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Memo

DATE: *November 7, 2002*

TO: RHIC E-Coolers

FROM: *Ady Hershcovitch*

SUBJECT: **Minutes of the November 1, 2002 Meeting**

Present: Ilan Ben-Zvi, Michael Brennan, Xiang Yun Chang, Ady Hershcovitch, Michael Iarocci, Derek Lowenstein, Jorg Kewisch, William MacKay, Satoshi Ozaki, Flemming Pedersen (CERN), Stephen Peggs, Thomas Roser, Dejan Trbojevic, Dong Wang, Jie Wei.

Topics discussed: Simulation & Calculations, Stochastic Cooling.

Simulation & Calculations: Ilan opened the meeting with a presentation of calculations performed with SIMCOOL for gold ions. In that presentation, Ilan showed plots of luminosity, integrated luminosity, and normalized emittance all versus time with and without electron beam cooling. As expected electron beam cooling proved to be extremely beneficial. Luminosity and integrated luminosity were larger by a substantial factor with electron beam cooling than without cooling, while the normalized emittance was reduced by over a factor of three with electron beam cooling. The luminosity versus time plot with electron beam cooling is characterized by oscillations. Ilan explained it to be an art effect of the algorithm used. In that simulation, the electron beam current varied with cooling, i.e., the current was increased to enhance luminosity and decreased when luminosity became large, hence the noise.

Ilan explained that burn off has been incorporated in all calculation results. The effect of particle loss due to burn off leads, naturally to a reduction in the luminosity. However, a side effect leads to enhance cooling, since intrabeam scattering decreases. Finally, Ilan showed the effect of electron beam cooling on the ion density in a three dimensionally plot, in which the ion radial density profile is plotted as a function of time. The plot is characterized by a dramatic axial ion density increase with “tails” at the outer radii. The reason is that electron beam cooling does not cool the tails as fast as it cools the central balk of the ion radial distribution. Thomas suggested adding stochastic cooling, which can cool the tails preferentially. Waldo expressed concern about adverse interference effects.

In an answer to Thomas’ question regarding the status of the “ring” computations, Jorg reported on calculations performed with MAPLE. In those calculations Jorg compared the effect of bunch stretching (to reduce energy spread at the solenoid entrance) with 700 MHz and 200 MHz cavities. Results were better with 200 MHz cavity yielding energy spread of $1.8x10^{-4}$ compared with $3.8x10^{-4}$ for the 700 MHz cavity. In answer to Mike’s question regarding the cavity voltage, Jorg's reply was 150 keV, to which Thomas added that it is much less than in RHIC.

Stochastic Cooling: (courtesy of Mike Brennan)
While it is recognized that stochastic cooling could complement electron cooling in the sense that stochastic cooling works best on hot beam (tails of a distribution) whereas electron cooling works best on pre-cooled beam (the core), it is remains controversial whether or not bunched-beam stochastic cooling will work for high frequency bunches (200 MHz). Brennan described the status of the on-going beam experiments with gold beam at 100 GeV in RHIC to address this question. At the TEVATRON and SPS stochastic cooling programs were abandoned because anomalous coherent signals polluted the Schottky spectrum and saturated the electronics, killing the feedback gain and defeating the cooling. We have examined the Schottky signals from gold ions in RHIC and found essentially no problem from anomalous coherent signals. The observations were made with a 4-8 GHz stochastic cooling pickup, on loan from Fermilab, installed in the Yellow ring. Brennan offered some speculation as to why the RHIC situation should be qualitatively different than TEVATRON and SPS. One, the charge 79 of the gold ions naturally gives an almost 20 dB better signal to noise ratio of the Schottky signal. Two, RHIC has a full rf buckets and this gives much more Landau damping to stabilize local instabilities within the bunch (solitons). For the coming run a Fermilab stochastic cooling kicker has been added to the Yellow ring and the goal is to measure a beam transfer function in the 4 to 8 GHz band. This information would be used to specify the hardware needed to build a functional cooling system for longitudinal cooling in RHIC that could counteract the de-bunching caused by IBS. Some key technical questions are unresolved. How can the expense of a system be reduced by new concepts in kicker design? One idea is to use pulse compression techniques to exploit the dead time between bunches to level the rf power. Another is to use the ample available insertion length to install several kickers, which would increase the effective kicker impedance. No effort has yet been made at scoping out a stochastic cooling system that would cool in the transverse plane and be appropriate to use in conjunction with electron cooling.