Quad-Module characterization with the MALTA monolithic pixel detector

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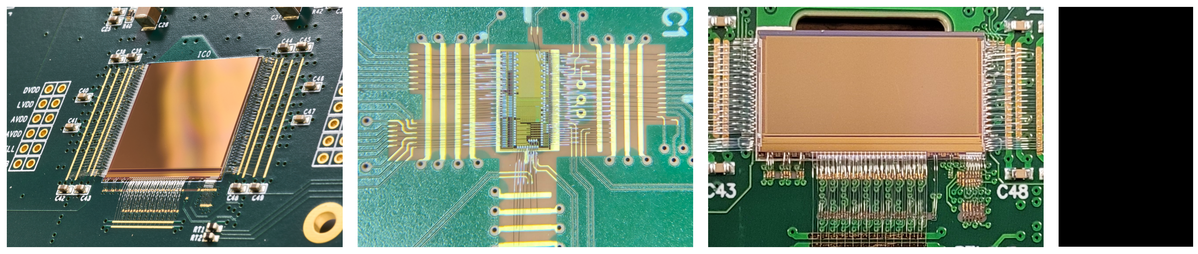
The MALTA detector family

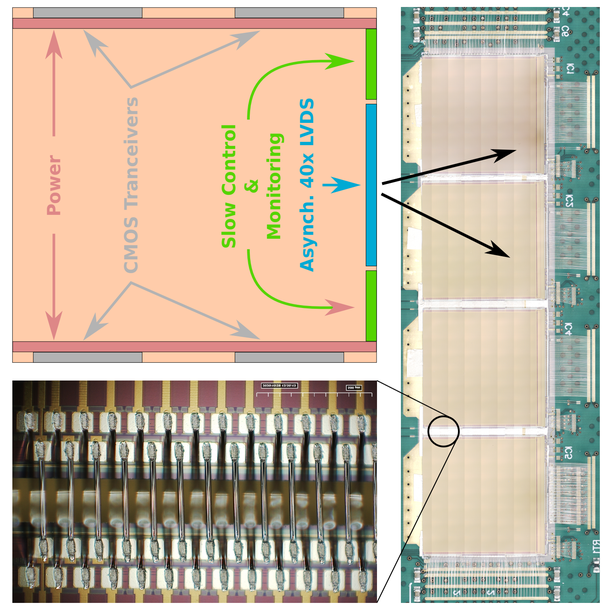


MALTA → MiniMALTA → MALTA2 → MALTA3

The goal for MALTA is to develop a radiation hard large-area DMAPS with high-granularity and ~1ns timing precision produced with an industrial standard CMOS process (180nm TowerJazz) for environments such as the outer layers of the ATLAS ITK.

MALTA module capability

MALTA and MALTA2 can send data as 40x parallel signals either from the default LVDS output or **transmit to a neighbor via redundant CMOS transceivers**. Both, transceivers and powering pads are located on the chip to allow **chip-to-chip data and power transmission** in a module structure.

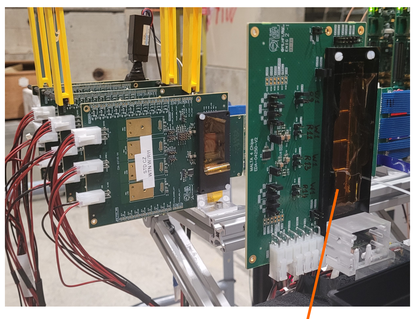


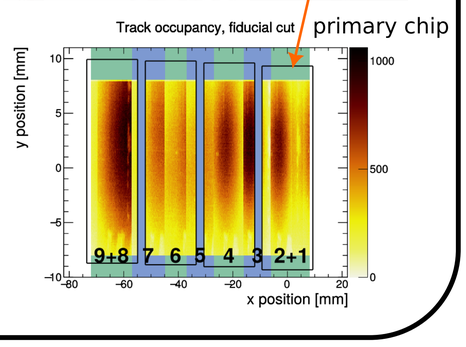
Beam Tests at the SPS North Area

Multiple beam test campaigns were performed at the SPS North Area during 2022 and 2023.

The beam telescope used was the MALTA telescope which features 6 MALTA planes for position reference.

Since the module DUT is larger than the acceptance window of the telescope, an XY stage was used to scan across the module in several steps. Merging the separate data sets reduced the alignment precision somewhat but a resolution of ~12µm was still achived



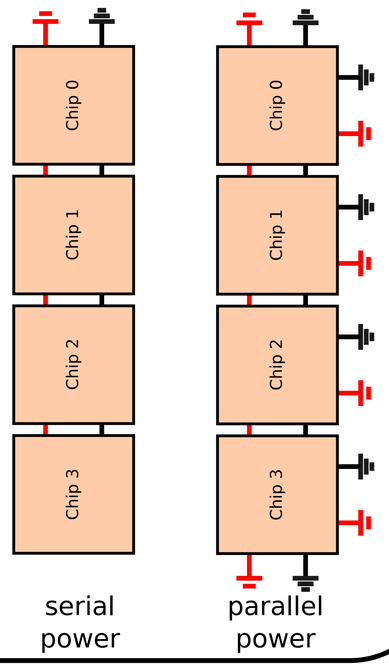


Parallel and serial powering

Several MALTA quad modules were tested with a serial or parallel powering scheme.

