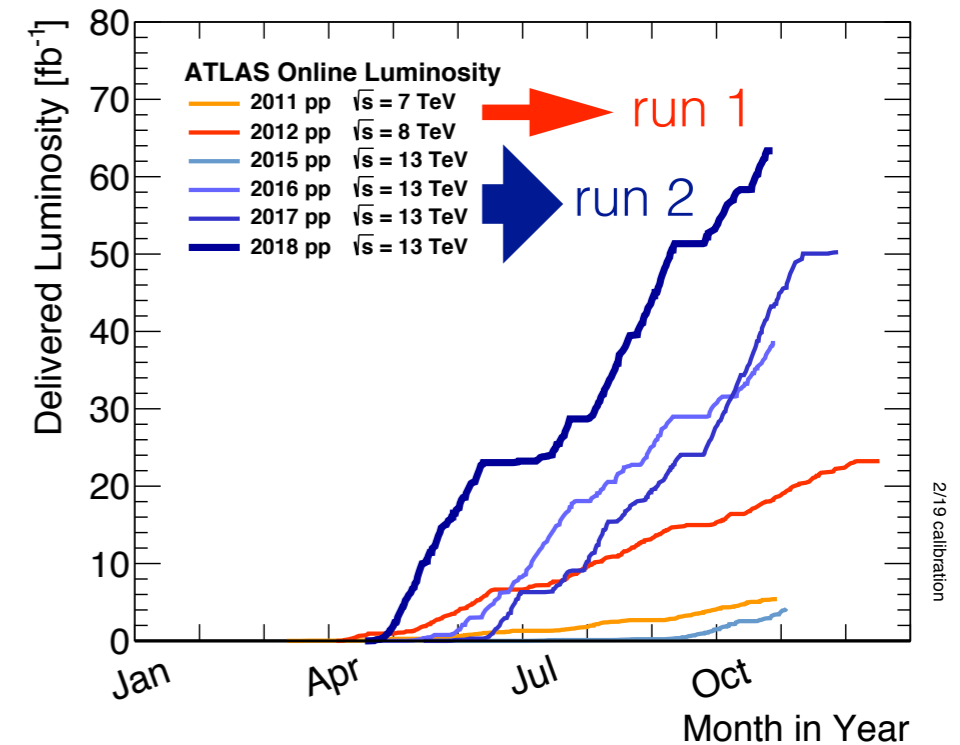
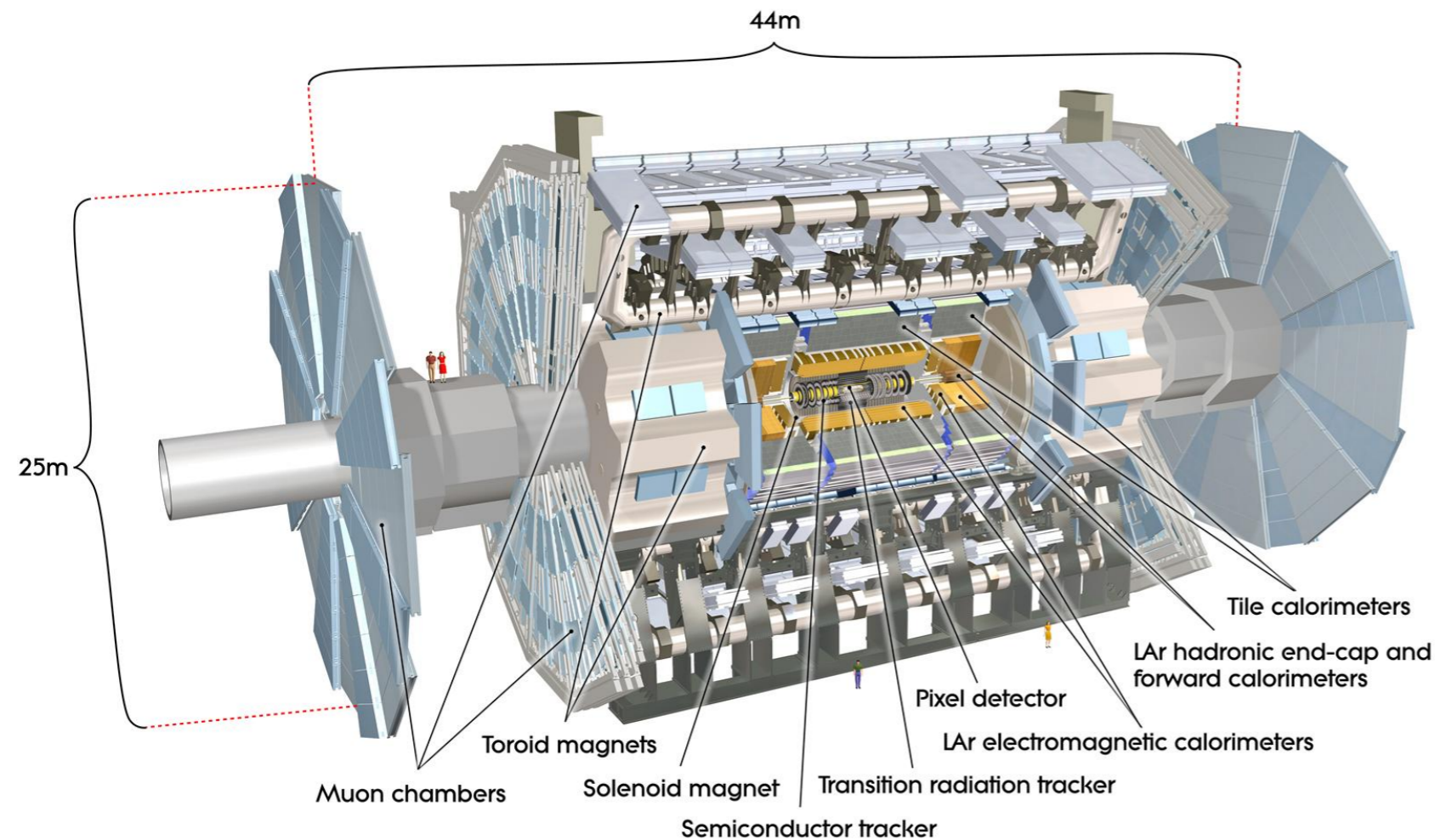


# ATLAS

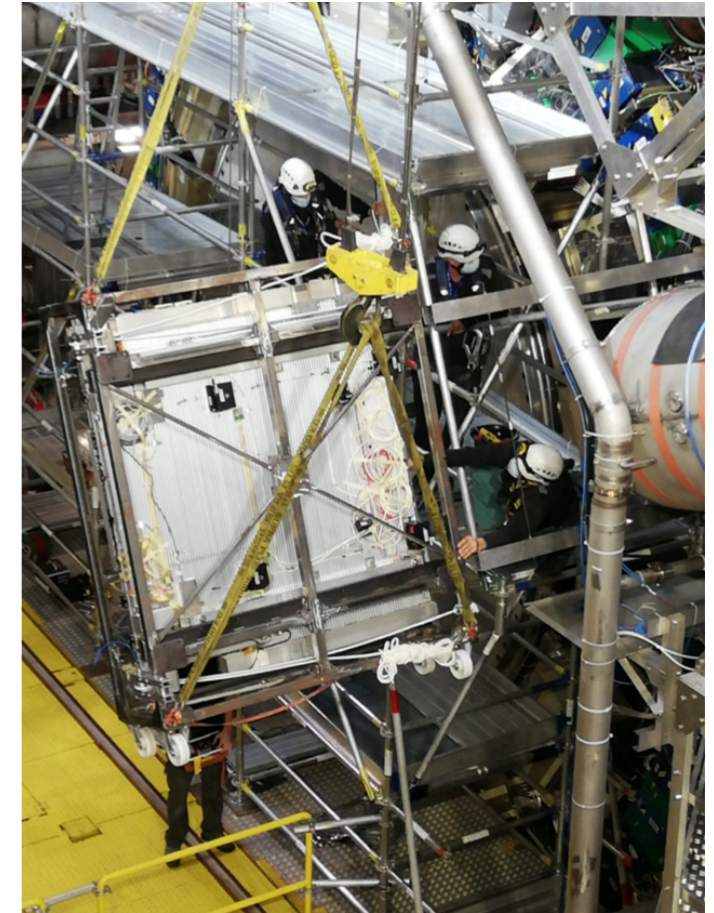
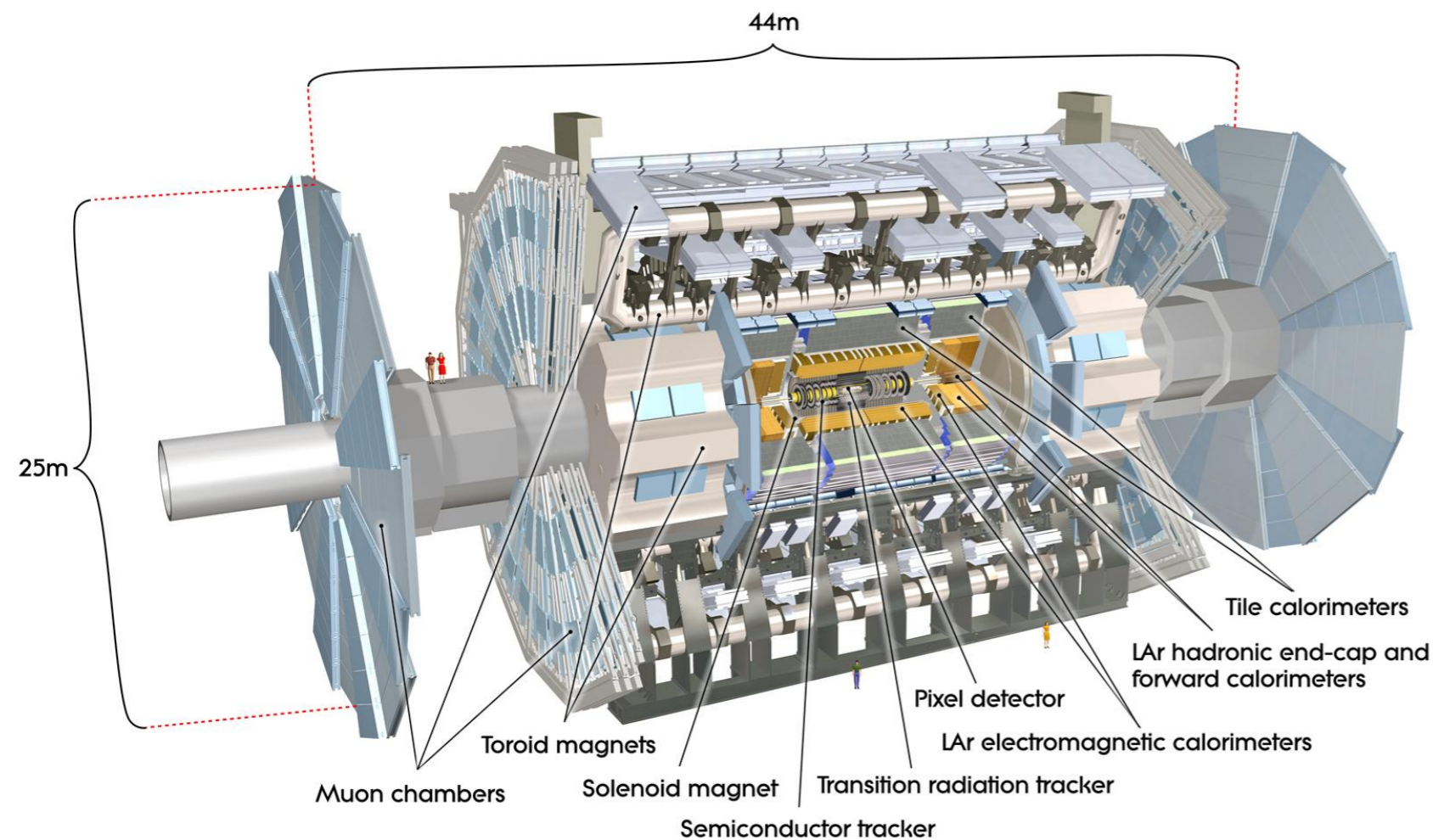
Mark Owen on behalf of ATLAS UK  
PPAP Meeting 20 November 2020

# ATLAS



- General purpose detector with wide ranging physics programme: QCD, EW, Higgs, Top, B, Heavy Ion, Searches.
  - 968 papers to date ( $\sim 7$  / month).
  - Data analysis is not finished when the data is on tape - big effort ongoing to exploit the run-2 data (67 papers use the full run-2 dataset).
  - In parallel, preparing for run-3 and the upgrade of ATLAS for HL-LHC.

# ATLAS

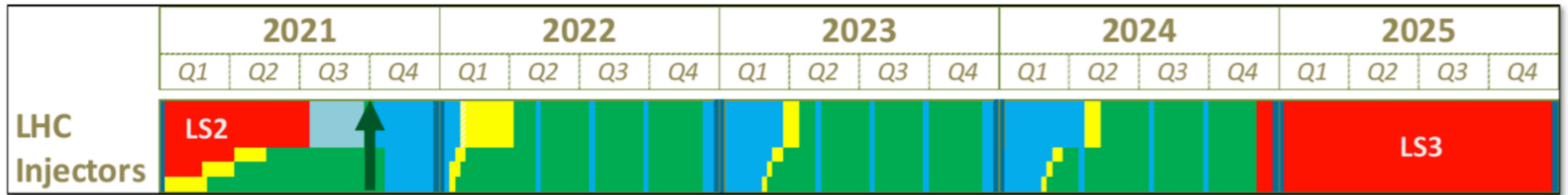


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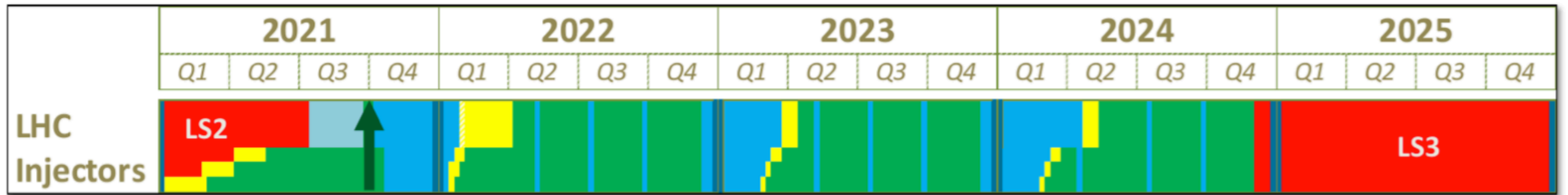
# ATLAS UK

- UK is one of the leading countries in ATLAS.
- Consistently hold leadership roles across all areas of the experiment above our weight (10.5% of authors).
- Recent roles held by UK people in the last year:
  - Conveners of 6/10 physics groups (typically >200-300 physicists in each group).
  - Chair of collaboration board (~180 institutes).
  - Trigger coordinator.
  - ITK deputy project leader, ITK pixels project leader.
  - SCT project leader.
  - Deputy run coordinator.
- Impossible to cover the huge breadth of work done by >500 ATLAS UK people in 20 mins.

