Electron Identification and Trigger Performance of the ALICE Transition Radiation Detector in p-Pb collisions

Yvonne Pachmayer for the ALICE Collaboration

Physikalisches Institut - Ruprecht-Karls-Universität, Heidelberg

Probing the Quark-Gluon Plasma (QGP)

Essential, but rare probes involve electrons e.g. from
- Open heavy-flavour hadron decays
- Virtual photons and Drell-Yan production
- Decays of the ψ and Υ families

Study of p-Pb Collisions

Disentangle hot (QGP-related) and cold nuclear matter effects in Pb-Pb collisions

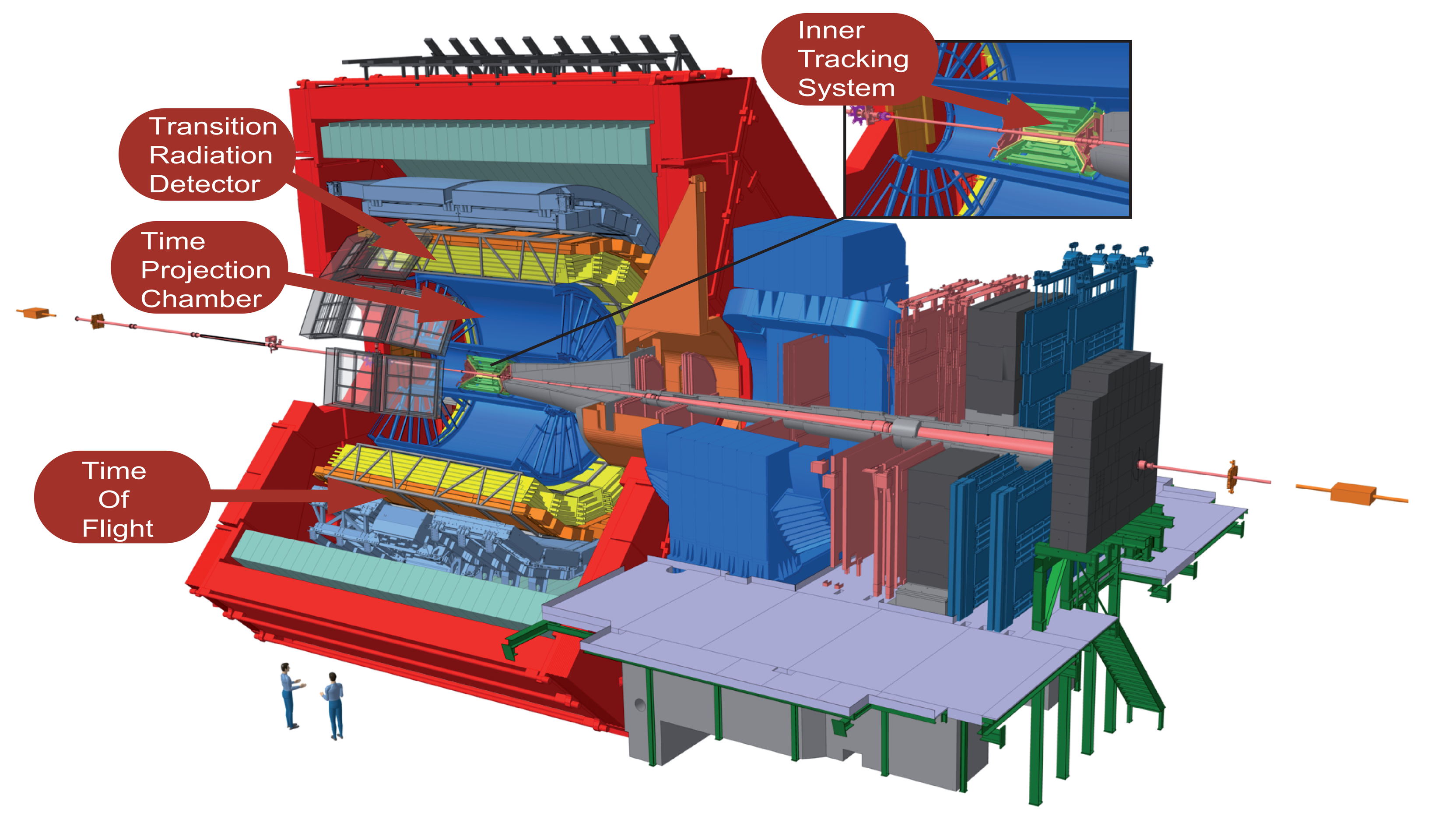
Requirements

