Study of Kaonic Final State Events at COMPASS

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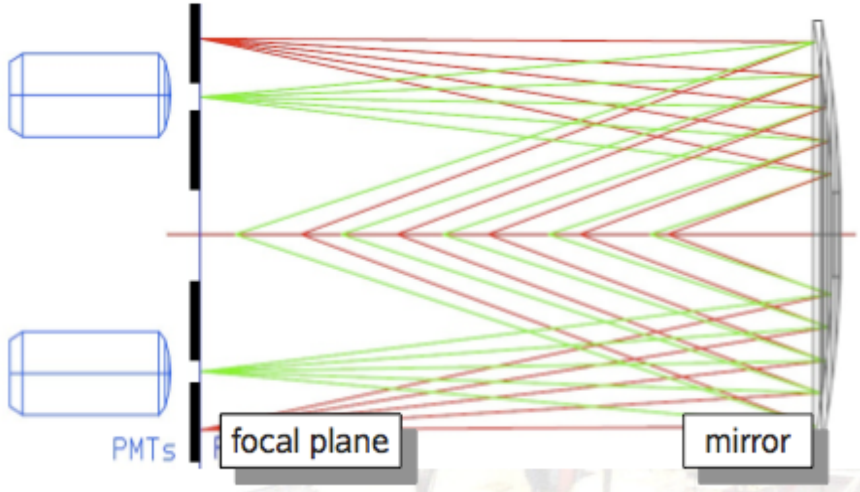
On behalf of the COMPASS Collaboration

Motivation

- Primary Goal: Search for JPC exotic resonances and glueball candidates
- Centrally produced kaonic systems are interesting for the production of glueballs as they are considered to be
  - "glue-rich"
  - preferred due to chirality arguments
  - (Chanowitz, PRL 95:172001, 2005).
- We're currently looking at a number of kaonic final states
  - $K^-\pi^+\pi^-$ (kaon beam)
  - $\pi^-K^+K^-$ (pion beam)
  - $\pi^-K_S K_S$ (pion beam)
- The K_SK_S system selects a subset of the possible quantum numbers for KK, whereas K^+K^- exposes the whole set.
  - Studying both channels provides an excellent opportunity for cross-checks

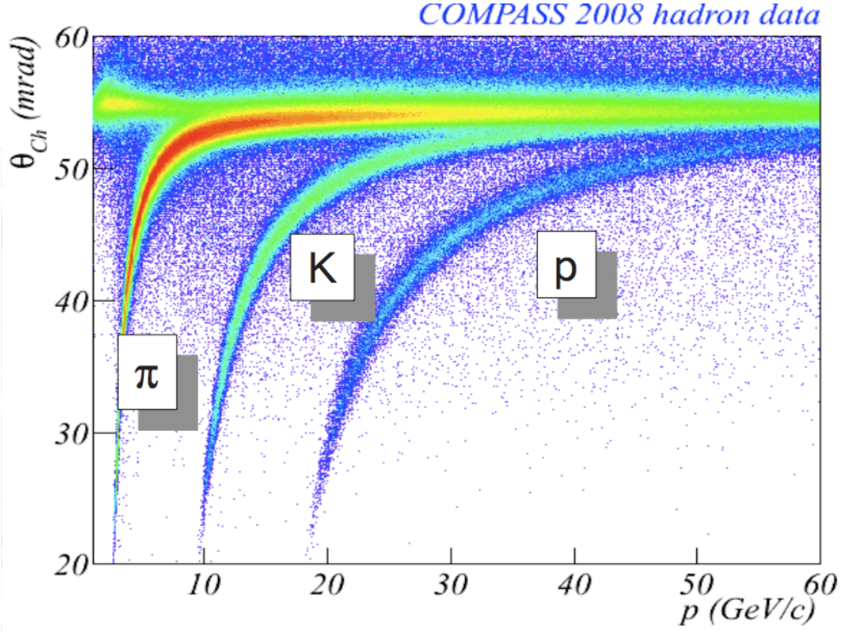
state	allowed J^{PC}				
$K^0_S K^0_S$	0^{++}		2^{++}		4^{++}
K^+K^-	0^{++}	1^{--}	2^{++}	3^{--}	4^{++}

