Progress in the Arcadia project

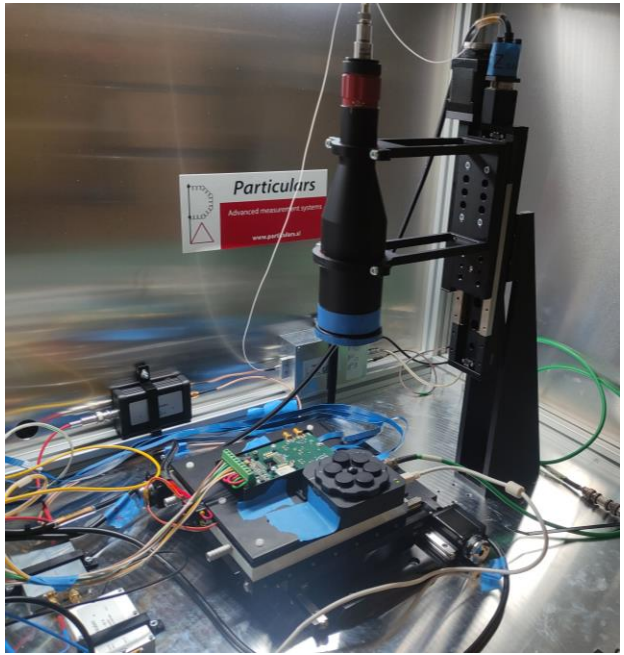
Nelson Salvador

First results on ARCADIA chip with Laser

17-10-2024

In partnership with:

Arcadia Setup



Setup based on Large Scanning TCT

- It consists of a platform that allows adjustment of the X-Y axes (the plane where the MAPS sensor is located) and the Z axis where the optical system is positioned.
- It has a movement step resolution of 1 µm.
- It allows for programming a simple path through the software (GUI/script).

Pilas Laser

Features

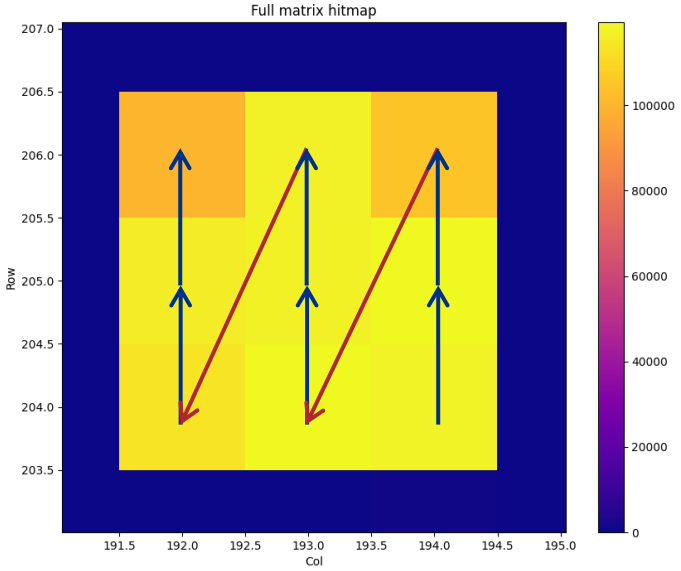
- λ= 1062 nm
- The minimum Laser spot achieved is approximately 12 µm
- This laser has a power on the order of µW

Configurable options

- The attenuation is configurable from 0 to 100%
- The internal trigger frequency (which is the one used) ranges from 25 Hz to 40 MHz

Test Setup for Measuring Efficiency

- 3 x 3 pixels are selected for the study.
- An 89.8% attenuation is configured on the laser to achieve detection on a single pixel.
- The figure shows the programmed path followed by the laser.
- The laser is maintained on each pixel for 4 seconds.
- To obtain efficiency, the code uses a variable called *TimeWidth* → adjusts the time window to use only events occurring at key moments as the system moves from one pixel to another.

