MATISSE

Multi AperTure mid-Infrared SpectroScopic Experiment

MATISSE status and expected precision

Alexis Matter

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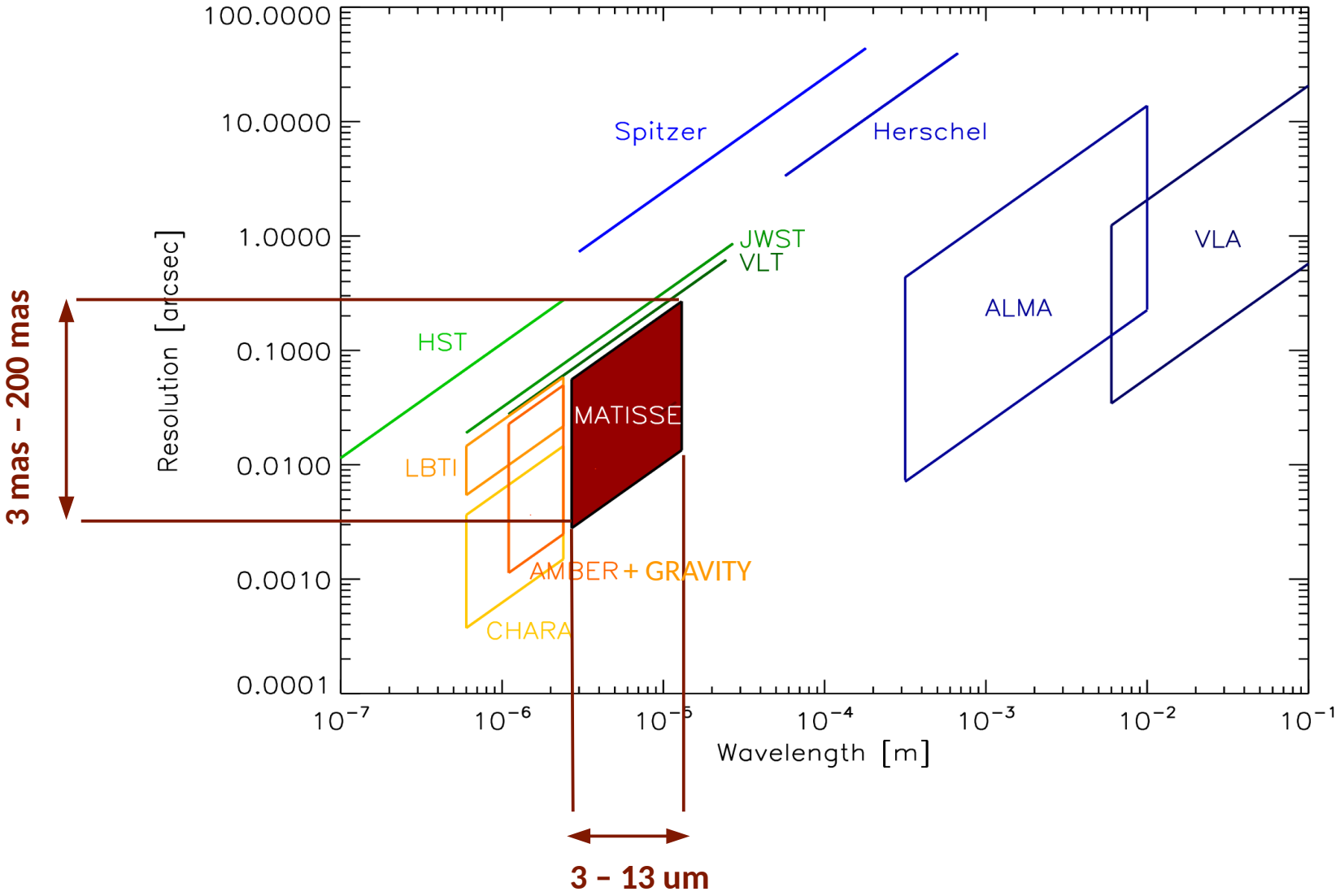
Instrumental context

MATISSE 2nd generation (4 telescopes) VLTI spectro-interferometer



MATISSE consortium

Observatoire Côte d'Azur Laboratoire Lagrange Université de Nice IPAG & CEA Saclay (France) *	Science – General concept & system – Management – Warm Optics – Control Command –Data reduction -Assembly, Integration, Tests - Commissioning
Université de Leiden ** ASTRON (Netherlands)	Science – Cold optics – Interfaces
Max Planck Institüt Heidelberg (Germany)	Science – Cryogenics – Electronics
Max Planck Institüt Bonn (Germany)	Science – Detector – Image reconstruction
Université Vienne (Austria) Université de Kiel (Germany)	Science
European Southern Observatory (Germany)	Science- Detector – Infrastructure and VLTI logistics

* & ** : Contributions from University of Cologne et Konkoly Observatory

MATISSE – Current status and agenda

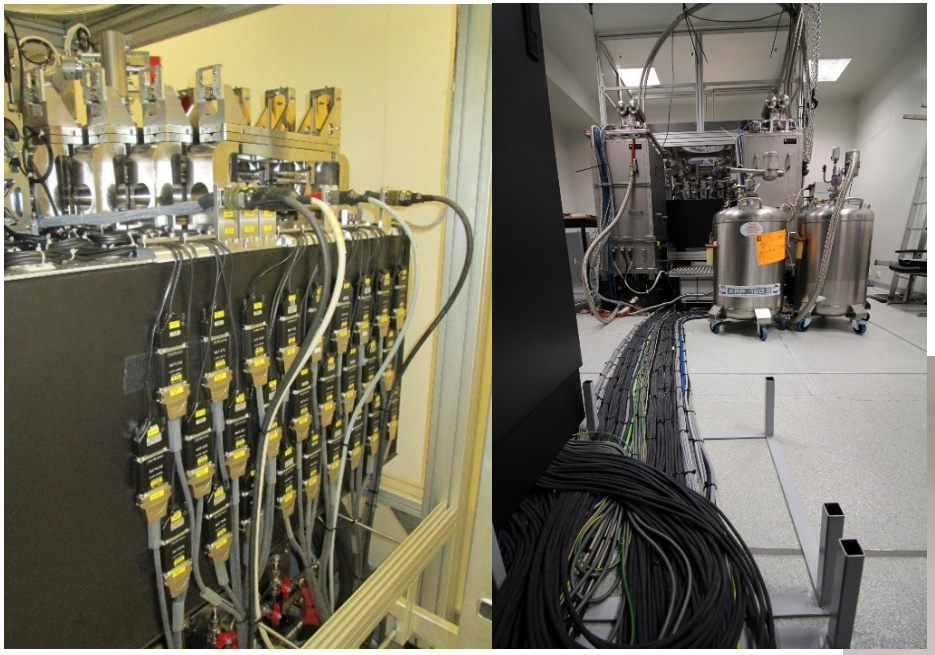
✱ **We are here : packing in Nice**

Kick-off		PDR	O-C FDR	Inst FDR		PAE	✱		First light		PAC
Nov 2006	Concept and science cases studies	Dec 2010	Sept 2011	April 2012	Manufacturing Assembly Integration Tests (53 months)	July-Sept 2017	Packing Transport plane (1.5month)	AIV (~2 months)	February 2018	Commissioning 8-10 months	Late 2018

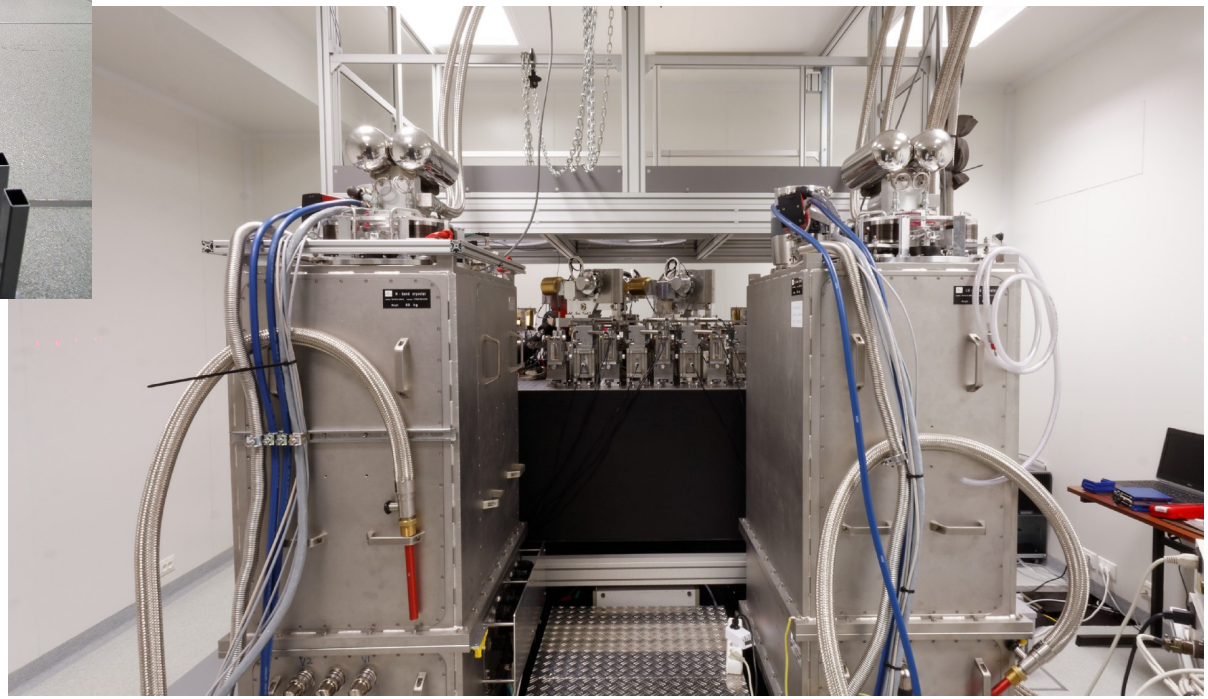
PDR: Preliminary Design Review
O-C FDR: Optics and Cryogenics Final Design Review
Inst FDR: Instrument Final Design Review
PAE: Preliminary Acceptance in Europe
AIV: Assembly, Integration and Verification
PAC: Provisional Acceptance in Chile

MATISSE in the white room (Nice)

