New physics ideas with NPS

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The concepts shown here are not “new”, and most have already been submitted to the Hall C white paper.

NPS calorimeter in future Hall C

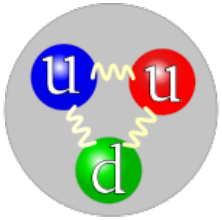
"Old"

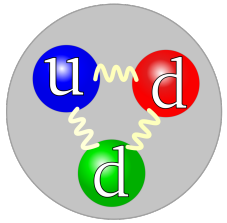
1. Wide Angle Compton Scattering, E12-14-03 with NPS + HMS
2. Wide Angle, Exclusive Photoproduction of π^0 Mesons, E12-14-05
3. Polarization Observables in WACS, E12-17-008, CPS+NPS+HMS
4. Timelike Compton Scattering, C12-18-005, CPS + NH3 + NPS*2

"New"

5. Strange Form Factor at high Q2, PR-06-004, arXiv:2001.02190
6. CPS as a source of positrons for TPE at high Q2, CPS + BB + NPS
7. A1p/A2p experiment with 11 GeV beam, wide aperture NH3 + BB/NPS

Strange Form Factor at high Q2



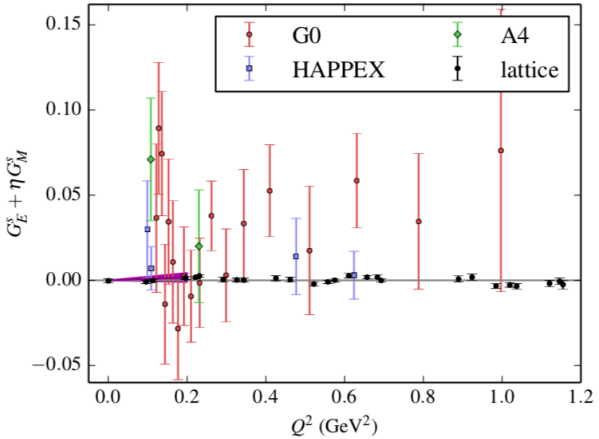


Expectations for
the strangeness FF

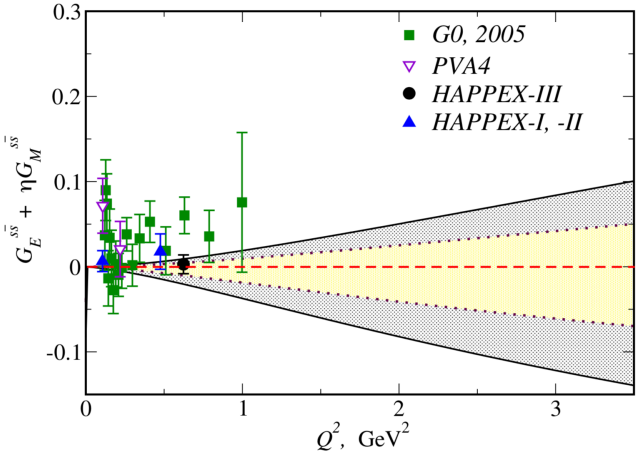
G_D at 3 GeV^2 is 0.037

G_s/G_D ~ 1 is not excluded

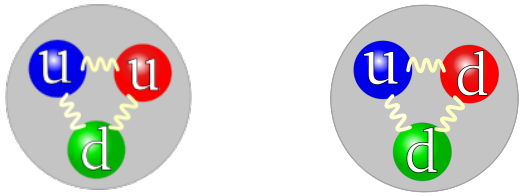
J.Green etal, 2015



T.Hobbs & J.Miller, 2018



The proton and the neutron

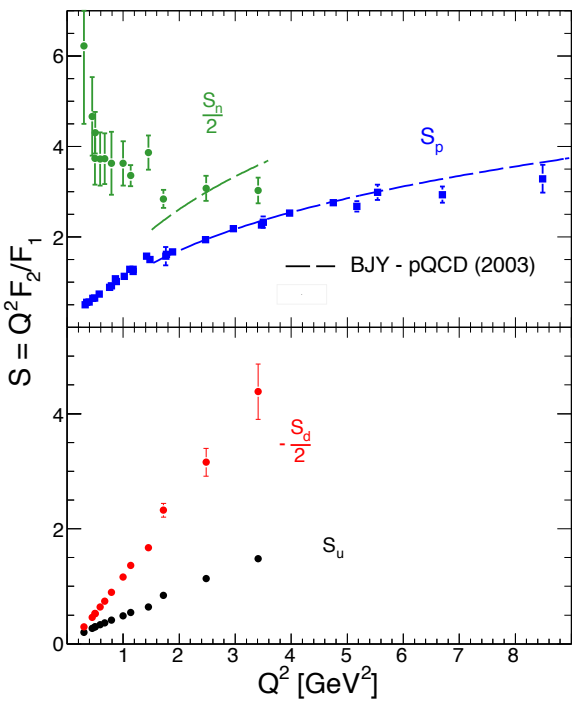


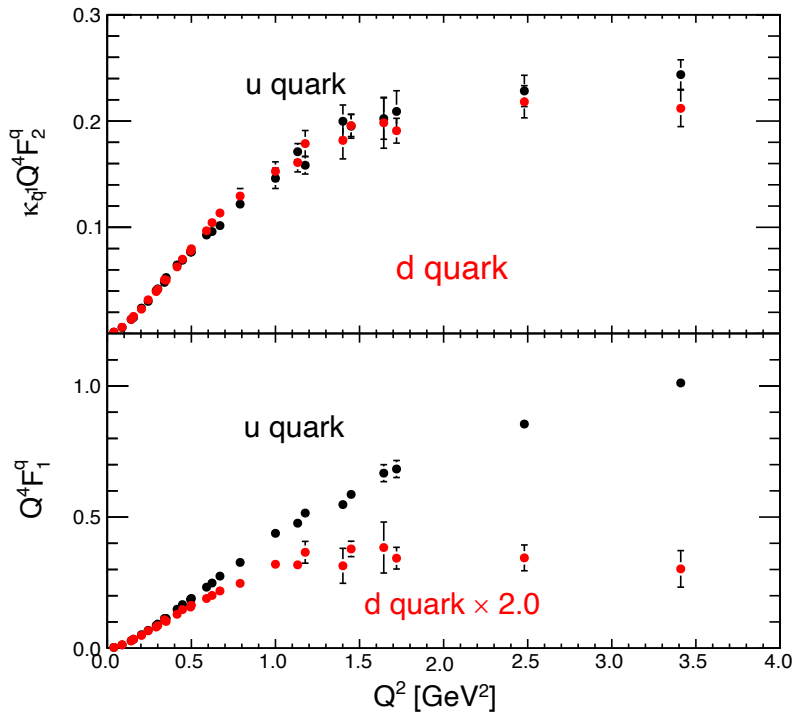
$$F_{1p} = \frac{+2}{3} F_{1u} + \frac{-1}{2} F_{1d}$$