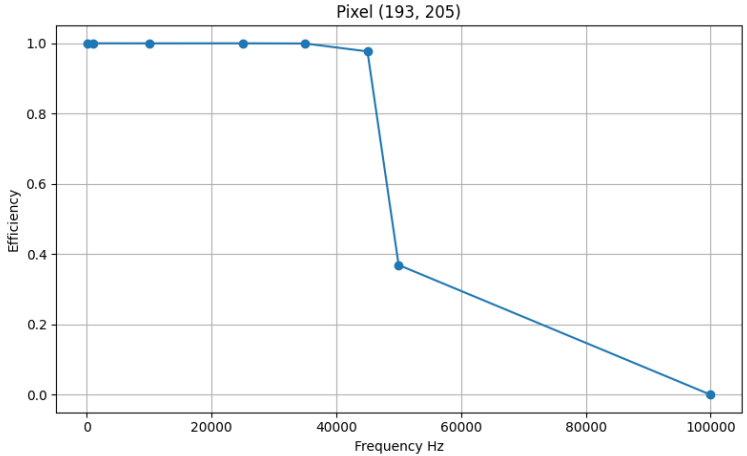


Programmed laser path

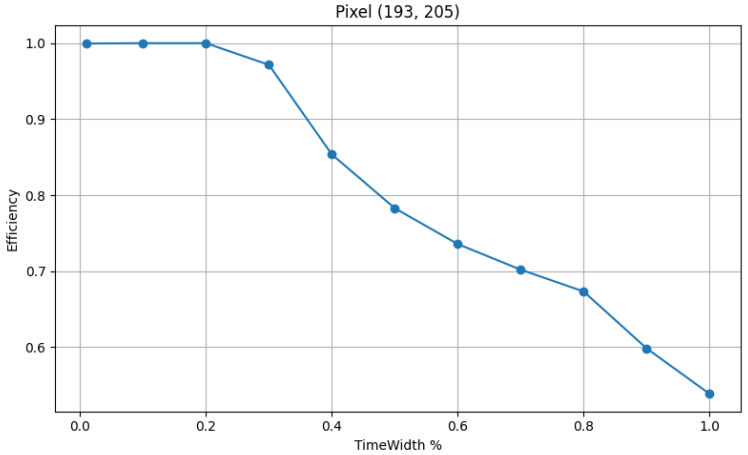
Operating Point Selection

*The 3x3 pixel graphs are in the backup

By comparing efficiency versus trigger frequency and TimeWidth, it is determined which values will be used to achieve good and reliable measurements.



