HEPHY

Institut für Hochenergiephysik

LPTPC Silicon Envelope Status & Plans

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LCTPC collaboration meeting 2009

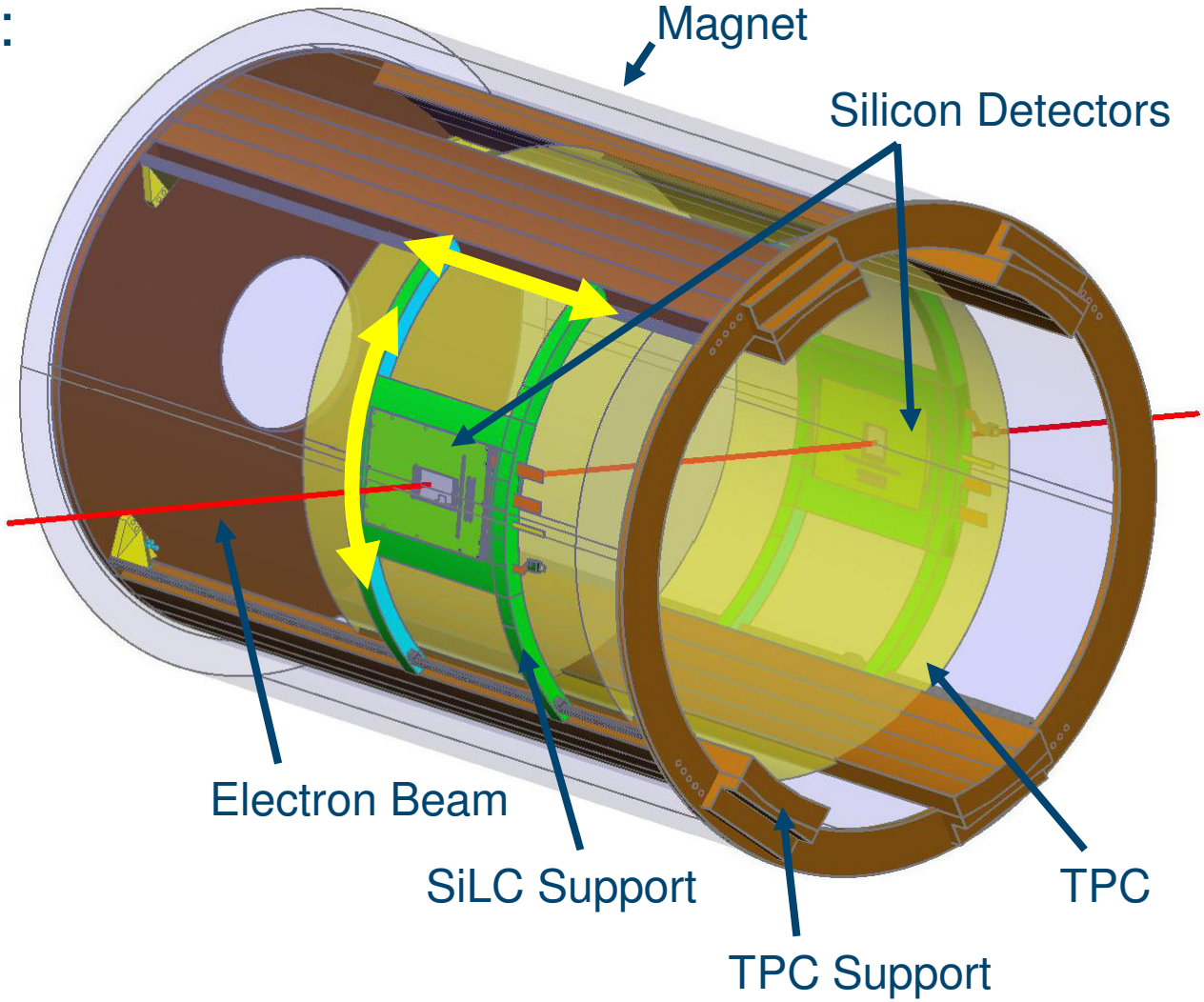
21.09.2009

This work is performed within the SiLC R&D collaboration.

Introduction

the idea is known:

Improve the resolution of the Large Prototype TPC by adding a precise measured point of the track (order of 10µm), inside the gap, between magnet and TPC, on both sides of the TPC.



Ultimate Ambition!

Combined data taking before the end of November 09!

What do we need to reach the target?

- Hardware TPC
  - Field Cage
  - Magnet
  - Magnet Support
  - TPC readout
- Hardware Silicon Envelope
  - Silicon sensors
  - Support for the silicon sensors
  - Silicon readout
- Software
  - TPC DAQ (-> tracks)
  - Silicon DAQ (-> points)
  - It has to be possible to align the whole system!

What is our status at the talk's beginning?

- Hardware TPC
  - Field Cage ✓
  - Magnet ✓ … till end of November
  - Magnet Support ✓
  - TPC readout
- Hardware Silicon Envelope
  - Silicon sensors
  - Support for the silicon sensors
  - Silicon readout
- Software
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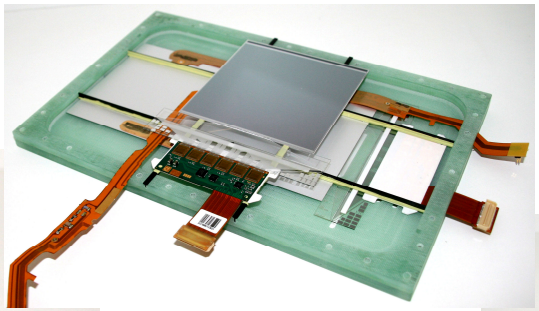
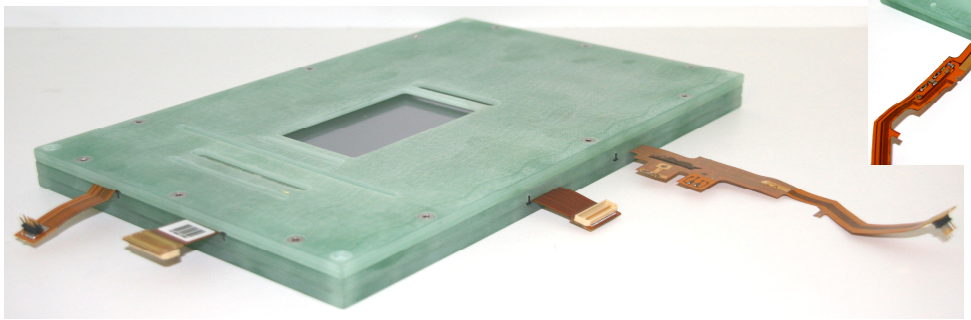
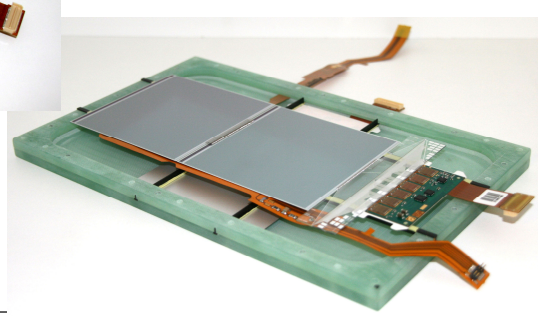
  - It has to be possible to align the whole system!

