

Front-end Electronics representation in the MVD Software

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- ① Geometry
- ② Software Layout
- ③ Digitization/Reconstruction
- ④ Some simulation plots
- ⑤ ToPix VHDL simulation

① Geometry

② Software Layout

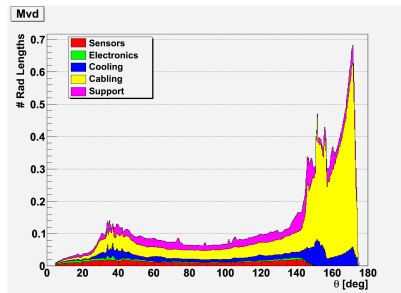
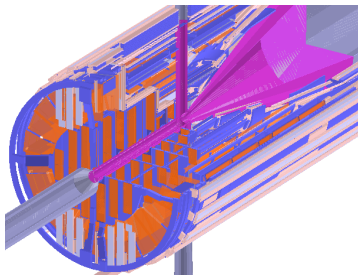
③ Digitization/Reconstruction

④ Some simulation plots

⑤ ToPix VHDL simulation

Geometry

- Derived from the **detailed** CAD model
- Geometry contains:
 - Sensors (Si)
 - Front-end pieces (Si)
 - Support structure (C, foam)
 - Cooling pipes
 - Cabling



Material budget:

- Sensors: $2\% X_0$
- Complex routing at 40° :
 $14\% X_0$ max
- Barrel part: below $10\% X_0$

Hybrid Pixel Sensors

- Rectangular shape, different lengths
- Custom front-end ToPix2
- Sensors & Front-end bump-bonded
- $100 \times 100 \mu\text{m}^2$ pixel size

Double Sided Strip Sensors

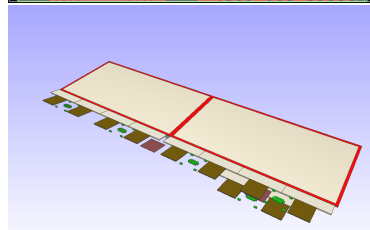
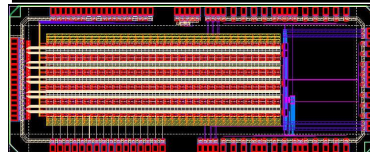
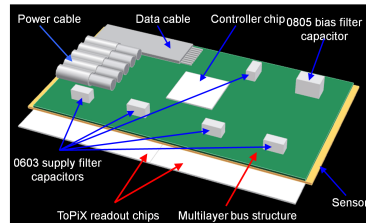
Rectangular:

- 90° stereo angle
- Pitches: $130 \mu\text{m}$ both sides
- Readout chips at the long sides

Trapezoidal:

- 30° stereo angle
- Pitches $67.5 \mu\text{m}$ both sides
- Readout chips at the long base edge

