IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Modernized Stopping Power Database

Vivian Dimitriou
Nuclear Data Section
International Atomic Energy Agency

Legacy Stopping Power Database

- Created in 1990 by Helmut Paul, Linz Univ.
- Contains purely experimental data for electronic stopping powers – nuclear component removed
- Graphical comparisons with SRIM, MSTAR, etc. – only when two or more measurements exist
- Access to MSTAR, statistical analysis, literature
- All data accessible for download

Since 2015

Electronic Stopping Power of Matter for Ions

Graphs, Data, Comments and Programs

Last update: December, 2021 (see Updates)

This collection of stopping power measurements includes data published as early as 1928 by Rosenblum, and is **continuously updated**. The collection, originally created and maintained by Helmut Paul, considers **any ion and target** combination that is measured and published, including solids (amorphous or polycrystalline), gases, elements or compounds, new materials such as polymers, oxides, silicates, and also biological targets. It deals with the **electronic** stopping power, assuming that nuclear stopping has been subtracted or is negligible.

Data and graphs can be downloaded from the tables for **H**, **He**, **Li to Ar**, and **K to U** ions. Detailed information on the content and organization of the database is provided in the **Introduction**.

Since 2015 the stopping database is maintained by the IAEA Nuclear Data Section. Dr. Claudia Montanari (Universidad de Buenos Aires-CONICET) is responsible for the compilation of data and graphs, and the development of the database. In **About** you can read about the history of the database and the pioneering work of Helmut Paul. Articles about the database can be found in **Literature**.

Please send your questions, comments and suggestions regarding...

...data, graphs and methods to:
Dr. Claudia Montanari / Instituto de Astronomía y Física del Espacio / Universidad de Buenos Aires - CONICET
Email: mclaudia@iafe.uba.ar

...this site to:
International Atomic Energy Agency / Nuclear Data Section
Email: nds.contact-point@iaea.org

https://nds.iaea.org/stopping-legacy/

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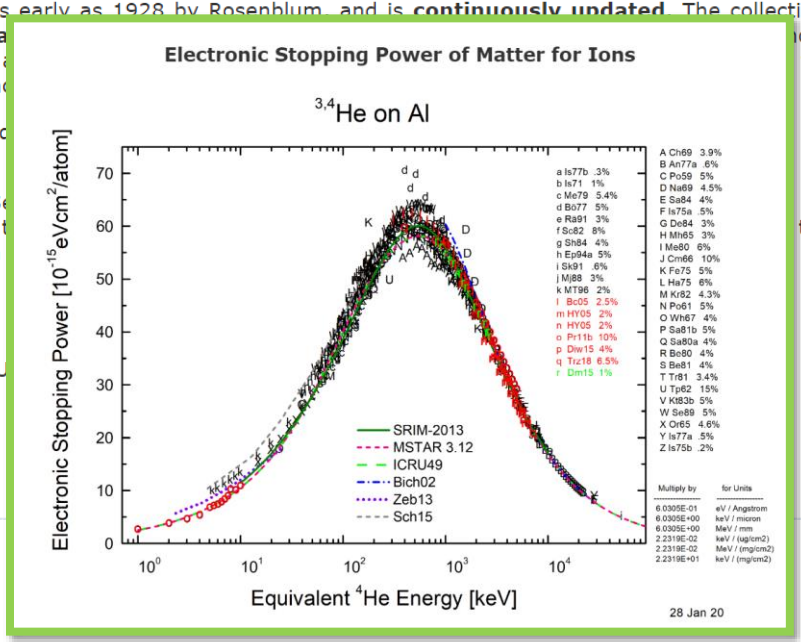
Electronic Stopping Power of Matter for Ions

Helium Ions in Atoms and Compounds

In the following table you can find the electronic stopping power of He ions in atoms and compounds, plotted versus the projectile energy. For each ion-target, you can download the graphs as images, the data as ascii files and the origin plots.

Some systems with only one or two sets of measurements have not been plotted yet although the data is in the database. To get all the data on He ions, check out the list of data for He ions, and download all data for He ions. The reference codes are explained in the list of all data references, and the curve designations in the list of stopping power tables and programs. All the available ORIGIN files for He ions in this table can be downloaded here.

