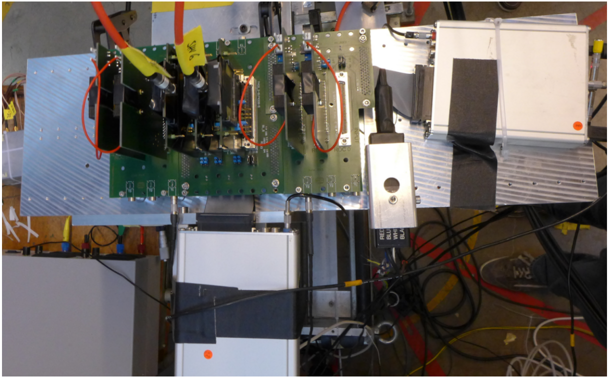

Preliminary Results of Pixel Detectors in 2015 PSI Testbeams

Michael Reichmann

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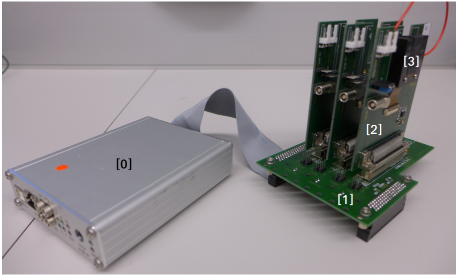
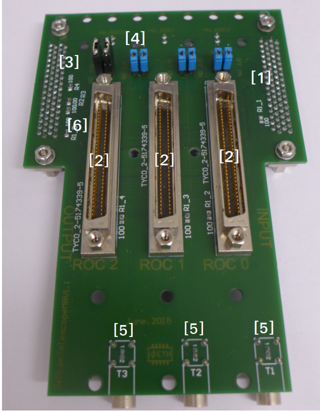
The Telescope

General Setup



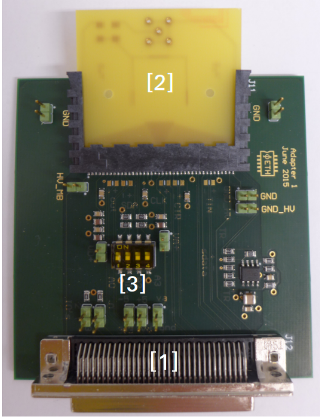
- [0] DTB (Digital Test Board) as interface between telescope and computer
- [1] Motherboard as main frame for the telescope
- [2] Adapter Planes as mounting framework for the single pixel chips
- [3] CMS Pixel Chip (analogue or digital)

Motherboard



- [1] input scsi connector to the DTB
- [2] sockets for the adapter planes
- [3] optional output scsi connector to another motherboard (chainable)
- [4] token jumpers (blue: plane active, black: plane inactive)
- [5] LEMO output of the fast-OR trigger signal
- [6] termination of the signals

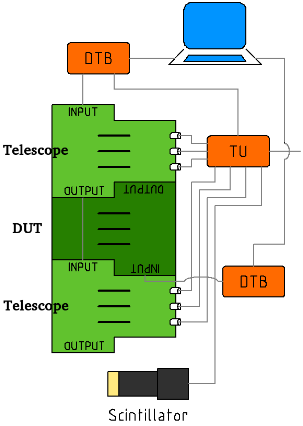
Adapter Plane



- [1] scsi connector to the motherboard
- [2] digital CMS pixel chip on a pcb (back side)
- [3] I^2C address bit switch

The Pixel Setup

Pixel Setup



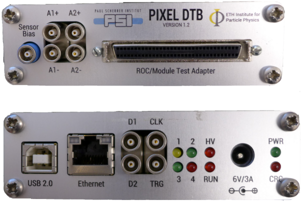
- telescope consistant of two chained motherboards with 4 (6) planes and analogue ROCs (Read Out Chips)
- DUT consistant of one motherboard with up to three planes with digital pixelated diamond sensors
- both read out by seperate DTBs
- scintillator for precise timing
- fast-OR triggers of the analogue chips and scintillator connected to a TU (Trigger Unit)
- TU sends trigger back to the DTBs

