Large Acceptance High Luminosity Detector at 12 GeV

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Outline

1. Motivation for a Large Acceptance at High Luminosity
   - DIS Parity Violation at high X at 12 GeV
   - Other Potential Experiments
2. Apparatus
   - Requirements
   - Options
   - Solenoidal spectrometer
3. Conclusion

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DIS Parity Violation at $X > 0.6$ at 12 GeV

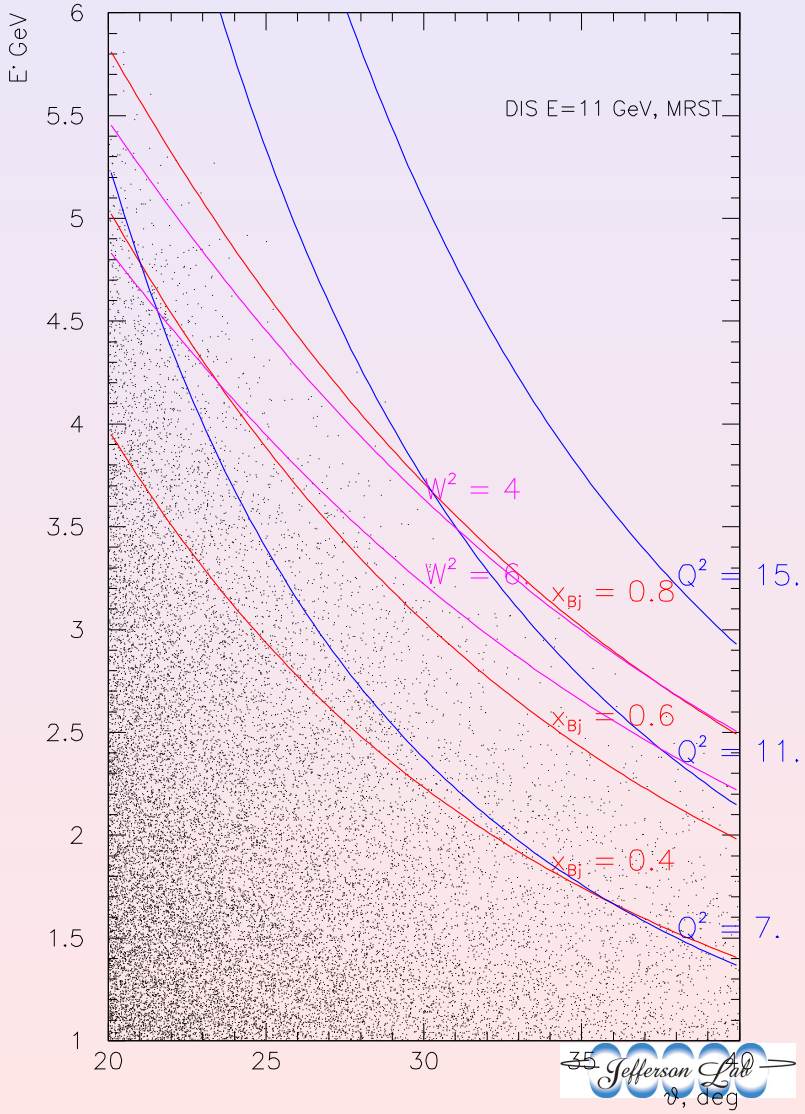
Motivation will be discussed today by Kent Paschke

Kinematics and Luminosity

- 50 μA, 40 cm LH $\sim 0.54 \mathrm{fb}^{-1}\mathrm{s}^{-1}$
- $22^\circ < \theta < 40^\circ$
- $2 < E' < 5 GeV$
- Rate 30kHz $X > 0.6$, $W^2 > 4$
- $A \approx 10^{-4} \cdot Q^2 \sim 10^{-3}$

Sensitivity required

- 1% stat $\Rightarrow 1.5 \cdot 10^{10}$ events
- 30 days $\times$50% $\Rightarrow$
  Acceptance
  $\varepsilon > 0.4$ ($\Delta\Omega > 0.27$ str)

