

Champion Data Comparison in Prestigious Nuclear Research Institute in the U. S., Europe and Japan

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Abstract- Bibliometric study was carried out for champion data comparisons among prestigious international nuclear research institutes (PNRI) existed in Japan, the U. S., France and Germany. The study was relied on database INIS (IAEA), ECD (DOE), WOS (Thomson) and SCOPUS (Elsevier). Over the 35-year time span of research paper publication, the world champion among 11 PNRI is JAERI confirmed by INIS but ORNL confirmed by ECD, WOS and SCOPUS, the latter two collected journal submitted research papers.

Keywords- *Bibliometric Study; Champion Comparison; INIS; ECD; WOS; SCOPUS*

I. INTRODUCTION

Valuable and retention-worthy knowledge is born as a result of research activities in nuclear institutes. Such knowledge should be provided explicitly in the form of research papers to facilitate more usage for nuclear research and development (R&D) and nuclear knowledge management (NKM). Using research papers provided by JAERI-Japan and 10 PNRI, an institutional comparison by bibliometric method was performed for this study from the view point of professional knowledge retention. This comparison is aimed at learning the volume of intellectual assets produced by each institute and also looking from the view point of NKM for the benefit of taxpayers in order to explain an accountability or a transparency of national institutes funded mainly by the government [1].

II. ANALYTICAL METHOD

A. Prestigious Institutes Chosen

The following 11 PNRI were chosen for the present study. They are all well-renowned national institutes (laboratories) with historical nuclear research programs.

JAPAN: Japan Atomic Energy Research Institute (JAERI)¹

The U.S.: Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Idaho National Engineering Laboratory (INL or Idaho), Oak Ridge National Laboratory (ORNL), and Sandia National Laboratory (SNL)

EUROPE: Karlsruhe (FZK) and Jeulich (FZJ) in Germany. CEA/Grenoble, CEA/Saclay and CEA/Cadarache in France

Note that a total number of commercial nuclear power reactors belonged to these four countries was 234 units, which corresponded to 54% of 431 units in total of the 29 countries [2].

B. Research Tools

As the principal research tool, the International Nuclear Information System (INIS), owned and operated by International Atomic Energy Agency (IAEA) was used [3]. INIS has been in existence since the year 1970 and today 128 countries and 24 international organizations co-operate for managing nuclear information resources. Research outputs from JAERI and the other PNRI chosen for the study are provided into the system regularly. The INIS is the general world-wide database, where the subject scope includes all nuclear energy-related topics, even though domestic papers and proceedings of the meeting.

¹ JAERI and the Japan Nuclear Cycle Development Institute (JNC) were reorganized in October, 2005 and newly established as the Japan Atomic Energy Agency (JAEA). The present study will cover the years from 1978 to 2012, where the most intellectual assets created were addressed to JAERI. Hence, JAERI is used in the text. Strictly speaking, the consistency of the paper comparison between JAERI and the other PNRI was slightly shifted after the reorganization.

Additionally, the U.S. Department of Energy (DOE) Office of Scientific and Technical Information (OSTI) builds the Energy Citation Database (ECD), operating since 1948 [4]. Research outputs of JAERI and other renowned international research institutes are partly included in this database. The subject scope includes all energy-related topics. ECD includes international information published through the mid-1970's. Since that period, ECD is populated primarily with U.S.-published research results due to dissemination limitations placed on internationally-exchanged information. ECD in the present study was used as a reference. Further, the Web of Science (WOS) from THOMSON REUTERS [5] was also used as a reference because managers interviewed indicated it to be a more familiar tool collected the journal submitted research papers, especially in the US. For many of the major nuclear research institutes located in Europe, the SCOPUS from Elsevier, Netherlands [6] was additionally used as a reference. It is also a more familiar tool collected the journal submitted research papers and proceedings, especially in the Europe. The characteristics of the four tools are described in TABLE I.

TABLE I CHARACTERISTICS OF FOUR RESEARCH EVALUATION TOOLS USED

Database	Display	Owner	Main fields collected	Papers published (No.of journals)
		Language	Operating since	Participants
INIS	Disclosed	IAEA	Nuclear energy	3,494,544 (14,377)
		English	1970~	128 countries, 24 organizations
ECD	Disclosed	DOE-OSTI	All energy -related topics	unknown
		English	1948~	DOE subsidiary institutes etc
WOS	Closed (Charged)	Thomson Reuters	Natural and Social Sciences Humanic Learning	49,750,000 (12,000)
		English	1900~	>100 countries, >5,000 organizations
SCOPUS	Closed (Charged)	Elsevier	Natural and Social Sciences Humanic Learning	50,242,346 (20,500)
		English	1823~	82 countries, 5,000 organizations

INIS; International Nuclear Information System owned by IAEA (International Atomic Energy Agency),

ECD; Energy Citation Database owned by DOE-OSTI, i.e., U. S. Department of Energy, Office of Scientific and Technical Information,

WOS; Web of Science owned by Thomson Reuters, SCOPUS owned by Elsevier

C. Time span

In one of author's previous study [7], from CD-ROM or the Website, INIS provides published papers with a time span of 30 years (1978-2007) and for 5-year periods. In the present study, the authors renewed the INIS published papers with a time span of 35 years (1978-2012) and for 5-year periods, that is, present++(2008-2012), present+(2003-2007), present (1998-2002), past 5 (1993-1997), past 10 (1988-1992), past 15 (1983-1987) and past 20 (1978-1982). In comparison, ECD can provide submitted papers with a time span of 60 years (1953-2012), 35 years (1978-2012) and 5-year periods. WOS and SCOPUS have similar functionalities as those of ECD.

