Full simulated events on $\tilde{\tau}$ searches

Teresa Núñez

DESY

- Introduction
- Reduction of overlay tracks
- Effect of overlay tracks on signal/background ratio
- Overview and prospects

Introduction

In previous study background and signal events were reconstructed by sgv fast simulation

Check effect of full reconstructed events in $\tilde{\tau}$ searches

Main difference:

Low p_T electron/positron pairs and hadrons from γγ interactions

87% (13%) overlay particles identified as pions (e^+/e^-)

At ILC with $\sqrt{s}$ = 500 GeV in average 1.5 $\gamma\gamma$-background events per bunch
2000 $\gamma\gamma$-background events per train

Introduction

Signal signature:

- large missing energy and momentum
- large fraction of detected activity in central detector (isotropic production of scalar particles)
- unbalanced transverse momentum
- no forward-backward asymmetry

Overlay tracks:

- low transverse momentum
- forward direction
- displaced vertices

Samples:

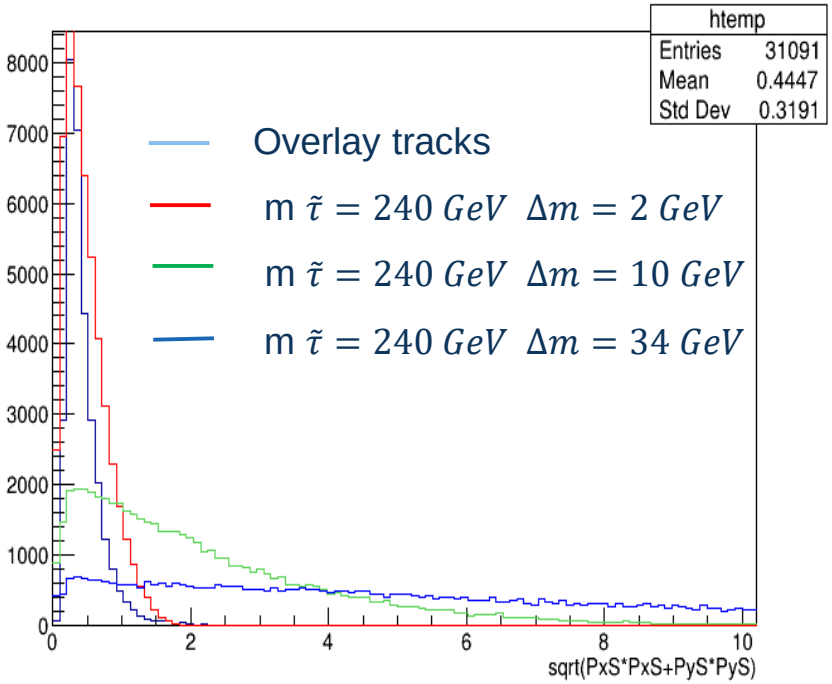
- Background: ILD full simulated files
- Signal: generated by whizard and reconstructed by sgv + overlay tracks from full simulated background files

Overlay tracks reduction

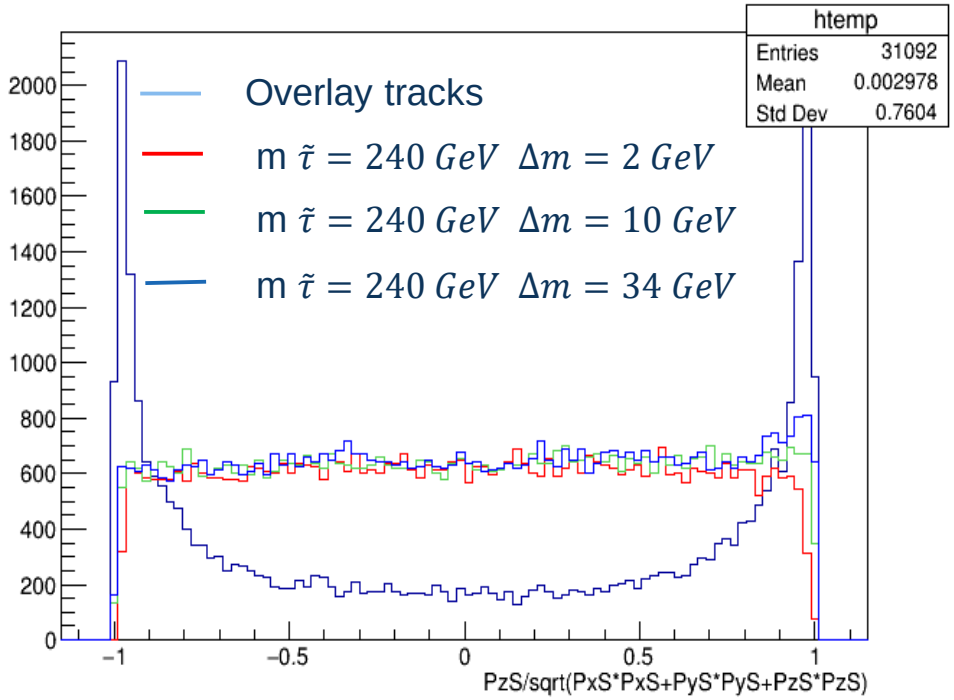
Search for algorithm reducing overlay tracks

