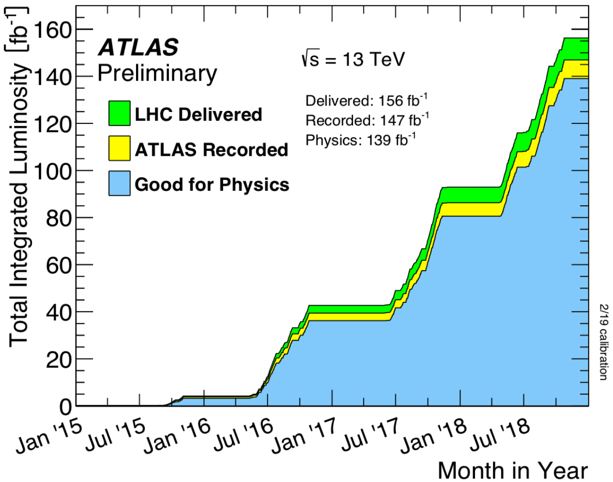
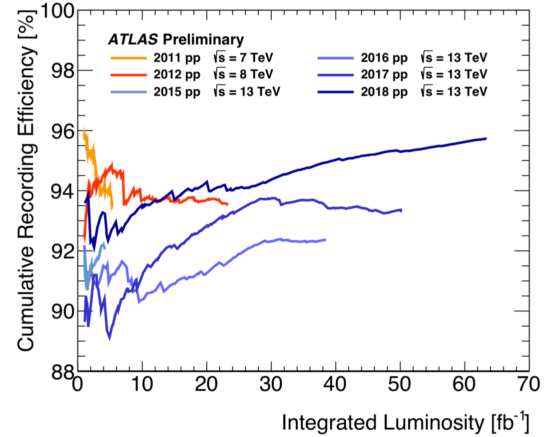
ATLAS Status Report

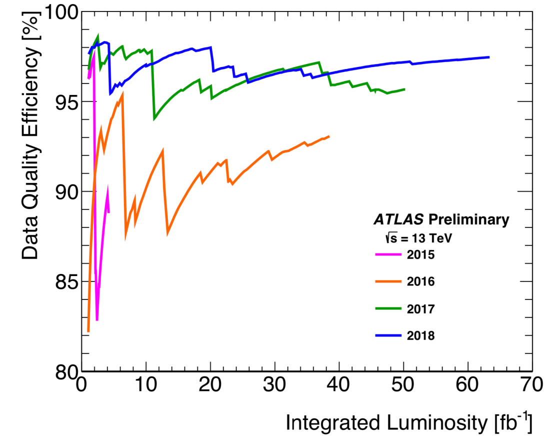
Bogdan Malaescu, on behalf of the ATLAS collaboration

LHCC open session – 11/09/2019

Introduction







Continuously improving data taking and data quality efficiency

ATLAS pp Run-2: July 2015 – October 2018										
Inner Tracker			Calorimeters		Muon Spectrometer				Magnets	
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
99.5	99.9	99.7	99.6	99.7	99.8	99.6	100	100	99.8	98.8
Good for physics: 95.6% (139 fb^{-1})										Full Run-2

Large ongoing effort to analyse this data sample

→ 35 full Run-2 public results: *Focusing on a few in this talk*

Reconstruction and Calibration Performance

→ Benefit from excellent reconstruction and calibration performance up to very large pileup values *(up to three times above design)*

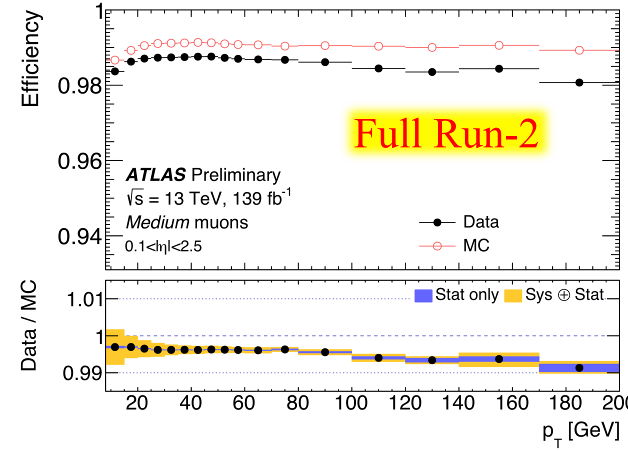
For example, reached (over a large p_T range):

~percent precision on small-/large-R jet energy scale

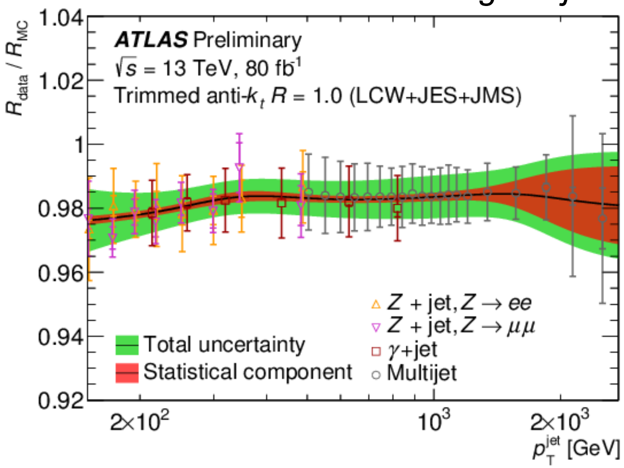
~percent uncertainty on b-tagging efficiency

~per-mil uncertainty on muon efficiency

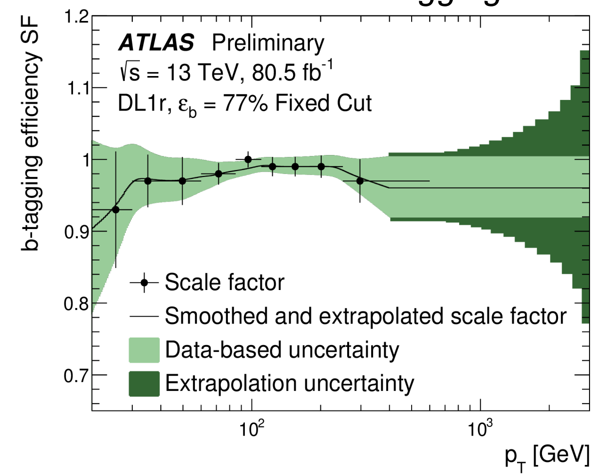
Data-driven calibration of muon efficiency



Data-driven calibration of large-R jets



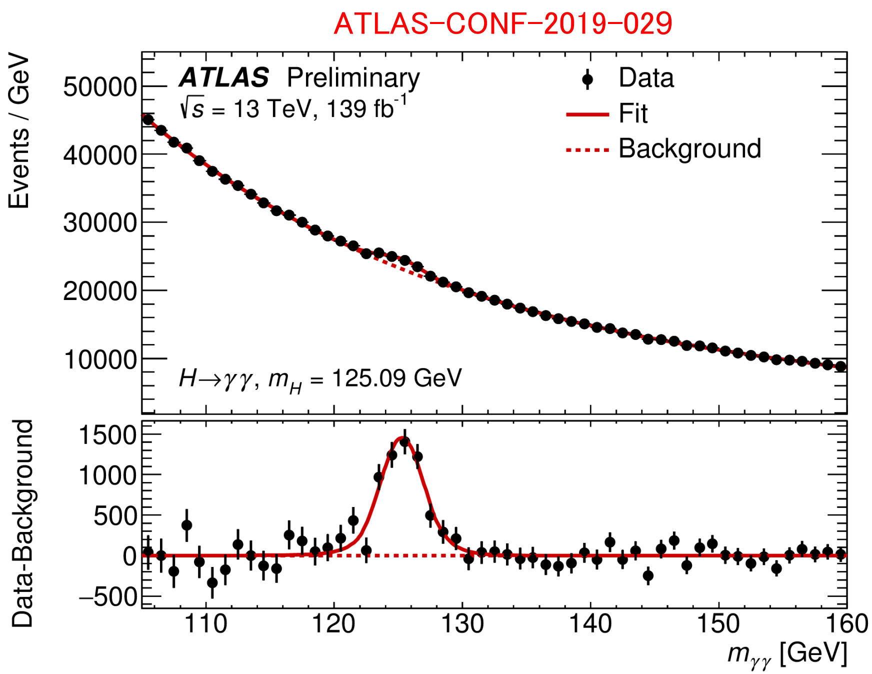
Data-driven calibration of b-tagging efficiency

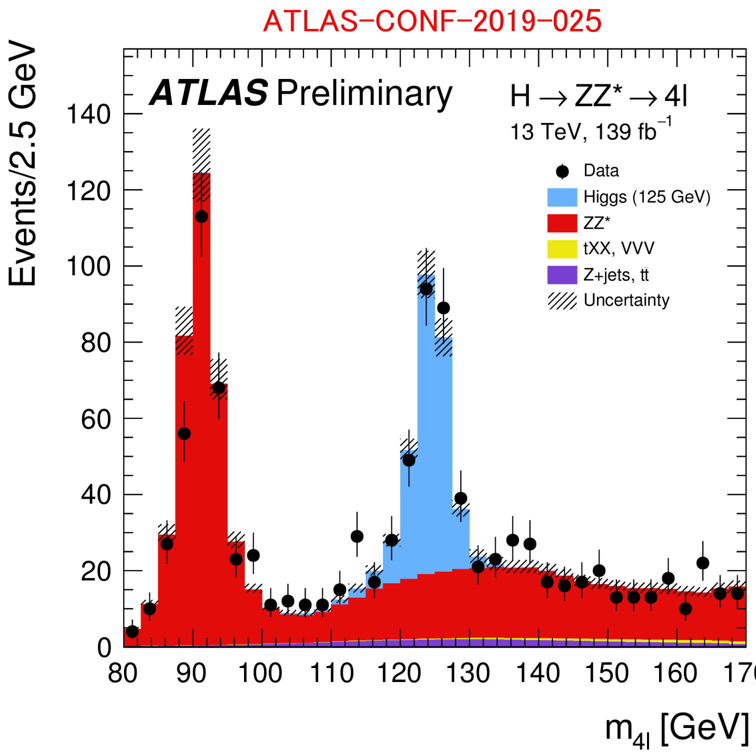


Higgs reconstruction @ ATLAS

Combination of the γγ and 4l Higgs decay channels

Full Run-2





Combination of the γγ and 4l Higgs decay channels

Full Run-2

Statistical (likelihood-based) combination for total and differential cross section measurements extrapolated to the full phase space

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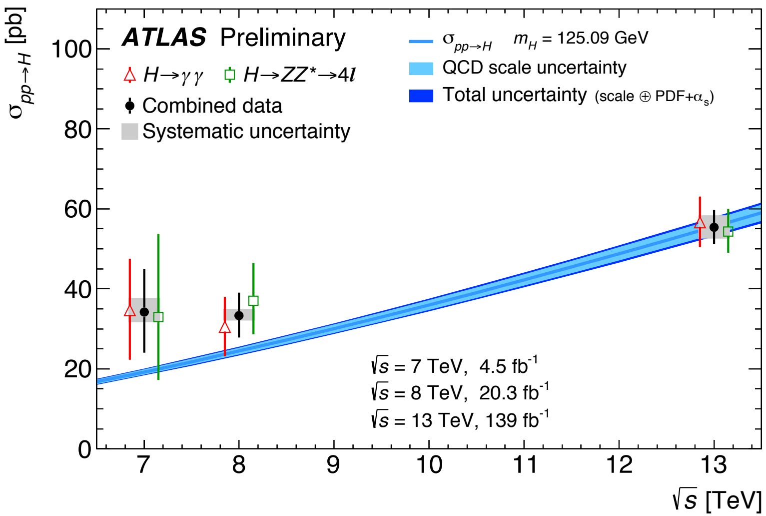
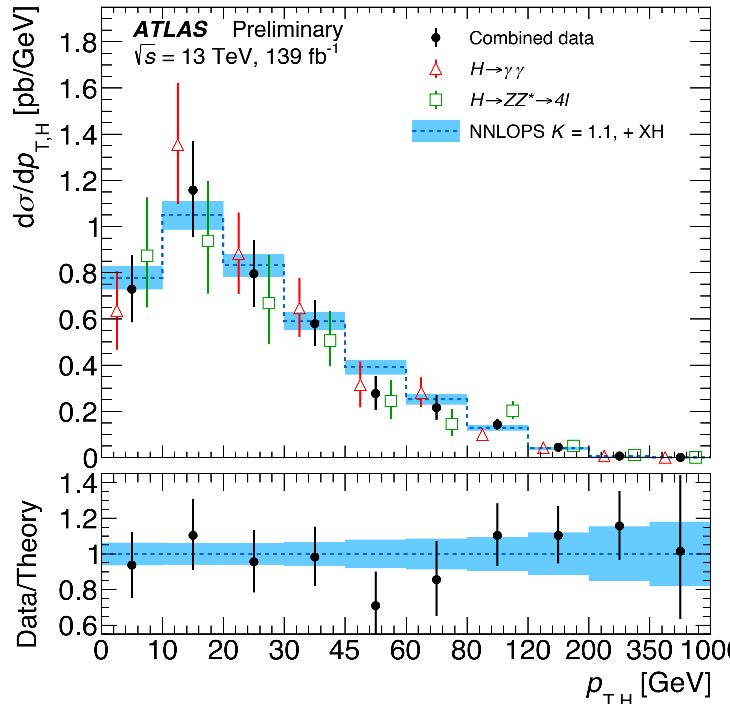




Combined inclusive pp → H + X cross section (13 TeV):

$$\sigma(pp\to H) = 56.7\,^{+6.4}_{-6.2}(\gamma\gamma),\ 54.4\,^{+5.6}_{-5.4}(4\ell),\ 55.4\,^{+4.3}_{-4.2}(\text{comb})\ \text{pb}$$

(7.7%, stat./syst.~1)

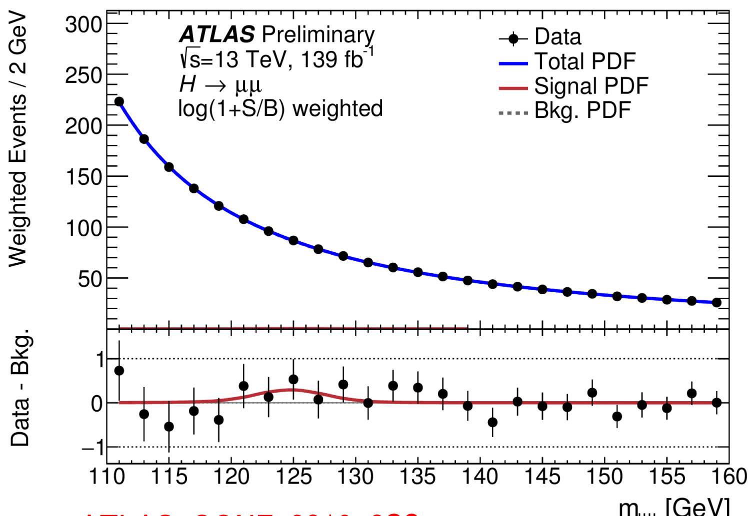
SM: 55.6 ± 2.5 pb (NLO–3NLO QCD, NLO EW)

Higgs Boson: μμ (ee) Decays

Full Run-2

Next frontier: coupling to 2nd generation

- Challenging: small couplings in SM and large bkg. ($pp \to Z/\gamma^* \to \mu\mu$ dominant)
- Search performed using *event categorization* and *BDTs* for Signal/Background discrimination based on their expected features
- Background empirical modelling validated against "spurious signal" using large simulated samples
- $\sigma(obs) / \sigma(SM) = 0.5 \pm 0.7$, observed (expected) sensitivity: 0.8σ (1.5σ)



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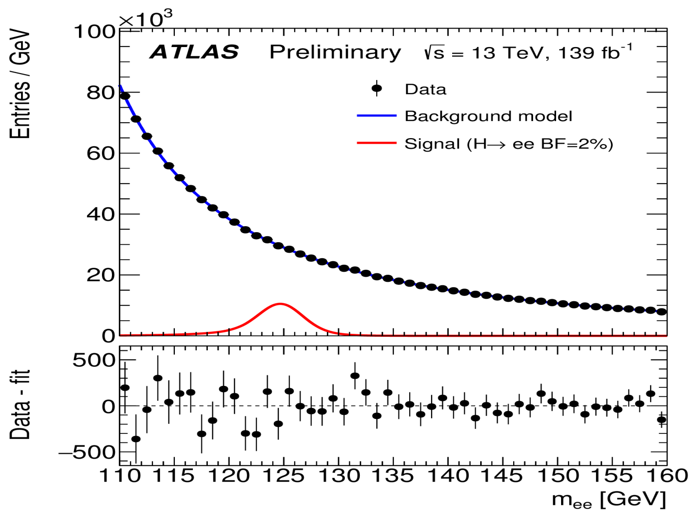
Decay to 1st generation $H \to ee$, no sensitivity at LHC to SM couplings → No significant excess

Limit on branching ratio: 3.6×10^{-4} (3.5×10^{-4} exp.)



