DISPERS

Deep learning for slit-less Spectroscopic Redshift survey Simulator

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ANR funding, project begin October 1st 2022

+ 1 PhD, starting October 1st
+ 1 postdoc, recrutement early 2023

CNRS funding:

+ Apprentice, recrutement now

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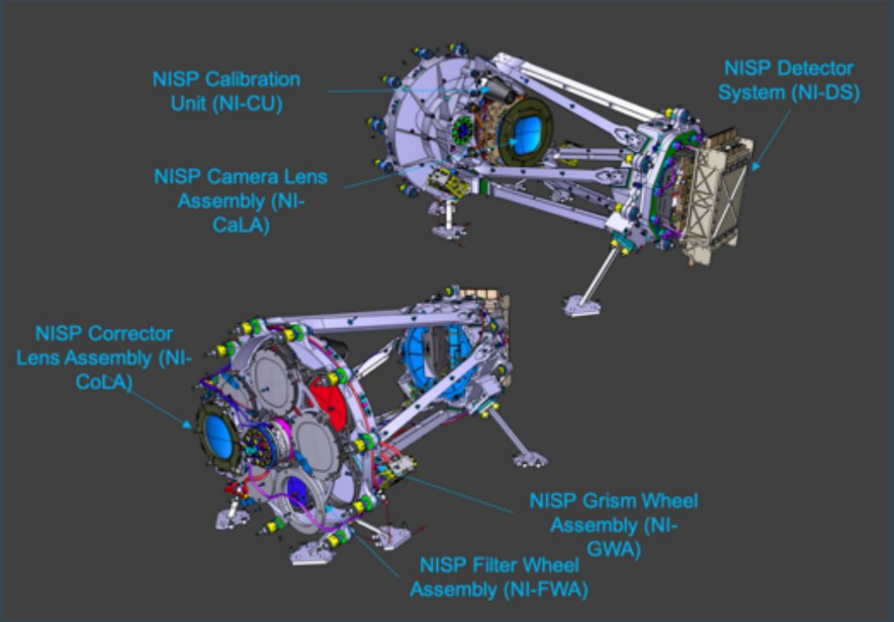
Context: Euclid Mission in 1 slide

- ESA mission
- Goal: investigate the nature of dark energy, dark matter, and gravity
- Main probes: cosmic shear and matter power spectrum
- Instruments:
  - Visible Imager (VIS)
  - Near-Infrared Slitless Spectro-Photometer (NISP)
- Main Surveys:
  - Wide Survey covering 15,000 deg2
  - Deep Fields (2 magnitude deeper) covering ~40 deg2

Credit: ESA/ATG medialab

Context: Euclid NISP in 1 slide

- Filter/Grism Wheel
  - 3 photometric filters [Y, J, H]
  - 3 “red” grism [1.25, 1.85] µm
    + 1 “blue” grism [0.92, 1.30] µm
- Focal plane:
  - 4x4 near-infrared detectors
  - 2k x 2k pixels each
- Field of view 0.7 deg2
- Spatial resolution 0.3”/pix
- Spectral resolution 13.5 Å/px

