Large Acceptance PVDIS Setup project update

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Hall A Collaboration meeting, JLab, June 2008

Outline

1. Introduction
2. Physics Requirements
3. Apparatus
   - Requirements and options
   - Large Solenoid (Solid)
   - Double Toroid (DTS)
4. Conclusion

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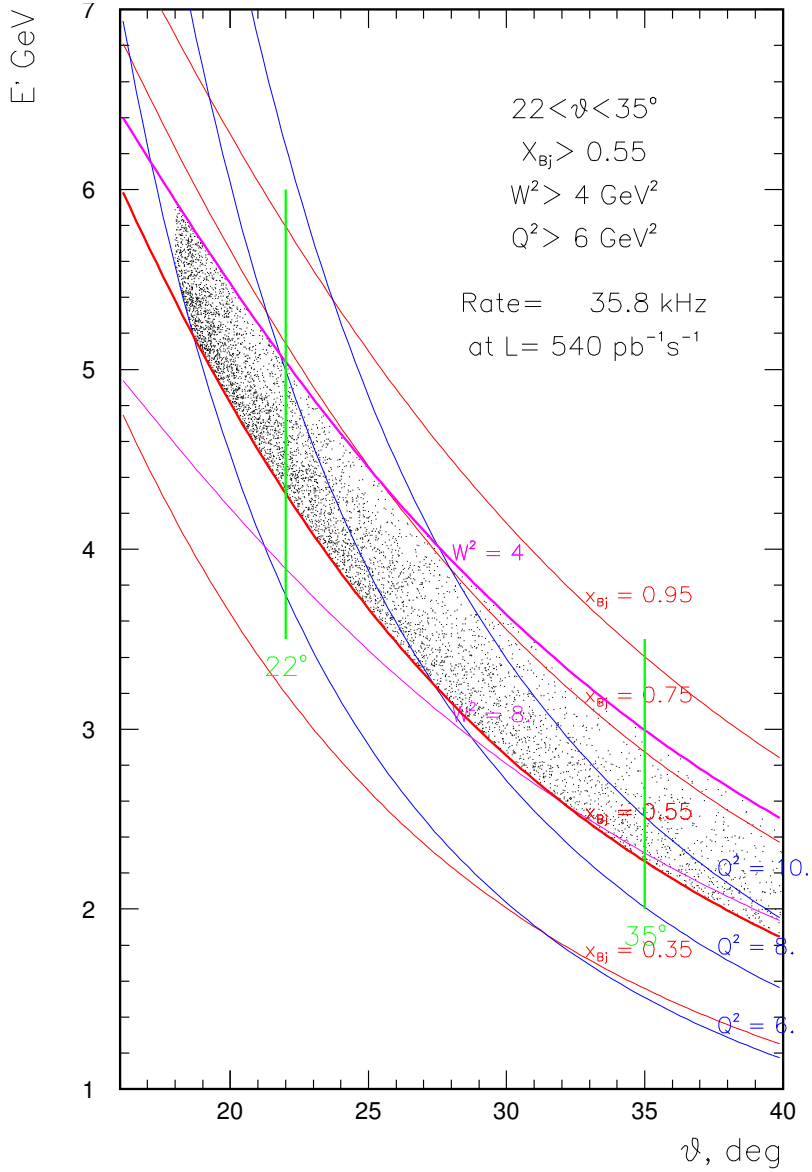
Introduction

Goal of the talk: give an update of the project

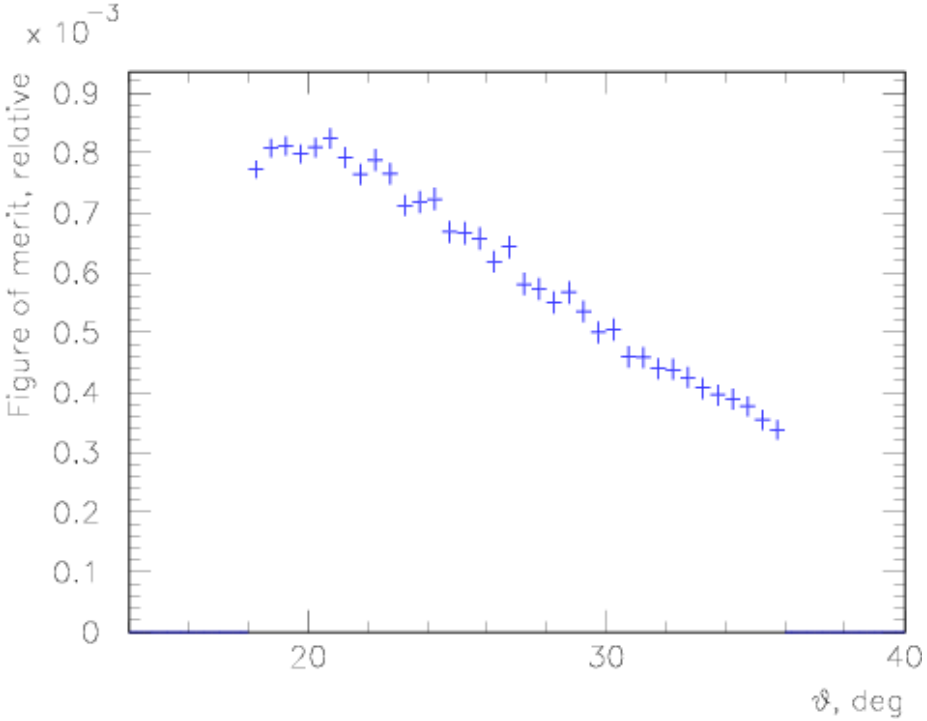
- Motivation has been discussed, the latest Dec 2007
- Two options considered:
  - Large solenoid (SoLID), relatively developed
  - Double toroid (DTS), initial stage

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



Motivation: CSV, d/u, high twists

$A \approx 10^{-4} \cdot Q^2 \sim 0.7 \cdot 10^{-3}$



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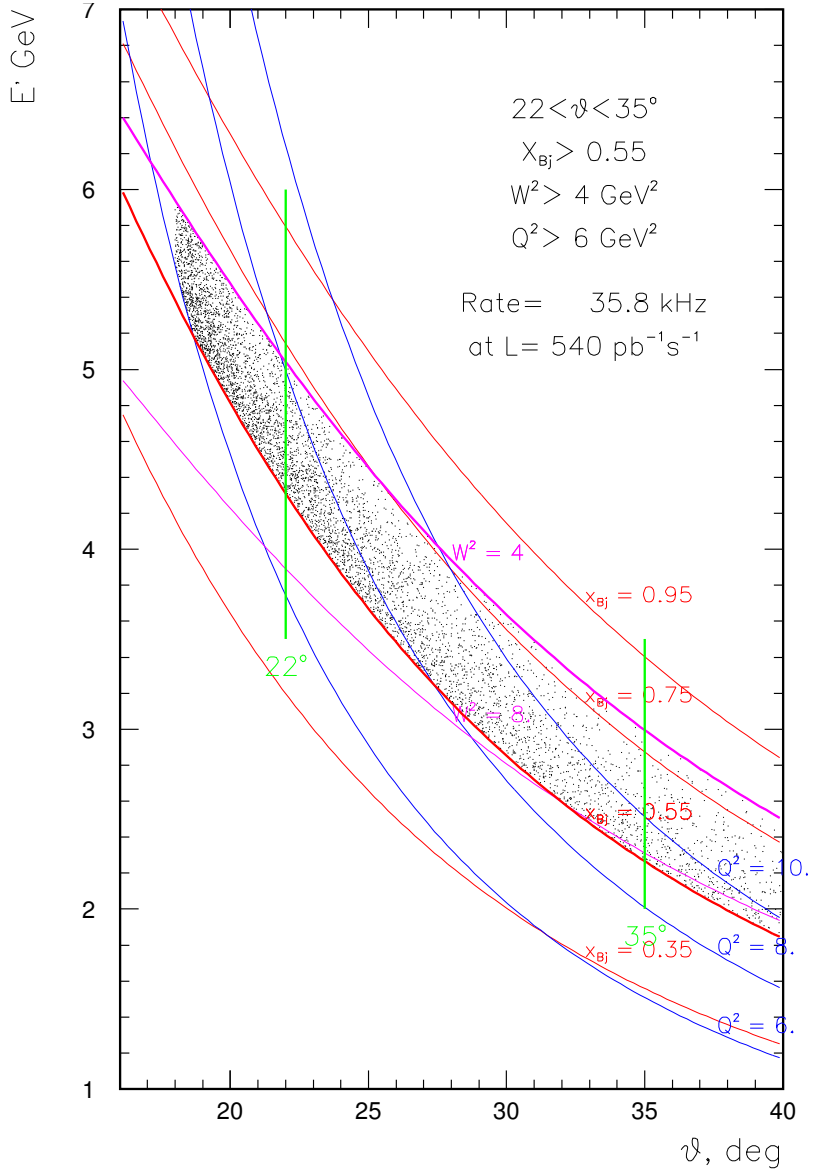


