



Two-Photon Physics in elastic electron scattering

"Experimental Status"

Frank E.Maas for the A4 Collaboration

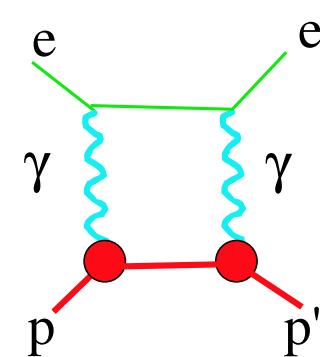
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Institut für Kernphysik

ECT*, Trento

April 4, 2003

- Two-Photons: doubly virtual
Compton scattering (elastic $e^- p$ scattering)

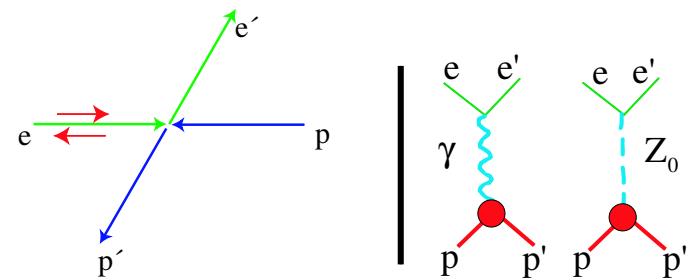


- Experiments and Measurements
 - SAMPLE@MIT-Bates
 - A4@MAMI

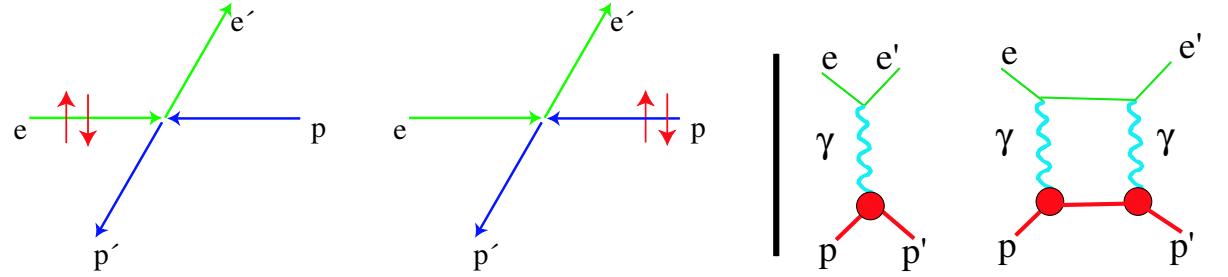


Elastic Scattering

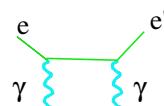
- single spin asymmetry: e^- spin **longitudinal**, parity violating, ϕ -symmetric
strangeness contribution to formfactors, $A_{LR} = 10^{-6}$



- single spin asymmetry: e^- spin **transversal**, $\sin(\phi)$, **doubly virtual Compton scattering**, $A_{UD}^{beam} = 10^{-5}, A_{UD}^{target} = 10^{-2}$



