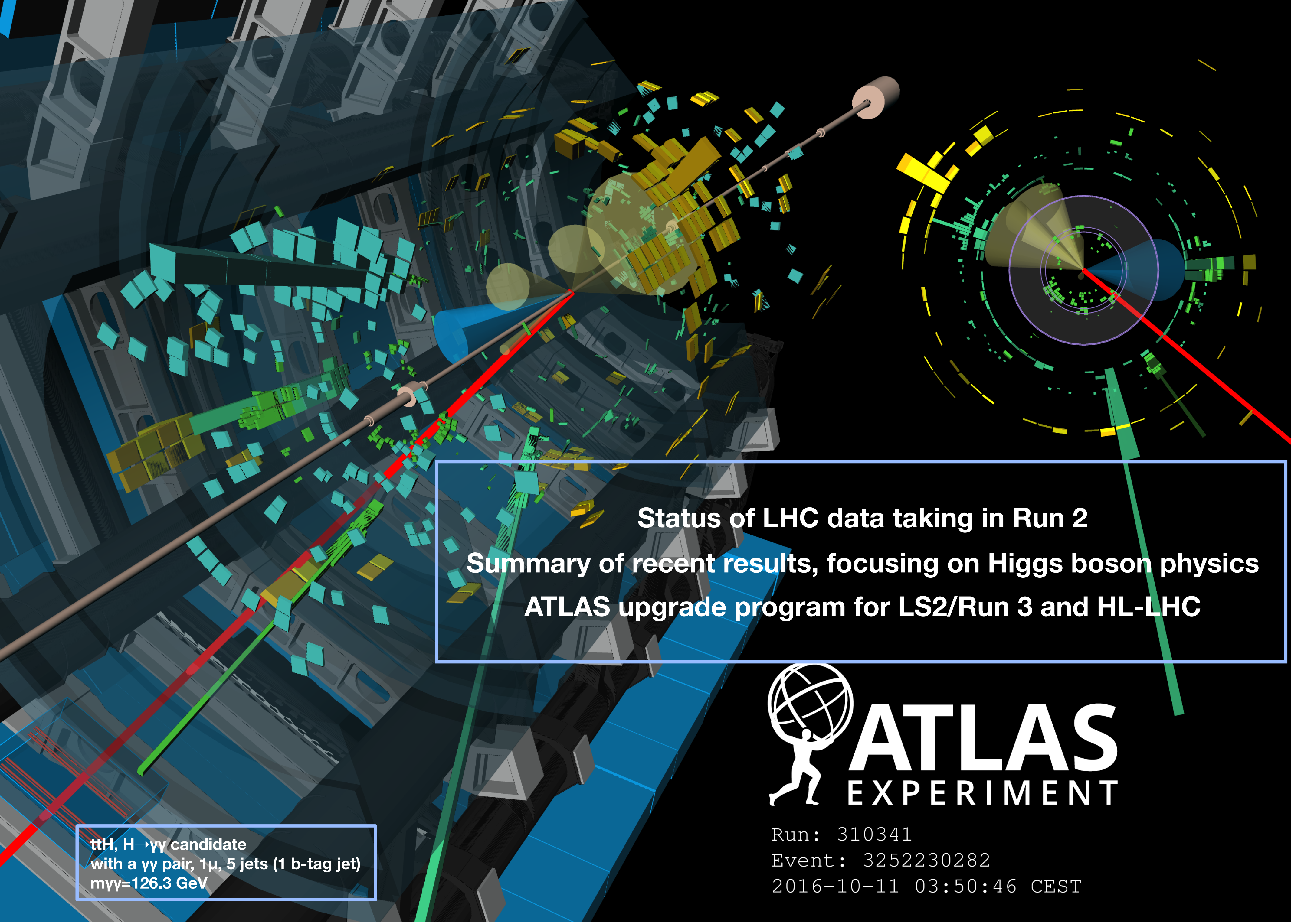
Highlights from ATLAS

Isabelle Wingerter-Seez

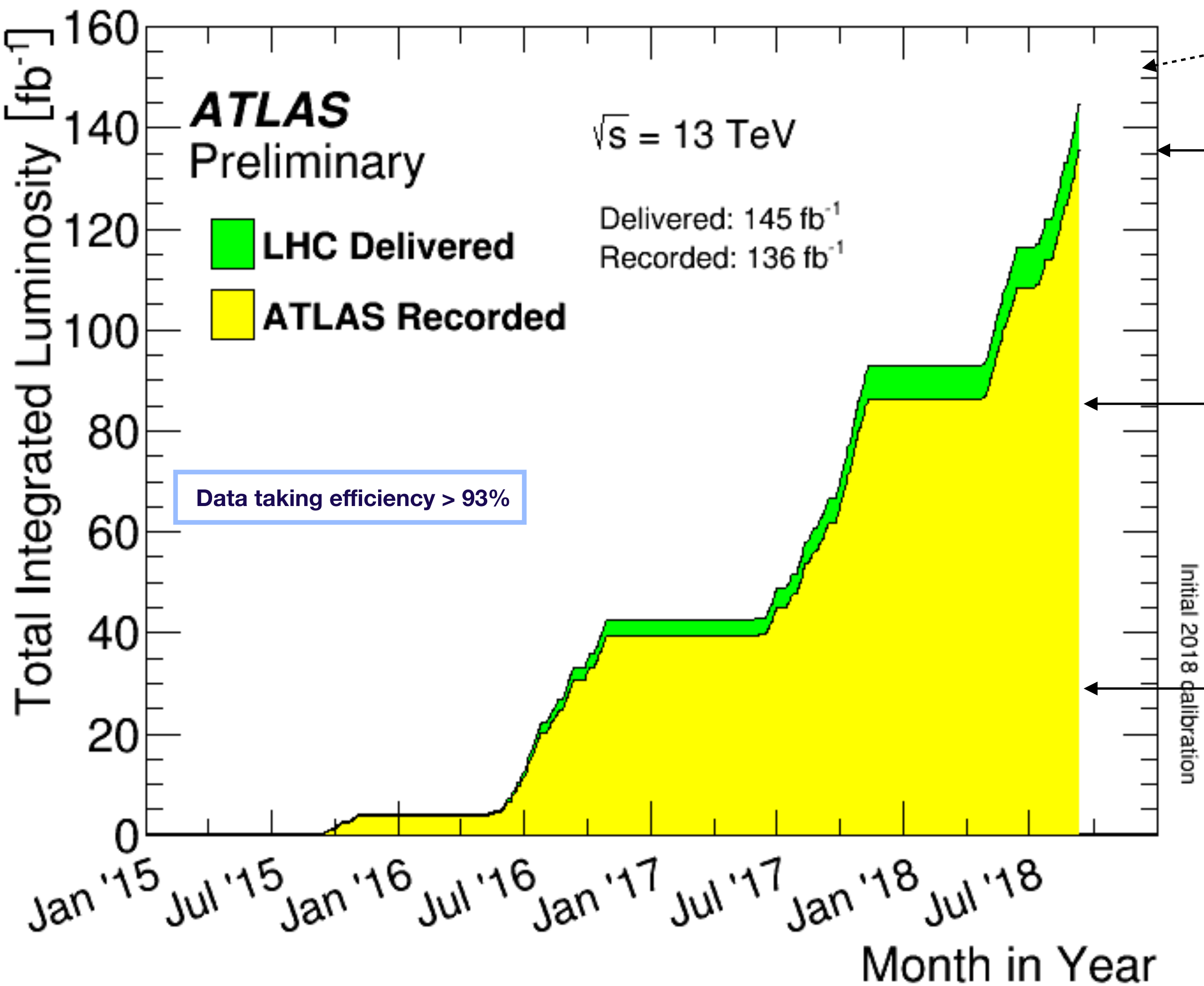
LAPP/CNRS - Annecy-France

On behalf of the

ATLAS Collaboration


Status of LHC data taking in Run 2
Summary of recent results, focusing on Higgs boson physics
ATLAS upgrade program for LS2/Run 3 and HL-LHC
ATLAS
EXPERIMENT
Run: 310341
Event: 3252230282
2016-10-11 03:50:46 CEST
ttH, H→γγ candidate
with a γγ pair, 1μ, 5 jets (1 b-tag jet)
mγγ=126.3 GeV

LHC performance for run 2 (2015-2018)



2015-2018 dataset (expected)
L=150 fb^{-1} recorded ???

2015-2018 (so far) dataset
L=136 fb^{-1} recorded

2015-2017 dataset
L=80 fb^{-1}
17 public results

2015-2016 dataset
L=36 fb^{-1}
90 publications on arXiv

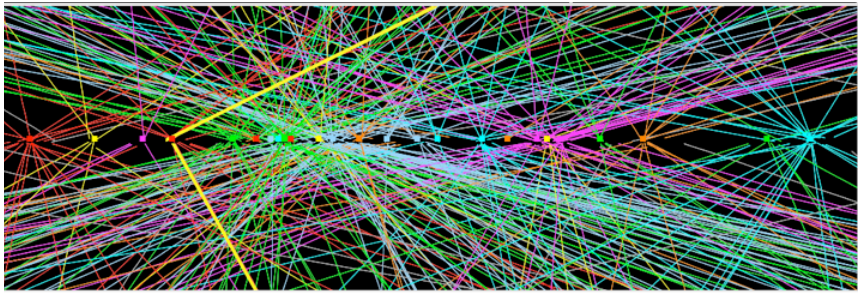
Week 02.09.2018 - 08.08.23018
5.3/fb delivered

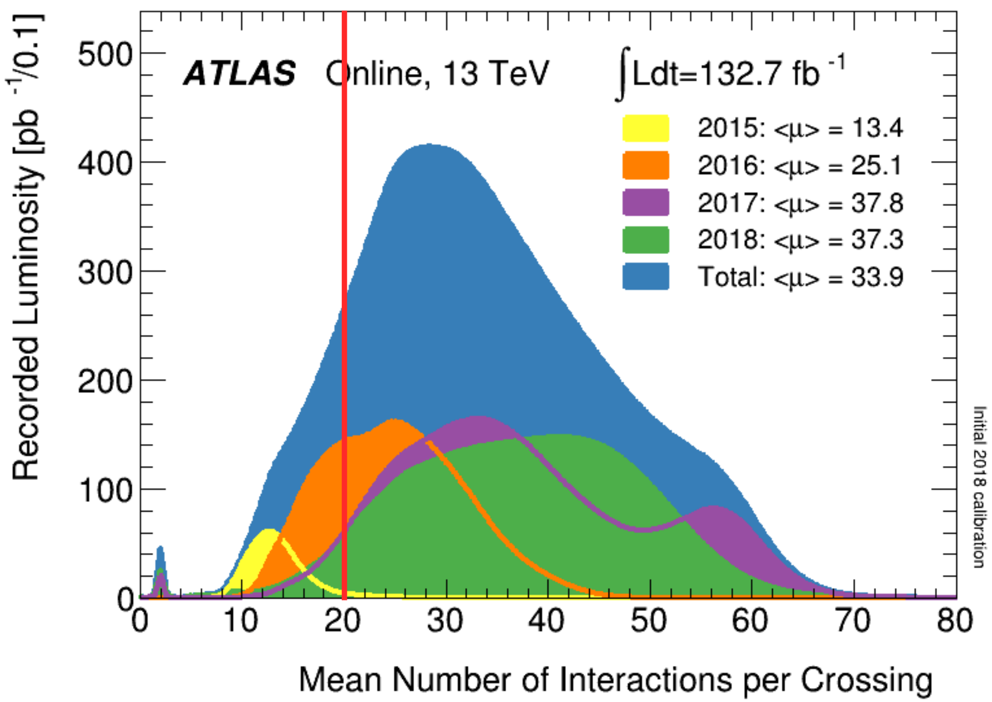
BRAVO LHC

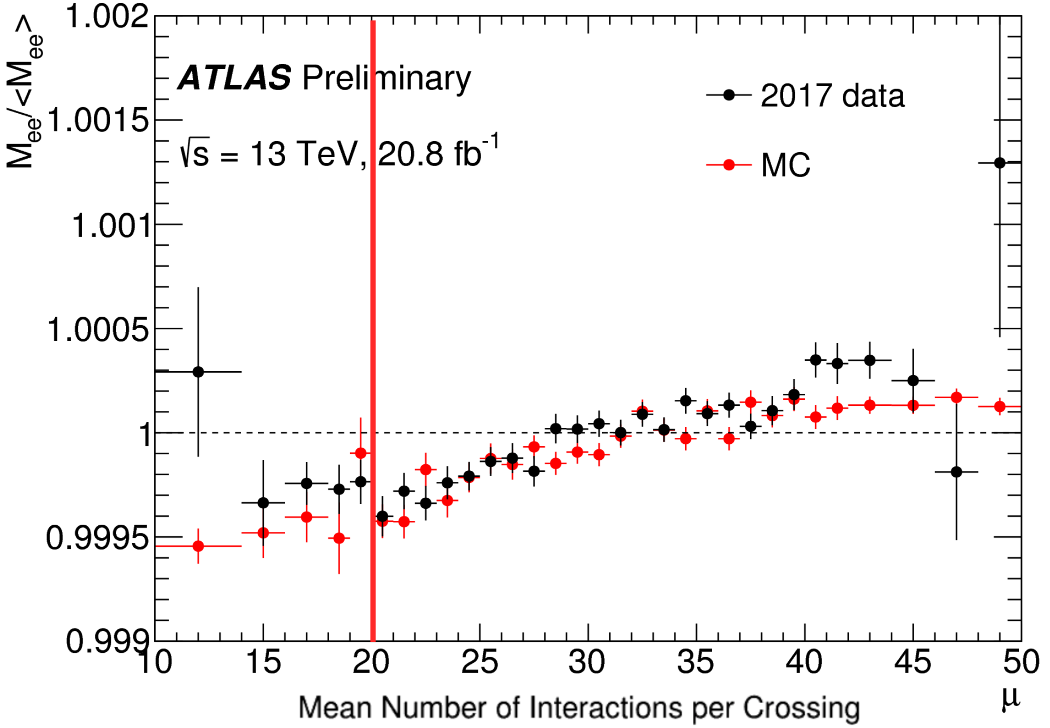
On Sunday 22nd July, the total integrated luminosity delivered by LHC reached **150 fb^{-1}**.

LHC has delivered to ATLAS 50/fb in 2018
50/fb recorded as of today

The pile-up challenge







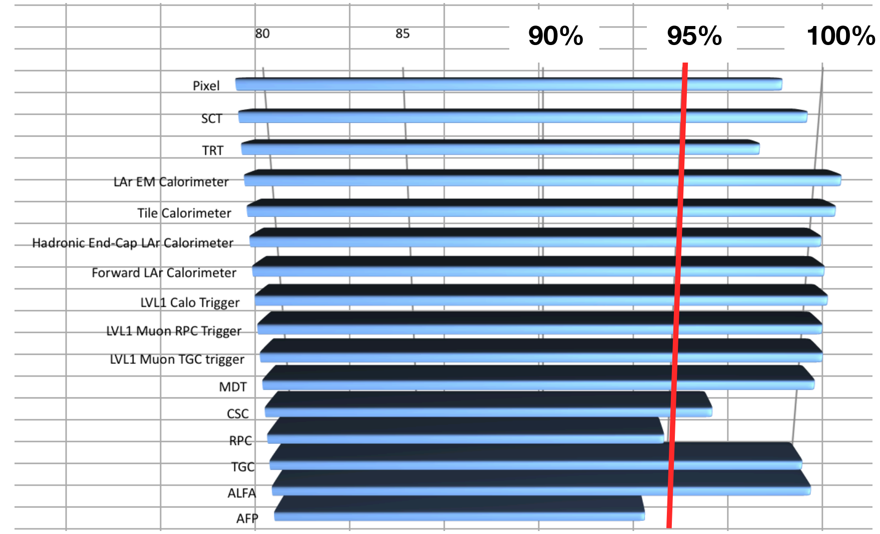
The delivered luminosity is about a factor of 2 above the LHC design luminosity.

The large number of additional interactions (pile-up) cause some performance degradation.

Powerful pile-up mitigation techniques have been and are being developed.

The performance loss is well described by Monte Carlo simulation.

ATLAS data taking in 2018



ATLAS has operated very well so far.

The fraction of operating channels is remaining very high after 10 years of operation: ≳95%

- Redundancy allows to maintain ~100% acceptance

Data taking efficiency: **95.5%**

Data quality: **96.5%** (36/fb)

- fraction of collected data good for physics

Computing performing extremely well

- Tier0 23k cores
- Sustained production with smooth operations with 300-350k cores
- Moving >1PB/day, > 20GB/s, 1.5-2M files/day

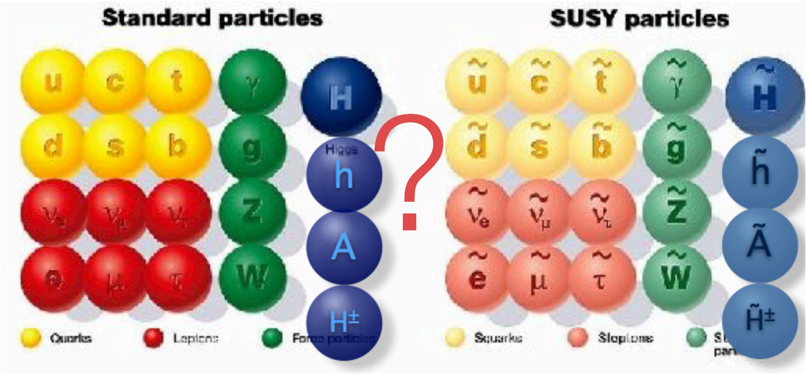
ATLAS pp data: April 25-August 20 2018										
Inner Tracker			Calorimeters		Muon Spectrometer				Magnets	
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
99.7	99.6	100	99.6	100	99.7	99.6	100	100	100	99.3
Good for physics: 96.5% (36.4 fb^{-1})										

Luminosity weighted relative detector uptime and good data quality efficiencies (in %) during stable beam in pp collisions at $\sqrt{s}$=13 TeV between April 25 – August 20 2018, corresponding to a delivered integrated luminosity of 39.2 fb^{-1} and a recorded integrated luminosity of 37.7 fb^{-1}. Dedicated luminosity calibration activities during LHC fills used 0.7% of recorded data and are included in the inefficiency. The luminosity includes 193 pb^{-1} of good data taken at an average pileup of μ=2.

