Status Report: Muon g-2 anomaly + SUSY at the ILC

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Muon g-2 + SUSY: status report

- Sample generation with WHIZARD, detector simulation with DELPHES, physics analysis
  - see details of physics analysis (tight cuts) in backup
- Stared to detect edge using fit (smuon events)

Two-body decay kinematics (1)

- In the end, we have
  - $E^{+} = \frac{\sqrt{s}}{4}\left[1 - \left(\frac{m_{\chi}}{m_{\mathrm{SUSY}}}\right)^{2}\right]\left[1 + \sqrt{1 - 4\left(\frac{m_{\mathrm{SUSY}}}{\sqrt{s}}\right)^{2}}\right]$
  - $E^{-} = \frac{\sqrt{s}}{4}\left[1 - \left(\frac{m_{\chi}}{m_{\mathrm{SUSY}}}\right)^{2}\right]\left[1 - \sqrt{1 - 4\left(\frac{m_{\mathrm{SUSY}}}{\sqrt{s}}\right)^{2}}\right]$
  - where E^{+}/E^{-} is the maximum/minimum energy of lepton (electron/positron/muon/tau), m_{SUSY} is the mass of SUSY particle (selectron/smuon/stau), $\sqrt{s}$ = 500 GeV in this analysis, and m_{χ} is the neutralino mass and equals to 99 GeV on BLR1 parametrization
  - Ignored lepton masses

Two-body decay kinematics (2)

$\sqrt{s}$ = 500 GeV, $\widetilde{\chi_1^0}$ = 99 GeV, ignored lepton masses

SUSY particle	mass (GeV)	E^+ (GeV)	E^- (GeV)
$\tilde{e}_L$	157	133.9	16.7
$\widetilde{e_R}$	156	133.0	16.3
$\widetilde{\mu_L}$	158	134.8	17.1
$\widetilde{\mu_R}$	154	131.1	15.6
$\tilde{\tau}_1$	113	55.0	3.1
$\tilde{\tau}_2$	190	150.2	31.9

Mass extraction

- It is possible to extract the masses of selectron/smuon/neutralino once we measure E^+ and E^- from the experiment
- In the end, we have
  - $m_{\text{SUSY}}^2 = (\sqrt{s})^2 \frac{E^+E^-}{(E^+ + E^-)^2}$
  - $m_\chi^2 = m_{\text{SUSY}}^2 \left[1 - \frac{2\left(E^+ + E^-\right)}{\sqrt{s}}\right]$
- Start edge detection for smuons

Edge detection

This time I adopted **single error function** as a fitting function.

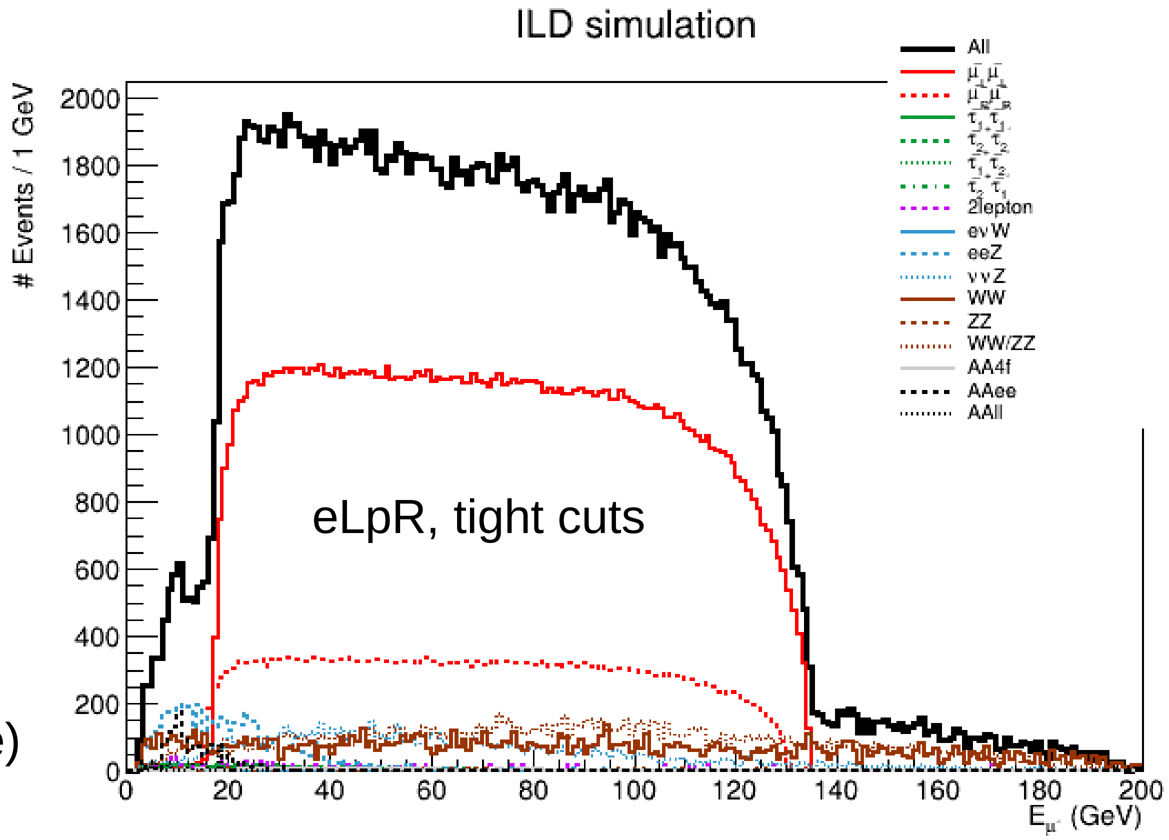
$$f_{\mathrm{low}} = [0] + [1] * \mathrm{erf}\left(\frac{x - [2]}{[3]}\right)$$

[0]: background level
[1]: coefficient
[2]: edge (actually Gaussian mean but interpret as edge)
[3]: sigma (Gaussian sigma)

$$f_{\mathrm{high}} = [0] + [1] * \mathrm{erfc}\left(\frac{x - [2]}{[3]}\right)$$

$$\mathrm{erf}(x) = 1 - \mathrm{erfc}(x)$$

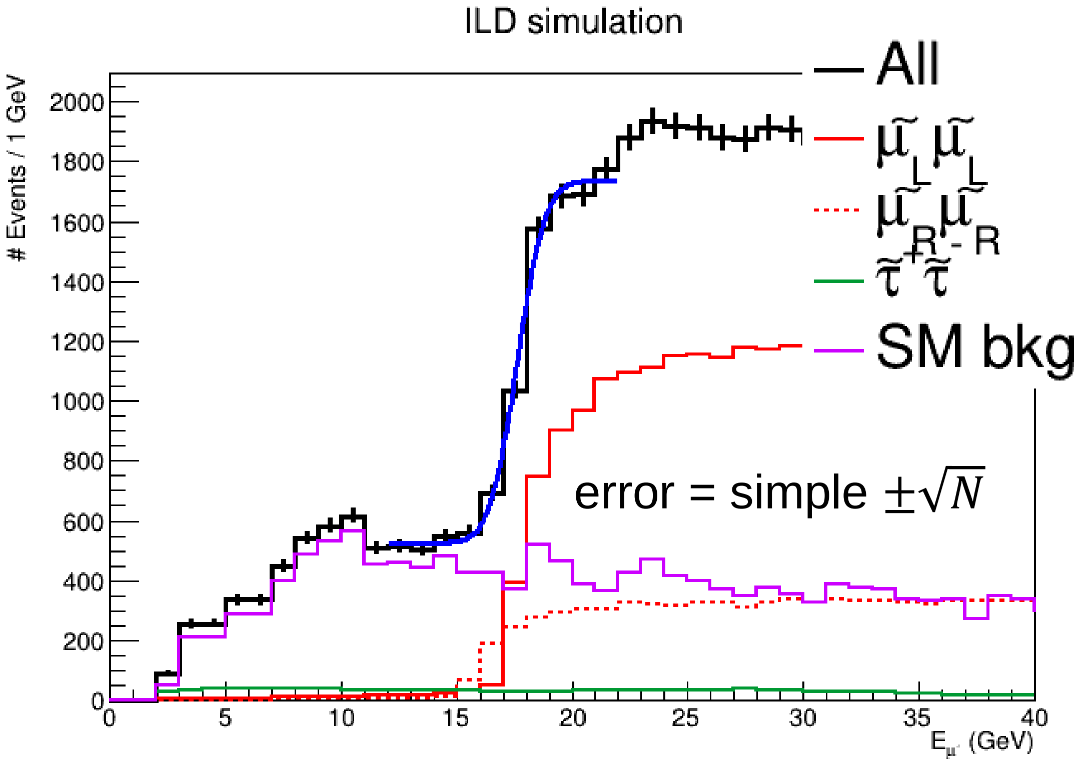
[0]: background level
[1]: coefficient
[2]: edge (actually Gaussian mean but interpret as edge)
[3]: sigma (Gaussian sigma)



Low edge (eLpR)

$$f_{\text{low}} = [0] + [1] * \text{erf}\left(\frac{x - [2]}{[3]}\right)$$

[0]: background level
[1]: coefficient
[2]: edge (actually Gaussian mean but interpret as edge)
[3]: sigma (Gaussian sigma)

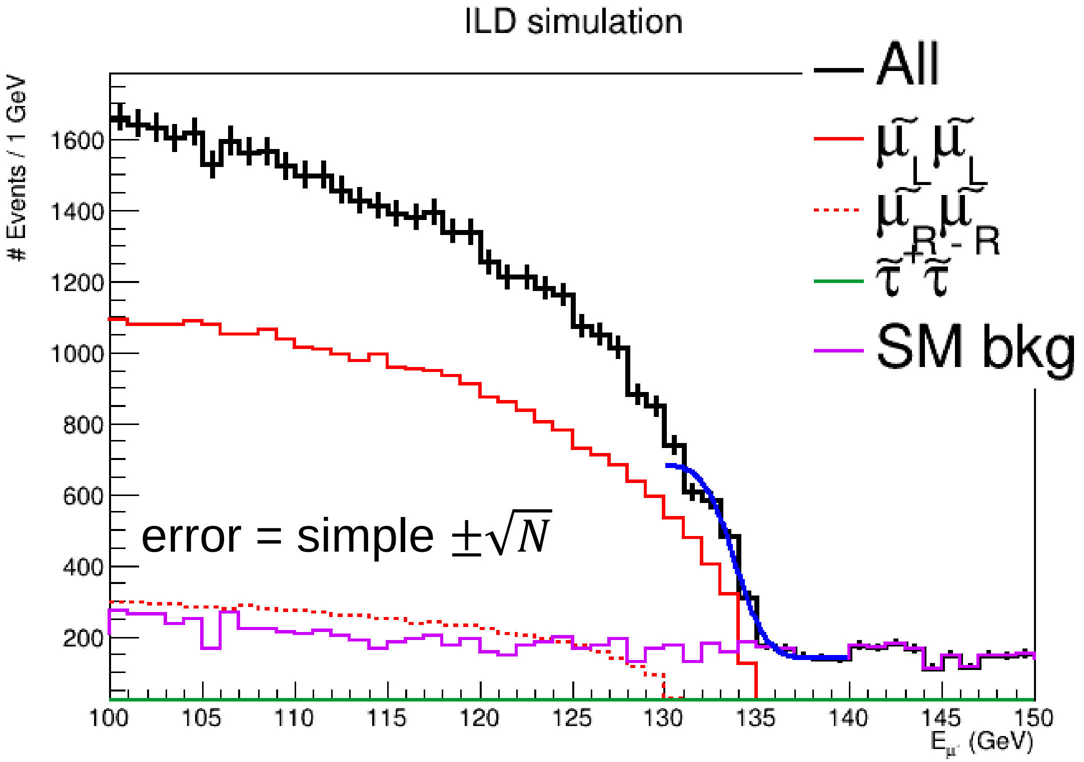


fit range [12, 22]	initial value	result
[0]	400	1131 +- 14
[1]	500	604 +- 15
[2]	17	17.615 +- 0.063
[3]	1	1.35 +- 0.12

theory	mass (GeV)	E^+ (GeV)	E^- (GeV)
$\widetilde{\mu_L}$	158	134.8	17.1
$\widetilde{\mu_R}$	154	131.1	15.6

χ^2/NDF = 8.41007/(10-4)

High edge (eLpR)



$$f_{\text{low}} = [0] + [1] * \text{erfc}\left(\frac{x - [2]}{[3]}\right)$$

[0]: background level
[1]: coefficient
[2]: edge (actually Gaussian mean but interpret as edge)
[3]: sigma (Gaussian sigma)

fit range [130, 140]	initial value	result
[0]	250	140.6 +- 6.7
[1]	400	272 +- 15
[2]	135	133.79 +- 0.16
[3]	2	1.88 +- 0.26

theory	mass (GeV)	E^+ (GeV)	E^- (GeV)
$\widetilde{\mu_L}$	158	134.8	17.1
$\widetilde{\mu_R}$	154	131.1	15.6

χ^2/NDF = 15.0322/(10-4)

First results (eLpR)

- $m_{\text{SUSY}}^2 = (\sqrt{s})^2 \frac{E^+E^-}{(E^+ + E^-)^2}$, $m_\chi^2 = m_{\text{SUSY}}^2 \left[1 - \frac{2(E^+ + E^-)}{\sqrt{s}}\right]$
- $m_{\text{SUSY}} = \sqrt{s}\frac{\sqrt{E^+E^-}}{E^+ + E^-}$, $m_\chi = m_{\text{SUSY}}\sqrt{1 - \frac{2(E^+ + E^-)}{\sqrt{s}}}$
- $E^+ = 133.79 \pm 0.16$, $E^- = 17.615 \pm 0.063$
- With error propagation, we have
  - $m_{\text{SUSY}} = 160.32 \pm 0.23$ GeV
  - $m_\chi = 100.68 \pm 0.23$ GeV

	theory (GeV)	fit result (GeV)
$\widetilde{\mu_L}$	158	160.32 +- 0.23
$\widetilde{\mu_R}$	154	
χ	99	100.68 +- 0.23

Edge detection

This time I adopted **single error function** as a fitting function.

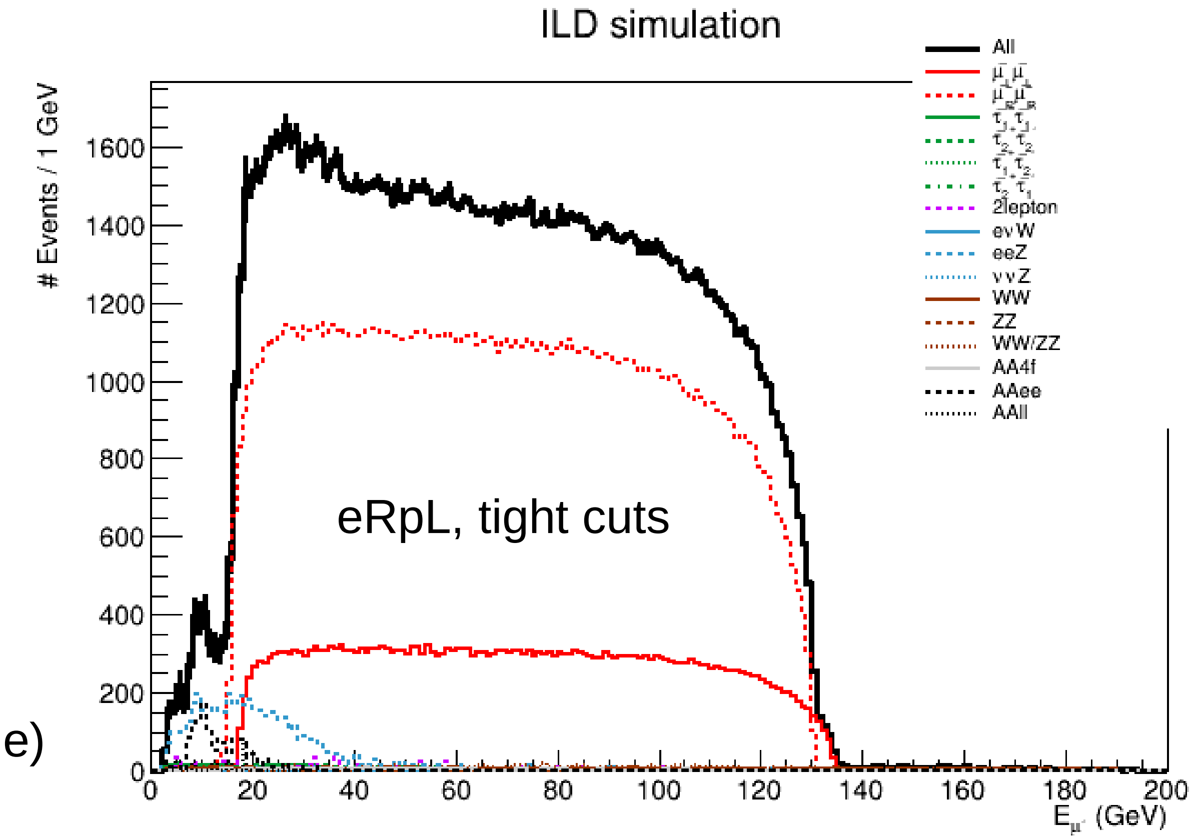
$$f_{\mathrm{low}} = [0] + [1] * \mathrm{erf}\left(\frac{x - [2]}{[3]}\right)$$

