Recasting CMS-EXO-19-010 Disappearing Track search(es)

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With: Lakshmi Priya (IISER, now DESY) arXiv: 2106.08815

Code hosted at:

https://github.com/llprecasting/recastingCodes/tree/master/DisappearingTracks/CMS-EXO-19-010
https://goodsell.pages.in2p3.fr/hackanalysis/

LPTHE
LABORATOIRE DE PHYSIQUE THEORIQUE ET HAUTES ENERGIES

SORBONNE UNIVERSITÉ

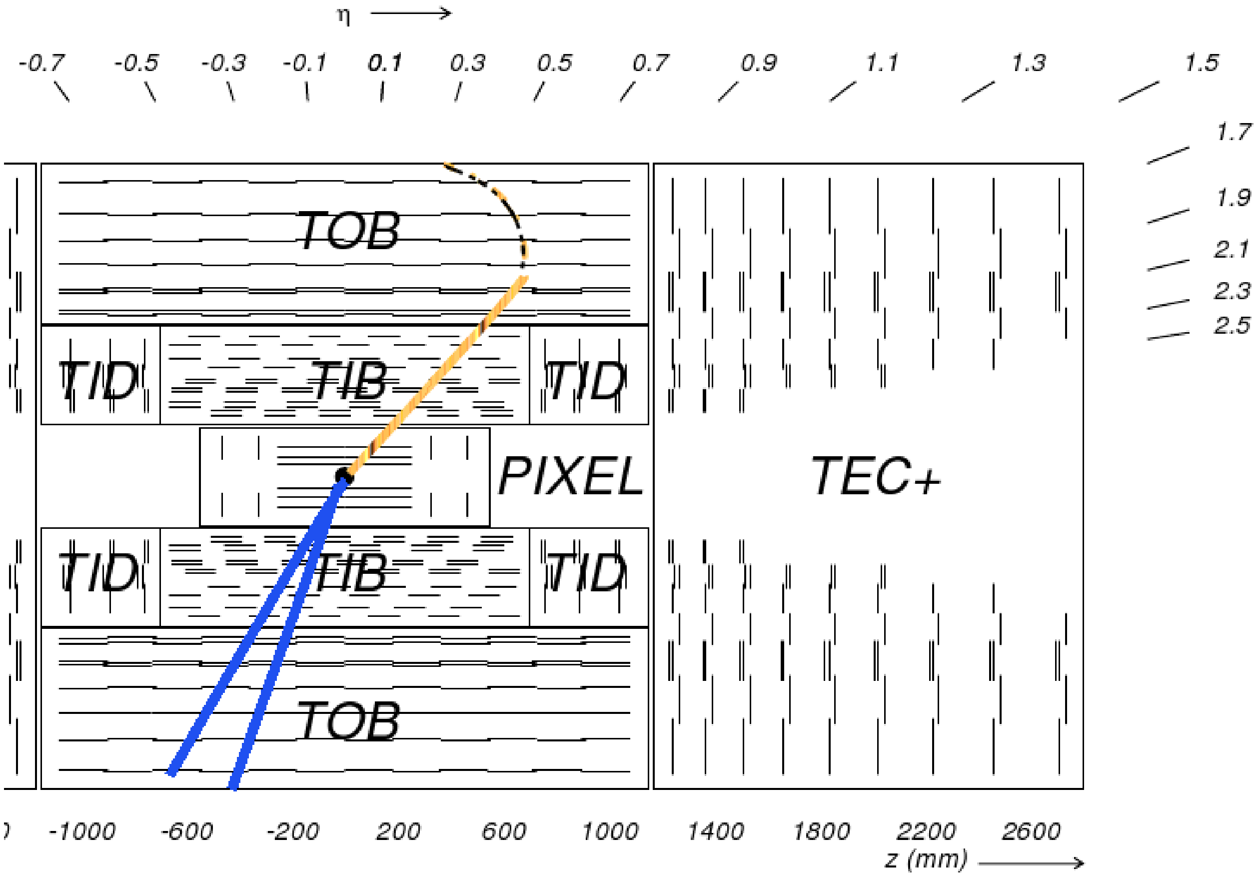
PROJET FINANCÉ PAR L'ANR - PROJECT FUNDED BY THE ANR

cnrs

A full Run 2 analysis

Made of 2 analyses: 2004.05153 (EXO-19-010) and the older 1804.07321 (EXO-18-044)

$101\ \mathrm{fb}^{-1}$ $38.4\ \mathrm{fb}^{-1}$



See the RAMP talk by Brian Francis https://indico.cern.ch/event/1023551/

See also the excellent Thesis of Adam Hart

Look for tracks that "disappear" in the tracker and after the pixel detector

i.e. one or more heavy charged particles that decay to something neutral and non-hadronic

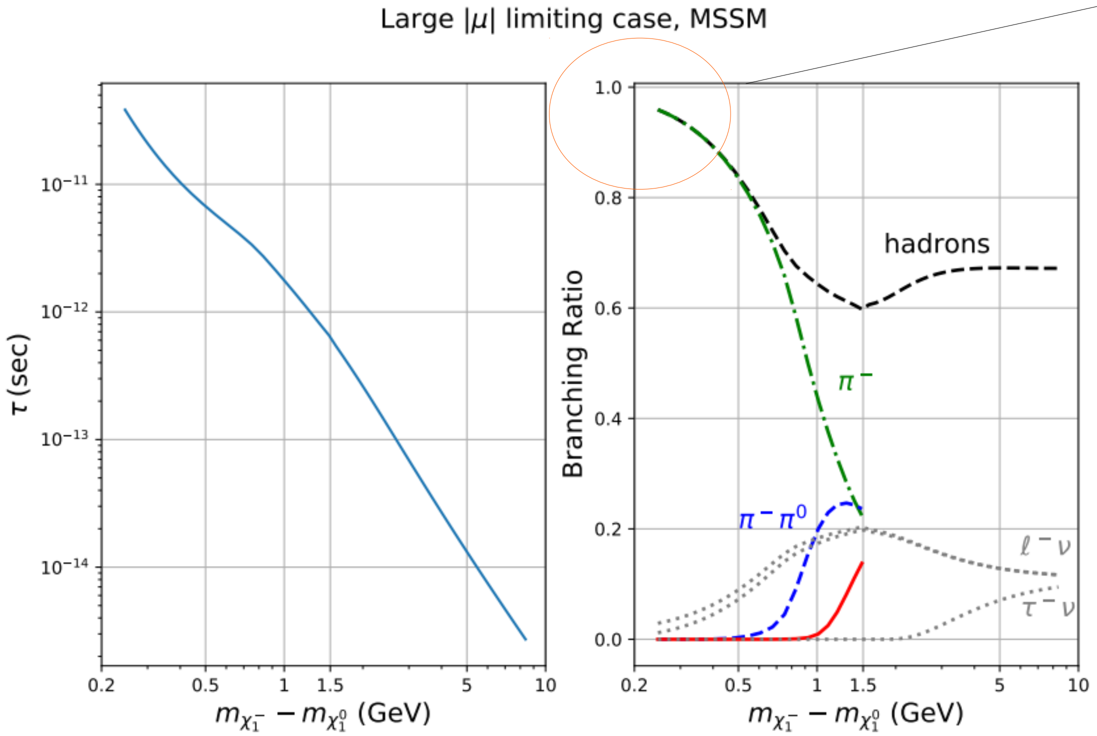
Disappearing tracks are a **classic LLP signature:**

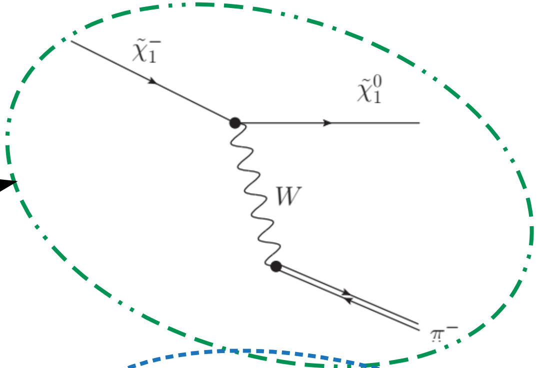
Canonical example: any BSM electroweak multiplet where the lightest state is neutral (e.g. minimal DM, winos, higgsinos, …)

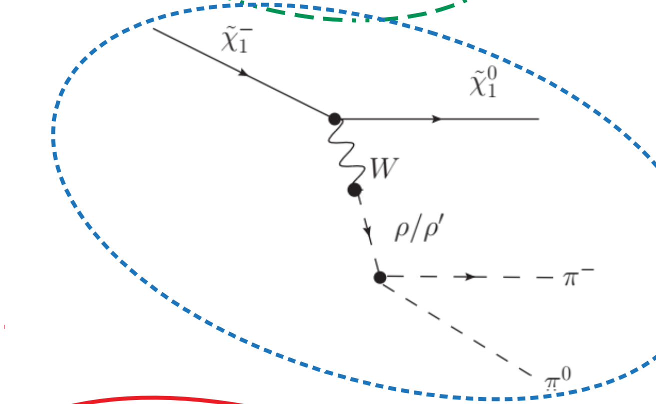
- Mass splitting is induced by electroweak loops, e.g. for pure triplet $$\Delta M = 166\ \mathrm{MeV}$$
- Lifetime is suppressed by the mass splitting $$\Gamma \propto G_F^2 (\Delta M)^3$$
- Neutral component carries off most of the energy → **large MET**

