Auxiliary information for paper SUSY-2018-42 by the ATLAS Collaboration:

Search for heavy, long-lived, charged particles with large ionisation energy loss in pp collisions at $\sqrt{s} = 13$ TeV using the ATLAS experiment and the full Run 2 dataset

This material aims to give people outside the ATLAS Collaboration the possibility to reinterpret the results from the search for heavy charged long-lived particles (CLLPs), using only particles from Monte Carlo event generators. The reinterpretation material is provided for signal regions `SR-Inclusive_Low`, `SR-Inclusive_High`. The "long" lifetime regime of mass windows is used.

Model Assumptions

The CLLP is assumed to be produced promptly at the pp collision. It is assumed to deposit energy in the calorimeter as an electrically charged particle with $|q| = 1$. Due to impact parameter requirements imposed on the signal tracks, it is not adequate to apply the provided efficiencies for signals with a significant displacement.

Accuracy of the estimation by the following procedure is not satisfactory when the offline $E_{\mathrm{T}}^{\mathrm{miss}}$ reconstruction value is largely determined by the resolution of the measurement and its magnitude is relatively small compared to the $E_{\mathrm{T}}^{\mathrm{miss}}$ requirement threshold of 170 GeV. For example, in case of stau pair-production of $m(\tilde{\tau}) = 300$ GeV and stable lifetime, the majority of events do not pass the offline $E_{\mathrm{T}}^{\mathrm{miss}}$ requirement, and the estimated events passing the event selection does not accurately reproduce the full simulation. In the following, it is assumed that the the decay process and position of CLLP are implemented and available in the truth-level information.

Truth-level variables

- The decay transverse radius of the CLLP is denoted as r_{decay}.
- The true p_{T}, $\beta\gamma$ and η of the CLLP are also used hereafter.
- Calorimeter-level true missing transverse momentum, $E_{\mathrm{T,calo}}^{\mathrm{miss}}$, is the magnitude of the vectorial sum of momenta of all particles interacting similar to or less than minimal ionising particles (MIPs) with the detector material of both of SM and BSM particles, including muons, neutrinos as well as neutralinos, charginos, staus:
  - if such a particle is promptly produced and it does not decay before the end of the hadronic calorimeter, the transverse momentum is included;
  - if such a particle is produced as a decay product of a LLP before the end of the hadronic calorimeter and it does not decay before the end of calorimeters, the transverse momentum is included.

  The outer surfaces of the hadronic calorimeter is approximately defined as a cylinder of $r = 3.9$ m and $|z| = 6.0$ m. This variable is suited to estimate the trigger efficiency. Some examples of particle inclusion or exclusion to $E_{\mathrm{T,calo}}^{\mathrm{miss}}$ are illustrated in Figure 1.

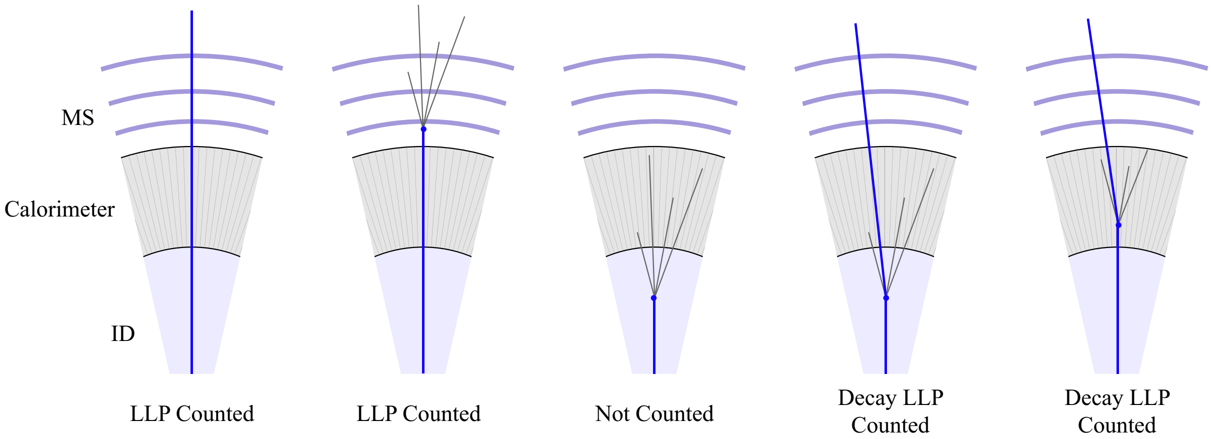


Figure 1: Examples of particle inclusion or exclusion to $E_{\mathrm{T,calo}}^{\mathrm{miss}}$, depending on particle species and their production and decay positions. The blue thick line represents a charged or neutral LLP which does not deposit energy in the calorimeter. The gray thin line represents a SM particle which is absorbed by the calorimeter.