$$F_{1n} = \frac{-1}{3} F_{1u} + \frac{+2}{2} F_{1d}$$

Assuming the charge symmetry and zero strangeness contribution

Flavor decomposition of FF at high Q2





Here we assumed the s-quark role is zero

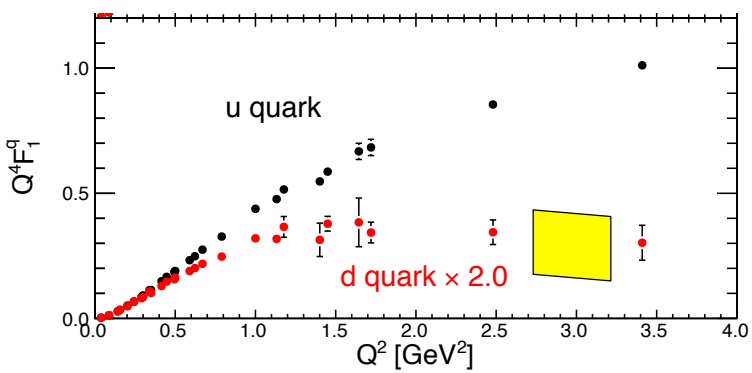
Uncertainty due to sFF is significant

Electromagnetic Form Factors

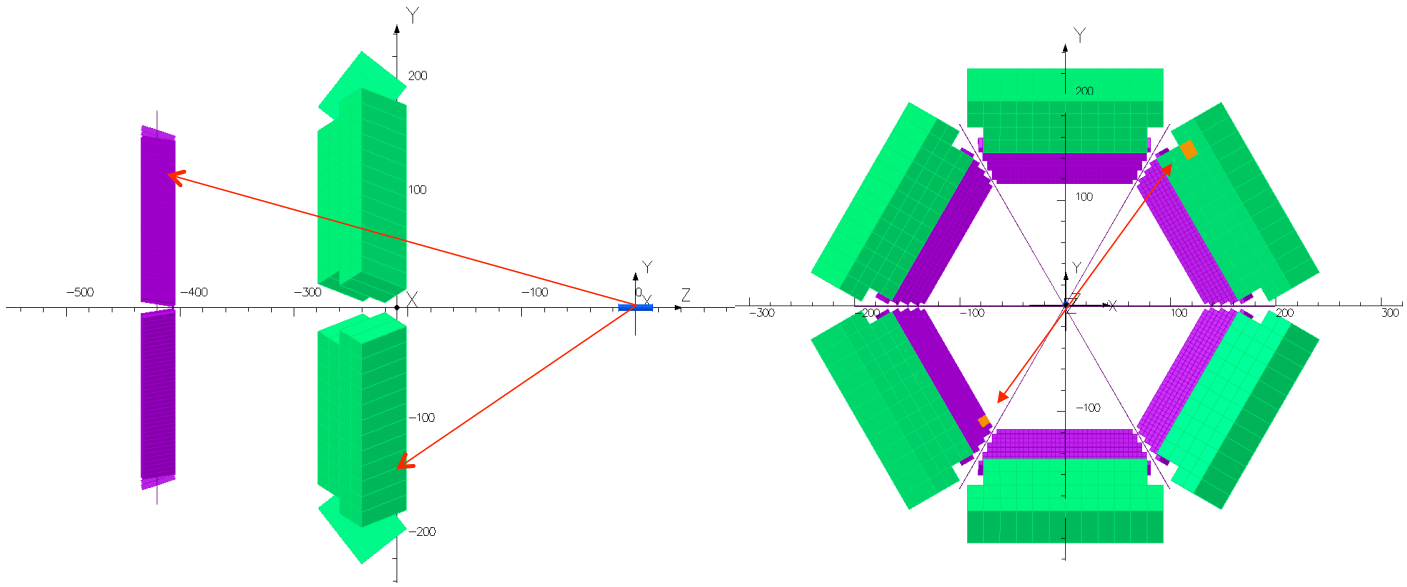
$$F_{1p} = e_u\, F_1^u \;+\; e_d\, F_1^d \;+\; e_s\, F_1^s$$

$$F_{1n} = e_u\, F_1^d \;+\; e_d\, F_1^u \;+\; e_s\, F_1^s$$

$$F_1^u = 2\, F_{1p} \;+\; F_{1n} - \tfrac{1}{3} F_1^s, \quad F_1^d = 2\, F_{1n} \;+\; F_{1p} - \tfrac{1}{3} F_1^s$$



