Radiation Effects Facility

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The activity of the Radiation Effects Facility (REF) decreased slightly over the previous reporting year. In this reporting period, the facility was used for 1327 hours, which is an ~11% decrease over the 1500 hours used in the 2000-2001 reporting period. Users of the facility (and hours used) over the past year were: Boeing Satellite Systems (530), NASA GSFC (213.5), NASA JPL (200), Prairie View A&M University (80.5), Novus Technologies (62.5), General Dynamics (40), Grenoble (32.5), Intersil (32), BAE Systems (32), Naval Research Laboratory (28), Raytheon (22), Sandia National Laboratory (16), Motorola (14), Aeroflex UTMC (8), Harris Electronics (8) and Xilinx (8). From the list above, BAE Systems, Grenoble, Raytheon, Aeroflex UTMC and Xilinx were all new customers of the facility.

Table 1 compares the facility usage by commercial and government customers. The months following the "911 tragedy" and the delay in the 2002 cyclotron start up (~100 hours lost). Additionally, the reduction in hours can also be attributed to the efficiency of the facility's "in-air" testing station. The station has allowed groups to be much more productive--faster set up-tear down and less idle cyclotron time. Despite the downturn in the U.S. economy and the ailing telecommunications market, the need for single event upset testing of space flight equipment has remained strong and our facility was quite active. It is expected that the facility will remain as active in the future.

Table 1: Radiation Effects Facility usage by commercial and government customers for this and previous reporting years.

Reporting Year	Total Hours	Commercial Hours (%)	Government Hours (%)
2001-2002	1327	757 (57%)	570 (43%)
2000-2001	1500	941 (63%)	559 (37%)
1999-2000	548	418 (76%)	131 (24%)
1998-1999	389	171 (44%)	218 (56%)
1997-1998	434	210 (48%)	224 (52%)
1996-1997	560	276 (49%)	284 (51%)
1995-1996	141	58 (41%)	83 (59%)

Table 2 lists the beams used this year and the number of times each was requested. In total, 207 beams were run this year, which is slightly higher than the year previous. No new beams were developed. 10.5A MeV ^{197}Au and 55A MeV H-H have been removed from the list.

Table 2: Beams used and the number of times requested for this reporting year and last. 207 beams were run this year.

Particle Type	A MeV	Requests 2001-2002	Requests 2000-2001
^{197}Au	10.5		4
^{4}He	12.5	1	1
^{20}Ne	15	13	1
^{40}Ar	"	24	4
^{84}Kr	"	26	6
^{129}Xe	"	18	5
^{165}Ho	"	11	3
^{181}Ta	"	5	4
^{197}Au	"	9	12
H-D	25	0	1
^{22}Ne	"	13	27
^{40}Ar	"	20	31
^{84}Kr	"	20	32
^{129}Xe	"	18	25
H-D	40	8	1
^{20}Ne	"	3	5
^{40}Ar	"	8	12
^{78}Kr	"	9	13
H-H	55		2
^{16}O	"	0	1
^{36}Ar	"	1	2
Total		207	192

Beams that may be added back to the list are 15A Cu and Nb. These beams are necessary to fill the LET gaps between Ar-Kr and Kr-Xe. Beams that may be developed over the next year include 55A MeV Ni and Kr and 25A MeV Ho, Ta and Au. The development of these beams depends entirely on the success of the ECR-LS project.

Hardware and software improvements have been made to the REF facility. The features that have been implemented since last year's report include the following listed below:

Hardware

A new beam degrader system is being designed. The present degrader system allows for three foils of various thicknesses to rotate up to 71°. This degrader rotation allows for complete thickness coverage up to three times the thickness of the degrader. In addition, there are four non-rotating degraders that may be used in combination with the rotating degraders to allow for necessary beam energies.

The present system presents numerous problems. First, the degraders do not degrade the entire usable beam, only the central portion. When used in combination with some of the non-rotating degraders an even smaller area of degraded beam is provided. Second, the rotation of the degraders to 71° degrees has proven to be problematic. At rotations above 60° a significant energy spread of the beam is noted.

To simplify operation and correct for these problems a new degrader system has been proposed. It will eliminate the need for combinations of degraders by providing a series of ten degraders such that only one degrader will be used at any time. This set of degraders will vary in thickness from 0.001" to 0.512", doubling in thickness with each degrader. This will require only rotations of up to 60 for complete thickness coverage, eliminating the possibility of spread in beam energy. Finally, the degraders will be large enough in area to degrade the entire beam, providing a totally degraded beam. These modifications will provide better results for end users.

The new degrader system will implement aluminum foils of varying thickness measuring 5.8" x 2". As shown in Fig. 1, each of ten foils will be held by an individual support frame. These individual frames will then be attached to a larger support frame to form a single unit. This unit of frames will be mounted to a custom-made UniSlide positioner system, similar to that used for the in-air positioning system [1], which will allow for vertical motion