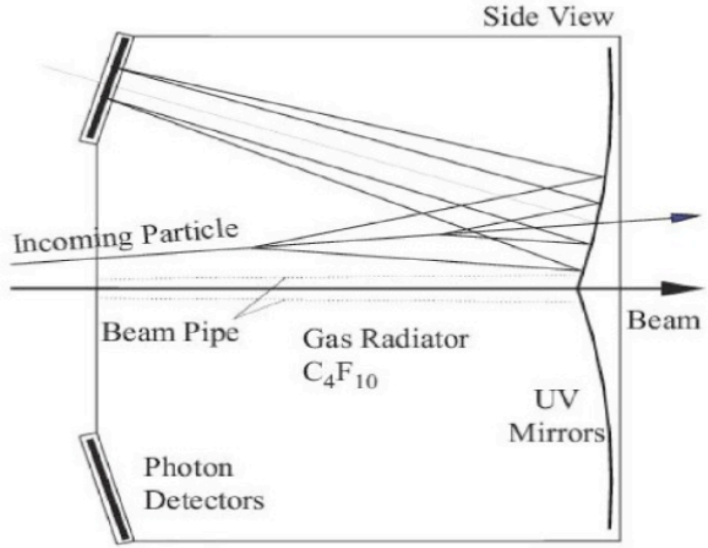
Beam Particle Identification



- The incoming beam has an energy of 191 GeV. It consists of π^- (93%), K^- (2.5%), μ^- (3%), p^- (0.6%) and e^-(0.1%)
- The CEDAR (ChErenkov Differential counter with Achromatic Ring focus) detectors before the target are used to select a specific beam particle, e.g. kaons

Decay Particle Identification

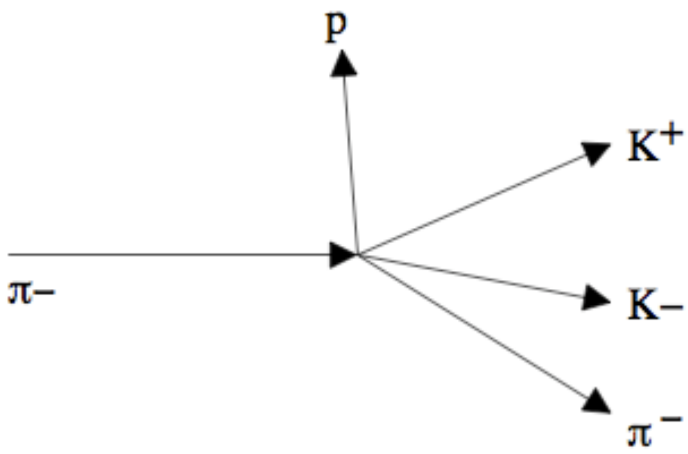




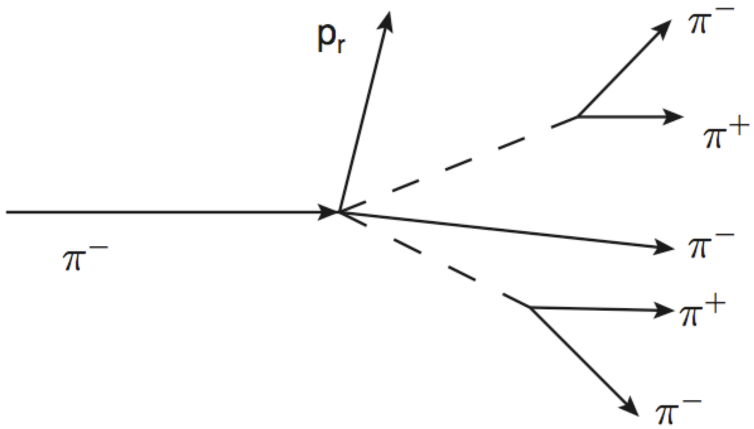
- Pionic final states have overwhelming cross-section compared to charged kaonic final states. Hence a decay particle identification is required.
- The COMPASS RICH detector allows a pion/kaon/proton separation up to a momentum of 55 GeV/c

