Charm Upgrade at HERMES

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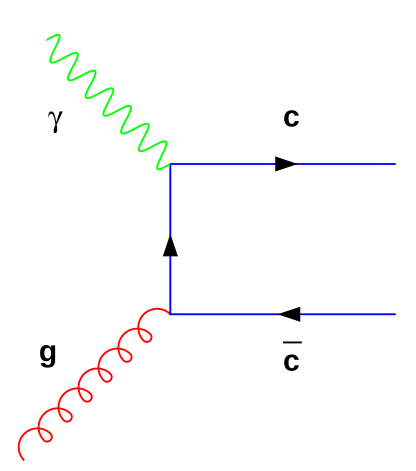
The Experiment

The Goal

$$\frac{1}{2} = \frac{1}{2}\Delta\Sigma + \Delta G + L_z$$

- Isolation of photon gluon fusion process
  → sensitivity to **gluon distribution**
- Spin asymmetry in photon gluon fusion
  → sensitivity to **gluon polarization** $\Delta G/G$

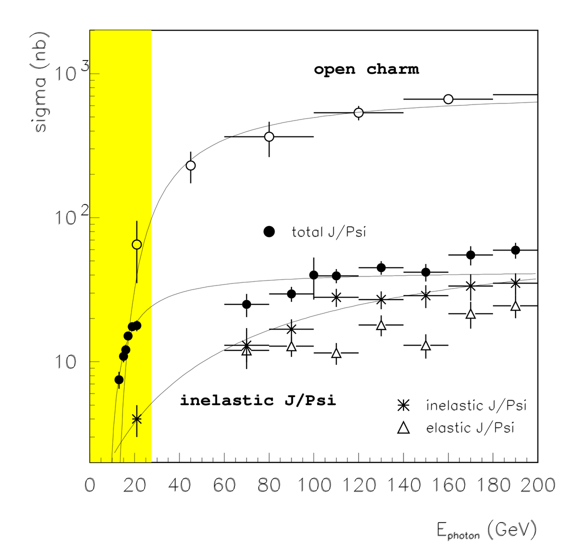


- Measurement strategy:
  Look for charmed particles to enhance photon-gluon fusion process

The Physics

The Physics Goal

- cross sections for open charm and J/ψ production near threshold ?
- s channel helicity conservation in J/ψ production ?
- spin dependent charm production $\longrightarrow \Delta G/G$



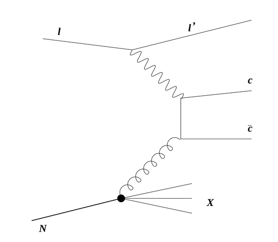
The Challanges

- Low cross section at threshold
- Physics at threshold complicates interpretation

Reaction Channels

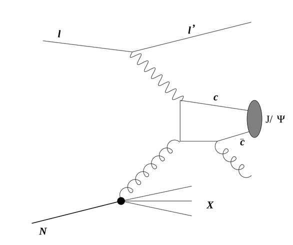
Photon-Gluon Fusion

- Open Charm



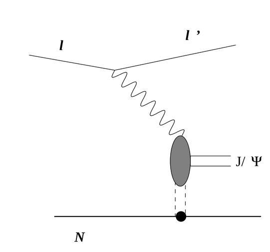
– Reaction
$D^0, \bar{D}^0 \to K\pi$
$D^0, \bar{D}^0 \to K\mu X$
– Clear interpretation for $\frac{\Delta G}{G}$
$A^{c\bar{c}}_{\gamma N} \sim \frac{1}{1.2}\frac{\Delta G}{G}$

- Inelastic J/ψ



– Reaction
$J/\psi \to e^- e^+$
$J/\psi \to \mu^- \mu^+$
– Interpretation for $\Delta G/G$ in Colour Singlet Model
$A^{J/\psi}{}_{\gamma N} \sim \frac{1}{1.8}\frac{\Delta G}{G}$

Diffractive Elastic J/ψ



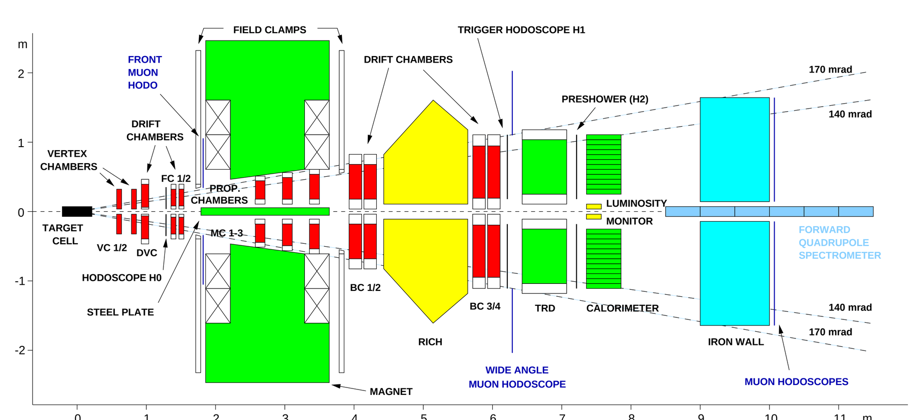
– Reaction
$J/\psi \to e^- e^+$
$J/\psi \to \mu^- \mu^+$
– Relationship to $\Delta G/G$ theoretically unclear (uner investigation)
$A^{J/\psi}{}_{\gamma N} = 0$
in non-relativistic models

The Upgrade

Charm Upgrade

New instrumentation :

- Muon identification → Muon Hodoscopes
  → increase signal to background ratio for μ detection
- Widen angular acceptance for muons → Muon Hodoscopes
  → increase acceptance for J/ψ detection
- Kaon identification → RICH
  → increase signal to background ratio for open charm detection
- Measurement of e for low Q^2 events → FQS
  → determination of kinematics for photoproduction reactions.



