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ANALYSIS OF LOW AND MEDIUM ENERGY PHYSICS RECORDS IN DATABASES

SCIENCE AND TECHNOLOGY INDICATORS IN LOW AND MEDIUM ENERGY PHYSICS

(WITH PARTICULAR EMPHASIS ON NUCLEAR DATA)

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Abstract

An analysis of the literature on low and medium energy physics, with particular emphasis on nuclear data, was performed on the basis of the contents of the bibliographic database INIS (International Nuclear Information System). Quantitative data were obtained on various characteristics of the relevant INIS records such as subject categories, language and country of publication, publication types, etc. Rather surprisingly, it was found that the number of records in nuclear physics has remained nearly constant over the last decade. The analysis opens up the possibility for further studies, e.g. on international research co-operation and on publication patterns.

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ANNEX

Introduction

Low and medium energy physics publications are stored in bibliographic databases such as the International Nuclear Information System (INIS). The objective of this study is to quantify and analyse bibliographic records on low and medium energy physics which include nuclear data records and nuclear physics records in INIS*) (hereafter simply referred to nuclear physics records) and to offer an overview of the developments in this research field. For the first time, a scientometric study (p.14) has been performed to investigate a selected field of science and technology and the INIS and CINDA databases have been used as a source of data. A variety of science and technology indicators are retrieved. Possible applications of this study are outlined. The scope of nuclear physics records in INIS is described in the Categories section. (A description of INIS and CINDA Database is given in the Annex).

Nuclear physics lies within the scope of INIS and represents about 9% of the whole INIS database (more than 180 000 nuclear physics and nuclear data relevant records were entered in the period from 1970 to mid-1998). In this field, there is an input of 6000--8000 records every year. Figure 1 shows the time development of these records over the publication year for the last 28 years. In the 1970s, the increase in the number of records was due to the start-up of INIS. In the 1980s, there were 6000--8000 records per year. In the 1990s, the number of records per publication year totalled between 6000--7000. Between 1993 and 1995 the number of records per year increased steadily. The input for the last 2--3 years is still continuing as the input preparation of each publication represents an extra step. The projection of input for the last two years is indicated by the dashed lines.

Seven Member States provide about 83% of the INIS input in nuclear physics (Fig. 2). Nuclear physics records come from 77 different input centres (INIS members which also include international organizations) in the period between 1970 and mid--1998. It is to be noted that the number of publications per country reflects the concentration of scientific publishing houses in those countries rather than research activities (see Author section).

Language

About 80% of all documents related to nuclear physics are published in English. This includes translated publications. These are mainly published in the United States of America and these records are therefore provided by the INIS centre in the USA. Translated records represent nearly 10% of the input from the USA. Of all the authors listed in the nuclear physics records, roughly 66% are from non-English speaking countries. Altogether there are Nuclear Physics records in 34 different languages (Fig. 3).

Categories

INIS records are categorized according to the INIS subject categories and scope descriptions arranged in conformity with the International Classification System for Physics developed by the International Council for Scientific and Technical Information. The physics category scheme was changed in 1992. For that reason, the following analysis mainly covers the period from 1992 until mid-1998, with more than 36 000 records. The main subject category of interest is nuclear physics (theoretical and experimental), the subcategories are: **nuclear structure** (respective subfields: general and average properties

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*) This paper is an expanded study of " Time Development of Records on Nuclear Physics and Data in INIS Database" presented at the IAEA Advisory Group Meeting of Nuclear Reaction Data Centres 11-15 May

of nuclei and nuclear energy levels; nuclear structure models and methods), radioactivity and electromagnetic transition (excluding fission) (respective subfields: ground-state radioactivity, electromagnetic transitions); nuclear reactions and scattering, general; specific nuclear reactions and scattering (photonuclear reactions and photon scattering; lepton-induced-reactions and -scattering; nucleon-induced reactions and scattering; 2H, 3H and He-induced reactions and scattering; heavy-ion-induced reactions and scattering; meson and hyperon-induced reactions and scattering; fission), nuclear mass ranges (A=1-5; A=6-19 etc.) and radiation physics (with two subfields: neutron physics; physics of radiations other than neutrons), see annex: INIS subject scope: nuclear physics subject categories in INIS see Table I.

In the period from 1992 to mid-1998, the subject fields with the highest number of records were: general and average properties of nuclei and nuclear energy levels, heavy-ion -induced-reactions-and-scattering, nucleon-induced-reactions and-scattering, nuclear-structure-models and-methods and nuclear-reactions and scattering, general (Fig. 4).

The time development of records within the subfields in general shows a small fluctuation in yearly number of records in nuclear physics within the considered time period (1991--1996). The number of records in publication years 1992 and 1995 per subfield is higher than in years 1993 and 1994. This is in accordance with the total number of records versus publication year (Fig. 1) and this probably reflects the number of triennial conferences, in particular on nuclear data (see Keywords and Free Text section).

The multidisciplinary nature of the INIS database allows the study of the correlation between scientific disciplines. For each record, up to three subject categories can be assigned, if the record covers more than one subject field. The nuclear physics records with second and third categories have the following subject fields assigned (listed in order of importance): engineering and technology (Category E), other aspects of nuclear and non-nuclear energy (Category F), chemistry, materials and earth sciences (Category B), life and environmental sciences (Category C), isotope and radiation and isotope applications (Category D), Fig. 5.

In other physics fields (Category G; Fig. 6), there are second and third assignment categories in physics of elementary particles and fields (with a total number of 8000 records, which represents more than 50% of all physics subfields), general physics, atomic and molecular physics, plasma physics and fusion, and the physics of condensed matter.

Publication types

The record type (e.g. journal articles, reports, books, miscellaneous and patents) and literary type (e.g. short communications, conferences, numerical data and progress reports) of each record entry are indicated in the database. This allows the publishing format to be characterized (Table II).

