



IAEA NKM Programme



International Fast Reactor Knowledge Organization System

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*International Conference on Fast Reactors and Related Fuel
Cycles (FR09): Challenges and Opportunities
7-11 December 2009, Kyoto, Japan*



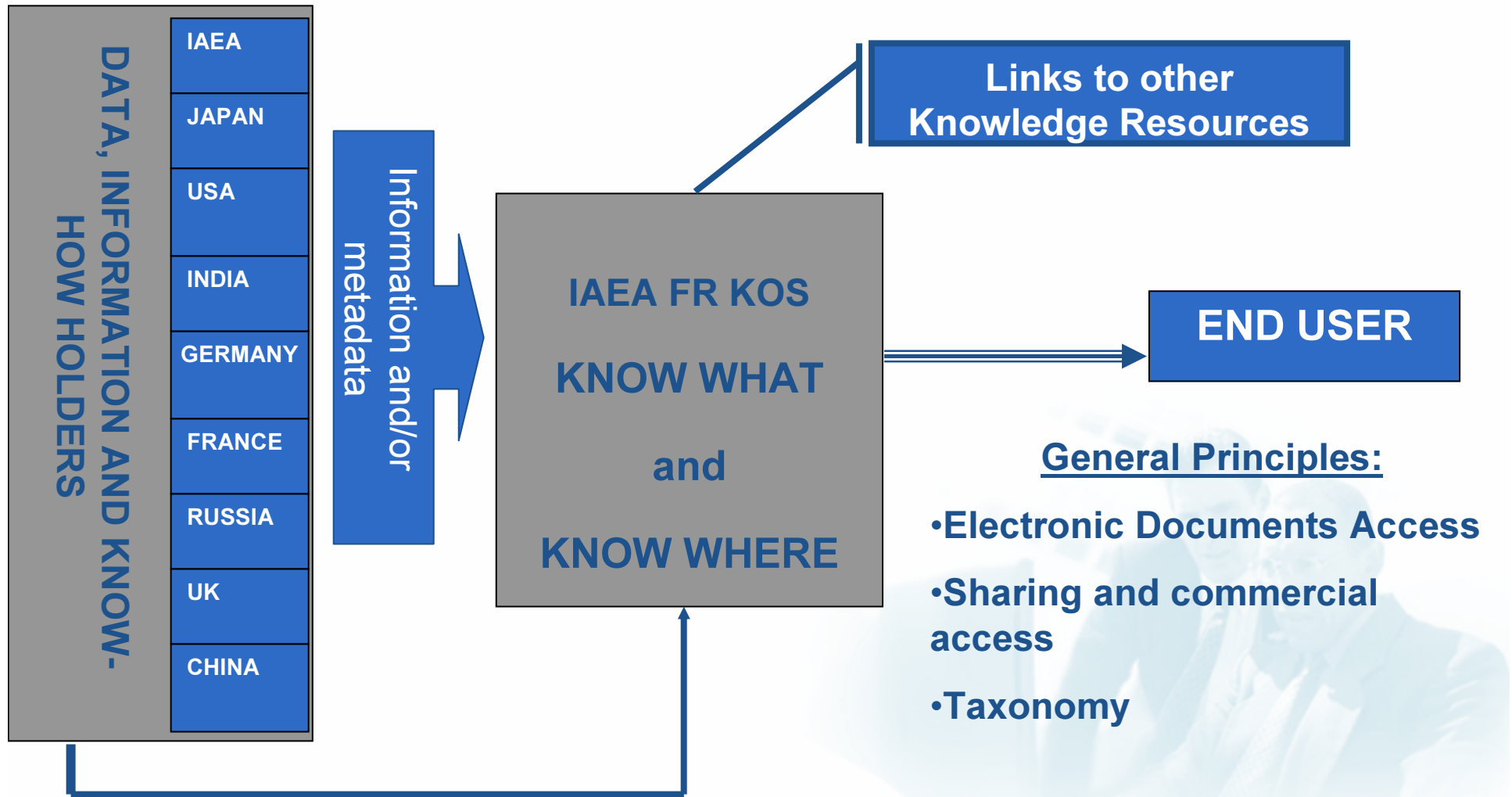
Fast Reactor Knowledge Preservation Initiative

- **To capture, preserve, maintain and share with interested Member States knowledge on Fast Reactors which exists on national level and complement current and future Member States' nuclear knowledge capacity.**





Fast Reactor Knowledge Partnership





FR KOS Project Objective

- **To develop a Knowledge Organization System into which existing national knowledge and information systems will fit, and which will complement and integrate current and future Member States' efforts to preserve fast reactor data and knowledge.**



FR KOS Motivation factors

- **Continuing knowledge loss over decades**
- **Research and Development**
- **Nuclear Education, scientists and students**
- **From Nuclear Renaissance
to Fast Reactors Innovative Renaissance, FR09**
- **Developed countries, Developing countries, Nuclear
Newcomers**



FR Knowledge Preservation Initiative

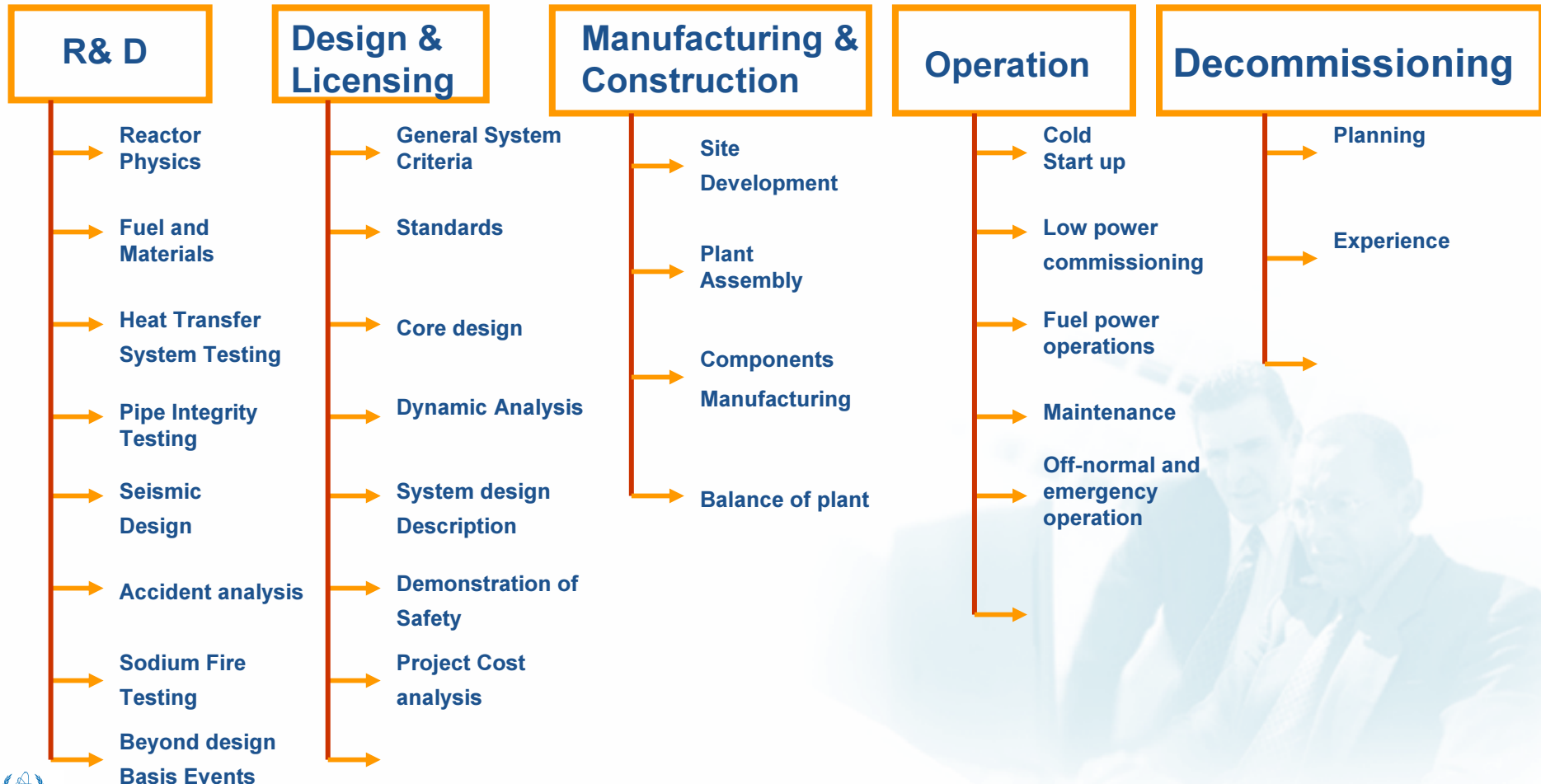
- **Contributors:**
 - **Participating Member States: China, France, Germany, Japan, Russia, UK, USA, India**
 - **Role of the IAEA**
 - **New members are welcome**
- **Common approach:**
 - **System requirements and implementation**
 - **FR Knowledge Domain**



