NEXT GENERATION X-RAY BEAM POSITION MONITOR SYSTEM FOR THE ADVANCED PHOTON SOURCE MBA UPGRADE*

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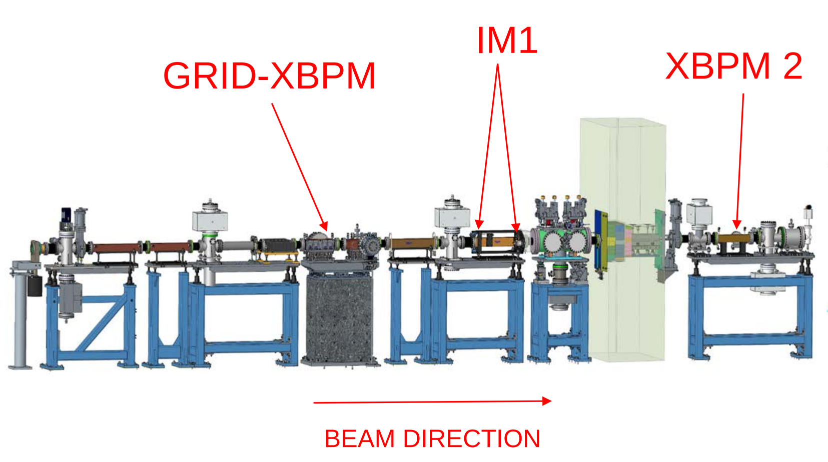
Abstract

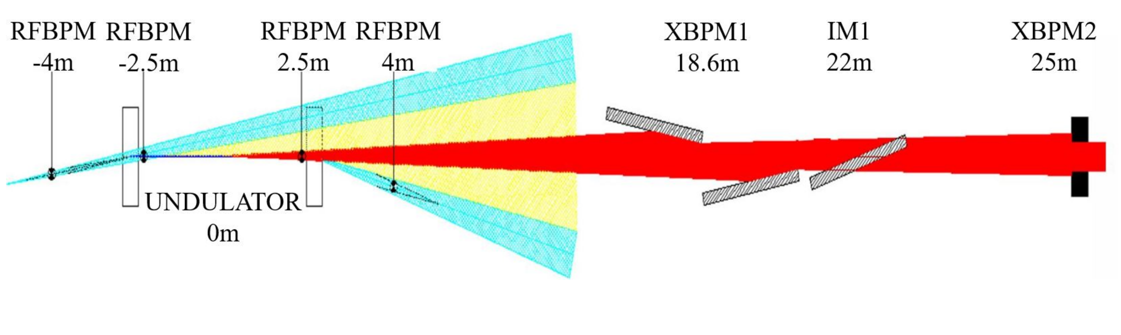
The Advanced Photon Source (APS) upgrade from double-bend achromats (DBA) to multi-bend achromats (MBA) lattice has increased the need for reliable diagnostic systems. This upgrade will decrease the size of the photon beam drastically and beam current will be in-creased from 100 mA to 200 mA. The small beam and intense heat loads provided by the upgraded APS requires unique and innovative approaches to beam position monitoring. To meet the need for a reliable diagnostic system for the APS upgrade, the next generation X-ray Beam Position Monitoring System (XBPM) is required which includes the first XBPM (XBPM1), the Intensity Monitor (IM1) and the second XBPM (XBPM2). This paper presents progress and status of the current configuration of the XBPM system especially the development work involving the IM1 and XBPM2.
The R&D work to develop an alternative XBPM1 using the Compton scattering principle is also presented.

The next generation XBPM system uses high heat load front end components for beam diagnostics: Two beam position measurements: XBPM1 and XBPM2, and one beam intensity measurement IM1.
Four RFBPMs are used for orbit control and calibration of XBPMs.

