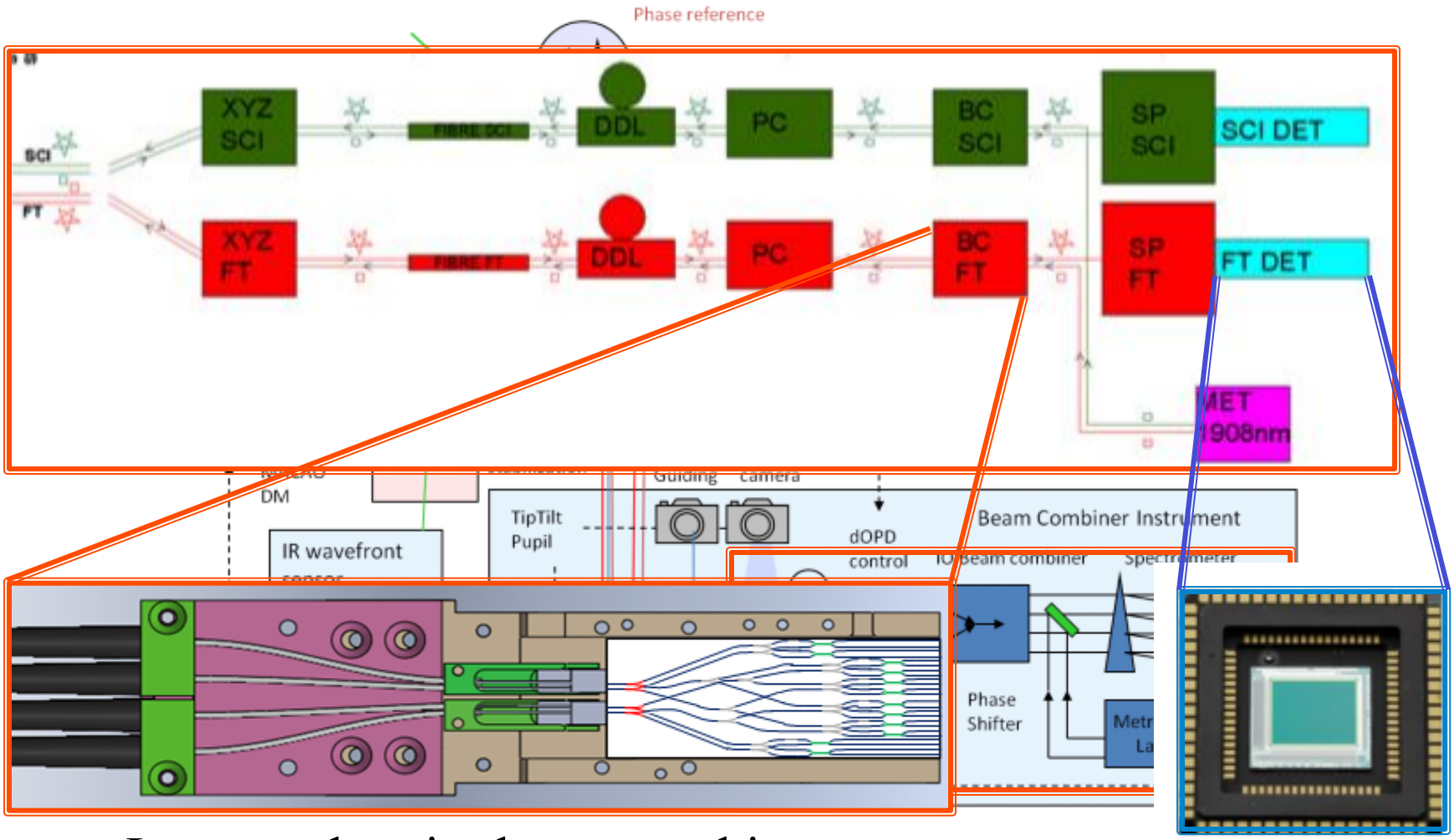
Fringe Tracking and GRAVITY

Karine PERRAUT on behalf the GRAVITY consortium

CHARA Meeting – March 2016

Overview of GRAVITY



Integrated optics beam combiner

Selex APD

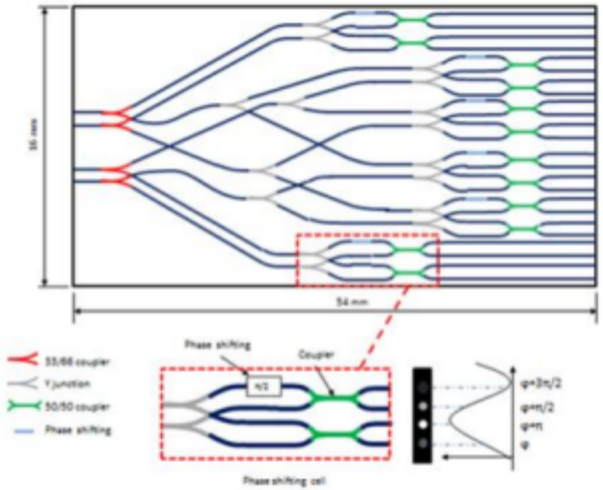
FT High Level Specifications

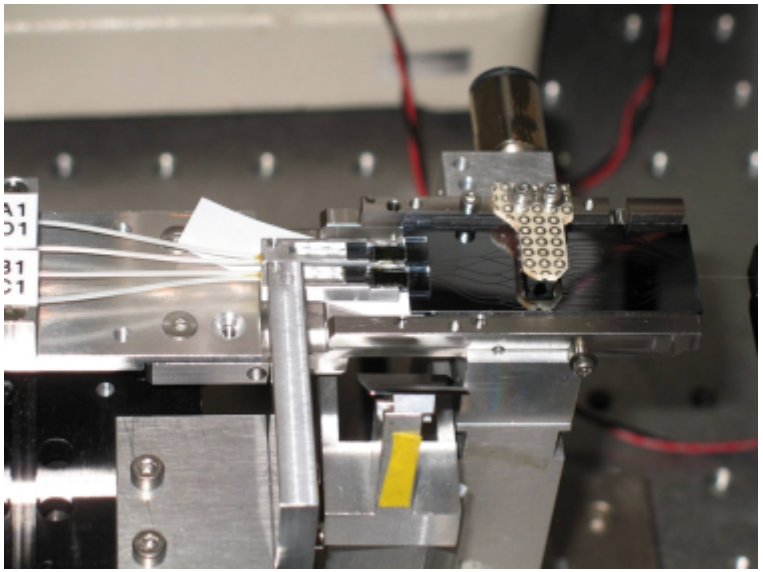
- Track the central fringe down to K=10 with UTs and K=7 with ATs
- Reach 300 nm residuals without vibrations (goal: 200 nm)
- Allow coherent integrations of duration ≥ 100 s

- Fringe track despite OPD vibrations
- Fringe track despite flux drop outs
- Be as robust as possible to make observations efficient (make decisions to be taken by the observer as few as possible)

FT design

- Pair-wise combination with ABCD sampling
- No scan
- Dispersion on 5 spectral channels
- Integrated optics beam combiner cooled down to 200 K





