SUMMARY OF SESSION 6
WHAT IS SO SPECIAL ABOUT OPERATING BIG SUPERCONDUCTING ACCELERATORS?

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Abstract

Summary of session 6, held at the workshop on accelerator operations at Villars-sur-Ollon, 2001.

1. INTRODUCTION

In this session the specific problems of operating super conducting accelerators were discussed. Reports were given on four big super conducting magnet machines (RHIC, TEVATRON, HERA and LHC) and on the operation of two smaller super conducting linear accelerators (ATLAS and JAERI).

2. CRYOGENICS

Cryogenic systems are common to all these accelerators, whether it be super conducting magnet- or super conduction cavity machines. The cryogenic system is very closely linked to the performance of all these accelerators.

First of all, there is direct link between the cryogenics and the energy deposited by the beam through parasitic mode losses, beam losses, synchrotron radiation and electron cloud.

The field which, can be obtained in Pure Nb super-conducting cavities is directly related to the speed at which the cavities can be cooled down (JAERI).

The correct and fast operation of cryo systems has an important impact on the down time. The recovery from a quench takes typically (depending on the machine) 0.5 to 7 hours if everything works correctly. In the case of wrong or late reactions in the cryo system the recovery time can be days.

The same is true for the recovery after a power cut where the consequences can be even worse, depending on the length of the cut.

This means that a good and fast (direct) communication with the cryogenics operations is indispensable.

3. SAFETY

Cryostats with liquid Helium and/or liquid Nitrogen in the tunnel are potentially dangerous. Super conducting accelerators require special access procedures and adequate operator training.

4. QUENCH PREVENTION AND QUENCH PROTECTION

Magnet quenches do occur from time to time, but if possible, they have to be avoided. Not only do they create down time (0.5 to 7 hrs), but they also result in a severe mechanical shock for the magnet. Specialists are not clear about the number of quenches a magnet can have, but the number is certainly finite. An enormous amount of energy (for the LHC: the equivalent of two big jetliners flying at 900 km/hr) has to be dissipated quickly. A good quench prevention system that dumps the beam before it can provoke a quench is vital. The system has to act fast, -in the LHC the time between failure and beam hitting the magnets varies between 6 and 200 turns, depending on the equipment. All running machines rely on a robust beam-loss monitor system. At the TEVATRON de beam position monitors are also included in the protection system.

The quench protection system itself (the system that deviates the energy once a quench is detected) has to be 100% reliable. On the other hand, it should not be too sensitive in order avoid false quench events (RHIC suffered from this problem in the early stages of ramp commissioning).

It was stressed by all the speakers, representing the super conducting magnet accelerators, that a post mortem system is mandatory. An exact timing in the post mortem is very important in order to establish the right sequence of events and in order to make the right diagnostics.

5. STABILITY AND DYNAMIC EFFECTS

The persistent currents in super conducting magnets cause quit some problems for stability and reproducibility of energy, tune and chromaticity. Reference magnets are used to measure and compensate drifts during injection. Pilot bunches have to be used frequently in order to re-trim the machine and the monitor system has to cover the dynamic range between pilot and production beam. The control system needs very good function editors.

Ramps with super conducting magnets are very slow, so that a tune and chromaticity feedback should not be to difficult to realize.

6. SUPER CONDUCTING CAVITIES

The most predominant characteristic of a supper conducting cavity is its high Q-value (10^9), which means a very narrow resonance line. This makes the tuning of the cavity very critical. It can also lead to mechanical vibrations (ATLAS). The mechanical stress provoked by the high field in the cavity drives it off resonance so that the field disappears. The cavity relaxes and comes back on resonance. This phenomenon creates vibrations in the order of 50 to 100 Hz. A fast feedback can help here.