Based on:

- angular distribution
- transverse momentum
- impact parameter significance

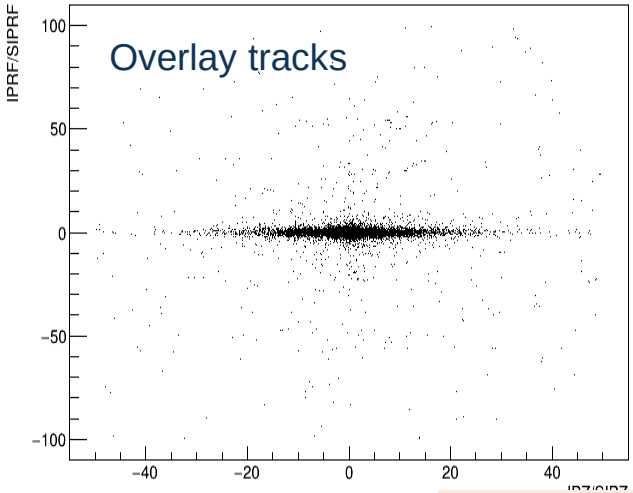


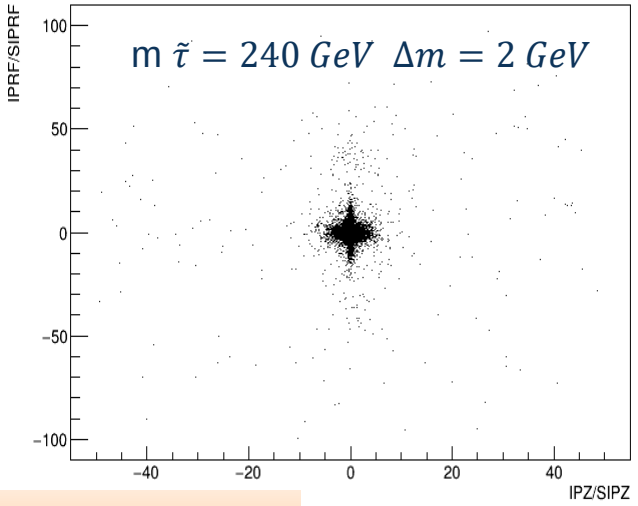
P_T charged tracks



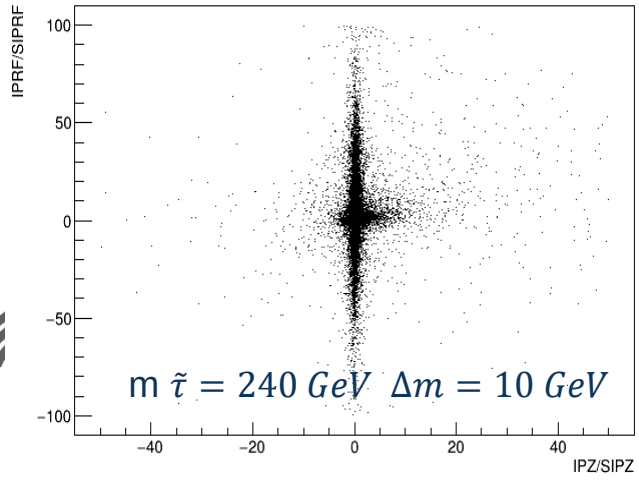
Cosθ charged tracks

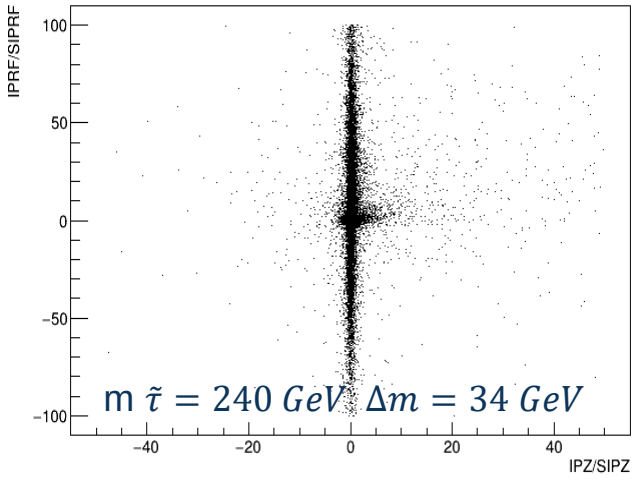
Overlay tracks reduction





IPZ/SIPZ vs IPRF/SIPRF charged tracks with cosθ < 0.7





Overlay tracks reduction

Remaining charged tracks after cuts (% more than 2 tracks)