Fast Reactors Knowledge

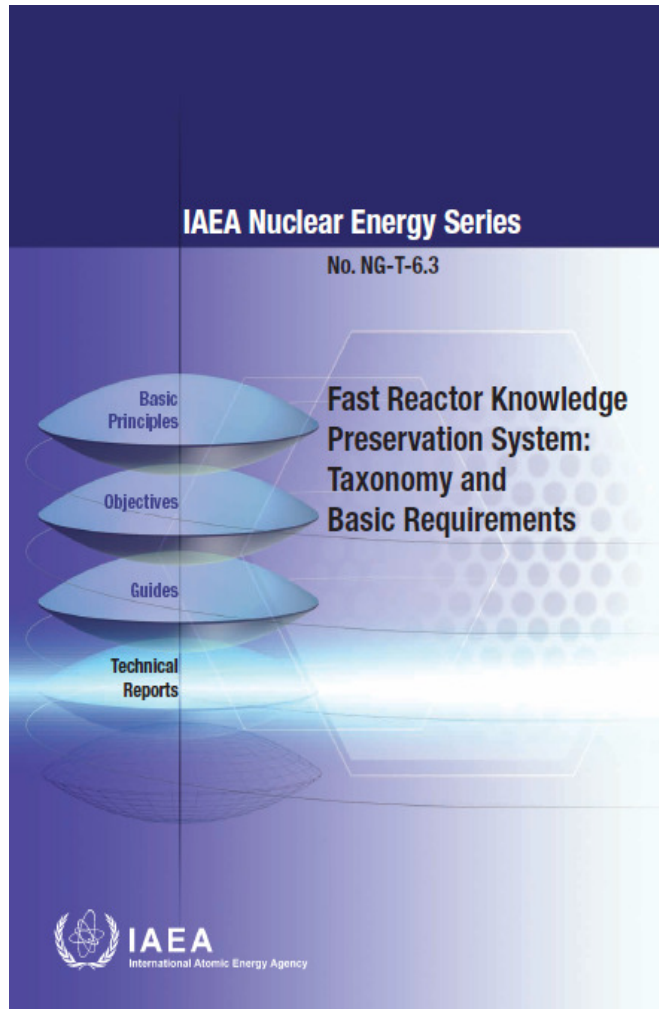
Technology development

Technology utilization





Project milestones



NE Series Report NG-T-6.3 defines

- Taxonomy
- Basic Requirements

for

Fast Reactor
Knowledge Organization System



Fast Reactor Taxonomy

- Fast Reactor Taxonomy is
 - a hierarchical model
 - of knowledge domain
 - in the field of Fast Reactor Science and Technology



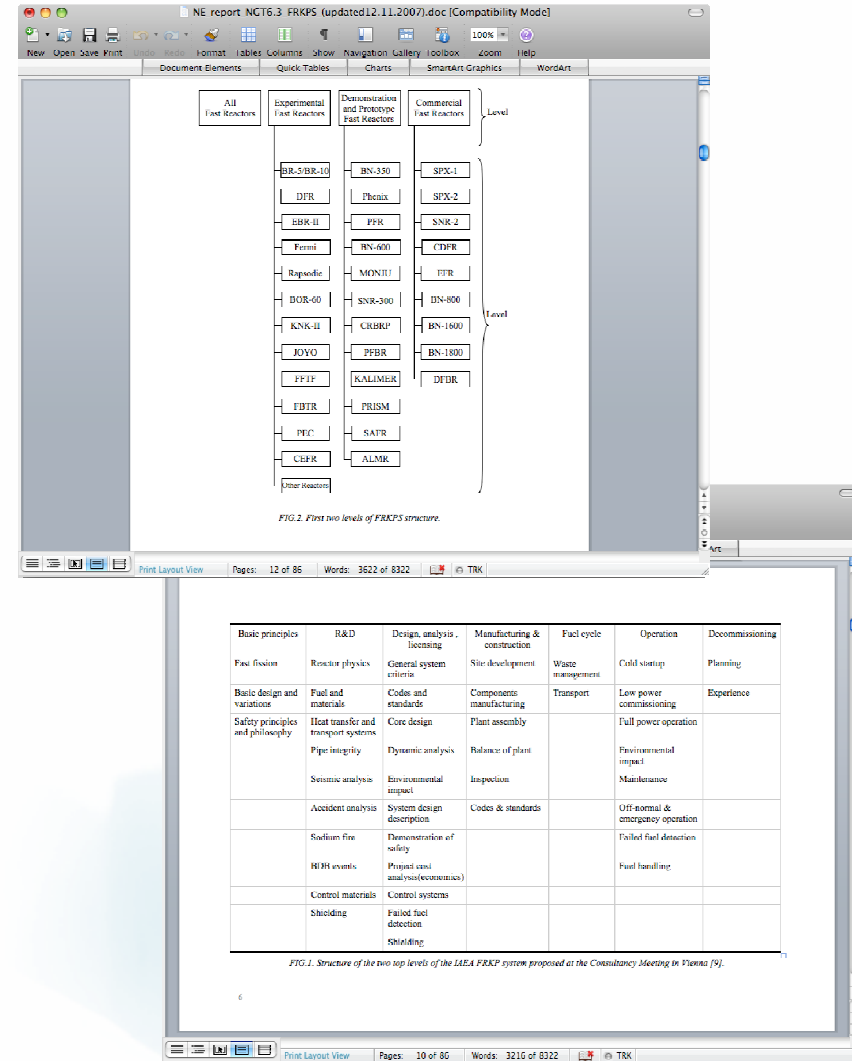
Fast Reactor Taxonomy

- Covers

- all possible types of fast reactors
- all aspects of fast reactors
- all stages of implementation of fast reactor technology

- Based on 2 dimensional matrix (2 top levels):