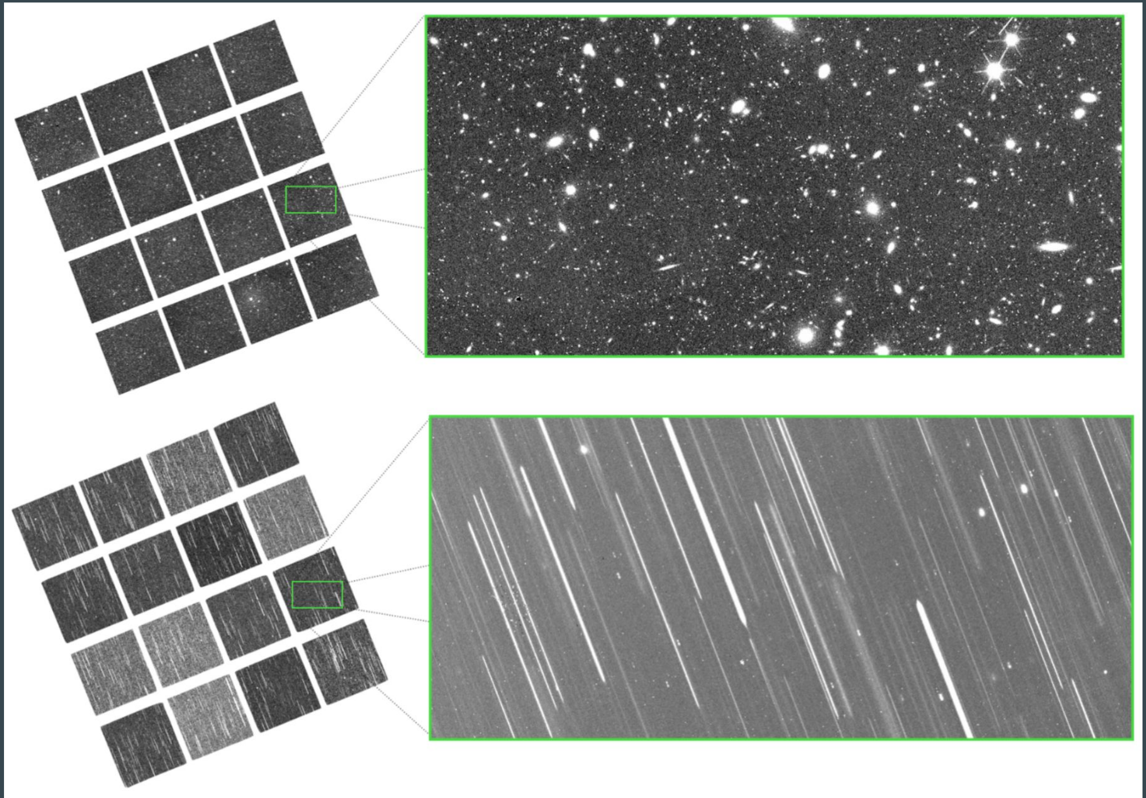


credit: Euclid/NISP team

Example: simulation of the NISP exposure

Simulated NISP-Photo exposure (H-band)

Simulated NISP-Spectro exposure (one of the red grism)



credit: Serrano et al in prep

Motivations

Realistic simulations of sky images are essential

- to prepare and validate the mission strategy and the ground segment pipelines
- to monitor of the scientific performances along the mission lifetime
- to control the various systematic errors that arise at all levels of the analysis

Current spectroscopic simulation approach are based on parametric models and external data (Walsh 2010, Zoubian 2014) and the simulation complexity

- limit our capacity to provide large simulation for the survey preparation
- (almost) exclude the usage of the simulation in the data reduction and the analysis
- limit our capability to identify and to interpret systematic effects due to instrumental features.

Objectives and strategy

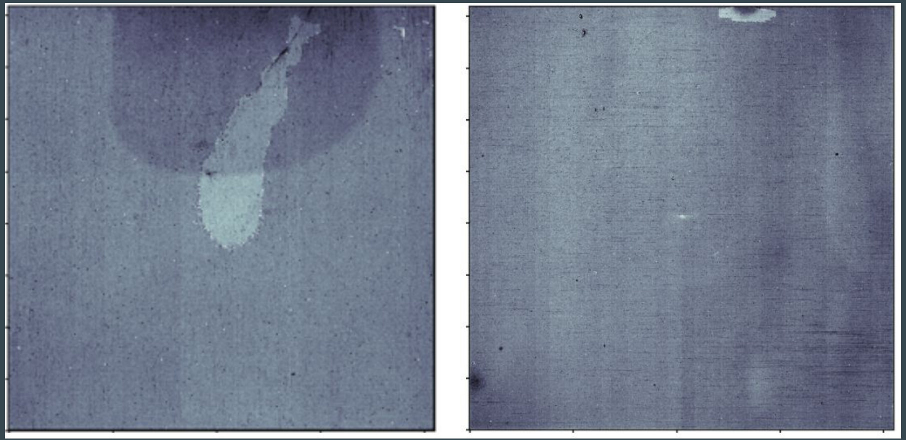
- Exploit the data acquired during the instrument test campaigns
- Take advantage of the ML/DL technics developed for photometry (Guilloteau 2019, Razavi 2019, Smith 2019, Lanusse 2020)
- Combine simple physical models of the instrument with machine learning models

1 framework and 4 axis of work:

- Calibration models
- PSF models
- Detector models
- Simulation models

Data: detector characterization

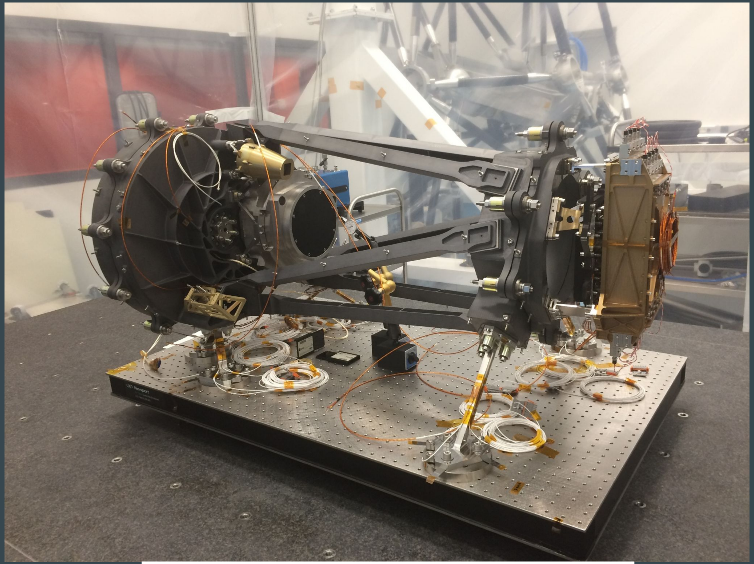
- 20 flight detectors have been characterized by CNRS/IN2P3 between 2018 and 2019
- under vacuum and at operational temperature (80-85-90 K)
- darks and flats
- 20 Tb of data
- 24 millions of images