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Higgs boson: Lepton Flavour Violating Decays

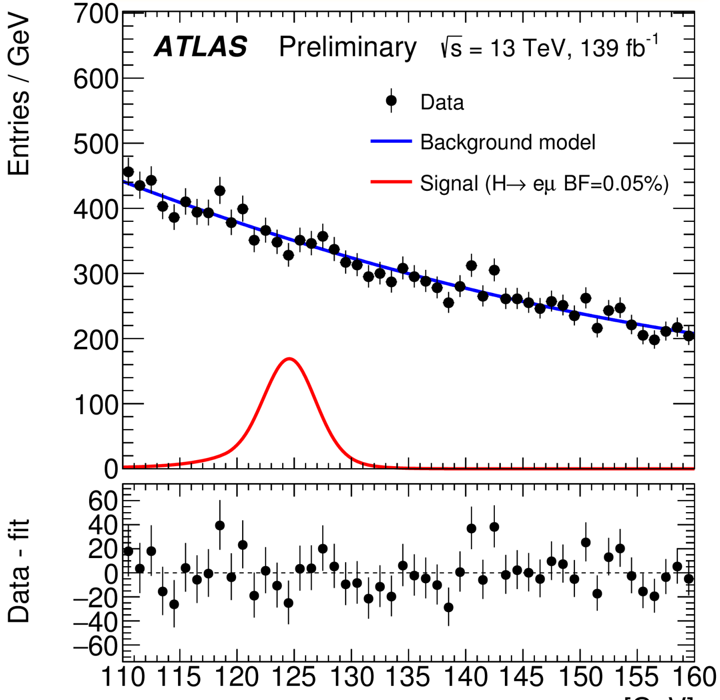
Full Run-2

Large sample of Higgs bosons in Run 2 allows for sensitive searches for non-SM decays:

Lepton flavour violating Higgs decays: no significant excess;

limits on branching ratios significantly more stringent than from √s = 8 TeV

H→eμ
Br limit: 6.1 x10^{-5} (5.8 x10^{-5} exp.)



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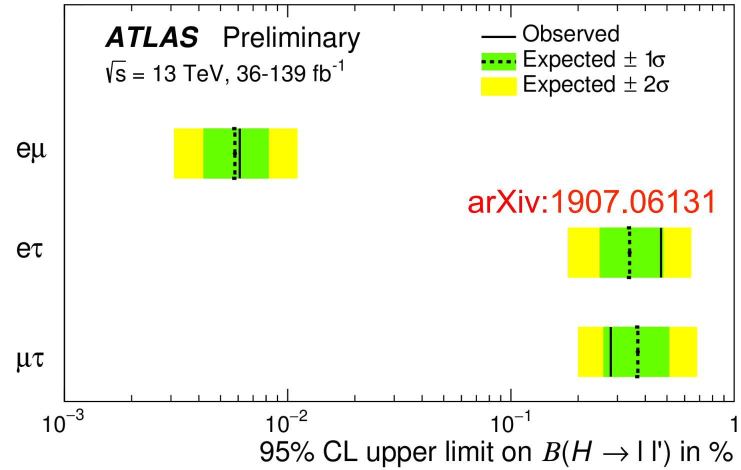
Higgs lepton flavour violation limits

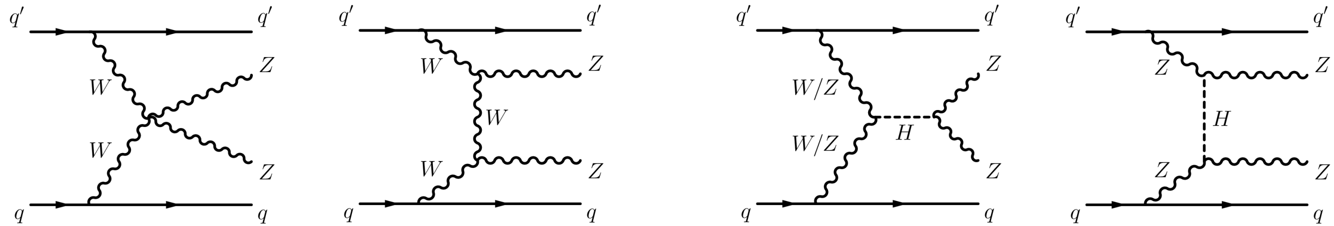


arXiv:1907.06131

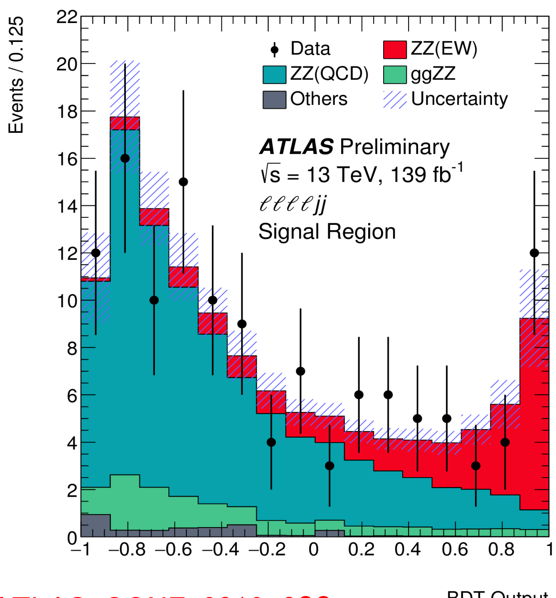
Observation of Vector Boson Scattering in ZZjj

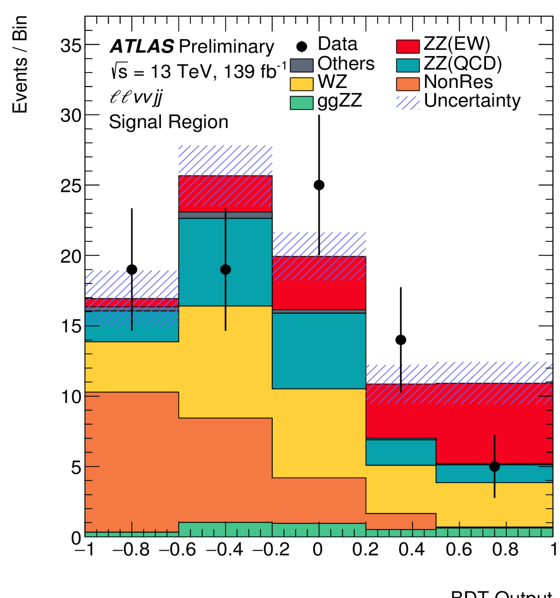
Full Run-2

Higgs boson regularizes the weak boson scattering cross section at high energies to ensure unitarity



- ZZjj analysis exploits decays to four charged leptons (*llll*) and (*llνν*)
- Multivariate analysis to separate EW signal from backgrounds (e.g. QCD ZZ)





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Observed (expected) significance for EW production: 5.5σ (4.3σ)

σ (EW) = 0.82 ± 0.21 fb

SM pred.= 0.61 ± 0.03 fb

ATLAS already observed vector boson scattering at:
6.5σ in W±W±jj channel
5.3σ in WZjj channel

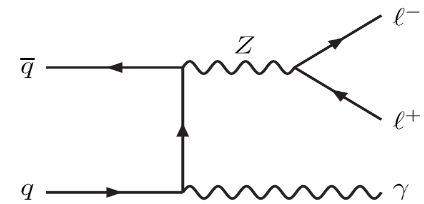
→ All VBS processes involving weak bosons observed by ATLAS

→ 4.1σ evidence for Z(ll) γ jj

Differential Measurement of Z(ll)γ

Full Run-2

Distinguish signal / FSR: $m(\ell\ell) + m(\ell\ell\gamma) > 182\,\mathrm{GeV}$



Data-driven studies of main backgrounds:

- Z+jets: 2D sideband (γ ID & γ isolation)
- "Pile-up bkg." with Z and γ from different vertices: *NEW type of pile-up* studied with converted γ fraction$_{PU}$= 2.1 ± 2.1% (conservative unc.)

→ Measured several unfolded distributions

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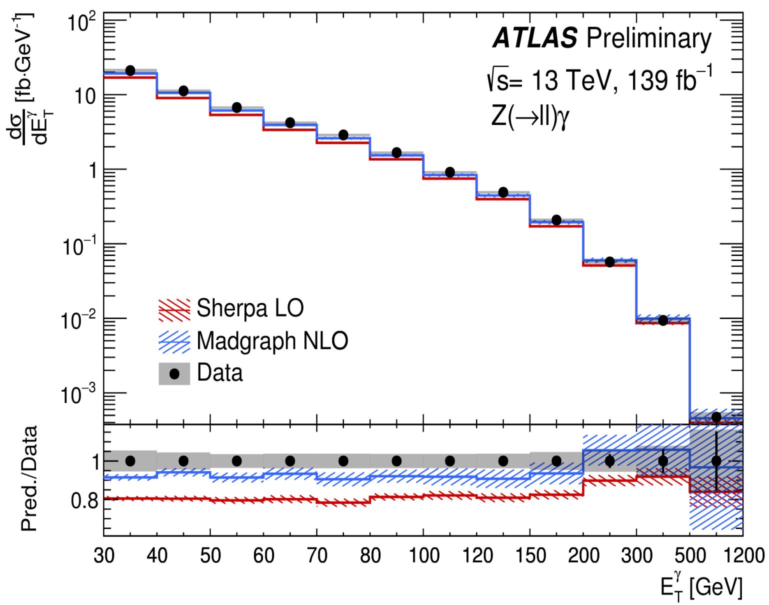
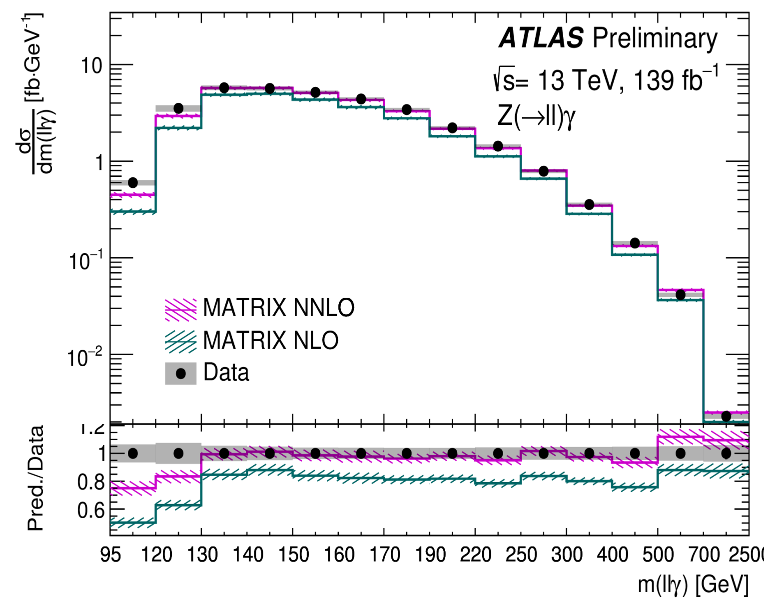
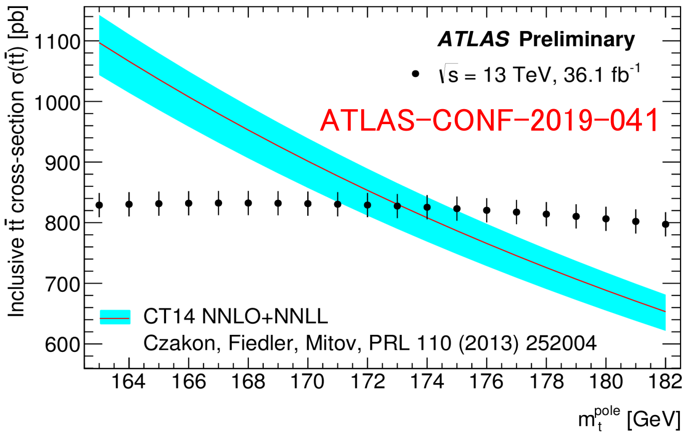
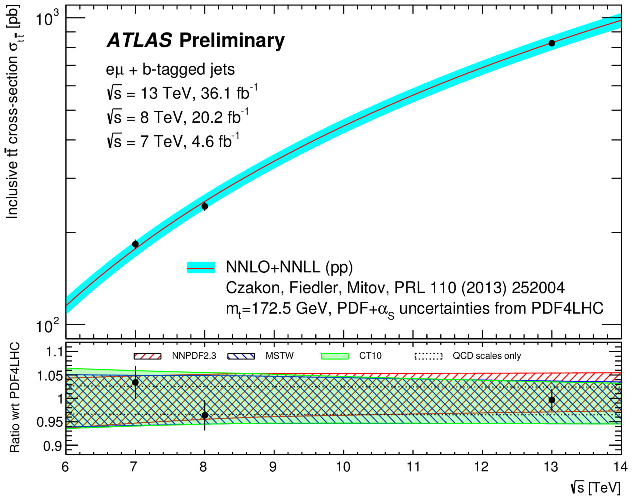




Top Physics: Cross Section, Mass, Width Measurements

Measure tt cross section, final state: eμ and >= 1 b-tagged jet; constraining b-tagging efficiency in-situ (1 b-tag & >= 2 b-tag categories)





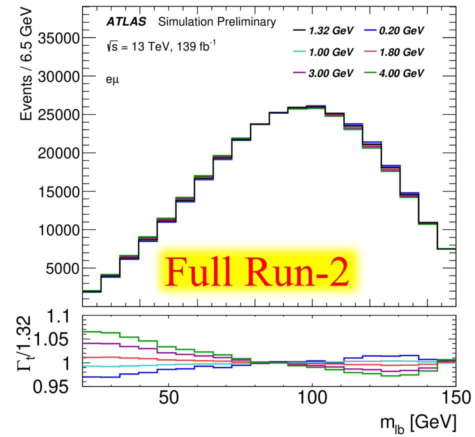
Total $\sigma_{t\bar{t}} = 826.4 \pm 3.6\,(\text{stat}) \pm 11.5\,(\text{syst}) \pm 15.7\,(\text{lumi}) \pm 1.9\,(\text{beam})\,\text{pb}$ (2.4%)

NNLO+NNLL prediction: $832 \pm 35^{+20}_{-29}$ pb

Pole mass measurement: $m_t^{\text{pole}} = 173.1^{+2.0}_{-2.1}$ GeV

Direct measurement of Top quark width: $\Gamma_t = 1.94^{+0.52}_{-0.49}$ GeV

- Template fit of m_{lb} for eμ channel
- Uncertainties constrained through m_{bb} fit for ee and μμ modes



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Top Physics: Precision Cross Section Measurements

- Cross section ratios allow to cancel systematic uncertainties
- Fiducial and (double-)differential cross sections also provided

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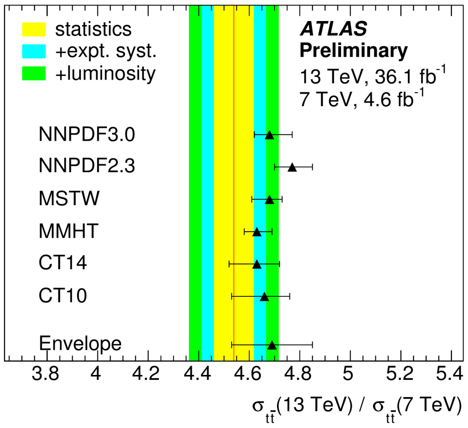
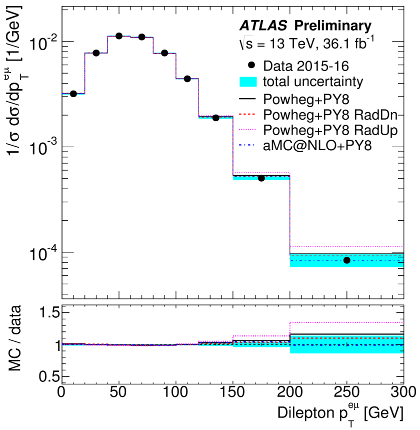
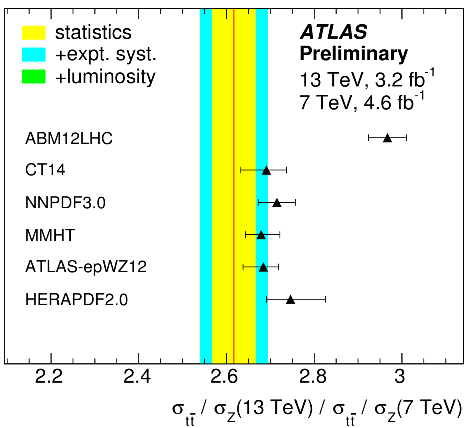
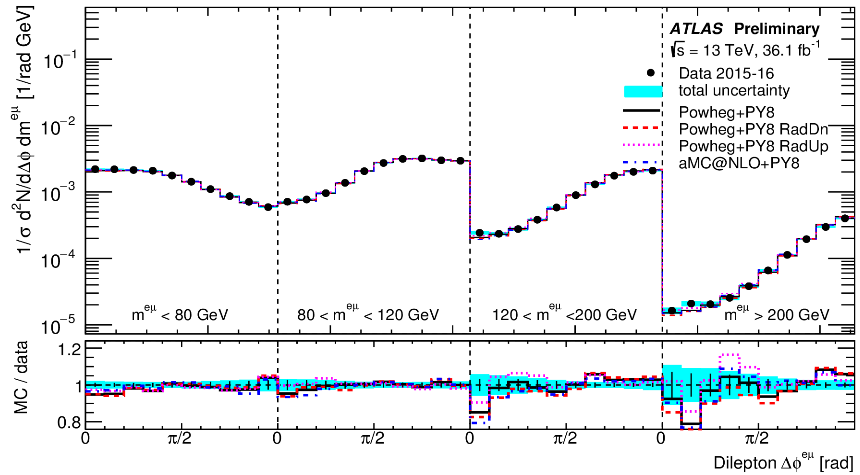








