$h \to \tau^+\tau^-$ BR Study Some Updates

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Review: Numbers in 36th GM

Signi. $\frac{\Delta(\sigma \times \mathrm{BR})}{(\sigma \times \mathrm{BR})}$	$\nu\bar{\nu}h$	$q\bar{q}h$	e^+e^-h	$\mu^+\mu^-h$
Cut-based	11.7σ 8.5%	20.5σ 4.9%	3.2σ 31.3%	5.0σ 20.0%
TMVA	13.6σ 7.4%	21.2σ 4.7%	3.2σ 31.2%	5.7σ 17.6%

Analysis @ ILC500, 500fb^{-1}, left beam pol.
used all available TDR samples + aa_2f (SGV) samples

Review: Next Steps in 36th GM

- 500 GeV
  - check more optimization including tau finder study
  - separation of Zh and $\nu\bar{\nu}h$
- 250 GeV (not started)
- Write a paper & PhD thesis

Some Updates

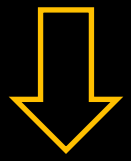
- 500 GeV $\nu\bar{\nu}h$ (today's talk)
  - tau finder & kT clustering
  - more optimization (TMVA)
- 250 GeV: first (practice) results
- Separation: now stopping...
- Write a paper: need discussion among collaborators
- PhD thesis: just wrote a little

500 GeV $\nu\bar{\nu}h$

- tau finder & kT clustering study
- more optimization

Reconstruction for 500 GeV $\nu\bar{\nu}h$

kT clustering (previous: R = 1.0)
to remove beam-induced objects



tau finder
to reconstruct taus

Tau Finder for $\nu\bar{\nu}h$

1. Search most energetic charged track
2. Combine neighboring particles to 1. with satisfying $m_{\mathrm{combine}} < 2\ \mathrm{GeV}$
3. Repeat 1. and 2. until there are no charged tracks

- Most energetic τ^+ and τ^- are combined as a Higgs boson.

MC Matching

- Tau finder performance depends on the kT clustering, so I checked tau finder performance by using MC matching as a function of R-value of kT clustering.

MC Matching Results

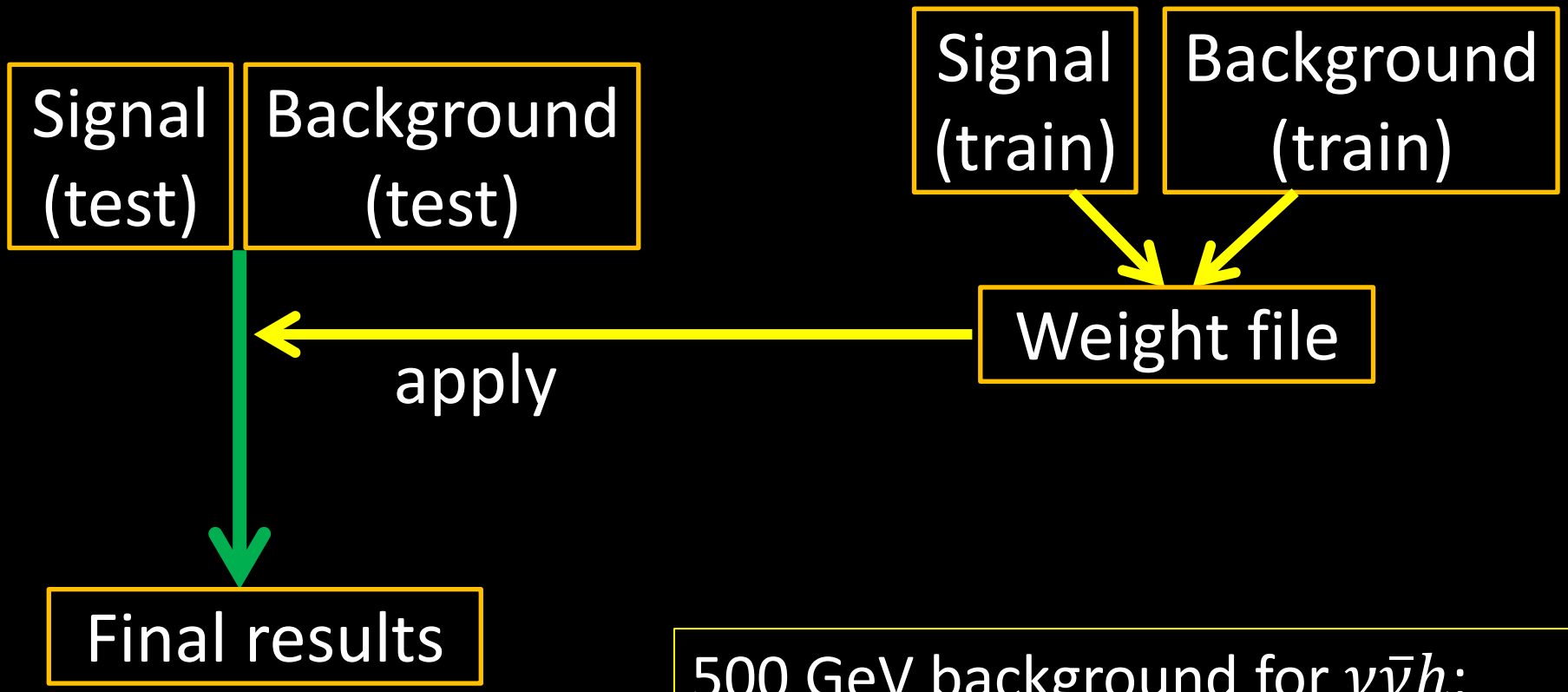
# of PFOs	R = 0.5		R = 1.0	
	OK	not	OK	not
τ^- charged	18296	501	18164	1083
τ^- neutral	20935	1099	21066	2258
τ^+ charged	18449	479	18257	978
τ^+ neutral	20989	1210	21063	2337

