The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

1944-25

Joint ICTP-IAEA Workshop on Nuclear Reaction Data for Advanced Reactor Technologies

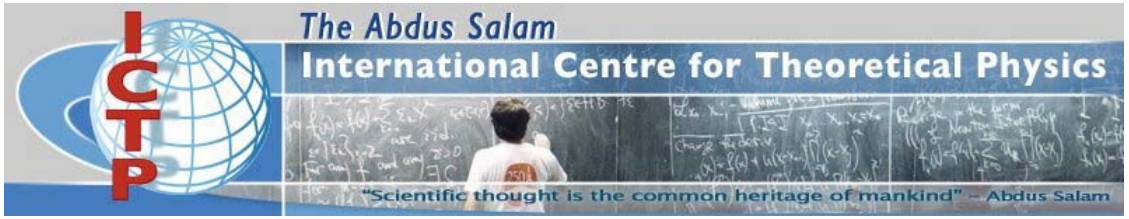
19 - 30 May 2008

Nuclear Data Libraries: Where? How?

MENGONI Alberto

ENEA
Applied Physics Section
V. Don Fiammelli. 2
40128 Bologna
ITALY

International Atomic Energy Agency

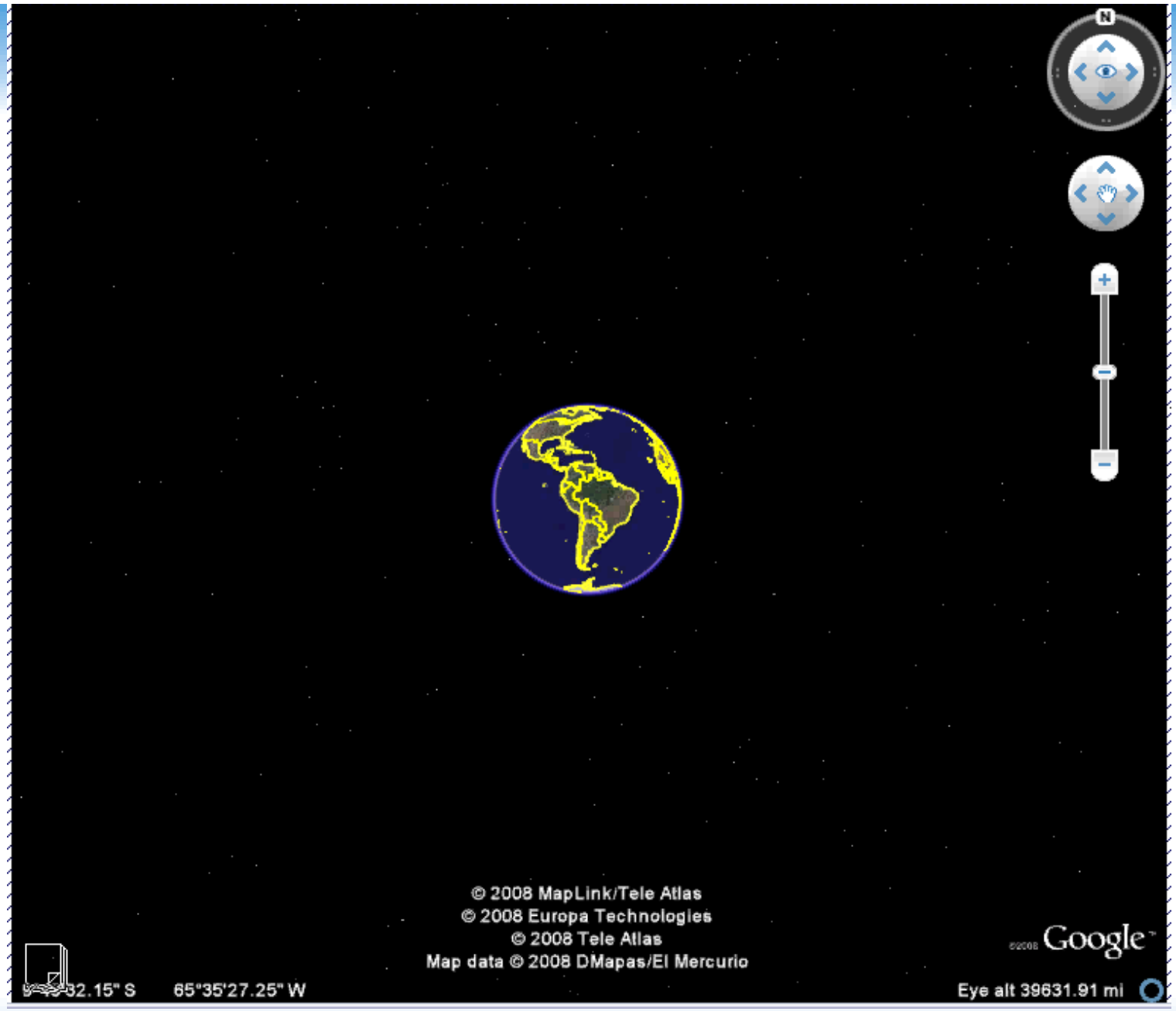


Joint IAEA-ICTP Workshop on

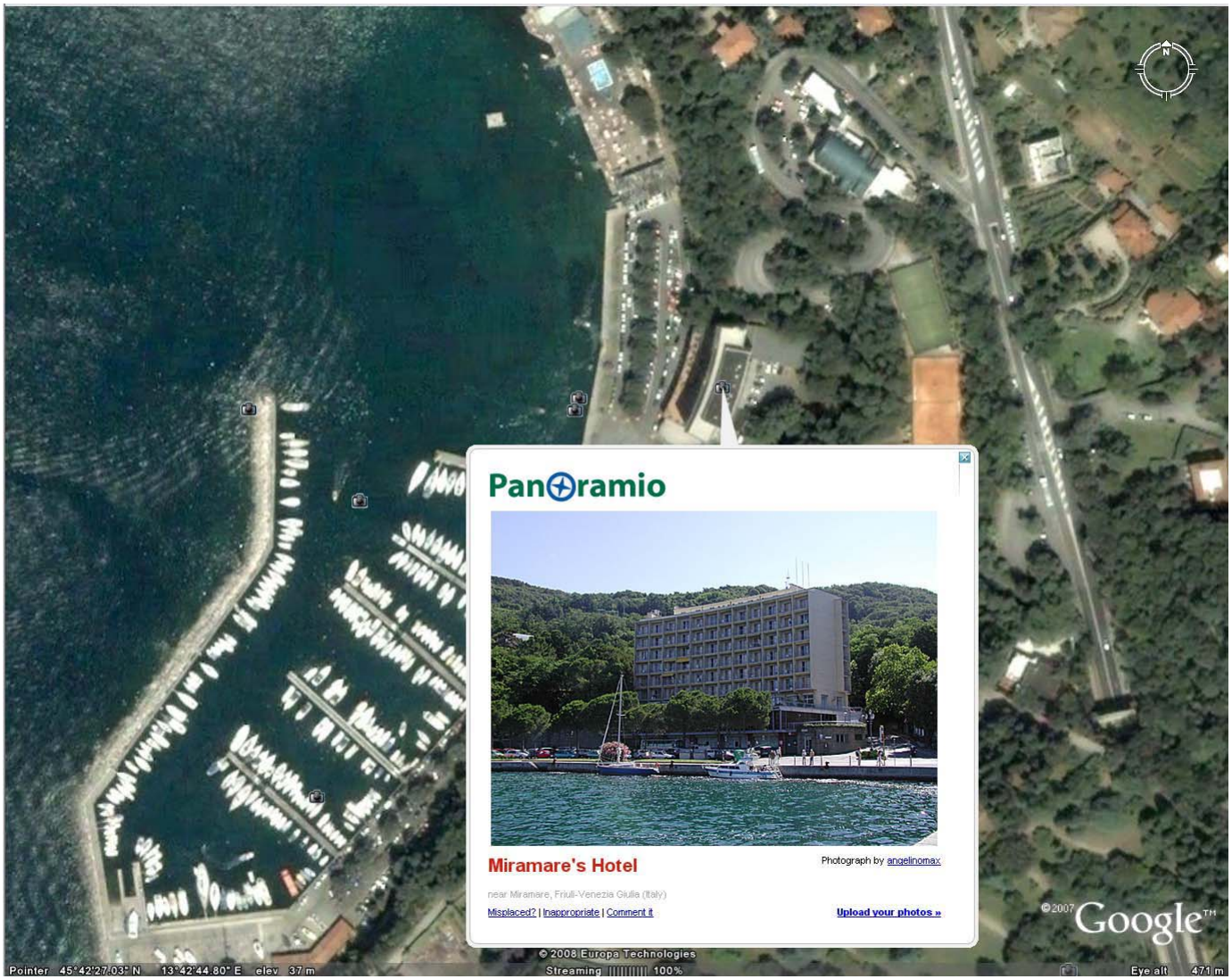
Nuclear Reaction Data for Advanced Reactor Technologies

Welcome!