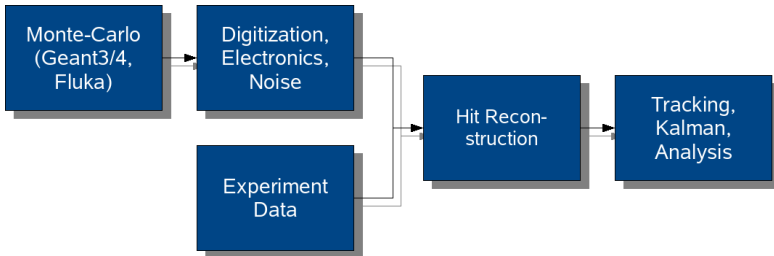
Front-end type not yet decided

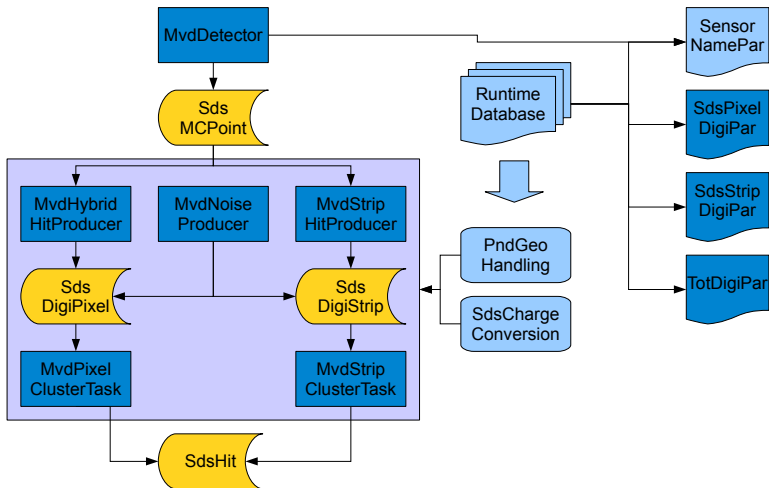


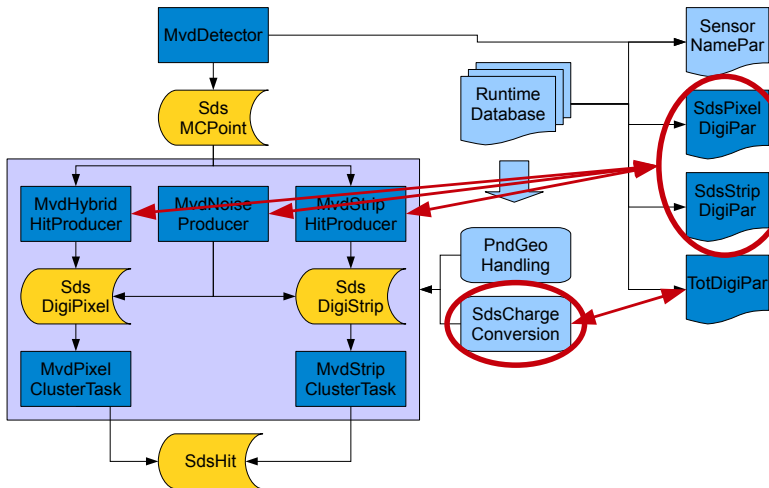
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Mvd Software

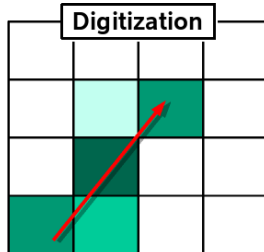
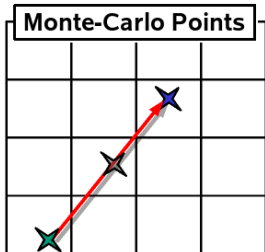
- Package of PandaRoot
- Organized in Tasks
- Settings via the parameter database
- Modular Ansatz when selecting Algorithms
- Lab data as input possible







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Position Digitization

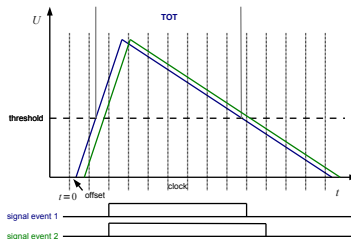
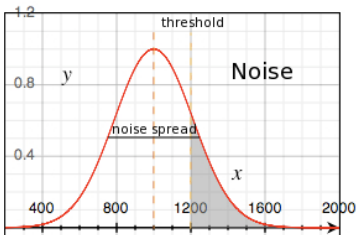
- Project track piece to the sensor plane
- Calculate channel & front-end numbers
- Distribute the energyloss by path length
- Charge diffusion cloud (preliminary)

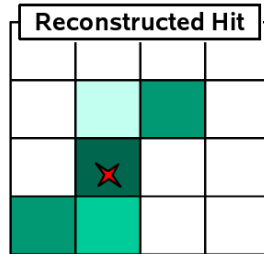
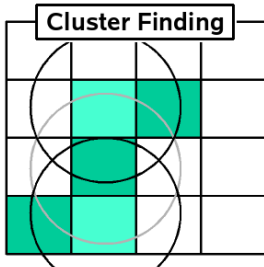
Data at Digi level:

- Sensor ID
- Channel number
- Front-end number
- Charge (ToT)

Charge digitization

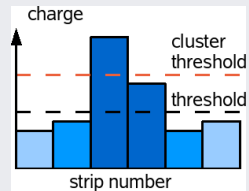
- Gaussian noise smearing
- Random noisy channels
- Minimum charge threshold (cut)
- Time over Threshold calculation
- No detailed electronics
- No data taking limits (buffer sizes, pile-up...)
- Time stamps not implemented, yet
- No strip sensor chaining





Hit Reconstruction

- Clusters: neighbouring strips above a threshold or neighbouring pixel set
- Chargedweighted mean: hit position & charge sum for the cluster
- Charge correlation (bottom & top side) to reduce fake combinations



Parameters (see macro/params/mvd.digi.par)