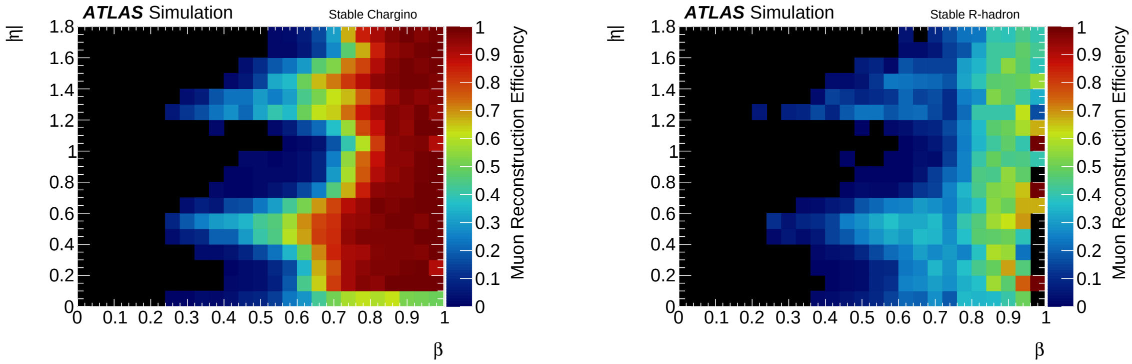
- The total true missing transverse momentum, $E_{\mathrm{T,total}}^{\mathrm{miss}}$, is similar to $E_{\mathrm{T,calo}}^{\mathrm{miss}}$, but removing contributions of muons, and those from CLLPs if they are tagged to be reconstructed as muons. Since a CLLP could have a large amount of momentum, the value of the total $E_{\mathrm{T}}^{\mathrm{miss}}$ would drastically change whether it is reconstructed as a muon or not. The probability of muon reconstruction for a sufficiently long decay length is dependent on β and $|\eta|$: since SM muons fly with the speed of light, for β significantly smaller than 1 the efficiency is low. The probability of muon reconstruction can be expressed as

$$\varepsilon_{\mathrm{muon}}^{\mathrm{MS}}(r_{\mathrm{decay}}, \beta, |\eta|) \sim \mathcal{A}_{\mathrm{MS}}(r_{\mathrm{decay}} > r_{\mathrm{MS}}) \cdot \hat{\varepsilon}_{\mathrm{stable}}(\beta, |\eta|)$$

where $\mathcal{A}_{\mathrm{MS}}$ is the acceptance of having a sufficiently long decay length, r_{MS} is the representative transverse radius of the muon spectrometer of $\sim$ 10 m, and $\hat{\varepsilon}_{\mathrm{stable}}$ is the probability of muon reconstruction for stable charged LLPs, as presented in Figure 2. Here, the efficiency $\hat{\varepsilon}_{\mathrm{stable}}(\beta, |\eta|)$ should be implemented as a *random variable* instead of a weight factor to be applied to each CLLP; the transverse momentum of a CLLP satisfying the acceptance is subtracted from the calorimeter-level true missing transverse momentum with a probability $\hat{\varepsilon}_{\mathrm{stable}}$:

$$\begin{aligned} \vec{p}_{\mathrm{T,total}}^{\,\mathrm{miss}} &= \vec{p}_{\mathrm{T,calo}}^{\,\mathrm{miss}} - \sum_{m \in \mathrm{muons}} \vec{p}_{\mathrm{T}}^{\,(m)} - \sum_{k \in \mathrm{CLLPs}} \mathcal{A}_{\mathrm{MS}} \cdot \hat{\varepsilon}_{\mathrm{stable}} \cdot \vec{p}_{\mathrm{T}}^{\,(k)} , \\ E_{\mathrm{T,total}}^{\mathrm{miss}} &= \left| \vec{p}_{\mathrm{T,total}}^{\,\mathrm{miss}} \right| . \end{aligned}$$

In other words, $E_{\mathrm{T,total}}^{\mathrm{miss}}$ is not a deterministic variable and it is to be implemented by a Monte Carlo method.



(a) Stable chargino

(b) Stable R-hadron

Figure 2: Muon reconstruction efficiency as a function of β and $|\eta|$ for (a) stable charginos and (b) stable charged R-hadrons. For weakly interacting LLPs with calorimeter materials the efficiency for the chargino is recommended to refer to. The muon reconstruction efficiency for R-hadrons is significantly lower due to having QCD interactions with materials.

The model

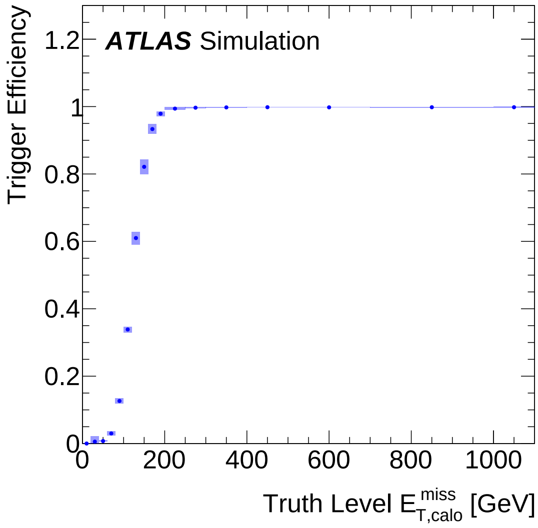
The approximate number of signal events passing the signal selection for the signal region bin j (j =`Inclusive_High` or `Inclusive_Low`) is evaluated using the following equation:

$$\left\langle N_{\text{sig}}^{(j)} \right\rangle \simeq \frac{\sigma_{\text{sig}}\,\mathcal{L}}{\sum_{i\in\text{events}} w_i} \sum_{i\in\text{events}} w_i \cdot \varepsilon_{\text{trig}} \cdot \varepsilon_{\text{event}} \cdot \left[1 - \prod_{k\in\,\text{CLLPs}} \left(1 - \mathcal{A}_k \cdot \varepsilon_k^{(j)} \cdot w_{\text{mass}}^{(j)} \right) \right]$$