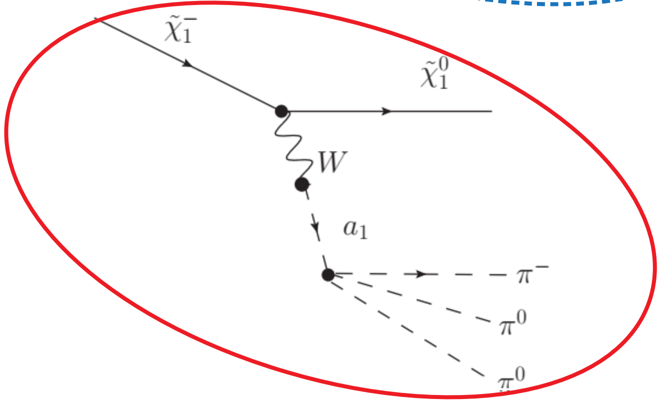
Therefore having a recast code for the latest searches should be very useful for phenomenologists

E.g. in MSSM with SUSY scalars heavy, get quasi-degenerate chargino-neutralino pair, decay is via W into pions, or leptons at smaller mass splitting









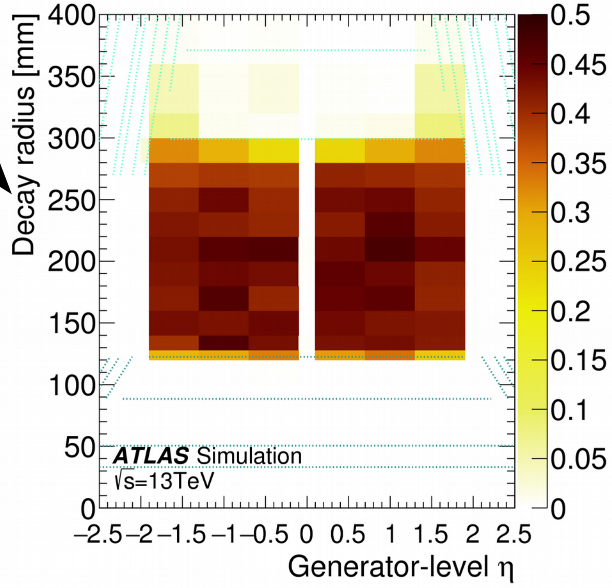
This is a feature of many scenarios: minimal dark matter, split/heavy **SUSY**, type-III seesaw (e.g. 2006.04123) etc

- Until recently, the CMS analyses were the most powerful disappearing track analysis with full run 2 data
- ATLAS also had 36.1 fb^{-1} analysis …
- … with "tracklet" efficiencies for "strong" and "weak" production + SimpleAnalysis code.
- These are incorporated into llpRecasting Codes and CheckMATE 2
- Recently full 136 fb^{-1} results were released, no HEPData/paper yet (is it the same as for the previous paper?)

arXiv:1712.02118

HEPData:78375

ATLAS-CONF-2021-015



The ATLAS information is a blessing but also: how model-independent is it?

Don't have this "problem" for the CMS analyses!

It will be very interesting to compare the two approaches for different models

Recasting material

- Analysis focussed on charginos in SUSY decaying to near-degenerate neutralinos (plus pions or leptons).
- Two sets of HEPData material: ins1669245 and ins1790827
- **Detailed** cutflows for 300 GeV and 700 GeV charginos, for $c\tau$=10cm, 100cm, 1000cm for *each signal region!*
- Tables of acceptances for **single** and **double** charged track events for ***each signal region***, masses 100 – 1100 GeV in 100 GeV steps, **45 lifetimes** in logarithmic steps from $c\tau$=0.2cm to 10000cm!
- Spectrum files suitable for Pythia input
- No efficiencies or similar; cutflows/acceptances at rather low stats

What are the cuts?

- Triggers followed by a cut on MET (120 GeV) – *without muons*
- At least one high-pT jet (110 GeV), no jets within $|\Delta\Phi| < 0.5$ of the MET vector
- Remaining cuts are all on the tracks: pT > 55 GeV
- Sufficiently isolated
- No missing hits in the pixel detector, no missing inner hits
- Sufficiently separated ($\Delta R < 0.5$) from jets, ($\Delta R < 0.15$) from electrons, *muons*
- Must actually disappear! That means, >2 missing outer hits, < 10 GeV calorimeter energy around the track.

Pileup!

Long-lived charginos get mistaken for muons and get included in MET calculation!

Pixels, hits, track isolation, forget about using any standard detector simulation!

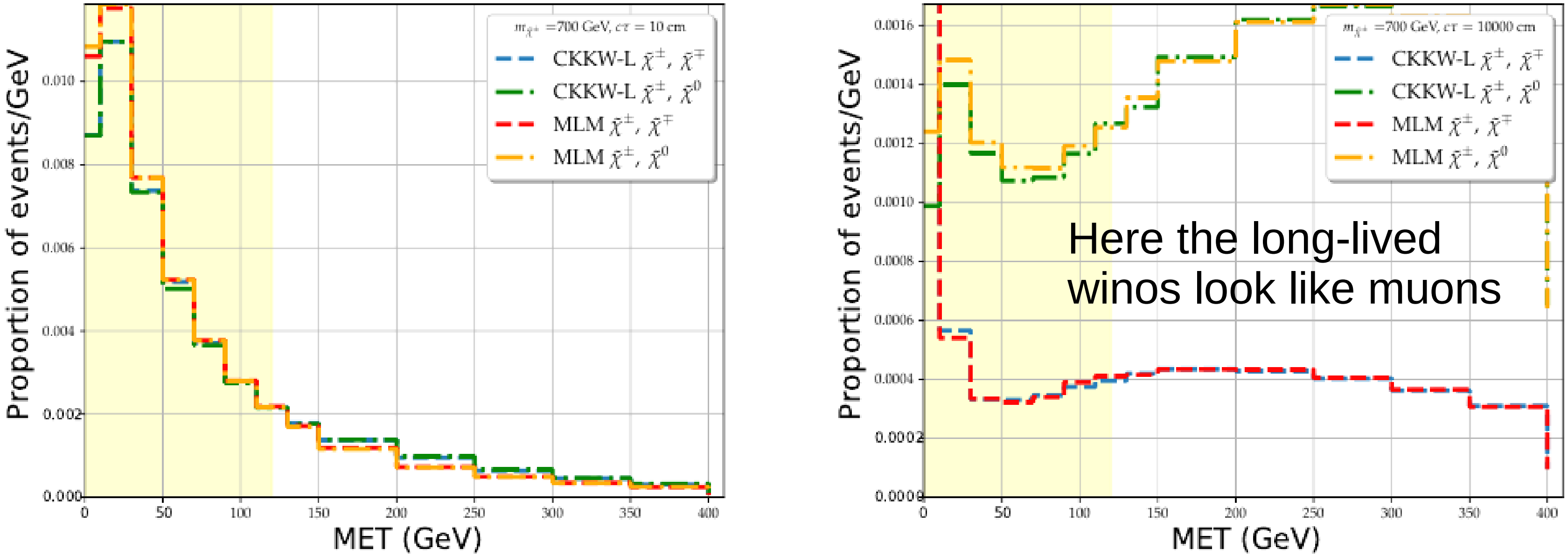
- Extra complication: data split into 6 different data taking periods! 2015, 2016A/B, 2017, 2018A/B (due to malfunctioning parts of detector)
- Three signal regions per data period (=18 signal regions in total!) depending on number of tracker layers that have been hit!

Period	Integrated Luminosity (fb^{-1})	Expected Background			Observed Events		
		$n_{lay} = 4$	$n_{lay} = 5$	$n_{lay} \geq 6$	$n_{lay} = 4$	$n_{lay} = 5$	$n_{lay} \geq 6$
2015	2.7	–	–	0.1 ± 0.1	–	–	1
2016A	8.3	–	–	2.4 ± 0.6	–	–	2
2016B	27.4	–	–	4.0 ± 1.1	–	–	4
2017	42.0	12.2 ± 4.8	2.1 ± 0.7	6.7 ± 1.3	17	4	6
2018A	21.0	7.3 ± 3.5	0.6 ± 0.3	1.8 ± 0.6	5	0	2
2018B	39.0	10.3 ± 5.4	1.0 ± 0.3	5.7 ± 1.3	11	2	1

Layers correspond to ~ 20cm, 20-30cm, >30cm transverse distance, but cannot apply this naively: we need to model the tracker.

MET modelling

To accurately model MET, can't use LO pythia + data-driven corrections as CMS does, so instead use MadGraph with up to 2 additional jets & either MLM, CKKW-L or MadGraph MLM matching ('HEPMC'):



Cut on tail → can be significant differences after triggers even if generally good agreement: matching/merging differences lead to ~ 20% uncertainty in the end.

