Overlay removal with a MVA approach

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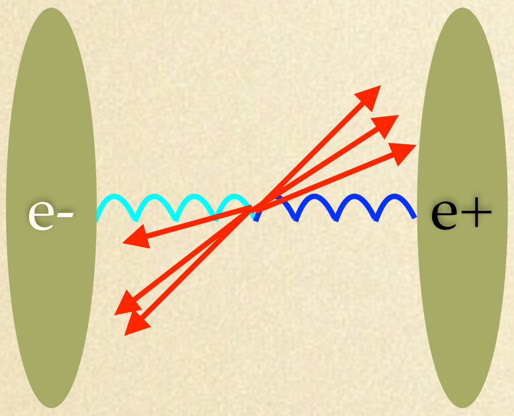
overlay (beam-beam interaction)

each physics event is overlaid with <N> γγ—> hadron events
(statistically in Poisson)



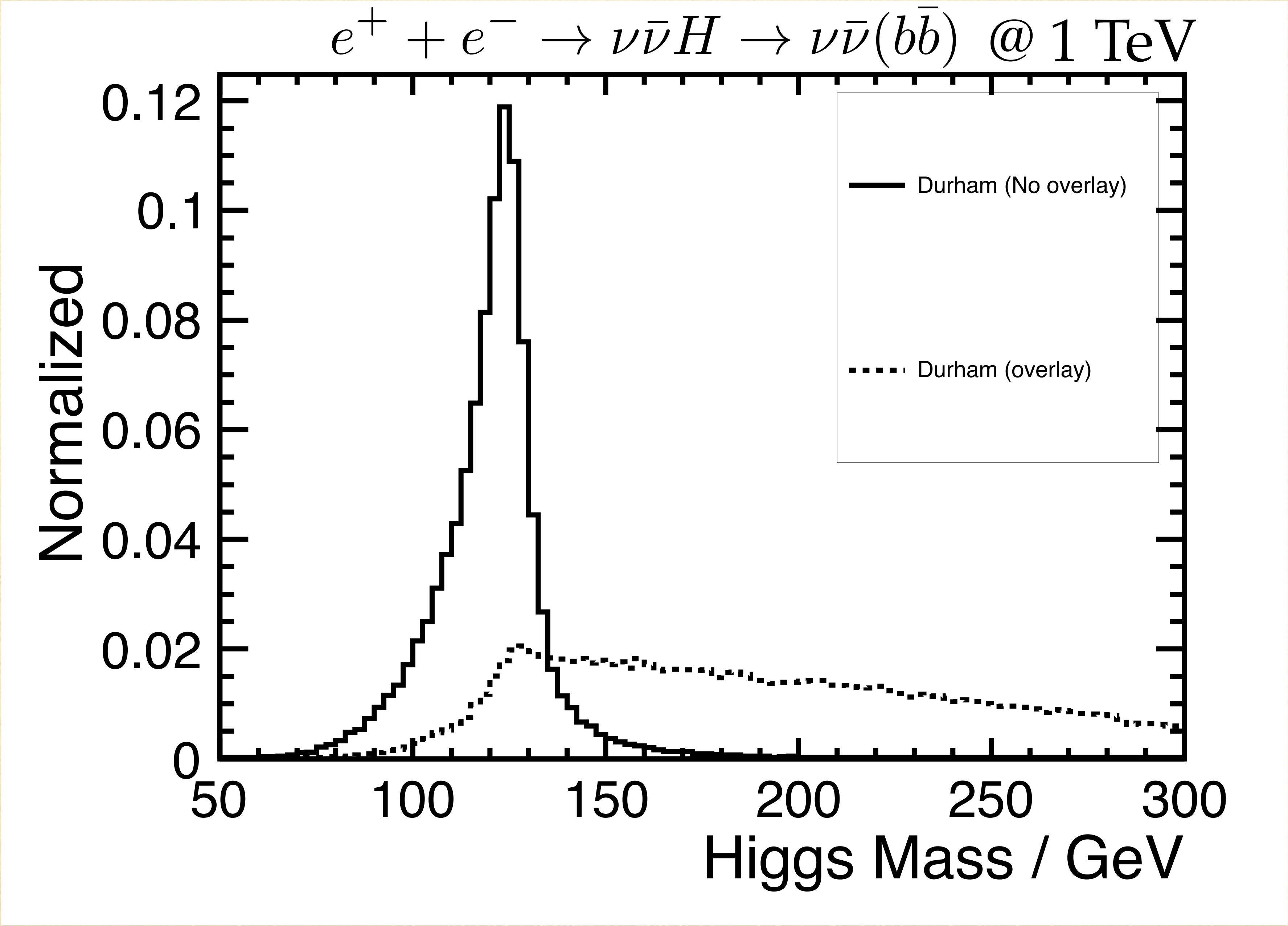
$$\langle N \rangle = \begin{cases} 0.4 \ @ \ 250 \text{ GeV} \\ 1.7 \ @ \ 500 \text{ GeV} \\ 4.1 \ @ \ 1 \text{ TeV} \end{cases} \quad @ \text{ ILC}$$

