Larger beam profile for K150 radiation effects facility testing

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A 4.5" diameter beam profile has been developed for proton testing with the K150 Radiation Effects Facility beam line. This new beam profile will allow for larger devices to be placed under test as well as a greater number of devices to be tested simultaneously. Most existing elements of the beam line have been remade to facilitate the beam profile enlargement.

All elements (shutters, viewers, etc.) of the beam line are housed in three ISO250 six-way crosses (Fig. 1). Pneumatic thrusters are used to move elements into and out of the beam path. Existing thrusters, all with 4" of travel, were replaced by thrusters with 5" or 7" of travel, as needed, to allow for elements to completely move out of the larger beam path.

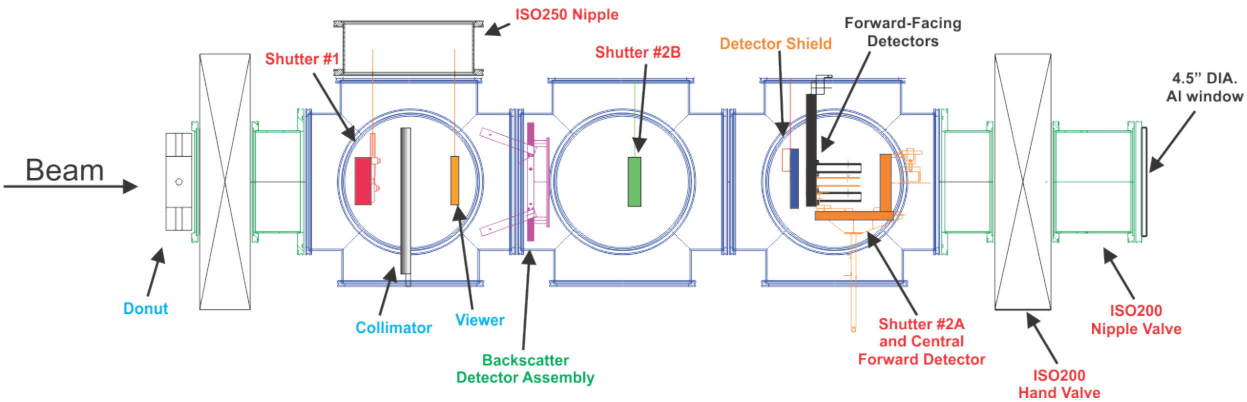

Fig. 1. K150 SEE Beam Line Components.

A ISO250 nipple was added to the top of first six-way cross to provide more space for shutter one and the beam viewer to move out of the beam path (Fig. 1) as there was not enough height in the six-way cross for complete removal. Shutter #1 (Fig. 1), a standard sized faraday cup, was replaced with a larger (6.5"x6.5") faraday cup. The existing beam viewer was mounted to a new longer support rod. In the second six-way cross shutter #2B (Fig. 1) was enlarged and mounted on a longer support rod.

During testing beam dosimetry is measured using a set of five forward-facing detectors. Four stationary detectors are mounted on a support frame and positioned on the outer edges of the beam profile. A new detector support frame was made with a larger diameter opening and with the four stationary detectors placed further out. During high intensity proton testing a movable aluminum shield is used to protect the stationary detectors from exposure. The exiting shield was replaced to accommodate the new detector holder geometry and was attached to a new longer support rod.

One removable detector is positioned on beam line center and is part of the Shutter #2A (Fig. 1) assembly. This shutter assembly also contains a tantalum plate used to block the beam from devices under test. The size of the tantalum plate was increased to completely block the new beam profile. A new longer support rod was also installed.

At the rear of the beam line, the ISO100 hand valve was replaced with an ISO200 hand valve (Fig. 1). A ISO200 Nipple (Fig. 1) was installed after the hand valve. New beam exit windows have been made by attaching aluminum foil (5 mil thick) to an aluminum support plate using double sided tape. This support plate is then mounted on to a modified ISO200 blank flange (Fig. 2). The flange and window were mounted to the backend of the ISO200 nipple.