III. RESULTS AND DISCUSSION

A. Copyright of the Published Paper

By INIS, dynamics of paper copyright published from 11 PNRI for 10-year intervals (2003-2012) was studied. Note first that a paper copyright is owned by a publisher run at any country. The copyright of all papers published through the ORNL, for example, were broadly addressed to different publishers (countries). The authors found that the copyrights of the ORNL papers were addressed to the U.S (3,571 papers), the Netherlands (1,106), the United Kingdom (905), and so on. Lastly, the copyrights of ORNL papers were held by 87 different countries. Taking the volume of papers as the parameter, top ten countries out of 87 were ranked of the order of the U.S., the Netherlands, the United Kingdom, IAEA, Germany, Japan, Austria, France, Republic of Korea, NEA (Nuclear Energy Agency of the OECD), respectively. The procedure was repeated to the other PNRI and obtained result is summed up in Figure 1.

As seen from the figure the copyright was not always adhering to home country, although many U.S. papers were held by the U.S. publishers. Additionally, research papers born originally in EU (Germany and France) and Japan were partly registered as the U. S. paper. In previous study made by one of authors [8] it was revealed that 12% of the U. S. papers were come out from no-U.S. countries as Germany, France, Italy, Russian Federation, China and Japan. It is important to point out that no-PNRI country such as the Netherlands, the United Kingdom and IAEA had a lot of copyrights, perhaps due mainly to the historical reasons or international agreements. Because of the copyright, the champion data comparison in the present study was carried out by the volume of papers published by PNRI, not by the country.

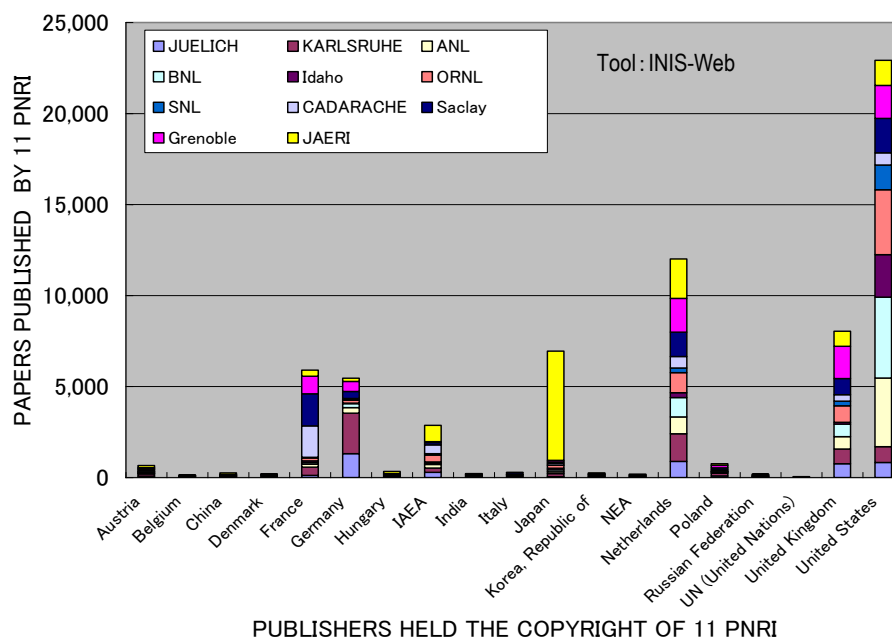


Fig. 1 Publishers having a large number of copyrights during 10-year intervals (2003-2012)

B. Trials to Determine the Representative Institutes for France

France is a very advanced country in applications for the peaceful use of nuclear energy. At the moment, a total of 58 nuclear power plants (PWR) are in operation. The share of nuclear was about 78% of the gross electricity totals. As far as the principal author's knowledge is concerned, there existed CEA (Commissariat à l'Energie Atomique) and 10 research institutes under the umbrella of CEA covering the country. The former is big because of ministry having fund delivery function. The latter is composed of Siege, Fontenay-aux-Roses (since about 2000 main interest in life sciences), Saclay (main interest in physical sciences and fundamental research), DAM Ile de France (defence sector), Valduc (defence sector), Grenoble (technological research, electronics, instrumentation, etc), Cadarache and Valrho (nuclear sector), Cestra and Le Ripault (defence sector). Note that four are partly served for defense (military) service marked by the circle in the Figure 2. The less paper publication may be due to such reason. In accordance with the purpose of this study, a domestic comparison to gain a few French representative institutes was carried out. Using the INIS database, the papers published by the prestigious French nuclear research institutes during past 30 years are studied. Results shown in Figure 2 revealed that the papers are ranked in the following order:

Grenoble(19,616)>Saclay(19,203)>Cadarache(8,185)>Fontenay-aux-Roses(6,342)>other institutes...../1/

