lake Geneva

ATLAS Highlights

lake Pamvotis

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on behalf of the ATLAS Collaboration

HEP2023 - 40th Conference on Recent Developments
in High Energy Physics and Cosmology, Ioannina, Greece
5–8 Apr 2023

HELLENIC REPUBLIC
National & Kapodistrian
University of Athens

ATLAS EXPERIMENT

H.F.R.I. Hellenic Foundation for Research & Innovation

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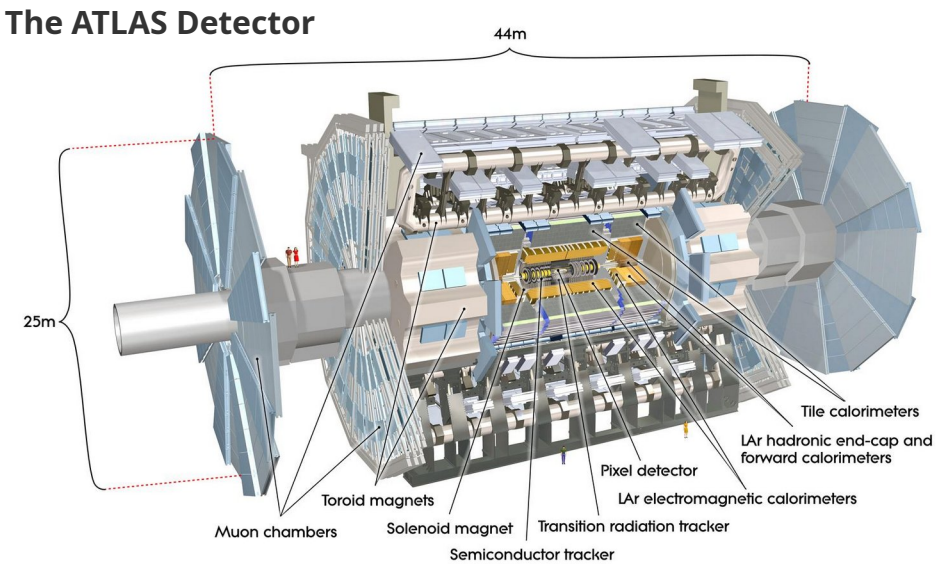
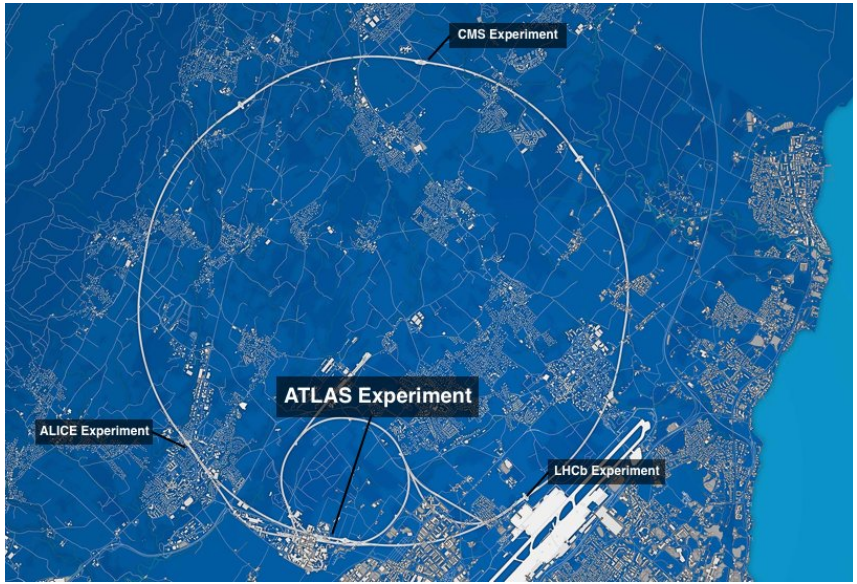
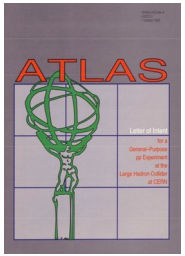
ATLAS @ LHC







- 30 years of collaboration (Oct. 1, 1992).
- 10 years from the discovery of the Higgs boson (Jul. 4, 2012) .

Interactive timeline: https://atlas.cern/about.

Outline of this talk

Broad research program

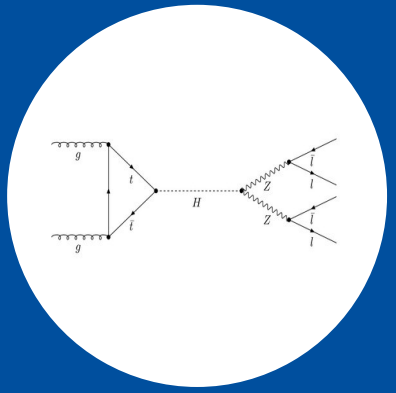
1219 papers (until March 24, 2023).

Physics Theme	Papers
Standard Model	222
Higgs	207
Top	157
B-physics	37
BSM (SUSY, HDBS, Exotics)	512
Heavy Ion	84

In this talk

LHC Run-3
First year of data-taking

LHC Runs-2 (& 1)
Selected recent results



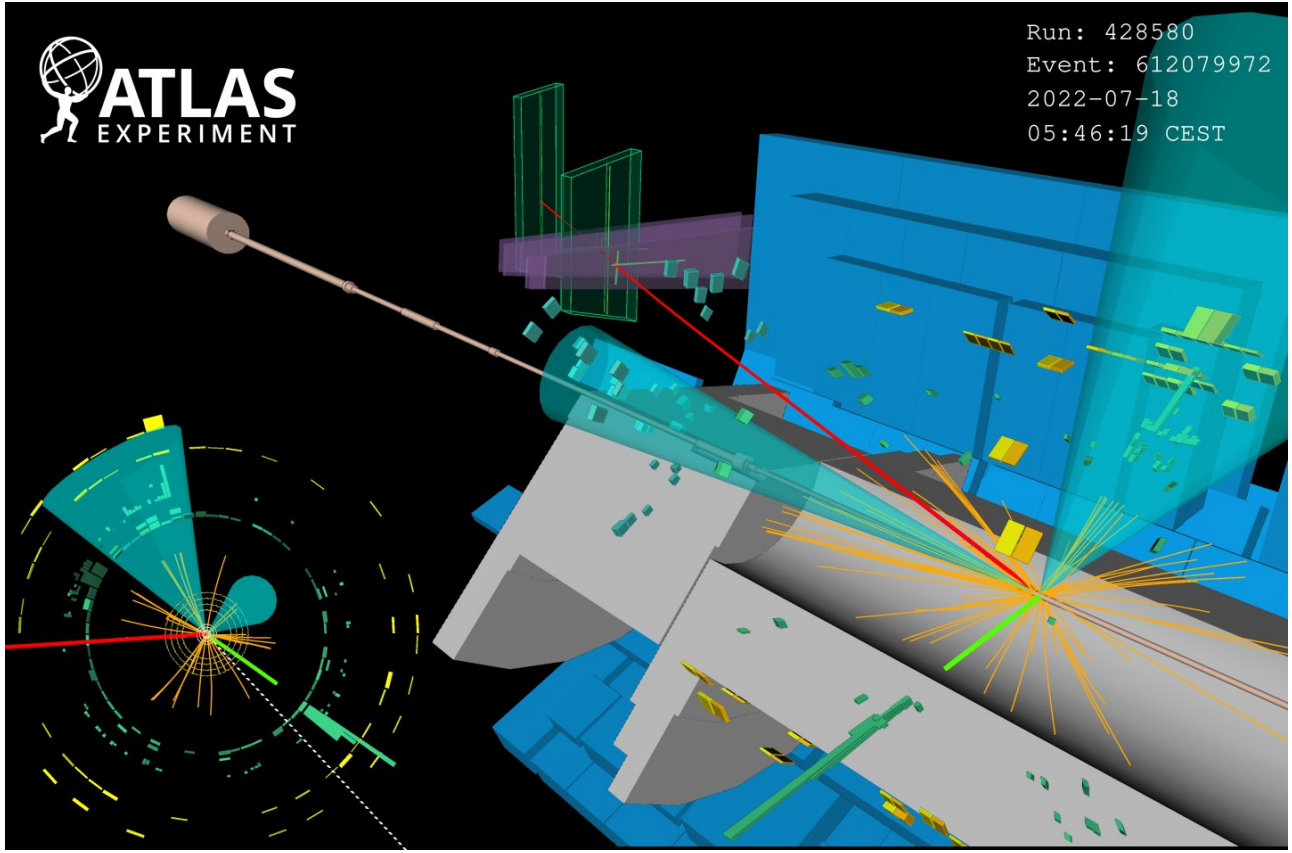
LHC Run-3

ATLAS-upgrades-LS2

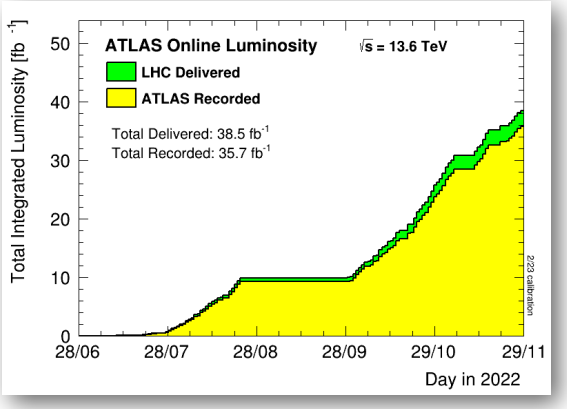
After a challenging phase-I upgrade during the 2nd long shutdown of the LHC, ATLAS records and analyzes the first data.

LHC Run-3

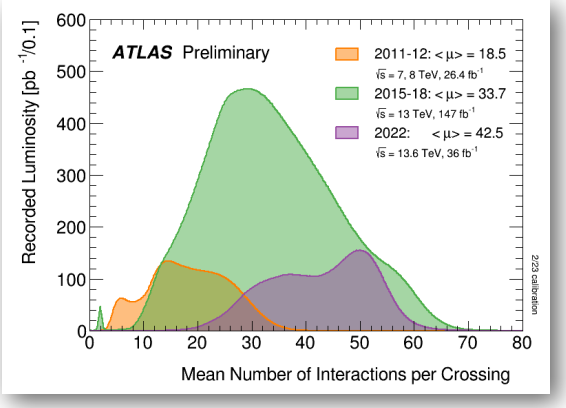
LuminosityPublicResultsRun3



ATLAS Event Display of top-pair production in 13.6 TeV collisions (ATLAS-PHOTO-2022-061-1).



93% recording eff. (slightly lower than in Run-2).

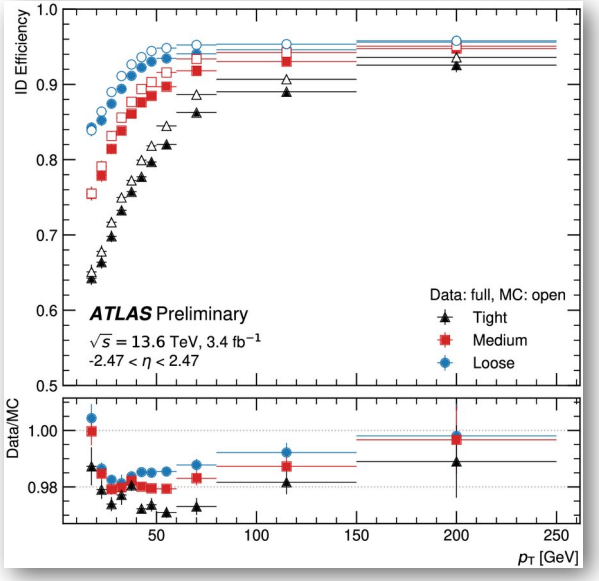


<μ> 26% higher than in Run-2.

