Tracking detectors for R^3B

Jacob G. Johansen

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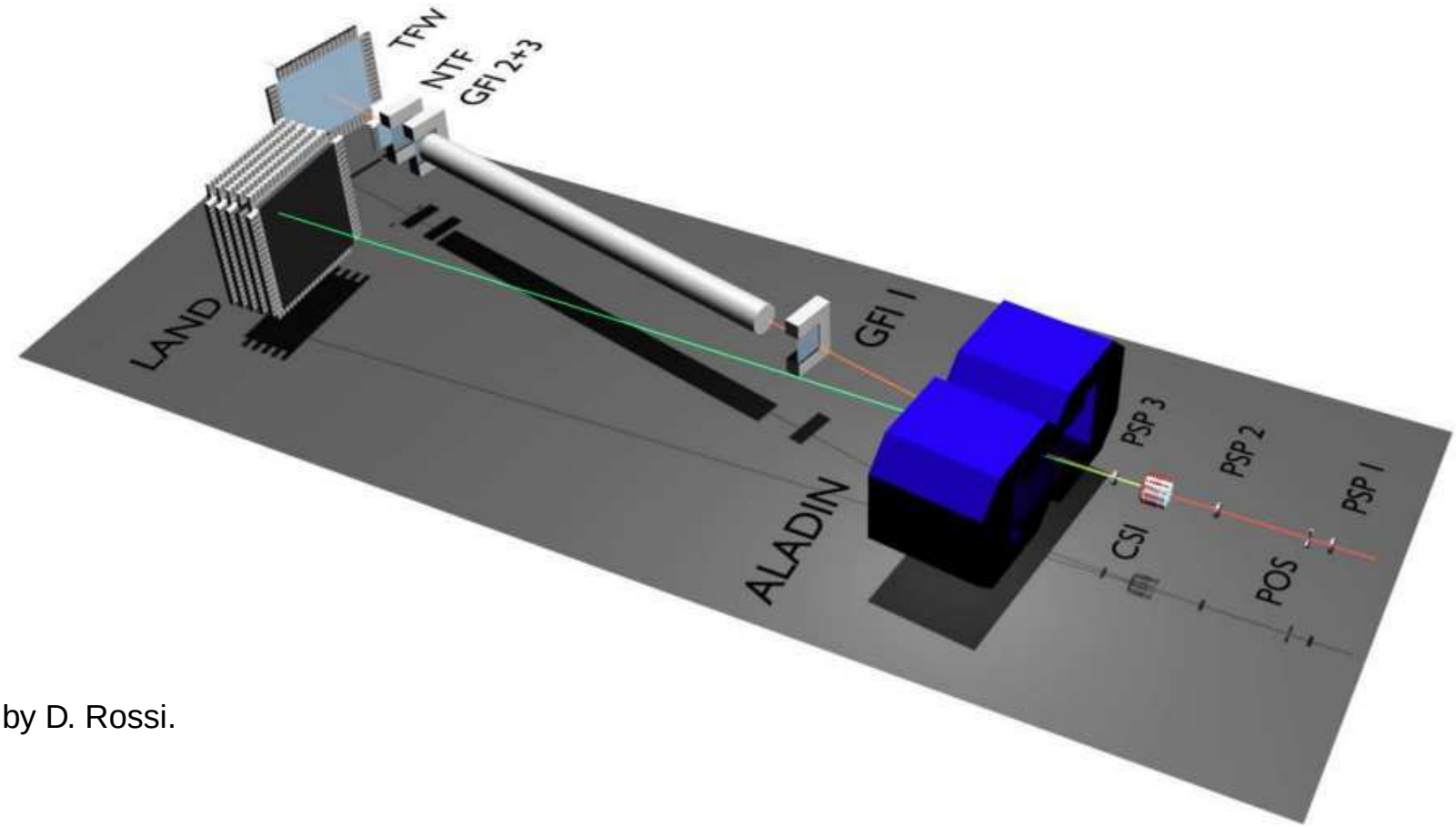

Drawing by D. Rossi.

The current R^3B tracking

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Detectors:

PSP

- 2D position sensitive Si detectors
- Energy + position

POS

- Scintillating plastic + PMT
- Time

GFI

- Fibers of scintillating plastic + PMT
- Position

TFW + NTF

- Paddles of scintillating plastic + PMT
- Time + Energy

Reconstructed values:

- Incoming mass
- Incoming charge
- Outgoing mass
- Outgoing charge

The need for an upgrade

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Mass: e.g. for Sn:

- sigma = 0.4u using 1mm fibers (insufficient)
- sigma = 0.25u using 0.25mm fibers (just enough)

  Mass reconstruction is limited by material budget $\rightarrow$ thinner detectors

Charge: e.g. for Sn:

- sigma = 1.0 % (100um Si) (insufficient)
- sigma = 0.5 % (300um Si) (just enough)
- sigma = 0.5 % (NTF) ongoing analysis

  Charge resolution is limited by energy straggling $\rightarrow$ thicker detectors

Rate: 10 kHz

Limited by 2D Position sensitive Si detector, but also TFW (energy)

Detector upgrades for beam-like fragments

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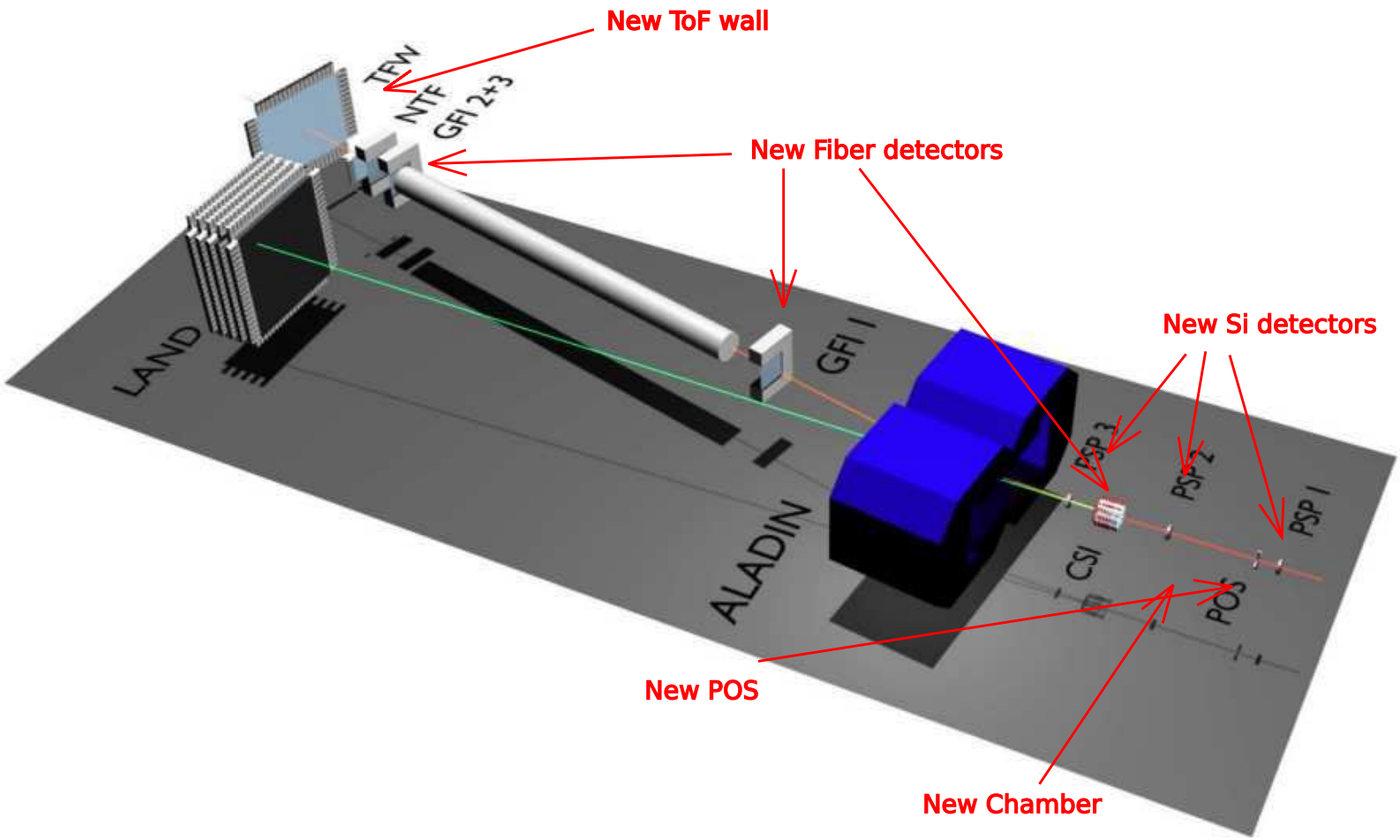

