Study of central production of charged pionic modes at COMPASS - Status

XIII International Conference on Hadron Spectroscopy

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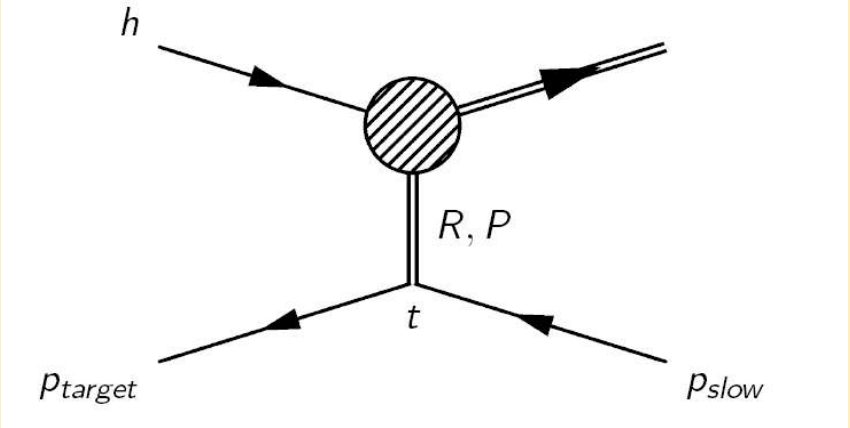
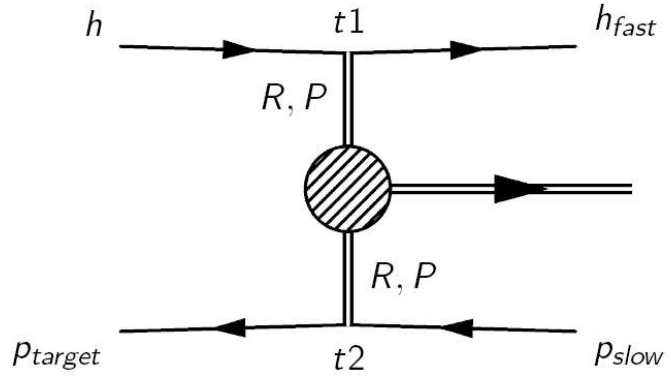
Outline

Introduction

Diffractive Scattering:



Central Production:



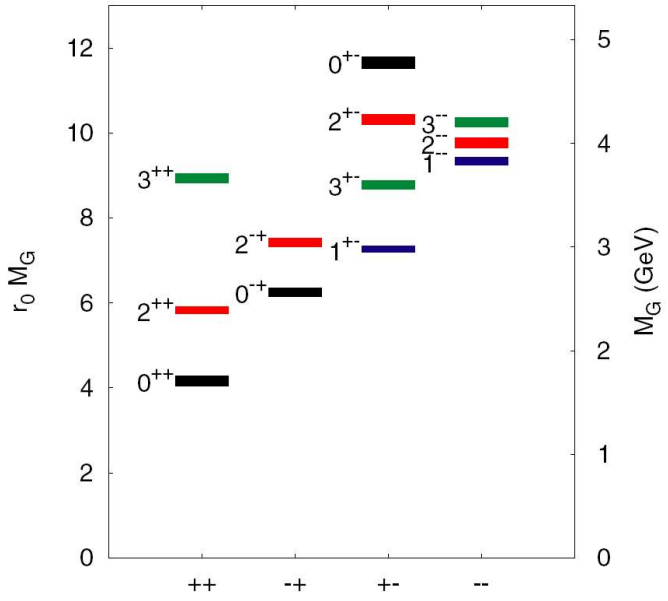
Context: Definition of Central Production

- Original definition, **not only** Double-Pomeron-Exchange
- formation of resonances at central rapidities

CP of charged pionic modes (e.g. $\pi^-\pi^+\pi^-\pi^+$)

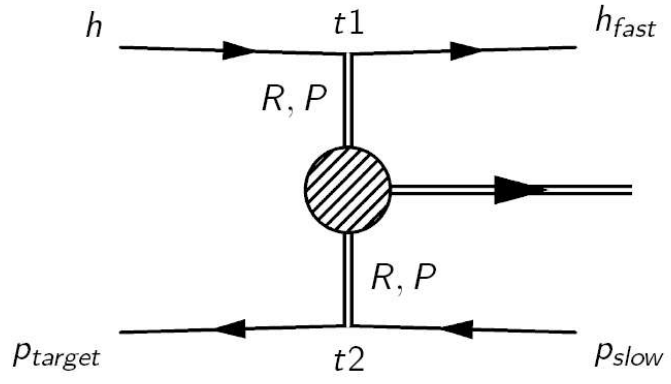
$\rightarrow$ well suited for the search for scalar and tensor glueballs
f_0 family of resonances most interesting to study

Introduction



Y. Chen et al., Phys. Rev. D 73, 014516 (2006)

Central Production:



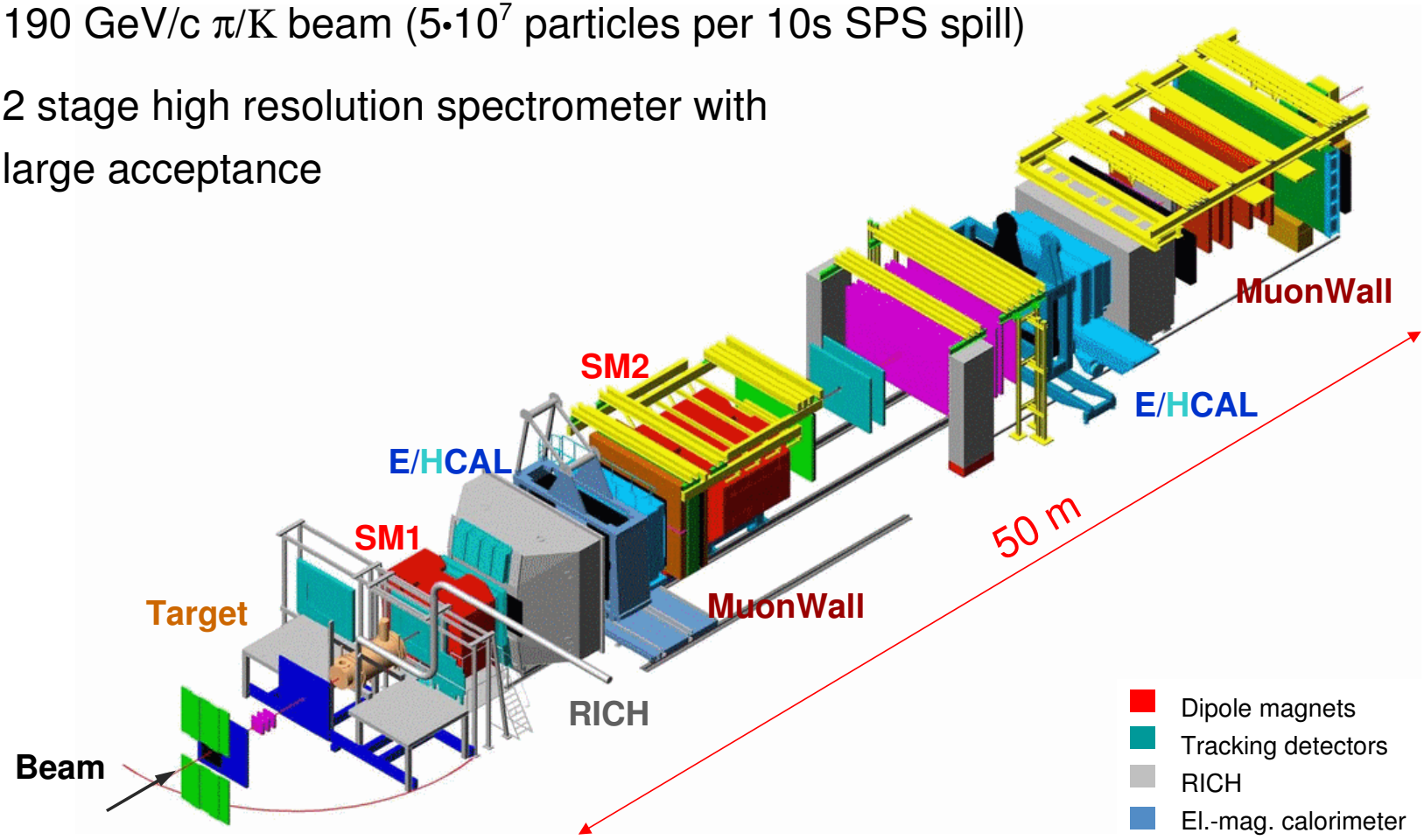
Some examples of central production studies with 4π final states

- F. Binon et al. GAMS Collaboration. *Nuovo Cimento*, 78, 1983
- S. Abatzis et al. WA91 Collaboration. Phys.Lett.**B** 324, 1994
- F. Antinori et al. WA102 Collaboration, Phys.Lett.**B** 353, 1995
- C. Amsler et al. Crystal Barrel Collaboration. Phys.Lett.**B** 380, 1996

