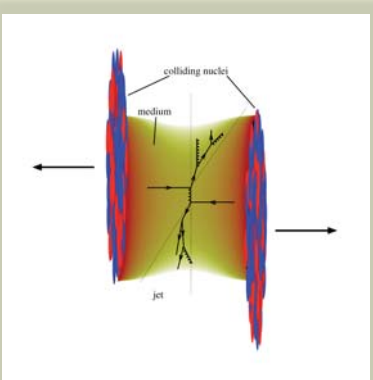
Study of Single Electron Production in p-Pb Collisions at $\sqrt{s_{NN}}$ = 5.02 TeV Triggered with the ALICE Transition Radiation Detector

Yvonne Pachmayer for the ALICE Collaboration

Physikalisches Institut - Ruprecht-Karls-Universität, Heidelberg



J. Klein (University of Heidelberg)
In-medium shower evolution

Probing Dense Matter

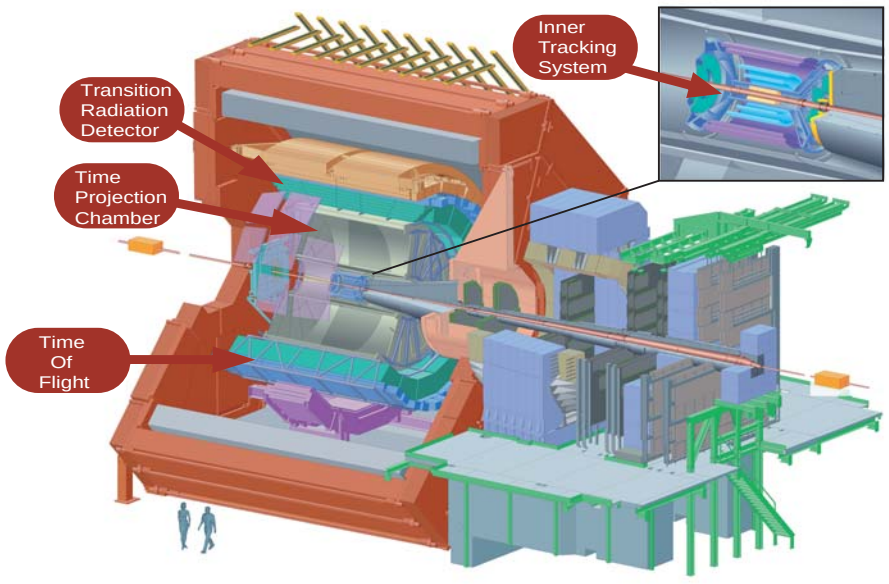
Heavy quarks (charm, beauty) are excellent probes of a Quark Gluon Plasma (QGP)

- Produced in initial hard scattering processes
  - → very short time scale
  - → sensitive to the full history of the collision
- Parton energy loss
- Quark mass dependence

} reveal properties of the medium

Study of p-Pb Collisions

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



Indirect Measurement of Charm and Beauty Production

Identified through measurement of single electrons from semi-leptonic decays of heavy-flavour hadrons:

$c \rightarrow e^+ + \text{anything}$ (B.R. 9.6%)
$b \rightarrow e^+ + \text{anything}$ (B.R. 10.9%)

Background contributions, e.g. electron pairs from photon conversion in the detector material and π^0- and η– Dalitz decays, subtracted with a cocktail

Requirements

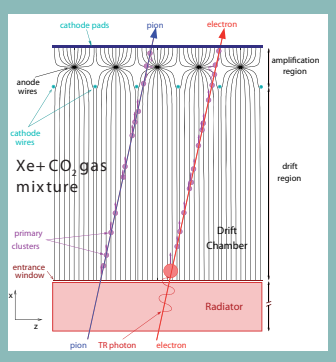
- Excellent electron identification
- Trigger to enhance events with electrons