- stages of implementation
- technology elements

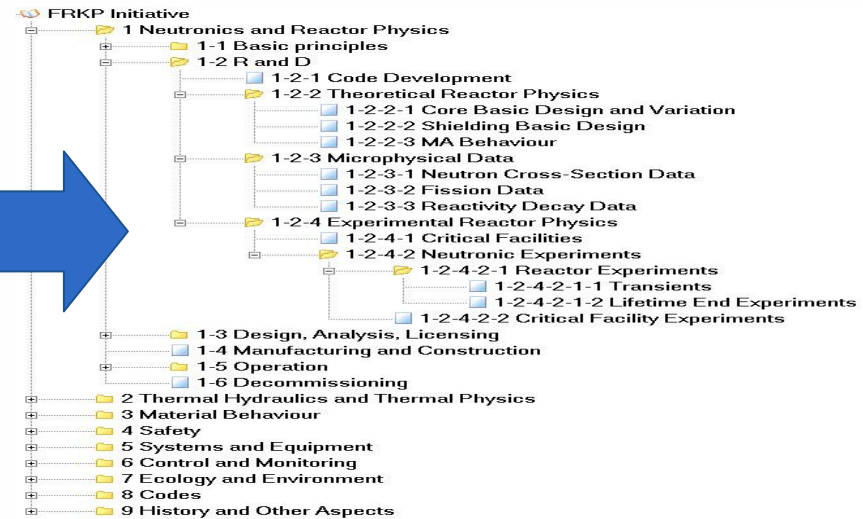




Fast Reactor Taxonomy - Topic Trees

STAGE	1	2	3	4	5	6	
TOPIC	Basic Principles	R&D	Design, Analysis, Licensing	Manufacturing & Construction	Operation	Decommissioning	
1 Neutronics & Reactor Physics	Branch 1-1	Branch 1-2	Branch 1-3	Branch 1-4*	Branch 1-5	Branch 1-6*	
2 Thermal Hydraulics & Thermal Physics	Branch 2-1	Branch 2-2	Branch 2-3	Branch 2-4	Branch 2-5	Branch 2-6	
3 Material Behaviour	Fuel	Branch 3-1-1	Branch 3-1-2	Branch 3-1-3	Branch 3-1-4	Branch 3-1-5	Branch 3-1-6
	Coolant	Branch 3-2-1	Branch 3-2-2	Branch 3-2-3	Branch 3-2-4	Branch 3-2-5	Branch 3-2-6
	Structural Materials	Branch 3-3-1	Branch 3-3-2	Branch 3-3-3	Branch 3-3-4	Branch 3-3-5	Branch 3-3-6
	Absorber	Branch 3-4-1	Branch 3-4-2	Branch 3-4-3	Branch 3-4-4	Branch 3-4-5	Branch 3-4-6
	Other Materials	Branch 3-5-1	Branch 3-5-2	Branch 3-5-3	Branch 3-5-4	Branch 3-5-5	Branch 3-5-6
4 Safety	Branch 4-1	Branch 4-2	Branch 4-3	Branch 4-4	Branch 4-5	Branch 4-6	
5 Systems & Equipment	Branch 5-1	Branch 5-2	Branch 5-3	Branch 5-4	Branch 5-5	Branch 5-6	
6 Control & Monitoring	Branch 6-1	Branch 6-2	Branch 6-3	Branch 6-4	Branch 6-5	Branch 6-6	
7 Ecology & Environment	Branch 7-1	Branch 7-2	Branch 7-3	Branch 7-4*	Branch 7-5	Branch 7-6	
8 Codes	Branch 8-1	Branch 8-2	Branch 8-3	Branch 8-4*	Branch 8-5	Branch 8-6	
9 History & Other Aspects	Branch 9-1	Branch 9-2	Branch 9-3	Branch 9-4	Branch 9-5	Branch 9-6	

FIG.3. The First Two Levels of the USTS (Stage & Topic Matrix).



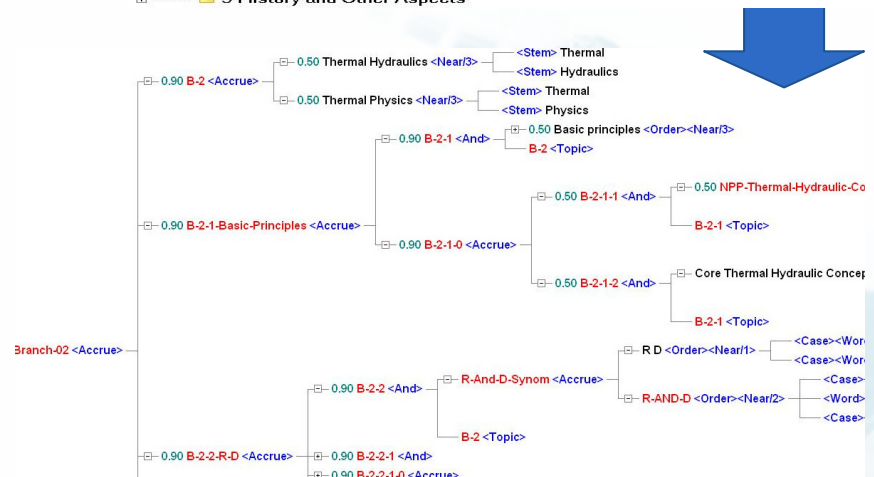
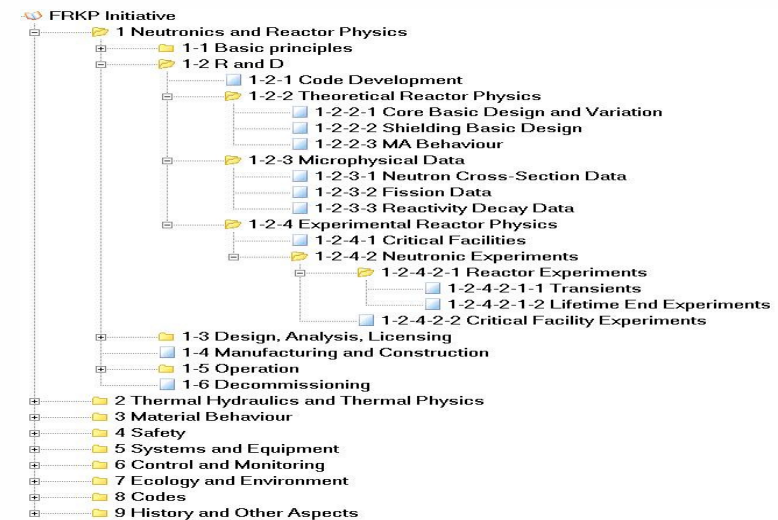
- Fast Reactor Topic Trees are digital implementation (in knowledge organization system) of Fast Reactor Taxonomy



Fast Reactor Topic Trees

■ Topic trees

- are predefined queries
- organized in tree-like form
- with the purpose of searching on Fast Reactor (FR) Knowledge Base (KB)
- are available to end users as a shared resources
- encapsulate a hierarchical structure the expert's knowledge

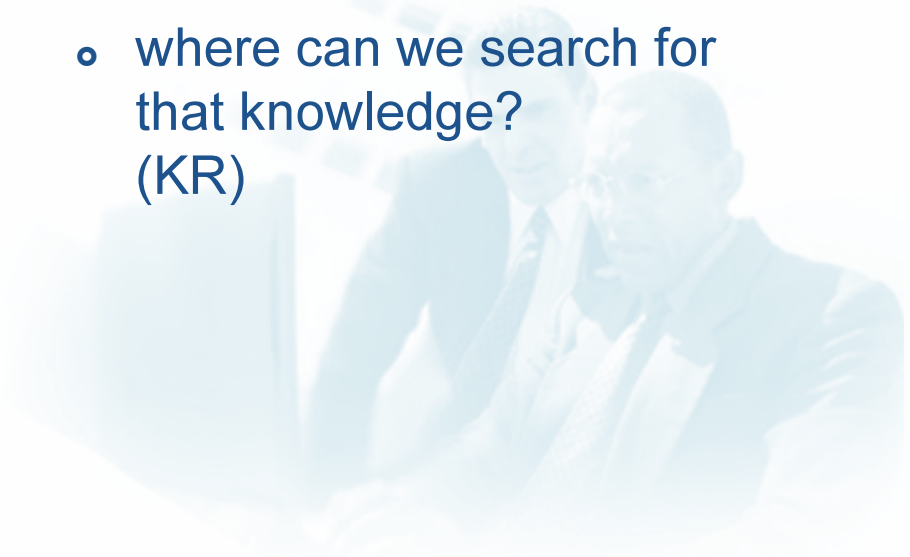




Fast Reactors Knowledge – Where to get?



