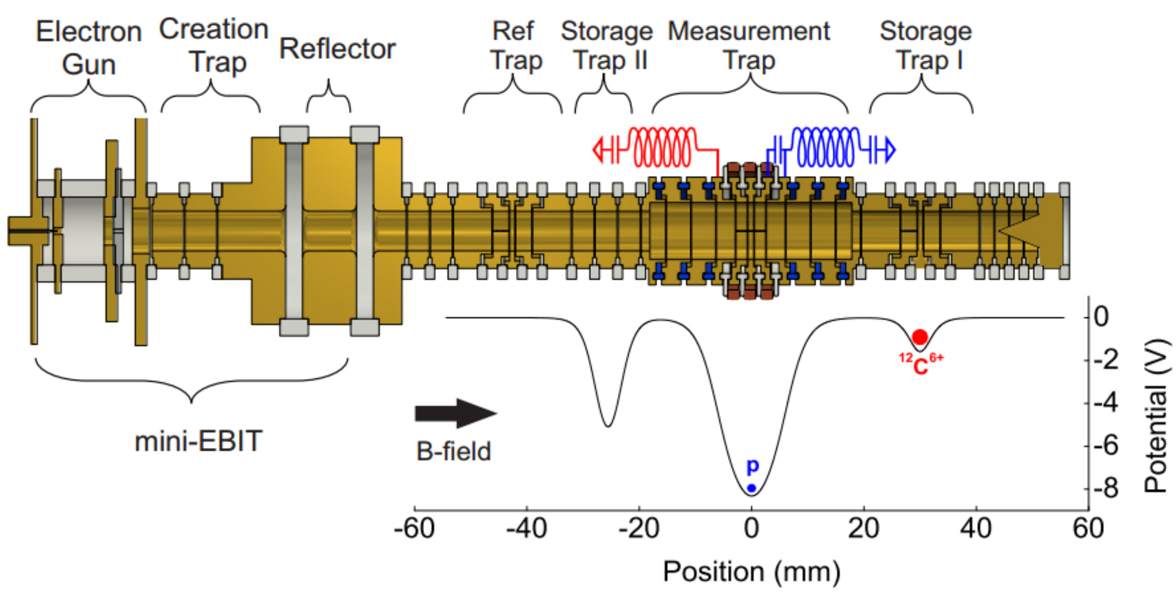
Higher precision measurements show proton mass less than thought

July 5 2017, by Bob Yirka



Sketch of the trap setup. The trap tower includes two separate storage traps (ST-I, ST-II), the measurement trap (MT) and a reference trap (RT) for magnetic field monitoring, which is presently not used. Ions are created in-situ using a mini-EBIT. By shuttling the ions between the storage traps and the MT, the time between successive measurements is minimized. Individual superconducting detection circuits for the proton (blue) and for the carbon ion (red), allow measurements at the identical electrostatic field configurations and thus guarantee the identical position and magnetic field. Credit: arXiv:1706.06780 [physics.atom-ph]

(Phys.org)—An international team of researchers has developed a new way to measure the mass of a proton and found the particle to be approximately 30 billionths of a percent less than previously thought. The group has written a paper describing their process and results and have uploaded it to the prepress server *arXiv*.

For some time now, the atomic mass of a proton has been an accepted standard measurement used to calculate other physics properties. Now, it appears researchers may have to revisit some of those entities as the most accurate ever measurement of the mass of a proton shows less mass than has been believed.

In this new effort, the researchers fired an electron beam at a selected target atom held in a chilled vacuum chamber, releasing a proton. The group was then able to isolate the proton in a Penning trap, which is a device that creates both an electronic and magnetic field. Inside the trap, the proton moved in circles—measuring its velocity allowed the researchers to calculate its mass, which was 1.007 276 466 583(15)(29) atomic mass units. The 15 in parentheses represented the statistical uncertainty and the 29 that followed represented the systematic uncertainty.

The group reports that their technique was three times more precise than any other technique used to date.

Others have noted that making more precise measurements of protons and other particles could explain some of the big mysteries in physics—such as why the radius of a proton has been found to be smaller than theory has suggested, or why there is more matter than antimatter. It could also help research efforts exploring apparent discrepancies between protons and antiprotons.

The research group has made clear its plans to continue refining its measuring technique—their goal is to improve the measurement for a proton by a factor of six. Meanwhile, if others are able to reproduce the work by the team, the new measurement could be included in the newest CODATA, which is scheduled for publishing in just a few months.

More information: High-precision measurement of the proton's atomic mass, arXiv:1706.06780 [physics.atom-ph]
arxiv.org/abs/1706.06780

Abstract
We report on the precise measurement of the atomic mass of a single proton with a purpose-built Penning-trap system. With a precision of 32 parts-per-trillion our result not only improves on the current CODATA literature value by a factor of three, but also disagrees with it at a level of about 3 standard deviations.