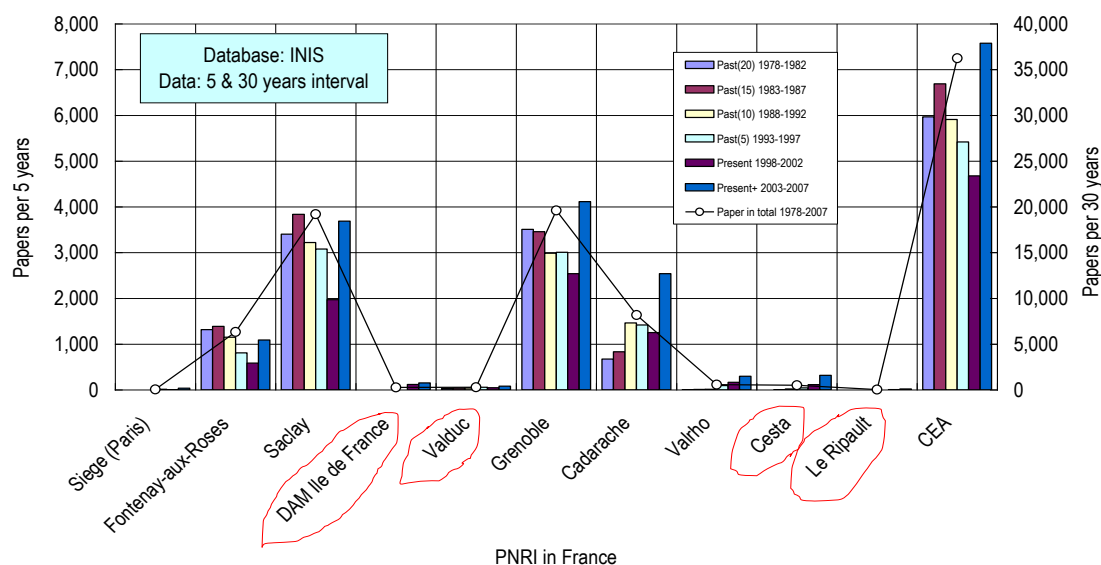


Fig. 2 All papers published at CEA and 10 French PNRI during the period 1978-2007. Open circles show the total published papers during 30 years at each institute (scale is shown on the right-hand side) and the columns show the papers published during 5-year increments at each institute (scale is shown on the left-hand side). Database used was INIS.

It is worth to mention that the order was Saclay > Grenoble > Cadarache when the comparison was made at 5 years ago [9]. Of course CEA is the top of rank (36,243 papers per 30 years) but used here only as a reference because it is not R&D performer as same as the Department of Energy (DOE) in the U. S. In the Grenoble and Saclay institutes alone, more than 38,000 papers were published during the 30-year period and they are still available for reference. The retained knowledge in the form of these papers will be of much benefit to many French researchers and international users. For the wider bibliometric comparison used in this study, the Top Three institutes, CEA/Grenoble, CEA/Saclay and CEA/Cadarache, were selected.

C. Institutional Comparison by INIS

The next step was to look at comparing these top French institutes to a selection of international institutes noted in section II.A. Figure 3 shows the total number of papers provided by JAERI and 10 other PNRI over the 35-year period of the study.

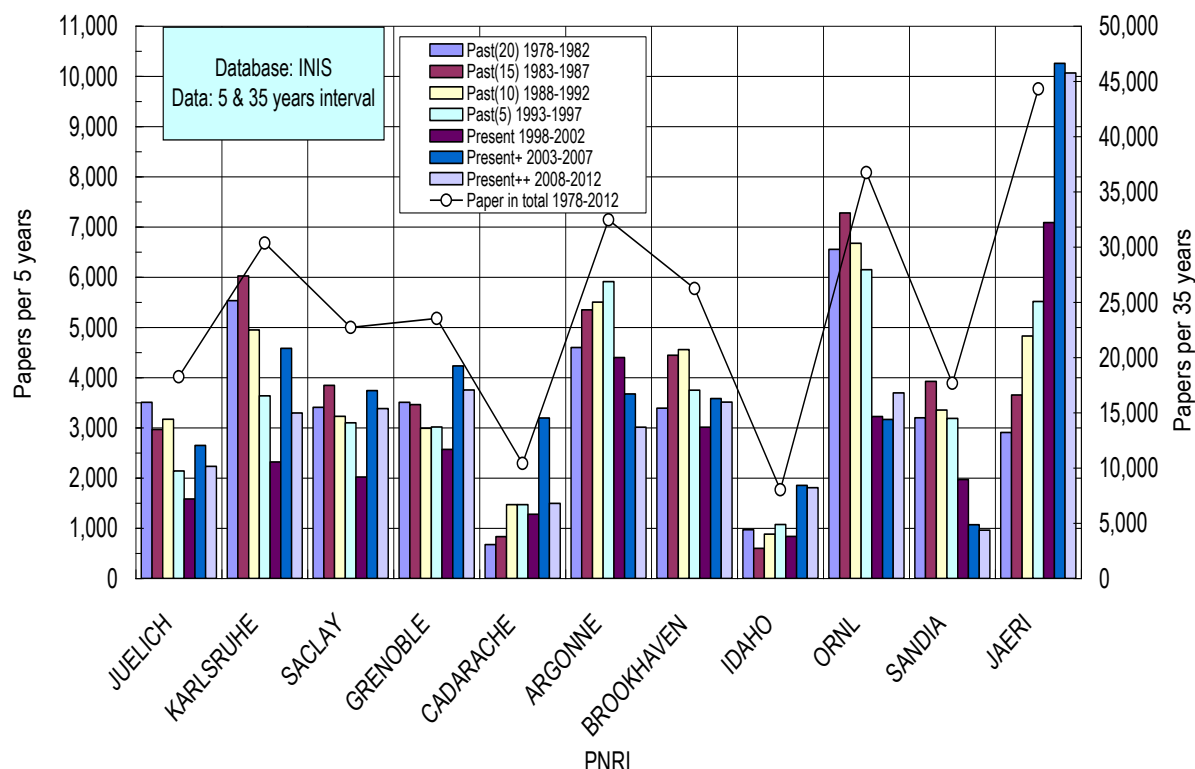


Fig. 3 All papers published in JAERI and 10 PNRI during the period 1978-2012. Open circles show the total published papers during 35 years at each institute (scale is shown on the right-hand side) and the columns show the papers published during 5-year increments at each institute (scale is shown on the left-hand side). Database used was INIS.

