Data analysis of NISP ground test campaign

Euclid National Meeting Italy

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ON BEHALF OF NISP IDT

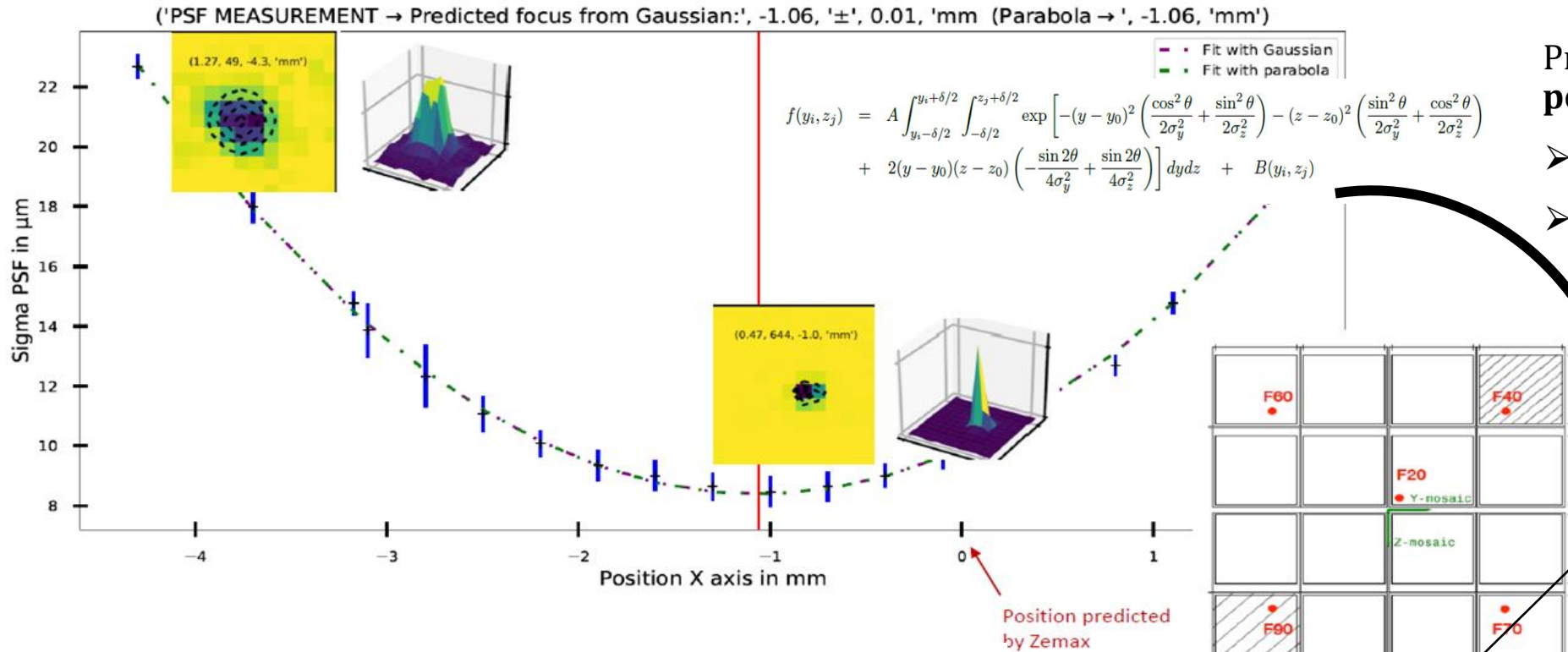Friday the 25th of February 2021

Summary

PLM @ CSL
Summer 2021

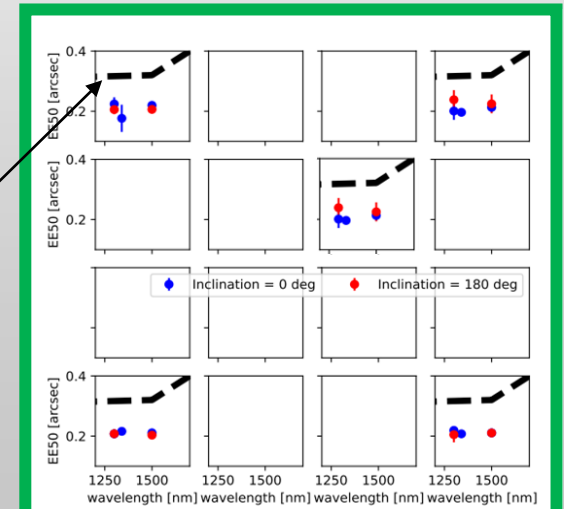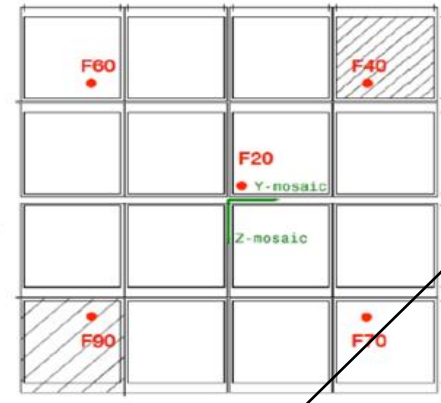**NISP-S simulations**
In progress

NISP @ LAM
Early 2020

Study of NISP images:
- Best focus determination
- PSF study
- Spectral calibration
- Study of systematics

Fine focus determination & Optical quality assessment:
NISP level @ LAM 2020

('PSF MEASUREMENT → Predicted focus from Gaussian:', -1.06, '±', 0.01, 'mm (Parabola → ', -1.06, 'mm')

$$f(y_i, z_j) = A \int_{y_i-\delta/2}^{y_i+\delta/2} \int_{-\delta/2}^{z_j+\delta/2} \exp\left[-(y-y_0)^2 \left(\frac{\cos^2\theta}{2\sigma_y^2} + \frac{\sin^2\theta}{2\sigma_z^2}\right) - (z-z_0)^2 \left(\frac{\sin^2\theta}{2\sigma_y^2} + \frac{\cos^2\theta}{2\sigma_z^2}\right)\right.$$
$$\left. + 2(y-y_0)(z-z_0) \left(-\frac{\sin 2\theta}{4\sigma_y^2} + \frac{\sin 2\theta}{4\sigma_z^2}\right)\right] dy\,dz + B(y_i, z_j)$$

- - Fit with Gaussian
- - Fit with parabola

(1.27, 49, -4.3, 'mm')

(0.47, 644, -1.0, 'mm')

Sigma PSF in µm

Position X axis in mm

Position predicted by Zemax

F60 F40

F20
Y-mosaic

Z-mosaic

F90 F70

*Tests made with a point like source with filter Y and wavelength of 1000 nm falling on the reference position F20

Probing **PSF** with a **monochromatic point-like source** on **5 detectors:**

➢ in **Y, J, H band**

➢ Through both **grisms**:

  – 3 wavelengths for both blue and red grisms

 – 7 tilt positions for red grism (**0°, 180°, +/- 4°, +270°**)

EE50 [arcsec]

EE50 [arcsec]

EE50 [arcsec]

Inclination = 0 deg   Inclination = 180 deg

1250 1500   1250 1500   1250 1500   1250 1500
wavelength [nm] wavelength [nm] wavelength [nm] wavelength [nm]

NISP PSF requirement fulfilled!