ID/Reco Performance (preliminary)

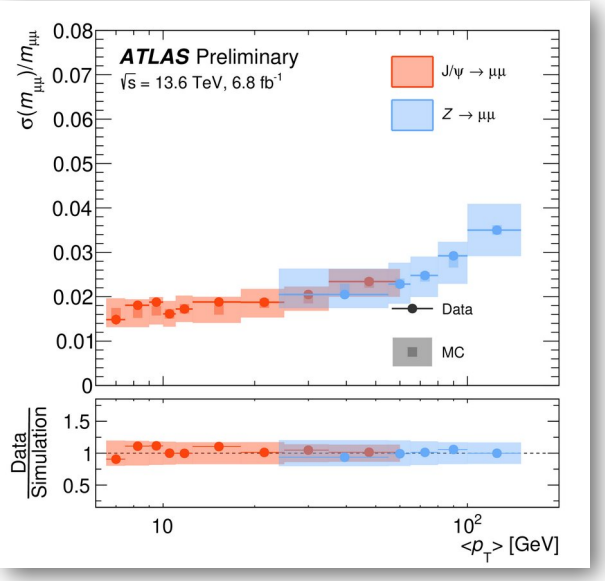
EGAM-2022-04

Electron identification efficiency Vs p_T



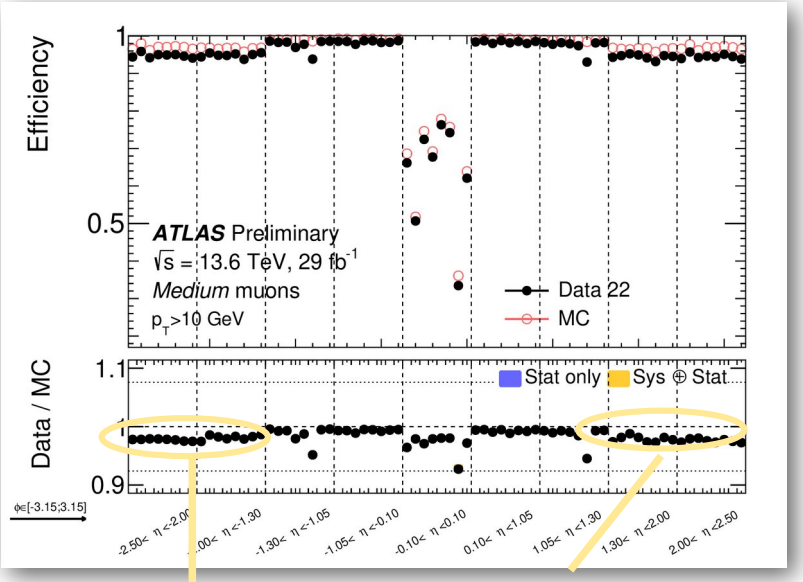
MUON-2022-02

Dimuon invariant mass resolution.



MUON-2023-01

Muon identification efficiency Vs η.

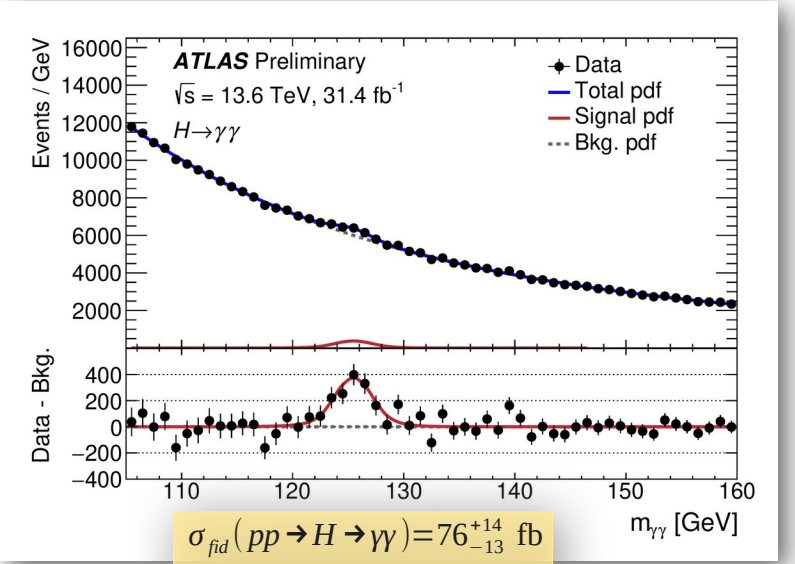


NSW commissioning period: NSW hits are not yet counted as precision-layer hits.

H → γγ fiducial cross-section measurement

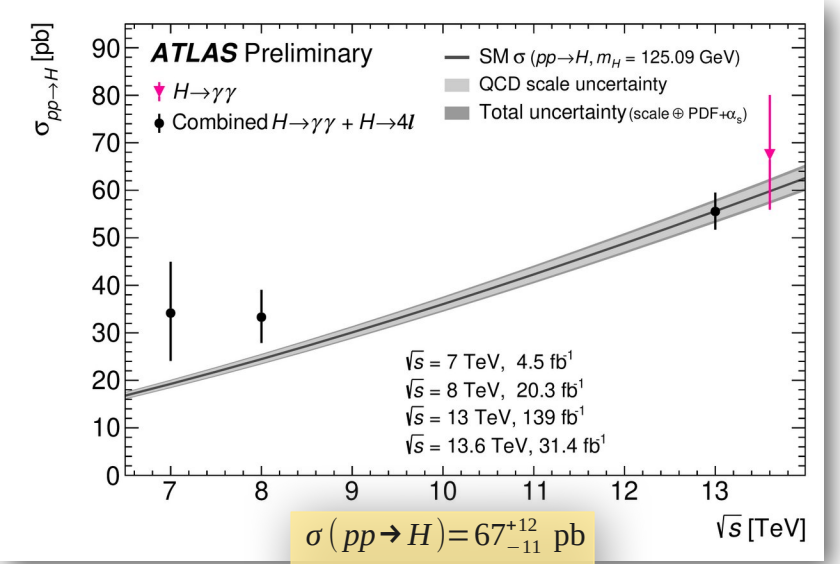
ATLAS-CONF-2023-003

- First measurement of $\sigma(H \to \gamma\gamma)$ @ 13.6 TeV.
- Two isolated photons, $E_T/m_{\gamma\gamma} > 0.35$ and > 0.25, $m_{\gamma\gamma} \in (105, 160)$ GeV.
- Main backgrounds: non-prompt $\gamma\gamma$, γj, jj.
- $\sigma_{fid}(H \to \gamma\gamma)$ extracted by unbinned max LH fit to $m_{\gamma\gamma}$ spectrum.



$\sigma_{fid}(pp \to H \to \gamma\gamma) = 76^{+14}_{-13}$ fb

$\sigma_{fid}^{theory} = 67.5 \pm 3.4$ fb

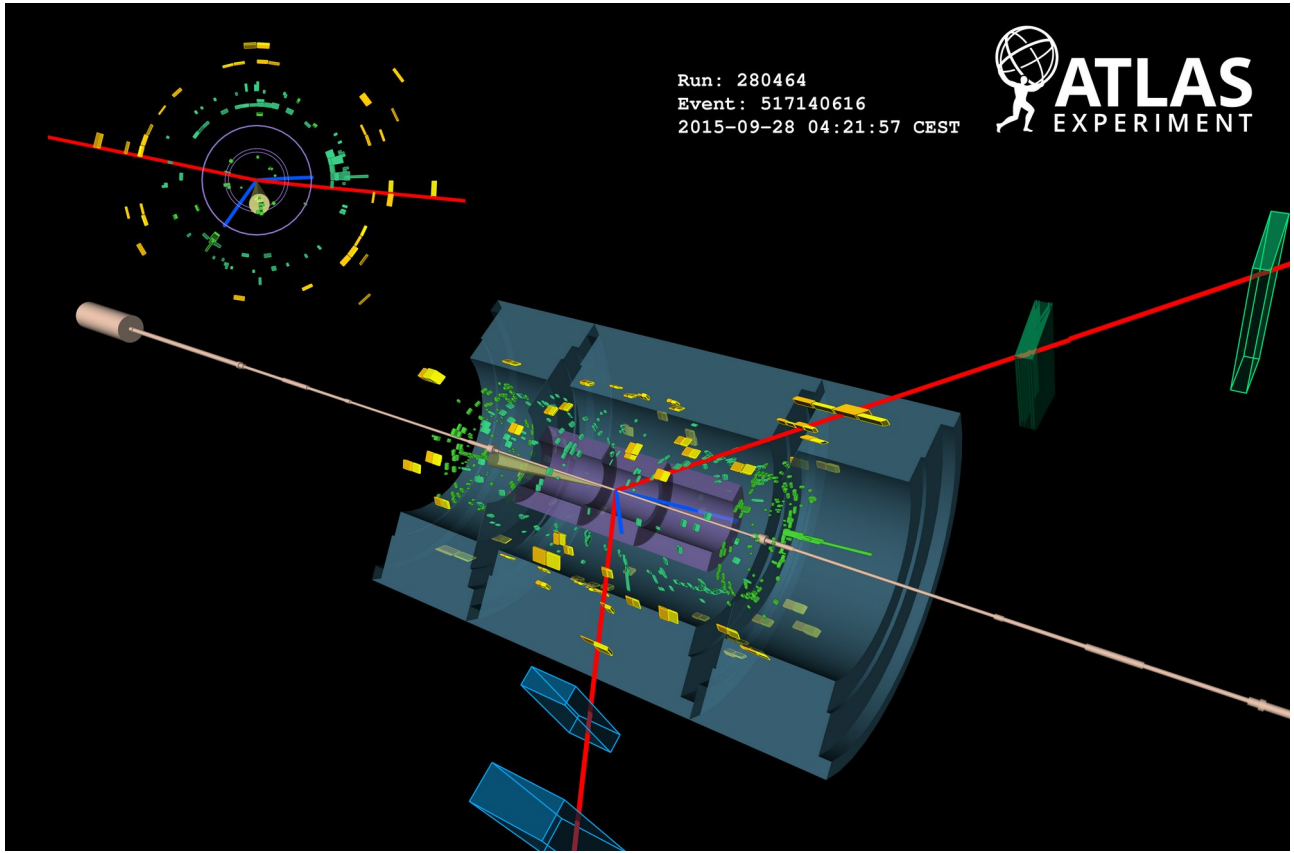


$\sigma(pp \to H) = 67^{+12}_{-11}$ pb

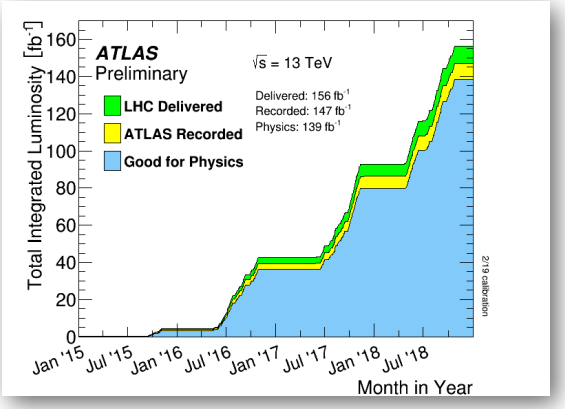
$\sigma_{SM} = 59.8 \pm 2.6$ pb

LHC Run-2

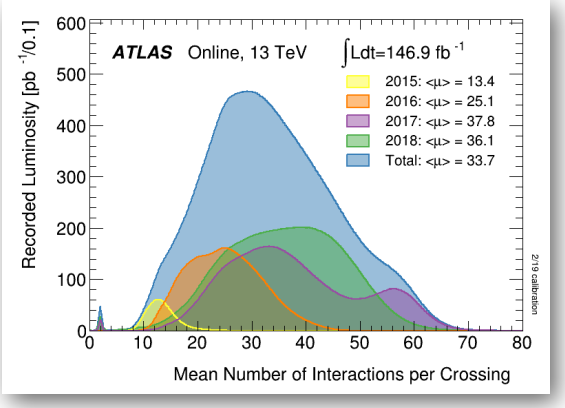
ATLAS public online estimates



H → ZZ* → 2e2μ candidate event recorded in 2015 (ATLAS-PHOTO-2022-061-1).



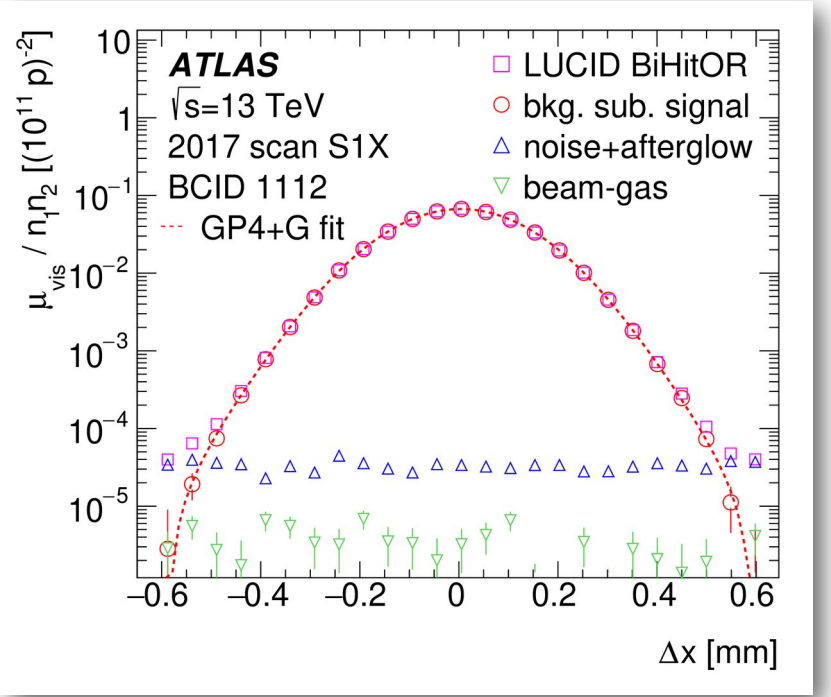
94% recording eff. / 96% data-quality eff.