THE MISSION of the LHC

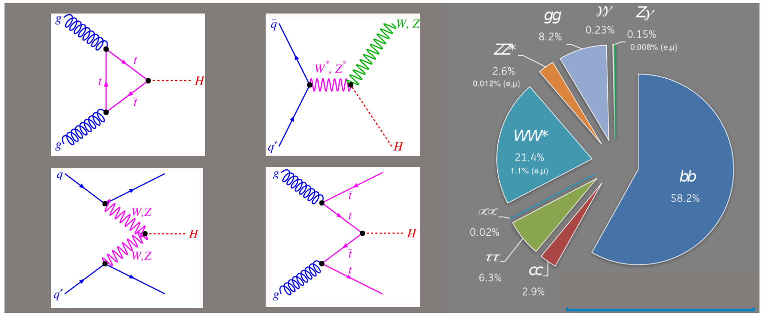
LHC Explore the TeV energy range

Direct searches for Physics Beyond
the Standard Model at the highest energies



Exploration of the Higgs sector

- Precision measurements of the Higgs boson properties
  - Higgs boson couplings
  - Self coupling
  - New Higgs bosons ?

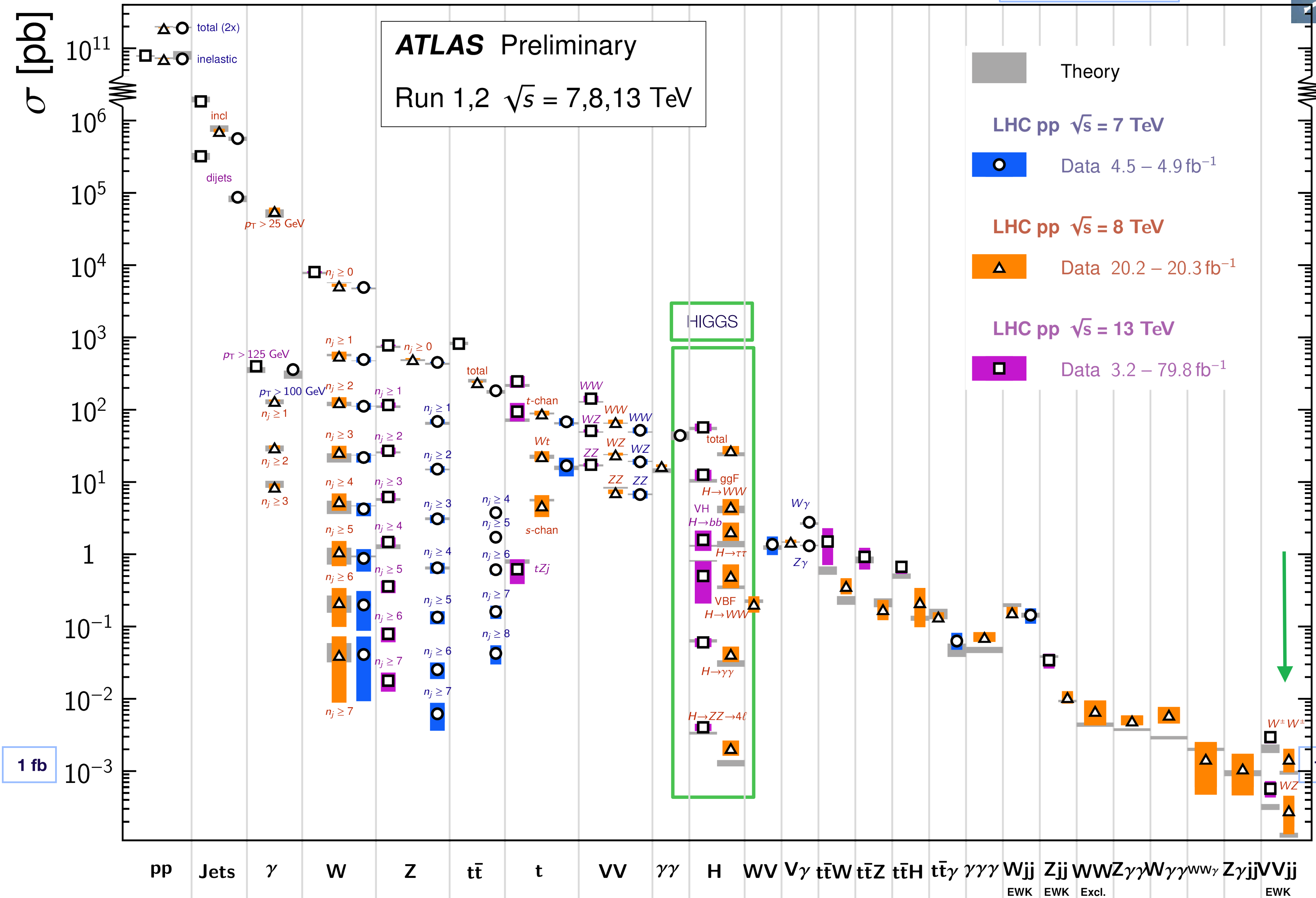


Precision measurements

SMALL CROSS SECTION
HIGH LUMINOSITY

Standard Model Production Cross Section Measurements

Status: July 2018

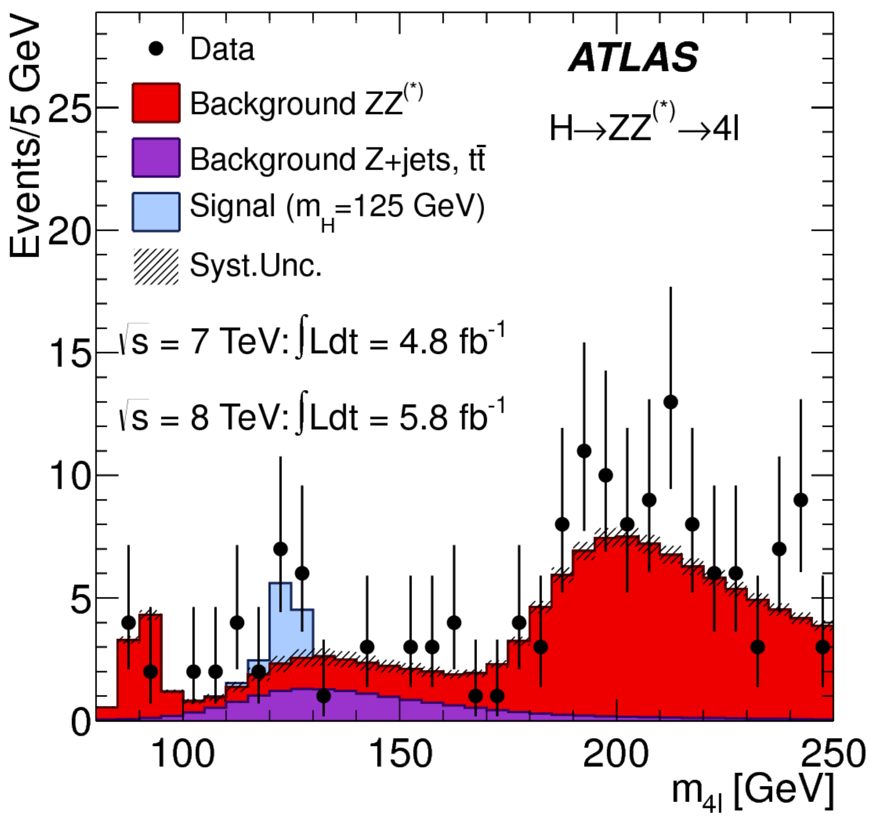


Progress: example of the H→ZZ→4l channel

Higgs boson discovered in July 2012 at LHC, by the ATLAS and CMS collaborations.
Is the new particle THE SM Higgs boson ? → Measure its properties

L=4.8 fb-1 and 5.8 fb-1 at √s=7 and 8 TeV

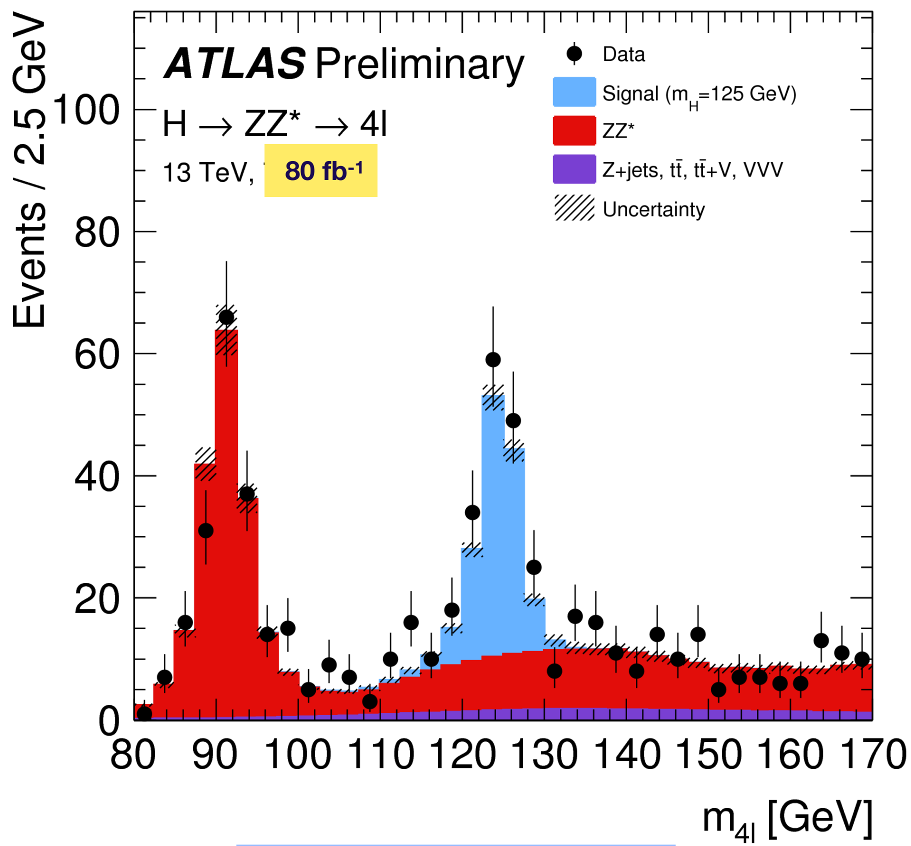
Phys. Lett. B 716 (2012) 1-29



13 events 120 < m_{4l} < 130 GeV

L=80 fb-1 at √s=13 TeV

ATLAS-CONF-2018-018



195 events 120 < m_{4l} < 130 GeV

Standard Model Lagrangian

Higgs boson measurements at LHC test new part of the Standard Model

$$\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} + i\bar{\psi} \not{D} \psi + h.c.$$

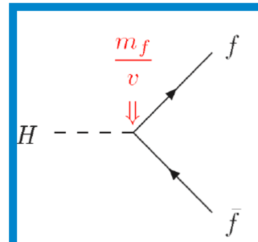
Describes everything experimental confirmed before 2012.

The Higgs sector

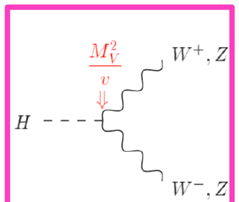
$$+ \bar{\psi}_i y_{ij} \psi_j \phi + h.c.$$

$$+ |D_\mu \phi|^2 - V(\phi)$$

Yukawa couplings with Higgs boson (completely new interaction type)
ttH, H→bb and H→ττ are important



Gauge boson interaction with Higgs boson (new for scalar, but known for fermion)



Higgs potential ($\mu^2\phi^2 + \lambda\phi^4$)
(to be explored at HL-LHC)

Inspired by Gavin Salam - LHCP 2018

Higgs boson production and decays

Four main channels at the LHC

σ_H = 56 pb at $\sqrt{s}$=13 TeV

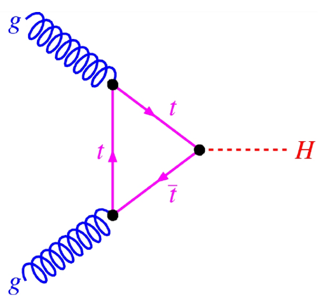
~6 millions Higgs bosons produced in ATLAS

Many decays are accessible at the LHC

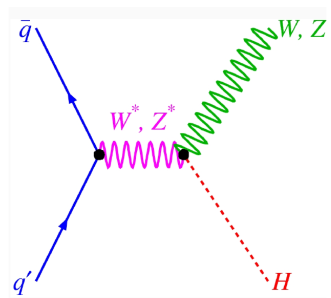
In SM, bb larget BR

- drives the total width
- measurement of absolute couplings

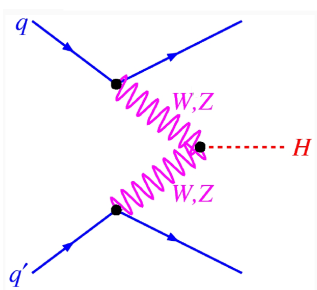
Measurement of H→bb limits BSM branching fraction allowed



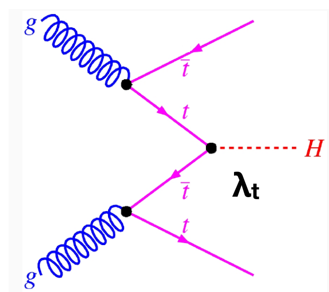
Gluon-gluon fusion (ggF)
dominant - 88% of the total



VH - WH/ZH
3% of the total

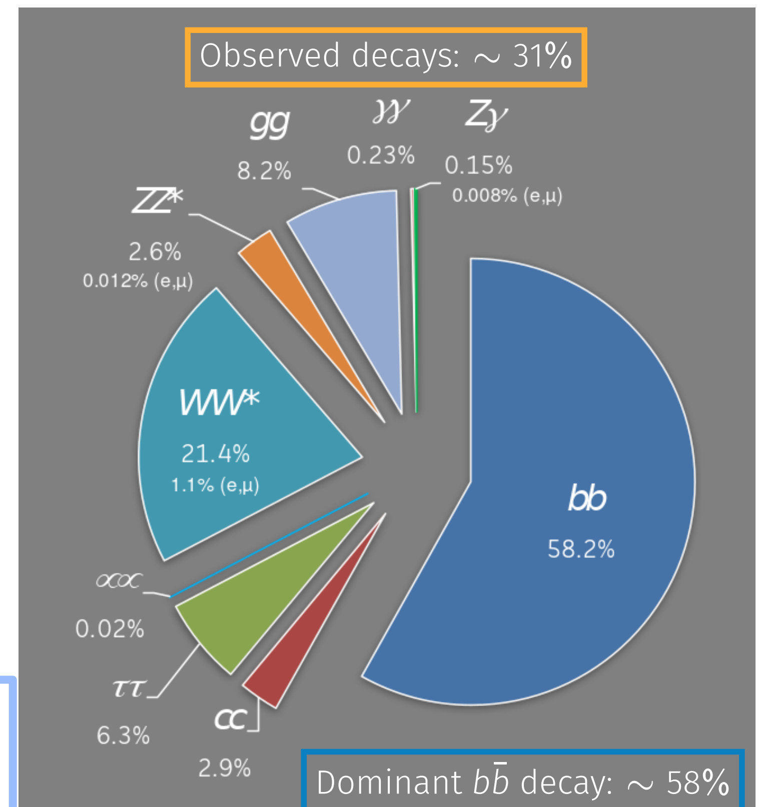


Vector boson fusion (VBF)
7% of the total



ttH
1% of the total

Yukawa coupling $\boldsymbol{\lambda_t = \sqrt{2} \,.\, m_{top}/v \sim 1}$
Large top mass → Higgs boson coupling to top is strong (it might contain BSM contribution)
ttH production gives direct constraint on $\boldsymbol{\lambda_t}$.



Gauge boson and Yukawa fermion coupling

$|D_\mu \phi|^2$

Interaction with gauge bosons

Earlier $\sqrt{s}$ = 7 and 8 TeV results
At $\sqrt{s}$ = 7 and 8 TeV Higgs boson discovered
Main channels H→γγ, H→ZZ, H→WW

Yukawa couplings to fermions

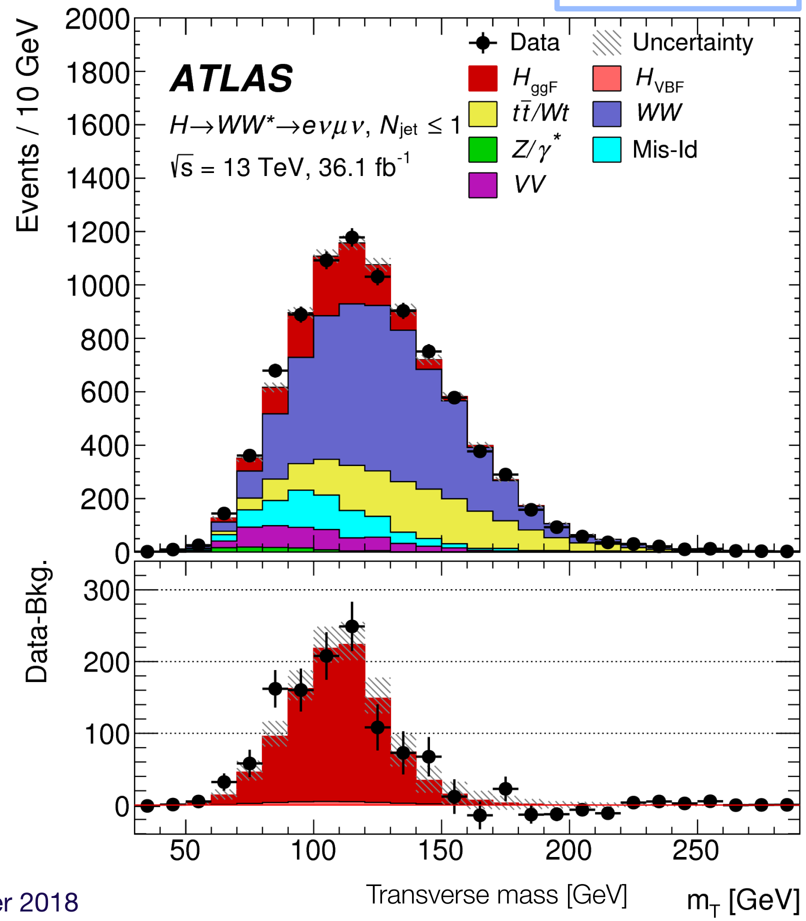
$+ \bar{\psi}_i y_{ij} \psi_j \phi + h.c.$

Only glimpse at $\sqrt{s}$ = 7 and 8 TeV (2012)
ATLAS/CMS combined **H→ττ**:
5.5 σ (5.0σ) obs. (exp.) for 7/8 TeV
JHEP 08 (2016) 045

RECENT 13 TeV RESULTS

H→WW

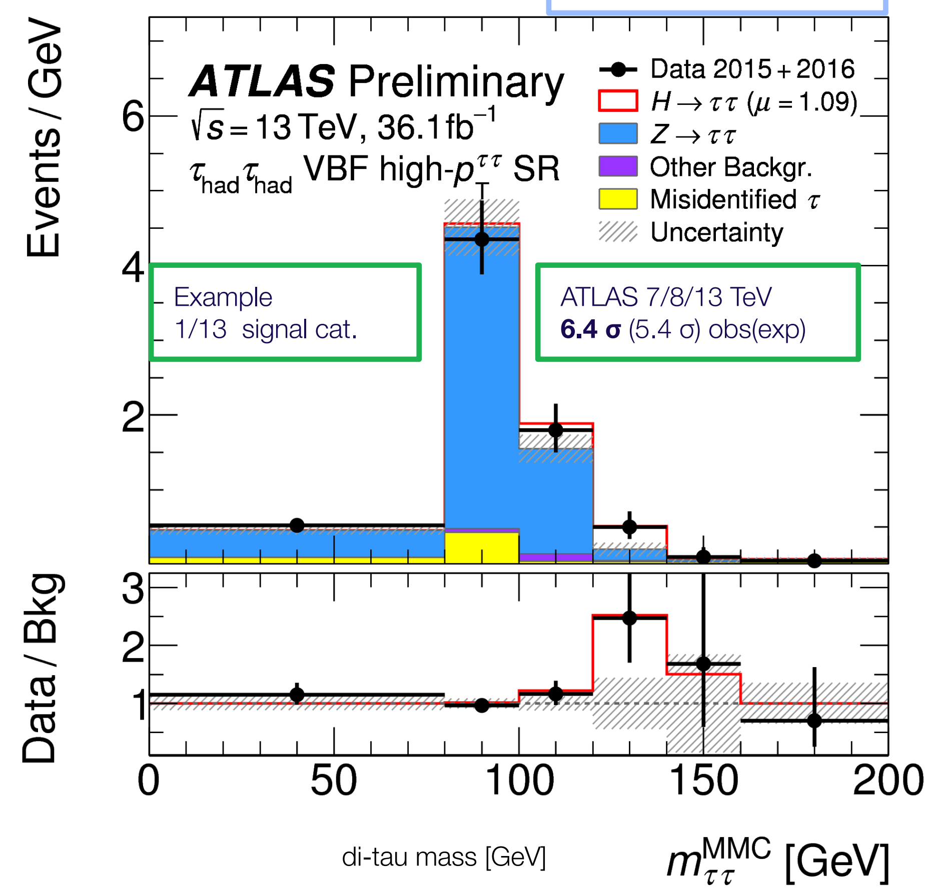
arXiv:1808.09054



Transverse mass [GeV]

H→ττ

ATLAS-CONF-2018-021



Example
1/13 signal cat.