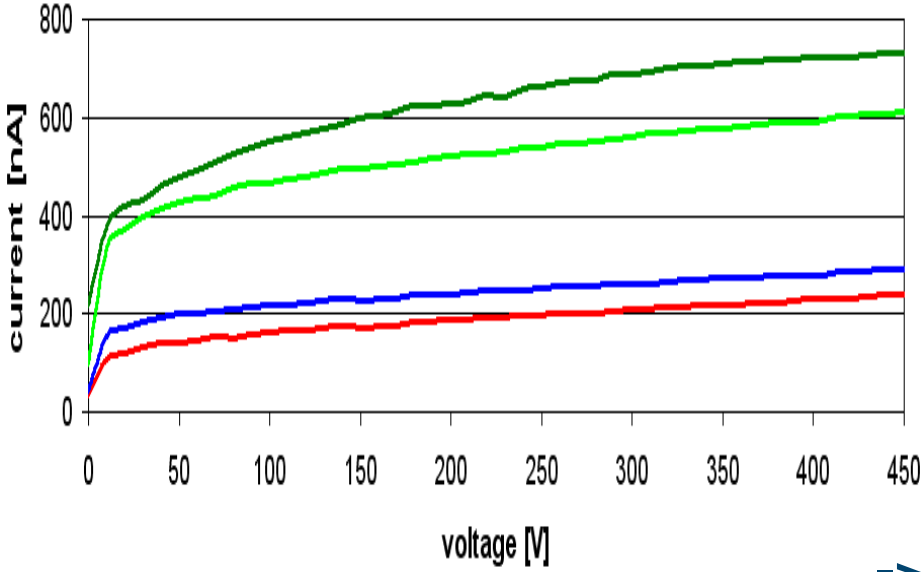
Si-Hardware – Sensor Modules

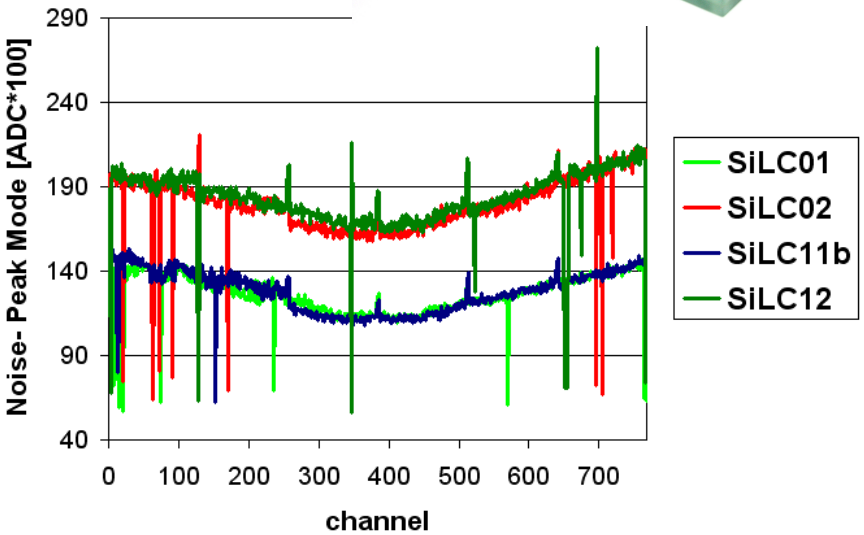
- **Built and tested in Vienna**











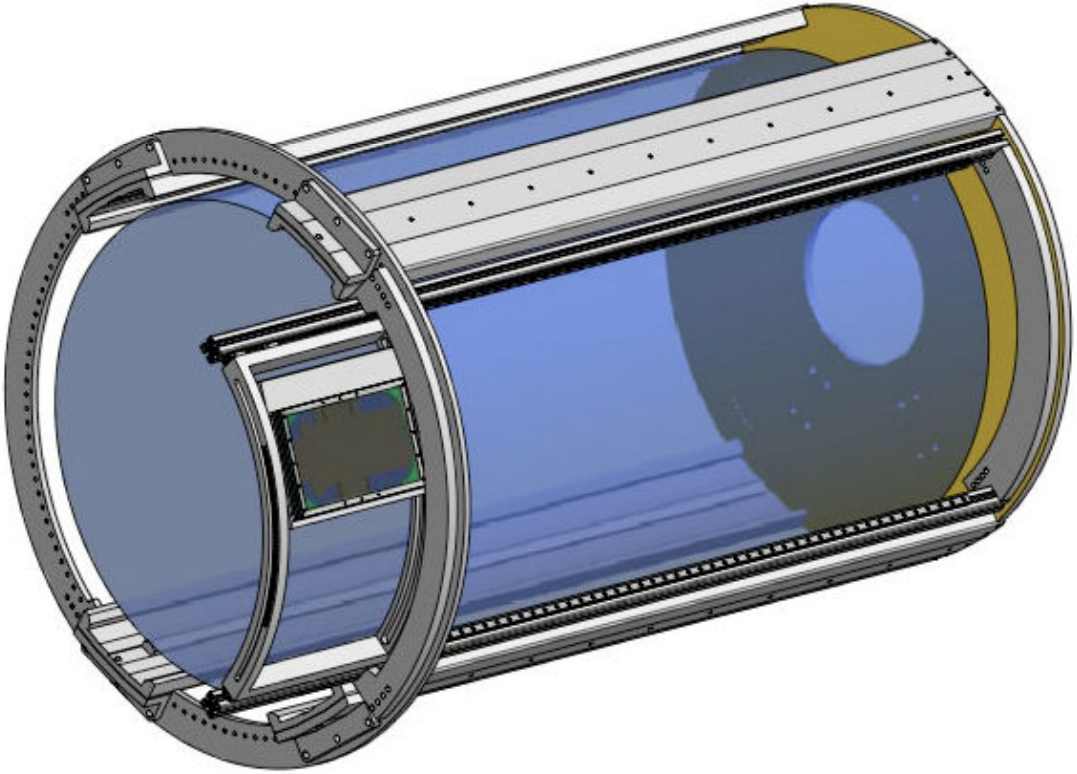
-> brought to Karlsruhe for final test

Si-Hardware – Moveable Support

- **little space** (2 x 35mm) between TPC and magnet
- silicon detectors must be **moveable in both z and phi** because the sensors have to stay in the beam during magnet and TPC movements (remember: the read out silicon area is just 38,4 x 38,4 mm^2)