The Digital Test-Board

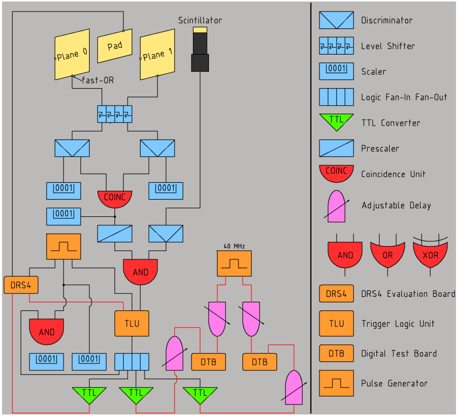
- FPGA including soft Token Bit Manager (TBM) emulator
- clock and external trigger inputs
- connectors: USB, low voltage and scsi
- LEMO high voltage input for biasing the sensors
- internal ADC

Figure : DTB inside

Figure : DTB front and back



Trigger Logic



- coincidence between a fast-OR of planes before and after the DUT
- AND of scintillator and fast-OR coincidence as trigger
- trigger has adjustable delays for both telescopes
- global external clock with adjustable delays for pixel telescope
- generated busy signal after trigger to avoid event misalignment
  - useful for long events with many pixels hit

The Datataking

pXar

- short for Pixel eXpert Analysis Readout
- software for communication between the telescope and a computer
- pXar-core libraries: program and readout information of the the CMS pixel chips
- python CLI (Command Line Interface) to perform simple tests

EUDAQ

- portable, modular and cross-platform DAQ framework
- developed for the EUDET Pixel Telescope
- can combine data streams from several different devices into an event based data stream
- adapting software to our purposes with help of DESY
- using pXar core libraries

WBC scan

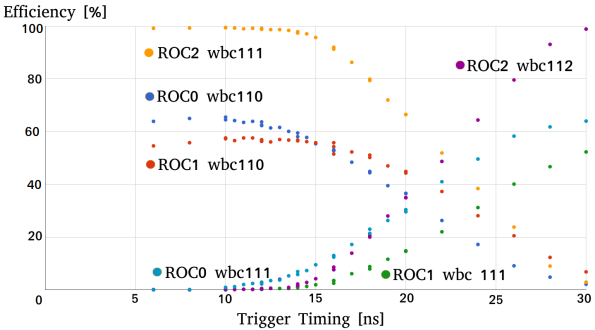
```
pxarCore =>> wbcScan

wbc     yield

090      0%
091      0%
092      0%
093      0%
094      0%
095      0%
096      0%
097      0%
098      0%
099      0%
100      2%
101     20%
102     98%
103      8%
104      0%
105      0%

ROC STATISTICS:
wbc     roc0    roc1    roc2    roc3
100     0       2       0       0
101     6       12      10      4
102     60      92      96      56
103     2       6       6       0
104     0       0       0       0

TRIGGER PHASE:
3       |||| 8.9%
4       |||||||||||||||||||||||||||||||||||||||||||||| 89.0%
5       | 2.1%
```

- ROC saves bunch crossing when particle hits the sensor
- programmable setting called wbc (wait bunch crossing)
- trigger only validates if time the trigger takes back to the ROC matches the wbc setting
- automated wbc scan using the pXar CLI
- detailed information about the hit yield (event has at least one hit) for every connected ROC
- information of the trigger phase (relative timing of the trigger compared to the clock)

Telescope

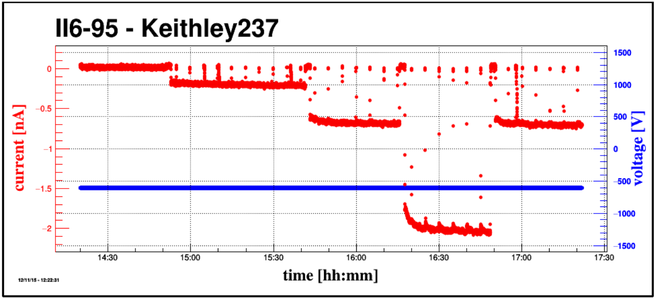
- fast-Or trigger sampled with 25ns clock $\rightarrow$ jitters within 25ns window
- coincidence with scintillator splits up trigger phase
- use trigger delay to shift the trigger into the place within the clock so that efficiency is maximised