Coincidence parity experiment

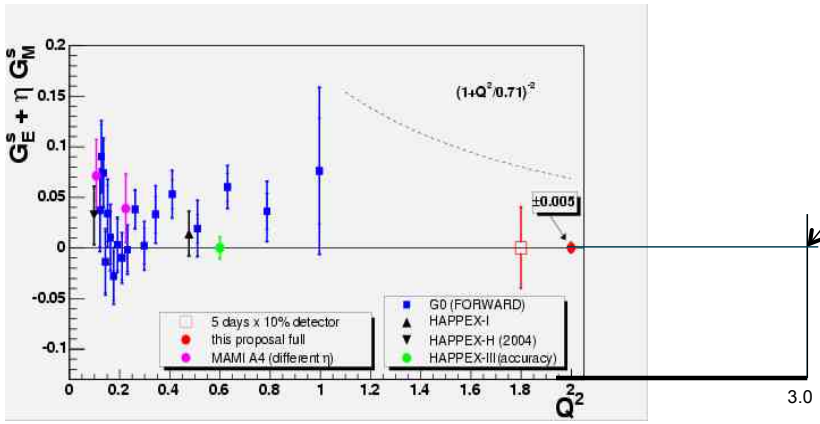


Coincidence parity experiment

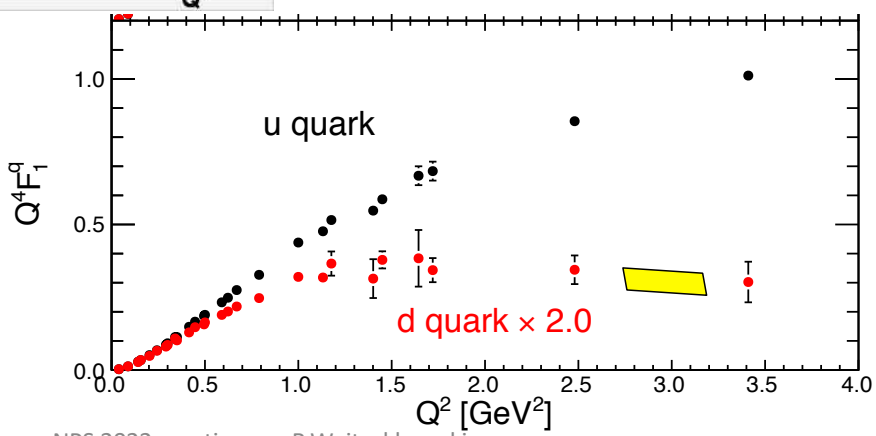
Strangeness Form factor

projected precision
at Q^2 = 3 GeV^2

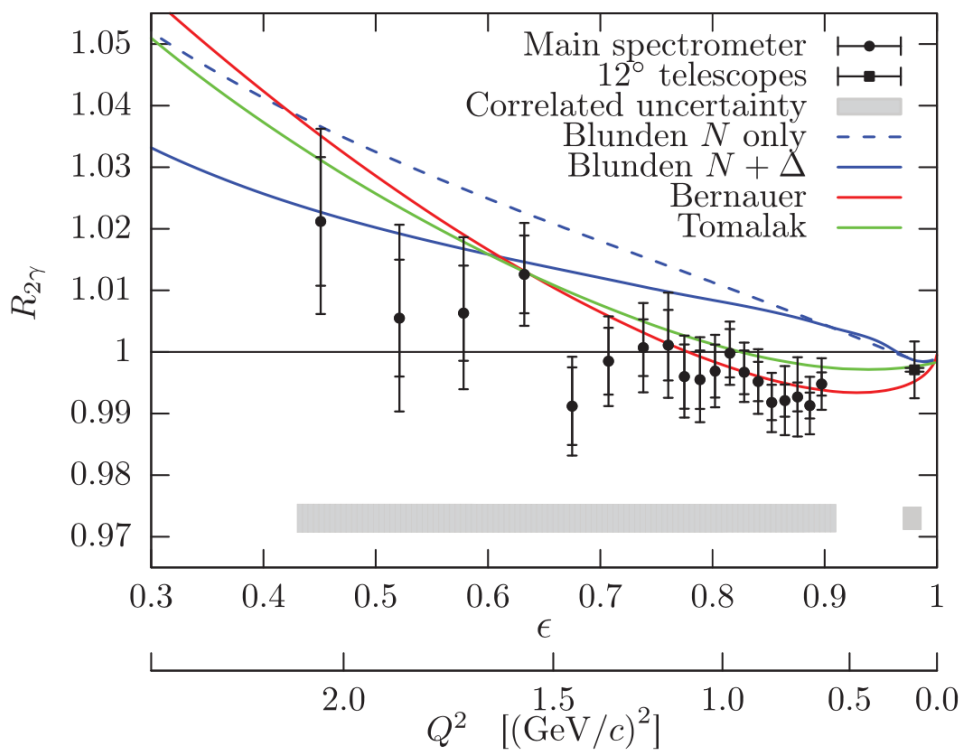
$\Delta G^s/G_D$ = 0.05



3.0



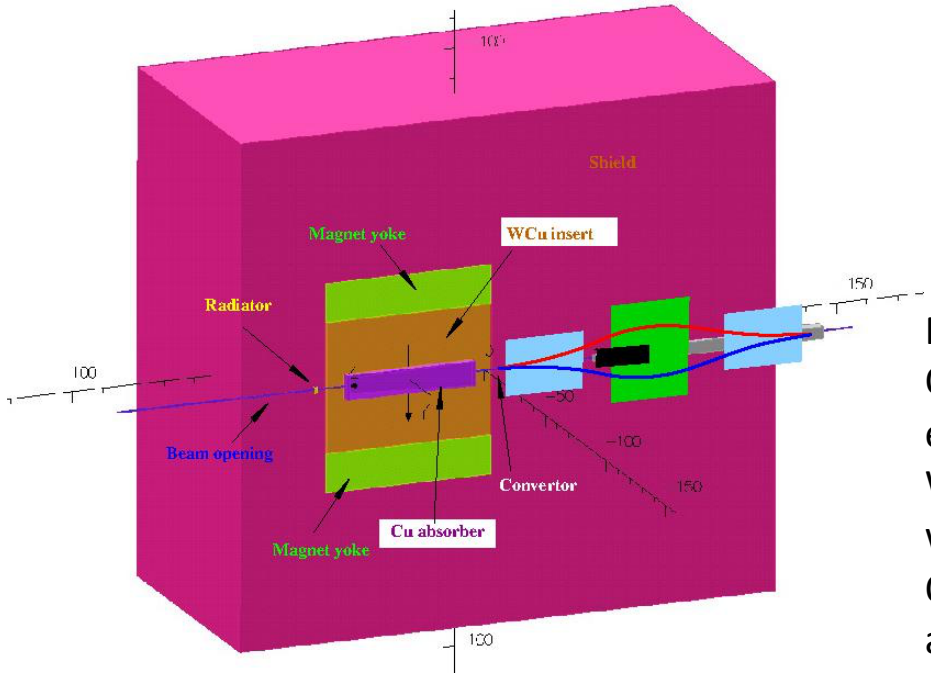
Two Photon Exchange in e-p scattering



Not sufficiently large Q2

Systematics of the detector acceptance in the toroidal system

Positron source based on CPS

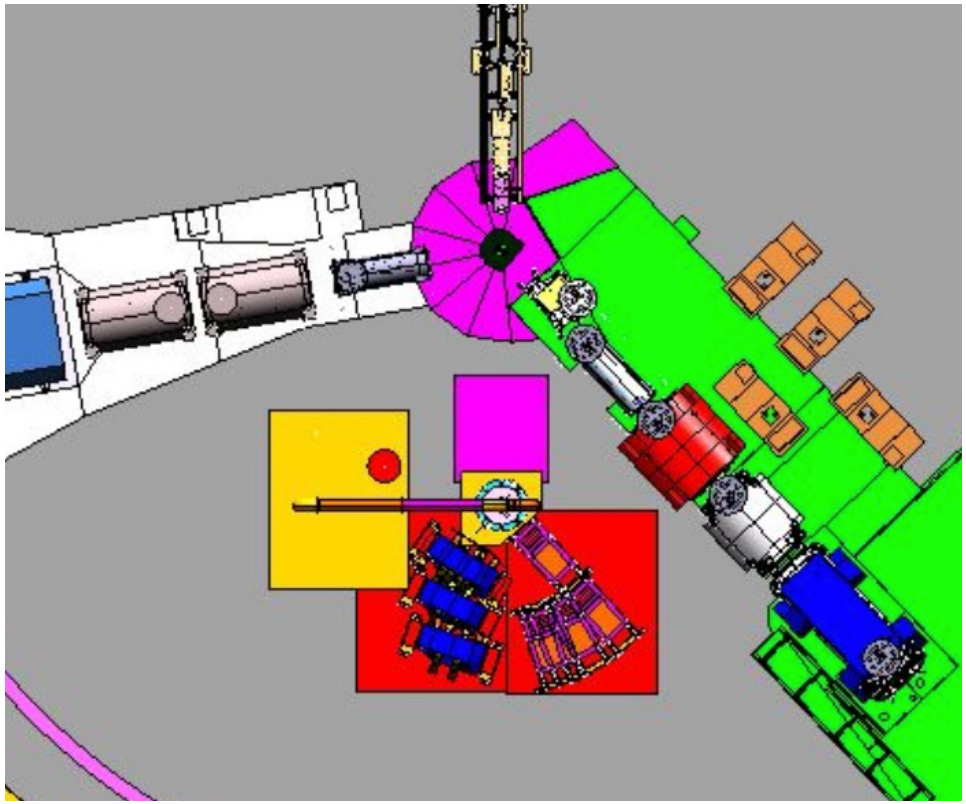