The COMPASS spectrometer

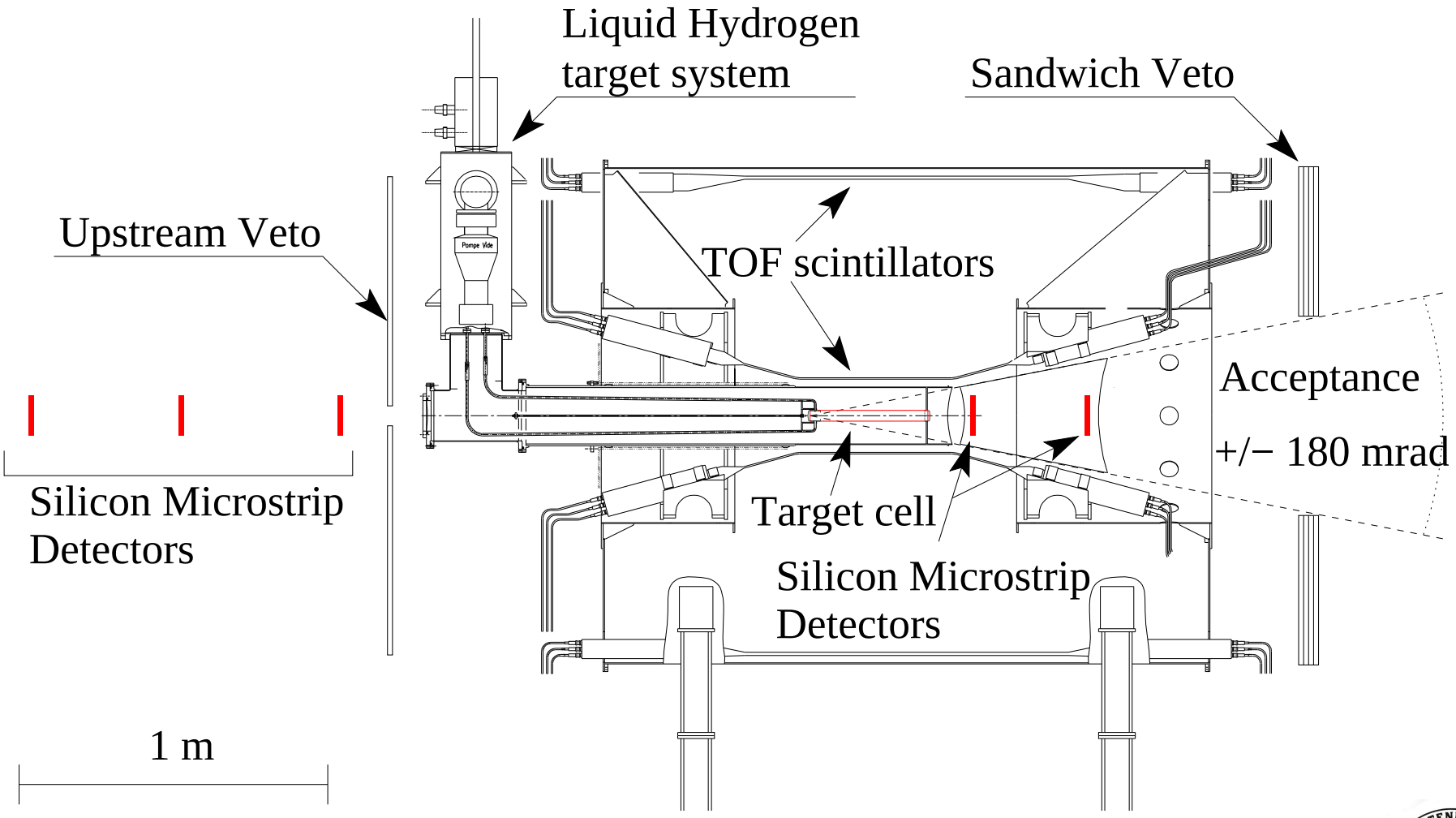
190 GeV/c π/K beam ($5 \cdot 10^7$ particles per 10s SPS spill)

2 stage high resolution spectrometer with large acceptance



[hep-ex/0703049, NIM A 577, 455 (2007)]

Target Zone

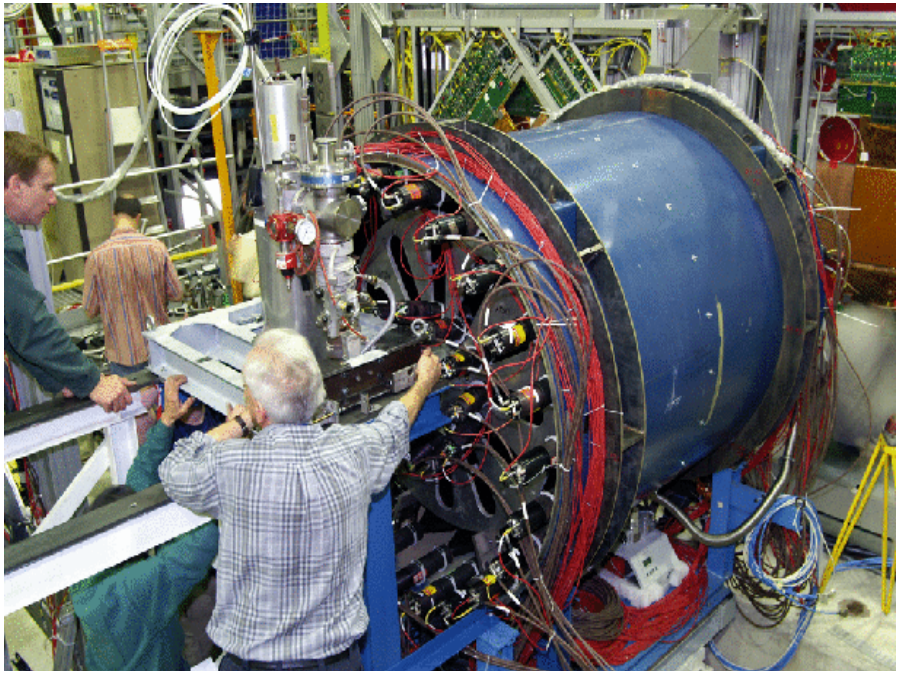


- 40cm lH_2 target

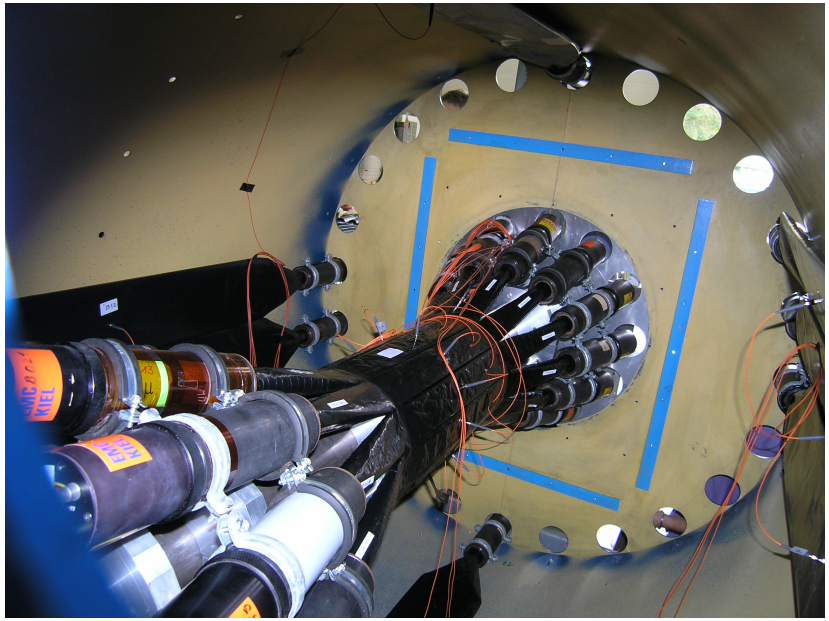
Recoil Proton Detector

Function:

1. fast **trigger** on recoil proton
2. Proton **PID** via TOF and dE/dx measurement



