

ATLAS Physics Data Analysis 2015-2016

7th September 2016

PhDs completed

- Richard Mudd, $H \rightarrow 4l$ (November 2015)
- Andrew Daniells, $hh \rightarrow bb\tau\tau$ (viva June 2016)
- Mark Levy, top quark spin correlations (viva August 2016)

Funding/Manpower

- Kostas ERC grant to study the Higgs boson interactions with light quarks, through meson+photon final states
- Simon Head left physics, Nancy (joined on Marie Curie March 2016), Andy Chisholm left for CERN (June 2016), Ludovica will be leaving (October 2016)
- Students: Elliot Reynolds, James Kendrick, Daniel Briglin, Matt Baca, Rhys Owen, James Broughton, Andrew Foster

Positions of responsibility

- Kostas. UK Physics Convener. Data reprocessing coordinator. Higgs Prospects group convener (from October 2016)
- Ludovica. Standard model W/Z +jets subgroup convener (from October 2015)
- Paul T. Physics Modelling Group MC performance subgroup convener (from October 2015)

Plus many other group level responsibilities (including combined performance), analysis contacts, membership of Editorial boards

Ed Board Chairs: Kostas: h to diphoton plus MET [ATLAS-CONF-2016-011](#), electron performance in 2015 [ATLAS-CONF-2016-024](#)

Miriam: $B_s \rightarrow J/\psi\phi$ Run 1 paper published this week, **JHEP 1608 (2016) 147**

Paul T: Z +jets in Run 2 using 2015 data [ATLAS-CONF-2016-046](#)

Higgs Physics

Kostas, Paul T, Nancy, Matt, Rhys, James, Elliot

Contributions across all regions of many Higgs physics groups including standard model searches and measurements to constrain model parameters and also use H(125 GeV) as a probe for new physics beyond the SM (BSM).

ATLAS large focus on rapid analysis for conference results, publish at relevant times as we go along.

2015: 3.2 fb⁻¹ commissioning + searches

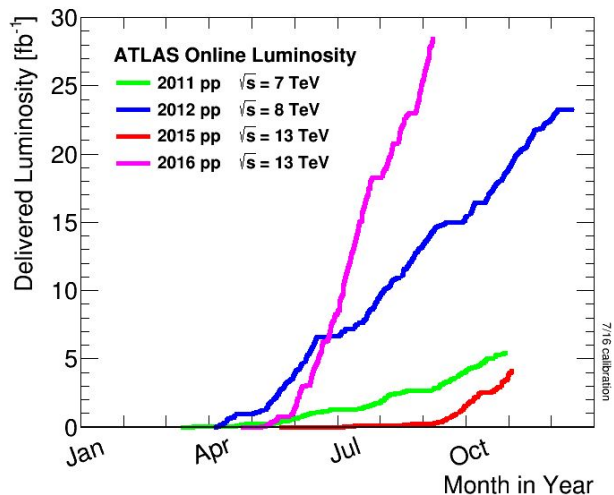
2016: ICHEP additional 10 fb⁻¹.

Run 1 still significant luminosity, many Run 1+2 combinations

Aim for publications on 2015+full 2016 in early 2017

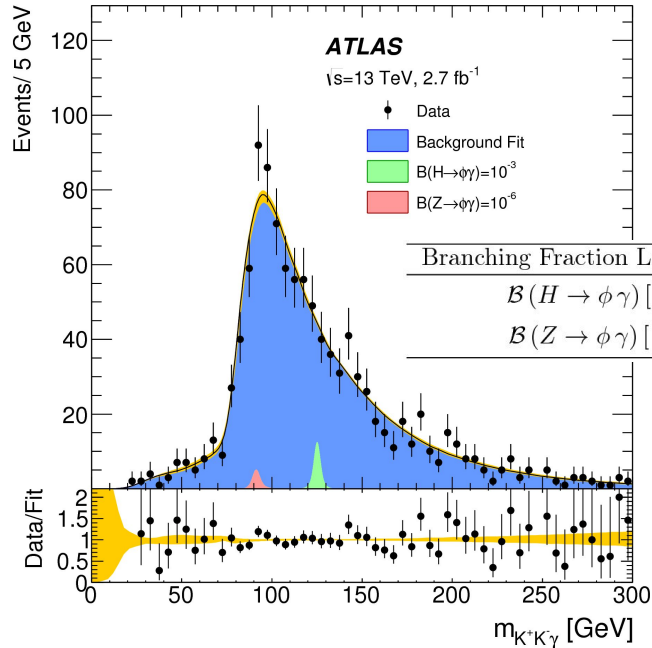
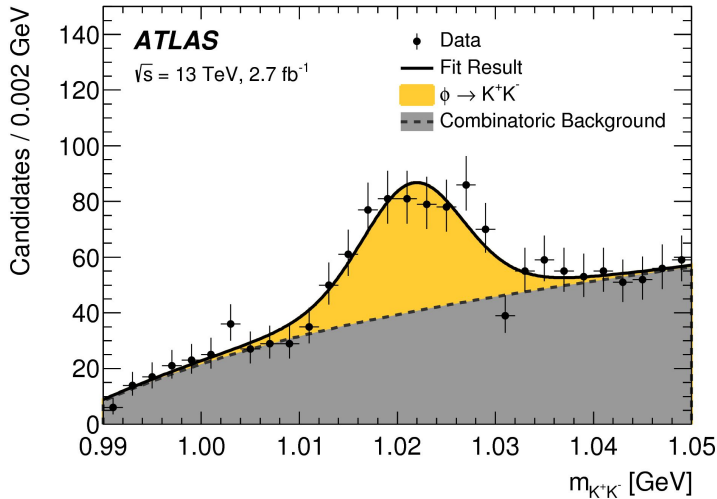
Main Birmingham areas include:

