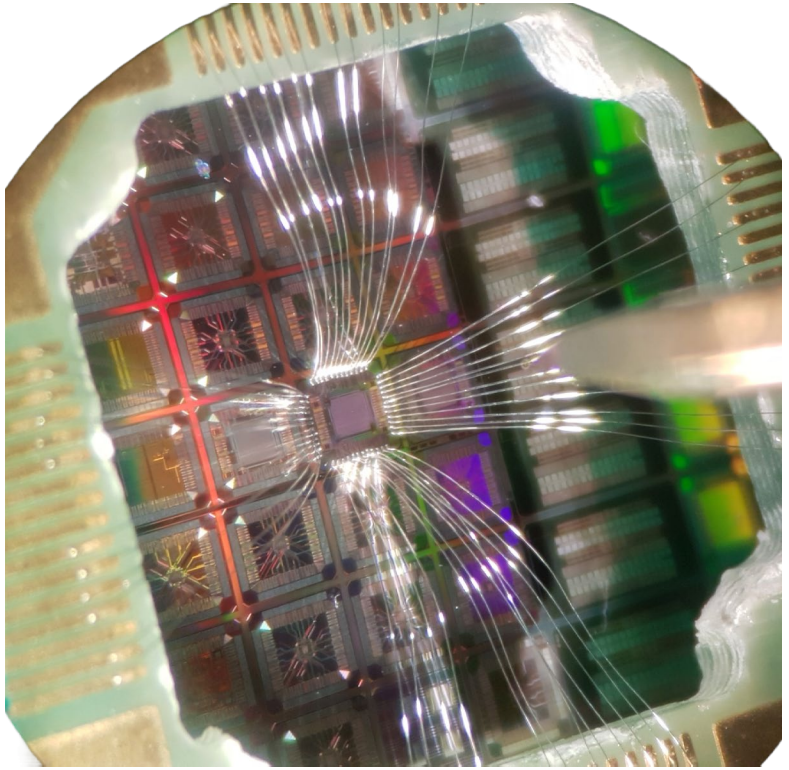
Università degli Studi di Bari Aldo Moro
Dipartimento Interateneo di Fisica "*Michelangelo Merlin*"

APTS OA Laboratory Activities and TB Analysis

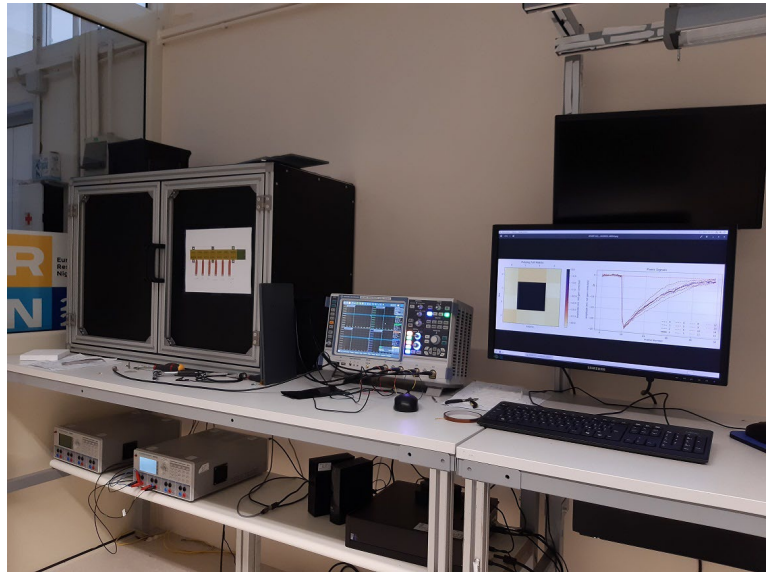


Angelo Colelli, Francesco Barile, Rajendra Patra, Shyam Kumar, Triloki Triloki

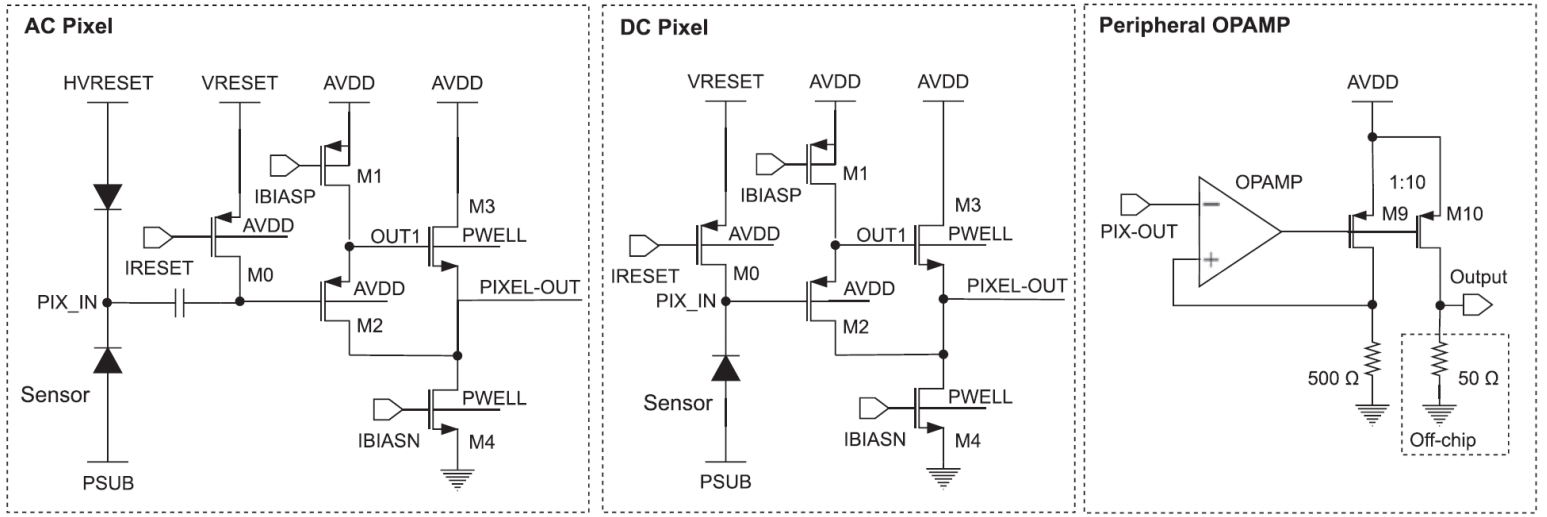
Bari, 5 novembre 2024

APTS OA Chip Characterization

Baseline Calibration | **Test Pulsing** | Operating point | **Pulse Scanning** | **X-rays source meas.**



Oue High Technology Lab



Main Goals:

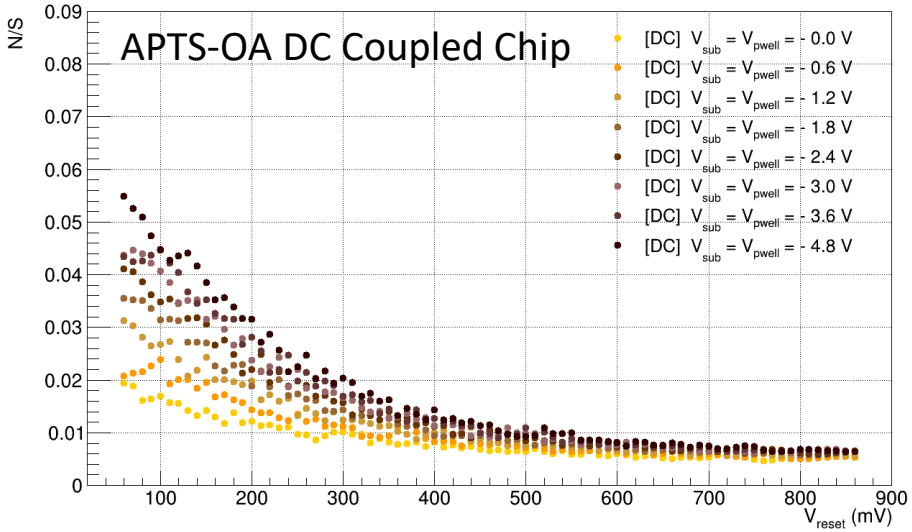
Electronic and bias parameters fine tuning to achieve the best performance (no simulations available)

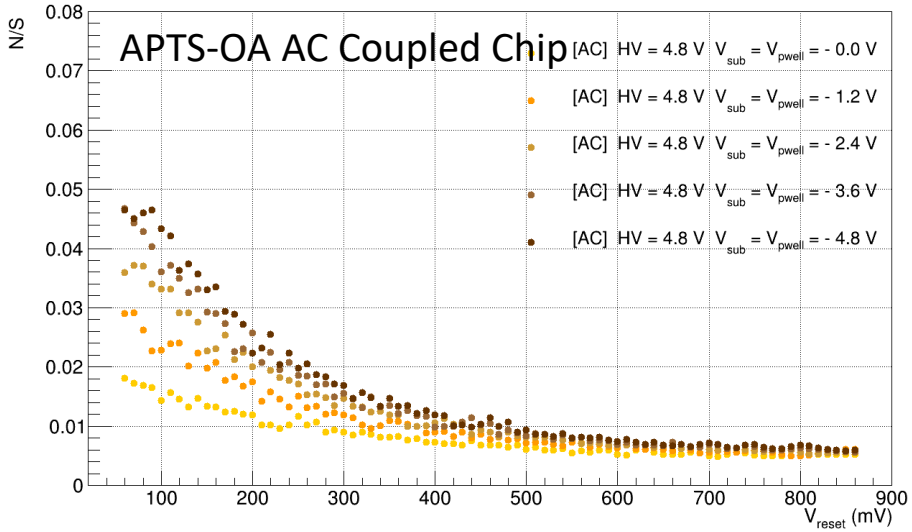
Direct investigation of the pixel chip with radiation ≈ MIP particle

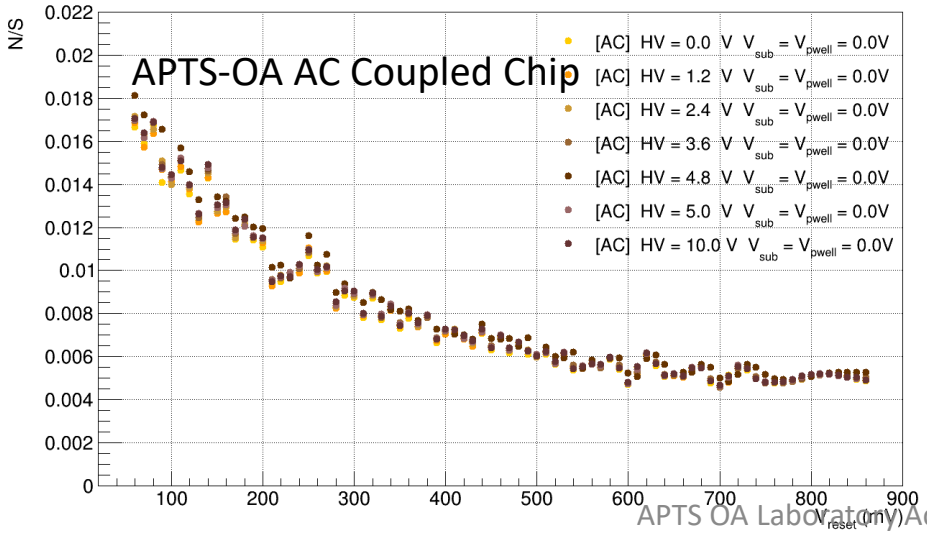
Baseline Noise evaluation

Baseline Calibration | **Test Pulsing** | Operating point | **Pulse Scanning** | **X-rays source meas.**

Goal: Investigate the bias voltage effect on the output voltage





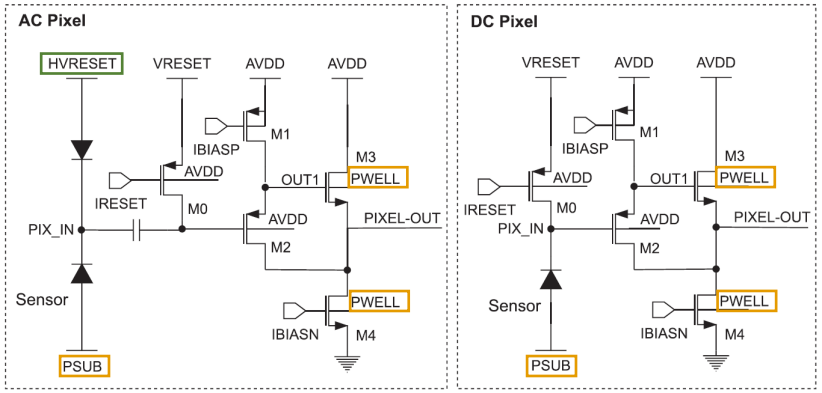


- Meaningful N/S variation w.r.t. V_{sub} and V_{pwell} (DC and AC coupled).
- Negligible N/S variation w.r.t. HV (only AC coupled).