Motivation: CSV, d/u, high twists

$A \approx 10^{-4} \cdot Q^2 \sim 0.7 \cdot 10^{-3}$

Kinematics and Rates

- $22^\circ < \theta < 35^\circ$, $W^2 > 4$
- 50 μA, 40 cm LH $0.54 \mathrm{fb}^{-1}\mathrm{s}^{-1}$
- Rate 34kHz $X > 0.55$
- Rate 8.7kHz $X > 0.65$

acceptance = 100%, eff=50%

- 1% stat $\Rightarrow 2 \cdot 10^{10}$ events
- $X > 0.55$: 13 days
- $X > 0.65$: 40 days

Other Potential Experiments

Experiments considered at 12 GeV

- SIDIS: transversity, etc. 2 paricles to detect
- $\gamma p \rightarrow J/\Psi p$ photoproduction close to threshold
- DVCS $e^- p \rightarrow e^- \gamma p, e^- l^+ l^- p,$?

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
- $\Delta\Omega > 0.3 str$ solid angle
- PID $e/\pi \sim 10^5$
- Trigger rate <20 kHz/DAQ

If it were easy - would have been done somewhere

Options

- Magnetic spectrometer for long targets, $\sigma P/P \sim 1\%$
- Baffles to block the line of sight
- Calorimeter for electron detection, gas Cherenkov

Solenoidal field

- Møller electrons contained
- Long targets no problem
- At lower $\mathcal{L}$: 2π

