Functional tests and selection of detectors for JEDI

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together with ROB & CSL teams

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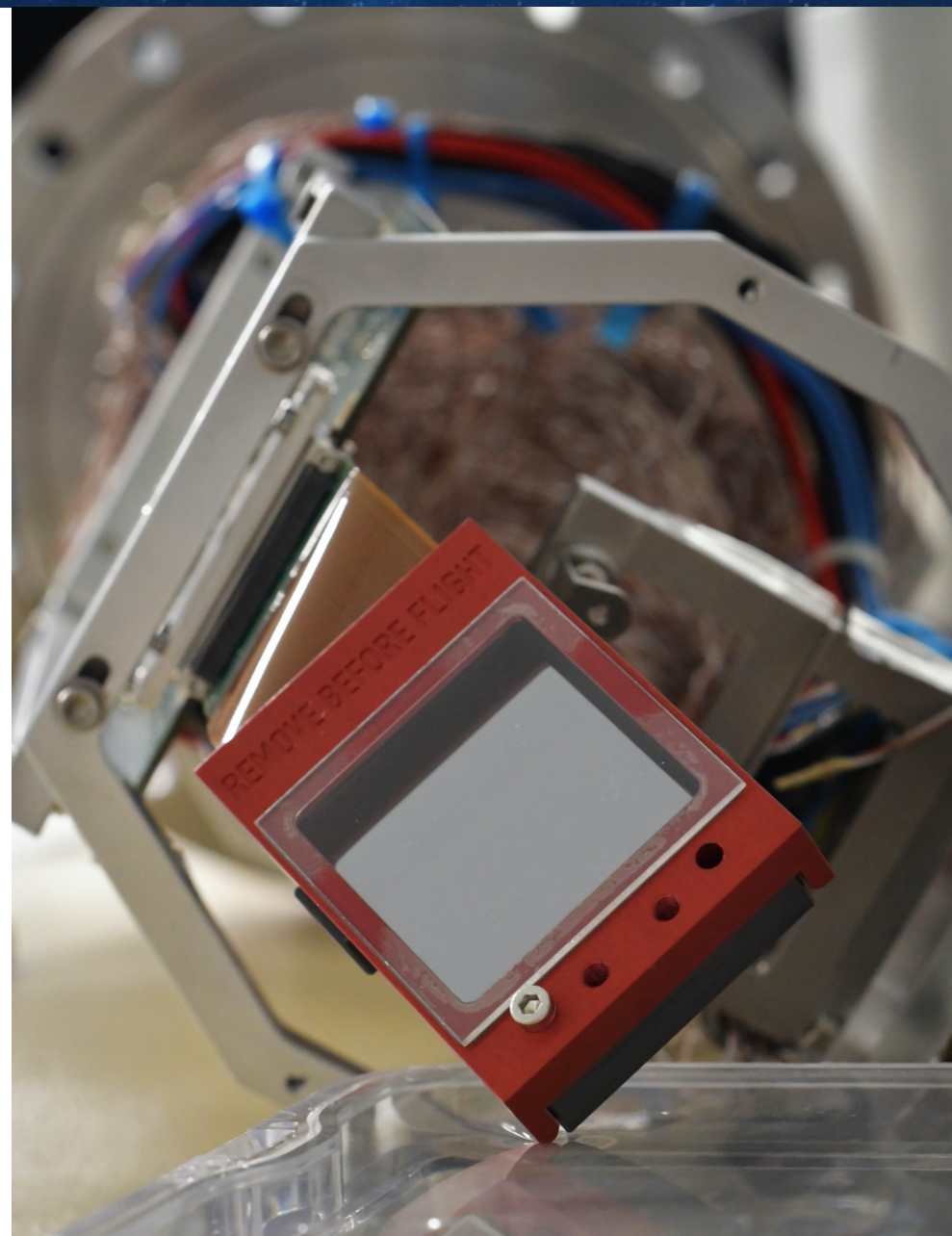
Main motivation