[0]: background level
[1]: coefficient
[2]: edge (actually Gaussian mean but interpret as edge)
[3]: sigma (Gaussian sigma)

$$f_{\mathrm{high}} = [0] + [1] * \mathrm{erfc}\left(\frac{x - [2]}{[3]}\right)$$

$$\mathrm{erf}(x) = 1 - \mathrm{erfc}(x)$$

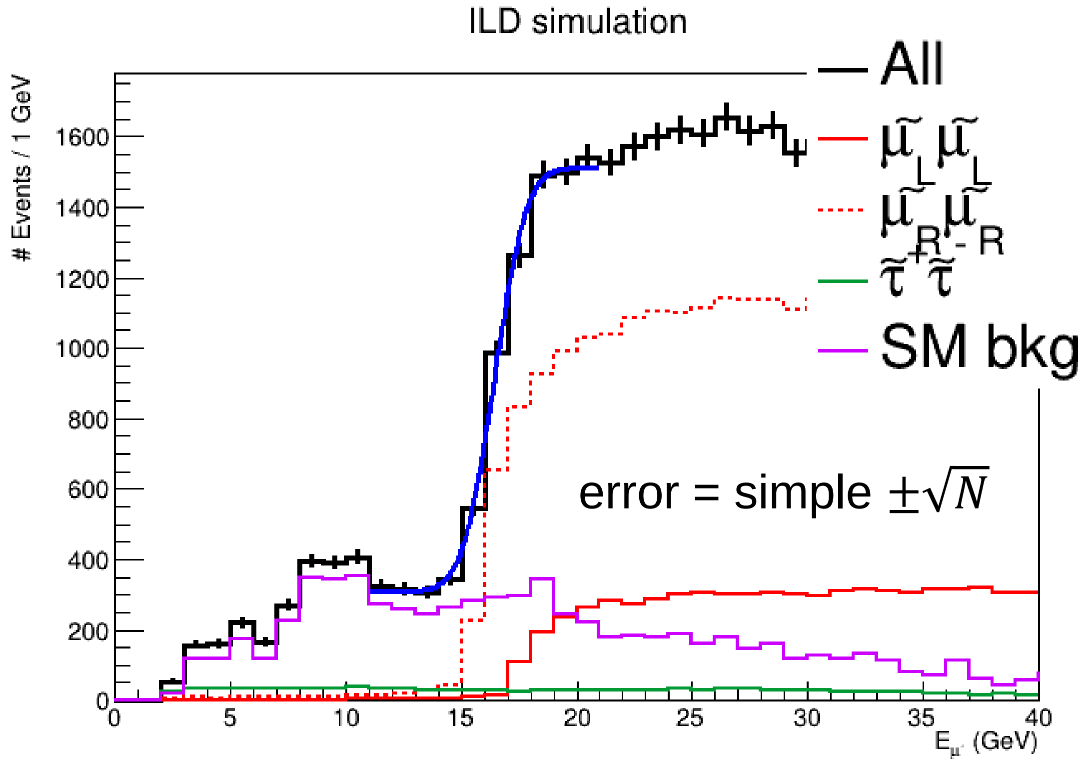
[0]: background level
[1]: coefficient
[2]: edge (actually Gaussian mean but interpret as edge)
[3]: sigma (Gaussian sigma)



Low edge (eRpL)

$$f_{\text{low}} = [0] + [1] * \text{erf}\left(\frac{x-[2]}{[3]}\right)$$

[0]: background level
[1]: coefficient
[2]: edge (actually Gaussian mean but interpret as edge)
[3]: sigma (Gaussian sigma)



fit range [11, 21]	initial value	result
[0]	250	911 +- 13
[1]	500	601 +- 14
[2]	16	16.420 +- 0.068
[3]	1	1.55 +- 0.11

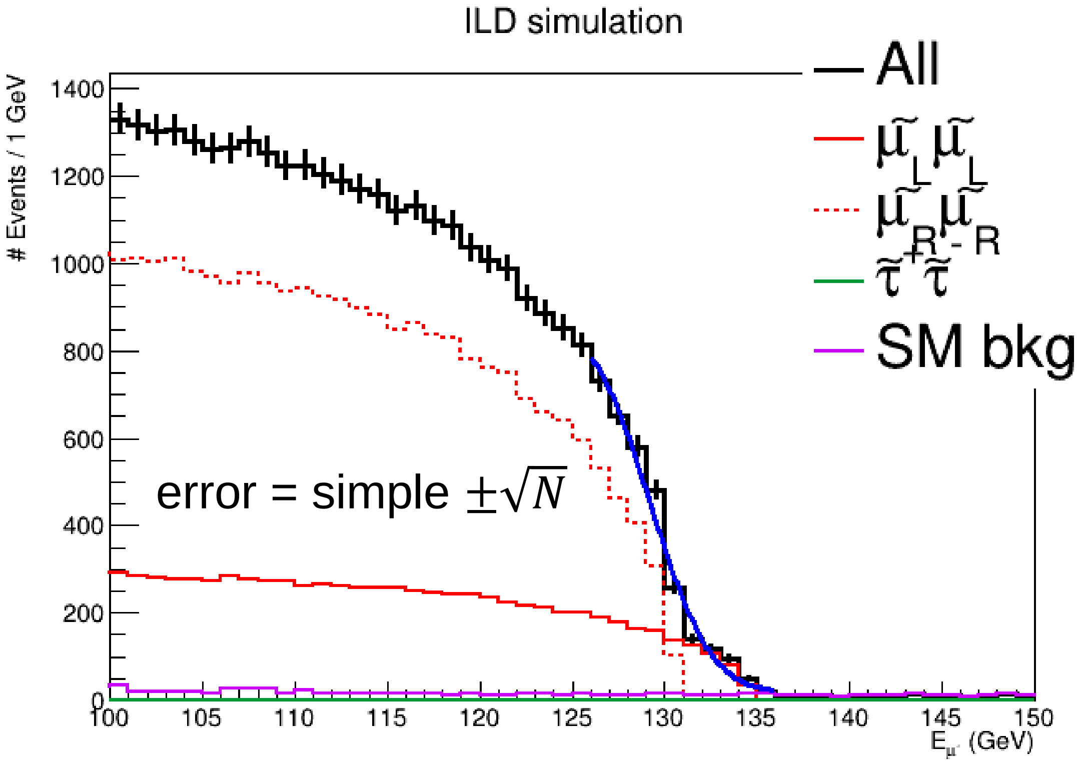
theory	mass (GeV)	E^+ (GeV)	E^- (GeV)
$\widetilde{\mu_L}$	158	134.8	17.1
$\widetilde{\mu_R}$	154	131.1	**15.6**

χ^2/NDF = 6.53593/(10-4)

High edge (eRpL)

$$f_{\text{low}} = [0] + [1] * \text{erfc}\left(\frac{x - [2]}{[3]}\right)$$

[0]: background level
[1]: coefficient
[2]: edge (actually Gaussian mean but interpret as edge)
[3]: sigma (Gaussian sigma)



fit range [126, 136]	initial value	result
[0]	0	19.7 +- 6.6
[1]	300	429 +- 41
[2]	131	129.24 +- 0.35
[3]	2	3.63 +- 0.42

theory	mass (GeV)	E^+ (GeV)	E^- (GeV)
$\widetilde{\mu_L}$	158	134.8	17.1
$\widetilde{\mu_R}$	154	**131.1**	15.6

χ^2/NDF = 49.1601/(10-4)

First results (eRpL)

- $m_{\mathrm{SUSY}}^2 = (\sqrt{s})^2 \frac{E^+E^-}{(E^+ + E^-)^2}, \; m_\chi^2 = m_{\mathrm{SUSY}}^2 \left[1 - \frac{2(E^+ + E^-)}{\sqrt{s}}\right]$
- $m_{\mathrm{SUSY}} = \sqrt{s}\frac{\sqrt{E^+E^-}}{E^+ + E^-}, \; m_\chi = m_{\mathrm{SUSY}}\sqrt{1 - \frac{2(E^+ + E^-)}{\sqrt{s}}}$
- $E^+ = 129.24 \pm 0.35, E^- = 16.420 \pm 0.068$
- With error propagation, we have
  - $m_{\mathrm{SUSY}} = 158.13 \pm 0.30$ GeV
  - $m_\chi = 102.16 \pm 0.40$ GeV

	theory (GeV)	fit result (GeV)
$\widetilde{\mu_L}$	158	158.13 +- 0.30
$\widetilde{\mu_R}$	154	
χ	99	102.16 +- 0.40

Summary

- First edge detection performed with error function fitting
- Measurement error is maybe not so bad, but the measured value differs from the theory value by a few GeV.

	theory (GeV)	fit result (GeV, eLpR)	fit result (GeV, eRpL)
$\widetilde{\mu}_L$	158	160.32 +- 0.23	158.13 +- 0.30
$\widetilde{\mu}_R$	154		
χ	99	100.68 +- 0.23	102.16 +- 0.40

Problems & Next step

- Fitting quality is not so good for high edge
  - Due to different edge value for different smuon mass
  - eRpL case is heavily affected by $\widetilde{\mu_L}$ distribution
- Measured value has positive bias by a few GeV

- How to improve?
  - Better modeling function?
  - Pseudo-experiment?

BACKUP

eLpR analysis

Statistics (eLpR)

	$\tilde{e}_L\tilde{e}_L$	$\tilde{e}_R\tilde{e}_R$	$\tilde{\mu}_L\tilde{\mu}_L$	$\tilde{\mu}_R\tilde{\mu}_R$	$\tilde{\tau}_1^+\tilde{\tau}_1^-$	$\tilde{\tau}_2^+\tilde{\tau}_2^-$	$\tilde{\tau}_1^+\tilde{\tau}_2^-$	$\tilde{\tau}_2^+\tilde{\tau}_1^-$
No cuts	4.59*10^4	8.57*10^4	1.59*10^5	4.31*10^4	1.49*10^5	4.65*10^4	1.31*10^4	1.31*10^4

SM bkg	Bhabha	2lepton	$e\nu W$	eeZ	$\nu\nu Z$	$e\nu W/eeZ/\nu\nu Z$	WW	ZZ	WW/ZZ	AA4f	AAee	AAll
No cuts	5.40*10^6	5.44*10^6	2.59*10^6	1.14*10^7	2.62*10^5	1.04*10^6	7.40*10^5	5.82*10^4	7.68*10^5	3.36*10^5	1.15*10^9	2.25*10^9

precuts

$N_{\mu\text{-PFO}} == 2$

$N_{\text{chargedPFO}} == 2$

※These precuts might change when we switch to ILD full simulation because of different PFA performance and $\gamma\gamma \rightarrow$ low P_t hadron backgrounds.

※pfo->getType() does not work for SGV samples because it is always 0. Instead, getPDG() is used (this will pick up PDG value of detailed PID info) for SGV.

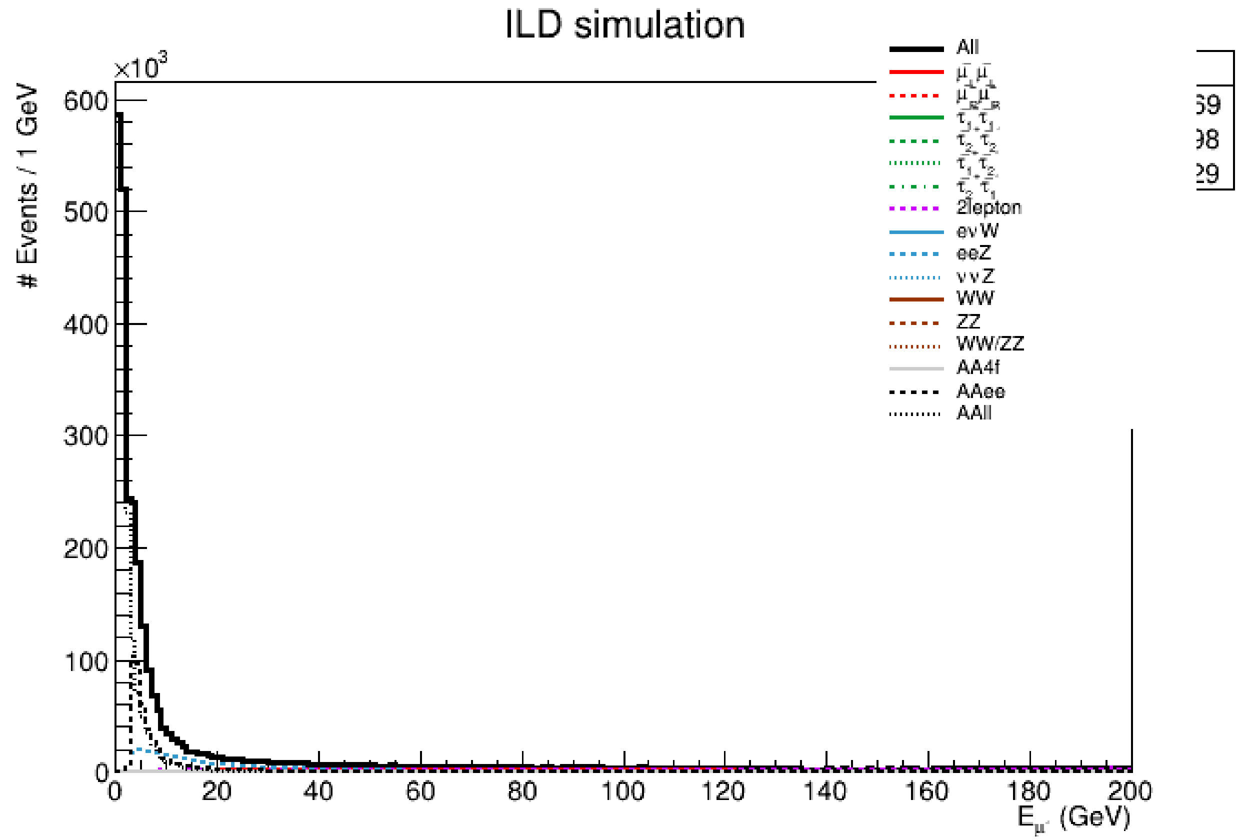
	$\tilde{e}_L\tilde{e}_L$	$\tilde{e}_R\tilde{e}_R$	$\tilde{\mu}_L\tilde{\mu}_L$	$\tilde{\mu}_R\tilde{\mu}_R$	$\tilde{\tau}_1^+\tilde{\tau}_1^-$	$\tilde{\tau}_2^+\tilde{\tau}_2^-$	$\tilde{\tau}_1^+\tilde{\tau}_2^-$	$\tilde{\tau}_2^+\tilde{\tau}_1^-$
precuts	0	0	1.38*10^5	3.77*10^4	2.71*10^3	1.11*10^3	274	271

SM bkg	Bhabha	2lepton	$e\nu W$	eeZ	$\nu\nu Z$	$e\nu W/eeZ/\nu\nu Z$	WW	ZZ	WW/ZZ	AA4f	AAee	AAll
precuts	0	6.44*10^5	22.0	3.72*10^5	2.97*10^4	0	3.20*10^4	3.74*10^3	9.78*10^4	858	4.42*10^5	1.69*10^6

Distribution of E_{μ^-} at precuts

Solid Black histogram is the sum up all processes and this is the histogram we can obtain from the real experiment.

Clearly, more background rejection is necessary to measure edges.
Dominant backgrounds:
AAll, AAee, 2lepton, eeZ(singleZee)



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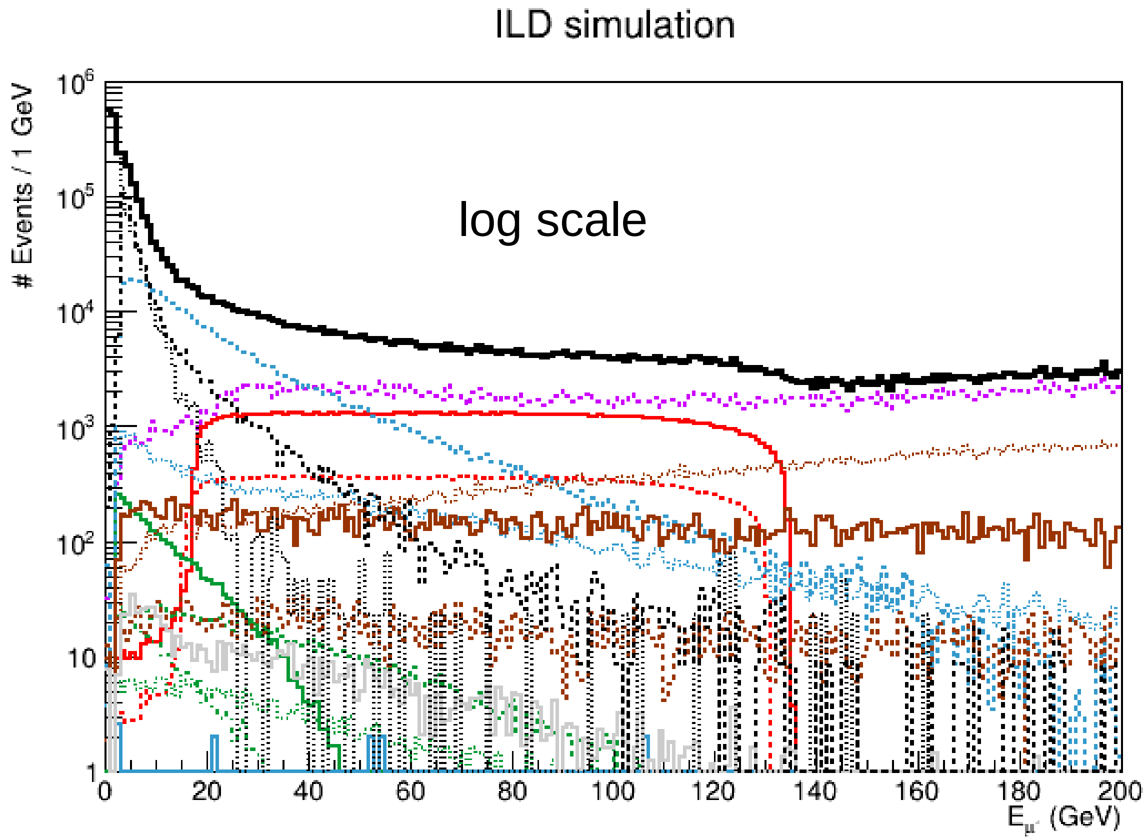