ATLAS 7/8/13 TeV
6.4 σ (5.4 σ) obs(exp)

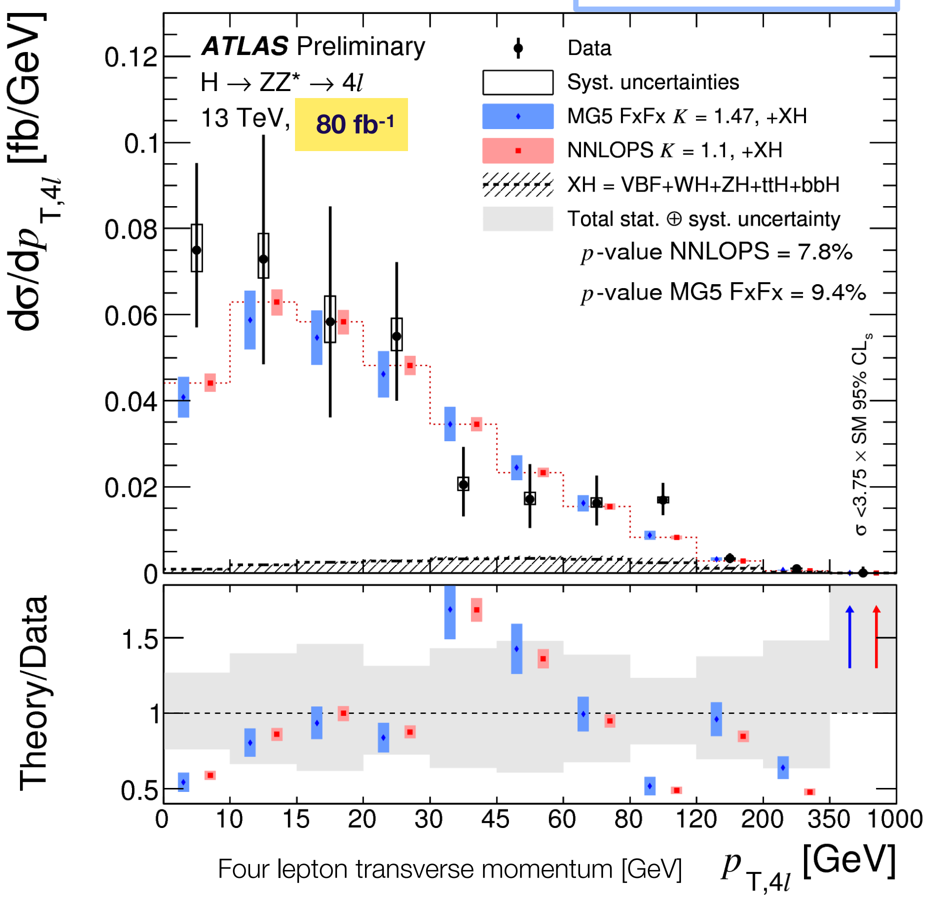
di-tau mass [GeV]

Differential fiducial cross-section using gauge boson decays

Higgs boson decay to gauge bosons used for fiducial differential cross-section measurements

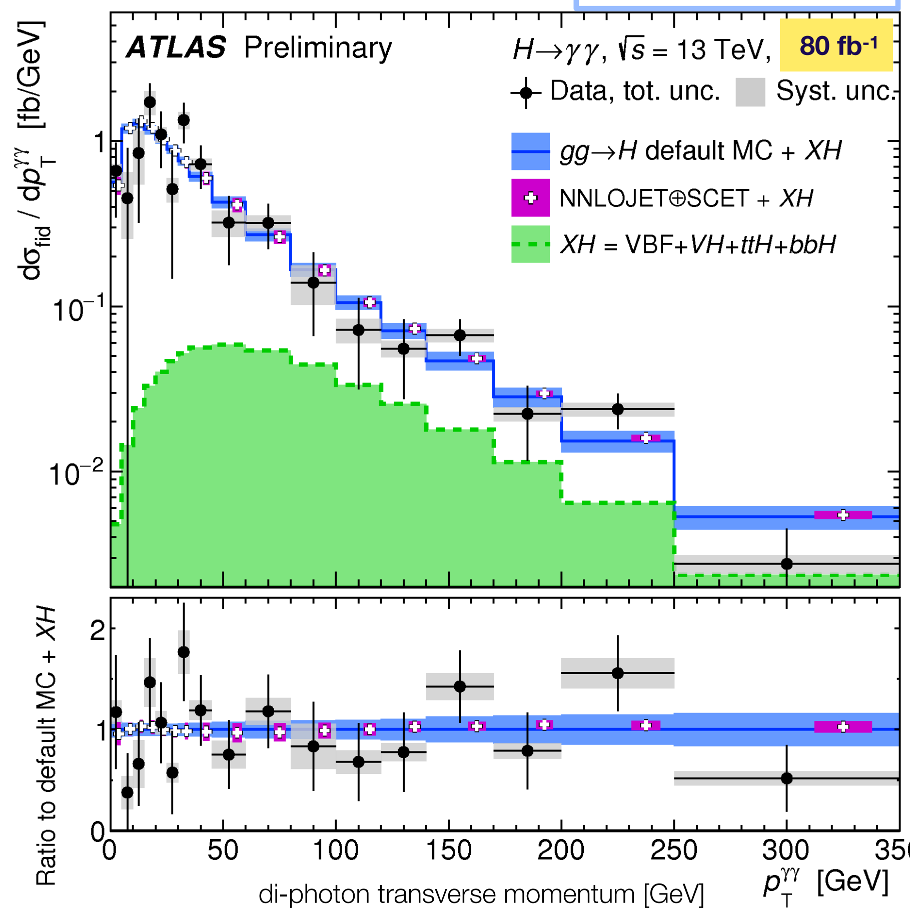
4 lepton channel

ATLAS-CONF-2018-018



γγ channel

ATLAS-CONF-2018-028



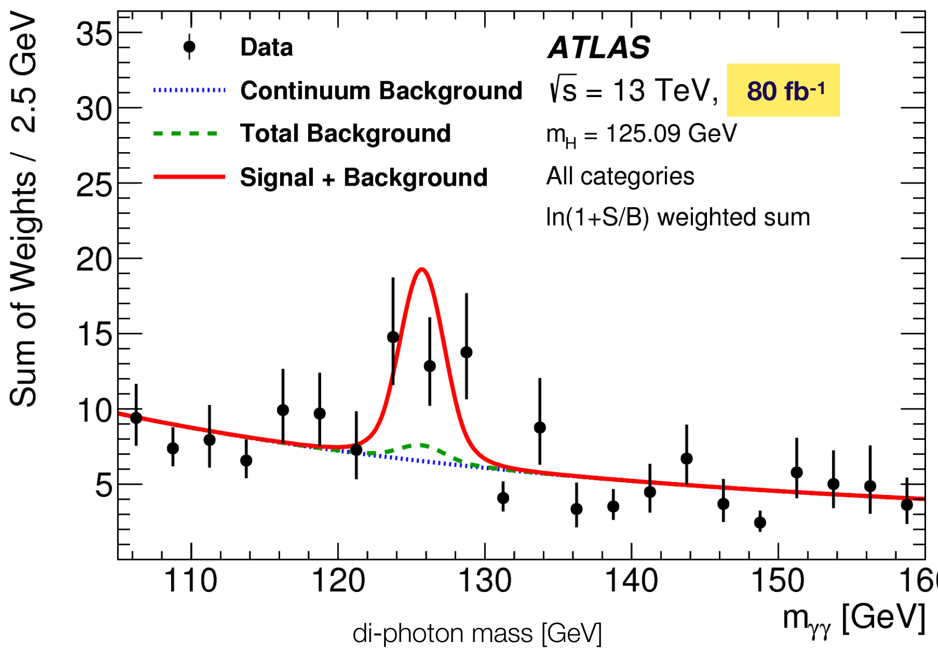
Differential cross-section becoming more and more precise with increasing statistics.
Data well described by recent SM predictions.
Simplified template cross-section measurements included in the publication.

Observation of ttH production

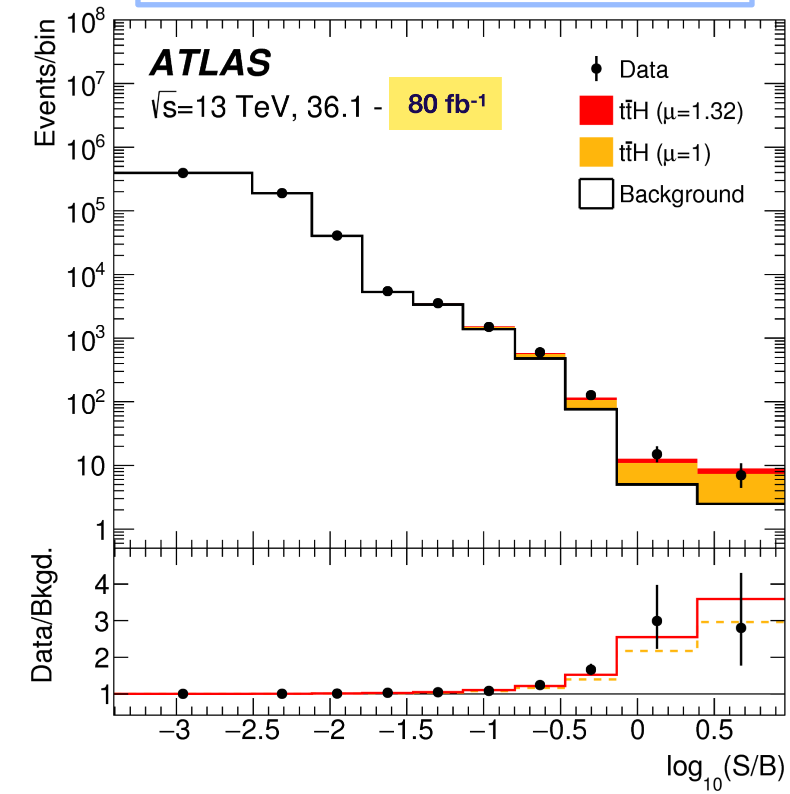
arXiv:1806.00425

December 2017 (36/fb): 4.2 σ (3.8 σ) obs (exp) (*)
June 2018: update ttH(H→γγ) and ttH (H→ZZ→4l) with **80fb^{-1}**

ttH - H→γγ



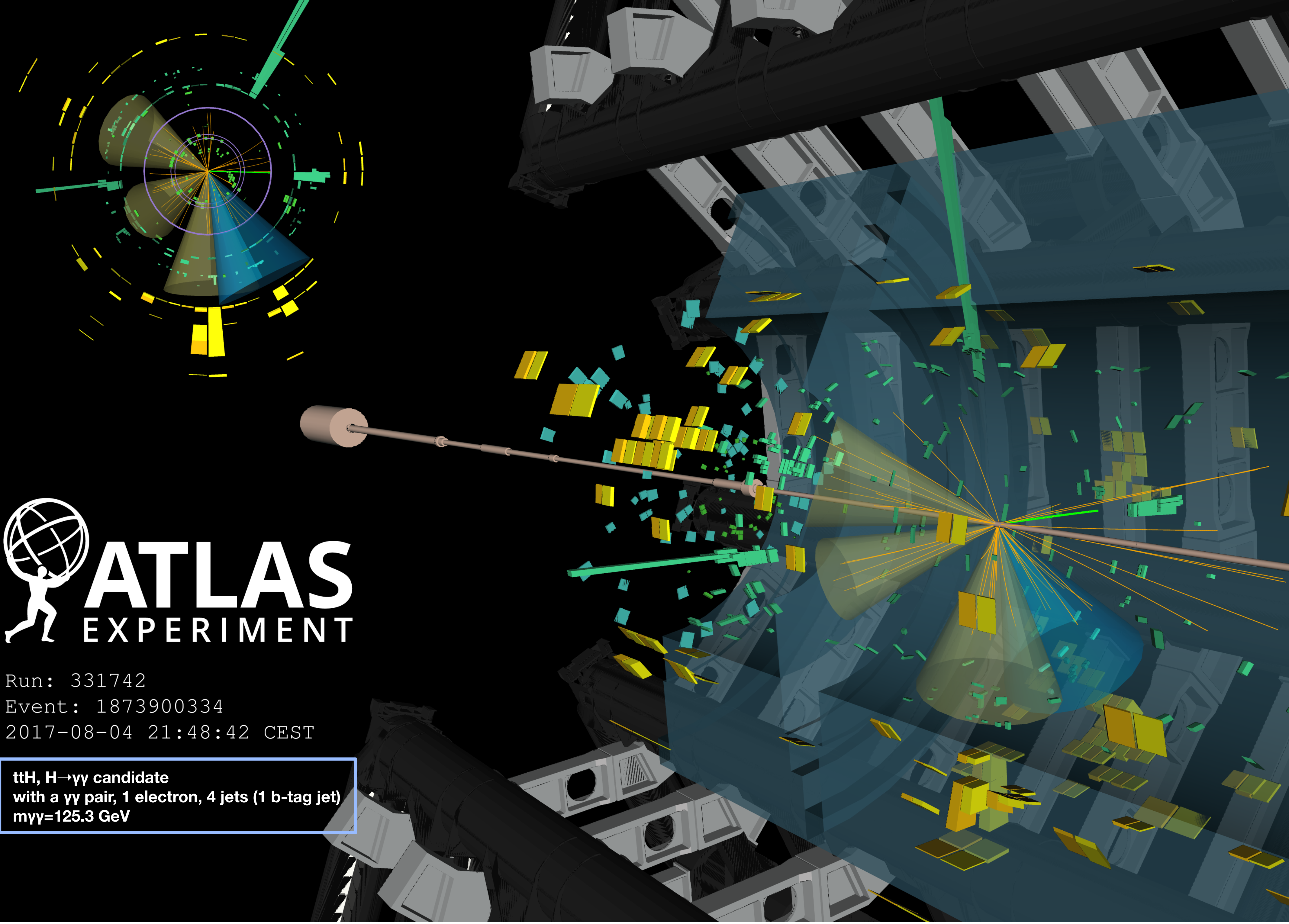
All channels combined



Analysis	Integrated luminosity [fb^{-1}]	Obs. sign.	Exp. sign.
$H \to \gamma\gamma$	79.8	4.1 σ	3.7 σ
$H \to$ multilepton	36.1	4.1 σ	2.8 σ
$H \to b\bar{b}$	36.1	1.4 σ	1.6 σ
$H \to ZZ^* \to 4\ell$	79.8	0 σ	1.2 σ
Combined (13 TeV)	36.1–79.8	5.8 σ	4.9 σ
Combined (7, 8, 13 TeV)	4.5, 20.3, 36.1–79.8	6.3 σ	5.1 σ

Direct observation of top Higgs coupling. Confirmation of Yukawa coupling to fermions.

