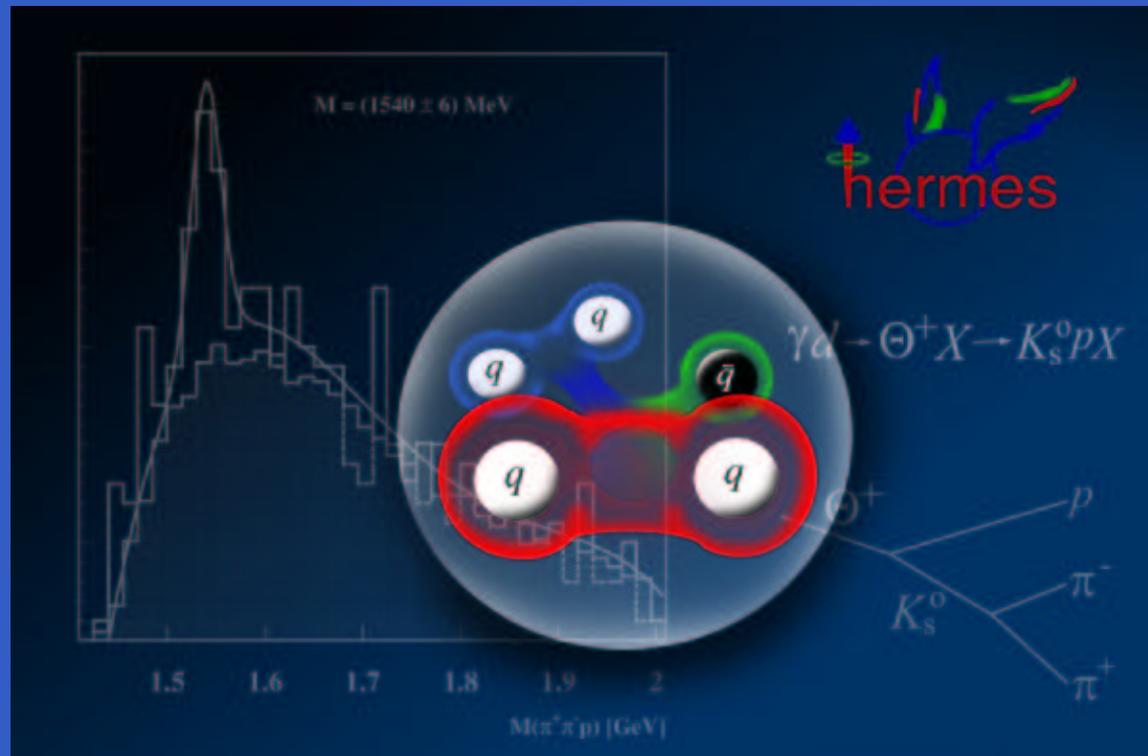


Observation of the Θ^+ Pentaquark at HERMES

Brecht Hommez

University of Gent

On behalf of the HERMES Collaboration



Introduction

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''The general prejudice against baryons not made of three quarks and the lack of any experimental activity in this area make it likely that it will be another 15 years before this issue is decided.'' (PDG 1986)

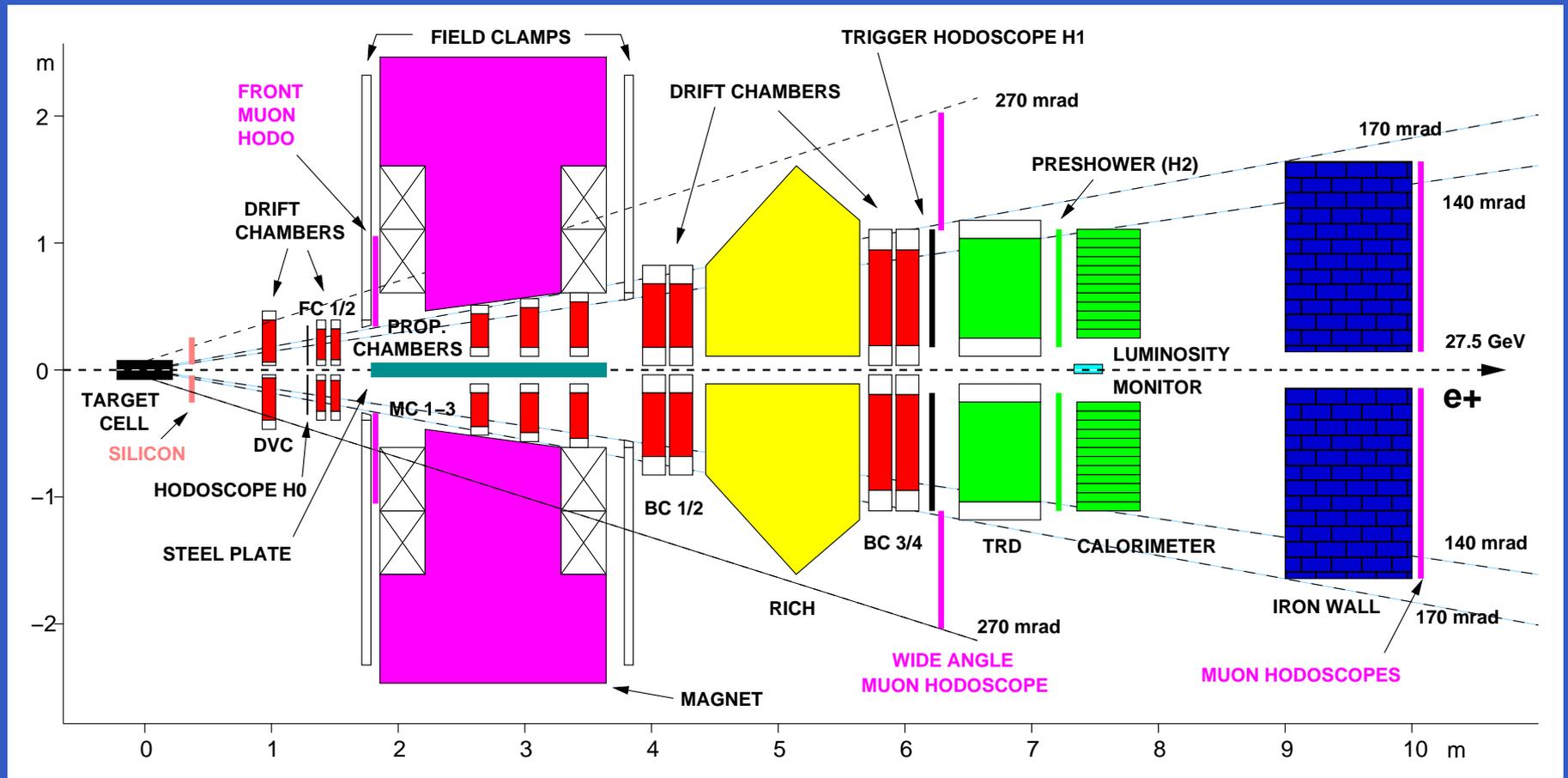
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 - Mass ≈ 1530 MeV - Width \approx a few MeV (longliving)
 - $uudd\bar{s}$
 - Decays in $K^+ + n$ or $K_s + p$ ($K_s \rightarrow \pi^+ + \pi^-$)