Toroidal fields

- Long target - two toroids
- Large acceptance
- Low BG

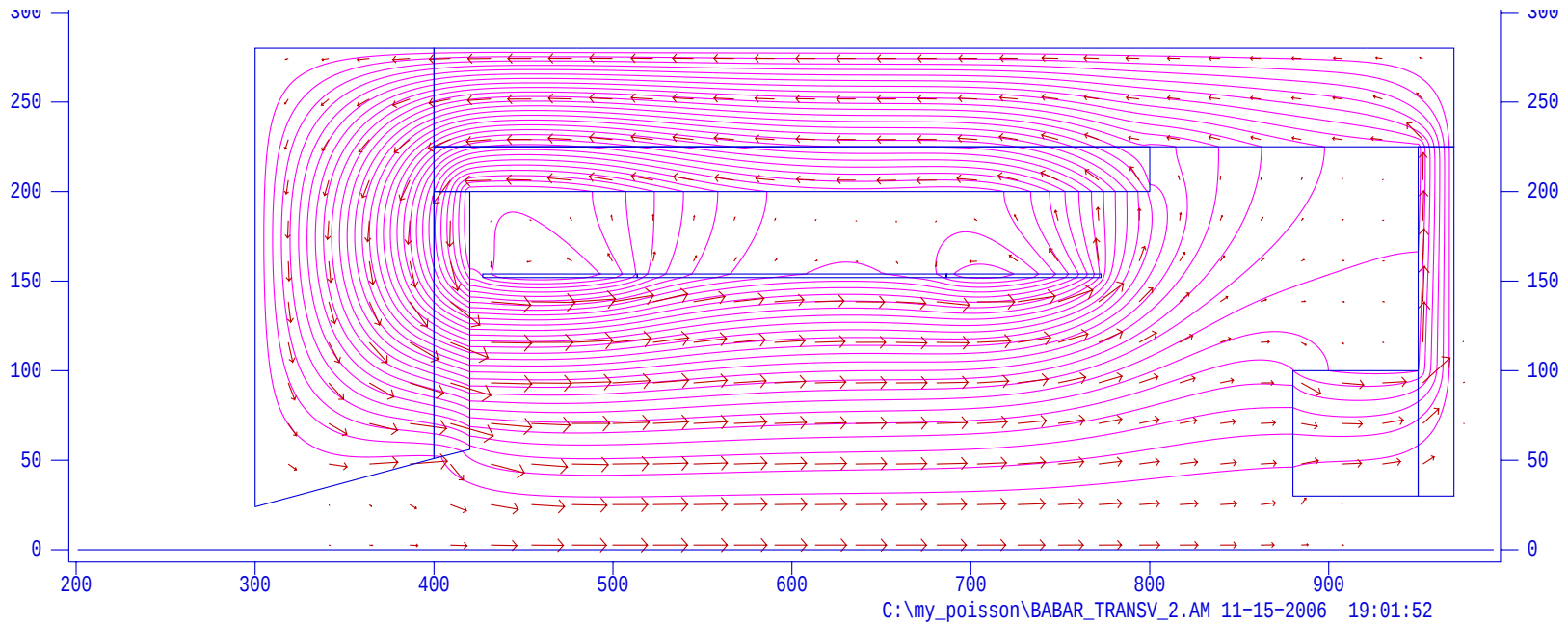
Radial field

- Ring of dipoles
- $<$50% of 2π
- TOSCA: field far from perfect

2 large dipoles

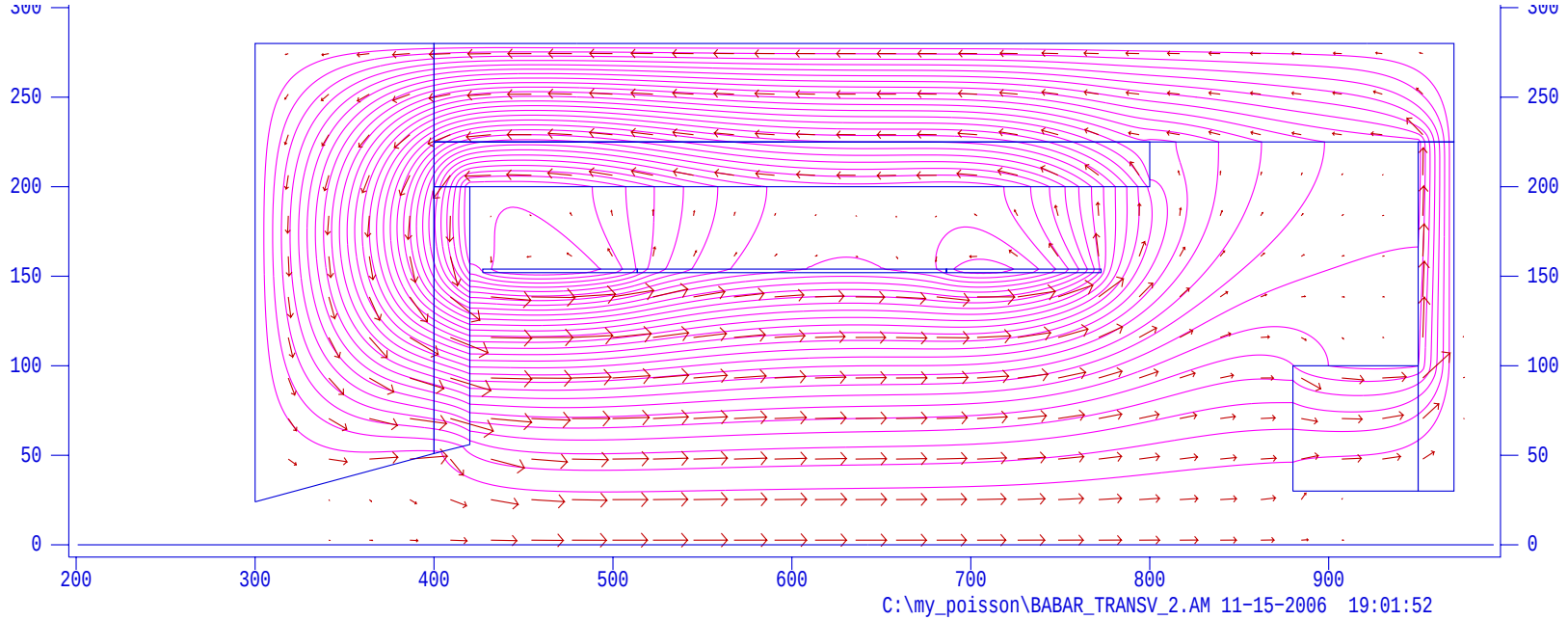
- easiest
- Time needed: $\times 6$

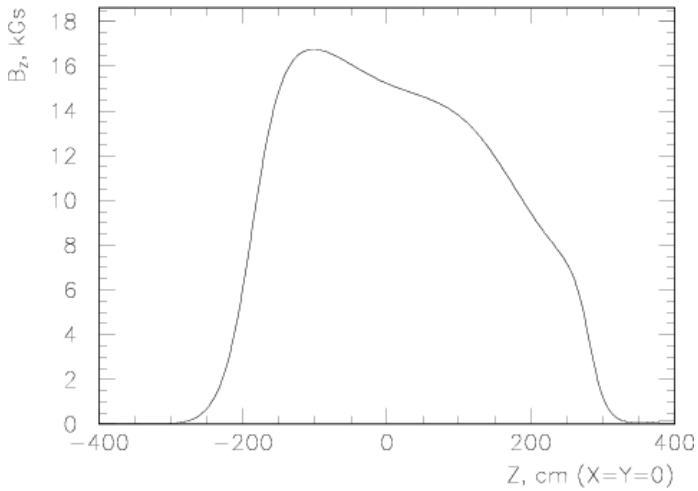
Solenoid from BaBar with a custom yoke



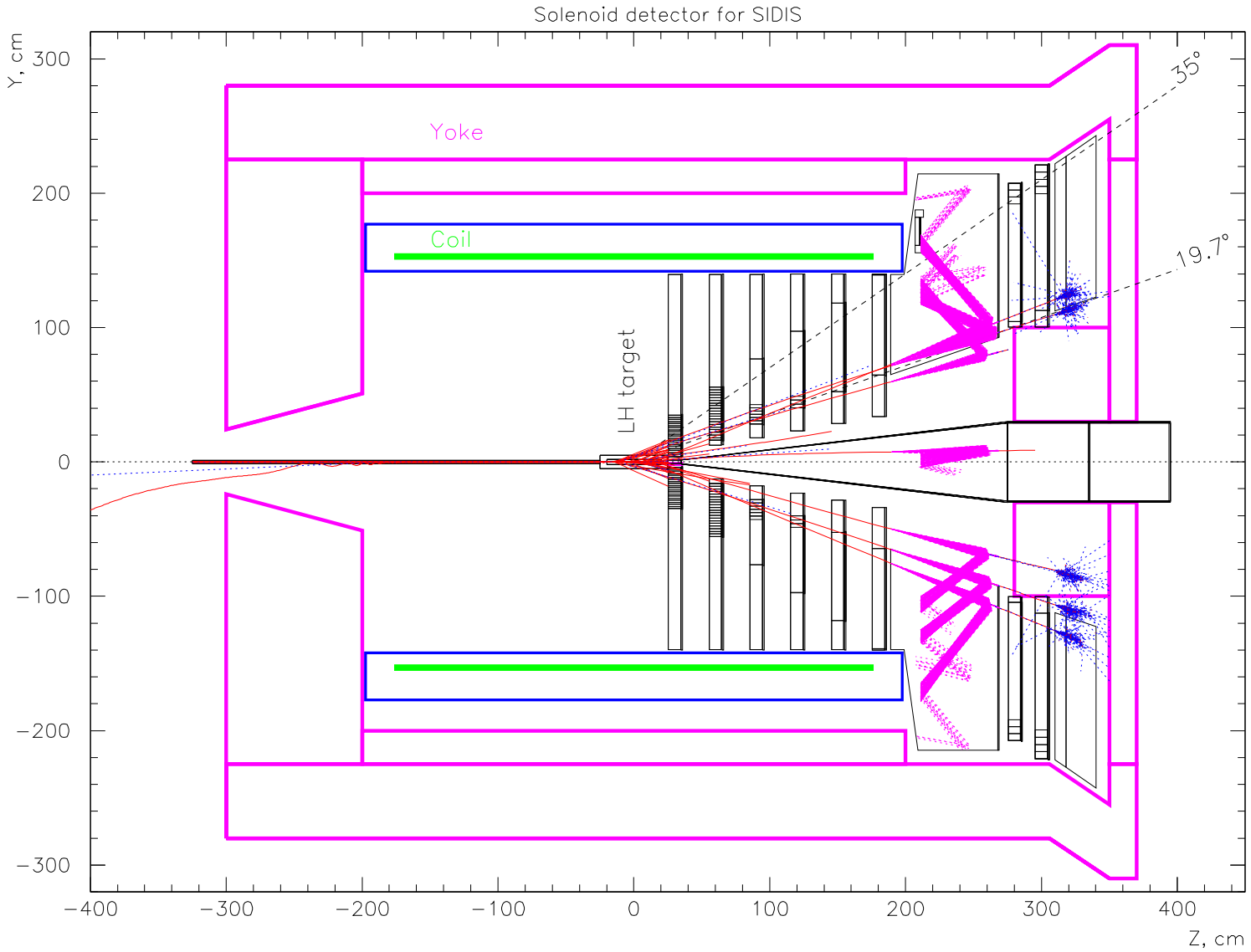
- Target center at -250 cm
- Field at the target $B_Z \sim 4$ Gs
- Gradients at the target $\frac{B_Z}{dZ} \sim 0.1$ Gs/cm, $\frac{B_R}{dr} \sim 0.02$ Gs/cm
- Field at the solenoid center $B = 1.52$ T
- Potential problem: asymmetric yoke (forces on the coil)

Solenoid from BaBar with a custom yoke





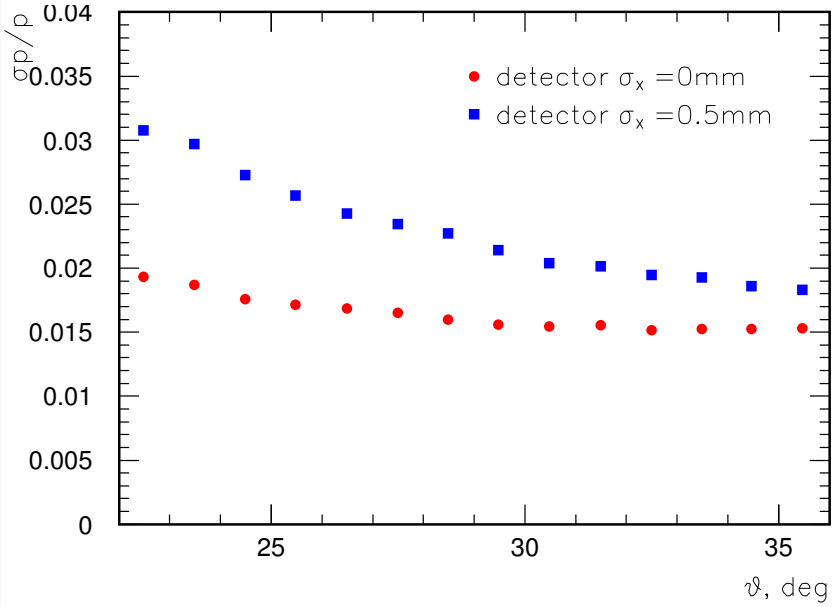
Spectrometer



Where to place the coordinate detectors?

Tracking

- No need for planes inside the solenoid!
- Used - planes 6,8
- Parameters: $\Delta\phi^{-1}, r_6, r_8$
- Fit parameters in $\Delta r_6, r_8$ slices
- Coordinate resolution 0.2-0.4 mm - OK
- Calibration - ep at 6.6 GeV



