UHV Slits

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Abstract. Advanced Design Consulting, Inc. (ADC) designed slits for applications where high accuracy is required. The system is consists of vertical and horizontal slit mechanisms, a double sided flange which houses them, stepper motors with linear encoders, limit (home position) switches and electrical connections including internal wiring for a drain current measurement system. The total slit size is adjustable from 0 to 30 mm both vertically and horizontally depending on the flange size. Each of the four blades are individually controlled and motorized.

Keywords: Slits, Current measurement, UHV
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INTRODUCTION

Advanced Design Consulting USA, Inc. (ADC) in collaboration with Diamond Light Source (DLS) has developed a new monochromatic slits to obtain a well defined narrow beam, such as is essential in Small Angle X-ray scattering (SAXS) experiments. These guard slits are used to remove the fringes and diffraction effects from the first slits and to limit the background. The aperture is defined by 4 independently movable highly polished blades. The respective location of the blades are staggered so that the blades can pass over each other and thus insure complete closure of the slit, without damaging the blades. These slits are only exposed to monochromatic beam and so will not require water cooling. The jaws are electrically isolated to allow drain current measurements for beam position monitoring.

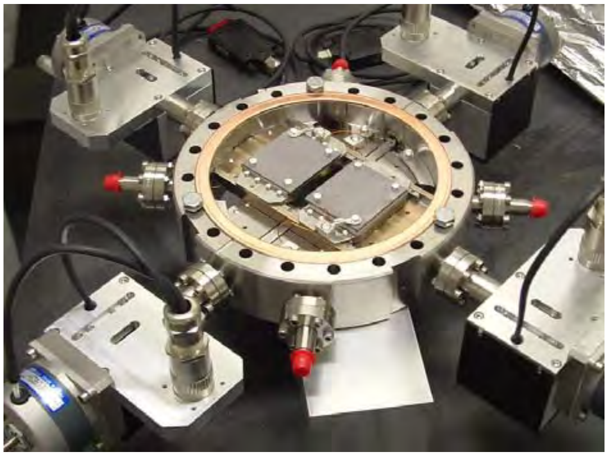


Figure 1. Slits assembly

DESIGN PRICIPALS

This unit consists of vertical and horizontal slit mechanisms, a vacuum vessel which houses them, stepper motors, limit switches, electrical connections for a drain current measurement system. Each of the four blades are individually controlled and motorized. The range of travel for each blade is up to +/- 25 mm depending on the size of the configuration. The vacuum vessel, a double sided flange, contains ports for feedthroughs for drain current measurement. With modification, the blades can withstand a heat load of 5 watts. This modification precludes drain current measurement.

A spring-extended linear encoder with built-in home position is provided for each individual blade. The accuracy of the linear encoder is better than 1 micron. An easily-visible linear scale for each blade is attached to its translation system to provide an alternate way of reading the blade position. Limit switches and hard stops prevent damage by over-travel. The four blades are electrically conducting and insulated from the vacuum vessel. Each such blade is connected to a feedthrough with a standard BNC connector. The signal current resulting from the beam hitting the blades is in the milli- to micro-amp range per blade. The drive assembly uses stepper motor actuation and crossed-roller bearings. All UHV sections are vacuum tested to better than $5x10^{-9}$ with an option of 10^{-10} torr and have a leak rate of less than $2x10^{-10}$ mbar $1^{-1}s^{-1}$. A test report, shipped with each unit, includes a residual gas analysis of each section showing the sum of all partial pressures for masses larger than 46 AMU is less than 10^{-11} torr.

