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Test report on MATISSE ETC / ASPRO 2

ASPRO2 version : 20.01 beta 4

2020.01.31

Introduction

This document presents a comparison between the reference MATISSE ETC with ASPRO2. Only fundamental noises (source photon noise, detector readout noise, thermal background photon noise) are taken into account at the moment. The different SNR and error estimations shown here do not include broadband calibration errors such as the thermal background subtraction errors (affecting especially the non-chopped LM band photometries, and the N-band photometries in general) or the variations of the interferometric transfer function. Such broadband calibration errors will affect the accuracy (e.g., the absolute visibility level) but not the precision of the data. They will be included later.

LM band

Instrumental setup :

Telescopes : ATs
Spectral resolution : LOW_LM
Observing mode : Si_phot
DIT = 111 ms
Exposure time : 4min on interferometry + 4 min on photometry (per beam)

LM-LOW				
Observable (at 3.5 um)	**1 Jy source**		**30 Jy source**	
	MATISSE ETC	**ASPRO2**	**MATISSE ETC**	**ASPRO2**
Squared coherent flux SNR	17	18.5	540	590
Photometry SNR	28	29.5	800	845
Squared visibility SNR	13	14.5	395	425
Closure phase error [deg]	3 °	2.8 °	0.1 °	0.09 °

Case 1 : 1 Jy source (m_L = 6.16)

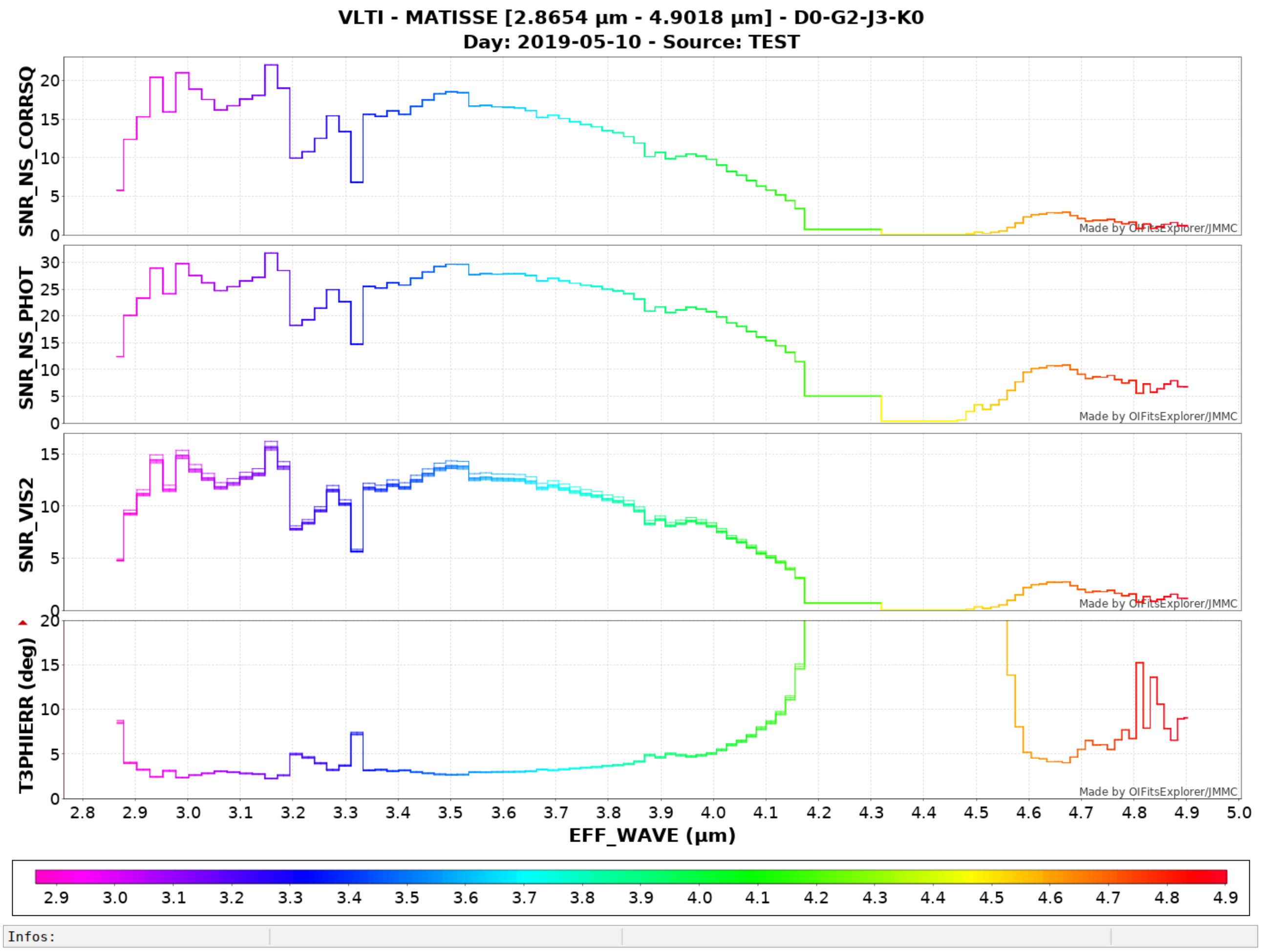


Fig 1: ASPRO2 SNR values. From top to bottom: squared coherent flux, photometry, squared visibility, closure phase & closure phase error

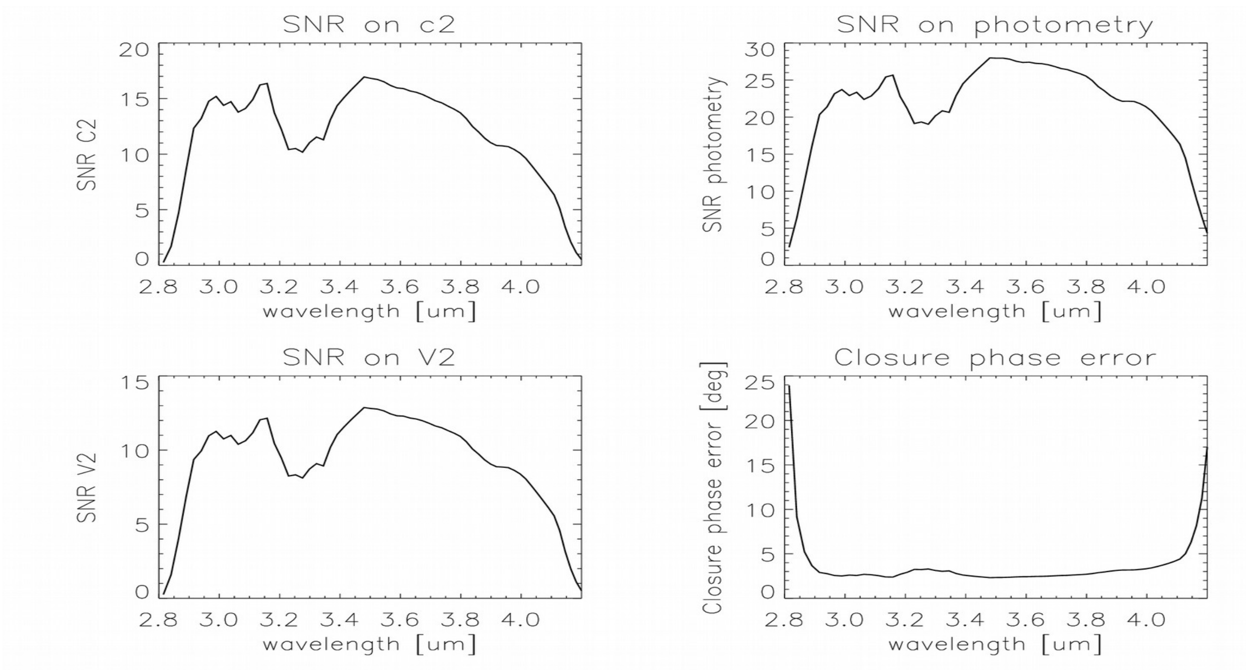


Fig 2: ETC MATISSE SNR values. Top left: squared coherent flux; top right: photometry; bottom left: squared visibility ; bottom right : closure phase error.

Case 2 : 30 Jy source (m_L = 2.45)

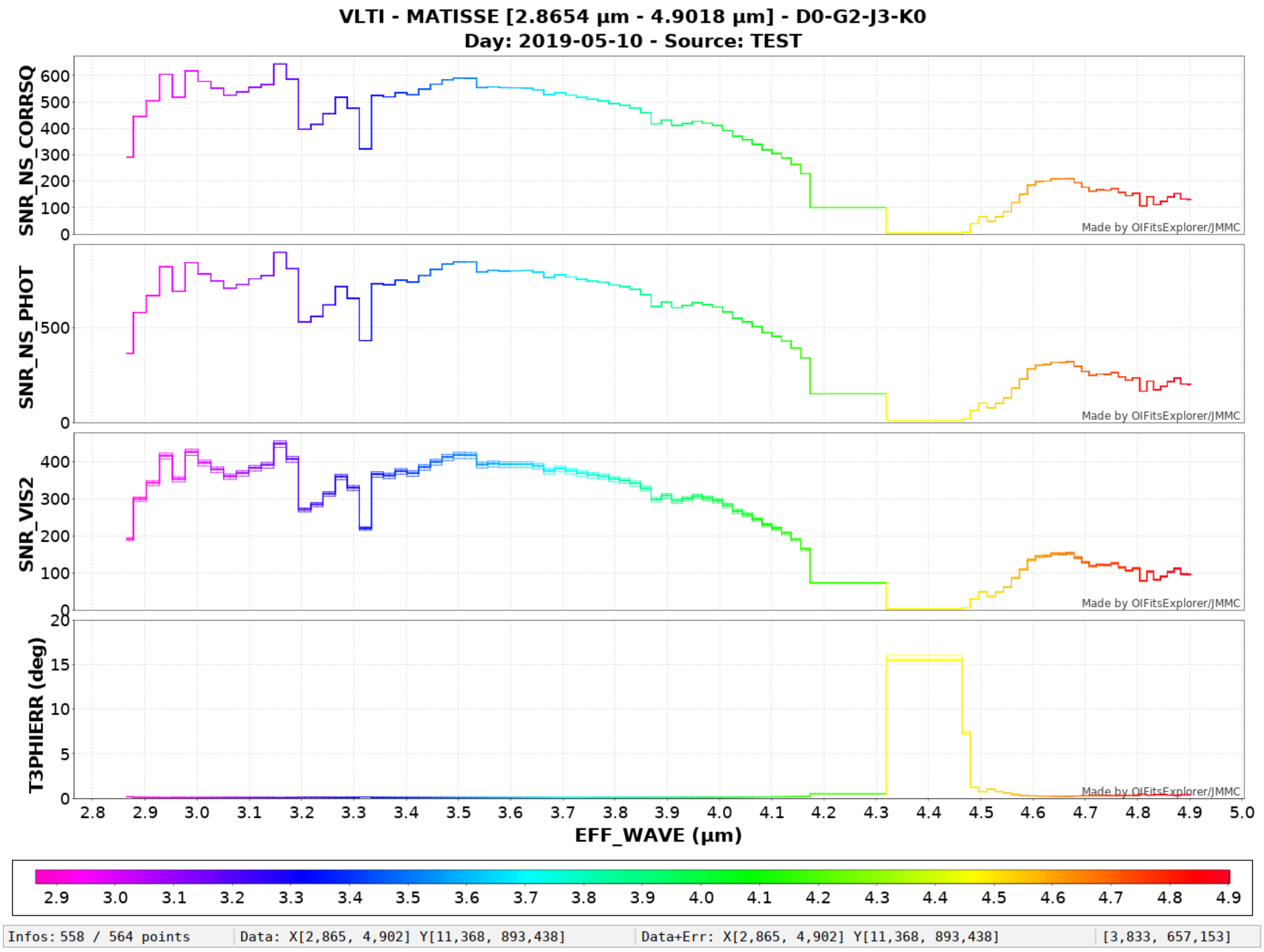


Fig 3: ASPRO2 SNR values. From top to bottom : Squared coherent flux, photometry, squared visibility