After review of the data, the following conclusions can be reached:

1) 35-Year Intervals:

Over the 35 years of research activities, the papers are of the order

JAERI(44,322)>ORNL(36,747)>ANL(32,458)>Karlsruhe:FZK(30,351)>BNL(26,253)>Grenoble
(23,541)>Saclay(22,724)>Juelich:FZJ(18,251)>SNL(17,667)>Cadarache(10,421)>INL(8,028)/2/

It is worth to mention that JAERI was in the 3rd position, following ORNL and ANL at comparison made ten years ago (1978-2002) and JAERI was in the 1st position at comparison made five years ago (1978-2007) and the present (1978-2012).

Figure 4 shows each 1-year period of research activities for JAERI and ORNL. Through interviews with corresponding managers, it was understood that the change of nuclear policies (e.g., de-emphasis of reprocessing policies in the U. S., and reorganization of JAERI (2005)), the nuclear accidents (e.g., TMI-2 (1979), Chernobyl (1986), and Fukushima Daiichi (2011)), and economical dynamics (e.g., the 2nd oil shock in Japan (1979), Plaza accord (1985), bubble boom (1986-1991), Lehman shock (2008) and the retirement of baby boomers(2007-2009)), are significant factors having much influence on research activities, including the number of research publications produced. During the period present++ (2008-2012), JAERI reduced significantly the papers due to the occurrence of the retirement of baby boomers, that is, human aging problem and the Great East Japan Earthquake followed by the Fukushima Daiichi severe core accident. It is clear that the capability of knowledge is affected by those external events.

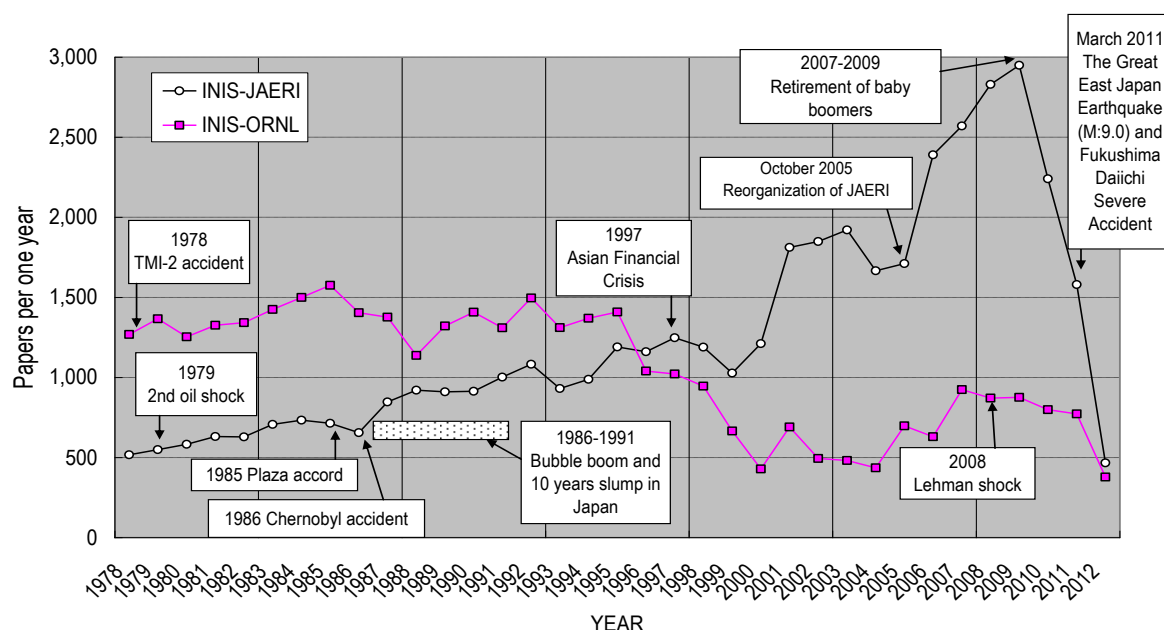


Fig. 4 Papers published in each 1-year period for JAERI and ORNL covering the period 1978-2012. External events were indexed from the viewpoint of nuclear policy, reactor safety and economy. Database was INIS.

2) 5-Year Intervals:

For each 5-year period of research activities in Figure 3, the number of papers in JAERI increased from period to period. However, research papers in the other 10 PNRI decreased or increased from the past (20) to the present++. A comparison between ORNL and JAERI at present++ (2008-2012) shows that ORNL is about 3,695 and JAERI is about 10,067. Just reviewing the numbers, it appears that readers would think that JAERI, EU countries and BNL and INL are increasing its research activity in the world but ANL, ORNL and SNL are decreasing their research activities. To gain further insight as to its validity, the authors carried out a similar bibliometric analysis using ECD, WOS and SCOPUS.

D. Institutional Comparison by ECD

To gain a second perspective of the results available from these prestigious institutes, Figure 5 illustrates the total number of papers using ECD as the basis.

