PFC Experimental Protocol at Burr Center

Draft 150701 20:30 EDT

Andrew D. Hodgdon, Principal Investigator
617-835-6755
andrew@radsim.org

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1.0 BACKGROUND

Beam stops (here called portable Faraday cups) that measure the beam current directly are proposed as convenient QA devices that avoid issues of gain calibration and gas density compensation. However the currents to be measured are small, and the fate of secondary electrons and other charged particles can degrade accuracy. An in-air monolithic copper beam stop/collector (PFC) is being developed, based on the “magic Faraday” type used by Bernie Gottschalk at the Harvard Cyclotron Laboratory [1], but with industrial coating methods used to form the dielectric and conductive overlayers. The geometry of the beam stop and the thickness of the overlayers will affect the accuracy of the readings, and this work was performed to assess various alternatives.

In the HIT experiment [2] five prototype PFCs were tested, three cylinders with 60 mm diameter and different thicknesses of polymer dielectric (S59, S100 and S200), and two with 100 mm diameter, one a simple cylinder (LNoCup) and the other with a cup structure (LCup). Copper depth was 100 mm. The large collector with the cup structure had been tested previously at MGH with protons at three energies, and was found to agree to about 1% or better with a conventional (vacuum) reference Faraday collector from the Harvard Cyclotron Laboratory [3].[1]

The charge defect of the three small PFCs was simulated in GEANT4 and compared to the HIT experiment. Those results are shown in

[1] These two paragraphs mostly stolen from J. Gordon et al [2].

Figure 1-1. Agreement is good for high energy and high kapton thickness. Agreement is poor at low proton beam energies and the lowest Ka thickness, 59 um. This might be due to differences in beam spread between the experiment and simulation. Beam spread in the HIT experiment was not known by the simulators and assumed to be a line at all energies. It is proposed to repeat the experiment at the Burr Center at MGH where the beam spread as a function of energy has been well characterized and is available for input into the simulations.

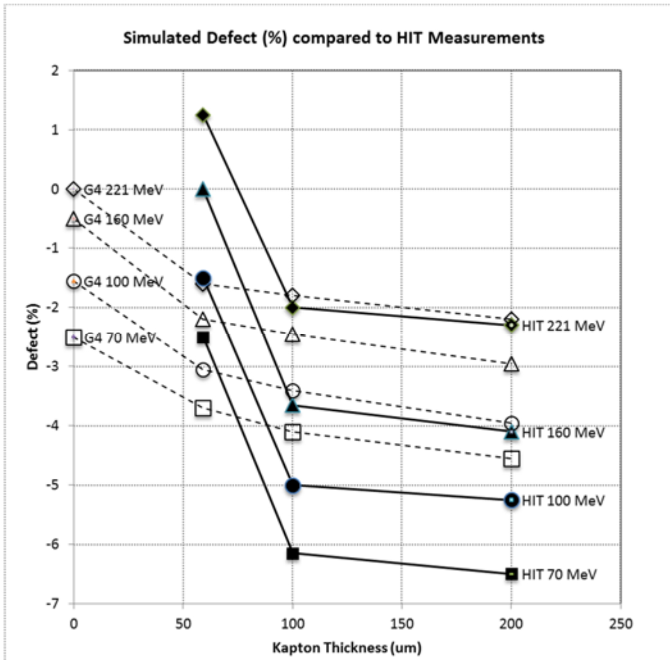

Figure 1-1: Simulated Defect vs Measurements at HIT

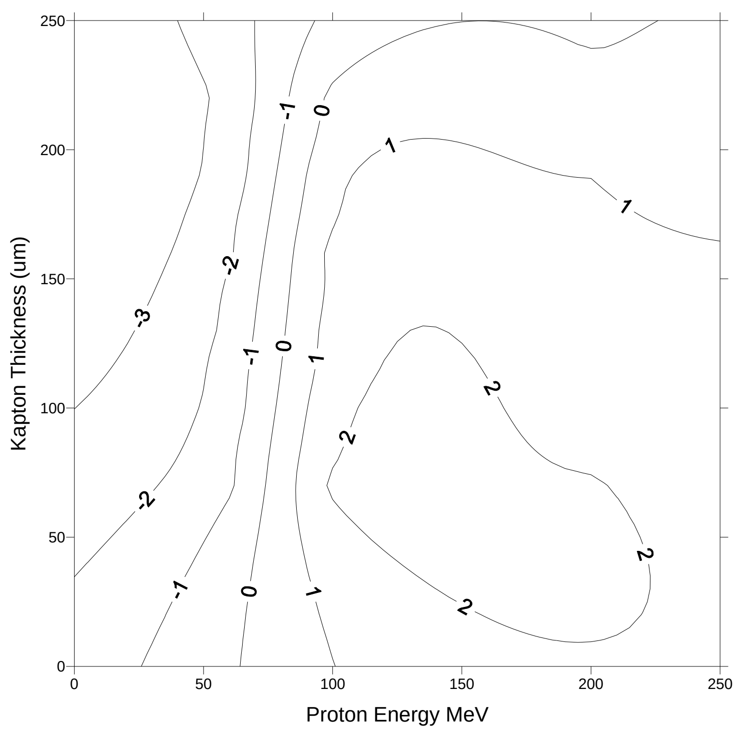

Figure 1-2: %Error (G4 Defect vs HIT Defect) by Energy and Kapton Thickness

2.0 DATA NEEDED TO SETUP SIMULATION

The following parameters are listed to allow replication of the experiment and simulation by GEANT4.

2.1 Beam Energy

Energy values (MeV)

Energy spread

How calibrated,

Accelerator settings

2.2 Known Beam Fluence

Calibration

Basis

2.3 Beam Geometry

Beam geometric spread as function of energy

Beam direction

Scatter upstream of PFC, nozzles, windows

Air, density

In-scatter from adjacent mass

2.4 PFC Position

Distance to PFC face

Axial position and how confirmed

2.5 PFC and Readout Setup

Identity of each PFC

Identity and source of Electrometer

Setup of electrometer, cables, locations

Readout processing (time averaging, combining multiple readings …)

Data collection, variables, units, format (paper, file …)

Photograph(s)

3.0 DATA TO COLLECT

3.1 Background levels

3.2 Spills

3.3 Linearity

3.4 Signal

4.0 CONCLUSIONS

5.0 REFERENCES

1. B. Gottschalk, 'A Poor Man's Faraday Cup,' Abstracts XIX PTCOG Meeting, Cambridge MA (1993) 13
2. J. Gordon and L. Magallanes, “Evaluation of Current Measuring Beam Stop,” 2014, Proprietary Calculations.
3. LATER get reference for 100mm PFC measurements at MGH.