Top Physics: Charge Asymmetry

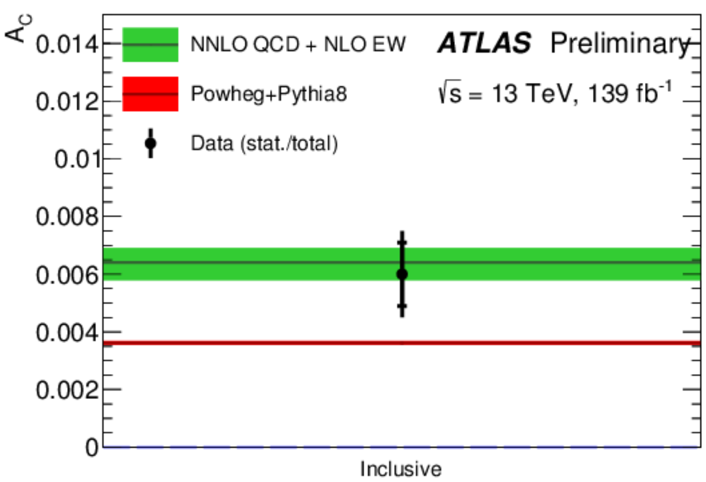
Full Run-2

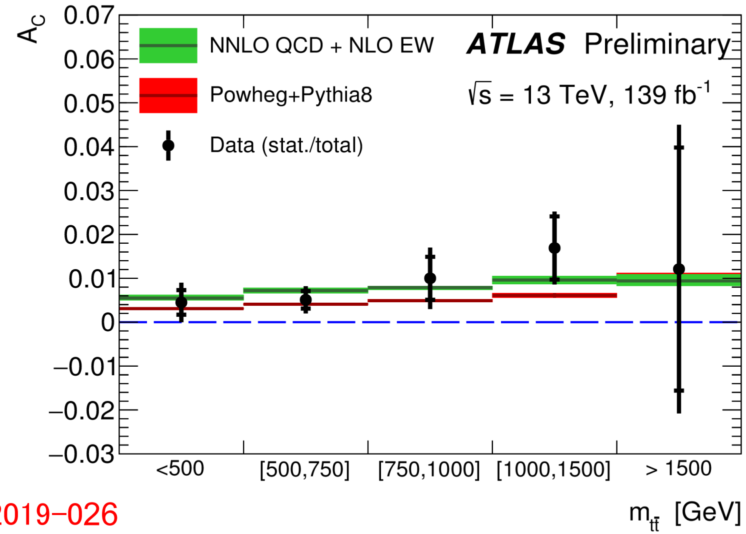
- Measure asymmetry of top-antitop system using resolved and boosted top-quark decays in lepton+jets events

$$A_C^{t\bar{t}} = \frac{N(\Delta|y| > 0) - N(\Delta|y| < 0)}{N(\Delta|y| > 0) + N(\Delta|y| < 0)} = 0.0060 \pm 0.0011_{stat} \pm 0.0010_{sys}$$

$$\Delta|y| = |y_t| - |y_{\bar{t}}|$$

- Asymmetry at LHC from higher order QCD effects from qqbar and qg initial states
- Measurement consistent with predictions from NNLO QCD with NLO EW corrections
- Significance of non-zero asymmetry at 4σ level





ATLAS−CONF−2019−026

Ultra Peripheral Pb-Pb Collisions in 2018 Data

Observation of ***Light-by-Light*** events (8.2 σ): Phys. Rev. Lett. 123 (2019) 052001

New: ***Two particle correlations*** *in photo-nuclear events*

- Two particle correlations in non-UPC Pb+Pb, p+Pb or pp collisions:
  - → Long-range azimuthal correlations ("ridge"), quantified via Fourier decomposition of yields in ϕ (v_2 is the leading term, called elliptic flow)
  - → Understanding collective behavior: quark-gluon plasma, described by relativistic hydrodynamics
- How to understand this in **γ+Pb collisions**?
  - → Vector Meson Dominance (photon fluctuates to vector meson)

    γ+Pb ⇔ ρ+Pb
- Ridge in small systems like p+Pb or pp still open to new interpretations and more experimental studies

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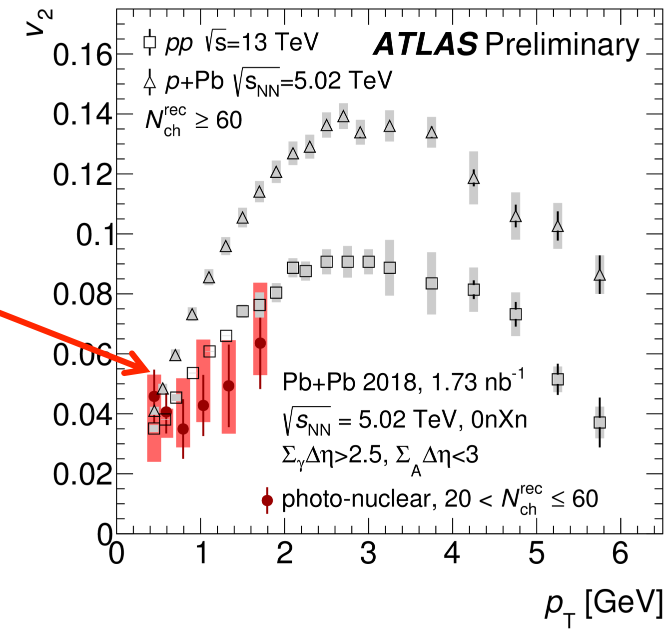
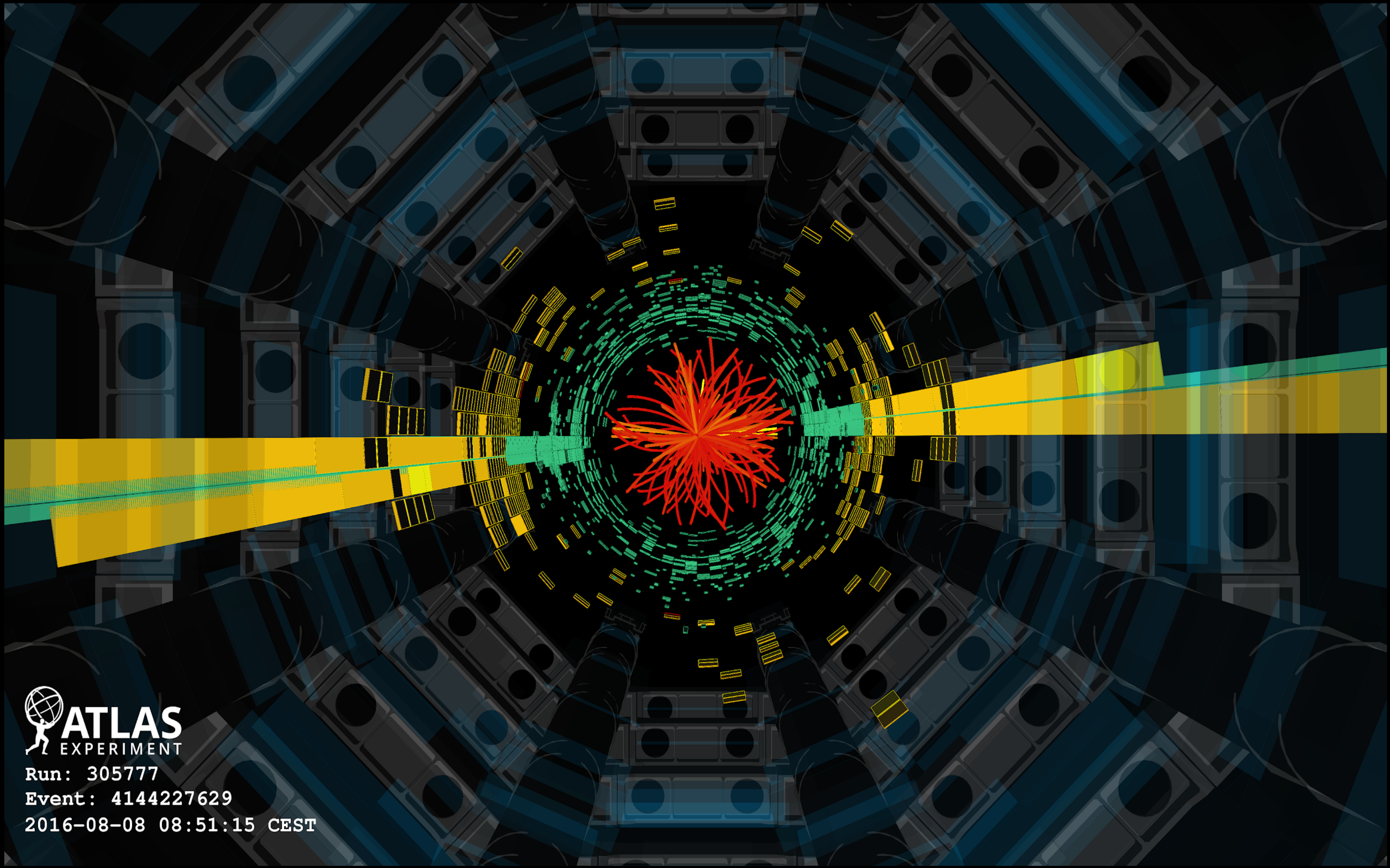


Highest-mass Central Dijet Event of 8.0 TeV Selected in Resonance Search

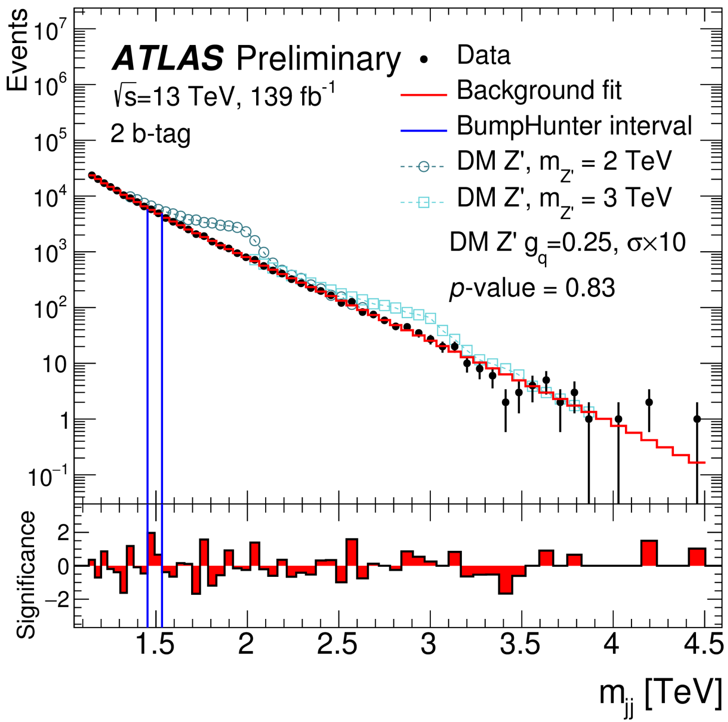


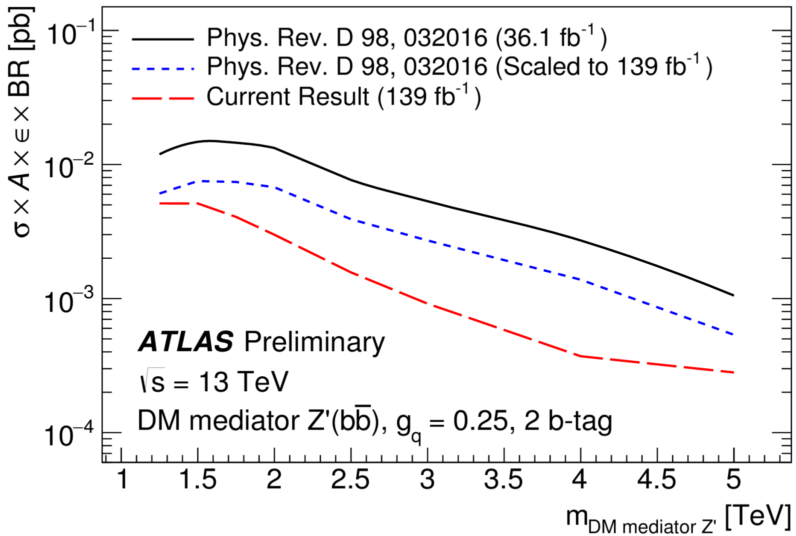
BSM Searches: Di-(b)jet Resonances

Full Run-2

CERN-EP-2019-162

- New search for particles decaying to two b-tagged jets
- Benefits of significant improvement of b-tagging at high-p_T





SUSY: Strong Production of Squarks and Gluinos

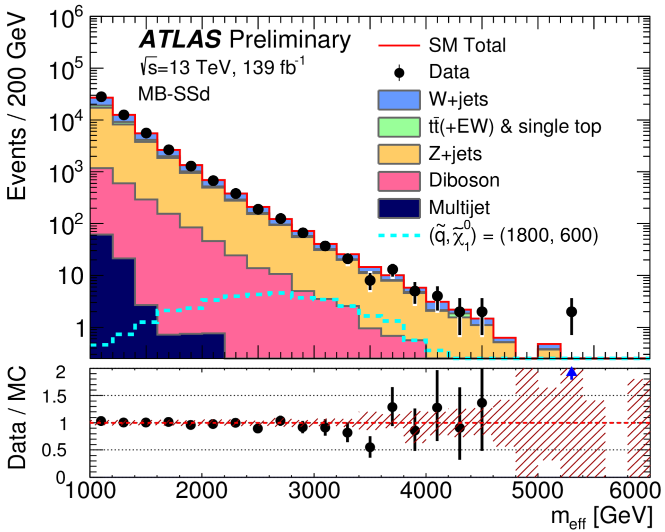
Full Run-2

- Sensitive searches for squarks and gluinos in R-parity conserving scenarios with neutralino as LSP (no leptons)

  → High mass reach

- Many different scenarios investigated with cut-based multi-bin(MB) analyses and boosted decision trees(BDT)
- Effective Mass variable used for some searches

  M_{eff} = scalar sum p_T of jets (p_T > 50 GeV) and missing p_T



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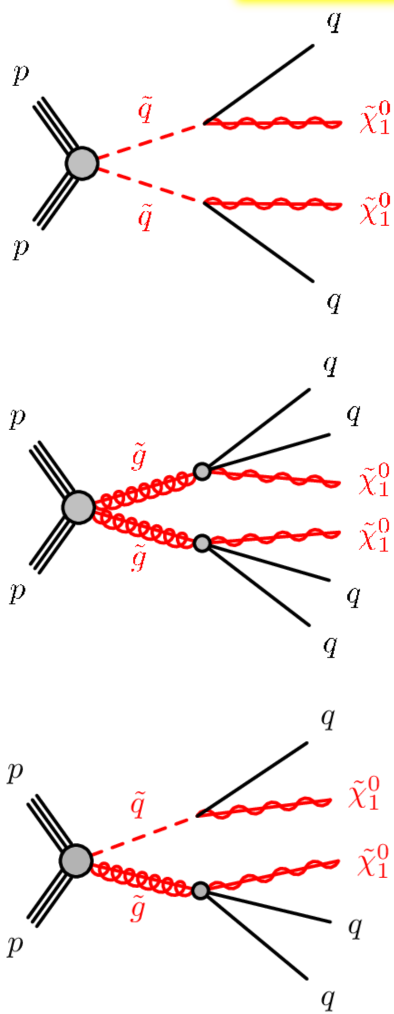
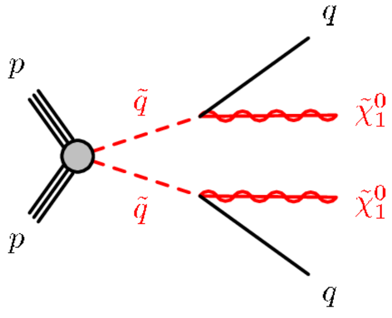
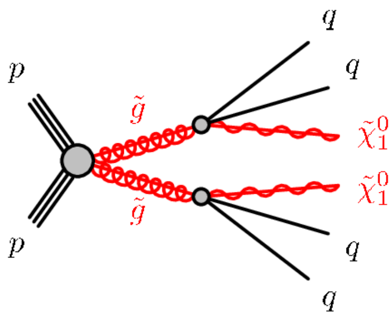


