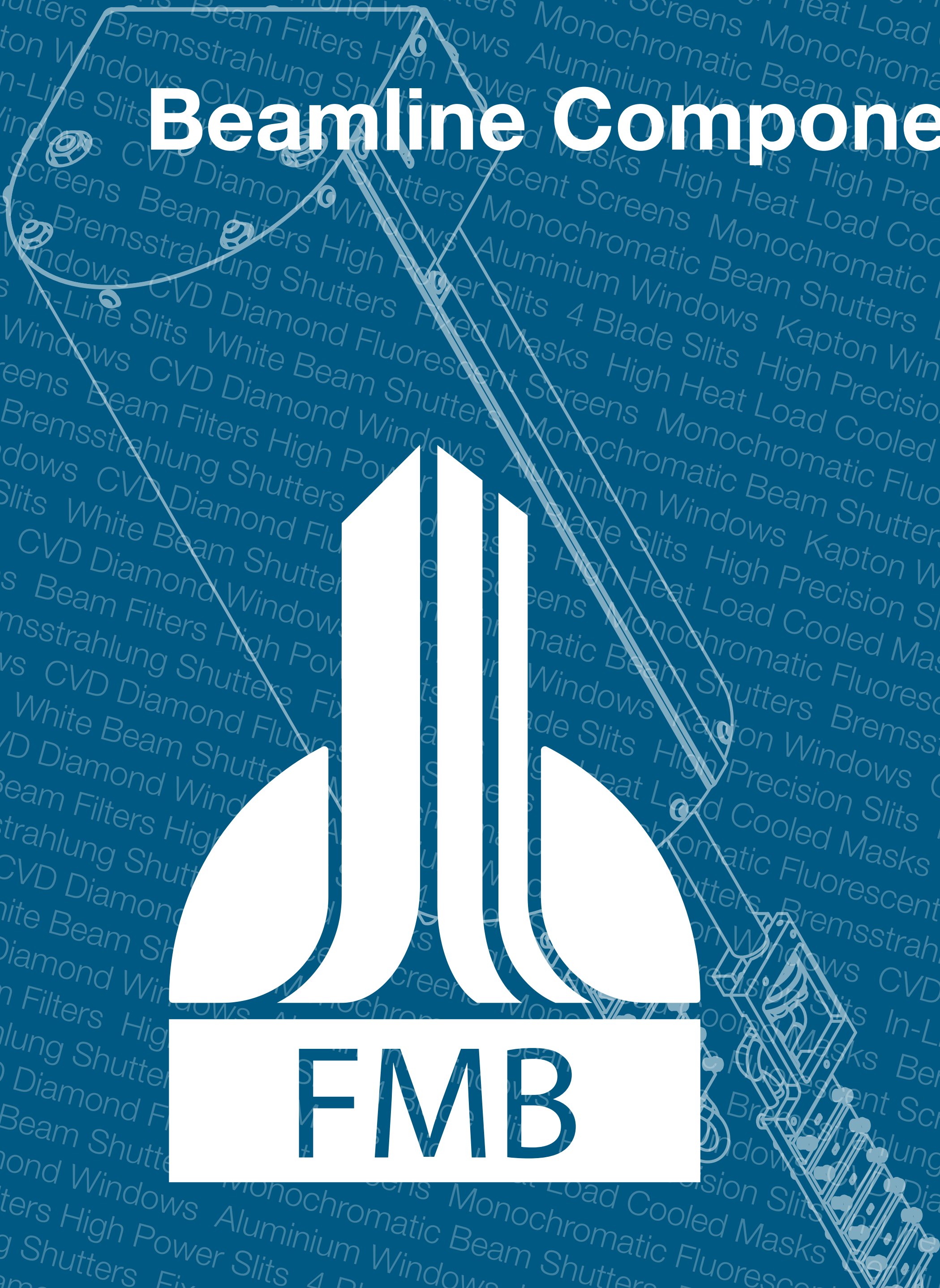
FMB Oxford

Beamline Components



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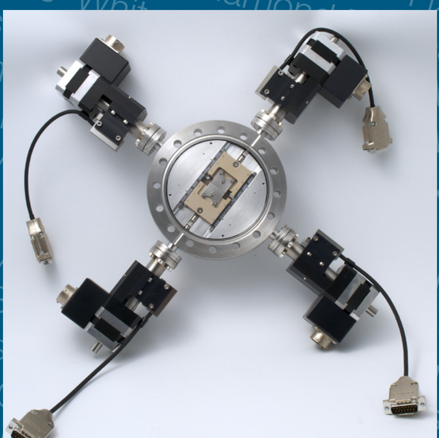