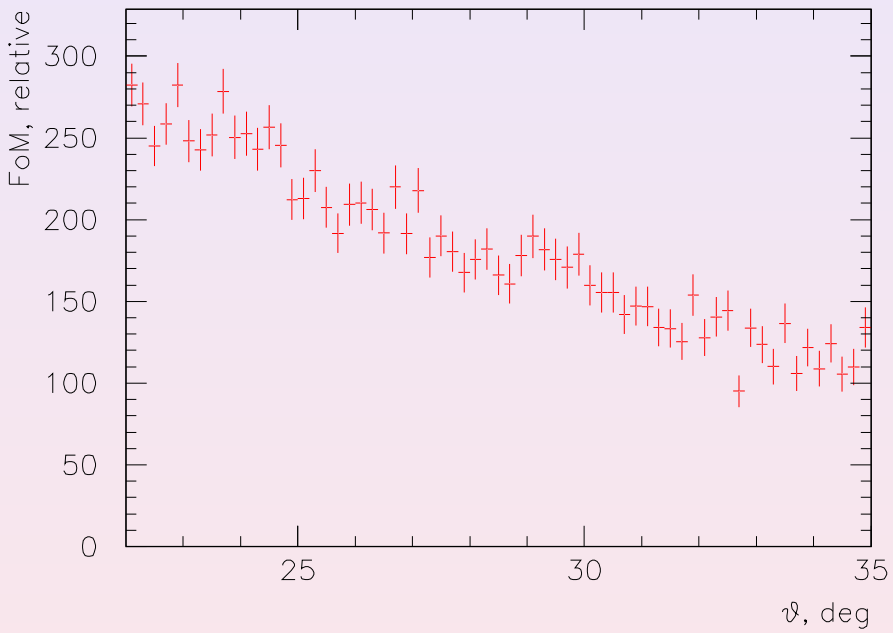


DIS Parity - Figure of Merit

FoM

- $\propto N_{events}$
- $\propto A^2 \propto Q^4$

A smooth dependence on θ
Effective rate
$0.8 \cdot 30kHz = 24kHz$



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Other Potential Experiments

Experiments considered at 12 GeV

- Polarized DIS at high X
- $\gamma p \rightarrow J/\Psi p$ photoproduction close to threshold
- DVCS $e^- p \rightarrow e^- \gamma p, e^- l^+ l^- p,$

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Requirements

Acceptance

- Working at $\mathcal{L} \sim 0.54\mathrm{fb}^{-1}\mathrm{s}^{-1}$
- $E' > 1.5$ GeV to remove low energy e^-, π^-
- $E' < \infty$ no line of sight, to remove γ
- $\sigma E'/E' < 2\%$ energy resolution
- $\Delta\Omega \sim 0.3 str$ solid angle
- PID $e/\pi \sim 10^5$
- Trigger rate $<$10 kHz/DAQ

Is it possible?

- If it were easy - would have been done somewhere
- New detectors with high rate capabilities may help

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Options

General

- Magnetic spectrometer
- Baffles to block the line of sight
- Calorimeter for electron detection
- Gas Cherenkov

Toroidal spectrometers

- CLAS++ $\mathcal{L}$ is 5000 times lower
- G0, QWEAK - lower momentum
- Needs a cleaning magnet for Møller electrons

Solenoid spectrometers

- Møller electrons contained
- Potentially - more compact than toroids
- Long targets make no problem