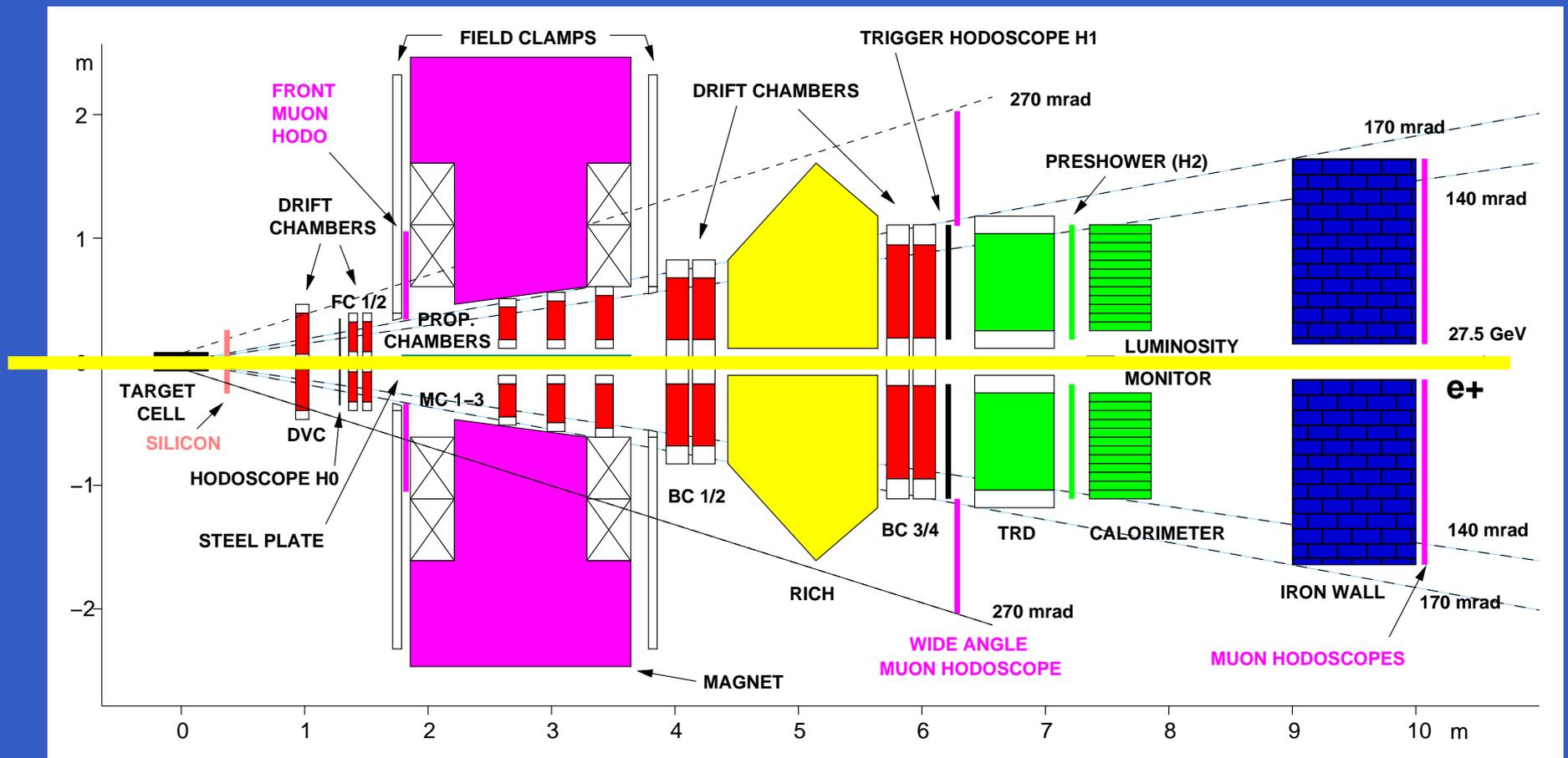
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- 2003: Evidence for a $S = +1$ Pentaquark from LEPS (Spring 8), DIANA (ITEP), CLAS (JLAB), SAPHIR (ELSA), ITEP2, HERMES (DESY), SVD-2 (IHEP)