- Excellent electron identification
- Trigger to enhance events with electrons

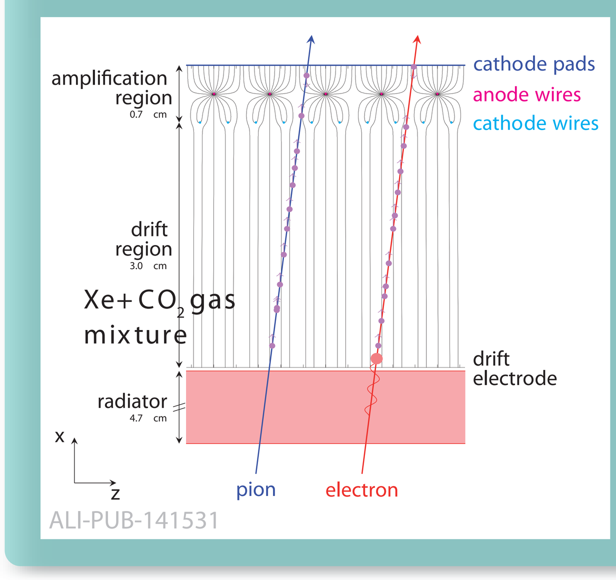
→ ALICE TRD

ALICE TRD in Numbers

- Radial position: $2.9 < r < 3.7$ m
- Geometrical coverage: $|\eta| < 0.84$ and 2π in azimuthal direction
- Total thickness: $<X/X_0>$ ~25%
- 18 sectors in azimuthal direction
  5 stacks in beam direction
  6 layers in radial direction
- Total active area: ~673 m^2
- Gas volume: ~27 m^3 Xe/CO_2 (85:15)
- 1.15 million read-out electronics channels



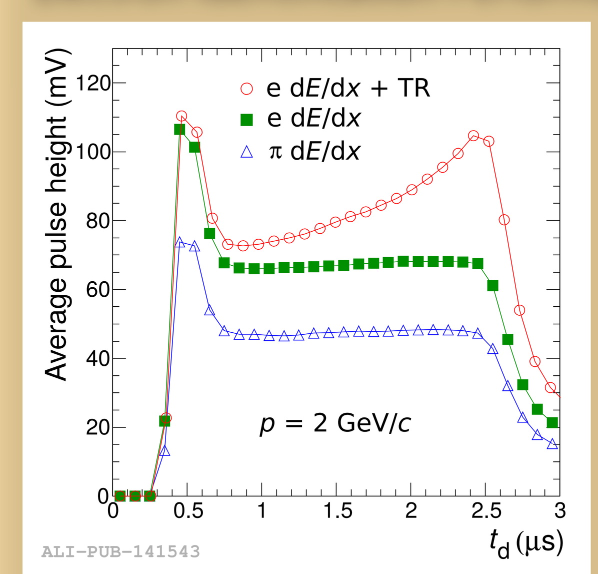
ALICE TRD (Drift Chamber + Transition Radiator) [1]



