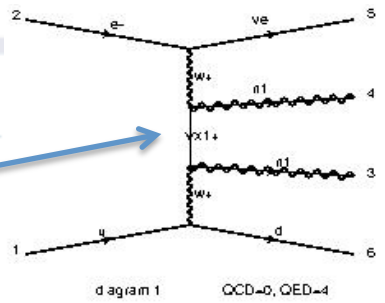
Search for SUSY DM at future ep colliders

Kechen Wang

February 6, 2017

Preliminary results !

EWK RPC-SUSY production



- Question: can anything be done at the FCC-eh ?
- Production of monojet-like signatures → not feasible
- Production of the kind e+j+MET → possible
- Polarization -0.8 lead to a 30% increase in x-sections, which are anyway small:

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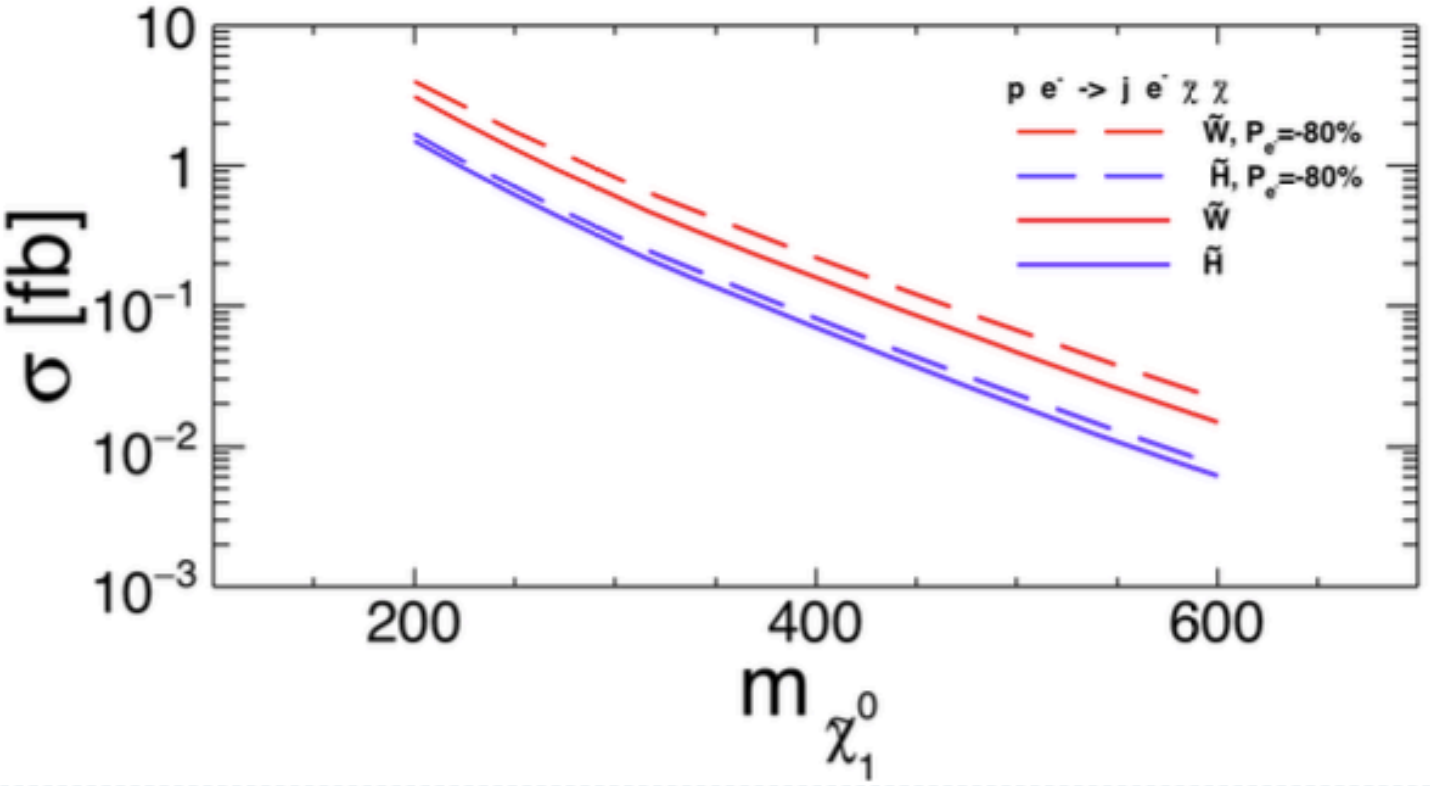


Signal Event Generating

Collider:
FCC-eh (Ep = 50 TeV, Ee = 60 GeV).

Benchmark point:
pure Wino DM: M2 ~ 200 GeV; M1, μ >> M2;
m(neutrino1) ~ m(chargino1) ~ 200 GeV.

MadGraph generating:
“import model mssm-full
define dm = n1 n2 x1+ x1-
generate p e- > dm dm e- j / go ul cl t1 ur cr t2 dl sl b1 dr sr b2 ul~ cl~ t1~ ur~ cr~ t2~ dl~ sl~ b1~ dr~ sr~ b2~ h2 h3 h+ h- sve svm svt el- mul- ta1- er- mur- ta2- sve~ svm~ svt~ el+ mul+ ta1+ er+ mur+ ta2+ n3 n4 x2+ x2- QCD=0 QED=4 ”

Signal Event Generating

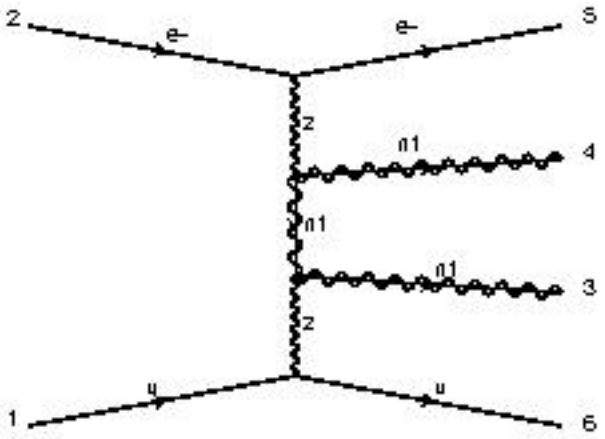
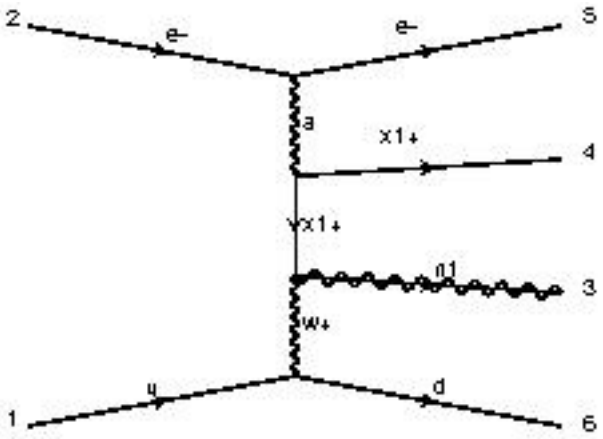


diagram 1 QCD=0, QED=4



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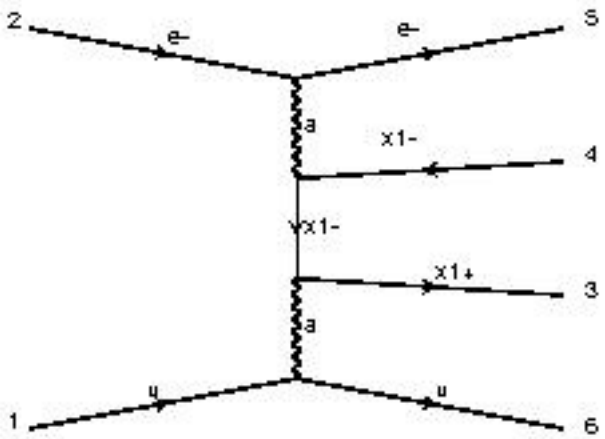

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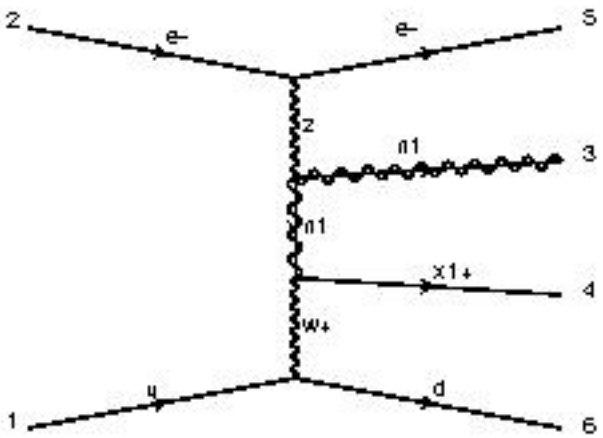


diagram 3 QCD=0, QED=4

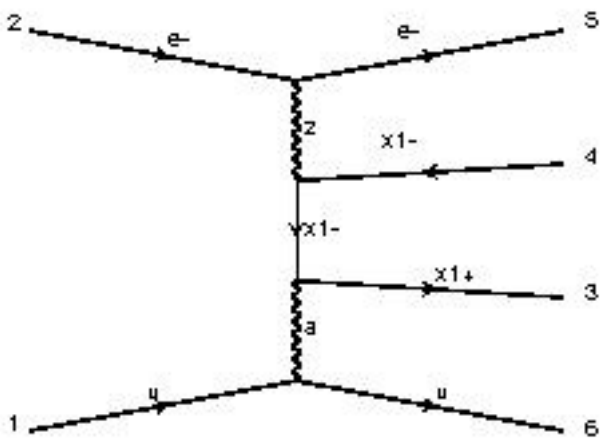


diagram 3 QCD=0, QED=4

Background Event Generating

Collider:
FCC-eh (Ep = 50 TeV, Ee = 60 GeV).

