INTRODUCTION

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OVERVIEW

The primary task of GFA is to provide high quality proton and electron beams for users, with maximum possible availability. Beside this, a substantial fraction of manpower is dedicated to ongoing PSI projects, as UCN, MEGAPIE, PROSCAN and LEM.

The consolidation of the new organization during the year 2003 is best characterized by the unification of SLS and proton accelerator operation in one common control room. This resulted in an increase of efficiency and therefore a gain in manpower that became available for urgently needed upgrades on the accelerator facilities.

In order to evaluate the technical conditions of all GFA accelerators a workshop was held in Riedern am Wald, in September 2003. The goal was to discuss critical issues of all accelerator facilities and to establish a catalogue of urgent actions in order to reduce the risk of machine failures.

OPERATION

The overall performances of the proton and electron facilities in year 2003 are comparable to those of the previous year. The integrated beam charge of the cyclotron delivered to target E amounted to 8.1 Ah as in 2002, despite the slightly longer shutdown. The availability was close to 90 %. Short term (< 15 min) and medium term (15 min to 2 hrs) interruptions contributed to about 30 % each to the down time. Interruptions longer than 2 hours due to more severe failures account for about 40 % of the down time. Most of the problems could be solved within less than 6 hours.

The long, exceptionally hot period during this year's summer was adversely affecting the running statistics of all facilities. The increase in temperature of the Aare River to a maximum of 26°C and of the ground water to 16°C, the primary cooling sources for the accelerators, caused a reduction in cooling capacity which became insufficient for normal operation of the facilities.

For the cyclotron, the beam current had to be limited during daytime to 1500 μA. The air-conditioning and the heat-exchangers for the RF-systems were running at the limit of their capacity with the consequence of poor beam stability.

Although the SLS cooling system is equipped with additional refrigerators, the very high outside air temperatures exceeding 40°C caused a reduction in efficiency and frequent interruptions due to breakdowns of the cooling compressors and instabilities in the cooling regulations. The temperature in the experimental hall and the storage ring tunnel had to be increased. These changes triggered a long series of problems, among them the most harmful, mechanical displacements of magnetic and diagnostic elements in the tunnel.

PROTON ACCELERATORS

The operation after the yearly shutdown started with a small inconvenience but was concluded very successfully at the end of the year.

At the beginning, the electrostatic extractor revealed many discharges while RF was on. An additional shielding cured the problem but the start up with beam currents beyond 1 mA was delayed by two days. The end of the running period was characterized by two very successful weeks. It was possible to increase the beam current up to 1900 μA for a longer period (10 days) without significant change of the overall losses. During the last 24 hours, very stable operation at 2000 μA could even be demonstrated. This improvement was achieved mainly by the power increase in the 150 MHz resonators of the injector cyclotron and a modified beam trajectory at injection of the ring-cyclotron.

Injector 1 was operated on a reduced scale, with several long shutdowns and standby periods. Beam was delivered during 12 weeks to the OPTIS facility and, parasitically, to test electronic components for spatial research and industry. A period of 13 weeks was dedicated to the LISOR irradiation experiment. Four two week periods with Neon and Argon beams were scheduled for tests in the field of heavy elements but the last one had to be cancelled. The occasional occurrence of the well known vacuum problems required some patience from the users.

LIGHT SOURCE

The operation of the SLS in 2003 is characterized by a long series of very successful weeks interrupted by a few very bad ones due to the exceptional weather conditions. Nevertheless, the overall availability with 94.2 % was comparable to that of last year, with a current increase of about one third. The statistics was dominated by a single event, a moving obstacle in the vacuum chamber of sector 6. A defective support allowed an absorber to move into the beam pipe and inhibited injection. This accounted in total for 173 of 307 hours downtime. On the other hand, the mean time between failures of the storage ring could be improved by 50 % with respect to last year's operation to about 45.9 hours. The percentage of the injector downtime could even be reduced by a factor of two.

The 3rd harmonic cavity was suffering again from some "childhood diseases": a leak in the isolation vacuum of the liquid helium transfer (11 h) and a breakdown of a helium compressor turbine (24 h) were major contributions to the overall downtime.

In order to alleviate the extremely negative impact of such incidents on user operation, it was decided to schedule reserve time that can be offered to the users in such cases.