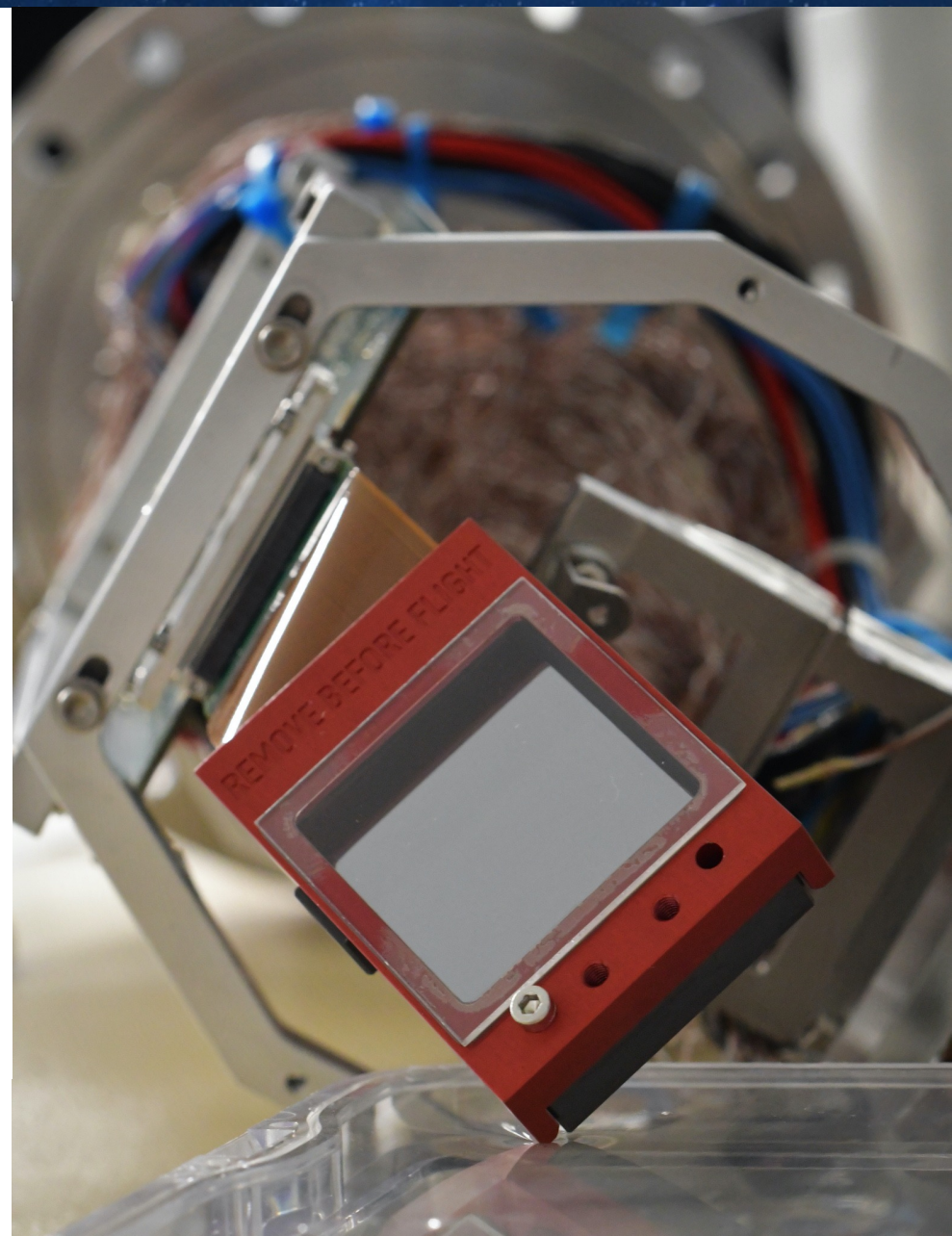
- To select the best “EUI” detector among ~10 available CMOS-BSI detectors* and provide basic characterization of its functionality.