[MVDDStripDigiParTrap]

```
top_pitch:Double_t 0.00675
bot_pitch:Double_t 0.00675
orient:Double_t 1.439896633
skew:Double_t 0.261799388
top_anchor_x:Double_t -1.72967
top_anchor_y:Double_t 2.78327
bot_anchor_x:Double_t -1.72967
bot_anchor_y:Double_t 2.78327
nr_fe_channels:Int_t 128
nr_fe_top:Int_t 4
nr_fe_bottom:Int_t 4
charge_threshold:Double_t 5000
charge_noise:Double_t 1000
sens_Type:Text_t Trap
fe_Type:Text_t APV25
cluster_mod:Int_t 0
cluster_mean:Int_t 1
cluster_radchan:Int_t 2
cluster_radtime:Int_t 0
cluster_corrchargecut:Double_t 12000.
cluster_singlechargecut:Double_t 3000.
chargeconv_method:Int_t 1
```

[MVDPixelDigiPar]

```
dimX:Double_t 0.01
dimY:Double_t 0.01
threshold:Double_t 1100
noise:Double_t 200
FECols:Int_t 104
FERows:Int_t 104
```

[MVDDStripTotDigiParTrap]

```
charge_time:Double_t 100.
const_current:Double_t 60.
clock_frequency:Double_t 50.
```

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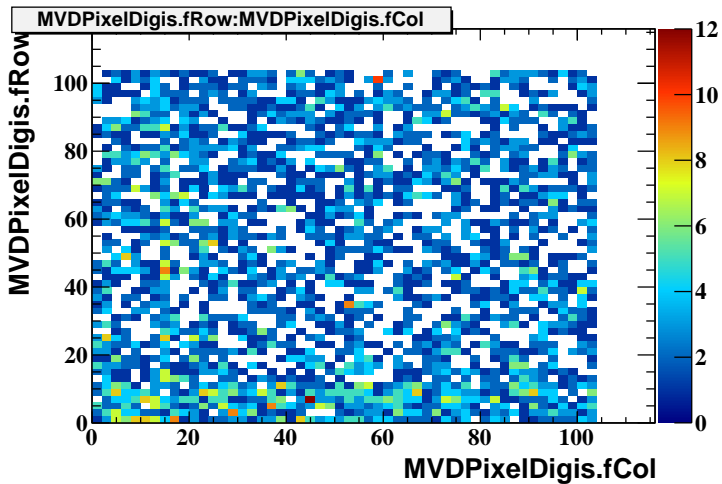


Figure: Pixel column/row (1000 protons, $1 \text{ GeV}/c \pm 0.1 \text{ GeV}/c$)

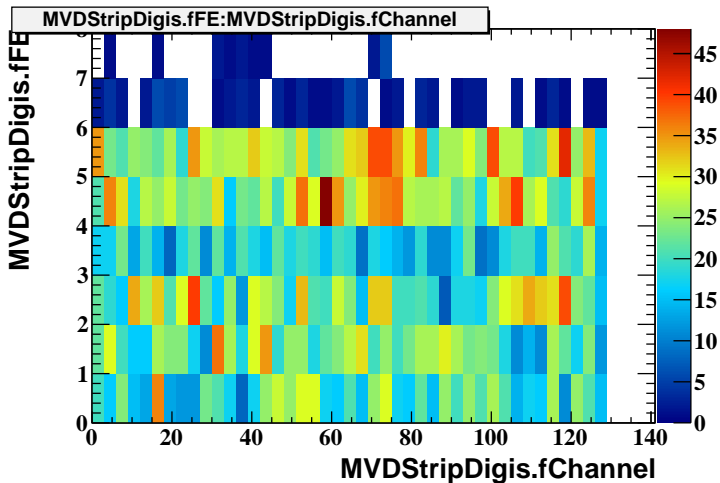


Figure: Pixel resolution (1000 protons, $1 \text{ GeV}/c \pm 0.1 \text{ GeV}/c$)

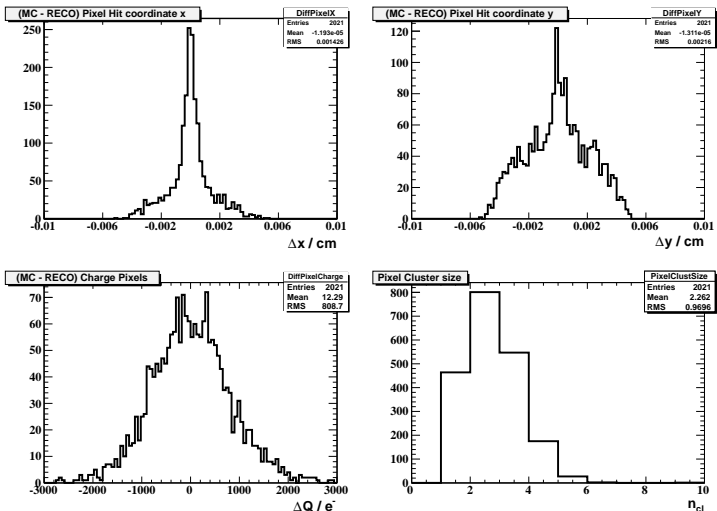


Figure: Pixel resolution (1000 protons, $1 \text{ GeV}/c \pm 0.1 \text{ GeV}/c$)