Final Luminosity for Run-2 pp

arXiv: 2212.09379 (sub. to EPJC)

- Based on complimentary measurements from LUCID, InnerDetector and Calorimeters.
- absolute calibration of LUCID from vdM scans each year.
- final result for standard high pileup sample $L_{\text{int}} = 140.1 \pm 1.2\ \text{fb}^{-1}$.
- unprecedented uncertainty of 0.83% (0.9% achieved by second-generation ISR experiments).



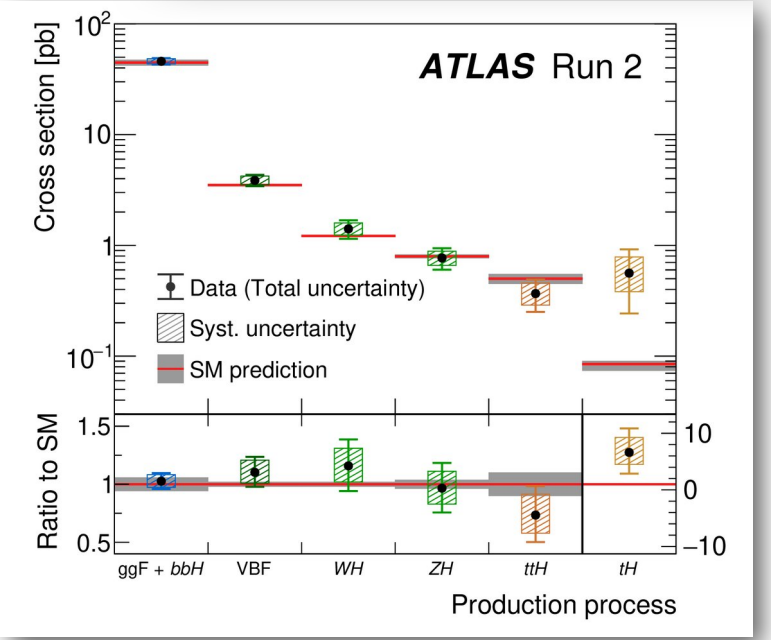
Visible interaction rate per unit bunch population product vs beam horizontal beam separation during a VdM scan.

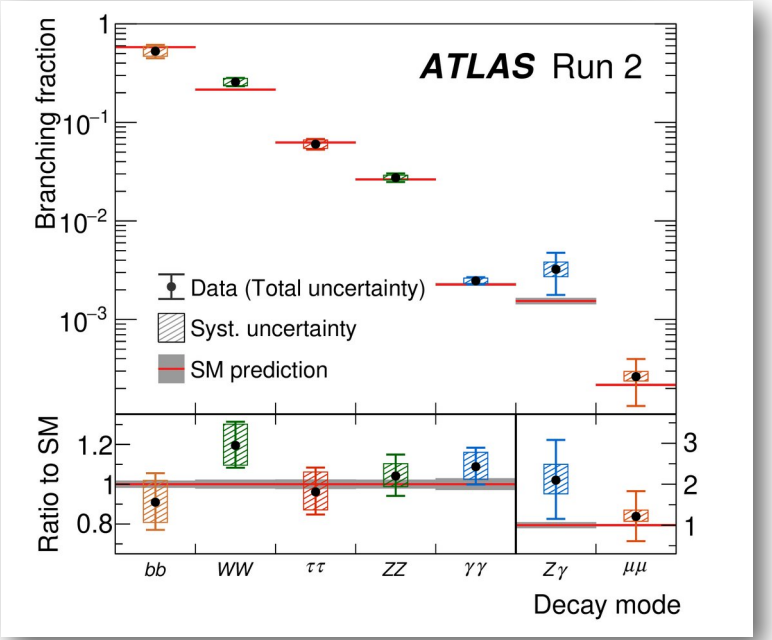
Higgs Production Cross-Section Measurements

10 years from the discovery of the Higgs boson: Nature volume 607, pages52–59 (2022)

- The Higgs boson discovered ten years ago is remarkably consistent with the predictions of the SM.
- Inclusive Higgs boson production rate relative to the SM prediction:

$$\mu = 1.05 \pm 0.06 = 1.05 \pm 0.03(\text{stat.}) \pm 0.03(\text{exp.}) \pm 0.04(\text{sig. th.}) \pm 0.02(\text{bkg. th.})$$

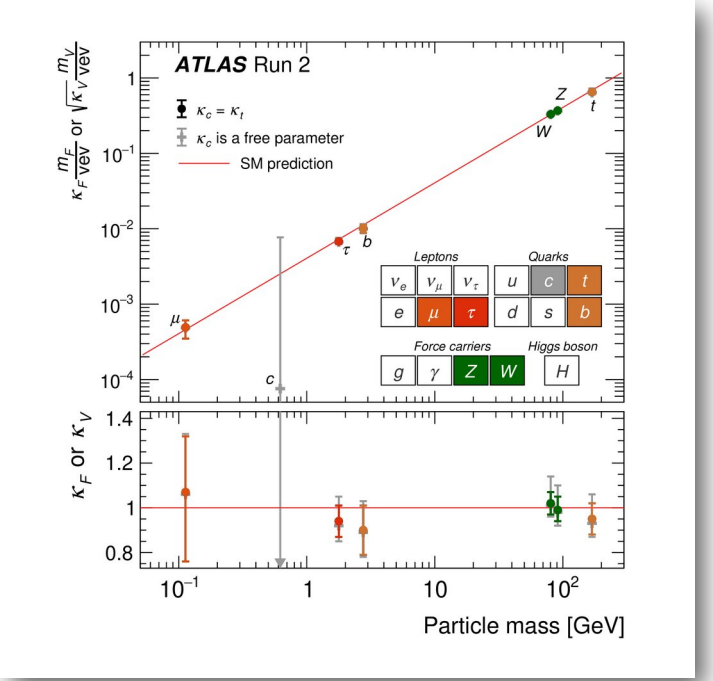




Higgs Coupling Measurements

10 years from the discovery of the Higgs boson: Nature volume 607, pages52–59 (2022)

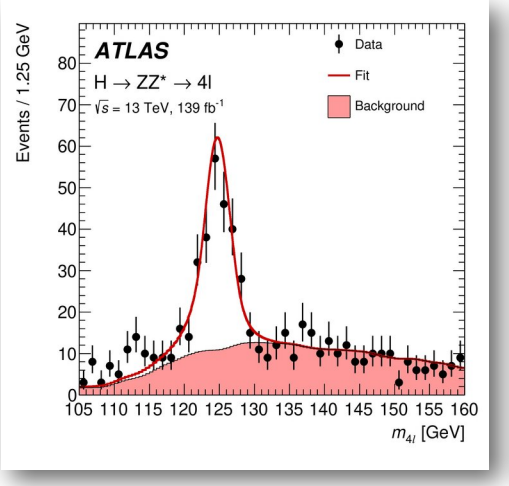
- Interactions scale with mass.
- Confirmed for vector bosons and all 3rd generation fermions (… except ν_τ).
- 2nd generation fermions are now being constrained too!

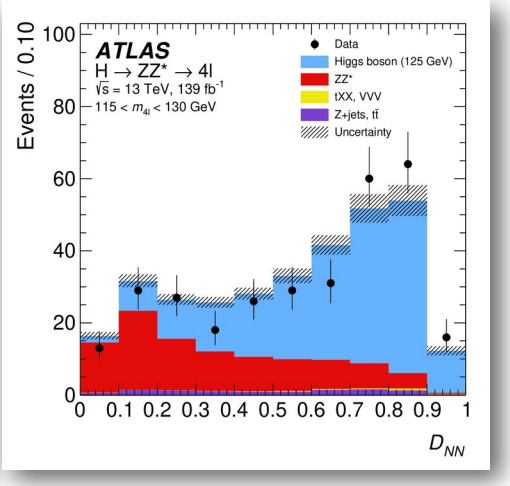


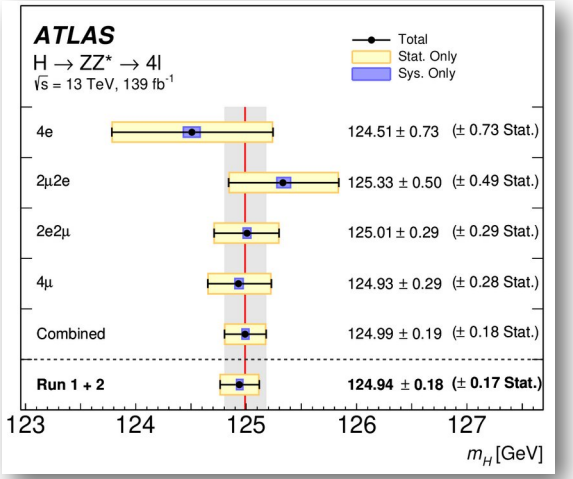
Higgs mass measurement ($H \to ZZ^* \to 4l$)

arXiv: 2207.00320 (sub. to PLB)

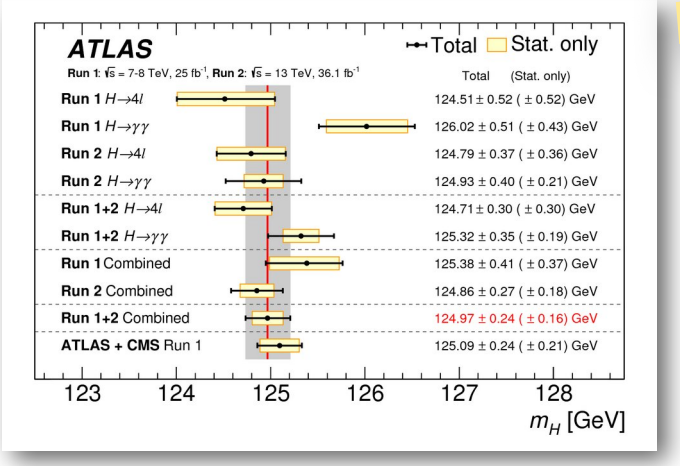
- Final states: 4μ, $4e$, $2\mu 2e$, $2e2\mu$.
- Discriminants: m_{4l}, D_{NN} (additional separation from $ZZ^* \to 4\ell$).
- Event-by-event invariant-mass resolution of 4l system.







more to come (γγ)



Combination of 7 TeV, 8 TeV and 13 TeV data sets:

$$m_H = 124.94 \pm 0.17(\text{stat.}) \pm 0.03(\text{syst.})\ \text{GeV}$$

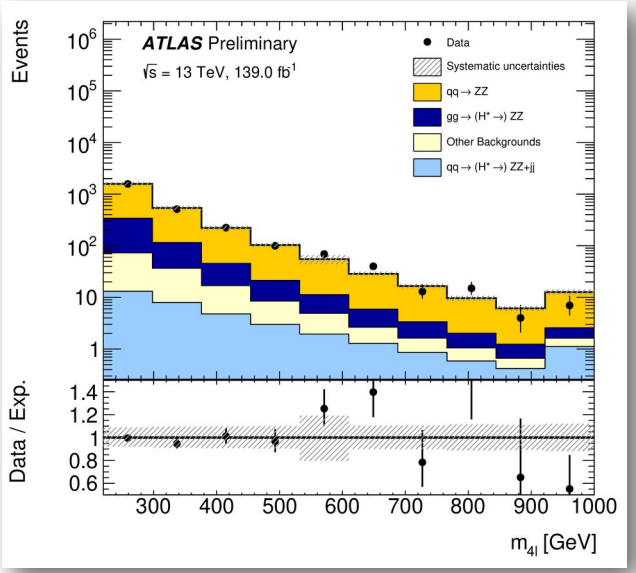
▲ dominant ▲ 28 MeV unc. from μ p_T scale