* they are already stored in the CSL in a clean room (ISO 5) and ready for testing



Requirements comparison to heritage

Characteristic	EUI detector	PROJECT Requirement	Heritage Margin to PROJECT Req
Detector Format	3072 x 3072	3k x 3k	Complies
Pixel Pitch:	10 µm	10 µm	Complies
Full Well Charge:	> 80 ke (LG), > 5 ke (HG)	>80 ke (LG)	Complies
Dynamic Range:	> 84 dB (dual gain) @ -40°C		
Dark Current:	< 5 e/s/pix at -20°C	0.05 e/sec/pix at -50 °C (?)	
Readout Noise	< 5 e (HG) , < 50 e (LG)	2.8 e (HG) ?	
Radiation Hardness	100 krad	>50 krad	Complies
Operational Temp.	-60 / -40 °C	-60 / -40 °C	Complies
Output Read Rate:	13.6 Msps (1.5 fps 3kx3k)		



EUI BSI detectors will be submitted to the following tests:

1. Functional Test
   (this is the first test that will be applied to all available detectors in order select the best ones for the further, more detailed tests)

- Dark current measurements taken at **different integration time** and at **ambient** temperature

  - Expected results:
    - Dark noise as a function of integration time
    - Number and type of defects (bright/dark pixels, rows etc)
    - Power consumption (should be less than 1 watt of power)

EUI BSI detectors will be submitted to the following tests:

2. Detector Performance Tests
   (those are the tests that will be applied to the "short-listed" detectors in order select the best "flying" one)

- Noise evaluation (different integration time and different temperatures)
  - Bias
  - Dark current map
  - Stability assessment (dark and under illumination, very long integration time)

- Optical sensitivity evaluation (different integration time and different temperatures)
  - Non-Linearity (depends on the gain level) and Conversion Factor (possible with the optical source)
  - Flat-field measurements (only with the EUV source)

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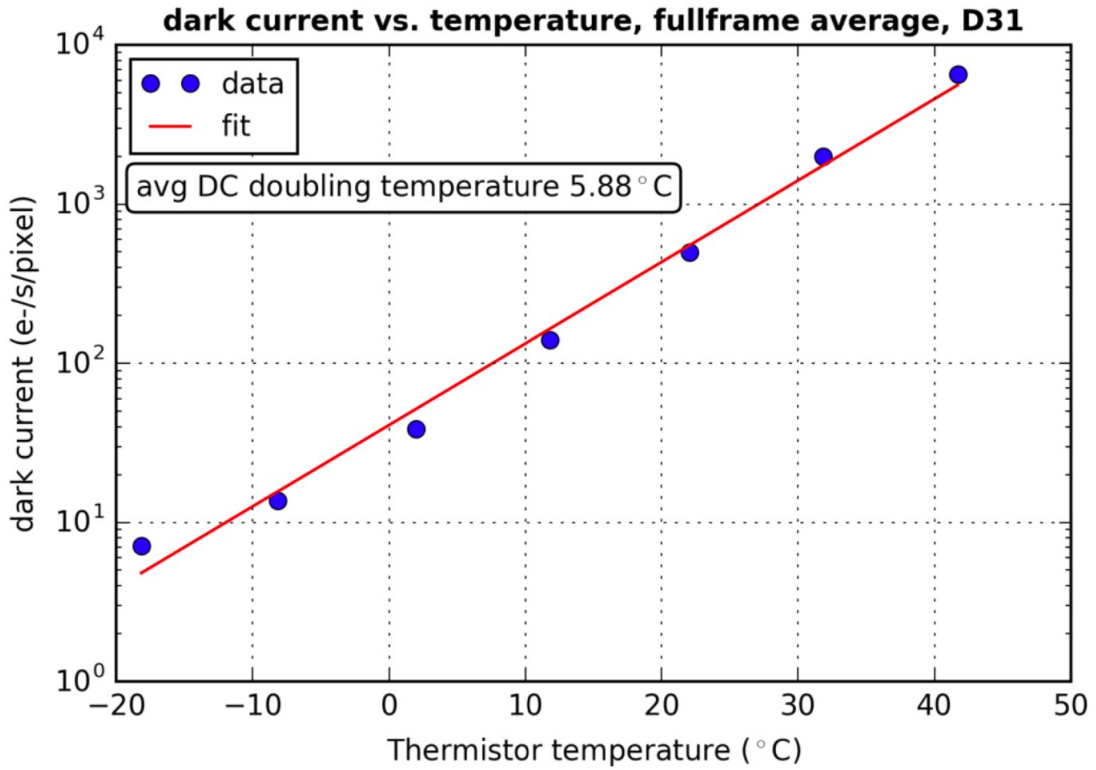

Figure 15: Dark current as function of temperature for BSI CoB D31.

