Hadron spectroscopy in photo- and hadroproduction at COMPASS

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on behalf of the COMPASS collaboration

bmb+f - Förderschwerpunkt
COMPASS
Großgeräte der physikalischen Grundlagenforschung

PANIC05

Outline

- The COMPASS Experiment
- $\Phi(1860)^{--}$ search with muon beam
- structure and spectroscopy with hadron beam
  - pilot run 2004
  - pion polarisability measurement
  - diffractive processes

COMPASS - Spectrometer

COmmon Muon and Proton Apparatus for Structure and Spectroscopy

fixed target experiments at SPS/CERN

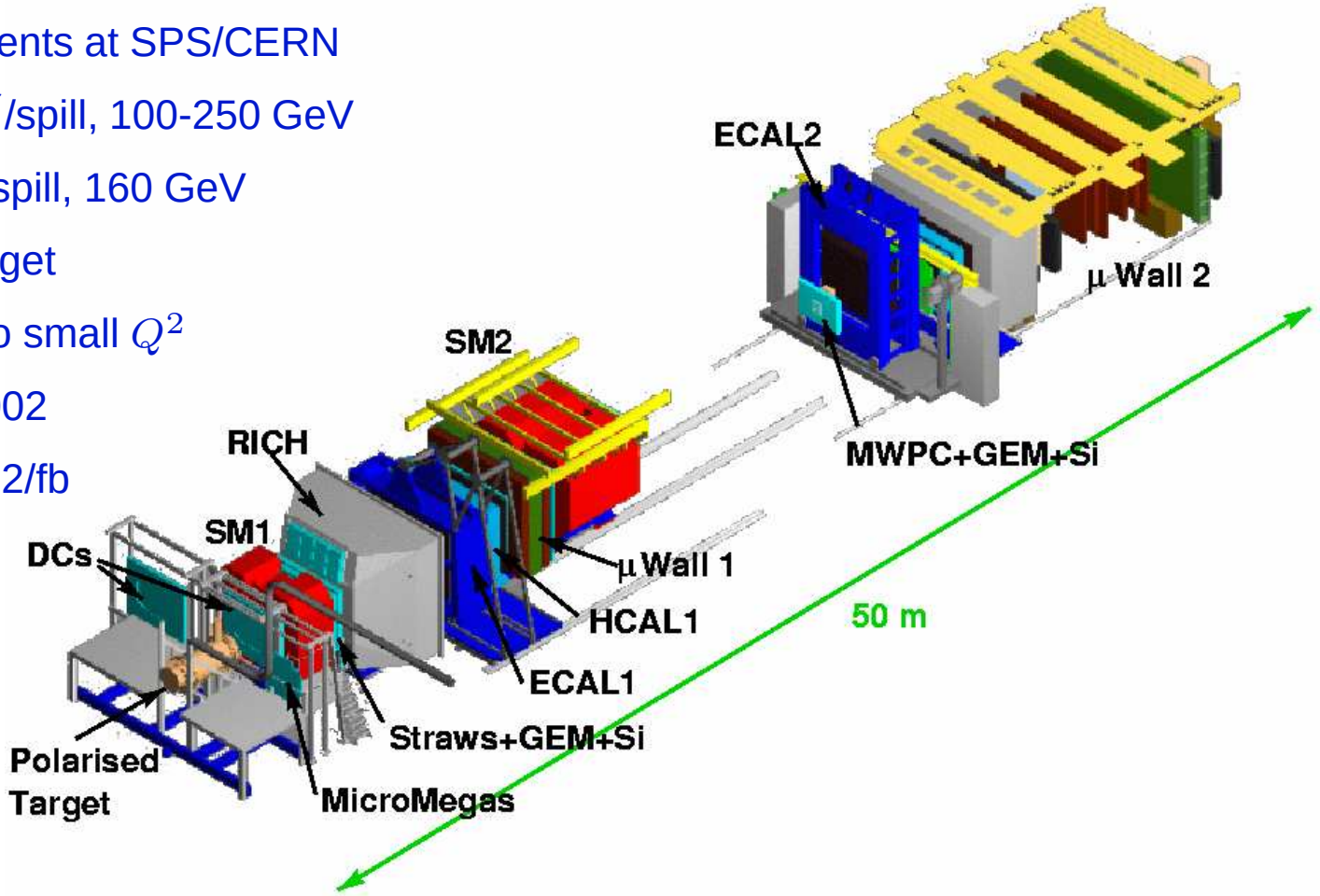
hadron beam: $5 \cdot 10^7$/spill, 100-250 GeV

