FB high rate tracker

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TIC meeting

Introduction

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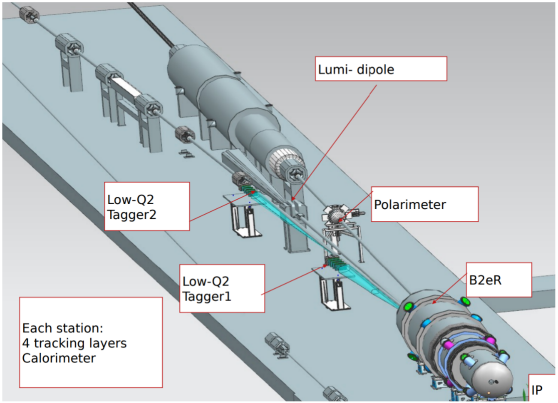
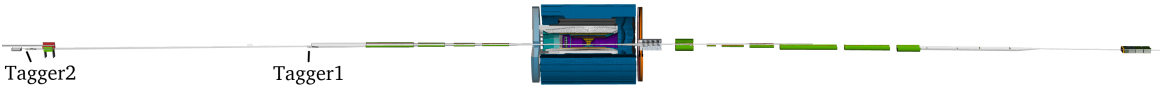
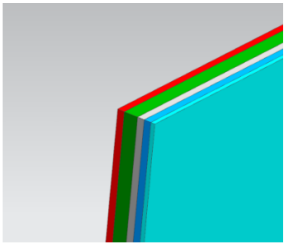
- Two low-Q^2 tagger detectors along outgoing electron beam pipe
- Placed at about -20 m and -35.5 m from IP

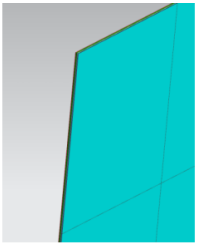




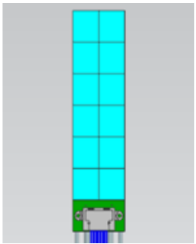
Tracker layout



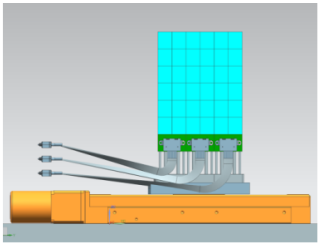
	Thickness
Silicon Sensor	60 um
Timepix4 ASIC	100 um
TSV bond	100 um
PCB	200 um
Cu (Cooling)	100 um
Total	**560 um (~1%X0)**



Timepix4 ASIC	
Pixel pitch (um)	55x55
Pixel array	448x512
Total (mm)	**24.64x 28.16**



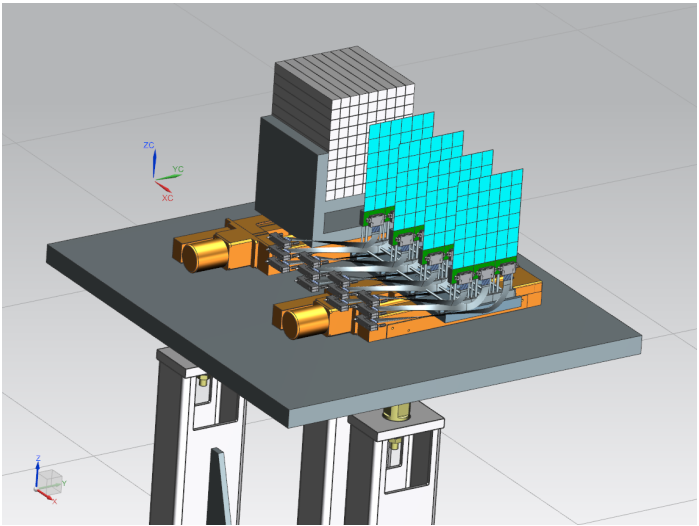
Timepix4 Module	
ASIC array	2x6
Acceptance	100%
Total (mm)	**49.28x 168.96**



