Euclid: OU-SIR and the Spectra Reduction pipeline

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on the behalf of OU-SIR people

IASF & spectroscopy

Instrument	***Software***	***Project***	***Amount of spectra***
VIMOS	VIPGI&EZ	VVDS	~35,000 spectra (Le Fèvre et al., 2005)
		zCosmos	~27,000 spectra (Lilly et al., 2009)
		VUDS	~10,000 spectra (Le Fèvre et al., 2016)
VIMOS	Easylife	VIPERS	~90,000 spectra (Scodeggio et al., 2018)
		VANDELS	~2000 spectra (Pentericci et al., 2018)
LUCI	lreducer	LBT Italy	PI Programs
MODS	vreducer		
NISP-S	**SIR pipeline**	**Euclid**	**~50,000 spectra per pointing ~30,000 pointings (OU-lead Scodeggio)**

Software and validation of data products must be automatic

Euclid mission

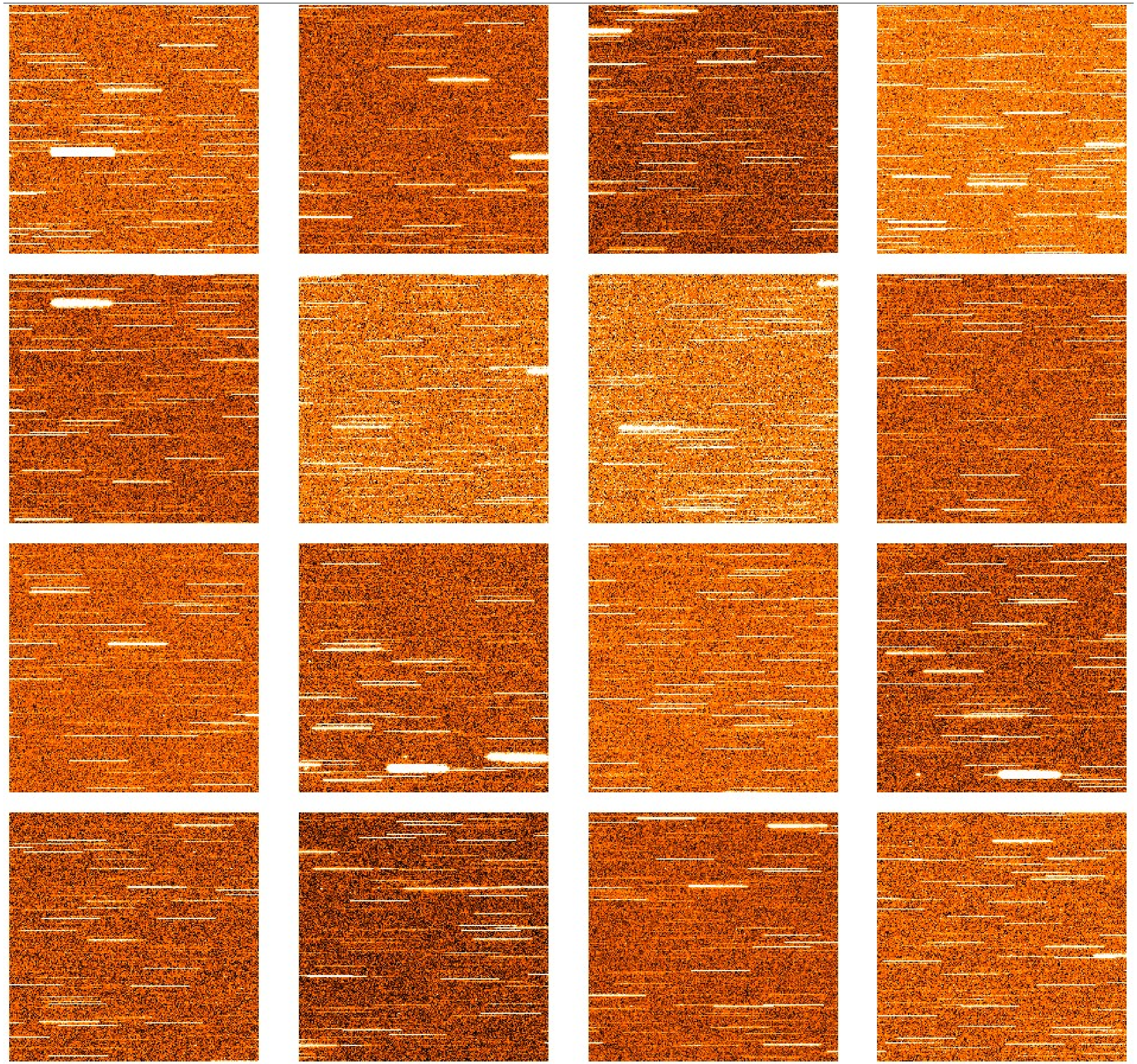
- ESA mission, M size
- Wide survey: ~15,000 deg^2, $H_{AB} < 24$
- Deep survey: ~ 40 deg^2, $H_{AB} < 26$
- Investigate the nature of dark energy and dark matter
- Independent cosmological probes:
  - Weak gravitational lensing
  - Baryonic acoustic oscillations
    - Spectroscopic redshifts required: **NISP-S**

