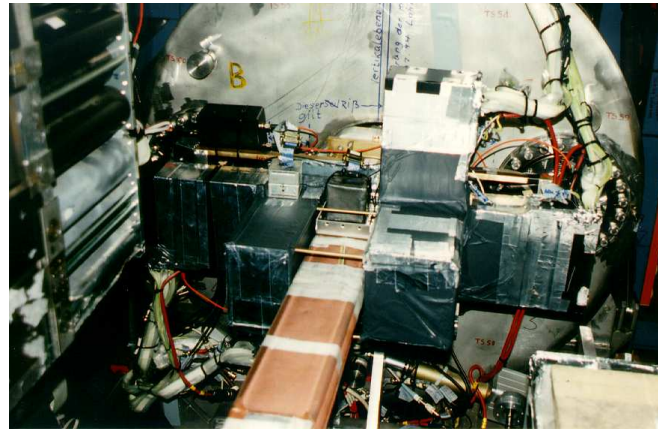


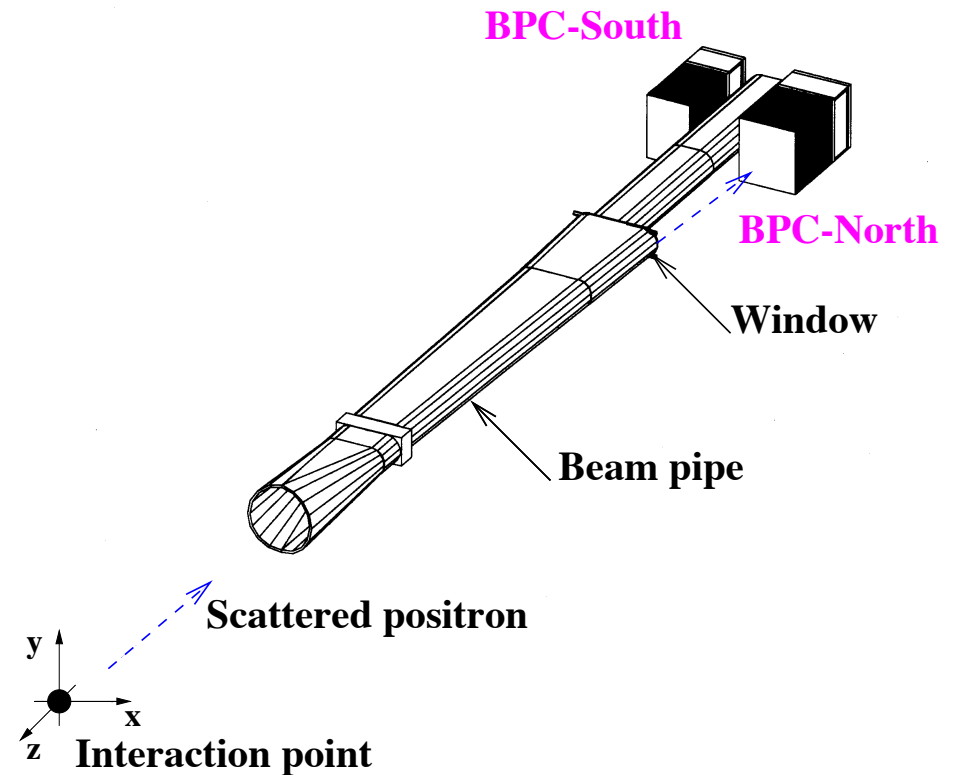
Initial thoughts Low- Q^2 tagger for EIC based on the ZEUS Beam Pipe Calorimeter (BPC)

Bernd Surov
(surov@temple.edu)



Outline

- Layout ZEUS BPC
- Highlights ZEUS BPC Physics Program
- Requirements ZEUS BPC
- Design ZEUS BPC
- Performance / Operation ZEUS BPC
- Summary / Outlook

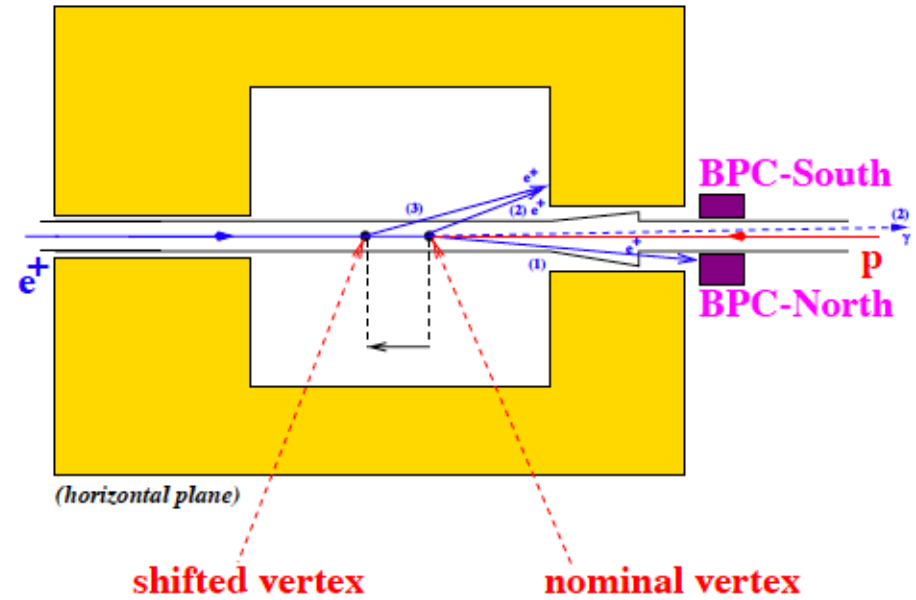
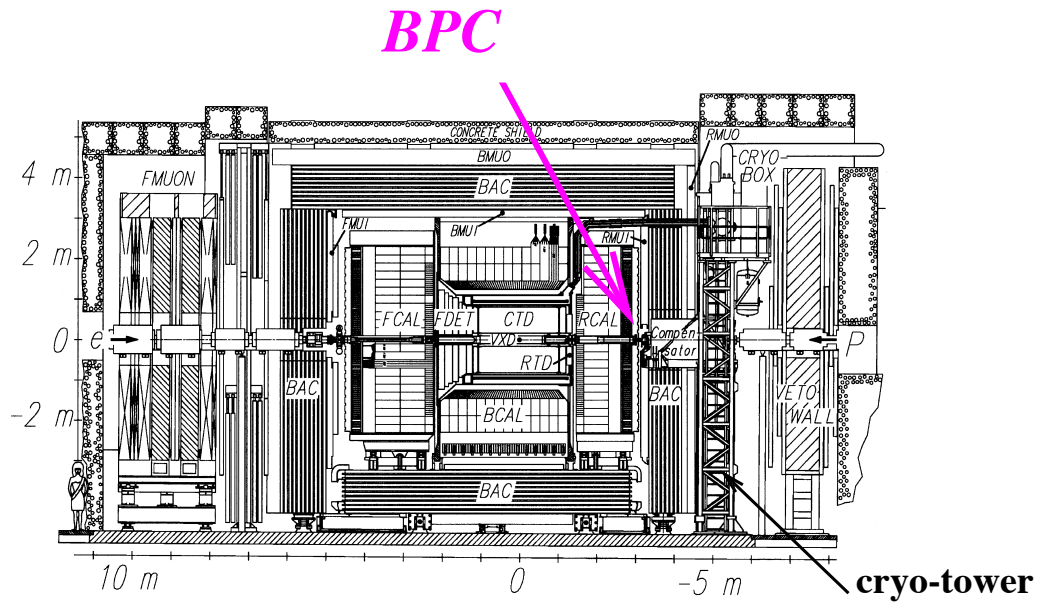


Reference: Bernd Surrow, Measurement of the proton structure function F_2 at low Q^2 and very low x with the ZEUS beam pipe calorimeter at HERA, *Eur. Phys. J. direct* 1 (1999) no.1, 2.

