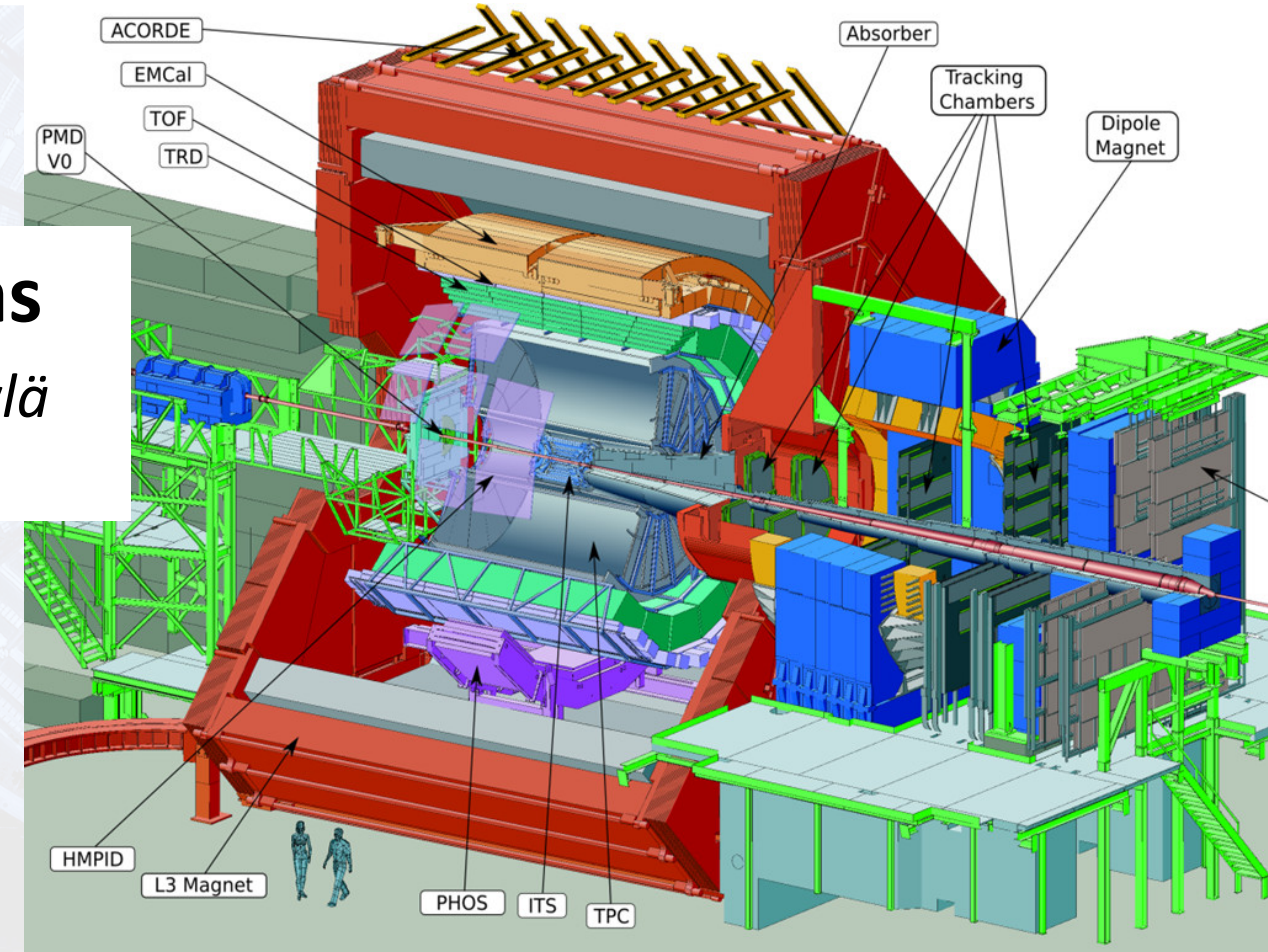
SUOMALAINEN TIEDEAKATEMIA
FINNISH ACADEMY OF SCIENCE AND LETTERS
ACADEMIA SCIENTIARUM FENNICA

