DEPFET PXD Data Rate & Data Reduction

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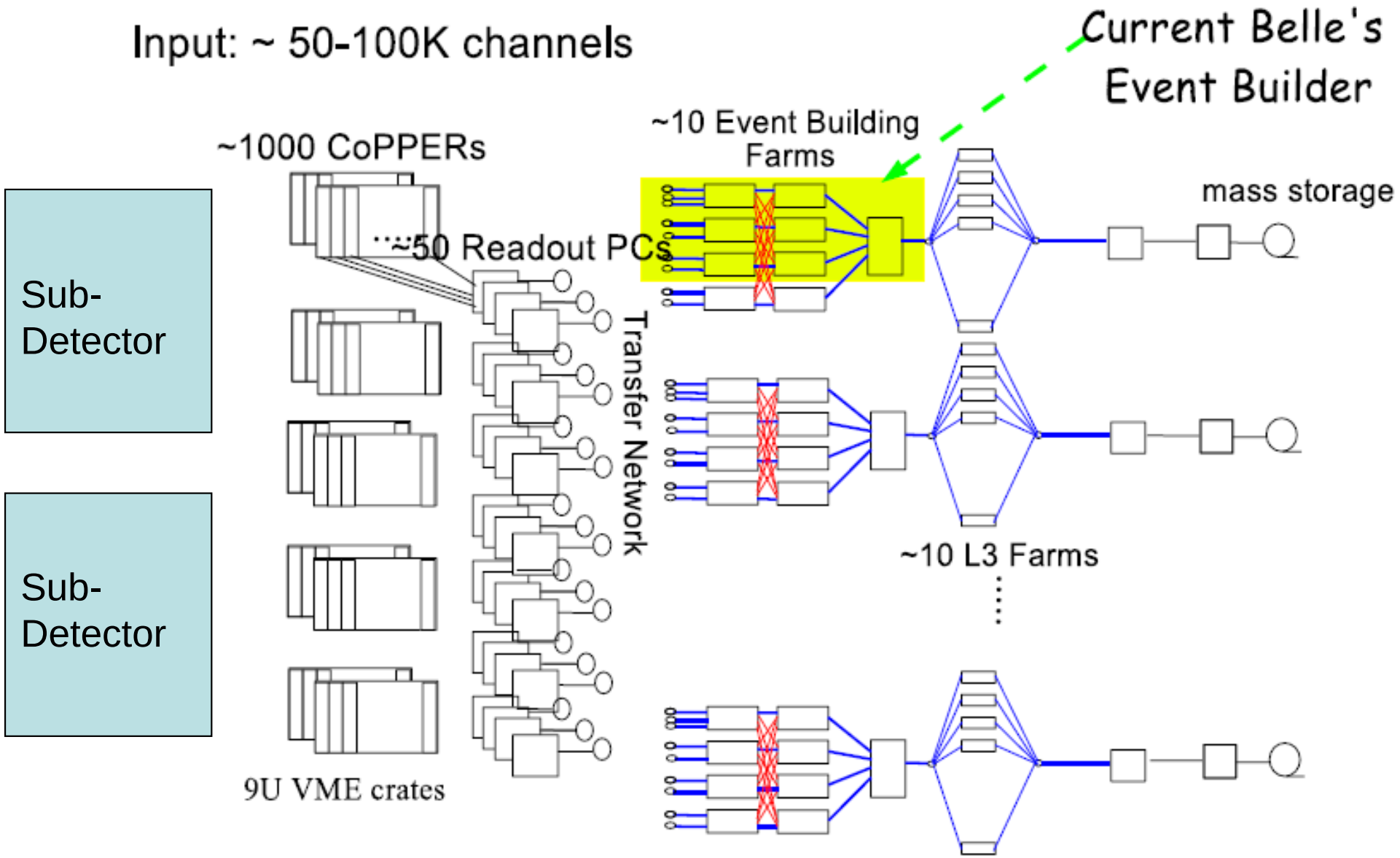
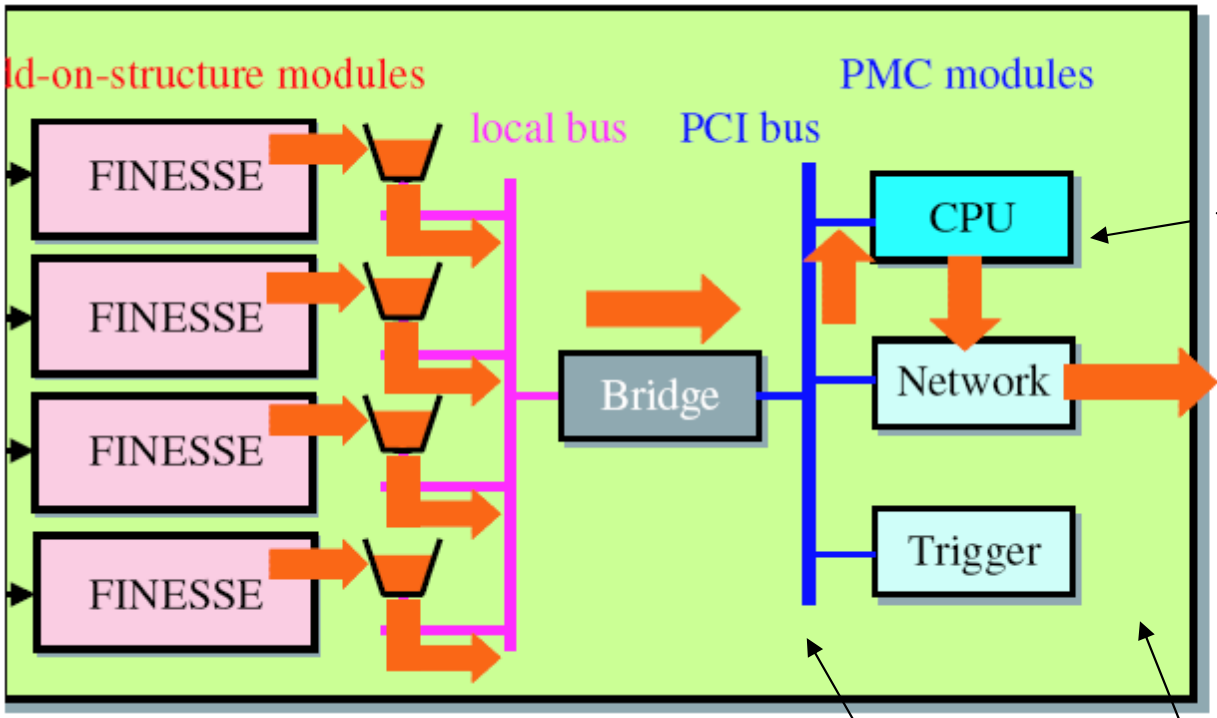
- SuperBelle‘s DAQ
- PXD Data Date
- Methods of Data Reduction