<https://www.dropbox.com/s/qou19qufz7jpjrw/surrow.pdf?dl=0>

Layout of ZEUS BPC

Location within ZEUS

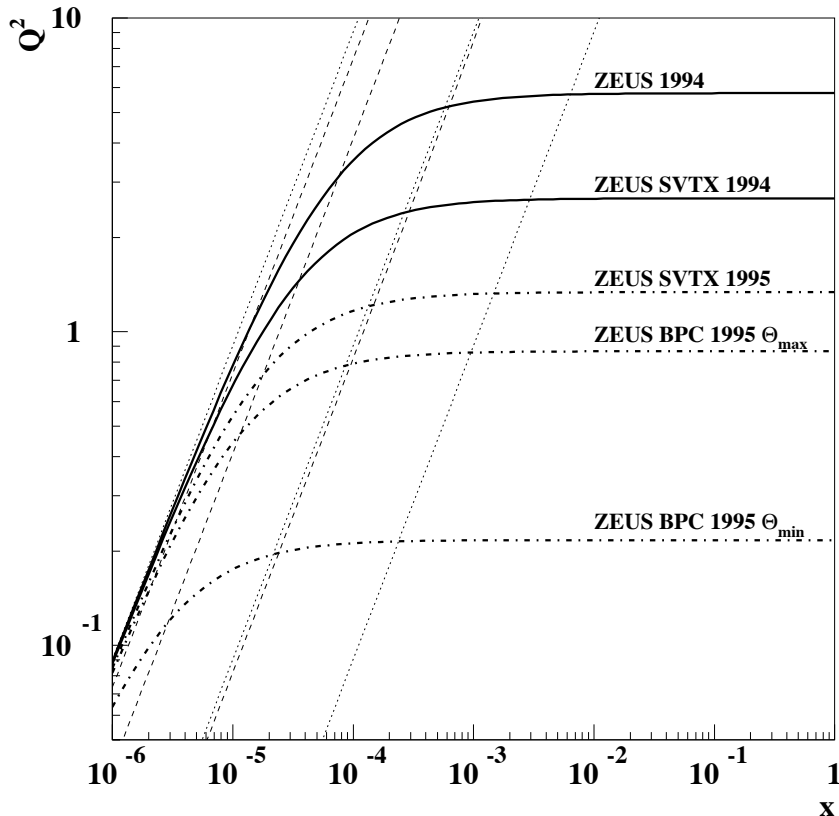




Layout of ZEUS BPC

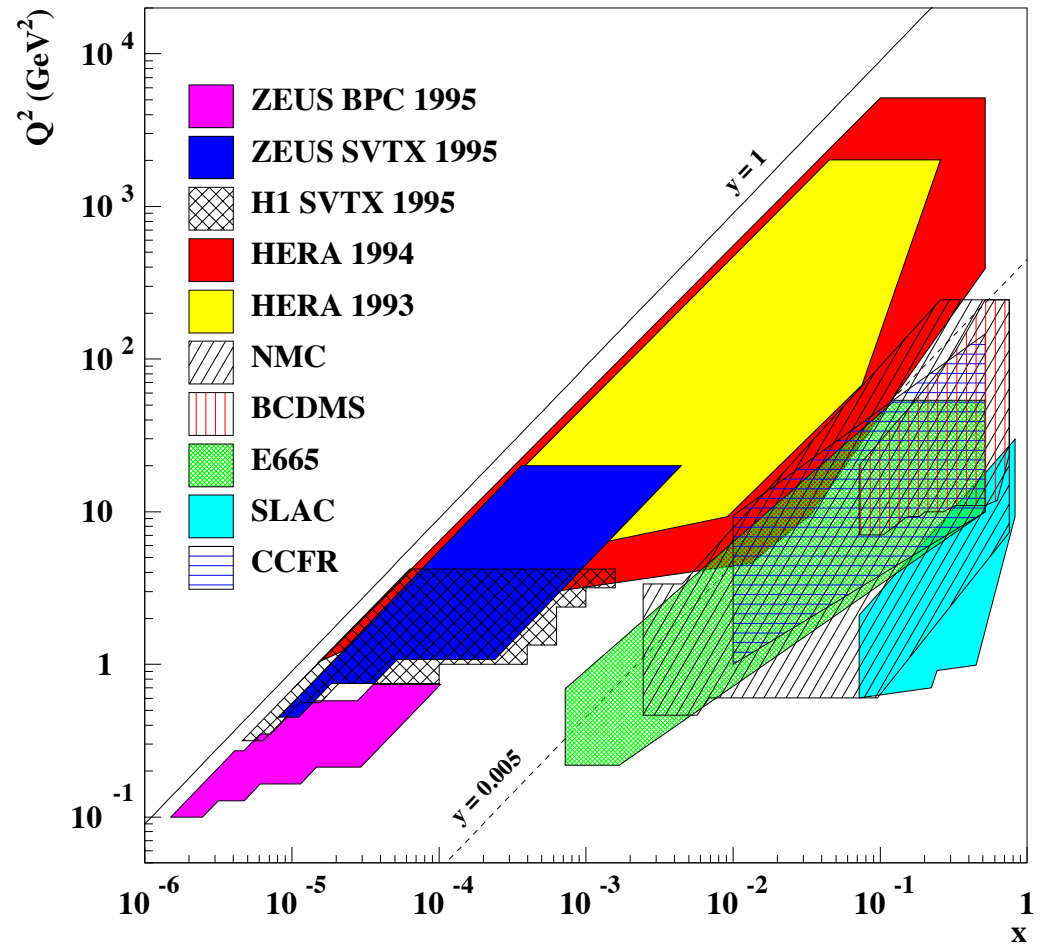
□ Kinematic coverage

$$\vartheta'_e = \pi - \theta'_e$$



$$Q^2 = 4E_e E'_e \sin^2 \left(\frac{\vartheta'_e}{2} \right) \simeq E_e E'_e \vartheta_e'^2$$

~30mrad

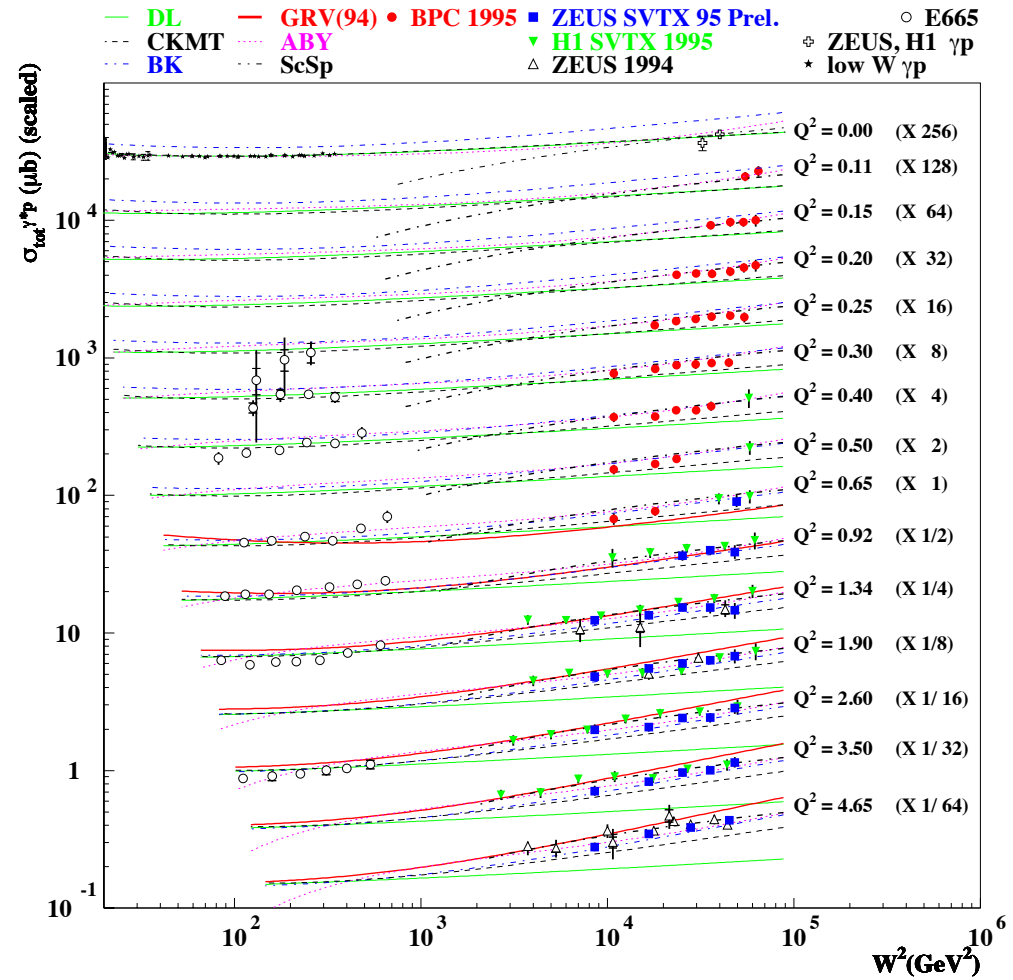
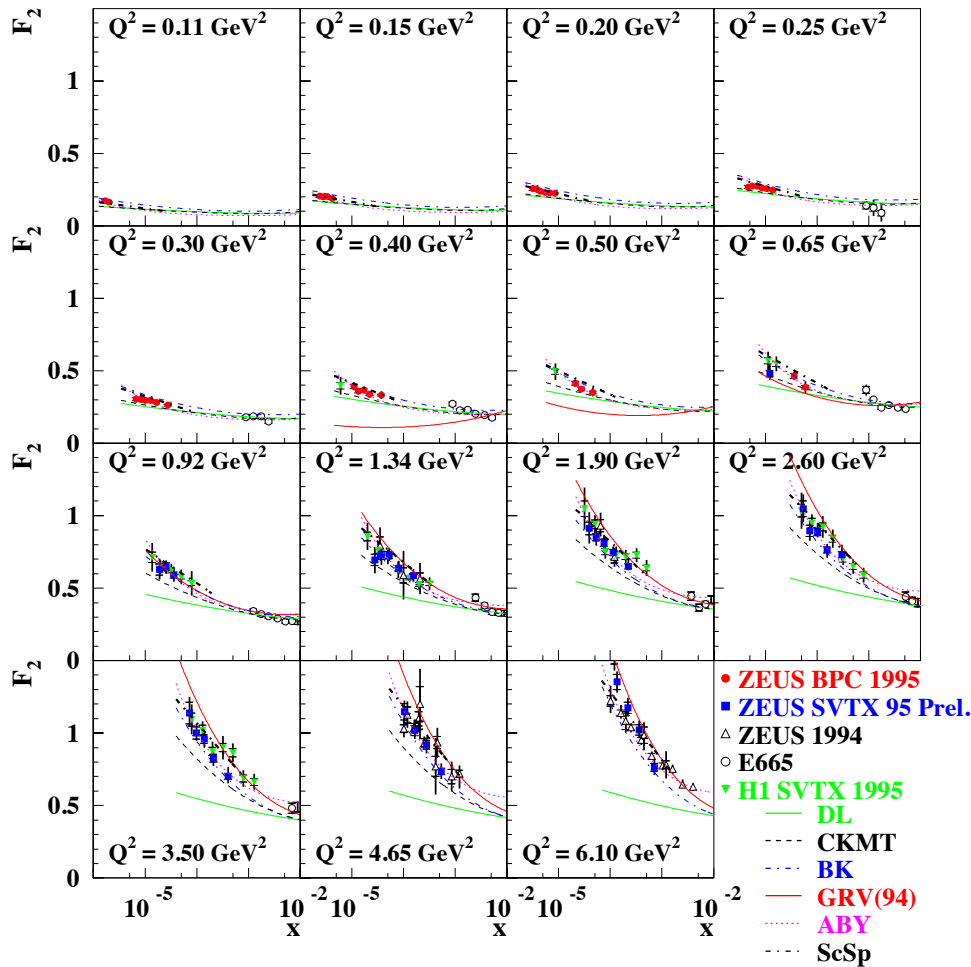