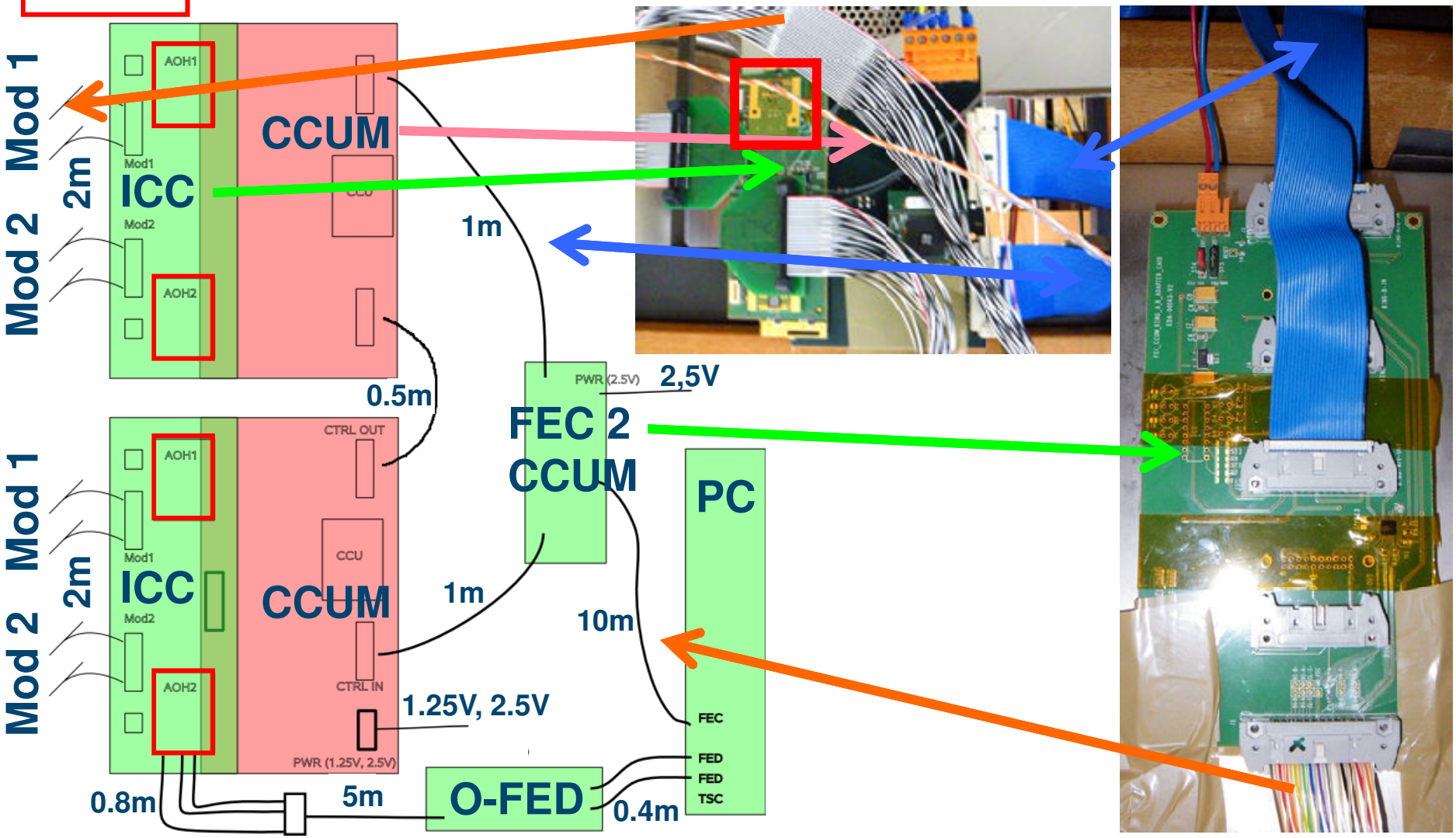
On each side of the TPC:

a sledge containing the silicon module can be moved on two rails screwed on the TPC support (everything made of nonmagnetic material)