„Current“ SuperBelle DAQ



The COPPER / FINESSE System

COPPER card
(VME 9U)



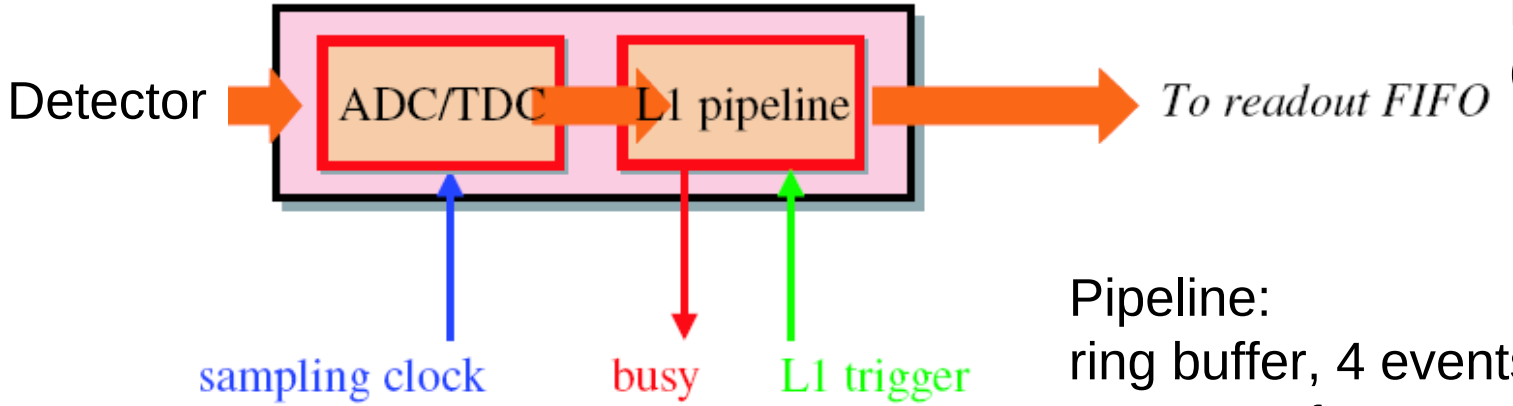
Analog signals
from
subdetector

L2 trigger

133 MB/s

Mezzanine
PCI slots
(PMC)

FINESSE daughter card

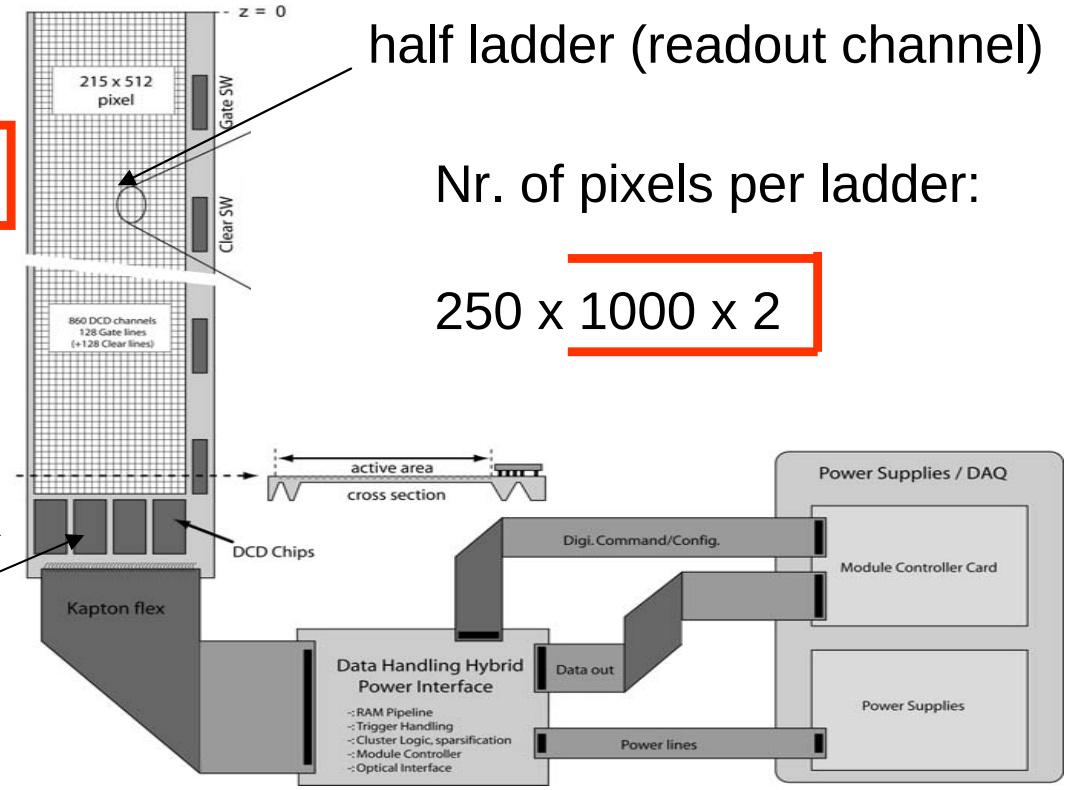


Pipeline:
ring buffer, 4 events deep
1 MByte of memory

Rate Estimates for the PXD (New Granularity)

