Jet Studies with Higgs Events

Workshop on the Future of Higgs Physics

May 5, 2001

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for the DØ Collaboration

Tune jet algorithms parameters for Higgs searches:

- Introduction
- Calorimeter Tower Thresholds
- b-Jets Reconstruction Efficiencies
- b-Jets Energy Resolution
- Higgs Mass Resolution
- Conclusions

Introduction

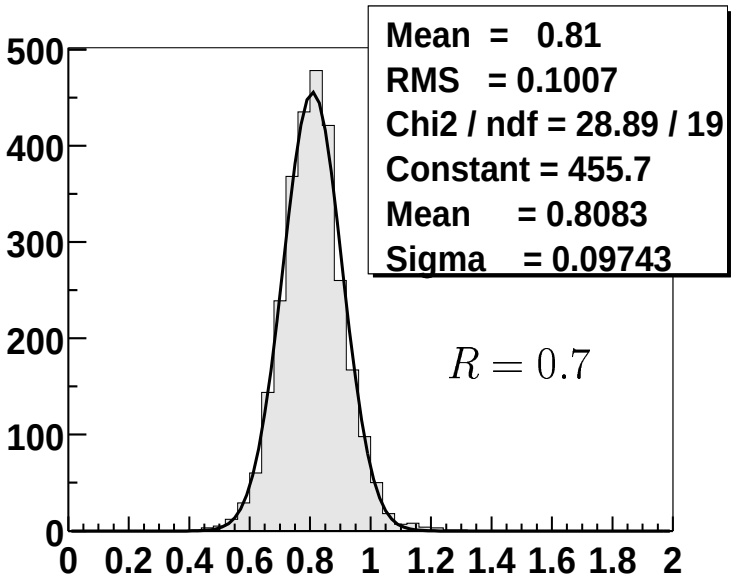
- Preliminary studies of jet algorithms (Cone, kT) and algorithm parameters (R, D) effects on resolution and efficiency reconstruction in Higgs events.
- Full GEANT simulation of Run II detector.
  [D0gstar (detector response) → D0Sim (digitalization) → D0reco (reconstruction)].
- Previous studies based on Run I detector simulation (hep-ph/0010338) or "fast" MC.
- RunII Jet Algorithms (kT, Cone) see hep-ex/0005012
- Work in progress!

Calorimeter Tower Threshold

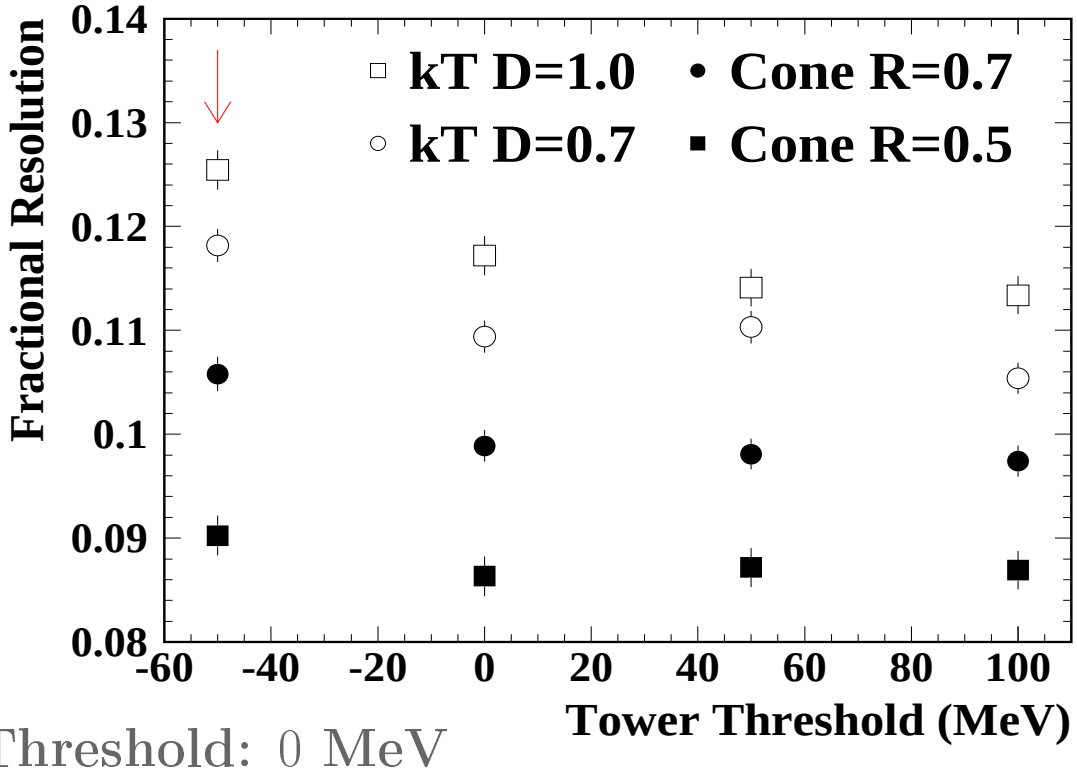
Energy associated with average # of min bias events for that luminosity is subtracted from the event ⇒ contribution from min bias events: Zero average ± fluctuations

Does the threshold of the calorimeter towers affect b jet resolution?

MC: $t\bar{t}$ with average 4.0 min bias overlayed (lowPt QCD) $E_{cal}/E_{particle}$ distributions ⟶