muon beam: $2 \cdot 10^8$/spill, 160 GeV

- polarised ^{6}LiD target
- trigger covers also small Q^2

data taking since 2002

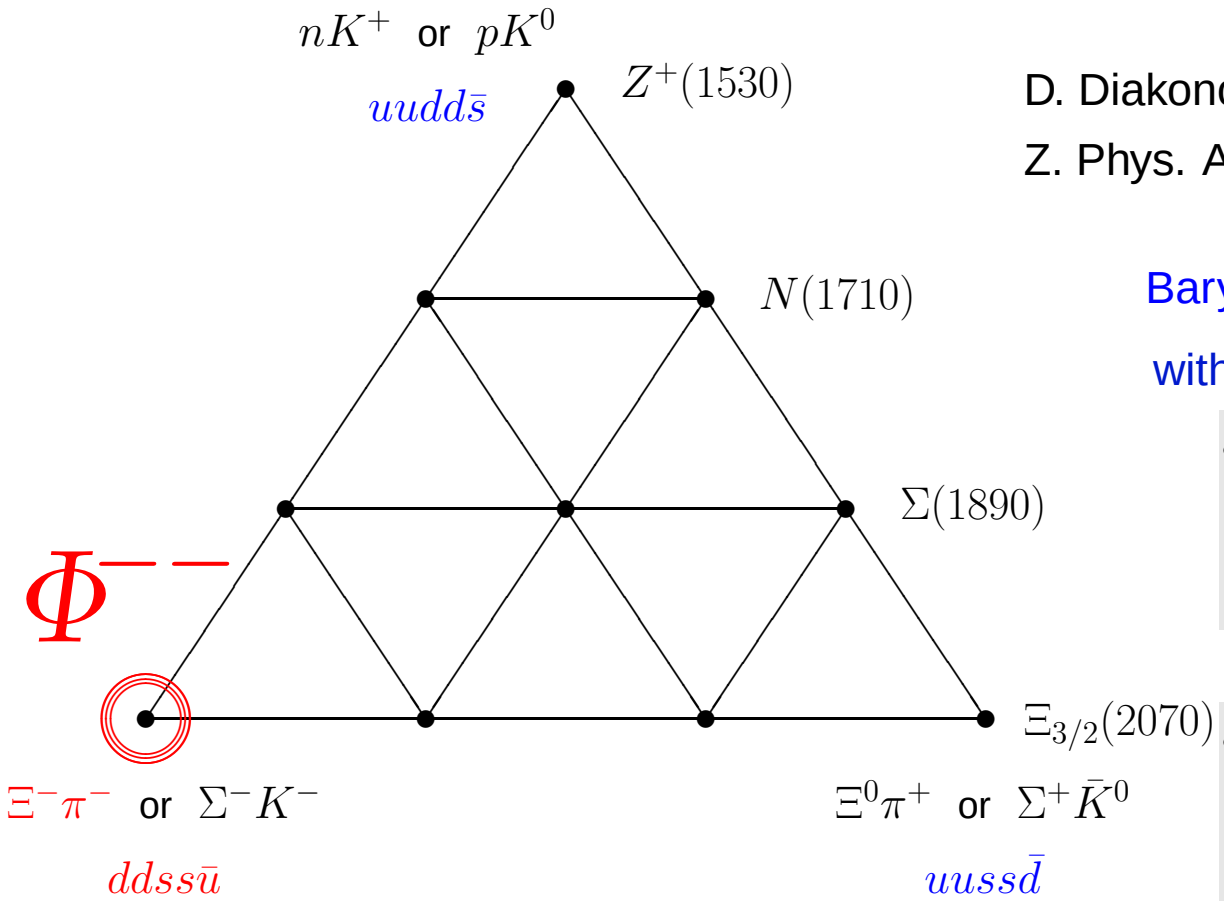
$20 \cdot 10^9$ events, $\mathcal{L} \approx 2$/fb



COMPASS Physics

muon beam	hadron beam
gluon polarisation $\Delta G/G$	
longitudinal/transverse spin distributions	hadron structure via Primakoff effect
Λ polarisation	
muoproduction of hadrons	charmed baryons
dominated by quasi-real photoproduction	gluonic systems
	exotic hadrons
	diffractive reactions

The 'pentaquark' anti-decuplet



D. Diakonov, V. Petrov, M. Polyakov,
Z. Phys. A359 (1997) [hep-ph/9703373]

Baryon resonances $J = \frac{1}{2}$
with $\Gamma \sim$ 20-200 MeV

Citation: S. Eidelman *et al.* (Particle Data Group), Phys. Lett. B **592**, 1 (2004) and 2005 partial update for edition 2006 (URL: http://pdg.l

