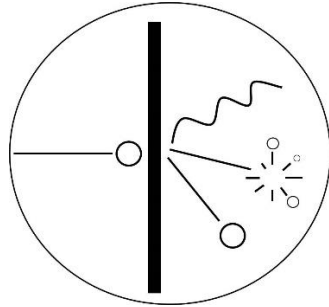# INTDS NEWSLETTER

International Nuclear Target Development Society

December 2019

Volume 43

Visualization of the future FAIR accelerator facility @ GSI, Germany

Contents

1   Editorial

Dear Members of the INTDS

Welcome to the first INTDS Newsletter edited by the Targetlaboratory@GSI-team. We, Birgit Kindler and Bettina Lommel, take over from John Greene, Argonne National Laboratory, who acted as an editor of this newsletter since 2003 and did a great job. Thanks a lot John Greene!

We are starting with a new classic layout and with a basic content. We count on your help to fill the INTDS-newsletter with more information and even more features with each edition.

As already stated, the INTDS Newsletter publishes advertisements that are relevant for the INTDS community, placed by members at no costs, at the discretion of the editors!
Please provide your advertisement in an adequate scalable format and send it to INTDS-Newsletter@gsi.de!

With this issue, we want to start with the series **Target Laboratories of the World** where target makers introduce briefly their institutions and laboratories. Dorothea Schumann from the Paul Scherer Institute, were the next INTDS conference in 2020 will be hosted, volunteered for the first contribution. Thanks a lot, Dorothea Schumann!

Please help us keeping the Newsletter interesting and informative and send contributions, ideas, advertisements, or whatever you want to share with all of us to INTDS-Newsletter@gsi.de.

We are curious, how you will like this newsletter and we are looking forward to receiving your contributions for the newsletters in 2020.

Birgit Kindler and Bettina Lommel

For information on the INTDS please refer to www.intds.org

2 Target Laboratories of the World

Paul Scherer Institute (PSI) in Villingen, Switzerland

by Dr. Dorothea Schumann

The Paul Scherrer Institute, PSI, is the largest research institute for natural and engineering sciences within Switzerland. World-class research in three main subject areas is performed here: Matter and Material; Energy and the Environment; and Human Health.

PSI operates large-scale research facilities for users from the national and international scientific community, in particular for condensed matter, materials science, particle physics and biology research. PSI is one of the very few locations in the world providing the three complementary probes of synchrotron X-rays, neutrons and muons at one site.

The world's most powerful High Intensity Proton Accelerator HIPA at PSI with its 590 MeV, 1.4MW proton beam drives several user facilities:

- SINQ - a state-of-the-art user facility for neutron scattering and imaging with a suite of totally 18 instruments;
- The Swiss Muon Source (SμS) - the world's most intense continuous muon source, with 6 beamlines available for experiments using muons as sensitive local magnetic probes.
- UCN with the highest intensities of very slow neutrons.

To run these complex instruments, PSI develops, maintains and constantly improves several high-power targets, among others the solid lead targets for SINQ and UCN and the rotating graphite wheel for muon production.

The research group "Isotope and Target Chemistry" (ITC), in charge to host INTDS 2020, belongs to the Laboratory of Radiochemistry (LRC), which is part of the Department of Nuclear Energy and Safety (NES). ITC deals not only with the study of the radioactive content of activated material and the physico-chemical behavior of selected radionuclides therein, but is also focused on separation of rare exotic radionuclides needed in different scientific research fields like astrophysics, environmental research, fundamental nuclear physics and others.

The group is experienced in target preparation and actively participates in key experiments like half-life and cross section measurements, partly under own leadership (e.g. 53Mn) or in collaborations (e.g. 60Fe, 7Be, 171Tm).

Further reading: https://www.psi.ch/en/lrc/isotope-and-target-chemistry.

3   Technical Contributions

Our former member Atsushi Yoshida, whom we thank explicitly for this honor, sent this contribution! For comments or questions, please contact Yoshida san directly.