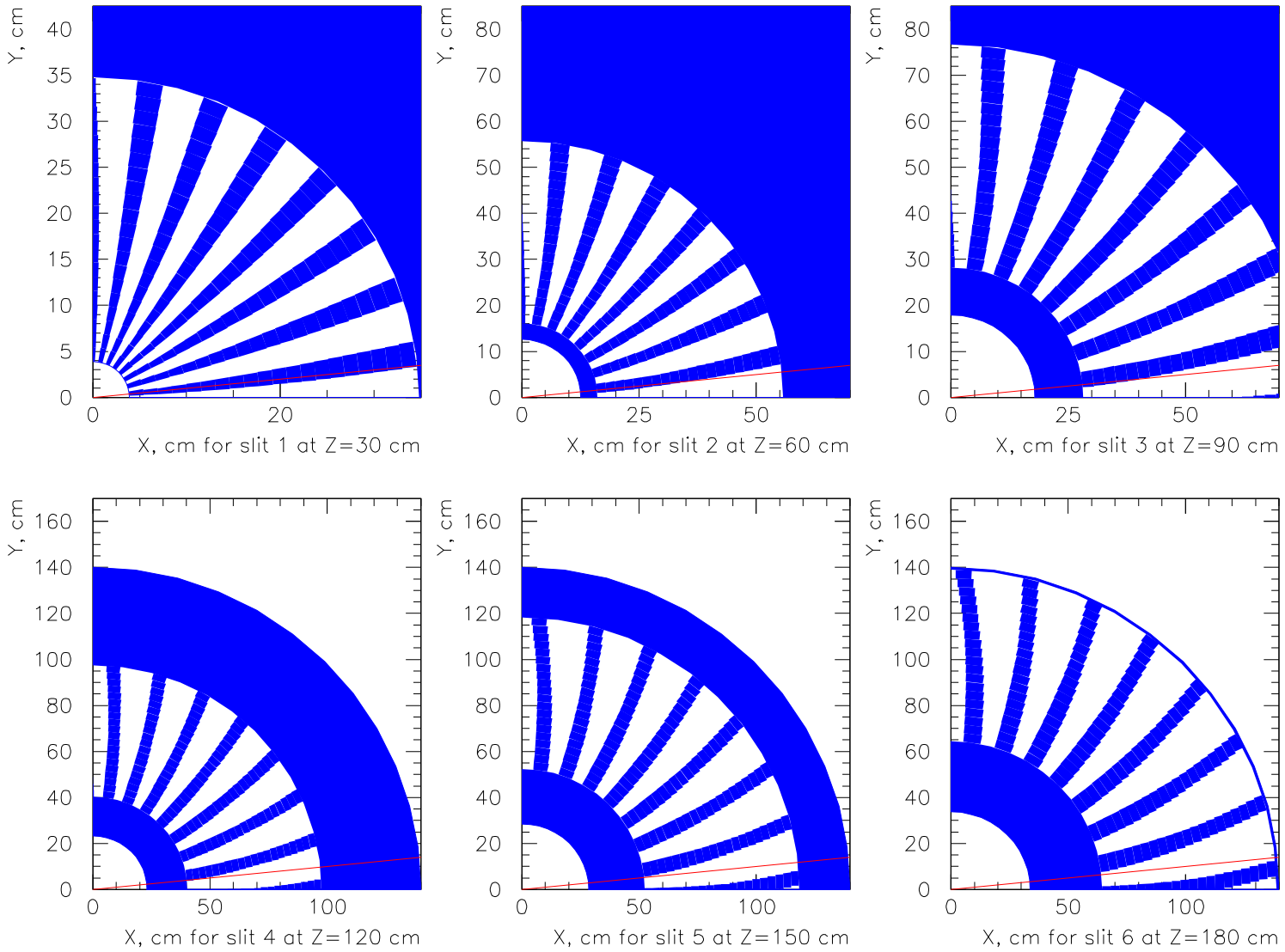
Baffles optimization

Baffles geometry

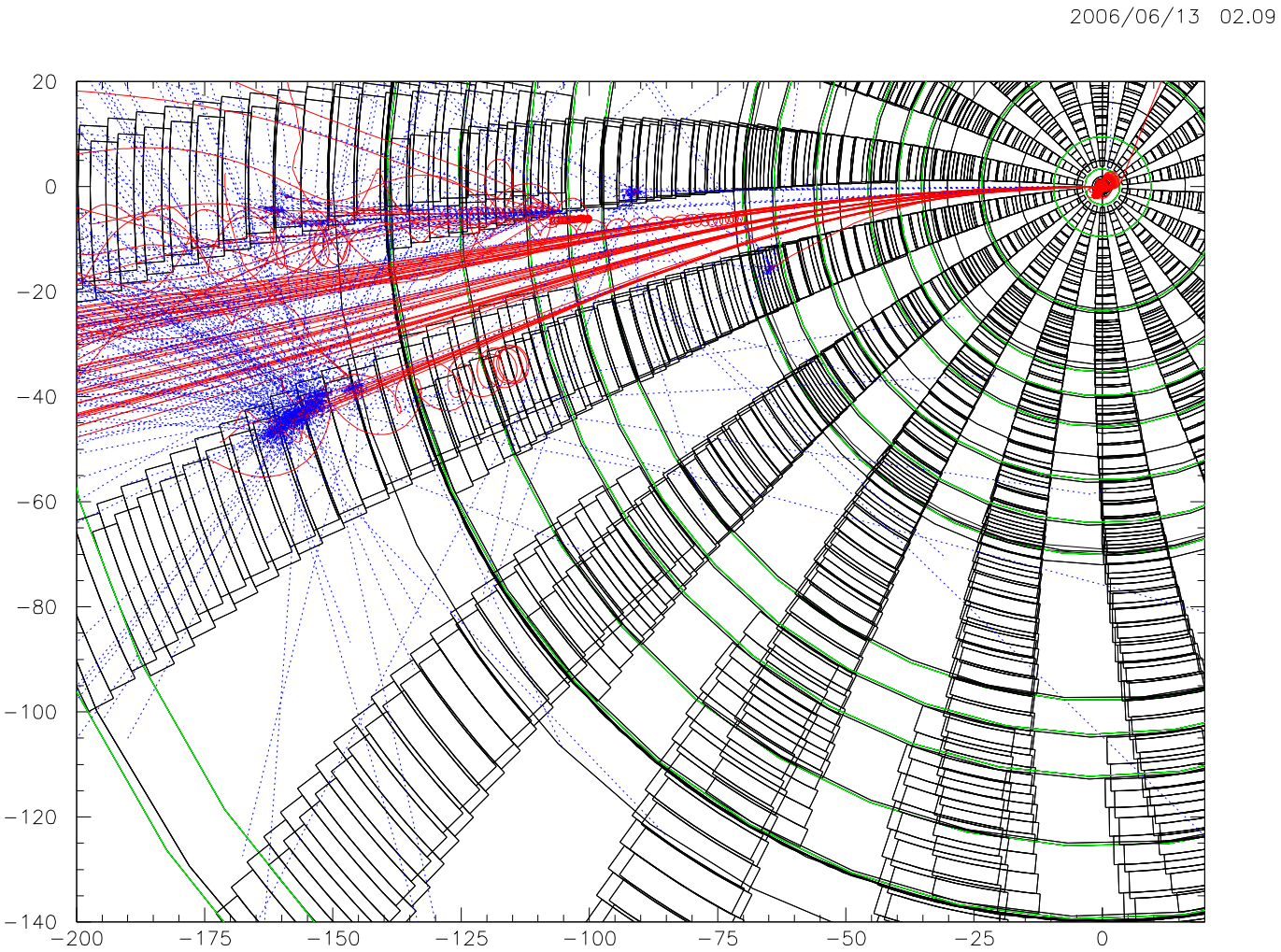
Allow all DIS in:

- $22^\circ < \theta < 35^\circ$
- $0.6 < X_{Bj} < 0.9, W > 2GeV$
- pitch $\Delta\varphi = 12^\circ \Rightarrow$ 30 sectors
- 9 cm of lead