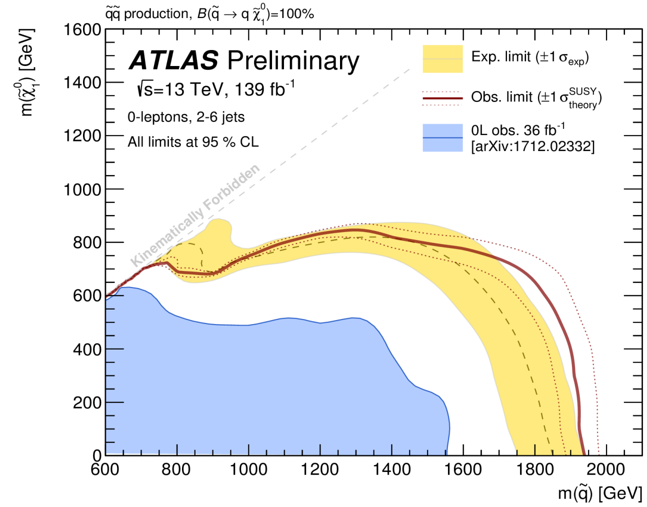
SUSY: Strong Production

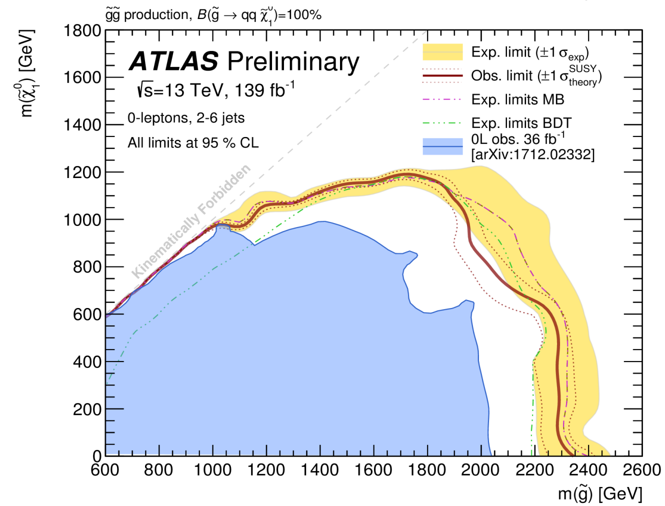
Use simplified scenarios

- Here squark or gluino decaying to quark(s) and neutralino









- Significant improvement over previous limits

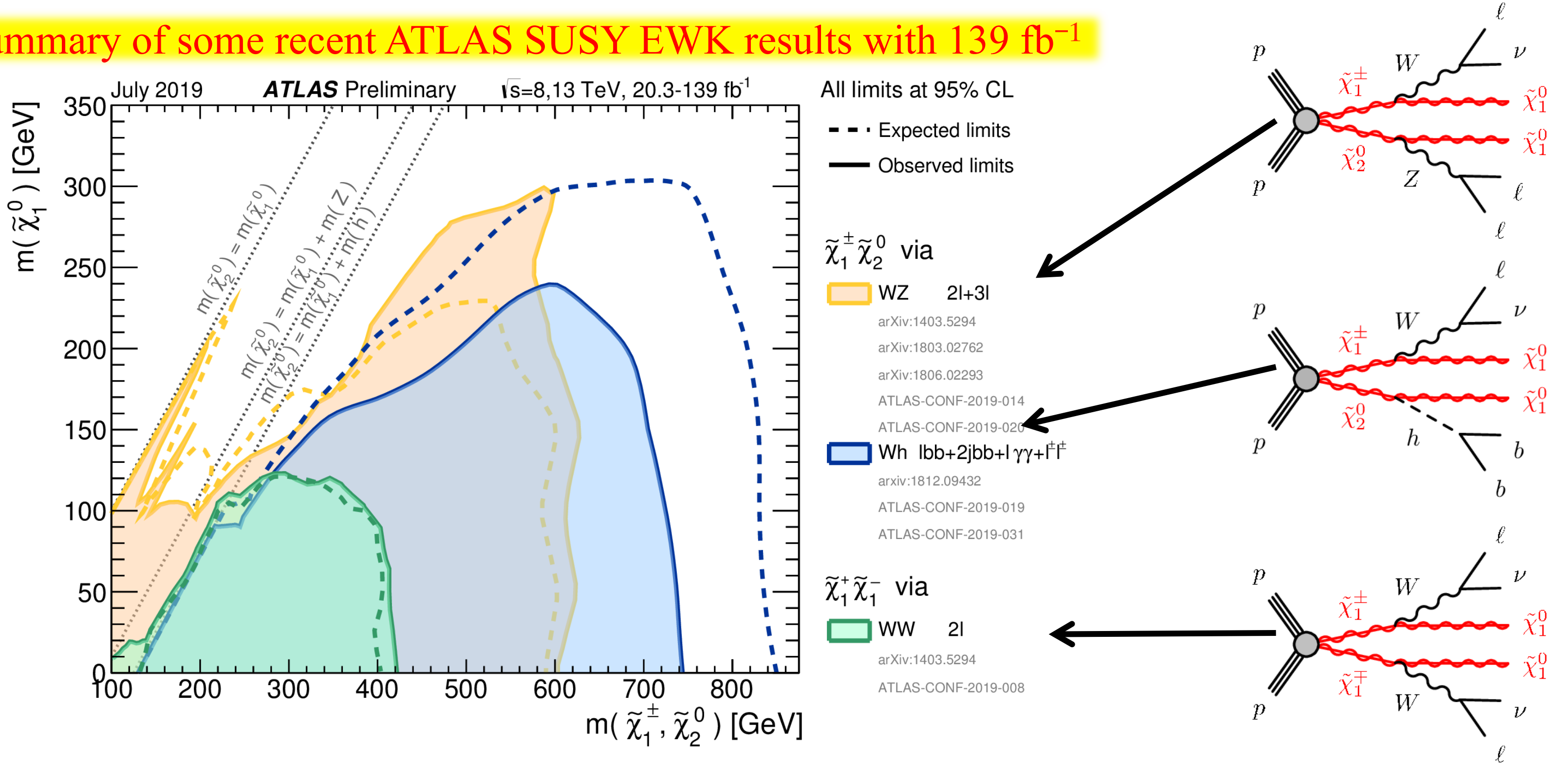
ATLAS−CONF−2019−040

SUSY: Electroweak Production

Full Run-2

If squarks and gluinos are very heavy, then electroweak production of SUSY particles could dominate
→ much lower cross sections, challenging phase space to explore

Summary of some recent ATLAS SUSY EWK results with 139 fb^{-1}

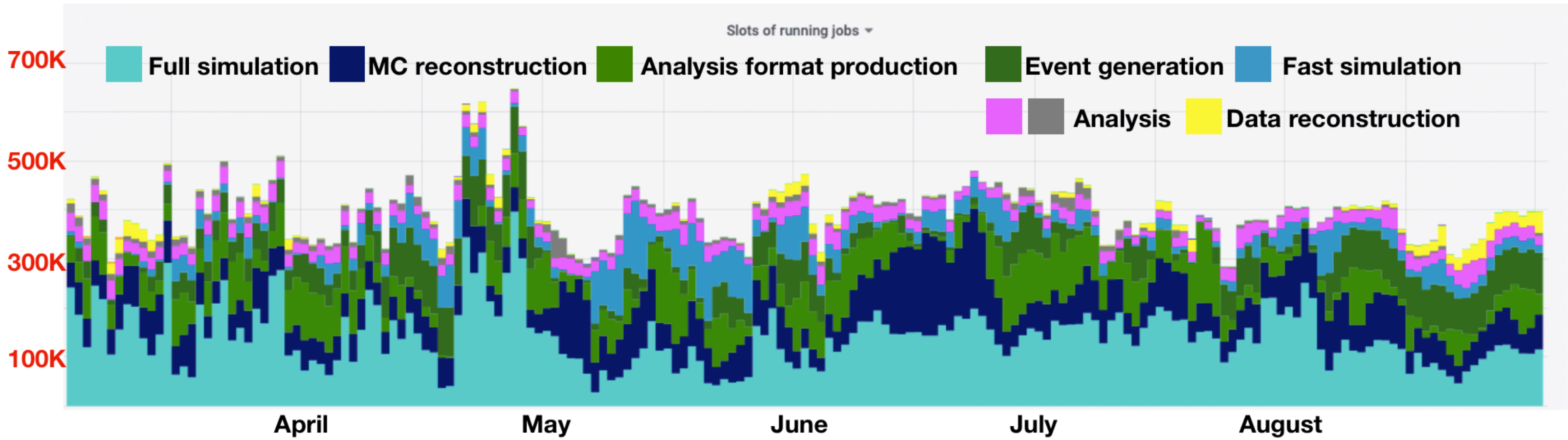


Direct slepton production excluded up to 700 GeV mass (arXiv:1908.08215)

Computing and Software

→ *Providing crucial continuous support to the physics program*

Computing usage in the past six months: running job slots

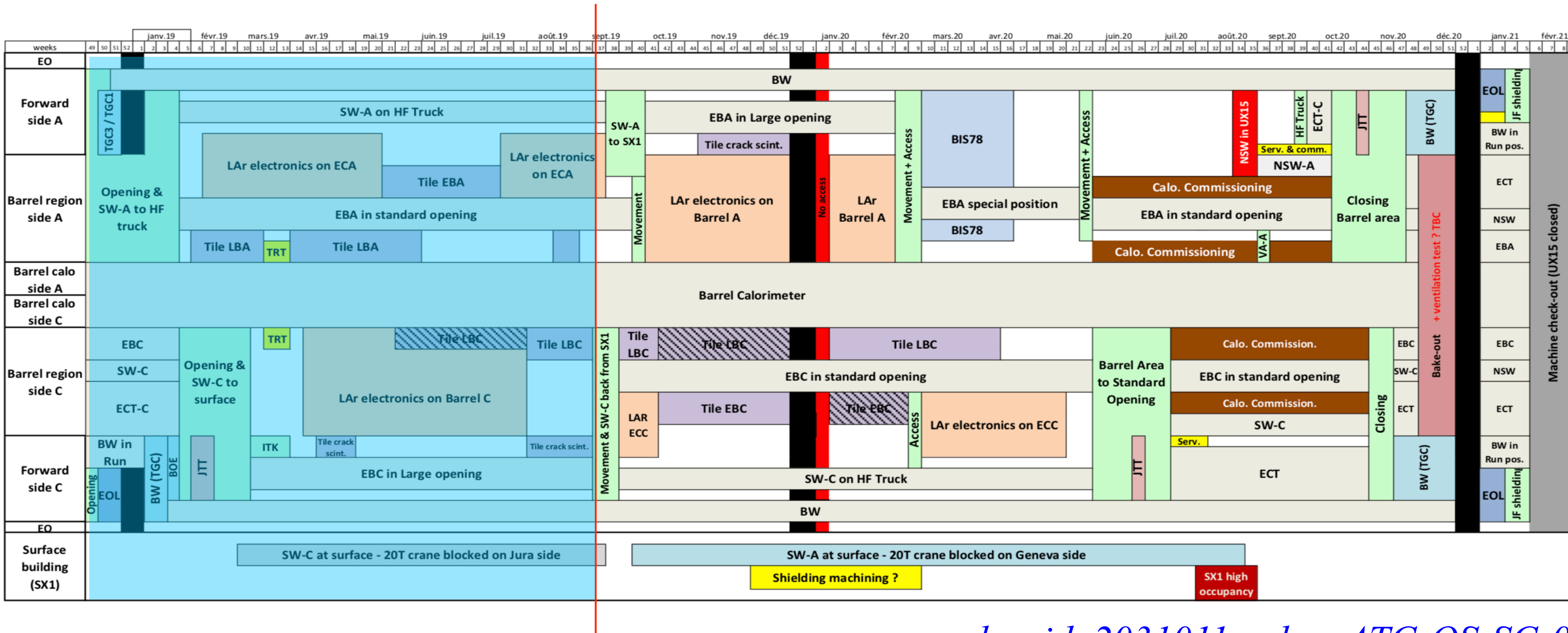


Main developments for Run 3:

- Software framework upgraded to *multi-threading*
  → more flexible; more efficient memory use
- FastCaloSimV2 for fast simulation (~50% MC events)
  → same CPU use, better physics performance
- New analysis model: streamlined analysis formats, reduced AOD size, on-demand recall of AOD from tape to reduce disk footprint
  → aim to reduce disk usage by at least 30%

LS2 Schedule

- Planning adapted to allow for late installation of NSW-A (August-September '20)
- Updates since last LHCC meeting: period and sequence of calorimeter work; closing Barrel Area C



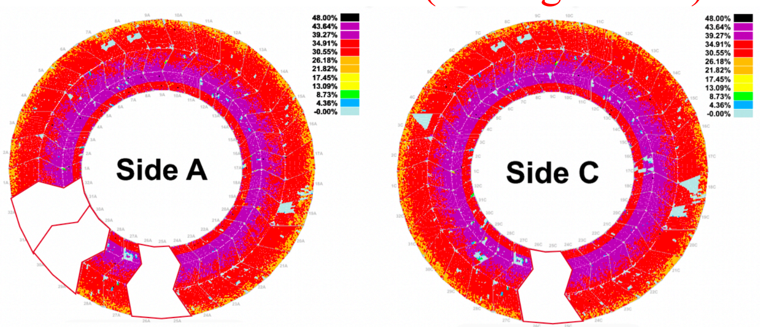
edms id. 2031011 − doc. ATC-OS-SC-0009

Inner Detector Status

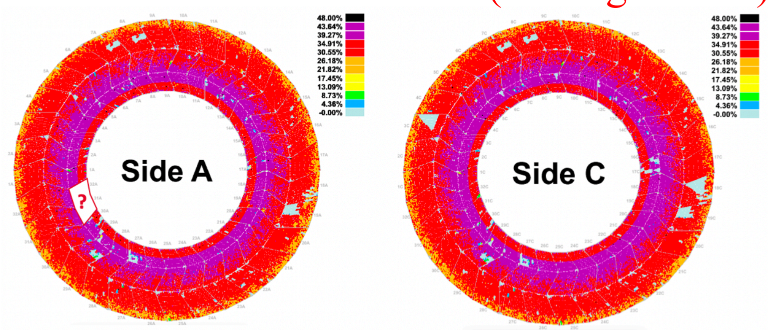
- *Pixel* optoboards refurbishment: Production Readiness Review passed, will be sent for production
- Replacement of the 272 boards scheduled for the first half of 2020

- Reduced concern for the *Transition Radiation Tracker* (TRT) Front-End cooling leak, but 2 sectors are likely to be off (*attempts to fix leaks still ongoing*)

TRT Leak Old Status (leaking sectors)



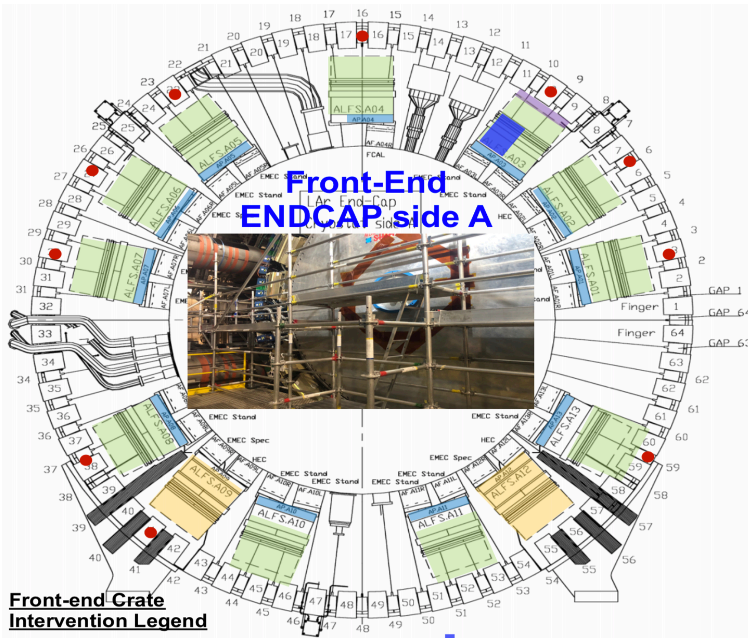
TRT Leak Current Status (leaking sectors)



- The TRT Barrel will be operated with Ar; Xe used for most of the End-Cap

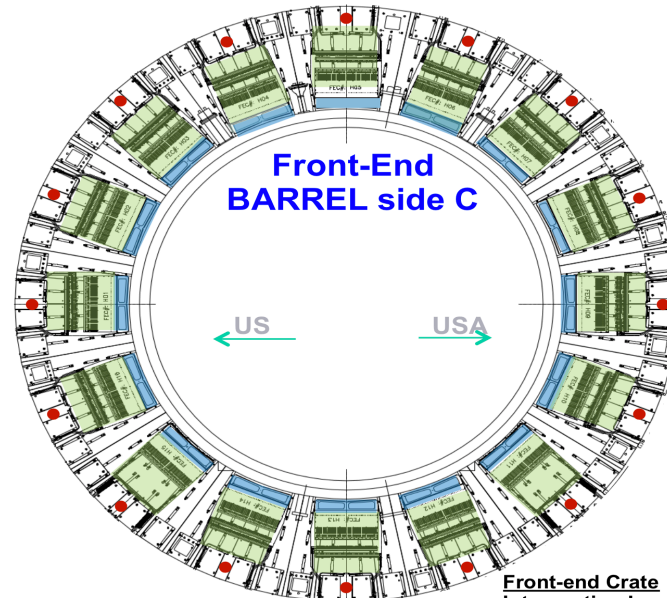
Maintenance and Upgrade - LAr

- Main activity: upgrade of the Front-End and Back-End electronics
  → finished for Barrel C
  → End-Cap A will converge in few weeks



Front-end Crate Intervention Legend

- 11 crates — Baseplane exchanged
- 1 crate — Re-cabled for commissioning
- 11 crates — Boards reinserted
- 0.5 crate — LTDB installed, in commissioning
- 10 crates — LVPS cooling hose replaced
- 2 crates — Boards Removed

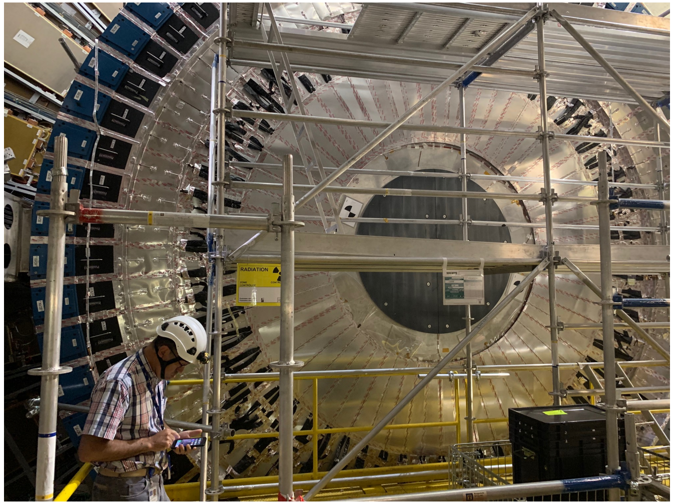


Front-end Crate Intervention Legend

- 16 crates — Baseplane exchanged
- 16 crates — Boards reinserted
- 16 crates — LVPS cooling hose replaced