Energy-Loss Calculation Function Library (SRIMfit) using Excel and SRIM-2013

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Abstract

SRIMfit is a macro function library for Microsoft Excel, which calculate range, stopping power and energy loss of ions in a matter. The function reads a stopping/range table provided by SRIM-2013 code[1] and returns a fitted value at specified energy. Since SRIMfit is installed as user-defined functions in Excel system, one can utilize those functions as usual Excel functions in one's spreadsheets. Using SRIMfit, some examples for heavy-ion-beam irradiation are displayed.

1. Introduction and Motivation

RIKEN Nishina Center provides fast heavy ion beams to private companies in Japan, which evaluate single-event effects (SEEs) of space-use semiconductors. At present, beams of 95 MeV/u Ar and 70 MeV/u Kr ions are in practical use. The clients irradiate their devices in the atmosphere. For the SEEs test, they order a certain value of linear energy transfer (LET, i.e. dE/dX) at the depth of sensitive layer of the device. Then a precise beam-energy control is indispensable. To perform confident energy calibrations of detectors placed in the atmosphere, energy-loss calculations of an ion beam passing through many materials (like a vacuum-window foil, air and energy-degrader foils, etc.) should be repeated in many times. For this purpose, I made this SRIMfit.

Semiconductor companies of our clients use SRIM-2013 code for the evaluation of LET value in a silicon material. Therefore, it is reliable to use the same energy-loss code for beam-energy tuning procedure, also. SRIM is quite versatile code, but unfortunately, there is no function-call interface for external programs like Excel. On the other hand, SRIM can generate a stopping/range tables for ion beams through a variety of target materials. Using this table, there was an article titled "Target thickness calculation using SRIM and Excel" reported in this News Letter[2]. This article inspired me to improve this approach by cording a macro-function library for Excel.

Examples using SRIMfit displayed in this report are related to high-energy heavy-ion irradiation. But some of them can be applicable for target makers who need sophisticated spreadsheets for their works.

2. Structure of SRIMfit

Figure 1 explains the structure of SRIMfit. The core of this macro-function library named as "SRIMfit.xlam" has been corded using Visual Basic included in Excel as default. In addition, its dedicated database file is named as "MySRIMwb.xlsx". This database includes many worksheets in which a stopping/range table provided by SRIM code is described. The name of each worksheet (*WSnm*) is named as "BeamNuclide_TargetMaterial", for example, "srim40Ar_Si". Then, these two files are installed in the System Add-In folder of MS-Office. When Excel program starts, the SRIMfit functions are registered as user-defined functions, therefor one can call them from one's own spreadsheet.

All SRIMfit functions are named as "*sr**( )*". For example, the range calculation function named *srE2Rng( )* needs two parameters; Energy of the beam and *WSnm* in order to specify the combination of beam nuclide and target material. The function retrieves the database file using a specified *WSnm*, then reads its stopping/range table and calculates range at a specified energy using a simple linear interpolation. Finally, the calculated range-value is returned to user's spreadsheet.
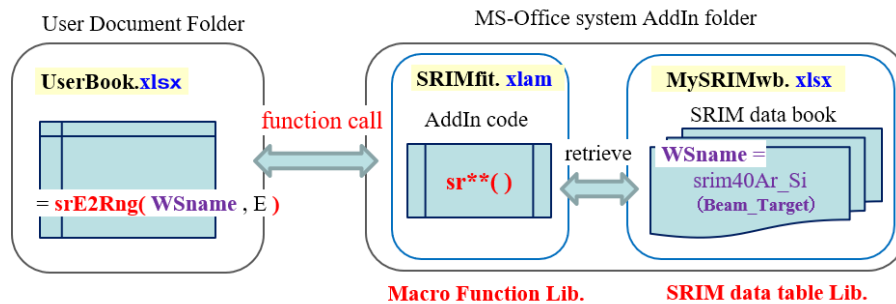