Detector upgrades for beam-like fragments

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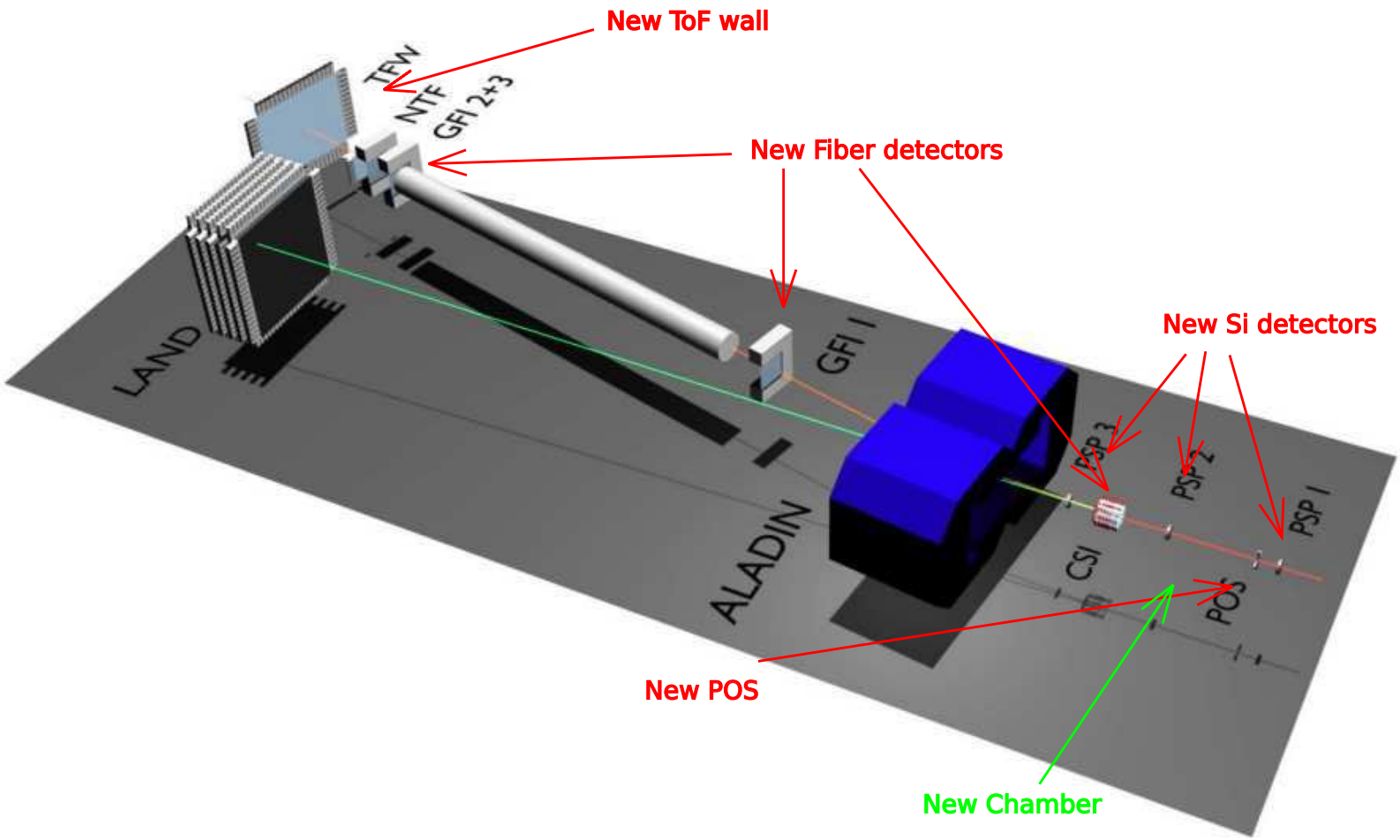
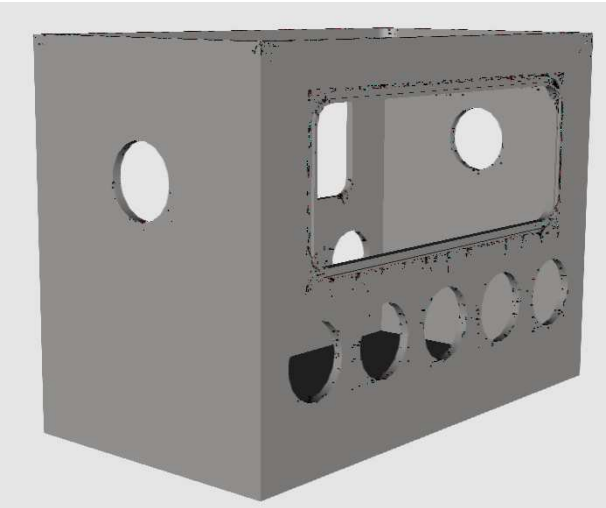
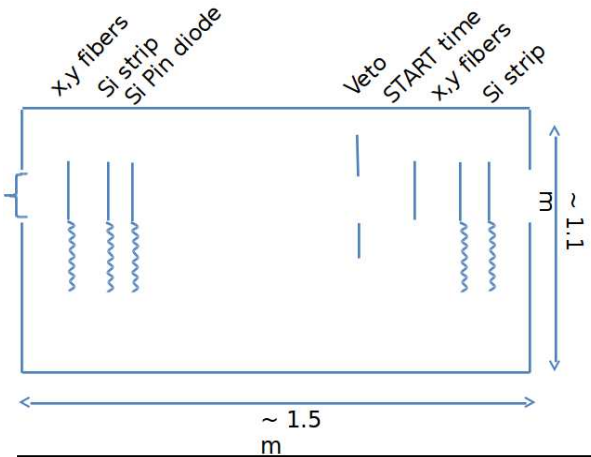


All-in-one Vacuum chamber (Preliminary concept)



Drawing by T. Metz



- All det. before the target in one chamber
- Common cooling for electronics
- Enough space for detectors + electronics
- Detectors easily in/out of the beam-line

Silicon:

- Primary detector
- Energy knowledge
- Good X position resolution

Fibers:

- Si detector calibration
- Small material budget
- No energy knowledge
- Good XY position resolution

Silicon detectors

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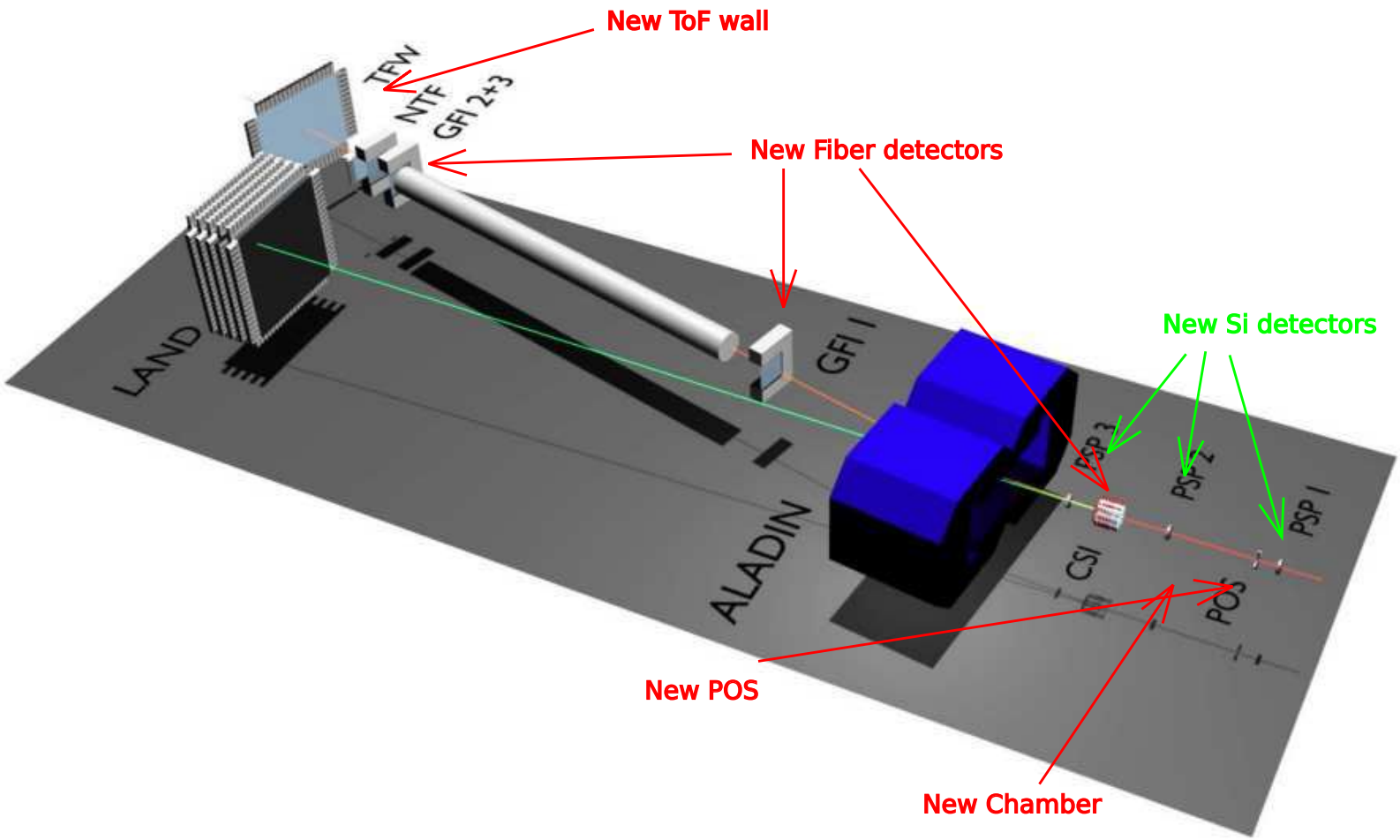