Recoil Proton Detector

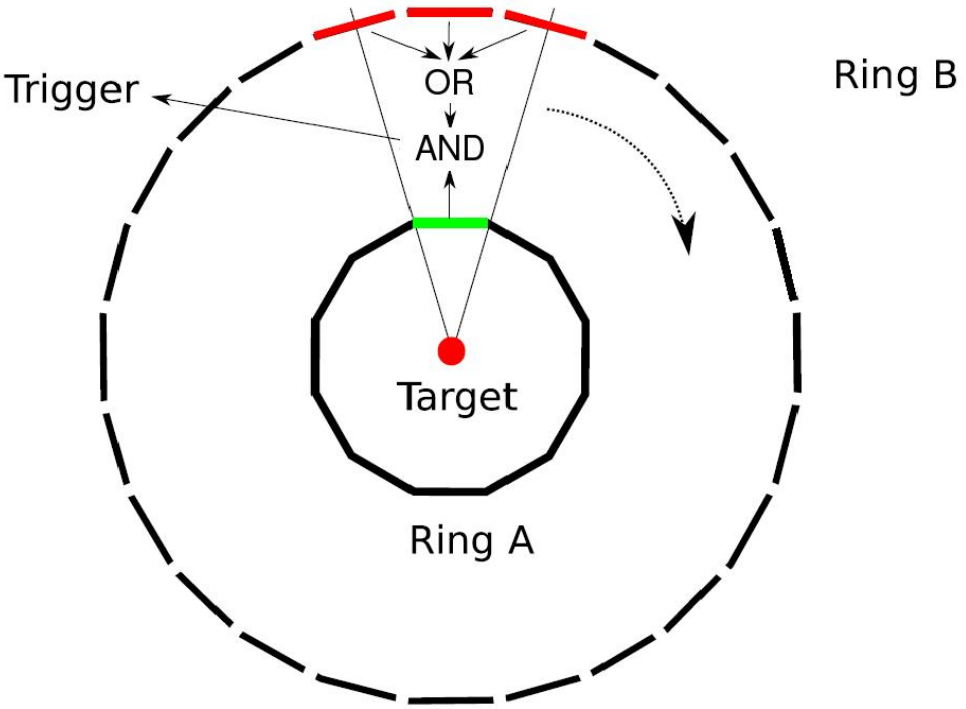


RPD during its assembly

- small e^- and π^- background
- time resolution $\sigma < 350\,\text{ps}$

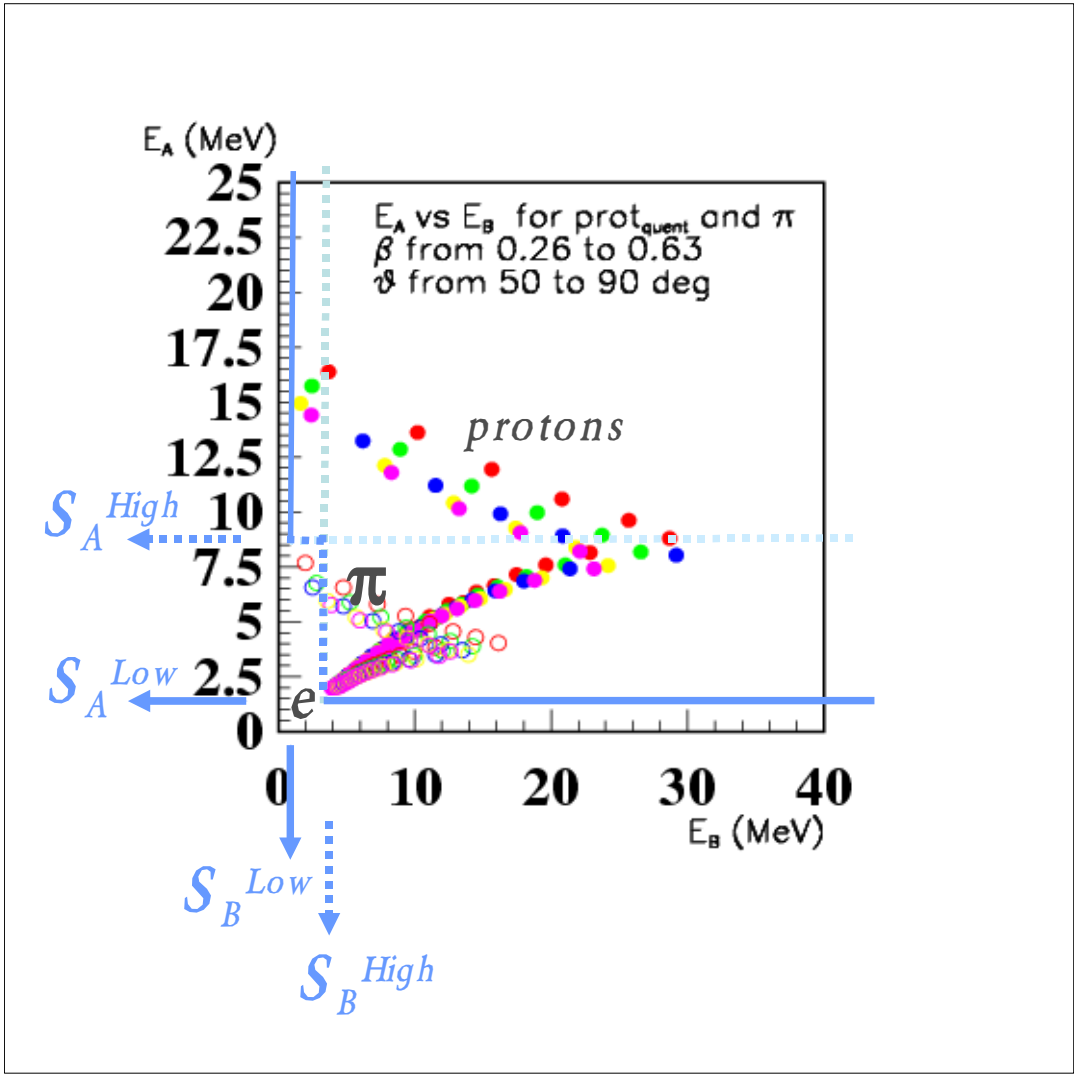
- layout: 2 cylindrical layers of scintillators ($r_1 = 120\,\text{mm}$ and $r_2 = 775\,\text{mm}$ surrounding the target)
- inner ring w/ 12 scintillator slabs (5 mm x 500 mm BC404, U Mainz)
- outer ring w/ 24 scintillator slabs (10 mm x 1080 mm, IHEP Protvino)
- large dynamical range of the signals due to small attenuation length ($\lambda_{eff} \approx 70\,\text{cm}$)

Proton Trigger



- no 2nd level trigger, so *fast*, *efficient* and *pure* trigger necessary
- trigger on slow recoil proton with RPD
- coincidence of one ring A element and one out of three possible ring B elements

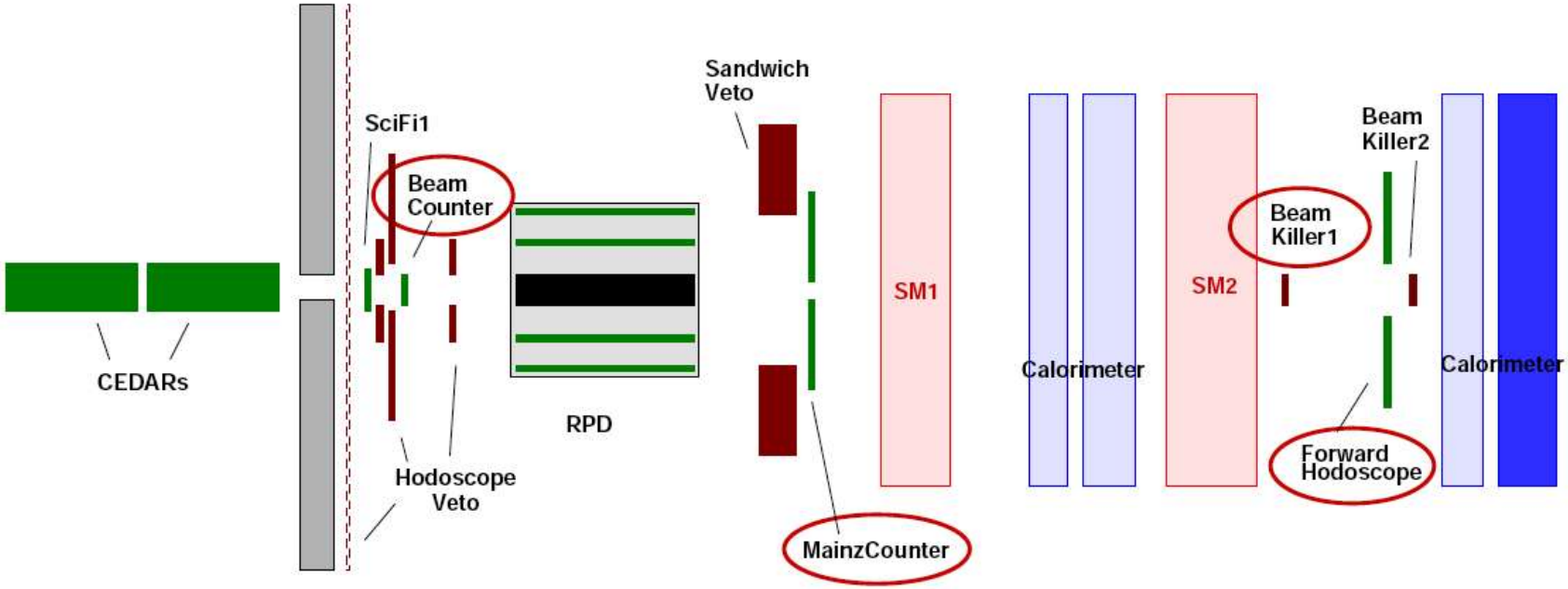
Proton Trigger



calculated energy losses in both rings for different incident angles and particles

- identify proton by TOF and dE/dx meas. (with thresholds to cut out e^- and $\pi^\pm$)

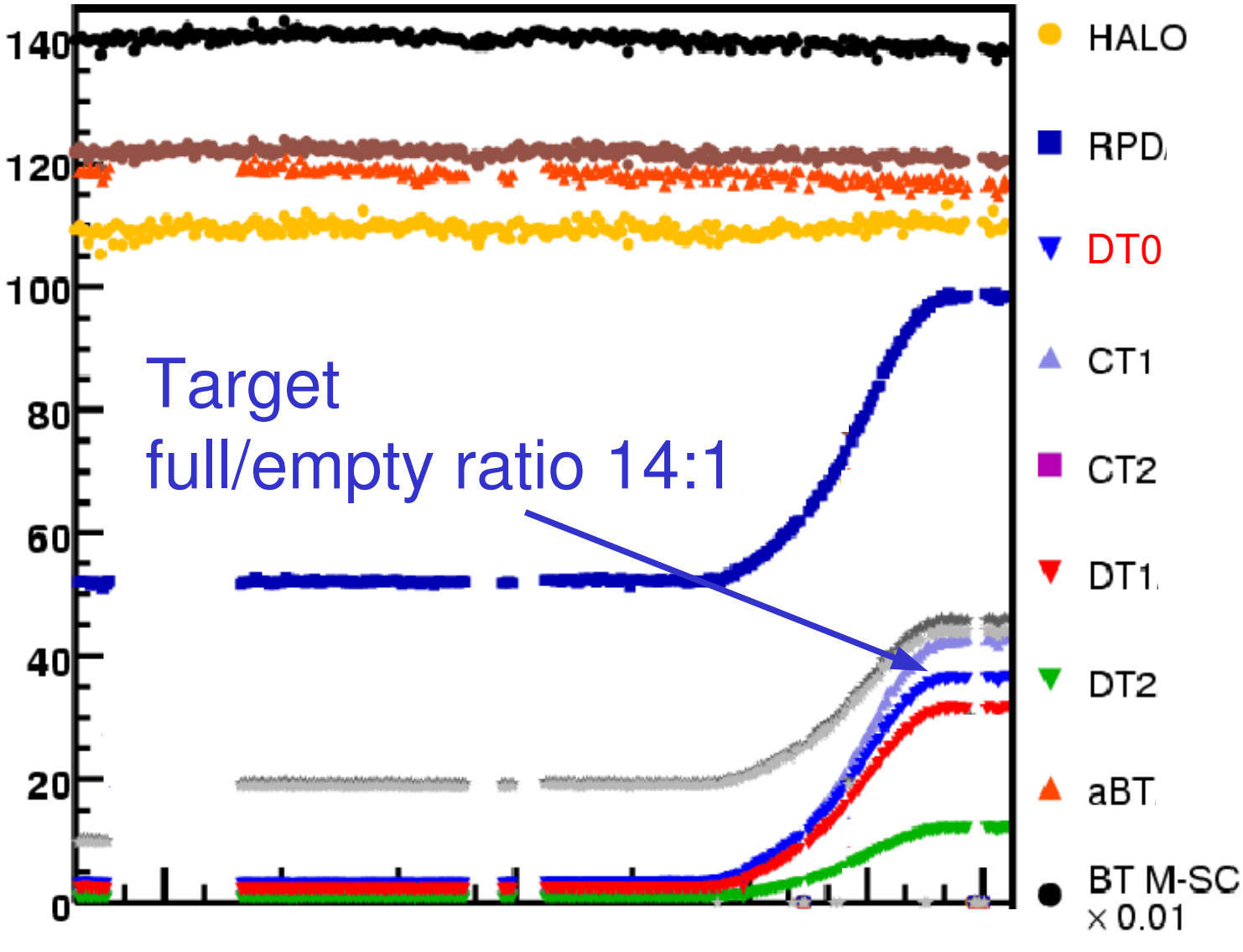
Physics Trigger



1. **Beam Definition:** Beamtrigger
2. **Target Pointing:** Proton Trigger
3. **Vetos**

