Coincidence Parity Experiment

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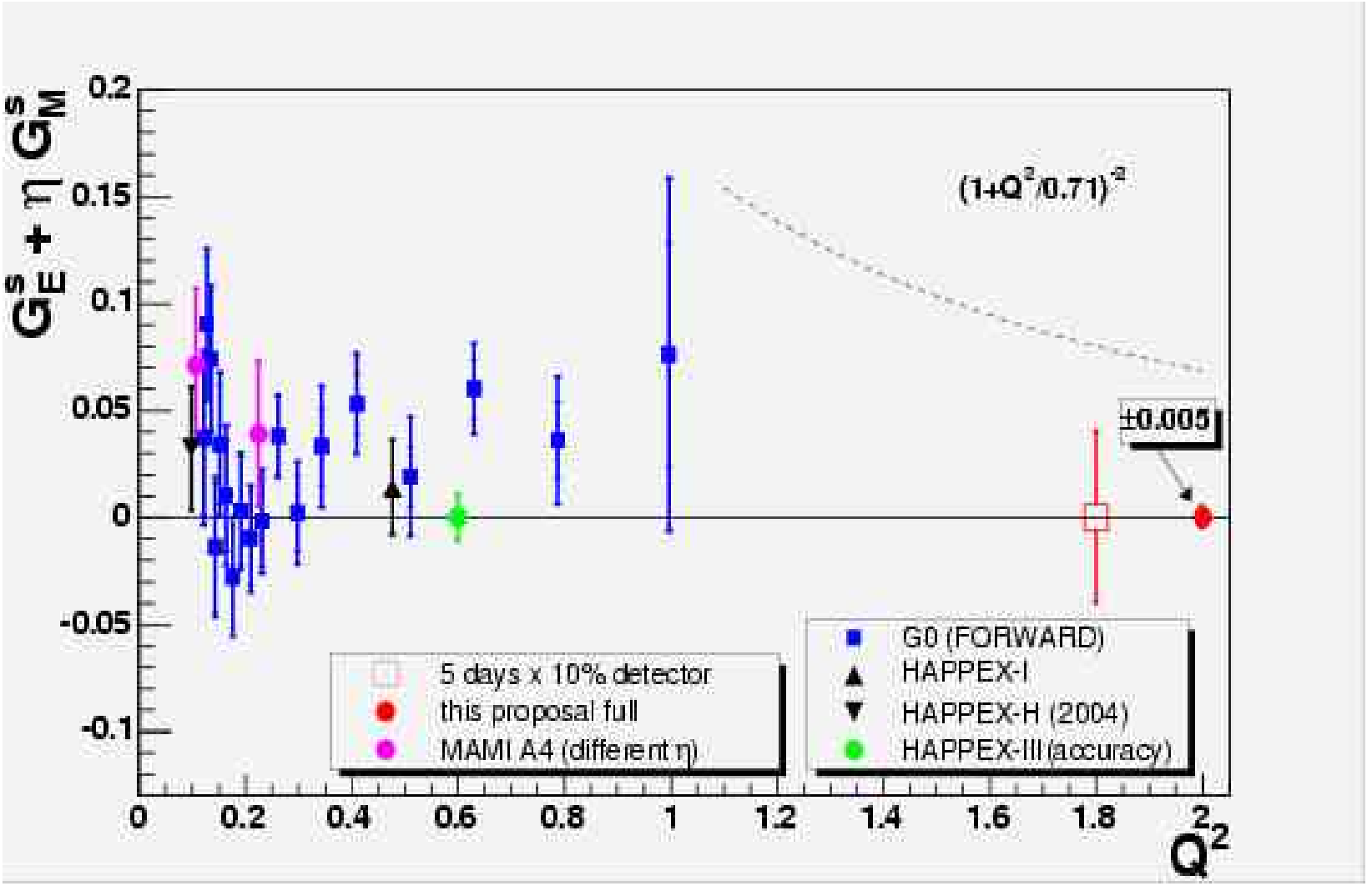
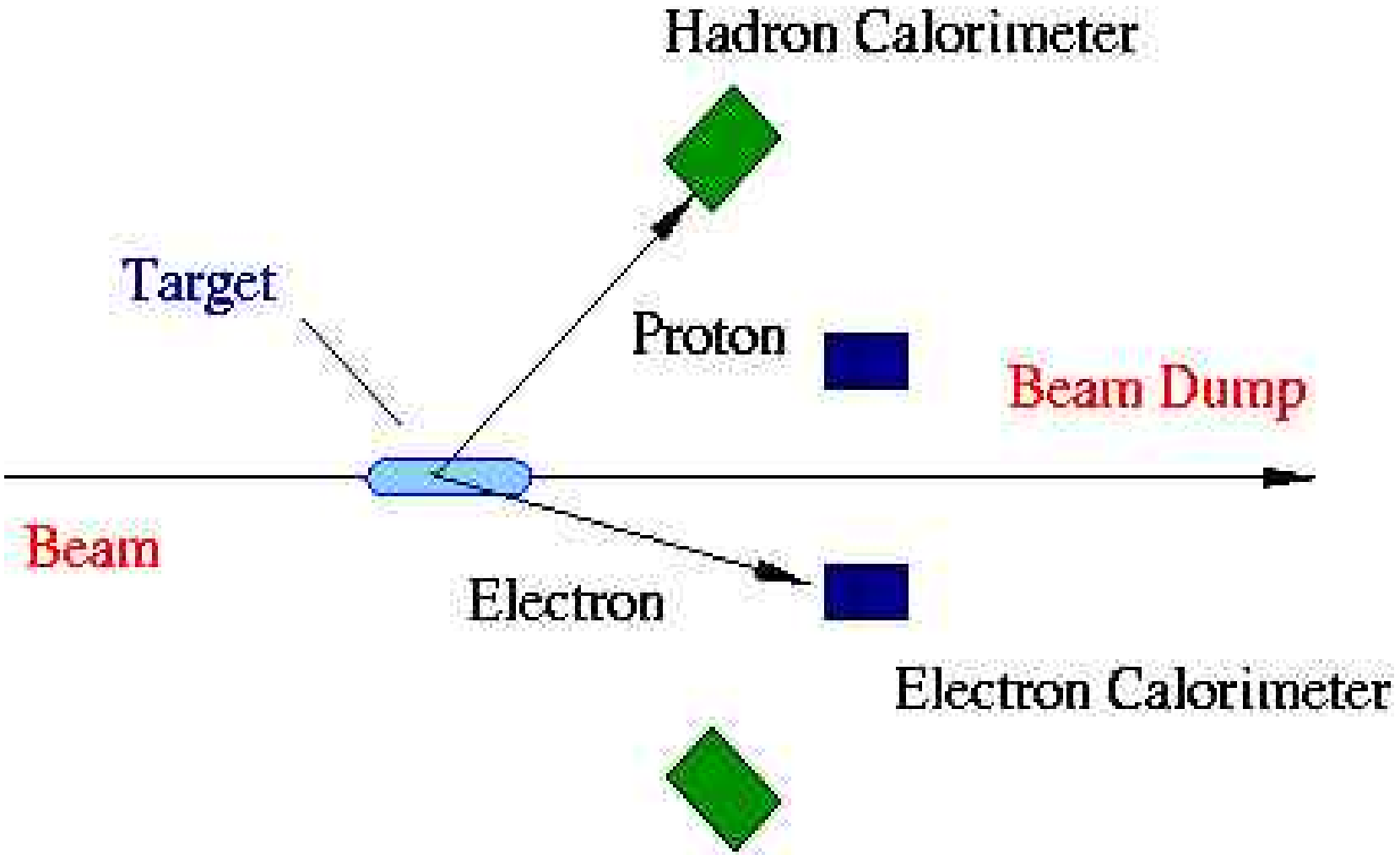
- Form Factors is JLAB discovery potential
- Strangeness – status and perspectives
- Elastic electron scattering kinematics
- Calorimeter – a detector for high luminosity
- Feasibility test with two calorimeters
- Concept of the CoPEx experiment
- Availability of the detectors and electronics
- Beam time and Summary

