DDVCS with SoLID

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Hall A
SoLID collaboration meeting
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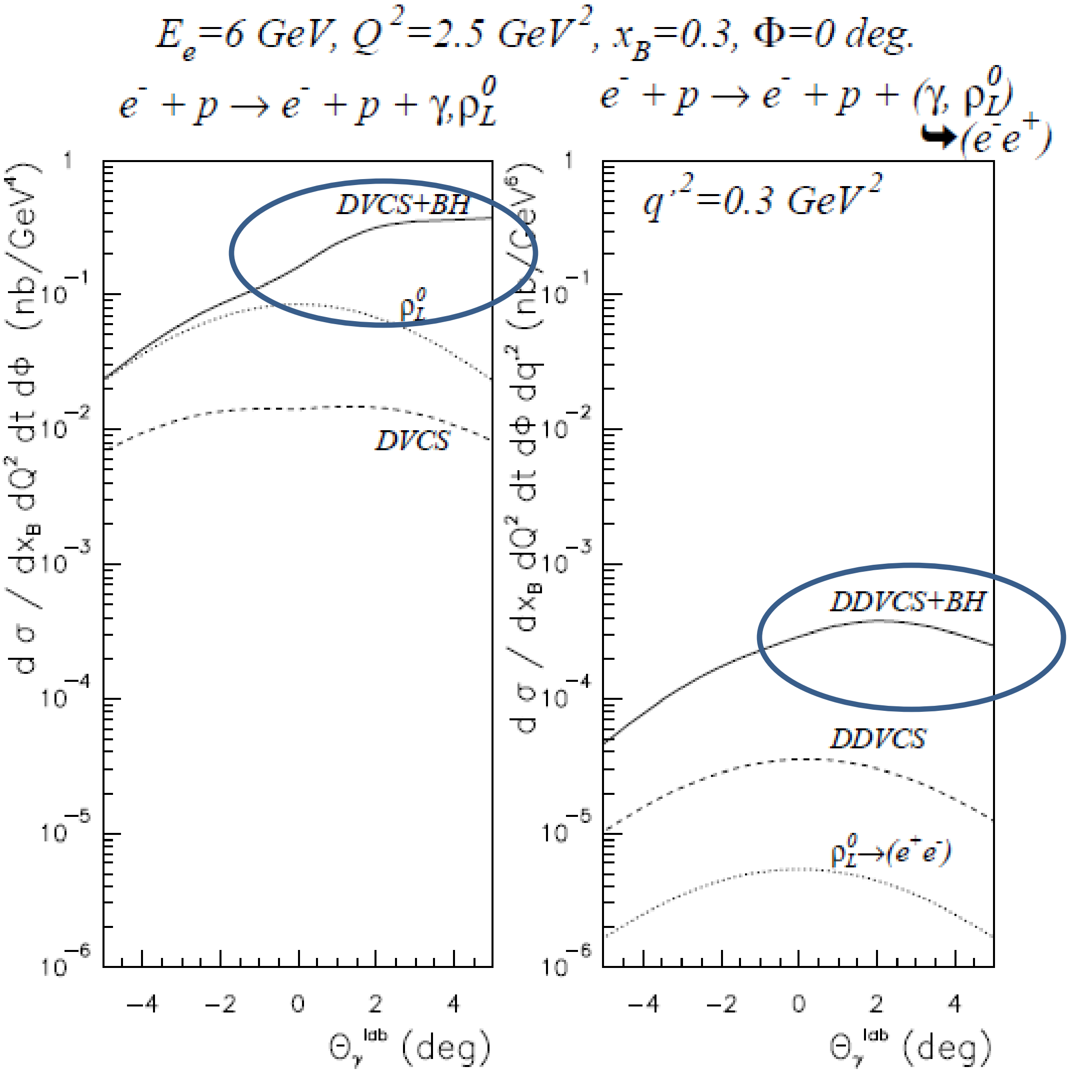
DVCS / Double DVCS

$$\gamma^* + p \longrightarrow \gamma'(*) + p'$$

$$\gamma'(*) \longrightarrow l^+ + l^-$$

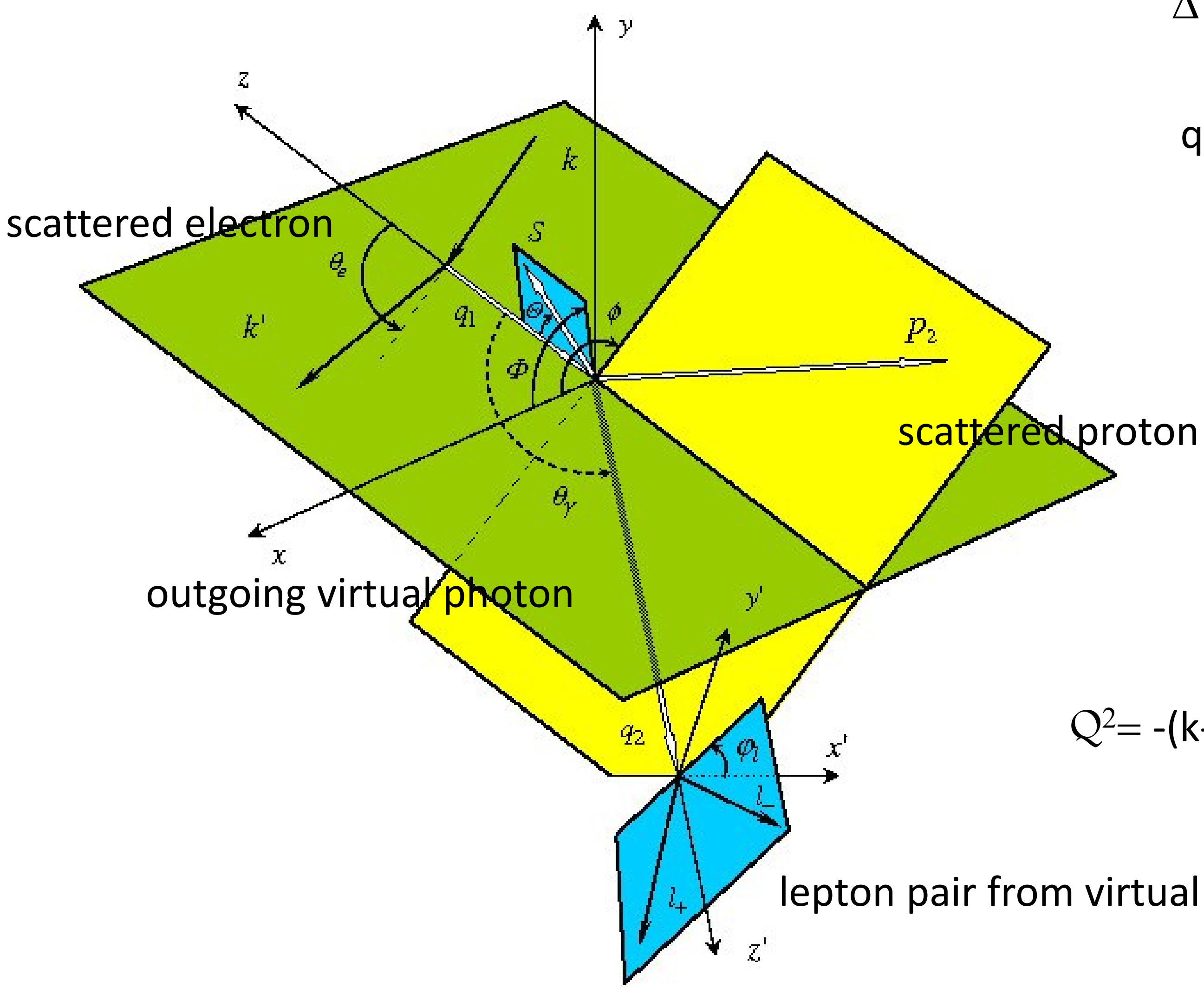
Guidal and Vanderhaegen : Double deeply virtual Compton scattering off the nucleon (arXiv:hep-ph/0208275v1 30 Aug 2002)
Belitsky Radyushkin : Unraveling hadron structure with generalized parton distributions (arXiv:hep-ph/0504030v3 27 Jun 2005)

DDVCS cross section



- VGG model
- Order of ~0.1 pb = 10^{-36}cm^2
- About 100 smaller than DVCS
- Virtual Beth and Heitler
- Interference term enhanced by BH
- Contributions from mesons small when far from meson mass

Double Deeply Virtual Compton Scattering



Δ = p1-p2 = q2-q1

p = p1+p2

q = ½ (q1+q2)