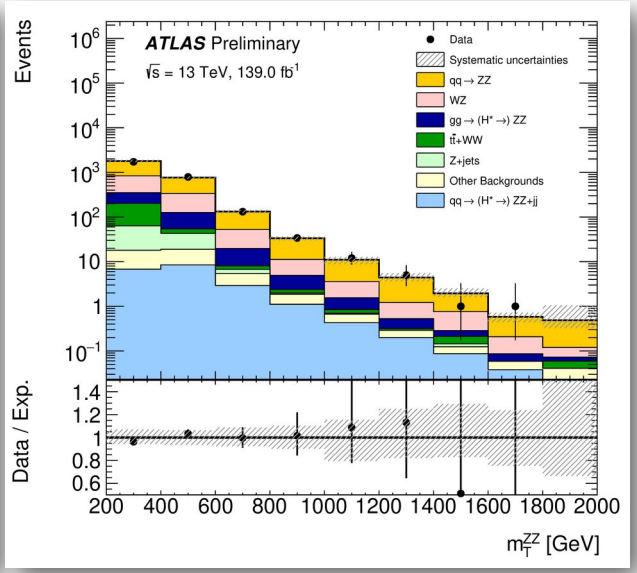
Higgs width measurement

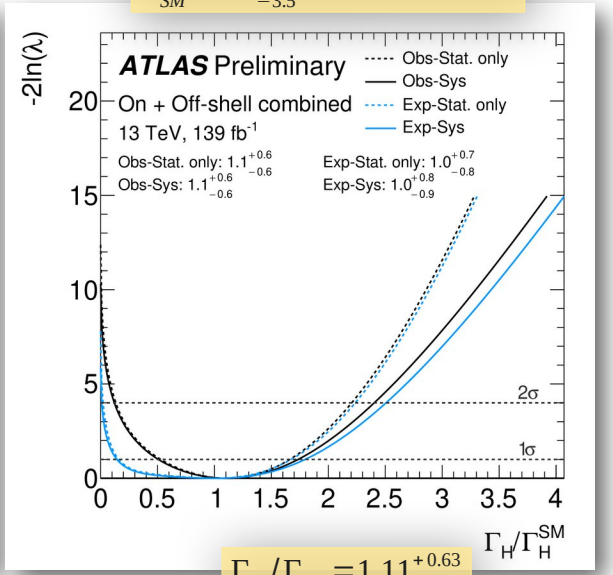
ATLAS-CONF-2022-068

- Γ_H measurements based on off-shell Higgs production study with $H \to ZZ \to 4\ell$ / $2\ell 2\nu$.
- Assumption that the Higgs boson decays to SM particles, with $\sigma^{\text{on-shell}}_{gg\to H\to VV} \sim \frac{g^2_{ggH} g^2_{HZZ}}{m_H \Gamma_H}$ and $\sigma^{\text{off-shell}}_{gg\to H\to VV} \sim \frac{g^2_{ggH} g^2_{HZZ}}{m^2_{ZZ}}$
- Destructive interference → less gg→(H*→)ZZ.
- **Measured off-shell production with 3.2σ.**

$\Gamma_H = 4.6^{+2.6}_{-2.5}$ MeV @ 68% CL.
$\Gamma_{SM} = 4.1^{+3.2}_{-3.5}$ MeV







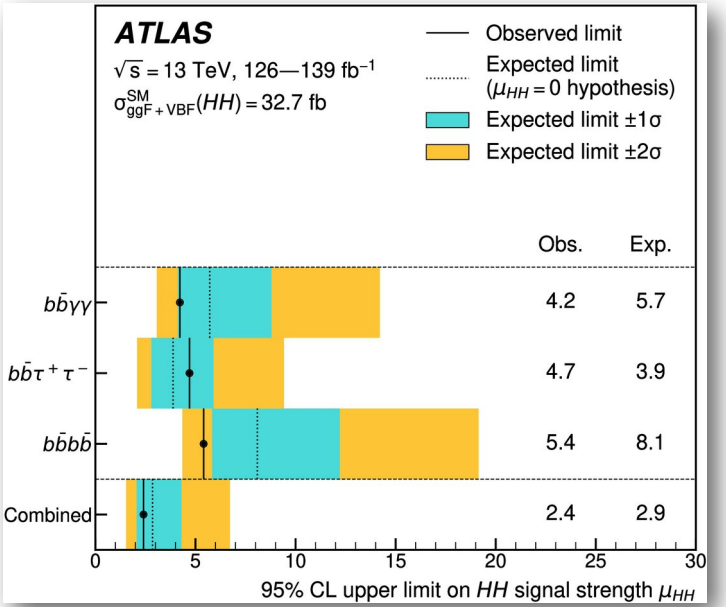
$\Gamma_H/\Gamma_{SM} = 1.11^{+0.63}_{-0.60}$

Higgs self-coupling

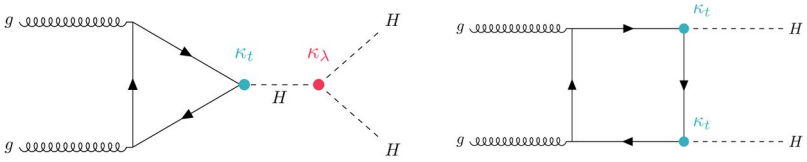
- Di-Higgs production: $\lambda_{HHH} = m_H^2 / 2v^2$
- SM HH production σ(HH) ~ 33 fb @ 13 TeV
- Expected near the end of HL-LHC; may come sooner…

Channel	*L_{int} (fb^{-1})*	*Reference*
$HH \to b\bar{b}\gamma\gamma$	139	Phys. Rev. D 106, 052001
$HH \to b\bar{b}\tau^+\tau$	139	arXiv: 2209.10910 (sub. to JHEP)
$HH \to b\bar{b}b\bar{b}$	126	arXiv: 2301.03212 (sub. to PRD)
Combination		arXiv: 2211.01216 (sub. to PLB)

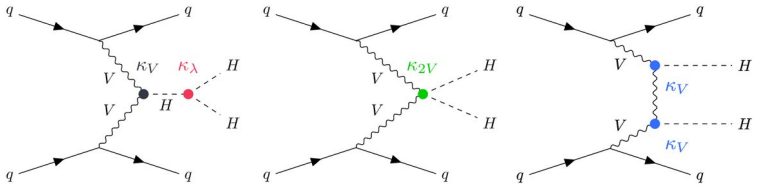
$$\mu_{HH} = \sigma^{HH}_{ggF+VFF} / \sigma^{HH,SM}_{ggF+VFF} = -0.7 \pm 1.3 \times SM$$



$\sigma^{SM}_{ggF}(pp \to HH) = 31^{+2.1}_{-7.2}$ fb @ 13 TeV

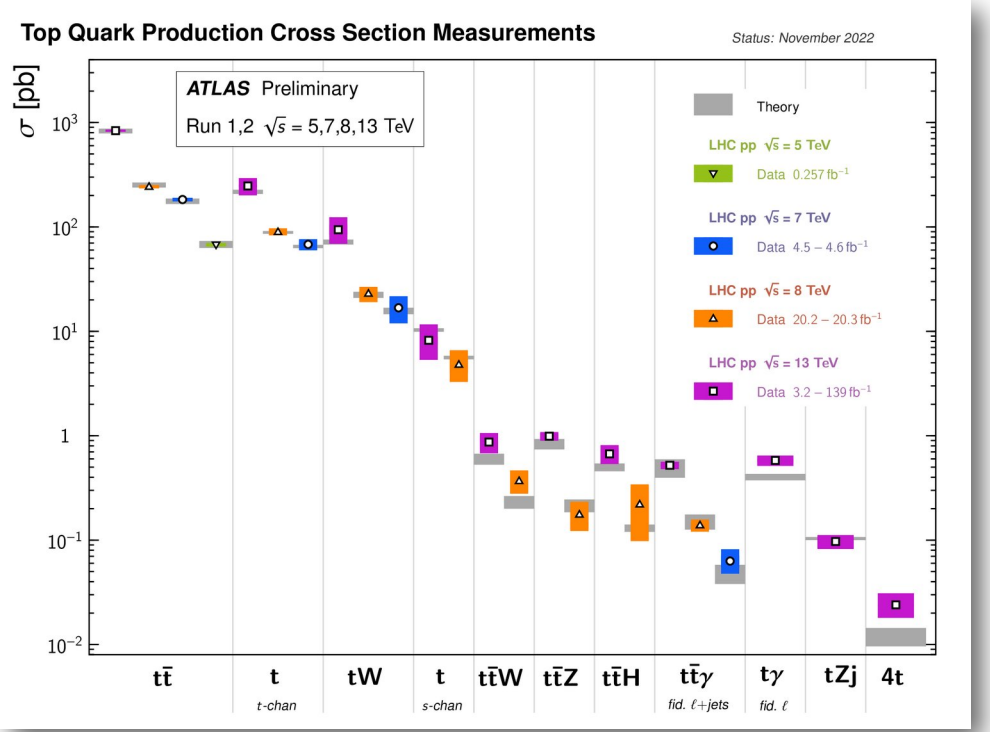


$\sigma^{SM}_{VBF}(pp \to HH) = 1.72 \pm 0.04$ fb @ 13 TeV



Top quark measurements

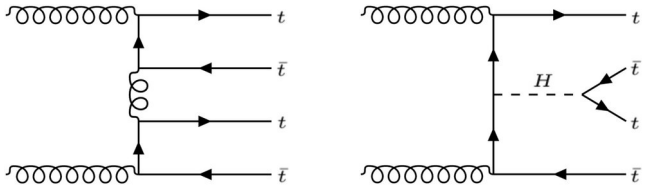
ATL-PHYS-PUB-2022-051



- Top is the heaviest elementary particle.
- Plays a special role in BSM physics.
- Heavy particle final states, $t\bar{t}V$, $t\bar{t}t\bar{t}$, $t\bar{t}H$ cross-sections (measured at Run 2), are background for new physics signatures at TeV energy scale.

Observation of 4-top production

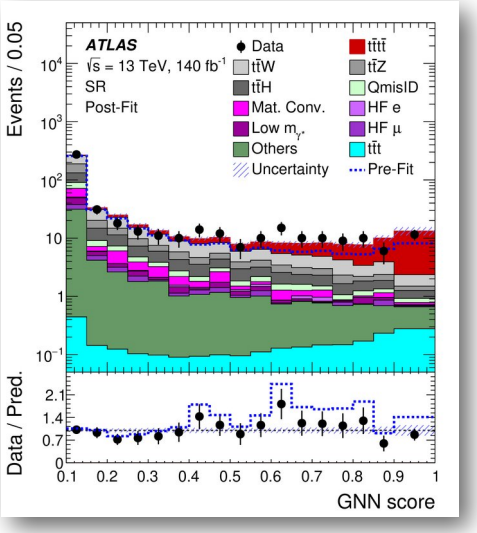
arXiv: 2303.15061 (sub. EPJC)

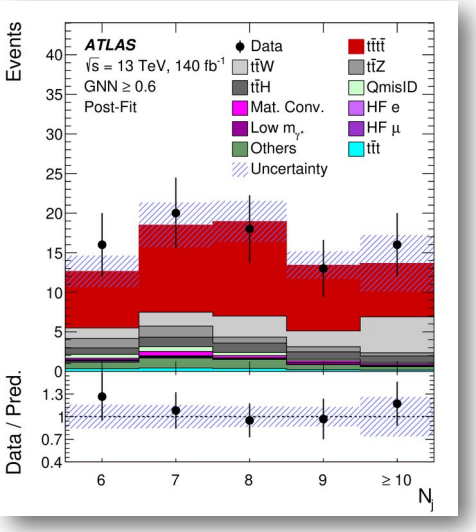


Most sensitive channels:

- **2 leptons SS, >= 6jets (>=2b)**
- **>= 3 leptons, >= 6jets (>=2b)**

Observable: GNN-based discriminant trained to separate the signal from dominant backgrounds.





Main Irreduclble backgrounds: $t\bar{t}W$, $t\bar{t}Z$, $t\bar{t}H$.

- $t\bar{t}W$ normalized in data CRs orthogonal to the SR.

