High Mass Drell-Yan measurements at ATLAS using Run 2 data

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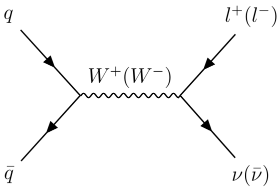
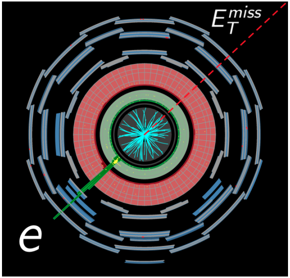
High Mass Drell-Yan

- My focus is making cross section measurements of the charged current Drell-Yan (CCDY) process in the e and μ channel.
- Search for W' has been carried out with Run 2 data [1] using m_T^W where,
  $m_T^W = \sqrt{2 p_T E_T^{miss}(1 - \cos\Delta\phi_{l,\nu})}$
- No new resonances found so now we make precision measurements of Standard Model.
- This measurement has not before been made at this m_T^W range.
- Cross sections of both e and μ channels can be measured and compared to test lepton universality.





[1] The ATLAS Collaboration, 2019. Search for a heavy charged boson in events with a charged lepton and missing transverse momentum from pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector. Physical Review D, 100(5).

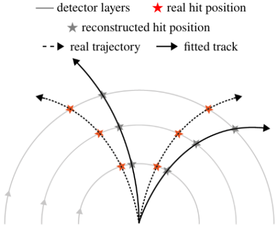
Event Selection

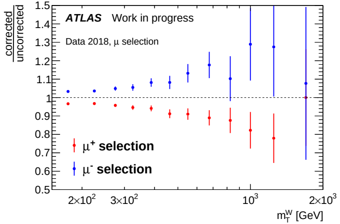
- Fiducial phase space region used for both channels:
  - $p_T > 65$ GeV
  - $E_T^{miss} > 85$ GeV
  - $m_T^W > 200$ GeV
  - $|\eta_\ell| < 2.4$
- As the neutrino cannot be directly measured, $m_T^W >$ is used, rather than the invariant mass.
- The following samples are used in the final measurement:
  - Data 2015/2016 (36.2 fb^{-1})
  - Data 2017 (44.3 fb^{-1})
  - Data 2018 (58.5 fb^{-1})

  and the corresponding simulation campaigns per year.
- Overall integrated luminosity is 139 fb^{-1}.

HMDY - Muon channel sagitta bias corrections

- To measure p_T of muon we measure its sagitta using inner detector and the muon spectrometer.
- Precision needs to be of a few 10µm, compared to detector diameter of 25m.
- Changes in temperature and magnetic field can warp the geometry of the detector [2].
- Large effect at high m_T^W.
- Plot shows corrected/uncorrected data.





[2] The ATLAS Collaboration, 2020. Alignment of the ATLAS Inner Detector in Run 2. The European Physical Journal C, 80(12).

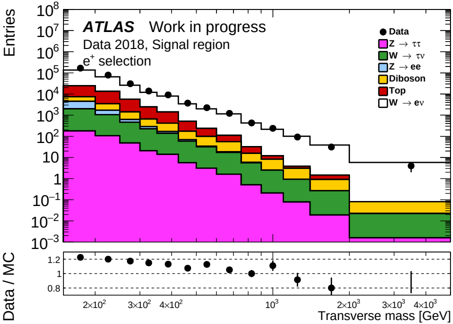
HMDY - Background samples

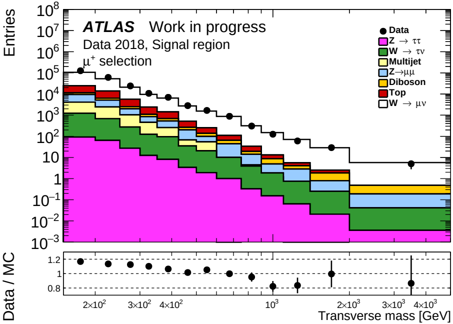
- Background signals contribute $\sim 30\%$ to total events.
- Most significant background is from top ($t\bar{t}$ and single top).
- The multijet background is a data driven estimate and has been derived by an ATLAS colleague for μ channel.
- Following background samples are considered in this analysis, where percentage is the contribution to the total background:

Process	Contribution	Colour
Top	48.2%	
$Z \rightarrow \ell^+\ell^-$	23.7%	
Multijet	18.5%	
Diboson	5.8%	
$W \rightarrow \tau\nu$	3.4%	
$Z \rightarrow \tau\tau$	0.4%	

