The Θ^+ Pentaquark Search at HERMES

Avetik Airapetian
University of Michigan
on behalf of the HERMES Collaboration

- **Introduction**
- **Data set, Event Reconstruction**
- **Proton and K_s identification**
- **Detector Mass calibrations**
- **Final Spectrum, Background models**
- **Conclusions**

Introduction

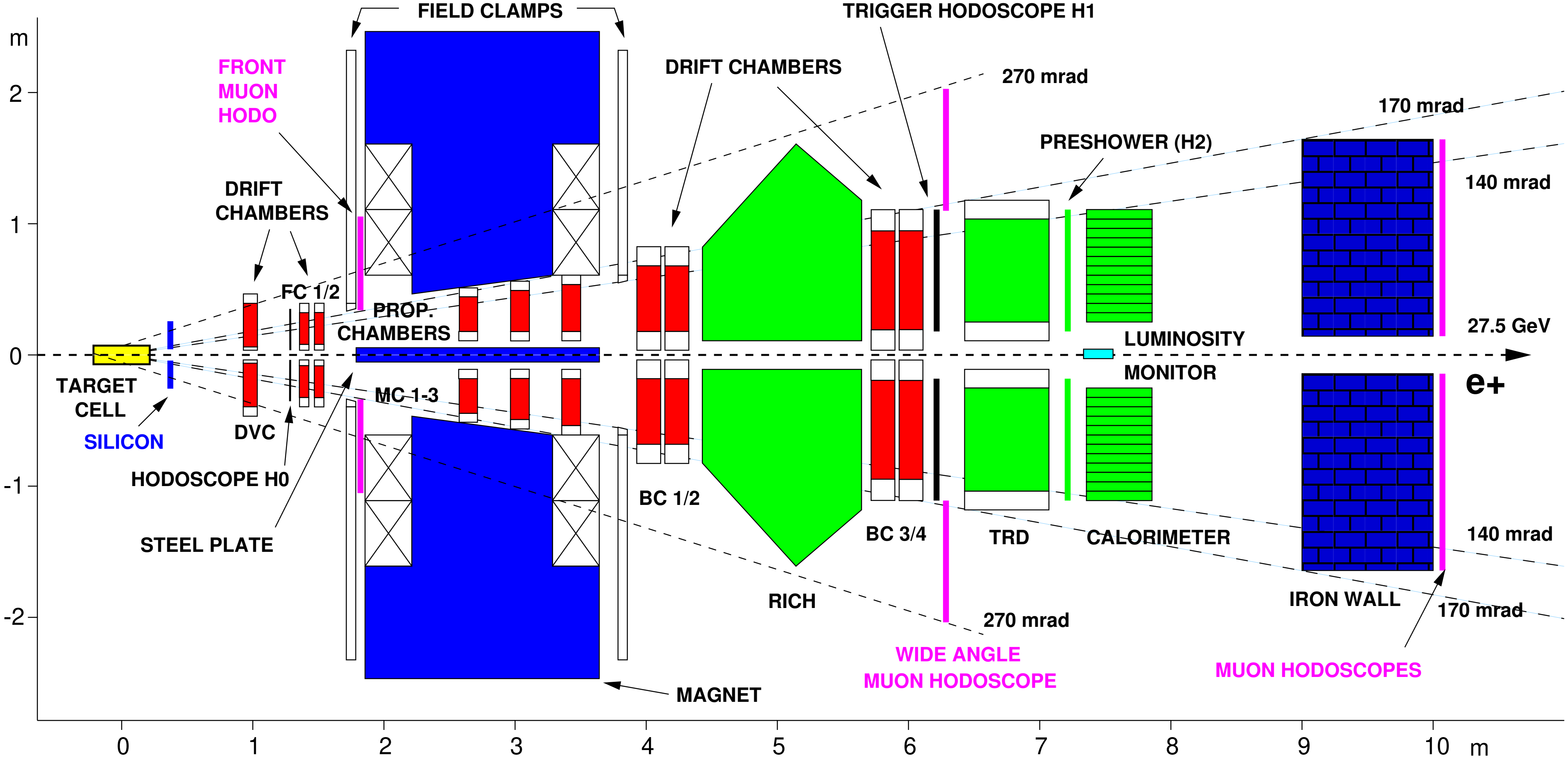
- **QCD allows existence of q^4q states, but up to 2003 searches failed to produce evidence for pentaquarks**