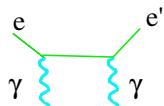
Two Photon Physics



- $\text{Re}(\text{p})$

e^-, e^+ asymmetries, accuracy $> 10^{-2}$ (Barnabeu et al.)

part of radiative corrections in Rosenbluth-separation



- $\text{Im}(\text{p})$

transverse polarised target asymmetry, accuracy $> 10^{-2}$
(DeRujula et al.)

transverse polarised beam asymmetry, accuracy 10^{-6}

- at high Q^2 : access to *GPD* with two space like photons



Experiments

- polarised target asymmetries: absolute cross section
- polarisation of recoil proton: proton polarisation
- single spin beam asymmetries

elastic \leftrightarrow inelastic scattering

SAMPLE: low beam energy

A4: calorimetric measurement

very high rates (high luminosity: $10^{38}/(cm^2 s)$)

SAMPLE: air cherenkov, integrating

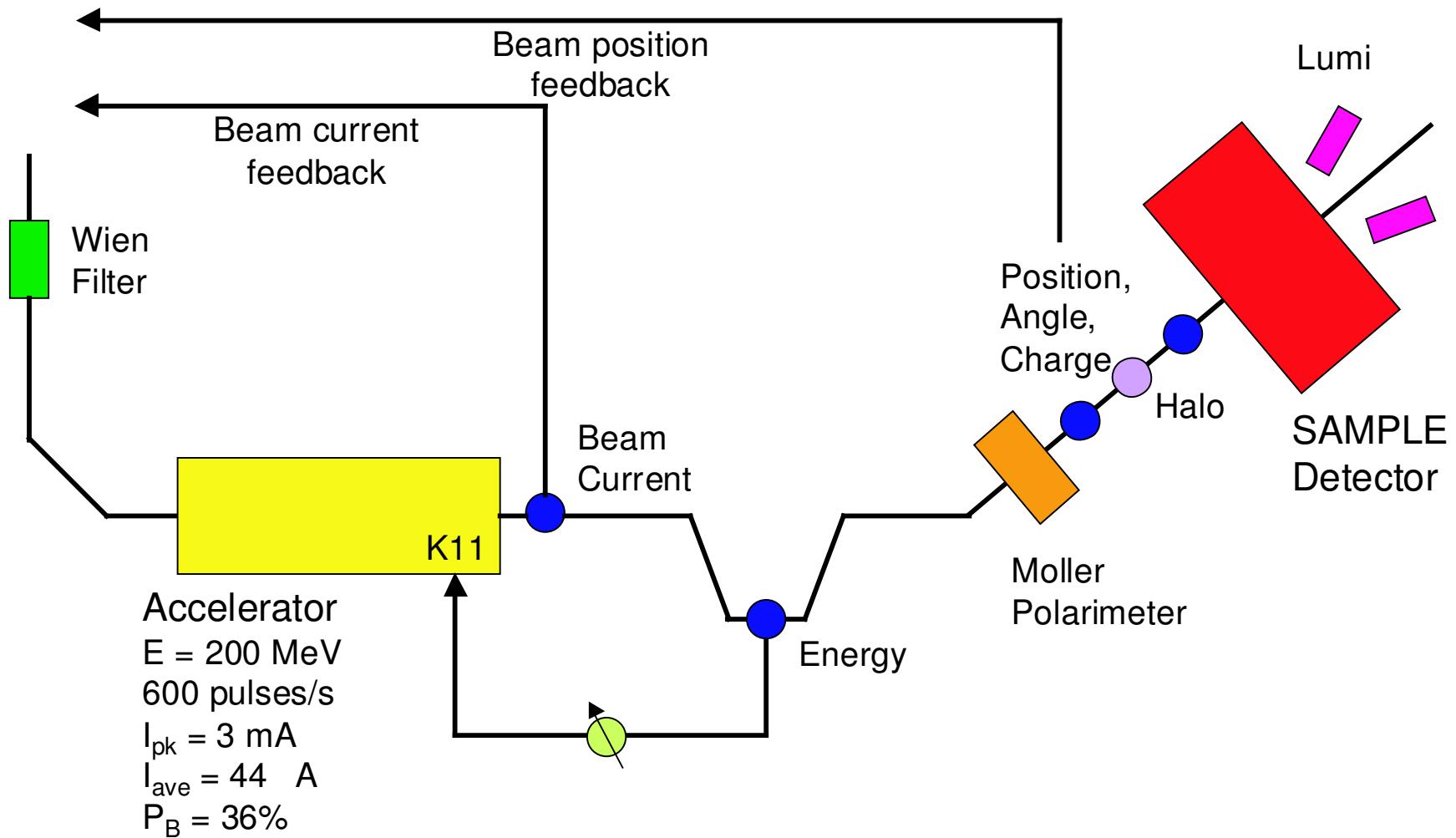
A4: PbF_2 cherenkov calorimeter with analogue

