Search for new resonances in events with one lepton and missing transverse momentum at $\sqrt{s} = 13\,\mathrm{TeV}$ with ATLAS

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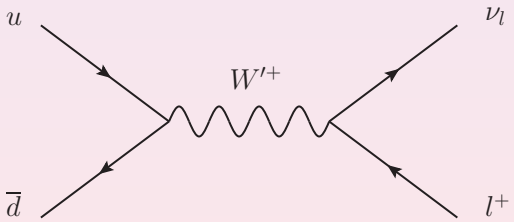
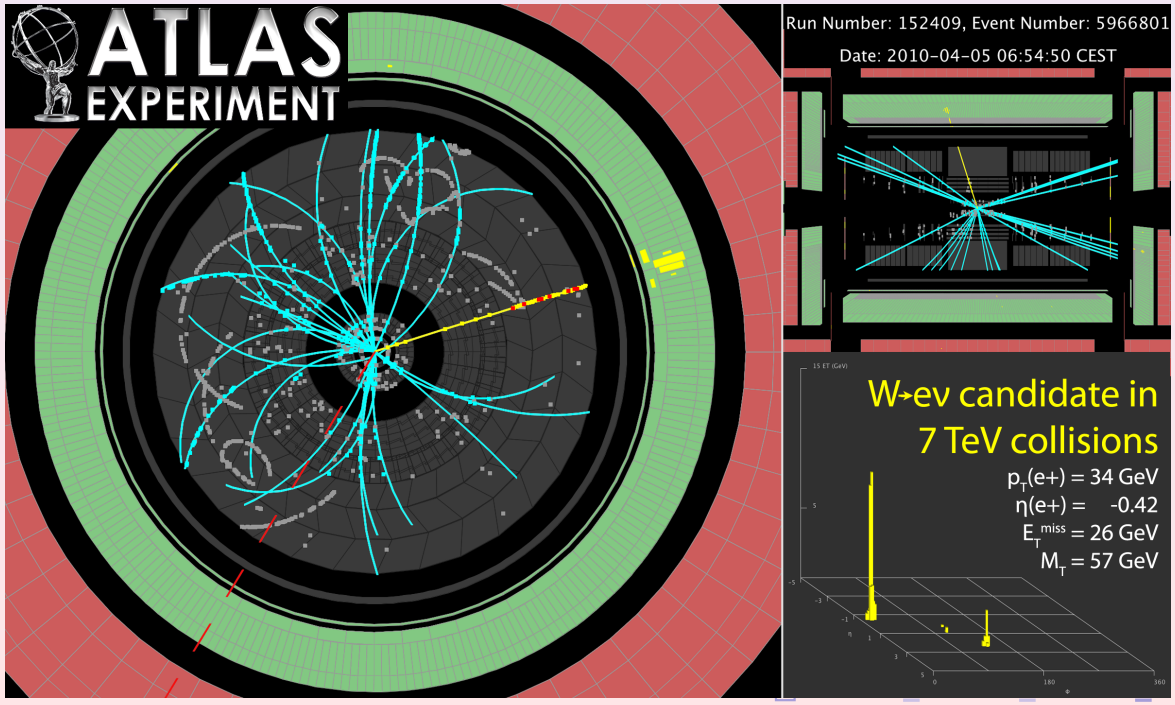
Motivation

- Additional charged gauge bosons W' appear in extended gauge models aiming to address the shortcomings of the Standard Model
  - E.g. left-right symmetric models
  - The decay $W' \to l\,\nu$ produces the $l + \not{E}_{\mathrm{T}}$ experimental signature
  - Benchmark model: Sequential Standard Model (SSM) – same couplings to fermions as SM W boson