different vertex with physics event, smeared with beam profile

latest news: <N>=0.7 @ 500 GeV

M. Peskin, et. al, hep-th/9305247; ILC TDR Volumn-4

overlay can significantly degrade signal performance

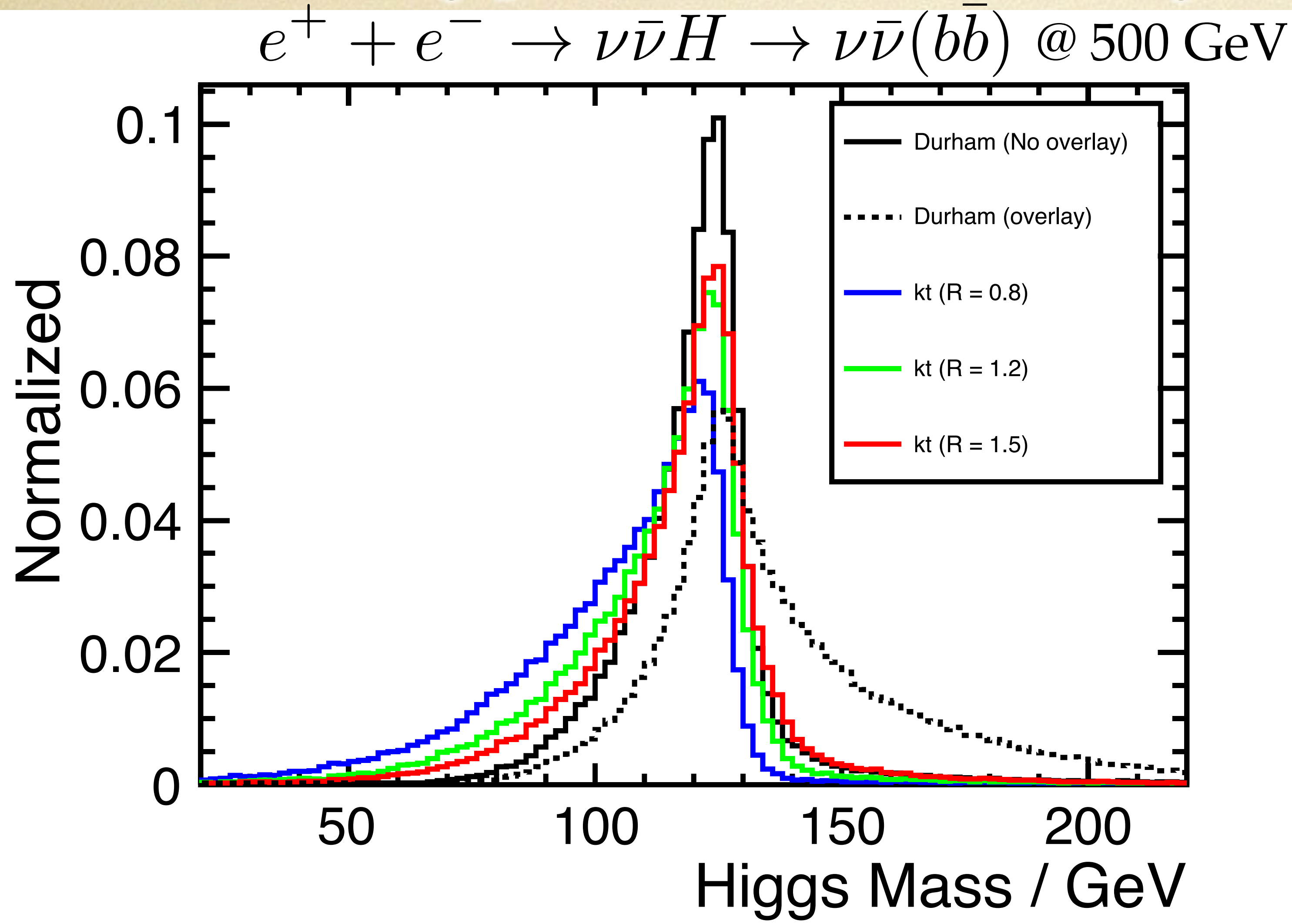


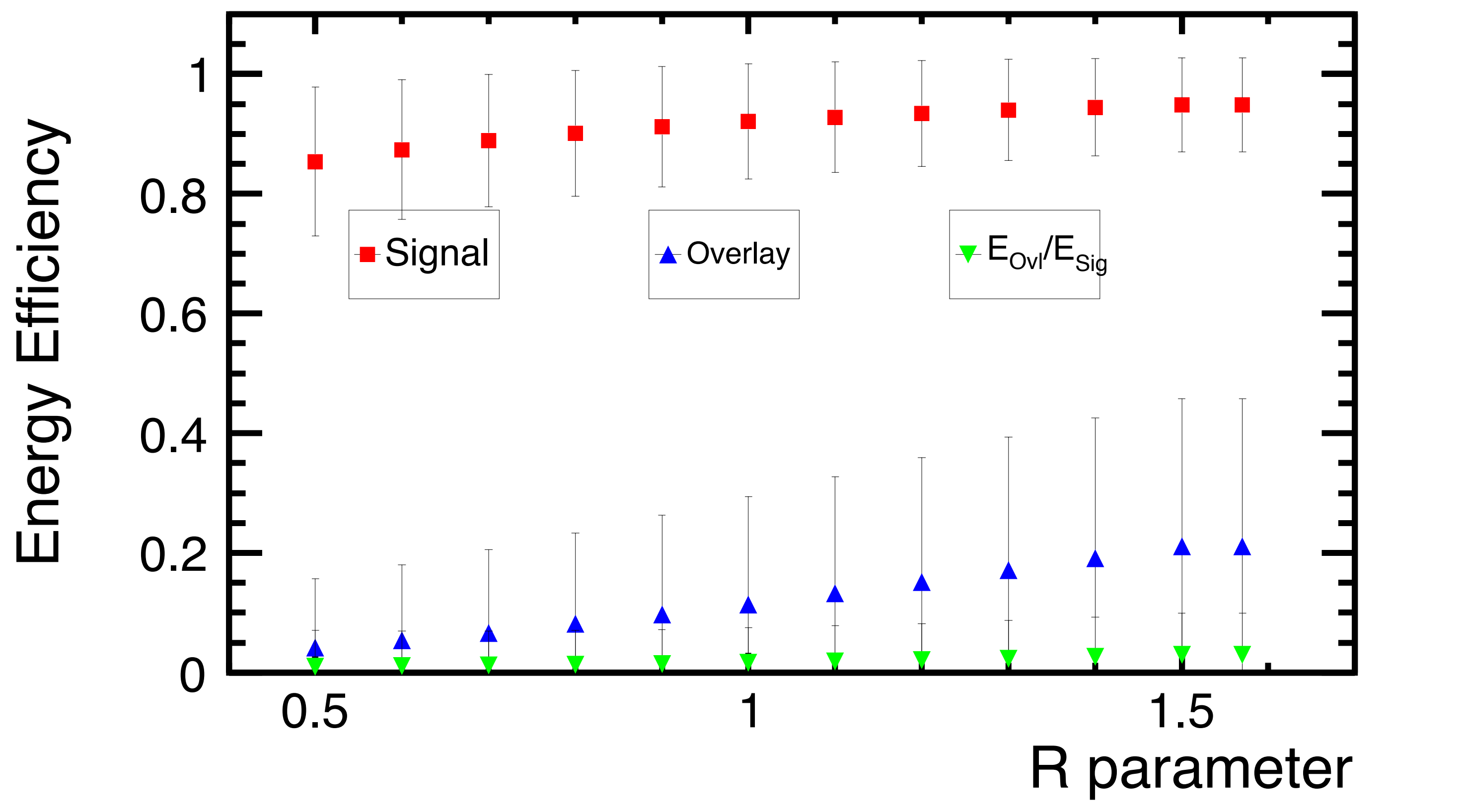
methods to remove overlay:

