E12-07-108: $\mathrm{G_M^p}$

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Introduction

In the Born approximation, the elastic cross section for elastic *ep* scattering can be written:

$$\frac{d\sigma}{d\Omega} = \sigma_{\text{Mott}} \frac{\epsilon (G_E^p)^2 + \tau (G_M^p)^2}{\epsilon (1+\tau)},$$

where

$$\sigma_{\text{Mott}} = \left(\frac{\alpha}{2E} \frac{\cos\frac{\theta}{2}}{\sin^2\frac{\theta}{2}} \right)^2 \frac{E'}{E},$$

and $\tau = Q^2/4M_p$ and $\epsilon = [1 + 2(1+\tau)\tan^2\theta/2]^{-1}$

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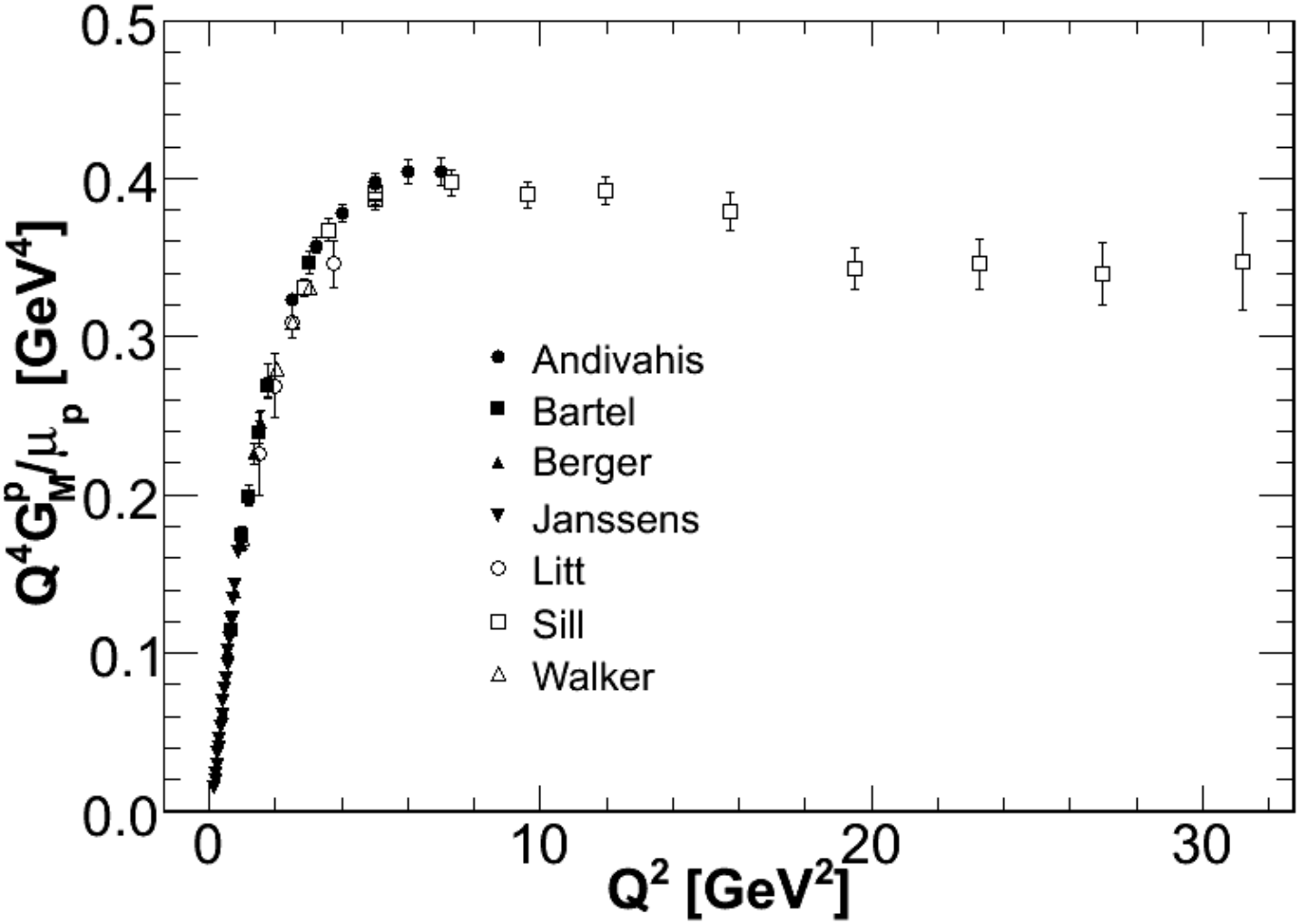
- Provide measurement of power scaling for G_M^p in the range $Q^2 = 7\text{-}16\mathrm{GeV}^2$