# ATLAS: 5 year view



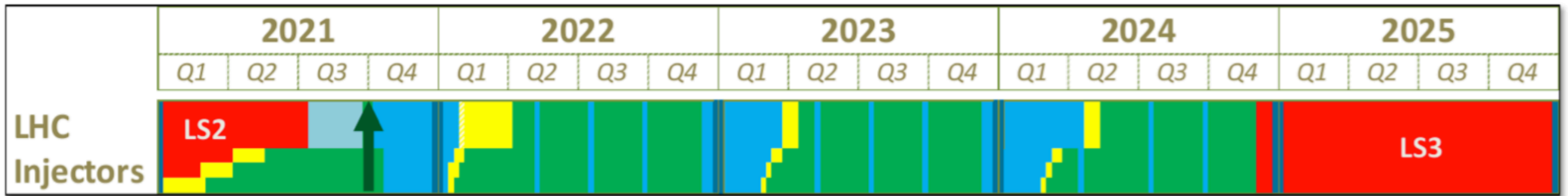
# ATLAS: 5 year view



← Analysis of run-2 data →

# ATLAS: 5 year view

Install & commission phase-1 upgrades



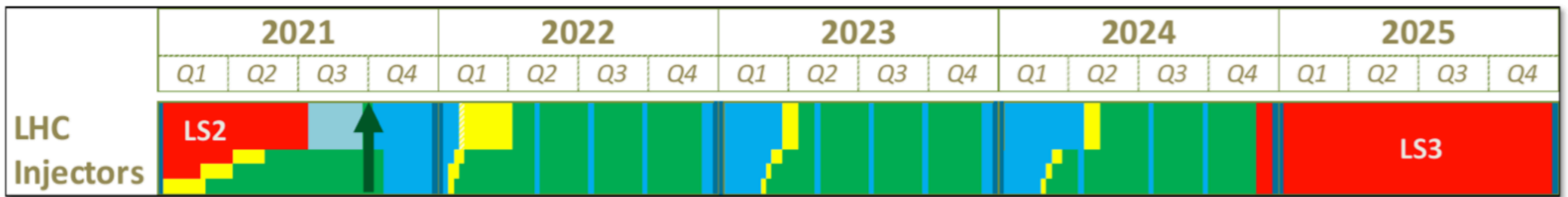
Analysis of run-2 data



# ATLAS: 5 year view

Maintain & operate detector

Install & commission phase-1 upgrades



Analysis of run-2 data

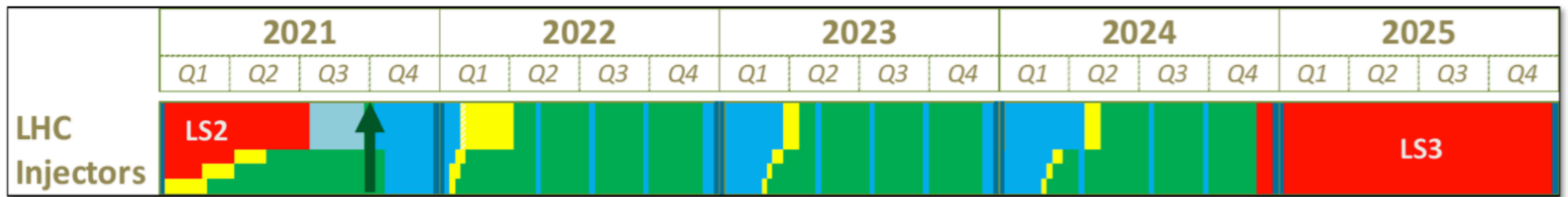


# ATLAS: 5 year view

Maintain & operate detector



Install & commission phase-1 upgrades



Analysis of run-2 data

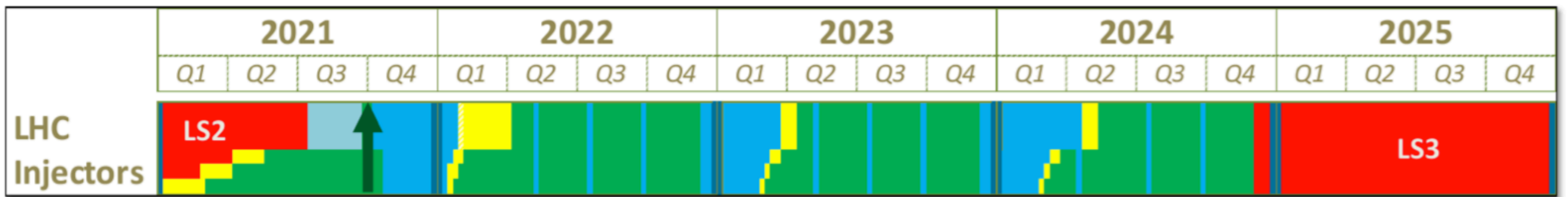


Build phase-2 upgrades

# ATLAS: 5 year view

Maintain & operate detector

Install & commission phase-1 upgrades



Analysis of run-2 data

Build phase-2 upgrades

Analysis of run-3 data

# Outline

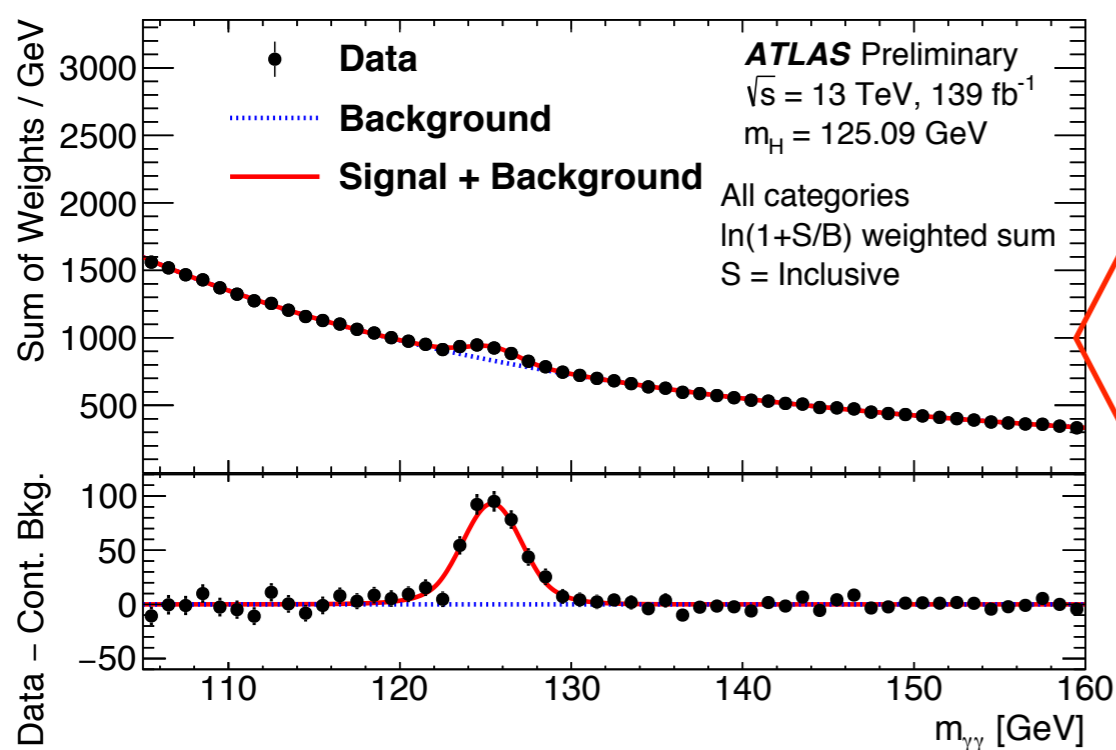
- Recent physics highlights
- Preparations for run-3
- Upgrading ATLAS for HL-LHC

UK continues to lead many activities in the experiment  
Everything shown here has strong UK leadership

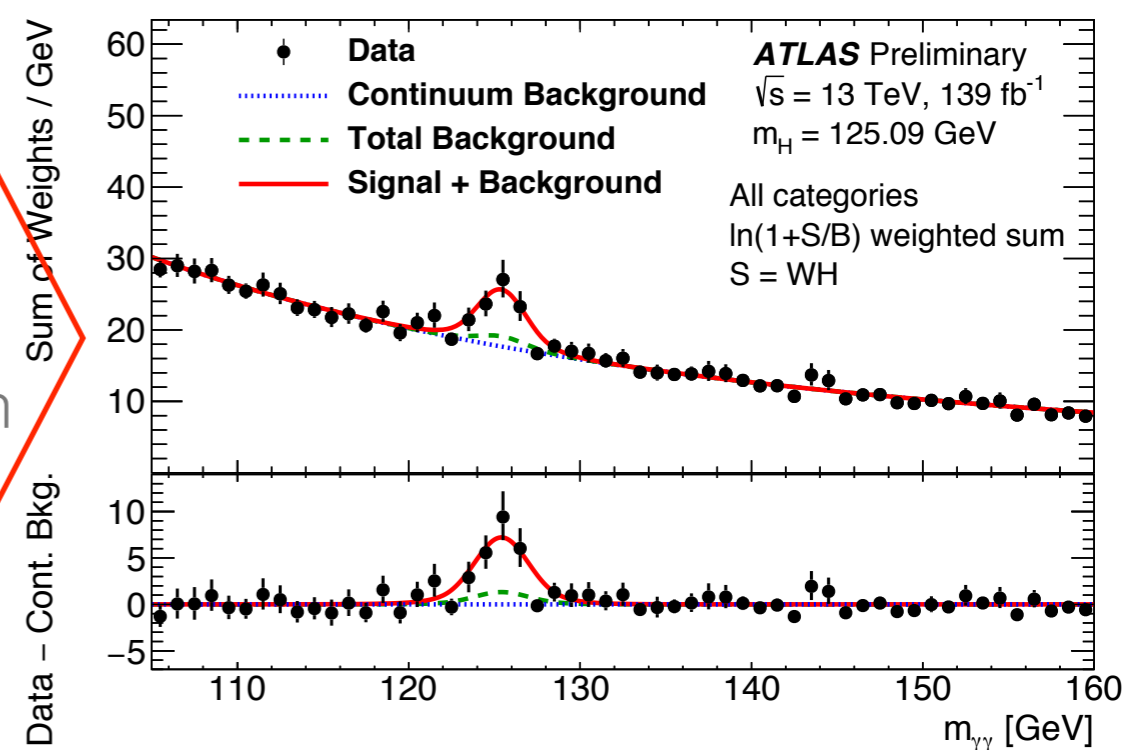
# Physics highlights

# H $\rightarrow$ $\gamma\gamma$

- Full dataset allows us to probe the different Higgs production modes:

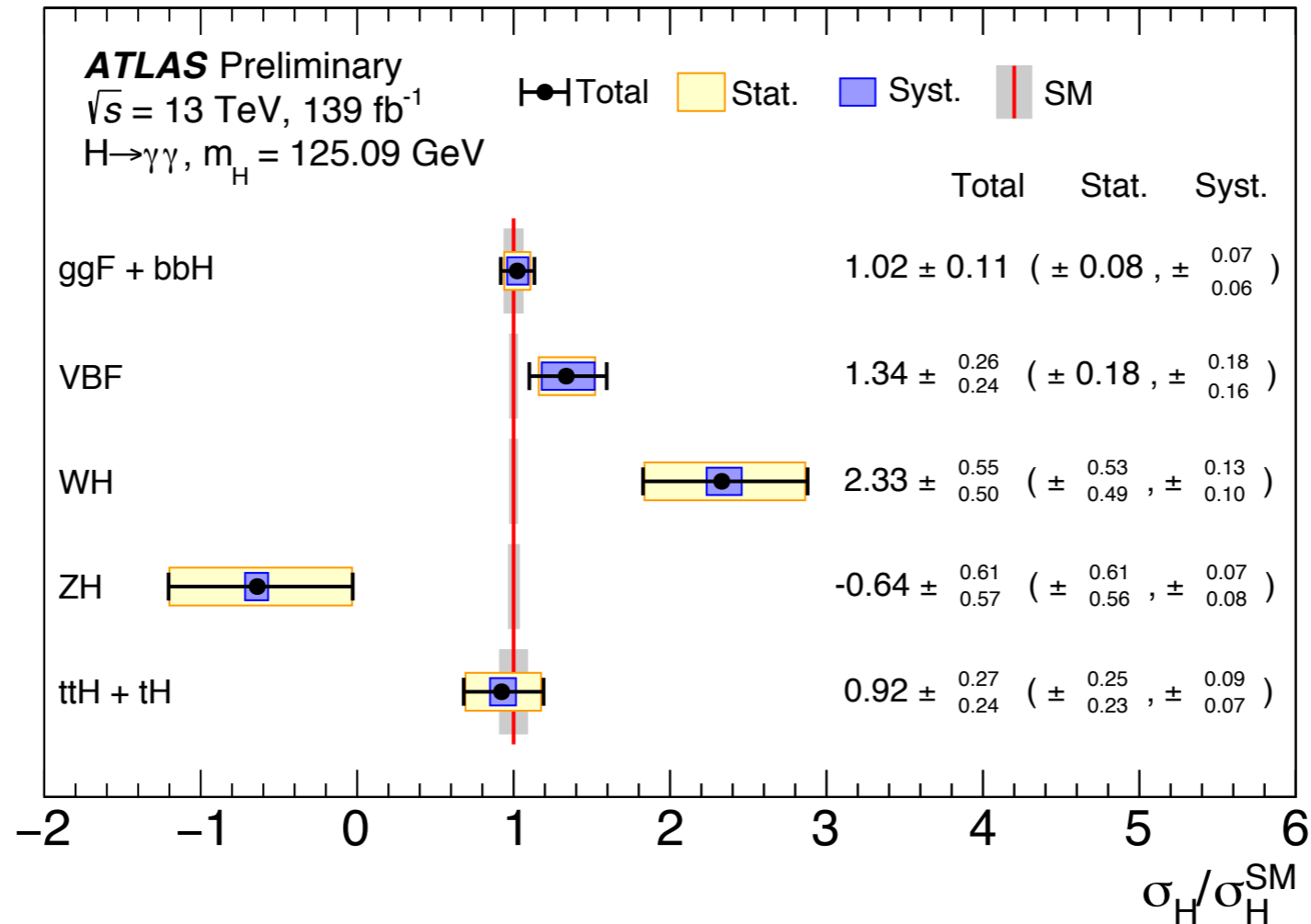


Complex  
BDTs for  
classification



# H → γγ

- Full dataset allows us to probe the different Higgs production modes:



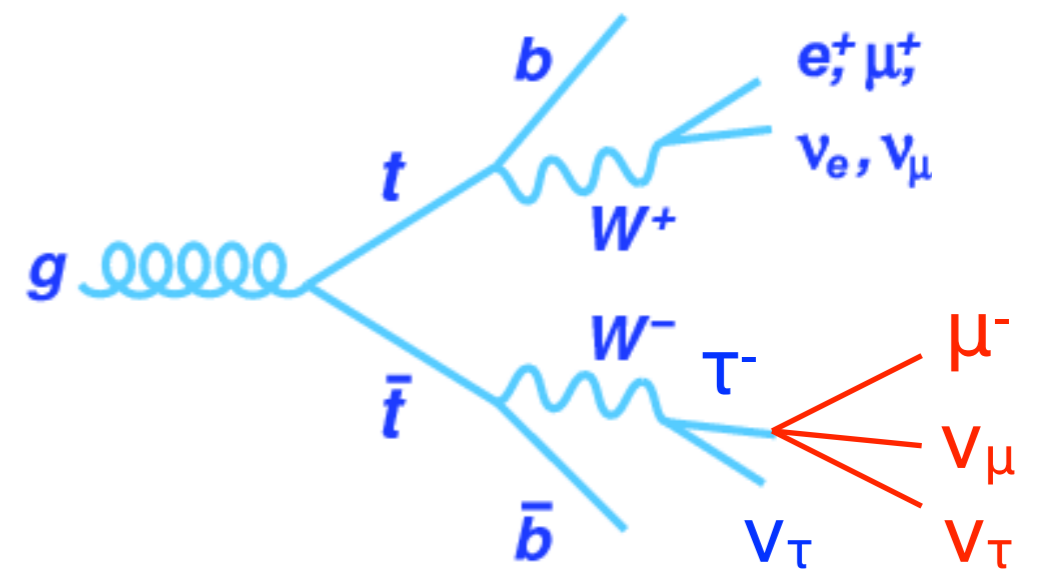
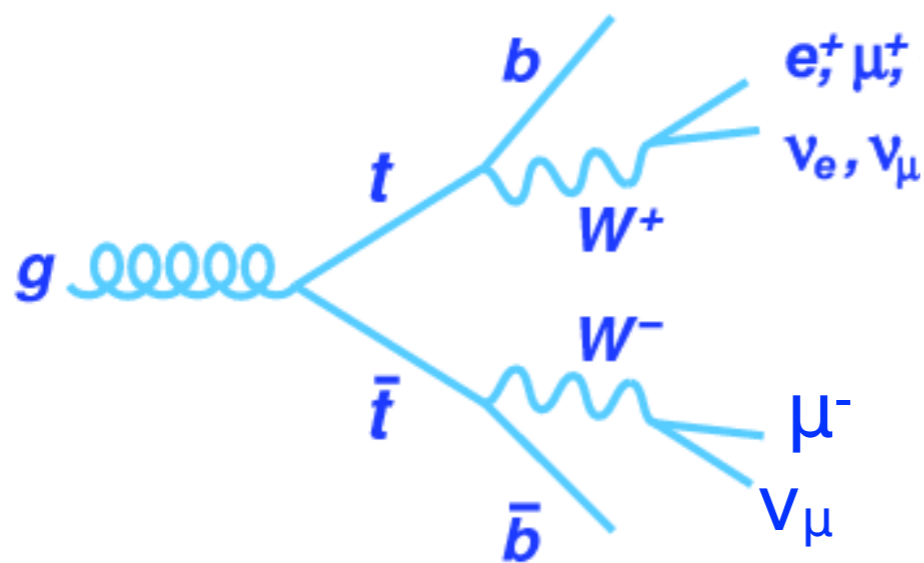
**2x improvement** in sensitivity above luminosity increase for VH and top.

Vital to have strong level of effort to exploit the run-2/3 data.