jet-based: kt algorithm

particle-based: MVA approach

typical method: kt jet-clustering





$$d_{ij} = \min(p_{ti}^2, p_{tj}^2)\,\Delta R_{ij}^2/R^2$$

$$\Delta R_{ij}^2 = (y_i - y_j)^2 + (\phi_i - \phi_j)^2$$

overlaid particles usually very forward —> large y —> far from physics jet

paras opt in kt jet clustering

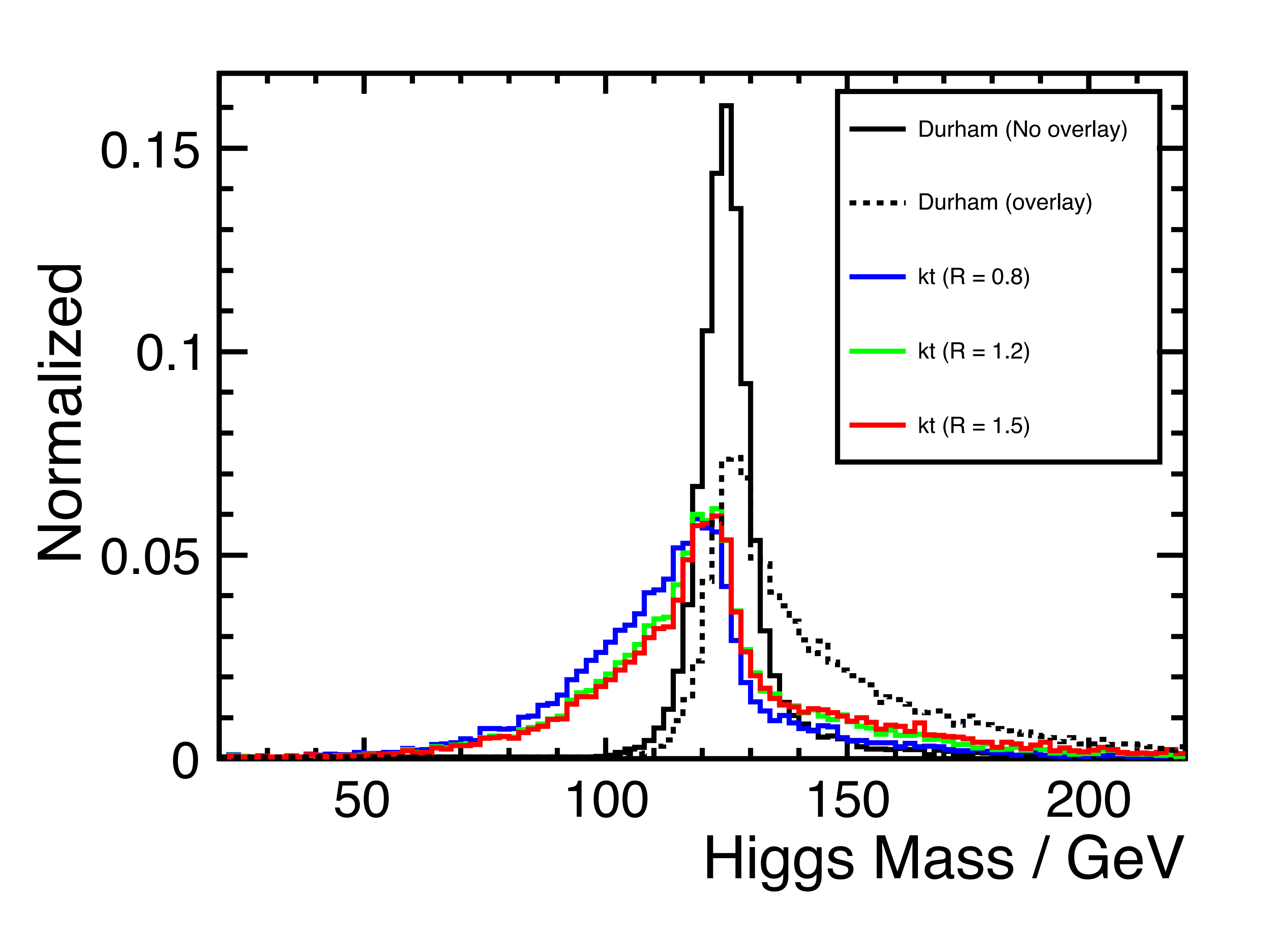
Max No. of Jets = 2

R = 1.5

overlay is removed efficiently

Eff(sig) ~ 95%
Eff(ovl) ~ 21%
purity ~ 97%

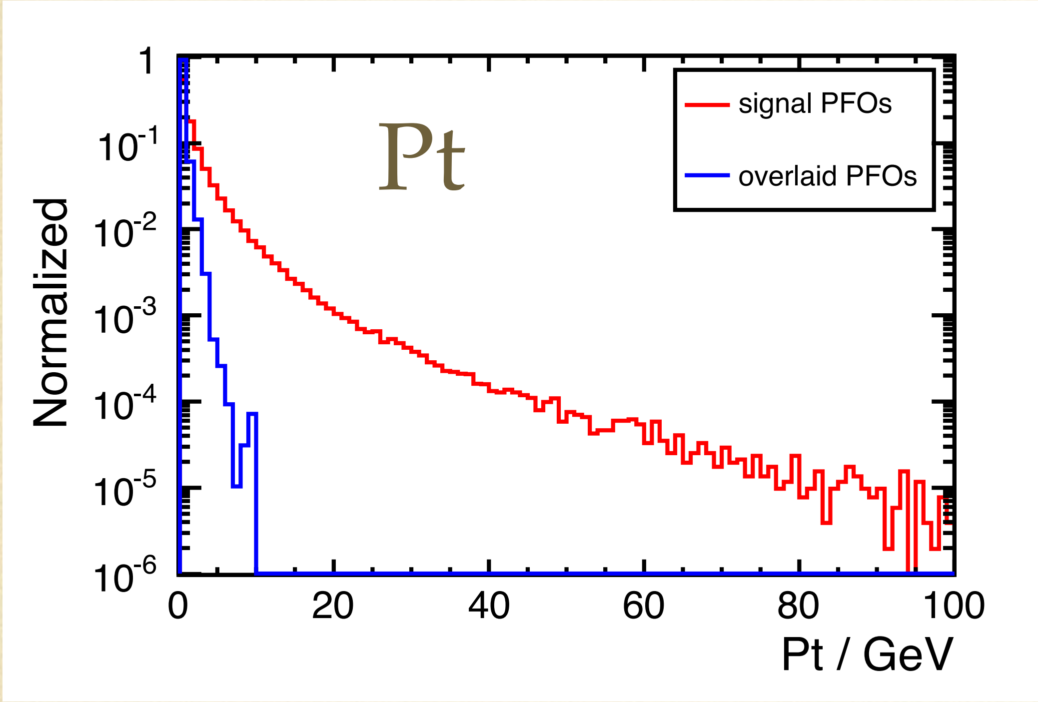
$$e^+ + e^- \to \nu\bar{\nu}H \to \nu\bar{\nu}(WW^*) \to \nu\bar{\nu}qqqq$$ @ 500 GeV