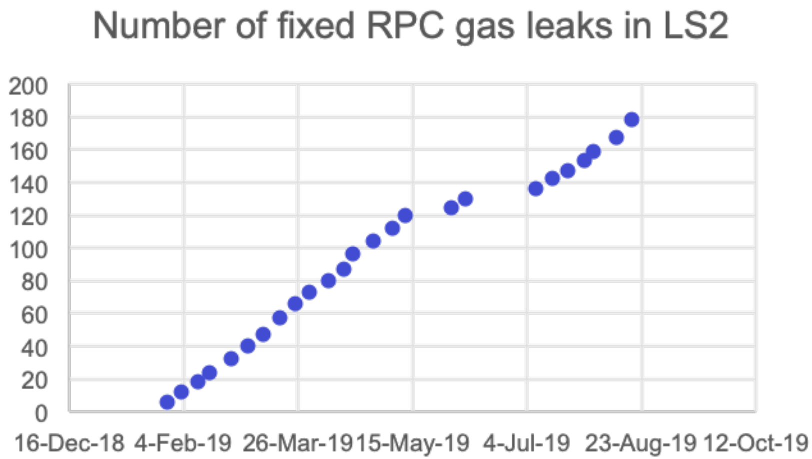
Maintenance and Upgrade - Tile

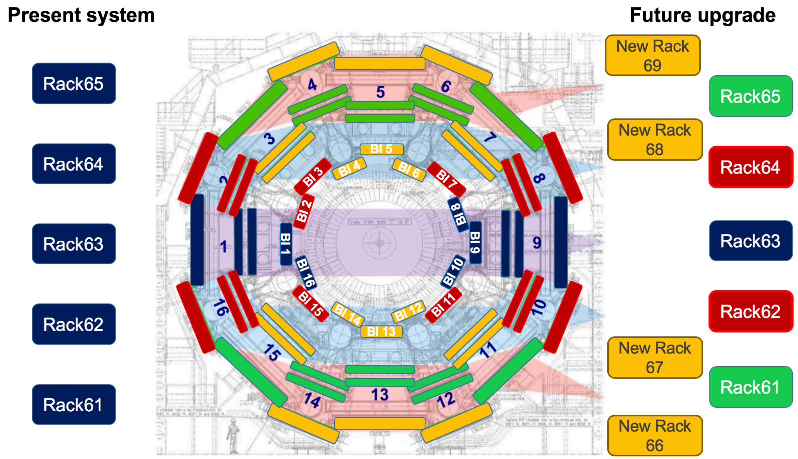
- Refurbishment of the Front-End electronics cooling (connectors replacement: 190 / 256 done)
- Standard Front-End electronics maintenance well advanced; taking regular calibration runs
- Phase-II demonstrator installed, under commissioning
- Replacement of Phase-I crack counters done on side C; ongoing for MBTS counters



Maintenance and Upgrade – Muon system

- Fixed one leaky sector for Cathode Strip Chambers Front-End cooling
- Resistive Plate Chambers (RPC) gas leak fixes: ongoing (see plot)
- Installation of new RPC gas racks to minimize the pressure difference between sectors: should hopefully reduce the development of new leaks in the future

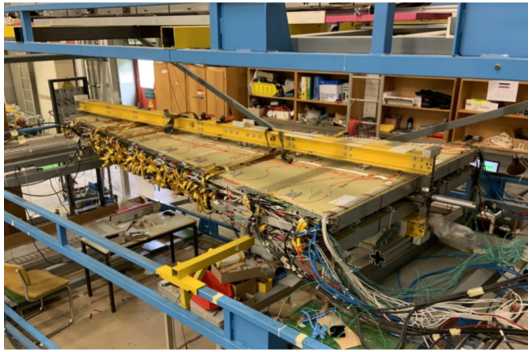




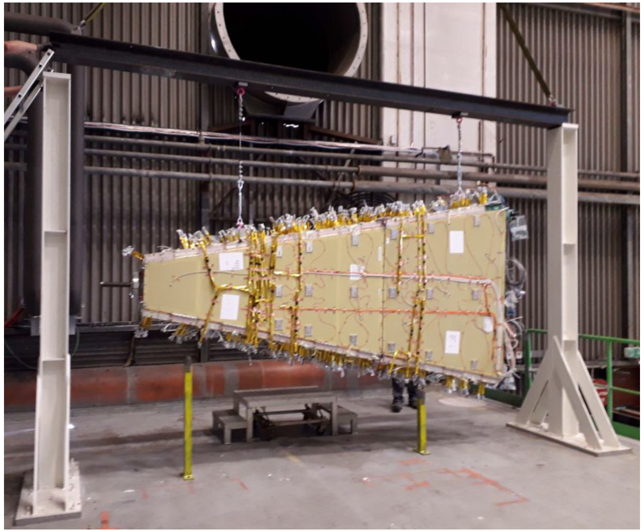
Muon New Small Wheel

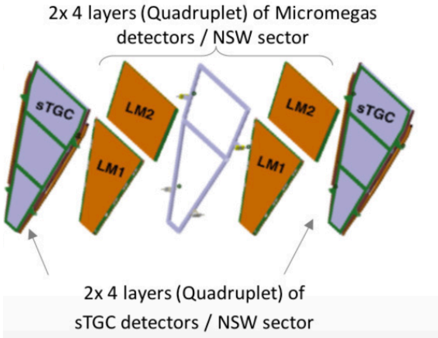
- NSW structure ready to be assembled with detectors
- small-strip Thin Gap Chambers (sTGC):
  - production on schedule: 51/96x2 chambers ready
  - 9/32x2 wedges completed; electronics integration ongoing
- Micromegas (MM):
  - good(~slow) rate for small (large) sector chambers
  - 4/16x2 double wedges fully integrated with electronics
- Electronics: 100% ASIC (VMM) received; packaged 50%; Testing ongoing
- First sectors are coming together; ongoing tests for one full sector → important input for decision to be taken in Nov.

Fully equipped Micromegas double wedge



Sector assembly





Muon New Small Wheel

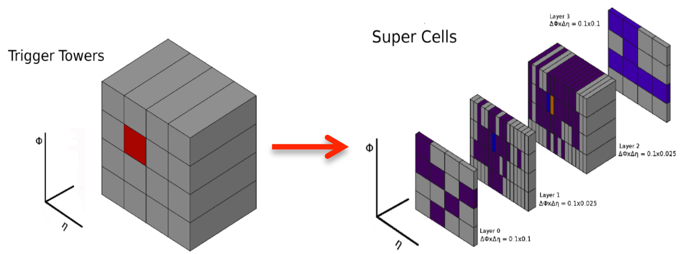
- NSW Trigger Processor

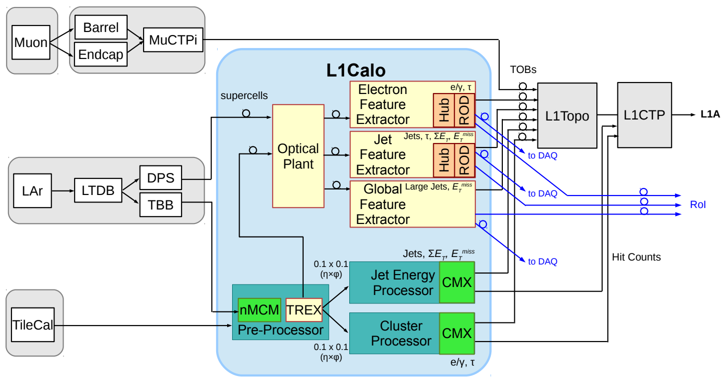
  → Pre-production modules available; ongoing firmware and software development for testing trigger path in slice test

  → Production Readiness Review scheduled for beginning of October

Lots of work ongoing, but installing NSW-A during LS2 remains a challenge

Maintenance and Upgrade – TDAQ





L1Calo:

- Prototype boards exist for all the FEXs. eFEX pre-production delayed by problem in PCB manufacturing. One board is populated for tests that do not require high power.
  Pre-production (eFEX delayed, jFEX, TREX); Production (ROD, L1Topo); Produced (gFEX, Hub, FOX)
- Baseline algorithms established for all FEXs
- Results from latency tests are within envelopes

L1Muon:

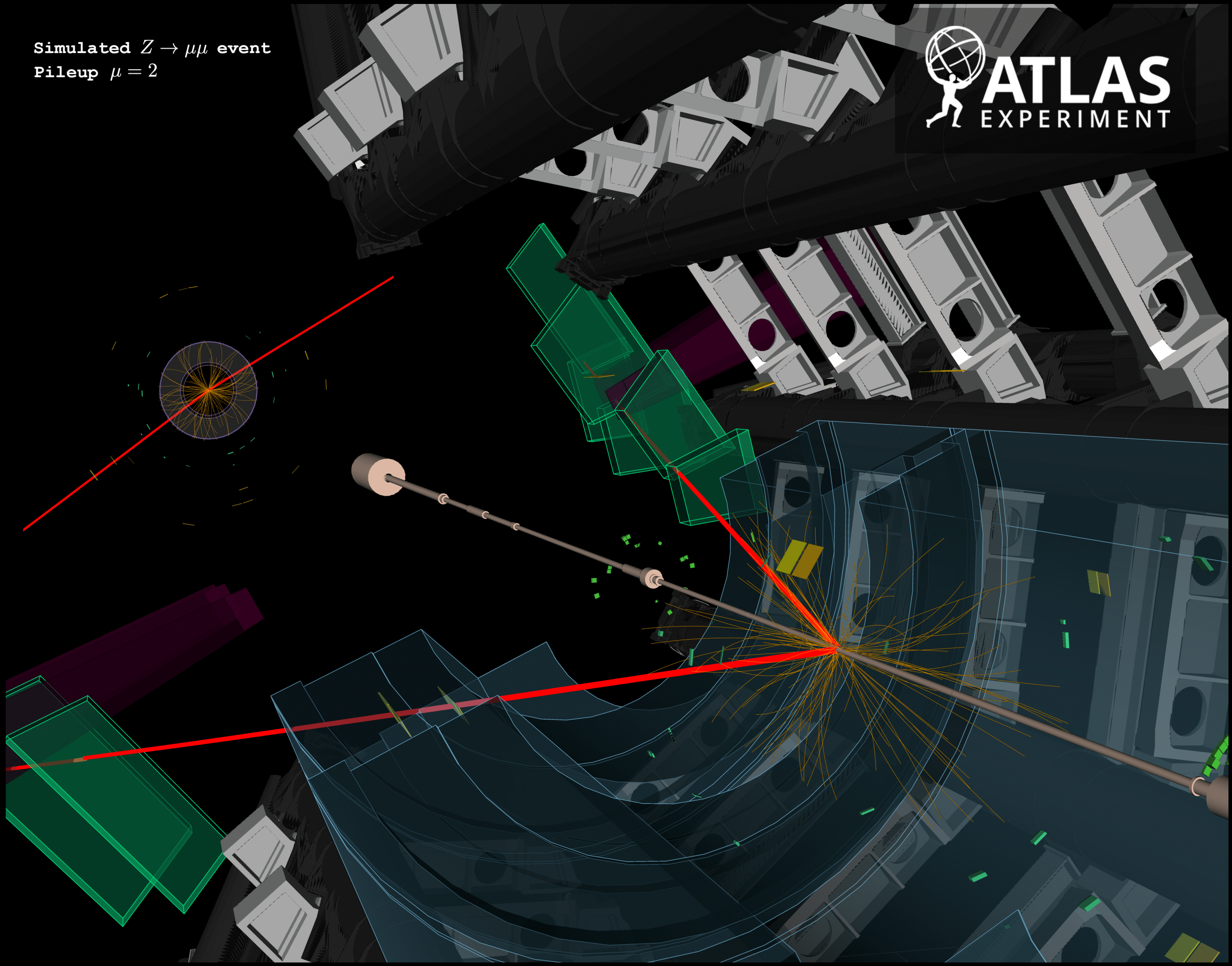
- Endcap Muon Sector Logic instalation largely completed

FrontEnd Link Interface eXchange (FELIX)

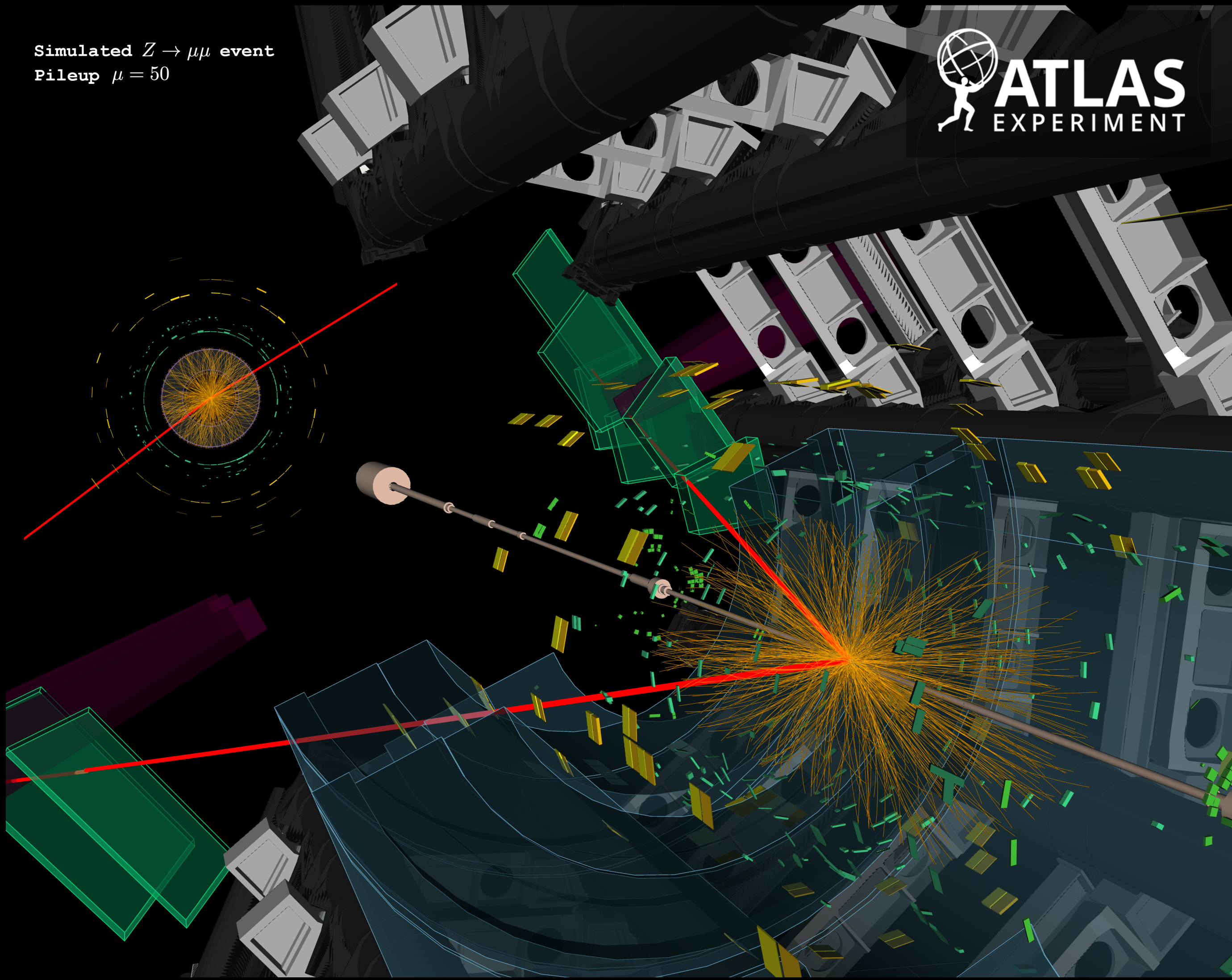
- Pre-production of 20 boards tested – All fine. PRR passed.
- Production launched