$\Theta(1540)^+$ $I(J^P) = 0(?^?)$ Status: $**$

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$\Theta(1540)^+$ MASS

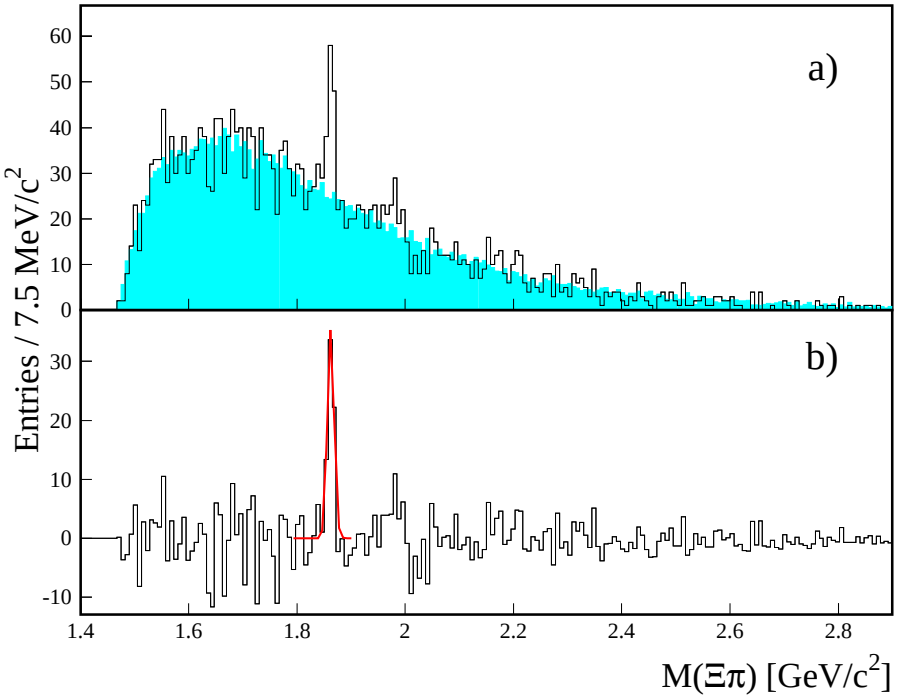
Citation: S. Eidelman *et al.* (Particle Data Group), Phys. Lett. B **592**, 1 (2004) and 2005 partial update for edition 2006 (URL: http://pdg.l

$\Phi(1860)$ $I(J^P) = \frac{3}{2}(?^?)$ Status: $*$

OMITTED FROM SUMMARY TABLE

NA49

C. Alt et al, Phys. Rev. Lett 92 042003 (2004)



search for decay chain

$$\Phi(1860)^{--} \longrightarrow \Xi^- \pi^-$$
$$\longrightarrow \Lambda^0 \, \pi^- \pi^-$$
$$\longrightarrow p \, \pi^- \pi^- \pi^-$$

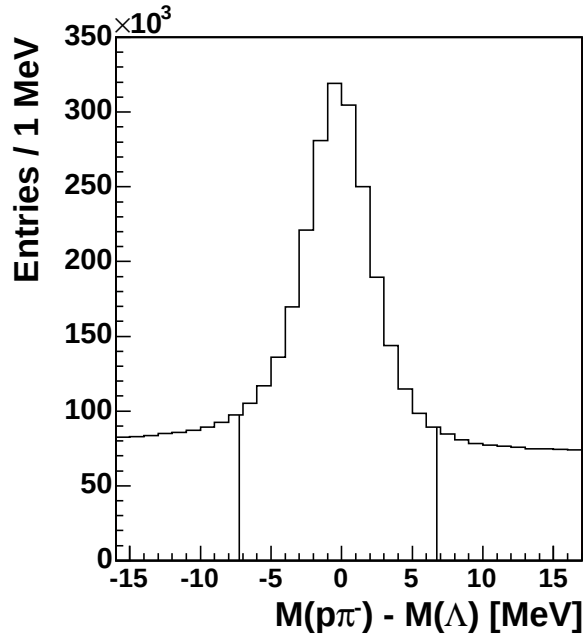
- ⋆ peak at 1862 MeV
- ⋆ FWHM 17 MeV
- ⋆ after kinematical cuts

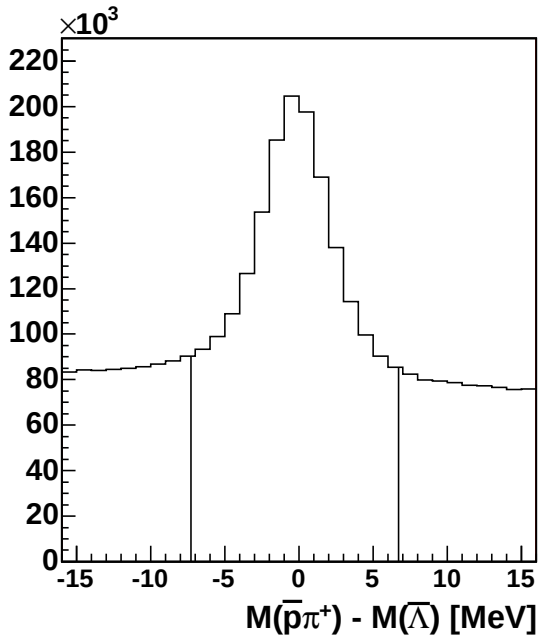
  S = 67.5, σ= 5.6

p-p collisions

COMPASS $\Phi(1860)^{--}$ Search

Ageev et al, EPJ C41 (2005) 469, COMPASS 2002-03





$$X \rightarrow \underbrace{\Xi^- \; \pi^\pm} \rightarrow \underbrace{\Lambda \; \pi^- \pi^\pm} \rightarrow \underbrace{p \; \pi^- \pi^- \pi^\pm}$$