Tight cuts (eLpR)

Cut 1: $25 < E_{vis} < 300$ GeV

Cut 2: $15 < M_{\mu\mu} < 250$ GeV

Cut 3: $\frac{\theta_{\mathrm{acop}}}{\pi} > 0.03$

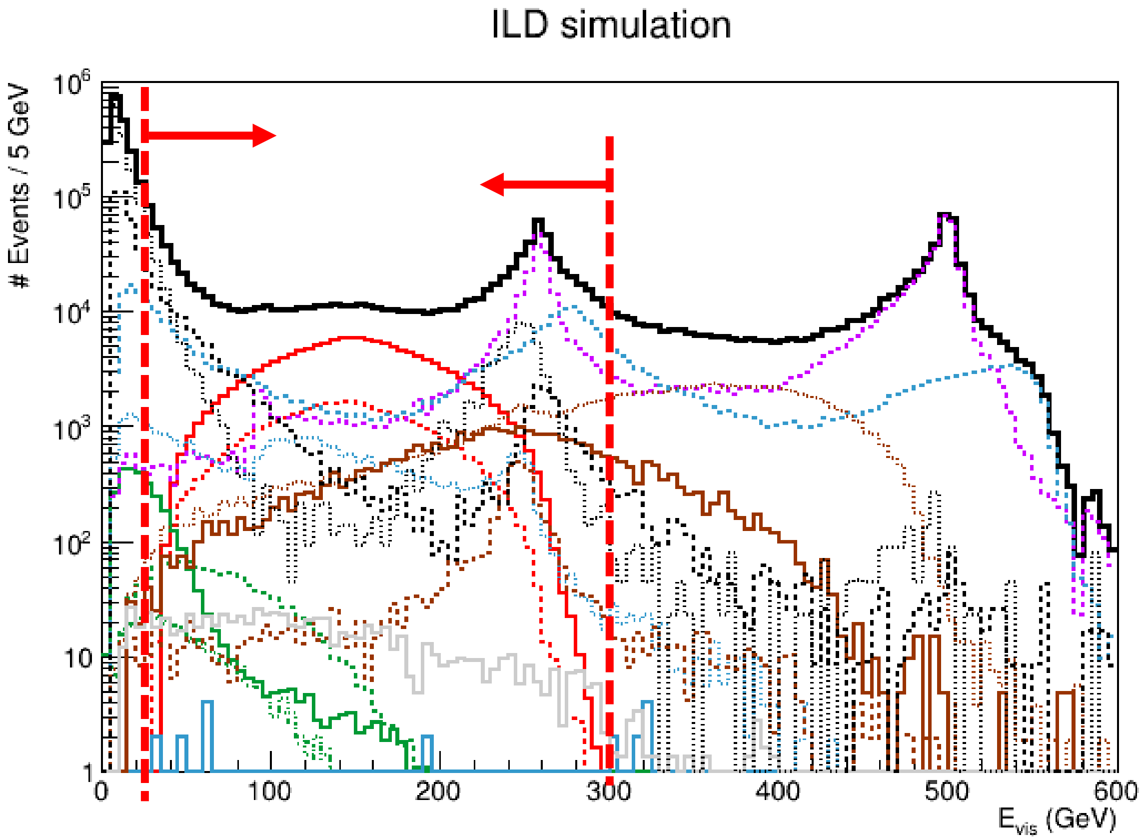
Cut 4: $\frac{\theta_{\mathrm{acol}}}{\pi} < 0.9$

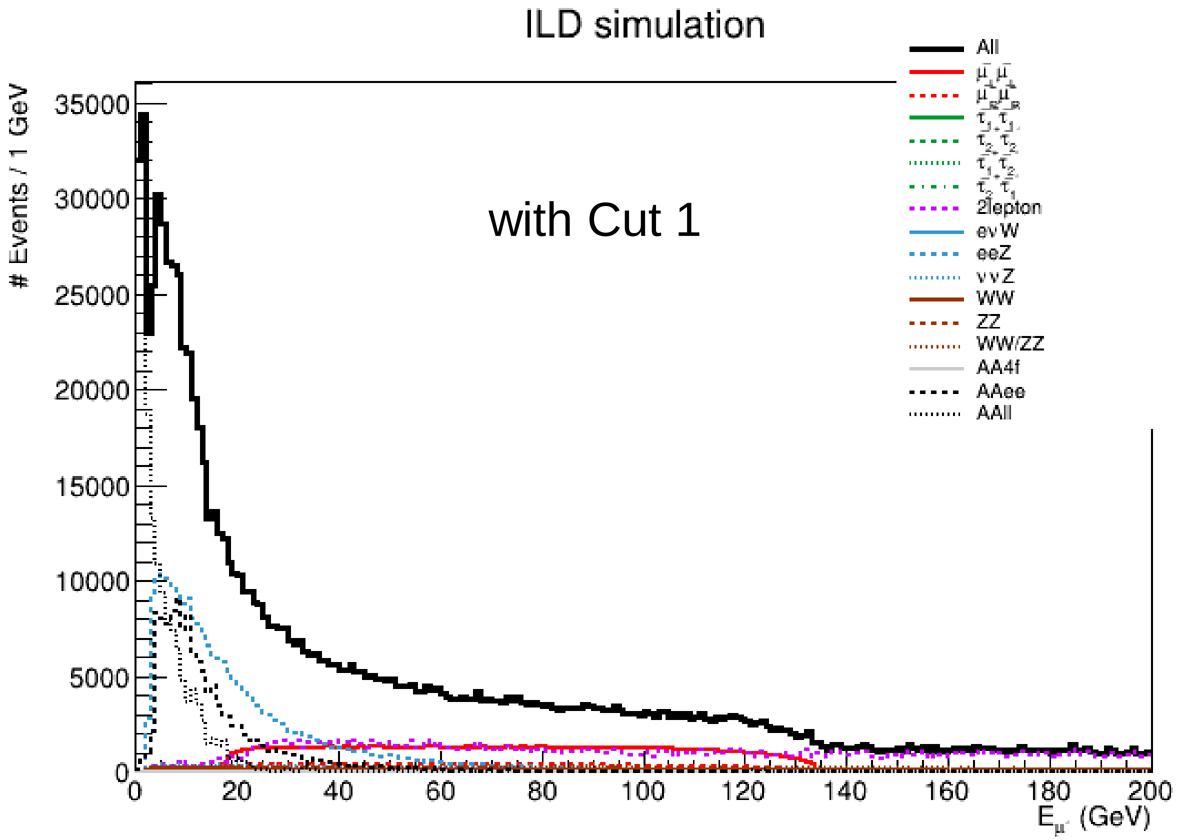
Cut 5: $|\cos\theta_{\mathrm{miss}}| < 0.95$

Cut 6: $10 <$ missing $P_t < 150$ GeV

Cut 7: $200 < M_{inv} < 470$ GeV

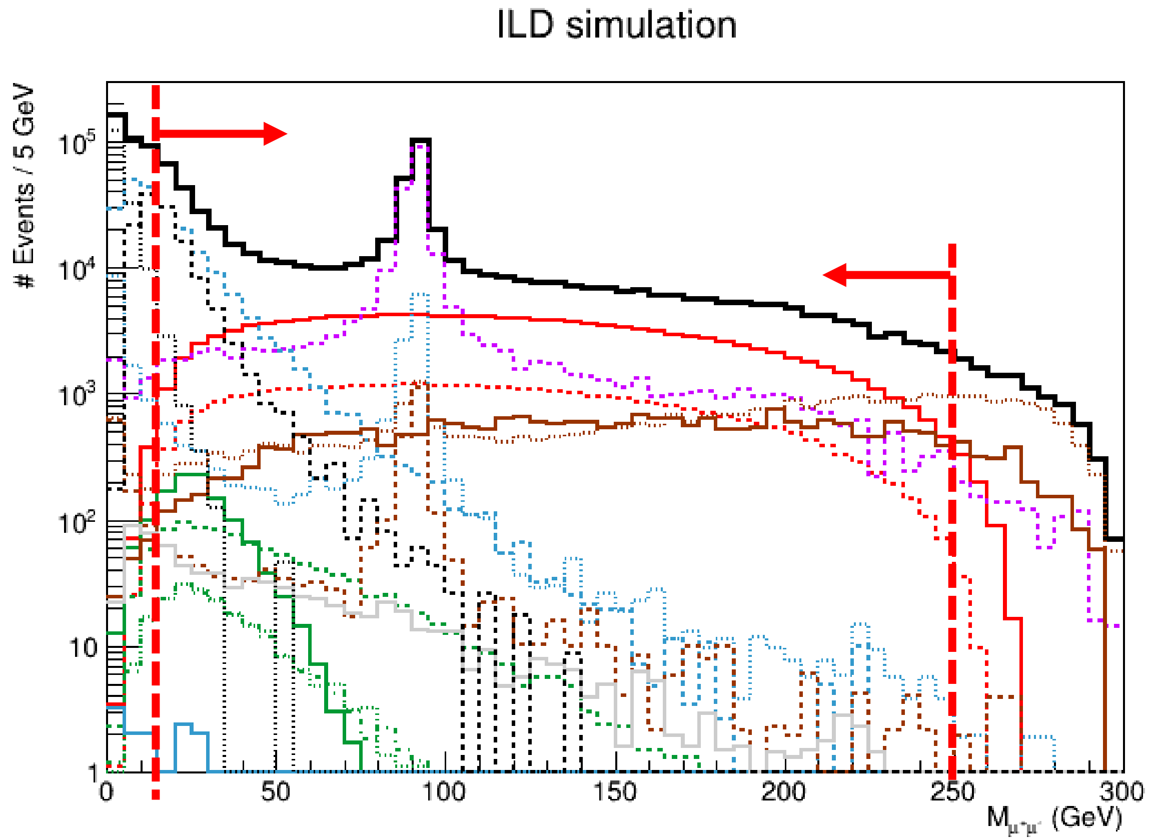
Cut on E_{vis}

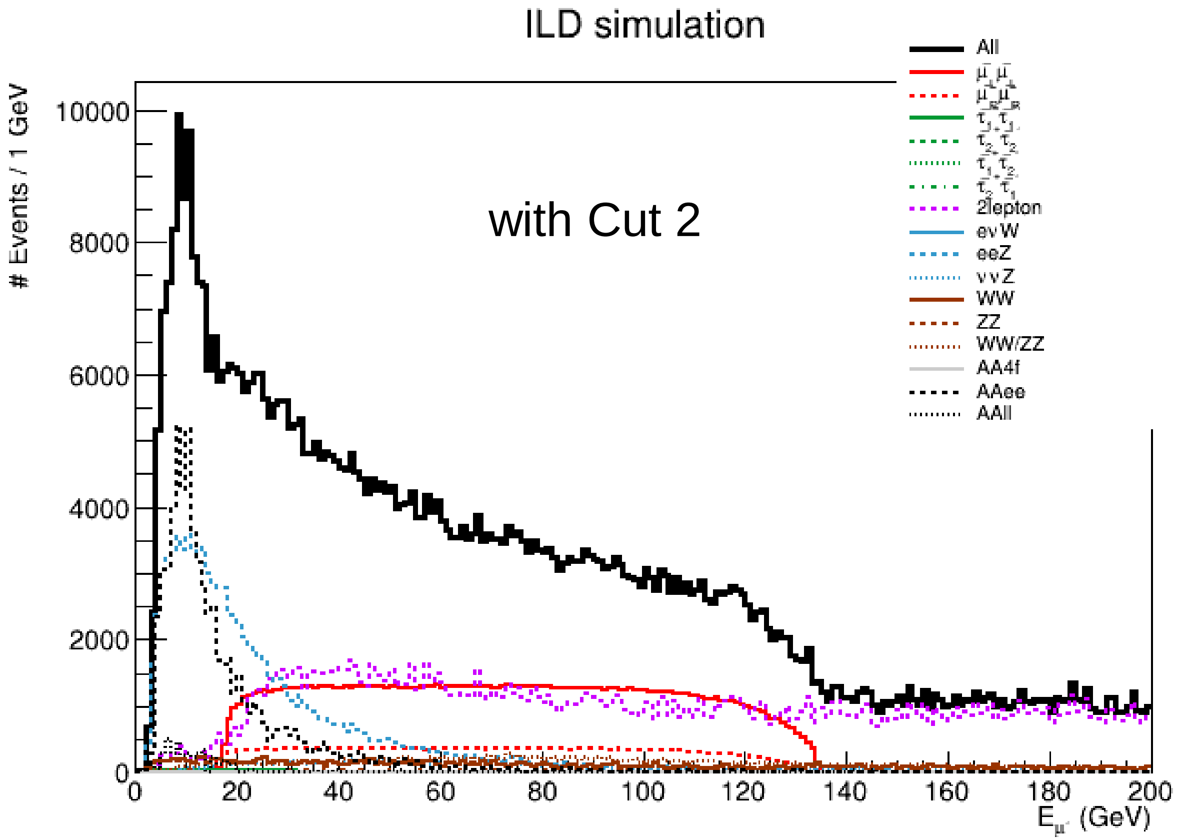




E_{vis} ~ 500 GeV: almost no missing component
E_{vis} ~ 0 GeV: almost all missing component
Cut 1: 25 < E_{vis} < 300 GeV

Cut on $M_{\mu\mu}$



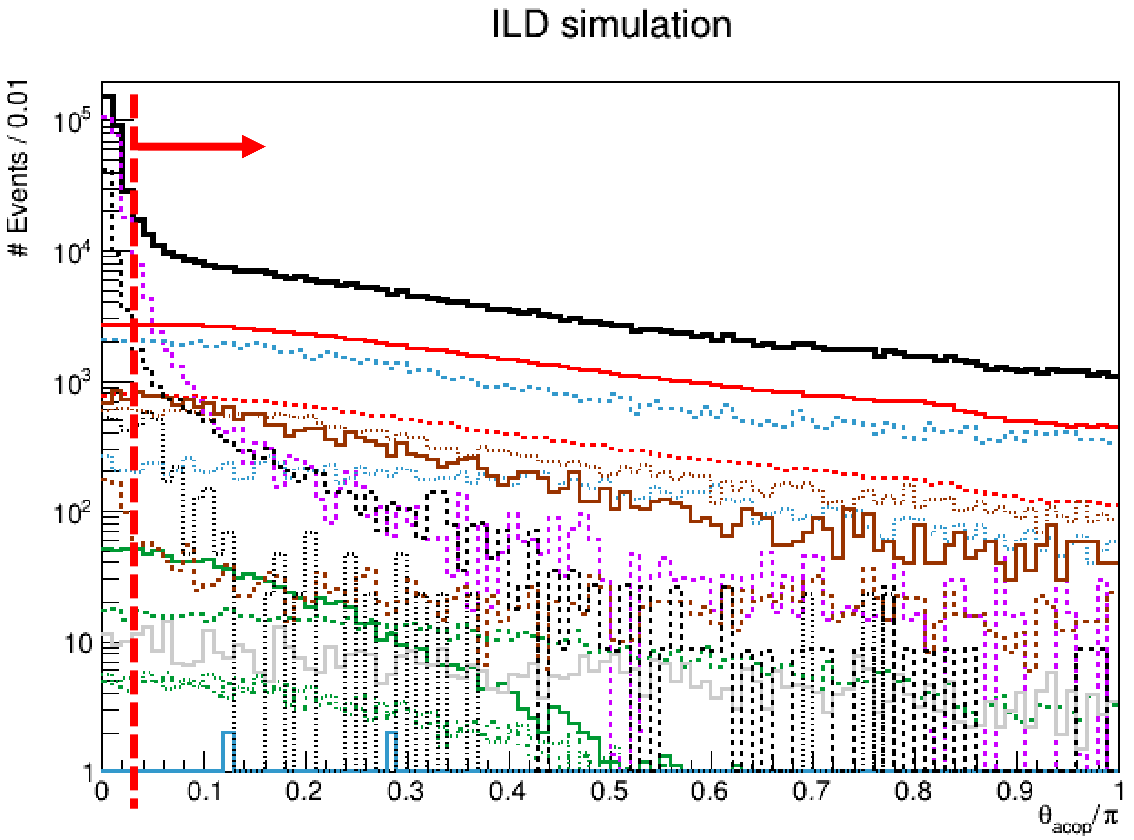


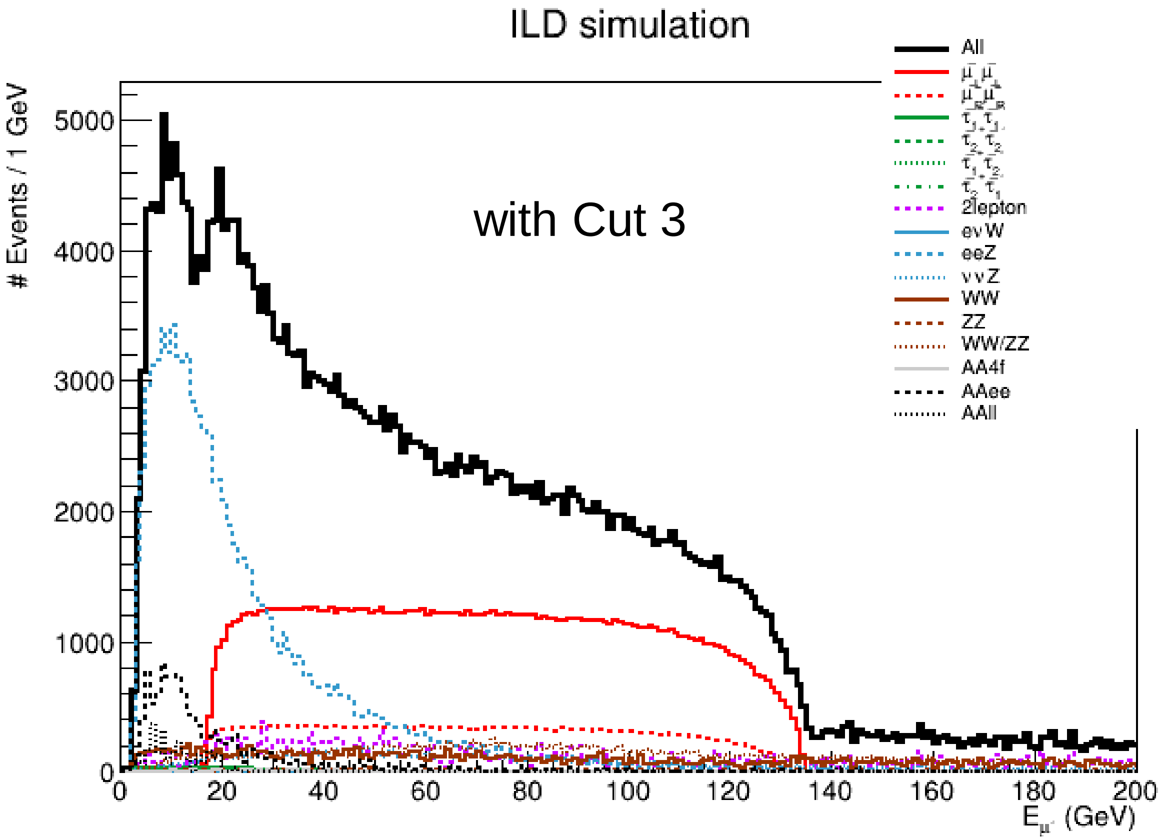
$M_{\mu\mu}$ ~ 0 GeV: two muons produced by photon