- Higgs to Quarkonia searches, Yukawa couplings
- Higgs to bb decay
- hh→bbγγ
- h→ZZ→4l
- mono-Higgs production in h→bb (ATLAS Exotics group)
- Others: Higgs BSM Higgs including Two Higgs Doublet Models (2HDM) using A→Zh (h→bb), h→aa (a→μμ)



Higgs to Quarkonia

- Following on from Run 1 publications
- **Search for Higgs and Z Boson Decays to $\phi\gamma$ with the ATLAS Detector.**
Accepted for publication to Physics Review Letters.
- Uses 2015 data at 13 TeV

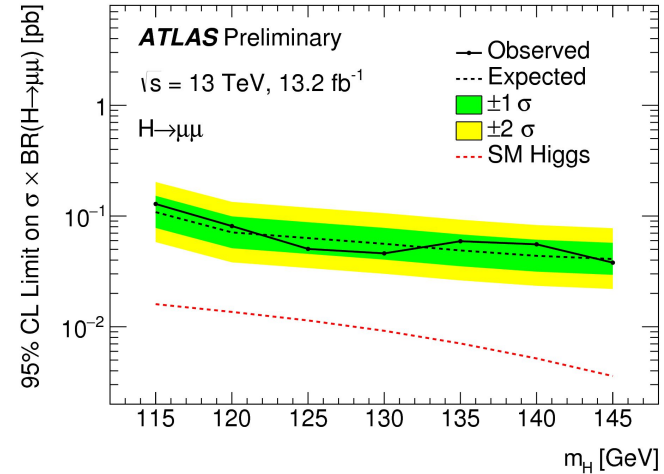
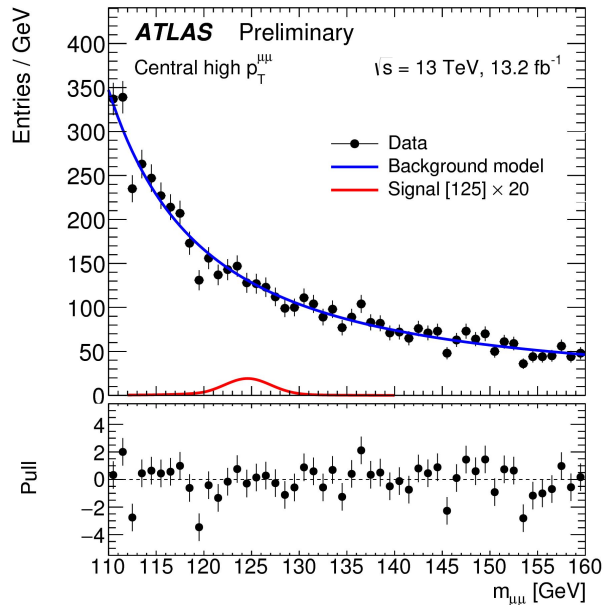


Branching Fraction Limit (95% CL)	Expected	Observed
$\mathcal{B}(H \rightarrow \phi\gamma) [10^{-3}]$	$1.5^{+0.7}_{-0.4}$	1.4
$\mathcal{B}(Z \rightarrow \phi\gamma) [10^{-6}]$	$4.4^{+2.0}_{-1.2}$	8.3