# Lepton Universality

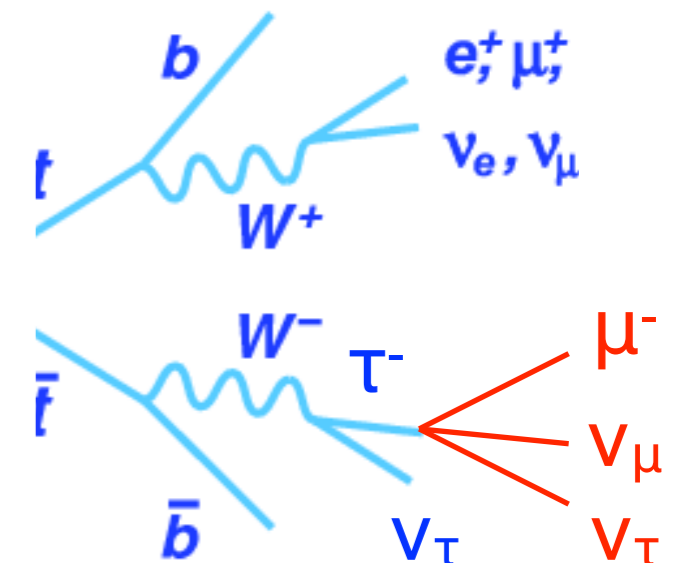
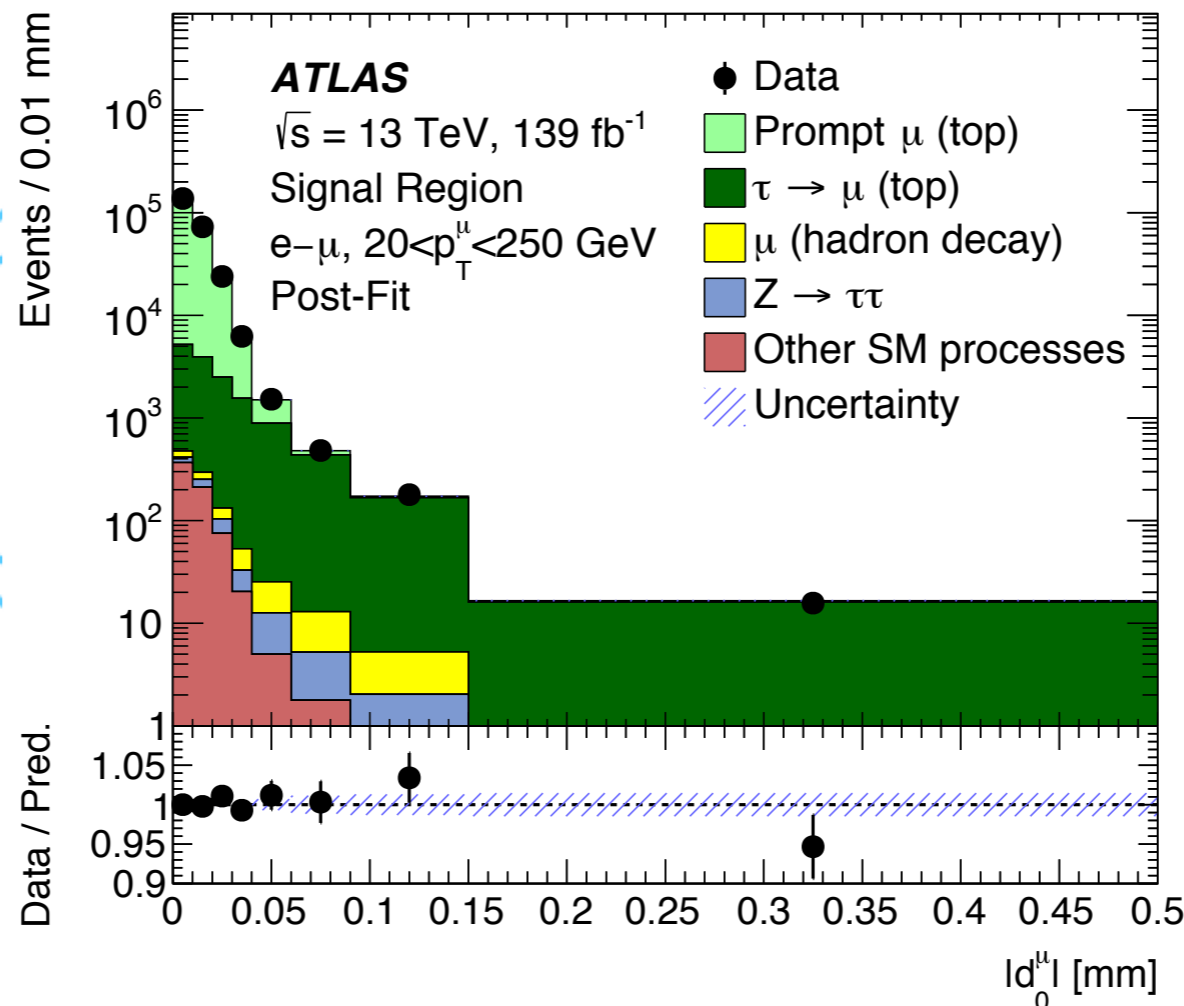
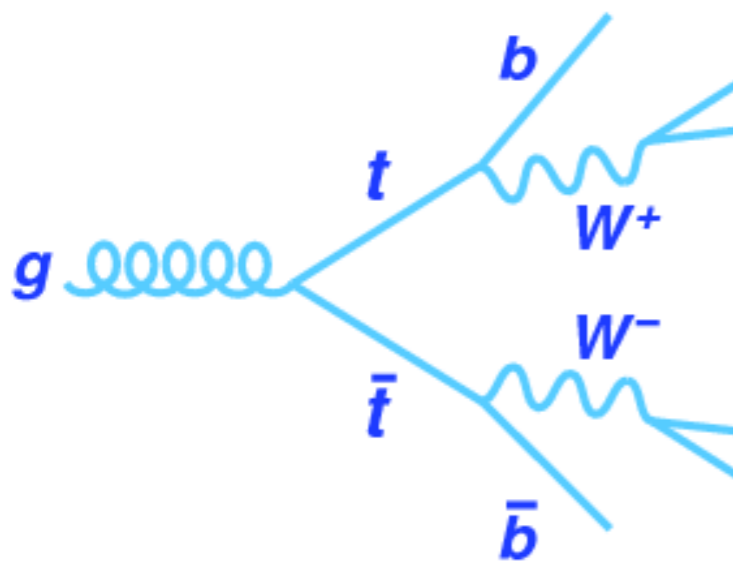
arXiv:2007.14040,  
submitted to Nature Physics

- Legacy result from LEP:
  - $\text{Br}(W \rightarrow \tau\nu)/\text{Br}(W \rightarrow \mu\nu) = 1.070 \pm 0.026$
  - $2.7\sigma$  away from 1.
- Exploit huge LHC  $t\bar{t}$  production rate to get sample of 500k muons.



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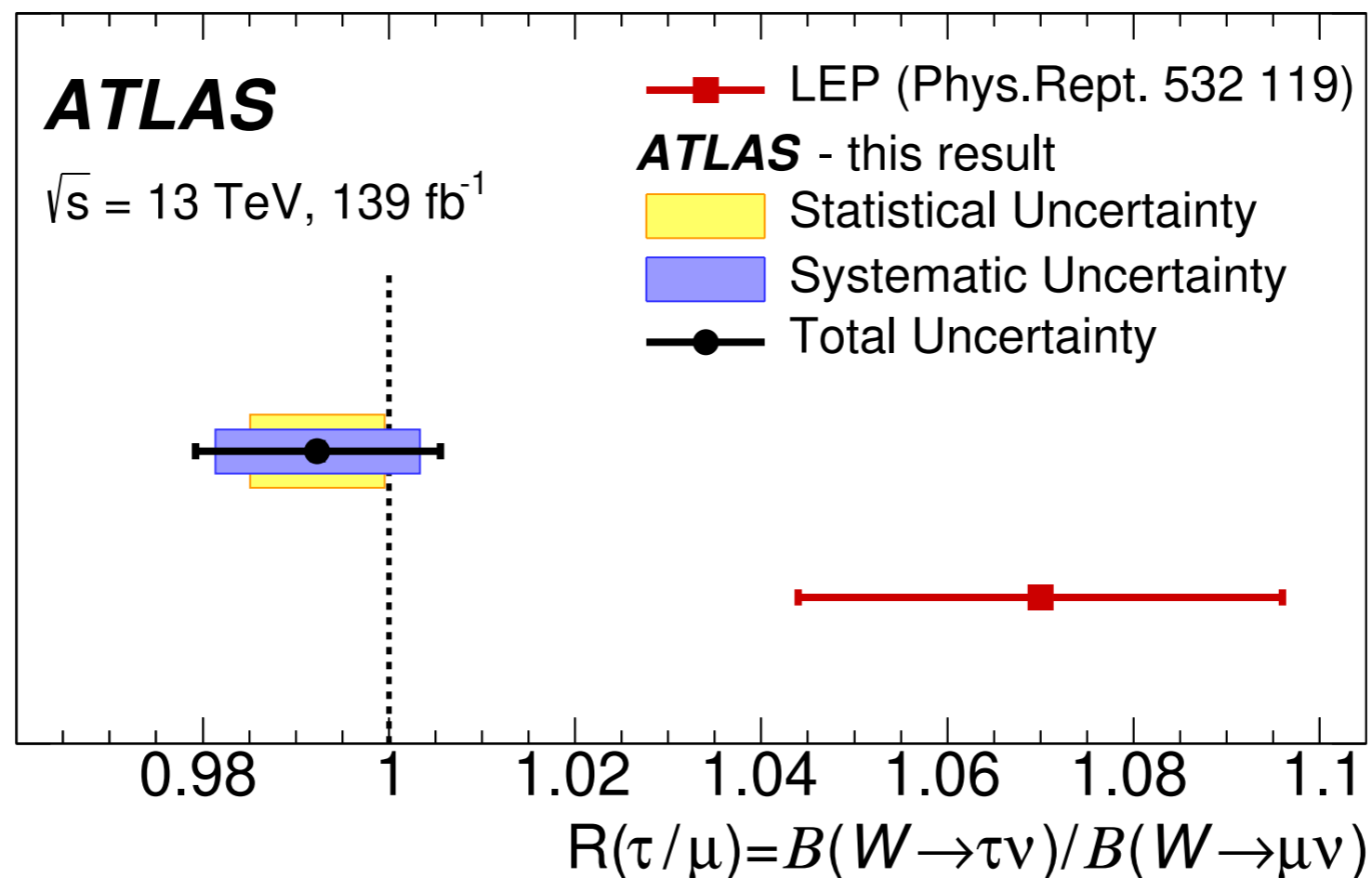
$d_0$  resolution from silicon tracker, UK experts provide main expertise on DAQ, DCS & operations.



# Lepton Universality

arXiv:2007.14040,  
submitted to Nature Physics

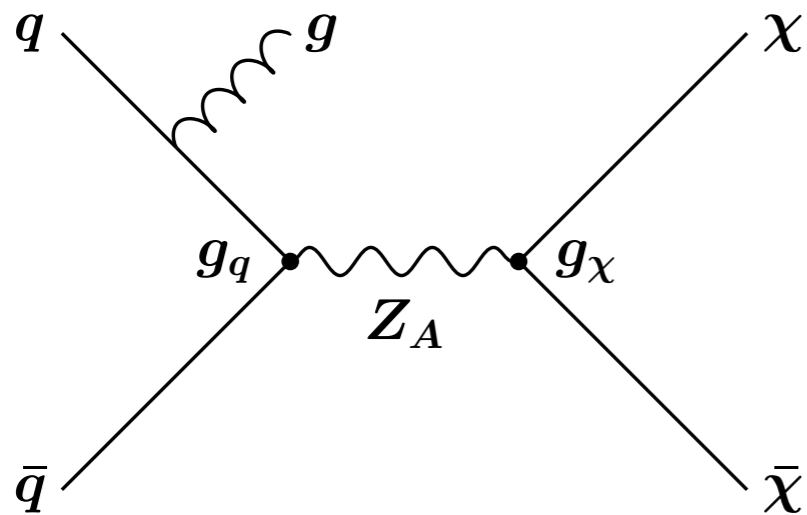
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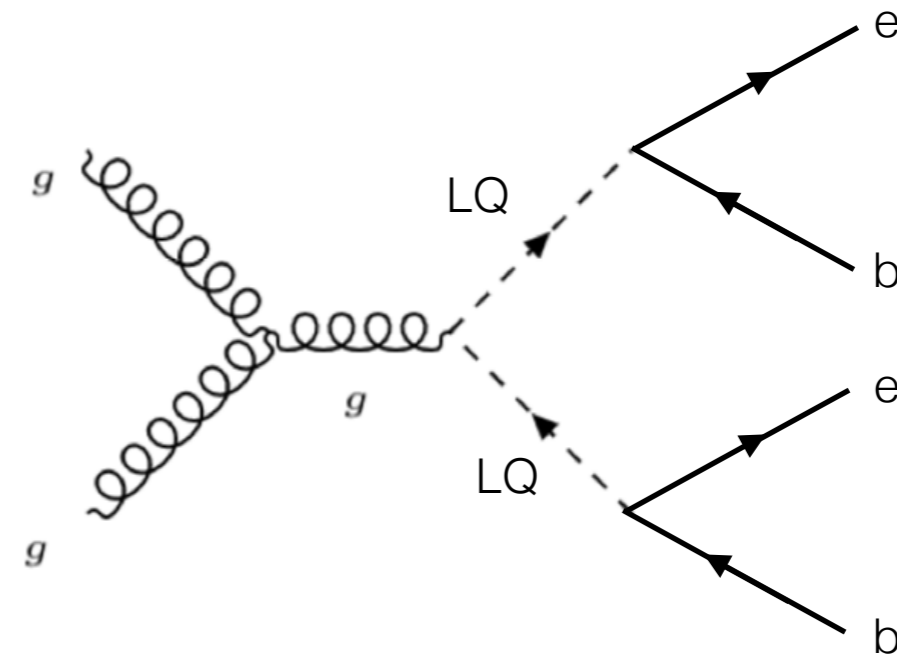
Factor 2 improvement in precision over LEP

# Searching for new physics

- Two examples of recent ATLAS searches:



Search for new invisible particles in mono-jet events

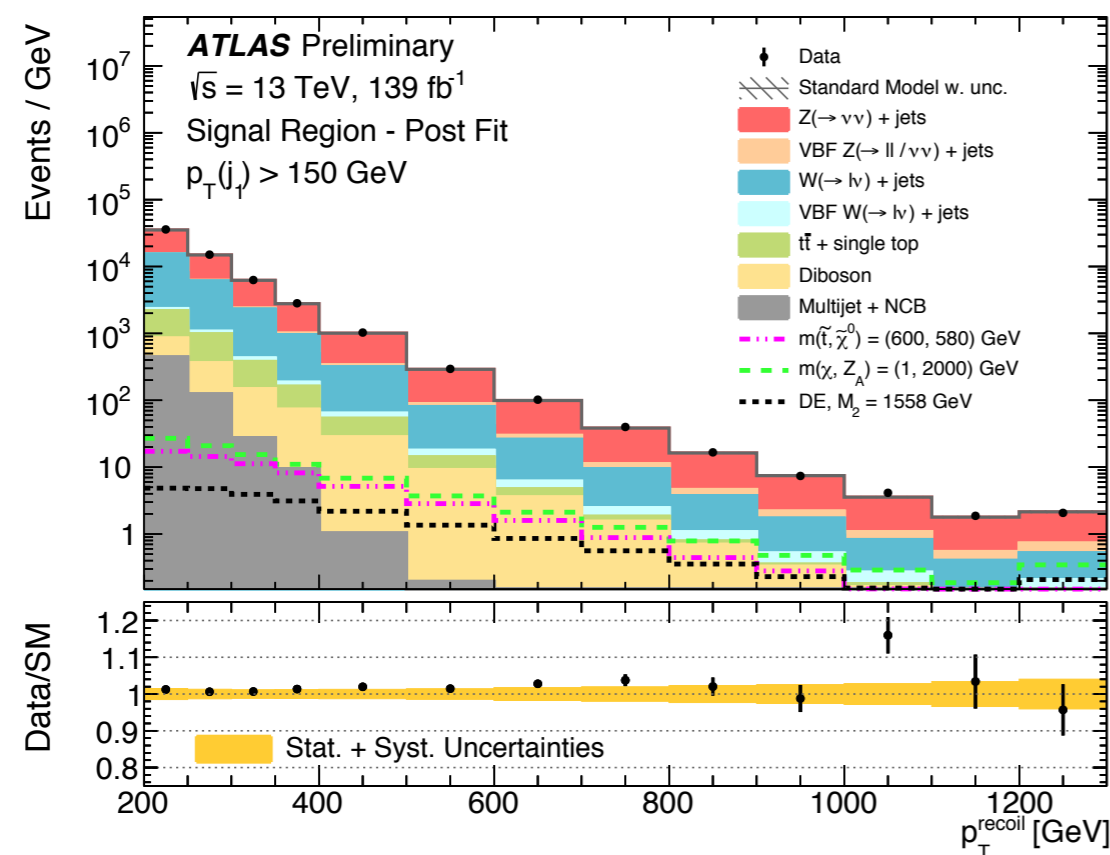


First time searching for lepto-quarks with “cross-generation” decays

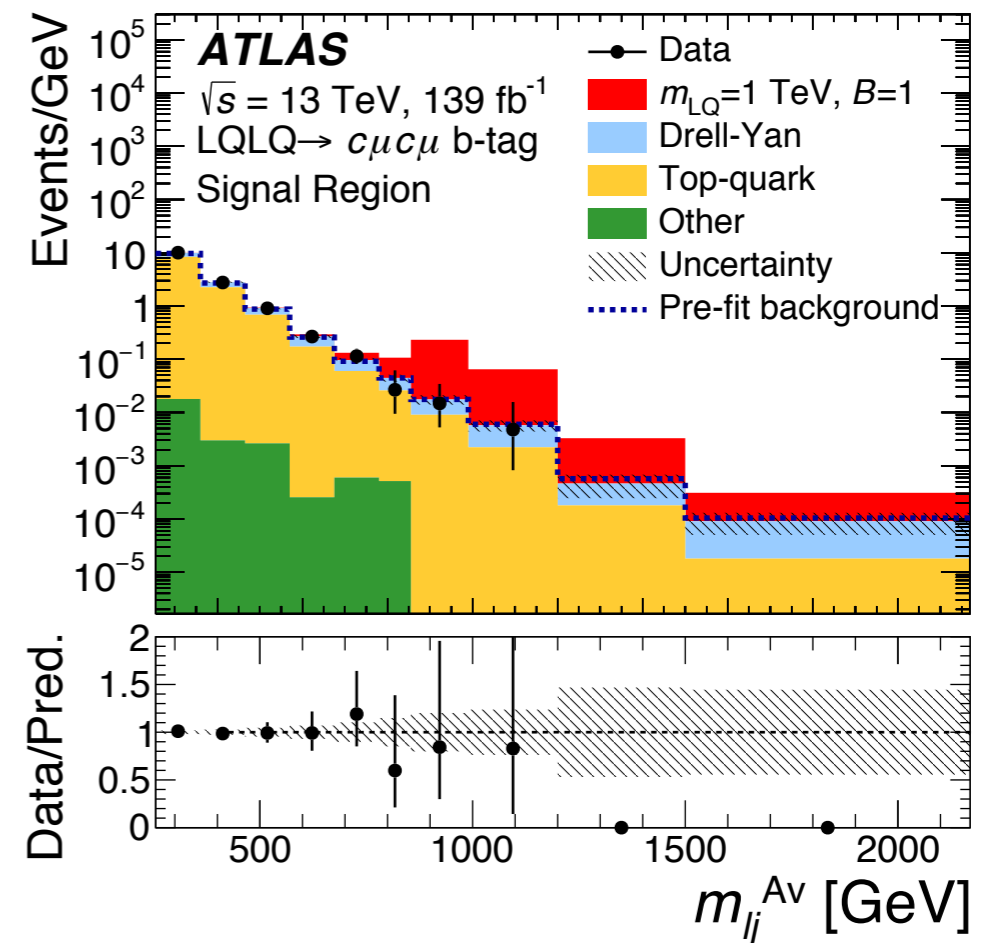
# Searching for new physics

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Searching for new invisible particles in mono-jet events



Searching for lepto-quarks with “cross-generation” decays



# Searching for new physics

- No evidence yet for new physics, but many channels have only fully analysed 36 fb<sup>-1</sup> - ~factor of 10 in luminosity to go to end of run-3.

ATLAS SUSY Searches\* - 95% CL Lower Limits  
July 2020

Model	Signature	$\int \mathcal{L} dt$ [fb <sup>-1</sup> ]	Mass limit	Reference							
Inclusive Searches	$\tilde{q}\tilde{q}, \tilde{q} \rightarrow q\tilde{q}^0$	0 $e, \mu$ mono-jet	2-6 jets 1-3 jets	$E_{miss}^T$ $E_T^{miss}$	139 36.1	$\tilde{q}$ [10x Degen] $\tilde{q}$ [1x, 8x Degen]	0.43 0.71	1.9	$m(\tilde{q}^0) < 400$ GeV $m(\tilde{q}) - m(\tilde{q}^0) = 5$ GeV	ATLAS-CONF-2019-040 1711.03301	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}^0$	0 $e, \mu$	2-6 jets	$E_T^{miss}$	139	$\tilde{g}$	Forbidden	2.35	$m(\tilde{g}^0) = 0$ GeV $m(\tilde{g}) = 1000$ GeV	ATLAS-CONF-2019-040 ATLAS-CONF-2019-040	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}W\tilde{X}_1^0$	1 $e, \mu$	2-6 jets	$E_T^{miss}$	139	$\tilde{g}$	Forbidden	2.2	$m(\tilde{g}^0) = 600$ GeV	ATLAS-CONF-2020-047	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}(L)\tilde{X}_1^0$	$e, \mu, \tau$	2 jets	$E_T^{miss}$	36.1	$\tilde{g}$	Forbidden	1.2	$m(\tilde{g}) - m(\tilde{q}^0) = 50$ GeV	1805.11381	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}WZ\tilde{X}_1^0$	0 $e, \mu$	7-11 jets	$E_T^{miss}$	139	$\tilde{g}$	Forbidden	1.97	$m(\tilde{g}^0) = 600$ GeV	ATLAS-CONF-2020-002	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}W\tilde{X}_1^0$	0 $e, \mu$	6 jets	$E_T^{miss}$	139	$\tilde{g}$	Forbidden	1.15	$m(\tilde{g}) - m(\tilde{q}^0) = 200$ GeV	1909.08457	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow \tilde{t}\tilde{t}^0$	0-1 $e, \mu$ SS $e, \mu$	3 $b$ 6 jets	$E_T^{miss}$ $E_T^{miss}$	79.8 139	$\tilde{g}$	Forbidden	2.25	$m(\tilde{g}^0) = 200$ GeV $m(\tilde{g}) - m(\tilde{q}^0) = 300$ GeV	ATLAS-CONF-2018-041 1909.08457	
	3 <sup>rd</sup> gen. squarks direct production	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow b\tilde{q}_1^0/\tilde{q}_1^+$	Multiple	Multiple	$E_T^{miss}$	36.1	$\tilde{b}_1$	Forbidden	0.74	$m(\tilde{q}_1^0) = 300$ GeV, $BR(\tilde{b}_1^0) = 1$ $m(\tilde{q}_1^+) = 200$ GeV, $m(\tilde{q}_1^0) = 300$ GeV, $BR(\tilde{q}_1^+) = 1$	1708.09266, 1711.03301 1909.08457
		$\tilde{b}_1\tilde{b}_1, \tilde{b}_1 \rightarrow b\tilde{q}_1^0 \rightarrow bb\tilde{q}_1^0$	0 $e, \mu$	6 $b$ 2 $\tau$	$E_T^{miss}$ $E_T^{miss}$	139 139	$\tilde{b}_1$	Forbidden	0.13-0.85	0.23-1.35	1908.03122 ATLAS-CONF-2020-031
		$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{q}_1^0$	0-1 $e, \mu$	$\geq 1$ jet	$E_T^{miss}$	139	$\tilde{t}_1$	Forbidden	1.25	$m(\tilde{q}_1^0) = 1$ GeV	ATLAS-CONF-2020-003, 2004.14060
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow Wb\tilde{q}_1^0$		1 $e, \mu$	3 jets/1 $b$	$E_T^{miss}$	139	$\tilde{t}_1$	Forbidden	0.44-0.59	$m(\tilde{q}_1^0) = 400$ GeV	ATLAS-CONF-2019-017	
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow \tilde{t}_1 b \nu, \tilde{t}_1 \rightarrow \tau G$		1 $\tau + 1 e, \mu, \tau$	2 jets/1 $b$	$E_T^{miss}$	36.1	$\tilde{t}_1$	Forbidden	1.16	$m(\tilde{q}_1^0) = 800$ GeV	1803.10178	
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow c\tilde{q}_1^0/\tilde{c}\tilde{c}, \tilde{c} \rightarrow c\tilde{q}_1^0$		0 $e, \mu$	2 $c$	$E_T^{miss}$	36.1	$\tilde{t}_1$	Forbidden	0.46	0.85	1805.01649 1805.01649	
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow \tilde{t}_1^0 Z/\tilde{q}_1^0$		0 $e, \mu$	mono-jet	$E_T^{miss}$	36.1	$\tilde{t}_1$	Forbidden	0.43	$m(\tilde{q}_1^0) = 0$ GeV $m(\tilde{t}_1^0) - m(\tilde{q}_1^0) = 50$ GeV $m(\tilde{t}_1^+) - m(\tilde{q}_1^0) = 5$ GeV	1711.03301	
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow \tilde{t}_1^0 Z/\tilde{q}_1^0$		1-2 $e, \mu$	1-4 $b$	$E_T^{miss}$	139	$\tilde{t}_1$	Forbidden	0.067-1.18	$m(\tilde{q}_1^0) = 500$ GeV	SUSY-2018-09	
$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow \tilde{t}_1^0 Z/\tilde{q}_1^0$		3 $e, \mu$	1 $b$	$E_T^{miss}$	139	$\tilde{t}_1$	Forbidden	0.86	$m(\tilde{q}_1^0) = 360$ GeV, $m(\tilde{t}_1^+) - m(\tilde{q}_1^0) = 40$ GeV	SUSY-2018-09	
EW direct		$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via WZ	3 $e, \mu$ $e, \mu, \tau$	$\geq 1$ jet	$E_{miss}^T$ $E_{miss}^T$	139 139	$\tilde{\chi}_1^0/\tilde{\chi}_1^+$ $\tilde{\chi}_1^0/\tilde{\chi}_1^+$	0.205	0.64	$m(\tilde{\chi}_1^0) = 0$ $m(\tilde{\chi}_1^+) = 5$ GeV	ATLAS-CONF-2020-015 1911.12606
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via WW	2 $e, \mu$	$\geq 1$ jet	$E_{miss}^T$	139	$\tilde{\chi}_1^0$	0.42	0.74	$m(\tilde{\chi}_1^0) = 0$	1908.08215	
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via Wh	0-1 $e, \mu$	2 $b/2 \gamma$	$E_{miss}^T$	139	$\tilde{\chi}_1^0$	Forbidden	1.0	$m(\tilde{\chi}_1^0) = 70$ GeV	2004.10894, 1909.09226	
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via $\tilde{t}_1/\tilde{b}_1$	2 $e, \mu$	2 $\tau$	$E_{miss}^T$	139	$\tilde{\chi}_1^0$	Forbidden	0.16-0.3	0.12-0.39	$m(\tilde{t}_1^0) = 0.5(m(\tilde{q}_1^0) + m(\tilde{q}_1^+))$ $m(\tilde{q}_1^0) = 0$	1908.08215 1911.06660
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via $\tilde{t}_1/\tilde{b}_1$	2 $e, \mu$	0 jets	$E_{miss}^T$	139	$\tilde{\chi}_1^0$	Forbidden	0.256	0.7	$m(\tilde{q}_1^0) = 0$	1908.08215 1911.12606
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via $\tilde{t}_1/\tilde{b}_1$	2 $e, \mu$	$\geq 1$ jet	$E_{miss}^T$	139	$\tilde{\chi}_1^0$	Forbidden	0.256	0.7	$m(\tilde{q}_1^0) = 0$	1908.08215 1911.12606
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via $\tilde{t}_1/\tilde{b}_1$	0 $e, \mu$	$\geq 3 b$	$E_{miss}^T$	36.1	$\tilde{\chi}_1^0$	Forbidden	0.13-0.23	0.29-0.88	$BR(\tilde{\chi}_1^0 \rightarrow h\tilde{q}_1^0) = 1$ $BR(\tilde{\chi}_1^0 \rightarrow Z\tilde{q}_1^0) = 1$	1806.04030 ATLAS-CONF-2020-040
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via $\tilde{t}_1/\tilde{b}_1$	4 $e, \mu$	0 jets	$E_T^{miss}$	139	$\tilde{\chi}_1^0$	Forbidden	0.55	0.29-0.88		
	Long-lived particles	Direct $\tilde{\chi}_1^0\tilde{\chi}_1^0$ prod., long-lived $\tilde{\chi}_1^0$	Disapp. trk	1 jet	$E_T^{miss}$	36.1	$\tilde{\chi}_1^0$	0.15	0.46	Pure Wino Pure Higgsino	1712.02118 ATL-CONF-2017-019
		Stable $\tilde{g}$ R-hadron	Multiple	Multiple	$E_T^{miss}$	36.1	$\tilde{g}$	2.0	2.05	2.4	$m(\tilde{g}^0) = 100$ GeV
RPV	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via WZ	3 $e, \mu$	Multiple	$E_T^{miss}$	139	$\tilde{\chi}_1^0/\tilde{\chi}_1^+$	0.625	1.05	Pure Wino	ATLAS-CONF-2020-009	
	LFV $pp \rightarrow \tilde{\nu}_\tau + X, \tilde{\nu}_\tau \rightarrow e\mu/\tau\mu$	$e, \mu, \tau, \mu, \tau$	Multiple	$E_T^{miss}$	3.2	$\tilde{\nu}_\tau$	0.82	1.33	$X_{511} = 0.11, X_{132/133/233} = 0.07$	1607.08079 1804.03602	
	$\tilde{\chi}_1^0\tilde{\chi}_1^0$ via WWZZll $\nu\nu$	4 $e, \mu$	0 jets	$E_T^{miss}$	36.1	$\tilde{\chi}_1^0/\tilde{\chi}_1^+$	1.05	1.3	$m(\tilde{q}_1^0) = 100$ GeV	1804.03568	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}^0$	4 $e, \mu$	4-5 large-R jets	$E_T^{miss}$	36.1	$\tilde{g}$	1.05	1.9	Large $A_{12}$	ATLAS-CONF-2018-003	
	$\tilde{g}\tilde{g}, \tilde{g} \rightarrow q\tilde{q}^0$	4 $e, \mu$	4-5 large-R jets	$E_T^{miss}$	36.1	$\tilde{g}$	1.05	2.0	$m(\tilde{q}_1^0) = 200$ GeV, bino-like	ATLAS-CONF-2018-003	
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{b}_1^0, \tilde{t}_1 \rightarrow t\tilde{b}_1^+$	Multiple	Multiple	$E_T^{miss}$	36.1	$\tilde{t}_1$	0.55	1.05	$m(\tilde{q}_1^0) = 200$ GeV, bino-like	ATLAS-CONF-2018-003	
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{b}_1^0, \tilde{t}_1 \rightarrow t\tilde{b}_1^+$	$\geq 4b$	Multiple	$E_T^{miss}$	139	$\tilde{t}_1$	Forbidden	0.95	$m(\tilde{q}_1^0) = 200$ GeV, bino-like	ATLAS-CONF-2020-016	
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{b}_1^0, \tilde{t}_1 \rightarrow t\tilde{b}_1^+$	2 jets + 2 $b$	Multiple	$E_T^{miss}$	36.7	$\tilde{t}_1$	0.42	0.61	$m(\tilde{q}_1^0) = 500$ GeV	1710.07171	
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{b}_1^0, \tilde{t}_1 \rightarrow t\tilde{b}_1^+$	2 $e, \mu$	2 $b$	$E_T^{miss}$	36.1	$\tilde{t}_1$	0.42	0.61	$BR(\tilde{t}_1 \rightarrow b\nu) > 20\%$ $BR(\tilde{t}_1 \rightarrow q\tilde{q}) = 100\%, \cos\theta = 1$	1710.05544 2003.11956	
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1 \rightarrow t\tilde{b}_1^0, \tilde{t}_1 \rightarrow t\tilde{b}_1^+$	1 $\mu$	DV	$E_T^{miss}$	136	$\tilde{t}_1$	1.0	1.6			

ATLAS Preliminary  
 $\sqrt{s} = 13$  TeV

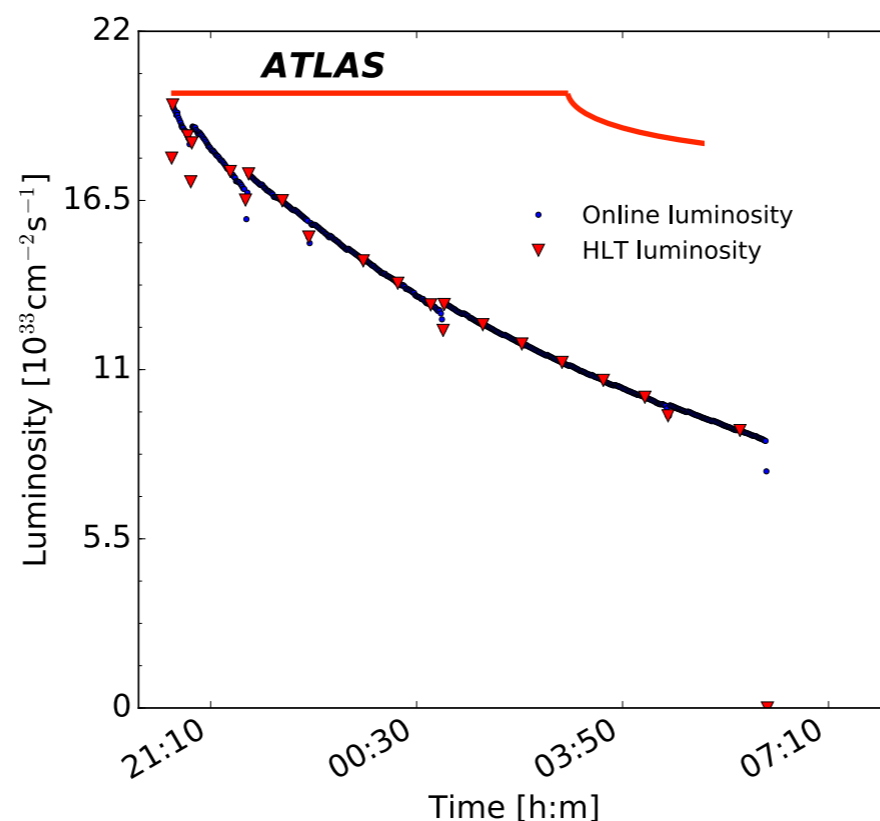
ATLAS Exotics Searches\* - 95% CL Upper Exclusion Limits  
Status: May 2020