assume pair production: maximum of $M_{\mu\mu}$ is 250 GeV

Cut 2: 15 < $M_{\mu\mu}$ < 250 GeV

Cut on acoplanarity $\theta_{\text{acop}} = \pi - (\phi_1 - \phi_2)$



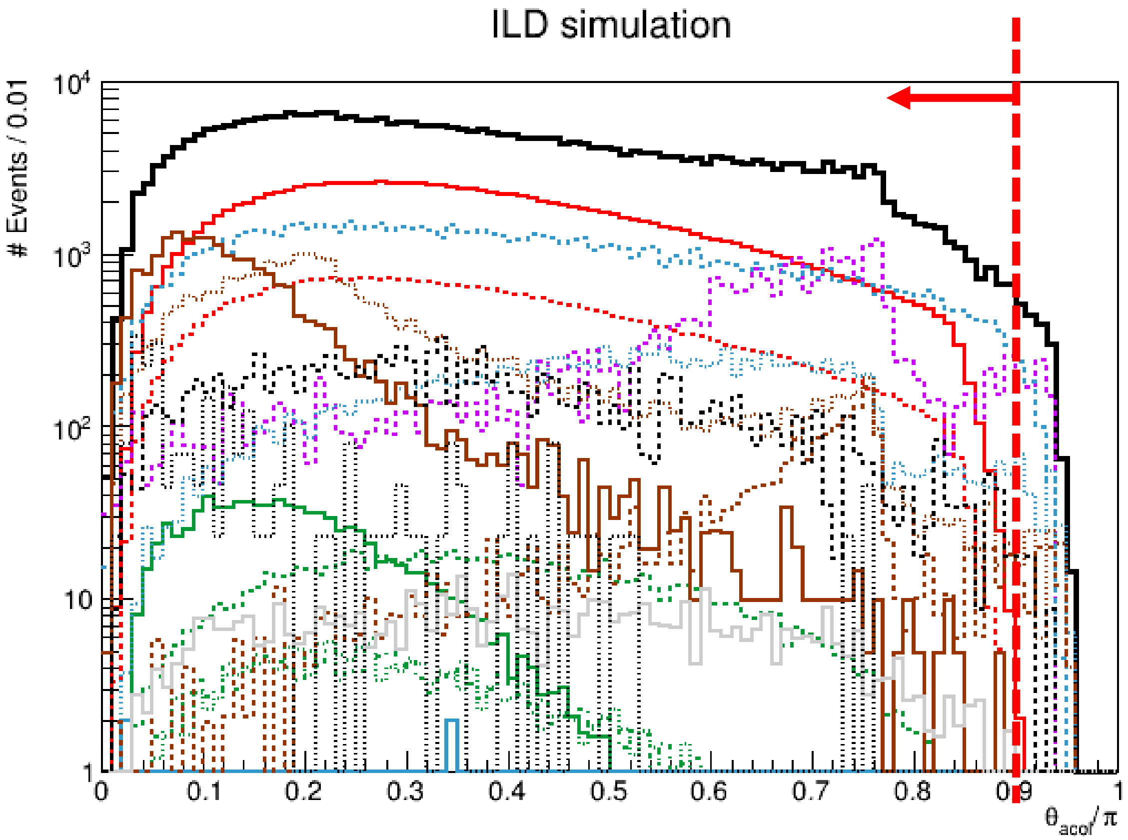


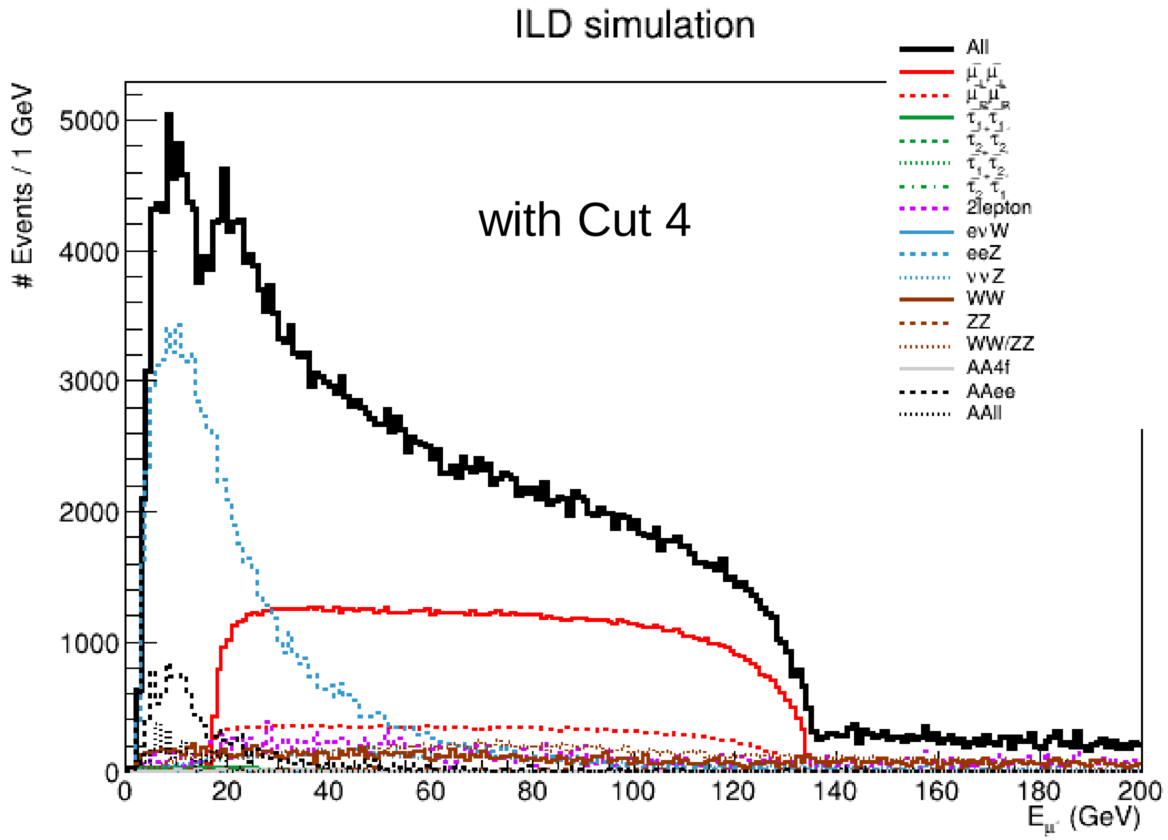
$\frac{\theta_{\text{acop}}}{\pi} \sim 0$: two muons are back-to-back in xy-plane

mostly for SM background rejection, some signals rejected as well

Cut 3: $\frac{\theta_{\text{acop}}}{\pi} > 0.03$

Cut on acolinearity $\theta_{\text{acol}} = \pi - (\theta_1 - \theta_2)$



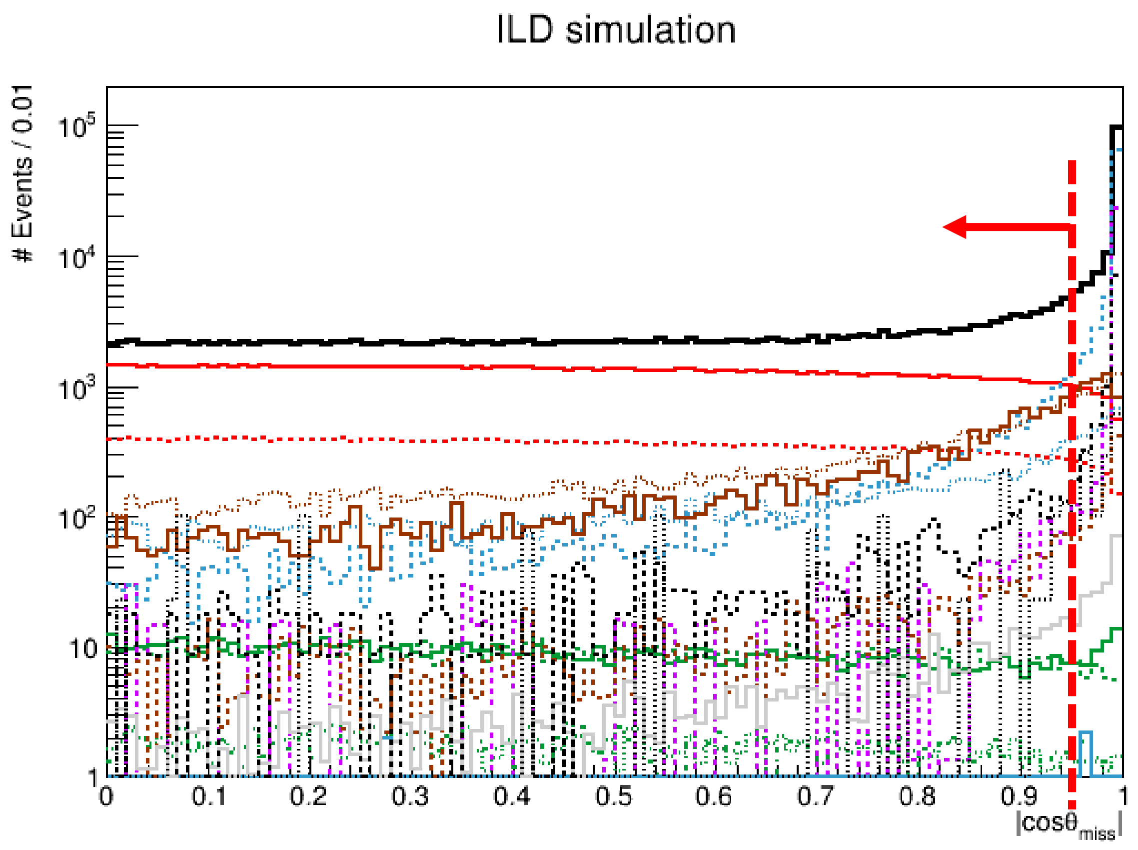


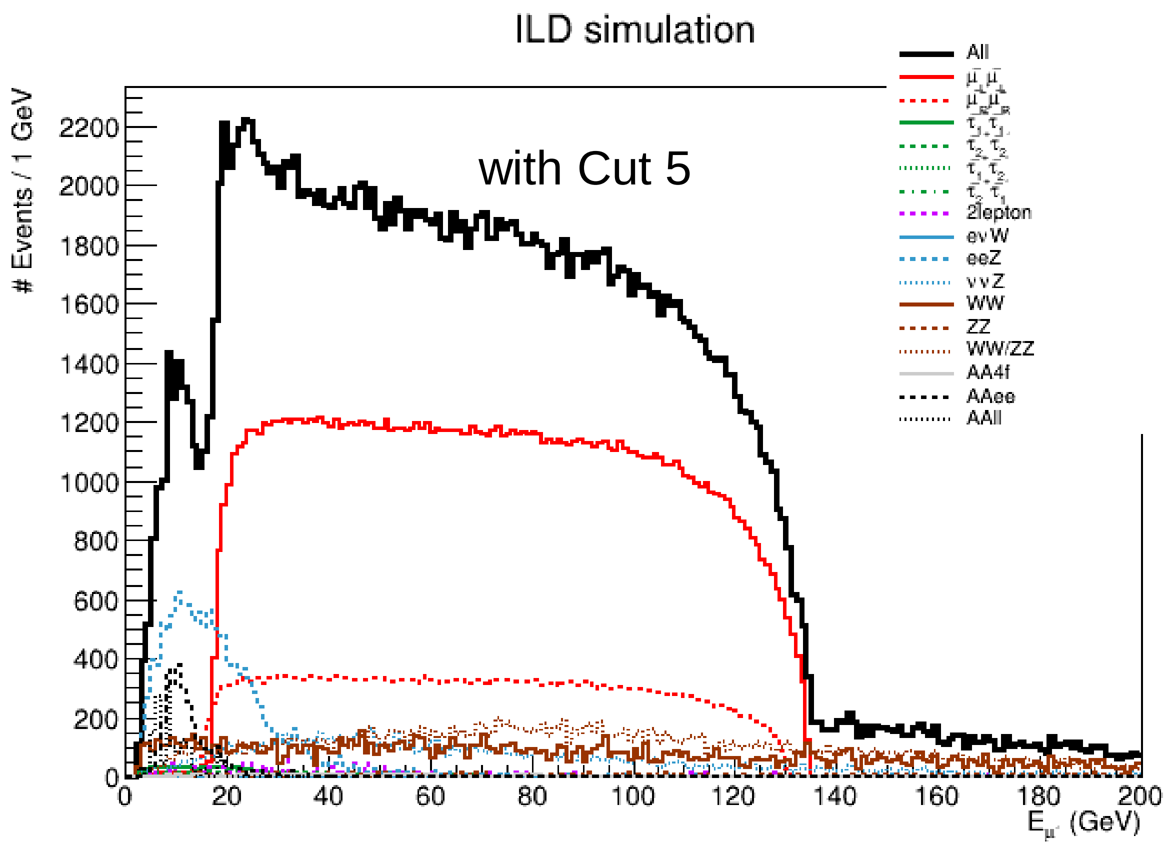
$\frac{\theta_{\text{acol}}}{\pi} \sim 1$: two muons flying the same direction