Journal articles represent about 55% of all records, reports 25%, books 10%, miscellaneous 10% and patents 0.1% (Fig. 7). The percentage of miscellaneous records seems high when compared with other physics disciplines. This may be due to the location of nuclear physics institutions in research centres in which many device specific documents and experimental results such as data tables are usually produced, as the readership of these documents is small and they are not suitable for publication in journals or books because of their length, technical content, etc. The `miscellaneous´ type is often used for progress reports, listing of numerical data and dissertations. The high number of book records results from the publication format of some conference proceedings in which each contribution counts as a book record. Also, under journal articles one can find a high number of conference contributions, numerical data and short communications (Fig. 8, records with two publication types). The input of patents covered has been somewhat erratic over the years. This has to do with the change of patent records copyright in some countries and the difficulty of converting records from patent to bibliographic databases. The number of patent records in nuclear physics are low when compared with other physics fields. No logical explanation of this has been found.

The number of journal records in percentage terms is higher (about 10%) in the field of nuclear physics than in plasma physics and fusion R&T, whereas in the latter the number of report and patent records is higher.

The time development of publication types gives an indication of research activities. The number of journal articles varied by 10--15% from year to year. The number of journal records per publication year entered in the INIS database averaged around 4000. The number of records has fluctuated around this level over the last 20 years. The number of report records has decreased since 1989. It has to be noted that the number of reports made available on the Internet increased and some research centres have changed their research programme. The frequency of book records over the publication years is very irregular, the reason probably being the irregular choice of formats in publishing conference proceedings.

Authors

The country tag in the author field indicates the actual national research activities better than the country in which the document has been published. More than 56% of the authors come from five countries (with more than 5% per country, Fig. 9). The distribution of authors according to country is different from the distribution of input countries because in some of these there is a high concentration of science publishing houses. The number of different countries from which authors are publishing totals 100. About 46% of the publications have at least one author of the document who is affiliated to a university. This indicates that about 50% of authors working in the field of nuclear physics are affiliated to institutes other than universities.

Journal statistics

Journal articles on nuclear physics are published in more than 1500 different journals and represent more than 55% of all nuclear physics records in INIS. The number of nuclear physics relevant records can be found in core nuclear physics journals and in general physics journals, as well as in national physics journals and in neighbouring disciplines. The few core journals have a high number of records and comprise more than 50% of all journal records. A detailed analysis can be performed in a specific study on nuclear physics journals in which the most frequent and average page number per journal articles can be determined.

A profile of the main journals can also be plotted against the nuclear physics subfields. The profiles allow comparison of the scope of each journal. The list of nuclear physics journals, a ranking of journals by the number of records (which is a function of publication years, input years, articles published per year and scope) can be compared with the list of the Science Citation Index (SCI) of the Institute of Scientific Information (Philadelphia, USA). The comparison made in fusion R&T shows that, for instance, the scope of the SCI list in fluids and plasmas (not controlled fusion itself) is broad but does not cover certain fields such as material studies, engineering, etc. Furthermore, fusion technology journals are not separated from fusion research journals in the SCI list. That means that the publications of nuclear physicists are not totally covered by the SCI Plasma Physics Category.

Keywords and Free Text

A common feature of a bibliographic database is the subject indexing of records by assigning of keywords. As the subject index is used in books, each database record is complemented by a list of ‘controlled terms’ (keywords, or in INIS terminology - descriptors) which are chosen to describe better the content, concepts, methods and models. These descriptors are scientific and technical words listed in the INIS thesaurus, which also defines relationships (hierarchical, affinitive, etc.) to other descriptors. The descriptors are used for the retrieval of documents. Descriptors are assigned to each input record by indexers working in each INIS centre. Descriptors in nuclear physics records in INIS database indicate that the main emphasis of the records is on nuclear physics.

The descriptor “ nuclear data collection” is a controlled term which is listed in the INIS thesaurus. The number of records with this descriptor over the publication years is plotted in Fig. 10. The records of the last two years are not complete (see above). The projection of the last two years is indicated with dashed lines. Over the last 24 years on average an increase of this descriptor in nuclear physics INIS records can been seen.

An alternative retrieval tool is the search by `free text´ (that is, natural language words and phrases occurring in all textual fields, including titles and abstracts). The free text can be a scientific term which appears in the title or abstract and is not necessarily a descriptor but nevertheless, can be used for retrieval. In addition to the use of descriptors, `non-standard keywords´ (in INIS terminology - free text terms) are permitted to be input in another indexing field and allow flexibility of indexing and searching. Newly proposed descriptors are usually accepted with a delay of several months. The free text `nuclear data´ is for example, such a term. In Fig. 11, the number of records in which this term has been used is plotted over the publication year . Over the last 24 years on average an increase of this term in nuclear physics INIS records can be seen. The years with a high number of records usually coincide with the publication of biannual or triennial conferences. The projection of the last two years is indicated with dashed lines.

In the nuclear physics records, some elements of the periodic table have a high frequency (number of records) (in order of importance) such as uranium, lithium, beryllium, boron, thorium, molybdenum, gadolinium etc. (Table III). In the CINDA bibliographic database the elements with the highest number of entries (CINDA blocks, see Annex) are uranium, plutonium, iron, nickel, molybdenum, hydrogen.

Outlook

This analysis of low and medium energy physics records in the INIS database contains many tables and graphs, which form the basis of this summary, and which provide more detailed information. A basic analysis was performed aimed at different interest groups such as the scientific and technology community, science publishers and editors, librarians and science managers.

In the study, additional information on science and technology indicators and trends is also shown, as well as information on nuclear physics and nuclear data related publications and their formats. Furthermore, more advanced and focused analyses and evaluation of the data for some of these interest groups are also possible. The analysis opens the possibility of further studies, e.g. the co-operation between different institutions and countries, mapping publication patterns, highlighting scientific co-operation, development of human resources and journal structure.

Scientometric studies can assist in analyses and formulation of science and technology policy by mapping changes in research activities, providing thematic and strategic analysis of relative position of research communities, sketching profiles of activities and performance of countries and institutions.

