Overview of the Pair Spectrometer Design and Performance

Dhevan Gangadharan, Nick Zachariou, Bill Schmidke
TIC meeting: Oct 16th 2023

Luminosity System Requirements

EIC Yellow Report Requirements:

- **Absolute lumi δL/L ~ 1%**
- Relative lumi $\delta(L\uparrow - L\downarrow)/(L\uparrow - L\downarrow) \sim 10^{-5}$

ZEUS Pair Spectrometer Systematics

Component		Sub-component systematics
Acceptance	(**1.6%: total**)	**1.0%**: Aperture and detector alignment
		1.2%: X-position of photon beam
Photon conversion in exit window	(0.7%: total)	0.1%: thickness of window
		0.3%: chemical composition
		0.6%: photon conversion cross section
RMS-cut correction	(0.5%: total)	0.5%: rejection of proton-gas interactions
Total		**1.8%**

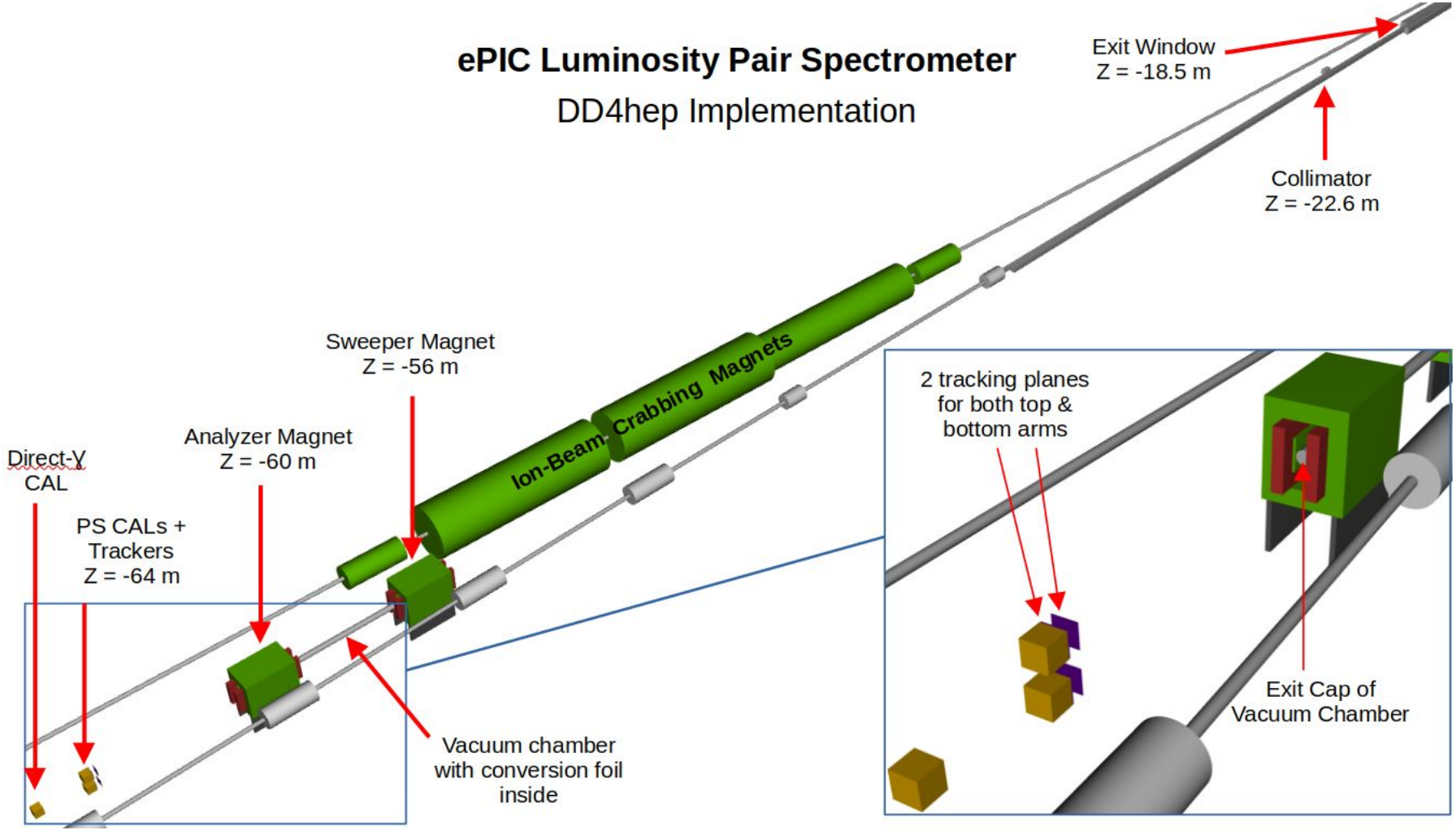
NIM A 744 (2014) 80-90

Lessons learned from ZEUS:

- Focus primarily on the acceptance uncertainties
- The ePIC lumi pair spectrometer is designed to reduce this uncertainty.

ePIC Luminosity Pair Spectrometer

DD4hep Implementation



PS Component Status

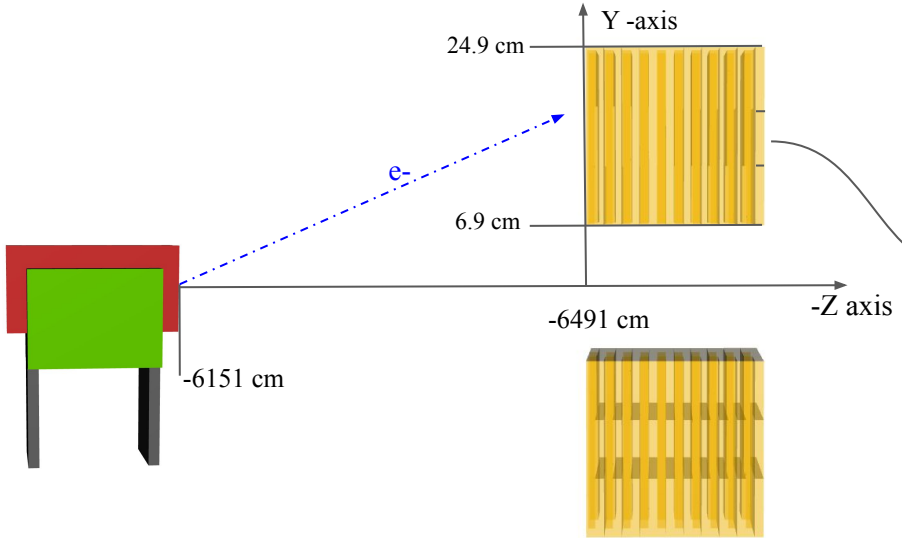
- **Sweeper and Analyzer Dipole Magnets** (controlled low rates)
  - Design completed by Xu Peng.
  - DX=76 cm, DY=96 cm, DZ=120 cm
  - Nominal field at center ~0.86 T, $\int Bx*dz = 1.14$ T*m

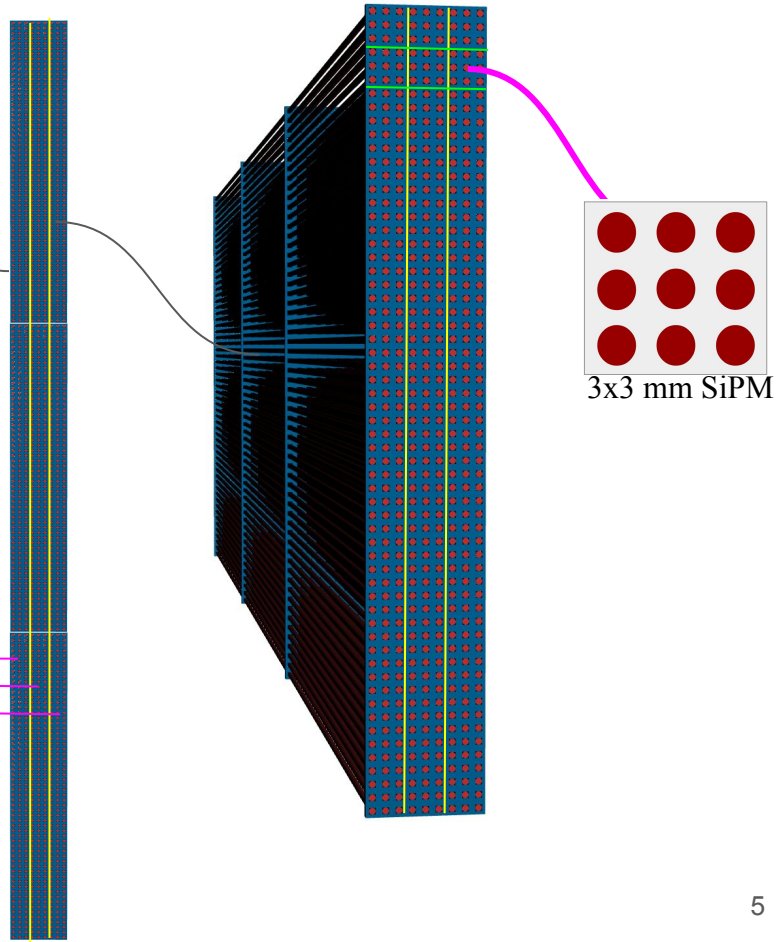
- **Vacuum Chamber** (controlled low rates & minimize conversions in air)
  - Preliminary design ready: Igor Korover.
  - Pipe Occupying region between dipole magnets, diameter=15 cm, DZ=520 cm.
  - Enlarged chamber in middle to house a thin conversion foil.