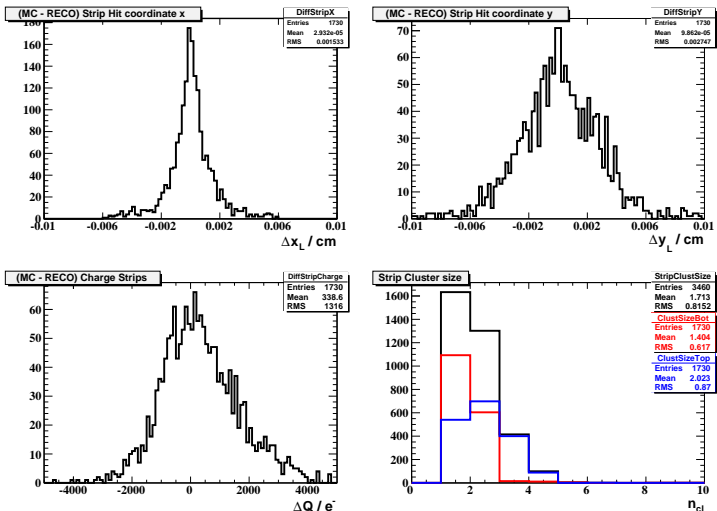


Figure: Strip resolution (1000 protons, 1 GeV/c ± 0.1 GeV/c)

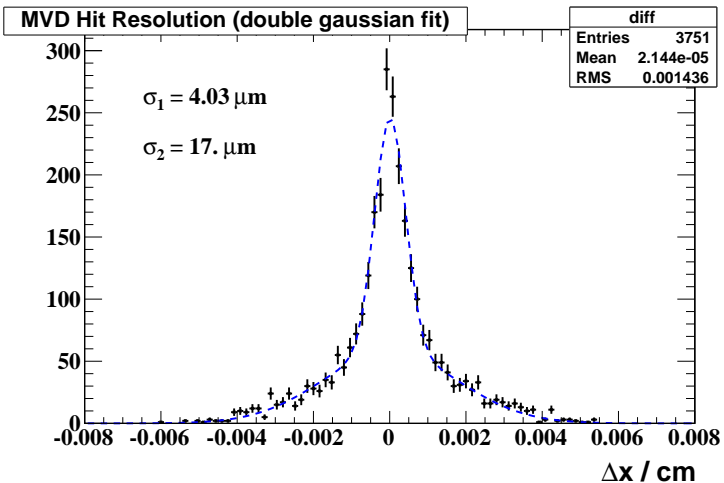


Figure: Pixel resolution (1000 protons, $1 \text{ GeV}/c \pm 0.1 \text{ GeV}/c$)

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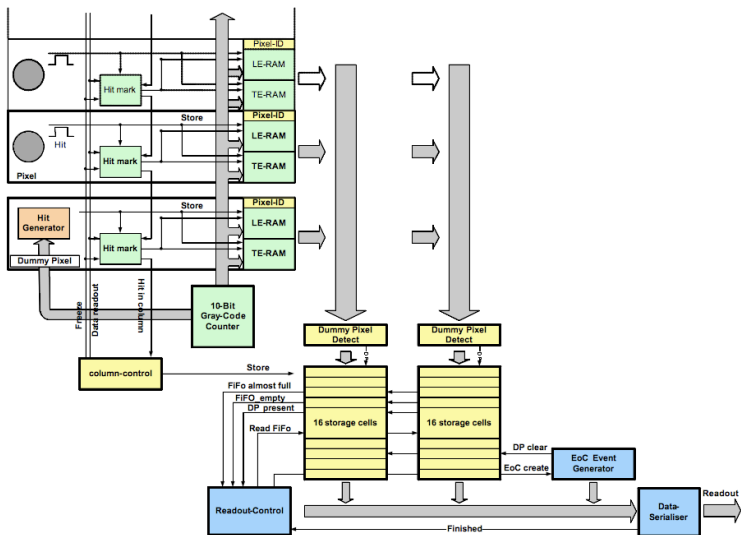


Figure: ToPix readout architecture. (See talk of T.Stockmanns at PANDA CM march 2007)

Simulations

VHDL simulation in CADENCE

- Full hardware emulation of one ToPix chip
- Input of fired pixels from the offline software
- System clock was 50 MHz !!!