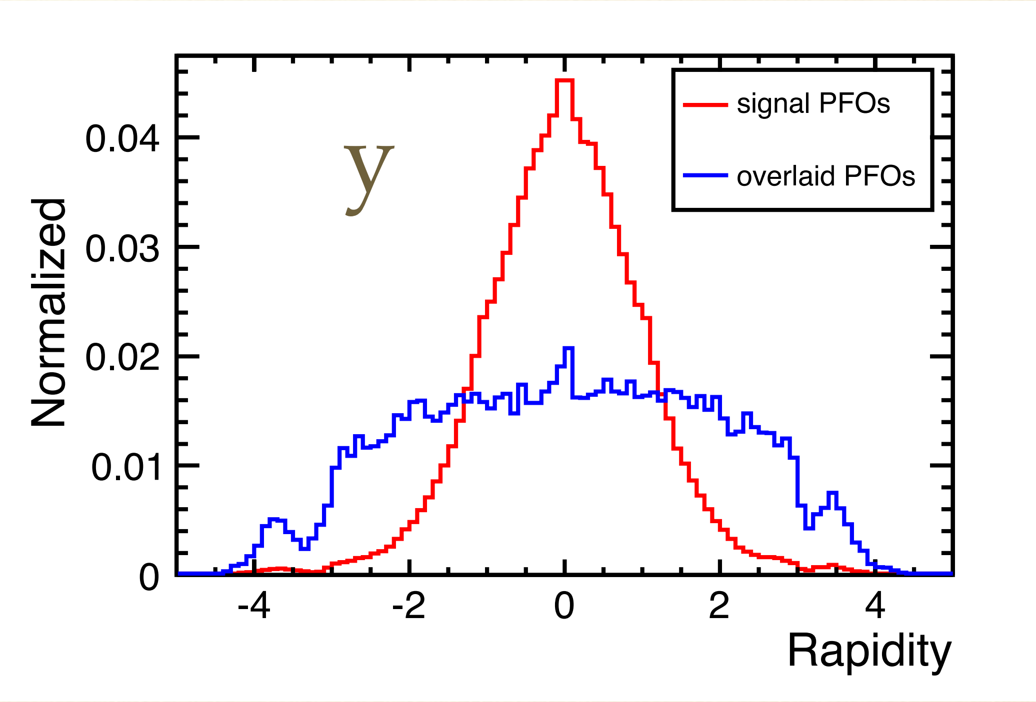


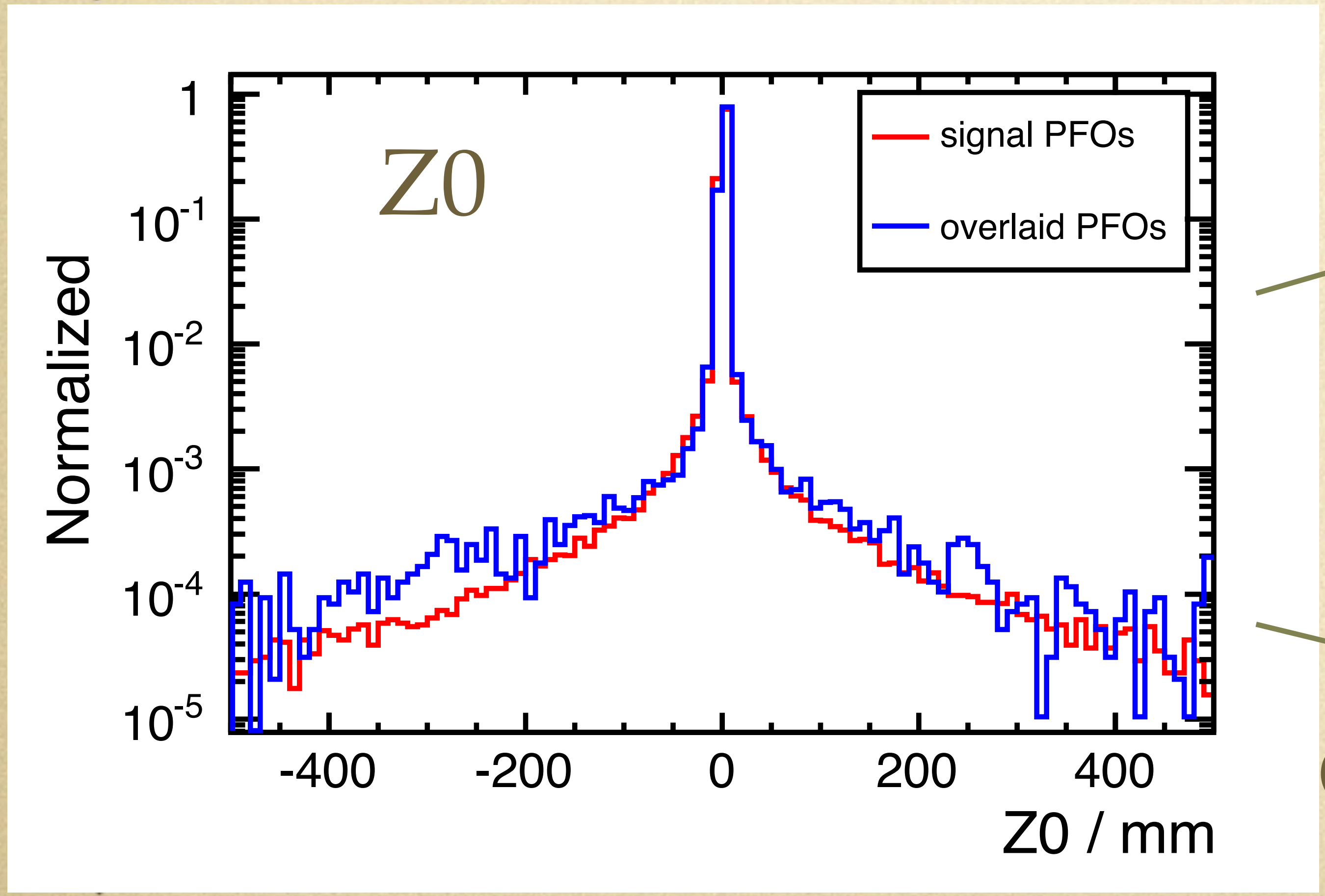
Eff(sig) ~ 93%
Eff(ovl) ~ 25%
purity ~ 96%