Toroidal magnet

Features

Strong deflection

Limited $\Delta\theta, Z_{targ}$

Field: $B \propto 1/R$

Iron: $B_{max} \sim 1.7\ T$

$< 50\%\ \ 2\pi$

Rates

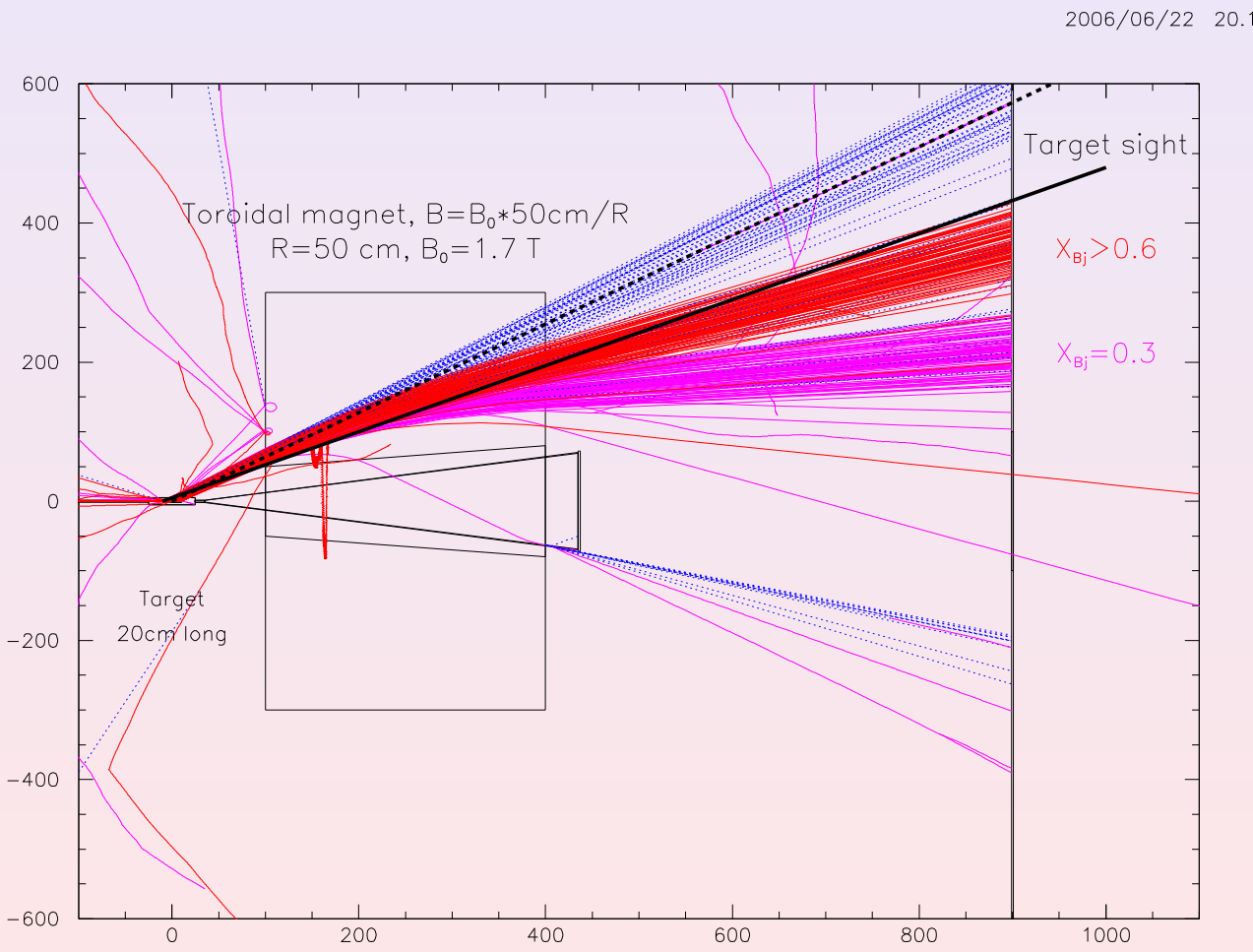
