STUDY OF PERSISTENCE AND COSMICS IMPACT ON EUCLID INFRARED DETECTORS

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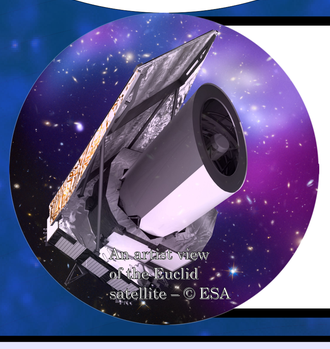


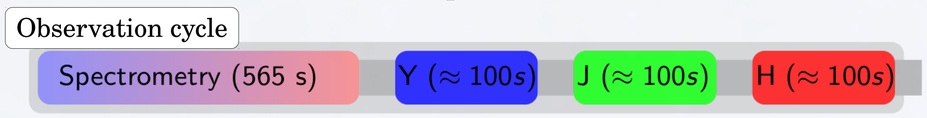
Euclid is a wide-field mission for the cartography of the dark Universe lead by European Space Agency (ESA) and the Euclid Consortium that is to launch on 2020. This mission was selected within the Cosmic Vision program and aims at bringing more understanding on the nature of the recent acceleration of the expansion of the Universe and the possible related nature of dark matter and dark energy. To fulfill this goal, the payload will consist of two instruments: VIS & NISP, one will focus on studying the weak-lensing effect on galaxies, the other will study the BAO effect on galaxy distributions.

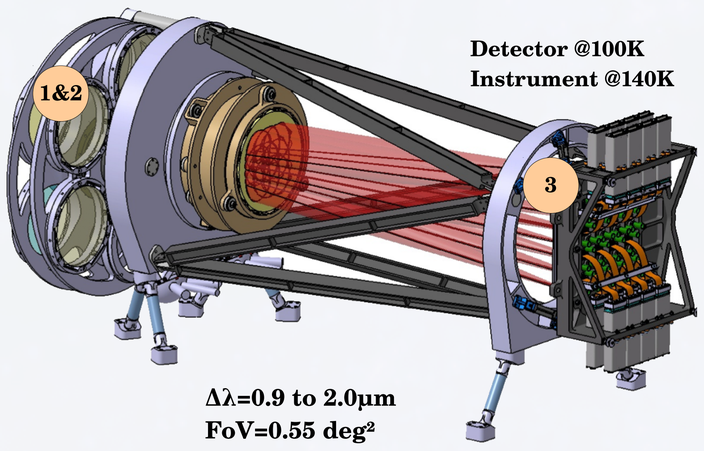
The NISP instrument

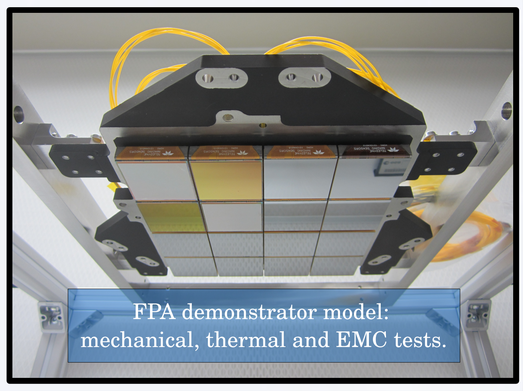
Challenging instrument for cosmology...

The NISP instrument has two main observing modes: the photometric mode, where the position of the galaxies will be acquired with high quality resolution (0.3 arcsec per pixel), and the spectroscopic mode, based on slitless spectroscopy, for the acquisition of spectrum that will be used to compute the distance of the observed galaxy.

Observation cycle







1 Photometer
Y, J, H filters
0.3"/pixel
100s exposure

2 Slitless spectrometer
3 red and 1 blue grisms
R >360 for 0.5" source
560s exposure

3 NISP IR (H2RG) detectors
- 16 detectors in the FPA
- 2048x2048 hybrid pixels
- 18μm pitch / 2.3μm cut-off
- Provided by TIS under ESA/NASA contract

