

Nuclear Reaction Compilation and Web Dissemination Efforts in the Area #1

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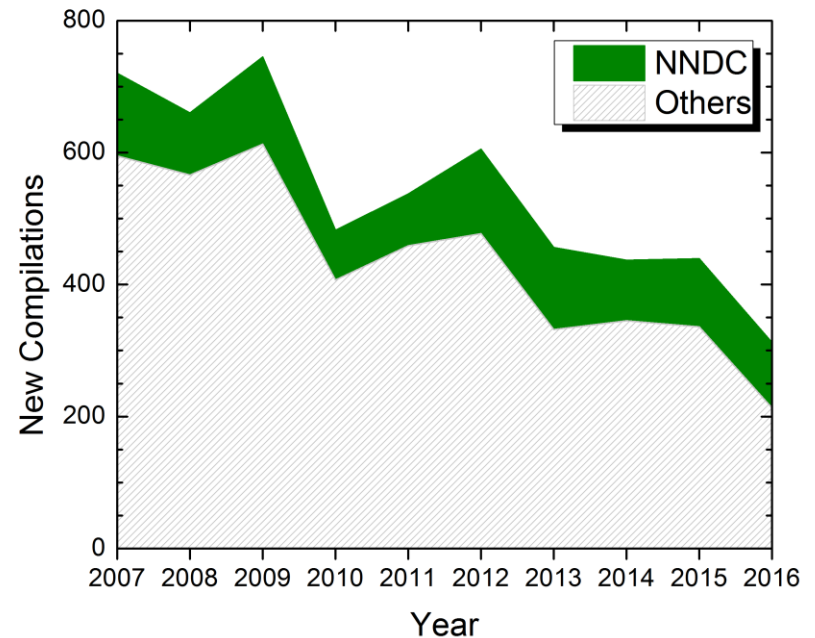


U.S. DEPARTMENT OF
ENERGY

Office of
Science

State of Compilations

- NNDC EXFOR team: B. Pritychenko, S. Hlavac, O. Schwerer.
- 97 new compilations and more in the final trans 1424.
- 245 revised compilations.
- 203,603 data points and more in prelims.
- https://www-nds.iaea.org/exfor-master/x4compil/exfor_input.htm
- *NNDC compilation productivity remained steady over the last 10 years.*
- We have kept our productivity in spite of changing requirements geared towards constantly increasing quality.



NNDC EXFOR Web Interface

- NNDC moved to the IAEA style Web Interface.
- Strong cooperation with V. Zerkin (IAEA) on EXFOR Web dissemination who is responsible for Web developments.
- We are running on a 24seven basis.
- Cybersecurity is a very big issue for all Web applications.
- Database updates are available on the same day as Viktor releases them.
- We have adopted Viktor's style of a "conservative" retrieval counting.
- 2016 EXFOR retrievals for two servers: 28,337 + 31,919 = 60,256.

The screenshot displays the NNDC Experimental Nuclear Reaction Data (EXFOR) Database Version of 2017-05-11. The interface includes a search bar, a 'Request' section with fields for Target, Reaction, Product, Energy from, and Publication, and an 'Options' section for refining search results. A 'Statistics of usage from 201601 to 201612' window is open, showing a table of user activity.

