The COMPASS Recoil Proton Detector

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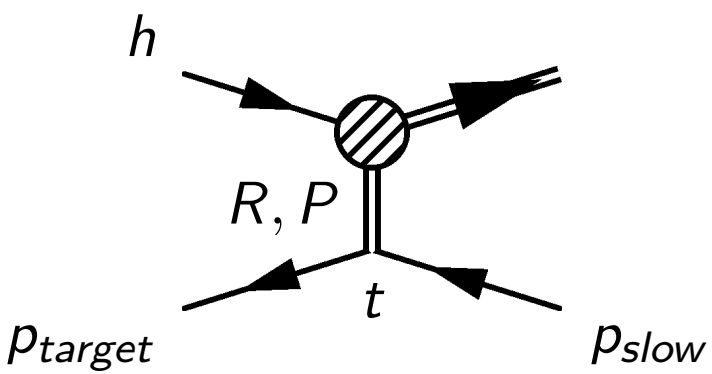
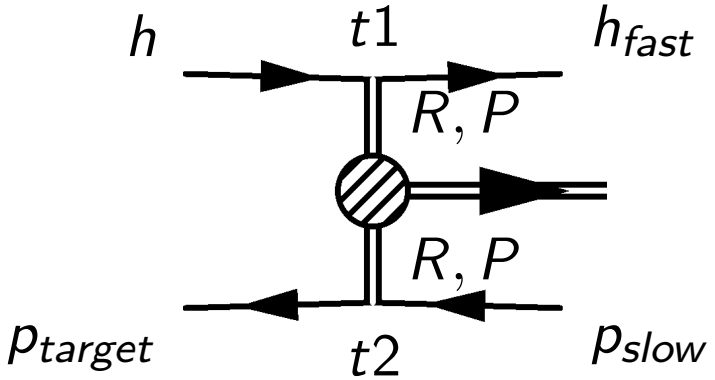
Motivation