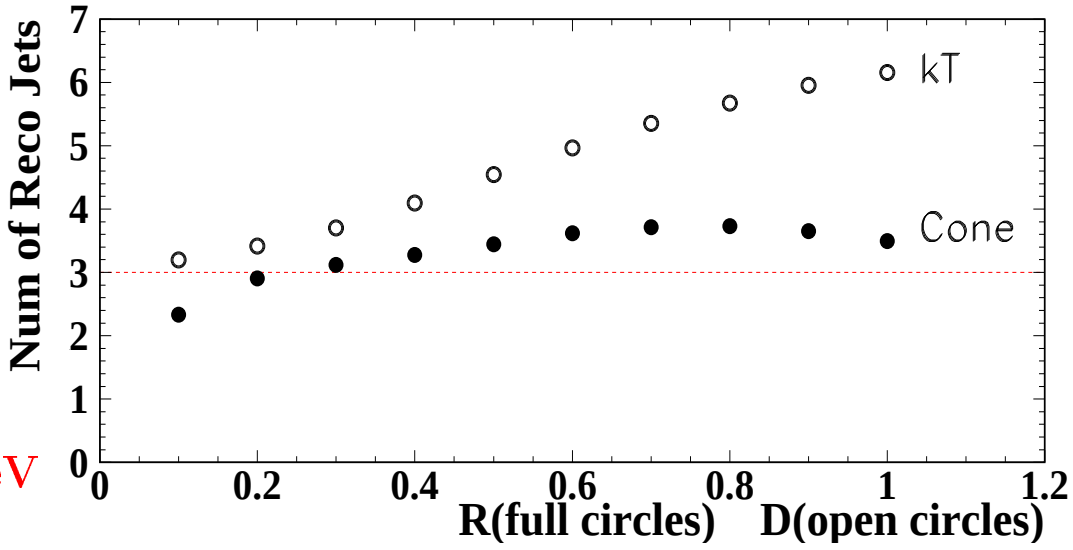
→ No Threshold



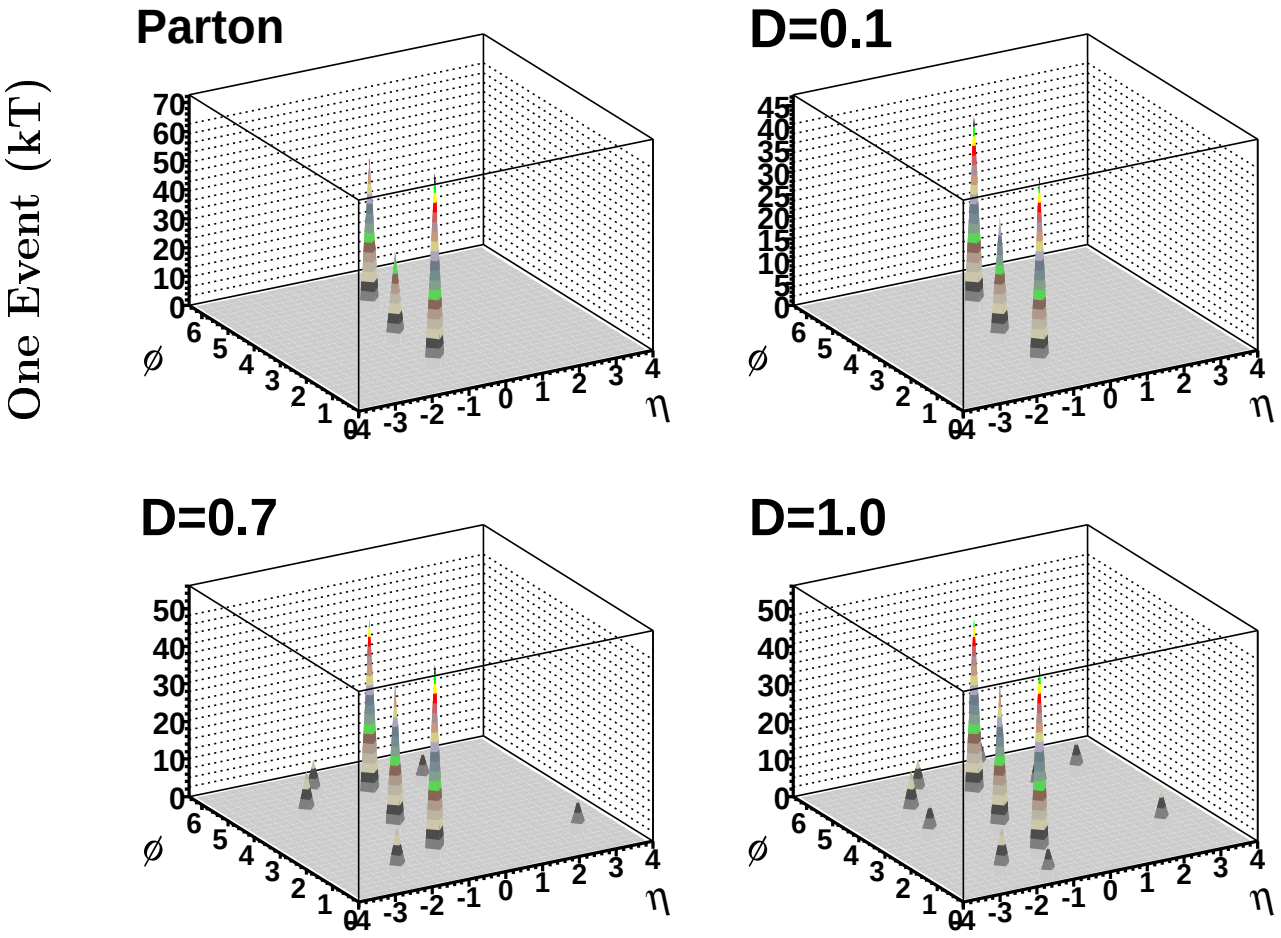
Selected Threshold: 0 MeV

Jets in Higgs Samples

MC Sample: WH $(W \to e\nu)$ **2.5mb** $(10^{32} cm^{-2} s^{-1})$ $[m_H = 120$ **GeV**$]$