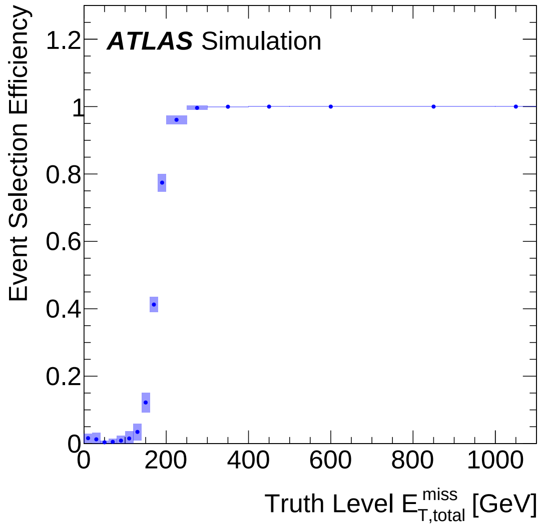
where σ_{sig} and $\mathcal{L}$ are the production cross-section and integrated luminosity and w_i is the generator's event weight for the i-th event. While $\varepsilon_{\text{trig}}$ is the trigger efficiency, parameterised as a function of $E_{\text{T,calo}}^{\text{miss}}$ (Figure 3(a)), $\varepsilon_{\text{event}}$ is the event-level selection efficiency for events passing the trigger requirement, parameterised as a function of $E_{\text{T,total}}^{\text{miss}}$ (Figure 3(b)). These two efficiencies are event weights. $\mathcal{A}_k$ is the acceptance of the k-th CLLP, defined as a product of step functions with the following thresholds:

- $p_{\text{T}} > 120$ GeV;
- $|\eta| < 1.8$;
- $r_{\text{decay}} > 500$ mm.

The track reconstruction and selection efficiency $\varepsilon_k^{(j)}$ for the region bin j is parameterised as a function of $\beta\gamma$ of the k-th CLLP (Figure 4). This efficiency is a weight on each track, and it includes the effect of all common track-quality requirements and the pixel dE/dx requirement for the bin. The fraction of events within the mass window for events passing the acceptance and the selection efficiency is denoted by $w_{\text{mass}}^{(j)}$, and this is a constant for the given CLLP mass (Table 1). Residual correlations between the event-level selection efficiencies and individual CLLP's kinematic properties are neglected and approximated to be orthogonal. The output expected signal events, $\left\langle N_{\text{sig}}^{(j)} \right\rangle$, is suited to be compared with the predicted background events and observation in the corresponding mass window to the LLP mass of the region bin j.



(a) Trigger efficiency



(b) Event selection efficiency

Figure 3: Trigger and event selection efficiencies. The band on the marker indicates a typical size of fluctuation by the LLP mass and lifetime observed by the samples used in efficiency derivation, but it does not indicate the full envelope of model dependence.

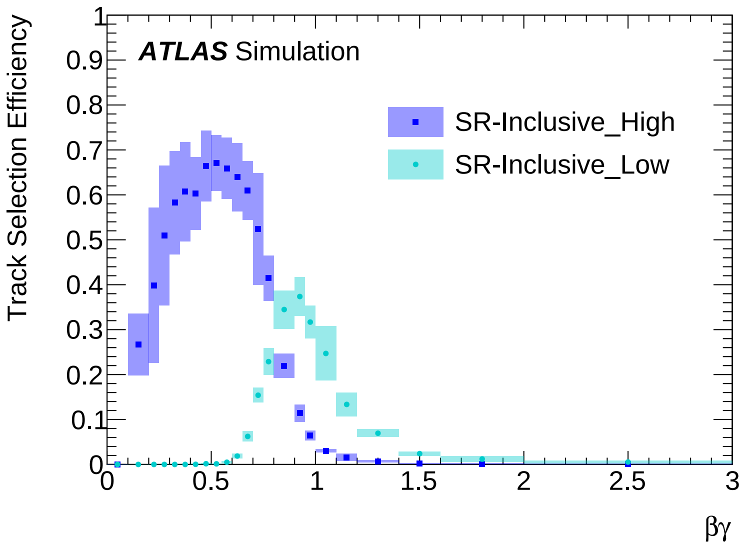


Figure 4: Signal track selection efficiency as a function of CLLP $\beta\gamma$ for `SR-Inclusive_Low` and `SR-Inclusive_High` bins. The band on the marker indicates a typical size of fluctuation by the LLP mass and lifetime observed by the samples used in efficiency derivation, but it does not indicate the full envelope of model dependence.

Table 1: Signal selection efficiency by the mass window for `SR-Inclusive_Low` and `SR-Inclusive_High` bins.

Region bin	$w_{\mathbf{mass}}$
`SR-Inclusive_Low`	0.60 ± 0.04
`SR-Inclusive_High`	$(0.74 - 0.052 \times (m/\mathrm{TeV})) \pm 0.04$

Acceptance and efficiency tables

In the following tables, the acceptance of a sample is defined as the fraction of events having at least one charged LLP satisfying $p_{\mathrm{T}} > 120$ GeV, $|\eta| < 1.8$ and $r_{\mathrm{decay}} > 500$ mm.

Three efficiency values are defined and presented:

- Event-level efficiency: the fraction of events satisfying the selection requirements of trigger, event and jet cleaning, $E_{\mathrm{T}}^{\mathrm{miss}}$ and primary vertex requirements per events satisfying the acceptance criteria;
- Efficiency for `SR-Inclusive_High`: the ratio of events satisfying the event selection criteria for `SR-Inclusive_High` to events satisfying the acceptance criteria;
- Efficiency for `SR-Inclusive_Low`: the ratio of events satisfying the event selection criteria for `SR-Inclusive_Low` to events satisfying the acceptance criteria.

