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JET ENERGY SCALE SETTING WITH «$\gamma + Jet$» EVENTS AT LHC ENERGIES. SELECTION OF EVENTS WITH A CLEAN «$\gamma + Jet$» TOPOLOGY AND $P_t^{\gamma} - P_t^{Jet}$ DISBALANCE

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1. INTRODUCTION

Here we continue a detailed study of the $P_t{}^{\gamma}$ and $P_t{}^{jet}$ disbalance and are planning to show how the calibration accuracy can be improved by simultaneous imposing both cuts Pt_{CUT}^{clust} and Pt_{CUT}^{out} as well as by introduction of jet isolation requirement.

2. DETAILS OF $P_t{}^{\gamma}$ and $P_t{}^{Jet}$ DISBALANCE DEPENDENCE ON Pt_{CUT}^{clust} AND Pt_{CUT}^{out} PARAMETERS.

In the previous papers ([1, 2]) we introduced observables (variables) and discussed what cuts for them may lead to a decrease in the $P_t{}^{\gamma}$ and $P_t{}^{Jet}$ disbalance. Below we concentrate on three of them: a restriction of cluster P_t (Pt_{CUT}^{clust}), limitation of the summed vector P_t of all particles detectable in the $|\eta| < 5$ region out of the "$\gamma + Jet$" system (Pt_{CUT}^{out}), the cut for jet isolation (ϵ^{jet}) [1].

Figs. 1–7 can be considered as an illustration and a complement to the tables of Appendixes 1–4 of [3]. In Fig. 1 we show a dependence of the ratio $(P_t{}^{\gamma} - P_t{}^{J})/P_t{}^{\gamma}$ on the Pt_{CUT}^{clust} value for the case of Selection 1 and two jetfinders LUCELL and UA1 for two $P_t{}^{\gamma}$ intervals $40 < P_t{}^{\gamma} < 50\ GeV/c$ and $300 < P_t{}^{\gamma} < 360\ GeV/c$. An evident tendency of balance improvement with decreasing Pt_{CUT}^{clust} is revealed for all three jetfinding algorithms and both $P_t{}^{\gamma}$ ($\approx P_t{}^{Jet}$) intervals. It is seen that we can essentially increase the accuracy by constraining Pt_{CUT}^{clust} (without $P_t{}^{out}$ restriction) by 5 GeV/c. Thus, for the UA1 algorithm the mean and RMS values of $(P_t{}^{\gamma} - P_t{}^{J})/P_t{}^{\gamma}$ drop from 0.029 down to 0.021 and from 0.174 down to 0.105, respectively, in the first $P_t{}^{\gamma}$ interval. For the LUCELL algorithm the situation after such a strict cut becomes even better. In Figs. 2–5 the average values for the $(P_t{}^{\gamma} - P_t{}^{J})/P_t{}^{\gamma}$ variable and the number of events for $L_{int} = 3\,fb^{-1}$ are displayed for two types of Selections as a function of Pt_{CUT}^{clust} for four $P_t{}^{\gamma}$ intervals and for all three jetfinders. Again, passing to Selection 2 we see that for all $P_t{}^{\gamma}$ intervals and for both jetfinders the balance gradually improves with restricting Pt_{CUT}^{clust}. After limiting P_t activity in the ring around the jet (Figs. 4, 5) the disbalance drops to the 1% level for the $40 < P_t{}^{\gamma} < 50\ GeV/c$ interval and for $Pt_{CUT}^{clust} = 5\ GeV/c$. The number of events in this case decreases by a factor of 5 as compared with Selection 1. It falls down to 30–50 thousand events at $L_{int} = 3\,fb^{-1}$, which seems to be still quite sufficient statistics for accurate determination of the jet scale and calibration. It should be noted that starting from $P_t{}^{\gamma}$=100 GeV/c practically all events in the Selection 2 sample are comprised inside the 1% accuracy window. At the same time the number of events decreases by about twofold with respect to Selection 1.