Investigation of exotic meson production as well as the search for glueballs
Compass = production experiment, i.e. t-channel production mechanisms:

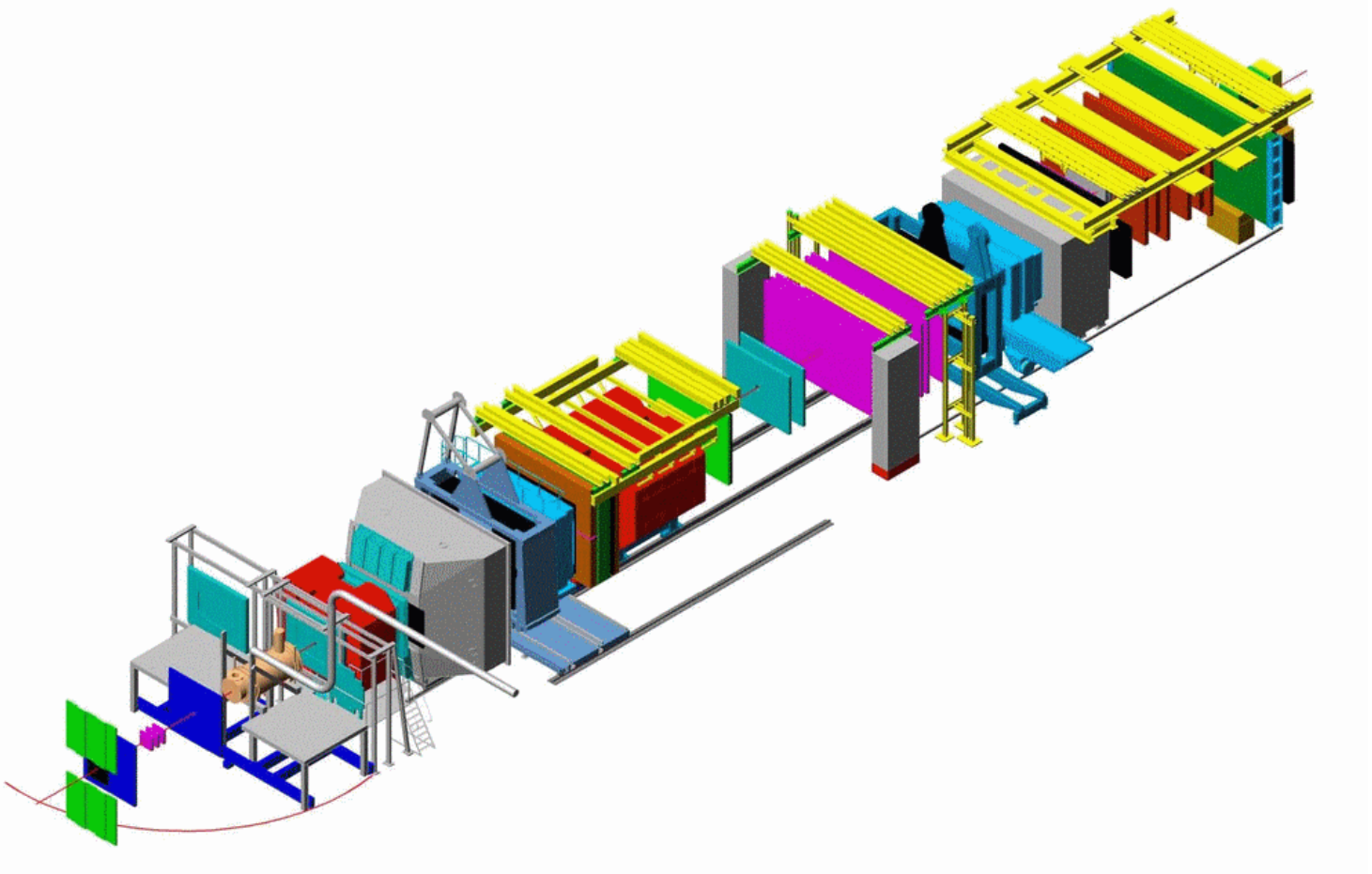
diffractive scattering and central production