Acceptance

Table 2: Acceptance for the R-hadron pair-production model with $m(\tilde{\chi}_1^0) = 100$ GeV for various masses and lifetimes. The acceptance is defined as the fraction of events having at least one charged LLP satisfying $p_{\mathrm{T}} > 120$ GeV, $|\eta| < 1.8$ and $r_{\mathrm{decay}} > 500$ mm.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns	stable
400	0.003	0.067	0.237	0.397	0.453	0.492
450	–	0.068	–	0.406	–	0.515
500	0.002	0.065	0.239	0.417	0.482	0.523
550	–	0.063	–	0.424	–	0.535
600	0.002	0.062	0.244	0.429	0.509	0.546
650	–	0.059	–	0.433	–	0.558
700	0.002	0.059	0.247	0.436	0.519	0.564
800	0.002	0.057	0.247	0.441	0.526	0.575
1000	0.001	0.050	0.241	0.444	0.538	0.594
1200	0.001	0.044	0.226	0.444	0.546	0.607
1400	0.001	0.040	0.216	0.440	0.551	0.611
1600	0.001	0.034	0.207	0.437	0.551	0.621
1800	0.000	0.031	0.197	0.440	0.548	0.617
2000	–	0.028	0.187	0.429	0.544	0.624
2200	–	–	0.177	0.420	0.547	0.625
2400	–	–	0.171	0.418	0.548	0.634
2600	–	–	0.166	0.410	0.546	0.628
2800	–	–	–	0.394	0.543	0.632
3000	–	–	–	0.401	0.546	0.638

Table 3: Acceptance for the R-hadron pair-production model with $\Delta m(\tilde{g}, \tilde{\chi}_1^0) = 30$ GeV for various masses and lifetimes. The acceptance is defined as the fraction of events having at least one charged LLP satisfying $p_{\mathrm{T}} > 120$ GeV, $|\eta| < 1.8$ and $r_{\mathrm{decay}} > 500$ mm.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns
400	0.003	0.067	0.241	0.396	0.455
500	0.002	0.065	0.247	0.416	0.481
600	0.002	0.063	0.247	0.430	0.501
700	0.002	0.059	0.245	0.437	0.516
800	0.001	0.057	0.244	0.441	0.531
1000	0.001	0.050	0.236	0.443	0.544
1200	0.001	0.045	0.227	0.442	0.546
1400	0.001	0.039	0.222	0.443	0.545
1600	0.000	0.035	0.204	0.439	0.548
1800	0.001	0.031	0.198	0.433	0.551
2000	–	0.028	0.182	0.427	0.551
2200	–	–	0.177	0.422	0.545
2400	–	–	0.170	0.421	0.548

Table 4: Acceptance for the chargino production model for various masses and lifetimes. The acceptance is defined as the fraction of events having at least one charged LLP satisfying $p_{\mathrm{T}} > 120$ GeV, $|\eta| < 1.8$ and $r_{\mathrm{decay}} > 500$ mm. For chargino samples, a truth-level preselection of vectorial sum p_{T} of the gaugino-pair must be greater than 60 GeVis applied, and the denominator of the acceptance calculation is the events after this preselection.

Mass [GeV]	0.2 ns	1 ns	4 ns	10 ns	30 ns	stable
90	0.009	0.118	0.388	0.233	0.247	0.115
200	0.004	0.142	0.415	0.451	0.494	0.405
250	–	–	–	–	0.550	0.494
300	0.002	0.131	0.409	0.535	0.594	0.146
350	–	–	–	–	0.624	0.607
400	0.002	0.123	0.430	0.572	0.652	0.637
500	0.001	0.112	0.394	0.596	0.690	0.697
600	0.001	0.105	0.442	0.610	0.678	0.737
700	0.001	0.116	0.437	0.483	0.731	0.373
800	0.001	0.092	0.434	0.625	0.203	0.785
900	0.001	0.084	0.428	0.629	0.751	0.805
1000	0.000	0.078	0.427	0.635	0.761	0.819
1100	–	–	0.419	0.634	0.771	0.834
1200	–	–	0.415	0.633	0.773	0.842
1300	–	–	0.409	0.634	0.780	0.853
1400	–	–	0.401	0.632	0.782	0.829
1500	–	–	0.394	0.629	0.783	0.867
1600	–	–	0.394	0.631	0.789	0.871

Table 5: Acceptance for the stau pair-production model for various masses and lifetimes. The acceptance is defined as the fraction of events having at least one charged LLP satisfying $p_{\mathrm{T}} > 120$ GeV, $|\eta| < 1.8$ and $r_{\mathrm{decay}} > 500$ mm.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns	stable
100	0.040	–	0.326	0.371	0.384	0.391
200	0.036	–	0.571	0.692	0.723	0.737
300	0.033	–	0.640	0.801	0.837	0.856
400	0.025	–	0.662	0.843	0.885	0.901
450	–	0.295	–	0.863	–	0.923
500	0.023	–	0.675	0.870	0.915	0.935
550	–	0.283	–	0.877	–	0.943
600	0.019	0.277	0.676	0.887	0.935	0.952
650	–	0.276	–	0.894	–	0.960
700	0.016	0.269	0.679	0.894	0.946	0.962
800	0.014	0.253	0.678	0.906	0.954	0.974
900	0.011	0.248	0.669	0.904	0.962	0.978
1000	0.010	0.233	0.665	0.911	0.965	0.983