Fig. 1. Structure of SRIMfit

In this manner, one function can calculate many combinations of beam and target, just changing the *WSnm* parameter. Figure 2 shows an example of the "MySRIMwb.xlsx" file. In a worksheet named "srim40Ar_Kapton", the values in yellow cells are copied from the stopping/range table provided by SRIM code. The format of the worksheet is strictly defined in the macro code. Not only E vs. Range table, but also dE/dX and straggling tables and all other information are included in this sheet. That is to say, this one worksheet has object-oriented data structure which includes all calculation conditions and results when a SRIM calculation was performed. Therefore, it is enough to specify just a *WSnm* parameter in order to extract many calculation conditions like; Zbeam = *srInfoIonZ(WSnm)*, TargetDens = *srInfoTrgDens(WSnm)*, etc. There are useful 80 functions, approximately, are included in SRIMfit. For further details, please see function list in the User's Manual.
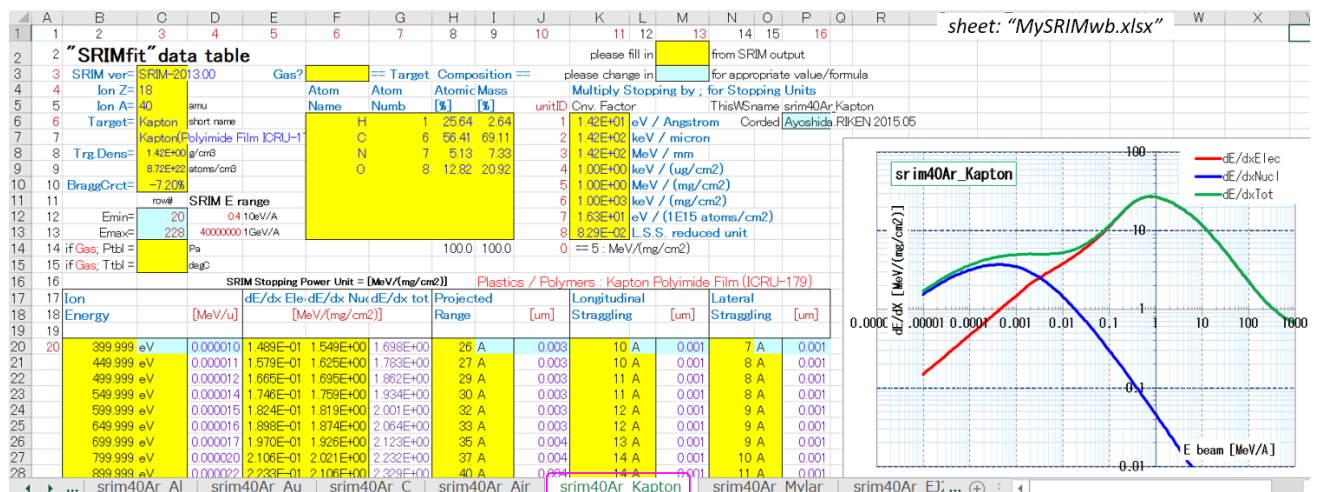

Fig. 2. Example of MySRIMwb.xlsx

Here, the "MySRIMwb.xlsx" data-base file should be prepared manually as users own purpose. It is tiresome to prepare this file. Comparing with SRIM-2013 code and LISE++ code[3], SRIMfit is not almighty. Because there is no physics calculation inside, you should prepare the reference data-base file in advance. But in some cases, this limited ability is enough for the users who need limited number of combinations between beam and target. In my case, the number of needed combinations is four beams (Ar, Kr, Xe and Au) times seven targets (Au, Kapton, Mylar, Air, Plastic scintillator, Al and Si)

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makes 28. I guess that target makers may have similar situation. Of course, you can add and update the database file at any time, just replacing the "MySRIMwb.xlsx" file placed in the AddIn folder.

Finally, you may be noticed, as long as the format of the data-base sheet is identical, one can use not only the SRIM output but can use any stopping/range table provided by other code. Preparing other database sheet with different name as "lise40Ar_Si", for example, you can compare the difference of energy-loss codes easily.

3. Installation

An operating environment for SRIMfit is the following.

       MS-Excel : later than Excel-2000
       OS: MS-Windows-10, -8, -7, -Vista, -XP and MacOS(10.14)

You can download SRIMfit module from my home page.

http://ribf.riken.jp/sisetu-kyoyo/Tips/SRIMfit/indexE.html

In this page, you can find Installation Guide, User's Manual and Examples Guide.