Reducible $t\bar{t}$+jets contaminates through:

- fake/non-prompt leptons
- electron charge mis-identification
- ▶ **data driven estimation.**

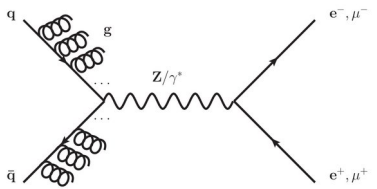
$$\sigma_{t\bar{t}t\bar{t}} = 22.5^{+4.7}_{-4.3}(\text{stat.})^{+4.6}_{-3.4}(\text{syst.})\ \text{fb} = 22.5^{+6.6}_{-5.5}\ \text{fb}$$

$$\sigma_{SM} = 12 \pm 2.4\ fb$$

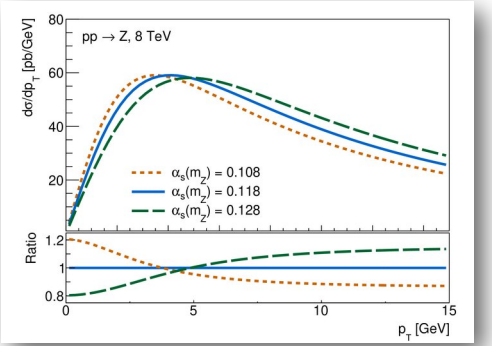
6.1 (4.3) observed (expected) significance above backround-only hypothesis.

Measurement of αs

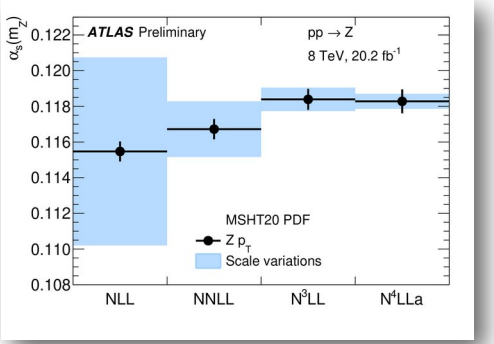
ATLAS-CONF-2023-015



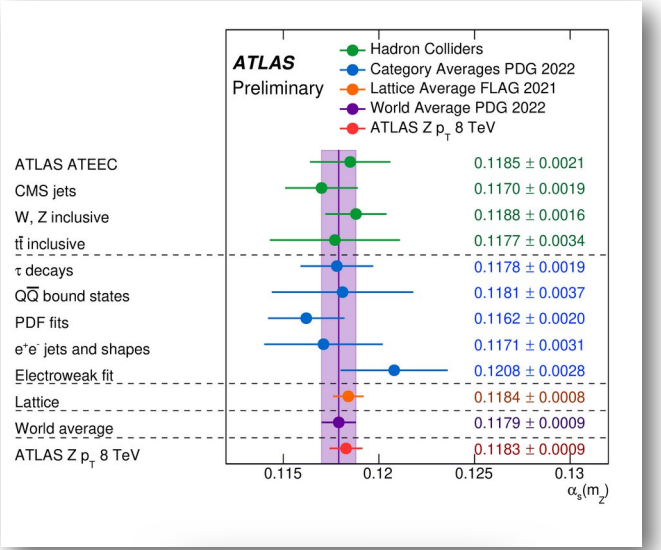
- Use 2012 dataset @ 8 TeV.
- Integrated luminosity: 20.2 fb^{-1}.
- Observable: recoil p_T of Z (→ ll).
- 9 bins in p_T^Z < 29 GeV
  x 8 bins in $|y_Z|$ < 3.6.
  within 80 < m_{ll} < 100 GeV.
- predictions using approximate N3LO MSHT20 PDF set.



p_T^Z distribution predicted at different values of $\alpha_s(m_Z)$, using the MSHT20 PDF set.



Determination of $\alpha_s(m_Z)$ at different orders in the QCD perturbative expansion,



$$\alpha_s(m_Z) = 0.11828^{+0.00084}_{-0.00088}$$

most precise determination of $\alpha_s(m_Z)$

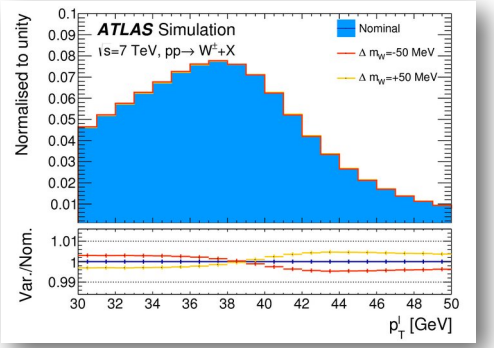
Experimental uncertainty	+0.00044	-0.00044
PDF uncertainty	+0.00051	-0.00051
Scale variations uncertainties	+0.00042	-0.00042
Matching to fixed order	0	-0.00008
Non-perturbative model	+0.00012	-0.00020
Flavour model	+0.00021	-0.00029
QED ISR	+0.00014	-0.00014
N4LL approximation	+0.00004	-0.00004
Total	+0.00084	-0.00088

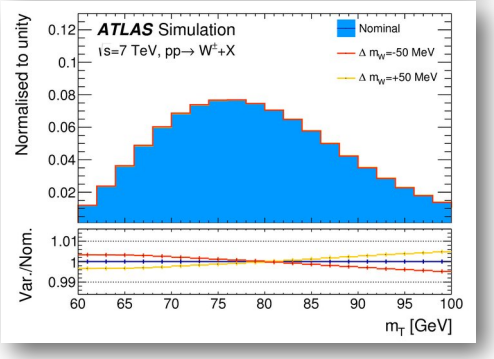
Measurement of the W boson mass

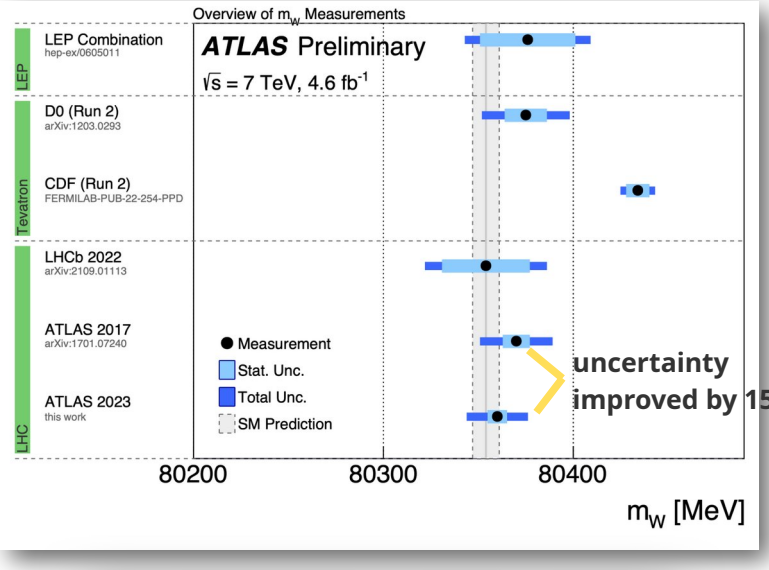
ATLAS-CONF-2023-004

- Use 2011 dataset @ 7 TeV.
- Integrated luminosity: 4.6 fb^{-1}.
- Observable: p_T^{lep}, m_T.
- Improved statistical model (employs profile likelihood fit).
- Improved pdf sets with smaller theoretical uncertainties.

Plot from STDM-2014-18







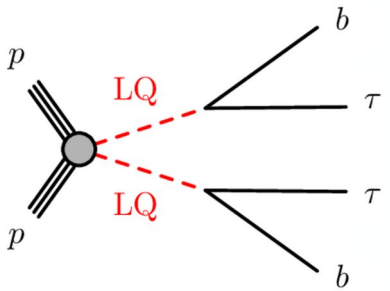
m_W=80360±5(stat.)±15(syst.) MeV

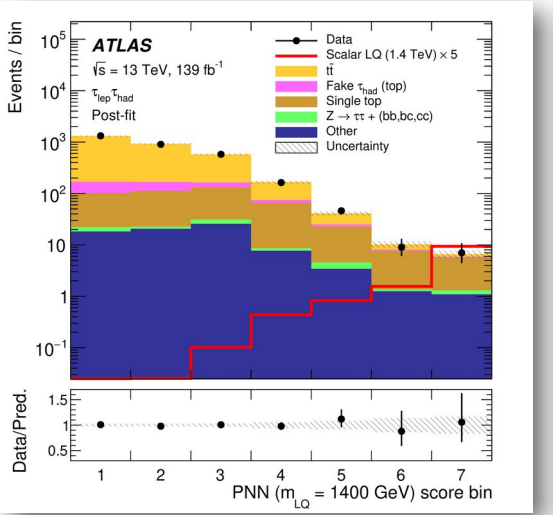
Obs.	Mean [MeV]	Elec. Unc.	PDF Unc.	Muon Unc.	EW Unc.	PS & A_i Unc.	Bkg. Unc.	Γ_W Unc.	MC stat. Unc.	Lumi Unc.	Recoil Unc.	Total sys.	Data stat.	Total Unc.
p_T^ℓ	80360.1	8.0	7.7	7.0	6.0	4.7	2.4	2.0	1.9	1.2	0.6	15.5	4.9	16.3
m_T	80382.2	9.2	14.6	9.8	5.9	10.3	6.0	7.0	2.4	1.8	11.7	24.4	6.7	25.3

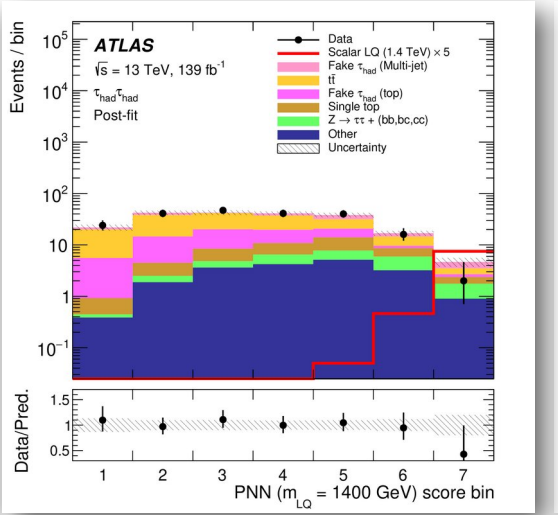
Search for pair production of 3rd-gen. leptoquarks

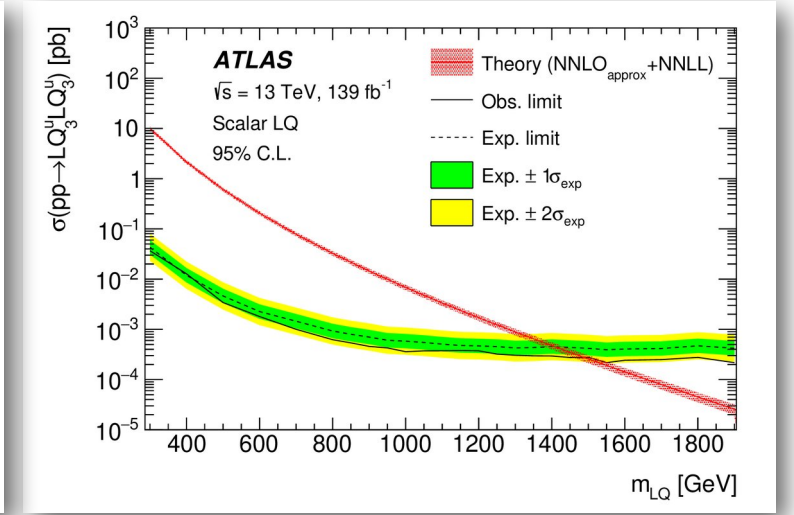
arXiv: 2303.01294 (sub. to EPJC)

- Final state: 2b2τ → two channels lep-had, had-had
- Observable: MVA (PNN) trained to discriminate signal from dominant top-quark background.
- Previous ATLAS search in this final state (36 fb^{-1}) surpassed by more than 450 GeV for scalar LQs.