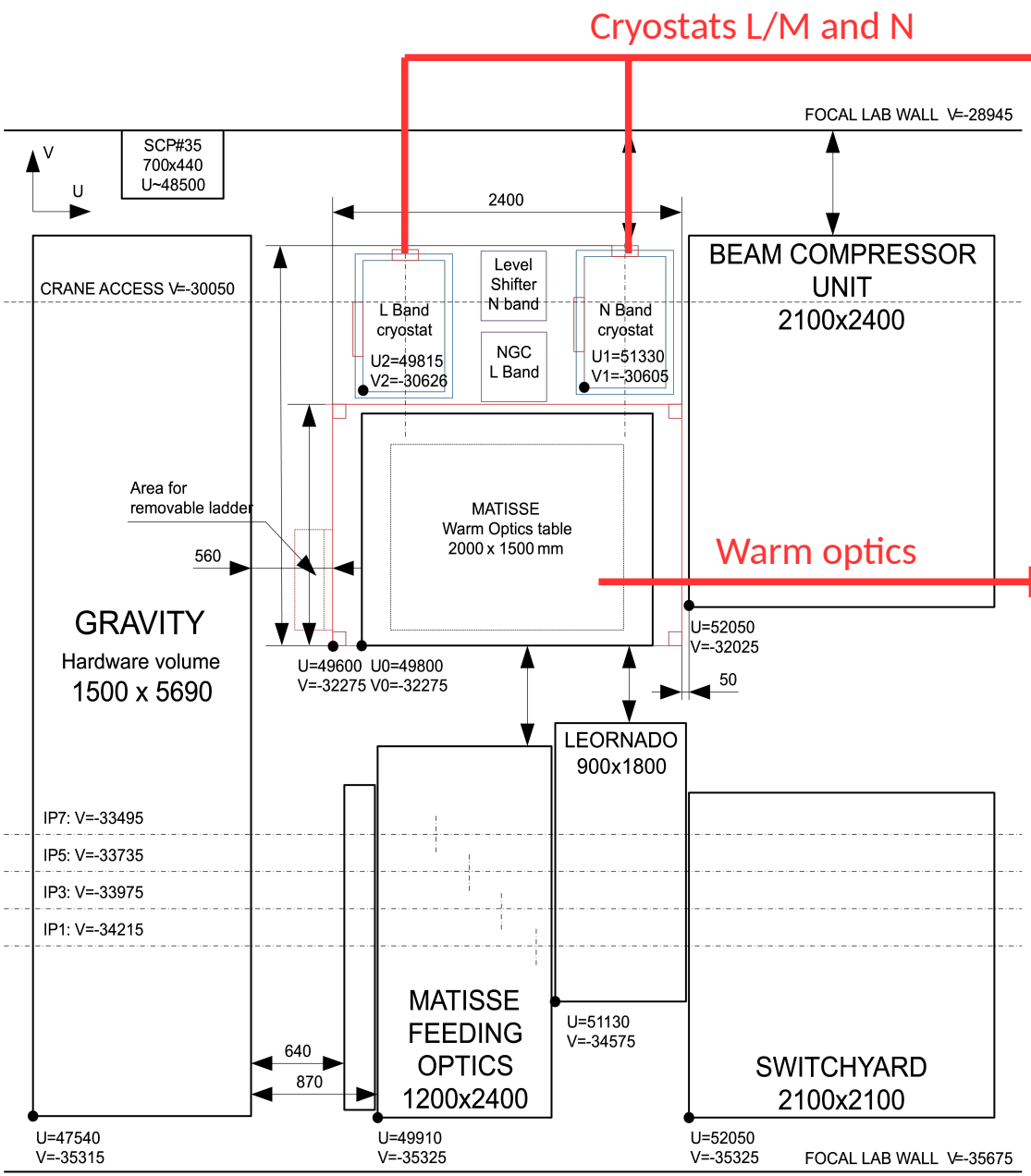
View of the electronics cabinets



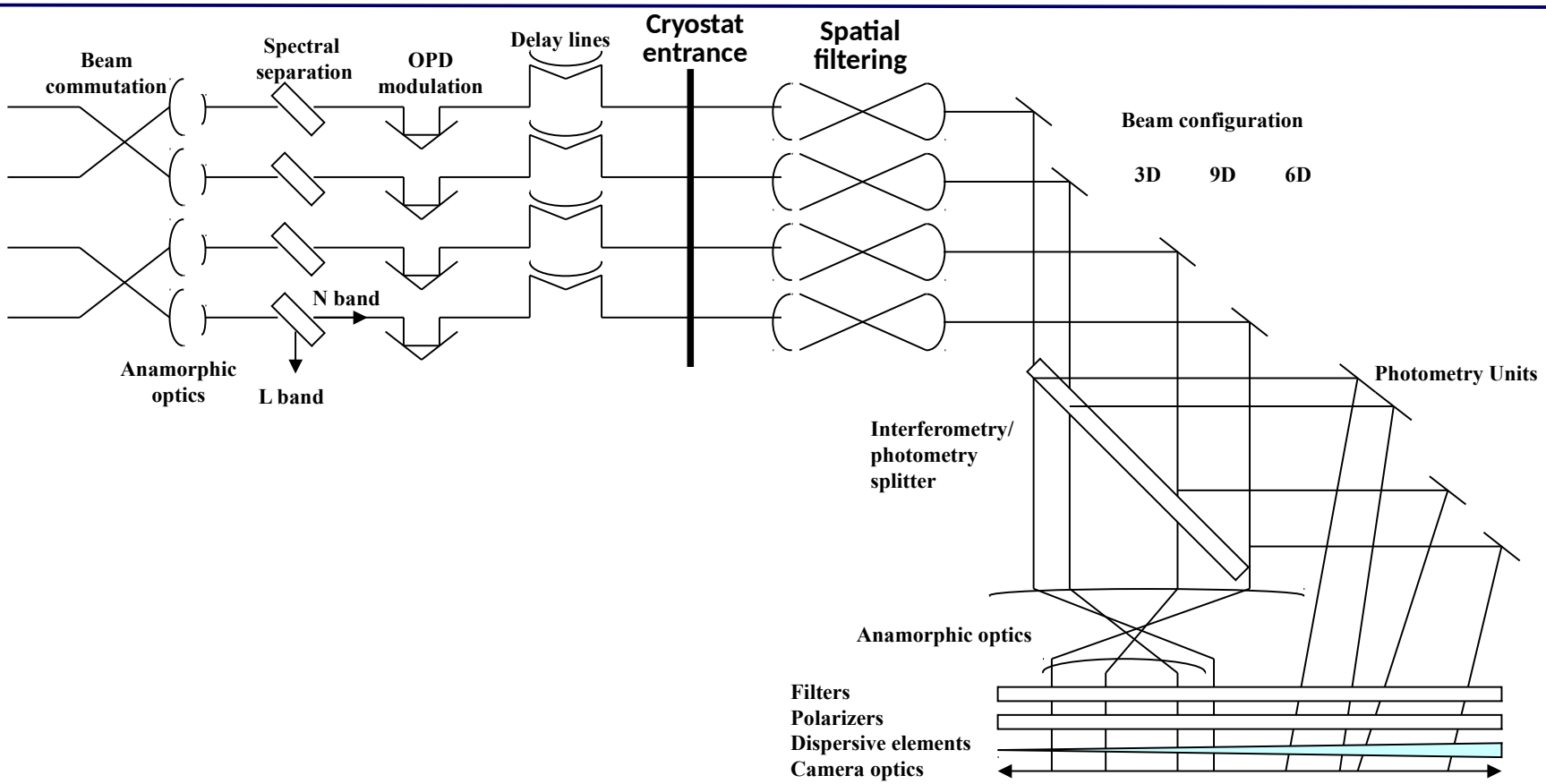
View of the two cryostats and the warm optics table (behind)