- *Instalation Q4 2019 until Q1 2020 (Q2 2020 for eFEX)*

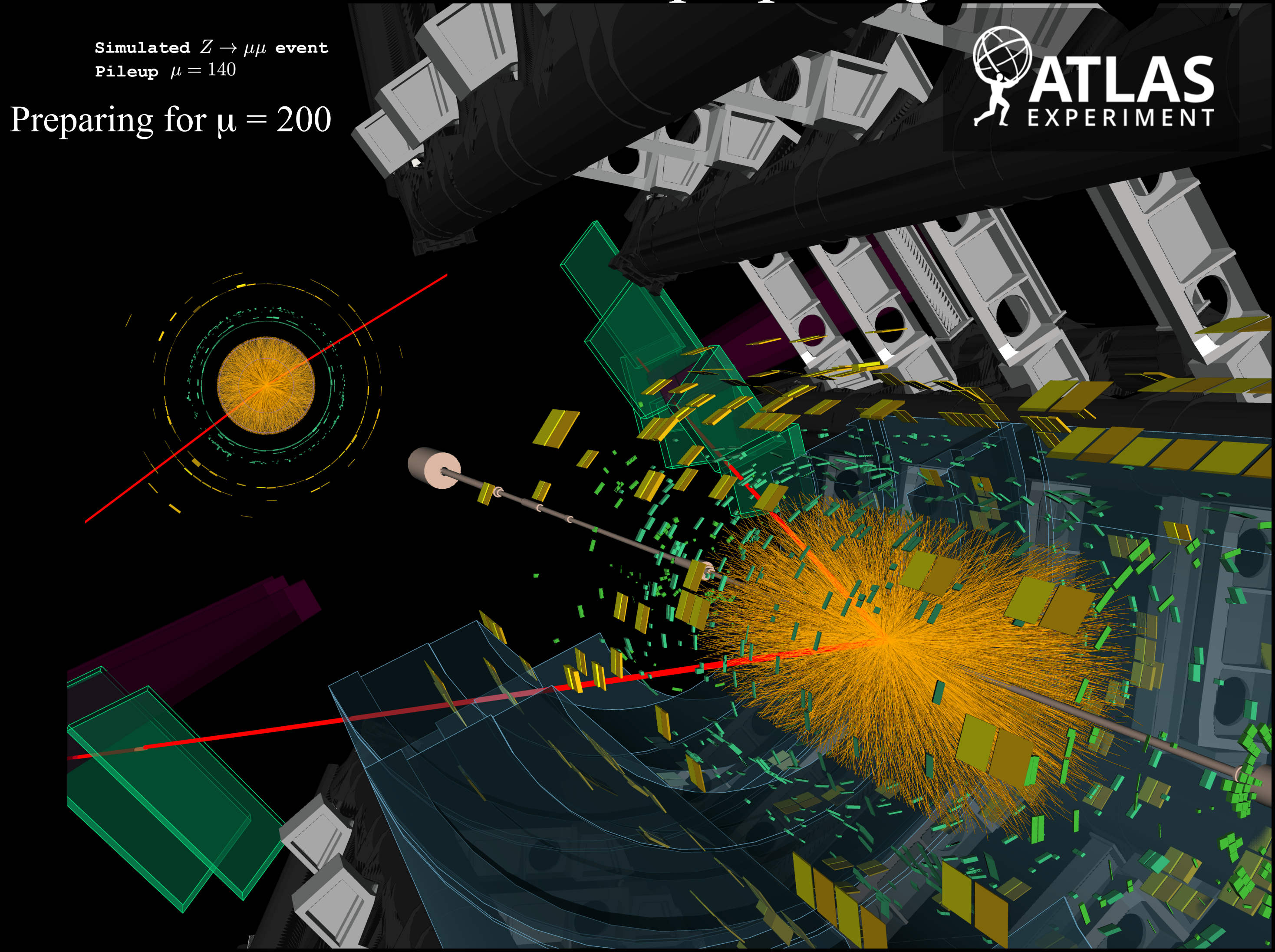
Where we started



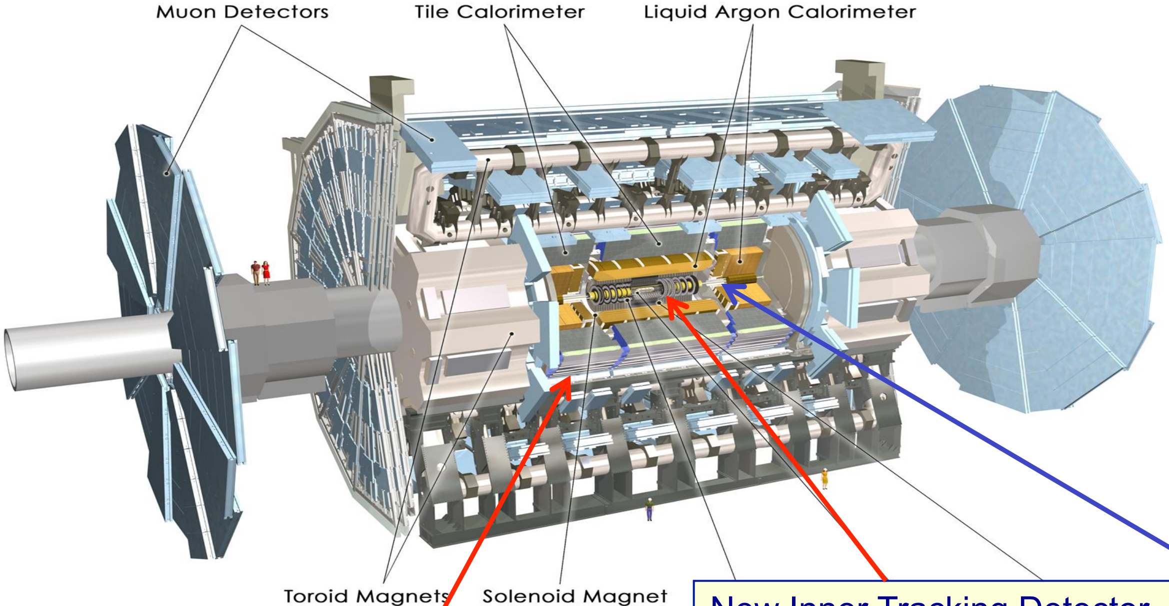
Where we are



What we are preparing for



ATLAS Phase-II Upgrade



Upgraded Trigger and Data Acquisition System:

- L0: 1 MHz
- Improved High-Level Trigger

Electronics Upgrade :

- LAr Calorimeter
- Tile Calorimeter
- Muon system

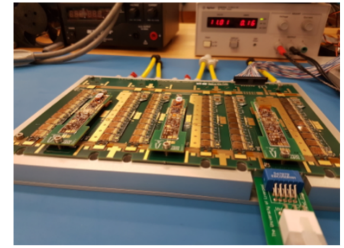
New Inner Tracking Detector (all silicon tracker, up to $|\eta| = 4$)

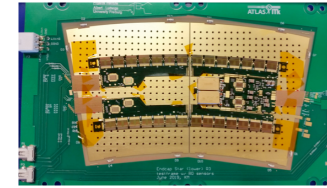
High Granularity Timing Detector (forward region) → TDR in 2020
New detector technology needs to cope with challenging radiation hardness requirements

New muon chambers in the inner barrel region

- 6 TDRs approved by CERN Research Board
- 5 Memoranda of Understanding completed
- Lots of work ongoing: progress in all areas

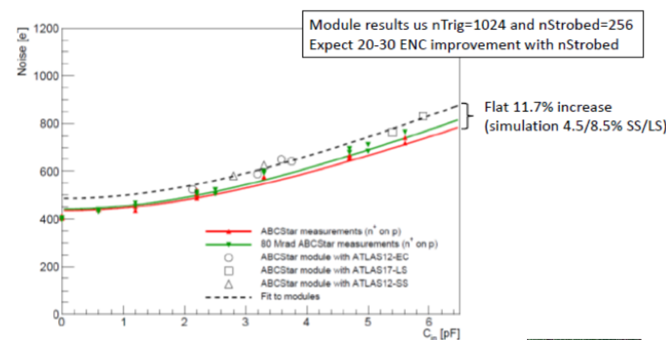
Example of recent progress: ITk-Strips



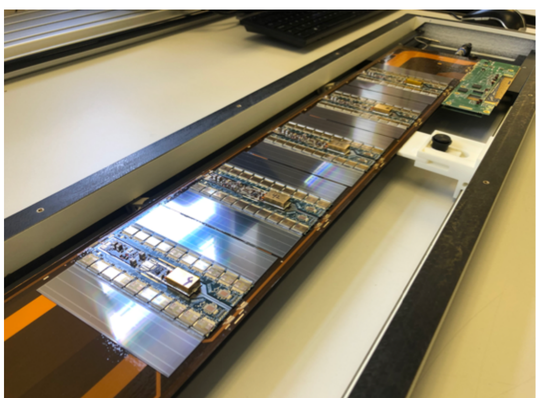


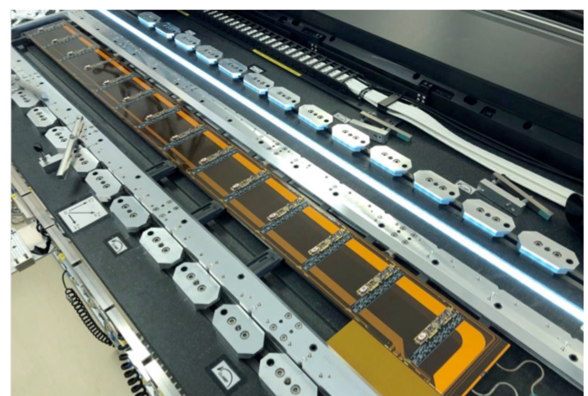
- Sensors are advancing toward pre-production
  → Contract with HPK signed on Aug. 23rd

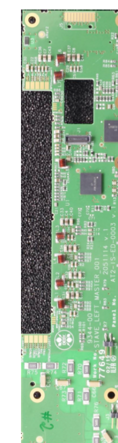
- Modules prototype available and performing as expected (eg. noise)
  → Preparing for Final Design Review



- Short-strip staves assembled to test full readout chain
  (5 modules, power boards and end-of-stave cards)







Summary and conclusions

- Lots of exciting physics results: 27 (20) papers (conference notes) made public by ATLAS since June LHCC meeting

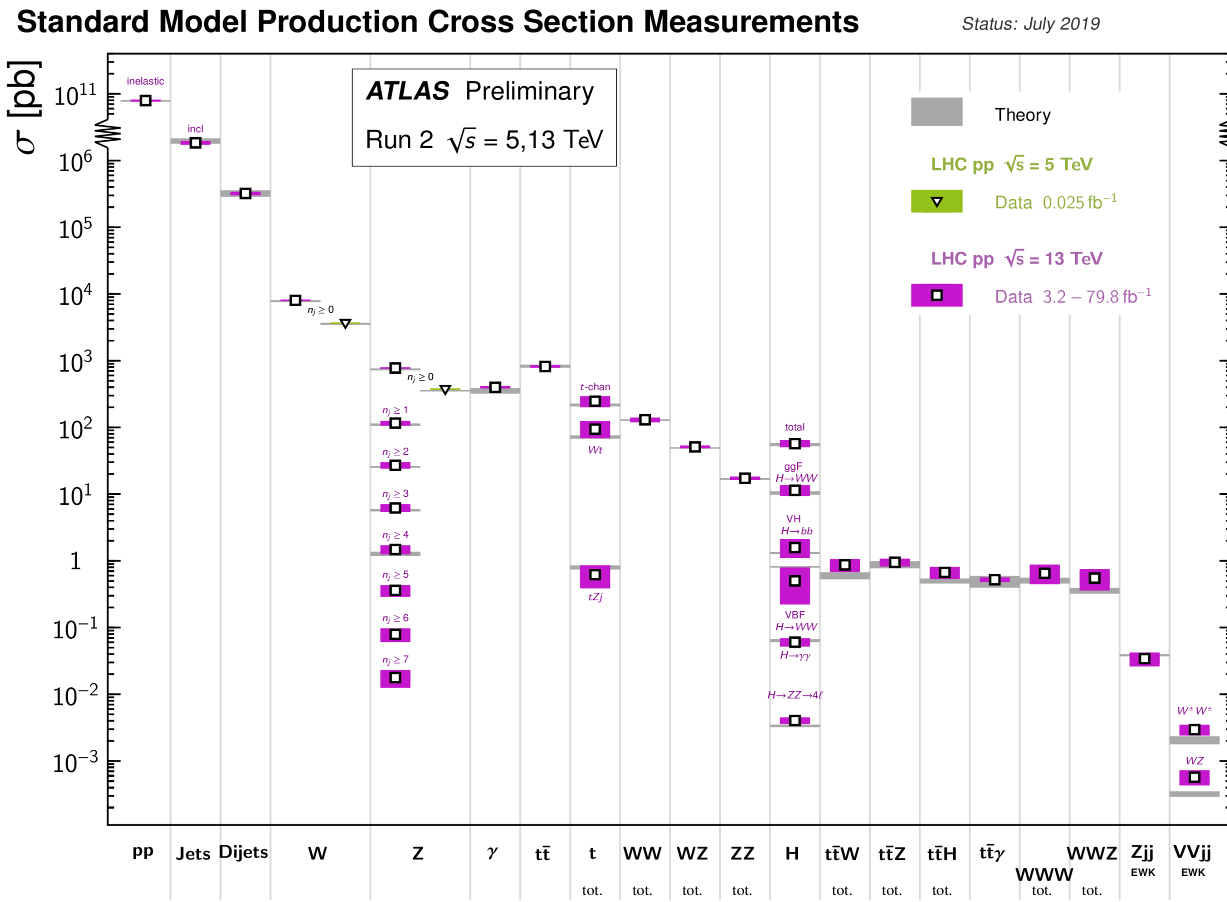
- Large amount of work ongoing during LS2, for detector refurbishment, for the Phase 1 and towards the Phase 2 upgrades

Many thanks to the CERN accelerator and support teams and World-wide computing facilities for making all this possible !!!

Backup

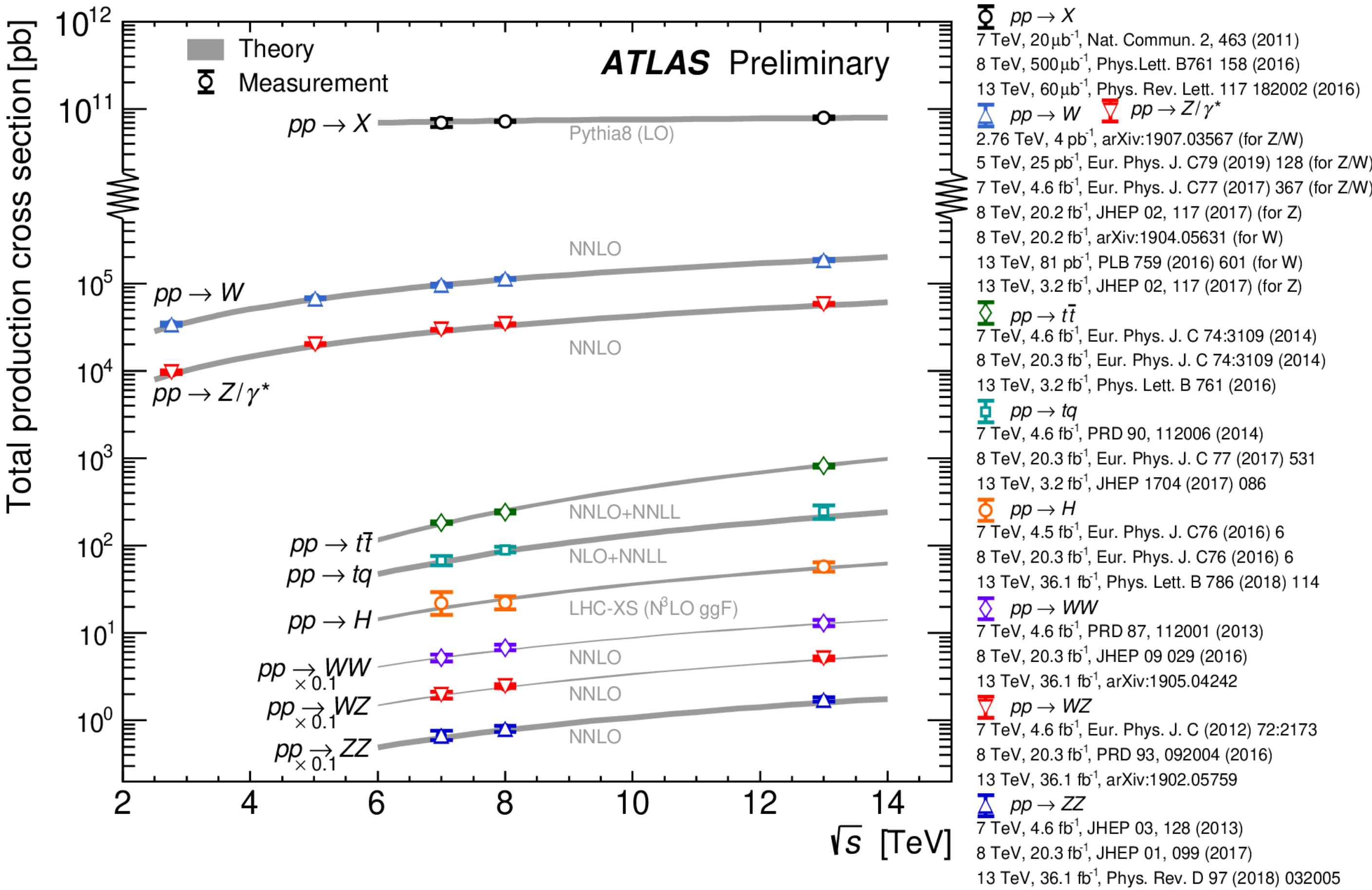
Standard Model Production Cross Sections

Good agreement with measurements for many processes, over 15 orders of magnitude



Standard Model Production Cross Sections

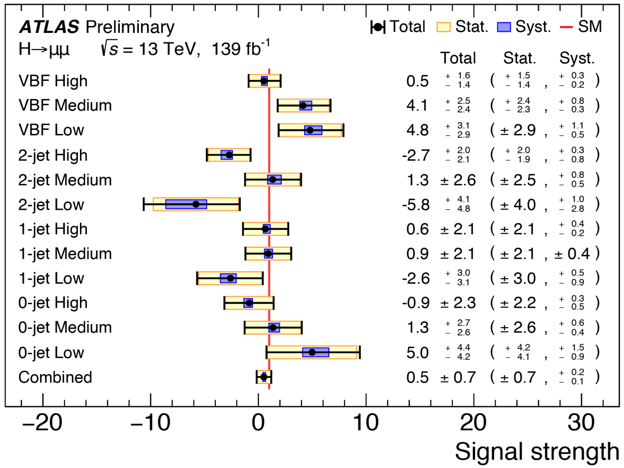
Good agreement with measurements for many processes, at different collision energies



Higgs → μμ

Full Run-2

	Selection
Common	Primary vertex Two opposite-charge muons Muons: $\|\eta\| < 2.7$, $p_T^{lead} > 27GeV$, $p_T^{sublead} > 15GeV$ No b-tagged jets
Z region	$76 < m_{\mu\mu} < 106GeV$
Sideband region	$110 < m_{\mu\mu} < 120GeV$ or $130 < m_{\mu\mu} < 180GeV$
Fit region	$110 < m_{\mu\mu} < 160GeV$
Jets	$p_T > 25GeV$ and $\|\eta\| < 2.5$ or with $p_T > 30GeV$ and $2.5 < \|\eta\| < 4.5$



ATLAS−CONF−2019−028

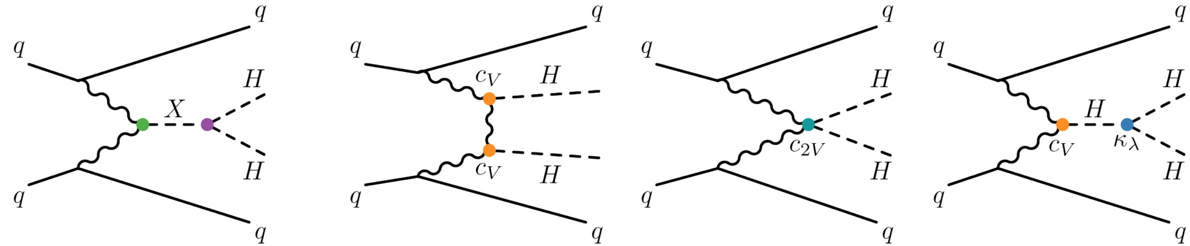
Category	Data	S_{SM}	S	B	$S/\sqrt{B}$	S/B [%]
VBF High	40	4.5	2.3	34	0.39	6.6
VBF Medium	109	5.5	2.8	100	0.28	2.8
VBF Low	450	9.6	4.9	420	0.24	1.2
2-jet High	3400	38	19	3440	0.33	0.6
2-jet Medium	13938	70	35	13910	0.30	0.3
2-jet Low	40747	75	38	40860	0.19	0.1
1-jet High	2885	32	16	2830	0.31	0.6
1-jet Medium	24919	107	54	24890	0.35	0.2
1-jet Low	77482	134	68	77670	0.24	0.1
0-jet High	24777	85	43	24740	0.27	0.2
0-jet Medium	85281	155	79	85000	0.27	0.1
0-jet Low	180478	144	73	180000	0.17	<0.1