Silicon detectors - Current ones

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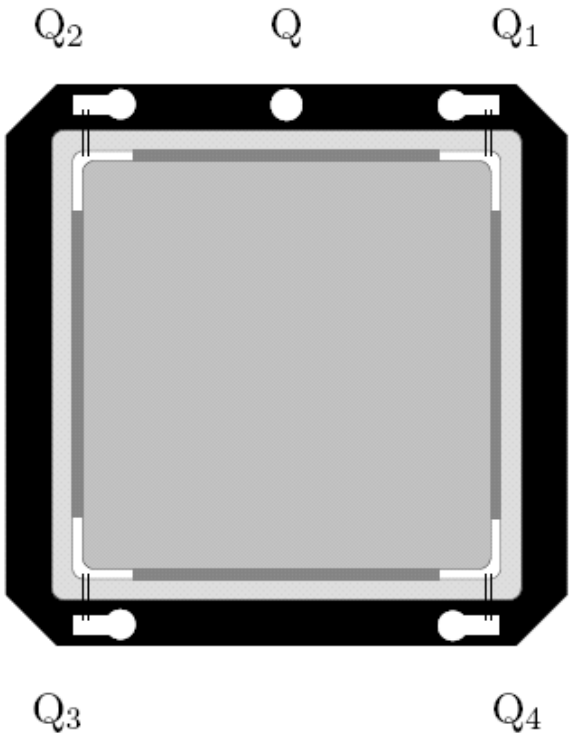
Position sensitive Si pin diode



- Active area: 45x45mm^2
- Thickness 300μm

Silicon detectors - New ones

(Thanks to I. Syndikus)

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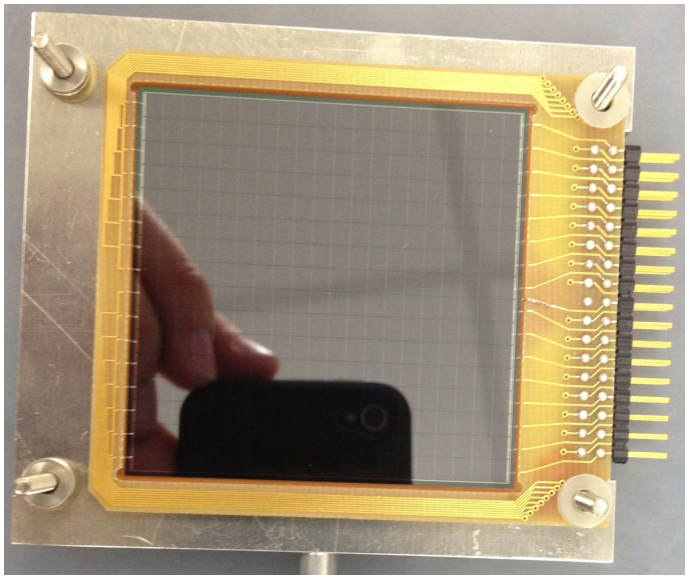
Micron X1



- 16 position sensitive strips
- Active area: 50x50mm^2
- Thickness 140μm (300μm)
- Readout: Strück, FEBEX

Comparison

- Faster signals
- Higher rate capacity
- Less energy dependency on position
- High position resolution in 1D
- More channels
- Interstrip (dead?) areas

Silicon detectors - New ones

(Thanks to I. Syndikus)

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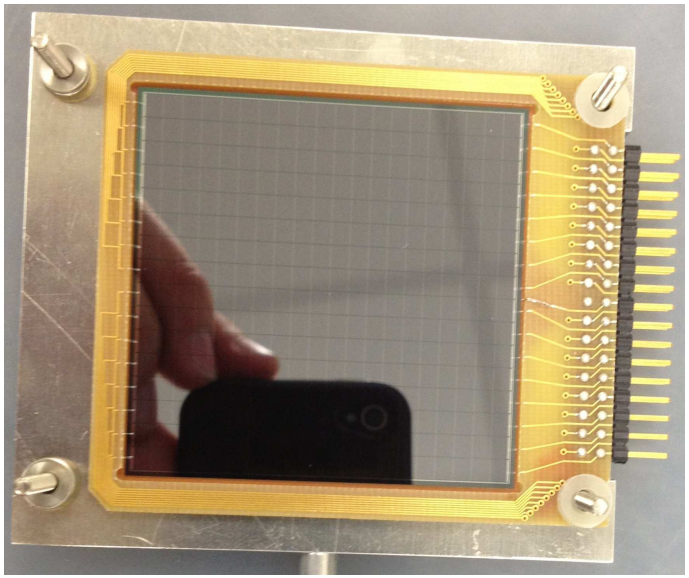

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Investigation of interstrip events

(Thanks to I. Syndikus)

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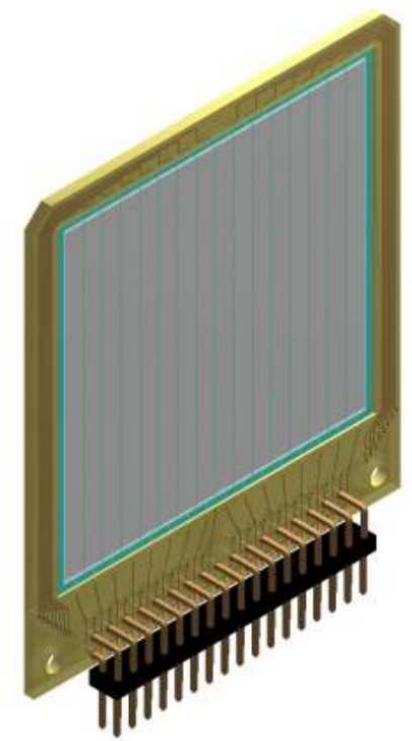

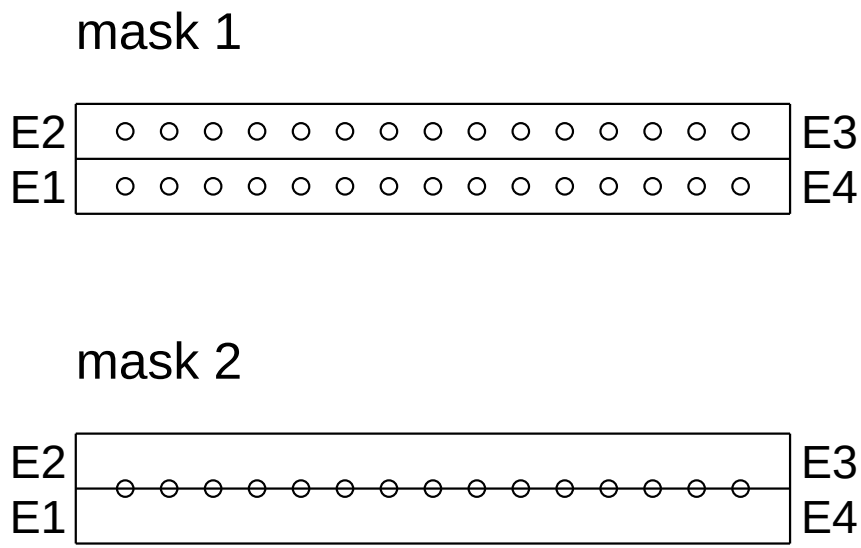

Investigation of interstrip events: left and right anode of one strip

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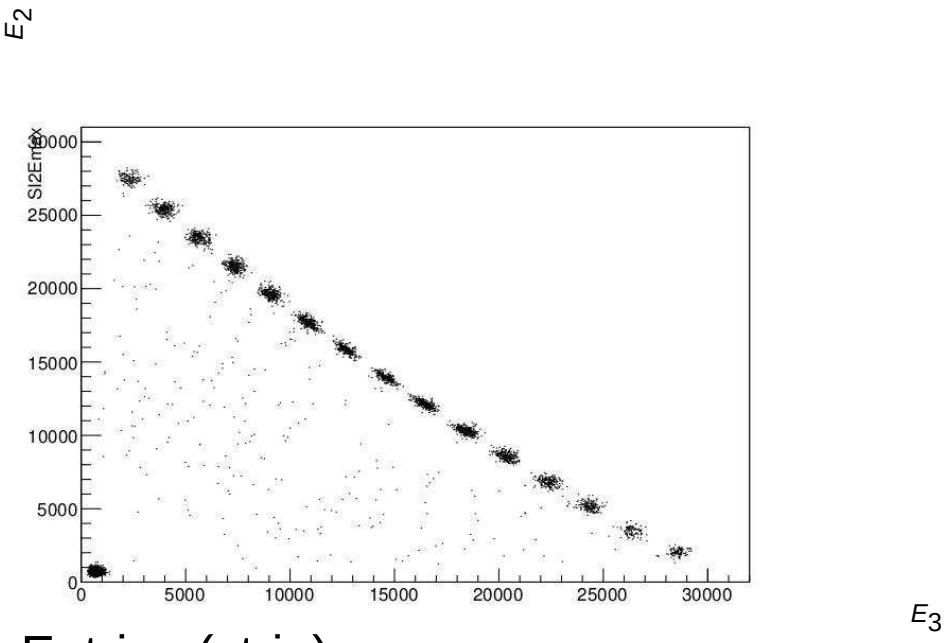
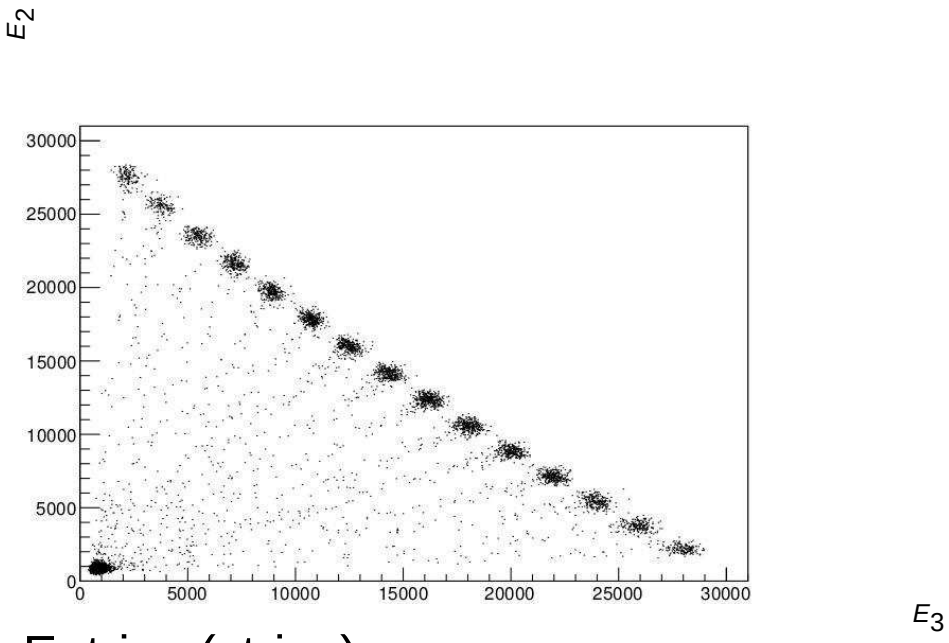
mask 1