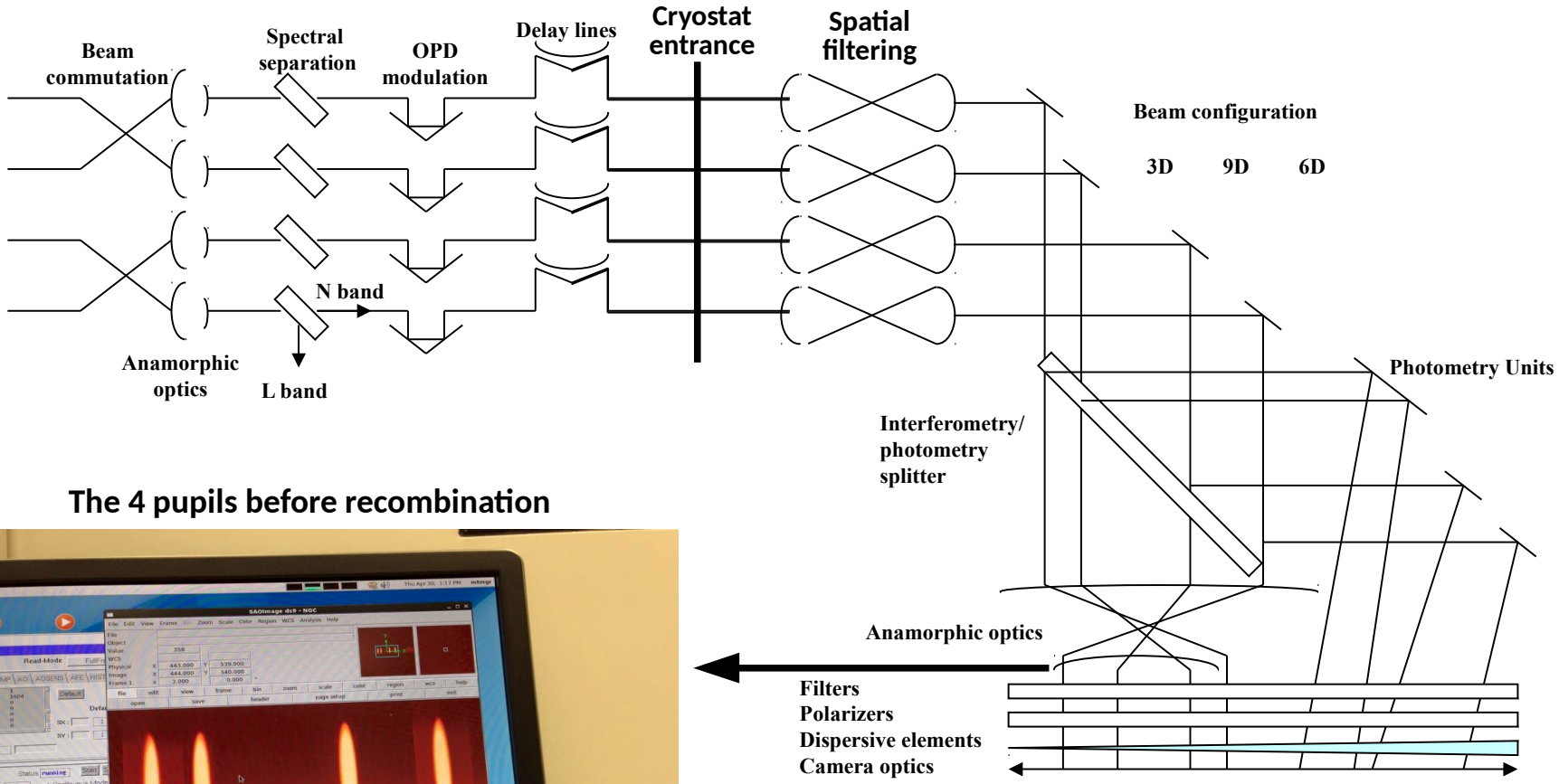
MATISSE in the VLTI focal lab



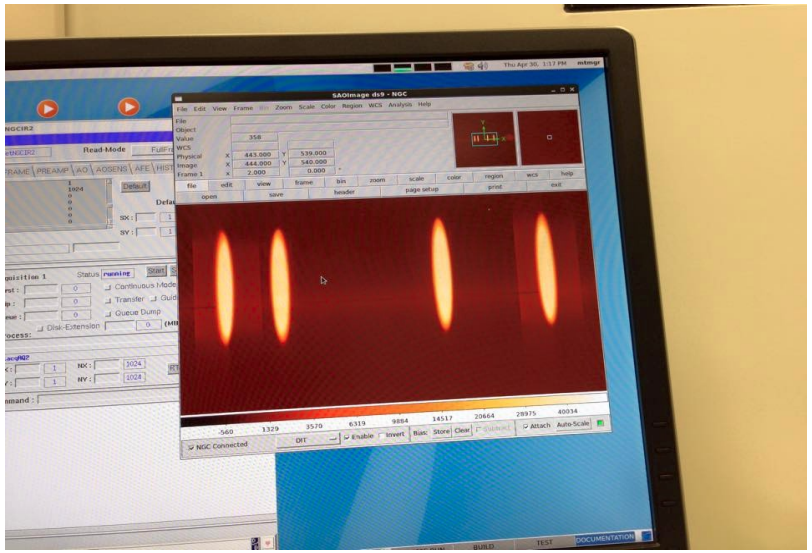
MATISSE design



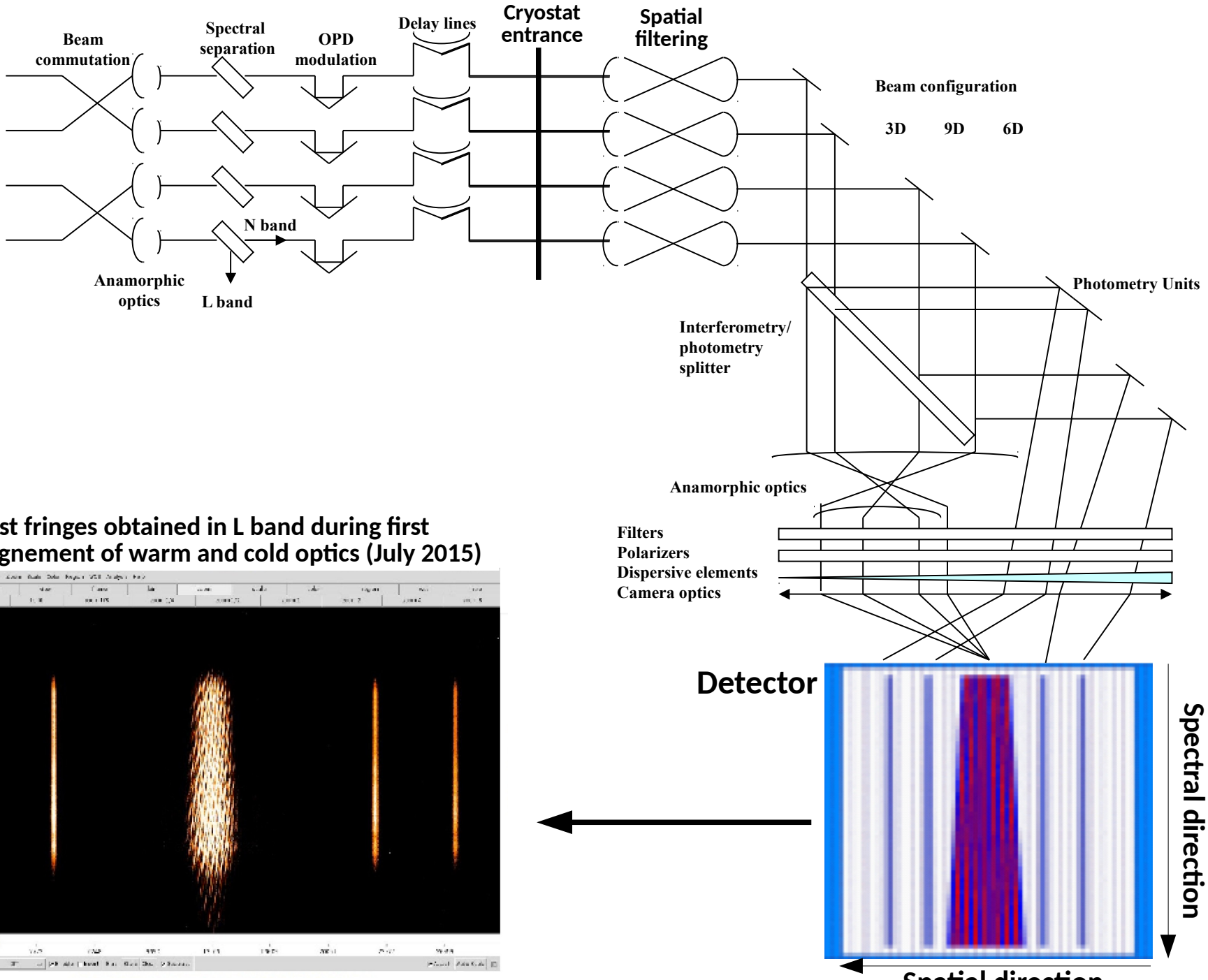
MATISSE design



The 4 pupils before recombination

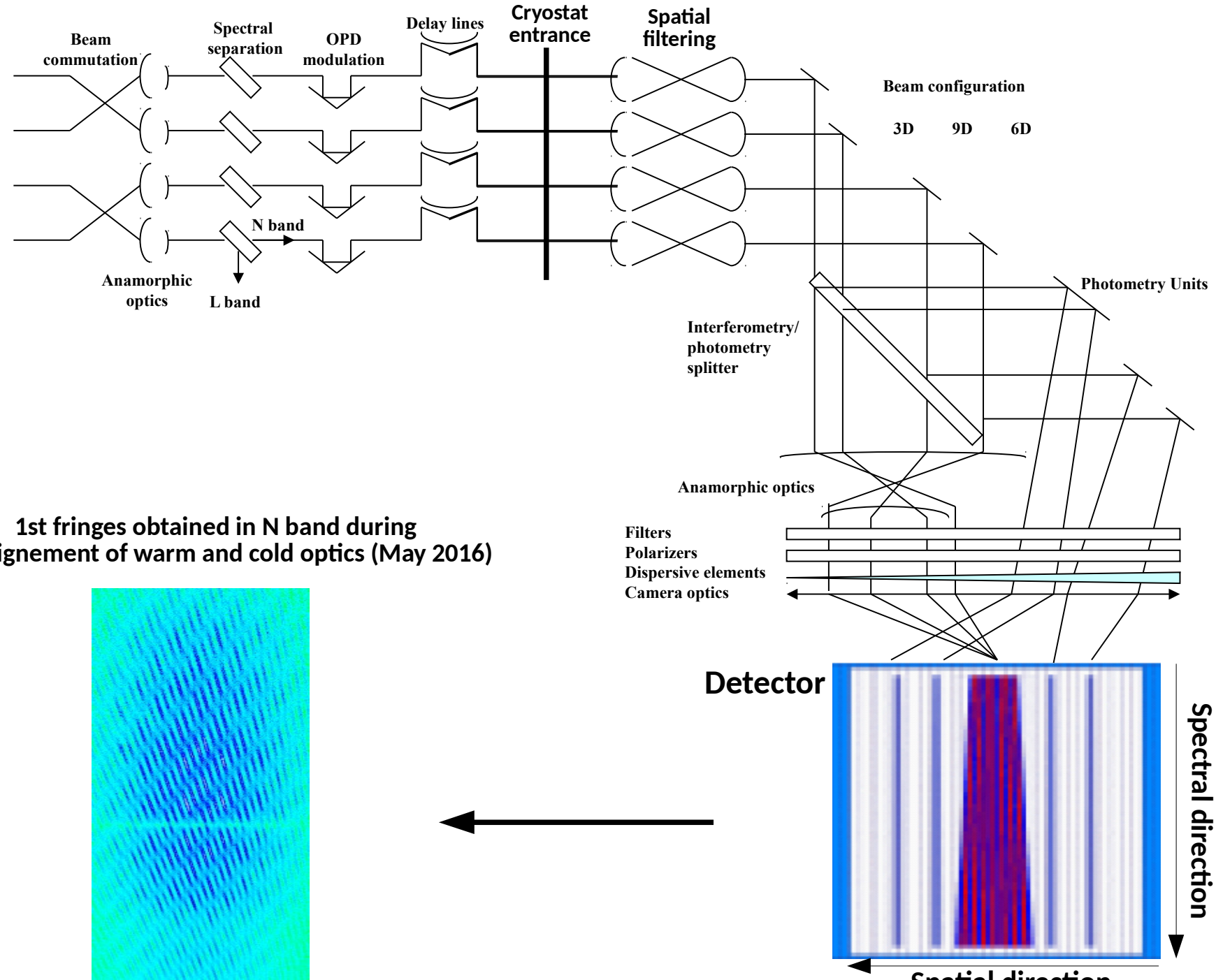


MATISSE interferometric signal



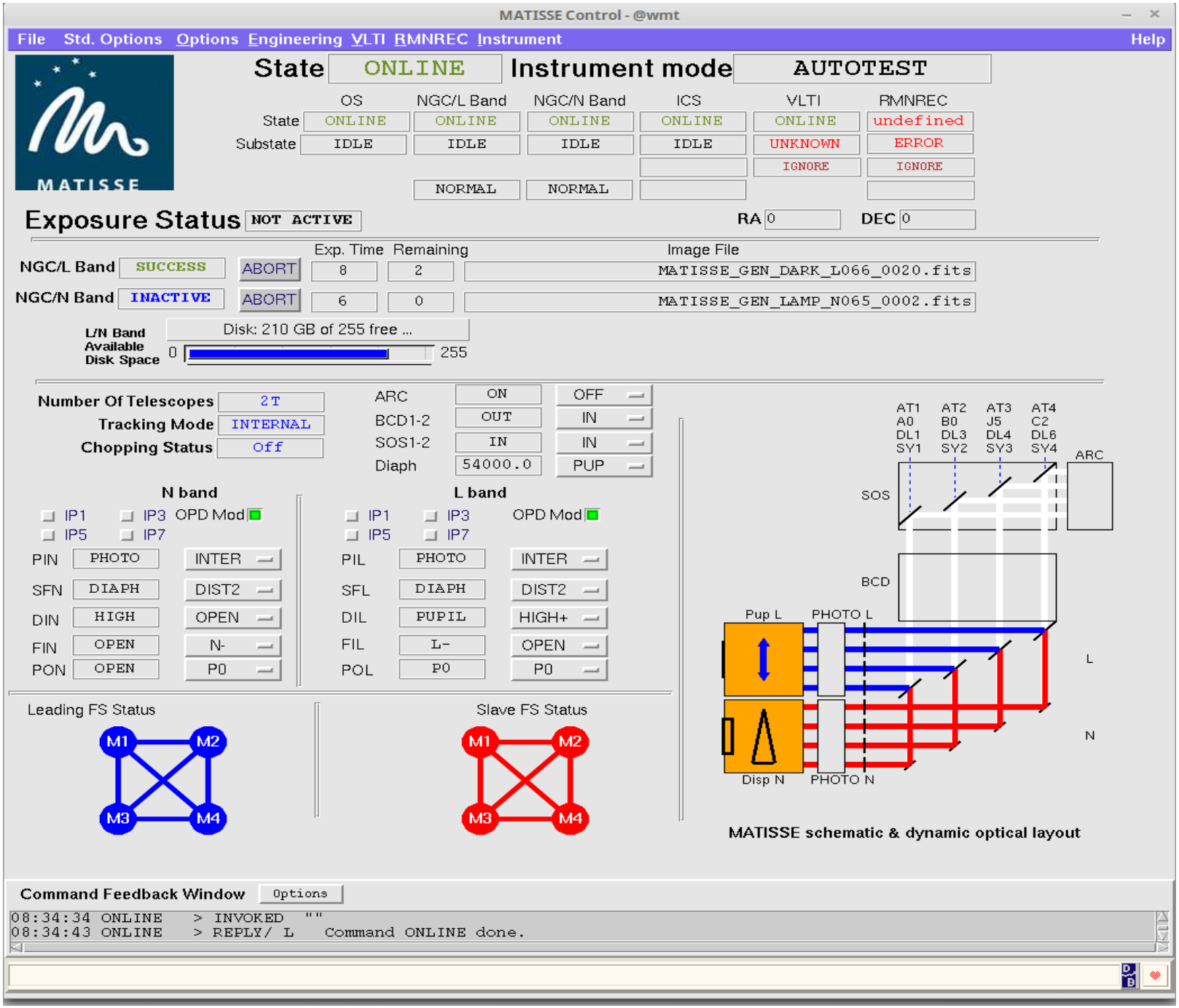
1st fringes obtained in L band during first co-alignement of warm and cold optics (July 2015)

MATISSE interferometric signal

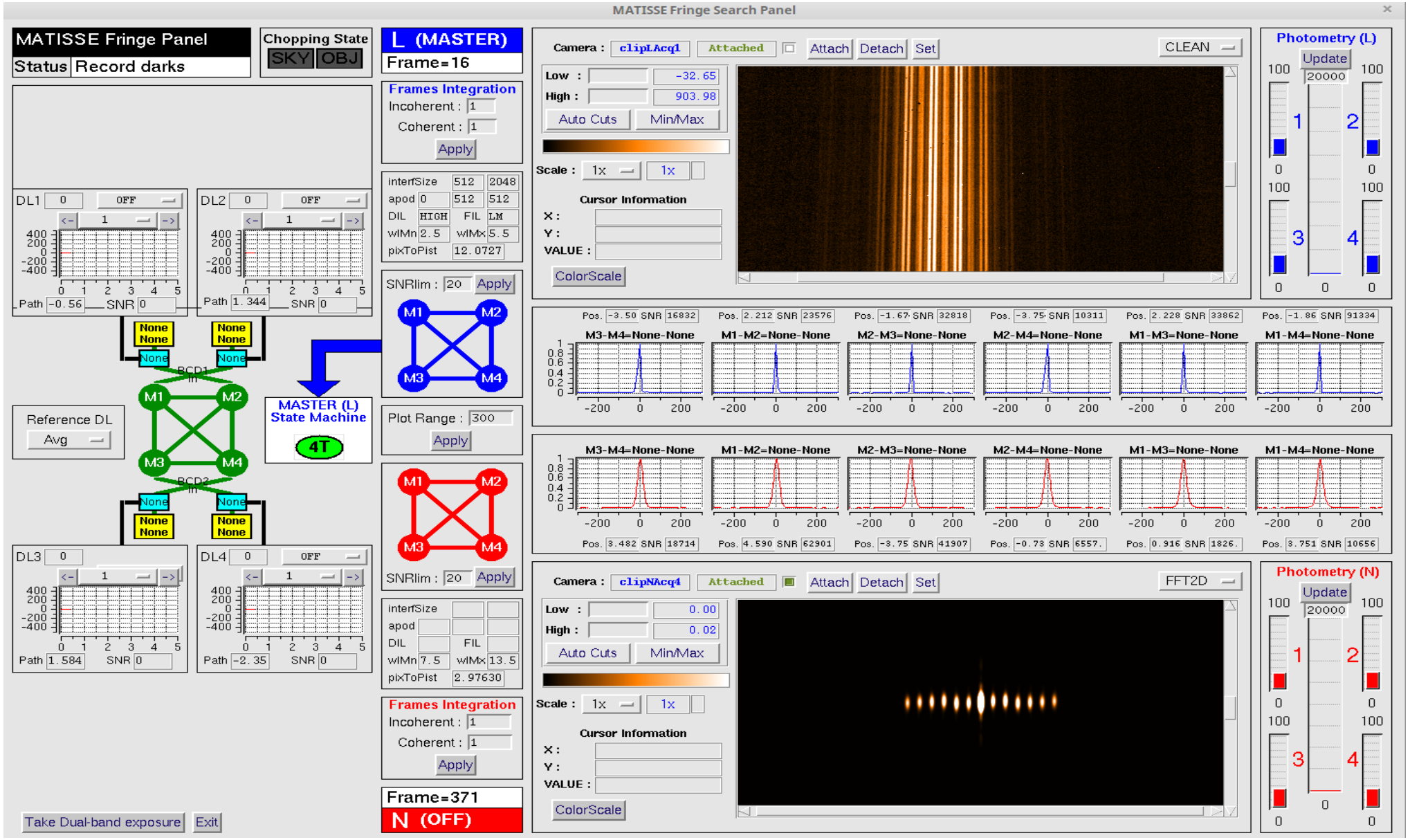


1st fringes obtained in N band during co-alignement of warm and cold optics (May 2016)