Work ongoing by students to analyse full 2015+2016 data including studies of $H \rightarrow J/\Psi\gamma$, plus many activities to come in this direction via ERC grant

Higgs to $\mu\mu$

- Preliminary result of Run 2 for ICHEP 2016 with 2015+2016 with 13.2 fb⁻¹ data [ATLAS-CONF-2016-041](#)
- Testing Higgs coupling to second generation fermions (small BR in SM)

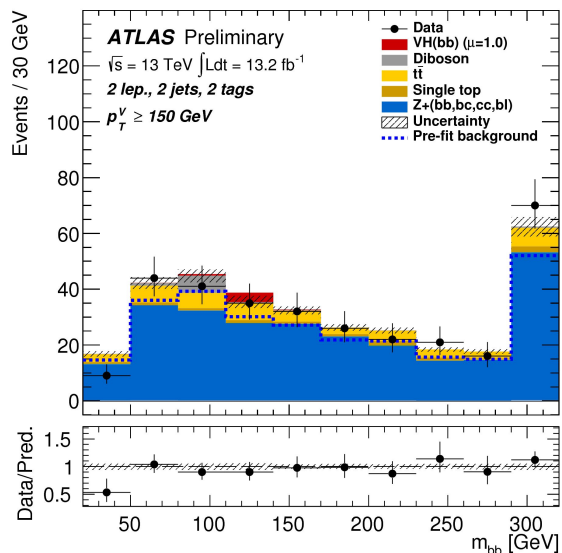


4.4(5.5) observed(expected) times SM exclusion at 95% CL

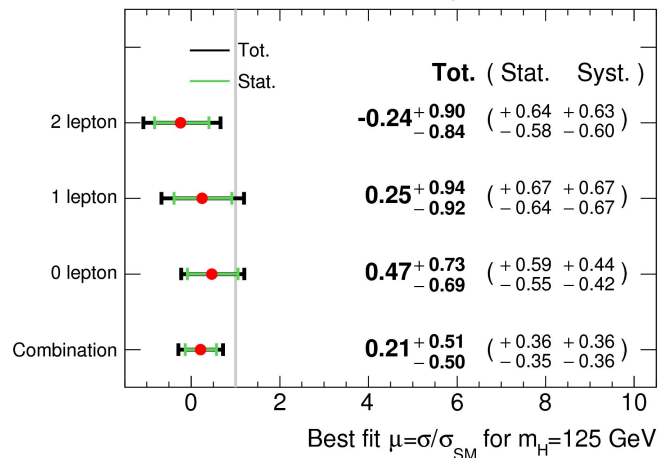
Also combine with Run 1 and get 3.5 (4.3) observed(expected) exclusion
Working towards publication with further optimisation (more categories, MVA) for full 2015+2016 data publication around Moriond 2017

Higgs to bb

- VH with $H \rightarrow bb$ preliminary result of Run 2 for ICHEP 2016 with 2015+2016 with 13.2 fb^{-1} data [ATLAS-CONF-2016-091](#)
- As with Run 1 use multivariate techniques (including b-jet invariant mass m_{bb} as input)
- To expand also in $H \rightarrow cc$



ATLAS Preliminary $\sqrt{s}=13 \text{ TeV}, \sqrt{L dt}= 13.2 \text{ fb}^{-1}$



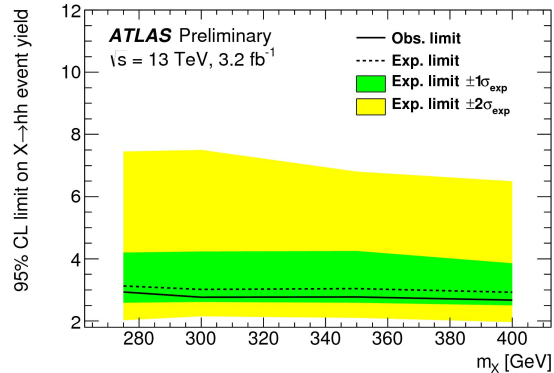
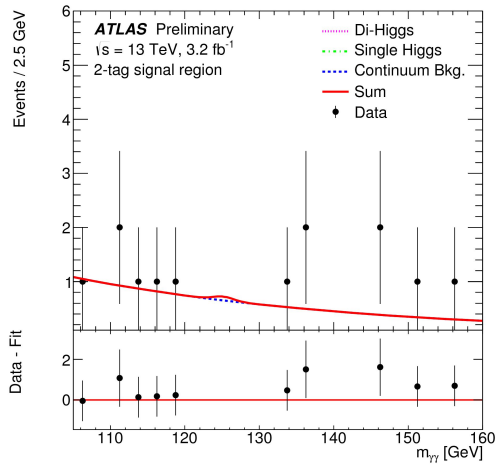
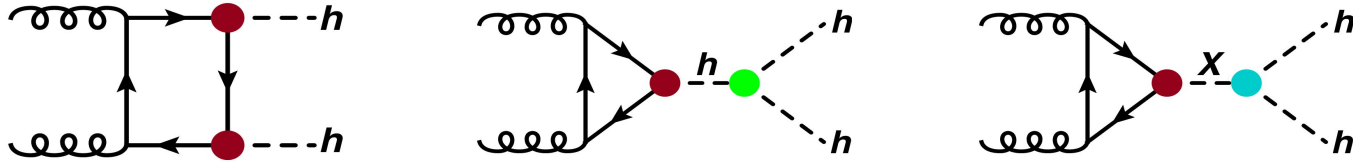
Working on combination with Run 1 plus final publication of 2015+2016 data for Moriond 2017 timescale