The HERMES spectrometer

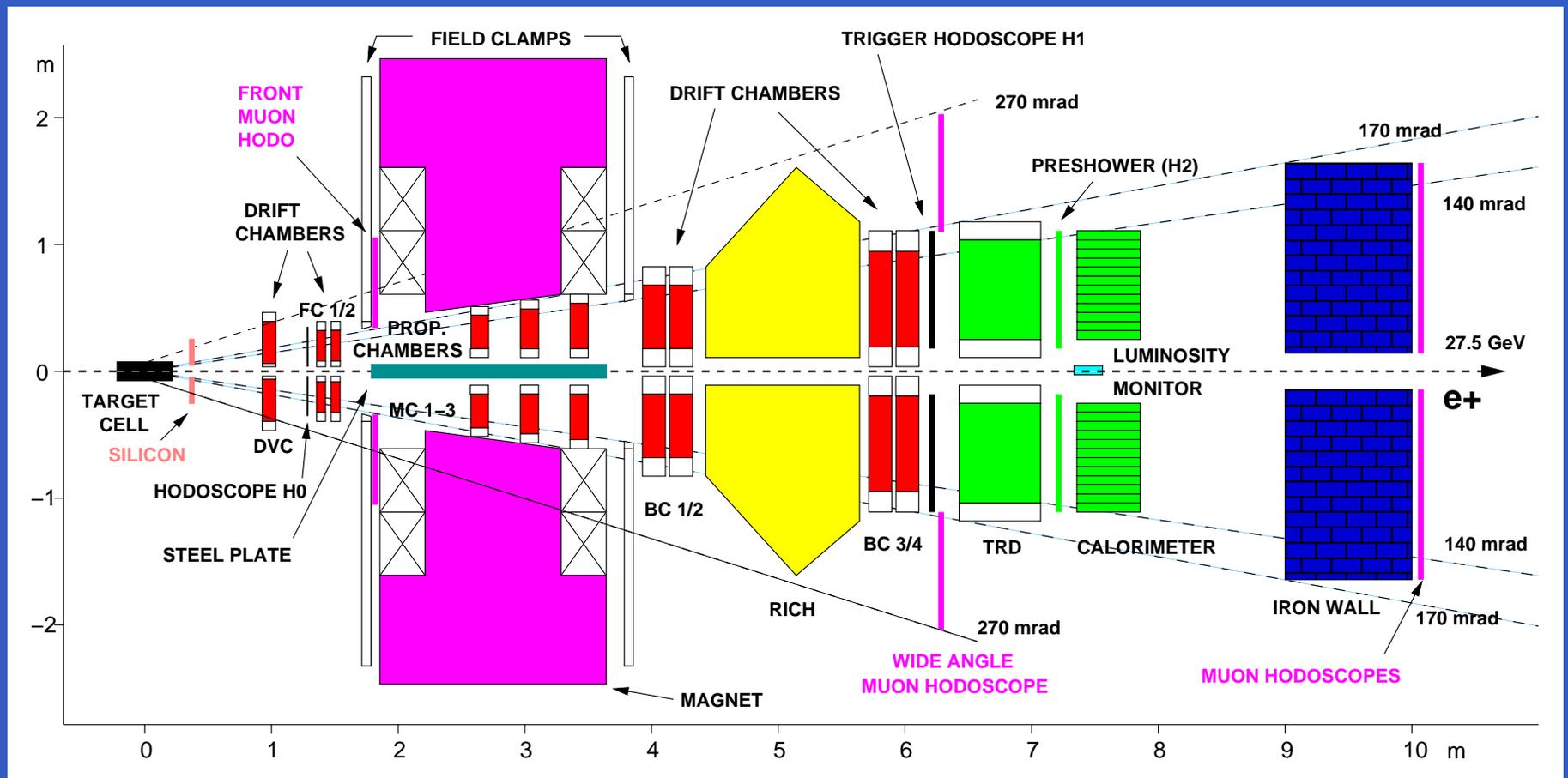


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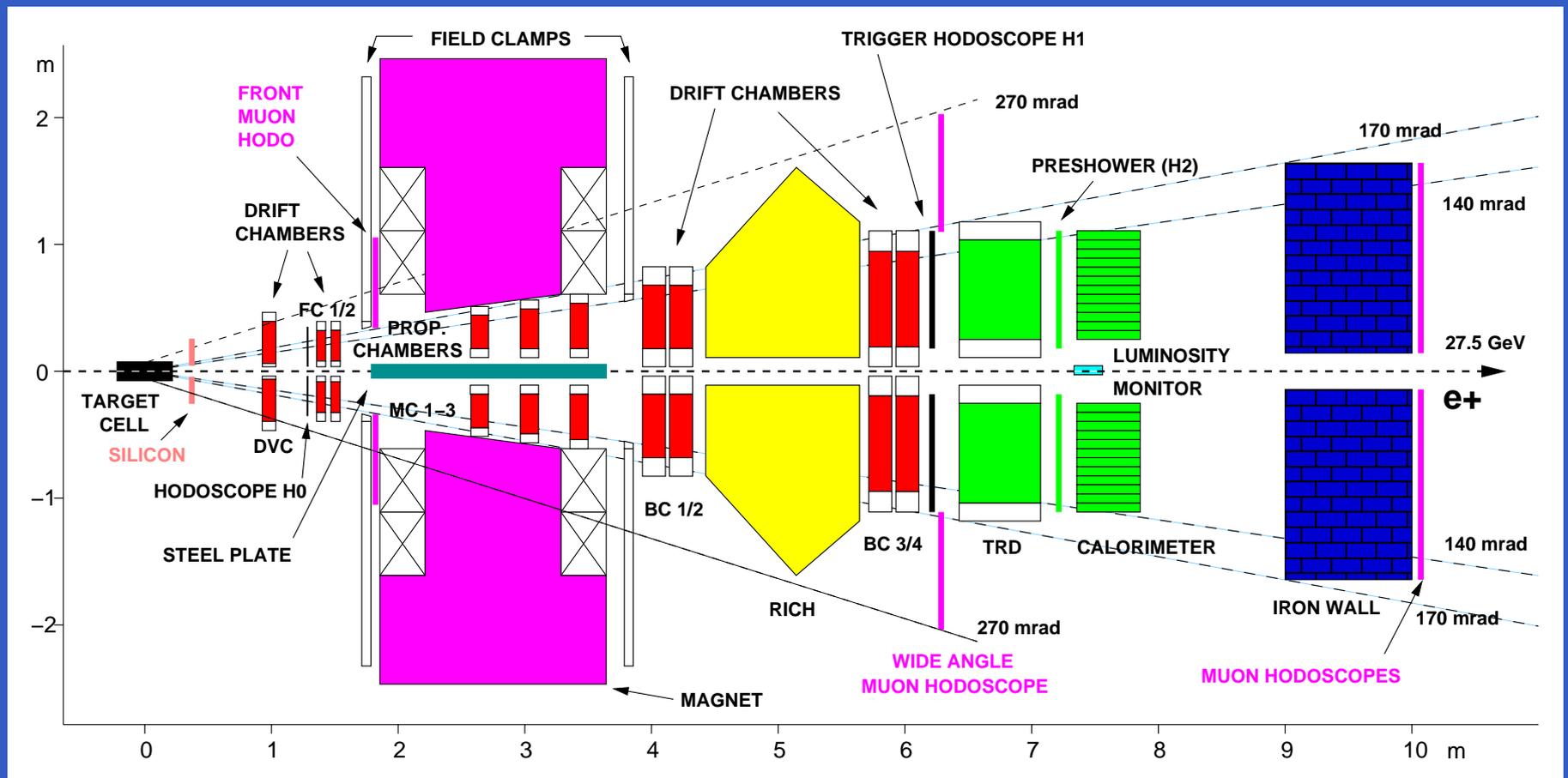
27.5 GeV e^+ beam from HERA accelerator

The HERMES spectrometer



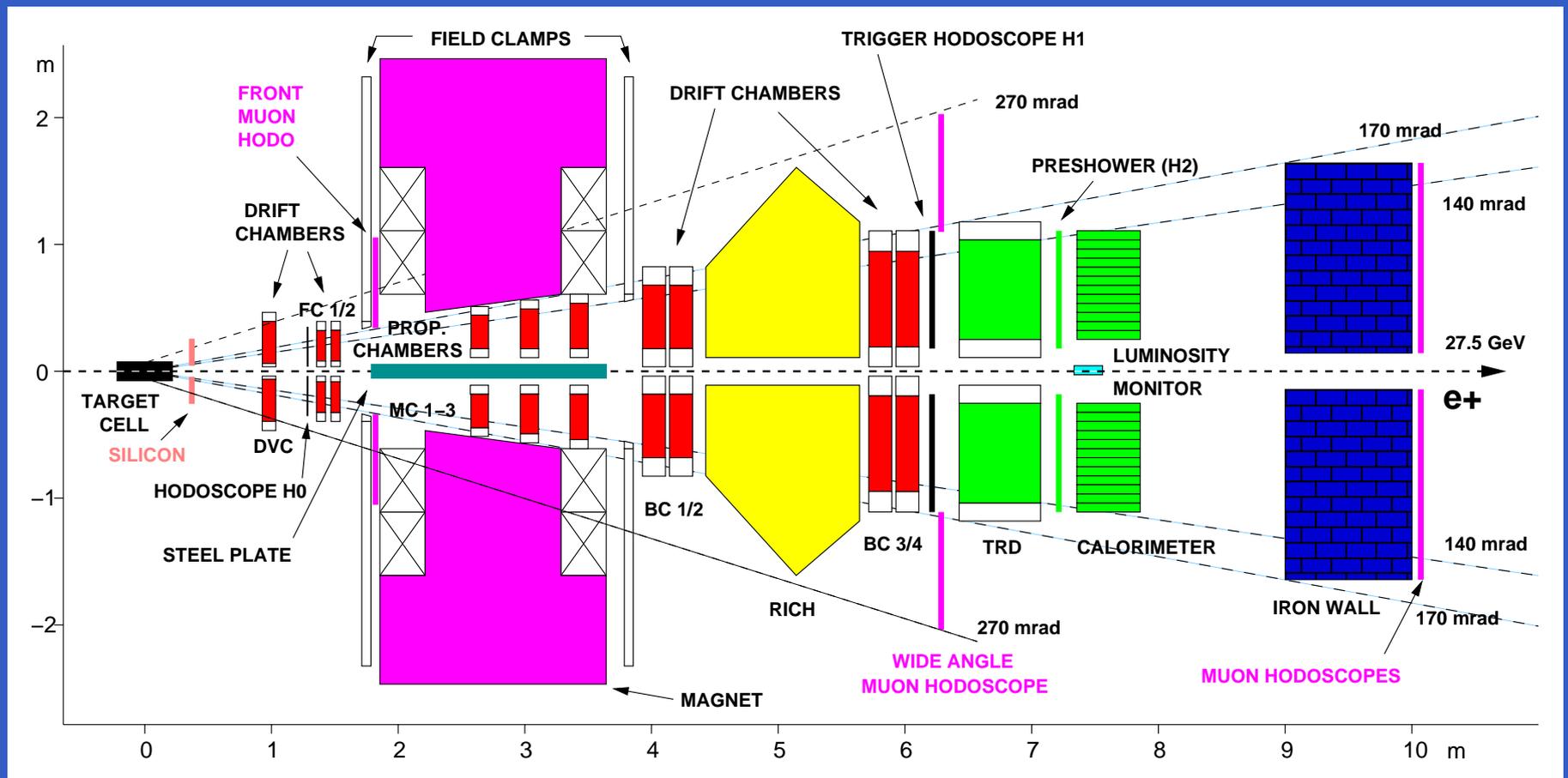
Tracking Chambers + Magnet $\Rightarrow \delta p/p = 1.4 \dots 2.5\%$
 $\delta\theta \leq 1 \text{ mrad}$