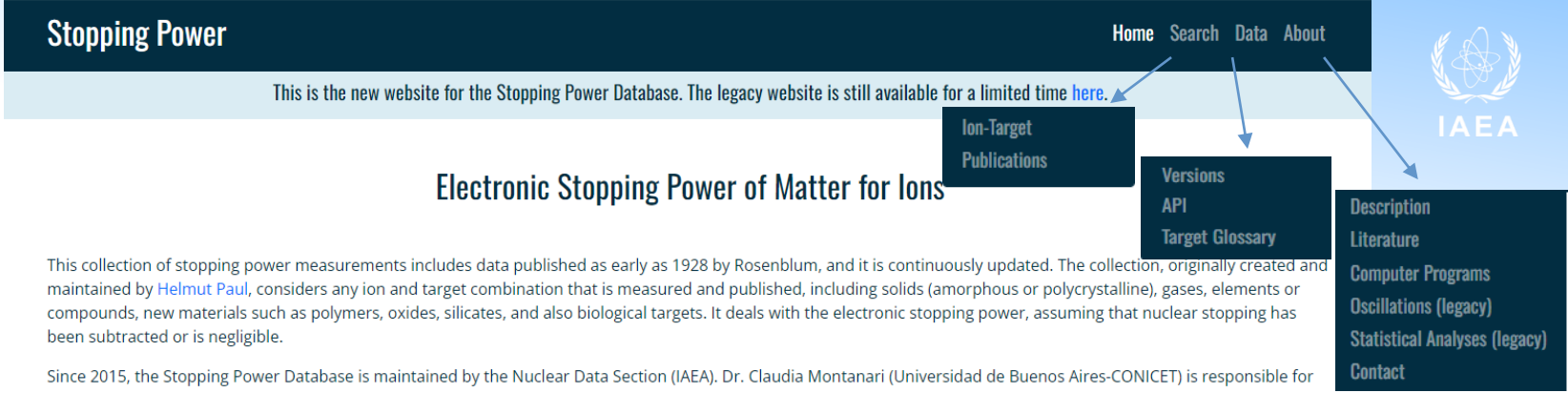
Ions	Target	Graph	Files	Comments
He Ions	Acetylene	Click here	ORIGIN, DATA	
He Ions	Ag	Click here	ORIGIN, DATA	*SRIM13 and ICRU49 do not describe the low energy data by Gö13. Change of slope at 3 keV, the velocity constant changes (see Gö13).*
He Ions	Air	Click here	ORIGIN, DATA	
He Ions	Al, *versus v*	Click here	ORIGIN	
He Ions	Al	Click here	ORIGIN, DATA	
He Ions	Al_2O_3	Click here	ORIGIN, DATA	
He Ions	Ar	Click here	ORIGIN, DATA (gas) DATA (solid)	*In agreement with Chu's and Besenbacher's measurements, SRIM2003 predicts no gas-solid difference. Excellent agreement of SRIM03 and ICRU 49 with the data*
He Ions	Au	Click here	ORIGIN, DATA	*Measurements since 1990 in colour*
He Ions	Au, *versus v*	Click here	ORIGIN	*There is an indication of a stopping threshold similar to the case of H ions in Au. The theory by Zeb12 shows a change of steepness there.*



Modernization

- Search filters:
  - Ion-target combination or Ion or Target
  - Authors - DOI links added
- Retrieval:
  - Ion-target or Ion or Target or All
  - Plots using plotly
  - CSV files containing all relevant information
  - APIs
- All data displayed – even if only one measurement

https://nds.iaea.org/stopping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Query the database
The database can be queried either by Ion, or by Target, or by Ion and Target. Querying by Ion will retrieve a summary of the information available for that Ion. Querying by Target will retrieve a summary of the information available for that Target. By quering or selecting a specific Ion-Target pair you can access all the datapoints available for that specific pair, both as a plot and as downloadable files.
Search by Ion or Target
The database can also be queried by Author. Quering by Author will return the list of all the publications available in the database for that Author.
Search by Author
The database can also be queried via a programmatic API.
Download the database
Download the latest version of the database in compressed format (~ 1MB):
Download data
Version 2023-11 - relesed on 27th of November, 2023
4,361 Experiments | 64,124 Datapoints
Download references
Version 2023-11 - relesed on 27th of November, 2023
729 References | 3,104 Authors
Previous releases of the database can be downloaded from the Versions page.

Search the database

The database can be searched only by Ion, or only by Target, or by both an Ion and a Target.

He

Search by Target (E.g: Au, Air, Polyvinyl toluene, ..)