Conclusion

Surprisingly, the number of publications in nuclear physics remained almost constant over the last decade. Taking into consideration the change in the nuclear research institutions and nuclear industry in the past decade which affected many nuclear physics institutions, the amount of research publications is nearly unchanged. An increase of number of records with the keyword `nuclear data collection´ can be seen.

References

- Time Development of Records on Nuclear Physics and Data in INIS Database” presented at the IAEA Advisory Group Meeting of Nuclear Reaction Data Centres 11-15 May 1998 , Vienna , Austria, by Claus-D. Hillebrand, IAEA, Division of Scientific and Technical Information, Vienna published in INDC(NDS)-383, July 1998, p. 139-142.

- CINDA ; bibliographic and Data Index on Neutron Nuclear Data, (1988 -1997), IAEA, Vienna, 1997.

- Fusion Research and Technology Records in INIS Database, C.D. Hillebrand; Div. of Scientific and Technical Information; IAEA, Vienna, Austria. ITER-Newsletter, April 1998; p.4-6

Annex

Table I

Nuclear Physics Subject Categories in INIS

-- G3000 NUCLEAR-PHYSICS-THEORETICAL-AND-EXPERIMENTAL
-- G3100 Nuclear-Structure
-- G3110 General / average-properties-of-nuclei----nuclear-energy-levels
-- G3120 Nuclear-Structure-models-and-methods
-- G3200 Radioactivity----Electromagnetic-Transitions-(excluding-fission)
-- G3210 Ground-state-radioactivity
-- G3220 Electromagnetic-transitions
-- G3300 Nuclear-Reactions-and-Scattering,-General
-- G3400 Specific-Nuclear-Reactions-and-Scattering
-- G3410 Photonuclear-reactions-and-photon-scattering
-- G3420 Lepton-induced-reactions-and-scattering
-- G3430 Nucleon-induced-reactions-and-scattering
-- G3440 2H-,-3H-and-He-induced-reactions-and-scattering
-- G3450 Heavy-ion-induced-reactions-and-scattering
-- G3460 Meson-and-hyperon-induced-reactions-and-scattering
-- G3470 Fission
-- G3500 Nuclear-Mass-Ranges
-- G3510 Nuclear-Mass-Ranges=1-5 -
-- G3520 Nuclear-Mass-Ranges=6-19
-- G3530 Nuclear-Mass-Ranges=20-38
-- G3540 Nuclear-Mass-Ranges=39-58
-- G3550 Nuclear-Mass-Ranges=59-89
-- G3560 Nuclear-Mass-Ranges-90-149
-- G3570 Nuclear-Mass-Ranges-150-189
-- G3580 Nuclear-Mass-Ranges-190-219
-- G3590 Nuclear-Mass-Ranges-220
-- G3600 Radiation-Physics
-- G3610 Neutron-physics
-- G3620 Physics-of-radiations-other-than-neutrons

ANNEX

About INIS and CINDA Databases

The decentralized multidisciplinary bibliographic database of the IAEA is a part of **INIS** which was created in 1970 and is administered by the INIS Section of the IAEA with the purpose of collecting and disseminating information on science and technology through its Member States.

INIS has 120 Members including 18 International Organizations which provide records on science and technology documents published in the states where the 120 INIS members are located. Records of documents are provided to INIS in English, along with the titles in the language of origin. All countries and international organizations participating in the Nuclear Reaction Data Centre network are also INIS Members. (United States of America, Japan, Russia, China, Germany, Hungary, Ukraine, NEA / DB - OECD, NDS-IAEA

The main INIS fields of scope are: (i) chemistry, materials and earth sciences; (ii) life and environmental sciences; (iii) isotopes, isotope and radiation applications; (iv) engineering and technology; (v) other aspects of nuclear and non-nuclear energy; (vi) physics.

The largest subject category is physics with about one third of all records, followed by engineering and technology with one fourth. Chemistry, material and earth sciences as well as life and environmental sciences represent about one fifth each.

CINDA (Computer Index of Neutron Data, contains bibliographical references to measurements, calculations, reviews and evaluations of neutron cross-sections and other microscopic data; it includes also index references to computer libraries of neutron data available from four regional neutron data centres.) is published on behalf of USA National Nuclear Data Centre, Russian Nuclear Data Centre, OECD / NEA Data Bank and IAEA Nuclear Data Section. CINDA is administered and published by the Nuclear Data Section, IAEA. Retrievals can be made through Internet (WWW or Telnet). The complete file is available as a book in several volumes: CINDA-A (1935-87) in 5 volumes; CINDA-97 (1988-97) and CINDA-98. Although much smaller in size than INIS (CINDA presently contains about 260000 entries), CINDA has several unique features. It covers the literature since the discovery of the neutron (i.e. from 1935 to present) and, unlike other bibliographic databases is data oriented rather than reference oriented. In the usual bibliography, there is a single entry for each publication or reference. In CINDA, there can be many entries for each publication, one for each data set reported. For example, if a publication reports on a measurement of the total cross sections for Fe and for 56Fe and the differential elastic scattering cross section for Fe, there will be three entries in the database. On the other hand, all references to the same data are linked together in a CINDA `block´ along with references to experimental or evaluated data if available.

CINDA began in 1956 as a private index maintained by Prof. H. Goldstein and his then colleagues at Nuclear Development Associates. Computer operation of the file dates from 1963, when the original punched cards were translated into computer format at Columbia University, and outside indexers were enlisted, to be joined in 1964 by the ENEA (European Nuclear Energy Agency) Neutron Data Compilation Centre (now OECD / NEA Data Bank) who maintained an identical master file, the IAEA Nuclear Data Section (1965) and the USSR Nuclear Data Centre (1966).