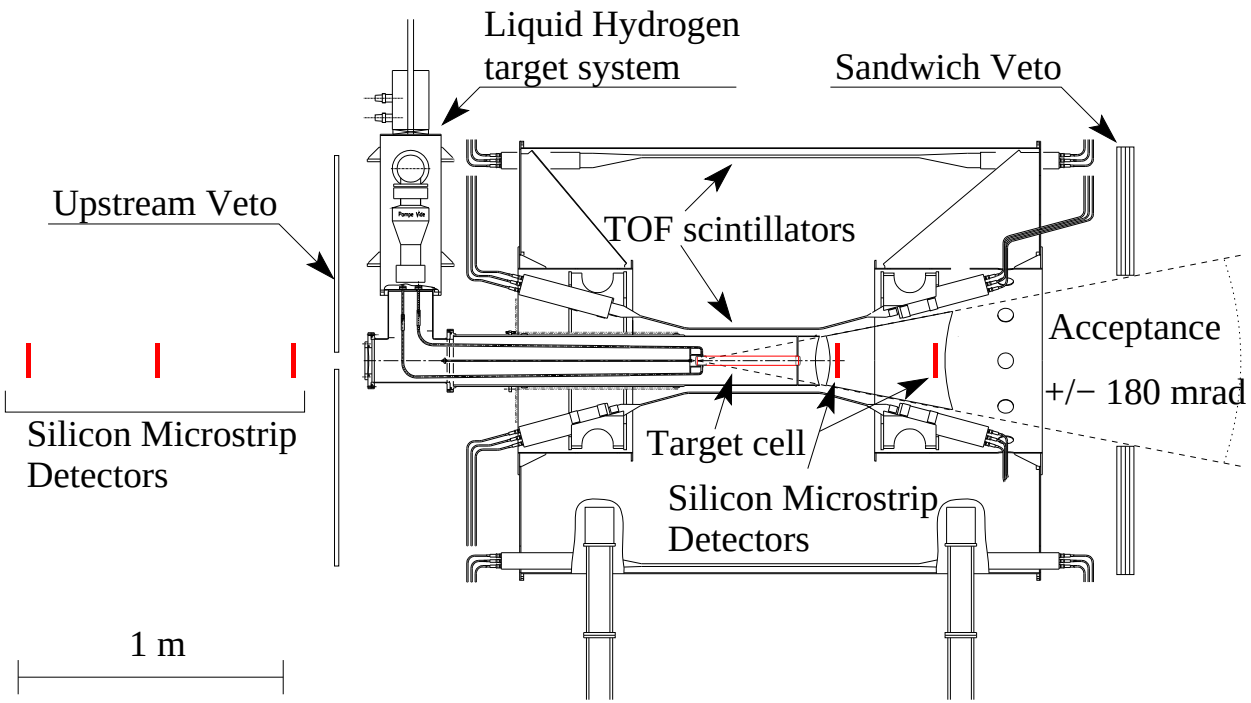


COMPASS spectrometer

- 2 stage spectrometer with large acceptance ($\pm$ 180 mrad for charged particles, $\pm$ 140 mrad for neutrals) and high resolution
- $>$ 300 layers of trackers: Si strip detector, GEMs, MICROMEGAS, Straws, DC, MWPC, ...
- PID w/ RICH up to 50 GeV/c (π/K separation)
- ECAL, HCAL, μ-Filter



Target zone

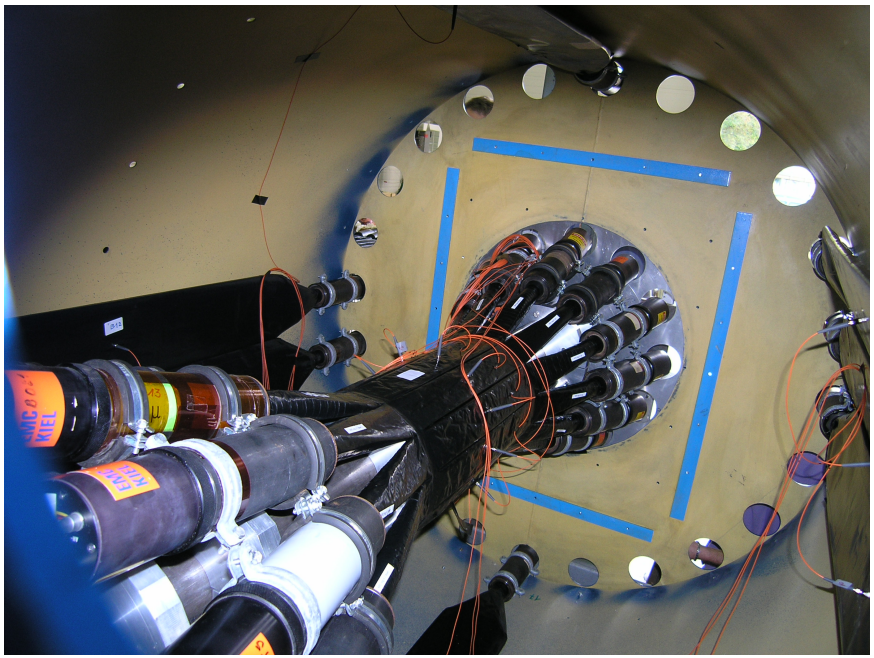


- π^-/K^- beam
  $E = 189$ GeV
  intensity 5×10^7
  per 10s spills with
  40s interspill
- 40cm lH_2 target
  (i.e. luminosity
  $0.15 pb^{-1}$/day)
- Si strip detectors
- veto-system
  (hodoscopes +
  γ-Veto)