Efficiency vs Frequency

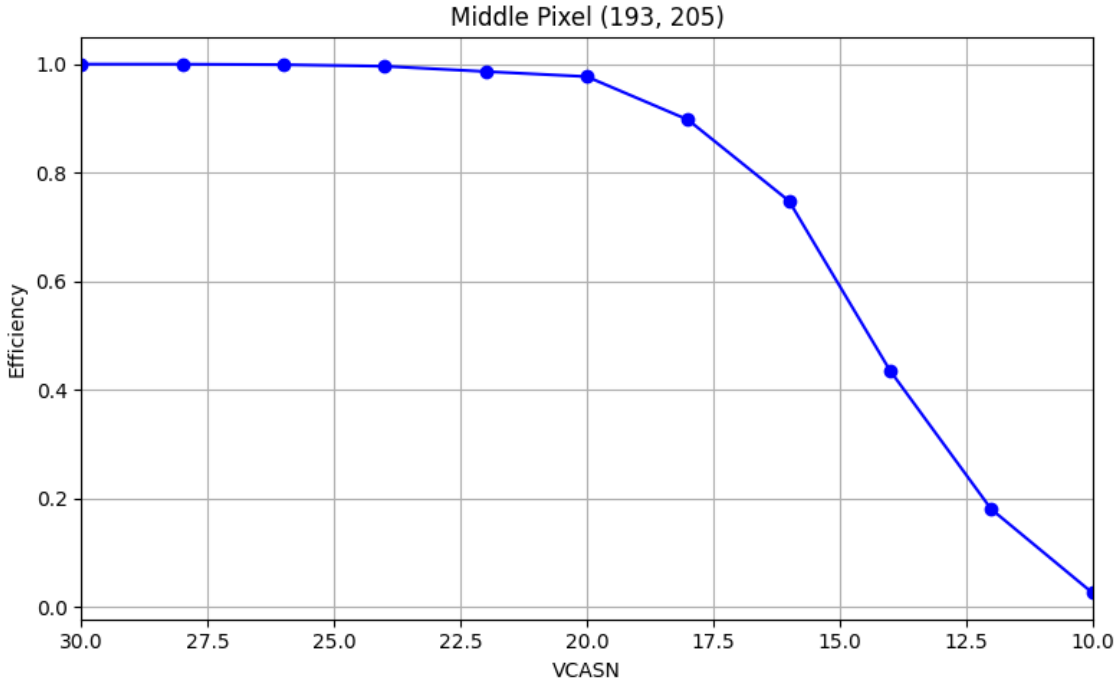


Efficiency vs TimeWidth for 25 kHz frequency

A trigger frequency of 25 kHz and a TimeWidth of 15% are selected

S-curves

*The 3x3 pixel graphs are in the backup



S-curve for a single pixel

Fermilab

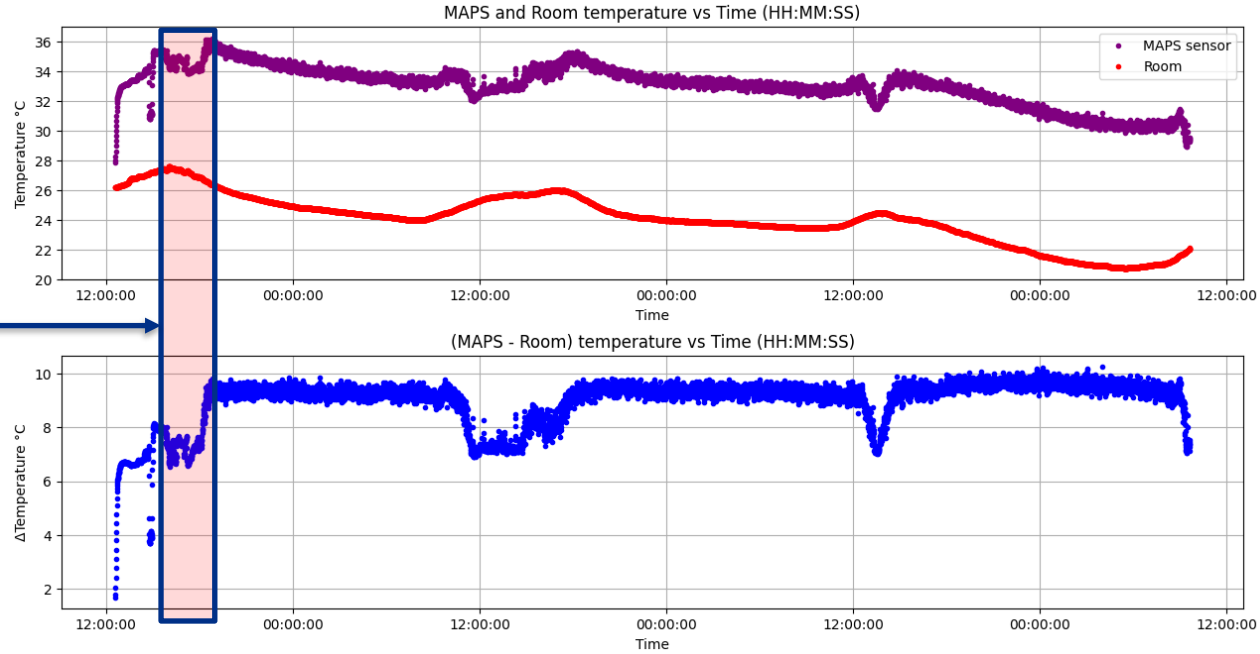
Issues observed

- It is observed that after a certain amount of time has passed since the start of a measurement, the readings from the MAPS sensor change and become inconsistent with the obtained previously, even under the same test conditions. It is believed that this is due to changes in temperature (we cannot control that parameter right now). This complicates the reproducibility of the results.

- When attempting to use the Particulars Laser, it is not possible to find a point where only one pixel detects the laser, even if the CCD camera shows that a minimum laser spot of approximately 13 µm is reached; instead, a shape similar to a diamond appears.

Weekend Temperature Measurement (update 10/14)

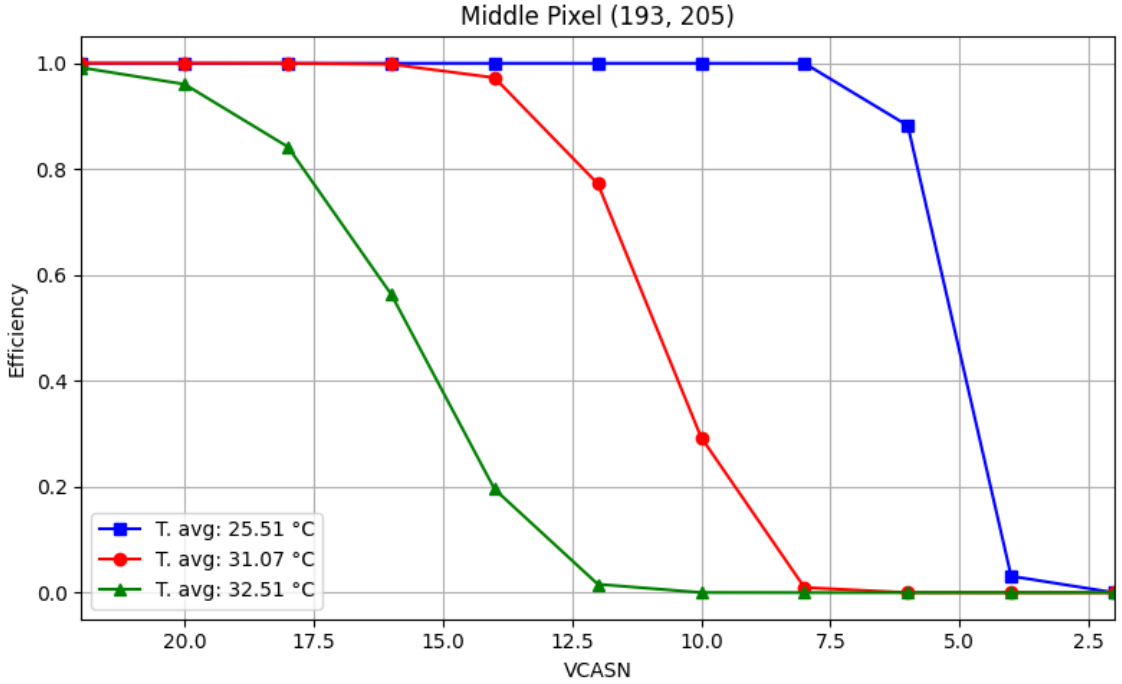
The sensor has temporarily gone out of position but quickly realigned