MadGraph generating:
“import model sm-full
define dm = ve vm vt ve~ vm~ vt~
generate p e- > j e- dm dm ”

→ Similar to Higgs->invisible
→ Including "W j v", "Z j e",
"e- j v v (via ZZ/WZ/WA fusion)”
→ Missing “W j e-”

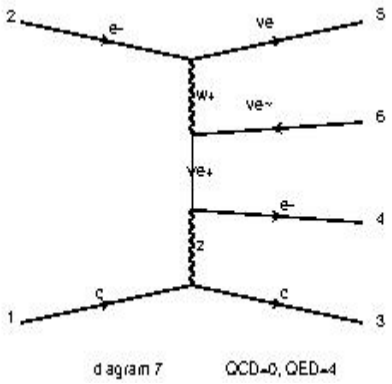


diagram 7 QCD=0, QED=4

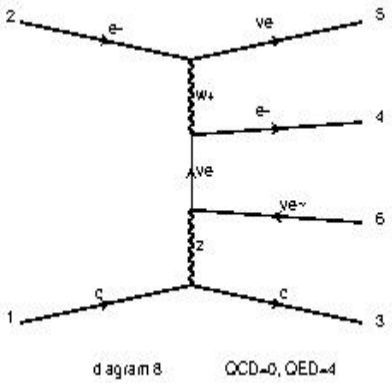


diagram 8 QCD=0, QED=4

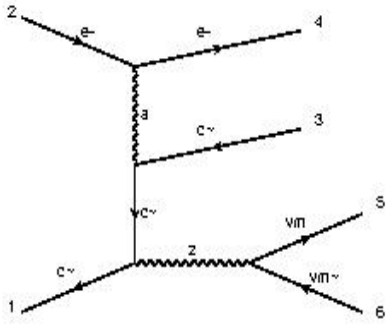


diagram 11 QCD=0, QED=4

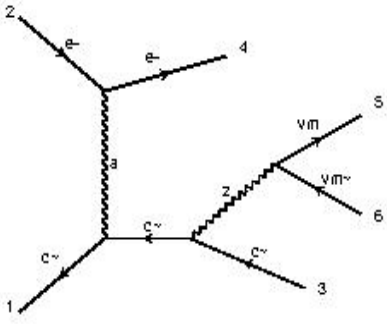


diagram 12 QCD=0, QED=4

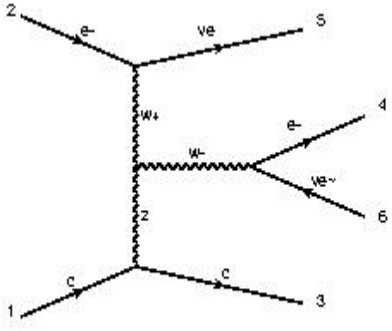


diagram 11 QCD=0, QED=4

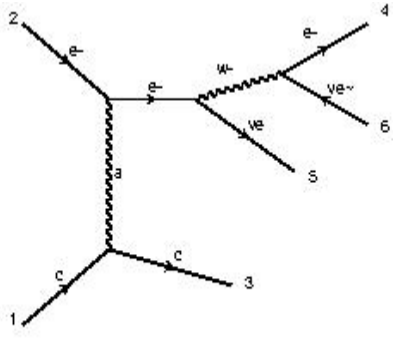
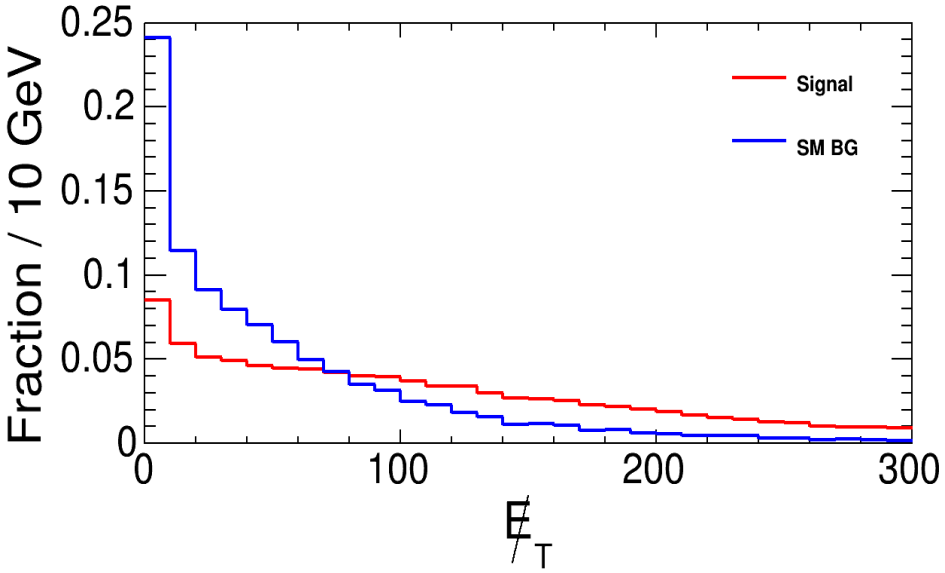


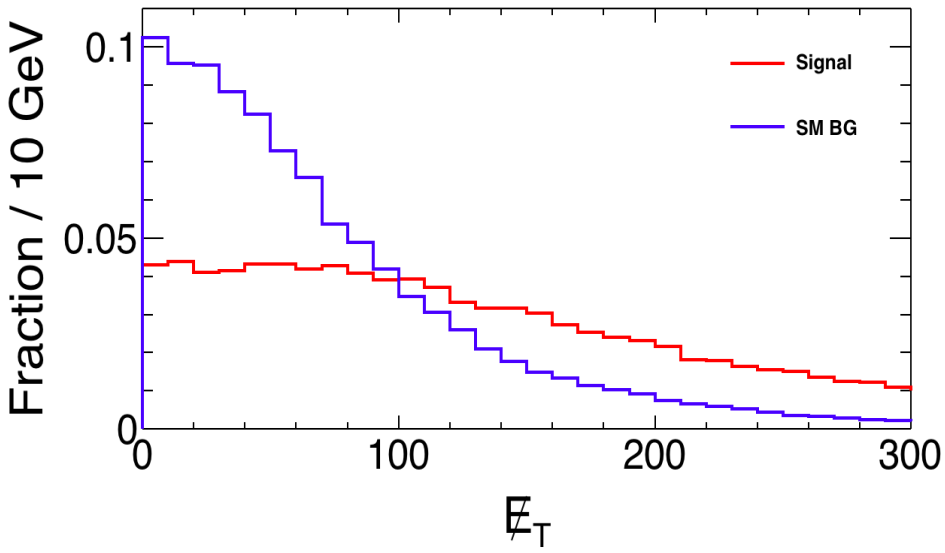
diagram 12 QCD=0, QED=4

Distributions

unpolarized beam $P(e^-) = 0$



polarized beam $P(e^-) = -80\%$



So far, parton level distributions.

