Optimization of tau cone size

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Introduction

- I've been studying the influence of cone size on some cutting variables such as emRadius, Et and centrality fraction.
- Idea -> Determine the optimal value of cone size -> Where we get the best signal vs. background performance
- Data samples used:
  - Signal: 5188 with cells (~ 100 pb^{-1})
  - High Pt signal: 29.5k A(800)->tautau /5862/ with cells
  - Background: J1-J4 with cells (~ 100 pb^{-1})
- Analysis running on TTP11a (thanks Pavel & Stefania) – ATHENA 14.2.XX
- Calculating basic variables from cells for 5 different cone sizes (ΔR = 0.4, 0.35, 0.3, 0.25, 0.2)

Calculating the variables

- Cone:

$$\Delta R = \sqrt{(\eta_{cell} - \eta_{tau})^2 + (\phi_{cell} - \phi_{tau})^2}$$

  - Event Filter Tau -> matched to MC truth "GoodTau" in the TrigChain
  - Offline Tau -> inside of 0.2 cone with respect to EF Tau

- Transverse energy:

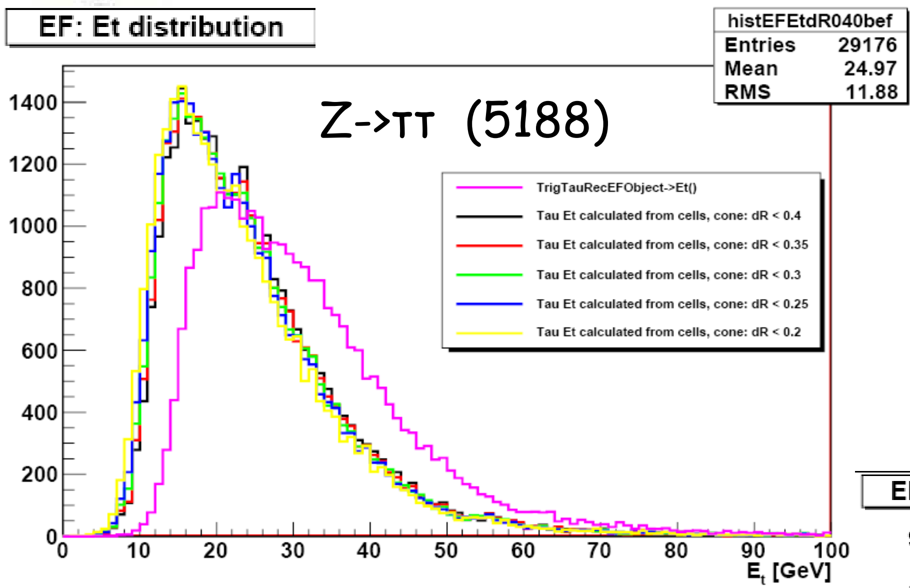
$$E_t(\Delta R < 0.4, \dots, 0.2) = \sum_{cells} \frac{E_{cell}(\Delta R < 0.4, \dots, 0.2)}{\cosh(\theta_{cell})}$$

- EM Radius:

$$emRad = \frac{\sum_{i=1}^{nCells} E_{t\,i} \Delta R_i}{\sum_{i=1}^{nCells} E_{t\,i}}$$