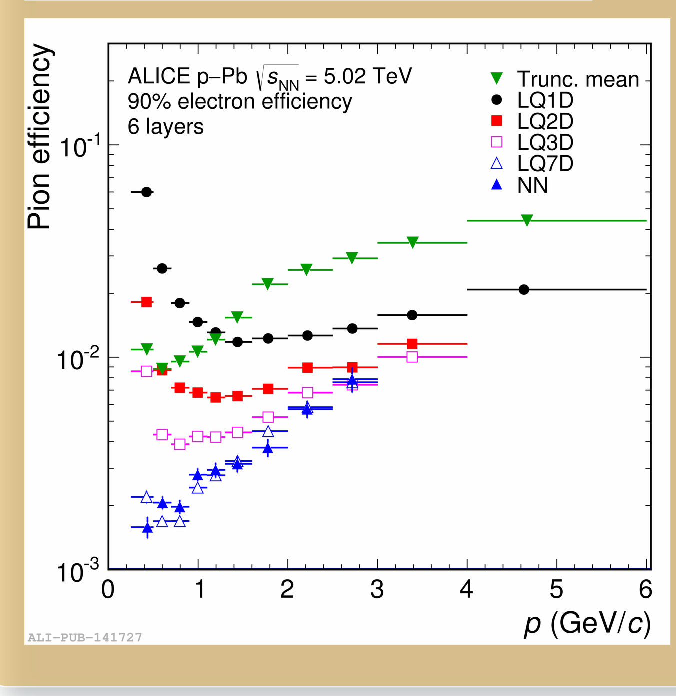
- Transition radiation (TR) produced by ultra-relativistic particles ($\beta\gamma > 500$) crossing the border between materials with different dielectric constants
- About 1 TR photon per electron with $p > 0.5$ GeV/c
- Each of the 522 read-out chambers comprises a radiator and a Xe+CO_2 filled multiwire proportional chamber with pad read-out preceded by a drift section
- Fully customised front-end electronics directly mounted on top of the read-out chamber

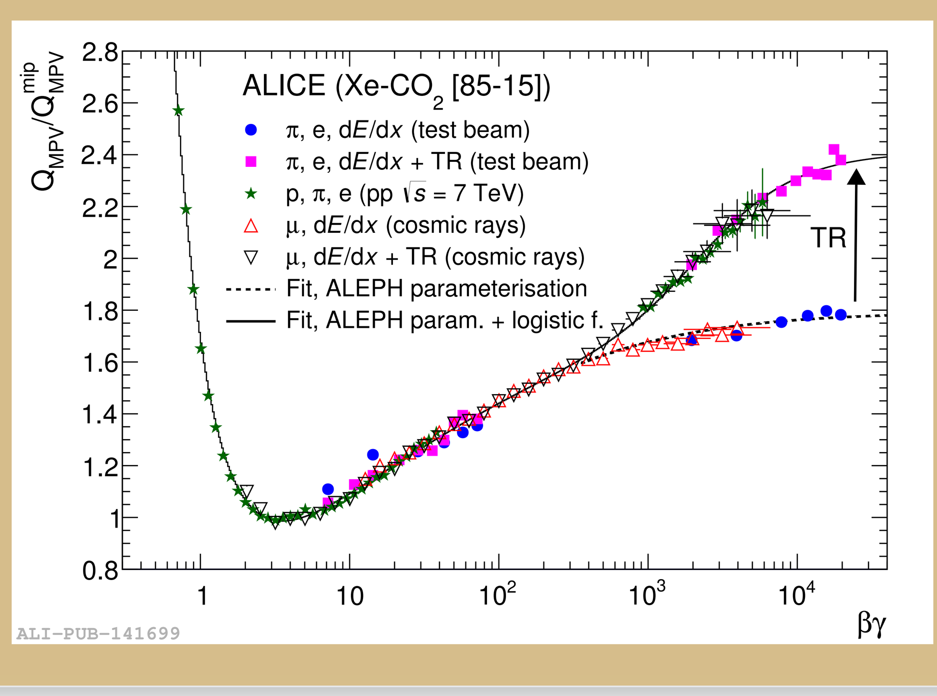
[1] ALICE Collaboration, The ALICE Transition Radiation Detector: Construction, operation, and performance, NIM A881 (2018) 88

