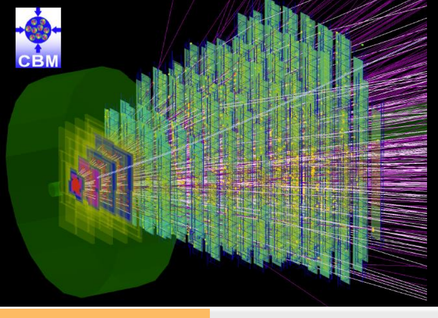
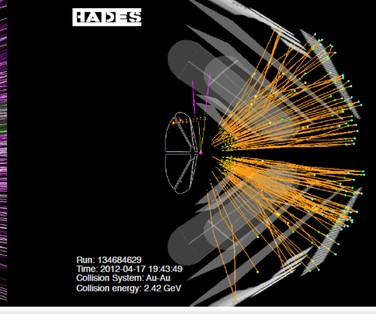
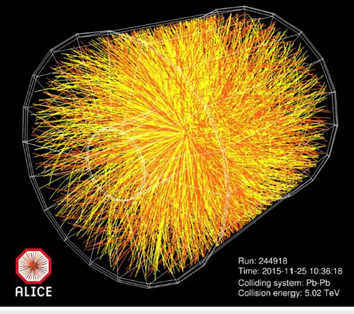
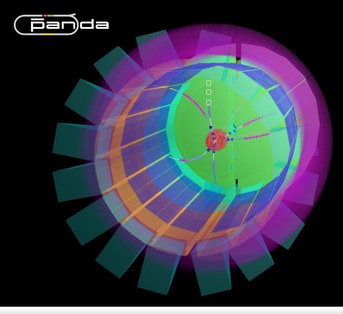
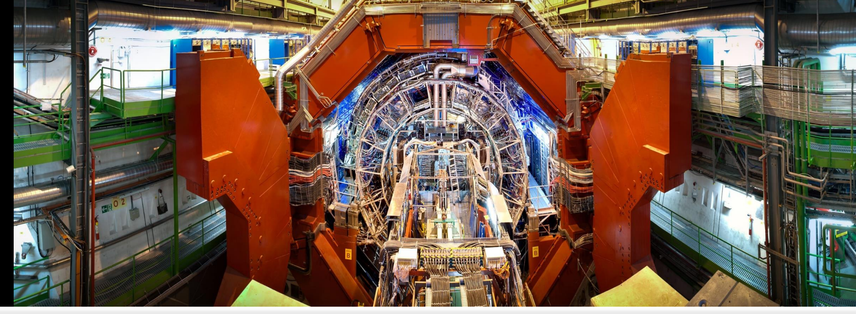










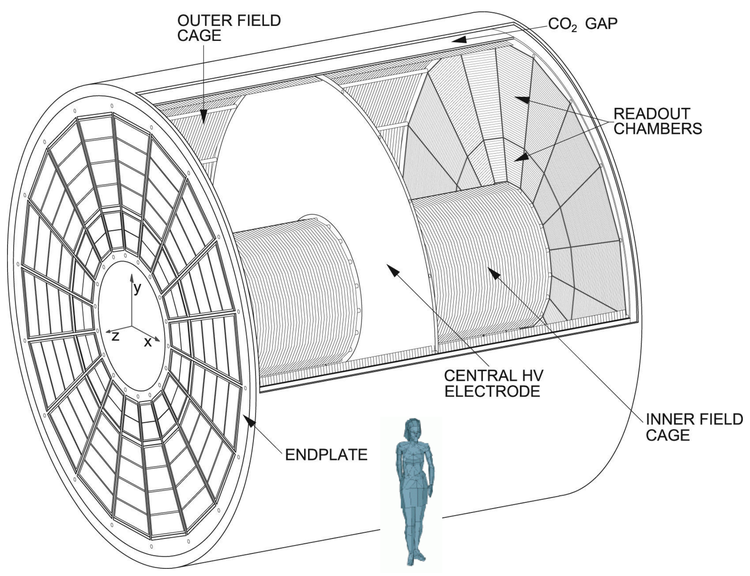
ALICE TPC Upgrade

Thomas Rudzki for the ALICE collaboration

XIV. ICFA School on Instrumentation in Elementary Particle Physics, La Habana, 2017

GSI

Time Projection Chamber – main detector of ALICE



Features

- main tracking detector in ALICE designed, constructed and operated by GSI personnel
- good particle identification (PID) capability
- largest (90 m^3) TPC in the world
- readout: 72 multi-wire proportional chambers
- gating grid: open for electrons for 100 µs, then closes to prevent ions from entering the drift volume
  → readout rate limited to 3 kHz