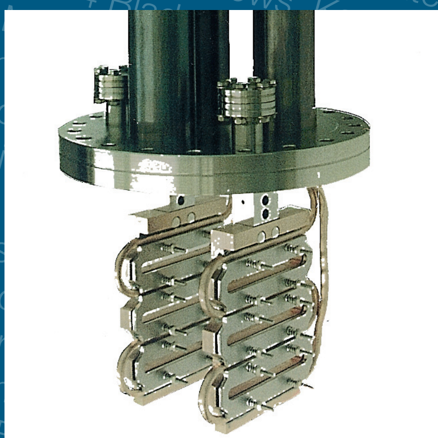

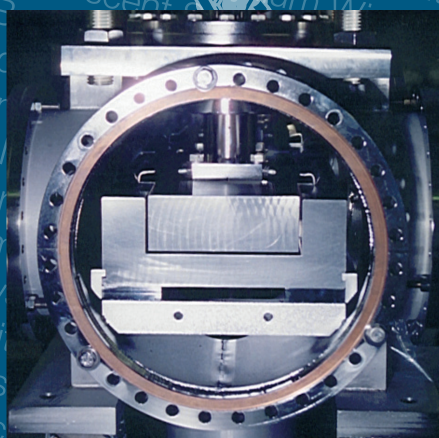

Beamline Components

FMB Oxford has supplied all the components required in a typical beamline, as standalone components, incorporated into diagnostic modules, and as part of our complete beamlines. The components are generally UHV, designed to meet our in-house and 3rd party vacuum specifications.

Beam size, beam acceptance, total power, power density and the source can all influence the detailed design of many of the components in this section. Our engineers are experienced in identifying critical criteria and our broad product range ensures that we have a suitable solution. We ensure that all engineering aspects of the design are considered, from the most appropriate materials, to geometrical design, optimal thermal arrangements through to in-field performance and reliability. We can provide such data, including synchrotron and Bremsstrahlung ray tracing for facility safety reviews if required.

The range shown in this catalogue is only a small part of the beamline components we have made. If you don't see exactly what you need then please ask as we are sure to have something close to your needs.

All components may be installed by technicians from the factory, if required.

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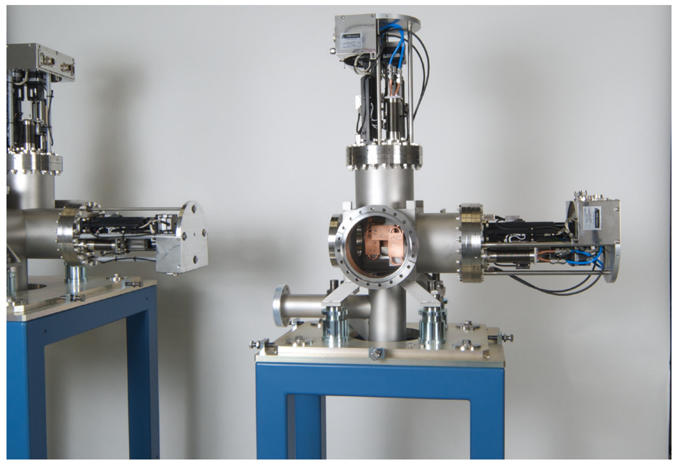


Slits

Slits are used to define the beam either horizontally or vertically. They can be used in pairs to define the beam in both directions. The maximum aperture size is selected to suit specific requirements. Options include cooled (white beam operation) or uncooled (monochromatic beam operation) slits and phosphor coating on the upstream side of the slit to assist with beam location. There are four main types of slit.

4 Blade Slits

The standard slit unit consists of a pair of blades mounted onto a Conflat flange that move together to define the aperture. The polished blades, typically Tungsten or Tungsten Carbide are shaped to define the beam whilst minimizing parasitic scattering. The blades are mounted on copper or Glidcop absorbers for white beam applications and are suitable for heatloads of up to 300W and power densities of 50W/mm^2. Each actuator is driven externally through bellows via a stepper motor driven and fitted with limit switches. Linear encoders are fitted for continuous feedback of the blade position.

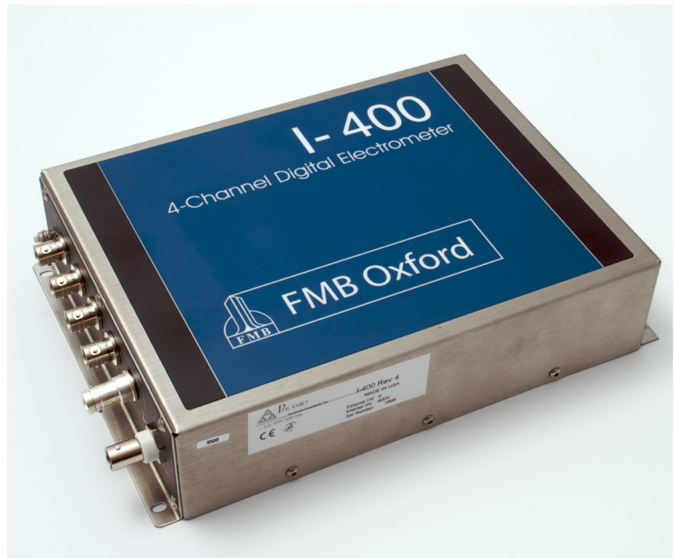
The slit units are mounted onto a supporting vacuum vessel and tested for parallelism, perpendicularity and precision of motion.