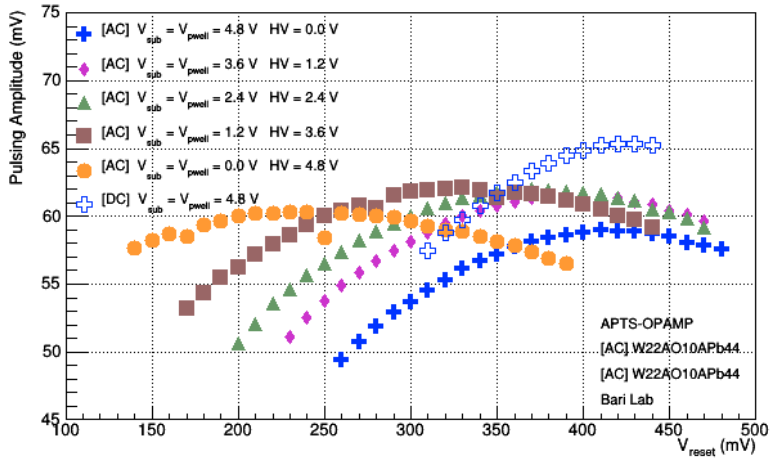
AC – DC chip prototype comparison

Baseline Calibration | **Test Pulsing** | Operating point | **Pulse Scanning** | **X-rays source meas.**

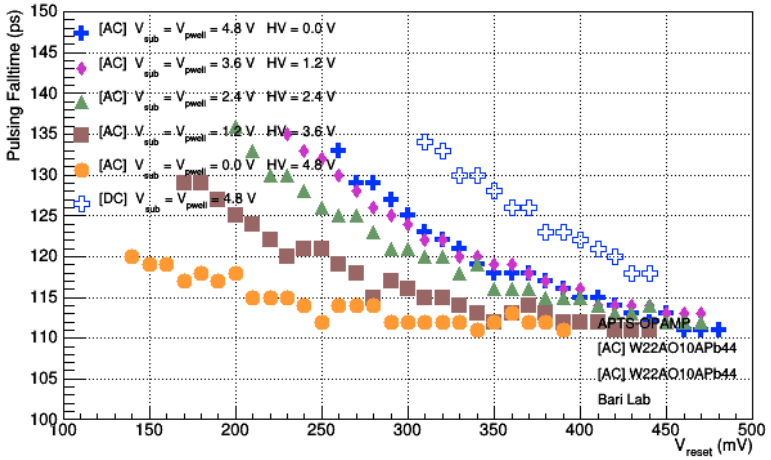
Goal: investigate bias voltages additive effect (AC) and compare (DC)

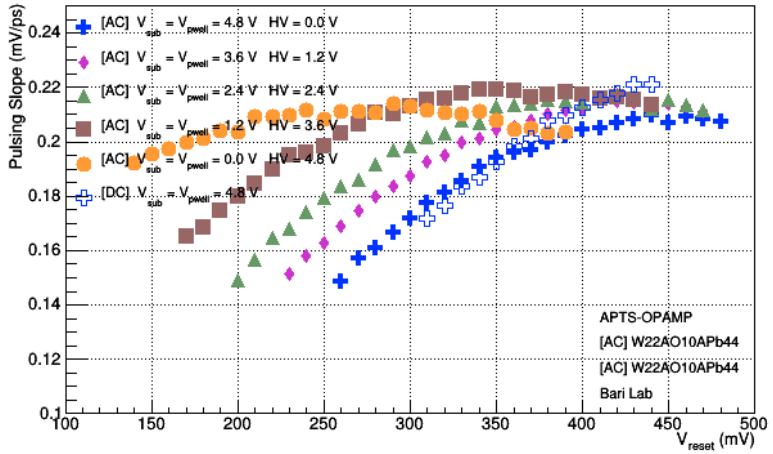


	HV (V)	$V_{sub/pwell}$ (-V)
AC	0	4.8
	1.2	3.6
	2.4	2.4
	1.2	3.6
	4.8	0
DC		4.8



No additive effect from signal amplitude comparison.



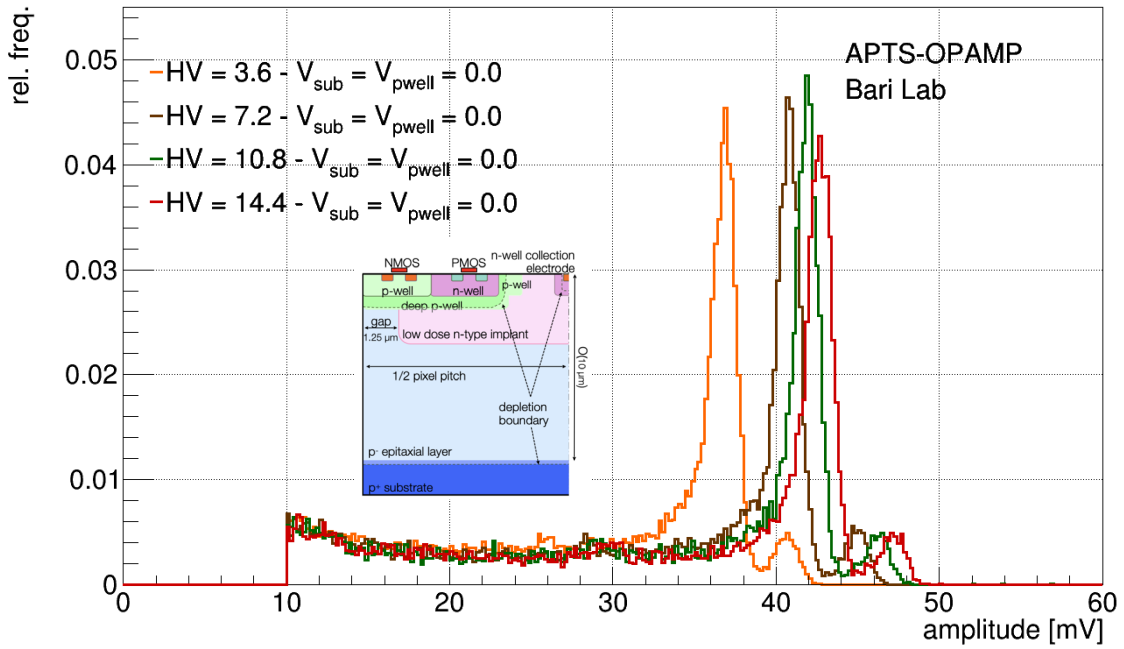


Fall time and slope convergence at high V_{reset} .

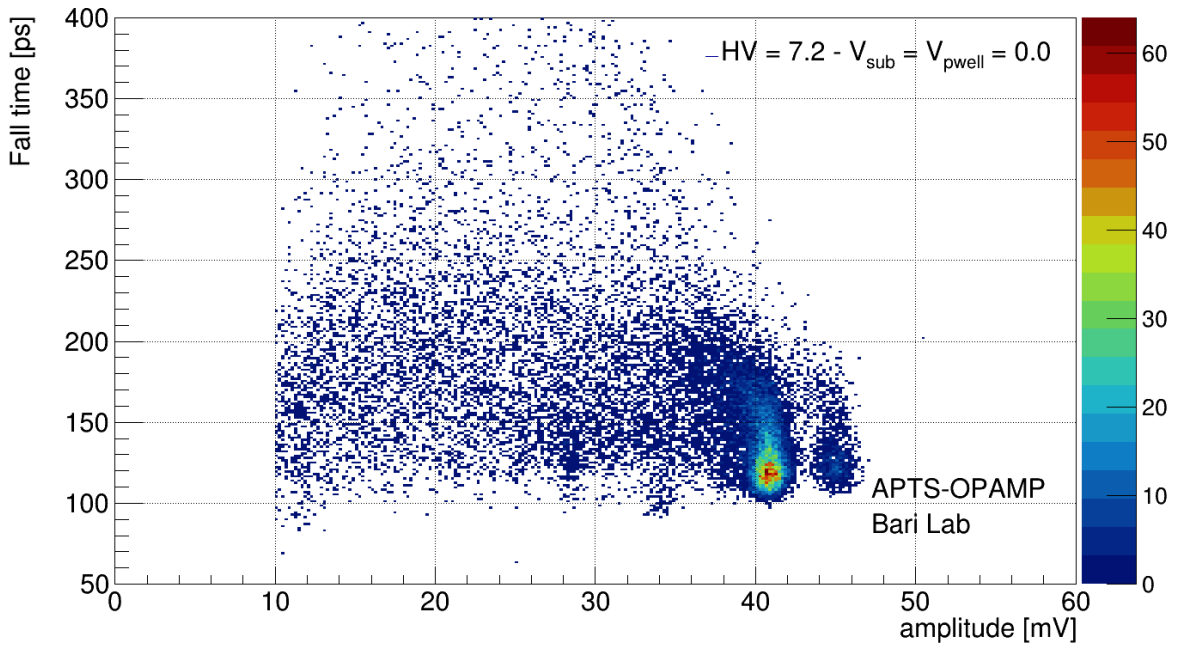
APTS OA Chip Characterization

Baseline Calibration | **Test Pulsing** | Operating point | **Pulse Scanning** | **X-rays source meas.**