250

1000



half ladder (readout channel)

Nr. of pixels per ladder:

250 x 1000 x 2

DHP:
zero-suppression
readout buffers (10 MB ?)
slow control …

DHH: module controller data link

Digitzation (DCD)

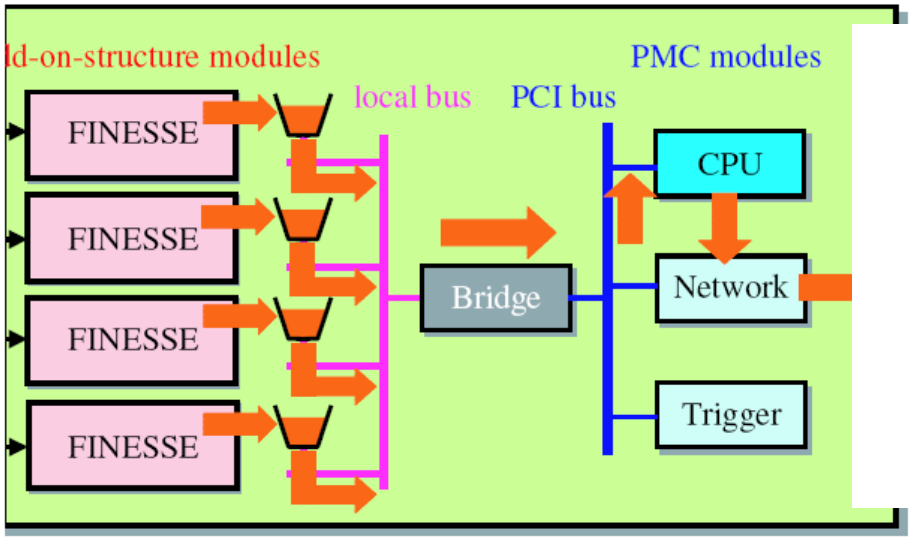
- 44 half ladders:
  11 Million pixels (px)
- 1% occupancy:
- 110 kpx on at any time
- ~ 3 x 10^5 px in each event
  (safety factor 3)
- Trigger rate: 10-30 KHz

  Total rate: 9 x 10^9 px/s
- 4 bytes per px (pos + ADC)

Total rate: 300 GBits/s

6.5 GBits/s
per R/O channel

PXD DAQ Requirement and COPPER/FINESSE



1 R/O channel needs 6.5 Gb/s
~ 30 COPPERS needed

COPPER: 133 MB/s max (PCI)

Bus too slow!

COPPER: Digitization is done on the Finesse Card
Zero-Suppression is done on COPPER CPU

If used: data rate is 2 orders of magitude larger
(zero supp. only after digitization)

COPPER / FINESSE is excluded for the PXD DAQ !

The PXD DAQ Challenge

- Readout speed:

  → have to manage large (44) parallel R/O channels, each with band width of 6.5 Gb/s (factor 3 safety)

- Data volume:

  → have about 300 k pixels per event (almost all background), > 10 times the data volume of all the other subdetectors together

→ need hard thinking how to manage both issues

PXD Data Reduction

Meeting of DAQ-Group (WP 1.7.1) , Giessen, 27. Feb. 2009

WP 1.7.1:	Lead Institution:	Gießen (Soeren Lange)
	Collaborators:	Hawaii, Göttingen, KEK, Krakow, MPI

Main Points of Discussion:

problem of band width for the DAQ system

first ideas for data reduction

possibilities for using the PXD/SVD for triggering

General Remarks (on PXD Data Reduction)

- Signal / Noise ~ 1/1000 („real“ hits / background hits)
- Data Reduction must be achieved with the tracking system:

  PXD; SVD; CDC

  (other subdetectors cannot help)