- WHAT?
 - we know what we want to find
(Topic Trees)
- WHERE ?
 - where can we search for that knowledge?
(KR)





Fast Reactor Knowledge Repository

- Sources of the FR Knowledge
 - Member States
 - INIS and other Information and Knowledge Systems
 - Topical events
 - Internet
 - NuArch (future prospective)

- Information types
 - Limited to Metadata
 - Full texts or availability in metadata

Fast Reactor Knowledge Repository

Groups in Repository

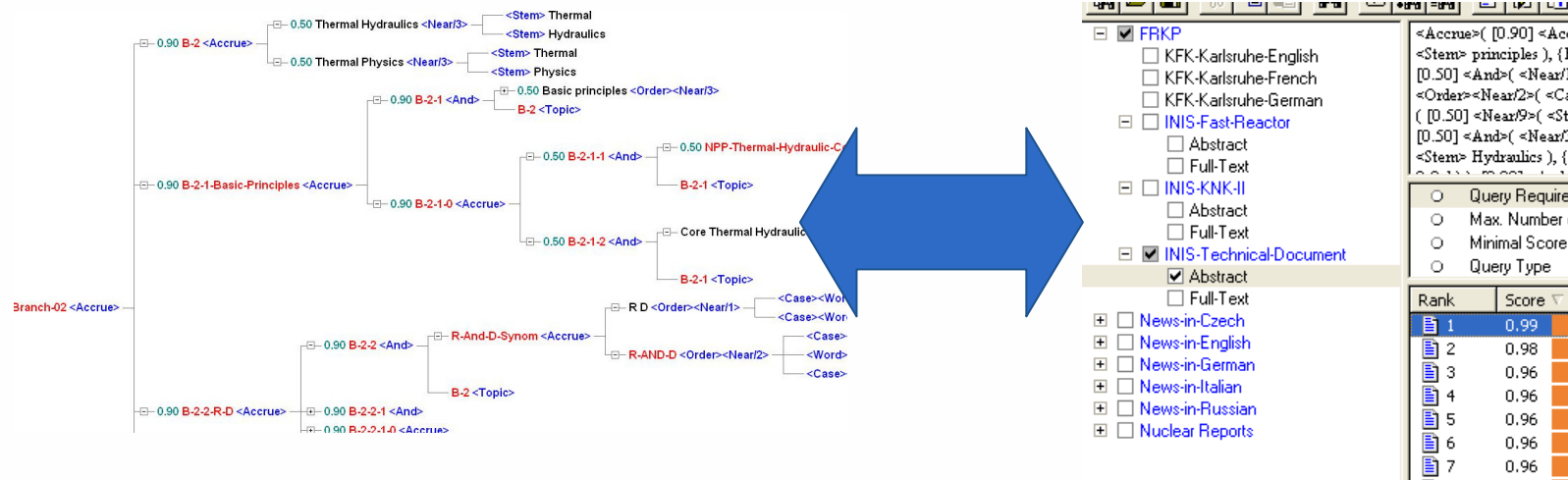
- Metadata
- Full texts
- Language
- Sources/MS
- Type of sources

Can be selected individually for further processing

Rank	Score	Title	Date	Source
1	0.99	...	2006-01-01	INIS-Technical-Doc-Abstract
2	0.98	...	1999-01-01	INIS-Technical-Doc-Abstract
3	0.96	...	2006-01-01	INIS-Technical-Doc-Abstract
4	0.96	...	2000-01-01	INIS-Technical-Doc-Abstract
5	0.96	...	1996-01-01	INIS-Technical-Doc-Abstract
6	0.96	...	1992-01-01	INIS-Technical-Doc-Abstract
7	0.96	...	2004-01-01	INIS-Technical-Doc-Abstract
8	0.95	...	2006-01-01	INIS-Technical-Doc-Abstract
9	0.95	...	2006-01-01	INIS-Technical-Doc-Abstract
10	0.95	...	2002-01-01	INIS-Technical-Doc-Abstract
11	0.94	...	1999-01-01	INIS-Technical-Doc-Abstract
12	0.94	...	2003-01-01	INIS-Technical-Doc-Abstract
13	0.94	...	1985-01-01	INIS-Technical-Doc-Abstract
14	0.93	...	2002-01-01	INIS-Technical-Doc-Abstract
15	0.93	...	2004-01-01	INIS-Technical-Doc-Abstract
16	0.93	...	1997-01-01	INIS-Technical-Doc-Abstract
17	0.92	...	1997-01-01	INIS-Technical-Doc-Abstract
18	0.92	...	1985-01-01	INIS-Technical-Doc-Abstract
19	0.92	...	2007-01-01	INIS-Technical-Doc-Abstract
20	0.91	...	2006-01-01	INIS-Technical-Doc-Abstract
21	0.91	...	2003-01-01	INIS-Technical-Doc-Abstract



Topic Trees and Document Collections



- Topic trees include intellectual rules how to filter documents based on the selected
 - Topic Tree
 - Document repositories



Document Search – How it works?

Topic Tree Search Element

Selected Repositories

Metadata

Results Documents found

Documents found !!!

Total number of documents

Rank	Score	Title	Date	Source
1	0.99	Advanced heavy water reactor (AHWR)	2006-01-01	INIS-Technical-Doc-Abstract
2	0.98	LMFR core and heat exchanger thermohydraulic design: former USSR and present ...	1999-01-01	INIS-Technical-Doc-Abstract
3	0.96	System-integrated modular advanced reactor (SIMAR)	2006-01-01	INIS-Technical-Doc-Abstract
4	0.96	Fast reactor core thermal-hydraulic analyses during transition from forced to natur...	2000-01-01	INIS-Technical-Doc-Abstract
5	0.96	Status of fast reactor developments in India	1996-01-01	INIS-Technical-Doc-Abstract
6	0.96	The convertible spectrum of a fast reactor	1992-01-01	INIS-Technical-Doc-Abstract
7	0.96	R and D LMFRs knowledge preservation French project	2004-01-01	INIS-Technical-Doc-Abstract
8	0.95	Thermal-hydraulic ADS Lead bismuth Loop (TALL) and experiments on a heat exch...	2006-01-01	INIS-Technical-Doc-Abstract
9	0.95	HELIOS for thermal-hydraulic behavior of Pb-Bi cooled fast reactor PEACER	2006-01-01	INIS-Technical-Doc-Abstract
10	0.95	Thermal-hydraulic aspects of CANDU reactor	2002-01-01	INIS-Technical-Doc-Abstract
11	0.94	Neutronics and thermal-hydraulics characteristics of the CANDU core fueled with sli...	1999-01-01	INIS-Technical-Doc-Abstract
12	0.94	Experimental and numerical studies on thermal-hydraulics of spallation targets	2003-01-01	INIS-Technical-Doc-Abstract
13	0.94	Development strategy of advanced and future PWR	1985-01-01	INIS-Technical-Doc-Abstract
14	0.94	Development strategy of advanced and future PWR	1985-01-01	INIS-Technical-Doc-Abstract
15	0.93	PACTEL passive safety injection experiments and APROS code analysis	2002-01-01	INIS-Technical-Doc-Abstract
16	0.93	Preserving safety margins with planned power uprate at Paks NPP	2004-01-01	INIS-Technical-Doc-Abstract
17	0.93	The MRX integral reactor: Maintenance and cost evaluation for ship application	1997-01-01	INIS-Technical-Doc-Abstract
18	0.92	An autonomous nuclear power plant with integrated nuclear steam supply system ...	1997-01-01	INIS-Technical-Doc-Abstract
19	0.92	Research reactor core conversion from the use of highly enriched uranium to the u...	1985-01-01	INIS-Technical-Doc-Abstract
20	0.92	Simulation of coupled phenomena for Advanced Heavy Water Reactor (AHWR): A...	2007-01-01	INIS-Technical-Doc-Abstract
21	0.91	Fast reactor database, 2006 update	2006-01-01	INIS-Technical-Doc-Abstract
22	0.91	3D calculations for Bubble Column Reactor qualification	2003-01-01	INIS-Technical-Doc-Abstract
23	0.91	3D calculations for Bubble Column Reactor qualification	2003-01-01	INIS-Technical-Doc-Abstract
24	0.91	3D calculations for Bubble Column Reactor qualification	2003-01-01	INIS-Technical-Doc-Abstract



Outputs of Fast Reactor Knowledge Organization System

- Documents from the result list can be
 - exported in different format (XML HTML, text) which can be analysed further
 - made available for Member States
 - used by subject matter experts (SME)

Ranked Document List

Rank	Score	Title	Date	Source
1	0.99	Advanced heavy water reactor (AHWR)	2006-01-01	INIS-Technical-Doc-Abstract
2	0.98	LMFR core and heat exchanger thermohydraulic design: former USSR and present day		
3	0.96	System-integrated modular advanced reactor (SMART)		

Keywords, Descriptors

designated, operation, construction, design, physics, thermal, hydraulic, analysis, fuel, natural, circulation, coolant, experimental, facilities, core, designs, cooled, convection, hydraulics