NISP-S instrument

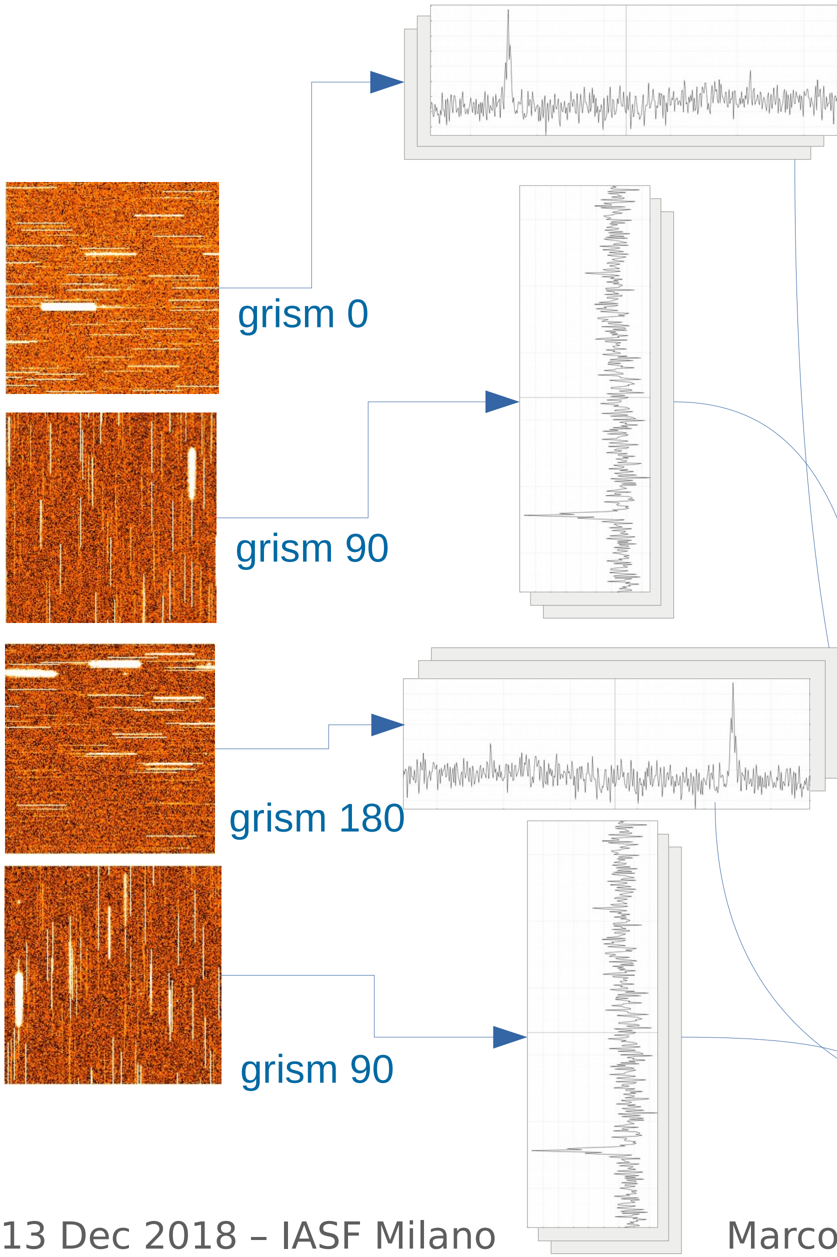
- NISP-S: **slitless** spectrograph
- Wavelength range: **12500-18500 Å**
- Redshift range: **$0.9 < z < 1.8$**
- Nominal linear dispersion: **13.4 Å / pixel**
- FOV: ~0.55 deg^2 covered by a 4x4 detectors grid
- Observing sequence: 3 photometric exposures, **1 spectroscopic exposure**
- **4 spectroscopic exposures** for each pointing at 3 different grism orientations: 0, 90, 180, 90