1 700	$\Xi(1530)^0$
18 000	Ξ^-
1 250 000	Λ

$$\bar{X} \rightarrow \underbrace{\bar{\Xi}^+ \; \pi^\pm} \rightarrow \underbrace{\bar{\Lambda} \; \pi^+ \pi^\pm} \rightarrow \underbrace{\bar{p} \; \pi^+ \pi^+ \pi^\pm}$$

920	$\bar{\Xi}(1530)^0$
10 600	$\bar{\Xi}^+$
640 000	$\bar{\Lambda}$

COMPASS $\Phi(1860)^{--}$ Search

Ageev et al, EPJ C41 (2005) 469, COMPASS 2002-03

X

$\downarrow$

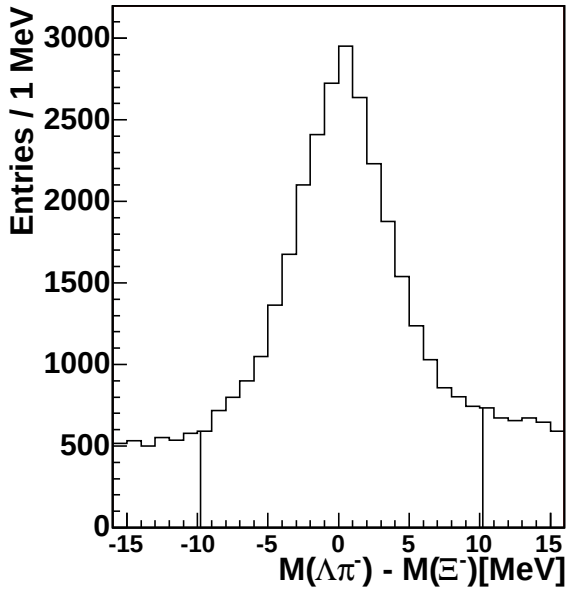
$\Xi^- \; \pi^\pm$

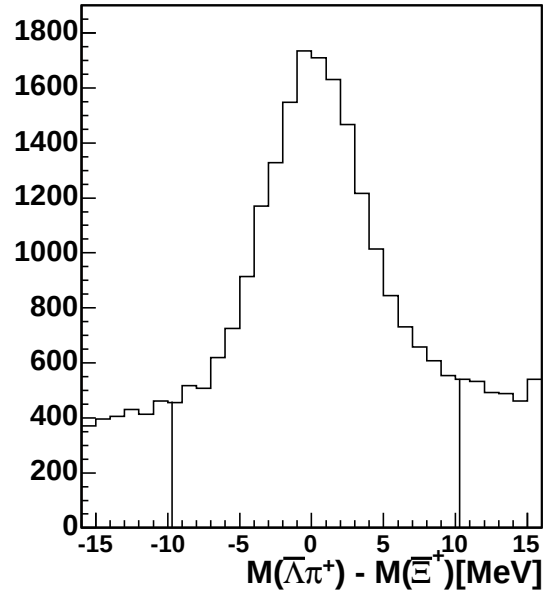
$\downarrow$

$\Lambda \, \pi^- \pi^\pm$

$\downarrow$

$p \; \pi^- \pi^- \pi^\pm$





1 700	$\Xi(1530)^0$	920	$\bar{\Xi}(1530)^0$
18 000	Ξ^-	10 600	$\bar{\Xi}^+$
1 250 000	Λ	640 000	$\bar{\Lambda}$