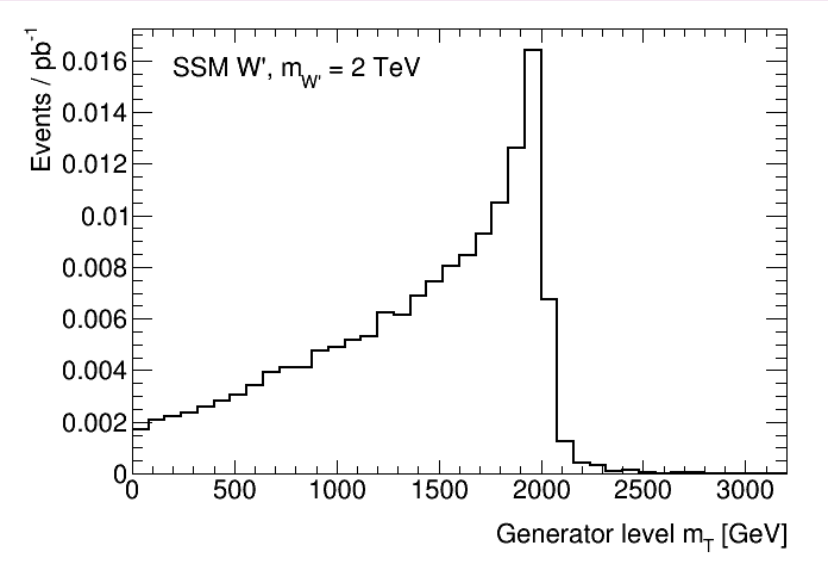


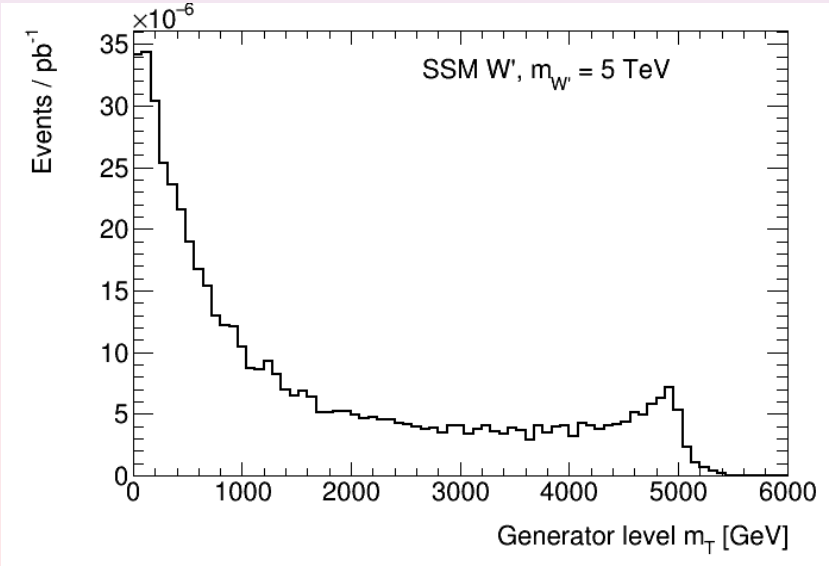


Basic procedure

- Identify events with one high-p_{T} lepton and large missing transverse momentum ($\not{E}_{\mathrm{T}}$)
- Search for deviations from SM predictions in the m_{T} distribution

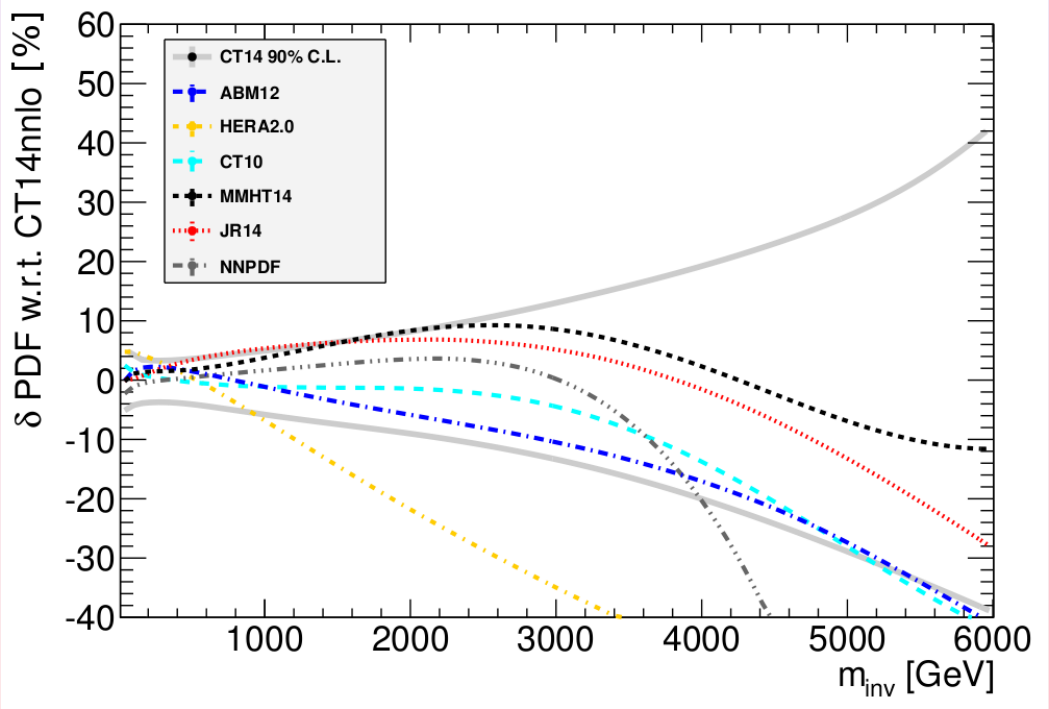
$$m_{\mathrm{T}} = \sqrt{2 p_{\mathrm{T}} \not{E}_{\mathrm{T}} \left(1 - \cos \Delta\phi_{l,\not{E}_{\mathrm{T}}}\right)}$$