Physics Trigger DT0 = Beamtrigger $\wedge$ RPD $\wedge$!(Vetos)

Physics Trigger - Empty/Full Target Effect



Event Selection

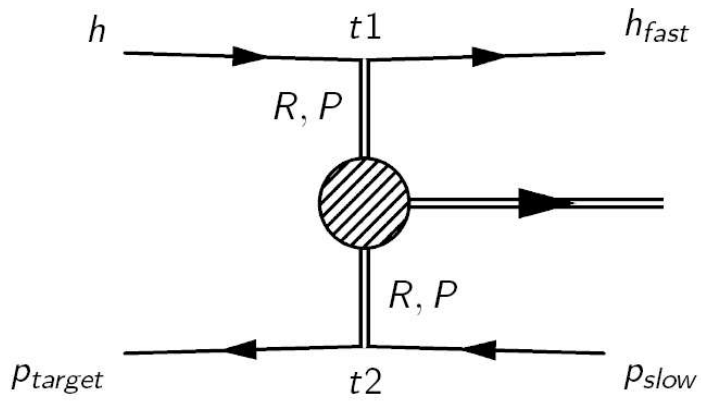
Compass 2008 Run (shown here: 13% of 2008 data)

$\pi^- p \rightarrow \pi^-_{fast}(\pi^+\pi^-\pi^+\pi^-)p_{recoil}$

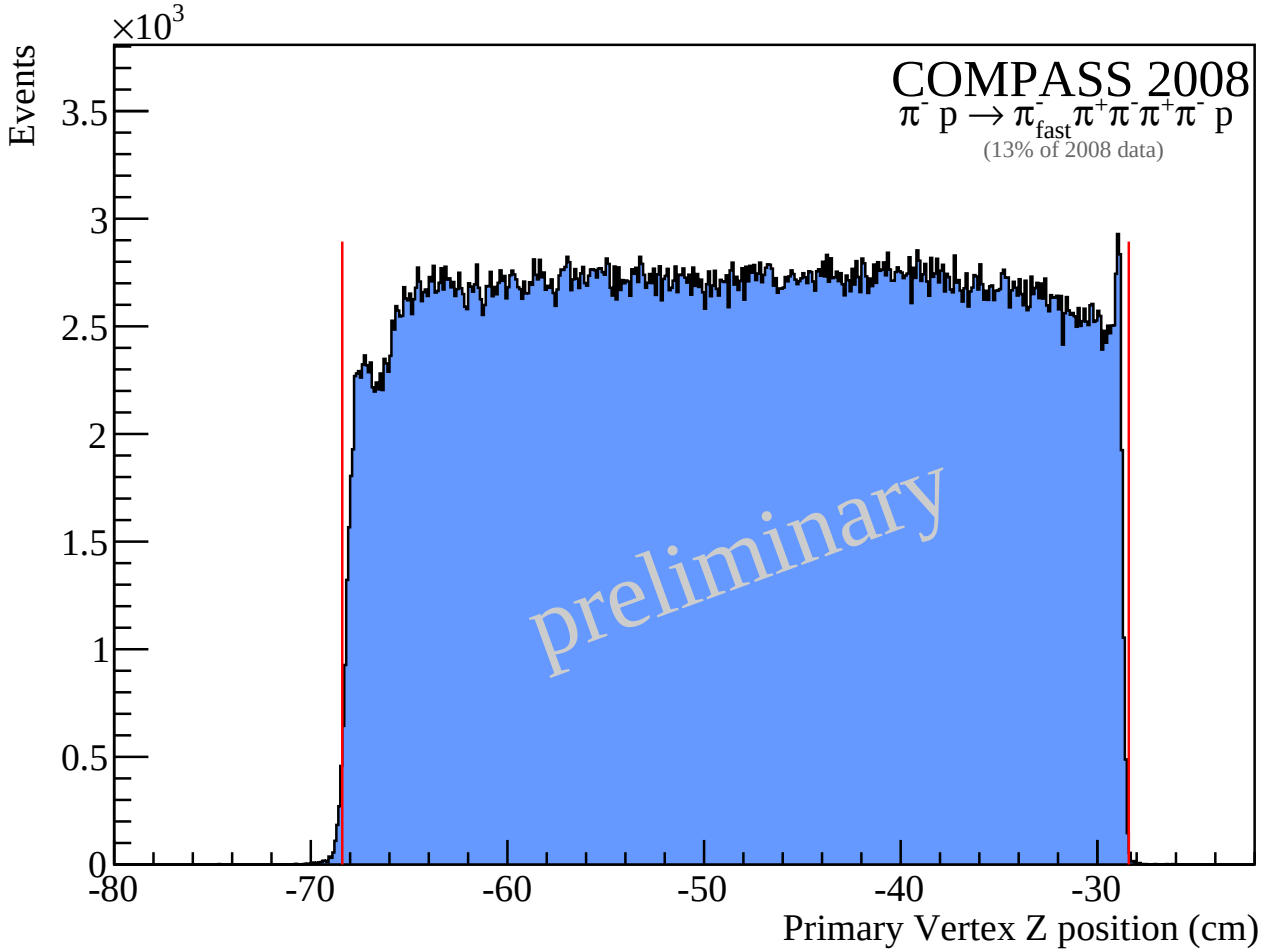
Cuts:

Cut	%
-no-	100
1 Primary Vertex	67.9
DT0 Trigger	58.4
5 Outgoing Charged Tracks	3.52
PV in Target	3.51
CEDAR Kaon Veto	3.46
Charge Conservation $\Sigma Q = -1$	2.52
Exclusivity (190 ± 5) GeV	0.27
$Q_{fast} = -1$	0.18

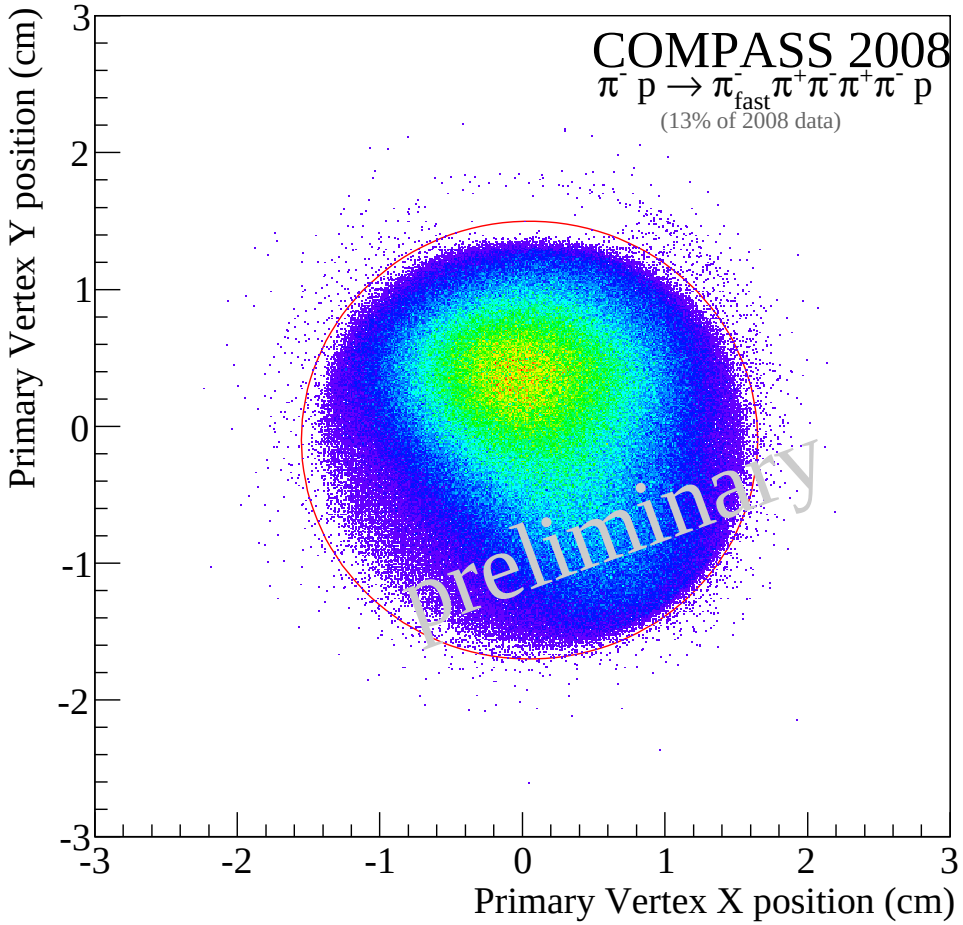
Central Production:



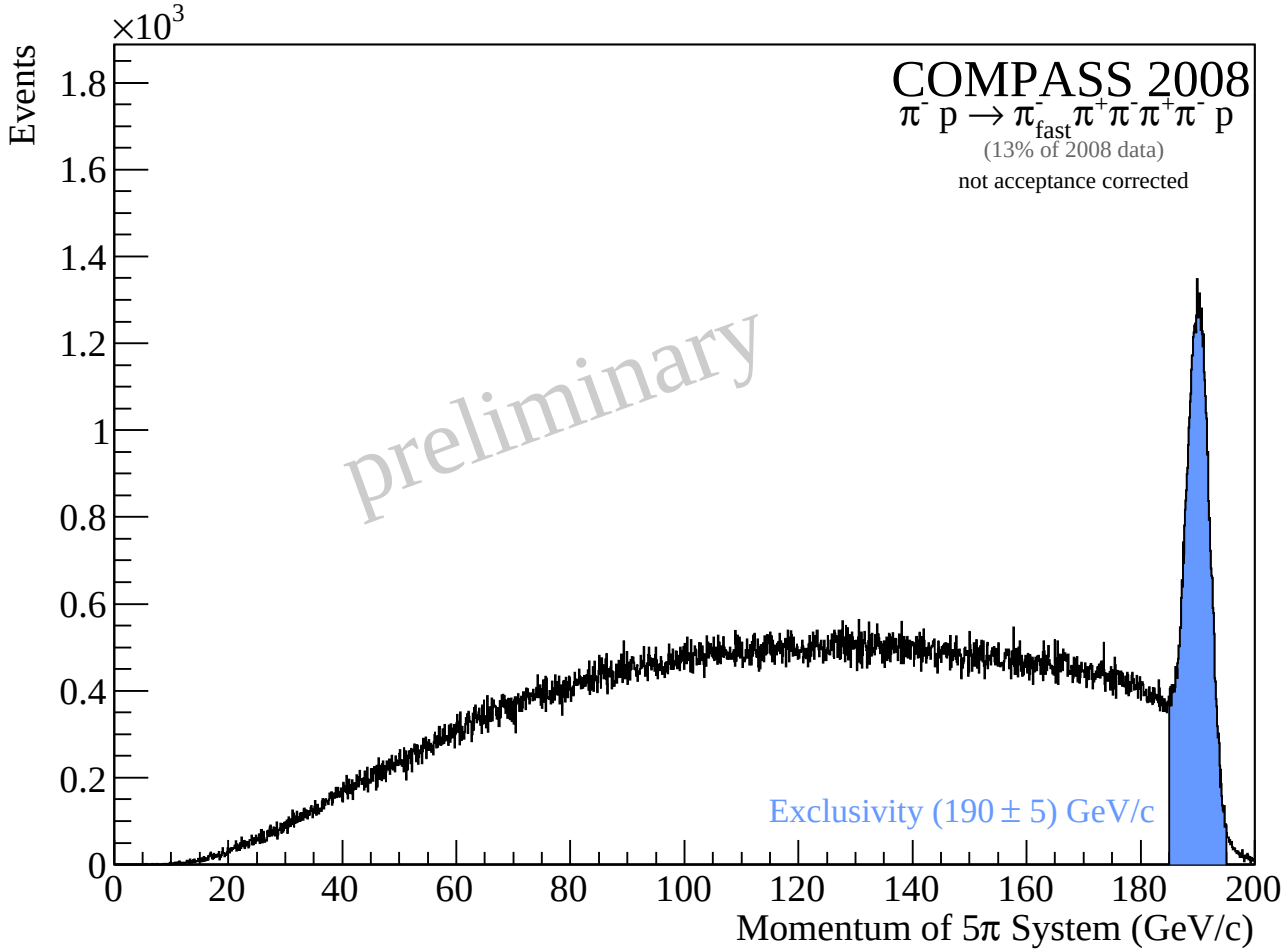
Vertex Distribution in Z (beam) direction



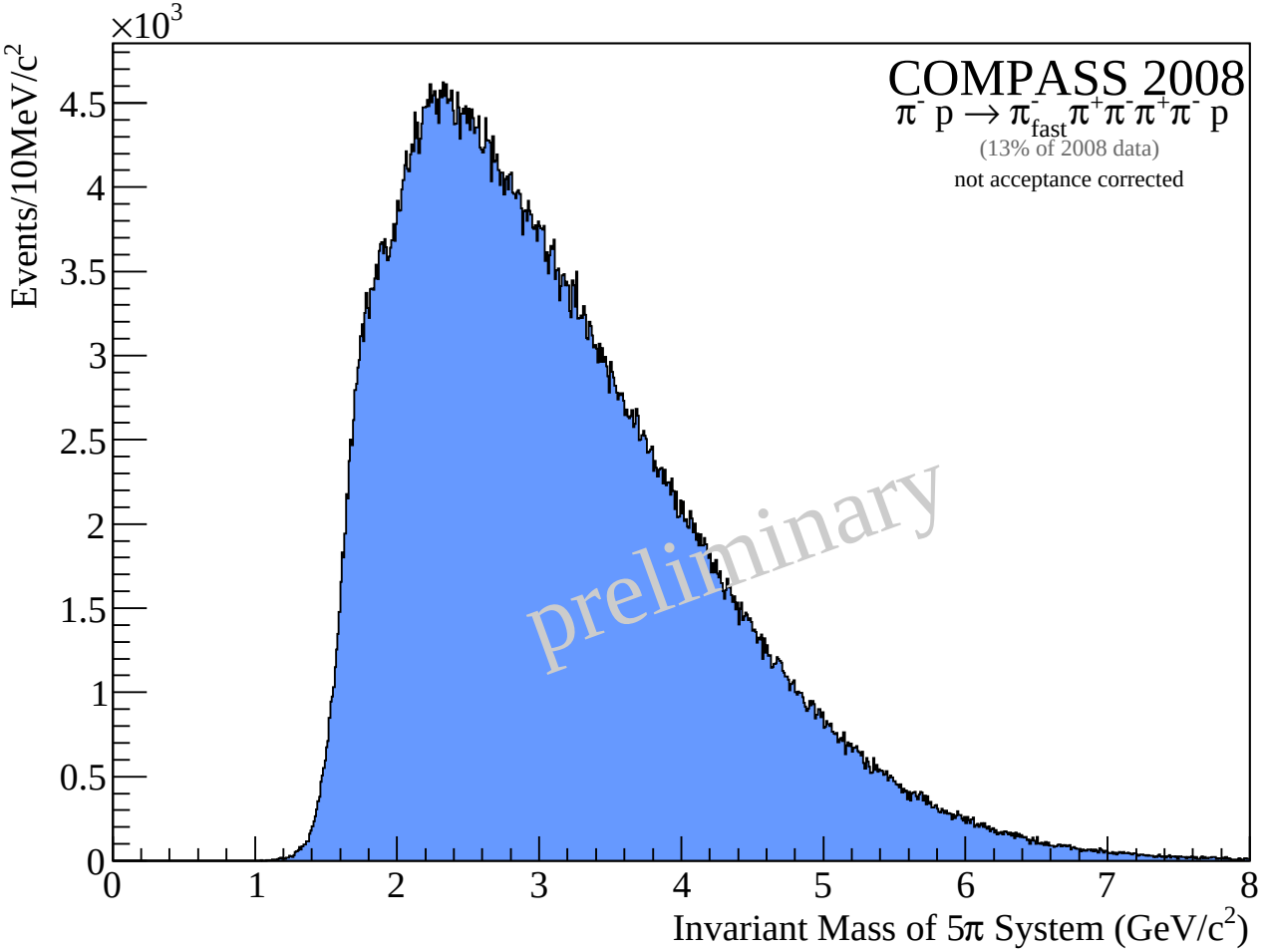
Vertex Distribution in XY-Plane



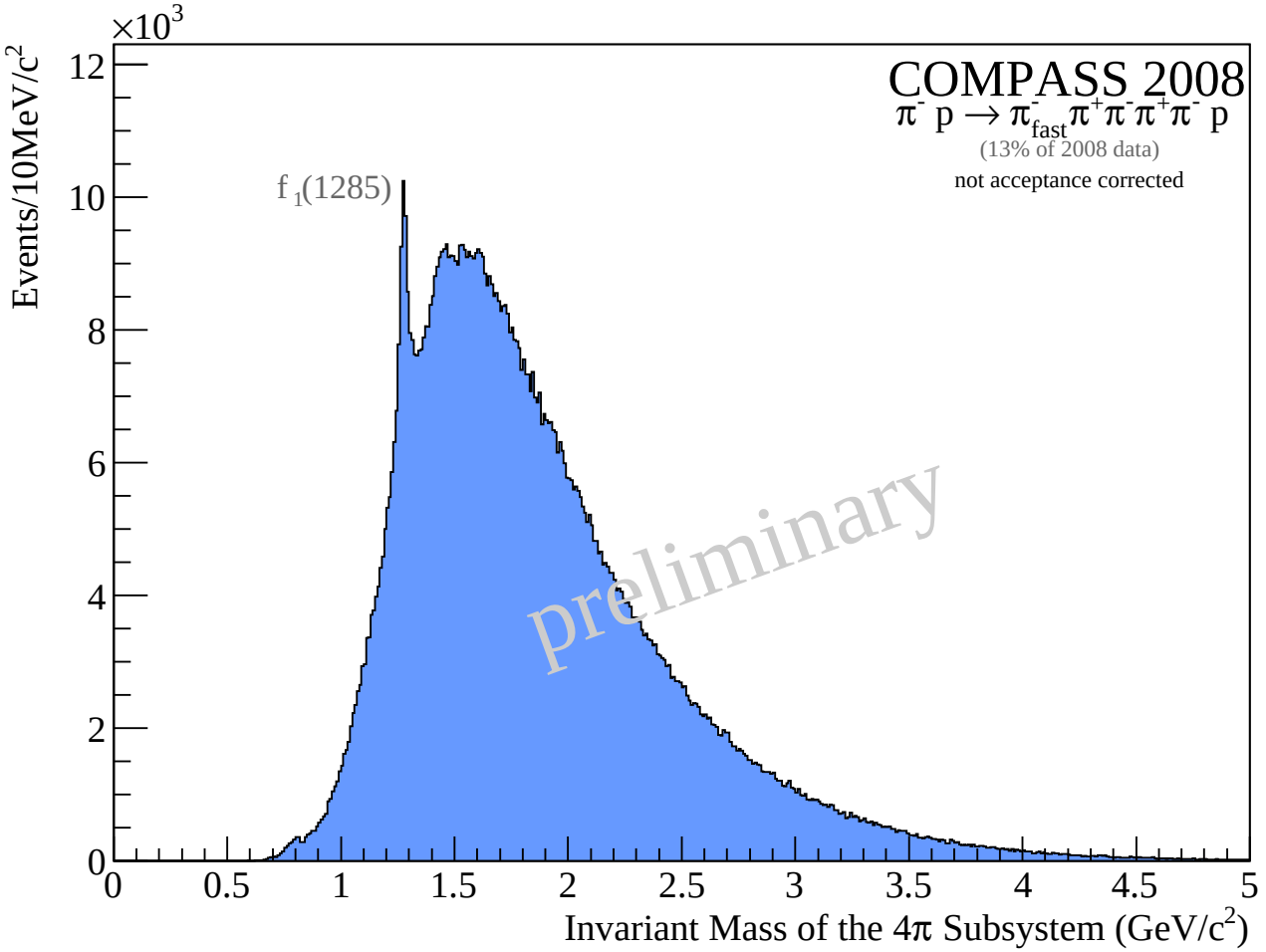
Exclusivity



Invariant Mass Distribution (5π)