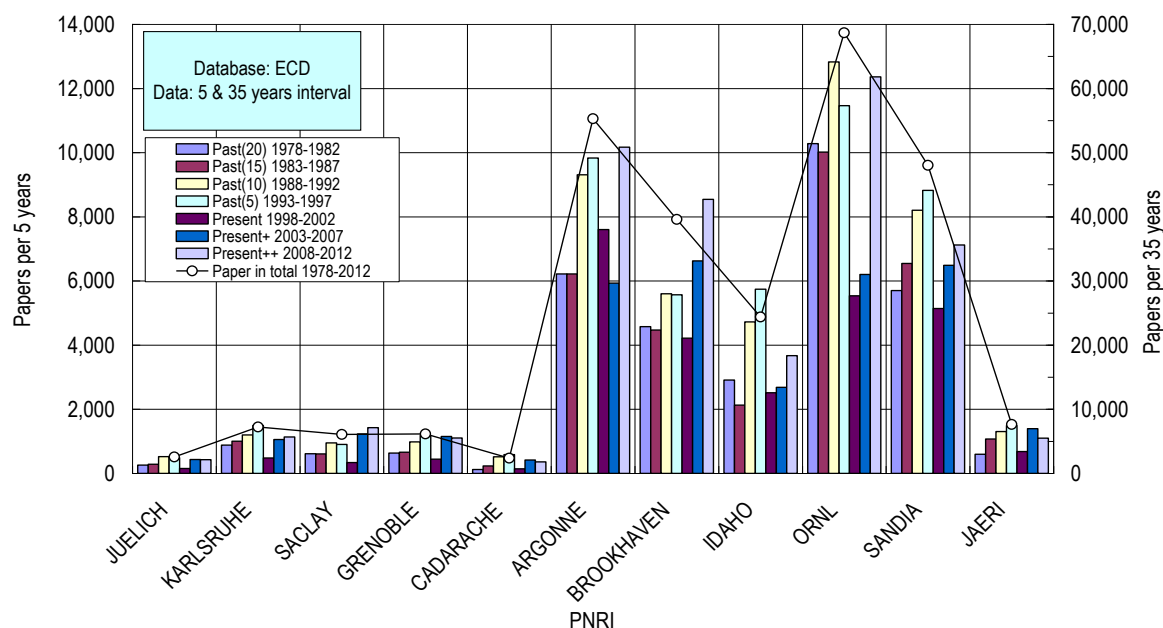


Fig. 5 All papers published in JAERI and 10 PNRI during the period 1978-2012. Open circles show total published papers during 35 years at each institute (scale is shown on the right-hand side) and the columns show papers published during 5-year increments at each institute (scale is shown on the left-hand side). Database used was ECD.

The following observations can be made from these results.

1) 35-year Intervals:

For the time span of 35 years (1978-2012), non-U.S institutes have a very poor number of papers reported. This is a quite different point of view from the INIS analysis. ECD is the distinguished databases targeted at reflecting U.S. research. Out of the U.S. papers evaluated in ECD, they are ranked in the order of

ORNL(68,692)>ANL(55,284)>SNL(48,028)>BNL(39,600)>Idaho:INL(24,374)...../3/

ORNL is here the champion. One regrets to say that JAERI is in the 6th position, almost negligible. However, this appears due to the strong U.S.-focus of the database, not necessarily reflective of JAERI's research efforts. The Equation /3/ was the same at the previous conclusion made at 5 years ago.

2) 60-year intervals:

For the time span of 60 years (1953-2012), the total number of papers was of the order of

ORNL(98,019)>ANL(73,015)>SNL(54,408)>BNL(52,000)>INL(19,733)/4/

It should be noted that SNL may have additional papers that have a different subject scope, while SNL and INL did not publish papers before 1979 and 1975, respectively as the named institute.

3) 5-Year Intervals:

For the 5-year increments of research activities, papers vary from one to another time span. Around the past (5) timeframe (1992-1998), a significant reduction of papers started to occur at most U.S. institutes. Possible factors contributing to this reduction learned during interviews could be changes to the nuclear mission by the U.S. government, reduction of human resources to create and process papers, and reduced reporting requirement policies being put into place.

E. Institutional Comparison by WOS

WOS focuses mainly on the research papers submitted to journals in the field of natural sciences; WOS has the advantage of being able to show a citation index or an impact factor. Research papers presented at international conferences and published in the form of proceedings are usually omitted, however. Because WOS has a large volume of citations, though, WOS data may be a good representation of publishing patterns in advanced research fields. A bibliometric study was done similar to that of the INIS database. Results obtained are shown in Figure 6.

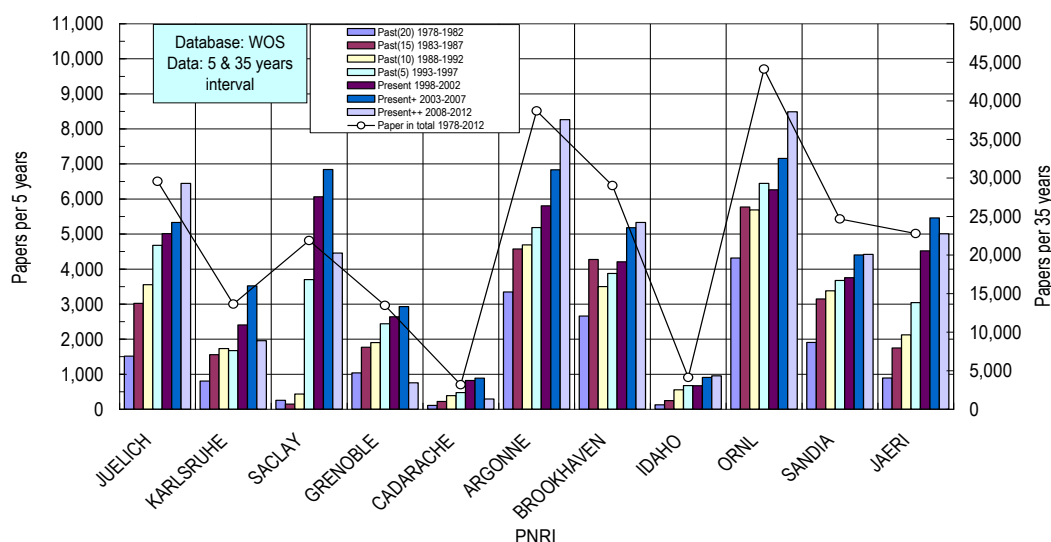


Fig. 6 All papers published in JAERI and 10 PNRI during the period 1978-2012. Open circles show the published papers during 35 years at each institute (scale is shown on the right-hand side) and the column shows the papers published during every 5-year intervals at each institute (scale is shown on the left-hand side). Database used was WOS.