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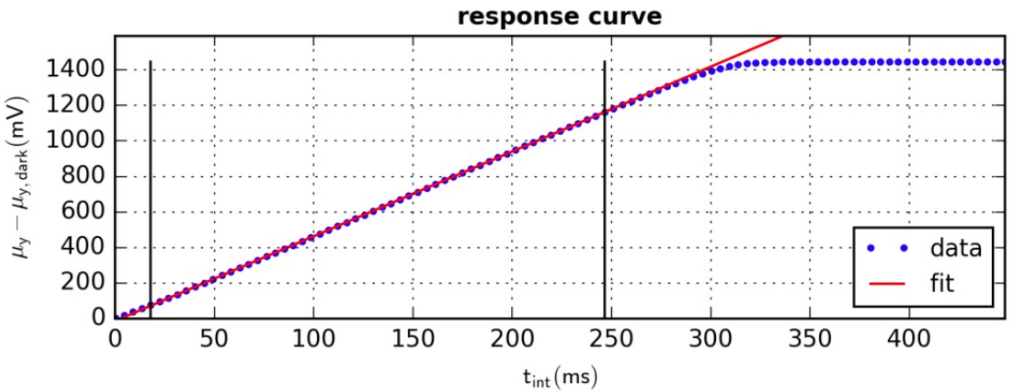
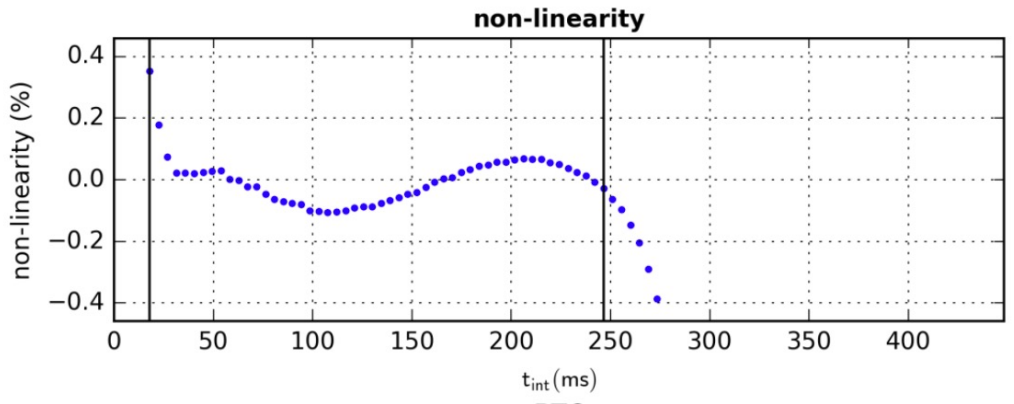
readout noise (*gain mode*) +





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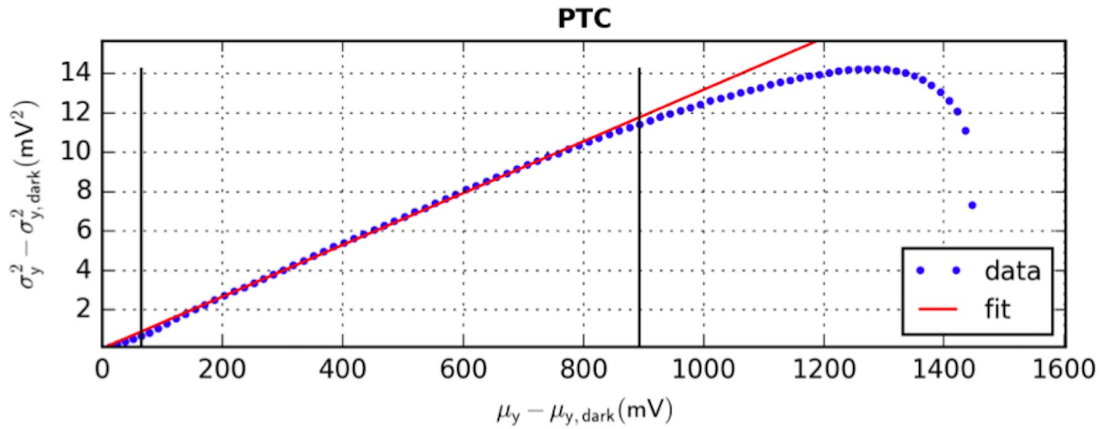
readout noise (*gain mode*) +

the number of photoelectrons read out at the output of the chip (*integration time*)