Specifications

Maximum Aperture	40mm x 40mm 80mm x 80mm
Resolution	0.5 µm
Repeatability	2 µm
Edge straightness	5 µm
Blade Parallelism	10 µm
Mounting Flange	DN150 CF or DN200 CF

Beam Position Monitoring Electronics

The individual slit blades can be electrically isolated and the drain currents used to monitor beam position and intensity. The blades are typically negatively-biased to prevent recombination of the electrons driven off by the photoionization effect which pollutes the signal. The electronics is a 4 channel current amplifier with biased inputs offering gated integrator channels that can operate in current or charge monitoring modes over a wide range of signal amplitudes.



Features

- Four gated integrator channels with adjustable bias voltage
- Dynamic range 0.1pA to 100µA
- Integrated digitization and communications
- Integrated calibration test source
- Selection of current and charge integration modes
- External synchronization capability

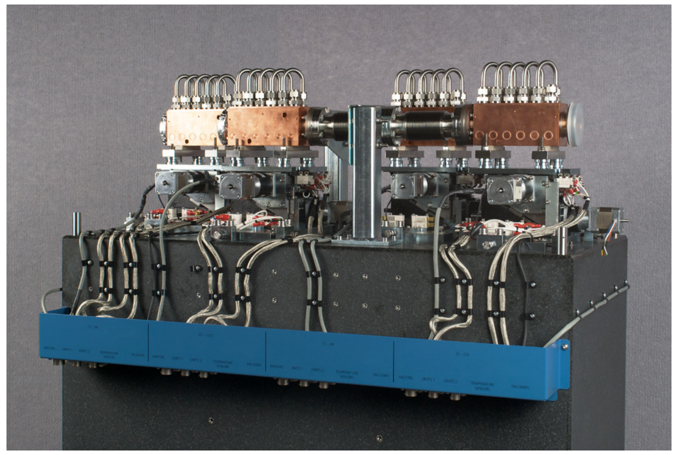
High Heat Load Slits

The high heatload slits consist of 2 L-shaped absorbers operating together to form the aperture. The absorbers are machined from copper or Glidcop and are suitable for heatloads of up to 3kW and power densities of 100W/mm2 via a low grazing incidence angle. Polished blades, typically Tungsten or Tungsten Carbide, are inserted into the exit port of the absorbers to define the beam whilst minimizing parasitic scattering.

The aperture is formed by mounting two absorbers in-line, individually adjustable on 2 precision X-Z stages that move in unison. Edge-welded bellows designed to accommodate the movement without imparting excessive force into the assemblies assure the vacuum seal. Typically the X-Z stages are connected to a granite pedestal and tested for parallelism, perpendicularity and precision of motion.

Specifications

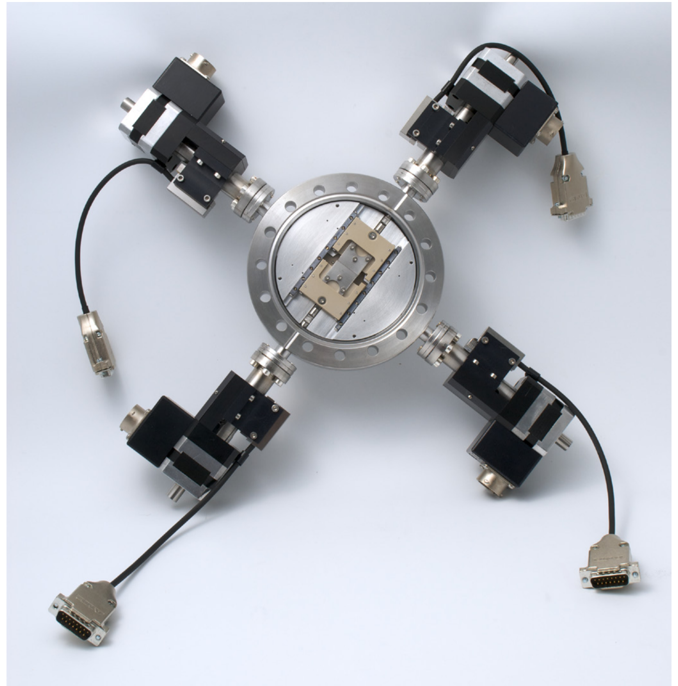
Maximum Aperture	10mm x 10mm
Resolution	0.5 µm
Repeatability	2 µm
Edge straightness	5 µm
Blade Parallelism	10 µm



In-Line Slits

For less demanding applications where space is at a premium we have designed In-Line slits specifically for monochromatic beams. Again 2 blades move independently in opposite directions to vary the aperture. Each blade is stepper motor driven and fitted with limit switches. Linear encoders are fitted for continuous feedback of the blade position. The slit assembly is contained within a DN150 CF flange.