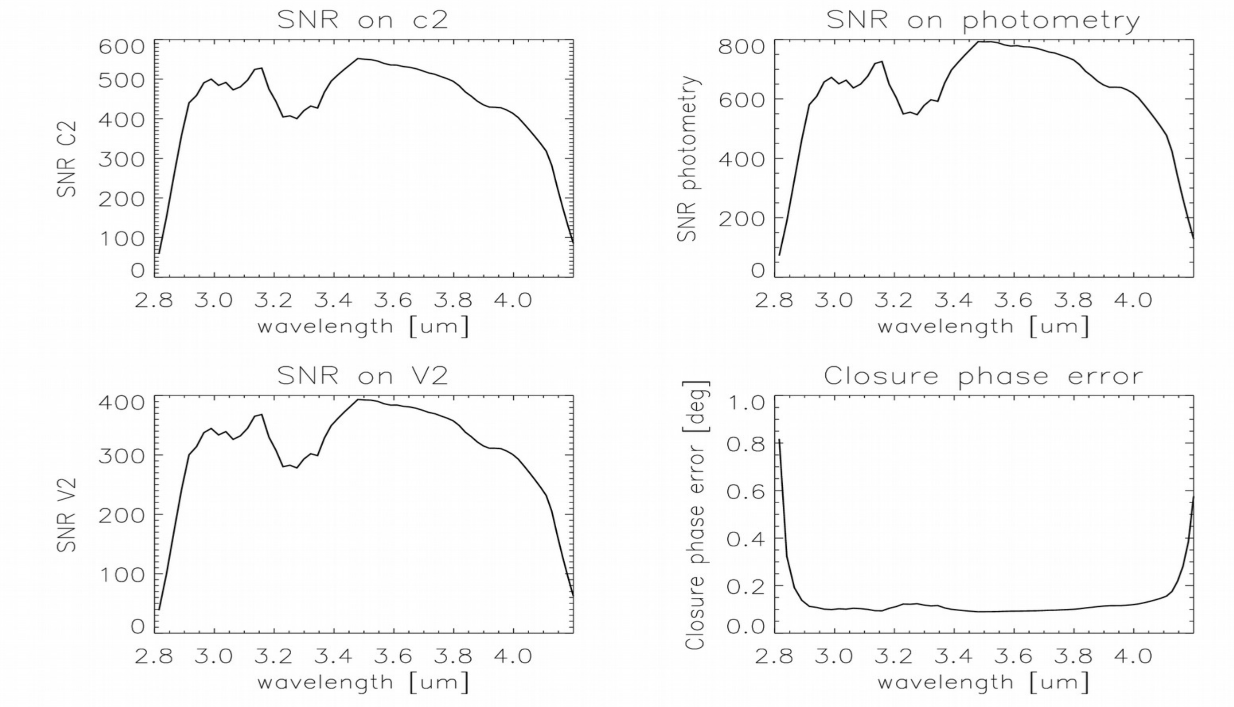


Fig 4: ETC MATISSE SNR values. Top left: squared coherent flux; top right: photometry; bottom left: squared visibility ; bottom right : closure phase error.

Instrumental setup :

Telescopes : ATs
Spectral resolution : MED_LM
Observing mode : Si_phot
DIT = 111 ms
Exposure time : 4min on interferometry + 4 min on photometry (per beam)

LM-MED				
Observable (at 3.5 um)	**30 Jy source**		**100 Jy source**	
	MATISSE ETC	**ASPRO2**	**MATISSE ETC**	**ASPRO2**
Squared coherent flux SNR	33	33	115	
Photometry SNR	41	41.6	135	
Squared visibility SNR	22	22.6	72	
Closure phase error [deg]	1.5 °	1.5 °	0.5 °	

Case 1 : 30 Jy source (m_L = 2.45)

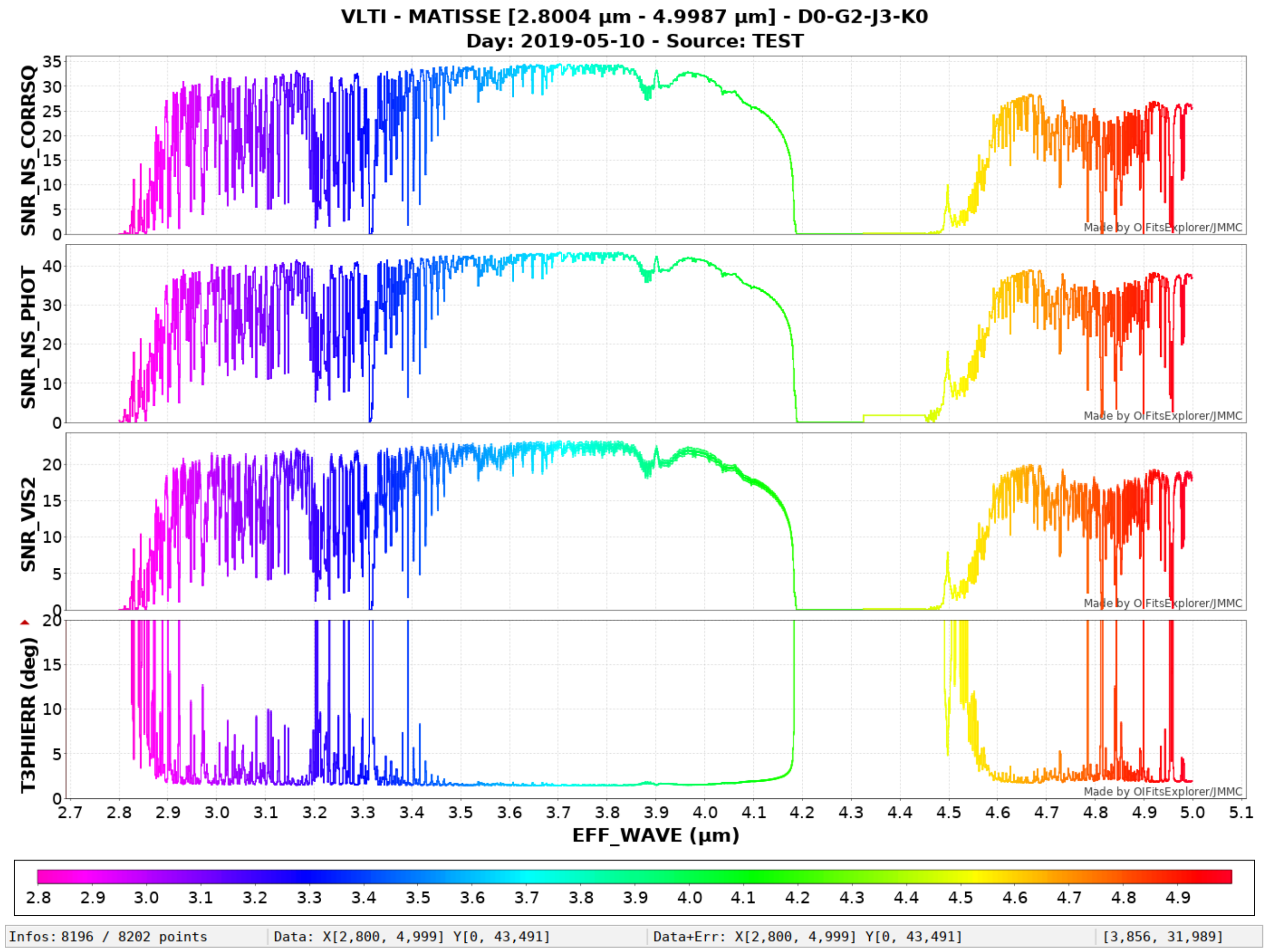


Fig 5: ASPRO2 SNR values. From top to bottom : Squared coherent flux, photometry, squared visibility

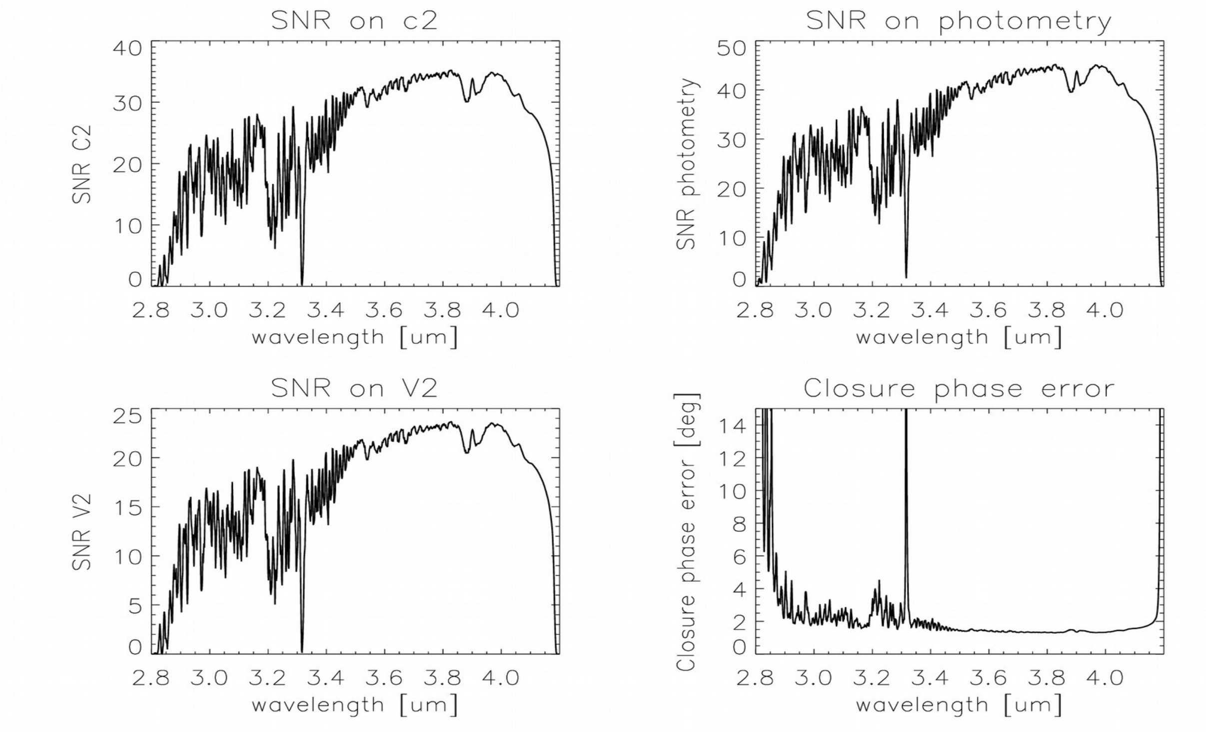


Fig 6: ETC MATISSE SNR values. Top left: squared coherent flux; top right: photometry; bottom left: squared visibility ; bottom right : closure phase error.