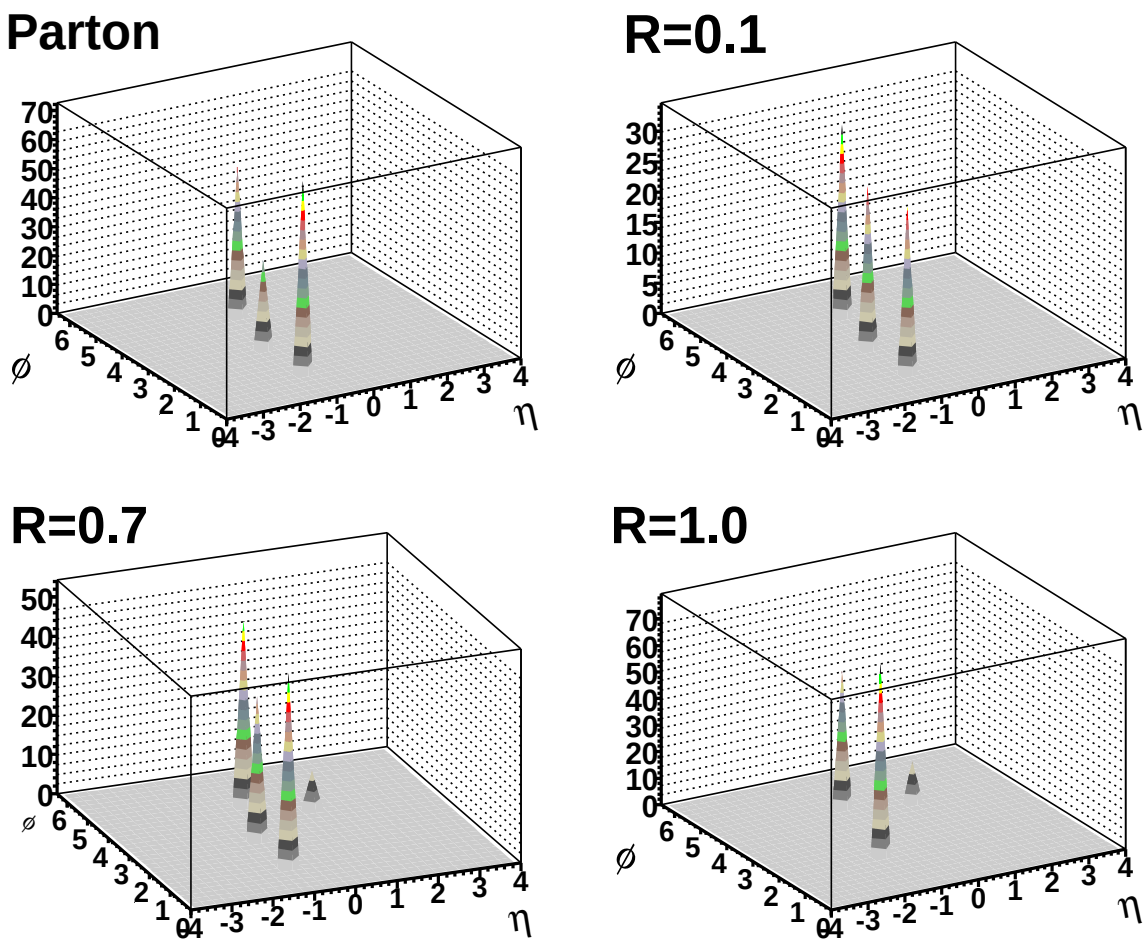
Min $E_T = 8$ GeV



For these events expect 3 jets ($b\bar{b}$ and e). "Min Bias" Jets.

Jets in Higgs Samples

Same Event shown for Cone:



$R = 1.0$ "lost" a jet (by merging)

- We are in the process of understanding the Run II jet algorithms and studying their performance for Higgs searches.

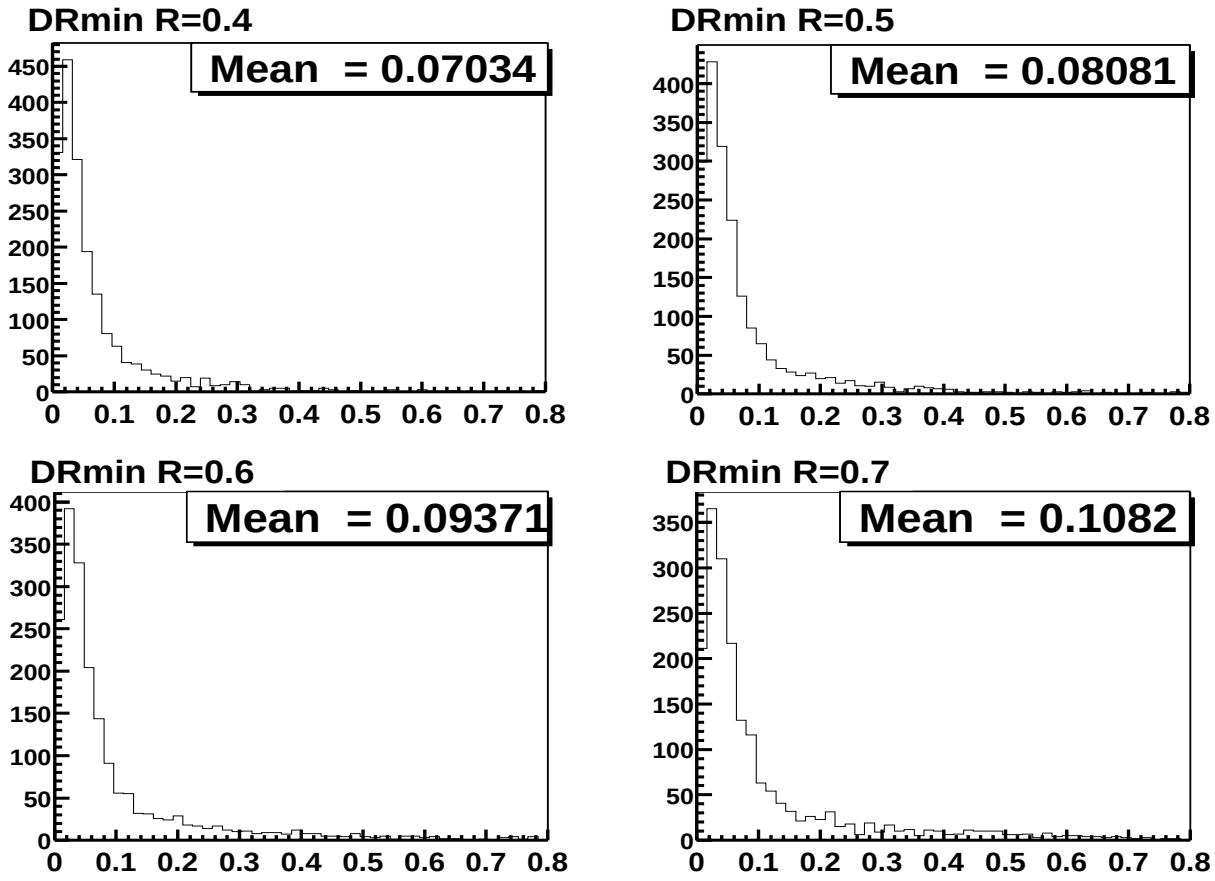
b-Jets "Reconstruction" Efficiencies

WH $(W \to e\nu)$ 2.5mb

b-quarks are matched in $\eta - \phi$ space to the reconstructed calorimeter jets. The "reconstruction" efficiency defined:

$(Num\_matched\_calor\_jets)/(Total\_Num\_of\_b\_quarks)$

DR distributions ($\Delta R = \sqrt{\delta\eta^2 + \delta\phi^2}$) between b-quarks and Calorimeter Jets (Cone):