Primary Event Selection

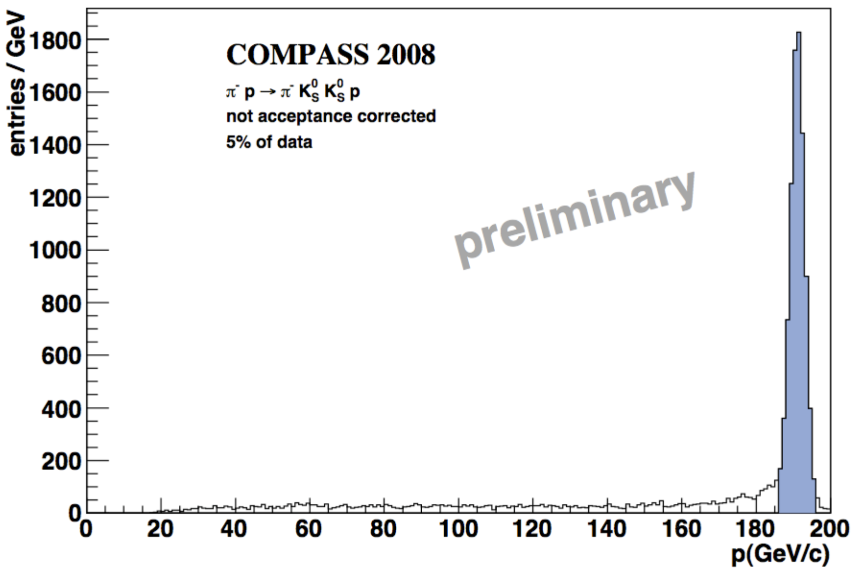
- Charged Kaonic Final States
  - Unique primary vertex in the event
  - 3 outgoing tracks with (+,-,-) charge assignment
  - One negative charged track
  - Clean RICH identification of one negative charged kaon below 30 GeV
  - Exclusivity requirement

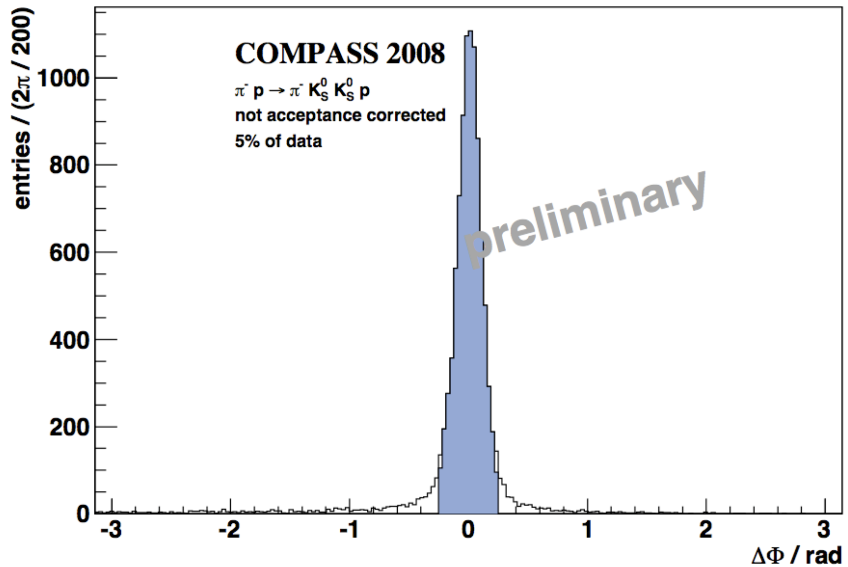


- Neutral Kaonic Final States
  - Reconstructed primary vertex
  - 1 negative charged outgoing tracks
  - Exactly 2 K_S candidates
    - secondary vertex with two outgoing oppositely charged tracks
    - Invariant mass close to KS mass [PDG]