Up to now we have been studying the influence of the Pt_{CUT}^{clust} parameter on the balance. Let us see in analogy with Fig. 1 what effect is produced by the Pt_{CUT}^{out} variation. If we constrain this variable by 5 GeV/c, keeping $P_t{}^{clust}$ weakly restricted by $Pt_{CUT}^{clust} = 30\ GeV/c$ (practically unbound), then, as can be seen from Fig. 6, the mean and RMS values of the $(P_t{}^{\gamma} - Pt^{J})/P_t{}^{\gamma}$ variable in the case of UA1 algorithm decrease from 3% down to 1.6% and from 17.4% down to 8.8%, respectively, for $40 < P_t{}^{\gamma} < 50\ GeV/c$. For LUCELL jetfinder the $(P_t{}^{\gamma} -$
$!Pt^{J})/P_t{}^{\gamma}$ value is even less. At $300 < P_t{}^{\gamma} < 360\ GeV/c$ practically all events have the mean and RMS values of $(P_t{}^{\gamma} - P_t{}^{J})/P_t{}^{\gamma}$ less than 1.3% and 5%, respectively.

The influence of the Pt_{CUT}^{out} variation (with the fixed value $Pt_{CUT}^{clust} = 10\ GeV/c$)

[1] For the detailed explanation of cuts used here we refer the reader to papers [1–3].

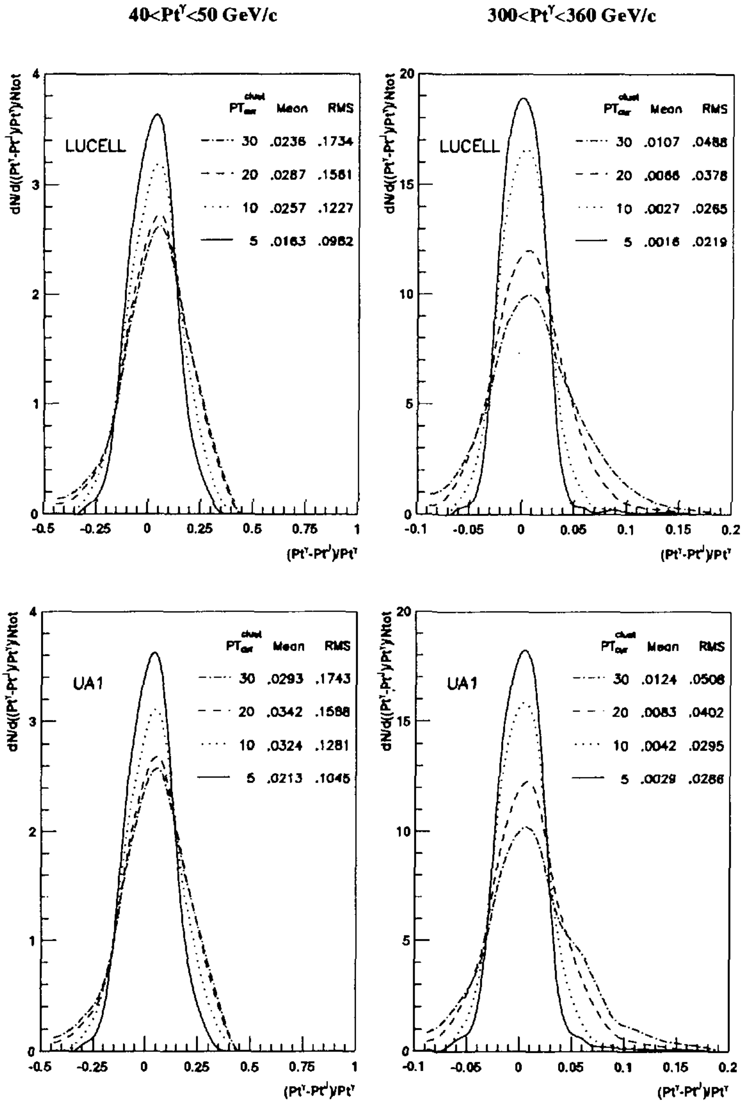


Fig. 1: A dependence $(Pt^{\gamma} - Pt^{J})/Pt^{\gamma}$ on Pt^{clust}_{CUT} for LUCELL and UA1 jetfinding algorithms and two intervals of Pt^{γ}. The mean and RMS of the distributions are displayed on the figures. Pt^{out} is not limited. Selection 1

