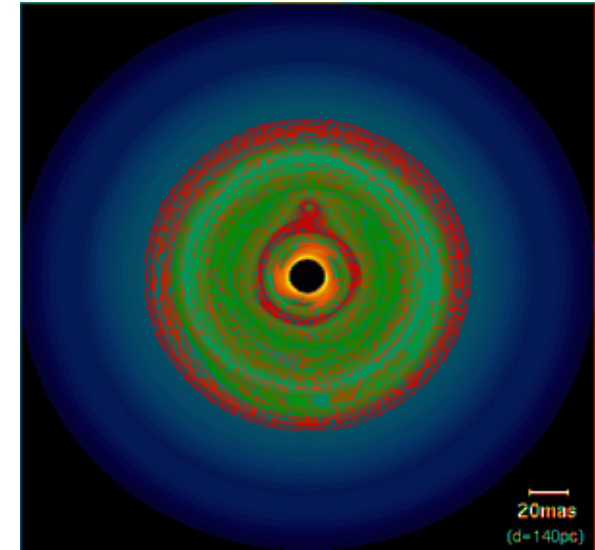
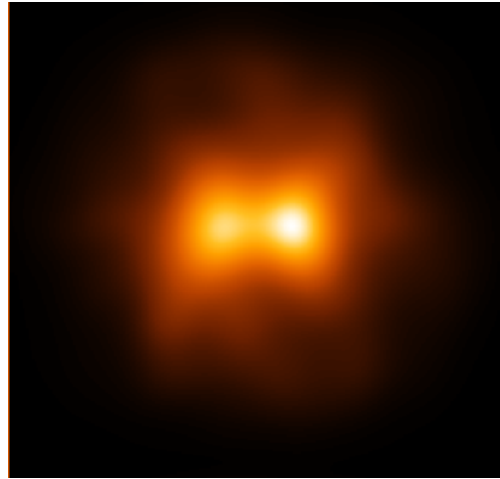
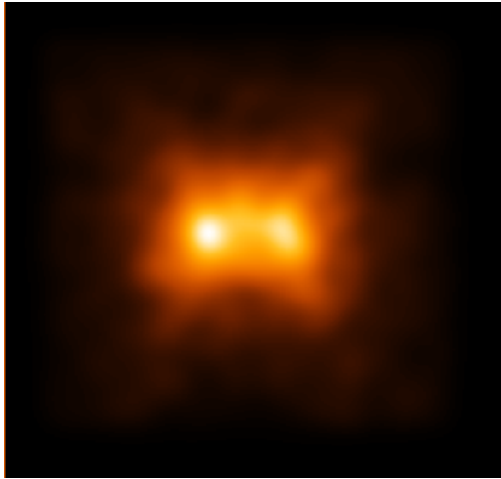
		technical spec.	estimated performance	
			without FT	with FT
L band				
	ATs	7.50 Jy (L = 3.9)	2.95 Jy (L = 5.0)	0.55 Jy (L = 6.8)
	UTs	0.75 Jy (L = 6.4)	0.26 Jy (L = 7.6)	0.05 Jy (L = 9.5)
N band				
	ATs	60 Jy (N = -0,6)	14.6 Jy (N = 1)	2.10 Jy (N = 3.1)
	UTs	4 Jy (N = 2.4)	0.9 Jy (N = 4)	0.12 Jy (N = 6.3)

MATISSE – science goals

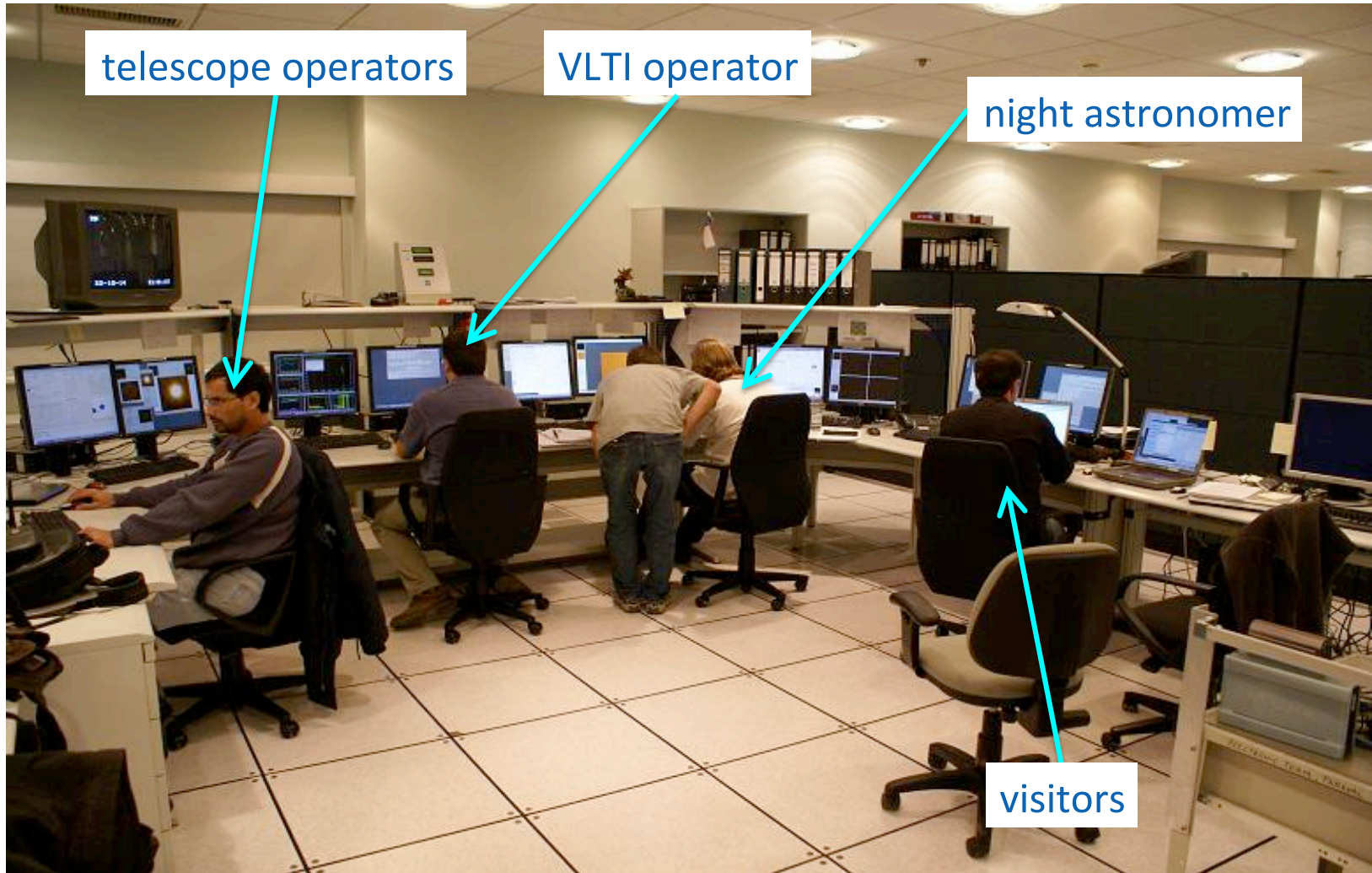


- Star and planet formation
 - Morphology & mineralogy of proto-planetary disks
 - Debris disks: grain properties, geometry, planets
 - Massive star formation: gas and dust distribution
- AGN: detailed morphology
- Dust and winds from evolved stars
- Solar system minor bodies
- Extrasolar planets
- the galactic centre

MATISSE – science goals



The goal: Observations





Hope to see you here soon!