- PXD in its present form (2 layers) cannot do the job by itself

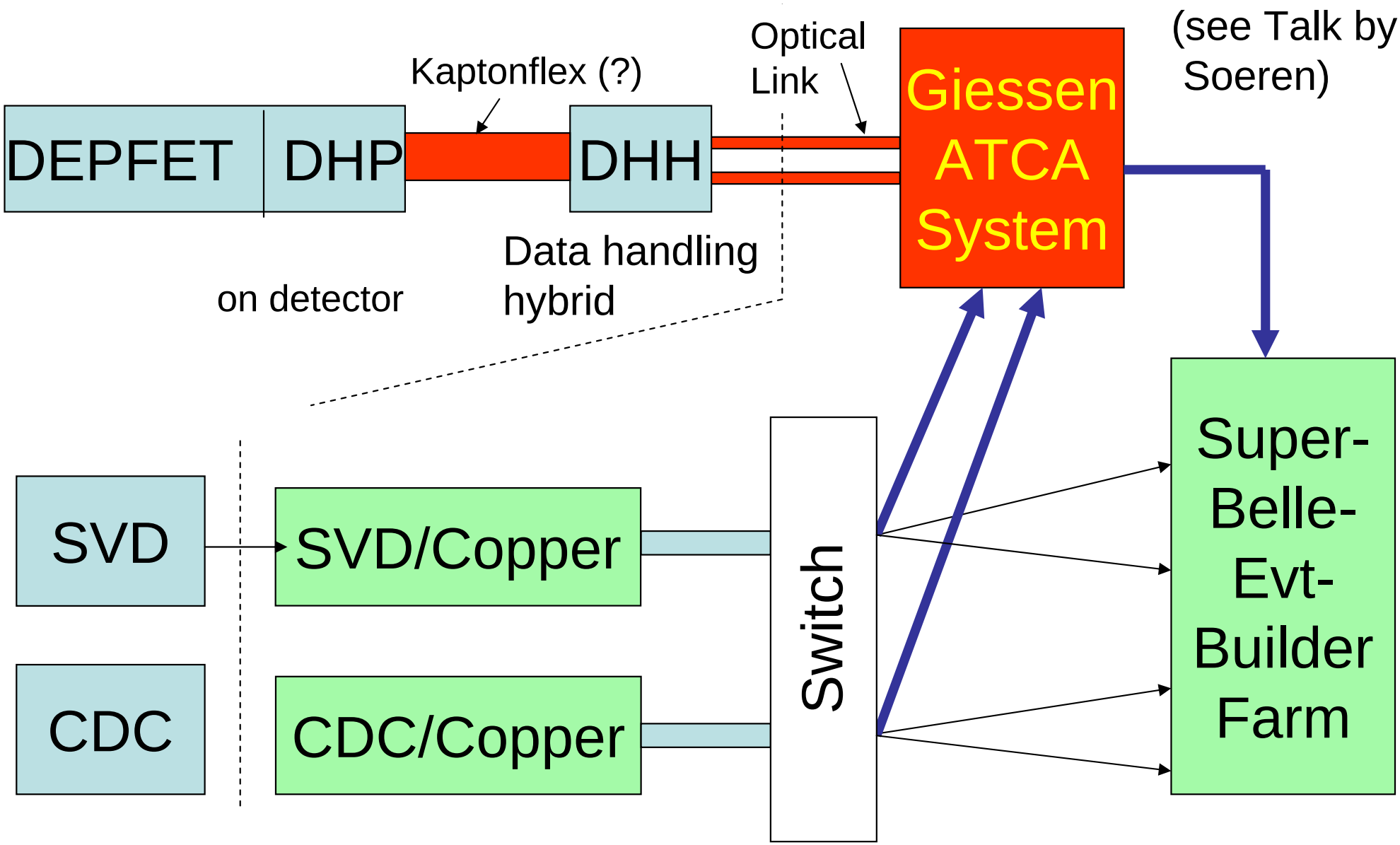
  .

  (small factor (of order 2) achievable by clustering)

- Basic Idea: Build „roads“ from non-PXD trackers and reject pixels outside these roads

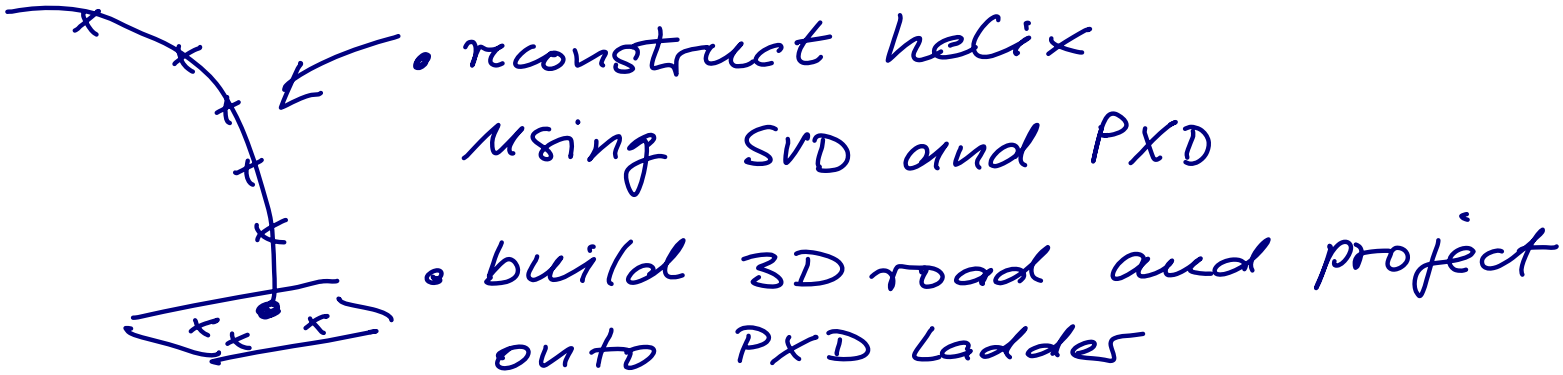
$$p[GeV] = r[m]0.3B[T]$$

Giessen-Meeting: Proposal for the PXD DAQ

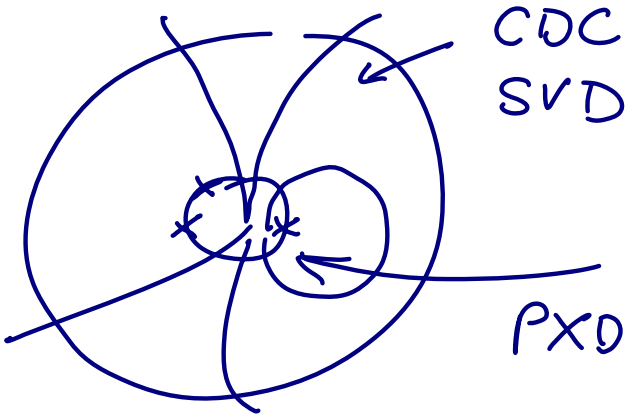


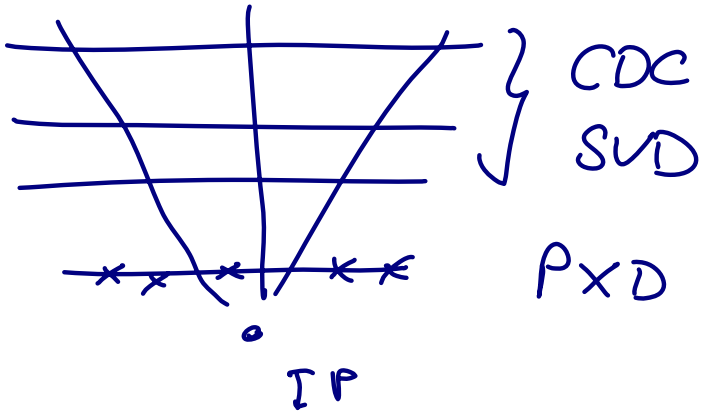
How to Build the Roads?

