Joint DESY and University of Hamburg Accelerator Physics Seminar

Friday, 16.05.2025 14:00

Hybrid Seminar:

Seminar Room 30b/459 & `zoom` Video Access

Muon Colliders — Challenges from Collective Effects

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Abstract

In the framework of the International Muon Collider Collaboration, a 10 TeV centre-of-mass muon collider ring is being studied, with a possible first collider stage at 3 TeV. Generating two counter-rotating high intensity low-emittance muon bunches of opposite charge for the experiments requires a specific complex of accelerators. First a proton driver produces a high power proton beam which hits a target to generate pions. The pions then decay into muons and anti-muons, and these bunches undergo 6D ionization cooling to reduce their transverse emittance by a factor $\sim$1000. When the target emittance is reached, the two counter-rotating bunches must be quickly accelerated in a series of Recirculating Linacs (RLAs) and Rapid Cycling Synchrotrons (RCS) to minimize the intensity loss from muon decay. The two bunches reach then the collider ring and collide at two interaction points. The whole complex operates at a 5 Hz repetition rate to increase the integrated luminosity.

The bunch intensity must reach $43 \cdot 10^{12}$ muons or anti-muons at the start of the ionization cooling to meet the intensity target of $1.8 \cdot 10^{12}$ in the 10 TeV collider ring. Coherent effects are therefore a concern in all the accelerators of the chain as they could lead to instabilities, therefore limiting the intensity reach and increasing the transverse emittance. Because of the variety of machines present in the complex, a diverse range of coherent effects will be present such as coherent direct space-charge, beam break-up, head-tail instability or beam-beam effects. Impedance models were developed for the RCS and collider rings, estimating the impact of the RF cavities and beam chamber on transverse beam stability. Simulations tools were developed to perform tracking simulations from the start of the acceleration chain to its end, through four different accelerators. In the RCS, studies on the impedance and eddy current effects in the pulsed magnets vacuum chambers have been undertaken and are driving the chamber design. Several other effects are still being investigated such as the direct space charge in the proton driver, the impact of beam loading in the muon cooling and the two-beam wakefields in the RCS.

NOTE THE UNUSUAL DATE AND TIME

W.Hillert, (Univ. HH), I.Agapov (MPY) and M.Vogt (MFL).