checked for R = 0.5 - 1.4, every 0.1
picked up only 0.5 and 1.0

$\tau^{-(+)}$: reconstructed energetic tau-(+)
OK = particle in tau is come from Higgs
not = particle in tau is NOT come from Higgs (mis-combined)

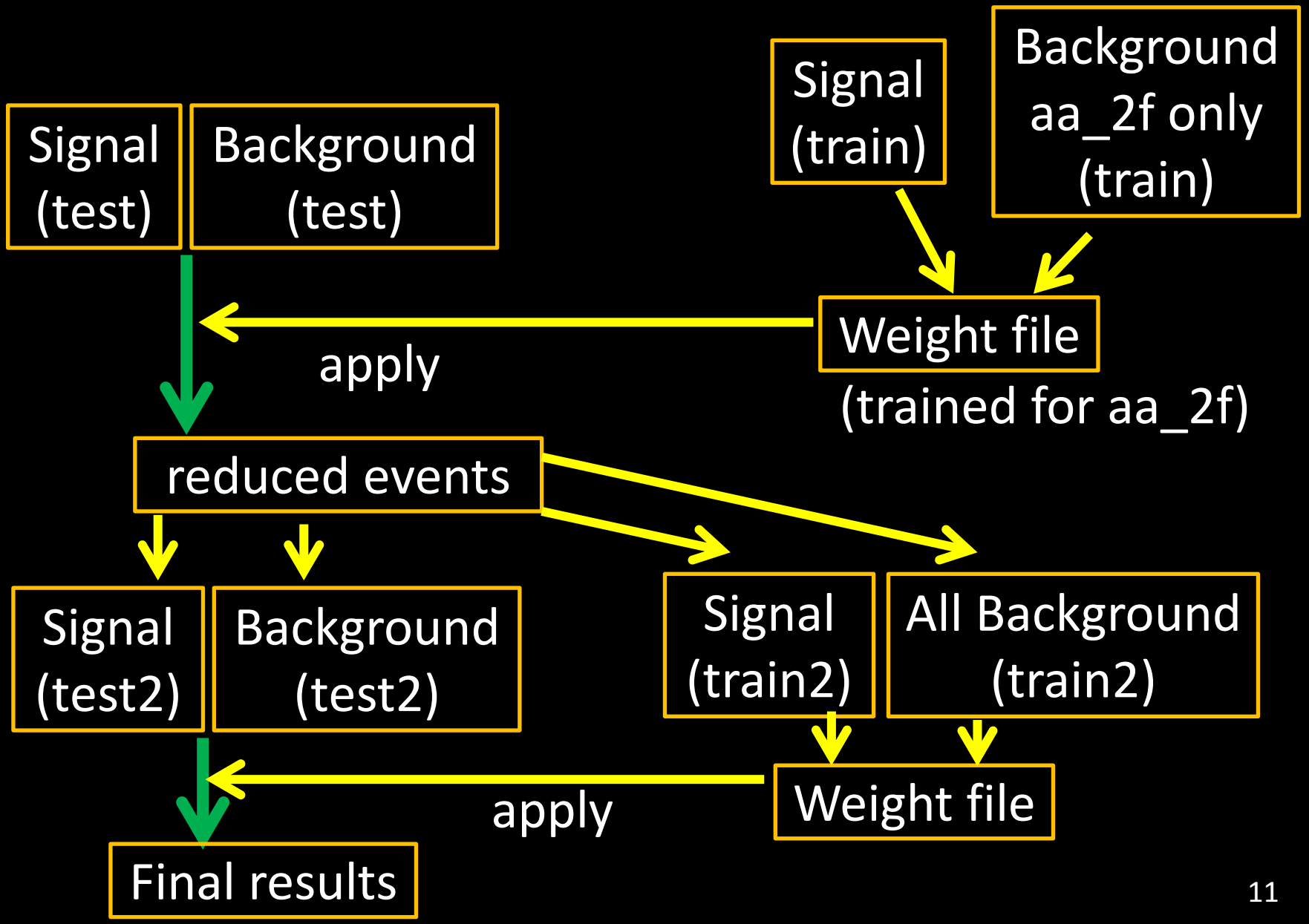
better tau reconstruction in R = 0.5 than R = 1.0
---> analysis with R = 0.5