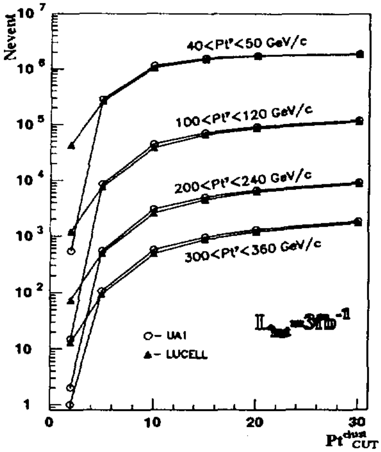
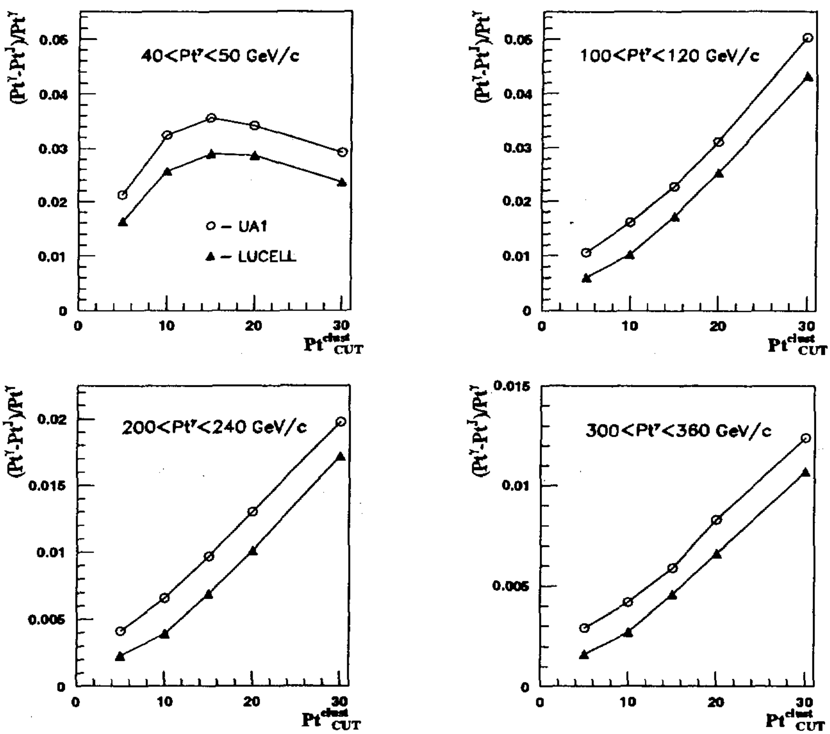


Fig. 2 (left): Selection 1. $\Delta\phi = 15°$. Number of events (for $L_{int} = 3fb^{-1}$) dependence on Pt^{clust}_{CUT} in cases of LUCELL and UA1 jetfinding algorithms. $P_t{}^{out}$ is not limited.

Fig. 3 (bottom): Selection 1. $\Delta\phi = 15°$. $(P_t{}^{\gamma} - P_t{}^{J})/P_t{}^{\gamma}$ dependence on $P_t{}^{clust}_{CUT}$ in cases of UA1 and LUCELL jetfinding algorithms. $P_t{}^{out}$ is not limited.



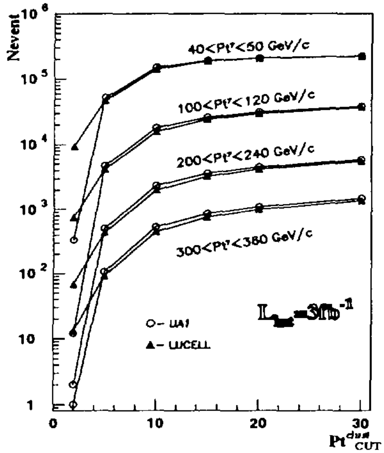
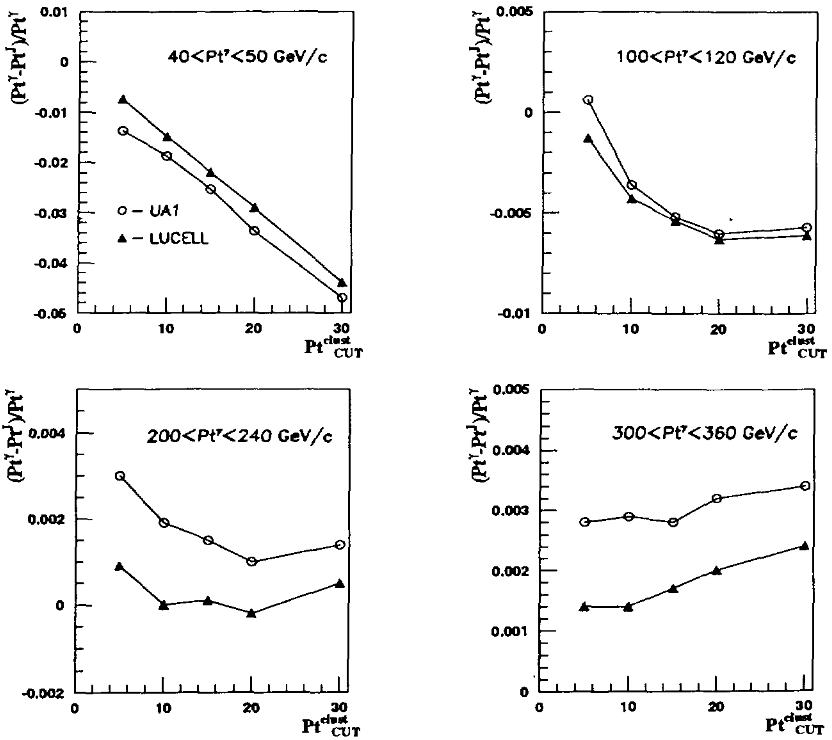