3D Method (full reconstruction)

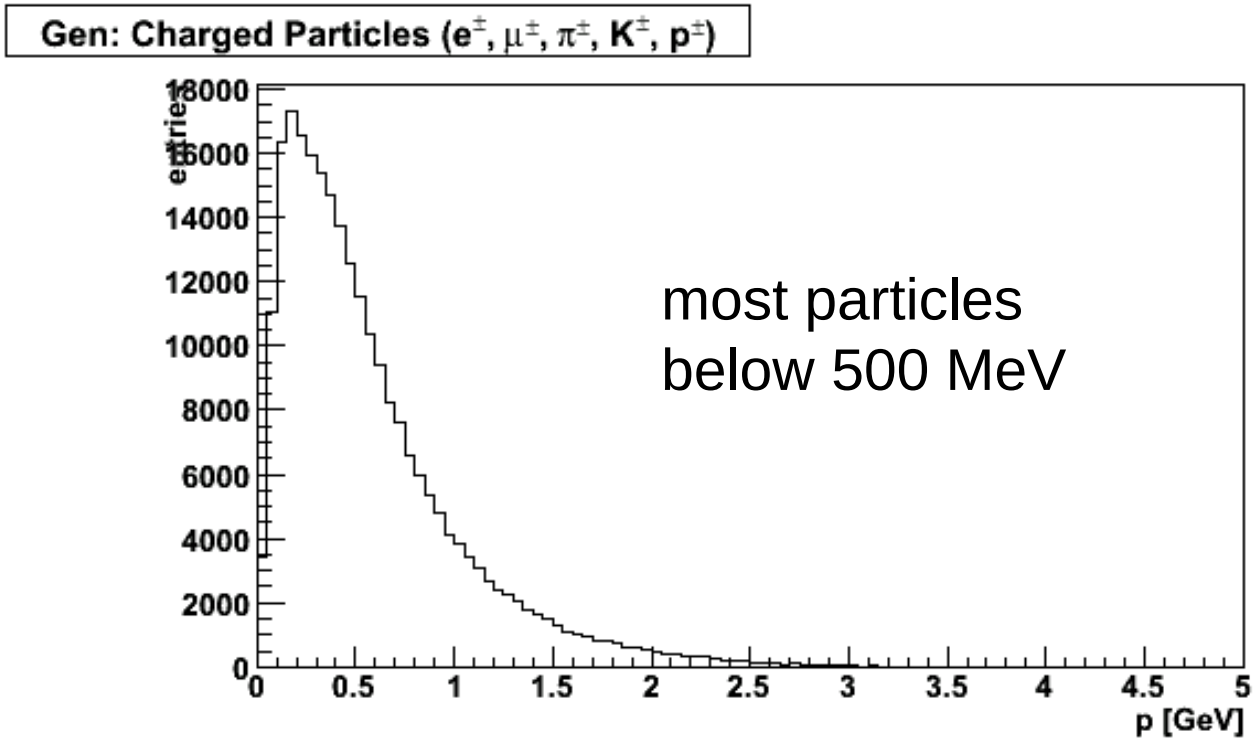


2D Method (work in Rφ or Rz Projections)