(*) Phys. Rev. D 97 (2018) 072003
Phys. Rev. D 97 (2018) 072016
arXiv:1802.04146

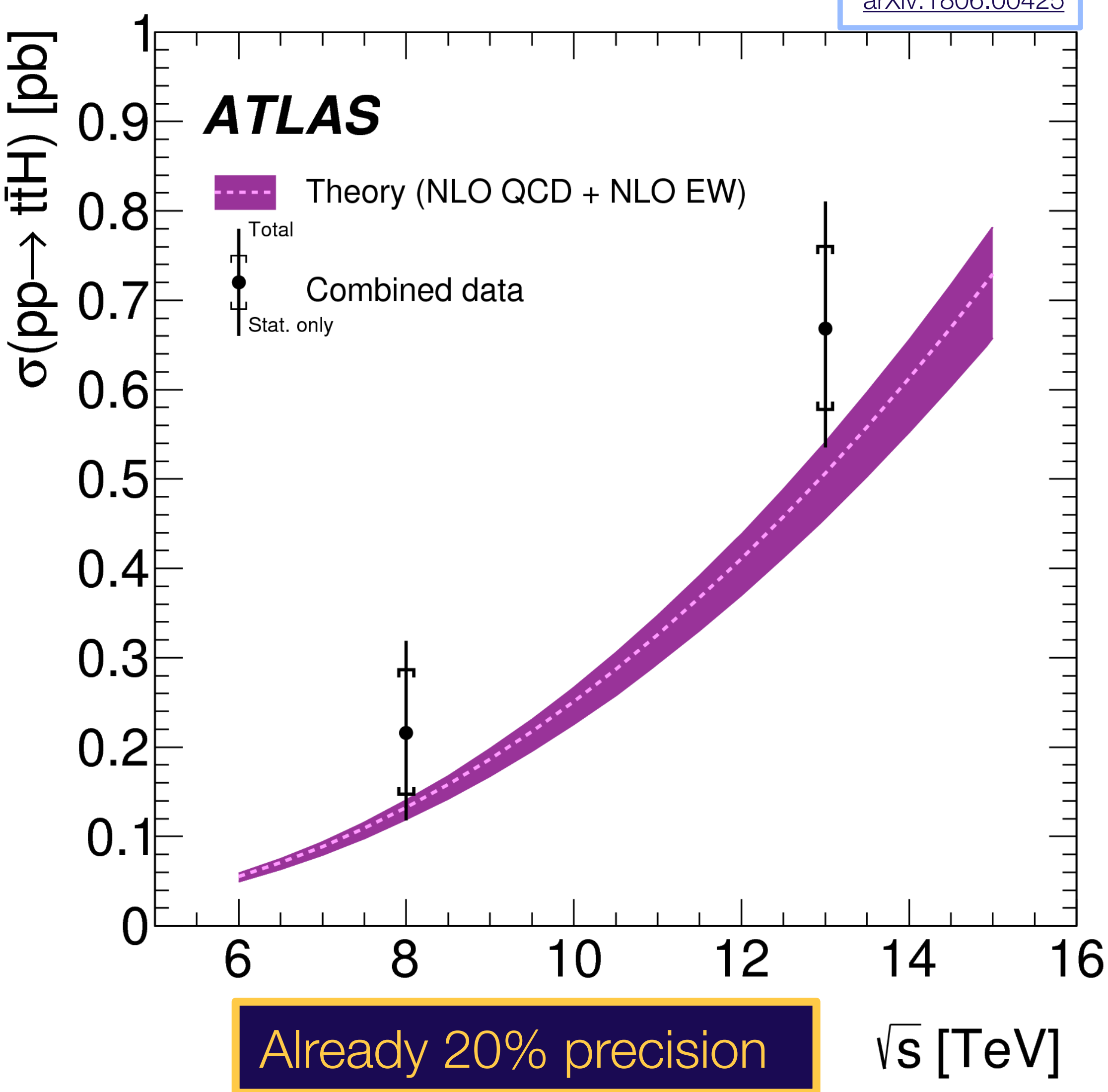

ATLAS
EXPERIMENT
Run: 331742
Event: 1873900334
2017-08-04 21:48:42 CEST
ttH, H→γγ candidate
with a γγ pair, 1 electron, 4 jets (1 b-tag jet)
mγγ=125.3 GeV

ttH production cross-section

June 2018: update ttH(H→γγ) and ttH (H→ZZ→4l) with **80fb⁻¹**

Inclusive ttH production cross-section

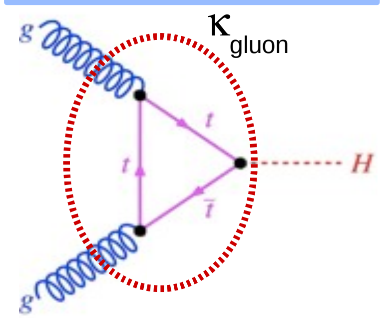
arXiv:1806.00425



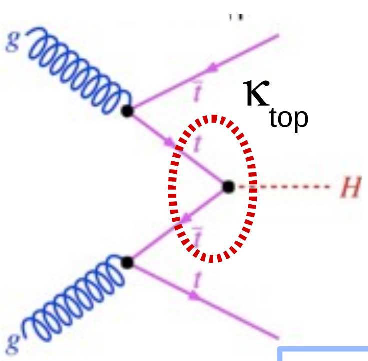
Already 20% precision

Effective Couplings

gluon-gluon fusion



ttH production



ATLAS-CONF-2018-031

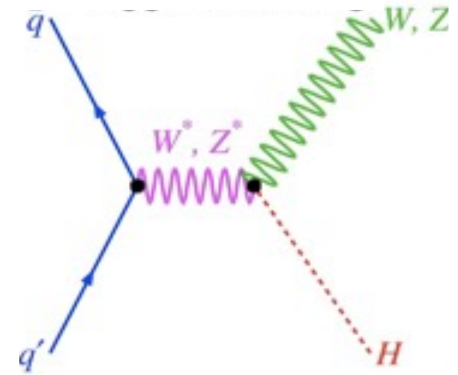
Effective coupling $\kappa_{gluon}/\kappa_{top}$=1.09±0.14
Consistent with Higgs boson couplings as in SM.
Constrains BSM contributions

Associated VH production and H→bb

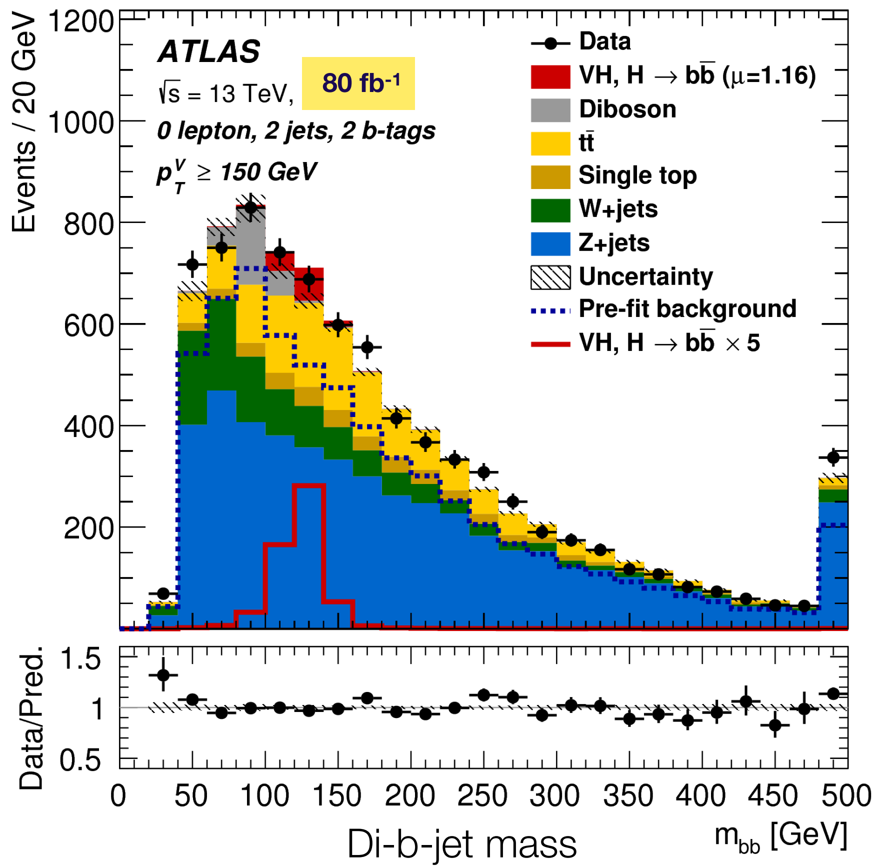
- H→bb highest branching ratio Br=58%
  - Br(H→bb) constrains invisible Higgs boson decays
  - Tests Higgs boson Yukawa coupling to fermions
- Analysis with large background
  - Use high-p_T boson region
  - **Multi-variate analysis in 0,1 and 2 lepton channels**
  - Di-jet mass analysis as cross-check

arXiv:1808.08238

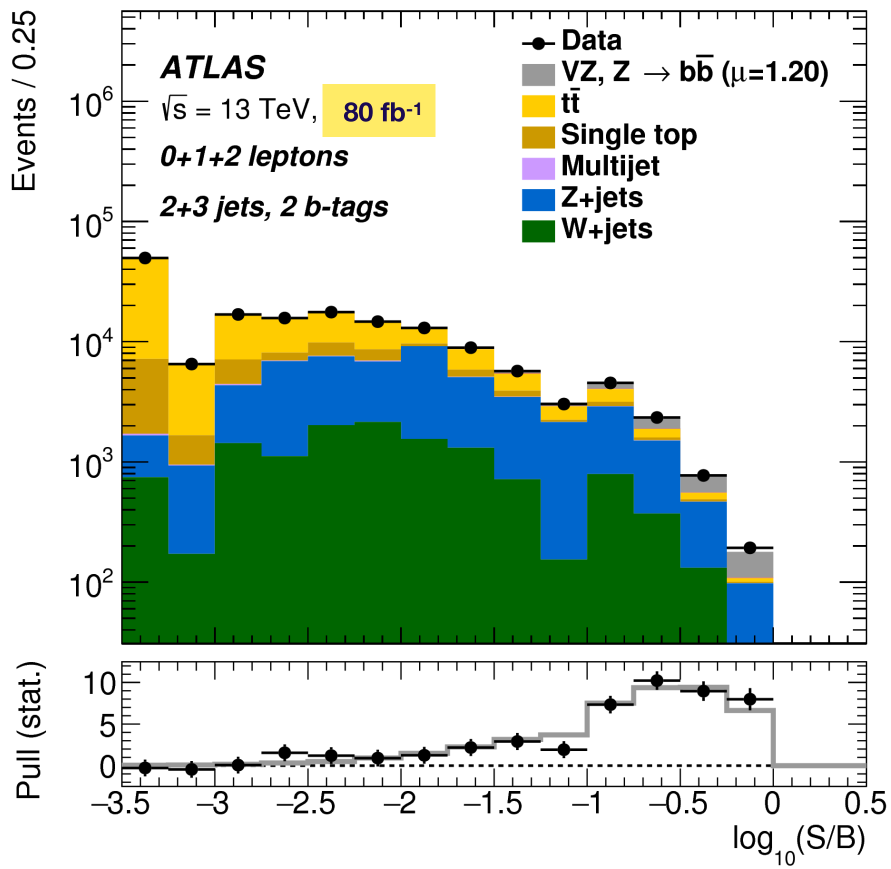
Associated production WH and ZH (VH)



One input to di-jet mass analysis global fit



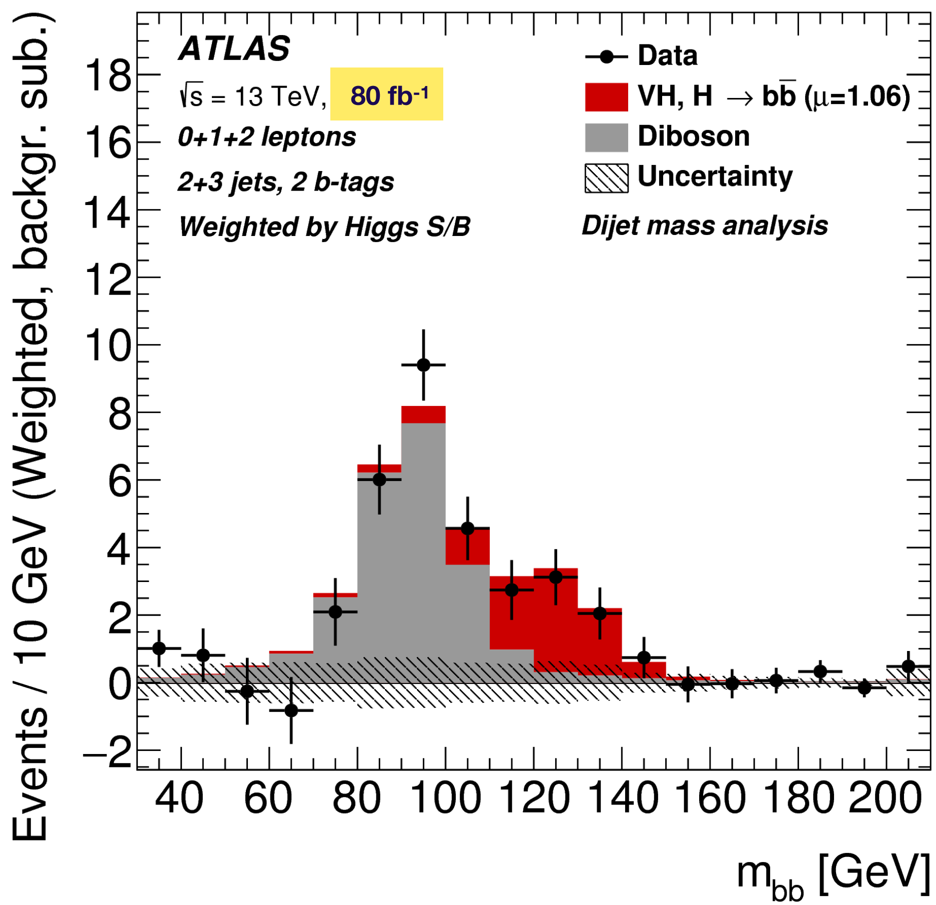
di-boson validation analysis VZ (Z→bb)



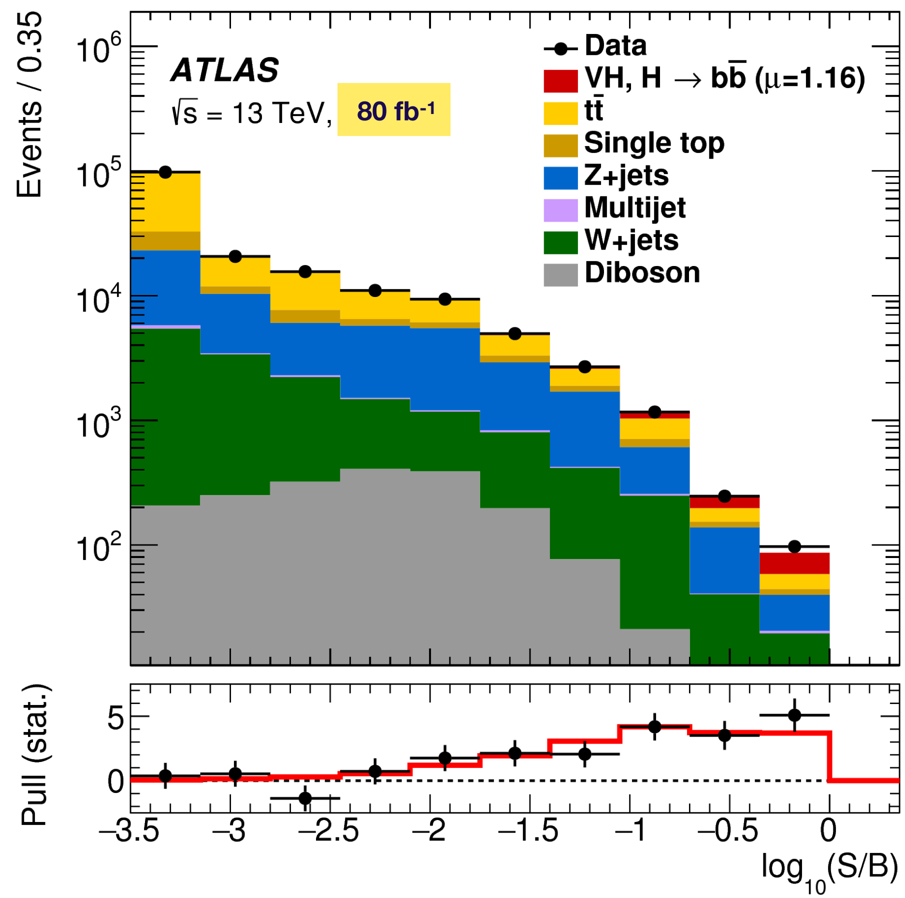
Observation of H→bb

[arXiv:1808.08238]

Di-jet mass analysis



Multi-variate analysis



Observation of Higgs boson decay to b-quarks

VH alone

4.9σ (4.3σ) obs (exp) - 13 TeV

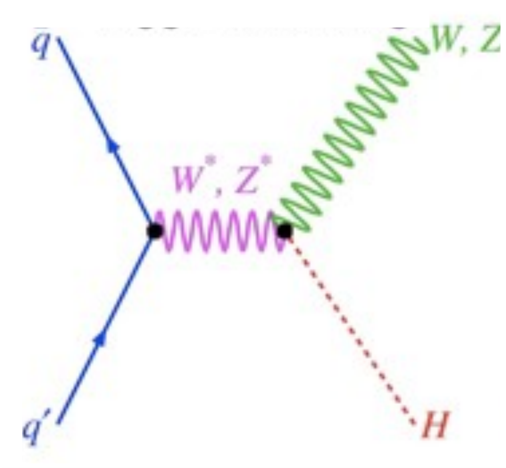
4.9σ (5.1σ) obs (exp) - Runs 1 + 2

Combining **VBF, ttH and VH** results, from **7,8 and 13 TeV** datasets:

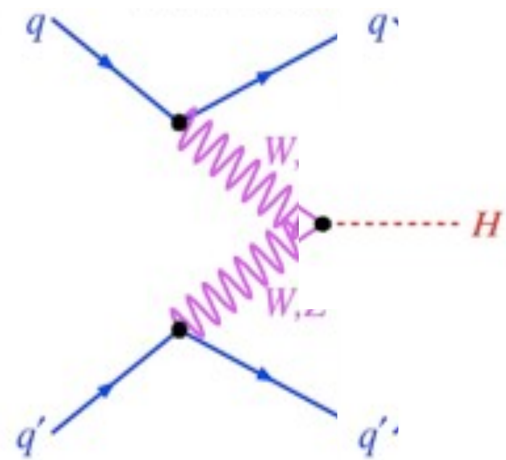
5.4σ (5.5σ) obs (exp)

Higgs production mode

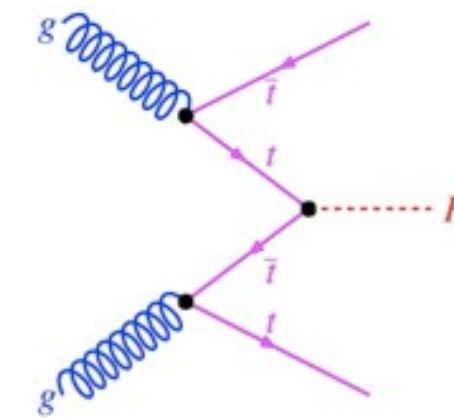
Associated WH or ZH production (VH)