DUT



- first use trigger delay to shift the the trigger in the middle of the clock
- shift trigger and clock delay together
  - leaves trigger phase constant
  - find optimal efficiency relative to the telescope clock

Current Monitor



- monitoring of the currents of the diamonds during the whole beam test
- beam induced currents for higher rates
- current drops to 0 at beam interruptions

The Measurements

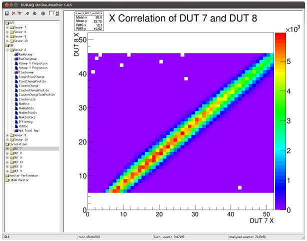
Types of Measurements

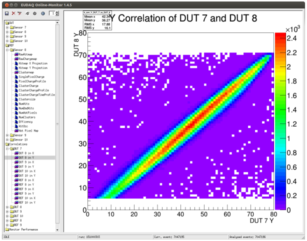
- two beam tests at PSI
- tested diamonds unirradiated:
  - II6-94, II6-95
- tested diamonds irradiated:
  - II6-95
- beam rate scans (up→down→up)
- different bias voltages
- closing beam shutter before the run was startet and open it during the begin of the run
- not closing the beam shutter
- experimental runs:
  - continuously changing the particle rate during the run
  - continuously changing the bias voltage during the run
  - very low ROC threshold (noisy chip)

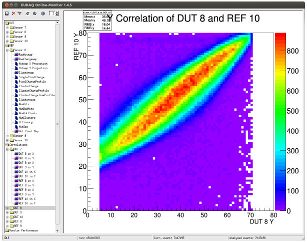
The Analysis

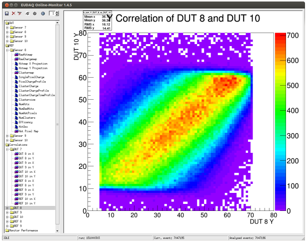
- preliminary results
- offline analysis has not started yet
- online analysis during the beam test with online monitor
- pre analysis with tracking software

Correlations

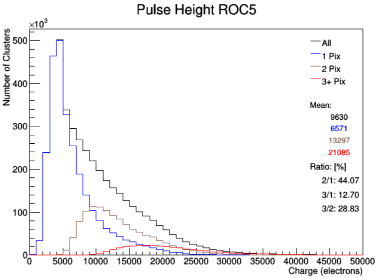


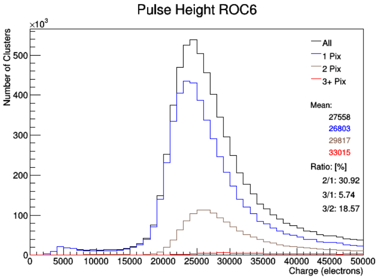






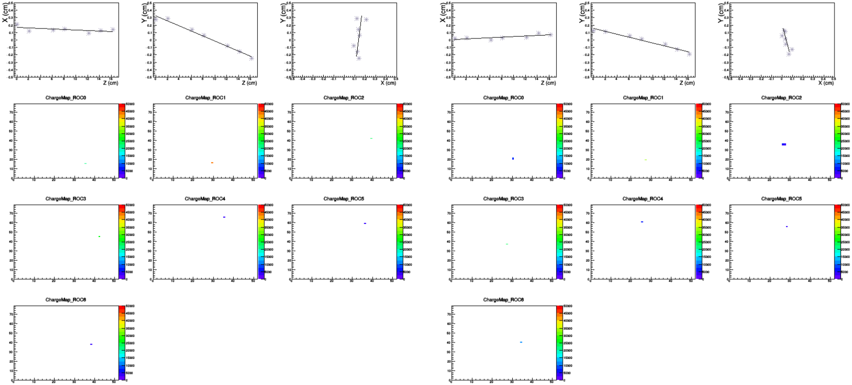
Pulseheight Distribution





- ROC5 digital silicon ROC well calibrated with Xray fluorescent lines
- ROC6 digital diamond pixel chip, not calibrated

Event Display



- display of random events of a run