2.8 Areas of Future Development

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High-field superconducting solenoids may open up new opportunities in the development of high-current linear accelerators for heavy ions. Substantial fractions of an ampere may be accelerated, but to satisfy HEDP target requirements of 1 nsec, 1 kA type beams, further beam manipulation beyond the linac is still required. Parallel-beam structures or accumulator rings may be used to provide the total charge and, and some sort of ballistic compression, probably with the use of an induction core, will be needed.

Several areas of future development emerged from the preliminary strawman design:

Accelerator

A 0.2 ampere, 1 microsecond beam macrobunch extractes about 1 Joule from a 500 keV cavity, which is up to 10% of the stored energy of the cavity. IH-mode cavities have a relatively small stored energy to start with, as the fields are concentrated in the gap region. This may lead to stability or energy spread problems which must be addressed.

The large gap capacitance in the multi-gap structures considered require a large RF power and geometric factors may result in an uneven distribution of potential across the gaps of a multi-beam structure. Recent calculations by Ostroumov (private communication) show that in the 16-beam scenario, the potential across the drift-tube structure may vary by as much as 8%.

Engineering issues of compact high-field superconducting solenoids and issues of placing them close together. Even with alternating polarities, asymmetry of the field across the apertures may cause emittance growth in each beam.

The sheer number of components, particularly focusing elements in a multiple beam structure, is a drawback. Multiple-aperture solenoids may be a partial solution, if feasible.

Beam Compression and Transport

The beam dynamics in the ballistic compression region must be clarified.

Combining multiple beams at the target will be a challenge.

Beam Dynamics

What is the ultimate current limitation of such RF-linac devices? Optimization, including careful study of space-charge effects, needs to be done to determine if one can reduce the number of beams below 16 in the multiple-beam scenario.

Summary

In the near-term, theoretical studies of highly space-charge beam transport through the accelerating and focusing structures is needed. The longitudinal emittance growth issues that limit the ultimate compression ratio at the target must be addressed.

In the one-beam scenario with the stacker ring, growth of the energy spread of the bunches due to space charge and stacking scenarios must be addressed.

In the longer term, hardware modeling of appropriate injector, accelerator structures and focusing solenoids in multiple-beam arrays needs to be carried out.