Average number of remaining charged tracks after the cuts

Cut id	Overlay	240dm2	240dm4	240dm10	240dm34
-9	2.472	2.6 (~19500)	2.687 (>19000)	2.76	2.83
0	0.01115	0.0003 (0)	0.2554 (< 1000)	1.217 (~7000)	2.251
1	1.224	1.884 (~12800)	1.917 (~12000)	1.937 (~12000)	1.968
2	0.0487	0.1863 (~250)	0.8353 (~3500)	1.428 (~9000)	1.831
3	0.009571		0.1795 (< 100)	0.4701(~1900)	0.921 (~3500)
4	0.02619	0.3348 (~900)	0.7145 (~3100)	1.007 (~4200)	1.242 (~6850)
5	0.02314	0.2822 (~500)	0.6099 (~2300)	0.8401(~4000)	1.004 (~5000)
6	0.2883	1.373 (~9400)	1.408 (~9000)	1.494 (~9100)	1.606 (~9700)
7	0.2803	1.302 (~8500)	0.9172 (~4000)	0.373 (~1000)	0.07325 (<100)

-9 not cut
0 p_trans > 2 GeV
1 cos_theta < 0.7
2 1 && p_trans > 1 GeV
3 1 && abs(ipz/sipz) < 2 && abs(iprf/siprf) > 10
4 1 && abs(ipz/sipz) < 0.6 && abs(iprf/siprf) > 2
5 4 && abs(ipz/sipz) > 0.03
6 1 && abs(ipz/sipz) < 0.6
7 6 && abs(iprf/siprf) < 5. && p_trans < 2 GeV

stau mixing 0

m $\tilde{\tau} = 240\ GeV$ $\Delta m = 10\ GeV$

Cut id	Remaining events	#norm	rel. eff.
-9	1662 (19775)	74.74	8.4%
0	927 (7062)	41.69	13.1%
1	1396 (12061)	62.78	11.6%
2	1199 (8941)	53.92	13.4%
3	151 (952)	6.79	15.9%
4	557 (3029)	23.11	17.0%
5	296 (1345)	13.31	22.0%
6	1201 (9192)	54.01	13.1%

Overlay tracks reduction

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Selected cuts:

- **DM10: $\cos\theta$ < 0.7, abs(ipz/sipz) < 0.6, abs(iprf/siprf) > 2 (cut 4)**
- **DM2: $\cos\theta$ < 0.7, abs(ipz/sipz) < 0.6, abs(iprf/siprf) < 5, p_trans < 2GeV (cut 7)**

2	1 && p_trans > 1 GeV
3	1 && abs(ipz/sipz) < 2 && abs(iprf/siprf) > 10
4	1 && abs(ipz/sipz) < 0.6 && abs(iprf/siprf) > 2
5	4 && abs(ipz/sipz) > 0.03
6	1 && abs(ipz/sipz) < 0.6
7	6 && abs(iprf/siprf) < 5. && p_trans < 2 GeV

stau mixing 0

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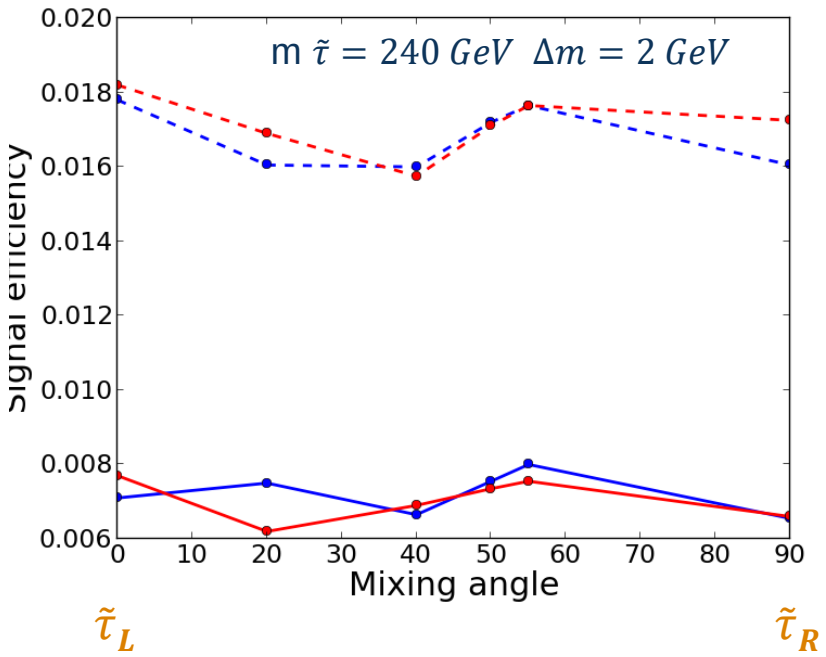
Effect of overlay tracks