Goal: direct investigation of pixels chip

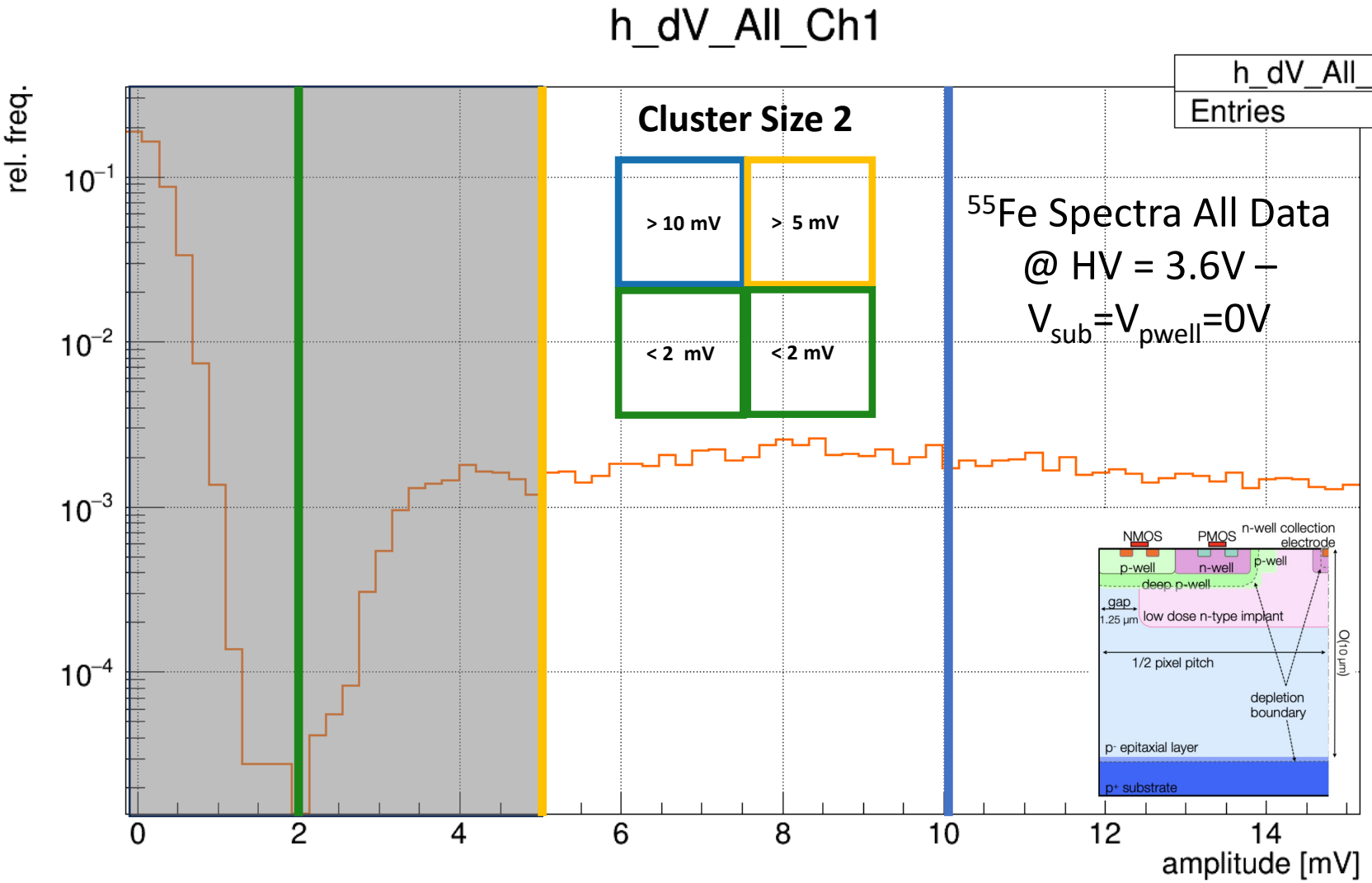


K_α and K_β peaks well reconstructed.

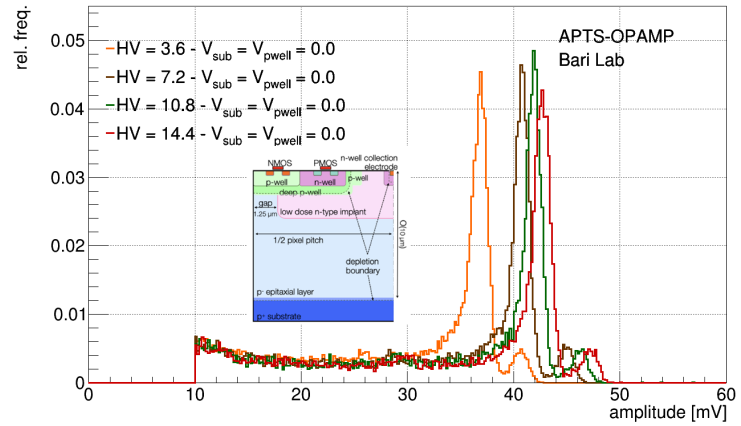


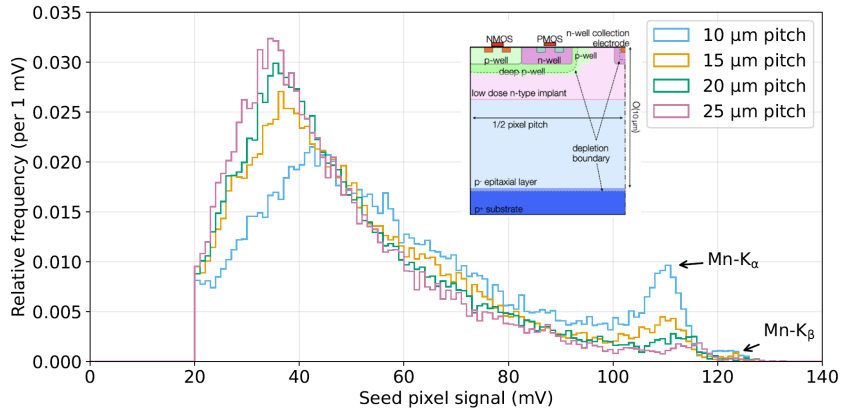
Fall time estimated at 110 ps.

APTS OA Cluster Size Investigation

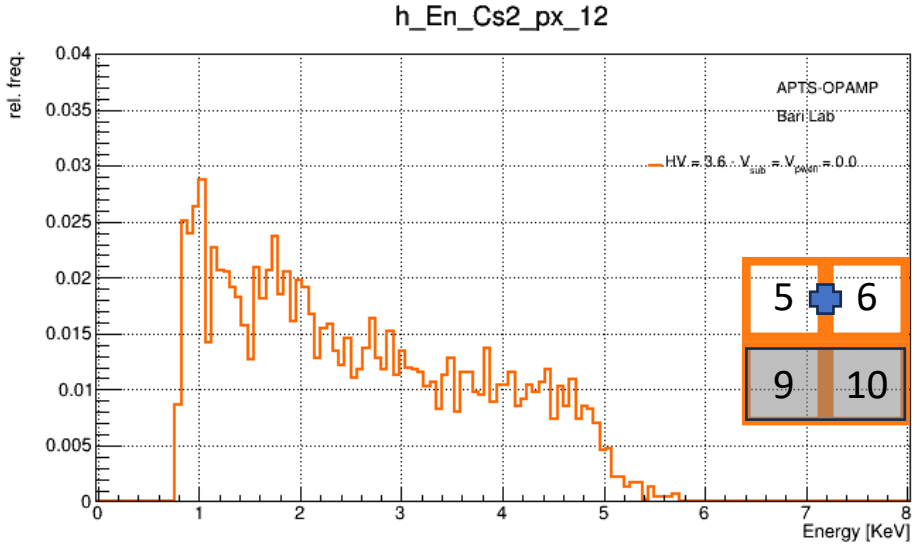


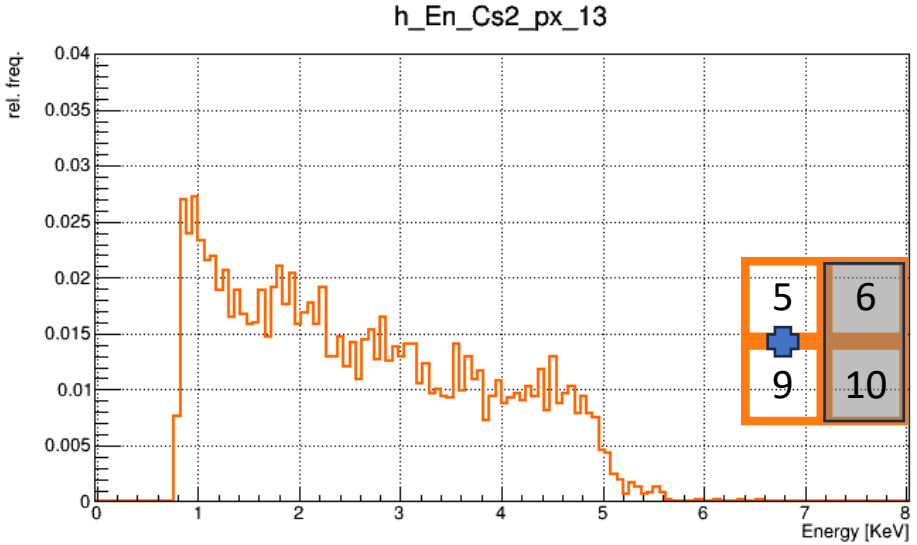
Scope Trigger @ 10 mV
Investigation of Events < 10 mV
Use as minimum threshold 2 mV
Use as upper threshold 5 mV