Alberto Mengoni
IAEA, Vienna



a.mengoni@iaea.org



a.mengoni@iaea.org

Joint IAEA-ICTP Workshop on

Nuclear Reaction Data for Advanced Reactor Technologies

Yahoo! Meteo - Trieste °C o °F

Meteo > Italia > Trieste

Oggi

17°		Massime 20°
5:55 CEST lun	Parzialmente nuvoloso	Minime 16°

<-10 -10 -5 0 5 10 15 20 25 30 35+

Umidità:	100%
Vento:	Nord/0 km/h
Visibilità:	9.99 km
Punto di condensazione:	17°
Barometro:	Sconosciuto
Alba:	5:29
Tramonto	20:34

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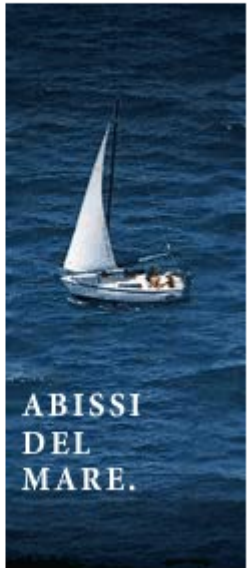
Pioggia Massime 17 Minime 15	Acquazzoni Massime 20 Minime 15	Acquazzoni Massime 21 Minime 15	Acquazzoni Massime 22 Minime 16



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Rationale for a Workshop on Nuclear Reaction Data for Advanced Reactor Technologies

Both the development and maintenance of nuclear technologies rely on the availability of atomic, molecular and nuclear data to provide accurate numerical representations of the underlying physical processes.
Essential data include energy-dependent reaction probabilities (cross sections), the energy and angular distributions of reaction products for many combinations of target and projectile, and the atomic and nuclear properties of excited states, and their radioactive decay data.

source: IAEA, Division of Physical & Chemical Sciences website

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Joint IAEA-ICTP Workshop on

Nuclear Reaction Data for Advanced Reactor Technologies

Topics

- facilities and instrumentation for nuclear reaction data measurements
- experimental techniques for measurements of nuclear reaction data
- modern theoretical nuclear structure and reaction models
- evaluation of nuclear data and creation of evaluated nuclear reaction data libraries
- simulation tools for design studies of advanced nuclear systems
- overview of strategies for advanced nuclear technologies

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Joint IAEA-ICTP Workshop on

Nuclear Reaction Data for Advanced Reactor Technologies

14 mathematics

14 MeV nuclear physics

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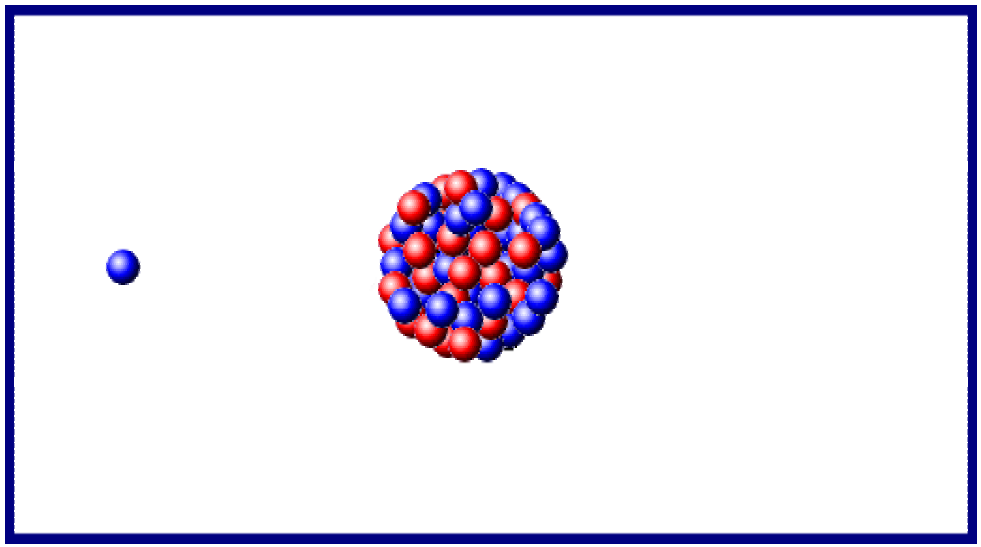
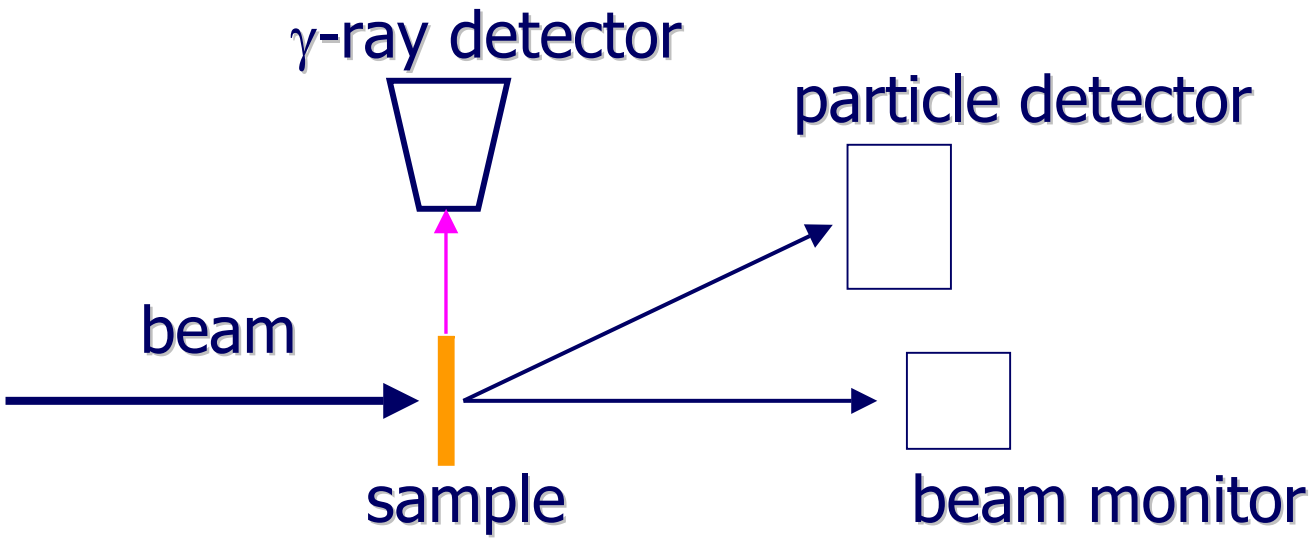
Nuclear Reactions