Case 2 : 100 Jy source (m_L = 1.15)

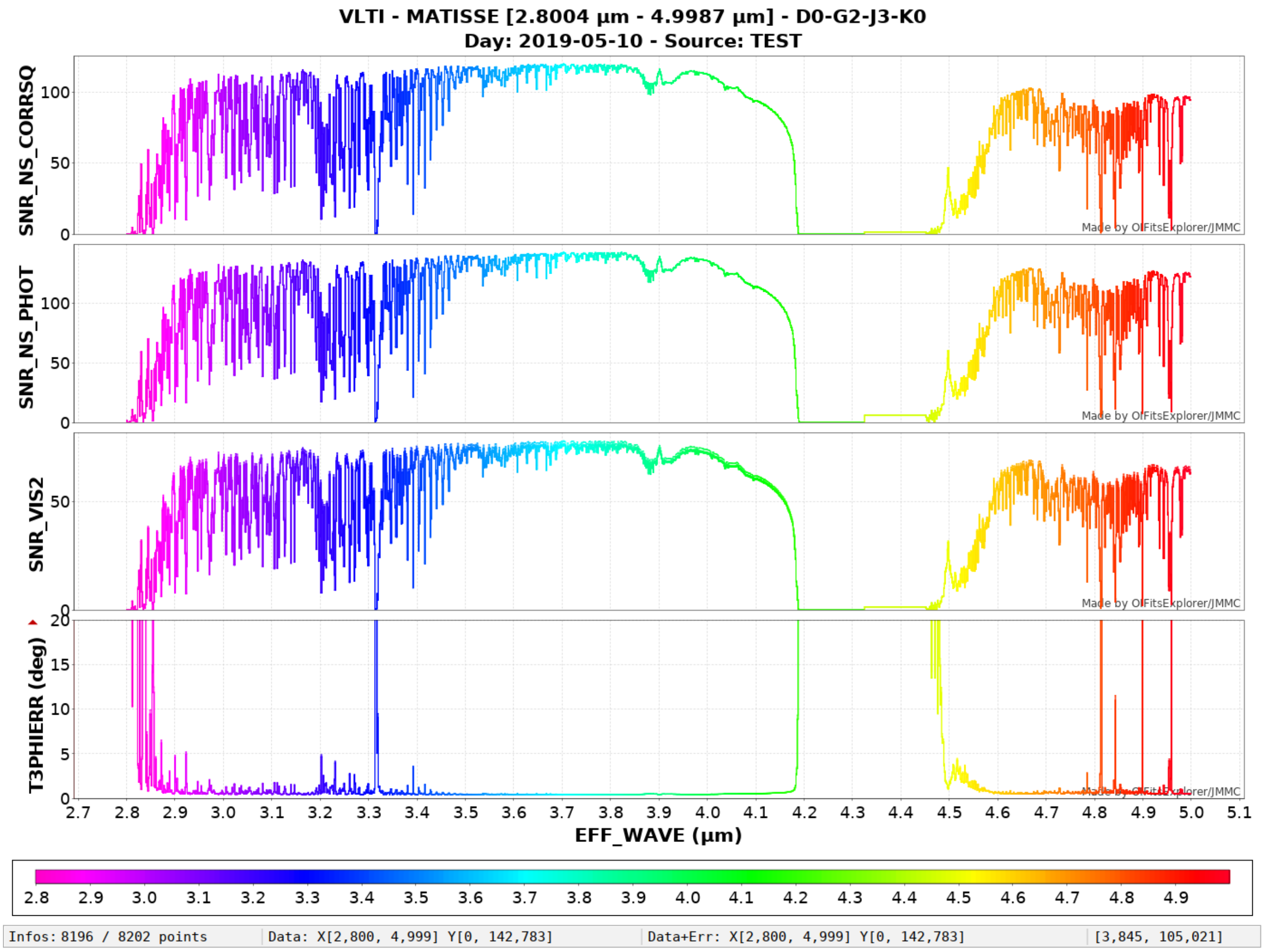


Fig 7: ASPRO2 SNR values. From top to bottom : Squared coherent flux, photometry, squared visibility

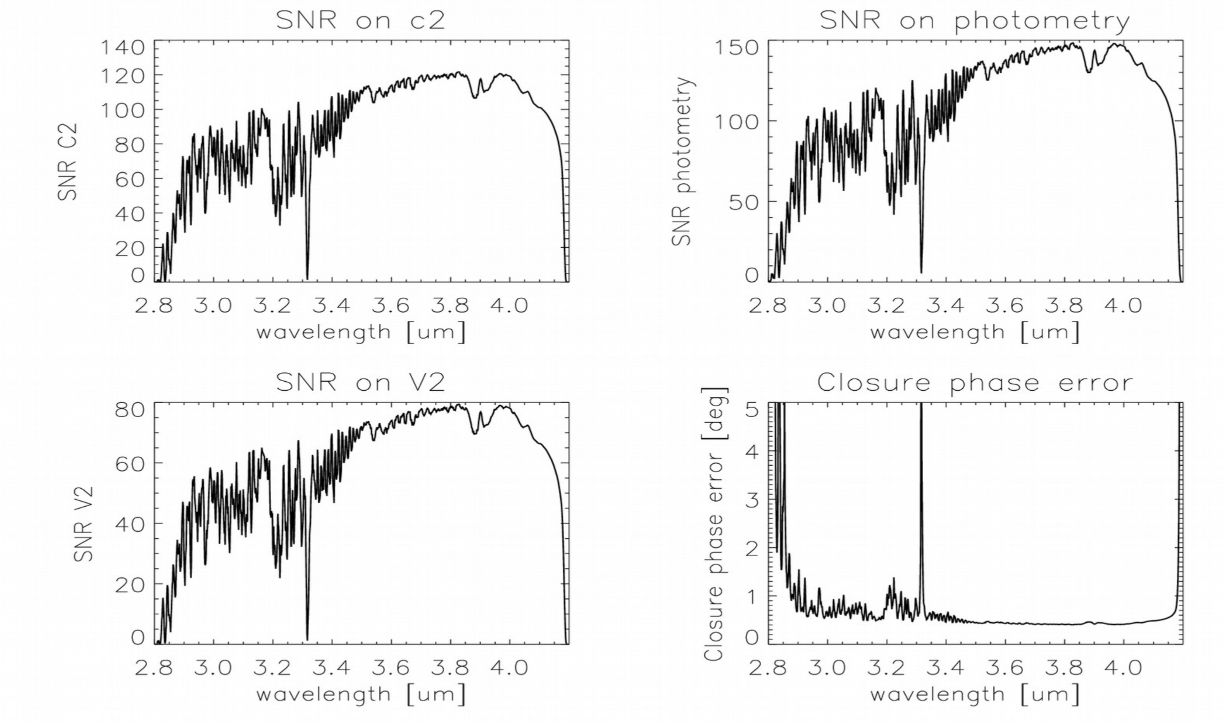


Fig 8: ETC MATISSE SNR values. Top left: squared coherent flux; top right: photometry; bottom left: squared visibility ; bottom right : closure phase error.

Instrumental setup :

Telescopes : ATs
Spectral resolution : HIGH_L
Observing mode : Si_phot
DIT = 111 ms
Exposure time : 4min on interferometry + 4 min on photometry (per beam)

L-HIGH				
Observable (at 3.5 um)	**30 Jy source**			
	MATISSE ETC	**ASPRO2**	**MATISSE ETC**	**ASPRO2**
Squared coherent flux SNR	5	5		
Photometry SNR	11	11		
Squared visibility SNR	4	4.2		
Closure phase error [deg]	5.5 °	11 °		

Case 1 : 30 Jy source (m_L = 2.46)

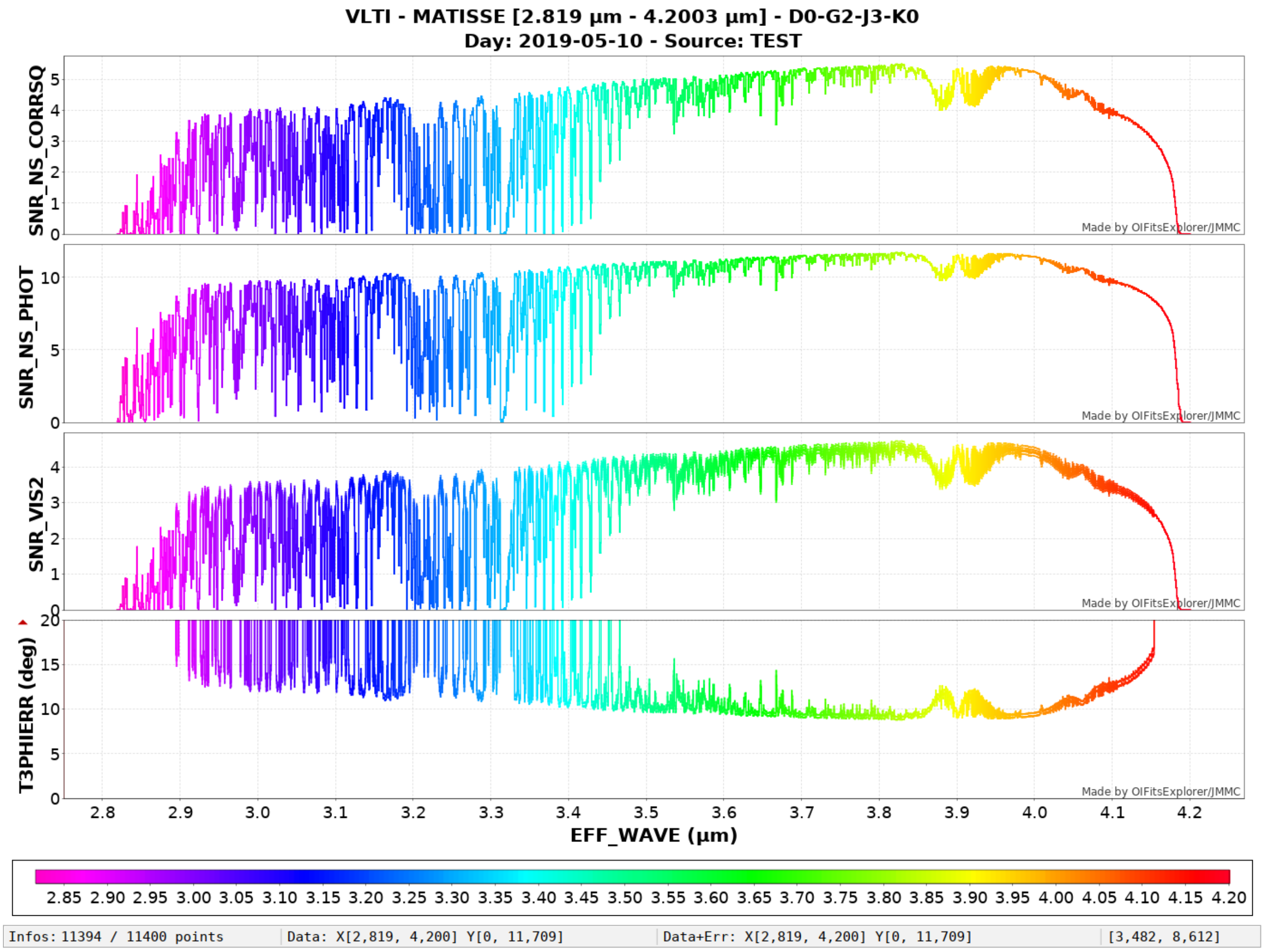


Fig 9: ASPRO2 SNR values. From top to bottom : Squared coherent flux, photometry, squared visibility