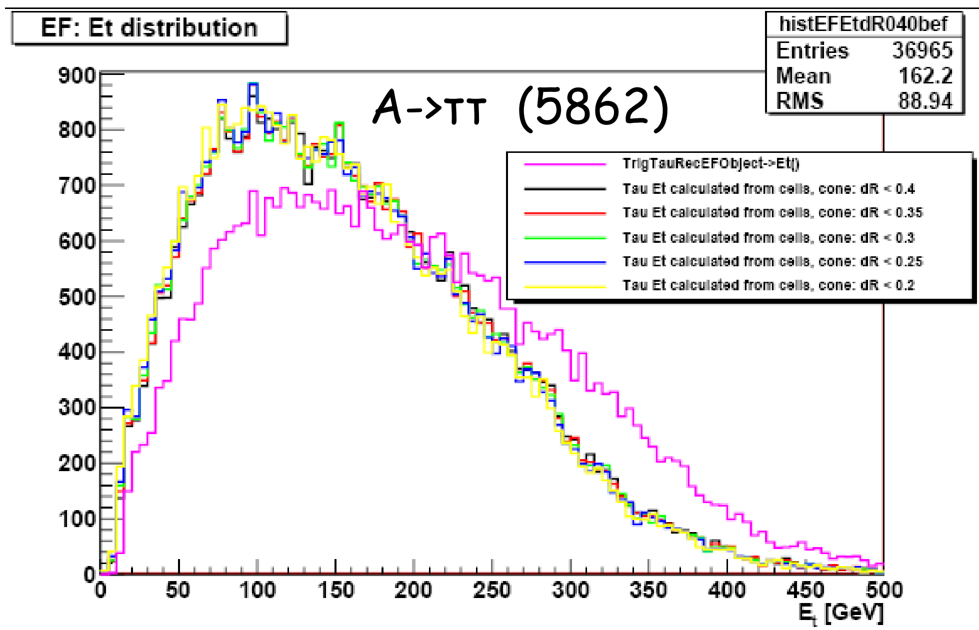
  - Only for layers 0-3

Et distributions: High Pt taus and Z taus

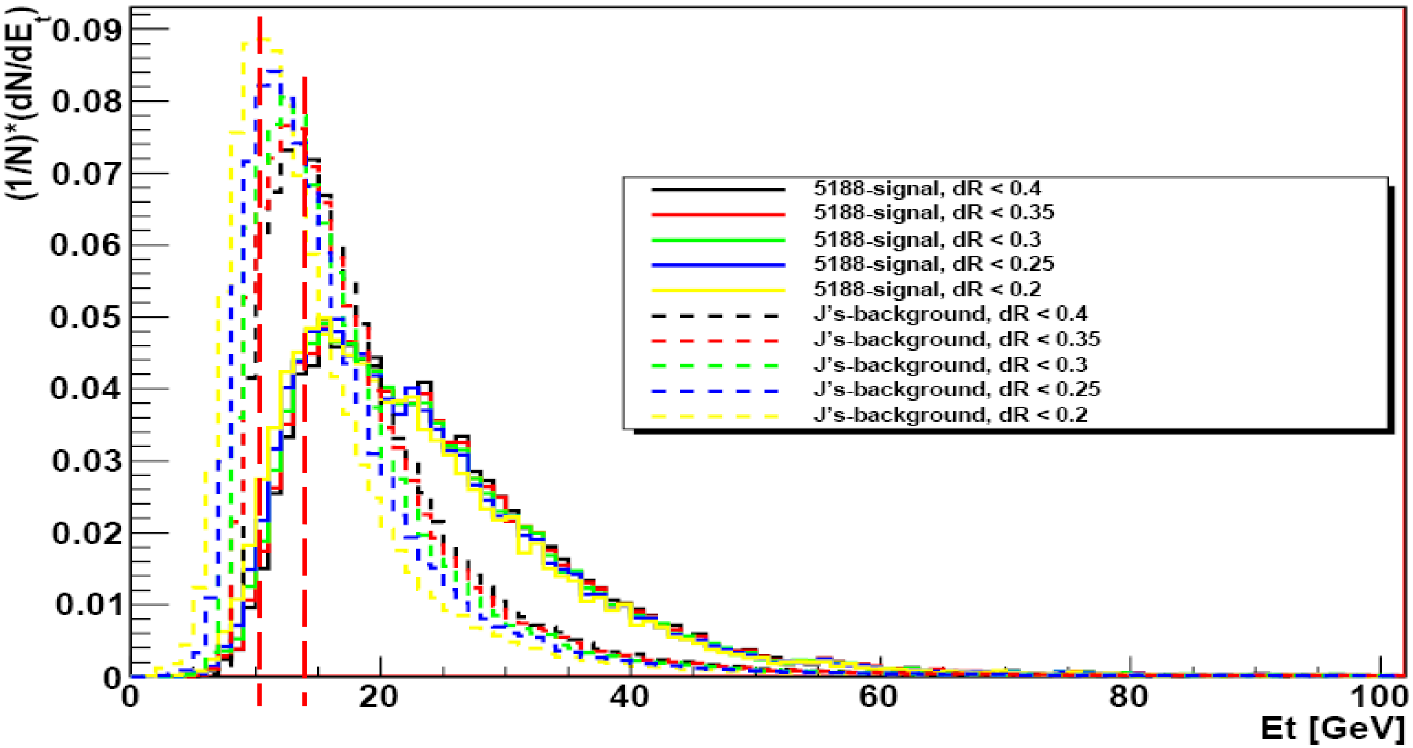


- As seen for both signal Et distributions, Et calculated from cells has shifted towards lower values if compared with EF Tau Et. This is due to calibration of EF Tau.

- However, there is no big shift between the total Et distributions for different ΔR cone sizes => the cone size within a reasonable range has a negligible influence on Et.

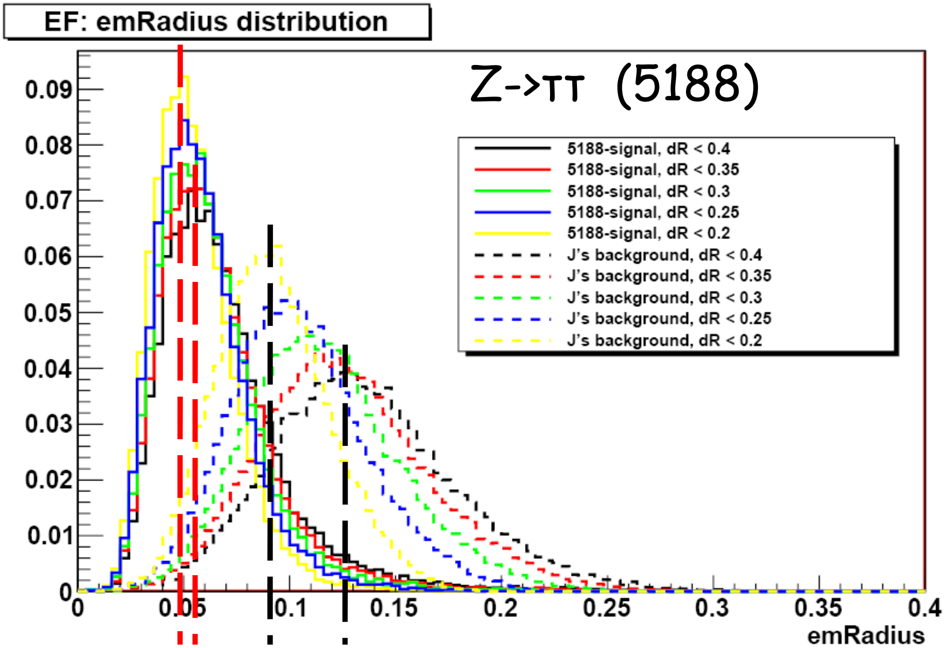


Et distributions: Signal/background



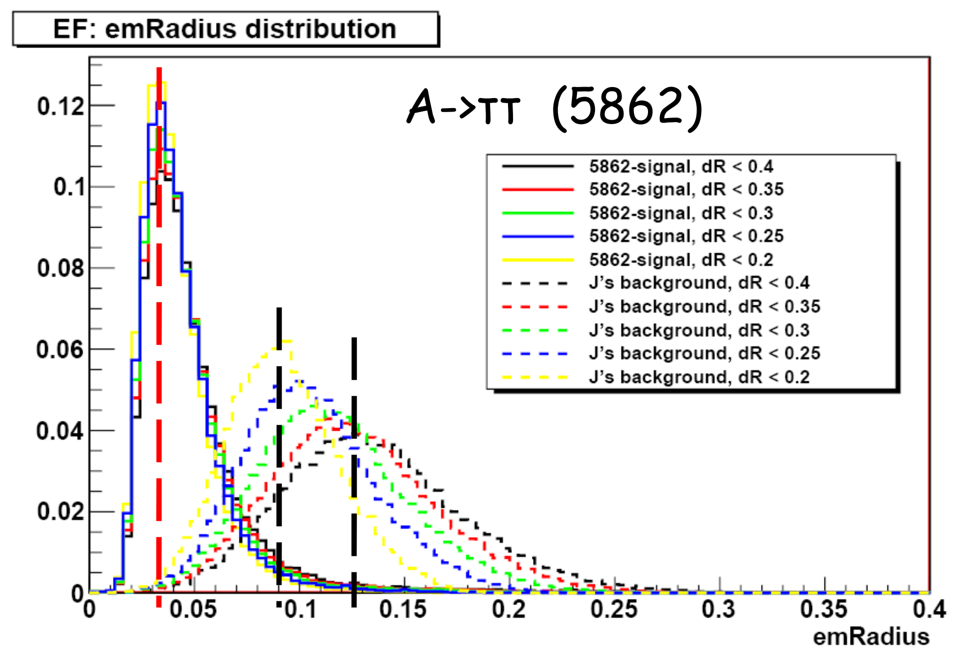
- We can see, while decreasing the cone size that almost nothing happens with the signal, the background peak however has shifted in around 5 GeV towards lower Et values.

