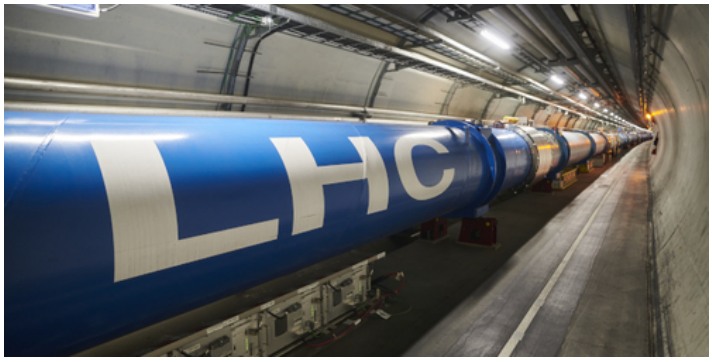
The Most Precise Value of the Top-Quark Mass to Date

Researchers at CERN have significantly increased the precision of the measured value of the top-quark mass, a key input for making standard-model calculations.

By **Nikhil Karthik**

In 1995, when scientists discovered the top quark, they estimated the particle's mass lay between 151 and 197 GeV/c^2, making it the heaviest-known elementary particle. Since then, scientists have worked on narrowing down the top quark's mass by accumulating more data. Now the CMS and ATLAS Collaborations at the Large Hadron Collider (LHC) in Switzerland have pooled 15 different measurements to obtain the most precise value for the top-quark mass to date: 172.52 $\pm$ 0.33 GeV/c^2 [**1**]. The top quark's mass is a key input for the standard model of particle physics for predicting parameters related to rare processes. The new top-quark-mass measurement will therefore enable improved calculations and a better understanding of issues such as quantum corrections to the Higgs boson properties.

The first determination of the top-quark mass was made using measurements of top–antitop-quark pairs produced in proton–antiproton collisions at the Tevatron, a particle accelerator that was active until 2011. Determining the new value involved measurements of such top–antitop-quark pairs as well, along with measurements of rarer single-top-quark events. In these events, a top quark emits a W boson and decays into a bottom quark in under 10^{-25} seconds, resulting in a stream of stable particles. The top quark's mass can be reconstructed from the characteristics of these particles.



Credit: CERN

In the new study, the CMS and ATLAS Collaborations considered statistical uncertainties that arose from having limited collision data. They also considered 25 classes of systematic uncertainties that occur in the calculations relating the top quark's mass to the properties of the particles observed in the LHC detectors. This combined effort resulted in a mass value that is 31% more precise than the most precise of the 15 input measurements.

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REFERENCES

1. A. Hayrapetyan *et al.* (CMS Collaboration, ATLAS Collaboration), "Combination of measurements of the top quark mass from data collected by the ATLAS and CMS experiments at $\sqrt{s} = 7$ and 8 TeV," **Phys. Rev. Lett. 132, 261902 (2024).**