Also working on first $H \rightarrow cc$ measurement/publication in 2016

Dataset	Limit		p_0		Significance	
	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.
0-lepton	$1.4_{-0.4}^{+0.6}$	2.0	0.07	0.15	1.45	1.02
1-lepton	$2.0_{-0.6}^{+0.8}$	2.1	0.15	0.46	1.04	0.10
2-lepton	$1.8_{-0.5}^{+0.7}$	1.7	0.13	0.57	1.14	-0.17
Combined	$1.0_{-0.3}^{+0.4}$	1.2	0.03	0.34	1.94	0.42

hh to bby

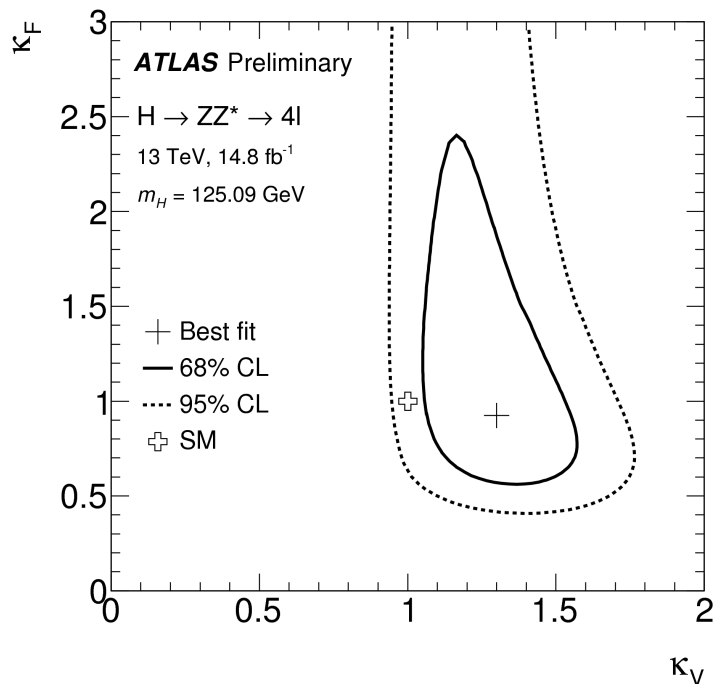
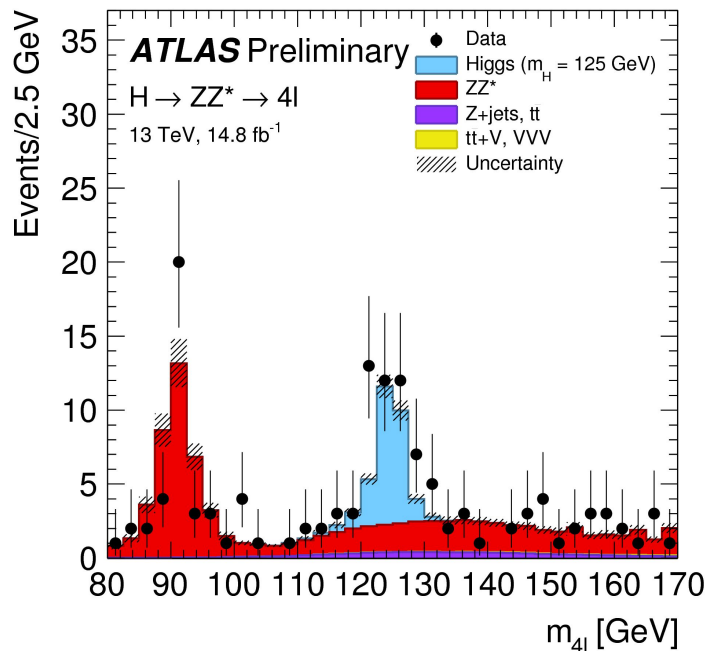
- Run 2 search preliminary for Moriond 2016 [ATLAS-CONF-2016-004](#)
- SM cross section very small, sensitive to non-resonant and resonant BSM contributions