Statistics of usage from 201601 to 201612
Generated: 2017-05-12 11:49:14

| # Action | Counts | # Client | Counts | Country | # Counts | % Country |
|----------|--------|----------|-----------------|--------------------|----------|--------------|
| 1 search | 4397 | 1 | 130,199,254.38 | United States | 1 | 3889 (88.4%) |
| 2 | 201602 | 2 | 194,102,58.6 | Romania | 2 | 56 (1.3%) |
| 3 | 201603 | 3 | 35,9,62.145 | United States | 3 | 44 (1.0%) |
| 4 | 201604 | 4 | 35,9,62.75 | United States | 4 | 40 (0.9%) |
| 5 | 201605 | 5 | 95,105,149,183 | Slovakia | 5 | 38 (0.9%) |
| 6 | 201606 | 6 | 131,229,23,168 | United States | 6 | 32 (0.7%) |
| 7 | 201607 | 7 | 130,199,215,104 | United States | 7 | 28 (0.6%) |
| 8 | 201608 | 8 | 134,158,216,219 | France | 8 | 27 (0.6%) |
| 9 | 201609 | 9 | 35,9,62.98 | United States | 9 | 18 (0.4%) |
| 10 | 201610 | 10 | 143,107,128,11 | Brazil | 10 | 17 (0.4%) |
| 11 | 201611 | 11 | 213,55,90.5 | Ethiopia | 11 | 17 (0.4%) |
| 12 | 201612 | 12 | 133,1,95,249 | Japan | 12 | 16 (0.4%) |
| 13 | | 13 | 35,9,61,194 | United States | 13 | 16 (0.4%) |
| 14 | | 14 | 192,130,129 | Italy | 14 | 14 (0.3%) |
| 15 | | 15 | 55,20,148,165 | United States | 15 | 10 (0.2%) |
| 16 | | 16 | 80,71,59,120 | France | 16 | 10 (0.2%) |
| 17 | | 17 | 151,100,44,240 | Italy | 17 | 9 (0.2%) |
| 18 | | 18 | 182,84,151,58 | Italy | 18 | 9 (0.2%) |
| 19 | | 19 | 78,168,193,81 | United States | 19 | 9 (0.2%) |
| 20 | | 20 | 144,16,112,91 | India | 20 | 7 (0.2%) |
| 21 | | 21 | 192,105,51,131 | United States | 21 | 6 (0.1%) |
| 22 | | 22 | 147,43,132,115 | Korea, Republic of | 22 | 4 (0.1%) |

EXFOR Operational Issues

- For some reasons NRDC and NSDD meetings were scheduled at the same time. Consequently, physicists who involved in both projects lost the opportunity to attend both meetings this issue should be resolved.
- Only 10 EXFOR updates since the last NRDC meeting, still long gaps: July-September and December-February.
- EXFOR rules and regulations
 - C0500 (ORNL data): area #... is jumping on NNDC data, compiles them without informing us and finally asks about an accession number.
 - Similar issue with $^{239}\text{Pu}(n,n')$ LLNL data: area #... compiled data without even talking to NNDC. I had contacted the authors and asked them to pass data to NNDC in the future.
 - I think that all of us should follow the EXFOR/NRDC rules and regulations. We should respect geographic areas and avoid overlaps, otherwise these issues would lead us to CHAOS.

| | | |
|-----------|---|---|
| TITLE | A kinematically complete, interdisciplinary, and coinstitutional measurement of the $^{19}\text{F}(a,n)$ cross section for nuclear safeguards science | C900100100003 C900100100004 C900100100005 |
| AUTHOR | (W.A.Peters, M.S.Smith, S.Pittman, S.J.Thompson, R.R.C.Clement, J.A.Cizewski, S.D.Pain, M.Febbraro, K.A.Chipps, S.Burcher, B.Manning, C.Reingold, R.Avetisyan, A.Battaglia, Y.Chen, A.Long, S.Lyons, S.T.Marley, C.Seymour, K.T.Siegel, M.K.Smith, S.Strauss, R.Talwar, D.W.Bardayan, A.Gurjinyan, K.Smith, C.Thornsberry, P.Thompson, M.Madurga, E.Stech, W.-P.Tan, M.Wiescher, S.Ilyushkin, Z.Tully, M.W.Grinder) | C900100100006 C900100100007 C900100100008 C900100100009 C900100100010 C900100100011 C900100100012 C900100100013 C900100100014 |
| INSTITUTE | (LUSARL, LUSAINL, LUSARUT, LUSANOT, LUSAMHG, LUSATEN, LUSACSM, LUSATTU) | C900100100015 C900100100016 |
| REFERENCE | (LUSAUSA) U.S. Air Force (R, INL/EXT-16-38791, 2016) | C900100100017 C900100100018 |