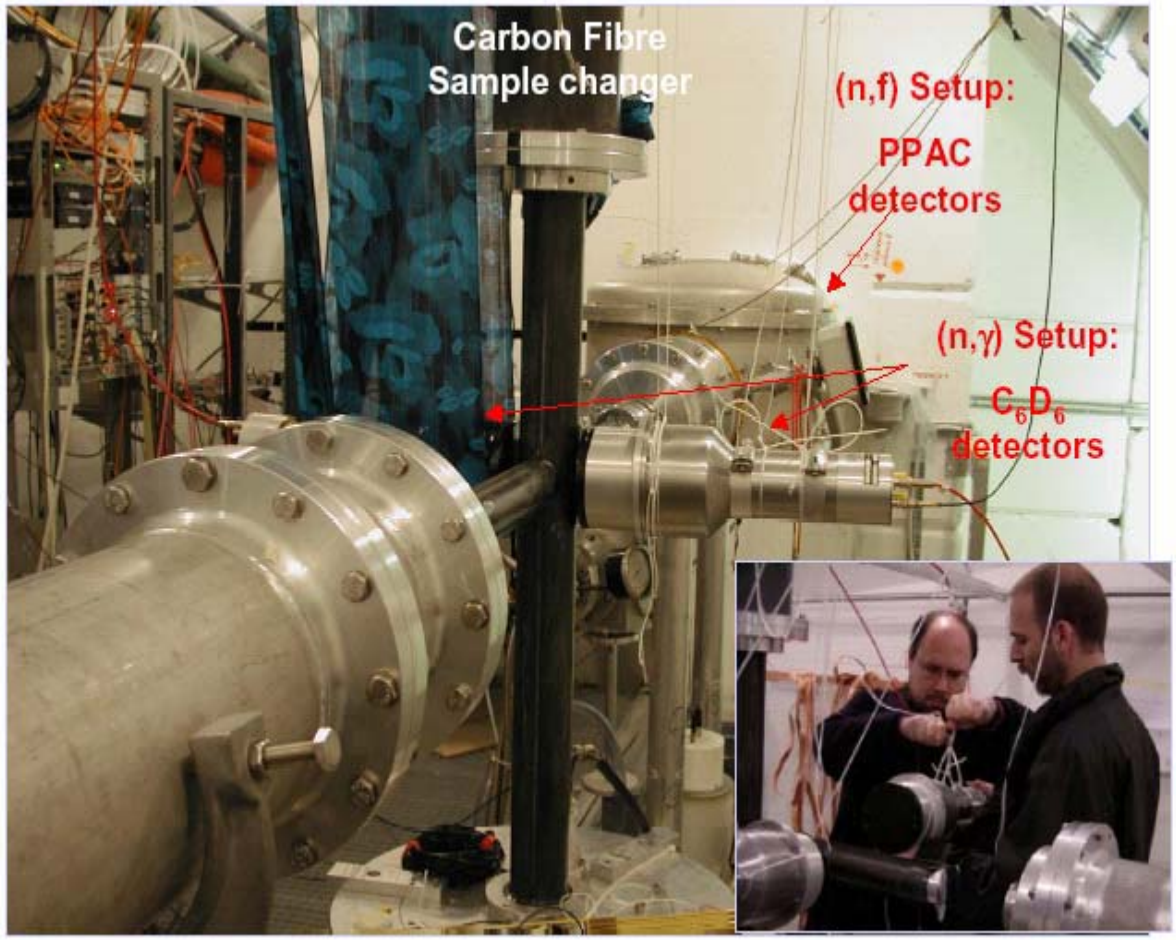


source: the Internet

Nuclear Reaction

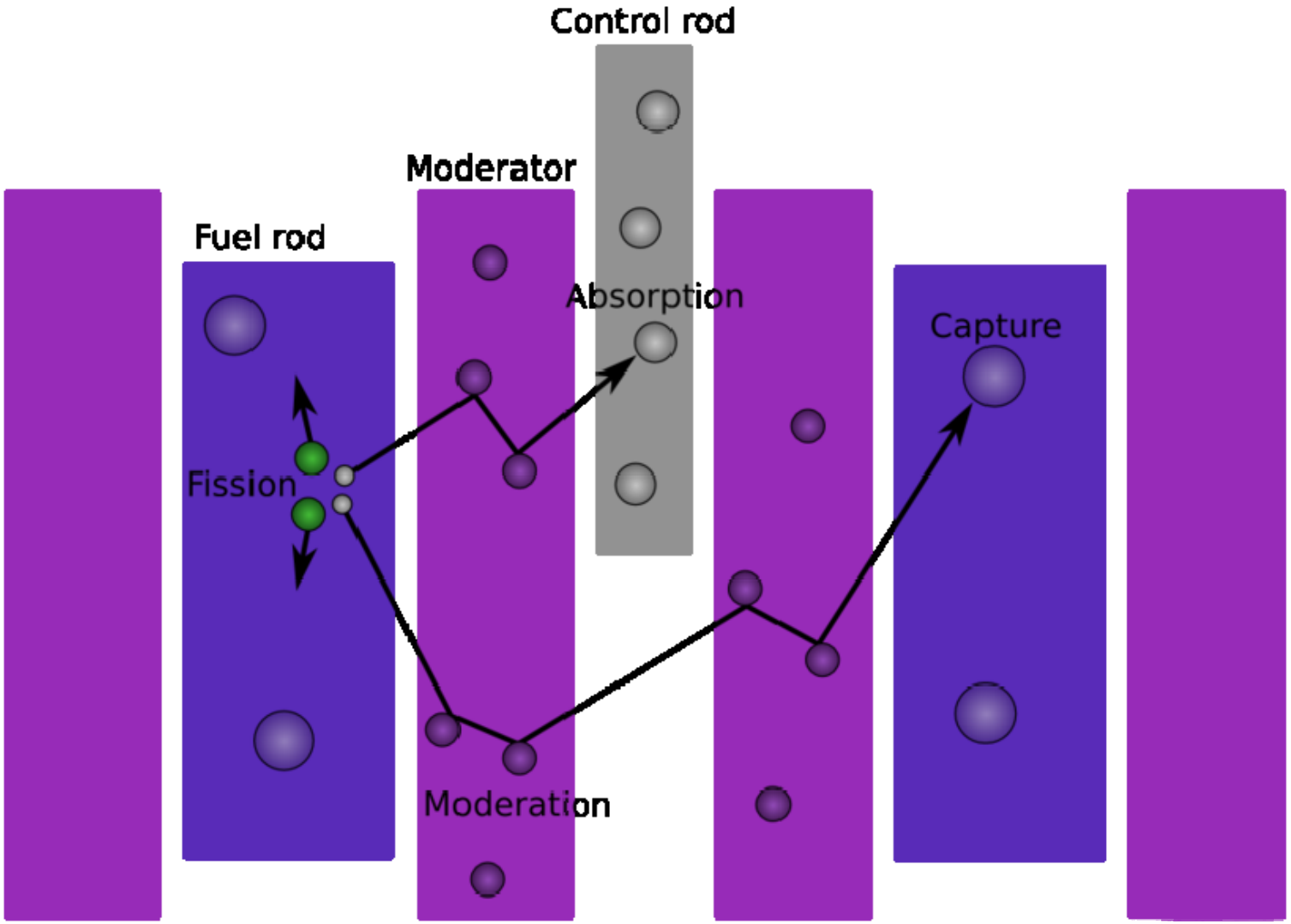


Nuclear Reactions: Measurement



source: The n_TOF Collaboration

Nuclear Reactions in Reactors



source: wikipedia.org

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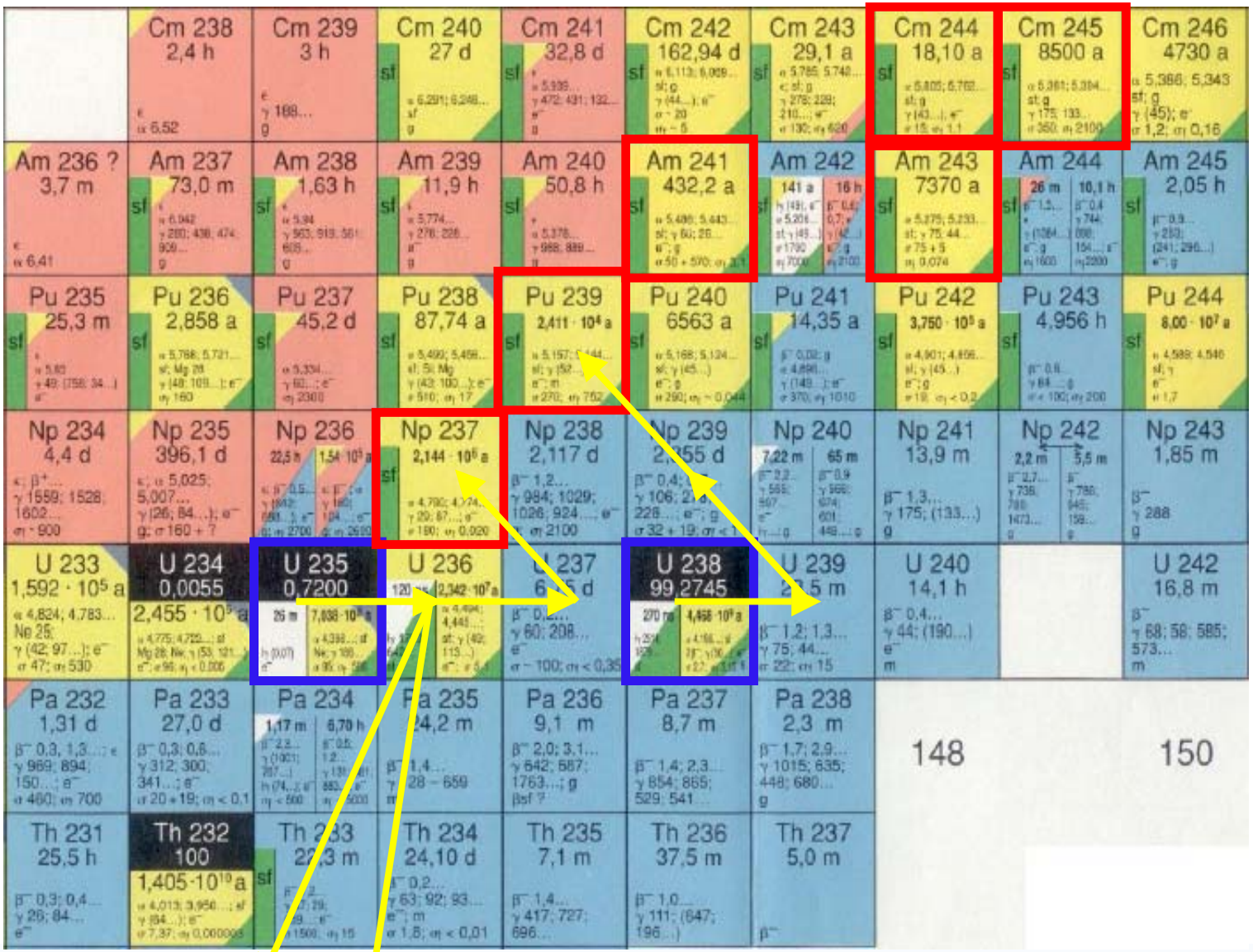
Nuclear reactions in Reactors