$Q^2 = -q^2$

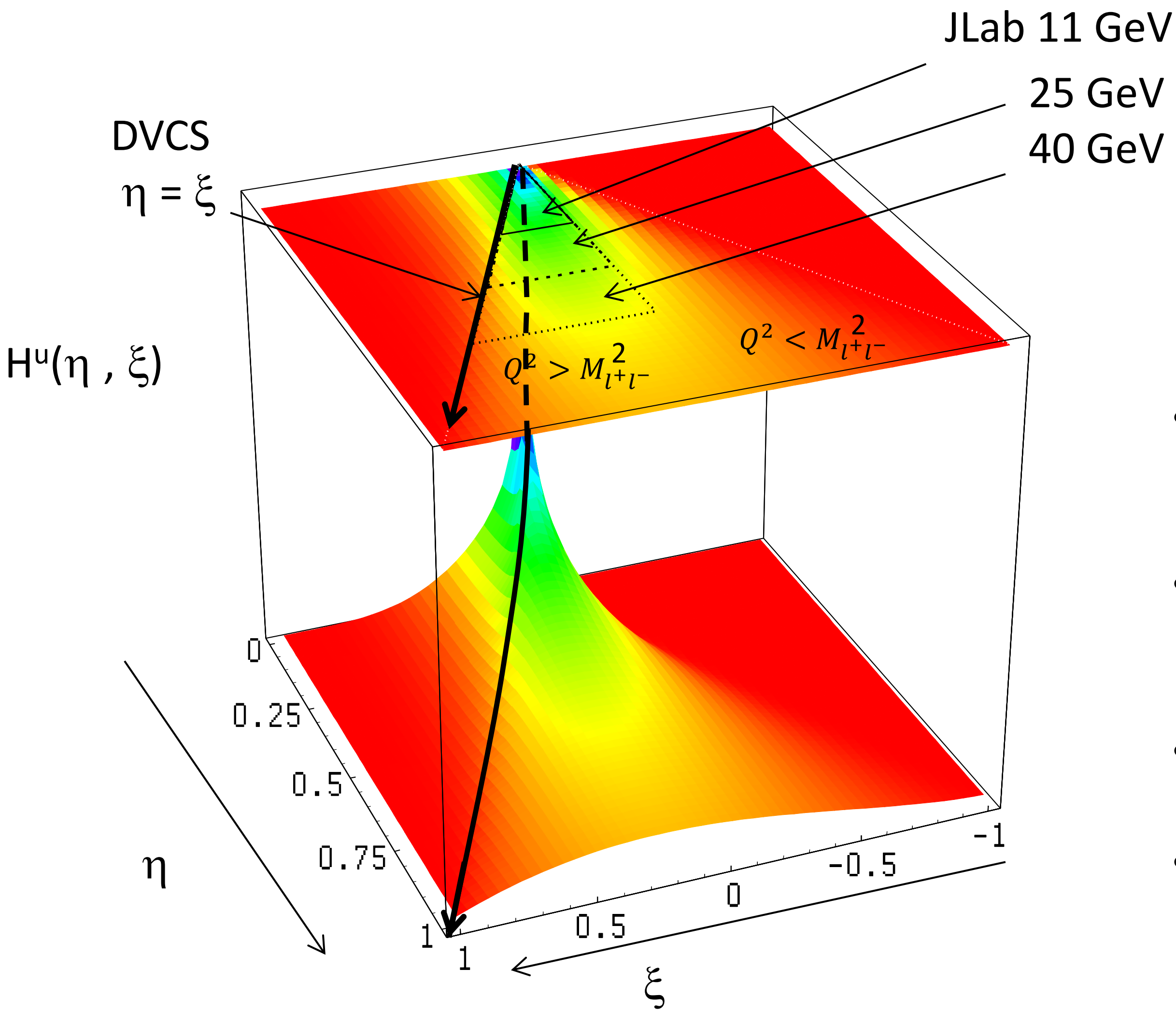
$\xi = \frac{Q^2}{2p.q}$

$\eta = \frac{\Delta.q}{p.q}$

$Q^2 = -(k-k')^2$

$x_{bj} = \frac{Q^2}{2p_1q_1}$

Kinematical coverage



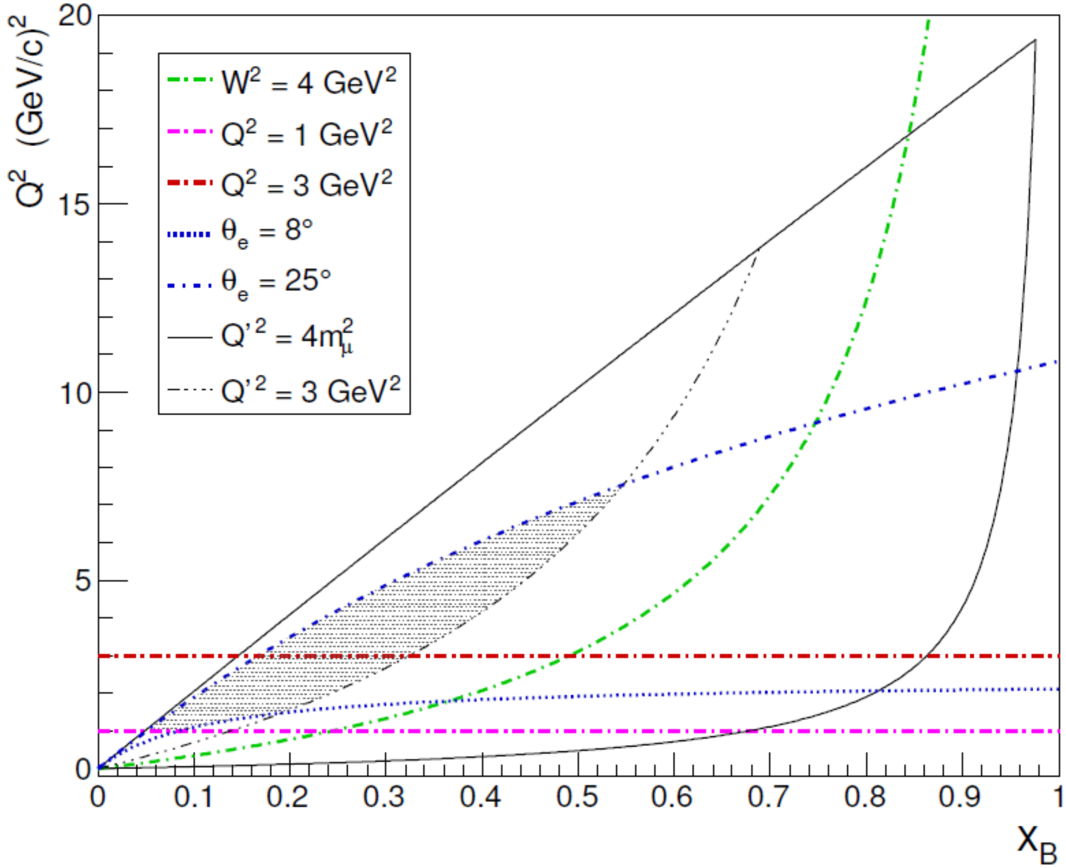
- DVCS only probes η = ξ line
- Example with model of GPD H for up quark
- Jlab : $Q^2>0$
- Kinematical range increases with beam energy (larger dilepton mass)

Observable

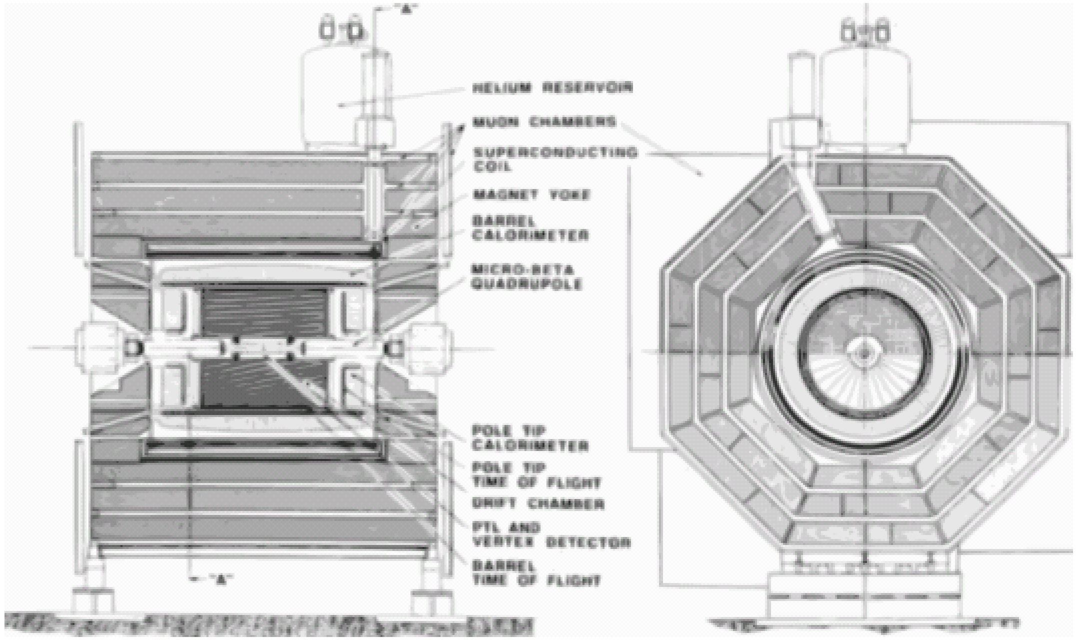
$$\left\{ \begin{array}{c} A_{\rm LU}^{\sin\phi} \\ A_{\rm LU}^{\sin\varphi_\mu} \end{array} \right\} = \frac{1}{\mathcal{N}} \int_{\pi/4}^{3\pi/4} d\theta_\mu \int_0^{2\pi} d\varphi_\mu \int_0^{2\pi} d\phi \left\{ \begin{array}{c} 2\sin\phi \\ 2\sin\varphi_\mu \end{array} \right\} \frac{d^7\overrightarrow{\sigma} - d^7\overleftarrow{\sigma}}{dx_B\, dy\, dt\, d\phi\, dQ'^2\, d\Omega_\mu}$$

$$\propto \Im{\rm m} \left\{ F_1 \mathcal{H} - \frac{t}{4M_N^2} F_2 \mathcal{E} + \xi (F_1 + F_2) \widetilde{\mathcal{H}} \right\} ,$$

Kinematic coverage



CLEO muon detector



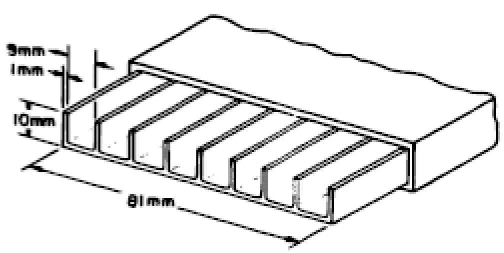


Fig. 2. Cross section of a plastic proportional counter.