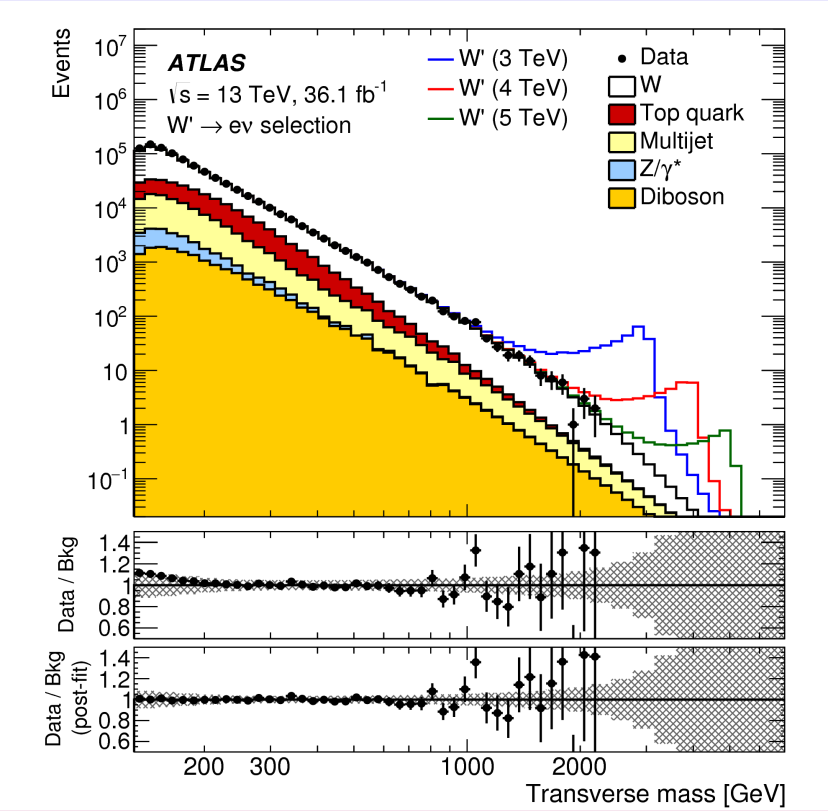
Background estimation

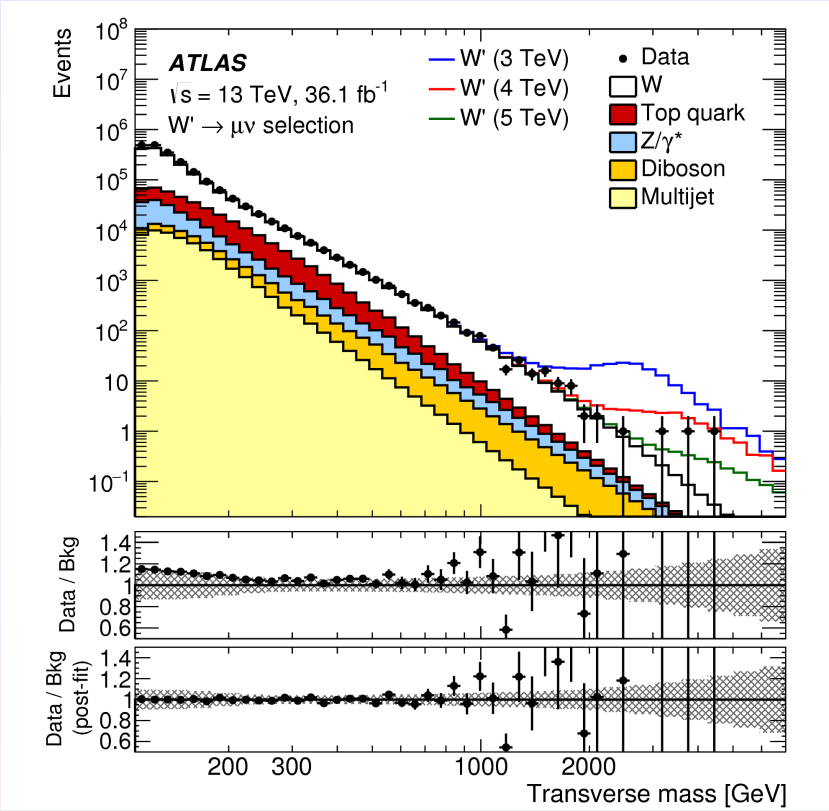
- Rely on MC for everything except “fake” leptons (from jets)
- NLO Powheg+Pythia samples for W and Z background, corrected with invariant mass dependent k-factors to NNLO in QCD (also signal), NLO in EW
- Leading uncertainty: PDF (CT14 90% CL + NNPDF deviation)



