Diffractive Dissociation of 190 GeV/c π^- into $\pi^-\pi^+\pi^-$ Final States at COMPASS

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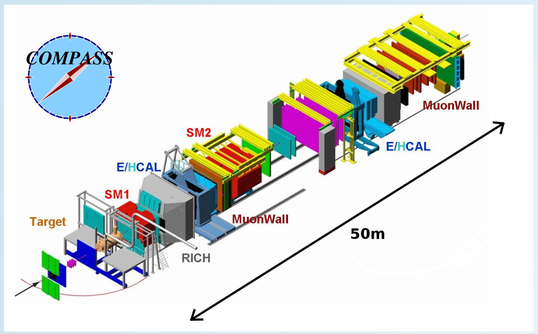
Experimental Setup

Common Muon and Proton Apparatus for Structure and Spectroscopy

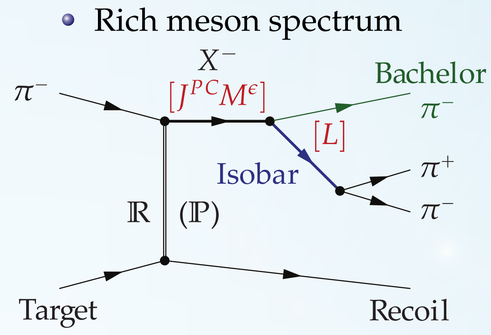
P. Abbon *et al.*, NIM A **577**, 455 (2007)



- Fixed-target two-stage spectrometer
- Excellent acceptance
- High-intensity beams from CERN SPS
  - Primary p
  - Secondary π and K
  - Tertiary μ
- Taking data since 2002 (600 TB/y)

Diffractive Production of Mesons

- Soft scattering of π^- beam off nuclear target
- Target particle remains intact
- At high energies Pomeron exchange dominates
- Rich meson spectrum

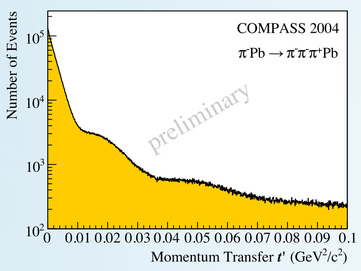


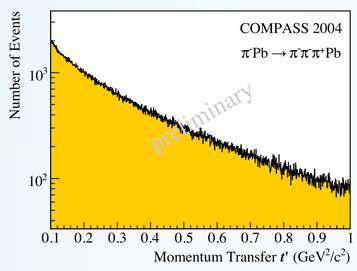
Analysis Technique

- Partial-wave analysis with isobar model (no final-state interactions)
- Partial wave in reflectivity basis: $J^{PC}\, M^{\epsilon}\, [\text{isobar}\, \pi^-] L$
- Nucleon target: rank-2 density matrix

Data Set from 2004 Pilot Run

- 190 GeV/c π^- beam on **Pb target**
- Momentum transfer $0.1 < t' < 1\ (\text{GeV}/c)^2$
  - Scattering off quasi-free nucleons in Pb nucleus
  - $\approx$ 450 000 exclusive events

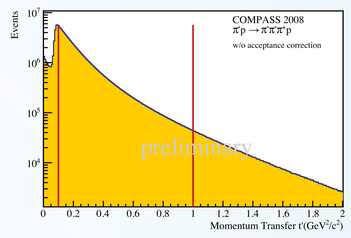




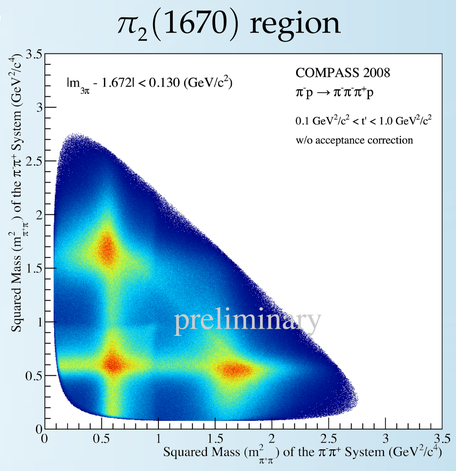
[Results from low-t' region: S. Grabmüller in session B4]

Data Set from 2008 Run

- 190 GeV/c π^- beam on **H_2 target**
- **Unprecedented statistics:** $\approx$ 96 M exclusive events
- Major spectrometer upgrade for 2008 run:
  - CEDAR detectors for beam particle ID
  - Proton recoil detector
  - Improved tracking and electromagnetic calorimetry [analysis of neutral final states: F. Nerling in session C4]



$\pi_2(1670)$ region

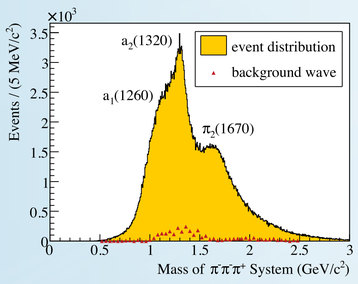


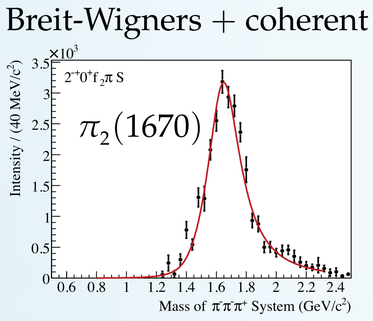
Partial-Wave Analysis of 2004 Data

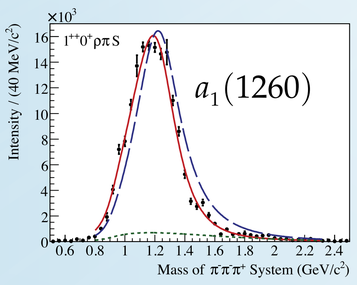
A. Alekseev *et al.*, arXiv:0910.5842, accepted by PRL