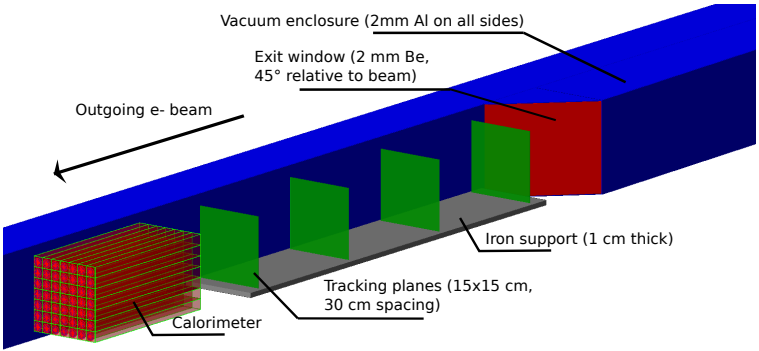
Tracker Layer	
Modules	3
Total ASICS	36
Table for alignment	O(10 mm)
Total (mm)	**147.84x 168.96**

CAD drawing

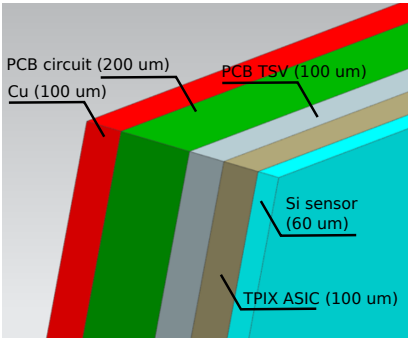
- Sensor layers on support structures
- Cooling and cabling
- Calorimeter behind the tracking layers (under discussion)



Tracker geometry



Detector geometry

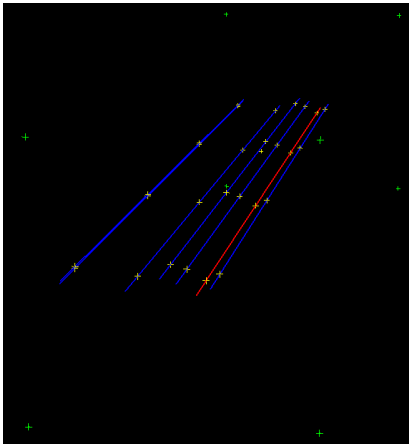


Tracking plane (Timepix4)

- Full beamline geometry, vacuum beampipe walls, preliminary exit window
- Realistic geometry for tracking planes as Timepix4, support structure is included

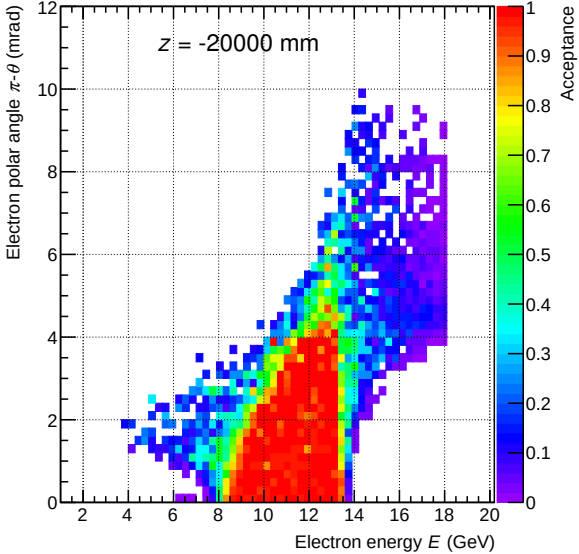
Simulation samples done so far

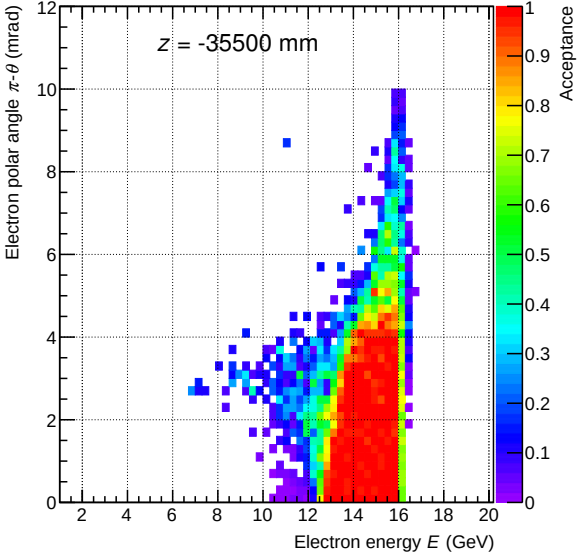
- Single interaction per event:
  - Quasi-real photoproduction (DIS signal)
  - Bethe-Heitler bremsstrahlung (background)
  - Electron beam-gas (background)
- Signal and multiple background interactions per event:
  - Multiple bremsstrahlung events are embedded into a quasi-real events in hepmc
  - Bremsstrahlung multiplicity is generated from Possion distribution set by luminosity per bunch crossing