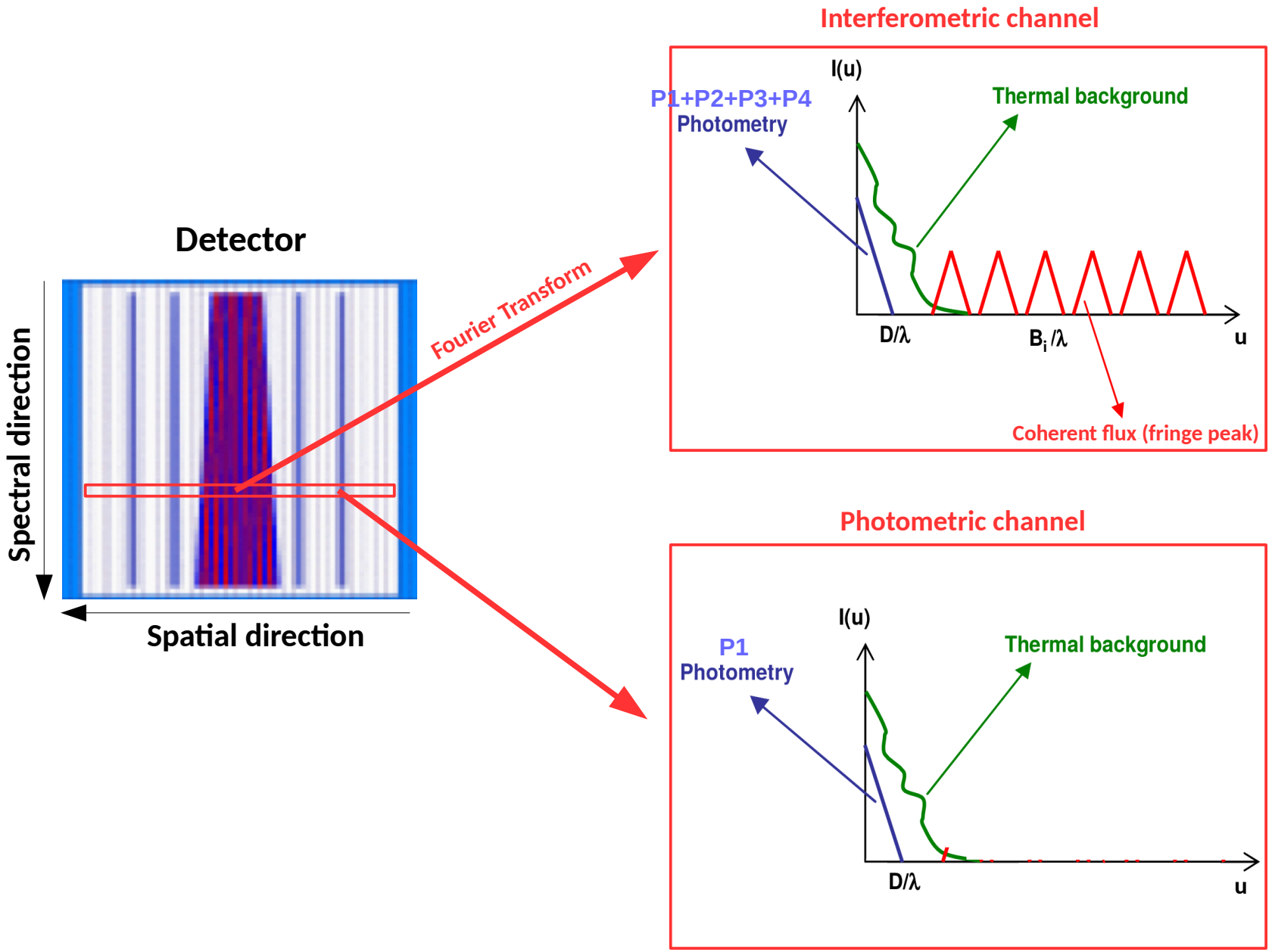
MATISSE control interface



MATISSE fringe panel

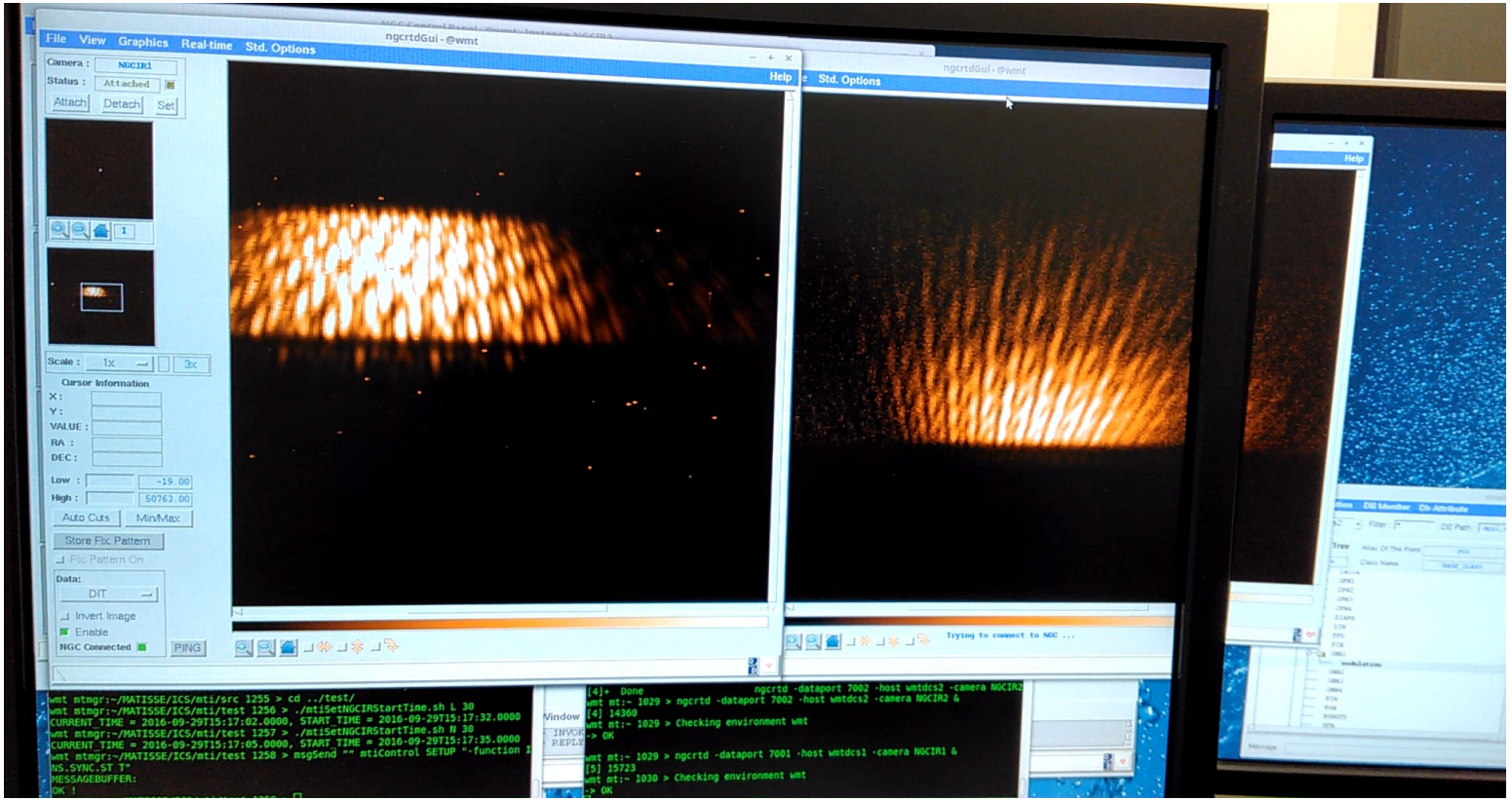


MATISSE interferometric signal



MATISSE temporal OPD modulation

First tests of the OPD modulation devices (piezo-electric motors) in Sept 2016



Expected performances (pre-PAE)

MATISSE performance analysis report, ESO document, 2012

Sensitivity performances (Low Spectral Resolution)

	L band sensitivity (Si_Phot)		N band sensitivity (High_Sens)	
	Without FT	With FT (DIT=300ms)	Without FT	With FT (Obs=10s)
AT	2.95 Jy (L=5)	0.55 Jy (L=6.8)	11.6 Jy (N=1.25)	0.7 Jy (N=4.3)
UT	0.26 Jy (L=7.6)	0.05 Jy (L=9.5)	0.9 Jy (N=4)	0.12 Jy (N=6.2)

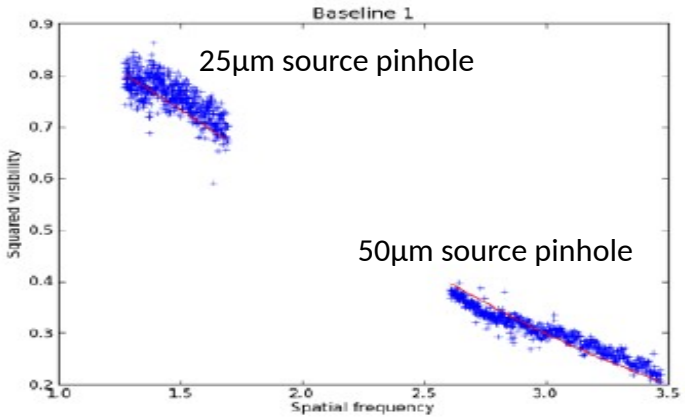
Accuracy performances (15min obs, 20 Jy source, Low Spectral Resolution, SiPhot mode, no fringe tracker)

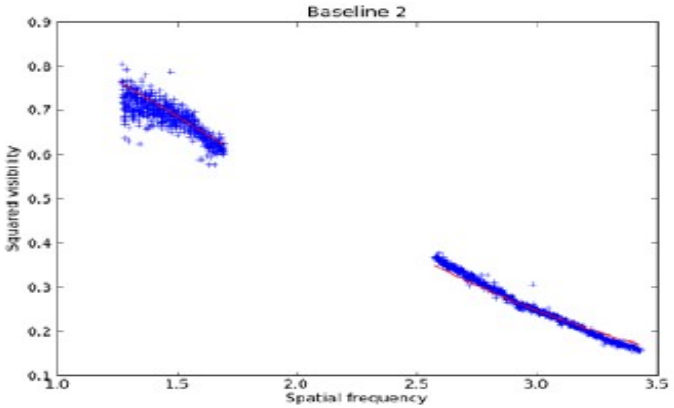
Observable		L-band	N-band
Visibility	AT	≤ 1.6 % (Goal : 2.5 %)	≤ 8.6 % (Goal : 10 %)
	UT	≤ 2.3 % (Goal : 2.5 %)	≤ 5.7 % (Goal : 2.5 %)
Closure phase	AT	≤ 20 mrad	≤ 28 mrad
	UT	≤ 20 mrad	≤ 17 mrad
Differential visibility	AT	≤ 1 % (Goal : 1 %)	≤ 8.4 % (Goal : 10 %)
	UT	≤ 0.5 % (Goal : 0.5 %)	≤ 1.5 % (Goal : 2 %)
Differential phase	AT	≤ 19 mrad	≤ 26 mrad
	UT	≤ 22 mrad	≤ 25 mrad

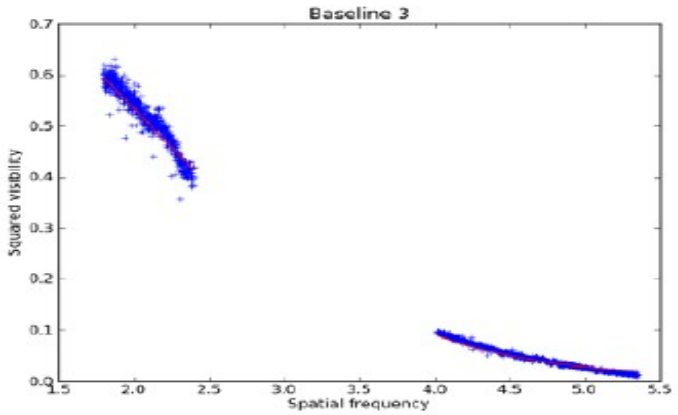
Lab performances (PAE) : instrumental contrast

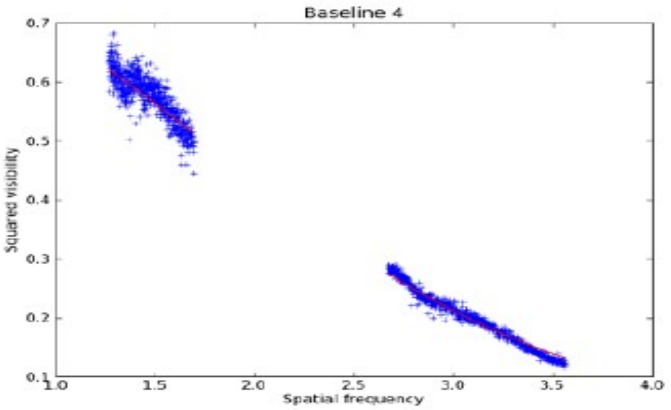
MATISSE Instrument Performance Report
PAE document, 2017