EM Radius distributions

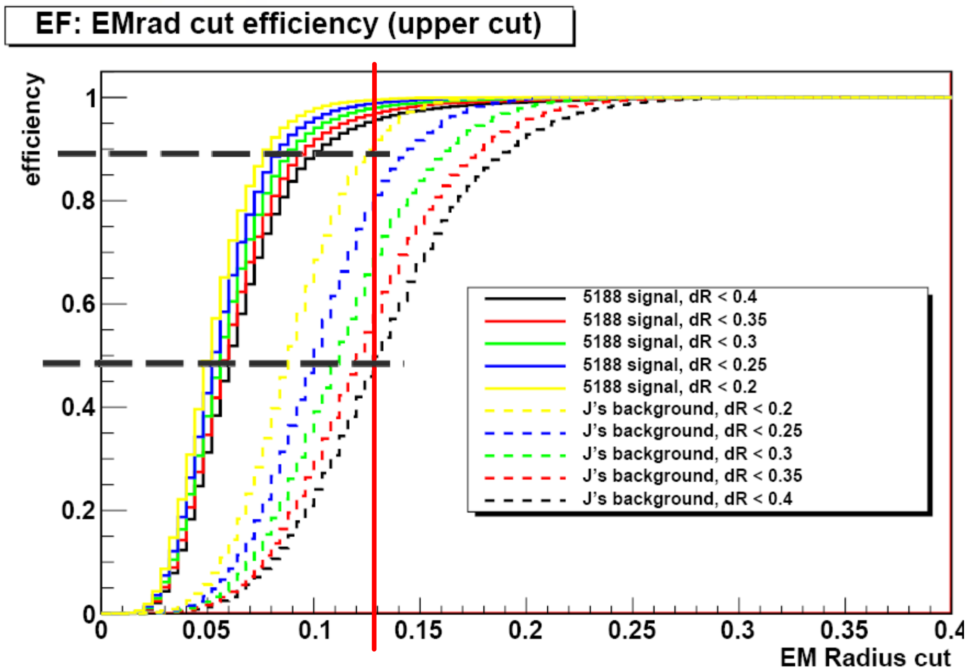


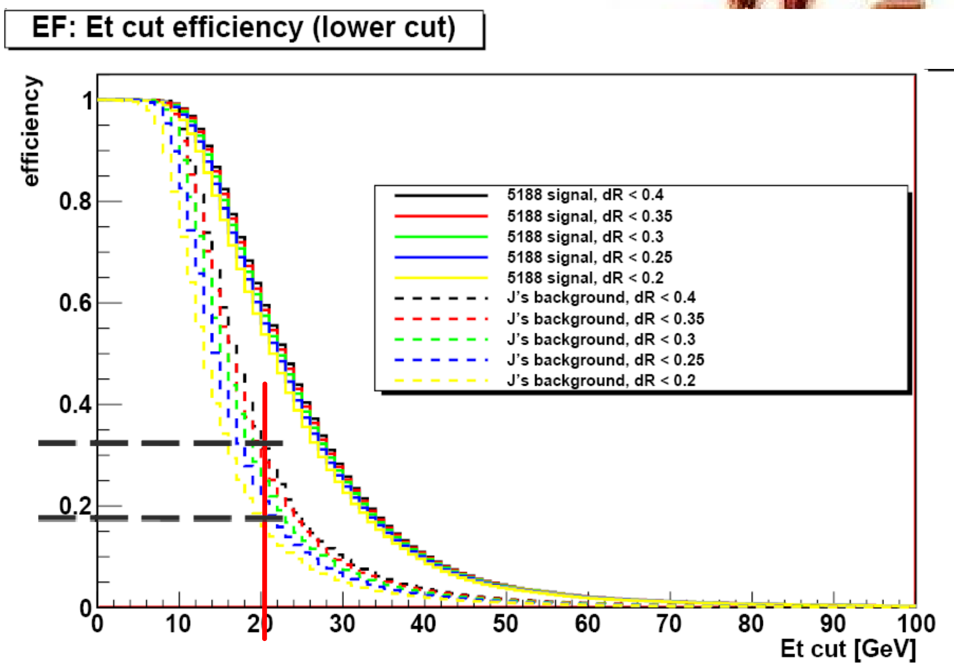
- The J background is shifting towards the signal if we decrease the cone size

- At the same time, the signal sample emRadius distributions are shifting very little in the case of 5188 sample and almost negligible in case of 5862.



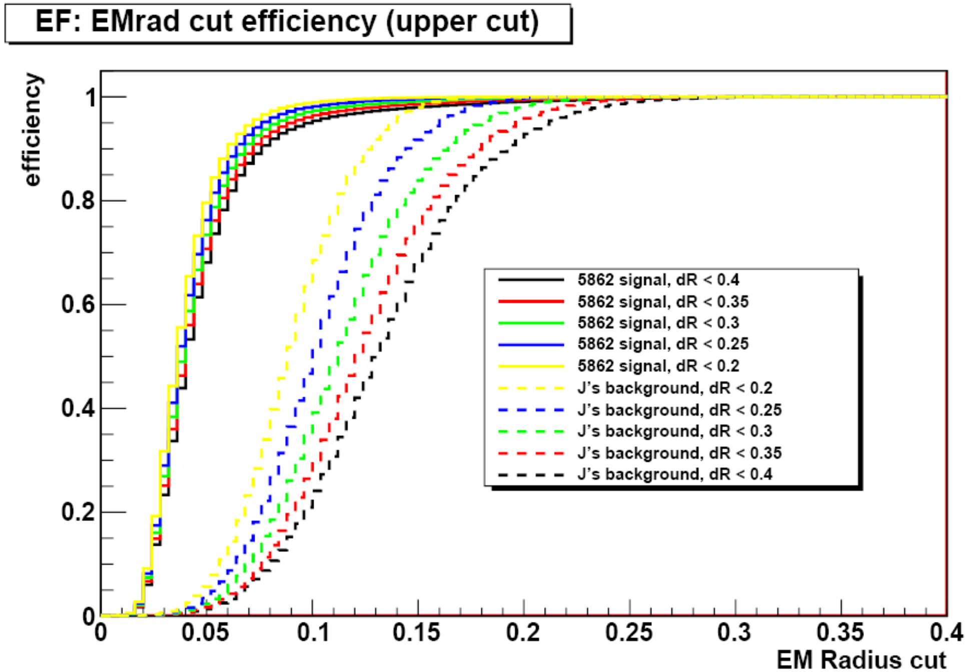
Efficiency plots (5188+J's)

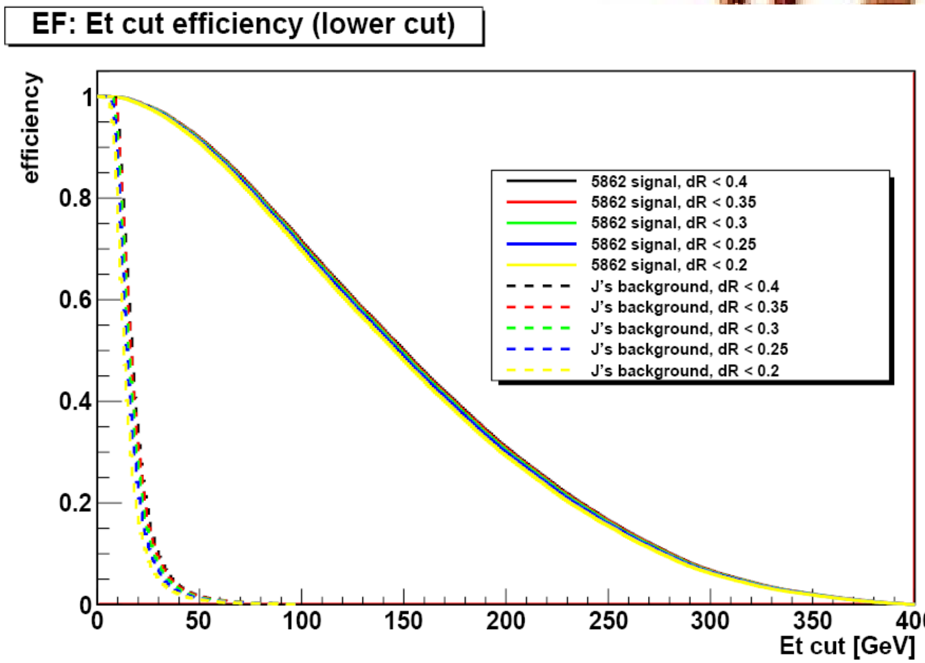




- One can see that while cutting on Et we get less "background efficiency" if we keep the cone size smaller, however if we cut on emRadius it is better to keep the 0.4 cone