	Plane	AC Motion (0.01-1000 Hz)	Long-term Drift (>100 s)
X-ray beam tolerance	Horizontal	5.3 μm	12 μm
	Vertical	3.4 μm	10 μm
Total XBPM Error Budget	Horizontal	3.7 μm	8.5 μm
	Vertical	2.4 μm	7.1 μm



HIGH HEAT LOAD FRONT END



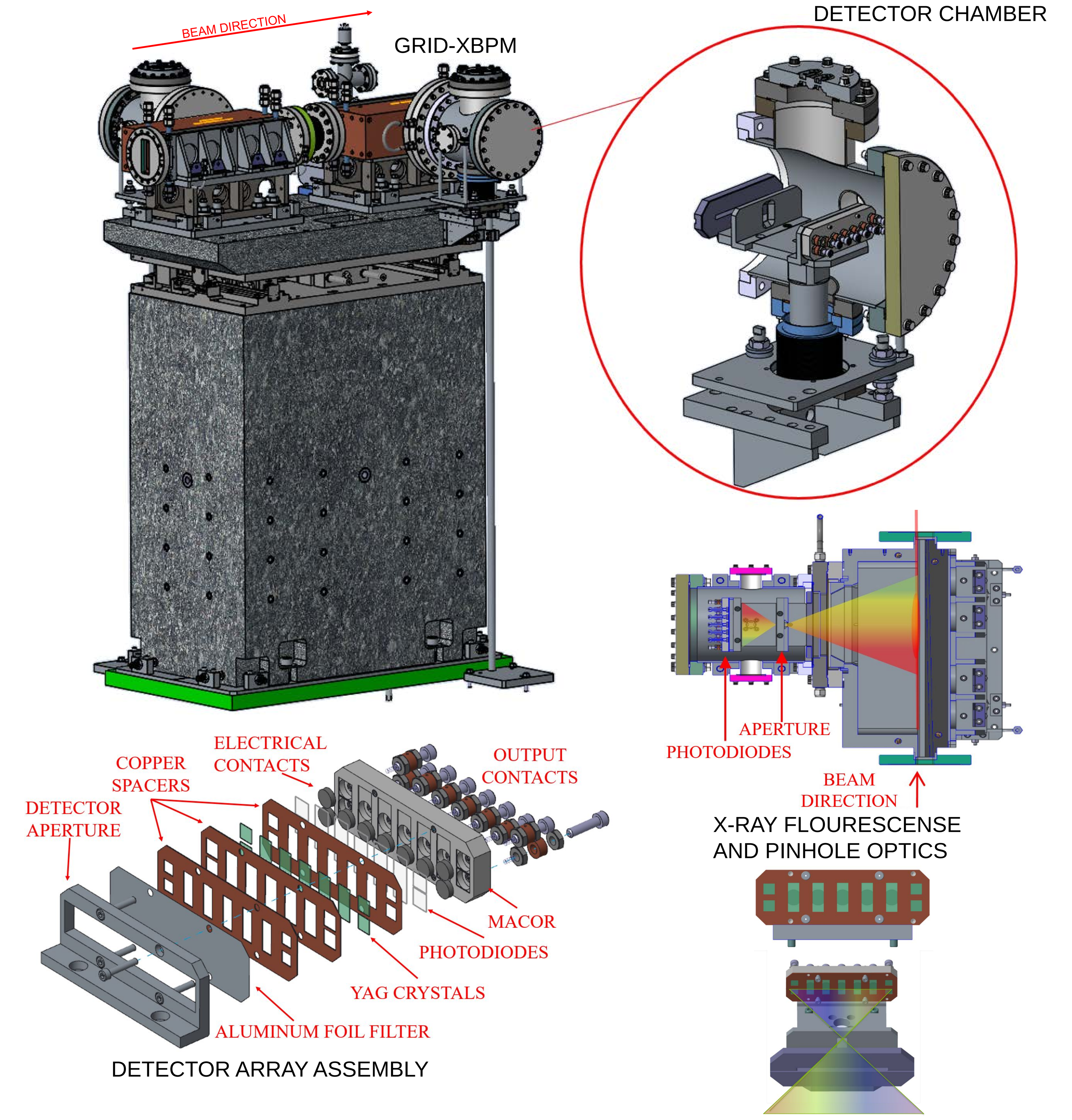
XBPM SYSTEM

Development of the Next Generation GRID-XBPM (XBPM1)

Design completed and fabrication started in January, 2017.
Assembly to be completed in Mid-2018 and installation at 28-ID in Late-2018.