→ ALICE TRD

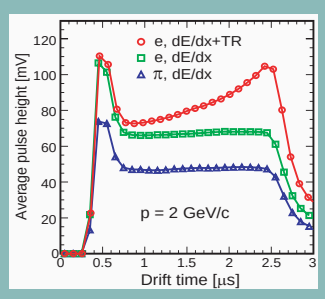
ALICE TRD in Numbers

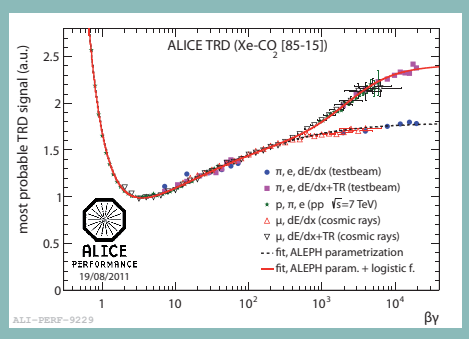
- Radial position: $2.9 < r < 3.7$ m
- Geometrical coverage: $|\eta| < 0.9$ and 2π in azimuthal direction
- Total thickness: $X/X_0 \sim 25\%$
- 18 sectors in azimuthal direction
  5 stacks in beam direction
  6 layers in radial direction
- Total active area: ~ 675 m²
- Gas volume: ~25 m³ Xe/CO_2 (85:15)
- 1.15 million read-out electronics channels

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

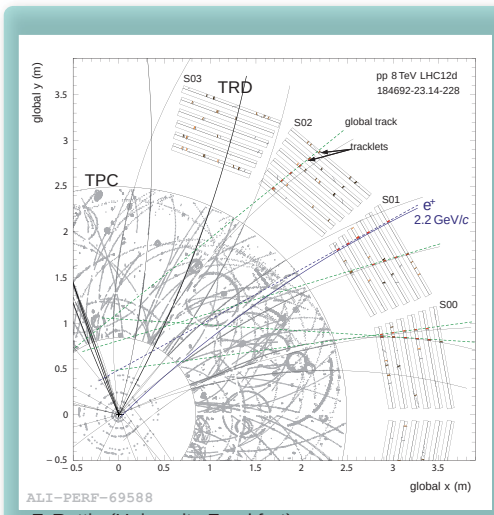


- Transition radiation (TR) produced by ultra-relativistic particles ($\beta\gamma \geq 800$) crossing the border between materials with different dielectric constants
- About 1 TR photon per electron with $p > 0.41$ GeV/c
- TR photon preferentially aborbed at entrance of the chamber
  → characteristic peak at large drift times





[1] ALICE Collaboration, A Transition Radiation Detector for Electron Identification within the ALICE Central Dector, CERN/LHCC 99-13, 200 LHCC/P3-Addendum 2, 1999; ALICE Transition Radiation Detector Technical Design Report, ALICE TDR 9, CERN/LHCC 2001-021.



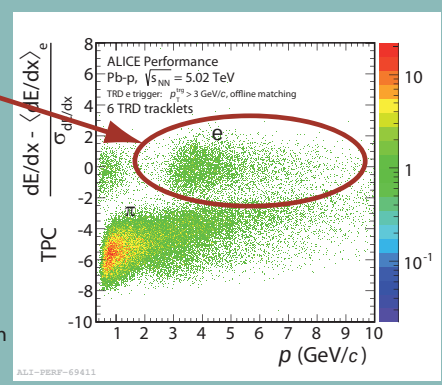
F. Rettig (University Frankfurt)

TRD Trigger

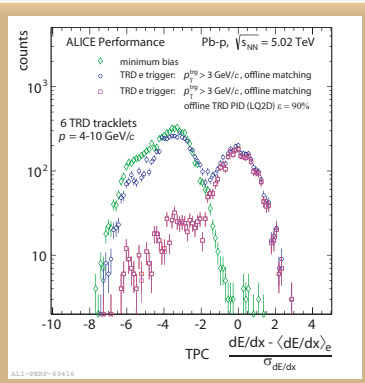
- Trigger to enhance quarkonia, heavy-flavour decays and jets at high transverse momenta[2]
- Trigger decision within 8 μs after the collision
- Chamber-wise tracking (tracklets): processing in multi-chip modules on-detector, incl. pedestal correction, gain correction
- Stack-wise tracking in Global Tracking Unit (FPGA based): tracklet matching and track reconstruction through linear fit
- Calculate Level1 trigger based on transverse momentum and PID of individual tracks
- Conversion in detector material at large radii; creating true electrons fulfilling trigger condition
  → removal via offline track matching