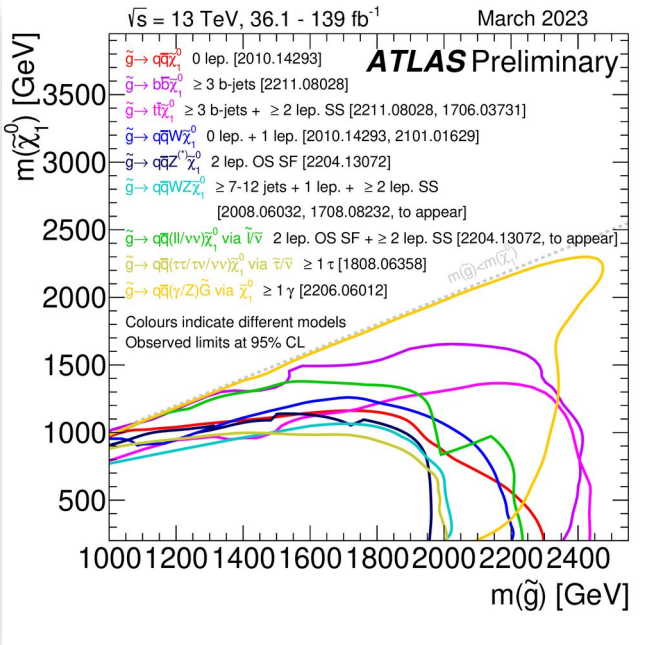
Supersymmetry

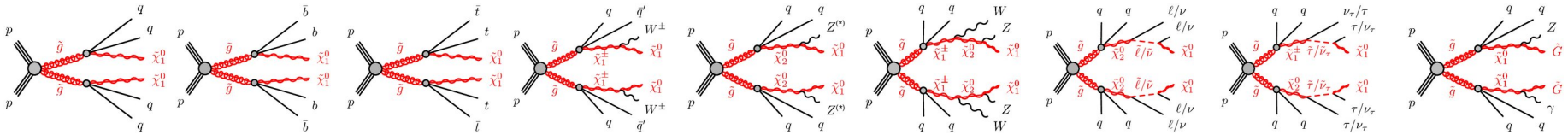
ATL-PHYS-PUB-2023-005

- Impressive amount of work by search groups. Exclusion of large areas of the phase space.

Example #1:

- Analyses focusing on the pair production of gluinos, supersymmetric partner of the gluon.
- Different decay modes of gluinos to the LSP (neutralino or gravitino) are probed; assumed to proceed with 100% branching ratio.
- Strong increase in exclusion limits. Gluino masses below 2.44 TeV (Gtt) and 2.35 TeV (Gbb) are excluded for a massless neutralino.





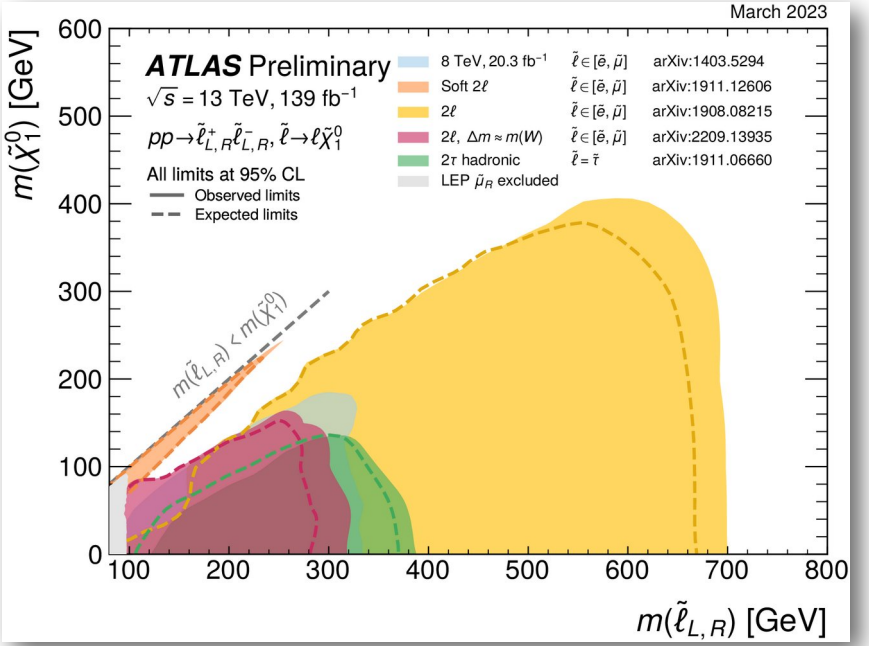
Supersymmetry

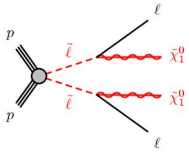
ATL-PHYS-PUB-2023-005

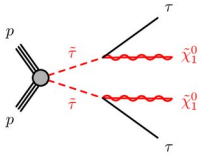
- Impressive amount of work by search groups. Exclusion of large areas of the phase space.

Example #2:

- Analyses probing the electroweak production of sleptons with decays to lepton, neutralino.
- For a massless neutralino, masses up to 700 GeV are excluded assuming three generations of mass-degenerate sleptons.



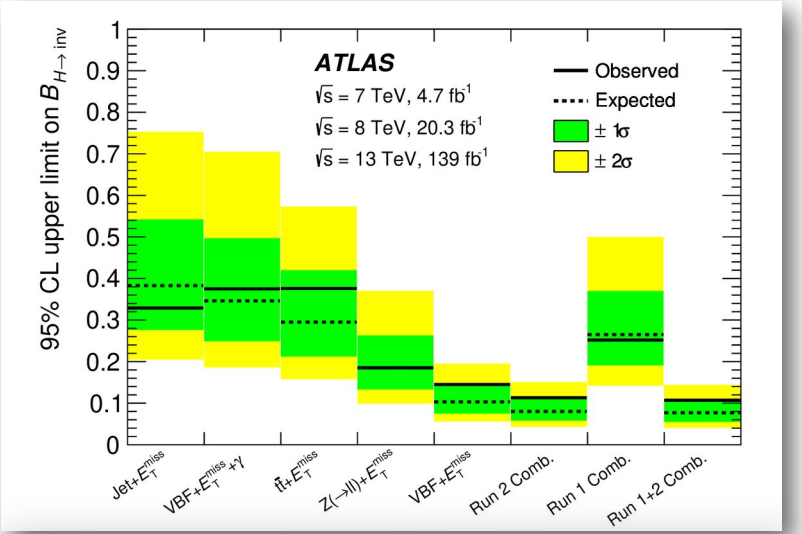




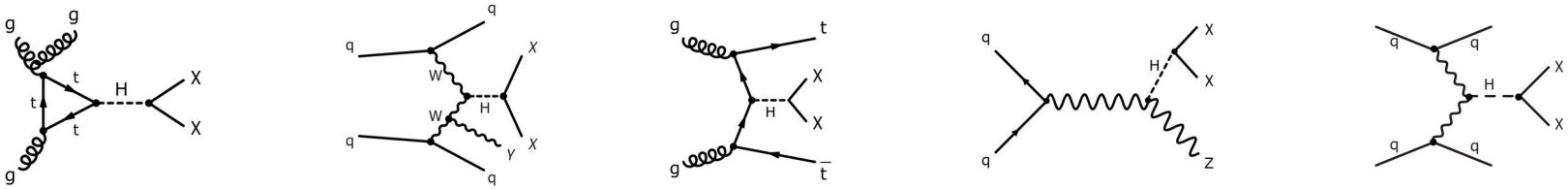
H→invisible search combination

arXiv: 2301.10731 (sub. to PLB)

- Several models predict a massive, stable and electrically neutral particle X as a dark matter candidate.
- SM branching ratio for Higgs invisible decay (H→ZZ→4ν) ~0.1%
- If DM exists in the right mass range, we may observe larger BR(H→inv) than SM prediction.



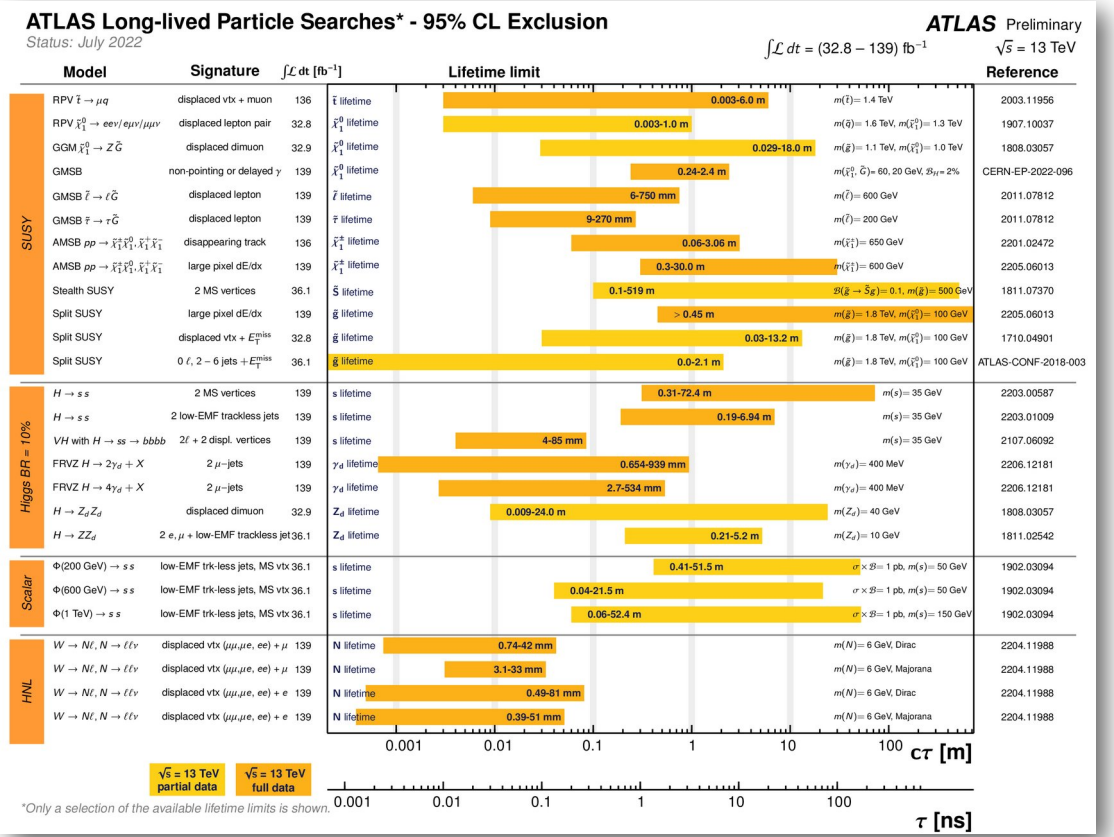
BR(H→inv) < 0.107 (0.077) @ 95% CL obs (exp)



Searches for long-lived particles

ATL-PHYS-PUB-2022-034

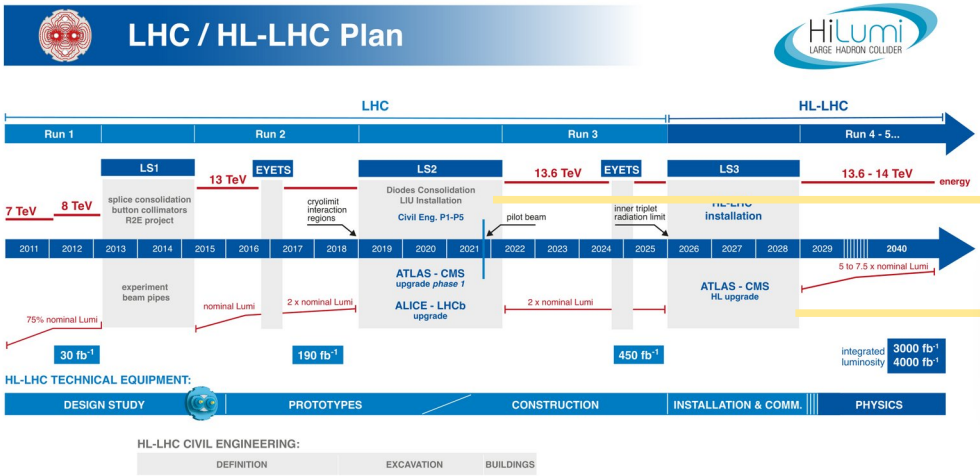
- No signs of BSM physics so far → search further away…
- A rich set of searches have been performed using LHC Run-2 data.
- LLPs are theoretically motivated, and experimentally motivating.
- Here: representative set of most sensitive recent results.



Conclusions

https://hilumilhc.web.cern.ch

- ATLAS is using 139fb^{-1} @ 13TeV for most results.
- No signs of BSM physics in Run-2; SM predictions getting constrained.
- Run 3 expected to bring more than 300fb^{-1} @ 13.6 TeV.
- HL-LHC will bring an order of magnitude more.



More on Phase-I upgrade in Theo's talk tomorrow.

More on Phase-II upgrade in Ilya's talk tomorrow.