$30 < \theta < 35°$

target 20 cm

Iron: $\Delta\Omega \sim 0.15$ str

Effective rate:

17% of the goal



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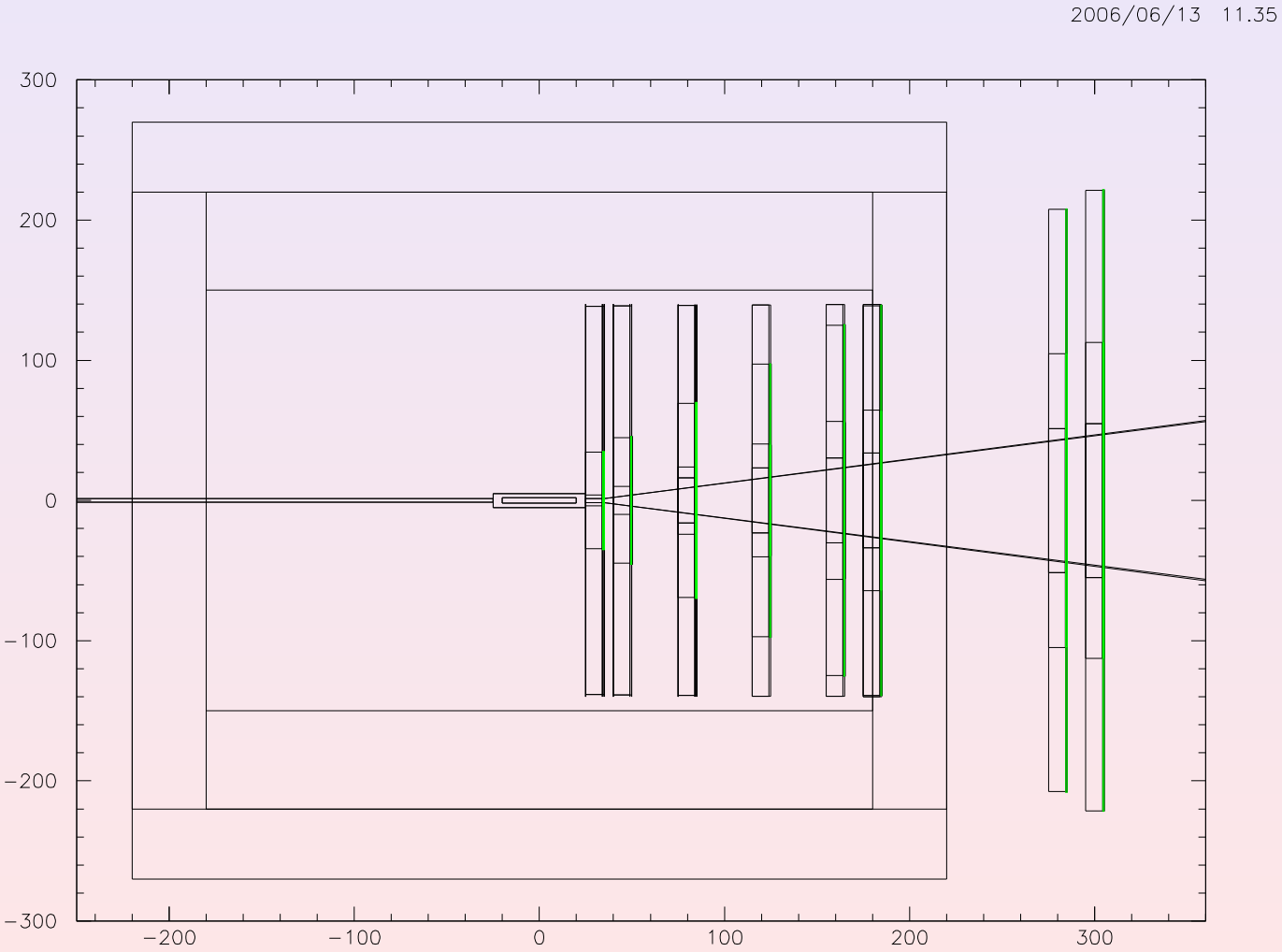
Solenoids