Performance

- main detector in 147 of the 182 published papers of ALICE
- dE/dx resolution of 5-7%
- momentum resolution of 0.8 % at 1 GeV/c and 2.5 % at 30 GeV/c (for primary particles)
- works at high interaction rates: 4.5 kHz Pb-Pb, 1 MHz pp, 10 kHz Pb-Pb planned in 2018

ALICE plans for 2021-2029

- LHC Run 3 and Run 4: high luminosity
- expected Pb–Pb collision rate: 50 kHz
- TPC gating grid operation too slow
- solution: GEM-based readout chambers
  - continuous operation, 3.5 TBytes/s
  - continuous readout
  - acceptable ion backflow ≤ 1 %
  - PID capability comparable to the present one

Timeline of the TPC upgrade project

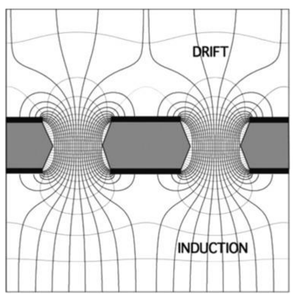
2016-2018	GEM foil production
2017-2018	OROC and IROC production
2019	chamber installation
2021	Run 3 start

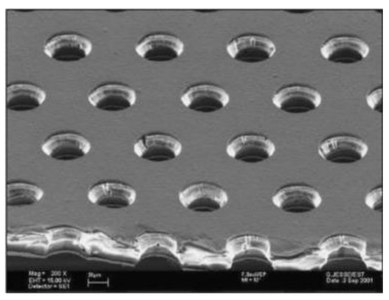
Upgrade of TPC readout

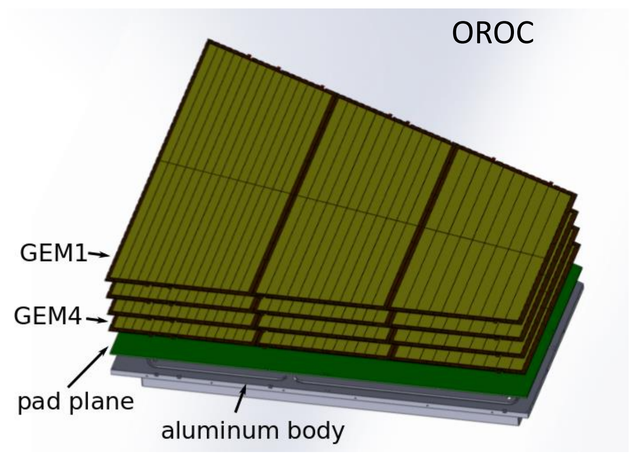
New readout chambers

Gas Electron Multipliers (GEMs) are:

- 50 µm thick Kapton foils covered on both sides with a 5 µm layer of Cu
- holes of 70 µm diameter are etched in the foils
- strong electric fields inside the holes





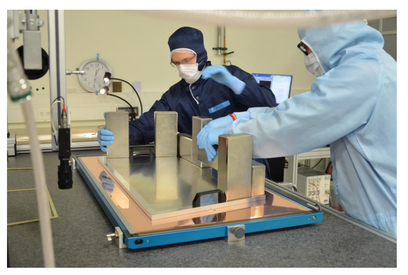


- inner and outer readout chambers (IROCs, OROCs) will be equipped with stacks of four GEM foils
- voltage, hole orientation, and pitch are optimized for low ion backflow and good energy resolution

Upgrade activities at GSI

GSI contributes to the TPC Upgrade Project twice, as framing and assembly institute:

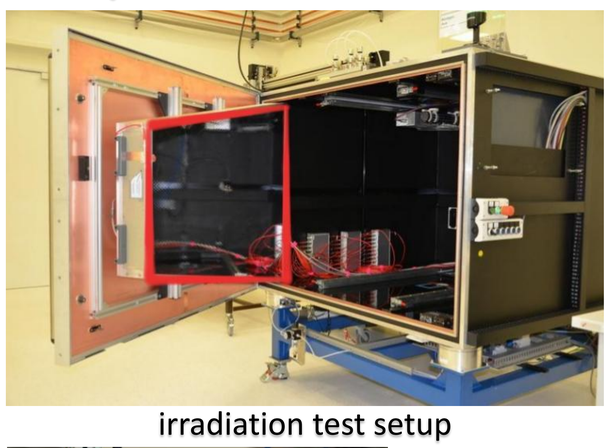
- framing of all OROC3 GEM foils
- assembly of 20 out of 40 OROCs
- commissioning and testing of the OROCs
- parts of setup used in synergy with PANDA