Limits set on non-resonant and narrow width resonant production.
Work ongoing with full 2015+2016 data aim for Moriond 2017 publication

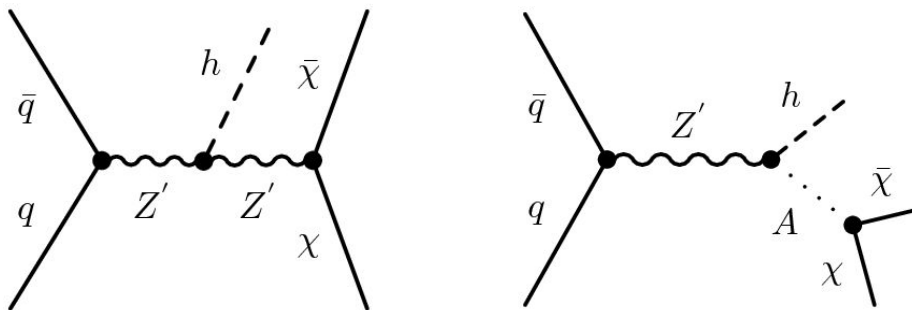
h to ZZ to 4l

- Updated with the 13TeV data
- Vital combined performance contribution from Birmingham in e/gamma software validation and development
- Ludovica gave the ICHEP talk [ATLAS-CONF-2016-079](#)
- More activity towards this area as higher statistics will allow coupling measurements.

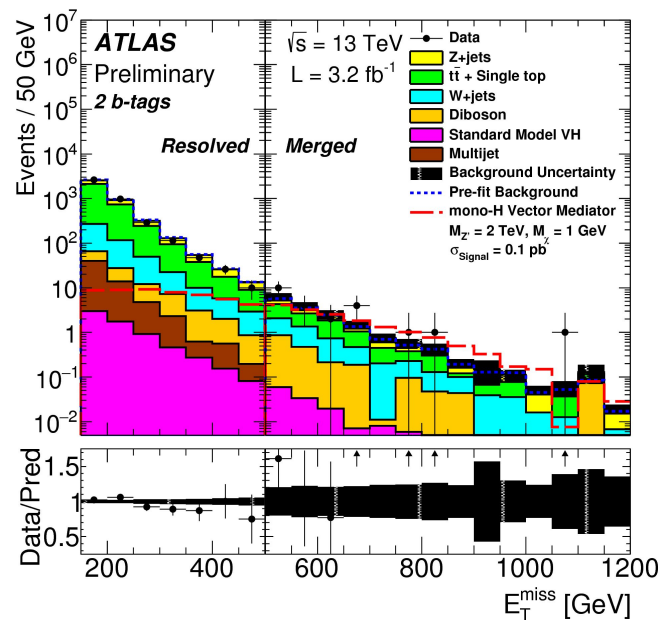


Mono Higgs

- Higgs portal to dark matter at the LHC. $h+DM$ with $h \rightarrow bb$ gives “mono-Higgs”. Investigate simplified models
- Preliminary result of Run 2 for Moriond 2016 with 3.2 fb^{-1} of 2015 data [ATLAS-CONF-2016-019](#)
- Use “resolved” and “merged” $h \rightarrow bb$ regions using jet substructure techniques



Delay due to additional signal MC points
 Will be submitted to journal for publication soon
 Continue towards full 2015+2016 analysis for publication