Conclusions reached from this analysis were interesting.

(1) It is evident that there is a significant difference between the totals for U.S. papers and those from the other international sources. It is surmised that WOS may draw its data primarily from U.S. data sources, especially for historical periods.

Among PNRI papers, the ranking according to WOS is of the order of

ORNL(44,119papers)>ANL(38,689)>Jeulich:FZJ(29,549)>BNL(29,018)>SNL(24,674)>JAERI(22,782)>Saclay(21,884)>Karlsruhe:FZK(13,639)>Grenoble(13,464)> INL(4,128)>Cadache(3,185)>/5/

(2) As was clear from Equation /5/, ORNL here is the champion, too. One regrets to say that Germany, France and Japan totals are less, based on the data available within WOS.

(3) It is worth to mention that in the 5-year data increment comparisons within WOS, all research institutes, especially in the U.S., had a tendency to increase from the past (20) to date. This observation is apparently the reverse to that shown using the INIS database. The authors attribute this reversal to the likelihood that journal publishing is less dependent on the factors influencing research report and conference paper generation noted as contributing factors to the INIS database results.

F. Institutional Comparison by SCOPUS

SCOPUS focuses mainly on the journal submitted research papers in the field of natural and social sciences; it has a function to show a citation index (*h-index*) [10]. Research papers presented at international conferences and published in the form of proceedings are partly adopted, however. Because SCOPUS has a large volume of citations, though, SCOPUS data may be a good representation of publishing patterns in advanced research fields. A bibliometric study was done similar to that of the INIS database. Results obtained are shown in Figure 7.

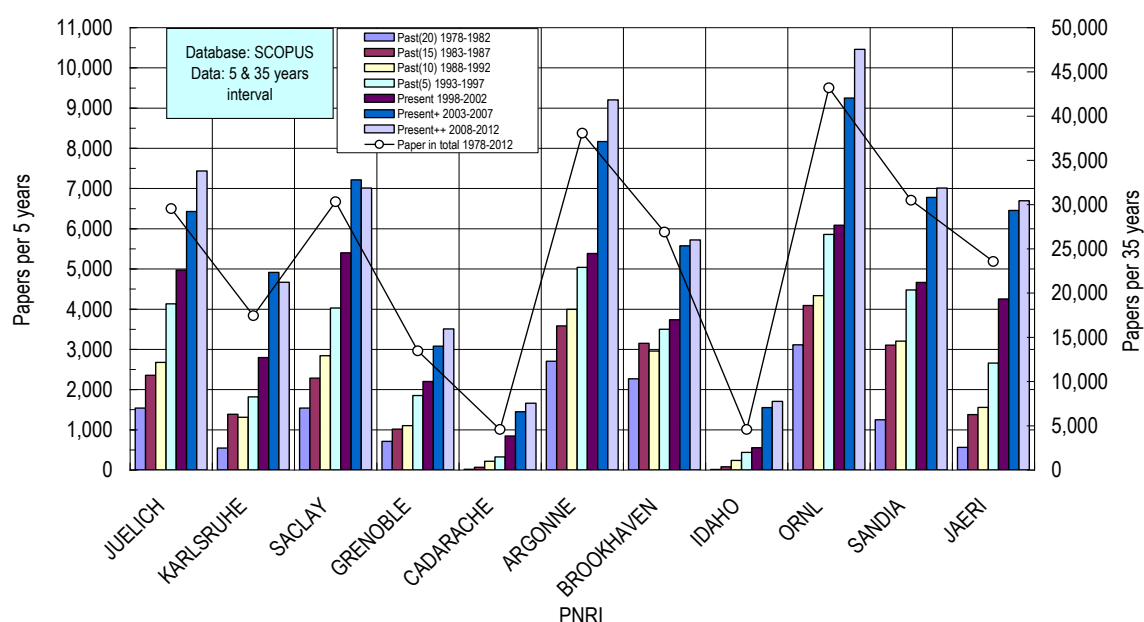


Fig. 7 All papers published in JAERI and 10 PNRI during the period 1978-2012. Open circles show the published papers during 35 years at each institute (scale is shown on the right-hand side) and the column shows the papers published during every 5-year intervals at each institute (scale is shown on the left-hand side). Database used was SCOPUS.

Conclusions reached from this analysis were interesting.

(1) Among PNRI papers, the ranking according to SCOPUS is of the order

ORNL(43,186papers)>ANL(38,071)>SNL(30,479)>Saclay(30,317)>Jeulich:FZJ(29,532)>BNL(26,900)>JAERI(23,555)>Karlsruhe:FZK(17,438)>Grenoble(13,466)>Cadache(4,576)>INL(4,575)/6/

(2) As was clear from Equation /6/, ORNL here is the champion, too. Saclay is the 4th position, FZJ is the 5th position and JAERI is the 7th position, based on the data available within SCOPUS.

(3) It is worth to mention that in the 5-year data increment comparisons within SCOPUS, all research institutes had a tendency to increase from the past (20) to date. This observation is apparently the reverse to that shown using the INIS database. This reversal has the similar reason explained in WOS.

G. Comparison of Databases for the U.S., European and Japan Sites

The results from the four databases used in the present study were compared with each other, using ORNL, CEA/Saclay and JAERI as representative international institutes for each figure. Figures 8 through 10 illustrate these comparisons.

Trends from Fig. 8 (ORNL) show that research papers registered by INIS gradually decrease from the past to the present. Those registered by ECD also show a decrease after the 1992-1998 timeframe but increased significantly at 2004-2010. While

journal submitted research papers registered by WOS and SCOPUS increased overall. With respect to ORNL, INIS, ECD, WOS and SCOPUS worked well, as all databases show good coverage.