Event-level efficiency

Table 6: Event-level efficiency for the R-hadron pair-production model with $m(\tilde{\chi}_1^0) = 100$ GeV for various masses and lifetimes. The efficiency is defined as the fraction of events satisfying the selection of trigger, event and jet cleaning, $E_{\mathrm{T}}^{\mathrm{miss}}$ and primary vertex requirements per events satisfying the acceptance criteria.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns	stable
400	0.657	0.464	0.387	0.395	0.334	0.168
450	–	0.541	–	0.460	–	0.195
500	0.785	0.602	0.529	0.513	0.428	0.210
550	–	0.641	–	0.558	–	0.226
600	0.758	0.687	0.628	0.595	0.500	0.237
650	–	0.722	–	0.635	–	0.253
700	0.790	0.754	0.704	0.662	0.552	0.261
800	0.886	0.791	0.760	0.713	0.594	0.276
1000	0.951	0.853	0.829	0.779	0.645	0.295
1200	0.966	0.883	0.873	0.824	0.680	0.302
1400	0.939	0.913	0.905	0.849	0.707	0.301
1600	1.000	0.947	0.917	0.880	0.719	0.297
1800	1.000	0.947	0.934	0.892	0.727	0.283
2000	–	0.959	0.943	0.902	0.731	0.280
2200	–	–	0.957	0.913	0.737	0.267
2400	–	–	0.959	0.928	0.736	0.250
2600	–	–	0.964	0.929	0.731	0.238
2800	–	–	–	0.929	0.733	0.222
3000	–	–	–	0.932	0.735	0.208

Table 7: Event-level efficiency for the R-hadron pair-production model with $\Delta m(\tilde{g}, \tilde{\chi}_1^0) = 30$ GeV for various masses and lifetimes. The efficiency is defined as the fraction of events satisfying the selection of trigger, event and jet cleaning, $E_{\mathrm{T}}^{\mathrm{miss}}$ and primary vertex requirements per events satisfying the acceptance criteria.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns
400	0.289	0.189	0.163	0.156	0.168
500	0.163	0.229	0.201	0.194	0.205
600	0.289	0.263	0.224	0.220	0.221
700	0.313	0.297	0.253	0.243	0.249
800	0.237	0.295	0.269	0.261	0.262
1000	0.263	0.326	0.297	0.279	0.284
1200	0.294	0.313	0.308	0.287	0.294
1400	0.430	0.312	0.307	0.295	0.293
1600	0.259	0.333	0.296	0.287	0.287
1800	0.354	0.326	0.292	0.276	0.280
2000	–	0.277	0.273	0.280	0.268
2200	–	–	0.271	0.262	0.259
2400	–	–	0.255	0.247	0.242

Table 8: Event-level efficiency for the chargino production model for various masses and lifetimes. The efficiency is defined as the fraction of events satisfying the selection of trigger, event and jet cleaning, $E_{\mathrm{T}}^{\mathrm{miss}}$ and primary vertex requirements per events satisfying the acceptance criteria. For chargino samples, a truth-level preselection of vectorial sum p_{T} of the gaugino-pair must be greater than 60 GeVis applied, and the denominator of the acceptance calculation is the events after this preselection.

Mass [GeV]	0.2 ns	1 ns	4 ns	10 ns	30 ns	stable
90	0.423	0.264	0.370	0.142	0.119	0.036
200	0.423	0.328	0.395	0.248	0.220	0.062
250	–	–	–	–	0.252	0.073
300	0.402	0.351	0.391	0.310	0.283	0.047
350	–	–	–	–	0.311	0.099
400	0.437	0.366	0.335	0.336	0.327	0.111
500	0.406	0.385	0.341	0.358	0.355	0.134
600	0.313	0.391	0.372	0.367	0.160	0.156
700	0.460	0.392	0.381	0.330	0.392	0.097
800	0.474	0.392	0.379	0.384	0.168	0.185
900	0.436	0.384	0.383	0.387	0.408	0.191
1000	0.334	0.403	0.393	0.390	0.404	0.197
1100	–	–	0.388	0.389	0.408	0.202
1200	–	–	0.395	0.389	0.410	0.202
1300	–	–	0.391	0.395	0.407	0.208
1400	–	–	0.396	0.394	0.408	0.205
1500	–	–	0.390	0.397	0.406	0.212
1600	–	–	0.396	0.395	0.405	0.209

Table 9: Event-level efficiency for the stau pair-production model for various masses and lifetimes. The efficiency is defined as the fraction of events satisfying the selection of trigger, event and jet cleaning, $E_{\mathrm{T}}^{\mathrm{miss}}$ and primary vertex requirements per events satisfying the acceptance criteria.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns	stable
100	0.000	–	0.000	0.000	0.000	0.000
200	0.001	–	0.003	0.002	0.001	0.000
300	0.001	–	0.013	0.012	0.007	0.001
400	0.003	–	0.025	0.028	0.019	0.004
450	–	0.018	–	0.040	–	0.006
500	0.005	–	0.043	0.047	0.033	0.008
550	–	0.027	–	0.059	–	0.012
600	0.006	0.030	0.060	0.066	0.045	0.014
650	–	0.033	–	0.080	–	0.017
700	0.008	0.043	0.082	0.086	0.063	0.021
800	0.004	0.047	0.094	0.111	0.080	0.027
900	0.015	0.060	0.117	0.134	0.093	0.033
1000	0.018	0.073	0.138	0.155	0.113	0.042

