



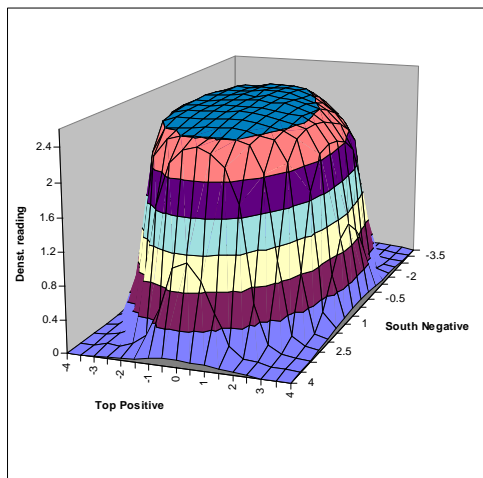
Crocker Nuclear Laboratory Radiations Effects Facility

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The 76" Cyclotron of the Crocker Nuclear Laboratory (CNL) at the University of California at Davis (UCD) provides an excellent proton energy range for simulation of fluences (particles/cm²) seen by materials and microelectronic devices behind spacecraft's shielding. The proton energy range spans from 1.2MeV to 68MeV. The average particle beam flux provided, ranges from tens of particles/(cm²×s) up to a very large flux of approximately 10¹¹ particles/(cm²×s).

Beams of deuterons and ⁴He (alpha-particles) up to 45 and 90-MeV respectively can be provided if requested.

CYCLOTRON PARTICLE BEAM ENERGIES AND MAX INTENSITIES:

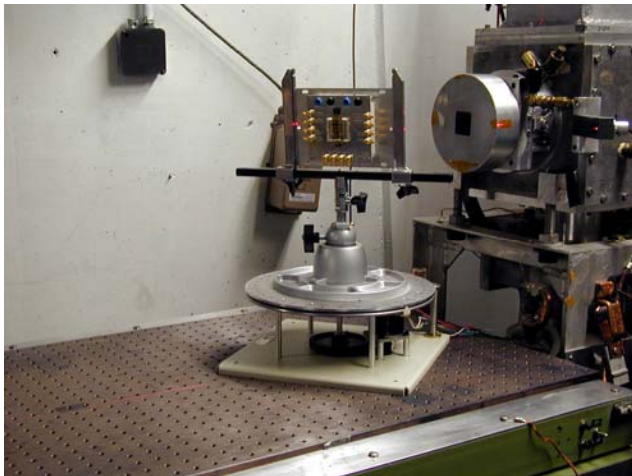
PARTICLE BEAM	ENERGIES (MeV)	Max I (micro Amps)
PROTON	1.25 to 68	30
DEUTERON (² H)	15 to 45	40
ALPHA (⁴ HE)	5 to 90	40
HELIUM (³ He)	6 to 130	1

RADIATION EFFECTS FACILITY

- Facility based on the University of California 76" variable energy Isochronous Cyclotron.
- Particle distribution uniformity generated by diffusing beam with Tantalum foils (>400cm from DUT).
- Diffused beam collimated to generate a beam spot 7cm in diameter at the Device Under Test (DUT) location.
- Particle counting by a Secondary Electron Emission Monitor (SEEM) calibrated to the beam line Faraday CUP (FC).

PROTON FLUX 3.13×10^{10} proton/ (cm²-sec) or less
ENERGY RANGE 1 to 68 MeV
BEAM SIZE 2.75 INCHES IN DIAMETER
DOSIMETRY: SEEM & FCUP with Keithlys 617 interfaced to a PC

Other flux and size can be accommodated. (Arrangements must be made with enough lead time to prepare facility)



- BEAM DOSIMETRY SOFTWARE (BEAMMON)