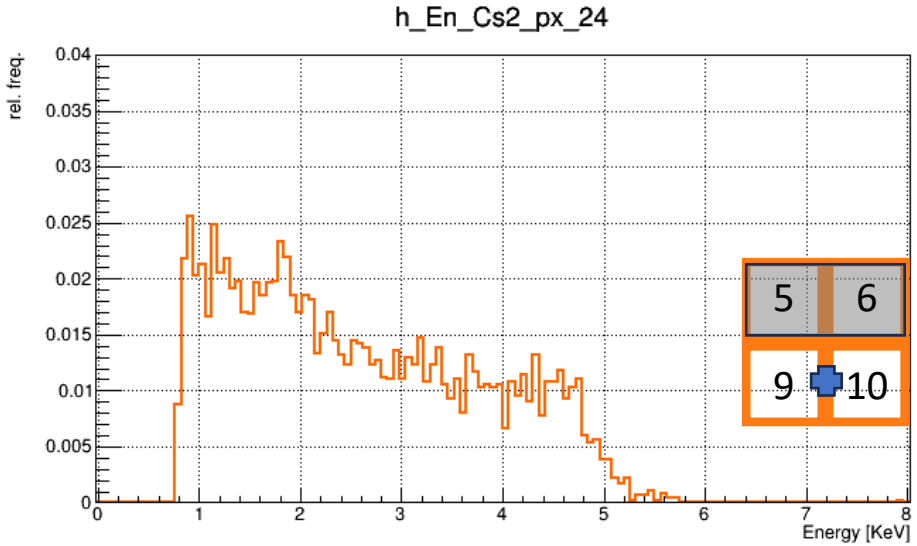


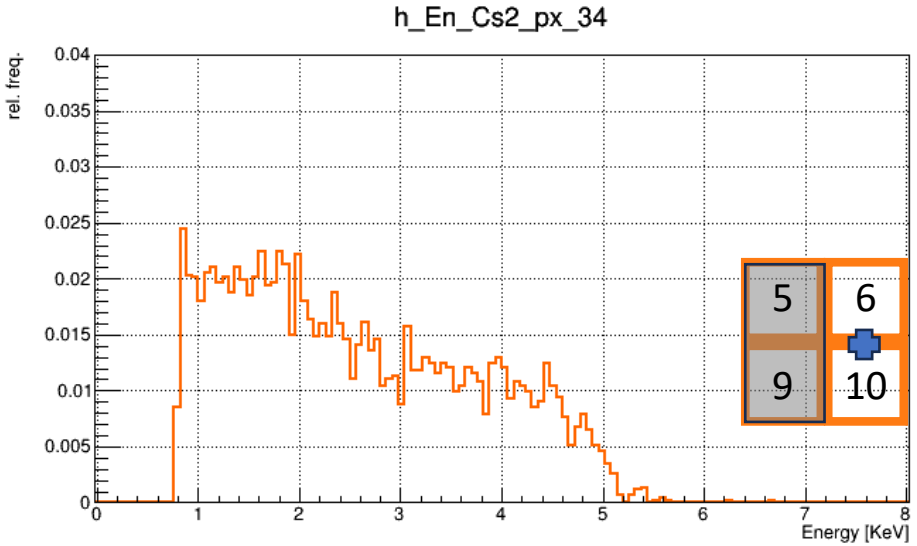


APTS OA Cluster Size Investigation







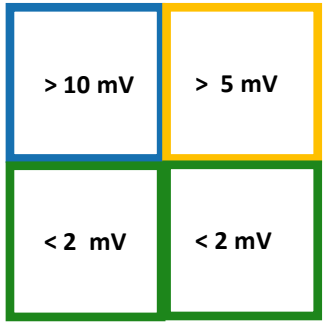


^{55}Fe Spectra Cluster Size 2 @ HV = 3.6V – V_{sub}=V_{pwell}=0V

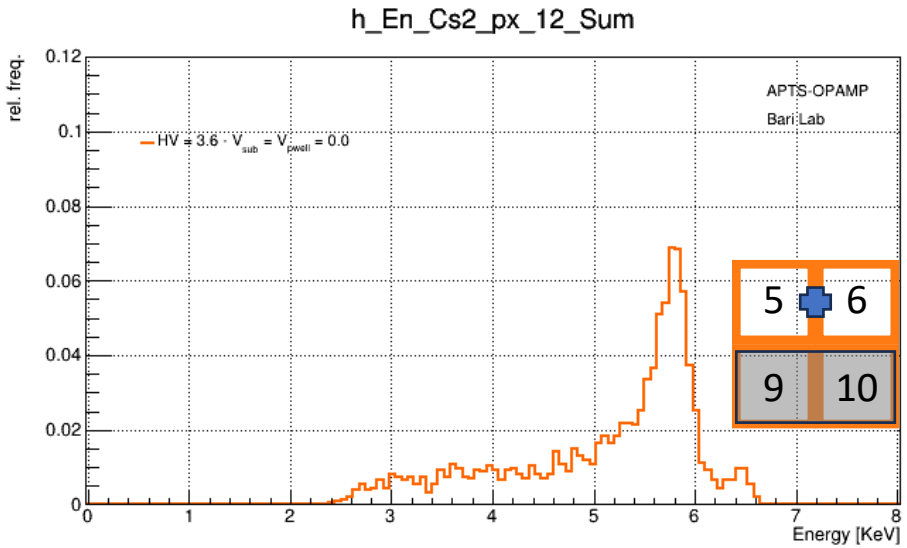
Energy Converted

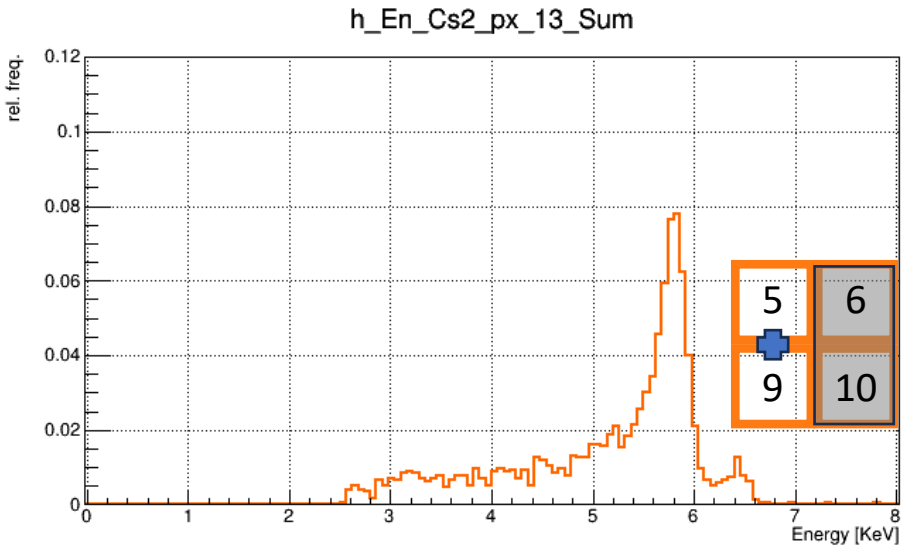
Summing signals from adjacent pixels in the same event

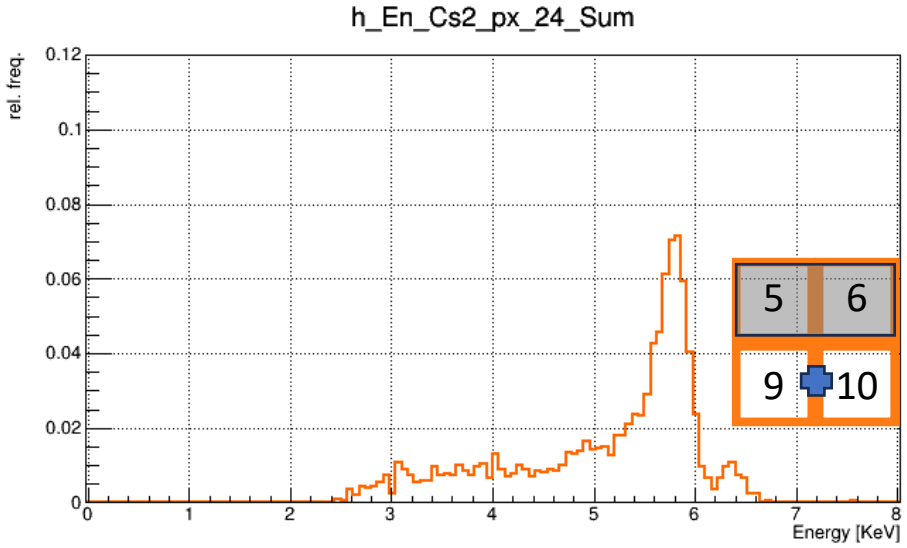
Cluster Size 2

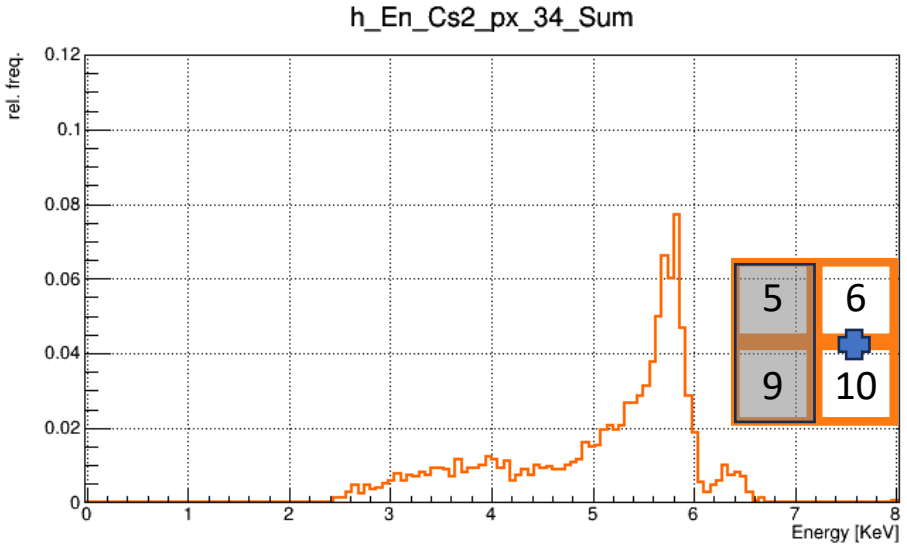


APTS OA Cluster Size Investigation





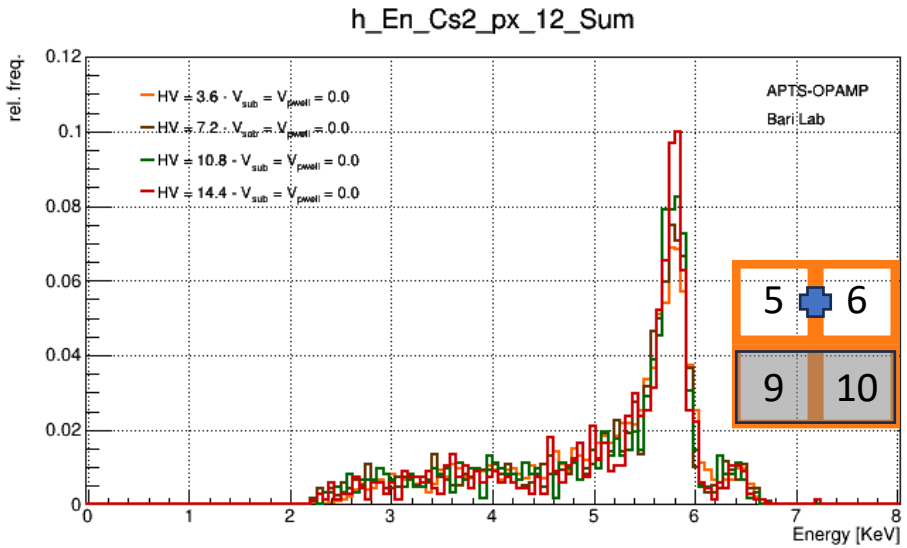


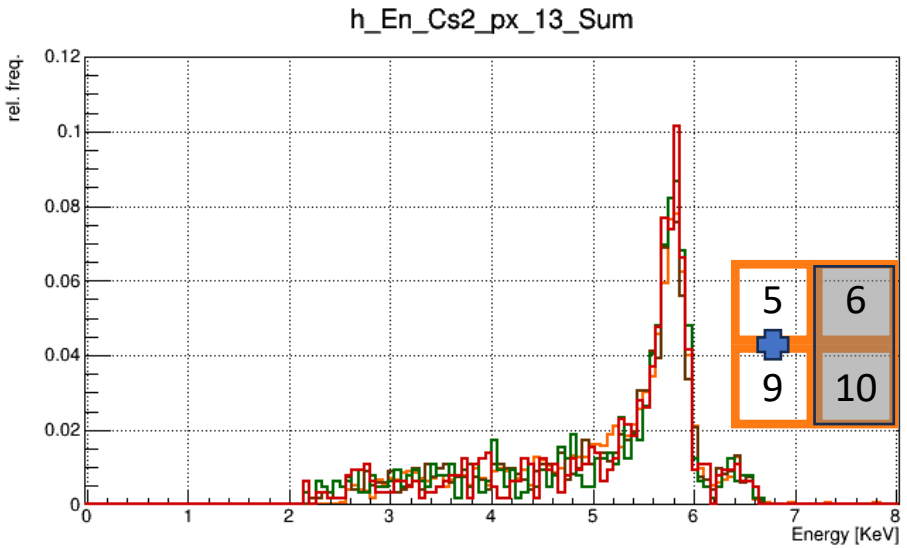


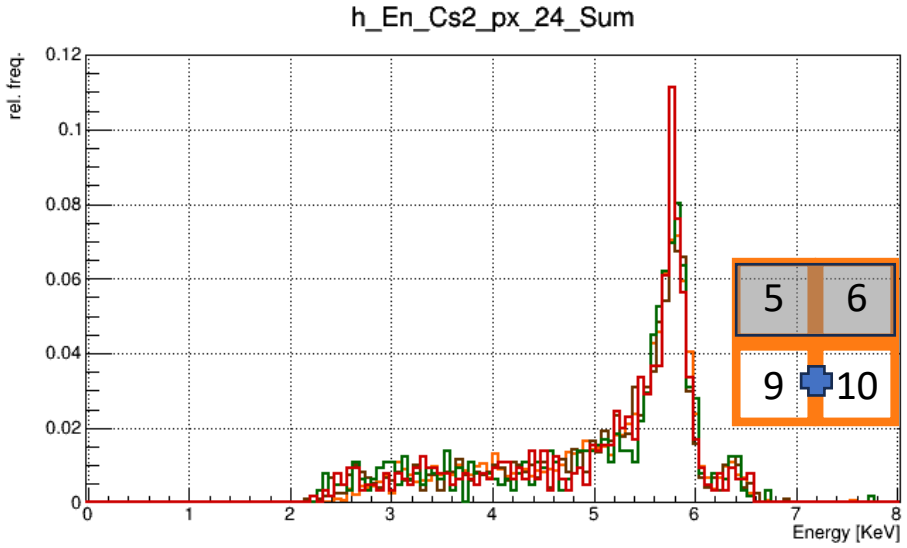
^{55}Fe Spectra Cluster Size 2 @ HV = 3.6V – V_{sub}=V_{pwell}=0V