Distributions

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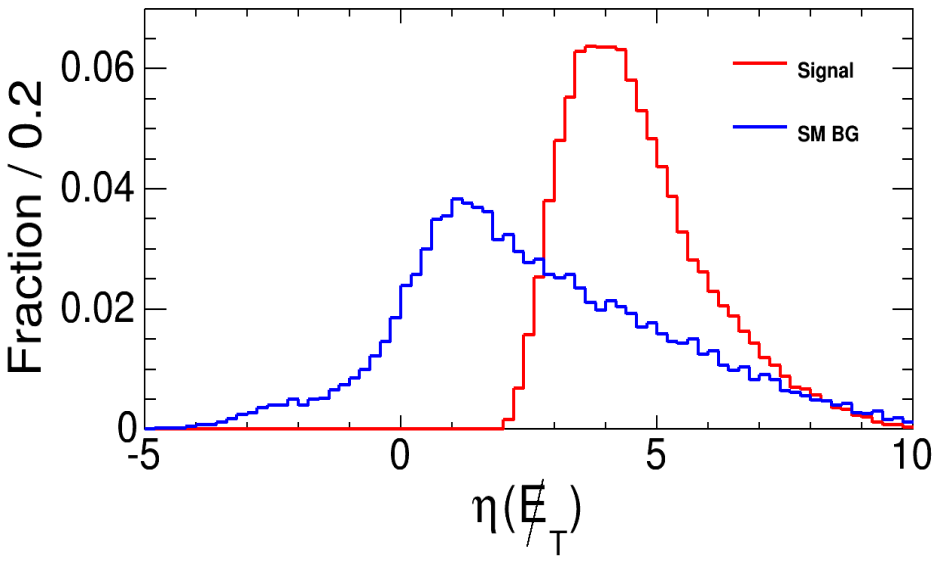

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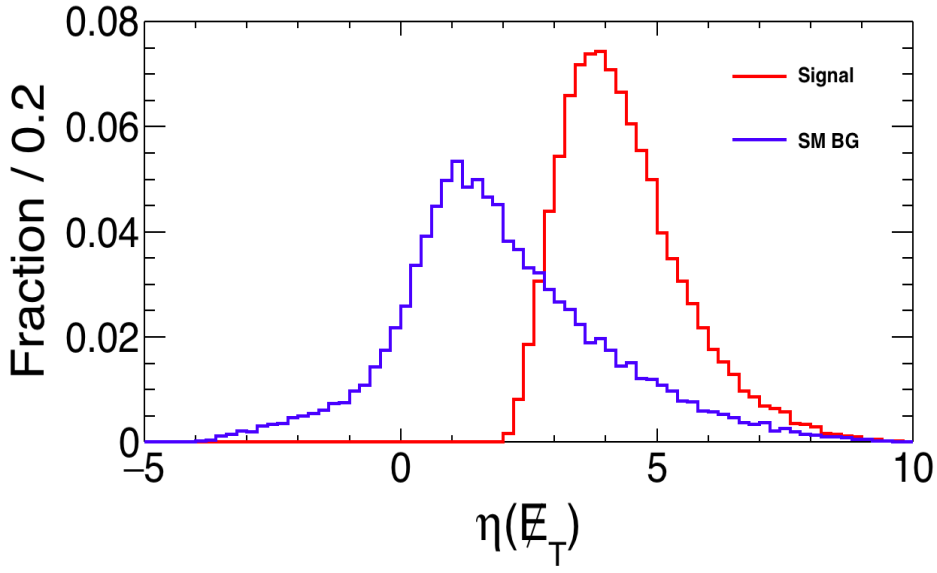

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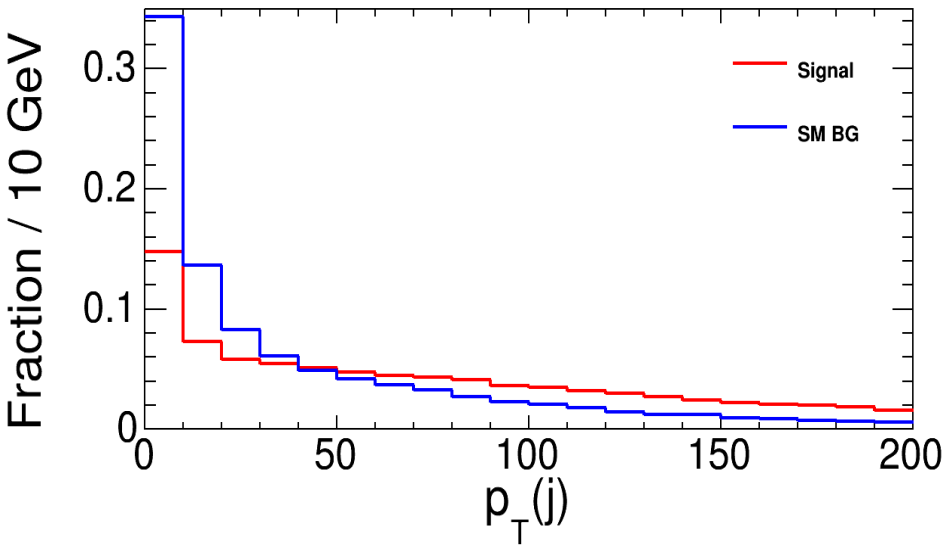

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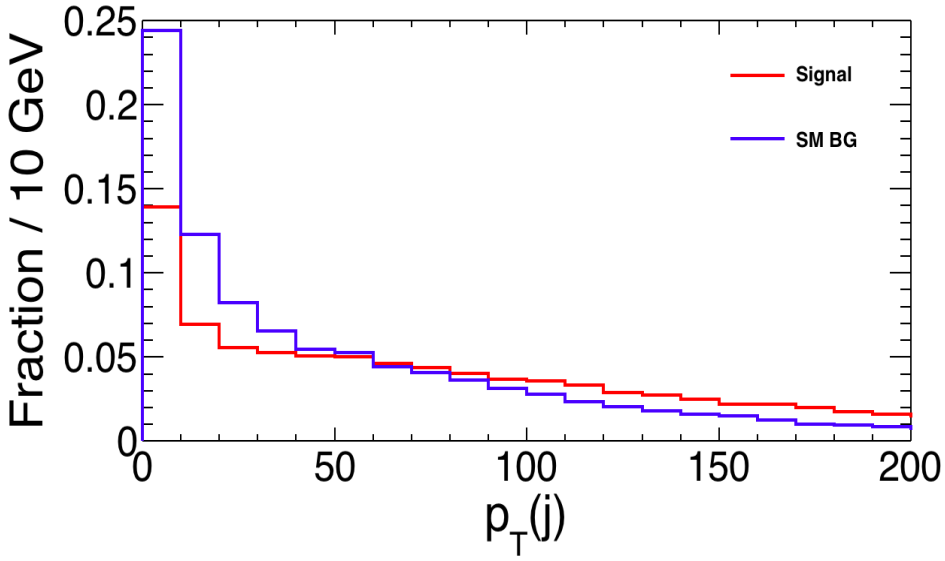

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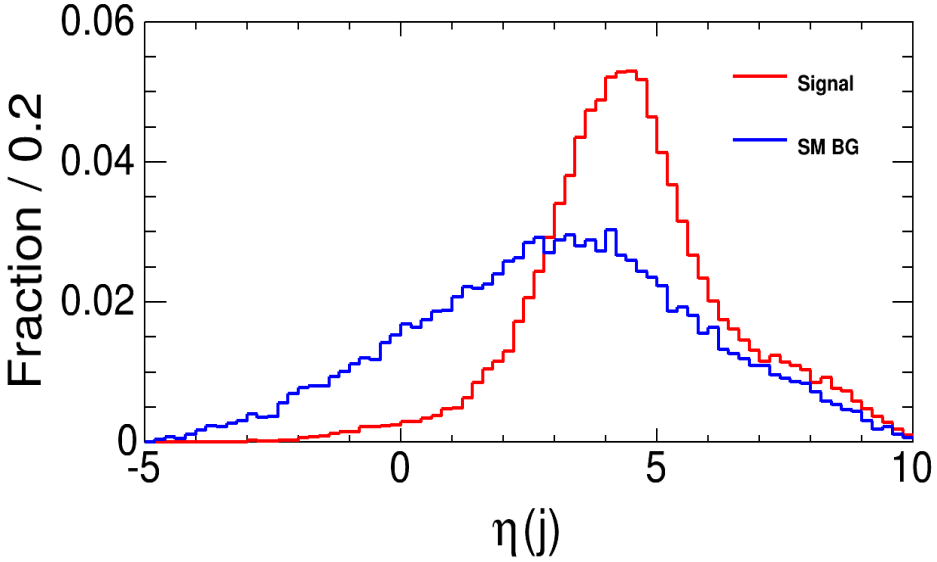