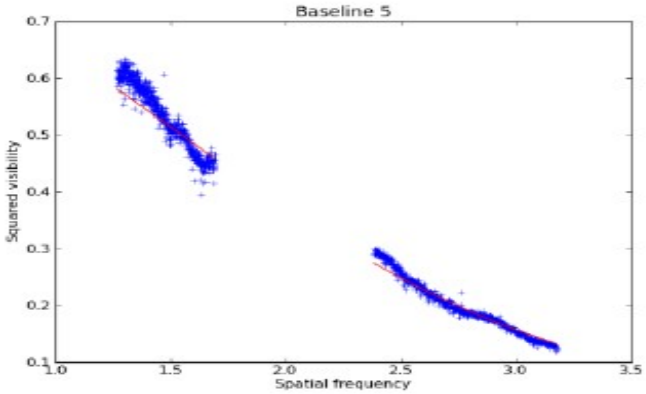
L band instrumental visibility

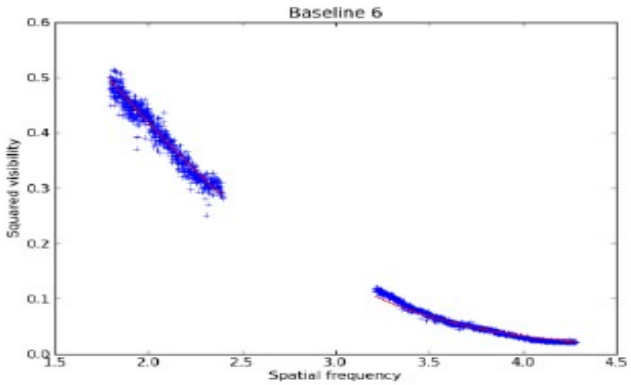












Lab performances (PAE) : instrumental contrast

MATISSE Instrument Performance Report, PAE document, 2017

Item #	Name	Specification	Section	Results	Compliance
SP-10	Instrumental contrast L (most favorable polarization)	≥ 0.6 (0.5 at the edges of the band)	2.3.1	≥ 0.89 ± 0.01 (center) ≥ 0.86 ± 0.05 (edges)	C
SP-11	Instrumental contrast N (most favorable polarization)	≥ 0.6 (0.5 at the edges of the band)	2.3.1	≥ 0.83 ± 0.02 (center) ≥ 0.69 ± 0.02 (edges)	C

L band

- Instrumental contrast ≥ 0.89 ('center' → between 3 and 4 µm)
- Instrumental contrast ≥ 0.86 ('edges' → between 3 and 3.2 µm)

N band

- Instrumental contrast ≥ 0.83 ('center' → between 9.75 and 10 µm)
- Instrumental contrast ≥ 0.69 ('edges' → between 8 and 8.25 µm)

Lab performances (PAE) : flux stability

MATISSE Instrument Performance Report, ESO document, 2017

Item #	Name	Specification	Section	Results	Compliance
SP-39	Flux measurement L band	Accuracy ≤ 1% Stability (30mn) ≤ 2%	2.8	≤ 0.007% ≤ 0.42%	C
SP-40	Flux measurement M band	Accuracy ≤ 1% Stability (30mn) ≤ 2%	2.8	≤ 0.017% ≤ 0.28%	C
SP-41	Flux measurement N band	Accuracy ≤ 1% Stability (30mn) ≤ 2%	2.8	≤ 0.28% ≤ 2%	C

'Flux' = mean flux of the 4 beams, which is then 'band-integrated'

L band

- **Accuracy ≤ 0.01 %** (standard deviation within an exposure ~ 15s)
- **Stability ≤ 0.4 %** (standard deviation within exposures separated by 30 min)

N band

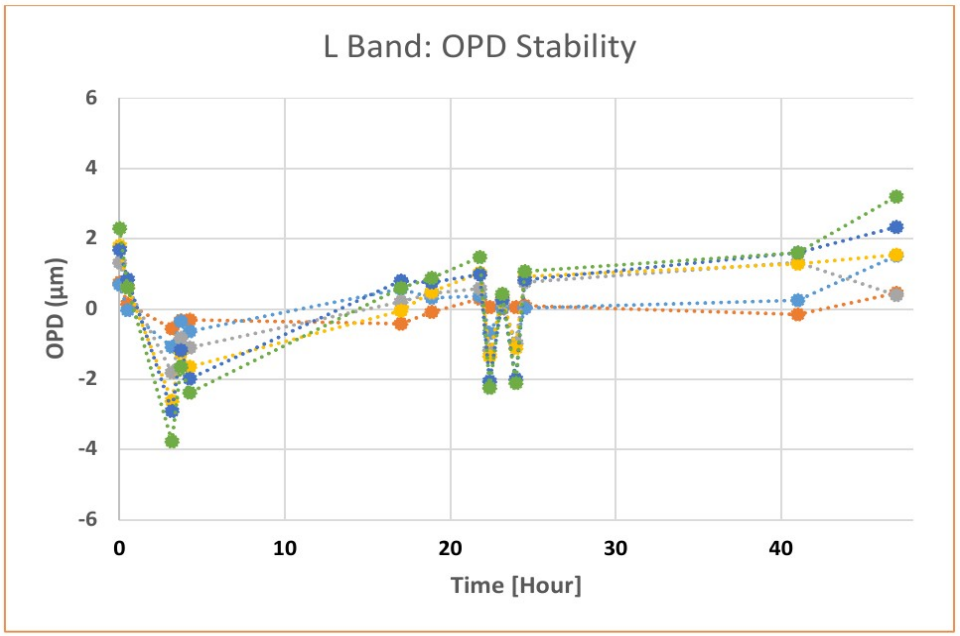
- **Accuracy ≤ 0.28 %** (standard deviation within an exposure ~ 15s)
- **Stability ≤ 2 %** (standard deviation within exposures separated by 30 min)

Lab performances (PAE) : OPD stability

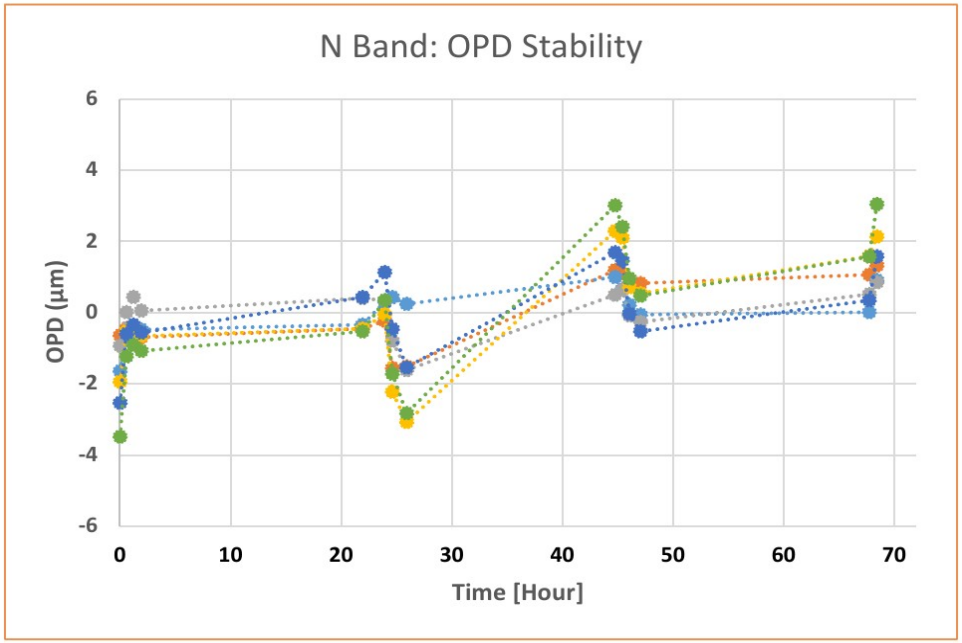
MATISSE Instrument Performance Report, PAE document, 2017

Item #	Name	Specification	Section	Results	Compliance
SP-32	OPD stability over 30 min L	≤ 7 µm	2.4	≤ 3 µm PTV	C
SP-33	OPD stability over 30 min N	≤ 11 µm	2.4	≤ 3 µm PTV	C
SP-34	OPD stability over 8h L	≤ 100 µm	2.4	≤ 8 µm PTV	C
SP-35	OPD stability over 8h N	≤ 300 µm	2.4	≤ 8 µm PTV	C

OPD stability in LM band during 2 days



OPD stability in N band during 3 days



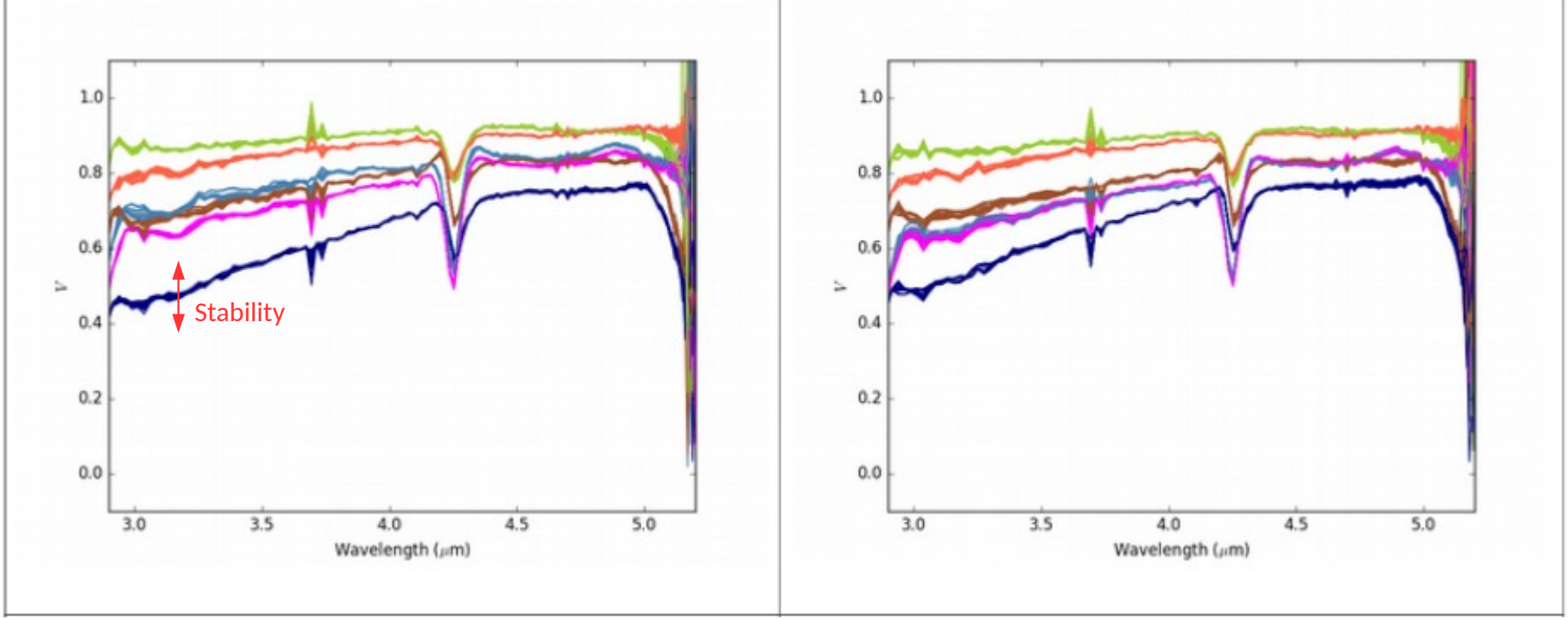
Lab performances (PAE) : visibility

MATISSE Instrument Performance Report, PAE document, 2017

	Requirements	Results	Conformity
L-band	≤ 7.5 % (goal 2.5%)	≤ 0.5%	C
M-band	-	≤ 0.4%	
N-band	≤ 7.5 % (goal 2.5%)	≤ 2.5%	C

LM band Visibility

BCD OUT	BCD IN
Visibility	



Lab performances (PAE) : visibility

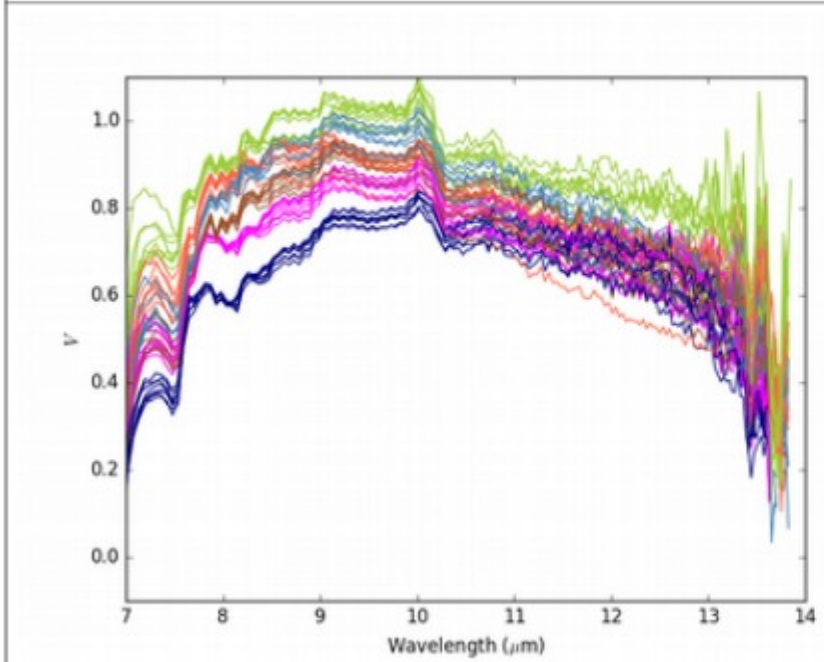
MATISSE Instrument Performance Report, PAE document, 2017