Electron Identification Performance

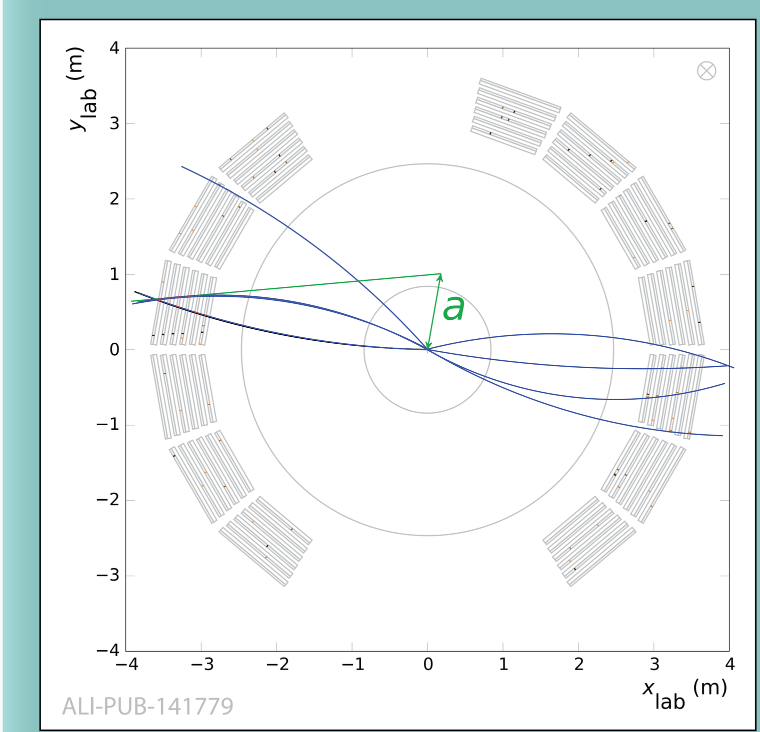


- Recording of the temporal evolution of the signal allows the contributions of the TR photon and the specific ionisation energy loss of the charged particle to be separated
- TR photon preferentially absorbed at entrance of the chamber → characteristic peak at large drift times
- Pion rejection factor (inverse of the efficiency) of up to 410 achieved at a momentum of 1 GeV/c in p–Pb collisions when using the temporal evolution of the signal
- Clear measurement of the onset of the TR production, both for electrons ($\beta\gamma > 500$) and high-energy (TeV scale) cosmic-ray muons





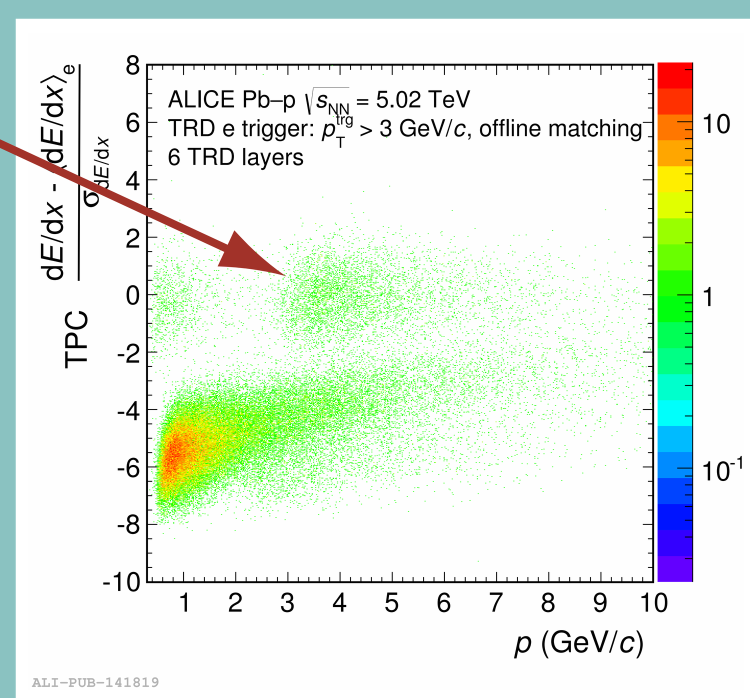
TRD Trigger



- Trigger to enhance quarkonia, heavy-flavour decays and jets at high transverse momenta as well as light nuclei
- Trigger decision within 8 μs after the collision
- Chamber-wise tracking (tracklets): detector-mounted front-end electronics; processing in multi-chip modules, including pedestal and gain correction
- Stack-wise tracking in Global Tracking Unit (FPGA based): tracklet matching and track reconstruction through linear fit
- Derive Level1 trigger based on transverse momentum and PID of individual tracks
- Problem: conversion in detector material at large radii; creating true electrons fulfilling trigger condition
  → removal via online sagitta cut