The HERMES spectrometer



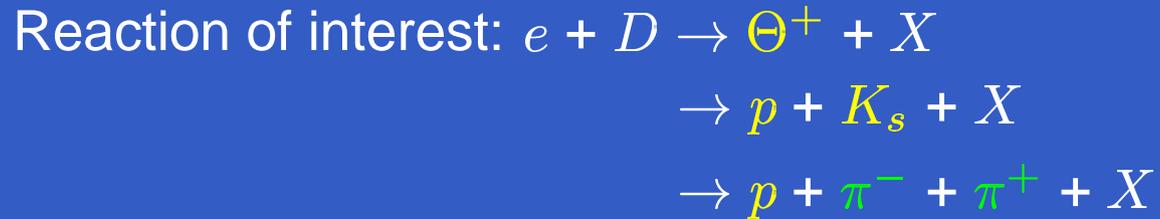
Hadron/lepton separation: TRD, Preshower, Calorimeter

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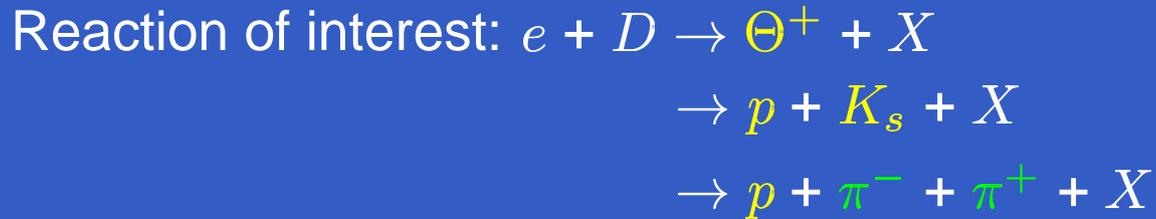


Hadron identification (π, K, p): RICH

Hunting for the Θ^+ Pentaquark at HERMES

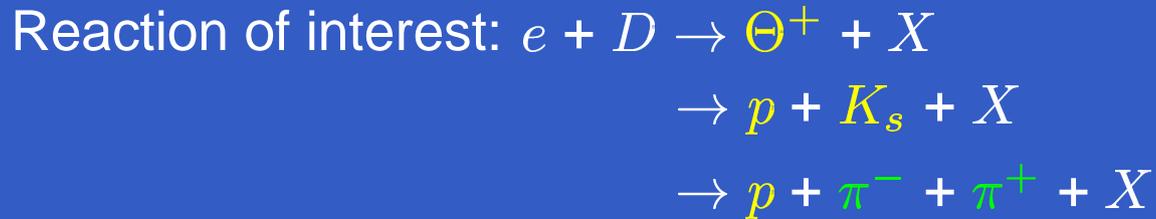


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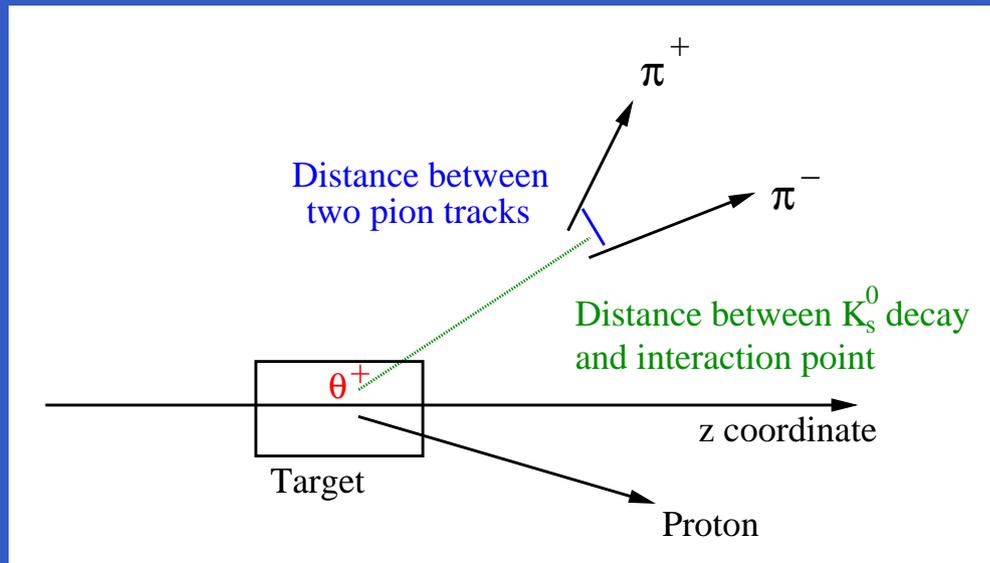