Detector development with the ALICE TPC

Zimányi Winter School on Heavy Ion Physics 2016

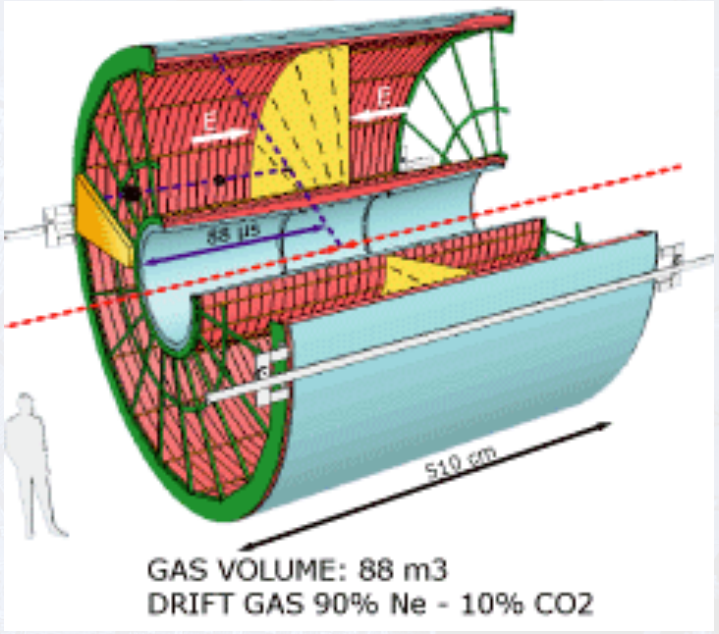
Márton Vargyas

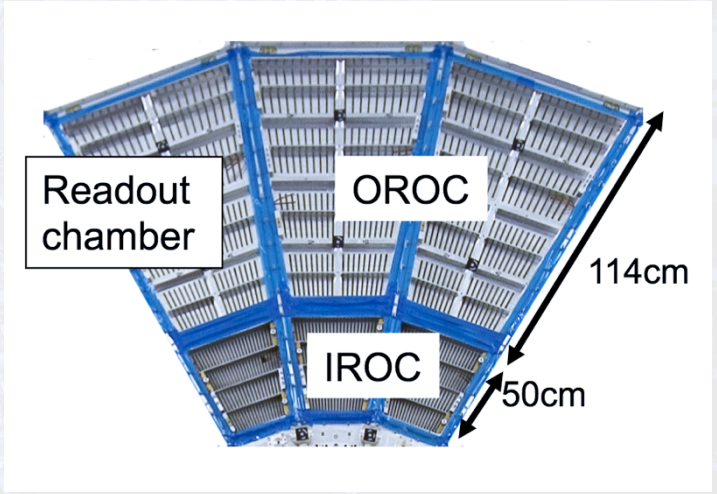
University of Jyväskylä



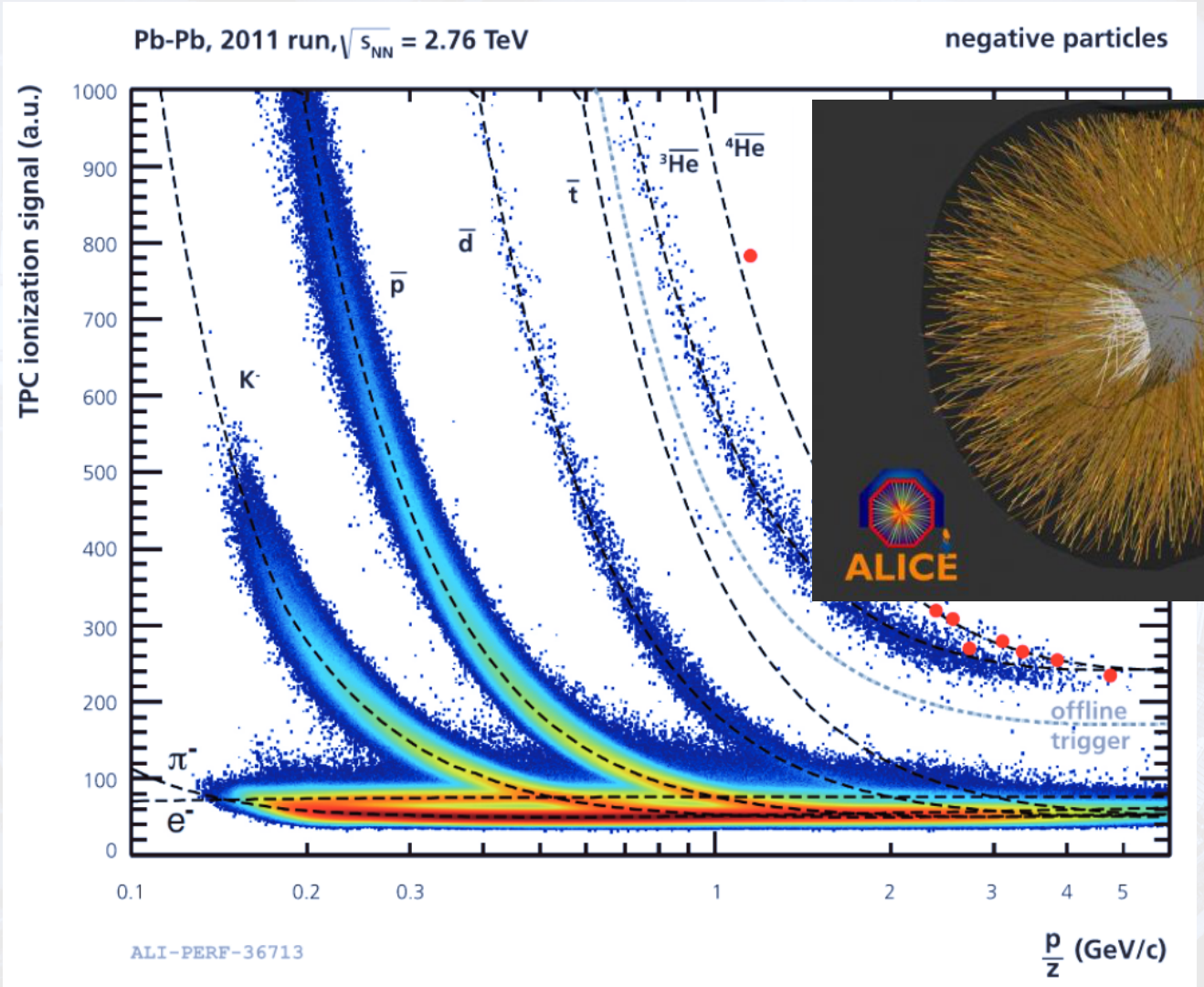
The Time Projection Chamber (TPC)

- Diameter: 5 m, length: 5 m
- Acceptance: $|\eta|<0.9$, $\Delta\phi=2\pi$
- Gas: Ne-CO_2-N_2
  at drift field = 400V/cm
- Total drift time: 92μs