Annex

Definition of Scientometrics and Bibliometrics

The terms bibliometrics and scientometrics were introduced almost simultaneously by Pritchard and by Nalimov and Mulchenko in 1969. While Pritchard explained the term bibliometrics as “the application of mathematical and statistical methods to books and other media of communication, Nalimov and Mulchenko defined scientometrics as “the application of those quantitative methods which deal with the analysis of science viewed as an information process. According to these interpretations, scientometrics is restricted to the measurement of science communication, whereas bibliometrics is designed to deal with more general information processes. The at best fuzzy distinction between the two has virtually disappeared over the course of the last three decades and, today, the terms are more or less synonymous. Meanwhile, the term infometrics has come to replace the originally broader specialty of bibliometrics.

(Source: 2nd European Report on Science and Technology Indicators, Dec. 1997, page 111, EC-Luxembourg, EUR17639)

Table II Publication Types

Records Types:

J	Journals
R	Reports
B	Books
I	Miscellaneous
P	Patents

Literary Types

E	Short Communication
N	Numerical Data
V	Computer Program Description
X	Nonconventional Literature
Y	Progress Reports
U	Dissertations
K	Conference
Z	Bibliography

Annex

Table III

Frequency of Periodic Elements in Nuclear Physics Records (since 1992) (total 36293)

Alphabetic Order	Number of Records
97 Actinium	1714 Uranium
196 Americium	1704 Lithium
477 Astatine	1393 Beryllium
35 Berkelium	887 Boron
1393 Beryllium	712 Thorium
887 Boron	705 Molybdenum
489 Cadmium	550 Gadolinium
330 Californium	538 Samarium
294 Cerium	509 (Tungsten or Wolfram)
253 Cesium	499 Niobium
178 Curium	489 Cadmium
424 Dysprosium	477 Astatine
27 Einsteinium	477 Plutonium
418 Erbium	467 Tantalum
249 Europium	462 Neodymium
72 Fermium	424 Dysprosium
113 Francium	418 Erbium
550 Gadolinium	406 Tellurium
368 Hafnium	373 Indium
268 Holmium	368 Hafnium
373 Indium	330 Californium
304 Iodine	317 Radium
263 Lanthanum	304 Iodine
9 Lawrencium	294 Cerium
1704 Lithium	282 Strontium
218 Lutetium	276 Terbium
19 Mendelevium	268 Holmium
705 Molybdenum	263 Lanthanum
462 Neodymium	261 Neptunium
261 Neptunium	260 Scandium
499 Niobium	253 Cesium
39 Nobelium	250 Ruthenium
477 Plutonium	249 Europium
174 Polonium	218 Lutetium
152 Praseodymium	202 Thulium
125 Promethium	196 Americium
143 Protactinium	178 Curium
317 Radium	174 Polonium
134 Radon	158 Technetium
153 Rhenium	153 Rhenium
250 Ruthenium	152 Praseodymium
538 Samarium	143 Protactinium
260 Scandium	134 Radon
282 Strontium	125 Promethium
467 Tantalum	113 Francium

158	Technetium	97	Actinium
406	Tellurium	72	Fermium
276	Terbium	39	Nobelium
712	Thorium	35	Berkelium
202	Thulium	27	Einsteinium
509	(Tungsten or Wolfram)	19	Mendelevium
1714	Uranium	9	Lawrencium
		18946	

CINDA Database Blocks by Elements (selection of 6 elements)		
	11808	Uranium
	6539	Plutonium
	4046	Iron
	3702	Nickel
	3001	Molybdenum
	2673	Hydrogen

Table III continued

Annex

Figure Caption:

Figure 1: Number of Records versus Publication Year

Figure 2: Number of Records per Input Countries

Figure 3: Number of Records per Language

Figure 4: Number of Records per Subject Category

Figure 5: Number of Records (%) with Secondary Category

Figure 6: Number of Records (%) per Secondary Category in Physics

Figure 7: Number of Publication Type Records

Figure 8: Number of Records with Two Publication Types

Figure 9: Number of Records (%) per Author Country

Figure 10: Number of Records with Descriptor: `Nuclear Data Collections´ in INIS versus Publication Year

Figure 11: Number of Records with Free Text `Nuclear Data´ in INIS versus Publication Year.