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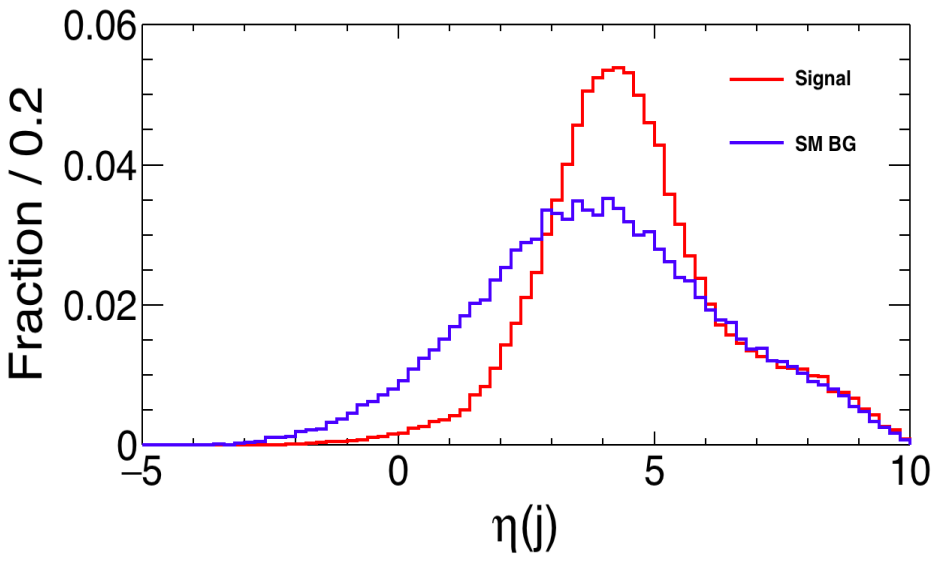

Distributions

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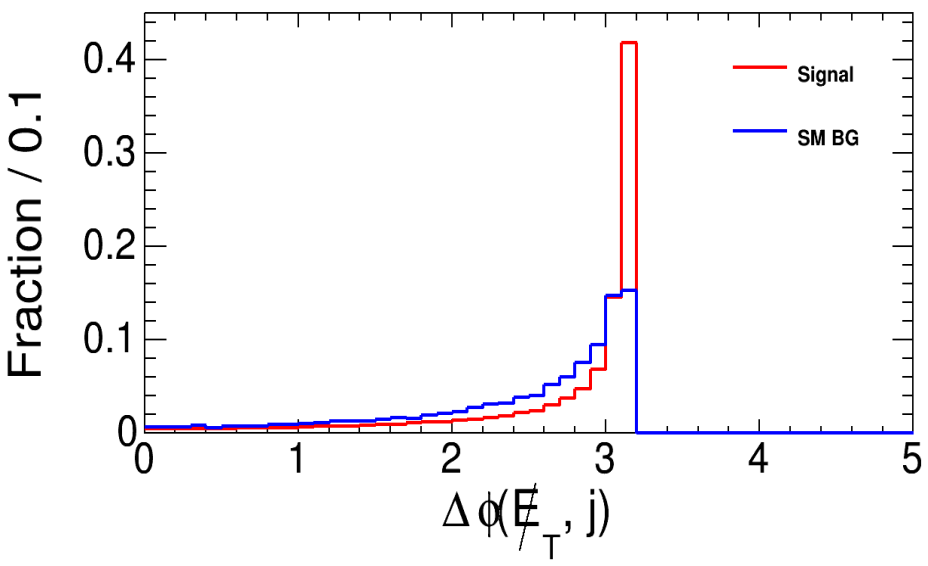

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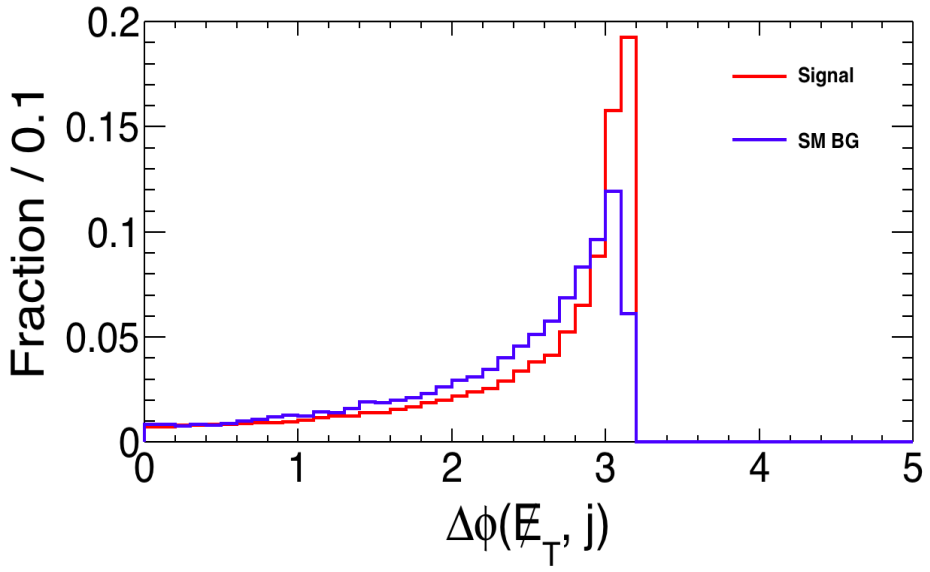

Distributions

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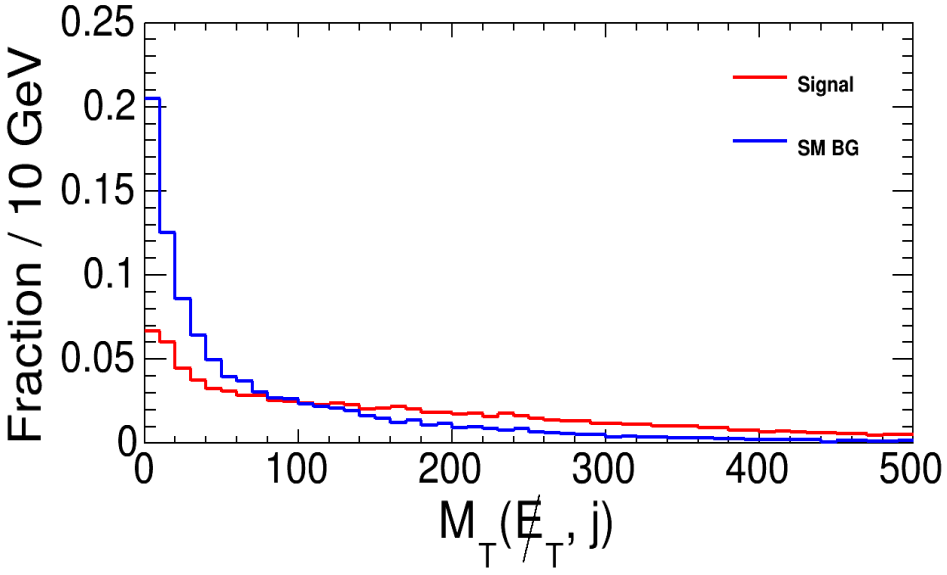

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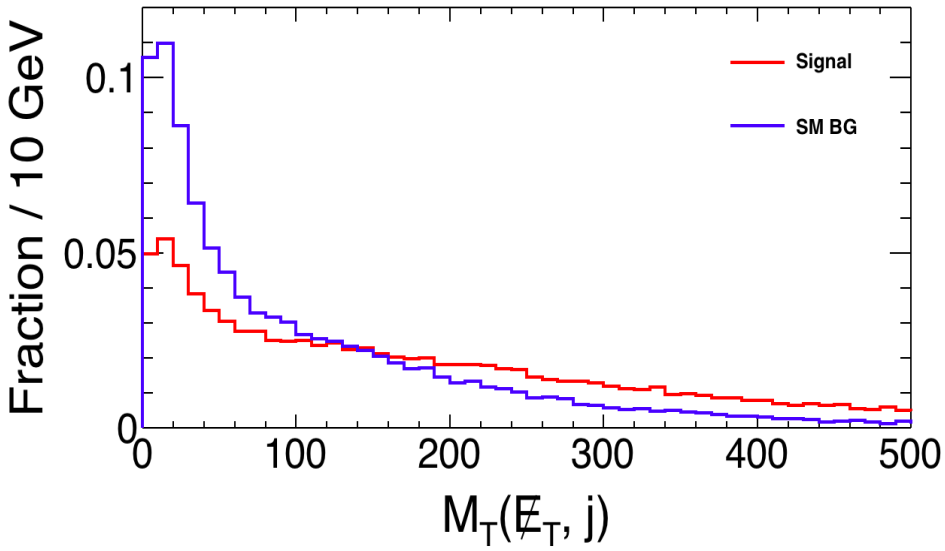

