Polarization Observables in Wide-Angle Compton Scattering at Photon Energies up to 8 GeV

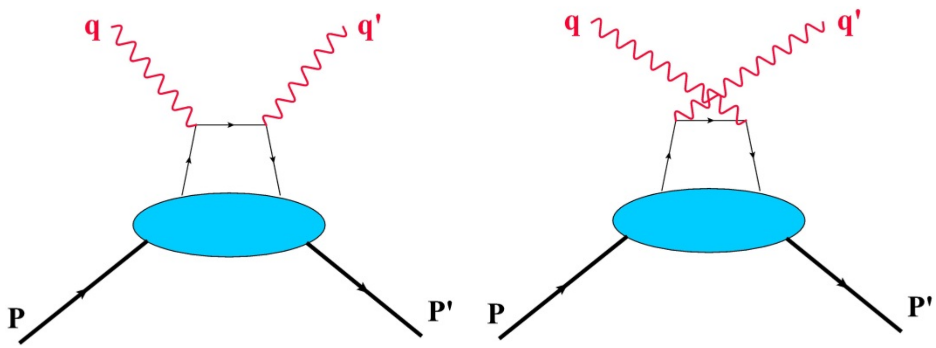
Sergey Abrahamyan (YerPhI)
Gabriel Niculescu (JMU)
Bogdan Wojtsekhowski (JLab)

NPS & SBS collaborations

Collaboration

B. Wojtsekhowski (spokesperson-contact), A. Camsonne, P. Degtiarenko, D. Gaskell,
D. Higinbotham, M. Jones, C. Keith, C. Keppel, D. Mack, R. Michaels, B. Sawatzky, S.A. Wood
Thomas Jefferson National Accelerator Facility, Newport News, VA 23606
S. Abrahamyan (co-spokesperson), A. Asaturyan, H. Mkrtchyan,
V.Tadevosyan, A. Shahinyan, H. Voskanyan, S. Zhamkochyan
A.I. Alikhanyan National Science Laboratory, Yerevan 0036, Armenia
G. Niculescu (co-spokesperson), I. Niculescu
James Madison University, Harrisonburg, VA 22807
J. R. M. Annand, D. Hamilton, D. I. Glazier, D. G. Ireland,
K. Livingston, I.J.D. MacGregor, B. McKinnon, B. Seitz, D. Sokhan
University of Glasgow, Glasgow, Scotland
V. Bellini, M. Capogni, E. Cisbani, A. Del Dotto, C. Fanelli, F. Garibaldi, S. Frullani,
F. Mammoliti, G. Salme, C.M. Sutera, F. Tortorici, G. M. Urciuoli
INFN, Italy
G.B. Franklin, B. Quinn , Carnegie Mellon University, Pittsburgh, PA 15213
A.J.R. Puckett , University of Connecticut, Storrs, CT 06269
A. Ahmidouch and S. Danagoulian , North Carolina A&T State University, Greensboro, NC 27411
G. Cates, R. Lindgren, N. Liyanage, V. Nelyubin , University of Virginia, Charlottesville, VA 22901
The Neutral Particle Spectrometer collaboration:
https://wiki.jlab.org/cuawiki/index.php/Collaboration

Compton scattering



In the GPD approach, interaction goes with a single quark, and the handbag diagram dominates.

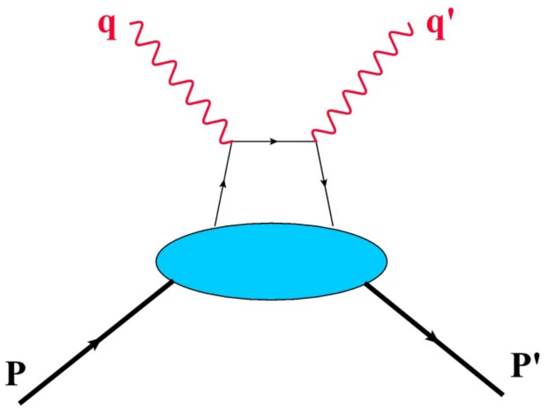
M.Diehl & P.Kroll

$$\frac{d\sigma}{dt} = \frac{d\sigma}{dt}_{KN}\left(\frac{1}{2}\left[R_V^2 + \frac{-t}{4m^2}R_T^2 + R_A^2\right] - \frac{us}{s^2+u^2}\left[R_V^2 + \frac{-t}{4m^2}R_T^2 - R_A^2\right]\right)$$

$$K_{LL} = A_{LL} \qquad K_{LL}\frac{d\sigma}{dt} \equiv \frac{1}{2}\left[\frac{d\sigma(+,\uparrow)}{dt} - \frac{d\sigma(-,\uparrow)}{dt}\right]$$

- Test of the handbag predictions to the <10% level is an important task.
- The K_{LL} (A_{LL}) asymmetry is an observable of choice to test a reaction mechanism.
- The NLO corrections are supposed to vary as 1/s (e.g. N.Kivel & M.Vanderhaeghen).

FFs, GPDs and Polarization Observables



$$R_V(t) = \sum_a e_a^2 \int_{-1}^{1} \frac{dx}{x} H^a(x,0,t)$$

$$R_A(t) = \sum_a e_a^2 \int_{-1}^{1} \frac{dx}{x} sign(\mathrm{x}) \hat{H}^a(x,0,t)$$

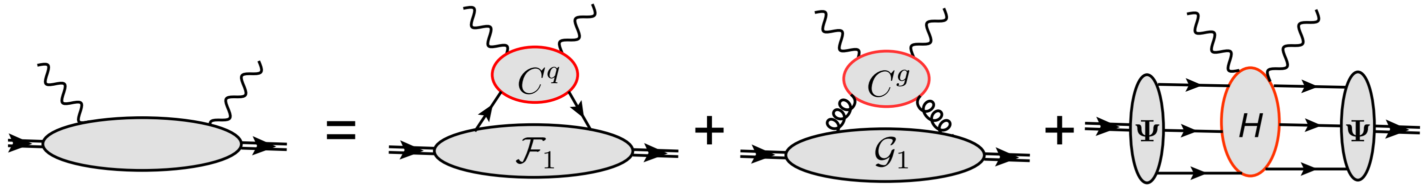
$$R_T(t) = \sum_a e_a^2 \int_{-1}^{1} \frac{dx}{x} E^a(x,0,t)$$

$$K_{LL}^{KN} = \frac{s^2 - u^2}{s^2 + u^2}$$

M.Diehl & P.Kroll

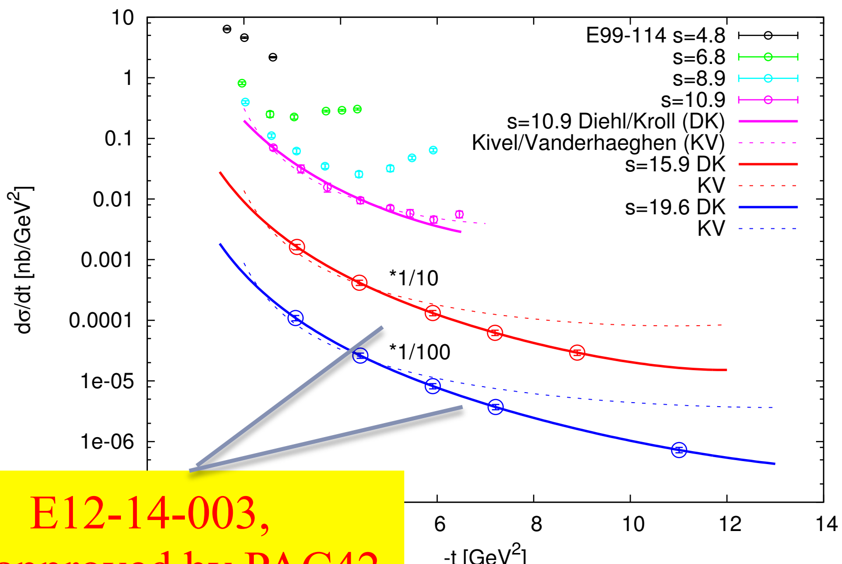
$$A_{LL} = K_{LL} = K_{LL}^{KN} \frac{R_A}{R_V} \left[1 - \frac{t^2}{2\left(s^2 + u^2\right)} \left(1 - \frac{R_A^2}{R_V^2} \right) \right]^{-1}$$

GEp/GMp and WACS

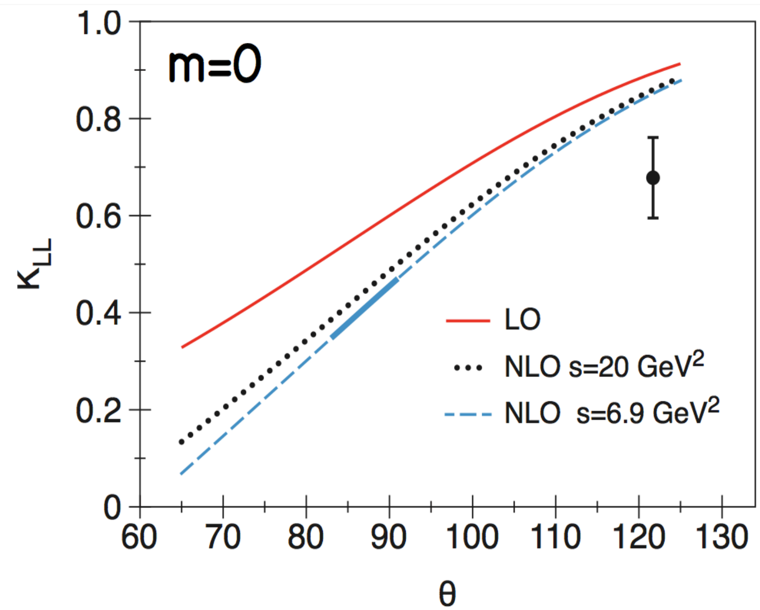


N.Kivel & M.Vanderhaeghen

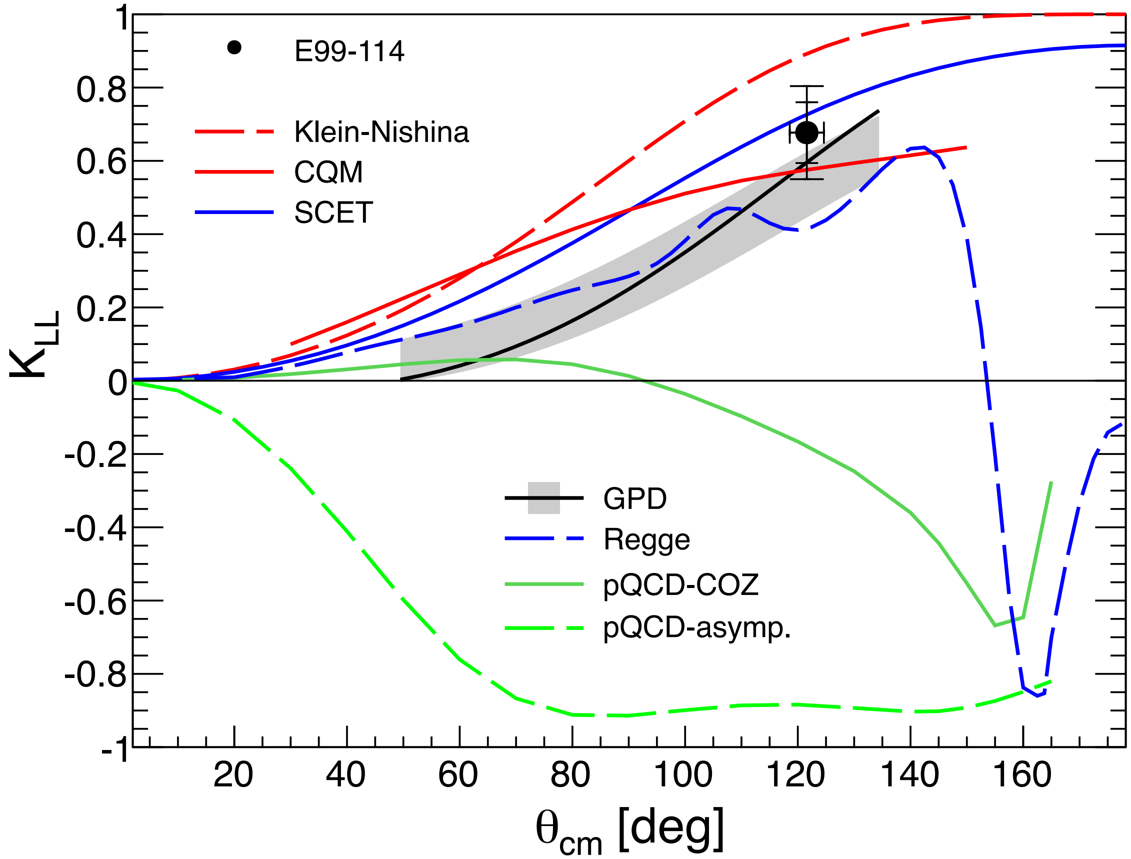
$$\frac{d\sigma}{dt} = \frac{\pi\alpha^2}{s^2}\,|\mathcal{R}(s,t)|^2(-su)\left(\frac{1}{2}|C_2(s,t)|^2 + \frac{1}{2}|C_4(s,t)|^2 + |C_6(s,t)|^2\right)$$