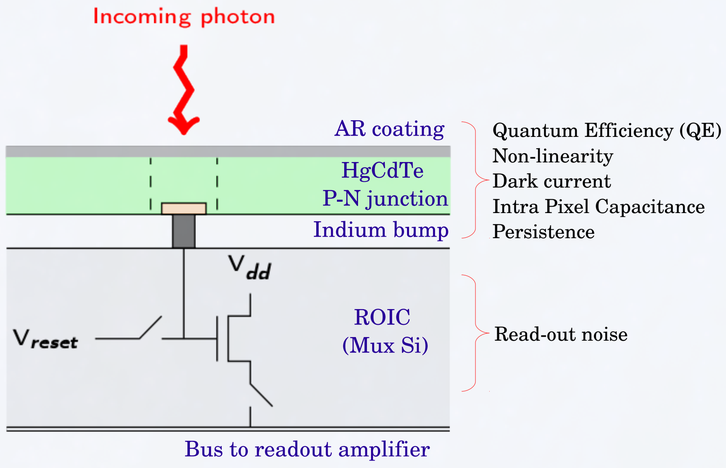
Good knowledge of the instrument
Specifications require high accuracy and low noise

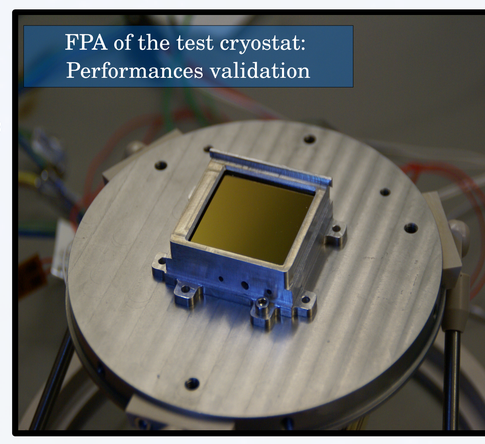
NISP detector specifications

High performances low noise detectors in space...

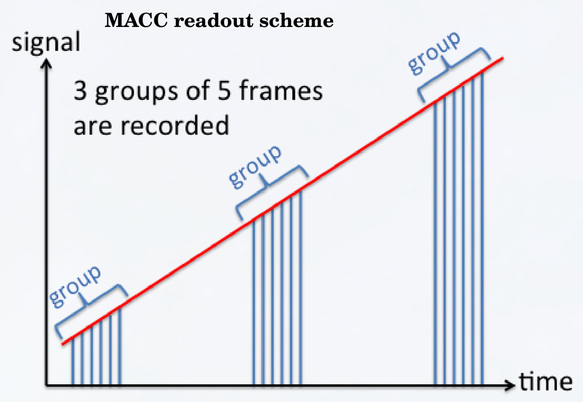
/renoir/serra/Shared_documents

Hybrid pixel techonology





Readout strategy optimized for low noise performances– Non destructive MACC



- Average down readout noise
  Photo :MACC(3/4,16,xx)
  Spectro :MACC(15,16,13)
- Detection of cosmic rays

Limited telemetry
- Compute χ^2 on board
- Transfer of slopes and χ^2 of least square fit

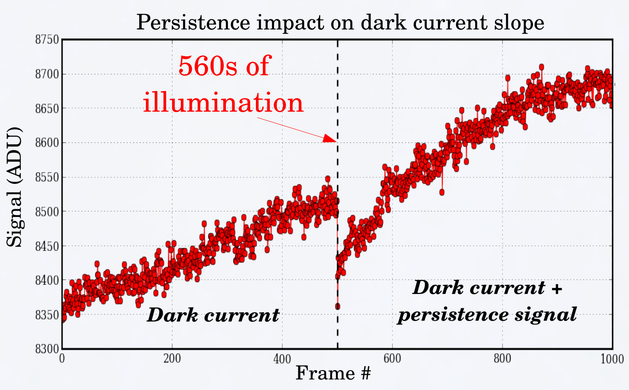
Study of particular effects impacting slope measurements

Persistence & Cosmics studies

Correction or elimination...

Persistence

The H2RG detector shows strong persistence effect with long decay time due to trapped charges.