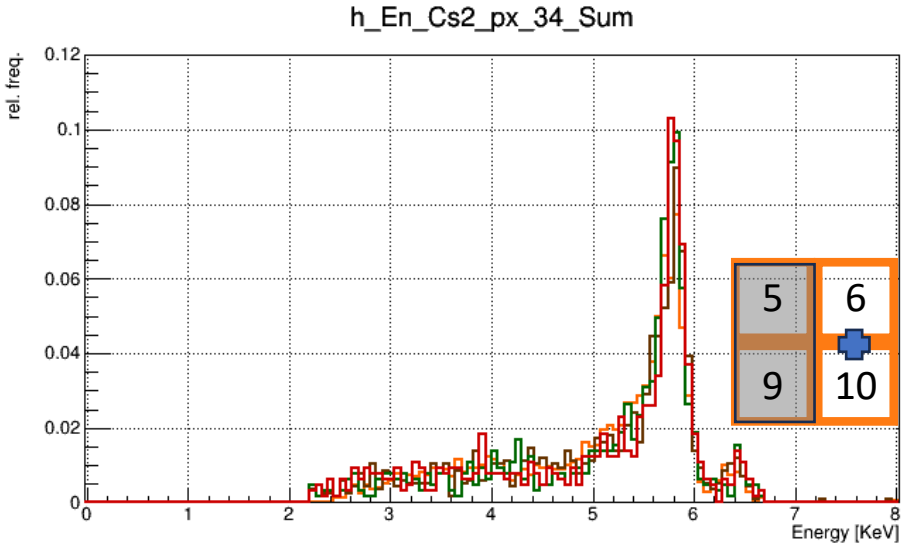
Summing signals from adjacent pixels in the same event:
it allows to reconstruct the two ^{55}Fe peaks

APTS OA Cluster Size Investigation







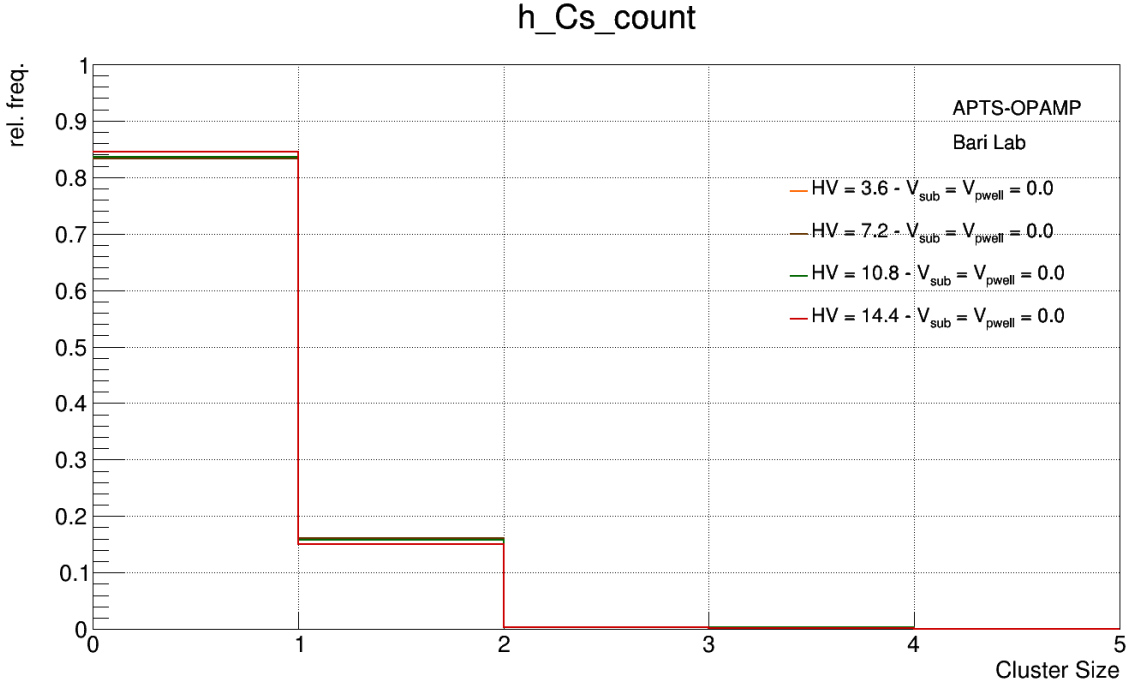


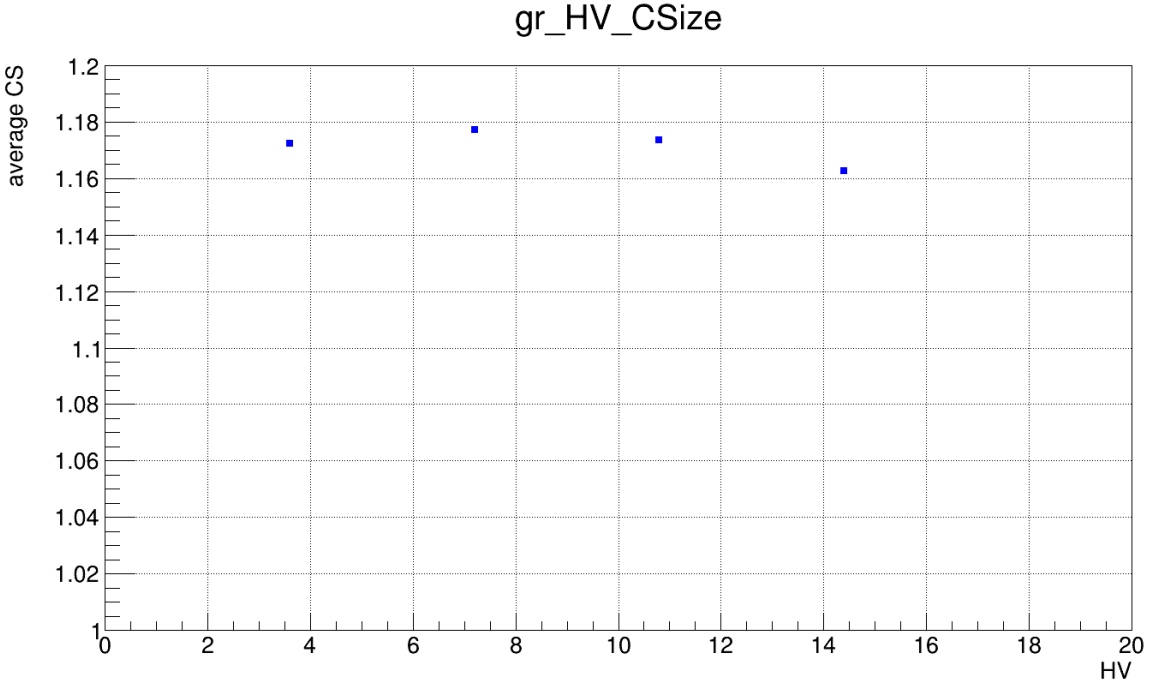
^{55}Fe Spectra Cluster Size 2 @ different HV – V_{sub}=V_{pwell}=0V

Summing signals from adjacent pixels in the same event:
it allows to reconstruct the two ^{55}Fe peaks

APTS OA Cluster Size Investigation

Average Cluster Size at different HV





- **CS1 : more than 80%**
- **CS2 : less than 20%**

- **CS average: ≈ 1.17**

APTS OA TB Analysis

Corryvreckan

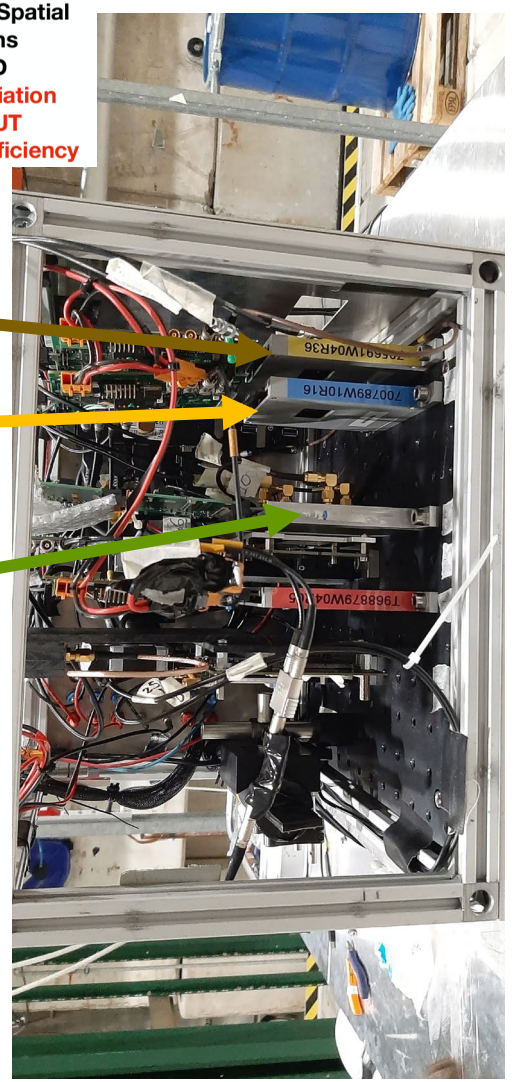
Geometry

```
[ALPIDE_0]
type = "ALPIDE"
number_of_pixels = 1024, 512
position = 0um, 0um, -96mm
pixel_pitch = 29.24um, 26.88um
spatial_resolution = 5.00um, 5.00um
time_resolution = 2us
material_budget = 0.0005
coordinates = "cartesian"
orientation_mode = xyz
roi = [[541,273],[541,213],[481,213],[481,273]]

# roi = [[435,290],[435,310],[460,310],[460,290]] #TODO change this?

[ALPIDE_1]
type = "ALPIDE"
number_of_pixels = 1024, 512
position = 0um, 0um, -71mm
pixel_pitch = 29.24um, 26.88um
spatial_resolution = 5.00um, 5.00um
time_resolution = 2us
material_budget = 0.0005
coordinates = "cartesian"
orientation_mode = xyz
role = "reference"
roi = [[521,273],[521,213],[461,213],[461,273]]


[OPAMP_2]
type = "OPAMP"
role = "DUT"
position = 0mm, 0mm, 0mm
number_of_pixels = 4, 4
pixel_pitch = 10.0um, 10.0um
spatial_resolution = 2.9um, 2.9um  # let's start from the binary resolution of the pixel
time_resolution = 10ns
material_budget = 0.0005  # plus the glue (pretty much unknown)
coordinates = "cartesian"
#calibration_file = "/home/data/55Fe/Python_Analysis/AO10P_b06/Vbb_1.2V/Scope/not_calibrated/Corry_DB/
merged_runs_not_calibrated_seed_pixels_charge_calibration_fit_parameters.json"
calibration_file = "/mnt/c/prove_installazione/its-corryvreckan-tools/calibration/fit_parameters.json"
orientation = 0deg, 180deg, 90deg
orientation_mode = xyz
```

Processes

createmask	prealign	align	analyse
• MaskCreator	• ClusteringSpatial • Correlations • Prealignment	• ClusteringSpatial • Correlations • Tracking4D • AlignmentMillepede	• ClusteringSpatial • Correlations • Tracking4D • DUTAssociation • AnalysisDUT • AnalysisEfficiency