Coincidence Parity Experiment



Experiment layout



Asymmetry

$$A_{PV} = -\frac{G_F Q^2}{4\pi\alpha\sqrt{2}} \cdot \left|(1 - 4\sin^2\theta_W) - \frac{\epsilon G_E^p G_E^n + \tau G_M^p G_M^n}{\epsilon (G_E^p)^2 + \tau (G_M^p)^2} - \frac{\epsilon G_E^p G_E^s + \tau G_M^p G_M^s}{\epsilon (G_E^p)^2 + \tau (G_M^p)^2}\right|$$

$$A_{PV}(ppm) = 89.9 \cdot Q^2 \cdot \left|(1 - 4\sin^2\theta_W) - \frac{G_E^n/G_D \; + \; \tau\mu_p\mu_n}{1 + \tau\mu_p^2} - \frac{(G_E^s \; + \; \tau\mu_p G_M^s)/G_D}{1 + \tau\mu_p^2}\right|$$

$$A_{PV} = 115\text{ppm}$$

$$\frac{\delta A_{PV}}{A_{PV}} = \frac{\delta G^s / G_{Dipole}}{3.2}$$

~2.2%

$$\frac{\delta A_{PV}}{A_{PV}} = \frac{\delta G_E^n / G_{Dipole}}{3.2}$$

~1%

$$\frac{\delta A_{PV}}{A_{PV}} = \frac{\delta G_M^n / G_M^p}{0.79}$$

~3%

Uncertainties for the asymmetry and G_s

#	item	ppm
1	Statistics	2.5
2	Beam polarization	2.3
3	G_E^n	1.2
4	G_M^n/G_M^p	3.7
5	accidental	0.5
6	false asymmetry	0.5
	Total systematics	4.6