The inconsistency was observed before and after lunch (i.e., before 12 PM and after 1 PM). This was recorded by leaving the MAPS running over the weekend.

Temperature Analysis in S-Curve (update 10/14)

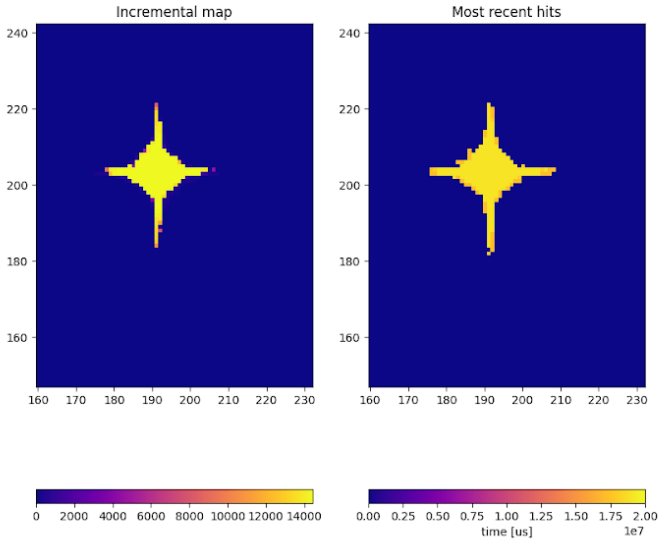
*The 3x3 pixel graphs are in the backup



S-curve for three different temperatures

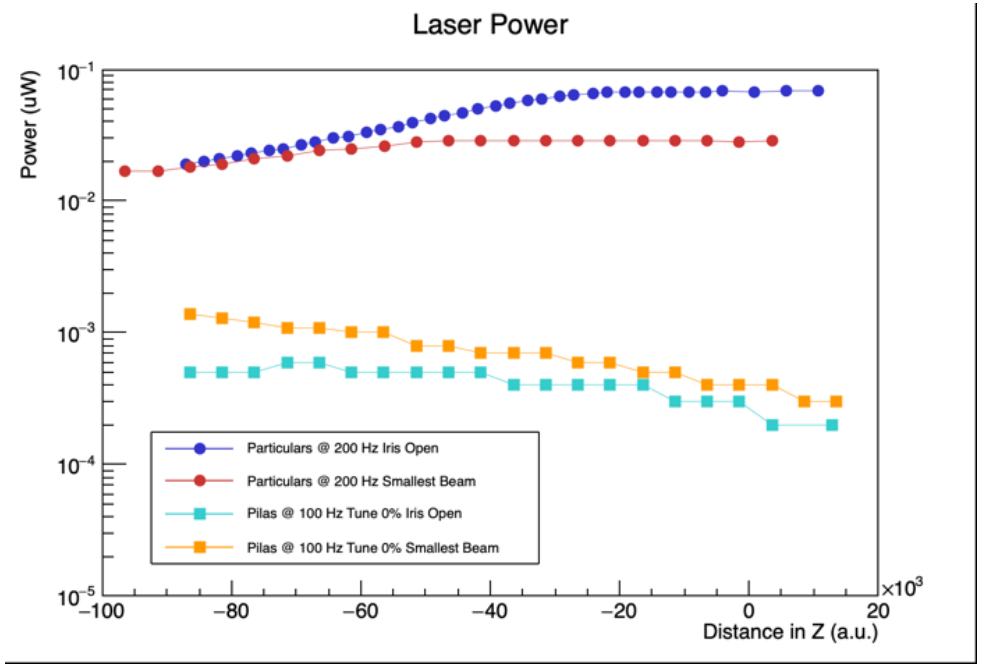
Diamond shape using the Particulars Laser

- When we attempt to use the Particulars Laser with the MAPS sensor, the following figure is observed (regardless of the VCASN threshold used)
- It is theorized that this is related to the laser power, as compared to the Pilas laser, it is more than one order of magnitude greater.
- After a meeting with a person related to the Particulars team, it was concluded that a physical filter is needed to attenuate the power by two orders of magnitude.