Simulated full NISP-S FOV

- SC3 data
- $H_{AB} < 24$
- $H_{\alpha} > 2 \cdot 10^{-16}$
- $0.9 < z < 1.8$



Main SIR data products

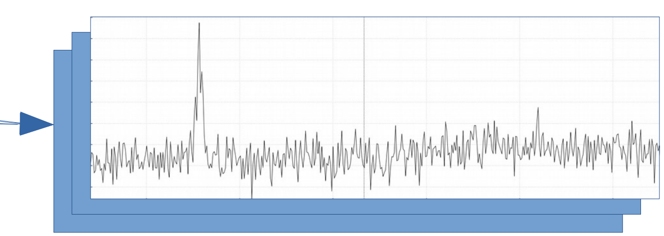


Inputs

- Level 1 raw exposures
- Catalog (H_{AB} < 24)

For each object collected into the input catalog, the SIR pipeline **must produce**

- 1D spectrum for each orientation
- 1D combined spectrum
- Both wavelength and flux calibrated



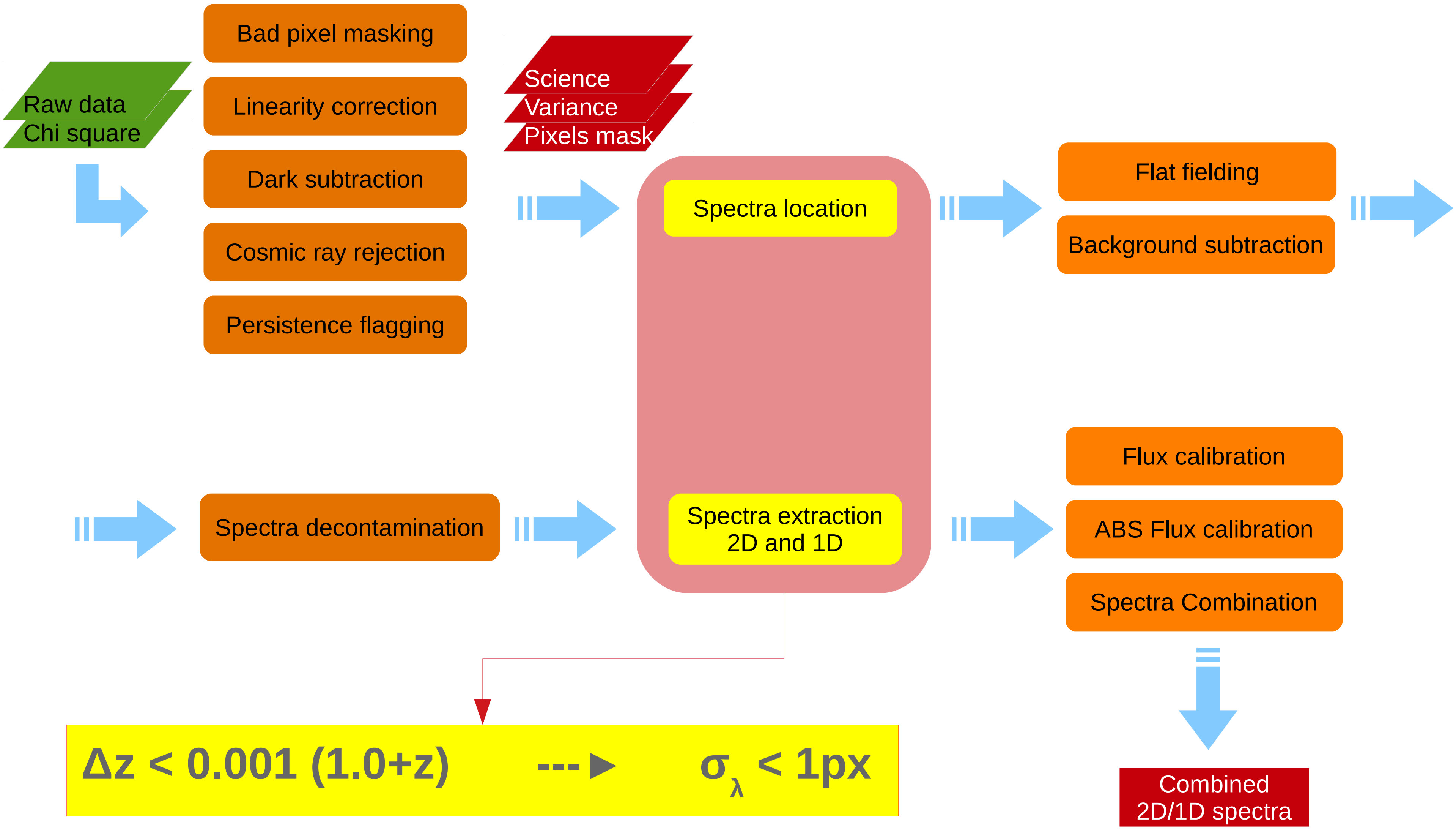
DP: quality requirements

All quality requirements (see GDPRD document) on 1D extracted spectra can be roughly summarized into