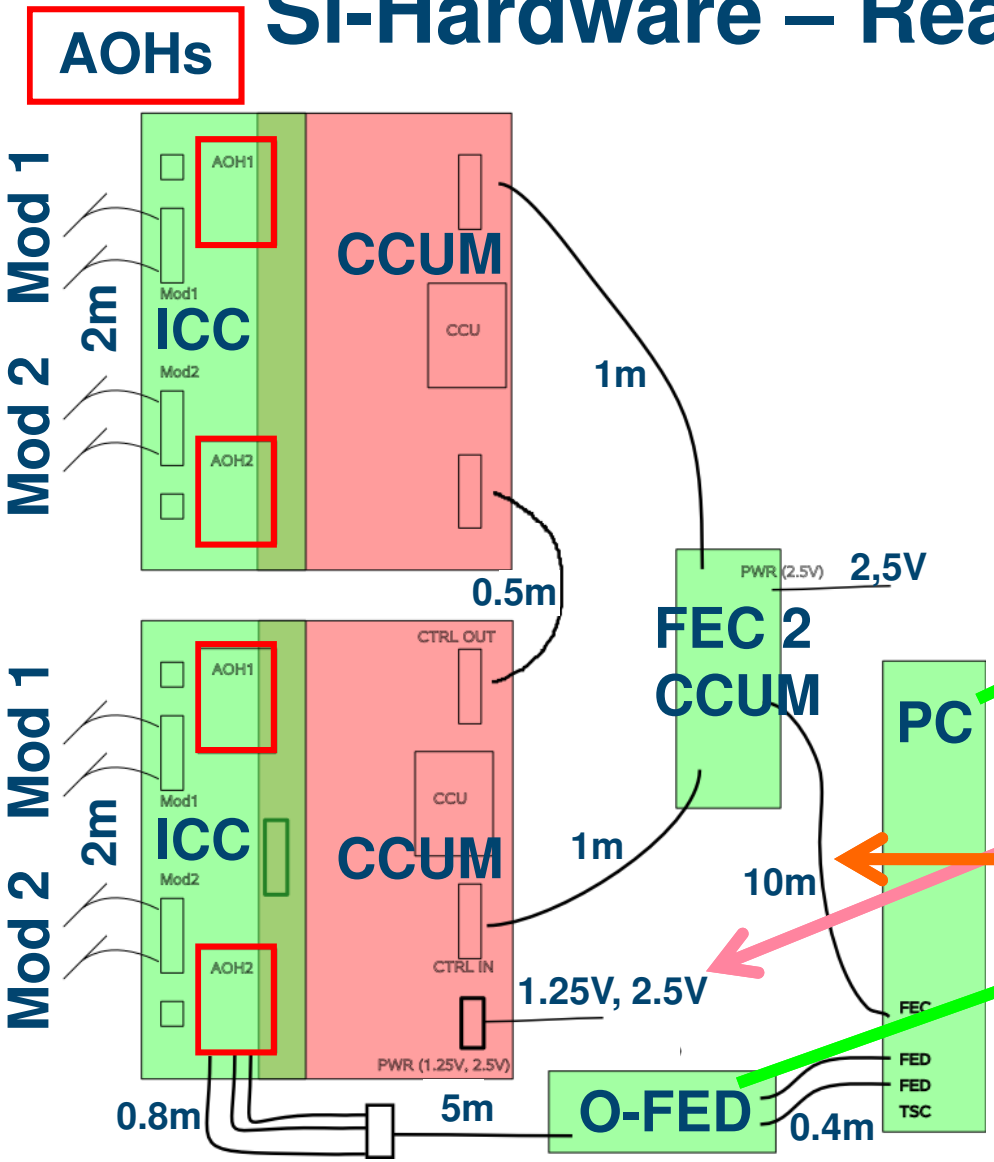


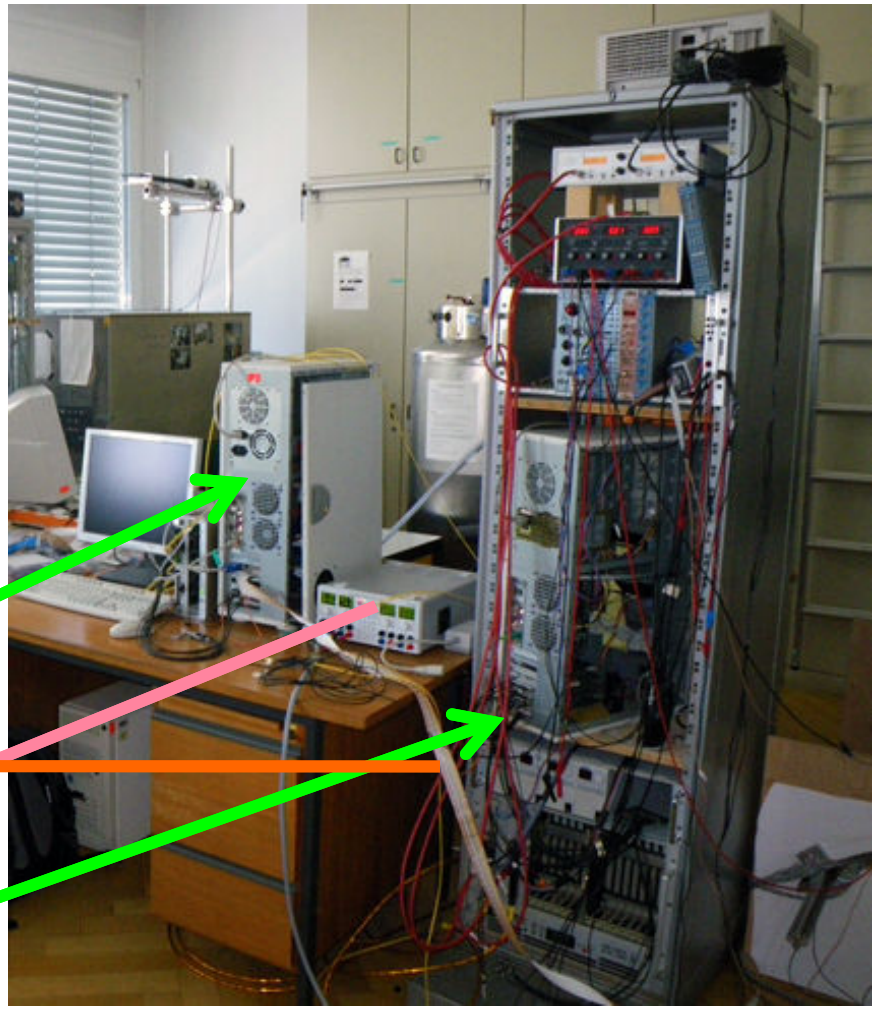
Build in Karlsruhe (IEKP)

Si-Hardware – Readout System @ IEKP



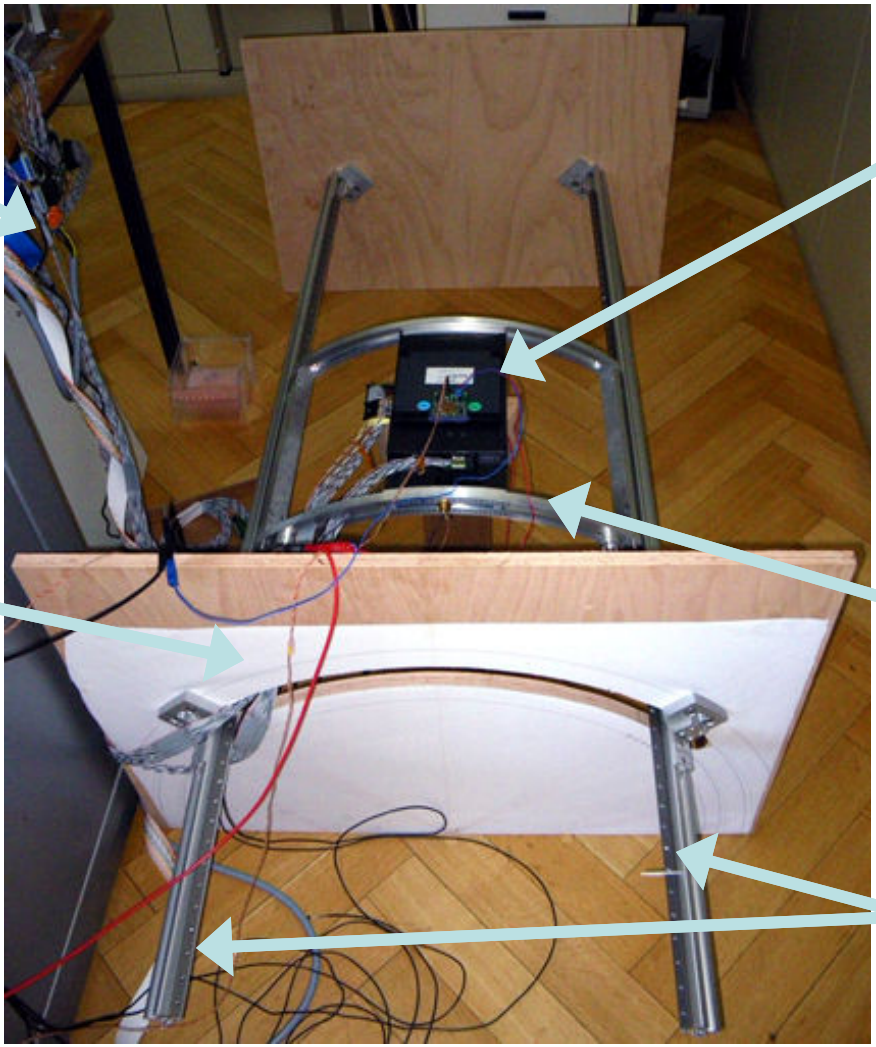
Si-Hardware – Readout System @ IEKP





Si-Hardware – Final Test @ IEKP (May 09)

Silicon Readout as shown in the pictures before



Scintillators to trigger on cosmic Muons (on top and bottom of the silicon module)

