Moller Polarimetry
PREX vs. MOLLER

S. Glamazdin, R. Pomatsalyuk

PREX /CREX vs. MOLLER

PREX/CREX	MOLLER
2018+ (before SBS or after?) Beam energy: 1/2GeV Required accuracy: ΔP/P<1% Time to run experiment: Short (a few Moller measurements at given beam energy) Operation experience: 1GeV – no experience after upgrade 2GeV – short experience in 2015 (two measurements with straight beam)	2020+ Beam energy: 11GeV Required accuracy: ΔP/P~0.5% Time to run experiment: Very long with the same beam conditions - perfect for systematics study Operation experience: Have experience with polarimetry!? (Moller polarimeter will be moved closer to Compton –> new alignments -> have to study spectrometer)

POLARIZED ELECTRON TARGET

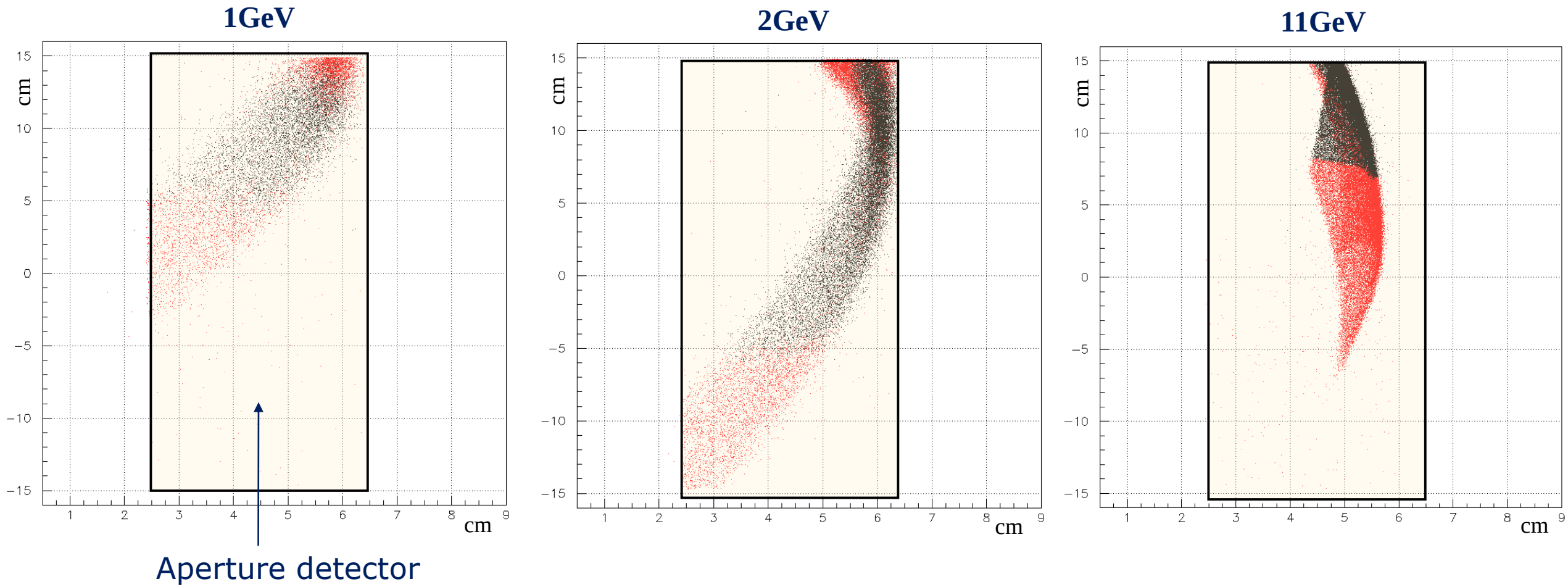
More detailed in Jim's talk

PREX/CREX	MOLLER
If PREX before SBS: New target has to be commissioned (Measurements in test Lab and Kerr-apparatus can help a lot) If SBS before PREX: Well known target mechanics Target systematics known with limited statistics	Well known target with limited statistics but running time enough for high accuracy

