Design, Implementation and Verification of a Data Acquisition System for the Prototypes of the Front-End Electronics of the $\bar{P}$ANDA Micro Vertex Detector

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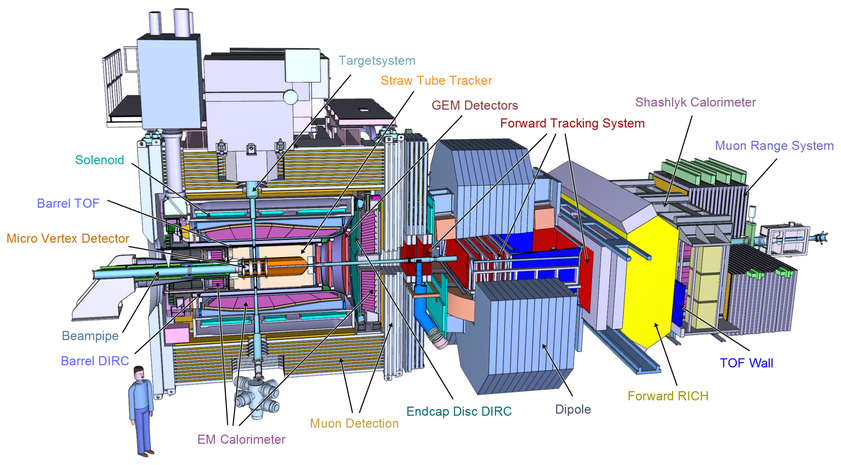
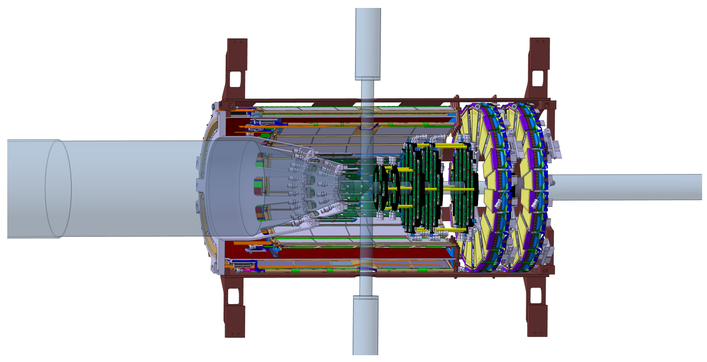
The $\bar{P}$ANDA Experiment



Antiproton **an**nihilation at **Da**rmstadt
Fixed p target, 1.5 – 15 GeV/c antiproton beam

Micro Vertex Detector



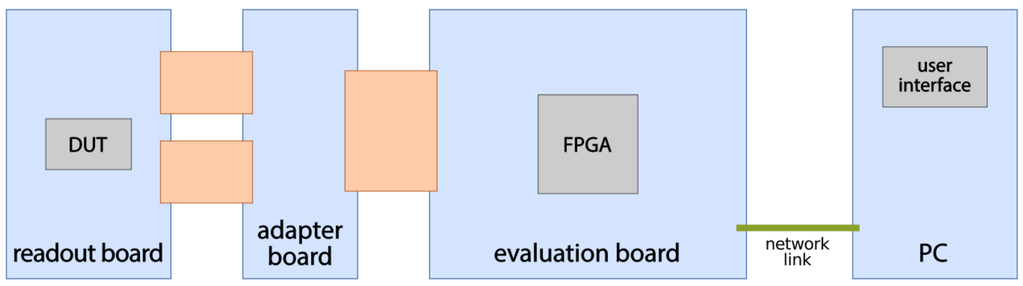
pixel detectors in the inner part
front-end chip: ToPix
strip detectors in the outer part
front-end chip: PASTA

→ High performance and flexible test system needed for ToPix and PASTA.

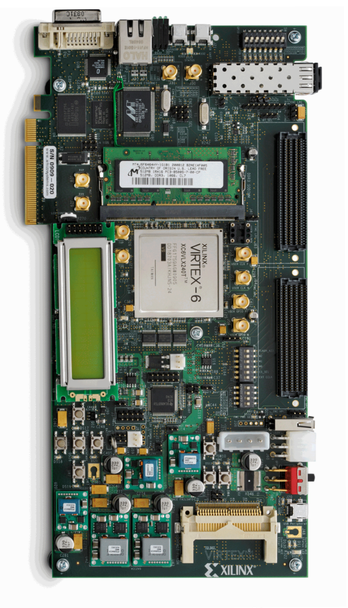
Requirements

- Free running readout: no first level hardware trigger.
- Fast readout @clk freq. 160 MHz.
- 3D hit information with spatial resolution < 100 µm.
- Time resolution ~ 10 ns.
- Deposited energy information.

