Small Updates on $h \to \mu^+\mu^-$ @ 500 GeV

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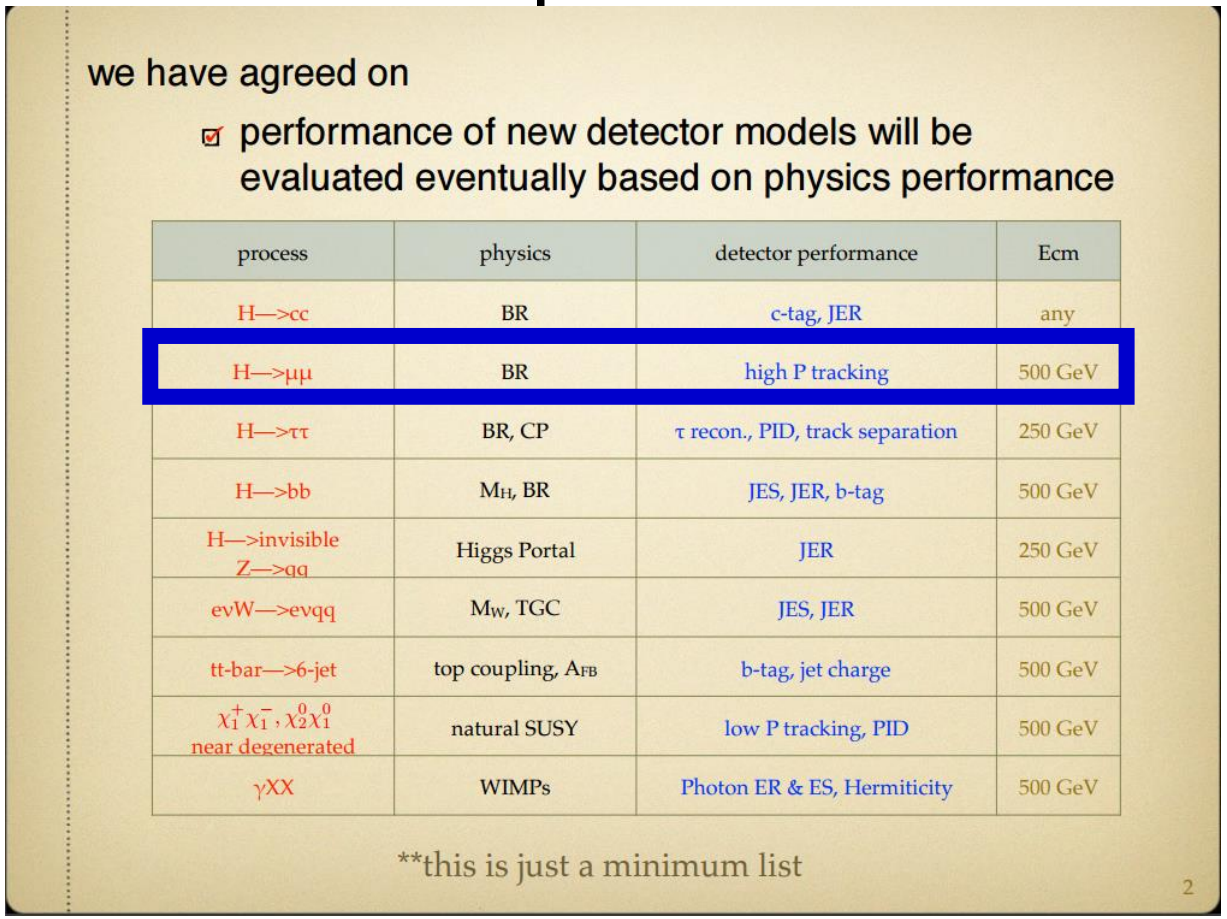
ILD Analysis/Software Meeting

Quick Introduction

- $h \to \mu^+\mu^-$ @ 500 GeV is selected as the one of the physics benchmark process of ILD optimization.



we have agreed on

- ☑ performance of new detector models will be evaluated eventually based on physics performance

process	physics	detector performance	Ecm
H—>cc	BR	c-tag, JER	any
H—>μμ	BR	high P tracking	500 GeV
H—>ττ	BR, CP	τ recon., PID, track separation	250 GeV
H—>bb	M_H, BR	JES, JER, b-tag	500 GeV
H—>invisible Z—>qq	Higgs Portal	JER	250 GeV
evW—>evqq	M_W, TGC	JES, JER	500 GeV
tt-bar—>6-jet	top coupling, A_{FB}	b-tag, jet charge	500 GeV
$\chi_1^+\chi_1^-, \chi_2^0\chi_1^0$ near degenerated	natural SUSY	low P tracking, PID	500 GeV
γXX	WIMPs	Photon ER & ES, Hermiticity	500 GeV