summation and fast counting



SAMPLE Experiment Schematic

Polarized
Injector

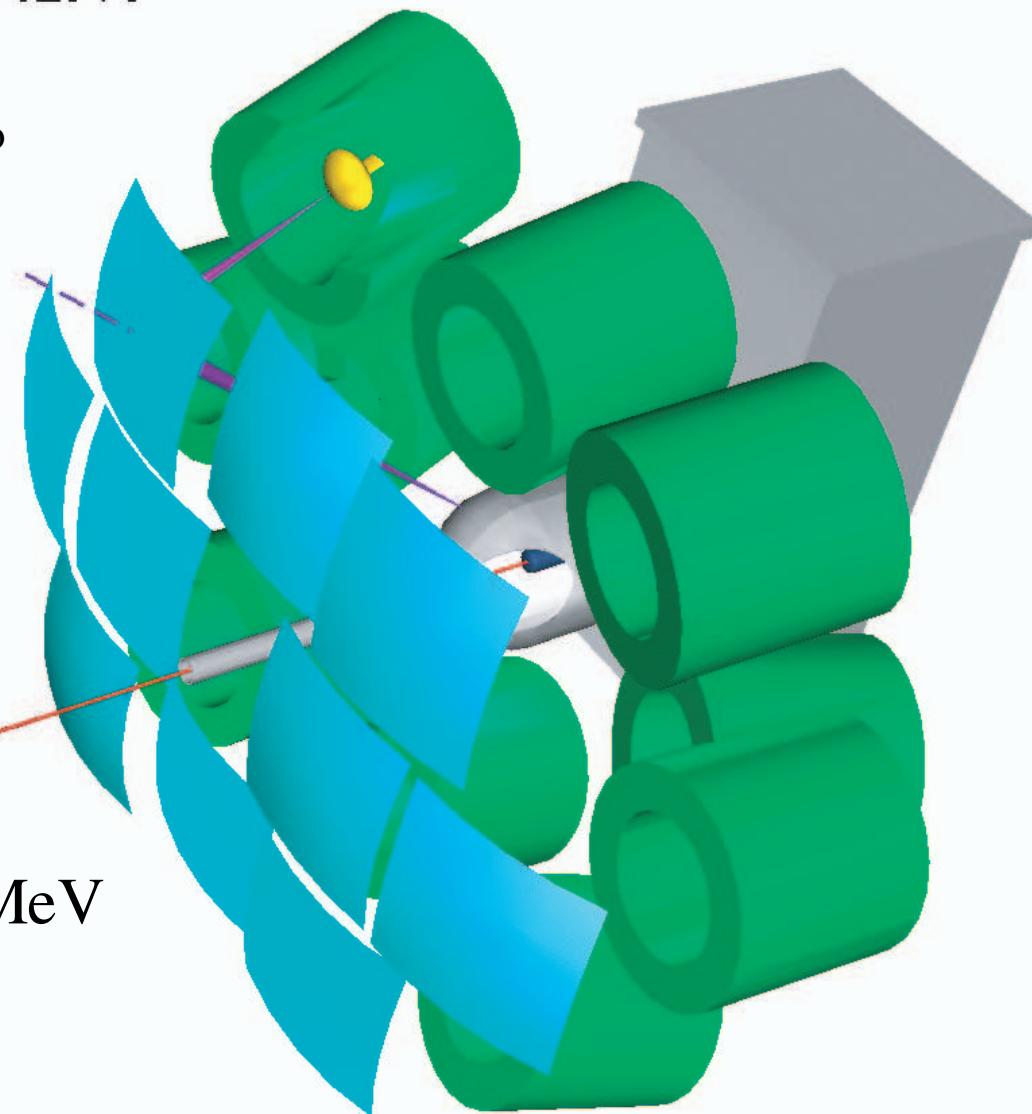


SAMPLE Apparatus

SAMPLE EXPERIMENT

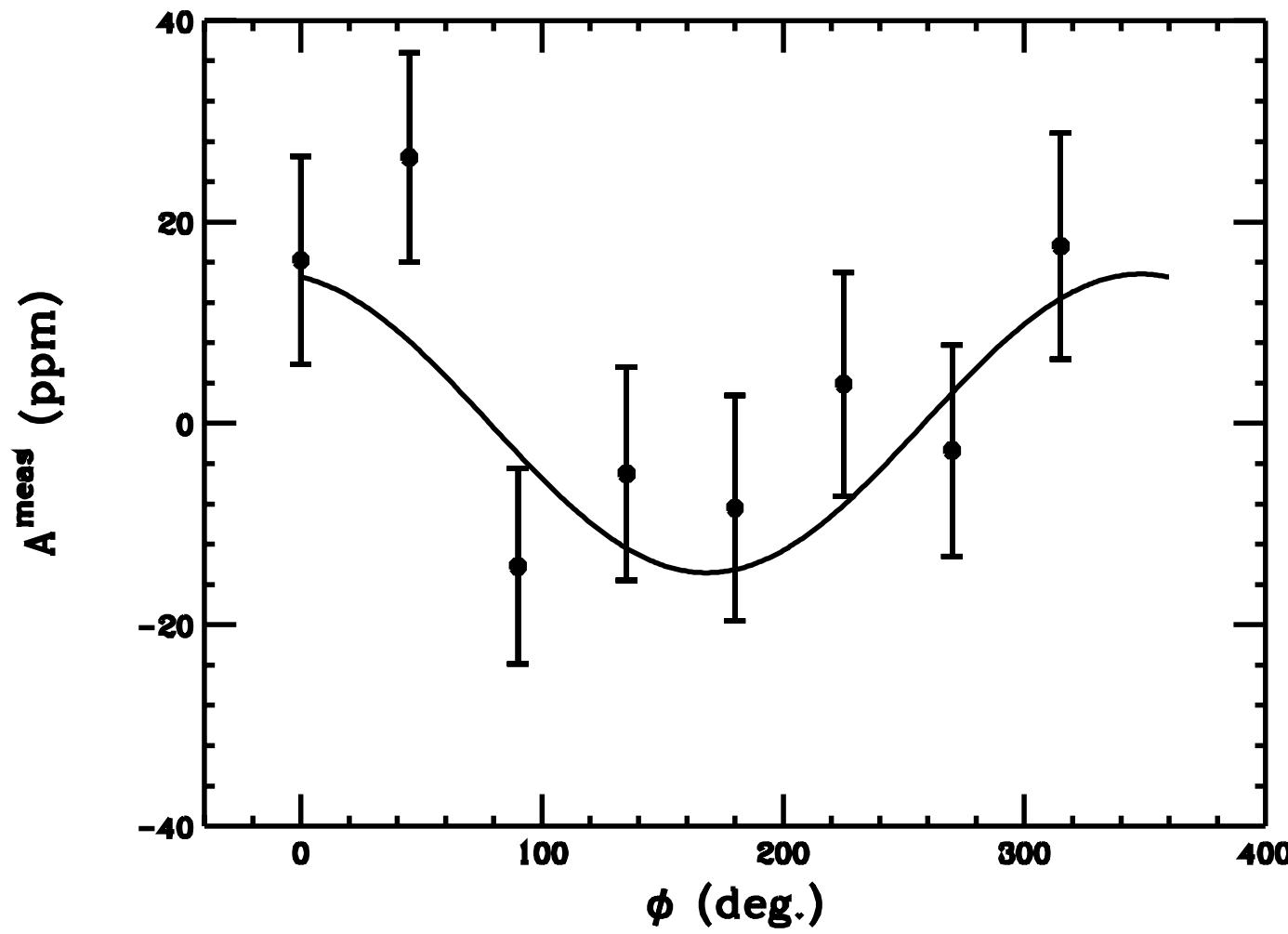
 $\theta_{\text{scatt}} = 130 - 170^\circ$

