Introduction to Particle Accelerator Complex at GSI/ FAIR and Some Interesting Aspects of SIS Upgrade Program

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Introduction

A heavy-ion particle accelerator facility Gesselschaft für SchwerIonenforschung (GSI) [1], in Darmstadt, Germany, permits experimental investigations in the field of nuclear and hydronic physics, atomic and laser physics, material science, plasma and bio physics with applications to cancer therapy. Particles from Proton to Uranium are accelerated in this accelerator complex.

An International, next generation, accelerator facility (Facility for Antiproton and Ion Research, FAIR) with unprecedented ion-beam intensities and energies is foreseen alongside the GSI (Ref. Fig. 1). As per the plan, the existing UNIversal Linear ACcelerator, UNILAC and Heavy-ion synchrotron, SIS at GSI, with modified parameters, will be used to inject a high quality and high intensity particle beam to the

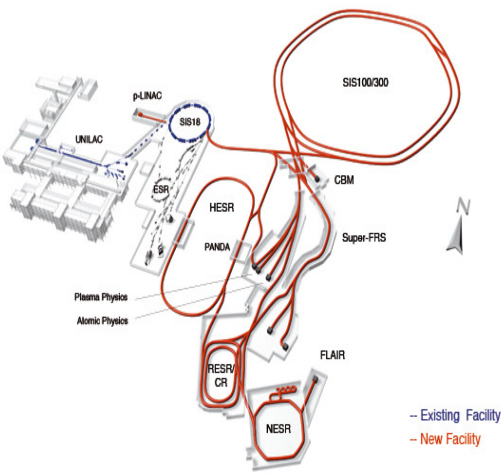

Fig. 1 Existing GSI and upcoming FAIR accelerator complex

FAIR synchrotron rings, SIS100/300 [2]. From this perspective, SIS upgrade program is an important and integral part of the FAIR.

It includes studies like capturing of un-bunched coasting beam in SIS entering from UNILAC [3]. An efficient adiabatic capturing process assuring the required beam quality will be discussed.

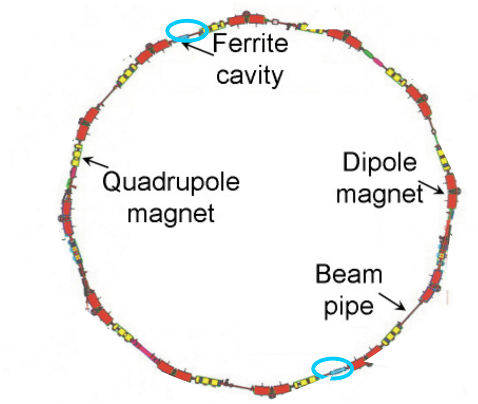

Fig. 2 Major components in SIS ring at GSI.

In a synchrotron, beam acceleration is effectuated by an alternating longitudinal electrical field. This field is generated in the radio frequency (rf) resonator, known as rf cavity (Ref. Fig. 2), which is powered by a rf generator. The interaction of charged particles with the beam surroundings like vacuum chamber, rf cavities etc., and with each other are among the principle limiting factors governing the beam intensity. Among other beam-intensity-dependent effects, beam loading and space charge will be briefly addressed [3, 4].

At GSI/FAIR, achieving the high intensity of rare isotopes, with low abundance and lifetime, is a technically challenging task. These particles are to be collected and cooled in order to achieve a sufficient intensity to perform different experiments. As a possible technical solution, a dedicated rf cavity known as barrier-bucket cavity is designed and developed to perform this task [5].

In a synchrotron, charged particle beam is guided and focused by transverse magnetic field. This field is generated by several type of magnetic elements (electromagnets) cascaded in vacuum chamber of synchrotron ring (Ref. Fig. 2). These electromagnets are powered by specially designed power supplies widely known as power converters. At GSI these electromagnets are of normal conducting type and operated by power converters ranging from few volts up to 300kV encompassing several topologies to fulfill the operational demands. At the heart of the FAIR is superconducting synchrotron (SIS100) with technically advanced, fast ramped (4T/s), superconducting magnets ramped up to 1.9 T. Peculiarities of these power converters and design considerations, keeping in view these complex magnetic loads will be presented.

References

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