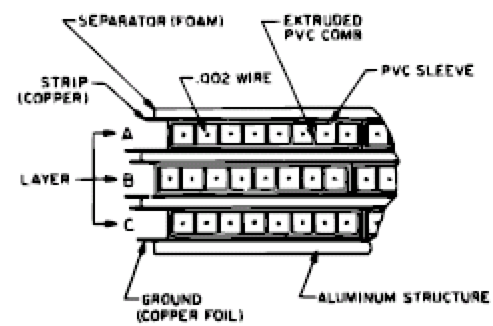
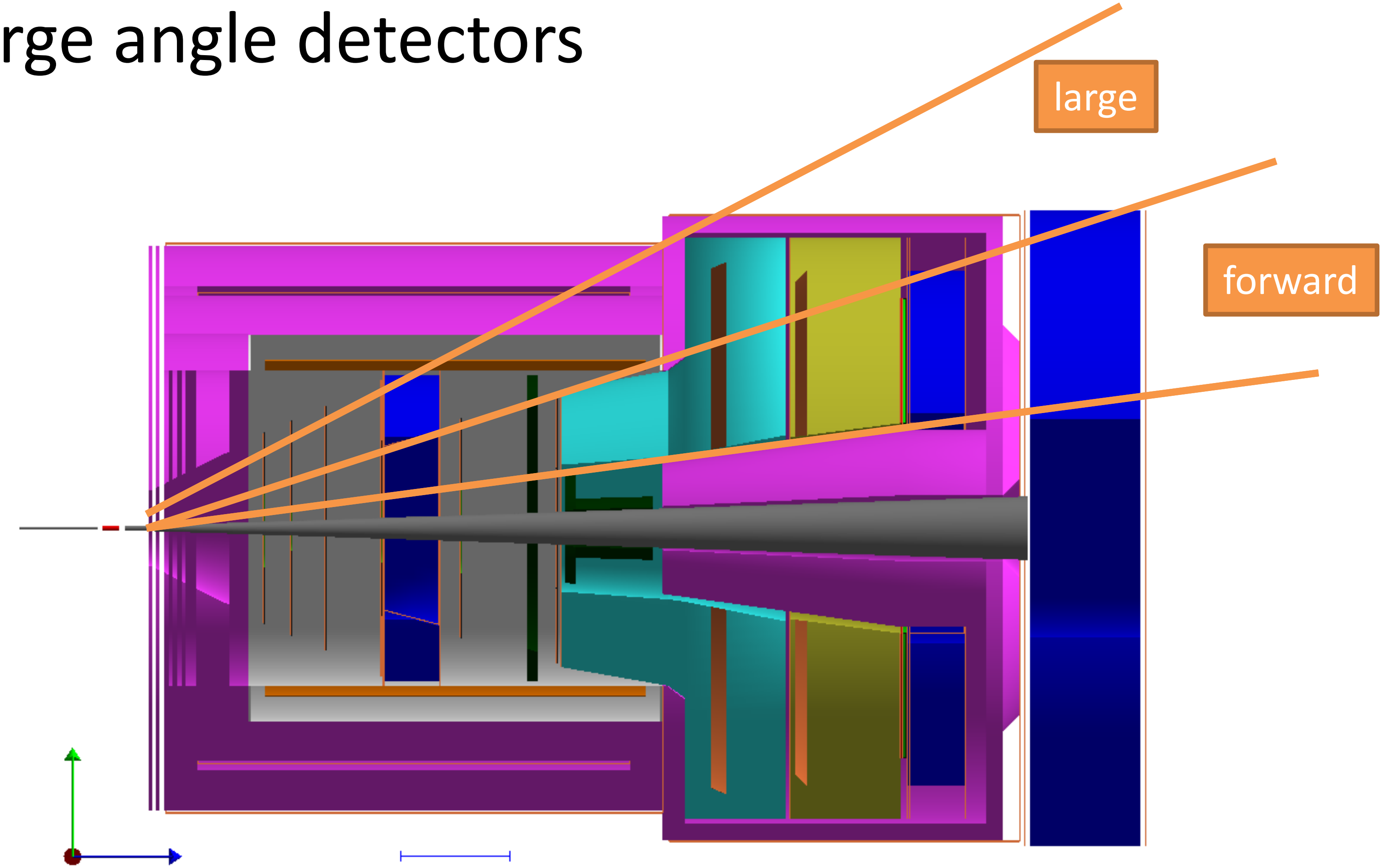


Fig. 3. Partial cross section of a unit, showing the slightly staggered three layers of counters, interleaved with foam boards carrying the copper pickup strips on one side and copper shield on the other.

