ATLAS activities at Sydney

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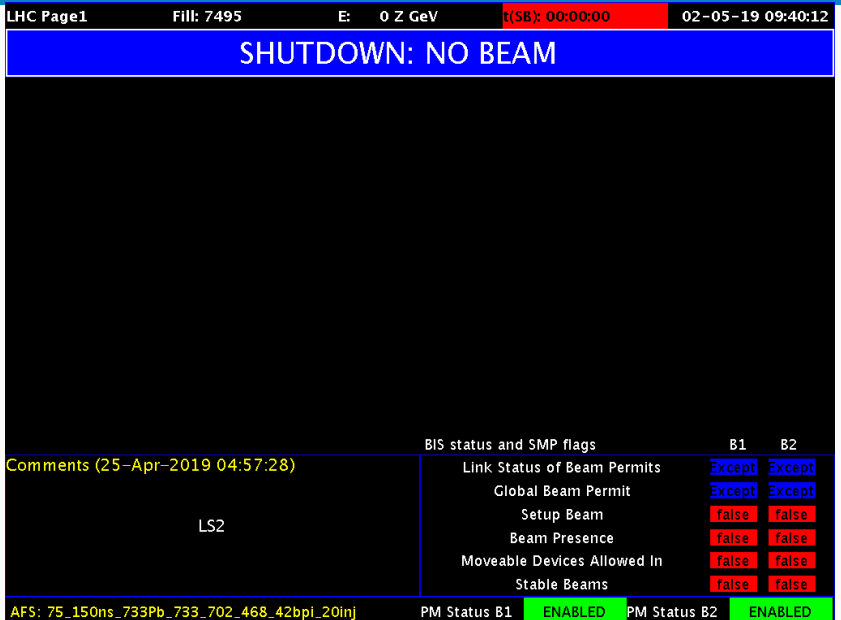
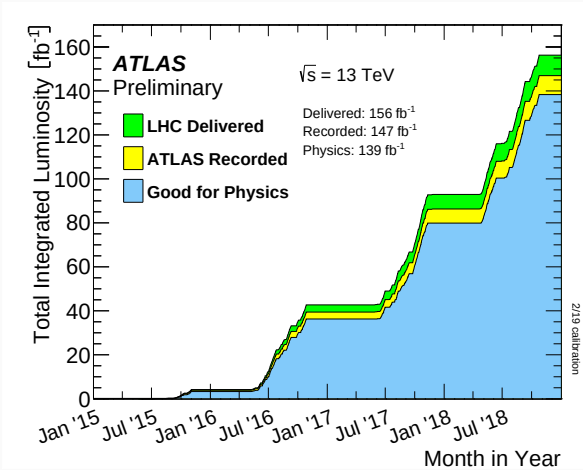
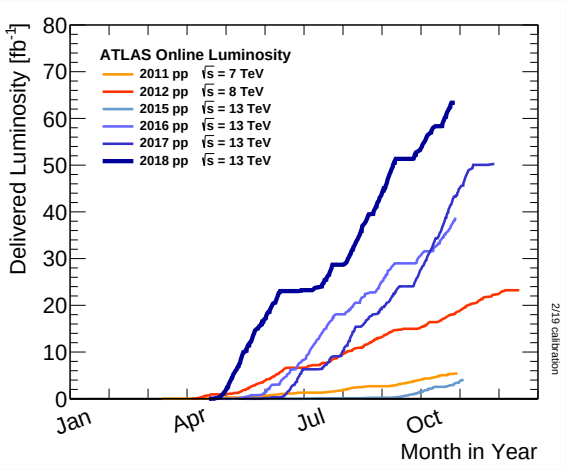
Current LHC status



LHC long-term schedule

The ATLAS *pp* datasets in run 2





Physics with ATLAS

- Supersymmetry searches
- Exotics searches
- Higgs and diboson searches
- Higgs physics
- Standard Model
- Top physics
- Heavy ion physics
- B physics and light states
- Physics modelling

+ hardware, upgrades, operations, organisation, ...

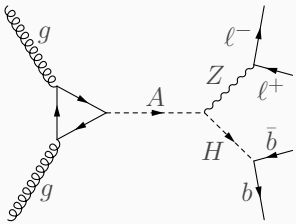
Physics with ATLAS

- Supersymmetry searches
- Exotics searches
- Higgs and diboson searches – search for a heavy neutral Higgs
- Higgs physics
- Standard Model
- Top physics – single top tW production, AIDA
- Heavy ion physics
- B physics and light states – quarkonium production spectroscopy
- Physics modelling

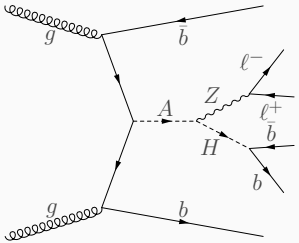
+ hardware, upgrades, operations, organisation, ...

