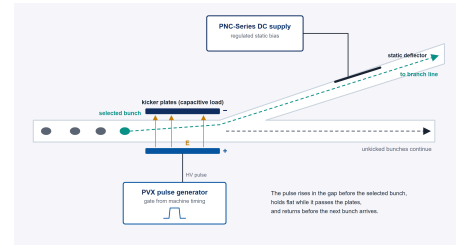


Particle Accelerators & Beam Kickers

Pulse kicker and deflector plates and bias detectors across a beamline. BNC DEI pulse generators deliver flat-top, low-jitter high-voltage pulses synchronized to machine timing, backed by PNC-Series supplies for static bias.

APPLICATION BRIEF · DEI PULSERS · dc-62022201



Schematic of a transport-line kicker: a PVX pulse generator drives the kicker plates so the selected bunch is deflected into the branch line while the other bunches continue straight, and a PNC-Series supply holds the static deflector at a regulated DC bias.

Particle Accelerators & Beam Kickers

In an accelerator or beamline, a kicker is a set of electrodes that deflects the beam on command. Pulse them at the right instant and a kicker injects a bunch into a ring, extracts it, dumps it, or steers it between branches of a transport line. The deflection has to happen in the gap between bunches, hold flat while the chosen bunch passes through, and return cleanly so the next bunch is undisturbed. The pulse generator that drives those plates is therefore a timing-critical, fidelity-critical part of the machine.

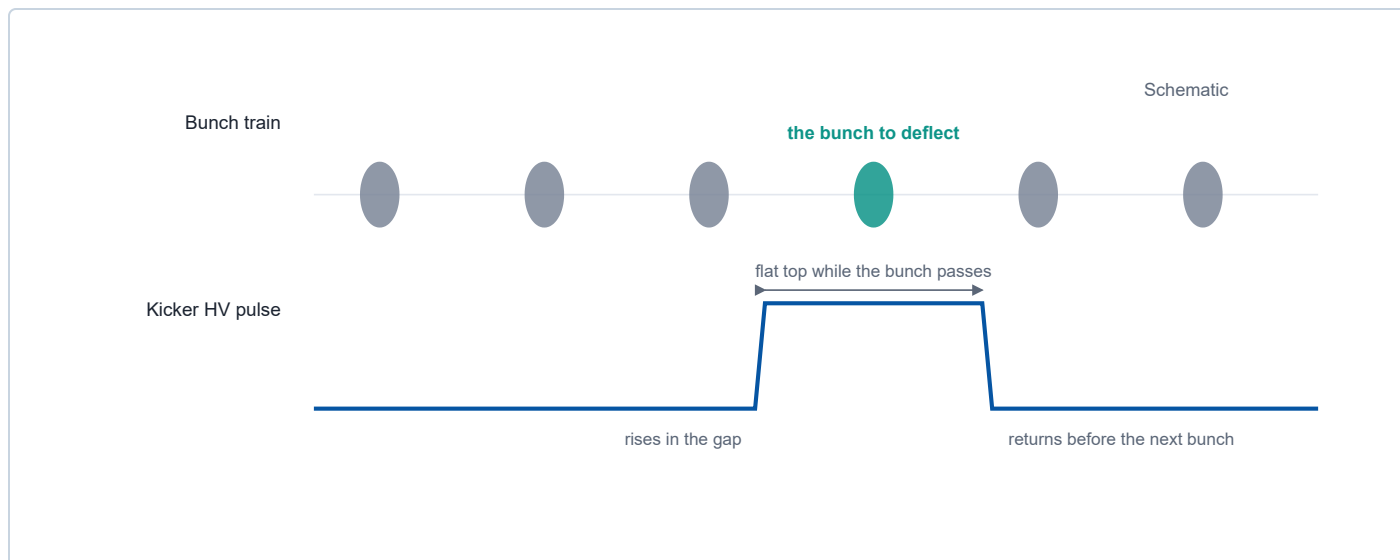
The plates look capacitive to the driver, and the requirement is a high-voltage pulse with a fast rise, a genuinely flat top for the duration of the passage, and a clean return, all placed precisely against the machine clock. Alongside the pulsed kickers, the beamline needs steady high-voltage bias for static deflectors, electrostatic optics, and the detectors that diagnose the beam. The two needs, pulsed deflection and stable bias, are best served by instruments built for each job and timed into one chain.

The Challenge

Flat-top fidelity is the defining requirement for a kicker pulse. While the selected bunch traverses the plates, the deflecting field must stay constant, because any droop, tilt or ripple on the top of the pulse becomes a position or angle error on the beam (Figure 1). A pulse that rises fast and then sags across its flat region kicks the head of a bunch differently from its tail, and in a circulating machine that error compounds turn after turn. The driver has to source the current that holds the capacitive plates at a steady voltage for the full passage, not only reach the level briefly.