NISP specification

Fine focus determination:
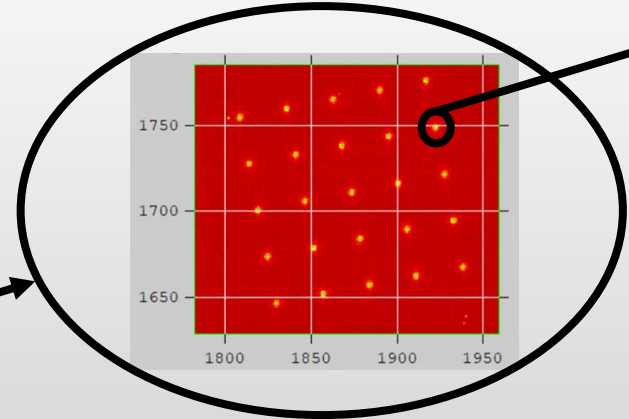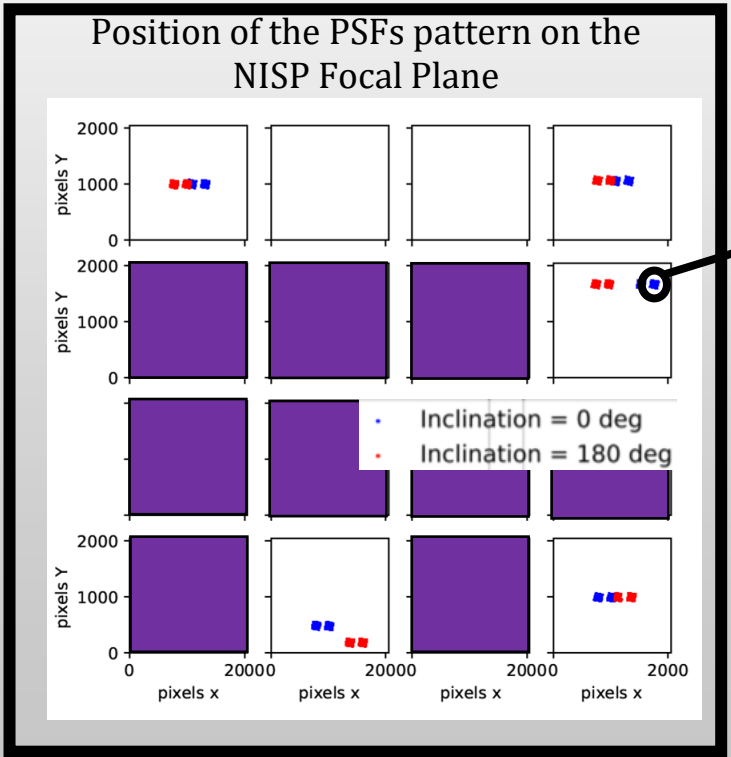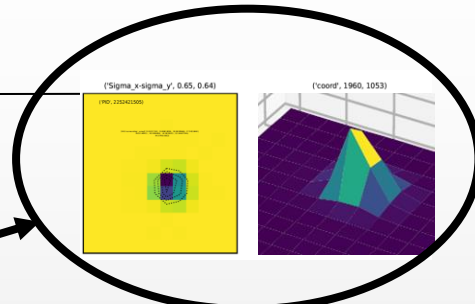## PLM level @ CSL 2021

- ➤ **M2 mirror** best focus position is determined on VIS images (and confirmed for NISP)

