Estimates of Systematic Uncertainty for PSCAL at Early Stages of ePIC.

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ZEUS PSCAL systematics over the years

Table 3
Estimated systematic errors associated with the issues creating the largest effects

Cause	Uncertainty in luminosity
Vertical alignment and y_γ measurement	2.5%
Photon conversion rate	2%
Pile-up	0.5%
Deadtime measurement	0.5%
Theoretical Bethe–Heitler cross-section	0.5%
Dipole magnetic field	Small
Trigger threshold correction	Small
Total	3.5%

The systematic uncertainties estimated for the luminosity measurement in the photon calorimeter and the spectrometer for electron and positron beams. All values in %.

Source of systematics	Photon calorimeter	Spectrometer	
		2005/2006 e^{-p}	2006/2007 e^{+p}
Common systematics	1.6	1.6	1.5
Photon conversion		0.7	0.7
In the beam exit window			
Rms-cut correction		0.5	
Pedestal shifts	1.5		
Photon rate			0.6
Pile-up	0.5		
Sum	2.2	1.8	1.8

Early stages of ZEUS [published 2006]

By the end of ZEUS [published 2014]

50% Improvement after 8 year

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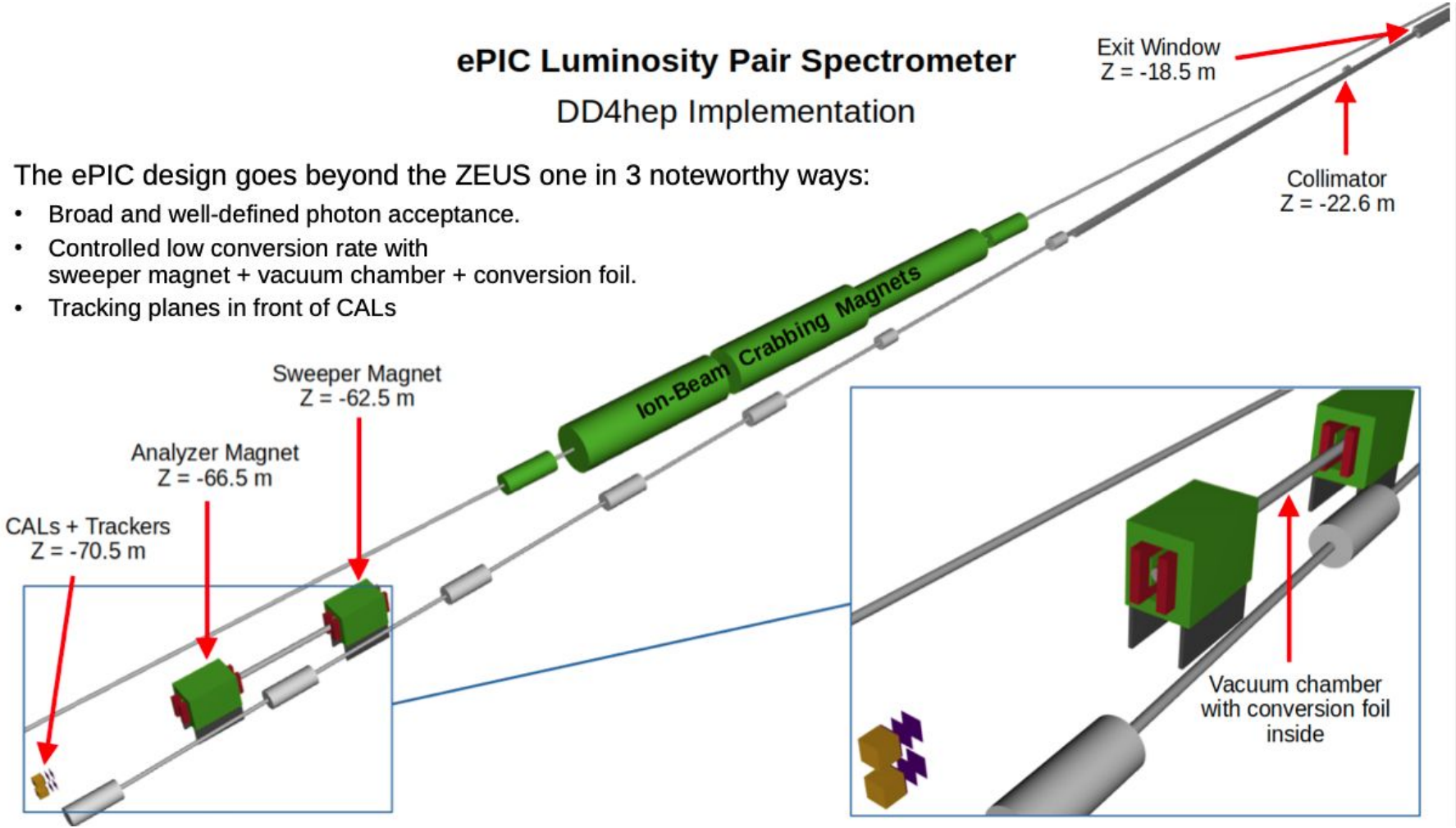
ePIC Luminosity Pair Spectrometer

DD4hep Implementation

The ePIC design goes beyond the ZEUS one in 3 noteworthy ways:

- Broad and well-defined photon acceptance.
- Controlled low conversion rate with
  sweeper magnet + vacuum chamber + conversion foil.
- Tracking planes in front of CALs



ZEUS vs ePIC at early stages

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Early stages of ZEUS [published 2006]

- Shape of the aperture and its alignment relative to the detectors [measurement with an accuracy of 1 mm.]
- 5 x LumiBeam Divergence obstruction free.
- Effect of gain drifts in calorimeter, cause shift in y_γ of 2 mm. [Effect by radiation damage to CAL WLS]
- 2 Trackers System with pos resol. of 0.1 mm.
- WScFi CAL with 0.7 mm pos and 9% /√E energy resolution.
- Real time CAL calibration with low-Q^2 tagger.
- Better CAL shielding.

Produces overall uncertainty on acceptance 2.5%
Reduces the uncertainty to 0.5-1%

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Total	3.5%

Early stages of ZEUS [published 2006]

- Uncertainties on x-section from conversion at exit window (EW), its thickness and its material
  [Al 85%, Si 11%, Cu 3% , …].
- Pure Diamond [C 99%],
- Well studied xsection for pair conversions.
- Removing these conversion using Sweeper Magnet

Produces overall uncertainty on acceptance of 2.0%
Reduces uncertainty to 0.5-1 %

ZEUS vs ePIC at early stages

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Deadtime measurement	0.5%
Theoretical Bethe–Heitler cross-section	0.5%
Dipole magnetic field	Small
Trigger threshold correction	Small
Total	3.5%

Early stages of ZEUS [published 2006]

- Uncertainties due to multiple conversion at thick exit window.
- Use of 1 mm thin converter, reduces the pile up to max 2 hits at CAL.

Produces overall uncertainty of 0.5 %
Reduces the uncertainty to 0 - 0.2%

Systematic Uncertainty of ePIC at early stages

Cause	Uncertainty in luminosity
Vertical alignment and y_γ measurement	0.5 – 1.0 %
Photon conversion rate	0.5 – 1.0 %
Pile-up	0.0 – 0.2 %
Deadtime measurement	0.5 % **[kept same as ZEUS]**
Theoretical Bethe–Heitler cross-section	0.5 % **[kept same as ZEUS]**
Total (quadratic sum)	**1.0 – 1.6 %**

At Early stage : ZEUS 3.5% & ePIC 1.0 -1.6%