- Hadron identification: RICH detector
- Define appropriate event topology

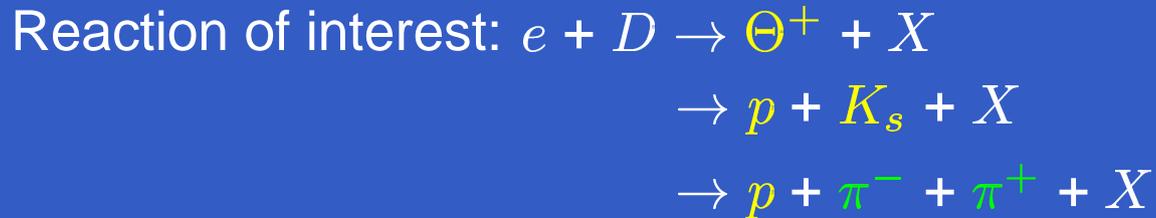
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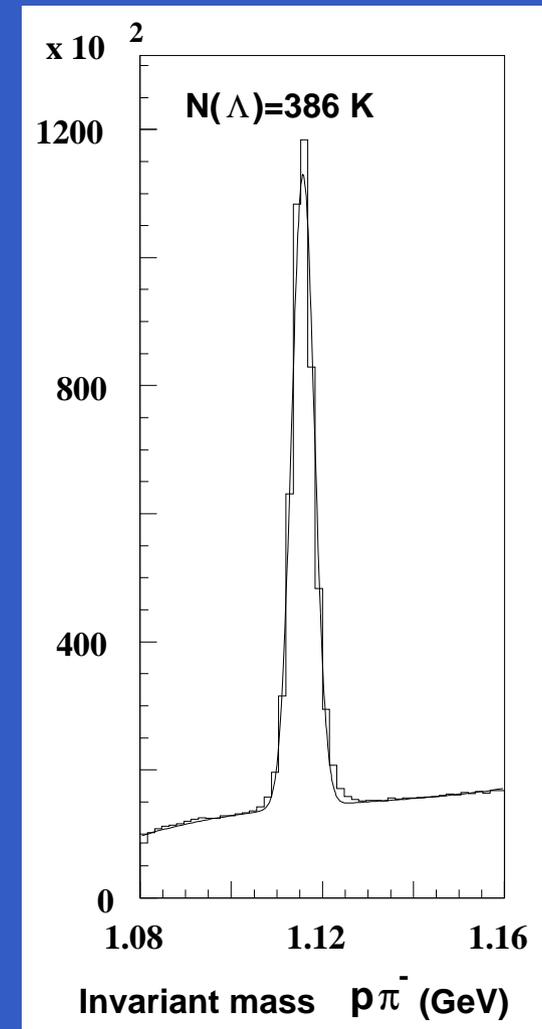
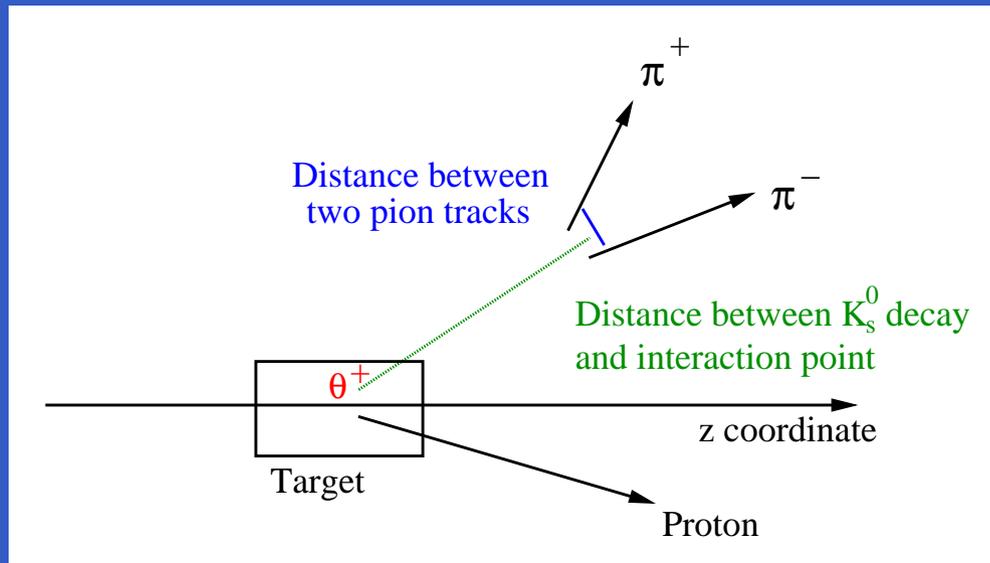
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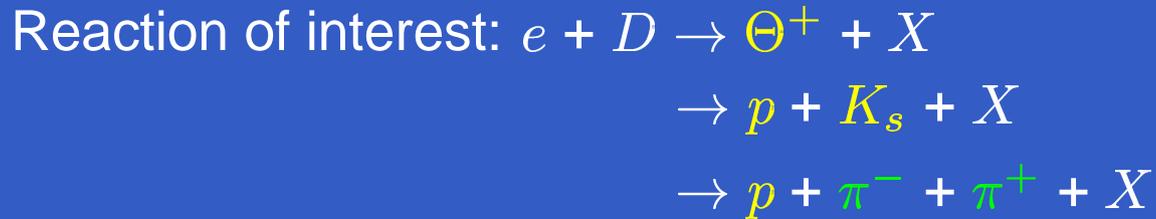
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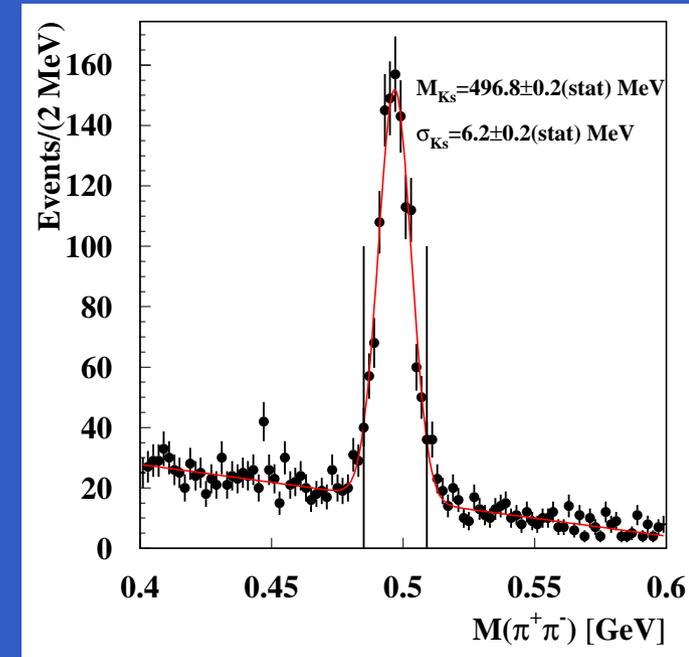
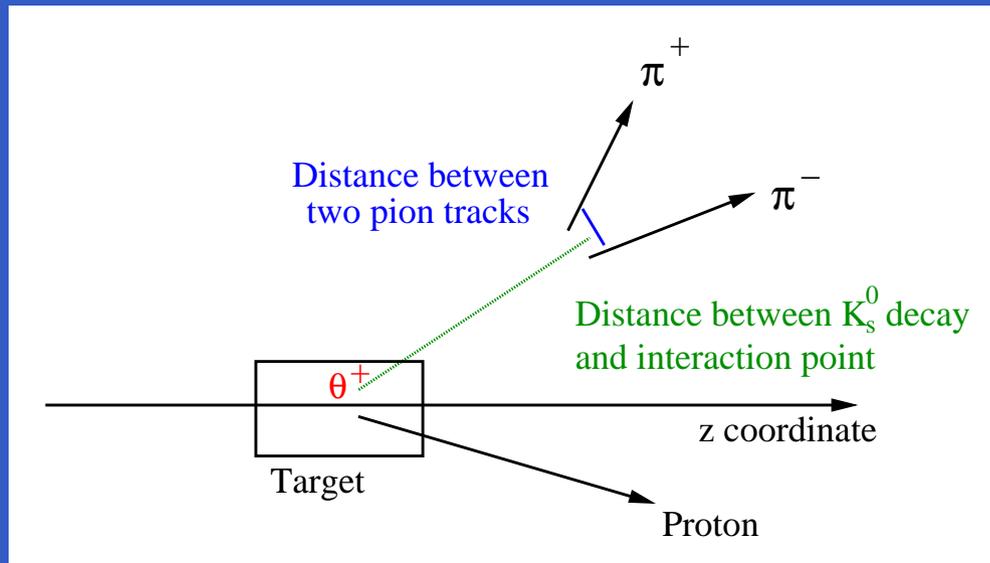
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- Suppress contamination from $\Lambda(1116) \rightarrow p\pi^-$