SoLID JPsi Setup

- Particle can be accepted by both forward and large angle detectors

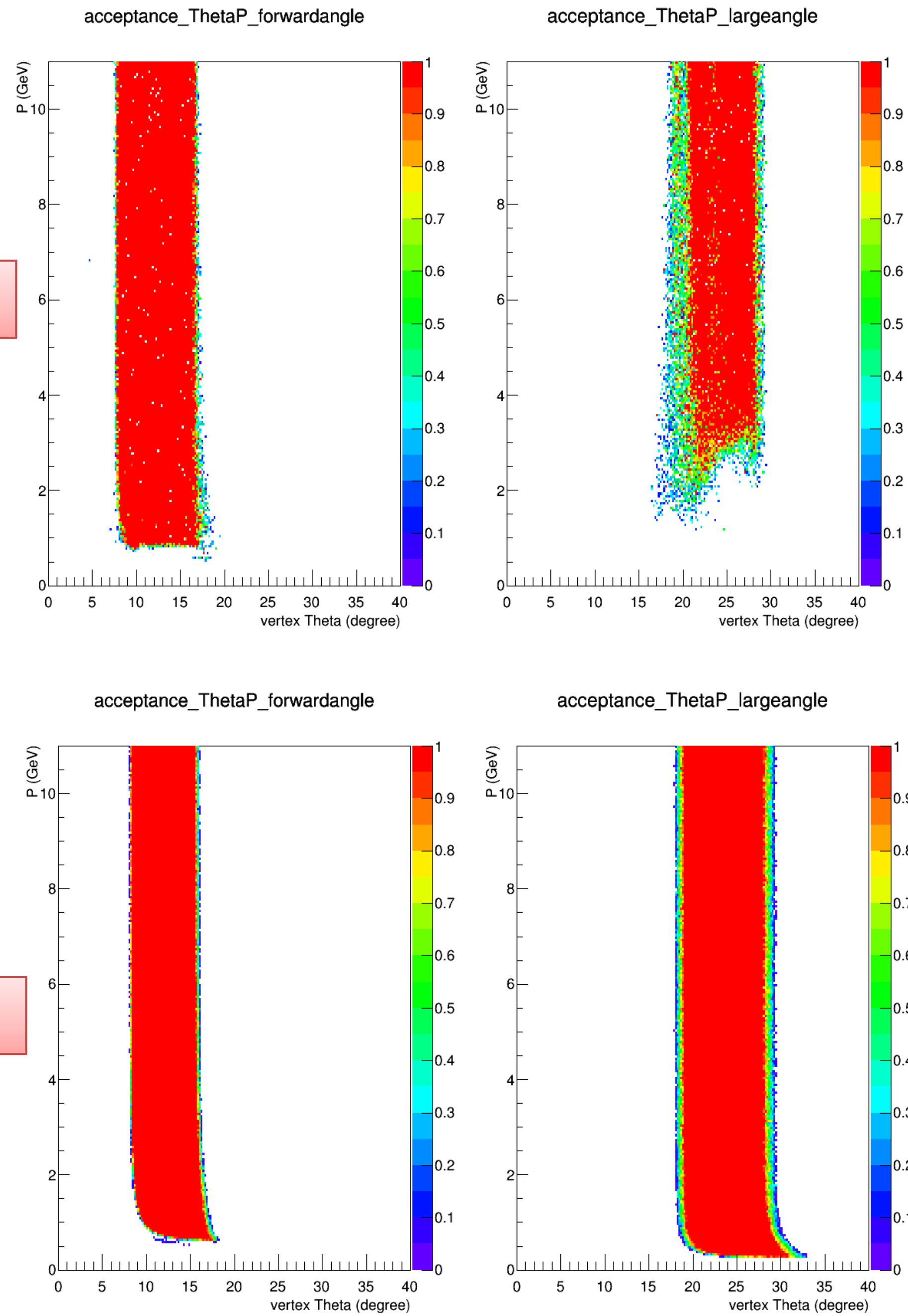


acceptance

- Some low energy muon are lost, especially at large angle

muon

e and p

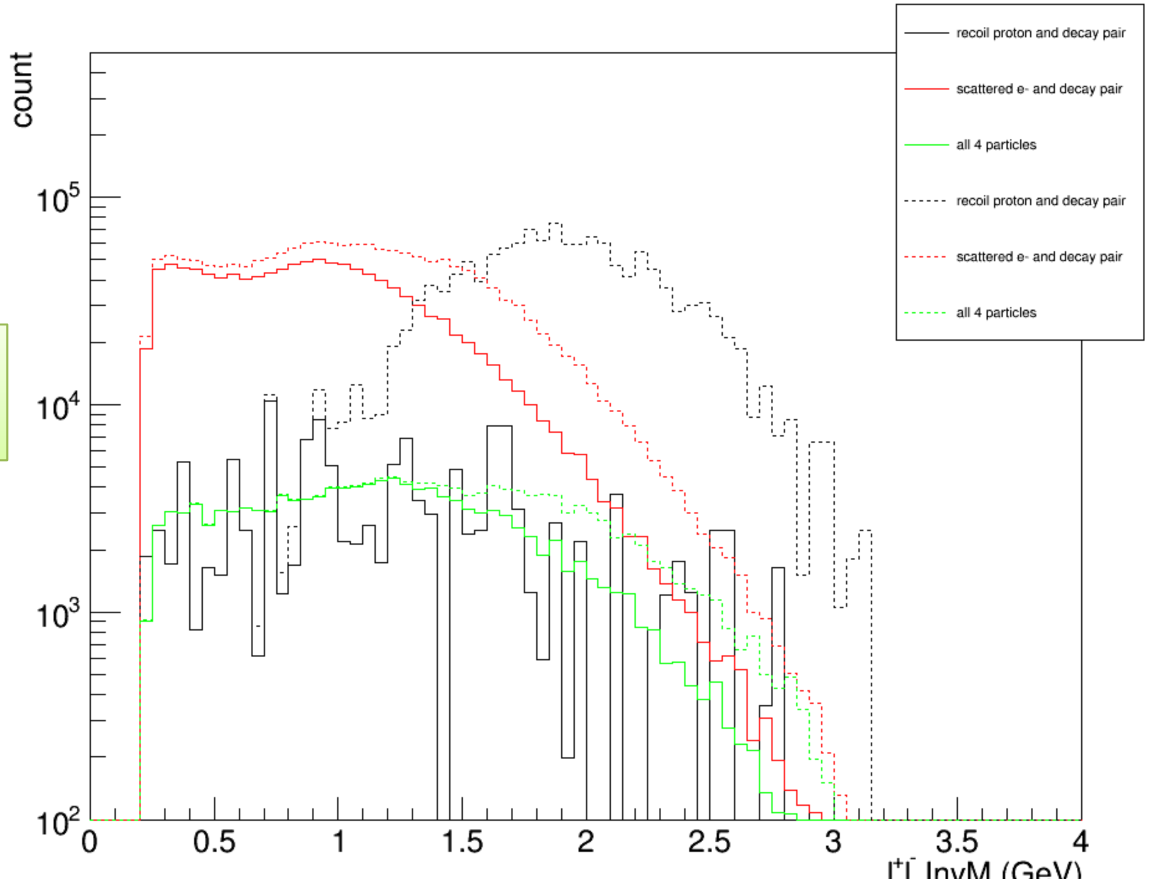


Count Estimation

- 11GeV, 3uA 1cm LH2 target, 1e37/cm2/s, 50 days, 85% eff.

Decay pair accepted at both forward and large

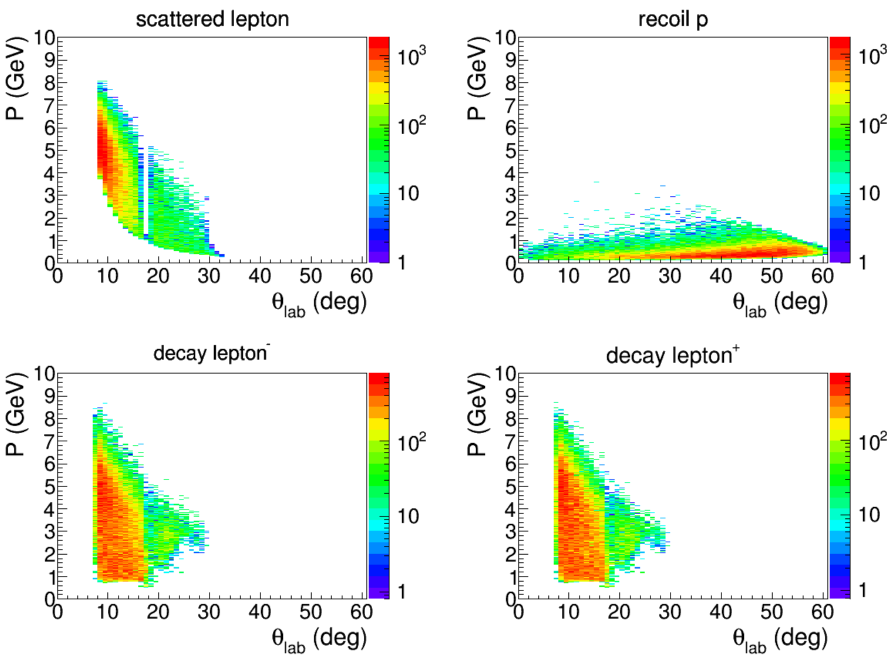
Dot line: before cut Q2
Solid line: cut Q2>=1



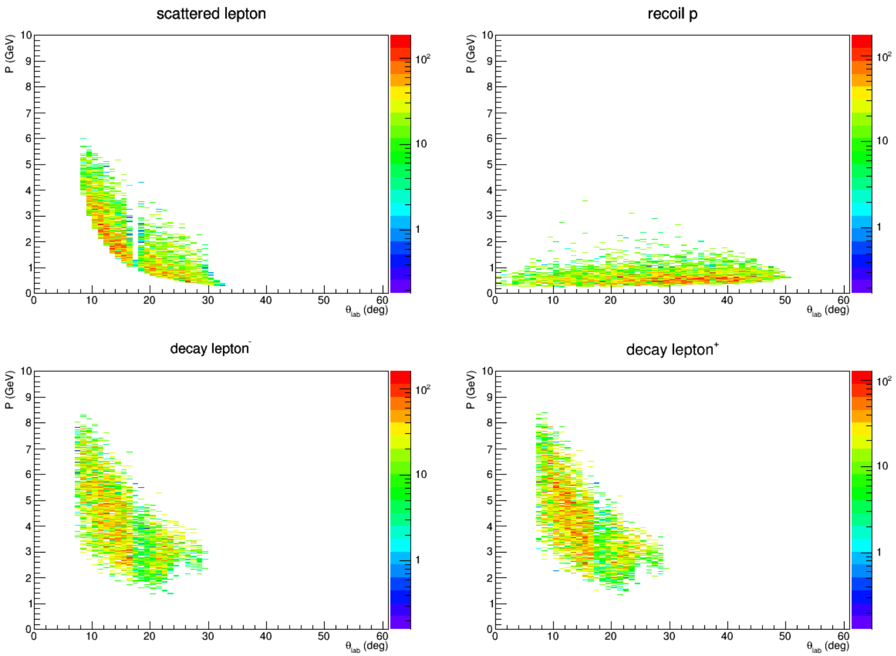
- Topology of detecting scattered ele and decay pair is best
- plots in the next slides are only for this topology with cut Q2>1 applied