Entries (strip)
≈ 3600
Entries (“rest“)
≈ 230 = 6%

mask 2



Entries (strips)
≈ 4000
Entries (”rest“)
≈ 900 = 18%

Investigation of interstrip events: sum of the anodes of both strips

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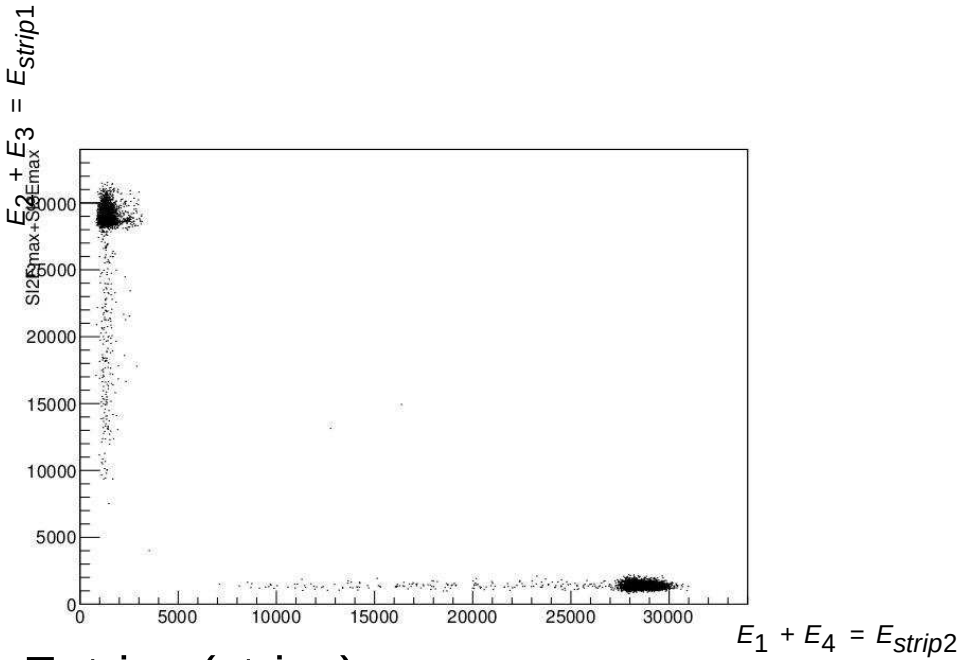
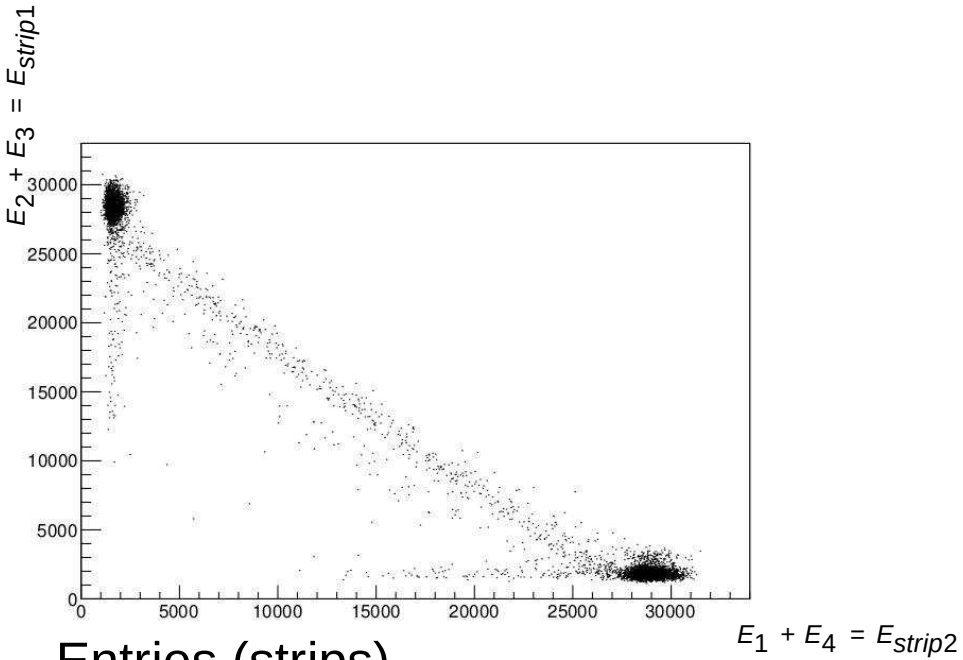
mask 1



Entries (strips)
≈ 7700
Entries (rest)
≈ 420 = 5%

mask 2



Entries (strips)
≈ 7200
Entries (in-between)
≈ 800 = 10%
Entries (rest)
≈ 330 = 4%

Investigation of interstrip events: measurement without mask

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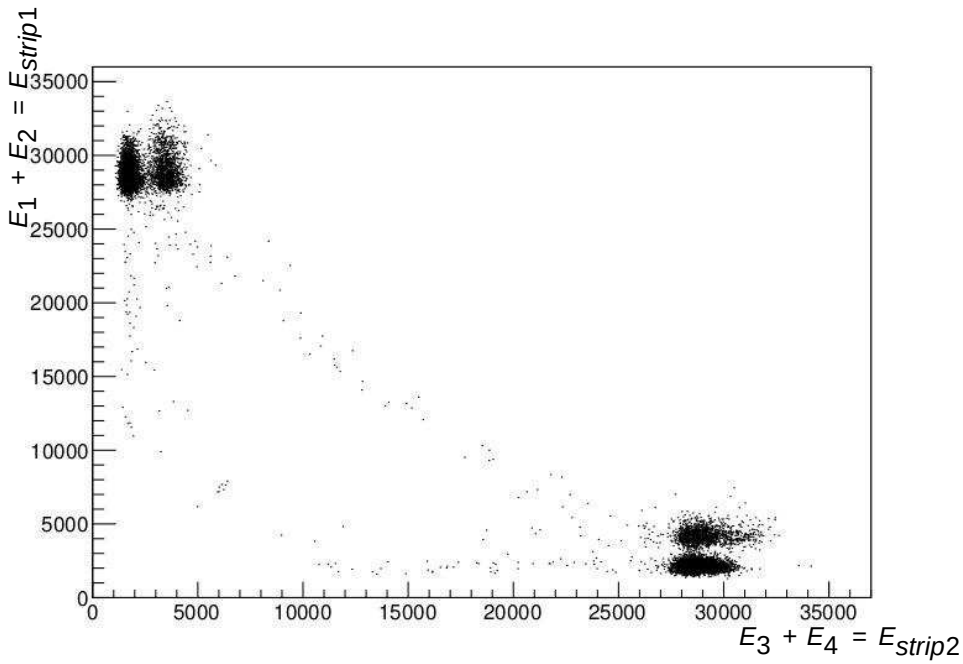

Entries (strips)	Entries (in-between)	Entries (rest)
≈ 12000	≈ 100 = 0.8%	≈ 130 = 1.1%

Investigation of interstrip events: position resolution

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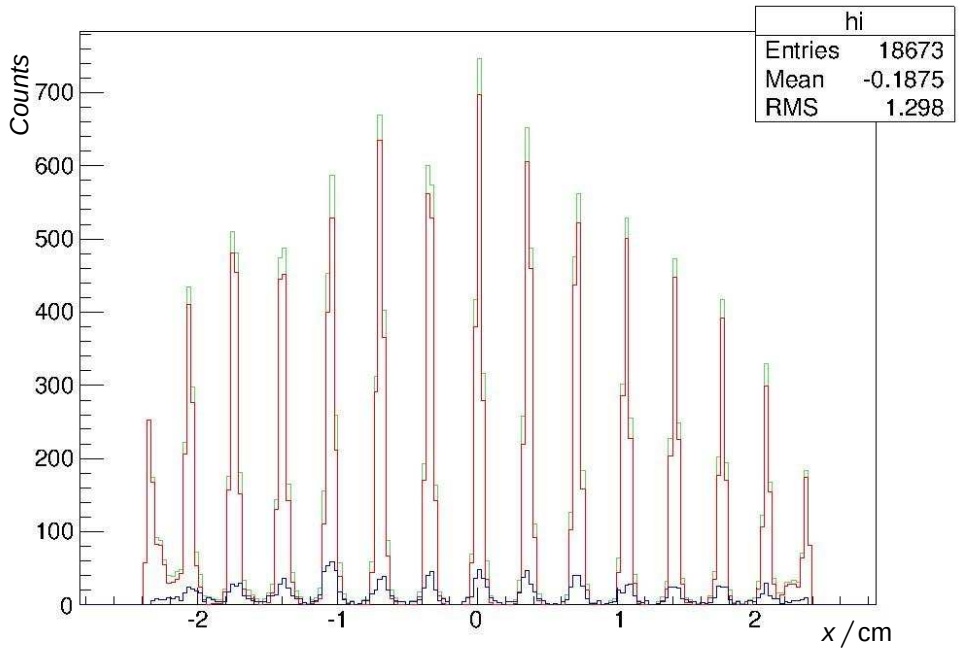

	all	strips	in-between
σ_x / mm	0.254	0.235	0.503
$FWHM_x$ / mm	0.598	0.552	1.184

Investigation of interstrip events: Conclusion

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- around 1% of all hits hit the inter-strip region
  $\rightarrow$ both position and energy recoverable
  $\rightarrow$ resolution around the factor 2 worse
- around 1% of all hits are strange
  $\rightarrow$ might hit the inter-strip region on the other side of the examined strip