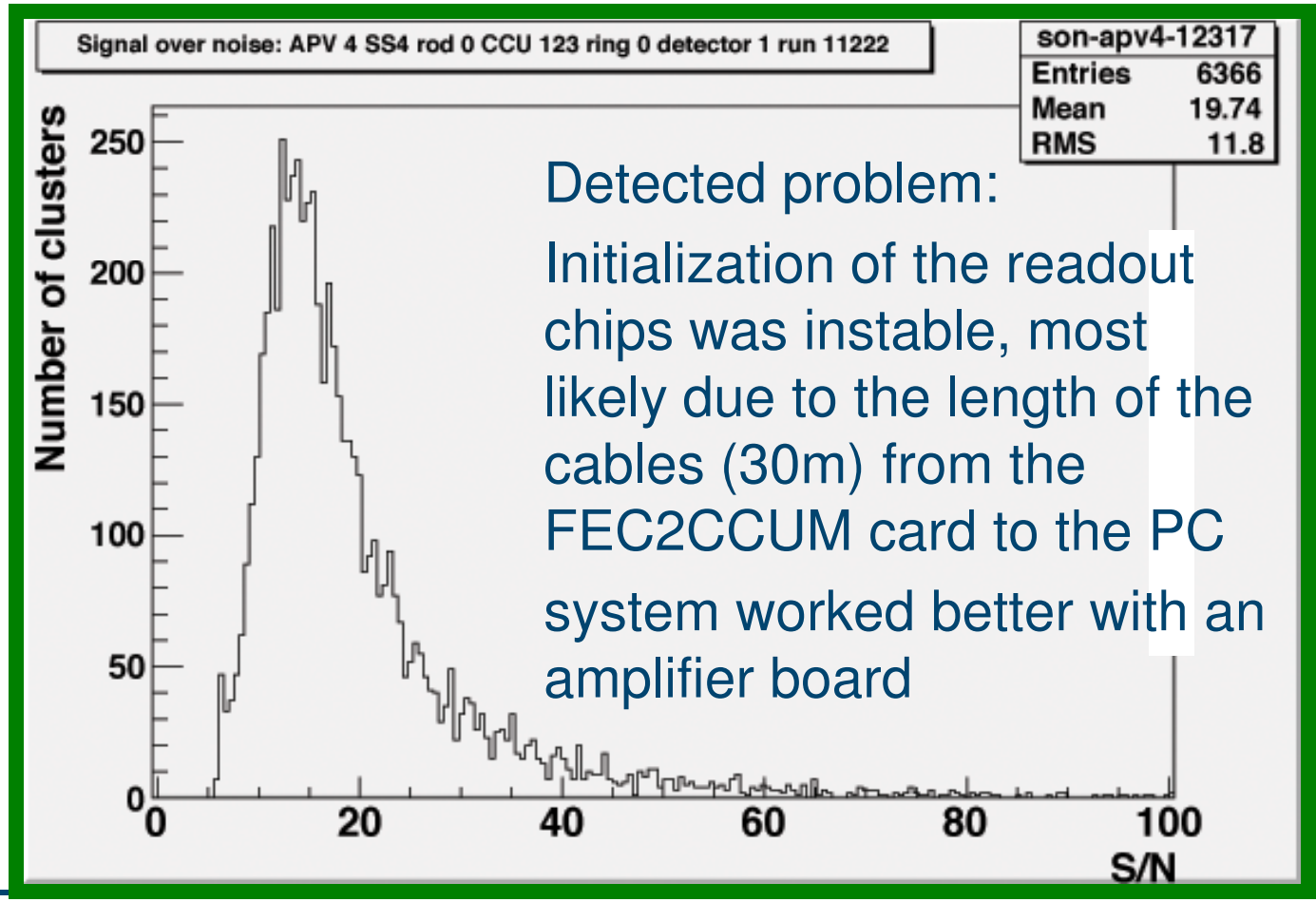
Sledge with mounted Silicon Sensor Module

wooden plates as dummy for the TPC-support and the gap between magnet and TPC

2 bars for each side of the TPC

Si-Hardware – Final Test @ IEKP (May 09)

- It was possible to take data with cosmic Muons
- Data was stored in root files
- pedestal subtraction, common mode correction and cluster search leading to the hit positions done with root



Detected problem:

Initialization of the readout chips was instable, most likely due to the length of the cables (30m) from the FEC2CCUM card to the PC system worked better with an amplifier board

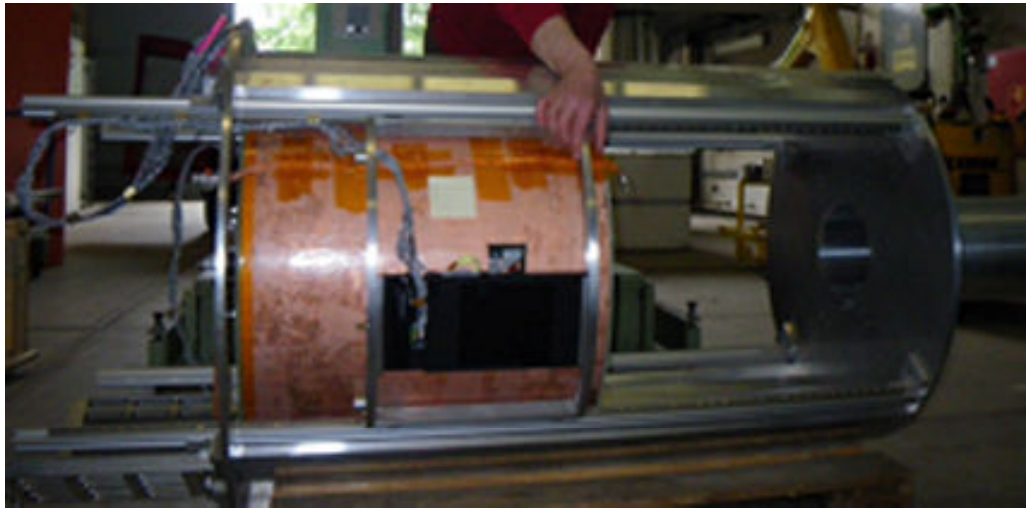
Signal over Noise of one APV

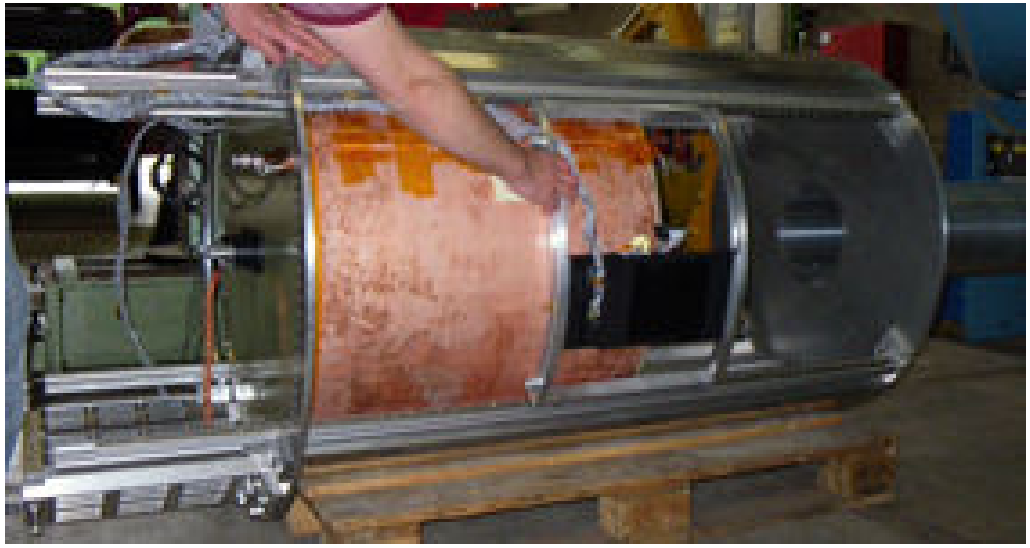
In June the silicon envelope moved from Karlsruhe to DESY

