

Prospects for BSM at LHC (experimental vision)

Livia Soffi on behalf of ATLAS and CMS Collaboration

ELECTRON

ARGED HADE

MUON

JTRAD HADR

Setting the stage



- Long Shutdown 2 (Phase-1 upgrade) preparing Run 3 Luminosity at 2 x 10³⁴/cm²/s, possible increase to \sqrt{s} =13.5 or 14 TeV
- Long Shutdown 3 (Phase-2 upgrade) preparing HL-LHC Luminosity at 7.5 x 10^{34} /cm²/s at $\sqrt{s}=14$ TeV
 - Large data samples and major experimental challenges



A New Understanding of Particle Physics

Overview of CMS EXO results CMS preliminary 36-140 fb⁻¹ (13 TeV) 0.5-8.1 1911.03947 (2j) String resonance 137 fb⁻¹ 0.35-4 1712.03143 (2µ+1y; 2e+1y; 2j+1y) 36 fb⁻¹ 36 fb⁻¹ Zy resonance 0.72-3.25 1808.01257 (**1**j + 1γ) . Higgs γ resonance 0.5-3.7 1911.03947 (2j Color Octect Scalar, $k_{\star}^2 = 1/2$ 137 fb⁻¹ 0.5-7.5 1911.03947 (2j Scalar Diguark 137 fb⁻ $t\bar{t} + \phi$, pseudoscalar (scalar), $g_{top}^2 \times BR(\phi \rightarrow 2l) > = 0.03(0.004)$ 0.015-0.075 1911.04968 (**3***l*, ≥ **4***l*) 137 fb-0.108-0.34 1911.04968 (**3**ℓ, ≥ **4**ℓ) $t\bar{t} + \phi$, pseudoscalar (scalar), $g_{top}^2 \times BR(\phi \rightarrow 2\ell) > = 0.03(0.04)$ 137 fb⁻¹ quark compositeness ($q\bar{q}$), $\eta_{LUBB} = 1$ <12.8 1803.0803 (2j) 36 fb⁻¹ <20 1812.10443 (2*l*) 36 fb⁻¹ quark compositeness (ll), $\eta_{LURR} = 1$ A+.,... quark compositeness $(q\bar{q}), n_{LURR} = -1$ Λ-.... <17.5 1803.0803 (2j) 36 fb⁻¹ <32 1812.10443 (2*l*) quark compositeness (ll), $\eta_{URR} = -1$ 36 fb⁻¹ ٨., Excited Lepton Contact Interaction 0.2-5.6 2001.04521 (2e+2j) 77 fb⁻¹ Excited Lepton Contact Interaction 0.2-5.7 2001.04521 (2µ+2j 77 fb⁻¹ (axial-)vector mediator ($\chi\chi$), $g_q = 0.25$, $g_{DM} = 1$, $m_\chi = 1$ GeV <1.8 1712.02345 (≥ 1j + E_T^{min} 36 fb⁻¹ (axial-)vector mediator $(a\ddot{a})$, $a_n = 0.25$, $a_{nM} = 1$, $m_n = 1$ GeV 0.5-2.8 1911.03947 (2j) 137 fb⁻¹ 1901.01553 (0, $1\ell + \ge 3j + E_T^{min}$ 36 fb⁻¹ scalar mediator (+ $t/t\tilde{t}$), $g_q = 1$, $g_{DM} = 1$, $m_x = 1$ GeV < 0.29 pseudoscalar mediator (+ $t/t\bar{t}$), $g_q = 1$, $g_{DM} = 1$, $m_\chi = 1$ GeV 1901.01553 (0, 1/ + \ge 3j + E_T^{min} 36 fb⁻¹ scalar mediator (fermion portal), $\lambda_{1} = 1.m_{2} = 1$ GeV <1.4 1712.02345 ($\geq 1j + E_{T}^{minn}$) 36 fb⁻¹ <1.54 1810.10069 (4j) complex sc. med. (dark QCD), $m_{\pi_{0.6}} = 5$ GeV, $c\tau_{x_{cm}} = 25$ mm 36 fb⁻¹ Darl Baryonic Z', $g_q = 0.25$, $g_{DM} = 1$, $m_\chi = 1$ GeV <1.9 1908.01713 (h + E_T^{min}) 36 fb⁻¹ Z' = 2HDM, $g_{Z} = 0.8$, $g_{GM} = 1$, $tan\beta = 1$, $m_r = 100 \text{ GeV}$ 0.5-3.2 1908.01713 (h + E^{mins}) 36 fb⁻¹ vector mediator $(q\bar{q})$, $g_q = 0.25$, $g_{DM} = 1$, $m_\chi = 1$ GeV 18 fb⁻¹ 0.35-0.7 1911.03761 (≥ 3j) 0.3-0.6 1811.10151 (1µ+1j+E_T^{mins} Leptoquark mediator, $\beta = 1, B = 0.1, \Delta_{X,DM} = 0.1, 800 < M_{LQ} < 1500 \text{ GeV}$ 77 fb⁻¹ RPV stop to 4 guarks 0.08-0.52 1808.03124 (2i; 4i) 36 fb⁻¹ 0.1-0.72 1806.01058 (2j) RPV squark to 4 quarks 38 fb⁻¹ 0.1-1.41 1806.01058 (2j) ğ RPV gluino to 4 guarks 38 fb⁻¹ <1.5 1810.10092 (6j) 36 fb⁻¹ RPV gluinos to 3 guarks ADD (ij) HLZ, $n_{ED} = 3$ <12 1803.0803 (2j 36 fb⁻¹ ADD $(\gamma\gamma, ll)$ HLZ, $n_{ED} = 3$ <9.3 1812.10443 (2v.2l) 36 fb⁻¹ <9.9 1712.02345 (≥ 1j + E^{min} ADD G_{KK} emission, n = 236 fb⁻¹ ADD QBH (jj), $n_{ED} = 6$ <8.2 1803.0803 (2j) 36 fb⁻¹ ADD OBH (eu), $n_{ro} = 6$ <5.6 1802.01122 (eu 36 fb⁻¹ RS $G_{KK}(\gamma\gamma)$, $k/\overline{M}_{Pl} = 0.1$ <4.1 1809.00327 (2y) 36 fb⁻¹ RS QBH (jj), $n_{ED} = 1$ <5.9 1803.0803 (2j) 36 fb⁻¹ 36 fb⁻¹ RS OBH (eu), $n_{PD} = 1$ <3.6 1802.01122 (eµ) non-rotating BH, $M_D = 4 \text{ TeV}$, $n_{ED} = 6$ <9.7 1805.06013 (≥ 7i(l, y)) 36 fb⁻¹ plit-UED, μ≥4 TeV 0.4-2.9 1803.11133 (ℓ + E_T^{mins} 36 fb⁻¹ RS $G_{\text{icc}}(q\bar{q}, gg), k/\overline{M}_{\text{Pl}} = 0.1$ 0.5-2.6 1911.03947 (2j) 137 fb⁻¹ excited light quark (qq), $f_5 = f = f' = 1$, $\Lambda = m_q^*$ 1-5.5 1711.04652 (v + j) 36 fb⁻¹ excited b quark. $f_c = f = f' = 1$. $\Lambda = m^*$ 1-1.8 1711.04652 (y + j) 36 fb⁻¹ excited light quark (qg), $\Lambda = m_q^*$ 0.5-6.3 1911.03947 (2i) 137 fb⁻¹ excited electron, $f_{s} = f = f' = 1$, $\Lambda = m_{o}^{*}$ 0.25-3.9 1811.03052 (y + 2e) 36 fb excited muon. $f_{c} = f = f' = 1$. $\Lambda = m$. 025-38 1811.03052 (v + 2u 36 fb⁻¹ 36 fb⁻¹ vMSM, $|V_{eN}|^2 = 1.0$, $|V_{\mu N}|^2 = 1.0$ 0.001-1.43 1802.02965; 1806.10905 (3/(µ, e); ≥ 1j + 2/(µ, e) vMSM, $|V_{oN}V_{\mu N}^*|^2/(|V_{oN}|^2 + |V_{\mu N}|^2) = 1.0$ 0.02 - 1.6 1806.10905 ($\geq 1j + \mu + e$) 36 fb⁻¹ <0.88 1911.04968 (31. ≥ 41) Type-III seesaw heavy fermions, Flavor-democratic 137 fbector like taus, Doublet 0.12-0.79 1905.10853 (3*l*, ≥4*l*, ≥1τ + 2*l*) 77 fb⁻¹ scalar LQ (pair prod.), coupling to 1^{st} gen. fermions, $\beta = 1$ <1.44 1811.01197 (2e+2i) 36 fb⁻¹ <1.27 1811.01197 (2e+ 2j; e + 2j + E_T^{minn}) scalar LQ (pair prod.), coupling to 1^{st} gen. fermions, $\beta = 0.5$ 36 fb⁻¹ scalar LQ (pair prod.), coupling to 2^{nd} gen. fermions, $\beta = 1$ <1.53 1808.05082 (2µ+2j) 0.8-1.5 1811.10151 (1µ+1j + E^{min}_T 36 fb⁻¹ scalar LQ (pair prod.), coupling to 2^{nd} gen. fermions, $\beta = 1$ 77 fb⁻¹ scalar LQ (pair prod.), coupling to 2^{nd} gen. fermions, $\beta = 0.5$ <1.29 1808.05082 (2 µ + 2j; µ + 2j + E_T^{mins}) 36 fb⁻¹ scalar LQ (pair prod.), coupling to $3^{\rm rd}$ gen. fermions, $\beta = 1$ <1.02 1811.00806 (2T + 2i) 36 fb⁻¹ scalar LQ (single prod.), coup. to 3^{rd} gen. ferm., $\beta = 1, \lambda = 1$ < 0.74 1806.03472 (2 τ + b) 36 fb⁻¹ Z_p, narrow resonance 1912.04776 (2u 137 fb⁻¹ 0.0115-0.075 1912.04776 (2u) Zo, narrow resonance 011-02 137 fb⁻¹ SSM Z'(qq) 0.5-2.9 1911.03947 (2j) 137 fb-Z'(qq̃) Superstring Z'_g 1905.10331 (**1**j, 1γ) 36 fb⁻¹ 0.01-0.125 02-4.6 2103.02708 (2e, 2µ) 140 fb⁻¹ LFV Z', BR(eµ) = 10% 0.2-4.4 1802.01122 (eµ) 36 fb⁻¹ Leptophobic Z' 78 fb⁻¹ 0.05-0.45 1909.04114 (2j) SSM W'(tv) 0.4-5.2 1803.11133 (l + E^{minu} 36 fb⁻¹ 0.4-4 1807.11421 (T + E_T^{mins}) 36 fb⁻¹ SSM W'(TV) 0.5-3.6 1911.03947 (2j) SSM W(qq) 137 fb⁻¹ LRSM $W_{\alpha}(lN_{\alpha}), M_{N_{\alpha}} = 0.5M_{M_{\alpha}}$ <4.4 1803.11116 (21 + 2i) 36 fb⁻¹ LR SM $W_{R}(\tau N_{R}), M_{N_{R}} = 0.5 M_{W_{R}}$ <3.5 1811.00806 (2T + 2j) 36 fb⁻¹ 0.5-6.6 1911.03947 (2j) Axigluon, Coloron, cotθ = 1 137 fb⁻¹ 0.1 10 10.0