- Wavelength calibration accuracy:
  $\Delta z < 0.001\,(1. + z)$ $\sigma_\lambda < 1$ pixel

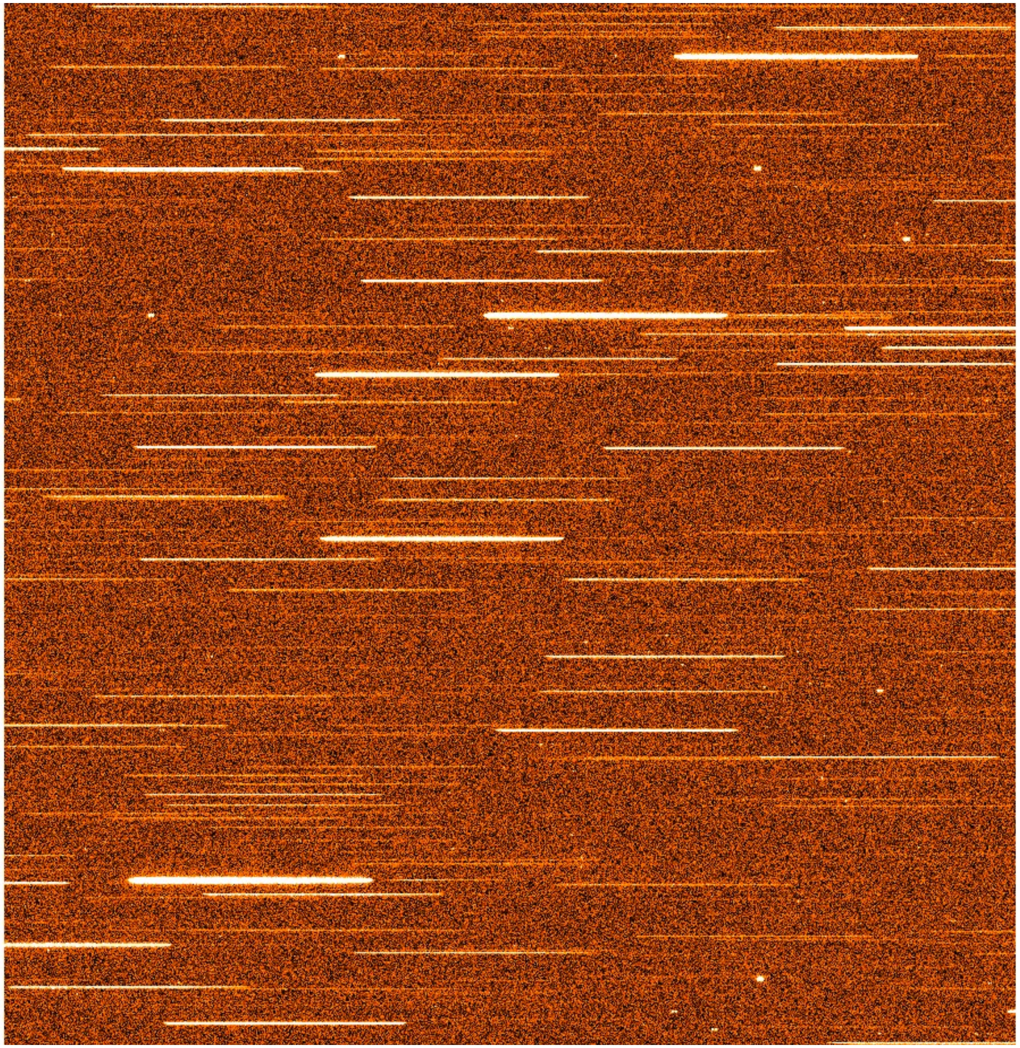
- Flux calibration accuracy:
  - Accuracy on single exposure < 3.5%
  - Variations pointing to pointing < 0.7%