Model	$\ell, \gamma$	Jets <sup>†</sup>	$E_{miss}^T$	$\int \mathcal{L} dt$ [fb <sup>-1</sup> ]	Limit	Reference			
Extra dimensions	ADD $G_{KK} + g/q$	0 $e, \mu$	1-4 j	Yes	36.1	$M_0$	7.7 TeV	$n = 2$	1711.03301
	ADD non-resonant $\gamma\gamma$	2 $\gamma$	-	-	36.7	$M_S$	8.6 TeV	$n = 3$ HLZ NLO	1707.04147
	ADD OBH	-	2 j	-	37.0	$M_{BH}$	8.9 TeV	$n = 6$	1703.09127
	ADD BH high $\Sigma p_T$	$\geq 1 e, \mu$	$\geq 2 j$	-	3.2	$M_{BH}$	8.2 TeV	$n = 6, M_D = 3$ TeV, rot BH	1606.02265
	ADD BH multijet	-	$\geq 3 j$	-	3.6	$M_{BH}$	9.55 TeV	$n = 6, M_D = 3$ TeV, rot BH	1512.02586
	RS1 $G_{KK} \rightarrow \gamma\gamma$	2 $\gamma$	-	-	36.7	$G_{KK}$ mass	4.1 TeV	$k/\overline{M}_{pl} = 0.1$	1707.04147
	Bulk RS $G_{KK} \rightarrow WW/ZZ$	multi-channel	-	-	36.1	$G_{KK}$ mass	2.3 TeV	$k/\overline{M}_{pl} = 1.0$	1808.02380
	Bulk RS $G_{KK} \rightarrow WV \rightarrow \ell\nu qq$	1 $e, \mu$	2 j / 1 J	Yes	139	$G_{KK}$ mass	2.0 TeV	$k/\overline{M}_{pl} = 1.0$	2004.14636
	Bulk RS $G_{KK} \rightarrow tt$	1 $e, \mu$	$\geq 1 b, \geq 1 J/2$	Yes	36.1	$G_{KK}$ mass	3.8 TeV	$\Gamma/m = 15\%$	1804.10823
	2UED / RPP	1 $e, \mu$	$\geq 2 b, \geq 3 j$	Yes	36.1	$KK$ mass	1.8 TeV	Tier (1,1), $\mathcal{B}(A^{(1,1)} \rightarrow tt) = 1$	1803.09678
Gauge bosons	SSM $Z' \rightarrow \ell\ell$	2 $e, \mu$	-	-	139	$Z'$ mass	5.1 TeV		1903.06248
	SSM $Z' \rightarrow \tau\tau$	2 $\tau$	-	-	36.1	$Z'$ mass	2.42 TeV		1709.07242
	Leptophobic $Z' \rightarrow bb$	-	2 $b$	-	36.1	$Z'$ mass	2.1 TeV		1805.09299
	Leptophobic $Z' \rightarrow tt$	0 $e, \mu$	$\geq 1 b, \geq 2 j$	Yes	139	$Z'$ mass	4.1 TeV	$\Gamma/m = 1.2\%$	2005.05138
	SSM $W' \rightarrow \ell\nu$	1 $e, \mu$	-	Yes	139	$W'$ mass	6.0 TeV		1906.05609
	SSM $W' \rightarrow \tau\nu$	1 $\tau$	-	Yes	36.1	$W'$ mass	3.7 TeV		1801.06992
	HVT $W' \rightarrow WZ \rightarrow \ell\nu qq$ model B	1 $e, \mu$	2 j / 1 J	Yes	139	$W'$ mass	4.3 TeV	$\delta_V = 3$	2004.14636
	HVT $W' \rightarrow WV \rightarrow qq qq$ model B	0 $e, \mu$	2 J	-	139	$W'$ mass	3.8 TeV	$\delta_V = 3$	1906.05609
	HVT $W' \rightarrow WH$ model B	multi-channel	-	-	36.1	$W'$ mass	2.93 TeV	$\delta_V = 3$	1712.05518
	HVT $W' \rightarrow WH$ model B	multi-channel	0 $e, \mu$	$\geq 1 b, \geq 2 j$	139	$W'$ mass	3.2 TeV	$\delta_V = 3$	CERN-EP-2020-073
LRSB $W_R \rightarrow tb$	multi-channel	-	-	36.1	$W_R$ mass	3.25 TeV	$m(N_R) = 0.5$ TeV, $g_L = g_R$	1807.10473	
LRSB $W_R \rightarrow \mu N_R$	2 $\mu$	1 J	-	80	$W_R$ mass	5.0 TeV		1904.12679	
CI	CI $qqqq$	-	2 j	-	37.0	A	21.8 TeV	$\eta_{LL}$	1703.09127
	CI $\ell\ell qq$	2 $e, \mu$	-	-	139	A	35.6 TeV		CERN-EP-2020-066
	CI $t\bar{t}tt$	$\geq 1 e, \mu$	$\geq 1 b, \geq 1 j$	Yes	36.1	A	2.57 TeV	$ C_{41}  = 4\pi$	1811.02305
DM	Axial-vector mediator (Dirac DM)	0 $e, \mu$	1-4 j	Yes	36.1	$m_{DM}$	1.55 TeV	$g_s = 0.25, g_t = 1.0, m(\chi) = 1$ GeV	1711.03301
	Colored scalar mediator (Dirac DM)	0 $e, \mu$	1-4 j	Yes	36.1	$m_{DM}$	1.67 TeV	$g_s < 1.0, m(\chi) = 1$ GeV	1711.03301
	VV $\chi\chi$ EFT (Dirac DM)	0 $e, \mu$	1 J, $\leq 1 j$	Yes	3.2	M.	700 GeV	$m(\chi) < 150$ GeV	1608.02372
Scalar reson. $\phi \rightarrow t\bar{t}$ (Dirac DM)	0-1 $e, \mu$	1 b, 0-1 J	Yes	36.1	$m_\phi$	3.4 TeV	$y = 0.4, \lambda = 0.2, m(\chi) = 10$ GeV	1812.09743	
LQ	Scalar LQ 1 <sup>st</sup> gen	1, 2 $e$	$\geq 2 j$	Yes	36.1	LQ mass	1.4 TeV	$\beta = 1$	1902.00377
	Scalar LQ 2 <sup>nd</sup> gen	1, 2 $\mu$	$\geq 2 j$	Yes	36.1	LQ mass	1.56 TeV	$\beta = 1$	1902.00377
	Scalar LQ 3 <sup>rd</sup> gen	2 $\tau$	2 b	-	36.1	LQ mass	1.03 TeV	$\mathcal{B}(LQ_3^+ \rightarrow b\tau) = 1$	1902.08103
Scalar LQ 3 <sup>rd</sup> gen	0-1 $e, \mu$	2 b	Yes	36.1	LQ mass	970 GeV	$\mathcal{B}(LQ_3^+ \rightarrow t\tau) = 0$	1902.08103	
Heavy quarks	VLQ $TT \rightarrow Ht/Zt/Wb + X$	multi-channel	-	-	36.1	T mass	1.37 TeV	SU(2) doublet	1808.02343
	VLQ $BB \rightarrow Wt/Zb + X$	multi-channel	-	-	36.1	B mass	1.34 TeV	SU(2) doublet	1808.02343
	VLQ $T_{5/3} T_{5/3} \rightarrow Wt + X$								

# Preparing for run-3

# Preparing for run-3

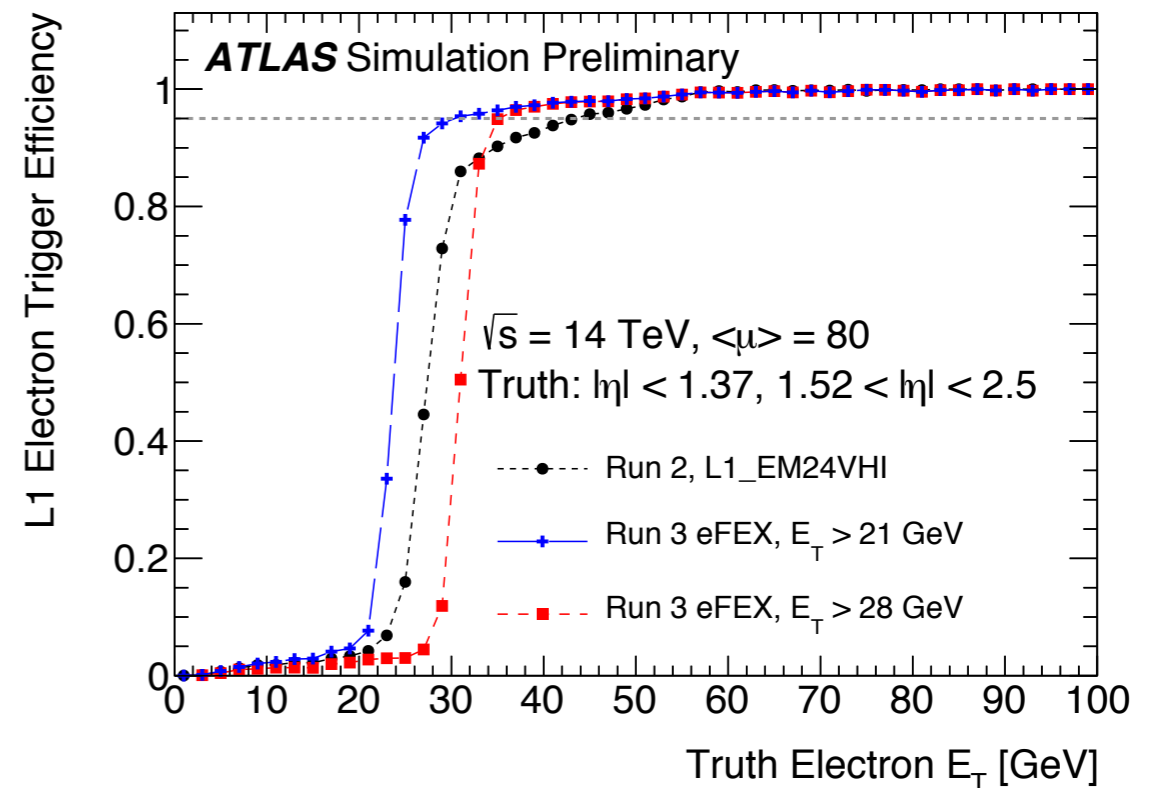
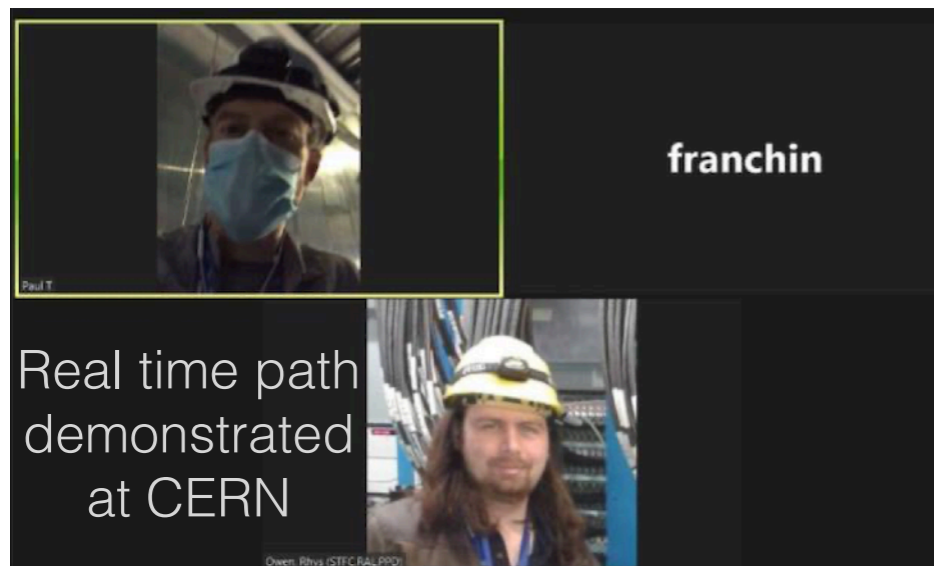
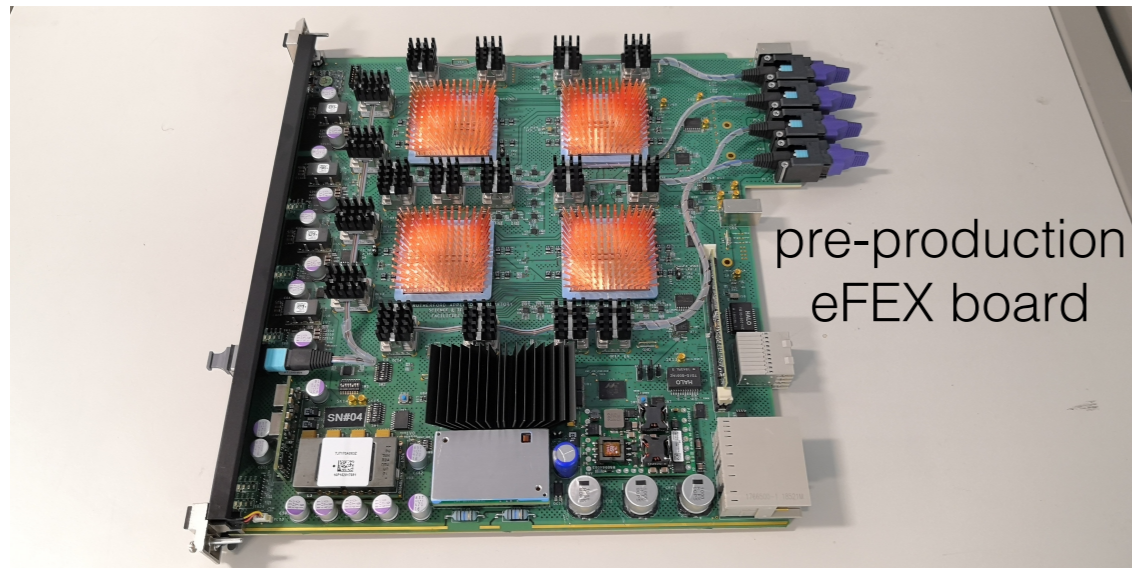
- Run-3: higher average pileup than run-2 & hopefully higher energy:
  - L1 calorimeter: all new hardware with better performance.
  - HLT & offline software: new framework for fully-parallel processing.
  - SCT: Maintenance & operation of ~16 year-old system.
  - Muon: new detectors to cope with trigger rates.