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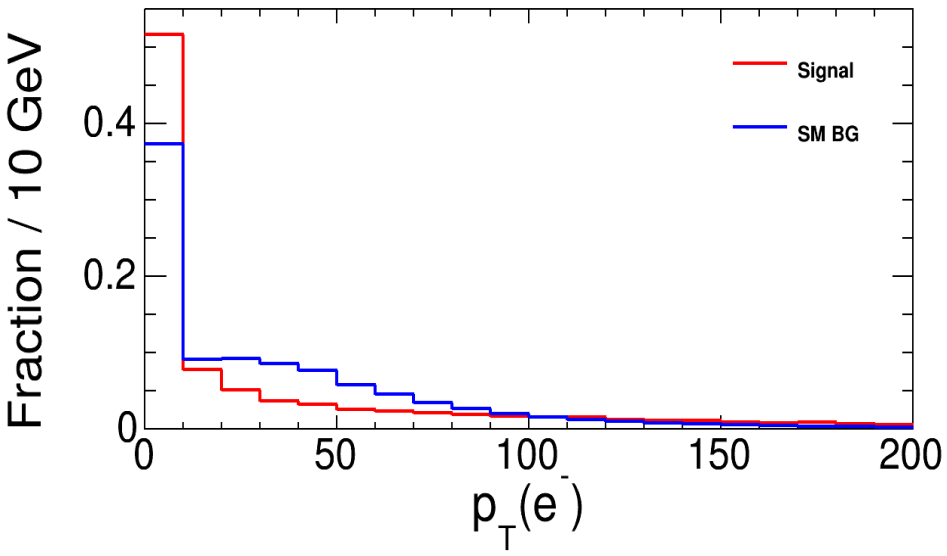

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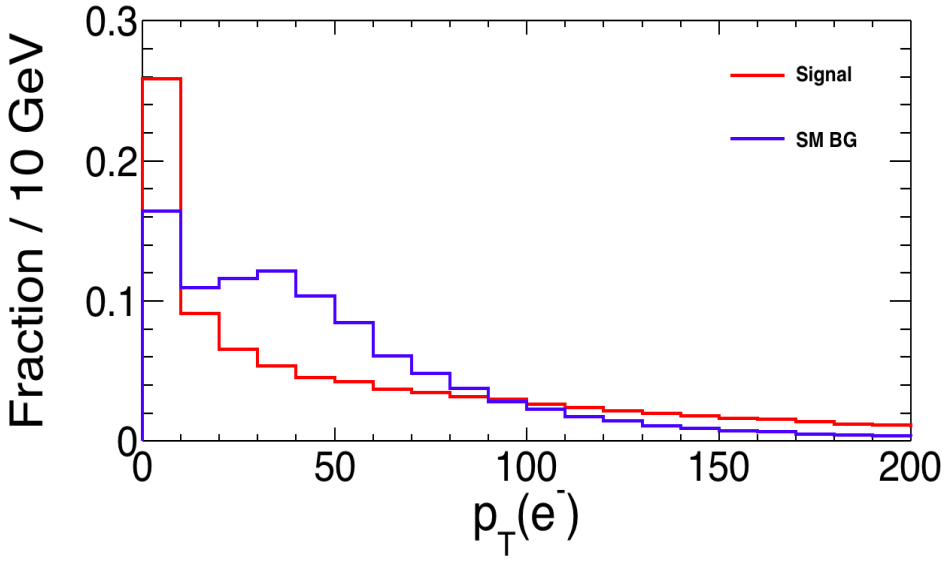

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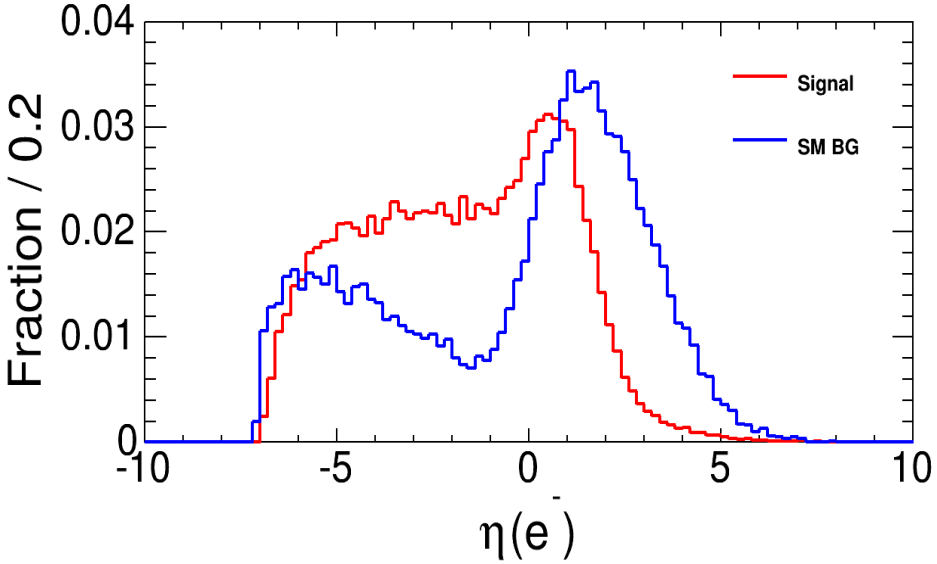

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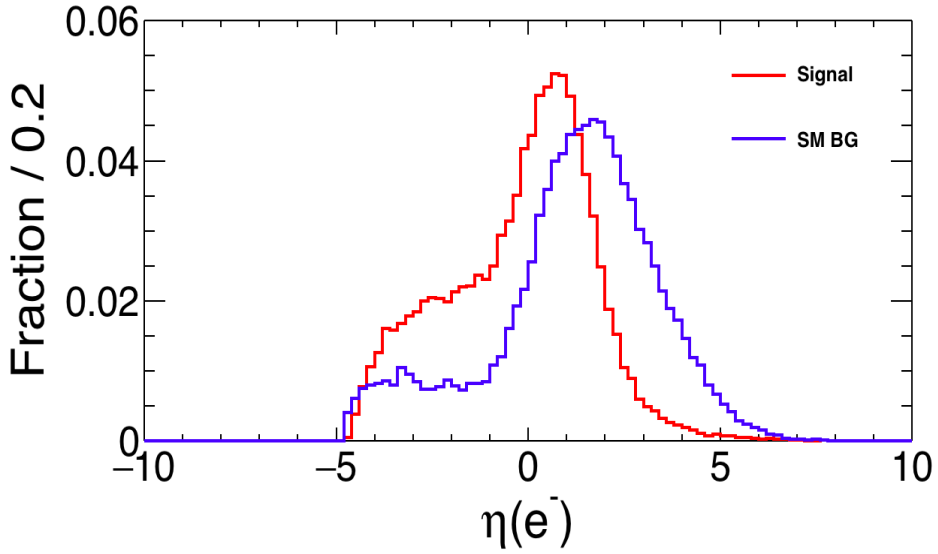

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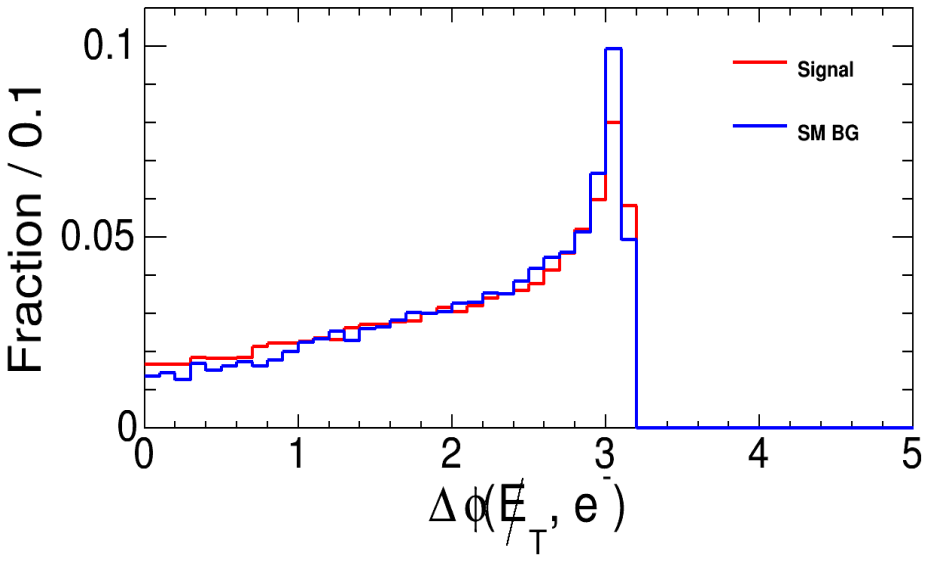