	Requirements	Results	Conformity
L-band	≤ 7.5 % (goal 2.5%)	≤ 0.5%	C
M-band	-	≤ 0.4%	
N-band	≤ 7.5 % (goal 2.5%)	≤ 2.5%	C

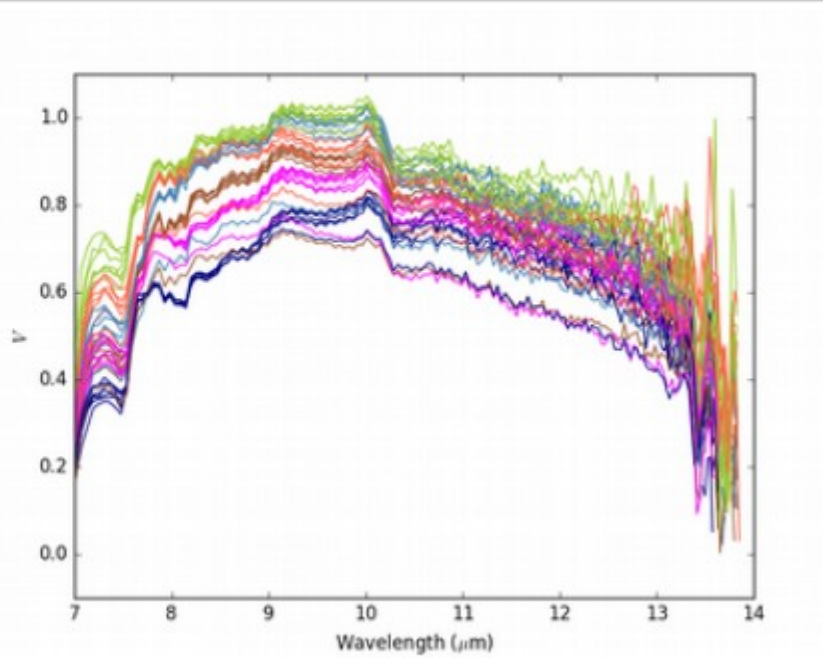
N band Visibility

Visibility (with OPD modulation)

BCD OUT



BCD IN



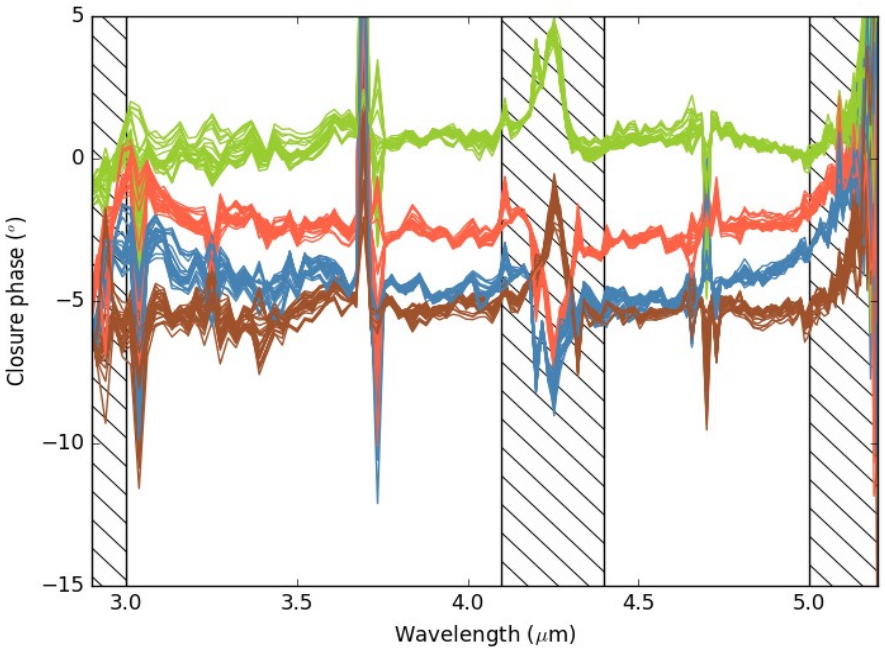
Lab performances (PAE) : closure phase

MATISSE Instrument Performance Report, PAE document, 2017

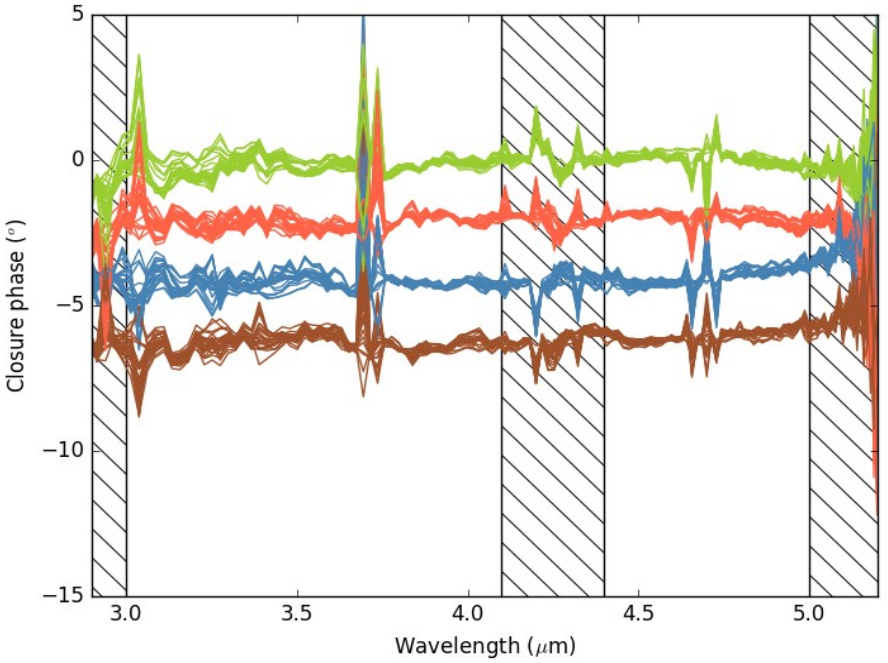
	Requirements	Results	Conformity
L-band	≤ 40 mrad (≤ goal 1 mrad)	≤ 5.2 mrad (0.30°)	C
M-band	-	≤ 2.6 mrad (0.15°)	
N-band	≤ 40 mrad (≤ goal 1 mrad)	≤ 5.8 mrad (0.33°)	C

LM band Closure phase

BCD_in



BCD_out – BCD_in

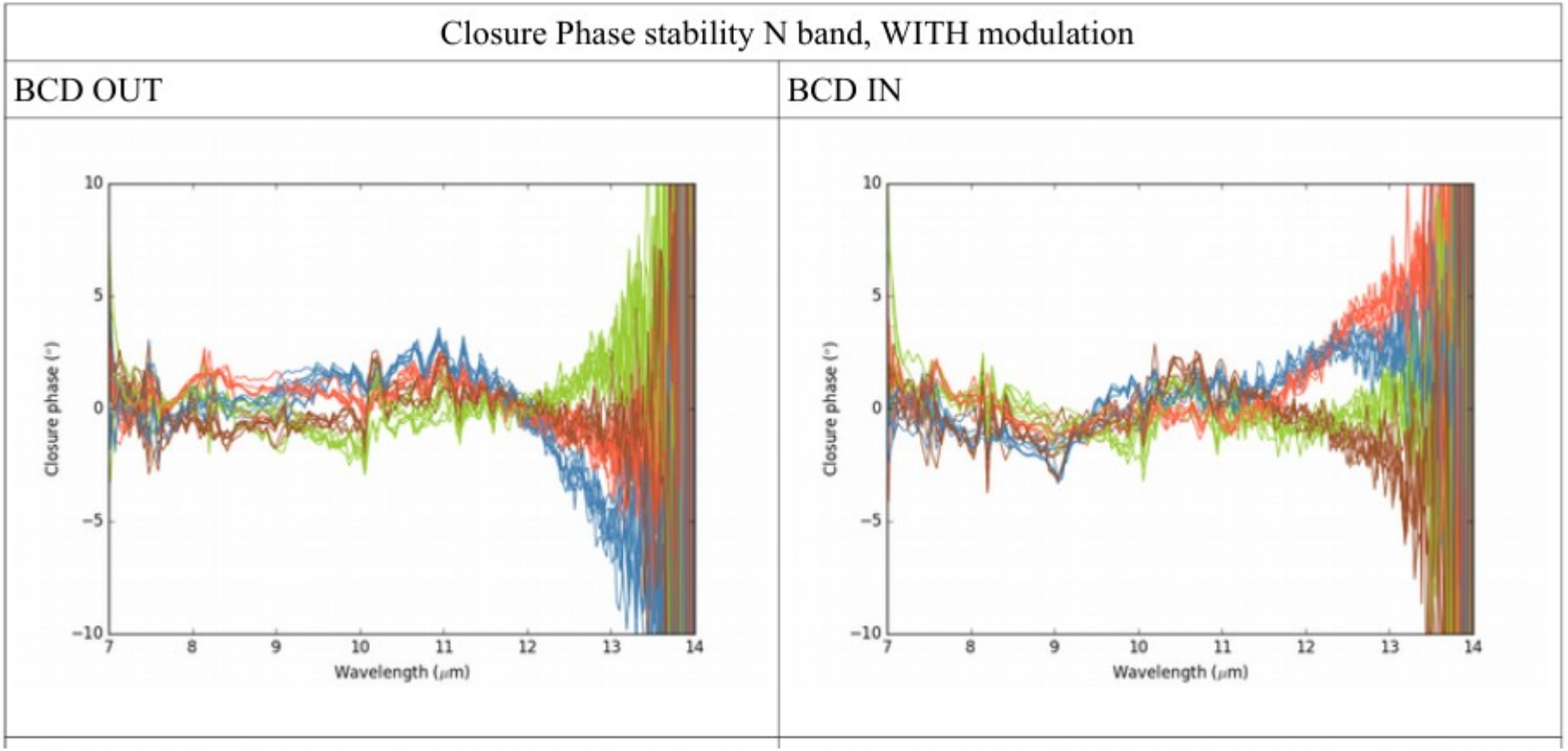


Lab performances (PAE) : closure phase

MATISSE Instrument Performance Report, PAE document, 2017

	Requirements	Results	Conformity
L-band	≤ 40 mrad (≤ goal 1 mrad)	≤ 5.2 mrad (0.30°)	C
M-band	-	≤ 2.6 mrad (0.15°)	
N-band	≤ 40 mrad (≤ goal 1 mrad)	≤ 5.8 mrad (0.33°)	C

N band Closure phase



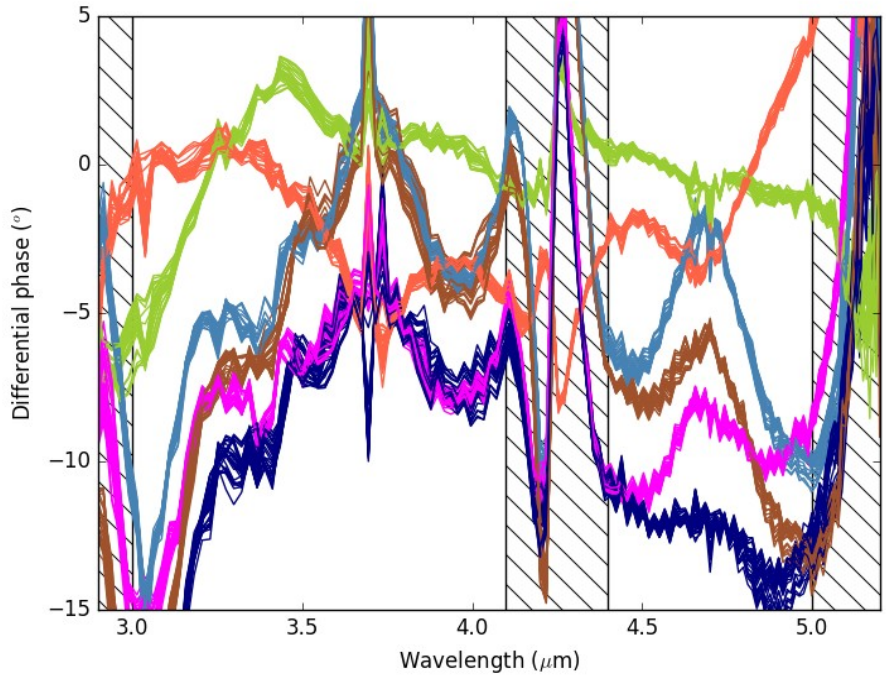
Lab performances (PAE) : differential phase

