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The Nuclear Science References Database

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DISCLAIMER

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The Nuclear Science References (NSR) database together with its associated Web interface, is the world's only comprehensive source of easily accessible low- and intermediate-energy nuclear physics bibliographic information for more than 210,000 articles since the beginning of nuclear science. The weekly-updated NSR database provides essential support for nuclear data evaluation, compilation and research activities. The principles of the database and Web application development and maintenance are described. Examples of nuclear structure, reaction and decay applications are specifically included. The complete NSR database is freely available at the websites of the National Nuclear Data Center *http://www.nndc.bnl.gov/nsr* and the International Atomic Energy Agency *http://www-nds.iaea.org/nsr*.

I. INTRODUCTION

The NSR database is a bibliography of nuclear physics articles, indexed according to content and spanning from 1896 to present days. The database originated at the Nuclear Data Project at Oak Ridge National Laboratory as part of the systematic evaluation of nuclear structure data [1] and was later adopted by the wider research community. It has been used since the early 1960's to produce bibliographic citations for nuclear structure and decay data evaluations published in Nuclear Data Sheets.

In October 1980, database maintenance and updating became the responsibility of the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory (BNL). During this time the database has been through a scope expansion, several modernizations, and technical improvements [2–5]; however, the basic structure and contents have remained unchanged. Presently, NSR database compilations and Web developments have been conducted in collaboration with the Nuclear Data Group at McMaster University, Canada and Nuclear Data Section, IAEA [6], respectively. The collaborative approach helped to improve the database content and develop new features.

In this paper, we present the recent changes to NSR contents and features which make the database an essential nuclear bibliographic source. A brief description of the database, Web interface, and update policies are given in the following sections.

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II. DATABASE SCOPE AND STRUCTURE

The NSR database aims to provide primary and secondary bibliographic information for low- and intermediate-energy nuclear physics [7]. The diverse contents of the database are cataloged under seven major physics topics

Atomic Masses	Nuclear Reactions
Atomic Physics	Nuclear Structure
Compilation	Radioactivity
Nuclear Moments	

NSR entries include extensive information, starting with a unique eight-character identifier (NSR keynumber), journal/reference, publication year, article title, author list, journal digital object identifier (DOI) link, and a keyworded abstract (for articles reporting on appropriate physical quantities). All entries are stored in a relational database structure.

III. NSR KEYWORDS

The main goal of NSR is to provide bookmarks for experimental and theoretical articles in nuclear science using keywords. In NSR, keywords serve a dual purpose

- They are used to generate database *selectors*, which produce the correct article indexing and allow specific and detailed searches to be made quickly and easily. (Searching can also be done within the general text of entries.)

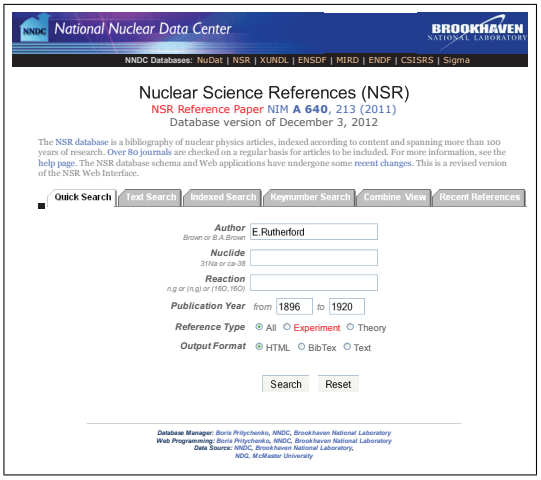

FIG. 1. NSR Web Interface *http://www.nndc.bnl.gov/nsr*. Example of Boolean search for author E.Rutherford and 1896-1920 time range.

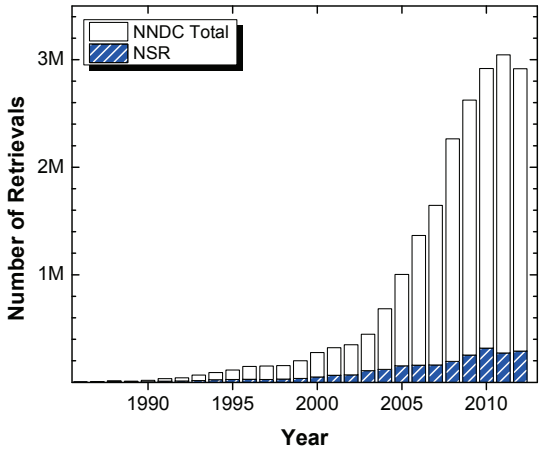

FIG. 2. The time evolution of the number of electronic retrievals - web, telnet and FTP - from 1986 to 2012.

- They allow a user to quickly determine which articles are of specific interest from a list of entries returned following a given query.

By the very nature of the NSR database, the keyworded abstracts are very well structured. They begin with the topic identifier, as listed in section II, and a list of nuclei, nuclear reactions, or decays follow. Then the measured and/or calculated/analyzed quantities are given, followed by deduced (derived) quantities.