Particle acceptance

Before cut 3<Q’2<9

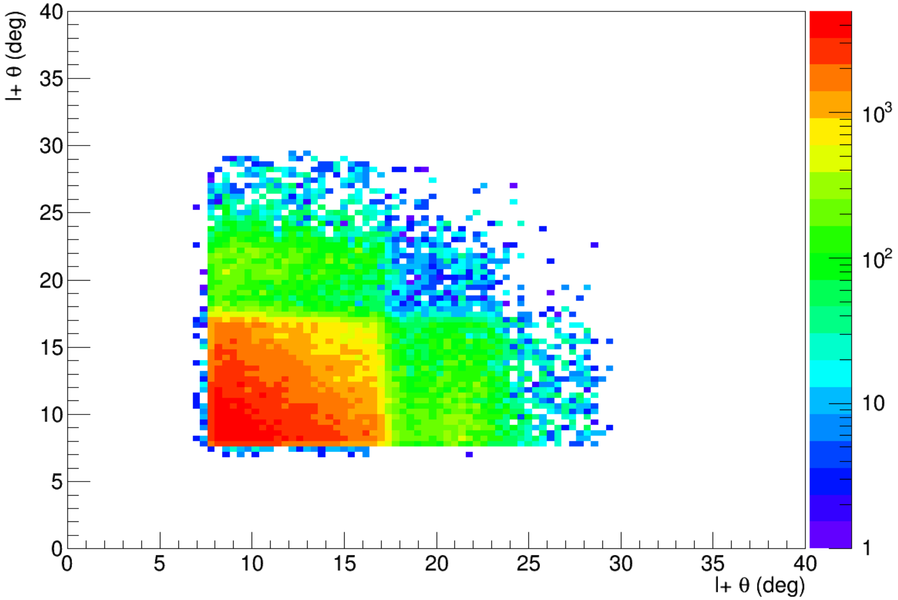


After cut 3<Q’2<9

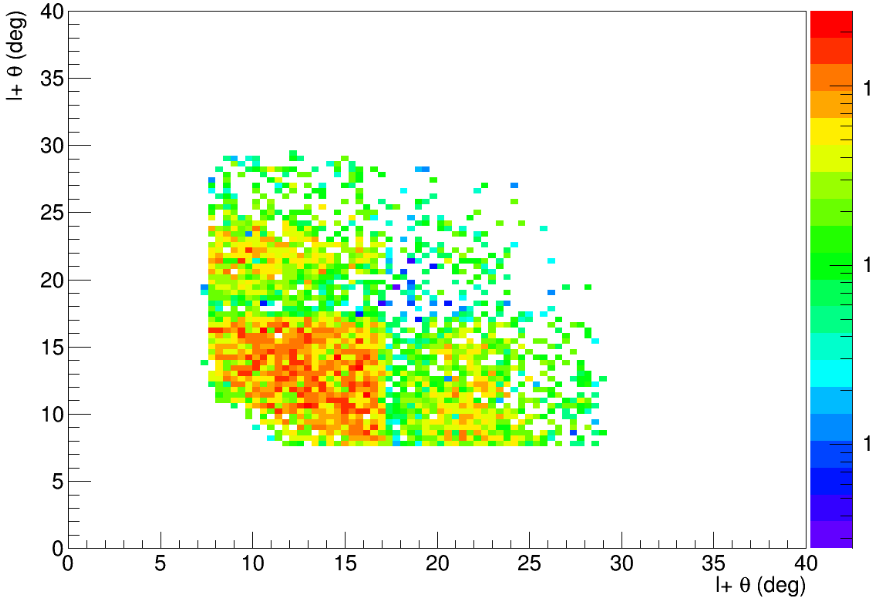


Decay angle

Before cut 3<Q'2<9

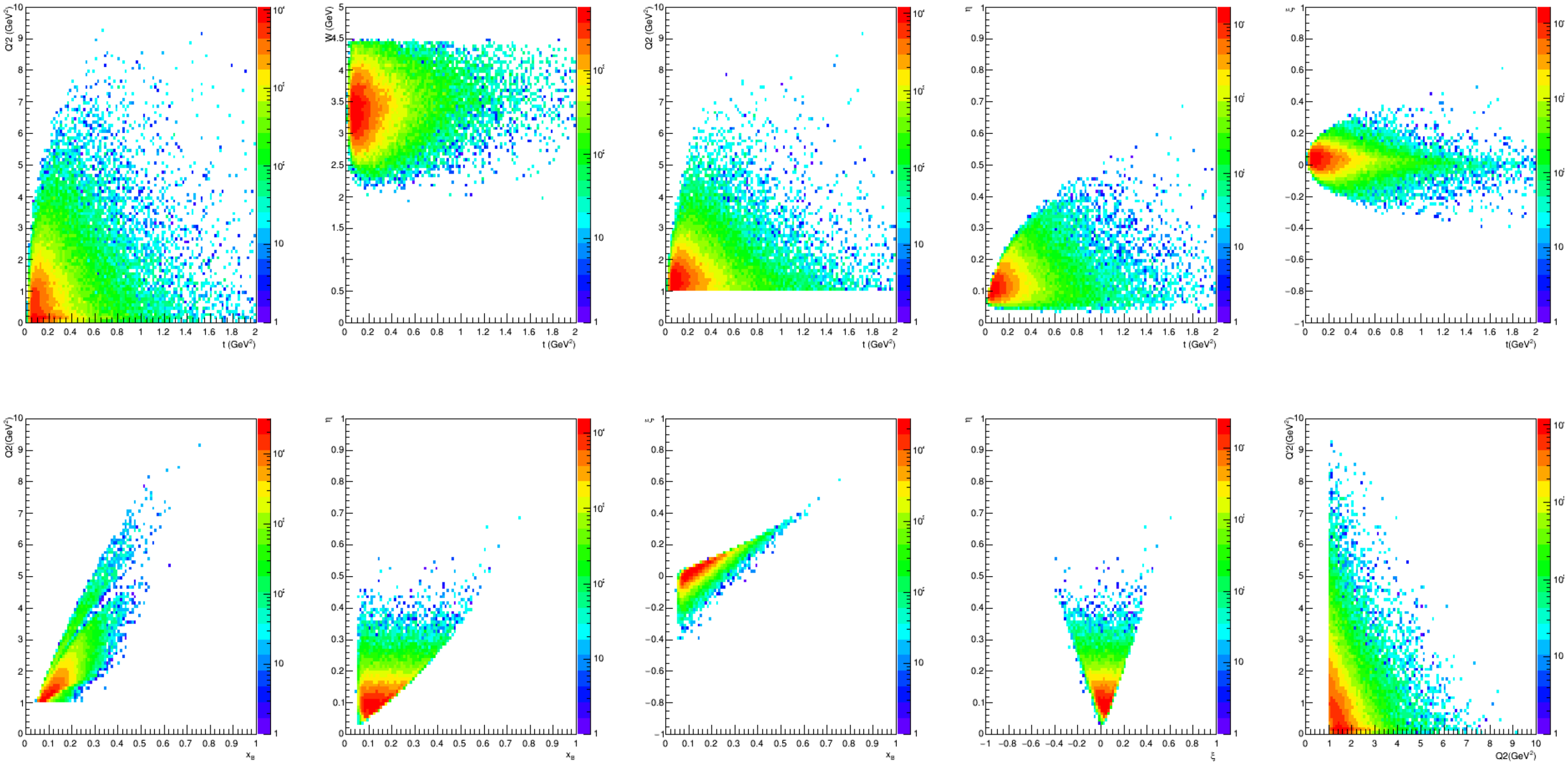


After cut 3<Q'2<9



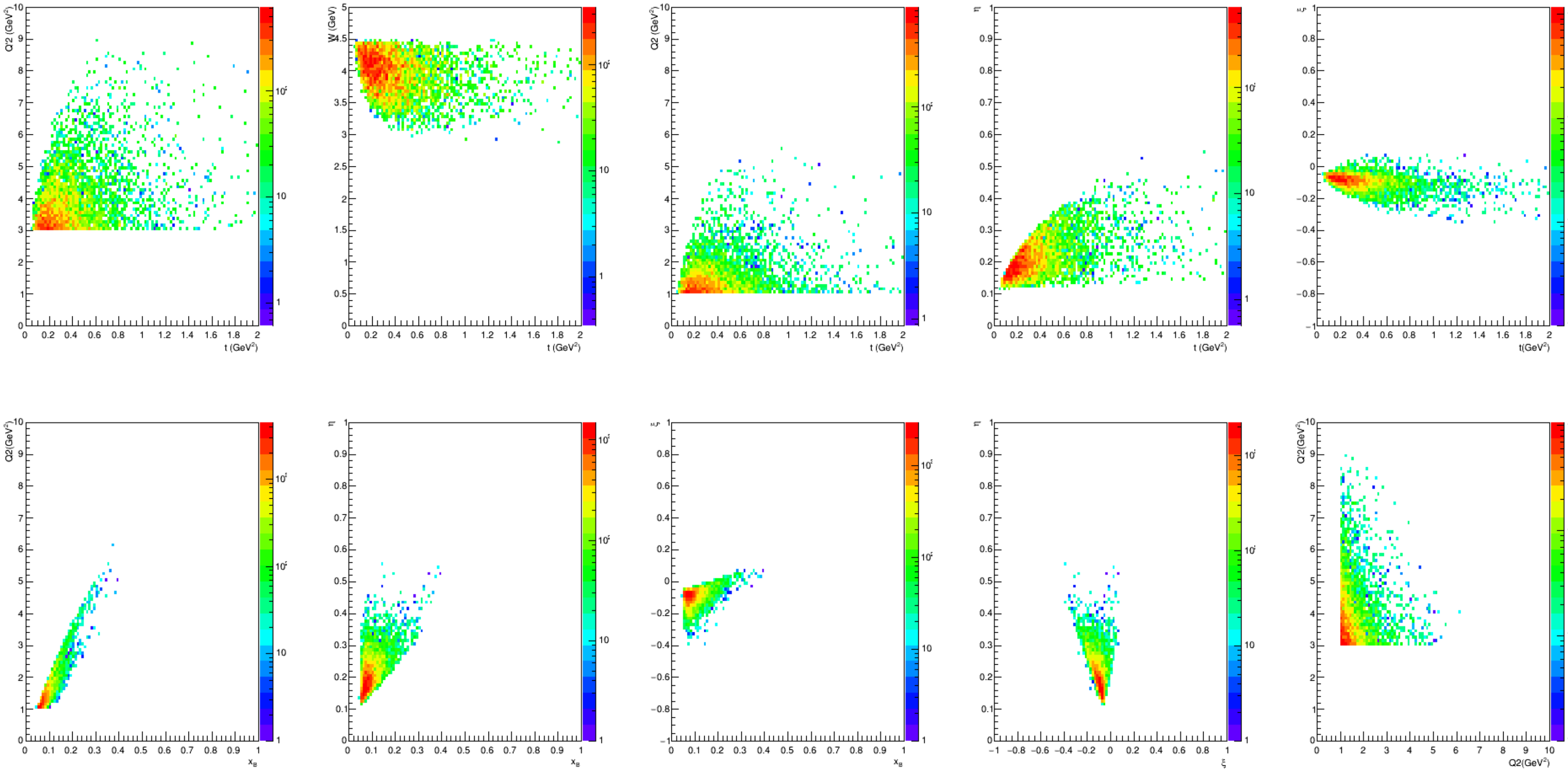
kinematics

Before cut 3<Q'2<9



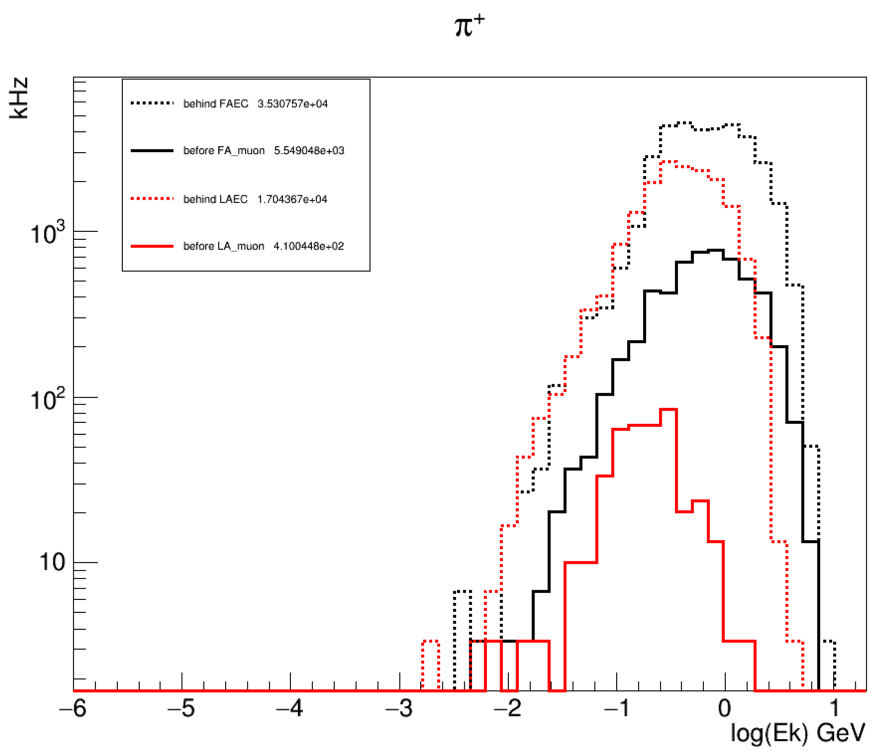
kinematics