Previous Measurements



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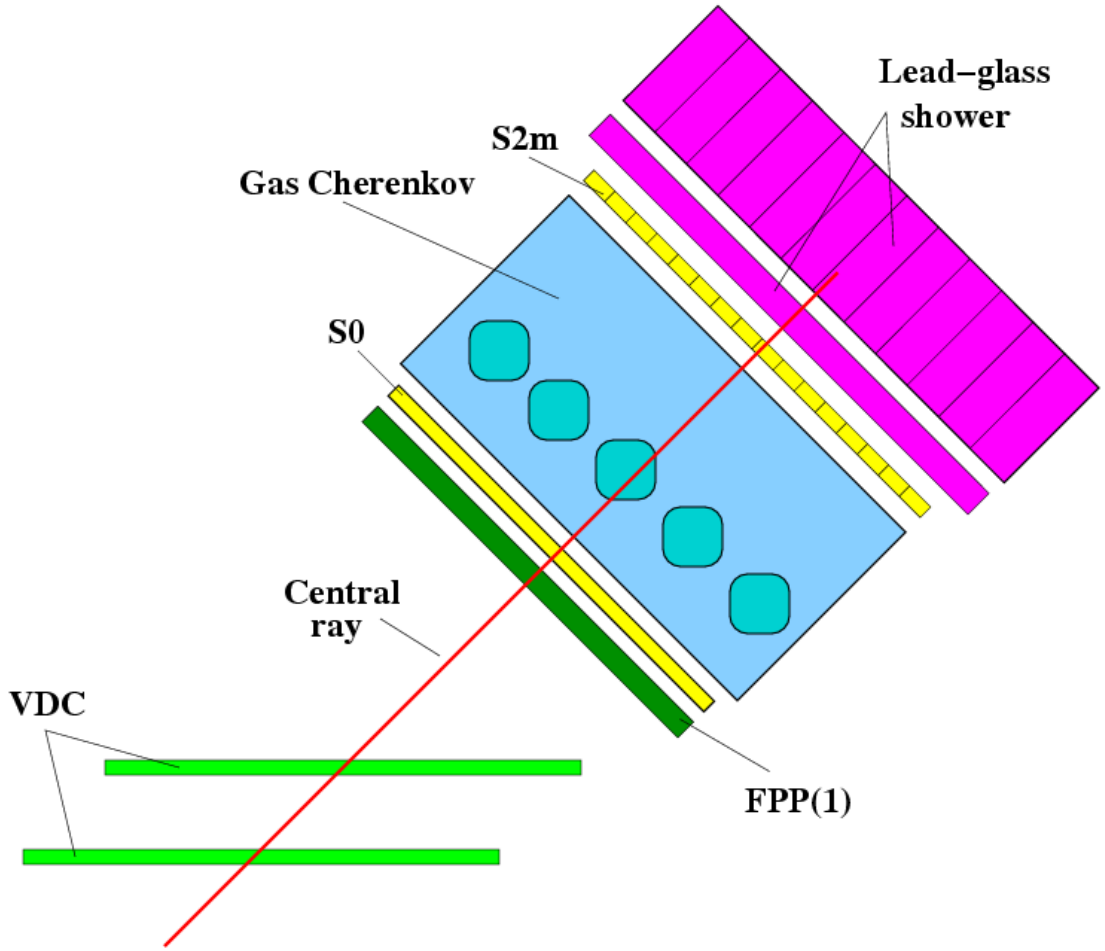
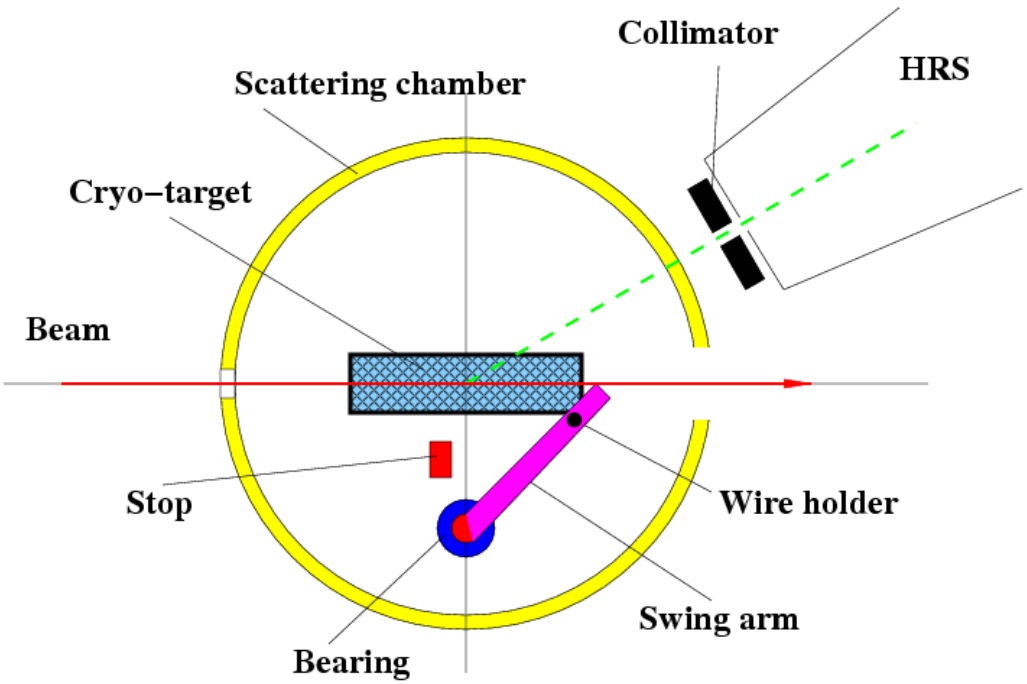
- Measure cross-section at
  $Q^2 = 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0,$ and $15.5\mathrm{GeV}^2$

