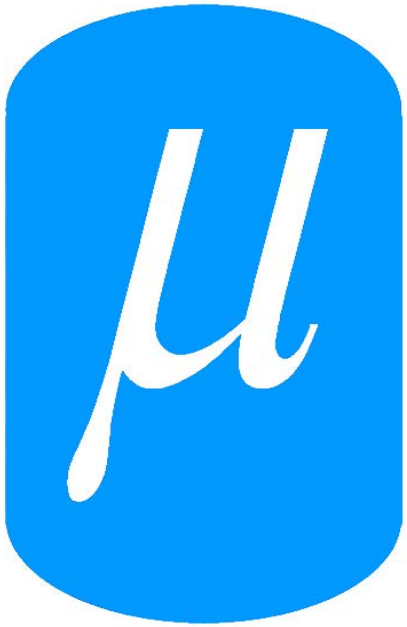
Worried about Space Charge, Multi-turn Stripping Injection, Transition Crossing, Feedback Delay, Instabilities… ?



Muons, Inc.
Innovation in Research

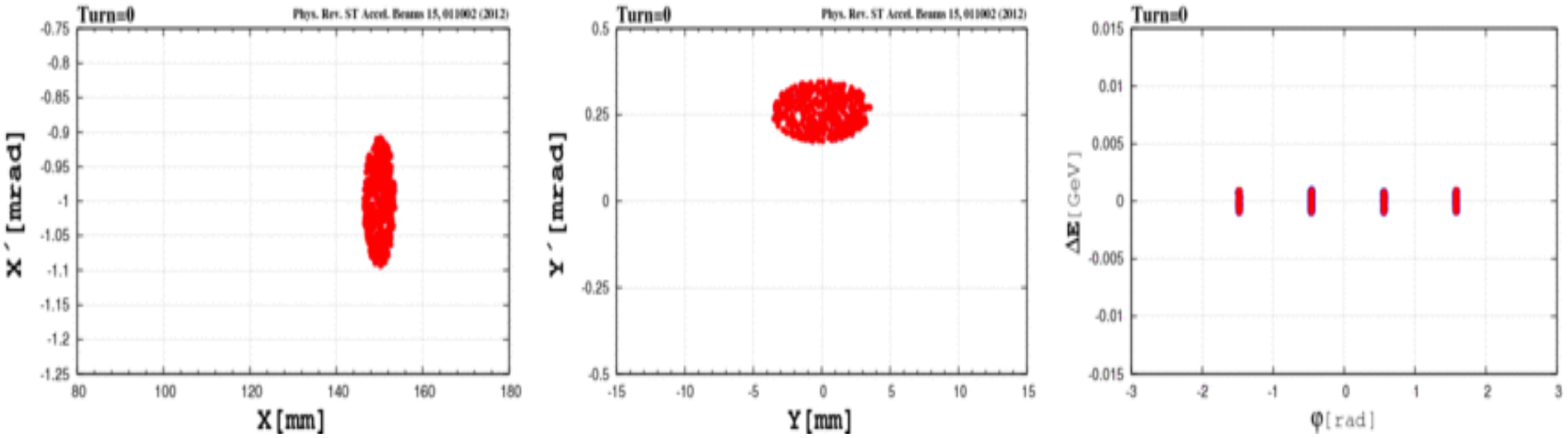
What Muons, Inc. Offers

The Muons, Inc. Simulation team can provide the expertise to address the challenges of:

- Multi-turn Stripping Injection
- Space charge effects
- Self-consistent acceleration with Transition crossing
- Instabilities, due to beam loading, etc
- ….

We have expertise with numerous simulation codes. Here we present a brief overview of what our team members can do with ORBIT (Objective Beam Injection and Tracking Code- originally developed at Oak Ridge National Lab). Orbit is a particle tracking code for rings. Its capabilities include longitudinal and transverse space charge effects, second order matrix and higher-order symplectic maps tracking . We have developed many new modules for ORBIT (see the above-mentioned items), made the verifications and cross-checking with other codes.