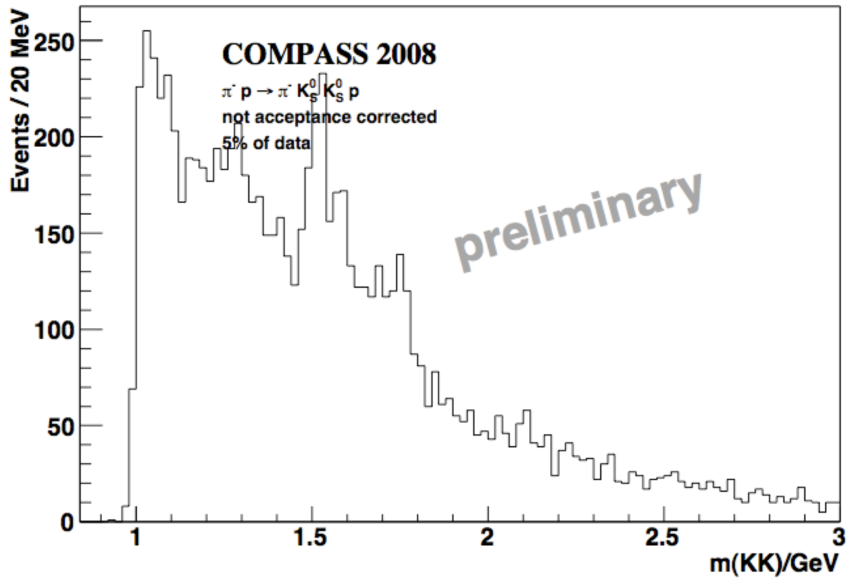
Exclusivity Requirement

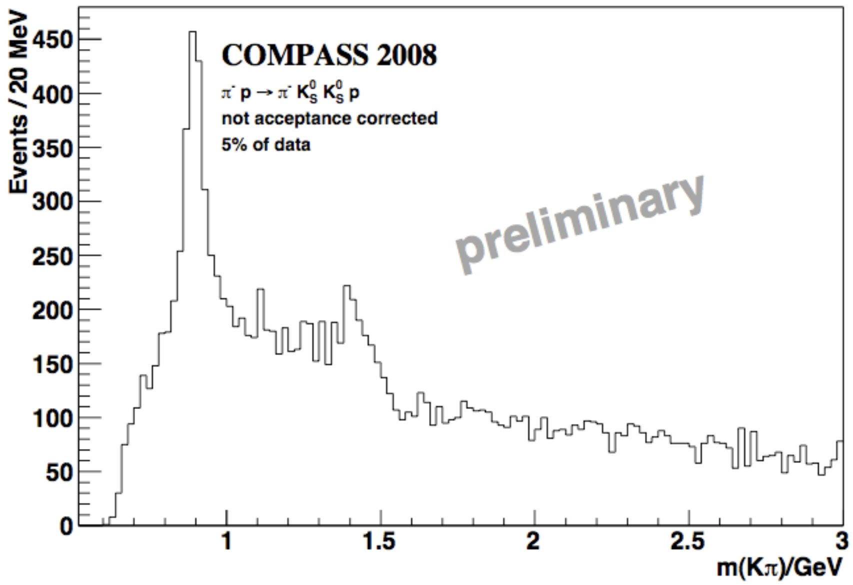




- The reconstructed final state is required to be exclusive, i.e. all final state particles have been detected and reconstructed
  - Momentum sum of all decay objects is required to be close to the incoming beam momentum (191±5GeV)
  - The angle difference in the ϕ-plane between the recoil proton and the vector sum of all reconstructed particles is required to be close to 0