$\delta G_s / G_{Dipole} \sim +/-0.07 +/-0.13$

statistics and systematics

Cross section and event rate

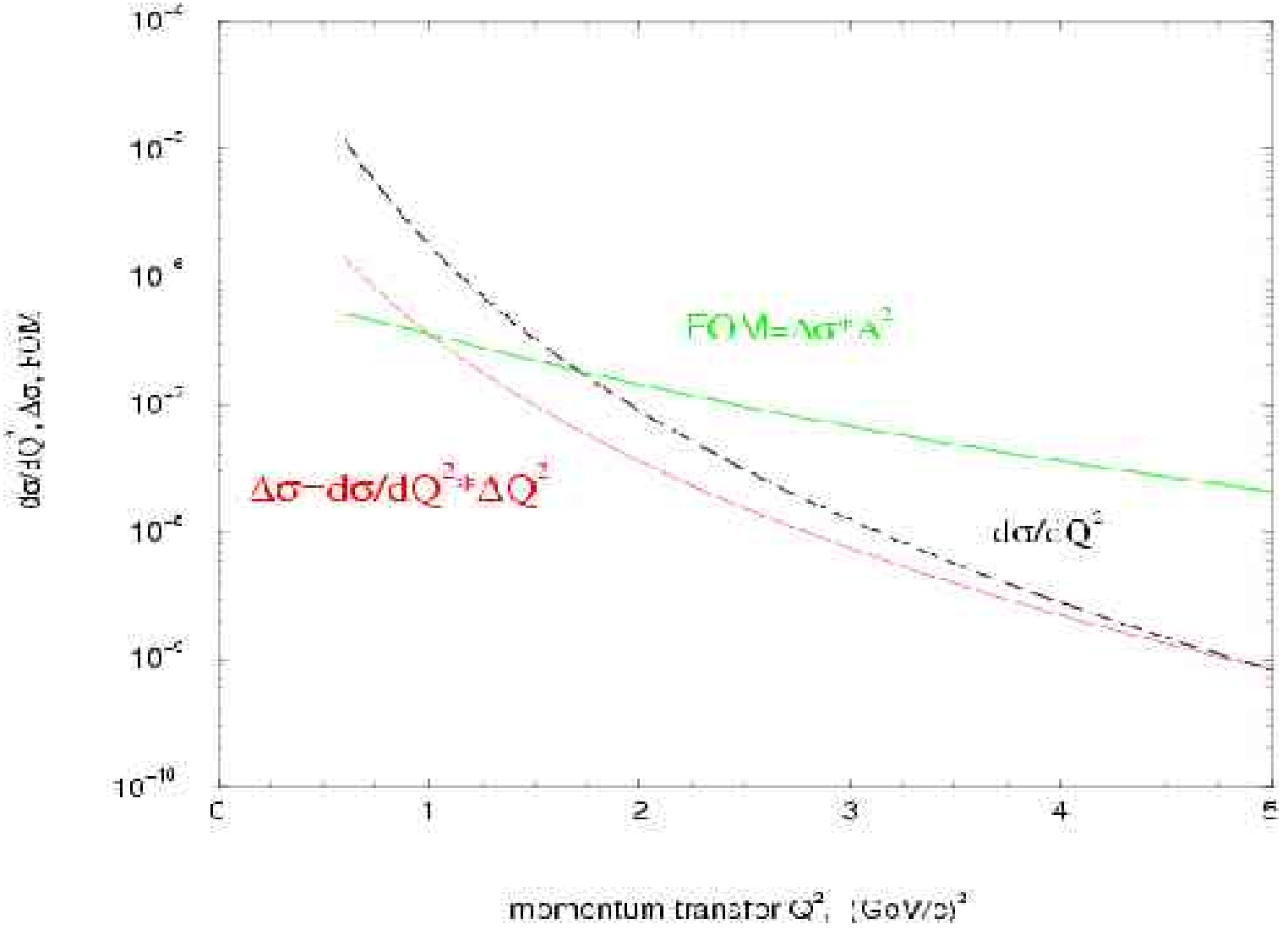
$$\frac{d\sigma}{dQ^2} = \frac{\pi \cdot r_e^2}{Q^4} \cdot \left[|G_E^p(Q^2)|^2 \left[\frac{(2 - \frac{Q^2}{2ME})^2}{1 \mid \tau} - \frac{Q^2}{E^2} \right] - \tau |G_M^p(Q^2)|^2 \left[\frac{(2 - \frac{Q^2}{2ME})^2}{1 \mid \tau} + \frac{Q^2}{E^2} \right] \right]$$