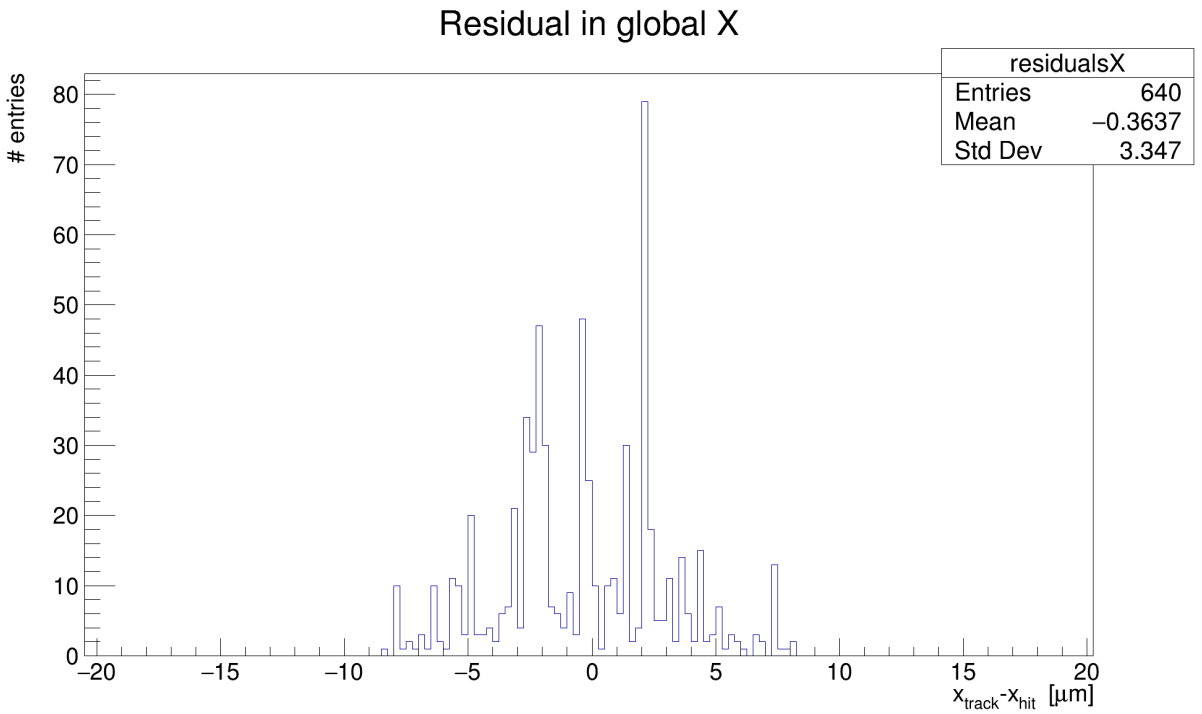
Telescope

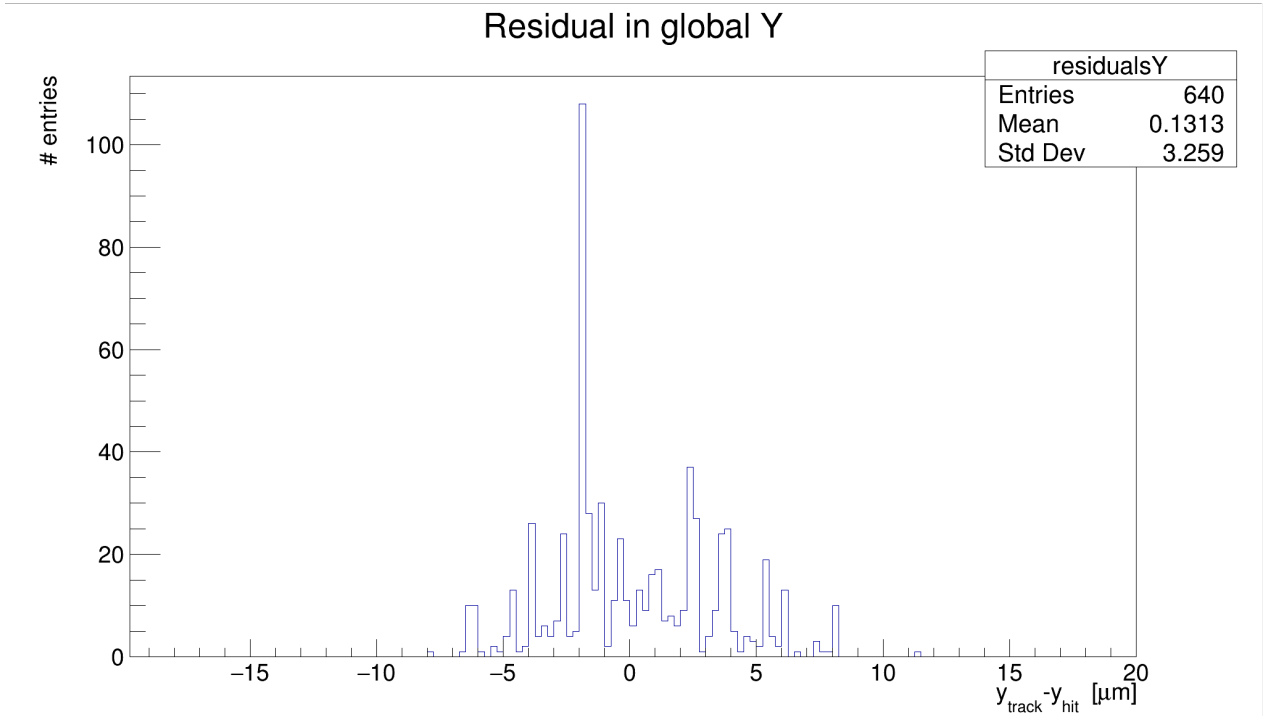


APTS OA TB Analysis

Corryvreckan

QA running to validate data

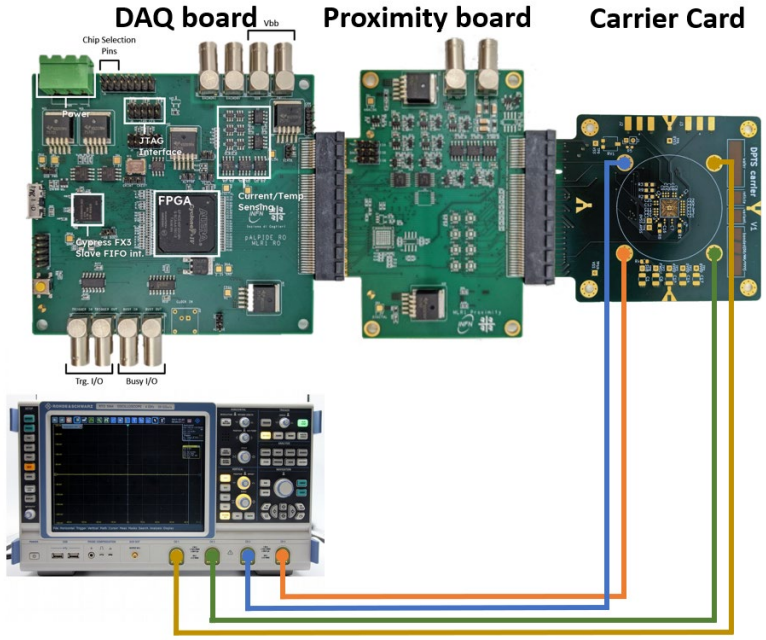




Next Step: **Tracking** and **Timing** analysis

Backup Slides

APTS OA Chip Readout System

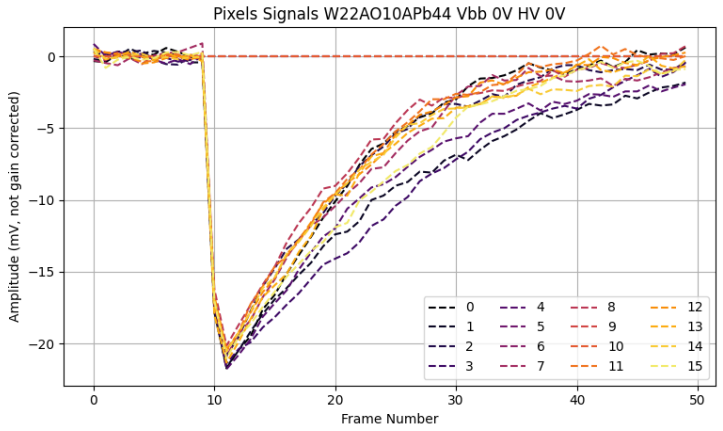


- An FPGA-based **DAQ board** via USB interface (5V power) PC controlled.
- A **Proximity board**:
  - host the analog to digital converters (ADCs) for the readout of peripheral pixels
  - bias the chip.
- A **Carrier Card** to which the chip is glued and bonded
  - 4 innermost pixels directly readout with an oscilloscope Rohde & Schwarz, RTO 1044 (20GSa/s - 4 GHz) by high bandwidth SMA connectors
  - 12 outer pixels readout by 4 MHz ADCs

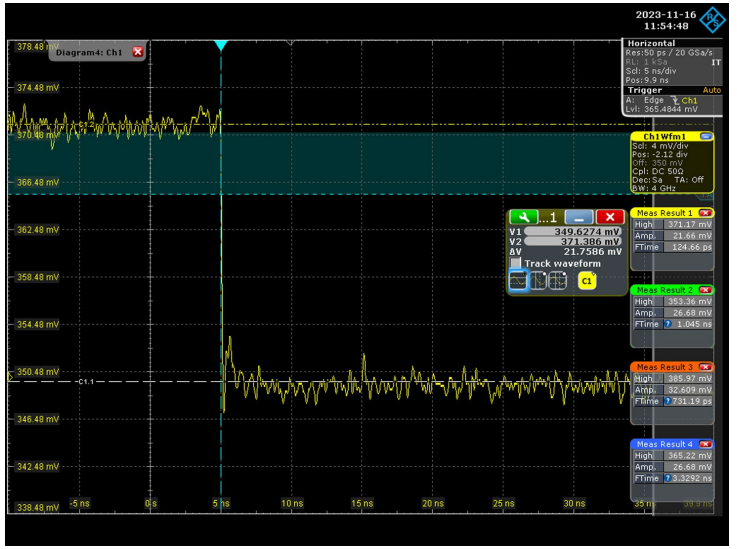
Code development (Python and C++) for:

- fully automatized data acquisition, trigger and communication between the experimental setup and the oscilloscope
- Data dumping and analysis

Approved and part of the collaboration repository (GitLab)