- From 62,000 hits 800 hits in total were lost.
The reason was:
 - 468 with energy below threshold of 1,200 eV → no problem!
 - 332 with a double hit → value depends on desired energy resolution

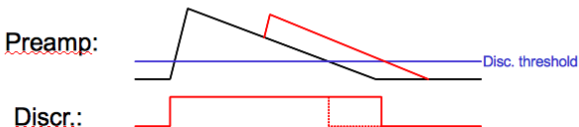
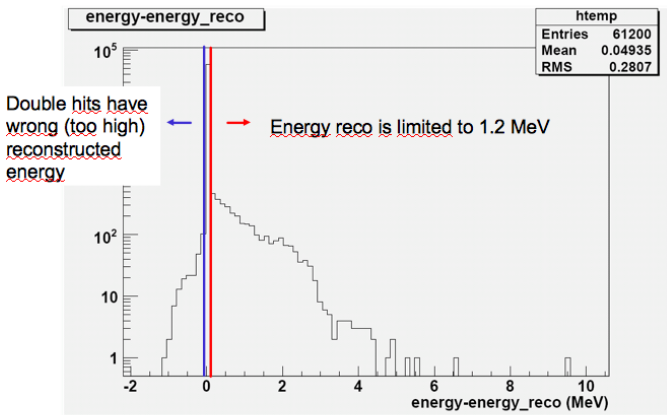


Figure: Simulated hit loss. (See talk of T.Stockmanns at PANDA CM march 2007)



Energy reconstruction



Tobias Stockmanns, FZ Jülich

Panda-Meeting



Figure: ToPix Energy resolution. (See talk of T.Stockmanns at PANDA CM march 2007)

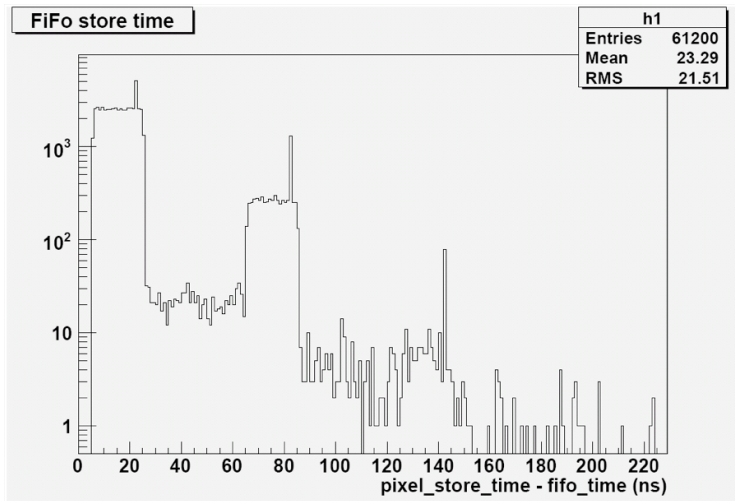


Figure: ToPix Time between leading edge and fifo write-in. (See talk of T.Stockmanns at PANDA CM march 2007)

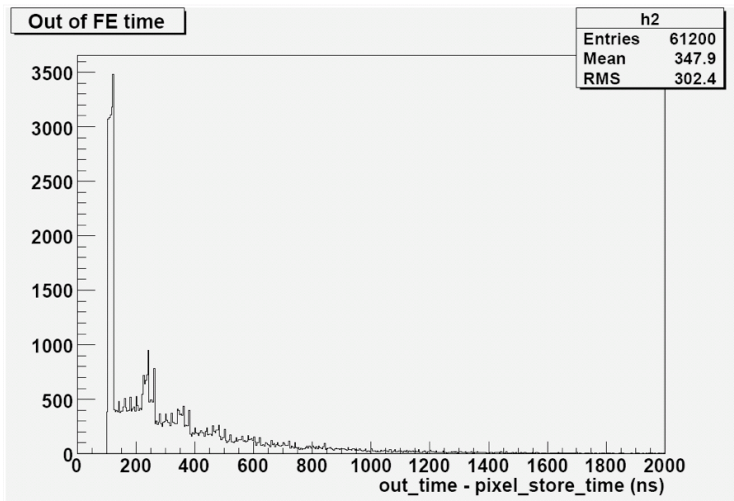


Figure: ToPix Time between leading edge and readout at the end. (See talk of T.Stockmanns at PANDA CM march 2007)

Summary

- Mvd software ready since..
- Electronics implemented effectively
- ToT addon done recently
- Detailed electronics simulations were done externally

To Do List

- Charge diffusion cloud interfacing
- Strip Sensor ganging
- Time ordered simulation/pile-up in pandaroot

Thanks for listening.