Efficiency for SR-Inclusive_High

Table 10: Efficiency of SR-Inclusive_High for the R-hadron pair-production model with $m(\tilde{\chi}_1^0) = 100$ GeV for various masses and lifetimes. The efficiency is defined as the ratio of events satisfying the signal region selection to those satisfying the acceptance criteria. The mass window is not applied for the presented numbers.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns	stable
400	0.022	0.036	0.055	0.058	0.053	0.031
450	–	0.043	–	0.077	–	0.039
500	0.000	0.054	0.095	0.095	0.081	0.048
550	–	0.071	–	0.111	–	0.054
600	0.036	0.078	0.127	0.127	0.104	0.061
650	–	0.088	–	0.140	–	0.067
700	0.000	0.101	0.156	0.159	0.131	0.071
800	0.010	0.123	0.183	0.188	0.145	0.081
1000	0.000	0.153	0.236	0.240	0.187	0.098
1200	0.000	0.192	0.292	0.290	0.229	0.111
1400	0.000	0.221	0.321	0.325	0.260	0.126
1600	0.090	0.303	0.366	0.375	0.294	0.132
1800	0.072	0.287	0.392	0.401	0.313	0.132
2000	–	0.315	0.432	0.425	0.330	0.137
2200	–	–	0.446	0.449	0.350	0.137
2400	–	–	0.465	0.466	0.362	0.132
2600	–	–	0.485	0.469	0.363	0.130
2800	–	–	–	0.482	0.373	0.120
3000	–	–	–	0.495	0.382	0.115

Table 11: Efficiency of SR-Inclusive_High for the R-hadron pair-production model with $\Delta m(\tilde{g}, \tilde{\chi}_1^0) = 30$ GeV for various masses and lifetimes. The efficiency is defined as the ratio of events satisfying the signal region selection to those satisfying the acceptance criteria. The mass window is not applied for the presented numbers.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns
400	0.002	0.013	0.019	0.024	0.029
500	0.000	0.016	0.027	0.039	0.047
600	0.000	0.027	0.038	0.051	0.053
700	0.000	0.032	0.051	0.059	0.065
800	0.021	0.033	0.060	0.070	0.071
1000	0.000	0.053	0.077	0.086	0.093
1200	0.000	0.053	0.092	0.100	0.108
1400	0.000	0.072	0.099	0.116	0.121
1600	0.000	0.070	0.109	0.120	0.128
1800	0.060	0.093	0.115	0.123	0.127
2000	–	0.080	0.113	0.128	0.131
2200	–	–	0.116	0.127	0.128
2400	–	–	0.115	0.129	0.121

Table 12: Efficiency of `SR-Inclusive_High` for the chargino production model for various masses and lifetimes. The efficiency is defined as the ratio of events satisfying the signal region selection to those satisfying the acceptance criteria. The mass window is not applied for the presented numbers. For chargino samples, a truth-level preselection of vectorial sum p_{T} of the gaugino-pair must be greater than 60 GeVis applied, and the denominator of the acceptance calculation is the events after this preselection.

Mass [GeV]	0.2 ns	1 ns	4 ns	10 ns	30 ns	stable
90	0.000	0.000	0.065	0.000	0.001	0.001
200	0.000	0.003	0.122	0.008	0.007	0.002
250	–	–	–	–	0.016	0.005
300	0.000	0.007	0.127	0.027	0.027	0.002
350	–	–	–	–	0.039	0.012
400	0.000	0.014	0.037	0.046	0.046	0.015
500	0.000	0.023	0.041	0.063	0.067	0.024
600	0.000	0.029	0.063	0.076	0.034	0.033
700	0.000	0.036	0.076	0.031	0.095	0.003
800	0.000	0.041	0.082	0.098	0.000	0.046
900	0.000	0.048	0.096	0.108	0.115	0.053
1000	0.000	0.059	0.101	0.118	0.125	0.061
1100	–	–	0.112	0.124	0.134	0.064
1200	–	–	0.122	0.137	0.145	0.069
1300	–	–	0.127	0.146	0.154	0.077
1400	–	–	0.142	0.155	0.162	0.076
1500	–	–	0.147	0.164	0.169	0.087
1600	–	–	0.151	0.172	0.173	0.090

Table 13: Efficiency of `SR-Inclusive_High` for the stau pair-production model for various masses and lifetimes. The efficiency is defined as the ratio of events satisfying the signal region selection to those satisfying the acceptance criteria. The mass window is not applied for the presented numbers.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns	stable
100	0.000	–	0.000	0.000	0.000	0.000
200	0.001	–	0.003	0.002	0.001	0.000
300	0.001	–	0.013	0.012	0.007	0.001
400	0.003	–	0.025	0.028	0.019	0.004
450	–	0.018	–	0.040	–	0.006
500	0.005	–	0.043	0.047	0.033	0.008
550	–	0.027	–	0.059	–	0.012
600	0.006	0.030	0.060	0.066	0.045	0.014
650	–	0.033	–	0.080	–	0.017
700	0.008	0.043	0.082	0.086	0.063	0.021
800	0.004	0.047	0.094	0.111	0.080	0.027
900	0.015	0.060	0.117	0.134	0.093	0.033
1000	0.018	0.073	0.138	0.155	0.113	0.042