Some useful Excel macro-utility tools are included in the download module, also.

➢ "srOut2Ws.xlsm" converts a SRIM output.txt file to the worksheet format of "MySRIMwb.xlsx".
➢ "mkR(E) LET(E)array.xlsx" makes E vs. Range, E vs LET table used for C programing language.

4. Some useful functions: *srEnew(), srEold()*

The *srE2Rng(WSnm, E)* function denotes energy to range conversion and its invers function is *srRng2E(WSnm, R)*. Using these two fundamental functions, a 'new-beam energy' after passing through a target material and an 'old-beam energy' before passing through the target are easily calculated. Those two functions are implemented in the macro-code as following.

srEnew(WSnm, E1, Thick) {	*srEold(WSnm, E1, Thick)* {
R1 = *srE2Rng(WSnm,E1)* ;	R1 = *srE2Rng(WSnm,E1)* ;
if((R2 = R1 -Thick) <= 0) return(0) ;	R2 = R1 + Thick ;
E2 = *srRng2E(WSnm,R2)* ;	E2 = *srRng2E(WSnm,R2)* ;
return(E2) ; }	return(E2) ; }

Similar functions for Gas-material version named as *srEnewGas(WSnm,E,Thick,Press,Temp)* and *srEoldGas()* are implemented also.

Fig. 3. Example spreadsheet using *srEnew()* and *srEold()*

Figure 3 shows an example spreadsheet using these two functions. When my client orders me to irradiate ^{84}Kr beam to his Si sample placed in the atmosphere under the condition of LET=39 MeV/(mg/cm^2) at the depth of 20 µm from the surface, then I use this sheet to determine the beam energy in vacuum. This spreadsheet is included in the download file and its usage is simple. You just fill values of given conditions in the blue cells as beam=84Kr, depth, LET and thicknesses of many materials which the beam pass through. Then the starting energy at the given depth is calculated by using *srLETt2E()* function as 4.61 MeV/u at <1> in Fig.3. And the energies before pathing through materials are calculated to upstream direction using *srEold()* function. The final answer is displayed as 67.15 MeV/u at <2>. In the lower columns in this sheet, the energies after pathing through materials are re-calculated to downstream direction using *srEnew()* function, and the given initial condition of LET=39.00 is proved at <3> .

5. Example

Other example for an actual measurement is displayed in Figure 4. In order to determine the thickness of an energy-degrader material made by aluminum, two beam-energy spectra were measured using a Si-detector of 2 mm thickness placed in the atmosphere. A beam of ^{84}Kr 70 MeV/A extracted to the atmosphere was used for this measurement. Obtained two energy spectra are the following.

'Ye1' : measured without the degrader material. 'Ye2' : measured with the material.

