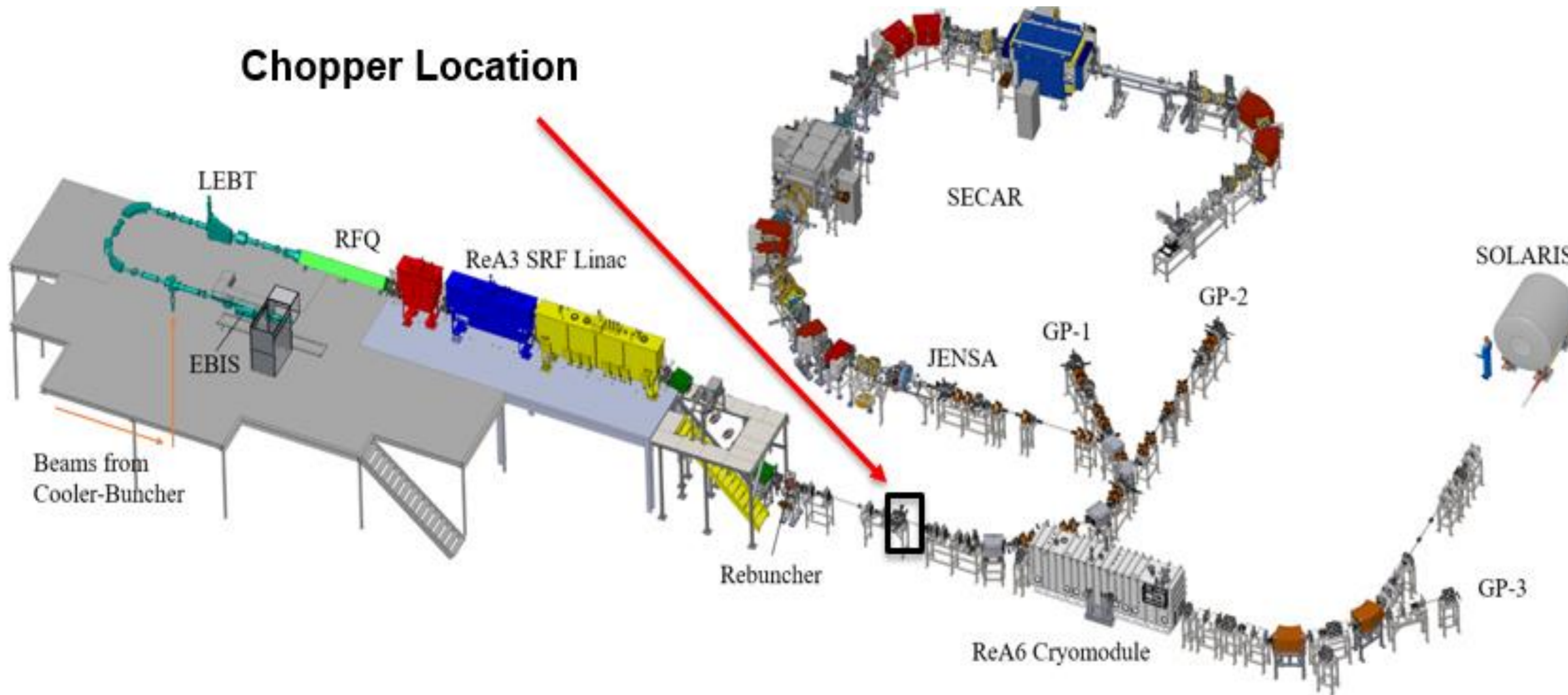


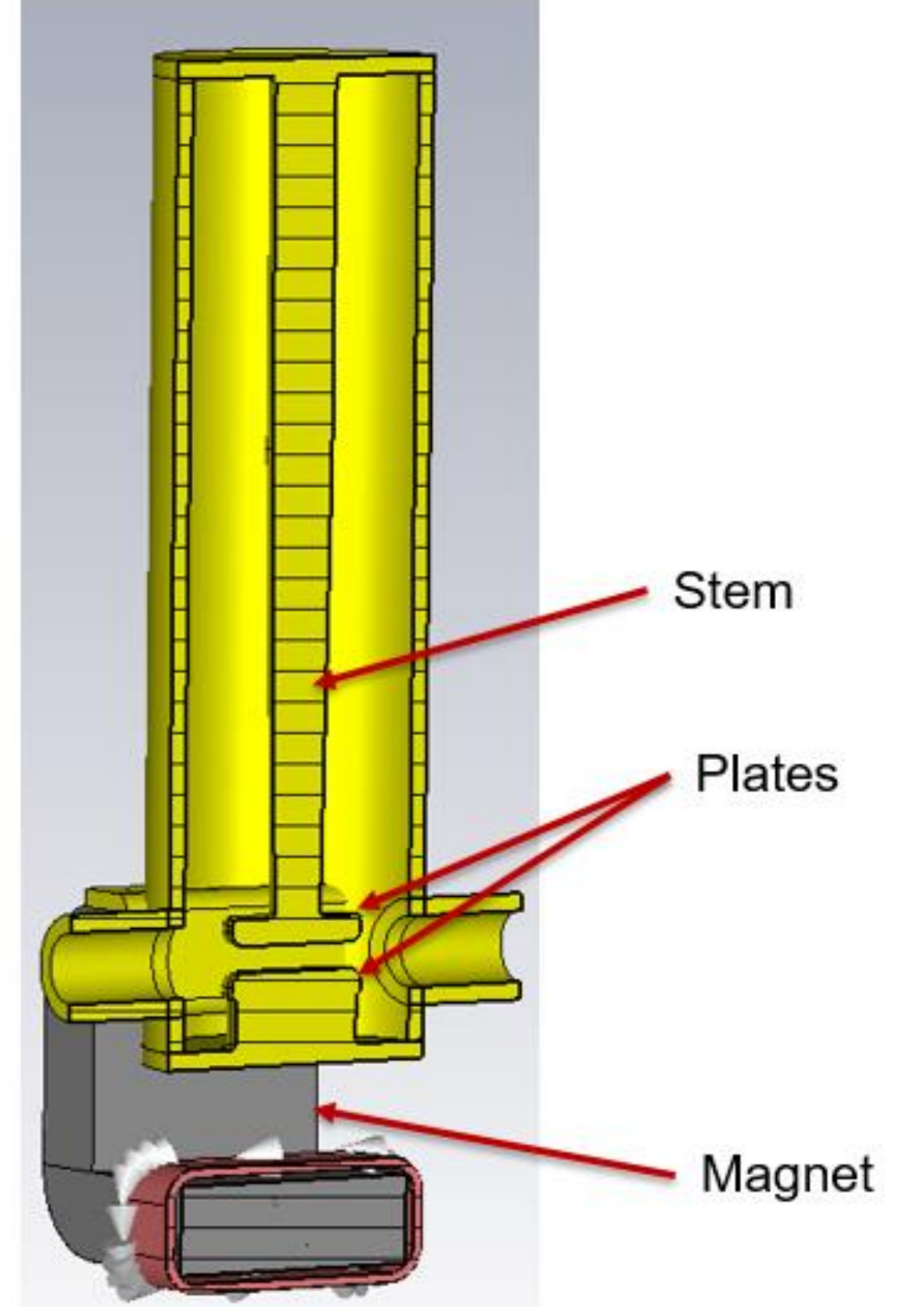
An RF chopper system is being designed for the Re-Accelerator (ReA) linac at the Facility for Rare Isotope Beams (FRIB) at Michigan State University (MSU). The chopper system is designed to clean out satellite bunches and produce a 16.1 MHz bunch structure, which allows for time-of-flight separation of the isotopes. The chopper system's location in the beamline is between the ReA3 and ReA6 cryomodules. In ReA, the beam can be prebunched at the frequency of 16.1 MHz and accelerated in a 80.5 MHz RFQ, producing four satellite bunches for every one high-intensity bunch. The chopper system includes a 64.4 MHz RF deflector, which deflects every bunch to spatially separate high-intensity and satellite bunches. The beam trajectory is biased by a constant magnetic field to ensure the high-intensity bunches do not experience any total deflection. The kicked bunches are low in intensity and will be sent to a beam dump, resulting in a clean 16.1 MHz beam structure injected into the ReA6 cryomodule.