**this is just a minimum list

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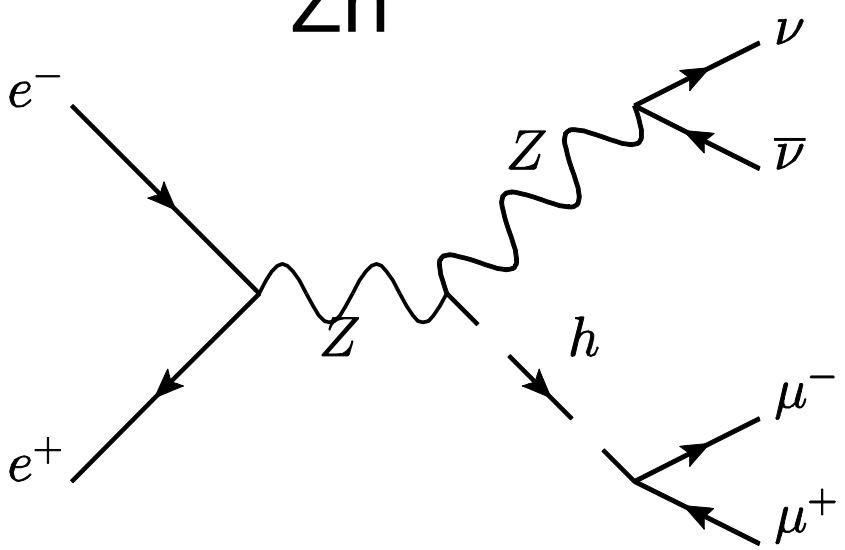
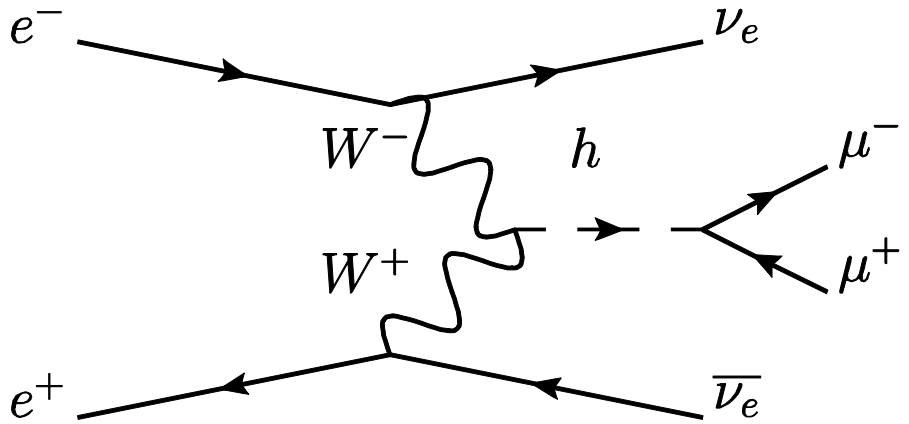
Signal

signal: $e^+e^- \to \nu\bar{\nu}h, h \to \mu^+\mu^-$

Zh



WW-fusion (WWF)



BR($h \to \mu^+\mu^-$) ~ **2.2*10^{-4}**

expected # events: **~60**

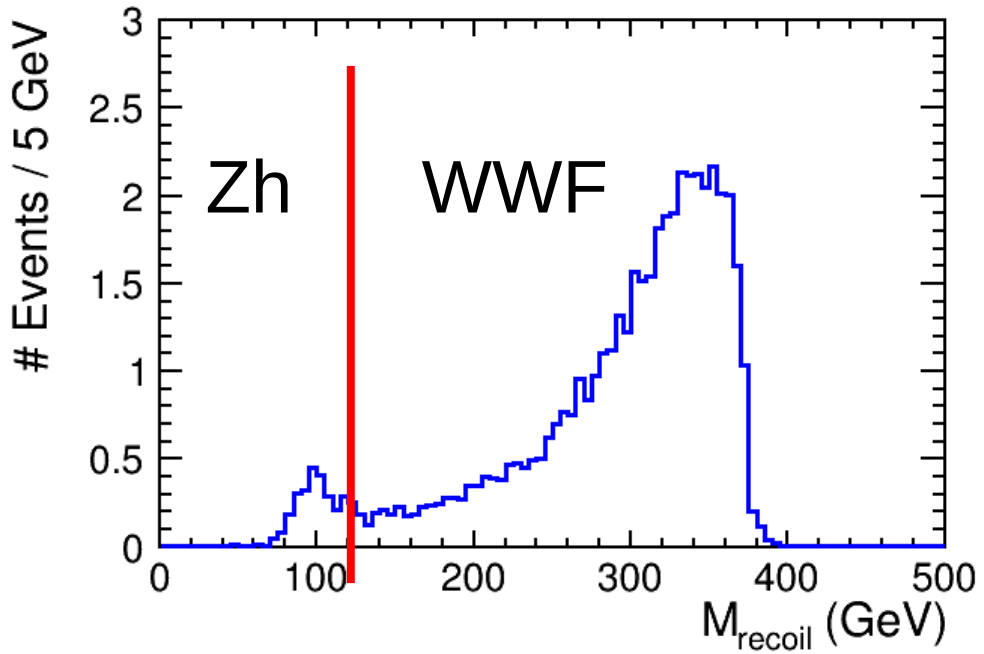
with 1600 fb^{-1}, $P(e^-, e^+)$ = (-0.8, +0.3) (“H20” scenario)

Reminder

- Last talk (Jan./11)
  - Fully-simulated samples with DBD configuration
  - Implemented IsolatedLeptonTagger
  - Developed efficient precuts
  - Separation: Zh and WWF (WW-fusion)
  - TMVA analysis

