

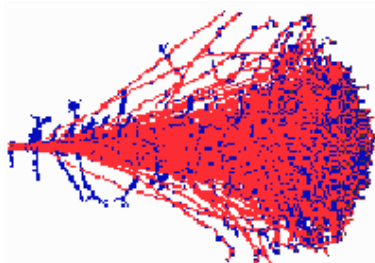
PARTICLE INTERACTIONS WITH MATTER

This website contains software on THREE Topics:

[SRIM - The Stopping and Range of Ions in Matter](#)

[SER - Electronic Soft Error Rates](#)

[IBA - Ion Beam Analysis](#)



The Stopping and Range of Ions in Matter

 <u>SRIM Textbook</u> 	
Software	Science
<u>SRIM / TRIM Introduction</u>	<u>Historical Review</u>
<u>Download SRIM-2010</u>	<u>Details of SRIM-2010</u>
<u>SRIM Install Problems</u>	<u>Experimental Data Plots</u>
<u>SRIM Tutorials</u>	<u>Stopping of Ions in Matter</u>
<u>Download TRIM-2008 Manual Part-1, Part-2</u>	<u>Stopping in Compounds</u>
	<u>Scientific Citations of Experimental Data</u>

<u>Stopping, Range and Damage by Neutrons</u>	<u>High Energy Stopping Theory & Experiments</u>
<u>SREM - Stopping and Range of Electrons</u>	<u>Ranges of Ions</u>
<u>SRIM - Supporting Analytic Software</u>	

[SRIM Web Statistics](#)

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Buttons in * **LHHQ** are links to other sites.

The Stopping and Range of Ions in Matter Software -

SRIM is a collection of software packages which calculate many features of the transport of ions in matter. Typical applications include:

- **Ion Stopping and Range in Targets:** Most aspects of the energy loss of ions in matter are calculated in **SRIM**, the Stopping and Range of Ions in Matter. SRIM includes quick calculations which produce tables of stopping powers, range and straggling distributions for any ion at any energy in any elemental target. More elaborate calculations include targets with complex multi-layer configurations.
- **Ion Implantation:** Ion beams are used to modify samples by injecting atoms to change the target chemical and electronic properties. The ion beam also causes damage to solid targets by atom displacement. Most of the kinetic effects associated with the physics of this kind of interactions are found in the **SRIM** package.
- **Sputtering:** The ion beam may knock out target atoms, a process called *ion sputtering*. The calculation of sputtering, by any ion at any energy, is included in the **SRIM** package.
- **Ion Transmission:** Ion beams can be followed through mixed gas/solid target layers, such as occurs in ionization chambers or in energy degrader blocks used to reduce ion beam energies.
- **Ion Beam Therapy:** Ion beams are widely used in medical therapy, especially in radiation oncology. Typical applications are included.

Science -

The science of ion beams goes back almost a century to the earliest explanations of radioactive particles transiting thin films (1904). The field is so rich that it is difficult for a non-expert to understand any of the current papers in the field. But basically, the stopping of ions in matter can not be calculated from first principles. Hidden in stopping theories are parameters which normalize calculated stopping powers to existing data. The "**Science**" section of SRIM will review the basic theories of the stopping of ions in matter. Then some of the major parameters are reviewed and it will be shown how they are derived from experimental data. Examples are *shell corrections*, *mean ionization potentials*, the *effective charge of ions* and the *Fermi velocity of solids*.

Over 2000 papers have been published in the experimental stopping of ions in solids. Experimental measurements of stopping powers is a difficult task, and there is wide variation in the results.. Plots will show how existing stopping calculations compare to experimental data from these papers. Since the stopping calculations are based in great part on theory, the interpolation of stopping powers between various ions and targets is often more accurate than individual measurements, especially for difficult targets.

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Soft Errors in Electronics from Cosmic Rays

Electronic Reliability - Effects of Terrestrial Cosmic Rays

Technology Soft Error Rates	Science of Terrestrial Cosmic Rays
Introduction	History
Current Status (1MB)	Neutron Sea Level Flux
History of Accelerated Testing	Neutron Spectrometers
Current Status Accelerated Testing	

Buttons in * [UHQ](#) are not yet active.