- Model tracker as set of discs or cylinders, and work out which layers are hit by each charged track
- Assign hit probability of 94.5%
- Allow charged hadrons to be fake tracks
- Implemented track isolation including hadrons since don’t have efficiencies for these
- Using particle-level information (i.e. no Delphes)

Component	Layer positions (mm)								
Inner Barrel (radii)	230	300	400	500					
Inner discs (z)	775	900	1025						
Outer barrel (radii)	608	692	780	868	965	1080			
Endcaps (z)	1250	1400	1550	1700	1950	2000	2225	2450	2700

Cut	300 GeV, 10cm		700 GeV, 10cm	
	$\epsilon_i^{\mathrm{CMS}}$	$\epsilon_i^{\mathrm{sim}}$, HEPMC	$\epsilon_i^{\mathrm{CMS}}$	$\epsilon_i^{\mathrm{sim}}$, HEPMC
total	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$
trigger	$9.1^{+0.13}_{-0.13} \times 10^{-2}$	$9.2^{+0.09}_{-0.09} \times 10^{-2}$	$1.5^{+0.02}_{-0.02} \times 10^{-1}$	$1.5^{+0.01}_{-0.01} \times 10^{-1}$
passes $p_{\mathrm{T}}^{\mathrm{miss}}$ filters	$9.1^{+0.13}_{-0.13} \times 10^{-2}$	$9.2^{+0.09}_{-0.09} \times 10^{-2}$	$1.4^{+0.02}_{-0.02} \times 10^{-1}$	$1.5^{+0.01}_{-0.01} \times 10^{-1}$
$p_{\mathrm{T}}^{\mathrm{miss}} > 120\,\mathrm{GeV}$	$8.9^{+0.13}_{-0.13} \times 10^{-2}$	$9.2^{+0.09}_{-0.09} \times 10^{-2}$	$1.4^{+0.02}_{-0.02} \times 10^{-1}$	$1.5^{+0.01}_{-0.01} \times 10^{-1}$
≥ 1 jet with $p_{\mathrm{T}} > 110\,\mathrm{GeV}$ and $\lvert\eta\rvert < 2.4$	$8.0^{+0.13}_{-0.13} \times 10^{-2}$	$7.5^{+0.09}_{-0.09} \times 10^{-2}$	$1.3^{+0.02}_{-0.02} \times 10^{-1}$	$1.3^{+0.01}_{-0.01} \times 10^{-1}$
==0 pairs of jets with $\Delta\phi_{\mathrm{jet,\ jet}} > 2.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$6.3^{+0.08}_{-0.08} \times 10^{-2}$	$1.1^{+0.01}_{-0.01} \times 10^{-1}$	$1.1^{+0.01}_{-0.01} \times 10^{-1}$
$\lvert\Delta\phi(\mathrm{leading\ jet}, \vec{p}_{\mathrm{T}}^{\mathrm{miss}})\rvert > 0.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$6.3^{+0.08}_{-0.08} \times 10^{-2}$	$1.1^{+0.01}_{-0.01} \times 10^{-1}$	$1.1^{+0.01}_{-0.01} \times 10^{-1}$
≥ 1 track with $\lvert\eta\rvert < 2.1$	$6.8^{+0.12}_{-0.12} \times 10^{-2}$	$6.3^{+0.08}_{-0.08} \times 10^{-2}$	$1.1^{+0.01}_{-0.01} \times 10^{-1}$	$1.1^{+0.01}_{-0.01} \times 10^{-1}$
≥ 1 track with $p_{\mathrm{T}} > 55\,\mathrm{GeV}$	$3.2^{+0.08}_{-0.08} \times 10^{-2}$	$3.0^{+0.06}_{-0.06} \times 10^{-2}$	$4.7^{+0.10}_{-0.10} \times 10^{-2}$	$4.7^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track passing fiducial selections	$2.0^{+0.06}_{-0.06} \times 10^{-2}$	$2.3^{+0.05}_{-0.05} \times 10^{-2}$	$3.1^{+0.08}_{-0.08} \times 10^{-2}$	$3.6^{+0.05}_{-0.05} \times 10^{-2}$
≥ 1 track with ≥ 4 pixel hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$1.7^{+0.04}_{-0.04} \times 10^{-2}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$2.6^{+0.05}_{-0.05} \times 10^{-2}$
≥ 1 track with no missing inner hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$1.3^{+0.04}_{-0.04} \times 10^{-2}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$2.0^{+0.04}_{-0.04} \times 10^{-2}$
≥ 1 track with no missing middle hits	$1.0^{+0.05}_{-0.05} \times 10^{-2}$	$1.3^{+0.04}_{-0.04} \times 10^{-2}$	$1.5^{+0.05}_{-0.05} \times 10^{-2}$	$2.0^{+0.04}_{-0.04} \times 10^{-2}$
≥ 1 track with relative track isolation $< 5\%$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$6.2^{+0.26}_{-0.26} \times 10^{-3}$	$5.3^{+0.34}_{-0.34} \times 10^{-3}$	$6.2^{+0.23}_{-0.23} \times 10^{-3}$

Good agreement at the level of cutflows

Cut	700 GeV, 1000 cm, region 2017			
	$\epsilon_i^{\mathrm{CMS}}$	$\epsilon_i^{\mathrm{sim}}$, HEPMC	$\epsilon_i^{\mathrm{sim}}$, CKKW-L	$\epsilon_i^{\mathrm{sim}}$, MLM
total	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$
trigger	$2.0^{+0.02}_{-0.02} \times 10^{-1}$	$1.8^{+0.01}_{-0.01} \times 10^{-1}$	$2.1^{+0.01}_{-0.01} \times 10^{-1}$	$1.7^{+0.01}_{-0.01} \times 10^{-1}$
passes $p_{\mathrm{T}}^{\mathrm{miss}}$ filters	$2.0^{+0.02}_{-0.02} \times 10^{-1}$	$1.8^{+0.01}_{-0.01} \times 10^{-1}$	$2.1^{+0.01}_{-0.01} \times 10^{-1}$	$1.7^{+0.01}_{-0.01} \times 10^{-1}$
$p_{\mathrm{T}}^{\mathrm{miss}} > 120\,\mathrm{GeV}$	$1.9^{+0.02}_{-0.02} \times 10^{-1}$	$1.8^{+0.01}_{-0.01} \times 10^{-1}$	$2.1^{+0.01}_{-0.01} \times 10^{-1}$	$1.7^{+0.01}_{-0.01} \times 10^{-1}$
≥ 1 jet with $p_{\mathrm{T}} > 110\,\mathrm{GeV}$ and $\lvert\eta\rvert < 2.4$	$1.4^{+0.02}_{-0.02} \times 10^{-1}$	$1.4^{+0.01}_{-0.01} \times 10^{-1}$	$1.4^{+0.01}_{-0.01} \times 10^{-1}$	$1.0^{+0.01}_{-0.01} \times 10^{-1}$
==0 pairs of jets with $\Delta\phi_{\mathrm{jet,\ jet}} > 2.5$	$1.2^{+0.02}_{-0.02} \times 10^{-1}$	$1.2^{+0.01}_{-0.01} \times 10^{-1}$	$1.2^{+0.01}_{-0.01} \times 10^{-1}$	$9.3^{+0.08}_{-0.08} \times 10^{-2}$
$\lvert\Delta\phi(\text{leading jet}, \vec{p}_{\mathrm{T}}^{\mathrm{miss}})\rvert > 0.5$	$1.2^{+0.02}_{-0.02} \times 10^{-1}$	$1.2^{+0.01}_{-0.01} \times 10^{-1}$	$1.1^{+0.01}_{-0.01} \times 10^{-1}$	$8.8^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with $\lvert\eta\rvert < 2.1$	$1.2^{+0.02}_{-0.02} \times 10^{-1}$	$1.2^{+0.01}_{-0.01} \times 10^{-1}$	$1.1^{+0.01}_{-0.01} \times 10^{-1}$	$8.8^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with $p_{\mathrm{T}} > 55\,\mathrm{GeV}$	$1.1^{+0.02}_{-0.02} \times 10^{-1}$	$1.1^{+0.01}_{-0.01} \times 10^{-1}$	$1.0^{+0.01}_{-0.01} \times 10^{-1}$	$8.2^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track passing fiducial selections	$7.9^{+0.12}_{-0.12} \times 10^{-2}$	$8.7^{+0.08}_{-0.08} \times 10^{-2}$	$8.7^{+0.08}_{-0.08} \times 10^{-2}$	$6.9^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with ≥ 4 pixel hits	$5.9^{+0.10}_{-0.10} \times 10^{-2}$	$7.0^{+0.07}_{-0.07} \times 10^{-2}$	$6.9^{+0.07}_{-0.07} \times 10^{-2}$	$5.5^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with no missing inner hits	$5.9^{+0.10}_{-0.10} \times 10^{-2}$	$4.8^{+0.06}_{-0.06} \times 10^{-2}$	$4.7^{+0.06}_{-0.06} \times 10^{-2}$	$3.8^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with no missing middle hits	$5.4^{+0.10}_{-0.10} \times 10^{-2}$	$4.8^{+0.06}_{-0.06} \times 10^{-2}$	$4.7^{+0.06}_{-0.06} \times 10^{-2}$	$3.8^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with relative track isolation $< 5\%$	$4.6^{+0.10}_{-0.10} \times 10^{-2}$	$3.8^{+0.06}_{-0.06} \times 10^{-2}$	$3.5^{+0.05}_{-0.05} \times 10^{-2}$	$2.9^{+0.05}_{-0.05} \times 10^{-2}$
≥ 1 track with $\lvert d_{\mathrm{xy}}\rvert < 0.02\,\mathrm{cm}$	$4.6^{+0.10}_{-0.10} \times 10^{-2}$	$3.8^{+0.06}_{-0.06} \times 10^{-2}$	$3.5^{+0.05}_{-0.05} \times 10^{-2}$	$2.9^{+0.05}_{-0.05} \times 10^{-2}$
≥ 1 track with $\lvert d_z\rvert < 0.5\,\mathrm{cm}$	$4.6^{+0.10}_{-0.10} \times 10^{-2}$	$3.8^{+0.06}_{-0.06} \times 10^{-2}$	$3.5^{+0.05}_{-0.05} \times 10^{-2}$	$2.9^{+0.05}_{-0.05} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{jet}) > 0.5$	$4.5^{+0.10}_{-0.10} \times 10^{-2}$	$3.7^{+0.06}_{-0.06} \times 10^{-2}$	$3.4^{+0.05}_{-0.05} \times 10^{-2}$	$2.8^{+0.05}_{-0.05} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{electron}) > 0.15$	$4.0^{+0.09}_{-0.09} \times 10^{-2}$	$3.7^{+0.06}_{-0.06} \times 10^{-2}$	$3.4^{+0.05}_{-0.05} \times 10^{-2}$	$2.8^{+0.05}_{-0.05} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{muon}) > 0.15$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$2.5^{+0.05}_{-0.05} \times 10^{-2}$	$2.3^{+0.04}_{-0.04} \times 10^{-2}$	$1.9^{+0.04}_{-0.04} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \tau_{\mathrm{h}}) > 0.15$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$2.5^{+0.05}_{-0.05} \times 10^{-2}$	$2.3^{+0.04}_{-0.04} \times 10^{-2}$	$1.9^{+0.04}_{-0.04} \times 10^{-2}$
≥ 1 track with $E_{\mathrm{calo}} < 10\,\mathrm{GeV}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$2.5^{+0.05}_{-0.05} \times 10^{-2}$	$2.3^{+0.04}_{-0.04} \times 10^{-2}$	$1.9^{+0.04}_{-0.04} \times 10^{-2}$
≥ 1 track with ≥ 3 missing outer hits	$5.4^{+0.33}_{-0.33} \times 10^{-3}$	$5.7^{+0.22}_{-0.22} \times 10^{-3}$	$5.1^{+0.21}_{-0.21} \times 10^{-3}$	$4.4^{+0.19}_{-0.19} \times 10^{-3}$
≥ 1 track with 4 layers	$8.1^{+1.38}_{-1.38} \times 10^{-4}$	$6.9^{+0.77}_{-0.77} \times 10^{-4}$	$6.8^{+0.77}_{-0.77} \times 10^{-4}$	$5.9^{+0.71}_{-0.71} \times 10^{-4}$
≥ 1 track with 5 layers	$6.6^{+1.21}_{-1.21} \times 10^{-4}$	$8.4^{+0.85}_{-0.85} \times 10^{-4}$	$6.9^{+0.77}_{-0.77} \times 10^{-4}$	$6.9^{+0.77}_{-0.77} \times 10^{-4}$
≥ 1 track with ≥ 6 layers	$4.0^{+0.29}_{-0.29} \times 10^{-3}$	$4.1^{+0.19}_{-0.19} \times 10^{-3}$	$3.6^{+0.18}_{-0.18} \times 10^{-3}$	$3.0^{+0.16}_{-0.16} \times 10^{-3}$