Progress/Updates

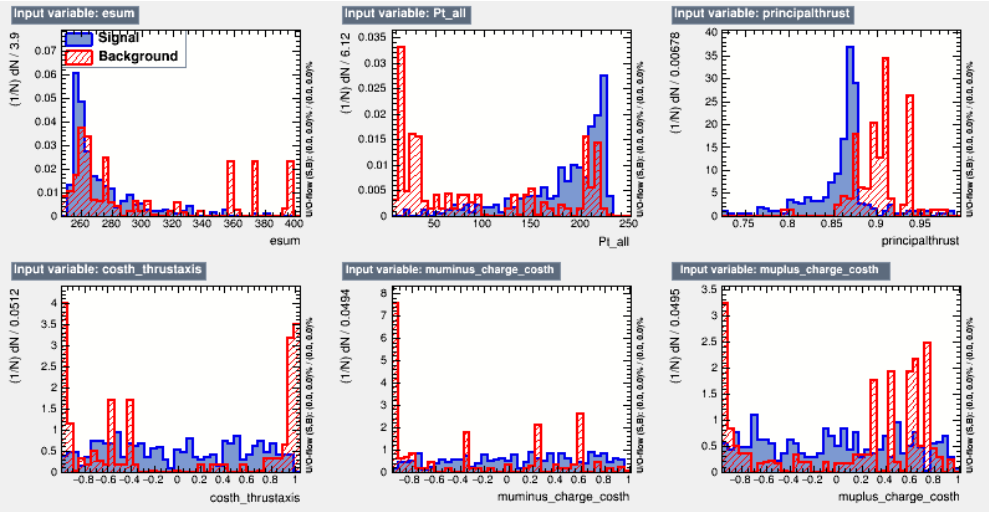
- Found a stupid bug. Some MC events were not included.
- Re-do TMVA analysis
- With/Without separation (Zh/WWF/Mixed)



Try & Error with TMVA(BDTG)

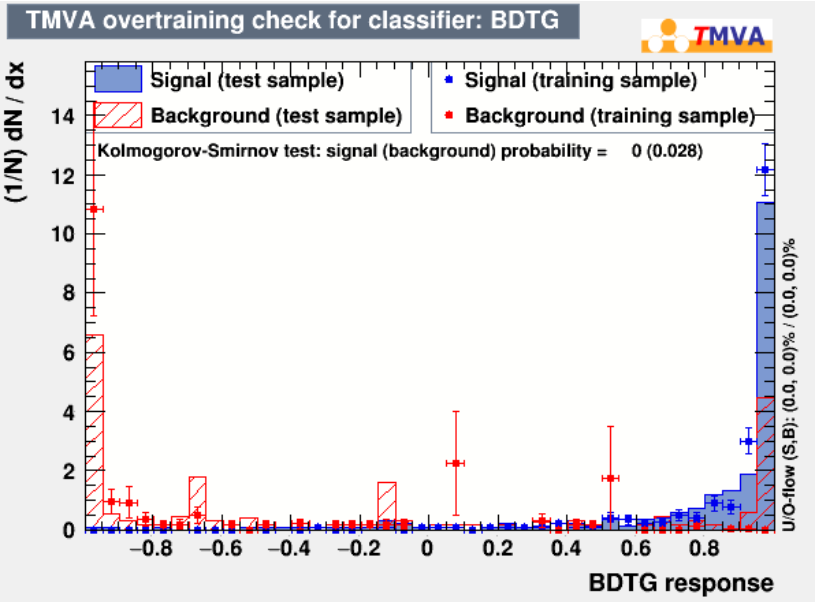
- Usually gives better results than cut-based
  - Half of MC are used for training and other for testing
  - Low MC stat...
- Mostly determined by $M_{\mu\mu}$, I tried without and with $M_{\mu\mu}$
- 3 cases (Zh/WWF/Mixed)

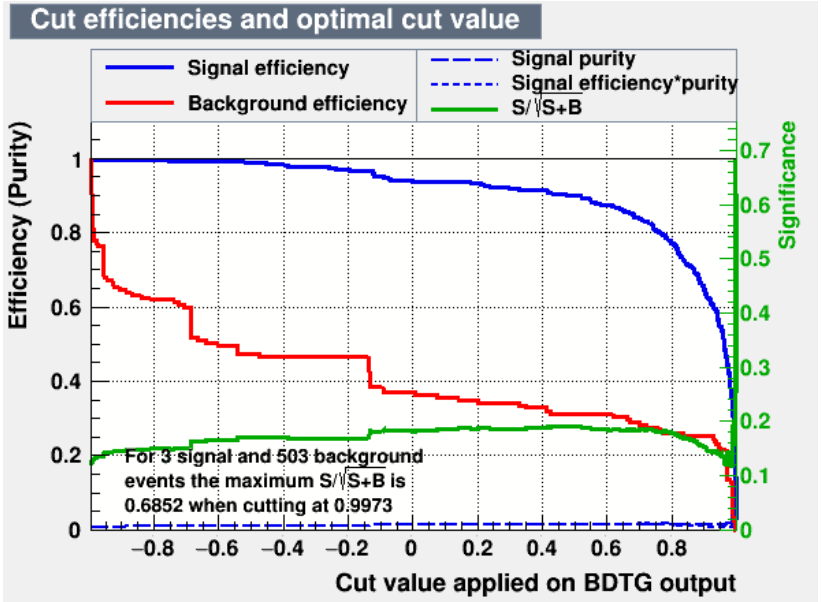
Zh without $M_{\mu\mu}$



6 inputs:

E_{vis}, P_t, thrust, $\cos\theta_{\text{thrust}}$, charge * $\cos\theta_{\mu^{\pm}}$