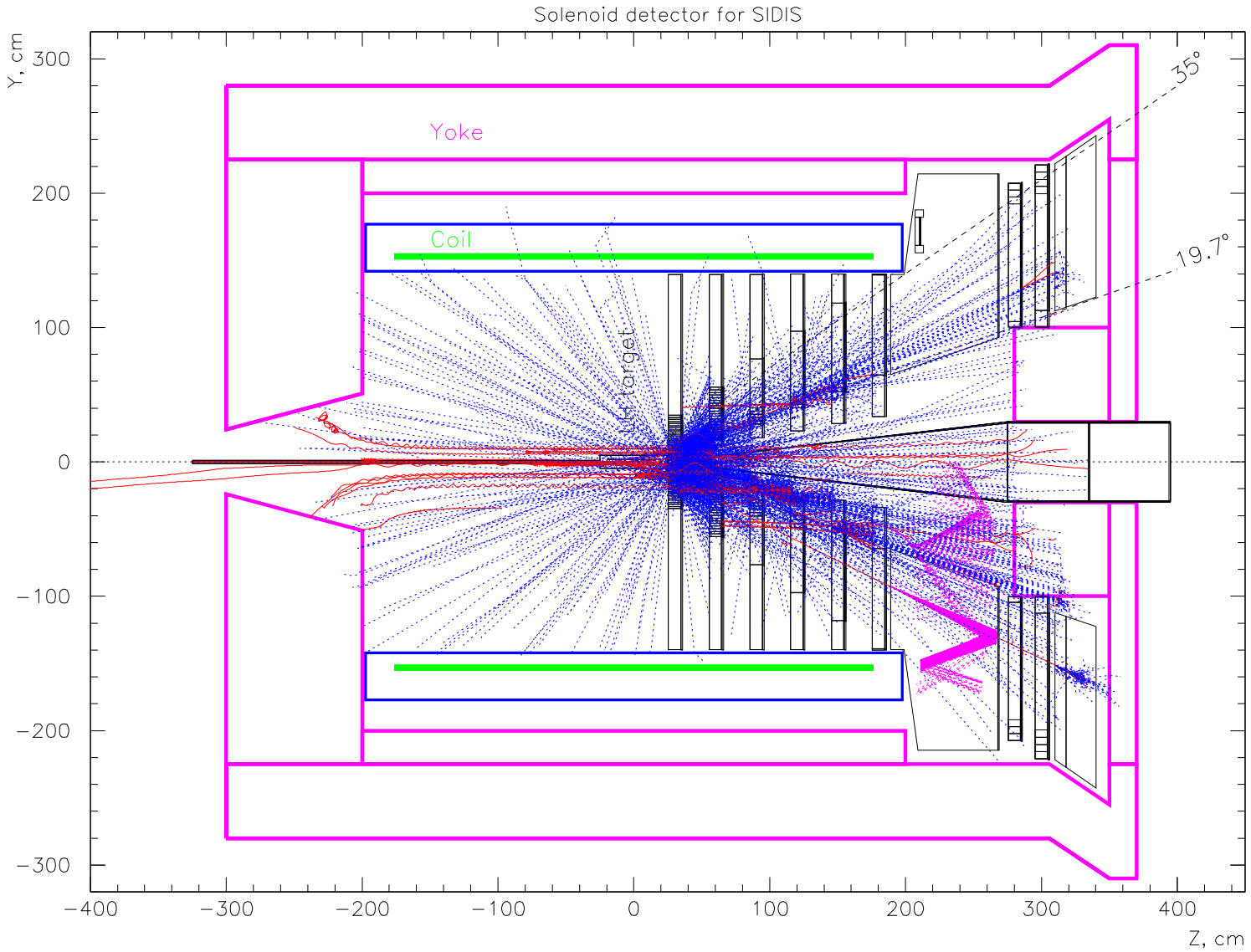
Baffles


Y, cm
X, cm for slit 1 at Z=30 cm
X, cm for slit 2 at Z=60 cm
X, cm for slit 3 at Z=90 cm
X, cm for slit 4 at Z=120 cm
X, cm for slit 5 at Z=150 cm
X, cm for slit 6 at Z=180 cm