Run-2 typical  
Run-3 plan

# L1 Calorimeter Trigger

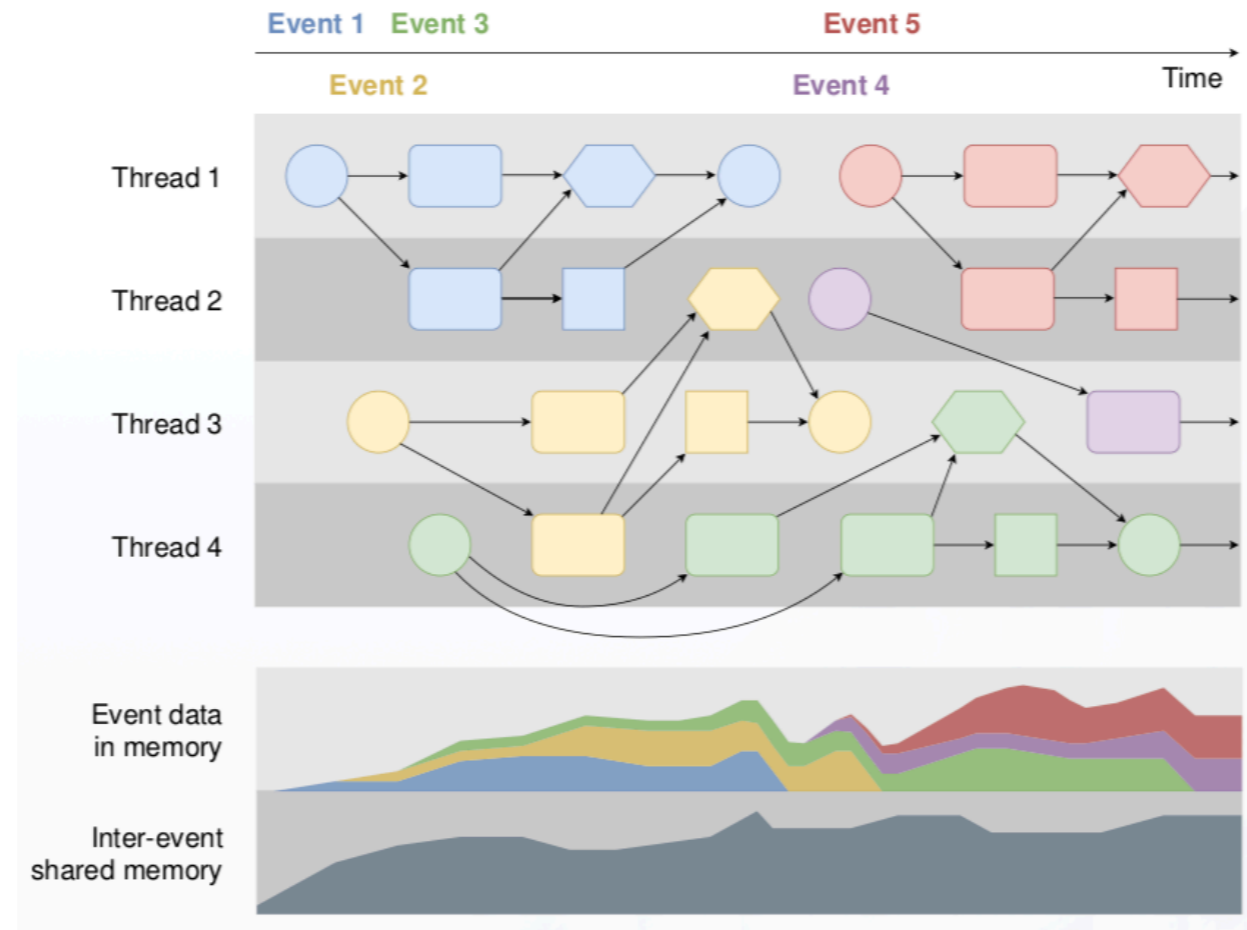
- Improved granularity of calorimeter data -> better performance.
- UK responsible for electron & tau finding board & readout modules for full system.



- Important to have sufficient effort for all the software needed to actually run the system!

# Software trigger & offline computing

- Trend in modern computing: more cores and less memory / core.
- Motivated rewrite of software framework to support parallel processing.



- Good progress: both trigger and offline reconstruction are running with  $n(\text{threads}) > 1$ .
- Computing system must be as efficient as possible to cope with run-3 demands.
- Run-4 will mean a step-change for computing - need additional effort – looking to meet this through SWIFT-HEP bids and working in collaboration through IRIS-HEP



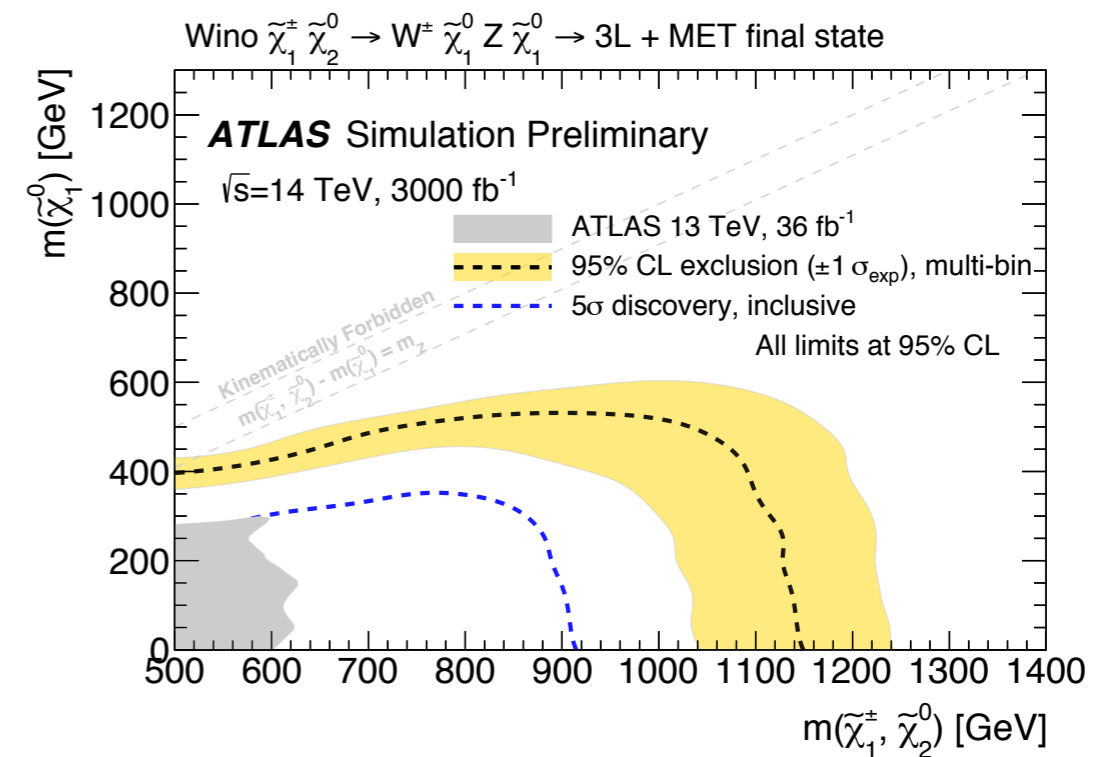
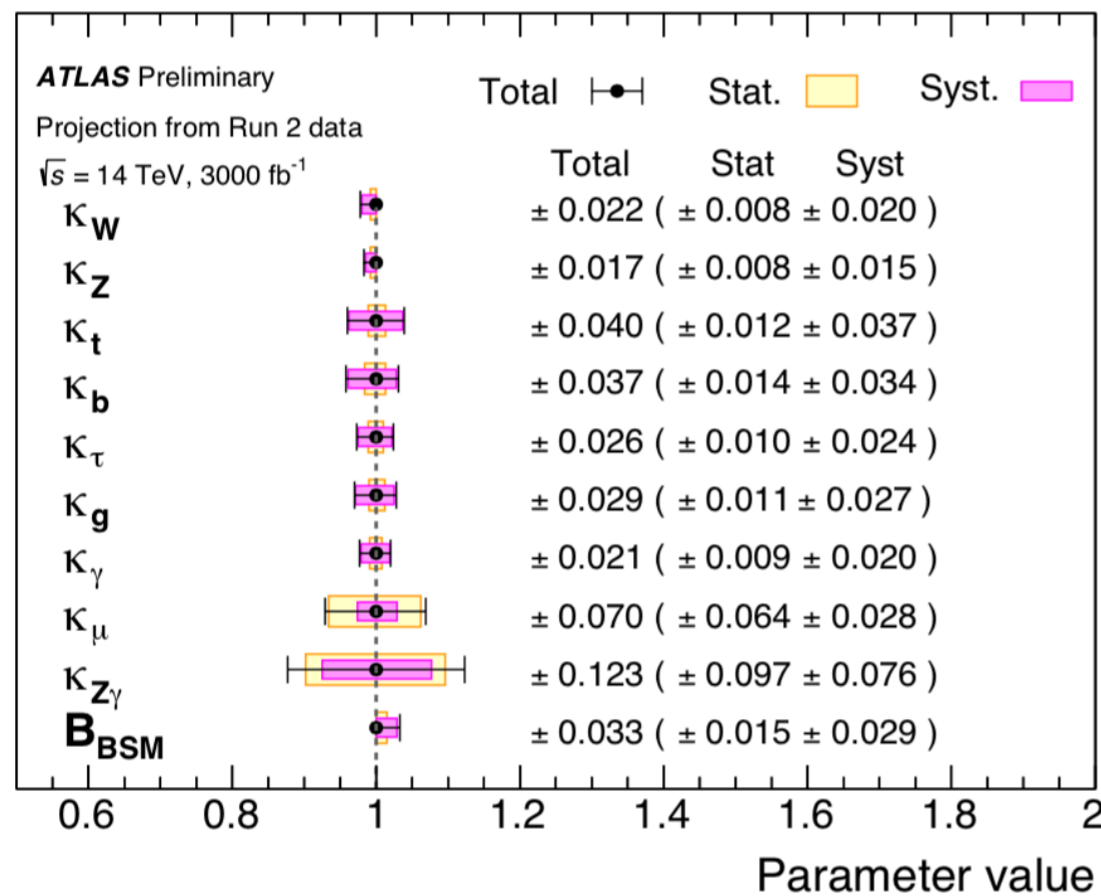
# Upgrading ATLAS for HL-LHC

The successful completion of the high-luminosity upgrade of the machine and detectors **should remain the focal point of European particle physics**, together with continued innovation in experimental techniques. The full physics potential of the LHC and the HL-LHC, including the study of flavour physics and the quark-gluon plasma, should be exploited.

(European strategy update 2020)

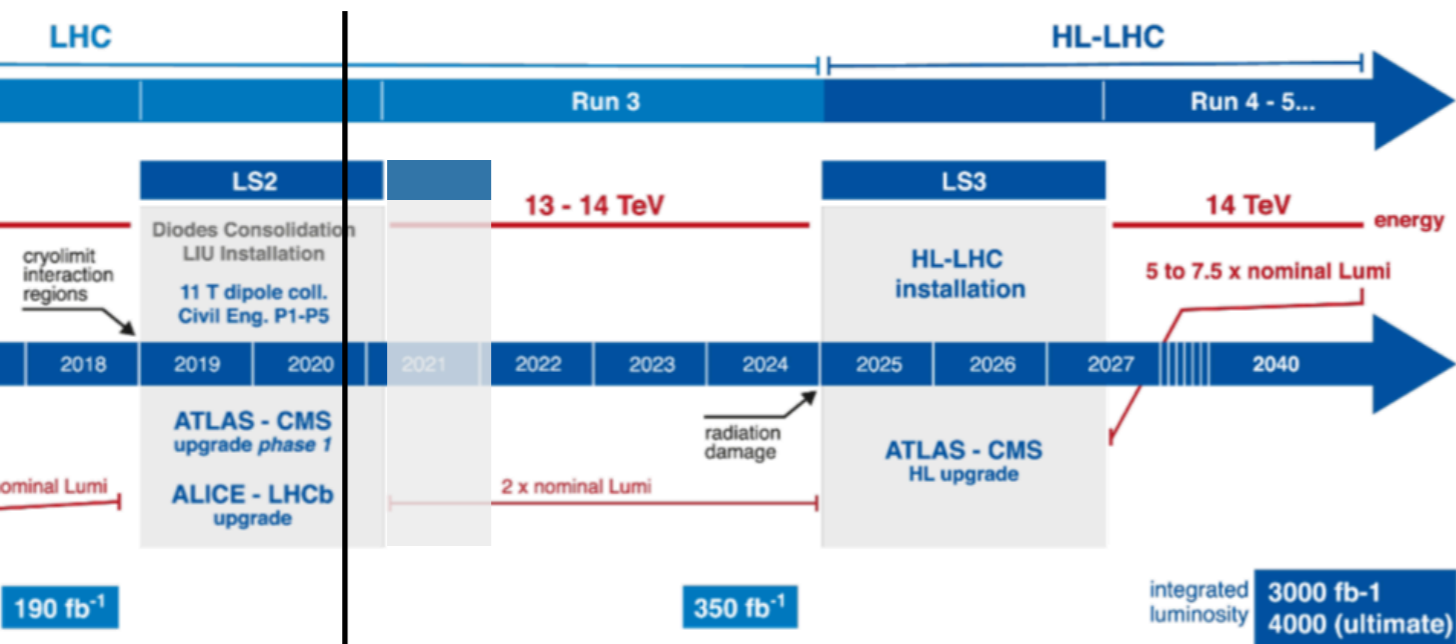
# Physics at HL-LHC with ATLAS

- HL-LHC aims to provide 10x more luminosity than LHC.
- Headline goals are Higgs self-coupling, precision Higgs measurements and extending new physics search reach.



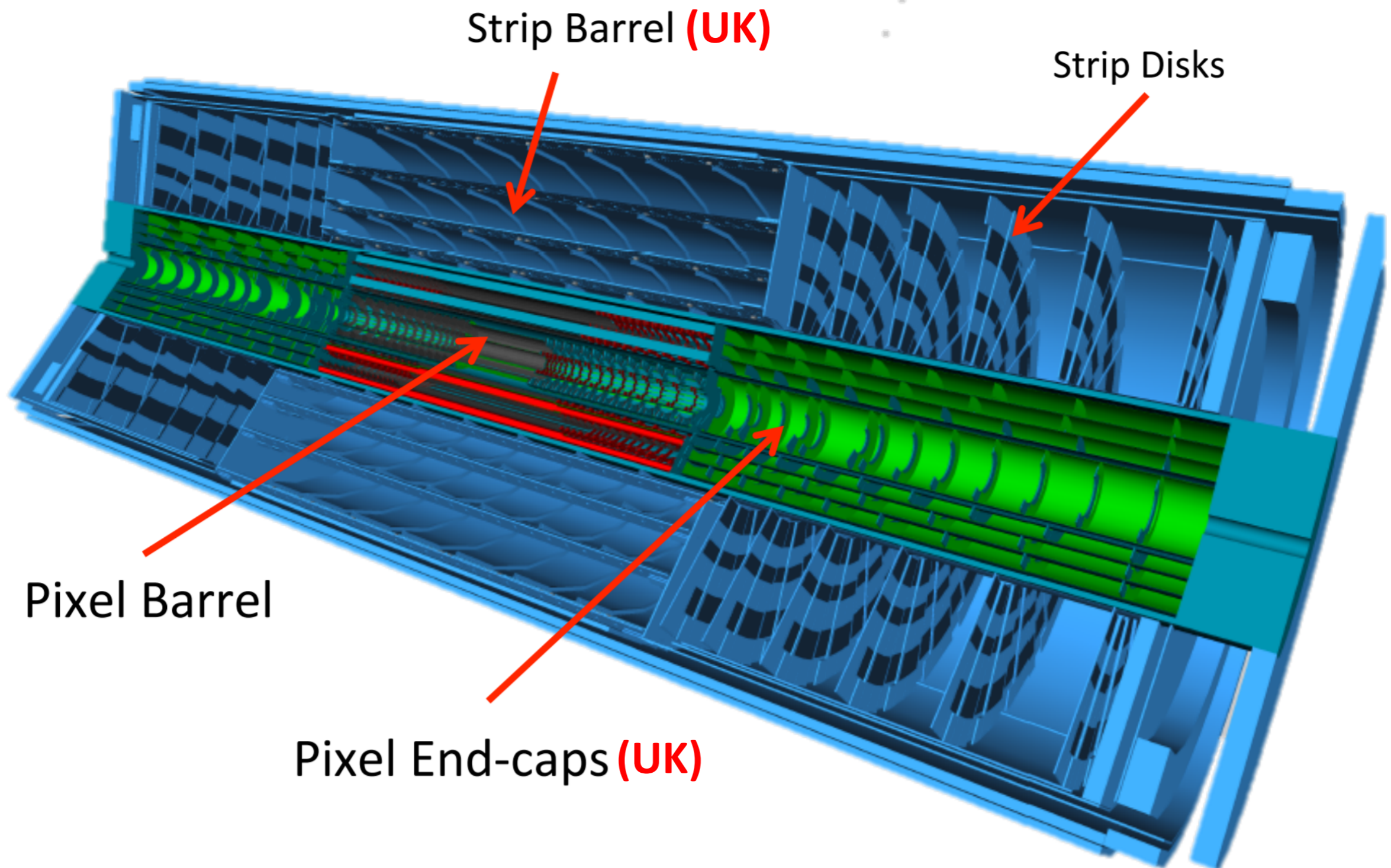
- Requires a detector performing as well as current ATLAS, in much higher pile-up environment.