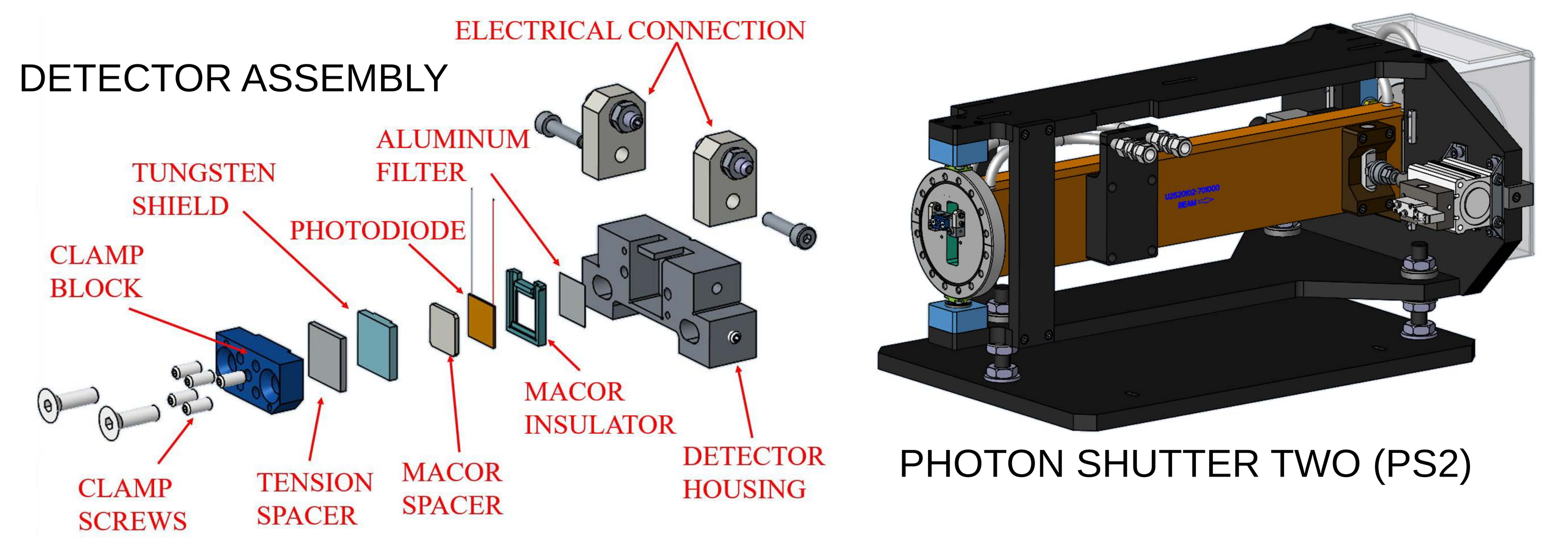
Design features include:

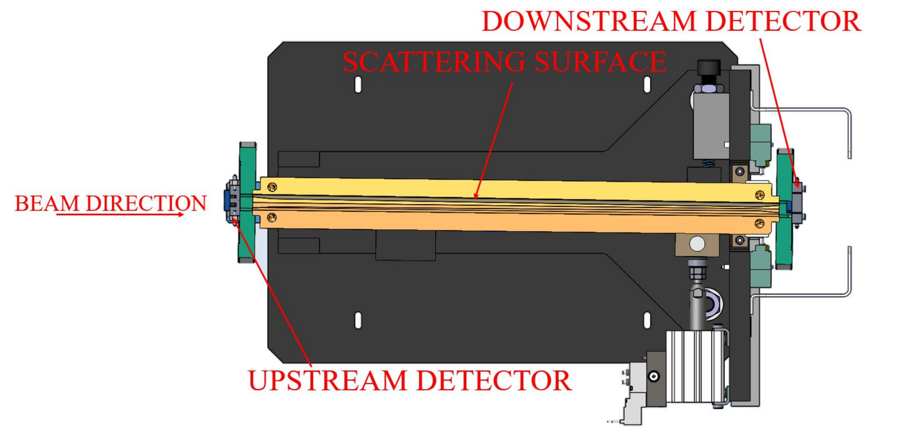
- Water-cooled GlidCop takes undulator power up to 17kW at 1.0˚ angle, absorbing up to 11.5 kW in normal operations.
- Independently supported pinhole optics + Array of PIN diodes for position readout.
- Strong gap dependence of horizontal calibration.
- Vertical readout independent of gap. But thermal distortion causes gap dependence of 7μm offset.