Check the Target Glossary for a full list of Target names and formulas

Results for Ion: He

Download data for Ion: He

Version 2023-11

206 Targets | 826 Experiments | 13,898 Datapoint

Show 10 entries

Search:

Ion	Target	Datapoints Measured	Experiments	Last Publication Year	Detailed Information
He	2-Butanone	18	1	1978	He - 2-Butanone
He	3-Pentanone	54	3	1985	He - 3-Pentanone
He	Acetaldehyde	18	1	1978	He - Acetaldehyde
He	Acetone	18	1	1978	He - Acetone
He	Acetylene	60	4	1984	He - Acetylene
He	Ag	609	43	2018	He - Ag
He	Air	118	7	2022	He - Air
He	Al	606	44	2018	He - Al
He	Al2O3	221	9	2012	He - Al2O3
He	Allene	33	2	1974	He - Allene

Showing 1 to 10 of 206 entries

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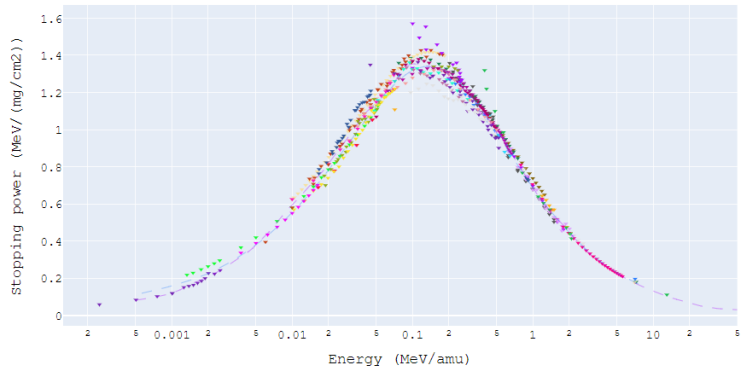

Energy unit: MeV / MeV/amu

Stopping unit: MeV/(mg/cm2) / E-15eV cm2/atom

Solid / Gas / Liquid

Reload graph

*Data has been converted to the same units for plotting purposes.

Data last updated: Nov. 27, 2023, 12:18 p.m.

Experimental Data 43

Download all

Trz2018	W.H.Trzaska,G.N.Knyazheva,J.Perkowski,J.Andrzejewski,S.V.Khlebnikov, E.M.Kozulin,T.Malkiewicz,M.Mutterer, E.O.Savelieva Nucl.Instrum.Methods Phys.Res. B 418, 1-12 (2018).	[csv] [txt]
Diw2015	P.K.Diwan,S.Kumar, Nucl. Instrum. Methods B 359 (2015) 78	[csv] [txt]
Dm2015	D.Moussa, S.Damache, S.Ouichaoui Nucl. Instrum. Methods B 343, 44-47 (2015)	[csv] [txt]
Pr2011b	D.Primetzhofer,S.Rund,D.Roth,D.Goebl,P.Bauer Phys. Rev. Lett. 107, 163201	[csv] [txt]
Bc2005	M.Bianconi,N.P.Barradas,L.Correra Nucl.Instrum.Methods B239, 127	[csv] [txt]
HY2005	J.Y.Hsu,Y.C.Yu,J.H.Liang,K.M.Chen Nucl.Instrum.Methods B 241, 155 (2005)	[csv] [txt]
MT1996	G.Martinez-Tamayo,J.C.Eckardt,G.H.Lantscher,N.R.Arista Phys.Rev. A54, 3131	[csv] [txt]
Ep1994a	Chr. Eppacher Ph.D.Thesis, Univ. of Linz, Austria, Schriften der Johannes-Kepler- Universität Linz, Universitätsverlag Rudolf Trauner (1995),	[csv] [txt]

Theoretical Data 2

ESPNN	Electronic Stopping Power Neural Network (ESPNN). Part I: atomic targets, https://pypi.org/project/ESPNN/, J. Appl. Phys. 132, 245103 (2022)
SRIM2013	The stopping and range of ions in matter, J.F. Ziegler, M.D. Ziegler, J.P. Biersack, Nucl. Instr. and Meth. B 268 (2010) 1818–1823

Stopping Power

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Search by Author

Ion-Target Publications

Search the database

Search by Author..

peter b

Peter Bauer

Peter Børgensen

Results for Author: Peter Bauer

Show 10 entries Search:

Ref. ID	Citation	Year	Datapoints	Experiments	Plots
Br1984a	P.Bauer,F.Aumayr,D.Semrad and B.M.U.Scherzer, Nucl.Instrum.Methods Phys.Res. B1,1 (1984)	1984	55	2	H - Cu
Br1986	P.Bauer and D.Semrad, Nucl.Instrum.Methods Phys.Res. B13,201 (1986)	1986	23	2	H - Nb
Br1992a	P.Bauer, W. Rössler, P. Mertens, Nucl.Instrum.Methods Phys.Res. B69,46 (1992)	1992	100	2	H - Al2O3 H - SiO2
Mi1990	C.Mitterschiffthaler and P.Bauer Nucl.Instrum.Methods Phys.Res. B48,58	1990	13	1	H - H2O
Sor2019	M. A. Sortica,V. Paneta,B. Bruckner,S. Lohmann,M. Hans,T. Nyberg,P. Bauer,D. Primetzhofer Nature Scientific Reports 9, 176 (2019); DOI 10.1038/s41598-018-36765-7	2019	21	1	N - TiN Al - TiN B - TiN
Tra2019	T T Tran, L Jablonka, B Bruckner, S Rund, D Roth, M A. Sortica, P Bauer, Z Zhang, D Primetzhofer, Phys. Rev. A 100, 032705 (2019).	2019	176	5	H - Ni H - NiSi H - Si He - Si He - NiSi He - Ni

Showing 1 to 6 of 6 entries

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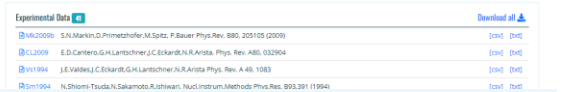

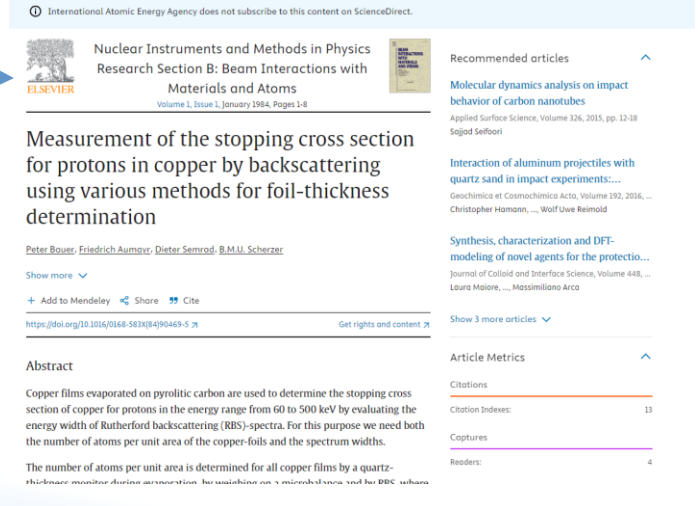

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Literature

Publications on the Stopping Power Database

- C.C. Montanari, P. Dimitriou, The IAEA stopping power database, following the trends in stopping power of ions in matter, Nucl. Instrum. Methods Phys. Res. B 408 (2017) 50-55
- H. Paul, New results about stopping power for positive ions: Experiment and theory, AIP Conf. Proc. 1525 (2013) 295
- H. Paul, D. Sánchez-Parcerisa, Acritical overview of recent stopping power programs for positive ions in solid elements, Nucl. Instr. Methods in Phys. Res. B 312 (2013) 110
- H. Paul, The Stopping Power of Matter for Positive Ions, Modern Practices in Radiation Therapy, ch. 7, G.Natanasabapathi (Ed.), InTech, ISBN 978-953-51-0427-8 (2012)
- Recent results in stopping power for positive ions, and some critical comments, Nucl. Instrum. Methods Phys. Res. B 268 (2010) 3421
- Some new results on stopping power for fast ions, A.I.P. Conf. Proceedings 1099 (2009) 251
- P.Sigmund, A.Schinner and H.Paul, Errata and Addenda for ICRU Report 73, Stopping of Ions Heavier than Helium, J. of the ICRU (Oct. 8, 2009)
- New developments in stopping power for fast ions, Nucl. Instrum. Methods Phys. Res. B 261 (2007) 1176
- Statistical analysis of stopping data for protons and alphas in compounds, Nucl. Instrum. Methods Phys. Res. B 249 (2006) 1
- A comparison of recent stopping power tables for light and medium
  Methods Phys. Res. B 247 (2006) 166
- Judging the reliability of stopping power tables and programs for pr
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- R.Bimbot, H.Geissel, H.Paul, A.Schinner, and P. Sigmund, ICRU Repor
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Particular Aspects of Stopping Power