~17mrad



Highlights ZEUS BPC Physics Program

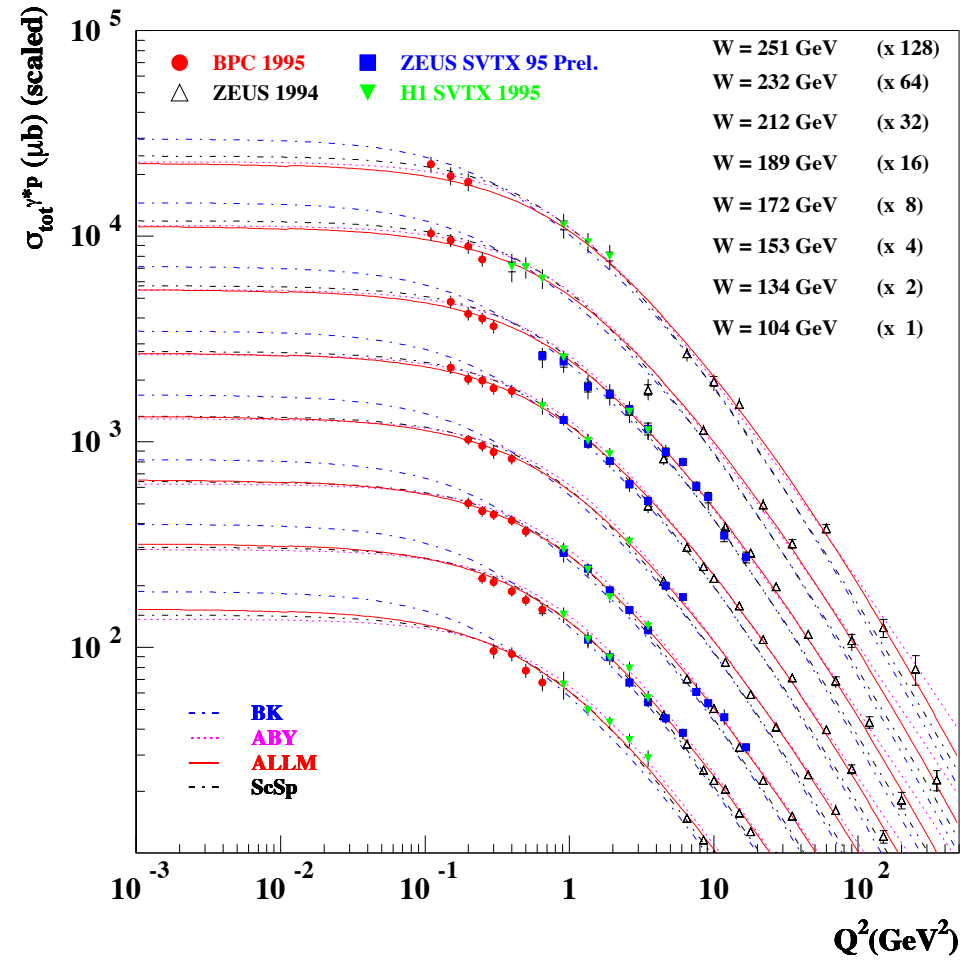
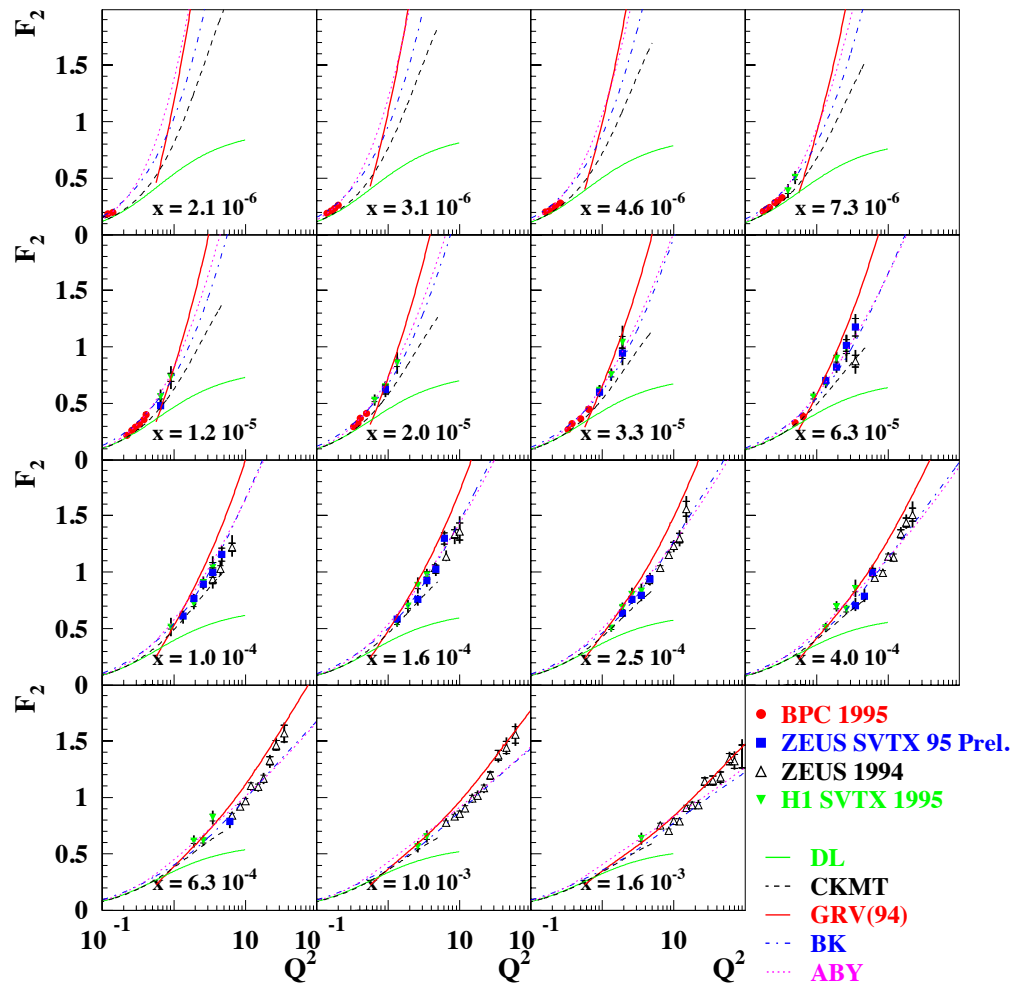
□ F_2 / γ^*p cross-section at low Q^2 and very low x : x / W dependence





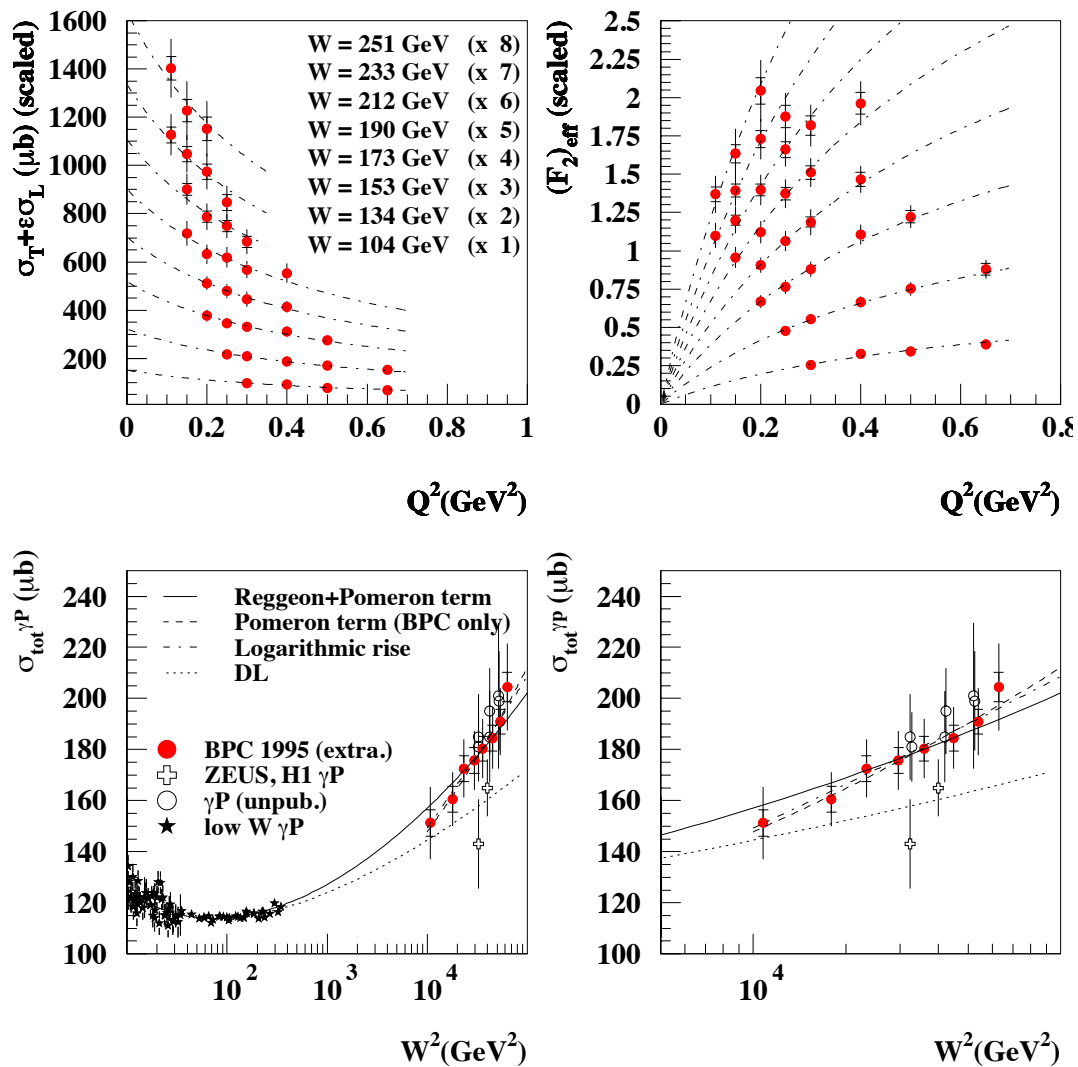
Highlights ZEUS BPC Physics Program

□ F_2 / γ^*p cross-section at low Q^2 and very low x : Q^2 dependence



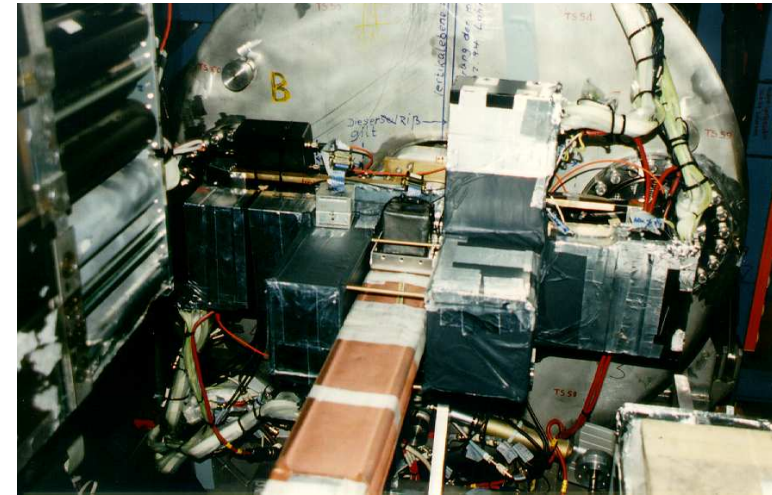
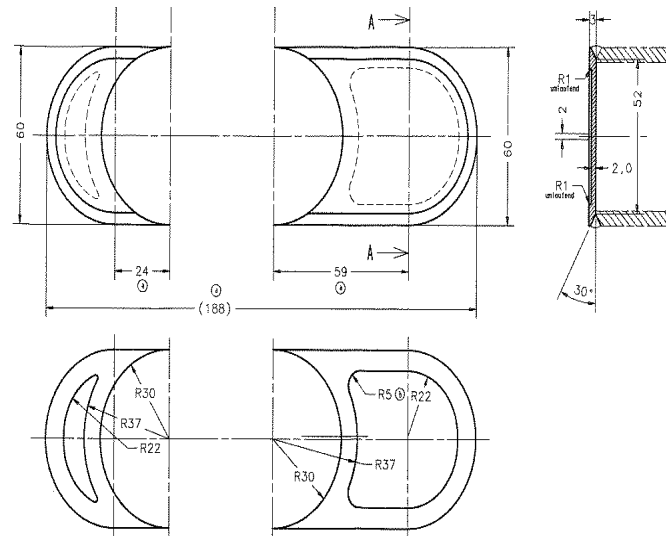
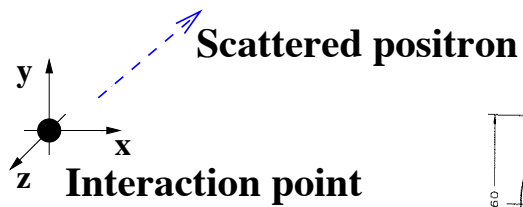
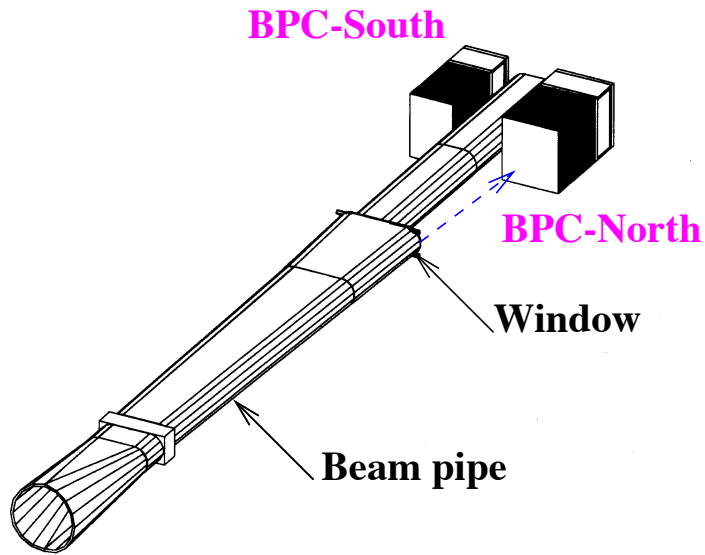
Highlights ZEUS BPC Physics Program