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LE VERRE FLUORÉ
INFRARED SOLUTIONS

Georgia State University

l'Observatoire de Paris LESIA

NExScI

Observatoire de la Côte d'Azur

FT beam combiner performance

- Derived from P2VM

Wavelength averaged photometric transmissions (%)

FT	tel1	tel2	tel3	tel4
12	51.01	48.93	0.027	0.024
13	51.62	0.066	48.24	0.061
14	51.02	0.067	0.032	48.87
23	0.035	50.72	49.18	0.062
24	0.055	50.18	0.057	49.70
34	0.025	0.036	49.71	50.22

Coherent flux (%)

FT	1-2	1-3	1-4	2-3	2-4	3-4
12	99.9	0.02	0.03	0.01	0.01	0.00
13	0.16	99.1	0.24	0.15	0.00	0.24
14	0.15	0.03	99.6	0.00	0.15	0.03
23	0.03	0.03	0.00	99.6	0.13	0.16
24	0.09	0.01	0.10	0.12	99.5	0.11
34	0.00	0.03	0.08	0.04	0.04	99.7

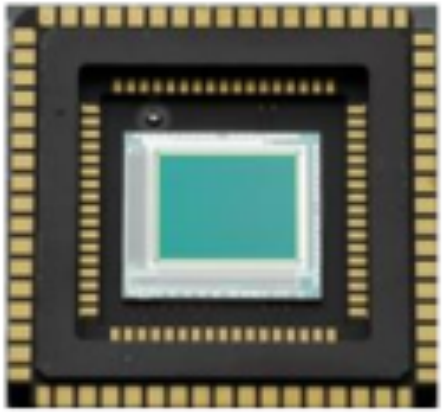
FT	12	13	14	23	24	34
Transfer function (%)	95.25	94.43	95.35	96.17	95.16	94.25
Standard dev. (%)	0.74	1.08	1.63	1.28	2.57	2.64

