Dear all,

We try in this synthesis document to summarize the status of the BBLR studies before deriving what should be their natural extension to hopefully define better solid proposals for the future

1-FACTS:

1) The efficiency of the compensation method is "established" in simulation for the specific case of the LHC, where the LR beam-beam interactions are lumped and where the compensators can be installed a few degrees away from the perturbations. The underlying understanding of the compensation principle should guaranty that the simulation results are not a numerical feature due to a simplified model or whatever.

2) The SPS experiments confirm cleanly the efficiency of the LR compensation in this LHC scenario. The use of one wire to simulate the exciting beam is justified for the relevant amplitude range (0 to 6 or 7 sigma for a beam separation of 9.5 sigma).

3) Without compensation, the SPS experimental results are consistent with the prediction from simulations of the onset of a sudden strong diffusion. The observations (beam loss, beam lifetime, transverse distribution cuts) tend to show that the beam-beam separation at the LHC is just sufficient. Some observations show a significant effect at unexpectedly low excitation of the perturbation. The experiment is nevertheless delicate and the SPS environment unfavorable (often the base beam lifetime does not reach one hour and sometimes minutes).

4) The simulations made at Fermilab to evaluate the effectiveness of wire compensation in the case of a large number of LR b-b interactions spread in phase around the machine showed mixed results. By memory, there is a significant improvement of the dynamic aperture at injection and possibly no effect at collision, using several wires around the machine.

5) There is a signature of significant LR b-b effect at RHIC with several encounters spread around the machine.

2-PROGRAMME OF STUDIES

From these facts, a programme of studies can be drawn;

i) Investigation of the threshold for fast diffusion using beams with a long base lifetime (hours) in the well-controlled environment of a collider (aperture, beam instrumentation, long base beam lifetime). It is especially interesting to verify that the LHC beam-beam separation is sufficient and to investigate the cases where a drop of the lifetime was observed for unexpectedly weak perturbations. This should be complemented by simulations to build up the confidence in the predictivity of the codes.

ii) Verification of the compensation quality with a wire compensating an actual beam in conditions identical or scaled from the LHC case.

iii) Investigations on the efficiency of a simple partial compensation in the case of multiple LR interactions spread over the machine and bench-marking of simulations aiming at a calculation of the beam lifetime.

iiii) Investigations of the use of a wire for other purposes. A possible use is that of a scatterer (collimator) for amplitudes above the threshold of strong diffusion.

3-PROPOSALS FOR AN IMPLEMENTATION OF THE STUDY PROGRAMME AT RHIC

The compensation of the long-range beam-beam effect is expected to become necessary when approaching the nominal LHC performance. However, the lead time to explore innovative ideas in a domain as complex as the beam-beam effect and install challenging devices in the much demanding environment of running colliders calls for a solid preparation. We therefore recommend going ahead as soon as possible with experiments using a dc LR compensator:

i) A wire compensator installed in RHIC would allow exploring point 2-i) of the study programme by substantially expanding the results of the SPS experiments, with a much larger physical aperture, a much better natural beam lifetime, and superior beam diagnostics. It would potentially give more accurate results on the required LHC beam separation versus bunch intensity and number of LR interactions and an excellent bench-mark for simulation codes.

ii) After first calculations, the verification of the quality of the LR compensation in LHC conditions appears out of reach of a RHIC experiment: the RHIC BBLR experiments are indeed complicated by an unfavorable phase advance between LR compensator and possible LR collision points, allowing for a maximum of only 1 LR collision to be compensated, as well as by the large (50 mm) beam stay-clear required at the foreseen compensator location, excluding the installation of existing SPS BBLR devices and requiring the production of a new unit with large aperture and with a few cm lateral motion. In addition, a single bunch carries too low a charge and would require a beam-wire distance less than 1 sigma, making wire compensation unsuitable. However, circumstantial evidence during some of the SPS MDs has indicated an effect on the beam lifetime even at much lower excitation current than predicted by the scaling. Possibly this is due to large tune ripple at the SPS injection energy, or else it could point to another aspect of the LR-collision physics which has hitherto been overlooked and could be observed in RHIC.

iii) Given the fact that the effect of the LR interactions (several bunches and interactions spread in phase) can be observed on the beam in RHIC, the study of the effectiveness of a partial compensation can be carried out. The choice of the beam-wire separation and of the wire current allows a non-orthogonal but still somewhat selective compensation of non-linear terms.

iiii) An LR compensator could be used to experiment a wire as a non-interacting scraper/collimator by observation of the distribution cut and lifetime.

In conclusion, we ask the support of LARP for

- the construction and installation in RHIC of a dedicated wire device adapted to the machine requirement (wire movable by cm’s) and able to provide an LHC equivalent kick.
- A programme of numerical simulation of the experiments with the goal of predicting the beam lifetime.
- An experimental programme in the RHIC machine

The expected yield is a much better knowledge of the beam-beam phenomenology to be expected in the LHC, the development of suitable simulation programme to be operational in time, the development and experience of hardware compensators in a high energy collider environment and answers to the questions raised in all colliders where upgrades are contemplated by decreasing the bunch-to-bunch spacing, thereby increasing the LR interactions.

With our best regards,

Jean-Pierre & Frank