- Readout Chambers: total = 72
  - Outer (OROC): 18 x 2
  - Inner (IROC): 18 x 2
- MWPC + Gating Grid
  - Open every 100μs
  - Closes for 300-500μs





Performance during Run 1



Tracking efficiency 98% (pp)

Excellent PID

TPC Upgrade (1)

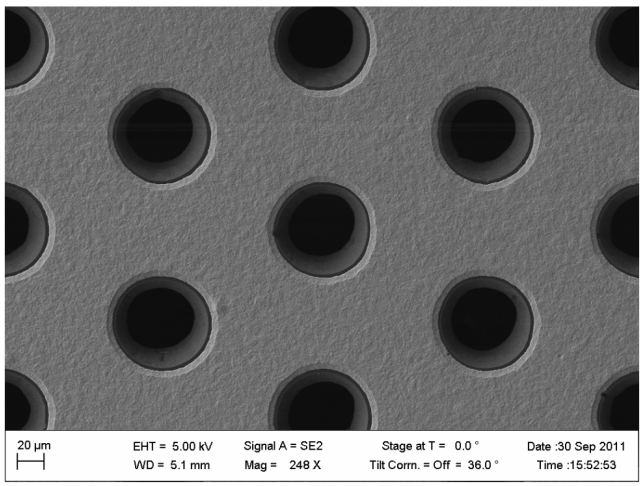
ALICE Upgrade LoI: http://cds.cern.ch/record/1475243

ALICE Upgrade TDR: https://cds.cern.ch/record/622286

EXPECTED **50kHz** (5 pileup during drift time)