Small phase space of the photon beam

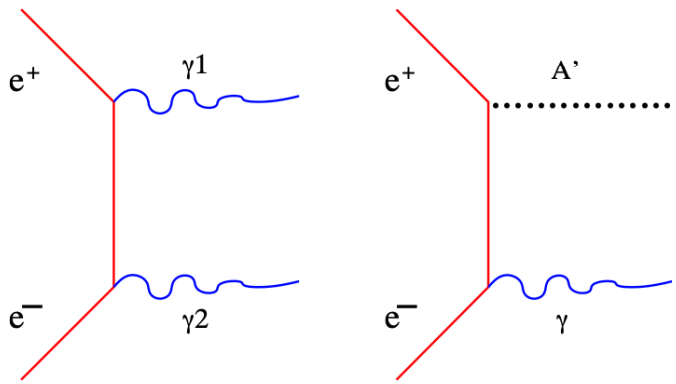
$$I_{\pm} = \frac{P}{E_{beam}} \times t1 \cdot \frac{\Delta E_{\gamma}}{E_{\gamma}} \times t2 \cdot \frac{\Delta E_{\pm}}{E_{\pm}}$$

Measurements at Q2=3 GeV2 at several kinematic points.
Q2 projected counting rate (using a magnetic spectrometer, e.g. BigBite with a solid angle of 50 msr) to be 2.5 Hz .
With 10 hours of production time, e±p event statistics will be ~90k events.
Overall beam time for a sub 0.5% accuracy experiment at 3 GeV2 is about 500 hours.