HRS Tracking



Uses standard detectors with additional tracking plane from FPP

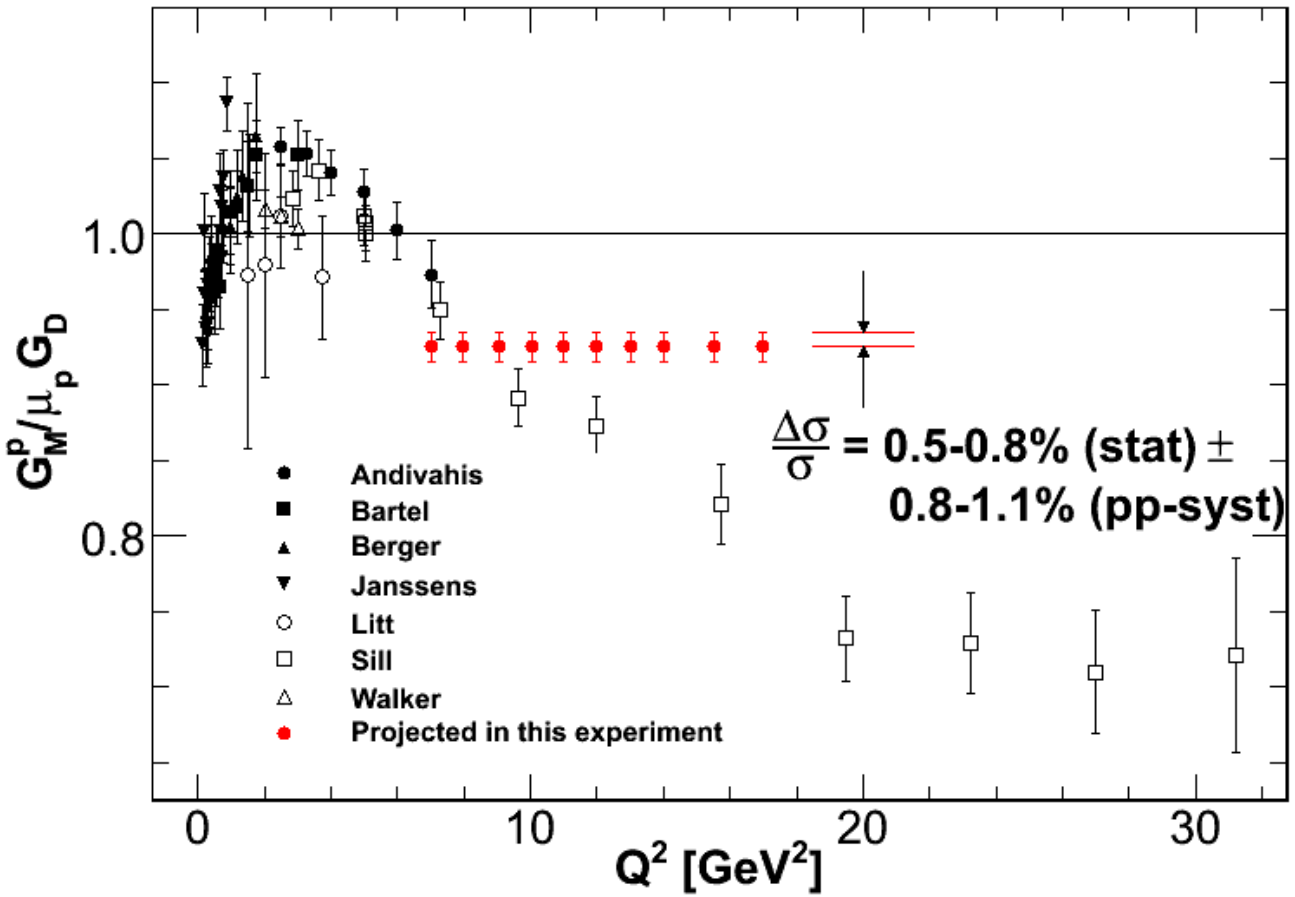
HRS Optics



Additional wire target on swing arm, location reproducible to 20μm, and single hole collimators will allow an expected accuracy of $\pm$0.1mrad

E_e (GeV)	Q^2 (GeV)^2	θ_e (deg)	E' (GeV)	ϵ	Rate (Hz)	Time (hours)	Events
4.8**	7.0	71.0	1.08	0.25	0.80	5.2	30k
6.6	7.0	35.4	2.87	0.62	6.21	0.7	30k
6.6	8.0	42.0	2.35	0.51	1.90	2.2	30k
5.8**	9.0	77.0	1.00	0.18	0.16	26.1	30k
6.6	9.0	52.0	1.78	0.37	0.40	10.3	30k
8.8	9.0	29.3	4.00*	0.67	2.82	2.9	30k
6.6	10.0	67.0	1.25	0.23	0.12	34.1	30k
8.8	10.0	33.3	3.46*	0.59	1.09	7.6	30k
8.8	11.0	38.0	2.94	0.51	0.44	9.4	30k
8.8	12.0	44.0	2.42	0.41	0.17	23.8	30k
8.8	13.0	53.0	1.86	0.30	0.05	69.0	24k
11.0	13.0	31.3	4.06*	0.58	0.30	21.7	24k
11.0	14.0	35.0	3.53*	0.50	0.14	40.3	20k
11.0	15.5	42.0	2.74	0.39	0.04	55.2	18k
						308.5	

Expected Precision



Error Budget – Point to Point

Source	$\Delta\sigma/\sigma$ (%)
Point to point uncertainties	
Incident Energy	$<$0.3
Scattering Angle	0.1–0.3
Incident Beam Angle	0.1–0.2
Radiative Corrections*	0.3
Beam Charge	0.3
Target Density Fluctuations	0.2
Spectrometer Acceptance	0.4–0.8
Endcap Subtraction	0.1
Detector efficiencies and dead time	0.3
Sum in quadrature	*0.8–1.1*

* Not including TPE

Error Budget – Normalization

Source	$\Delta\sigma/\sigma$ (%)
Normalization uncertainties	
Beam Charge	0.4
Target Thickness/Density	0.5
Radiative Corrections*	0.4
Spectrometer Acceptance	0.6–1.0
Endcap Subtraction	0.1
Detector efficiencies and dead time	0.4
Sum in quadrature	*1.0–1.3*
Statistics	*0.5–0.8*
Total (Scale+Rand.+Stat.)	**1.2–1.7**

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- Design for swing arm calibration target
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- Start looking for a graduate student
  - Good candidate for early running
  - Can make significant contribution even if restricted to 8.8GeV beam

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- Plans are underway for nearly parasitic test runs in January.
- Request: designer time ($\sim$ 3 months) for simple swing-arm target
- Ideal candidate for first experiment in 12 GeV era.