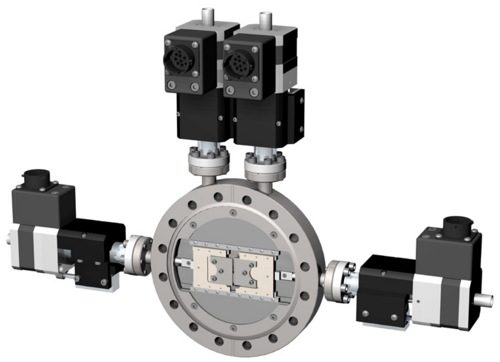
The slit mechanisms are mounted into a DN150 CF flange and tested for parallelism, perpendicularity and precision of motion.



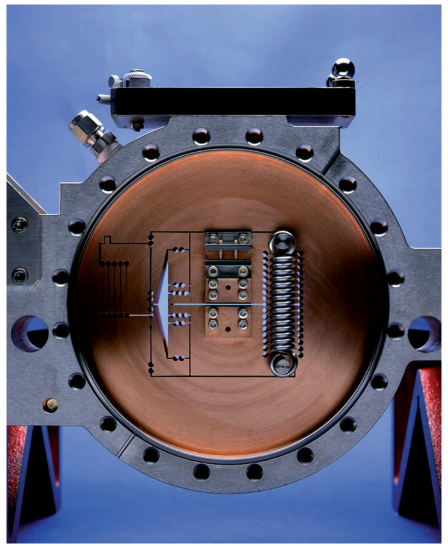
Specifications

Maximum Aperture	15mm x 15mm
Resolution	1 µm
Repeatability	5 µm
Edge straightness	5 µm
Blade Parallelism	20 µm

A specific version of the In-Line slits, with identical performance parameters has been released for applications where space below the components is at a premium.



High Precision Slits



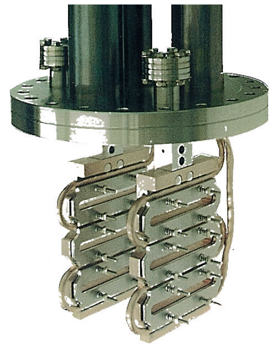
In our high precision slits a flexure mechanism is used to move the slit blades over a small range while maintaining a high level of parallelism. The slit opening is performed symmetrically using a single actuator. The slits can be oriented in both vertically and horizontally defining geometry for use as a secondary source aperture in hard x-ray beamlines. The slit blades can be isolated to enable measurement of beam photoionization currents for beam position and intensity monitoring. A high stability motorized X-Z stage has been developed precisely position the slit assembly in the beam.

Specifications

Aperture	1 – 2000 µm
Resolution	0.1 µm
Repeatability	0.5 µm
Edge straightness	1 µm
Opening Accuracy/Parallelism	<0.5 µm to 100 µm <2 µm to 250 µm <5 µm to 2000 µm

Beam Filters

Beam Filters (or attenuators) remove unwanted energy ranges from the beam by passing the incident synchrotron radiation through a thin transmissive foil. They are often used to manage heatloads of white beams to optimize beamline performance according to the energy of operation.



A typical filter has two or three racks, with each rack holding three of four separate foils, depending upon the beam cross-section. The foils are held in carriers that are cooled or uncooled, depending upon the characteristics of the incident beam. The temperatures of the cooled foils are monitored via thermocouples or thermistors. The racks are motorized to move perpendicular to the beam to select between particular foils. Each rack actuator is driven externally through bellows via a stepper motor driven and fitted with limit switches. Linear encoders are fitted for continuous feedback of the blade position.

We also have solutions for filter racks with pneumatic actuators – both cooled and uncooled.

Specifications

Typical Apertures	8mm x 5mm (undulator) 50mm x 10mm
Foil Thickness	20 µm to 5mm
Maximum Absorbed Power	500W (cooled)
Typical Materials (cooled)	HOPG, CVD Diamond, SiC, Cu
Mounting Flange	DN150 CF or DN200 CF

Beam Shutters are used to interrupt radiation from the front end, or optics enclosures when it is not required downstream. They have an equipment and personnel safety function. FMB Oxford offers a range of standard and high heat load photon shutters to stop synchrotron radiation and personnel safety shutters to stop Gas Bremsstrahlung radiation.

Photon Shutters

Photon Shutters incorporate OFHC Copper, Glidcop or other materials to interrupt the synchrotron beam by insertion perpendicular to the incident beam. The cooling method, heat absorber geometry and material selection depends upon the beam size, power density and the total absorbed power. The temperatures of the cooled foils are monitored via thermocouples or thermistors. High power in-vacuum undulator beamlines will typically use grazing incidence shutters manufactured from Glidcop.