## The Re-Accelerator

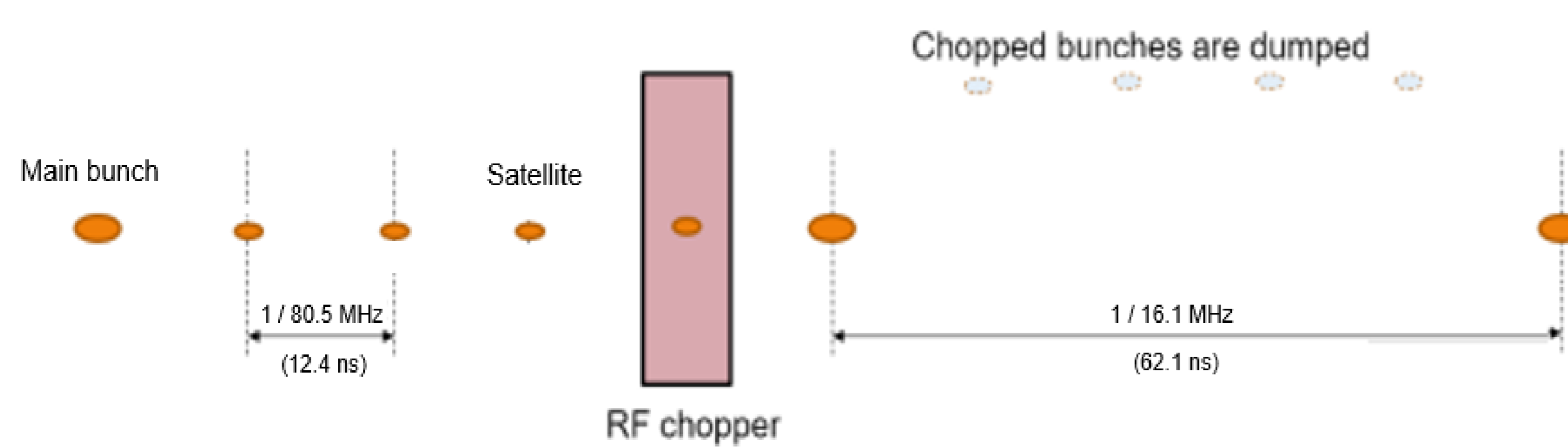


## Chopper Design Parameters

Parameter	Value
Cavity Height	1130 mm
Cavity Diameter	340 mm
Plate Length	168 mm
Gap Between Plates	30 mm
Power	10 kW
Electric Field in Gap	4.6 MV/m
Voltage in Gap	137 kV
Peak Electric Field	7.9 MV/m
Magnetic Field in Gap	68 mT