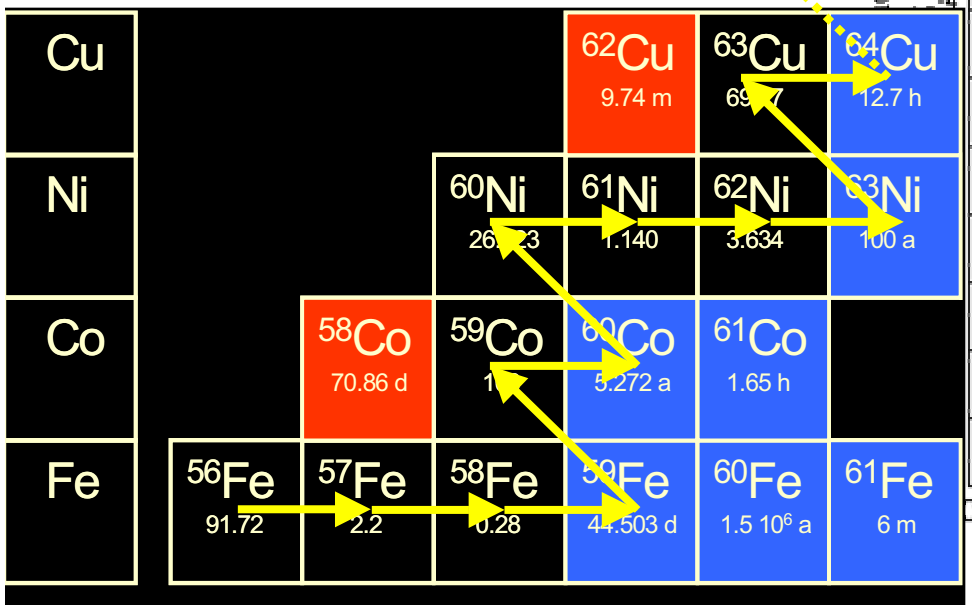


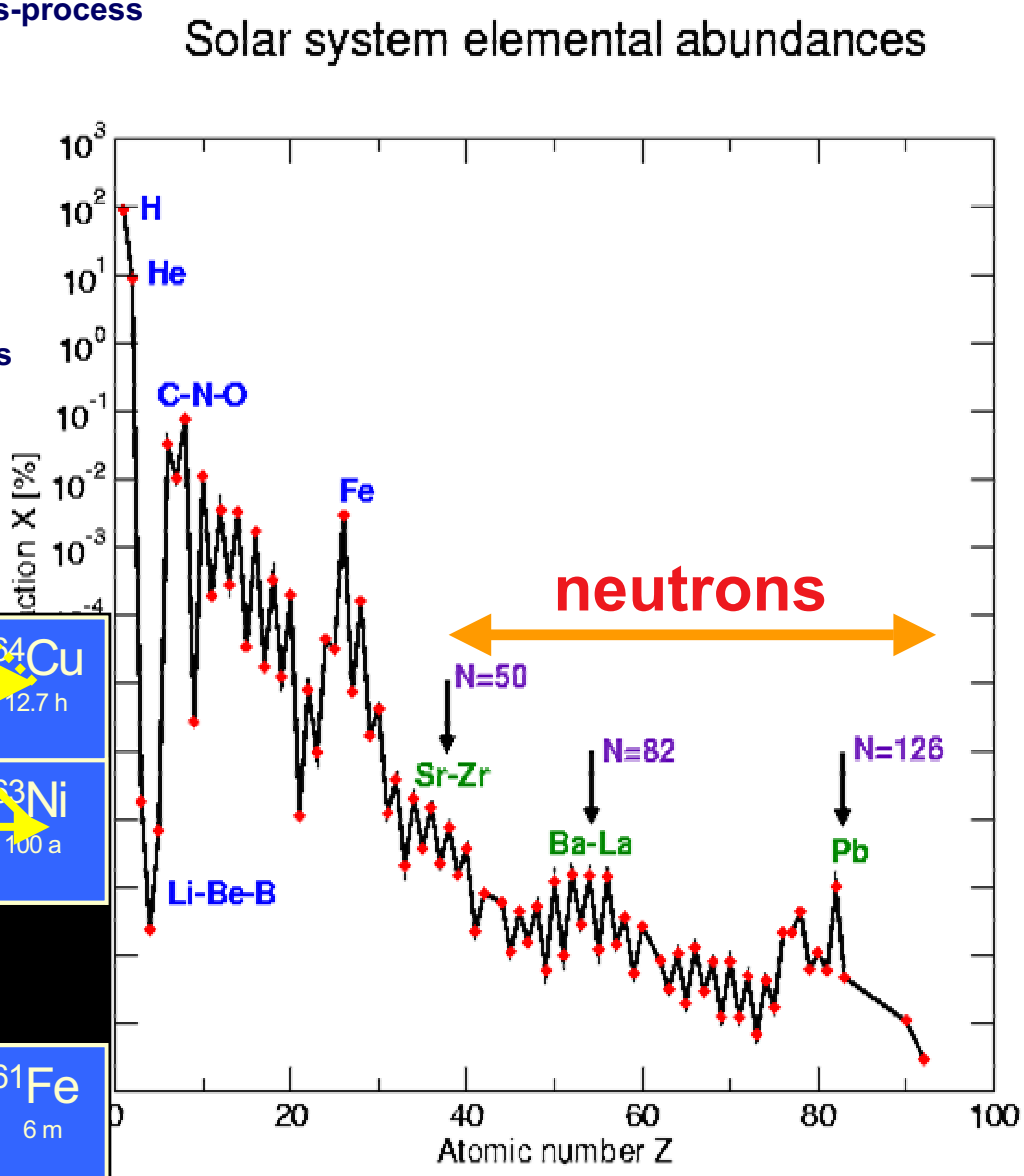
Th/U fuel cycle

Nucleosynthesis: the s-process

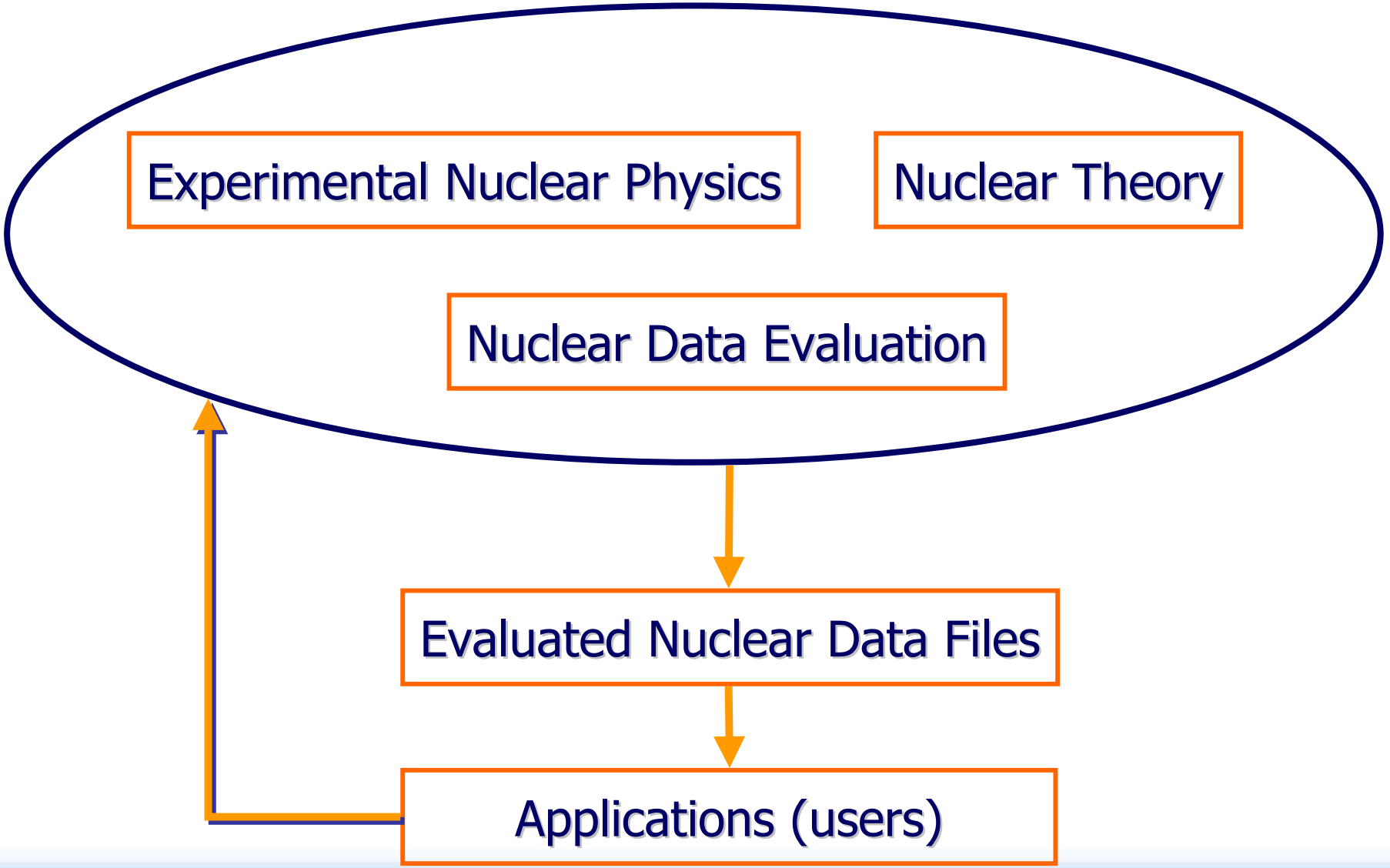
- ½ of the elements above Fe are produced by the s-process
- The astrophysical sites of the s-process are:
  - He burning in intermediate/massive stars
  - Low-mass AGB's
- There exists a direct correlation between the neutron capture cross section and the abundance ($\sigma(n,\gamma) \cdot N = const.$)
- The neutron capture cross sections are key ingredients for s-process nucleosynthesis

The canonical s-process





Nuclear Reactions & Nuclear Data Libraries



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Nuclear Reaction Data for Advanced Reactor Technologies

1. Nuclear Data Measurements

2. Theory/Modeling/Evaluation of Nuclear Data

3. Applications: Advanced Reactor Systems

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Q. Where to get Nuclear Data?