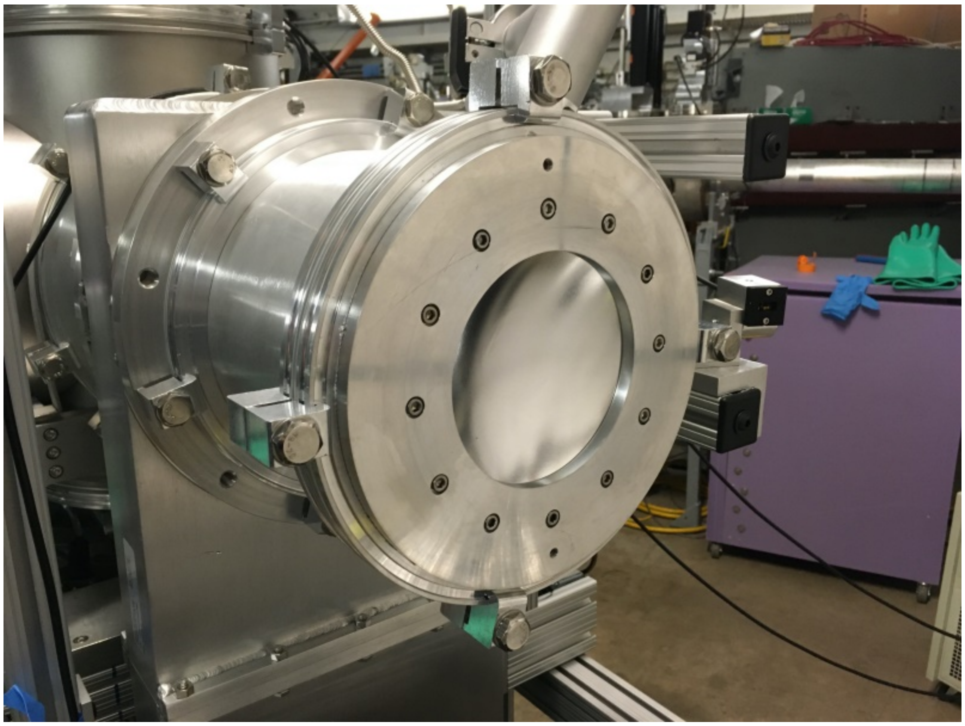

Fig. 2. Aluminum Exit Window mounted on an ISO200 nipple.

For high intensity proton testing a set four backscatter detectors are used for beam dosimetry [1]. As with the forward-facing detectors it was necessary to remake the geometry of the backscatter detector holder to accommodate the larger beam profile. Modifications were also made to the backscatter detector shielding features previously added to the beam line [2]. A new collimating "donut" was installed in front of the beam line isolation valve (Fig. 1). A flange-mounted collimator with a larger opening was placed in between shutter 1 and the viewer (Fig. 1). Individual aluminum detector shields were also remade to fit the new backscatter detector holder geometry.

Initial uniformity test with a 30 MeV proton beam using Gafchromic dosimetry film seems promising (Fig. 3), but beam uniformity is less than optimum. An aluminum beam collimator has been added to the rear ISO200 nipple to hopefully rectify this issue (Fig. 4). Additional test will be carried out in the near future to verify that the uniformity issues have been resolved.