Minimum laser spot

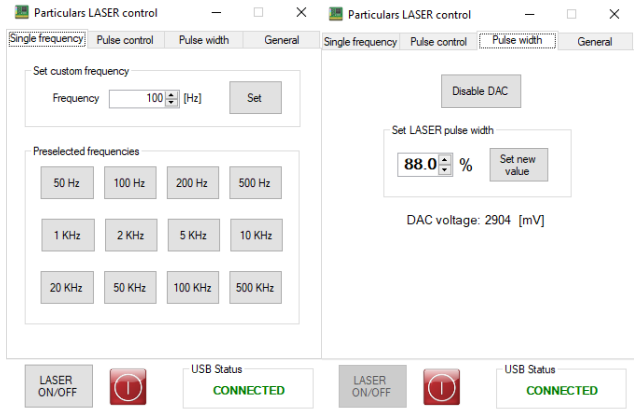
Power Measurement

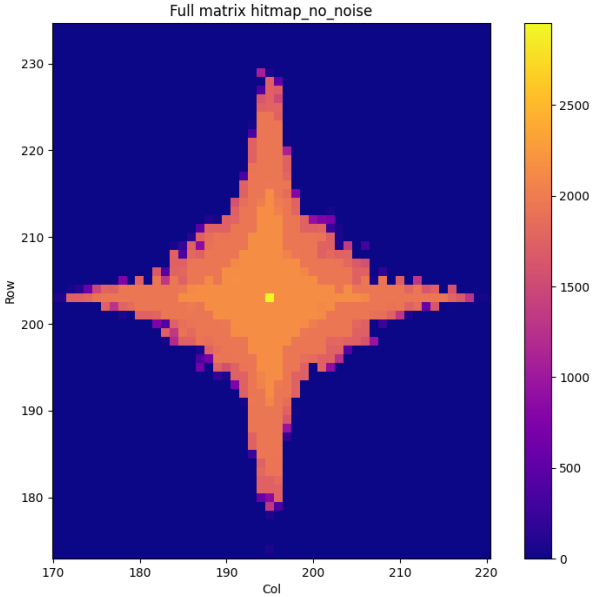


Power measurement for Particulars and Pilas Laser

Diamond shape using the Particulars Laser (Update 10/15)

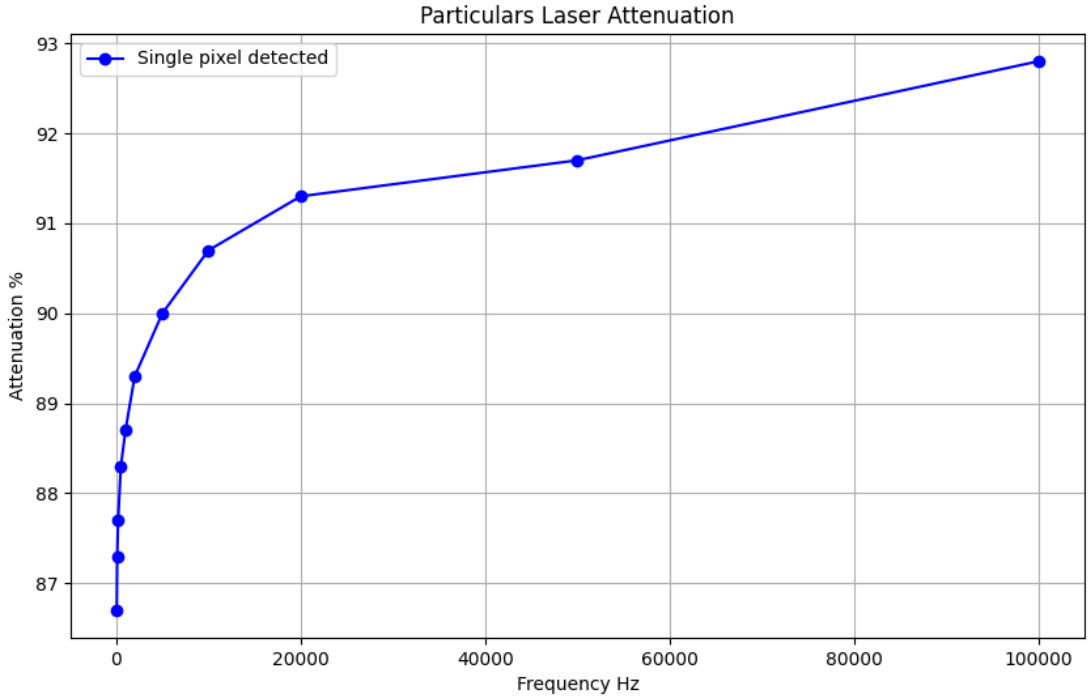
- Indeed, the diamond shape was due to the laser power. With other software to control the laser power, it was possible to attenuate by 88%, which at a frequency of 100 Hz allows MAPS to detect a single pixel.