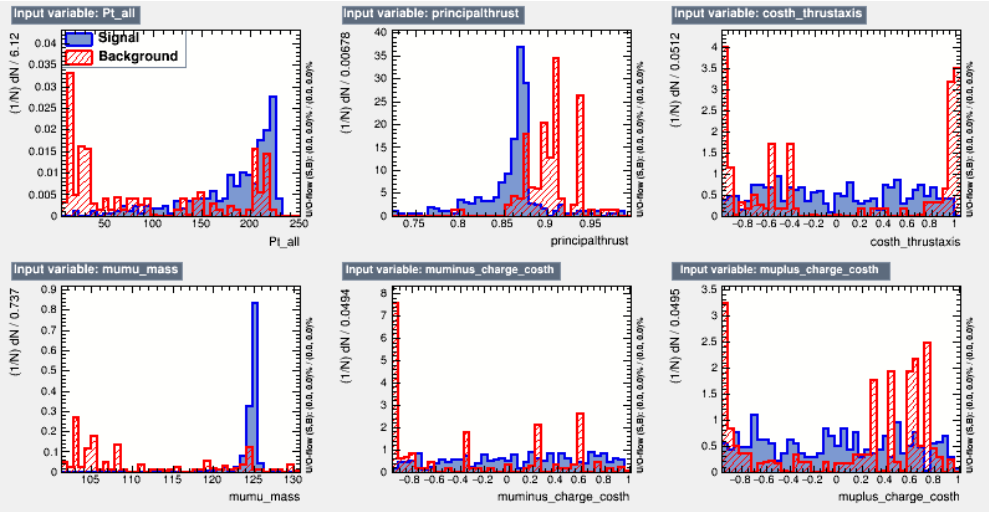
$N_{sig} = 0.47$

$N_{bkg} = 0$

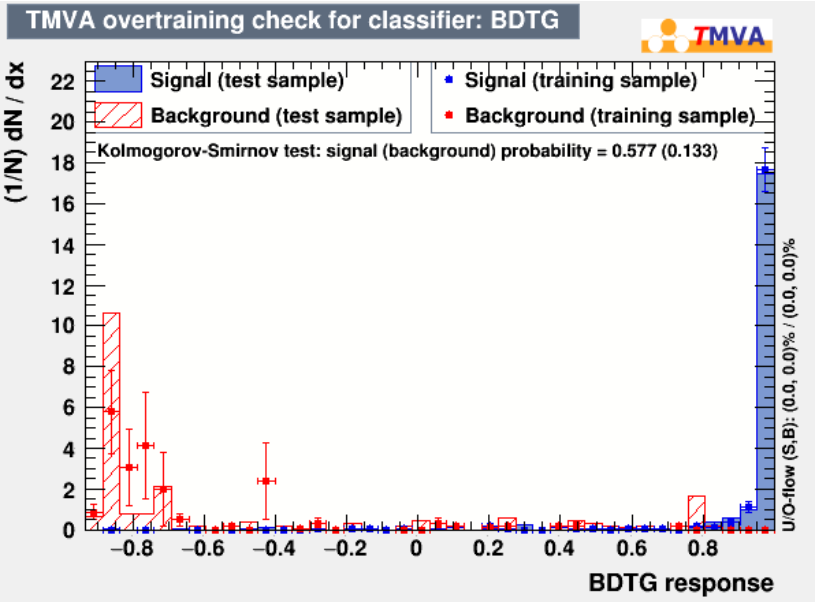
$\frac{S}{\sqrt{S+B}} = 0.7$

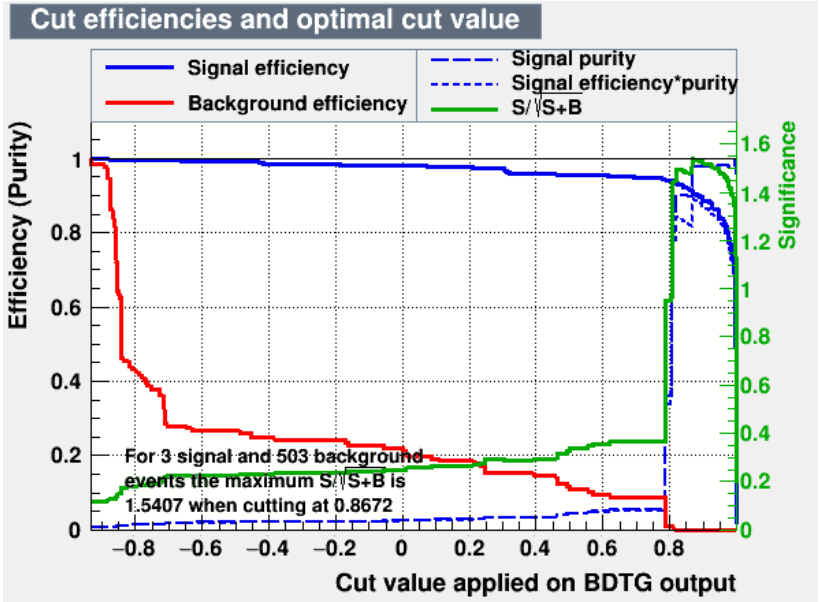
precision = 146%

Zh with $M_{\mu\mu}$



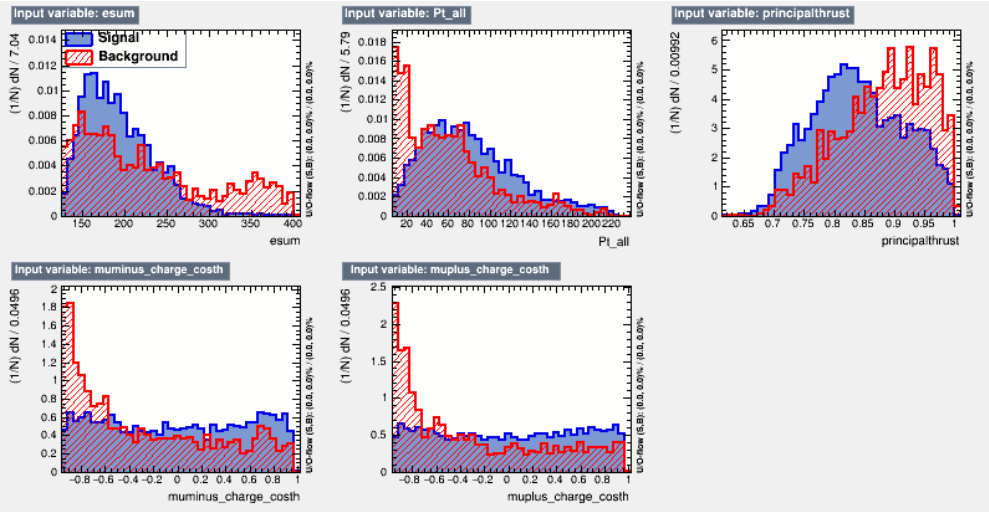
6 inputs:
P_t, thrust, $\cos\theta_{\text{thrust}}$, $M_{\mu\mu}$
charge * $\cos\theta_{\mu^{\pm}}$





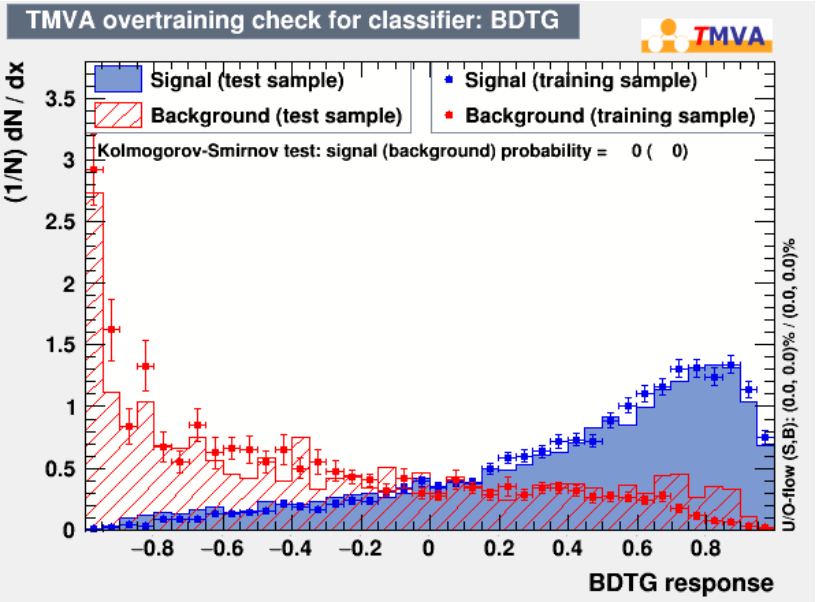
$N_{sig} = 2.43$
$N_{bkg} = 0.05$
$\frac{S}{\sqrt{S+B}} = 1.5$
precision = 65%

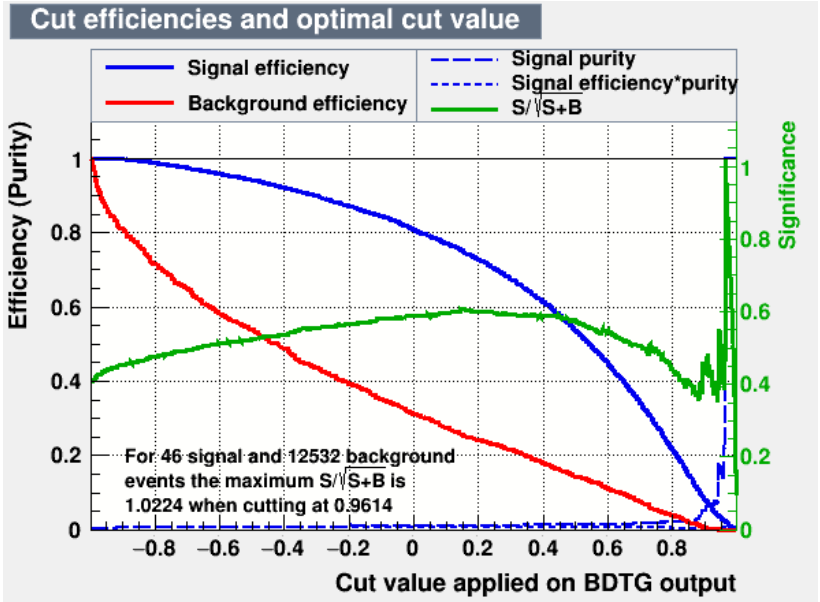
WWF without $M_{\mu\mu}$



5 inputs:

E_{vis}, P_t, thrust, charge * $\cos\theta_{\mu^{\pm}}$





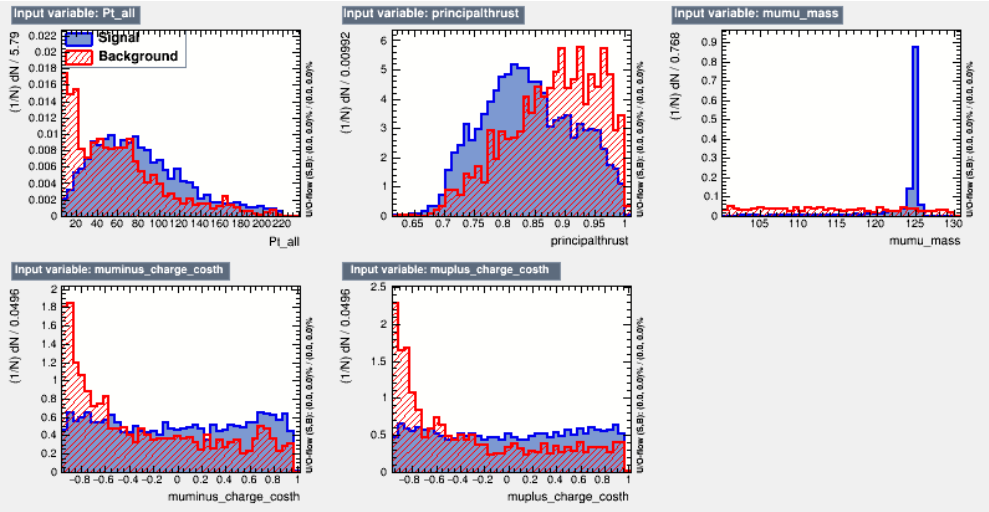
$N_{sig} = 1.05$

$N_{bkg} = 0$

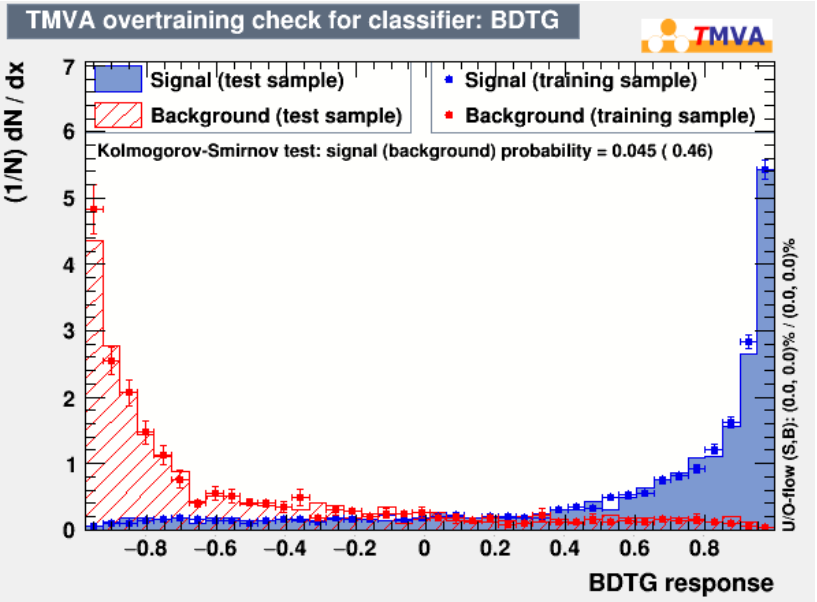
$\frac{S}{\sqrt{S+B}} = 1.0$

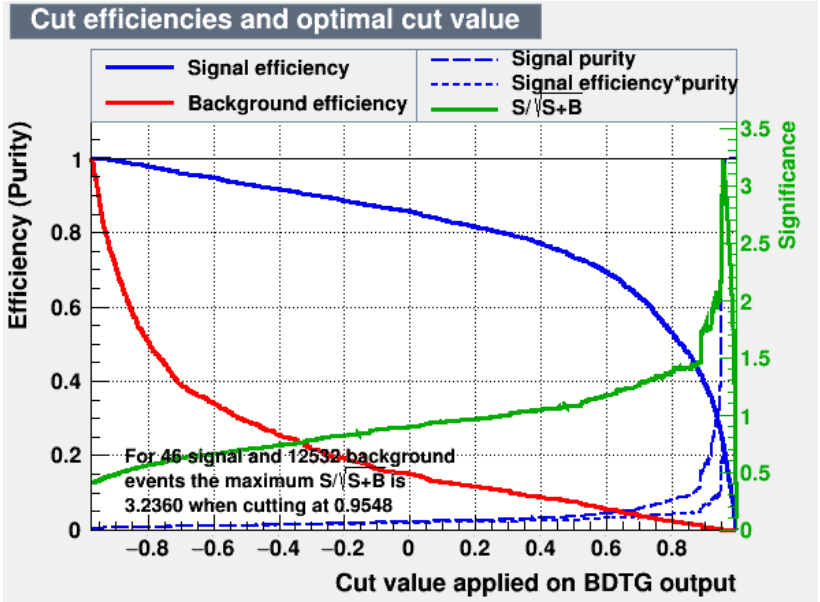
precision = 98%

WWF with $M_{\mu\mu}$



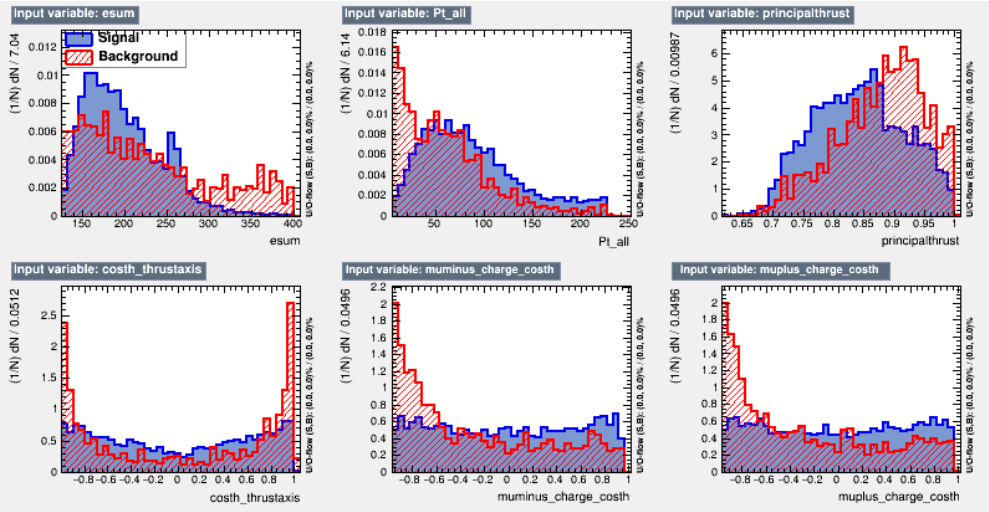
5 inputs:
P_t, thrust, $M_{\mu\mu}$,
charge * $\cos\theta_{\mu^{\pm}}$





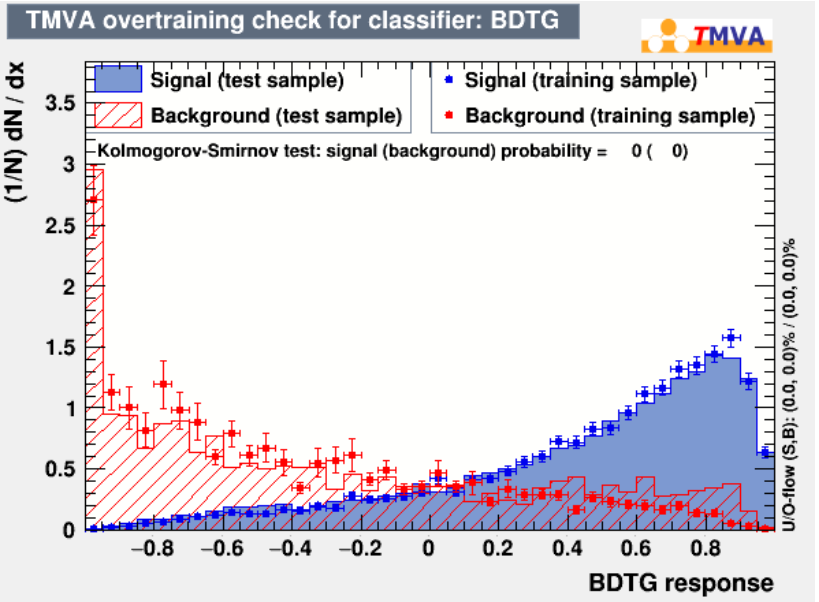
N_{sig} = 10.96
N_{bkg} = 0.51
$\frac{S}{\sqrt{S+B}}$ = 3.2
precision = 31%

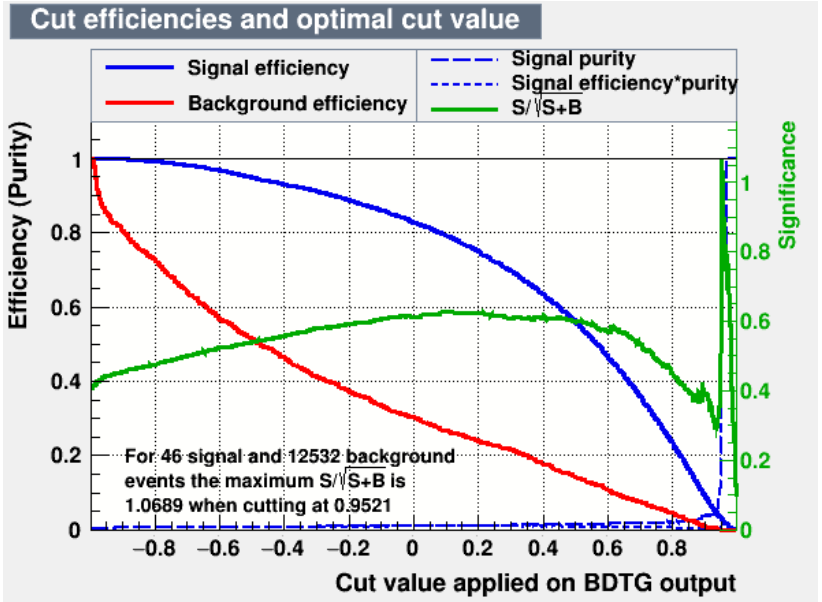
Mixed without $M_{\mu\mu}$



6 inputs:

E_{vis}, P_t, thrust, $\cos\theta_{\text{thrust}}$, charge * $\cos\theta_{\mu^{\pm}}$