- ➤ **5 fields positions** for fine focus determination

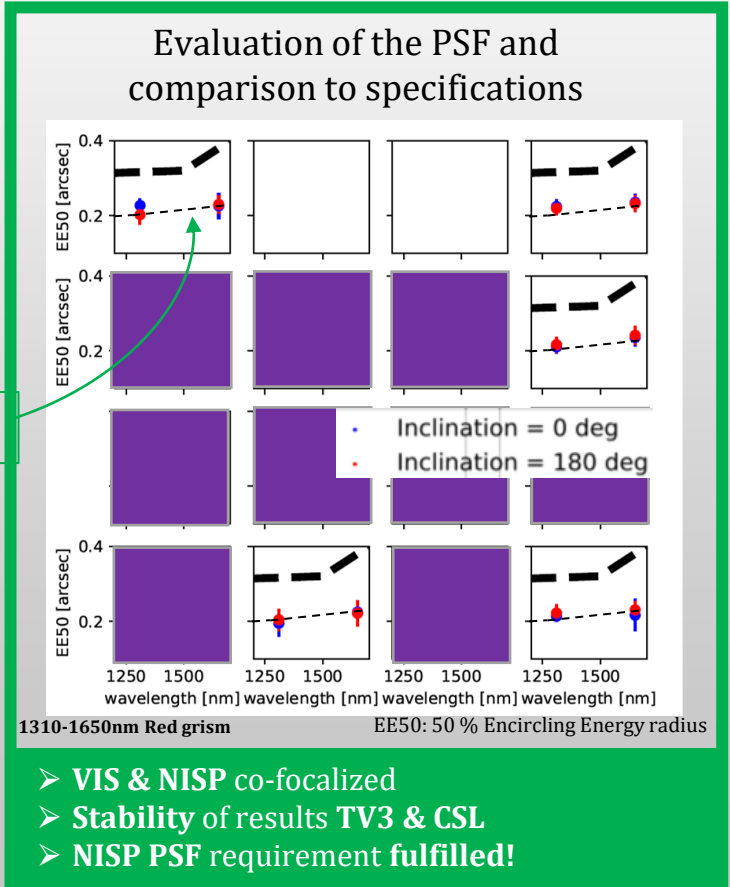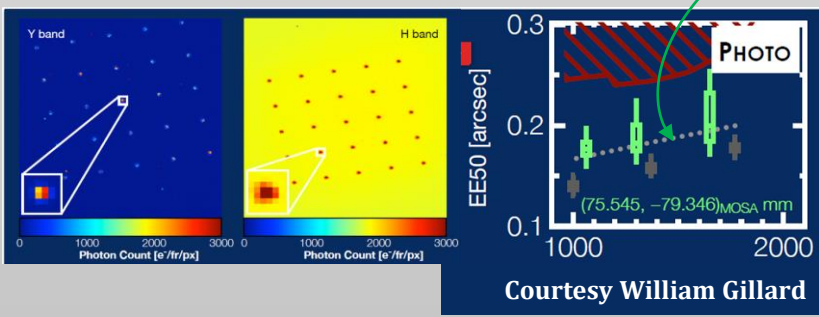- ➤ **VIS an NISP's** PSFs are monitored **simultaneously**
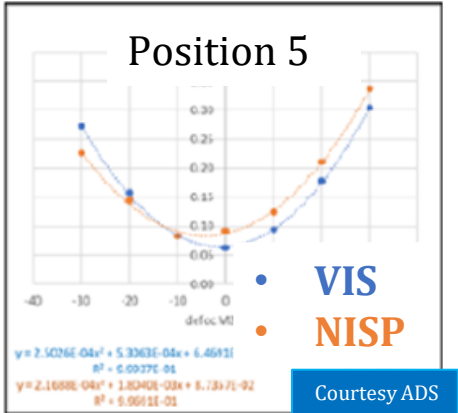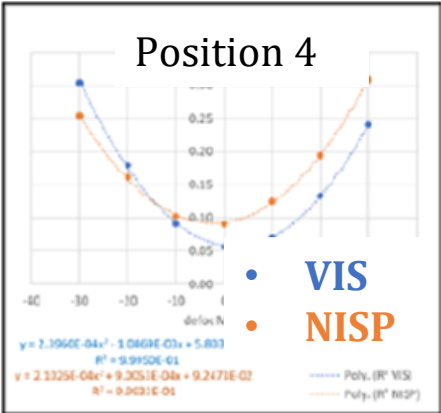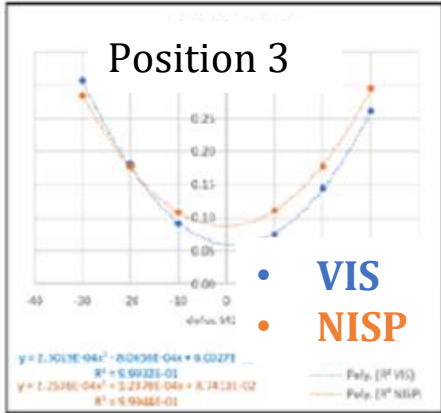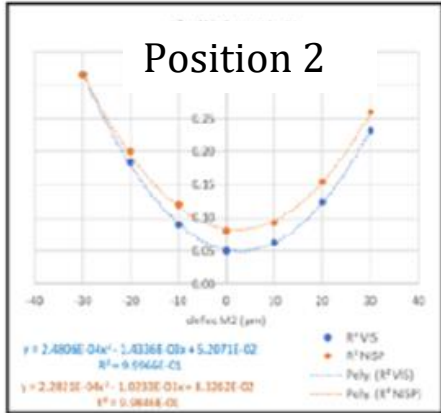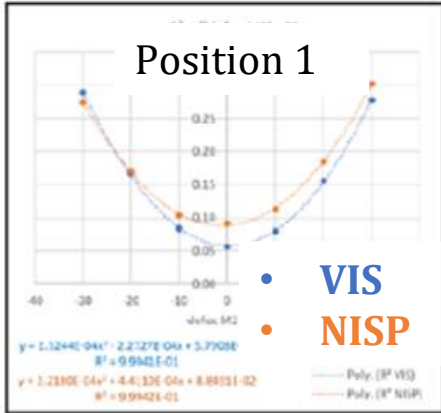
NISP Optical quality assessment:
PLM level @ CSL 2021