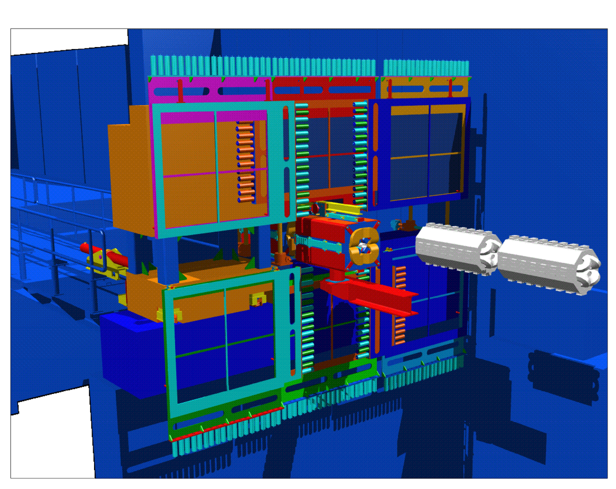
Muon Hodoscopes

Muon Detectors in standard acceptance:

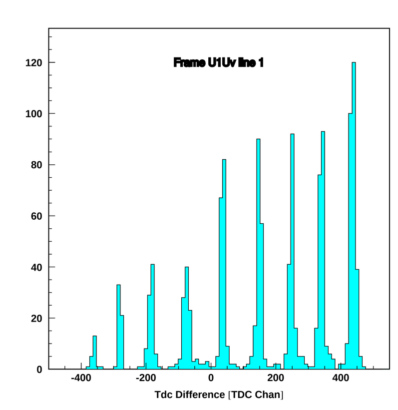
- 1 m Iron Wall acts as hadron absorber
- 214 plastic scintillators providing X and Y position information
- Delay line readout scheme: up to 10 PMTs connected in each line
  → only 48 analog signals to digitize

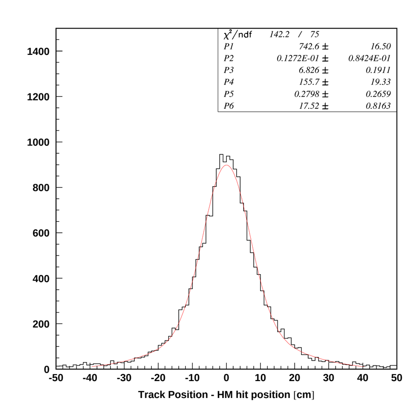
Muon Detectors in wide acceptance:

- 90 plastic scintillators provide X position information outside HERMES standard acceptance
- Up to 12 PMTs connected in each delay line
- Poles of main spectrometer magnet serve as hadron absorber and permit momentum determination



Muon Hodoscopes (contd.)

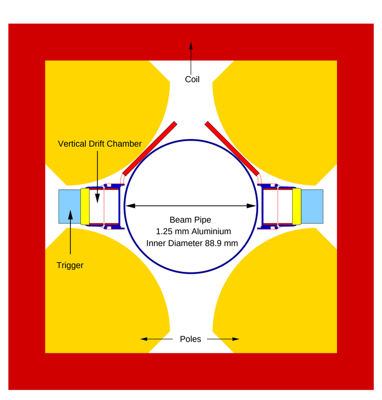


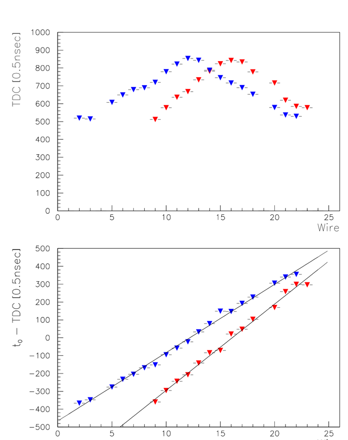


Physics in Future

Forward Quadrupole Spectrometer

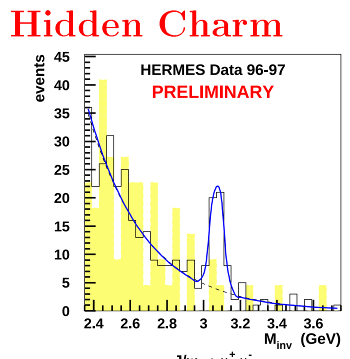
- Measurement of the scattered e^+ for vey low Q^2 events.
- Vertical Drift Chambers on either side of and parallel to the beampipe, downstream of main spectrometer
- Use field of beam quadupole magnets to perform momentum determination





Charm Detection

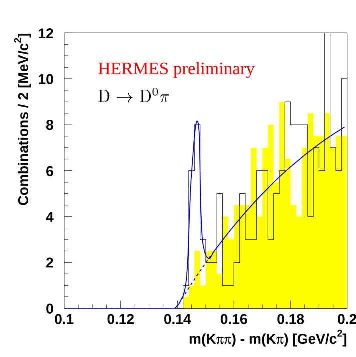
Hidden Charm



Charm upgrade provides:

- Background reduction
- Acceptance increase
  2.5 × Total yield J/ψ
  4 × Inelastic yield J/ψ
- Enhanced coverage for study of angular decay distribution

Open Charm



Charm upgrade provides new channels:

- $D \to K\pi$
  background will be suppressed by RICH (factor 15)
- $D \to K\mu X$
  possible detection channel using RICH and Muon Hodoscopes

Δ G at Hermes

- Other analyses that don't use the Charm upgrade to extract $\frac{\Delta G}{G}$.
- Future prospects for $\frac{\Delta G}{G}$ at HERMES and other experiments.