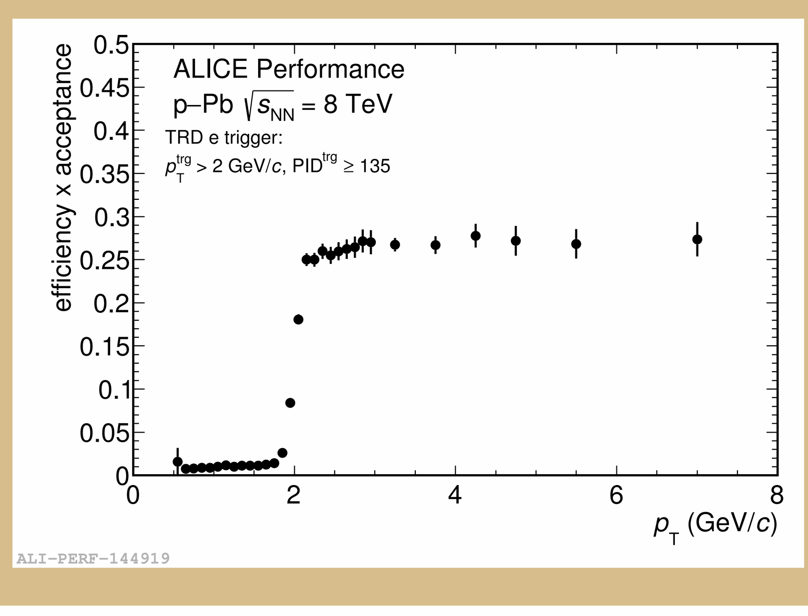
TRD Electron Trigger

- Total integrated charge
- Look-up table (LUT) translates charge into electron likelihood
  - Extracted from reference spectra from real data
    $\gamma \rightarrow e^+e^-$
    $K^0 \rightarrow \pi^+\pi^-$
- Global track PID obtained by averaging likelihoods from all tracklets
- TRD electron trigger: adjustable threshold on transverse momentum and electron likelihood
  - Presently adjusted to obtain good rejection