Si-Hardware – Moveable Support @ DESY

- Silicon support installed into TPC support

  -> everything fitted perfectly
- Inserted Field Cage with Dummy Endplates into jointed support
- No problems during z- and phi-movements of the sledges of the Si-support containing the silicon modules

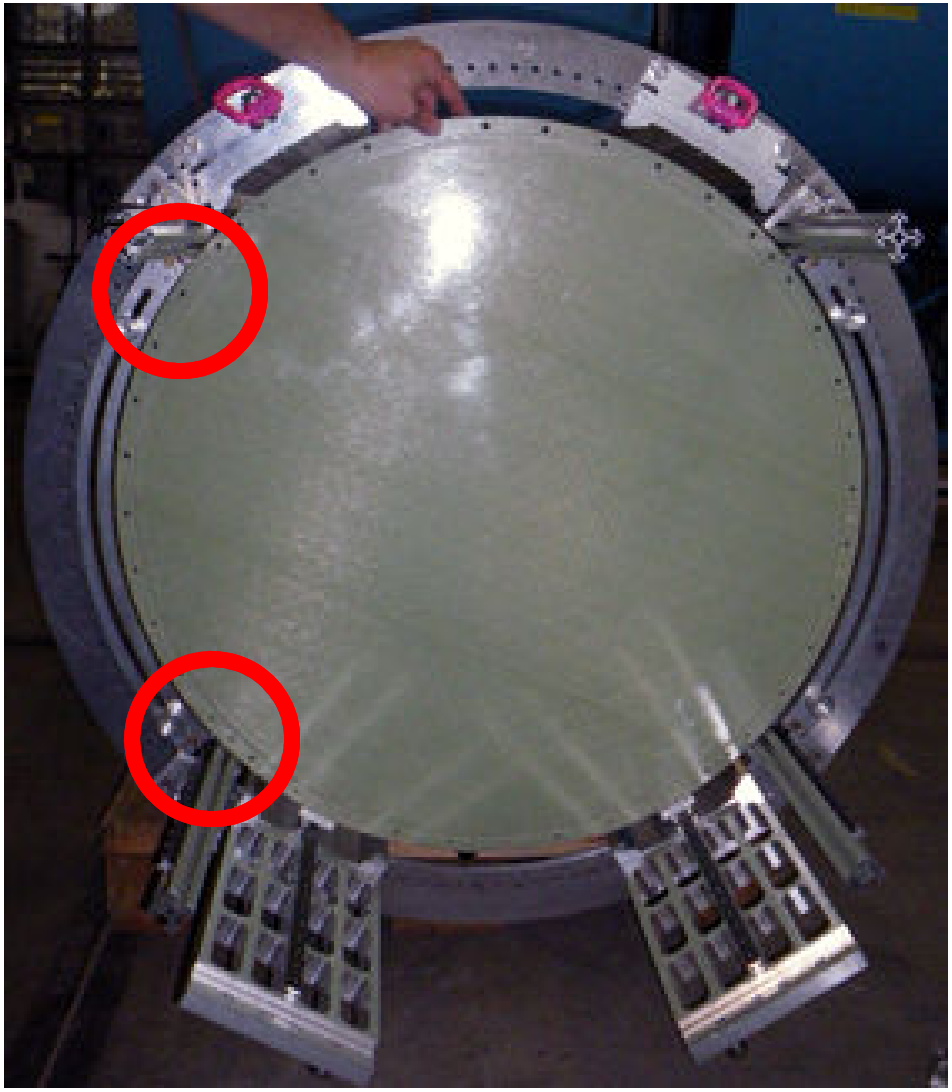




Si-Hardware – Moveable Support @ DESY

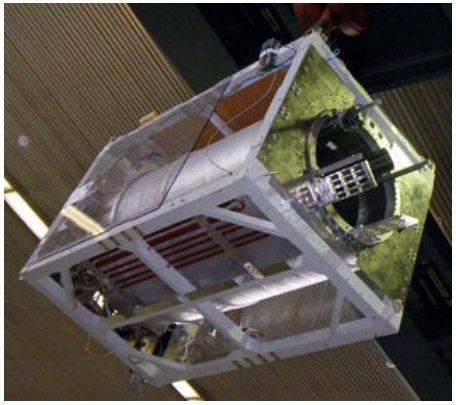
- BUT, since the mounting holes of the End Plates are not centric, the Field Cage touches the sledges of the Si-support slightly during rotations

-> Sledges brought back to Karlsruhe for some minor grinding



Si-Hardware – Moveable Support @ DESY

- The combined support was inserted into the magnet and moved to the test beam area
- sledges containing the Si-Modules can move freely inside the magnet



Si-Hardware – Si-Readout @ DESY

- optical and ribbon cables from test beam area to hut installed
- PC installed in hut
- Power supply in hut

- FEC2CCUM will be mounted on top of the magnet

- Black boxes will be mounted directly on the front side of the magnet (ICC + CCUM) – space marked on PCMAG

BUT:
Same Problem as in IEKP: initialization of the readout not reliable -> back to IEKP for close investigations

11 slides later - what is our status?

- Hardware TPC
  - Field Cage ✓
  - Magnet ✓ … till end of November
  - Magnet Support ✓
  - TPC readout
- Hardware Silicon Envelope
  - Silicon sensors ✓
  - Support for the silicon sensors ✓
  - Silicon readout ? … problems with the initialization
- Software
  - TPC DAQ (-> tracks)
  - Silicon DAQ (-> points) ✓
  - It has to be possible to align the whole system!

