First Results of the new CBM Timing System

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2nd CARAT Workshop @ GSI 13.–15.12.2010
Outline

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  - GET4
  - ROC
- Beamtime August
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- Beamtime November
  - Setup
  - Problems
  - Results
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CLOSY (CBM–CLOCK–SYTEM)

Requirements for CBM–Time of Flight (ToF) detector readout

- two phase coupled high-performance frequencies are needed
  - 156.25MHz: used for the time measurements with an event driven TDC (FEET-board, GET4 TDC chip)
  - 250MHz: used for the synchronous data transportation (Read Out Controller board, ROC)
  - jitter, less than 5 ps sigma
- to synchronize these frequencies over a long distance epoch markers are needed
  - $t_{\text{epoch}} = 26.2144 \mu s \Rightarrow \text{Sync Signal}$
TDC GET4

Full size prototype with 4 channels
- UMC 180nm process
- 1P6M layer
- 3240μm x 3240μm, 64 Bondpads
- Submitted in Oct. 2008

EE - GSI
Dr. Holger Flemming
Harald Deppe

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TDC GET4

- Clock frequency: 156.25 MHz
- Power consumption: 27 mW/Ch
- Linearity:
  - DNL < +/- 60 ps = +/- 1.2 LSB
  - INL < +/- 80 ps = +/- 1.5 LSB
- min Puls Width < 1ns
- puls spacing < 3.2 ns
- RMS = 25.1 ps
Readout Controller (ROC)

- SYSCORE V2 = ROC
- FPGA based readout controller for CBM
- free running data-processing
  - non triggered system
    - takes everything what the front end card delivers
  - Data Transport: Ethernet & Optic

KIP Heidelberg
Dirk Gottschalk
Beamtime Setup End August

CLOSY & CLK DIS.
Sync
156.25MHz
250.00MHz

Beam

Diamond-Stack

Get4
Sync
156.25MHz

Get4

R2F

Sync
156.25MHz
250.00MHz

PC
DAQ

ROC
Beamtime Setup End August

PADI IV with Diamond Detector

Readout Electronic (GET4-FEET & ROC)

Clock Distribution
Problems with one FEET–GET4

- Due to problems on first GET4–FEET–PCB the data shows bad sync-spacing behavior

(should be a peak at 25)

- only data of the second PCB is useable
  - ref. Diamond
Correlation between the 4 working Channels (log)

**CH 8–9**  **CH 8–10**  **CH 8–11**

Sigma: 53.00ps  33.74ps  42.40ps
TOT Measurement (log/lin)

TOT CH8
Beamtime November Setup

Diamond Stack

HV

ROC Power Clock
Problems with Beam Intensity

- unfortunately the lithium beam was too light for reference diamond
  - signal is shared between 4 PADI channels
    - same threshold for all 3 diamonds
    - only data of the first two diamonds are usable
TOT Measurement (log)

- **TimeOverThreshold0**
  - Entries: 75206
  - Mean: 2.771
  - RMS: 1.16
  - Underflow: 0
  - Overflow: 0
  - Integral: 7.82e+04
  - Skewness: 2.375

- **TimeOverThreshold1**
  - Entries: 2254
  - Mean: 3.503
  - RMS: 3.154
  - Underflow: 0
  - Overflow: 0
  - Integral: 2254
  - Skewness: 1.511

- **TimeOverThreshold2**
  - Entries: 114447
  - Mean: 3.348
  - RMS: 1.138
  - Underflow: 0
  - Overflow: 2
  - Integral: 1.144e+05
  - Skewness: 1.748

- **TimeOverThreshold3**
  - Entries: 8238
  - Mean: 2.446
  - RMS: 1.929
  - Underflow: 0
  - Overflow: 0
  - Integral: 8238
  - Skewness: 3.42

- **TimeOverThreshold4**
  - Entries: 46272
  - Mean: 2.61
  - RMS: 1.403
  - Underflow: 0
  - Overflow: 2
  - Integral: 4.627e+04
  - Skewness: 3.483

- **TimeOverThreshold5**
  - Entries: 104302
  - Mean: 3.614
  - RMS: 1.32
  - Underflow: 0
  - Overflow: 4
  - Integral: 1.043e+05
  - Skewness: 1.785

- **TimeOverThreshold6**
  - Entries: 5661
  - Mean: 2.976
  - RMS: 2.55
  - Underflow: 0
  - Overflow: 0
  - Integral: 5667
  - Skewness: 2.676

- **TimeOverThreshold7**
  - Entries: 9607
  - Mean: 3.207
  - RMS: 1.287
  - Underflow: 0
  - Overflow: 10
  - Integral: 9.84e+04
  - Skewness: 2.861
Correlation between the Diamond_1(CH2) & Diamond_2(CH4−7)

Sigma ~ 490ps
Conclusions

- all 12 Channels were working

![Graph showing number of rising edges per channel]

- due to the different thresholds of PADI4 it is necessary to be able to set values separately to reach better results
Improvements (FPGA Code)

- up to "now" we had problems in data-sorting due to missing "Sync-messages" in the data stream => time ordering not possible
  - sync messages have now a higher priority (FPGA)
    - input stage of the ROC should not miss any sync message from GET4
Improvements (analyzing Data)

- GO4 online monitoring & data cleaning
  - time ordering
  - Time over Threshold spectra
  - correlations

- free running System with additional trigger
  - injection of an external trigger into Get4
    - stored with a timestamp in the data stream

- ROOT Analyses
  - cutting on conditions
    - e.g. 4PMTs in the data stream? ⇒ time window cut
    - cutting on external trigger ⇒ time window cut
  - Data calibration (under construction)
Outlook Get4

- new test chip of GET4 CORE
  - improvement nonlinearity (ordered)
  - new layout:
    - expertise layout – strategy (shielding)
      - beginning 2011
    - layout GET4 test chip with intelligent readout
      - beginning of 2011
- end 2011 new version of GET4
  - improvement nonlinearity & shielding
Thank you for your attention