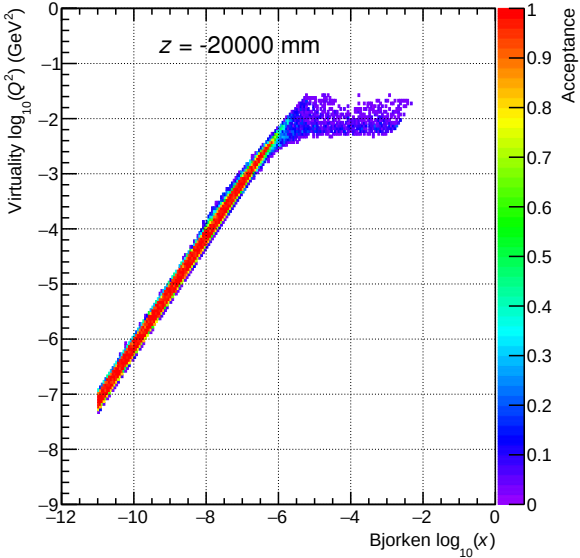
Reconstructed tracks in multiple-interactions sample (red track is the signal)

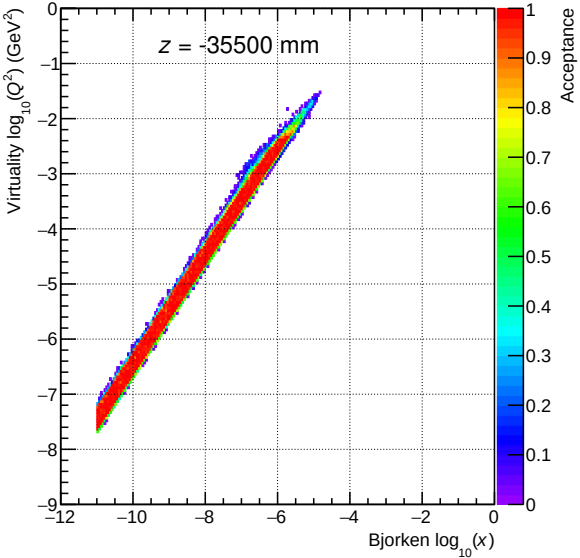
Acceptance in electron energy and polar angle (quasi-real)





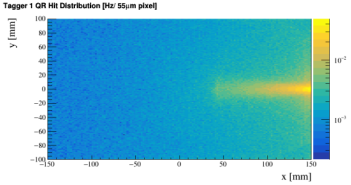
Acceptance in Q^2 and Bjorken-x (quasi-real)

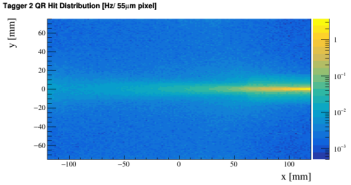


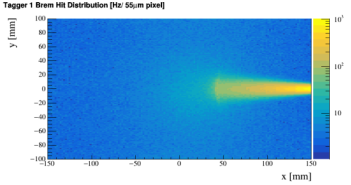


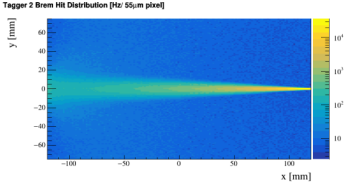
Hit rates at the level of single pixels

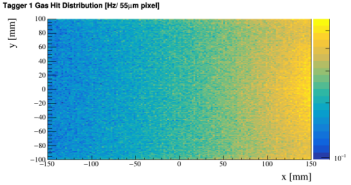
- Quasi-real (top)
- Bremsstrahlung (middle)
- Electron beam-gas (bottom)

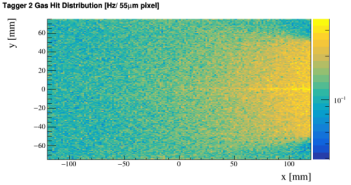




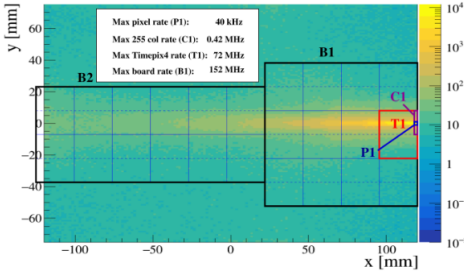




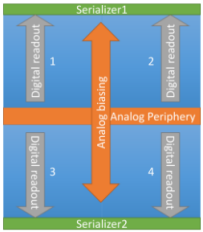




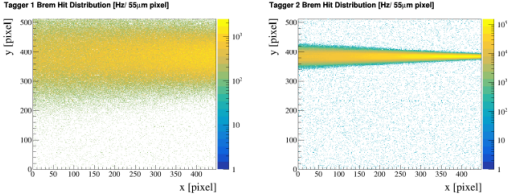
Readout scheme based on the rates



Bremsstrahlung rates on Tagger 2 - Layer 1
(per pixel averaged over mm²)



