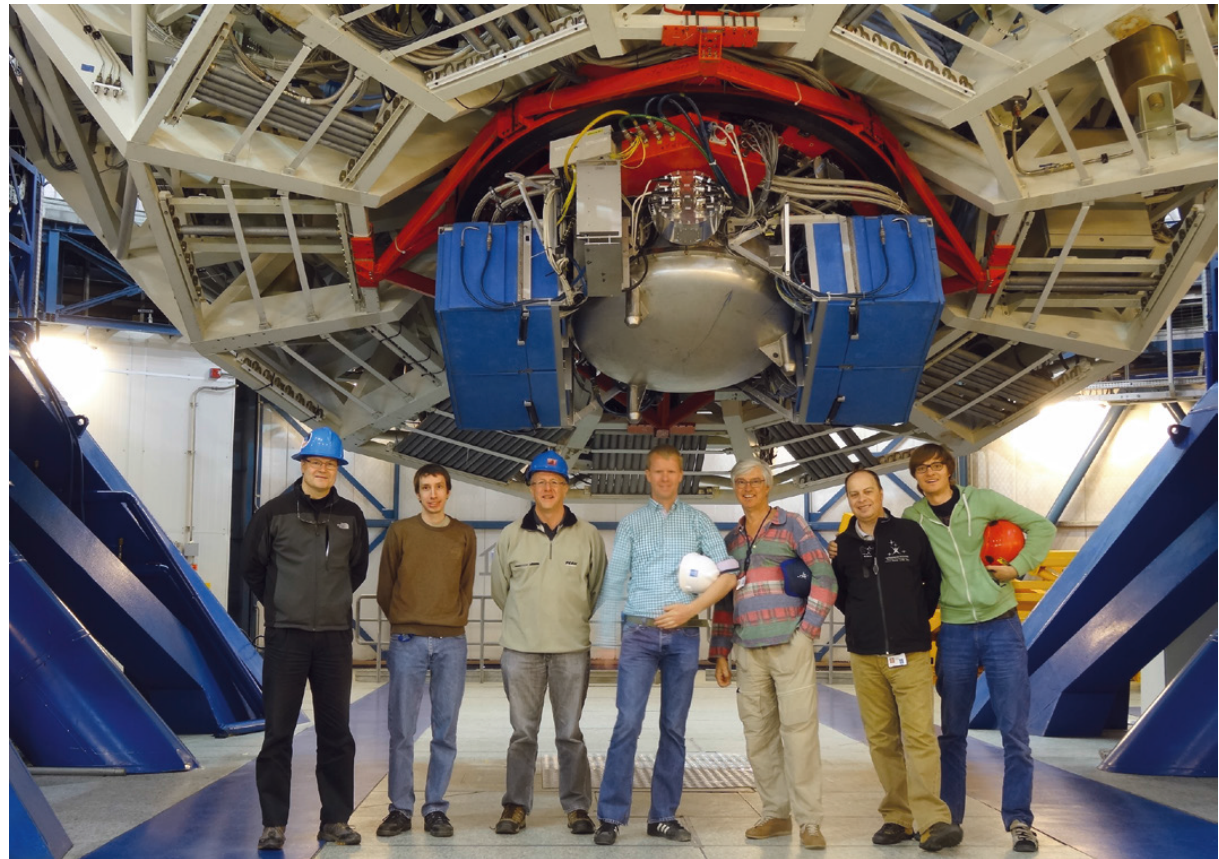


Challenges of calibrations in the mid-infrared with VISIR

Konrad R. W. Tristram
VISIR instrument scientist

Overview

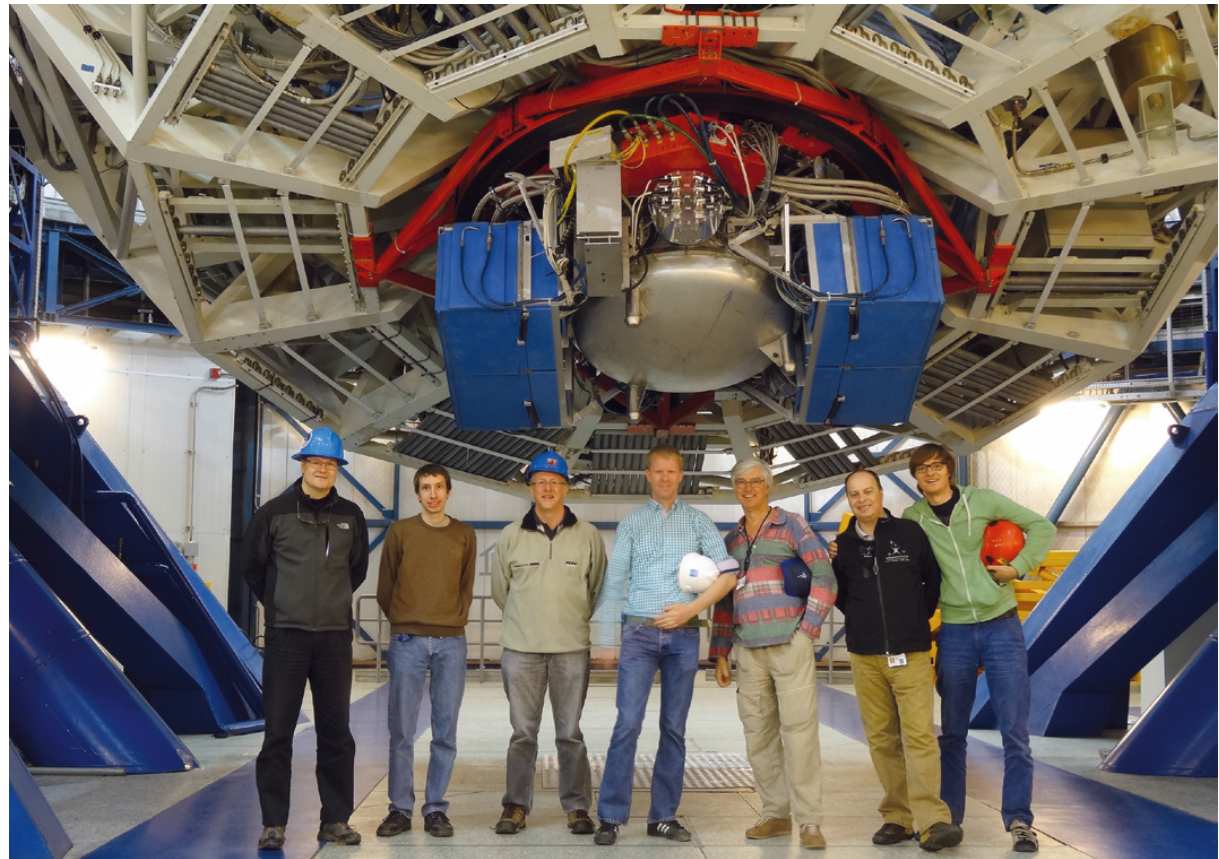
- Part 1: Description of the Instrument
- Part 2: Calibrations in the mid-infrared