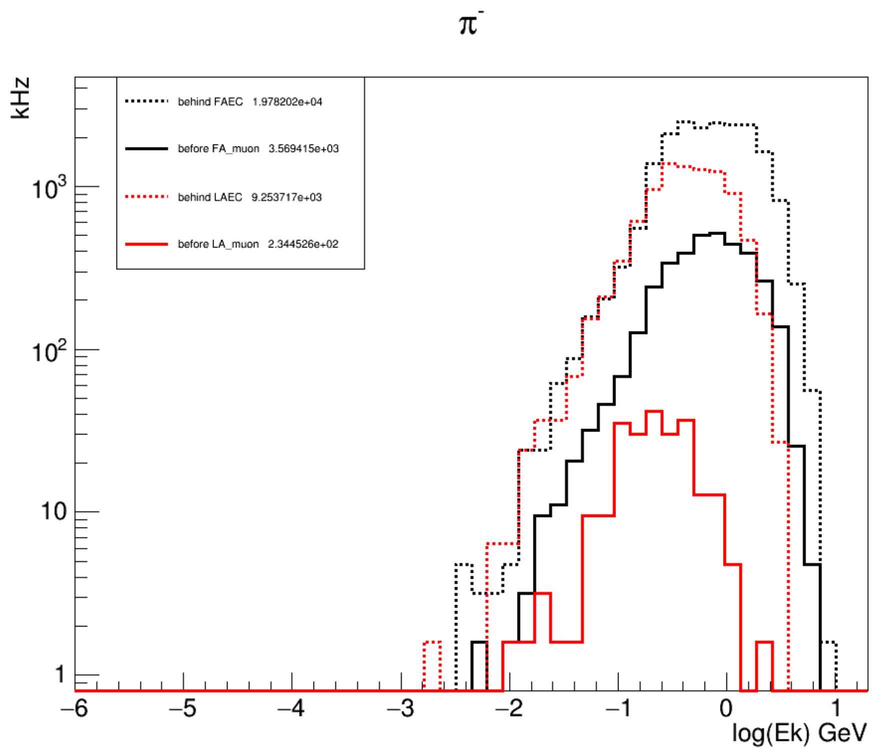
After cut 3<Q’2<9



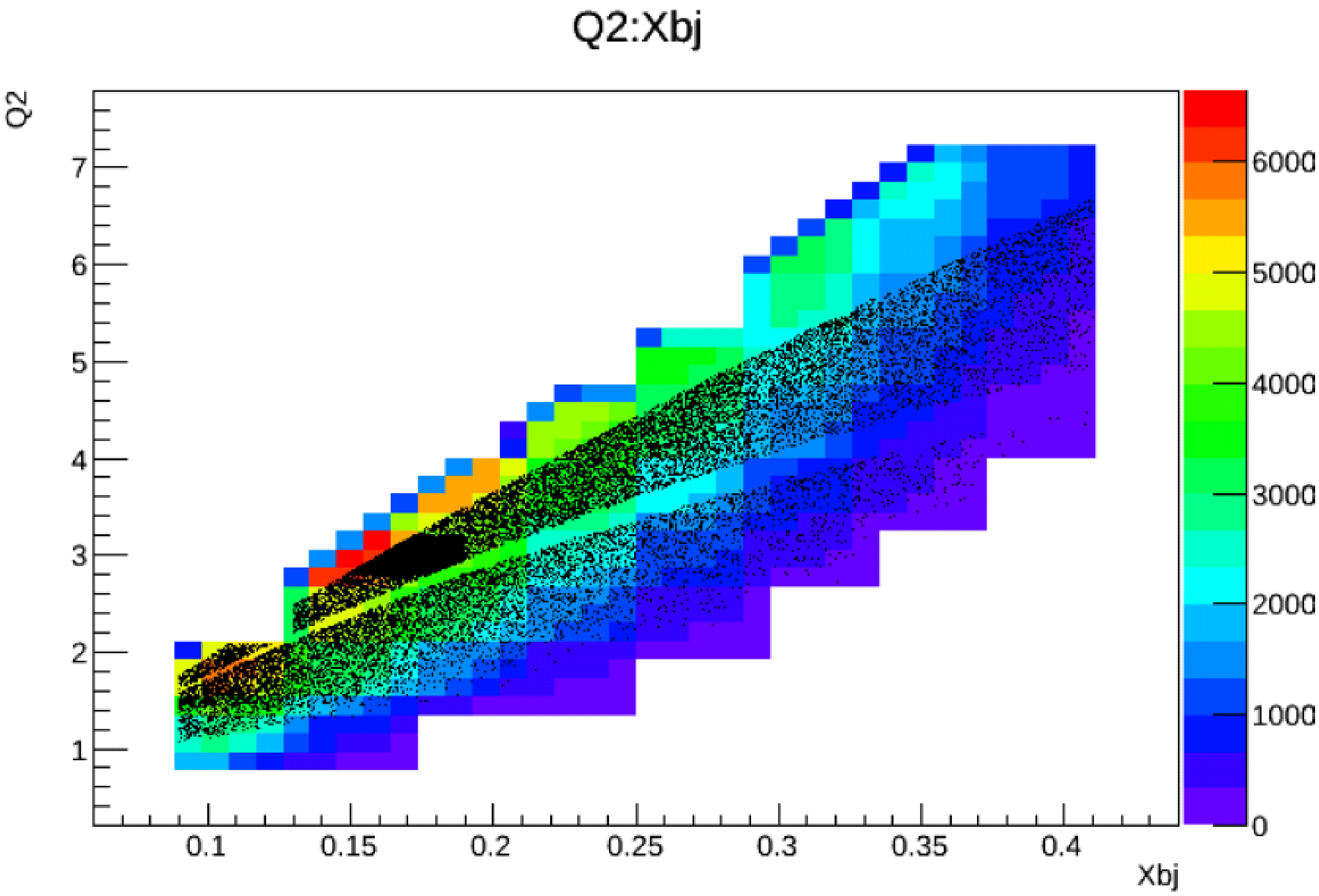
background

- Pion rate before and after iron flux return

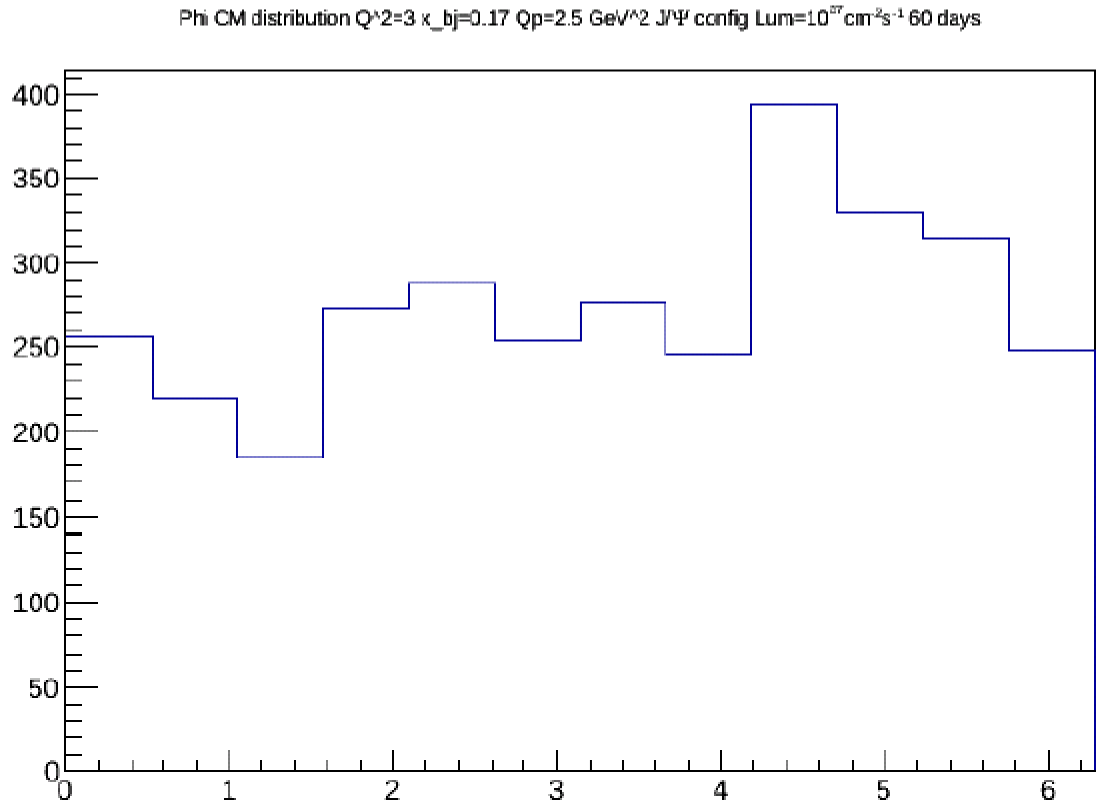




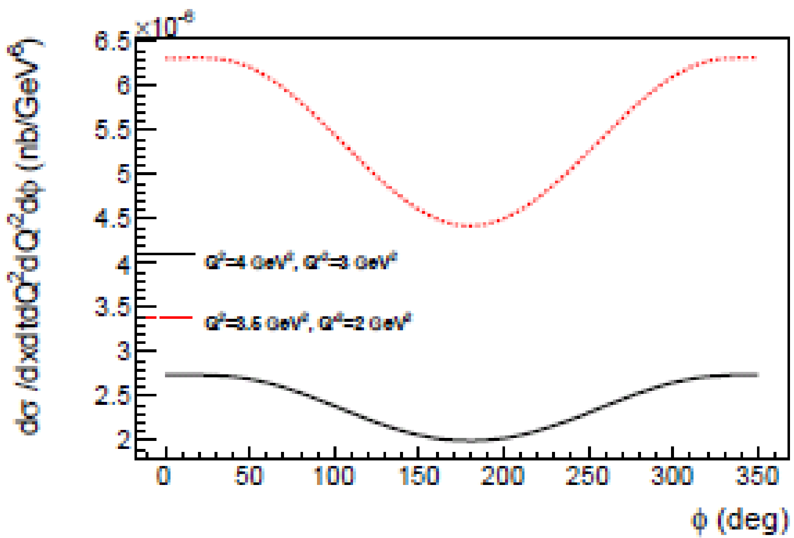
Kinematical coverage JPSi setup

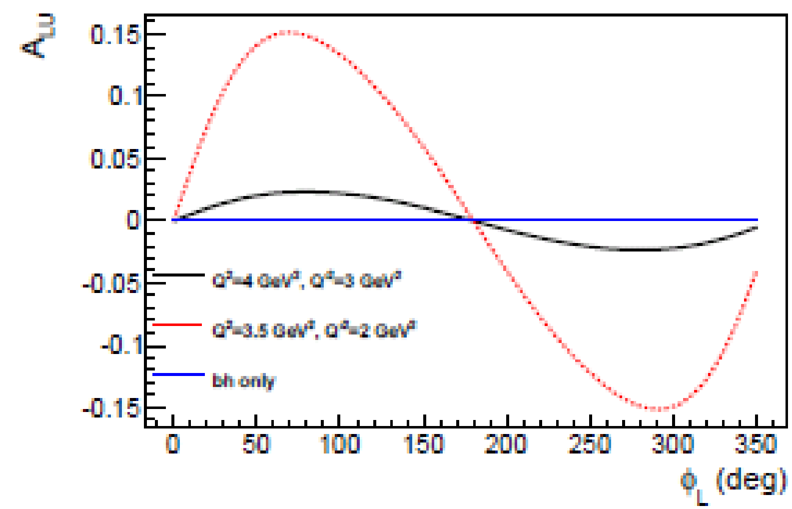


Counts J/psi setup 60 days at 10^37 $cm^{-2}s^{-1}$

