BEAM INSTRUMENTATION FOR AUTOMATIC BEAM STEERING AND SHAPING

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SUMMARY FOR SESSION

Only four papers were presented in this session, which is little compared to the role of instrumentation in this type of process.

From the other sessions it was clear that Beam Instruments are an important part in the ABS process, which can only be as good as the information provided by the instruments. Most of the procedures presented in these sessions used inputs from beam position monitors. It can probably be concluded that the existing position monitors are considered as adequate for ABS. It has to be remembered that BPMs have been used to correct orbits and trajectories for a long time, and that their performance in precision and resolution have followed the user requirements and the general progress in technology. Another ABS type application which has been around for some time is the minimisation of beam losses by adequate beam steering using beam position monitors, beam loss detectors and current monitors. A new field which was presented in this session is the betatron matching in a chain of accelerators which makes use of profile measurements.

The first presentation of the session was by two GSI representatives (ref 1). The presentation described the various beam intensity and beam loss monitors used over the large dynamic range of five orders of magnitude in intensity available at GSI, a position measurement with Multiwire Proportional Chambers and a beam steering process to put the extracted beams on targets by using an on-line version of a beam optics design program. A feedback system acting on an accelerator quadrupole and using the measurement of the extracted current is foreseen in the near future to control and stabilise the extracted spill. One of the applications described was centred on the ion cancer therapy facility where the area of interest is scanned with a raster scan technique delivering well defined and localised doses. The importance of its precision and reliability is straightforward.

The second presentation (ref 2), reported on a collaboration between french and italian laboratories and advocated the use of Optical Transition Radiation as a technique which can be useful in ABS applications. As the OTR production results from a pure electromagnetic effect, it has a high temporal resolution and a high dynamic range, able to measure two dimensional beam profiles when using imaging optics. From these profiles, the various characteristics of the beam can be deduced: intensity, centre of charge, rms beam size, and higher order momenta if desired. The beam angular distribution can also be determined as well as the beam energy if certain conditions are satisfied, from where a six dimensional emittance volume can be defined. The temporal resolution is limited only by the opto-electronic signal processing equipment. No particular application was described.

The last two presentations described the more recent type of ABS applications dealing with the matching of a transfer line or an injector to an accelerator, and using beam profile measurements. The process is based on the fact that if a beam is perfectly matched to an accelerator, the beam profiles measured at a given location of the accelerator will remain constant for many turns, while if the beam is mismatched it's size will be modulated at twice the betatron frequency, the modulation depth being a function of the mismatch (ref 3). This beam size modulation will lead to a beam blow-up through filamentation, which will be detrimental to the luminosity obtained in the final collider of the accelerator chain.

The first presentation on matching was reporting on tests in the CERN SPS for an instrument under development for SPS and LHC (ref 4). It is based on an OTR screen which is left in the circulating beam which is dumped approximately 200 revolutions after injection. The beam size is measured with a CCD camera operated in a special mode in order to acquire several revolutions after

each injection. The whole sequence of beam sizes for typically 64 revolutions is acquired in successive injections, under the assumption that everything remains stable during this period, which lasts for a few minutes. This assumption was verified to be true in general. The results shown indicate that with the resolution limit of the instrument it is possible to correct the matching and decrease the blow-up through mismatch filamentation to less than a few percents. There is good hope to automate the procedure in the near future.

The last presentation was reporting on a similar experiment in the Fermilab Main Injector where the beam size oscillations are measured this time with a rest gas monitor for each beam dimension (ref 5). The detector can measure turn-by-turn beam sizes. Unfortunately no beam size oscillation measurements after injection could be performed before the workshop, but results should be available for the 1999 PAC to be held in New-York.

Finally a discussion took place between the participants to find out if there is an exchange of instruments between laboratories, as is usual for algorithms for instance. It came out that this is a rather rare procedure. Examples were given of exchange of instruments between CERN and DESY: Wire scanners from CERN and a Rest Gas Profile monitor from DESY, and between SLAC and another laboratory. On the other hand, it seems that collaborations and exchanges are frequent between laboratories on instrumentation techniques and technologies.

In conclusion it seems possible to state that beam position monitors seem a mature enough technology for the needs of ABS as are beam loss monitors. Efforts concentrate in this field on data processing and algorithms. It would nevertheless be interesting to have a global overview presentation of these monitors from an ABS point of view at a future workshop. Beam profile monitors enter only now the ABS game and various interesting developments are under way for a precise control of emittance preservation which is vital for the future colliders but should also be of interest for the present machines. It will be interesting to follow the progress in this area. Finally the exchange of technology, and where possible of complete instruments, should be encouraged and practised whenever possible in the present context of limited resources striking all laboratories.

References

[1] P. Fork et al.: “Current measurements of slowly extracted ions from a synchrotron”

[2] M. Castellano et al.: “Beam characteristics control using Optical Transition Radiation”

[3] C. Bovet, R. Jung: “A New Diagnostic for Betatron Phase Space Matching at Injection into a Circular Accelerator”, Proc. of EPAC’96, Sitgès, Spain,

[4] J. Camas et al: “The OTR screen betatron matching monitor of the CERN SPS”

[5] S. M. Pruss et al.: “Using the IBS to match the injection line to the Main Injector”