- H. Paul, Nuclear stopping power and its impact on the determinatio
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- H.Paul, P.L.Grande, D.Y.Smith, Optical Oscillator Strengths, Mean Ex
  in Phys. Res. B 267 (2009) 2471
- H. Paul, The Solid-Gas Difference in Stopping Powers, and Statistical
- H. Paul, On the Gas-Solid Difference in Stopping Power for low Energ
- H. Paul, Erratum to "On the Gas-Solid Difference in Stopping Power f
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Applications to Radiation Therapy

- H.Paul, O.Geithner and O.Jaekel, The ratio of stopping powers of wat
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- H.Paul, O.Geithner and O.Jaekel, The influence of Stopping Powers u
- H.Paul, The mean ionization potential of water and its connection to
- H.Paul, On the I values for Liquid Water used in ICRU Reports 49 and
- H.Paul, On the Accuracy of Stopping Power Codes and Ion Ranges us
  Belkic, ed., Elsevier/Academic Press (2013), ISBN 978-0-12-396455-7

Computer Programs

Some of the computer programs for stopping power:

SRIM (version 2013)

For **all ions and targets**, including compounds using the Bragg rule and also an option for compound correct
Reference: *The stopping and range of ions in matter, J. F. Ziegler, M. D. Ziegler, Biersack, Nucl. Instr. and Meth. B 2*

MSTAR (version 2003)

For **Li to Ar ions in different targets.**
Reference: *Empirical stopping power tables for ions from 3Li to 18Ar in solids and gases, H. Paul and A. Schinner,*

CasP (version 6.0, March 2021)

For **all ions and targets**, atoms and compounds. CasP is the Convolution approximation for swift Particles, b
Reference: *G. Schiwietz and P. L. Grande , Nucl. Instr. and Meth. B 273, 1-5 (2012); F. Matias et al, J. Phys. B 50, 18*

DPASS (version 21.06, Feb 2020)

For **ions Z=1 to 92 in targets Z=1 to 92.** DPass code is the "Binary theory of electronic stopping", by Sigmund and Schinner
Reference: *Expanded PASS stopping code. A. Schinner and P. Sigmund. Nucl. Instr. and Meth. B 460, 19-26 (2019).*

ESPNN (version 2022)

For **ions Z=1 to 92 in atomic targets.**
Reference: *Electronic Stopping Power Neural Network, code built on the IAEA stopping power database. Part I: atomic targets. F. Mitnik, J. Appl. Phys. 132, 245103 (2022); doi: 10.1063/5.0130875.*

PSTAR and ASTAR

For **protons and alphas in different targets.**
Reference: *M. J. Berger, NIST, Report NISTIR 4992 (1992).*

ATIMA

For **protons and heavy ions, and specific kinetic energies** from 1 keV/u to 450 GeV/u.
Reference: *H. Geissel, C. Scheidenberger, Nucl. Instr. and Meth. B136 (1998) 114.*

SDU

Research areas | Researchers | Funding | Contact

SDU > Research > Researchers > Quantum optics and nanophysics > DPASS

DPASS

DPASS is a Windows program tabulating output from the PASS code developed by Andreas Schinner and Peter Sigmund.

Download DPASS version 21.06 from 17 February 2020

bpeak is a list of heights and positions of the Bragg peak for 92x92 extracted from PASS output by Andreas Schinner and Peter Sigmund.

Download bpeak

Applications of the PASS Stopping Code (pdf)

PASS bibliography (pdf)

NIST National Institute of Standards and Technology Physical Meas. Laboratory

estar dstar pstar

3. PSTAR and ASTAR Databases for Protons and Helium Ions

Access the PSTAR or ASTAR Databases

ATIMA

ATIMA is a program developed at GSI which calculates various physical quantities

- stopping power
- energy loss
- energy-loss straggling
- angular straggling
- range
- range straggling
- mean projectile charge