# Upgrading for HL-LHC



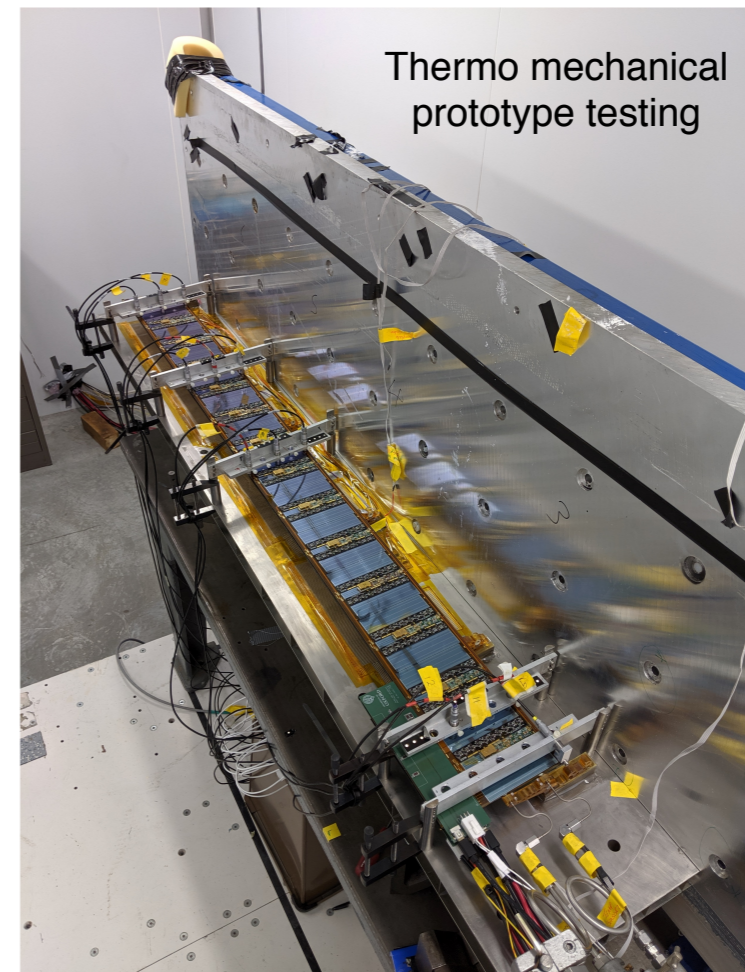
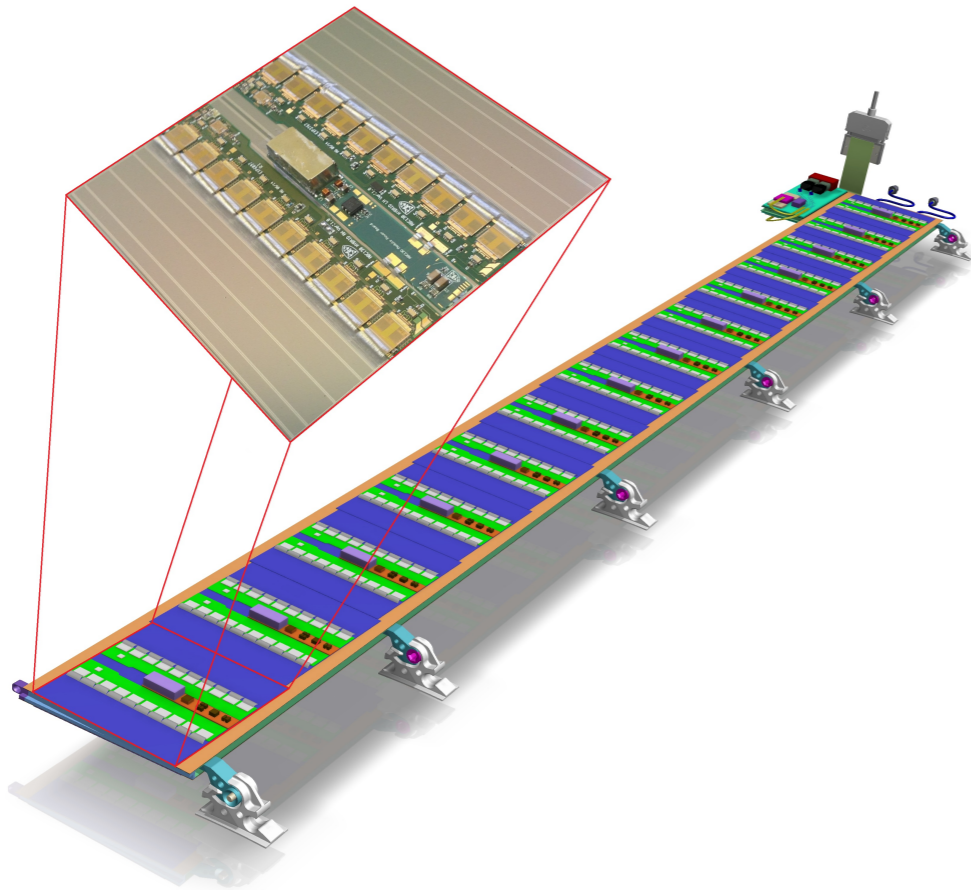
- **All new Inner Tracking Detector ITk**
  - **Strips and Pixels**
- Muon system upgrade.
- Upgrades to the LAr & Tile Calorimeters
  - **& associated Triggering**
- **Upgraded TDAQ System**
  - **DAQ**
  - **Event triggering & filtering,**
- **Computing**
  - **Offline software**
  - **Simulation & reconstruction**
- High Granularity Timing Detector HGTD

# ITK



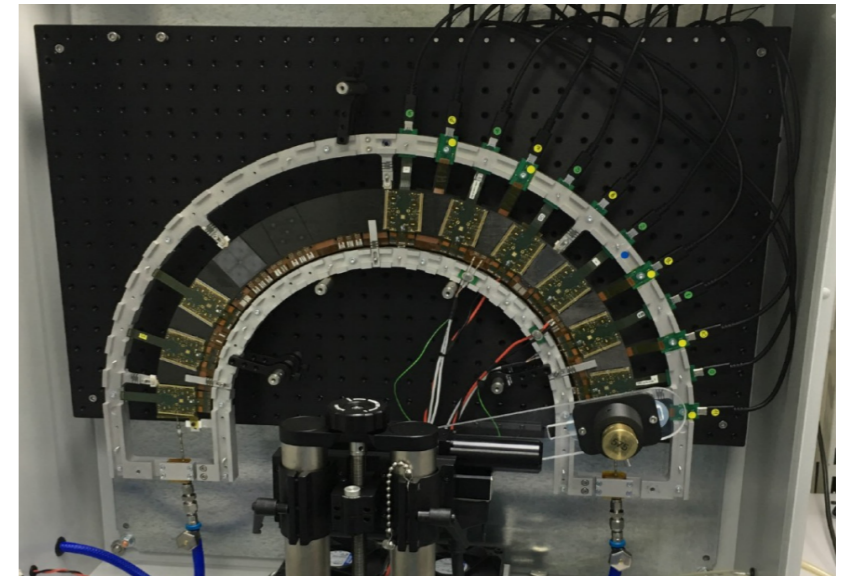
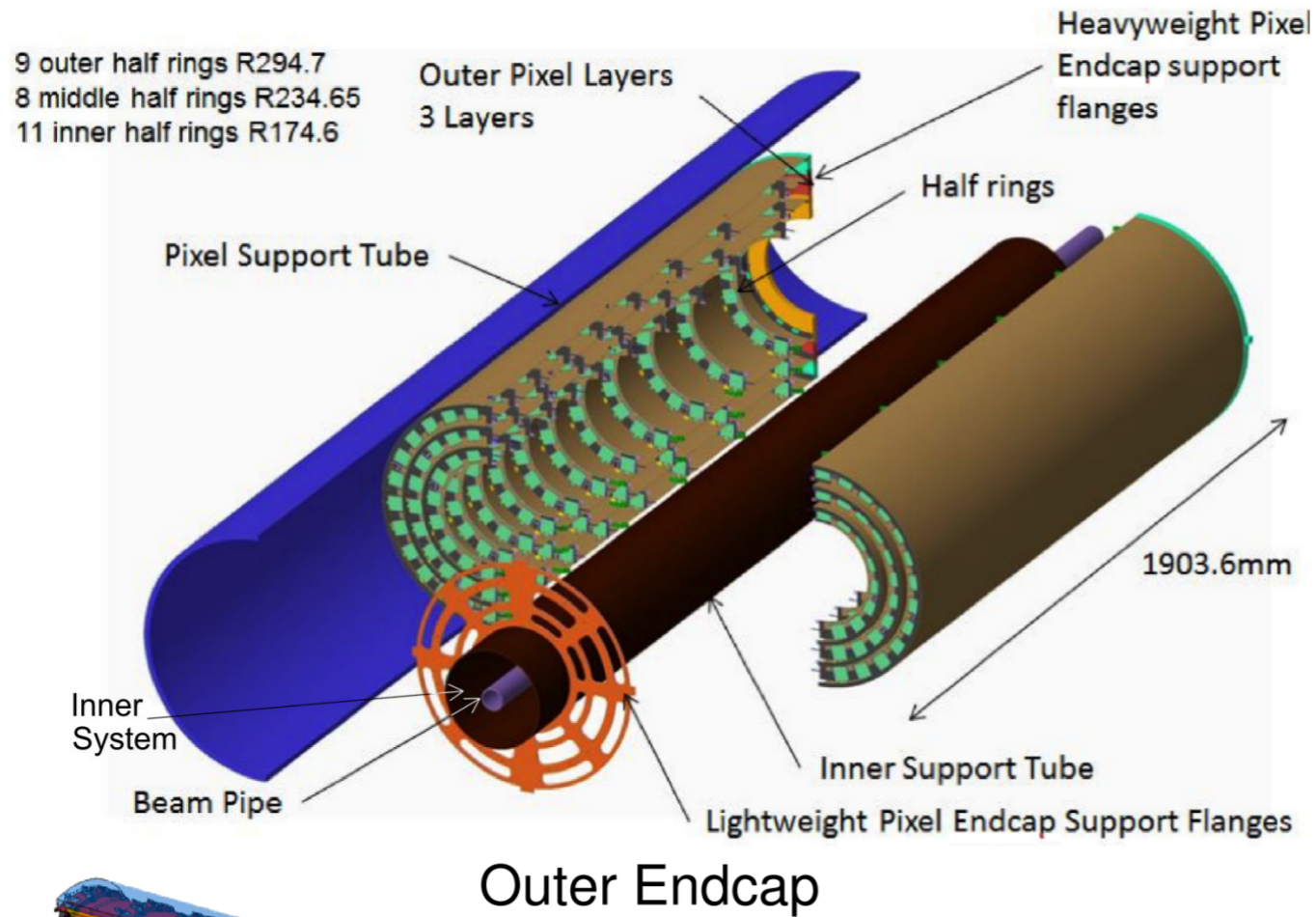
# ITK Strips

- Barrel strip detector constructed of staves, with  $\sim 10 \times 10 \text{ cm}$  modules, strip pitch  $\sim 70 \mu\text{m}$ . UK responsible for  $\sim 220$  (half) of the staves.
- Design & prototyping largely complete, pre-production next year.



# ITK Pixel

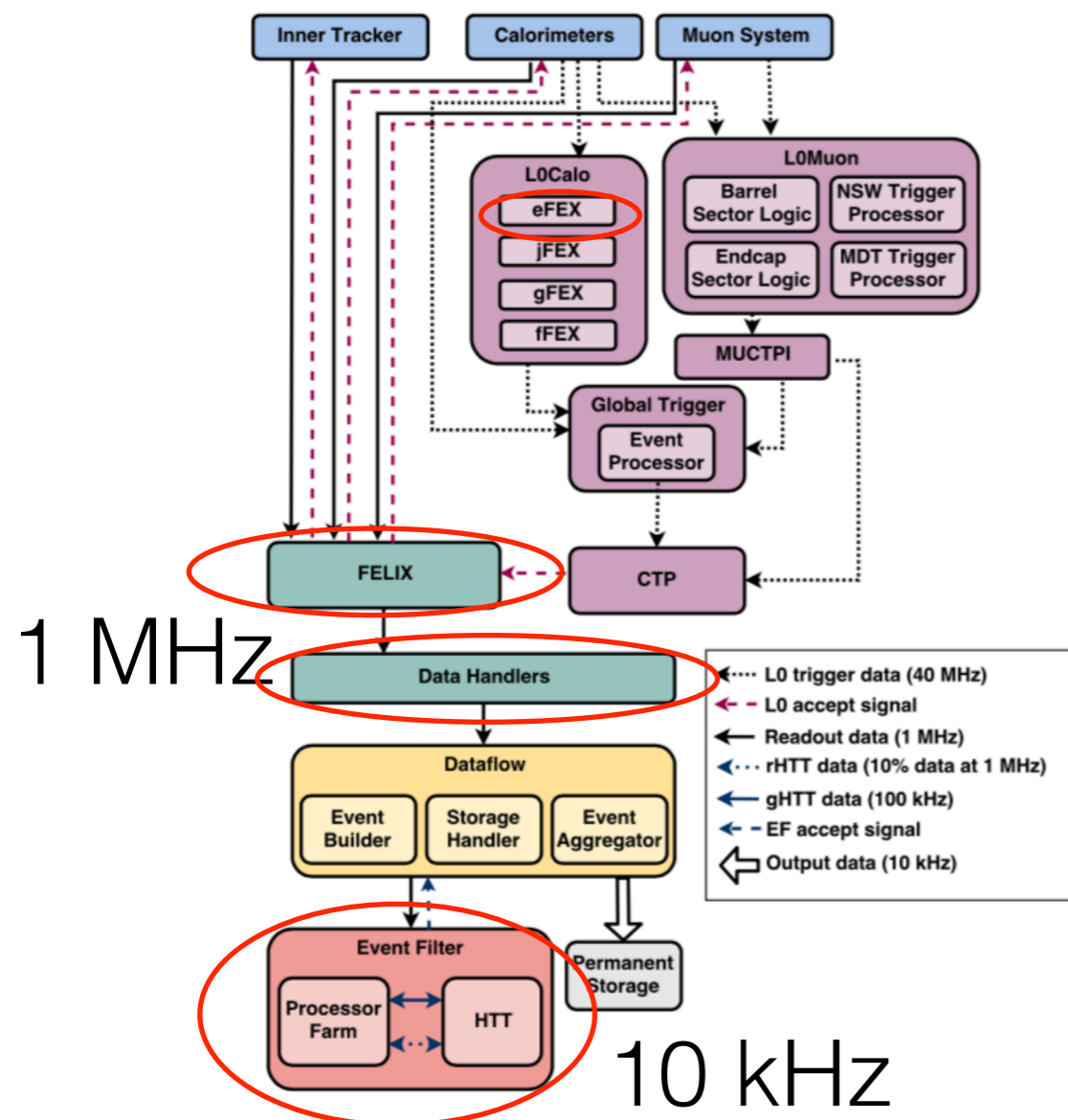
- Pixel end-cap detectors constructed from half-rings, cell size  $50 \times 50 \mu\text{m}^2$  or  $25 \times 100 \mu\text{m}^2$ . UK responsible for 1 of 2 endcaps.



- Prototype ring-0 built & operated. Lessons learned incorporated into final design.
- Various design features under study & final chip is to be produced.

