Special Relativity in Beam trajectory simulation in small accelerators

* Not accounting for relativity in particle beam trajectory yields lower kinetic energy than what is observed, 300kV expected
* Under effects of DC current (ie time and position dependent E field) (position dependent B field)
* Higher relativistic factor for larger radius or higher energy beam
* PET: “baby” cyclotron, lower energy accelerates protons up to 5-18MeV
  + Requires radial increase of B field to maintain isochronous (defined as repeating?) beam

Take away from this paper: use the two equations of motion for the parallel and perpendicular components of the relativistic Lorentz force (under the conditions of the aforementioned E and B fields)

Most important element is calculating “s” component because the perpendicular component can be written in terms of the parallel component, and the parallel component relies on s and velocity, which is convenient because it is the full velocity not just one component (ie easier to plug in)

Faster speed, gamma approaches infinity

Cyclotron exploration

* Synchronous radiation: particle radiates light at the cost of kinetic energy when accelerated, more costly in terms of energy on lighter particles (negligible for protons, effective on muons and electrons)
* Relativistic effects apparent at .1c or greater when accelerated in cyclotron,need to use relative mass (large gamma causes large increase in observed mass)
* Radius grows at accelerated rate under relativistic speeds
* Electrons respond too well to the acceleration and have a max orbital radius of 2mm when accelerated in this way