ADC pixel readout - time frame 50 µs

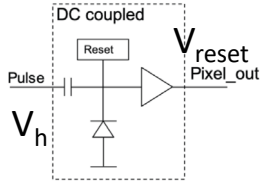


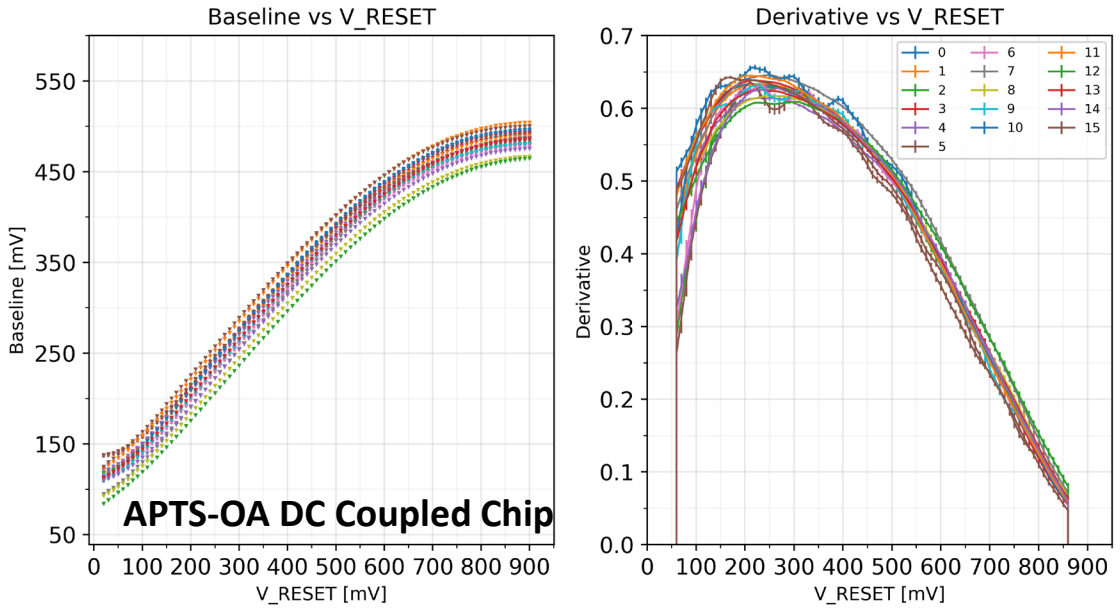
Scope pixel readout - time frame 50 ns

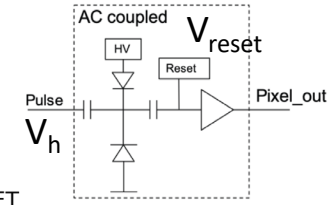
APTS OA Chip Characterization

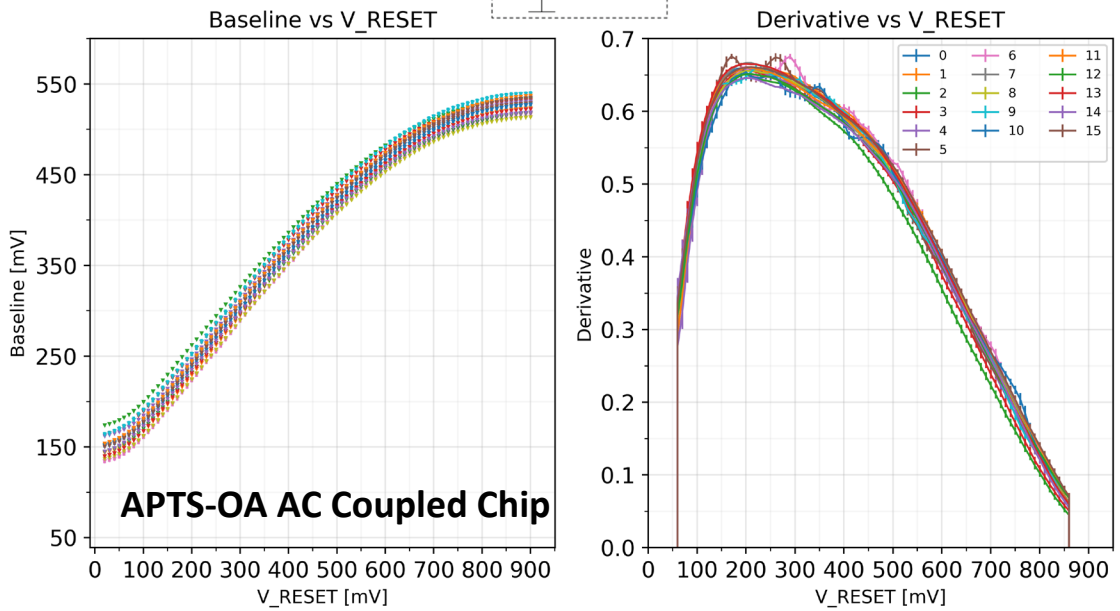
Baseline Calibration | **Test Pulsing** | Operating point | **Pulse Scanning** | **X-rays source meas.**

Goal: Study output voltage w.r.t. voltage reset V_{reset}







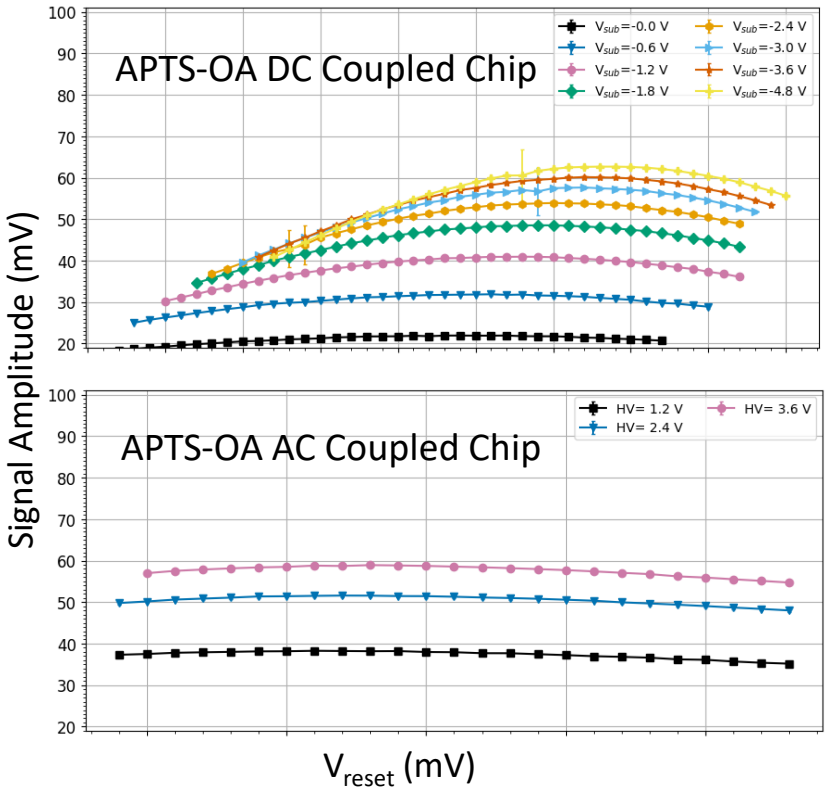


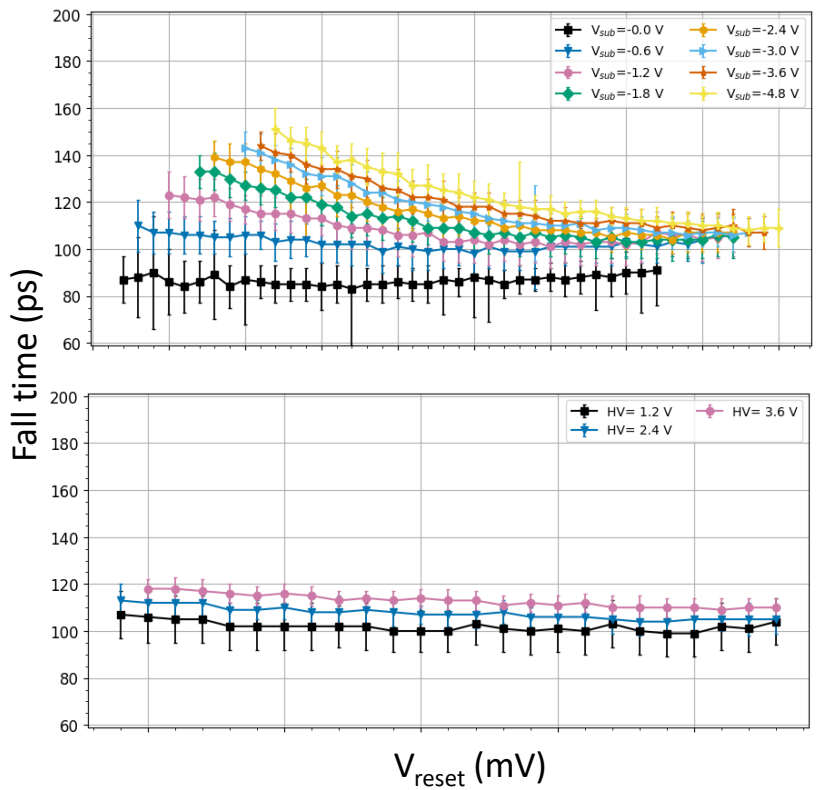
Analysis: calculation of $\Delta baseline/\Delta V_{reset}$ to find best circuitry response in a wide V_{reset} range

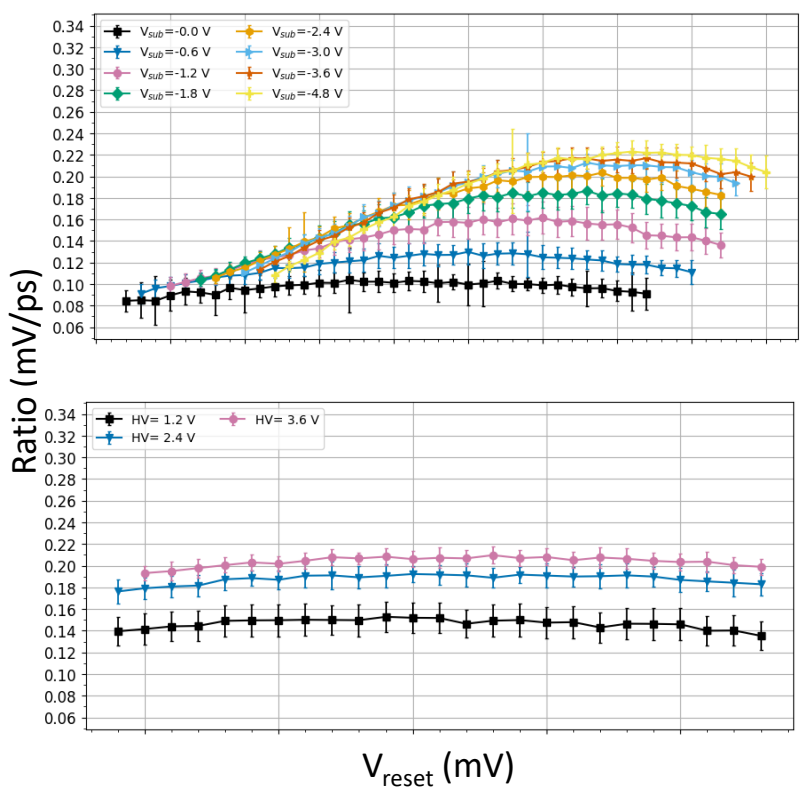
APTS OA Chip Characterization

Baseline Calibration | **Test Pulsing** | Operating point | **Pulse Scanning** | **X-rays source meas.**

Goal: find best circuitry response.