POS

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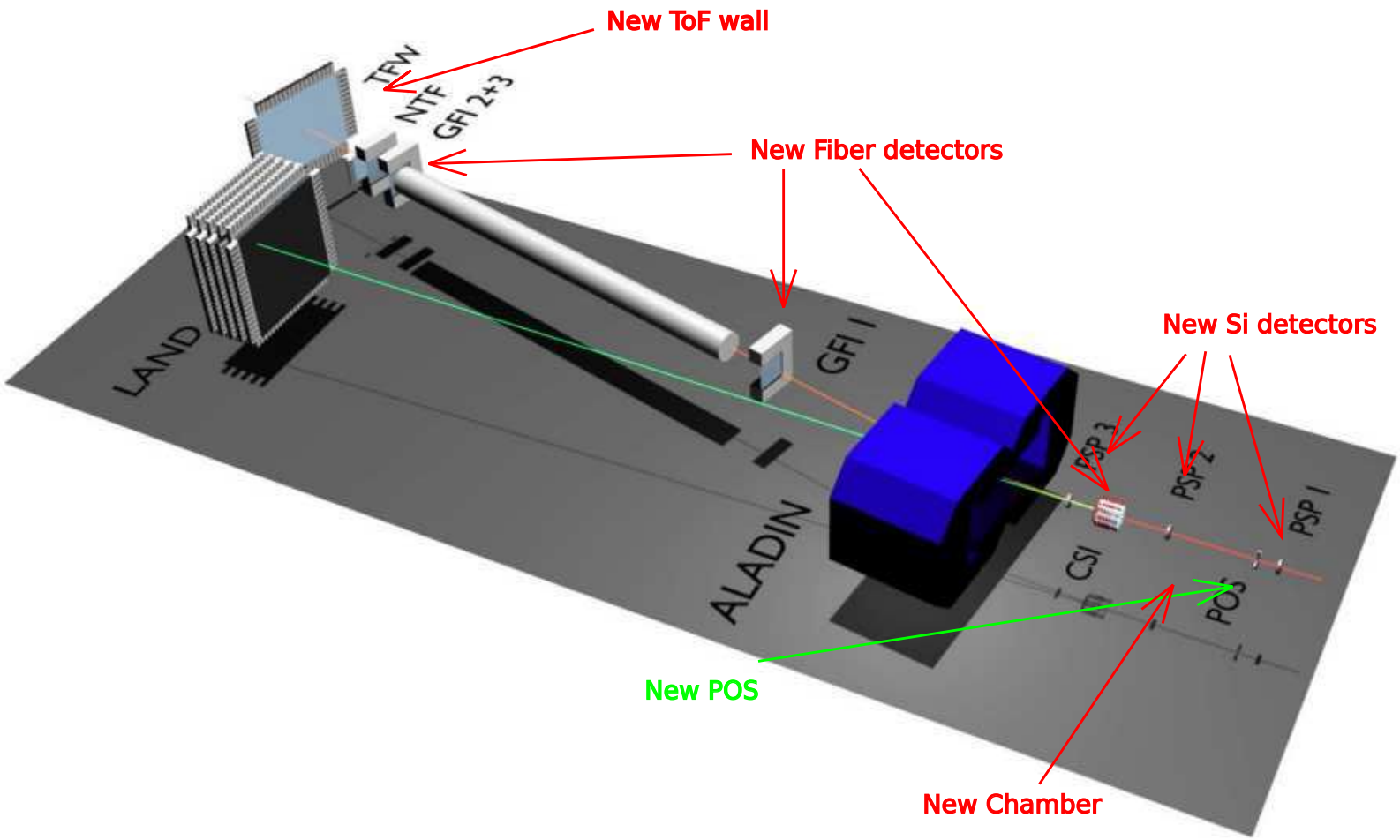

POS - Current status

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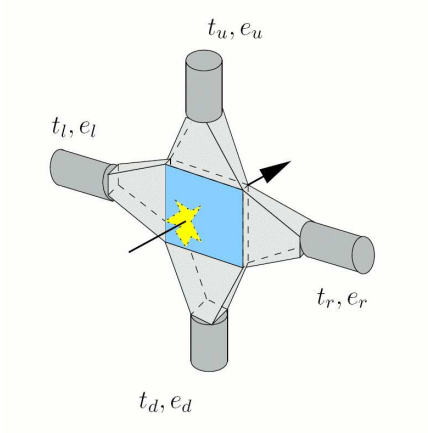
Existing POS:



To be tested:

- Aim: $\Delta t < 10$ ps.

POS - Current status

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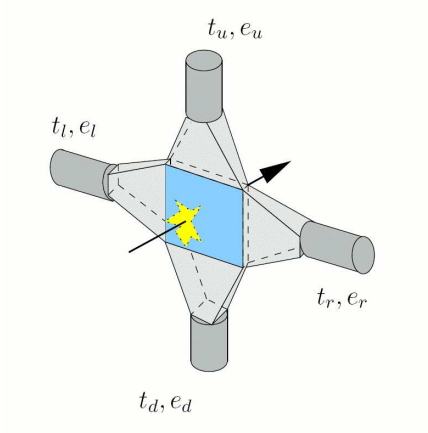
Existing POS:



To be tested:

- Aim: Δt < 10 ps.
- refurbished POS
  - No light guides
  - 2 inch PMTs (previous 1 inch)
  - 1PMT meas.: Δ t = 14ps

- Plastic thicknesses: 100 - 500 μm
- Readout: CFD and VFTX

  No(little) walkeffect $\rightarrow$ Fast online particle ID.

POS - Current status

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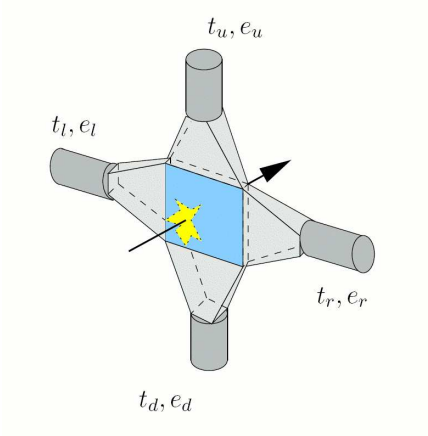
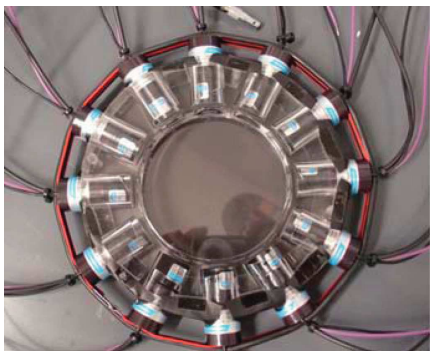
Existing POS:



LYCCA:



To be tested:

- Aim: Δt < 10 ps.
- refurbished POS
  - No light guides
  - 2 inch PMTs (previous 1 inch)
  - 1PMT meas.: Δ t = 14ps
- LYCCA ToF start:
  - 12 PMT's
  - Ø7.3 cm active area
  - Δt $\sim$ 5 ps (1 mm thick sheet)
- Plastic thicknesses: 100 - 500 μm
- Readout: CFD and VFTX

  No(little) walkeffect $\rightarrow$ Fast online particle ID.