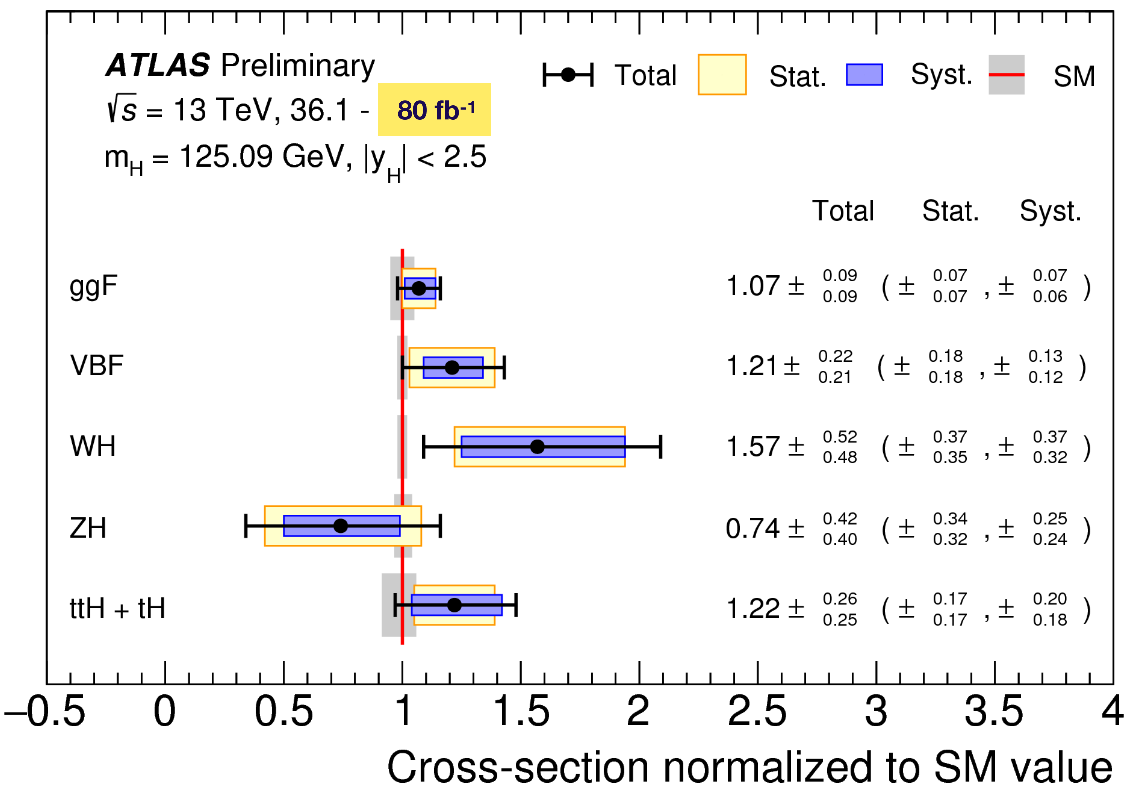


Vector boson fusion (VBF)



Associated ttH production (ttH)





Gluon-gluon fusion (ggF) observed since 2012 used for precision measurements ($\Delta(\sigma_{ggF}/\sigma_{SM})$~10%)

VH **5.3σ** (4.8σ) obs (exp) arXiv:1808.08238

VBF **6.5σ** (5.3σ) obs (exp) ATLAS-CONF-2018-031

ttH **6.3σ** (5.1σ) obs (exp) arXiv:1806.00425

Observed all major Higgs boson production modes. Consistent with SM

$$\mu = 1.13^{+0.09}_{-0.08} = 1.13 \pm 0.05\,(\text{stat.}) \pm 0.05\,(\text{exp.})\,^{+0.05}_{-0.04}\,(\text{sig. th.}) \pm 0.03\,(\text{bkg. th.})$$

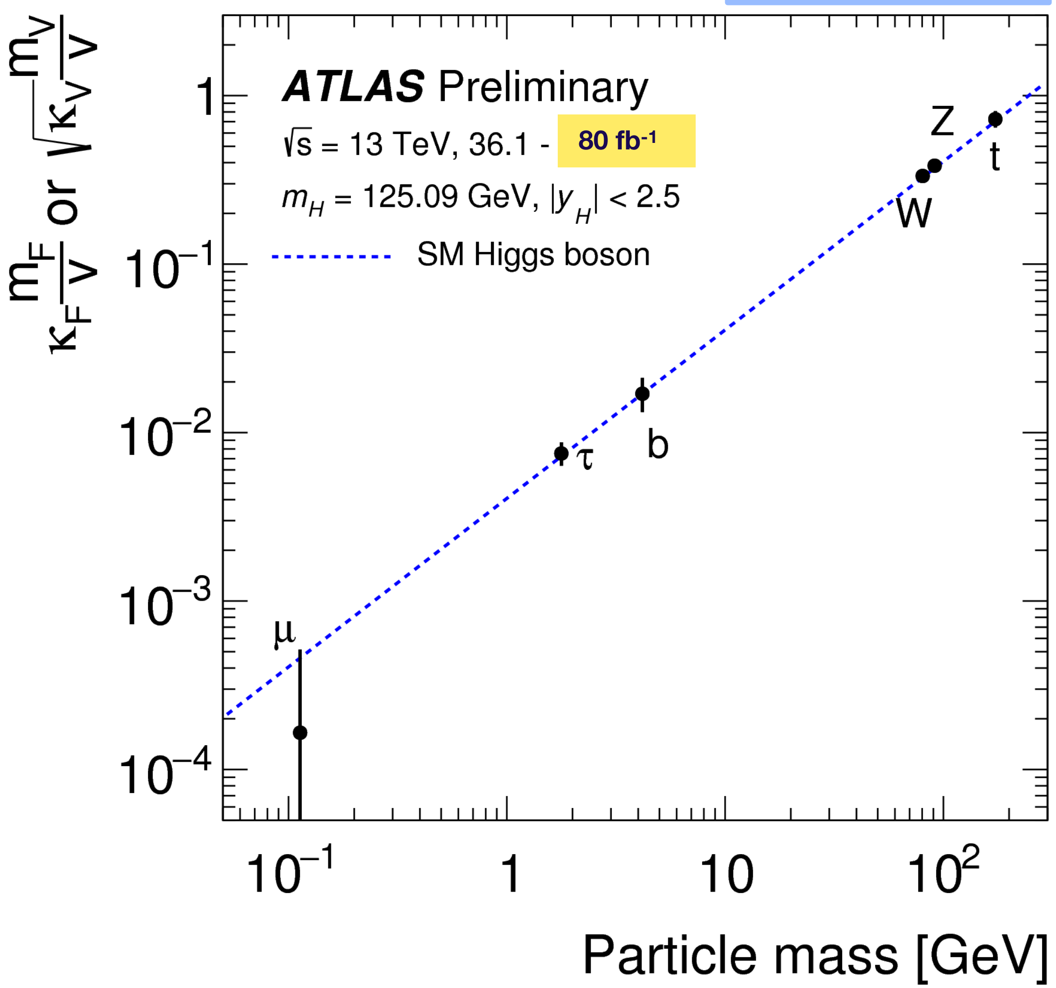
ATLAS-CONF-2018-031

Higgs coupling measurements

arXiv:1808.08238

Higgs boson coupling = f(particle mass)

ATLAS-CONF-2018-031



Interaction with gauge bosons

H→ZZ* ATLAS-CONF-2018-018

Well established in run 1

H→WW* arXiv:1808.09054

6.3σ (5.2 σ) obs (exp) run 2 only

Yukawa coupling to fermions

Top-quark ttH **80 fb-1** arXiv:1806.00425

6.3σ (5.1σ) obs (exp)

b-quark H→bb **80 fb-1** arXiv:1808.08238

5.4σ (5.5σ) obs (exp)

τ-letpon H→ττ ATLAS-CONF-2018-021

6.4σ (5.4σ) obs (exp)

μ-letpon H→μμ **80 fb-1** ATLAS-CONF-2018-026

$\sigma_{limit}/\sigma_{SM}<2.1$ (obs)

Charm-quark H→cc PRL 120 (2018) 211802

$\sigma_{limit}/\sigma_{SM}<104$ (obs)

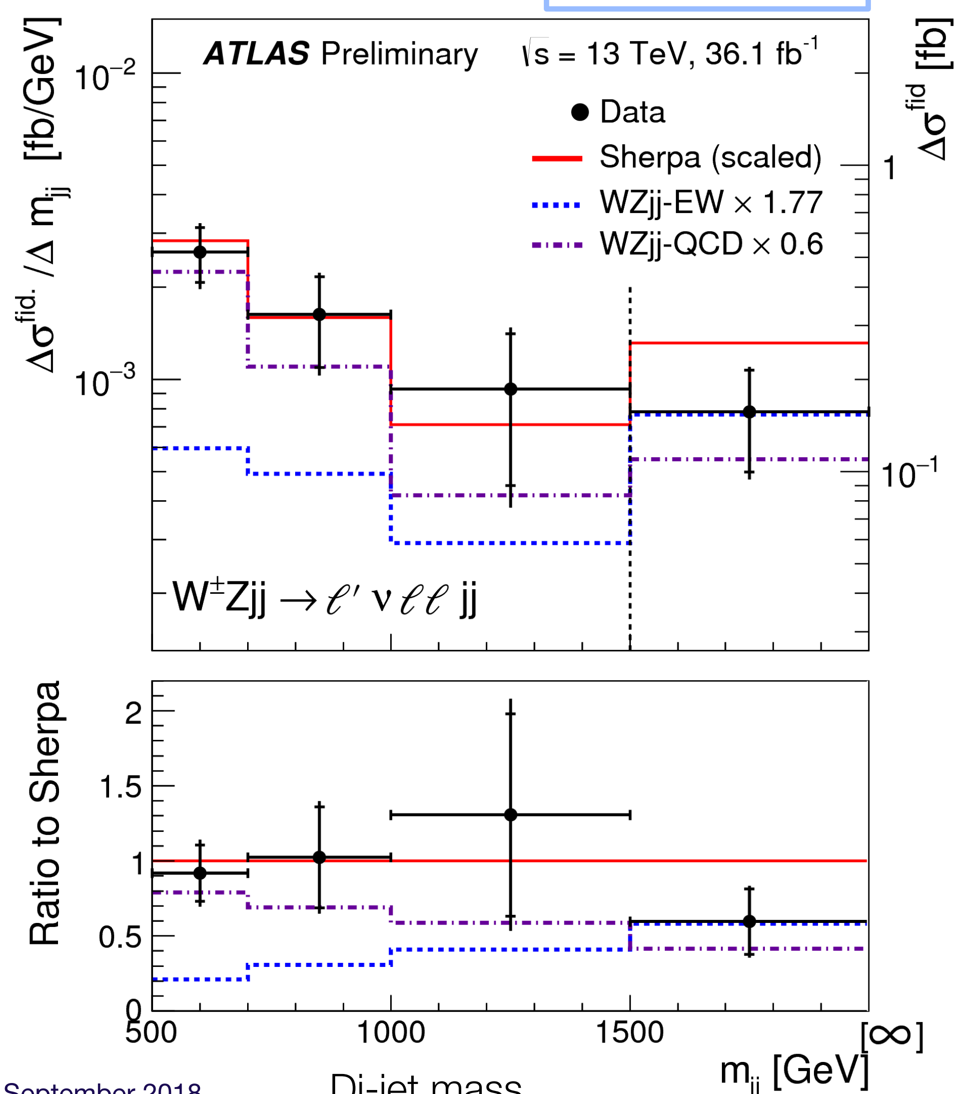
All couplings to high mass particles measured.
Next challenge: μ, charm quark….
(Latest VHbb result not included in this plot.)

WZ and WZjj production

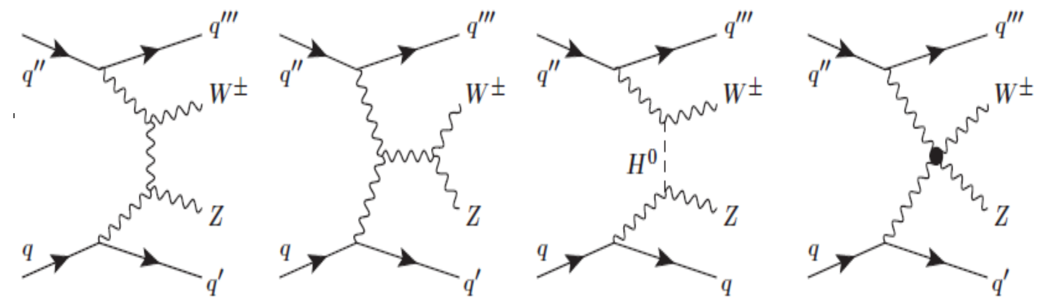
Electroweak production of WZ bosons in association with two jets: pp→W±Z jet jet
Process sensitive to triple and quartic gauge couplings and anomalous couplings.

Differential electroweak cross-section

ATLAS-CONF-2018-033



Di-jet mass



5.6σ (3.3σ) obs (exp)
Observation of EW W/Z jet jet process

Total fiducial WZ jet jet cross-section
σ_{EW}(pp→W±Z jet jet)=0.57±0.15 fb
LO (Sherpa): 0.32±0.03 fb

ATLAS-CONF-2018-034

Also, new result on inclusive WZ production
Fiducial cross-section in agreement with NNLO QCD (inclusive and differential)
Evidence for longitudinal W polarisation (4.2σ)
Measurement of Z polarisation

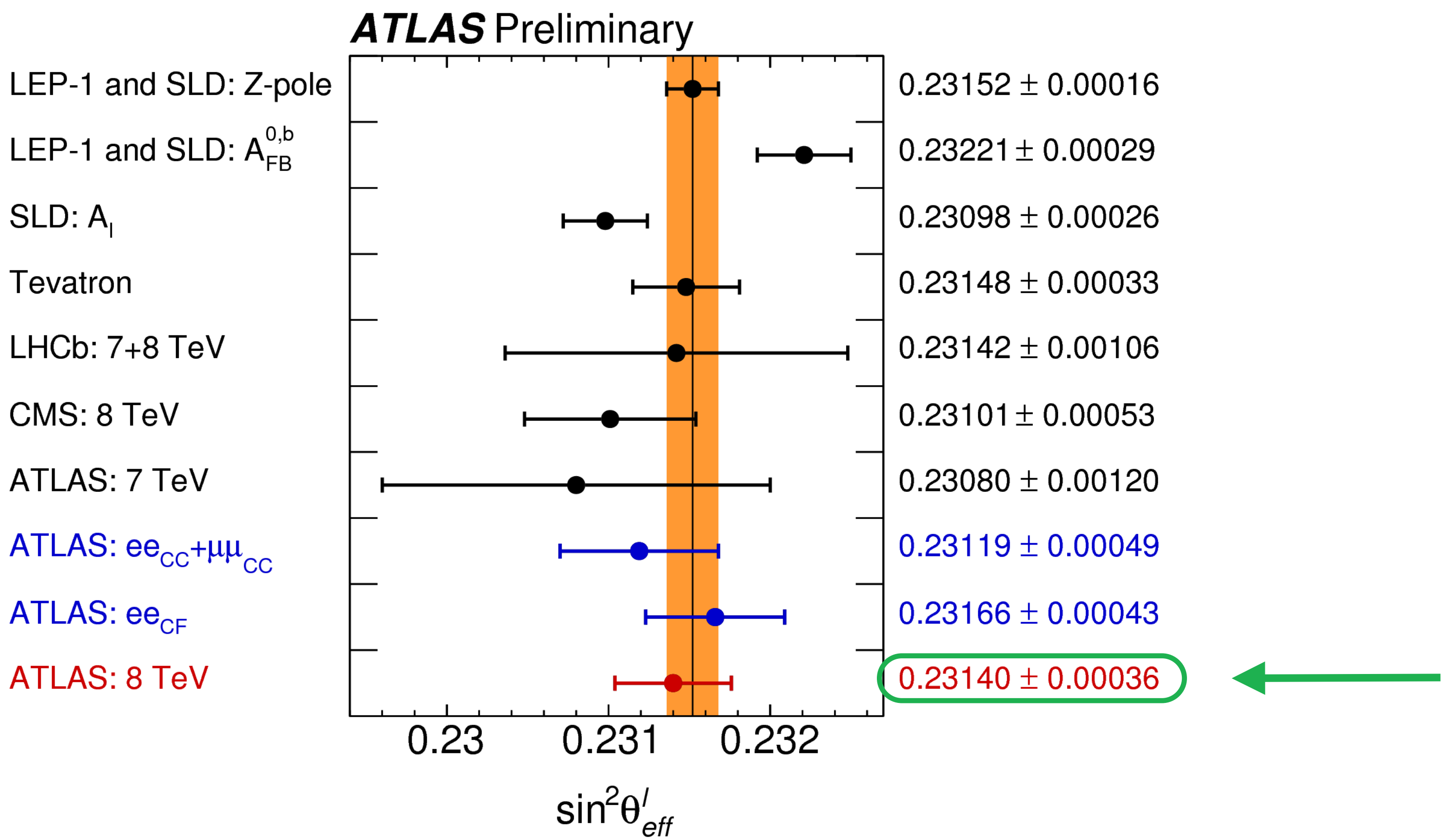
Measurement of electroweak parameters

ATLAS-CONF-2018-037

Measurement of the electroweak mixing angle

$$\frac{\mathrm{d}\sigma}{\mathrm{d}y^{\ell\ell}\,\mathrm{d}m^{\ell\ell}\,\mathrm{d}\cos\theta} = \frac{3}{16\pi}\frac{\mathrm{d}\sigma^{U+L}}{\mathrm{d}y^{\ell\ell}\,\mathrm{d}m^{\ell\ell}}\left\{(1+\cos^2\theta) + A_4\,\cos\theta\right\}$$

A_4 (and A_3) sensitive to the weak rising angle



m_W =	80370 ± 19 MeV	~0.02%
m_H =	124970 ± 240 MeV	~0.2%
m_{top} =	172510 ± 500 MeV	~0.3%