mass scale [TeV]

Selection of observed exclusion limits at 95% C.L. (theory uncertainties are not included)

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Α	TLAS Exotics S	Search	es* - 9	95%	6 CL	Upper Exclusion Limits		ATLA	S Preliminar
St	atus: May 2020						$\int \mathcal{L} dt = (3)$	3.2 − 139) fb ^{−1}	$\sqrt{s} = 8, 13 \text{ TeV}$
	Model	<i>ℓ</i> ,γ	Jets†	E ^{miss} T	∫£ dt[fb	⁻¹] Limit			Reference
Extra dimensions	ADD $G_{KK} + g/q$ ADD non-resonant $\gamma\gamma$ ADD QBH ADD BH high $\sum p_T$ ADD BH multijet RS1 $G_{KK} \rightarrow \gamma\gamma$ Bulk RS $G_{KK} \rightarrow WW/ZZ$ Bulk RS $G_{KK} \rightarrow WV \rightarrow \ell \gamma qq$ Bulk RS $g_{KK} \rightarrow tt$ 2UED / RPP	$\begin{array}{c} 0 \ e, \mu \\ 2 \ \gamma \\ \hline \\ - \\ 2 \ \gamma \\ \end{array}$ $e \ 1 \ e, \mu \\ 1 \ e, \mu \end{array}$	$1 - 4j$ $-$ $2j$ $\geq 2j$ $\geq 3j$ $-$ $2j/1J$ $\geq 1 b, \geq 1J/2$ $\geq 2 b, \geq 3j$	Yes - - - Yes Yes Yes	36.1 36.7 37.0 3.2 3.6 36.7 36.1 139 36.1 36.1	Mp Ms Mth Mth Gкк mass Gкк mass 2.3 Te Gкк mass 2.0 TeV gкк mass KK mass 1.8 TeV	7.7 TeV 8.6 TeV 8.9 TeV 8.2 TeV 9.55 TeV 4.1 TeV V 3.8 TeV	n = 2 n = 3 HLZ NLO n = 6 $n = 6, M_D = 3 \text{ TeV, rot BH}$ $n = 6, M_D = 3 \text{ TeV, rot BH}$ $k/\overline{M}_{Pl} = 0.1$ $k/\overline{M}_{Pl} = 1.0$ $k/\overline{M}_{Pl} = 1.0$ $\Gamma/m = 15\%$ Tier (1,1), $\mathcal{B}(A^{(1,1)} \rightarrow tt) = 1$	1711.03301 1707.04147 1703.09127 1606.02265 1512.02586 1707.04147 1808.02380 2004.14636 1804.10823 1803.09678
Gauge bosons	$\begin{array}{l} \mathrm{SSM}\ Z' \to \ell\ell\\ \mathrm{SSM}\ Z' \to \tau\tau\\ \mathrm{Leptophobic}\ Z' \to bb\\ \mathrm{Leptophobic}\ Z' \to tt\\ \mathrm{SSM}\ W' \to \ell\nu\\ \mathrm{SSM}\ W' \to \tau\nu\\ \mathrm{HVT}\ W' \to WZ \to \ell\nuqq \ \mathrm{model}\\ \mathrm{HVT}\ V' \to WV \to qqqq \ \mathrm{model}\\ \mathrm{HVT}\ V' \to WH/ZH \ \mathrm{model}\ B\\ \mathrm{HVT}\ W' \to WH \ \mathrm{model}\ B\\ \mathrm{LRSM}\ W_R \to tb\\ \mathrm{LRSM}\ W_R \to \mu N_R \end{array}$	$\begin{array}{c} 2 \ e, \mu \\ 2 \ \tau \\ - \\ 0 \ e, \mu \\ 1 \ e, \mu \\ 1 \ \tau \\ B 1 \ e, \mu \\ B 0 \ e, \mu \\ \end{array}$ multi-channe \\ 0 \ e, \mu \\ multi-channe \\ 2 \ \mu \end{array}	$\begin{array}{c} - \\ 2 b \\ \geq 1 b, \geq 2 J \\ - \\ 2 j / 1 J \\ 2 J \\ \geq 1 b, \geq 2 J \\ \geq 1 b, \geq 2 J \\ \Rightarrow 1 \\ 1 J \end{array}$	- Yes Yes Yes -	139 36.1 36.1 139 36.1 139 36.1 139 36.1 139 36.1 80	Z' mass 2.42 Te Z' mass 2.1 TeV Z' mass 2.1 TeV Z' mass 2.1 TeV W' mass 3.1 TeV Wr mass 3.1 TeV Wr mass 3.1 TeV	5.1 TeV eV 4.1 TeV 6.0 TeV 3.7 TeV 4.3 TeV 3.8 TeV 3.8 TeV 3.2 TeV .25 TeV 5.0 TeV	$\Gamma/m = 1.2\%$ $g_V = 3$ $g_V = 3$ $g_V = 3$ $g_V = 3$ $g_V = 3$ $m(N_R) = 0.5 \text{ TeV}, g_L = g_R$	1903.06248 1709.07242 1805.09299 2005.05138 1906.05609 1801.06992 2004.14636 1906.08589 1712.06518 CERN-EP-2020-073 1807.10473 1904.12679
CI	CI qqqq CI ℓℓqq CI tttt	_ 2 e, μ ≥1 e,μ	2 j _ ≥1 b, ≥1 j	_ _ Yes	37.0 139 36.1	Λ Λ Λ 2.57 1	TeV	21.8 TeV η_{LL}^{-} 35.8 TeV η_{LL}^{-} $ C_{4t} = 4\pi$	1703.09127 CERN-EP-2020-066 1811.02305
DM	Axial-vector mediator (Dirac DM Colored scalar mediator (Dirac I $VV_{\chi\chi}$ EFT (Dirac DM) Scalar reson. $\phi \rightarrow t\chi$ (Dirac DM	1) 0 e, μ DM) 0 e, μ 0 e, μ 1) 0-1 e, μ	$\begin{array}{c} 1-4 \ j \\ 1-4 \ j \\ 1 \ J, \leq 1 \ j \\ 1 \ b, \ 0\text{-}1 \ J \end{array}$	Yes Yes Yes Yes	36.1 36.1 3.2 36.1	m _{med} 1.55 TeV m _{med} 1.67 TeV M₂ 700 GeV m _φ 100 GeV	3.4 TeV	$\begin{array}{l} g_{q} \!=\! 0.25, g_{\chi} \!=\! 1.0, m(\chi) = 1 \mathrm{GeV} \\ g \!=\! 1.0, m(\chi) = 1 \mathrm{GeV} \\ m(\chi) < 150 \mathrm{GeV} \\ y = 0.4, \lambda = 0.2, m(\chi) = 10 \mathrm{GeV} \end{array}$	1711.03301 1711.03301 1608.02372 1812.09743
ΓО	Scalar LQ 1 st gen Scalar LQ 2 nd gen Scalar LQ 3 rd gen Scalar LQ 3 rd gen	1,2 <i>e</i> 1,2 μ 2 τ 0-1 <i>e</i> , μ	≥ 2 j ≥ 2 j 2 b 2 b	Yes Yes - Yes	36.1 36.1 36.1 36.1	LQ mass 1.4 TeV LQ mass 1.56 TeV LQ ^w mass 1.03 TeV LQ ^d mass 970 GeV		$\begin{split} \beta &= 1 \\ \beta &= 1 \\ \mathcal{B}(\mathrm{LQ}_3^u \to b\tau) &= 1 \\ \mathcal{B}(\mathrm{LQ}_3^d \to t\tau) &= 0 \end{split}$	1902.00377 1902.00377 1902.08103 1902.08103