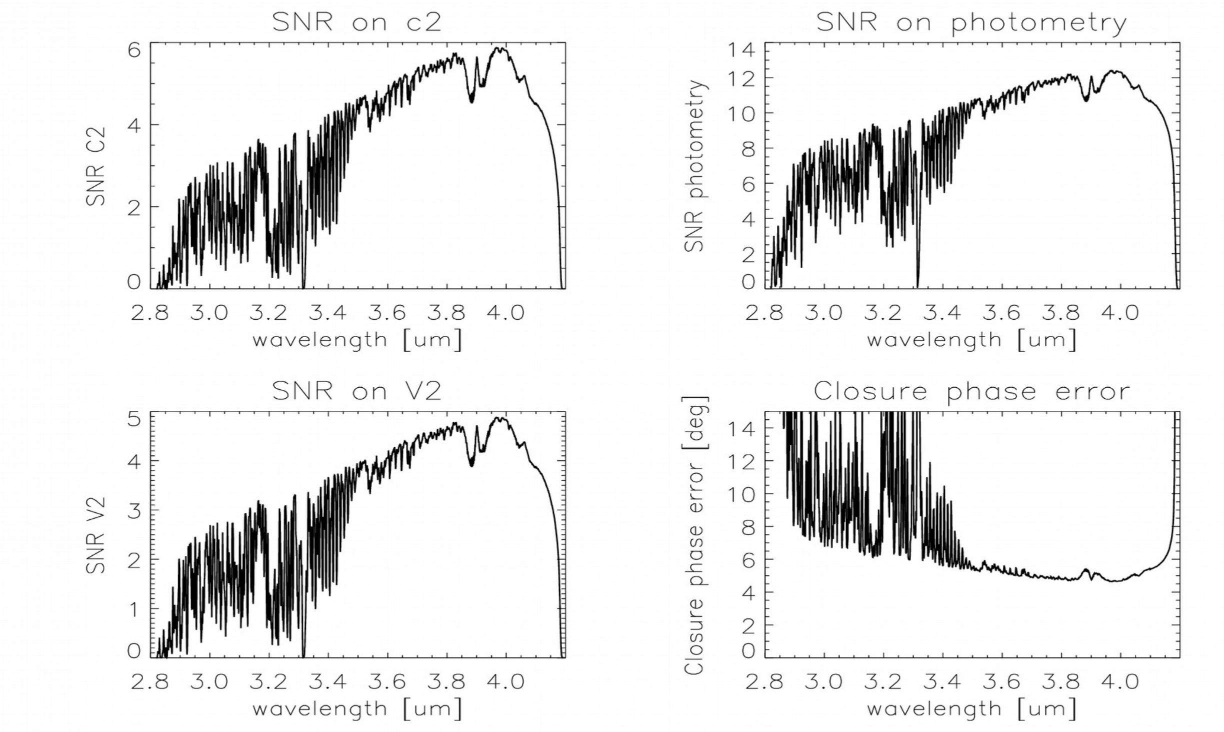


Fig 10: ETC MATISSE SNR values. Top left: squared coherent flux; top right: photometry; bottom left: squared visibility ; bottom right : closure phase error.

Instrumental setup :

Telescopes : ATs
Fringe tracker : GRA4MAT
Spectral resolution : VERY_HIGH_L (Warning : Instrumental transmission to be updated. The actual transmission profile of the very-high resolution grism is significanyl increasing between 3.6 and 4 um. At the moment, only an average constant transmission is used across the spectral band.)
Observing mode : Si_phot
DIT = 10 s
Exposure time : 4min on interferometry + 4 min on photometry (per beam)

L-VERY_HIGH				
Observable (at 3.95 um)	**20 Jy source**			
	MATISSE ETC	**ASPRO2**	**MATISSE ETC**	**ASPRO2**
Squared coherent flux SNR	9.5	8.9		
Photometry SNR	12	11.8		
Squared visibility SNR	6.5	6.0		
Closure phase error [deg]	5.5 °	5.7 °		

Case 1 : 20 Jy source (m_L = 2.9)

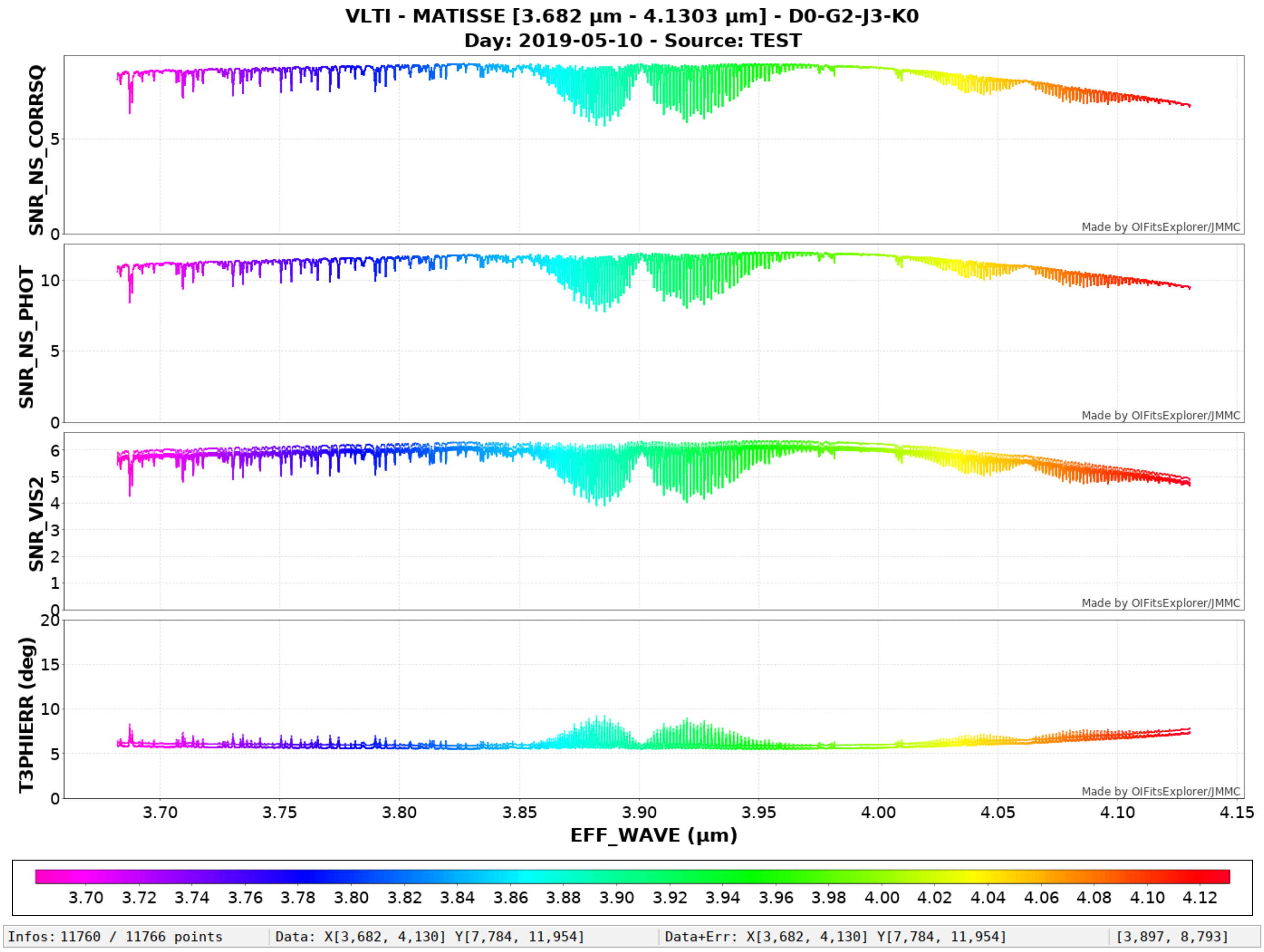


Fig 11: ASPRO2 SNR values. From top to bottom : Squared coherent flux, photometry, squared visibility

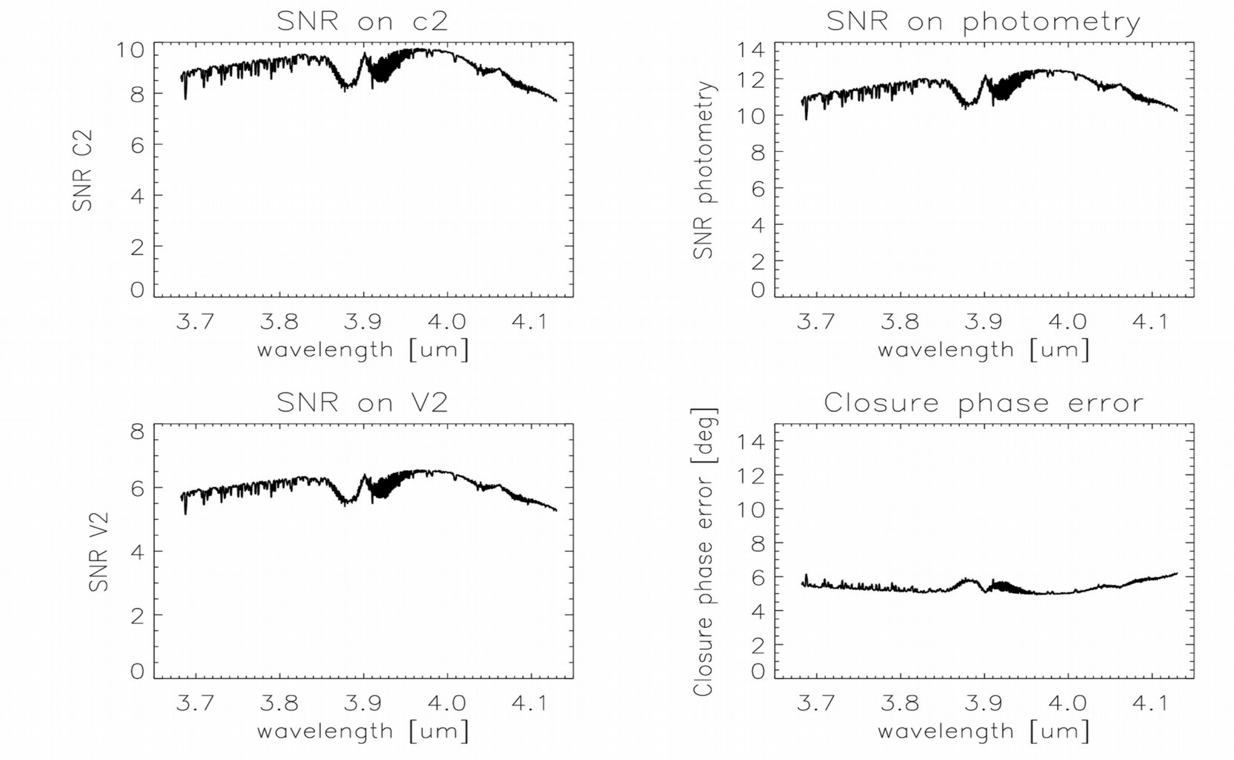


Fig 12: ETC MATISSE SNR values. Top left: squared coherent flux; top right: photometry; bottom left: squared visibility ; bottom right : closure phase error.