Space point distortions up to 1 m

Continuous readout with GEMs
(Gas Electron Multiplier)

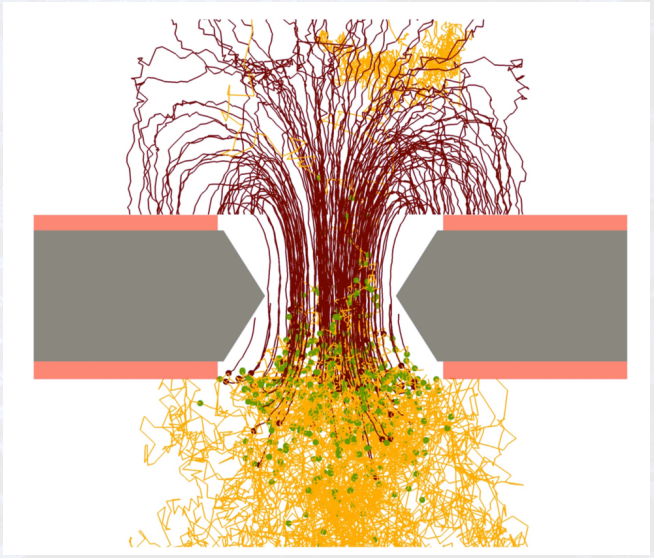


GEM has advantages in:

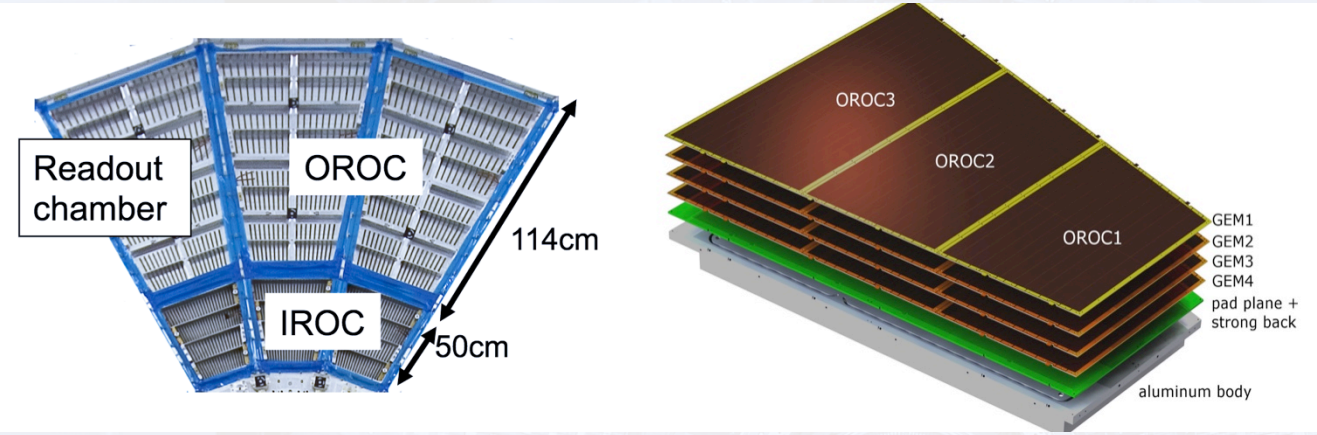
- Reduction of ion backflow (IBF)
- High rate capability
- No ion tail