Heavy quarks	$\begin{array}{c} VLQ\;TT \rightarrow Ht/Zt/Wb + X\\ VLQ\;BB \rightarrow Wt/Zb + X\\ VLQ\;T_{5/3}T_{5/3} T_{5/3} \rightarrow Wt + X\\ VLQ\;Y \rightarrow Wb + X\\ VLQ\;B \rightarrow Hb + X\\ VLQ\;QQ \rightarrow WqWq \end{array}$	multi-channe multi-channe $2(SS)/\geq 3 e,$ $1 e, \mu$ $0 e, \mu, 2 \gamma$ $1 e, \mu$	$ \begin{array}{l} \text{el} \\ \text{el} \\ \mu \geq 1 \ \text{b}, \geq 1 \ \text{j} \\ \geq 1 \ \text{b}, \geq 1 \ \text{j} \\ \geq 1 \ \text{b}, \geq 1 \ \text{j} \\ \geq 4 \ \text{j} \end{array} $	Yes Yes Yes Yes	36.1 36.1 36.1 36.1 79.8 20.3	T mass 1.37 TeV B mass 1.34 TeV T _{5/3} mass 1.64 TeV Y mass 1.85 TeV B mass 1.21 TeV Q mass 690 GeV		SU(2) doublet SU(2) doublet $\mathcal{B}(T_{5/3} \rightarrow Wt) = 1, c(T_{5/3}Wt) = 1$ $\mathcal{B}(Y \rightarrow Wb) = 1, c_R(Wb) = 1$ $\kappa_B = 0.5$	1808.02343 1808.02343 1807.11883 1812.07343 ATLAS-CONF-2018-024 1509.04261
Excited	Excited quark $q^* \rightarrow qg$ Excited quark $q^* \rightarrow q\gamma$ Excited quark $b^* \rightarrow bg$ Excited lepton ℓ^* Excited lepton γ^*	- 1 γ - 3 e,μ 3 e,μ,τ	2 j 1 j 1 b, 1 j - -	- - - -	139 36.7 36.1 20.3 20.3	q* mass q* mass b* mass 2.6 ° /* mass 3. v* mass 1.6 TeV	6.7 TeV 5.3 TeV TeV .0 TeV	only u^* and d^* , $\Lambda = m(q^*)$ only u^* and d^* , $\Lambda = m(q^*)$ $\Lambda = 3.0 \text{ TeV}$ $\Lambda = 1.6 \text{ TeV}$	1910.08447 1709.10440 1805.09299 1411.2921 1411.2921
Other	Type III Seesaw LRSM Majorana v Higgs triplet $H^{\pm\pm} \rightarrow \ell \ell$ Higgs triplet $H^{\pm\pm} \rightarrow \ell \tau$ Multi-charged particles Magnetic monopoles	1 e, μ 2 μ 2,3,4 e, μ (S 3 e, μ, τ -	≥ 2 j 2 j 5) - - -	Yes _ _ _ _ _	79.8 36.1 36.1 20.3 36.1 34.4	N ⁰ mass 560 GeV N _R mass : H ^{±±} mass 870 GeV H ^{±±} mass 400 GeV multi-charged particle mass 1.22 TeV monopole mass 2.37 Te	3.2 TeV	$\begin{split} m(W_R) &= 4.1 \text{ TeV}, g_L = g_R \\ \text{DY production} \\ \text{DY production}, \mathcal{B}(H_L^{\pm\pm} \to \ell \tau) = 1 \\ \text{DY production}, q &= 5e \\ \text{DY production}, g &= 1g_D, \text{ spin } 1/2 \end{split}$	ATLAS-CONF-2018-020 1809.11105 1710.09748 1411.2921 1812.03673 1905.10130
	$\sqrt{s} = 8 \text{ TeV}$	s = 13 TeV artial data	√s = 13 full da	TeV ta		10 ⁻¹ 1	1	⁰ Mass scale [TeV]	