- **The Prediction by** *(Diakonov,Petrov ,Polyakov Z. Phys. A359(1997)305)*, **based on Chirial Soliton Model, of baryon anti-decuplet triggered new wave of exp. search**

- **using $P_{11}(1710)$ as an "anchor" they predict Θ^+ with M=1.53 and narrow width of 15 MeV with nK^+ or pK^0 decay mode, suitable for search for already existing Experiments**

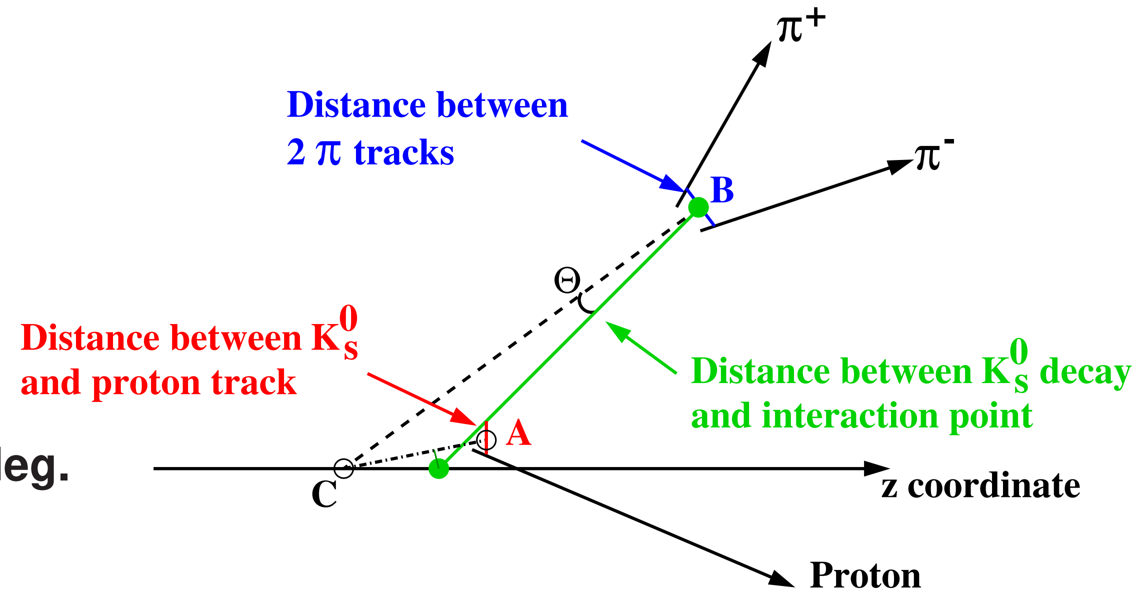
- **already there is 6 reports(LEPS(SPring-8),DIANA(ITEP),CLAS(JLAB1,JLAB2), ELSA(BONN),ITEP) about evidence for a $S = +1$ Pentaquark**

