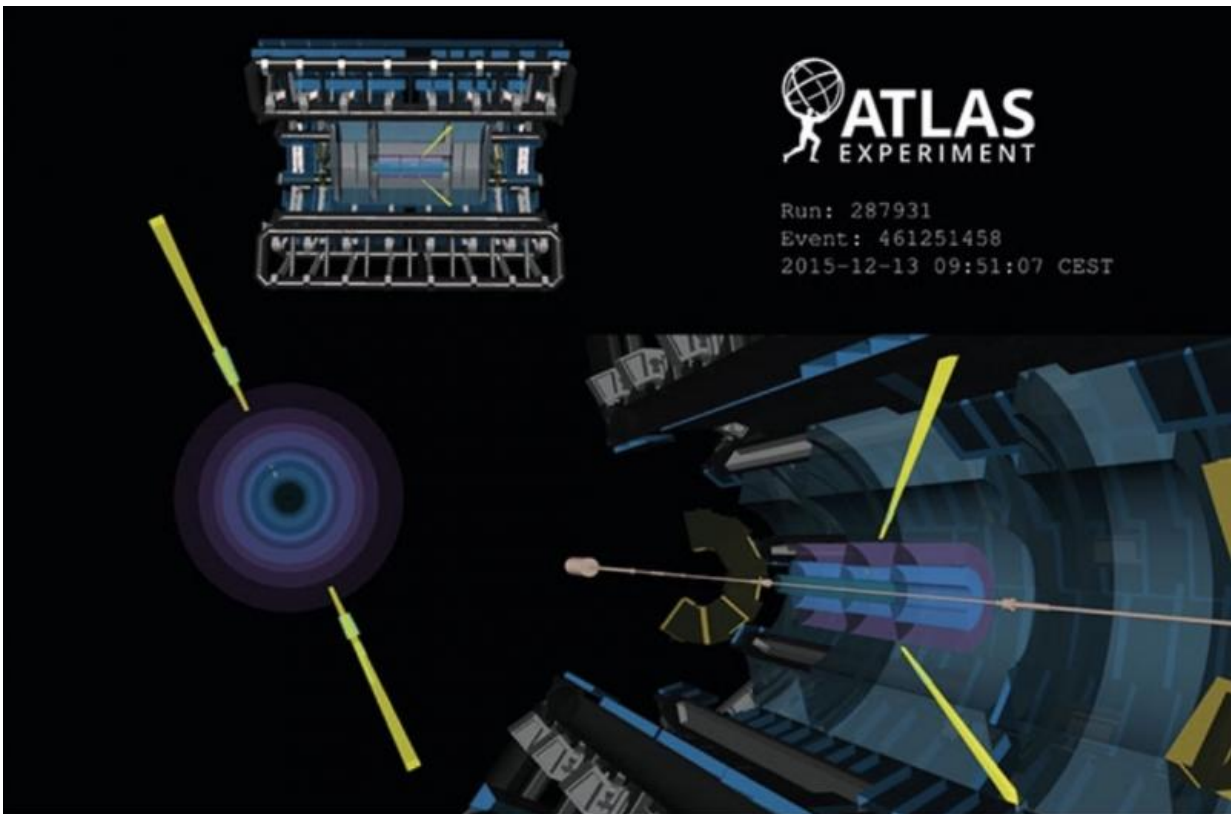


ATLAS observes direct evidence of light-by-light scattering

August 15 2017, by Katarina Anthony



A light-by-light scattering event measured in the ATLAS detector. Credit: ATLAS/CERN

Physicists from the ATLAS experiment at CERN have found the first direct evidence of high energy light-by-light scattering, a very rare process in which two photons – particles of light – interact and change

direction. The result, published today in *Nature Physics*, confirms one of the oldest predictions of quantum electrodynamics (QED).

"This is a milestone result: the first direct [evidence](#) of light interacting with itself at high energy," says Dan Tovey (University of Sheffield), ATLAS Physics Coordinator. "This phenomenon is impossible in classical theories of electromagnetism; hence this result provides a sensitive test of our understanding of QED, the quantum theory of electromagnetism."

Direct evidence for light-by-light scattering at high energy had proven elusive for decades – until the Large Hadron Collider's second run began in 2015. As the accelerator collided [lead ions](#) at unprecedented [collision](#) rates, obtaining evidence for light-by-light scattering became a real possibility. "This measurement has been of great interest to the heavy-ion and high-energy physics communities for several years, as calculations from several groups showed that we might achieve a significant signal by studying lead-ion collisions in Run 2," says Peter Steinberg (Brookhaven National Laboratory), ATLAS Heavy Ion Physics Group Convener.

Heavy-ion collisions provide a uniquely clean environment to study light-by-light scattering. As bunches of lead ions are accelerated, an enormous flux of surrounding photons is generated. When ions meet at the centre of the ATLAS detector, very few collide, yet their surrounding photons can interact and scatter off one another. These interactions are known as 'ultra-peripheral collisions'.

Studying more than 4 billion events taken in 2015, the ATLAS collaboration found 13 candidates for light-by-light scattering. This result has a significance of 4.4 standard deviations, allowing the ATLAS collaboration to report the first direct evidence of this phenomenon at [high energy](#).

"Finding evidence of this rare signature required the development of a sensitive new 'trigger' for the ATLAS detector," says Steinberg. "The resulting signature—two photons in an otherwise empty detector—is almost the diametric opposite of the tremendously complicated event typically expected from lead nuclei collisions. The new trigger's success in selecting these events demonstrates the power and flexibility of the system, as well as the skill and expertise of the analysis and trigger groups who designed and developed it."

ATLAS physicists will continue to study light-by-light scattering during the upcoming LHC heavy-ion run, scheduled for 2018. More data will further improve the precision of the result and may open a new window to studies of new physics. In addition, the study of ultra-peripheral collisions should play a greater role in the LHC heavy-ion programme, as collision rates further increase in Run 3 and beyond.

More information: M. Aaboud et al. Evidence for light-by-light scattering in heavy-ion collisions with the ATLAS detector at the LHC, *Nature Physics* (2017). [DOI: 10.1038/nphys4208](https://doi.org/10.1038/nphys4208)

Provided by CERN

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