- **Calorimeter** (primary detector)
  - Preliminary design ready: UH and York groups. Based on W-powder SciFi design of fECAL.
  - 18 cm cube

- **Trackers** (precision measurement of fiducial area and photon beam profile, CAL calibration)
  - 2 layers of AC-LGAD (pixel or strip) sufficient: UH.
  - 20 cm x 20 cm sheets. 1st layer at CAL face, 2nd layer 10 cm away.

Schematic of PS CALs and its modules





CAL design

Alternating layers of X-oriented and Y-oriented scintillating fibers.

Fibers in each layer are grouped into 3x3 mm squares, and readout by a SiPM.

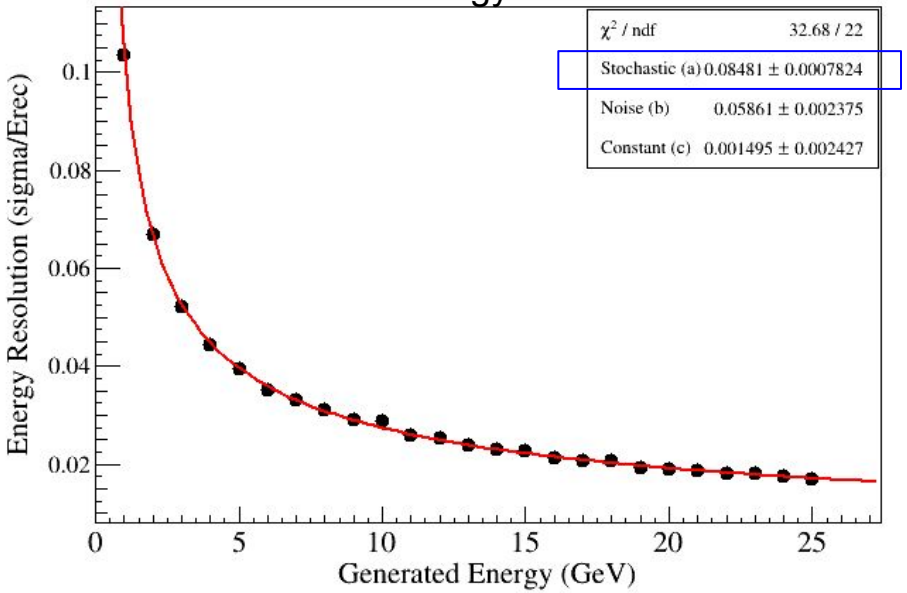
W-powder+epoxy fills the space between the fibers (similar to fECAL).

PS CALs

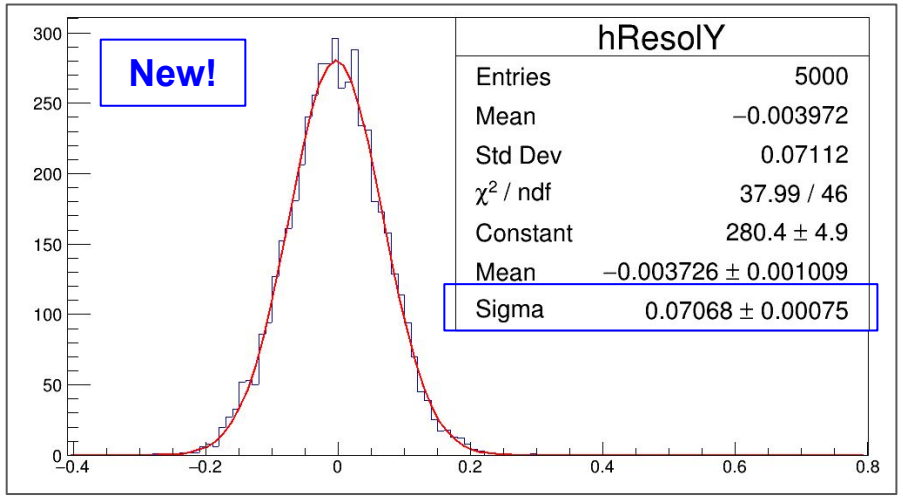
Performance metrics:

- δE/E ~ 9%/√E. Much better than the baseline ZEUS spectrometer CAL: 17%/√E.
- Position resolution ~ 0.7 mm

Energy Resolution



Position Resolution (zero degree electrons)



- X - X_{Gen} looks similar

Tracking planes (2 layers)

What information they provide:

- Precise photon transverse position measurements: X_γ and Y_γ
- Precise E measurement (~1%).
- Precisely known fiducial area.
- Online E calibration for PS CALs (angle of track related to E).