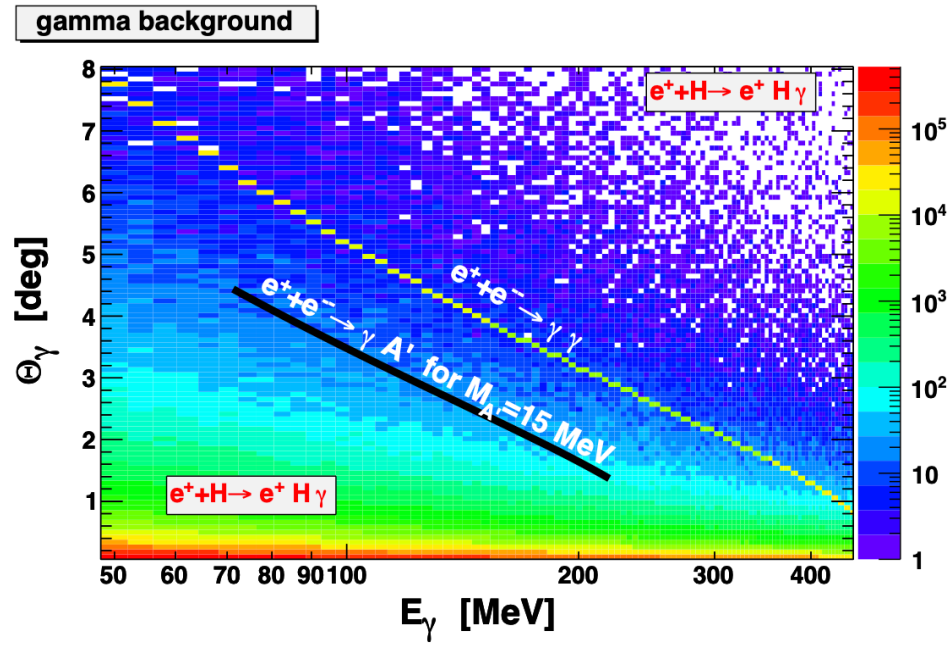
TPE experiment with the CPS positron source



A'/X17 search experiment based on CPS + NPS



arXiv:0906.5265

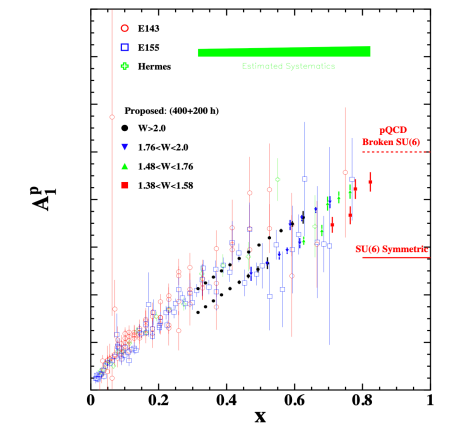


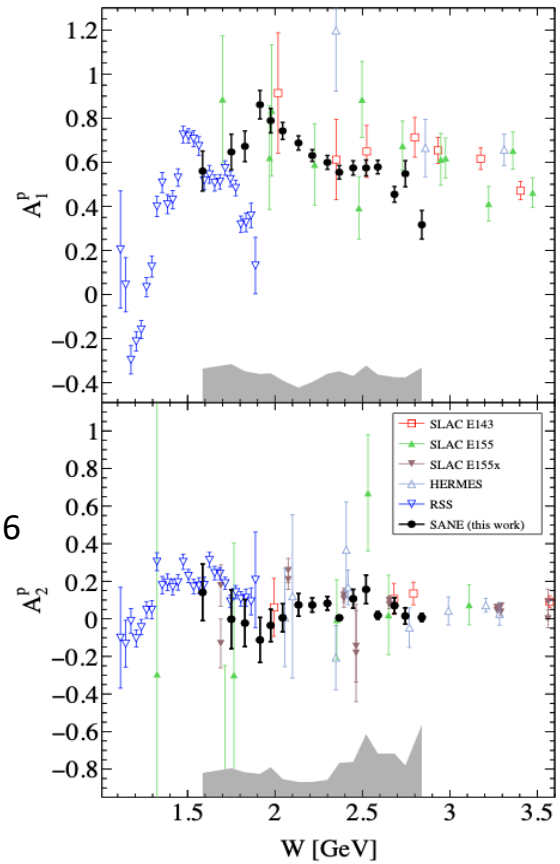
With 1% energy spread, the intensity is 10^9 e+/sec