Re-Analysis of the NNDC EXFOR Compilation Progress

- https://www-nds.iaea.org/exfor-master/x4compil/progress_NNDC.htm
- Useful page; it is not as bad as it looks.
- 20 entries prior to 2008 were re-analyzed and compiled
 - 2 papers were wrongly assigned to the area #1
 - 5 reviews, just the existing entries reference update
 - 5 particle physics (pi, eta mesons, ...)
 - Exotic ^{271}Ds production cross section based on a single event
 - 2 Level densities parameters (LDP) papers from Ohio University, thanks to A. Voinov I was able to compile the cross sections that were not publicly available
 - Plenty of digitization cases for yields with heavy ions
 - This case study provides a glimpse into missing data in the recent years and EXFOR compilers selection process
- This list should be periodically revisited and cleaned by the compilers and list managers.

EXFOR Compilation Progress.
Information updated: 10-May-2017, 16:10:36
Data Center: (NNDC)
US National Nuclear Data Center (Brookhaven, USA)

| # | Volume | Issue | Page | Lab | Published | Scanned | Status | Action | Compiled | (Time/Month) | CompilerName | ENTRY | Trans | Projectile | Author1 |
|-----|-------------|-------|------|---------|------------|------------|---------|---------|------------|--------------|--------------|-------|--------|------------|--------------|
| 1 | 2012CARS | 044 | | IUSARA | 2013-07-03 | | | | | 0 | | | | cp | |
| 2 | 2004SANTA | 1345 | | ICANSRU | 2004-09 | 2005-08-06 | Reserve | | | | | | | cp | C.K. Diebel |
| 38 | 2008NOTRED | 1 | 312 | IUSALAS | 2005-09 | 2006-09-02 | Reserve | Compile | 2016-08-30 | | UNOBT | 14153 | 1423 | n | |
| 4 | 2006VANCOU1 | (R07) | | IUSALAS | 2006-09 | 2006-11-20 | Reserve | | | | | | | n | |
| 5 | 2006VANCOU1 | (C03) | | IUSALAS | 2006-09 | 2006-11-20 | Reserve | | | | | | | n | |
| 60 | 2007NICE | 1 | 1 | IUSADU | 2007-04 | 2007-05-14 | PRELIM | | 2017-05-10 | 121 | UNOBT | 14149 | P1426n | T1362 | H. Jander |
| 76 | 2007NICE | 1 | 1 | IUSADU | 2007-04 | 2007-05-14 | PRELIM | | 2017-05-10 | 121 | UNOBT | 14155 | P1426n | T1362 | K.H. Guber |
| 8 | 2007TOYO | 522 | | IUSAANL | 2007-12 | 2009-03-06 | Reserve | | | | | | | n | |
| 9 | 2008INTJAC | 1 | PP01 | IUSACAL | 2008-04 | 2009-03-04 | Reserve | | | | heavy ions | | | n | |
| 100 | 2009RUDA | 93 | | ZOEKZPK | 2010-01 | 2011-10-28 | Reserve | Compile | 2009-07-14 | | | 14234 | 1423 | g | |
| 11 | 2009VARENN | 1 | 217 | IUSALAS | 2010-01 | 2012-06-28 | Reserve | | | | | | | n | D. Boig |
| 12 | 2014OBEREC | 028 | | IUSANSU | 2015-08 | 2015-08-13 | Reserve | | | | | | | cp | A. Spyro |
| 13 | 2014OBEREC | 040 | | IUSANSU | 2015-08 | 2015-08-13 | Reserve | | | | | | | cp | M.B. Bennett |

Re-Analysis of the NNDC EXFOR Compilation Progress

- Relevant findings stipulated by the list and Nuclear Science References database analyses: it useful to consider multiple data sources.
- SuperHeavy are often missing in EXFOR
 - Areas #1,2,4 - plenty of missing publications
 - Area #3 (Japan) is clean, RIKEN results are compiled
 - Large number of publications have been identified and passed to the relevant centers
- R.J. Hoff measurement of $^{255}\text{Fm}(n,\gamma)$ cross sections at Livermore
 - Potential for recovery of Missing Data at Livermore Lab.
- Finally, proactive additions to the EXFOR list, when all possible marginal papers (high-energy, LDP reviews) are included, demonstrates the same situation as with the UNOBT data at NNDC in the past: poor selectivity and luck priorities.
- We have to prioritize better because our resources are limited!!!