('Sigma_x-sigma_y', 0.65, 0.64)   ('coord', 1960, 1053)

- ➤ **25 PSFs per acquisitions** (7 out of 16 detectors available)

- ➤ Probing PSF in **Y, J, H bands, BG, band & RG** in 5 tilt positions (**+0°, - 4°,+180°, +184°**, **+270°**)

Position of the PSFs pattern on the NISP Focal Plane

Inclination = 0 deg
Inclination = 180 deg

Results @ LAM

Courtesy William Gillard

Evaluation of the PSF and comparison to specifications

Inclination = 0 deg
Inclination = 180 deg

1310-1650nm Red grism   EE50: 50 % Encircling Energy radius

- ➤ **VIS & NISP** co-focalized
- ➤ **Stability** of results **TV3 & CSL**
- ➤ **NISP PSF** requirement **fulfilled!**

Louis Gabarra – 25/02/2022
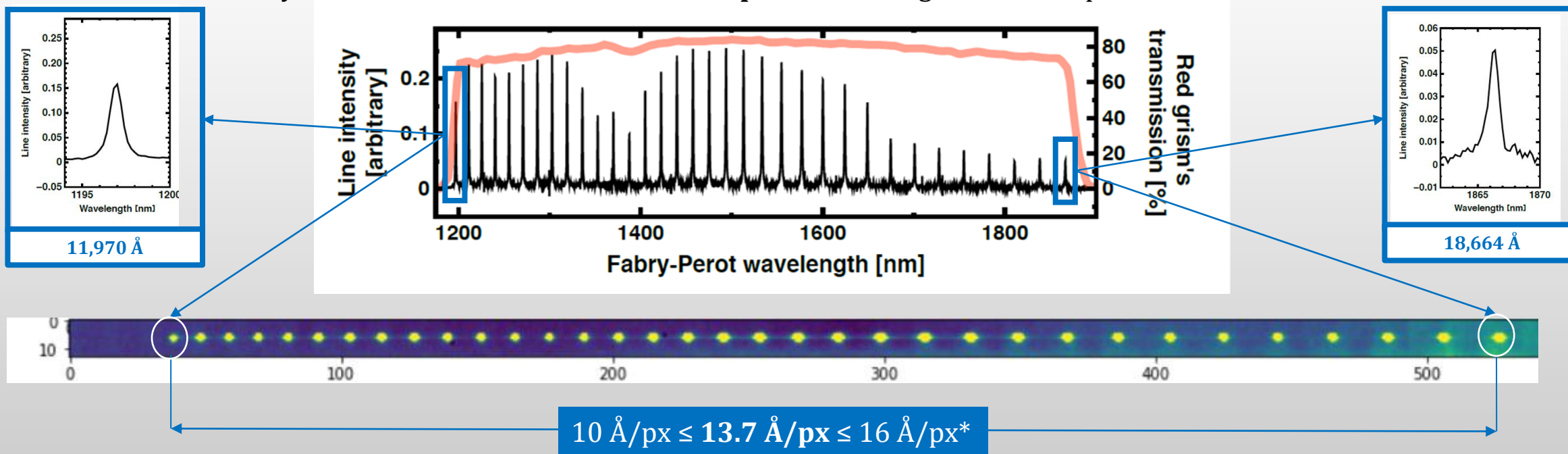
Spectral resolution:
PLM level @ CSL 2021

➢ **NISP spectral calibration** test sequence is performed using **multi emission-line source**

➜ A Fabry-Perot with about **33 transmission peaks** in each grism's band-pass

11,970 Å

18,664 Å

10 Å/px ≤ **13.7 Å/px** ≤ 16 Å/px*

*Mean resolution measured on an image taken with the RGS180 on detector 41 within the NISP specifications.