CPS-based experiment will be 1000x the productivity of PADME

A1p/A2p was done with a 5.9 GeV beam by SANE

Expected in SANE proposal, 2002

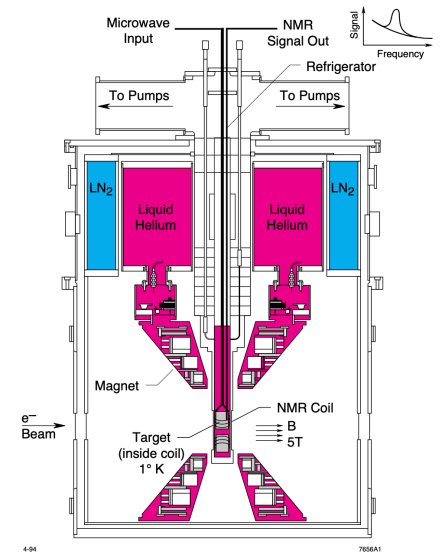


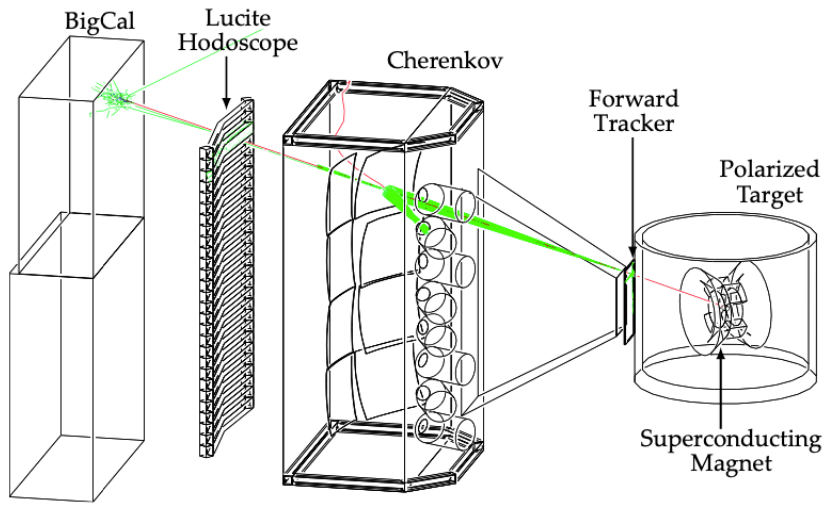


Published results
arXiv:1805.08835v4
PRL 122, 022002 (2019)

The advance in data accuracy and high x (low W) is needed. Reference to P. Bosted's comment in 2016

Apparatus in SANE experiment





Kinematics in DIS experiment with polarized target

E_{beam} (GeV)	I (nA)	θ_N (°)	θ_e (°)	Time (h)
6.0	85	180	40	325
6.0	85	80	40	75
4.8	85	180	40	170
4.8	85	80	40	30
2.4	1000	26	58	50

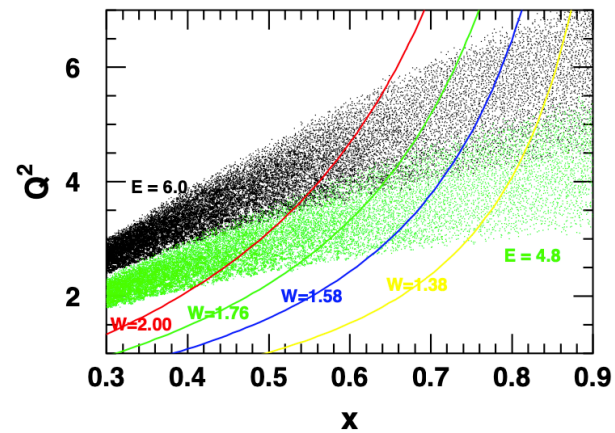
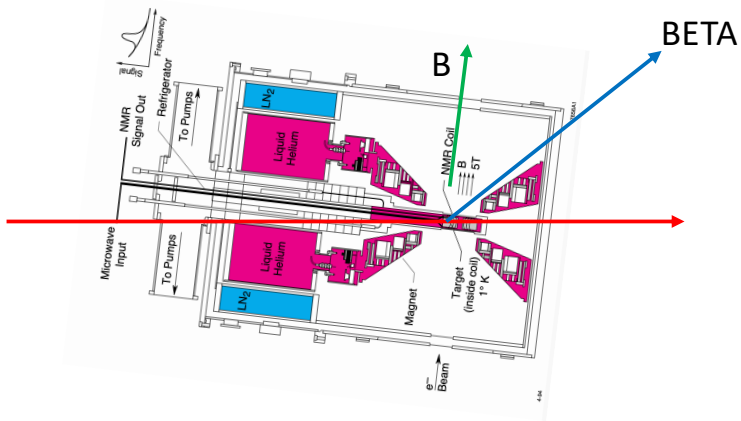