□ Total cross-section



Design ZEUS BPC

Layout

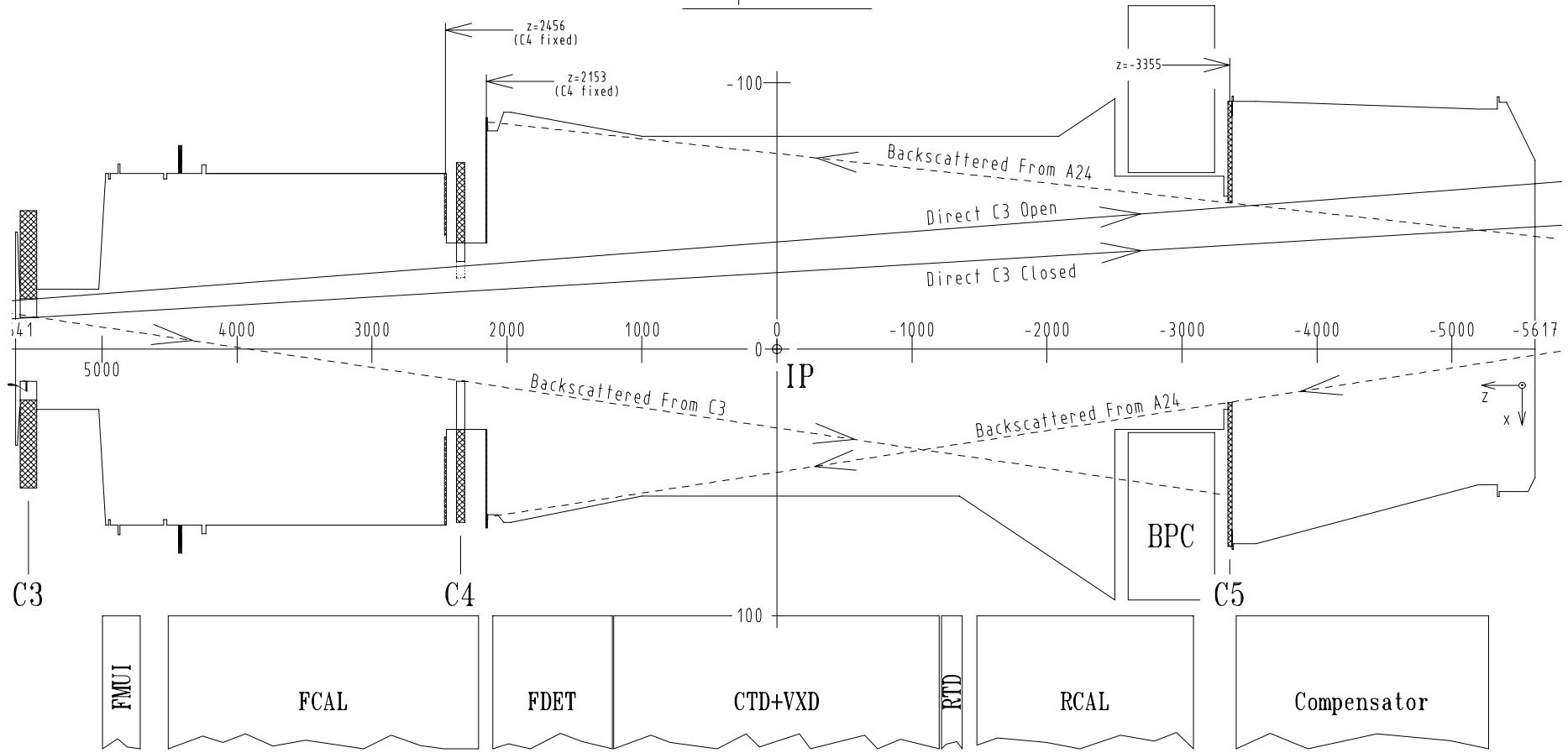




Design ZEUS BPC

□ Beamline

Top View



Requirements ZEUS BPC

□ Energy and position resolution:

- Energy: Energy resolution at the level of $15\%/\sqrt{E}$ or better
- Position: 1mm or better

BPC specification	BPC performance	reference
Depth	$\simeq 24 X_0$	5.2 and 5.4.2
Molière radius	$\simeq 13$ mm	5.2
Energy resolution	$17\%/\sqrt{E}$ (stochastic term)	8.5.4
Energy scale calibration	$\pm 0.5\%$	8.5.3
Energy uniformity	$\pm 0.5\%$	8.5.3
Linearity	$\leq 1\%$	8.5.4
Position resolution	< 1 mm	8.3.3
Intrinsic position bias	< 1 mm	8.3.3
Alignment accuracy	± 0.5 mm	5.8 and 8.3.4
Time resolution	< 1 ns	8.6

□ Longitudinal and transverse dimensions:

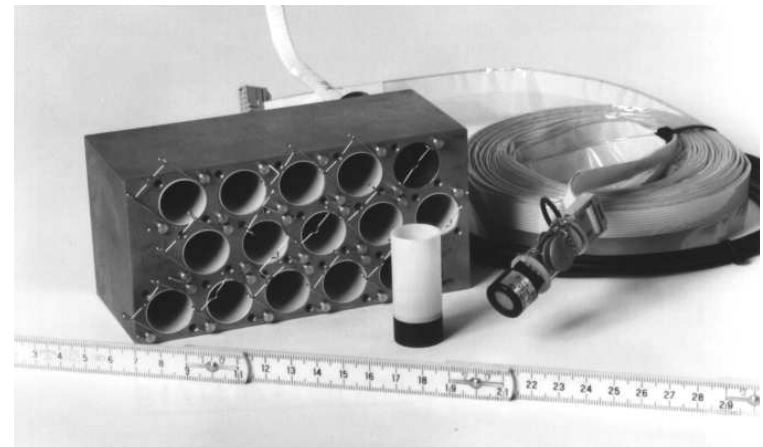
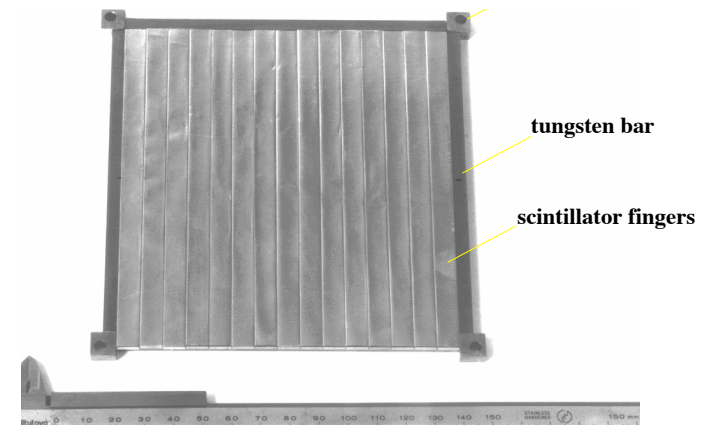
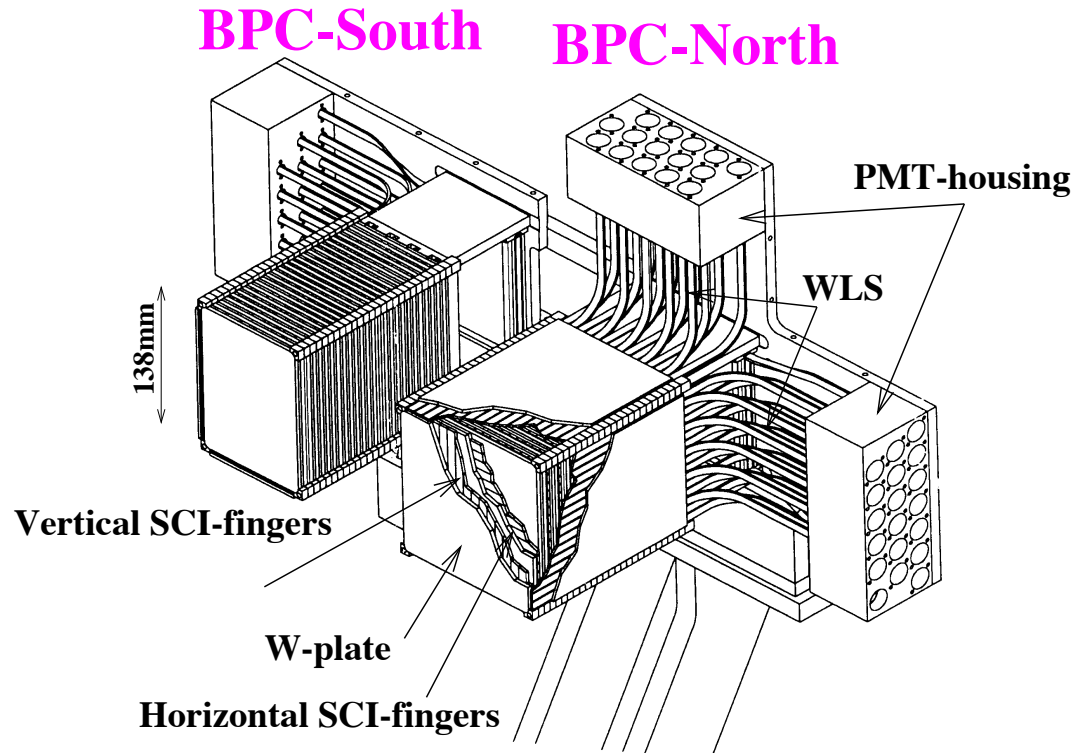
- Longitudinal: Contain 27GeV e^-/e^+
- Transverse: Small Molière radius / Compact - e.g. tungsten-type material