Search for a heavy neutral Higgs [Shyam]

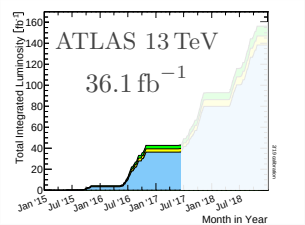
- 2HDM has 5 Higgs bosons after EWSB: h and H (CP-even), A (CP-odd), and $H^{\pm}$ (charged).
- For 2HDM EW baryogenesis we need $125\,\text{GeV} < m_H < m_A \lesssim 800\,\text{GeV}$.
- Search for $A \to ZH$ with $Z \to \ell^+\ell^-$ (clean) and $H \to b\bar{b}$ (high branching fraction).



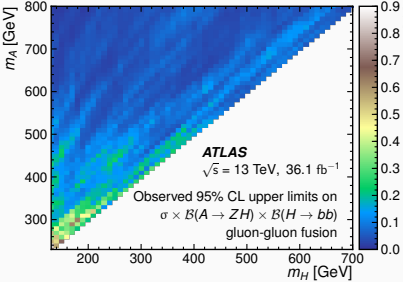
gluon-gluon fusion

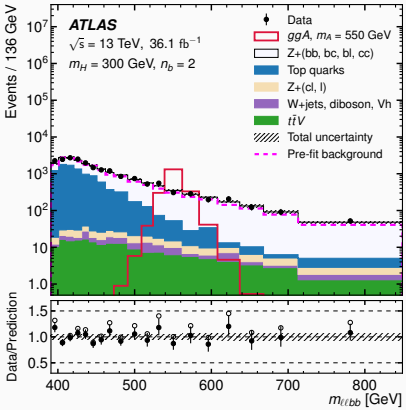


associated $b\bar{b}$

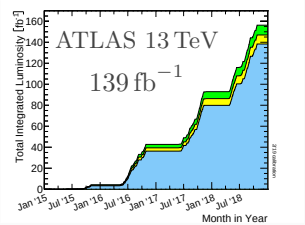


Phys. Lett. B 783 (2018)





- Select events with m_{bb} in a window around m_H.
- Then scan over m_A, searching for resonances in $m_{\ell\ell bb}$.
- Main backgrounds are Z+jets and $t\bar{t}/tW$.
- Scan over mass points ensuring $m_A - m_H \geq 100\,\text{GeV}$.

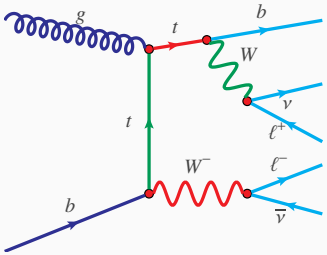


- Shyam is involved in the update of this search to the full dataset:
  - optimising the event selection using machine learning, and
  - signal interpolation.
- Recent improvements in b-jet tagging will help the analysis.
- There will be a focus on making the results re-interpretable.

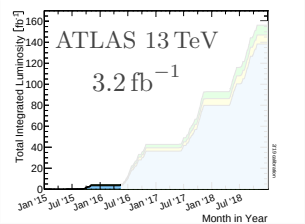
- Shyam is also involved in improving photon reconstruction at ATLAS.
- He is also pursuing several theory projects:
  - B physics: SU(4) unified models to explain the $R_{K^{(*)}}$ and $R_{D^{(*)}}$ anomalies,
  - Higgs portal dark matter models, and
  - simplified dark matter models.

Single top tW production [Carl]

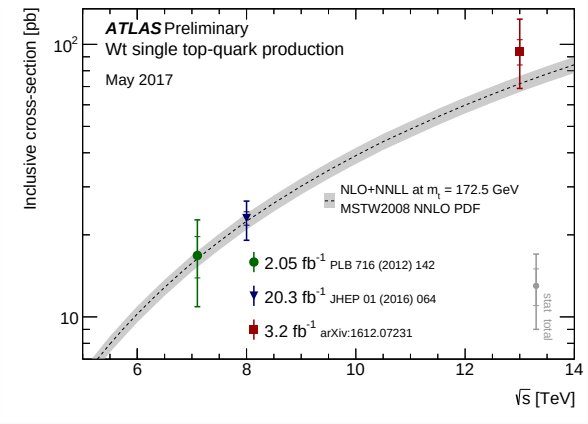
- Top quark production at the LHC is predominantly via $t\bar{t}$.
- Rarer weak force processes produce top quarks singly, proportional to $|V_{tb}|$.
- The tW channel was first observed in run 1 of the LHC at ATLAS and CMS.
- We use events with exactly two oppositely-charged electrons or muons (dilepton).