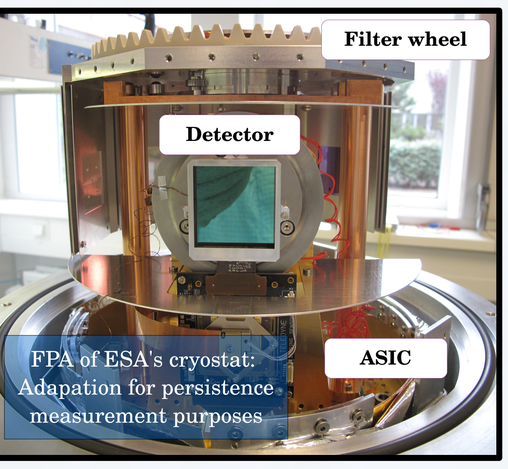
Objectives

A full plan has been set to :
- characterize the effect
- develop realistic models for simulations
- develop correction procedure

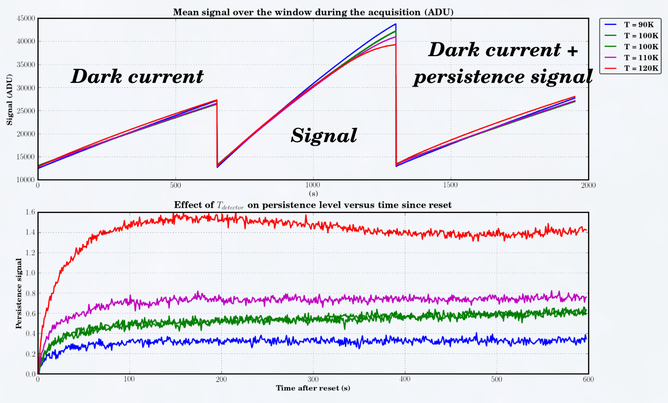
Status

- decay models have been developed
- use CPPM set up to validate models under different configurations
- use consortium data (provided by ESA, NASA..) to test different configurations

Tests plan for persistence provided to ESA and data delivered in september.
Observation scheme : reference dark exposure + not saturated signal + dark exposure
Subtract reference dark slope from second observed dark to derive persistence signal

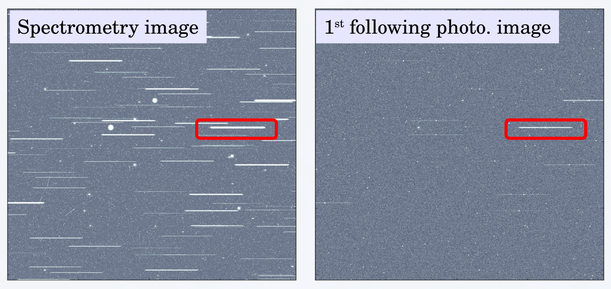


Temperature impact on persistence signal



NISP detector (TIPS) simulated with persistence: simple double decay model has been implemented

$$S_{persistence} = A \cdot \left(p_{slow} \cdot e^{-t \cdot \sigma_{slow}} + p_{fast} \cdot e^{-t \cdot \sigma_{fast}} \right)$$



Simulated frames using TIPS simulator

Decay can last up to a few hours !

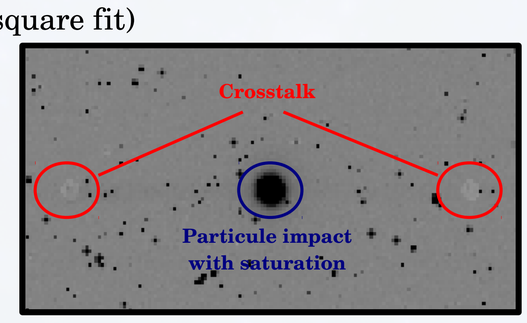
Parameter	Value for sim.
A	6.101389
p_{fast}	0.81
σ_{fast}	0.001885
p_{slow}	1-p_{fast}
σ_{slow}	σ_{slow}/10

Parameters for simulation using NASA-GSFC persistence data

Cosmics

Objectives

- cosmic rays impact final performances
- final science result depends on their incident energy and the possible correction algorithm
- use existing data to study their impact and rejection algorithms (using χ^2 least square fit)



Status

- current data shows large cosmic impact with saturation
- a full study of cosmic reconstruction and impact of diffusion is undergoing
- Reject all pixels and neighbors affected by saturation
- Account all neighbours when computing a non-saturated energy deposit of a particle on a pixel

Perspectives

Persistence model in detector simulator to be validated by analysis
Impact of observation time, flux, or source shape
Cosmics study ongoing using extracted energy spectrum

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