Efficiency for SR-Inclusive_Low

Table 14: Efficiency of SR-Inclusive_Low for the R-hadron pair-production model with $m(\tilde{\chi}_1^0) = 100$ GeV for various masses and lifetimes. The efficiency is defined as the ratio of events satisfying the signal region selection to those satisfying the acceptance criteria. The mass window is not applied for the presented numbers.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns	stable
400	0.041	0.045	0.042	0.038	0.034	0.021
450	–	0.056	–	0.047	–	0.023
500	0.047	0.071	0.068	0.055	0.043	0.027
550	–	0.086	–	0.061	–	0.032
600	0.047	0.093	0.087	0.068	0.055	0.032
650	–	0.103	–	0.072	–	0.037
700	0.030	0.107	0.097	0.078	0.061	0.038
800	0.040	0.123	0.108	0.087	0.070	0.041
1000	0.072	0.147	0.127	0.100	0.078	0.045
1200	0.046	0.182	0.134	0.107	0.084	0.045
1400	0.085	0.178	0.148	0.108	0.084	0.041
1600	0.169	0.176	0.133	0.105	0.073	0.037
1800	0.000	0.204	0.141	0.095	0.072	0.032
2000	–	0.177	0.128	0.090	0.067	0.029
2200	–	–	0.118	0.080	0.056	0.023
2400	–	–	0.112	0.073	0.048	0.020
2600	–	–	0.099	0.069	0.045	0.016
2800	–	–	–	0.055	0.042	0.016
3000	–	–	–	0.050	0.034	0.010

Table 15: Efficiency of SR-Inclusive_Low for the R-hadron pair-production model with $\Delta m(\tilde{g}, \tilde{\chi}_1^0) = 30$ GeV for various masses and lifetimes. The efficiency is defined as the ratio of events satisfying the signal region selection to those satisfying the acceptance criteria. The mass window is not applied for the presented numbers.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns
400	0.000	0.015	0.018	0.018	0.020
500	0.000	0.025	0.023	0.024	0.024
600	0.020	0.030	0.031	0.030	0.031
700	0.000	0.041	0.037	0.034	0.038
800	0.000	0.043	0.041	0.039	0.040
1000	0.120	0.052	0.050	0.044	0.044
1200	0.000	0.050	0.051	0.043	0.043
1400	0.040	0.055	0.042	0.040	0.042
1600	0.104	0.060	0.047	0.036	0.036
1800	0.000	0.047	0.043	0.033	0.035
2000	–	0.051	0.033	0.035	0.029
2200	–	–	0.032	0.027	0.023
2400	–	–	0.023	0.020	0.019

Table 16: Efficiency of `SR-Inclusive_Low` for the chargino production model for various masses and lifetimes. The efficiency is defined as the ratio of events satisfying the signal region selection to those satisfying the acceptance criteria. The mass window is not applied for the presented numbers. For chargino samples, a truth-level preselection of vectorial sum p_{T} of the gaugino-pair must be greater than 60 GeVis applied, and the denominator of the acceptance calculation is the events after this preselection.

Mass [GeV]	0.2 ns	1 ns	4 ns	10 ns	30 ns	stable
90	0.000	0.001	0.045	0.001	0.002	0.001
200	0.006	0.011	0.066	0.014	0.014	0.003
250	–	–	–	–	0.019	0.007
300	0.006	0.016	0.063	0.030	0.024	0.002
350	–	–	–	–	0.033	0.010
400	0.000	0.025	0.034	0.035	0.036	0.013
500	0.019	0.033	0.035	0.041	0.043	0.017
600	0.000	0.039	0.044	0.047	0.020	0.021
700	0.010	0.039	0.053	0.033	0.050	0.006
800	0.000	0.050	0.057	0.053	0.002	0.027
900	0.000	0.051	0.057	0.057	0.058	0.026
1000	0.000	0.055	0.063	0.057	0.058	0.029
1100	–	–	0.063	0.058	0.059	0.030
1200	–	–	0.066	0.058	0.061	0.030
1300	–	–	0.063	0.061	0.059	0.030
1400	–	–	0.062	0.058	0.060	0.029
1500	–	–	0.061	0.058	0.058	0.030
1600	–	–	0.060	0.055	0.057	0.028

Table 17: Efficiency of `SR-Inclusive_Low` for the stau pair-production model for various masses and lifetimes. The efficiency is defined as the ratio of events satisfying the signal region selection to those satisfying the acceptance criteria. The mass window is not applied for the presented numbers.

Mass [GeV]	0.3 ns	1 ns	3 ns	10 ns	30 ns	stable
100	0.000	–	0.000	0.000	0.000	0.000
200	0.001	–	0.006	0.004	0.002	0.000
300	0.010	–	0.021	0.016	0.010	0.001
400	0.012	–	0.035	0.031	0.020	0.005
450	–	0.034	–	0.040	–	0.006
500	0.013	–	0.056	0.049	0.034	0.010
550	–	0.053	–	0.058	–	0.012
600	0.025	0.056	0.074	0.064	0.046	0.015
650	–	0.068	–	0.074	–	0.020
700	0.019	0.075	0.090	0.082	0.058	0.022
800	0.032	0.090	0.110	0.095	0.066	0.027
900	0.031	0.098	0.119	0.110	0.080	0.034
1000	0.032	0.114	0.141	0.125	0.089	0.038

Selection flow tables

Tables 18–21 present the steps of event selections and remaining events for representative signal samples. The efficiency is defined as the surviving events to the all generated samples.

Table 18: Passing events in event selection steps for gluino R-hadron production for the case of $m(\tilde{g})$ = 2.2 TeV, $m(\tilde{\chi}_1^0)$ = 100 GeV and $\tau(\tilde{g})$ = 10 ns.