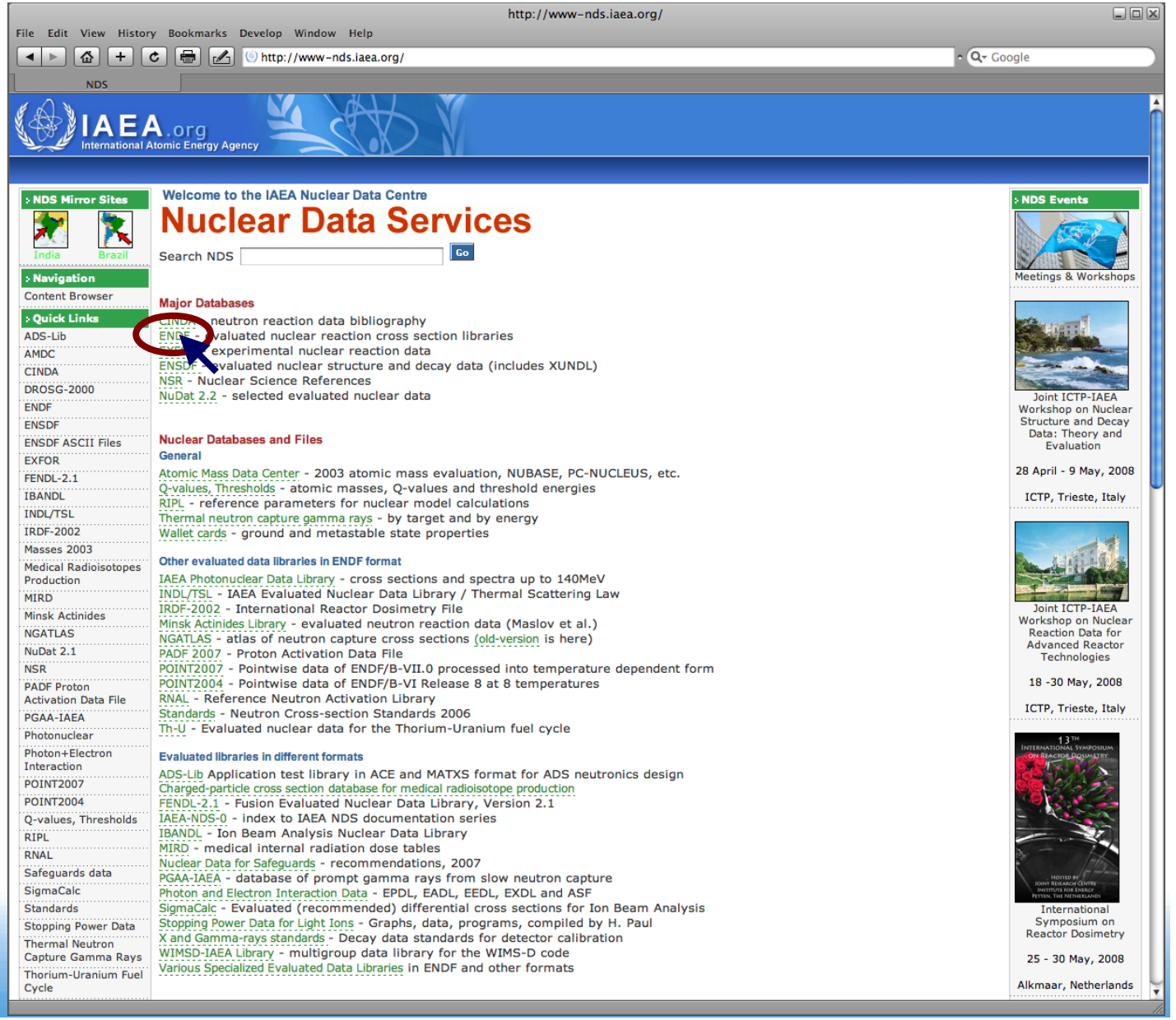
A. The Internet

Example:

what is the capture cross section
of Zr-91 at E_n = 30 keV ?

Nuclear Data Online

www-nds.iaea.org



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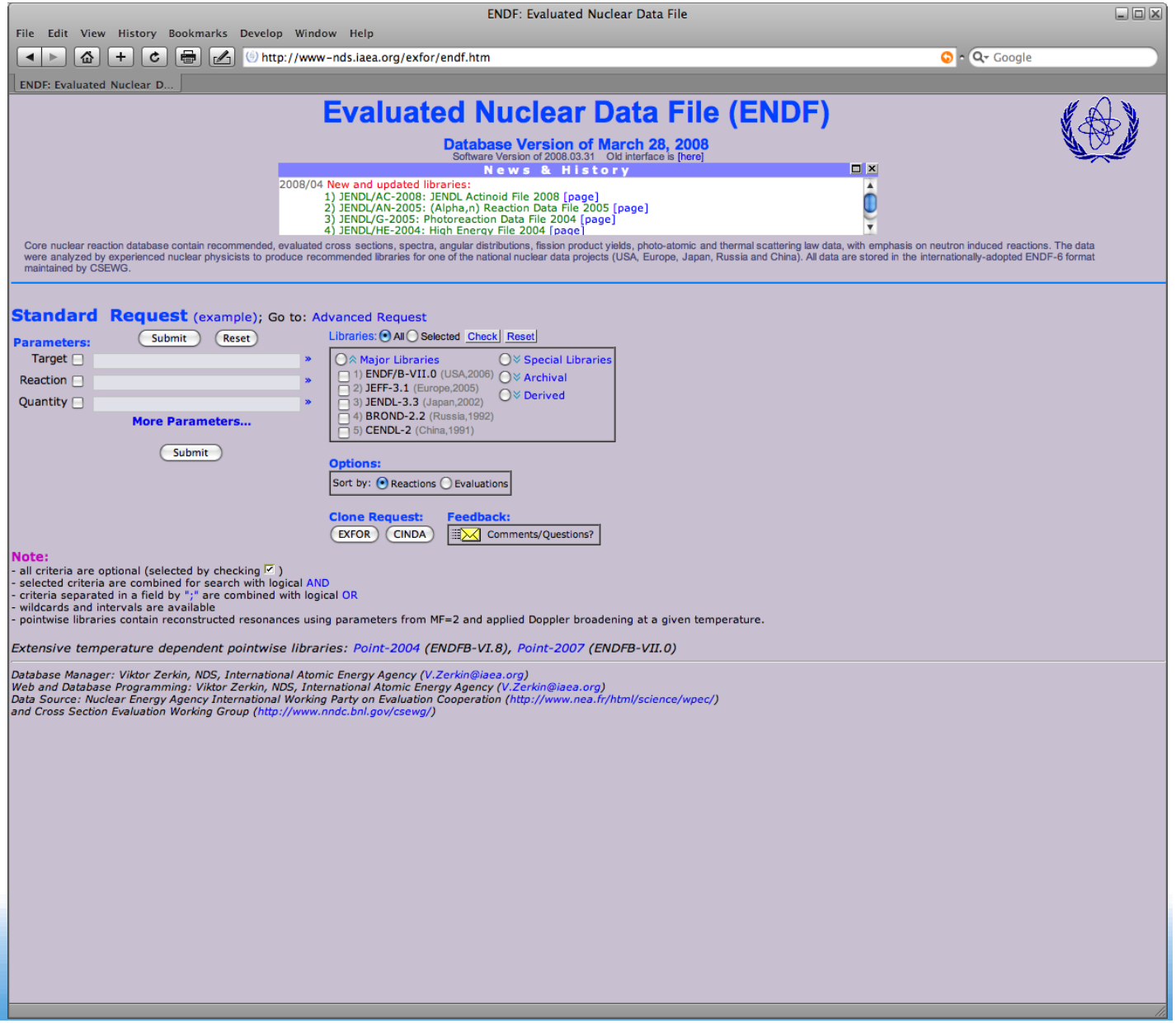
Nuclear Data Online