Existing solenoids which may fit

Experiment	B, T	Bore D, m	Length, m	MJ	X_0
BaBar	1.5	2.80	3.46	27	<1.4
Cleo-II	1.5	2.90	3.80	25	2.5

Spectrometer



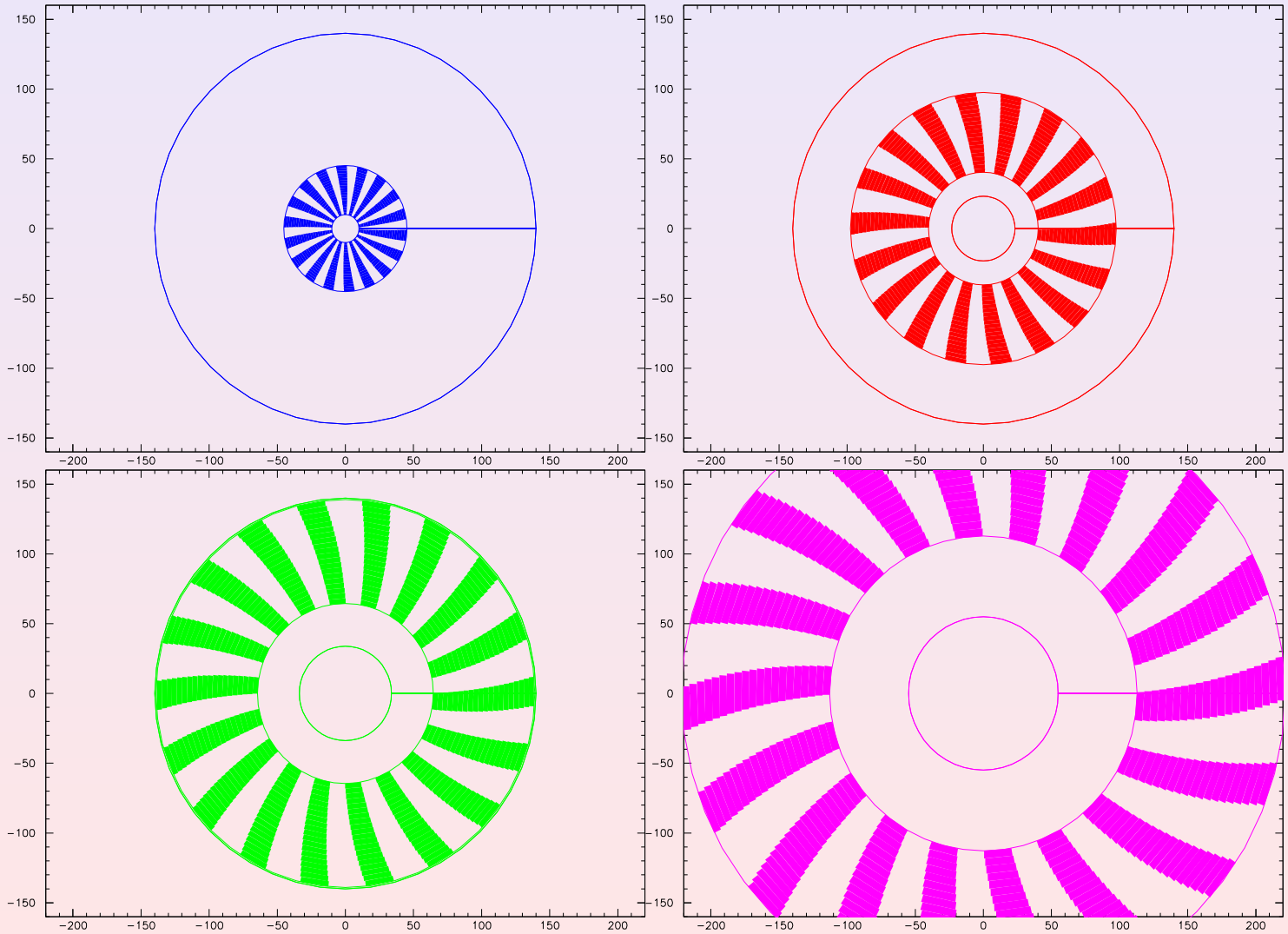
Baffles optimization

Baffles geometry

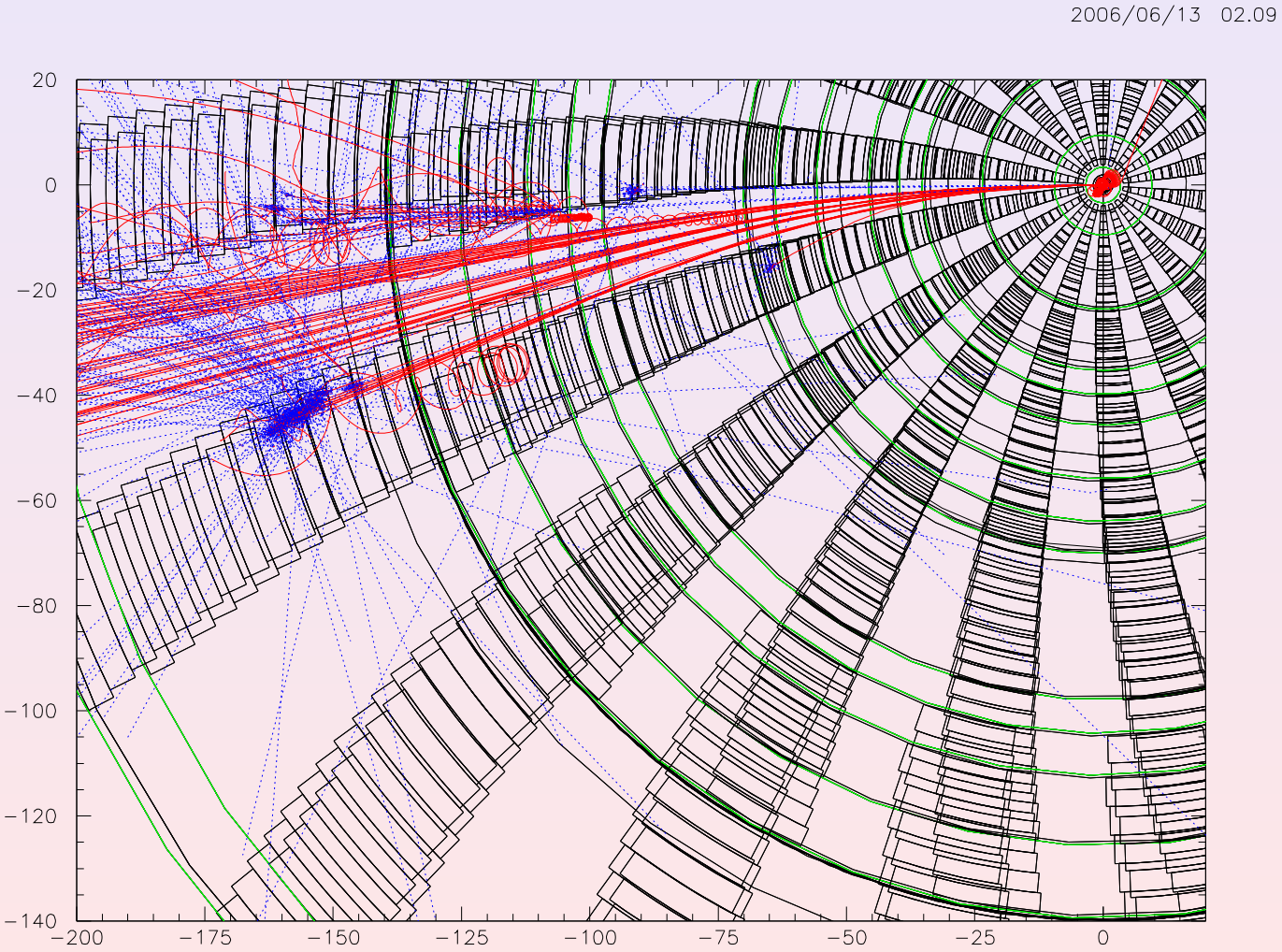
Allow all DIS in:

- $22^\circ < \theta < 35^\circ$
- $0.6 < X_{Bj} < 0.9$
- $\delta\varphi \sim 5.0 - 9.0^\circ$
- pitch $\Delta\varphi = 20^\circ \Rightarrow$ 18 sectors
- 9 cm of lead

Baffles



Trajectories

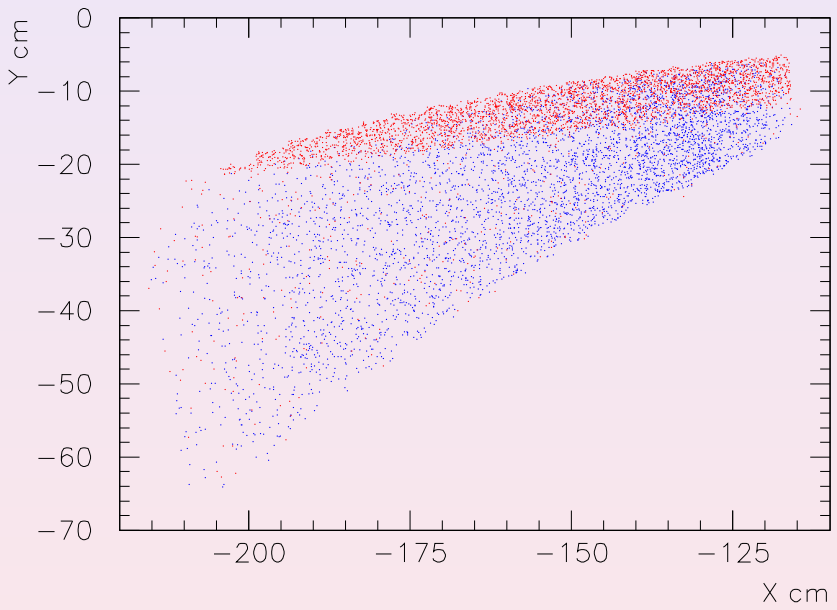


Line of sight

Corrections to the baffles

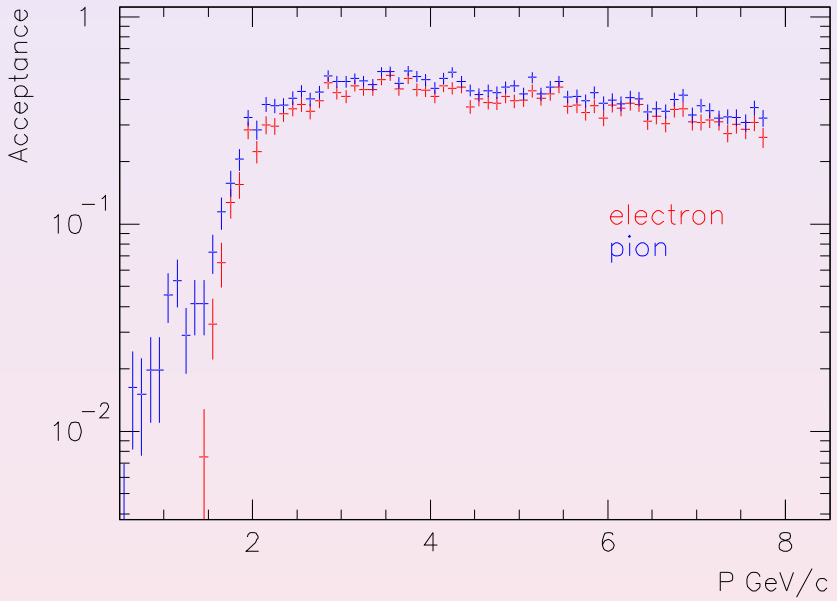
Ways to remove the line of sight: squeeze the baffles

