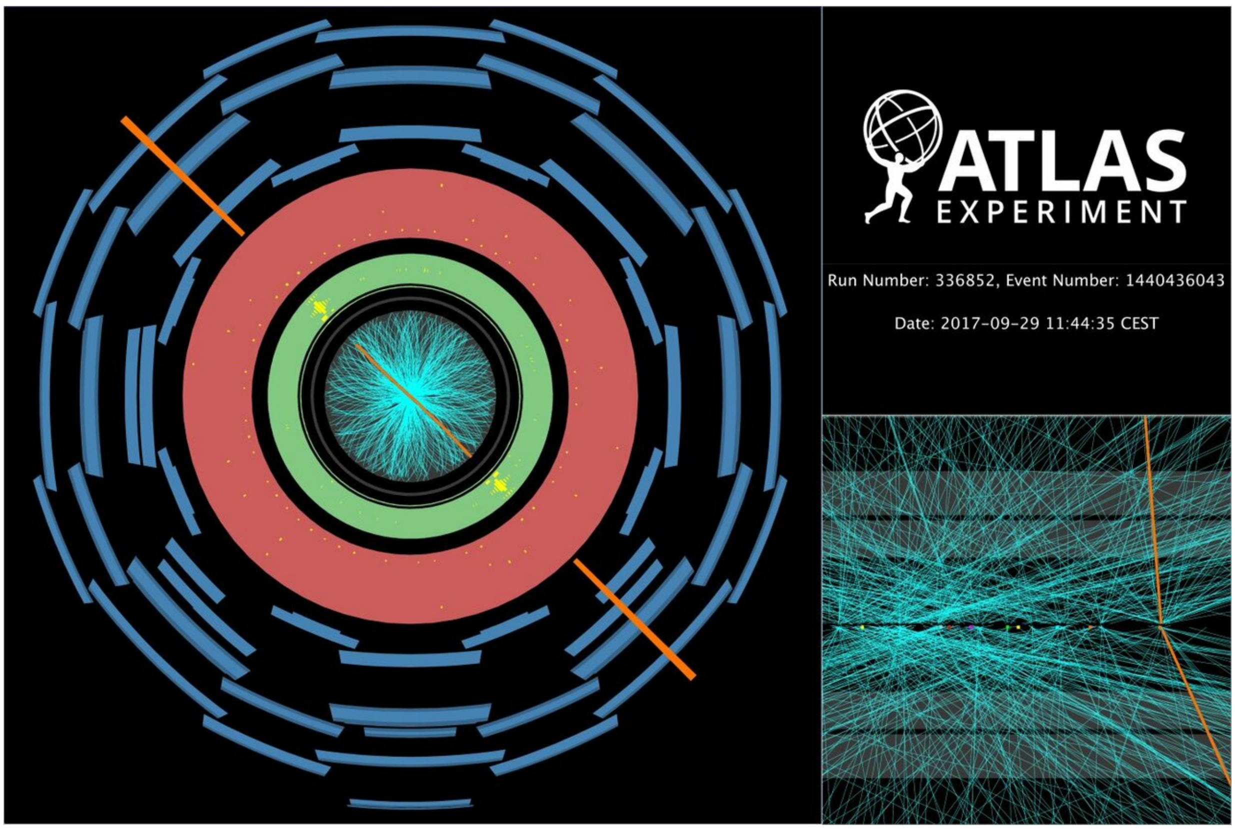
ATLAS Experiment releases first result with full LHC Run 2 dataset