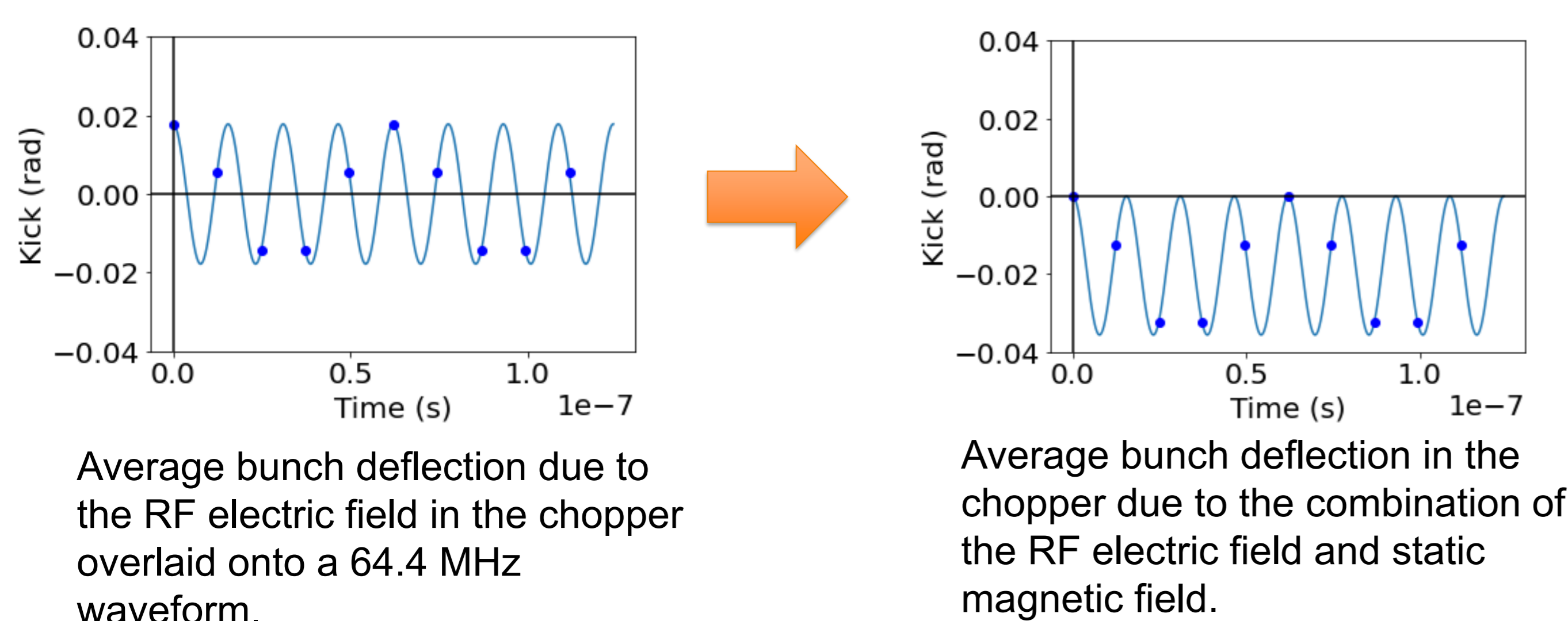


## Bunch Structure



The chopper system will produce a beam with a clean 16.1 MHz bunch structure, which will allow ReA users to perform time-of-flight measurements. The ReA beamline includes a radio-frequency quadrupole (RFQ), which generates an 80.5 MHz bunch repetition rate. Upstream from the RFQ is a multi-harmonic buncher (MHB) which produces high-intensity bunches at a frequency of 16.1 MHz. This means that, after the RFQ, there are four low-intensity ("satellite") bunches for every one intense ("main") bunch.