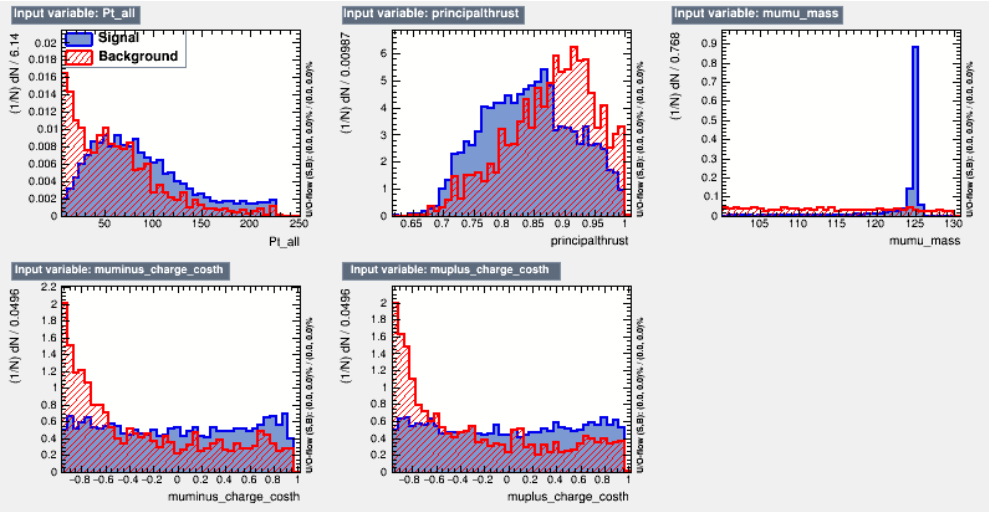
N_{sig} = 1.33

N_{bkg} = 0.22

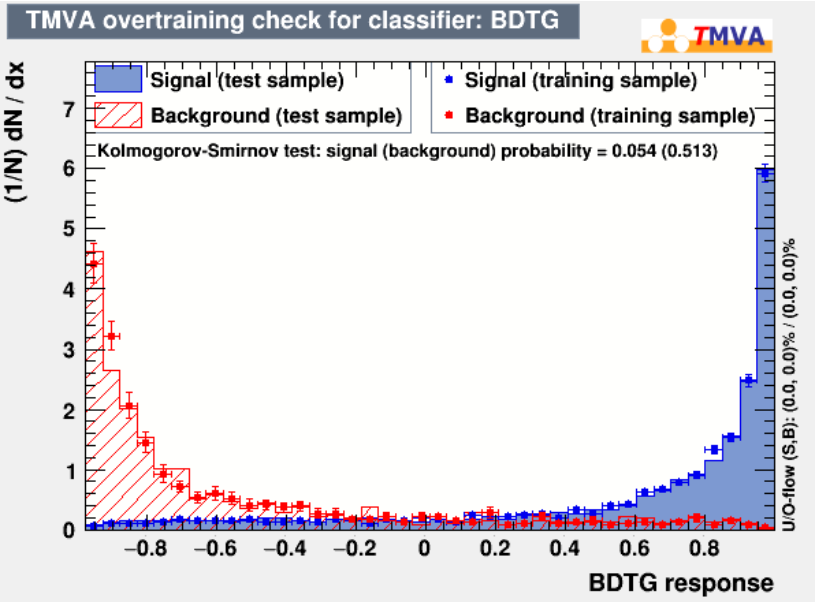
$\frac{S}{\sqrt{S+B}}$ = 1.1

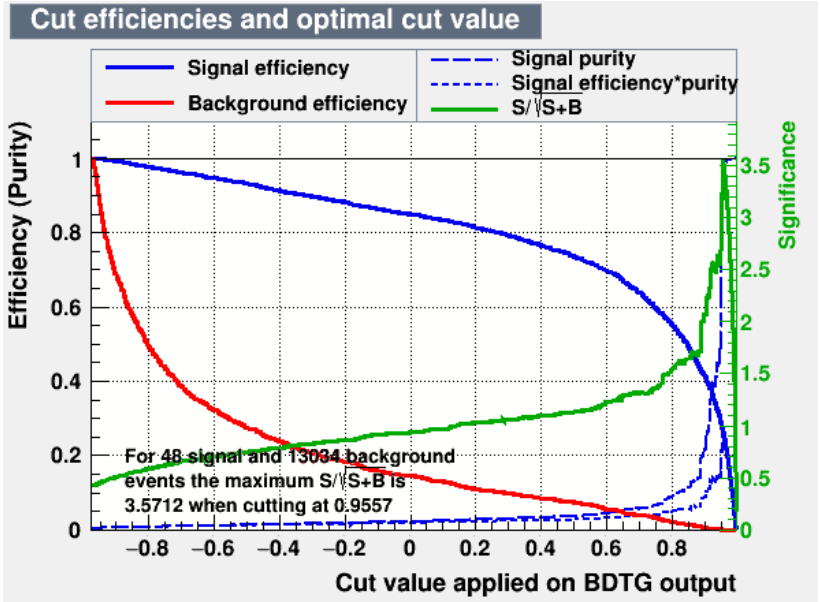
precision = 94%

Mixed with $M_{\mu\mu}$



5 inputs:
P_t, thrust, $M_{\mu\mu}$,
charge * $\cos\theta_{\mu^{\pm}}$





$N_{sig} = 13.04$
$N_{bkg} = 0.30$
$\frac{S}{\sqrt{S+B}} = 3.6$
precision = 28%

Summary

Various configurations are tested
Best precision: 28%

500 GeV, 1600 fb^{-1} left pol.	Zh	WWF	Mixed
without $M_{\mu\mu}$	146%	98%	94%
with $M_{\mu\mu}$	65%	31%	28%

- better than extrapolation
  -- ~50% in Zh, ~40% in WWF
  -- ~31% in Zh+WWF
- factor 2 from ideal case
  -- 13% if 100% eff. & no bkg.
- MC stat., overtraining...
- separation doesn't help for improvement???
  -- combine Zh+WWF = 28%

Plans:
FSR study, re-weighting, search better way/variables...
check the difference between Reco. and MC