BEAM DIAGNOSTIC COMPONENTS
National Electrostatics Corp.

Beam Profile Monitors

The NEC beam profile monitor (BPM) system provides a continuous oscilloscope display of the shape and position of the beam cross section in both X and Y coordinates. The unique design of NEC's beam profile monitors has made them among the most popular and reliable beam diagnostic instruments available, with over 2,000 BPMs provided for customers worldwide. The NEC beam profile monitor reliably gives accurate information concerning the beam cross-section for ion beams with currents as low as 1 nA for most models.

The NEC beam profile monitor, Model BPM90.

Application

The NEC BPM system is ideally suited for applications that require instantaneous oscilloscope display of beam cross-sectional shape and position without significantly interrupting beam transmissions. Particle beams of electrons, positive or negative ions, or energetic neutrals can all be monitored. The complete system includes a BPM in an NEC or customer-supplied housing, a preamplifier, a controller, and an oscilloscope.

Beam Profile Monitor Design

The unique design of the NEC BPM relies on the collection of secondary electrons from a grounded scanning wire. This arrangement eliminates contact noise at the rotating scanning wire. In each rotation of the wire, the following steps occur:

1. A helical wire sweeps across the beam twice during each revolution to give a Y profile in a half revolution and an X profile during the next half revolution at a frequency of 20 Hz.
2. A cylindrical collector surrounding the grounded wire collects beam-induced secondary electrons to provide a signal proportional to the intercepted beam intensity at every instant.
3. The signal from the collector cylinder is received by a preamplifier and an NEC controller, resulting in the direct viewing of the beam on an oscilloscope. The signal resulting from the interaction of the ion beam and the scanning wire is dependent on the beam current density, which also affects the maximum beam power that can be accepted and the ultimate sensitivity of the BPM.

The BPM is ultra-high vacuum compatible; under typical vacuum conditions, no pressure rise is seen when turning the scanning wire on in the 10-9 Torr range.

Using a servo-controlled motor instead of an AC motor, the BPM 90 series provides precise control of the scanning wire position and speed. This is advantageous for high power beams as the wire accelerates and decelerates outside of the field of view of the beam when starting and stopping to prevent damage to the wire. The servo-controlled motor provides a controlled stop (parking) on power loss, which protects the wire from the beam.

Increased torque capability allows more responsive changes in speed and direction as needed and the improved magnetic coupling provides more reliable startup after long periods of dormancy.

Beam power- The standard 0.5 mm diameter scanning wire will accept a maximum beam power density of 140 W/ mm2 of continuous beam with no deformation. This means that the beam power can be a maximum of 1 kW for a 3 mm diameter beam or 2 kW of beam power for a beam diameter no less than 4.3 mm.

Sensitivity- The standard BPM system will routinely monitor beams with current densities to 10 nA/cm2. Therefore, a 1 nA beam with a diameter of 1 mm is readily monitored. However, a 1 nA beam with a diameter of 10 mm is less readily observed. The sensitivity is ultimately set by the preamp gain.

Beam size- Standard BPMs include apertures to measure beams up to 2.5 cm in diameter, while BPMs in larger housings allow measurements up to 7 cm in diameter.

BPM Preamplifiers

BPM preamps are usually mounted on the BPM B/L component for convenience and to keep signal cables short.

BPM 3 preamps have a rotary switch on the unit to select gains from 1E-3 to 1E-7 A/V. In addition, a remote contact closure can select X1 or X10 gain for each range, expanding the gain to 1E-8 A/V.

BPM 8 preamps have an analog input for remote gain selection. This signal ranges from 1E-3 to 1E-8 A/V.

The outputs from the preamps include the amplified collector signal as well as the fiducial signal from the magnetic pick-up indicating start of rotation, and Y and X center of B/L.

BPM 3 preamp

BPM 8 preamp and BPM 3 preamp

	BPM90	BPM91	BPM92	BPM93
Overall Length	6.7” (17.15 cm) - 7.38” (18.73 cm) dependent on flange type	N/A	N/A	8.0"(20.32 cm) for 8.0" O.C CF flanges
Standard Flanges*	Housing Flanges: 6.0" or 8.0" O.D. CF	Housing Flanges: 4.5" O.D. CF 4.25" O.D. NEC	Mounting Flange: 6.0" O.D. CF 6.0" O.D. NEC	Mounting Flange: 6.0" or 8.0" O.D. CF
Housing	4.0” (10.16 cm) dia. (nominal)	N/A	N/A	6.0” (15.24 cm) dia. (nominal)
Scanning Wire material/dia.	Molybdenum / 0.020" (0.5 mm) dia.	Molybdenum / 0.020" (0.5 mm) dia.	Molybdenum / 0.040” (1 mm) dia.	Molybdenum / 0.060" (1.5 mm) dia.
Beam Aperture dia./material	1.0" (2.54 cm) dia. / molybdenum	1.0" (2.54 cm) dia. / molybdenum	2.0” (5.08 cm) dia./ molybdenum	2.75" (6.98 cm) dia./ molybdenum
Maximum Beam Power Density	140 Watts/mm^2 (1 kW for 3 mm dia. beam)	140 Watts/mm^2 (1 kW for 3 mm dia. beam)	140 Watts/ mm^2 (1 kW for 3 mm dia. beam)	150 Watts/mm^2
Insertion Length	N/A	Insertion distance from flange gasket surface to beamline center is 2.72" (6.9cm)	Insertion distance from flange gasket surface to beamline center is 4.5" (11.43 cm)	N/A
Catalog No.	2EA076000 (6.0” O.D. CF)	2EA076040 (4.50” O.D. CF)	2EA076080 (6.0” O.D. CF)	2EA076130 (8.0” O.D. CF)

Optional high-power wires are available.

BPM91 and BPM92 can have custom insertion lengths.

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