The COMPASS Recoil Proton Detector
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1. Motivation
2. Trigger
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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 ($\pi / K$ separation)
- ECAL, HCAL, $\mu$-Filter
Target zone

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

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

- small $e^-$ and $\pi^-$ background
- goal: time resolution $\sigma < 350 \text{ ps}$
- layout: 2 cylindr. layers of scint. (120 mm and 775 mm surrounding the target)

-inner ring w/ 12 scintillator slabs (5 mm $\times$ 500 mm BC404, U Mainz)
-outer ring w/ 24 scintillator slabs (10 mm $\times$ 1080 mm, IHEP Protvino)

large dynamical range of the signals due to small attenuation length ($\lambda_{\text{eff}} \approx 70 \text{ cm}$)
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 $E_{\text{loss}}$ 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 $\rightarrow$ hit positions
- combine measurements of TOF and positions to calculate angles and $\beta = \frac{v}{c}$
- no magnetic field around the target $\rightarrow$ no direct $p$ measurement
- combine with $E_{\text{loss}}$ meas. to obtain $p$
- calibration of energy and TOF necessary
Strategy of calibration:

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

![Elastic recoil proton signal (rec. data)](image)
calibration of $\beta$ 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 ≈ 1 cm)
- energy loss in the target material
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 → correlation of recoil proton and outgoing particle tracks selects very efficiently exclusive events