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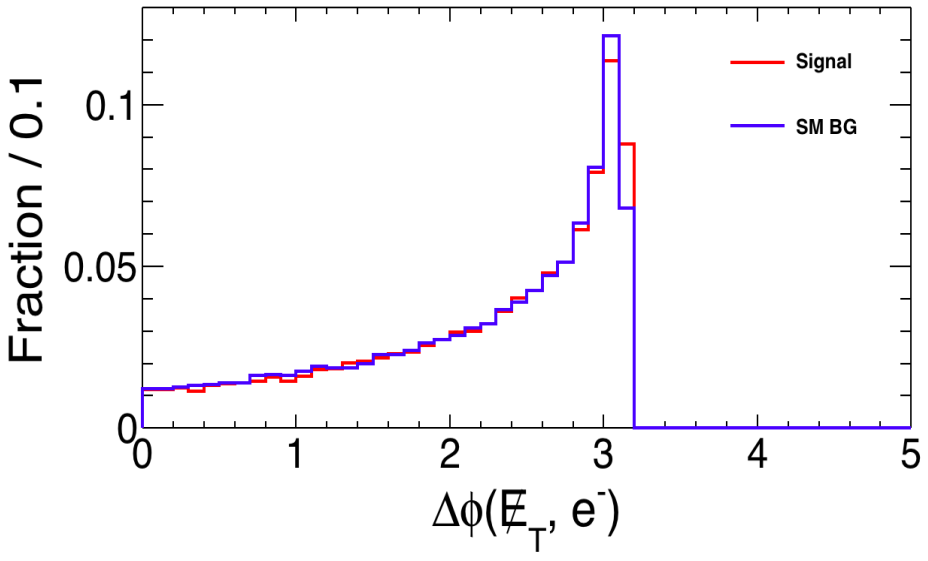

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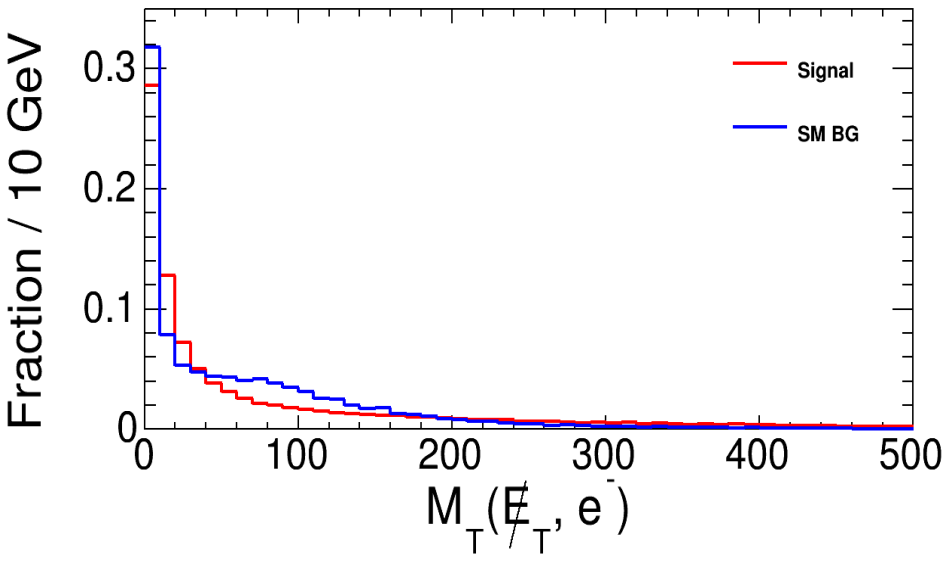

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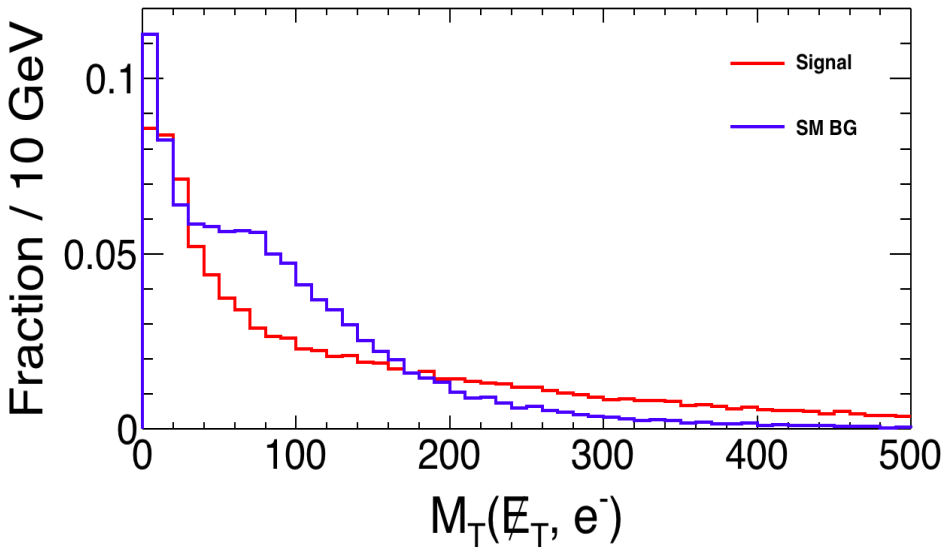

Distributions

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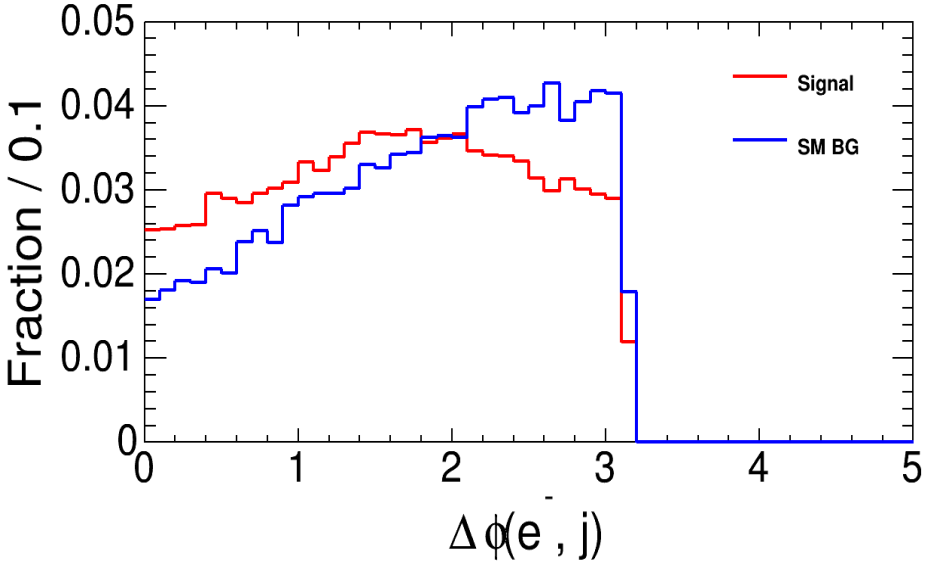

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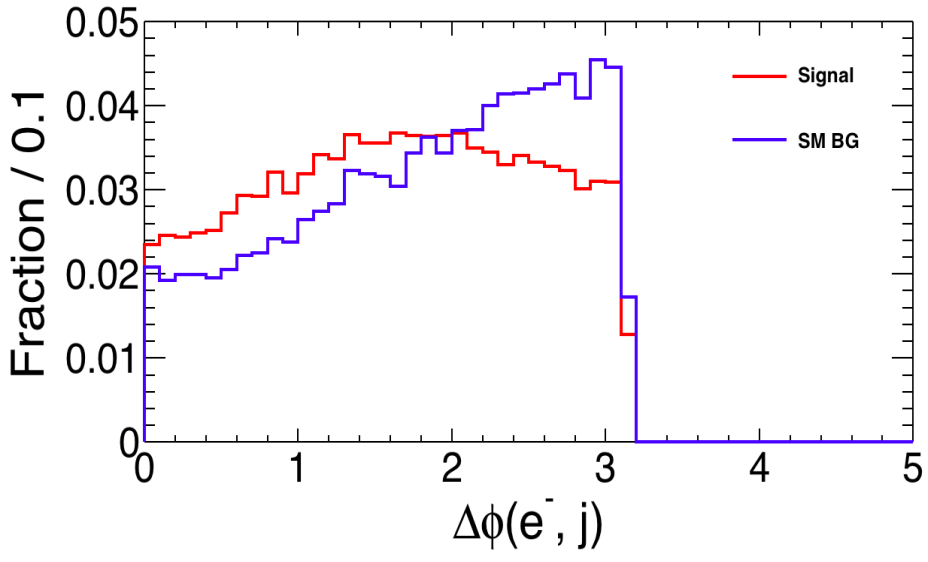