VISIR on the Cassegrain focus of UT3 and the recommissioning team

Overview

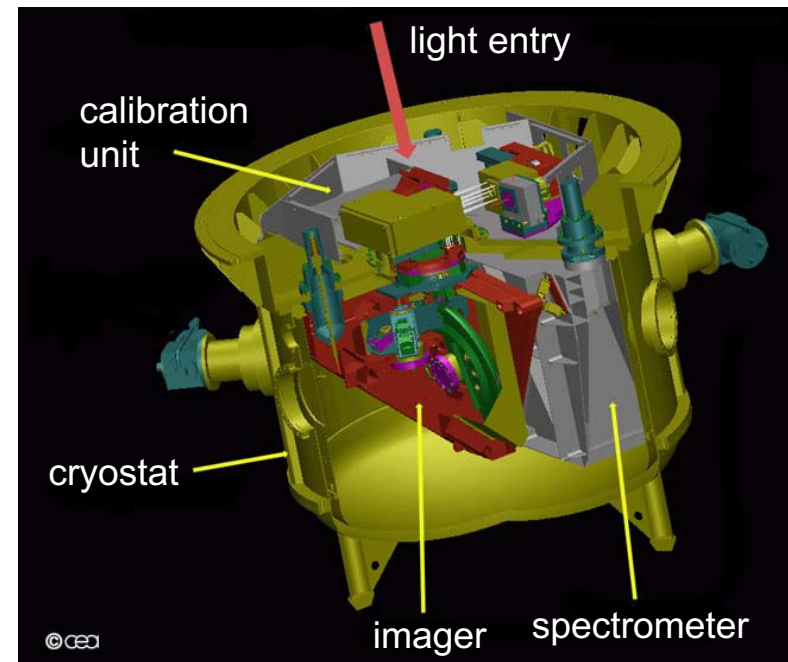
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VISIR on the Cassegrain focus of UT3 and the recommissioning team

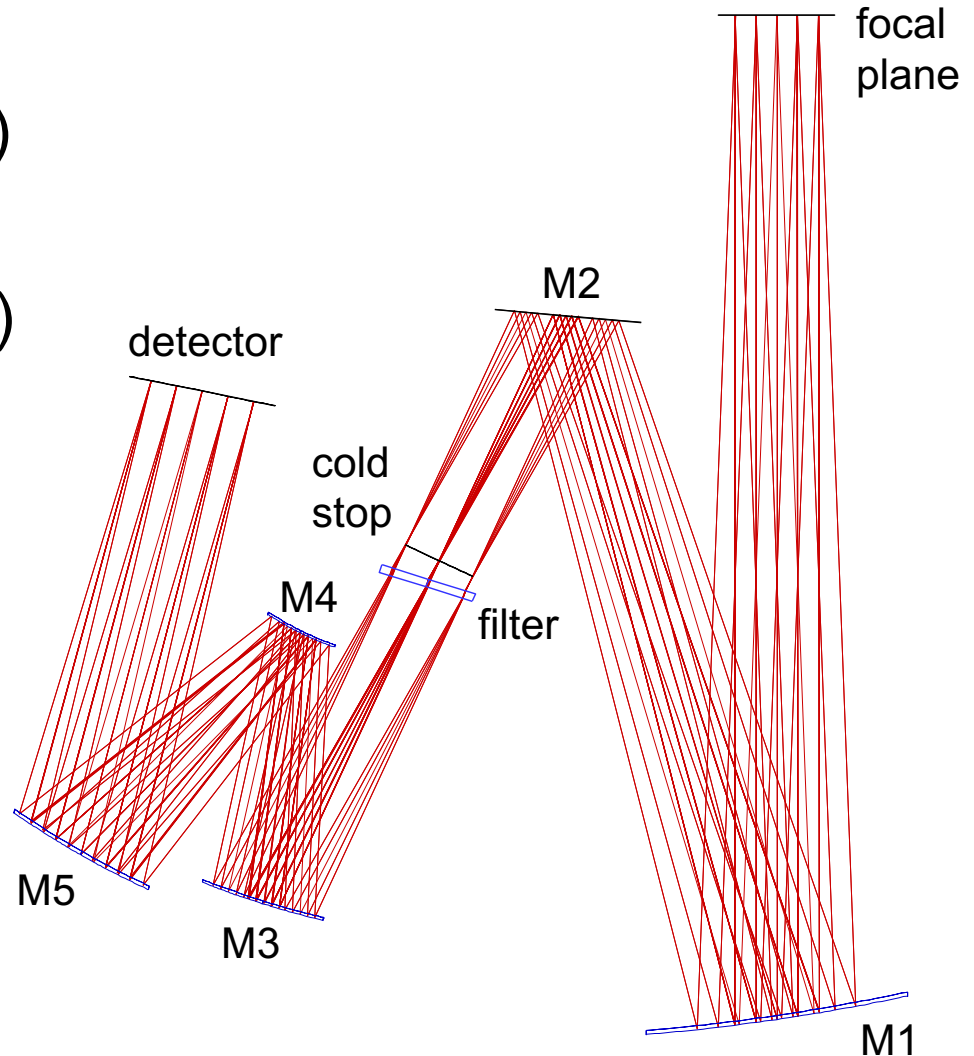
VISIR: General overview

- VISIR = VLT spectrometer & imager for the mid-IR
- Imaging & spectroscopy between $5\mu\text{m}$ and $20\mu\text{m}$
- Built by CEA/DAPNIA/SAP and NFRA/ASTRON in 2004, upgraded by ESO in 2014
- Located at UT3 Cassegrain
- Three main components:
 - imager
 - spectrometer
 - calibration unit



