VARIABLE IRIS APERTURE BEAM COLLIMATOR

T.Varughese and N.Madhavan
Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi - 110067, INDIA
** email: thomas@iuac.res.in*

Introduction

In HYRA beam line we are using, at present, a fixed opening beam collimator. However, a variable aperture collimator is preferable due to its many advantages in beam tuning and selection of the beam size. A four jaw slit is an option but we have to operate all the four jaws to vary the size of the aperture. In order to use only one drive to vary the aperture systematically, an iris shutter design was thought of and a prototype has been successfully made and tested offline. This shutter is precise and reliable. A single, vacuum-compatible, linear motion drive is integrated to move all its aperture blades in order to vary the aperture size.

An iris diaphragm is a variable diameter circular opening device used to regulate the amount of light which can be admitted to a camera lens.

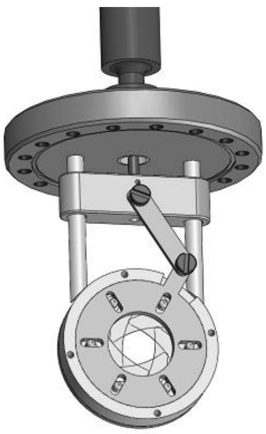

Fig. 1 Inside view of the beam iris

Working mechanism of the iris

The iris mechanism is simplified and customized for vacuum and beam line use. A linear drive moves a disc which has slots in it. Six blades of special design are chosen (Fig. 1) with pins spot-welded on the front and back side of each blade. The pins on the front side of the blades are inserted in the slotted disc. Pin on the back side of each of the blades is pivoted to a fixed flange. When the movable disc is rotated by an external drive, it actuates all the blades simultaneously.

A prototype using six stainless steel blades has been fabricated (Fig. 2). Since there are six blades in this aperture the aperture is hexagonal in shape. The present iris aperture is designed for an aperture opening varying from 1.5 mm to 25 mm and has two uses. Using this iris diaphragm we can precisely vary the size of the beam. After beam tuning and focusing the beam through the aperture, it can be kept fully open to avoid scattering of beam from the edges which may increase the beam background. Alternatively, if a small beam size is required which is beyond the capability of focusing devices, the iris aperture can be used continuously.

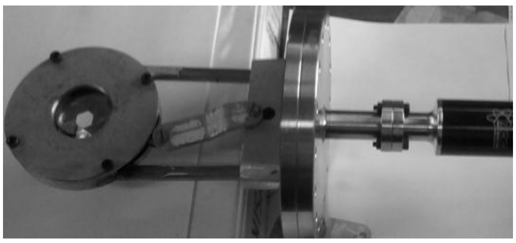

Fig. 2 Prototype of iris

Thermal study of the IRIS aperture

We have calculated the temperature rise at the center of this iris when Pelletron beam of 5 pnA current at 200 MeV falls continuously on it.

For a SS blade thickness of 0.2 mm used in the prototype, a temperature rise of 45 ^{o}C was calculated. A steady state thermal study was simulated using "Solidworks" thermal analysis software. This will result in a blade temperature of 69 ºC in the steady state thermal equilibrium condition.

Temperature rise is given by

$\Delta T = Q / (m \cdot s)$

where ΔT is the temperature rise (in K), Q is the heat energy dissipated (in Joules), m is the mass of the portion of blade on which beam falls (in kg) and s is the specific heat capacity of the blade material (in J/kg.K).

When the heat energy dissipated per second is provided to the "Solidworks" thermal analysis software, the steady state temperature is calculated. As the iris aperture will be used in vacuum, only conduction of heat to the flange and convection from outer surface of flange to air are considered.

Table.1 Below shows the properties of S.S.304.

Material properties	S.S. 304
Density	7.8 g/cm^3
Weight of blade material where beam of 6 mm diameter falls	44 mg
Specific heat capacity of Stainless Steel	510 J/kg.K
Melting Temperature(°C)	1454
Steady state temperature of blade tips	69 ^{o}C
Steady state temperature of flange	25.25 ^{o}C

The opening of the iris can be extracted from the micrometer reading of MDC linear drive, using a calibration table. The proptotype with stainless steel blades will be put for beam test soon. Though the prototype is made with stainless steel blades, in the final version we will be using tantalum blades. Tantalum has good thermal conductivity. The higher atomic number helps in reducing unwanted nuclear reaction with the beam which would otherwise increase the radiation related activity. Both properties are highly recommended for this purpose. We plan to use iris apertures before and after the target in HYRA for beam tuning and to regulate the evaporation residue (ER) angular acceptance in HYRA, respectively.

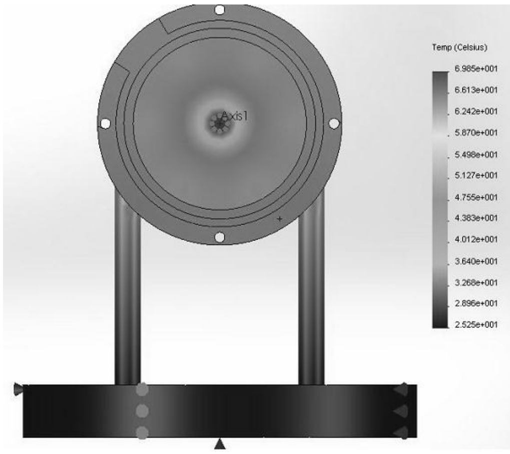

Fig.2. Steady state thermal study of the iris.

Conclusion

An iris aperture has been designed for use in beam lines, especially HYRA facility at IUAC. A prototype of the aperture has been fabricated with stainless steel blades and tested offline. The design details, estimation of steady state temperature and future plans are described.

References

[1] http://www.wikipedia.org.