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Memo

DATE: *May 6, 2005*

TO: RHIC E-Coolers

FROM: *Ady Hershcovitch*

SUBJECT: **Minutes of the May 6, 2005 Meeting**

Present: Rama Calaga, Alexei Fedotov, Wolfram Fischer, Ady Hershcovitch, Dmitry Kayran, Jorg Kewisch, Derek Lowenstein, Christoph Montag, George Parzen, Thomas Roser, Trbojevic, Gang Wang (SUNY Stony Brook), Jie Wei.

Topics discussed: IBS Reduction, Magnetized Cooling Force.

IBS Reduction: the meeting started with a presentation by George Parzen on investigation of proposed lattices designed to reduce intrabeam scattering (IBS). George first showed a comparison of copper ion emittance growths in lattices that have 80 degrees and 92 degrees phase shifts in cells. He showed that emittance growth due to IBS is smaller at lower values of gamma for the 80 degrees case than for the 92 degrees case. But, at higher values of gamma, it is the opposite: emittance growth due to IBS is smaller at higher values of gamma for the 92 degrees case than for the 80 degrees case. The crossover in IBS growth is at a gamma value of 38. There is experimental data at a gamma value of 33.5, which is consistent with theoretical predictions. At gamma value of 100, there is a 20% improvement for 92-degree case over the 80-degree phase shift lattice (please see below diagram in Parzen's presentation). George pointed out that although there is some disagreement between codes, they all predict lower growth at gamma of 100 and a crossover at a gamma of 38. Ady asked whether 20% improvement is worth the effort, Thomas commented that there is substantial improvement at 120 degrees phase shift. To Ady's question on how much is that improvement, George referred the question to Alexei, who replied a factor of 2!

George continued with a discussion on the accuracy of IBS theory and possible reasons for its deficiencies, as well as on ways for improvements (shown on last page of presentation).

Magnetized Cooling Force: Alexei presented new calculations using the VORPAL code for magnetized cooling. Computations show that the Derbenev, Skrinsky and Meshkov model, without the previously used logarithmic approximation, is in good agreement with VORPAL. And, these new results showed that previous magnetized cooling results underestimated the cooling force. Consequently, the VORPAL code predicts much faster magnetized cooling that is feasible even for E-RHIC parameters.

<u>George Parzen's Presentation</u>

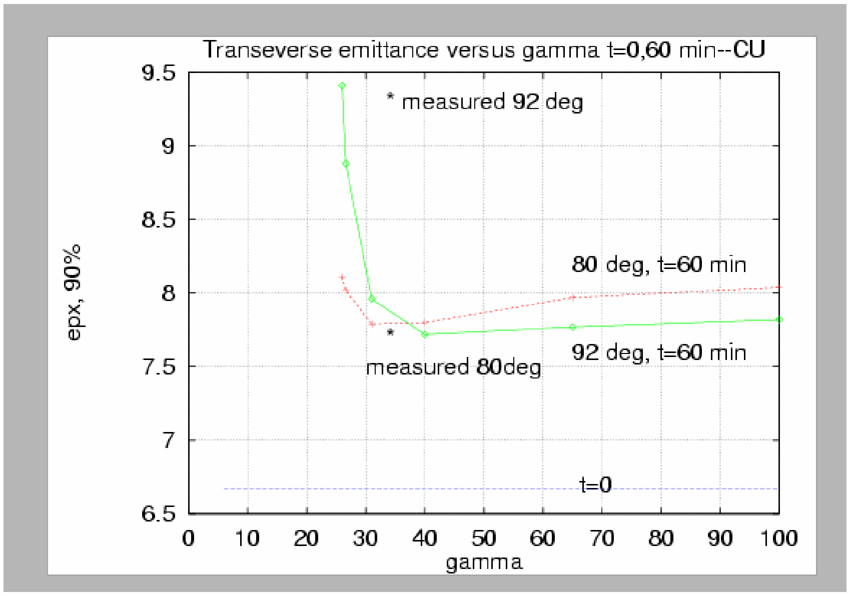
Computed growth results for the 80 deg and 92 deg lattices for Cu

George Parzen
April 29, 2005

<u>Emittance growth results for the 80 deg and 92 deg lattices—Cu</u>

<u>Comparing computed results with measured data</u>

<u>Improving IBS theory</u>



1. Normalized emittances are plotted. Transition energy is 25.6 for 92 deg and 23 for 80 deg. (Lattice data from Steve)
2. Less growth for the 92 deg lattice at higher values of gamma, but the curves cross at about gamma=38.
3. Seems safe to say curves have to cross as one approaches the transition energy where sigma_p gets larger.
4. The IBS codes, IBS_P and BETACOOL (Alexei result), give some what different results for the location of the crossing point.
5. * indicate measured data at gamma=33.5 ..(measured dat from Jie)

Comparing computed results with measured data

1. Which Gaussian should one use in the IBS program when the actual distribution is only approximately gaussian? In IBS theory , the Gaussian is specified by 3 parameters, which are the average emittances of all the particle in the bunch. How does one find these average emittances from the measured data ?

2. What is the accuracy of IBS theory results ? Is the theory exact? I think not.

a. error due to using coulomb cross section , sigma (theta)~1/theta^4. This has to be incorrect at larger impact parameters because of the presence of neighboring ions.

b. error due to the treatment of transverse coupling .

c. For energies near the transition energy, there is a possible additional error. As the energy approaches the transition energy, sigma_p , the energy spread in the bunch, becomes larger. This may require keeping terms of higher order in dp/p in the dispersion which will affect the coupling between the longitudinal and horizontal motions.

Improving IBS theory

1. Does any body want to do this?
2. One way is to use measured data to patch up the theoretical results. The alternative is to try to improve the theoretical treatment.
3. Usual treatments of IBS, assume that sigma (theta) is given by the coulomb cross section. A recent reformulation of IBS theory by myself gives a result for a general sigma (theta) which results simply in a factor which is just the integral over theta of sigma (theta) sin(theta)^3. One could then try to find a more accurate sigma (theta) by fitting measured data..
4. A complete treatment of the effect of skew quadruople fields that couple the transverse motion has been given by Piwinski. This result is not used as far as I know because of the difficulty in applying it. One could manipulate the theory to find which properties of the skew quadruople fields . such as integrals around the ring of skew quadruople fields, are important and determine these properties for RHIC by comparing with measured data.