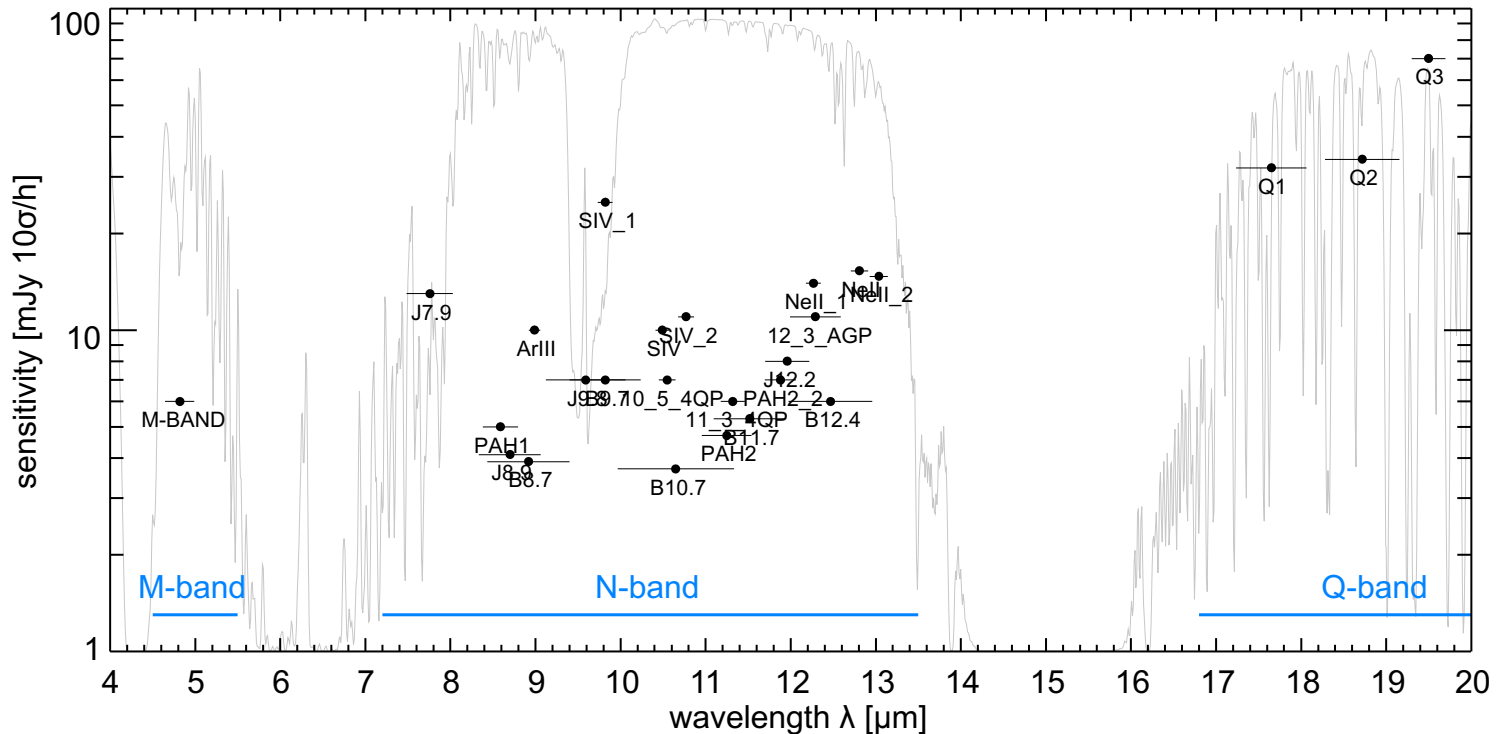
VISIR: the imager

- Three components:
 - collimator (M1 & M2)
 - cold stop & filter
 - objectives (M3 – M5)



VISIR: the imager

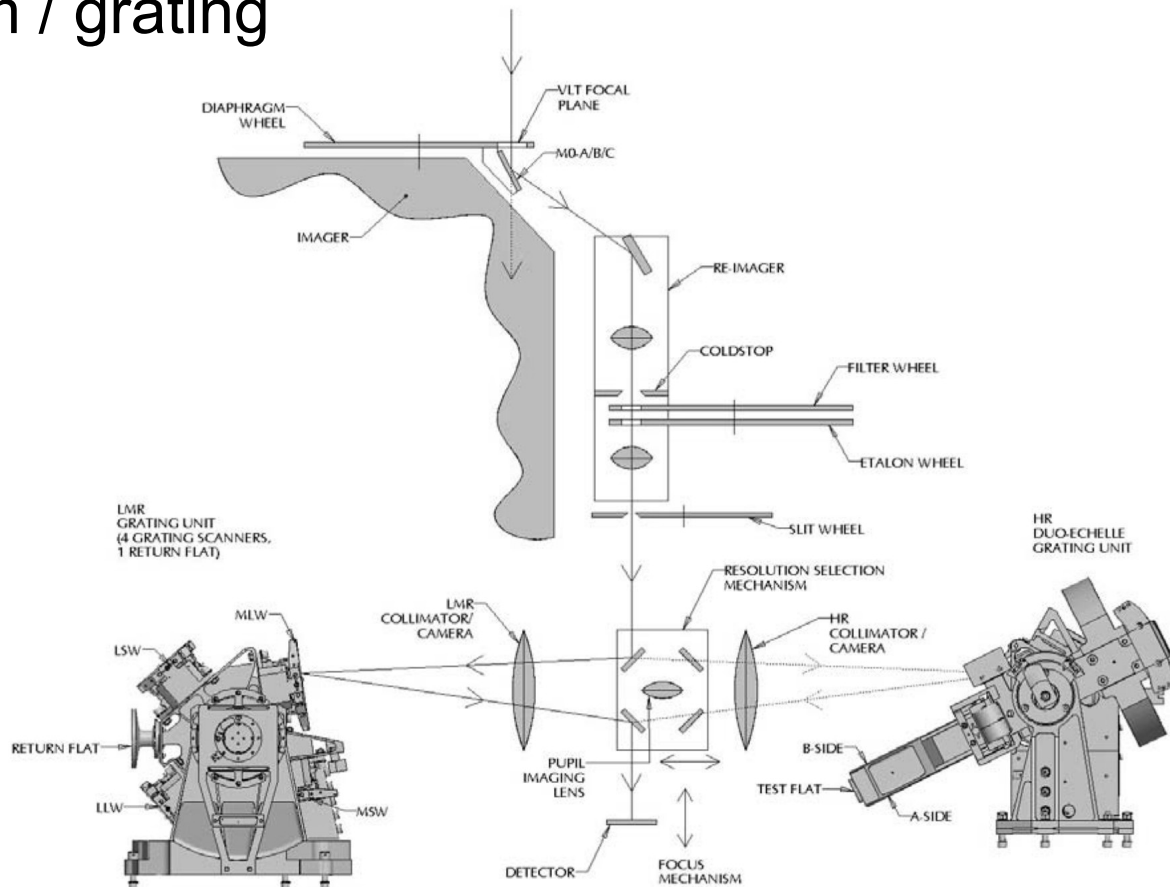
- 26 filters between 5 and 20 μm
- 0.045 (SF) & 0.076 (IF) pixel scale
- AGPM & 4QPM coronagraphy; SAM



VISIR: the spectrometer

■ technical setup: two arms

- LR & MR prism / grating
- HR gratings



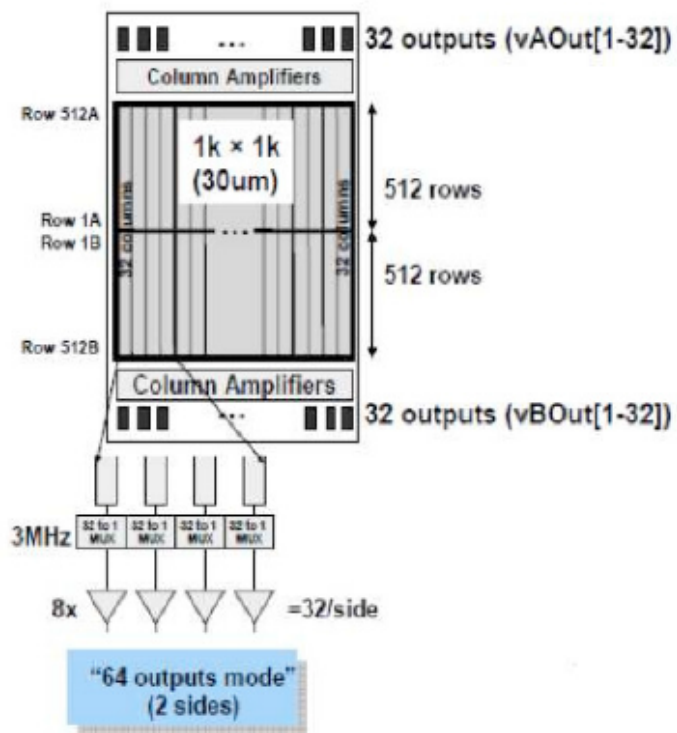
VISIR: the spectrometer

■ Several resolution modes:

grating	offered wavelengths [μm]	resolving power
low resolution (LR)	8 – 13 μm	R ~ 350 at 10 μm
medium resolution (MR)	7.5 – 9.3 μm , 10.2 – 13.0 μm , 17.1 – 19.0 μm	R ~ 3200 at 10 μm
high resolution - long slit (HR)	8.02, 12.81 and 17.03 μm	R ~ 25000 at 10 μm
HR - cross dispersed (HRX)	7.7 – 24.0 μm	R ~ 25000 at 10 μm