Instrumental setup :

Telescopes : ATs
Fringe tracker : GRA4MAT
Spectral resolution : VERY_HIGH_M (Warning : chopping will actually be required in that mode to obtain accurate absolute measures at any source brightness)
Observing mode : Si_phot
DIT = 10 s
Exposure time : 4min on interferometry + 4 min on photometry (per beam)

M-VERY_HIGH				
Observable (at 4.75 um)	**20 Jy source**			
	MATISSE ETC	**ASPRO2**	**MATISSE ETC**	**ASPRO2**
Squared coherent flux SNR	~ 20	19.3		
Photometry SNR	~ 29	31.25		
Squared visibility SNR	~ 15	14.8		
Closure phase error [deg]	~ 3 °	2.5 °		

Case 1 : 20 Jy source (m_M = 2.3)

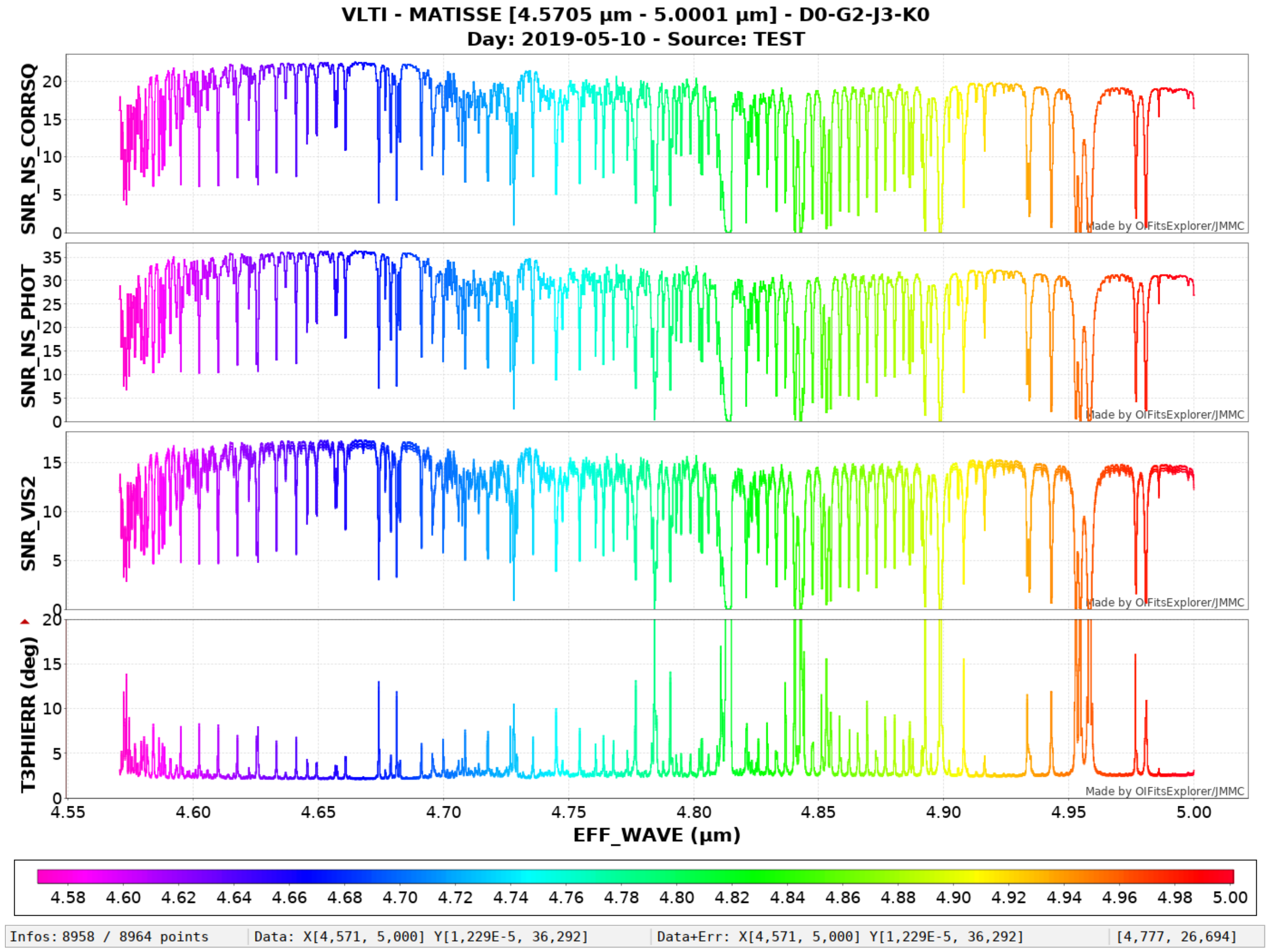


Fig 11: ASPRO2 SNR values. From top to bottom : Squared coherent flux, photometry, squared visibility

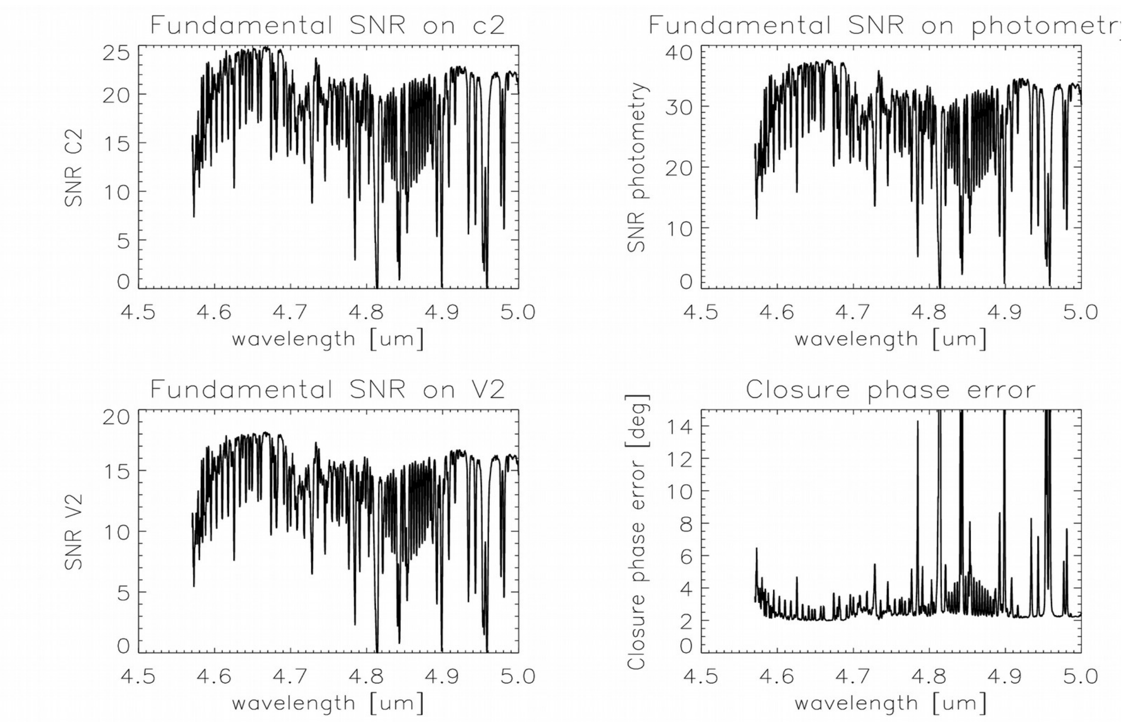


Fig 14: ETC MATISSE SNR values. Top left: squared coherent flux; top right: photometry; bottom left: squared visibility ; bottom right : closure phase error.

Conclusion on MATISSE LM band comparison :

Good agreeement between both tools.
The SNR estimates are consistent for all observables

N band

Instrumental setup :

Telescopes : ATs
Spectral resolution : LOW_N
Observing mode : High_Sens
DIT = 20 ms
Exposure time : 4min on interferometry + 2 min on photometry per beam (with chopping)

N-LOW				
Observable (at 10.5 um)	**20 Jy source**		**100 Jy source**	
	MATISSE ETC	**ASPRO2**	**MATISSE ETC**	**ASPRO2**
Squared coherent flux SNR	4	4	55	59
Photometry SNR	16	16.1	75	81
Squared visibility SNR	3.7	3.9	39	41.7
Closure phase error [deg]	3.7 °	13.5 °	0.8 °	0.86 °

Case 1 : 20 Jy source (m_N = 0.7)