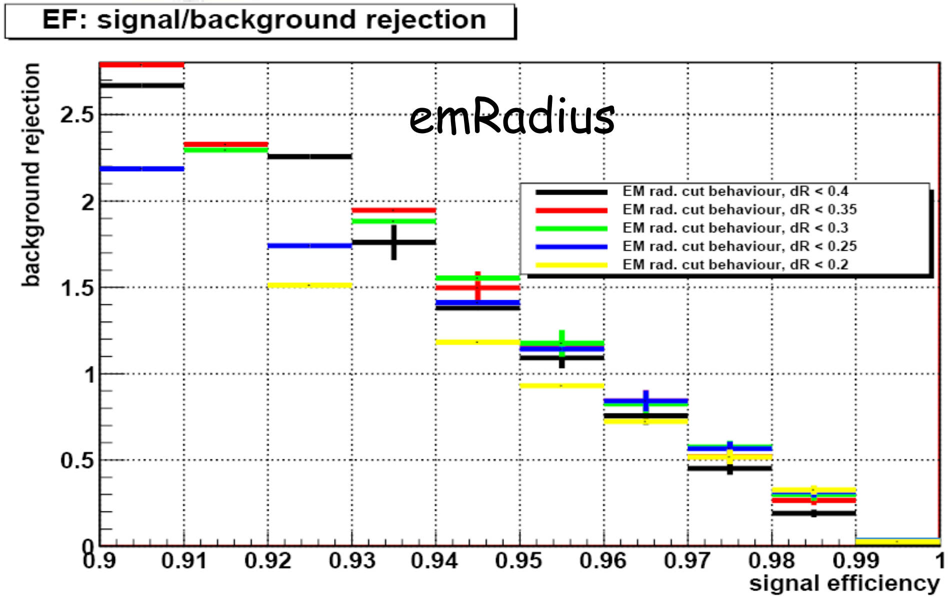
Efficiency plots (5862+J's)





- Comparing the efficiency plots of the emRadius cut in case of 5862 and 5188 sample one can see that they are behaving slightly different, however due to the fact that high Pt tau jets are much narrower this is not very surprising.

Signal Efficiency vs. Background Rejection (5188 & J's)

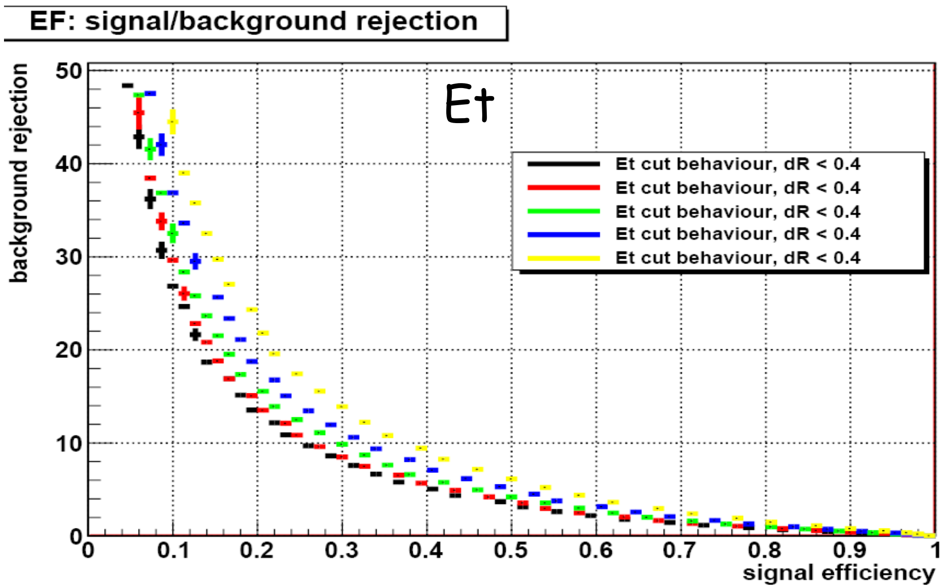


- Efficiency:

$$\varepsilon = \frac{N_{after\ cut}}{N_{before\ cut}}$$

- Rejection:

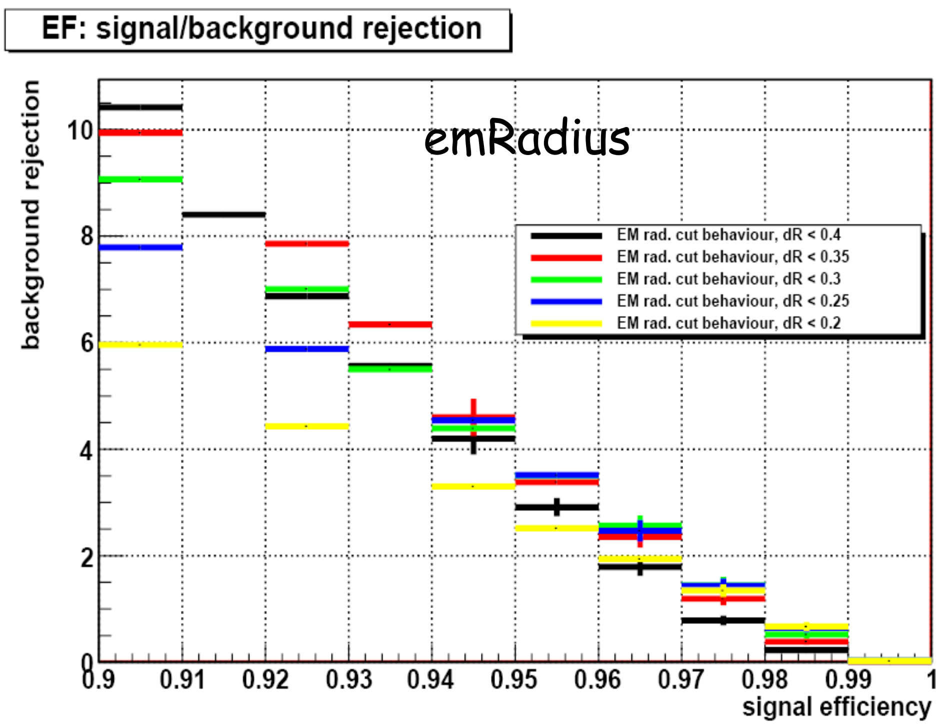
$$Rej. = \frac{1}{\varepsilon} - 1$$

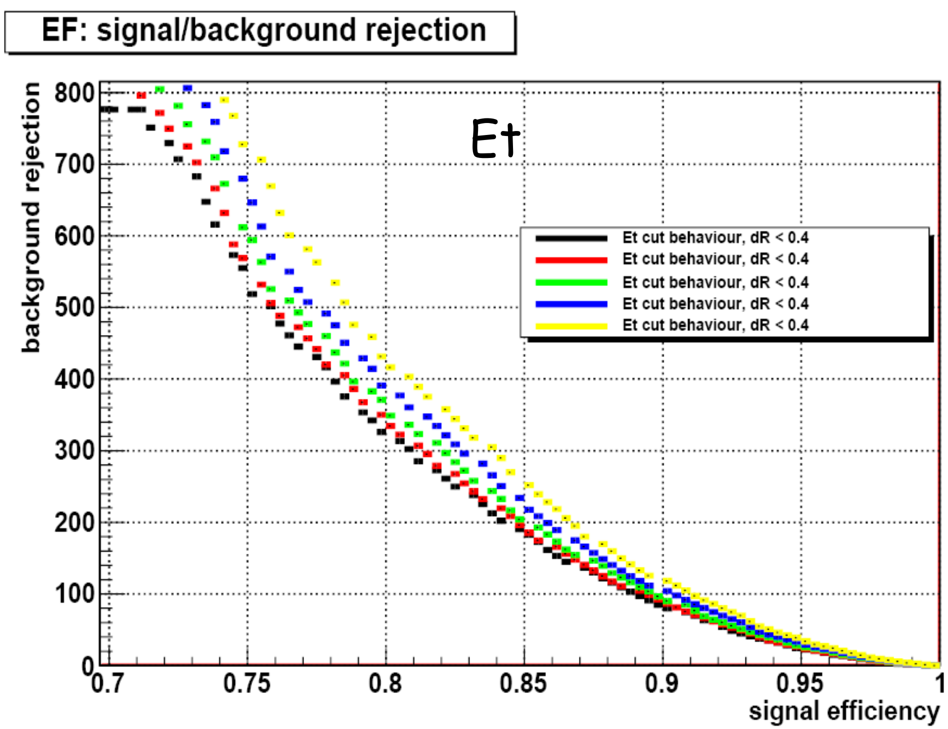


- We can see, that the difference of the rejecting power of emRadius can decrease almost by a factor of 2 (in the range of 50-100% signal efficiency) if we shrink the cone.