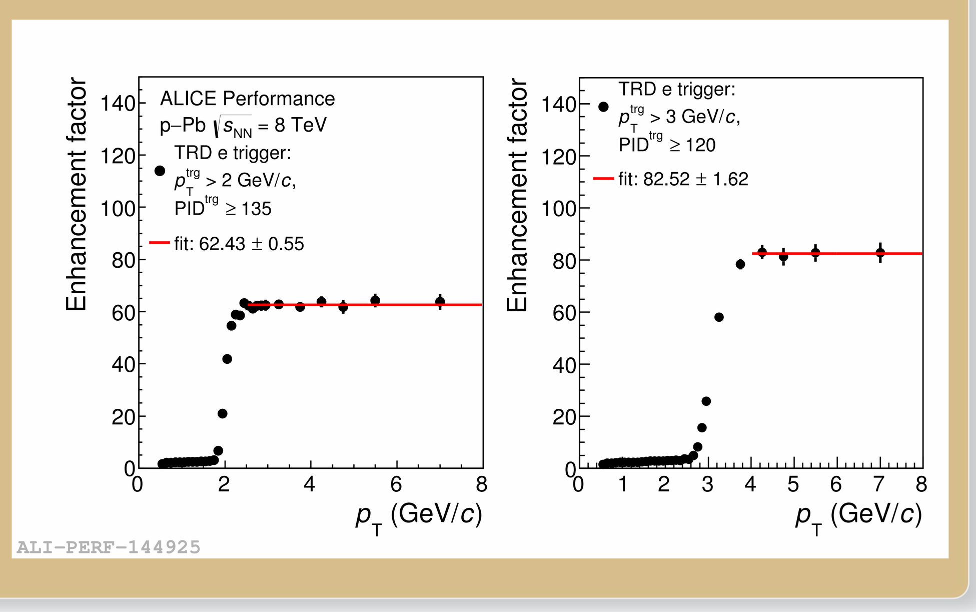


Electron Trigger Performance

- Electron candidate selection
  - Selection of tracks with good quality
  - Cut on electron hypothesis in TOF, removing
    - Kaons up to p = 1.5 GeV/c
    - Protons up to p = 3 GeV/c
  - Cut on electron hypothesis in TPC: 0 to 3 σ
- Trigger efficiency x acceptance
  - Evaluated in a minimum bias data sample
  - Counted how many events were also flagged by the TRD electron trigger
  - Shown for an electron trigger with a transverse momentum threshold of 2 GeV/c
  - Steep trigger turn-on curve visible
  - Efficiency x acceptance about 27%

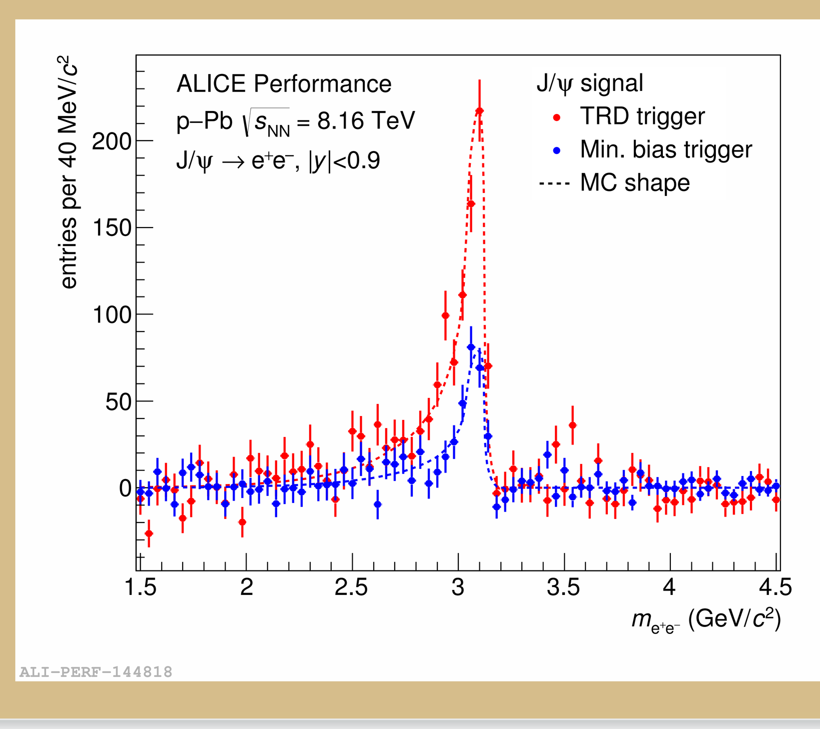


- Trigger enhancement factor
  - Comparison of the number of electrons in the TRD-triggered data sample to the one in the minimum bias data sample as a function of transverse momentum
  - Shown examples show enhancement factors of about 60 and 80



Offline Analysis - Invariant Mass Distribution of J/ψ mesons

- Electron/positron candidate selection
  - Selection of tracks with good quality
  - Electron identification based on TPC
- Signal extraction
  - Pairing of electrons and positrons
  - Rejection of leptons from conversion processes via cuts on ITS and inv. mass
  - Background pairs evaluated and subtracted via mixed-event technique
  - Remaining correlated background pairs estimated via pol1 fit and subtracted
  - Extracted J/ψ signal shown on the right
- Clear enhancement of the J/ψ signal in the TRD-triggered data sample compared to the minimum bias data sample



The ALICE Transition Radiation Detector provides excellent electron identification and trigger performance

XXVII Quark Matter, Venezia 2018

Supported by BMBF Forschungsschwerpunkt ALICE Experiment 202

pachmay@physi.uni-heidelberg.de