The goal is to investigate chip-to-chip data transmission and powering to guide the development of later generations of MALTA detectors.

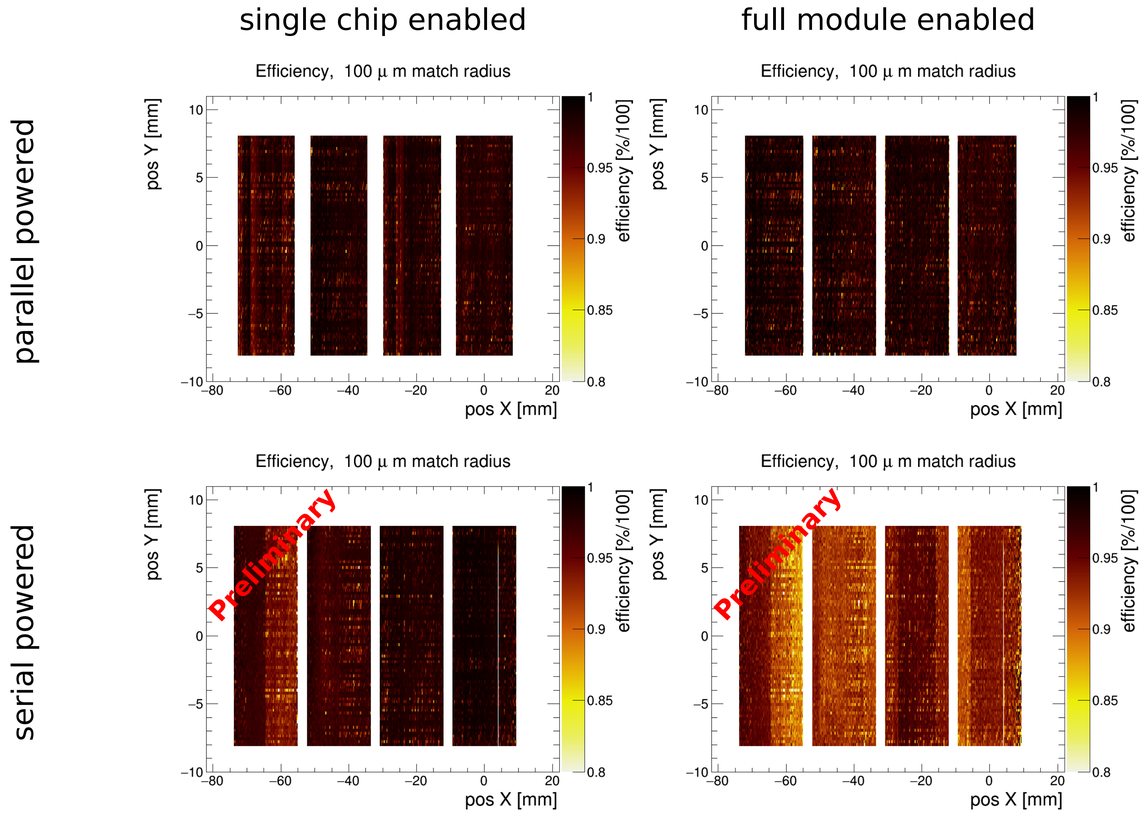
Especially serial powered modules require careful tuning of the front-end to allow stable operation in beam tests. Even then a loss in performance is observed.



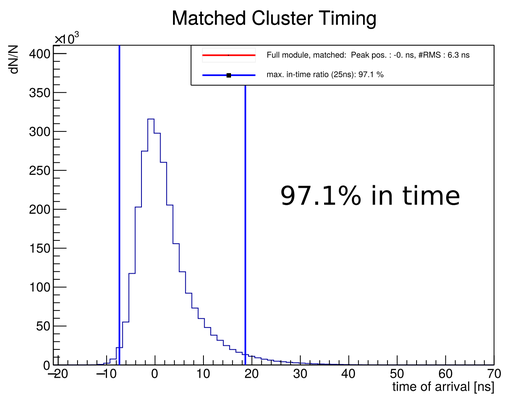
Detection efficiency

The fully powered module achieves and excellent efficiency of nearly 98% for both configuration (single chip and full module).

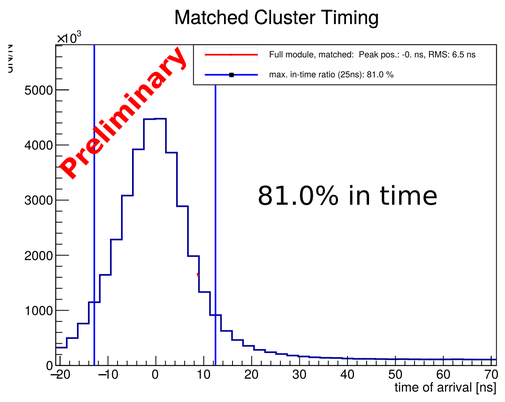
The serial powered module shows a degradation in efficiency that is still under investigation. Power management for this module is crucial and it is difficult to find a stable operation point for the front end.



In-time efficiency



parallel powering



serial powering

The in-time efficiency of the serial powering module is currently roughly 16 % worse for a 25% readout window which is attributed to sub-optimal power supply to the front-end.

Recent publications on MALTA

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