Can use the excellent table of acceptances to quantify ‘total error’:

$$\delta \equiv \frac{\sum_i (\epsilon_i^{CMS} - \epsilon_i)\mathcal{L}_i}{\sum_i \epsilon_i^{CMS}\mathcal{L}_i} \qquad i \in \{2015, 2016A, 2016B, 2017, 2018A, 2018B\}$$

Chargino + neutralino events:

CKKW-L merging											
	Mass (GeV)										
Decay Length (cm)	100	200	300	400	500	600	700	800	900	1000	1100
10	–	52%	14%	6%	5%	13%	8%	3%	-2%	-20%	-23%
100	–	35%	40%	30%	10%	4%	25%	10%	10%	-18%	-12%
1000	–	47%	33%	25%	47%	20%	24%	30%	31%	-19%	-48%
10000	25%	16%	21%	6%	-18%	-30%	-36%	-23%	-36%	-47%	-1%

MLM matching											
	Mass (GeV)										
Decay Length (cm)	100	200	300	400	500	600	700	800	900	1000	1100
10	–	56%	36%	21%	25%	31%	29%	25%	19%	2%	3%
100	–	30%	46%	47%	33%	24%	39%	31%	27%	4%	9%
1000	–	57%	42%	39%	56%	35%	35%	46%	50%	16%	26%
10000	34%	29%	43%	31%	7%	-10%	2%	-5%	-6%	-20%	22%

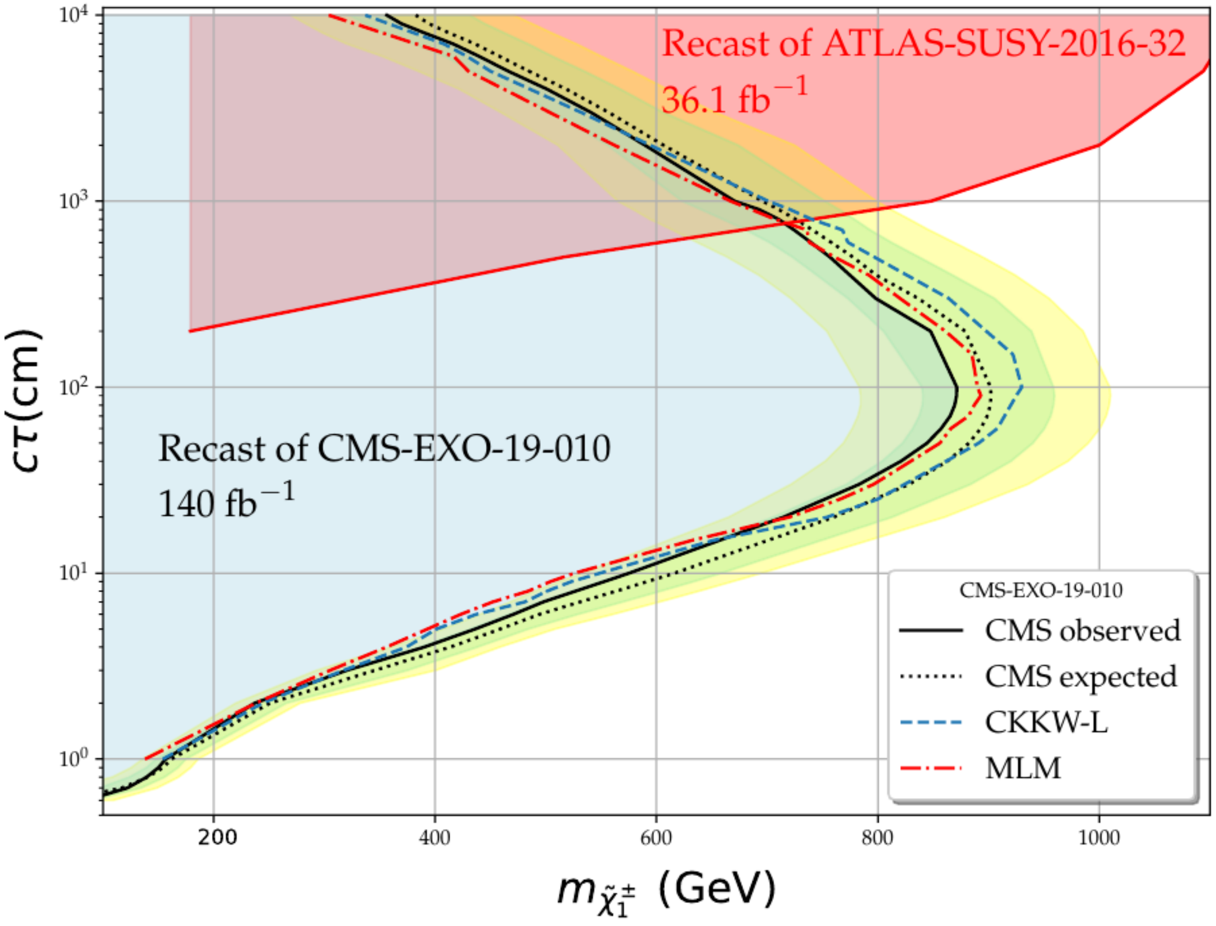
Chargino + chargino events:

CKKW-L merging											
	Mass (GeV)										
Decay Length (cm)	100	200	300	400	500	600	700	800	900	1000	1100
10	52%	42%	32%	19%	13%	13%	6%	3%	-4%	-30%	-25%
100	–	53%	35%	14%	16%	17%	13%	6%	-13%	-10%	-11%
1000	59%	17%	48%	50%	32%	26%	19%	16%	10%	-40%	-12%
10000	30%	20%	12%	5%	-66%	-14%	-57%	-29%	-31%	-49%	-25%

MLM matching											
	Mass (GeV)										
Decay Length (cm)	100	200	300	400	500	600	700	800	900	1000	1100
10	46%	47%	42%	32%	28%	27%	24%	21%	15%	-7%	-5%
100	–	50%	45%	31%	33%	29%	28%	23%	11%	9%	6%
1000	92%	30%	65%	51%	33%	35%	31%	37%	31%	-28%	-15%
10000	33%	34%	26%	19%	-34%	1%	-29%	-1%	-12%	-19%	2%

Easier to interpret: reproduce exclusion plot

Acceptance rapidly varying function of lifetime, cross-section rapidly varies with mass, so it can be quite forgiving albeit significant uncertainties due to matching/ merging remain:



Application to a toy model

Model of (hyper)charged scalar + neutral fermion:

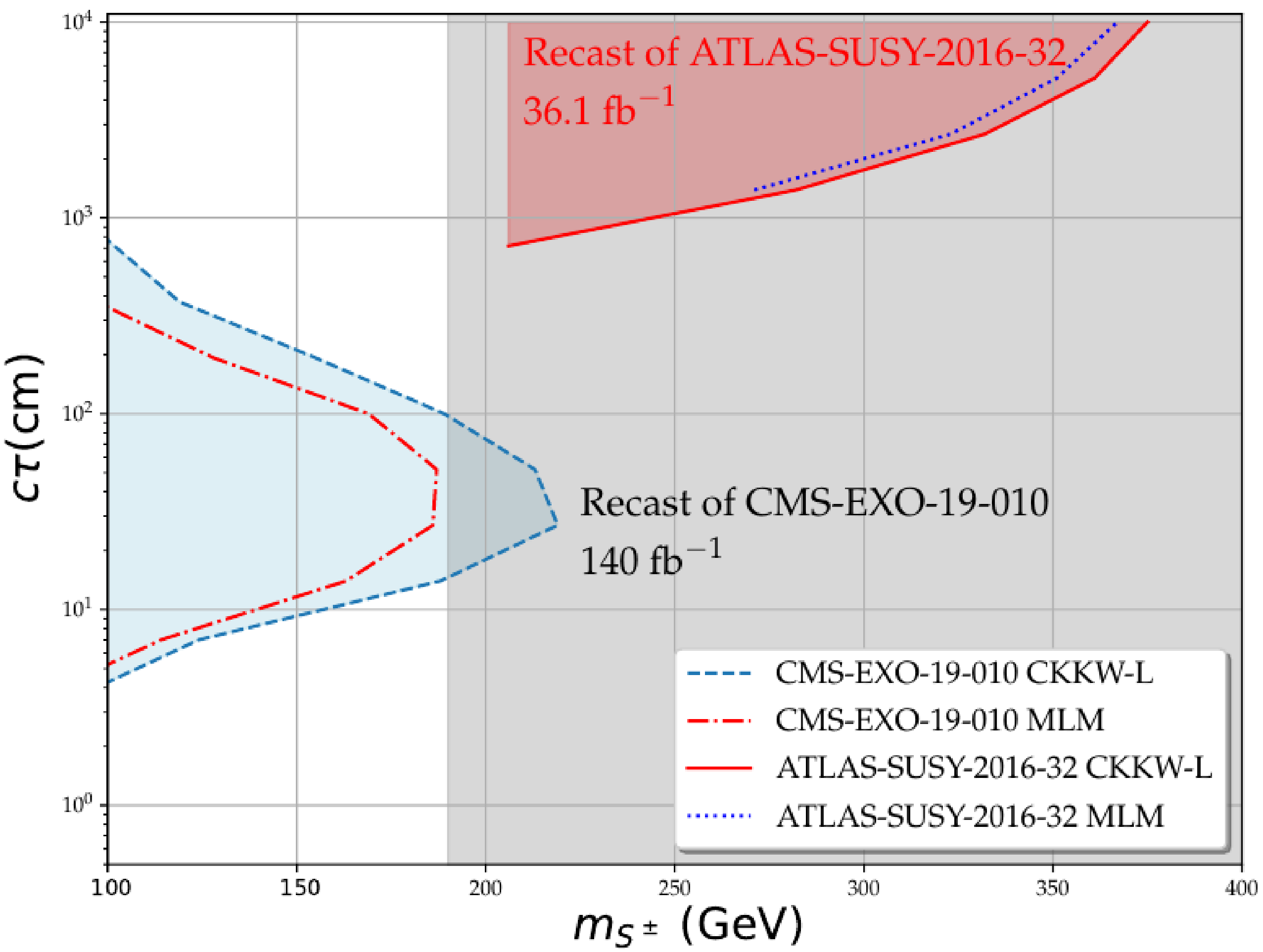
$$\mathcal{L} = \mathcal{L}_{SM} - m_{S^\pm}^2 |S^-|^2 - \frac{1}{4}\lambda_2 |S^-|^4 - \lambda_3 |S^-|^2 |H|^2 - \left[y_{RS} \overline{S}^- e^c \tilde{\chi}^0 - \frac{1}{2} m_{\tilde{\chi}^0} \tilde{\chi}^0 \tilde{\chi}^0 + h.c. \right]$$

Prototype of RH slepton + bino

- Scalar decays only to lepton + neutralino
- Long-lived if accidentally small mass difference
- R-parity means *only double track events*
- But can also be DM
- Small production cross-section

$$c\tau \simeq 100 \text{ cm} \times \left(\frac{m_{S^\pm}}{100 \text{ GeV}} \right) \times \left(\frac{90 \text{ MeV}}{m_{S^\pm} - m_{\tilde{\chi}^0}} \right)^2 \times \left(\frac{5.5 \times 10^{-6}}{y_{RS}} \right)^2$$

Complementarity of disappearing tracks, heavy stable charged particles and DM searches!



Conclusions

- Code and recasting material online at llpRecasting repo and in2p3 gitlab pages site
- With Jack Araz, Benj Fuks, Manuel Utsch, we've been working on implementing an LLP toolbox in MadAnalysis5 SFS. This analysis is now in it … see talk by Jack Araz
- Will be very interesting to compare the code for other models …
- … and also to compare with the ATLAS analysis when the full dataset is recastable, to compare approaches.
- Most useful would be a way of comparing the simple tracker modelling with the real thing!
- But wouldn't have been possible without feedback, which in turn was only possible thanks to the CERN long lived particles workgroup and these LLP workshops. These interactions are fun and very useful!

BACKUP

Consider e.g. 100 GeV wino, 2018A, single charged track events, 4 layers:

Data only meaningful for intermediate lifetimes

Decay length (cm)	Acceptance
0.2	$6.4 \times 10^{-13} \pm 6 \times 10^{-13}$
1	$1.15 \times 10^{-5} \pm 7.4 \times 10^{-6}$
2	$9.5 \times 10^{-5} \pm 4.0 \times 10^{-5}$
10	$5.6 \times 10^{-4} \pm 1.5 \times 10^{-4}$
100	$2.4 \times 10^{-4} \pm 1.0 \times 10^{-4}$
1000	$2.5 \times 10^{-5} \pm 2.5 \times 10^{-5}$
10000	$4.3 \times 10^{-6} \pm 4.3 \times 10^{-6}$

Experimental cutflows for 300 GeV winos

Cut	ϵ_i^{CMS} 10cm	ϵ_i^{CMS} 100cm	ϵ_i^{CMS} 1000cm
total	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$
trigger	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
passes $p_{\mathrm{T}}^{\mathrm{miss}}$ filters	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
$p_{\mathrm{T}}^{\mathrm{miss}} > 120\,\mathrm{GeV}$	$8.9^{+0.13}_{-0.13} \times 10^{-2}$	$9.3^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$
≥ 1 jet with $p_{\mathrm{T}} > 110\,\mathrm{GeV}$ and $\lvert\eta\rvert < 2.4$	$8.0^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$
==0 pairs of jets with $\Delta\phi_{\text{jet, jet}} > 2.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
$\lvert\Delta\phi(\text{leading jet}, \vec{p}_{\mathrm{T}}^{\mathrm{miss}})\rvert > 0.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $\lvert\eta\rvert < 2.1$	$6.8^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $p_{\mathrm{T}} > 55\,\mathrm{GeV}$	$3.2^{+0.08}_{-0.08} \times 10^{-2}$	$5.5^{+0.10}_{-0.10} \times 10^{-2}$	$6.1^{+0.11}_{-0.11} \times 10^{-2}$
≥ 1 track passing fiducial selections	$2.1^{+0.06}_{-0.06} \times 10^{-2}$	$3.8^{+0.09}_{-0.09} \times 10^{-2}$	$4.2^{+0.09}_{-0.09} \times 10^{-2}$
≥ 1 track with ≥ 4 pixel hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing inner hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing middle hits	$1.0^{+0.05}_{-0.05} \times 10^{-2}$	$2.2^{+0.07}_{-0.07} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with relative track isolation $< 5\%$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_{\mathrm{xy}}\rvert < 0.02\,\mathrm{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_z\rvert < 0.5\,\mathrm{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{jet}) > 0.5$	$5.0^{+0.32}_{-0.32} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{electron}) > 0.15$	$4.9^{+0.31}_{-0.31} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$1.9^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{muon}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $\Delta R(\text{track}, \tau_{\mathrm{h}}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $E_{\text{calo}} < 10\,\mathrm{GeV}$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.5^{+0.06}_{-0.06} \times 10^{-2}$	$6.5^{+0.36}_{-0.36} \times 10^{-3}$
≥ 1 track with ≥ 3 missing outer hits	$4.7^{+0.31}_{-0.31} \times 10^{-3}$	$8.8^{+0.42}_{-0.42} \times 10^{-3}$	$2.0^{+0.20}_{-0.20} \times 10^{-3}$
$\phi(p_{\mathrm{T}}^{\mathrm{miss}}) < -1.6$ or $\phi(p_{\mathrm{T}}^{\mathrm{miss}}) > -0.6$	$4.0^{+0.28}_{-0.28} \times 10^{-3}$	$7.8^{+0.39}_{-0.39} \times 10^{-3}$	$1.6^{+0.18}_{-0.18} \times 10^{-3}$
≥ 1 track 4 layers	$2.2^{+0.21}_{-0.21} \times 10^{-3}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$3.3^{+0.81}_{-0.81} \times 10^{-4}$
≥ 1 track 5 layers	$9.4^{+1.39}_{-1.39} \times 10^{-4}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$2.0^{+0.64}_{-0.64} \times 10^{-4}$
≥ 1 track with ≥ 6 layers	$9.2^{+1.34}_{-1.34} \times 10^{-4}$	$5.2^{+0.32}_{-0.32} \times 10^{-3}$	$1.1^{+0.15}_{-0.15} \times 10^{-3}$