Uta Klein using VRAP 0.9

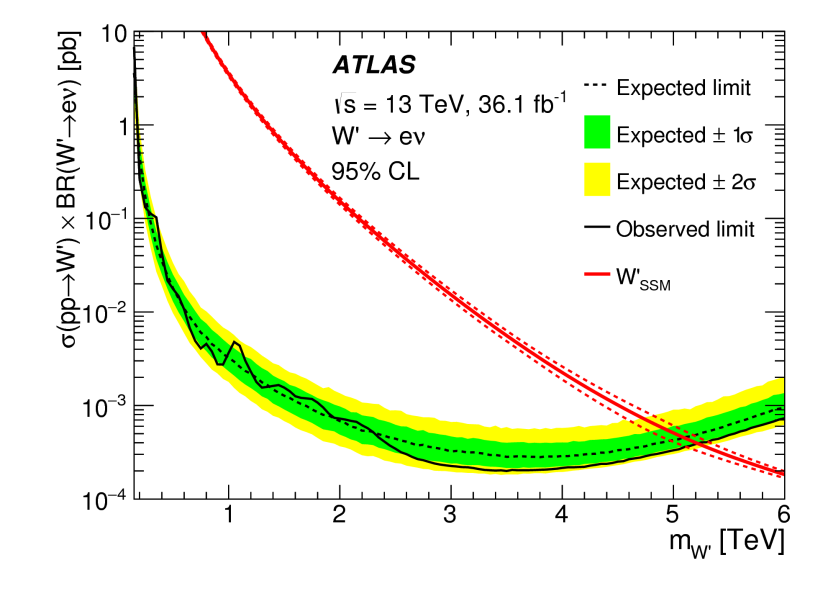
Transverse mass distributions

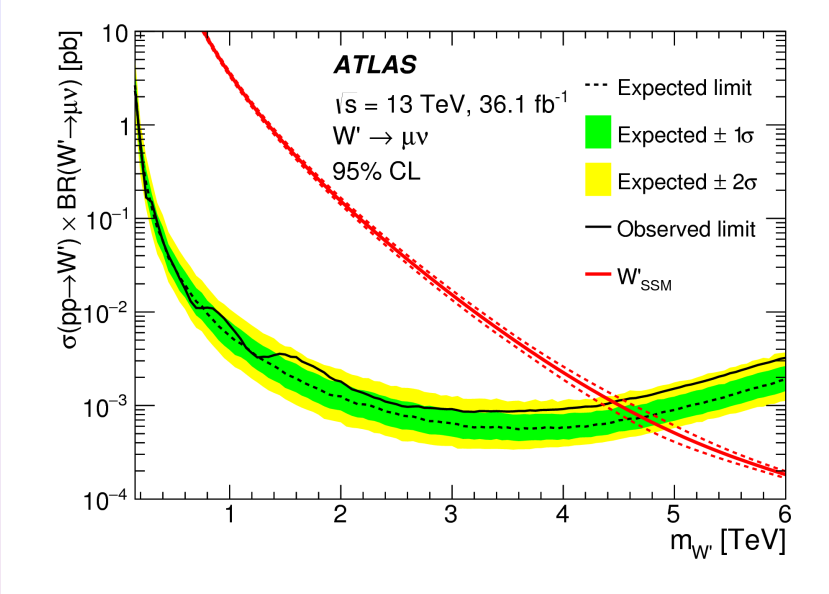




- Observation in generally good agreement with the background prediction
- Leading background uncertainties:
  - Low m_{T}: jet/$\not{E}_{\mathrm{T}}$ resolution and pile-up
  - High m_{T}: PDFs, background extrapolations, muon resolution