Constraining the VVHH coupling

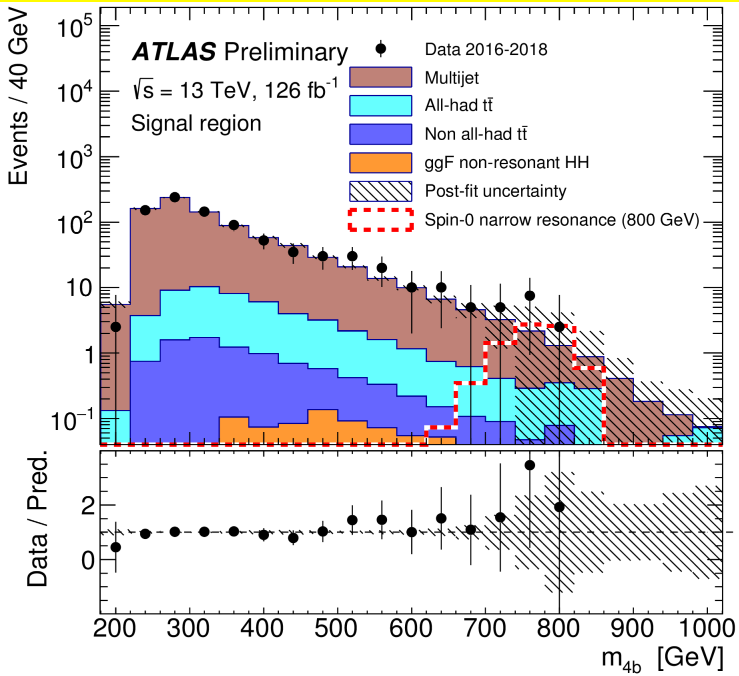
Full Run-2

Search for HH production in 4b channel through VBF

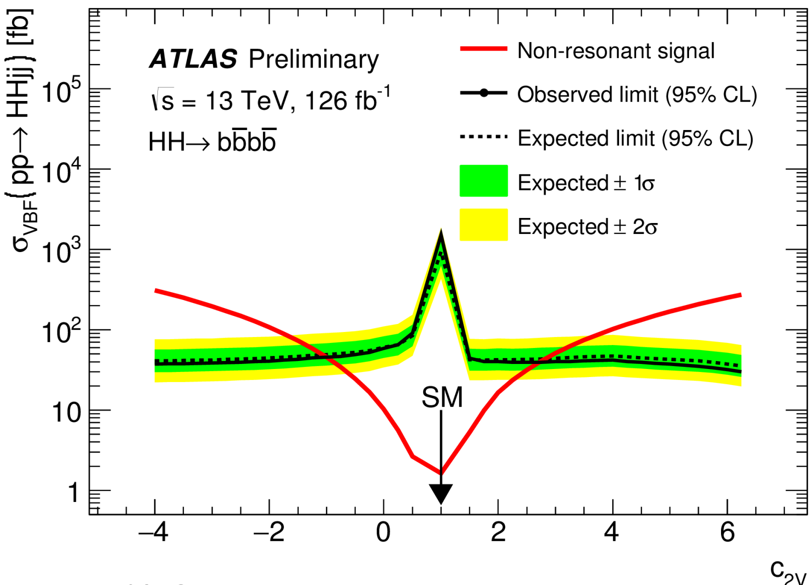
Backgrounds from data using m_{bb} sidebands



Measured 4b mass in HH resonance search



ATLAS−CONF−2019−030



95% CL limits $-1.0 < c_{2V} < 2.7$
(non-resonant search)

$HH \rightarrow 4b$ selection

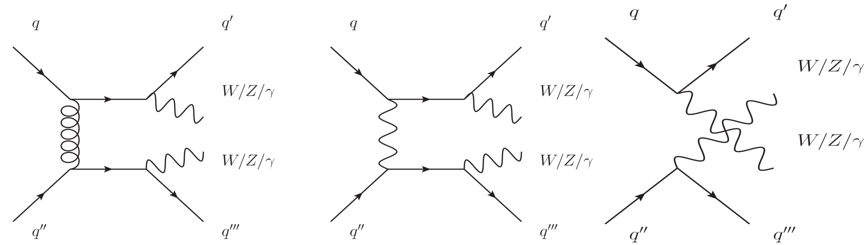
Full Run-2

ATLAS-CONF-2019-030

VBF topology	At least two jets with $p_T > 30$, $\|\eta\| > 2.0$	Two highest-p_T jets with opposite sign η
		$\|\Delta\eta_{jj}^{VBF}\| > 5.0$ and $m_{jj}^{VBF} > 1000$
Signal topology	At least 4 b-tagged jets with $p_T > 40$, $\|\eta\| < 2.0$	
	If $m_{4b} < 1250$	$\frac{360}{m_{4b}} - 0.5 < \Delta R_{bb}^{lead} < \frac{653}{m_{4b}} + 0.475$
		$\frac{235}{m_{4b}} < \Delta R_{bb}^{subl} < \frac{875}{m_{4b}} + 0.35$
	If $m_{4b} \geq 1250$	$\Delta R_{bb}^{lead} < 1$
		$\Delta R_{bb}^{subl} < 1$
	Pairs with minimum $D_{HH} = \sqrt{(m_{2b}^{lead})^2 + (m_{2b}^{subl})^2} \left\| \sin\left(\tan^{-1}\left(\frac{m_{2b}^{subl}}{m_{2b}^{lead}}\right) - \tan^{-1}\left(\frac{116.5}{123.7}\right)\right)\right\|$	
Background rejection	Multijet	$\|\Delta\eta_{HH}\| < 1.5$
		$\|\Sigma_i \vec{p}_{T_i}\| < 60$, where i = b-jets and VBF-jets
		$p_{T,H}^{lead} > 0.5 m_{4b} - 103$
		$p_{T,H}^{subl} > 0.33 m_{4b} - 73$
	$t\bar{t}$	$X_{Wt} = \sqrt{\left(\frac{m_W - 80.4}{0.1 m_W}\right)^2 + \left(\frac{m_t - 172.5}{0.1 m_t}\right)^2} > 1.5$
Region definition	Signal region (SR)	$X_{HH} = \sqrt{\left(\frac{m_{2b}^{lead} - 123.7}{11.55}\right)^2 + \left(\frac{m_{2b}^{subl} - 116.5}{18.05}\right)^2} < 1.6$
	Validation region (excluding SR)	$\sqrt{\left(m_{2b}^{lead} - 123.7\right)^2 + \left(m_{2b}^{subl} - 116.5\right)^2} < 30$
	Sideband region (excluding SR, VR)	$\sqrt{\left(m_{2b}^{lead} - 123.7\right)^2 + \left(m_{2b}^{subl} - 116.5\right)^2} < 45$

Evidence of Vector Boson Scattering in Z(ll)γjj

Measure Zγjj electroweak production, involves SM quartic ZγWW diagram



Data-driven estimates of backgrounds

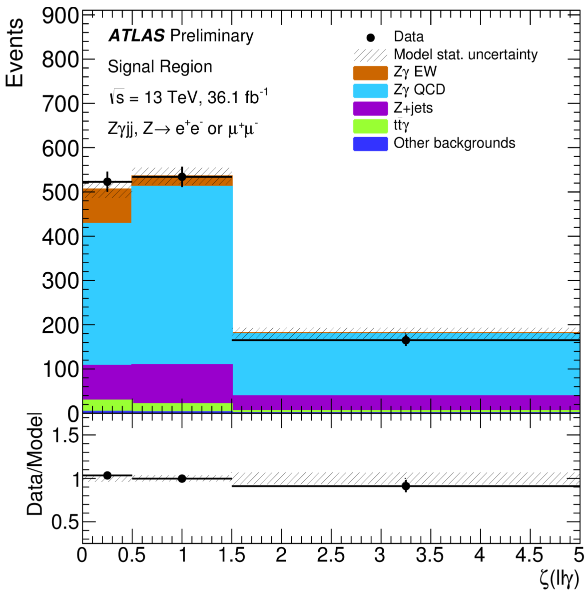
Use BDT with 13 variables to discriminate S/B

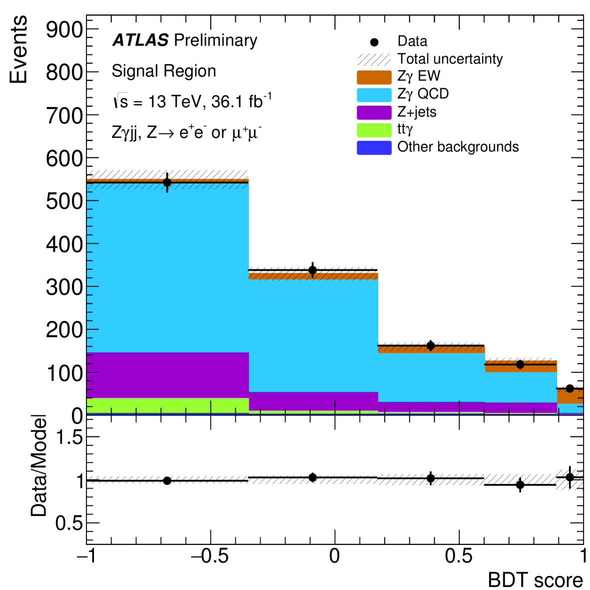
- Dedicated centrality variable used in BDT

$$\zeta(\ell\ell\gamma) = \left|\frac{y_{\ell\ell\gamma} - (y_{j1} + y_{j2})/2}{(y_{j1} - y_{j2})}\right|$$

$$\sigma^{\text{fid.}}_{Z\gamma jj} = 71 \pm 2\,(\text{stat.})\,^{+9}_{-7}\,(\text{exp. syst.})\,^{+21}_{-17}\,(\text{mod. syst.})\text{ fb}$$

$$\sigma^{\text{fid., MadGraph+Sherpa}}_{Z\gamma jj} = 88.4 \pm 2.4\,(\text{stat.}) \pm 2.3\,(\text{PDF} + \alpha_S)^{+29.4}_{-19.1}\,(\text{scale})\text{ fb}$$





Observed (expected) significance for EW production: 4.1σ (3.8σ)

ATLAS-CONF-2019-039

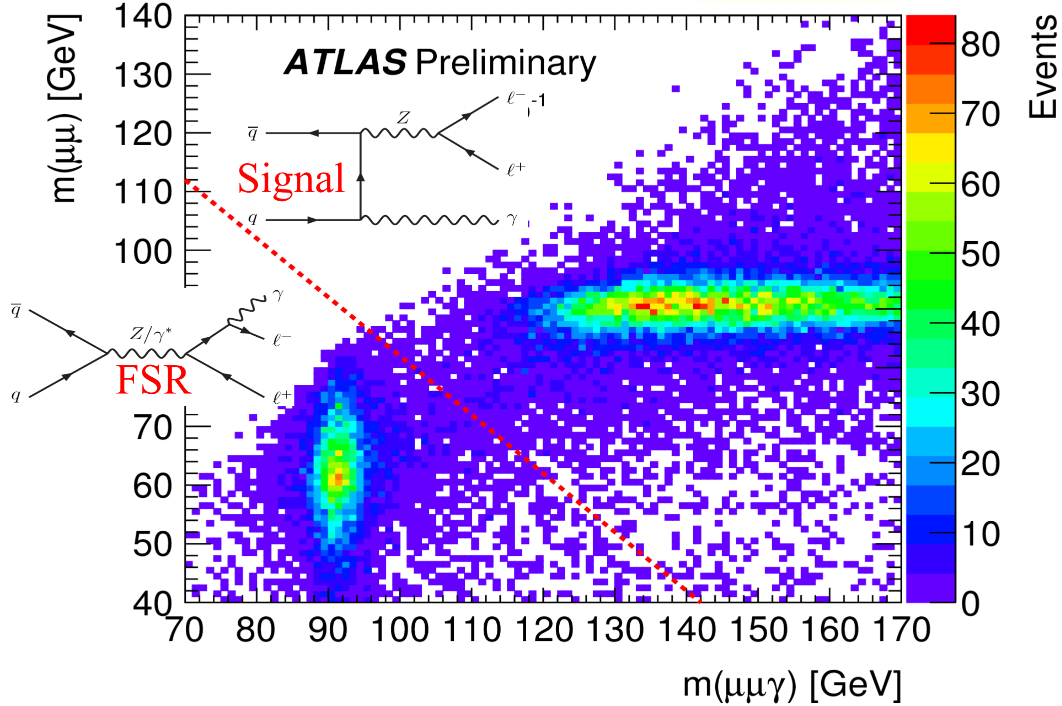
Differential Measurement of Z(ll)γ - Event Selection

ATLAS-CONF-2019-034

Non-prompt γ/l removed: isolation cuts

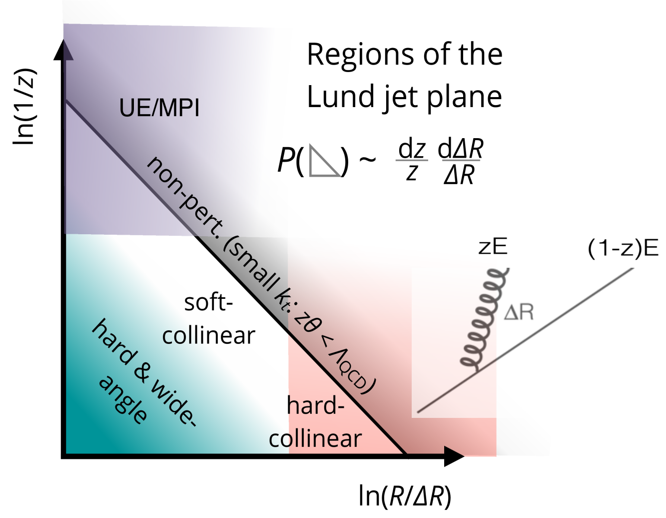
Distinguish signal / FSR: $m(\ell\ell) + m(\ell\ell\gamma) > 182\,\text{GeV}$

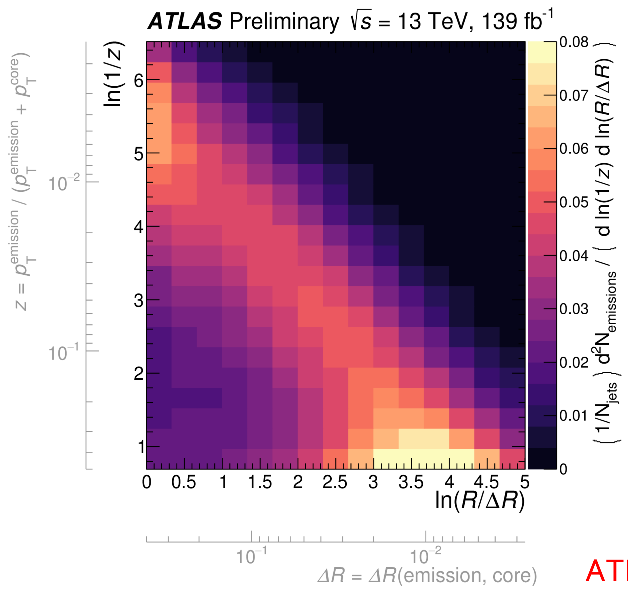
Full Run-2



Measurement of the Lund Jet Plane

- Recluster track constituents of jets with C/A
- Decluster following the harder branch and plot emissions in the plane
→ Using tracks allows to have precise measurements for small angle splittings
- Unfolded to charged particle level and compared with several theoretical predictions





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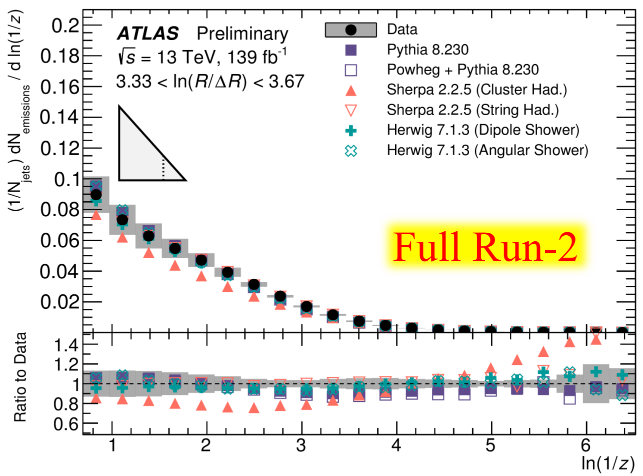
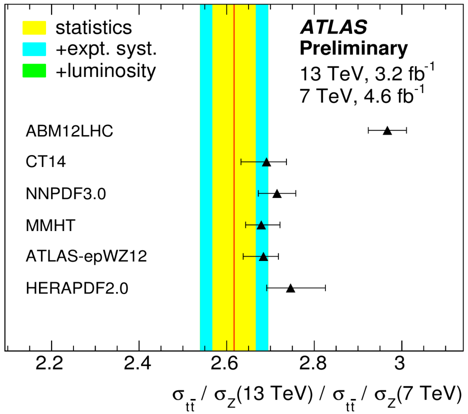
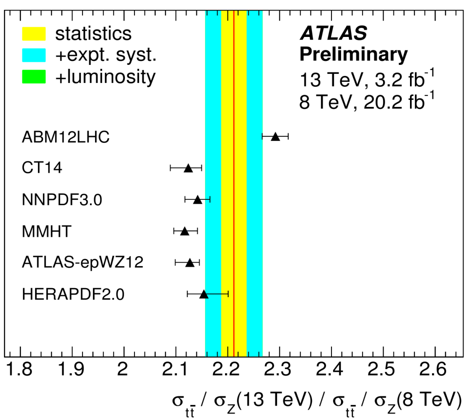