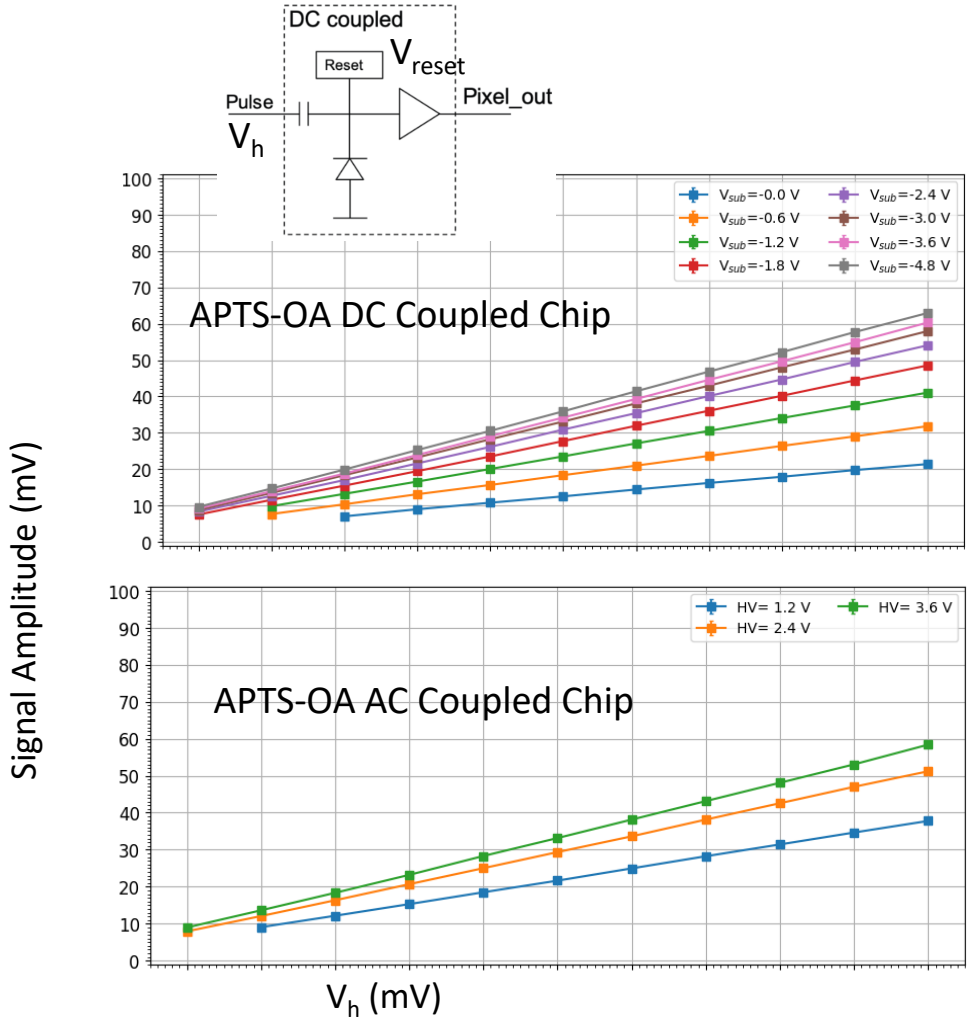


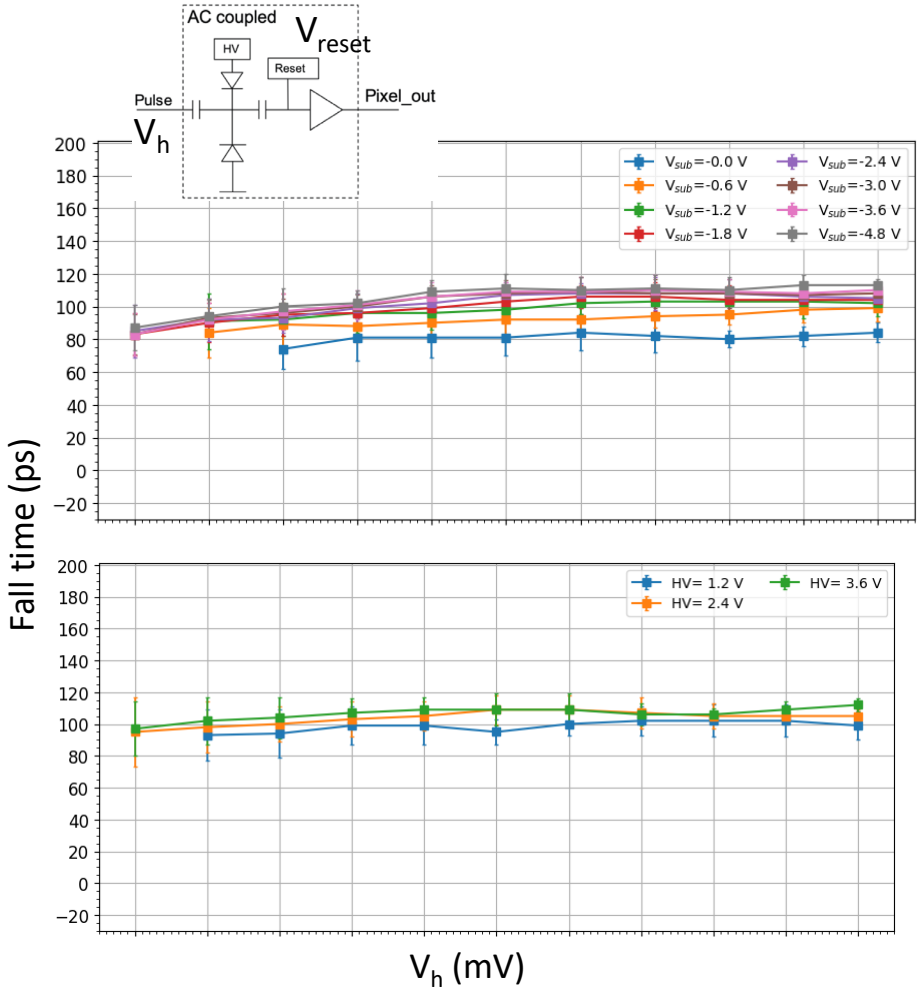
Analysis: Δamplitude/ΔV_{reset} to find best V_{reset} @ maximum signal amplitude and minimum signal Fall Time

APTS OA Chip Characterization

Baseline Calibration | Test Pulsing | Operating point | **Pulse Scanning** | X-rays source meas.

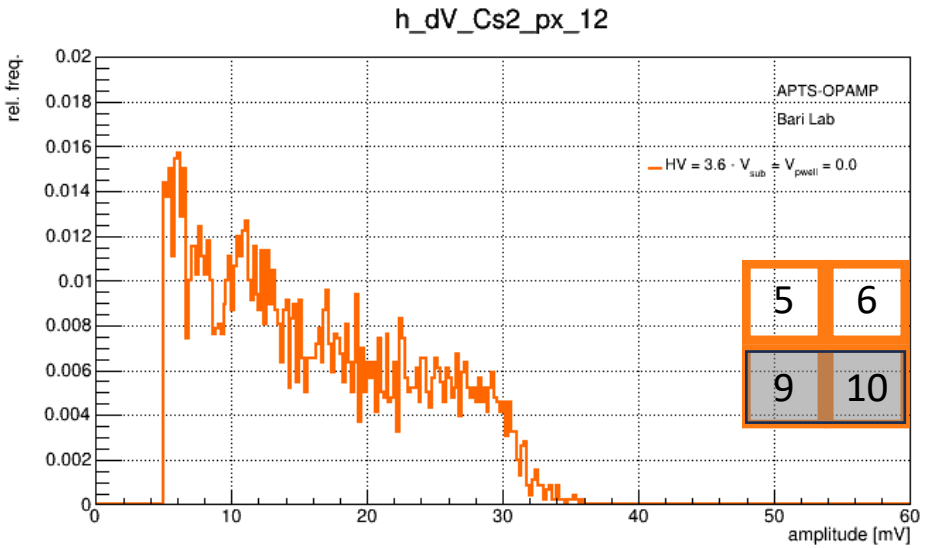
Goal: evaluation of the sensor circuitry response at the V_{reset} operationg point

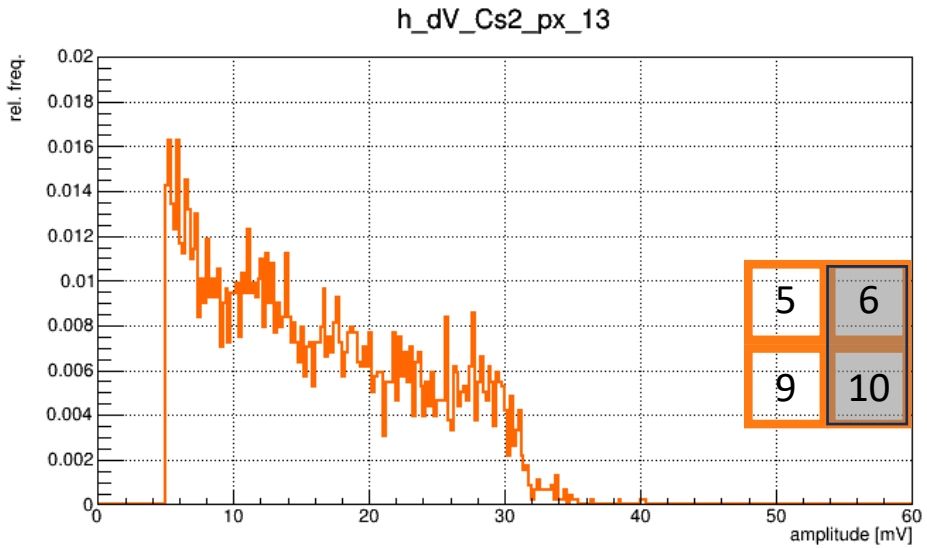


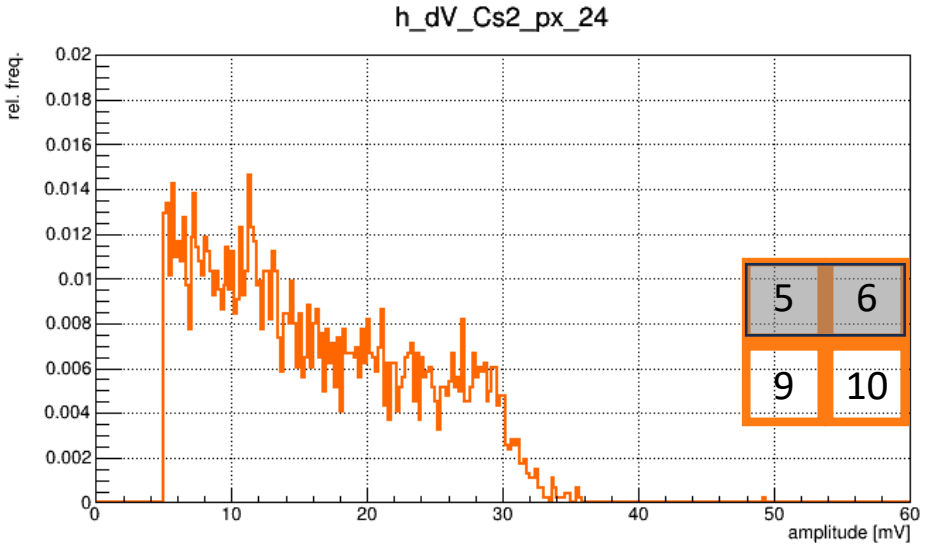


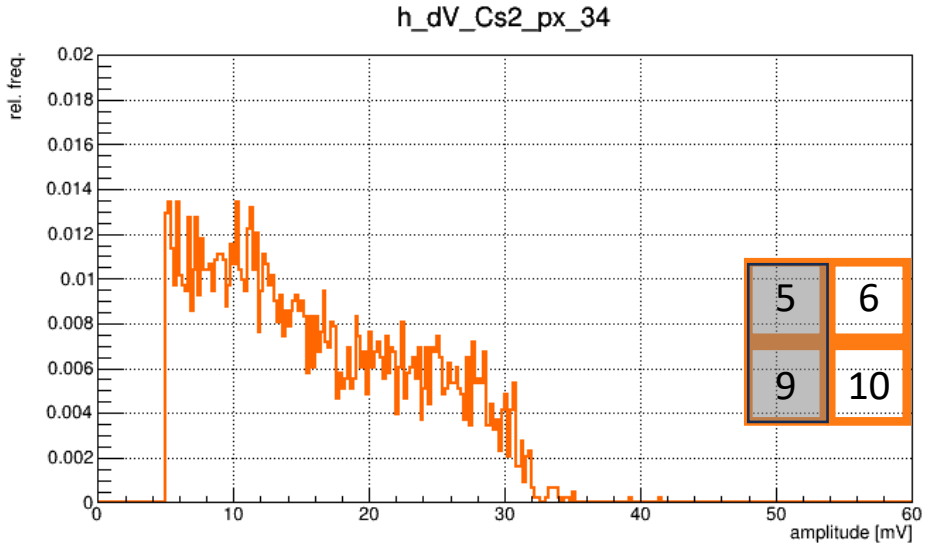
- Signal amplitude linear response w.r.t. injection voltage V_h
- Almost stable fall time.

APTS OA Cluster Size Investigation









^{55}Fe Spectra Cluster Size 2 @ HV = 3.6V – V_{sub}=V_{pwell}=0V