Stopping Power

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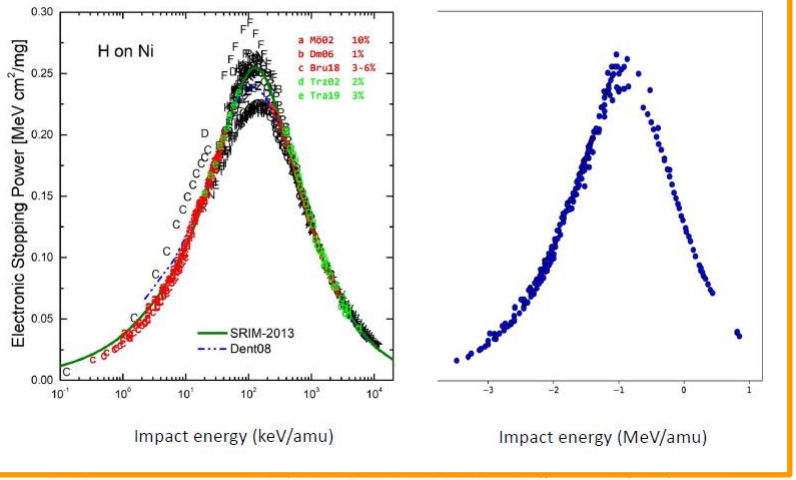
c/o: Claudia Montanari

Data review, Machine Learning and DBSCAN



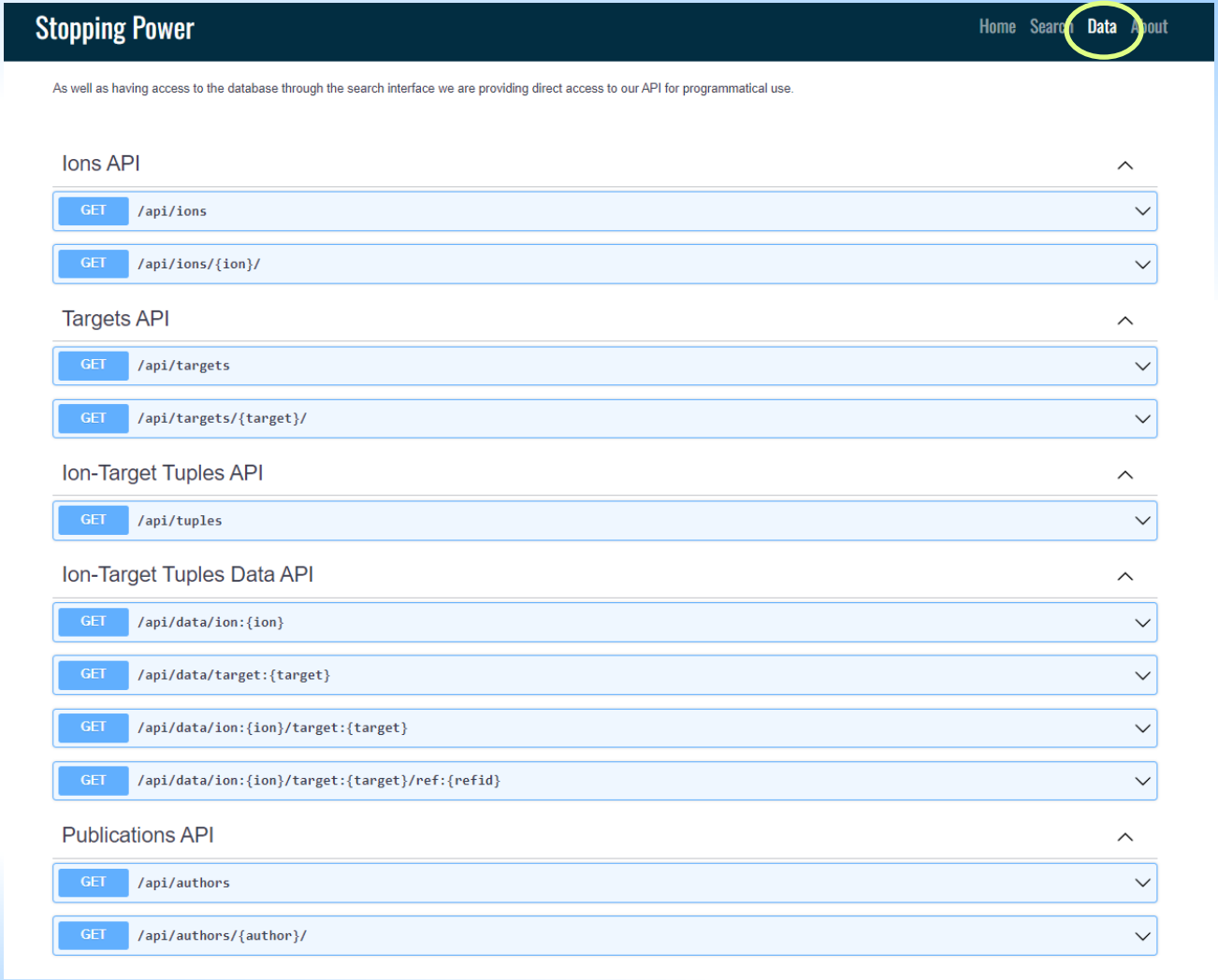
Meta

License: GNU General Public License v3 (GPL v3) (The GPL v3 License)