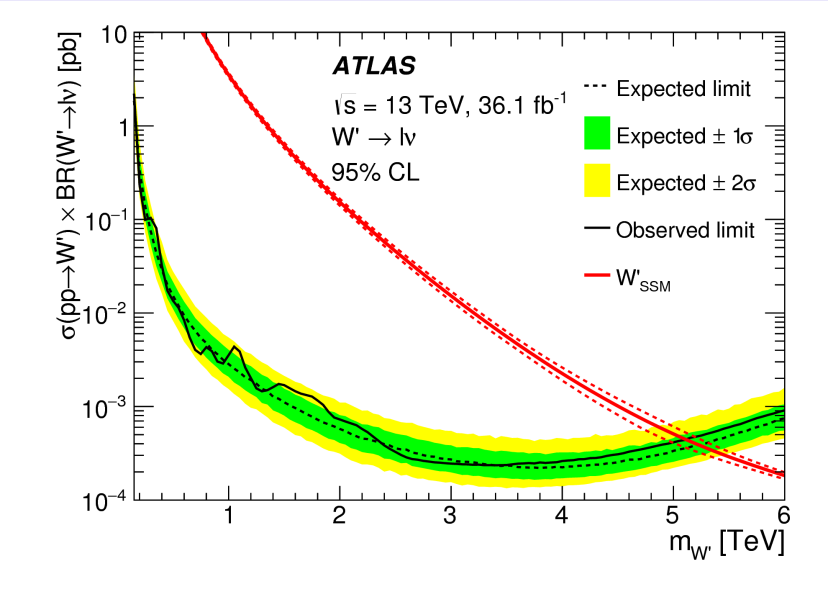
Statistical analysis results

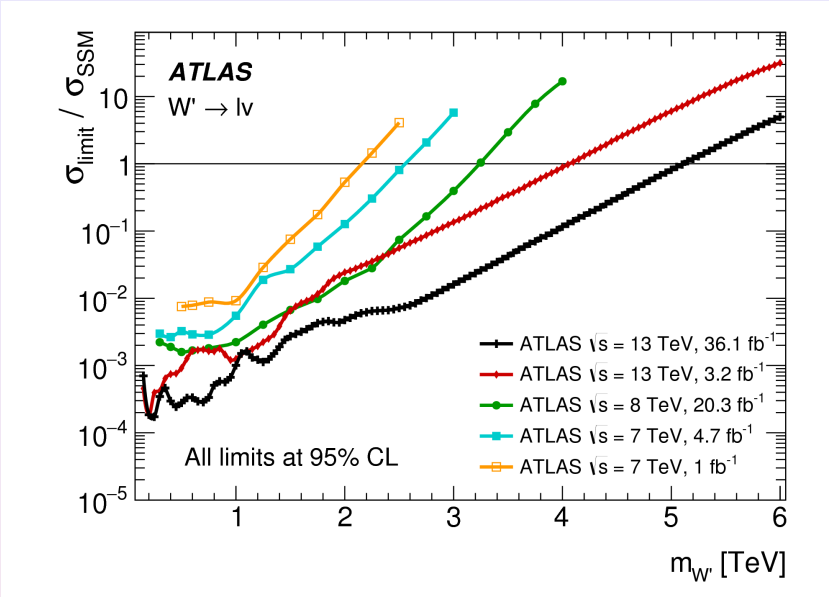




- Multi-bin statistical analysis with log-normal description of systematic uncertainties
- Dedicated treatment of MC statistical uncertainty
- Highest excesses at $m_{W'} = 350\,\mathrm{GeV}$ in the electron channel and $m_{W'} \approx 5\,\mathrm{TeV}$ in the muon channel
  - 2.0σ and 1.8σ local significance respectively
  - Spot on with expected background fluctuations (0.1σ global significance)