HERMES Experiment

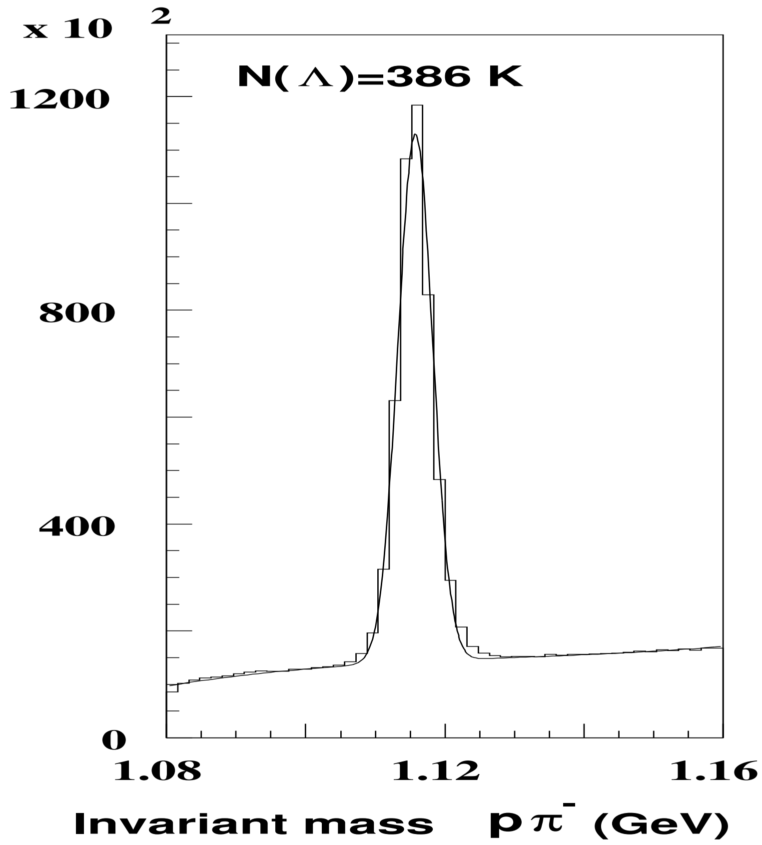


Data set, Event Reconstruction, Cuts

- $E_{beam} = 27.6$ **GeV, Target Pol/unPol D**
- **Reaction of interest** $eD \rightarrow PK_sX$
- **DATA set HERMES 1998-2000**
- **RICH identification**
- **Momentum range Pions** $1 - 15$**,**
  Proton $4 - 9$ **GeV**
- **CUTS DQ,Distance between**
  two Pions, K_s $Proton$**,**Θ^+ **Beam**
- **Collinearity** $\vec{K}_s X C \vec{B}$ $angle < 2.6$ **deg.**
- **"True"** K_s**, decay** $length > 7cm$**,**
  485 $<$ K_s**-Mass** $<$ **509 MeV**
- **Target Vertex,**
  Fiducial volume-cuts on all tracks
- **NO Lambda**