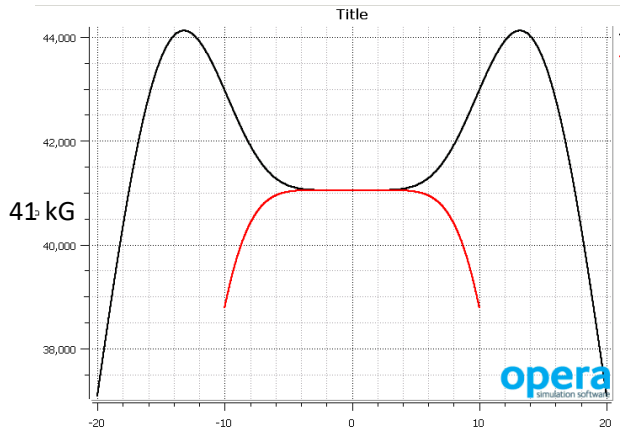
Table 2: Resolutions of SANE for $E = 4.8$ and 6.0 GeV and $\theta_{central} = 40°$. The momenta shown roughly correspond to the lowest and highest x for DIS and the highest x for the second resonance region.

E' (GeV)	x	W (GeV)	$\delta\theta$ (mrad)	$\delta E'$ (GeV)	δx	δQ^2 (GeV^2/c^2)	δW (GeV)
			$E = 6.0$ GeV				
1.0	0.30	2.73	10.1	0.050	0.024	0.160	0.045
1.7	0.59	2.04	4.5	0.065	0.035	0.196	0.076
2.2	0.87	1.35	2.9	0.074	0.048	0.214	0.130
			$E = 4.8$ GeV				
0.8	0.24	2.57	17.0	0.045	0.028	0.131	0.039
1.4	0.49	2.03	5.9	0.059	0.034	0.143	0.061
1.9	0.78	1.43	3.9	0.069	0.050	0.162	0.100



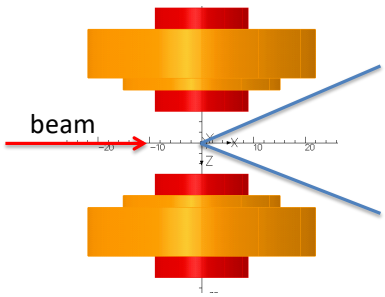
Motivated by need for a wider magnet opening
I presented an option at 2017 NPS meeting

Obtained solution



Red is Bz along the beam direction
Black is Bz along the axis of a solenoid

Double gap (+ 10 cm)!
Opening is 50 deg.
~ 2 * 21*tan((5+4.8)/21)



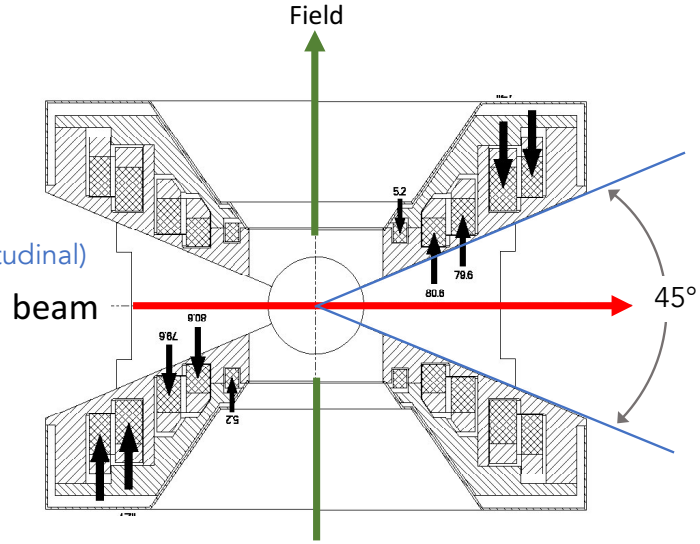
Correction solenoids are outside of the aperture

A real magnet is built by JLab target group

Future Magnet Designs

Oxford Instruments

- ±22.5° open aperture
- 4.2 Tesla central field
- 300 ppm
- 10 cm vertical bore
- ±35° open aperture (longitudinal)



Jefferson Lab Target Group

NPS/CPS Collaboration Meeting
1 February 2019

19

The next A1p/A2p experiment with 11 GeV beam,
wide aperture NH3, BigBite and SBS/NPS
is ready for PAC proposal formulation