Transition from diamond shape to pixel, increasing the pulse width.

Laser Attenuation Behavior as a Function of Frequency (update 10/16)



Particulars laser attenuation as a function of frequency for a single pixel detected

Next Steps (update 10/16)

1. Find the optimal point on the Z-axis where the laser spot is minimized (expected to be at most 10 µm) to investigate whether the pixel provides a uniform reading, regardless of the location within the pixel.

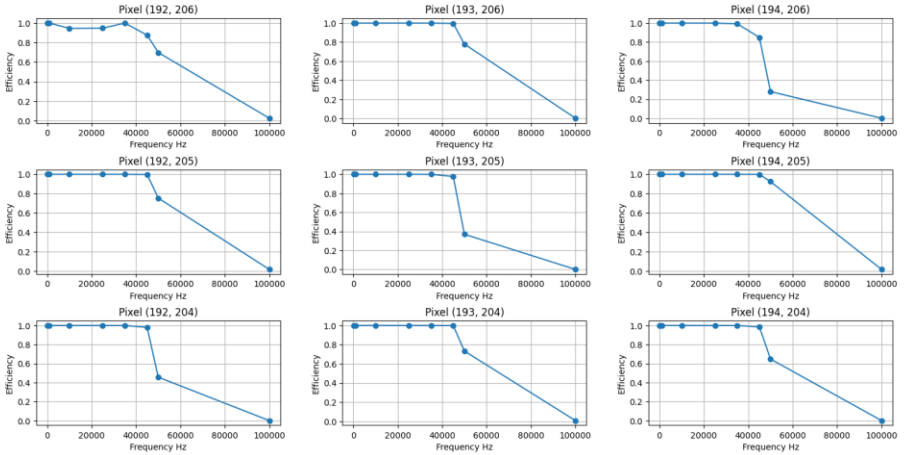
2. Control the temperature inside the box in the Arcadia Setup to better characterize the variation of the threshold with temperature. To achieve this, we need to understand the Peltier-cooled surface in the Scanning TCT.

3. Redo S-curve and perform the VCASN threshold vs. temperature characterization with the Particulars laser.

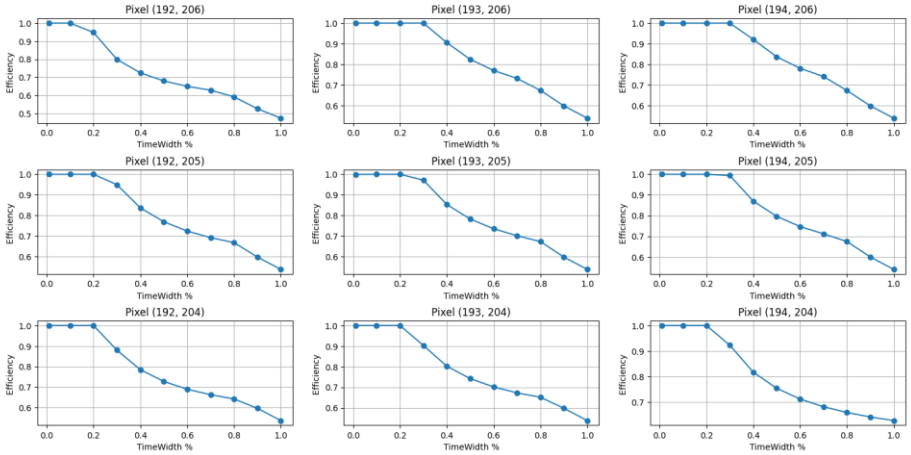
Thank you

Operating Point Selection

By comparing efficiency versus trigger frequency and TimeWidth, it is determined which values will be used to achieve good and reliable measurements.