such probability is expected to be small in signal

Cut 4: $\frac{\theta_{\text{acol}}}{\pi} < 0.9$

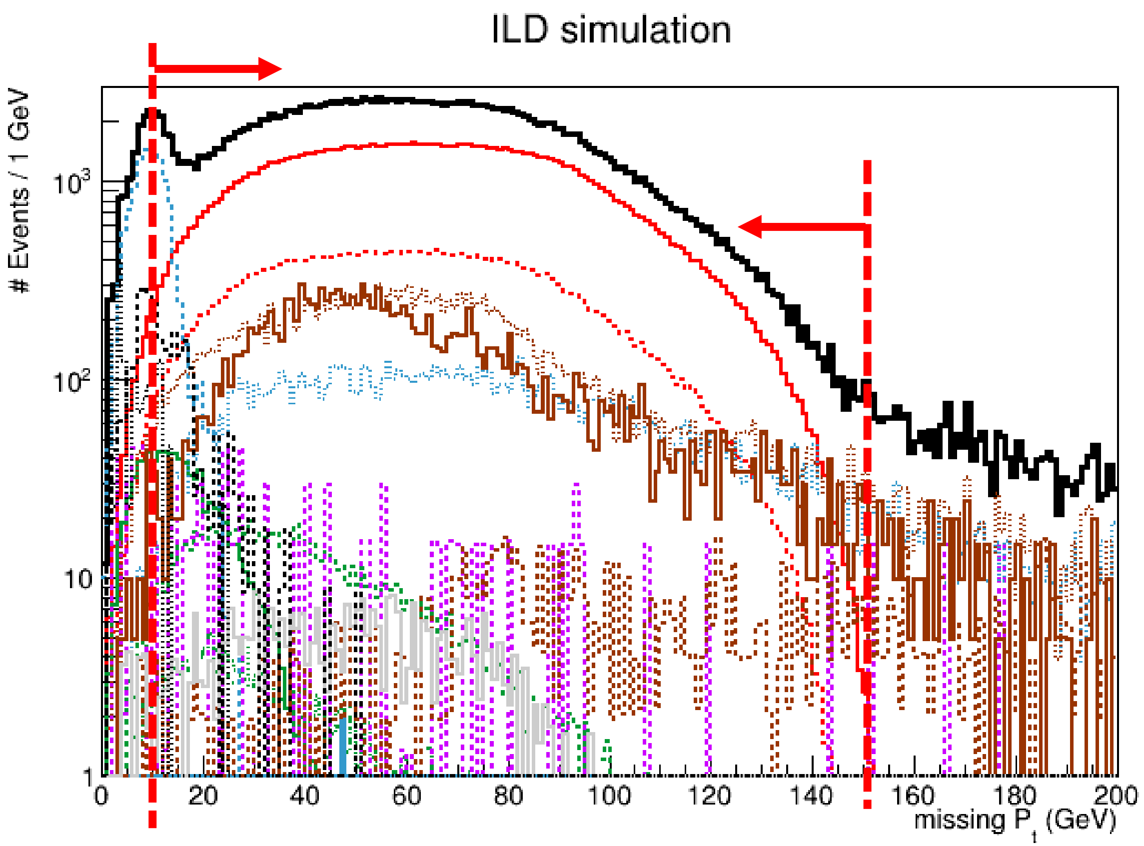
Cut on $\cos\theta_{\mathrm{miss}}$

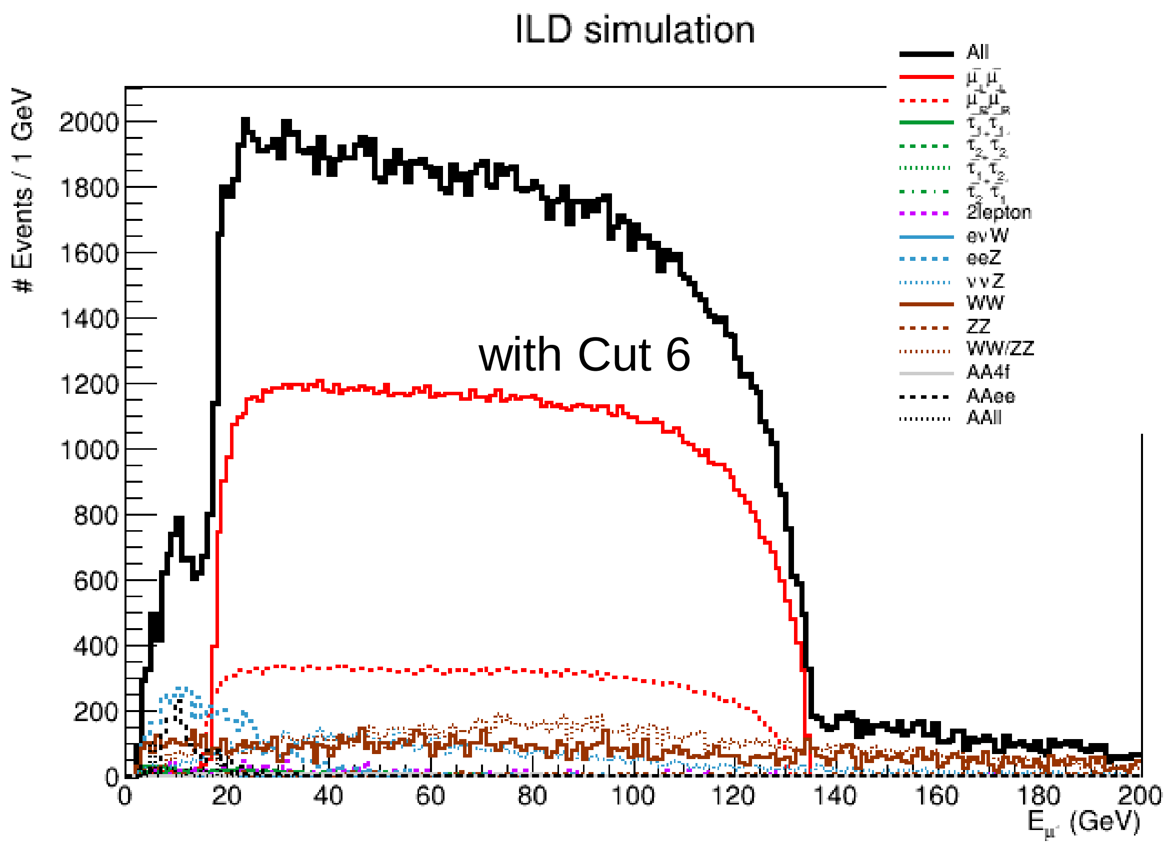




$|\cos\theta_{\mathrm{miss}}| \sim 1$: almost no missing component
signal have large missing component
Cut 5: $|\cos\theta_{\mathrm{miss}}| < 0.95$

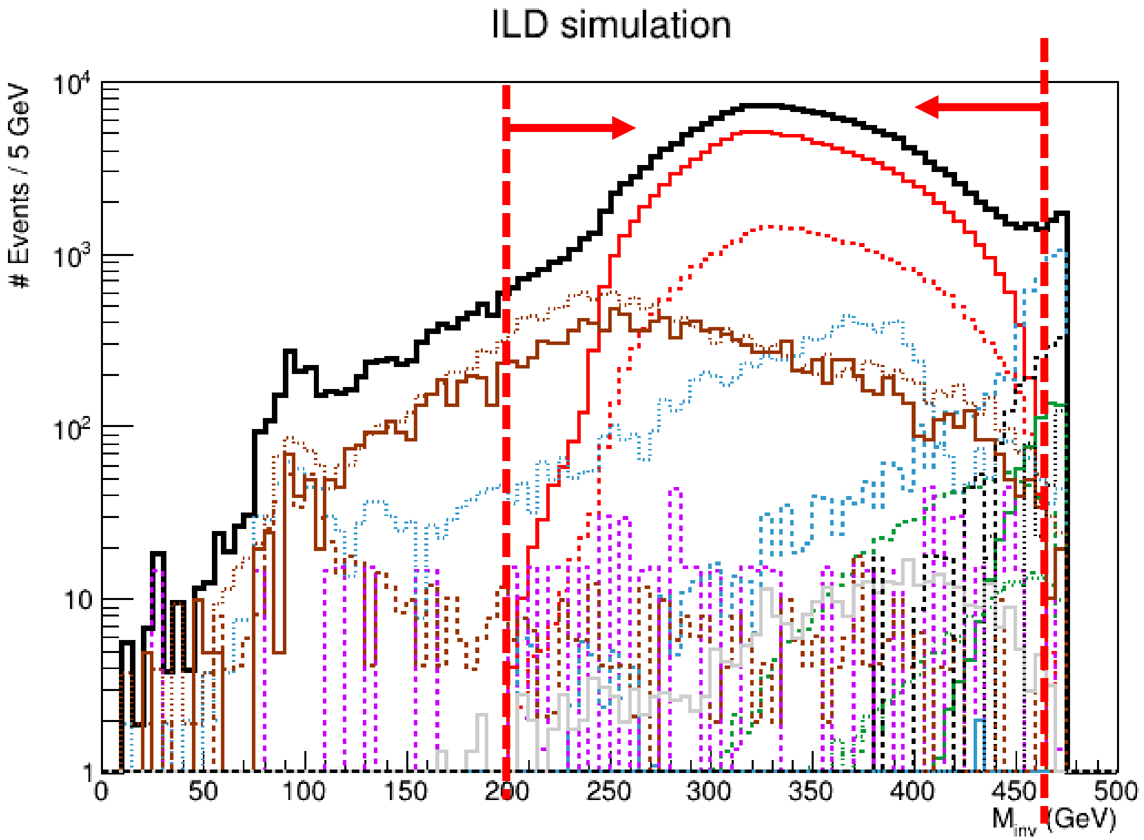
Cut on missing P_t

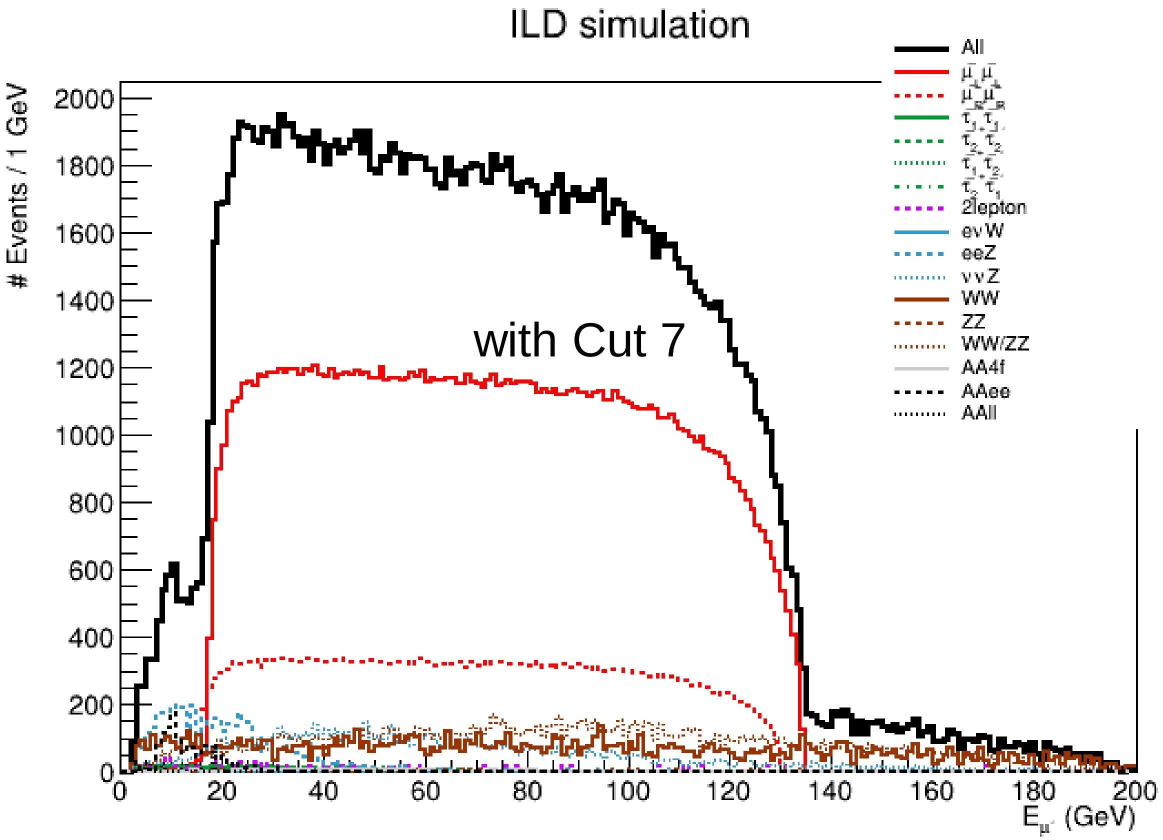




missing P_t ~ 0 GeV: almost no missing component
signal have large missing component
Cut 6: 10 < missing P_t < 150 GeV

Cut on M_{inv} (invariant mass of missing component)





M_{inv} ~ 500 GeV: almost all missing component
signal have large missing component
Cut 7: 200 < M_{inv} < 470 GeV

Cut table (Tight)

signal efficiency: ~79%

significance $= \frac{1.58\times10^5}{\sqrt{1.58\times10^5+4.68\times10^4}} = 349\sigma$

overall dominant backgrounds:
WW/ZZ, WW, nunuZ

affects E^- edge detection:
eeZ, (AAll, 170 event = 5 MC event)

	$\widetilde{\mu}_L\widetilde{\mu}_L$	$\widetilde{\mu}_R\widetilde{\mu}_R$	$\widetilde{\tau}_1^+\widetilde{\tau}_1^-$	$\widetilde{\tau}_2^+\widetilde{\tau}_2^-$	$\widetilde{\tau}_1^+\widetilde{\tau}_2^-$	$\widetilde{\tau}_2^+\widetilde{\tau}_1^-$
precuts	$1.38*10^5$	$3.77*10^4$	$2.71*10^3$	$1.11*10^3$	274	271
Cut 1	$1.38*10^5$	$3.77*10^4$	$1.20*10^3$	$1.01*10^3$	211	208
Cut 2	$1.37*10^5$	$3.75*10^4$	$1.03*10^3$	929	186	185
Cut 3	$1.29*10^5$	$3.51*10^4$	880	880	171	171
Cut 4	$1.29*10^5$	$3.51*10^4$	880	880	171	171
Cut 5	$1.25*10^5$	$3.40*10^4$	831	848	164	164
Cut 6	$1.24*10^5$	$3.38*10^4$	609	823	155	155
Cut 7	$1.24*10^5$	$3.38*10^4$	475	805	146	147

SM bkg	2lepton	$e\nu W$	eeZ	$\nu\nu Z$	WW	ZZ	WW/ZZ	AA4f	AAee	AAll
precuts	$6.44*10^5$	22.0	$3.72*10^5$	$2.97*10^4$	$3.20*10^4$	$3.74*10^3$	$9.78*10^4$	858	$4.42*10^5$	$1.69*10^6$
Cut 1	$2.28*10^5$	14.1	$2.15*10^5$	$2.54*10^4$	$2.55*10^4$	$3.42*10^3$	$3.51*10^4$	770	$1.26*10^5$	$1.69*10^5$
Cut 2	$2.23*10^5$	6.84	$9.39*10^4$	$1.42*10^4$	$2.33*10^4$	$2.53*10^3$	$2.76*10^4$	581	$6.59*10^4$	$4.19*10^3$
Cut 3	$2.58*10^4$	6.84	$8.77*10^4$	$1.36*10^4$	$2.11*10^4$	$2.10*10^3$	$2.76*10^4$	550	$1.20*10^4$	$2.76*10^3$
Cut 4	$2.51*10^4$	6.84	$8.72*10^4$	$1.33*10^4$	$2.11*10^4$	$2.03*10^3$	$2.57*10^4$	548	$1.20*10^4$	$2.76*10^3$
Cut 5	$1.02*10^3$	4.22	$1.25*10^4$	$1.08*10^4$	$1.60*10^4$	$1.19*10^3$	$2.06*10^4$	384	$2.87*10^3$	$1.37*10^3$
Cut 6	731	4.22	$5.66*10^3$	$9.84*10^3$	$1.54*10^4$	719	$1.93*10^4$	364	$1.62*10^3$	294
Cut 7	593	3.21	$4.62*10^3$	$8.89*10^3$	$1.29*10^4$	267	$1.61*10^4$	352	$1.30*10^3$	170

eRpL analysis

(repeating same cuts as I did in eLpR, only statistical number changed)

Statistics (eRpL)

	$\tilde{e}_L\tilde{e}_L$	$\tilde{e}_R\tilde{e}_R$	$\tilde{\mu}_L\tilde{\mu}_L$	$\tilde{\mu}_R\tilde{\mu}_R$	$\tilde{\tau}_1^+\tilde{\tau}_1^-$	$\tilde{\tau}_2^+\tilde{\tau}_2^-$	$\tilde{\tau}_1^+\tilde{\tau}_2^-$	$\tilde{\tau}_2^+\tilde{\tau}_1^-$
No cuts	$3.57*10^4$	$8.75*10^4$	$4.15*10^4$	$1.48*10^5$	$1.39*10^5$	$4.21*10^4$	$1.04*10^4$	$1.04*10^4$

SM bkg	Bhabha	2lepton	$e\nu W$	eeZ	$\nu\nu Z$	$e\nu W/eeZ/\nu\nu Z$	WW	ZZ	WW/ZZ	AA4f	AAee	AAll
No cuts	$5.16*10^6$	$4.38*10^6$	$3.07*10^5$	$1.13*10^7$	$2.95*10^4$	$1.79*10^5$	$4.82*10^4$	$3.78*10^4$	$6.37*10^4$	$3.36*10^5$	$1.15*10^9$	$2.25*10^9$

precuts

$N_{\mu\text{-PFO}}$ == 2

$N_{\text{chargedPFO}}$ == 2

※These precuts might change when we switch to ILD full simulation because of different PFA performance and $\gamma\gamma \rightarrow$ low P_t hadron backgrounds.

※pfo->getType() does not work for SGV samples because it is always 0. Instead, getPDG() is used (this will pick up PDG value of detailed PID info) for SGV.

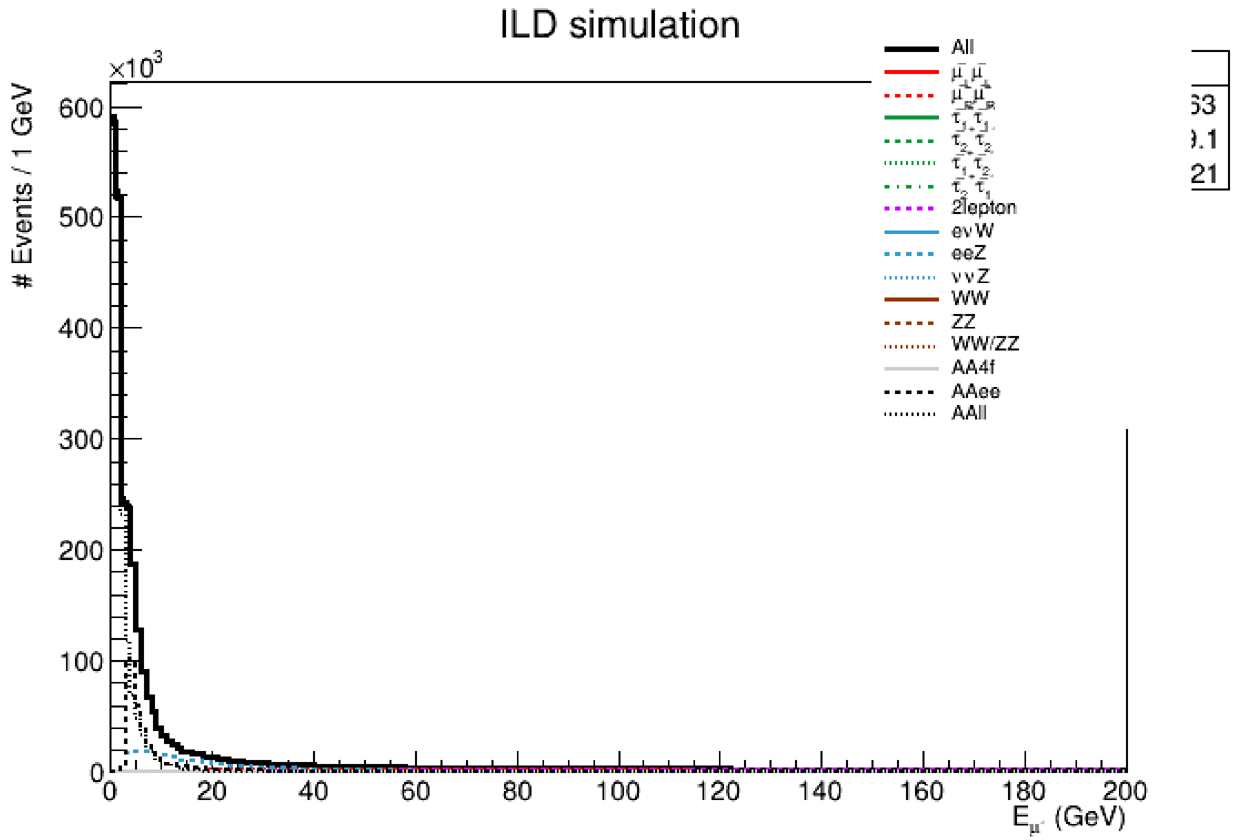
	$\tilde{e}_L\tilde{e}_L$	$\tilde{e}_R\tilde{e}_R$	$\tilde{\mu}_L\tilde{\mu}_L$	$\tilde{\mu}_R\tilde{\mu}_R$	$\tilde{\tau}_1^+\tilde{\tau}_1^-$	$\tilde{\tau}_2^+\tilde{\tau}_2^-$	$\tilde{\tau}_1^+\tilde{\tau}_2^-$	$\tilde{\tau}_2^+\tilde{\tau}_1^-$
precuts	0	0	$3.62*10^4$	$1.29*10^5$	$2.54*10^3$	$1.01*10^3$	217	217

SM bkg	Bhabha	2lepton	$e\nu W$	eeZ	$\nu\nu Z$	$e\nu W/eeZ/\nu\nu Z$	WW	ZZ	WW/ZZ	AA4f	AAee	AAll
precuts	0	$5.00*10^5$	6.74	$3.72*10^5$	$3.35*10^3$	0	$2.11*10^3$	$2.29*10^3$	$7.96*10^3$	858	$4.42*10^5$	$1.69*10^6$

Distribution of E_{μ^-} at precuts

Solid Black histogram is the sum up all processes and this is the histogram we can obtain from the real experiment.