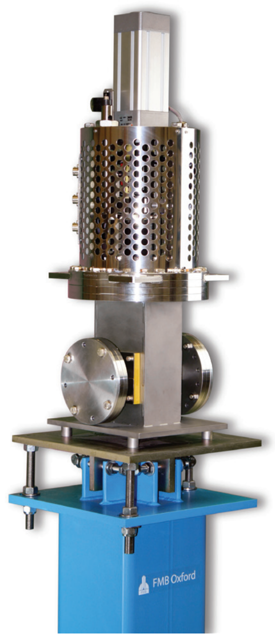
Photon shutters are supplied with pneumatic actuators and are equipped with several sets of limit switches to ensure the control system has the correct operational state of the unit. The actuator mechanism and controls interfaces have been subjected to rigorous FMEA to ensure that they are suitable for safety applications in synchrotron facilities.

Specifications

Absorber material	OFHC Copper, Glidcop, or others as required
Cooling	Water cooling with no water-vacuum joints
Actuation	Pneumatic with integral 24VDC solenoid valve
Actuation Position	Lockable via padlock
Position Indication	As per EN 1088

Monochromatic Beam Shutters

Monochromatic Beam Shutters are typically the final component in optical enclosures and prevent monochromatic radiation penetrating into the downstream experimental enclosure. The design of the shutter block and aperture plates are typically made in strict conformance with the stated facility radiation rules and as a function of specific radiation ray-tracing of the particular beamline.



Specifications

Absorber material	Tungsten or Pb-filled Stainless Steel
Aperture Plates	Tungsten or sealed Pb
Cooling	Uncooled
Actuation	Pneumatic with integral 24VDC solenoid valve
Actuation Position	Lockable via padlock
Position Indication	As per EN 1088

Custom Shutters

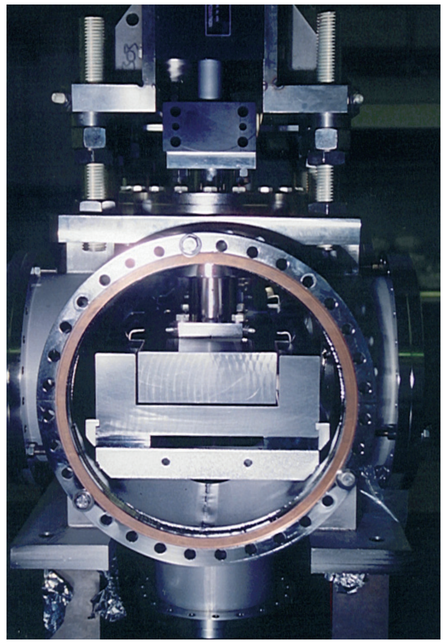
The requirements for shutters can be extremely varied. For example masks, aperture plates, photon shutters and Bremsstrahlung stops can be integrated into a combination shutter.

Bremsstrahlung shutters with shutter thicknesses of up to 250mm W have been configured with Beryllium windows.

Shutter blocks with cooled masks are routinely required and in certain instances we have coated the front face of the mask with a scintillator and added a camera for a Fluorescent screen.

We have delivered a number of fast monochromatic rotary shutters, operating at beam widths of up to 140mm and closing speeds of better than 10ms.

Please feel free to contact us to discuss your particular requirements.

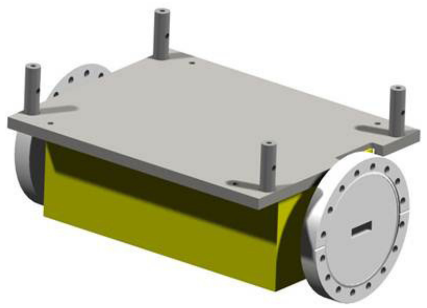


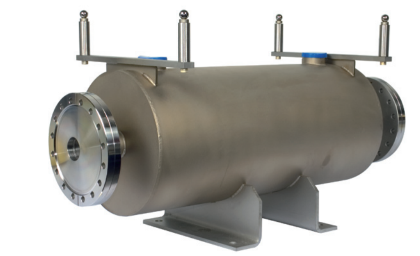
Beam Collimators are used to restrict the transmitted cone of Gas Bremsstrahlung radiation to direct it to stops and shutters to prevent it being transferred past the optical enclosure.

Collimators

Collimators for absorbing Gas Bremsstrahlung generally come in two varieties, a short sections of beam transport pipe surrounded by interlocked, painted lead bricks or a tungsten block contained within a vacuum vessel. They are not cooled and are typically protected from incident synchrotron radiation by upstream masks. Generally lead collimators are used where possible because of their relatively lower cost.