Distributions

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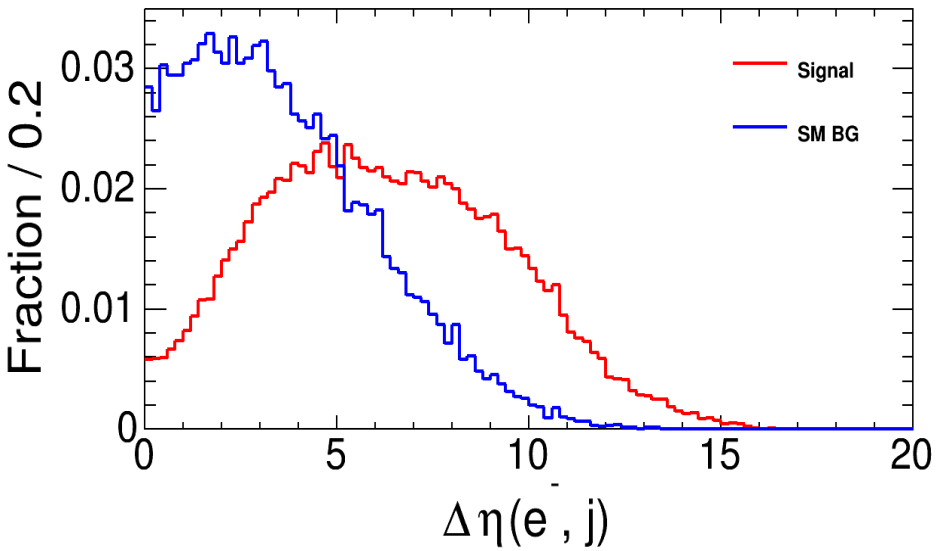

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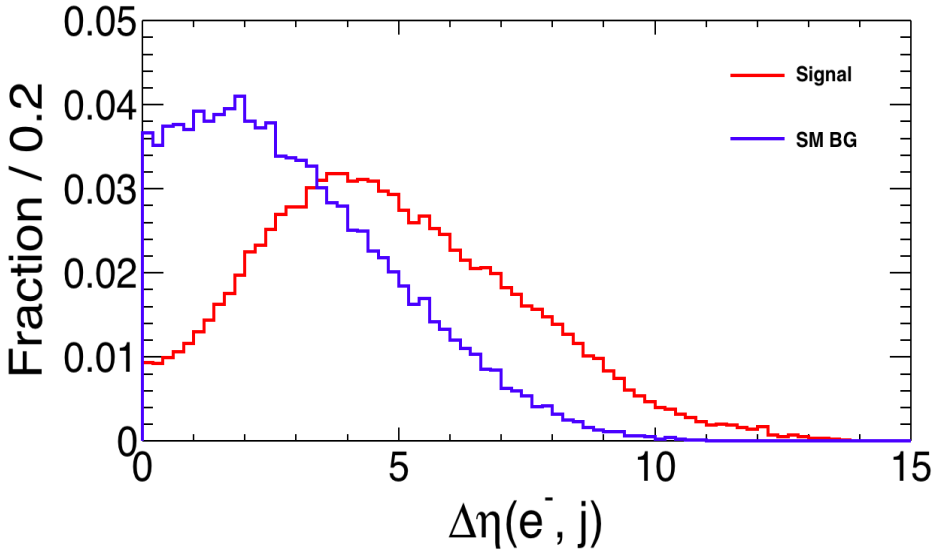

Distributions

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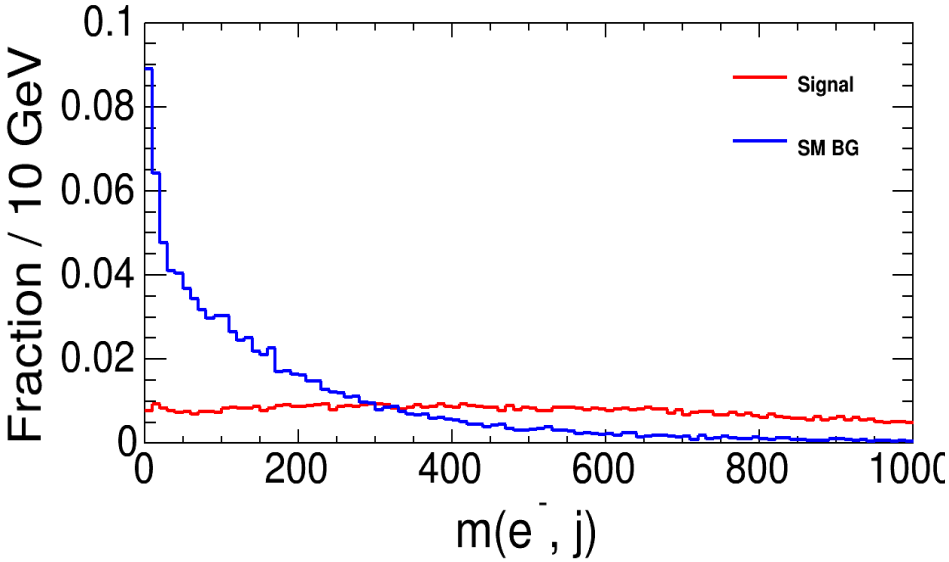

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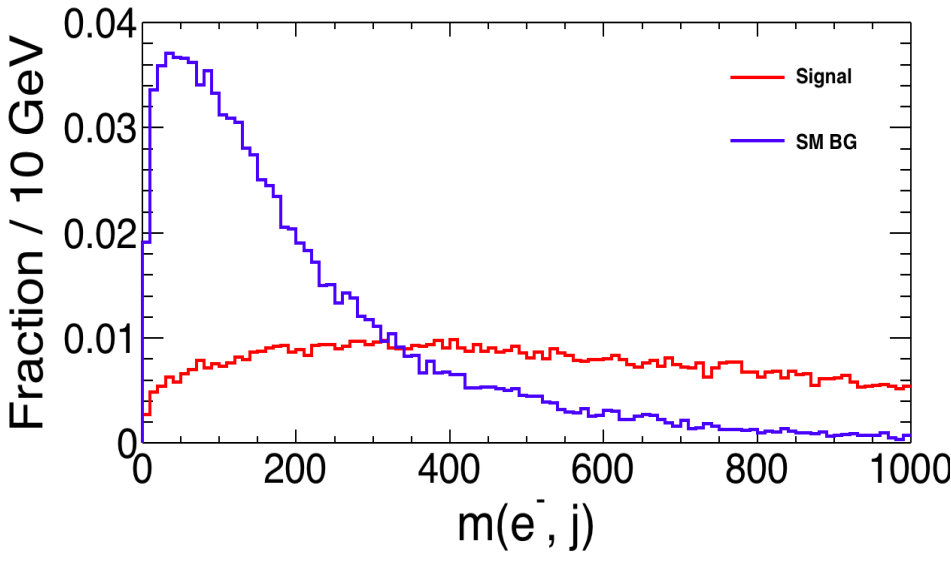

Distributions

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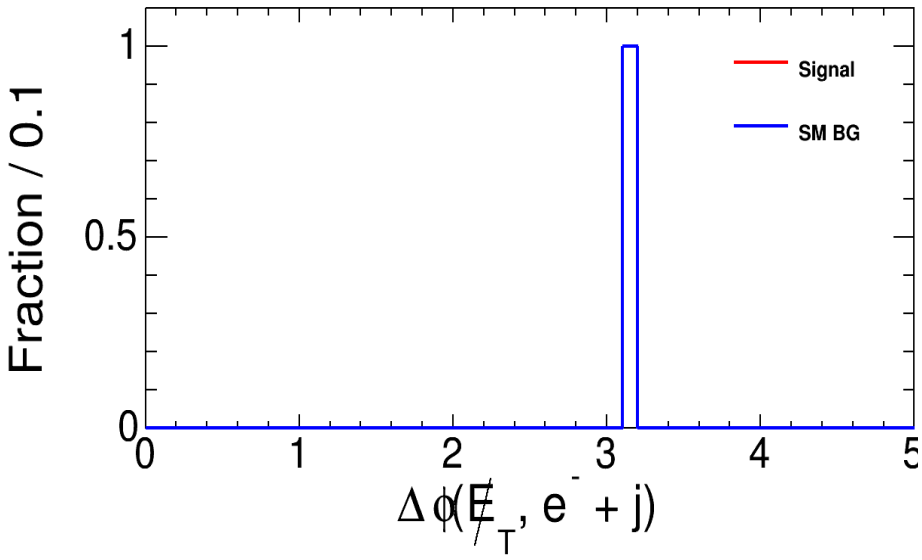

