Preparation of the Euclid mission : study of the correlations, at the pixel level, of the infrared detectors' response

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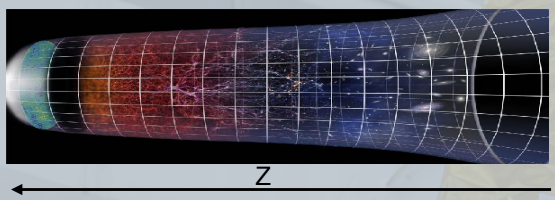
Euclid mission

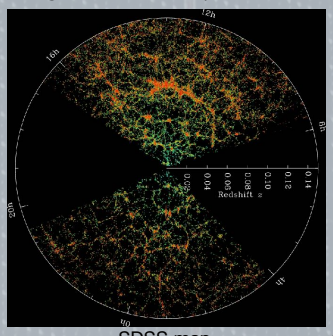
Objective : Understanding composition and evolution of the Universe



Universe expansion stretches light wavelengths creating redshift z

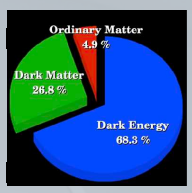
Method : map the 3D universe (40% celestial sphere)

- Photometry : angle position of matter
- Spectroscopy : distance of matter using redshift of Hα (656 nm at rest)



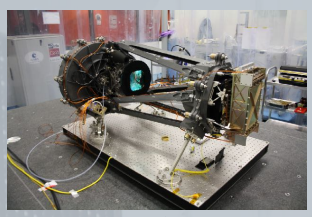
SDSS map

Λ CDM



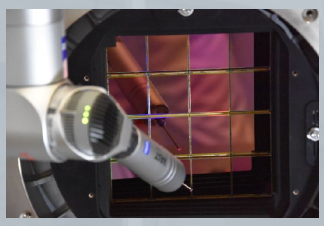
- Standard model
- Predict observations
  - Accelerated expansion (Λ)
  - Invisible matter (CDM)
- Euclid will constrain Λ CDM parameters

Near Infrared Spectrophotometer



Scientific needs	Technical solutions
0.8 < z < 1.8 3.5B < age of universe < 6.5B	Spectral band : 0.9 - 2 µm in Y, J and H
	Field of view 0.5 deg²
40B redshifts (slitless spectroscopy)	4 grims Grating Prism Filter
Very faint galaxies (~2 photons/s/px)	Ultra low noise detectors

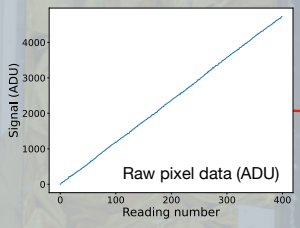
NISP Detectors

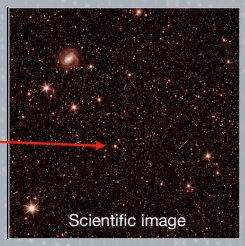


- 16 H2RG detectors
- 2048x2048 pixels
- λ cutoff 2.3 µm
- Non destructive readout

From raw data to scientific images, pixel's response needs to be corrected

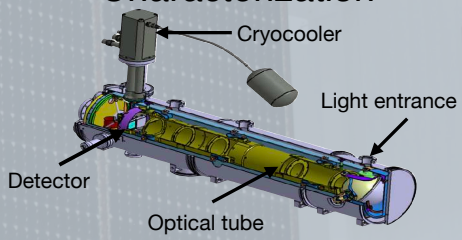
Photons → *electrons* → *V* → *ADU*





→ Per pixel characterization is mandatory

Characterization



To simulate space environments, we used a cryostat with cryocooling, vacuum pumping and thermal regulation. A LED is used to create uniform illumination.

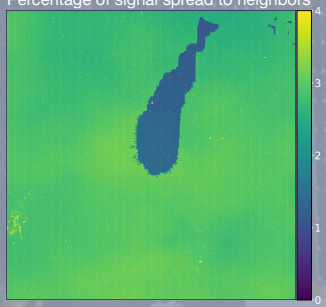
- Detector Temperature: 90K
- Pressure: 5.10^{-6} mbar
- Dark: < 4 photons/hour/pixel
- LED homogeneity: 1% on detector

Interpixel capacitance

The proximity of pixels produces an electrostatic coupling named **IPC** that causes the signal detected by a pixel to spread to its neighbors.

- Causes the galaxies to seems broader
- Currently measured per detector
- Euclid needs per pixel measures

Percentage of signal spread to neighbors

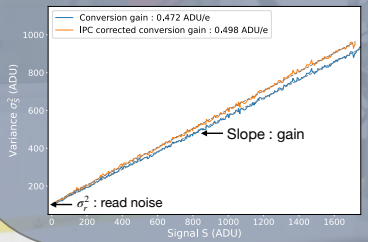


Results

- Adapted Single Pixel Reset method to produce per pixel IPC Maps
- Difference between green and blue region > 120%
- 20% variations in yellow-green region
- Adopted by Euclid consortium

Conversion gain

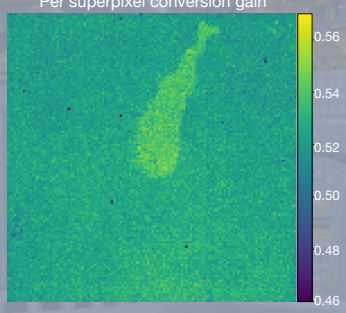
Conversion gain in ADU/e is the number of ADUs that represents an electron. Measured by mean variance method : $\sigma_S^2 = G * S + \sigma_R^2$



Adaptation of the classical method

- Variance and mean estimated spatially on super pixels
- Correction of IPC effect (decreases variance)
- Non linearity (NL) of pixel's response taken into account

Per superpixel conversion gain



Results

- Error on gain < 1%
- Bias due to IPC and NL of 6% corrected
- Spatial variations > 5 %
- Method submitted to EC

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