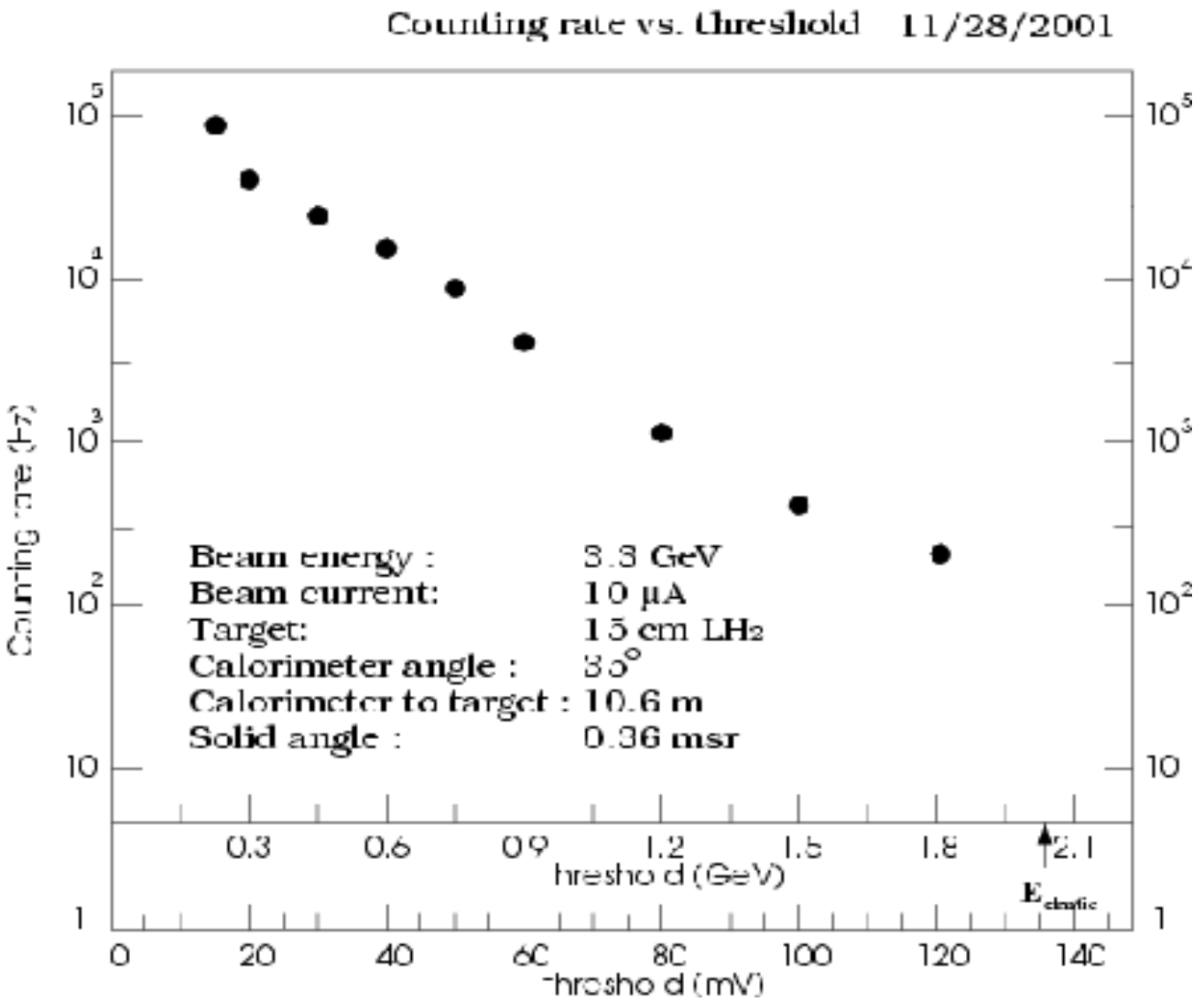
$$\frac{d\sigma}{dQ^2} = \frac{4\pi \cdot r_e^2}{Q^4} \cdot \frac{1 + \tau\mu^2}{(1 + Q^2/0.71)^4} \frac{1 - 2\tau M/E}{1 + \tau}$$