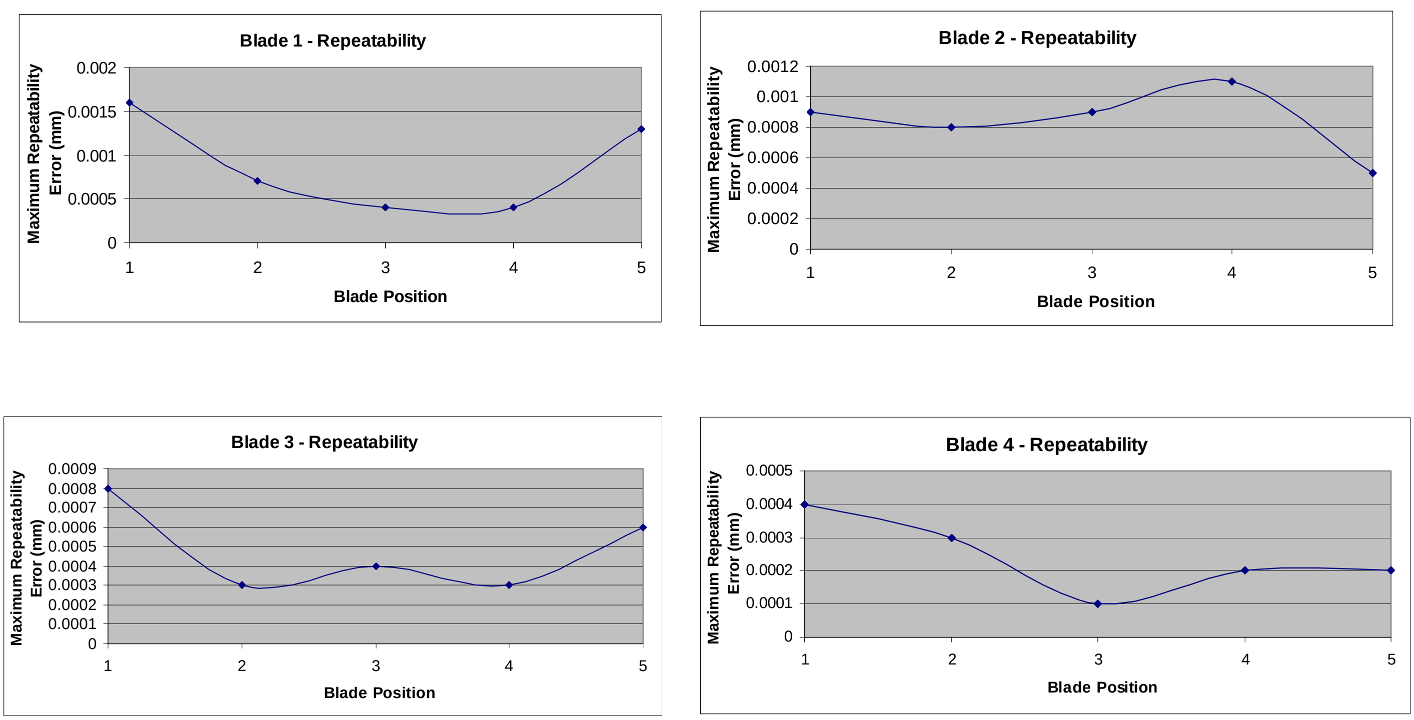


Figure 2. Blade Repeatability

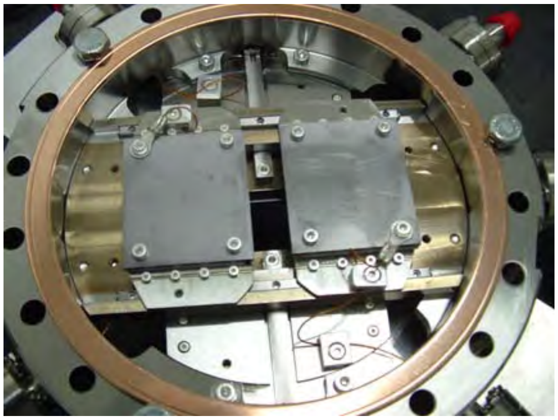
Blade Polishing

The process begins with a grinding operation designed to minimize the amount of material that must be removed during polishing. An edge and one of the faces are ground to an interior angle of 88° and then a second grinding operation relieves the face. Grinding produces an edge that is straight and true, but with pits and scratches that must be removed by polishing. Fixturing the slit is critical when polishing. The fixture must be extremely hard so that material is removed only from the blades, otherwise the knife-edge can become rounded. Two or more blades are usually polished together in a matched set to maintain parallelism. Both surfaces must be accessible without removing the blade as repositioning is impossible within the necessary tolerances.

Scratches are removed using a Buehler low-speed polisher with silicon carbide paper and polycrystalline diamond suspensions on fabrics of differing knaps. As finer grits are used the blades and fixturing must be thoroughly cleaned in an ultrasonic bath to remove larger particles. A final polish with colloidal silica is used when surface finish is critical. Wheel speed, applied force and polishing time varies with each step and is critical to the final quality. Too large a force leads to grain pull-out with Tungsten, which is extremely soft (Vickers hardness of 873). Relatively large force and long polishing time are required for Tantalum (Vickers hardness of 3430) yet overpolishing results in “orange-peel” that destroys the knife-edge.

ELECTRICAL ISOLATION

The blades of these slits are independently, electrically isolated and have a connector and wire to enable the drain current to be measured. This is used to determine the position of the beam. Four independent electrical connections were used. The currents measured were < 1nA therefore triaxial connector were fitted externally for each blade. The inner connection were in contact with the blade and the outer contact to the connector. The minimum DC resistance to blade earth were $>10^{10}$ ohms.



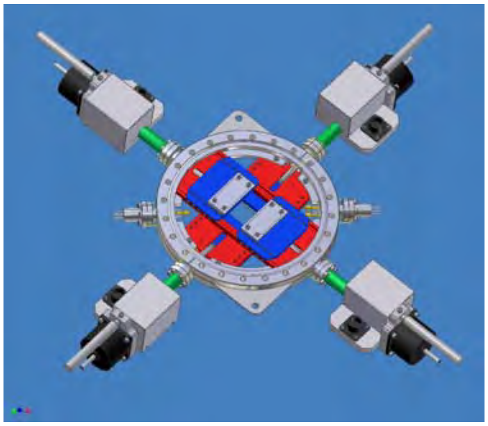


Figure 3. Electrical connection

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