Full text or information about the sources

The first phase of the Indian nuclear power programme is based on natural uranium fuelled, heavy water moderated pressurized tube type reactors commonly designated as pressurized heavy water reactors (PHWRs), also known as CANDUs for such reactors of Canadian origin. Thirteen out of fifteen Indian nuclear power reactors under operation, and five out of eight Indian nuclear power reactors under construction, at the beginning of April 2005, are PHWRs. The first two of these reactors, Rajasthan units -1 and -2 are similar in design to the Canadian Douglas Point reactor. Rajasthan-1 was built at Rawatbhatta in India with Canadian collaboration. This reactor started commercial operation in November 1972. Subsequently, the construction of Rajasthan-2 and design and construction of all future Indian PHWRs was done indigenously in India. The design of Indian PHWRs has progressively been improved and augmented to take into account the feedback from national as well as international

FR KOS – Knowledge Mining and Analytics

List of matched words (highlighted) in the selected document

Query in Time – Distribution of the retrieved documents in function of time (year)

Document Properties

Document: .../INIS-Technical-Documents/html/37052837.h
 Changed:
 Size:

Count	Text
10	design
4	operation
4	construction
3	thermal
3	natural
2	analysis
2	fuel
1	designs
1	hydraulics
1	experimental
1	designated
1	hydraulic

Query in Time

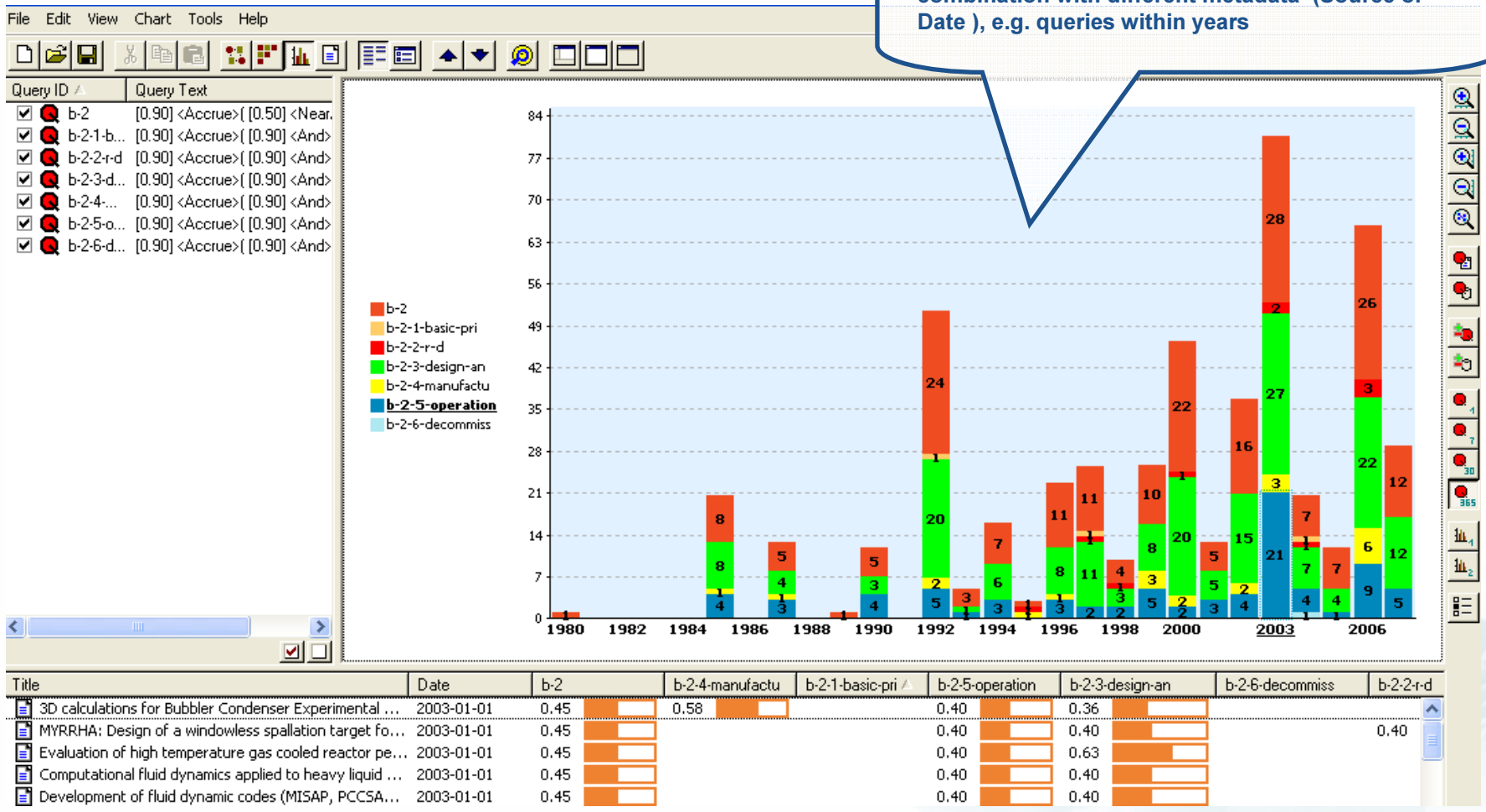
001 005 007 031 365

Year	Count
1980	1
1985	8
1988	5
1990	5
1992	24
1993	3
1994	7
1996	11
1997	11
1998	4
1999	10
2000	22
2001	5
2002	16
2003	28
2004	7
2005	7
2006	26
2007	12



FR KOS – Summary Graph

Visualisation of the results of the queries in combination with different metadata (Source or Date), e.g. queries within years

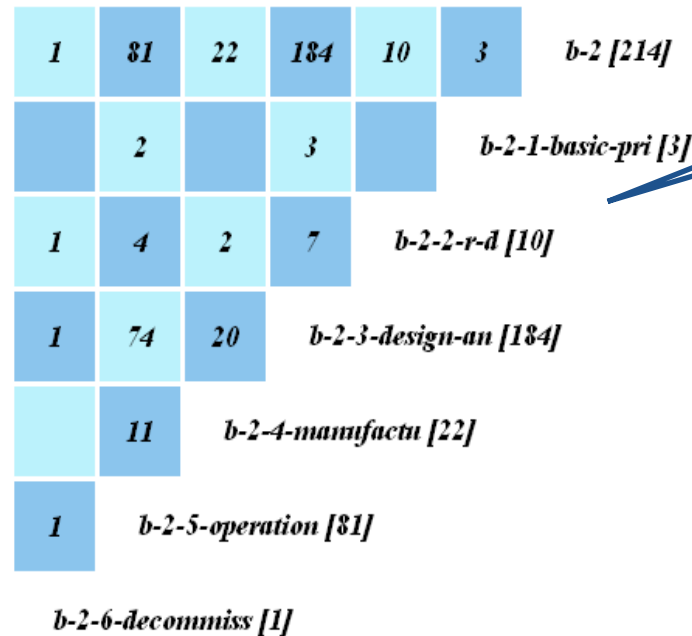


FR KOS – Cross Matrix

File Edit View Chart Tools Help



Query ID	Query Text
<input checked="" type="checkbox"/> b-2	[0.90] <Accrue>{ [0.50] <Near...
<input checked="" type="checkbox"/> b-2-1-b...	[0.90] <Accrue>{ [0.90] <And>
<input checked="" type="checkbox"/> b-2-2-r-d	[0.90] <Accrue>{ [0.90] <And>
<input checked="" type="checkbox"/> b-2-3-d...	[0.90] <Accrue>{ [0.90] <And>
<input checked="" type="checkbox"/> b-2-4...	[0.90] <Accrue>{ [0.90] <And>
<input checked="" type="checkbox"/> b-2-5-o...	[0.90] <Accrue>{ [0.90] <And>
<input checked="" type="checkbox"/> b-2-6-d...	[0.90] <Accrue>{ [0.90] <And>



Number of documents matching all the possible permutations by two queries (or topics)