□ Energy scale calibration: Better than 1%

□ Detector alignment: Better than 1mm

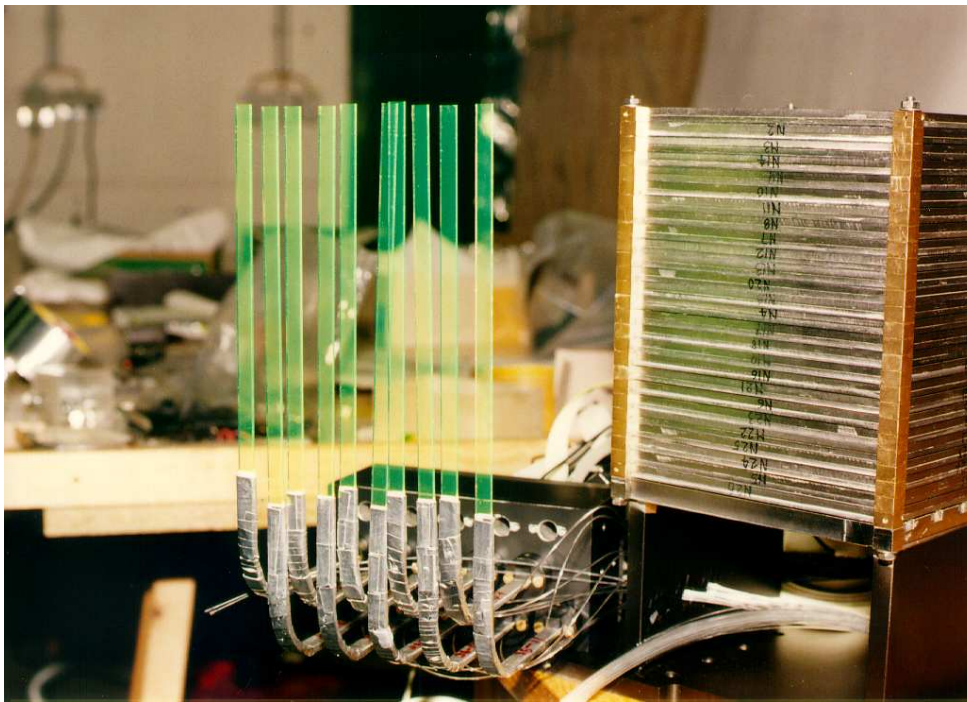
Design ZEUS BPC

Calorimeter design (1)



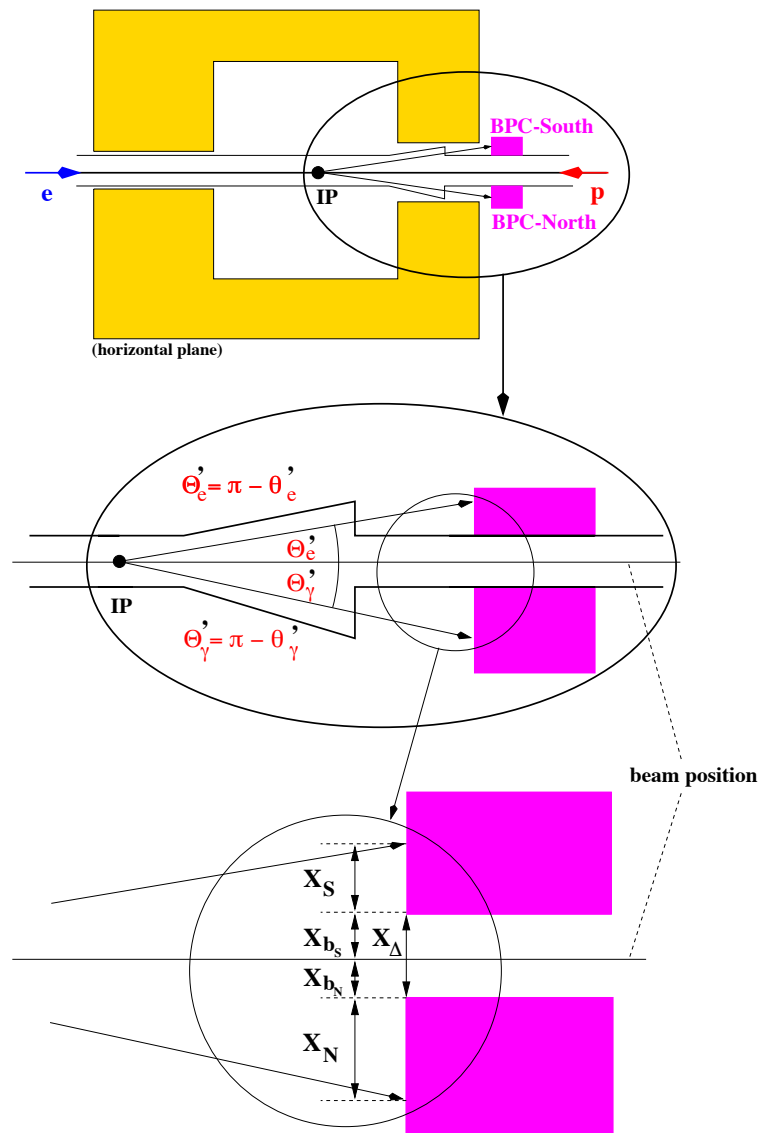
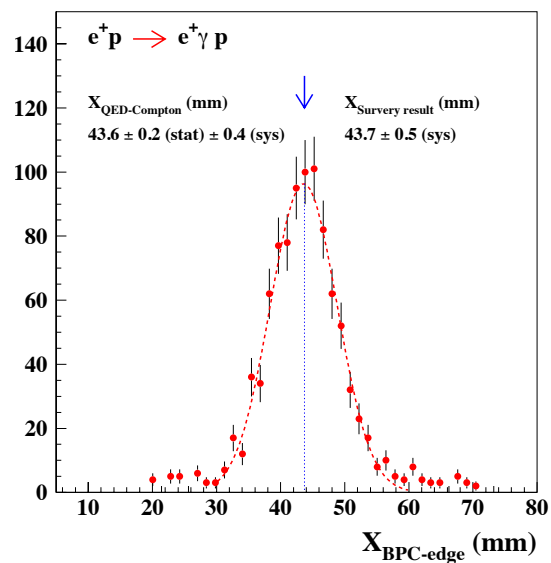
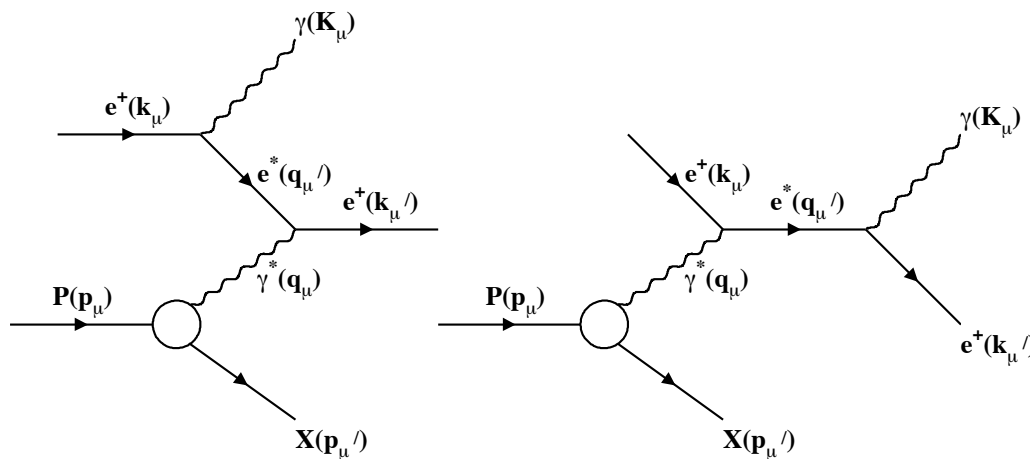
Design ZEUS BPC

□ Calorimeter design (2)



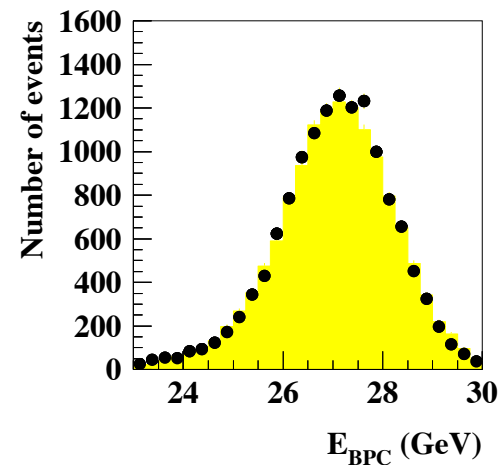
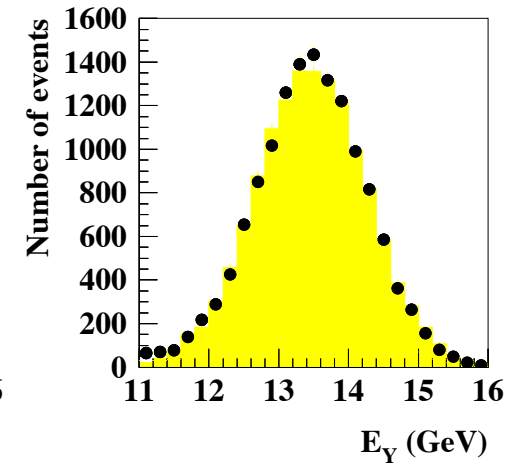
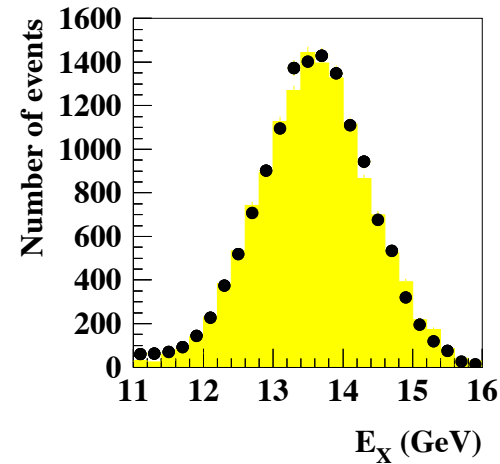
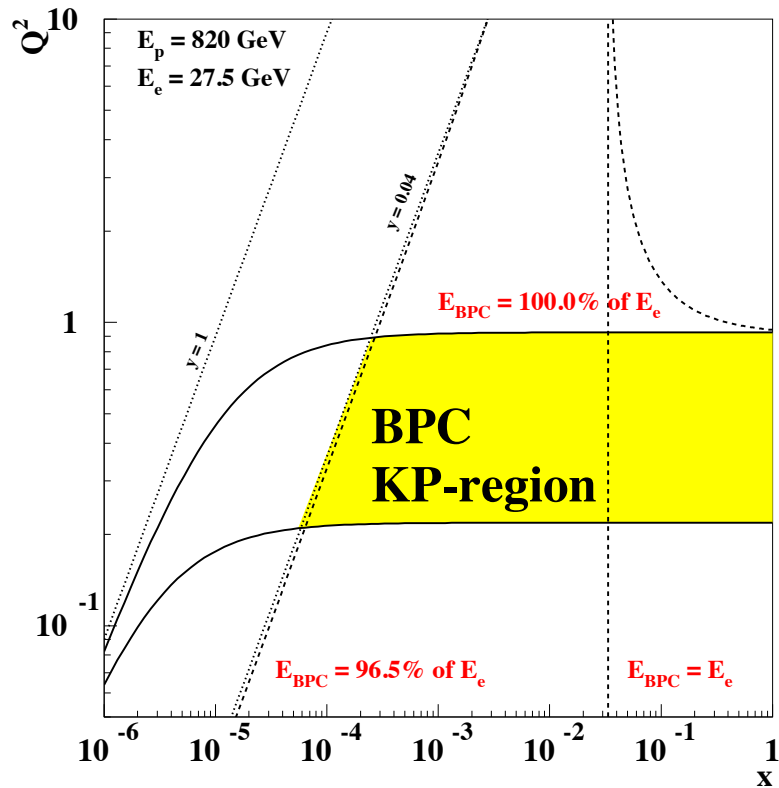
Performance and Operation ZEUS BPC