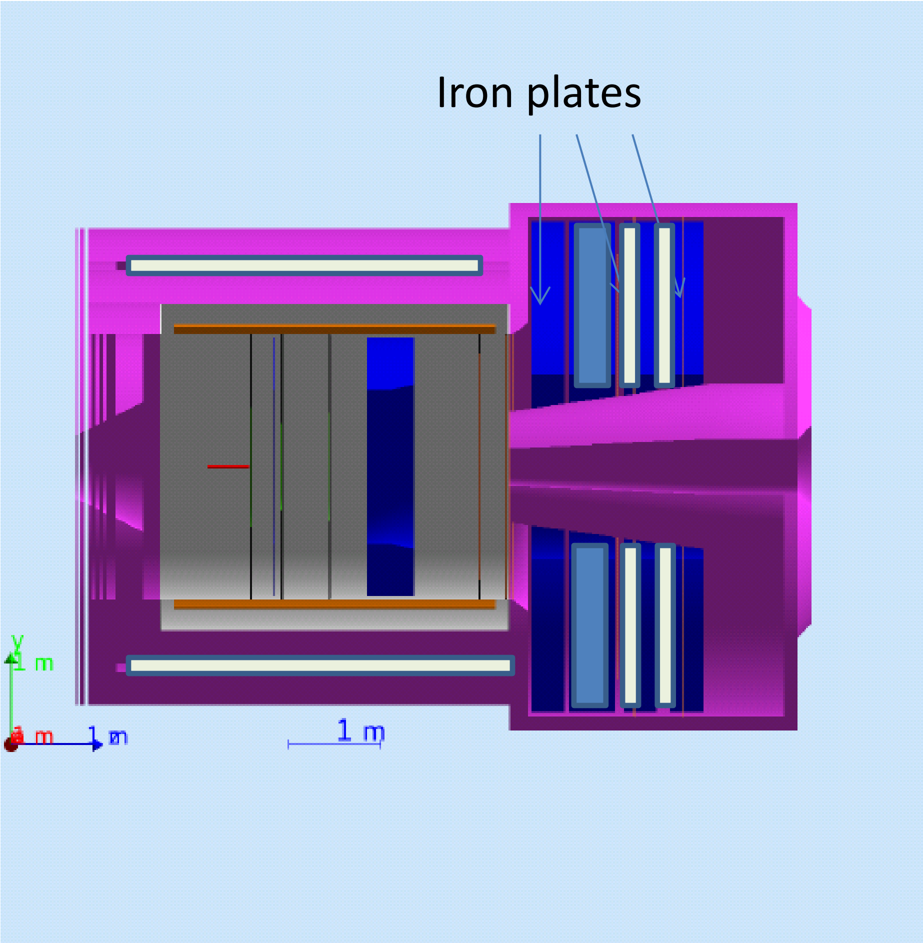


Cross sections / Asymmetry



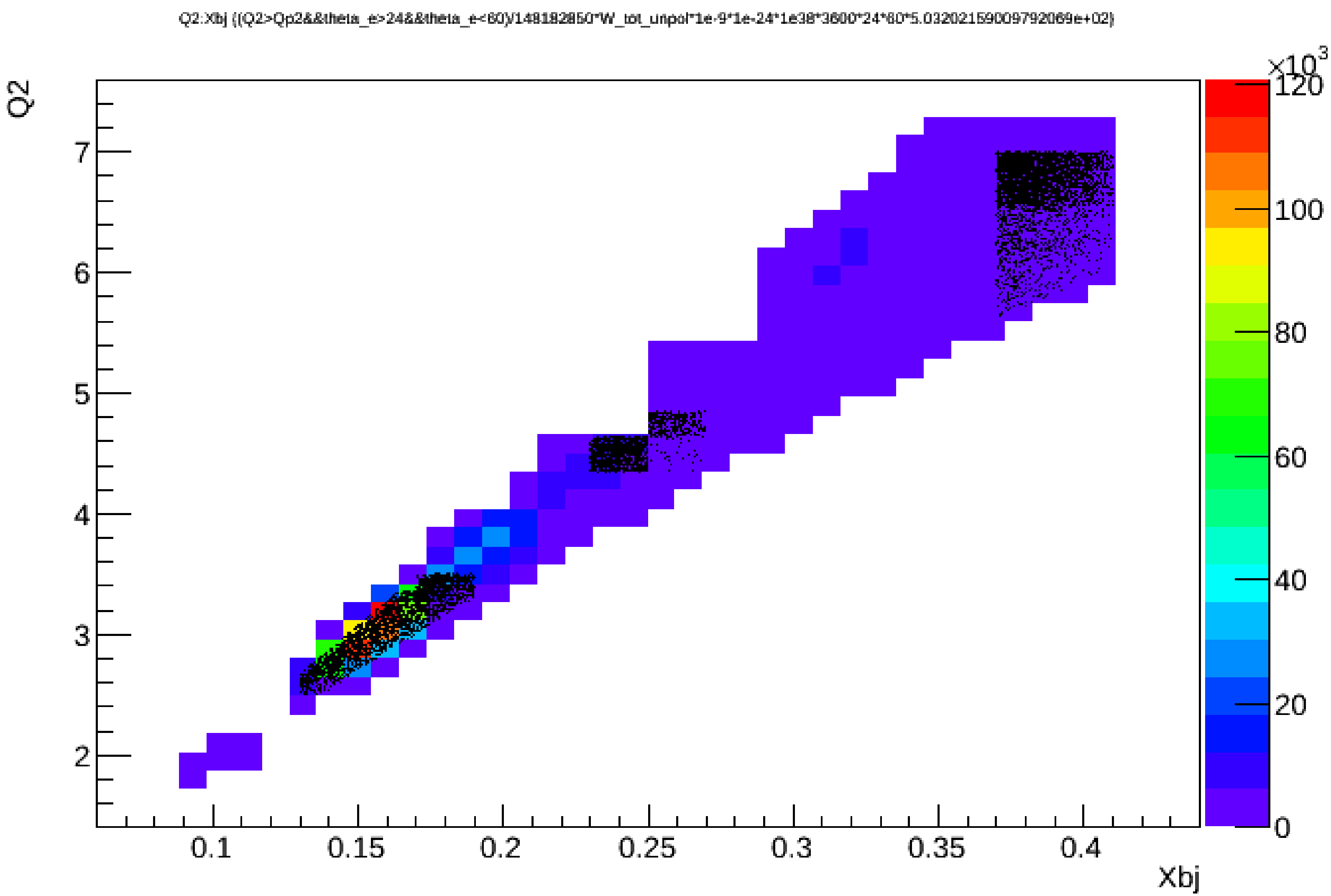


Dedicated setup

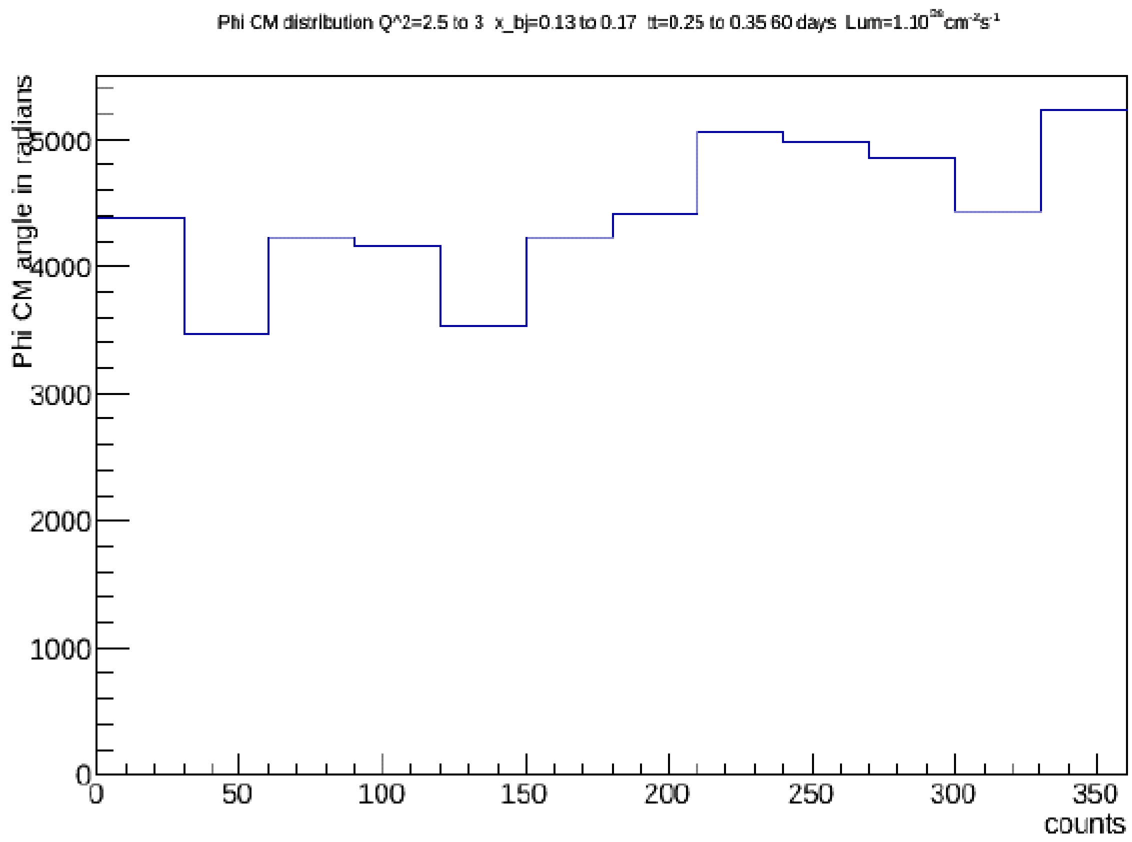


- Target moved 2m from Jpsi position inside and switch to 45 cm target
- Iron plate from 3rd layer yoke in fron and behind calorimeter
- Remove Gas Cerenkov
- Try to reach 10^38 $cm^{-2}s^{-1}$
- 10 uA on 45 cm target