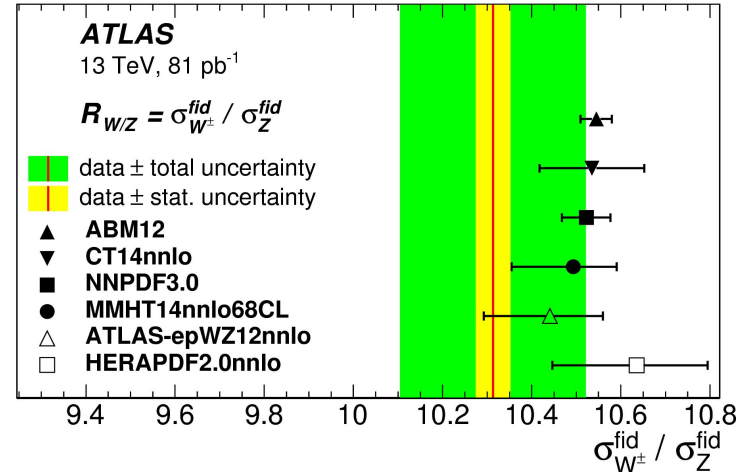
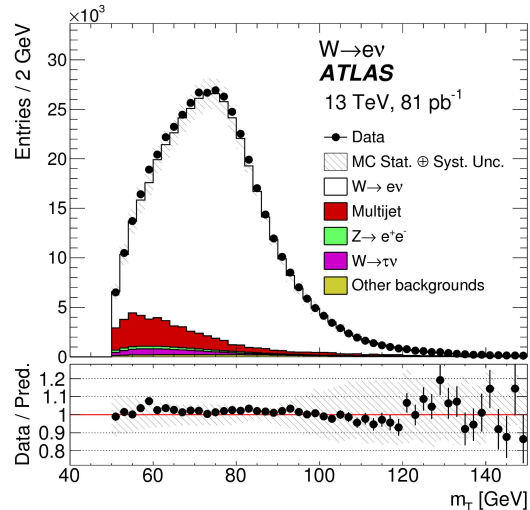


Standard Model Physics

Ludovica, Rhy, Kostas

W/Z measurements

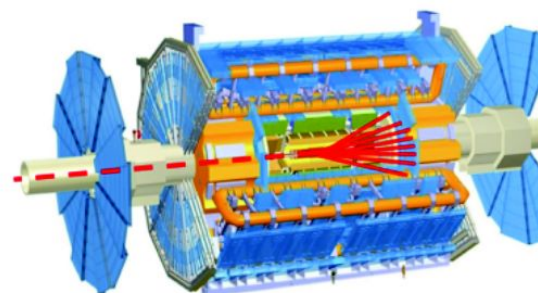
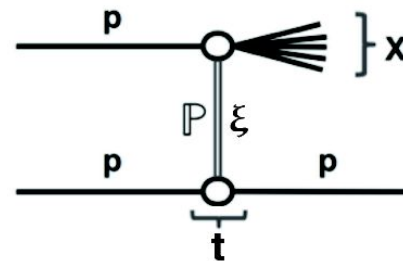
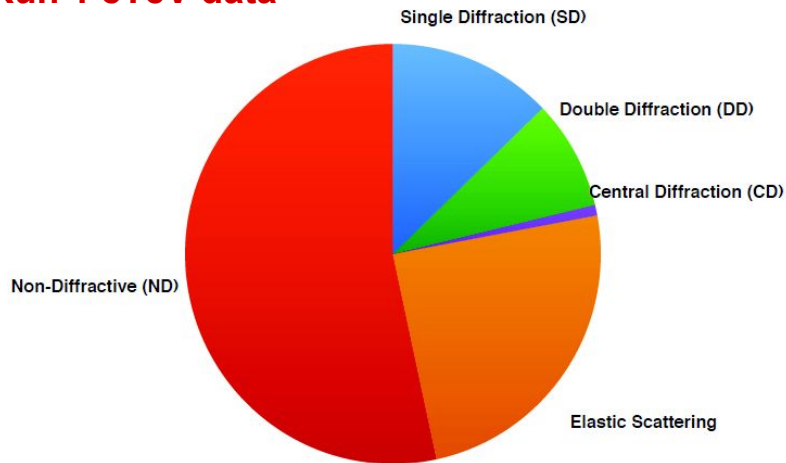
- Important for commissioning detector and physics models in Run 2 (with new COM energy of 13 TeV and detector upgrades). Important Birmingham contributions in e/gamma.
- Measurement of W^\pm and Z-boson production cross sections in pp collisions at $\sqrt{s} = 13$ TeV using 81 pb^{-1} [STDM-2015-03](#) now published [Phys. Lett. B 759 \(2016\) 601](#)
- Ludovica as convener of SM W/Z subgroup overseeing W/Z publications on complete 2015 data (including Z+jets cross section)



Diffractive Physics

Paul N, Andrew F, James K.