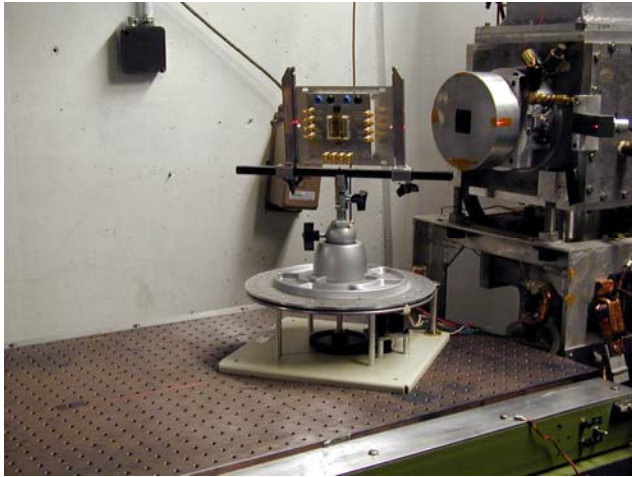
REQUIRED DATA

- Beam Profile (essential)
- Beam Energy
- Target material

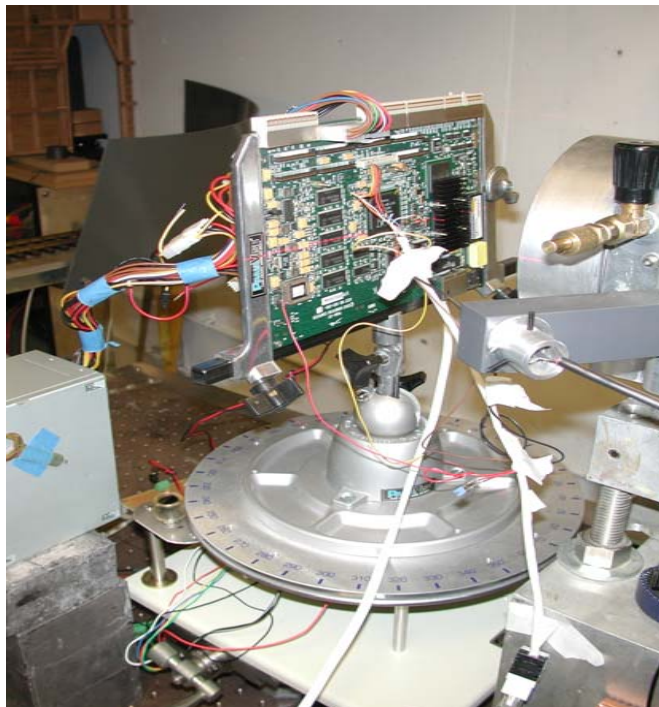
BEAMMON:

- Will obtain the ratio between SEEM and Faraday Cup.
- Will integrate the current of SEEM during the test and convert it to total charge.
- Will use the SEEM to FC ratio to convert the total SEEM charge to the total proton charge, and then to the total number of protons in that test.
- Will use the beam profile to obtain the fluence distribution.
- Will use this fluence and stopping power, for that energy and material, to calculate the dose in rads.
- **Essential to check, periodically, the beam integration and the beam intensity profile.**

CNL Radiation Effects Facility DUT Area

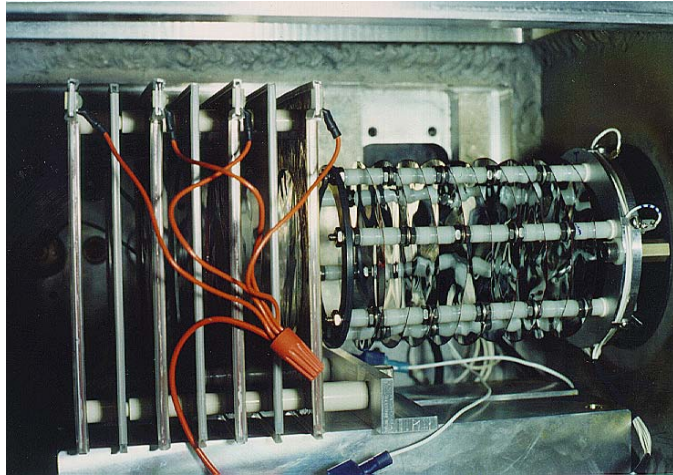


- The vertical adjustable table (29" X 37") at the end of the Beam line moves from 5.25 to 21.1 inches from beam center. An XY compound slide table is provided for horizontal plane movement. An X-Y Laser beam complements the DUT alignment system. Cable length from test area to the control area is 60 feet. Assorted beam apertures to modulate the beam at the DUT location are available. To reduce personnel radiation exposure, the external beam stop is moved to a shielded location when accessing the test area.



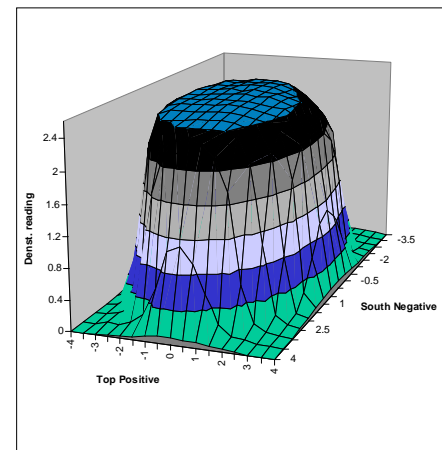
- To study angular dependence of radiations effects, we provide a remotely control rotating table, with a circuit board holder as illustrated. The stepping motor of the rotating mechanism gives the angular position within 0.1 degrees.

Beam Intensity Measurement And Distribution



- The Secondary Electron Emission (SEEM) at left,
- Is used to keep track of the beam intensity, and the Segmented Secondary Electron Emission Monitor (SEEM), at left, is for checking the spatial beam distribution. Both are located under vacuum just upstream from the DUT location. The SEEM is calibrated by the 6" removable Faraday Cup located downstream in the same vacuum box.

- **Three dimensional display of beam intensity distribution at DUT**
- **Surface plot of the beam distribution at the DUT location as measured with Gafchromic HD-810 film. Foreground axis is the beam vertical dimension, with the top of distribution at positive values. The other axis is the north-south dimension with negative values corresponding to the south beam distribution. Within a 2.5cm radius the distribution at the DUT location is fairly uniform.**





- A vacuum box, 24" X 16" X 16", can be attached to the dosimetry box to minimize straggling for low energies. Eight BNC feed trough connectors are available for electrical signals. A port, attached to the side plate, can be used to provide for other multiple wire connections to the interior.
- The beam center is 8.5" from the bottom. The box front plate can be flipped 180 degrees to have the center of the beam at 16.5" from the bottom.
- The front plate of the box can easily be changed by another with the beam port at different highs if necessary.