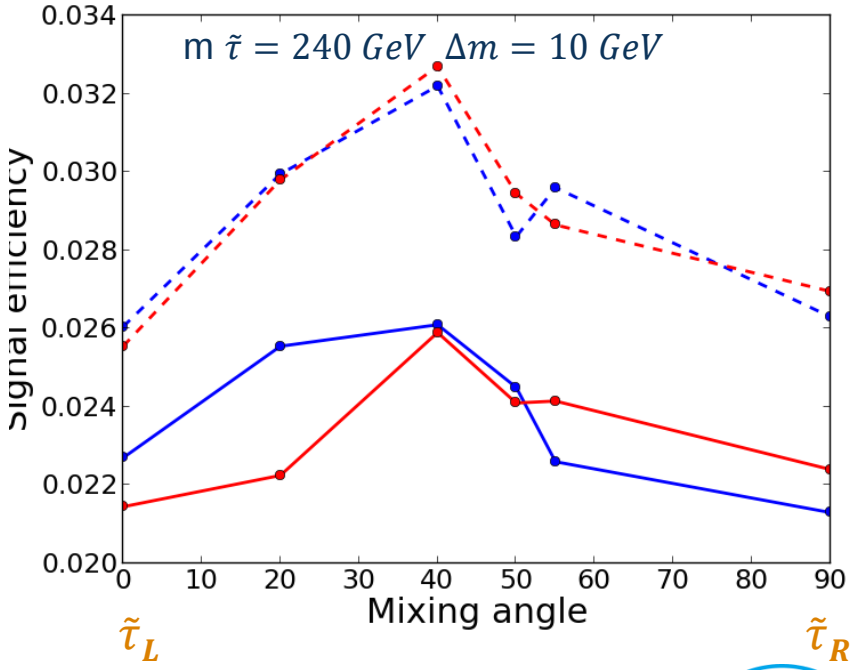
Pol=+80,-30

Pol=-80,+30

Overlay cut

Not overlay cut





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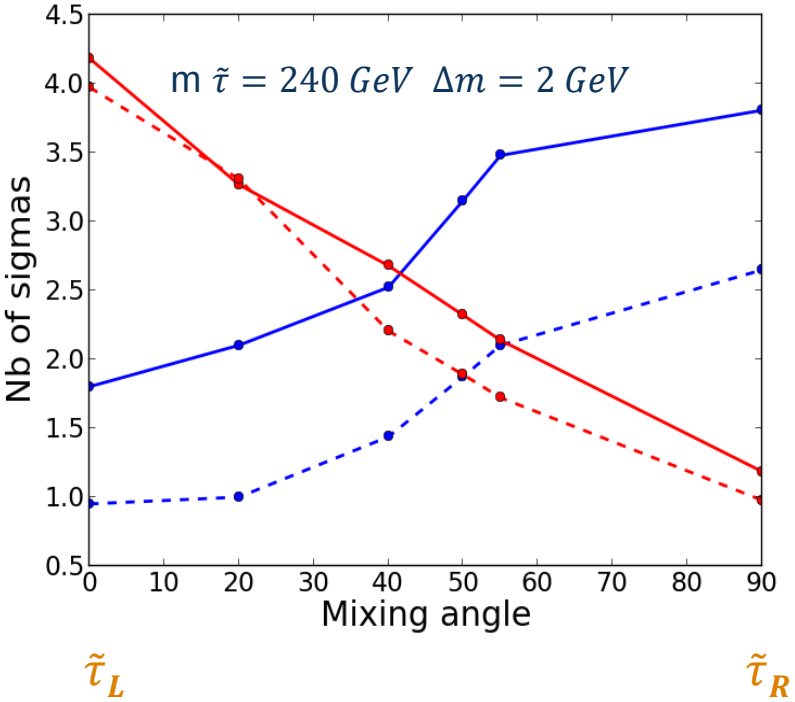
Effect of overlay tracks