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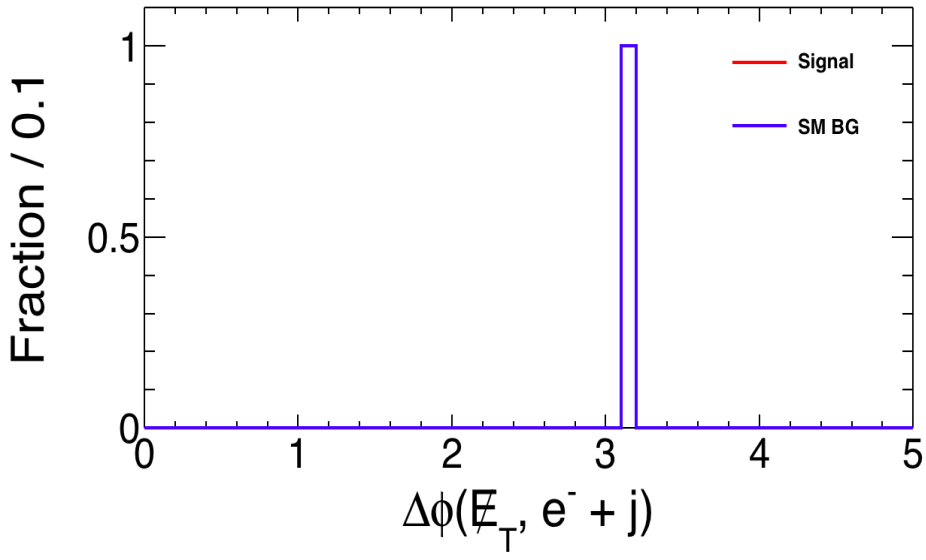
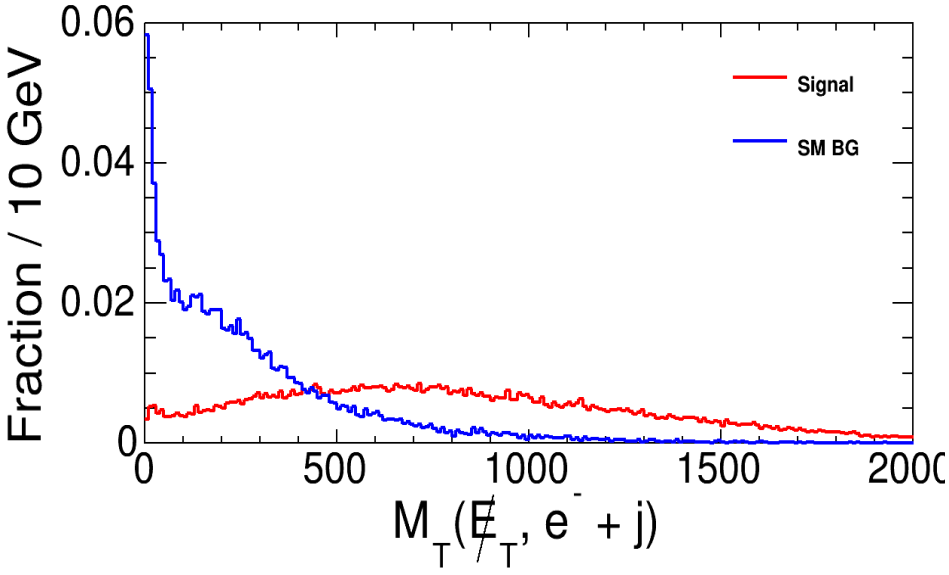
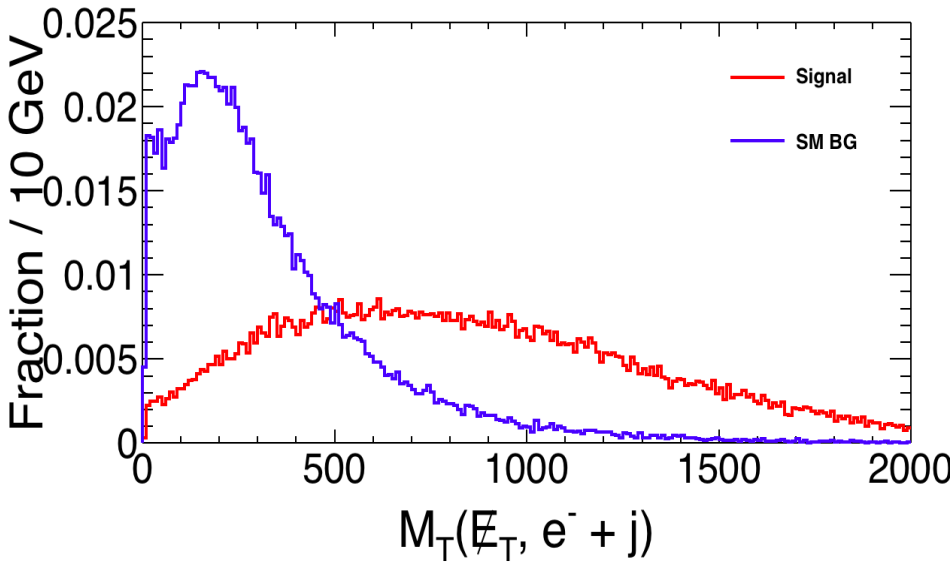


Distributions

unpolarized beam P(e^-) = 0



polarized beam P(e^-) = -80%



Cut Flow Table

Wino = 200 GeV

unpolarized beam

Cuts	tight run_card_1			loose run_card		
	Signal			Background		
	# of events	Cut efficiency	cross section [fb]	# of events	Cut efficiency	cross section [fb]
initial	50000		2.290	21058		1492
N(e) >= 1	50000	100%	2.290	21058	100%	1492
N(e-) >= 1	50000	100%	2.290	21058	100%	1492
N(j) >= 1	50000	100%	2.290	21058	100%	1492
p_T(e-) > 5 GeV	37903	76%	1.736	14374	68%	1018.426
eta(e-) > -5.0	37903	100%	1.736	14374	100%	1018.426
eta(e-) < 1.0	27464	72%	1.258	5625	39%	398.542
p_T(j) > 50 GeV	16987	62%	0.778	2087	37%	147.868
eta(j) > 3.0	14043	83%	0.643	984	47%	69.718
MET > 100 GeV	9903	71%	0.454	352	36%	24.940
M_T(met,j) > 150 GeV	9599	97%	0.440	336	95%	23.806
dPhi(met,j) > 3.0	5230	54%	0.240	123	37%	8.715
dPhi(e-,j) < 2.0	3592	69%	0.165	72	59%	5.101
dEta(e-,j) > 5.0	2072	58%	0.095	11	15%	0.779
m(e + j) > 350 GeV	2071	100%	0.095	11	100%	0.779
M_T(met,e + j) > 500 GeV	2067	100%	0.095	11	100%	0.779

Significance with 1000 fb^-1	3.2
Significance with 600 fb^-1	2.5

Total cut efficiency:

Signal: 4.1%; Background: 0.05%

Cut Flow Table

Wino = 200 GeV

polarized beam

+40%

Cuts	tight run_card_1 Signal			tight run_card_1 Background		
	# of events	Cut efficiency	cross section [fb]	# of events	Cut efficiency	cross section [fb]
initial	50000		3.197	60000		1905
N(e) >= 1	50000	100%	3.197	60000	100%	1905
N(e-) >= 1	50000	100%	3.197	60000	100%	1905
N(j) >= 1	50000	100%	3.197	60000	100%	1905
p_T(e-) > 5 GeV	41198	82%	2.634	53780	90%	1707.515
eta(e-) > -4.2	41198	100%	2.634	53780	100%	1707.515
eta(e-) < 1.2	30011	73%	1.919	21728	40%	689.864
p_T(j) > 60 GeV	17292	58%	1.106	7776	36%	246.888
eta(j) > 3.0	14353	83%	0.918	3797	49%	120.555
MET > 100 GeV	11007	77%	0.704	1522	40%	48.324
M_T(met,j) > 160 GeV	10625	97%	0.679	1446	95%	45.911
dPhi(met,j) > 3.0	4858	46%	0.311	515	36%	16.351
dPhi(e-,j) < 2.0	3313	68%	0.212	314	61%	9.970
dEta(e-,j) > 3.6	2785	84%	0.178	154	49%	4.890
m(e + j) > 350 GeV	2682	96%	0.171	128	83%	4.064
M_T(met,e + j) > 500 GeV	2676	100%	0.171	127	99%	4.032

Significance with 1000 fb^-1 2.6

Significance with 600 fb^-1 2.0

Total cut efficiency:

Signal: 5.4%; Background: 0.21%

(4.1%); (0.05%)

Future Work

→ More BG check, like “W j e”

→ More possible observables,
like “disappearing track” in the super compressed scenario (mC1-mN1 < 1 GeV)

→ Add detector study

→ Compressed scenario (mC1-mN1 ~ 5 GeV)

→ MVA