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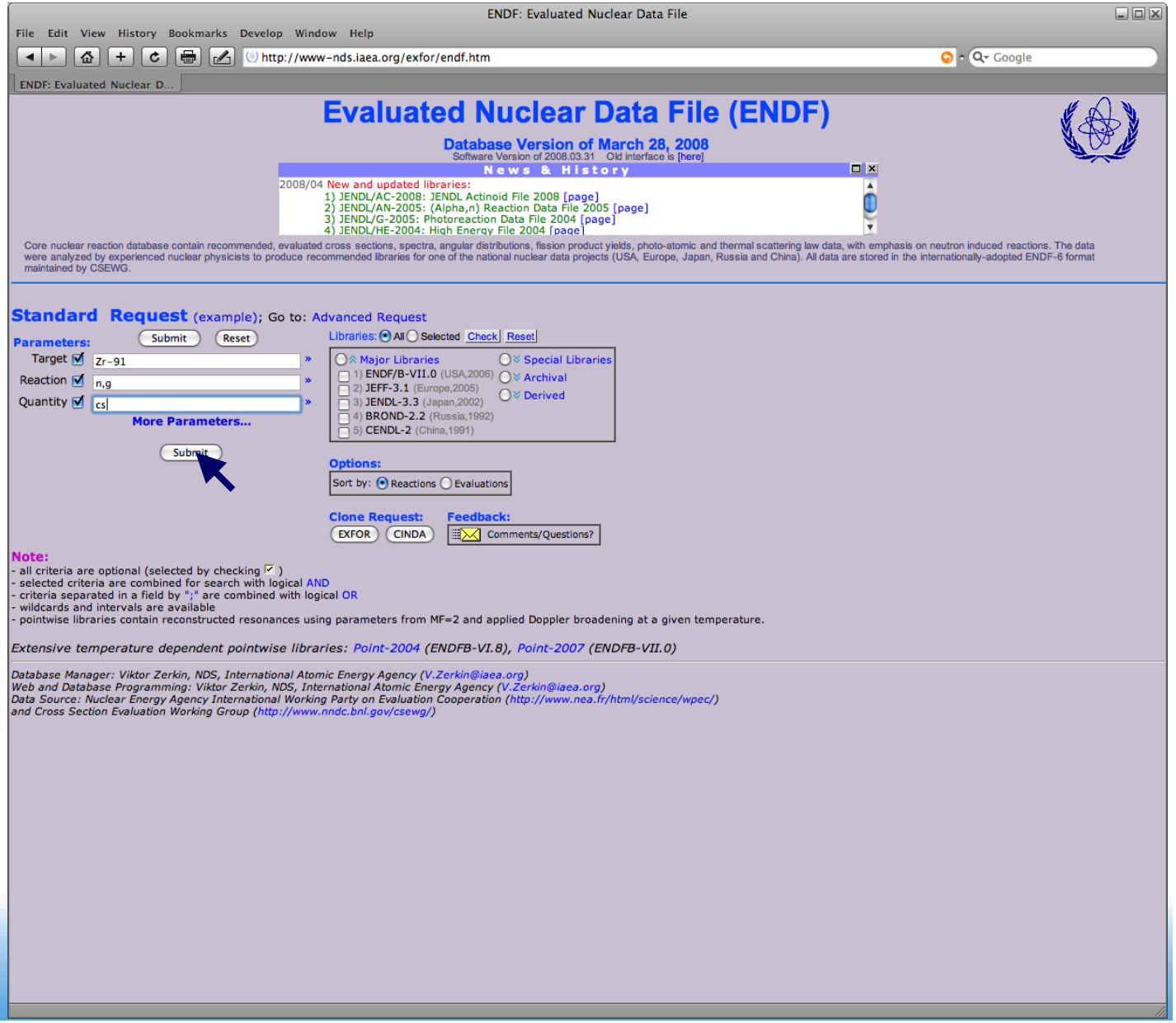
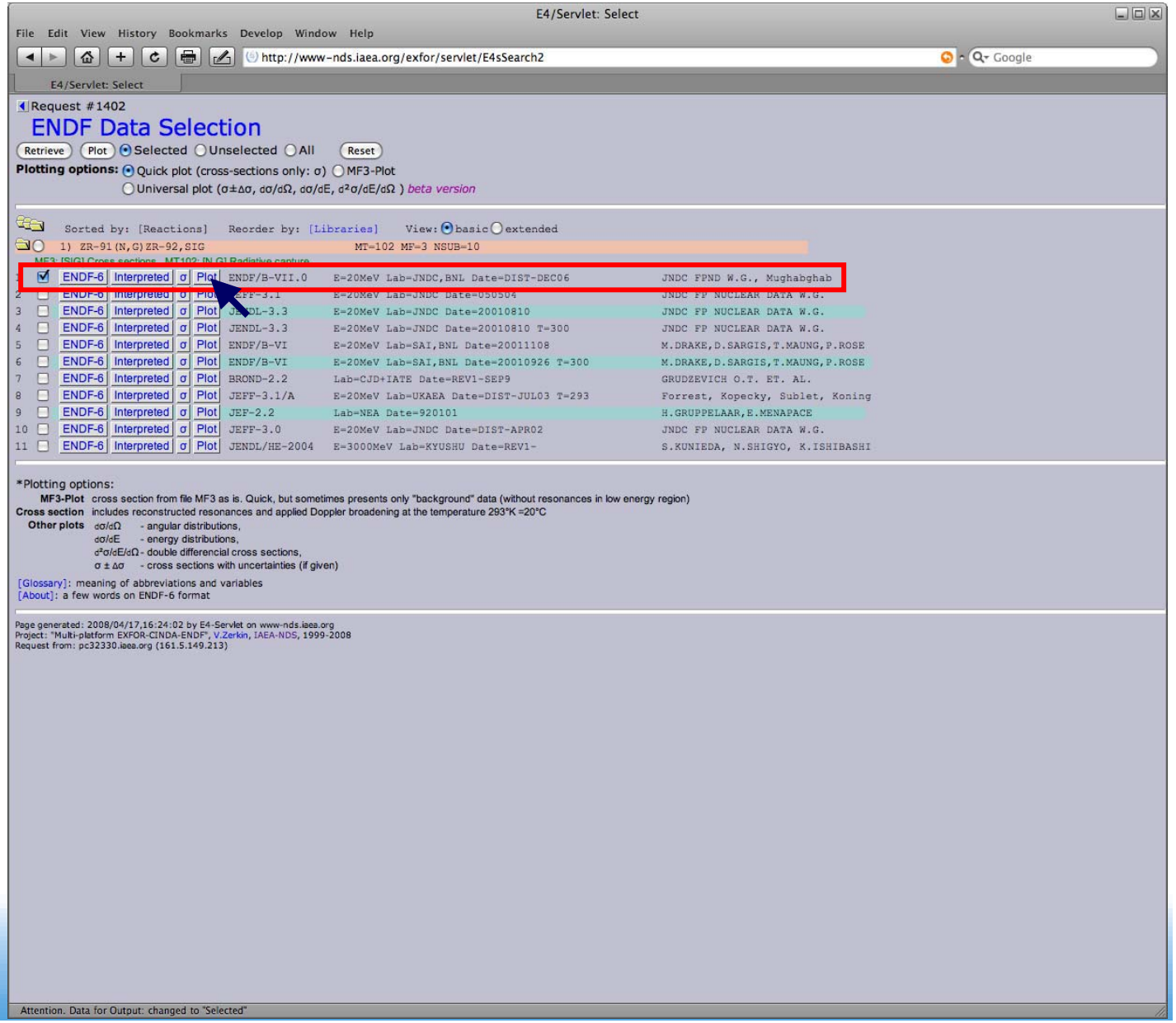
Nuclear Data Online