Fig. 4 (left): Selection 2. $\Delta\phi = 15°$, $\epsilon^{jet} < 2\%$. Number of events (for $L_{int} = 3fb^{-1}$) dependence on Pt_{CUT}^{clust} in cases of LUCELL and UA1 jetfinding algorithms. $P_t{}^{out}$ is not limited.

Fig. 5 (bottom): Selection 2. $\Delta\phi = 15°$, $\epsilon^{jet} < 2\%$. $(P_t{}^{\gamma} - P_t{}^{J})/P_t{}^{\gamma}$ dependence on Pt_{CUT}^{clust} in cases of LUCELL and UA1 jetfinding algorithms. $P_t{}^{out}$ is not limited.



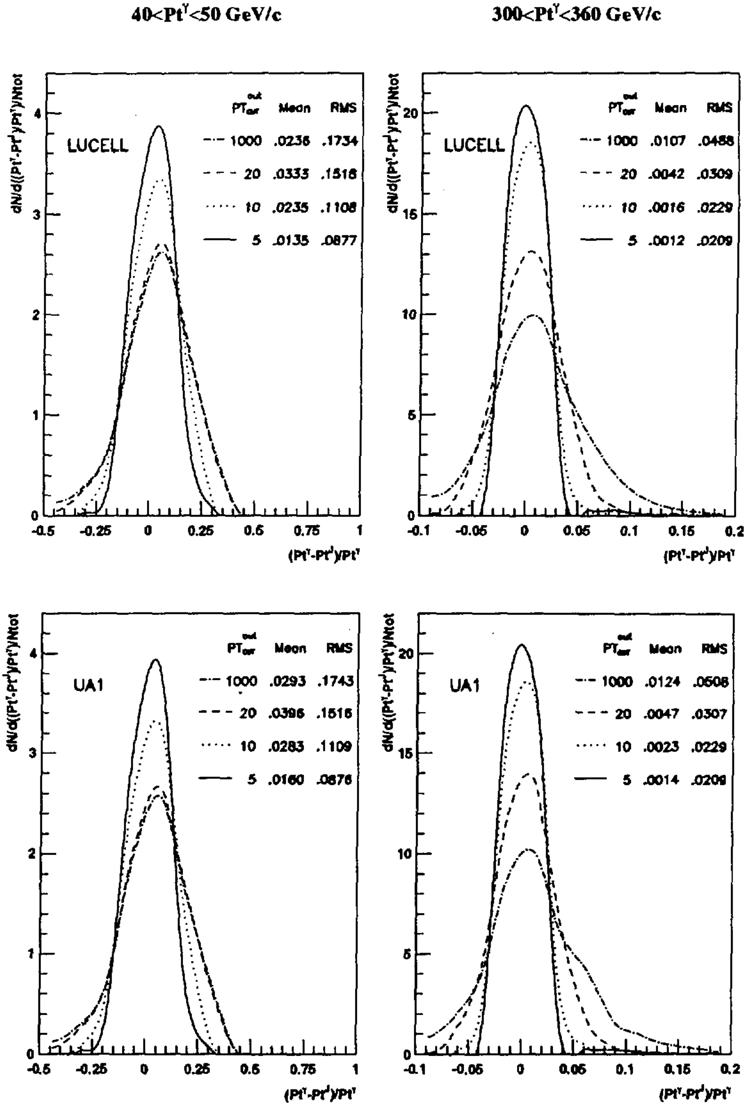


Fig. 6: A dependence $(P_t{}^{\gamma} - P_t{}^{J})/P_t{}^{\gamma}$ on $P_t{}^{out}_{CUT}$ for LUCELL and UA1 jetfinding algorithms and two intervals of $P_t{}^{\gamma}$. The mean and RMS of the distributions are displayed on the figures. $P_t{}^{clust} < 30\ GeV/c$. Selection 1