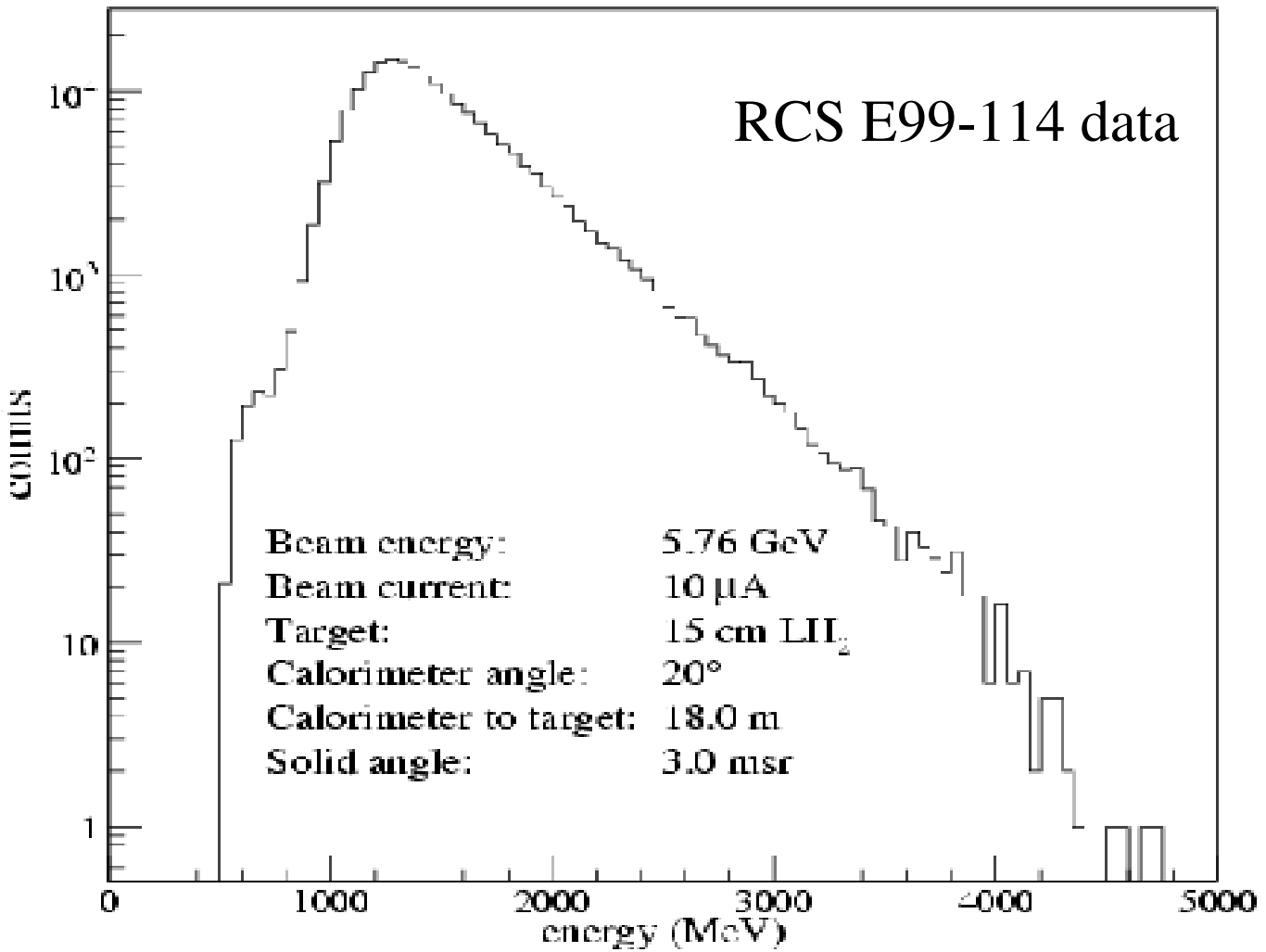
$$dQ^2/Q^2 \sim 0.1 - 0.2$$

At a projected luminosity of $4 \cdot 10^{38}$ $cm^{-2}sec^{-1}$ the total rate is 147 kHz. Taking into account proton detector efficiency and a radiative tail of electrons the rate of 128 kHz should be considered for statistics analysis. With 80% beam polarization and 30 days of production running the estimated statistical error of the asymmetry result will be $\perp 2.5$ ppm.