Pol=+80,-30

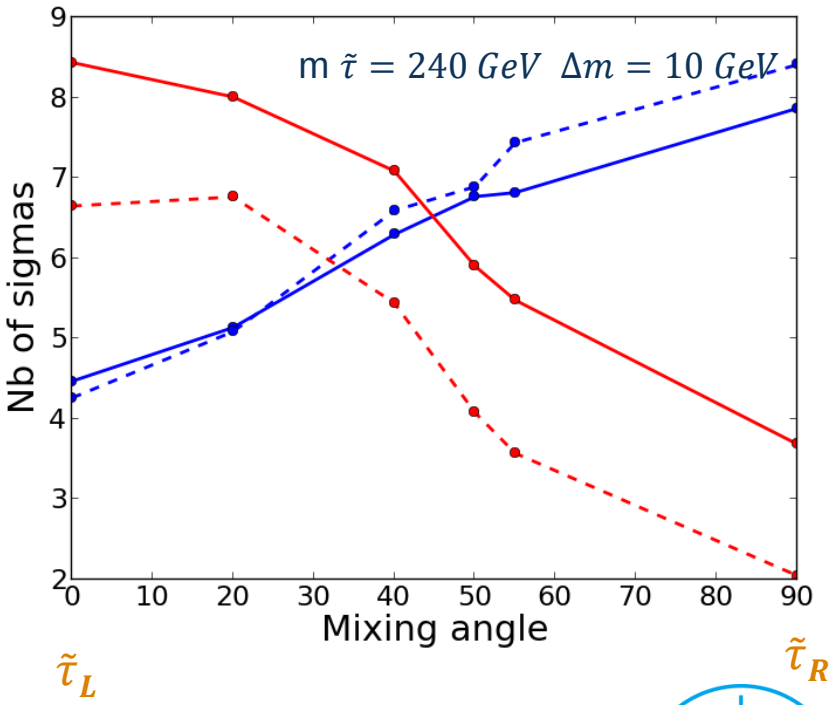
Pol=-80,+30



$\tilde{\tau}_L$ $\tilde{\tau}_R$

Overlay cut

Not overlay cut



$\tilde{\tau}_L$ $\tilde{\tau}_R$

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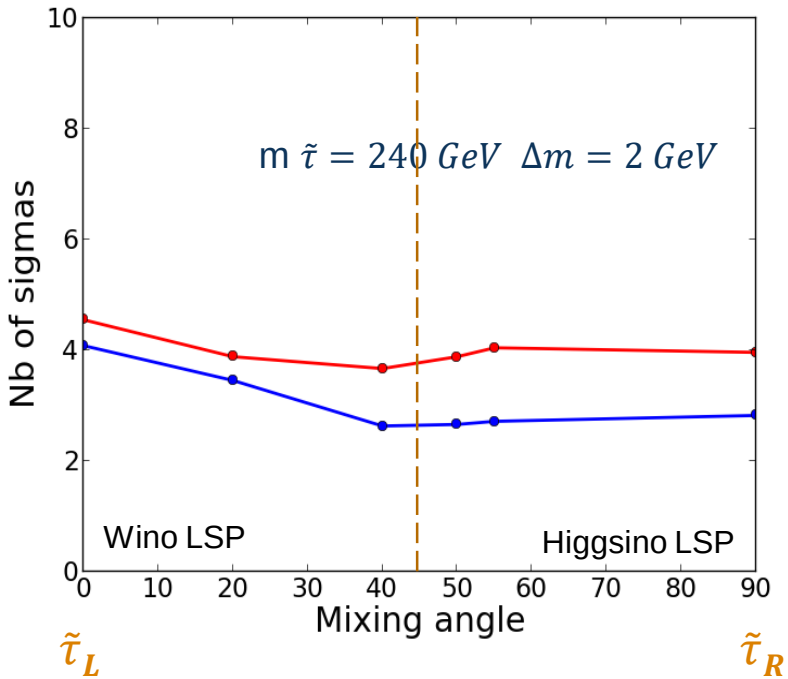
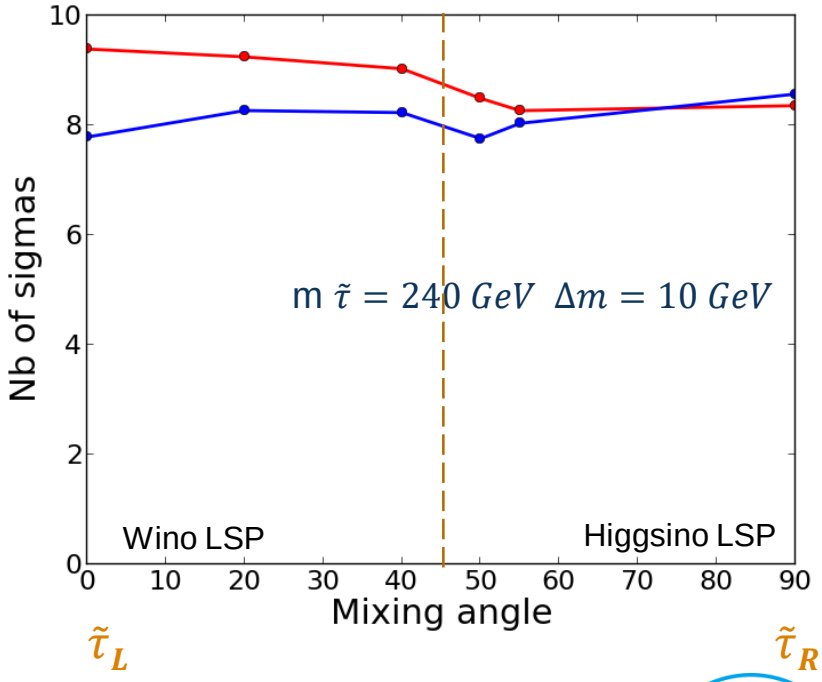
Effect of overlay tracks

Likelihood-ratio statistic used to weight both polarisations (H20 conditions)