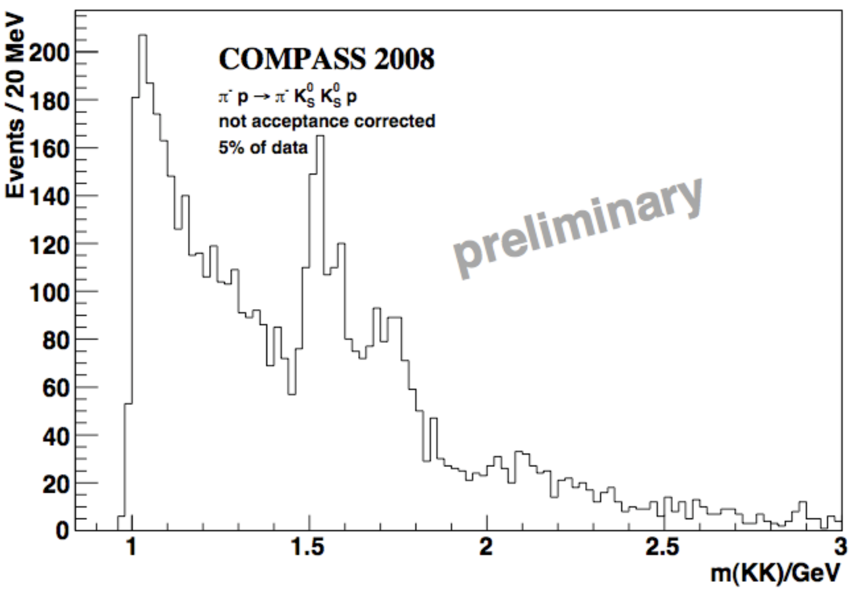
K_SK_S invariant mass spectra

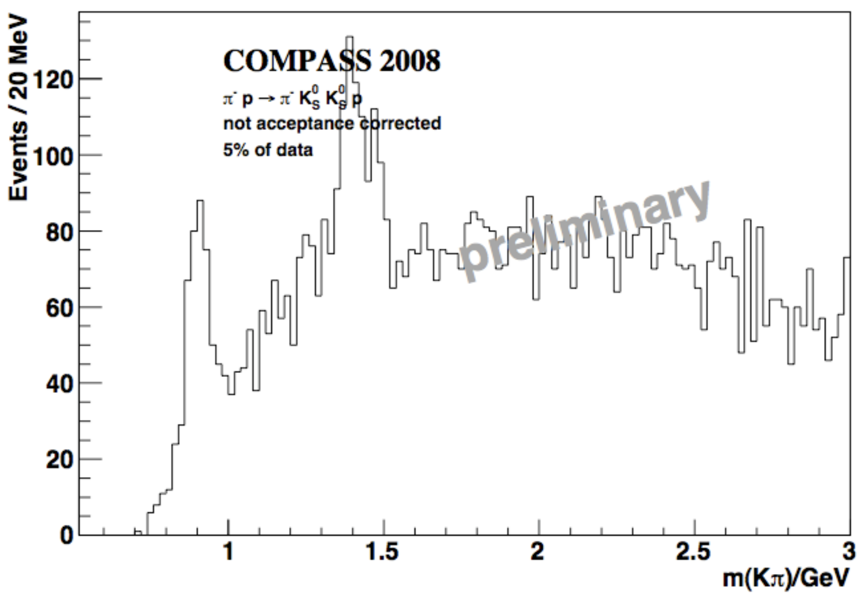




- Mass spectra reproduce known resonances well
  - KK: $a_0(980)$, $f_0(980)$, $f_2(1270)$, $f_0(1370)$, $f_0(1500)$, $f'_2(1525)$, $f_0(2150)$;
  - Kπ: K*(892), K*(1410), K*(1430).