Bremsstrahlung ray tracing is used to define the envelope required to be covered by the collimator and lateral overlaps and absorber lengths are typically defiend by the facility radiation safety advisors. As the unit is an important safety element the alignment features and manual adjustment mechanism of the collimators are important as the unit must be precisely positioned in place them locked with anti-tamper fixings.





Fluorescent Screens

Fluorescent Screens are used to visualize the incident synchrotron radiation beam. A paddle is inserted into the beam where the phosphor of equivalent material is excited and gives off visible light which is then viewed using a CCD or CMOS camera. These devices are deployed along the beamline as the primary beam diagnostic.

Cooled Fluorescent Screens

Screens generally consist of a fluorescing material or coating supported on a water-cooled actuator being inserted into the synchrotron beam. Viewing devices, typically CCD or CMOS cameras are positioned to view the illuminated area to determine the beam size and shape, with the vacuum assured by a non-discolouring viewport.

The standard screen materials used are CVD Diamond (for high power densities) and Yttrium Oxide.

Typically pneumatic actuators are provided for use with screens however certain applications, e.g. beam movements, dictate the use of motorized actuators fitted with incremental encoders.

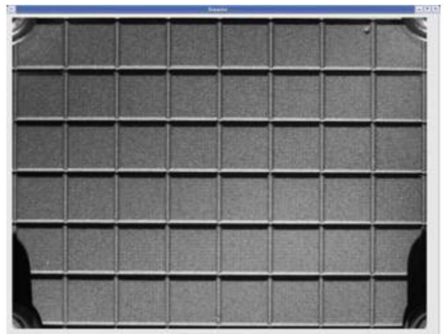
Uncooled Fluorescent Screens

Fluorescent Screens are also useful for viewing monochromatic beam.

The standard screen materials used are Yttrium Oxide, P43 (Gd_2O_2S:Tb) and YAG crystals.

Targets

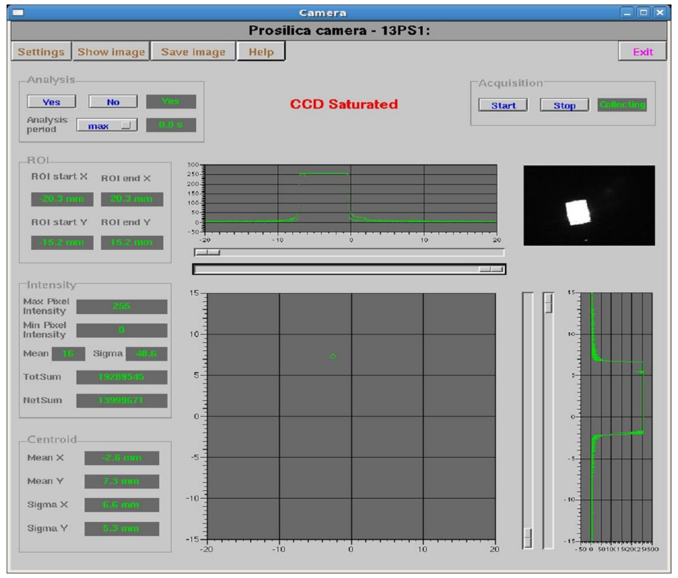
Targets are usually etched onto the screen allow the beamline user to identify the directions correctly.



Fluorescent Screens / Masks

Camera Interfaces

The camera/lens combination and location with respect to the screen are optimized for sensitivity given the beam cross section. EPICS and Labview interfaces are available to allow the user to process the data from the camera and extract information such as beam size and centroid position.



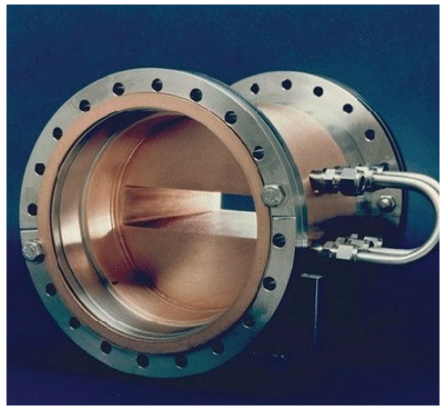
Fixed Masks are used to define the synchrotron radiation beam. They are often deployed at the head of the beamline to limit the power transmitted to the downstream components and to restrict the consequences of beam miss-steer.

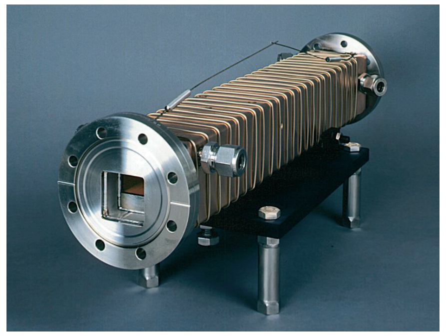
Fixed Masks

Fixed masks are water-cooled heat absorbers of OFHC copper or Glidcop that are used to aperture the synchrotron radiation cone. The cooling channels, heat absorber geometry and material selection depends upon the beam size, power density and the total absorbed power. The temperature of the absorber block is monitored via thermocouples or thermistors. The apertures and alignment features are precision machined and finished. High power in-vacuum undulator beamlines will typically use grazing incidence masks manufactured from Glidcop.

