Measurement of the mass of the W boson

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The mass of the W boson is one of the most important physical constants as it determines the strength and finite range of the charged weak interaction (like the beta decay). It is introduced by the Brout-Englert-Higgs mechanism of spontaneous symmetry breaking in the Standard Model and can be calculated at high precision. It was measured before 2013 by the two Tevatron and four LEP experiments and those results agreed very well with each other and the calculations. Using these measurements the W mass was determined to be 80387 \pm 15 MeV, which was accepted as a world average [1]. However, 12 years after the stop of the Tevatron collider, in 2022 the CDF experiment published a new result [2] of high precision (see Fig. 1), which deviated from the previous ones quite significantly: 80433.5 \pm 9.4 MeV.

This discrepancy excited the LHC experiments. It is very hard to estimate the W mass at hadron colliders. Because of an overwhelming hadron production background one has to rely on leptonic decays, where the escaping neutrino causes missing energy in the detected events. Two LHC collaborations, ATLAS and LHCb in 2022-23 checked proton-proton collision data from the beginning of the LHC runs when the rate of the simultaneous collisions was not yet that high as later, and have found W masses similar to the world average, although with higher uncertainties. In my talk I shall describe a new CMS measurement [3] of the W mass relying on the muonic decays of W bosons produced in proton-proton collisions at 13 TeV. We have obtained a W mass of 80360.2 ± 9.9 MeV, which has a very high precision, agrees with the world average, and contradicts the 2022 CDF result.



Figure 1: Measurements of the W mass as compared to the Standard Modell calculation (EW fit) shown as a shaded area. Note that the 2013 CDF measurement, which agreed with the D0 one, is not plotted as that was averaged in the new CDF result.

References

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- [2] T. Aaltonen et al. (CDF), Science 376 170-176 (2022)
- [3] V. Chekhovsky et al. (CMS), Submitted to Nature, arXiv:2412.13872 [hep-ex].