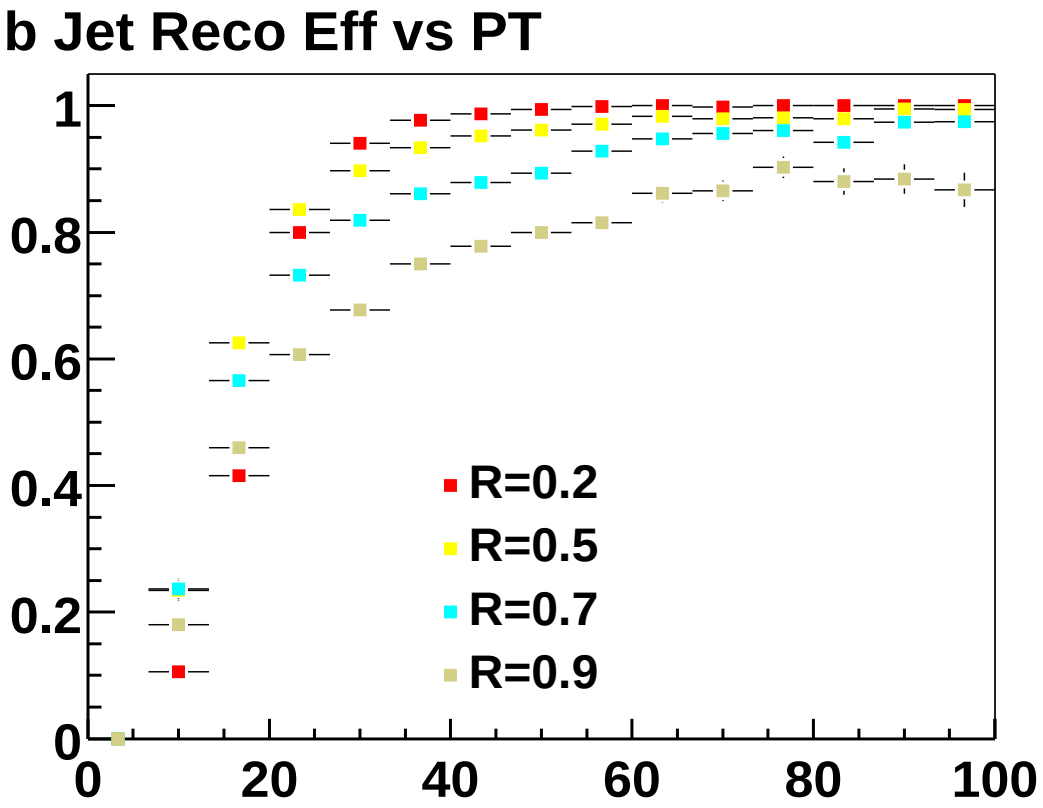
Similar distributions for kT.

$\Delta R \sim 0.2$ "reasonable" choice.