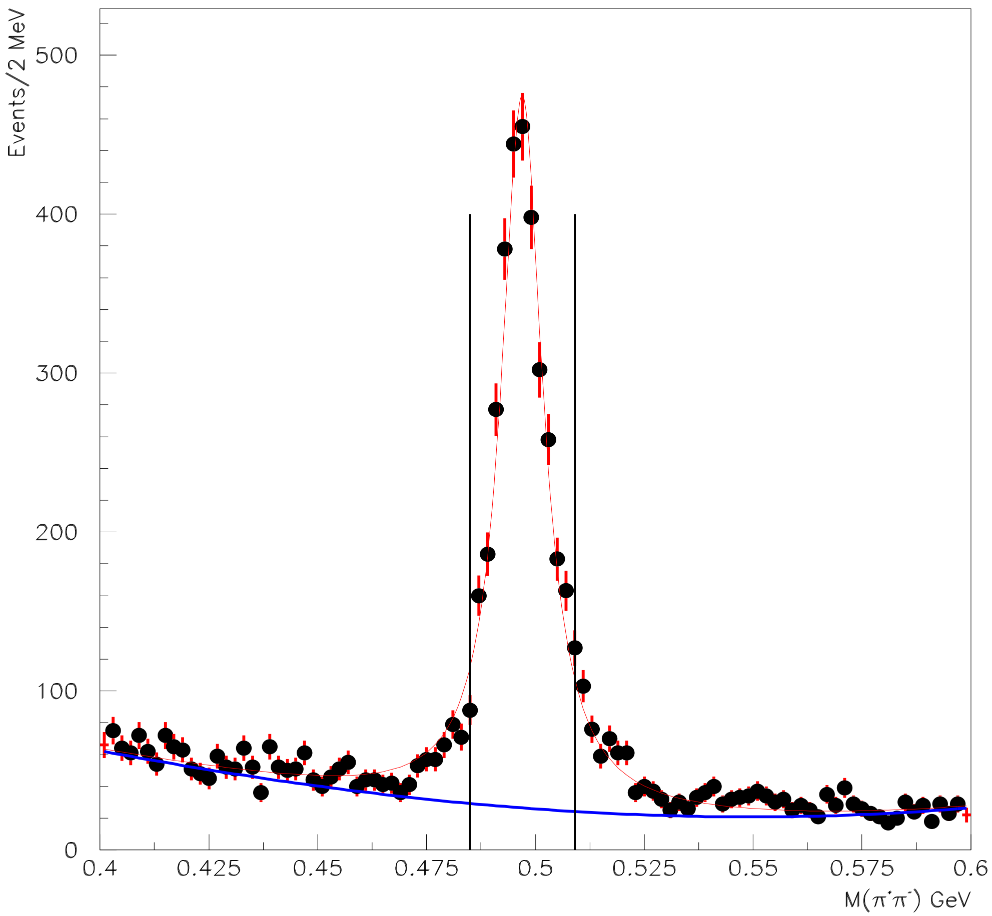


Proton identification



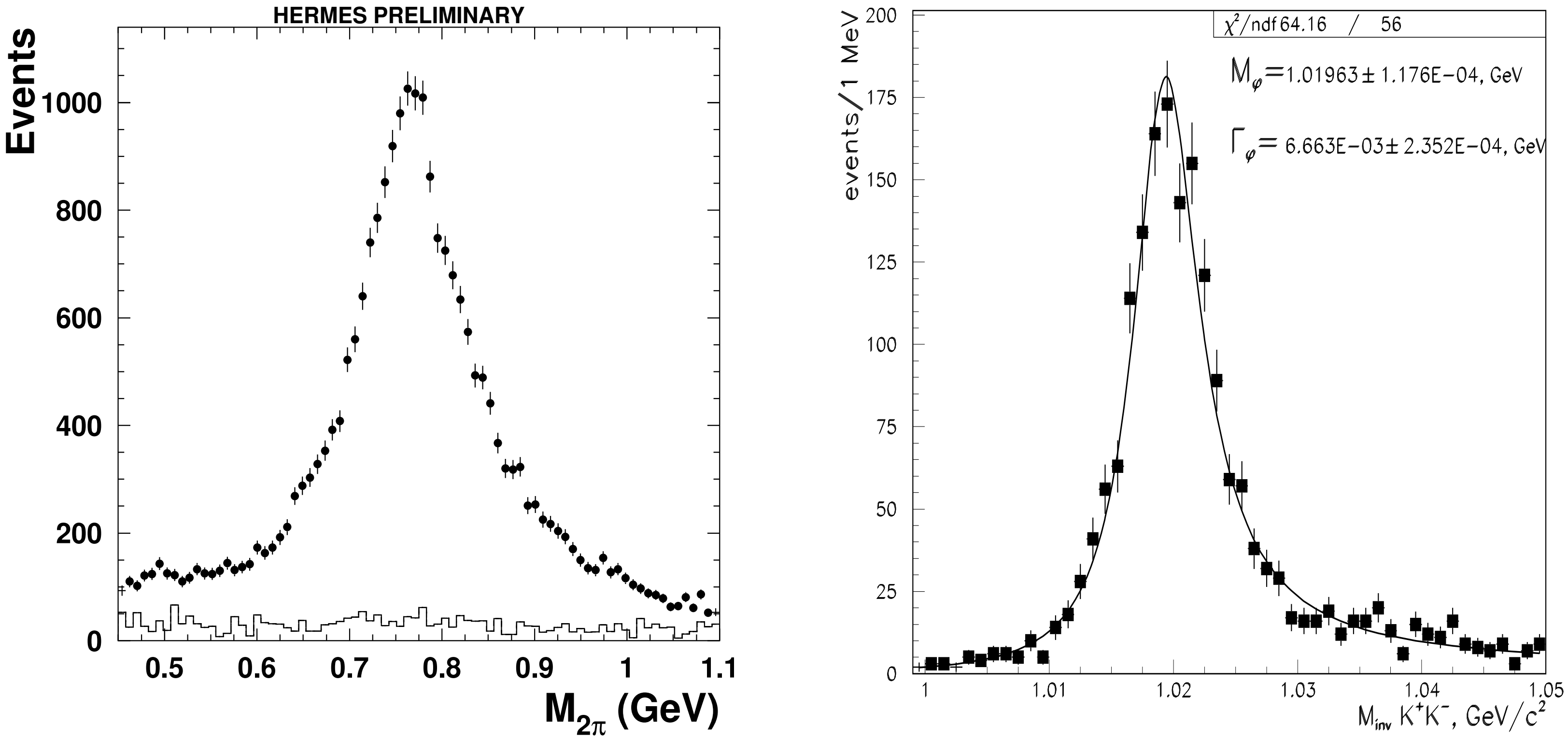
Lambda is well identified $\Longrightarrow$ protons are cleanly identified