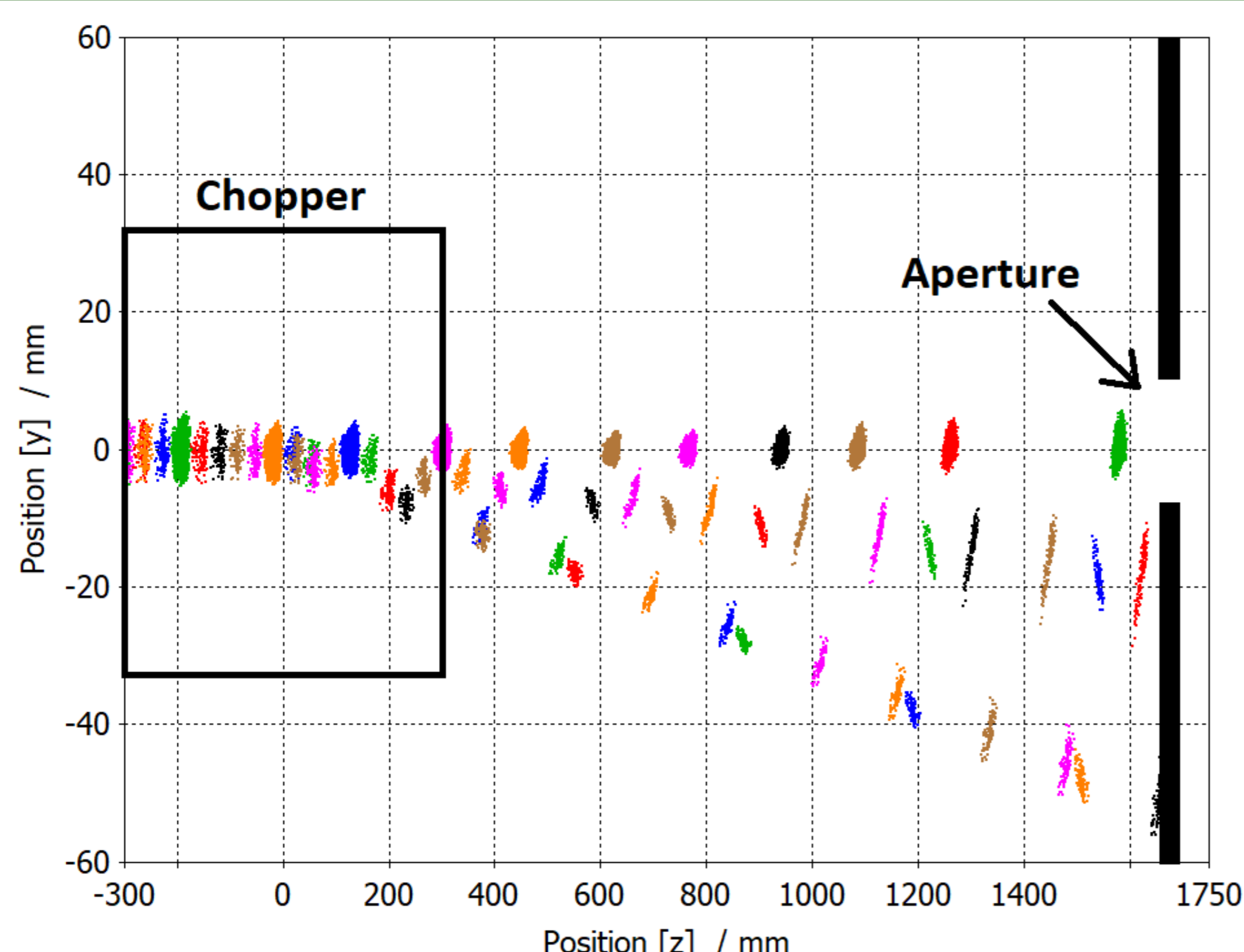
## Magnetic Bias



Average bunch deflection due to the RF electric field in the chopper overlaid onto a 64.4 MHz waveform.