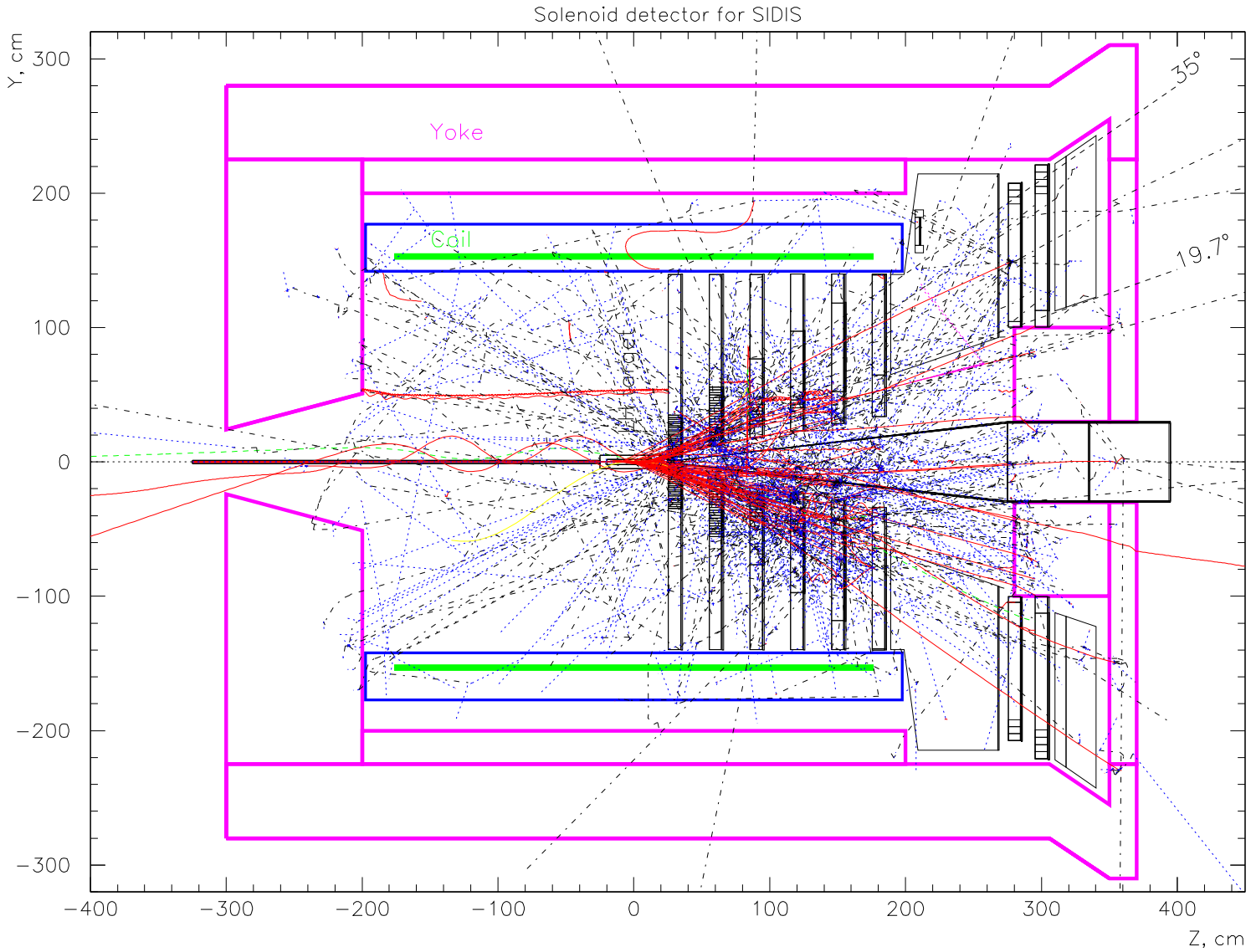
Trajectories



Filtering of electrons from DIS

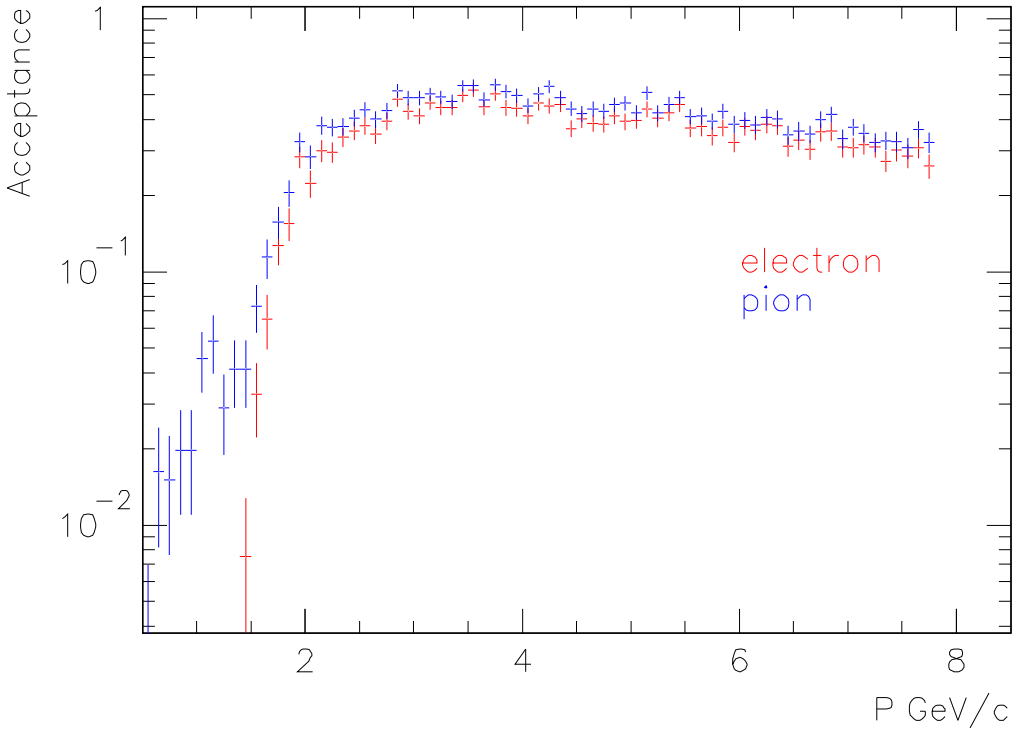


Filtering of pions

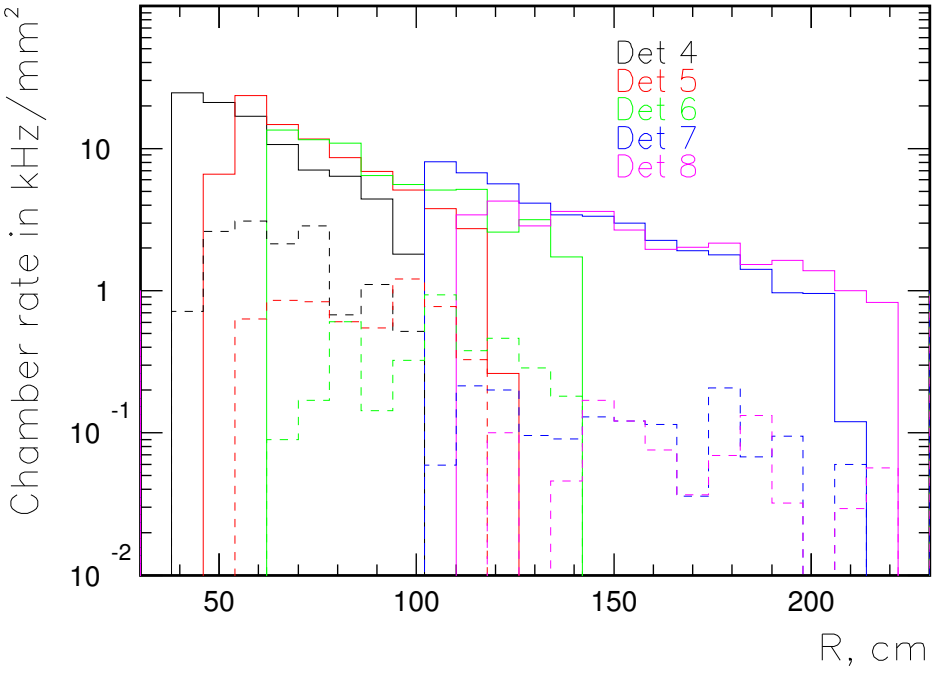


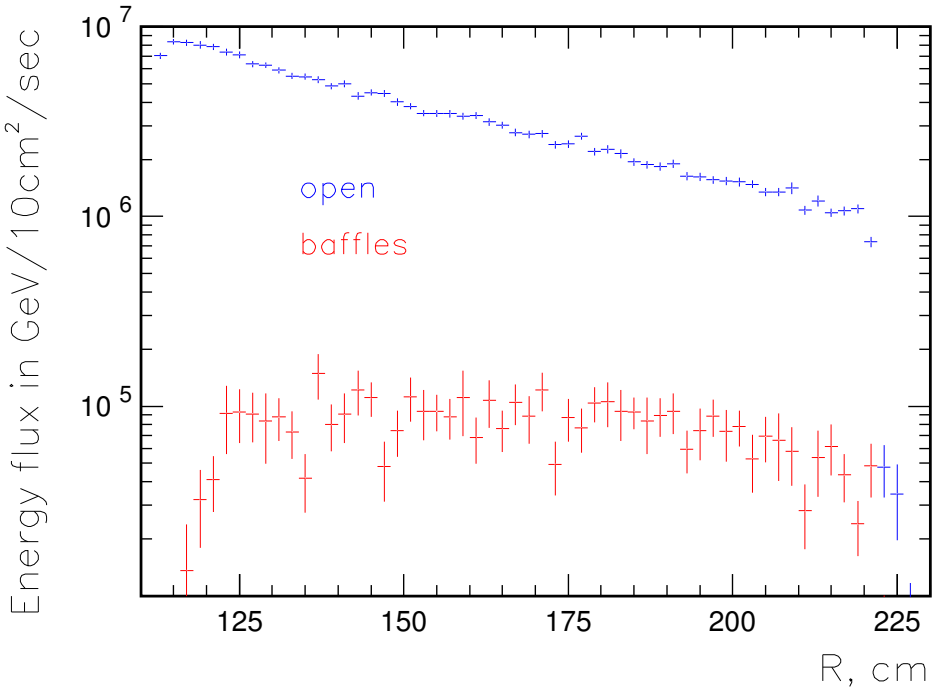
Acceptance

- e^- $P > 1.5$ GeV/c
- DIS X>0.55 $\sim$ 35%



Low energy background





Wire chamb. rate: $\times$ 3-5 GEANT3

- No baffles: $<$ 100 kHz/mm^2
- With baffles: $<$ 15 kHz/mm^2

Calorimeter rate: $\sim$ GEANT3

- No baffles: $\sim$ 1 GeV/module in 100 ns
- Baffles: $\times$0.01
- 4 months: 200 $\Rightarrow$ 2 krad

Rates

Proc.	Open	baffles	days
DIS total	2500 kHz	100 kHz	
DIS $W > 2$ GeV, $X > 0.55$	35 kHz	12 kHz	30
DIS $W > 2$ GeV, $X > 0.65$	8 kHz	3 kHz	120
π^- $P > 0.3$ GeV	2300 MHz	140 MHz	
π^- $P > 1.0$ GeV	460 MHz	70 MHz	
π^- $P > 2.0$ GeV	26 MHz	8 MHz	
DIS $E_{CALOR} > E_{thr}(R)$	120 kHz	35 kHz	
π^- $E_{CALOR} > E_{thr}(R)$	$<$30 kHz	$<$10 kHz	
π^- $E_{CALOR} > E_{thr}(R)$ pileup	$\sim$5 kHz	$<$1 kHz	

π contamination $e/\pi > 100$

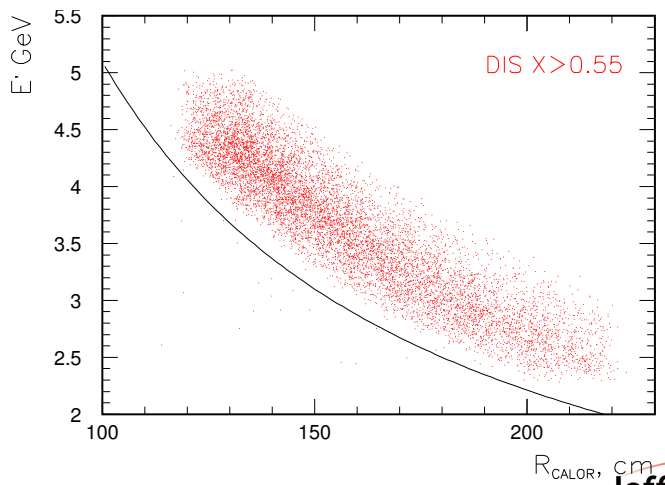
Shower+preshower - trigger

Shower/preshower $\times 3$

Gas Cher. $\times 10$

Trigger:

35/10 kHz e^-/π^- , 2 kHz/sector



Detectors

Issue - magnetic field 0.1 - 0.4 T - no PMT

Calorimeter

- Lead glass $\sigma E/E \sim 0.06/\sqrt{(E)} \sim 3\%$, NOT rad. hard, PMT mag. sensitive
- Shashlyk from KOPIO (2%?) rad. hard, APD used!
- Preshower/shower structure
- Time resolution $\sim$ 10 ns needed

Gas Cherenkov

- Pion threshold $\sim$ 3 GeV/c 1 m long $\Rightarrow > 15$ ph.e.
- Optics - OK
- Magnetic field - GEM-based photodetector?