Alignment of TPC and Silicon Envelope

- It is for sure not possible to align the TPC and the silicon envelope mechanically to a precision of 2µm (1µm would be optimal).
- Is it possible to align with tracks?
  - The silicon envelope measures just one point in z (TPC axis) and one in x, on both sides of the TPC

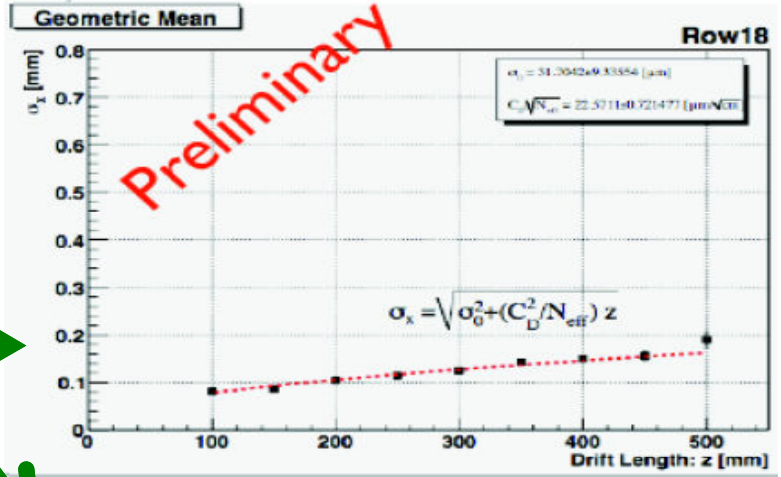
  -> thinking about the distance between the two planes it is not possible to get well defined tracks

  -> alignment strategy: use tracks from the TPC and extrapolate them to the two planes of the silicon envelope and then adjust everything

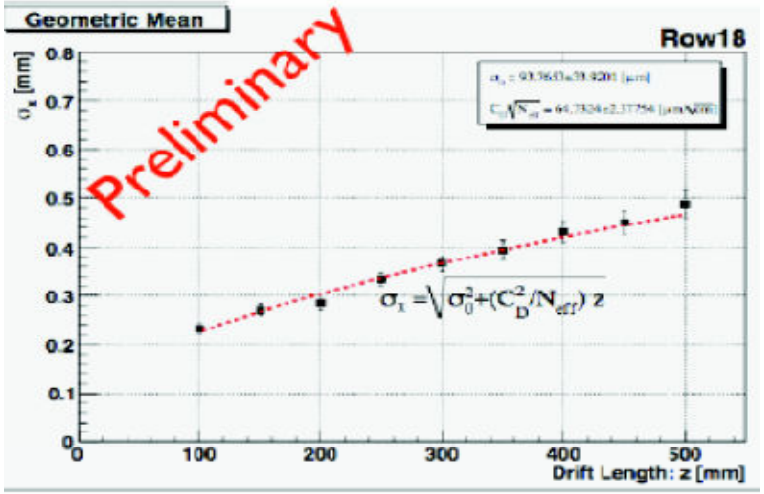
Looking at the Double GEM (JGEM) readout

- I used the Europhysics Conference 2009 talk from Klaus "A Large TPC Prototype for an ILC Detector" as reference for the TPC resolution with JGEM structure in x
- I have not found any measurements of the resolution in z (TPC axis)
- Fast simulations with LDT (Linear Collider Detector Toy[1])

-> only resolution in x (perpendicular to the beam and z) is investigated !!!



B=1T Garfield



B=0T Garfield

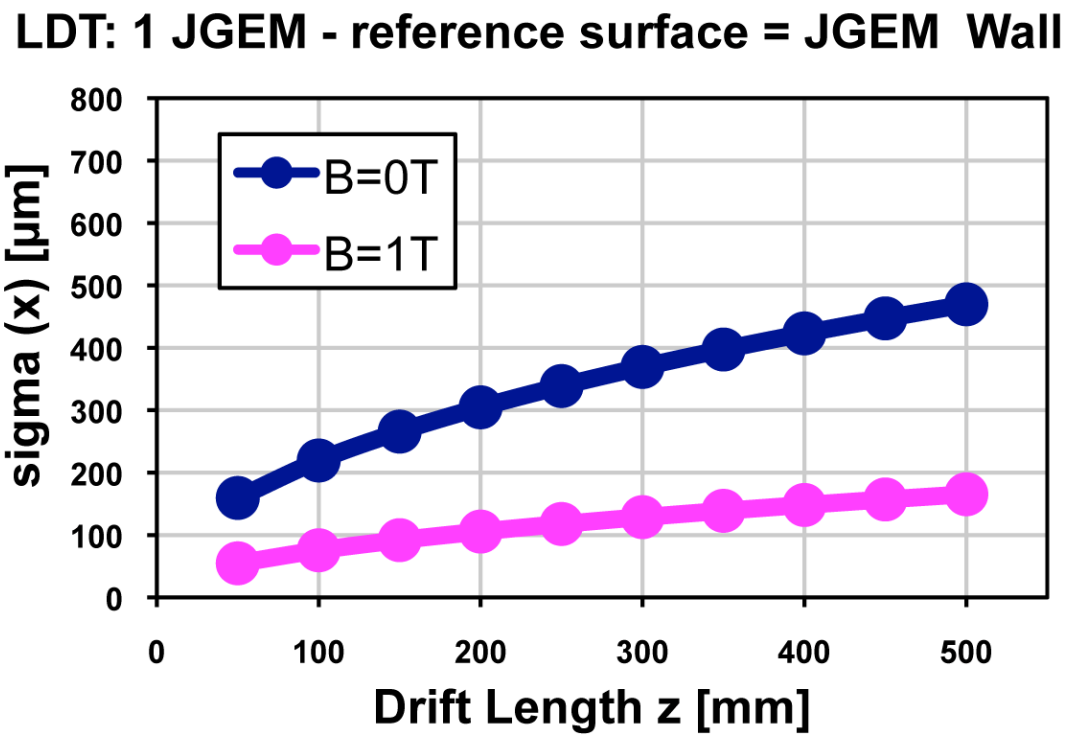
[1] Regler, Mitaroff, Valentan – HEPHY Vienna

Alignment of TPC and Silicon Envelope

one JGEM - reference surface = JGEM wall

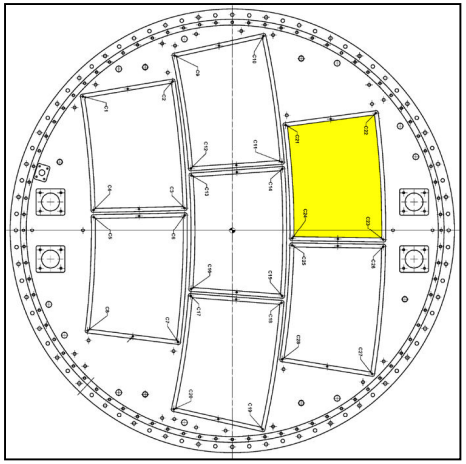
	sigma (x) [µm]	
z [mm]	B=0T	B=1T
50	159.405	54.666
100	219.433	75.557
150	265.733	91.791
200	304.64	105.538
250	338.723	117.674
300	369.328	128.654
350	397.27	138.755
400	423.083	148.155
450	447.145	156.98
500	469.729	165.323

Comparable to the JGEM values!