Alignment



Performance and Operation ZEUS BPC

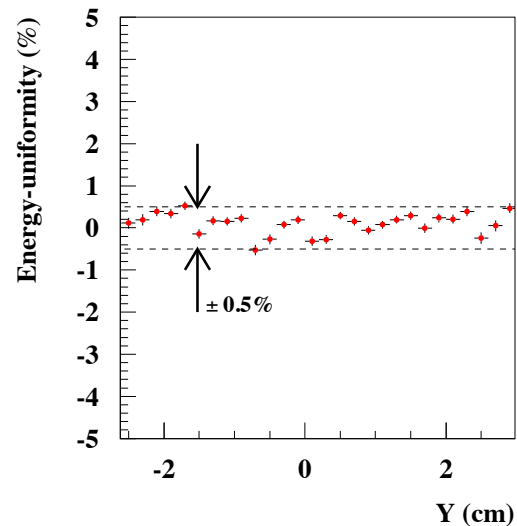
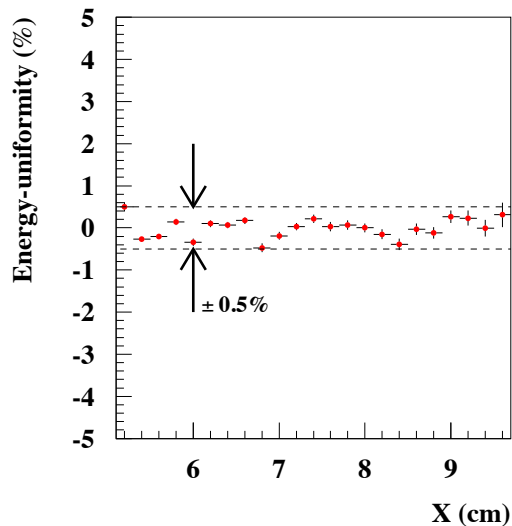
- Energy measurement: Kinematic peak



● BPC 1995
 ■ MC

Performance and Operation ZEUS BPC

□ Energy scale / Uniformity

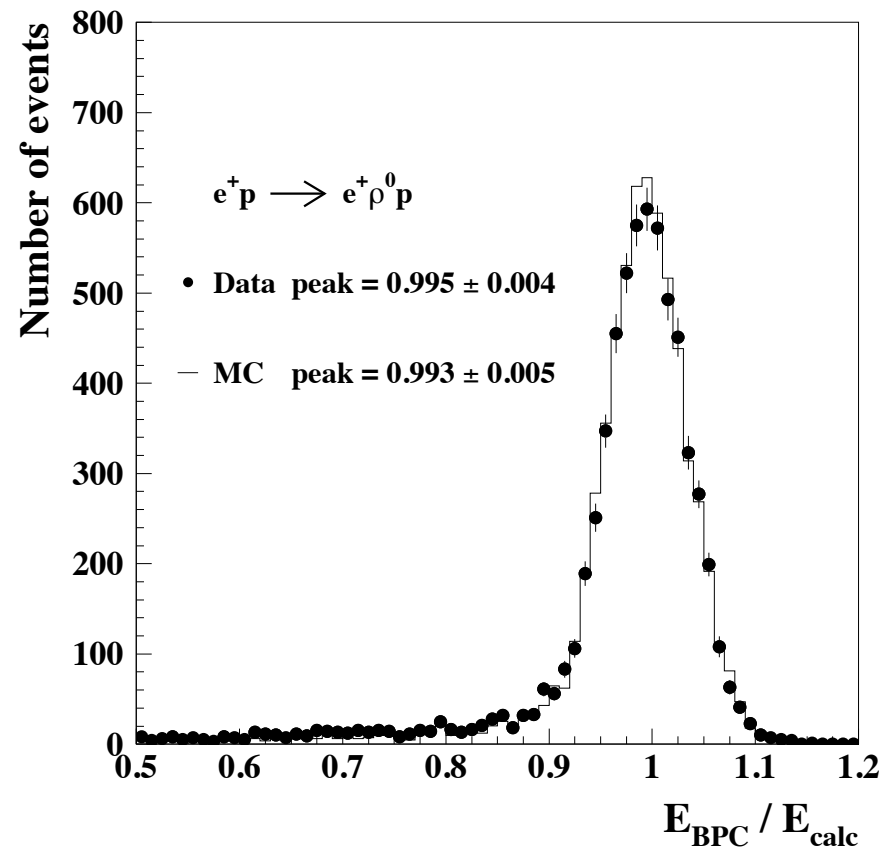
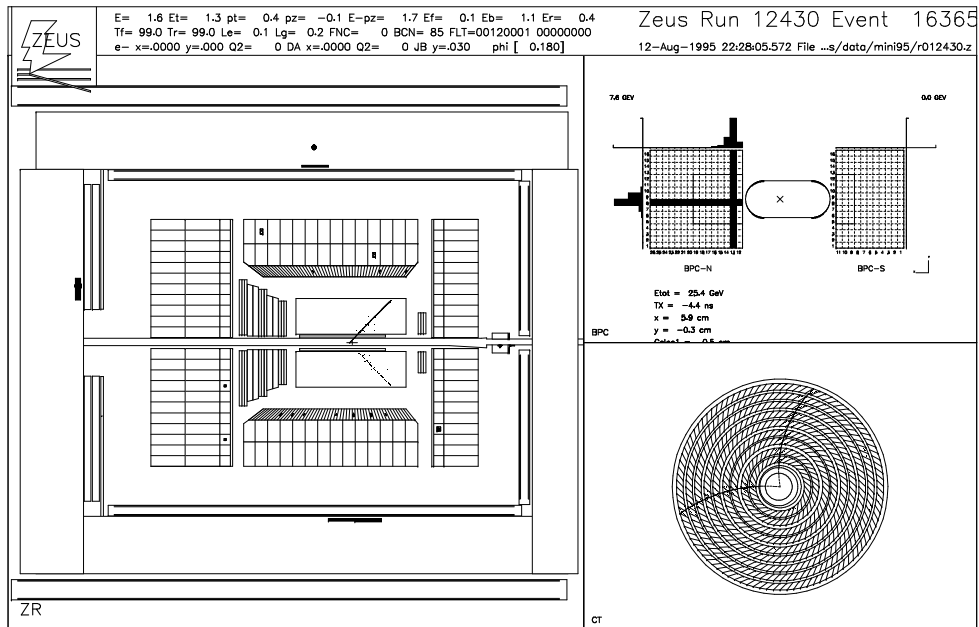


RMS=0.33

								Y12
	0.0	0.4	0.4	0.2	-0.1			Y11
	-0.5	-0.1	-0.0	0.3	0.5			Y10
	-0.7	-0.3	0.2	0.5	0.2			Y9
	-0.3	-0.2	-0.2	0.3	0.1			Y8
	0.2	0.0	-0.1	-0.1	-0.2			Y7
	0.5	0.4	-0.2	-0.7	-0.4			Y6
								Y5
X1	X2	X3	X4	X5	X6	X7	X8	

Performance and Operation ZEUS BPC

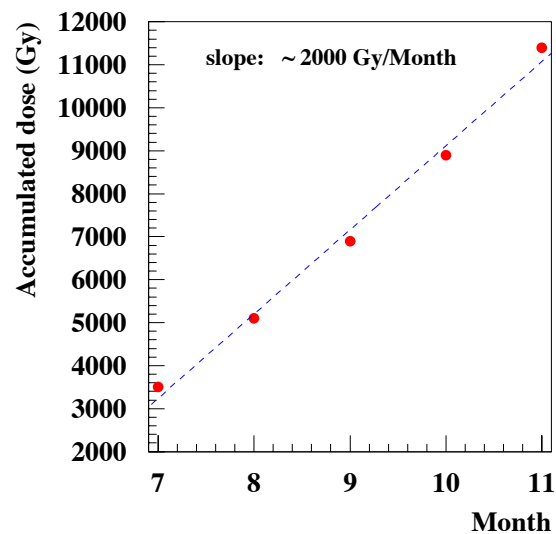
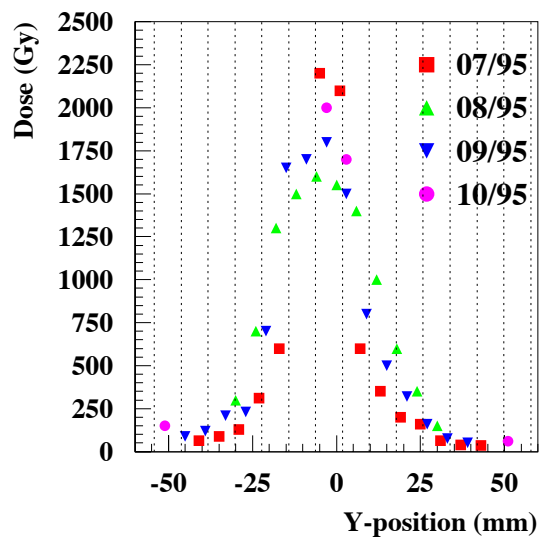
□ Energy-scale cross-check





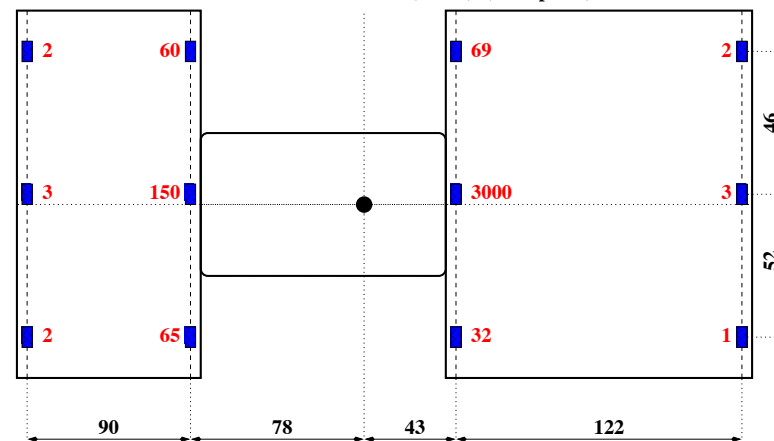
Performance and Operation ZEUS BPC

□ Radiation damage



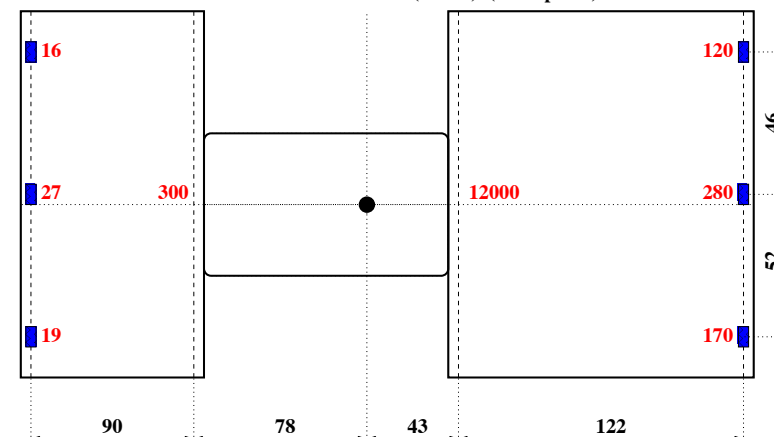
Dose measurements (in Gy)