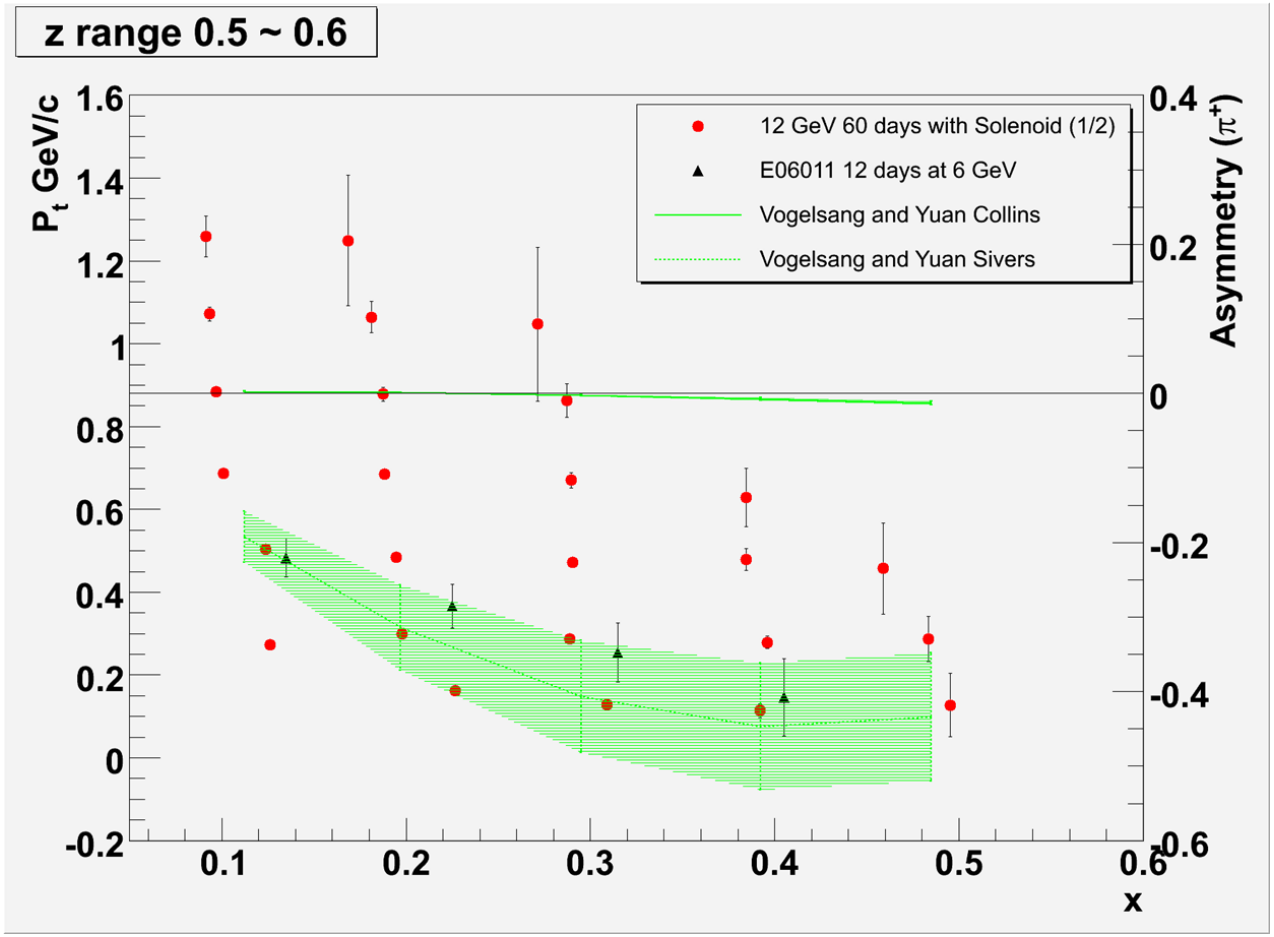
Detectors

Tracking - GEM/straw

- GEM similar to COMPASS ($\sim$ 30 kHz/mm^2)
- Rate $<$ 5 kHz/mm^2, 600 MHz/sector
- Time resolution $\sim$ 40 ns $\Rightarrow$ $<$20 hits/sector
- Coordinate resolution $<$ 100 μm
- Mometum resolution $\sim$ 2.%
- Straw (ATLAS) 4 mm $\times$ $\sim$600 mm rate 8 kHz/mm^2, 20 MHz/wire

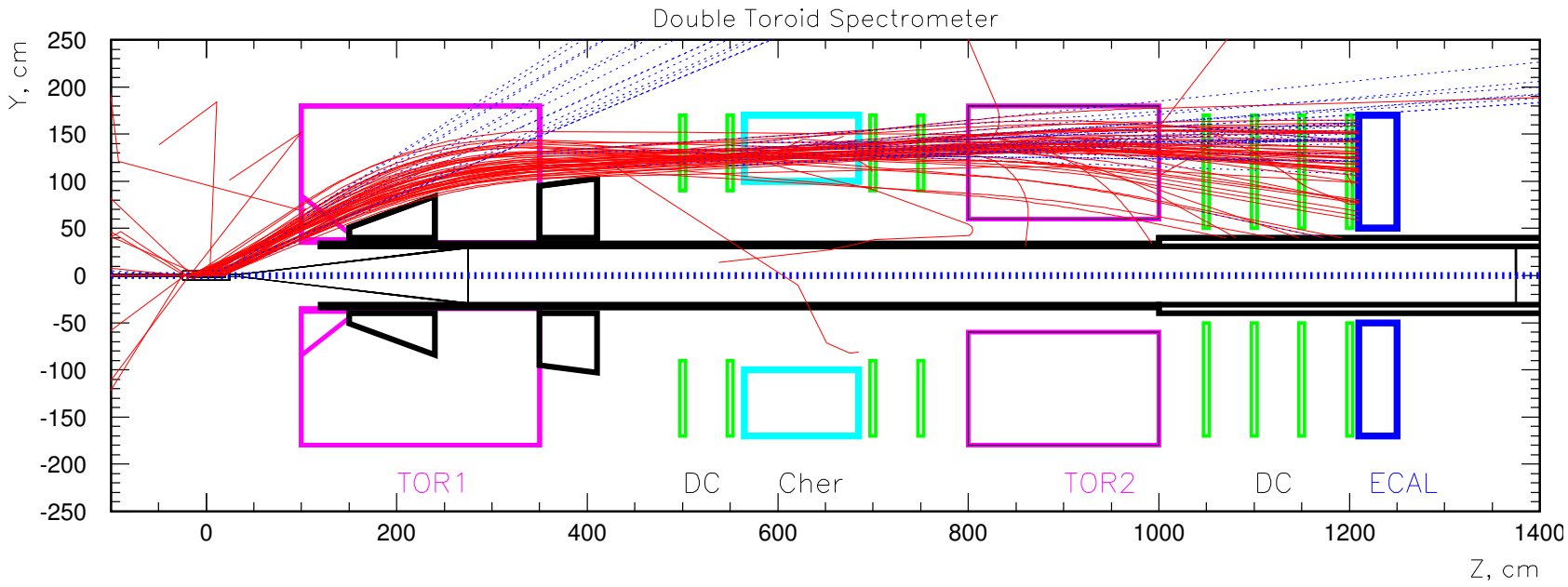
Application for Transversity

- Transversely polarized target in front of the solenoid
- No baffles
- 2 more detector planes

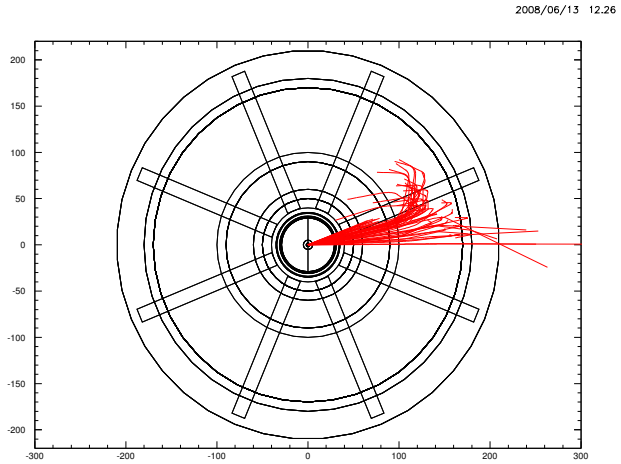


Promising!