E12-14-003,
approved by PAC42



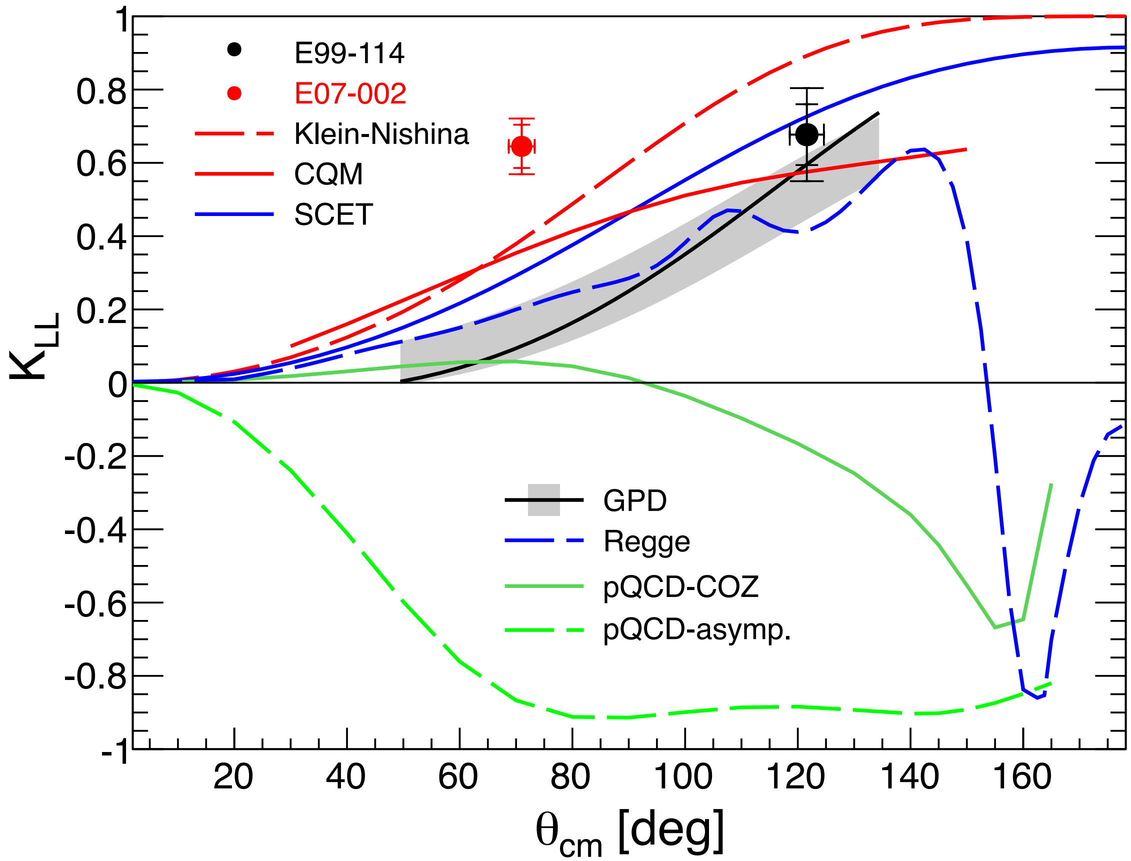
Physics Motivation: study of K_{LL}



E99-114

s=6.9, t=-4.0, u= -1.1 GeV^2

Physics Motivation and a surprise



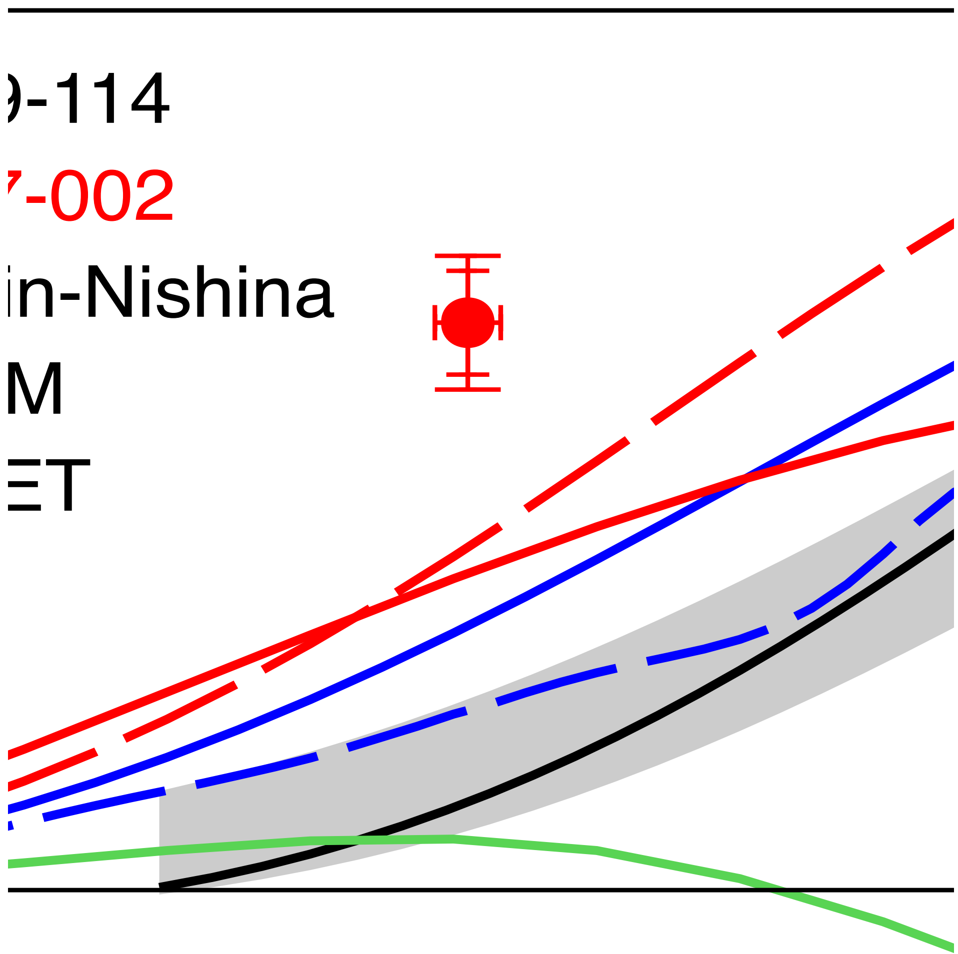
E99-114
s=6.9, t=-4.0, u= -1.1 GeV^2

E07-002
s=7.8, t=-2.1, u= -4.0 GeV^2

arXiv:1506.04045

New measurement at large (doubled) s, t, u values is necessary to clarify the mechanism of WACS.

Physics Motivation and a big surprise



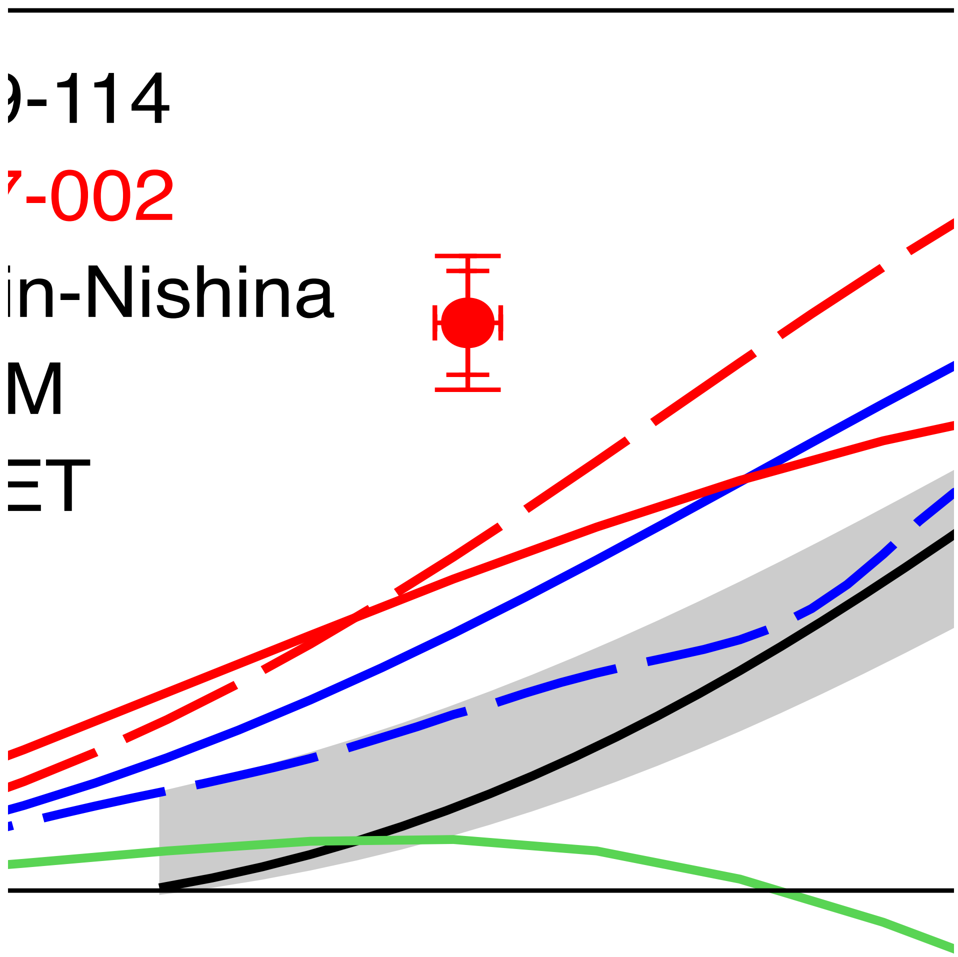
E99-114
s=6.9, t=-4.0, u= -1.1 GeV^2

E07-002
s=7.8, t=-2.1, u= -4.0 GeV^2

arXiv:1506.04045

3.4 σ from the CQM
5.5 σ from the GPD band

Physics Motivation and a big surprise



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s=6.9, t=-4.0, u= -1.1 GeV^2

E07-002
s=7.8, t=-2.1, u= -4.0 GeV^2

arXiv:1506.04045

What is the origin of large K_{LL}?

Quark OAM?

Diquark u-d correlations?

Theory division comments

PR12-15-003: *Polarization Observables in Wide-Angle Compton Scattering at Photon Energies up to 8 GeV*
D. Richards, E. Passemar

The correct mechanism for describing exclusive processes within QCD, and the range of validity in terms of energy scales, has long been a topic of exploration in hadronic physics. Whilst at asymptotic energy scales, the perturbative QCD mechanism proposed, and computed, by Brodsky and Farrar is understood to be correct, it appears clear that such a mechanism is not appropriate for the energy scales accessible at JLab, or indeed at even higher energies. Instead, other mechanisms, including the GPD mechanism (or "handbag diagram"), or the constituent quark model of Miller might provide a better description, though again the issue arises as to whether we are at sufficiently high energy scales.
This question is particularly important for the GPD program at the lab, and the proposed experiment aims at addressing it in the most straightforward system by measuring the initial–state helicity asymmetry ALL in Wide Angle Compton Scattering (WACS).

Theory division comments

The experiment aims at invariant s from 8 to 16 GeV^2 and for several scattering angles from $\theta_{cm} = 80^\circ$ to $\theta_{cm} = 100^\circ$. This is achieved by scattering circularly polarized photons on a polarized proton target, $\vec{\gamma}\vec{p} \to \gamma' p'$. The measurement is performed using an untagged bremsstrahlung photon beam and the polarized target of the g2p experiment. While the scattered photon is detected with the neutral particle spectrometer (NPS), the coincident recoil proton is detected with the Super Bigbite spectrometer (SBS).
The experiment has a similar scope and uses similar techniques of the experiment E12-14-006 supported last year by PAC 42. The difference is in the invariant energies explored. For the E12-14-006 the aim was to measure ALL in WACS for several scattering angles but for only one invariant mass energy s = 8 GeV^2 while in this proposal the aim is to go from 8 to 16 GeV^2 allowing to test the domain of applicability of GPDs (Generalized Parton Distributions). The proposal provides a very comprehensive description of the different mechanisms that can describe the process, and the comparison of the extant data with the expectations from the two mechanisms shown in Figure 21 shows that at the current energies the data are far from both mechanisms.