Period: 06.06.1995-18.12.1995 (North) (back plane)
Period: 20.03.1995-18.12.1995 (South) (back plane)



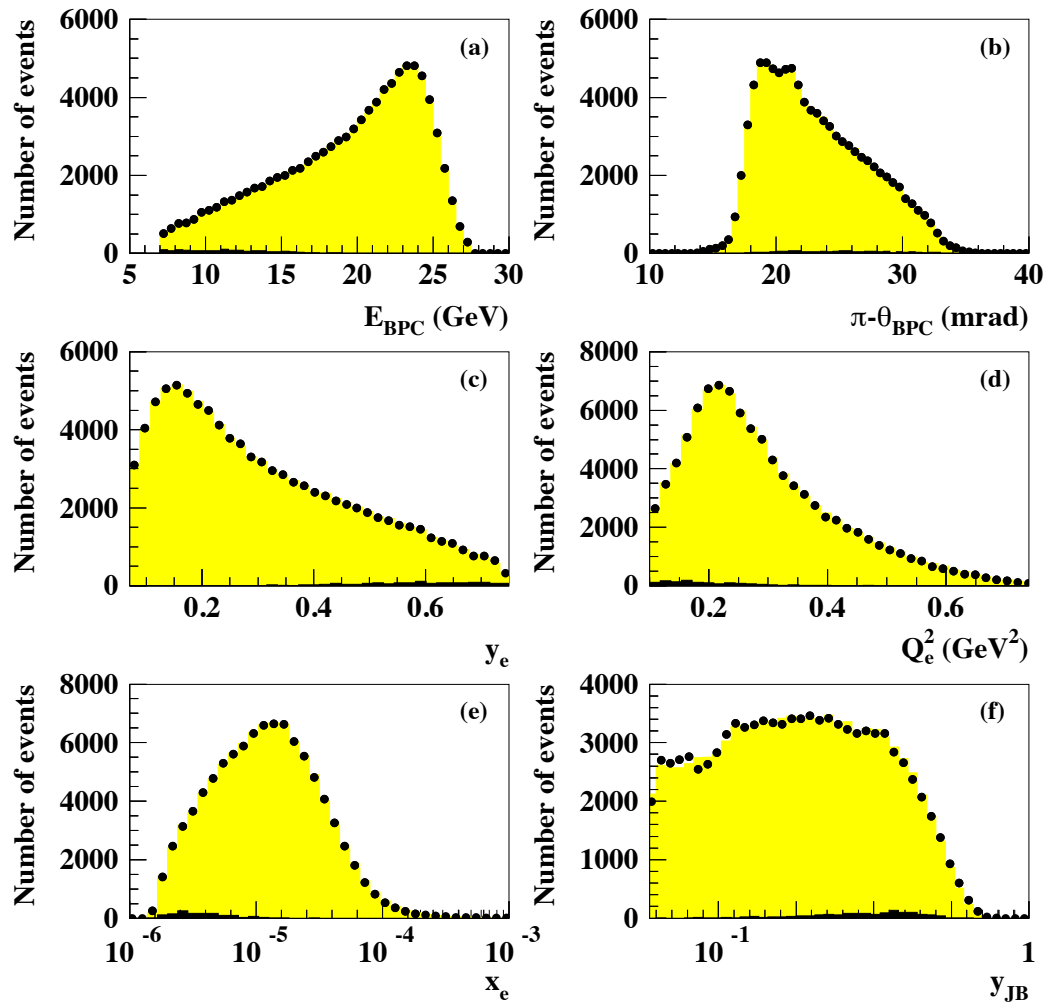
Dose measurements (in Gy)

Period: 20.03.1995-18.12.1995 (South) (front plane)
Period: 06.06.1995-18.12.1995 (North) (front plane)



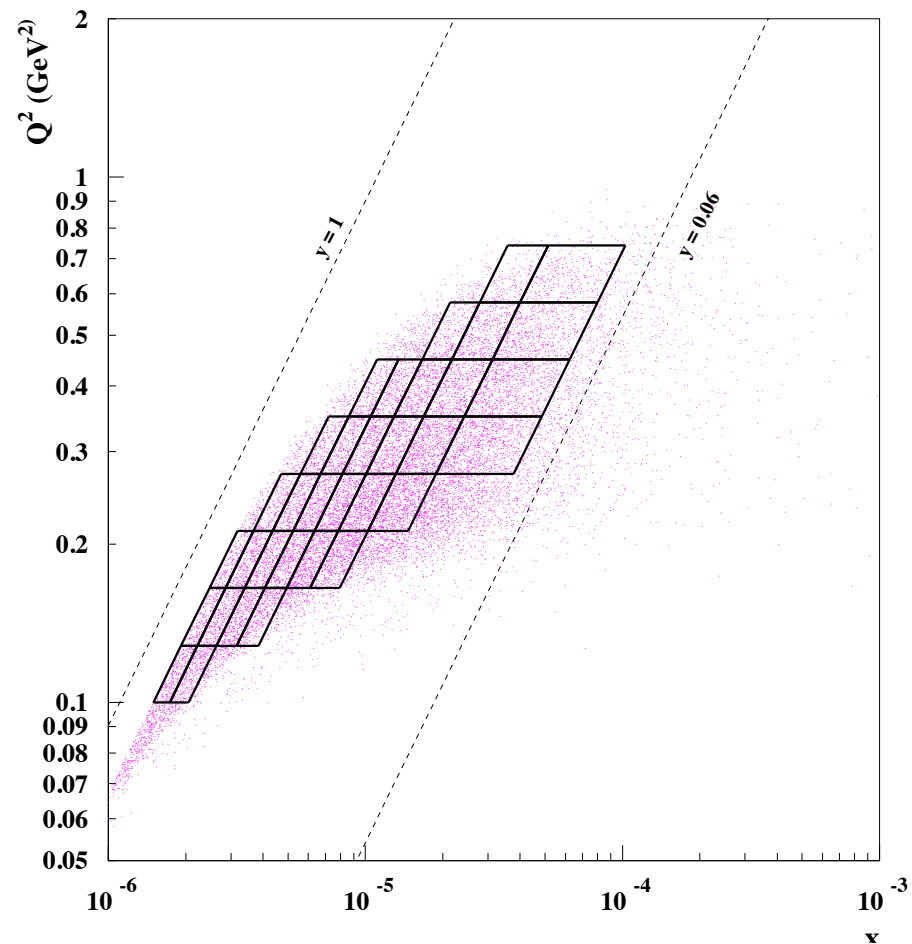
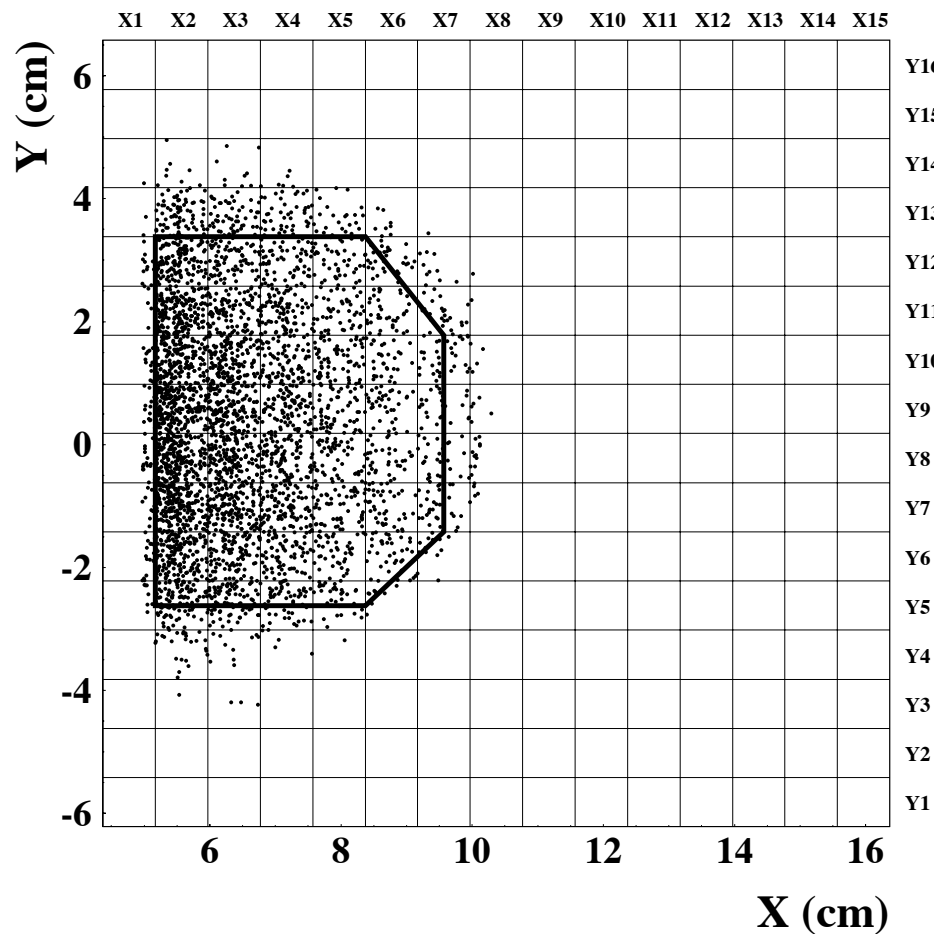
Performance and Operation ZEUS BPC