$\bar{X}$

$\downarrow$

$\bar{\Xi}^+ \; \pi^\pm$

$\downarrow$

$\bar{\Lambda} \, \pi^+ \pi^\pm$

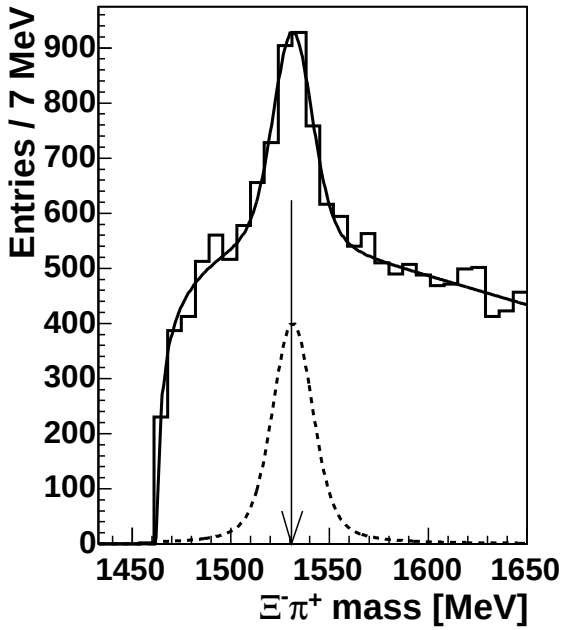
$\downarrow$

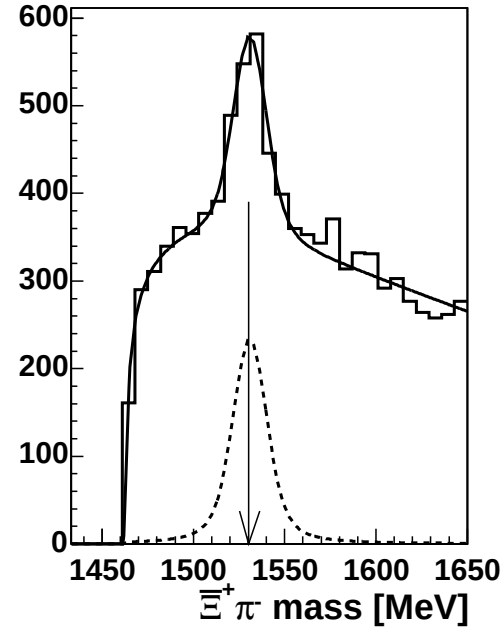
$\bar{p} \; \pi^+ \pi^+ \pi^\pm$

COMPASS $\Phi(1860)^{--}$ Search

Ageev et al, EPJ C41 (2005) 469, COMPASS 2002-03

X → $\Xi^- \pi^\pm$ → $\Lambda \pi^- \pi^\pm$ → $p \pi^- \pi^- \pi^\pm$



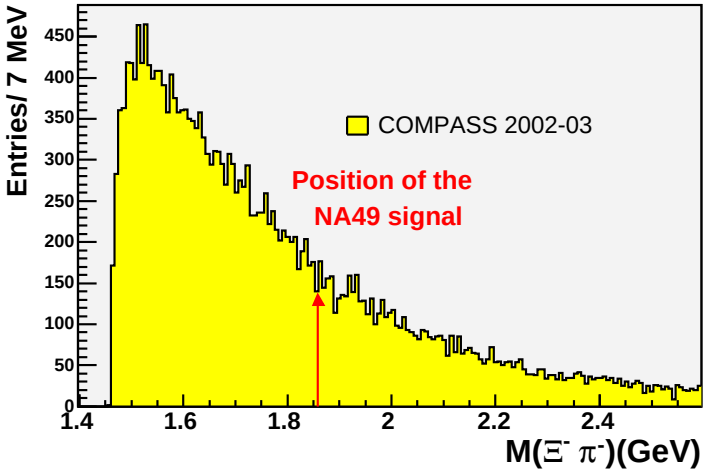


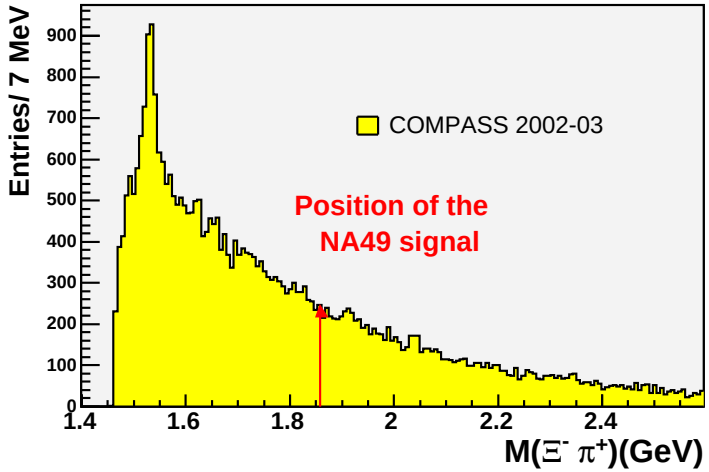
$\bar{X}$ → $\bar{\Xi}^+ \pi^\pm$ → $\bar{\Lambda} \pi^+ \pi^\pm$ → $\bar{p} \pi^+ \pi^+ \pi^\pm$

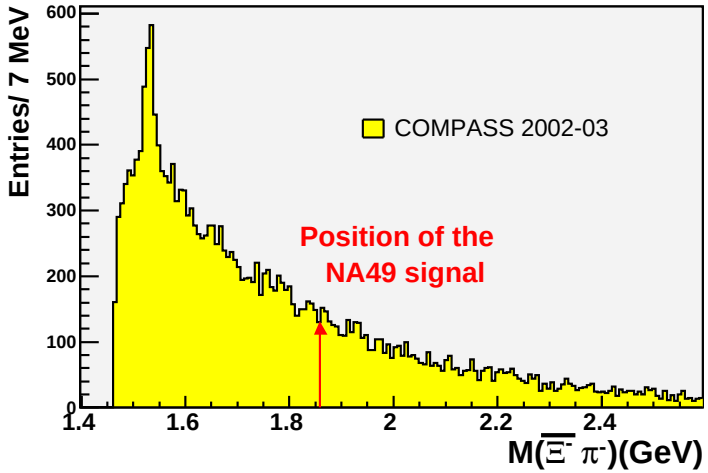
1 700	$\Xi(1530)^0$	920	$\bar{\Xi}(1530)^0$
18 000	Ξ^-	10 600	$\bar{\Xi}^+$
1 250 000	Λ	640 000	$\bar{\Lambda}$