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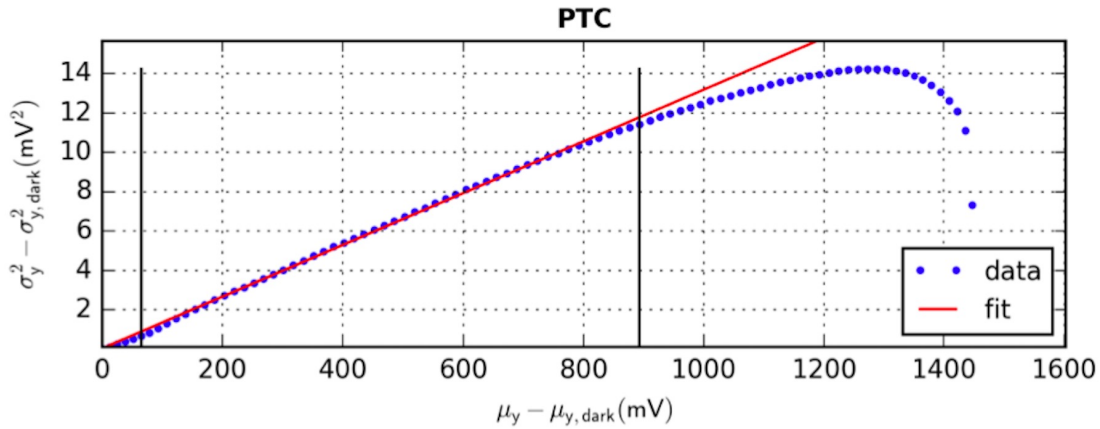
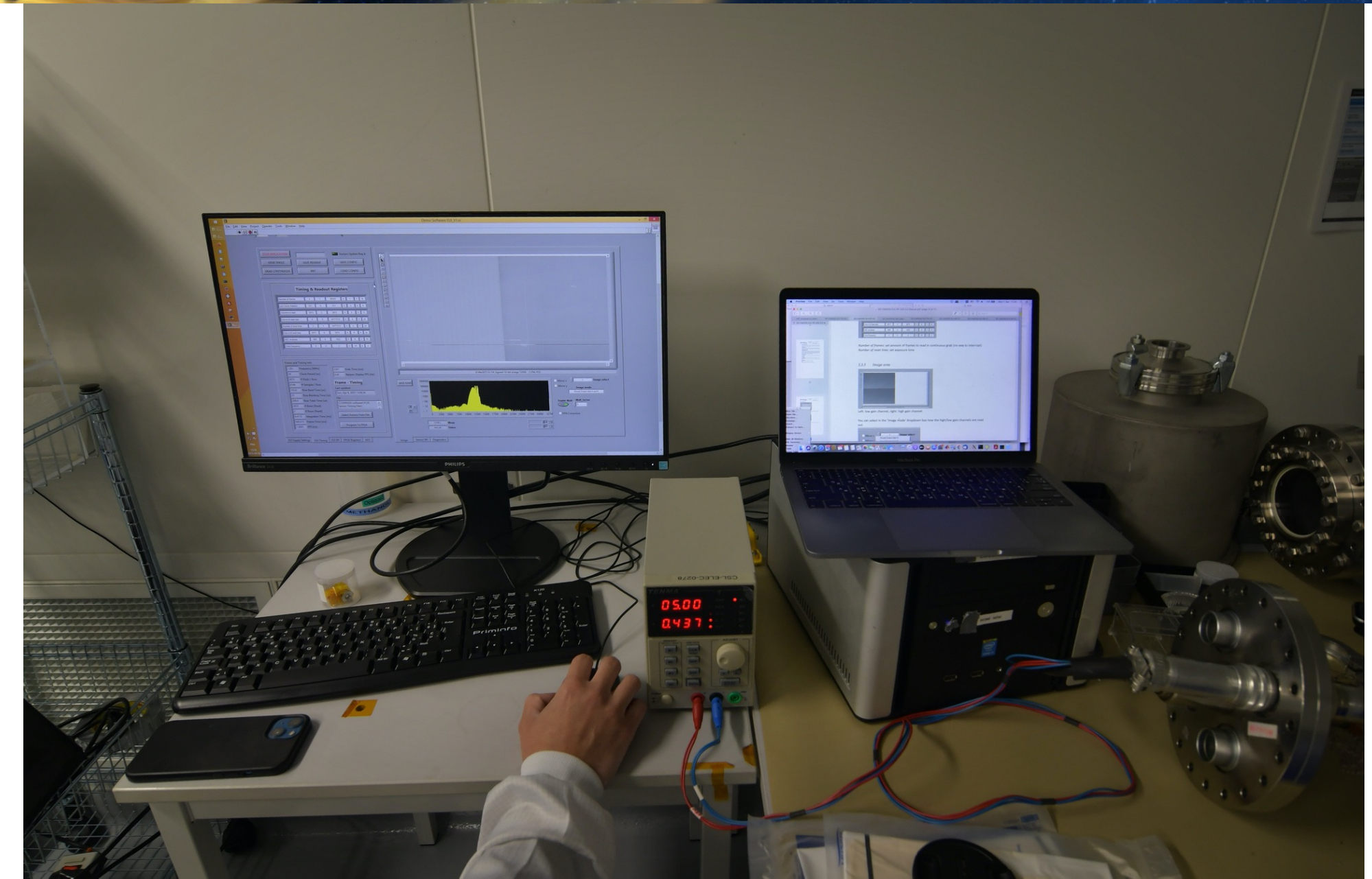