DTS: Double Toroid Spectrometer

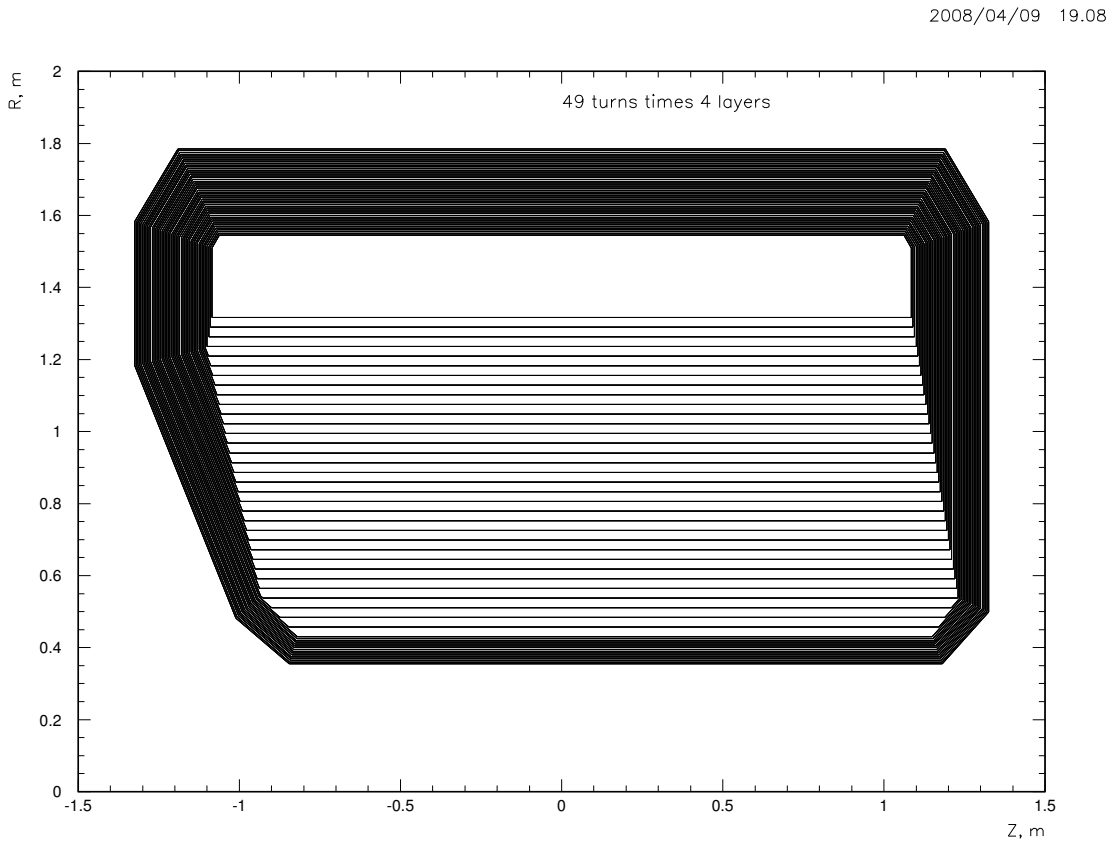


- Toroid 1 - focusing
  $B \sim const(R) \sim 2.1$ T
- Toroid 2 - for momentum, $B \sim 0.6$ T
- Low BG: regular detectors
- 8 coils $\times 15$ cm:
  DIS $\varepsilon \approx 0.7 \sim \times 2$ SoLID

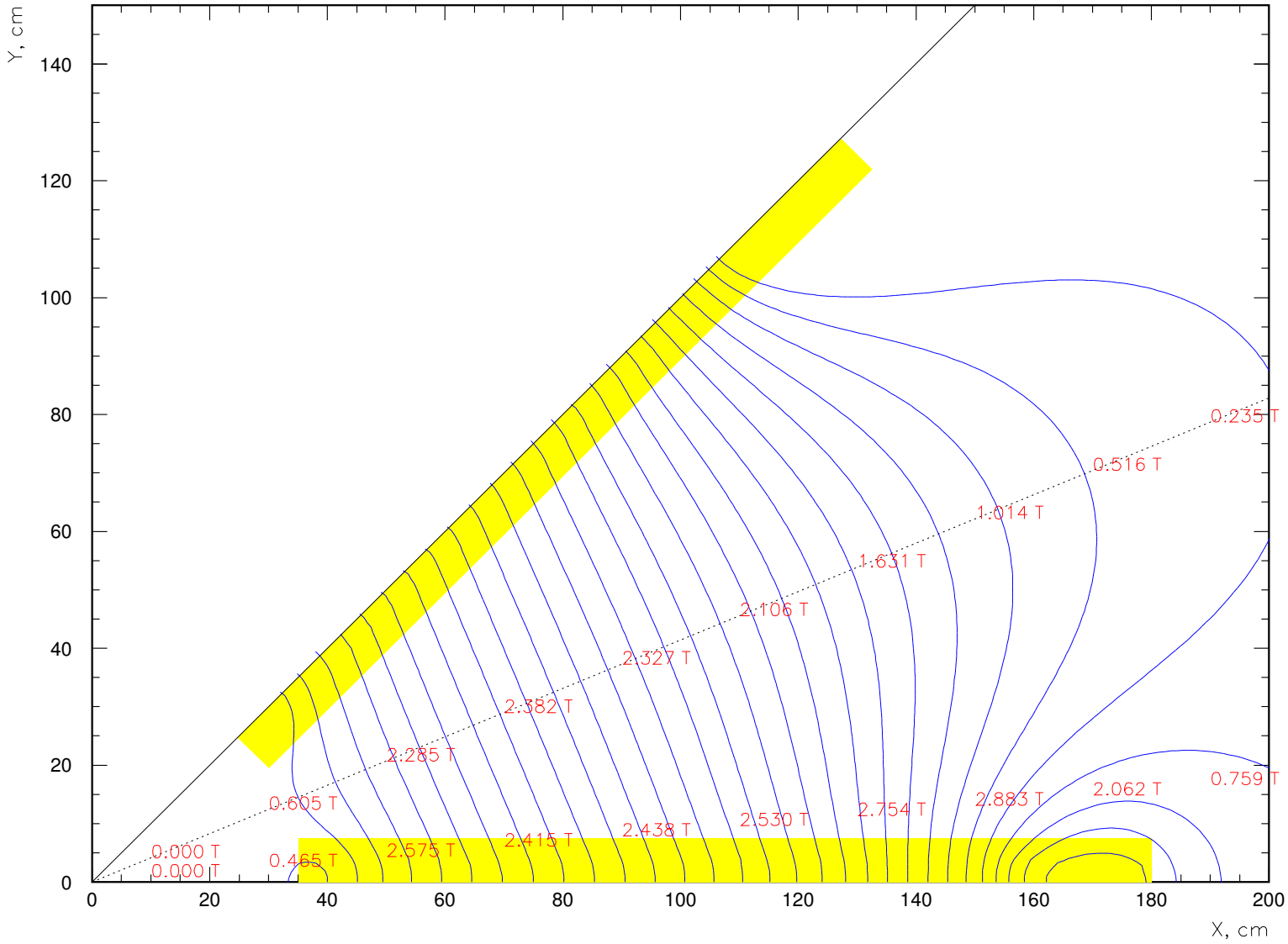


Toroid design

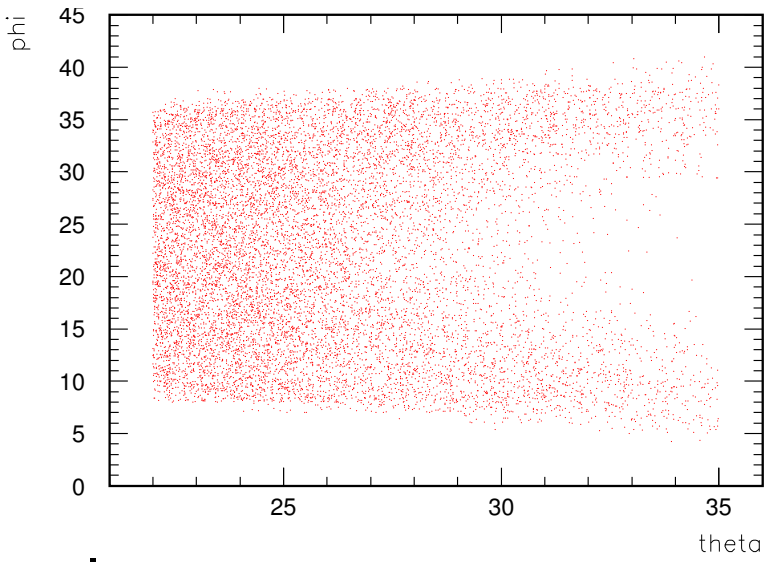
- G0 design considered
- SSC wire in 20×5 mm Al, 10 kA/cm^2
- 8 coils, 4 layers/coil, coil thickness 15 cm
- 196 turns per coil layer



Toroid field calculation



DTS acceptance



- DIS acceptance
  $\varepsilon \approx 0.52 \sim \times 1.5$ SoLID
- Drop due to field bulging
- Optimization in progress

Issues:

- Can such a toroid be built?
- Cost estimate
- Only one charge: can it be useful to SIDIS?

Conclusion

SoLID (solenoid)

Merits

- No magnet to build
- Good resolution
- SIDIS

Issues

- Obtaining a solenoid
- Builduing a new yoke
- Photodetectors in 0.4 T
- Complex baffles
- Target in 1.5 T - PV effects?

DTS (toroids)

Merits

- No baffles
- Low BG
- Regular detectors

Issues

- TOR1 feasibility
- New magnets
- Resolutions?
- Single charge

Goal: LOI by the end of 2008