Raw data sets of these two spectra (ADC [ch] vs. [counts]) are filled in the spreadsheet at <1> in Fig.4. The beam nuclide is specified as *WSnm* at <2>. Energy calibration of the Si-detector is described at <3>. A trial-thickness value for the degrader material is given at <4>.
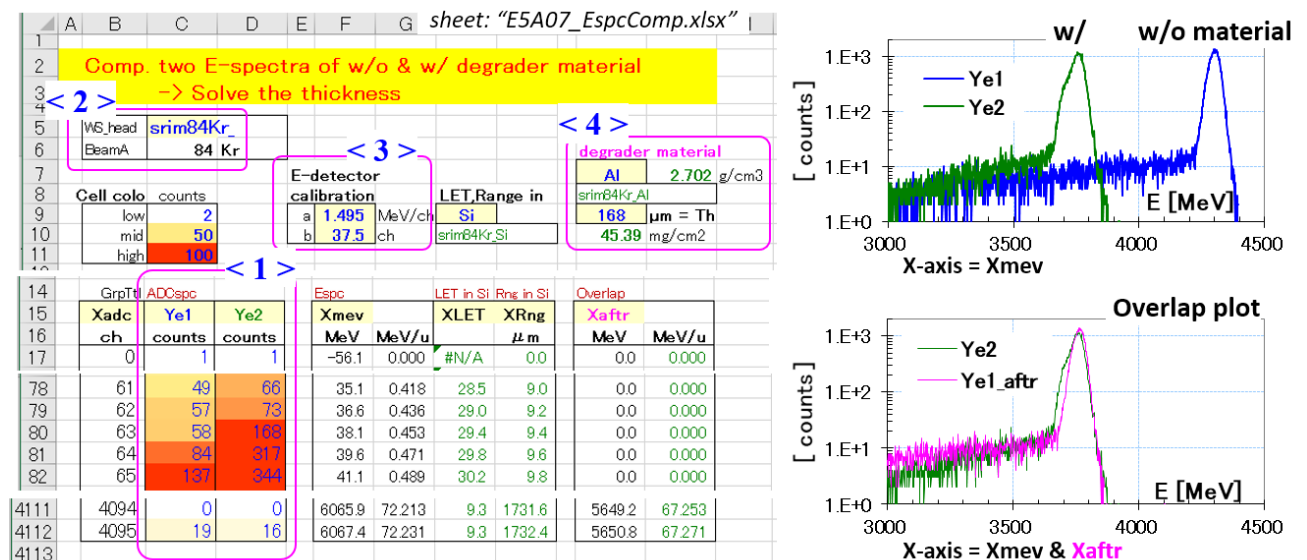

Fig. 4. Spreadsheet for thickness analysis

This spreadsheet only calculates the unit conversion of X-axis as following formula;

'Xmev' [MeV] = 'a' * ('Xadc' [ch] – 'b')   'Xaftr' [MeV] = *srEnew(* 'Xmev', 'Th' *)*

Here, 'a' and 'b' denote the coefficients of the energy calibration formula. Using the new X-axis of 'Xmev', same data sets of 'Ye1' and 'Ye2' are plotted (Fig.4 top right). The next new X-axis of 'Xaftr' denotes a 'new-beam energy' of 'Ye1' after passing through the material with 'Th' [µm] in thickness. An overlap plot is displayed (Fig.4 bottom right). Here, 'Ye2' is plotted according to 'Xmev' and 'Ye1' is plotted according to 'Xaft' indicated as 'Ye1_aftr'. Looking at the overlap plot with changing the value of 'Th', you can find a best-fit value for the material thickness.

This spreadsheet is included in the download file. There, other plots of 'LET in Si' and 'Range in Si' are included also. The unit conversions used for these plots are the following;

'XLET' [MeV/(mg/cm^2)] = *srE2LETt('Xmev')*   'XRng' [µm] = *srE2Rng('Xmev')*

This spreadsheet uses a brute-force method as it calculates all X-axis channels of 0 – 4096 ch for many times. So it takes about one second for all calculation when you change the 'Th' value. Although this method seems to be primitive, but it is visual and straightforward method to determine the thickness.

6. Summary

A macro function library for MS-Excel named as SRIMfit which calculate range, stopping power and energy loss of ions in a matter has been developed. The function works with reading a stopping/range table provided by SRIM-2013 code. Some examples using this library for heavy-ion irradiation in the atmosphere are introduced. SRIMfit is useful, especially, for whom needs energy-loss calculations through a stack of materials in many times. I shall be grateful if this SRIMfit help to my target-maker friends.

References)

1) J.F. Ziegler, SRIM-2013 code home page; http://srim.org/
2) A. S. Pawlak and J. P. Green, Technical Contributions, "Energy Loss Calculations for Target Thickness Determinations using SRIM and Excel", INTDS Newsletter, May 2011, Volume 36, Number 1.
3) O.B.Tarasov, D.Bazin et. al., LISE++ code home page; http://lise.nscl.msu.edu/