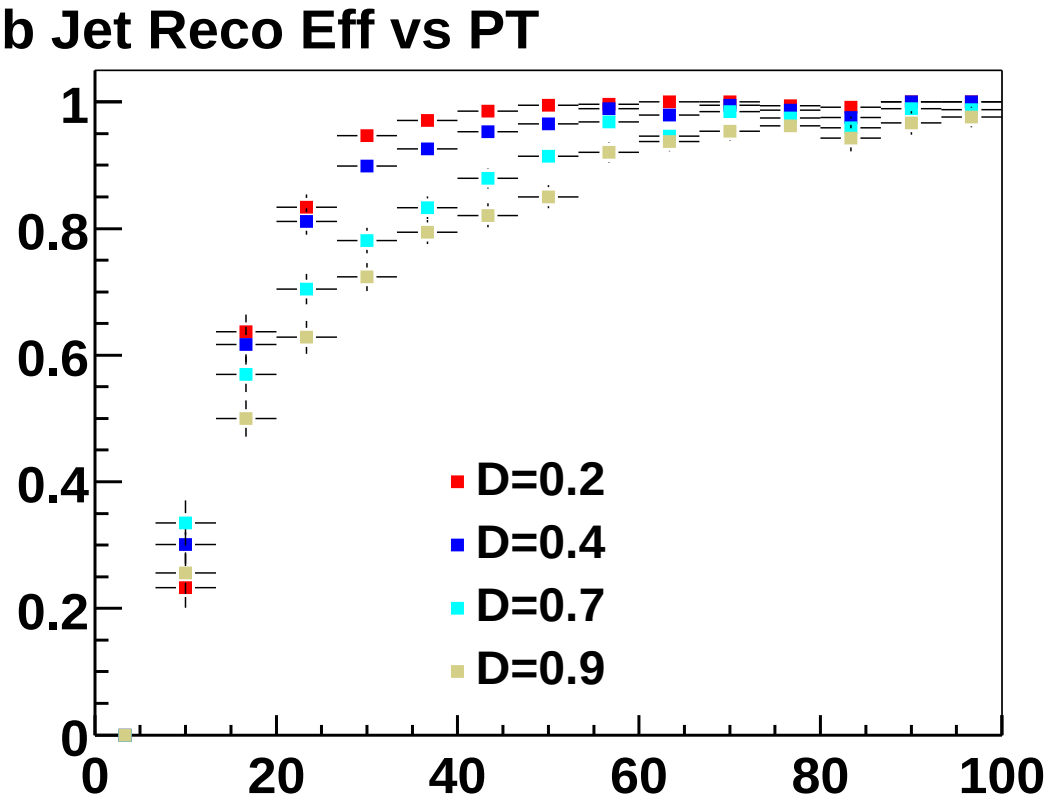
b-Jets "Reconstruction" Efficiencies

$\Delta R < 0.2$

Cone $\longrightarrow$

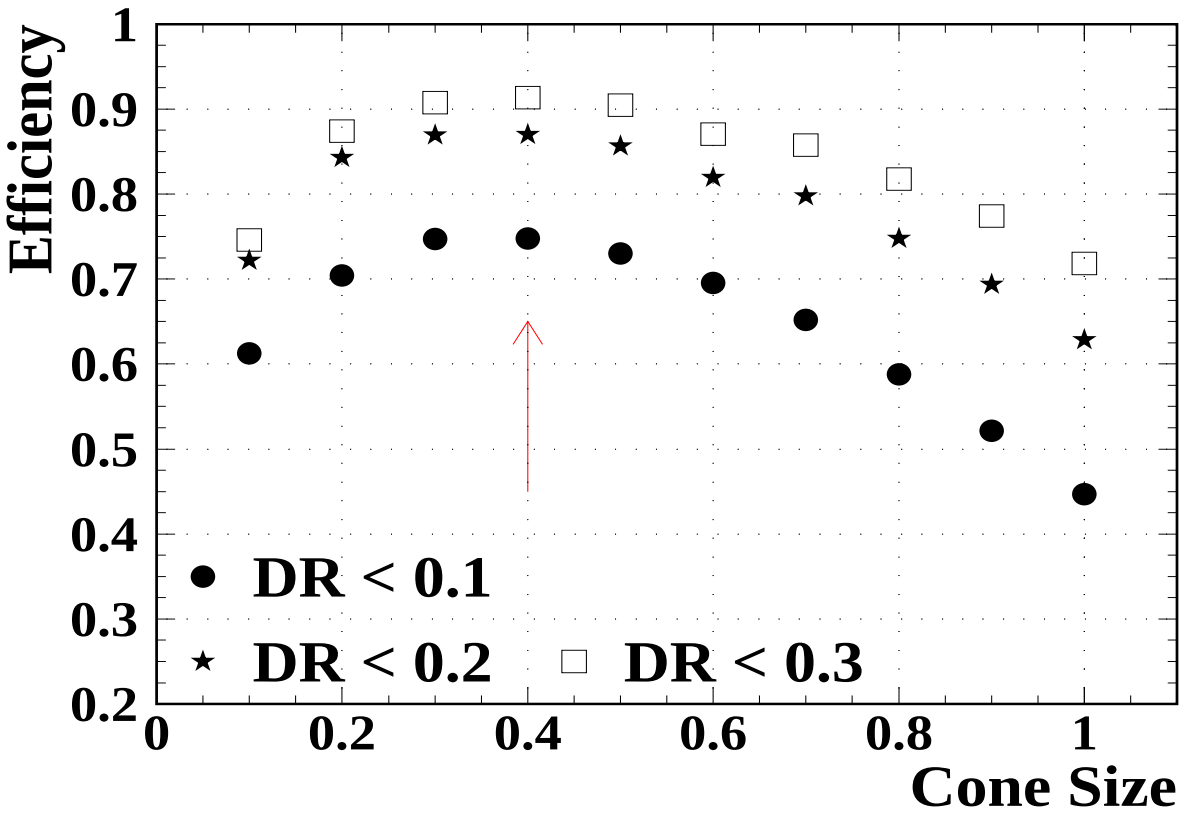


kT $\longrightarrow$



b-Jets "Reconstruction" Efficiencies

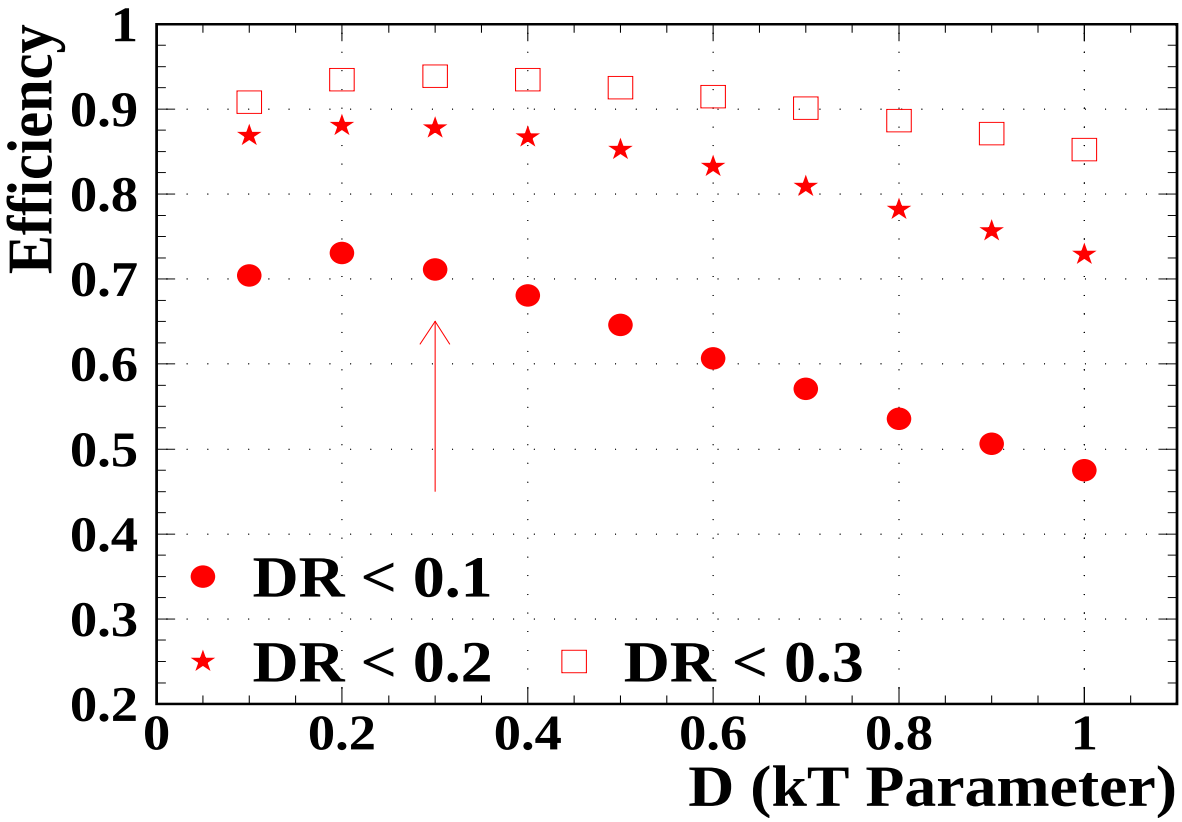
Cone Jets



- $R \sim 0.4$ provides the best overall "reconstruction" efficiency regardless the ΔR cut.
- Higher cone sizes sensitive to noise and smaller sizes affected by hadronization fluctuations.