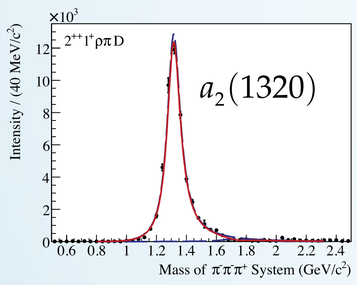
Two-Step Procedure

1. Extended maximum likelihood fit in 40 MeV/c^2-wide mass bins
   - Isobars: $(\pi\pi)_S$ with separated $f_0(980)$, $\rho(770)$, $f_2(1270)$, and $\rho_3(1690)$
   - 41 waves + isotropic flat wave
   - Takes acceptance into account
2. χ^2-fit of mass dependence of spin-density matrix
   - Subset of 6 waves with significant intensity and phase motion
   - Parameterization: Breit-Wigners + coherent exponential background

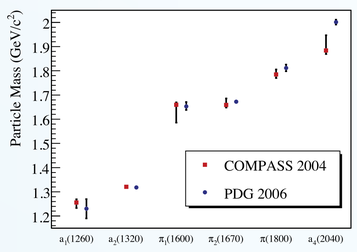








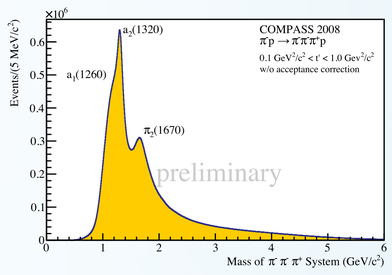
Comparison with PDG

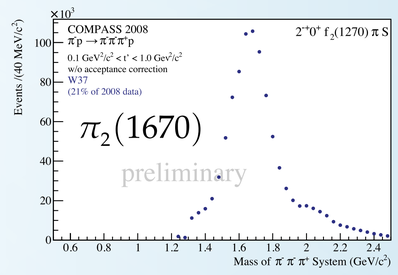


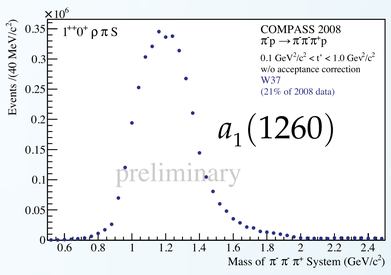
First Partial-Wave Analysis of 2008 Data

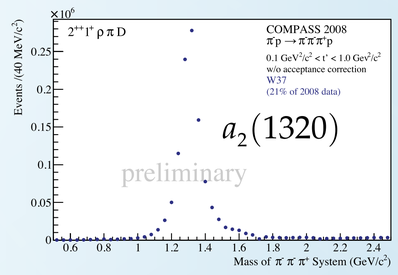
- No acceptance correction
- Mass-independent fit only

Intensity of Dominant Waves

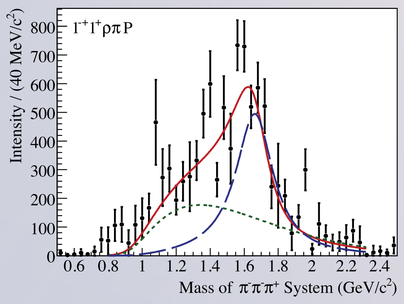


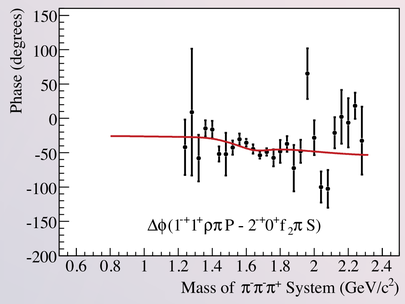


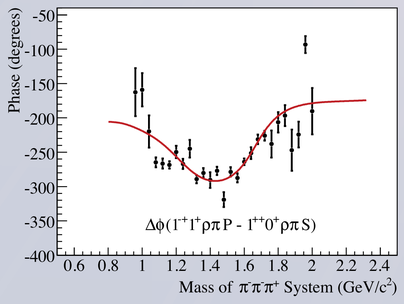




Significant $J^{PC} = 1^{-+}$ Spin-Exotic Wave







Resonant behavior consistent with controversial $\pi_1(1600)$

- $M = 1660 \pm 10^{+0}_{-64}$ MeV/c^2
- $\Gamma = 269 \pm 21^{+42}_{-64}$ MeV/c^2
- Negligible leakage (< 5 %)

Nuclear Effect in Meson Production

- Data sets: **Pb target** (2004) and **H_2 target** (2008) normalized to $a_2(1320)$
- Different intensity of spin projections:
  - **On Pb:** $M = 1$ strongly enhanced, whereas $M = 0$ suppressed
  - Intensity sum over spin projections comparable