Electron Beam 

 $E_e = 200 \text{ MeV}$
 $P_e \sim 37\%$ 



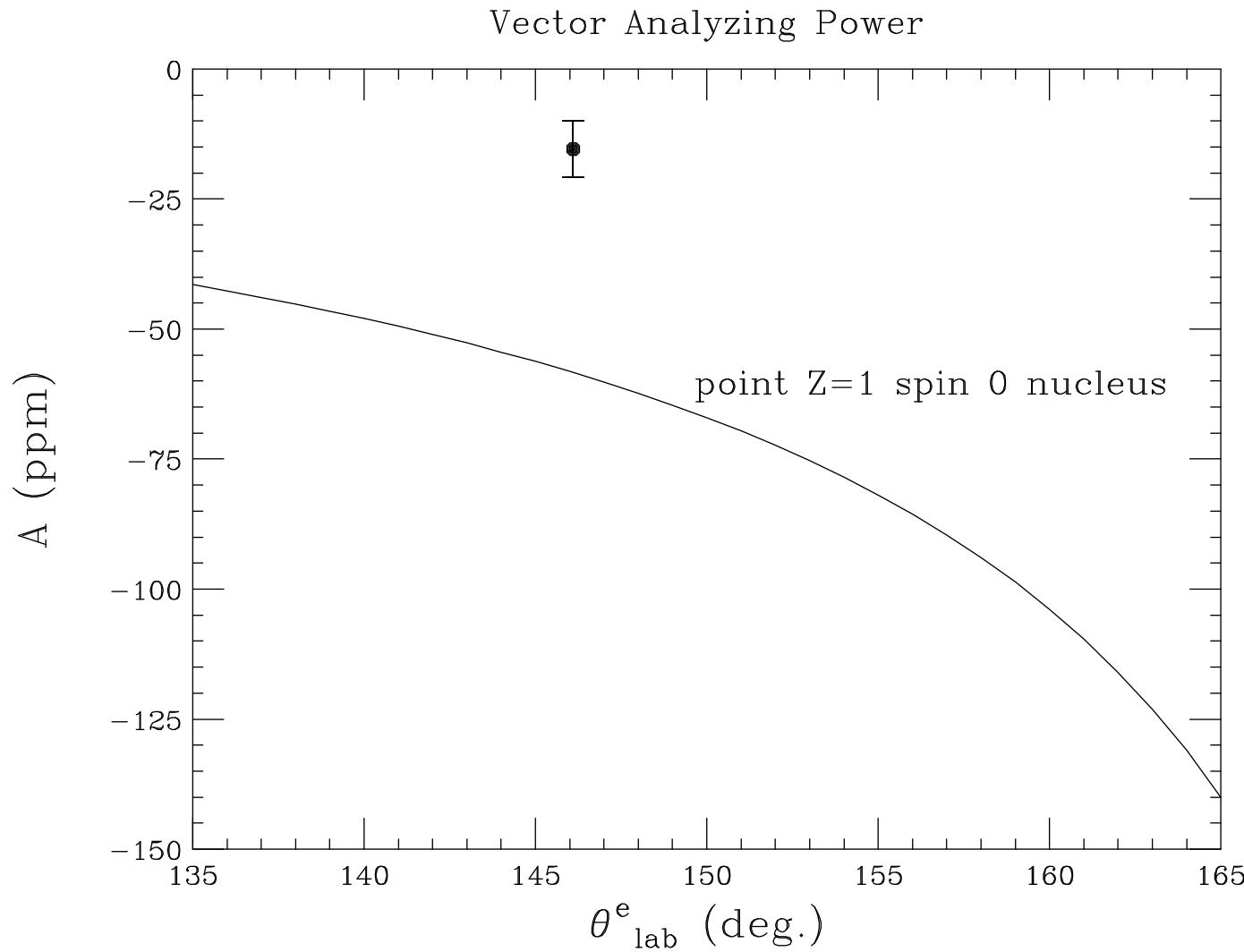
SAMPLE transverse beam asymmetry



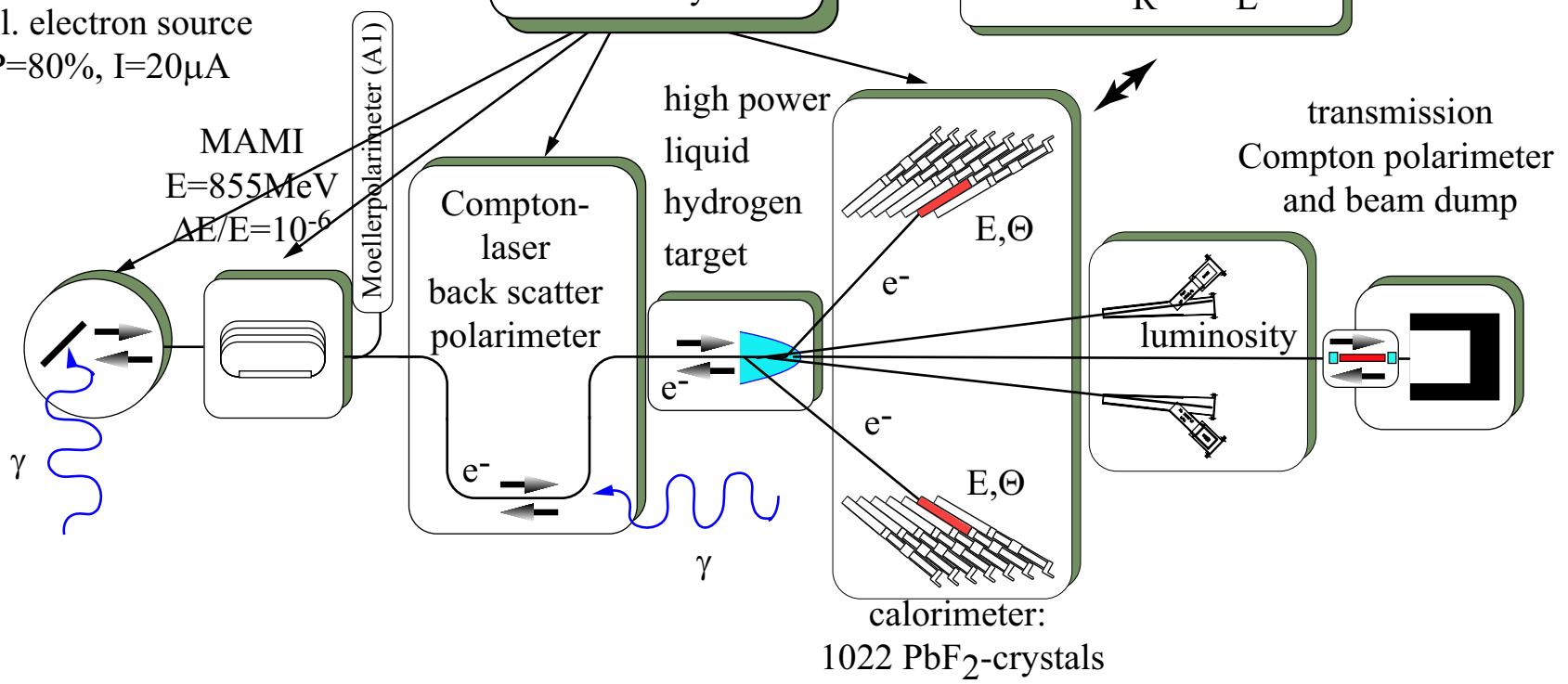