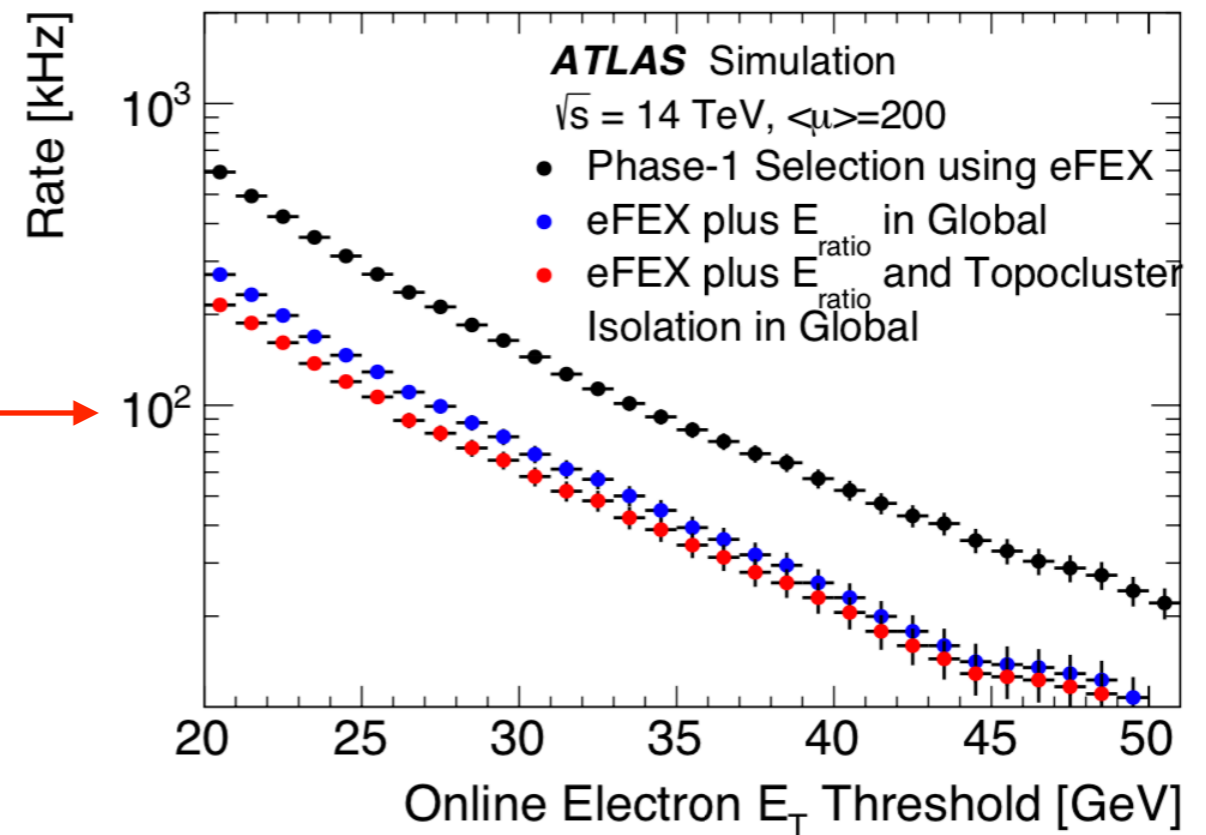
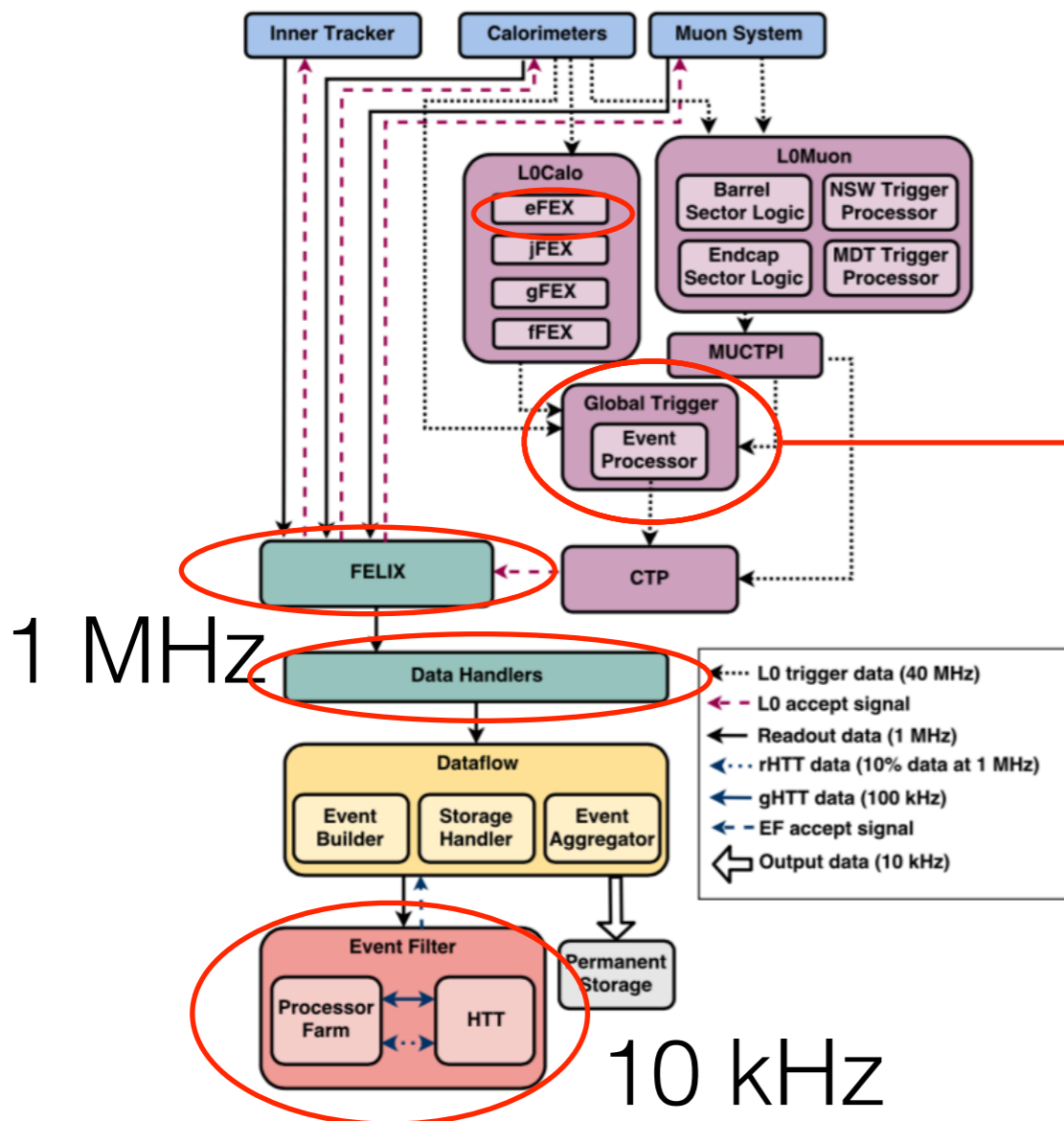
# Trigger & Data Acquisition

- Keep two level trigger system, output rates up by x10.
- Need improved hardware and software triggers to cope with rates:



# Trigger & Data Acquisition

- Keep two level trigger system, output rates up by x10.
- Need improved hardware and software triggers to cope with rates:



UK responsibilities & leadership

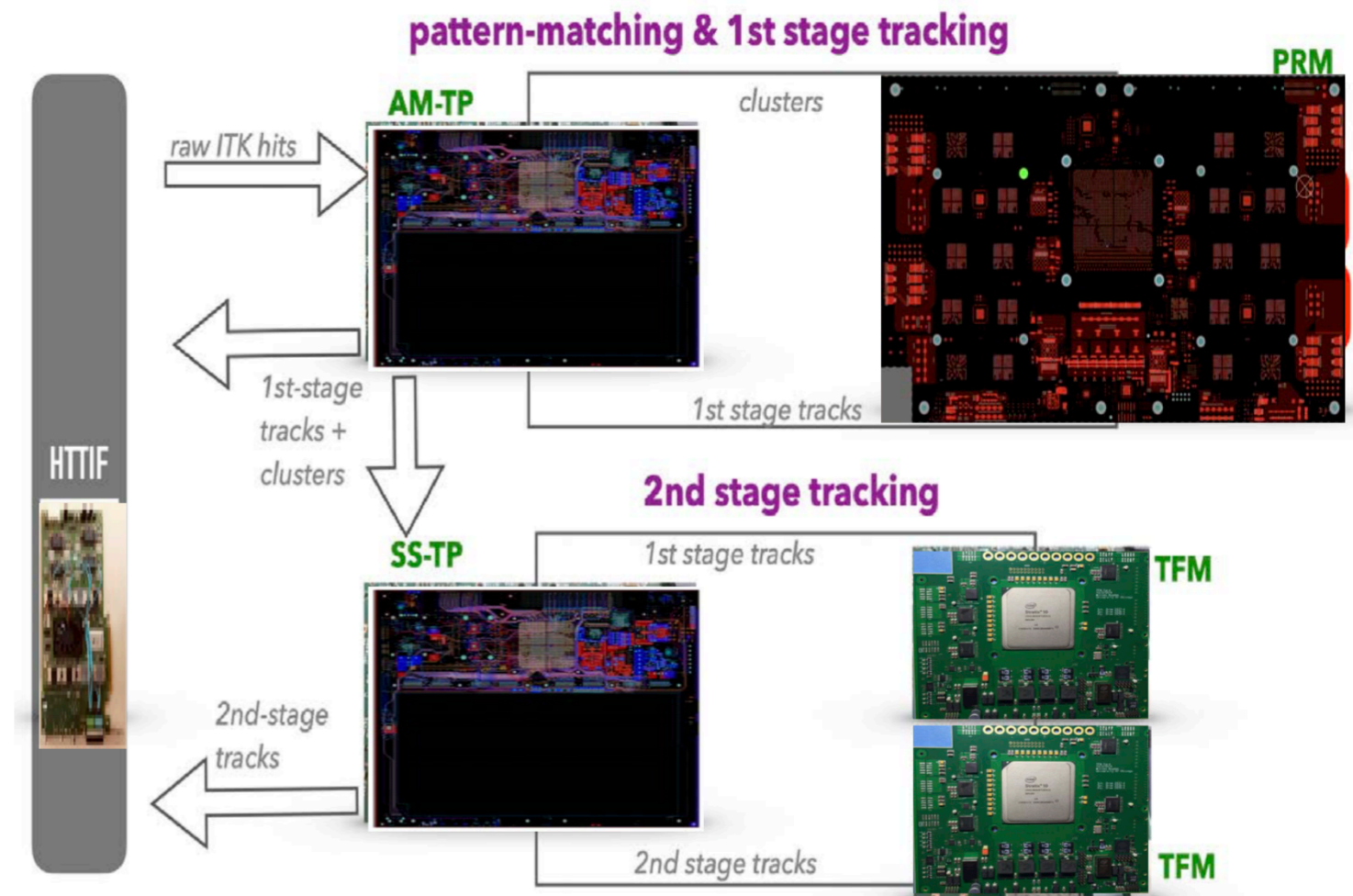


# Hardware Track Trigger

- Track finding implemented in AM ASICs will provide tracks to be used in the software stage of the trigger (EF).

- Goals:

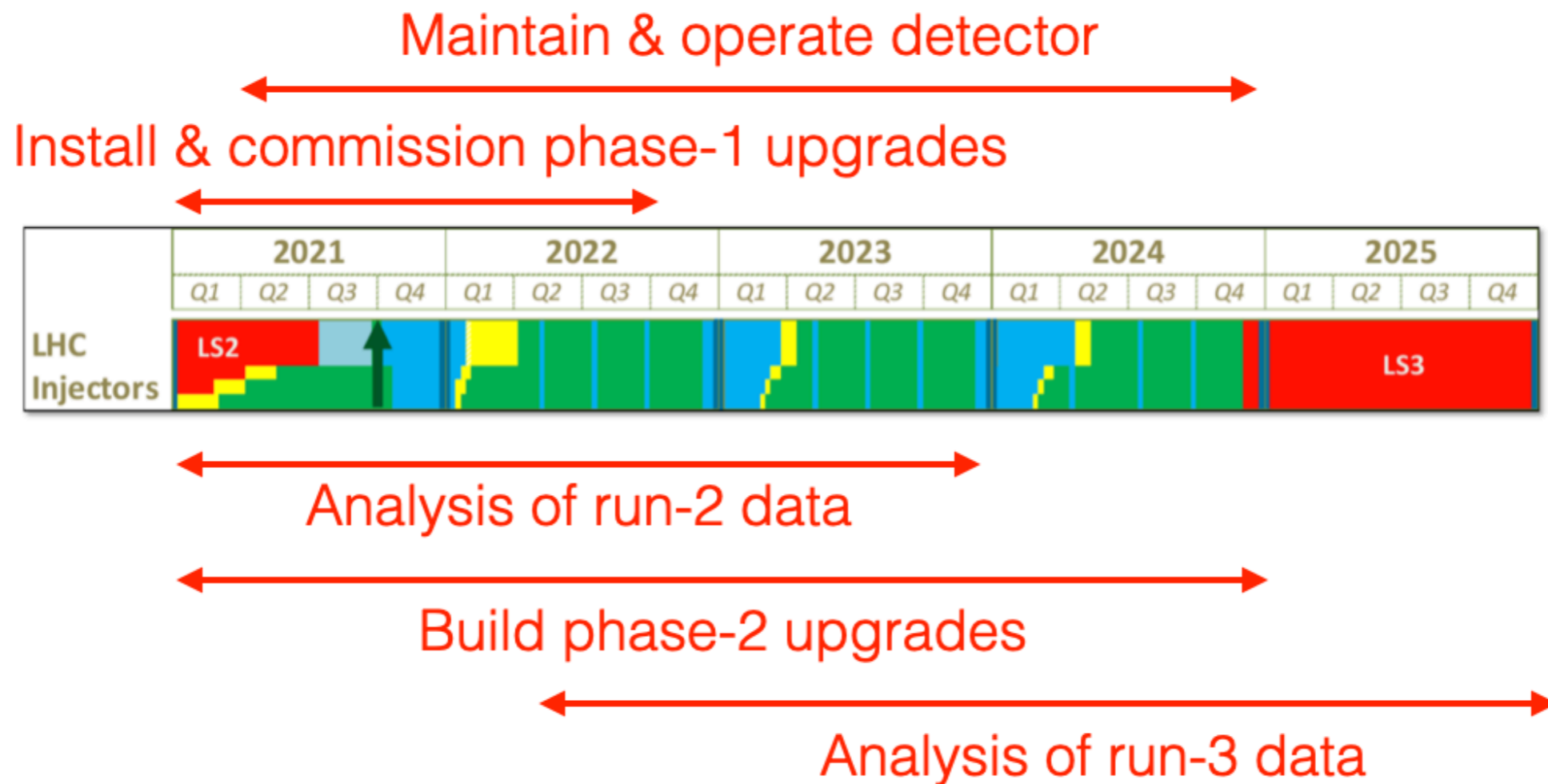
- Regional:** 10% of detector @ 1 MHz
- Global:** full detector @ 100 kHz



- Status: testing HW demonstrators and submitting smaller but fully functional version of final ASIC.

# Summary

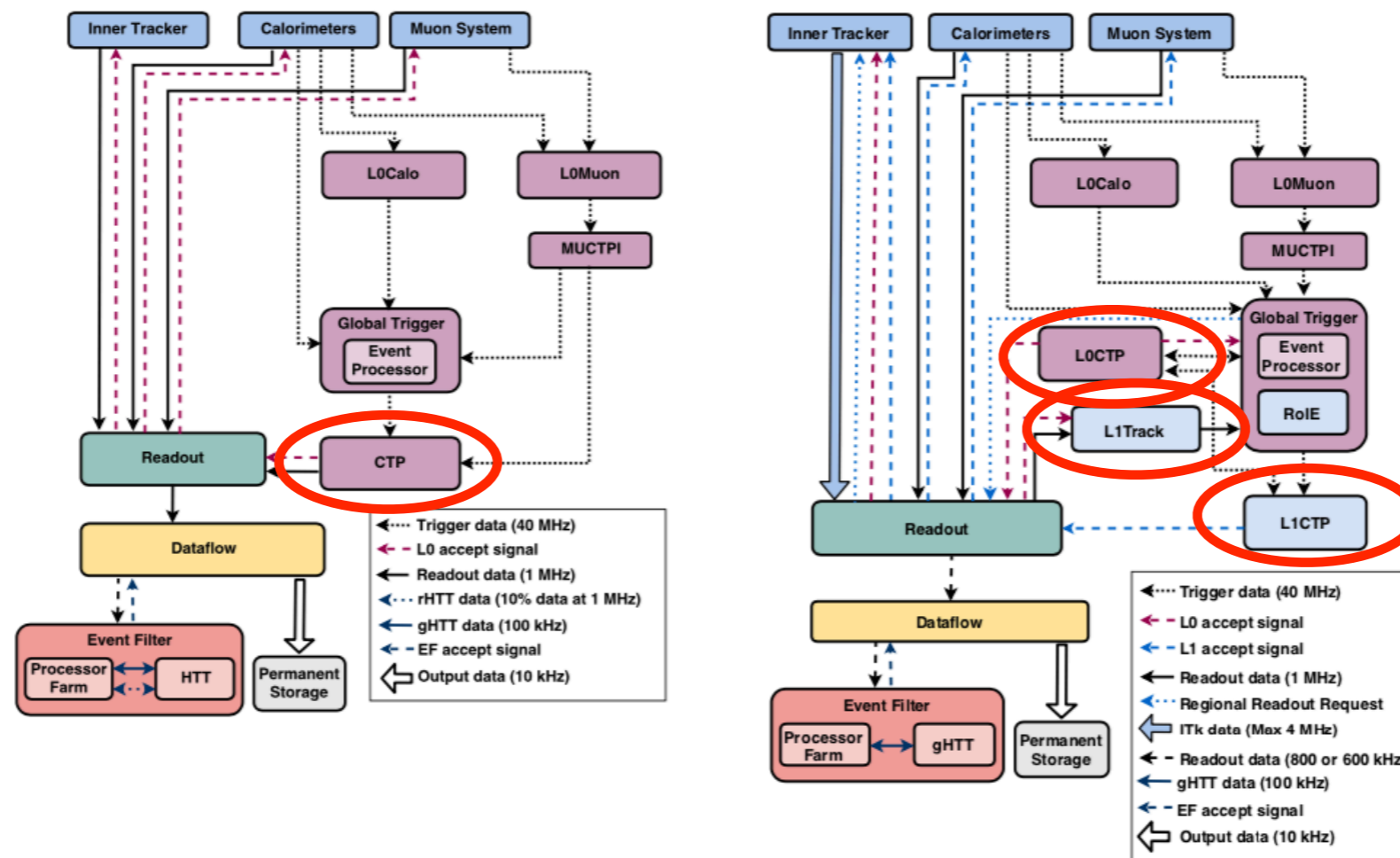
- ATLAS UK continues to produce important physics results & make vital contributions to the future of ATLAS.
- Next 5 years look to be as busy as any 5 before.



# Backup

# L1 evolution decision

- TDR included potential evolution from L0+HLT to L0+L1+HLT system, with tracks reconstructed at L1.



- Recent decision: do not proceed with the evolved setup, will build only the baseline system.