Mass spectra when π^- is the fastest particle

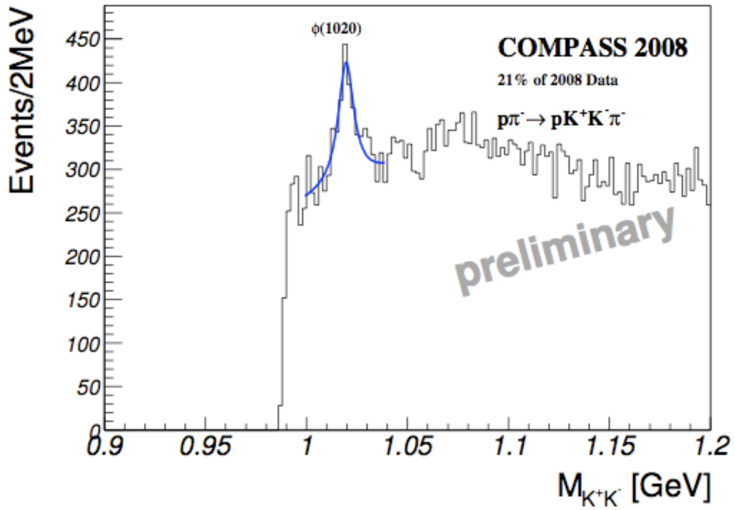




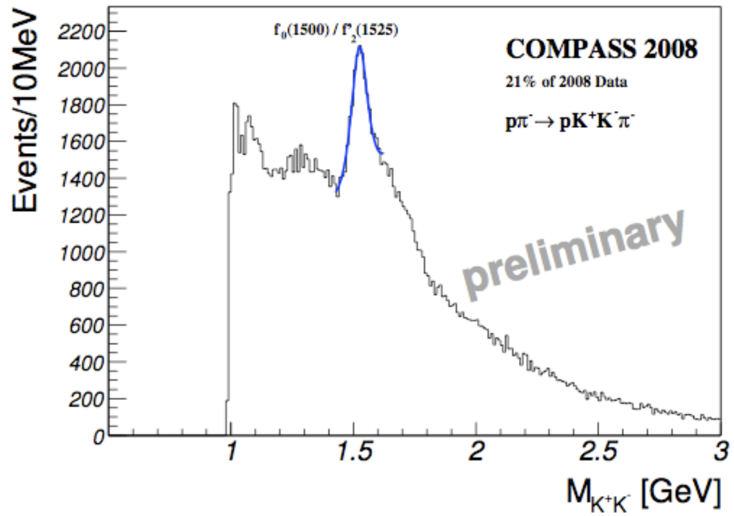
- Requiring that the fastest particle is π^- leads to different enhancement of the observed resonances compared to the previous selection
- Apparently we observe the selection of different production processes

K^+K^- invariant mass spectra

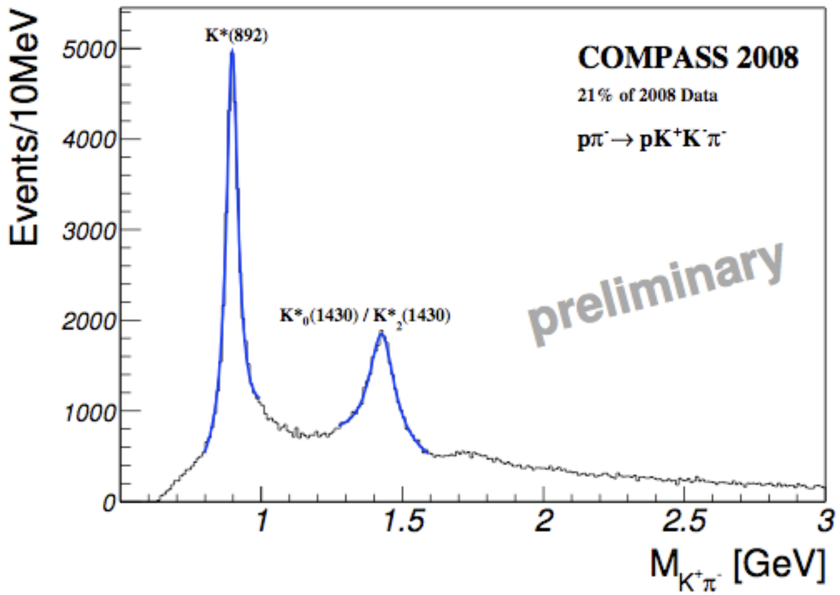
- The ϕ(1020) is clearly visible
  - A suppressed production is expected due to the OZI-rule
  - Large fraction of the ϕ(1020) is produced by the kaonic content of the incoming beam