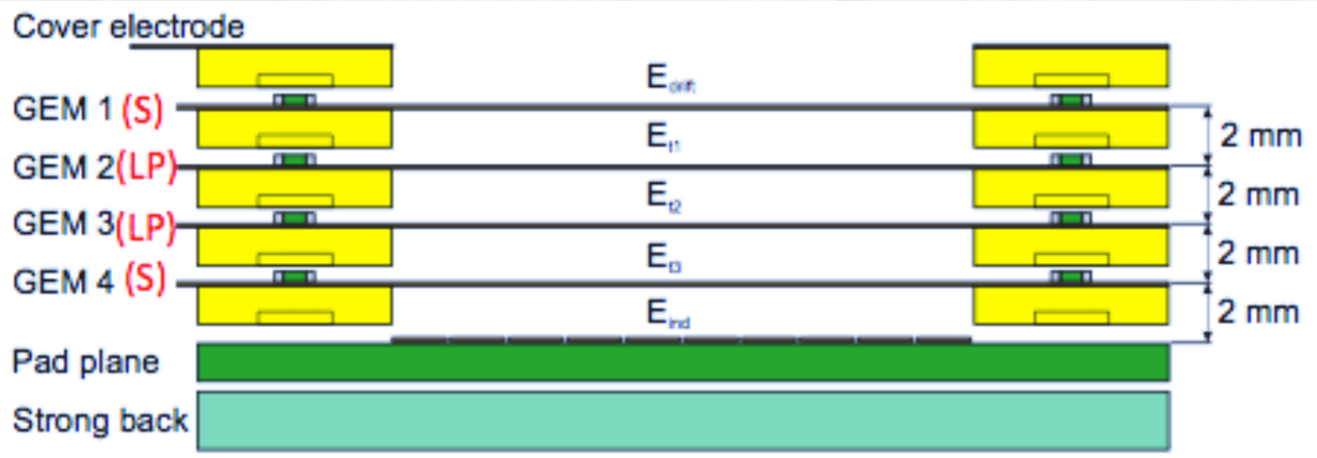
Requirement:

- IBF < 1% at Gain = 2000
- dE/dx resolution < 12% for ^{55}Fe
- Stable operation under LHC condition



TPC Upgrade (2)



