

## Improvements in the radiation-testing hardware and software

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In 2020 our software package (SEUSS), used for control of the hardware and characterization of the beams at the Radiation Effects (SEE-line) Facility, has undergone a major upgrade from its 2019 version. The main goal of the upgrade was to match SEUSS results for ion energy loss and range with those obtained using the latest version of the Stopping and Range of Ions in Matter (SRIM) code [1], while keeping an option to do the calculations using the pre-upgrade method. Keeping this legacy option is important to our customers for proper comparison between their new results and those they obtained previously.

We have been using the same method of energy-loss calculation consistently since 1996. That method was based on ion-energy dependence given by a semi-empirical formula and a table of the associated parameters specific for each ion species and each medium. They were made publicly available along with the 1995 version of SRIM. Meanwhile, SRIM methods of calculation evolved, but the updated formulas and the associated parameters were no longer made available. Therefore, to keep up, the new version of SEUSS has to rely on the energy-loss tables produced by the latest version of SRIM and on implementation of suitable methods of interpolation. The new method of calculation is conceptually very different from the old one and requires considerably more time to produce the results, so that most of the code had to be re-written and optimized for speed.

As an added benefit, the new method of calculation is much more flexible, and in the future, if needed, it can easily be updated just by preparing newer energy-loss tables, without having to update the software itself. The downside is that the new tables will have to be made for all SEE-line beams and for all substances these beams are expected to go through. While the number of beams that we offer for radiation testing is relatively small, the number of different substances in use could be extensive. However, a search through the archived "layer" files, which contain information on the substances our customers had used in the past, identified the substances that were used most frequently. These involve aluminum, aramica, air and silicon, as well as GaAs, GaN, SiC, SiGe, InP, and NaI. All of them are currently supported by the updated version of the SEUSS software, while other substances can be added to this list if needed. Alternatively, the calculations for the unsupported substances can be done using the legacy method.

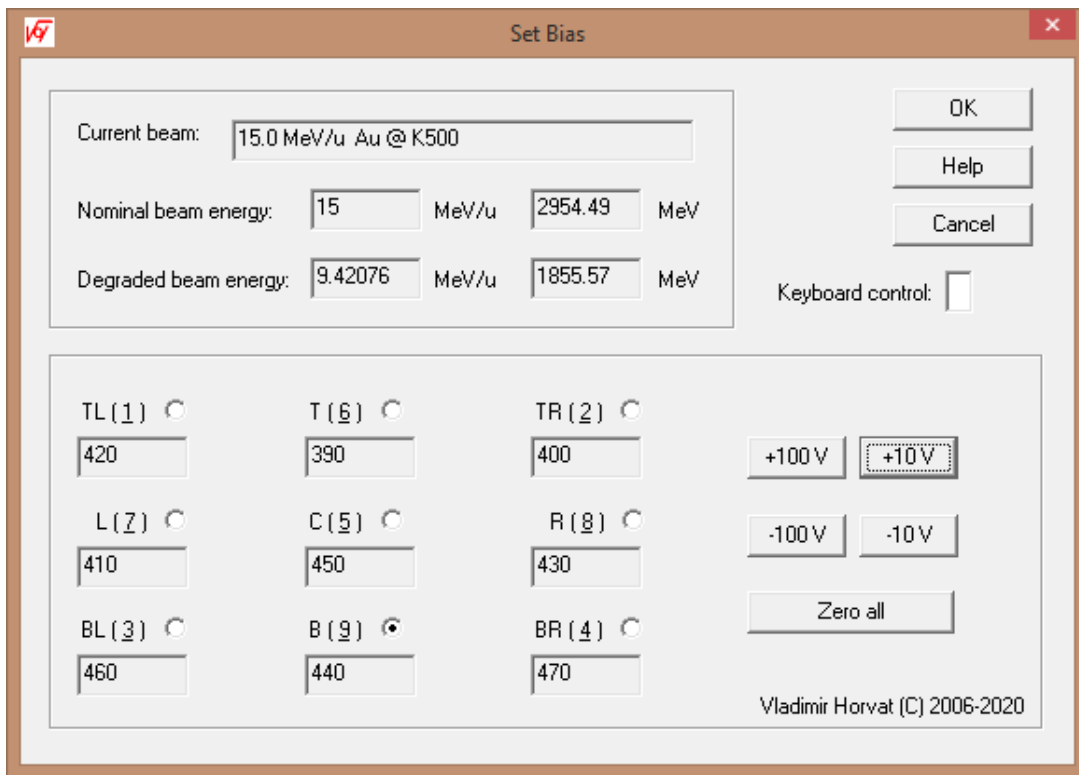
All graphs of energy loss vs. depth and the associated tables posted on our web site [2] and around the building have been updated to reflect the new SEUSS calculations. Other software improvements are minor and include the following:

- (a) The energy loss vs. depth tables produced by SEUSS are now more refined and more precise. The first row of the table reflects the current setting and the table caption contains the Bragg-peak information.
- (b) All reports that include accumulated fluence now also include the accumulated dose in rad. (c) Our customers now can choose the default run number increment.

Additionally, progress has been made regarding the migration toward a complete hardware and software solution supported by the Windows 10 operating system. To reach this goal, a new hardware has

to be acquired and set to be controlled by the software in order to perform the following tasks: (i) generate suitable output voltages for input to nine detector power supplies, as well as provide an indicator that the beam path is clear all the way to the target; (ii) count the signals originating from at least ten detectors; and (iii) physically move the target and the beam-energy degraders. The hardware for items (i) and (ii) already has been obtained from National Instruments [3], while the hardware for item (iii) is expected to become available soon.

The software solution is expected to be compatible with our SEUSS software package, which means that the hardware should have drivers that are compatible with the Microsoft Visual Studio C++ compiler and linker. For items (i) and (ii) such drivers have been adopted from the provided examples in ANSI C and made to work in the Visual Studio C++ environment. A trial window-based application, illustrated in Fig. 1, was developed to test one channel of the hardware that generates voltage output. Further development of the application and completing the set of hardware connections to include all available channels is in progress and no major problems are expected on the way to full functionality.



**Fig. 1.** New window for the control of nine detector power supplies. The default bias setting is determined programmatically based on the characteristics of the ion beam in use and the past performance of the detectors. Adjustments can be made on demand.

[1] <http://www.srim.org/> .

[2] <http://cyclotron.tamu.edu/vladimir/SeussW-Download.htm> .

[3] <http://www.ni.com> .