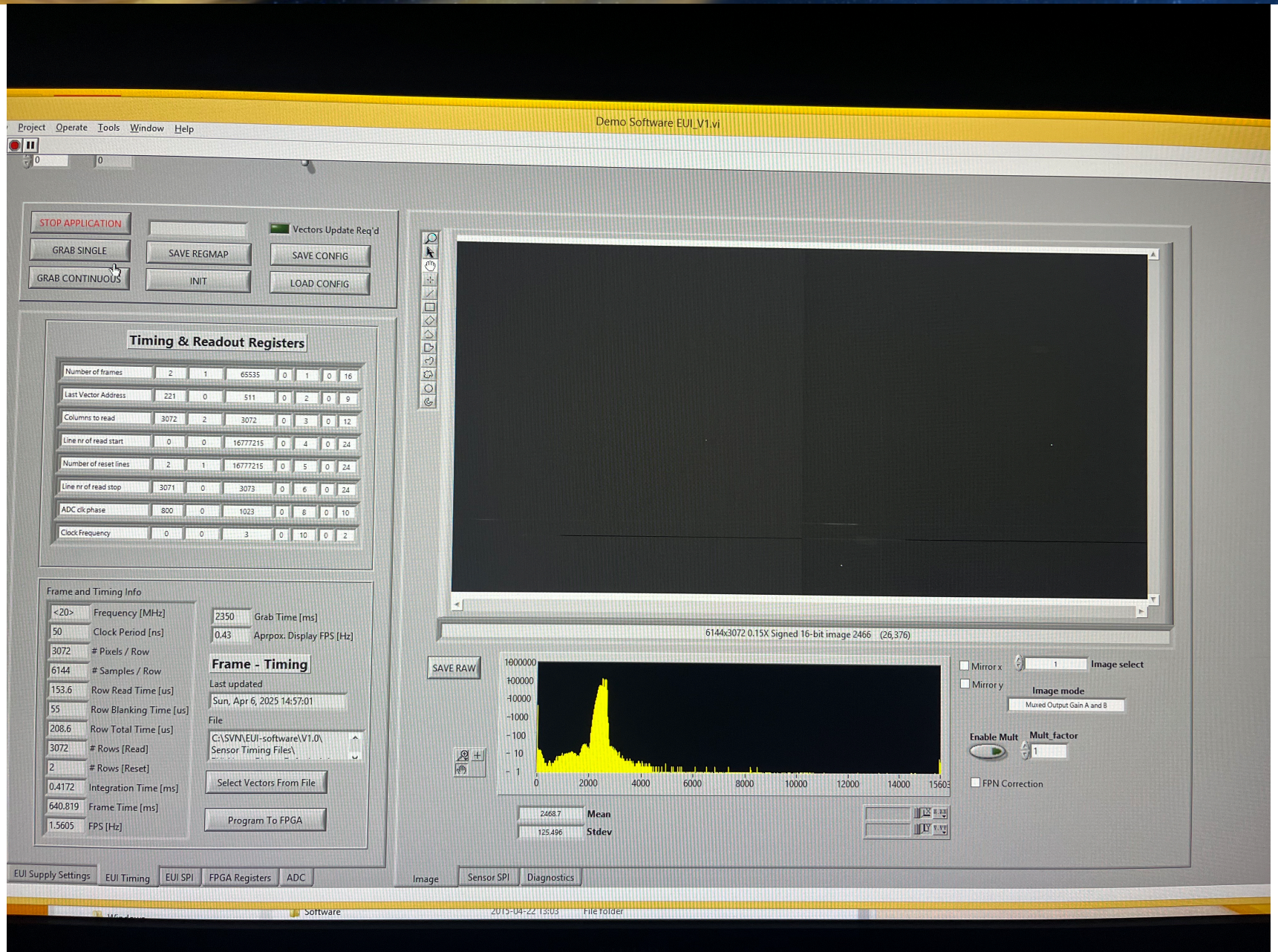
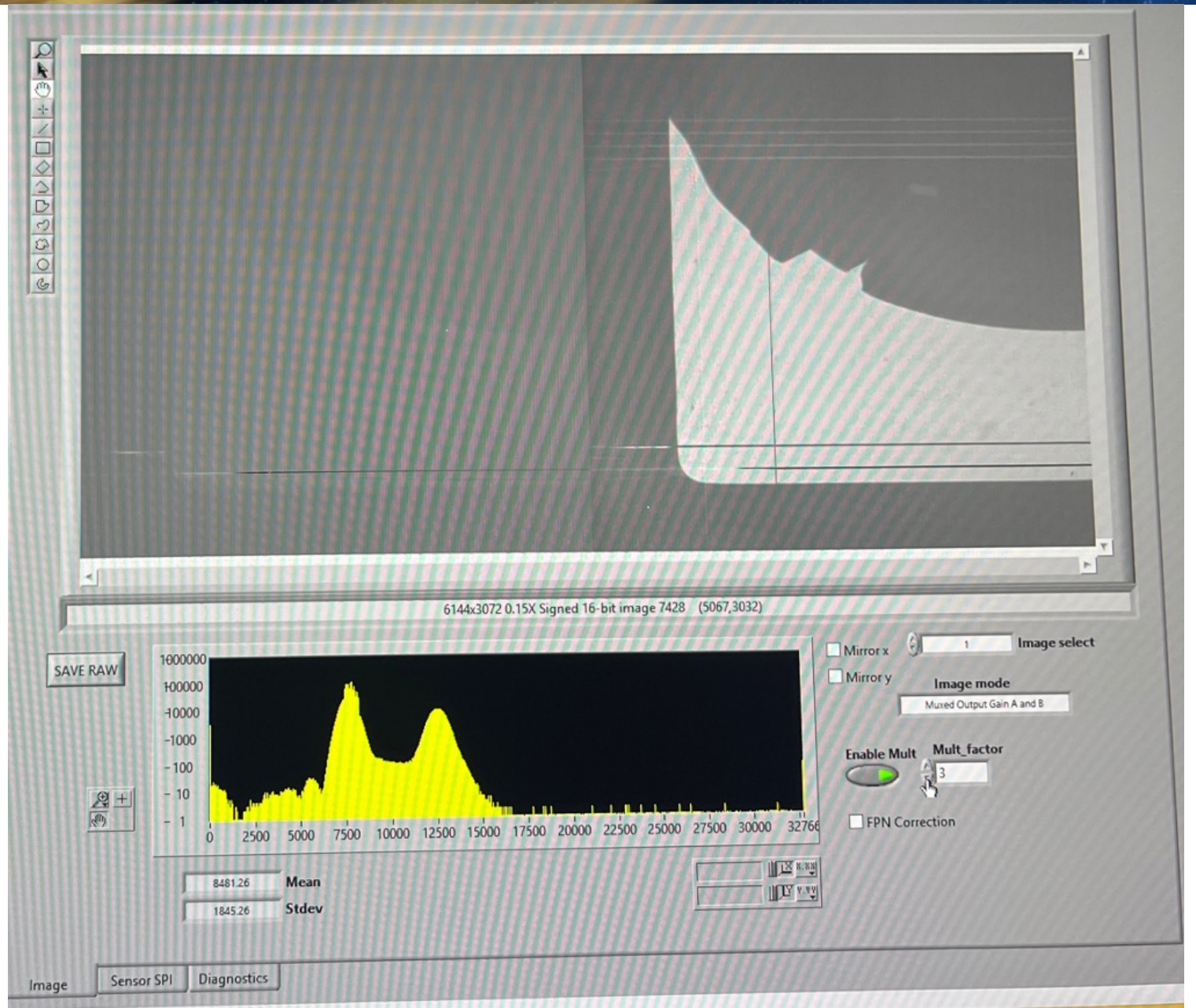