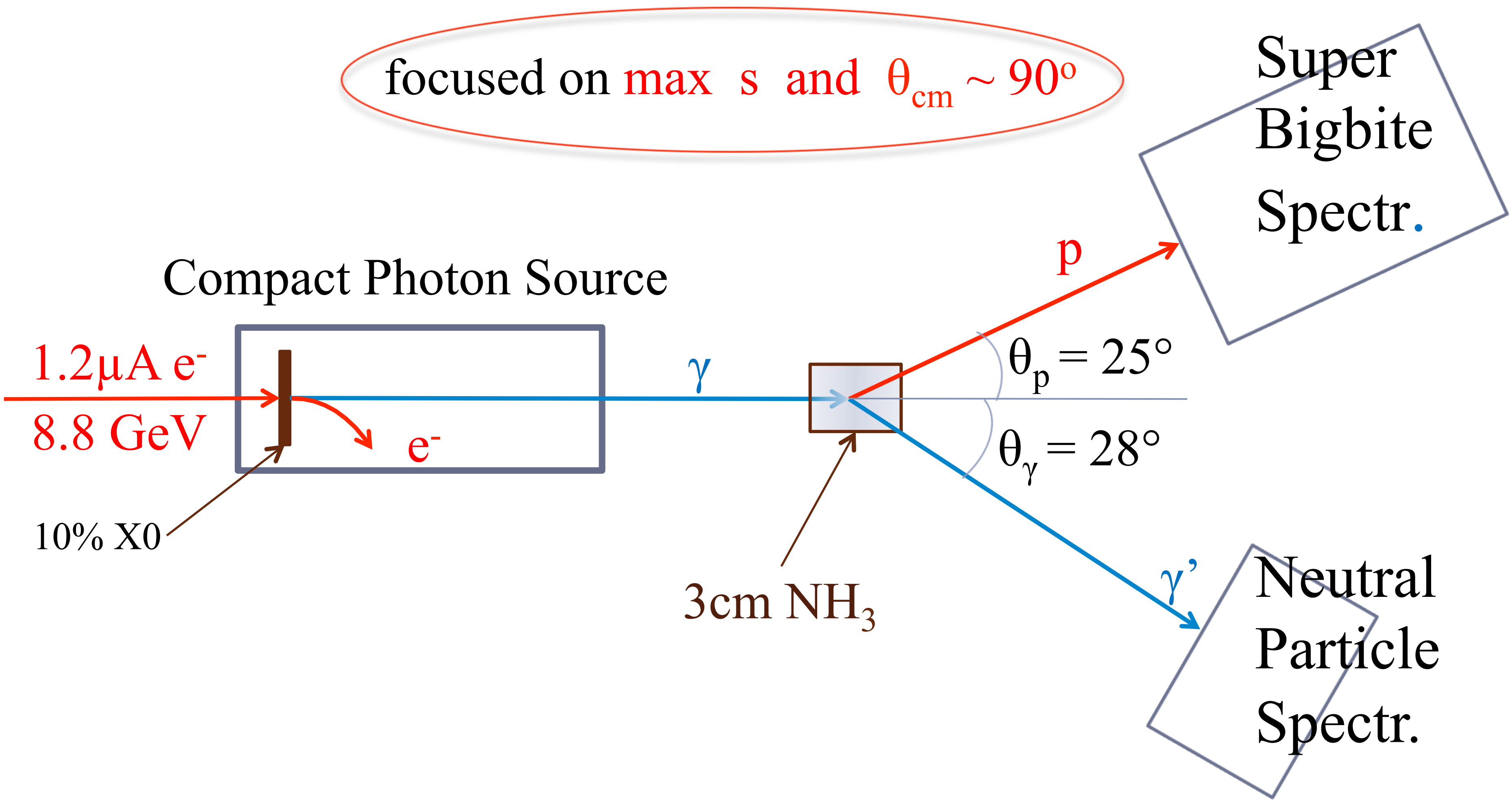
WACS experimental challenges

$$rate \propto 1/s^{7.5}$$

s=8 -> s =16: ~ 1/180

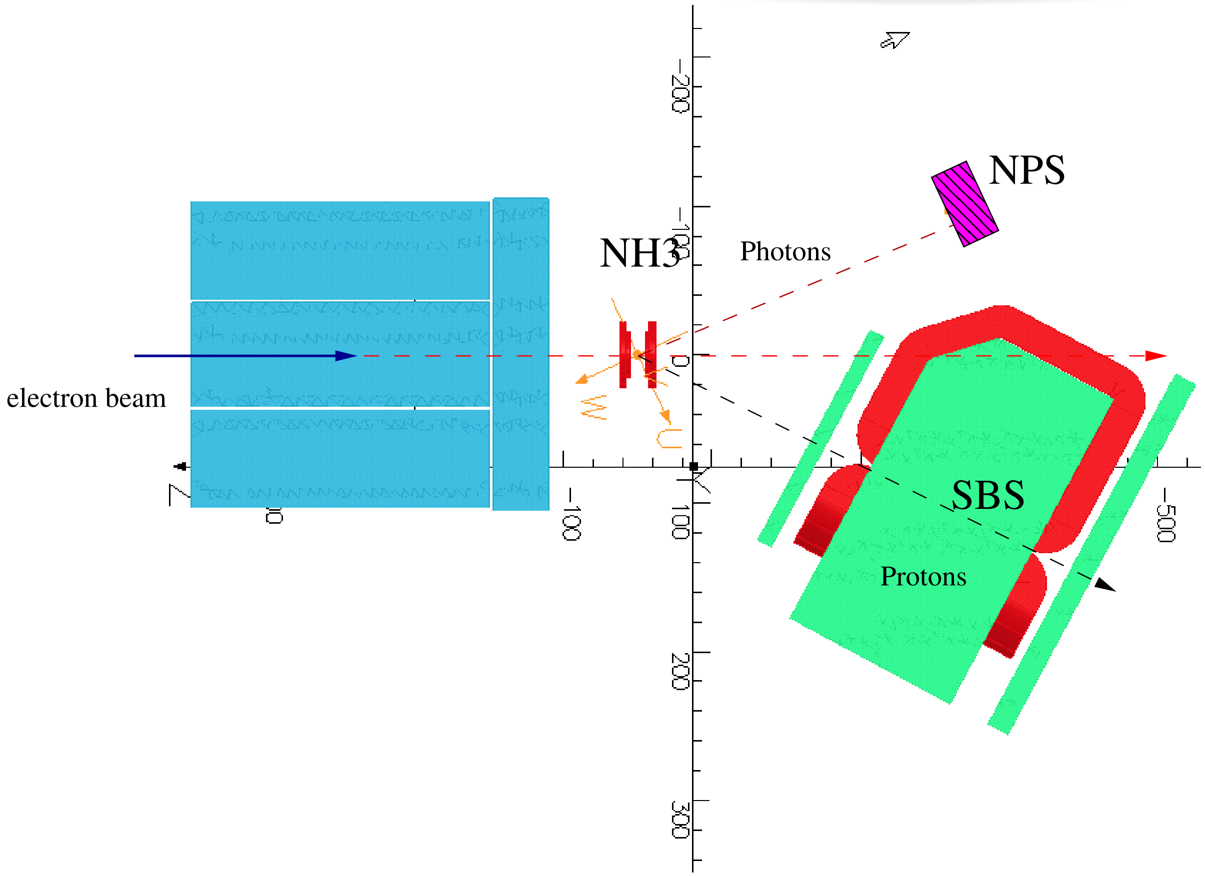
- Beam intensity:
- Polarimeter figure-of-merit (A_Y~1/p) or polarized target power limit (< 90 nA electrons)
- Solid angle of apparatus: HRS/HMS ~ 6-7 msr
- Neutral pion background (dilution): 4+

Proposed Experimental Setup



Proposed Experimental Setup

focused on max s and $\theta_{cm} \sim 90^o$



A floor plan:

the 3D model used in GEANT simulation of physics, radiation and magnetic field calculations

Neutral Particle Spectrometer

Key parameters:

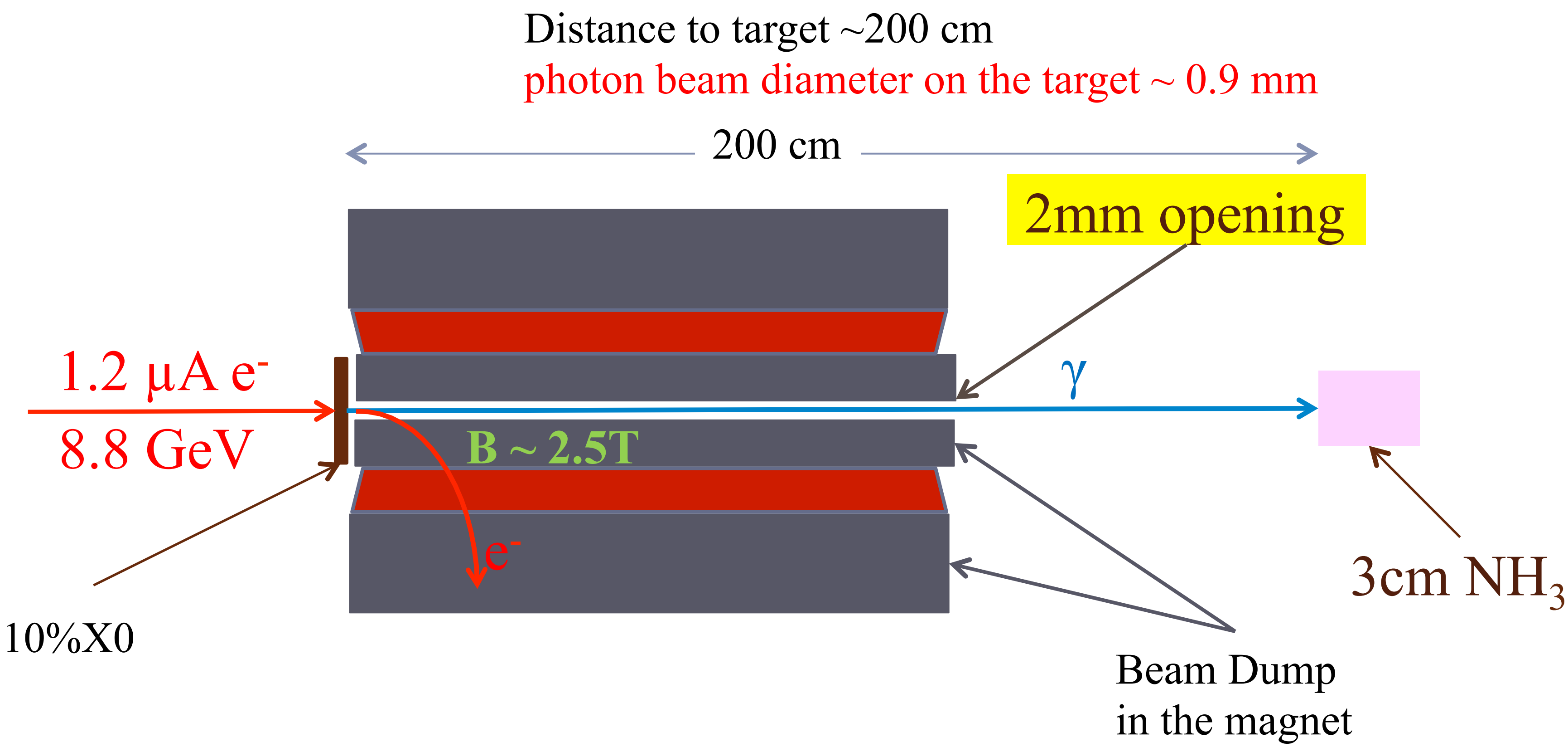
- Energy resolution ~$2\%/\sqrt{E}$
- Radiation hardness PbWO4
- Area/segmentation: 72 cm x 60 cm /1100 crystals
- Coordinate resolution: 2-3 mm

Super Bigbite Spectrometer

Key parameters:

- Solid angle: 70 msr for angle above 15^o
- Momentum acceptance: 2-10, GeV/c
- Angular range: from 5^o (12 msr) to 45^o
- Momentum resolution: 0.29 + 0.03*p, %
- Angular resolution: 0.14 + 1.3/p, mrad

Compact Photon Source



MC simulation and direct calculations show acceptable background rates on SBS and NPS.

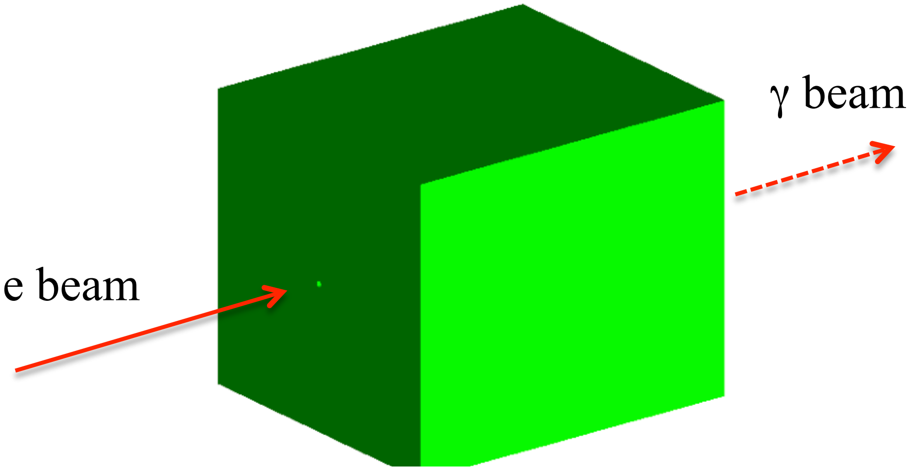
Compact Photon Source: pol. cell heat load

List of materials in the NH3 target for analysis of the heat load

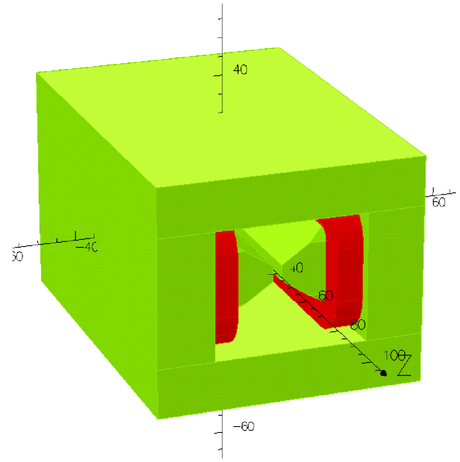
	Material	thickness	unit	density (g/cm3)	X0	Z	A
1.	Beam exit	0.0150	in	1.8500	65.190	4	9
2.	Air gap	3.0000	cm	0.0129	36.660	7	14
3.	OVC entr	0.0080	in	2.700	24.011	13	27
4.	LN2 can	0.0015	in	2.700	24.011	13	27
5.	4K shield	0.0015	in	2.700	24.011	13	27
6.	Tail piece	0.0020	in	2.700	24.011	13	27
7.	Liq. He	0.5000	cm	0.145	94.322	2	4
8.	End cap	0.0015	in	2.700	24.011	13	27
9.	Tgt ^{14}N	3.0000	cm	0.867	40.862	7	14
10.	Tgt H3	3.0000	cm	0.867	40.862	1	1
11.	Tgt He	3.0000	cm	0.145	94.322	2	4
12.	NMR Cu	0.01008	cm	8.960	12.860	29	64
13.	NMR Ni	0.00433	cm	8.760	12.680	28	59
14 .	End cap	0.0015	cm	2.700	24.011	13	27

The calculated heat load in the polarized cell for this experiment is 0.19 Watt, equivalent to a 35 nA electron beam passing through the NH_3 target