Specifications

Vacuum performance	< x10^{-10}mbar
Maximum Absorbed Power	2000 W (Cu) 10000W (Glidcop)
Maximum Absorbed Power Density	50W/mm^2 (Cu) 250W/mm^2 (Glidcop)
Standard Design Criteria	<150°C temp rise (Cu) <300°C temp rise (Glidcop)





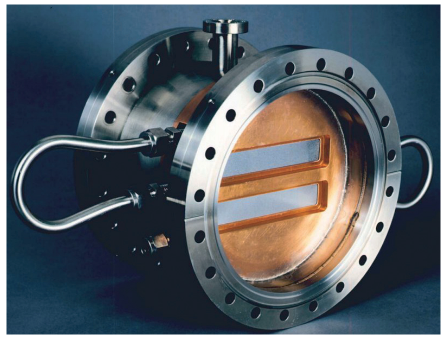
Windows

Windows are used to separate UHV and HV vacuum sections and to terminate the beamline. They are also used between UHV vacuum sections to provide protection from vacuum accidents. The foils used for the window membrane also attenuate the radiation spectrum in the region below 6keV.

Beryllium Windows

Beryllium windows can be supplied cooled, or uncooled, with various sizes (and numbers) of window apertures. Windows are sized to suit specific requirements, however the maximum size of a window is determined by the foil thickness and the pressure differential to be withstood. Windows can be supplied fitted with a range of beam entry/exit flange sizes to suite specific requirements.

Beryllium windows can also be fitted to UHV all metal gate valves.

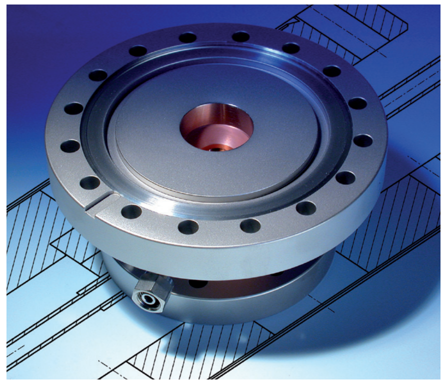


Specifications

Vacuum performance	$<2 \times 10^{-10}$ mbar
He Leak rate across window	$<5 \times 10^{-10}$ mbar.l/s
Foil Types	PF60, IF-1
Foil thickness range	75 µm to 1mm
Surface Finish	0.02 µm – 1 µm RMS
Coatings to prevent contact	Sputtered Al

CVD Diamond Windows

Chemical Vapour Deposition (CVD) Diamond offer extreme hardness, high thermal conductivity, chemical inertness, and high transparency over a very wide spectral range. Stronger and stiffer than Beryllium, with lower thermal expansion and lower toxicity, it is ideal for UHV isolation windows in X-ray beamlines. Windows can be supplied embedded in UHV flanges and with efficient water cooling.



Specifications

Vacuum performance	$<5 \times 10^{-10}$ mbar
He Leak rate across window	$<1 \times 10^{-9}$ mbar.l/s
Foil thickness range	250 µm to 1mm
Surface Finish	0.02 µm RMS

Exit Windows

Vacuum exit windows come in a variety of materials including Beryllium and CVD diamond detailed above. Depending upon the application we have delivered vacuum windows from polished aluminium, polyimide and Si3N4 . As the leak rate is often inferior to that obtain from diffusion bonded materials for certain applications we have elected to deploy dual exit windows with a differential pumping arrangement to achieve the required leak rate.

Beamline Diagnostics

FMB Oxford

FMB Oxford has an extensive range of beamline diagnostics. These devices assist with beam alignment and optimisation, whilst also providing information on stability. Most devices are designed to function in-situ to provide continuous monitoring of beam position, intensity and stability, however some devices, providing more information on the beam properties, interrupt the beam.

The various diagnostic heads shown herein require associated electronics to complete the diagnostic system where we offer the I400, I404E and F404E current amplifiers, C400 pulse processing unit and the B100 image processor.

Blade Beam Position Monitors

Used at the head of the beamline to monitor the stability of the beam coming from the front end. The device uses the photoionization effect coming from electrically isolated blades of tungsten or graphite to calculate the centroid of the beam to within 1-2 µm.

White/Pink BPMs

Used downstream of the white beam conditioning elements to monitor the stability of the beam coming into the monochromator. The device uses 4 x-ray photodiodes arranged in a quadrant to capture a given solid angle of scattered radiation from the beam hitting a cooled graphite or CVD diamond foil to calculate the centroid of the beam to within 5 µm.