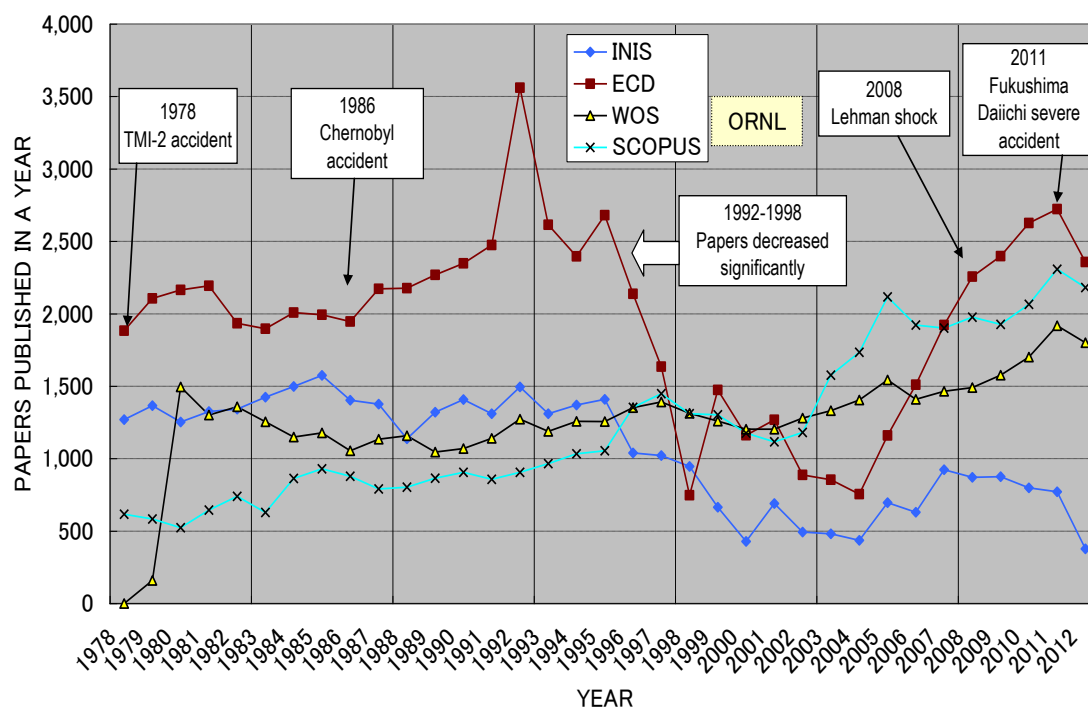


Fig. 8 Research papers registered in INIS, WOS, ECD and SCOPUS as a function of one year time spans at the PNRI ORNL, U.S

Trends from Fig. 9 (CEA/Saclay) show that research papers registered by INIS is almost constant or gradually decrease from the past to the present but those registered by ECD are much less and negligible. While those registered by WOS and SCOPUS are rapidly increasing from the past to the present. This appears to imply that both WOS and SCOPUS are preferred sources when trying to find papers from CEA/Saclay, France.

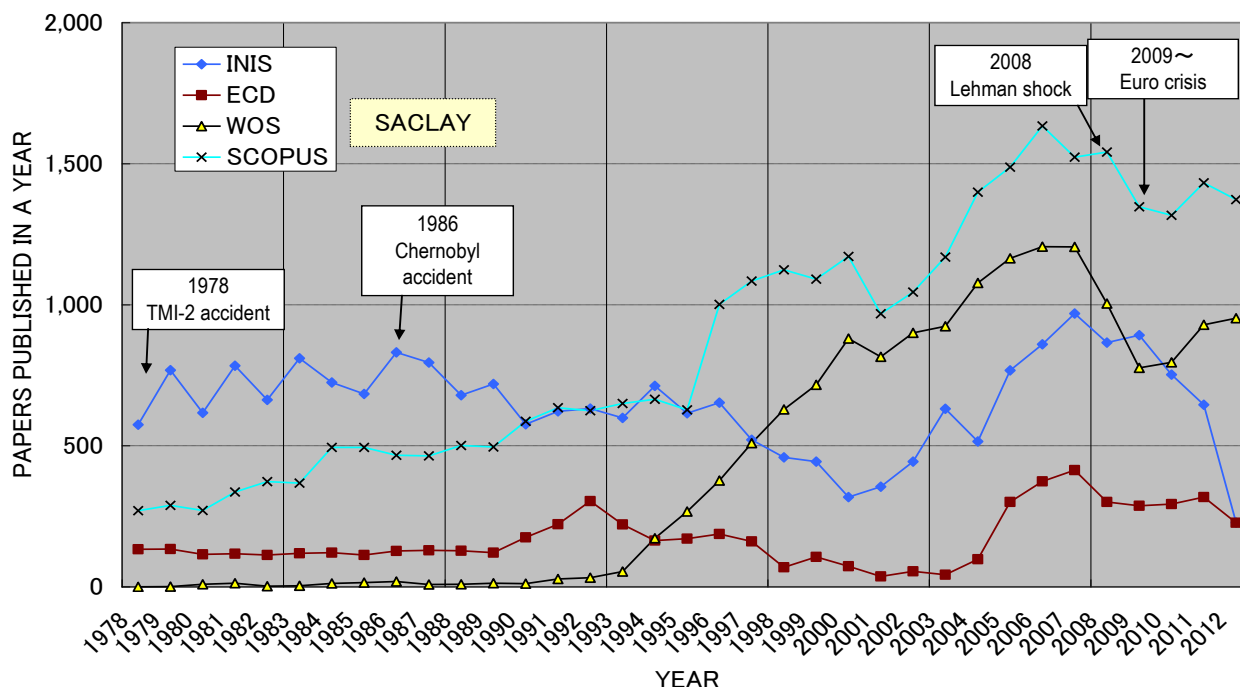


Fig. 9 Research papers registered in INIS, ECD, WOS and SCOPUS as a function of one year time span at the PNRI Saclay, France

Trends from Fig. 10 (JAERI) show that the number of research papers registered by INIS is significantly large in magnitude, while those registered by WOS and SCOPUS are rapidly increasing from the past to the present. Research papers registered by ECD are much less and negligible. This implies that the INIS database is the predominant source for research in Japan. WOS and SCOPUS are to be preferred sources in the near future.