Recoil Proton Detector

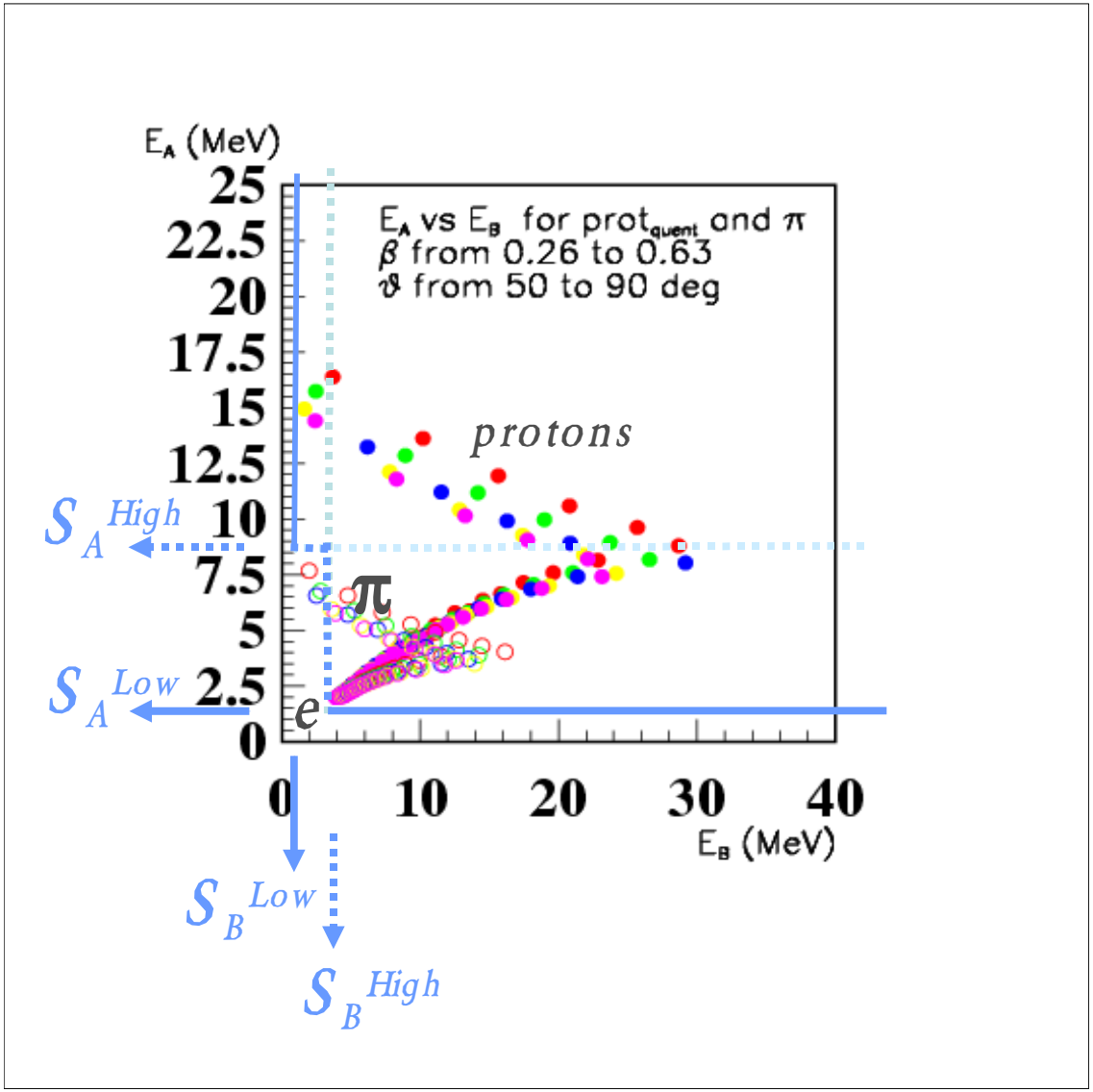
1. Proton **PID** via TOF and E_{loss} measurement
2. fast **trigger** on recoil proton

- small e^- and π^- background
- goal: time resolution $\sigma < 350\,\text{ps}$ $\surd$
- layout: 2 cylindr. layers of scint. (120 mm and 775 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 ($\lambda_{eff} \approx 70\,\text{cm}$)

RPD Trigger



- no 2nd level trigger, so *fast*, *efficient* and *pure* trigger necessary
- trigger on slow recoil proton w/ RPD
- identify proton by TOF and E_{loss} meas. (w/ thresholds to cut out e^- and $\pi^{\pm}$)
- coincidence of one ring A element and one out of three possible ring B elements