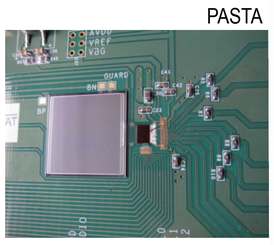
The Readout Chain: Basic Components



Xilinx ML605

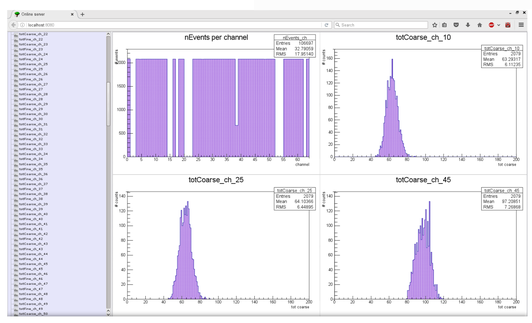


PASTA



Data conversion and communcation with the PC:
- **d**evice **u**nder **t**est: ToPix, PASTA
- evaluation board: Xilinx ML605 (Virtex-6 FPGA)
- firmware: VHDL

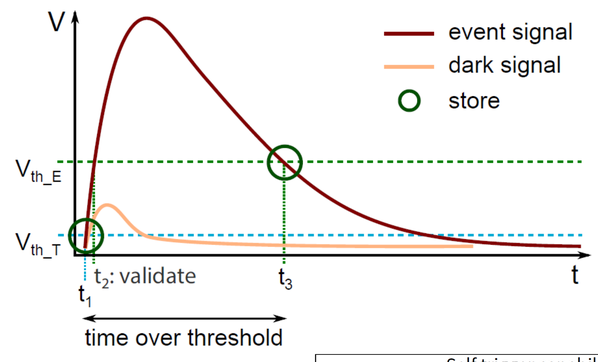
Configuration and data handling:
- PC
- software: C++
- MVD readout framework
- Qt-based user interface
- online monitoring (THttpServer)



The PASTA Chip

PASTA ($\bar{P}$ANDA **st**rip **A**SIC): 110 nm CMOS technology. Concept based on TOFPET ASIC (readout of SiPM for medical applications).

Time over threshold measurement based on two leading-edge discriminators:
- low threshold: resolve leading edge;
- high threshold: reduce jitter on falling edge.

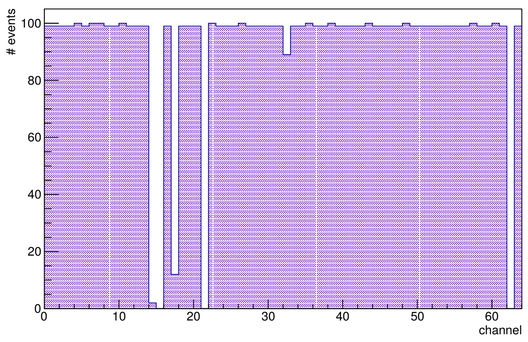


First prototype fabricated with a Multi Project Wafer run. Currently under evaluation.

Self trigger capability	
Input capacitance/charge	Si Strips: 50 pF / 38 fC
Power consumption	< 4 mW/ch
Channel pitch	63 µm
Radiation tolerance	100 kGy
Efficiency gap	no evt loss
Charge resolution	8 bit dyn. range
Time resolution (coarse)	6.25 ns
Time resolution (fine)	~ 50 ps

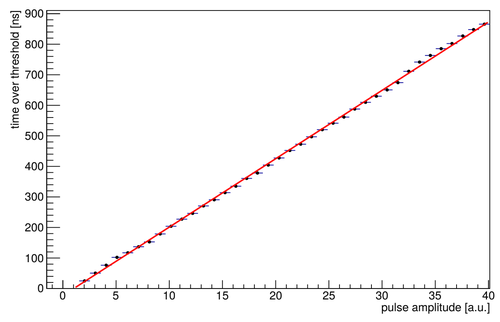
Measurements

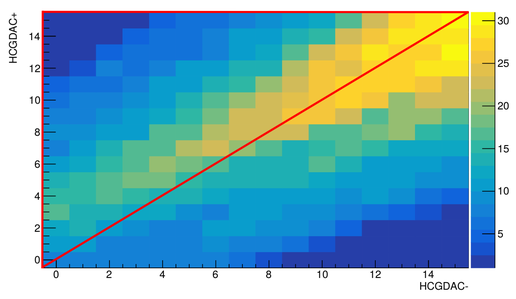
Laboratory Environment @ 80MHz



Channel response for 100 internally generated pulses of 20 fC charge each:
- optimized configuration
- only few unresponisive channels.

Time over threshold linearity over the foreseen working range:
- with coarse timestamp.

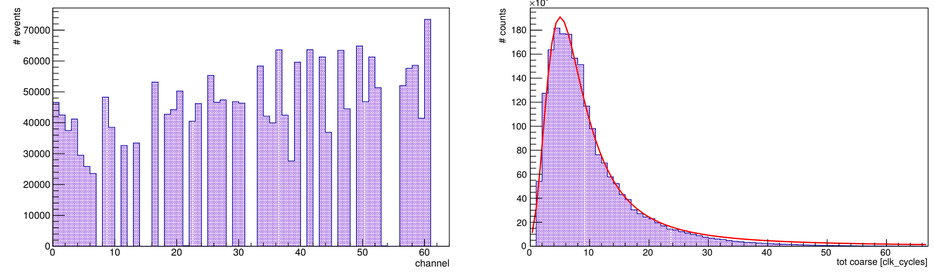




Threshold studies:
- two levels to define global threshold V_{th} = HCGDACp - HCGDACn ≥ 0
- find the combination that is suitable for correct operation, for the majority of the channels
- individual threshold parameters per channel for fine tuning.

Beam Test @ 80MHz

First test under proton beam with p = 800 MeV/c:
- more unresponsive channels for smaller charge
- time over threshold distribution Landau-shaped as expected.



Remarks and outlook:

- Data acquisition system designed and successfully integrated in a laboratory set up, as well as in a beam test environment (validated with PASTA).
- Operation is stable, but some issues regarding data transmission are still under study.
- Thorough investigation of the performances and weak points of PASTA necessary for the next iteration.
- Detailed analysis of the beam test data.
- Additional measurement with low rates (laboratory).

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