Combined SSM W' limits



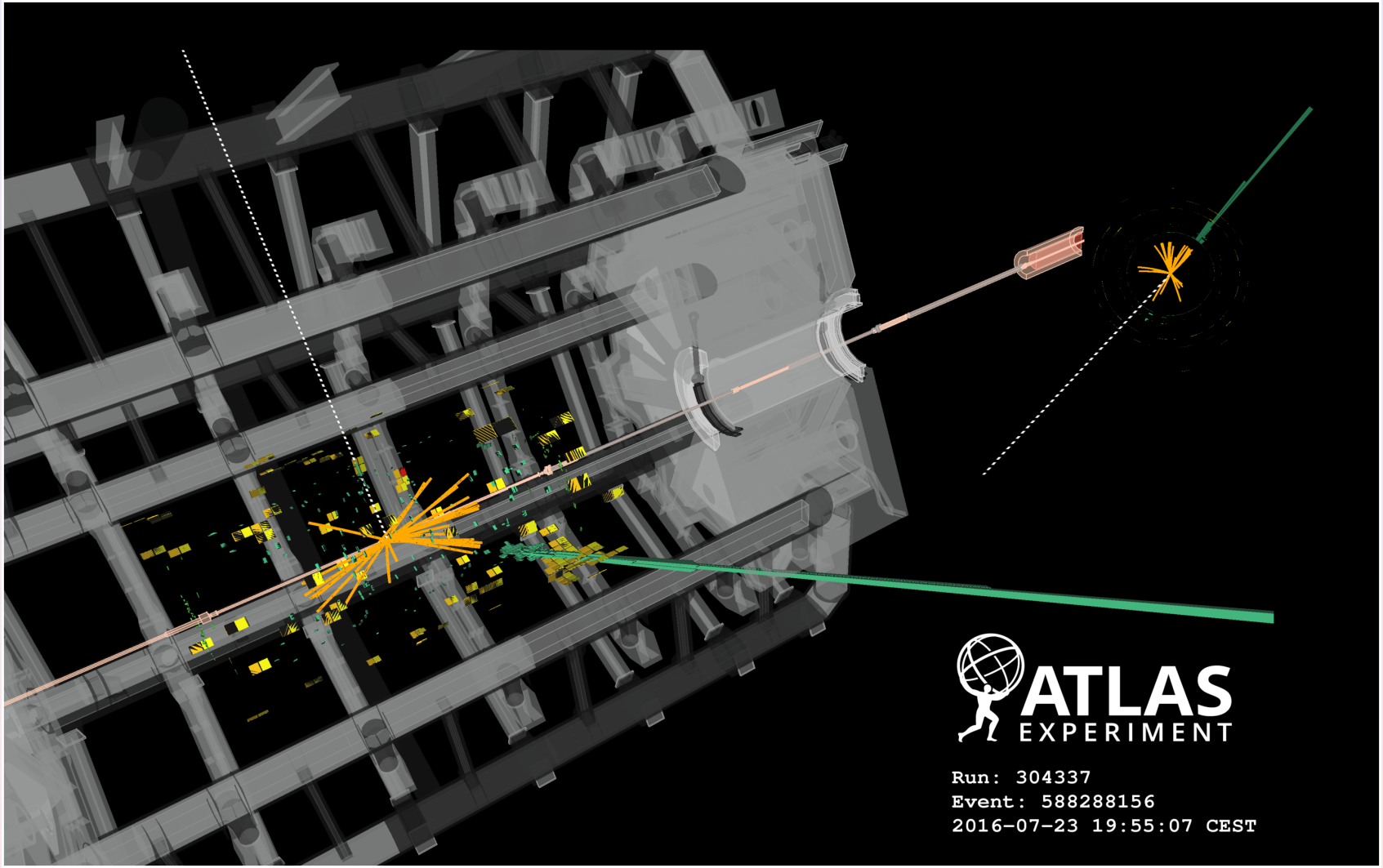


Decay	$m_{W'}$ limit [TeV] Expected	Observed
$W' \to e\nu$	5.1	5.2
$W' \to \mu\nu$	4.7	4.5
$W' \to l\nu$	5.2	5.1

- Combined observed: $m_{W'} > 5.1\ \mathrm{TeV}$
- Improvement of 1 TeV since last Spåtind

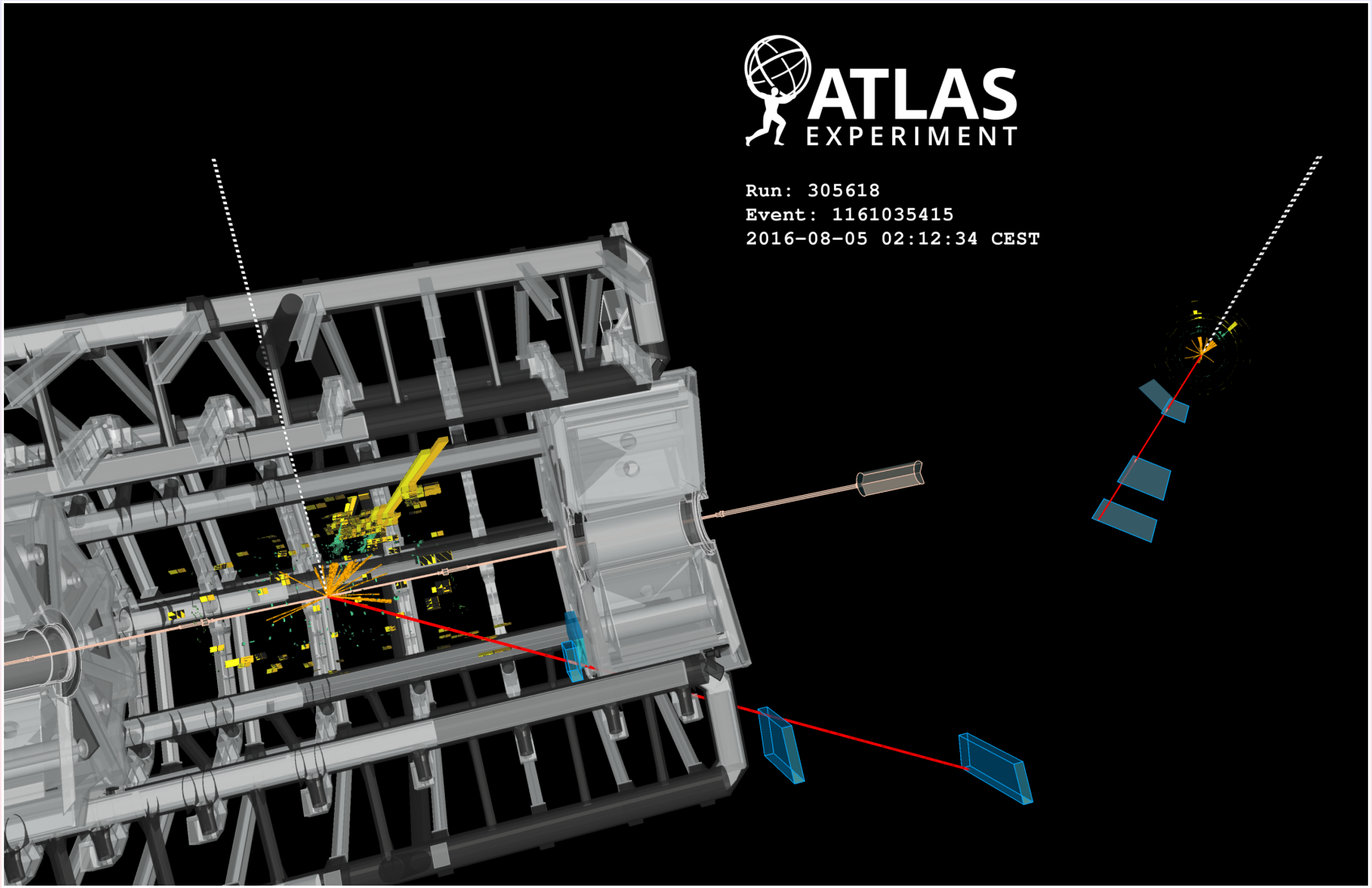
High-m_{T} electron channel event display