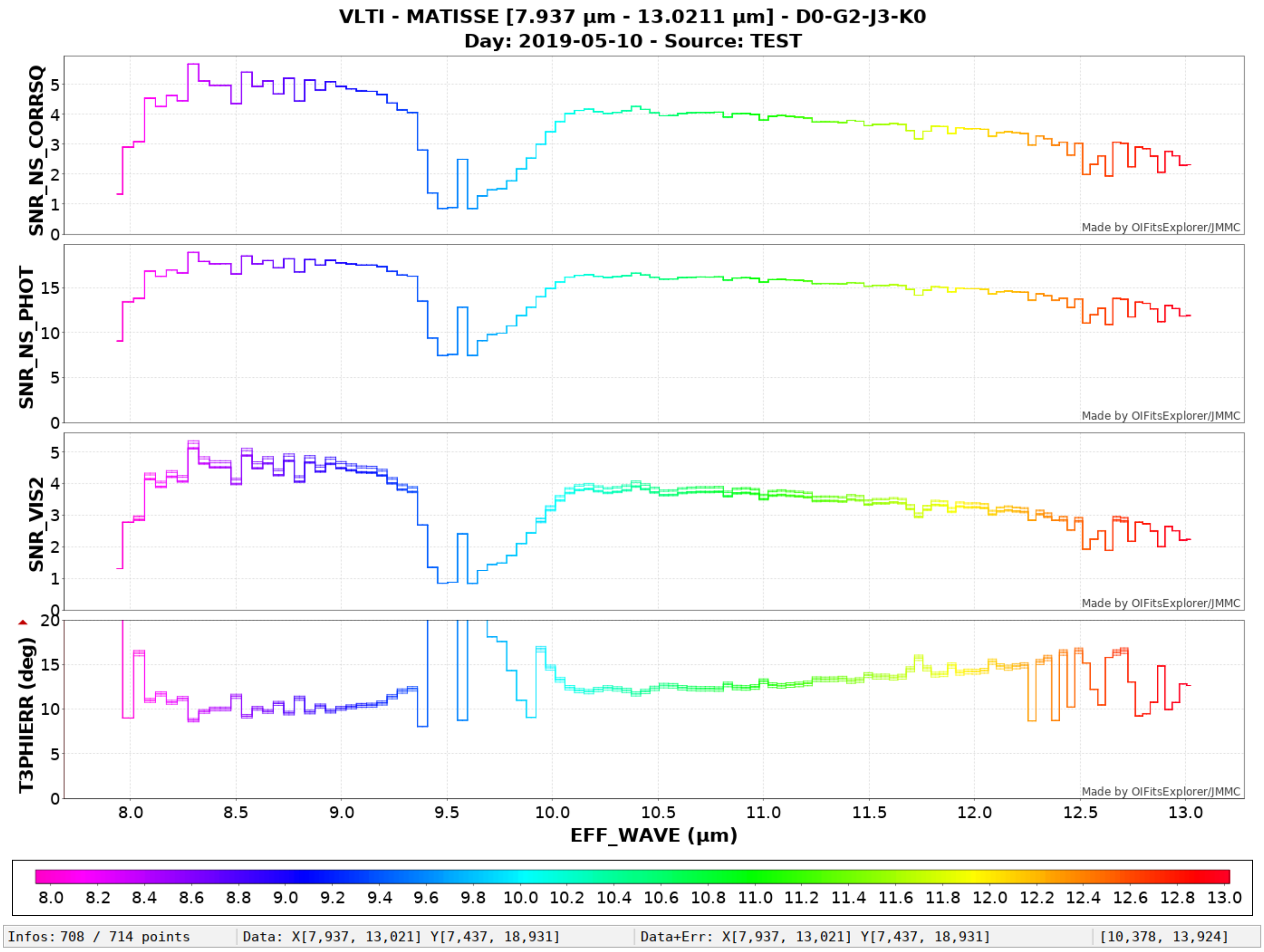


Fig 15: ASPRO2 SNR values. From top to bottom : Squared coherent flux, photometry, squared visibility

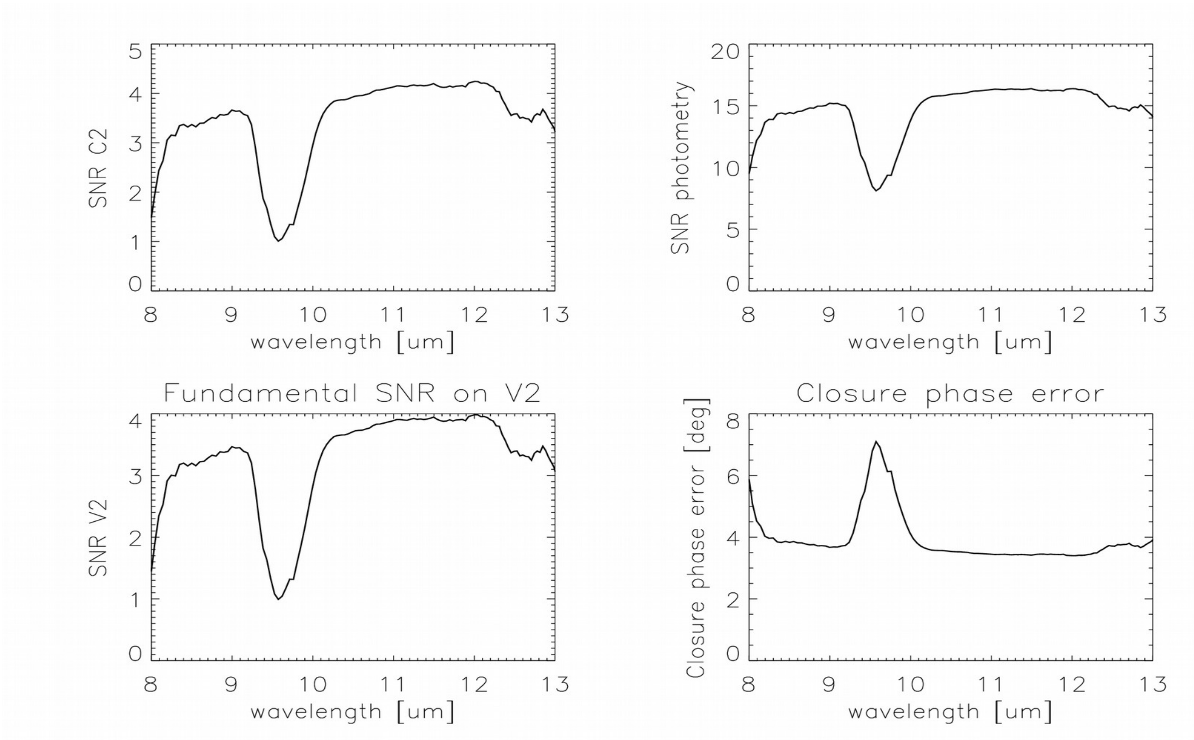


Fig 16: ETC MATISSE SNR values. Top left: squared coherent flux; top right: photometry; bottom left: squared visibility ; bottom right : closure phase error.

Case 2 : 100 Jy source (m_N = -1)

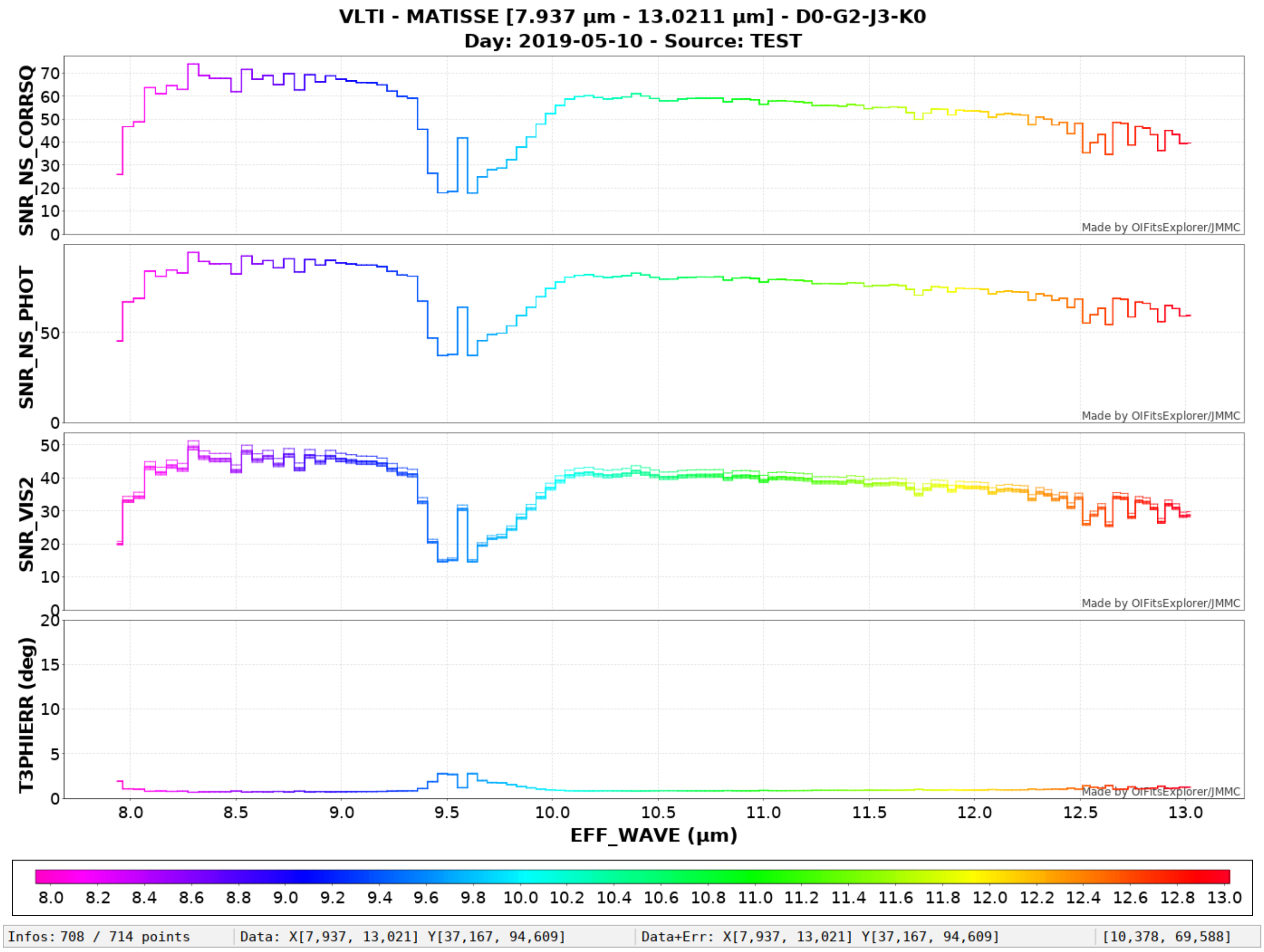


Fig 17: ASPRO2 SNR values. From top to bottom : Squared coherent flux, photometry, squared visibility

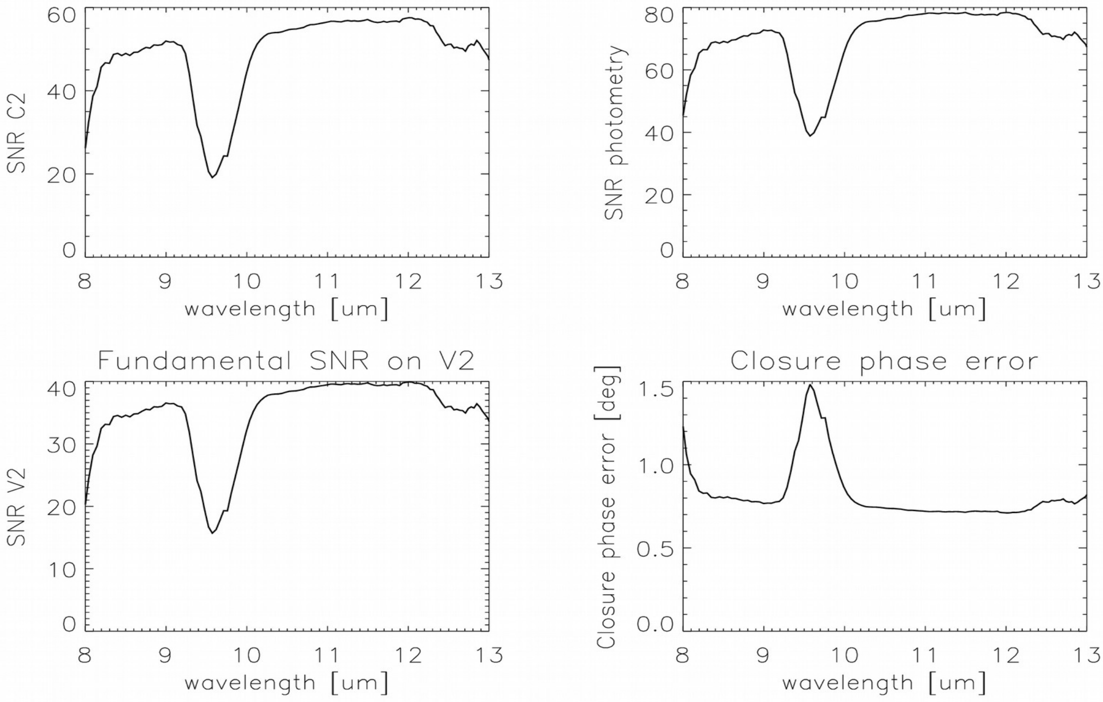


Fig 18: ETC MATISSE SNR values. Top left: squared coherent flux; top right: photometry; bottom left: squared visibility ; bottom right : closure phase error.

