Muon Bunch Compressor Based on a Low RF Ring Cooler

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I INTRODUCTION

One of the most serious problems concerning the construction of a Higgs factory (or any other muon collider) is the creation of very short high intensity muon bunches [1]. A precooling part including pion producing target, decay channel, and low RF phase rotation system, can provide a muon bunch of 6-10 m length in the best case [2], whereas a 200 MHz cooling channel requires at least 10-15 times shorter in bunch length. A strong emittance exchange combined with the beam cooling appears to be the most reasonable method to this end. A ring cooler proposed in Ref. [3]– [4] is considered in this paper. From a technical standpoint, a low frequency and high gradient accelerating system is the critical part in this scheme. Assumed is an 8 MHz and 3 MeV/m RF system that provides capture in the bucket of 10 m length, acceleration, and—with appropriate absorbers— a reasonable cooling rate / emittance exchange at modest beam loss caused by muon decays. Longitudinal cooling factor 6-40 is achievable in this system, depending on used approximations. Transverse nonlinearity of bending magnets, as well as dependence of the revolution frequency on transverse momentum, are the most serious causes of the degradation. These and other effects are investigated including some measures to improve the cooler performance.

II DESCRIPTION OF THE COOLER

The ring cooler described in the paper [4] is taken as a basis for the designed bunch compressor. Schematic and parameters of the compressor are given in Fig. 1 and Table 1. It consists of $8\times 45^\circ$ dipoles, 4 short straight sections (SS), and 4 long SS. The long SS containing RF cavities and liquid hydrogen absorbers are intended for transverse cooling of muons. Wedge absorbers for an emittance exchange are placed in the short SS where there is large dispersion. Thus, there are 4 periods, each including the bending part and the straight section.

Layout of the bending part is displayed in Fig. 2. It consists of 2 bending magnets and 2 solenoids with opposite direction fields. Besides forming a circular orbit, this part provides transverse focussing and dispersion required for the emittance exchange.

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