Calibration I

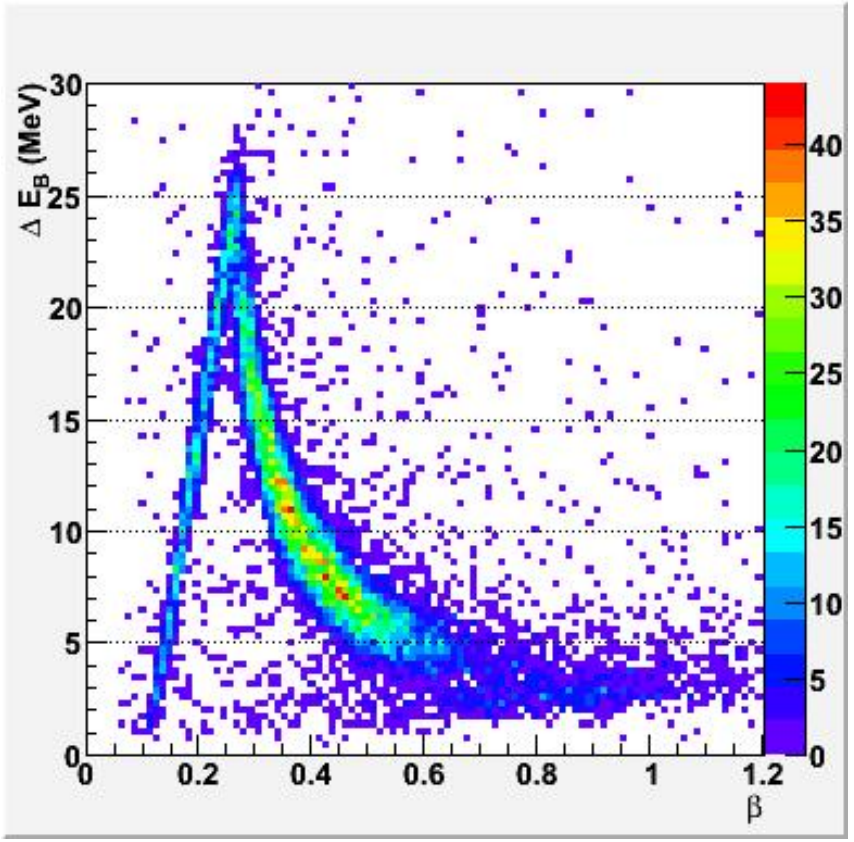
How to come to proton tracks?

- RPD measures **times** and **hits**
- with effective speed of light $\longrightarrow$ hit postions
- combine measurements of TOF and positions to calculate angles and $\beta = \frac{v}{c}$
- no magnetic field around the target $\longrightarrow$ no direct p measurement
- combine with E_{loss} meas. to obtain p
- calibration of energy and TOF necessary

Calibration II

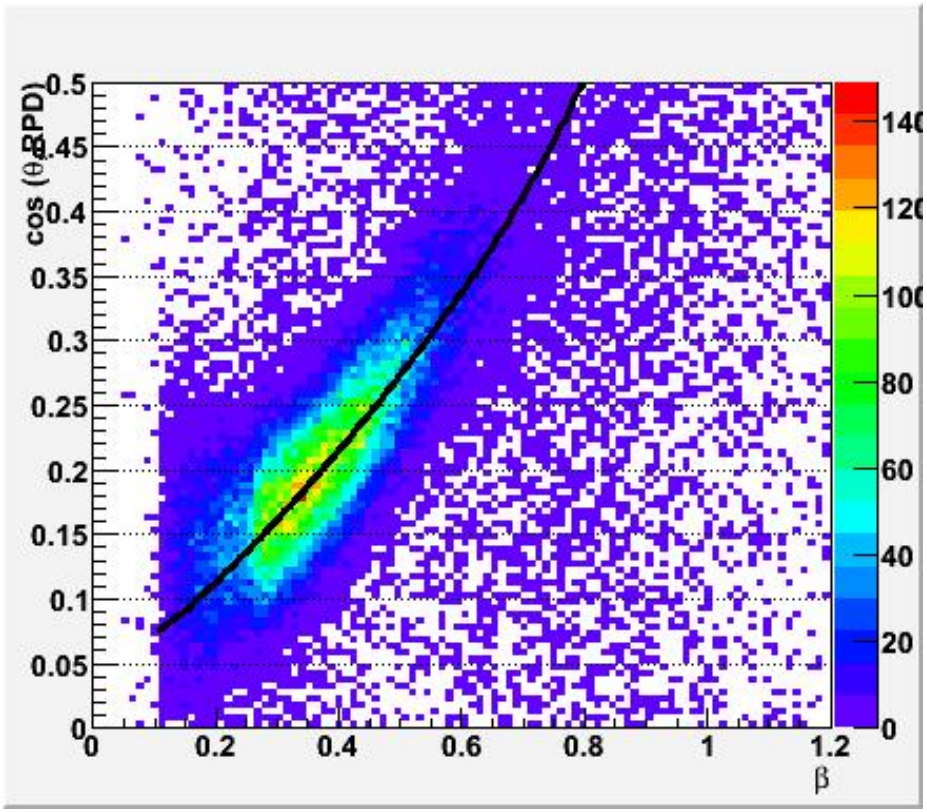
Strategy of calibration:

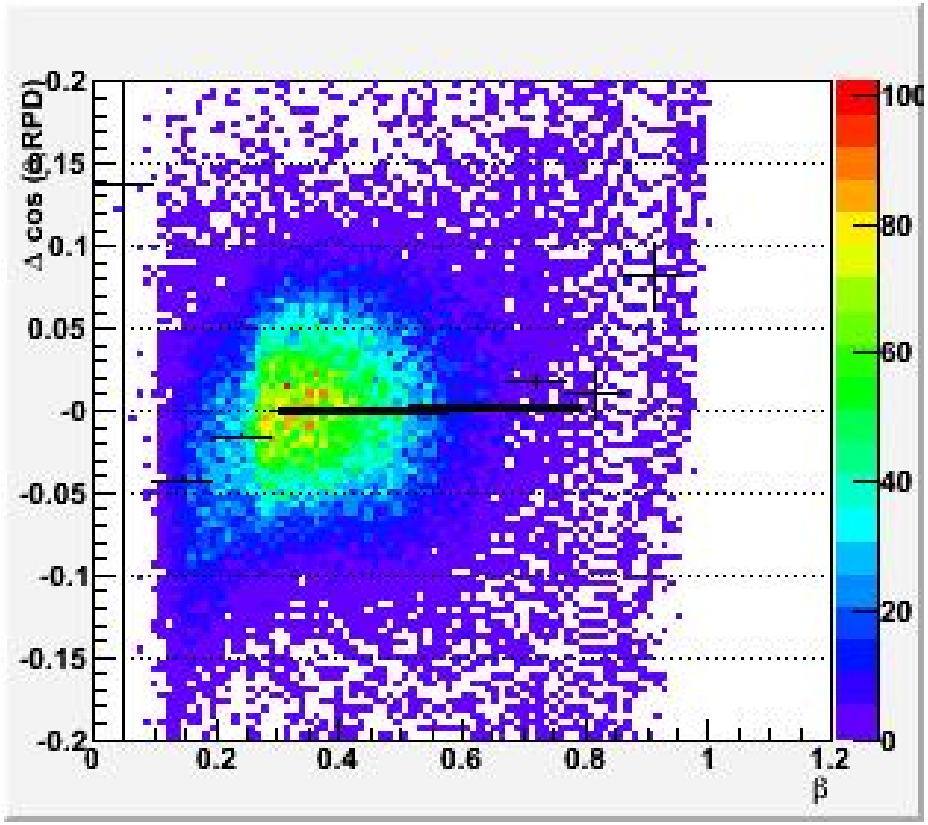
- test measurements w/ cosmics, μ- and e^- beam to determine eff. speed of light and MIP pulse spectra (HV settings), also energy cal.
- online calibration w/ hadron/μ on recoil proton signal to set β in the correct range
- offline calibration w/ elastic and diffractive events for final tuning



elastic recoil proton signal (rec. data)