Intermezzo: Spectra of Charged Particles

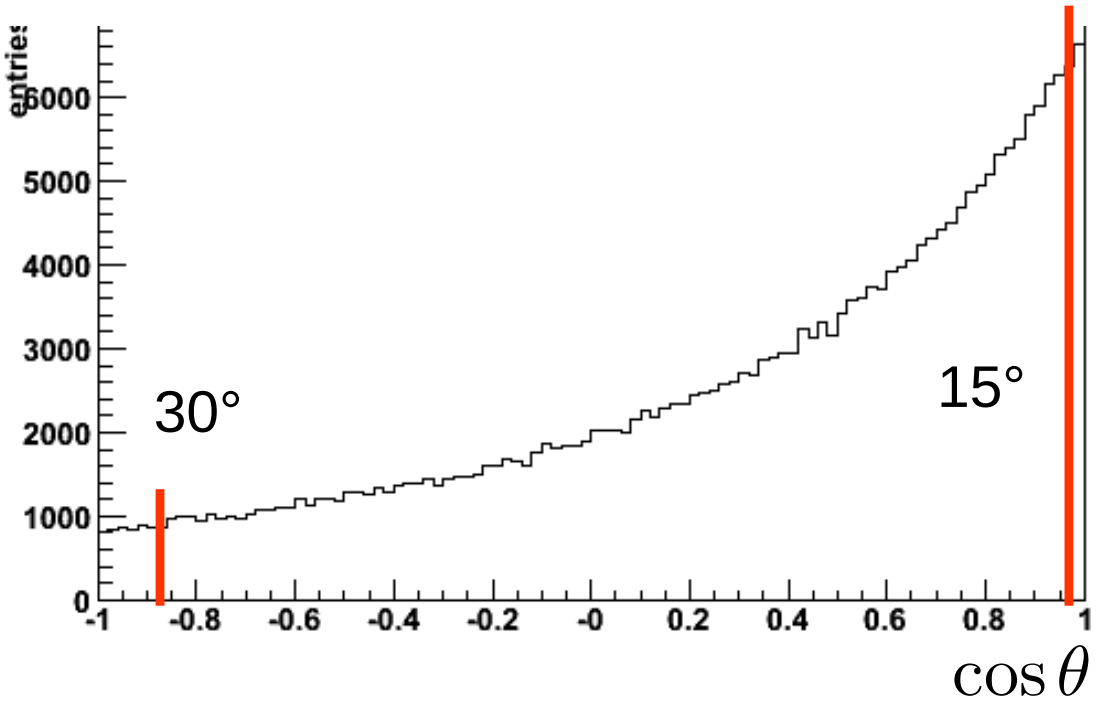


from

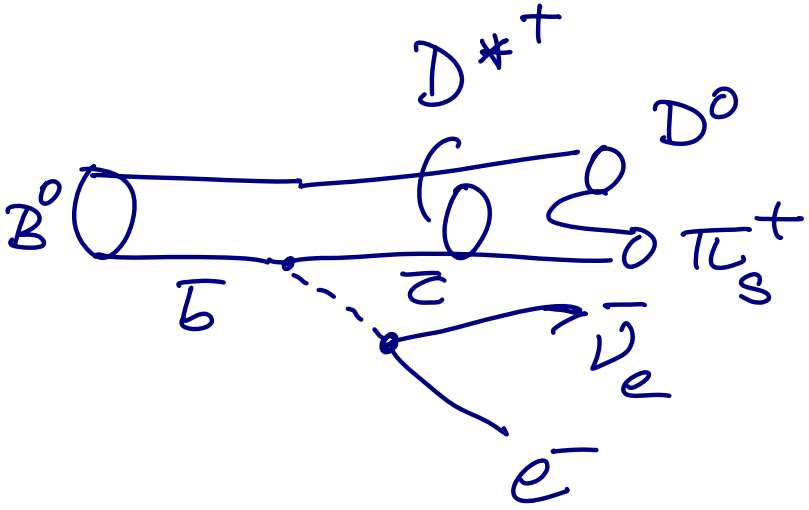
$\Upsilon(4S)$

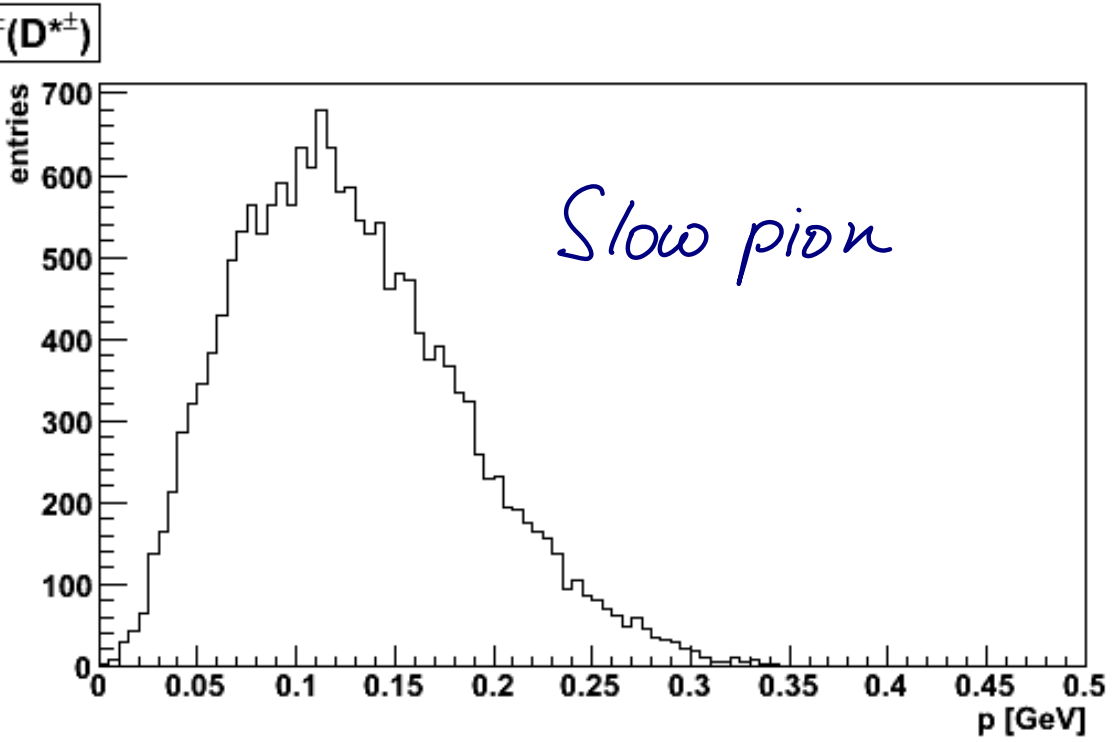
$B \rightarrow$ anything

(in the lab system)