TRD Electron Trigger

- Total integrated charge
- Look-up table (LUT) translates charge into electron likelihood
- Global track PID obtained by averaging likelihoods from all tracklets
- Present status:
  - Likelihood on total integrated charge
  - LUT – reference spectra from real data
    $\gamma \rightarrow e^+e^-$
    $K^0 \rightarrow \pi^+\pi^-$
  - Threshold adjusted to obtain good rejection
- TRD electron trigger: adjustable threshold on transverse momentum (shown: 3 GeV/c) and electron likelihood



[2] J. Klein [ALICE Collaboration], Triggering with the ALICE TRD, Nucl. Instrum. Meth A 706 (2013) 23–28



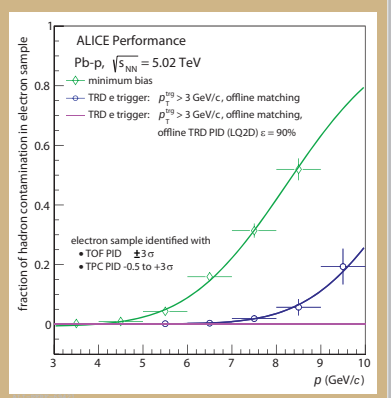
Electron Candidate Selection

- Requirement of a hit in the innermost layer of ITS (r = 3.9 cm) to reduce background from photon conversion
- 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: -0.5 to 3 σ

Hadron Contamination

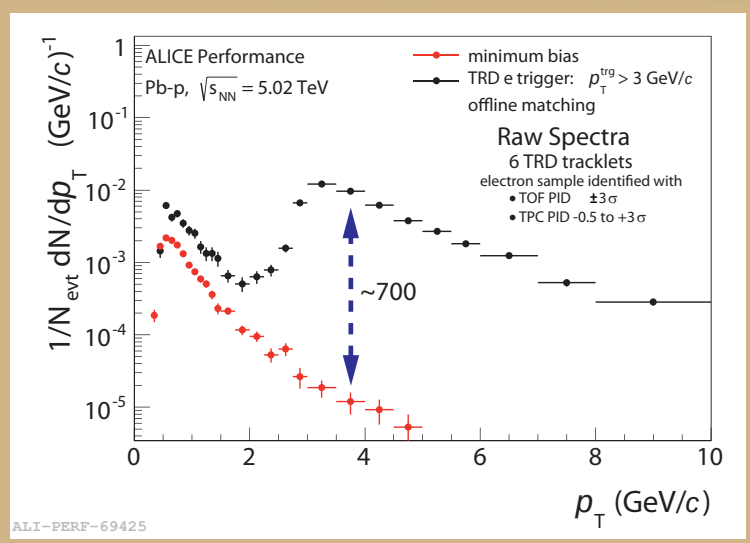
- Determined via fits of dE/dx in momentum slices
- Minimum bias sample
  - few electrons at intermediate and high momenta
  - large amount of hadron contamination
- TRD electron trigger
  - enhances electrons at intermediate and high momenta
  - intrinsically already suppresses hadrons

- Offline TRD electron PID offers further hadron suppression
  - example (LQ2D) with 90% electron efficiency yields no hadron contamination up to p = 10 GeV/c



LQ2D = two dimensional-likelihood
(exploit the temporal evolution of the recored signal)

Transverse Momentum Spectra of Electrons with TRD Electron Trigger



→ TRD trigger enhances electron content in the data sample by a factor of ~700 ←

XXIV Quark Matter, Darmstadt 2014

Supported by BMBF Forschungsschwerpunkt ALICE Experiment 201 ALICE EMMI

pachmay@physi.uni-heidelberg.de