Not overlay cut

Overlay cut





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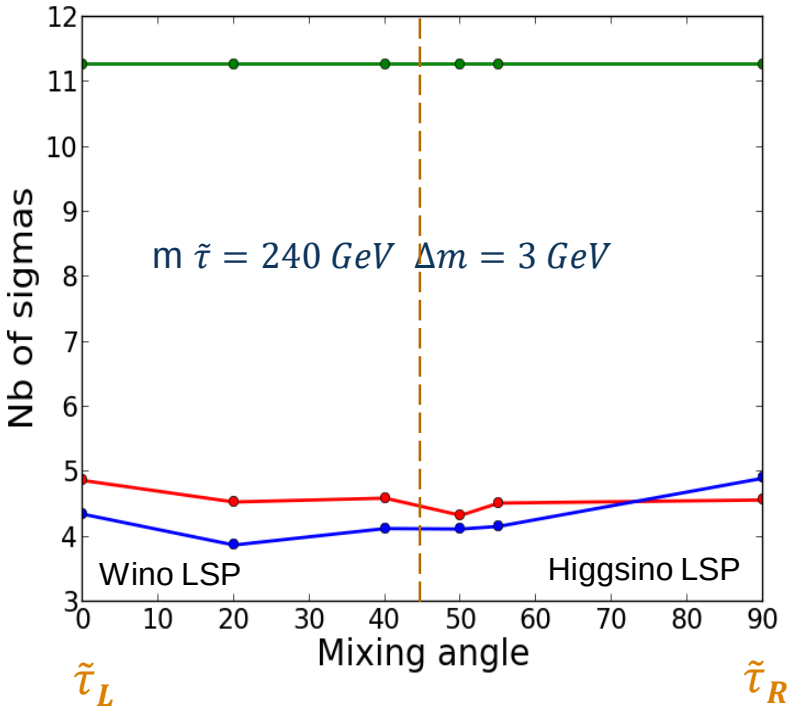
Full Simulation vs SGV

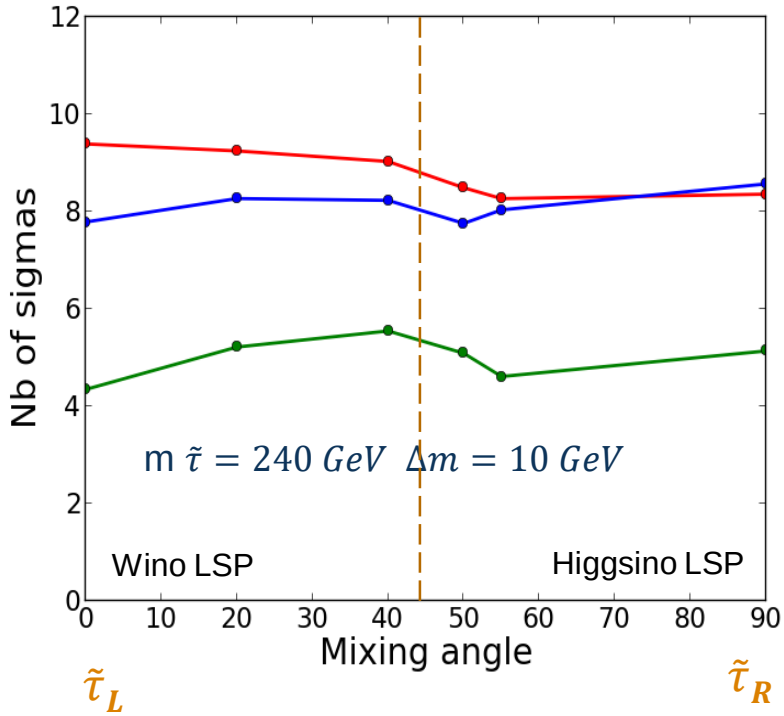
Fullsimulation

Not overlay cut

Overlay cut

SGV





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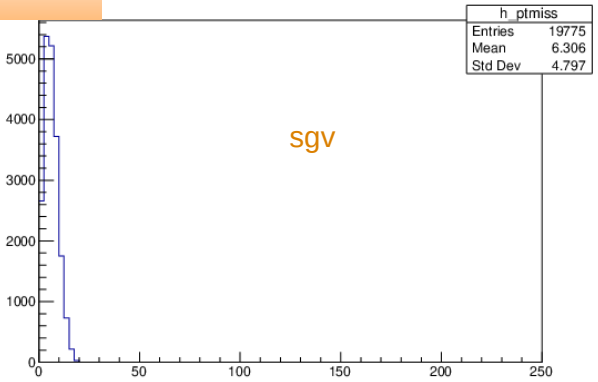
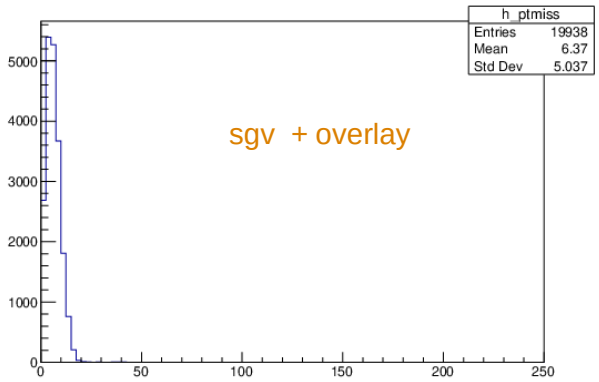
Why more significance if overlay?

