

Abstract Submitted  
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**Turning Light Into Matter: First Physics Results Using ATLAS Forward Proton** JESSE LIU, University of Chicago, ATLAS COLLABORATION  
— What happens when we collide light at the most extreme laboratory energies? A hallmark of LHC photon collisions is that incident protons can stay intact as light collides and turns into matter-antimatter. This remarkable phenomenon is observed with a significance exceeding  $5\sigma$  in the first physics results using a novel instrument installed in 2017 called the ATLAS Forward Proton spectrometer. The analysis pioneers new data-driven calibration, background estimation and proton reconstruction techniques in  $pp$  collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector. This enables the first fiducial cross-section measurements of forward proton scattering when dielectron and dimuon pairs are produced via photon fusion  $(\gamma\gamma \rightarrow \ell\ell) + p$ . Directly measuring the intact proton resolves a long-standing question in non-perturbative dynamics about how often protons scattered down the beam pipe survive such processes. The proton-tagging techniques introduced to ATLAS open novel tests of QED at unprecedented energies and searches for new phenomena such as dark matter using the LHC as a photon collider. Based on Phys. Rev. Lett. 125 (2020) 261801

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