Profile Monitors

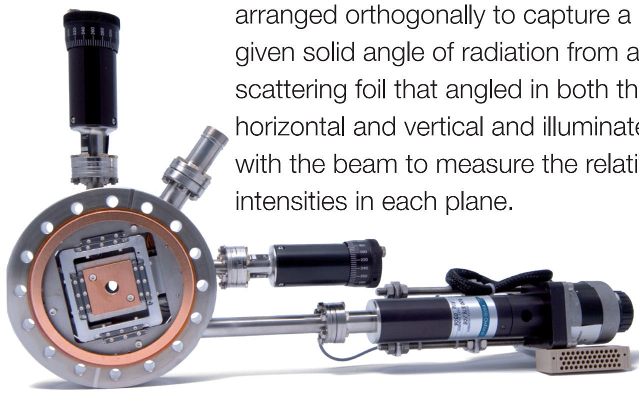
Used anywhere along the beamline – with white, pink or monochromatic beam - to determine the details of the beam cross-section. The device uses a tungsten pinhole that is scanned across the beam with an x-ray photodiode measuring the transmitted intensity building up a 3D contour of the beam. Profile monitors can be fitted with 2 pinhole/filter arrangements to be able to monitor both white beam and monochromatic beam.

Polarization Monitors

Used upstream of the final beam conditioning components to monitor the relative polarization of the beam entering the experiment. The device uses 2 x-ray photodiodes, or alternatively scintillation detectors, arranged orthogonally to capture a given solid angle of radiation from a scattering foil that angled in both the horizontal and vertical and illuminated with the beam to measure the relative intensities in each plane.

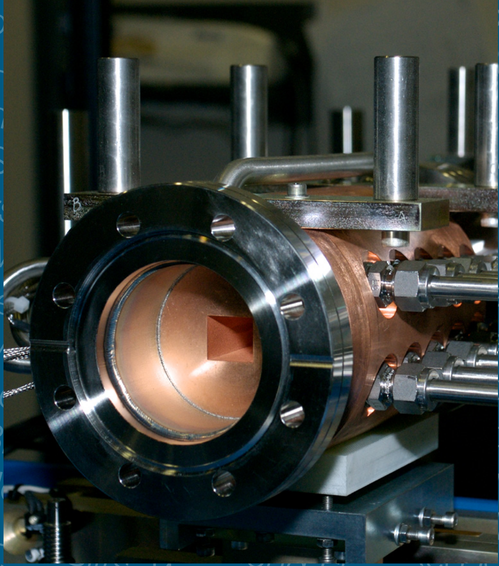
Quadrant BPMs

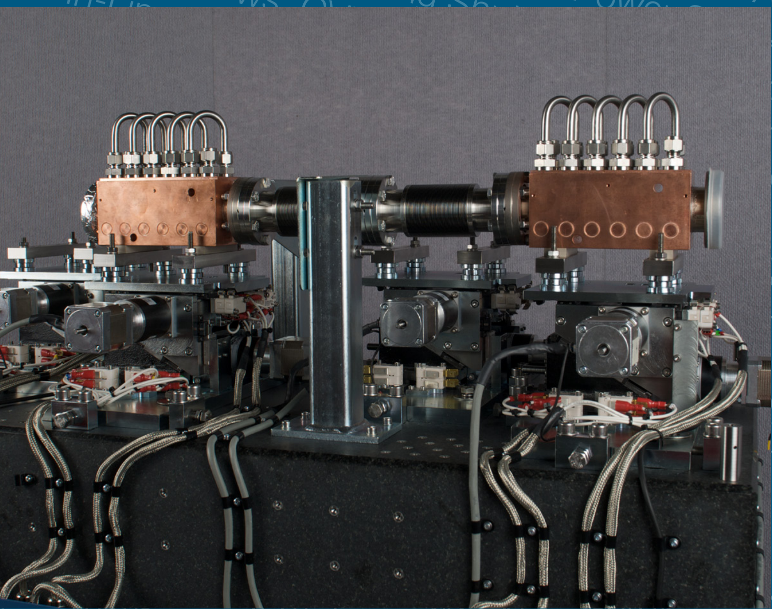
Used upstream of the final beam conditioning components to monitor the relative polarization of the beam entering the experiment. The device uses 2 x-ray photodiodes, or alternatively scintillation detectors, arranged orthogonally to capture a given solid angle of radiation from a scattering foil that angled in both the horizontal and vertical and illuminated with the beam to measure the relative intensities in each plane.



NANO BPMs

Used downstream of the monochromator to monitor the stability of the beam coming out of the monochromator. The device uses a pinhole CMOS camera to image the footprint of the incident beam onto a scattering foil to calculate the centroid of the beam to within 0.1 µm. The image of the beam is also viewable – as per a Fluorescent Screen.





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