Signal Efficiency vs. Background Rejection (5862 & J's)

- The same conclusion goes also for high Pt taus





Signal Efficiency and Background Rejection Table (5188 sample)

EF signal:	Cut efficiency for Et > 20GeV cut	Cut efficiency for EMRadius cut*	Cut efficiency for Et> 20GeV and EMRad cut.
dR < 0.4	59.4%	66.7%	39.7%
dR < 0.35	58.5%	67.3%	39.4%
dR < 0.30	57.3%	67.9%	39%
dR < 0.25	55.8%	70.4%	39.4%
dR < 0.20	53.6%	73.3%	39.4%

EF bckg.:	Rejection after Et > 20GeV cut	Rejection after EMRadius cut*	Rejection after Et> 20GeV and EMRad cut.
dR < 0.4	2.2	14.5	48.6
dR < 0.35	2.5	12.9	47.6
dR < 0.30	3	10.5	45
dR < 0.25	3.7	6.9	37
dR < 0.20	5.2	4.2	31.4

* the efficiency is calculated with respect to the number of EF taus which already has passed the Et cut

- emRadius cut ($\Delta R < 0.4$) = 0.074
- emRadius cut ($\Delta R < 0.35$) = 0.0713
- emRadius cut ($\Delta R < 0.3$) = 0.0686
- emRadius cut ($\Delta R < 0.25$) = 0.067
- emRadius cut ($\Delta R < 0.2$) = 0.064

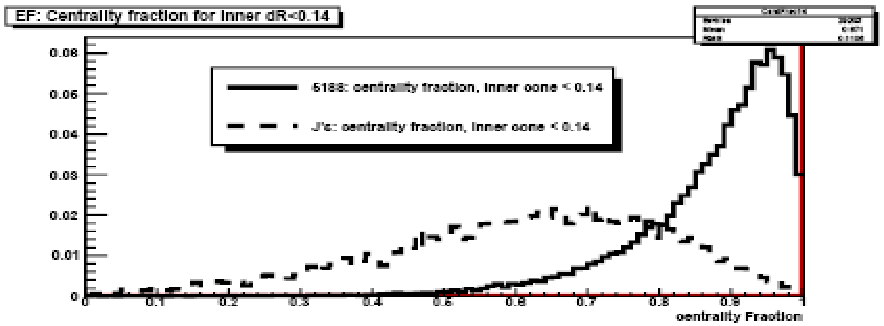
Centrality Fraction

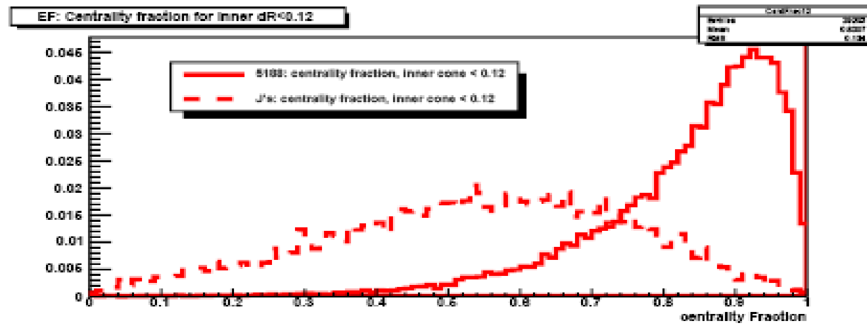
- In other cone based variables we can play with the cone sizes as well.
- Centrality Fraction is using 2 different cones – "inner cone" ($\Delta R < 0.1$) and the "outer cone" ($\Delta R < 0.4$).

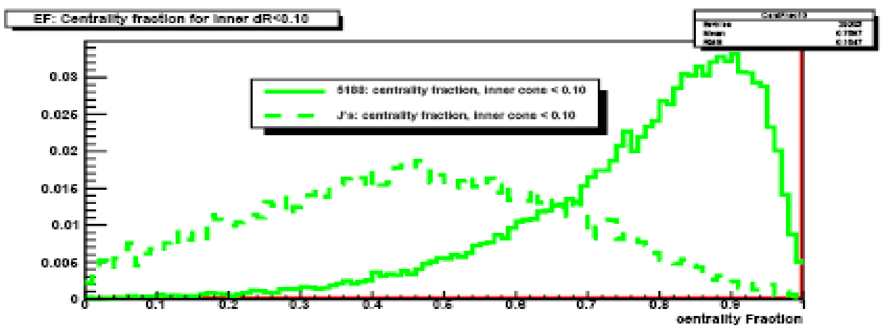
$$centr.Fraction = \frac{E_t(\Delta R < 0.1)}{E_t(\Delta R < 0.4)}$$

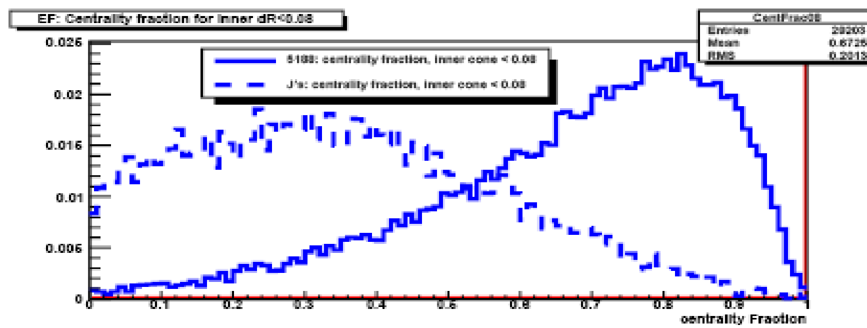
- Both Et's are in this talk calculated for EM calorimeter only!

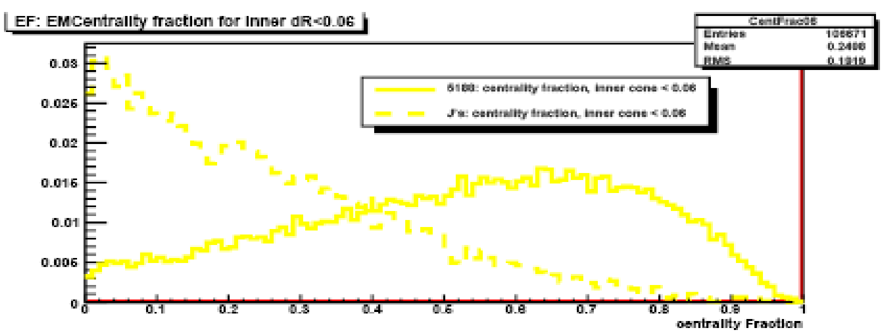
Centrality Fraction for low Et (20–30 GeV)