a.mengoni@iaea.org

Nuclear Data Online



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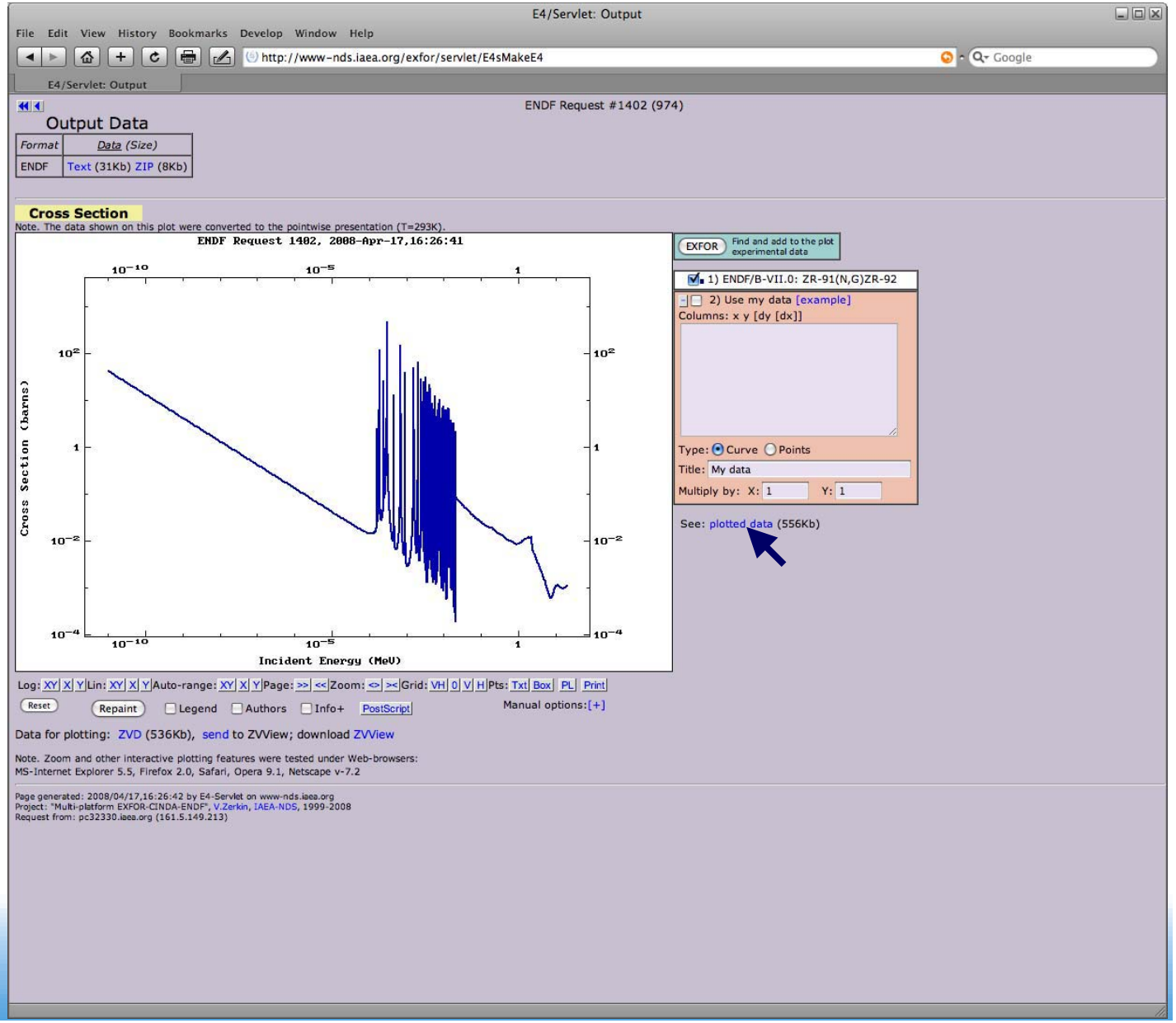
Nuclear Data Online



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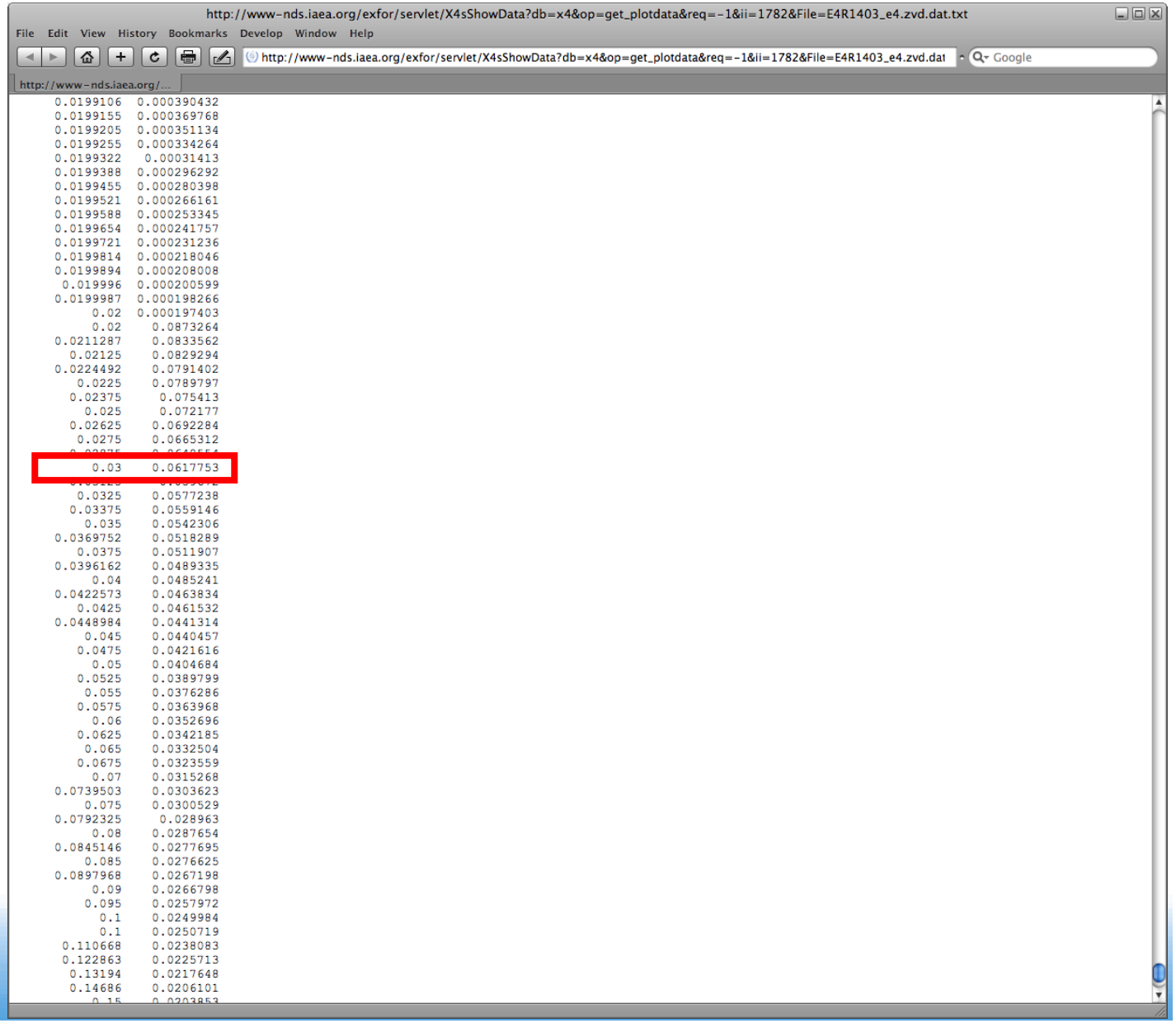
Nuclear Data Online