□ Kinematic variables



Performance and Operation ZEUS BPC

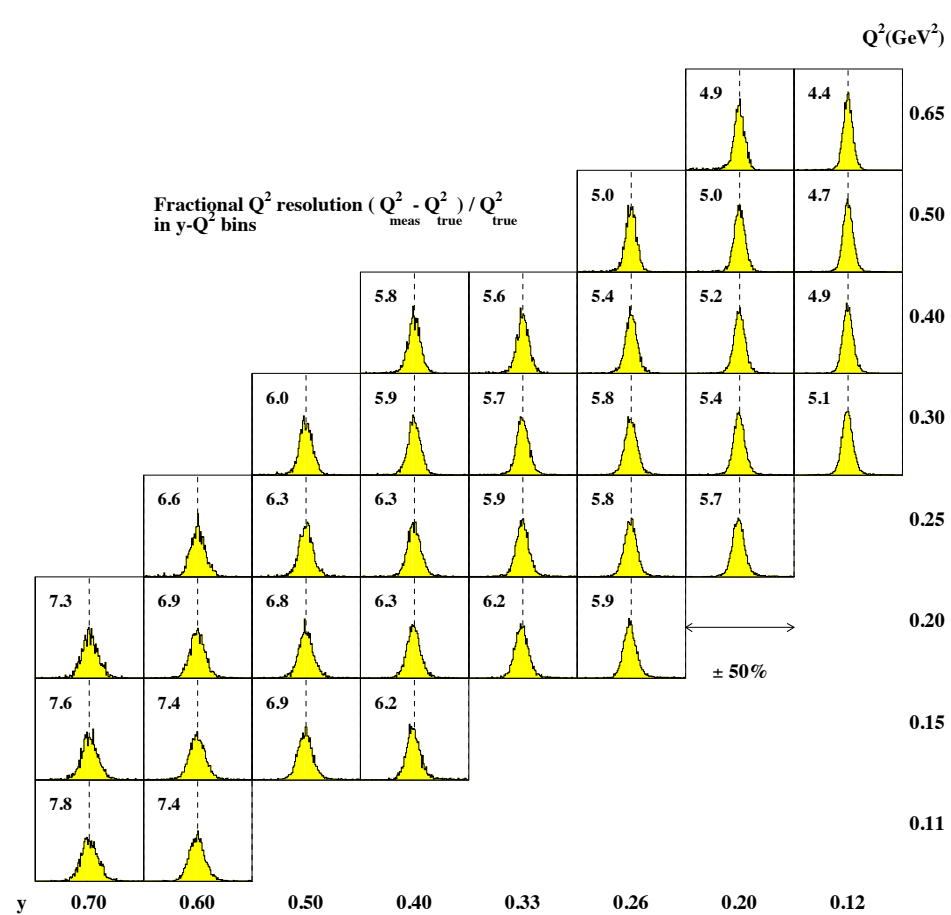
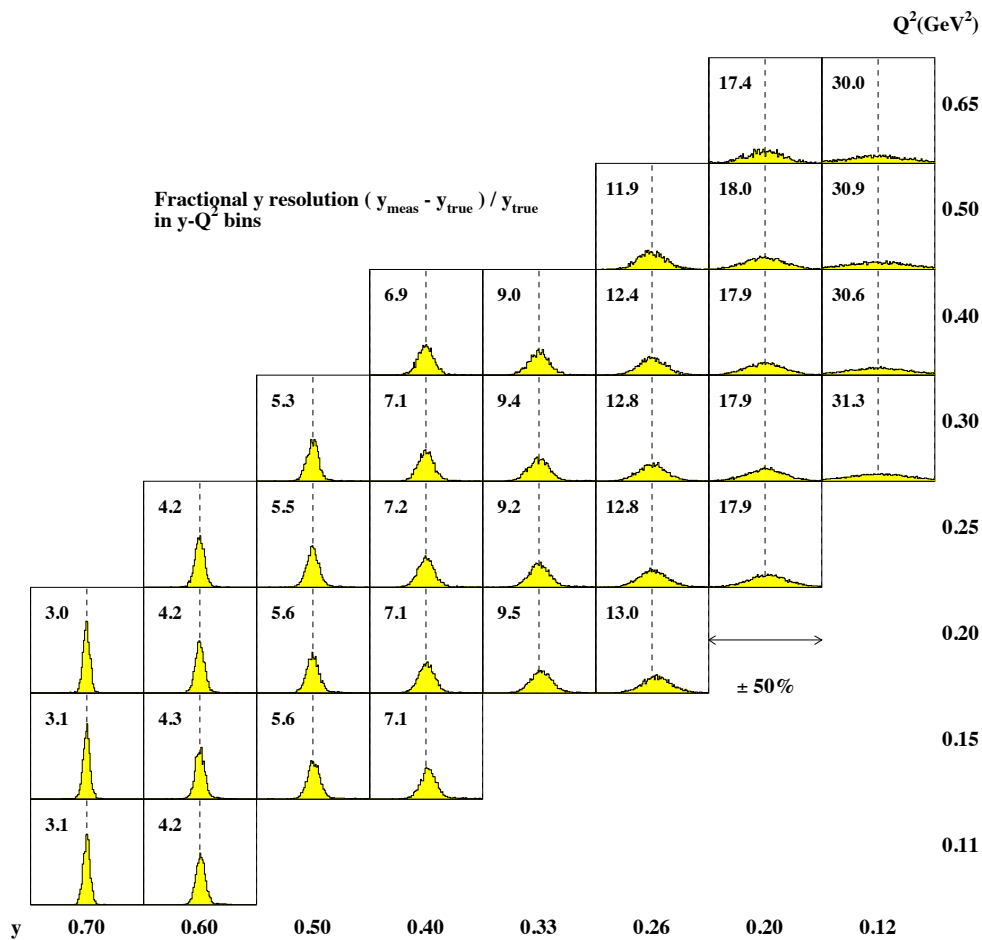
□ Fiducial volume / Kinematic coverage





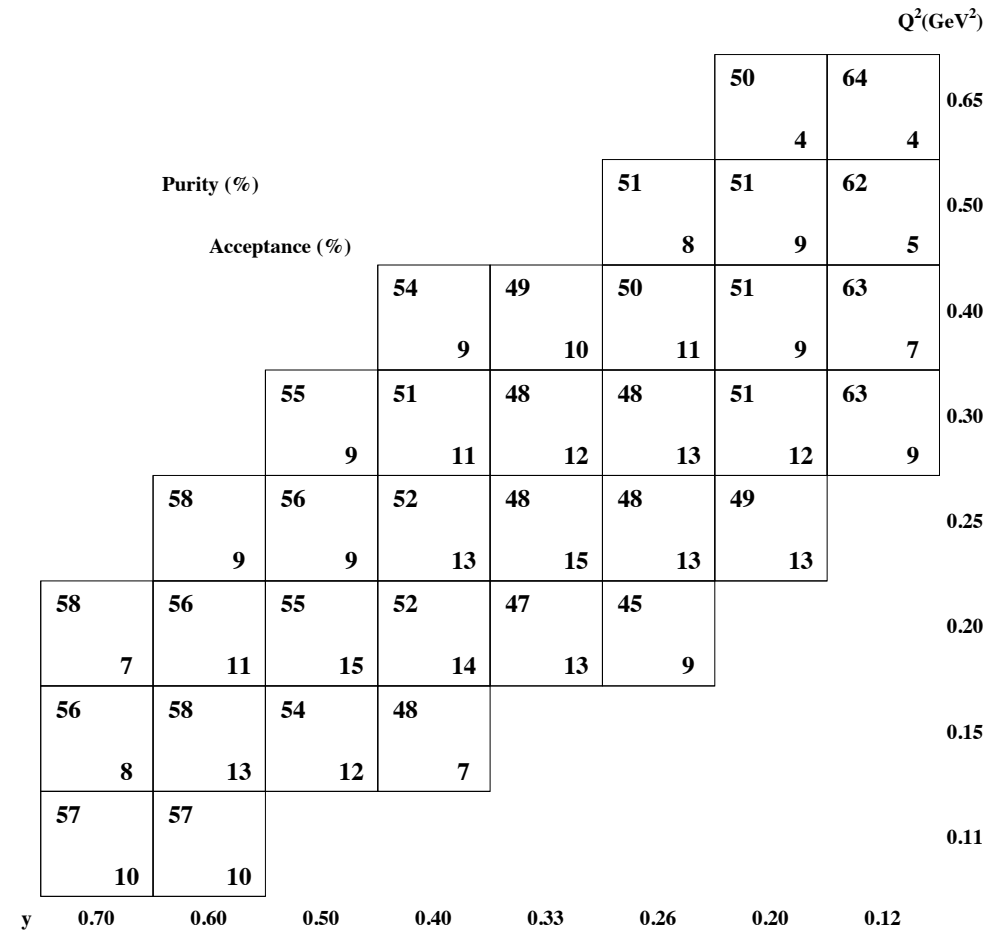
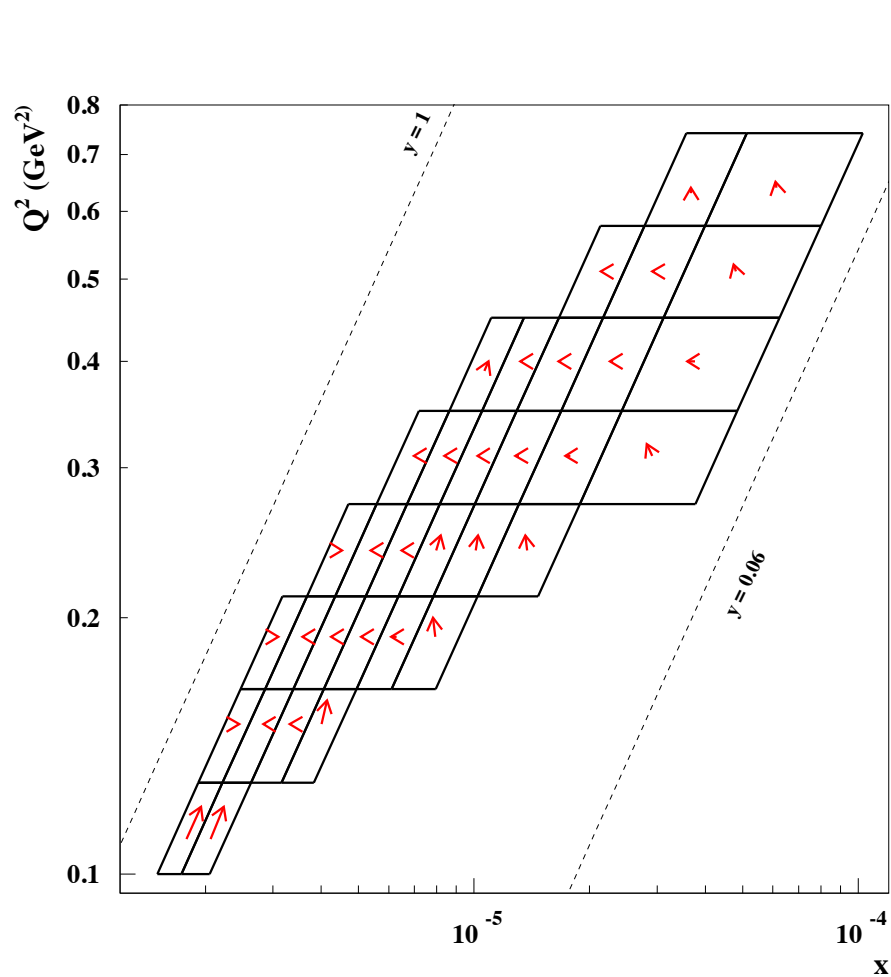
Performance and Operation ZEUS BPC

□ γ - Q^2 resolution



Performance and Operation ZEUS BPC

Bin migration



Summary and Outlook

- Strong interest to participate in low- Q^2 tagger design studies profiting from extensive ZEUS experience
- Possible contributions concerning design work: EIC Low- Q^2 tagger
 - Kinematic variable analytical studies / Essentially completed concerning resolution requirements (Bernd Surrow / Seamus Gallagher)
 - Acceptance studies for current machine and beam pipe layout
 - Help with implementation of beam line / machine elements and low- Q^2 tagger design into GEANT4 (Nick Luckow / Bernd Surrow)
 - Upgrade of ZEUS BPC / Monitoring tools / General comments
 - Position: Silicon strip tracker telescope- Realized
 - Energy: PbWO₄ calorimeter - Never installed
 - Radiation monitoring tools (Active / Passive)
 - Superb alignment and in-situ alignment as cross-check
 - Source / LED etc. monitoring tools
 - Strong technical support / Careful about dead material besides beam-pipe window
 - Explore implementation of silicon-strip / PbWO₄ calorimeter as an option for a low- Q^2 tagger (Nick Luckow / Bernd Surrow)