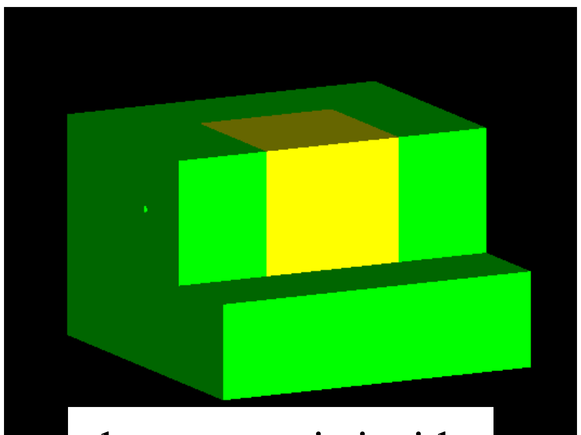
Compact Photon Source – structure



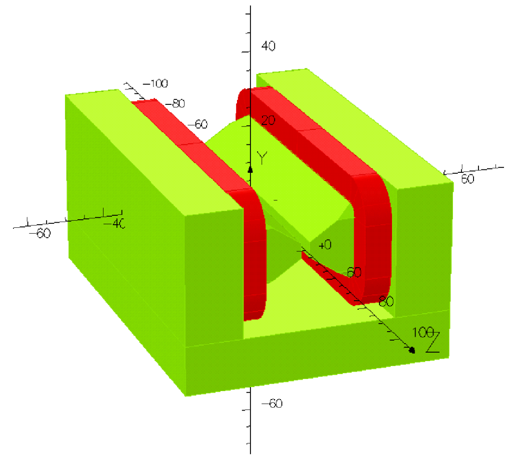
2.6 m x 2.5 m x 2.5 m structure



1 m x 0.6 m x 0.5 m magnet



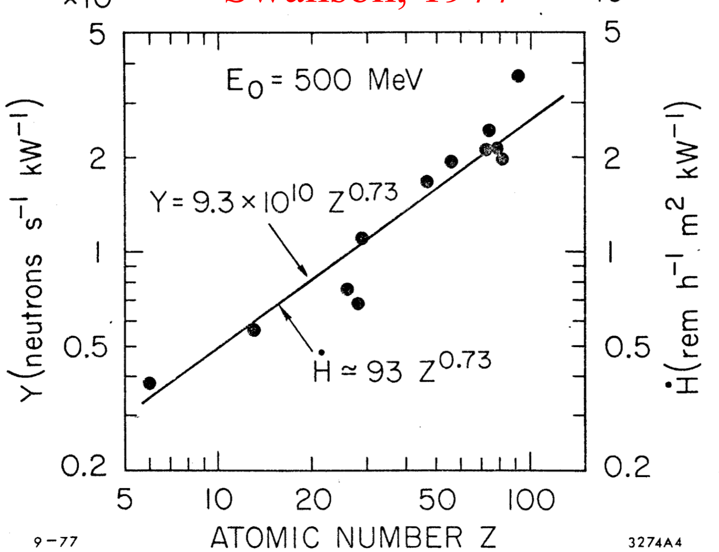
the magnet is inside



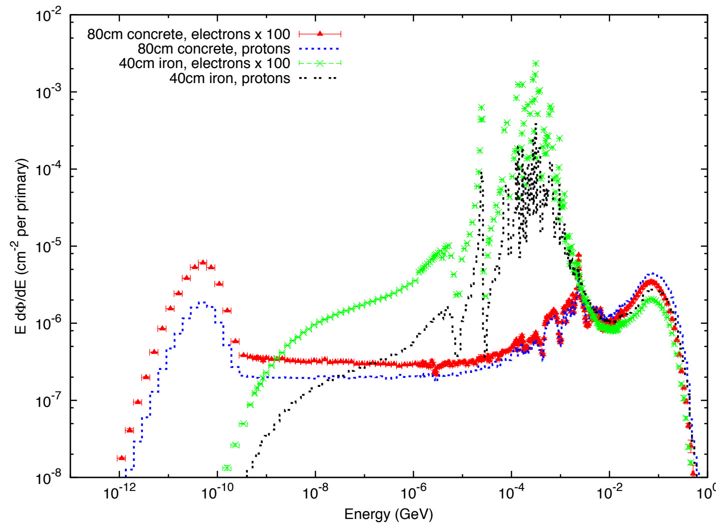
the magnet top plate is removed

Compact Photon Source: radiation

Swanson, 1977



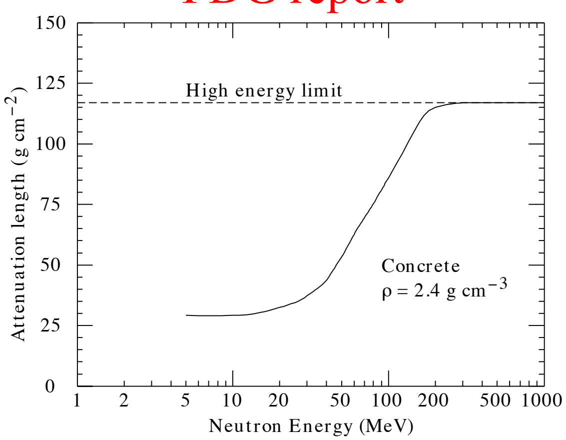
PDG report



1.2 μA x 8.8 GeV => 10kW

10 kW => 20 kRad/hour
at 1 m without a shield

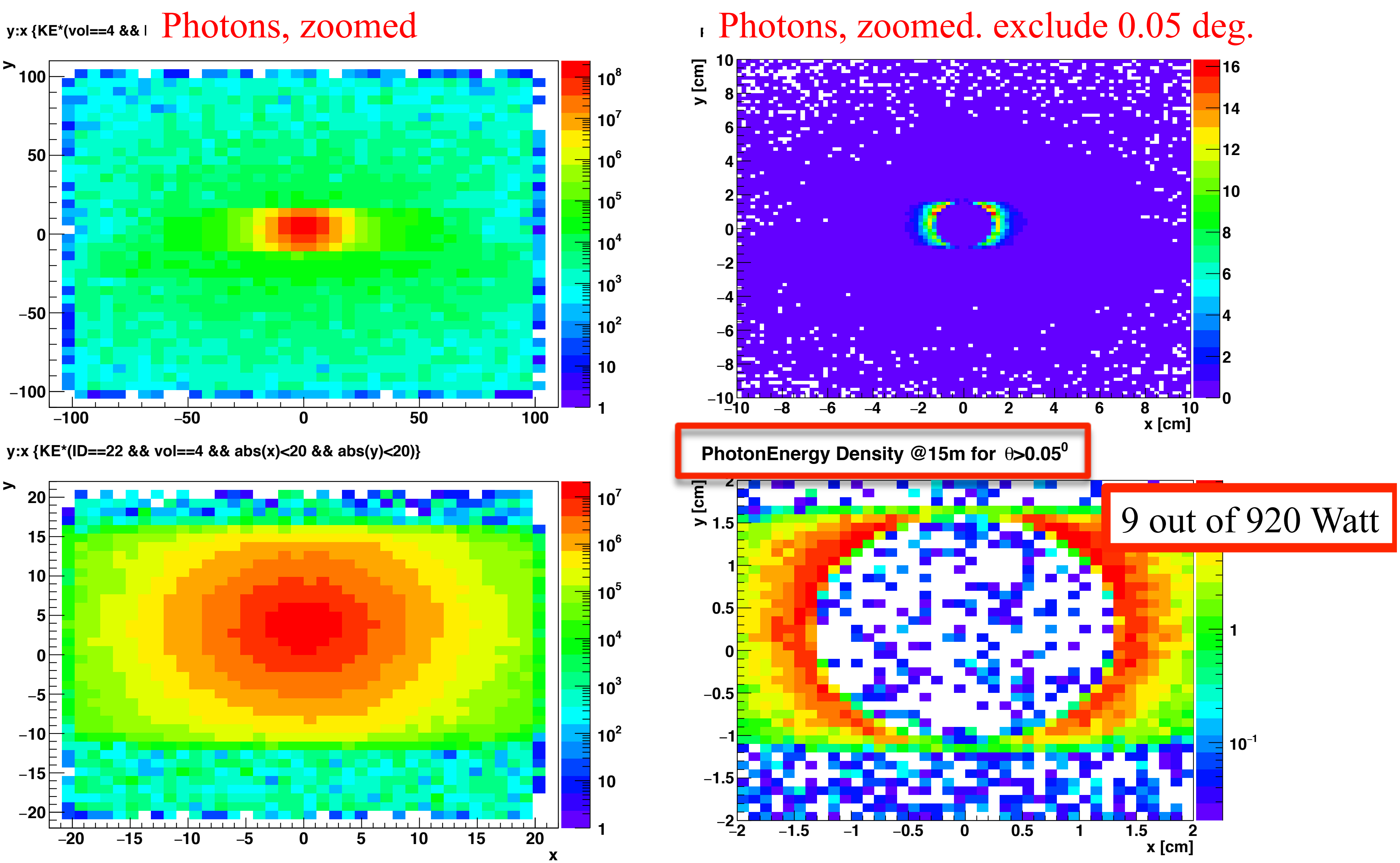
PDG report



10 kW => 0.1 Rad/hour
at 15 m with the 1 m shield

GEANT4-based analysis of the radiation level was performed.
See the backup slides for more information and technical report.

Compact Photon Source: GEANT4 results



Main Experimental Components

SBS	
Angle	25°
Distance [cm]	371 (to detector) 160 (to magnet)
$\Delta\Omega$ [msr]	70
δp [%]	0.5%
$\delta\theta$ [mrad]	0.4
$\delta\phi$ [mrad]	0.4

NPS [60cm x 70cm]	
Angle	28°
Distance [cm]	200
$\Delta\Omega$ [msr]	105
δp [%]	$2\%/E^{1/2}$
δX [mm]	3
δY [mm]	3

Beam	
I [μA]	1.2
E_e[GeV]	8.8
E_γ[GeV]	4 – 8
P_γ	0.45 – 0.78

Compact Photon Source	
Photon flux	6×10^{11} eq. γ/s
Beam spot size	0.9 mm diam.
Slow beam spot	2 cm diameter

NH_3 target	
t [g/cm^2]	2.61
$f_{packing}$	0.6
P_p	0.75

Key features of the proposed setup

- Photon detector, NPS: E, x and y high resolutions; 100 msr.
- Proton detector, SBS: 70 msr solid angle (10x of HRS/HMS).
- Photon flux, local Beam Dump: 6 x10^{11} eq. γ/s ~ 10x of mix e/γ
- Compact photon spot: 0.9 mm by means of the magnet-dump configuration (key importance for "pion" dilution).
- Polarized NH_3 target, as it was used in the Hall A g2p/gep exp.

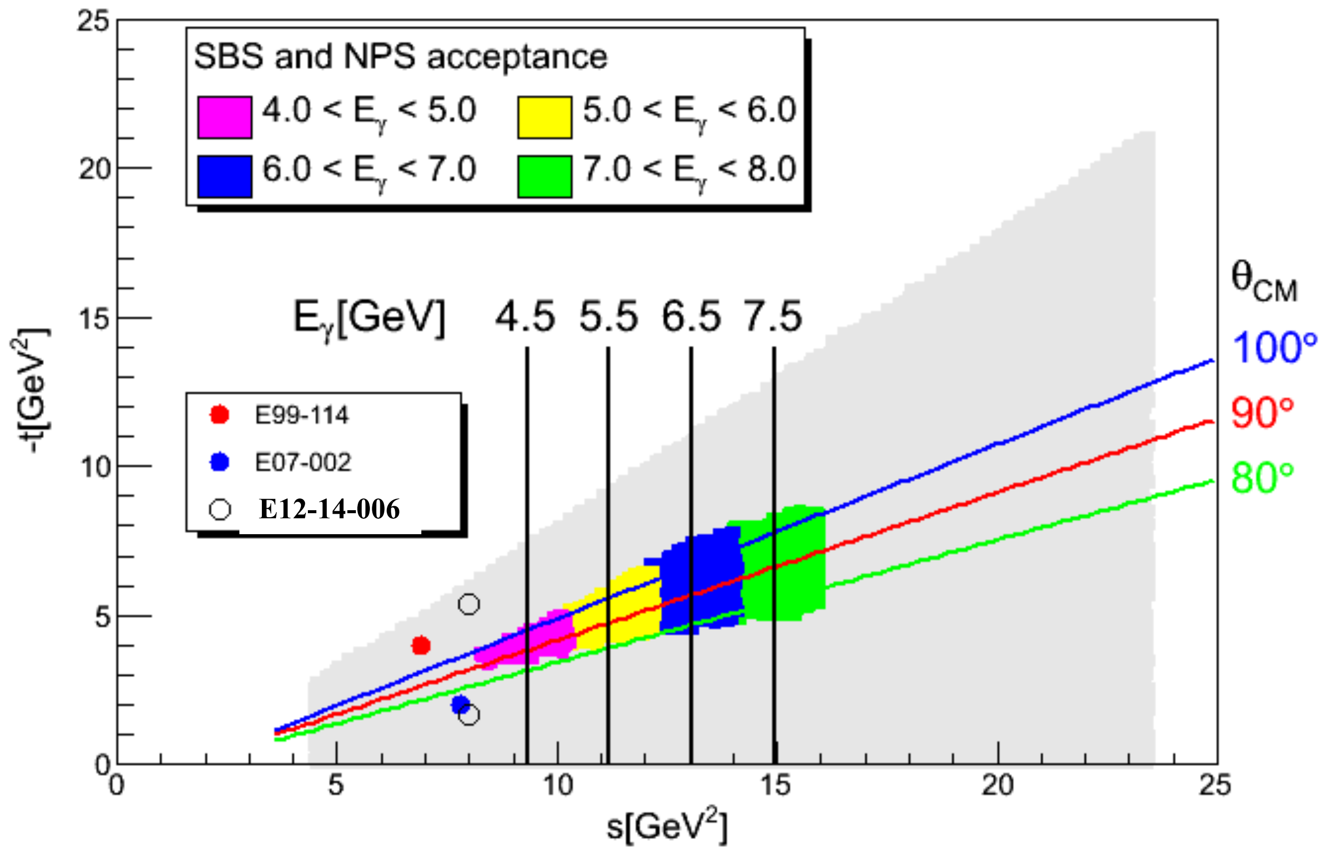
Kinematic range

Detector acceptance will cover wide kinematic range in "one set".

s: 8.0 – 16.0 GeV^2
-t: 3.0 – 7.0 GeV^2
-u: 3.0 – 7.0 GeV^2

θ_{cm} : 80° – 100°

$<\theta_{cm}> \sim 90°$



Statistics

$$N_{RCS} = \frac{d\sigma}{dt}\frac{\left(E'_{\gamma}\right)^2}{\pi}\cdot\Delta\Omega_{\gamma} f_{\gamma p}\cdot N_p\cdot N_{\gamma}$$

$\Delta\Omega_{\gamma} = 100$ msr $\quad N_p = 1.65\cdot 10^{23}$

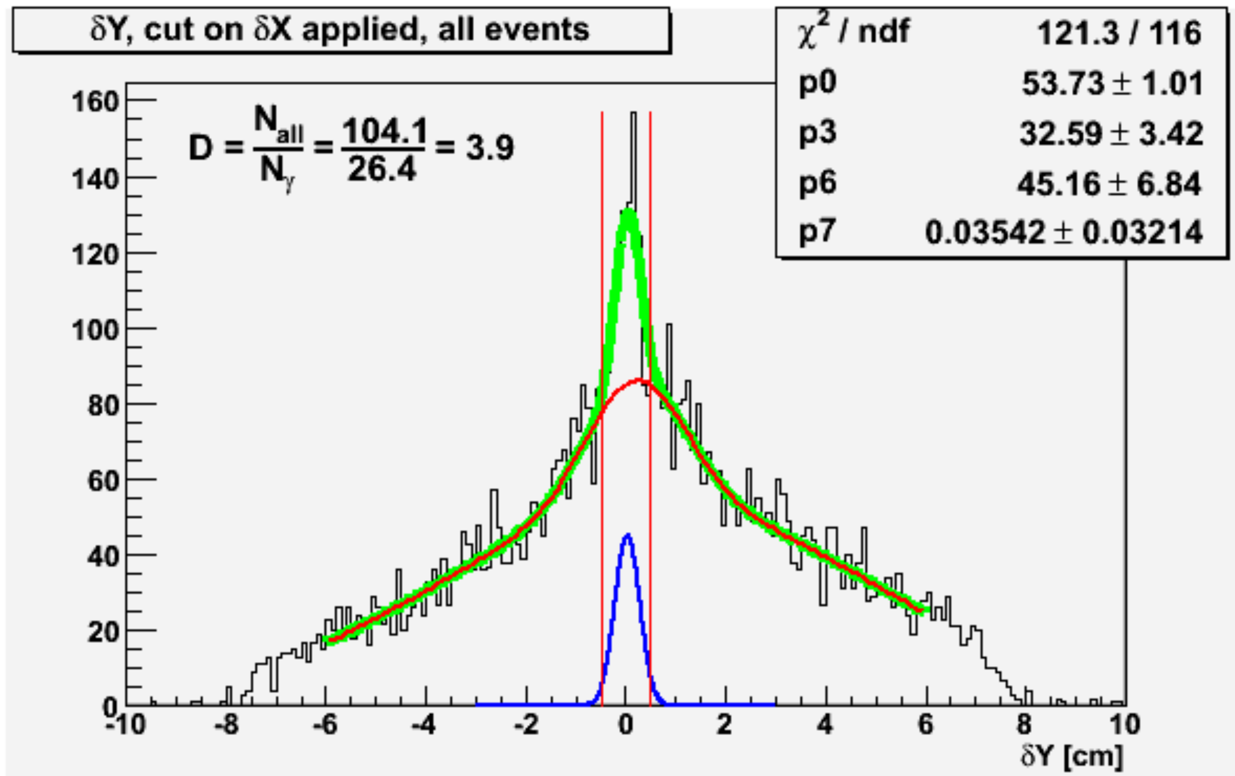
$$\Delta A_{LL} = \frac{1}{\sqrt{\frac{N_{RCS}}{D}}P_p P_{\gamma}}$$

Kinematics	1	2	3	4
s (GeV^2)	9.4	11.0	13.0	15.0
-t (GeV^2)	4.0	4.9	5.8	6.5
E'_{γ} (GeV)	2.4	2.7	3.3	4.0
$\frac{d\sigma}{dt}$ (cm^2/GeV^2)	$21\cdot 10^{-36}$	$5.3\cdot 10^{-36}$	$1.5\cdot 10^{-36}$	$0.6\cdot 10^{-36}$
$f_{\gamma p}$	0.21	0.43	0.49	0.45
N_{γ} (per sec)	$1.5\cdot 10^{11}$	$1.2\cdot 10^{11}$	$1.1\cdot 10^{11}$	$0.9\cdot 10^{11}$
N_{RCS} (per hour)	72	36	18	7.2
N_{RCS} (250 hours)	18000	9000	4500	1800

Dilution due to pion background

	Kin 1	Kin 2	Kin 3	Kin 4
D	3.1	3.8	4.0	3.9

$$\Delta A_{LL} = \frac{1}{\sqrt{\frac{N_{RCS}}{D} P_p P_\gamma}}$$



There are small contributions from ΔA_{LL}^{pion} and ^{14}N proton effects, see in backup slides.