Wavelength calibration



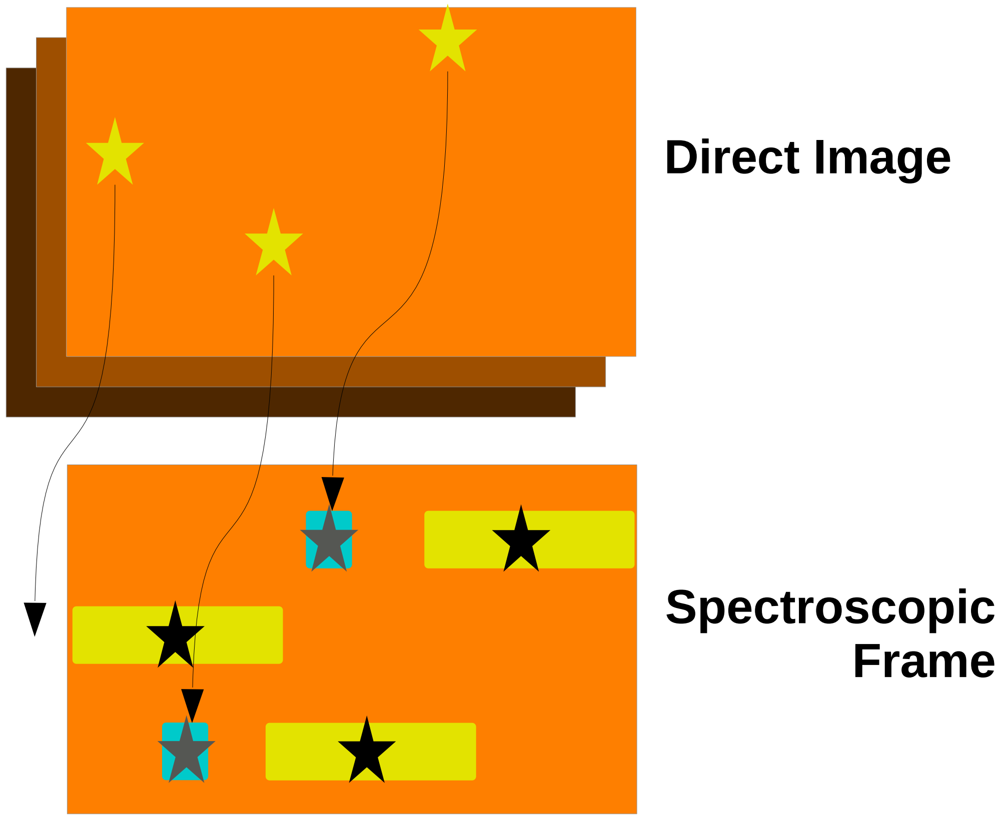
Spectra location

- Wavelength calibration depends on object positions
- Object positions are not measurable on dispersed images
- Pointing uncertainty: ± 5“



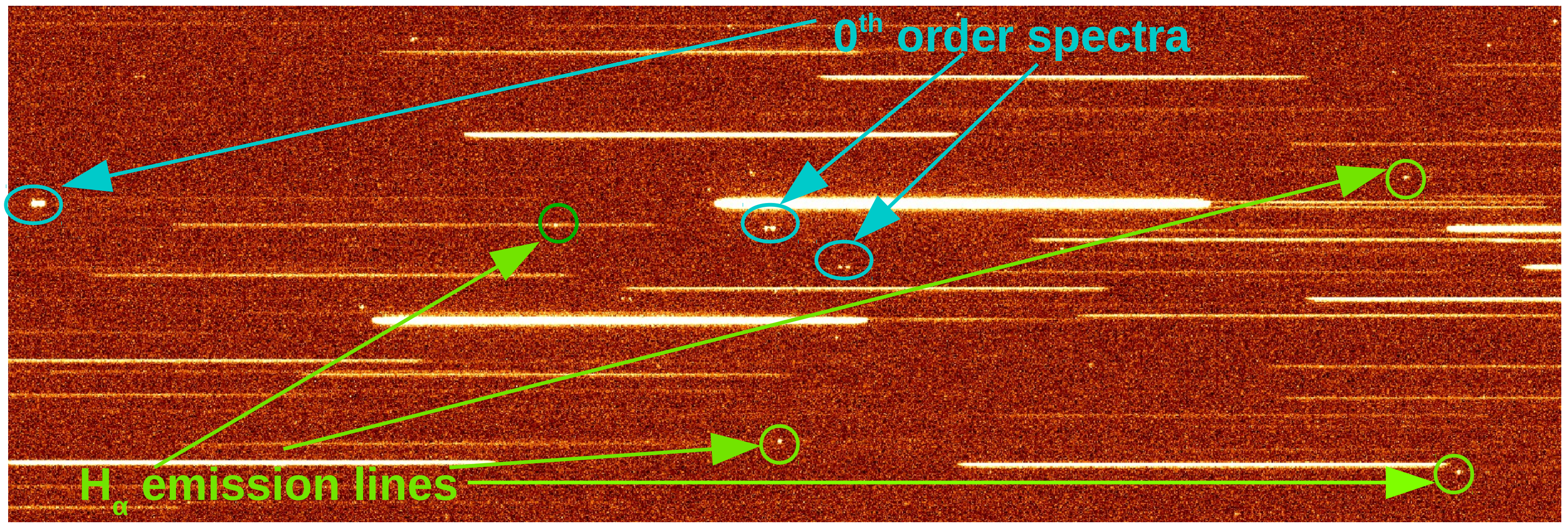
Compute the real pointing

0^{th} orders location



0^{th} order positions of:

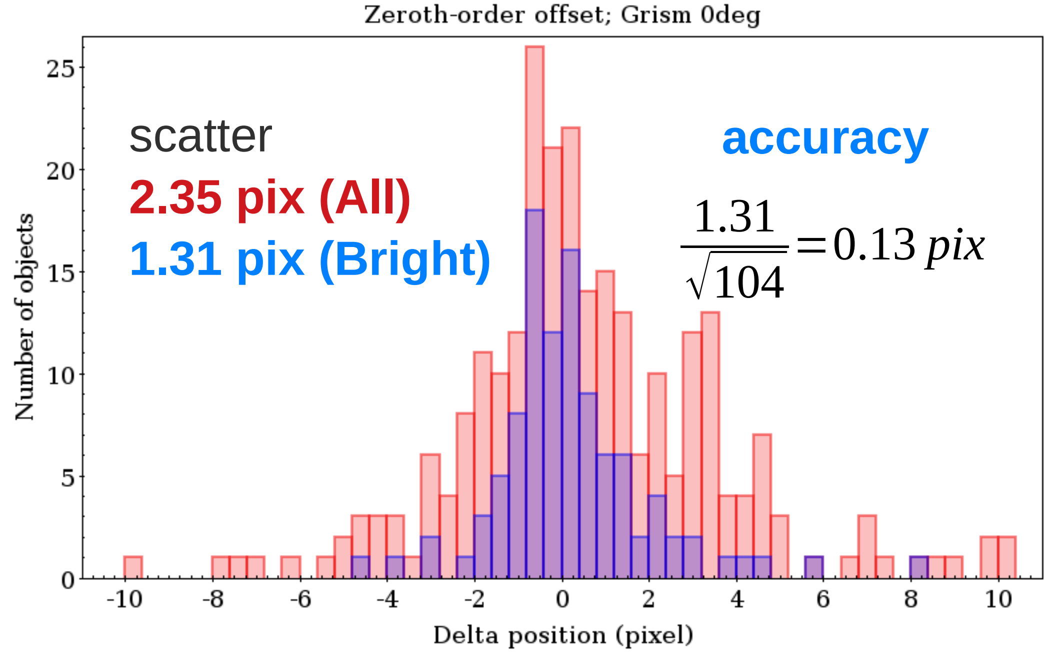
- Bright stars
- Not saturated

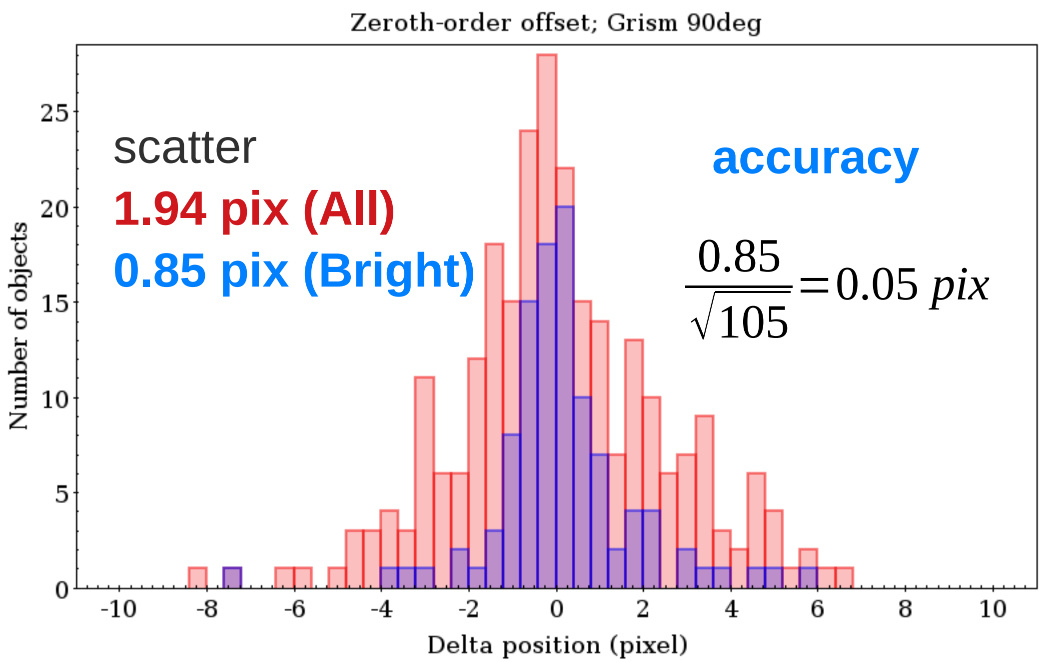


Pointing accuracy

All: J mag < 18

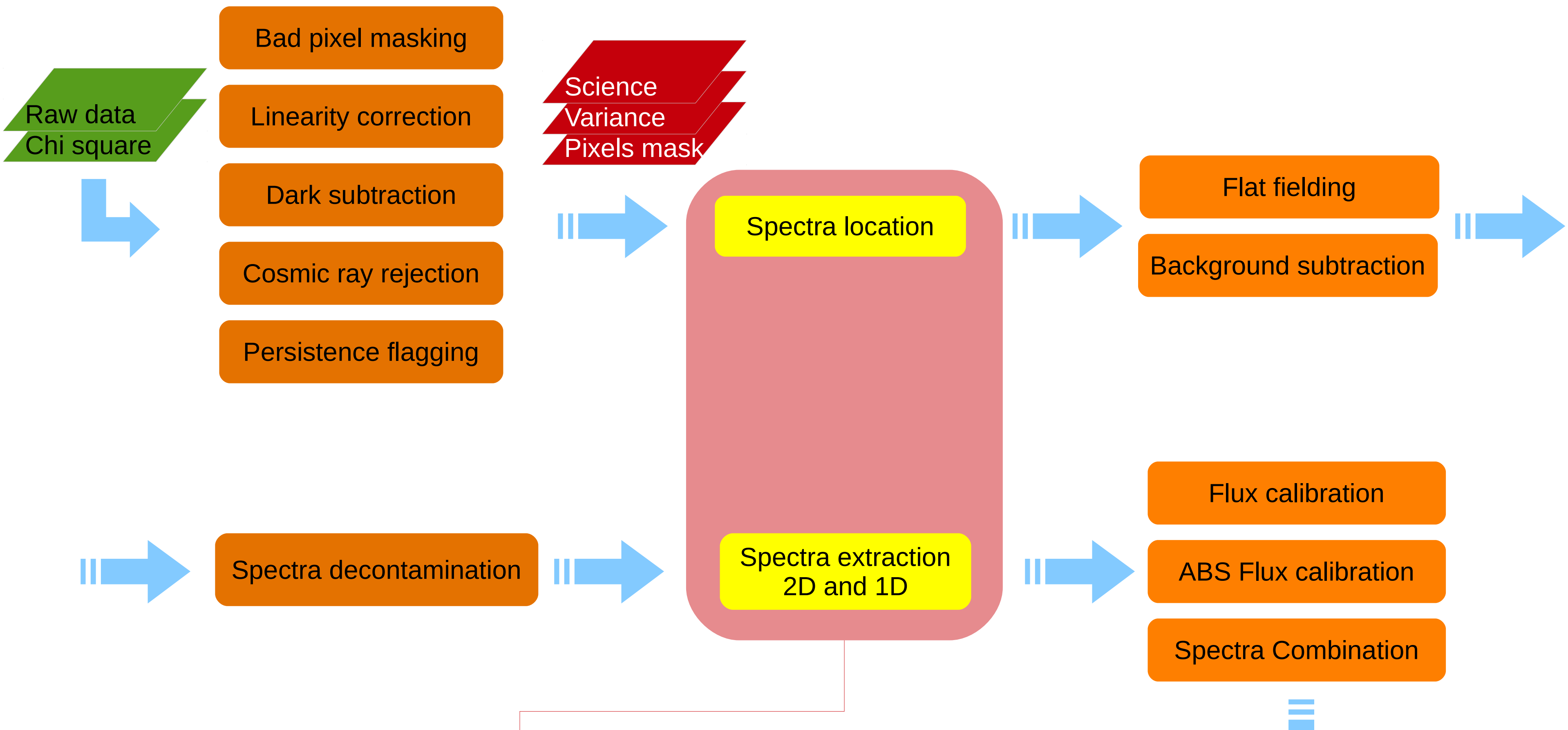
Bright: J mag < 16





Requirement < 0.3 pixel

Wavelength calibration

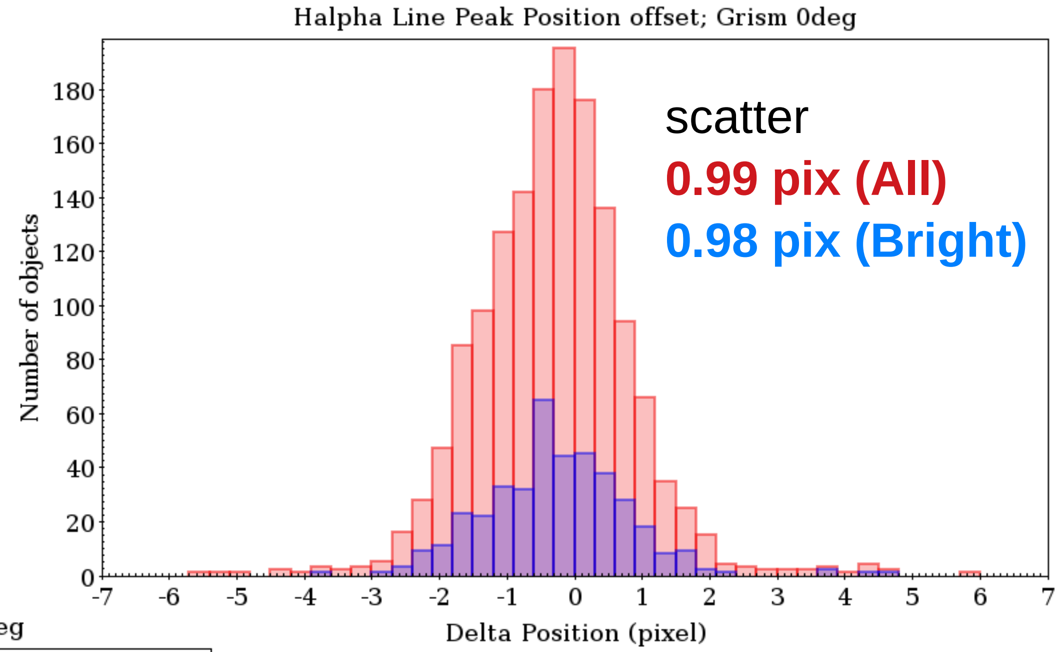


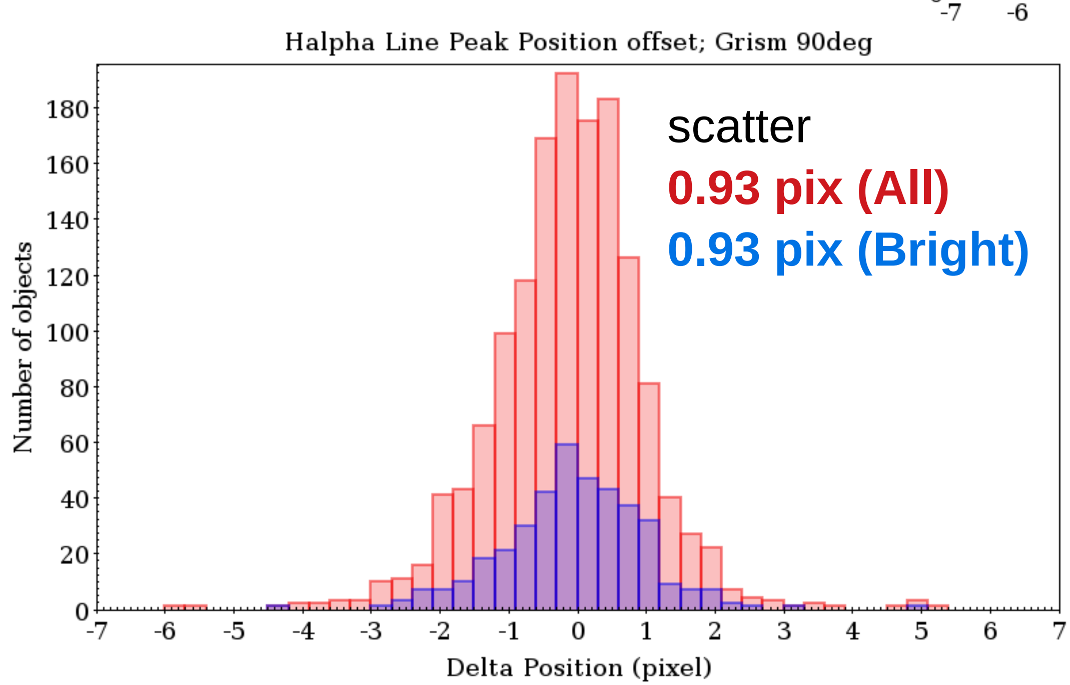
$\Delta z < 0.001\,(1.0+z)$ ---► $\sigma_\lambda < 1px$

Overall line position accuracy

All: $H_\alpha > 2\cdot10^{-16}$

Bright: $H_\alpha > 2\cdot10^{-15}$





Requirement < 1 pixel

Use star features

P. Battaglia PhD Thesis

Conclusions & discussion

- SC3 data products: compliant with requirements
- Unfortunately: no improvements can be tested yet for SC456, since simulated data so far do not contain the need instrumental effects

- Lots of spectra with good wavelength and flux calibration (not useful for cosmological probes of the Euclid mission), extracted and available:
  - Local universe (Paschen lines)
  - Stars
  - Any use of 2D spectra?
  - Any other interesting scientific case?

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