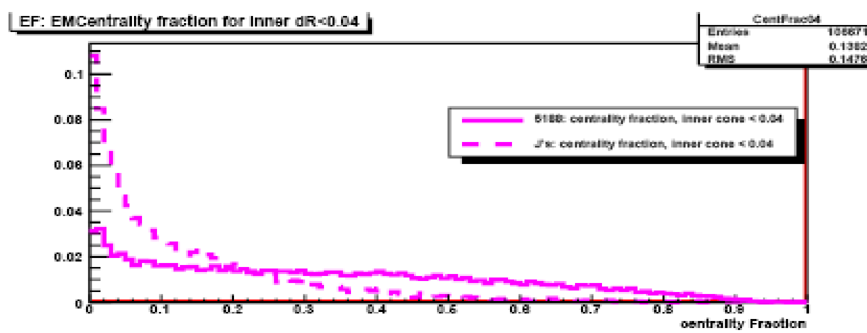




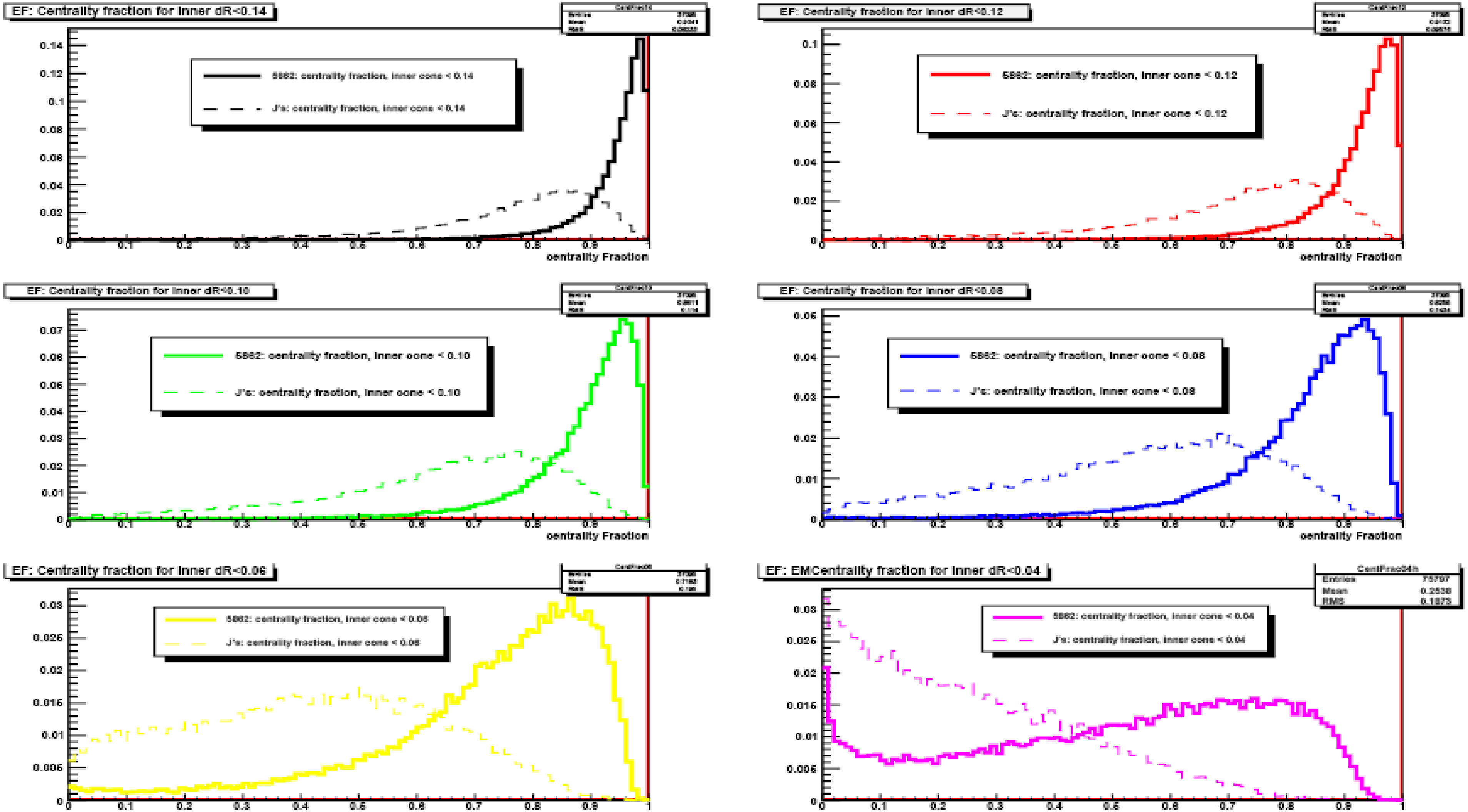




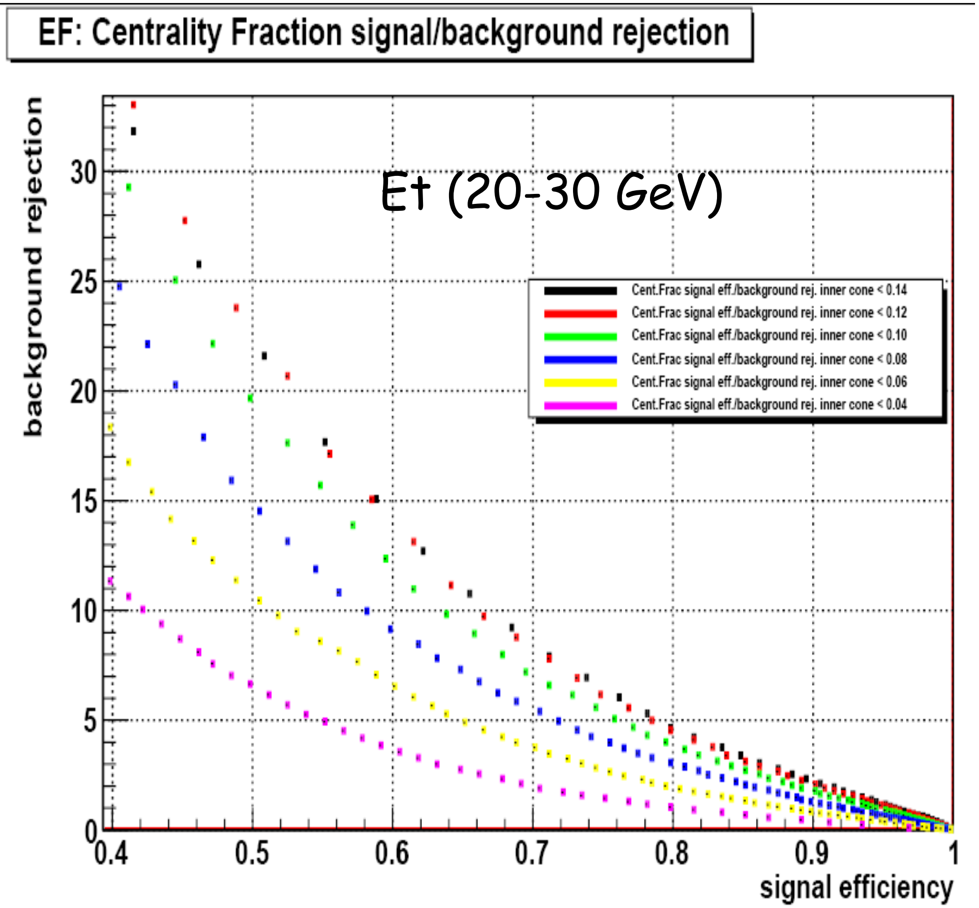


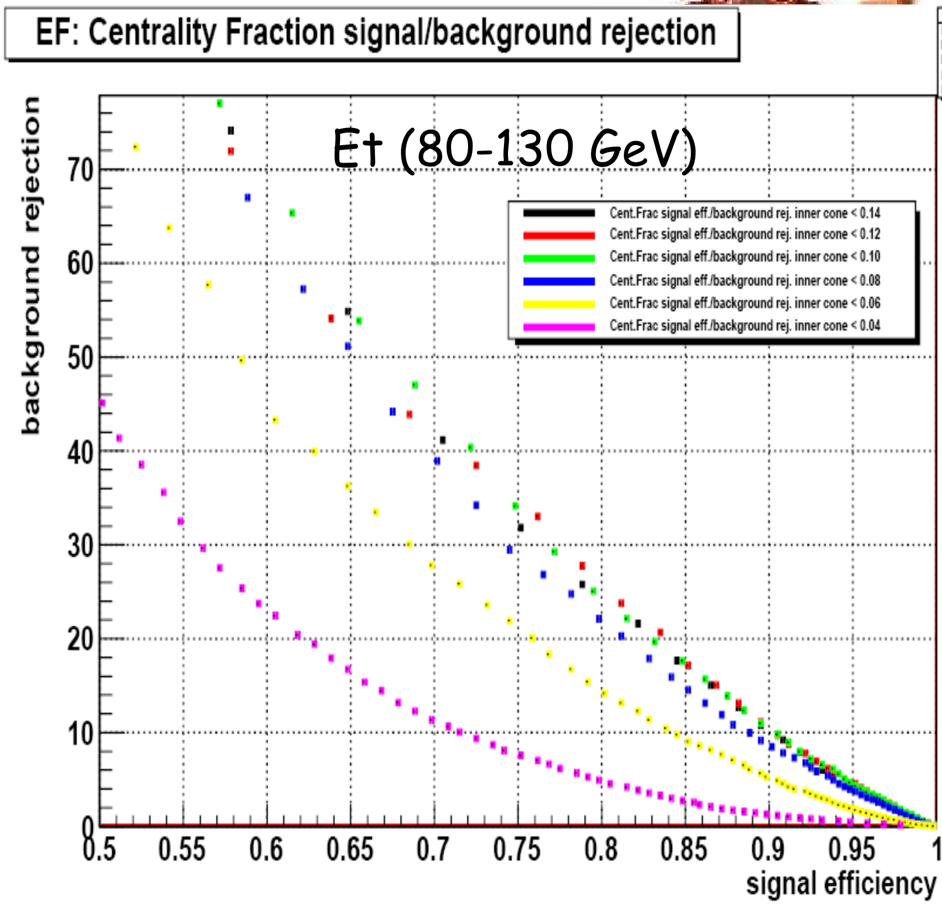


Centrality Fraction for high Et (80-120GeV



Centrality Fraction: Low Et vs. High Et





Conclusions

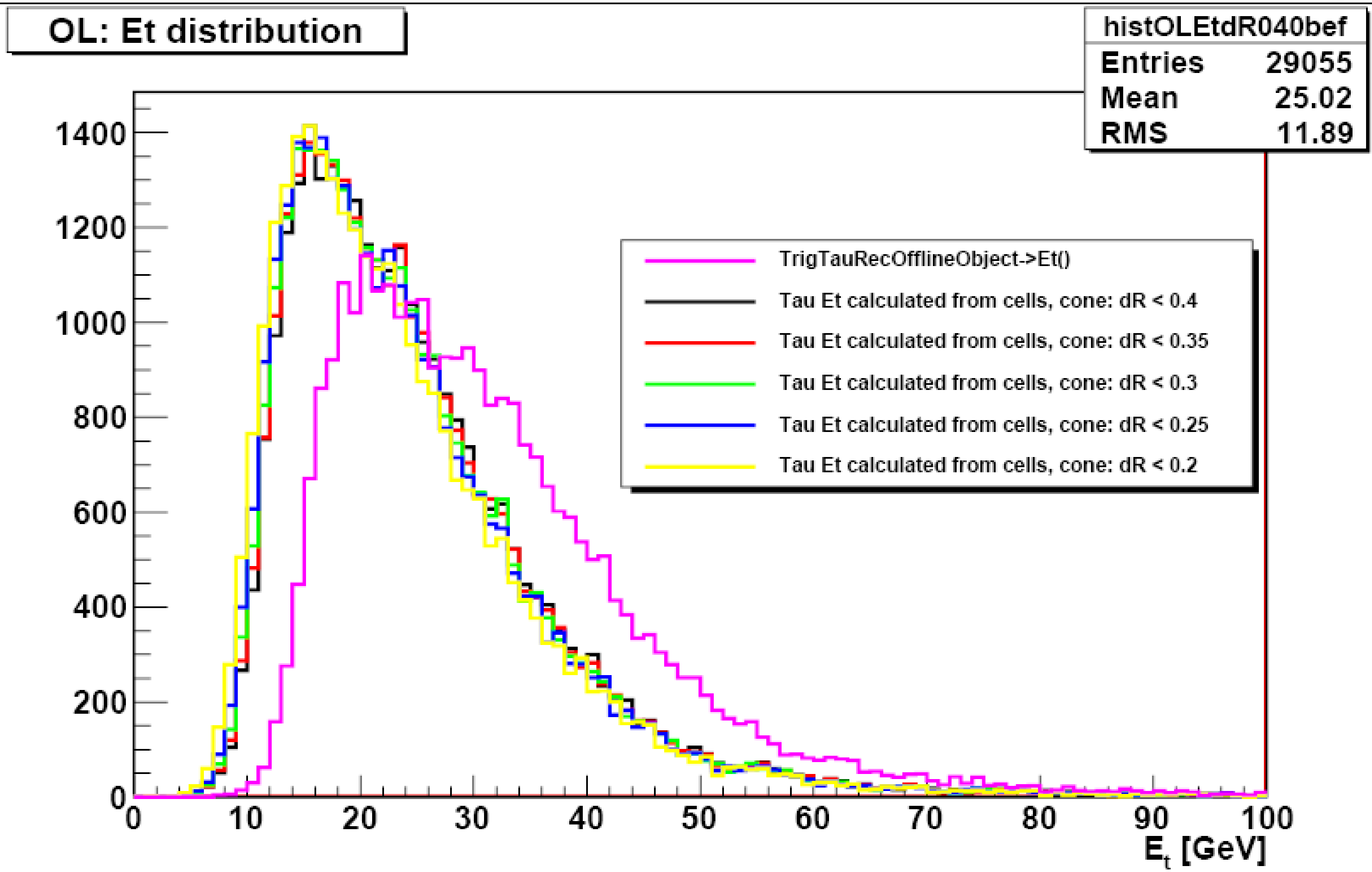
- Cutting variables are sensitive to the used cone size.
- We saw that the smaller the cone size was the worse background rejection we had while cutting on emRadius. Cone size of 0.4 gave the best bkcg. rejection however there was not much degradation while going to 0.35 cone.
- On the other hand, from the tables it is clear that if we cut on Et it's more convenient for us to use smaller cone sizes since the background rejection has grown more than 2x while going from 0.4 to 0.2 cone.
- We could consider different cone sizes for Et and emRadius.