(Single) TMVA Analysis

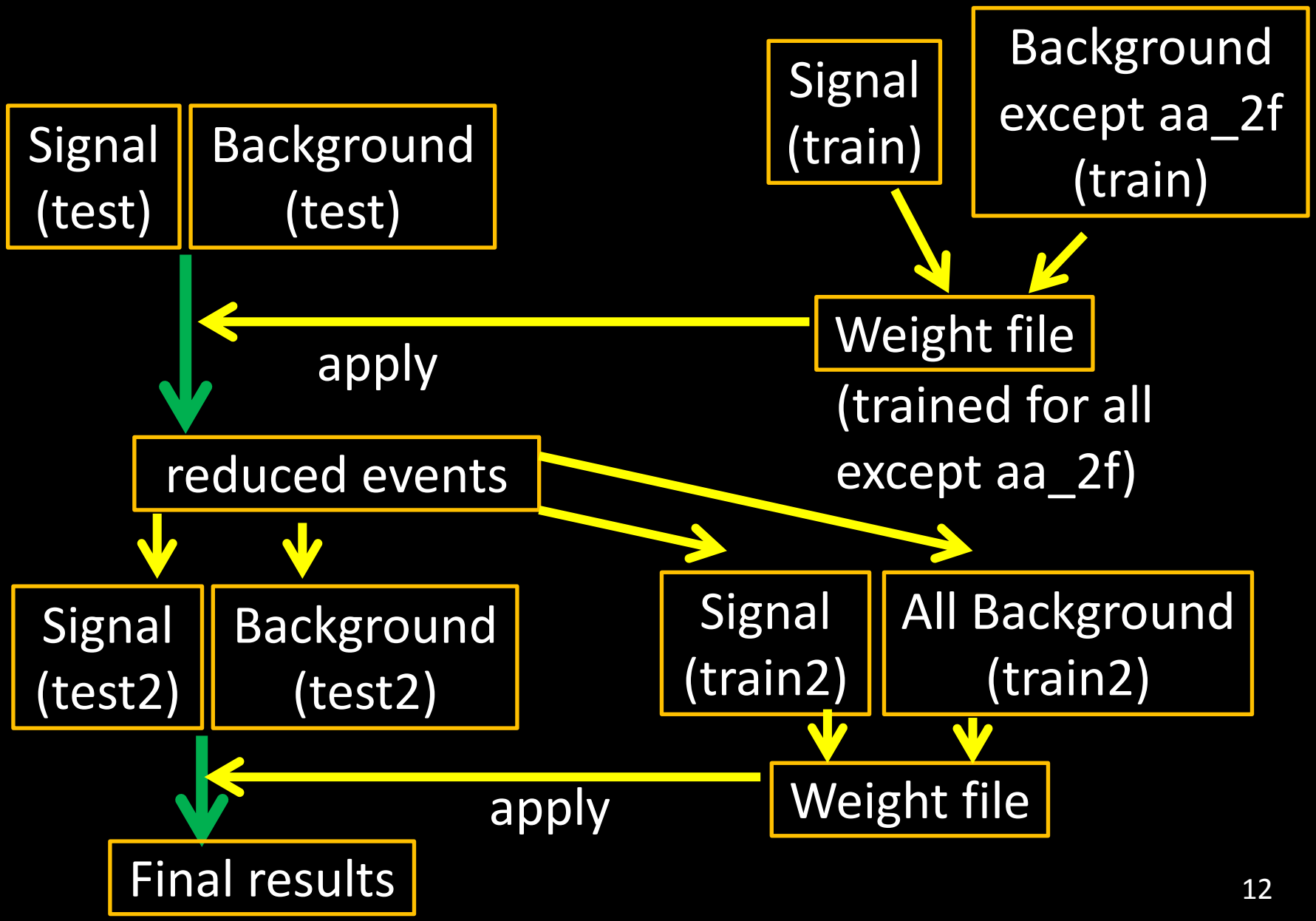


500 GeV background for $\nu\bar{\nu}h$:
aa_2f = huge xsec
heavily trained for aa_2f and
not trained for other backgrounds

Double TMVA Approach (1)



Double TMVA Approach (2)



Results

R = 1.0

Cut-based	single TMVA	double TMVA first: aa_2f	double TMVA first: except aa_2f
11.7σ	13.6σ	14.0σ	14.4σ

R = 0.5

Cut-based	single TMVA	double TMVA first: aa_2f	double TMVA first: except aa_2f
12.0σ	13.3σ	13.9σ	14.7σ

Double TMVA method looks useful

Summary

- I checked tau finder performance in 500 GeV $\nu\bar{\nu}h$ as a function of R of kT clustering.
  - At least, mis-combine probability is lower in R = 0.5 than R = 1.0.
- Double TMVA analysis in 500 GeV $\nu\bar{\nu}h$ looks useful for improvement.

Current Numbers

I put best value.

Signi. $\frac{\Delta(\sigma \times BR)}{(\sigma \times BR)}$	$\nu\bar{\nu}h$	$q\bar{q}h$	e^+e^-h	$\mu^+\mu^-h$
Cut-based	**12.0σ** **8.4%**	20.5σ 4.9%	3.2σ 31.3%	5.0σ 20.0%
TMVA	**14.7σ** **6.8%**	21.2σ 4.7%	3.2σ 31.2%	5.7σ 17.6%

Analysis @ ILC500, 500fb^{-1}, left beam pol.