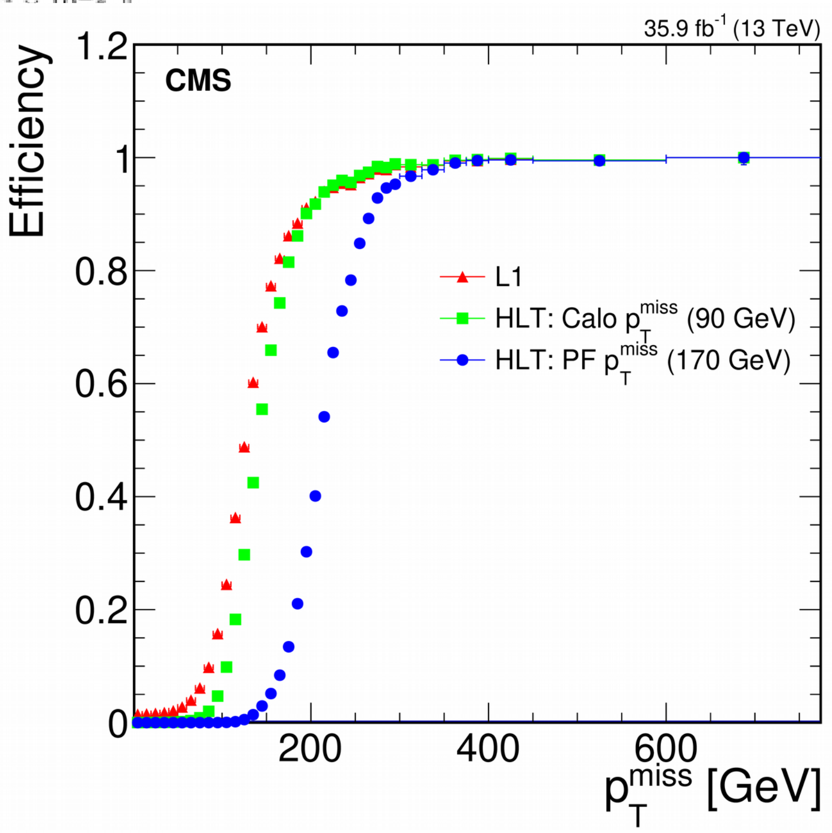
Table 1: Cutflow comparison for signal region 2018B

Experimental cutflows for 300 GeV winos

Cut	$\epsilon_i^{\rm CMS}$ 10cm	$\epsilon_i^{\rm CMS}$ 100cm	$\epsilon_i^{\rm CMS}$ 1000cm
total	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$
trigger	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
passes $p_{\rm T}^{\rm miss}$ filters	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
$p_{\rm T}^{\rm miss} > 120\,{\rm GeV}$	$8.9^{+0.13}_{-0.13} \times 10^{-2}$	$9.3^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}$ [illegible]
≥ 1 jet with $p_{\rm T} > 110\,{\rm GeV}$ and $\lvert\eta\rvert < 2.4$	$8.0^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$	8.2 [illegible]
==0 pairs of jets with $\Delta\phi_{\rm jet,\,jet} > 2.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	7.1 [illegible]
$\lvert\Delta\phi(\text{leading jet}, \vec{p}_{\rm T}^{\rm miss})\rvert > 0.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	7.1 [illegible]
≥ 1 track with $\lvert\eta\rvert < 2.1$	$6.8^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	7.0 [illegible]
≥ 1 track with $p_{\rm T} > 55\,{\rm GeV}$	$3.2^{+0.08}_{-0.08} \times 10^{-2}$	$5.5^{+0.10}_{-0.10} \times 10^{-2}$	6.1 [illegible]
≥ 1 track passing fiducial selections	$2.1^{+0.06}_{-0.06} \times 10^{-2}$	$3.8^{+0.09}_{-0.09} \times 10^{-2}$	4.2 [illegible]
≥ 1 track with ≥ 4 pixel hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	2.9 [illegible]
≥ 1 track with no missing inner hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	2.9 [illegible]
≥ 1 track with no missing middle hits	$1.0^{+0.05}_{-0.05} \times 10^{-2}$	$2.2^{+0.07}_{-0.07} \times 10^{-2}$	2.5 [illegible]
≥ 1 track with relative track isolation $< 5\%$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	2.1 [illegible]
≥ 1 track with $\lvert d_{xy}\rvert < 0.02\,{\rm cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	2.1 [illegible]
≥ 1 track with $\lvert d_z\rvert < 0.5\,{\rm cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	2.1 [illegible]
≥ 1 track with $\Delta R(\text{track}, \text{jet}) > 0.5$	$5.0^{+0.32}_{-0.32} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	2.1 [illegible]
≥ 1 track with $\Delta R(\text{track}, \text{electron}) > 0.15$	$4.9^{+0.31}_{-0.31} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	1.9 [illegible]
≥ 1 track with $\Delta R(\text{track}, \text{muon}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	6.6 [illegible]
≥ 1 track with $\Delta R(\text{track}, \tau_{\rm h}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	6.6 [illegible]
≥ 1 track with $E_{\rm calo} < 10\,{\rm GeV}$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.5^{+0.06}_{-0.06} \times 10^{-2}$	6.5 [illegible]
≥ 1 track with ≥ 3 missing outer hits	$4.7^{+0.31}_{-0.31} \times 10^{-3}$	$8.8^{+0.42}_{-0.42} \times 10^{-3}$	2.0 [illegible]
$\phi(p_{\rm T}^{\rm miss}) < -1.6$ or $\phi(p_{\rm T}^{\rm miss}) > -0.6$	$4.0^{+0.28}_{-0.28} \times 10^{-3}$	$7.8^{+0.39}_{-0.39} \times 10^{-3}$	1.6 [illegible]
≥ 1 track 4 layers	$2.2^{+0.21}_{-0.21} \times 10^{-3}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	3.3 [illegible]
≥ 1 track 5 layers	$9.4^{+1.39}_{-1.39} \times 10^{-4}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	2.0 [illegible]
≥ 1 track with ≥ 6 layers	$9.2^{+1.34}_{-1.34} \times 10^{-4}$	$5.2^{+0.32}_{-0.32} \times 10^{-3}$	1.1 [illegible]

Table 1: Cutflow comparison for signal region 2018B

Need MET trigger efficiencies from 1903.06078



Experimental cutflows for 300 GeV winos

Cut	ϵ_i^{CMS} 10cm	ϵ_i^{CMS} 100cm	ϵ_i^{CMS} 1000cm
total	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$
trigger	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
passes $p_{\text{T}}^{\text{miss}}$ filters	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
$p_{\text{T}}^{\text{miss}} > 120\,\text{GeV}$	$8.9^{+0.13}_{-0.13} \times 10^{-2}$	$9.3^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$
≥ 1 jet with $p_{\text{T}} > 110\,\text{GeV}$ and $\lvert\eta\rvert < 2.4$	$8.0^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$
==0 pairs of jets with $\Delta\phi_{\text{jet, jet}} > 2.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
$\lvert\Delta\phi(\text{leading jet}, \vec{p}_{\text{T}}^{\text{miss}})\rvert > 0.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $\lvert\eta\rvert < 2.1$	$6.8^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $p_{\text{T}} > 55\,\text{GeV}$	$3.2^{+0.08}_{-0.08} \times 10^{-2}$	$5.5^{+0.10}_{-0.10} \times 10^{-2}$	$6.1^{+0.11}_{-0.11} \times 10^{-2}$
≥ 1 track passing fiducial selections	$2.1^{+0.06}_{-0.06} \times 10^{-2}$	$3.8^{+0.09}_{-0.09} \times 10^{-2}$	$4.2^{+0.09}_{-0.09} \times 10^{-2}$
≥ 1 track with ≥ 4 pixel hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing inner hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing middle hits	$1.0^{+0.05}_{-0.05} \times 10^{-2}$	$2.2^{+0.07}_{-0.07} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with relative track isolation $< 5\%$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_{xy}\rvert < 0.02\,\text{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_z\rvert < 0.5\,\text{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{jet}) > 0.5$	$5.0^{+0.32}_{-0.32} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{electron}) > 0.15$	$4.9^{+0.31}_{-0.31} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$1.9^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{muon}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $\Delta R(\text{track}, \tau_{\text{h}}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $E_{\text{calo}} < 10\,\text{GeV}$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.5^{+0.06}_{-0.06} \times 10^{-2}$	$6.5^{+0.36}_{-0.36} \times 10^{-3}$
≥ 1 track with ≥ 3 missing outer hits	$4.7^{+0.31}_{-0.31} \times 10^{-3}$	$8.8^{+0.42}_{-0.42} \times 10^{-3}$	$2.0^{+0.20}_{-0.20} \times 10^{-3}$
$\phi(p_{\text{T}}^{\text{miss}}) < -1.6$ or $\phi(p_{\text{T}}^{\text{miss}}) > -0.6$	$4.0^{+0.28}_{-0.28} \times 10^{-3}$	$7.8^{+0.39}_{-0.39} \times 10^{-3}$	$1.6^{+0.18}_{-0.18} \times 10^{-3}$
≥ 1 track 4 layers	$2.2^{+0.21}_{-0.21} \times 10^{-3}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$3.3^{+0.81}_{-0.81} \times 10^{-4}$
≥ 1 track 5 layers	$9.4^{+1.39}_{-1.39} \times 10^{-4}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$2.0^{+0.64}_{-0.64} \times 10^{-4}$
≥ 1 track with ≥ 6 layers	$9.2^{+1.34}_{-1.34} \times 10^{-4}$	$5.2^{+0.32}_{-0.32} \times 10^{-3}$	$1.1^{+0.15}_{-0.15} \times 10^{-3}$