Development of the Intensity Monitor One

The first intensity monitor (IM1) measures the XRF intensity from the photon shutter (PS2), the figure shows the cross section of IM1/PS2. When the shutter is closed, it intercepts the beam on the outboard wall, the copper XRF photons will travel upstream and downstream through the imaging aperture and reach the silicon PIN diodes.

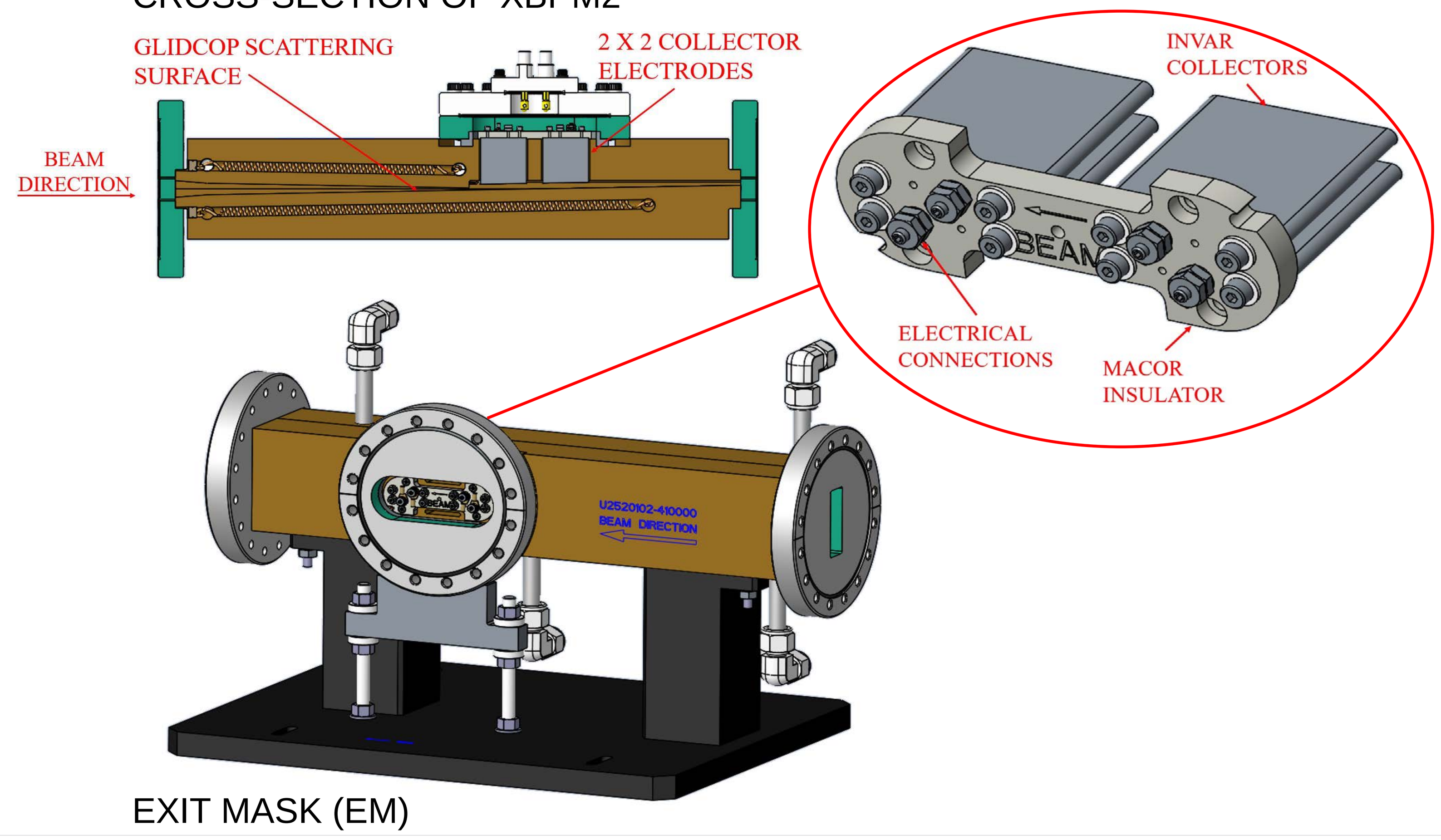




CROSS-SECTION OF IM1 AND PS2

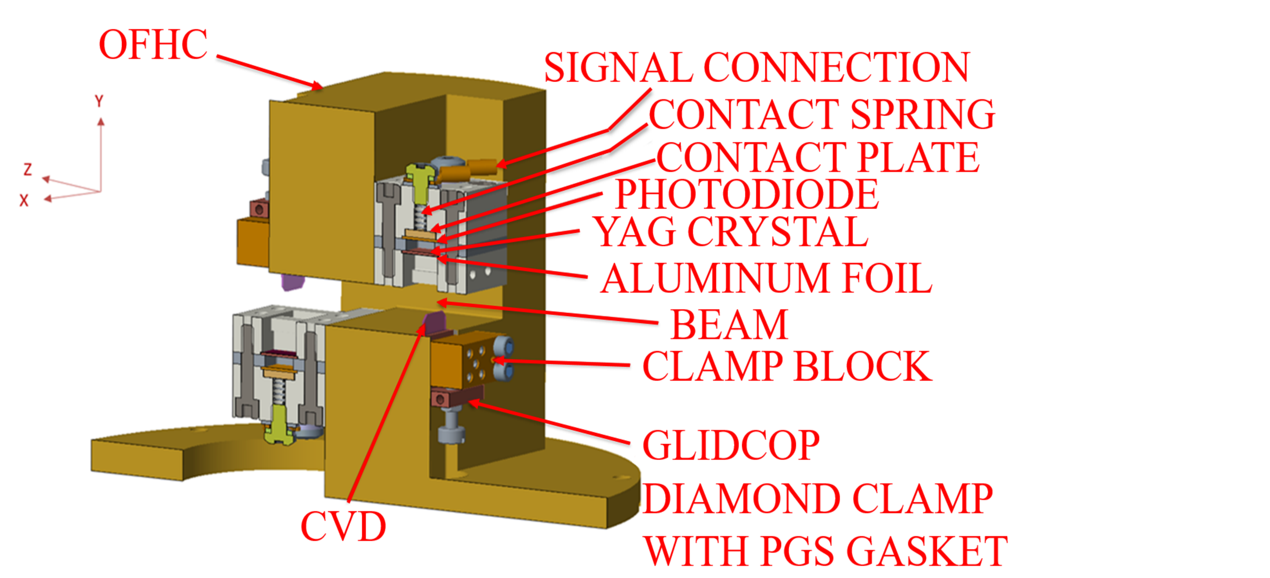
Development of the XBPM2

The latest high heat load front end (HHLFE) is equipped with a second XBPM based on x-ray fluorescence from the Exit Mask (EM). XBPM2 is mainly used to monitor relative beam motion during user operations. Since XBPM2 is not in the orbit feedback control loop, the XBPM2 is particularly useful for assessing the feedback performance.



Development of the Compton XBPM

The design for the Compton XBPM includes two blades that are placed above and below the beam to absorb the halo of the beam at normal incidence. The Compton XBPM tested one chemical vapor deposition (CVD) diamond blade and one pyrolytic graphite blade as absorbers. The Compton XBPM was tested in a canted beamline and a HHLFE. Blades survived the low power beamline test, but were destroyed during HHLFE survivability test. Results were comparable to GRID-XBPM but the design is less reliable. Further testing could be done to develop this technology, but for the APS-U, the GRID-XBPM was chosen.



Summary

Next generation XBPMs will be built for the APS-U, which will be one of the important components in the beam stabilization system. XRF and photoemission are used in unique ways to develop reliable and promising technology. The Compton XBPM concept is useful for beamlines, and with more development, can be a useful tool in the future.

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