Instrumental setup :

Telescopes : ATs
Spectral resolution : HIGH_N
Observing mode : High_Sens
DIT = 75 ms
Exposure time : 4min on interferometry + 2 min on photometry per beam (with chopping)

N-HIGH				
Observable (at 10.5 um)	**20 Jy source**		**100 Jy source**	
	MATISSE ETC	**ASPRO2**	**MATISSE ETC**	**ASPRO2**
Squared coherent flux SNR	0.9	0.9	16	16
Photometry SNR	5	5	24	24
Squared visibility SNR	0.8	0.9	11	11.8
Closure phase error [deg]	11 °	75 °	2.5 °	3.2 °

Case 1 : 20 Jy source (m_N = 0.7)

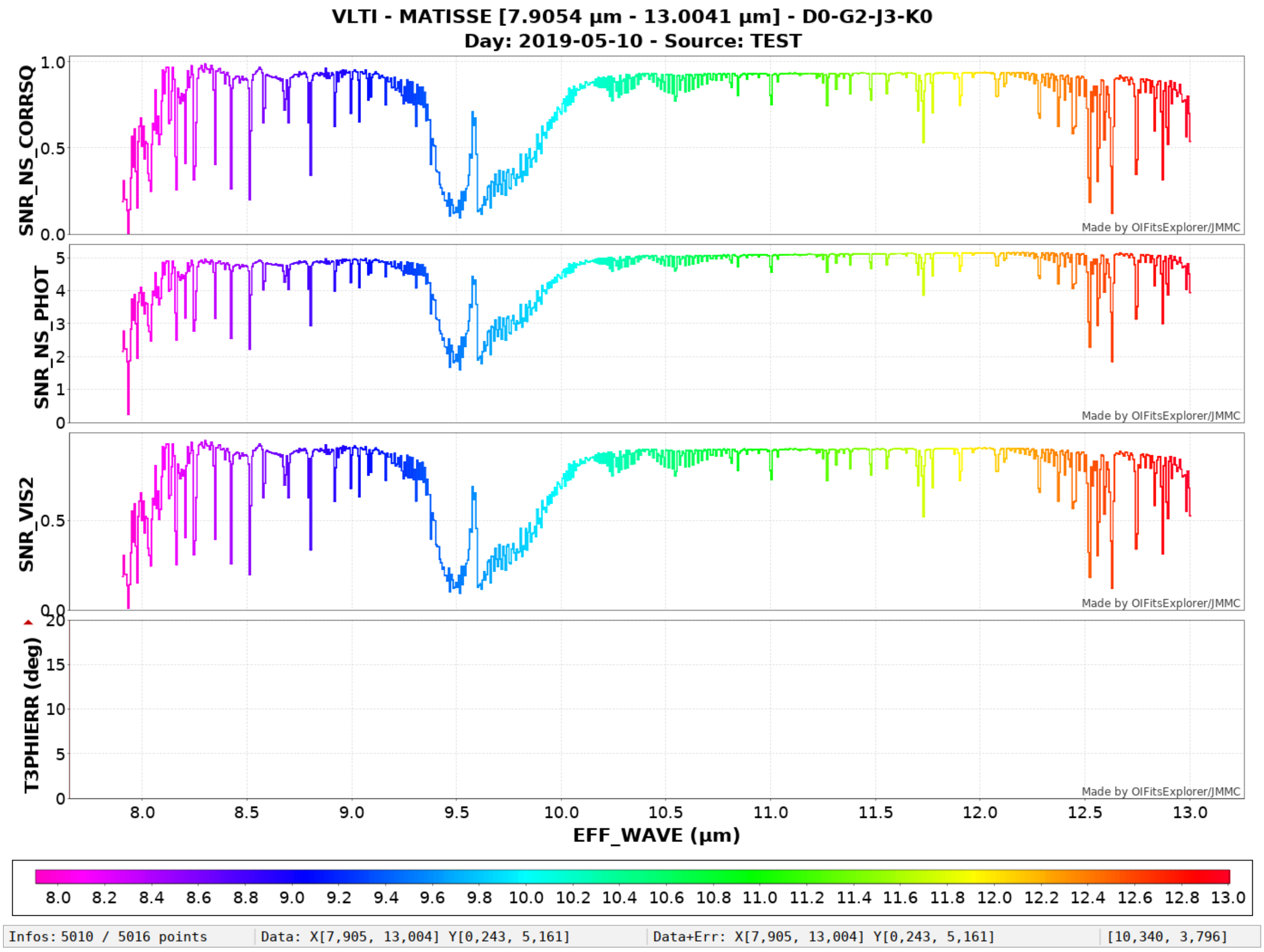


Fig 19: ASPRO2 SNR values. From top to bottom : Squared coherent flux, photometry, squared visibility

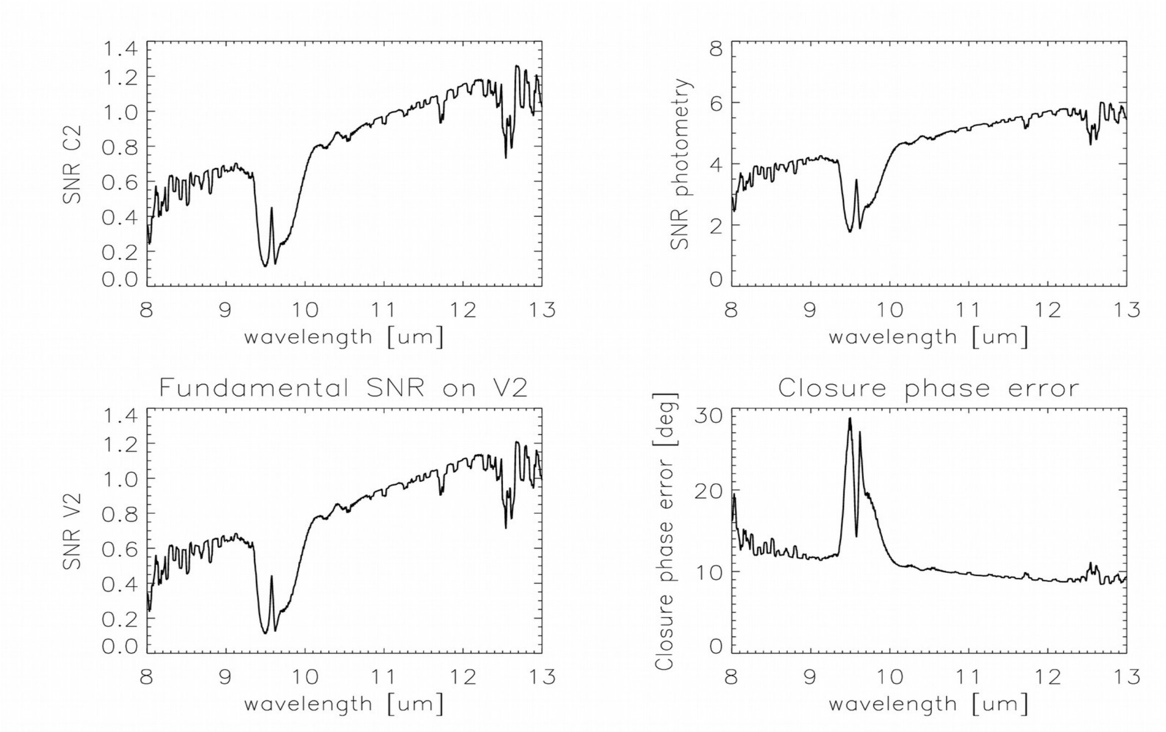


Fig 20: ETC MATISSE SNR values. Top left: squared coherent flux; top right: photometry; bottom left: squared visibility ; bottom right : closure phase error.

Case 2 : 100 Jy source (m_N = -1)