Table 1: Cutflow comparison for signal region 2018B

Experimental cutflows for 300 GeV winos

Cut	$\epsilon_i^{\mathrm{CMS}}$ 10cm	$\epsilon_i^{\mathrm{CMS}}$ 100cm	$\epsilon_i^{\mathrm{CMS}}$ 1000cm
total	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$
trigger	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
passes $p_{\mathrm{T}}^{\mathrm{miss}}$ filters	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
$p_{\mathrm{T}}^{\mathrm{miss}} > 120\,\mathrm{GeV}$	$8.9^{+0.13}_{-0.13} \times 10^{-2}$	$9.3^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$
≥ 1 jet with $p_{\mathrm{T}} > 110\,\mathrm{GeV}$ and $\lvert\eta\rvert < 2.4$	$8.0^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$
==0 pairs of jets with $\Delta\phi_{\mathrm{jet,\ jet}} > 2.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
$\lvert\Delta\phi(\text{leading jet}, \vec{p}_{\mathrm{T}}^{\mathrm{miss}})\rvert > 0.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $\lvert\eta\rvert < 2.1$	$6.8^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $p_{\mathrm{T}} > 55\,\mathrm{GeV}$	$3.2^{+0.08}_{-0.08} \times 10^{-2}$	$5.5^{+0.10}_{-0.10} \times 10^{-2}$	$6.1^{+0.11}_{-0.11} \times 10^{-2}$
≥ 1 track passing fiducial selections	$2.1^{+0.06}_{-0.06} \times 10^{-2}$	$3.8^{+0.09}_{-0.09} \times 10^{-2}$	$4.2^{+0.09}_{-0.09} \times 10^{-2}$
≥ 1 track with ≥ 4 pixel hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing inner hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing middle hits	$1.0^{+0.05}_{-0.05} \times 10^{-2}$	$2.2^{+0.07}_{-0.07} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with relative track isolation $< 5\%$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_{xy}\rvert < 0.02\,\mathrm{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_z\rvert < 0.5\,\mathrm{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track, jet}) > 0.5$	$5.0^{+0.32}_{-0.32} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track, electron}) > 0.15$	$4.9^{+0.31}_{-0.31} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$1.9^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track, muon}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $\Delta R(\text{track}, \tau_{\mathrm{h}}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $E_{\mathrm{calo}} < 10\,\mathrm{GeV}$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.5^{+0.06}_{-0.06} \times 10^{-2}$	$6.5^{+0.36}_{-0.36} \times 10^{-3}$
≥ 1 track with ≥ 3 missing outer hits	$4.7^{+0.31}_{-0.31} \times 10^{-3}$	$8.8^{+0.42}_{-0.42} \times 10^{-3}$	$2.0^{+0.20}_{-0.20} \times 10^{-3}$
$\phi(p_{\mathrm{T}}^{\mathrm{miss}}) < -1.6$ or $\phi(p_{\mathrm{T}}^{\mathrm{miss}}) > -0.6$	$4.0^{+0.28}_{-0.28} \times 10^{-3}$	$7.8^{+0.39}_{-0.39} \times 10^{-3}$	$1.6^{+0.18}_{-0.18} \times 10^{-3}$
≥ 1 track 4 layers	$2.2^{+0.21}_{-0.21} \times 10^{-3}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$3.3^{+0.81}_{-0.81} \times 10^{-4}$
≥ 1 track 5 layers	$9.4^{+1.39}_{-1.39} \times 10^{-4}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$2.0^{+0.64}_{-0.64} \times 10^{-4}$
≥ 1 track with ≥ 6 layers	$9.2^{+1.34}_{-1.34} \times 10^{-4}$	$5.2^{+0.32}_{-0.32} \times 10^{-3}$	$1.1^{+0.15}_{-0.15} \times 10^{-3}$

Table 1: Cutflow comparison for signal region 2018B

Naively need pileup events for isolation and charged hadronic tracks

Experimental cutflows for 300 GeV winos

Cut	$\epsilon_i^{\mathrm{CMS}}$ 10cm	$\epsilon_i^{\mathrm{CMS}}$ 100cm	$\epsilon_i^{\mathrm{CMS}}$ 1000cm
total	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$
trigger	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
passes $p_{\mathrm{T}}^{\mathrm{miss}}$ filters	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
$p_{\mathrm{T}}^{\mathrm{miss}} > 120\,\mathrm{GeV}$	$8.9^{+0.13}_{-0.13} \times 10^{-2}$	$9.3^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$
≥ 1 jet with $p_{\mathrm{T}} > 110\,\mathrm{GeV}$ and $\lvert\eta\rvert < 2.4$	$8.0^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$
==0 pairs of jets with $\Delta\phi_{\mathrm{jet,\,jet}} > 2.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
$\lvert\Delta\phi(\text{leading jet}, \vec{p}_{\mathrm{T}}^{\mathrm{miss}})\rvert > 0.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $\lvert\eta\rvert < 2.1$	$6.8^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $p_{\mathrm{T}} > 55\,\mathrm{GeV}$	$3.2^{+0.08}_{-0.08} \times 10^{-2}$	$5.5^{+0.10}_{-0.10} \times 10^{-2}$	$6.1^{+0.11}_{-0.11} \times 10^{-2}$
≥ 1 track passing fiducial selections	$2.1^{+0.06}_{-0.06} \times 10^{-2}$	$3.8^{+0.09}_{-0.09} \times 10^{-2}$	$4.2^{+0.09}_{-0.09} \times 10^{-2}$
≥ 1 track with ≥ 4 pixel hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing inner hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing middle hits	$1.0^{+0.05}_{-0.05} \times 10^{-2}$	$2.2^{+0.07}_{-0.07} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with relative track isolation $< 5\%$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_{\mathrm{xy}}\rvert < 0.02\,\mathrm{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_z\rvert < 0.5\,\mathrm{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track, jet}) > 0.5$	$5.0^{+0.32}_{-0.32} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track, electron}) > 0.15$	$4.9^{+0.31}_{-0.31} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$1.9^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track, muon}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $\Delta R(\text{track}, \tau_{\mathrm{h}}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $E_{\mathrm{calo}} < 10\,\mathrm{GeV}$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.5^{+0.06}_{-0.06} \times 10^{-2}$	$6.5^{+0.36}_{-0.36} \times 10^{-3}$
≥ 1 track with ≥ 3 missing outer hits	$4.7^{+0.31}_{-0.31} \times 10^{-3}$	$8.8^{+0.42}_{-0.42} \times 10^{-3}$	$2.0^{+0.20}_{-0.20} \times 10^{-3}$
$\phi(p_{\mathrm{T}}^{\mathrm{miss}}) < -1.6$ or $\phi(p_{\mathrm{T}}^{\mathrm{miss}}) > -0.6$	$4.0^{+0.28}_{-0.28} \times 10^{-3}$	$7.8^{+0.39}_{-0.39} \times 10^{-3}$	$1.6^{+0.18}_{-0.18} \times 10^{-3}$
≥ 1 track 4 layers	$2.2^{+0.21}_{-0.21} \times 10^{-3}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$3.3^{+0.81}_{-0.81} \times 10^{-4}$
≥ 1 track 5 layers	$9.4^{+1.39}_{-1.39} \times 10^{-4}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$2.0^{+0.64}_{-0.64} \times 10^{-4}$
≥ 1 track with ≥ 6 layers	$9.2^{+1.34}_{-1.34} \times 10^{-4}$	$5.2^{+0.32}_{-0.32} \times 10^{-3}$	$1.1^{+0.15}_{-0.15} \times 10^{-3}$

Table 1: Cutflow comparison for signal region 2018B

Experimental cutflows for 300 GeV winos

Cut	ϵ_i^{CMS} 10cm	ϵ_i^{CMS} 100cm	ϵ_i^{CMS} 1000cm
total	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$
trigger	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
passes $p_{\text{T}}^{\text{miss}}$ filters	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
$p_{\text{T}}^{\text{miss}} > 120\,\text{GeV}$	$8.9^{+0.13}_{-0.13} \times 10^{-2}$	$9.3^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$
≥ 1 jet with $p_{\text{T}} > 110\,\text{GeV}$ and $\lvert\eta\rvert < 2.4$	$8.0^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$
==0 pairs of jets with $\Delta\phi_{\text{jet, jet}} > 2.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
$\lvert\Delta\phi(\text{leading jet}, \vec{p}_{\text{T}}^{\text{miss}})\rvert > 0.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $\lvert\eta\rvert < 2.1$	$6.8^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $p_{\text{T}} > 55\,\text{GeV}$	$3.2^{+0.08}_{-0.08} \times 10^{-2}$	$5.5^{+0.10}_{-0.10} \times 10^{-2}$	$6.1^{+0.11}_{-0.11} \times 10^{-2}$
≥ 1 track passing fiducial selections	$2.1^{+0.06}_{-0.06} \times 10^{-2}$	$3.8^{+0.09}_{-0.09} \times 10^{-2}$	$4.2^{+0.09}_{-0.09} \times 10^{-2}$
≥ 1 track with ≥ 4 pixel hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing inner hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing middle hits	$1.0^{+0.05}_{-0.05} \times 10^{-2}$	$2.2^{+0.07}_{-0.07} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with relative track isolation $< 5\%$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_{xy}\rvert < 0.02\,\text{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_z\rvert < 0.5\,\text{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{jet}) > 0.5$	$5.0^{+0.32}_{-0.32} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{electron}) > 0.15$	$4.9^{+0.31}_{-0.31} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$1.9^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{muon}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $\Delta R(\text{track}, \tau_{\text{h}}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $E_{\text{calo}} < 10\,\text{GeV}$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.5^{+0.06}_{-0.06} \times 10^{-2}$	$6.5^{+0.36}_{-0.36} \times 10^{-3}$
≥ 1 track with ≥ 3 missing outer hits	$4.7^{+0.31}_{-0.31} \times 10^{-3}$	$8.8^{+0.42}_{-0.42} \times 10^{-3}$	$2.0^{+0.20}_{-0.20} \times 10^{-3}$
$\phi(p_{\text{T}}^{\text{miss}}) < -1.6$ or $\phi(p_{\text{T}}^{\text{miss}}) > -0.6$	$4.0^{+0.28}_{-0.28} \times 10^{-3}$	$7.8^{+0.39}_{-0.39} \times 10^{-3}$	$1.6^{+0.18}_{-0.18} \times 10^{-3}$
≥ 1 track 4 layers	$2.2^{+0.21}_{-0.21} \times 10^{-3}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$3.3^{+0.81}_{-0.81} \times 10^{-4}$
≥ 1 track 5 layers	$9.4^{+1.39}_{-1.39} \times 10^{-4}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$2.0^{+0.64}_{-0.64} \times 10^{-4}$
≥ 1 track with ≥ 6 layers	$9.2^{+1.34}_{-1.34} \times 10^{-4}$	$5.2^{+0.32}_{-0.32} \times 10^{-3}$	$1.1^{+0.15}_{-0.15} \times 10^{-3}$

Table 1: Cutflow comparison for signal region 2018B

Long-lived charginos
look like muons!