Missed transverse momentum

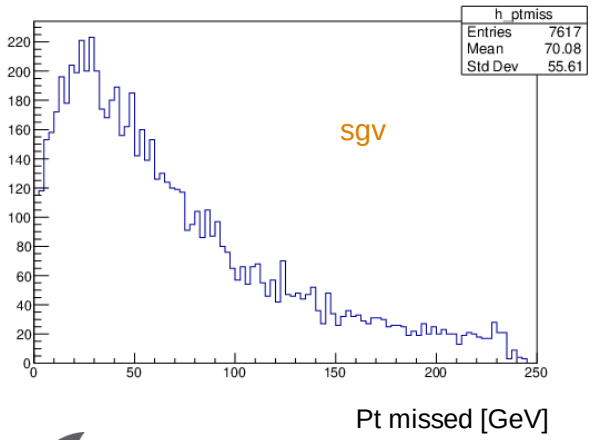
Signal

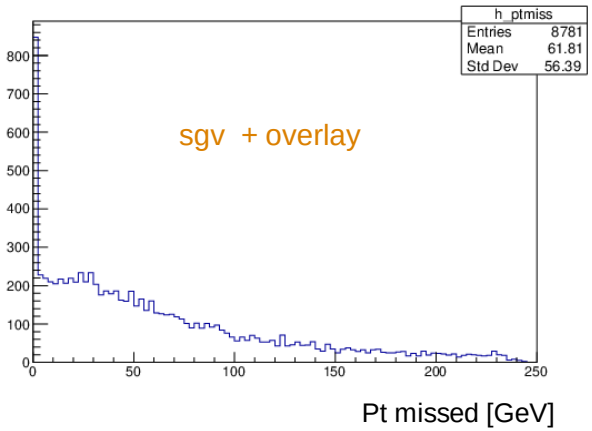
m $\tilde{\tau} = 240\ GeV\ \ \Delta m = 10\ GeV$

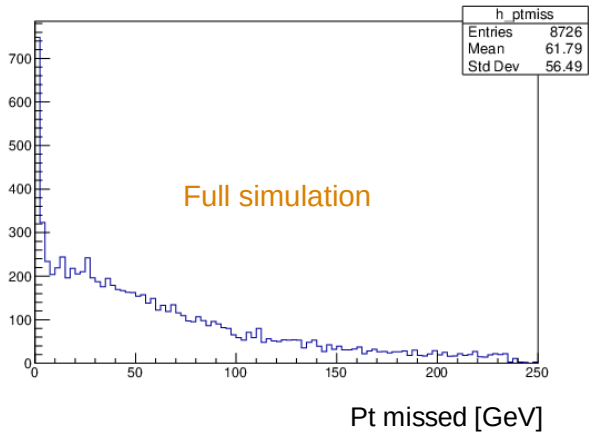




ZZ → ννττ (ννμμ), WW → ττν (μνμν)







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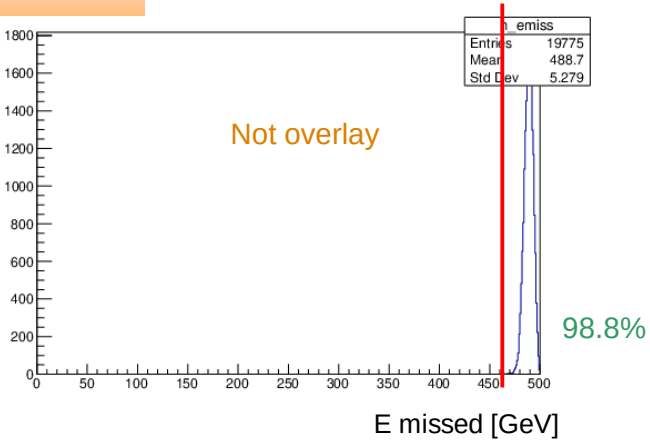
DESY

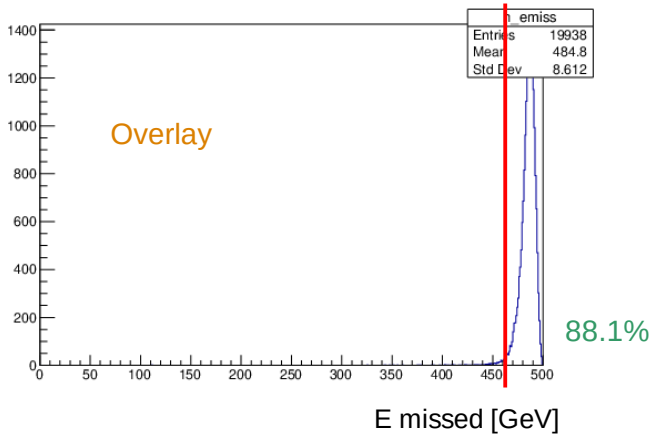
Why more significance if overlay?