Good news for EXFOR Compilers

- New data preservation requirements in Nature Physics (DOI: 10.1038/NPHYS3916) and Nature (doi:10.1038/nature21717) journals.
- The rest of physics journals will eventually follow.
- Steady, strong growth is expected for open-access journals by D. Kramer, <http://dx.doi.org/10.1063/PT.3.3550>.

NATURE PHYSICS DOI: 10.1038/NPHYS3916

Articles

Method
The statistical model and choice of parameters used to calculate the proton removal cross-section rates and the parallel momentum, p_{\parallel} , distributions of the nucleus are detailed in ref. 39. The shapes of the p_{\parallel} momentum parts of these distributions are used in the comparison of the experimental data with the theoretical predictions. The experimental p_{\parallel} distributions are compared to the theoretical p_{\parallel} distributions as convoluted secondary beams, the beam straggling is due to the reaction position within the target. The experimental partial cross-sections of a proton with quantum numbers n, l, m are compared to the theoretical p_{\parallel} distributions as convoluted secondary beams, the beam straggling is due to the reaction position within the target. The experimental partial cross-sections of a proton with quantum numbers n, l, m are compared to the theoretical p_{\parallel} distributions as convoluted secondary beams, the beam straggling is due to the reaction position within the target. The experimental partial cross-sections of a proton with quantum numbers n, l, m are compared to the theoretical p_{\parallel} distributions as convoluted secondary beams, the beam straggling is due to the reaction position within the target.

Statistical analysis. This section describes the statistical analysis of the GEORCA data. In particular, the procedure to derive the limit on $T_{1/2}$, the median sensitivity of the experiment and the treatment of systematic uncertainties are described. A combined analysis of data from Phase I and II is performed by fitting simultaneously the six data sets of Table 1. The parameter of interest for this analysis is the strength of a possible β -decay signal, $S = 1/T_{1/2}$. The number of expected β -decays in the i th data set T_i is a function of S given by:

$$N_i = \ln N_i + \ln \mu_i + S T_i$$

where N_i is Avogadro's number, μ_i the global signal efficiency of the i th data set, T_i the exposure and $\ln \mu_i$ the nuclear mass. The exposure quoted is the total detector mass multiplied by the data-taking time. The global signal efficiency accounts for the fraction of ^{137}Cs in the detector material, the fraction of the detector active volume, the efficiency of the analysis cuts, the fractional live time of the experiment and the probability that β -decay events in the active detector volume have a reconstructed energy E_{obs} . The total number of expected background events as a function of the background index B_i is:

$$B_i = E_{\text{obs}} B_i$$

where E_{obs} is 20 keV . Each data set T_i is a Gaussian distribution:

$$L_i(T_i; S, B_i) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{(T_i - N_i + B_i)^2}{2(N_i + B_i)}\right)$$

where T_i are the n observed in the i th data set, S is a possible β -decay signal and B_i is a background index. The likelihood is then:

$$L(S, B) = \prod_i L_i(T_i; S, B_i)$$

where B and S are the absolute maximum of the likelihood. The confidence interval for each S_i is obtained according to the χ^2 test. The 1σ and 2σ confidence intervals are indicated in the plot. The 1σ and 2σ confidence intervals are indicated in the plot.

ARTICLES

ARTICLE RESEARCH

Systematic uncertainties are folded into the likelihood by varying the parameters θ_i in the fit and constraining them by adding to the likelihood multiplicative Gaussian penalty terms. The central values and the standard deviations of the penalty terms for θ_i and σ_i are taken from Table 1. The penalty term on θ_i has a central value equal to zero and a standard deviation of 0.2 eV. Instead of the two-sided test statistics, one can use a one-sided test statistic defined as⁴⁵:

$$T = \begin{cases} 0, & \hat{S} \leq S_0 \\ -2 \ln \lambda(\hat{S}), & \hat{S} > S_0 \end{cases}$$

by construction $T=0$ for $S=S_0$ or for all realizations and consequently $S=S_0$ always includes in the 90% CL interval, that is, the one-sided test statistic will always yield a limit. In most cases the resulting limit would be 90%, stronger, similar to other experiments⁴⁶, we want to be able to detect a possible signal and thus we decided a priori to adopt the two-sided test statistic. It is noteworthy that, although the coverage of both statistics is correct by construction, deciding which one to use according to the outcome of the experiment would result in the flip-flop bias discussed in ref. 44.