used all available TDR samples + aa_2f (SGV) samples

LumiUP case

Signi. $\frac{\Delta(\sigma \times \mathrm{BR})}{(\sigma \times \mathrm{BR})}$	$\nu\bar{\nu}h$	$q\bar{q}h$	e^+e^-h	$\mu^+\mu^-h$
Cut-based	21.4σ 4.7%	36.6σ 2.7%	5.66σ 17.7%	8.9σ 11.2%
TMVA	26.3σ 3.8%	38.0σ 2.6%	5.73σ 17.4%	10.2σ 9.8%

Analysis @ ILC500, **1600fb^{-1}**(simple stat. scaling), left beam pol.

250 GeV Study, $M_h = 125$ GeV

Signi. $\frac{\Delta(\sigma \times \mathrm{BR})}{(\sigma \times \mathrm{BR})}$	$q\bar{q}h$	$q\bar{q}h$ LumiUP	e^+e^-h	$\mu^+\mu^-h$
Cut-based	22.6σ 4.4%	48.4σ 2.1%	---σ ---%	---σ ---%
TMVA	23.5σ 4.3%	50.4σ 2.0%	---σ ---%	---σ ---%

Analysis @ ILC250,
250fb^{-1}/1150fb^{-1}(simple stat. scaling),
left beam pol., used all available TDR samples

Task List

- Finalize 500 GeV analysis, including tau finder optimization
- Consider the separation of Zh and $\nu\bar{\nu}h$ in 500 GeV
- 250 GeV analysis with new signal samples (tau pol. included properly), and finalize
- Write a paper
  - need discussion among collaborators: NEXT WEEK
- Write my PhD thesis