H.F.R.I. Hellenic Foundation for Research & Innovation

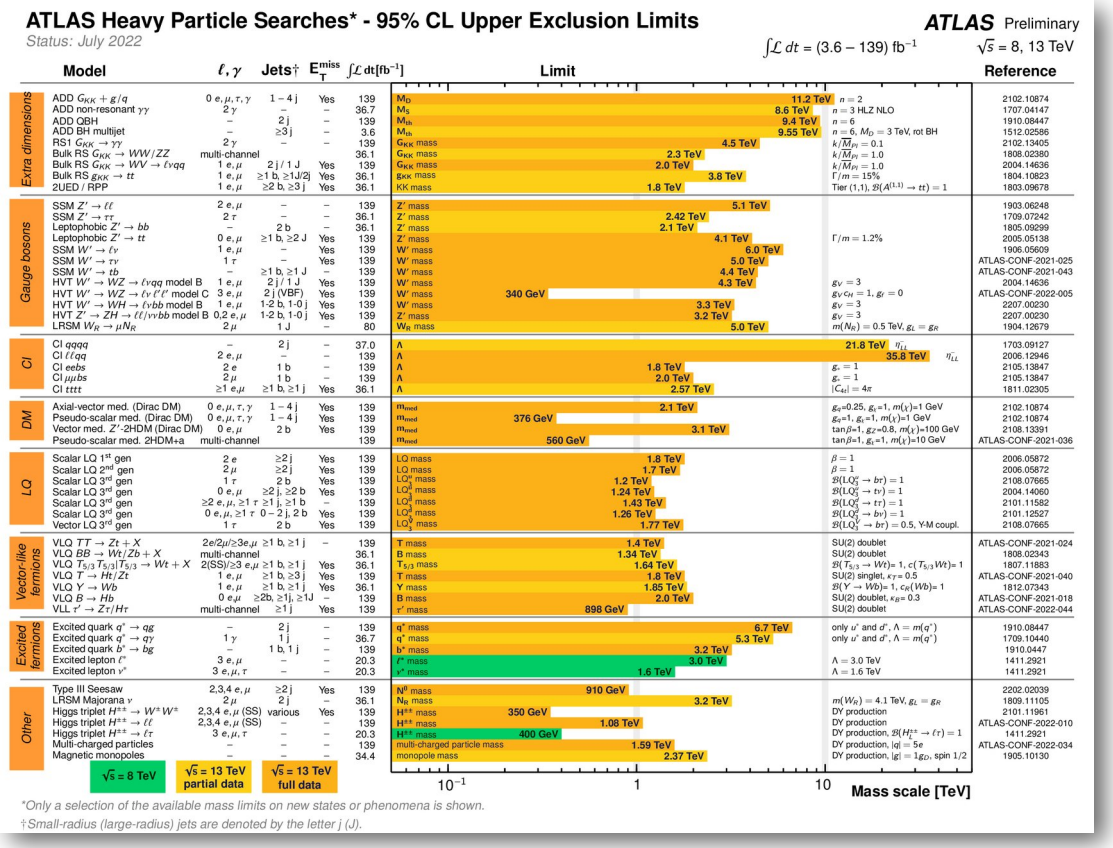
The research project was supported by the Hellenic Foundation for Research and Innovation (H.F.R.I.) under the "2nd Call for H.F.R.I. Research Projects to support Faculty Members & Researchers" (Project Number: 04612).

Additional Material

Heavy Resonance Searches

ATL-PHYS-PUB-2022-034

Representative set of most sensitive recent results



ATLAS SUSY Searches* - 95% CL Lower Limits

March 2023

ATLAS Preliminary

$\sqrt{s}$ = 13 TeV

	Model	Signature			$\int \mathcal{L}\,dt$ [fb^{-1}]	Mass limit		Reference
Inclusive Searches	$\tilde{q}\tilde{q}, \tilde{q}\to q\tilde{\chi}_1^0$	0 e,μ	2-6 jets	E_T^{miss}	139	$\tilde{q}$ [1×, 8× Degen.] 1.0 / 1.85	m($\tilde{\chi}_1^0$)<400 GeV	2010.14293
		mono-jet	1-3 jets	E_T^{miss}	139	$\tilde{q}$ [8× Degen.] 0.9	m($\tilde{q}$)-m($\tilde{\chi}_1^0$)=5 GeV	2102.10874
	$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}\tilde{\chi}_1^0$	0 e,μ	2-6 jets	E_T^{miss}	139	$\tilde{g}$ 2.3	m($\tilde{\chi}_1^0$)=0 GeV	2010.14293
						$\tilde{g}$ Forbidden 1.15-1.95	m($\tilde{\chi}_1^0$)=1000 GeV	2010.14293
	$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}W\tilde{\chi}_1^0$	1 e,μ	2-6 jets		139	$\tilde{g}$ 2.2	m($\tilde{\chi}_1^0$)<600 GeV	2101.01629
	$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}(\ell\ell)\tilde{\chi}_1^0$	$ee,\mu\mu$	2 jets	E_T^{miss}	139	$\tilde{g}$ 2.2	m($\tilde{\chi}_1^0$)<700 GeV	2204.13072
	$\tilde{g}\tilde{g}, \tilde{g}\to qqWZ\tilde{\chi}_1^0$	0 e,μ	7-11 jets	E_T^{miss}	139	$\tilde{g}$ 1.97	m($\tilde{\chi}_1^0$) <600 GeV	2008.06032
		SS e,μ	6 jets		139	$\tilde{g}$ 1.15	m($\tilde{g}$)-m($\tilde{\chi}_1^0$)=200 GeV	1909.08457
	$\tilde{g}\tilde{g}, \tilde{g}\to t\bar{t}\tilde{\chi}_1^0$	0-1 e,μ	3 b	E_T^{miss}	139	$\tilde{g}$ 2.45	m($\tilde{\chi}_1^0$)<500 GeV	2211.08028
		SS e,μ	6 jets		139	$\tilde{g}$ 1.25	m($\tilde{g}$)-m($\tilde{\chi}_1^0$)=300 GeV	1909.08457
3rd gen. squarks direct production	$\tilde{b}_1\tilde{b}_1$	0 e,μ	2 b	E_T^{miss}	139	$\tilde{b}_1$ 1.255	m($\tilde{\chi}_1^0$)<400 GeV	2101.12527
						$\tilde{b}_1$ 0.68	10 GeV<Δm($\tilde{b}_1$,$\tilde{\chi}_1^0$)<20 GeV	2101.12527
	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to b\tilde{\chi}_2^0 \to bh\tilde{\chi}_1^0$	0 e,μ	6 b	E_T^{miss}	139	$\tilde{b}_1$ Forbidden 0.23-1.35	Δm($\tilde{\chi}_2^0$,$\tilde{\chi}_1^0$)=130 GeV, m($\tilde{\chi}_1^0$)=100 GeV	1908.03122
		2 τ	2 b	E_T^{miss}	139	$\tilde{b}_1$ 0.13-0.85	Δm($\tilde{\chi}_2^0$,$\tilde{\chi}_1^0$)=130 GeV, m($\tilde{\chi}_1^0$)=0 GeV	2103.08189
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to t\tilde{\chi}_1^0$	0-1 e,μ	$\geq$ 1 jet	E_T^{miss}	139	$\tilde{t}_1$ 1.25	m($\tilde{\chi}_1^0$)=1 GeV	2004.14060, 2012.03799
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to Wb\tilde{\chi}_1^0$	1 e,μ	3 jets/1 b	E_T^{miss}	139	$\tilde{t}_1$ Forbidden 0.65	m($\tilde{\chi}_1^0$)=500 GeV	2012.03799
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to\tilde{\tau}_1 b\nu, \tilde{\tau}_1\to\tau\tilde{G}$	1-2 τ	2 jets/1 b	E_T^{miss}	139	$\tilde{t}_1$ Forbidden 1.4	m($\tilde{\tau}_1$)=800 GeV	2108.07665
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to c\tilde{\chi}_1^0$ / $\tilde{c}\tilde{c}$, $\tilde{c}\to c\tilde{\chi}_1^0$	0 e,μ	2 c	E_T^{miss}	36.1	$\tilde{c}$ 0.85	m($\tilde{\chi}_1^0$)=0 GeV	1805.01649
		0 e,μ	mono-jet	E_T^{miss}	139	$\tilde{t}_1$ 0.55	m($\tilde{t}_1$,$\tilde{\chi}_1^0$)-m($\tilde{\chi}_1^0$)=5 GeV	2102.10874
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to t\tilde{\chi}_2^0, \tilde{\chi}_2^0\to Z/h\tilde{\chi}_1^0$	1-2 e,μ	1-4 b	E_T^{miss}	139	$\tilde{t}_1$ 0.067-1.18	m($\tilde{\chi}_2^0$)=500 GeV	2006.05880
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2\to\tilde{t}_1 + Z$	3 e,μ	1 b	E_T^{miss}	139	$\tilde{t}_2$ Forbidden 0.86	m($\tilde{\chi}_1^0$)=360 GeV, m($\tilde{t}_1$)-m($\tilde{\chi}_1^0$)= 40 GeV	2006.05880
EW direct	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0$ via WZ	Multiple ℓ/jets		E_T^{miss}	139	$\tilde{\chi}_1^\pm/\tilde{\chi}_2^0$ 0.96	m($\tilde{\chi}_1^0$)=0, wino-bino	2106.01676, 2108.07586
		$ee,\mu\mu$	$\geq$ 1 jet	E_T^{miss}	139	$\tilde{\chi}_1^\pm/\tilde{\chi}_2^0$ 0.205	m($\tilde{\chi}_1^\pm$)-m($\tilde{\chi}_1^0$)=5 GeV, wino-bino	1911.12606
	$\tilde{\chi}_1^\pm\tilde{\chi}_1^\mp$ via WW	2 e,μ		E_T^{miss}	139	$\tilde{\chi}_1^\pm$ 0.42	m($\tilde{\chi}_1^0$)=0, wino-bino	1908.08215
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0$ via Wh	Multiple ℓ/jets		E_T^{miss}	139	$\tilde{\chi}_1^\pm/\tilde{\chi}_2^0$ Forbidden 1.06	m($\tilde{\chi}_1^0$)=70 GeV, wino-bino	2004.10894, 2108.07586
	$\tilde{\chi}_1^\pm\tilde{\chi}_1^\mp$ via $\tilde{\ell}_L/\tilde{\nu}$	2 e,μ		E_T^{miss}	139	$\tilde{\chi}_1^\pm$ 1.0	m($\tilde{\ell}$,$\tilde{\nu}$)=0.5(m($\tilde{\chi}_1^\pm$)+m($\tilde{\chi}_1^0$))	1908.08215
	$\tilde{\tau}\tilde{\tau}, \tilde{\tau}\to\tau\tilde{\chi}_1^0$	2 τ		E_T^{miss}	139	$\tilde{\tau}$ [$\tilde{\tau}_L$, $\tilde{\tau}_{R,L}$] 0.16-0.3 / 0.12-0.39	m($\tilde{\chi}_1^0$)=0	1911.06660
	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell}\to\ell\tilde{\chi}_1^0$	2 e,μ	0 jets	E_T^{miss}	139	$\tilde{\ell}$ 0.7	m($\tilde{\chi}_1^0$)=0	1908.08215
		$ee,\mu\mu$	$\geq$ 1 jet	E_T^{miss}	139	$\tilde{\ell}$ 0.256	m($\tilde{\ell}$)-m($\tilde{\chi}_1^0$)=10 GeV	1911.12606
	$\tilde{H}\tilde{H}, \tilde{H}\to h\tilde{G}/Z\tilde{G}$	0 e,μ	$\geq$ 3 b	E_T^{miss}	36.1	$\tilde{H}$ 0.13-0.23 / 0.29-0.88	BR($\tilde{\chi}_1^0\to h\tilde{G}$)=1	1806.04030
		4 e,μ	0 jets	E_T^{miss}	139	$\tilde{H}$ 0.55	BR($\tilde{\chi}_1^0\to Z\tilde{G}$)=1	2103.11684
		0 e,μ	$\geq$ 2 large jets	E_T^{miss}	139	$\tilde{H}$ 0.45-0.93	BR($\tilde{\chi}_1^0\to Z\tilde{G}$)=1	2108.07586
		2 e,μ	$\geq$ 2 jets	E_T^{miss}	139	$\tilde{H}$ 0.77	BR($\tilde{\chi}_1^0\to Z\tilde{G}$)=BR($\tilde{\chi}_1^0\to h\tilde{G}$)=0.5	2204.13072
Long-lived particles	Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^\pm$	Disapp. trk	1 jet	E_T^{miss}	139	$\tilde{\chi}_1^\pm$ 0.66	Pure Wino	2201.02472
						$\tilde{\chi}_1^\pm$ 0.21	Pure higgsino	2201.02472
	Stable $\tilde{g}$ R-hadron	pixel dE/dx		E_T^{miss}	139	$\tilde{g}$ 2.05		2205.06013
	Metastable $\tilde{g}$ R-hadron, $\tilde{g}\to qq\tilde{\chi}_1^0$	pixel dE/dx		E_T^{miss}	139	$\tilde{g}$ [$\tau(\tilde{g})$ =10 ns] 2.2	m($\tilde{\chi}_1^0$)=100 GeV	2205.06013
	$\tilde{\ell}\tilde{\ell}, \tilde{\ell}\to\ell\tilde{G}$	Displ. lep		E_T^{miss}	139	$\tilde{e},\tilde{\mu}$ 0.7	$\tau(\tilde{\ell})$ = 0.1 ns	2011.07812
						$\tilde{\tau}$ 0.34	$\tau(\tilde{\ell})$ = 0.1 ns	2011.07812
		pixel dE/dx		E_T^{miss}	139	$\tilde{\tau}$ 0.36	$\tau(\tilde{\ell})$ = 10 ns	2205.06013
RPV	$\tilde{\chi}_1^\pm\tilde{\chi}_1^\mp/\tilde{\chi}_1^0, \tilde{\chi}_1^\pm\to Z\ell\to\ell\ell\ell$	3 e,μ			139	$\tilde{\chi}_1^\pm/\tilde{\chi}_1^0$ [BR($Z\tau$)=1, BR(Ze)=1] 0.625 / 1.05	Pure Wino	2011.10543
	$\tilde{\chi}_1^\pm\tilde{\chi}_1^\mp/\tilde{\chi}_2^0 \to WW/Z\ell\ell\ell\ell\nu\nu$	4 e,μ	0 jets	E_T^{miss}	139	$\tilde{\chi}_1^\pm/\tilde{\chi}_2^0$ [$\lambda_{12k}\neq 0, \lambda_{i2k}\neq 0$] 0.95 / 1.55	m($\tilde{\chi}_1^0$)=200 GeV	2103.11684
	$\tilde{g}\tilde{g}, \tilde{g}\to qq\tilde{\chi}_1^0, \tilde{\chi}_1^0\to qqq$		4-5 large jets		36.1	$\tilde{g}$ [m($\tilde{\chi}_1^0$)=200 GeV, 1100 GeV] 1.3 / 1.9	Large λ''_{112}	1804.03568
	$\tilde{tt}, \tilde{t}\to t\tilde{\chi}_1^0, \tilde{\chi}_1^0\to tbs$		Multiple		36.1	$\tilde{t}$ [λ''_{323}=2e-4, 1e-2] 0.55 / 1.05	m($\tilde{\chi}_1^0$)=200 GeV, bino-like	ATLAS-CONF-2018-003
	$\tilde{tt}, \tilde{t}\to bs\tilde{\chi}_1^0, \tilde{\chi}_1^0\to bbs$		$\geq$ 4b		139	$\tilde{t}$ Forbidden 0.95	m($\tilde{\chi}_1^0$)=500 GeV	2010.01015
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to bs$		2 jets + 2 b		36.7	$\tilde{t}_1$ [qq, bs] 0.42 / 0.61		1710.07171
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to q\ell$	2 e,μ	2 b		36.1	$\tilde{t}_1$ 0.4-1.45	BR($\tilde{t}_1\to be/b\mu$)>20%	1710.05544
		1 μ	DV		136	$\tilde{t}_1$ [1e-10< λ''_{23k} <1e-8, 3e-10< λ''_{23k} <3e-9] 1.0 / 1.6	BR($\tilde{t}_1\to q\mu$)=100%, cosθ_t=1	2003.11956
	$\tilde{\chi}_1^\pm/\tilde{\chi}_2^0/\tilde{\chi}_1^0, \tilde{\chi}_{1,2}^0\to tbs, \tilde{\chi}_1^\pm\to bbs$	1-2 e,μ	$\geq$6 jets		139	$\tilde{\chi}_1^0$ 0.2-0.32	Pure higgsino	2106.09609