Number of Nuclear Physics Records per Publication Year

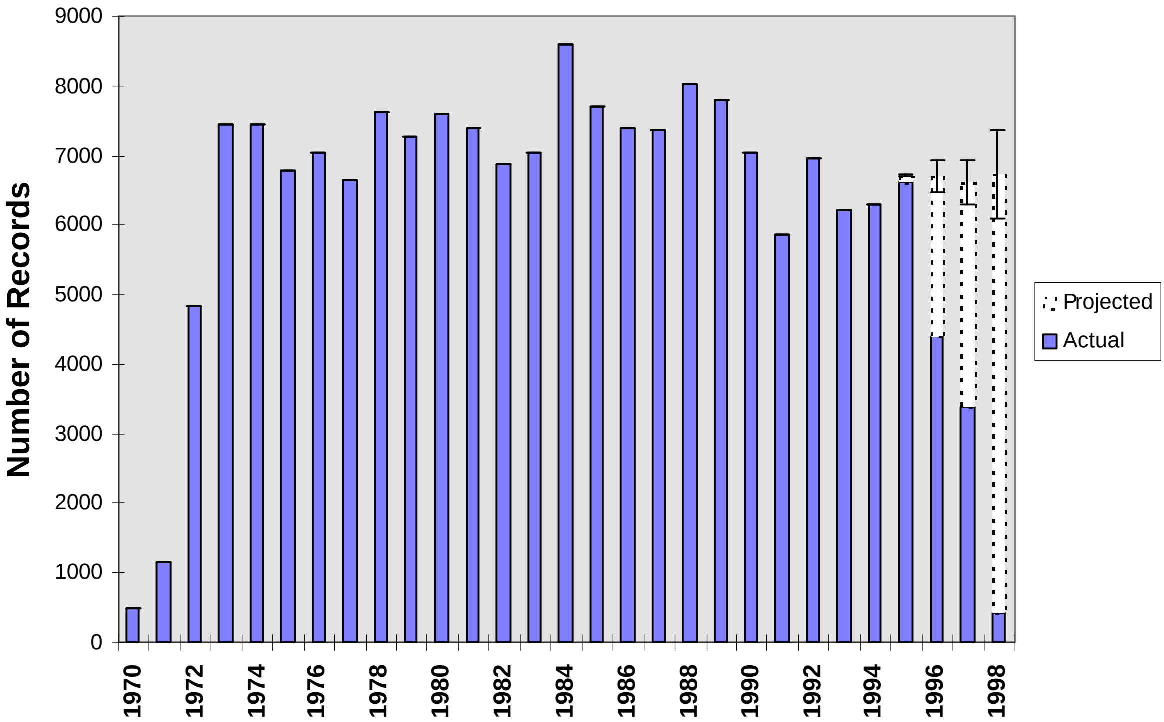
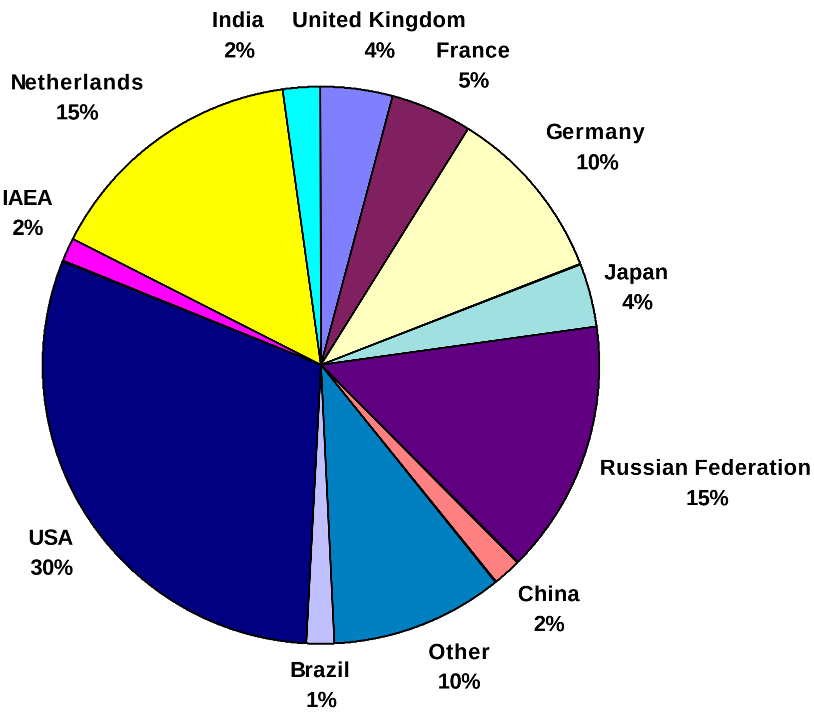