SUPERCONDUCTING MAGNET

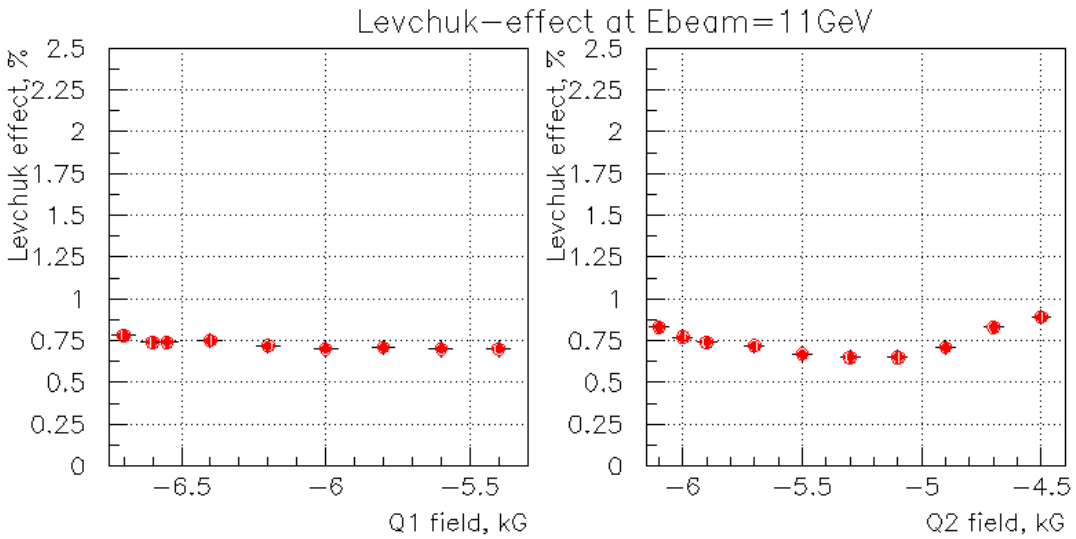
PREX/CREX	MOLLER
Magnet alignment is critically important Alignment test is ~6hours of beam We were not successful at PREX-I Strong influence on beam steering and Moller acceptance Prefer 3T to minimize influence of the Field Perfect alignment is needed to ramp magnet up in parallel with Moller settings	Magnet alignment is not too much important Can increase field to be sure in target magnetization saturation Can ramp magnet up and down in parallel with Moller settings -> save time for measurement