K_s identification



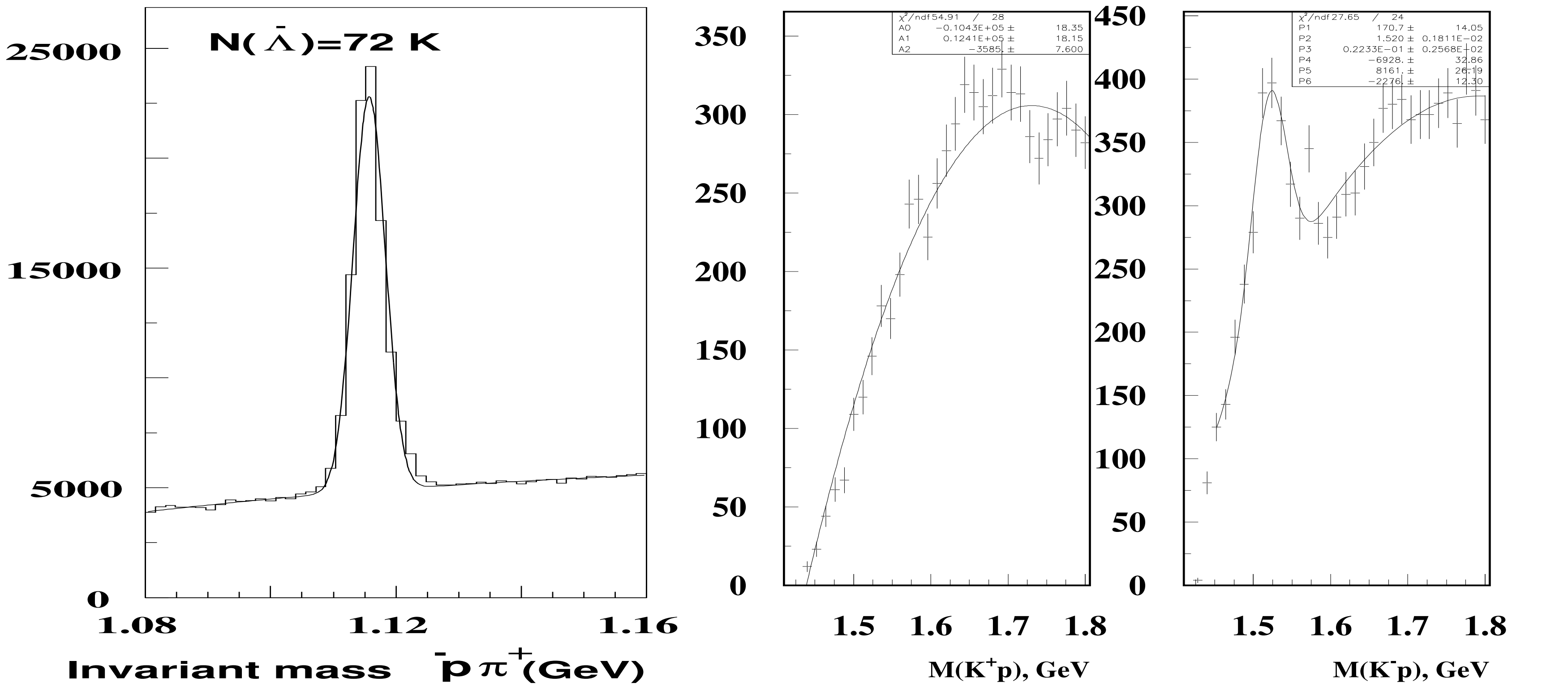
K_s after applying all described cuts
$\Longrightarrow$ well identified