Fig. 1 Publication Year

Number of Records (%) per Input Country Fig. 2



Number of Records (Logarithmic Scale) per Language

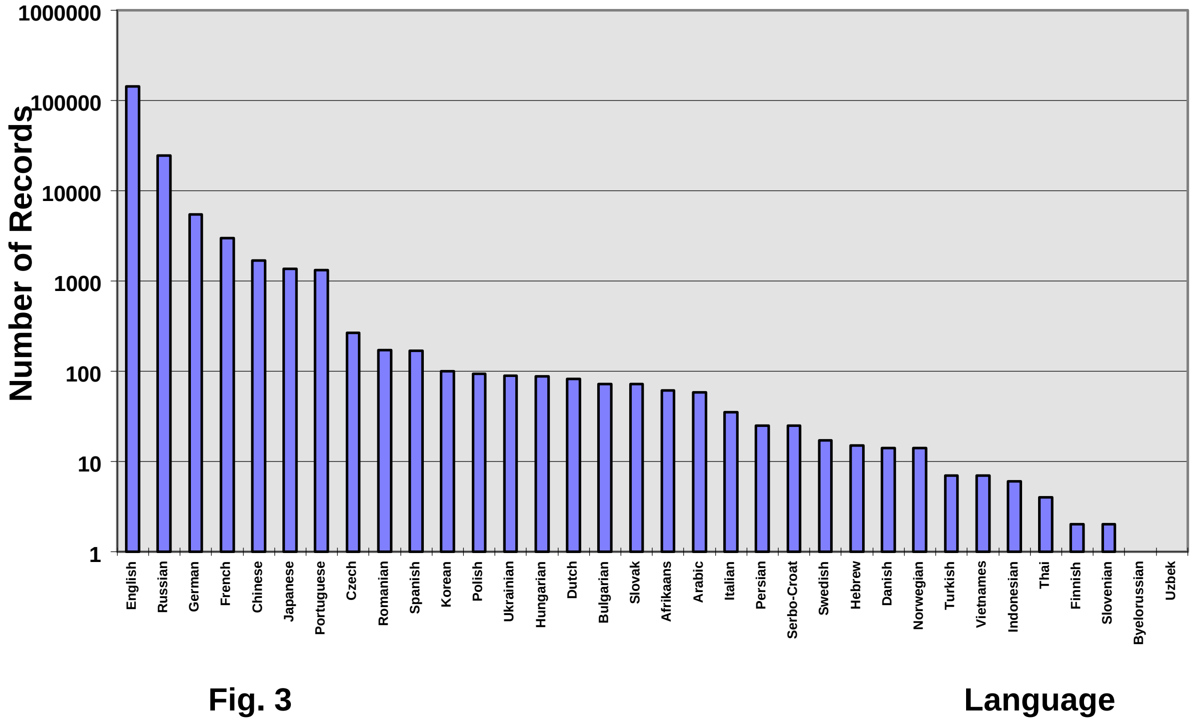


Fig. 3

No. of Records per Subject Category in Nucl. Phys. since 1992

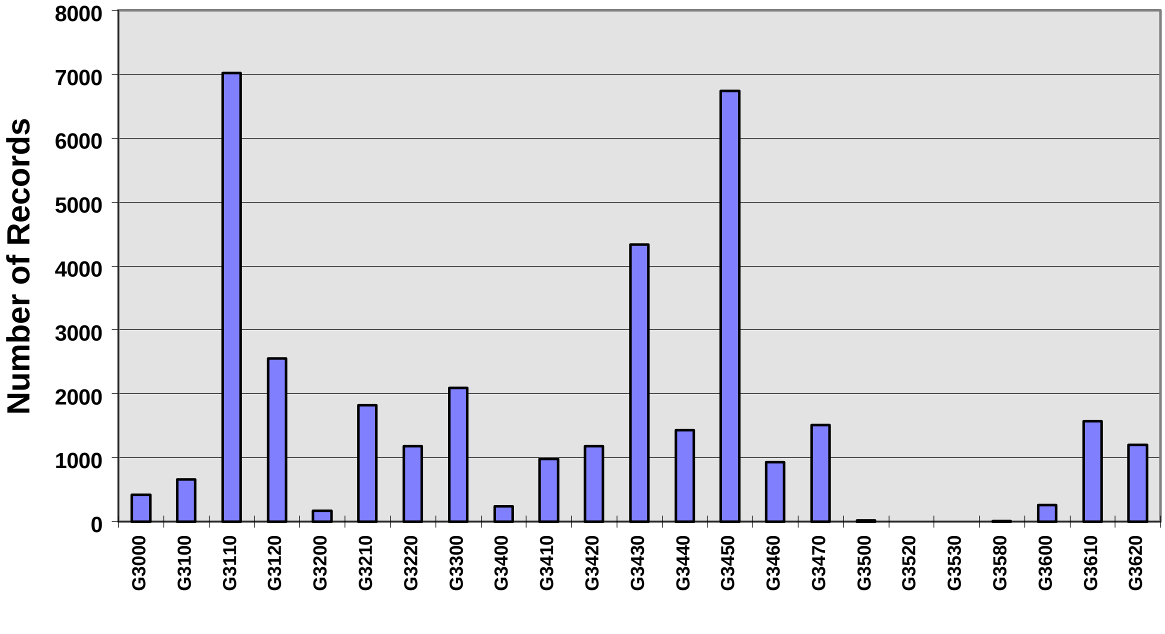
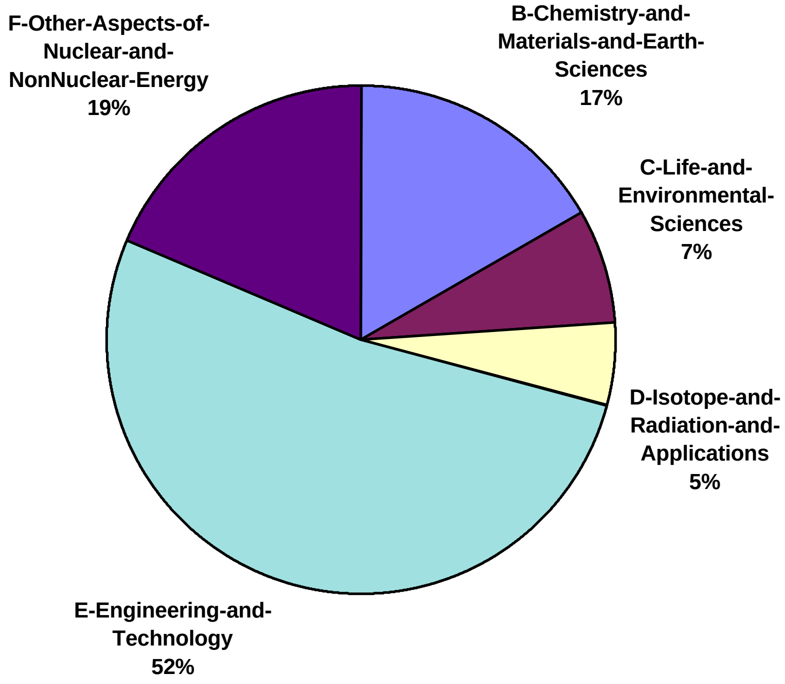
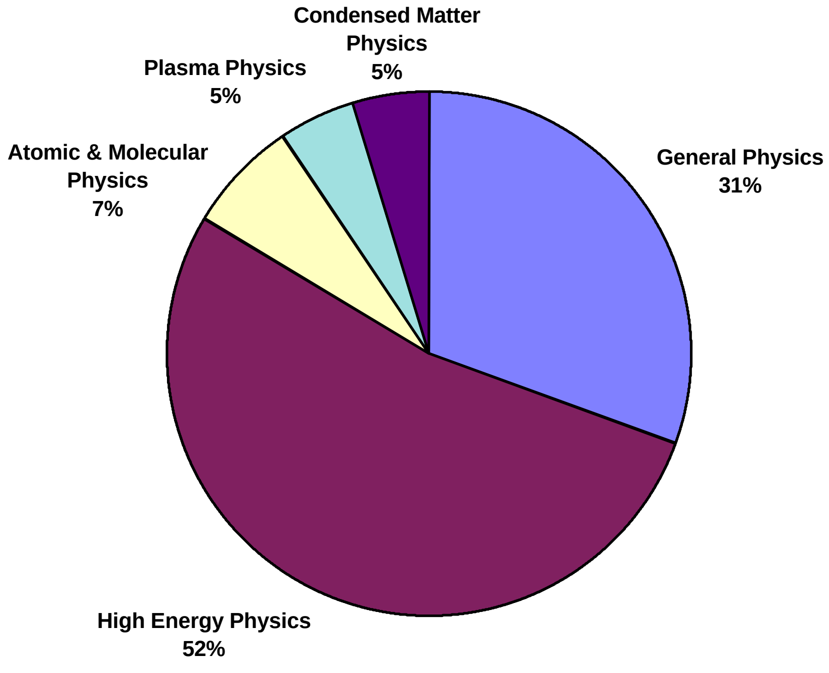