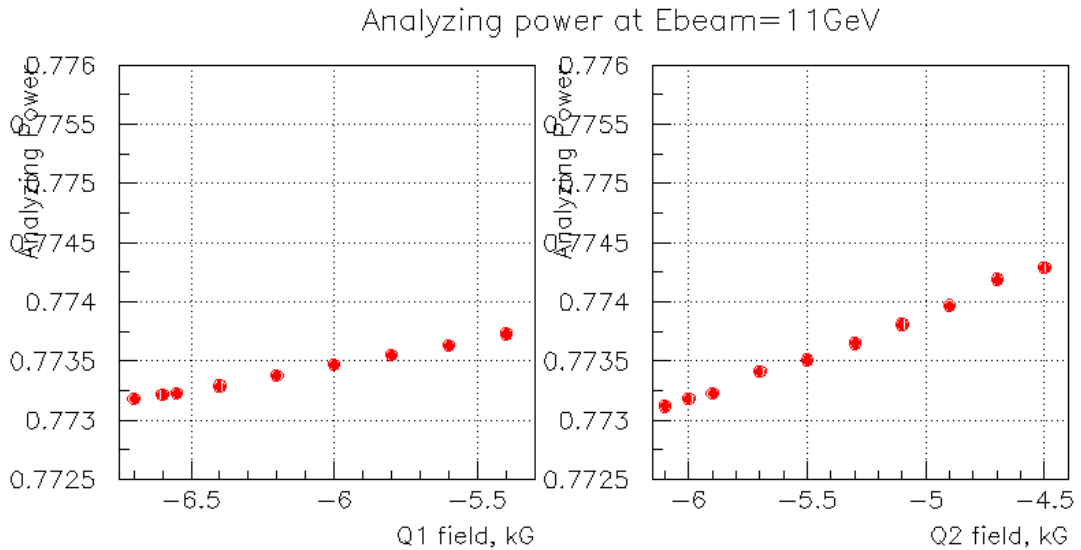
GEANT SIMULATION



Moller events (black – single arm, red – coincidence) vs beam energy

GEANT TEST





At 1 GeV GEANT precision is more important vs. 11 GeV

RATES

Beam energy, GeV	θ, deg	Φ, deg	Analyzing power	Single arm a.u.	Coincidence a.u.
1.0 PREX	***5.5***	***2.3***	***0.7667***	***13***	***7***
2.0 CREX	***10***	***3.8***	***0.7418***	***37***	***23***
11.0 MOLLER	***4***	***14***	***0.7724***	***74***	***32***

Rates difference can be compensated by target thickness (12μm → 20μm → 30μm)

MOLLER SPECTROMETER + DETECTOR

PREX/CREX	MOLLER
Known alignment of quads No data for 1GeV Limited data for 2 GeV Strong dependence of detector alignment	Have to prove/study alignment after moving Additional BPMs (from Jay) between quads –> more information about beam position/inclination -> better GEANT model Well known quads settings Low dependence of detector alignment (see slides above)

TARGET SYSTEMATICS STUDY OFF LINE

Has to be done in Test lab with magnetic field:
- Magnet field mapping
- Target loader survey
- Target rotation angular resolution
- Target linear motion accuracy

Can be done in the Test lab (off line) with Kerr-effect apparatus:
- Target saturation vs field for all foils
- Target saturation vs target angle for all foils (find 90° between foil and field)
- Warping effects: target saturation vs field in different points
- Foil thickness fluctuation effects (foils thickness <10μm±25%, foils thickness 10÷50μm±10%, pinholes)

TARGET SYSTEMATICS STUDY ON LINE

PREX/CREX	MOLLER
Has to be done before / at PREX /CREX with limited accuracy (statistics) - Target saturation test for one of the target foils - Polarization vs Target heating / beam current	Has to be done at MOLLER with high accuracy - Comparison of different materials (Fe, Co, Ni) - Target thickness dependence - Repeatability (same Moller settings, same beam current, same energy, same Wien filter)

DAQ's

PREX/CREX	MOLLER
Helicity frequency: 120 ÷ 250 Hz - Not a problem for both FADC and old DAQ - Hopefully, will be able to measure Levchuk-effect with FADC data triggers	Helicity frequency: 2kHz Only FADC No data triggers ?

Highly required for successful precise polarimetry:

- Cross check (spin dance) with Mott, Hall A and Hall C Compton and Hall C Moller
- Beat frequency test after injector upgrade to 4 halls running
- Target foils saturation measurement in Temple (see Jim's talk)
- Rad Corrections simulation by GEANT
- GEANT4
- Kerr-effect apparatus

SOLID

After MOLLER Moller polarimeter has to be
well known and in the best condition
at given energy (11GeV).
No any upgrades / tests / commissions needed
Ready to run with maximal possible accuracy

POLARIZED HYDROGEN TARGET

BRUTE FORCE	HYDROGEN
Invasive Accuracy: >0.4% Simple Commissioned Operation experience Understandable Spectrometer (QD): - Separate of Mott - Suppress Levchuk-effect - Separate Moller of the beam -> small solid angle Coincidence mode detector to suppress single Moller	Non invasive Accuracy: ~0.4-÷0.3%? Very complex Non-commissioned No experience with operation Systematics is unknown New spectrometer (Q or septum) preferable - Separate Moller of the beam - No Levchuk effect - 2 orders lower Mott -> can use large solid angle (ring like segmented detector) Coincidence mode detector to suppress single Moller

Thanks to Kent for this talk!