Historically, under measured quantities in NSR, we understand direct results of online measurements. For example, these primary quantities will include γ-transition energy and intensity, particle-γ coincidences, etc. Other quantities, such as σ, S-factors, log *ft*, $T_{1/2}$ and B(λ) values that are often derived offline, using the primary data, are considered deduced quantities. The same philosophy applies for calculated and analyzed quantities.

IV. NSR WEB RETRIEVALS

The NSR Web Retrieval Interface is an integral part of both the NNDC and IAEA Web Services [4–6]. The Web interface is based on current Java technologies and provides retrievals of the database content in HTML, Text, BibTex, XML and PDF formats. As shown in Fig. 1, the main Web interface consists of six sub-interfaces

Quick Search	Text Search
Indexed Search	Keynumber Search
Combine View	Recent References

The Quick Search allows a quick look-up of references for a given author, nuclide, or reaction within a publication period. The Text Search allows plain text searching of the title and keyword fields, whilst an Indexed Search allows a Boolean AND search over several indexed categories (e.g. author, nuclide, etc.). The Keynumber Search retrieves the information for a specific article(s) given the NSR keynumber(s). This type of specific retrieval is in large demand by nuclear structure evaluators. Finally, Combine View provides analysis and combination opportunities for previous retrievals, whilst Recent References provides downloads of quarterly compilation collections in text and PDF formats.

An important part of monitoring NSR operation is a correct estimate of the database usage. NSR retrieval statistics are very conservative and completely based on a count of successful database retrievals - any Web browser hits are ignored. The time evolution for NSR retrievals at NNDC over the last 25 years is shown in Fig. 2.

V. NSR APPLICATIONS

The NSR database was initially created to support the Evaluated Nuclear Structure Data File (ENSDF) [8] mass chain evaluations. All references in ENSDF evaluations are specified by their NSR keynumbers. Regular NSR database updates serve as an indicator for the international Network of Nuclear Structure and Decay Data Evaluators (NSDD) [9] on the requirement to revisit a particular isobaric mass chain. Fig. 3 shows number of references as a function of mass number, which has not yet been included in the ENSDF database. The large number of new articles for light nuclei are due to old evaluations and general availability of these projectiles in rare isotope beam research. As of February 2013, the average number of new references per mass chain is 52.

In addition to ENSDF mass chain or vertical evaluations [8, 10], NSR is actively used in a large number of horizontal evaluations of atomic masses and NUBASE

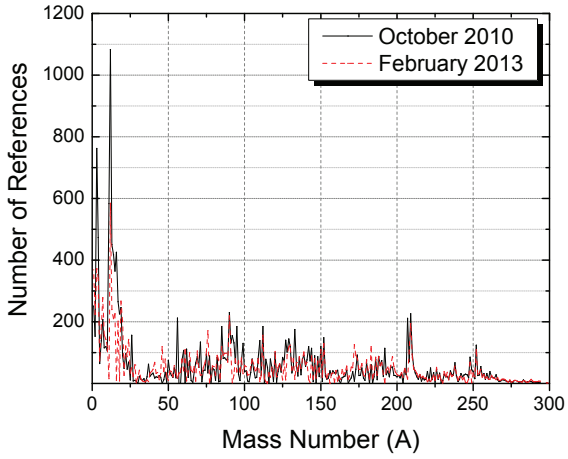

FIG. 3. Mass number distributions for references unevaluated by the NSDD network, as of October 2010 and February 2013 are shown in black and red colors, respectively.

[11, 12], B(E2) and $\beta\beta$-decay values [13, 14] and compilation of discovery of isotopes [15]. The NSR database and Web interface are also linked to a large number of other nuclear databases: ENSDF [8], XUNDL [16], and EXFOR [6, 17]. Thus, when a particular reference forms part of a compilation or evaluation in one of these other databases, NSR will provide a direct Web link to the publication.

VI. CONCLUSION AND OUTLOOK

The NSR database and its Web interface provide transparent and easy access to nuclear physics bibliographic information with direct links to the original articles and data provided, where possible. This project is conducted under auspices of the U.S. Nuclear Data Program in a collaborative approach.

Recent additions include extension of NSR coverage from 1896 to 1911 and more targeted coverage of fundamental physics; more than 600 articles of practical importance to nuclear science have been included. Further addition will improve database completeness by cross checking against the following sources

- Decay Data Evaluation Project [18] references.
- EXFOR database [17]; until 90's NSR scope was nuclear structure physics and approximately 40% of EXFOR references are missing from NSR.
- "Discovery of Isotopes" Project [15] references.

Many features for nuclear scientists and, specifically, *reaction* data users, such as user-friendly Web retrievals, Web integration with the EXFOR database and improvements in NSR terminology/keywording have been developed. As the result, NSR has greater potential in modern physics, as it is the major nuclear database that allows searches for rare isotope beam reactions.

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