

ISIS Neutron and Muon Source

Update of a Green Field Proton Driver Design

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Phase rotation basic

Linearised synchrotron Hamiltonian $H = \frac{1}{2}h\omega_{efh}\delta^{2} - \frac{\omega_{efe}v}{4\pi\beta^{2}E}\phi^{2} \qquad \frac{\phi_{max}}{\delta_{max}} = \sqrt{\frac{2\pi\beta^{2}Eh\eta}{eV}} = \frac{2}{B_{h}} \qquad B_{h} = \sqrt{\frac{2eV}{\pi\beta^{2}Eh\eta}}$ Preservation of longitudinal emittance before and after rotation $\phi_{max,i} \times \delta_{i} = \phi_{f} \times \delta_{max,f} \qquad \phi_{f} = \frac{\phi_{max,i}}{\delta_{max,f}} \delta_{i} = \frac{2}{B_{h}} \delta_{i}$

Once the bucket is formed, the final bunch length depends on **only the initial momentum spread,** not the initial bunch length.

Linearised synchrotron Hamiltonian is only valid around the fixed point.

Nonlinearity due to sinusoidal RF voltage, not a linear or saw tooth shape.
 ToF depends on momentum deviation from higher orders of eta.





Summary

- A single ring, one bunch proton driver with a full energy linac is proposed.
 10 GeV ACR produces 2~5 ns (rms) bunch with 2 MW and 3~6 ns with 4 MW.
- To GeV ACR produces 2~5 ns (rms) bunch with 2 MW and 3~6 ns with 4 MW.
 5 GeV ACR produces 3~5 ns (rms) bunch with 2 MW.
 Parrier bulket for a AP mode.
- Barrier bucket for a AR mode.
 Single sinusoidal RF (0.5~4 MV) for a CR mode.
- Minimise the initial dp/p is essential, but not the sufficient condition.
 Pro-bunching or pro-specification with a low PE frequency (...MHz) divides the sufficient condition.
- Pre-bunching or pre-acceleration with a low RF frequency (~ MHz) does not help because it increases dp/p before rotation.
 - Best to inject from a linac and rotate the bunch immediately after accumulation.
- Large chopping factor (80~90% of the beam is chopped before injection) is required.
- Either longer pulse or higher peak current from a linac.
- Longitudinal space charge (LSC) is more crucial than transverse.
 Seems a hard limit of LSC. Can the specification of 2 ns rms be relaxed?
 An idea of inductive insert may help. Experimental demonstration at KEK and
- PSR in 1990s. Demonstration should have the similar longitudinal space charge. • Experimental observation of a hard limit of LSC.
 - ISIS can be a testbed when a chopper becomes available.





Optics correction less than dQ=0.005 should be possible.



"A single ring" proposal