Invariant Mass of 4π System

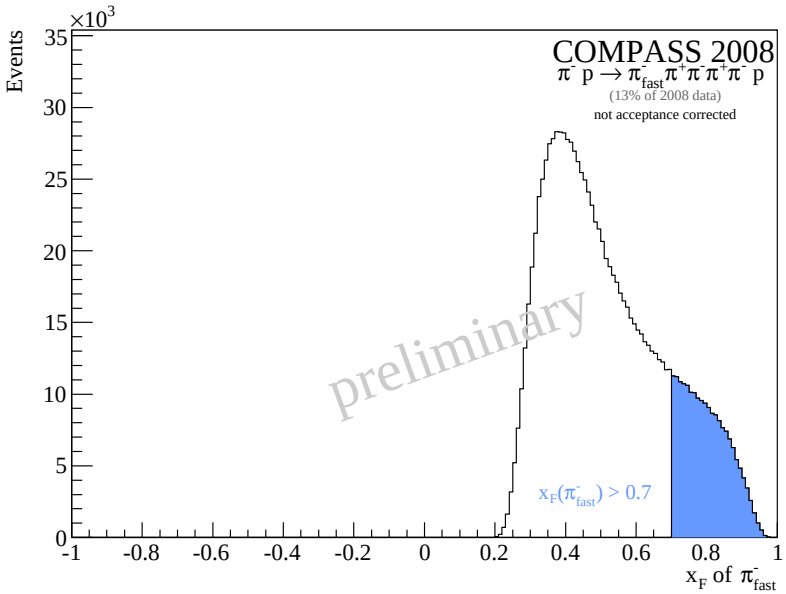


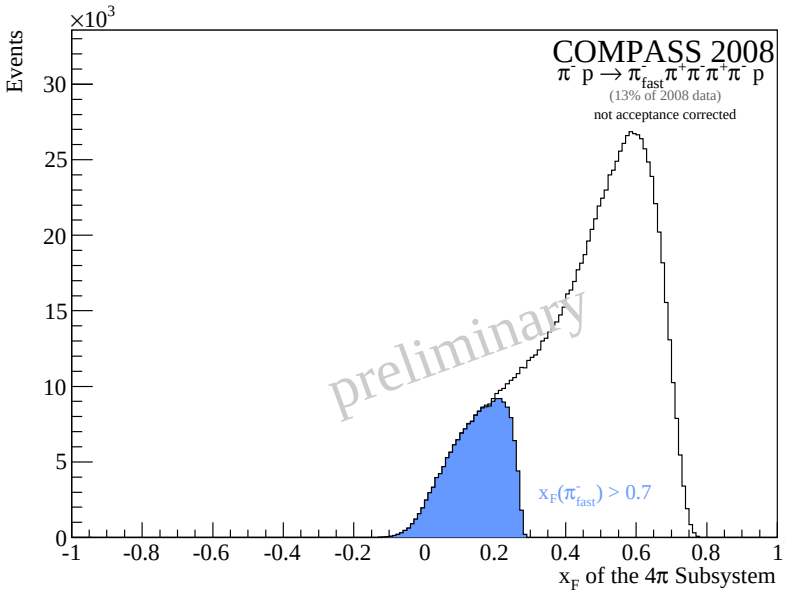
Enhancement of CP events: xF

One Approach to Select CP: Feynman x_F

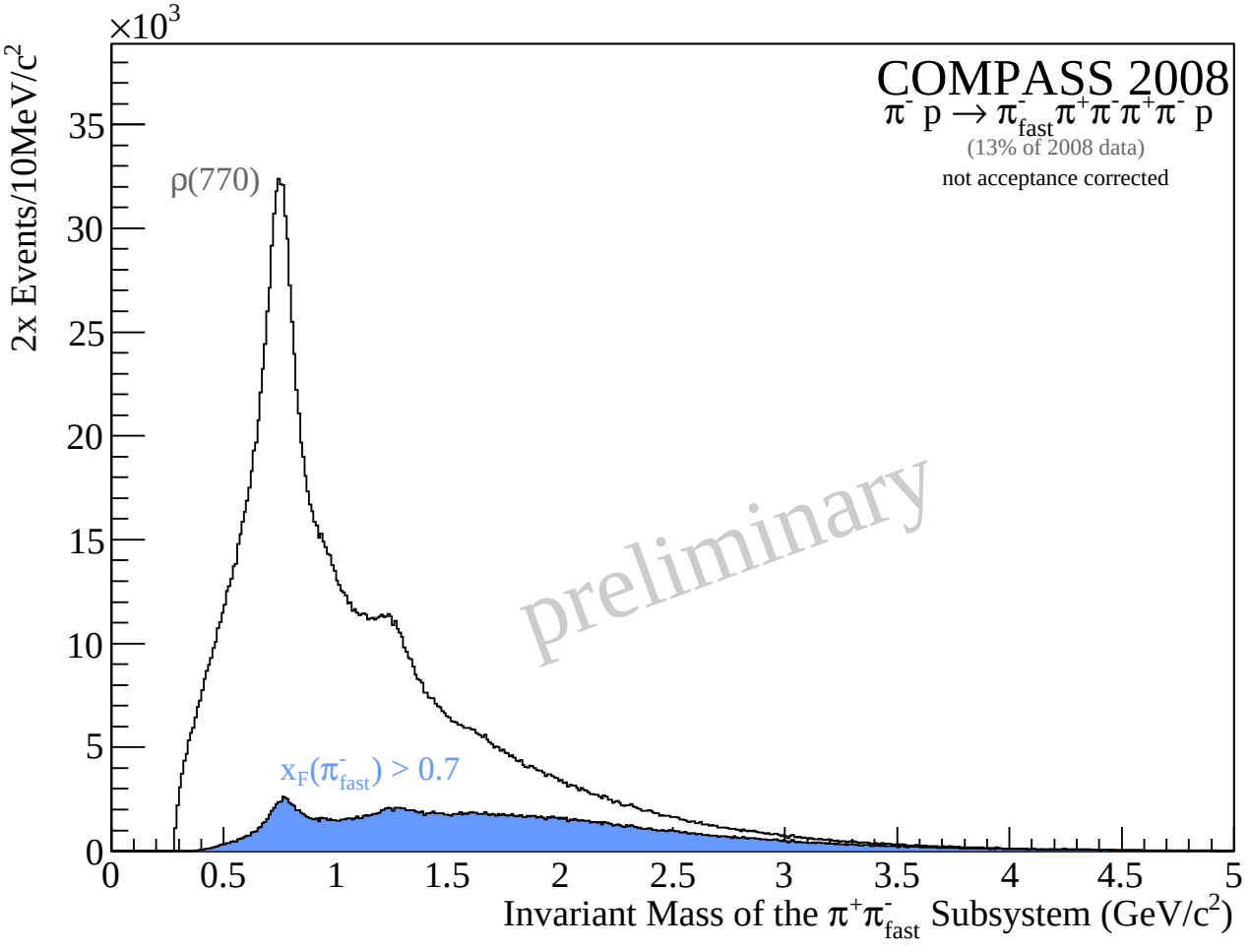
$$x_F = \frac{|\vec{p}_l|}{|\vec{p}_l^{\,max}|} = \frac{2\,|\vec{p}_l|}{\sqrt{s}},$$

- $|\vec{p}_l|$: longitudinal momentum
- $\sqrt{s}$: total center-of-mass energy of the interaction
- $|\vec{p}_l^{\,max}|$: the maximum allowed longitudinal momentum