Two Photon Physics: SAMPLE measurements

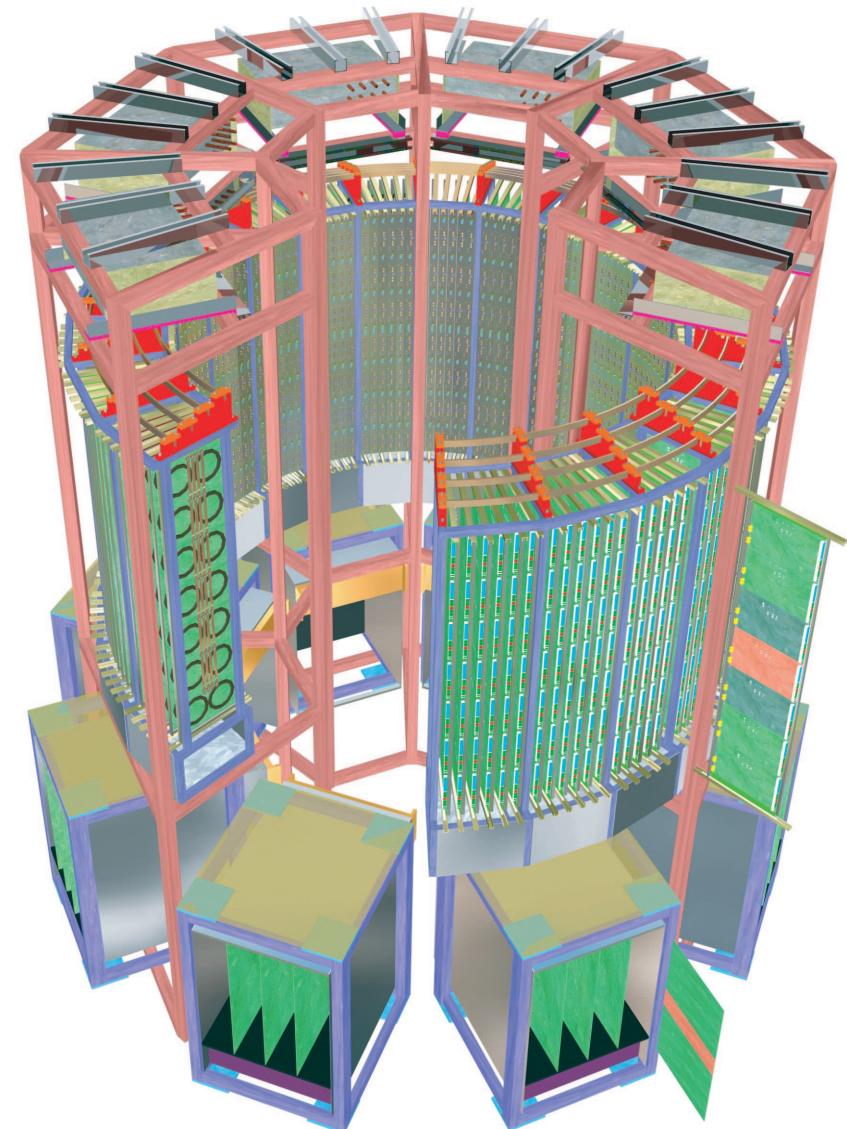
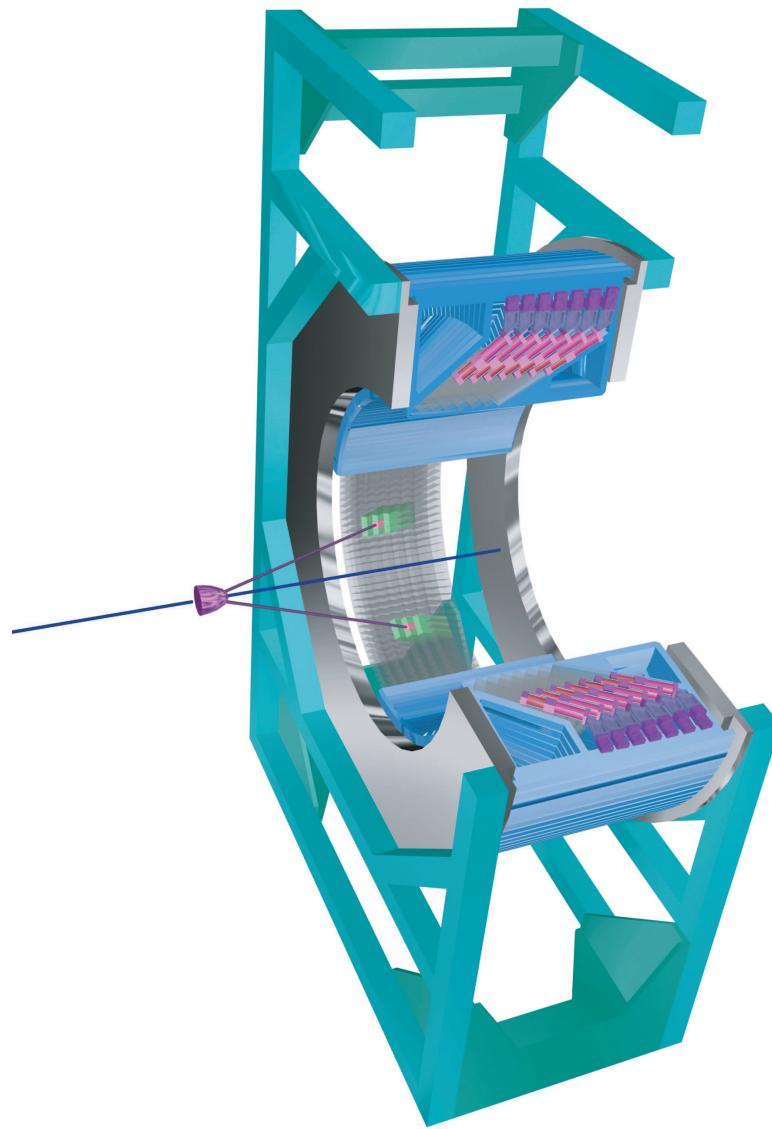
arXiv:nucl-ex/0002010 v1 22 Feb 2000