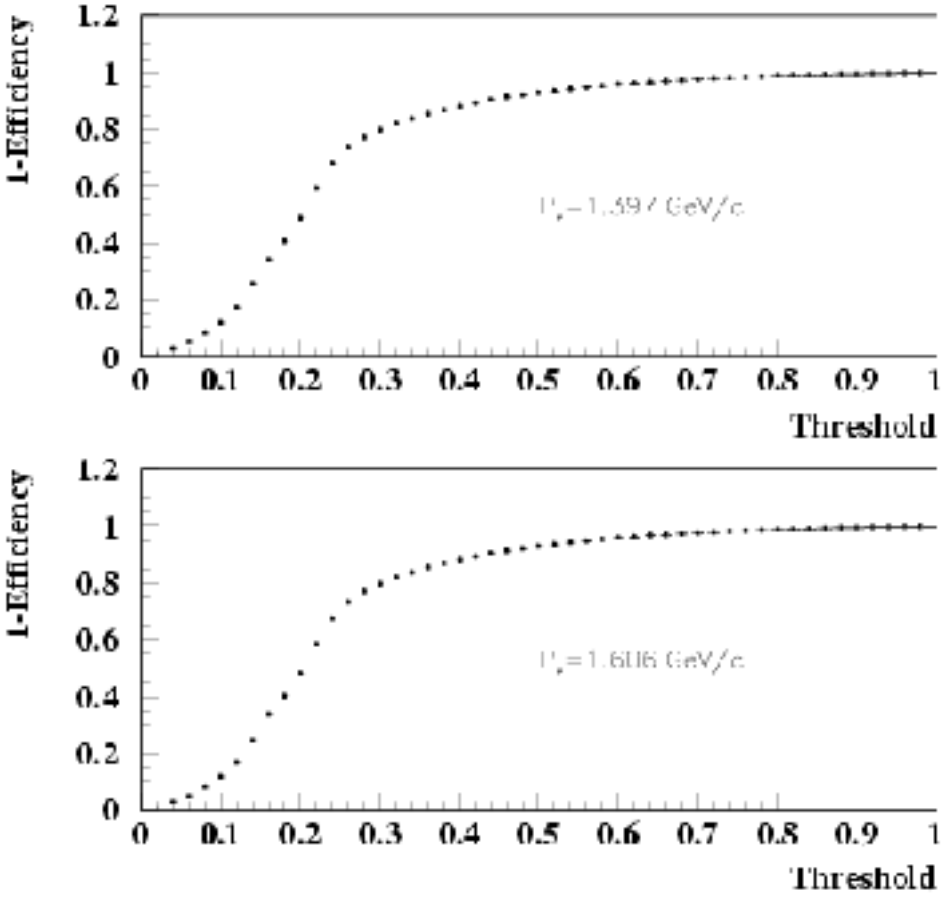
Coincidence Parity Experiment

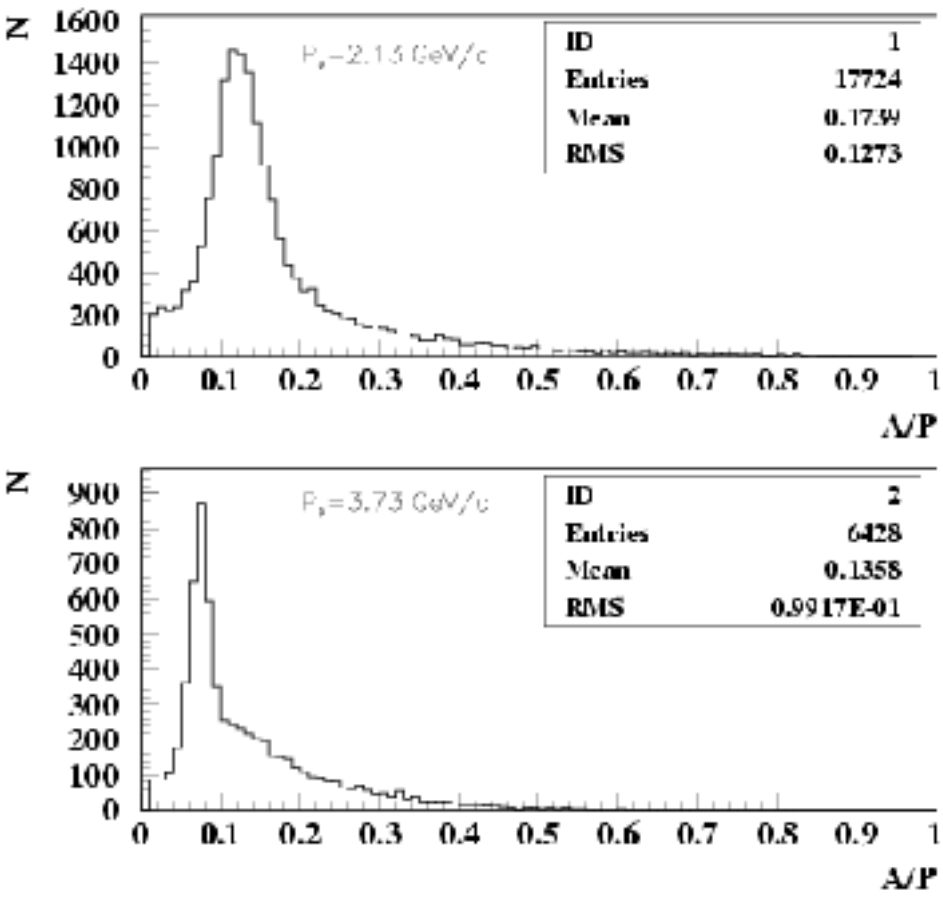



Counting rate vs. threshold 11/28/2001
Counting rate (Hz)
Beam energy : 3.3 GeV
Beam current: 10 μA
Target: 15 cm LH2
Calorimeter angle : 35°
Calorimeter to target : 10.6 m
Solid angle : 0.36 msr
0.3
0.6
0.9
1.2
1.5
1.8
2.1
threshold (GeV)
E elastic
0
20
40
60
80
100
120
140
threshold (mV)


RCS E99-114 data
Beam energy: 5.76 GeV
Beam current: 10 μA