Low Pile-up Run 1 8TeV data



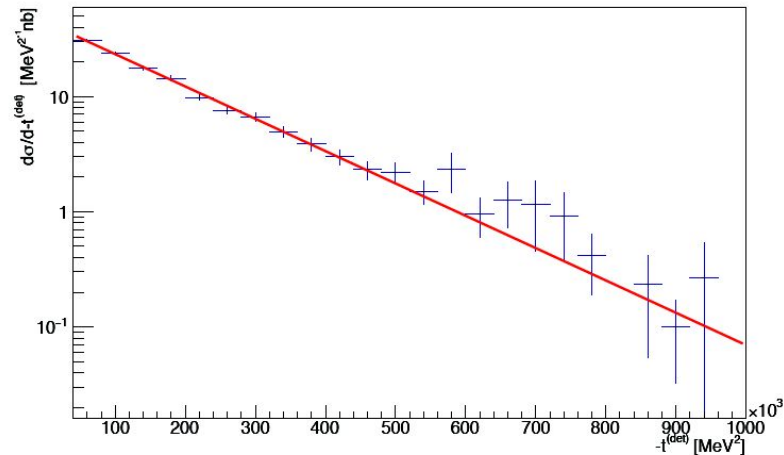
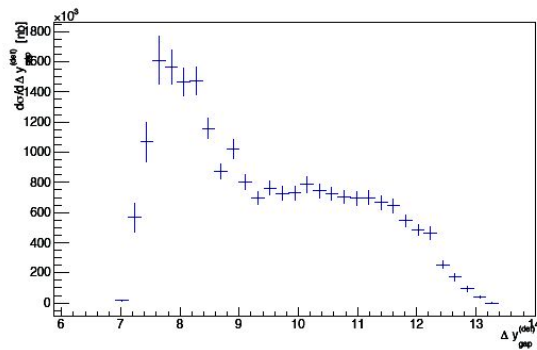
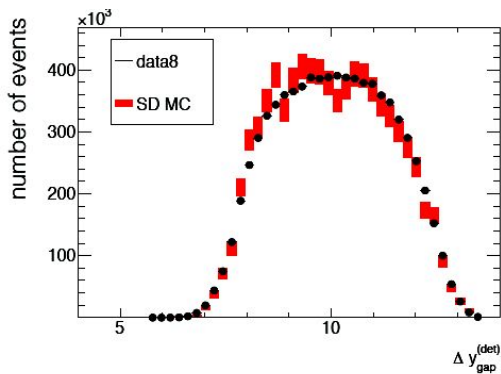
- Large SD cross section, but not well constrained
- Using ALFA detectors (240m from interaction point in region $\eta \sim 8$) to detect intact protons from collisions
- No measurement thus far of σ_{SD} as a function of t or ξ

$$\xi = 1 - \frac{E_{p'}}{E_p} = \frac{M_X^2}{s}$$

Diffractive Physics

Paul N, Andrew F, James K.

Low Pile-up Run 1 8TeV data (work in progress)



Δy = rapidity gap between proton and diffractive system

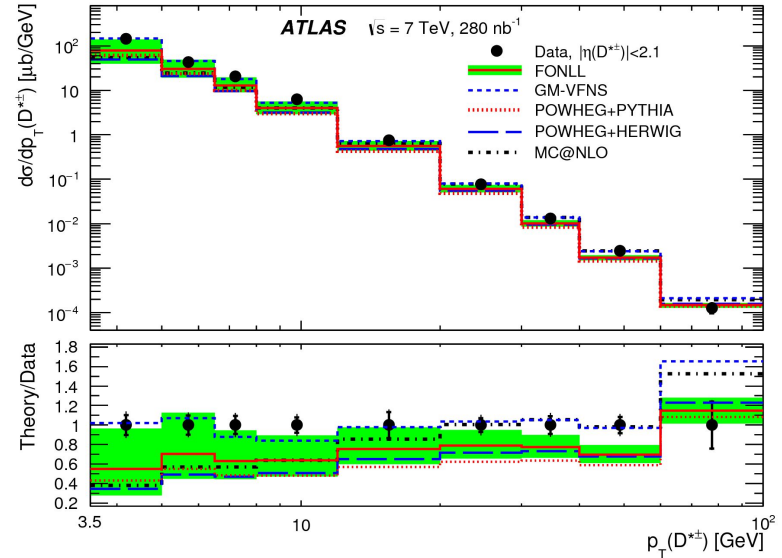
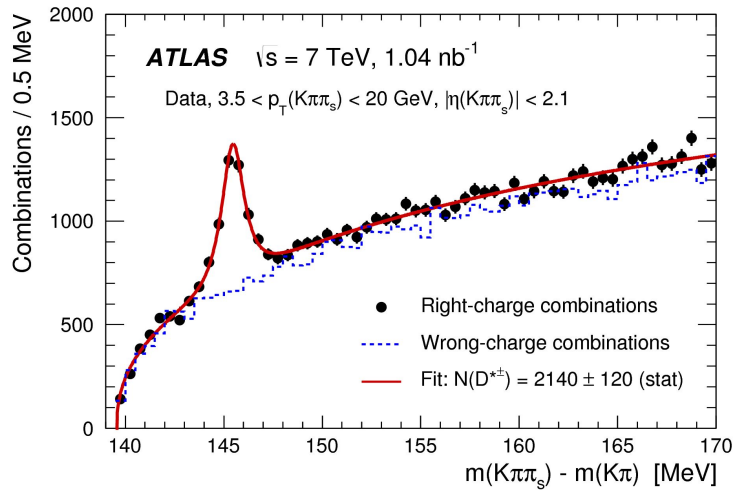
- Monte Carlo OK describing kinematic features, aiming for improved MC which describes all the details
- Unfolded cross sections implemented
- Whilst wait for MC James K looking at ALFA SD measurement at 13 TeV
- Run 2 AFP station at 420m being commissioned