March 13 2019

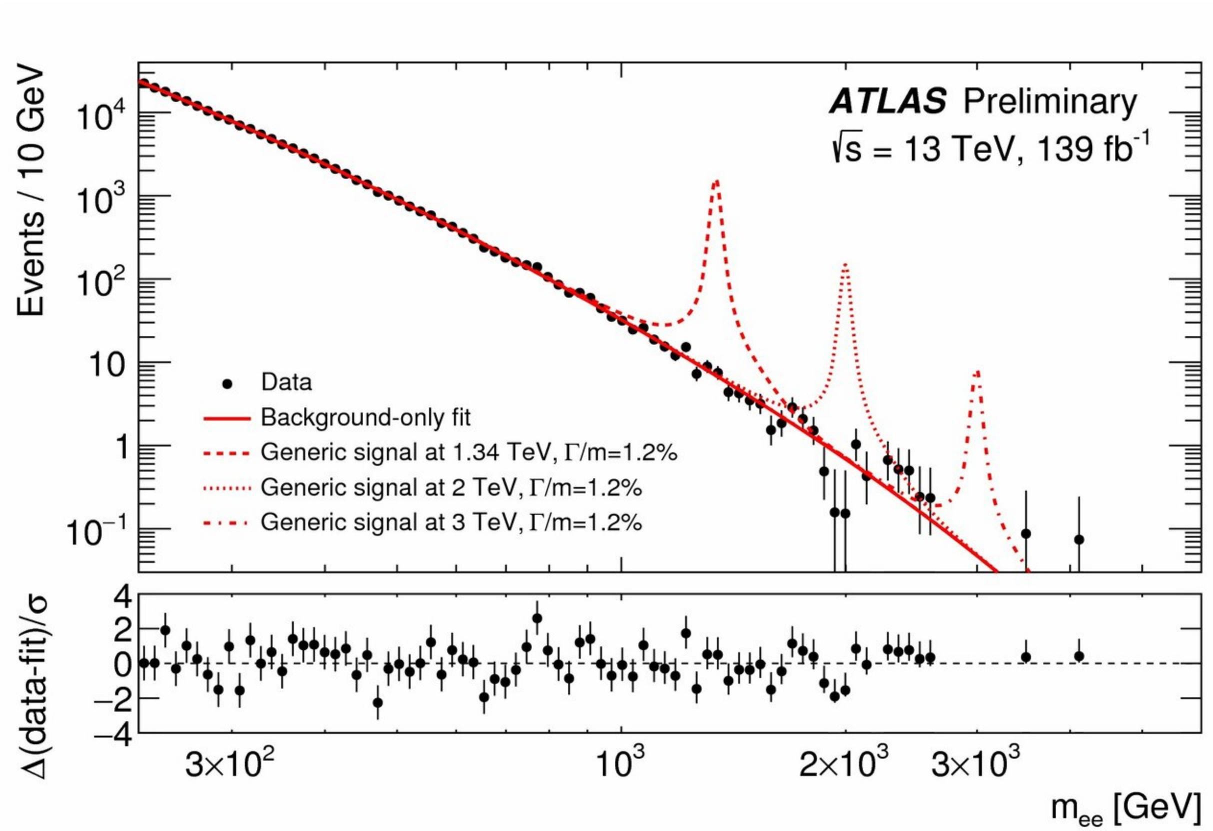


Display of a candidate event for new heavy particles decaying into two electrons in the ATLAS Experiment. Credit: ATLAS Collaboration/CERN

Could a Grand Unified Theory resolve the remaining mysteries of the Standard Model? If verified, it would provide an elegant description of the unification of Standard Model forces at very high energies, and might even explain the existence of dark matter and neutrino masses. Physicists at the ATLAS Experiment at CERN are searching for evidence of new heavy particles predicted by such theories, including a neutral Z' gauge boson.

The ATLAS collaboration has released its very first result utilising its entire Large Hadron Collider (LHC) Run 2 dataset, collected between 2015 and 2018. This analysis searches for new heavy particles decaying into dilepton final states, where the leptons are either two electrons or two muons. This is one of the most sensitive decays to search for new physics, thanks to the ATLAS detector's excellent energy and momentum resolution for leptons and the strong signal-to-background differentiation as a result of the simple two-lepton signature.

The new ATLAS result also employs a novel data-driven approach for estimating the Standard Model background. While the previous analysis predominantly used simulations for the background prediction and was carried out with a fraction of the data, this new analysis takes advantage of the vast Run 2 dataset by fitting the observed data with a functional form motivated by and validated with our understanding of the Standard Model processes contributing to these events. If present, the new particles would appear as bumps on top of a smoothly falling background shape, making them straightforward to identify (see Figure 2). This is similar to one of the ways that the Higgs boson was discovered in 2012, through its decay to two photons.



Measured dielectron mass distribution for the data (black points), together with the total background fit result is shown (red continuous line), with various possible Z' signal distributions overlaid (dashed red line). The sub-panel shows the significance of the deviation between the observed data and the background prediction in each bin of the distribution. Credit: ATLAS Collaboration/CERN

In addition to probing unexplored territory in the search for new physics, a great deal of work in this analysis has gone into understanding the ATLAS detector and collaborating with the various detector performance groups to improve the identification of very high-energy electrons and muons. This included accounting for the multiplicity of tracks in the inner part of the detector, as it continuously increased due to the rising average number of proton-proton collisions per bunch crossing during Run 2.

No significant sign of new physics has been observed thus far. The result sets stringent constraints on the production rate of various types of hypothetical Z' particles. As well as setting exclusion limits on specific theoretical models, the result has also been provided in a generic format that allows physicists to re-interpret the data under different theoretical assumptions. This study has deepened the exploration of physics at the energy frontier; ATLAS physicists are excited about further analysing the large Run 2 dataset.

More information: Search for high-mass dilepton resonances using 139 fb−1 of proton-proton collision data collected at 13 TeV with the ATLAS detector (ATLAS-CONF-2019-001): cdsweb.cern.ch/record/2663393

Provided by ATLAS Experiment

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