



# NANOSECOND PULSING SYSTEMS

## National Electrostatics Corp.

# NEC Nanosecond Pulsing System Product Specification Sheet

## Overview

National Electrostatics Corp. manufactures nanosecond pulsing and bunching systems for both tandem and single-ended electrostatic accelerators. The tandem pulsing and bunching systems can be designed for light and heavy ion operation. These systems, as with all NEC systems, are of all metal and ceramic construction capable of ultra-high vacuum operation.

All pulsing systems consist of two elements. First, a chopping element breaks a steady state ion beam into a train of chopped pulses of fixed pulse width. Second, a bunching element modulates the beam energy across the pulse width of the chopped beam pulses such that the ions in each chopped beam pulse arrive at the target within a time window on the order of a nanosecond wide.

The chopper must pass ion beams with no dark current between the chopped beam pulses. It is also important that the chopper imparts minimal energy spread to the chopped beam pulses.

The buncher utilizes the quasi-linear region of sine wave to modulate the beam energy across each chopped beam pulse. This energy shift is applied across the duration of each chopped beam pulse such that the ions early in each chopped beam pulse are slowed, and the ions that are late in each chopped beam pulse are accelerated. When the proper energy shift is applied the ions arrive at the same time as the ions at the center of the chopped beam pulse, which underwent no energy shift.

The phase of the chopper and buncher must be carefully synchronized so the middle of the applied energy shift aligns with the middle of each chopped beam pulse. The buncher voltage must be tuned so that the energy shift each ion experiences in a chopped beam pulse causes them to produce a time focus at the target.

## Standard Nanosecond Light Ion Pulsing System for Tandem Accelerators

The standard pulsing system produced by NEC is for creating nanosecond pulses of light ions in tandem accelerator systems. The standard NEC nanosecond light ion pulsing system is designed to generate pulses of hydrogen, deuterium, and helium with a FWHM of 2 ns or less. This pulsing system is designed to operate with an injection energy of 70 keV.

## Standard Light Ion Chopper

2EA010900

The standard pulsing system utilizes a fast-chopping switch to apply a sharp edged square pulse to a deflection plate. This deflects the beam in a periodic manner. A set of beam defining slits is placed downstream of the chopper, at a beam waist, such that the chopper can steer the beam completely off the aperture provided by the slits when voltage is applied, and beam can pass cleanly when the voltage is off. The chopper provides chopped beam pulses of roughly 20 ns at a frequency of 2.5 MHz, and halves of that frequency.

# NEC Nanosecond Pulsing System Product Specification Sheet

## Standard Light Ion Buncher

PN 2EA074420

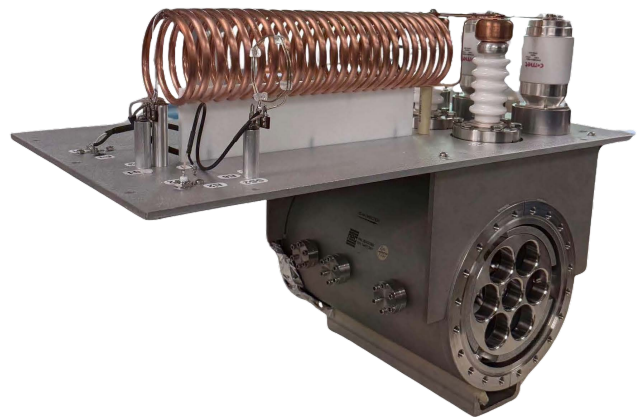
A 3-electrode buncher is placed at the beam waist before the accelerator. This buncher is driven with a 5 MHz sinusoidal voltage that is applied to the electrodes inside the buncher. The circuit is configurable without breaking vacuum, so that the suitable effective length of electrodes is active to match the buncher with 70 keV hydrogen, deuterium, or helium. It is possible to adapt this buncher to some heavier species by adjusting the injection energy, so its travel time matches one of the buncher lengths, typically at higher modes of the buncher frequency.