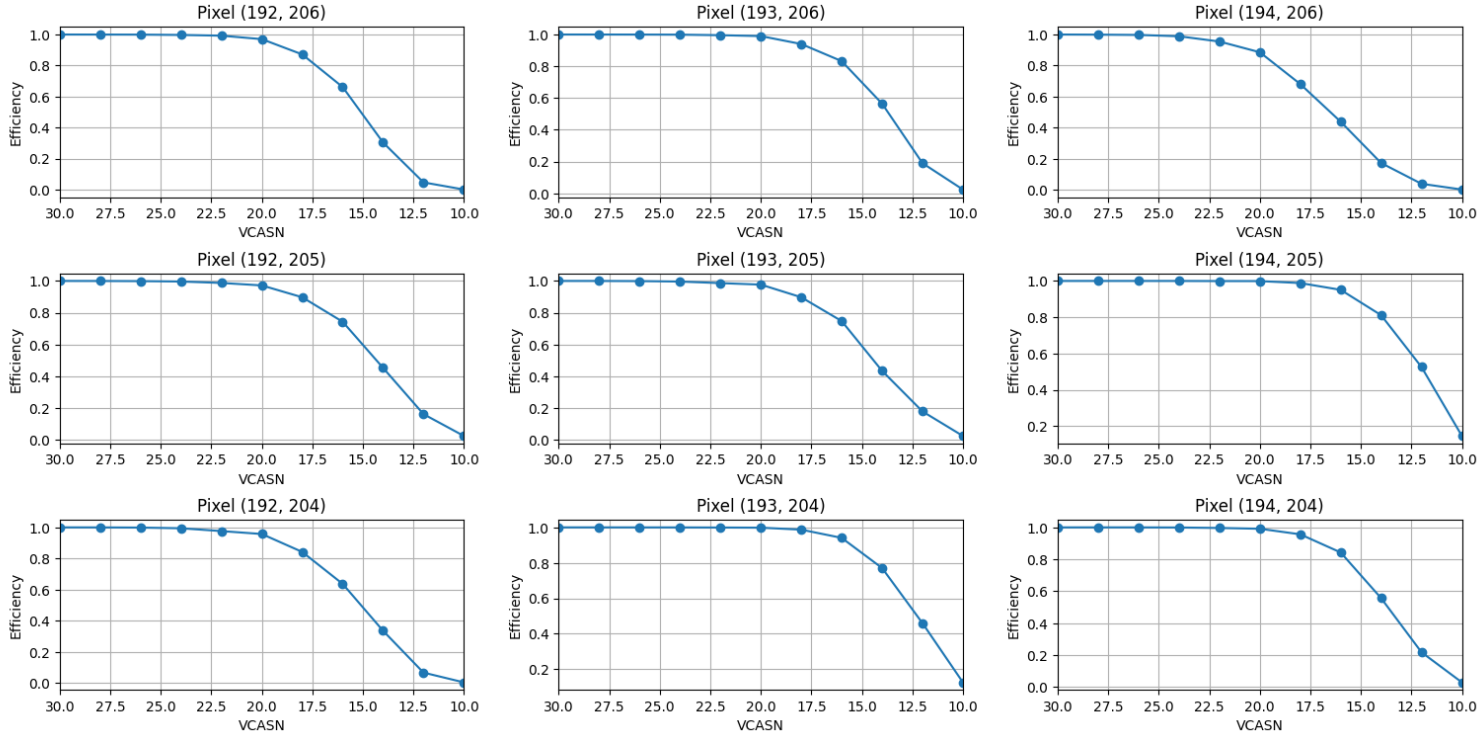
Efficiency vs Frequency



Efficiency vs TimeWidth for 25 kHz frequency

A trigger frequency of 25 kHz and a TimeWidth of 15% are selected.

