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Muon collider: the Low EMittance Muon Accelerator (LEMMA) approach

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Summary

In order to further consolidate the present knowledge of the Standard Model and to look for deviations from its predictions that would signal new physics effects, a new generation of hadron-hadron or electron-positron colliders is put forward.

However also the idea of a muon collider seems to be attractive because such a machine would provide the high centre of mass energy typical of a hadron-hadron machine in the clean experimental environment typical of an electron-positron machine.

Hence the muon collider can explore the multi-TeV energy frontier as well as be used as a clean Higgs factory. Clearly the muon collider has to face quite a few challenges.

One of these is the production of a low emittance muon (antimuon) beam to be fed into a suitable accelerator complex.

Recently the idea of getting such muons (antimuons) from collisions of an about 45 GeV low emittance positron beam on a fixed target has been put forward. The 45 GeV incident positron energy is chosen because it corresponds to the energy threshold of the process $e^+ e^- \rightarrow \mu^+ \mu^-$, which, at threshold, should give the wanted muon (antimuon) low emittance particles flux.

The experimental proof of this expectation is the goal of the Low EMittance Muon Accelerator (LEMMA) collaboration who carried out in Summer 2017 and Summer 2018 dedicated tests with a 45 GeV positron beam at the CERN H4 (2017) and H2 (2018) experimental areas. These tests were based on a silicon telescope setup complemented by a dipole magnetic field, muon chambers and a set of calorimeters, to tag electrons and positrons.

The ultimate goal of the LEMMA collaboration is the measurement of the emittance of the produced muon (antimuon) particles flux and of the corresponding cross section at threshold.

A description of the muon collider project and of the reaches in terms of physics will be given first.

Then the concepts and the experimental setup used for the 2017 and 2018 emittance test beams will be presented together with a summary of the results reached so far.

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