Heavy Flavour and Top Physics

Miriam, Chris, John, Mark

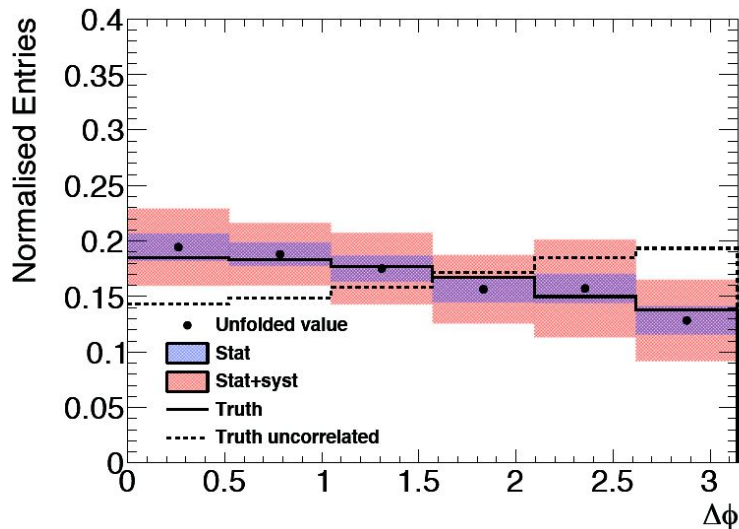
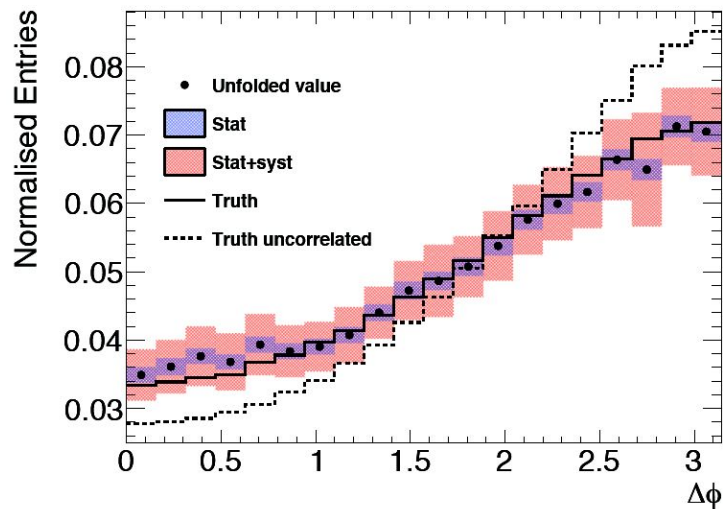
Heavy Flavour physics

- Charm meson cross-section paper (D^* , $D^{+/-}$ and D_s) Nucl.Phys. B907 (2016) 717 @7TeV published
- Paper on $W+J/\Psi$ production at 8 TeV in preparation



Top Production

- Mark Levy passed his viva on his analysis of inclusive and differential spin correlation measurements at 8 TeV, minor corrections by the end of Sept.
- First differential unfolded spin correlation measurement at ATLAS



Angular separation between leptons from W decay shown inclusively(left) and $M_{tt} > 405$ GeV (right)
Working towards publication on full 13 TeV 2015+2016 data asap