EPJ C78 (2018) 110

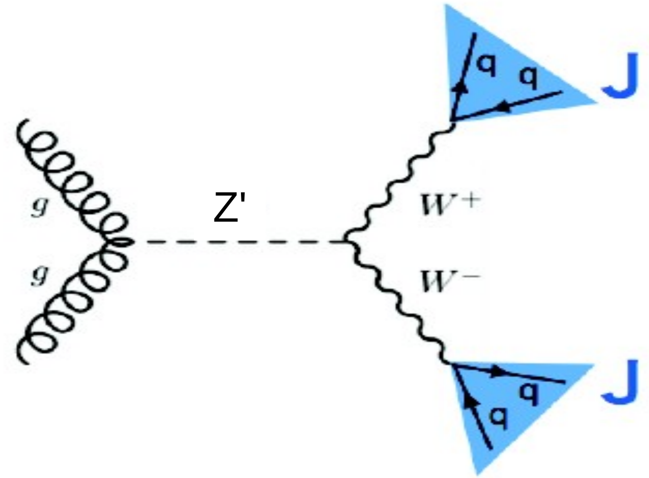
arXiv:1806.00242

ATLAS-CONF-2017-071

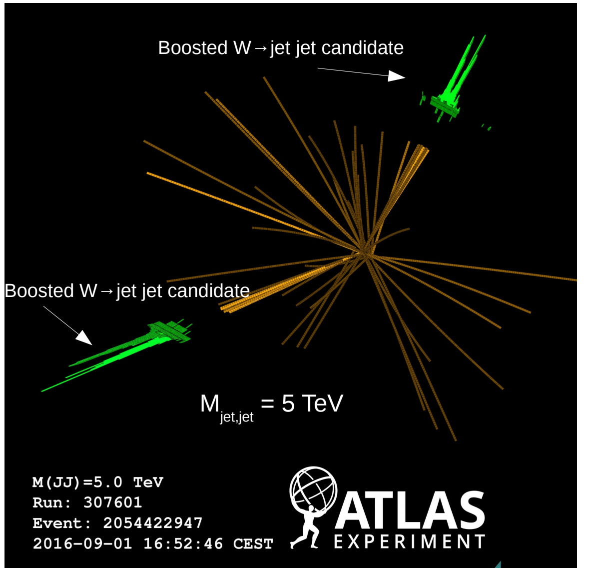
Di-boson resonance search

ATLAS-CONF-2018-016

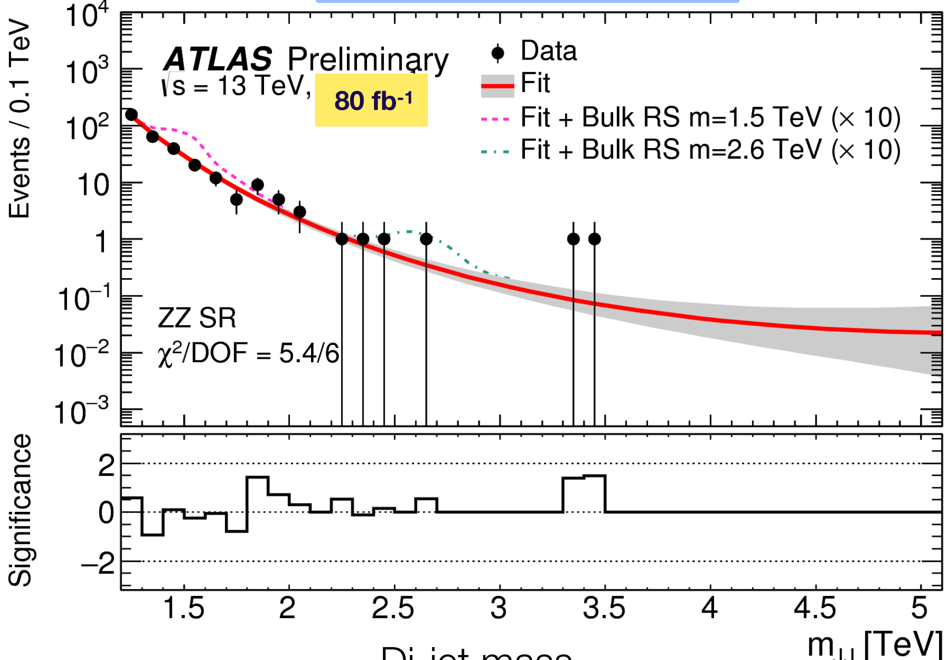
Select large p_T and large radius jet with boosted W/Z boson tagging.



Recent improvements
W/Z boson tagging using angles from tracker and energy from calorimeter
Tagger working point optimisation at high p_T.

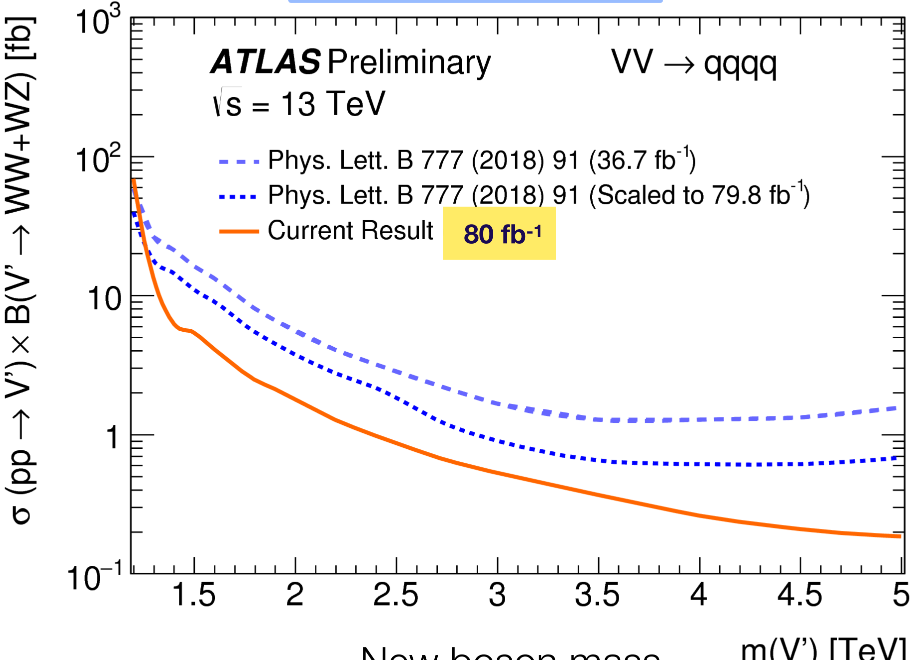


di-jet mass spectrum



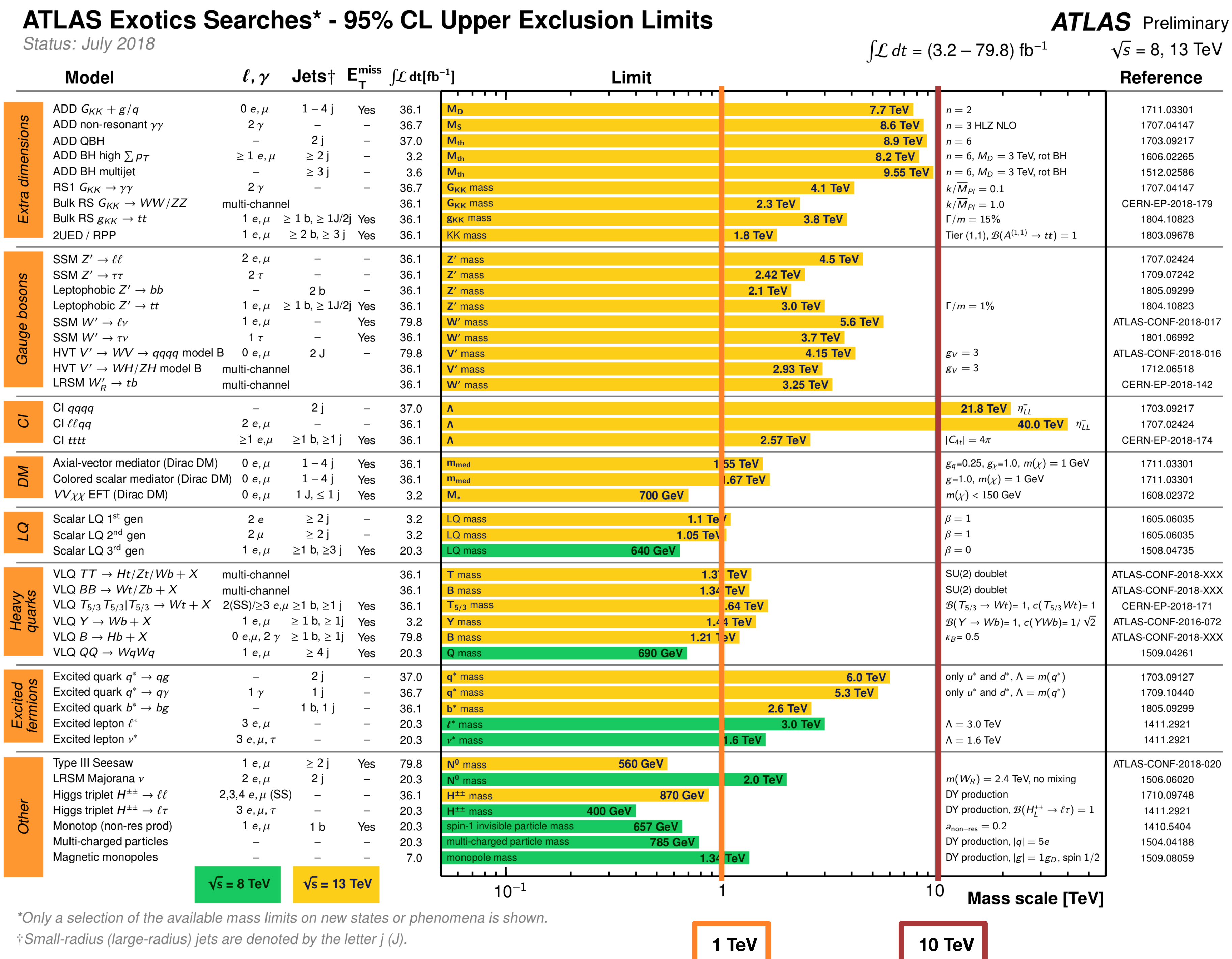
Di-jet mass

cross-section limit



New boson mass

Active BSM searches



Search for heavy charged long-lived particles using ionisation - $\sqrt{s}$=13 TeV (36/fb)

Trigger on E_T^{miss} - Event selection E_T^{miss} > 170 GeV - High p_T track with large dE/dx

Mass determined by the relation between dE/dx and momentum.

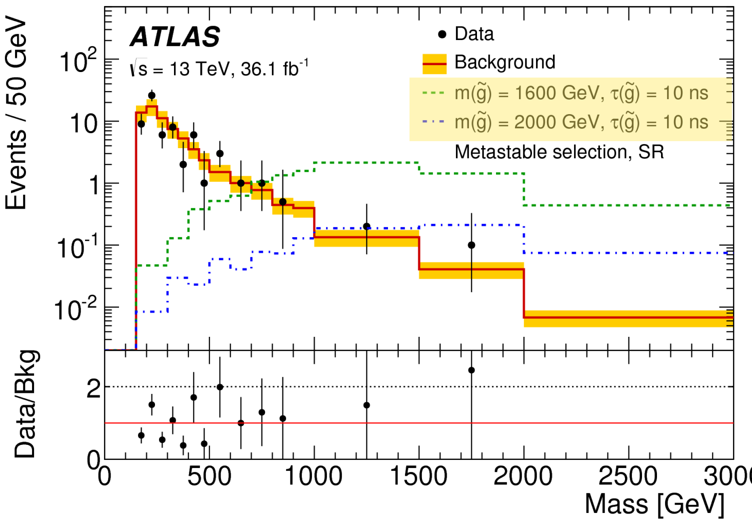
R-hadron in SUSY R-parity violated models

arXiv:1808-04095

Meta-stable selection

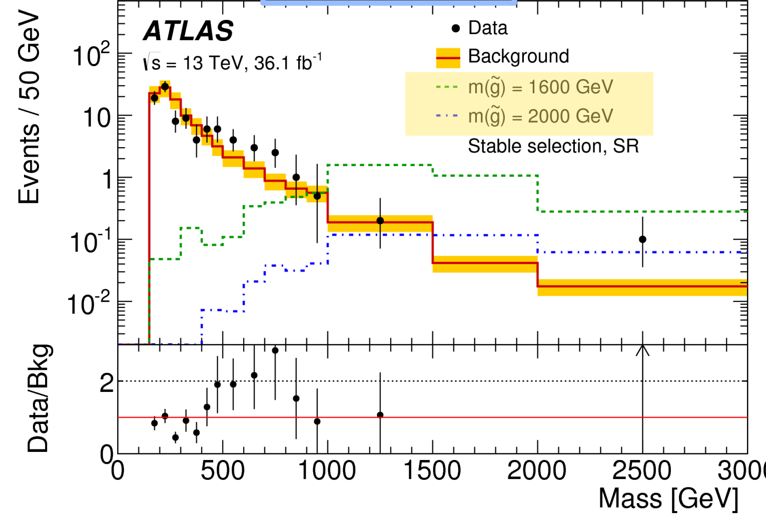
Search for parties which decay inside the detector with lifetimes ~1-10 ns

Charged particles reaching the muon spectrometer are removed

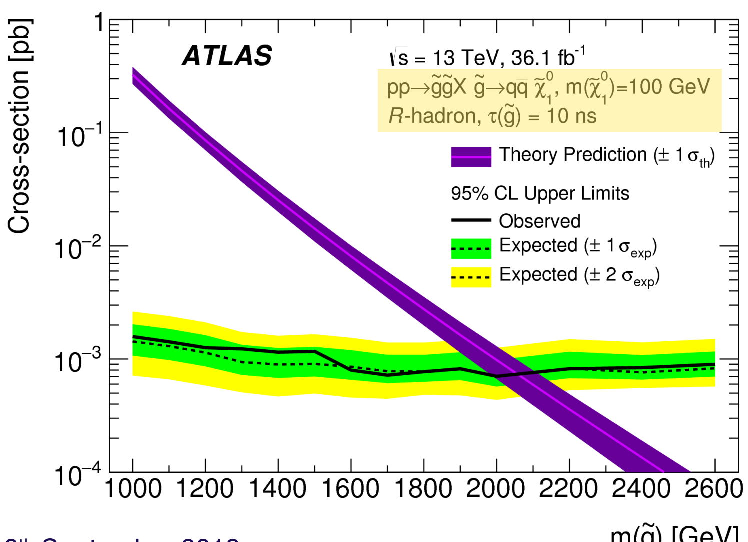


Stable selection

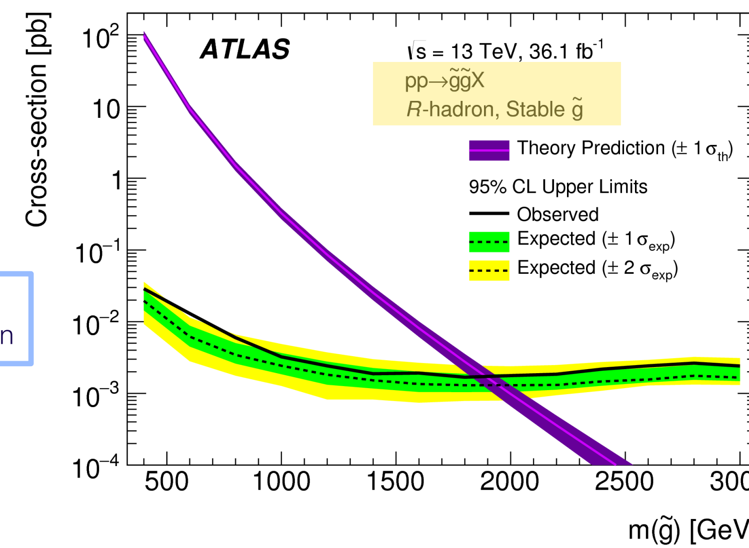
No μ-veto applied



Signal region data/background



Cross-section limit and comparison with prediction for gluino R-hadron production



Active SUSY search program

ATLAS SUSY Searches* - 95% CL Lower Limits

July 2018

ATLAS Preliminary

$\sqrt{s}$ = 7, 8, 13 TeV

Legend: $\sqrt{s}$ = 7, 8 TeV (green); $\sqrt{s}$ = 13 TeV (blue)