Fiber detectors

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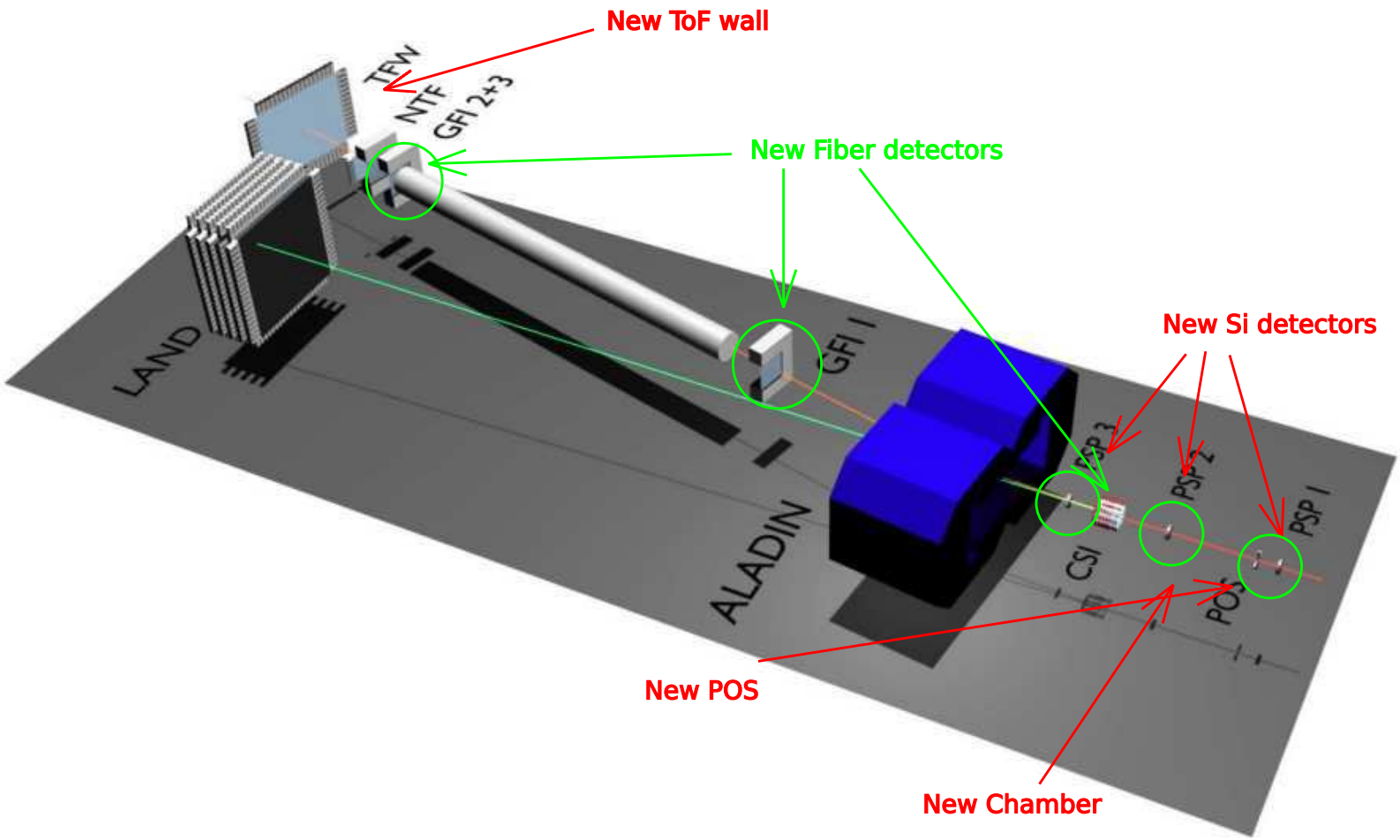

Fiber detectors

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Current fibers:

- 2 GFI's
  - One layer (1D)
  - Active area: 50x50cm^2
  - 500 1mm fibers
- 1 MFI
  - One layer (1D)
  - Active area: 24x26cm^2
  - 1024 0.25mm fibers

Fiber detectors

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  - 1024 0.25mm fibers

New fibers

- 2 fibers before target
  - Two layers (2D)
  - Active area: 5x5cm^2
  - 2x256 0.2mm fibers
- 1 fiber after target before GLAD
  - Two layers (2D)
  - Active area: 100x100cm^2
  - 2x512 0.2mm fibers
- 1 fiber after magnet
  - One layer (1D)
  - Active area: 24x20.5cm^2
  - 1024 0.2mm fibers
- 1 fiber together with the ToF wall
  - Four layers (2D)
  - Active area: 90x120cm^2
  - 4x6084 0.2mm fibers

Fiber detectors

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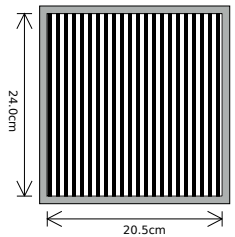
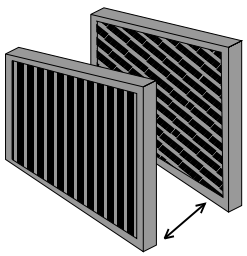
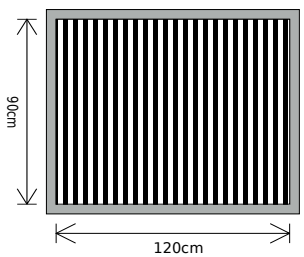
One layer:



Two layers:



Four layers:



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Fiber detectors

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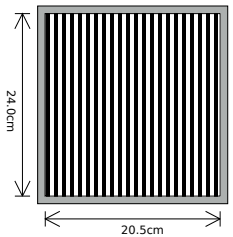

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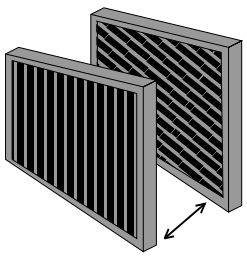

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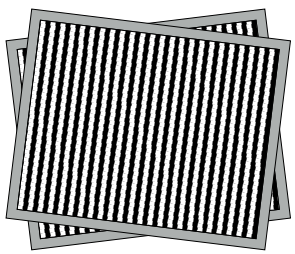

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Fiber detectors

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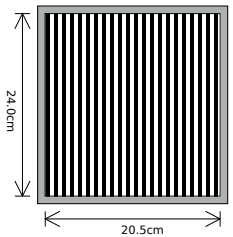

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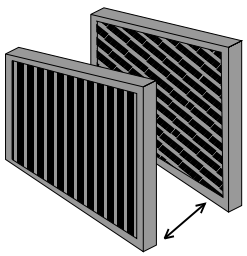

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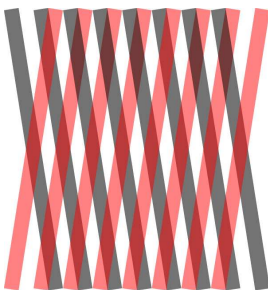

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How to build the detectors

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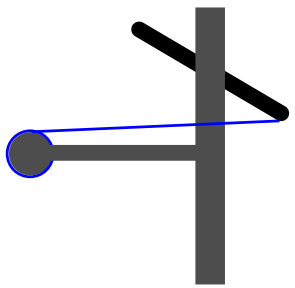
Winding machine at GSI:

Three steps to a nice fiber detector:



- Put the fibers around a large frame

How to build the detectors

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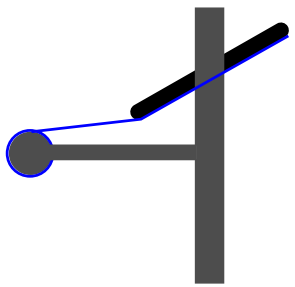

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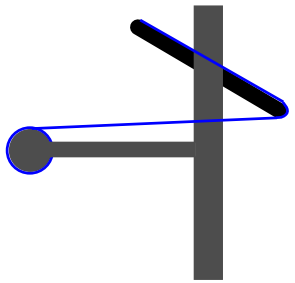

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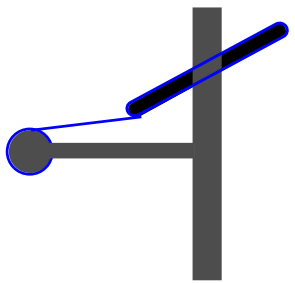

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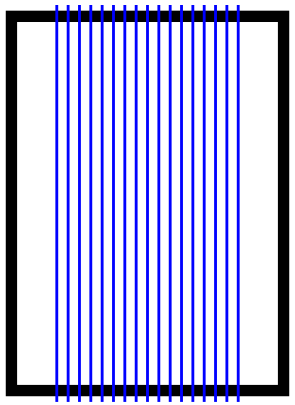

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How to build the detectors

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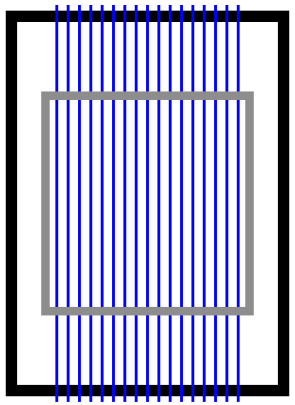


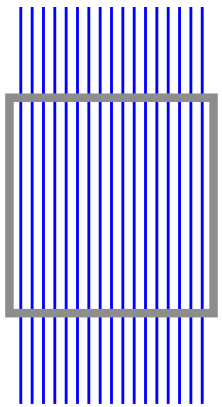
- Put the fibers around a large frame
- Glue the detector frame on to the fibers

How to build the detectors

TECHNISCHE UNIVERSITÄT DARMSTADT

Winding machine at GSI:

Three steps to a nice fiber detector:



- Put the fibers around a large frame
- Glue the detector frame on to the fibers
- Cut the fibers frome the large frame

The readout

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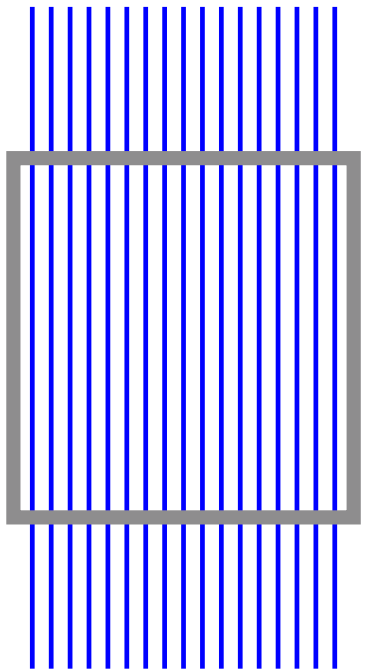
How to read out:

- 27634 fibers
- Read out in both ends

The frame:



The readout

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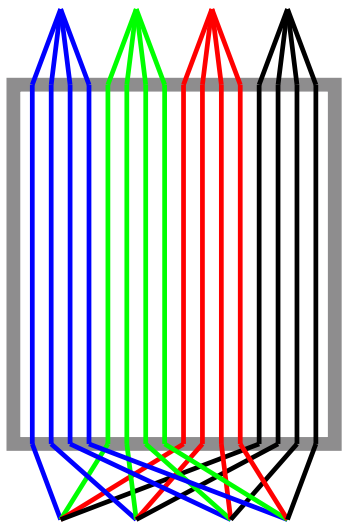
How to read out:

- 27634 fibers
- Read out in both ends
- Bundle the fibers
- reduces the number of channels to 944
  - 2x4x16
  - 4x32
  - 2x32
  - 8x78

The frame:



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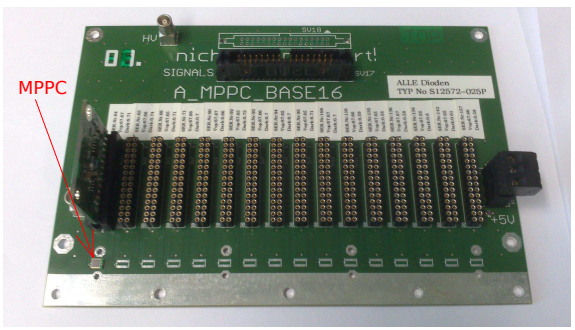
Multi anode PMT (256ch):

MPPC ($3x3mm^2$):



The readout

TECHNISCHE UNIVERSITÄT DARMSTADT

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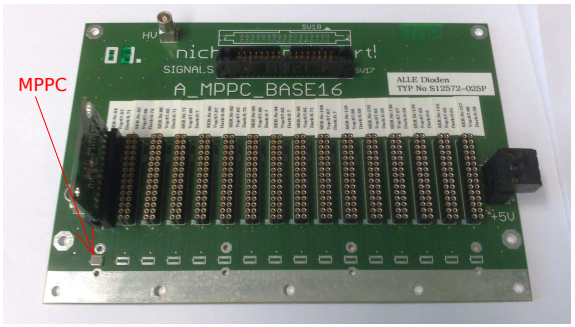
  - 8x78

Multi anode PMT (256ch):

Electronics to be tested:

- Small detectors:
  - FEBEX
  - Strück
- Large detector:
  - GEMEX
  - TAMEX

MPPC (3x3mm^2):



ToF wall

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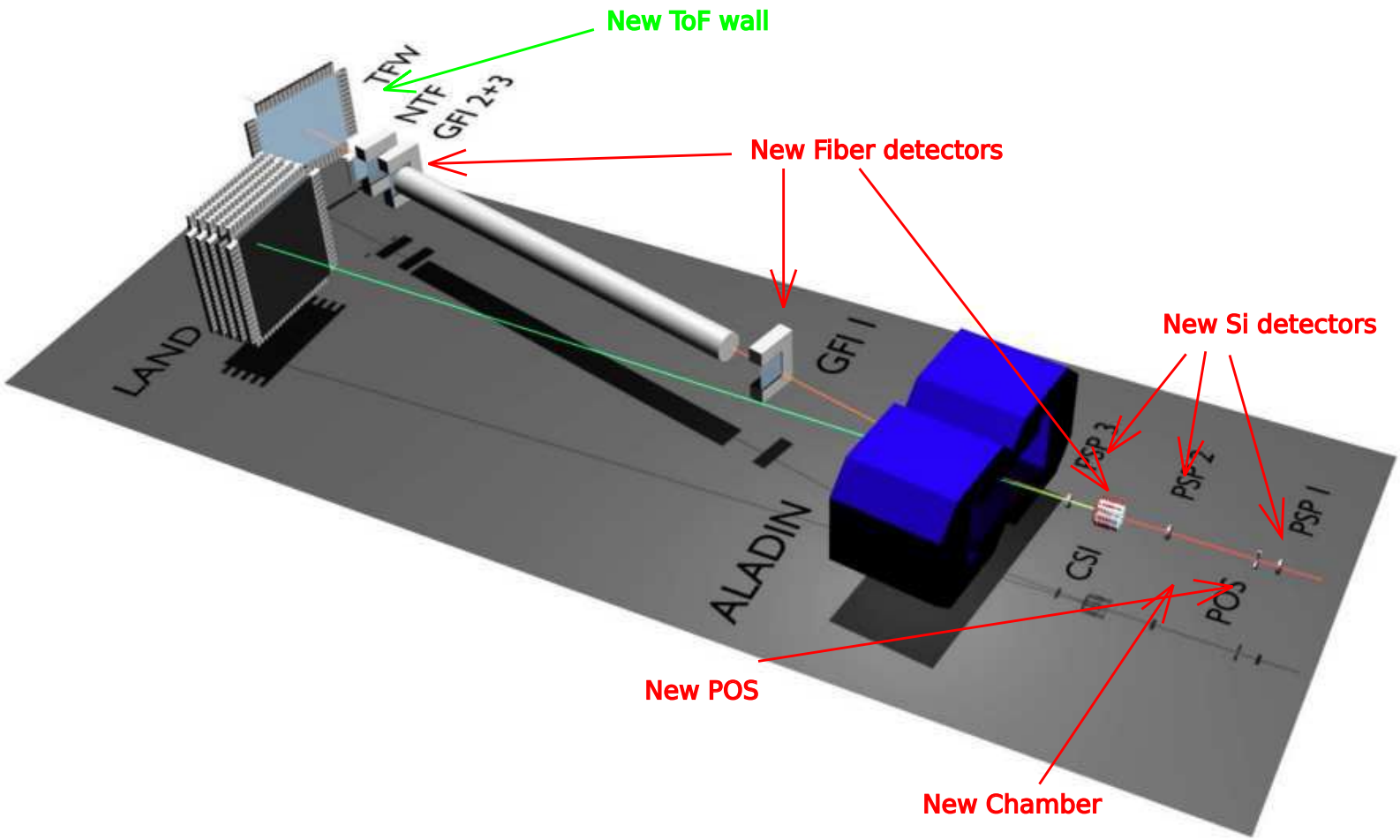

ToF wall - Current status

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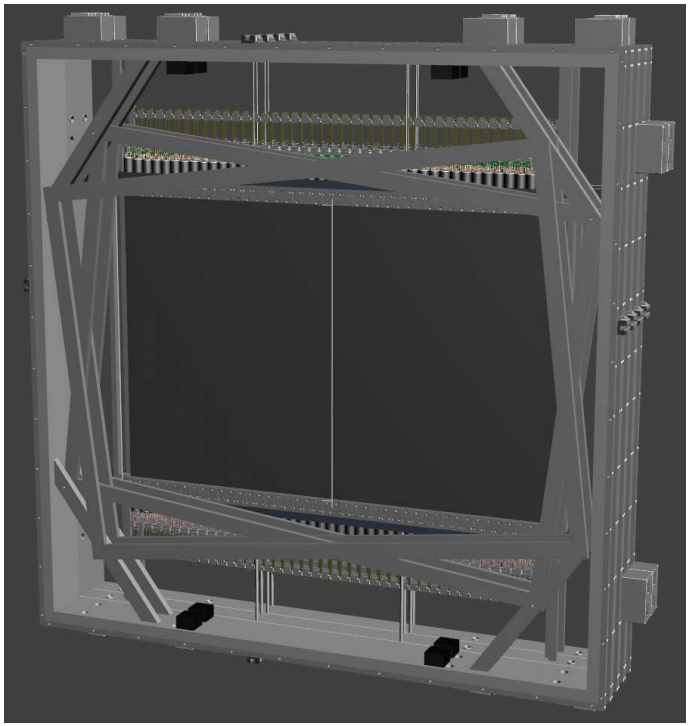
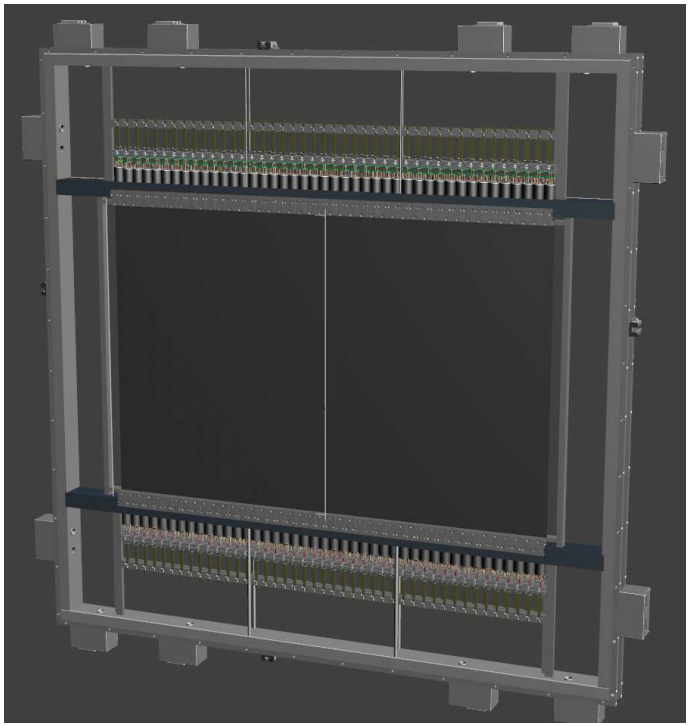


Drawing D. Körper.

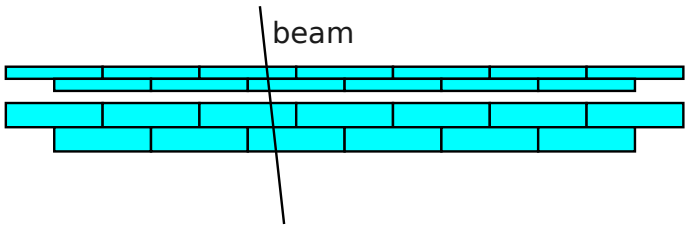
- Total active area: 110x80 cm^2
- 2x Two layers with vertical paddles
- 44 paddles pr. layer (40 in total recieved)
- SCIONIX Paddles:
  - 80x2.7x0.5cm^3
  - 80x2.7x0.3cm^3
- No light guides
- Readout: TAMEX (Test boards received)
- Alternative readouts to be tested:
  - QTC
  - PADI

ToF wall - Current status

TECHNISCHE UNIVERSITÄT DARMSTADT



Drawing D. Körper.