and compute the stopping power of any projectile-target combination.

Install ESPNN

API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As well as having access to the database through the search interface we are providing direct access to our API for programmatical use.
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Ion-Target Tuples Data API
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GET /api/data/ion:{ion}/target:{target}
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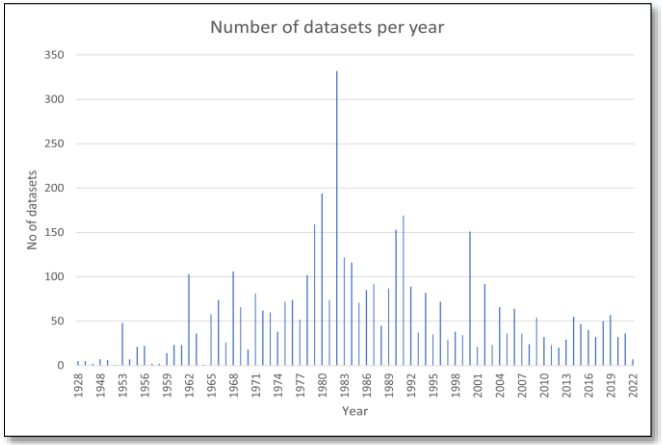
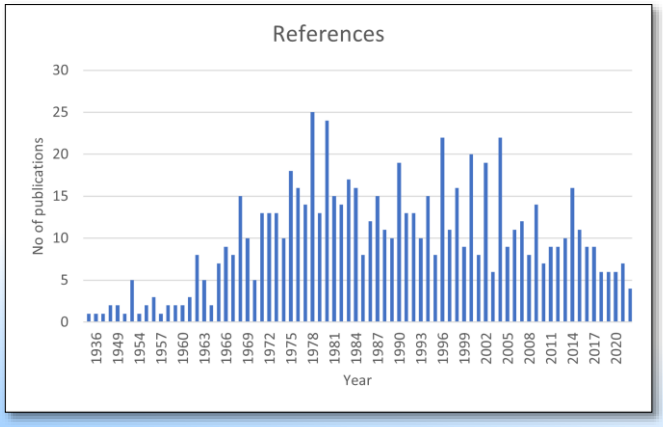
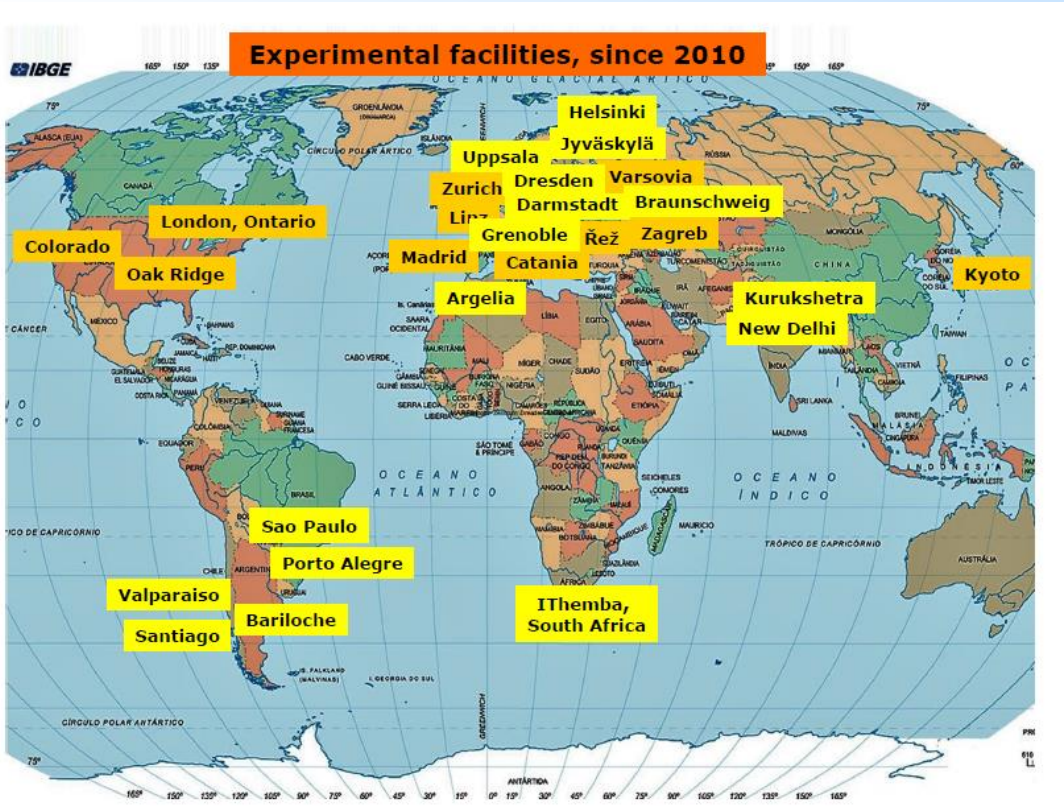
Statistics