Documents matching the selected element of the Cross Matrix

Title	Date	b-2	b-2-4-manufactu	b-2-1-basic-pri	b-2-5-operation	b-2-3-design-an	b-2-6-decommiss	b-2-2-r-d
RITME: A Fast and simple computing code for PWR co...	1992-01-01	0.44		0.40		0.36		
Preserving safety margins with planned power uprat...	2004-01-01	0.45		0.40	0.40	0.63		
An autonomous nuclear power plant with integrated ...	1997-01-01	0.45		0.40	0.63	0.36		
System-integrated modular advanced reactor (SMART)	2006-01-01	0.45	0.80		0.40	0.40		
LMFR core and heat exchanger thermohydraulic desi...	1999-01-01	0.45	0.77		0.40	0.75		
Fast reactor core thermal-hydraulic analyses during t...	2000-01-01	0.45	0.76			0.71		
A review on the Indian fast reactor programme. April...	1995-01-01	0.45	0.70					0.40
Experimental and numerical studies on thermal-hydra...	2003-01-01	0.45	0.70			0.40		0.40
Advanced heavy water reactor (AHWR)	2006-01-01	0.67	0.70		0.61	0.76		





FR KOS – Knowledge Mining and Analytics

Nuclear-General.tqv - InfoRating

File Edit View Chart Tools Help

Query ID /

- 1-neutronics-reactor-physics
- 2-thermal-hydraulics-thermal-physics
- 3-material-behaviour
- 4-safety
- 5-systems-equipment
- 6-control-monitoring
- 7-ecology-environment
- 8-codes
- 9-history-other-aspects

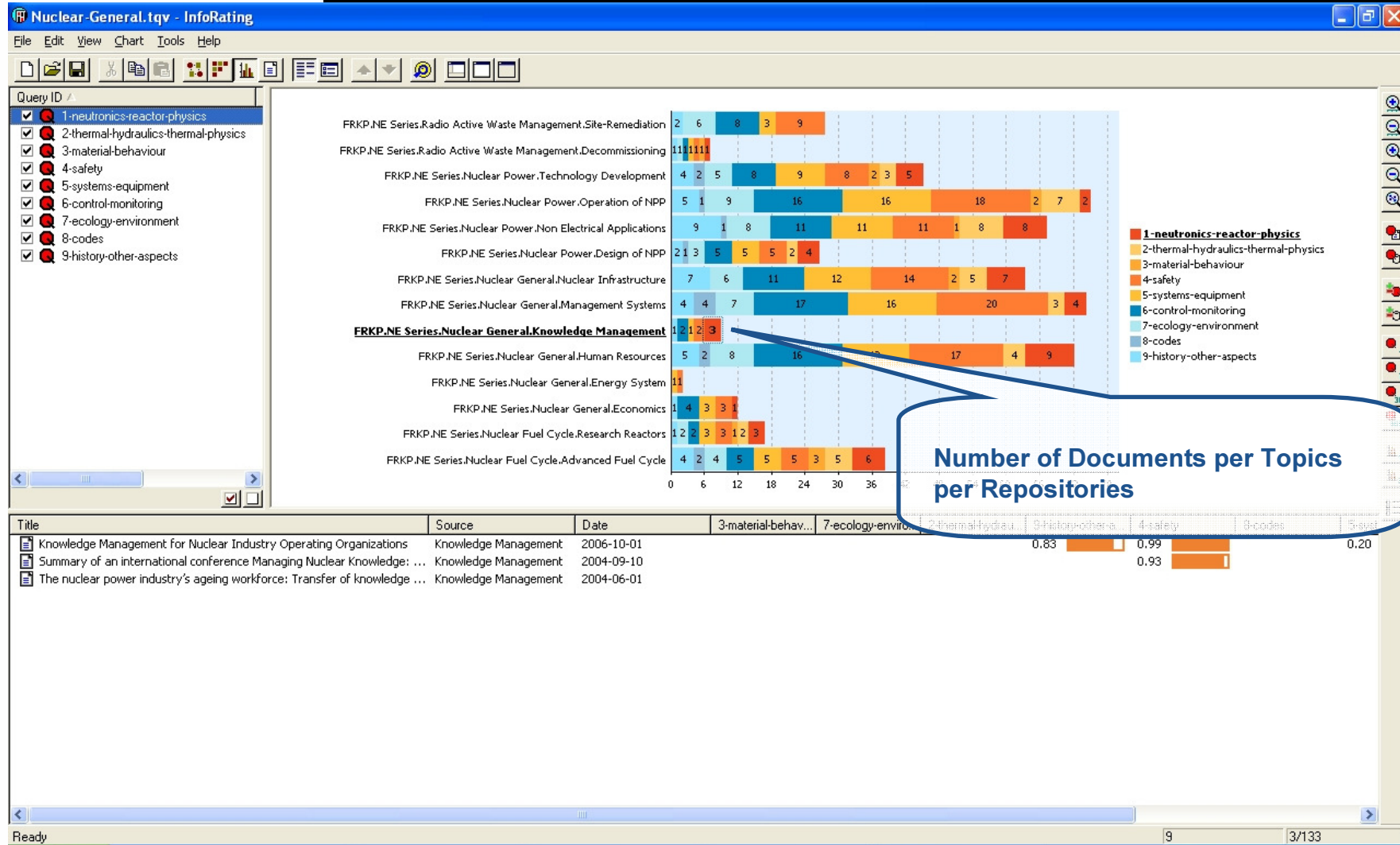
25	9	32	49	49	51	7	30	1-neutronics-reactor-physics [53]
21	8	24	38	37	37	7		2-thermal-hydraulics-thermal-physics [39]
8	1	9	10	11	10			3-material-behaviour [12]
45	12	56	98	95				4-safety [157]
39	11	52	87					5-systems-equipment [98]
41	12	56						6-control-monitoring [106]
30	7							7-ecology-environment [59]
4								8-codes [13]
								9-history-other-aspects [46]

Cross-referenced documents

Title	Source	Date	3-material-behav...	7-ecology-enviro...	2-thermal-hydrau...	9-history-other-a...	4-safety	8-codes	5-syst
Optimization of the coupling of nuclear reactors and desalination syste...	Non Electrical Applications	2005-06-01		0.47	0.97	0.73	1.00	0.92	0.75
Potential of thorium based fuel cycles to constrain plutonium and reduc...	Advanced Fuel Cycle	2003-05-01			0.63			0.83	
International outage coding system for nuclear power plants - Results o...	Operation of NPP	2004-05-01			0.61		0.95	0.58	0.15
Quality Assurance for Software Important to Safety	Management Systems	2000-12-01			0.22		0.99	0.94	0.15
Fuel cycle options for light water reactorsand heavy water reactors	Advanced Fuel Cycle	1998-05-01	1.00	0.31	0.82	0.94	1.00	0.83	0.35
Advanced calculational methods for power reactors and LWR core desig...	Design of NPP	1991-10-07		0.31	0.87	0.11	0.98	1.00	0.59
TRAINING TOWARDS QUALITY PERFORMANCE COMPETENCE OF MAN...	Human Resources	1992-10-01			0.41		0.91	0.89	0.23
Operator support systemsin nuclear power plants	Technology-Development	1994-09-01		0.50	0.91	0.81	0.98	0.88	0.73