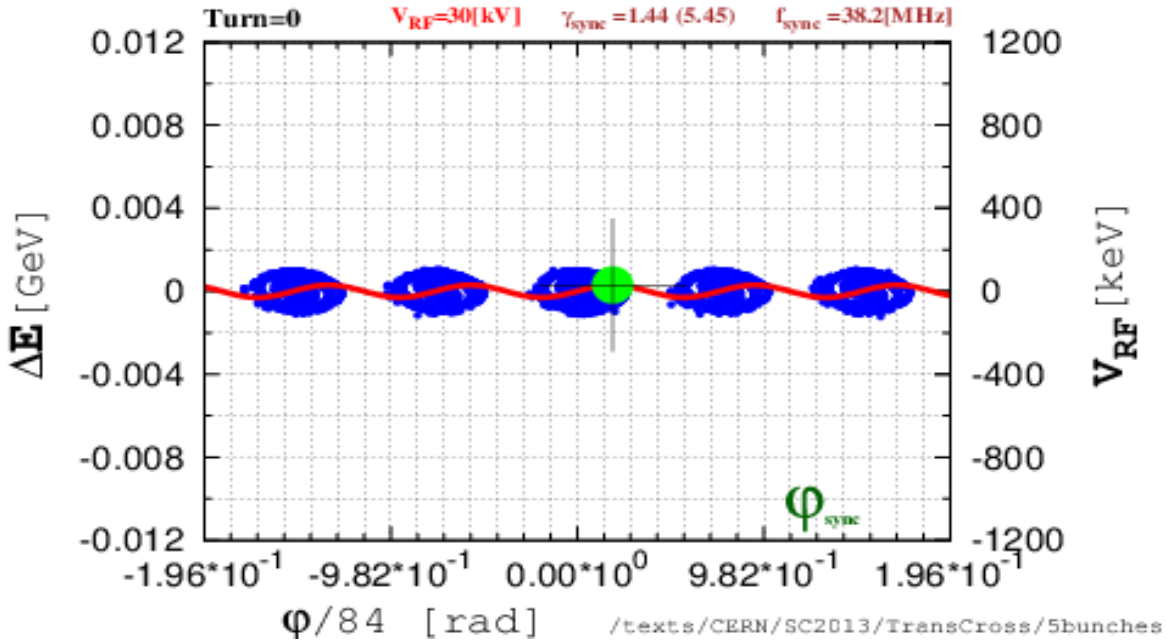
Multi-turn H^- Injection



Above we have an ORBIT simulation of H^- stripping injection painting into a Rapidly Cycling Synchrotron: a transverse (left, center) and longitudinal (right).

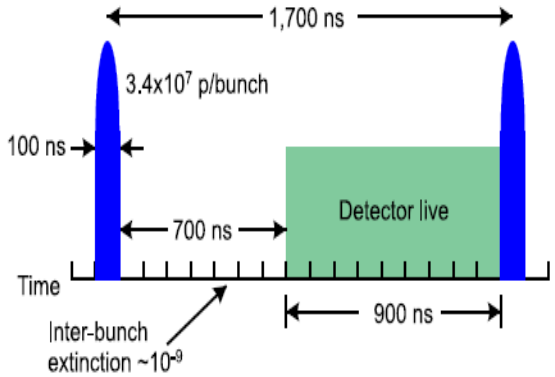
The simulations here are for the Fermi National Accelerator Labs proposed high power Linac (Project X) injecting H^- into the existing Main Injector ring.

Transition Crossing

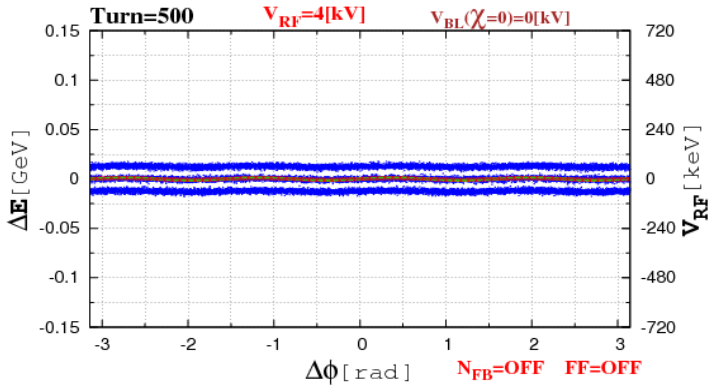


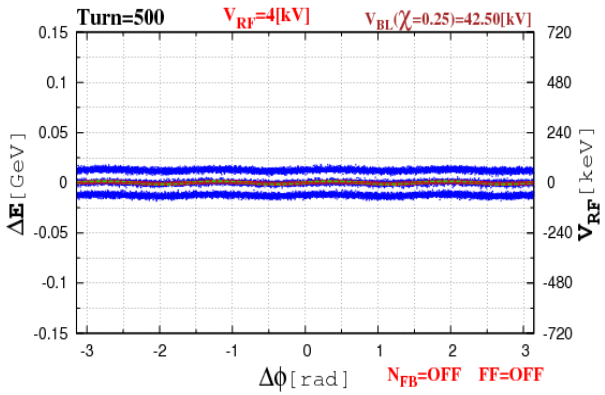
ORBIT simulation of the Fermi National Accelerator Lab Booster ring going through transition. RF cavities squeeze the bunches longitudinally creating space charge issues. The Booster ring, a Rapidly Cycling Synchrotron, is an integral part of the Fermi National Accelerator Labs accelerator complex, and the most critical part in FNAL Proton Improvement Plan (PIP).