- last baffle -25%
- first baffle -33%

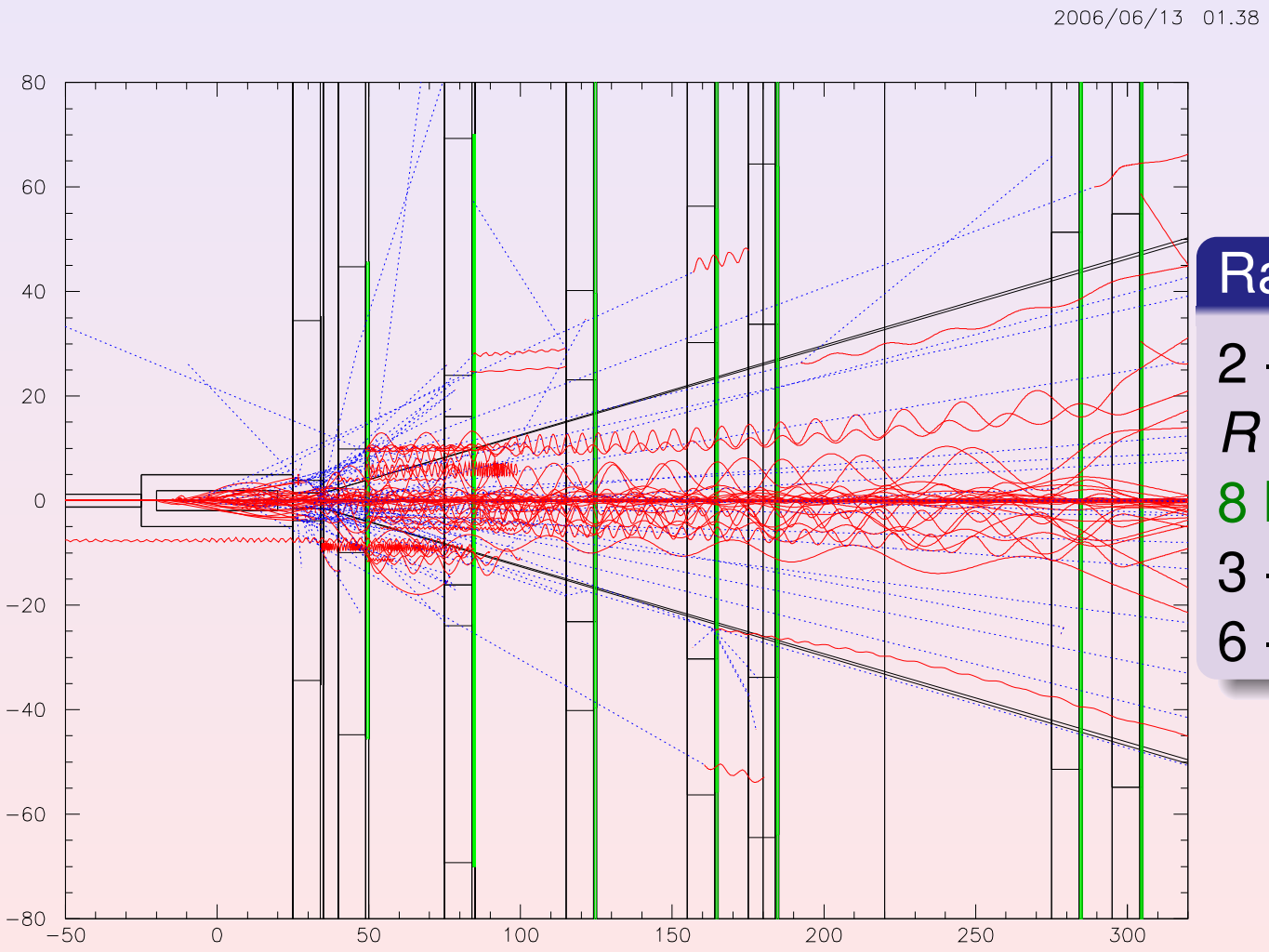


Acceptance

- e^- $P > 1.5$ GeV/c
- Rate: 56% of the goal



Low energy background



Rates

2 - 25 kHz/mm^2

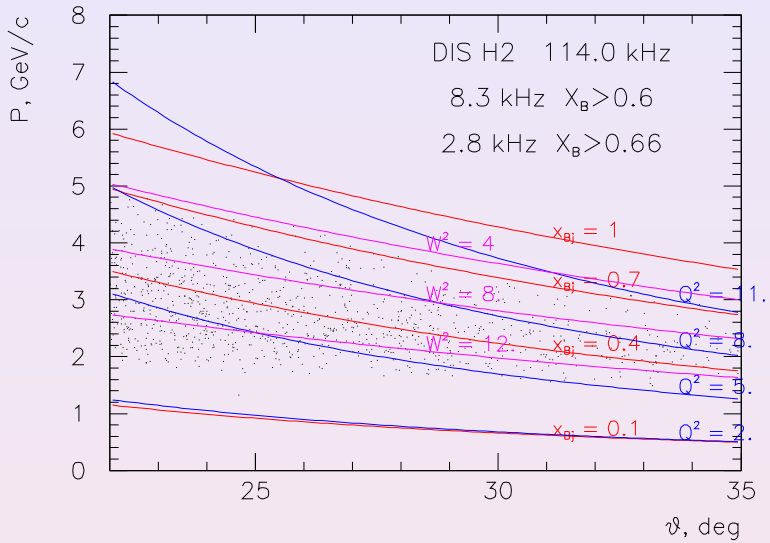
$R > 13$cm

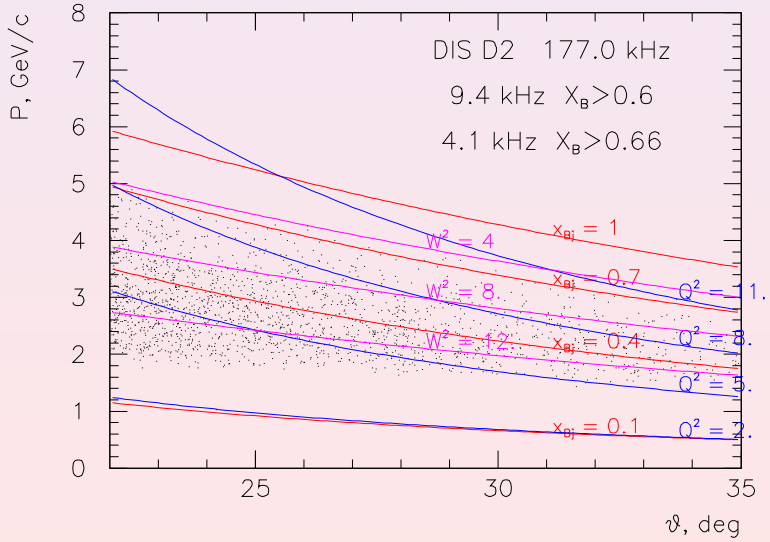
8 kHz/mm^2

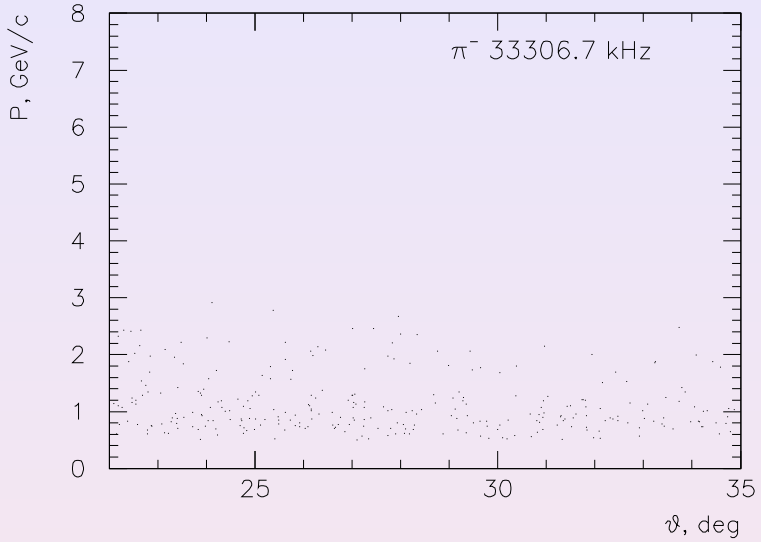
3 - 3 kHz/mm^2

6 - 1 kHz/mm^2

Rates







Rates

- $e^- \sim 100$ kHz
- $\pi^- \sim 33$ MHz
- Rates per sector $1/18$
- $\pi^- \times 1/100$ in trigger
- $D\ x \sim 0.7$, 1%stat $\Rightarrow$ 90 days at 50% efficiency

Detectors

Calorimeter

- Lead glass $\sigma E/E \sim 0.06/\sqrt{(E)} \sim 3\%$
- Electrons $\sim$ 6 kHz/sector, pions $\sim$ 2 MHz/sector
- Time resolution $\sim$ 10 ns needed

Gas Cherenkov

Pion threshold $\sim$ 3 GeV/c 1 m long $\Rightarrow > 10$ ph.e.

Tracking - GEM/straw

- GEM similar to COMPASS ($\sim$ 30 kHz/mm^2)
- Rate $<$ 8 kHz/mm^2, 50 MHz/sector
- Time resolution $\sim$ 40 ns $\Rightarrow$ 2 hits/sector
- Coordinate resolution $<$ 100 μm
- Mometum resolution $\sim$ 1-2%

Conclusion

Studies of the solenoid option

- Rates in the tracking chambers < 8 kHz/mm^2, COMPASS GEM ~ 30 kHz/mm^2
- Pion rate is high, but manageable
- The sensitivity is close to the goal
- trigger based on the calorimeter and the gas Cherenkov
- 18 independent sectors, trigger ~ 10 kHz/sector
- Seems feasible...

To do

- More realistic BG calculations (GEANT4?)
- Optimization of the geometry
- Comparison with the toroid option