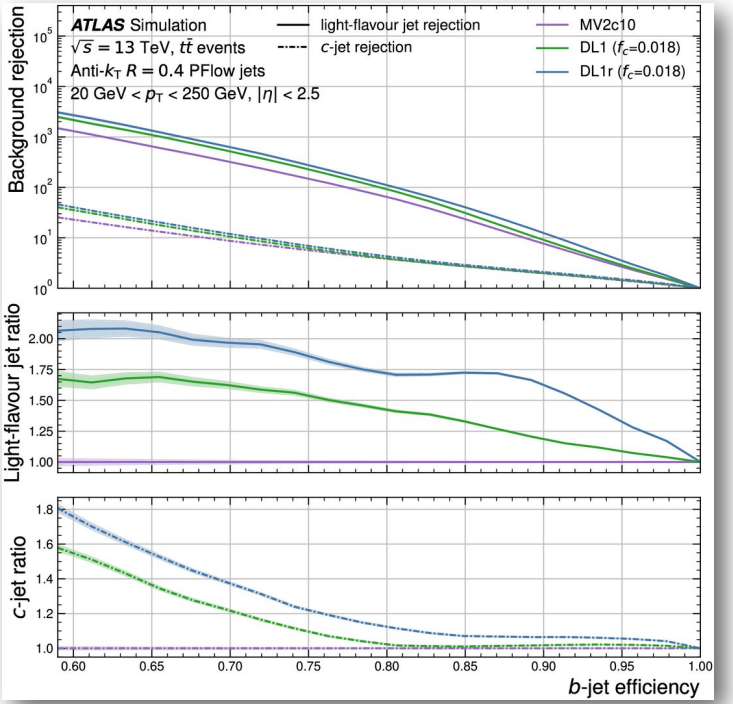
Mass scale [TeV] (axis: 10^{-1} … 1)

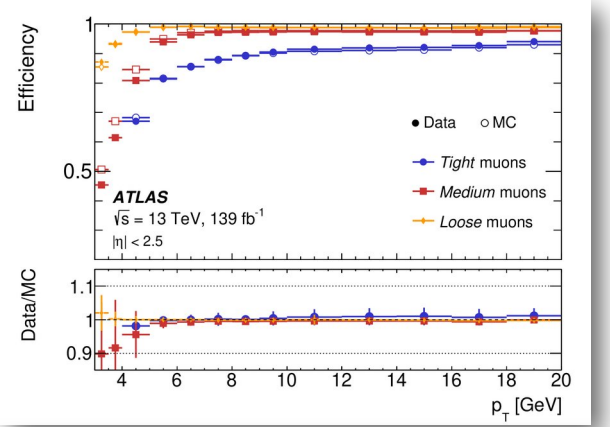
*Only a selection of the available mass limits on new states or phenomena is shown. Many of the limits are based on simplified models, c.f. refs. for the assumptions made.

Performance Measurements

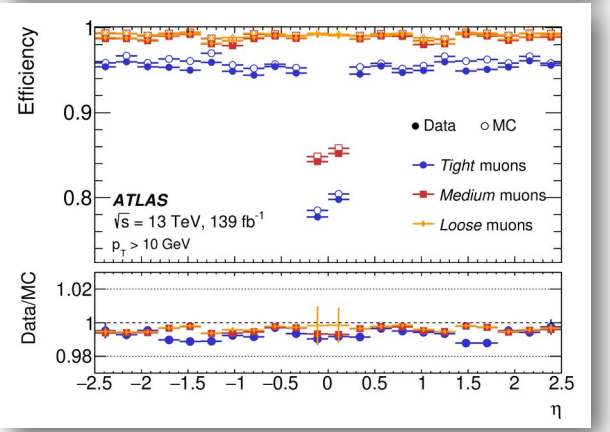
Eur. Phys. J. C 81 (2021) 578, **arXiv:** 2211.16345

Improved *b*-tagging algorithms boost searches for multiple *b*-tagged jets (e.g. *HH*, $t\bar{t}t\bar{t}$)





continuous improvements of identification and calibration of reconstructed objects.

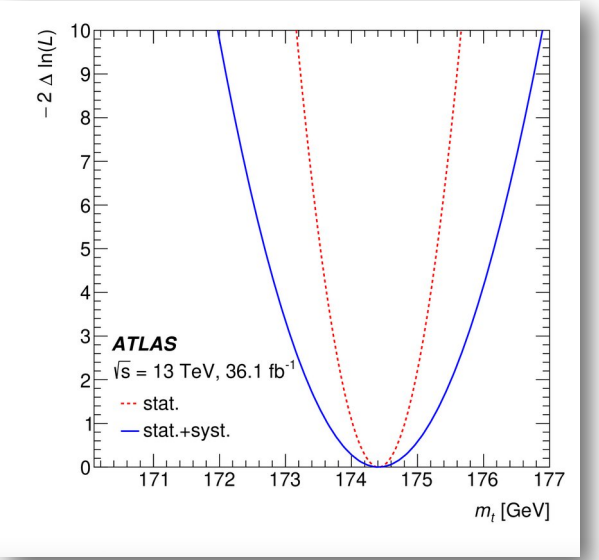


MC modelling with correction factors (close to 1) measured in data.

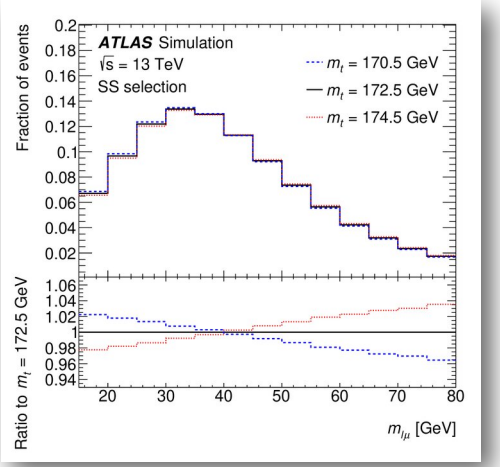
Top mass measurement

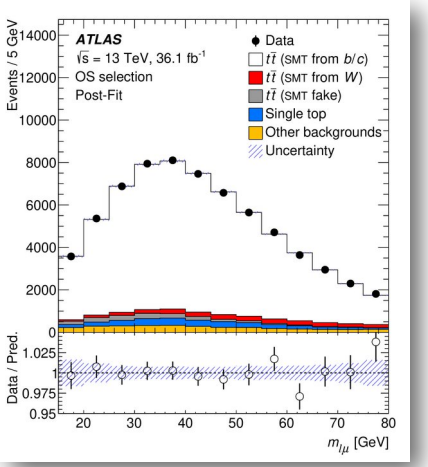
arXiv: 2209.00583 (sub. to JHEP)

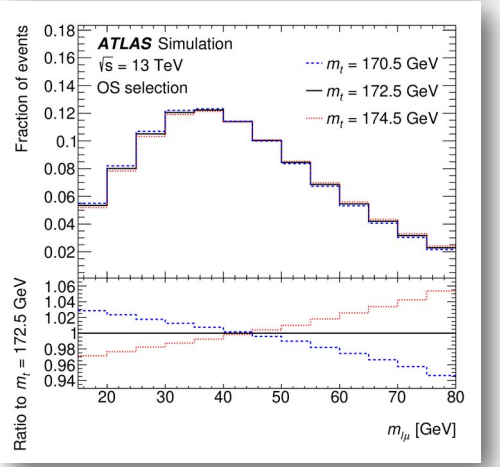
- New approach using semi-leptonic $t\bar{t}$ final state $t\bar{t} \rightarrow b\bar{b}WW \rightarrow b\bar{b}l\nu jj$.
- Observable: $m_{l\mu}$ of l (e, μ) from W decay and μ from B-hadron decay from the same top-quark.

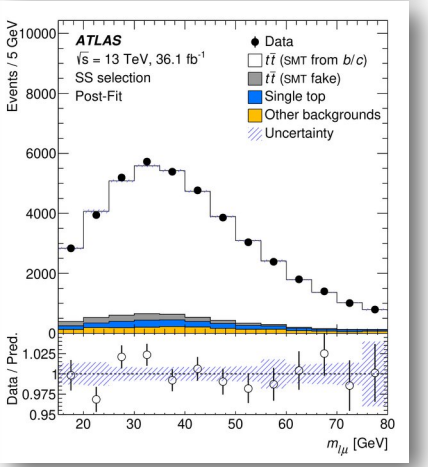


$$m_t = 174 \pm 0.39(\text{stat.}) \pm 0.66(\text{syst.}) \pm 0.25(\text{recoil})\ \text{GeV}$$









Dark Matter Searches

ATL-PHYS-PUB-2022-036

- Missing energy and resonance searches can be used to limit specific DM models.
- In the example shown, lepto-phobic vector mediator model is explored.
- Upper limits set with the LHC can compliment those of direct experiments.