What we have learned from the previous missions (EUI, ASPIICS):

- bias is not constant
- significant non-linearity depending on the gain mode (we should not exceed the 2% threshold)


Timing & Readout Registers
Frame - Timing
PHILIPS
Primina
05.00
0.437


Demo Software EUI_V1.vi
Project Operate Tools Window Help
STOP APPLICATION
GRAB SINGLE
GRAB CONTINUOUS
SAVE REGMAP
INIT
Vectors Update Req'd
SAVE CONFIG
LOAD CONFIG
Timing & Readout Registers
Number of frames
Last Vector Address
Columns to read
Line nr of read start
Number of reset lines
Line nr of read stop
ADC clk phase
Clock Frequency
Frame and Timing Info
Frequency [MHz]
Clock Period [ns]
Pixels / Row
Samples / Row
Row Read Time [us]
Row Blanking Time [us]
Row Total Time [us]
Rows [Read]
Rows [Reset]
Integration Time [ms]
Frame Time [ms]
FPS [Hz]
Grab Time [ms]
Aprpox. Display FPS [Hz]
Frame - Timing
Last updated
Sun, Apr 6, 2025 14:57:01
File
C:\SVN\EUI-software\V1.0\Sensor Timing Files\
Select Vectors From File
Program To FPGA
6144x3072 0.15X Signed 16-bit image 2466 (26,376)
SAVE RAW
Mean
Stdev
Mirror x
Mirror y
Image select
Image mode
Muxed Output Gain A and B
Enable Mult
Mult_factor
FPN Correction
EUI Supply Settings
EUI Timing
EUI SPI
FPGA Registers
ADC
Image
Sensor SPI
Diagnostics
Software
2015-04-22 13:03
File Folder


6144x3072 0.15X Signed 16-bit image 7428 (5067,3032)
SAVE RAW
1000000
100000
10000
1000
100
10
1
0
2500
5000
7500
10000
12500
15000
17500
20000
22500
25000
27500
30000
32766
8481.26
Mean
1845.26
Stdev
Mirror x
Mirror y
1
Image select
Image mode
Muxed Output Gain A and B
Enable Mult
Mult_factor
3
FPN Correction
Image
Sensor SPI
Diagnostics

We propose the next steps:

- To perform the functional tests for all available detectors at ambient temperature (ASAP);

- Depending on the number of short-listed detectors, put them in a vacuum chamber and perform different functional tests at various temperatures (check if the dark current measurements are in agreement with the previous “EUI” experiments);

- Perform the final flat-field measurements with the EUV source (Sergei’s calibration plan) for the best short-listed detectors.