Clearly, more background rejection is necessary to measure edges.
Dominant backgrounds:
AAll, AAee, 2lepton, eeZ(singleZee)



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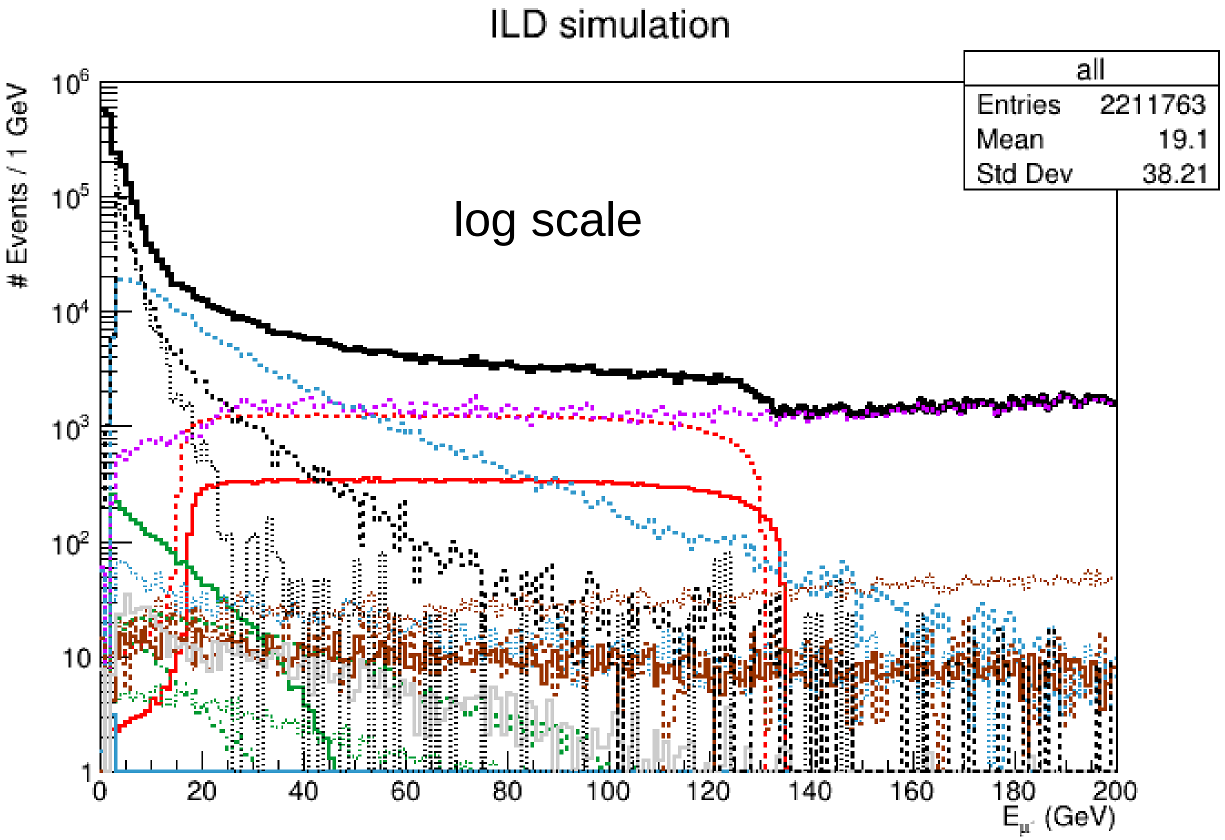
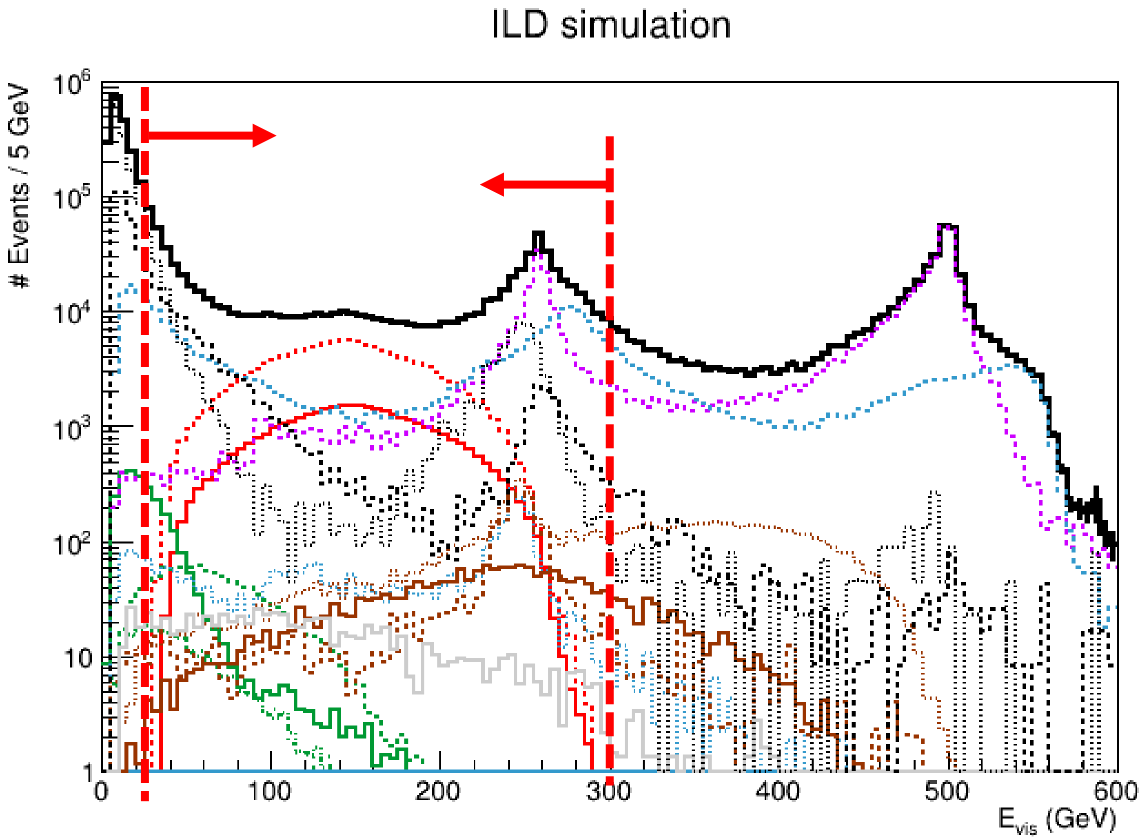
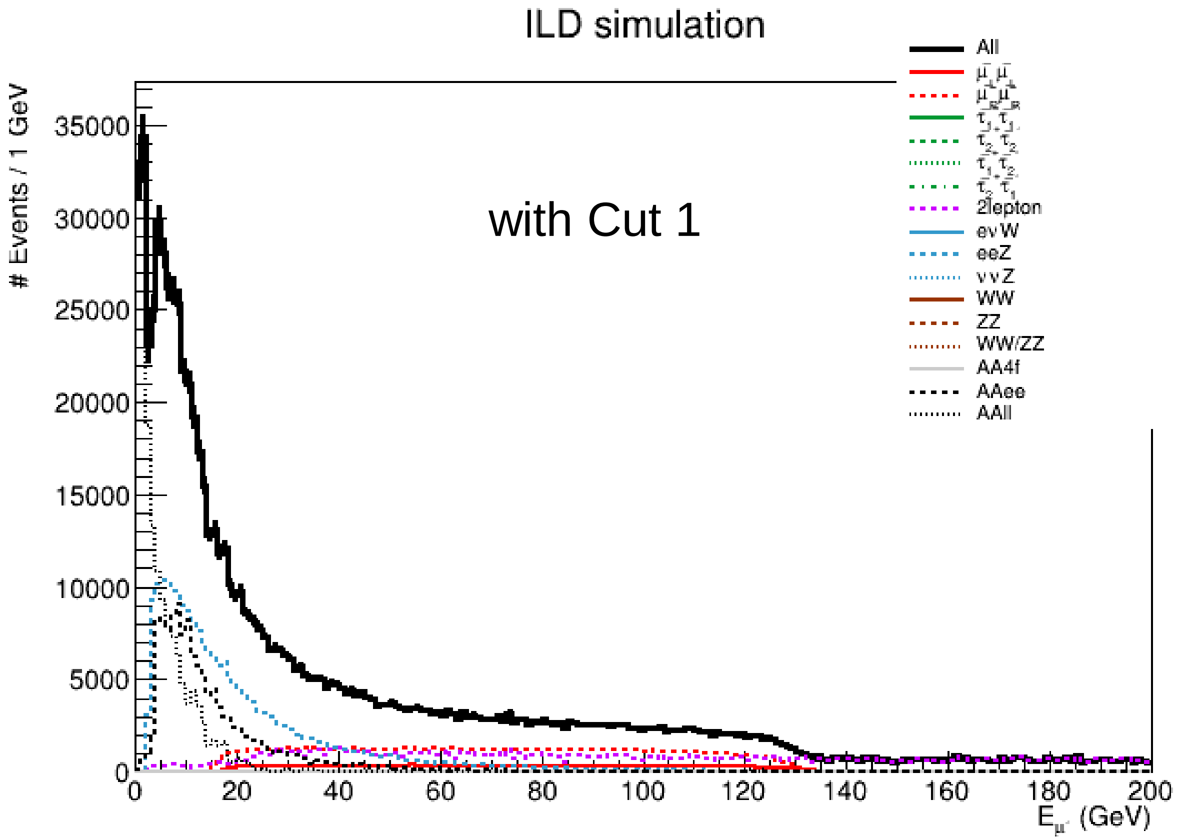


Tight cuts (eRpL)

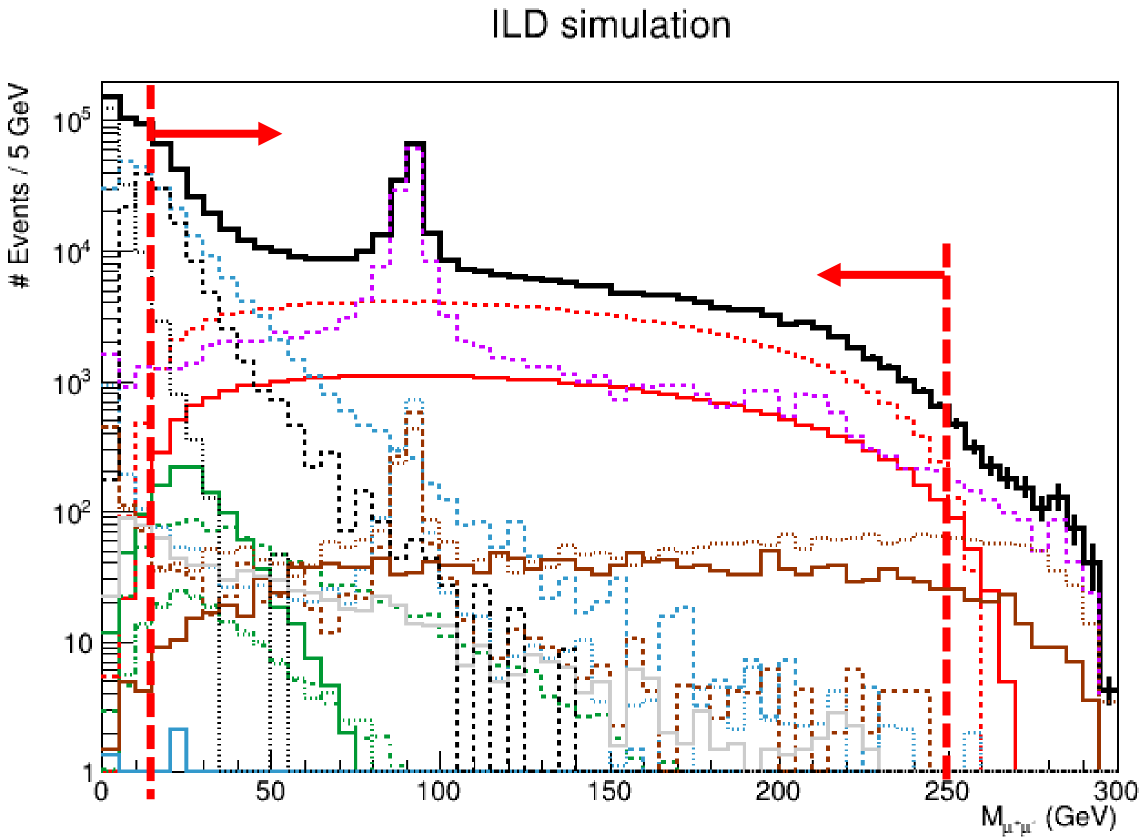
Cut on E_{vis}

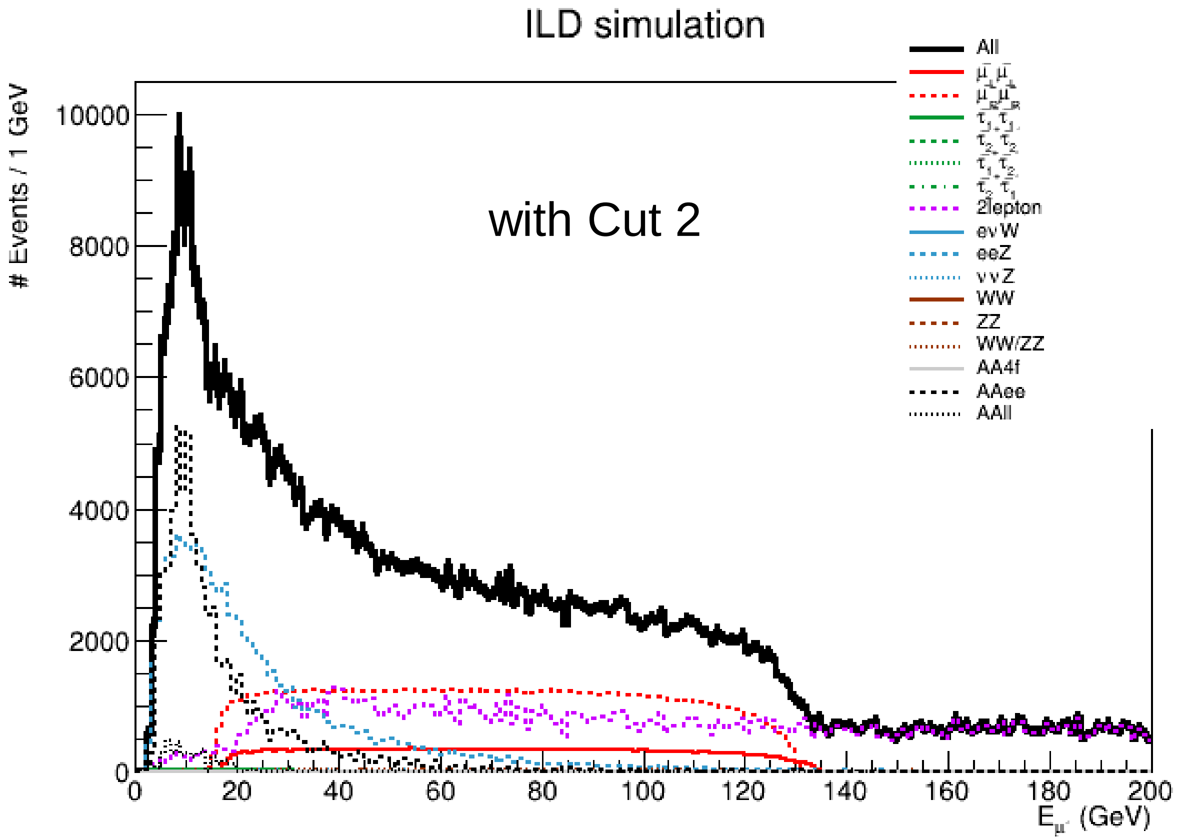




E_{vis} ~ 500 GeV: almost no missing component
E_{vis} ~ 0 GeV: almost all missing component
Cut 1: 25 < E_{vis} < 300 GeV