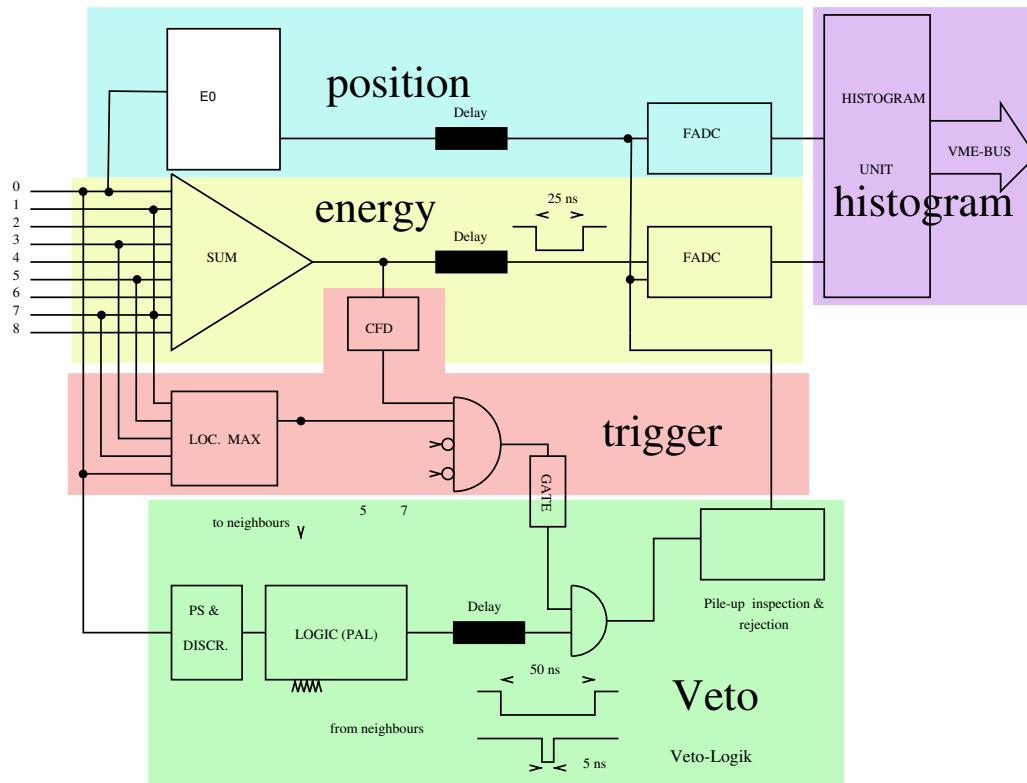
pol. electron source
 $P=80\%$, $I=20\mu A$



A4, fast PbF_2 calorimeter, 100 MHz total rate

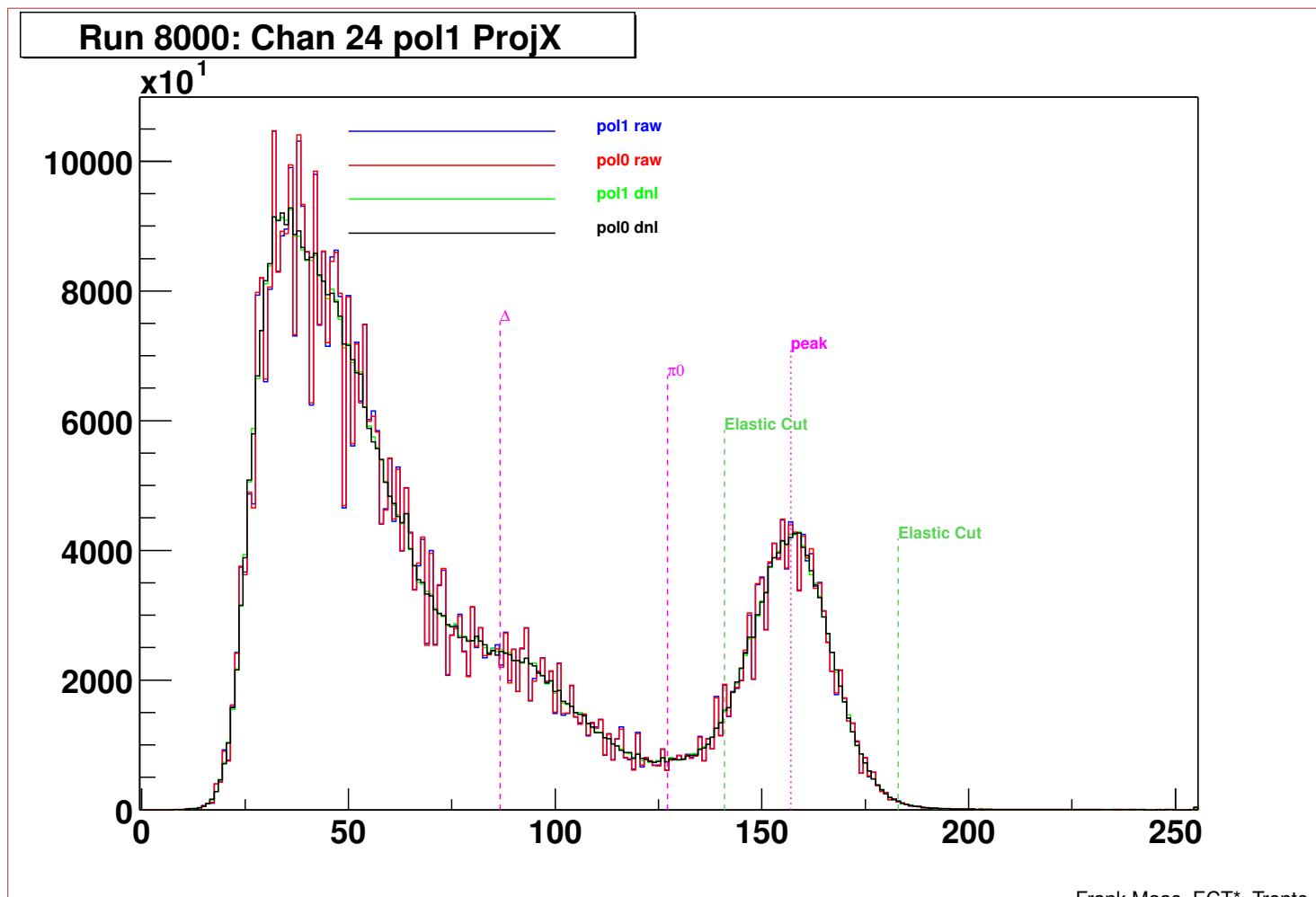


A4 read out electronics principle



A4 scattered particle spectrum (sum of 9 crystals)