## Customized Ion Pulsing Systems

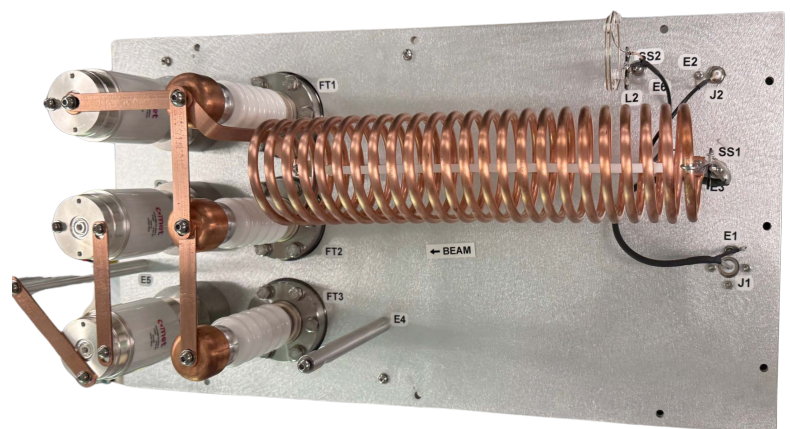
NEC has experience building a variety of pulsing systems to meet unique customer specifications and can bring this experience to your system. We have built heavy ion pulsing systems, including traveling wave deflectors for chopping heavy ion beams, and have designed Pelletrons with in-tank bunchers. These bunchers have multiple buncher electrode lengths, which can be engaged without opening the accelerator tank.

We have built pulsing systems in Pelletron terminals for single-ended accelerators. NEC has had extensive experience in the proper shielding techniques required to make the sensitive electronics of a pulsing and bunching system survive the hostile environment inside the high potential terminal of an electrostatic accelerator.

We have customized the number of buncher electrodes available for our customers' needs. We have customized operating frequencies to fit a buncher in a smaller available space. We can provide recommendations on how to adjust the injection energy to match the velocity of heavier species with the available buncher lengths at higher modes. For applications that desire a high pulse current we have designed double-drift bunchers that accept and bunch a longer duration chopped beam pulse than a single drift buncher.



NEC Nanosecond Pulsing System



NEC Nanosecond Pulsing System (Top View)

# NEC Nanosecond Pulsing System Product Specification Sheet

## Pulsed Beam Diagnostics

NEC provides a few diagnostics that provide feedback for the gross tuning of the parameters of the bunching components. While they don't provide sub nanosecond pulse resolution, they provide an operator real time feedback, allowing an operator to produce beam pulses than can be optimized for fine tuning. For high resolution measurement of the pulse width NEC has provided timing spectroscopy diagnostic apparatuses, or recommended application notes.

## FC-28 and FC-28 Retractable

PN 2EA023110 and 2EA073480

NEC makes two models of Faraday cups to assist in pulsing system tuning. The entrance of these Faraday cups is gridded to minimize the broadening of the measured pulse. A stripline feedthrough is used to provide optimal impedance matching from the cup through a 50 Ohm cable to an oscilloscope for display. The standard FC-28 is fixed in position, so if a target is used, it must be inserted upstream of the FC-28. The FC-28 Retractable has a similar Faraday cup construction, but it is on a retraction mechanism that allows the user to remove the diagnostic from the beam path so that beam can continue to a fixed target downstream.

## Capacitive Pickup

PN 2EA056270

It is also possible to get real time tuning feedback with a capacitive pick up. While this experiences significant broadening, it produces a resolvable signal pulse as pulses are formed. The Capacitive Pickup does not intercept the beam, which means it can be used while sensitive measurements are undertaken. It has been used as a stop trigger on a Time to Amplitude Converter used in Timing Spectroscopic techniques.



*Standard model FC-28 Faraday cup*

## Contact NEC

 [www.pelletron.com](http://www.pelletron.com)

 +1 (608) 831-7600

 [nec@pelletron.com](mailto:nec@pelletron.com)

 7540 Graber Rd, Middleton, WI 53562-0310 USA