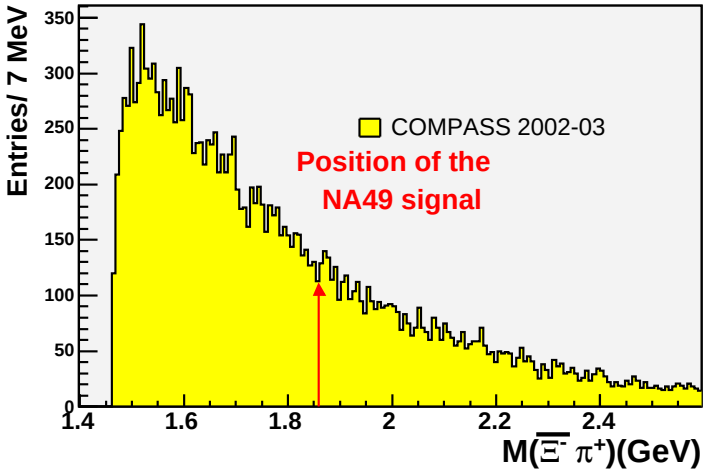
COMPASS Result

Ageev et al, EPJ C41 (2005) 469



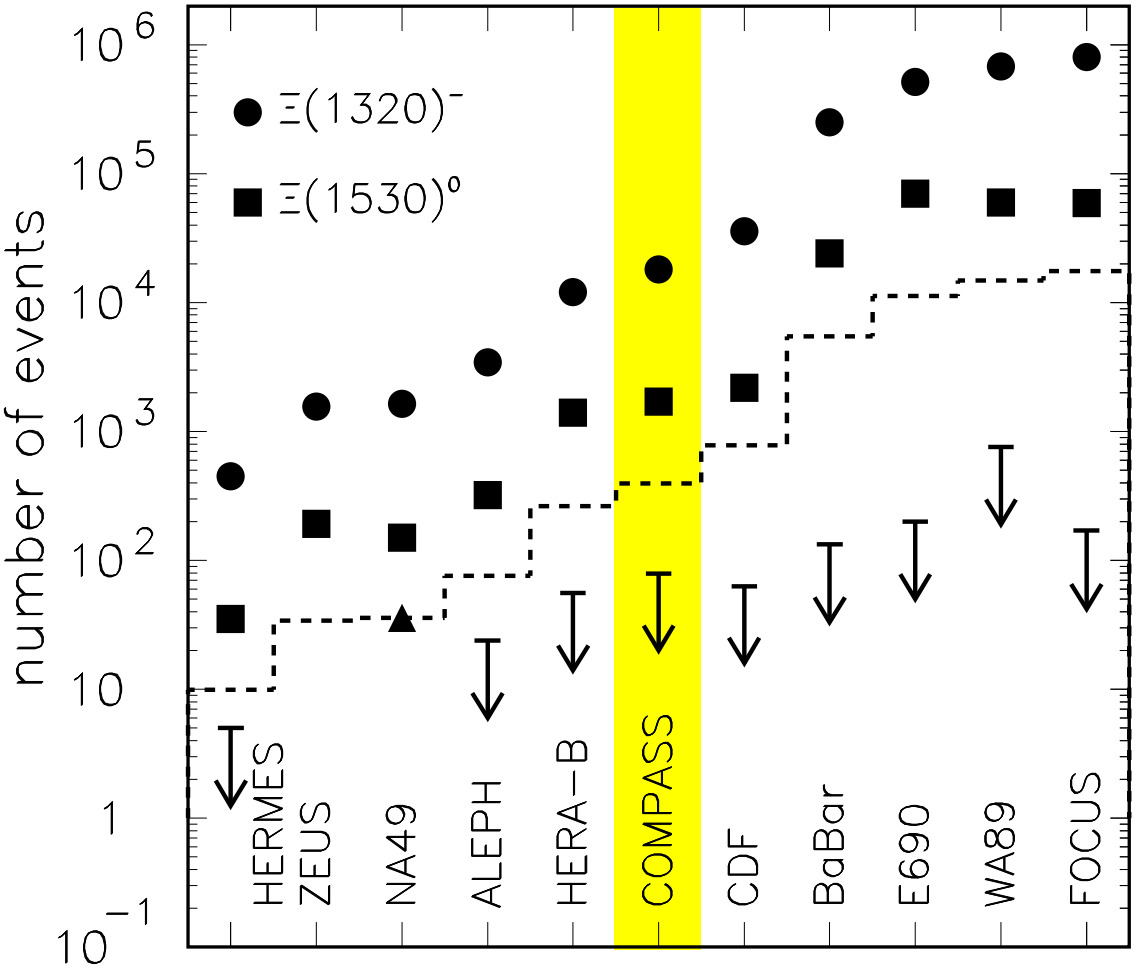






$S < 70$ at 99% CL (scaled NA49 would be $S \approx 400$)

