FROM COSY TO HESR

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Abstract

The High Energy Storage Ring (HESR) at the proposed Facility for Antiproton and Ion Research (FAIR) puts strong demands on quality and intensity of the stored antiproton beam in the presence of thick internal targets. The existing synchrotron and storage ring COSY in Juelich can be seen as a smaller model of the HESR.

In this paper we will discuss possible benchmarking experiments at COSY, involving effects like beam cooling, target heating, intra-beam scattering etc. The aim of these experiments is to support the design work for the HESR and ensure that the specified beam conditions can be achieved.

INTRODUCTION

The HESR is part of the antiproton facility of the proposed FAIR facility in Darmstadt [1]. It is designed to store the antiprotons from the RESR at 3.8 GeV/c and de- or accelerate them to momenta between 1.5 GeV/c and 15 GeV/c [2].

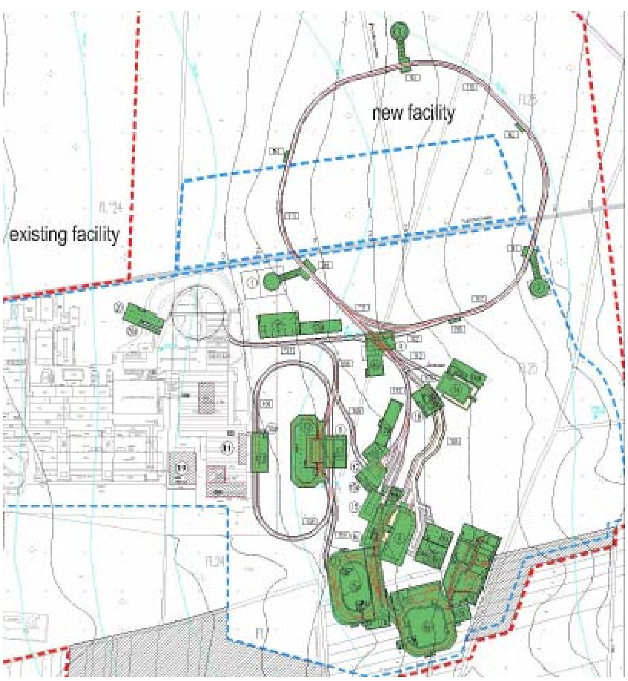

Figure 1: The FAIR facility

As first generation experiment the PANDA collaboration [3] requests highly demanding beam properties in terms of emittance and momentum resolution, which can only be fulfilled by strong beam cooling. To optimize a cooling scenario and to study the limits in beam quality and beam intensity the interaction between beam cooling and beam heating mechanisms have to be well understood and studied. Some of the necessary studies can and will be performed at the existing cooler synchrotron COSY in Jülich [4], which delivers protons in the momentum range between 300 MeV/c and 3.7 GeV/c.

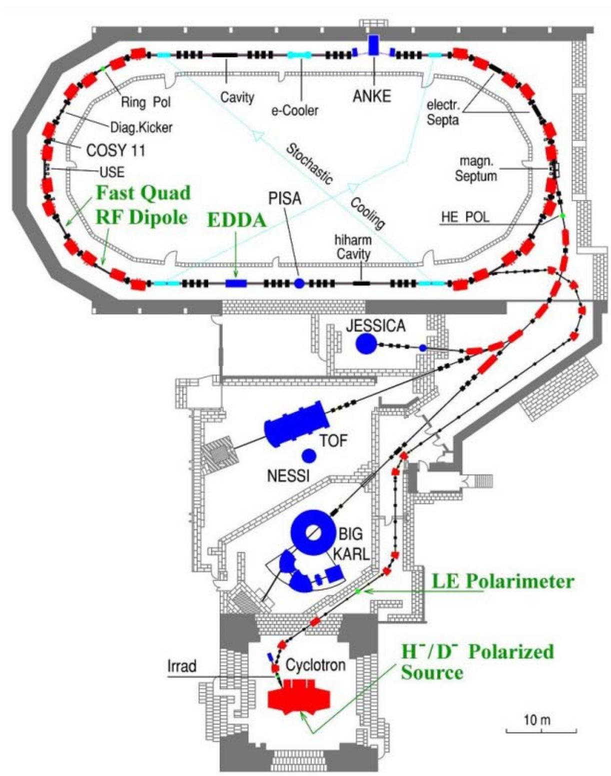

Figure 2: The COSY accelerator facility

At COSY an electron cooler with electron energies up 100 keV allows cooling of protons up to 600 MeV/c, and a stochastic cooling system for the momentum range from 1.5 GeV/c to 3.7 GeV/c is implemented. Several internal target areas with hydrogen cluster targets or the recently installed WASA-pellet target will be used to study the equilibrium beam properties with beam cooling and the influence of the beam – target interaction.

ELECTRON COOLING

The COSY electron cooler is designed for electron energies up to 100 keV, but is generally used at injection momentum to cool injected protons with a momentum of 300 MeV/c to the maximum achievable phase space density.

Figure 3: The COSY electron cooler

Beam lifetimes and beam instabilities as function of beam intensity were investigated [5]. In Figure 4 it is demonstrated how the beam lifetime of 45 MeV protons cooled with 150 mA electron current strongly depends on the intensity of thestored proton beam.

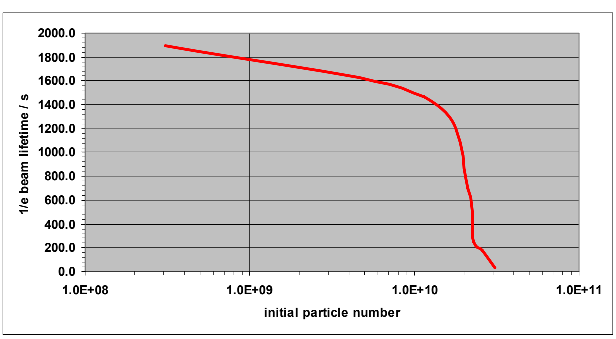

Figure 4: Beam lifetime of 45 MeV protons cooled with a 150 mA electron cooler beam current

First tests of cooling 130 MeV protons with 70 keV electrons were carried out. For the future this energy will be used to investigate the proton beam behaviour, equilibrium beam emittances etc. of electron cooled protons interacting with a hydrogen gas target.

STOCHASTIC COOLING

Stochastic cooling in COSY is used for equilibrium experiments with long flattop times of circulating protons and a hydrogen cluster target of appr. 10^{14} cm^{-2} thickness. Modell calculations were carried out to predict the beam conditions in the equilibrium between target interaction and stochastic cooling. The model description and the results are discussed in [6]. In future the Uppsala-WASA detector including the pellet target with an effective target thickness of 10^{15} cm^{-2} will be installed in COSY. [7]. With this and the solenoidal field of the WASA detection system COSY delivers similar experimental conditions as the HESR with the internal PANDA detector. So, it is obvious to test the beam behaviour in equilibrium conditions of stochastic cooling and target heating. These experimental results will be used as benchmarking of simulation results gained by several working groups [8].

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