Kinematical coverage

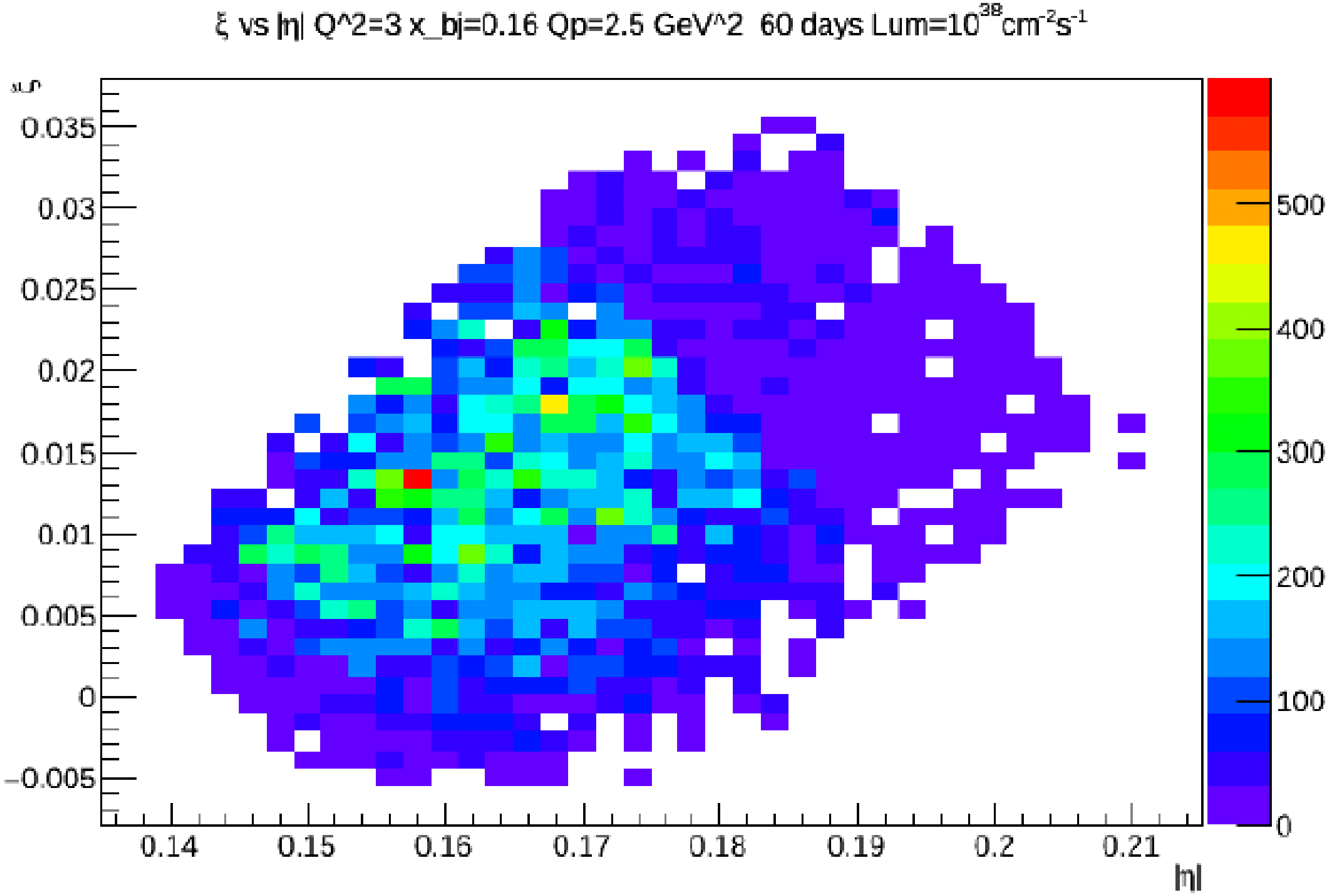


Counts

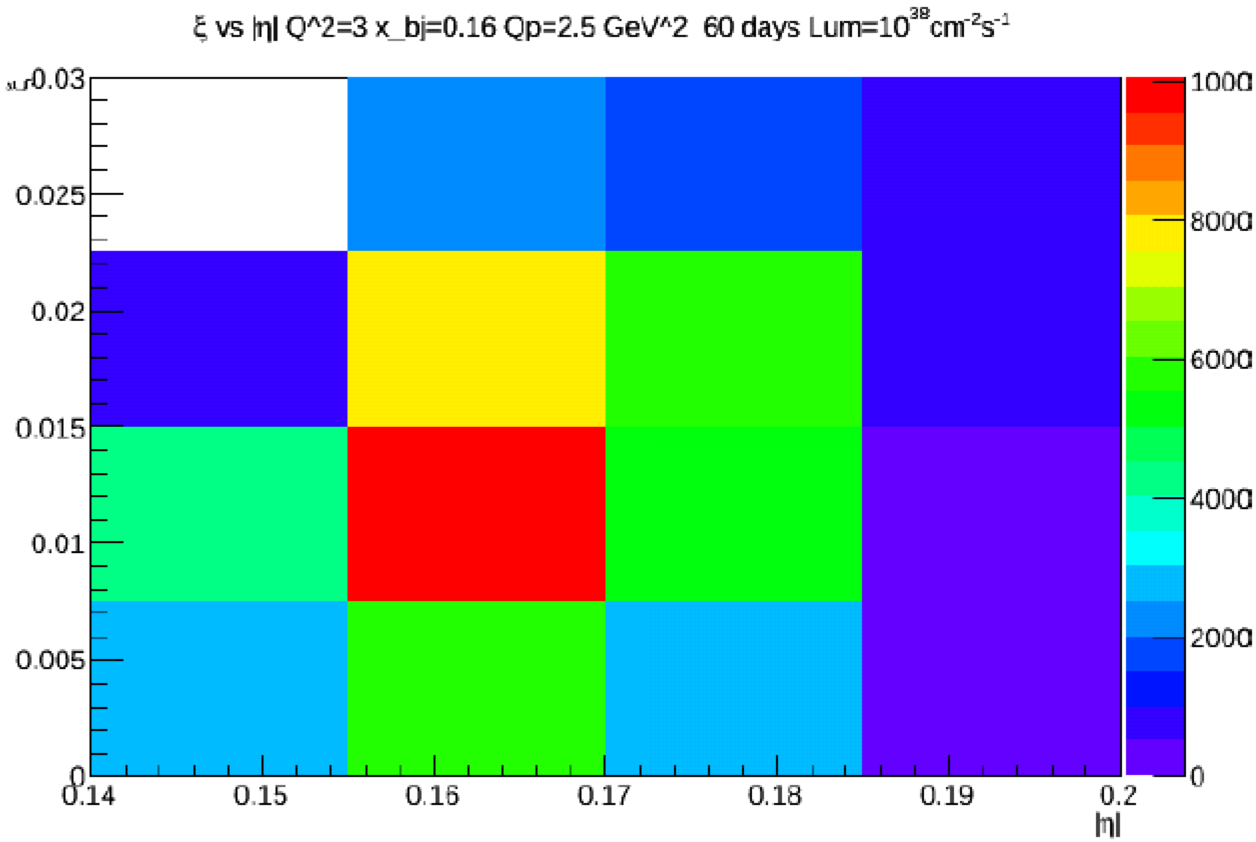


Phi CM distribution Q^2=2.5 to 3 x_bj=0.13 to 0.17 tt=0.25 to 0.35 60 days Lum=1.10 cm-2s-1
Phi CM angle in radians
0
1000
2000
3000
4000
5000
0
50
100
150
200
250
300
350
counts

Eta and xi coverage



Eta Xi coverage large bin



Higher luminosity ?

- Current could go up to 60 uA
- Tracker occupancy and photon background
  - Reduce amount of Copper in GEM
  - Micromegas option
  - Build smaller chambers and add more channels
  - Study complement with 2D pad readout
  - Superconducting tracker option
- Calorimetry
  - Study liquid scintillator and cryogenics calorimeter option
  - Superconducting detector to replace PMT (1 ns width pulse to increase rate capability)
- Cerenkov
  - Superconducting detector to replace PMT (1 ns width pulse to increase rate capability)
  - HBD type Cerenkov for Large Angle calorimeter

6. 10^38 $cm^{-2}s^{-1}$

Technically doable mostly matter of cost

Conclusion

- CLEO muon detector is a good opportunity to look at dimuon physics
- Parasitic measurement on J/Psi give a first measurement of DDVCS with low statistics
- Dedicated setup could increase luminosity by a factor of 10
- High statistics would allow binning in different variables to look a binning in Q'2 to probe xi eta surface with xi different of eta of GPDs