Concerns with the 12 GeV project accelerator design - Jay Benesch

1. "roll-over" dipoles in 6 GeV CEBAF are C magnets with coils at the top and bottom of the C rather than wrapped around the (curved) poles. Such magnets begin to leak flux ~7.2 kG for planned steel geometries and leak over 5% at needed bending fields. Cross-talk between these magnets in the spreaders/recombiners could make steering impossible at full energy. H magnets may be substituted. These use about two-thirds the steel and higher current density in the copper than the planned C magnets. *(draft TN available)*
2. BH curve used in TOSCA models is inaccurate at the 3% level in current at 14kG per comparison with measurements in MAN/MAM dipoles. Model and measurements diverge at 10 kG. All of the current requirements for the common dipoles and "roll-over" dipoles which exceed 10 kG need a larger error allowance. *(draft TN available)*
3. 2D and 3D models of dipoles suggest it will be very difficult to remain within the existing 20A shunt range for the common and roll-over dipoles even without the BH curve uncertainty. The 2001 12 GeV document planned for 60A shunts as a result of the 2D work. Recent work, including the BH curve uncertainty, suggests two 20A shunts will be needed for each of these dipoles unless the magnets are extended to reduce peak field.
4. small coils to compensate for synchrotron radiation induced beam energy change in an arc do not affect beam quality. They are necessary for simply changes for accelerator energy. Current requirement is a few amps so the coils can be cheap. Project has not agreed to their inclusion. *(TN available)*
5. TOSCA-modeled sextupole exceeds multipole specifications set in TN07-018 via analytic techniques when field > 11.3 kG. Tracking looks OK with modeled multipoles for perfect dipoles. Real dipoles? Common dipoles with high field? Multipoles generate halo and that may affect parity experiments. *(draft TN available)*
6. septa have not been modeled in 3D. Multipoles, including gradients, are unknown in the detail needed to model extracted beam in *elegant*.
7. beam pipes should be shielded (carbon steel water pipe) in the spreaders/recombiners even after H magnets are adopted to reduce remaining cross-talk.
8. project will not allow CASA to set an acceptance test for dipoles. CASA may only provide a listing of multipoles which the project intends to interpret and test for in a manner they choose. Gradients due to construction errors are unimportant because there are quads in the lattice. The addition of shims to reduce quadrupole, sextupole and higher multipoles will create both energy and path dependent optics, both present in 6 GeV CEBAF and both undesirable. The project should not be allowed to add shims without CASA evaluation of optics effects over the full 50-100% energy range.
9. there is ~6mm horizontal clearance between extracted beam centroid and vacuum vessel at several points. σ_x ~0.4mm in fifth pass at these locations with expected emittance one third above design. This may be ameliorated if a large bore quad is placed at the E03 location. PEP-II HER 4" quads would serve well. Arne Freyberger has requested five for this purpose. Extraction dipole fields must increase to take advantage of the extra quad bore so power supplies should be sized accordingly. Concern generated by parity experiment requirements.
10. NE spreader, which separates six beams including hall D, has the closest approach in the machine of beam to vacuum wall in the separation of fifth and sixth pass beams. CASA has a design using excess magnets to increase the spacing substantially. Power supply availability is not known to CASA. Project has not considered the solution.

11. instrumentation needed for matching at each spreader and recombiner is lacking. Beam must remain matched to keep size and scraping down. Note that we typically lose 0.1% of beam, tens of nA, in the present machine. With the larger beam??? *(TN with historical matching results available)*

Concerns related to possible increases in scope

12. If the first step spreader/recombiner dipoles were extended in length to keep their fields ~10 kG at nominal energy, beam quality at 11 GeV (A/B/C) would be improved for parity experiments as outlined above. For other experiments an increase in energy at the expense of beam quality would be enabled by the lower magnet fields at 11 GeV. Dipole power supplies have ~5% headroom. Quads have 10%. The cost of 10% margin for dipoles be determined. Should shunt capacity be evaluated with this in mind?
13. An optics design exists which allows for three way split at 11 GeV. Eight RF separators are needed. The equivalent drift in the project AT line design should be preserved in length and location so as not to preclude the increase in capability.
14. current capability: 430 μA in the linacs. This is limited by the klystrons for the new cryomodules and by the environmental impact statement (EIS). The beam dumps are capable of 1 MW each. The associated heat exchanger can do only 1 MW total. If a new EIS were submitted for 2 MW beam power, a new heat exchanger purchased, and at least ten more old cryomodules were refurbished, the new cryomodules could be run at higher current and lower gradient with the planned klystrons. This would allow, for example, a long 75μA, 11 GeV Moller experiment in hall A in parallel with a variety of experiments in C. All of the old cryomodules should eventually be refurbished to eliminate arc trips.