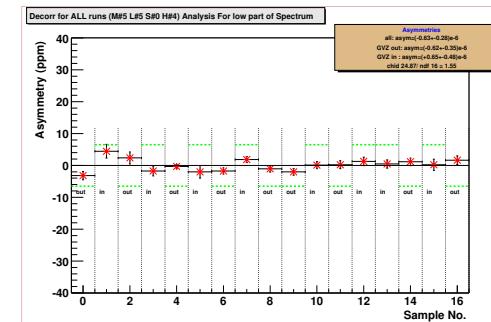
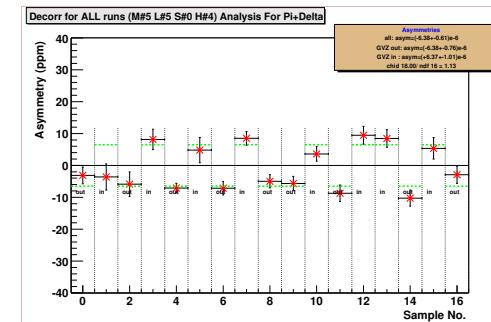
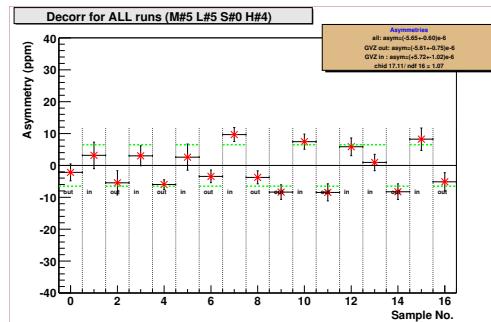
16×10^6 histograms $\leftrightarrow 10^{13}$ elastic event



- 600 hours of data at 854MeV (longitudinal)
strangeness contribution at 0.23 GeV^2
- Compton transmission polarimeter
- Laser Compton backscatter polarimeter
- 50 hours of data at 855 MeV (**transversal**)
- 750 detector channels installed (1022
channels installed in at eastern 03)
- 200 hours of data at 570 MeV (longitudinal)
strangeness contribution at 0.1 GeV^2

A4, fast PbF_2 calorimeter, 100 MHz total rate

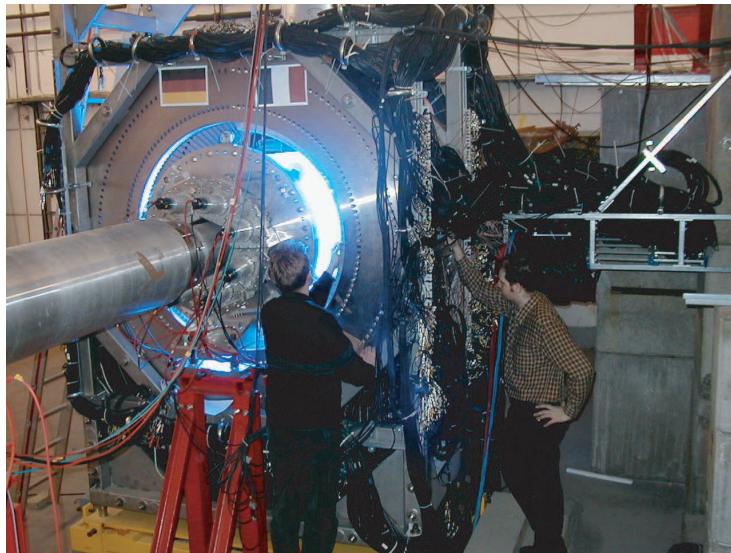
elastic Δ -excitation background



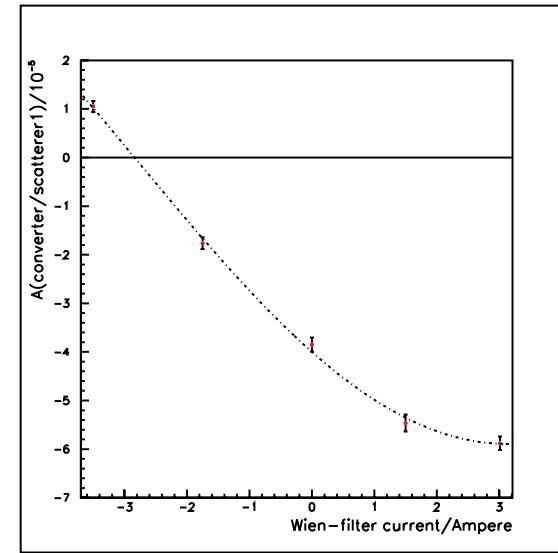
A

elastic	-5.7 ppm	0.6 ppm (0.56stat 0.19corr 0.06pol)
Δ	-6.4 ppm	0.6 ppm (0.56stat 0.19corr 0.10pol)
background	0.6 ppm	0.4 ppm

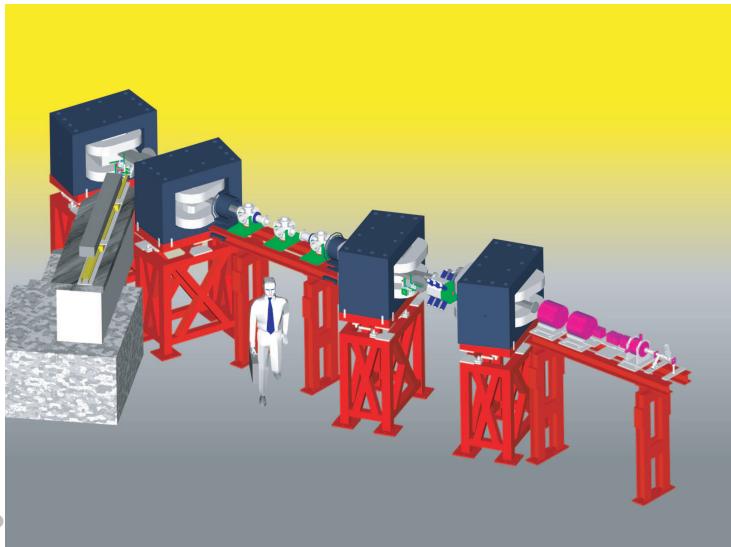
750 detectors



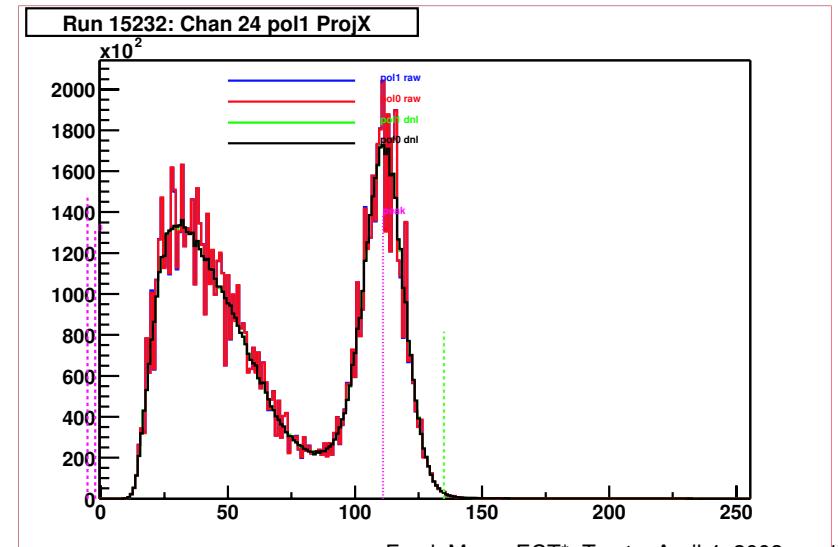
Compton Transmission Pol.