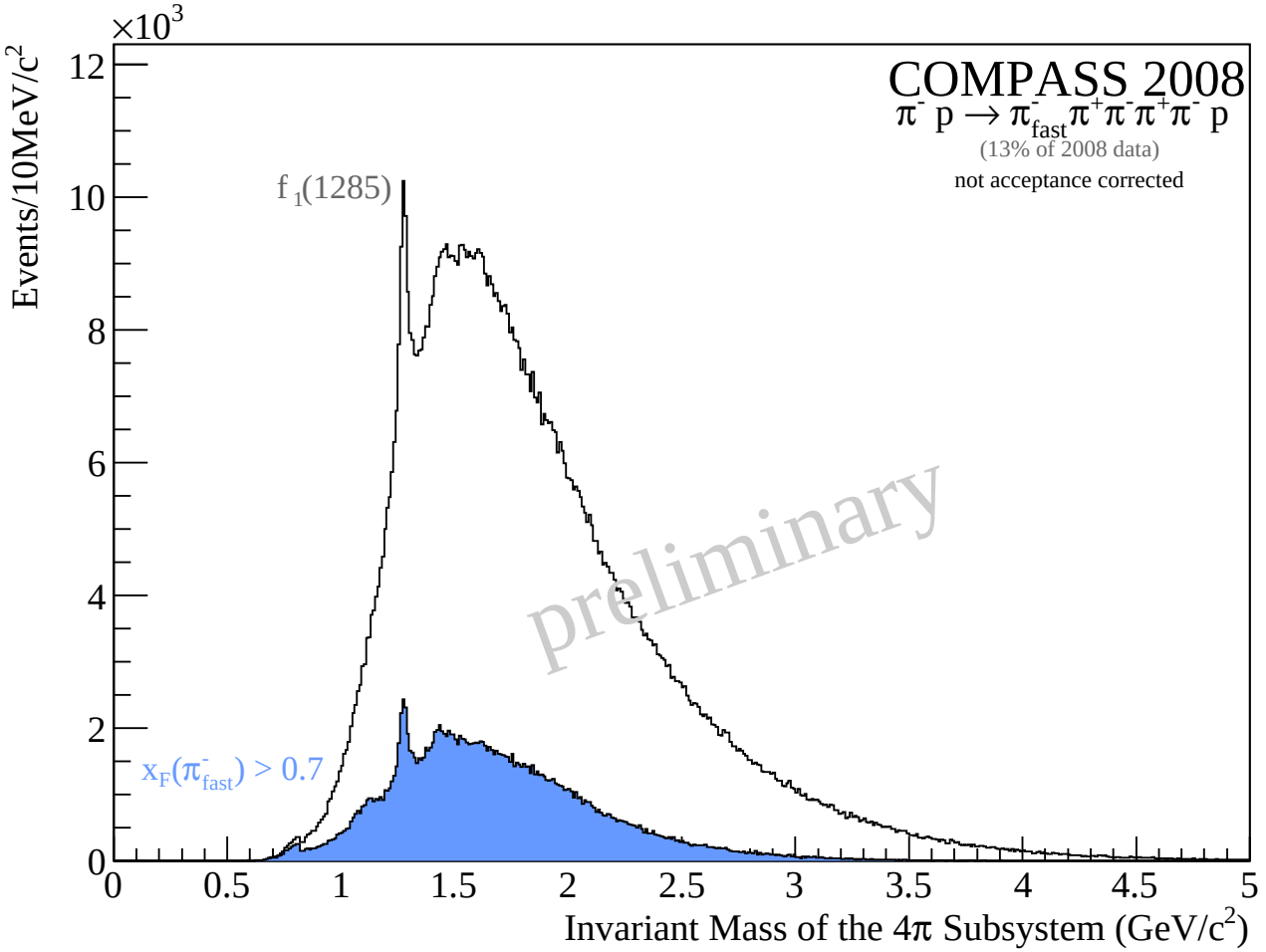




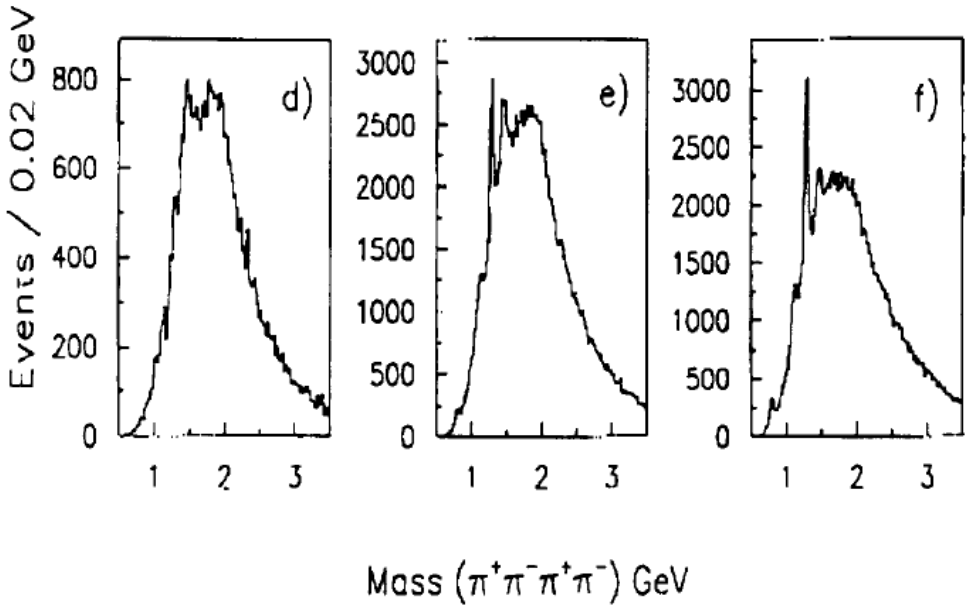
Invariant Mass of 2π System with π^-_{fast}

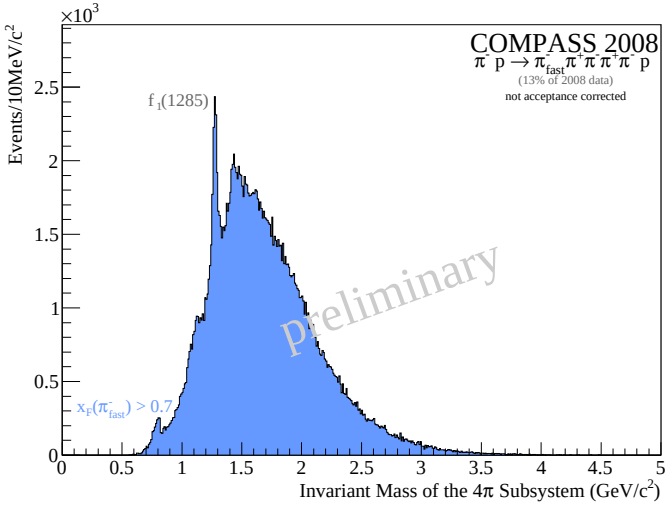


Invariant Mass of 4π System



Invariant Mass of 4π System





WA102:

d) $dPt < 0.2$ GeV

e) 0.2 GeV $< dPt < 0.5$ GeV

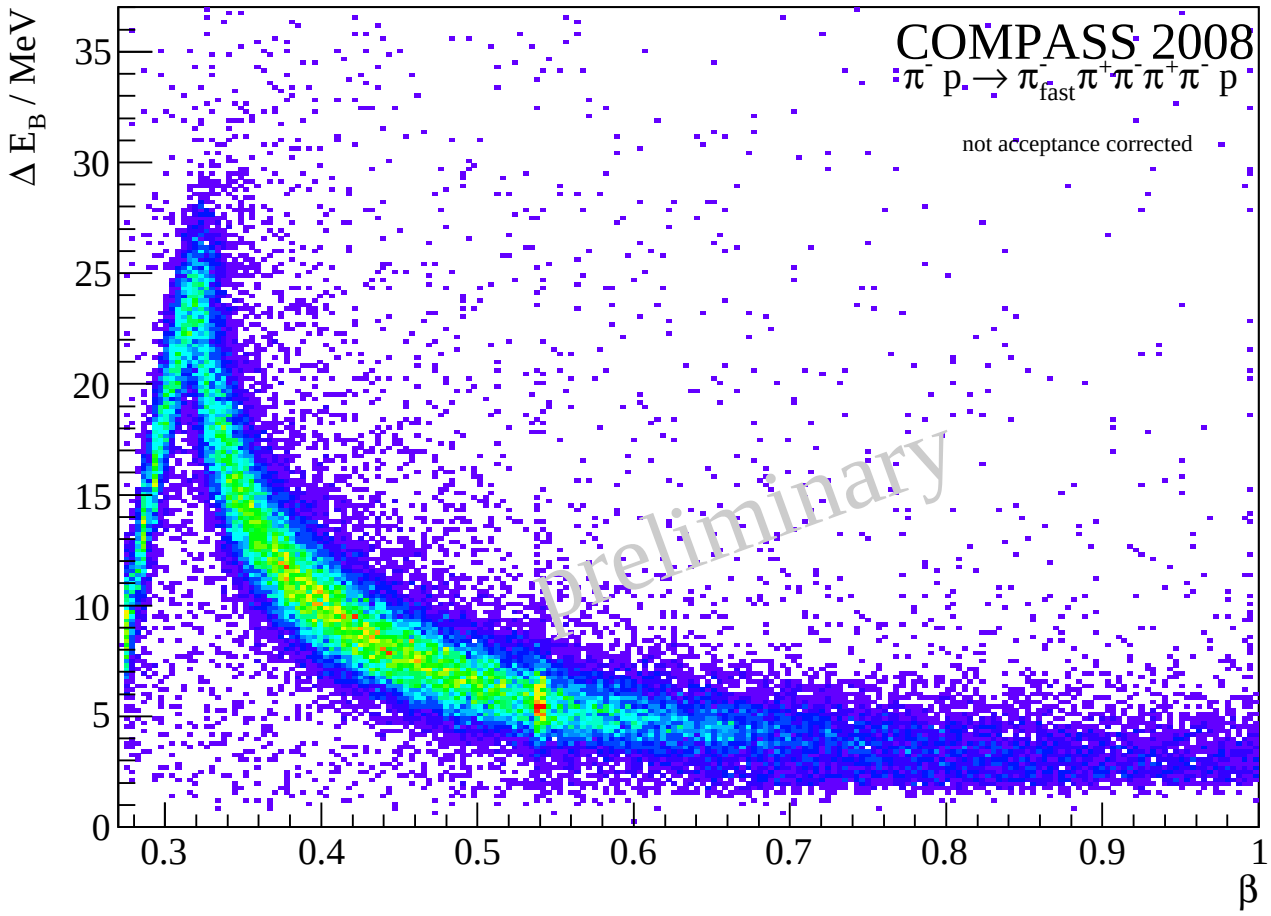
f) $dPt > 0.5$ GeV

COMPASS: all dPt up to now, binning in dPt with the full data set to come

RPD information

RPD not only used in the trigger, but also in the offline analysis:

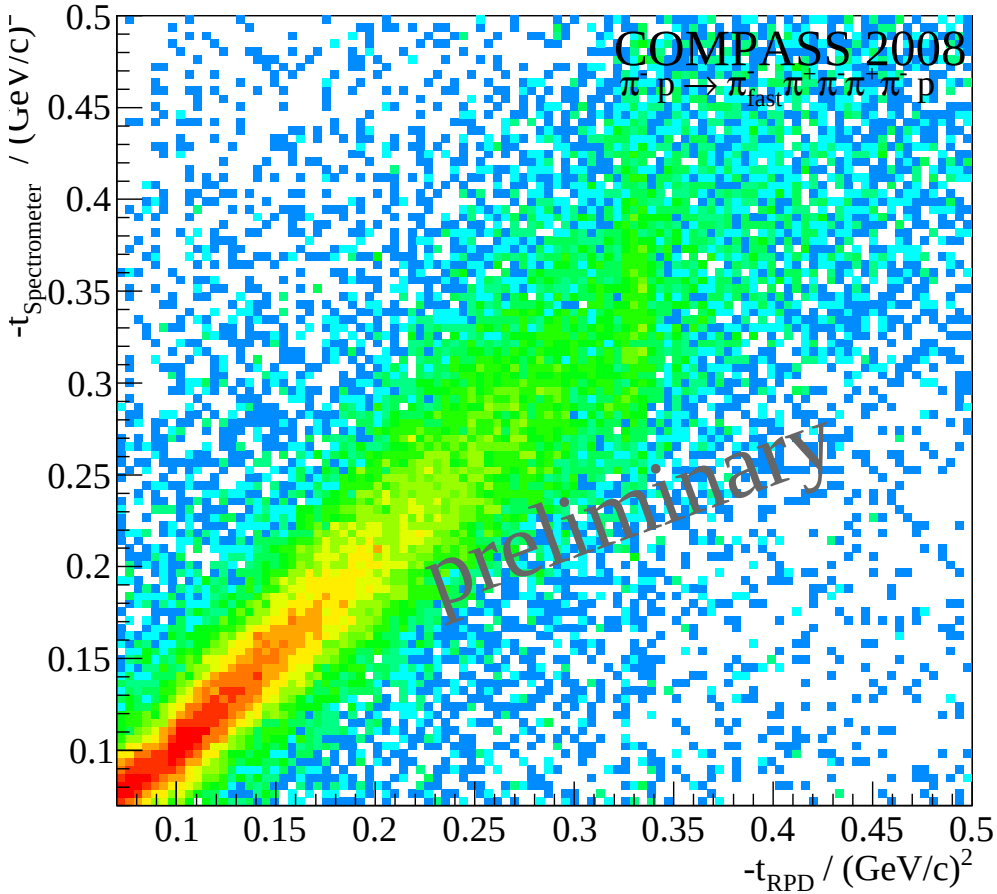
- measures TOF and $dE/dx \rightarrow$ recoil particle momentum and PID