Synchronization to machine timing is the second hard requirement. The kick has to fire in the abort gap or the inter-bunch interval, which means the delay between the machine trigger and the HV edge must be both small and stable. Jitter on that delay smears the kick across the wrong part of the bunch train, so low trigger-to-output jitter is essential for clean injection and extraction. The rise and fall must also fit inside the available gap, which sets a hard edge-speed budget tied to the machine bunch spacing.

The static side has its own demands. Bias supplies for deflectors and detectors need low ripple and good stability, because noise on a bias electrode shows up directly in beam position or in detector baseline. A pulsed source and a quiet DC source are different instruments, and a well-built beamline uses each for what it does best.



■ **SCHEMATIC** **Figure 1.** The kicker pulse rises in the gap, holds flat while the chosen bunch passes, and returns before the next one. Flatness during the passage keeps the deflection uniform across the bunch.

The BNC Approach



■ **PHOTO** **Figure 2.** PVX-4110 high-voltage pulse generator, front panel, with the I Mon, V Mon and Gate connectors.

For the pulsed kickers and deflectors, the DEI PVX pulse generators bring a capacitive-load output that holds a flat top under load: droop under 1 percent and over/undershoot under 5 percent. The half-bridge (totem-pole) stage drives the plates actively up and back, which keeps the rising edge fast and the flat region settled while the bunch passes, then returns the plates for the next interval. The output switches between two user-supplied DC supplies, VHigh and VLow, which set the

deflection levels directly, and shot-to-shot jitter is under 1 ns on both the PVX-4110 and the PVX-4130. Front-panel voltage monitors (2000:1) and current monitors (10 A/V) bring the plate waveform to a scope so the kick can be checked against the timing system.

For the static bias, the **PNC-Series** switched-mode supplies provide regulated DC from 600 V to 300,000 V, with ripple of 0.01 percent peak to peak of nominal voltage (plus 50 mV) and 8-hour stability of 0.01 percent; the PNChp variant reaches 0.001 percent (10 ppm) ripple and stability. A PVX pulse generator on the kicker and a PNC-Series supply on the static electrodes cover both the pulsed and the steady sides of the deflection chain.

Recommended Instruments

For kicker and deflector pulsing, the **PVX-4110** supplies up to $\pm 10,000$ V into capacitive plates, with rise and fall under 60 ns (about 54 ns typical at 10,000 V into 120 pF), pulse width from under 200 ns to DC, and single shot to 10 kHz. The **PVX-4130** covers lower deflection voltages, to $\pm 6,000$ V. Its rise time is in the same class, under 60 ns (about 45 ns at 6,000 V), so the choice between the two follows the voltage the plates need, not edge speed.

Which kickers these edges suit. A 50 to 60 ns edge with a flat top to DC fits deflectors and kickers whose bunch gap or abort gap is longer than the edge with margin, roughly 100 ns or more: transport-line switching and branch selection, choppers and beam blankers in low-energy injector lines, and injection or extraction in machines with long gaps. Ring kickers that must rise within a gap of a few tens of nanoseconds at tens of kilovolts, usually into matched transmission-line magnets, need a different class of pulser than these capacitive-load drivers.

For the static electrodes and detector bias alongside the kickers, the **PNC-Series** supplies cover regulated DC from 600 V to 300,000 V, in single-phase models to 2 kW and three-phase PNC3p models to 6 kW at up to 60,000 V. A PVX pulse generator on the kicker and a PNC-Series supply on the static bias give the beamline one high-voltage chain for pulsed and steady deflection.

Fit the edge to the gap

Size the rise and fall against your bunch spacing and abort gap, and the flat-top duration against the bunch length, before choosing a model. The plate capacitance sets the current the pulser must source to hold the top flat. An applications engineer can work that budget against your machine timing.

Getting Started

Start from the machine: the bunch spacing and abort-gap width that set the edge-speed budget, the bunch passage time that sets the flat-top duration, the deflection voltage your plates need, and the jitter your timing system can tolerate. Separately, list the static bias requirements for deflectors and detectors. The pulsed numbers point at a PVX model and the static numbers at a PNC-Series supply, and the built-in monitors let you verify the kick against the machine clock during commissioning.

Talk to a BNC applications engineer at info@berkeleynucleonics.com or 800-234-7858. Bring your bunch spacing, deflection voltage, flat-top requirement, and bias levels, and we will match a DEI pulse generator and a PNC-Series supply to your beamline.

Berkeley Nucleonics Corp.

Test, Measurement and Nuclear Instrumentation since 1963
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Application Brief

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