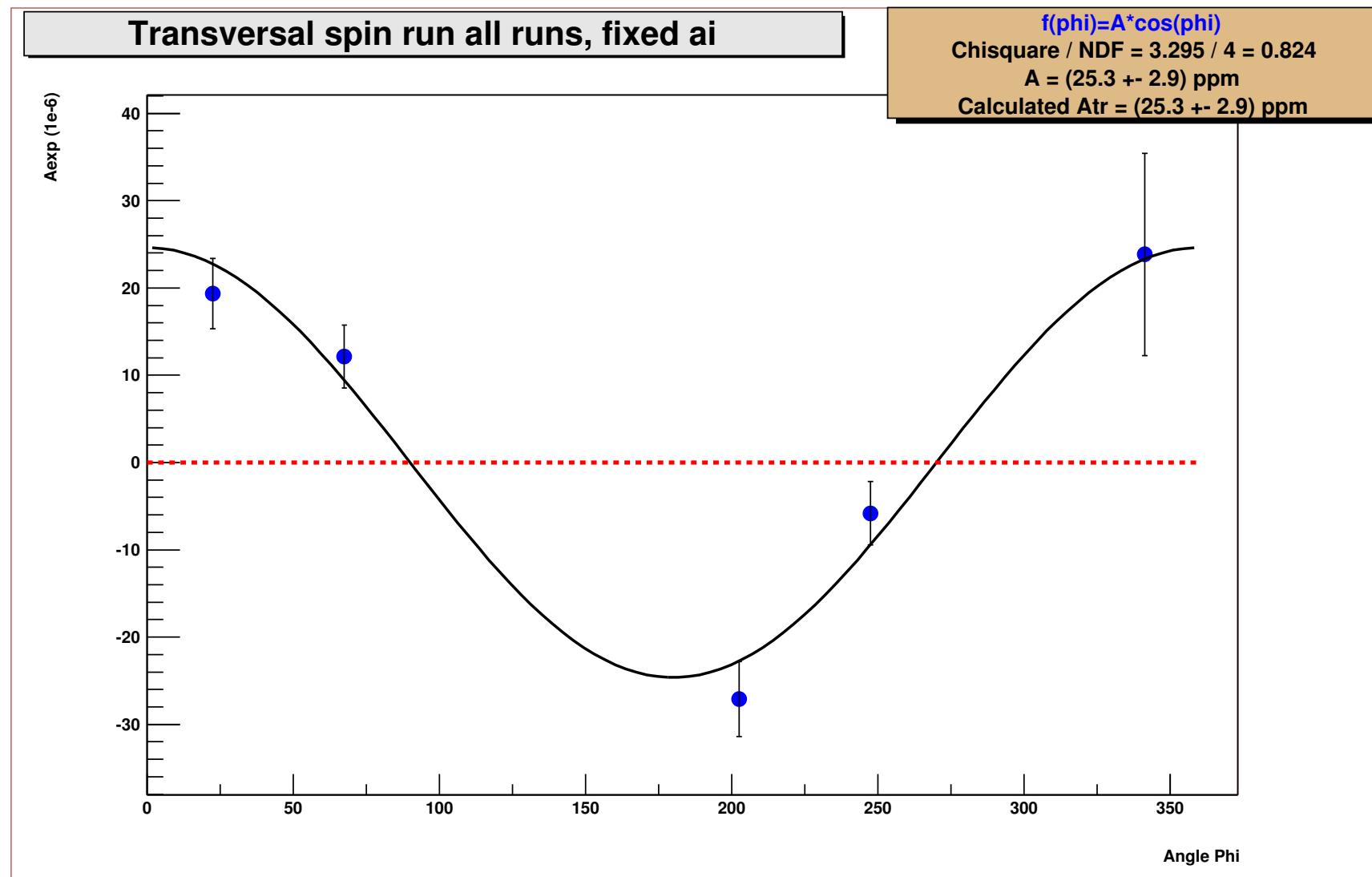
Laser Compton backscatter Pol.



570 MeV, 0.1 GeV²



Transverse Single Spin Asymmetry from A4



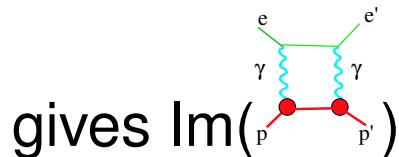
Transverse Single Spin Asymmetry (all in units of 10^{-6})

Experiment	Q^2	A	θ_{Lab}
SAMPLE	0.10 GeV^2	-15.4 ± 5.4	$130 < \theta_{Lab}^e < 170$
A4	0.10 GeV^2	-	$30 < \theta_{Lab}^e < 40$
A4	0.23 GeV^2	-25.3 ± 2.9	$30 < \theta_{Lab}^e < 40$

Q^2	$A(F_1)$	$A(F_1, F_2)$	$A(F_1, F_2, \Delta)$
0.10 GeV^2	- 26.1	-5.3	-6.4
0.10 GeV^2	-	-	-
0.23 GeV^2	-0.34	-0.25	-13.39

Conclusion

- transverse single spin beam asymmetries



- can be related to $\text{Re}(p \rightarrow p')$
radiative corrections
- at high Q^2 access to GPD with two spatial γ
- results from parity violation experiments
- next point: 570 MeV, $\theta_{Lab} = 35^\circ$ in A4