Other $\Phi(1860)^{--}$ searches



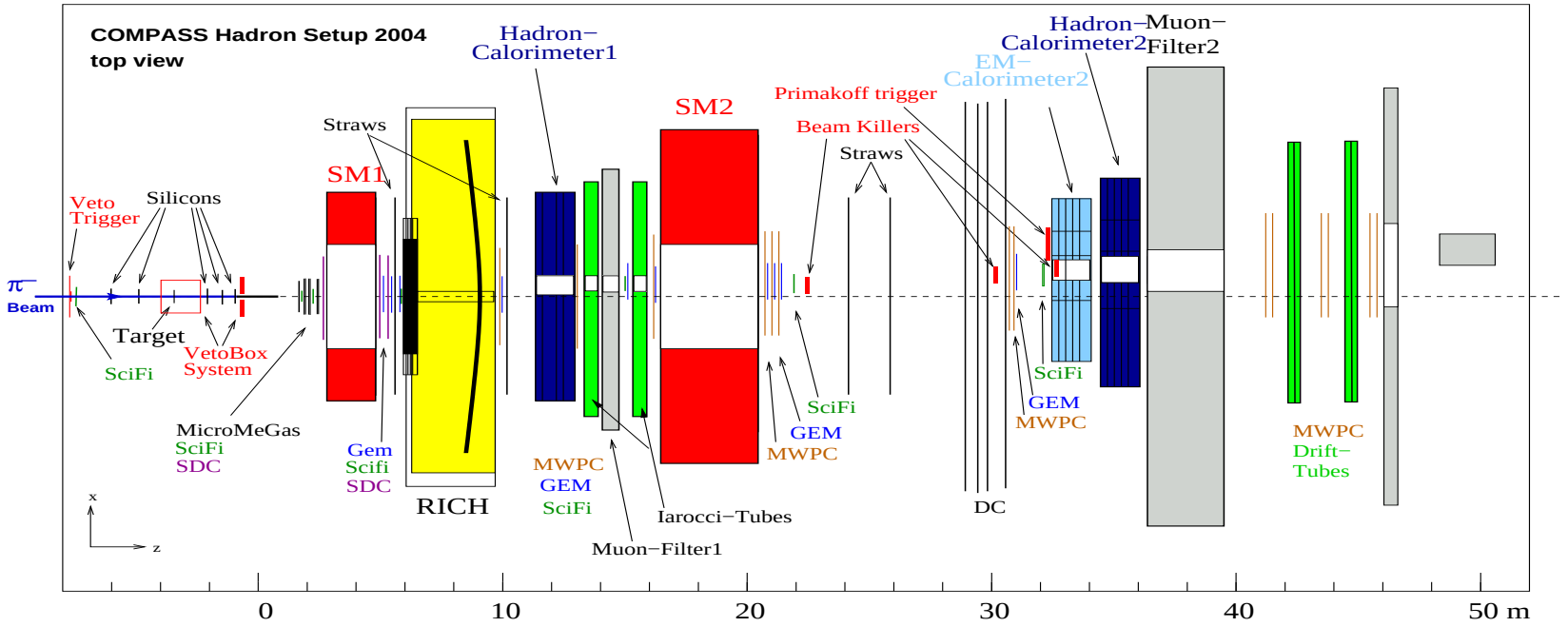
Soft hadronic reactions at COMPASS

Pilot hadron run (3 weeks in Oct/Nov 2004)

190 GeV/c π^- beam (10^6/s) on Pb, Cu, C targets

muon runs (to check with pointlike projectile)

trigger on events with small-angle scattered pion



Primakoff reactions

$\pi + \mathrm{Pb} \longrightarrow \pi' + \mathrm{Pb} + \gamma$

pole at $Q^2 \approx 0$ selects electromagnetic

$\pi\gamma^{(*)} \longrightarrow \pi'\gamma$

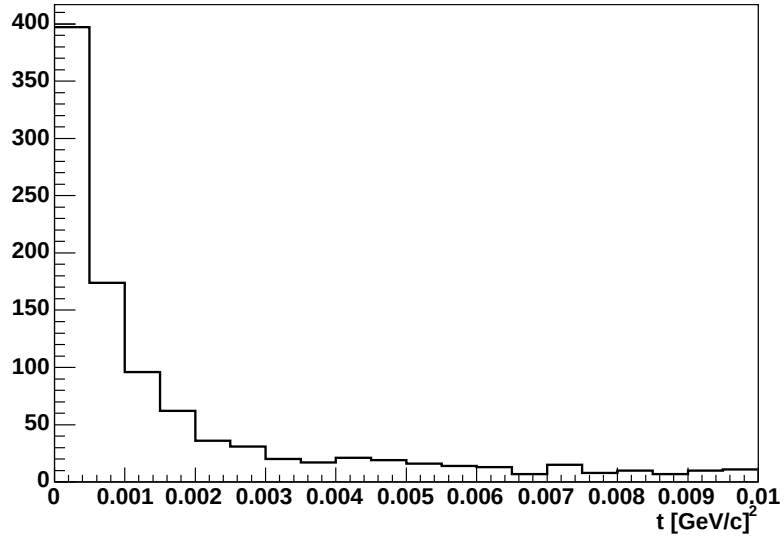
(Compton scattering in inverse kinematics)

