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PHYSICS WITH THE ALICE TRD

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ABSTRACT

With 6 layers of drift chambers, each equipped with a layer of transition radiator, the Transition Radiation Detector (TRD) of ALICE is dedicated to selecting and fast tracking of high transverse momentum electrons within an environment of very large particle multiplicity corresponding to Pb-Pb collisions at the full LHC energy of 5.5 TeV/nucleon pair ($dN_{ch}/d\eta = 8000$ for $|\eta| < 0.5$). We present results on the particle identification, reconstruction efficiency, momentum resolution and background estimation obtained from simulations describing the trigger capability of the TRD.

1 Introduction

The heavy ion program at LHC will look for the properties of a new matter state (QGP) by detecting products from the early stages in the evolution of

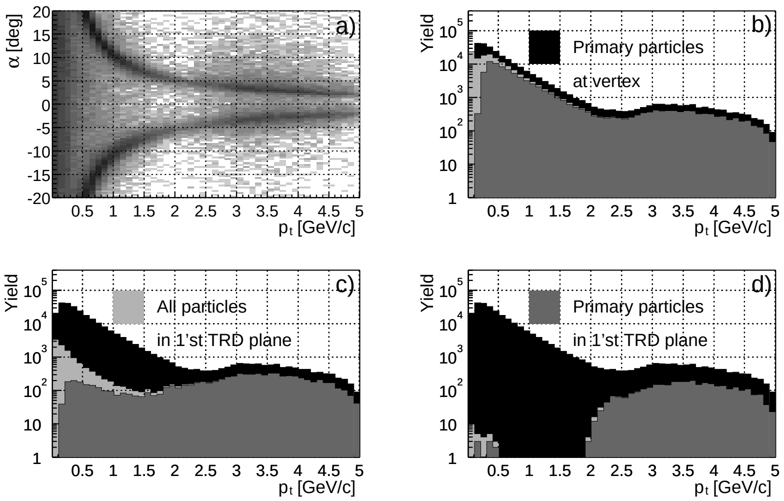

Figure 1: *Illustration of particle multiplicity reduction during on-line tracking: a) deflection angle in 0.4 T magnetic field from reconstructed tracklets in one TRD layer; b) charged particles spectra: primary particles within TRD acceptance, all particles found from reconstructed tracklets in one layer (local tracking, including secondaries) and only the primary ones; c) same spectra as in b) after local momentum cut; d) same spectra as b) after global tracking and momentum cut.*

the collision process. One of the most interesting probes are heavy vector meson resonances (J/Ψ, Υ) that are produced with probabilities of $\approx 10^{-5}$ per event. To gather enough statistics, in order to determine their abundance under various conditions (centrality, transverse momentum), requires an enhancement of their detection rate by a dedicated trigger.

2 Simulations

In order to simulate the trigger efficiency for a single high p_t electron in the Pb-Pb collision environment, we used a parametrisation of the HIJING spectra and varied the particle multiplicity. Few hundred e^+ and e^- were added in the range of 3 to 5 GeV/c (Υ di-lepton decay). The first action of the trigger process is to track particles independently in each of the six TRD layers, to build track segments (tracklets) and to evaluate from these the transverse momentum with a resolution of ≈ 20 %. To a certain transverse momentum corresponds a local

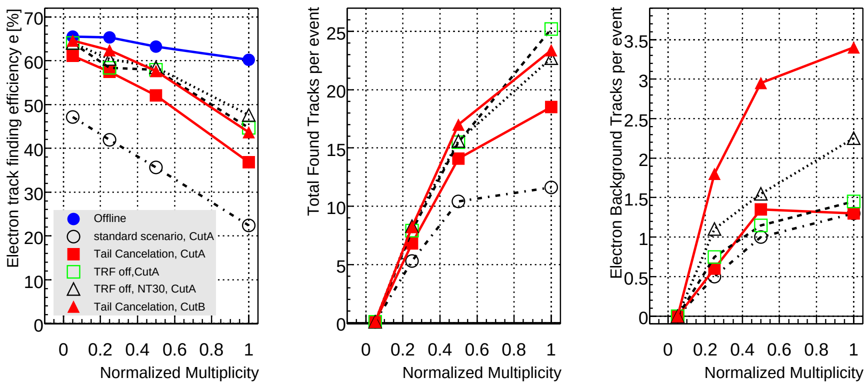

Figure 2: *Tracking performance for single electron as function of normalized event multiplicity. The central panel shows the pion contamination to be rejected by PID. The number of tracklets that originate from secondary electrons is displayed on the right panel.*

deflection of the tracklet in one drift chamber (Fig. 1a). The low p_t part of the spectrum is eliminated by cutting at the deflection angle corresponding to a primary momentum of 2 GeV/c (Fig. 1b,c). With still a large number of candidates, most of them secondary particles, the second step of the trigger is to combine the detected tracklets in all 6 layers of the TRD by matching them into full tracks and by applying a second cut based on the globally reconstructed transverse momentum having a resolution of about 3 % (Fig. 1d). Although the low p_t part of the spectrum is eliminated, there is still some background originating from fake tracks and high p_t conversion electrons from π^0 decays. A simple Particle Identification (PID) scheme is adapted [2)] into the global tracking, with a pion rejection of 15-35 over the multiplicity range. Changing the selectivity of the implemented cuts costs efficiency, as visible in Fig. 2 CutA, CutB. Beyond the flexibility of the tracking scenario, the performance is limited by the Bremsstrahlung loss of the electrons, from the vertex to the TRD, which develops into tails of the momentum distributions and further reduces the efficiency.

3 Results

Fig. 2 shows the single electron tracking efficiency, the pion content and the secondary electrons background per event, for different trigger schemes. For Υ

Table 1: *Integral numbers of* Υ *for one year of ALICE run:* 10^6 *s, integrated luminosity* $\mathcal{L}_{int}^{Pb-Pb} = 0.5/nb$ *(T=trigger, MB=minimum bias, Muon=ALICE muon arm).*

	N^{Y}_{T8000}	N^{Y}_{T2000}	N^{Y}_{MB8000}	$N^{Y}_{T8000}(Muon)$
$dN_{ch}/d\eta \quad \lvert\eta\rvert < 0.5$	8000	2000	8000	8000
produced number of Υ	285000			
decaying into acceptance	24750			15019
...without TPC pile-up	13238			-
off-line	5125	5628	5125	9349
standard	1339	2557	194	8414
digital filter	2878	5302	-	-

reconstruction, the integral numbers are shown in table 1 (with and without trigger, for two values of the maximum multiplicity of a central collision) and compared with predictions of the complementary measurements with the ALICE muon arm. The "off-line" case assumes infinite bandwidth of the DAQ and maximum possible trigger efficiency. The "standard" configuration combines the present trigger performance with the actual bandwidth DAQ. Without trigger one would get only about 200 Υ. The resolution of the TRD can be further improved by canceling the ion tail in the drift signal, with a significant increase in the trigger performance, as shown in the "digital filter" row. The invariant mass resolution for the Υ is 400 MeV.

4 Conclusions

By detailed simulations of the ALICE TRD it is shown that, even in high multiplicity environment of Pb-Pb collisions at the LHC, di-lepton decays of rare heavy meson probes can be selected on the trigger level. The efficiency and background rates are calculated for different event centrality and the improvement by using a trigger is discussed for Υ rates.

References

1. ALICE TRD Technical Design Report, CERN/LHCC 2001-021.
2. A. Andronic, these proceedings.