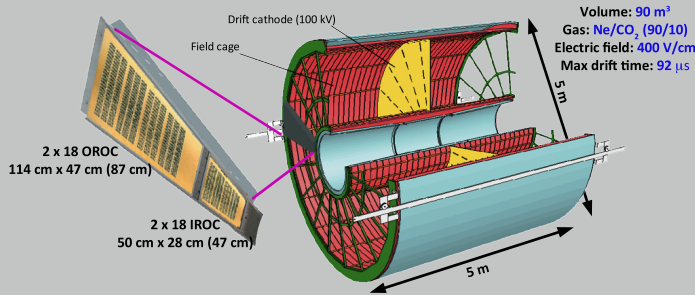


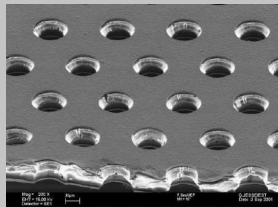
ALICE TPC upgrade

ALICE at the LHC at CERN is planning a major upgrade of the central barrel detectors to cope with an increase of the LHC luminosity in Pb-Pb after 2018. The goal is to record Pb-Pb interactions at a rate of 50–100 kHz after Long Shutdown 2 (LS2), which is a factor of about 100 more than the current data acquisition rate. For the Time Projection Chamber (TPC) this implies replacement of the existing MWPC-based readout chambers by continuously operated GEM (Gas Electron Multiplier) detectors to overcome the rate limitations imposed by the present gated readout scheme.



Gas Electron Multiplier

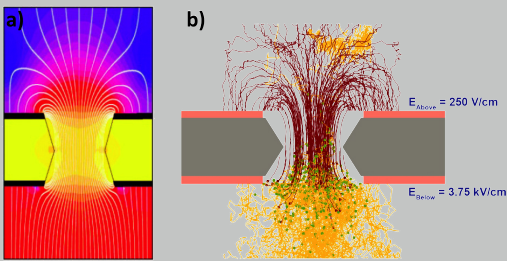
GEM foil



"Standard" dimensions

- ▶ 50 μm thin polyimide foil (Kapton®)
- ▶ 5 μm Cu-clad on both sides
- ▶ 50/70 μm inner/outer hole diameter
- ▶ 140 μm pitch

GEM principles

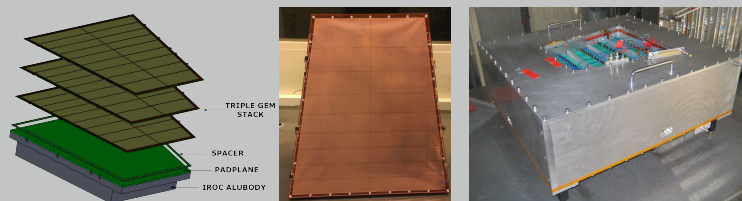


GARFIELD/MAGBOLTZ simulations of a) electric field inside a GEM; b) 2 electrons entering GEM hole

GEM as an alternative for MWPC readout

- ▶ no issue with rate capability
- ▶ possibility to efficiently block ions
- ▶ lower (effective) gain since signal is produced by electrons (fast) + lower noise

GEM-IROC prototype



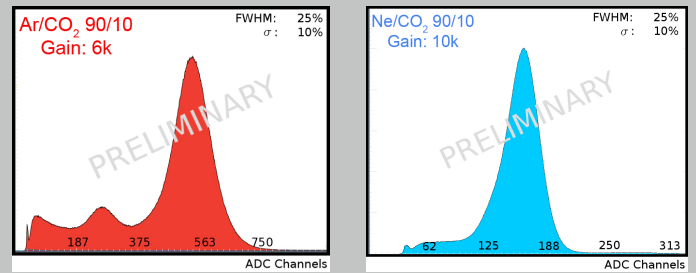
GEM foils for the prototype

- ▶ 3 single-mask, large-size foils
- ▶ 18 sectors (top side segmented), ~100 cm² each
- ▶ 2 mm frame (G10 fiber glass) glued on bottom side

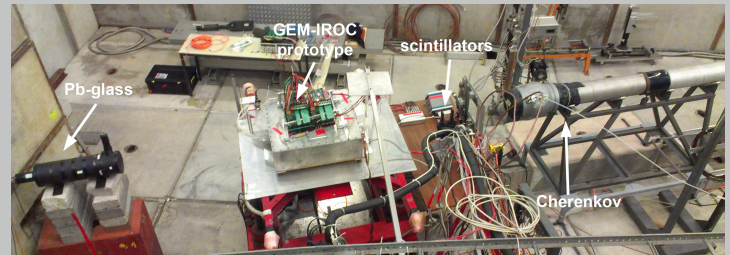
Test box with field cage

- ▶ Drift length: 11.5 cm
- ▶ Drift field: 400 V/cm

Commissioning with ⁵⁵Fe



PS (CERN) beamtime – Nov/Dec 2012



▶ Readout

- ▶ 10 EUDET Front-End Cards (*borrowed from the LCTPC Collaboration*)
- ▶ PCA16 charge preamp. + ALTRO chip for digitization and signal processing
- ▶ 16–18 pads (size 4×7.5 mm²) on 64 pad rows
- ▶ Average noise (ENC) at the level of 500–600 e⁻

▶ Beam rate: 2000 particles/spill (0.5 s); DAQ rate: 500 events/spill

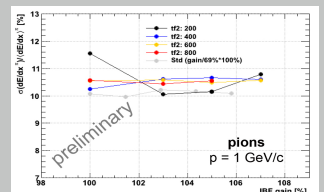
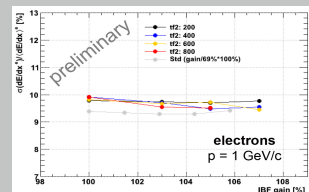
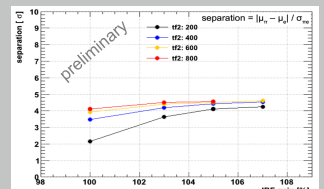
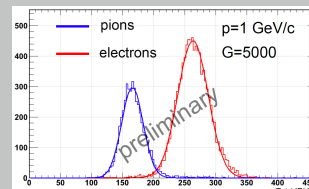
▶ Beam settings:

- ▶ 1 GeV/c, 2 GeV/c, 3 GeV/c negative (e⁻, π⁻)
- ▶ 1 GeV/c, 6 GeV/c positive (e⁺, π⁺, p)

▶ GEM settings: Stability-optimized or Ion Back Flow-optimized

▶ Gas mixture: Ne/CO₂ (90/10)

dE/dx measurements



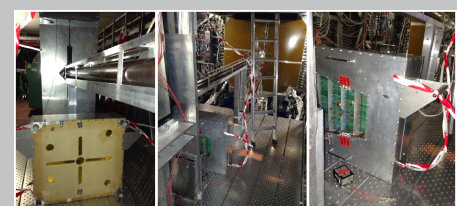
▶ Gain equalization using tracks

▶ No T/P correction

▶ Truncated mean of cluster charge (5–70 %)

▶ For comparison: IROC only in ALICE TPC σE/E ≈ 9.5% (for high η)

ALICE p-Pb beamtime (LHC) – Jan/Feb 2013



Chamber installed underneath LHC beampipe (η ≈ 2.6)

▶ > 3 weeks under LHC conditions (200 kHz interaction rate)

▶ Particle rate ~5000 kHz per rapidity unit

▶ Standalone readout: waveforms, discharges, trips