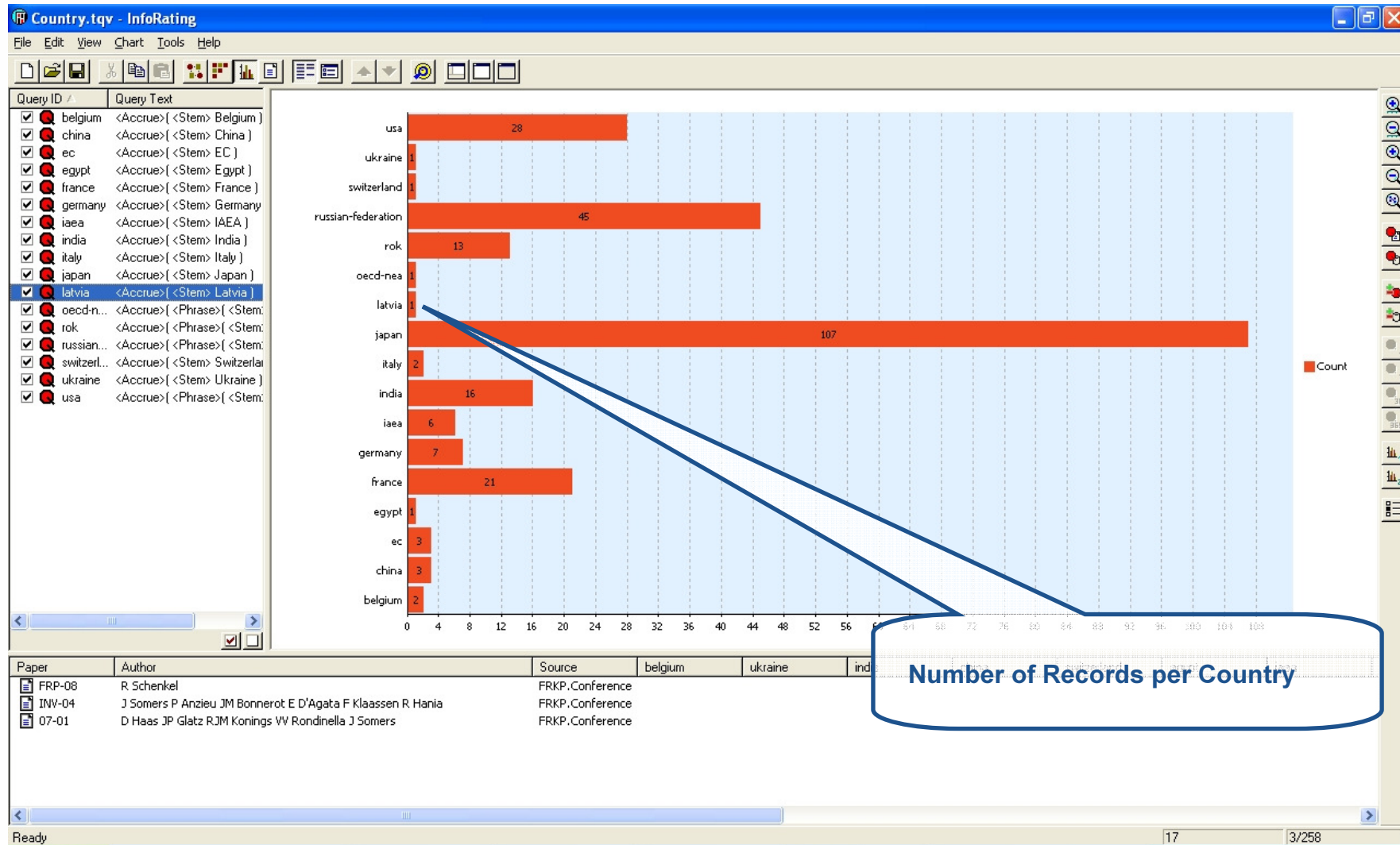
Ready 9 8/133

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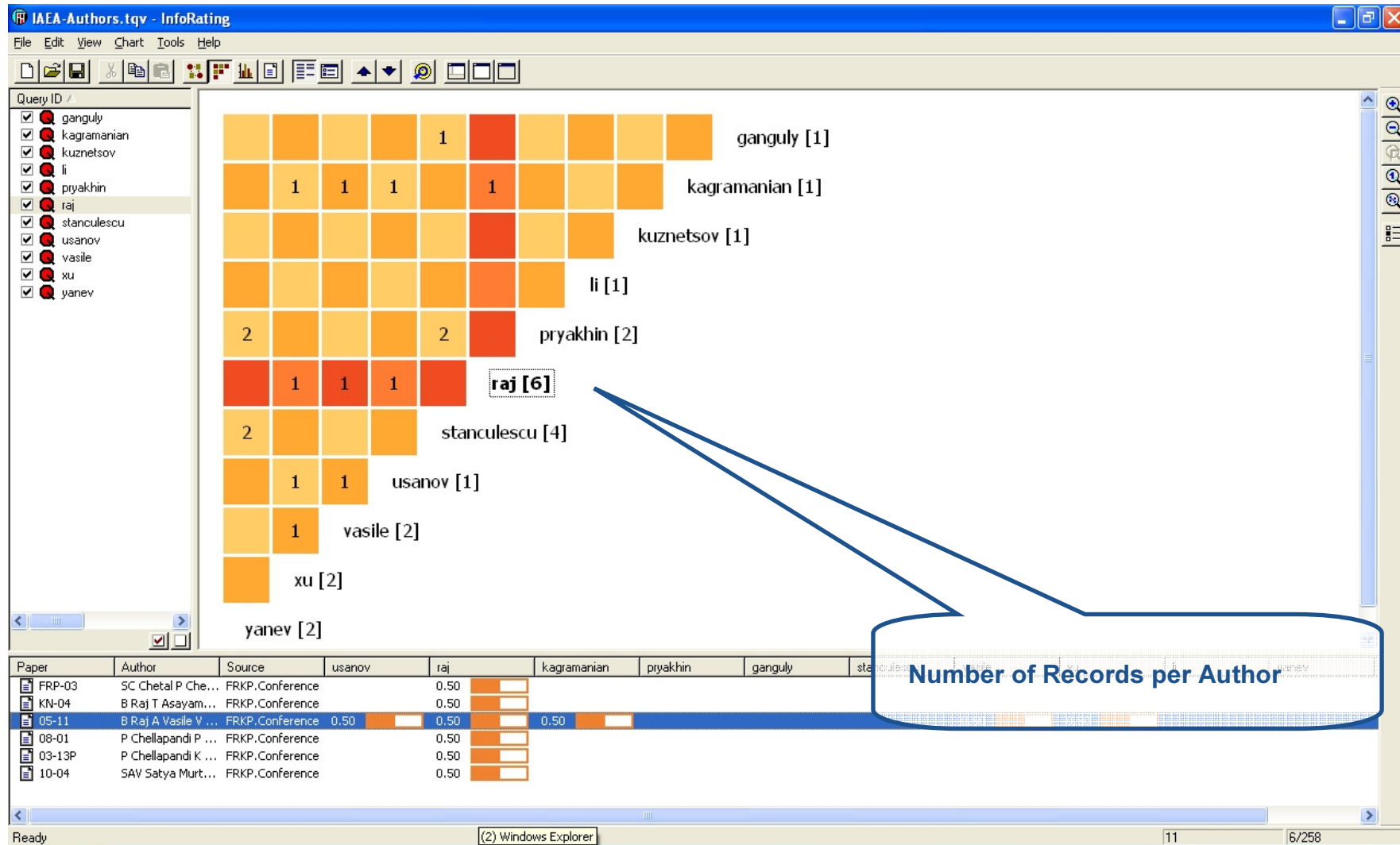