Fig. 4

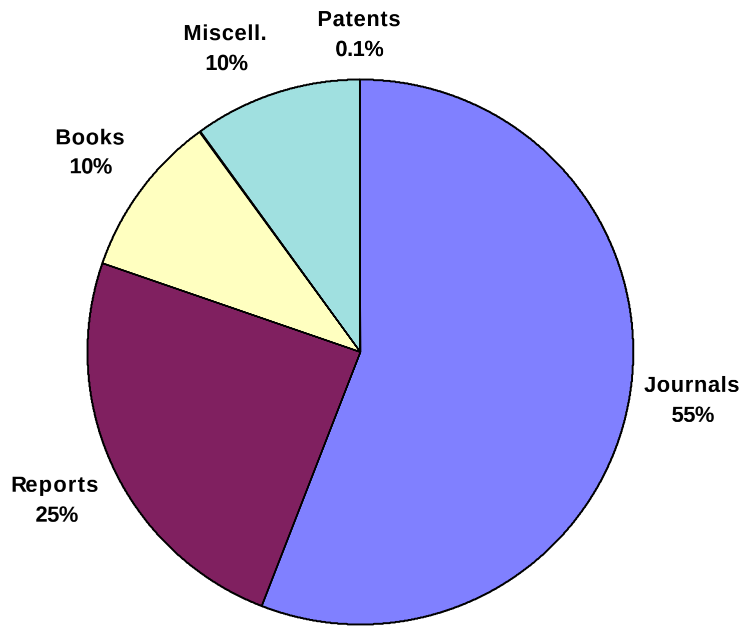
No. of Records (%) with Secondary Category (excl. Physics) Fig. 5



No. of Records (%) with Secondary Category (Physics) Fig.6



Number of Records (%) per Publication Type **Fig. 7**



Number or Records with Two Publication Types (PT)

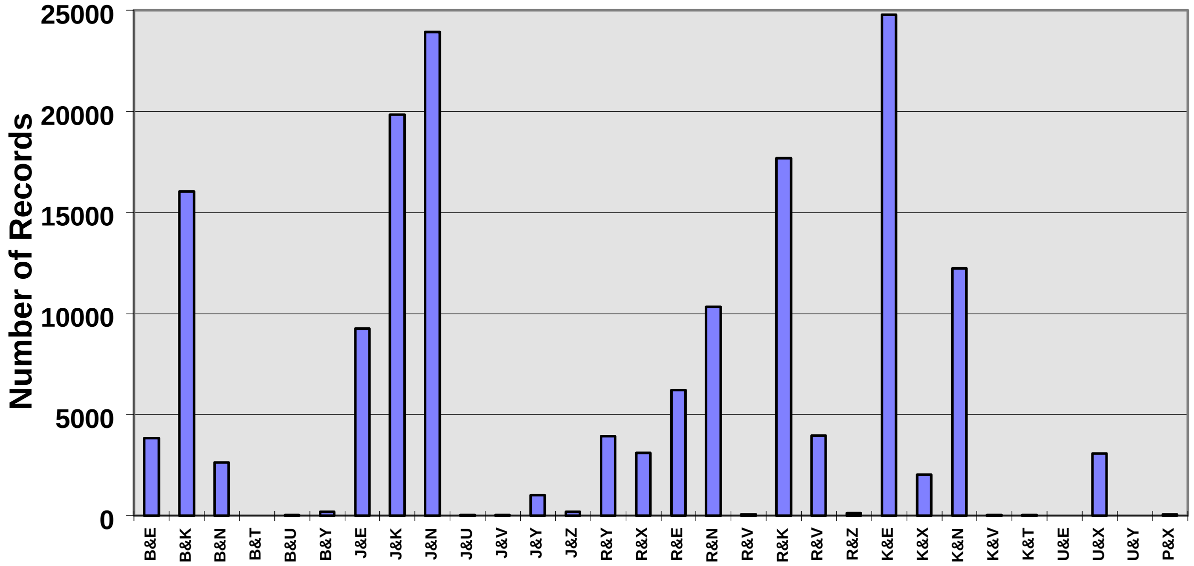
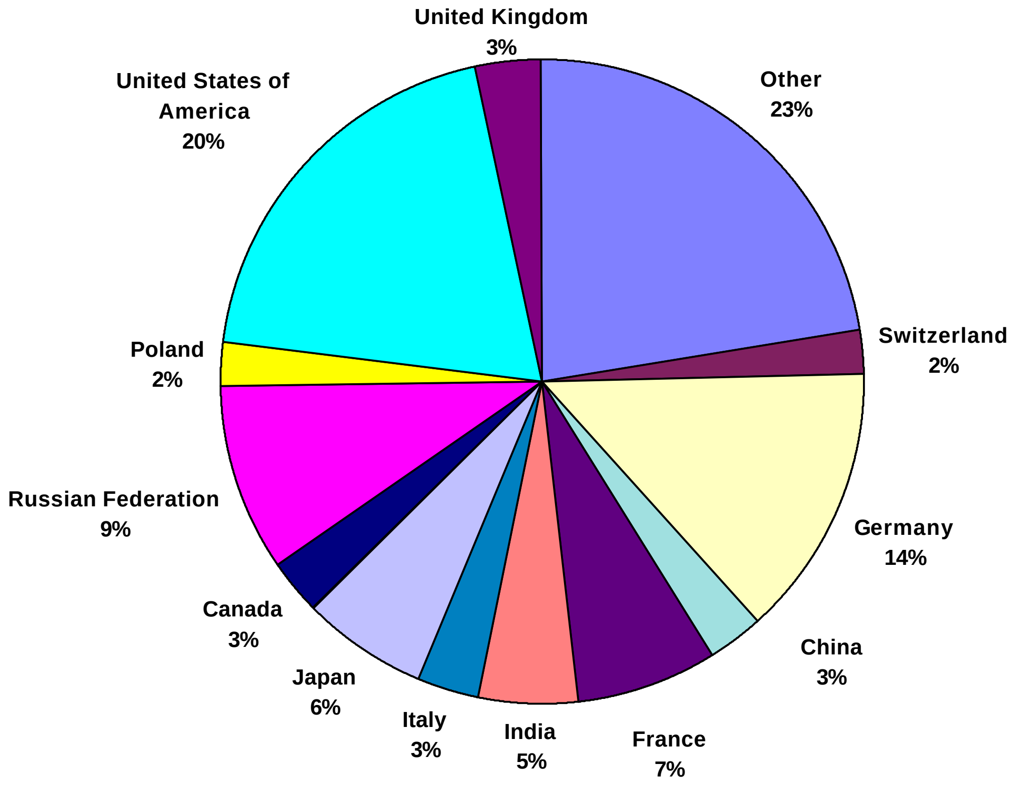