$p_{\mathrm{T}} = 1.1\,\mathrm{TeV}$, $\eta = 1.2$, $\phi = 0.9$, $\not{E}_{\mathrm{T}} = 1.2\,\mathrm{TeV}$, $m_{\mathrm{T}} = 2.3\,\mathrm{TeV}$

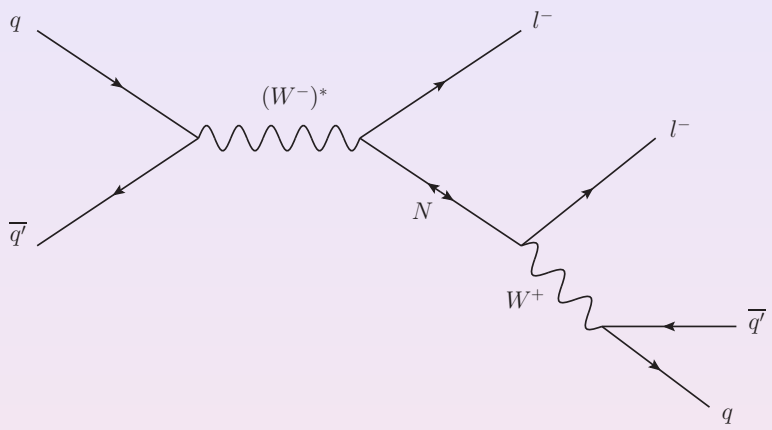


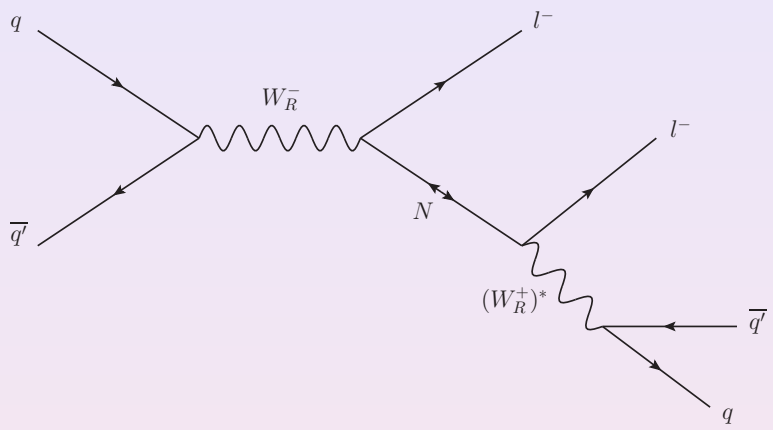
High-m_{T} muon channel event display

$p_{\mathrm{T}} = 2.8\,\mathrm{TeV}$, $\eta = -1.3$, $\phi = -2.1$, $\not{E}_{\mathrm{T}} = 1.9\,\mathrm{TeV}$, $m_{\mathrm{T}} = 4.5\,\mathrm{TeV}$



Plans for future involvement in heavy neutrino searches





- Hypothetical heavy right-handed neutrinos could potentially explain the lightness of the known left-handed neutrinos via the “seesaw mechanism”
- Majorana nature provides striking signature with *same sign* leptons

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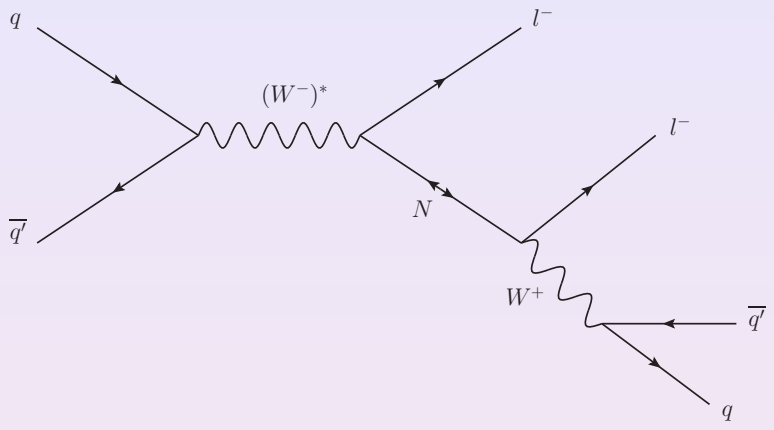