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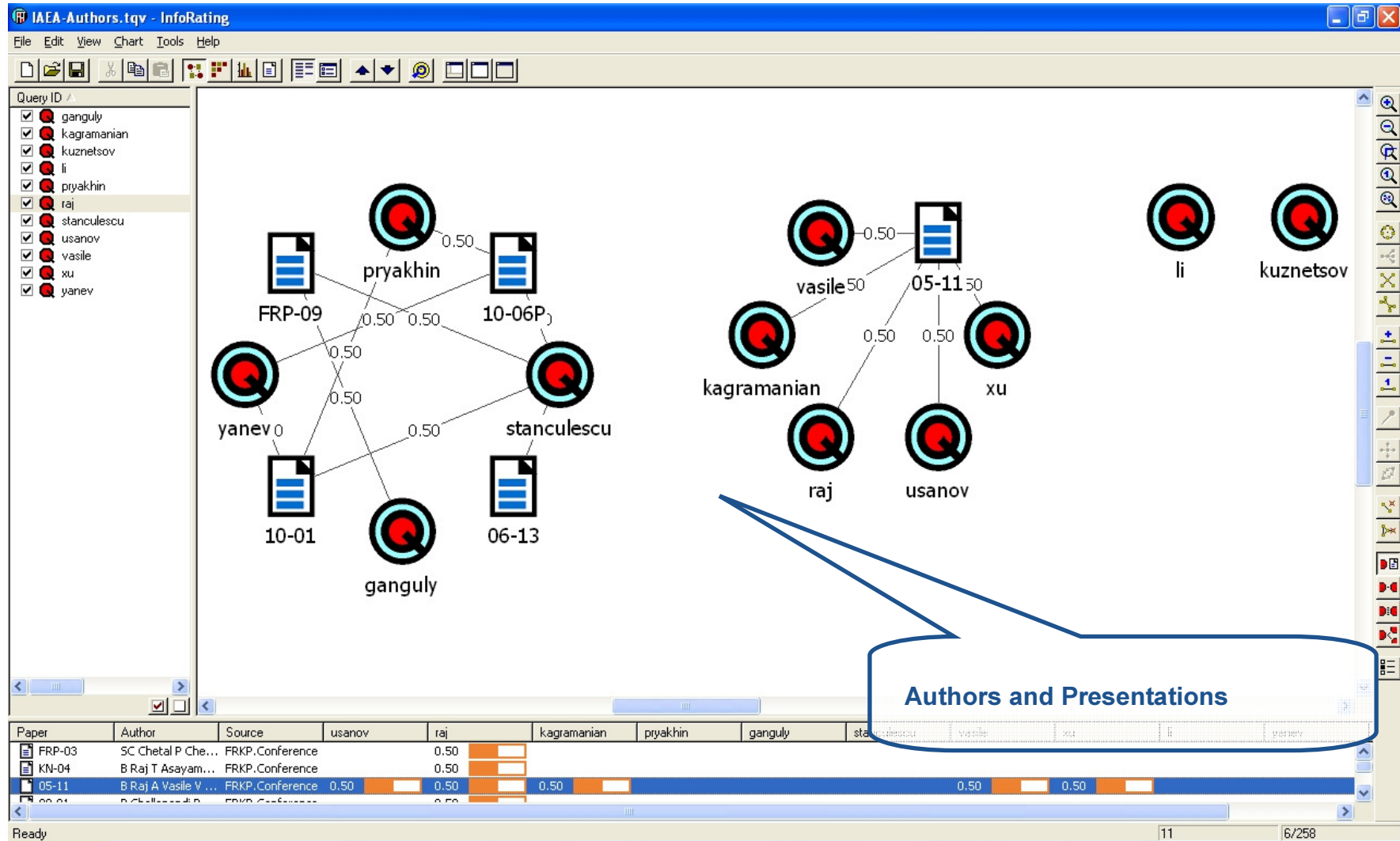


FR KOS – Knowledge Mining and Analytics





FR KOS – Knowledge Mining and Analytics





Contributions to FR KOS (Content)

- IAEA Contribution
 - 3 collections:
 - KNK-II, IAEA-TECDOCS, INIS Fast Reactors records
 - 50 000 metadata records, 9 000 full texts

- Member States
 - China, France, Germany, India, Japan, Russia, UK, USA
 - ?



Conclusions

- **Fast Reactors Knowledge Preservation (FRKP)**
 - A unique experience to preserve comprehensive knowledge for future generations
 - International innovation in knowledge management technology

- **Fast Reactor Knowledge Taxonomy**
 - Unique and Single in the Nuclear World
 - 2 000 elements cover R&D, Design, Operation, Maintenance, Decommissioning and all fast reactor technology elements as well;

- **IAEA contribution to Knowledge Base**
 - 50 000 metadata records; 9 000 full texts

- **Contribution from Member States**
 - Russia submitted more than 500 records; format is a challenge
 - Contribution from other Member States is being encouraged

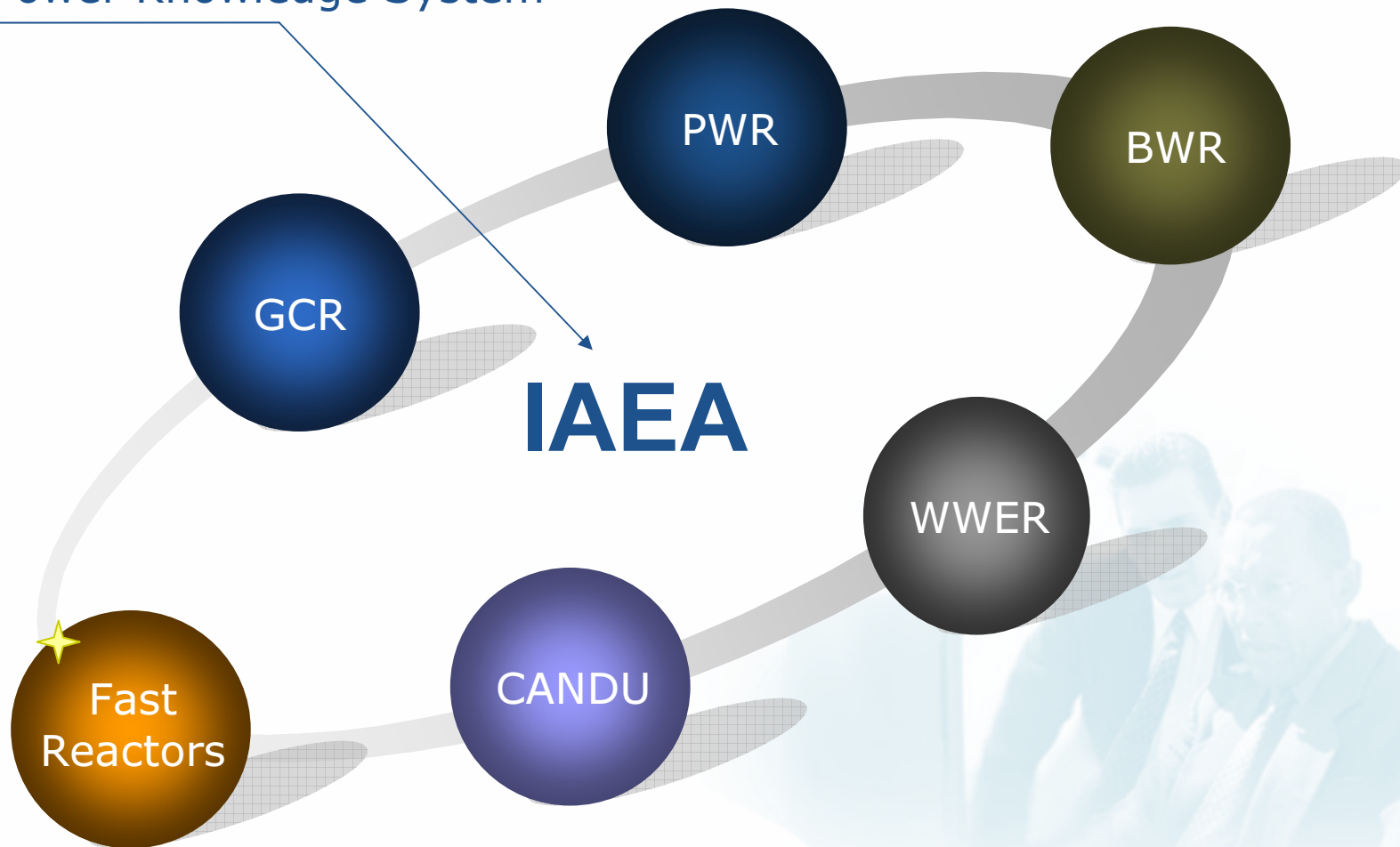
- **Interest for Countries introducing Nuclear Power**
 - Capacity building and Intellectual Capital

- **Available for all participating members**



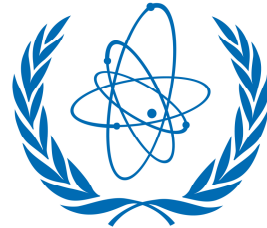
Future KOS Opportunities

Nuclear Power Knowledge System





Fast Reactor Knowledge Organization System



IAEA

International Atomic Energy Agency

Atoms for Peace

- Prepared by

Nuclear Knowledge Management Unit (NKM Unit),

INIS&NKM Section,
Department of Nuclear Energy,
International Atomic Energy Agency

<http://www.iaea.org/NuclearKnowledge/>