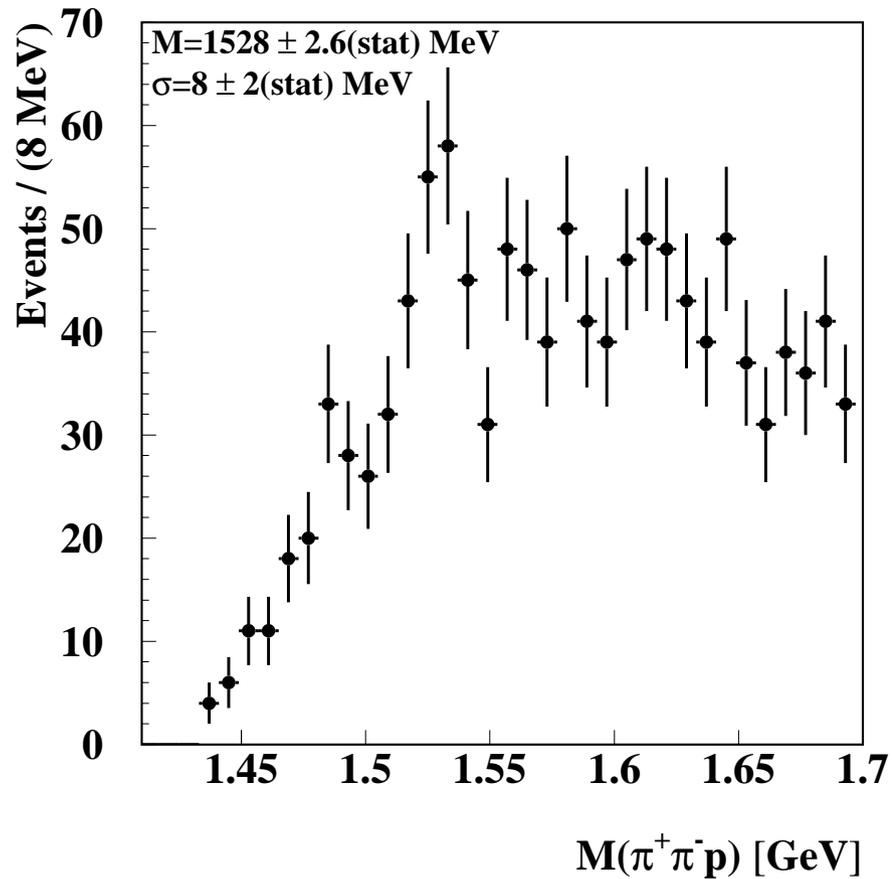
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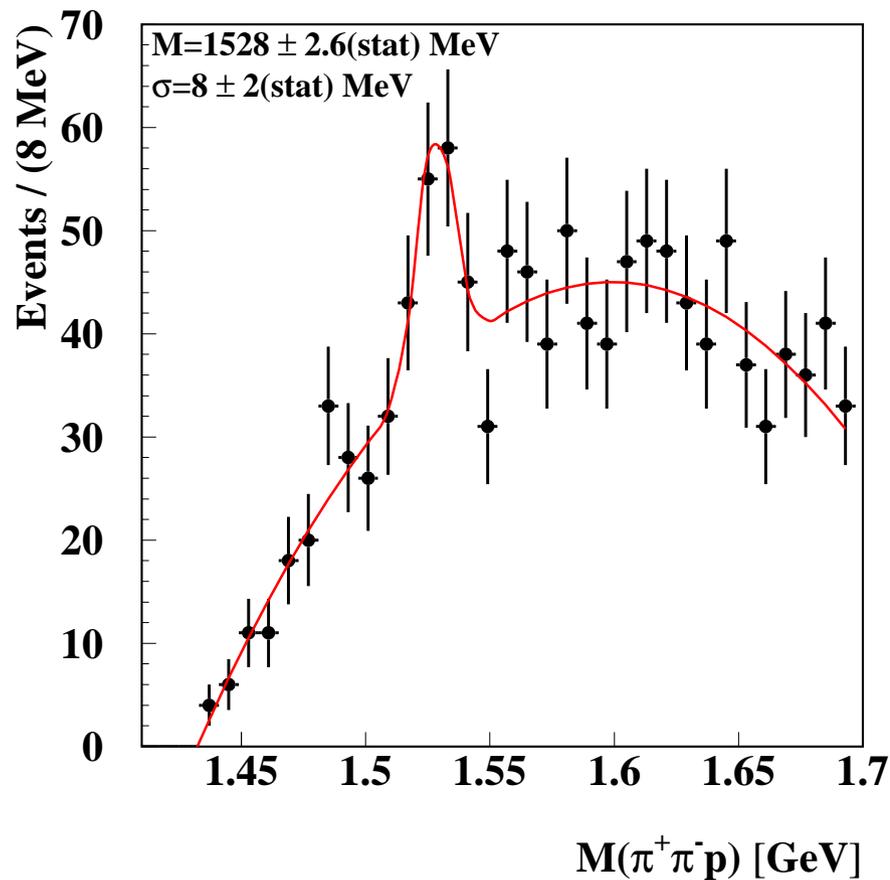
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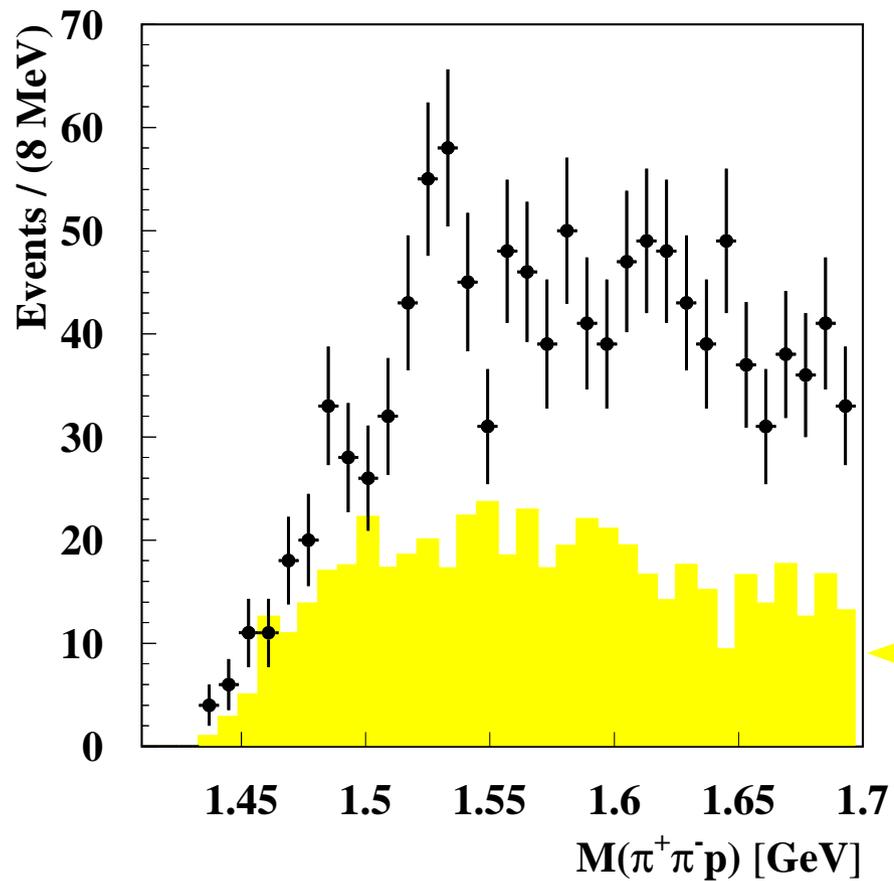
Observation of the Θ^+ Pentaquark at HERMES