HMDY m_T control plots - ℓ^+ selection

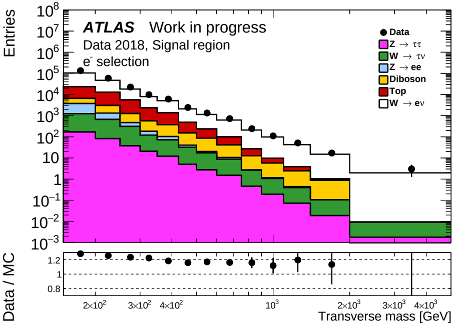
- Control plots showing both data taken during 2018 and corresponding simulated MC signal and backgrounds.
- A very large m_T range is covered from 150 GeV to 5 TeV.

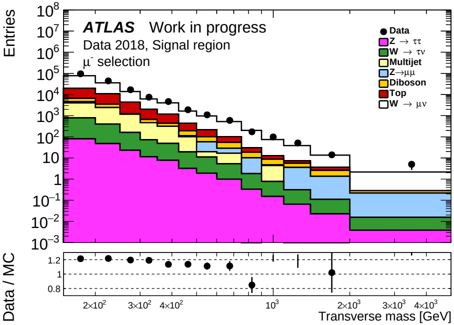




HMDY m_T control plots - ℓ^- selection

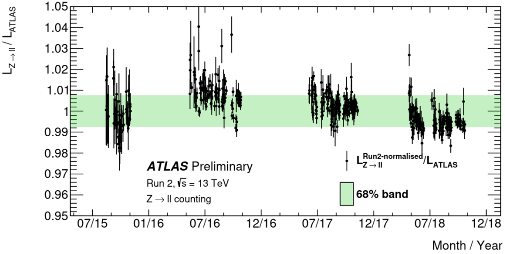
- Control plots showing both data taken during 2018 and corresponding simulated MC signal and backgrounds.
- A very large m_T range is covered from 150 GeV to 5 TeV.





Z-Counting

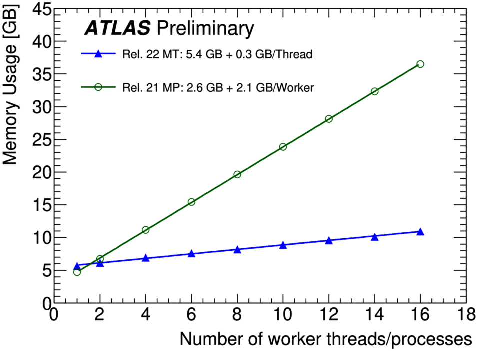
- LUCID luminosity measurement taken yearly.
- The number of $Z \to \ell^+\ell^-$ events can be used to calculate the luminosity, $\mathcal{L}_Z = N_Z/\sigma_Z$.
- Continuous luminosity measurements provided by Z-Counting provides additional checks for understanding time and pileup dependence of the ATLAS baseline measurement.
- Liverpool led Z-Counting team then compares with the ATLAS baseline luminosity measurement [3].



[3] The ATLAS Collaboration, 2021. Luminosity monitoring using $Z \to l^+l^-$ events at $\sqrt{13}$ TeV with the ATLAS detector. ATLAS PUB Note.

Z-Counting - ATLAS service task

- My service task is to update the Z-Counting analysis framework to ATLAS software framework called Release 22.
- Allows for comparisons with CMS using $Z \to \mu\mu$ events.
- High priority task for Run 3 .
- New version (rel 22) supports multithreading, reducing memory usage [4].



[4] The ATLAS Collaboration, 2022. Teaching established software new tricks. [online] Available at: <https://atlas.cern/updates/briefing/renovating-athena> [Accessed 11 May 2022].

Conclusion and outlook

HMDY:

- Similar data/MC trend between e and μ channels up to m_T^W of 1 TeV and good agreement between data/MC up to higher m_T^W.
- Investigate control regions to understand background and perform new multijet background estimate for e channel (written by Michael O'Keefe).
- Need to add systematics and unfold the cross section.
- Starting LTA at CERN in July.
- Will be taking data quality shifts in ATLAS control room.

Z-Counting:

- Updating one tool at a time and testing using a small sample file.
- Once the whole Z-Counting framework moved to Release 22, we can compare the Run 3 luminosity measurements with CMS.