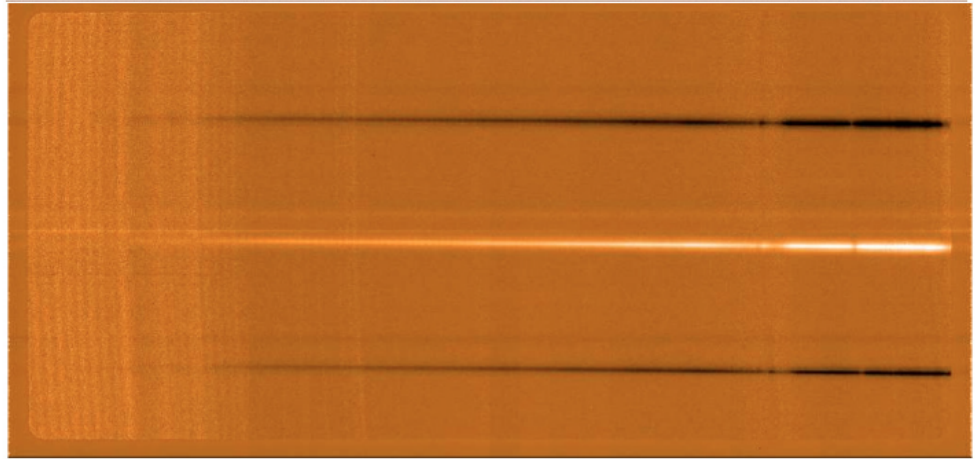
VISIR: detectors

- Two AQUARIUS 1024 × 1024 detectors
 - 110 Hz frame rate
 - excess low frequency noise ⇒ fast chopping

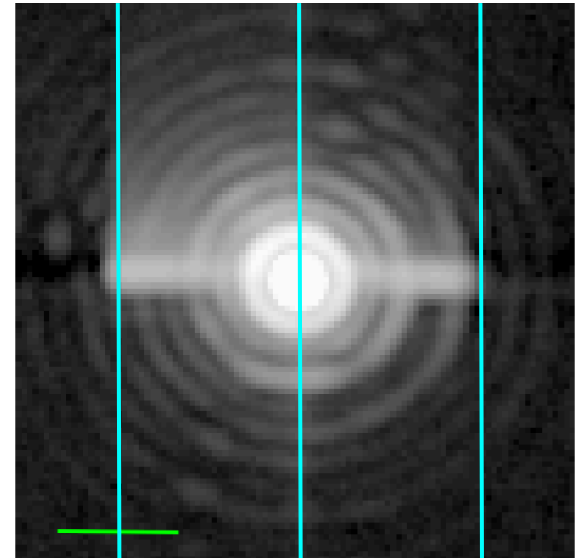


VISIR: detectors

- Very good cosmetics:
(example: LR spectro)

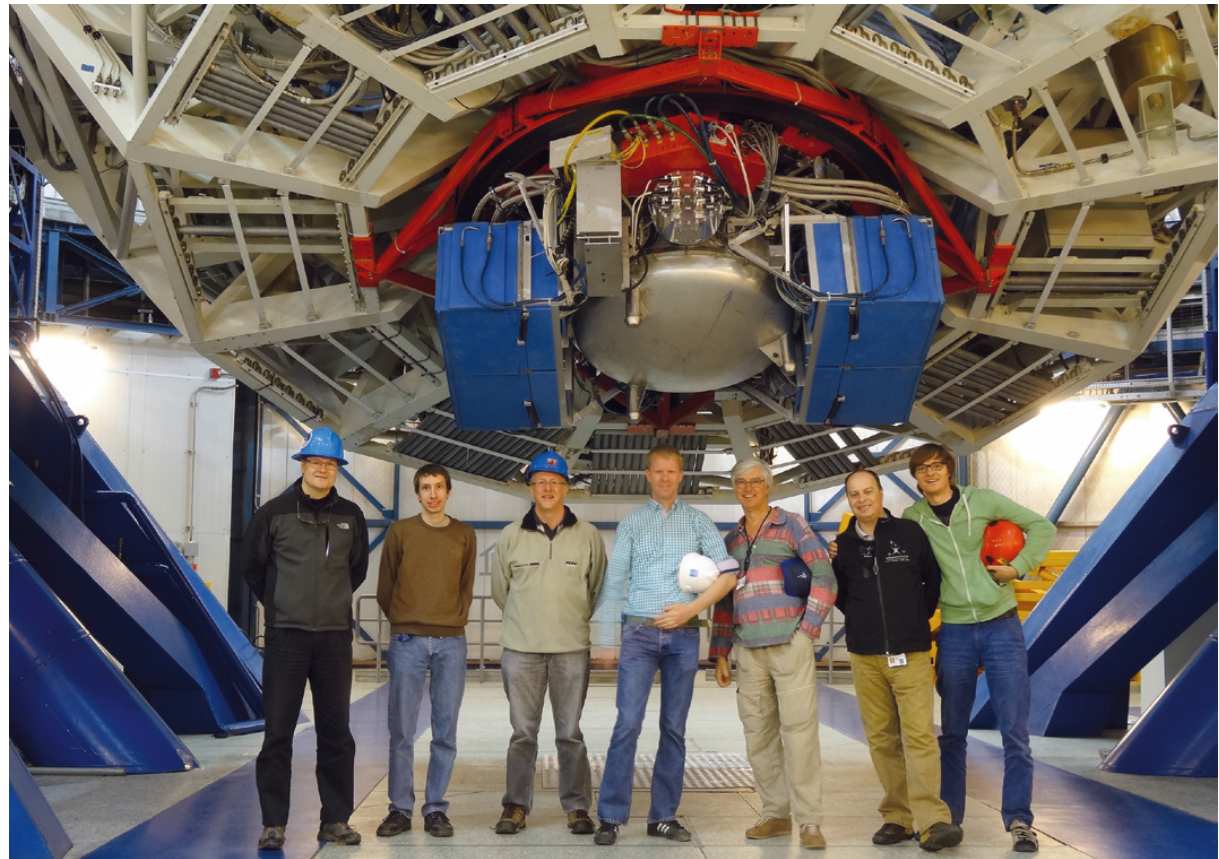


- Bleeding effect for bright sources:



Overview

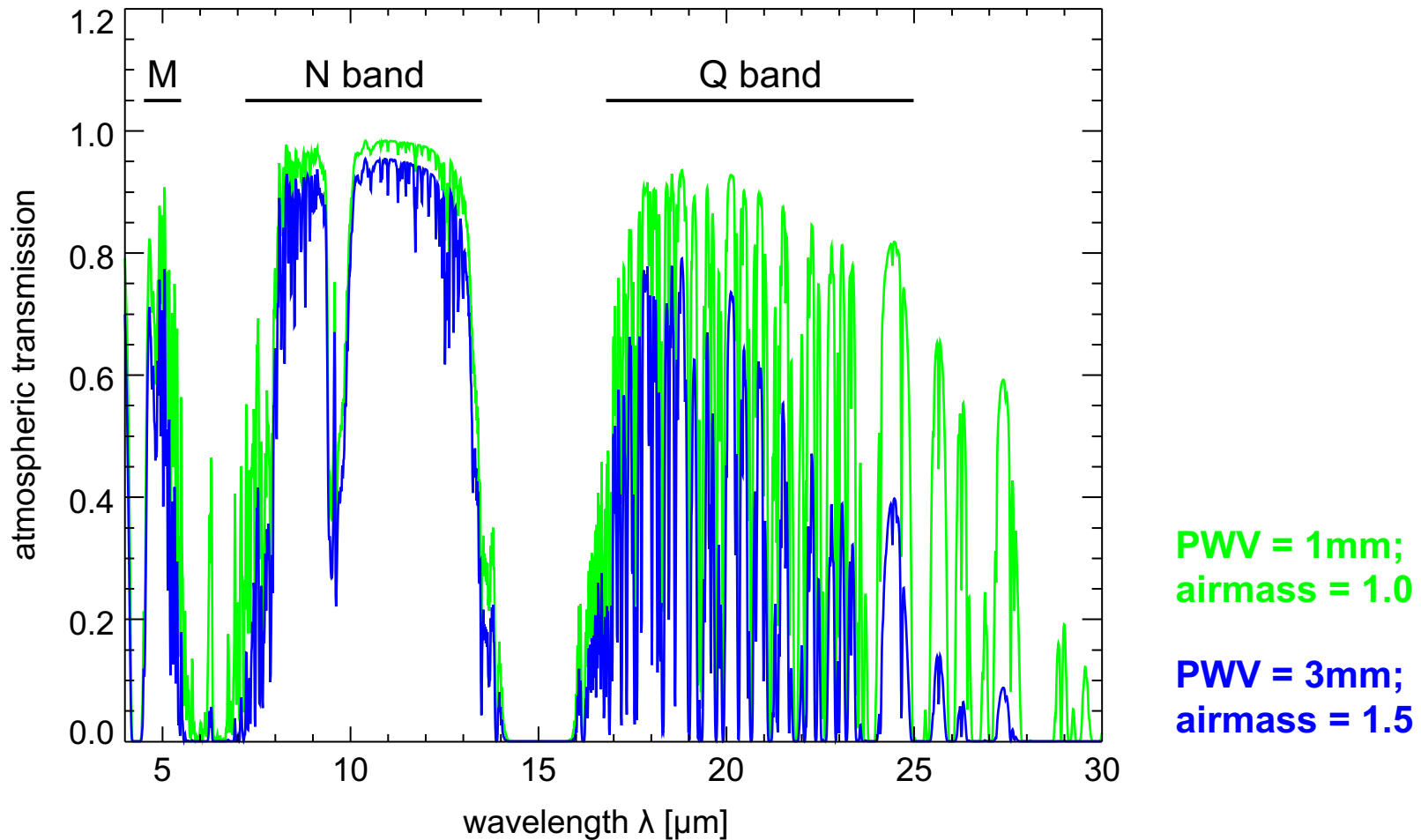
- Part 1: Description of the Instrument
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VISIR on the Cassegrain focus of UT3 and the recommissioning team

Observing in the MIR: transparency

■ Atmosphere transparent in three MIR bands:

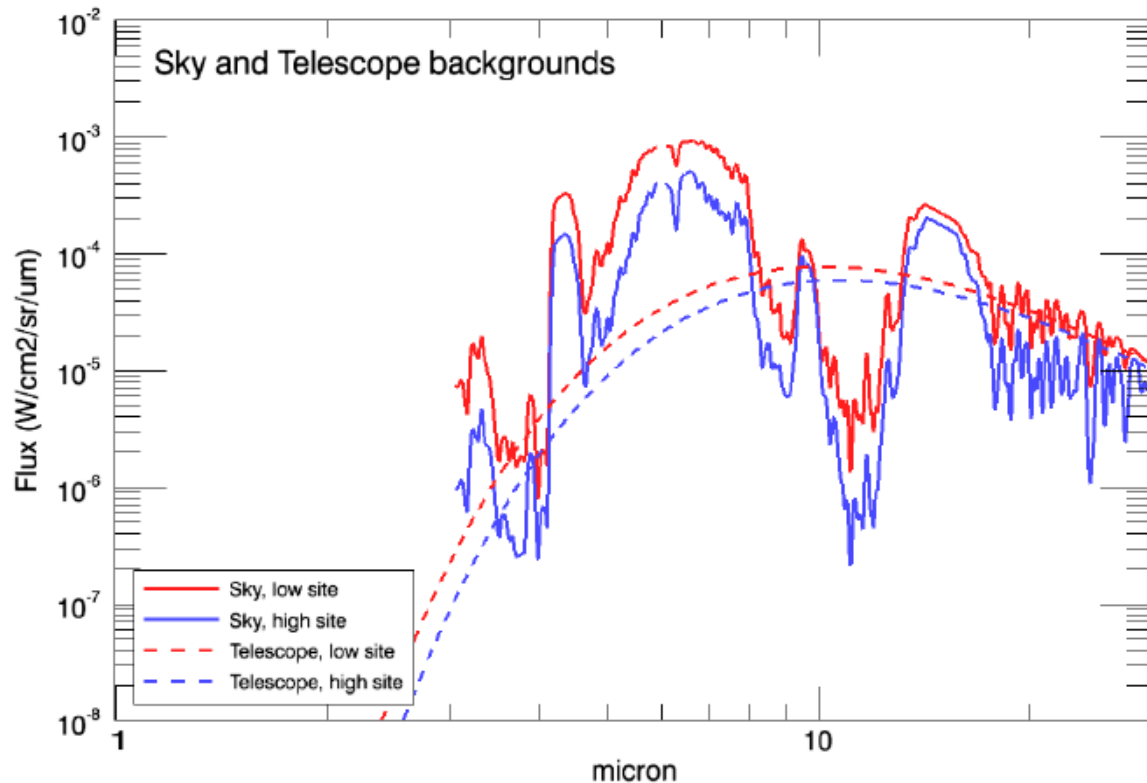


Observing in the MIR: background

■ High background due to:

- atmosphere
- telescope
- instrument

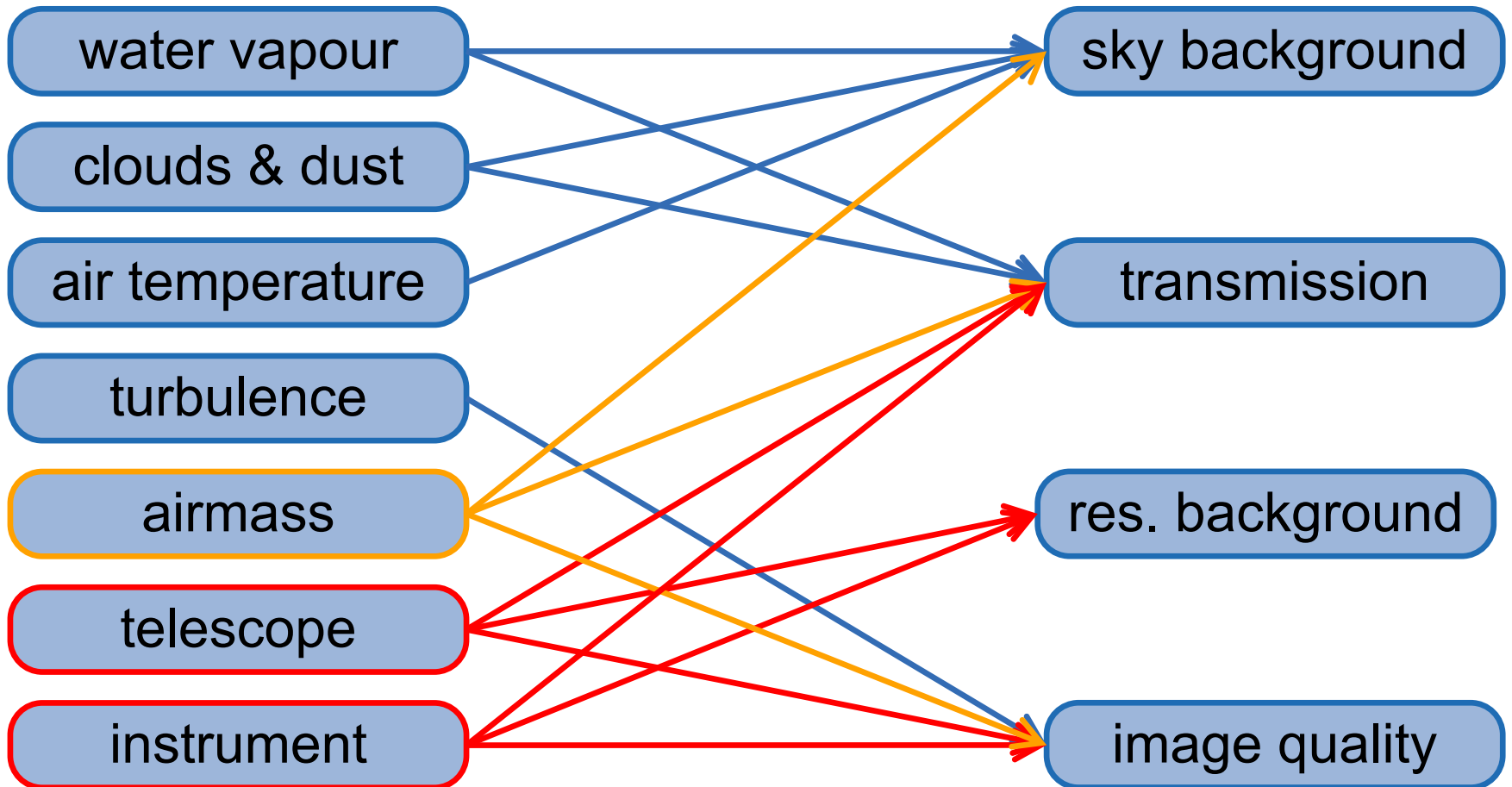
➔ 4000 Jy/arcsec^2



Kendrew et al. 2010

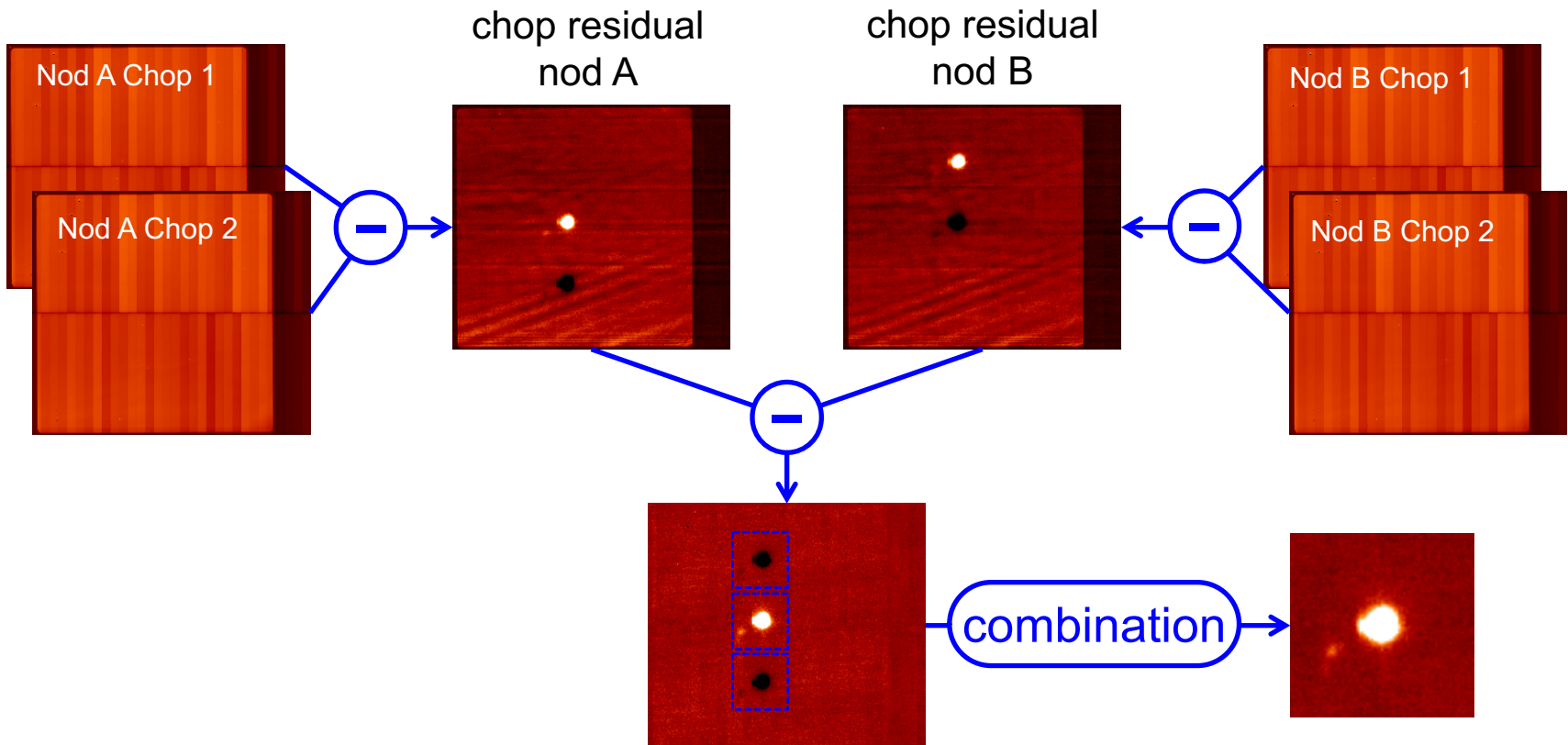
Observing in the MIR

■ Ambient quantities and their influence



Chopping / nodding

- Chopping with the M2 up to 4 Hz
- Nodding with telescope at ~ 0.01 Hz

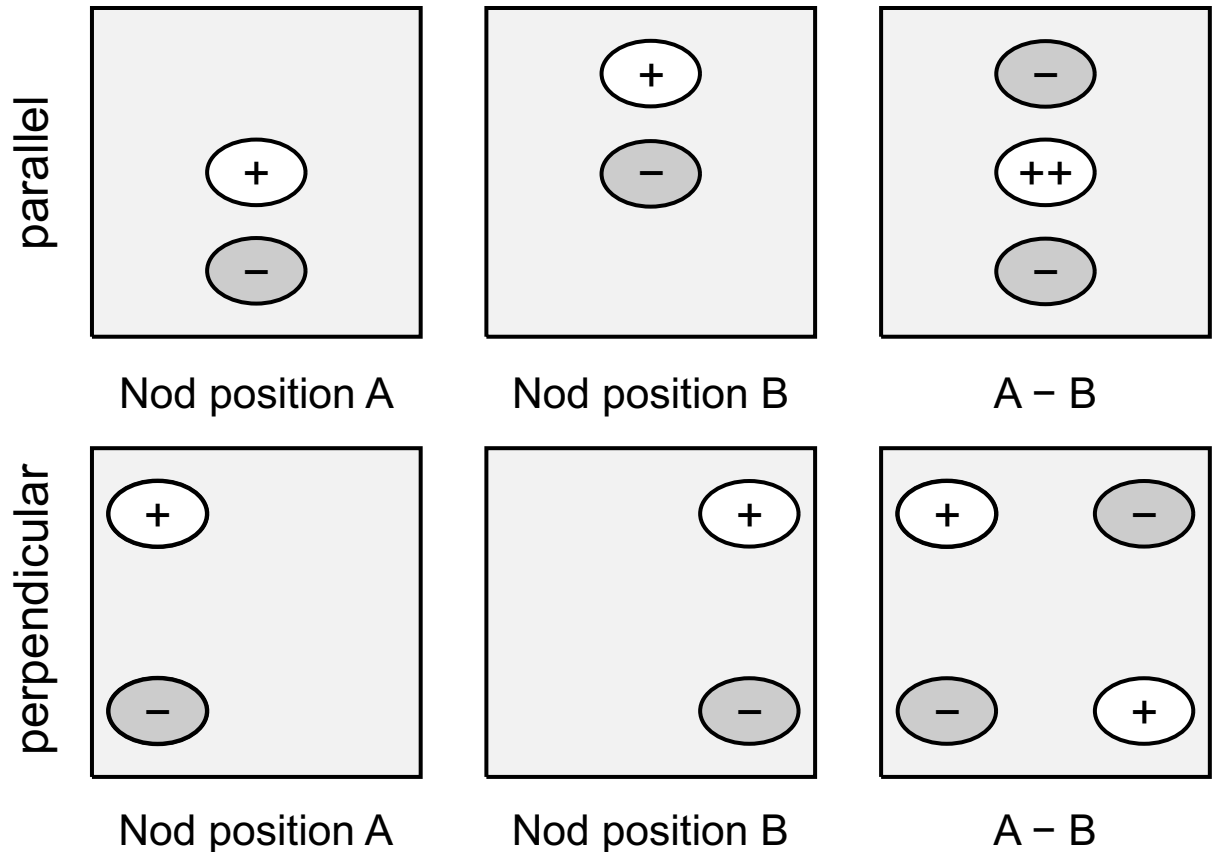


Chopping / Nodding

■ Two chopping modes:

- parallel
- perpendicular

■ Jittering also possible



Chopping / Nodding

■ Issues:

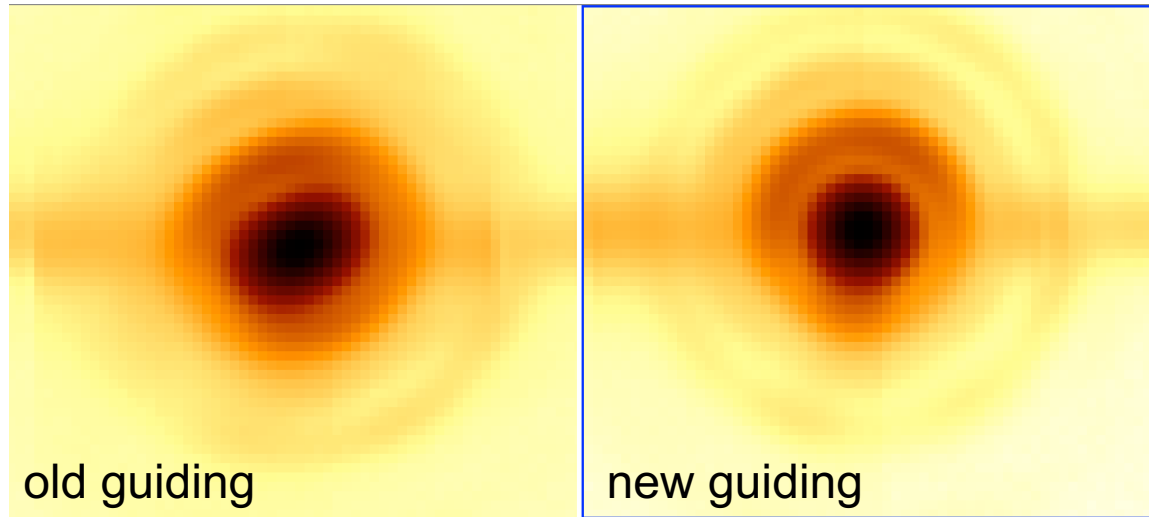
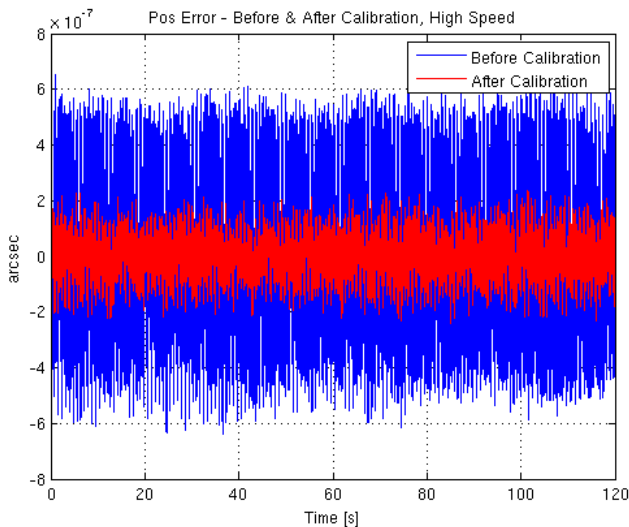
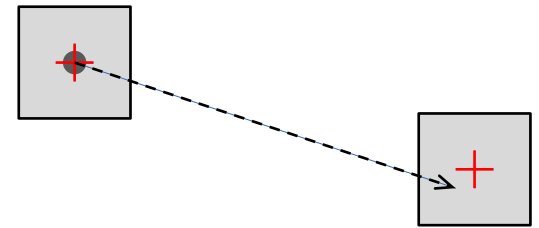
- Fast vs. slow chopping (ELFN noise)
- Efficiency (settle time)