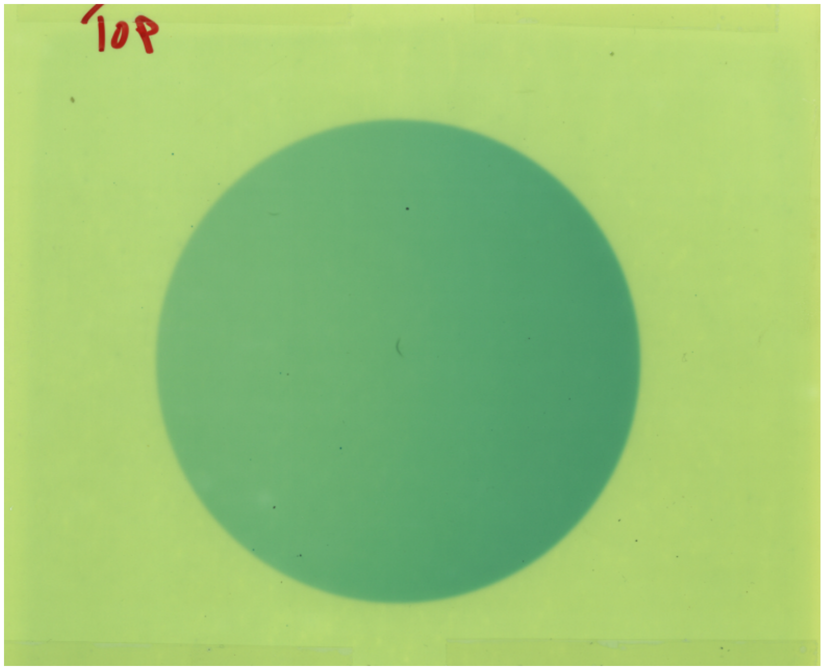

Fig. 3. Gafchromic film exposure of 4.5” diameter beam profile.

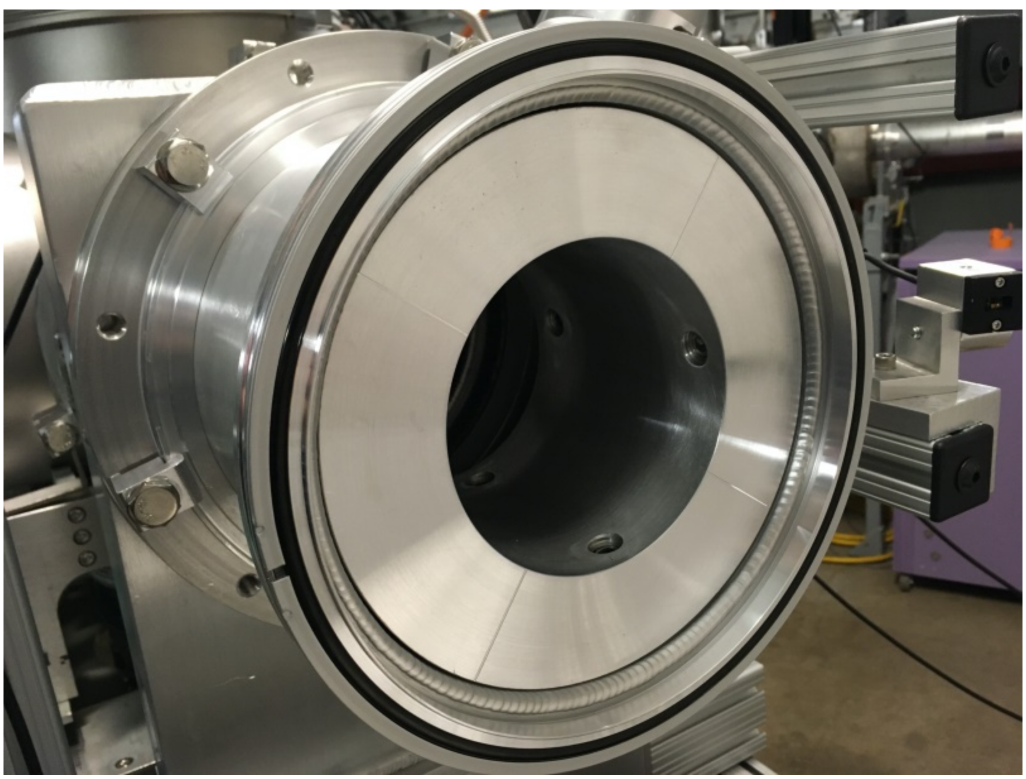

Fig. 4. Aluminum exit collimator.

The larger beam profile improvements to the K150 radiation effects beam line were made at the request of the United States Air Force/Ball Aerospace group. Additional radiation effects testing groups have also expressed interest in using the larger beam profile. These beam line improvements should provide increased testing flexibility. An increase in outside customer use of the K150 SEE Line is anticipated going forward.

[1] B.C. Hyman *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2016-2017), p. IV-9.

[2] H.L Clark *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2018-2019), p. IV-9.