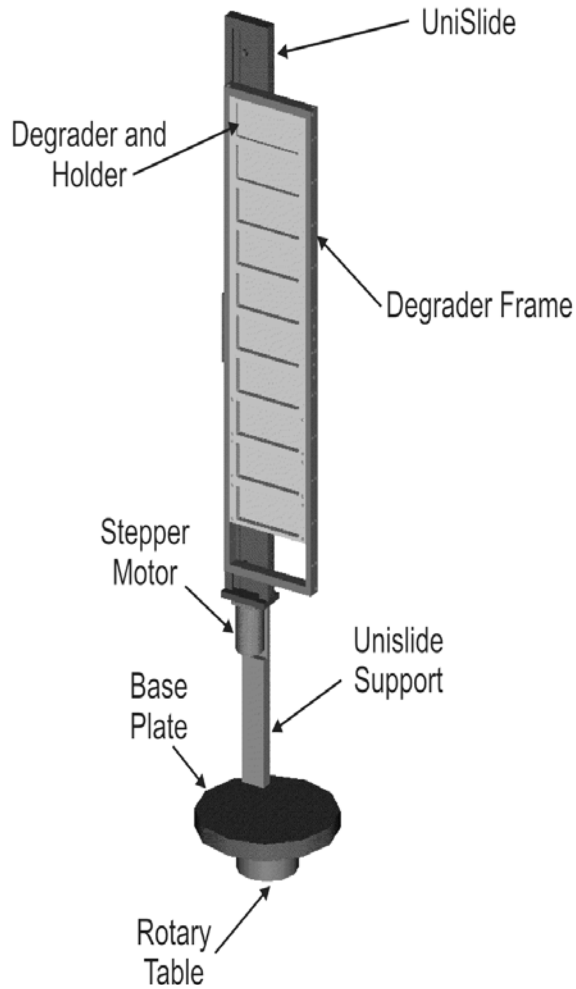

Figure 1: Schematic of the new degrader system. Ten foils, with increasing thickness by a factor of two, will rotate up to 60° to allow degradation of beams as high as 60A MeV.

and positioning of the desired foil in front of the beam. A UniSlide rotary table will be used to rotate the entire vertical assembly to the necessary angle. Computer-controlled stepper motors will power both the vertical slide and rotary table. These motors will interface with the existing hardware and SEUSS software to provide ease of transition to the new system. Cameras will be appropriately placed to verify accurate vertical and rotary positions. The assembly will be housed in a large-diameter stainless steel pipe and replace the beam box of the radiation effects line in which the current three foil degrader system is housed.

Software

For the most part, improvements in the SEUSS control software were aimed at simplifying the usage of the new in-air positioning system. A considerable effort was put into developing and setting up a safe maneuvering protocol. Namely, during the transitions between the previously defined target positions, preventing any contact between the target assembly and the fragile vacuum window at the end of the beamline is vitally important. This requires careful planning of the order in which the target assembly is moved in each direction, considering the integrity of beamline vacuum, possible limitations in the slack of the cables used in the setup, and the time it takes to complete the transition.

Information regarding the layers of material placed between the active part of the device under test (DUT) and the beamline vacuum (including the air and the vacuum window) is now named and stored in a file. This way it can be reused as needed without reentering the data. Reference to the file with the current layer information is put into each run report file and into the run summary file. This greatly reduces the complexity of these files. The current layer-information file name is also displayed in the main window and in the DUT position-control window, along with the total number of layers defined.

A series of layer-information files was created for users who test fully exposed devices in order to help reduce the level of their mandatory involvement in the software setup. All these files include the information about the vacuum window, while each contains specific information about the air thickness. Included air thicknesses range from 1 to 30 mm in steps of 1 mm. Consequently, these users just need to load the file according to the actual air thickness and do not have to go through the layer-definition routine or know about the specifics of the vacuum window.

Other improvements are related to the beam quality monitoring and control. Combinations of the measured beam quality parameter values suggesting a potential problem have been identified and classified according to their importance. Users are now notified about the nature and possible causes of the potential problem at the start of the run, before the beam hits the target. These warnings are very noticeable and hard to ignore, because they require a specific user response. Users may choose from several options regarding further diagnostic and/or remedy of the problem or they may choose to ignore the warning and even suppress future warnings of the same kind for the rest of their run. The type of problem and the user's response is then entered into the log file.

The control software has a built-in emergency run termination procedure, in which the beam gets blocked by a shutter and is prevented from hitting the target. This procedure is activated if any key on the keyboard or any button on the mouse is pressed after the run starts. To alleviate the complications due to accidental run terminations, the users are now notified if this procedure is activated (after the beam is blocked) and are given an option to resume the run.

Administrator utilities feature an improved and simplified method of scintillation detector voltage adjustment as a function of beam energy. The calibration is now based on two points. Selection of calibration points is flexible. However, choosing one point corresponding to the undegraded beam and the other point corresponding to the beam degraded down to the Bragg-peak energy is preferred. Degrader configuration corresponding to the latter situation (the lowest recommended beam energy to be used) can be set by selecting that option from the menu. Therefore, knowing or looking for the Bragg-peak energy or the maximum linear energy transfer (LET) rate is not necessary. Calibration data are stored in a dedicated file along with the date and time of the calibration. They will be in use until new data are entered for the same beam. The two calibration points can be redefined independently from one another. Records from the calibration data file can be used later to track the beam usage. This is particularly useful in determining the date and time of the most recent run with the given beam, which helps speed up the beam change procedure.

To protect the detectors from unnecessary excessive exposure to the beam particles, a new feature lets the administrator enter the maximum tolerable beam flux. If the actual beam flux exceeds 30% of this value while the software is in the idle mode (i.e., with no run in progress), the beam will be blocked after thirty seconds, unless a run starts in the meantime. The control program now also prompts for the detector voltage adjustment if it finds that any of the detectors are unbiased.

Axial gain tolerance limits are now defined with a single parameter that defines either the higher or the lower acceptable limit. The other limit is assumed to be given by the reciprocal value of this parameter. Finally, the beam energy can now be specified in MeV as well as in MeV/u.

References

[1] H. L. Clark, V. Horvat, B. Hyman, and D. Utley, *Progress in Research*, Cyclotron Institute, Texas A&M University (2000–2001), p. V-5.