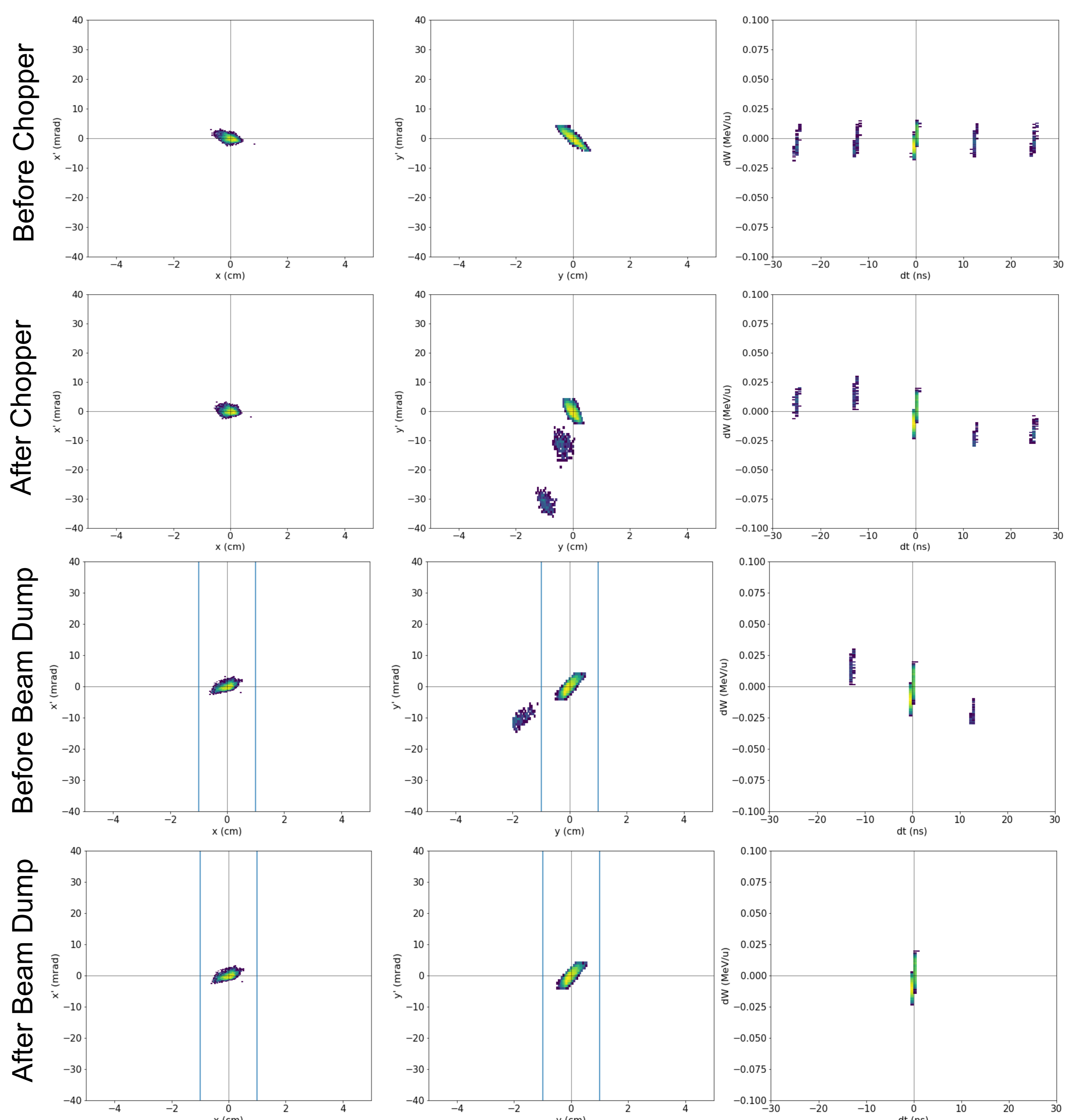
Average bunch deflection in the chopper due to the combination of the RF electric field and static magnetic field.

## Beam Dumping



The satellite bunches are dumped on the beampipe and on a circular aperture 1.4 meters downstream from the chopper. The aperture has a diameter of 1.0 cm, which allows all the particles in the main bunches to pass through and intercept the satellites before they reach the ReA6 cryomodule.

## Beam Snapshots



## Conclusion

- Project goal: develop an RF chopper for ReA
  - Kick satellite bunches, keep main bunches
  - Provide ability to perform time-of-flight measurements in ReA beamline
- Limitations: power, size, peak fields, location
- The chopper was designed in CST Studio and influenced by the ReA buncher and FRIB MEBT buncher designs.
- The design was confirmed with simulations in both CST Studio and TRACK
- Next step: construct and install the chopper system