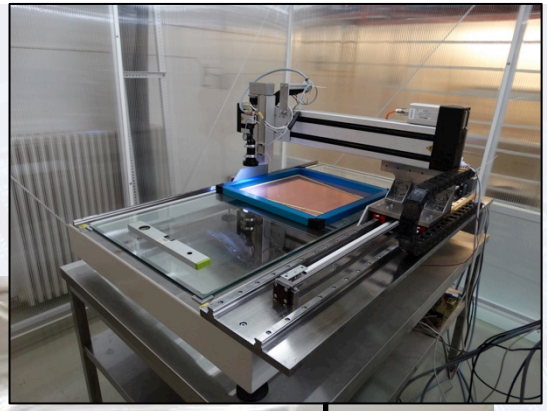


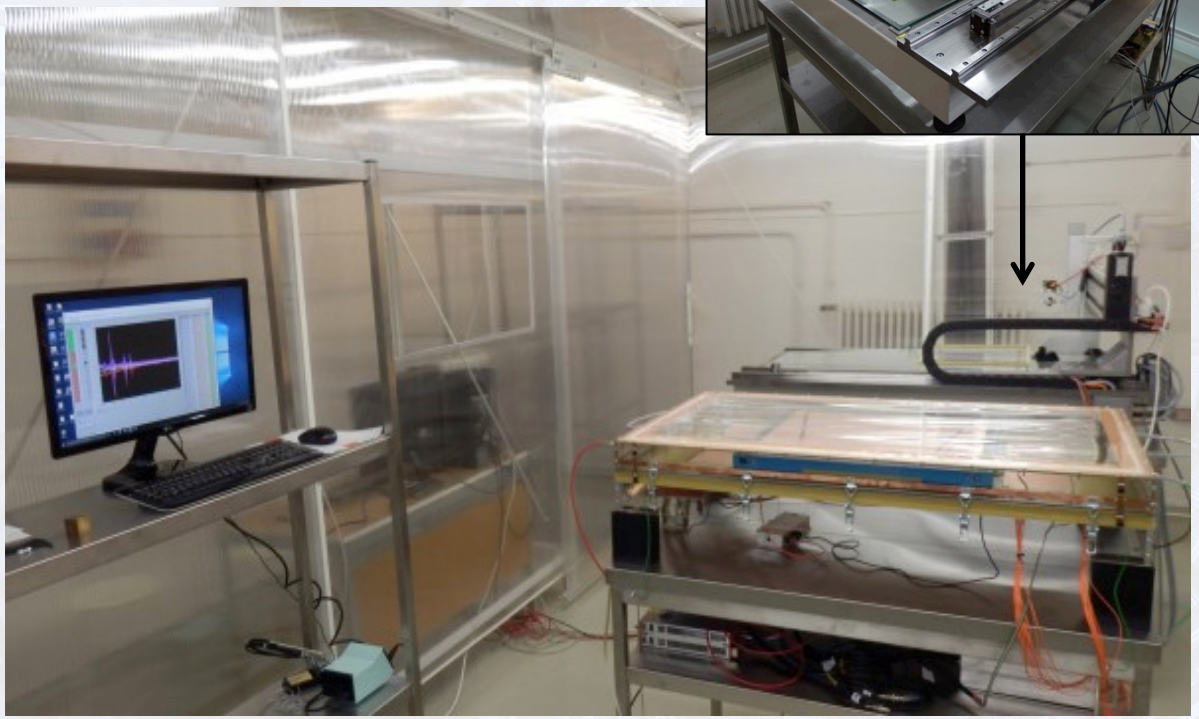
ALICE Physics Program in Run 3

- Yields and azimuthal distributions of hadrons with (**c**, **b**) heavy-quark thermalization in the QGP
- Production of quarkonia at low-p_T
  study of their possible dissociation and regeneration QGP.
- Low-mass di-electron production to extract information on early temperature and the partonic equation of state, and to characterize the chiral phase transition
- Jets and jet correlations, in particular their structure and particle composition, to study the mechanism of partonic energy loss in medium
- The production of nuclei, anti-nuclei and hyper-nuclei

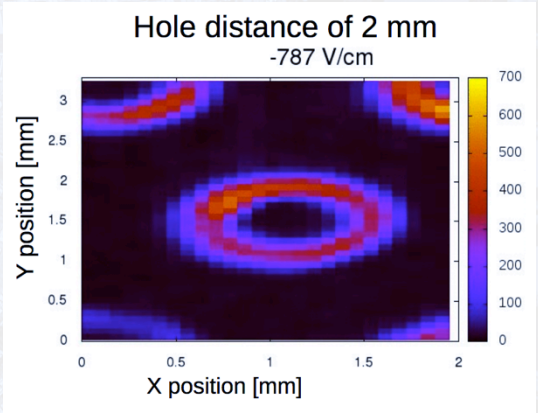
Budapest R&D Center (1)

3 testing techniques:





In collaboration with University of Helsinki and RD51



Gain scan
+ HV leakage

Optical scan

Leopard
Gabor Nyitrai's talk

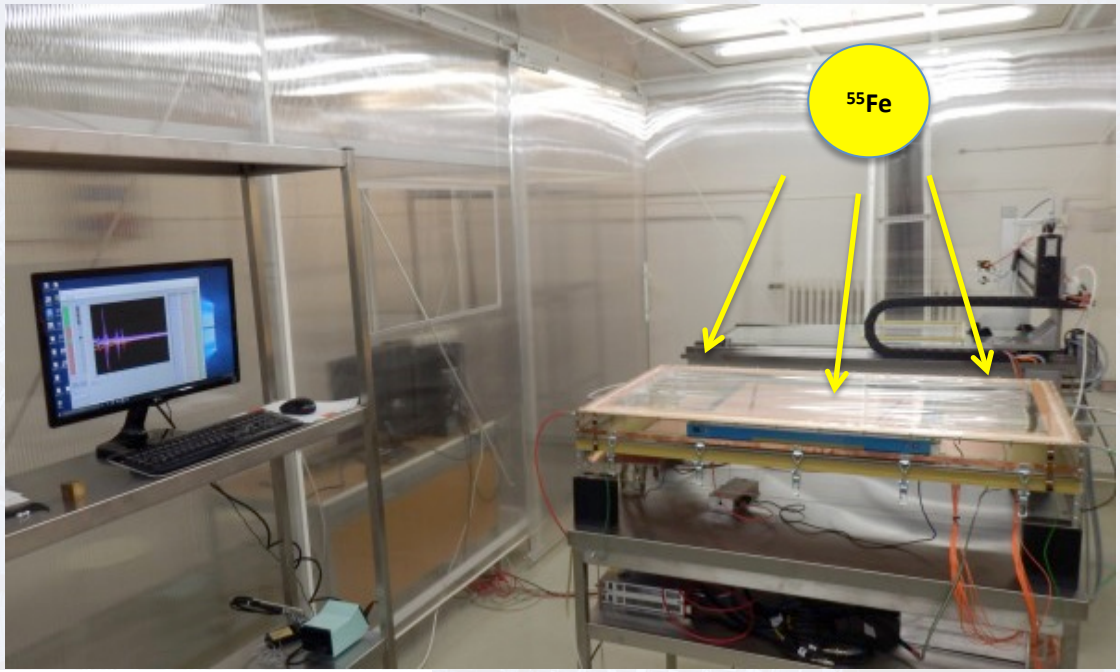
Budapest R&D Center (2) - Gain

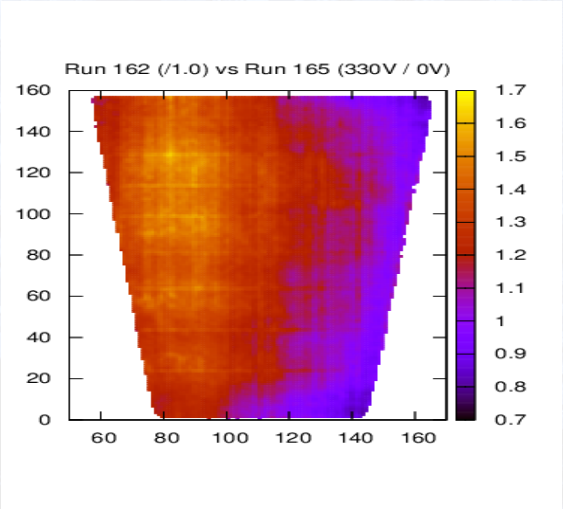
Looking at electrical signal induced by source

High voltage on/off

Flushing with N_2

Offline processing



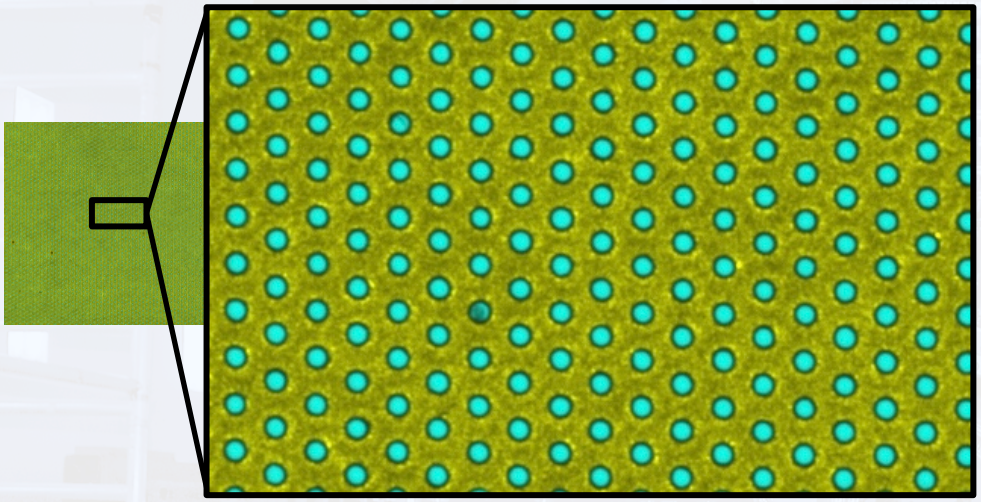


Additional QA:
HV test: leakage current measurement

Picoamper-meter

Budapest R&D Center (3) - optical

Technique developed by Uni. of Helsinki



Automatic scan with robot (X-Y-Z table)