MATISSE Instrument Performance Report, PAE document, 2017

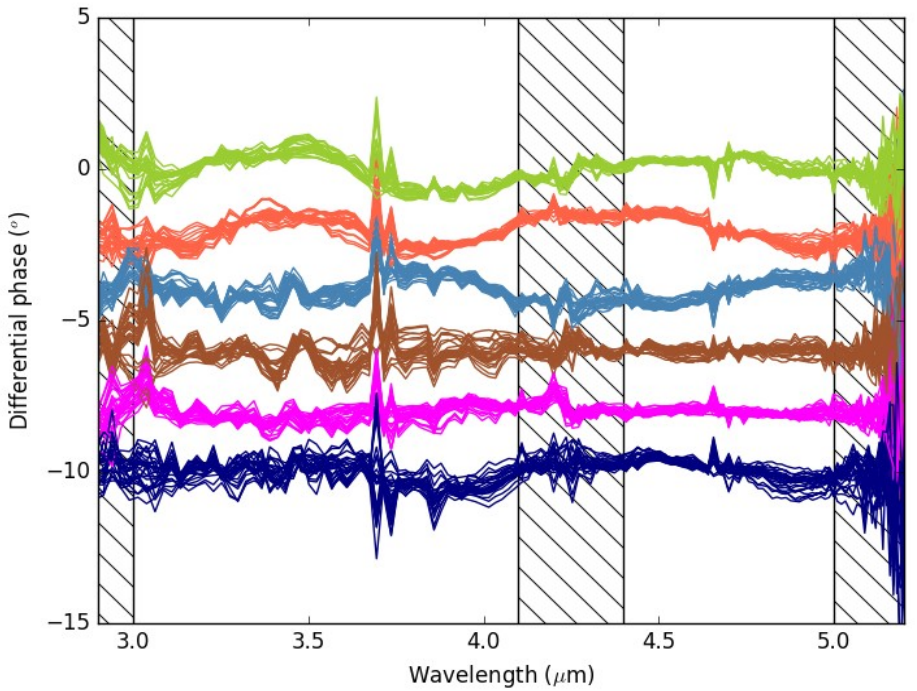
	Requirements	Results	Conformity
L-band	≤ 30 mrad (≤ goal 1 mrad)	≤ 6.6 mrad (0.38°)	C
M-band	-	≤ 1.7 mrad (0.10°)	
N-band	≤ 30 mrad (≤ goal 1 mrad)	≤ 4.4 mrad (0.25°)	C

LM band Differential phase

BCD_in



BCD_out – BCD_in

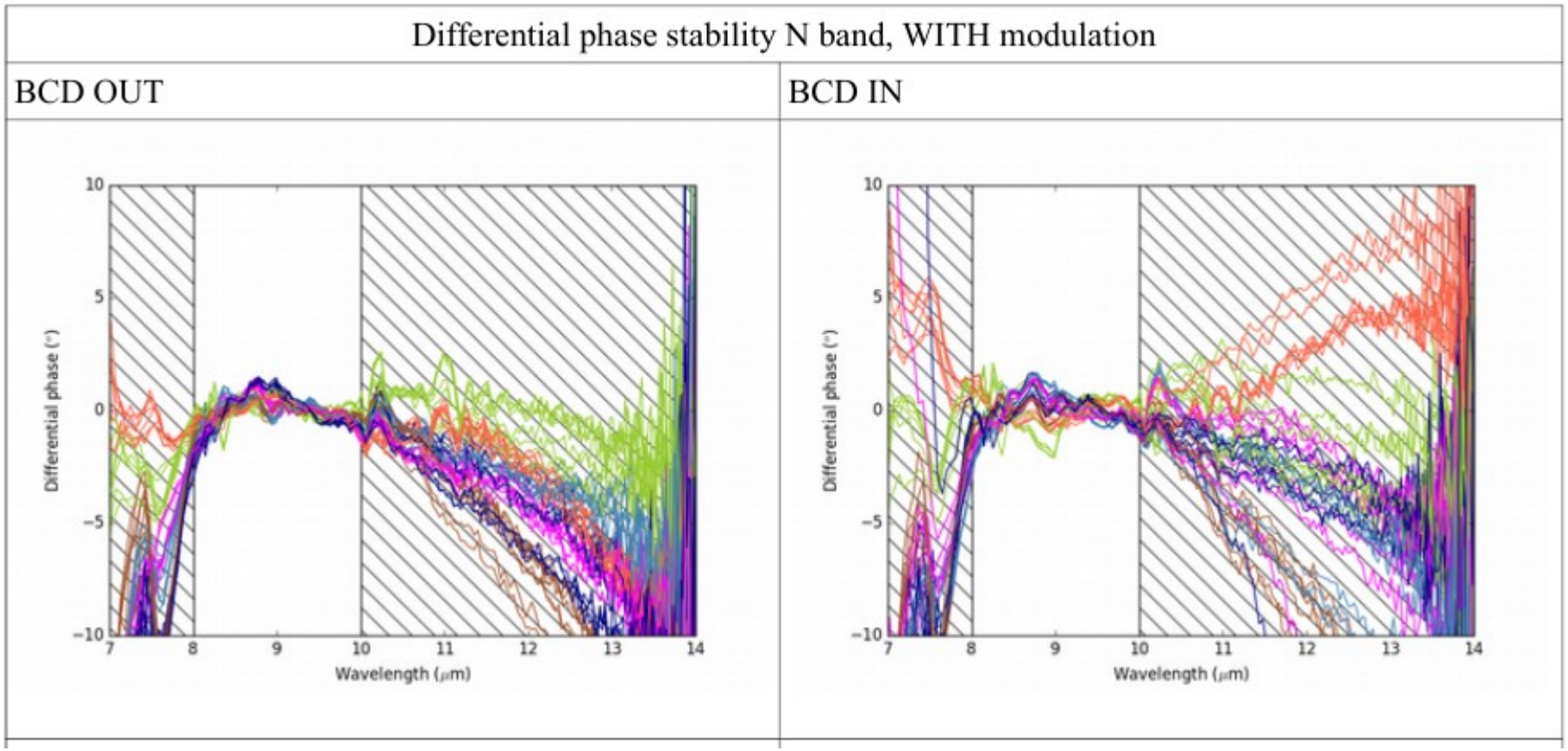


Lab performances (PAE) : differential phase

MATISSE Instrument Performance Report, PAE document, 2017

	Requirements	Results	Conformity
L-band	≤ 30 mrad (≤ goal 1 mrad)	≤ 6.6 mrad (0.38°)	C
M-band	-	≤ 1.7 mrad (0.10°)	
N-band	≤ 30 mrad (≤ goal 1 mrad)	≤ 4.4 mrad (0.25°)	C

N band Differential phase



Lab performances (PAE) : differential visibility

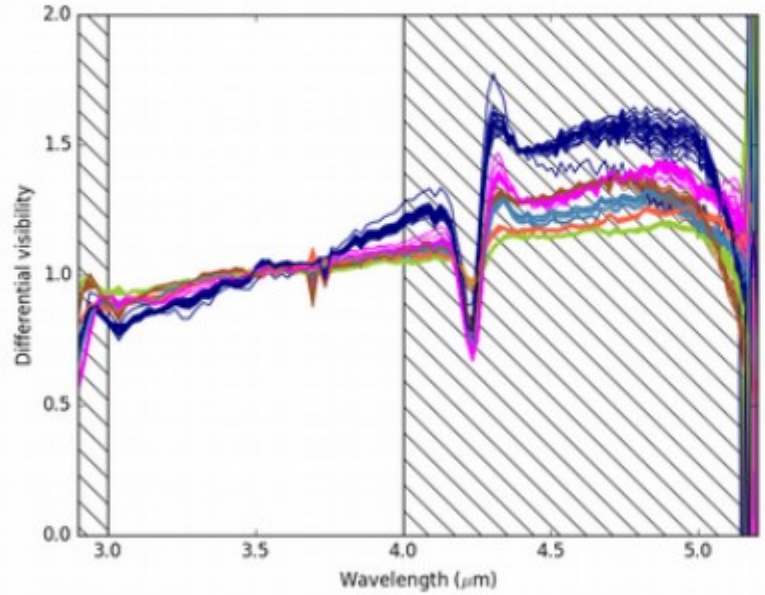
MATISSE Instrument Performance Report, PAE document, 2017

	Requirements	Results	Conformity
L-band	≤ 1.5% (≤ goal 0.5%)	≤ 1.35%	C
M-band	-	≤ 1.8%	
N-band	≤ 5% (goal ≤ 2%)	≤ 0.9%	C

L band Differential visibility

Differential visibility stability L band

BCD OUT



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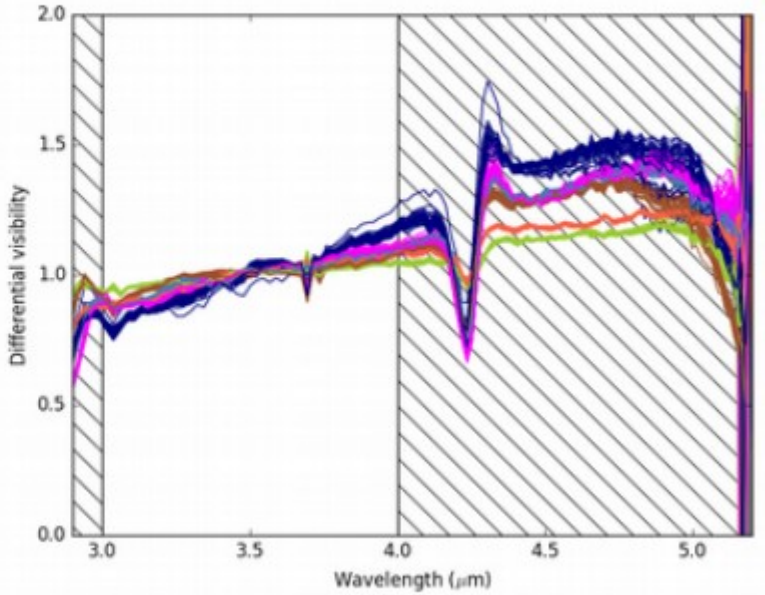


Lab performances (PAE) : differential visibility

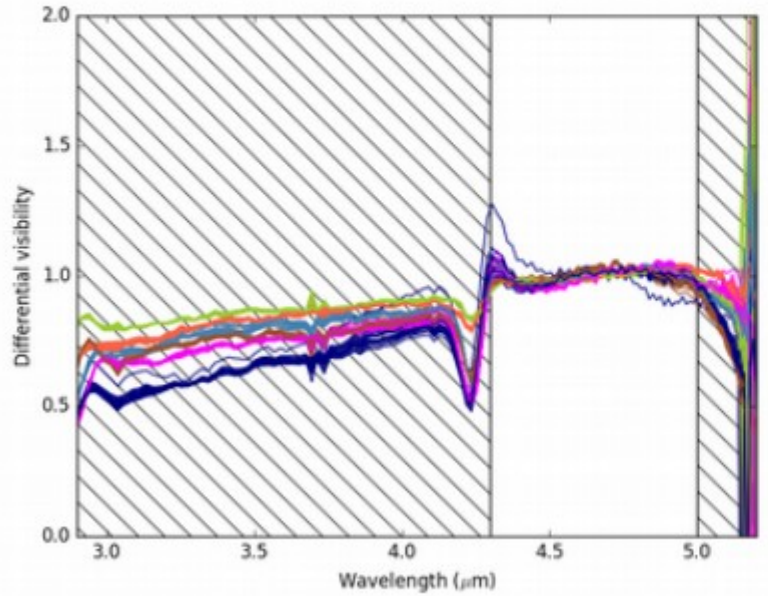
MATISSE Instrument Performance Report, PAE document, 2017

	Requirements	Results	Conformity
L-band	≤ 1.5% (≤ goal 0.5%)	≤ 1.35%	C
M-band	-	≤ 1.8%	
N-band	≤ 5% (goal ≤ 2%)	≤ 0.9%	C