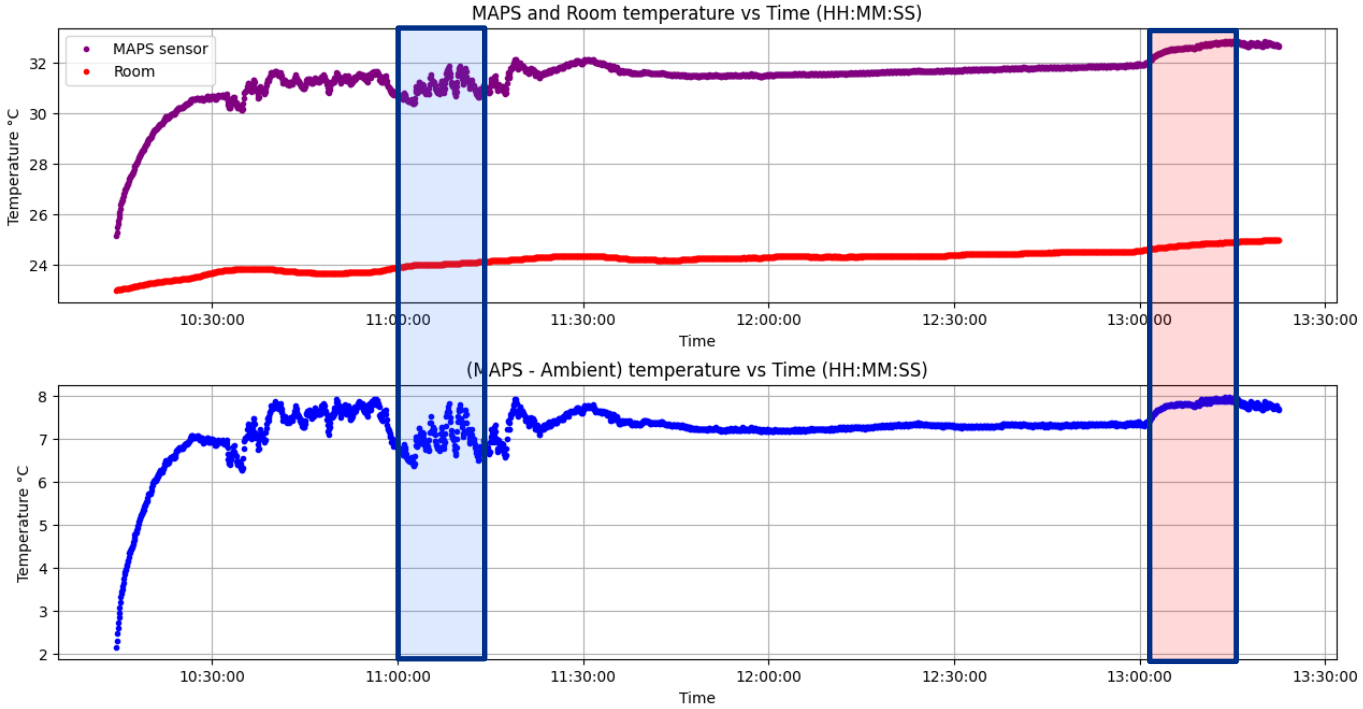
S-curves



S-curves for 3x3 Pixels

Fermilab

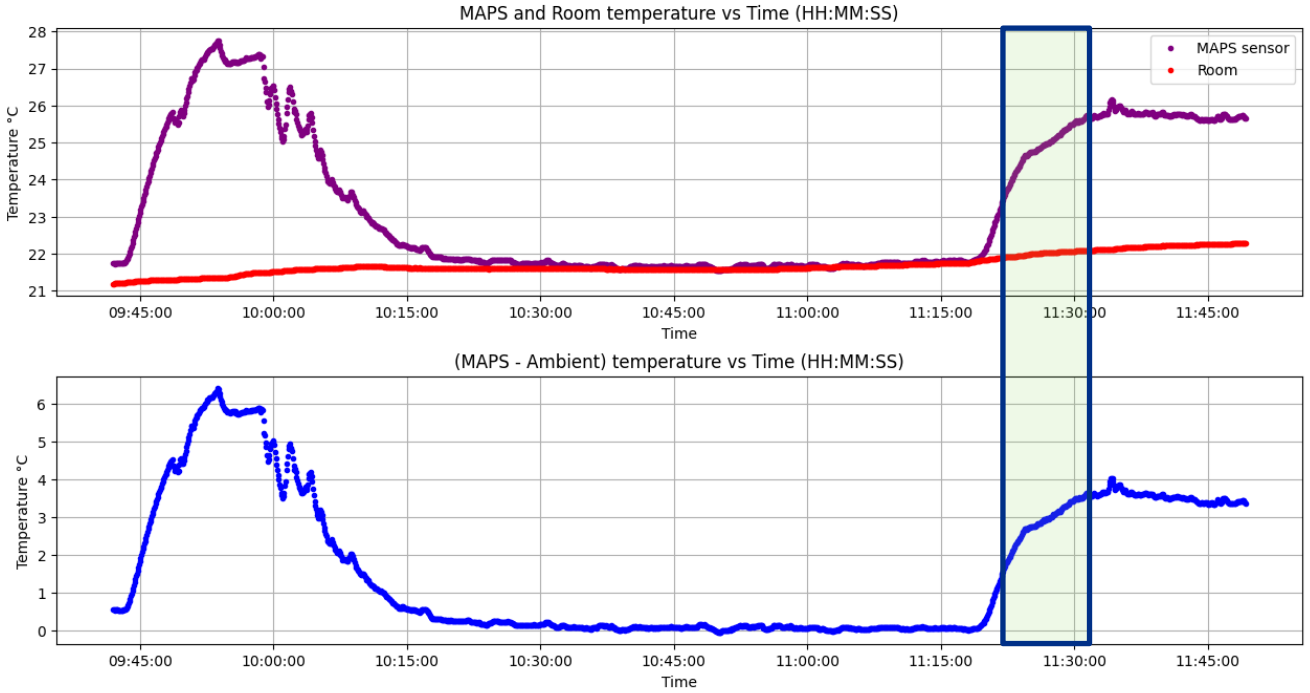
Temperature Analysis in S-Curve cont.



Temperature measurement at the time of obtaining the Efficiency vs. VCASN tests.

Fermilab

Temperature Analysis in S-Curve cont.



Temperature measurement at the time of obtaining the Efficiency vs. VCASN tests.