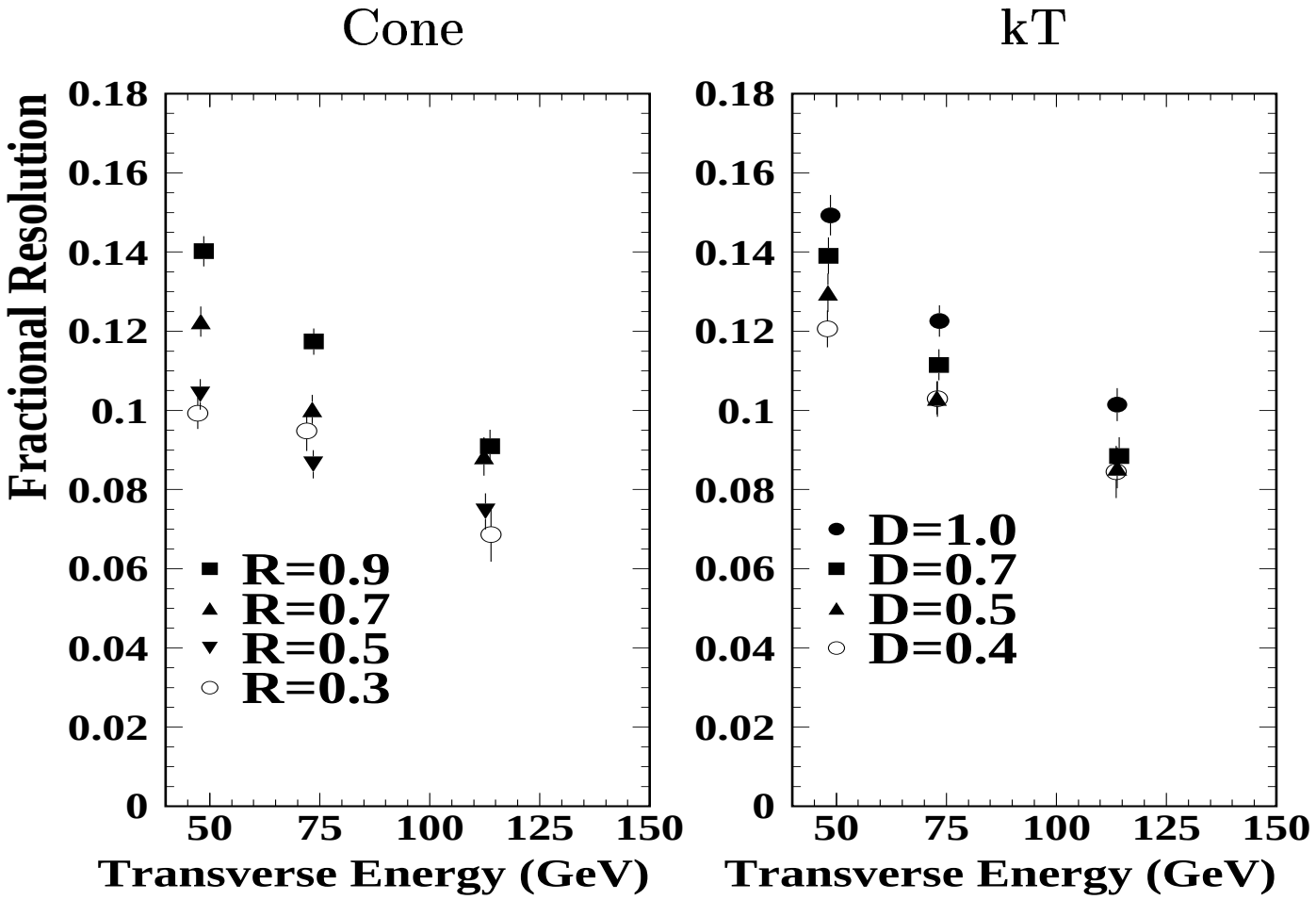
b-Jets "Reconstruction" Efficiencies

kT Jets



- Similar behavior than Cone. $D \sim 0.3$ provides best overall "reconstruction" efficiency.

b-Jets Energy Resolutions

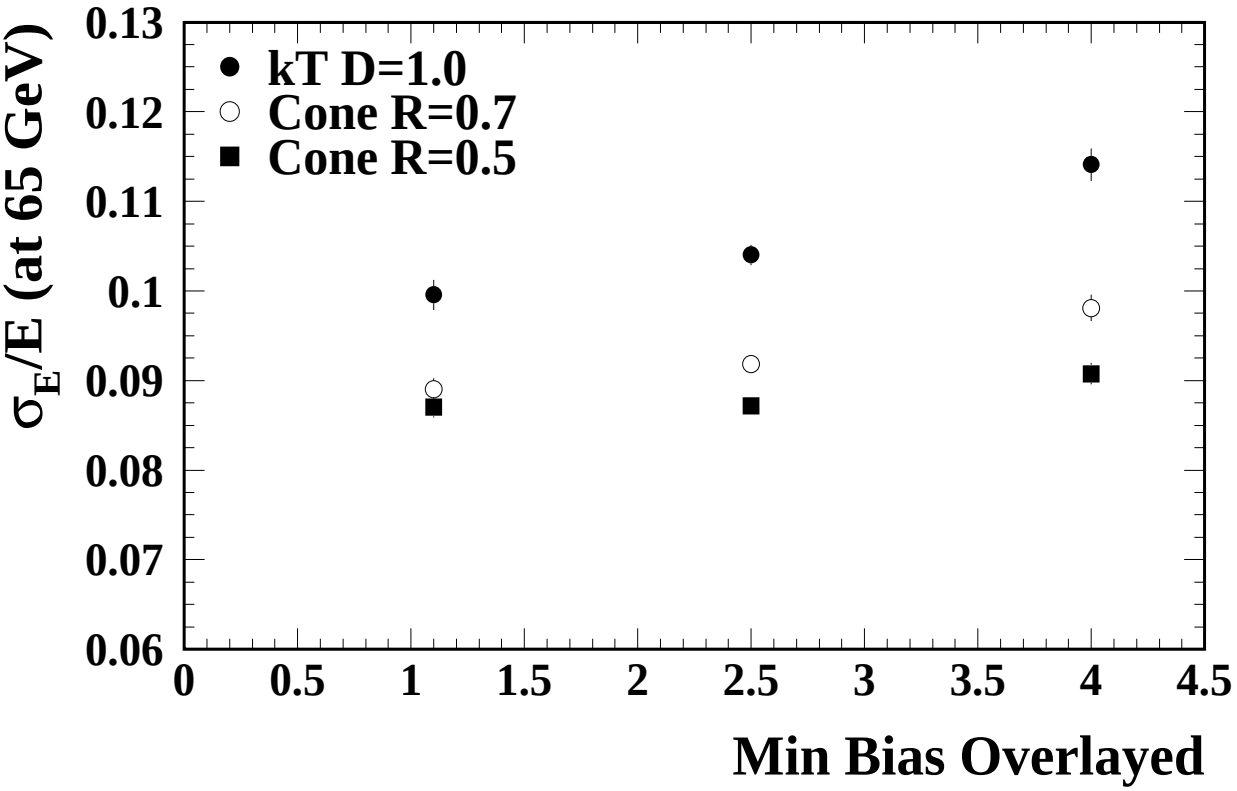


- WH $(W \to e\nu)$ 2.5mb
- Matched Particle jets with calorimeter jets and calculate the variance of the $E_{cal}/E_{particle}$ distributions.
- Larger algorithm parameter choices yield poorer resolutions.

b-Jets Energy Resolutions

How much does the luminosity affect the resolutions?