Category	Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L}\, dt[fb^{-1}]$	Mass limit [TeV]	Conditions	Reference
Inclusive Searches	$\tilde q\tilde q, \tilde q \to q\tilde\chi^0_1$	0	2-6 jets	Yes	36.1	$\tilde q$ [2×, 8× Degen.] 0.9 / 1.55	$m(\tilde\chi^0_1)$<100 GeV	1712.02332
		mono-jet	1-3 jets	Yes	36.1	$\tilde q$ [1×, 8× Degen.] 0.43 / 0.71	$m(\tilde q)$-$m(\tilde\chi^0_1)$=5 GeV	1711.03301
	$\tilde g\tilde g, \tilde g \to q\bar q\tilde\chi^0_1$	0	2-6 jets	Yes	36.1	$\tilde g$ 2.0	$m(\tilde\chi^0_1)$<200 GeV	1712.02332
						$\tilde g$ Forbidden 0.95-1.6	$m(\tilde\chi^0_1)$=900 GeV	1712.02332
	$\tilde g\tilde g, \tilde g \to q\bar q(\ell\ell)\tilde\chi^0_1$	3 e,μ	4 jets	-	36.1	$\tilde g$ 1.85	$m(\tilde\chi^0_1)$<800 GeV	1706.03731
		$ee,\mu\mu$	2 jets	Yes	36.1	$\tilde g$ 1.2	$m(\tilde g)$-$m(\tilde\chi^0_1)$=50 GeV	1805.11381
	$\tilde g\tilde g, \tilde g \to qqWZ\tilde\chi^0_1$	0	7-11 jets	Yes	36.1	$\tilde g$ 1.8	$m(\tilde\chi^0_1)$ <400 GeV	1708.02794
		3 e,μ	4 jets	-	36.1	$\tilde g$ 0.98	$m(\tilde g)$-$m(\tilde\chi^0_1)$=200 GeV	1706.03731
	$\tilde g\tilde g, \tilde g \to t\bar t\tilde\chi^0_1$	0-1 e,μ	3 b	Yes	36.1	$\tilde g$ 2.0	$m(\tilde\chi^0_1)$<200 GeV	1711.01901
		3 e,μ	4 jets	-	36.1	$\tilde g$ 1.25	$m(\tilde g)$-$m(\tilde\chi^0_1)$=300 GeV	1706.03731
3rd gen. squarks direct production	$\tilde b_1\tilde b_1, \tilde b_1 \to b\tilde\chi^0_1/t\tilde\chi^\pm_1$		Multiple		36.1	$\tilde b_1$ Forbidden 0.9	$m(\tilde\chi^0_1)$=300 GeV, BR($b\tilde\chi^0_1$)=1	1708.09266, 1711.03301
			Multiple		36.1	$\tilde b_1$ Forbidden 0.58-0.82	$m(\tilde\chi^0_1)$=300 GeV, BR($b\tilde\chi^0_1$)=BR($t\tilde\chi^\pm_1$)=0.5	1708.09266
			Multiple		36.1	$\tilde b_1$ Forbidden 0.7	$m(\tilde\chi^0_1)$=200 GeV, $m(\tilde\chi^\pm_1)$=300 GeV, BR($t\tilde\chi^\pm_1$)=1	1706.03731
	$\tilde b_1\tilde b_1, \tilde t_1\tilde t_1, M_2 = 2\times M_1$		Multiple		36.1	$\tilde t_1$ 0.7	$m(\tilde\chi^0_1)$=60 GeV	1709.04183, 1711.11520, 1708.03247
			Multiple		36.1	$\tilde t_1$ Forbidden 0.9	$m(\tilde\chi^0_1)$=200 GeV	1709.04183, 1711.11520, 1708.03247
	$\tilde t_1\tilde t_1, \tilde t_1 \to Wb\tilde\chi^0_1$ or $t\tilde\chi^0_1$	0-2 e,μ	0-2 jets/1-2 b	Yes	36.1	$\tilde t_1$ 1.0	$m(\tilde\chi^0_1)$=1 GeV	1506.08616, 1709.04183, 1711.11520
	$\tilde t_1\tilde t_1$, $\tilde H$ LSP		Multiple		36.1	$\tilde t_1$ 0.4-0.9	$m(\tilde\chi^0_1)$=150 GeV, $m(\tilde\chi^\pm_1)$-$m(\tilde\chi^0_1)$=5 GeV, $\tilde t_1 \approx \tilde t_L$	1709.04183, 1711.11520
			Multiple		36.1	$\tilde t_1$ Forbidden 0.6-0.8	$m(\tilde\chi^0_1)$=300 GeV, $m(\tilde\chi^\pm_1)$-$m(\tilde\chi^0_1)$=5 GeV, $\tilde t_1 \approx \tilde t_L$	1709.04183, 1711.11520
	$\tilde t_1\tilde t_1$, Well-Tempered LSP		Multiple		36.1	$\tilde t_1$ 0.48-0.84	$m(\tilde\chi^0_1)$=150 GeV, $m(\tilde\chi^\pm_1)$-$m(\tilde\chi^0_1)$=5 GeV, $\tilde t_1 \approx \tilde t_L$	1709.04183, 1711.11520
	$\tilde t_1\tilde t_1, \tilde t_1 \to c\tilde\chi^0_1$ / $\tilde c\tilde c, \tilde c \to c\tilde\chi^0_1$	0	$2c$	Yes	36.1	$\tilde t_1$ 0.85	$m(\tilde\chi^0_1)$=0 GeV	1805.01649
						$\tilde t_1$ 0.46	$m(\tilde t_1,\tilde c)$-$m(\tilde\chi^0_1)$=50 GeV	1805.01649
		0	mono-jet	Yes	36.1	$\tilde t_1$ 0.43	$m(\tilde t_1,\tilde c)$-$m(\tilde\chi^0_1)$=5 GeV	1711.03301
	$\tilde t_2\tilde t_2, \tilde t_2 \to \tilde t_1 + h$	1-2 e,μ	4 b	Yes	36.1	$\tilde t_2$ 0.32-0.88	$m(\tilde\chi^0_1)$=0 GeV, $m(\tilde t_1)$-$m(\tilde\chi^0_1)$= 180 GeV	1706.03986
EW direct	$\tilde\chi^\pm_1\tilde\chi^0_2$ via WZ	2-3 e,μ	-	Yes	36.1	$\tilde\chi^\pm_1/\tilde\chi^0_2$ 0.6	$m(\tilde\chi^0_1)$=0	1403.5294, 1806.02293
		$ee,\mu\mu$	≥ 1	Yes	36.1	$\tilde\chi^\pm_1/\tilde\chi^0_2$ 0.17	$m(\tilde\chi^\pm_1)$-$m(\tilde\chi^0_1)$=10 GeV	1712.08119
	$\tilde\chi^\pm_1\tilde\chi^0_2$ via Wh	$\ell\ell/\ell\gamma\gamma/\ell bb$	-	Yes	20.3	$\tilde\chi^\pm_1/\tilde\chi^0_2$ 0.26	$m(\tilde\chi^0_1)$=0	1501.07110
	$\tilde\chi^\pm_1\tilde\chi^\mp_1/\tilde\chi^0_2, \tilde\chi^+_1 \to \tilde\tau\nu(\tau\tilde\nu), \tilde\chi^0_2 \to \tilde\tau\tau(\nu\tilde\nu)$	2 τ	-	Yes	36.1	$\tilde\chi^\pm_1/\tilde\chi^0_2$ 0.76	$m(\tilde\chi^0_1)$=0, $m(\tilde\tau,\tilde\nu)$=0.5($m(\tilde\chi^\pm_1)$+$m(\tilde\chi^0_1)$)	1708.07875
						$\tilde\chi^\pm_1/\tilde\chi^0_2$ 0.22	$m(\tilde\chi^\pm_1)$-$m(\tilde\chi^0_1)$=100 GeV, $m(\tilde\tau,\tilde\nu)$=0.5($m(\tilde\chi^\pm_1)$+$m(\tilde\chi^0_1)$)	1708.07875
	$\tilde\ell_{L,R}\tilde\ell_{L,R}, \tilde\ell \to \ell\tilde\chi^0_1$	2 e,μ	0	Yes	36.1	$\tilde\ell$ 0.5	$m(\tilde\chi^0_1)$=0	1803.02762
		2 e,μ	≥ 1	Yes	36.1	$\tilde\ell$ 0.18	$m(\tilde\ell)$-$m(\tilde\chi^0_1)$=5 GeV	1712.08119
	$\tilde H\tilde H, \tilde H \to h\tilde G/Z\tilde G$	0	$\geq 3b$	Yes	36.1	$\tilde H$ 0.13-0.23 / 0.29-0.88	BR($\tilde\chi^0_1 \to h\tilde G$)=1	1806.04030
		4 e,μ	0	Yes	36.1	$\tilde H$ 0.3	BR($\tilde\chi^0_1 \to Z\tilde G$)=1	1804.03602
Long-lived particles	Direct $\tilde\chi^+_1\tilde\chi^-_1$ prod., long-lived $\tilde\chi^\pm_1$	Disapp. trk	1 jet	Yes	36.1	$\tilde\chi^\pm_1$ 0.46	Pure Wino	1712.02118
						$\tilde\chi^\pm_1$ 0.15	Pure Higgsino	ATL-PHYS-PUB-2017-019
	Stable $\tilde g$ R-hadron	SMP	-	-	3.2	$\tilde g$ 1.6		1606.05129
	Metastable $\tilde g$ R-hadron, $\tilde g \to qq\tilde\chi^0_1$		Multiple		32.8	$\tilde g$ [$\tau(\tilde g)$ =100 ns, 0.2 ns] 1.6 / 2.4	$m(\tilde\chi^0_1)$=100 GeV	1710.04901, 1604.04520
	GMSB, $\tilde\chi^0_1 \to \gamma\tilde G$, long-lived $\tilde\chi^0_1$	2 γ	-	Yes	20.3	$\tilde\chi^0_1$ 0.44	1<$\tau(\tilde\chi^0_1)$<3 ns, SPS8 model	1409.5542
	$\tilde g\tilde g, \tilde\chi^0_1 \to ee\nu/e\mu\nu/\mu\mu\nu$	displ. $ee/e\mu/\mu\mu$	-	-	20.3	$\tilde g$ 1.3	6 <$c\tau(\tilde\chi^0_1)$< 1000 mm, $m(\tilde\chi^0_1)$=1 TeV	1504.05162
RPV	LFV $pp \to \tilde\nu_\tau + X, \tilde\nu_\tau \to e\mu/e\tau/\mu\tau$	$e\mu,e\tau,\mu\tau$	-	-	3.2	$\tilde\nu_\tau$ 1.9	λ'_{311}=0.11, $\lambda_{132/133/233}$=0.07	1607.08079
	$\tilde\chi^\pm_1\tilde\chi^\mp_1/\tilde\chi^0_2 \to WW/Z\ell\ell\ell\ell\nu\nu$	4 e,μ	0	Yes	36.1	$\tilde\chi^\pm_1/\tilde\chi^0_2$ [$\lambda_{i33} \neq 0, \lambda_{12k} \neq 0$] 0.82 / 1.33	$m(\tilde\chi^0_1)$=100 GeV	1804.03602
	$\tilde g\tilde g, \tilde g \to qq\tilde\chi^0_1, \tilde\chi^0_1 \to qqq$	0	4-5 large-R jets	-	36.1	$\tilde g$ [$m(\tilde\chi^0_1)$=200 GeV, 1100 GeV] 1.3 / 1.9	Large λ''_{112}	1804.03568
			Multiple		36.1	$\tilde g$ [λ''_{112}=2e-4, 2e-5] 1.0 / 2.0	$m(\tilde\chi^0_1)$=200 GeV, bino-like	ATLAS-CONF-2018-003
	$\tilde g\tilde g, \tilde g \to tbs$ / $\tilde g \to t\bar t\tilde\chi^0_1, \tilde\chi^0_1 \to tbs$		Multiple		36.1	$\tilde g$ [λ''_{323}=1, 1e-2] 1.8 / 2.1	$m(\tilde\chi^0_1)$=200 GeV, bino-like	ATLAS-CONF-2018-003
	$\tilde t\tilde t, \tilde t \to t\tilde\chi^0_1, \tilde\chi^0_1 \to tbs$		Multiple		36.1	$\tilde g$ [λ''_{323}=2e-4, 1e-2] 0.55 / 1.0	$m(\tilde\chi^0_1)$=200 GeV, bino-like	ATLAS-CONF-2018-003
	$\tilde t_1\tilde t_1, \tilde t_1 \to bs$	0	2 jets + 2 b	-	36.7	$\tilde t_1$ [qq, bs] 0.42 / 0.61		1710.07171
	$\tilde t_1\tilde t_1, \tilde t_1 \to b\ell$	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

Mass scale [TeV] (axis from 10^{-1} to 1 and above)

1 TeV

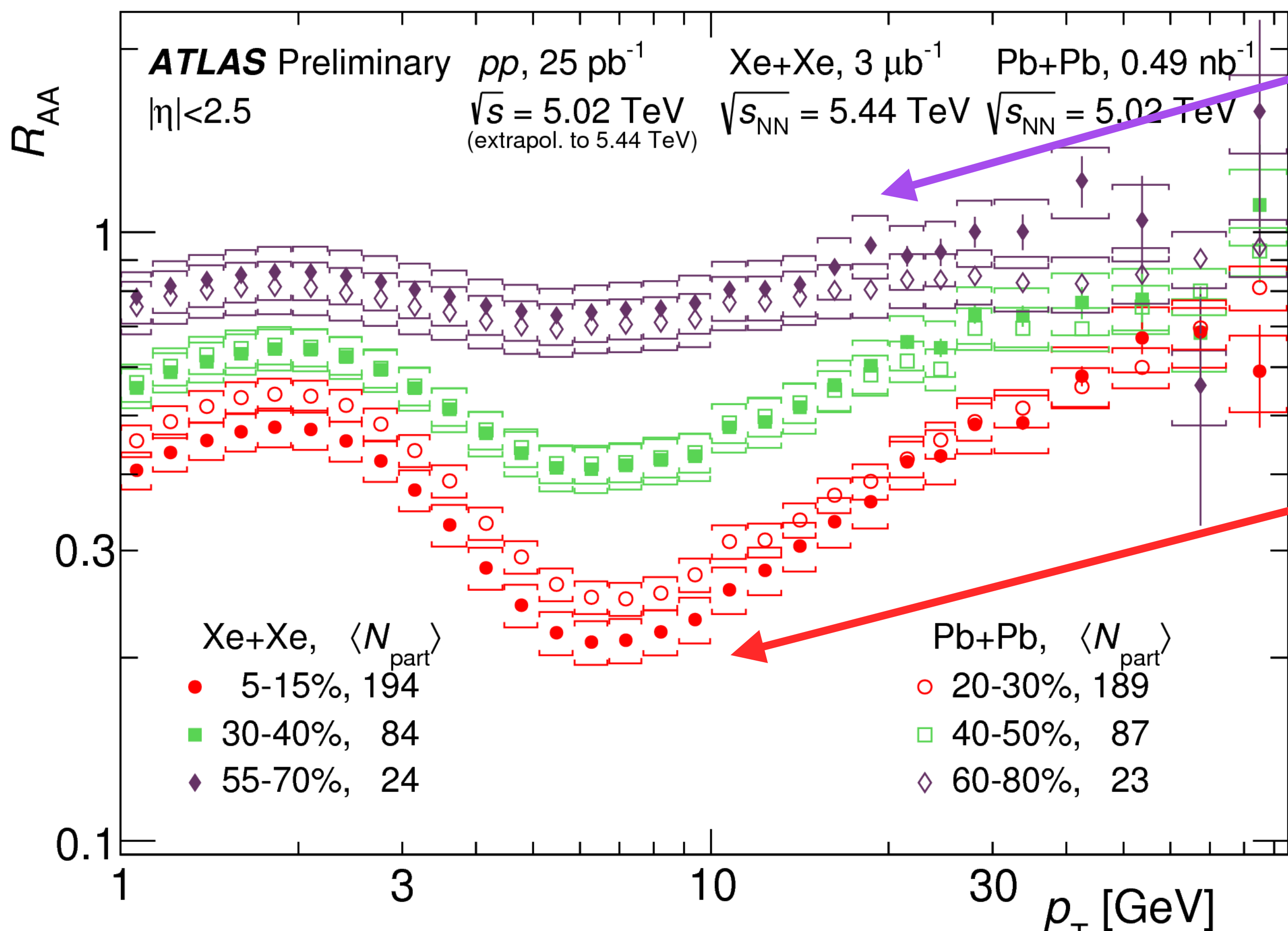
*Only a selection of the available mass limits on new states or phenomena is shown. Many of the limits are based on simplified models, c.f. refs. for the assumptions made.

Rich harvest of heavy ions results - one example

ATLAS-CONF-2018-007

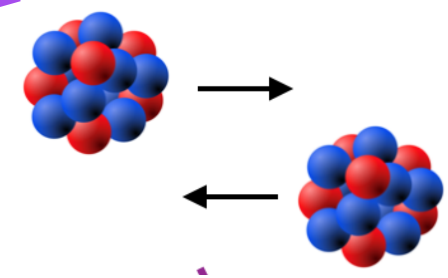
Charged particles suppression in Pb-Pb and Xe-Xe collisions with respect to pp collisions

Nuclear modification factor, R_{AA} vs p_T for different centralities

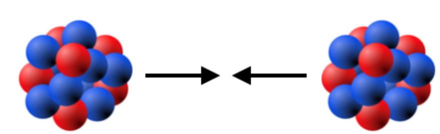


Peripheral collisions milder suppression in Xe-Xe

<N_{part}> ~ 24



<N_{part}> ~ 190



Central collisions larger suppression in Xe-Xe than in Pb-Pb

The main proton-proton physics goal

Run 1 (7-8 TeV)

Discovery of Higgs boson

Searches for additional new physics (negative)

Observation of rare processes, such as $B_s \rightarrow \mu\mu$

Precision measurements of Standard Model processes

Study of CP asymmetries in the Bs sector

Run 2 & 3 (13-14 TeV)

Searches for new physics

Improved measurements of Higgs boson coupling in main channels

Consolidation and observation of Higgs boson channels

Measurements of rare Standard Model processes & more precision

Improved measurements of rare B decays and CP asymmetries

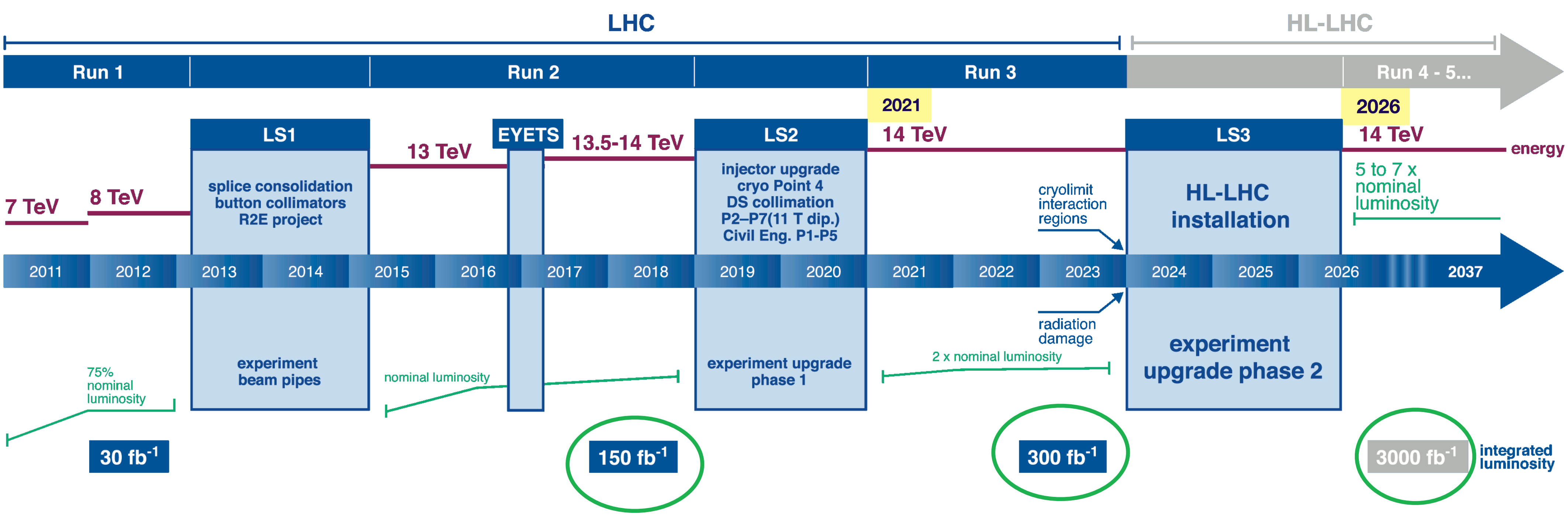
HL-LHC (14 TeV)

