AN OVERVIEW OF COOLER STATUS

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The Cooler (an electron-cooled storage ring-synchrotron) has completed its third year of operation. While it is a still evolving and far from mature facility, the Cooler has begun to generate results which offer a glimpse of its potential. Details of a number of completed experiments appear elsewhere in this report. The following is a somewhat subjective list of notable aspects of the past year's activity:

- experiments mounted and operated in all of the four straight sections where access to the beam is possible ("T", "S", "A", and "G"), with a waiting list for each location;
- sustained average luminosity above 10^{30} cm^{-2} s^{-1} for a beam accelerated to the NNπ threshold (averaged over a fill/run cycle and over several days of running);
- an increased range of beam species and energies developed, with protons cooled at 400 MeV and accelerated to 470 MeV, deuterons and ^{3}He^{++} ions also accelerated and cooled (all after stripping injection);
- methods for injection and accumulation of polarized protons developed to the point that an intensity of 0.3 mA of stored polarized protons has been observed. Scattering experiments using this mode have been completed (with average luminosity about 3% of that obtained for unpolarized (stripping) injection);
- acceleration of polarized beam after accumulation has been demonstrated;
- the feasibility of operation with a fixed small diameter windowless target cell of the type proposed for polarized targets has been demonstrated.

Although the accomplishments of the past year are a source of some pride, there is still much to be done before the full potential of the Cooler can be realized. Among the significant tasks remaining, we note:

- jet targets work well, but use many vacuum pumps. At this time we have just enough pumps to operated one jet target at one location. The pump shortage defers scheduling of experiments otherwise ready to run;
- solid target technology (dust and wiggling fibers) has shown promise but is not yet developed to the point of routine use;
- another factor of five to ten in average luminosity for both unpolarized and polarized beam operation appears feasible with the present configuration but has yet to be demonstrated. A further increase for polarized beams is expected when the higher intensity source comes into operation;
- experiments mounted in the "T" straight, which lies immediately downstream of the injection "I" straight have had detector difficulty with stray beam spilled during injection. We must develop cleaner beam splitting procedures;
- the stripped beam accumulation procedures raise the stored intensity to the threshold of instability. Further improvements in stored intensity will involve damping of coherent instabilities, judicious selection of operating parameters to minimize the effects of

tune shift, and perhaps other measures to prevent the beam from becoming too cold at the injection energy;

- detectors at small angles see a beam halo. While the rates are less than would be seen for a comparable detector in a cyclotron beam line, they are troublesome at present luminosities and may limit some experiments at the higher luminosities expected in future operation. Attempts to limit the small angle rate with cleanup slits and scrapers elsewhere in the ring have not yet been very successful. A better understanding of the tail of the beam distribution is required.

To summarize, the Cooler is now contributing to the research output of the laboratory and drawing interest from a growing fraction of our user community. Exploration of the parameter space of Cooler operation has defined the boundaries of a quite wide region available now for research use. Further extensions of the boundaries are possible. Work toward this end is resource-limited and is largely concentrated on the needs of experiments in the pipeline: diversity of target technologies; maximum event rates and the quietest possible environment for the detectors clustered around internal targets.

COOLER INTENSITY LIMITATIONS

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I. Introduction

The combination of our ability, based upon experience, to produce better ramp waveforms, our Cool-Ramp-Cool capabilities, and the new beam phase feedback system, now allow us to accelerate beams with very high efficiency, approaching 100%. The maximum stored beam current at high energies ($\approx$ 1 mA) is now limited by instabilities at the low energy used for stripping injection (90 MeV H_2^+). The simplest way to increase the threshold currents for instabilities is to simply not cool the injected beam (as is being done at Uppsala and will be done in COSY) since the threshold current for instabilities increases with the beam emittance, momentum spread and beam energy. However, due to the low current of our injector, we need electron cooling to accumulate beam up to the level where instabilities are observed. Consequently, we need to learn to operate in a mode where we take advantage of cooling to accumulate beam, but avoid the accompanying problems associated with these low equilibrium emittance and momentum spread beams. Thus far we have identified two limitations: coherent transverse instabilities and the space charge tune shift. Below we briefly discuss each of these limitations, and the work we will be doing to alleviate them.