4   Announcements

4.1.   Workshop at Paul-Scherrer-Institut:

1st SANDA - user – producer – interaction meeting

Dear colleagues,
In the frame of the EC-funded project SANDA (**S**upplying **A**ccurate **N**uclear **D**ata for energy and nonenergy
Applications) we have several tools available regarding target production for scientific
experiments. To improve the quality of targets in terms of manufacturing tailored targets meeting the
specific requirements of the envisaged experiments, we organize dedicated workshops to bring together the experimenters and the target makers.
The first meeting of this kind will be performed
30.3. – 3.4.2020 at Paul Scherrer Institut Villigen.
The meeting will cover two kinds of presentation:
1. Target makers present their methods and capabilities. They will explain which boundary conditions have to be fulfilled and which information on the specific experiments are
necessary to produce a suitable target. They inform about schedules, paperwork, shielding
and transport issues as well as on the efforts necessary to manufacture what is needed.
2. Users are encouraged to present details of their envisaged experiments in terms to better inform potential target makers on the specific requirements of the needed targets. For SANDA collaborators, who intent to apply for a target manufacturing in the frame of SANDA WP3
(targets which have to be produced by the two SANDA collaborators PSI and JRC), this presentation is mandatory.
Additionally, time for individual meetings will be given to have the opportunity for detailed discussions
of specific targets, in particular with the partners from PSI and JRC.
The meeting can be partially funded by SANDA. No workshop fee is required, coffee breaks, meals and
accommodation for 3 nights are provided.
The number of attendees is limited to 30. If you intend to request a target manufacturing in the frame
of SANDA, please mention it in your application. Applicants with such experiments will have priority.
For the others, it will be a first-come-first go.
If you intend to attend the meeting, please send your application (abstract one page maximum; please
use the attached WORD template) till **31.12.2019**
to Dorothea Schumann dorothea.schumann@psi.ch / Goedele Stibbens
goedele.SIBBENS@ec.europa.eu
        Acceptance of contributions will be given till **31.1.2019.**

4.2. INTDS 2020 in Villingen, Switzerland:

PAUL SCHERRER INSTITUT
PSI

30th Conference
of the International Nuclear Target Development Society
INTDS 2020

September 20-25 2020

Paul Scherrer Institut Villigen PSI, Switzerland

Scope

Despite beam facilities, detectors and elaborated data analysis, the target is one of the indispensable components in scientific experiments aimed to investigate nuclear reactions and it plays also an important role for the performance of nuclear installations, for instance spallation neutron sources. Correspondingly high is the influence of the target quality on the quality of the final experimental result. The focus of this conference series is the research and development of techniques for the production and characterization of targets and target-related material for a broad range of applications. Performed every second year, the conference is aimed to bring together the target makers from all over the world to report about newest developments, share their knowledge, build up synergies for efficient exploration of the available resources and foster their networks to be able to produce:

Tailored Targets for Science

Topics

- Preparation techniques for thin films, e.g., vacuum evaporation/condensation, sputtering, electrochemical deposition, powder distribution, rolling etc.
- Separation and chemical processing of stable and radioactive isotopes;
- Preparation and characterization of high-purity and special materials;
- Development of highly material-conservative methods of preparation;
- Effects of contaminants;
- Target and sample encapsulation;
- Radiation and beam heating effects;

- Targets for radionuclide production;
- Liquid and Gas Targets
- Availability of isotopes;
- Target and sample thicknesses from gas densities to kg/cm².
- Isotopically enriched and radioactive targets
- Beam charge strippers (foil, liquid, gas, plasma)
- Targets for high intensity beams
- Target characterization
- Targets for special applications (medical, industrial, controlled fusion)

Important dates

1.2.2020:	Second announcement
15.3.2020	Submission of abstracts
15.4.2020:	Notification of acceptance
15.5.2020:	End of Early registration
15.8.2020:	End of Registration
20.9.2020:	Late registration
31.12.2020:	Deadline for proceedings contributions

Website: https://indico.psi.ch/event/7834/

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7   Laughs for Target Makers

Optimist

The glass is half full!

Pessimist

The glass is half empty!

Chemist

The glass contains:
50% $H_2O(l)$
39% $N_2(g)$
10.5% $O_2(g)$
.44% $Ar(g)$
.06% $CO_2(g)$

Source: www.cplabsafety.com or CP Lab Safety