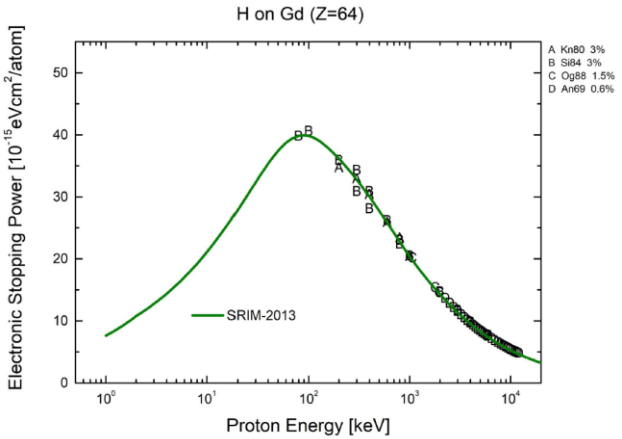


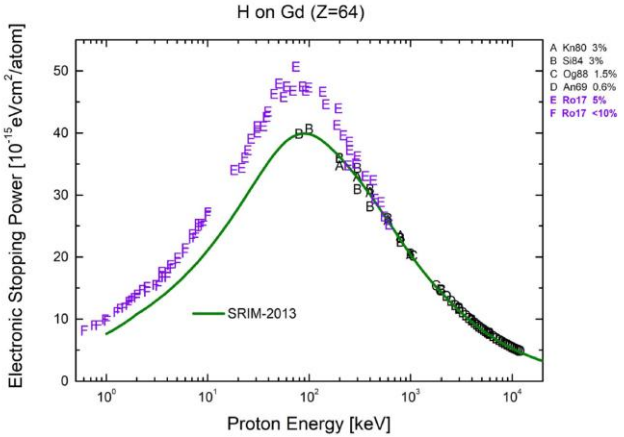


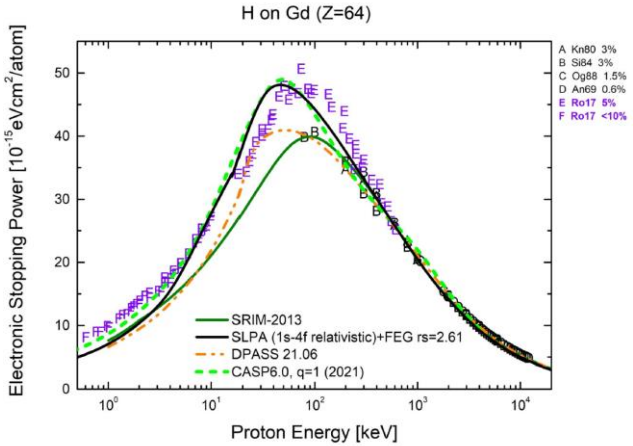
c/o: Claudia Montanari

Useful resource

SRIM: widely used – very good performance BUT it is empirical and fitted to available data







c/o: Claudia Montanari

Things to do

- Add more codes calculations (DPASS, CASP, ASTAR, etc)
- Fix issues with DOIs, author names, etc.
- Other from user feedback

SEND US YOUR FEEDBACK

https://nds.iaea.org/stopping/

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Thank you!