kt algorithm is not working efficiently for H—>WW*

a different approach: based on each particle

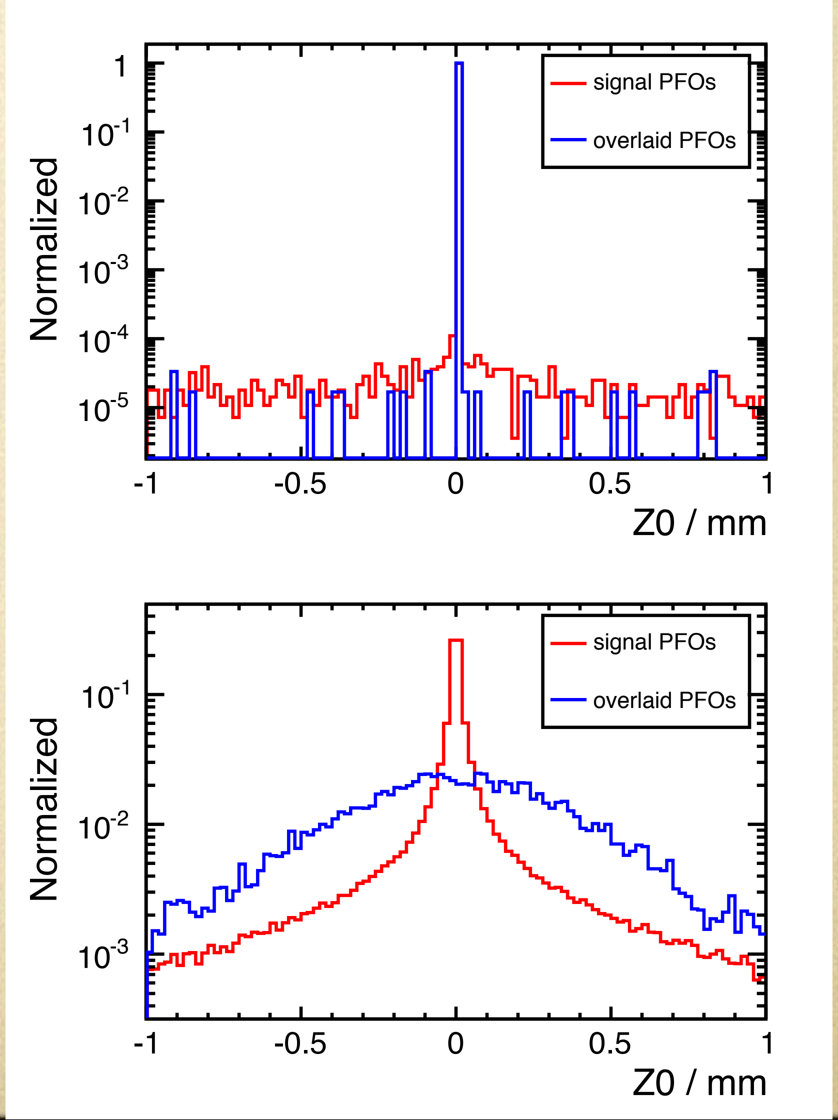




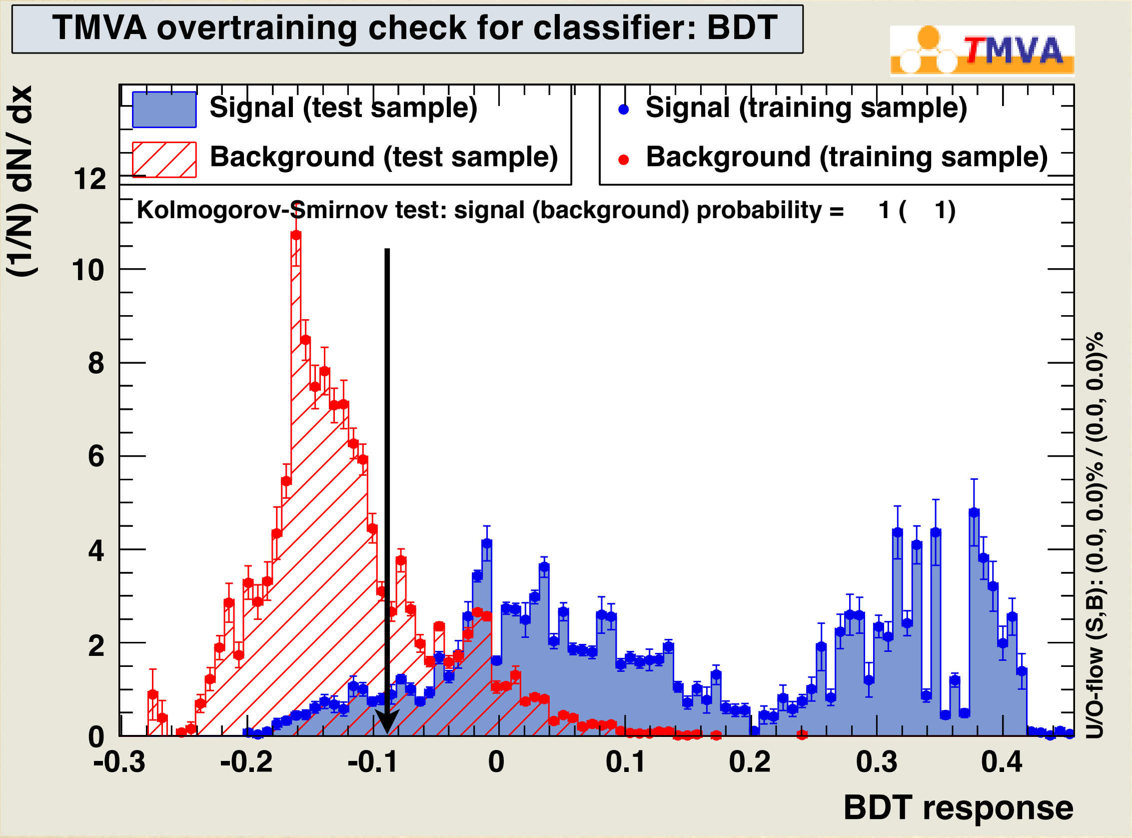


Neutral

Charged