Throughput over the K band > 50%

FT detector concept

- Near infrared electron avalanche photodiode arrays (eAPD)
- Coming from the ESO program with Selex
- 320 x 256 pixels
- Operation at 40 K

- 24 outputs x 5 channels x 2 polarizations read at 1 kHz with a noise of 1 e-/pix at 40 K

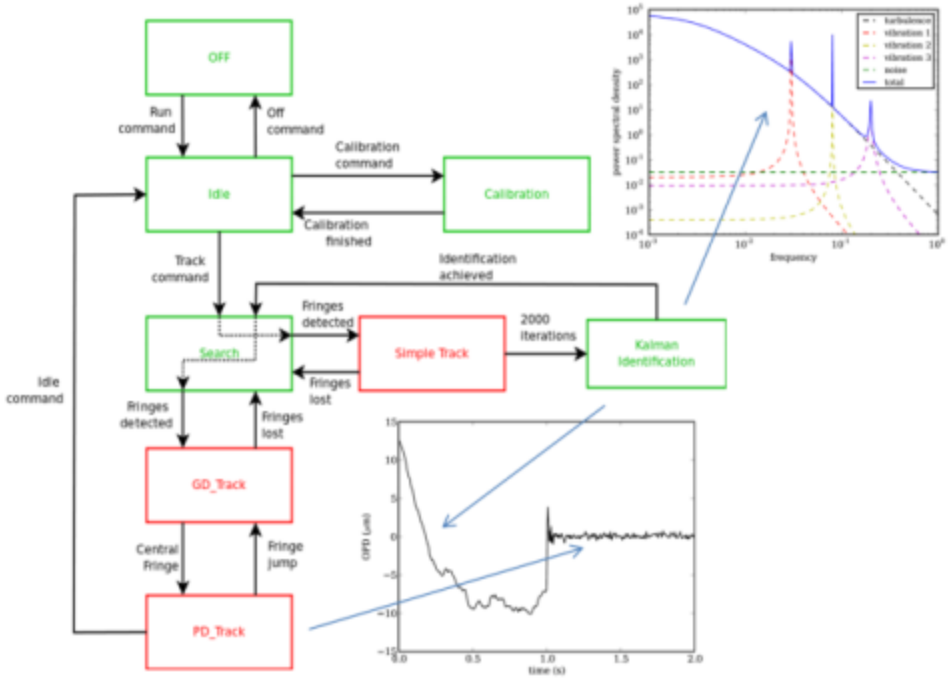


SELEX GALILEO

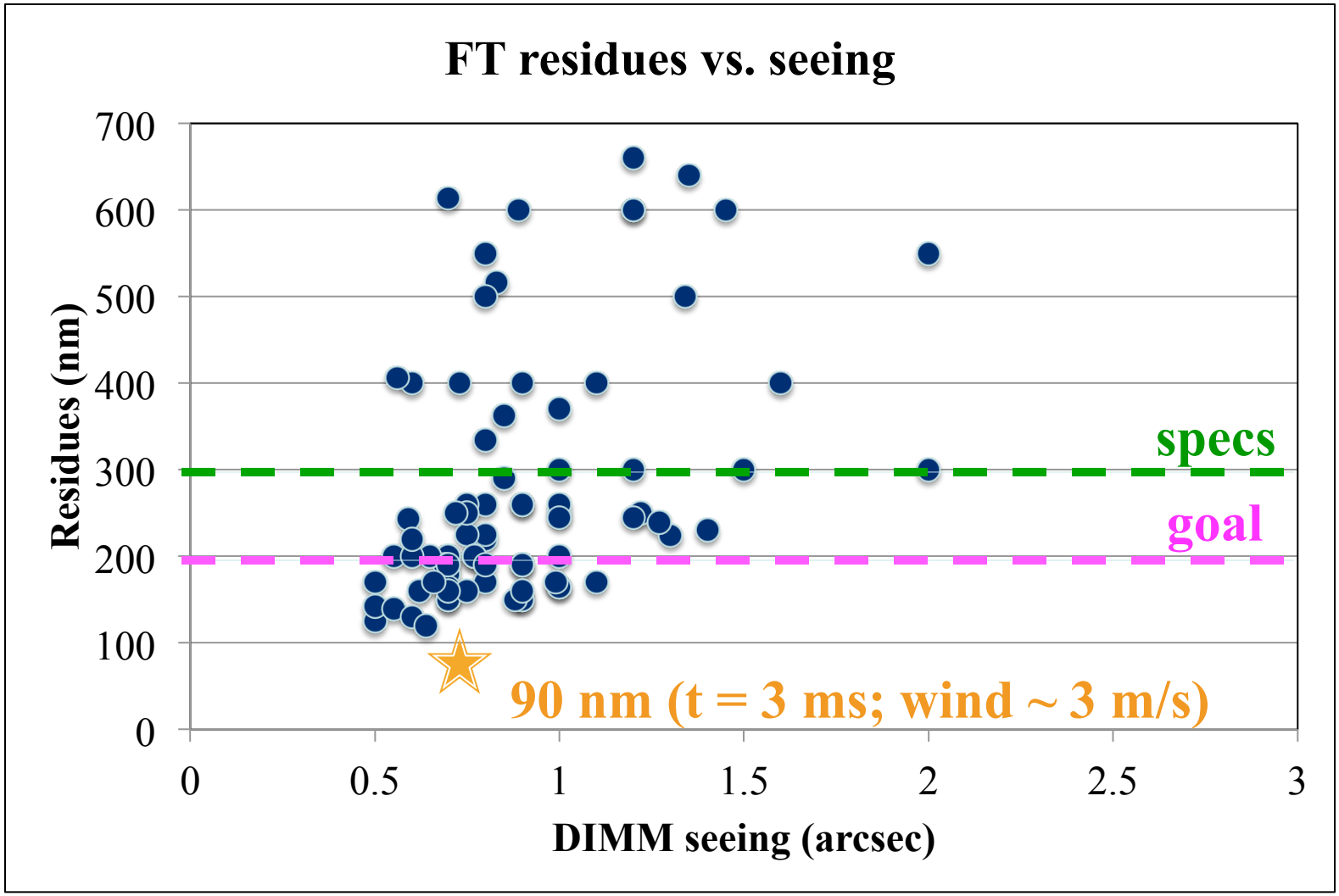
ESO

FT architecture

- Real-time loop shall deal with the 6 phases
  ⇒ 4-commande inversion in the context of frequent SNR dropout, resolved baseline, non-zero closure phase… is **NOT EASY**