$\lambda_{obs} = \lambda_{int} (z + 1)$ and $\Delta z/z \leq 0.001$ for Hα at z = 1.5 translates into an accuracy required of **9.85 Å ⇔ 0.71 pixel**
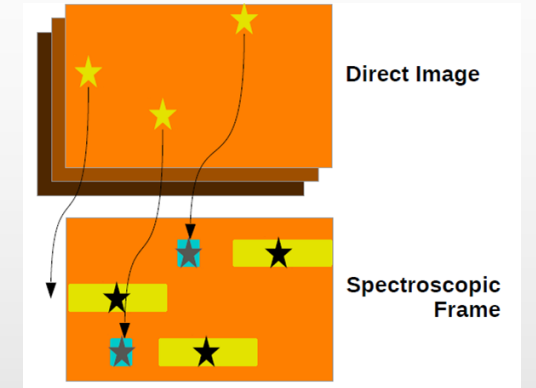
$\Delta z/z \leq 0.001$ ⇔ **σ_λ < 1 pixel!**

Resolution Validated for:
➢ BGS000 (12.4 Å/px)
➢ RGS000 (13.7 Å/px)
➢ RGS180 (13.7 Å/px)

Spectral calibration:
PLM level @ CSL 2021

➢ **Location of the zeroth order** centroid position using **TV3 calibration and optical model**

➢ Spectral attenuation @ PLM level induced by the fiber used to couple the light source

Direct Image

Spectroscopic Frame

Courtesy Marco Fumana - OUSIR

Comparison between RGS000 PLM spectra (*colour*) and TV3 spectra (*contour*)

Comparison between BGS000 PLM spectra (*colour*) and TV3 spectra (*contour*)

Courtesy William Gillard

Consistent with spectral calibration @ LAM

Simulations of the NISP spectroscopic channel using OU-SIM + OU-SIR

- ➤ **Comparison** of the **OU-SIM output** with **results from the test campaign**

- ➤ **Predictions on systematics** (ReadoutNoise, DarkCurrent, spectral & astrometric distortion, zodiacal light, quantum efficiency, persistence ....)

<u>**OU-SIM**</u>
Generates **simulated images** of the NISP
INPUT:
- ➤ Catalogs and Spectra of **Stars and Galaxies**
- ➤ List of **parameters** (e.g. **Source of noises** to be considered**)**
OUTPUT:

<u>**OU-SIR**</u>
Data reduction of the images to extract spectra
INPUT:
- ➤ Output from **OU-SIM &**
- ➤ **Images** from test campaigns performed **@ LAM & CSL**
OUTPUT:

Simulations of the NISP spectroscopic channel using OU-SIM + OU-SIR
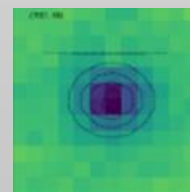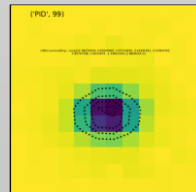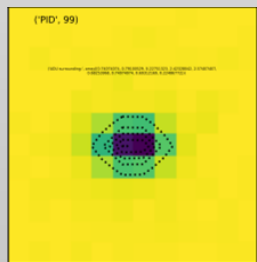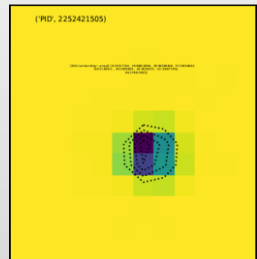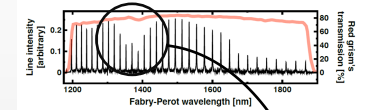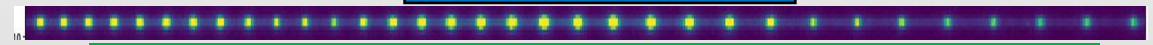
Conclusion

➢ **VIS** and **NISP co-focalized** at **PLM** level

➢ **Stability of performance** during the two test campaigns (**LAM & CSL**)

➢ **NISP specifications fulfilled** in term of optimal quality of images for both **photometric and spectroscopic channels**

➢ **Simulations** analysis **in progress**