CMOS camera + telecentric optics

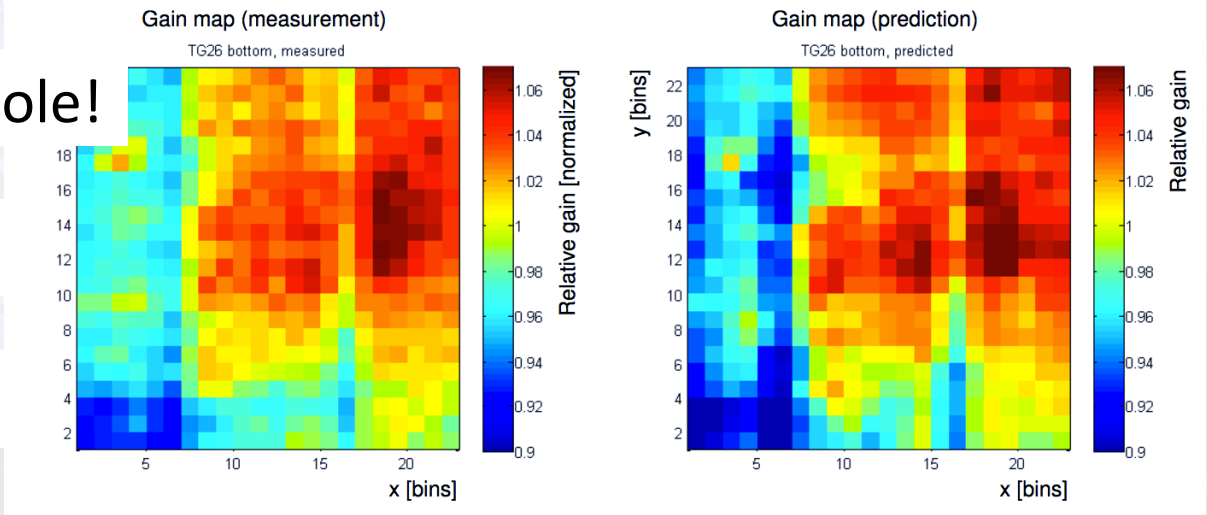
Convolutional Network algorithm:

- stitch the images
- recognize holes

Measuring every hole!

70 (55) µm ± 5 µm

Predicting the gain



Thank you for your attention!

- TPC upgrade for Run3
- Cont. readout at 50kHz interaction rate …
- … with GEM foils instead of MWPC
- R&D and QA in Budapest
- ALICE TPC QA UG Workshop on 16th of December

and T. Gunji, C. Lippman, E. Brücken, D. Varga!

CERN Courier April 2016

Detectors

ALICE selects gas electron multipliers for its new TPC

Although the ALICE TPC has reached its design specifications, intrinsic limitations remain, which will be removed with the planned upgrade.

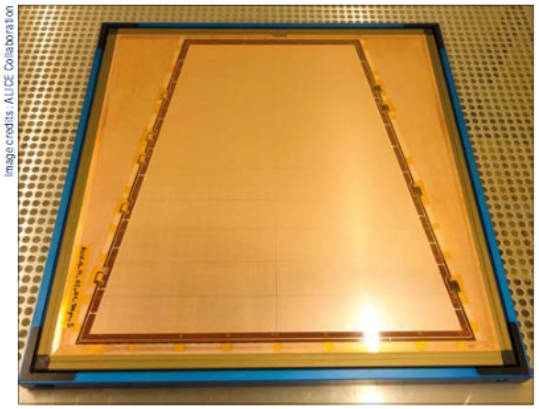
Harald Appelshäuser, Johann Wolfgang Goethe-Universität Frankfurt am Main (Germany).

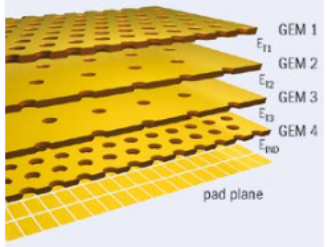
The ALICE experiment is devoted to the study of strongly interacting matter, where temperatures are sufficiently high to overcome hadronic confinement, and the effective degrees of freedom are governed by quasi-free quarks and gluons. This type of matter, known as quark–gluon plasma (QGP), has been produced in collisions of lead ions at the LHC since 2010. The detectors of the ALICE central barrel aim to provide a complete reconstruction of the final state of Pb–Pb collisions, including charged-particle tracking and particle identification (PID). The latter is done by measuring the specific ionisation energy loss, dE/dx.

The main tracking and PID device is the ALICE time projection chamber (TPC). With an active volume of almost 90 m³, the ALICE TPC is the largest detector of its type ever built. During the LHC's Runs 1 and 2, the TPC reached or even exceeded its design specifications in terms of track reconstruction, momentum resolution and PID capabilities.

ALICE is planning a substantial detector upgrade during the LHC's second long shutdown, including a new inner tracking

Image credits: ALICE Collaboration





Left: Fig. 1. Schematic view of a 4-GEM stack.

Above: Fig. 2. Large-size GEM foils produced with so-called single-mask technology.