Beam Loading



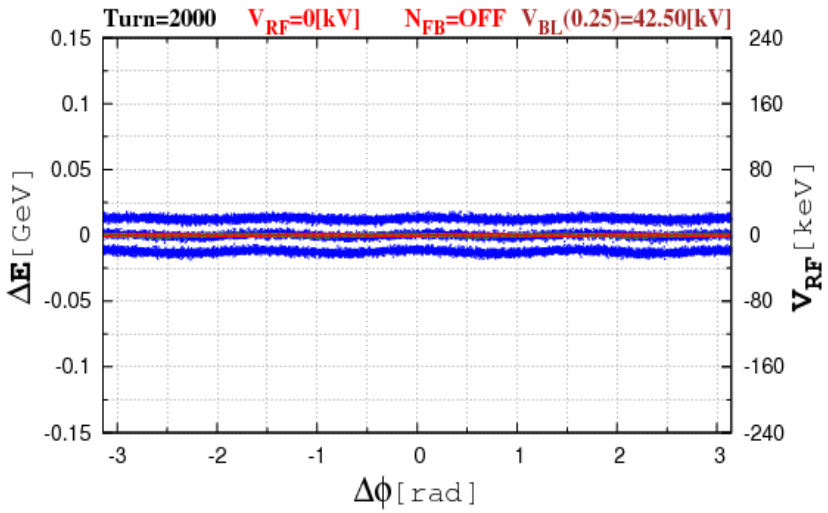
The proton bunch time structure and extinction interval for the mu2e experiment

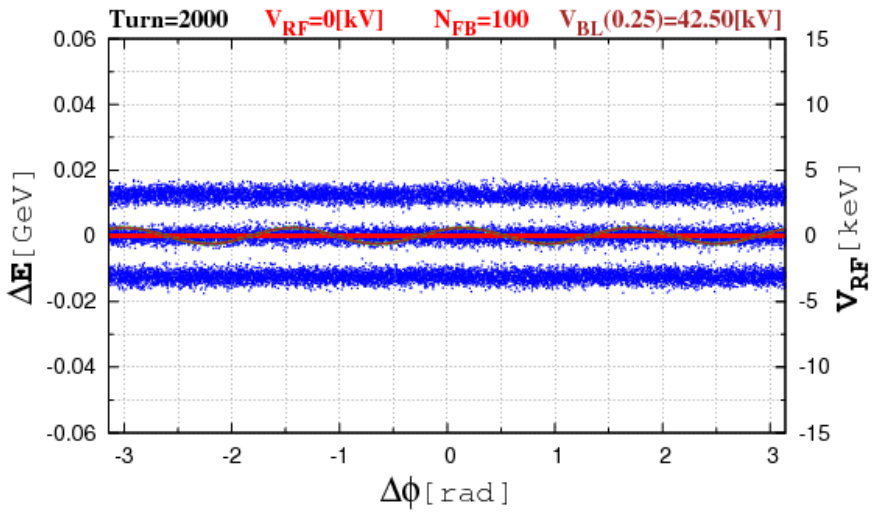




Experiments such as mu2e require strictly defined proton bunch structure and extinction intervals (suppress backgrounds). Here we see a simulation of the longitudinal dynamics with and without beam loading – understanding these dynamics is crucial to providing the optimal beam for this type of experiment

Instability Suppression with Feed Back





Beam loading effects with coasting beam (RF turned off): investigation of instability suppression with various feedback delays (No feedback LHS, Feedback with 100 turn delay LHS).

This and previous page were based on beams in the now decommissioned Fermi National Accelerator Labs 8 GeV Accumulator ring in the context of the mu2e experiment.

High Luminosity LHC

For the high luminosity LHC (HL-LHC), space charge study requires high quality modeling.

We are actively investigating the sources of numerical errors in space charge algorithms, both conventional space charge grid solvers (based on PIC formalism) and hybrid solvers, and formulating mitigation strategies for them.

The implementation of these improvements will significantly increase the accuracy, speed and physical validity of multiple-particle tracking and contribute to achieving the required beam parameters in the LHC accelerator complex.