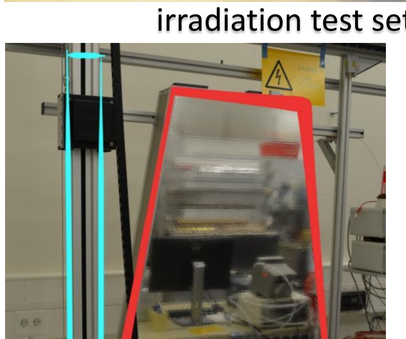

framing


assembly

Test results of first OROCs

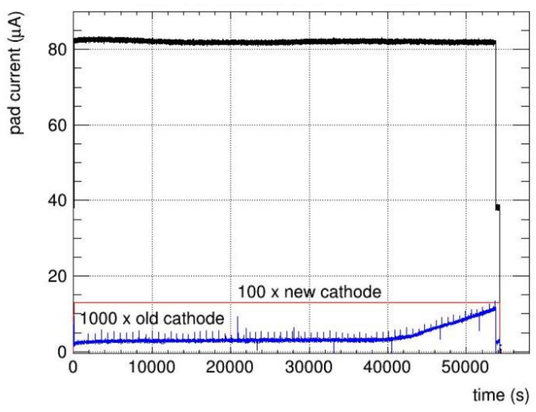
Test setups


irradiation test setup


scanning test setup

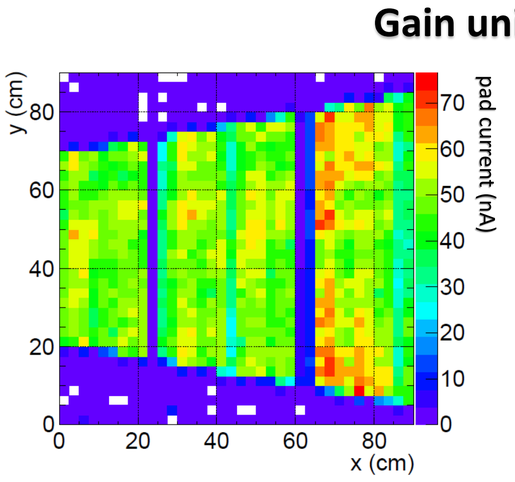
OROC stability at high rates

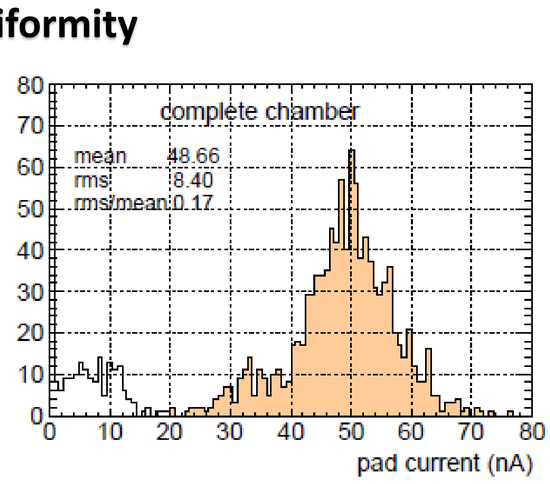
full-area x-ray irradiation at 10 nA/cm^2 pad current



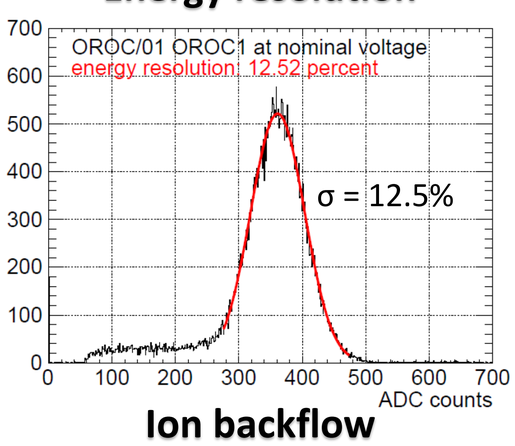
Pad current (black) stable during several hours of x-ray irradiation. Induced pad current equivalent to the maximum expected in operation in ALICE.

Gain uniformity

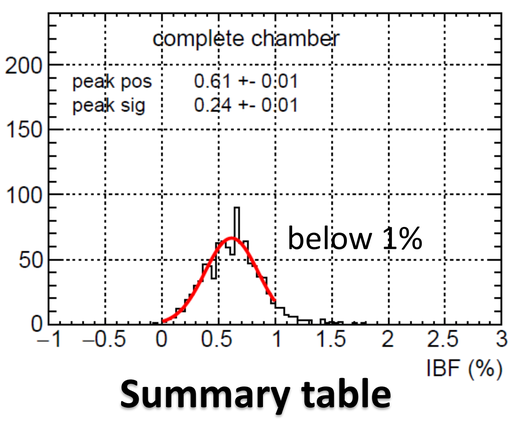




Energy resolution



Ion backflow



Summary table

	requirement	first 2 OROCs
gain nonuniformity	< 20 %	17-18 %
ion backflow	< 1 %	0.6 %
energy resolution	≤ 12 %	13-14 %

→ The first 2 OROCs, assembled and commissioned at GSI, were performing as expected

HELMHOLTZ