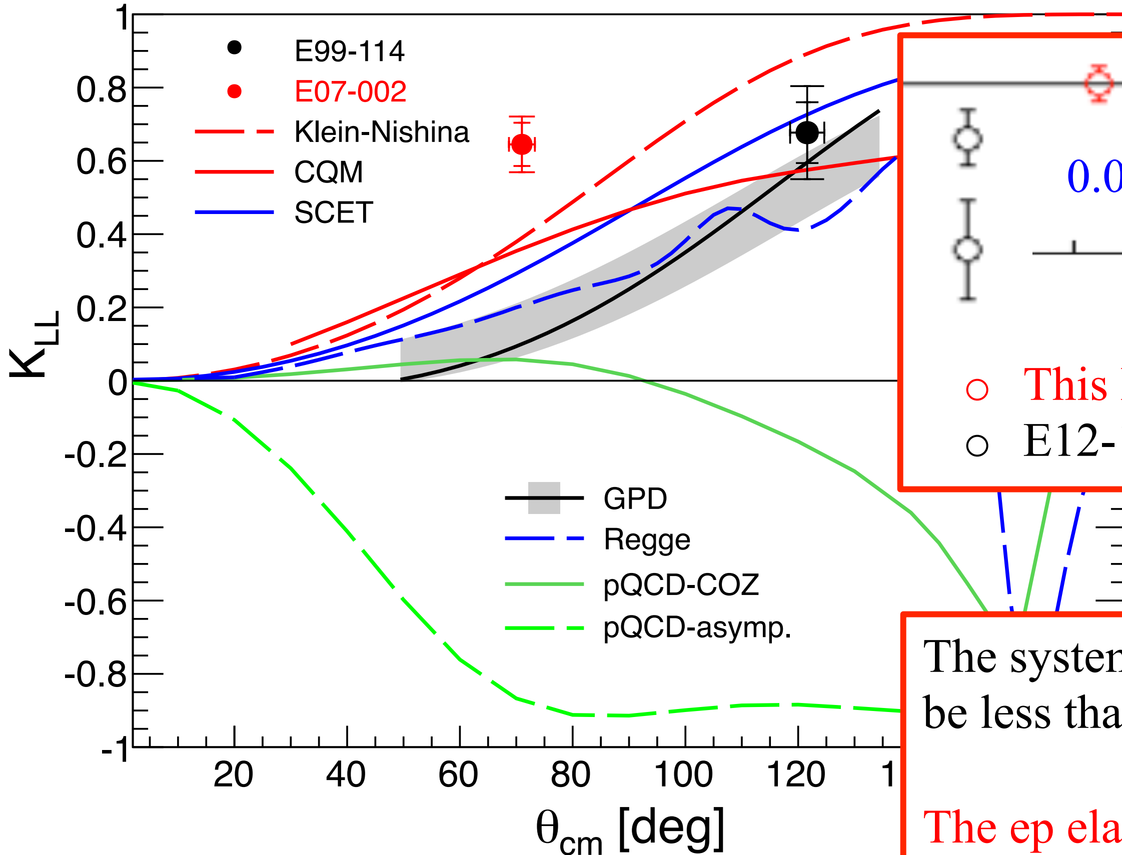
Estimated statistics and A_{LL} uncertainties

$$P_p = 0.75$$

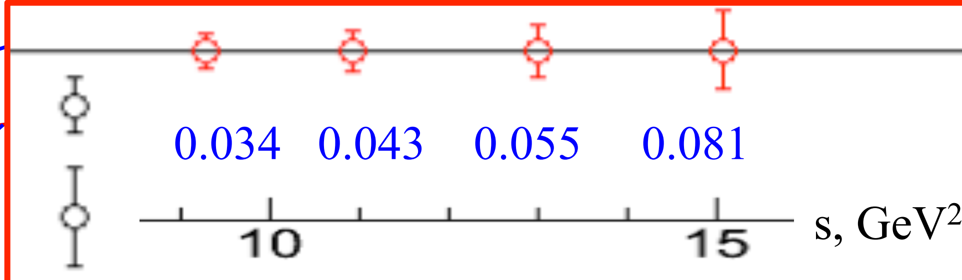
$$\Delta A_{LL} = \frac{1}{\sqrt{\frac{N_{RCS}}{D}} P_p P_\gamma}$$

Kinematics	1	2	3	4
s (GeV^2)	9.4	11.0	13.0	15.0
-t (GeV^2)	4.0	4.9	5.8	6.5
θ_{cm}	93	92	91	89
P_γ	0.52	0.63	0.72	0.77
D	3.1	3.8	4.0	3.9
N_{RCS} (250 hours)	18000	9000	4500	1800
ΔA_{LL}	0.034	0.043	0.055	0.081

Physics Motivation, projected accuracy



High statistical accuracy



○ This Proposal, $\theta_{cm} = 90^o$

○ E12-14-006, θ_{cm}=60^o, 136^o (-u~0.8 GeV^2)

Good systematic accuracy

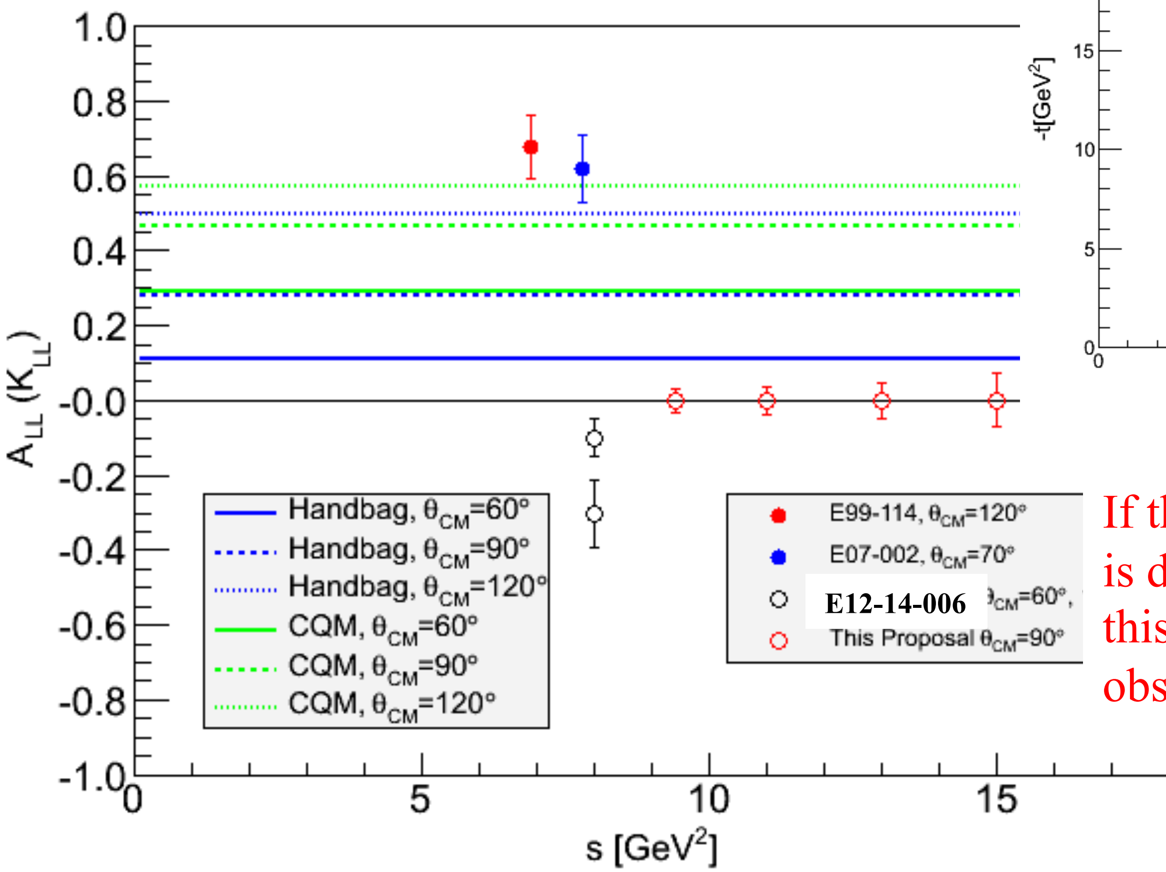
The systematics for the A_{LL} is projected to be less than 0.03 (absolute):

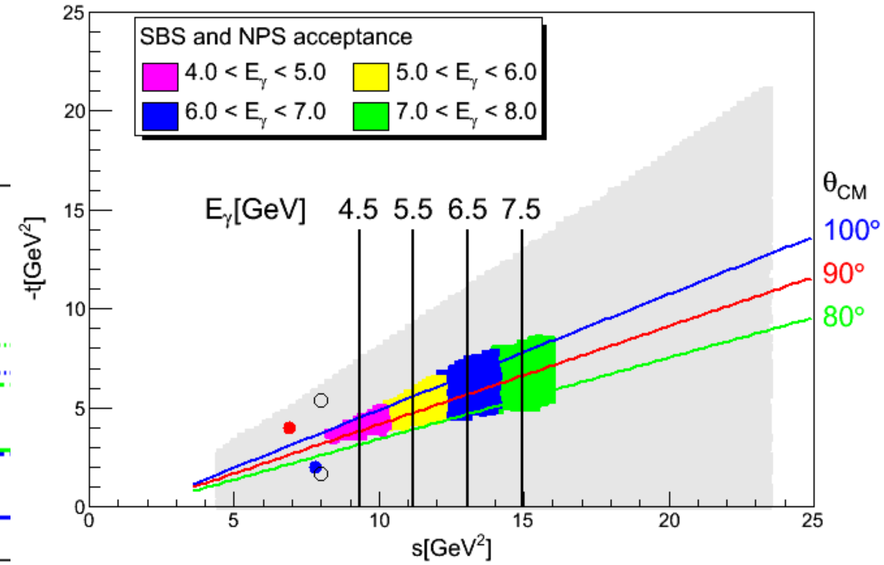
The ep elastic data A_{LL} –> product of the beam and target polarizations, $\delta(P_t{*}P_b)$~ 4%;

the beam pol. via Moller measurement, ~1%;

the target pol. via NMR, δP_t ~5%.

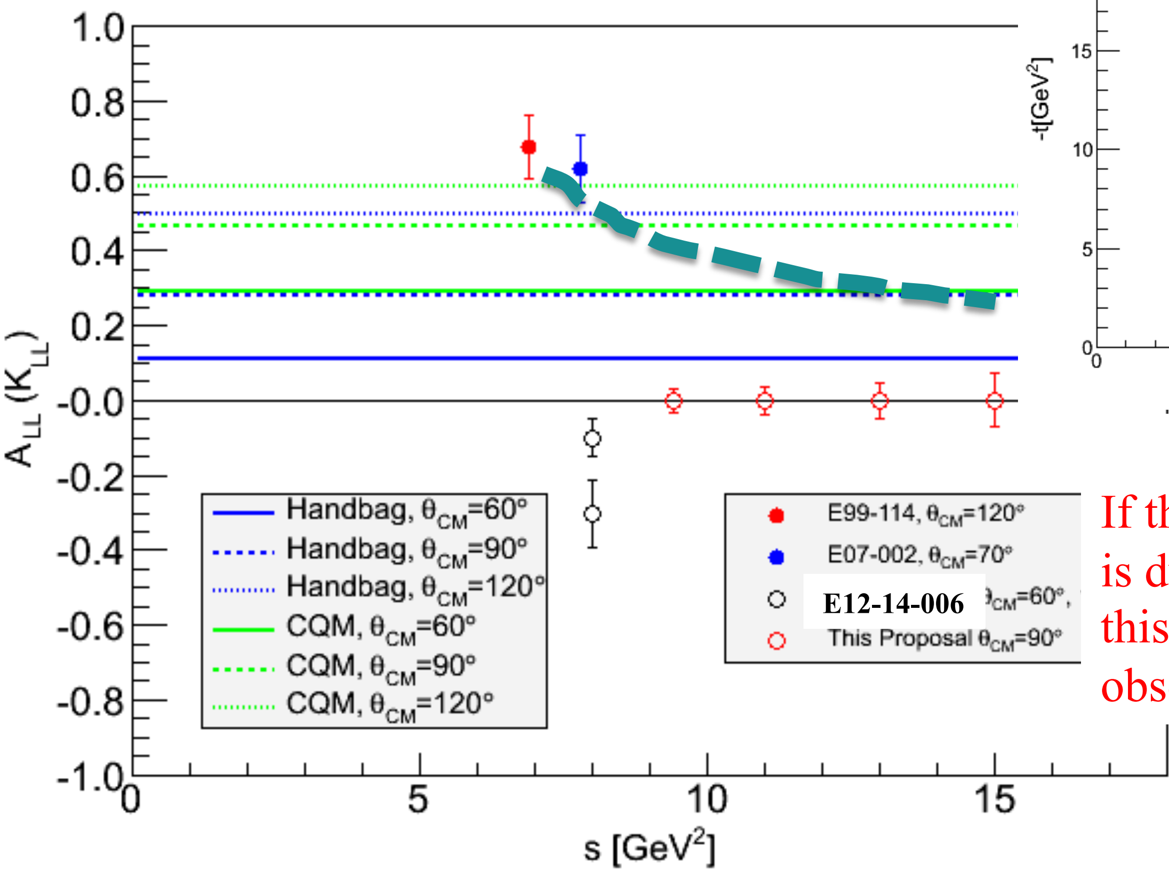
Projected impact of the results

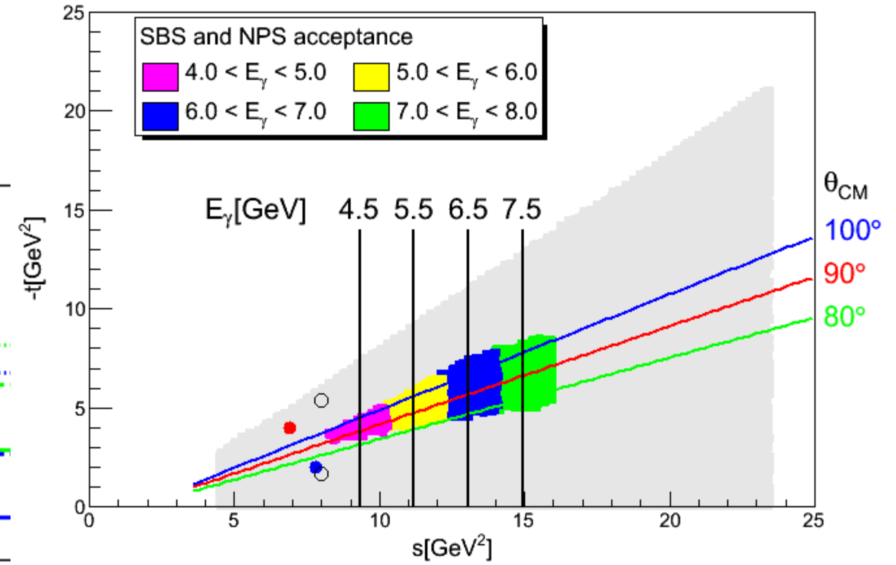




If the observed large K_{LL} at θ_{cm} = 70° is due to large 1/*s* NLO contributions, this experiment should be able to observe an *s* dependence.