Detector Mass calibrations



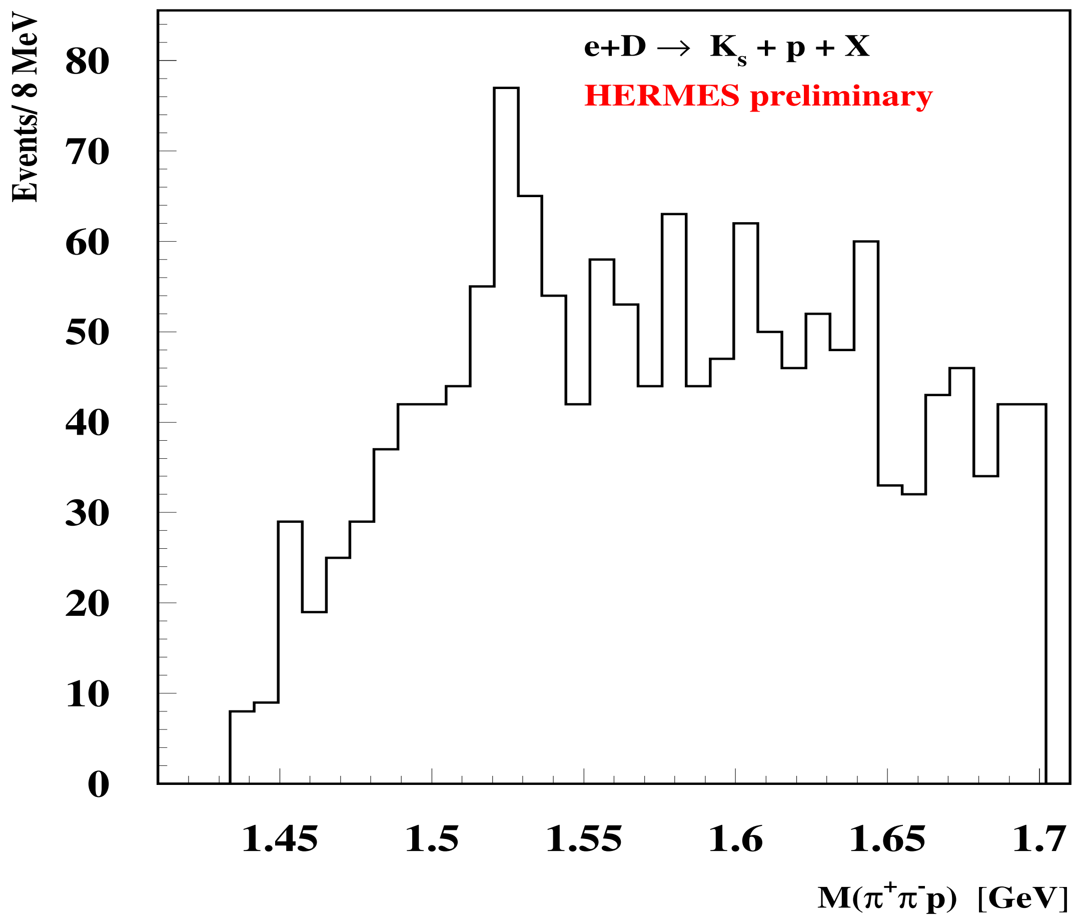
Reconstructed $\rho(770)$ **,**$\phi(1020)$ **...**

Detector Mass calibrations



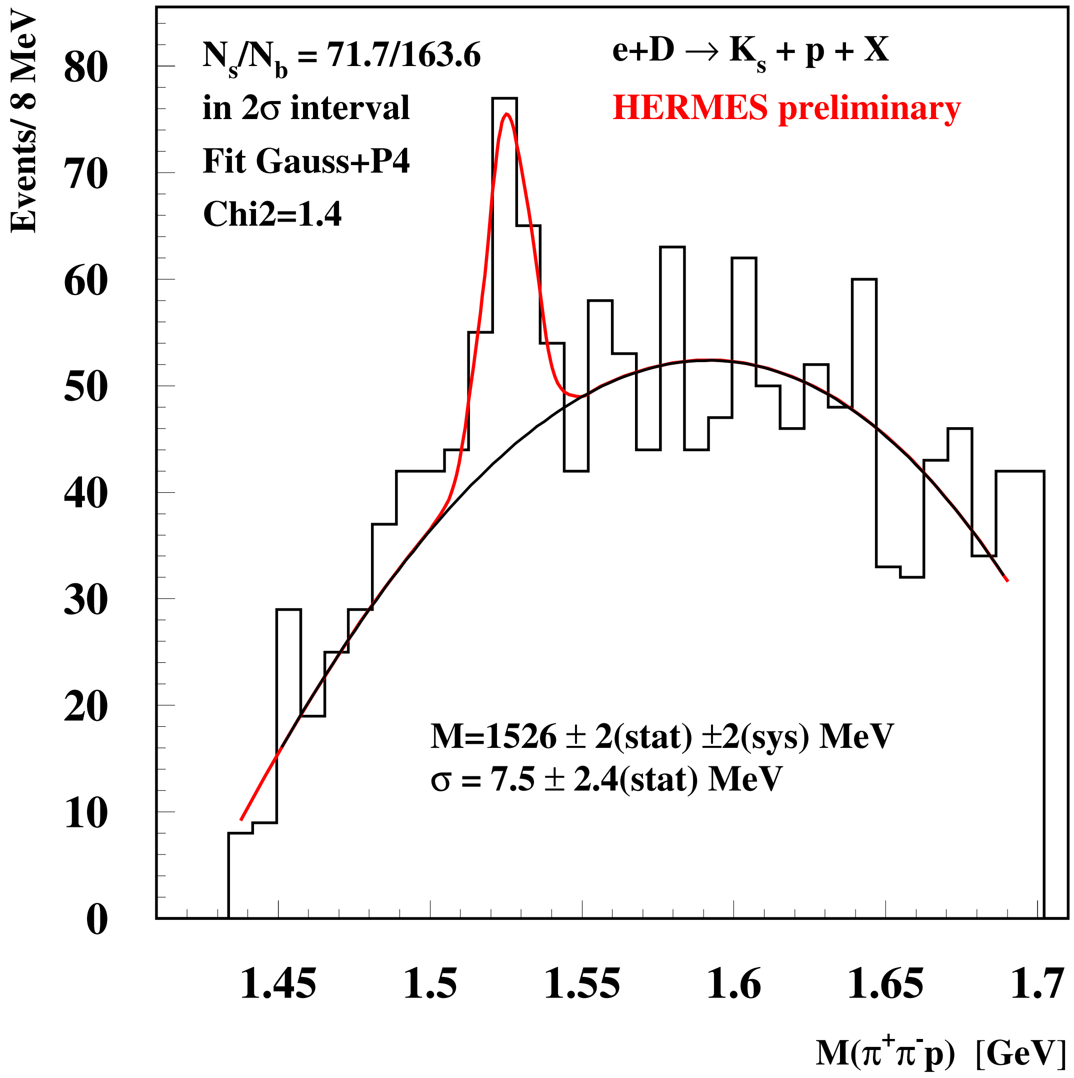
...and $\bar{\Lambda}(1116)$, $\Lambda^*(1520)$ are in agreement with PDG $\pm$ 1 MeV