Conclusions

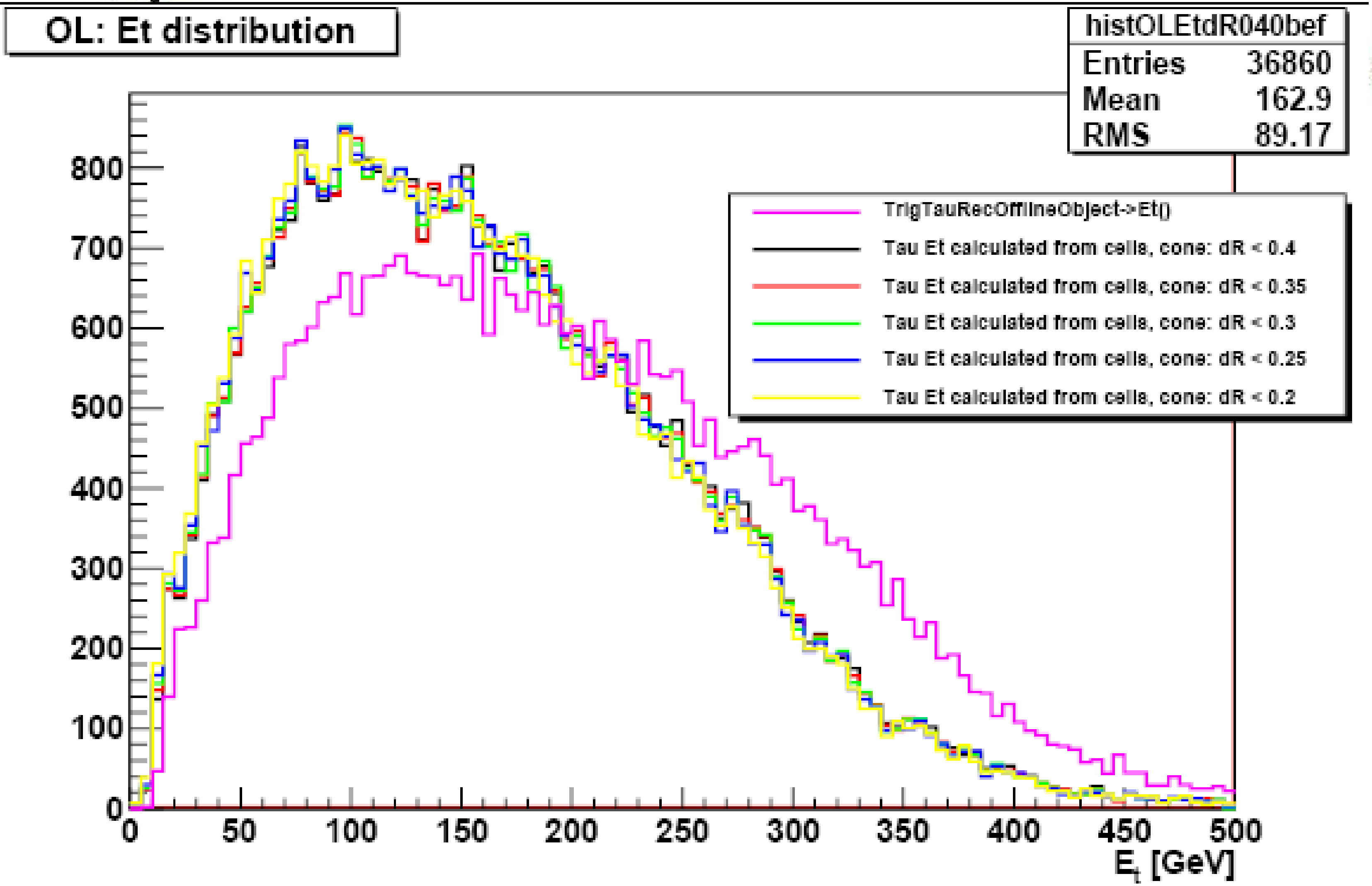
- In the Centrality Fraction study for various inner cone sizes in 5188 sample we can still get a better background rejection if we slightly increase the inner cone size from 0.1 to 0.12 or 0.14
- For high Et taus the signal efficiency vs. signal rejection behaves almost the same for inner cone sizes in the range from 0.1-0.14 (for 0.1 cone in many cases even better) -> High Et tau prefers smaller inner cone sizes.

Backup slides

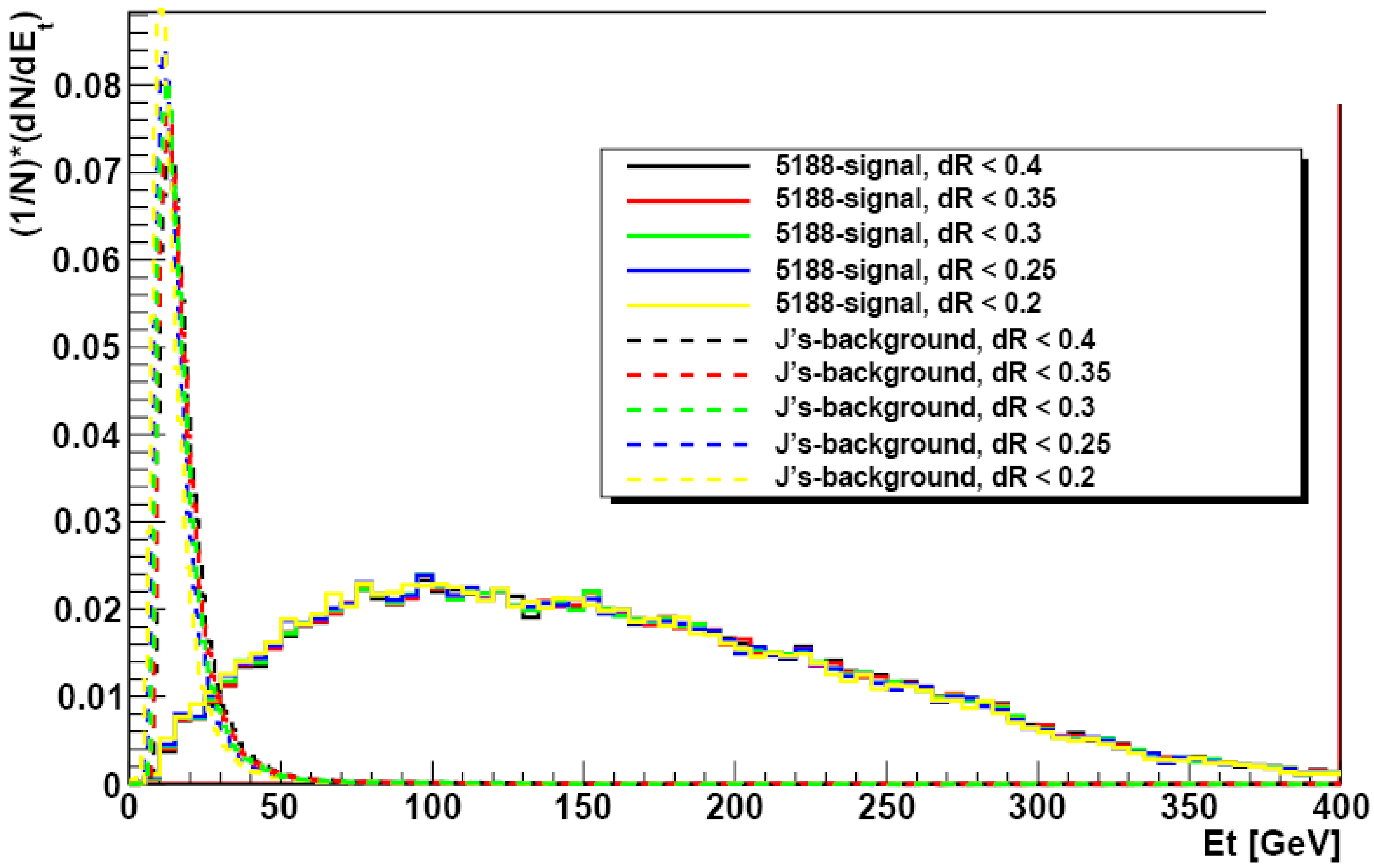
5188 Offline Et distribution



5862 Offline Et distribution



Et distributions: Signal/background (5862 sample)



Centrality Fraction cut efficiencies