MACHINE UPGRADES

During the shutdown in 2003, a test installation of the prototype cavity in the ring cyclotron was performed. The site acceptance test of the cavity could be successfully concluded by a 24-hour power run dissipating the nominal 500 kW of RF power. In January 2004, the cavity will be installed in the ring cyclotron and RF power tests will confirm the functionality of the cavity in the accelerator.

For Injector 2, the 150 MHz RF-system was upgraded according to the concept proposed in 2001. The number of turns has been reduced from 85 to 82 by almost doubling the RF-Power fed to the 150 MHz resonators. This results in a reduced beam emittance of the extracted 72 MeV proton beam and in consequence to a substantial reduction of the losses in the extraction region of the 590 MeV cyclotron. This demonstrates that the replacement of the 150 MHz flat top resonators by 50 MHz accelerating units will be an essential step to increase the current in the 590 MeV cyclotron beyond 2 mA.

At the SLS, after 2 years of slow orbit feedback (SOFB) operation, the fast orbit feedback (FOFB) became operational which suppresses orbit fluctuations up to ~ 60 Hz. In addition, the SOFB readings on X-BPMs could compensate for slow drifts caused by temperature dependent BPM readings without interfering with the FOFB. This allowed us to further optimize the already excellent orbit stability and to reduce the orbit distortions generated by the operation of insertion devices. The position stability in the low frequency range could be improved to values of 100 nm and less.

Improvements were performed on the cryogenic system of the superconducting higher harmonic cavity. The multi-bunch feedback system has been commissioned and will be implemented for high current operation in 2004.

PROJECTS

Like in previous years, there was a strong involvement of the GFA department in other PSI projects.

Special attention has to be paid to the target assembly of the UCN since it will become the highest activated component. Nuclide inventories have been calculated for the different components of the target, assuming an irradiation of 1 year with an average proton current of 20 μA. Based on the results an exchange flask to safely remove the target has been designed.

For the project MEGAPIE an optical detection system (Vimos) has been developed that monitors the beam intensity distribution at the entrance to the target. This is crucial to avoid damage to the container that would result in a leakage of liquid metal.

For the LEM project, problems came into being with the supplier of the radiation hard Pyrotenax coils. He could not maintain his promises and a new contract had to be placed to BINP in Novosibirsk. In the meantime, all installations that could be done during machine operation were anticipated and completed before the final reconstruction in shut-down 2004.

A pre-assembly of the beamline was performed to minimise last-minute corrections. Compared to the old design several improvements were implemented for the shielding and in order to facilitate the handling. The first bending magnet was shielded by extra copper plates, the second by polyethylene plates. Another improvement is the vacuum flange compression chain developed by the PSI vacuum group. The new chain connection optimally applies the pressure to the metallic seal and is easy and fast to dismantle.

The effort for the PROSCAN was maintained also this year at equally high level, covering essentially all accelerator aspects. In 2003 the preparations of the technical infrastructure of the facility have been widely concluded. A degrader system has been realized that meets the requirements as given by the application of the spot scan technique. By using two multi-wedge high-density graphite absorbers, the energy of the proton beam can be rapidly and continuously adjusted from 238 MeV down to 70 MeV. Two collimators, each with a stack of five different apertures can be inserted into the beam to define the emittance.

The LEG (low emittance gun) project was continuing. Due to the high load of all people contributing to this task, the critical mass could not been reached yet and the progress was slower than expected. At least one person could be hired who is now fully dedicated to the project. The development is pursued in four directions: (1) the theoretical investigations and simulations of particle dynamics; (2) the production of field emitter tip arrays and the set up of a test stand; (3) the development of a stable and fast high voltage pulser; (4) the design of a cathode assembly with high gradient acceleration.

OUTLOOK

The major highlight of 2004 will be the installation and commissioning of PROSCAN. The installation of the new cavity in the 590 MeV cyclotron also opens a new area of beam performance. In addition, LEM will go into operation and deliver high class muon properties. Activities for the proton machines will be oriented towards risk reduction and increase of machine availability. This includes the preparation of additional spare parts and the development of new systems as replacements for old high risk equipment.

At the SLS, it is scheduled to bring three new beamlines into operation next year and to prepare the machine for femto second X-ray pulses in 2005. At the same time the standard user operation will see an increased current of 400 mA. The work on the LEG project will be intensified and a first test set up will be brought in operation.