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Some known issues to be corrected

(Data from the s412 experiment ($^{124-134}$Sn))

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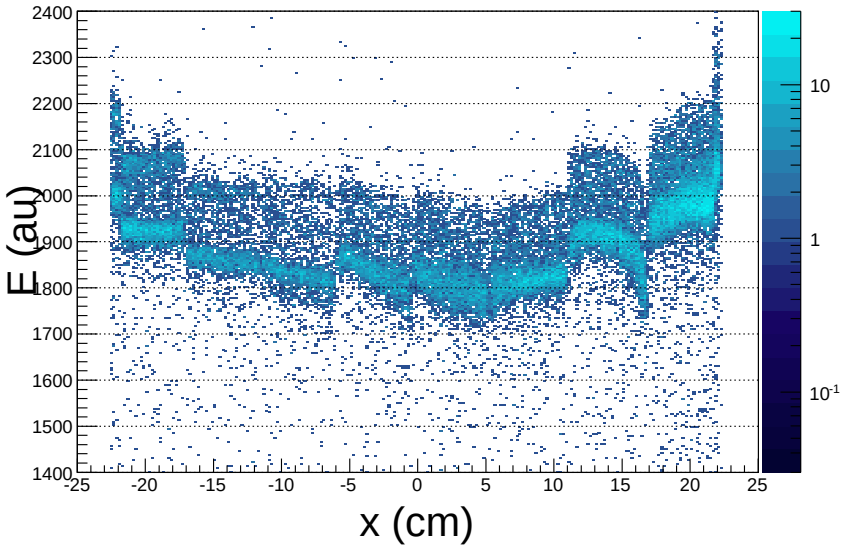
Energy vs. position for sweep-run with empty target:



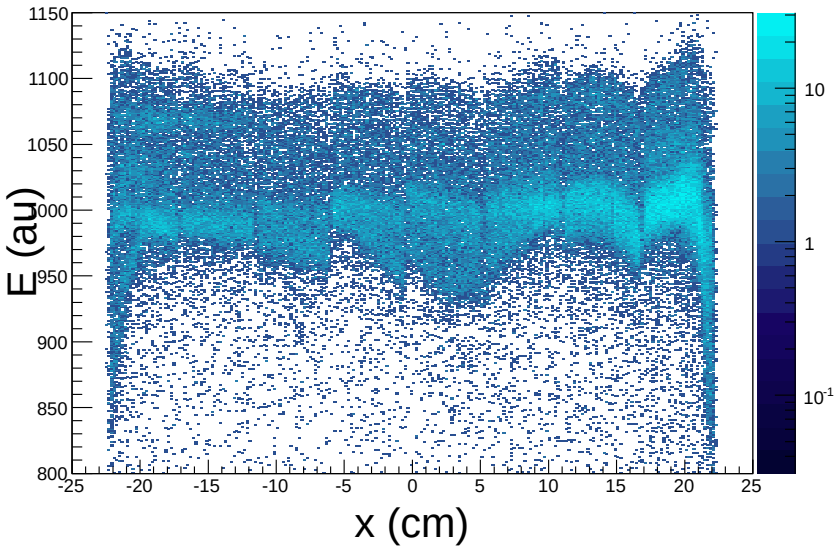
- $E = \frac{E_x + E_y}{2}$
- No corrections

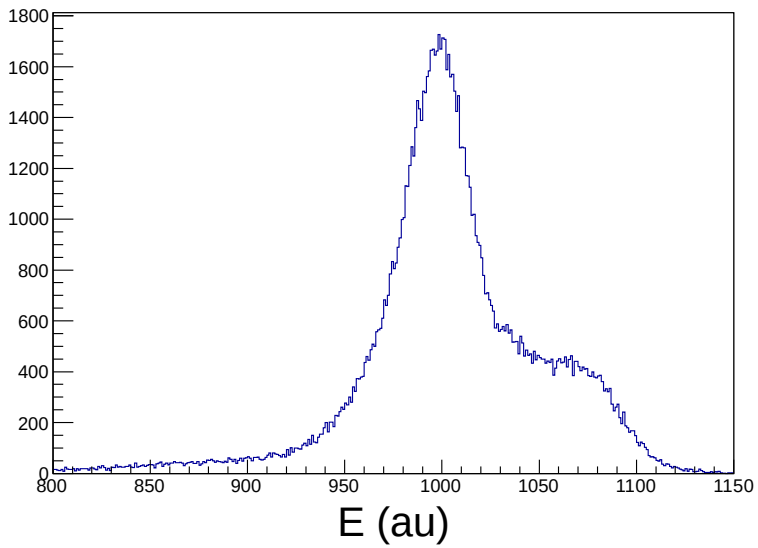
Some known issues to be corrected

(Data from the s412 experiment ($^{124-134}$Sn))

TECHNISCHE UNIVERSITÄT DARMSTADT

Energy vs. position for sweep-run with empty target:





- $E = \frac{E_x + E_y}{2}$
- Correction for Light guide effect
- $\frac{\sigma}{E_0}$ = 1.98% (Main peak)

Some known issues to be corrected

(Data from the s412 experiment ($^{124-134}$Sn))

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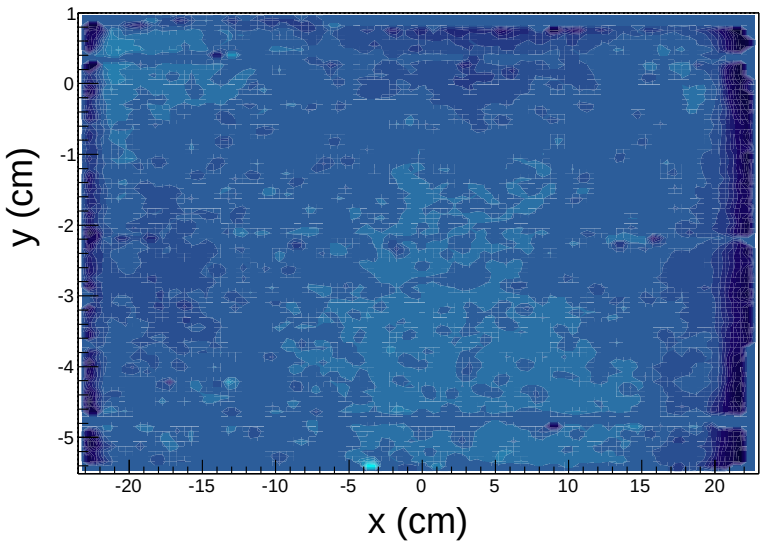
One of the problems:

E_{Sn} across one paddle:



- Area with more/less energy deposited
- Smooth changes in energy changes
- Indication of fluctuations in paddlethickness
- In good agreement with paddle specification

Some known issues to be corrected

(Data from the s412 experiment ($^{124-134}$Sn))

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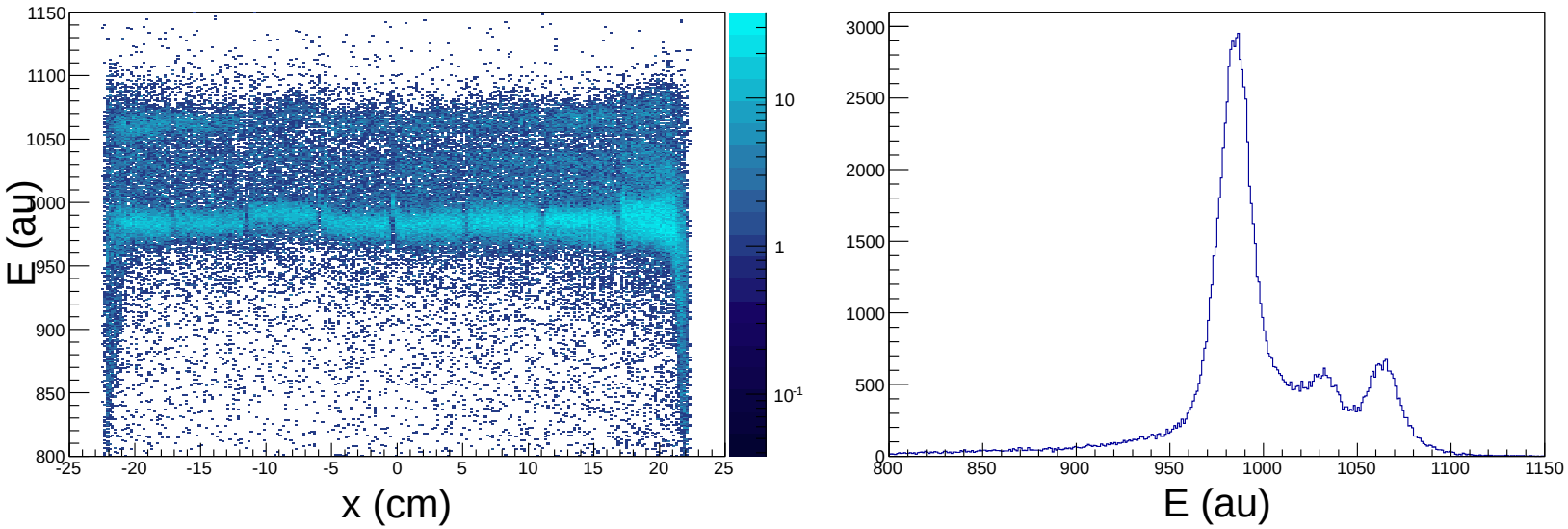
Energy vs. position for sweep-run with empty target (position corrected):



- $E = \frac{E_x + E_y}{2}$
- E_0 of Z=50 scaled to 983keV. (cut on incoming Z)
- $\frac{\sigma}{E_0}$ = 0.99% (Main peak)

The R^{3}B tracking detectors

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