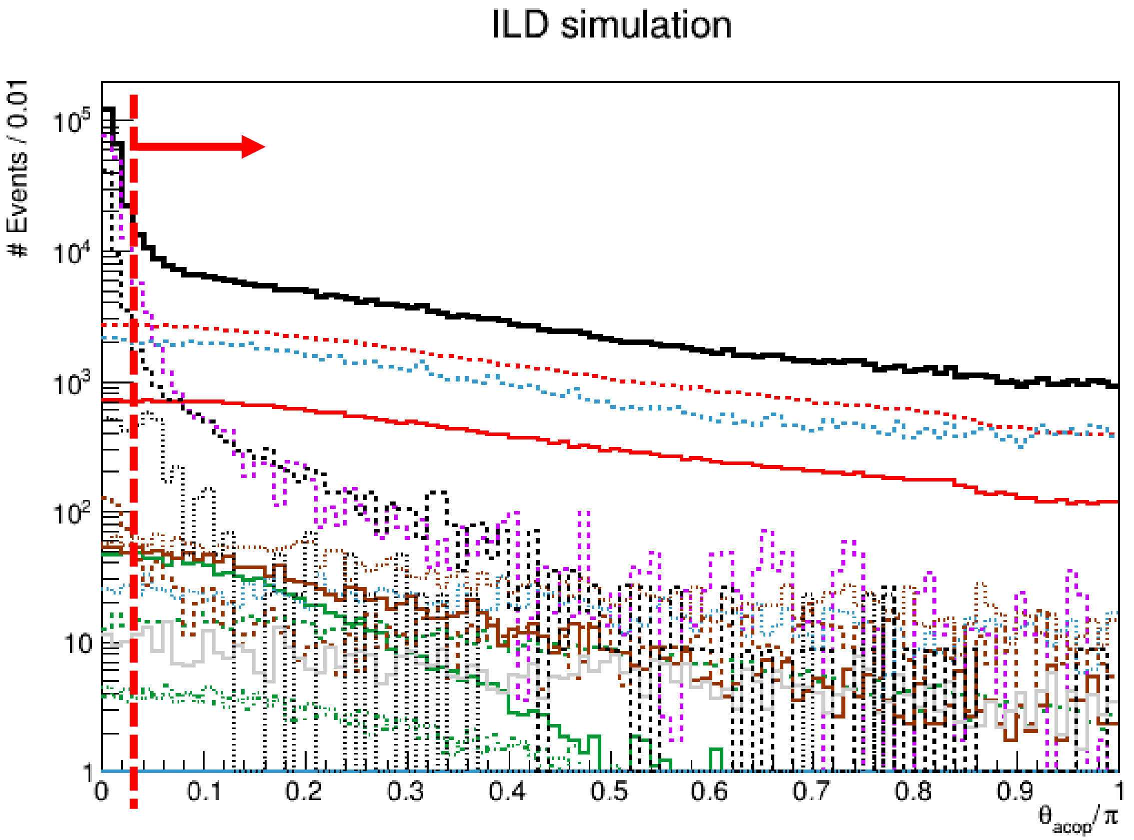
Cut on $M_{\mu\mu}$

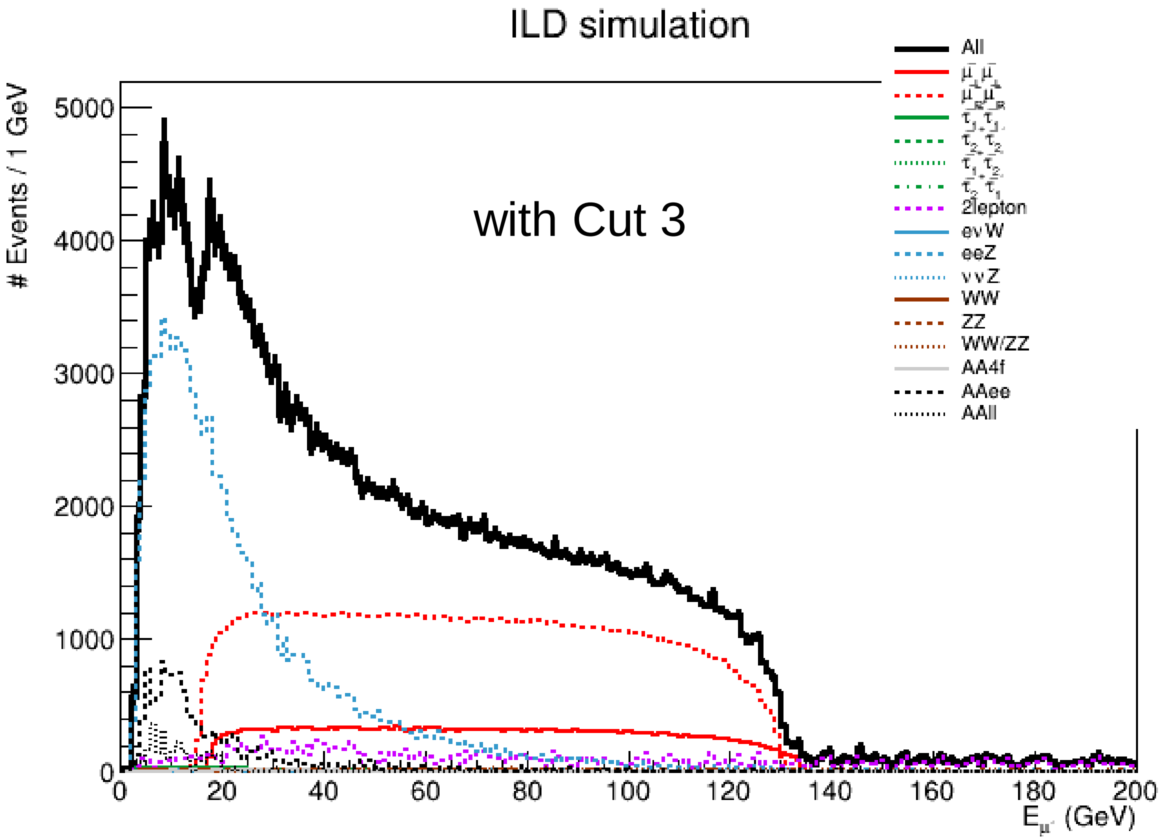




$M_{\mu\mu}$ ~ 0 GeV: two muons produced by photon
assume pair production: maximum of $M_{\mu\mu}$ is 250 GeV
Cut 2: 15 < $M_{\mu\mu}$ < 250 GeV

Cut on acoplanarity $\theta_{\text{acop}} = \pi - (\phi_1 - \phi_2)$



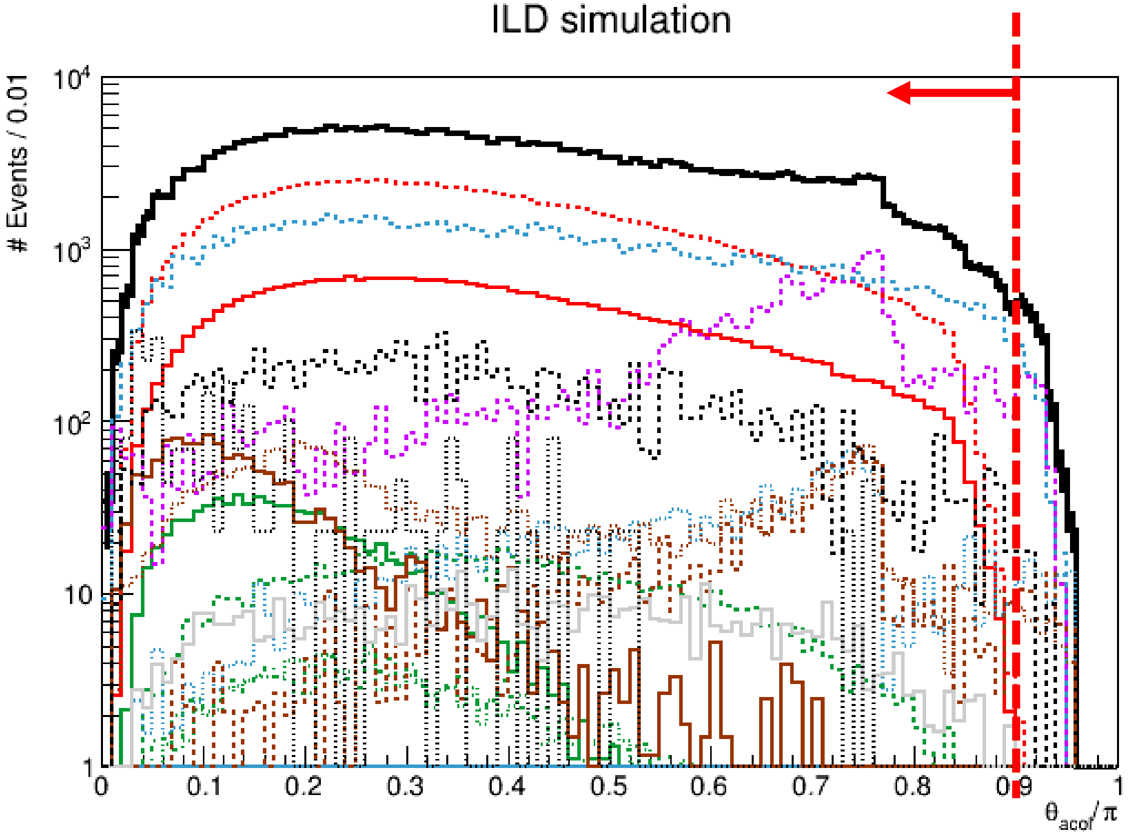


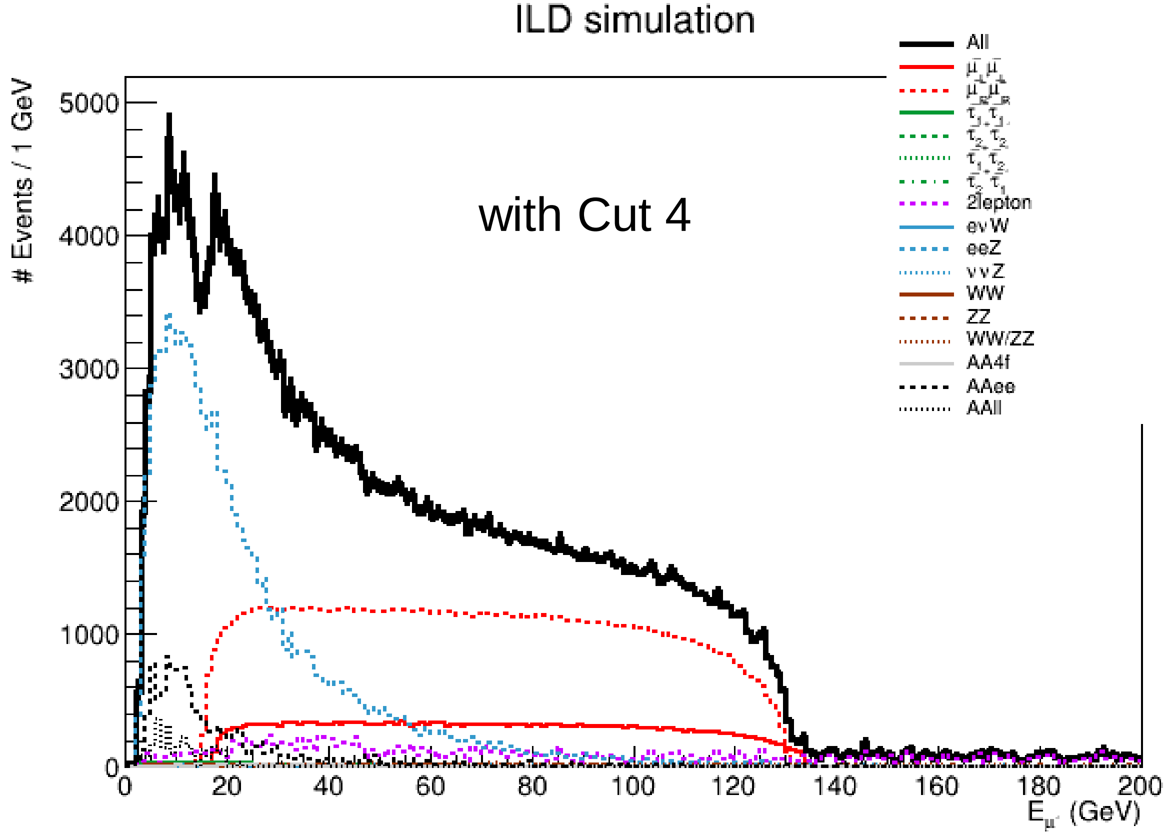
$\frac{\theta_{\text{acop}}}{\pi} \sim 0$: two muons are back-to-back in xy-plane

mostly for SM background rejection, some signals rejected as well

Cut 3: $\frac{\theta_{\text{acop}}}{\pi} > 0.03$

Cut on acolinearity $\theta_{\mathrm{acol}} = \pi - (\theta_1 - \theta_2)$



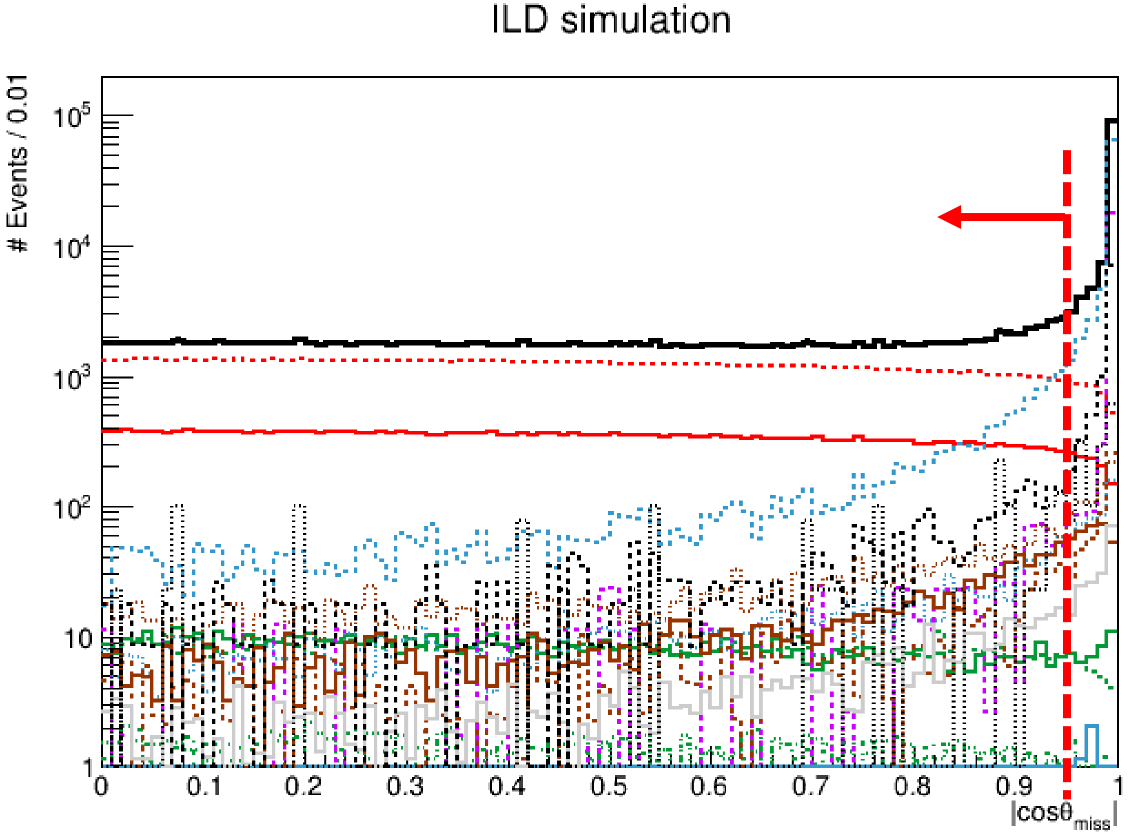


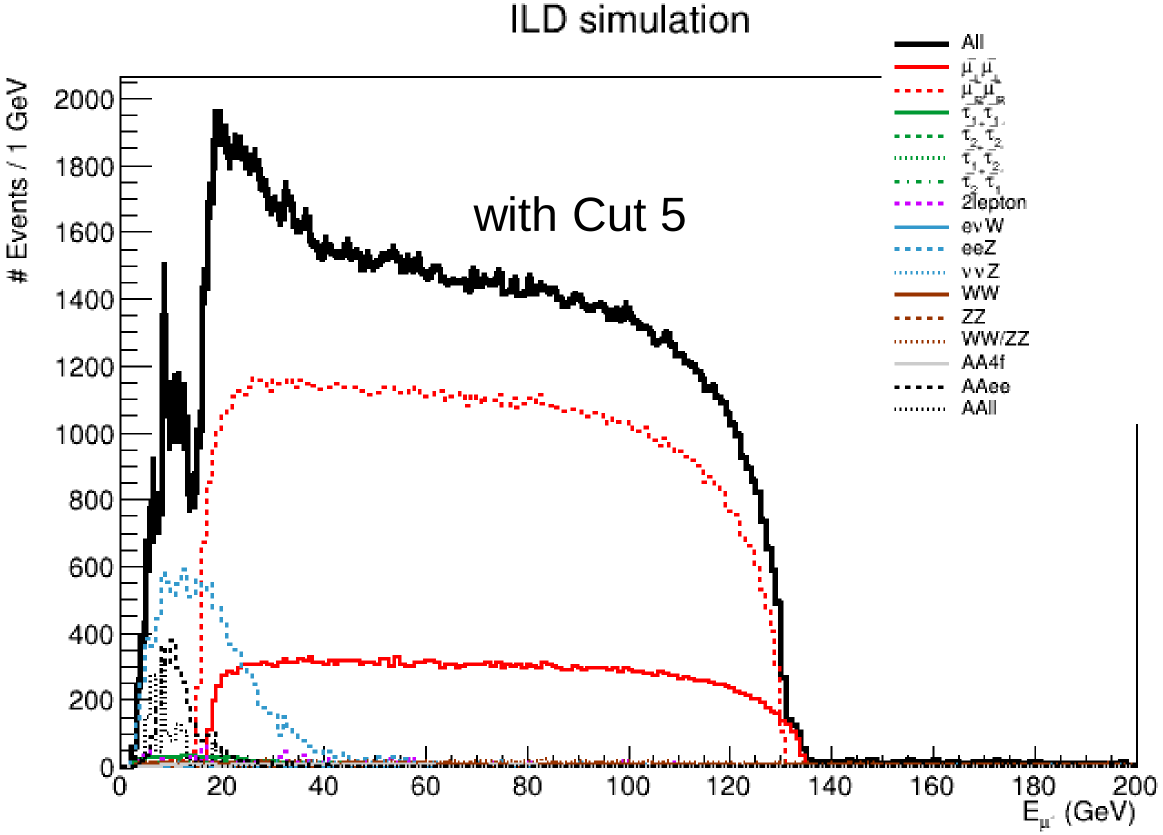
$\frac{\theta_{\mathrm{acol}}}{\pi} \sim 1$: two muons flying the same direction