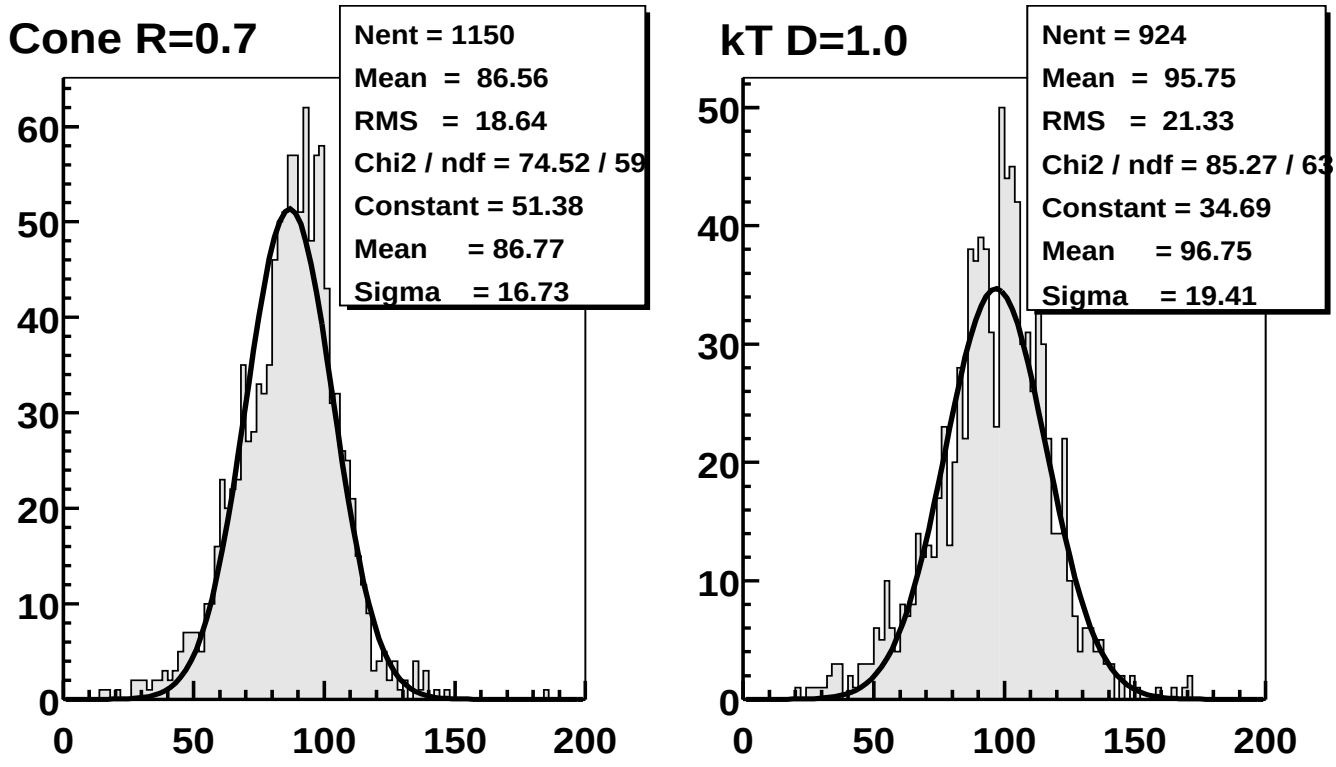
- MC $t\bar{t}$ sample
- Resolution as a function of min bias overlayed.
- E_T range of $40 - 70$ GeV



- Larger algorithm parameter sizes are more affected by luminosity.

Higgs Mass Resolution

- MC Sample: ZH $(Z \to \mu\mu)$ 2.5mb, with initial and final state radiation $[m_H = 120$ GeV$]$.
- b-quarks required to match calorimeter jets to simulate b tagging.
- Uncorrected calorimeter energies. Using reconstructed primary vertices.
- $M^2 = (E_1 + E_2)^2 - (p_{x1} + p_{x2})^2 - (p_{y1} + p_{y2})^2 - (p_{z1} + p_{z2})^2$



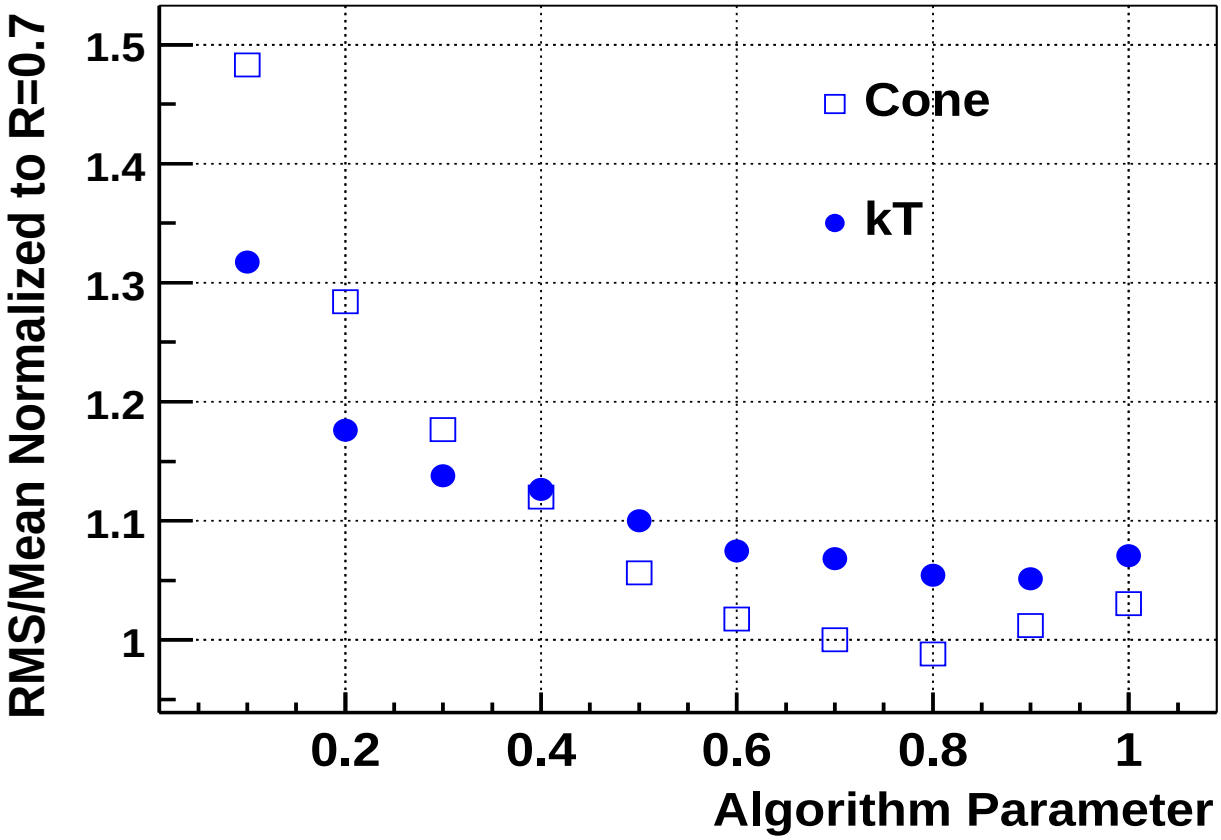
Preliminary results similar to previous studies with Run I detector simulation (hep-ph/0010338):