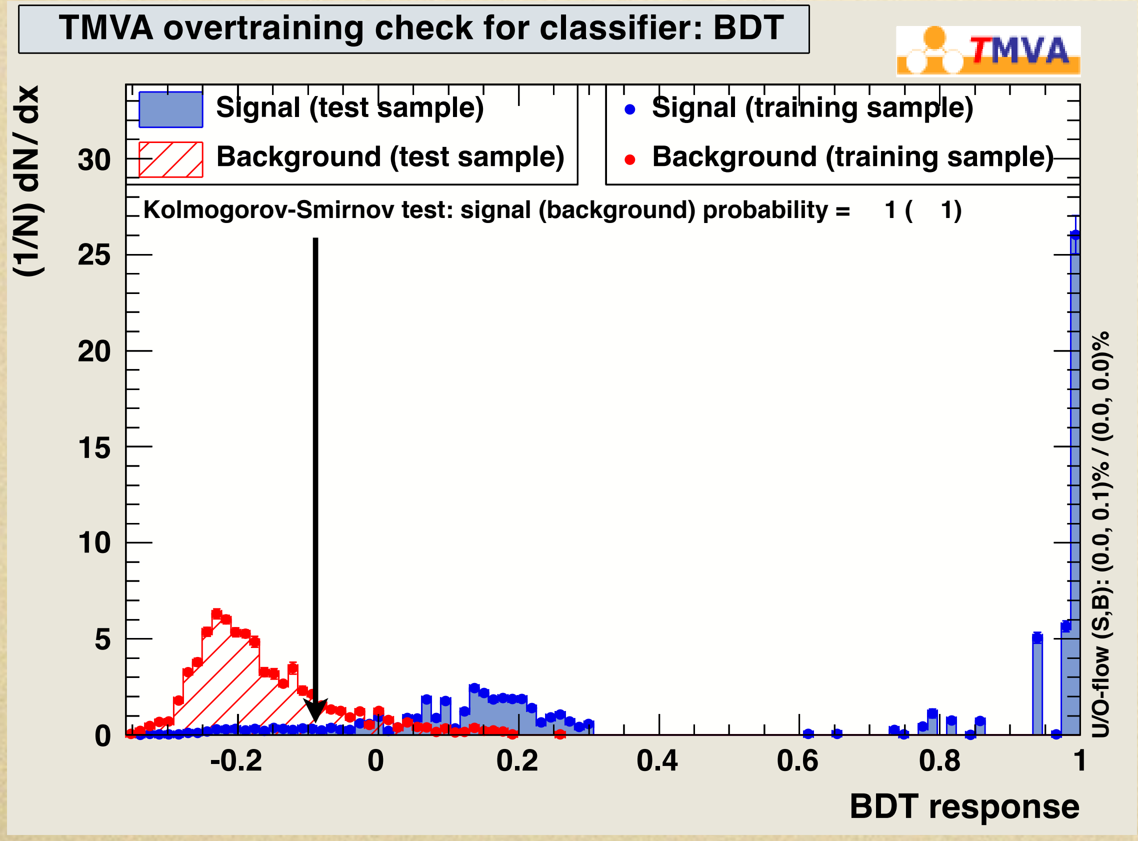


use MVA to tag overlaid particle



category 1: neural or large z0

input: Pt, Rapidity

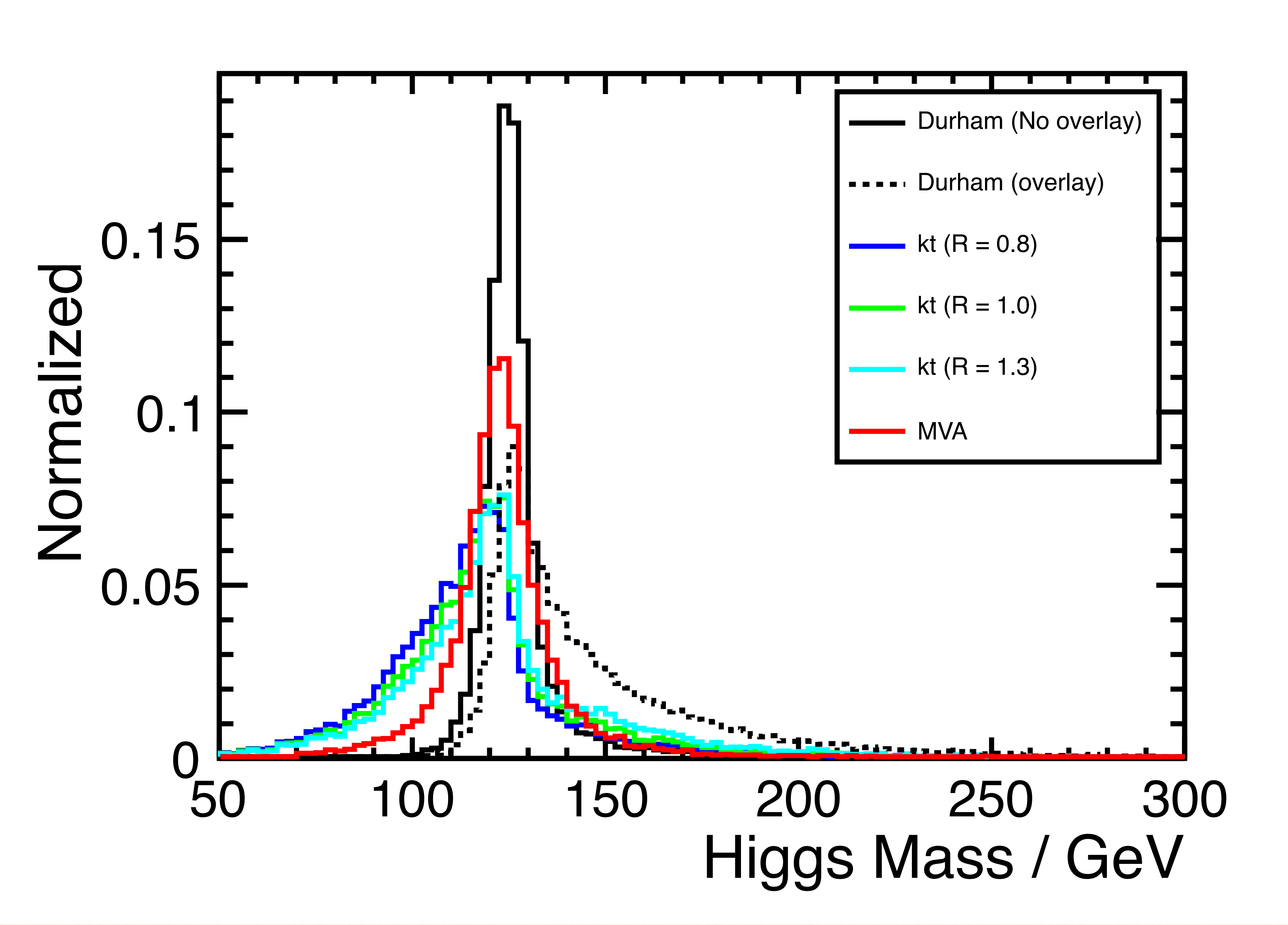


category 2: charged and small z0