40<Pt$^\gamma$<50 GeV/c 300<Pt$^\gamma$<360 GeV/c

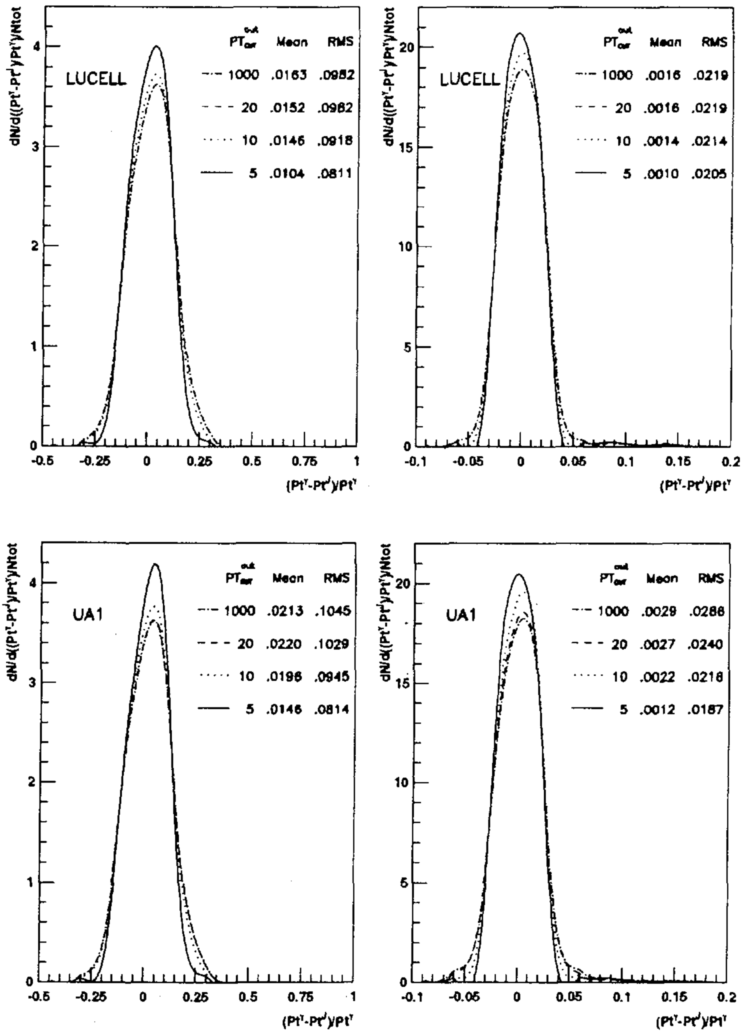


Fig. 7: A dependence $(P_t{}^\gamma - P_t{}^J)/P_t{}^\gamma$ on Pt^{out}_{CUT} for LUCELL and UA1 jetfinding algorithms and two intervals of $P_t{}^\gamma$. The mean and RMS of the distributions are displayed on the figures. $P_t{}^{clust} < 10\ GeV/c$. Selection 1

on the distribution of $(P_t{}^{\gamma} - P_t{}^{J})/P_t{}^{\gamma}$ is shown in Fig. 7 for Selection 1. In this case the mean value drops from 2% to 1.5% for UA1 and to about 1% for the LUCELL algorithm for $40 < P_t{}^{\gamma} < 50\, GeV/c$ interval. At the same time RMS changes from $10 - 11\%$ to 8% level for all algorithms.

3. SUMMARY

The new cuts introduced in [1] P_{tCUT}^{clust} and P_{tCUT}^{out} as well as introduction of a new object of isolated jet are found to be very efficient tools to improve the calibration accuracy. Their combined usage for this aim and for the background suppression will be shown in more details in paper [4].

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