Although this subject is more about the effects of energetic hadrons on terrestrial electronics than about ion beams, it is scientifically in a similar field (hadrons = protons, neutrons and pions, i.e. particles which respond to the nuclear force / strong interaction). The science and technology about cosmic ray induced soft fails was considered proprietary by IBM for more than 15 years. In 1996, a complete issue of the IBM Journal of Research and Development was devoted to reviewing this work. A summary of the issue, and the complete first article (the 15 year history of the development of the IBM scientific understanding of soft fails from radiation) is given at [IBM J. R. & D.](#)

The scientific history of this field is reviewed in detail. The field is not static because the technology of integrated circuits is still rapidly changing and the effects of cosmic rays on integrated circuits (ICs) show trends which are not well understood. The trends in the sensitivity of ICs to cosmic rays are reviewed for SRAMs, DRAMs and logic over the last 15 years.

Fundamental to any estimates of the fail rate of ICs is an understanding of the ambient flux of cosmic rays in the environment. As this flux has been investigated over the last 15 years, it has become fuzzier rather than more precise. Previous measurements of the ambient flux which were considered reliable have been shown to be suspect. New measurements rarely agree with past measurements. Recent reports of the flux of sea level cosmic ray hadrons vary by more than 10x, even though they were performed by highly competent scientists. The problem will probably be resolved by understanding that the immediate materials nearby an experiment can have significant effect on the measured flux. The field of the terrestrial flux of cosmic rays will be reviewed.

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Ion Beam Analysis (IBA)

This package contains programs for the analysis of data from ion scattering experiments (called **Rutherford Backscattering Spectroscopy, RBS**), and analysis of data from target sputtering experiments (called **Elastic Recoil Detection, ERD**). In general, the package is applicable to any ion, at any energy in any target material. It is written in a windows-based environment with a full graphics user interface (GUI) for analysis of complex spectra using mouse-based input. The software contains a full 32-bit instruction set to minimize computer delay in calculating simulations.

The software is written in a language called APL, which is a multi-window GUI application language particularly forgiving of mistakes. Since IBA analysis is so complex, and covers any ion at any energy for any target, it is

particularly difficult to make a program which will not get confused by user requests. APL allows the user to immediately recover with just two key strokes, without reloading any code or data, and continue executing the analysis from the point of error. The required APL compiler is available for both Win-95 and OS/2 systems (see the Installation Manual for details). For details on the APL environment for scientific programming, see the website: <http://www.software.ibm.com/ad/apl/apl2.html>. The APL compiler is normally very expensive (about \$1500) but it is available with "educational discounts" from IBM sales. The software requires the full APL package and will not work with any of the stripped down versions of APL.

The package has been used by many groups and is relatively bug-free. However, **this software is no longer supported by the author.**

Below are links to (a) an Introduction to the IBA software, (b) Installation requirements for the software, and (c) Samples of IBA applications. The sample IBA figures show some of the capabilities of the IBA package. These figures come from the *IBA Tutorial Manual*.

Introduction to IBA	One page brief description
"Samples of IBA Analysis"	Examples of IBA Applications
Windows Installation Requirements	Win-95 Installation Requirements
OS/2 Installation Requirements	OS/2 Installation Requirements
Windows Installation Manual	MS-Word (6.0) formatted - (60 kB)
IBA Application Package	IBA Source Code, and supporting files (version 1998.03, 1.2MB)

To obtain the IBA software package, you must download and print out the *Installation Manual* (in MS-WORD format) for your system, and then the Application Package, which is one ZIP file which contains both the Win-95 and OS/2 programs (the differences are minor). The application package also contains the *Tutorial Manual* which you will print out as part of the installation process.

Once you have installed the system, the *Tutorial Manual* introduces you to the Analysis software, and it can be used for later reference for menus for more complex operations such as introducing ion implanted distributions into complex layered targets.

[What's new in IBA \(for experienced users\)](#)



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