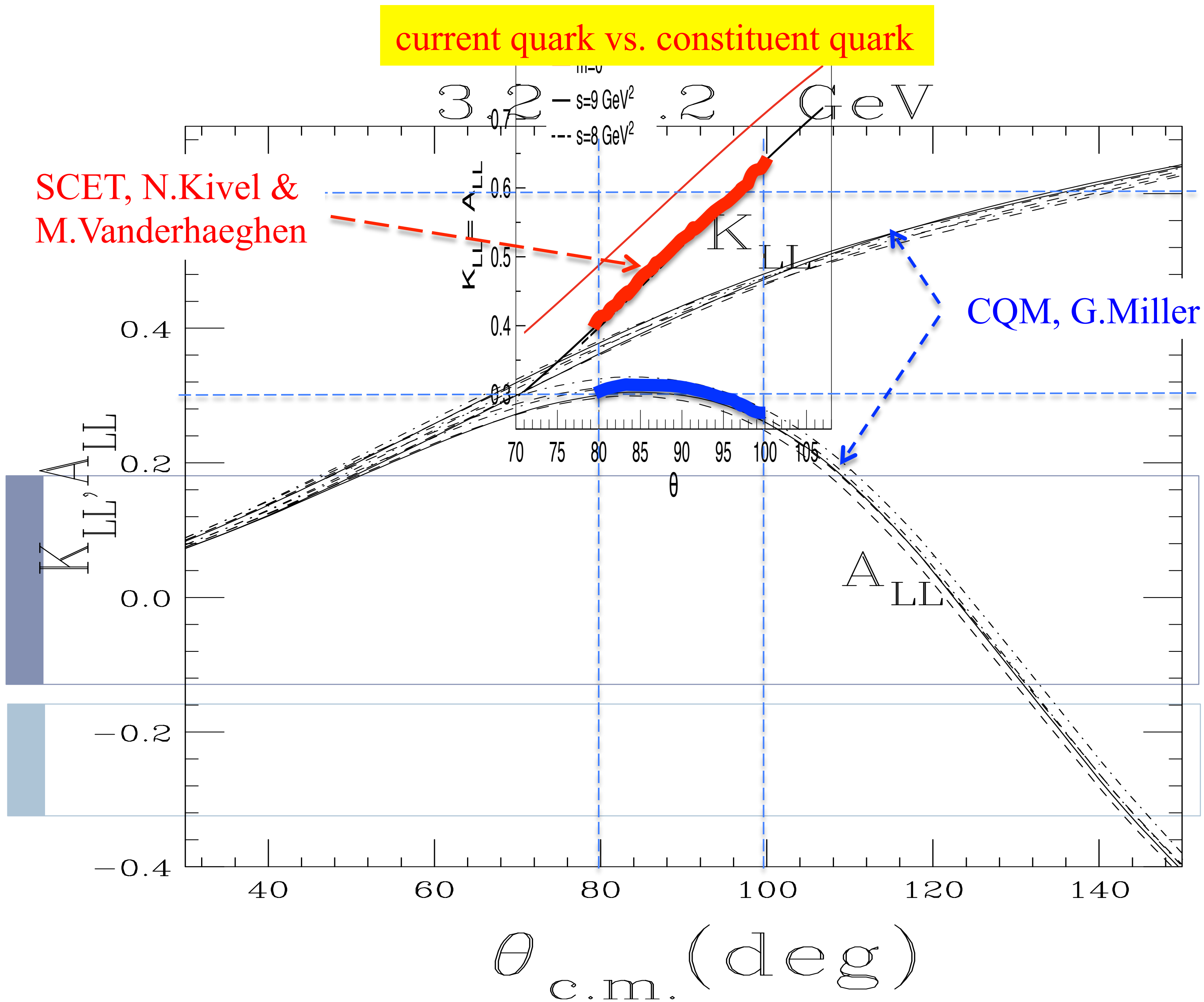
Projected impact of the results





If the observed large K_{LL} at θ_{cm} = 70° is due to large 1/*s* NLO contributions, this experiment should be able to observe an *s* dependence.

One more projected result (thanks to a question)



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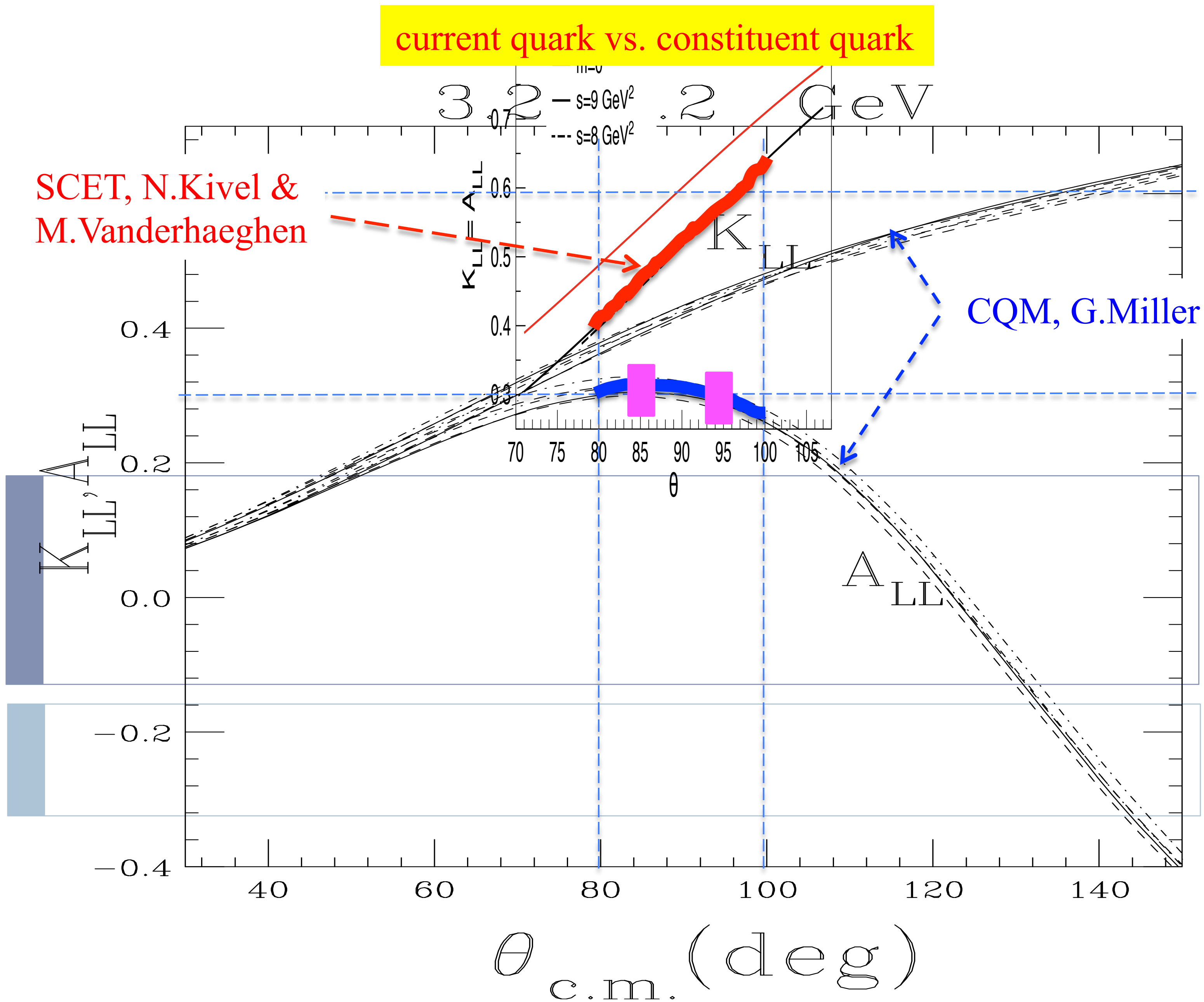


Beam time request in detail

Purpose	Description	Time Hours
NPS/SBS calibration	$e-p$ elastic	24
Photon beam commissioning		16
Packing fraction	Empty cell and C target	24
Beam polarization (x2)	Möller polarimetry	8
Target annealing	4 hours each	20
Extra target polarization		10
Total overhead time		102
WACS data production	A_{LL}	250
Total requested time		352

Plan of the experiment development

(assuming approval by PAC43)

1. Low intensity test of the shielding concept and the detector counting rates using a narrow tilted channel in a CuW80 bar located inside a pile of “green” blocks.

2. Design & testing of a vibrating CuW80 bar with a set of four narrow channels for the photon beam.

3. Development of monitoring of the force on the target solenoid.

4. Design of a slow raster with fast current control.

5. Construction of the SBS and NPS spectrometers (funded!).

Summary and Request

- ❖ Large K_{LL} at $\theta_{cm} = 70^o$: WACS is not as simple as expected, even in the range of s/t/u projected GPD applicability.

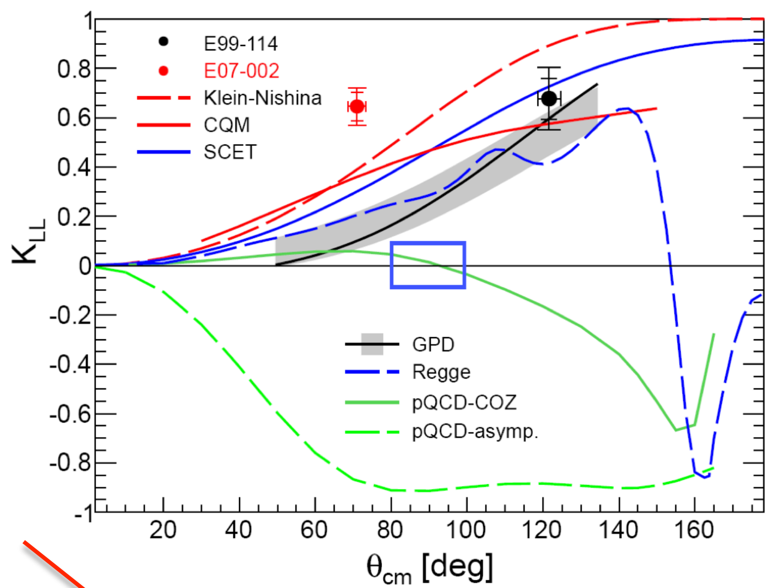
  A large acceptance spectrometer and a high resolution calorimeter allow a 10-fold increase in the acceptance.
  A novel scheme of the photon source-electron-dump allows a 10-fold increase in the photon intensity.
  With a factor of 100 of productivity gain, the A_{LL} could be measured at $s = 9$ & 11 &13 & 15 GeV^2 at $\theta_{cm} \sim 90^o$.

- ❖ We are requesting 15 days of beam time for these data points collected in parallel.

Backup Slides

Theory division comments

mechanisms. We were a little confused by the labels on the plot: ALL and KLL are expected to be equal within the GPD mechanism, as noted on page 12, but this is not the case for the CQM calculation. Therefore what is indeed being shown as the green and blue lines on the plot - the ALL expectation or the KLL expectation?



A typo is here
It should be K_{LL}

Figure 5: Predictions for A_{LL} in the GPD approach of Ref. [7] and CQM of Ref. [8] along with the data on K_{LL} from E99-114 and E07-002 and the expected range and precision of the proposed measurements (blue box).

Reply to Hall A TAC, Independent TAC and Theory division comments on the PR12-15-003

A full text of the "Reply" was send to the PAC on June 23.

"We would like to thank the TAC, the Independent TAC, and the Theory reviewers for their efforts and appreciate the comments which have helped us to optimize the proposal and the presentation to the PAC.

A 29-page CDR report on the Compact Photon Source was prepared.
It was used in our replies to the TAC comments.
The full text of the CDR report is attached to this document.

We carefully analyzed the reviewers' comments and provided our explanation/Reply to each of them. The comments of the TAC are reproduced verbatim. The replies to these comments are given in bold."

Reply to Hall A TAC, Independent TAC and Theory division comments on the PR12-15-003

A full text of the "Reply" was send to the PAC on June 23.

"TAC Comment 2: "2. This experiment uses a real photon beam created by Bremsstrahlung from a 1.2 μA electron beam on a copper radiator of 10% radiation length. A normal conducting magnet upstream of the polarized target will sweep the unconverted electrons away from their straight trajectories and into a slotted (for photons to escape) Cu beam dump in the bore of the magnet. This 10 kW is ~3x larger in-hall beam dump than an earlier hyper-nuclear experiment in Hall C at lower beam energy."

Reply: The key difference between the proposed in-hall beam dump and previously used in-hall dumps in Hall A and Hall C is its very good hermeticity (see CDR page 4), which provides a very efficient confinement of radiation inside the shielding structure. The protection efficiency of the proposed shielding is confirmed by the RadCon expert (see below the email from P. Degtyarenko)."

Reply to Hall A TAC, Independent TAC and Theory division comments on the PR12-15-003

TAC Comment 5: "5. The forces acting between the sweeping magnet and the 5 T target magnet should be evaluated, as should the influence of the sweeping field on the uniformity of the polarizing field. For optimum performance the field over the 2.5 x 3 cm volume of the NH_3 sample should vary by no more than about 25 gauss. The collaboration has recently notified the target group that they believe sweeper magnet has very little influence on the field uniformity at the target (less than 10^{-4}). This should be independently verified.
They also stated that the forces between the two magnets would be about 1 ton. Such forces (among other things) may produce a risk that the tubes from which polarized target assembly hangs (inside the cryostat) may fail and therefore a further engineering evaluation is required."