input: Pt, Rapidity, z0

each PFO weighted by energy in both cases

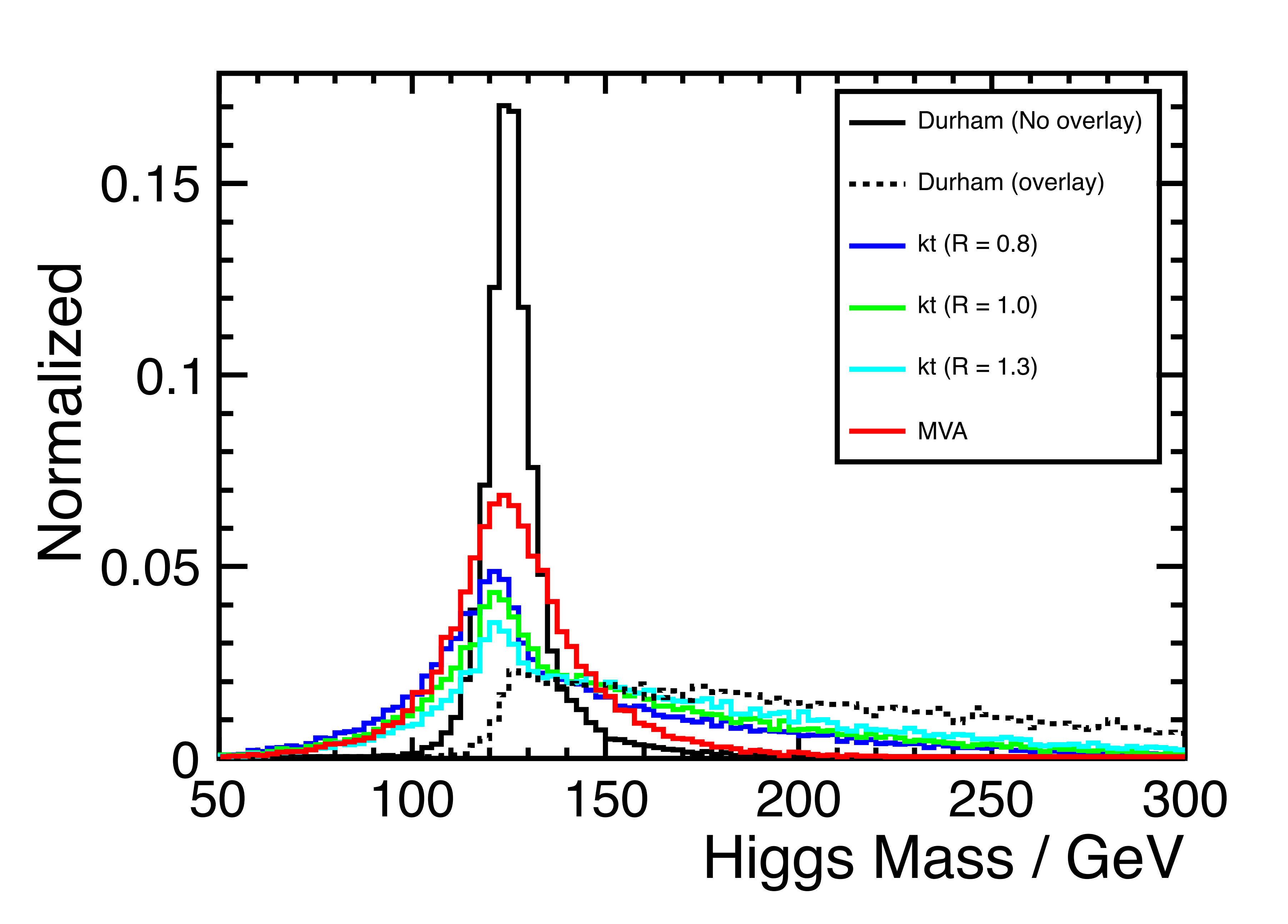
$$e^+ + e^- \to \nu\bar{\nu}H \to \nu\bar{\nu}(WW^*) \to \nu\bar{\nu}qqqq$$ @ 500 GeV