Resonance is observed at 1528 ± 2.6 (stat) ± 2.1 (syst) MeV in $K_s p$ invariant mass distribution

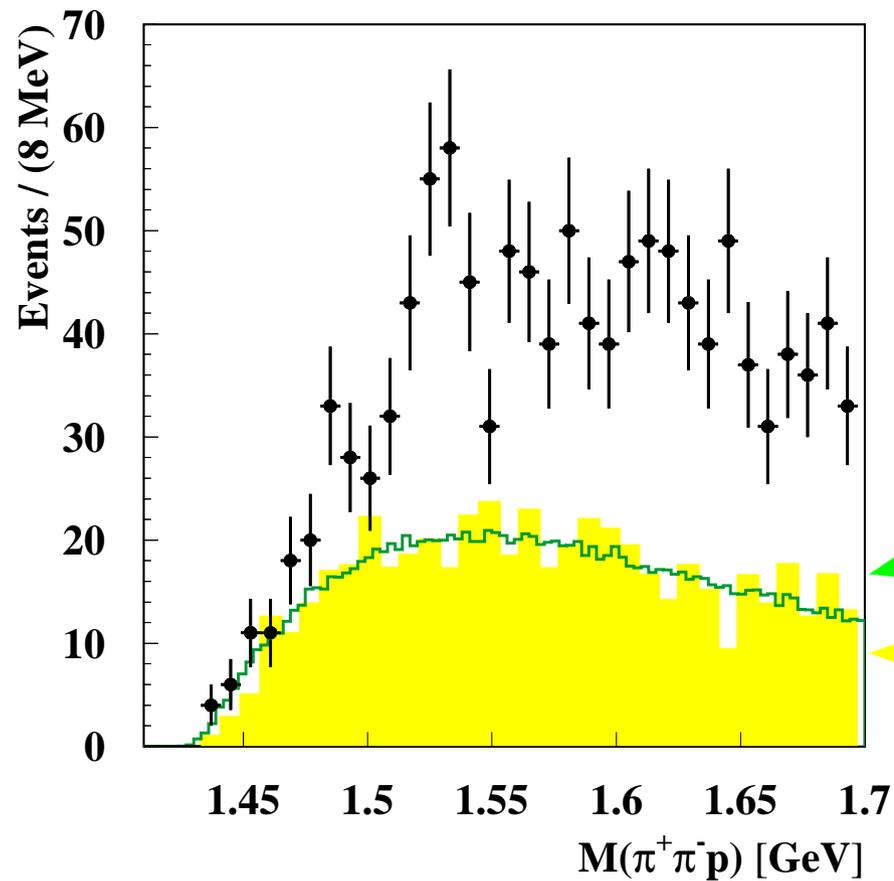
Width is dominated by experimental resolution