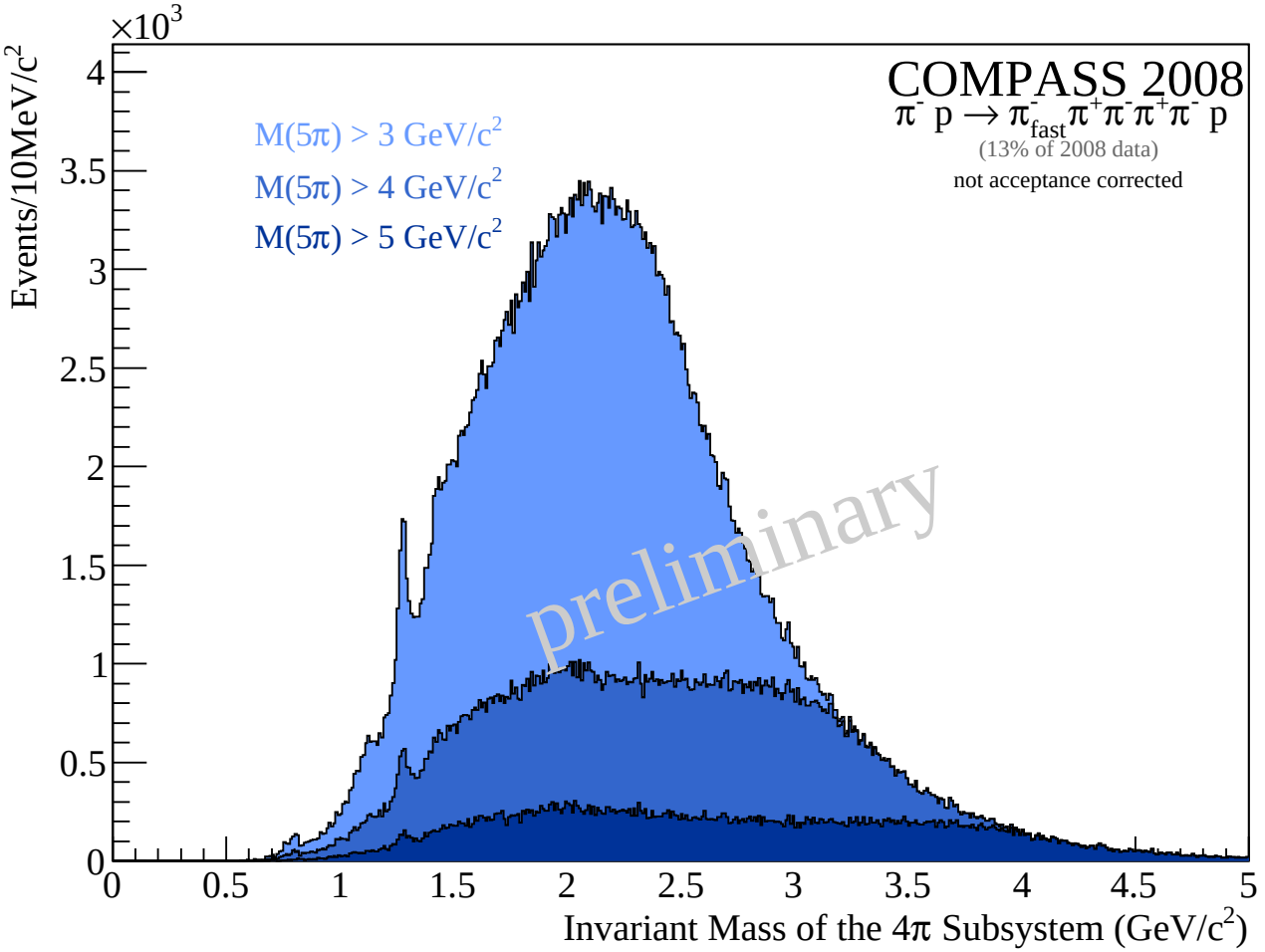
RPD information

RPD not only used in the trigger, but also in the offline analysis:

- measures TOF and $dE/dx \rightarrow$ recoil particle momentum and PID
- information on both t_1 and t_2

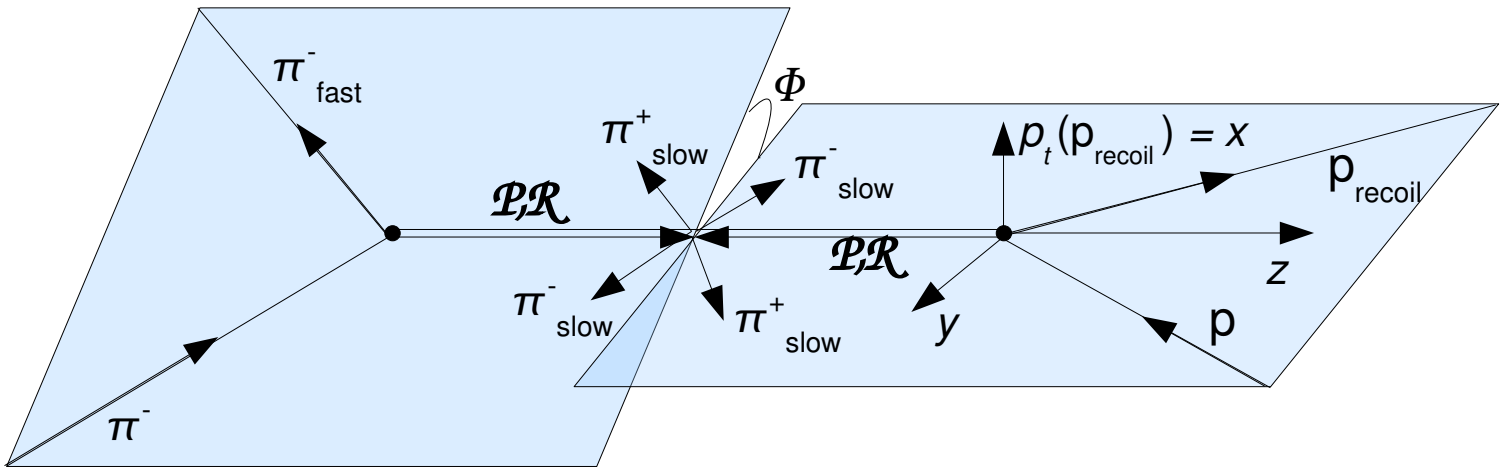


Different Approach: Cut on M(5π)



Preparing the PWA

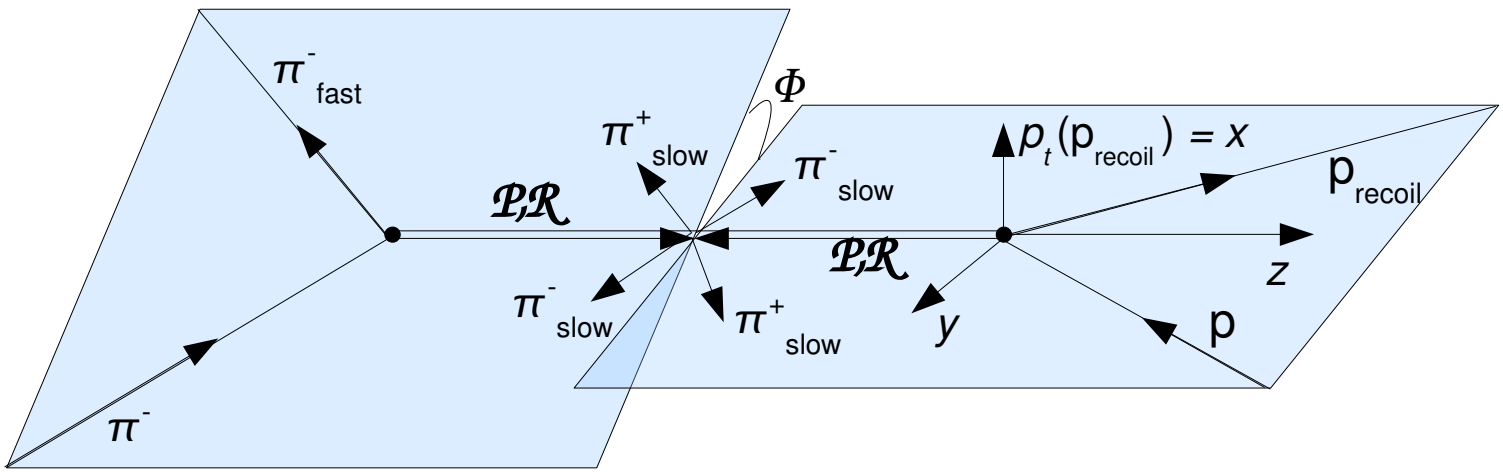
Partial Wave Analysis under preparation (with D.Ryabchikov)



- z in direction of the two Pomerons/Reggeons
- x as the transverse (p_t) component of the recoil particle momentum in the scattering plane
- y perpendicular to x and z (normal to the recoil scattering plane)

Preparing the PWA

Partial Wave Analysis under preparation (with D.Ryabchikov)



cf. Kaidalov et al. *Eur.Phys.J* **C** 31, 387-396 (2003)
First attempt of PWA performed just last week, $f_1(1285)$ could be reproduced well, results too preliminary

Summary and Outlook

- A first glance at centrally produced events was presented alongside a short overview over the RPD and Trigger
- ideas for central production cuts under investigation
- mass spectra compared to former experiments
- only a few days of 2008 data taking (13%) used yet in the analysis, 2009 proton data also to be included
- Partial Wave Analysis results not yet shown, but on the way

Next steps:

1. acceptance correction
2. study possibility of kinematic fitting with RPD information
3. investigate further kinematical cuts (glueball filter)
4. include both central and diffractive mechanisms in the PWA
5. develop formalisms for PWA further (comments welcome)