Spectra of Slow Pions

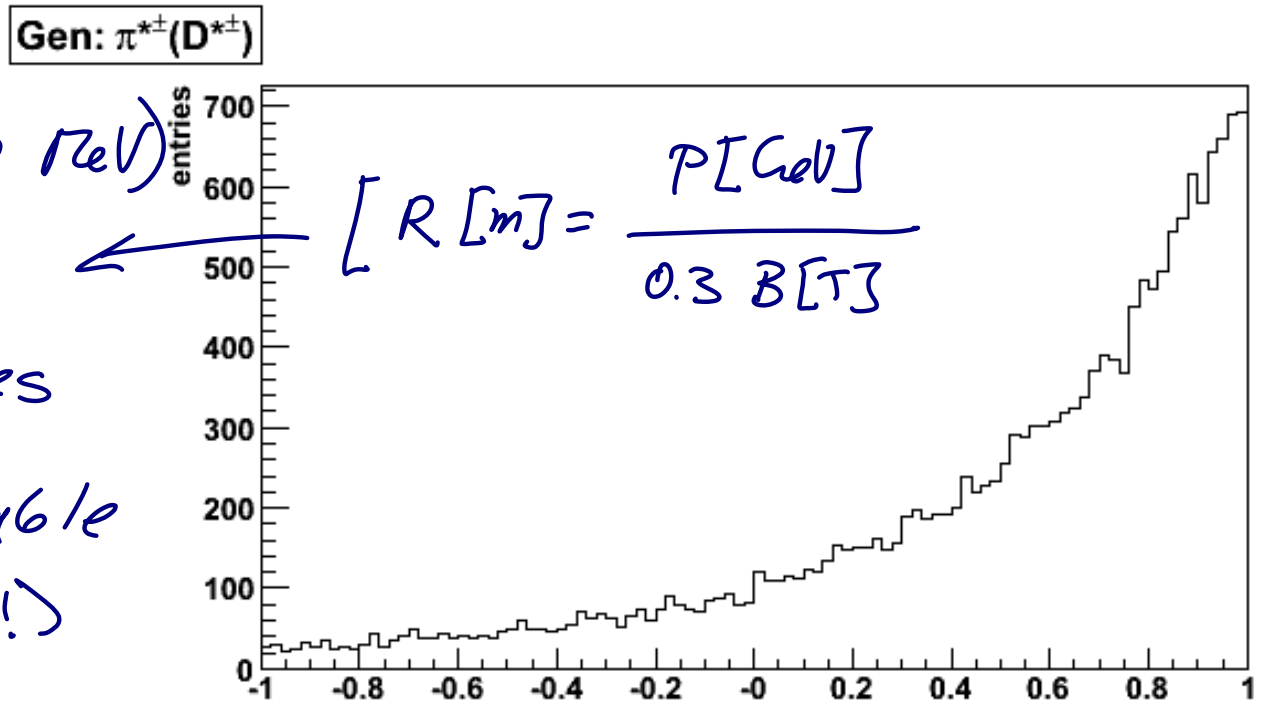




π_s is really slow! ($p < 200$ MeV)

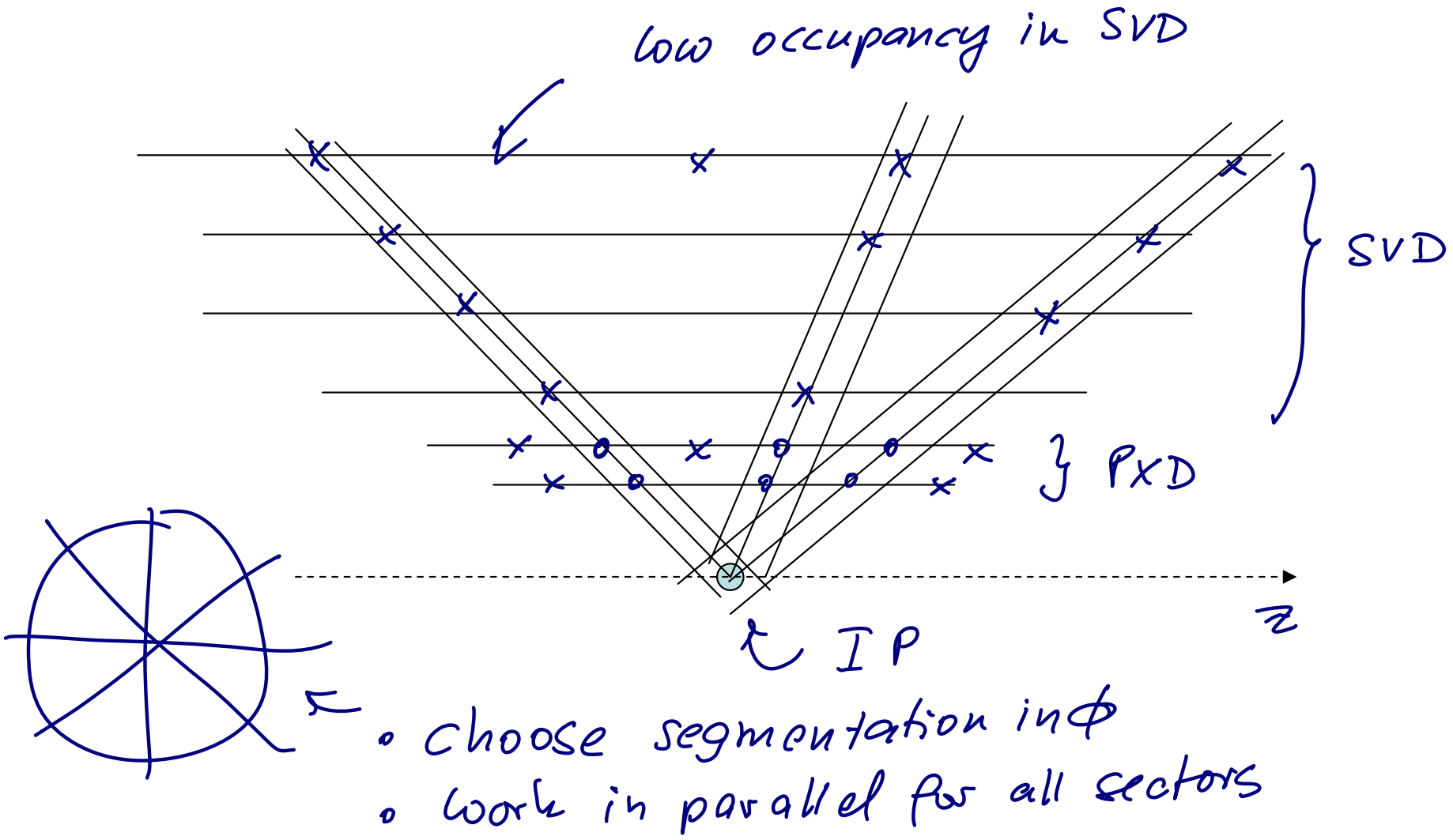
$R < 20$ cm in most cases

→ CDC not usable (starts there!)