such probability is expected to be small in signal

Cut 4: $\frac{\theta_{\mathrm{acol}}}{\pi} < 0.9$

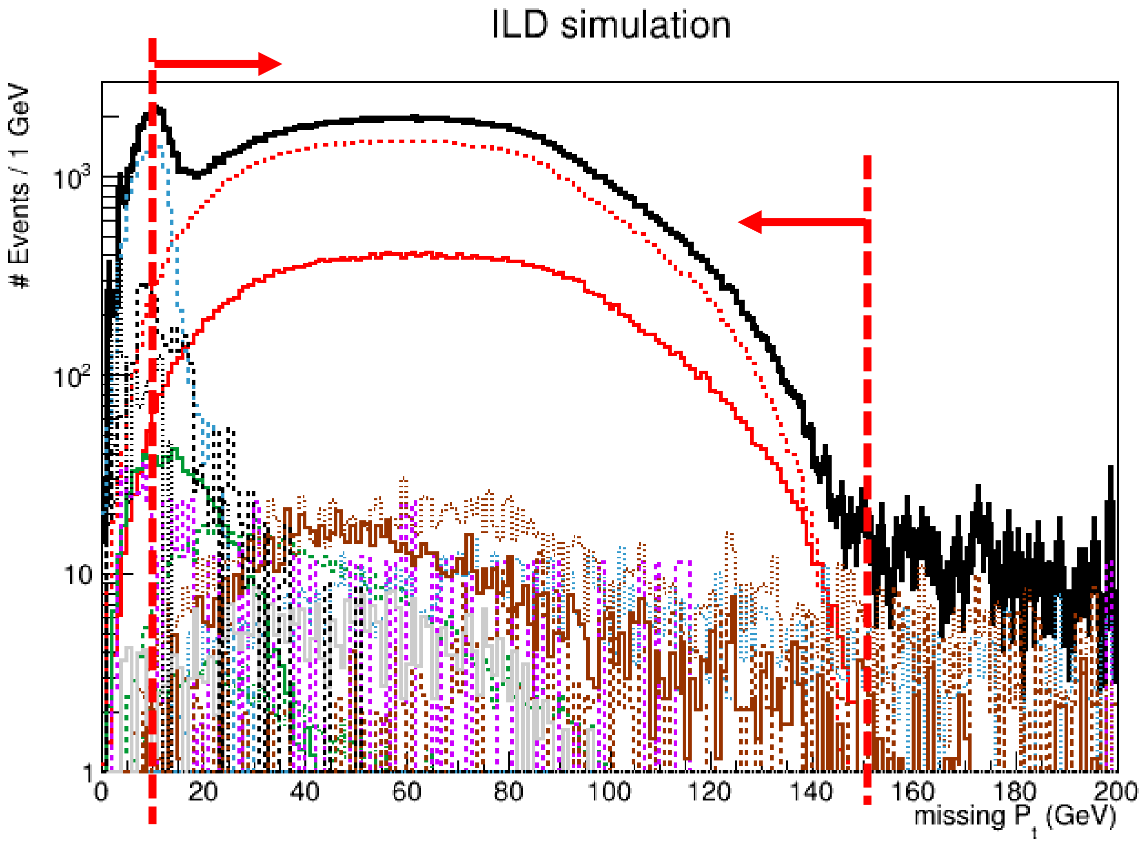
Cut on $\cos\theta_{\text{miss}}$

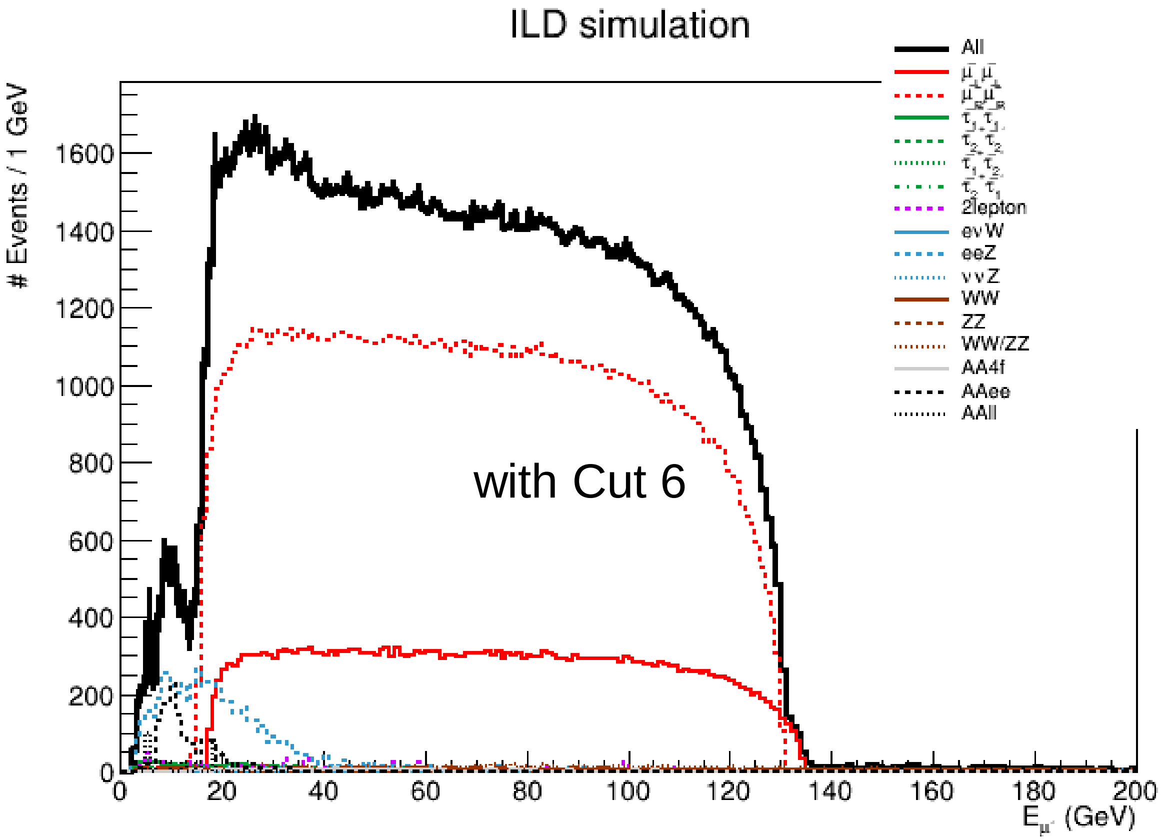




$|\cos\theta_{\text{miss}}| \sim 1$: almost no missing component
signal have large missing component
Cut 5: $|\cos\theta_{\text{miss}}| < 0.95$

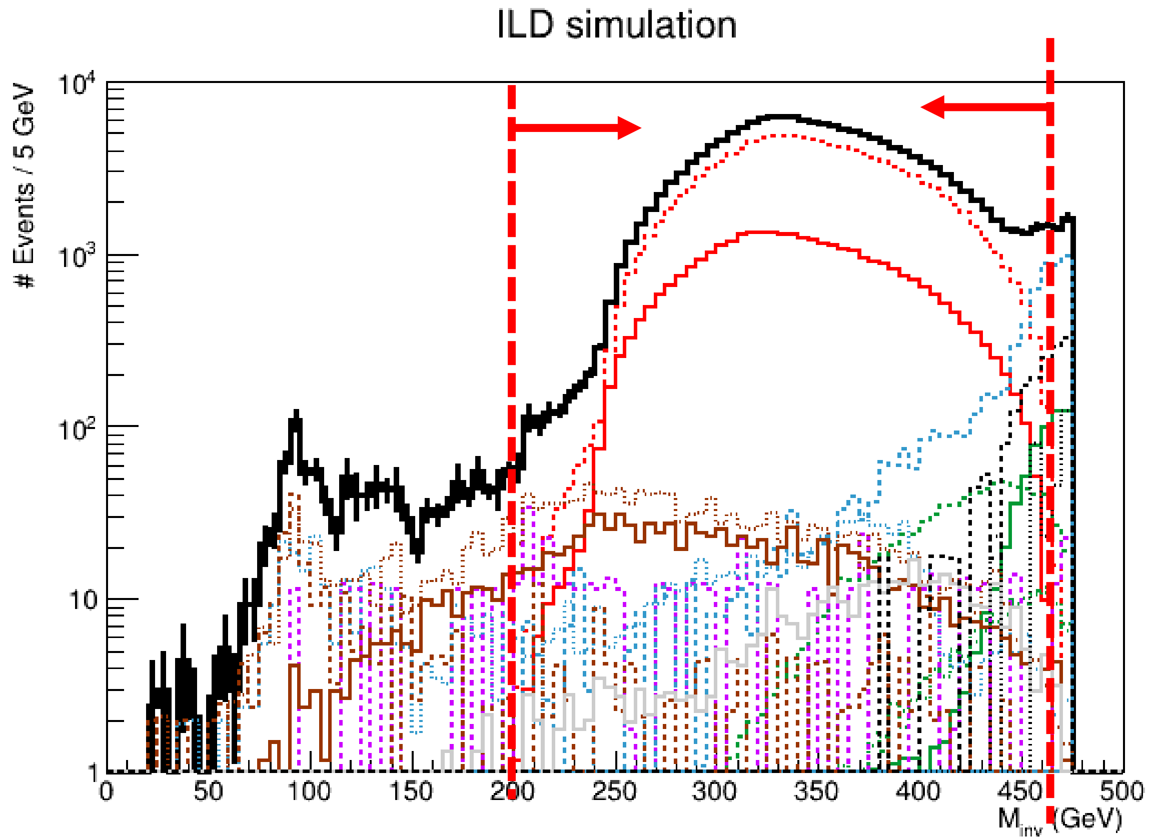
Cut on missing P_t

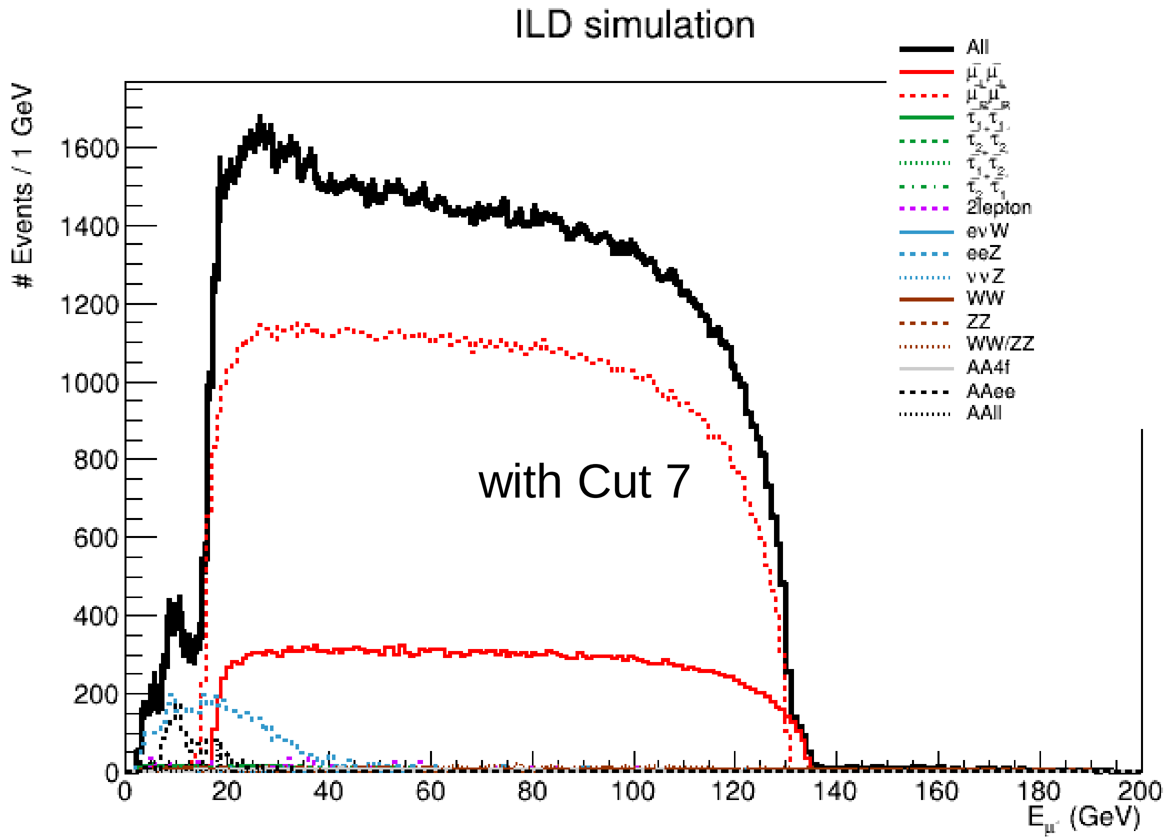




missing P_t ~ 0 GeV: almost no missing component
signal have large missing component
Cut 6: 10 < missing P_t < 150 GeV

Cut on M_{inv} (invariant mass of missing component)





M_{inv} ~ 500 GeV: almost all missing component
signal have large missing component
Cut 7: 200 < M_{inv} < 470 GeV

Cut table (Tight)

signal efficiency: ~79%

significance $= \frac{1.49\times10^5}{\sqrt{1.49\times10^5+1.15\times10^4}} = 372\sigma$

overall dominant backgrounds:
eeZ, WW/ZZ, AAee

affects E^- edge detection:
eeZ, (AAll, 170 event = 5 MC event)

	$\widetilde{\mu}_L\widetilde{\mu}_L$	$\widetilde{\mu}_R\widetilde{\mu}_R$	$\widetilde{\tau}_1^+\widetilde{\tau}_1^-$	$\widetilde{\tau}_2^+\widetilde{\tau}_2^-$	$\widetilde{\tau}_1^+\widetilde{\tau}_2^-$	$\widetilde{\tau}_2^+\widetilde{\tau}_1^-$
precuts	$3.62*10^4$	$1.29*10^5$	$2.54*10^3$	$1.01*10^3$	217	217
Cut 1	$3.62*10^4$	$1.29*10^5$	$1.17*10^3$	920	167	167
Cut 2	$3.59*10^4$	$1.29*10^5$	964	843	149	149
Cut 3	$3.38*10^4$	$1.21*10^5$	823	801	137	137
Cut 4	$3.38*10^4$	$1.21*10^5$	823	801	137	137
Cut 5	$3.28*10^4$	$1.17*10^5$	783	774	132	132
Cut 6	$3.26*10^4$	$1.16*10^5$	576	752	124	124
Cut 7	$3.26*10^4$	$1.16*10^5$	452	733	118	118

SM bkg	2lepton	$e\nu W$	eeZ	$\nu\nu Z$	WW	ZZ	WW/ZZ	AA4f	AAee	AAll
precuts	$5.00*10^5$	6.74	$3.72*10^5$	$3.35*10^3$	$2.11*10^3$	$2.29*10^3$	$7.96*10^3$	858	$4.42*10^5$	$1.69*10^6$
Cut 1	$1.65*10^5$	6.26	$2.15*10^5$	$2.99*10^3$	$1.72*10^3$	$2.07*10^3$	$3.99*10^3$	770	$1.26*10^5$	$1.69*10^5$
Cut 2	$1.61*10^5$	4.69	$9.41*10^4$	$1.77*10^3$	$1.58*10^3$	$1.46*10^3$	$2.96*10^3$	581	$6.59*10^4$	$4.19*10^3$
Cut 3	$1.97*10^4$	4.69	$8.77*10^4$	$1.69*10^3$	$1.42*10^3$	$1.15*10^3$	$2.78*10^3$	550	$1.20*10^4$	$2.76*10^3$
Cut 4	$1.91*10^4$	4.69	$8.71*10^4$	$1.62*10^3$	$1.42*10^3$	$1.09*10^3$	$2.75*10^3$	548	$1.20*10^4$	$2.76*10^3$
Cut 5	772	1.54	$1.23*10^4$	$1.16*10^3$	$1.11*10^3$	619	$2.09*10^3$	384	$2.87*10^3$	$1.37*10^3$
Cut 6	574	1.54	$5.73*10^3$	909	$1.06*10^3$	351	$1.75*10^3$	364	$1.62*10^3$	294
Cut 7	453	1.34	$4.77*10^3$	651	903	136	$1.33*10^3$	352	$1.30*10^3$	170