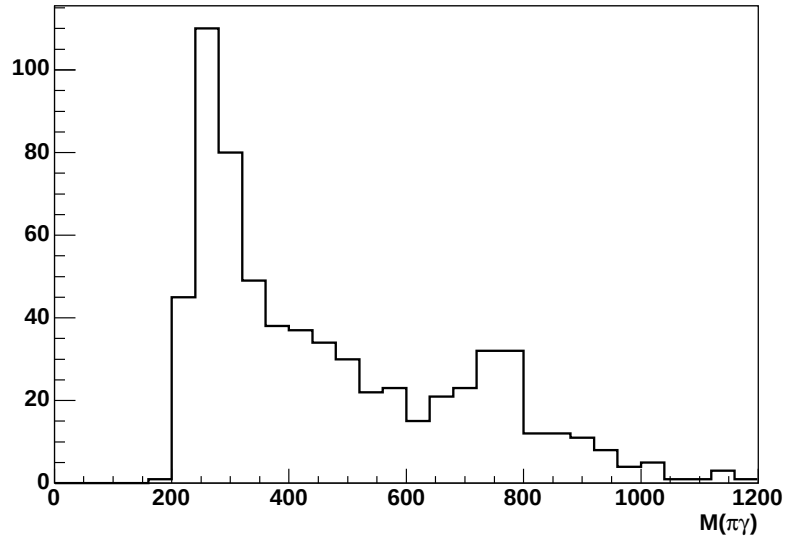
$> 10^{11}$ pion beam flux

$\sim$ 40 000 Primakoff events expected

$\longrightarrow$ at least $4\times$ more statistics
than previous Serphukov measurement

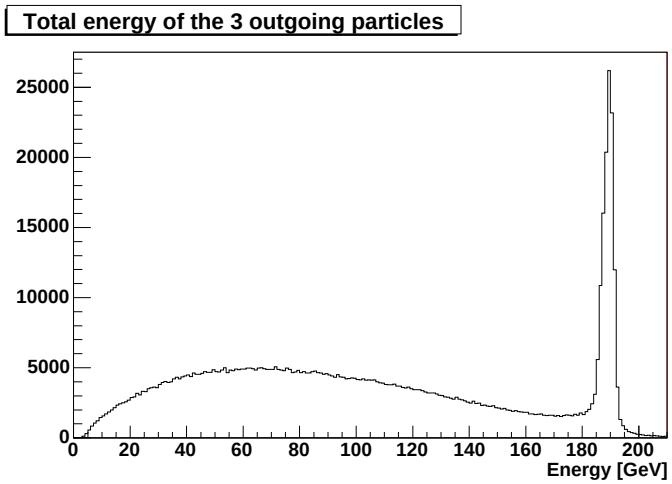
method to extract pion polarisabilities
complementary to Mainz $\gamma p \longrightarrow n\pi^+\gamma$
measurement

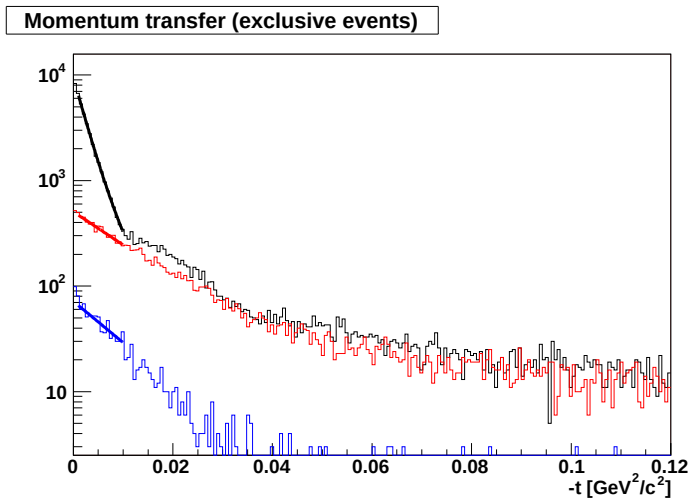




Diffractive reactions

Example: $\pi^- + \mathrm{Pb} \rightarrow \mathrm{Pb} + \pi^-\pi^-\pi^+$ (exclusive) at low t





- study of angular distributions (PWA) in preparation
- potential to reveal exotic objects (as 1^{-+} π_1 resonances)

Summary

- COMPASS finds no evidence for the $\Phi(1860)^{--}$ pentaquark in muoproduction
- The signature of Primakoff reactions is seen with pion beam. Potential to measure Kaon polarisability!
- The COMPASS hadron program has a large potential for contributing to the spectroscopy sector

s. also S. Platchkov:	nucleon spin and structure
J. Nassalski:	gluon polarisation
A. Sandacz:	diffractive ρ production
R. Joosten:	transversity
A. Bressan:	Collins and Sivers asymmetries