Fig. 8 **Two PT (see Annex)**

Number of Records distribution according to Author Country Fig. 9



Number of Records with descriptor "Nuclear Data Collections" vs. Publication Year

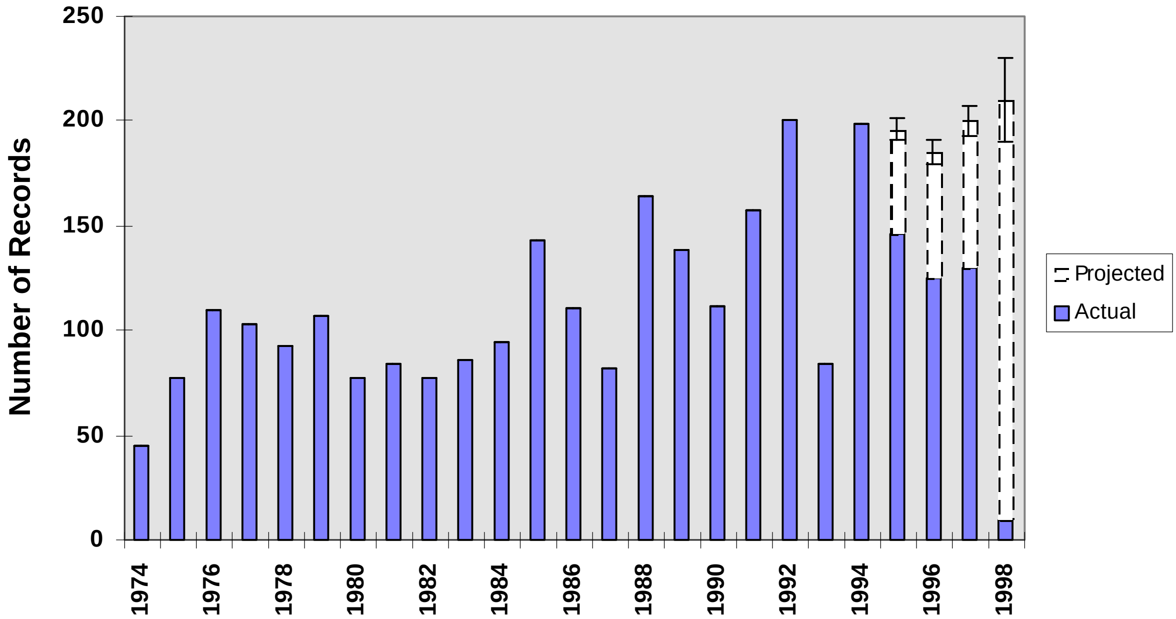


Fig. 10

No. of Records with Free Text 'Nuclear Data' vs. Publicat. Year

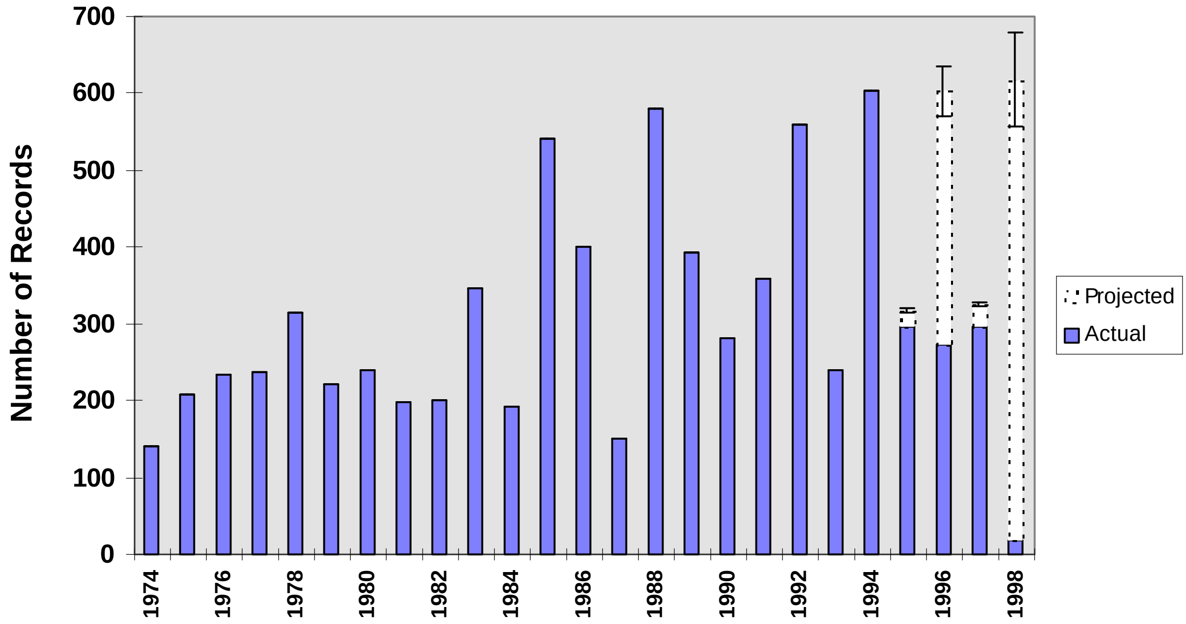


Fig. 11