Understanding the background



← PYTHIA 6 simulation

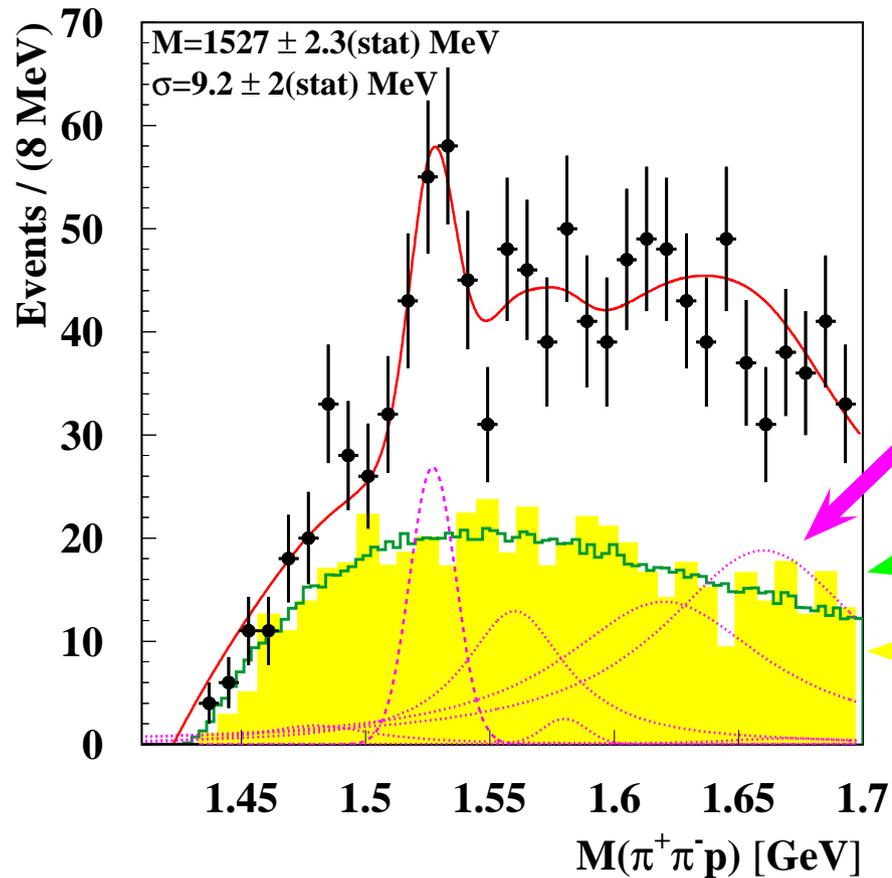
Understanding the background



mixed event background

PYTHIA 6 simulation

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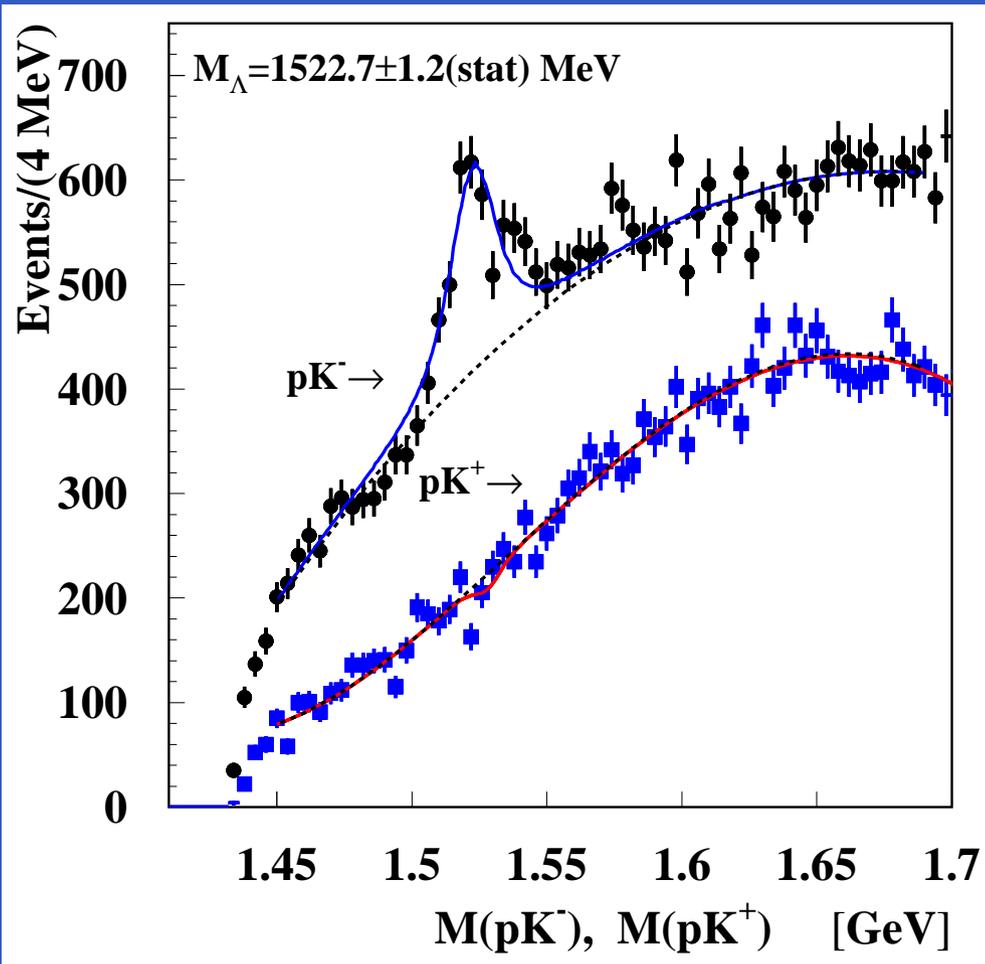


6 known Σ^{*+} resonances
+ narrow Gaussian
for expected peak

mixed event background

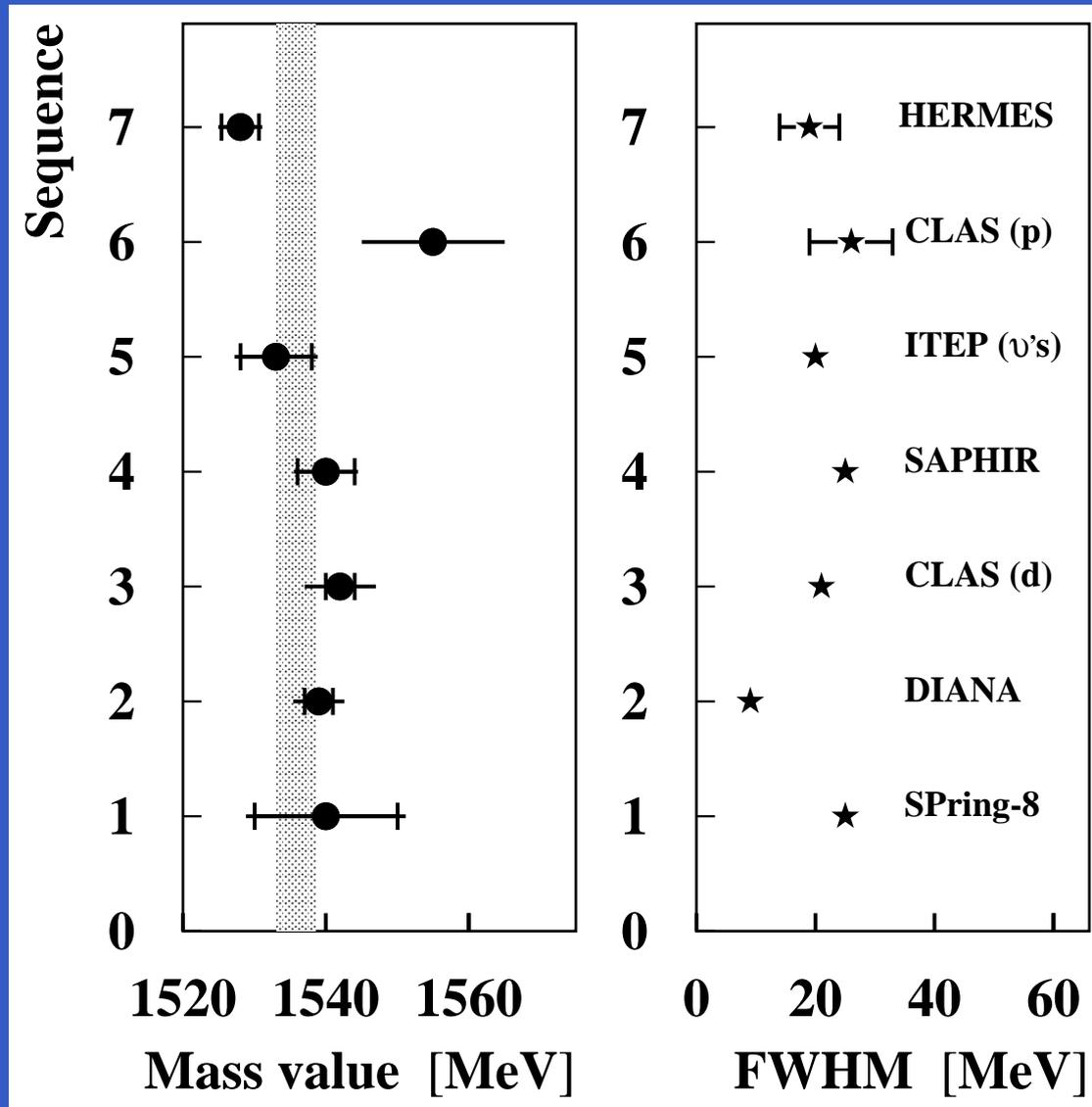
PYTHIA 6 simulation

Isospin of Θ^+



- if no $\Theta^{++} \Rightarrow$
 Θ^+ probably isoscalar
- Clear peak for $\Lambda(1520) \rightarrow pK^-$
- No peak for $\Theta^{++} \rightarrow pK^+$

Comparison with other experiments



Conclusions

- HERMES found evidence for a narrow baryon resonance in the pK_s spectrum
 - Quasi-real photoproduction
 - $e + D \rightarrow pK_s + X$
 - Produced in a fragmentation process, far from threshold
 - 1528 ± 2.6 (stat) ± 2.1 (syst) MeV
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 - Significance: 4-6 standard deviations

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 - Width: dominated by experimental resolution
 - Significance: 4-6 standard deviations
- Θ^+ is probably an isosinglet
- Precise (and different) pentaquark mass is quite relevant:
hep-ph/0402008: A Mass Inequality for the Ξ^ and Θ^+ Pentaquarks (M. Karliner, H. J. Lipkin)*