This study, Cone $R = 0.7$: $\sigma/M = 19.2\%$

Workshop 2000 $[m_H = 90$ **GeV**$]$: $\sigma/M = 17.6\%$

Higgs Mass Resolution

- MC Sample: WH $(W \to e\nu)$ 2.5mb $(m_H = 120$ GeV$)$.

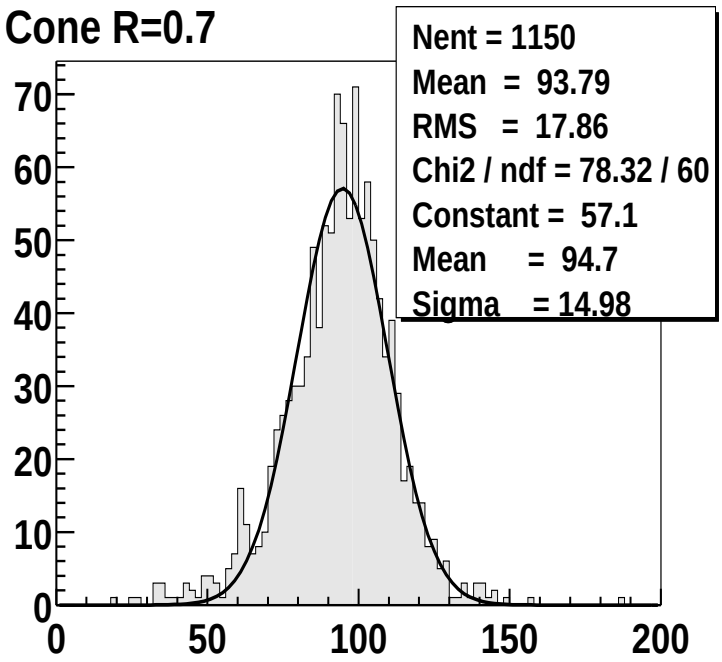


- Better mass resolution for $R \sim 0.8$.

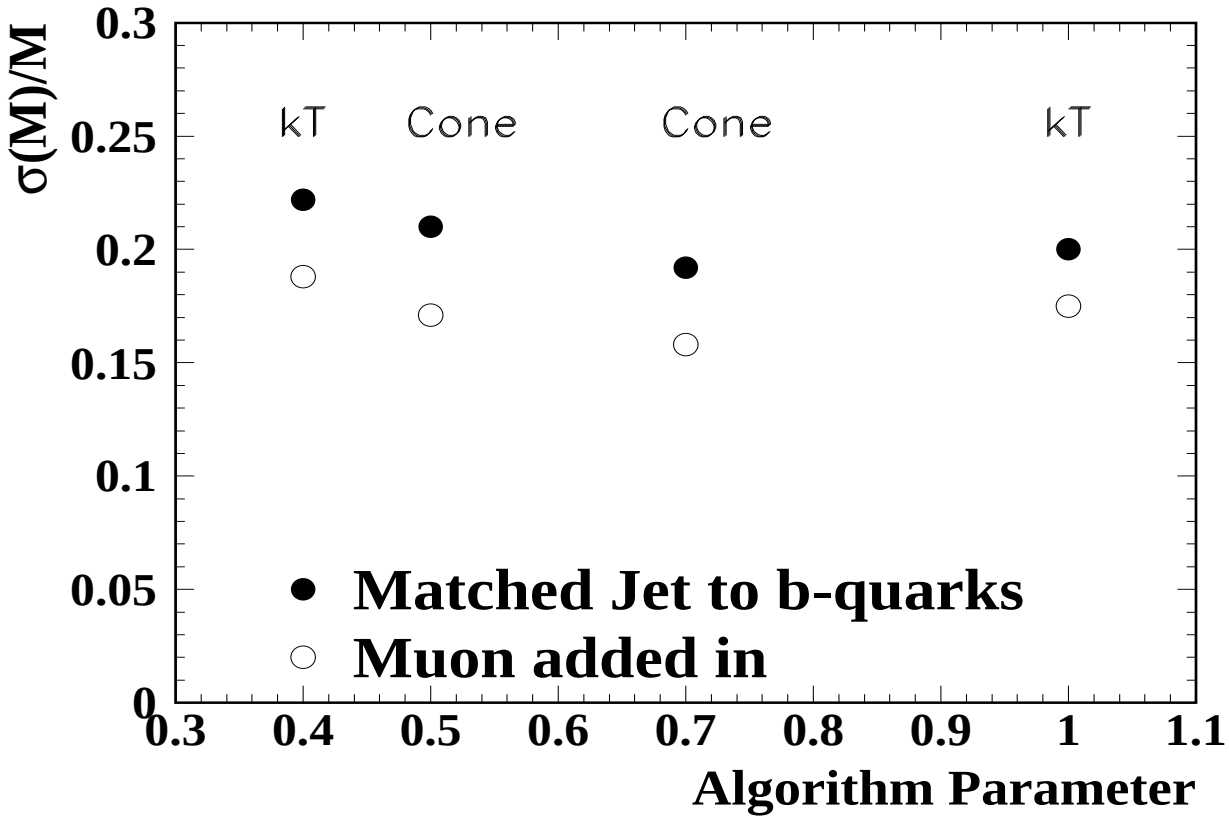
Higgs Mass Resolution

MC Sample: ZH $(Z \to \mu\mu)$ + 2.5mb

If muon close to the calorimeter jet axis is "added in" $\Rightarrow$ improves resolution.



Muon added to calorimeter jet.



Conclusions

- Preliminary results suggest Cone jets of $R \sim 0.5$ have good efficiency and resolution. Also used in Run I for top analyses.
- kT jets of $D \sim 0.4$ good efficiency and resolution compared to other D parameters.
- Higgs mass resolution results similar to those obtained for the "Higgs Workshop 2000" (hep-ph/0010338).

- All results are preliminary. Energy corrections and tracking information to be implemented soon.