Eff(sig) ~ 94%
Eff(ovl) ~ 23%
purity ~ 98%

looks working, better resolution than kt algorithm

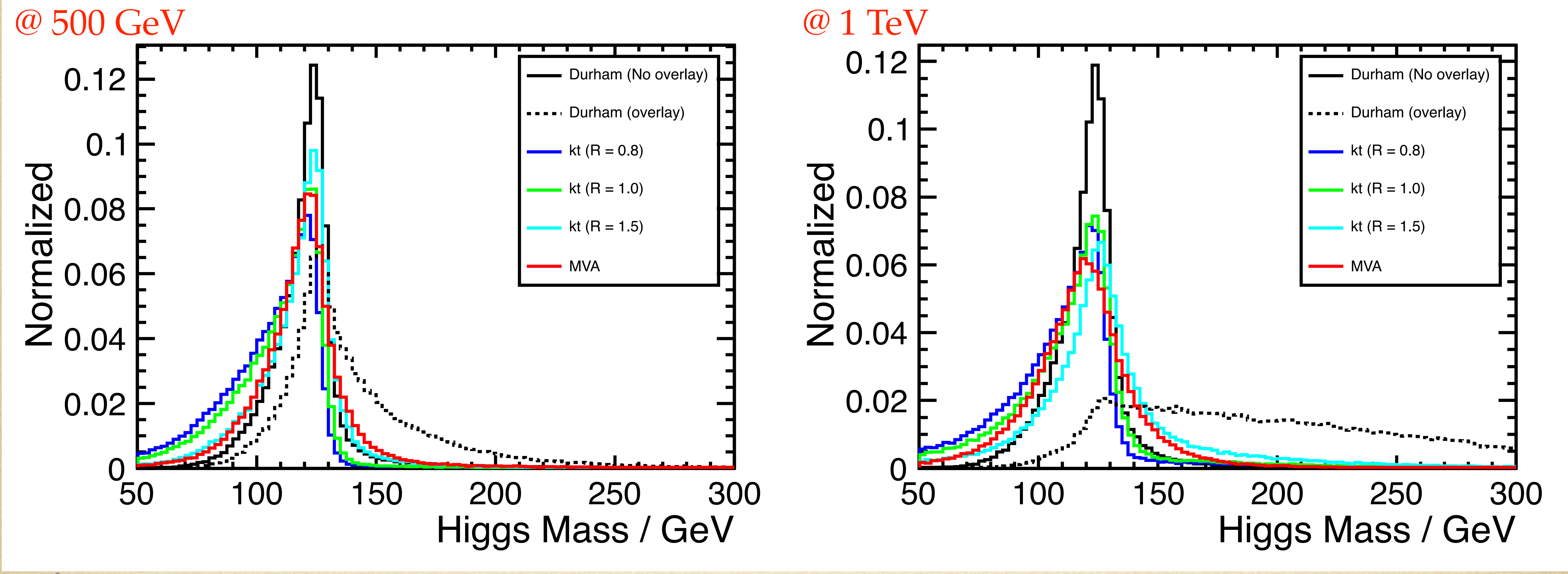
$$e^+ + e^- \to \nu\bar{\nu}H \to \nu\bar{\nu}(WW^*) \to \nu\bar{\nu}qqqq$$ @ 1 TeV



Eff(sig) ~ 89%
Eff(ovl) ~ 16%
purity ~ 95%

better than kt, but obviously not satisfactory

$$e^+ + e^- \to \nu\bar{\nu}H \to \nu\bar{\nu}(b\bar{b})$$



in this channel, MVA is not better than kt…

hint: we need more sophisticated method!

- use MVA method to find some most probable seeds of overlaid particles.
- use cluster method (vertex,jet,cone) to find other overlaid particles around the seeds.

available processors

- overlayMVAProcessor
- weights trained: vvH—>vvWW*—>vv4q, vvH—>vvbb @ 500 GeV and 1 TeV.

summary

- overlay need more attention for Higgs analysis with WW-fusion process, kt algorithm is not always satisfactory enough.
- a new method based on MVA tagging has been tested and shown better performance in H—>WW* mode, but worse in H—>bb; more sophisticated method combining advantages of these two methods worth a try.