Missed energy

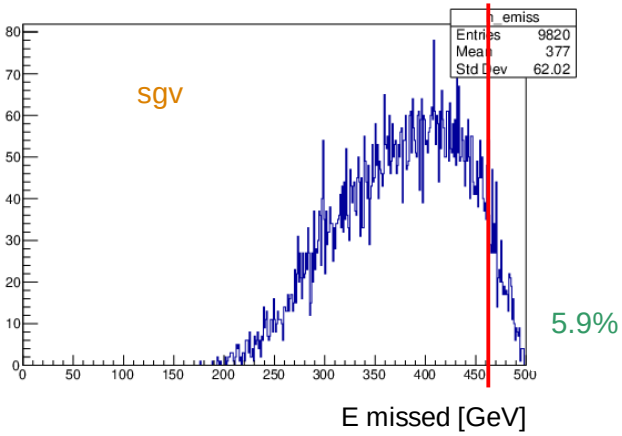
Signal

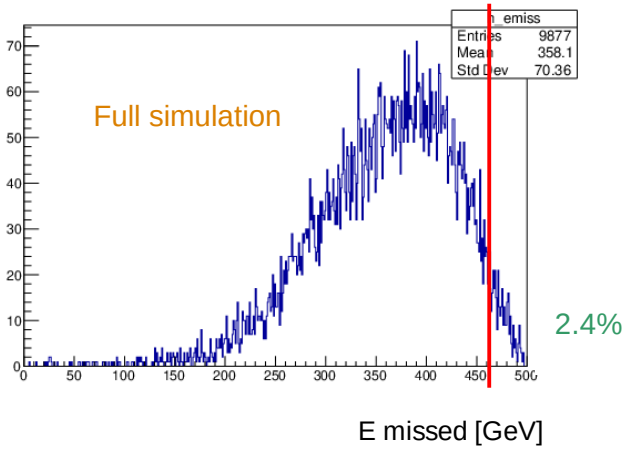
m $\tilde{\tau} = 240\ GeV\ \ \Delta m = 10\ GeV$





$\gamma\gamma \rightarrow\ llvv$





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Why more significance if overlay?

Missed energy

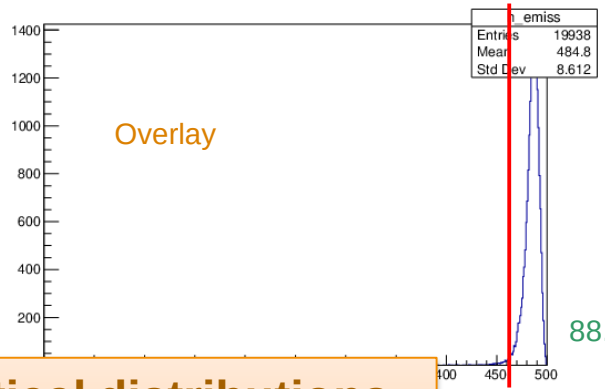
Signal

m $\tilde{\tau} = 240\ GeV\ \ \Delta m = 10\ GeV$

Not overlay

98.8%

Overlay

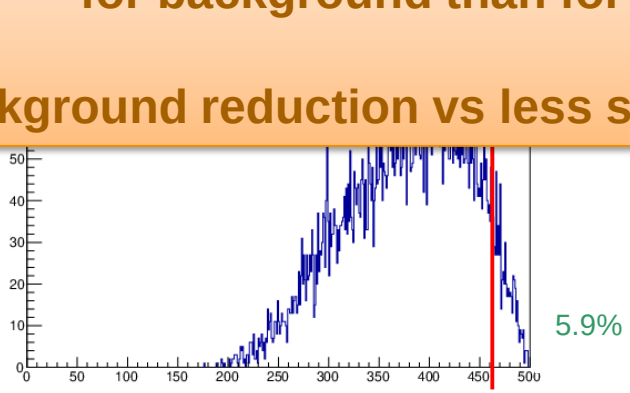


88.1%

Larger effect of overlay tracks on kinematical distributions for background than for signal:

more background reduction vs less signal efficiency loss

$\gamma\gamma$ →



5.9%

2.4%

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Overview and prospects

- Effect of overlay tracks on signal/background ratio for $\tilde{\tau}$ searches was analysed
- High DM: overlay harms background more than signal, increase of significance wrt sgv
- Low DM: overlay very similar to signal, strong reduction of significance
- In both cases effect of cuts against overlay tracks much smaller than adding overlay at all
- Study of possible fine tuning for improving significance in low DM case
- Study of “only overlay” events as possible misidentified $\tilde{\tau}$ events is undergoing