Precision measurements of Higgs boson couplings

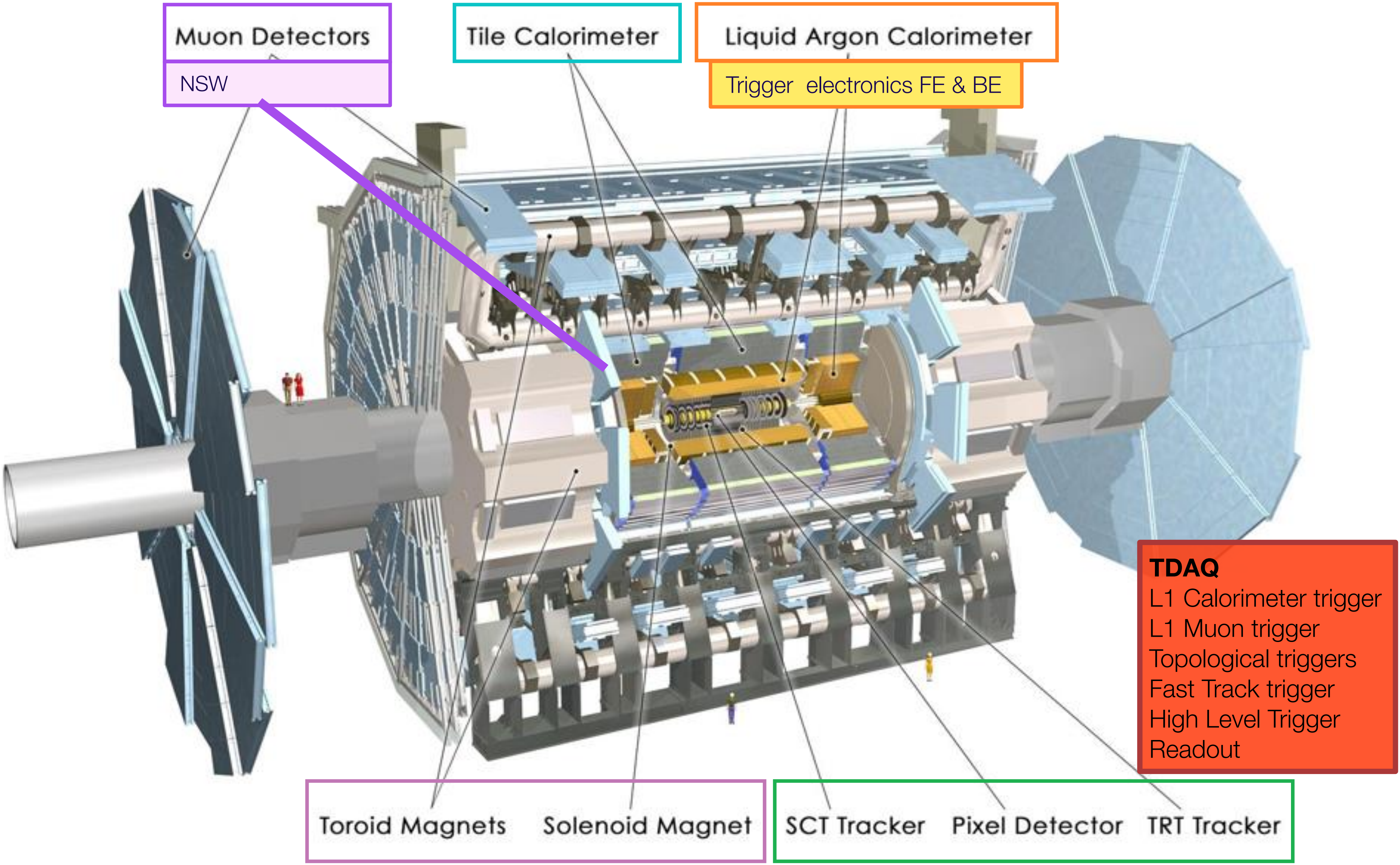
Observation of very rare Higgs boson modes

Ultimate new physics search reach (on mass and forbidden decays, e.g. FCNC)

Ultimate SM & HF physics precision for rare processes

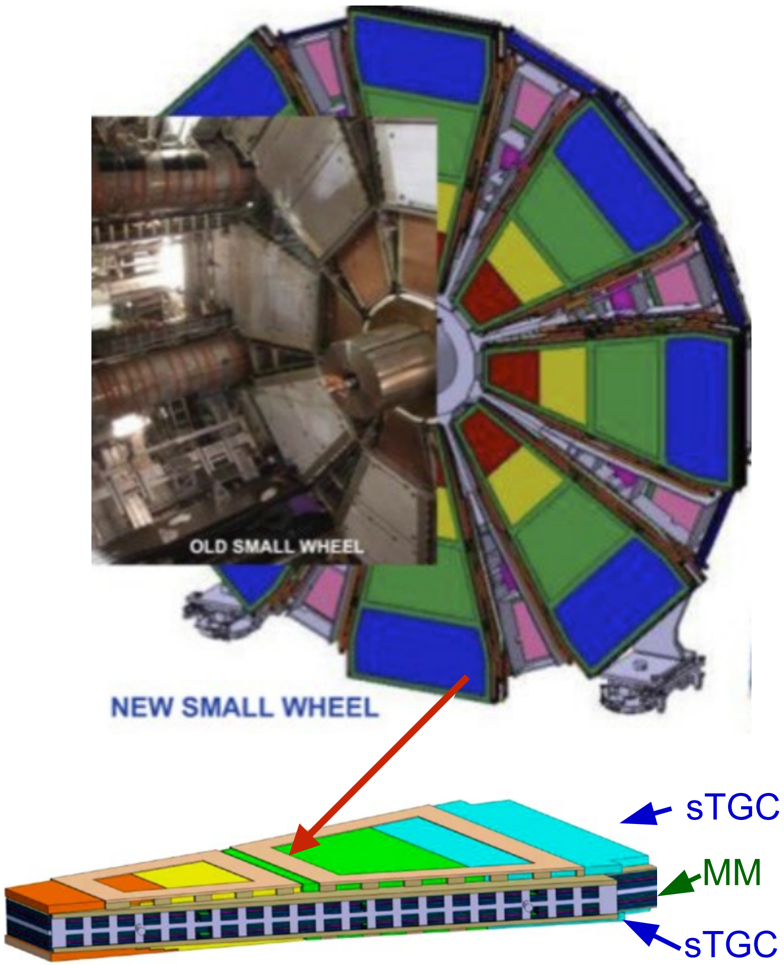


The ATLAS detector: Phase-I upgrades



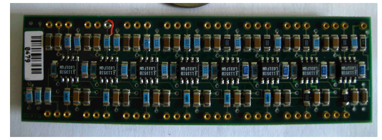
The ATLAS detector: Phase-I upgrades

Muon New Small Wheel

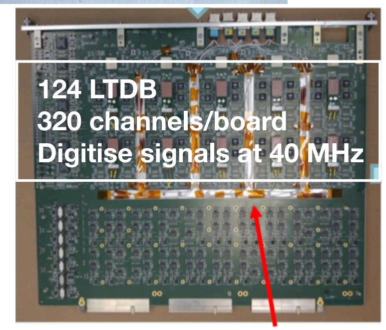


FINAL ADJUSTMENTS for PRODUCTION - VERY INTENSE CONSTRUCTION PERIOD AHEAD of US for INSTALLATION DURING LS2

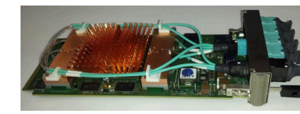
Liquid Argon Trigger electronics Frontend & Backend



new Layer Sum Board

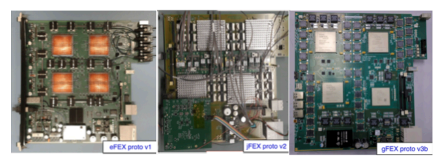


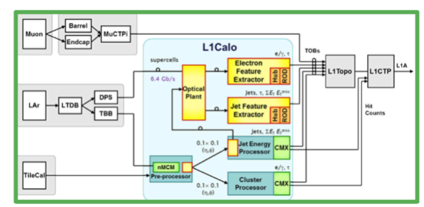
Pre-production LTDB with fiber trough



31 LDPS LArC
124 AMCs LATOME
320 channels/AMC
Reconstruct BCID, E_T at 40 MHz

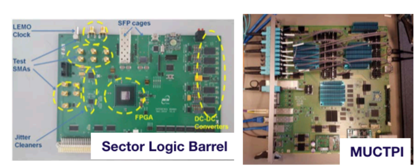
Trigger and Data Acquisition

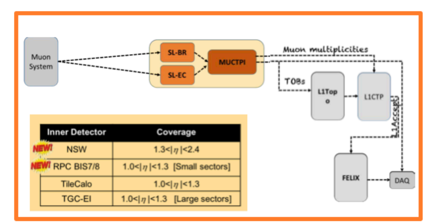




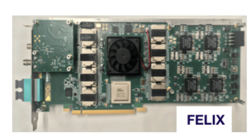
Improved LAr calorimeter segmentation for L1

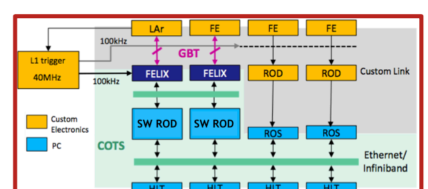
eFex, jFex, gFex....





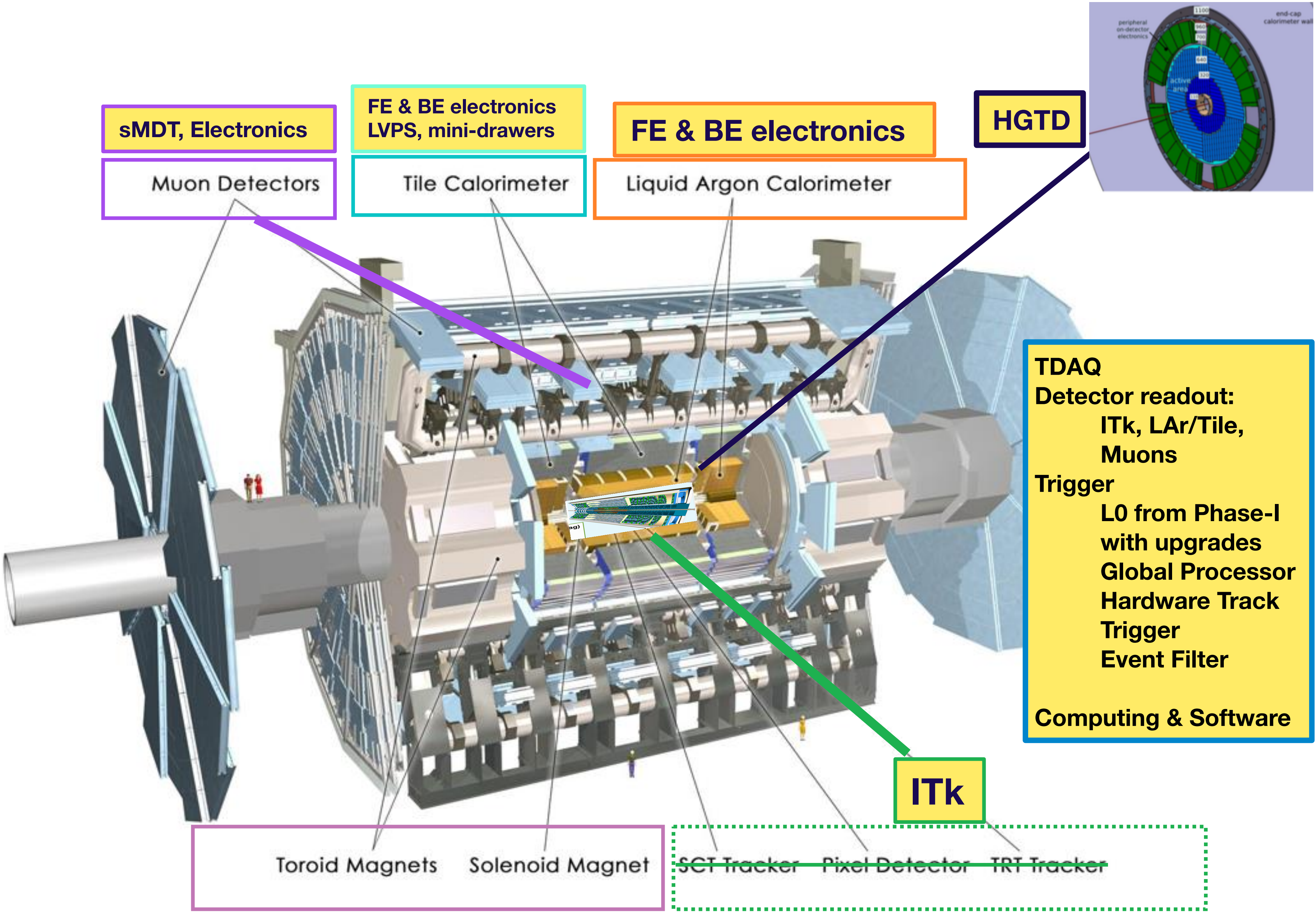
New Small Wheel for improvement background rejection at L1





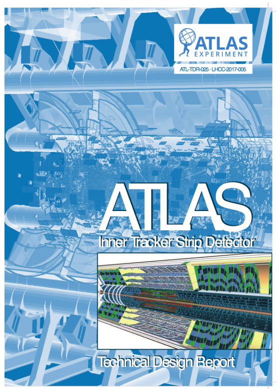
FELIX board

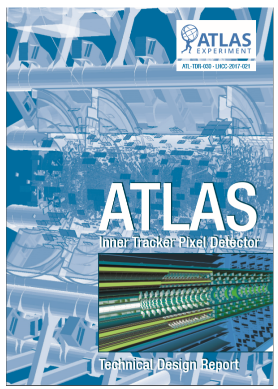
The ATLAS detector: Phase-II upgrades

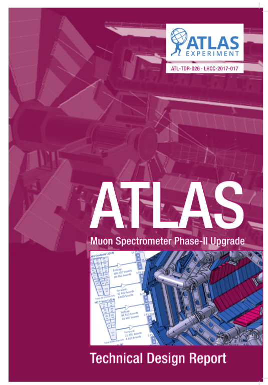


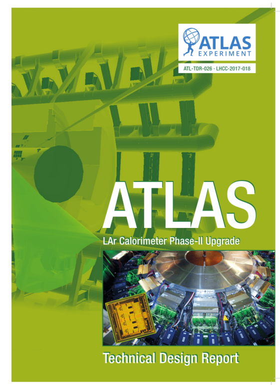
Status of the Phase II upgrade for HL-LHC

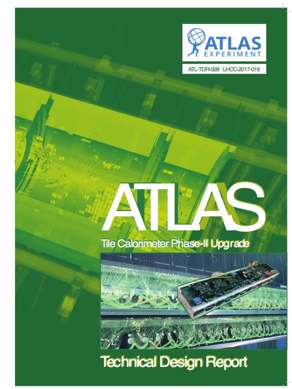
All six TDRs of the ATLAS Phase-II upgrade programme have been presented by ATLAS, review and approved by the LHC Committee and the Upgrade Cost Group, and finally approved by the CERN research board.

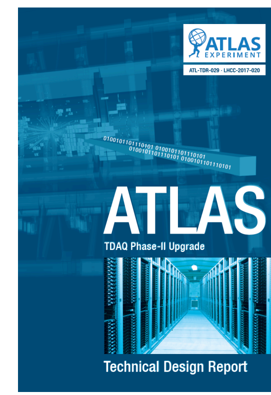












Silicon Strip + Pixel tracker Muon system Calorimeters TDAQ

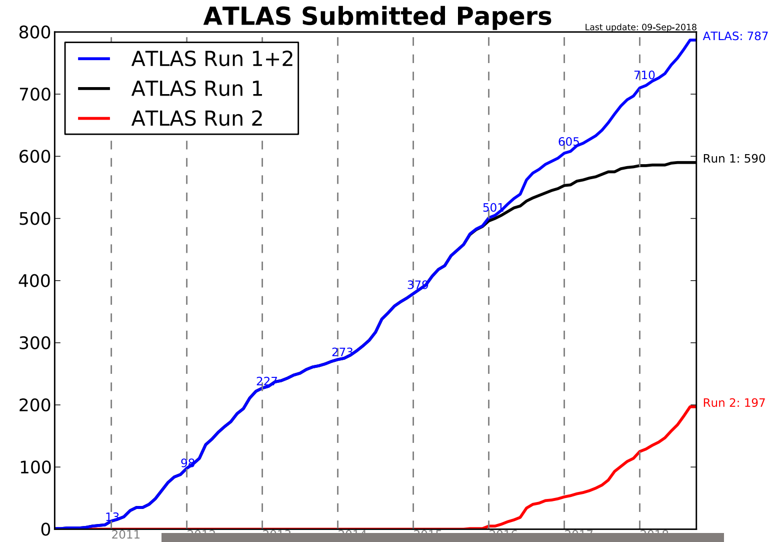
In addition, ATLAS is preparing a TDR for the High Granularity timing detector.

Towards update of the European Strategy: preparation of CERN Yellow Report with updated projections for HL-LHC.

Conclusions and outlook

ATLAS continues prolific physics production:

total of **787** papers on collision data



ATLAS collects high luminosity pp collision data with very high efficiency.

In 2012 a Higgs boson was discovered (ATLAS and CMS)

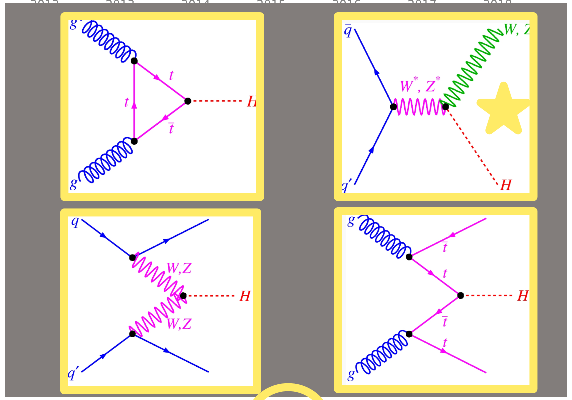
In 2018, ATLAS

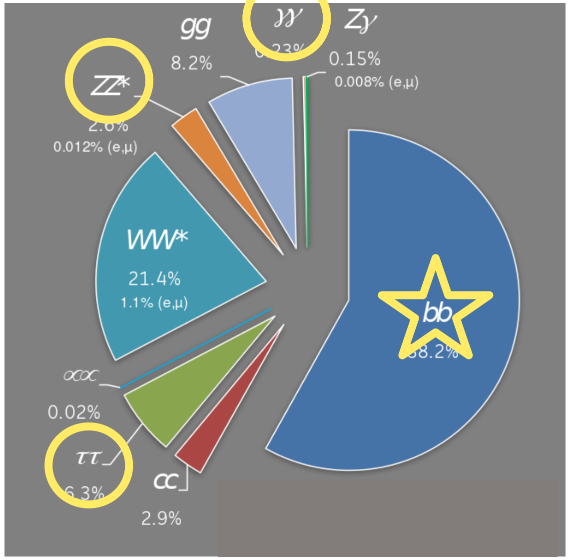
observed key production and decay modes of the Higgs boson

H→bb, ttH and VH production

measured more low cross-section SM processes

pushed the limits of Beyond the SM processes





In parallel, ATLAS is preparing the installation in 2019 and 2020 of the phase-I upgrade and getting ready for the construction of the phase-II detector upgrade

Excellent performance of the injectors+LHC: Thank you!