Road Finders in Rz

Advantage (over R-phi): tracks almost straight (easy pattern recognition)



Rz-Road Finders in phi-Sectors

- Occupancy of PXD: ~ 1%

  ↳ 20 pixels on per column

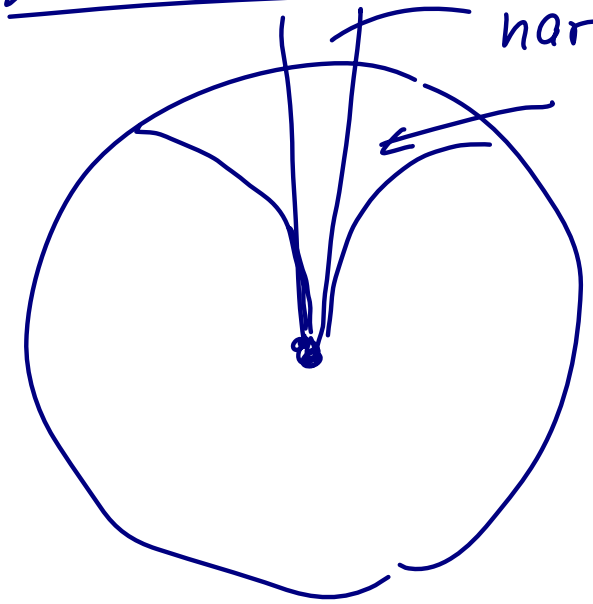
  5000 " on per Ladder!! (250 rows!)

  each cell of projection hit several times!

→ very narrow ϕ sectors needed! → 10 pixels wide

→ about 25 sectors per Ladder!

- Low momentum tracks



→ 22 × 25 ≈ 500 sectors

→ massively parallel computing

Hough Transforms

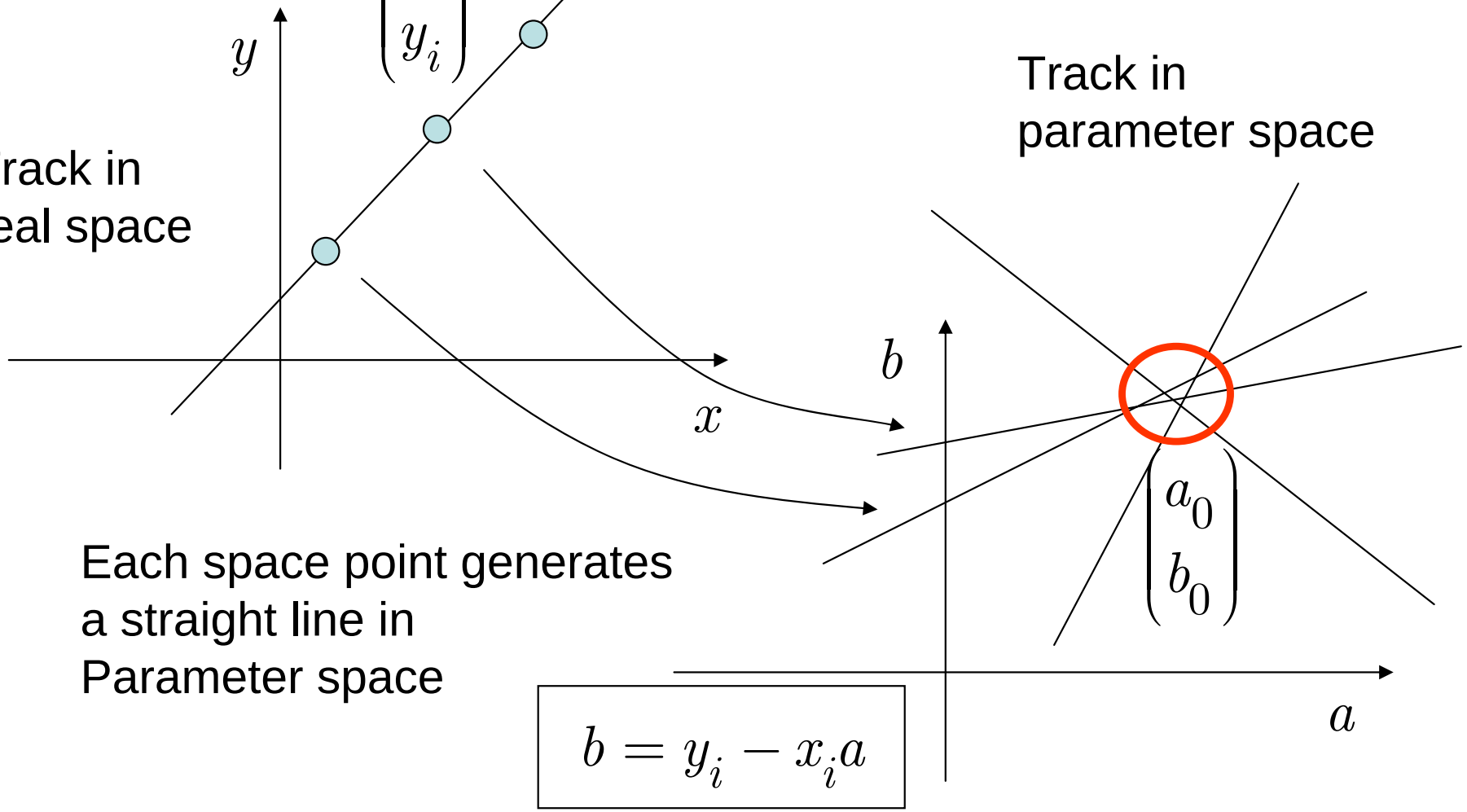
$$y = a_0 x + b_0$$

$$\begin{pmatrix} x_i \\ y_i \end{pmatrix}$$

„Track finding without pattern recognition“

Track in real space

Track in parameter space



Each space point generates a straight line in Parameter space

$$b = y_i - x_i a$$

Track parameters cluster!

Conclusions

- Due to bandwidth limitations, the foreseen COPPER/FINESSE system will not work for the PXD DAQ
- Severe problem to log the vast amount of pixel data
  (> 10 times the data volume of all the other subdetectors in SuperBelle)
- Order of magnitude data reduction required before going into the SuperBelle reconstruction farm
- Roads from full reconstruction (CDC) not usable (low efficiency for low momenta)
- Fast Rz algorithms (Hough), using SVD only, seem promising (giving also a z-trigger!)
- Suitable solution is most likely the ATCA system from Giessen (used for HADES and PANDA experiments at the GSI)