Target: 15 cm LH2
Calorimeter angle: 20°
Calorimeter to target: 18.0 m
Solid angle: 3.0 msr
counts
energy (MeV)
0
1000
2000
3000
4000
5000
1
10
10²
10³
10⁴

Proton detection in calorimeter (lead-glass)

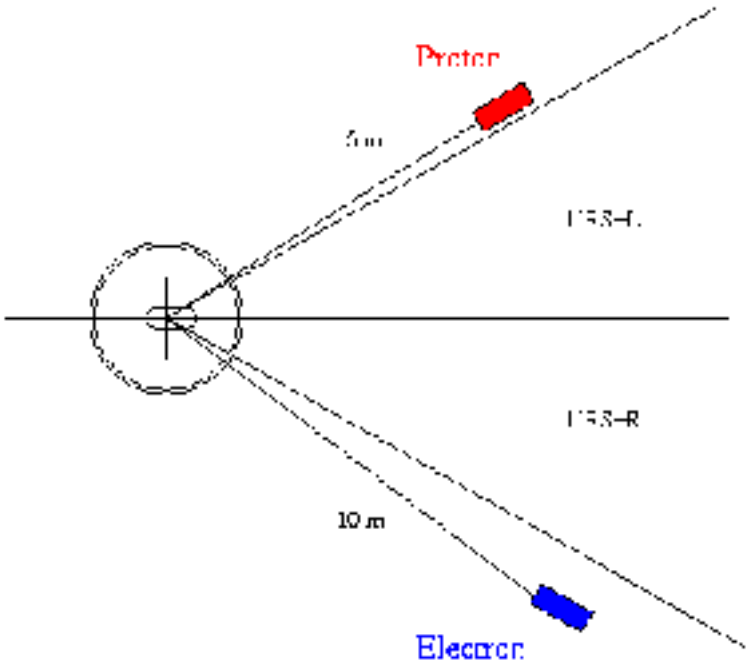


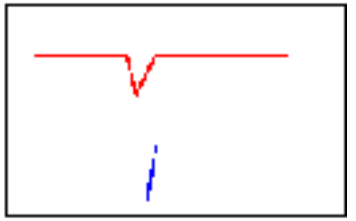


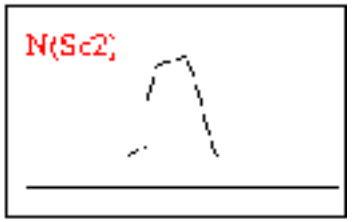
Proton momentum of 1.7 GeV/c -> 90% eff. require A_{thr} = 170 MeV

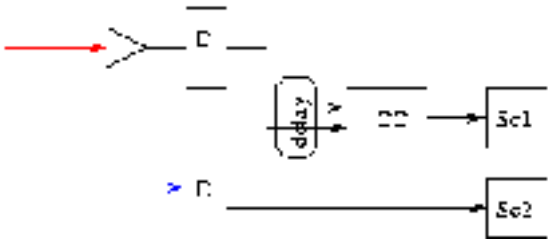
Feasibility test with two lead-glass blocks