Final Spectrum



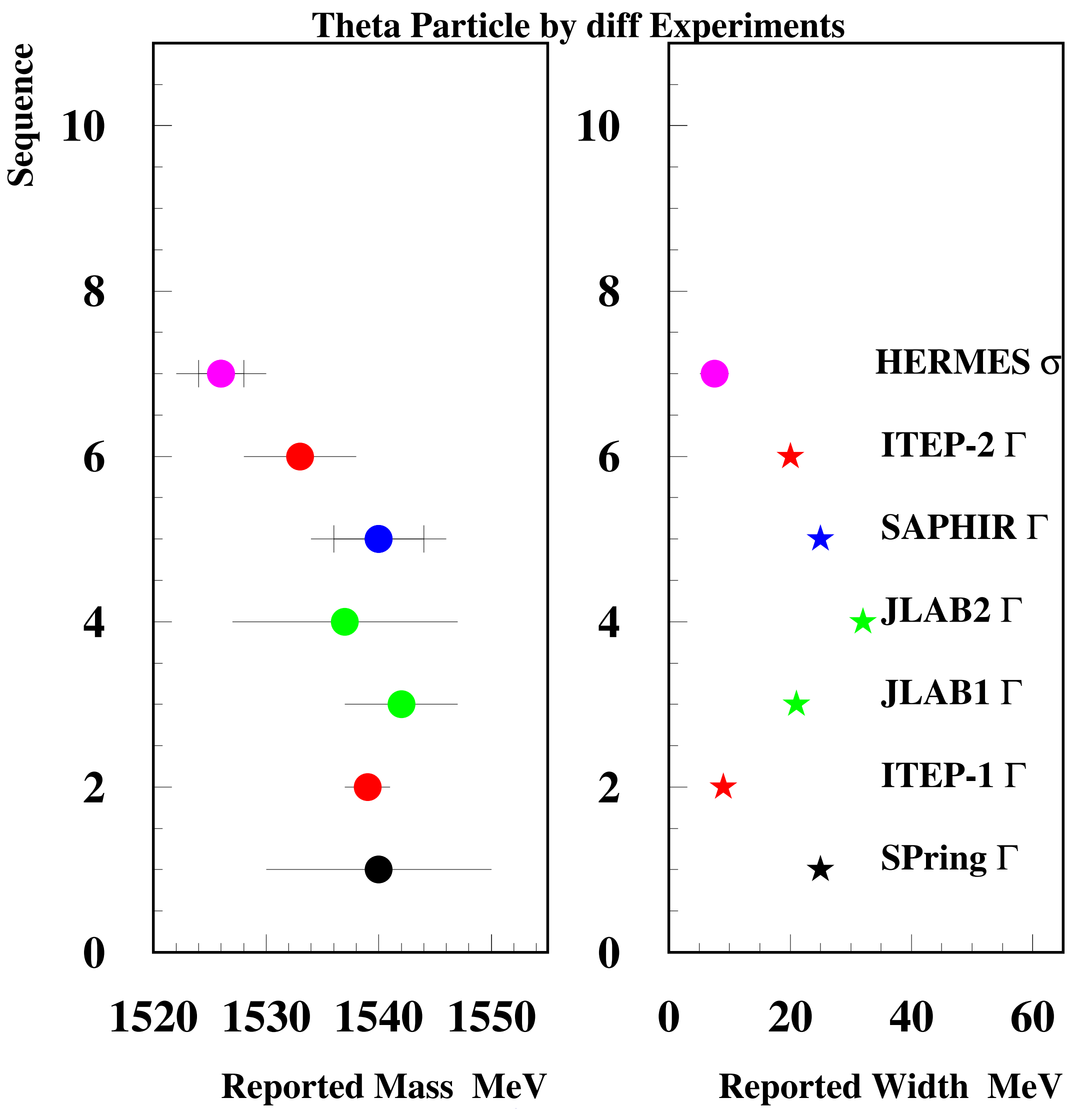
- **excess at 1526 MeV**
- **width 7.5 MeV dominated by Detector**