The statistical analysis is also performed within a Bayesian framework. The

ISSUES & EVENTS

Steady, strong growth is expected for open-access journals

Publishing models continue evolving to accommodate government mandates. Meanwhile, publishers look to cope with article-sharing sites that affect their business.

In the more than 15 years since the advent of open-access (OA) journals, scientific publishers who once viewed them as an existential threat are now operating their own. But despite double-digit growth in OA, scientific societies and commercial publishers alike agree that the vast bulk of their publications will remain wedded to the traditional subscription model for the foreseeable future.

"Open access is much less of a contentious issue now," says H. Frederick Dylla, retired executive director of the American Institute of Physics, which publishes Physics Today. "Technology is a business model." Of more concern to publishers today is the illicit posting of papers on article-sharing services. By some estimates, such as a 2014 report prepared for the European Commission, more than half of the scientific literature from 2007 to 2012 was accessible for free online. But it's unclear how much of that content consists of papers that infringe on publishers' copyrights because they are freely accessible despite licenses that are supposed to keep them behind paywalls.

Broadly speaking, scientific publishing follows two models. Traditionally, most journals obtain their revenues from institutional subscribers, mainly universities. Outside those licenses, the journal

content is located behind an online paywall. So-called gold OA journals provide their entire content for free online immediately upon publication. Their revenues are provided from fees, known as article processing charges, paid by the article authors or their institutional funders.

A second category, known as green OA, consists of nongold OA articles that are freely available in one of the following forms: An article may be made available prior to publication as a preprint. A manuscript version may be provided by the publisher so authors can post it to their websites and institutional archives at the time it is accepted for publication. Or it can be released in its final published form, known as the version of record, after a specified period, most often one year after publication (this is sometimes referred to as delayed gold OA). Most scientific papers today are or will become available in some fashion as green OA.

The extent of fully OA publishing, like that of journal publishing overall, is hard to measure. About 800 of the 11,000 or so journals included in Journal Citation Reports, the Clarivate Analytics (formerly Thomson Reuters) service that calculates the widely used journal impact factors, are gold OA. Of the 21,500 journals tracked by Scopus, an abstract and citation database, around 300 are gold



OA titles. But less exclusive indexes, such as the Directory of Open Access Journals, count more than 5000 journals published in 129 countries. Estimates of the total scientific journal population—subscriptions and OA—range from a low of 33,000 to a high of 60,000, depending in part on where the line is drawn between scholarly and trade journals.

The International Association of Scientific, Technical, and Medical Publishers, whose 120 members publish two-thirds of all STM journal articles, estimated annual revenues for English-language STM journal publishing at \$10 billion in 2015, up from \$8 billion in 2009. Delta Think, a scholarly publishing consulting firm, valued the fully OA journal market last year at \$374 million, and for 2017 it forecasts growth of 12%, roughly twice the rate of growth in the overall journal market. "Going forward, we think that the open-access market will continue to grow at about 10% to 15% through 2020," says Delta Think's Dan Pollock.

Mandates and archives

The growth of OA is largely driven by dozens of governments around the globe that have mandated free access to the results of publicly funded research. In most cases, including in the US, those

Conclusions & Outlook

- EXFOR compilation and Web dissemination efforts in Area #1 are going strong.
- We proactively compile new and previously missed references, improve the existing compilations.
- EXFOR Web Interface is running on a 24seven basis and provides a reliable dissemination and reaction-user interaction platform.
- EXFOR database updates are almost instantly (in a few hours) available at NNDC since the public release.
- More work on recovery of missing data and proactive interactions with USNDP and CSEWG is planned.
- Active interactions with basic science user communities: DNP APS, FRIB, Nuclear Astrophysics... are in progress.