Only a selection of the available mass limits on new states or phenomena is shown

⁺Small-radius (large-radius) jets are denoted by the letter j (J) Prospects for BSM at LHC - PANIC 2021

Long Shutdown 2: preparing for Run 3



Some new opportunities at Run 3

• ATLAS New Small Wheel: Fast readout and precision tracking resolution



• ATLAS LAr L1: super cells improved energy resolution and identification efficiency



• CMS HCAL electronics upgraded now read out in 4-7 depths

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Unconventional Data Taking

- Novel idea to circumvent bandwidth limitation w/ partial event building
- Going beyond the 1-kHz limit in two ways:
 - "data parking" \rightarrow offline reconstruction is delayed.
 - "data scouting" \rightarrow saving only objects reco'd at trigger level



Keep an eye on the other side of the ring

 Most spectacular example of vector portal address SM problems: dark photon



If epsilon < 10⁻⁵ A' can be longlived

Main challenge for ATLAS/CMS is triggering and discriminating
 backgrounds
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Scouting Dark Photons at CMS



Scouting Dark Photons at CMS



New forward detectors have their say



 Significant extension to the physics reach by tagging and measuring momentum and emission angle of very forward protons
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Exploring Squeezed Mass Spectra

- Forward detectors offer a unique opportunity to probe yy and gluongluon collisions
- Complete measurement of the final state



Looking forward for High Lumi



HL LHC Physics Opportunities



- Lower experimental uncertainties

New tools for searches:

- timing information
- extended tracking for forward boosted physics
- new trigger strategies

<u>Common Effort</u>

CERN-LPCC-2018-05

European Strategy

SnowMass2021

Accumulating data

 High mass sensitivity dominated by statistics and object performance at high energy



Accumulating data

- High mass sensitivity dominated by statistics and object performance at high energy
 - Hadronic channels dominated by top final states



Being inspired by Run 2













2000

M_{LQ} [GeV)

ATLAS ITK Silicon Tracker upgrade

- Nearly 13 m² of pills and 165 m² of strips with improved coverage and novel readout electronics
- Improves tracking and b-tagging performance compared to Run 2



Displaced Tracks at HL-LHC

- Higher reco efficiency with ITk detector
 Improved geometry and larger volume w/ lower material budget

1.4

ATLAS Simulation

R-hadron Decay Radius [mm]

 Sensitive to longlived particles with τ ~10 ps-10 ns decaying to multiple charged particles





800

CMS New MIP Timing Detector

 Significant PU contamination and whole event reconstruction degradation at HL-LHC



CMS Simulation Preliminary 14 TeV

 New Hermetic timing detector with various technologies optimized for different radiation levels



Displaced Photons w/ MTD





- Exploit MTD to reduce BS timing information crucial to evaluate photons TOF w/ ECAL
- Sensitivity of the analysis is explored requiring at least one displaced photon and making a 0 background assumption.



Being creative with timing

 Reconstructed vertex to measure the TOF of LLPs

 Kinematic closure: direct measurement of the LLP mass



Neutralino mass reconstruction

Stop production with LL neutralino decaying into Z and Gravitino





Conclusions

- Direct searches for BSM signatures important part of the (HL) LHC programme
- These signatures could have been missed or thrown away as noise: Important to check all our blind spots!

Conclusions



Conclusions



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