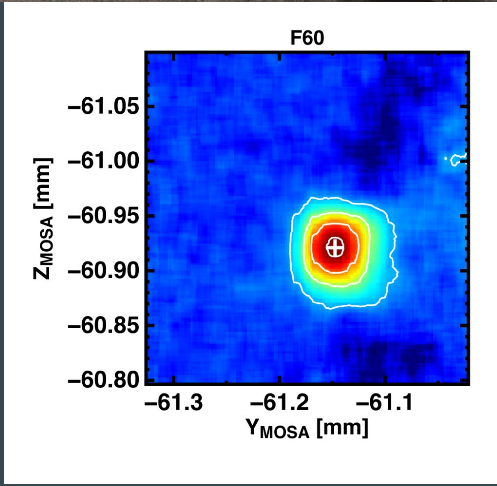


Secroun 2018

Data: TB/TV test campaigns

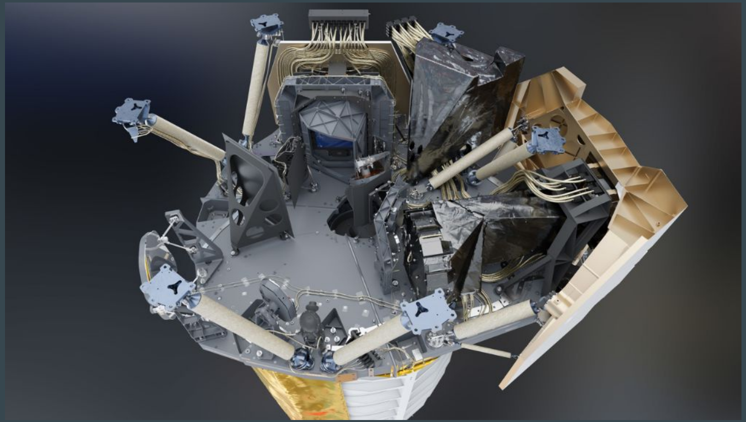
- NISP in standalone
- 4 campaigns - 1 to 2 month
- under vacuum and at operational temperature
- functional tests and performance validation
- 600 images of PSF with monochromatic sources
- 1152 images of the polychromatic source

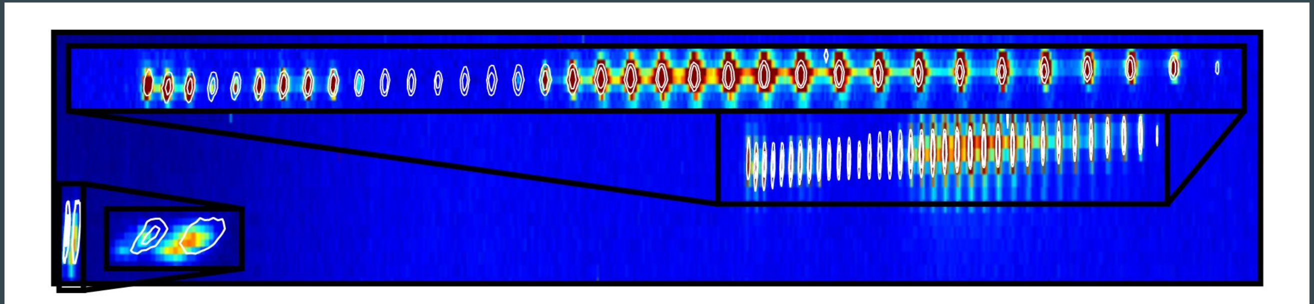




Data: PLM test campaigns

- NISP instrument with the optics of the telescope
- under vacuum and at operational temperature
- telecope with gravity
- 1400 images of PSF with monochromatic sources
- 119 images of the polychromatic source





Data: conclusion

- 20 Tb of detector data
- about 16300 PSF and 1271 spectra but with different setup
- The Euclid/NISP team also developped a ray tracing optical model
  - fed to our dataset to fill in the gap where ground test data are missing
  - and to fill the gap between the different setups
- In-flight data to verify the flight model and monitor stability of the instrument
  - The performance verification (PV)
    after Euclid launch, will last for two months while
  - Routine phase (RP) calibration
    every month
  - Validation and tuning of the models