Experimental cutflows for 300 GeV winos

Cut	$\epsilon_i^{\mathrm{CMS}}$ 10cm	$\epsilon_i^{\mathrm{CMS}}$ 100cm	$\epsilon_i^{\mathrm{CMS}}$ 1000cm
total	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$
trigger	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
passes $p_{\mathrm{T}}^{\mathrm{miss}}$ filters	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
$p_{\mathrm{T}}^{\mathrm{miss}} > 120\,\mathrm{GeV}$	$8.9^{+0.13}_{-0.13} \times 10^{-2}$	$9.3^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$
≥ 1 jet with $p_{\mathrm{T}} > 110\,\mathrm{GeV}$ and $\lvert\eta\rvert < 2.4$	$8.0^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$
==0 pairs of jets with $\Delta\phi_{\mathrm{jet,\,jet}} > 2.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
$\lvert\Delta\phi(\text{leading jet}, \vec{p}_{\mathrm{T}}^{\mathrm{miss}})\rvert > 0.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $\lvert\eta\rvert < 2.1$	$6.8^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $p_{\mathrm{T}} > 55\,\mathrm{GeV}$	$3.2^{+0.08}_{-0.08} \times 10^{-2}$	$5.5^{+0.10}_{-0.10} \times 10^{-2}$	$6.1^{+0.11}_{-0.11} \times 10^{-2}$
≥ 1 track passing fiducial selections	$2.1^{+0.06}_{-0.06} \times 10^{-2}$	$3.8^{+0.09}_{-0.09} \times 10^{-2}$	$4.2^{+0.09}_{-0.09} \times 10^{-2}$
≥ 1 track with ≥ 4 pixel hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing inner hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing middle hits	$1.0^{+0.05}_{-0.05} \times 10^{-2}$	$2.2^{+0.07}_{-0.07} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with relative track isolation $< 5\%$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_{xy}\rvert < 0.02\,\mathrm{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_z\rvert < 0.5\,\mathrm{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{jet}) > 0.5$	$5.0^{+0.32}_{-0.32} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{electron}) > 0.15$	$4.9^{+0.31}_{-0.31} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$1.9^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{muon}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $\Delta R(\text{track}, \tau_{\mathrm{h}}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $E_{\mathrm{calo}} < 10\,\mathrm{GeV}$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.5^{+0.06}_{-0.06} \times 10^{-2}$	$6.5^{+0.36}_{-0.36} \times 10^{-3}$
≥ 1 track with ≥ 3 missing outer hits	$4.7^{+0.31}_{-0.31} \times 10^{-3}$	$8.8^{+0.42}_{-0.42} \times 10^{-3}$	$2.0^{+0.20}_{-0.20} \times 10^{-3}$
$\phi(p_{\mathrm{T}}^{\mathrm{miss}}) < -1.6$ or $\phi(p_{\mathrm{T}}^{\mathrm{miss}}) > -0.6$	$4.0^{+0.28}_{-0.28} \times 10^{-3}$	$7.8^{+0.39}_{-0.39} \times 10^{-3}$	$1.6^{+0.18}_{-0.18} \times 10^{-3}$
≥ 1 track 4 layers	$2.2^{+0.21}_{-0.21} \times 10^{-3}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$3.3^{+0.81}_{-0.81} \times 10^{-4}$
≥ 1 track 5 layers	$9.4^{+1.39}_{-1.39} \times 10^{-4}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$2.0^{+0.64}_{-0.64} \times 10^{-4}$
≥ 1 track with ≥ 6 layers	$9.2^{+1.34}_{-1.34} \times 10^{-4}$	$5.2^{+0.32}_{-0.32} \times 10^{-3}$	$1.1^{+0.15}_{-0.15} \times 10^{-3}$

Table 1: Cutflow comparison for signal region 2018B

Experimental cutflows for 300 GeV winos

Cut	ϵ_i^{CMS} 10cm	ϵ_i^{CMS} 100cm	ϵ_i^{CMS} 1000cm
total	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$	$1.0^{+0.00}_{-0.00}$
trigger	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
passes $p_{\text{T}}^{\text{miss}}$ filters	$9.1^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$	$9.8^{+0.14}_{-0.14} \times 10^{-2}$
$p_{\text{T}}^{\text{miss}} > 120\,\text{GeV}$	$8.9^{+0.13}_{-0.13} \times 10^{-2}$	$9.3^{+0.14}_{-0.14} \times 10^{-2}$	$9.5^{+0.14}_{-0.14} \times 10^{-2}$
≥ 1 jet with $p_{\text{T}} > 110\,\text{GeV}$ and $\lvert\eta\rvert < 2.4$	$8.0^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$	$8.2^{+0.13}_{-0.13} \times 10^{-2}$
==0 pairs of jets with $\Delta\phi_{\text{jet, jet}} > 2.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
$\lvert\Delta\phi(\text{leading jet}, \vec{p}_{\text{T}}^{\text{miss}})\rvert > 0.5$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$	$7.1^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $\lvert\eta\rvert < 2.1$	$6.8^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$	$7.0^{+0.12}_{-0.12} \times 10^{-2}$
≥ 1 track with $p_{\text{T}} > 55\,\text{GeV}$	$3.2^{+0.08}_{-0.08} \times 10^{-2}$	$5.5^{+0.10}_{-0.10} \times 10^{-2}$	$6.1^{+0.11}_{-0.11} \times 10^{-2}$
≥ 1 track passing fiducial selections	$2.1^{+0.06}_{-0.06} \times 10^{-2}$	$3.8^{+0.09}_{-0.09} \times 10^{-2}$	$4.2^{+0.09}_{-0.09} \times 10^{-2}$
≥ 1 track with ≥ 4 pixel hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing inner hits	$1.1^{+0.05}_{-0.05} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$	$2.9^{+0.08}_{-0.08} \times 10^{-2}$
≥ 1 track with no missing middle hits	$1.0^{+0.05}_{-0.05} \times 10^{-2}$	$2.2^{+0.07}_{-0.07} \times 10^{-2}$	$2.5^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with relative track isolation $< 5\%$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_{xy}\rvert < 0.02\,\text{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\lvert d_z\rvert < 0.5\,\text{cm}$	$5.1^{+0.32}_{-0.32} \times 10^{-3}$	$1.8^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.07}_{-0.07} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{jet}) > 0.5$	$5.0^{+0.32}_{-0.32} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$2.1^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{electron}) > 0.15$	$4.9^{+0.31}_{-0.31} \times 10^{-3}$	$1.7^{+0.06}_{-0.06} \times 10^{-2}$	$1.9^{+0.06}_{-0.06} \times 10^{-2}$
≥ 1 track with $\Delta R(\text{track}, \text{muon}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $\Delta R(\text{track}, \tau_{\text{h}}) > 0.15$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.6^{+0.06}_{-0.06} \times 10^{-2}$	$6.6^{+0.37}_{-0.37} \times 10^{-3}$
≥ 1 track with $E_{\text{calo}} < 10\,\text{GeV}$	$4.8^{+0.31}_{-0.31} \times 10^{-3}$	$1.5^{+0.06}_{-0.06} \times 10^{-2}$	$6.5^{+0.36}_{-0.36} \times 10^{-3}$
≥ 1 track with ≥ 3 missing outer hits	$4.7^{+0.31}_{-0.31} \times 10^{-3}$	$8.8^{+0.42}_{-0.42} \times 10^{-3}$	$2.0^{+0.20}_{-0.20} \times 10^{-3}$
$\phi(p_{\text{T}}^{\text{miss}}) < -1.6$ or $\phi(p_{\text{T}}^{\text{miss}}) > -0.6$	$4.0^{+0.28}_{-0.28} \times 10^{-3}$	$7.8^{+0.39}_{-0.39} \times 10^{-3}$	$1.6^{+0.18}_{-0.18} \times 10^{-3}$
≥ 1 track 4 layers	$2.2^{+0.21}_{-0.21} \times 10^{-3}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$3.3^{+0.81}_{-0.81} \times 10^{-4}$
≥ 1 track 5 layers	$9.4^{+1.39}_{-1.39} \times 10^{-4}$	$1.4^{+0.17}_{-0.17} \times 10^{-3}$	$2.0^{+0.64}_{-0.64} \times 10^{-4}$
≥ 1 track with ≥ 6 layers	$9.2^{+1.34}_{-1.34} \times 10^{-4}$	$5.2^{+0.32}_{-0.32} \times 10^{-3}$	$1.1^{+0.15}_{-0.15} \times 10^{-3}$

Table 1: Cutflow comparison for signal region 2018B

Need a model of CMS pixel/tracker layers, and reco efficiency!