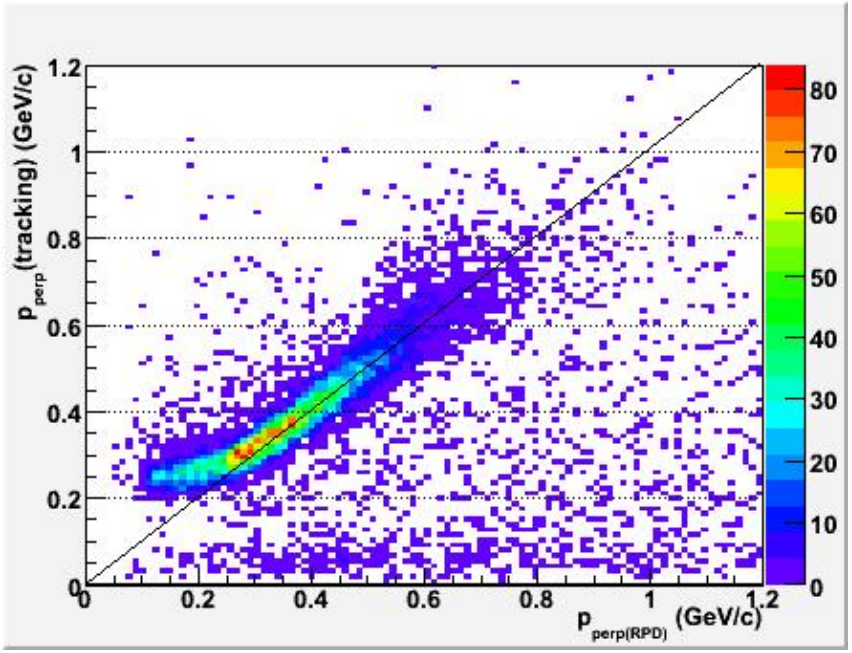
Calibration III





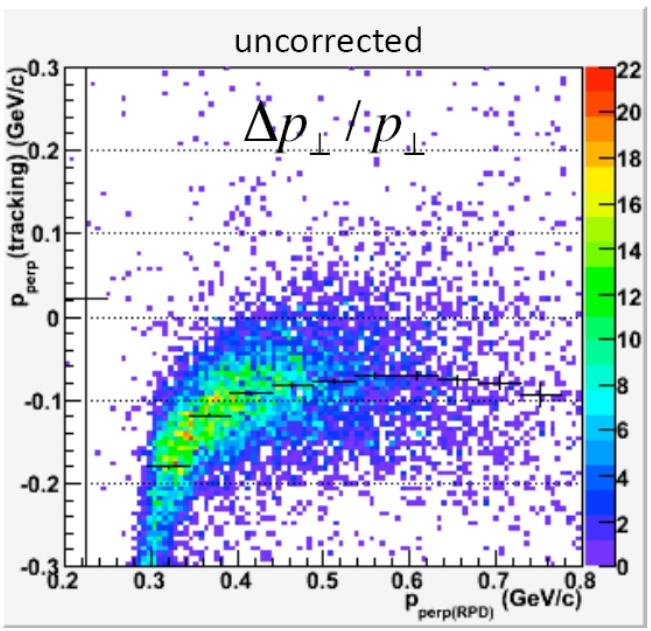
calibration of β with elastic events, determine offsets in time and space from position and slope

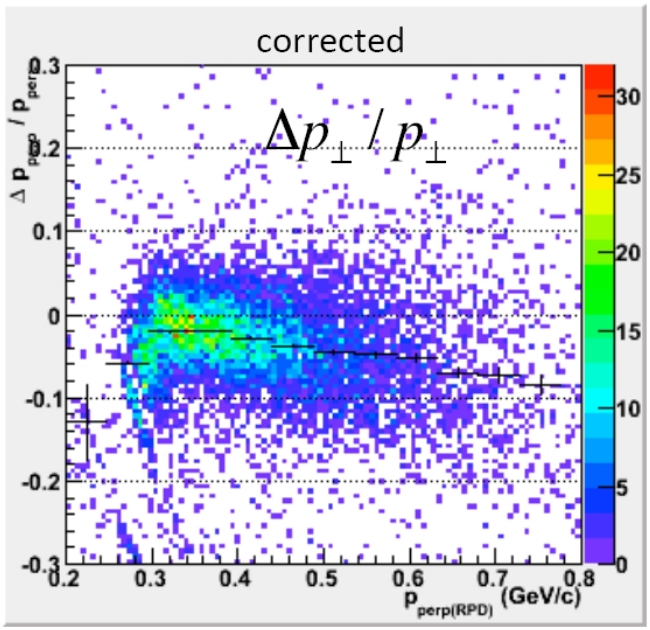
Calibration IV



correct for second order effects like

- vertex offsets due to no point-like beam (RMS $\approx$ 1cm)
- energy loss in the target material





Conclusion + Outlook

- **COMPASS Recoil Proton Detector** and **trigger** concept was presented
- calibration technique using elastic events
- RPD calibration still ongoing, now using also $3\pi^{\pm}$ and $5\pi^{\pm}$ data
- RPD is an important component to analyze diffractive and centrally produced events
- momentum resolution in fixed target experiments not sufficient for missing mass technique $\longrightarrow$ correlation of recoil proton and outgoing particle tracks selects very efficiently exclusive events