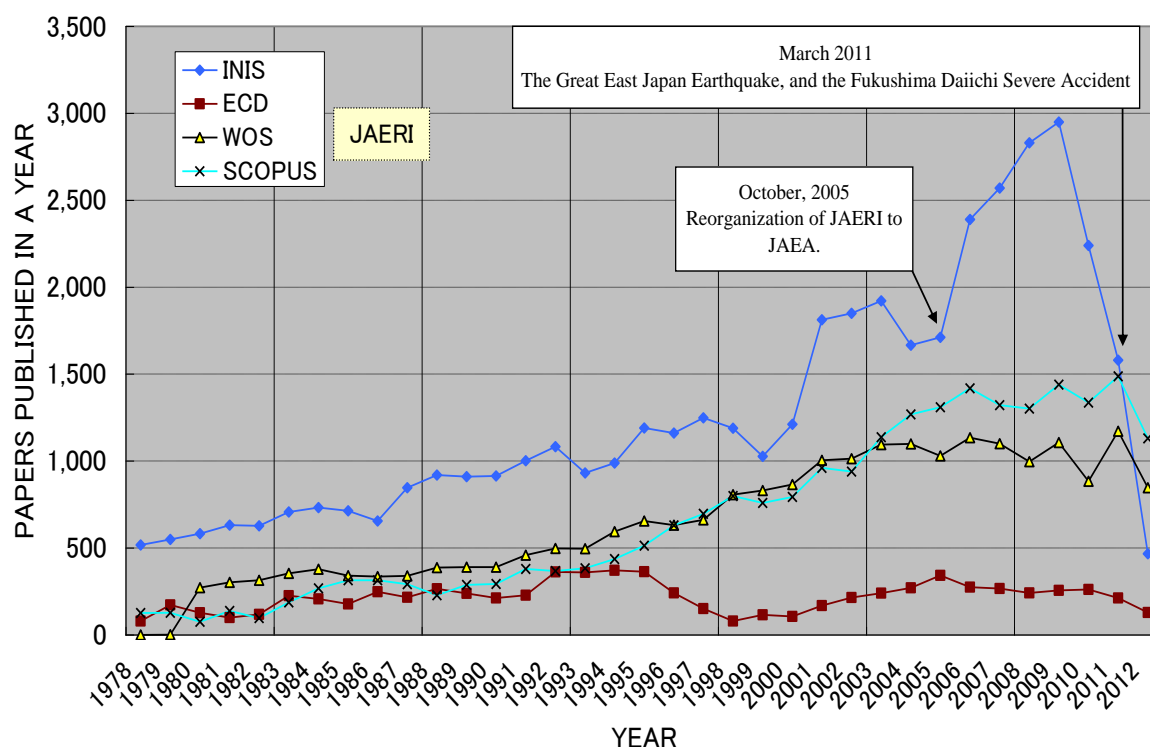


Fig. 10 Research papers registered in INIS, ECD, WOS and SCOPUS as a function of one year time span at the PNRI JAERI, Japan

IV. CONCLUSIONS

(1) The present bibliometric study shows that research knowledge from JAERI and 10 PNRI is retained successfully and is available in the INIS database, as well as the more U.S.-focused ECD and WOS, and global (especially Europe)-focused SCOPUS systems. The explicit knowledge (some over 60 years old) could and should be utilized for convenient R&D works, educational and training purposes.

(2) Well-indexed knowledge can provide a sound basis for institutional comparison which is valid from the viewpoint of nuclear knowledge management. Within the present scope of the study and period evaluated, the world champion among JAERI and the 10 PNRI is JAERI by INIS but ORNL according to ECD, WOS and SCOPUS. This is supported by the volume of papers included in INIS, ECD, WOS and SCOPUS, although international information in the ECD is limited.

(3) It is essential to say that the volume of paper publications from JAERI and other 10 PNRI affected significantly by the external events such as the change of nuclear policies (e.g., de-emphasis of reprocessing policies in the U. S., and reorganization of JAERI (2005), the nuclear accidents (e.g., Fukushima Daiichi (2011)), and economical dynamics (e.g., Lehman shock(2008)). It is clear that the capability of knowledge is affected by those external events.

(4) Different characteristics exhibited by individual databases can sometimes generate conflicting bibliometric results. This was true among INIS, ECD, WOS and SCOPUS when looking at trends especially between 5-year periods. It implies that results from analytical tools used in bibliometric studies should be viewed with careful consideration to learn of any influencing factors. INIS is useful for determining the research-oriented general champion in the world. WOS and SCOPUS are useful for determining the champion of journal submitted research papers. ORNL is the case.

(5) Use of INIS has predominance in Japan, and ECD in the U.S. Users from developed and developing countries assigned as the Member State of IAEA would be better served using INIS and ECD. Based on interviews, as the recent trend use of WOS and SCOPUS has tended to grow worldwide.

(6) Due to the copyright of the research papers, the champion data comparison is hard to perform with country-to-country, at moment the comparison with PNRI-to-PNRI is adequate.

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