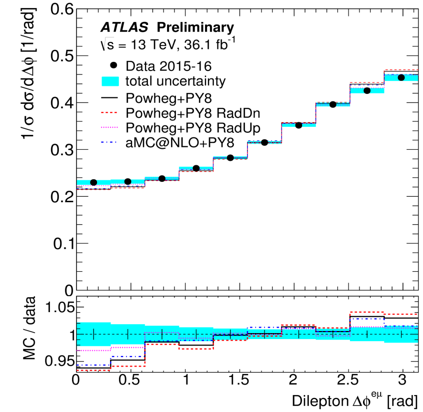
Top Physics: Precision Cross Section Measurements

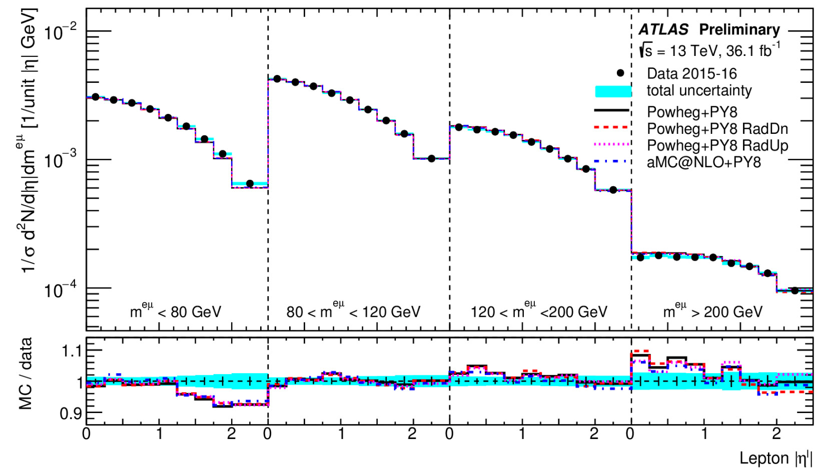
- Cross section ratios allow to cancel systematic uncertainties
- Fiducial and (double-)differential cross sections also provided

ATLAS-CONF-2019-041





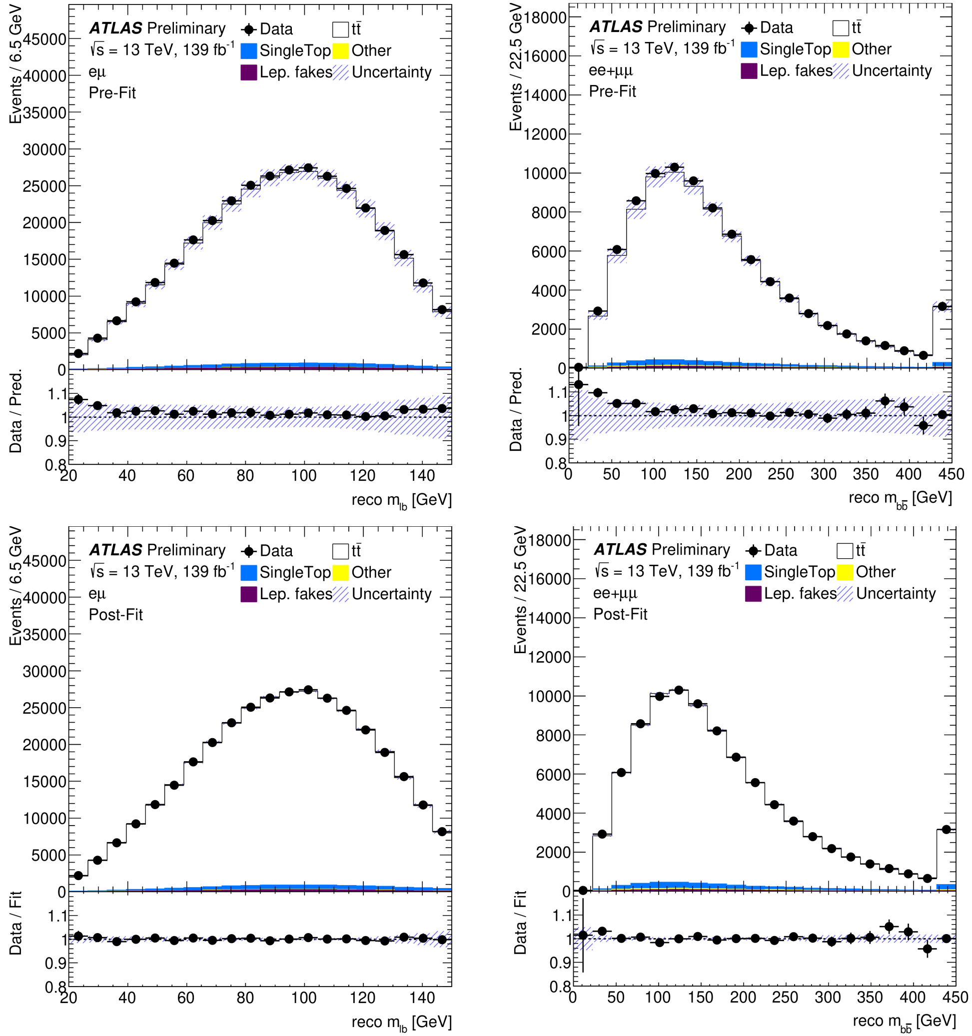




Top Physics: Direct Width Measurement

Direct measurement of Top quark width:

- Template fit of m_{lb} for eμ channel
- Uncertainties constraint through m_{bb} fit for ee and μμ modes

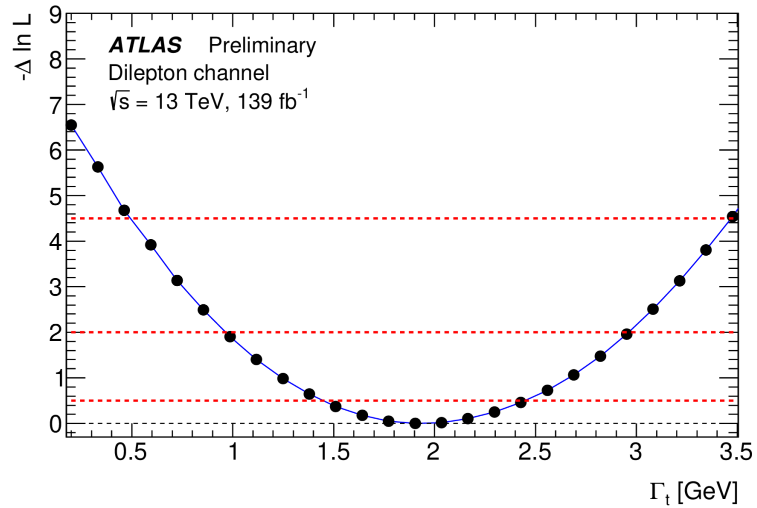


ATLAS−CONF−2019−038

Top Physics: Direct Width Measurement

ATLAS–CONF–2019–038

Source	Impact on Γ_t [GeV]
Jet reconstruction	±0.24
Signal and bkg. modelling	±0.19
MC statistics	±0.14
Flavour tagging	±0.13
E_T^{miss} reconstruction	±0.09
Pile-up and luminosity	±0.09
Electron reconstruction	±0.07
PDF	±0.04
$t\bar{t}$ normalisation	±0.03
Muon reconstruction	±0.02
Fake-lepton modelling	±0.01



	m_t = 172 GeV		m_t = 172.5 GeV		m_t = 173 GeV	
	Mean [GeV]	**Unc. [GeV]**	**Mean [GeV]**	**Unc. [GeV]**	**Mean [GeV]**	**Unc. [GeV]**
Measured	2.01	+0.53 −0.50	1.94	+0.52 −0.49	1.90	+0.52 −0.48
Theory	1.306	< 1%	1.322	< 1%	1.333	< 1%

Ultra Peripheral Pb-Pb Collisions in 2018 Data

- New: *2-particle correlations in photo-nuclear ultra-peripheral Pb-Pb collisions*

→ Energy deposit in exclusively one zero-degree calorimeter

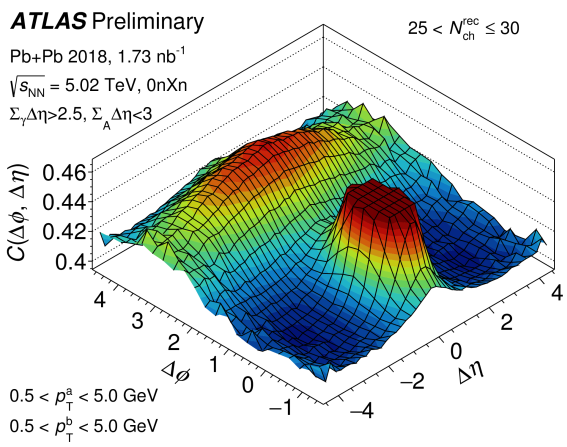
→ η gaps for calo' clusters and tracks in the photon- / nucleus-going directions

→ Measure two-(charged)particle correlations; remove non-flow effects and extract flow coefficients: template fit on events with low multiplicity ($15 \leq N_{ch}^{rec} \leq 20$) and high multiplicity

$$Y(\Delta\phi) = \int_{|\Delta\eta|=2.0}^{|\Delta\eta|=5.0} Y(\Delta\phi, |\Delta\eta|)\, d|\Delta\eta|$$

$$Y^{HM}(\Delta\phi) = FY^{LM}(\Delta\phi) + G\left\{1 + 2\sum_{n=2}^{3} v_{n,n}\cos(n\Delta\phi)\right\}$$

$$v_{n,n}(p_T^a, p_T^b) = v_n(p_T^a)v_n(p_T^b)$$



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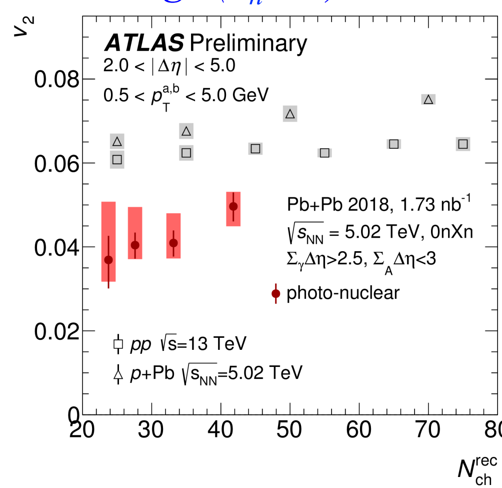
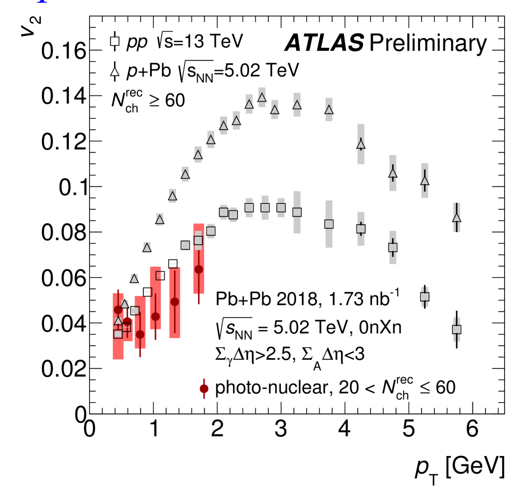
Ridge ($v_n \neq 0$) observed in photo-nuclear collisions



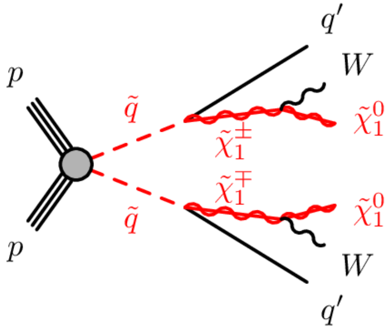


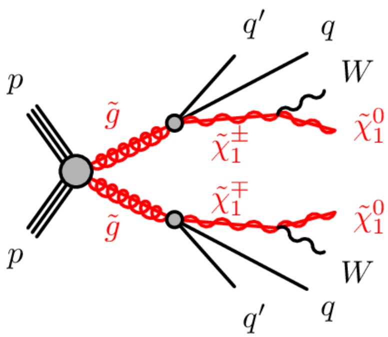
SUSY: Strong Production

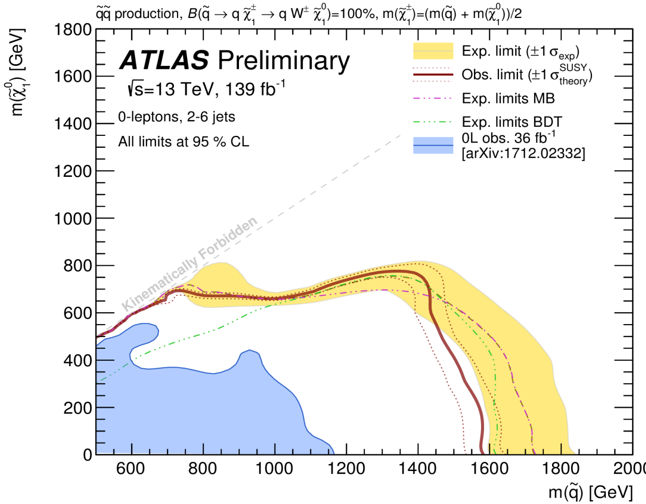
Full Run-2

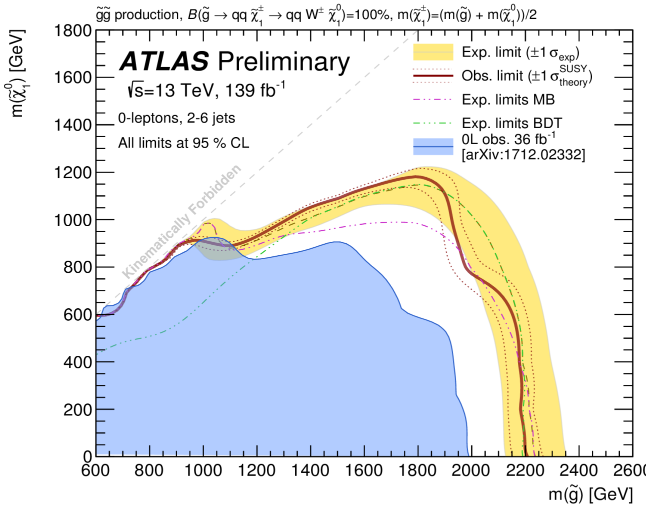
Use simplified scenarios

- Here squark or gluino decaying to quark(s), W boson and neutralino









- Significant improvement over previous limits

ATLAS-CONF-2019-040

Maintenance and Upgrade – Forward detectors

- Lucid (key input for luminosity determination) :

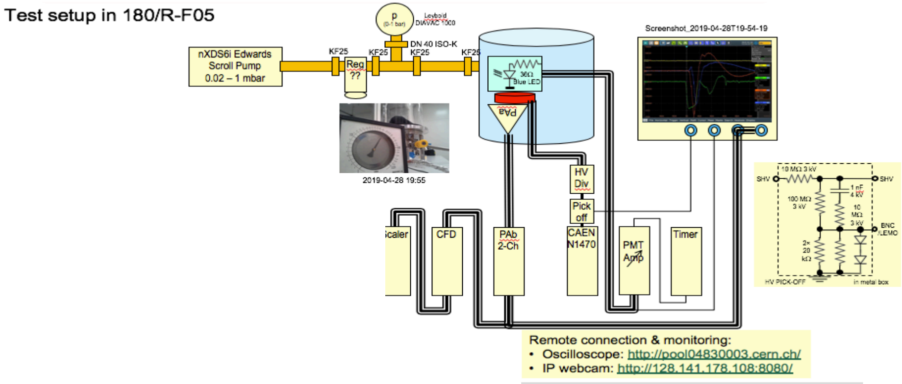
- various problems observed with photomultiplier functionning during running

- now cable arrives to the base through a connector allowing easy maintenance / replacement during YETS

- AFP:

- qualifying PMTs for TOF detector to work under vacuum: one OK after long term test, a 2nd one showed problems and is re-tested

- also new technique with PMs outside vacuum is being developed (signal through quartz window)

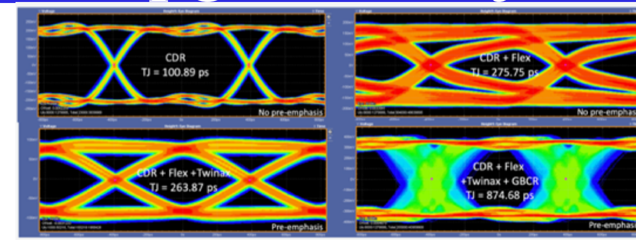


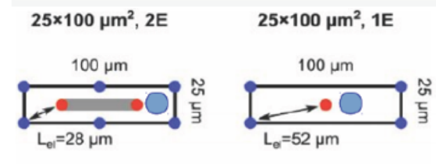
Example of Recent Progress on Upgrade Projects

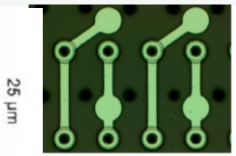
- ITk-Pixels:

→ First results with GBCR equalizer ASIC at the end of the data transmission cables (Flex and Twinax)

→ 3D sensors samples with 25x100 μm pixel geometry (possible use in layer-0 and layer-1) will be tested in Sep/October → Final Design Review in October







Stepper

- Calorimeters

→ LAr Analog Front-end ASICs ready for fab submission next week, ADC prototype submitted end of August

→ LAr Front-end board pre-prototype and Tile full prototype (FENICS) available and being characterized