Timepix4 ASIC periphery schematic

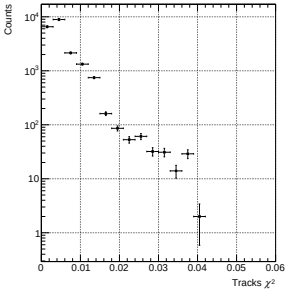


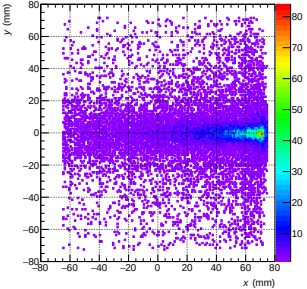
Bremsstrahlung per pixel rates
Taggers 1/2 - Layer 1 – Chip closest to beam

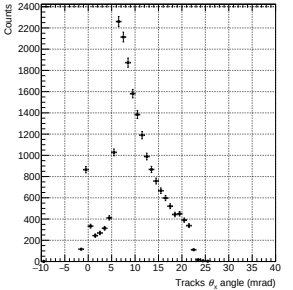
Considerations from to make most of Timepix4 ASIC
ASIC readout rate limited by double pixel column
ASIC orientation set to best distribute hits across columns
Detector shift by 7.04 mm in y to avoid highest rates on central/edge peripheries.

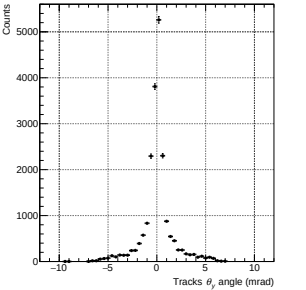
Tracking performance

- Example for Tagger 1
- Quasi-real events
- Tracks χ^2 and local position and angles in x and y





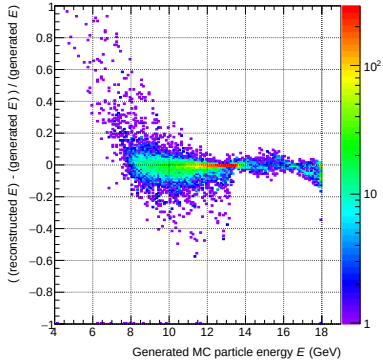




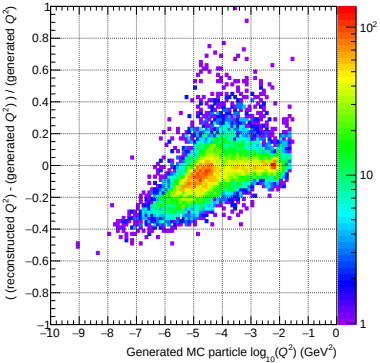
Energy and Q^2 resolution

- Electron kinematics from tracks by ML (two algorithms, custom made and TMVA)
- Q^2 is obtained by electron method (reconstructed energy and polar angle)

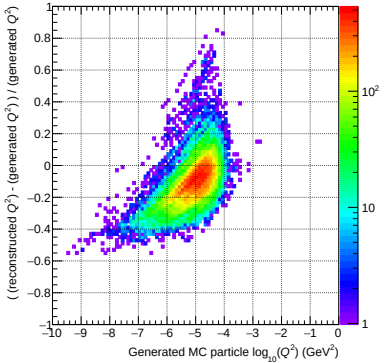
Energy (quasi-real)



Q^2 (quasi-real)



Q^2 (bremsstrahlung)



Summary and ongoing work

- Signal separation from bremsstrahlung works for $Q^2 \gtrsim 10^{-3}$ GeV^2 with taggers alone
- Event kinematics from central detector should help identify DIS track in taggers at lower Q^2
- Synchrotron radiation (and impedance) will set constraints on exit window
- Ongoing studies on reconstruction performance and rates per single pixel