FINAL TRANSPORT IN VACUUM -- SUMMARY

K. Brown (SLAC), E. Colton (ANL), S. Fenster (ANL), A. Garren (LBL),
I. Haber (NRL), I. Hofmann (Garching), J. Lawson (Rutherford),
S. Penner (NBS), and J. Peterson (LBL)

INTRODUCTION

Those considering final transport in vacuum believe that the main problem is the effect of space charge on the final focussing design. It was thought best to approach this from two directions:

1. Assume uniform charge density in the axial and transverse directions in order to modify the zero space-charge designs.

2. Evaluate the designs taking account of non-uniform densities by simulation and other methods.

CONTRIBUTIONS

The participants carried out a number of relevant studies which are included in these proceedings, and which are briefly summarized here:

1. Design and chromatic correction of final focus beam-line at zero current, by K. Brown and J. Peterson. The beam line is made up of three half-wave sections that include dipoles and sextupoles in the first two. The sextupoles are arranged in pairs at betatron phase intervals of 180 degrees in order to suppress their contribution to geometric aberrations. If chromatic corrections are not needed, the third section can stand alone. The corrections increase the momentum acceptance by a factor of two, permitting a 3% spread onto a 4 mm target.

2. Effects of third order aberrations in the above beam line were evaluated by E. Colton, and found to be negligible.

3. Beam line with space charge. The same beam-line, without dipoles or sextupoles, was modified by A. Garren to take account of space charge. Also procedure was proposed for calculation of dispersion in the presence of space charge.

4. Spherical aberration from non-uniform space charge. If the space charge density is non-uniform, it causes a variation of the focal length of the final quadrupole multiplet between the center and edge of the beam. An estimate of this effect by J. D. Lawson shows that this effect could be serious.

5. Numerical simulation of final transport have been made by I. Haber. The first example replaced the final quadrupoles with a single thin lens, the second was that of paragraph 3. Use of K-V distributions confirmed the envelope integrations used in 3. Use of a non-uniform distribution showed some worsening of performance.

6. Coherent Space Charge Instability. Analytic calculations by I. Hoffman show that stability thresholds are considerably reduced when the horizontal and vertical emittances are unequal.

CONCLUSIONS

Problems remain in the design, evaluation, and optimization of final vacuum transport beam lines due to the combination of large values of current and momentum spread. At present a reasonably conservative estimate of allowable momentum spread is about $\pm$ 1% until a chromatic correction system with space charge is demonstrated.