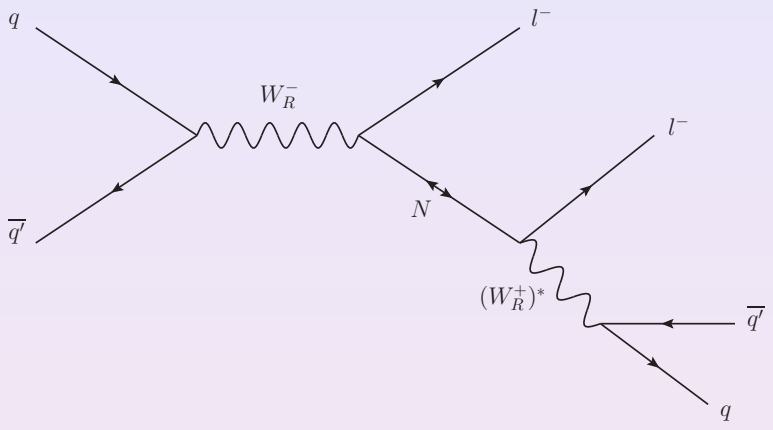

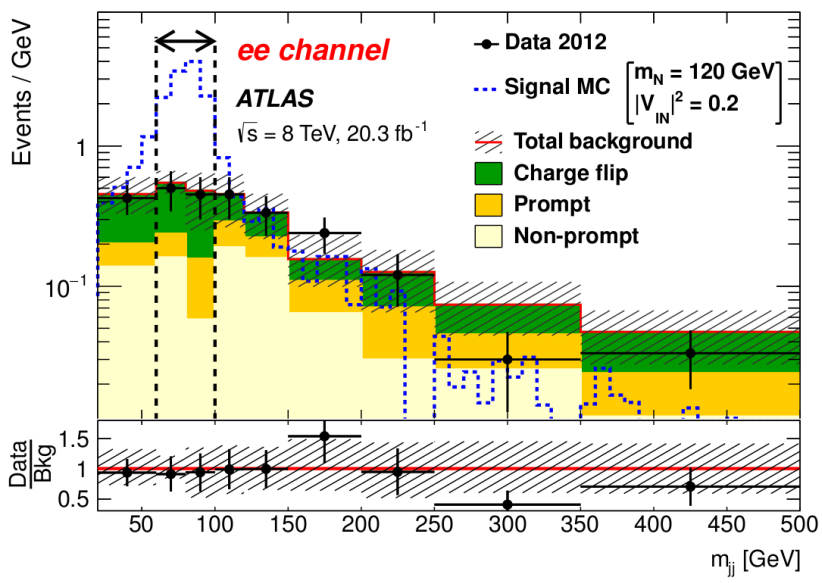

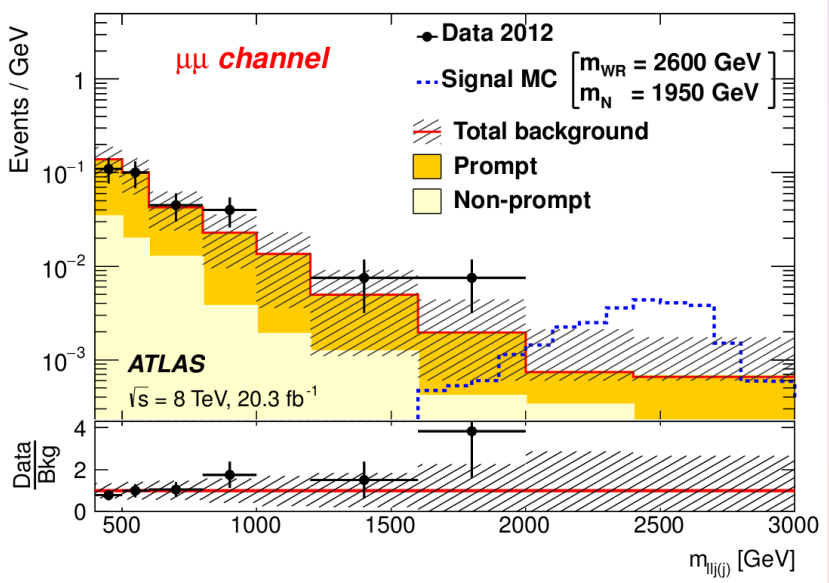

Conclusions

- A search for new physics in the lepton+$\not{E}_{\mathrm{T}}$ final state has been presented
- No significant deviation from Standard Model expectations is observed
- Limits are placed on the cross section for hypothetical new gauge boson production within the SSM reference model
- With an order of magnitude more integrated luminosity than for the 2015 data result, the mass reach is extended by about 1 TeV