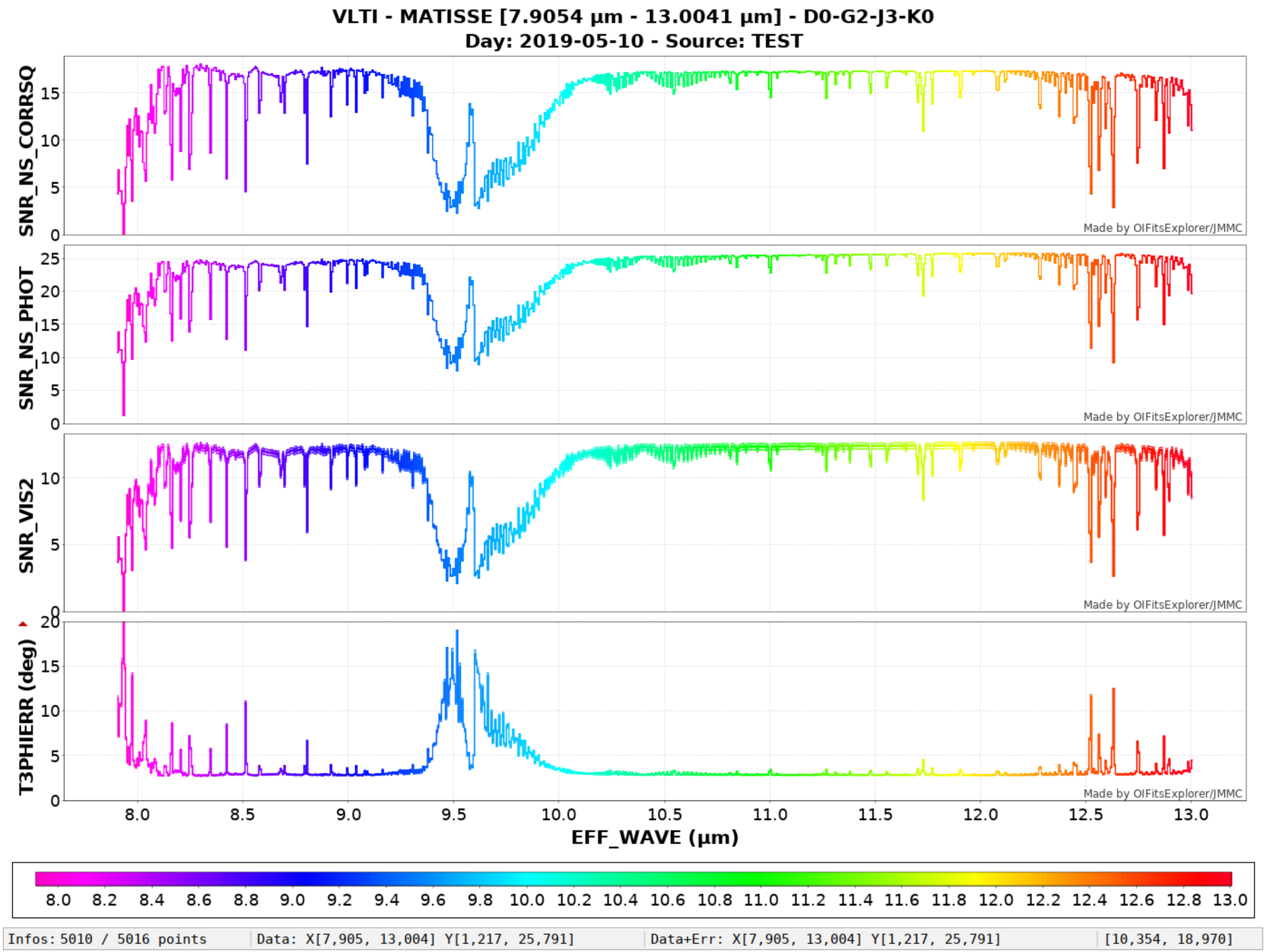


Fig 21: ASPRO2 SNR values. From top to bottom : Squared coherent flux, photometry, squared visibility

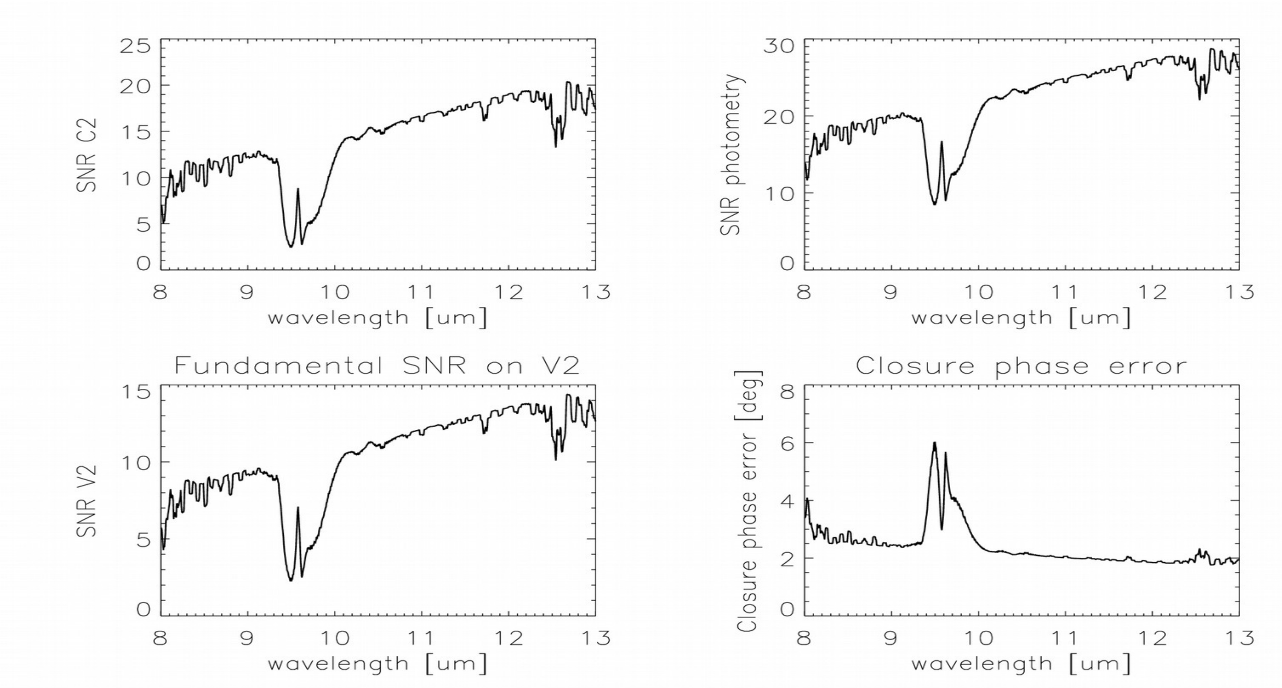


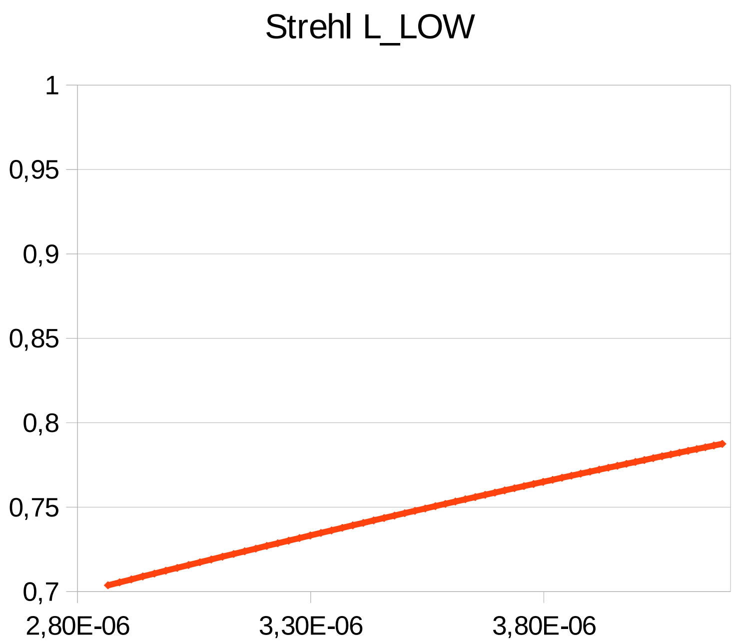
Fig 22: ETC MATISSE SNR values. Top left: squared coherent flux; top right: photometry; bottom left: squared visibility ; bottom right : closure phase error.

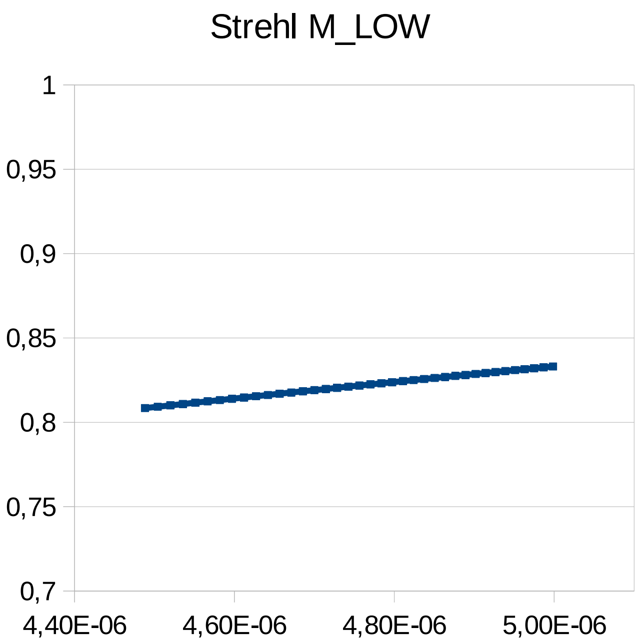
Conclusion on MATISSE N band comparison :

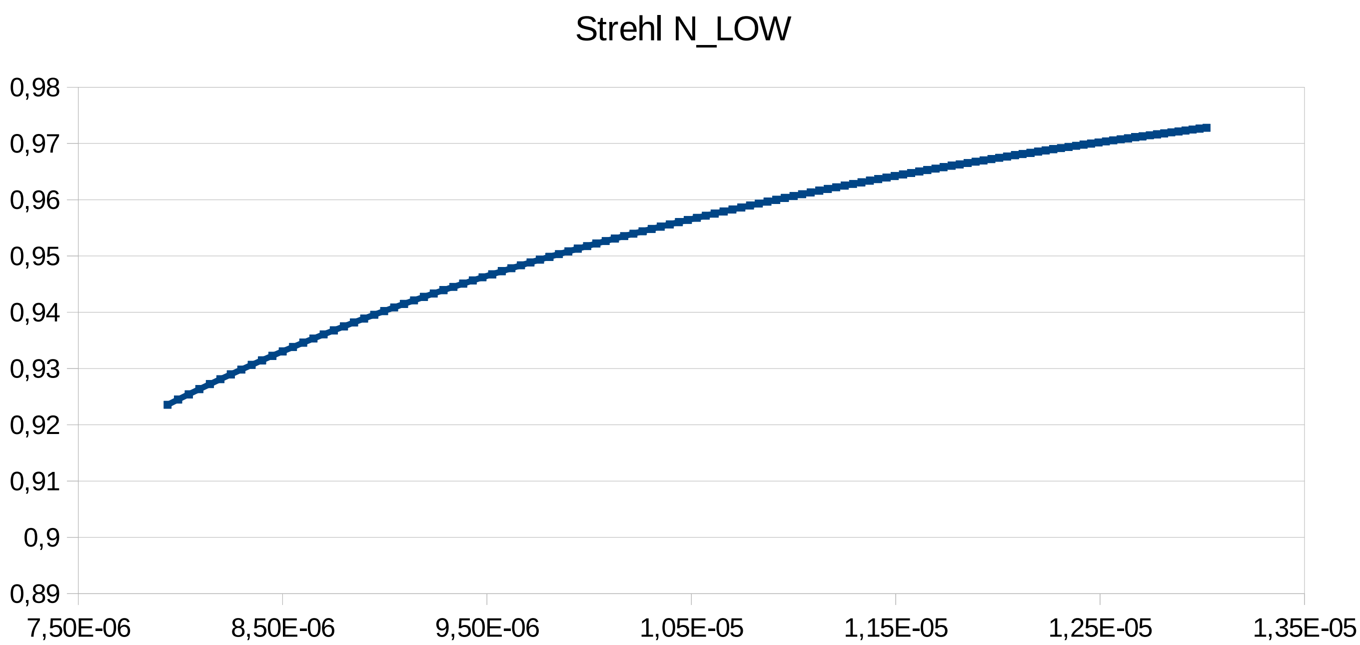
Good agreeement between both tools.
The SNR estimates are consistent for all observables at 10.5 microns, except T3phi_err that are very different at low SNR ~ 4 :

- **ASPRO2 : error sampling (more realistic)**
- **MATISSE ETC : approximation SNR(V) / 3**

ASPRO 2 Strehl







ASPRO 2 Atmosphere transmission profiles