- Accuracy in positioning
- Nodding & chopping overlap for parallel chopping
- Field stabilisation – M2 interaction

■ Alternatives:

- Dicke switch (VISIR-AO)
- 3 point chopping (Pietrow et al. 2016)

Image quality

- VISIR very sensitive to image quality problems
- Significant improvements by:
 - ALT-axis calibration
 - Separate controller for the 2 guiding windows when chopping



Calibration plan

- Data self consistent (no bias / dark / flat)
- Darks only observed to verify detector health
- Observatory standards for IMG & LR spec.

- Status verified by HealthChecker

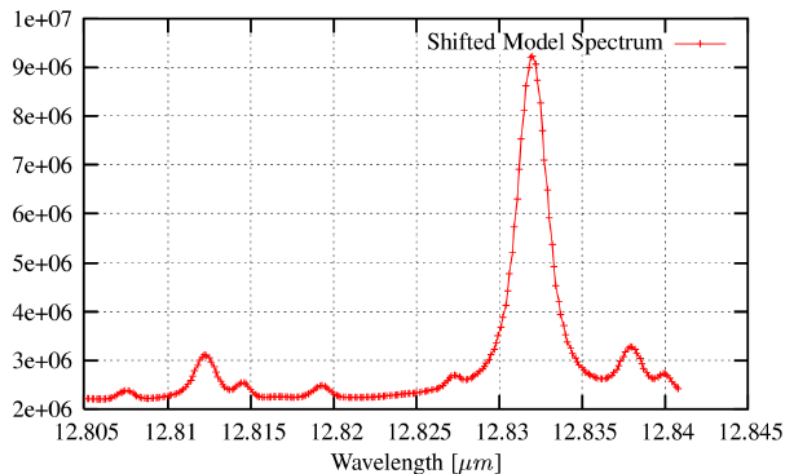
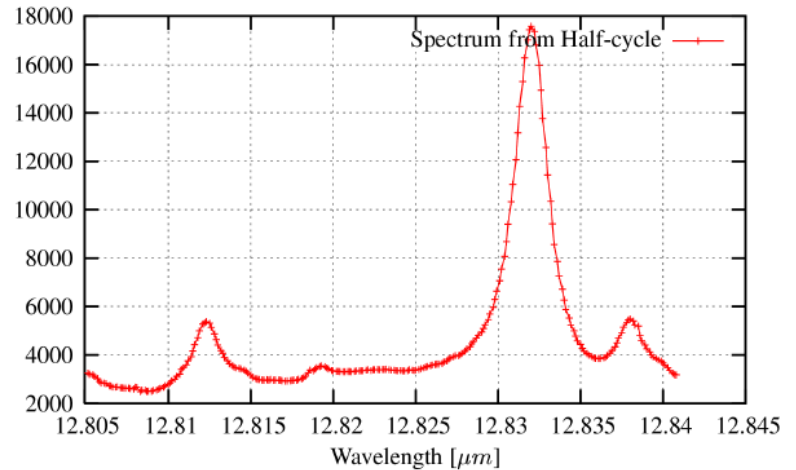
- Static calibration data:

- Standard stars:
based on Cohen et al.
426 imaging / 469 spectroscopy
 - Detector Quantum Efficiency
 - Atmospheric Emission Spectrum

		daytime calibs:		2017-01-09		2017-01-10		Calibration action?	
DATE: [?]		SM s5		SM s4				[?] [?]	
[?] Raw CAL displays:		raw		raw				[?] [?]	
[?] Product quality:		✓ products		✓ products				[?] [?]	
Data types:	Setup:								
SCI_IMG_CHN	B10.7_0.0453		ok						all ok
SCI_IMG_RCHN	J7.9_0.0453	ok	ok						all ok
	M-BAND_0.0453	ok	ok						all ok
	NEII_1_0.0453	ok	ok						all ok
	NEII_2_0.0453	ok	ok						all ok
	PAH1_0.0453	ok	ok						all ok
	Q1_0.0453	ok	ok						all ok
	Q2_0.0453	ok	ok						all ok
	Q3_0.0453	ok	ok						all ok
	SIV_2_0.0453	ok	ok						all ok
SCI_IMG_CHNB	M-BAND_0.0453		ok						all ok
SCI_SPEC_CHN	0.750_OPEN								all ok
SCI_SPEC_ECH	0.400_N_LW_GR	ok							all ok

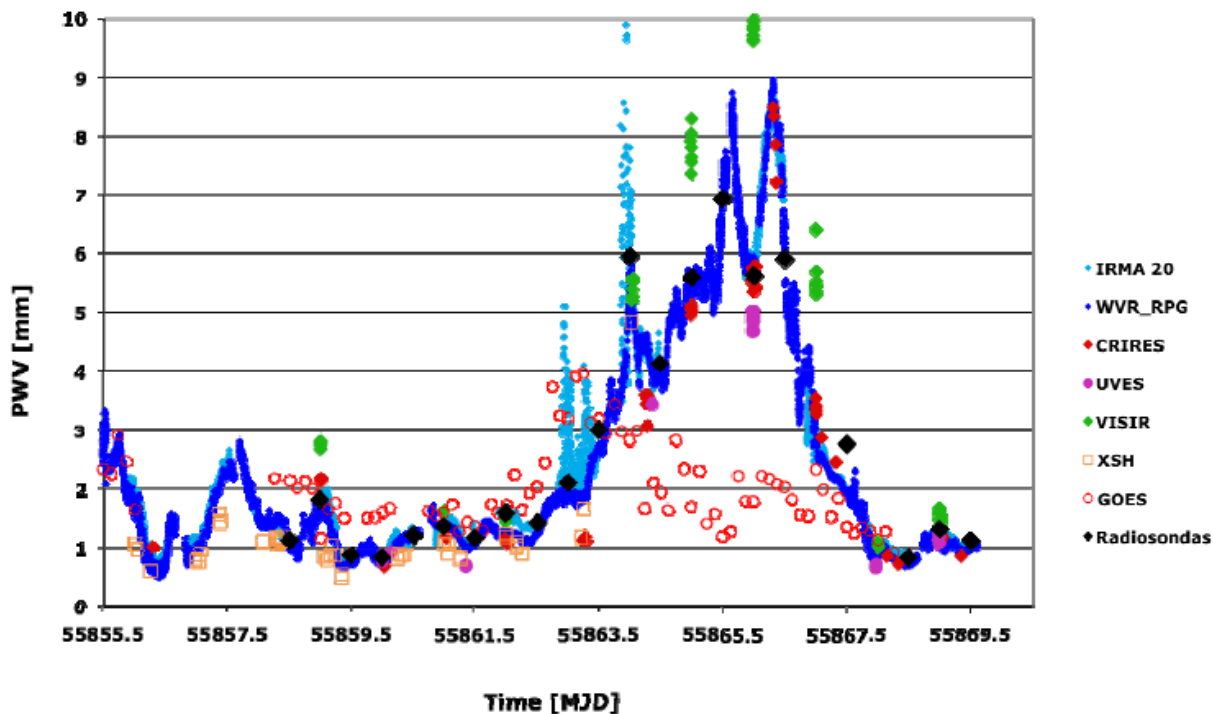
HR wavelength calibration

- Use atmospheric emission spectrum
- Cross correlation of observed spectrum with HITRAN model
- $\sim 1\text{\AA}$ ($\sim 2\text{ km/s}$, based on a single line)



Water vapour radiometer

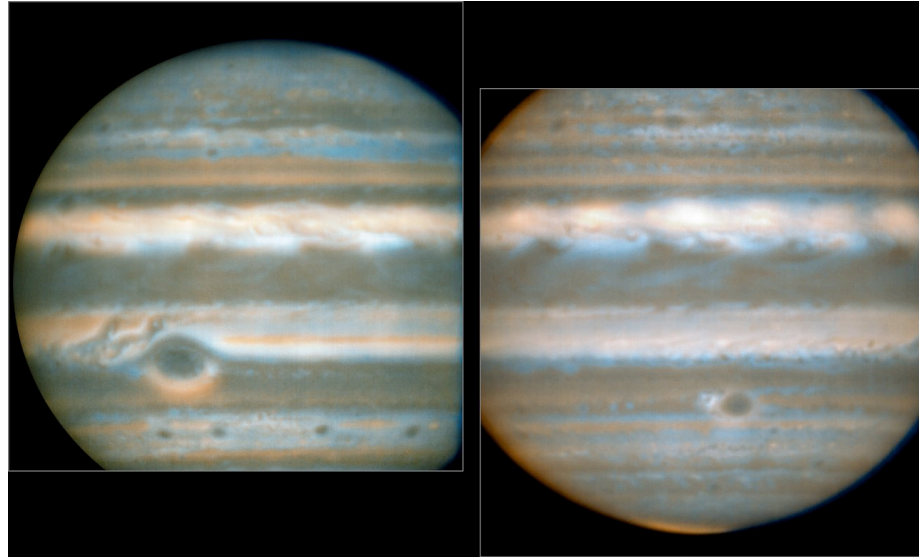
- Water vapour monitor installed as part of the VISIR upgrade: RPG-LHATPRO



Summary

■ Instrument description:

- M, N, Q-band imager
- coronagraphy, SAM
- LR prism, HR Echelle spectroscopy



Jupiter with VISIR (ESO PR eso1623b)

■ Calibrations:

- High background chopping / nodding
- Flux calibration procedures
- VISIR demanding w.r.t. image quality