	t-channel	tW	s-channel
Branching fraction	73%	24%	3%
Sensitive to...			
4-fermion operators	✓	×	✓
tWb vertex corrections	✓	✓	✓

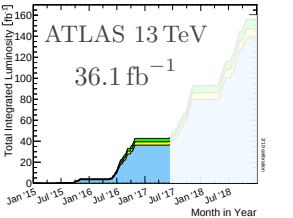


JHEP 01 (2018) 63



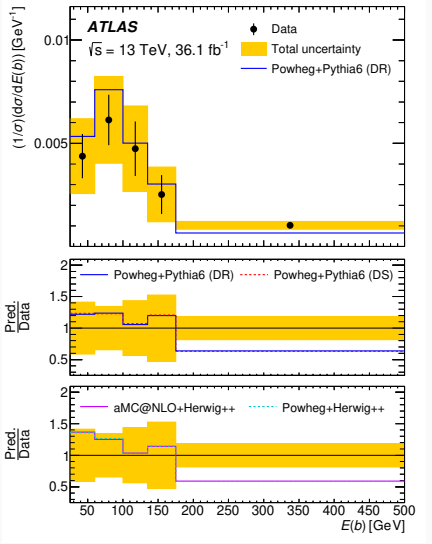
$$\sigma_{tW} = 94 \pm 10\,(\text{stat.})\ {}^{+28}_{-22}\,(\text{syst.}) \pm 2\,(\text{lumi.})\ \text{pb} \qquad \text{(measured)}$$

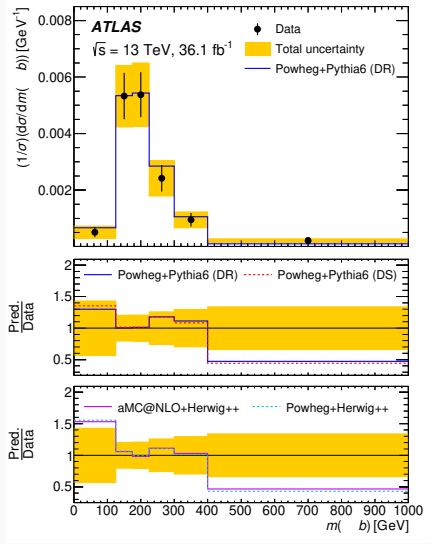
$$\sigma_{tW} = 71.7 \pm 1.8\,(\text{scale}) \pm 3.4\,(\text{PDF})\ \text{pb} \qquad (\text{NNLO+NNLL})$$

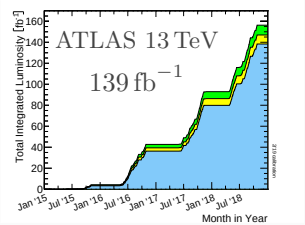


EPJC 78 (2018) 186

- First measurement of the shape of tW production.
- Differential with respect to 6 quantities.



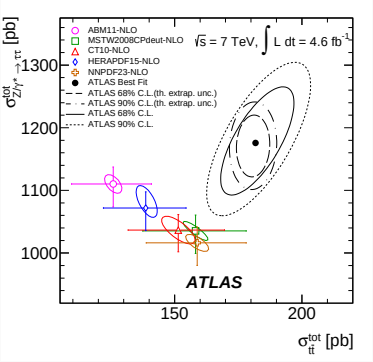




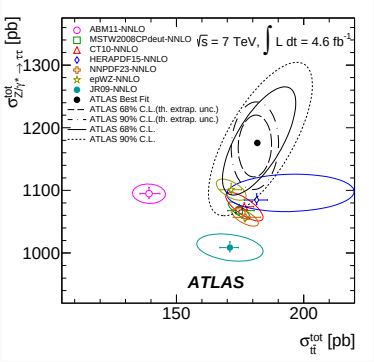
- I am continuing in the effort to update these measurements.
- Collaborators: Universität Bonn, Duke & Boston Universities.
- We will improve the precision of the measurements.
- Aim to inform tW modelling, particularly interference with $t\bar{t}$.

An inclusive dilepton analysis (LHC run 1)

- Our involvement in top physics began as a collaboration with Duke (Mark Kruse).
- Simultaneous measurement of $t\bar{t}$, W^+W^- and $Z/\gamma^* \to \tau\tau$: Phys. Rev. D 91 (2015) 052005
- We've been planning to resume this analysis, subject to funding for a new postdoc.



NLO



NNLO