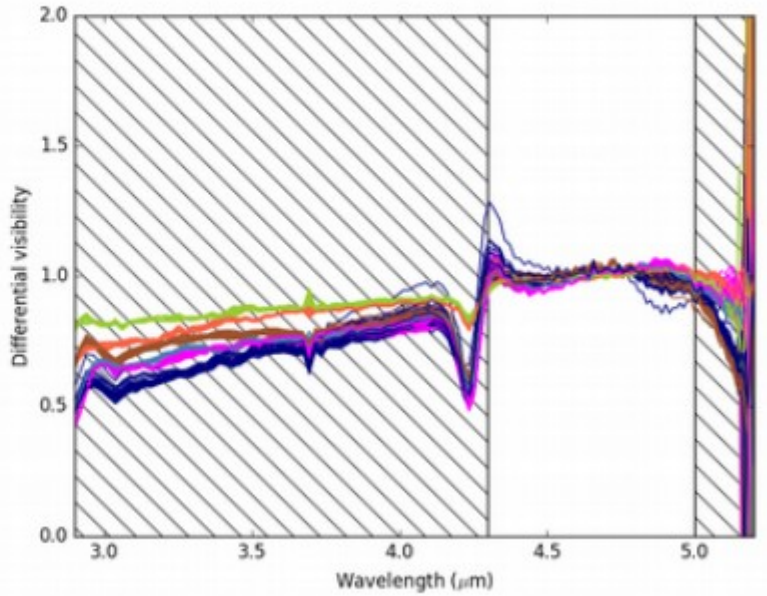
M band Differential visibility

Differential visibility stability M band

BCD OUT



BCD IN



Lab performances (PAE) : differential visibility

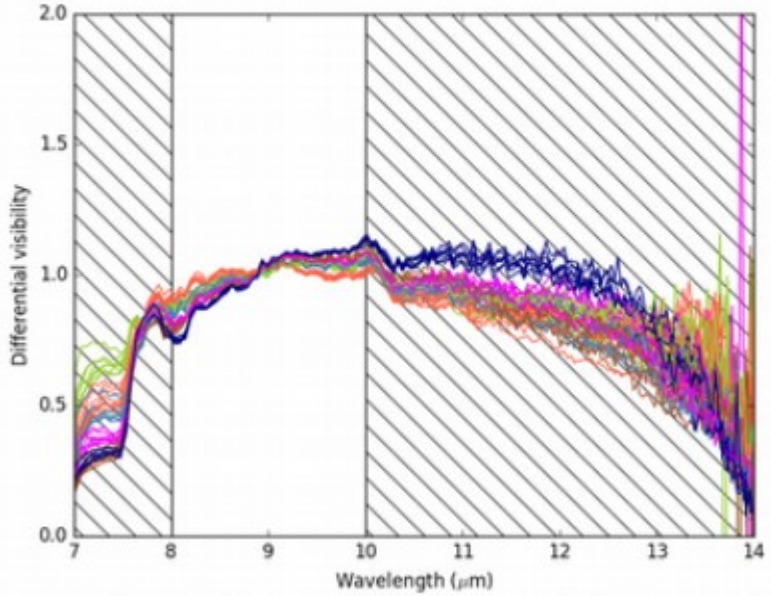
MATISSE Instrument Performance Report, PAE document, 2017

	Requirements	Results	Conformity
L-band	≤ 1.5% (≤ goal 0.5%)	≤ 1.35%	C
M-band	-	≤ 1.8%	
N-band	≤ 5% (goal ≤ 2%)	≤ 0.9%	C

N band Differential visibility

Differential visibility stability N band, WITH modulation

BCD OUT



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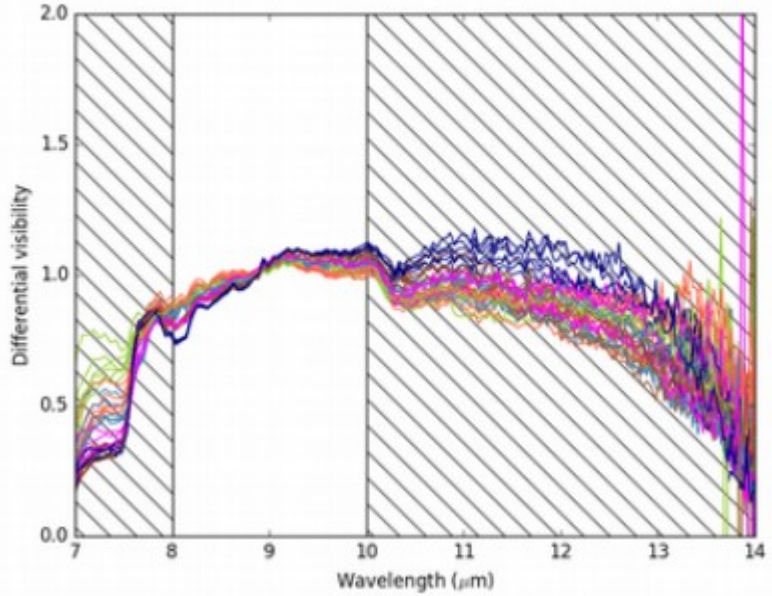
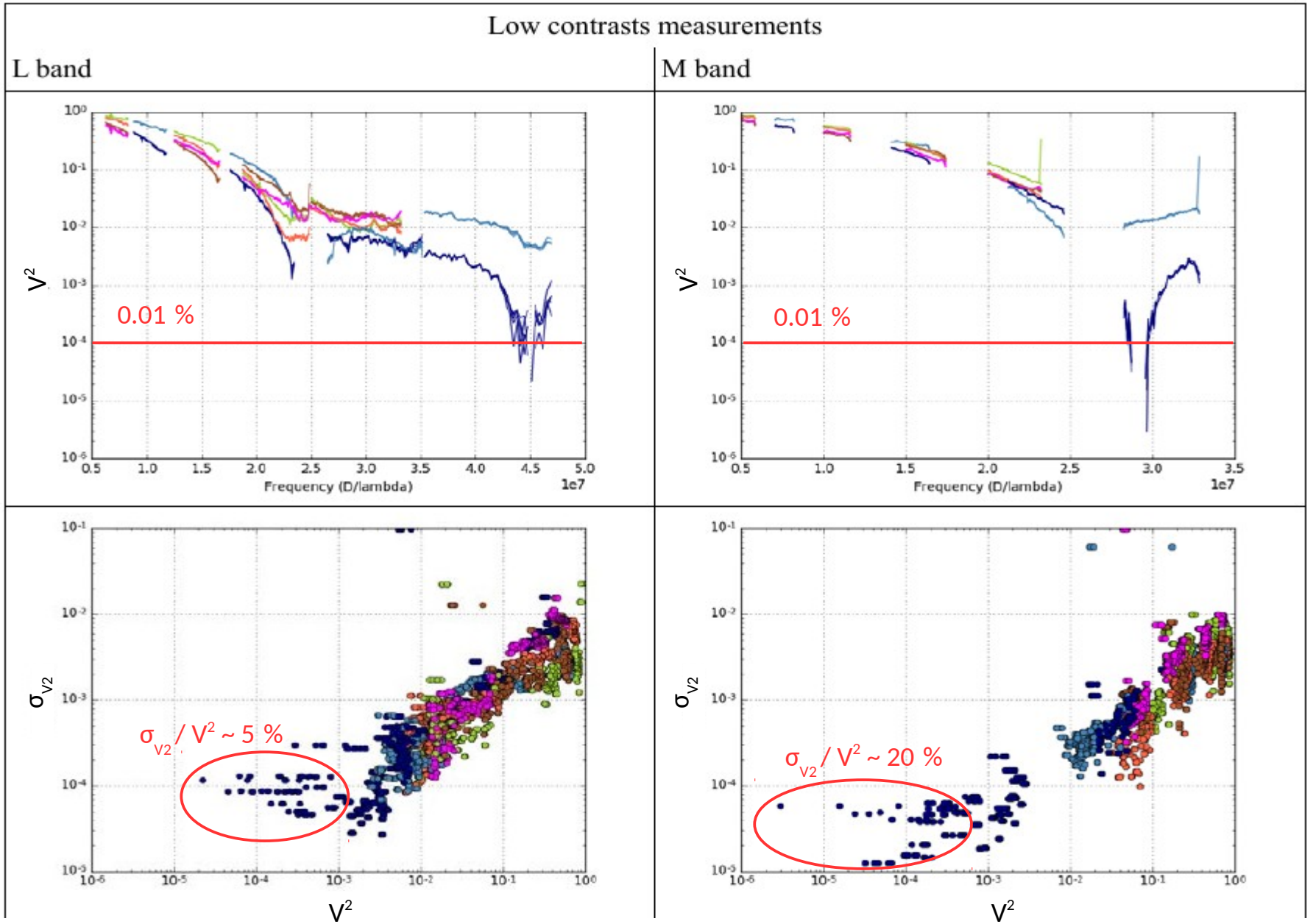


Lab performances (PAE) : Low contrast values

MATISSE Instrument Performance Report, PAE document, 2017



MATISSE PAE documents

MATISSE PAE documents numbering (issues and dates)

General documents			
Document code number	**Document Name**	**Issue**	**Date**
VLT-LIS-MAT-15860-9001	MATISSE Configuration Item Data List	11 New issue	24.05.2017
VLT-PLA-MAT-15860-9003	MATISSE Project Management Plan	8 New issue	24.05.2017
VLT-ICD-MAT-15860-9005	MATISSE Internal Interface Control Document	7 New issue	24.05.2017
VLT-ICD-MAT-15860-9006	Interface Control Document between MATISSE and VLTI	10 New issue	24.05.2017
VLT-MAN-MAT-15860-9009	MATISSE Operating Manual	4 New issue	24.05.2017
VLT-MAN-MAT-15860-9010	MATISSE User Manual	Draft 1 New issue	24.05.2017
VLT-PLA-MAT-15860-9020	MATISSE Commissioning Plan	2 New issue	24.05.2017
VLT-MAN-MAT-15860-9021	MATISSE Maintenance Manual and Spare Parts List	2 New issue	24.05.2017
VLT-LIS-MAT-15860-9022	MATISSE Mechanical Drawing List	2 Same issue than the one presented at the readiness review	10.11.2016
VLT-MAN-MAT-15860-9025	MATISSE Transport Specifications	2 New issue	24.05.2017
VLT-XXX-ESO-15860-XXXX	MATISSE Verification Matrix	2 New issue	24.05.2017
Quality, Safety, Reliability documents			
Document code number	**Document Name**	**Issue**	**Date**
VLT-TRE-MAT-15860-9033	MATISSE Hazard Analysis	5 Same issue than the one presented at the readiness review	10.11.2016
VLT-TRE-MAT-15860-9034	MATISSE Reliability Analysis	4 New issue	24.05.2017
VLT-TRE-MAT-15860-9036	MATISSE Safety Compliance Assessment	4 New issue	24.05.2017
Integration, Test documents			
Document code number	**Document Name**	**Issue**	**Date**
VLT-PLA-MAT-15860-9050	MATISSE Manufacturing, Assembly, Integration and Test Plan	6 Same issue than the one presented at the readiness review	31.07.2012
VLT-PLA-MAT-15860-9051	MATISSE On-site Assembly Plan	9 New issue	24.05.2017
VLT-MAN-MAT-15860-9053	MATISSE Optical Alignment Manual	1 New issue	24.05.2017
Hardware sub-system documents			
Document code number	**Document Name**	**Issue**	**Date**
VLT-TRE-MAT-15860-9102	MATISSE Design and Performance Report: Optics (Warm Optics)	5 Same issue than the one presented at the readiness review	10.11.2016
VLT-TRE-MAT-15860-9103	MATISSE Design and Performance Report: Cryostats	5 Same issue than the one presented at the readiness review	10.11.2011
VLT-TRE-MAT-15860-9104	MATISSE Design and Performance Report: Electronics	3.11 Same issue than the one presented at the readiness review	29.09.2016
VLT-TRE-MAT-15860-9112	MATISSE Design and Performance Report: Mechanics (Warm Optics)	5 Same issue than the one presented at the readiness review	31.08.2016
Test and Inspection Reports			
Document code number	**Document Name**	**Issue**	**Date**
VLT-TRE-MAT-15860-9130	MATISSE Test and Inspection Report: Electronics	2 New issue	24.05.2017
VLT-TRE-MAT-15860-9131	MATISSE Test and Inspection Report: Cryostats	2 New issue	24.05.2017
VLT-TRE-MAT-15860-9132	MATISSE Test and Inspection Report: Cold Optics	2 New issue	24.05.2017
VLT-TRE-MAT-15860-9133	MATISSE Test and Inspection Report: Detectors	2 New issue	24.05.2017
VLT-TRE-MAT-15860-9134	MATISSE Test and Inspection Report: Warm Optics	2 New issue	24.05.2017
VLT-TRE-MAT-15860-9135	MATISSE Instrument Performance Report	2 New issue	24.05.2017
Control Software documents			
Document code number	**Document Name**	**Issue**	**Date**
VLT-MAN-MAT-15860-9205	MATISSE Instrument Software User and Maintenance Manual	2 New issue	24.05.2017
VLT-MAN-MAT-15860-9206	MATISSE Template Manual	5 New issue	24.05.2017
VLT-PLA-MAT-15860-9208	MATISSE Instrument Software Acceptance Test Plan	2 New issue	24.05.2017
Data Reduction Software documents			
Document code number	**Document Name**	**Issue**	**Date**
VLT-PLA-MAT-15860-9306	MATISSE Data Reduction Library Validation and Test Plan	3 New issue	24.05.2017
VLT-TRE-MAT-15860-9305	MATISSE Data Reduction Library Design	3 New issue	24.05.2017
VLT-TRE-MAT-15860-9304	MATISSE Exposure Time Calculator Specifications	3 New issue	24.05.2017