Reply: Our magnetic analysis was verified by J. Benesch, who confirmed the low value of the field gradient. In the CDR report (page 27) we presented a scheme for the force compensation. J. Benesch also proposed an scheme for the magnetic shielding around the target which may reduce the force on the target solenoid to acceptable levels. (see below the email from J. Benesch).

Use of the Compact Photon Source

A 100x gain in productivity for the pol. γ - pol. target type experiment could benefit a number of other experiments:

- pion photo-production A_{LL} and A_{LS}
- time-like DVCS from the pol. proton (LOI12-15-007)
- φ-meson from the polarized target
- A_{LL} in WACS at large θ_{cm} (E12-14-006)

Compact Photon Source could be also useful for the LOI12-15-001.

Theory comment on 2005 proposal

PR-05-003: ***Initial state helicity correlation in Wide Angle Compton Scattering***

Marc Vanderhaeghen, Robert Edwards

This experiment addresses high energy wide angle real Compton scattering (WACS) on the proton. In a previous JLab experiment (E-99-114), the double polarization asymmetry K_{LL} for a circularly polarized photon and measuring the polarization of the recoiling proton (i.e. the process $\vec{\gamma} + p \rightarrow \gamma + \vec{p}$ has been measured. This experiment gave compelling evidence for the handbag mechanism where the Compton scattering takes place on one quark (in contrast to the two-gluon exchange process where there are 3 active quarks).

The present experiment would measure the double polarization asymme-

particular constituent quark model calculation, its physics interest is much broader. The difference between A_{LL} and K_{LL} would indeed allow to test the onset of the handbag approach in terms of generalized parton distributions, and would shed a light on the nature of quark helicity flip processes. In this context it would be worthwhile to make a measurement at two different beam energies, to really check that the difference between A_{LL} and K_{LL} diminshes with increasing energy.

context it would be worthwhile to make a measurement at two different beam energies, to really check that the difference between A_{LL} and K_{LL} diminshes with increasing energy.

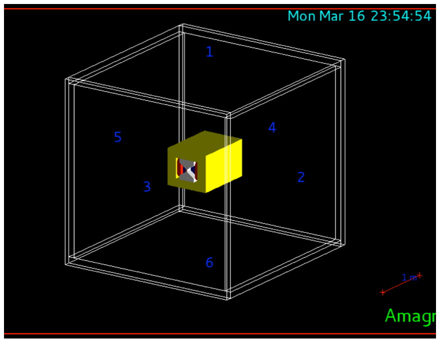
Detector rates in SBS and NPS

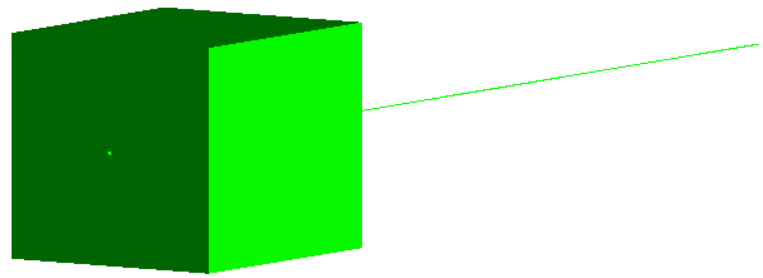
- Dominant source of the rate is the NH_3 target.
- Key parameter is the photon-nucleon luminosity.
- Proposed WACS setup has $L_{\gamma N} \sim 10^{36}$ [eqv. gamma-N].
- GEP/SBS experiment has $L_{eN} \sim 8 \times 10^{38}$ [electron-N]
  or an effective $L_{\gamma N} \sim 4 \times 10^{37}$ [eqv. gamma-N].

The projected rate in this experiment for the SBS GEM tracker is 10 kHz/cm^2, 100 times below the detector limit. Other detectors have high detection thresholds and are expected to operate in easy conditions (large scattering angle of 25-28^o), e.g. projected rate in SBS trigger ($p_{\pi(p)} > 2$ GeV/c) is about 50 kHz. The NPS trigger rate was found to be of 10 kHz.

The DAQ rate would be well below comfortable 1 kHz.

Compact Photon Source: GEANT4 results





For the beam of 1.2 μA x 8.8 GeV
Radiation dose rates summary

15-20 mrem/hour at 90-degree direction (15 m)
9 mrem/hour in the backward direction (15 m)
3.9 Rad/hour on the target solenoid (1.8 m)
2-3 Rad/hour on the SBS/NPS (~ 4-5 m)
80 kRad/hour on dipole coils (~0.5 m)
27 mrem/hour outside 0.5 degree cone (15 m)

Sample of tracks in the GEANT4

Statistics and estimated uncertainty

$$N_{RCS} = \frac{d\sigma}{dt} \cdot \frac{\left(E'_{\gamma}\right)^2}{\pi} \cdot \Delta\Omega_{\gamma} f_{\gamma p} \cdot N_p \cdot N_{\gamma}$$

Cross-Section ($\frac{d\sigma}{dt}$)

Scattered photon energy (E'_{γ})

Detectors acceptance ($\Delta\Omega_{\gamma} f_{\gamma p}$)

Number of protons (N_p)

Number of photons (N_{γ})

$$\Delta A_{LL} = \frac{1}{\sqrt{\frac{N_{RCS}}{D}}\, P_p P_{\gamma}}$$

Dilution due to pion background (D)

Proton polarization (P_p)

Photon polarization (P_{γ})

Photon flux and number of protons

$$N_{RCS} = \frac{d\sigma}{dt}\frac{\left(E_{\gamma}^{'}\right)^{2}}{\pi} \cdot \Delta\Omega_{\gamma} f_{\gamma p} \cdot N_{p} \cdot N_{\gamma}$$

$$N_{p} = \frac{Z}{A} \cdot t \cdot f_{pack} \cdot N_{A}$$

NH_3 Target	
t [g/cm^2]	2.61
$f_{packing}$	0.6

$$\Rightarrow N_{p} = 1.65 \cdot 10^{23}$$

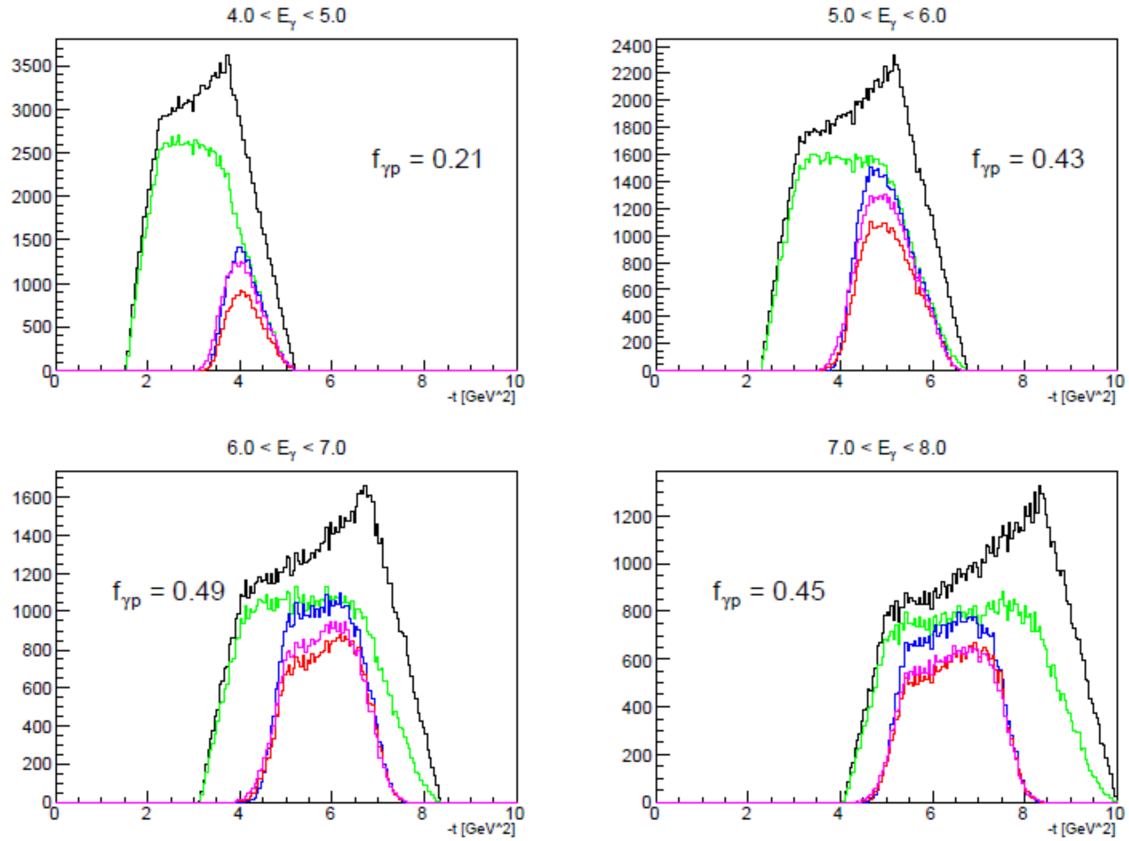
For 1.2 μA beam and 10% radiator

Kinematics	1	2	3	4
E_γ [GeV]	4 – 5	5 – 6	6 – 7	7 – 8
N_γ (per sec)	$1.5 \cdot 10^{11}$	$1.2 \cdot 10^{11}$	$1.1 \cdot 10^{11}$	$0.9 \cdot 10^{11}$

Solid angle

$$N_{RCS} = \frac{d\sigma}{dt}\frac{\left(E'_\gamma\right)^2}{\pi}\cdot\Delta\Omega_\gamma f_{\gamma p}\cdot N_p\cdot N_\gamma$$

- NPS acceptance
- SBS acceptance (no field)
- SBS acceptance (with field and target)
- SBS acceptance (with field and target, NPS shifted to match)



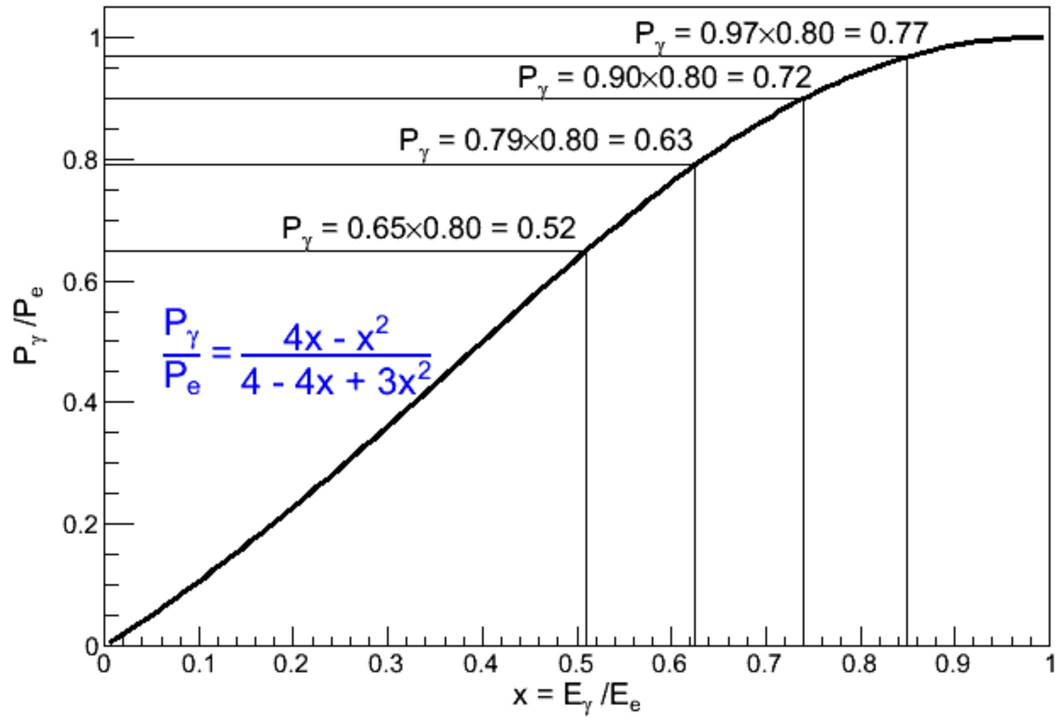
$$\Delta\Omega_\gamma = 100 \text{ msr}$$

Kinematics	1	2	3	4
$f_{\gamma p}$	0.21	0.43	0.49	0.45

Proton and photon polarization

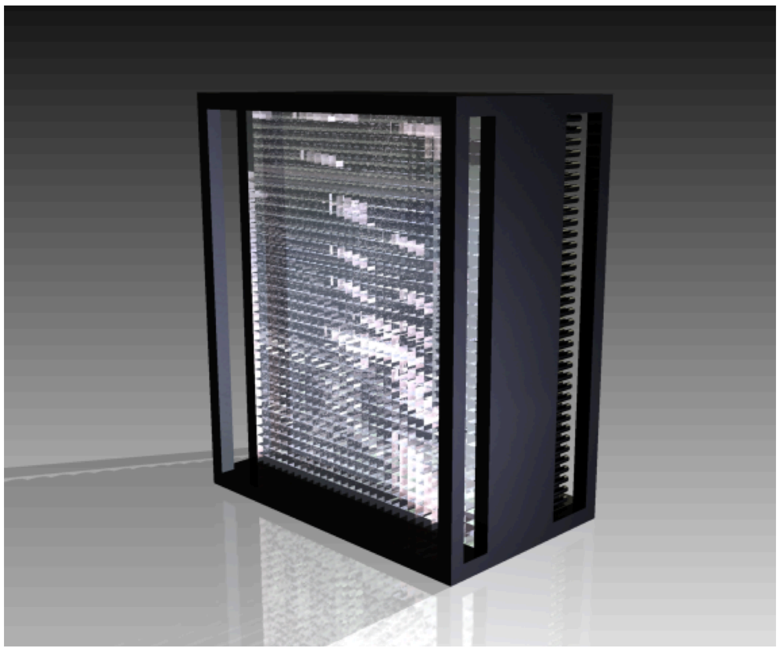
$$\Delta A_{LL} = \frac{1}{\sqrt{\frac{N_{RCS}}{D}} P_p P_\gamma}$$