Final Spectrum with Bckg assumption

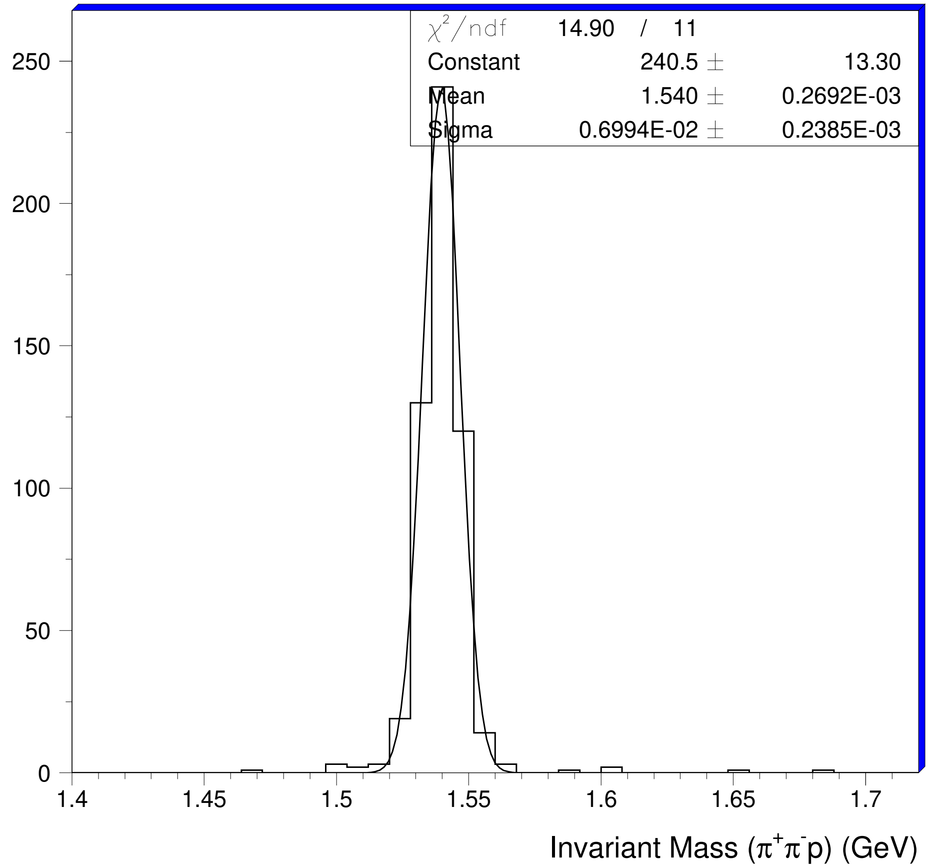


Background approximated by P4 polynom

Comparison with other Experiments



Monte Carlo Simulation



- **Simulate resonance at 1540 MeV with Γ: 2 MeV decaying to $K_s p$**
- **Full detector simulation**
- **Results: Mass: 1540 ± 0.3 MeV   Width: 7 ± 0.2 MeV**

Conclusions

- **A search for a narrow exotic baryon resonance was performed**
  Target: Deuterium
  Kinematics: quasi-real photo-production
  Reaction: $\mathbf{eD \longrightarrow pK_s}$
  Mass: 1526 $\pm$ 2 (stat.) $\pm$ 2 (sys.) MeV
- **The observed width of σ=7.5 MeV is entirely dominated by experimental resolution.**
- **Potentially the Isospin can be determined from K^+P inv. mass spectrum**