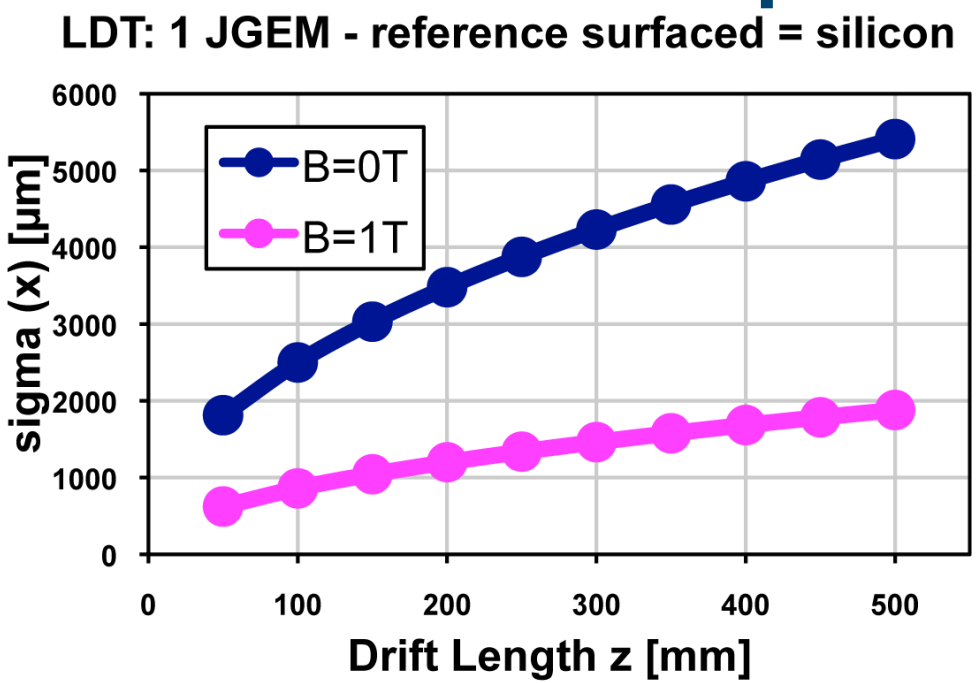


Alignment of TPC and Silicon Envelope

One JGEM – reference surface = silicon envelope



Silicon Envelope



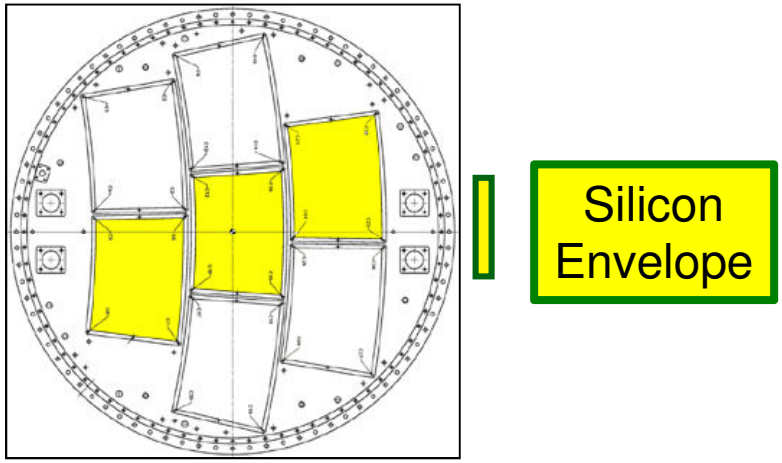
	sigma (x) [µm]	
z [mm]	B=0T	B=1T
50	1813.286	622.096
100	2499.653	859.056
150	3031.417	1043.438

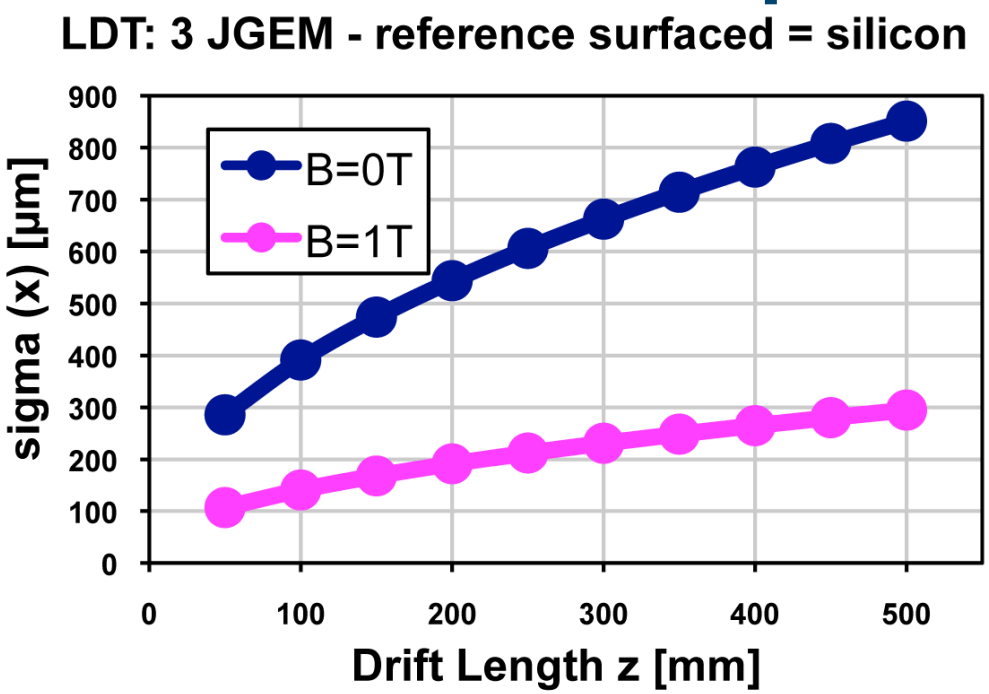
At z=50mm (B=1T): to achieve a resolution on the silicon plane of 2µm ~ 100000 and of 1µm ~ 400000 tracks are needed,

You must consider that only statistical errors are regarded!!!

Alignment of TPC and Silicon Envelope

Three JGEM – reference surface = silicon envelope





	sigma (x) [µm]	
z [mm]	B=0T	B=1T
50	285.915	106.845
100	391.359	140.795
150	473.88	168.007
500	851.011	294.98

At z=50mm (B=1T): to achieve a resolution on the silicon plane of 2µm ~ 3000 and of 1µm ~ 12000 tracks are needed,

In this configuration systematic errors will dominate!

Our status in the moment?

- Hardware TPC
  - Field Cage ✓
  - Magnet ✓ … till end of November
  - Magnet Support ✓
  - TPC readout … ?
- Hardware Silicon Envelope
  - Silicon sensors ✓
  - Support for the silicon sensors ✓
  - Silicon readout ? … problems with the initialization
- Software
  - TPC DAQ (-> tracks) … ?
  - Silicon DAQ (-> points) ✓
  - It has to be possible to align the whole system! ? ... depends

Things I really need to know by NOW!

- Is there an available TPC readout in Nov.?
  - In my opinion: 3 readout panels needed
    - JGEM? or Micromegas?
  - Systematic errors? – can someone make a guess
- What about the Silicon Readout?
  - A second amplifier board just arrived in IEKP
    -> Alexander will look into it.
    -> I assume this will solve the problem.
- Trigger number
  - Must be stored in all subsystems!
  - Who can get TLU + Distributor Box to operation?