$E = 3.179$ GeV, $\theta_e = 37^o$, $Q^2 \sim 2.4$ GeV^2

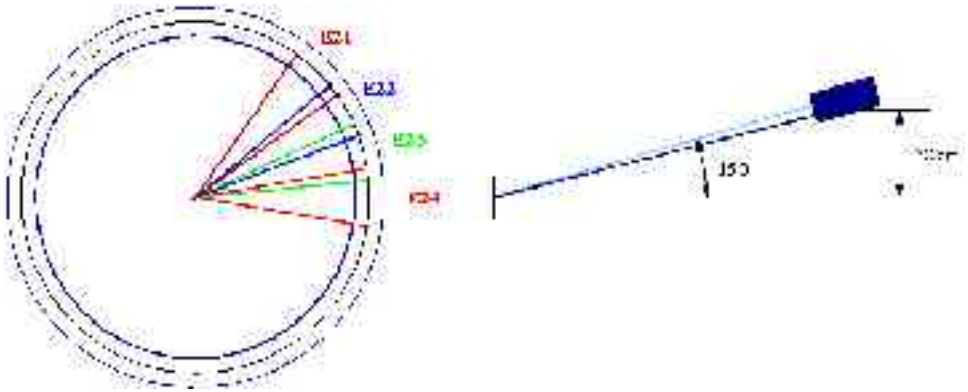


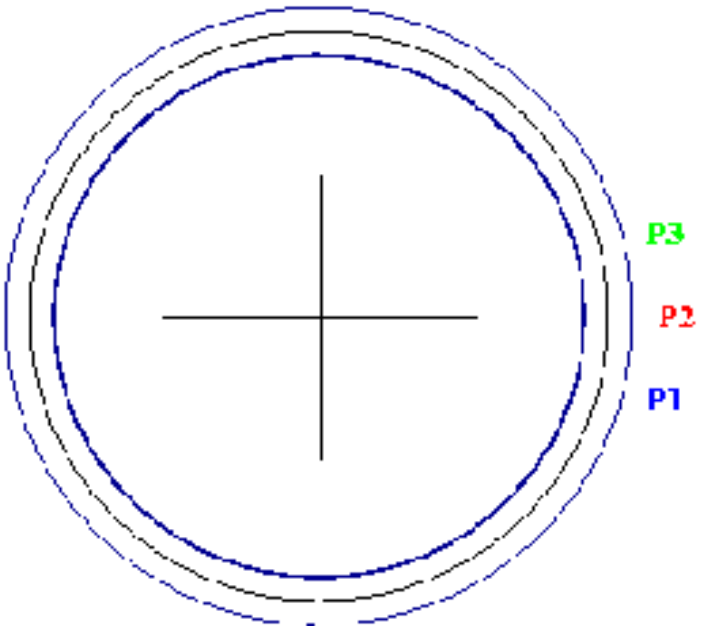


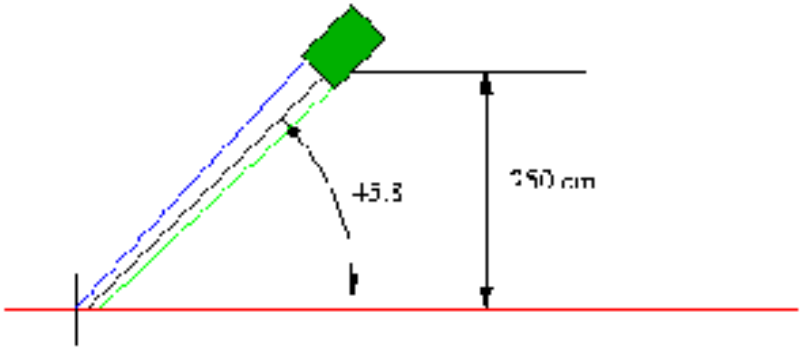




A concept scheme of the apparatus







Shower detectors and VME

- ~300 lead-glass blocks 15x15x30 cm – Hall A HRS + spare
- 244 lead-glass blocks 8.5x8.5x40 cm – Hall A BigBite
- 600 lead-glass blocks 4.2x4.2x40 cm – Hall A spare
- ~5500 shashluk shower blocks in HERA-B EM calorimeter

- 24 subsystems, each for 30 PMTs and BPM/BCM
- 10-15 kHz event rate in each with 300 bytes in event
- Could be done in 12 VME crates and CAEN ADC/TDC -> $500k
- Could be done with FADC like under development for Hall D

Beam time request for this proposal

Kin. #	Procedure	beam, μA	time days
CT	Concept test	100	5
C1	Beam parameters	1-100	4/3
C2	Detector calibration	10	2/3
C3	Polarimetery	1-5	1
C4	Pion yield calibration	50	2
E1	Production data	100	30
	Total requested time		40

Summary

- E-P coincidence is a key to large momentum transfer.
- Strange form factors could be measured up to several GeV^2.
- Calorimeters for detection of the elastic electron scattering offer a very large solid angle at a moderate cost.
- Expected accidental background at 2 GeV^2 on level of 1%, correlated background of 1-2%, false asymmetry of 0.5 ppm.
- Setup could be used with 12 GeV beam. There are other possible experiments with such detector.
- Preparation of this experiment could be completed in a couple years, this time defined mainly by development of the DAQ.