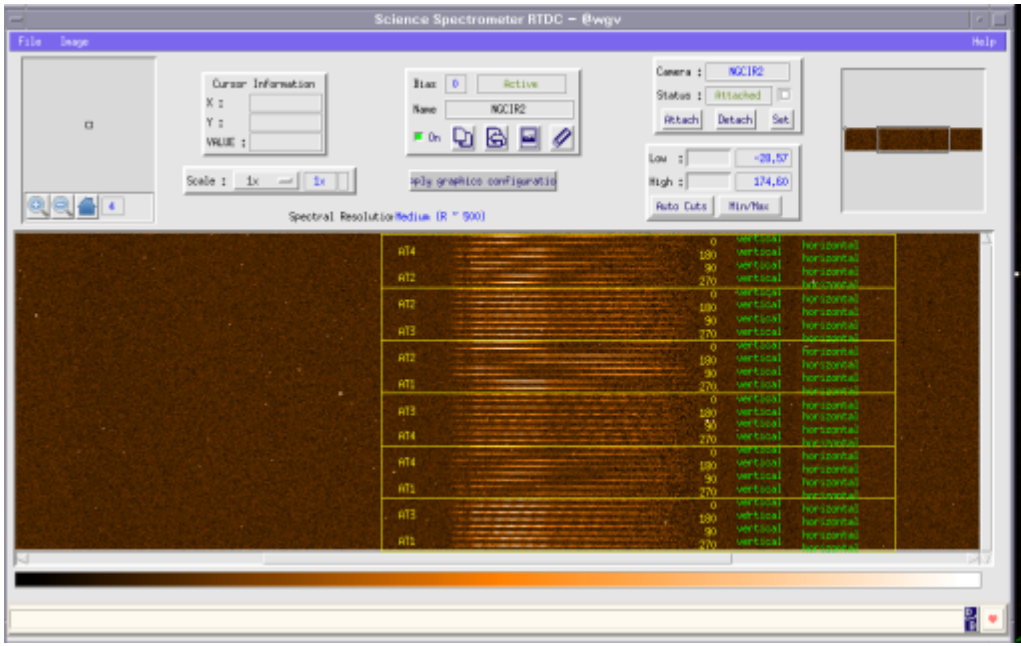
GRAVITY FT performance

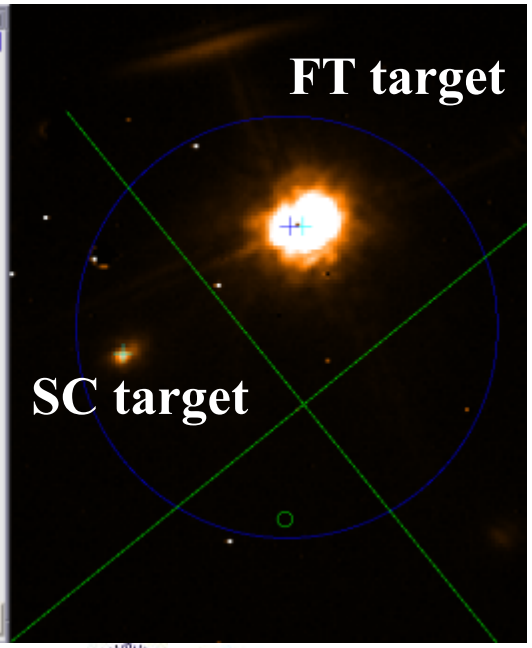


GRAVITY FT performance

- FT tracking down to K = 7.6 in on-axis mode
- FT tracking in off-axis mode

Fringes on the faintest target (K = 8.5) recorded the scientific detector)

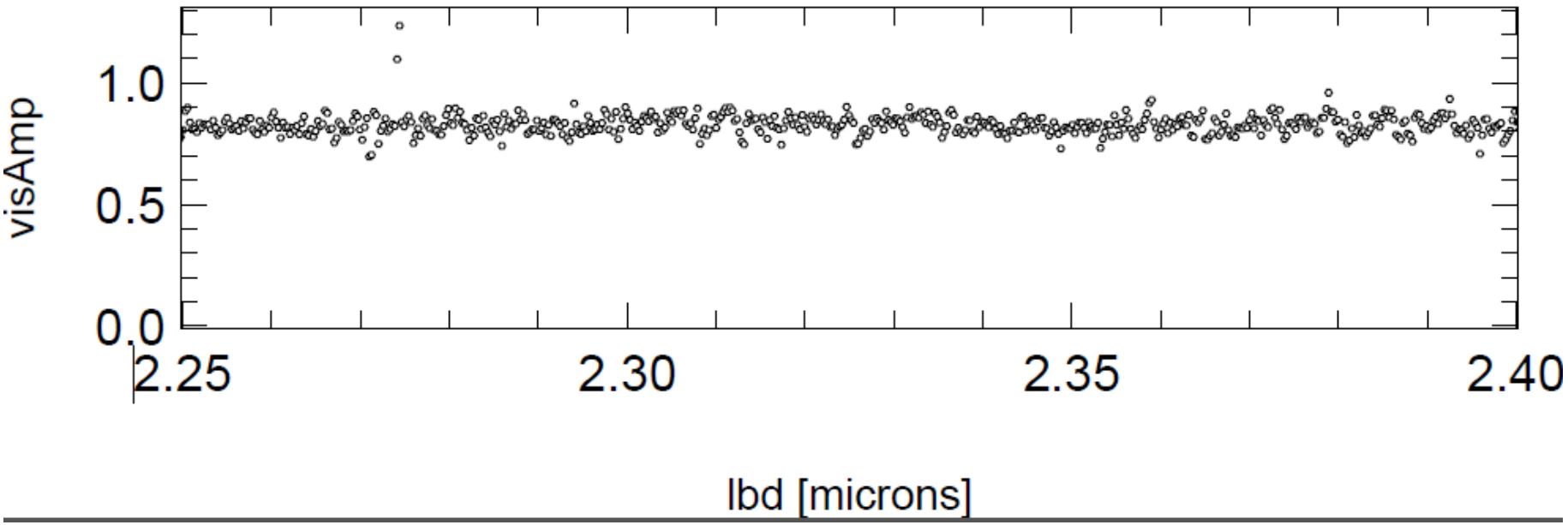




GRAVITY FT performance

- Long integrations for spectro-imaging

Transfer function of 30 min integration on the YSO (MWC 147 – K = 5.7)



Summary

- FT at 1 kHz up to K = 5 on ATs
- FT up to K = 7.5 by slowing the speed
- Residues ~ 100 nm in K band (i.e ~ λ/22)

- Detector performance (noise, speed) is a real breakthrough
- FT efficiency also strongly related to the state machine and the software optimization

- Next step: commissioning on UTs in May