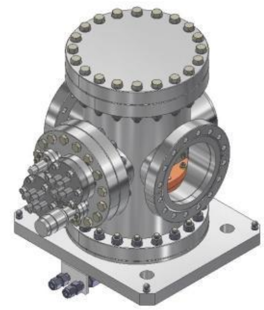
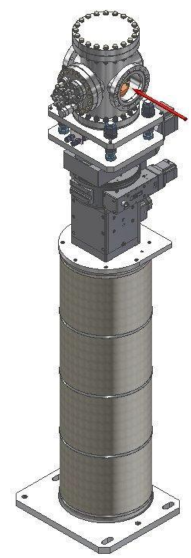
Overview:



This device is a cooled multi-blade system, in horizontal and vertical disposition, placed in the fringes of the beam to detect the position of the beam. Typically, there are two BPM's. The second is placed approximately several meters (~3.6 m) downstream of the first. Together they yield precise beam position information. When swept by the beam, the blades of the front end BPM's generate photoelectrons. This, in turn, causes a microampere-level photocurrent in each blade that can be measured and reduced to correlate with the degree of deviation of the beam from its orbit. The beam missteering on the ring side is to be kept within ten percent in both position and divergence. When excessive deviations are detected, the output from the BPM's is fed back into the ring correction (steering) magnets to adjust the beam's position and the angle at the ID center. In the extreme case of beam tracking loss, the BPM can trigger a beam dump. BPM signals are fed back to the ring for proper beam steering.



Extensive studies were conducted at APS looking at different design, blade material and stability of the system. The APS machine side, for example, requires, with the two BPM's spaced apart as described above, a precision of ±3.3 µm in the position and ±0.14 µrad in the angle of the particle beam. Given the power from the planned ID beams, early studies indicated that, with conventional blade materials, it would be very difficult to meet these specifications reliably. Therefore, new blade materials were investigated, and metallized CVD diamond blades were chosen for the ID front ends. Early tests proved beyond reasonable doubt that submicron sensitivity (on the order of 0.2 µm) can be achieved with CVD diamond blades under all conventional operations. The dynamic range of the current CVD diamond blades in synchrotron tests has been shown to be at least 2 mm.

Later tests proved that the CVD diamond blades can be heated to over 1000° C under very adverse conditions with no loss of integrity or performance. However, the BPM blades have been designed not to exceed 600° C under full beam missteering when the beam from a 5-m undulator is allowed to impinge directly on the blade.

Because the complete BPM assembly is comprised of three parts, namely the mounting post, the stage assembly, and the blade head assembly, the error sum from these parts should meet the total error budget of < ± 1 µm. Table 1 lists various post choices subjected to a 1° C temperature change and the resulting thermal elongation. A dynamic analysis of these post configurations proves that a post made of 3-mm-thick steel, filled on the inside with conductive loose material, and thermally insulated on the outside will have large thermal inertia. Such a post will expand/contract negligibly when subjected to a ± 2°C step change in the environment, requiring over a full day to reach steady state. Therefore, such a post design is very resilient to the more relevant shorter term temperature fluctuations.

Table 1

Beam Position Monitor Support Base Vertical Thermal Expansion for a 1°C Temperature Change

Case	Specification	Thermal Expansion
1	SS Cylinder	16.2 µm
2	SS Cylinder Filled with Water at Constant Temperature	0.82 µm
3	Case #2 with Ceramic Paper Insulation	0.33 µm
4	Ceramic Base Cylinder	0.50 µm

The PM stage assembly consists of vertical, horizontal, and rotational stages.

The first BPM has six CVD diamond blades, four placed vertically in pairs and two single blades placed horizontally. The downstream BPM also has six blades; however, the vertical blades are placed singly, and the horizontals are in pairs. This configuration eliminates blade shadowing problems. Undulator and wiggler BPM's have fixed but two different horizontal blade settings. The current design features fixed but resettable blade configurations for both the undulators and wigglers. For bending magnet front ends, the BPM is much simpler, consisting of only two vertical blades.

Features:

- 7 GeV positron beam energy
- 100 mA beam current
- Blade material CVD diamond
- Sensitivity approximately 0.2 µ
- Dynamic range >2 mm
- Maximum design temperature 600° C (1000° C observed)
- Entrance and exit flanges 152.4 mm [6 inch] (others available)
- Top access flange 203 mm [8 inch] (others available)
- Water-cooled
- Multiple thermocouple and electrical feedthroughs

Jack (DJ400-50):

ADC's high precision jacks provide an accurate and rigid platform for use in any positioning system. The rugged black anodized aluminum housing features a precision ground base and top plate, each with multiple utility holes for easy integration into the users' system. The vertical stage is driven by a high class preloaded ballscrew coupled to a high torque 200 step per revolution stepper motor which can be run in full, half, or microstepping mode to meet your resolution requirements. Maximum rigidity is assured through the use of preloaded crossed roller linear bearings. Each jack also features two adjustable, normally closed limit switches at the end of travel.

Travel	50 mm
Dynamic Load Capacity	1200 N
Bi-directional repeatability	≤1 μm
Accuracy	+/- 1 um/25 mm

Rotator (RS-200):

ADC’s precision rotation stages are built upon an industry leading, preloaded, duplexed angular contact bearing set. These stages not only give an exceptionally high running accuracy, but allow for large radial and thrust loads as well. Each stage is driven by a precision ground worm gear set and a high resolution, high torque stepper motor. Backlash is reduced by employing a felxure style shimming technique to preload the worm and worm wheel.

Parameter	**Value**
Outer Diameter	210 mm
Dynamic Radial Load Capacity	2200 N
Bi-directional repeatability	≤0.002º
Uni-directional repeatability	≤0.001º

Horizontal Translation Stage (DS400-100):

ADC's high precision linear slides provide an accurate and rigid platform for use in any positioning system. The rugged black anodized aluminum housing features a precision ground base and top plate, each with multiple utility holes for easy integration into the users' system. The stage is driven by a high class preloaded ballscrew coupled to a high torque 200 step per revolution stepper motor which can be run in full, half, or microstepping mode to meet your resolution requirements. Maximum rigidity is assured through the use of preloaded crossed roller linear bearings. Each slide also features two fully adjustable, normally closed limit switches to define the extents of travel.

Parameter	**Value**
Travel	75 mm
Normal Load Capacity	4575 N
Bi-directional repeatability	≤1 µm
Accuracy	+/- 1 um/25 mm