Effect of space charge on Bunching in ISIS

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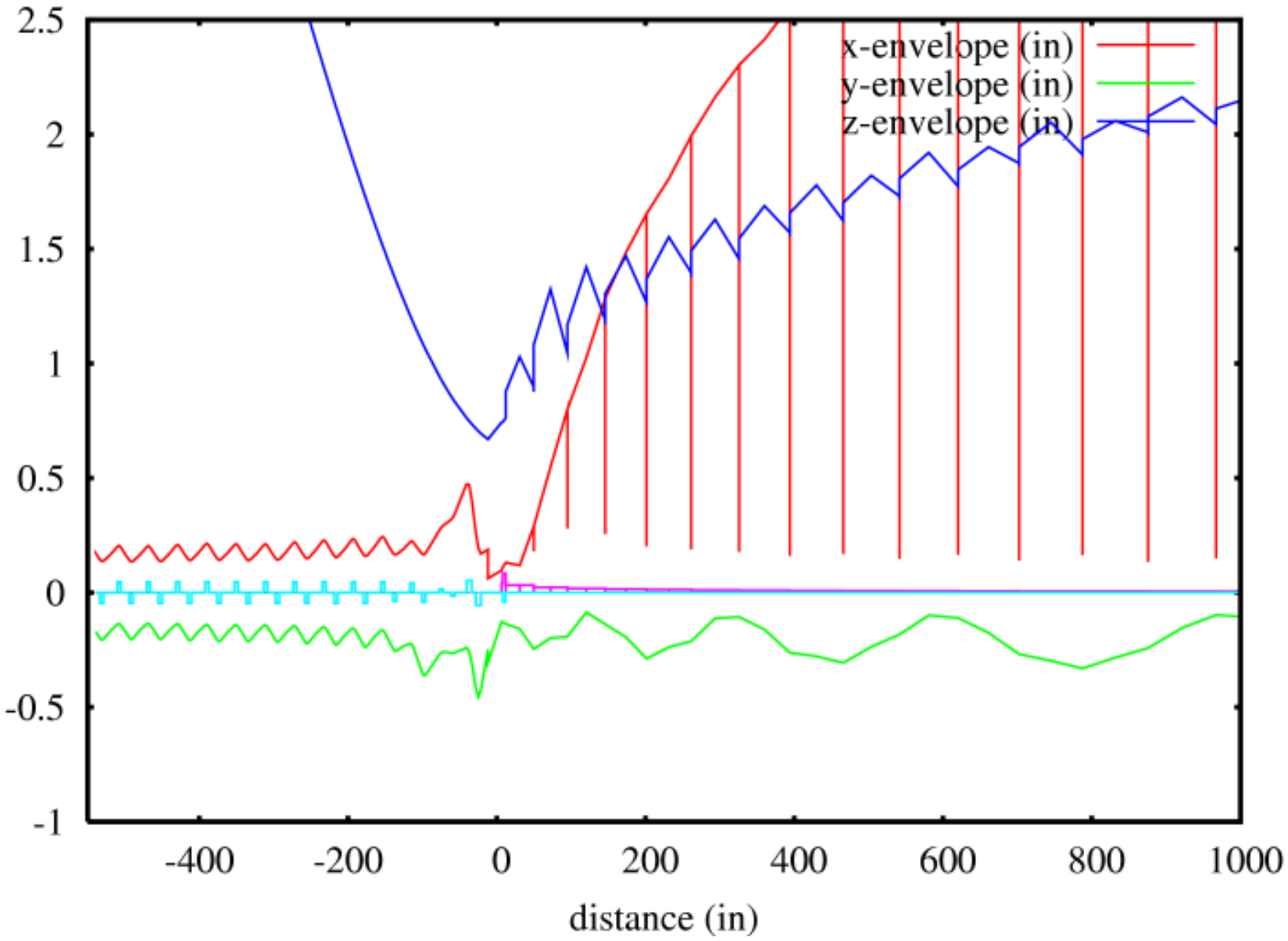
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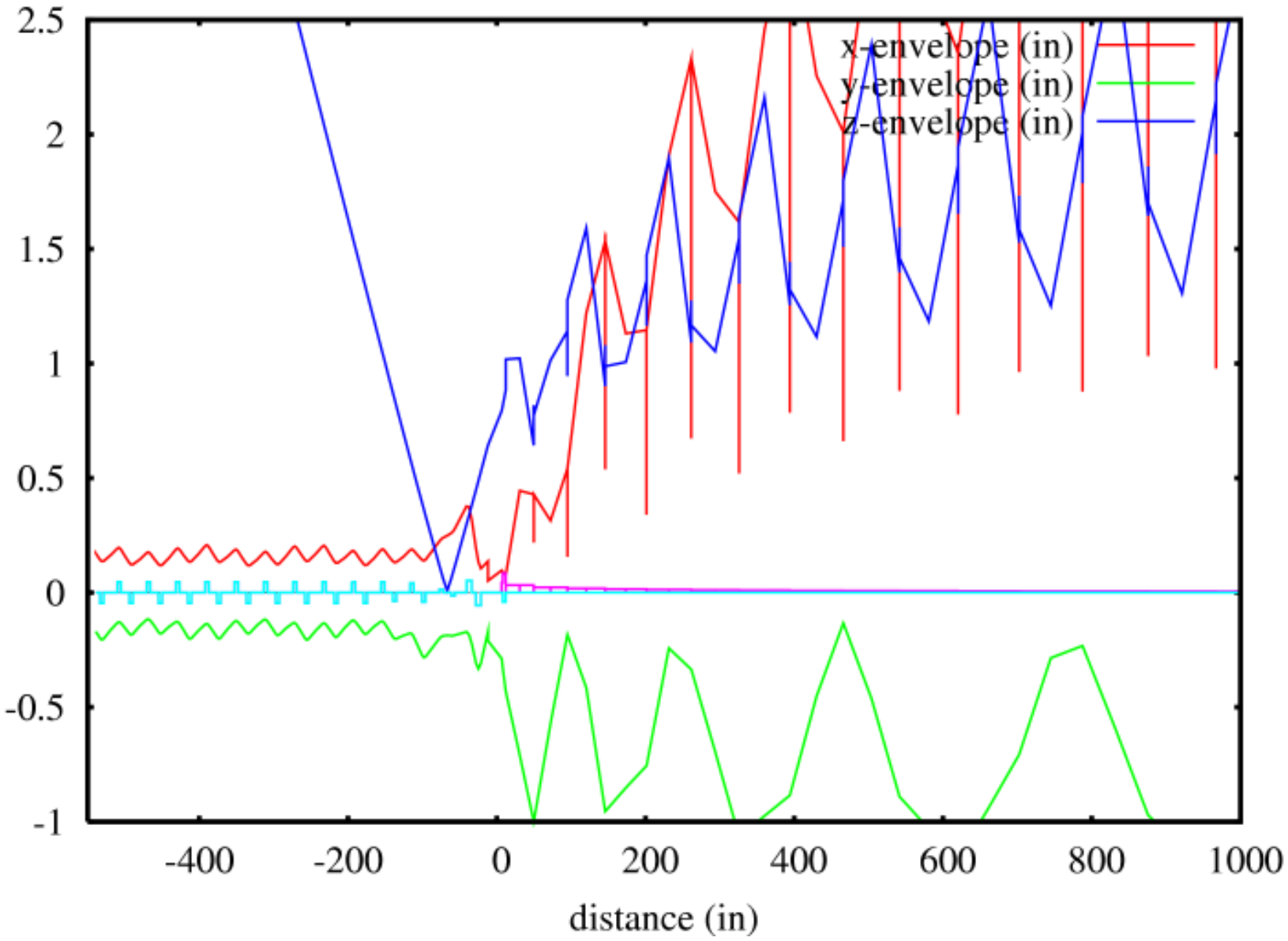
distance (in)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In the preceeding are beam envelope calculations taking the ISIS beam into the cyclotron. Included are the effects of space charge, bunching, axial mag field. It is actually for the new vertical line design, but this is not really relevant, since the effect is a global nature and does not depend on the transverse focusing details.

There are two cases plotted: The first is optimized with space charge, and the second has space charge turned off. Notice that in the first, the bunch length (blue curve) is decreasing gently and reaches a minimum at the injection gap. As is known, the buncher voltages depend sensitively on the transported current.

The reason is that the repulsive space charge forces slow down the bunching action and bring it to a halt. The game is to place that “halted” bunching action just at injection because it achieves two things: (1) fits the bunch length into the cyclotron phase acceptance, (2) minimizes the energy spread at the inflector thus minimizing the effects of the inflector’s dispersion.

Now if you take away space charge by for example inserting the pepperpot, this rebound effect disappears. the bunch continues to a very tiny minimum size and this is reached BEFORE injection, thus ruining the good match. As well, the quads, set up for the transverse effect of space charge defocusing, are no longer optimized for a good match. So the result is larger oscillating vertical and radial beam sizes in the cyclotron.

In short, inserting the pepperpot results in a situation far from the operational one. Scans taken this way are not representative of operational beam.