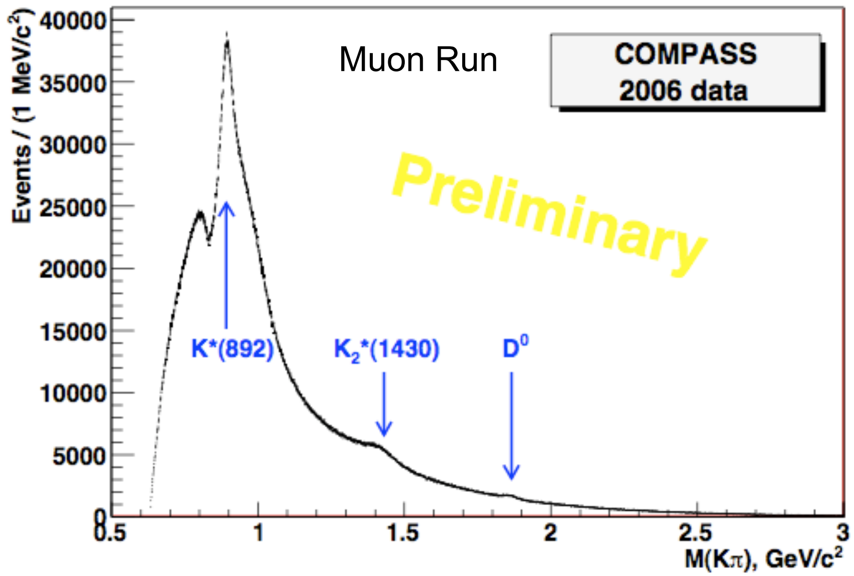


- Clean peak at 1.5 GeV can be due to
  - $f_0(1500)$: glueball candidate
  - Weak signal of $f_0(1270)$
  - $f_2'(1525)$
  - Final answer can be given after detailed partial wave analysis



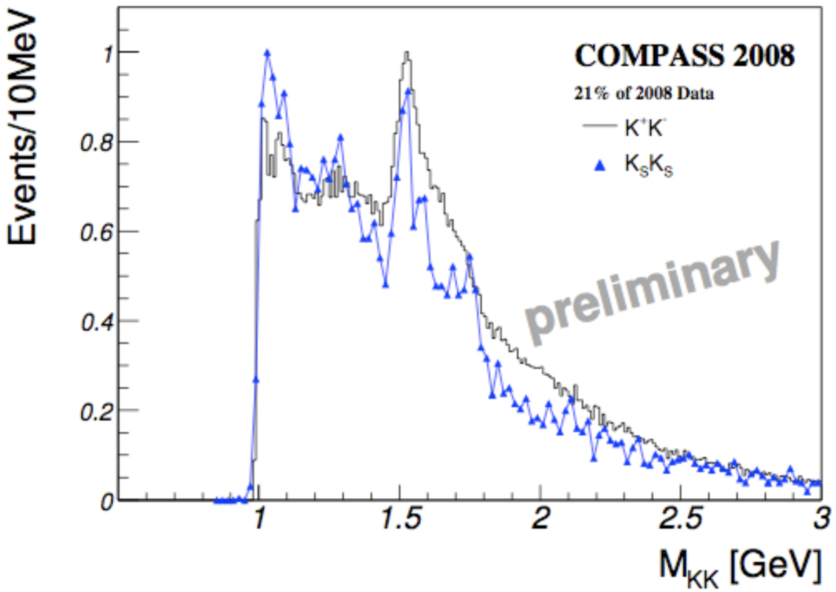
K^+K^- invariant mass spectra

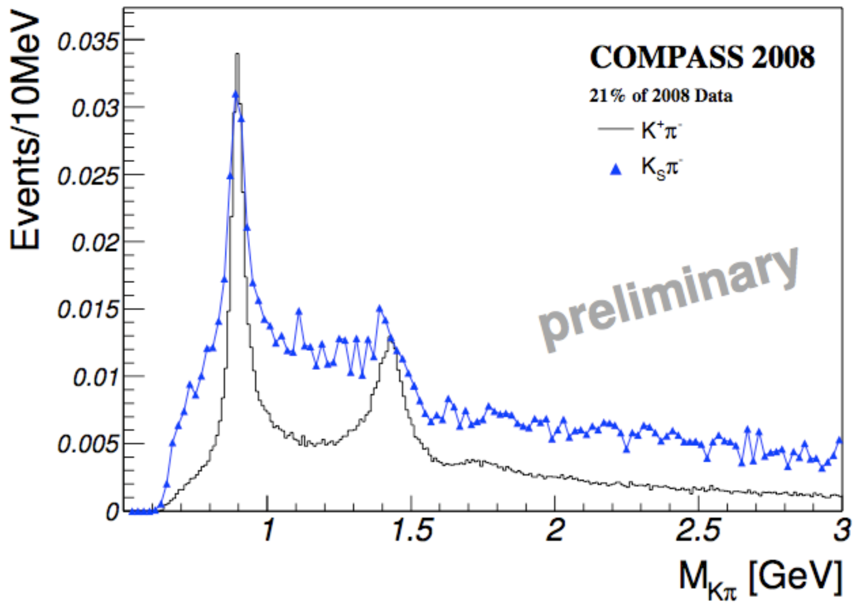




- Observed resonances
  - K*(892)
  - $K^*_2(1430)$ (Possible admixture of $K^*_0(1430)$ and K*(1410))
  - Peak around 1.7 GeV could be due to K*(1680) or $K^*_3(1780)$
- COMPASS allows the comparison of invariant mass spectra for hadron and muon beam data