$$P_p = 0.75$$



Kinematics	1	2	3	4
P_γ	0.52	0.63	0.72	0.77

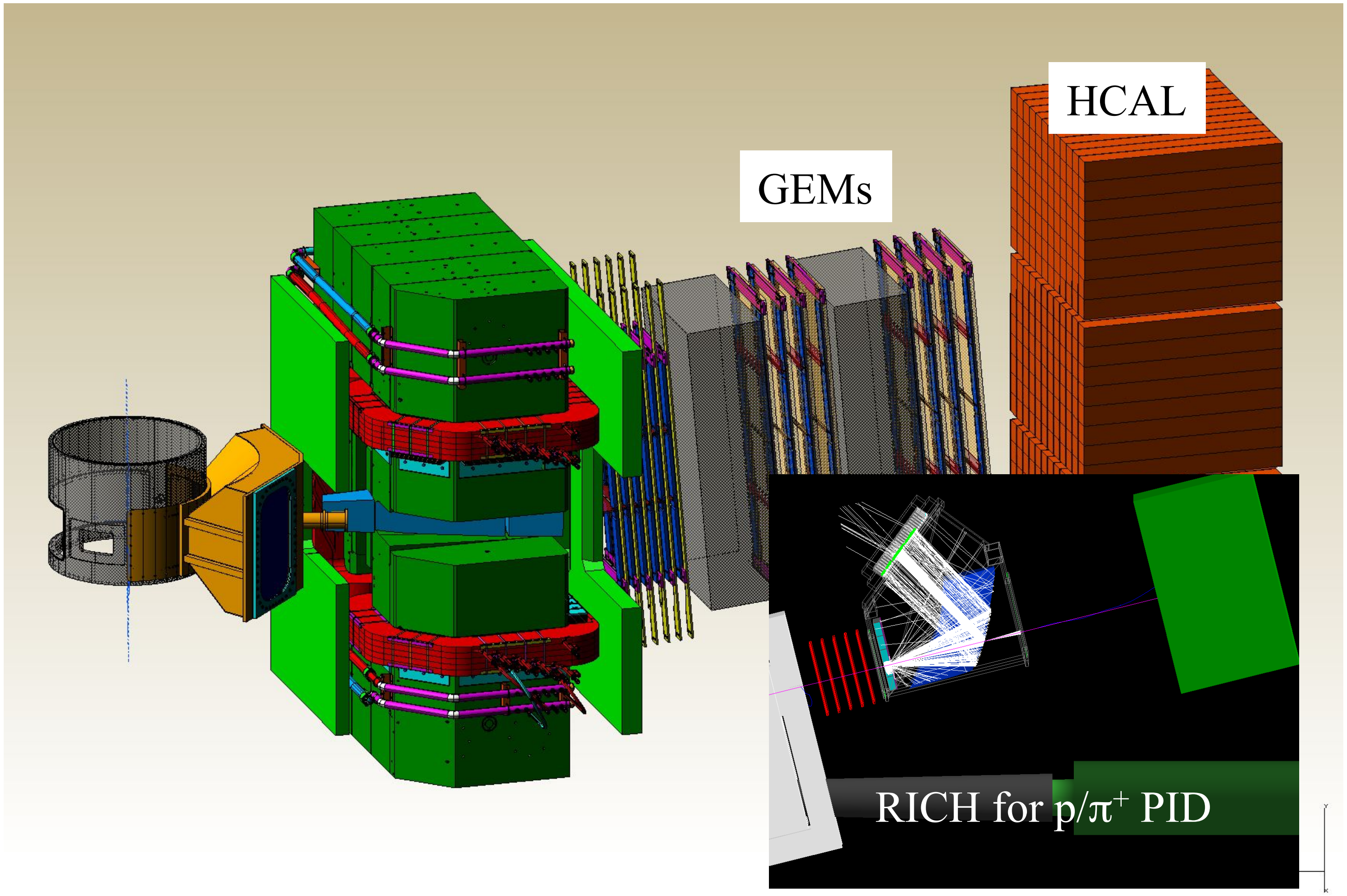
Neutral Particle Spectrometer



NPS collaboration
Catholic University of America,
Ohio University,
Old Dominion University,
Mississippi State University,
University of Virginia,
Jefferson Lab,
Glasgow University (UK),
IPN Orsay (France),
University of Ljubljana (Slovenia),
Yerevan Physics Institute (Armenia).

https://wiki.jlab.org/cuawiki/images/d/dc/NPS_WP_11142014_v3.pdf

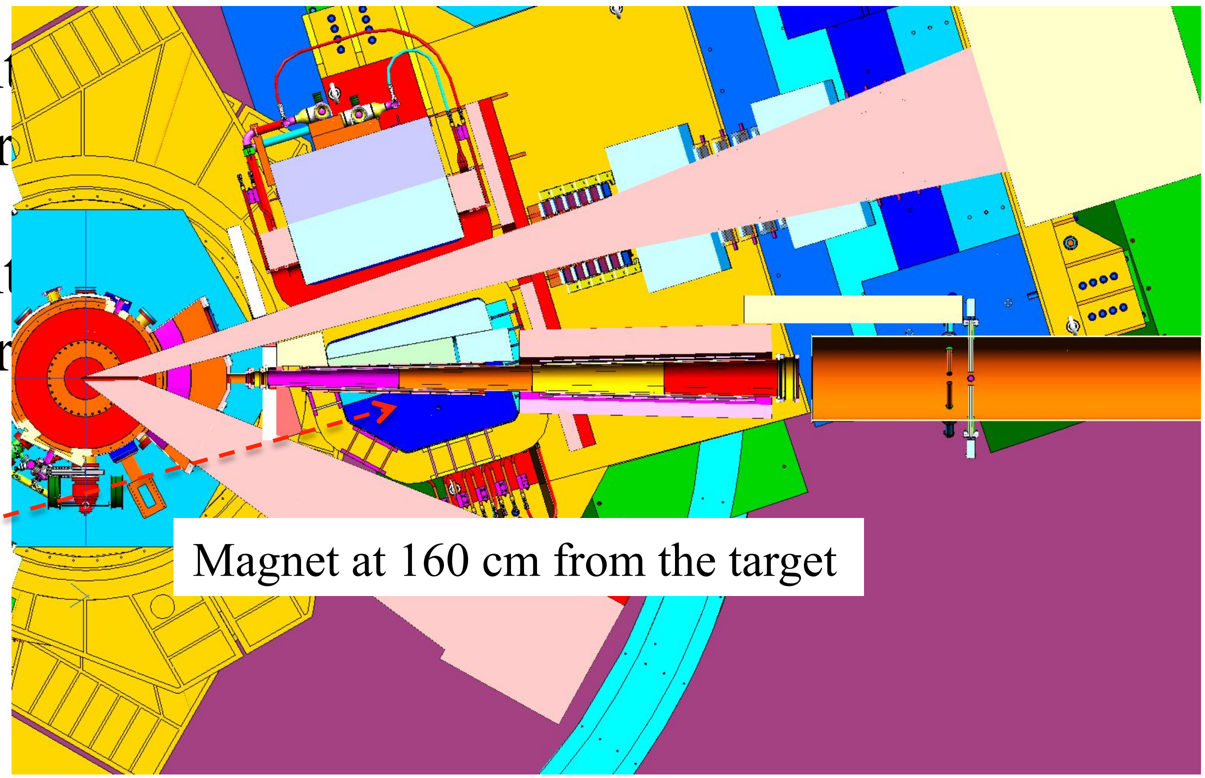
Super Bigbite Spectrometer



Super Bigbite Spectrometer

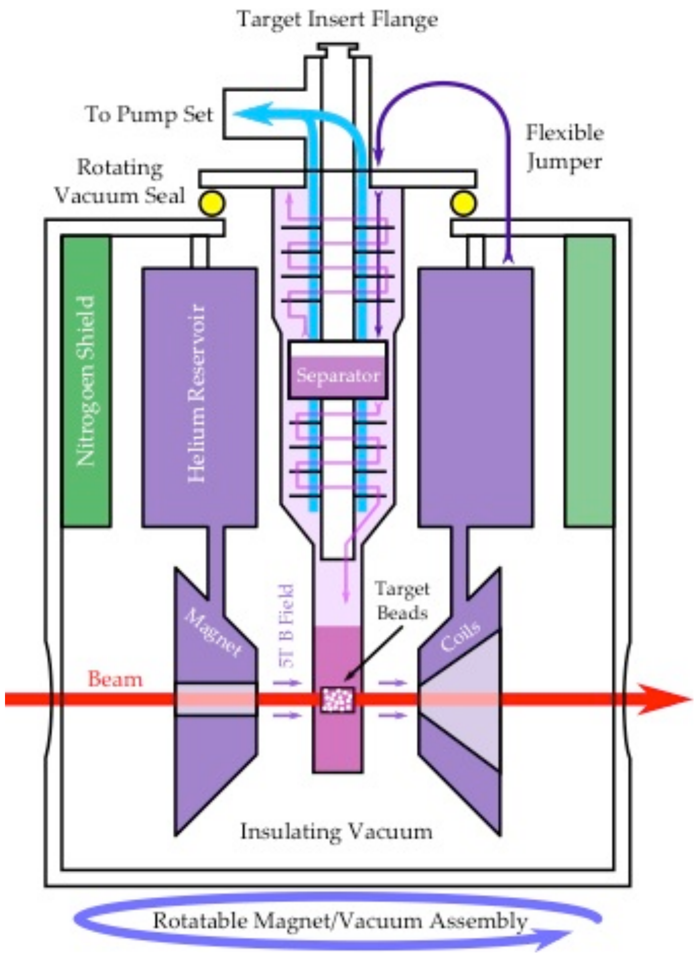
Key parameters:

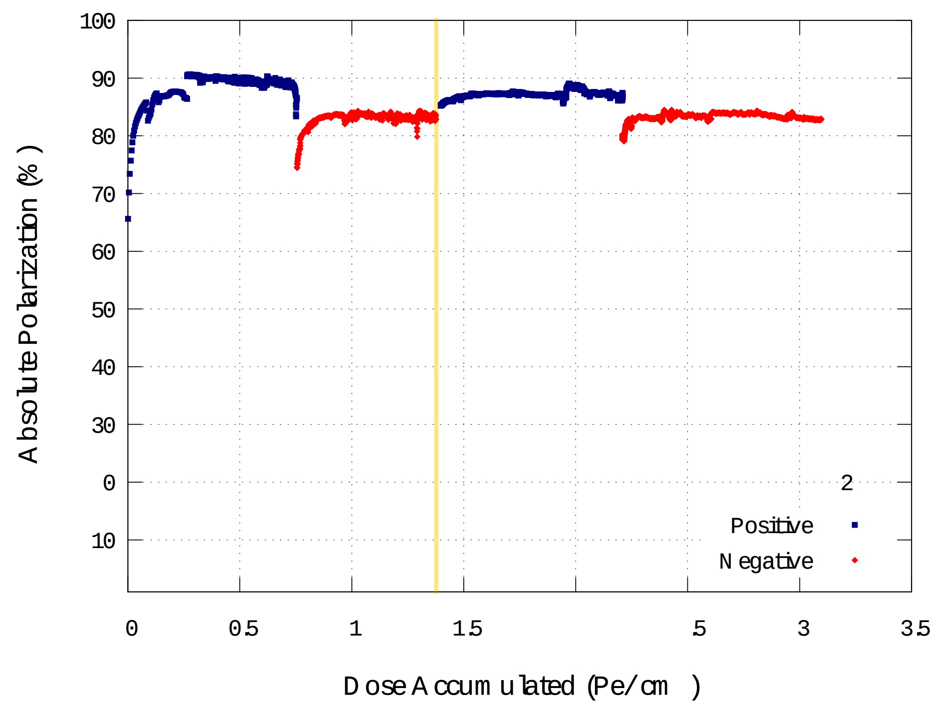
- Solid angle: 70 msr for angle above 15^o
- Moment
- Angular
- Moment
- Angular



Beam line goes through the yoke

Polarized target NH_3





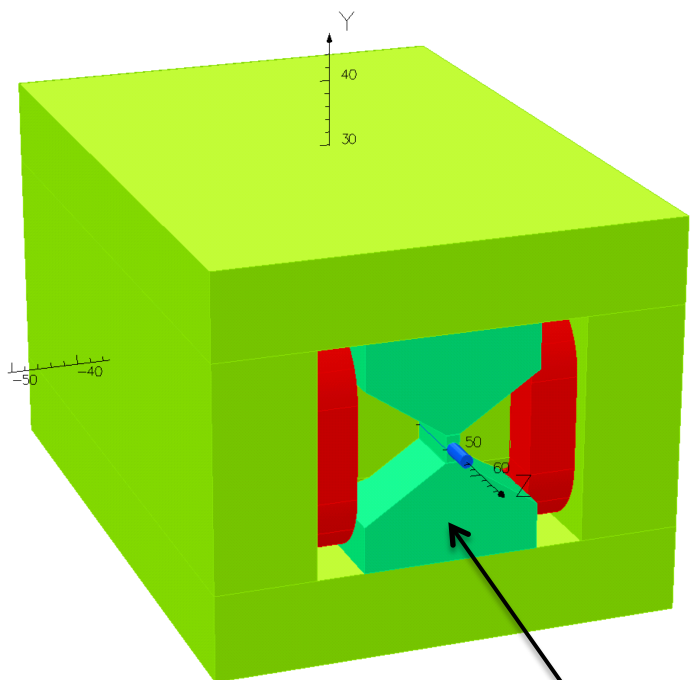
J. Pierce et al., NIM A 738 (2014) 54

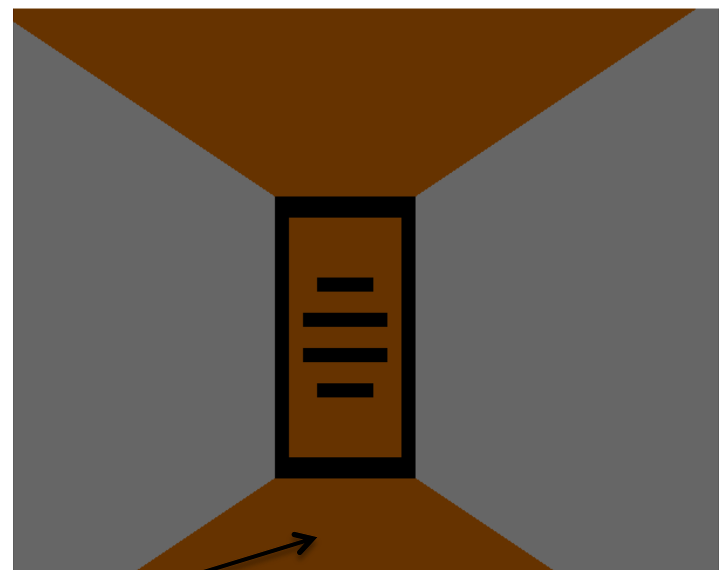
Polarized target NH_3: ^{14}N protons

- Photons from single-pion photo-production have p ~ 70 MeV/c
- Initial state momentum distribution: protons have p ~ 250 MeV/c
- Nuclear widening for both the pion and proton due to FSI
- Proton and pion absorption (transparency factor)

The resulting contribution from ^{14}N protons
could be estimated as: $7/3 \times (70/300)^2 \times (0.6)^2$
which leads in 5-10% in WACS/pion dilution factor.

Compact Photon Source: magnet views





magnet with the Copper inserts

front view with the slots
in the diffuser-absorber