Selection	Events	Efficiency
Total	49.5	1
Event and jet Cleaning	49.0	0.990
Trigger	47.1	0.951
Primary vertex	47.1	0.951
$E_{\mathrm{T}}^{\mathrm{miss}} > 170$ GeV	45.7	0.924
Track in PV	35.1	0.710
$p_{\mathrm{T}} > 50$ GeV	25.2	0.509
Track quality requirements	19.6	0.397
Track isolation	16.9	0.342
$p_{\mathrm{T}} > 120$ GeV	16.8	0.340
Track momentum uncertainty	15.1	0.306
$\lvert\eta\rvert < 1.8$	14.2	0.287
$m_{\mathrm{T}}(\mathrm{track}, \vec{p}_{\mathrm{T}}^{\mathrm{miss}}) > 130$ GeV	12.8	0.259
Electron veto	12.8	0.258
Hadron/tau veto	12.3	0.249
$\mathrm{d}E/\mathrm{d}x \in [1.8, 2.4]$ MeV g^{-1}cm^2	1.67	0.034
$\mathrm{d}E/\mathrm{d}x > 2.4$ MeV g^{-1}cm^2	9.34	0.189

Table 19: Passing events in event selection steps for gluino R-hadron production for the case of $m(\tilde{g})$ = 2.2 TeV, $\Delta m(\tilde{g}, \tilde{\chi}_1^0)$ = 30 GeV and $\tau(\tilde{g})$ = 10 ns.

Selection	Events	Efficiency
Total	49.47	1
Event and jet Cleaning	49.14	0.993
Trigger	17	0.344
Primary vertex	17	0.344
$E_{\mathrm{T}}^{\mathrm{miss}} > 170$ GeV	12.35	0.25
Track in PV	12.2	0.247
$p_{\mathrm{T}} > 50$ GeV	8.74	0.177
Track quality requirements	6.82	0.138
Track isolation	4.82	0.098
$p_{\mathrm{T}} > 120$ GeV	4.8	0.097
Track momentum uncertaintiy	4.31	0.087
$\lvert\eta\rvert < 1.8$	4.08	0.083
$m_{\mathrm{T}}(\mathrm{track}, \vec{p}_{\mathrm{T}}^{\mathrm{miss}}) > 130$ GeV	3.64	0.074
Electron veto	3.62	0.073
Hadron/tau veto	3.62	0.073
$\mathrm{d}E/\mathrm{d}x \in [1.8, 2.4]$ MeV g^{-1}cm^2	0.56	0.011
$\mathrm{d}E/\mathrm{d}x > 2.4$ MeV g^{-1}cm^2	2.65	0.054

Table 20: Passing events in event selection steps for chargino production (both $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^0$ and $\tilde{\chi}_1^{+}\tilde{\chi}_1^{-}$) for the case of $m(\tilde{\chi}_1^{\pm}) = 1.3$ TeV and $\tau(\tilde{\chi}_1^{\pm}) = 10$ ns. For this sample, a truth-level preselection of vectorial sum p_{T} of the gaugino-pair is greater than 60 GeV is applied, and the total events is the events after this preselection.

Selection	Events	Efficiency
Total	20.8	1
Event and jet Cleaning	20.6	0.995
Trigger	11.2	0.539
Primary vertex	11.2	0.539
$E_{\mathrm{T}}^{\mathrm{miss}} > 170$ GeV	7.9	0.381
Track in PV	7.8	0.378
$p_{\mathrm{T}} > 50$ GeV	6.8	0.326
Track quality requirements	5.8	0.279
Track isolation	5.1	0.244
$p_{\mathrm{T}} > 120$ GeV	5.0	0.242
Track momentum uncertainty	4.80	0.231
$\lvert\eta\rvert < 1.8$	4.39	0.211
$m_{\mathrm{T}}(\text{track}, \vec{p}_{\mathrm{T}}^{\mathrm{miss}}) > 130$ GeV	3.80	0.183
Electron veto	3.80	0.183
Hadron/tau veto	3.80	0.183
$\mathrm{d}E/\mathrm{d}x \in [1.8, 2.4]$ MeV g^{-1}cm^{2}	0.80	0.039
$\mathrm{d}E/\mathrm{d}x > 2.4$ MeV g^{-1}cm^{2}	1.92	0.092

Table 21: Passing events in event selection steps for stau pair-production for the case of $m(\tilde{\tau}) = 400$ GeV and $\tau(\tilde{\tau}) = 10$ ns.

Selection	Events	Efficiency
Total	258.4	1
Event and jet Cleaning	255.9	0.991
Trigger	128.8	0.499
Primary vertex	128.8	0.499
$E_{\mathrm{T}}^{\mathrm{miss}} > 170$ GeV	87.0	0.337
Track in PV	84.9	0.328
$p_{\mathrm{T}} > 50$ GeV	83.7	0.324
Track quality requirements	80.4	0.311
Track isolation	79.4	0.307
$p_{\mathrm{T}} > 120$ GeV	78.9	0.305
Track momentum uncertainty	78.3	0.303
$\lvert\eta\rvert < 1.8$	73.3	0.284
$m_{\mathrm{T}}(\text{track}, \vec{p}_{\mathrm{T}}^{\mathrm{miss}}) > 130$ GeV	60.6	0.234
Electron veto	60.0	0.232
Hadron/tau veto	58.8	0.228
$\mathrm{d}E/\mathrm{d}x \in [1.8, 2.4]$ MeV g^{-1}cm^{2}	6.79	0.026
$\mathrm{d}E/\mathrm{d}x > 2.4$ MeV g^{-1}cm^{2}	6.18	0.024