Comparison of the Kaonic Channels

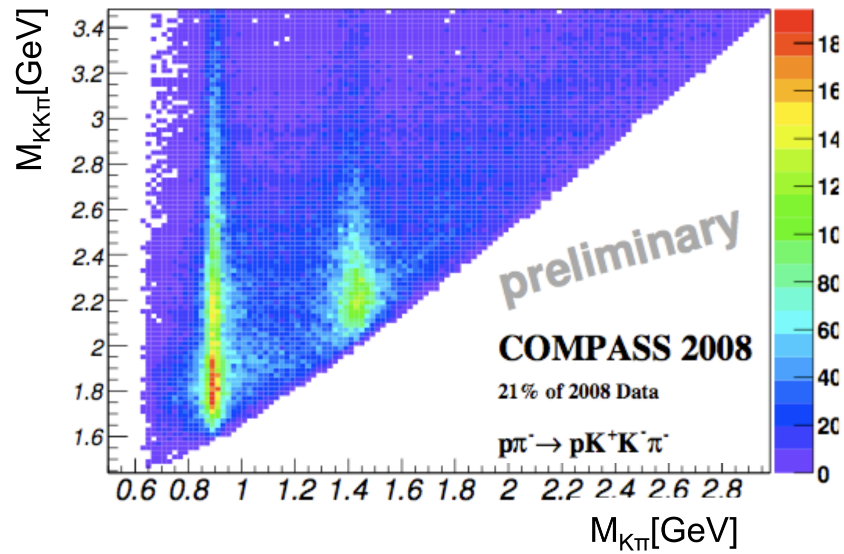




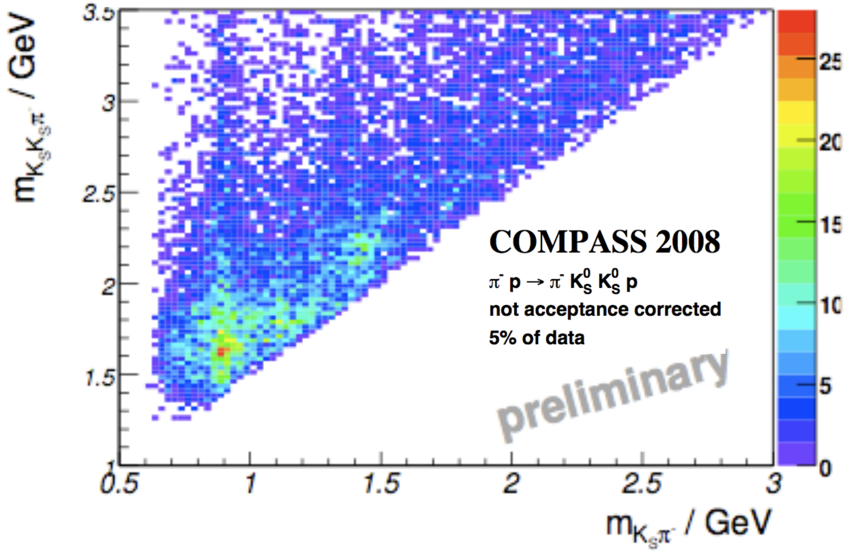
- Very nice similarity between invariant mass spectra of neutral and charged kaonic decay channels
- Differences can be explained by
  - Different allowed quantum numbers
  - Selection affects different phase-space regions and hence different production mechanisms

Search for K* decay resonances

Charged kaonic channel



Neutral kaonic channel



- Search for resonances which decay into πK*
  - Similar structure (factor 3 difference in statistics – full 2008 analysis for both channels expected soon)
- Promising peaks at 1.8GeV and 2.2GeV under further study

Conclusion and Outlook

- Kaonic channel looks promising
  - Clean signature of a large variety of resonances in the charged and neutral decay channel
  - We will have unprecedented statistics for both channels at the COMPASS hadron run
- Nice agreement between charged and neutral decay channel
  - acceptance issues are fairly different due to particle selection
- need to repeat analysis with proton beam
- Partial Wave Analysis will start soon