^{91}Zr capture cross section
at E_n=30 keV:
61.8 mb



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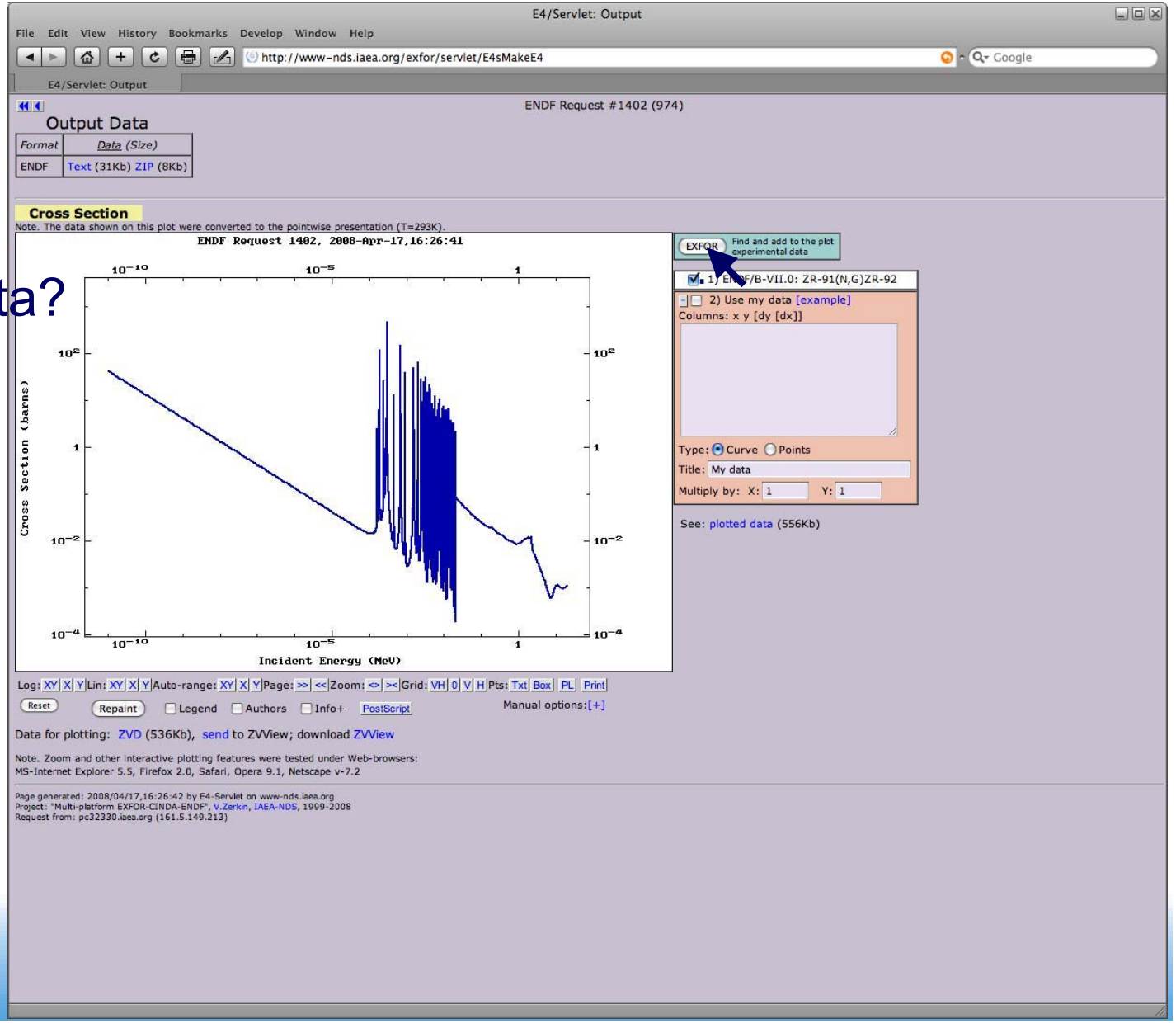
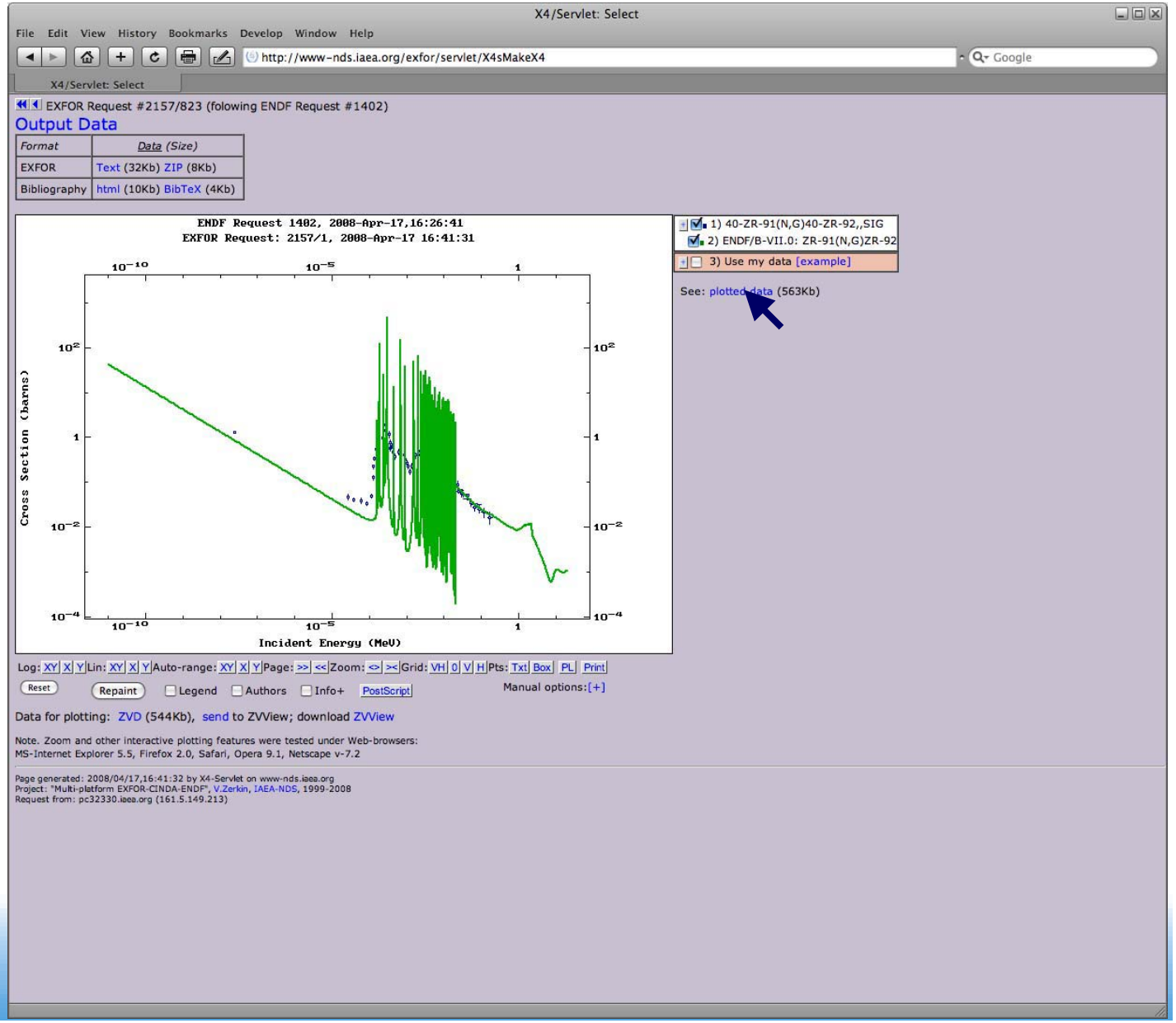
Nuclear Data Online

How about experimental data?



a.mengoni@iaea.org

Nuclear Data Online



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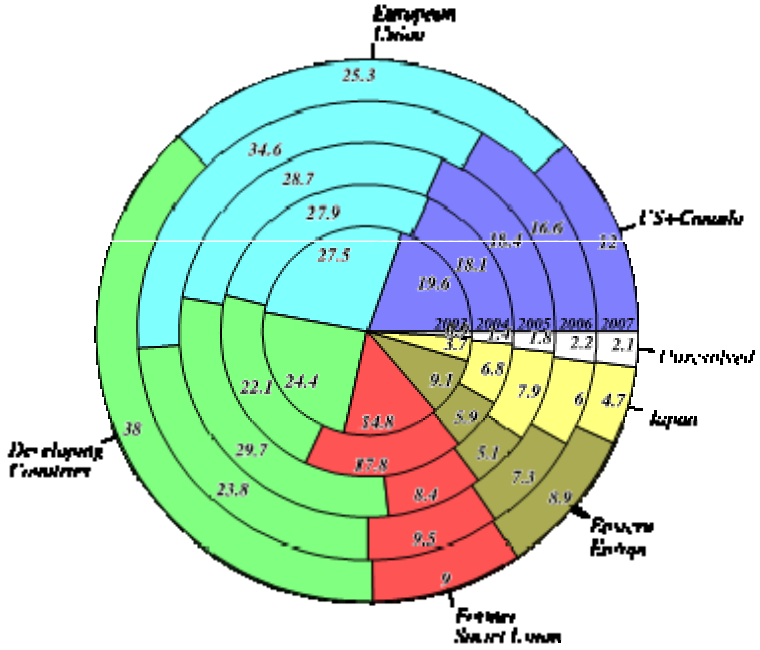
Providing On-line Services: Access Statistics



source: NDS report to the INDC (2008)

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1. Nuclear Data Measurements

2. Theory/Modeling/Evaluation of Nuclear Data

3. Applications: Advanced Reactor Systems

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1. Nuclear Data Measurements

facility		driver and energy	repetition rate	n source	n energy range	flight path length
FZK TIT ...	Karlsruhe Tokyo ...	varii in the MeV range	MHz	^{7}Li(p,n) & others	few keV up to 1 MeV monoE above	10s cm
GELINA	EC-JRC Geel	electron linac 150 MeV	800 Hz	photo-n photo-f	10 meV – 20 MeV	10m to 400m
LANSCE	Los Alamos National Laboratory	proton linac 800 MeV	20 Hz	spallation	< 500 keV (DANCE)	20m
n_TOF	CERN	PS 20 GeV	0.4 Hz (average)	spallation	10 meV – 250 MeV (or wider)	200m

World scene for tof measurements

1. Nuclear Data Measurements

Franz Käppeler
Forschungszentrum Karlsruhe, GERMANY
Capture Cross Section Measurements

Nicola Colonna
INFN, Sezione di Bari, ITALY
Fission Measurements

Peter Schillebeeckx
EC-JRC-IRMM, Geel, BELGIUM
Cross Section Measurements and Uncertainties of Cross Section Data

Frank Gunsing
CEA, Saclay, FRANCE
TBA

1. Nuclear Data Measurements

Alessandro Borella
EC-JRC-IRMM, Geel, BELGIUM
Cross Section Measurements and Uncertainties of Cross Section Data

Stefano Marrone
INFN, Sezione di Bari, ITALY
Capture Cross Sections: Data Analysis

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2. Theory/Evaluation/Modeling Nuclear Data

Stephane Hilaire
CEA, Bruyeres-le-Chatel, FRANCE
Statistical Modeling and Calculation (TALYS code)

Pierre Descouvemont
Université Libre de Bruxelles, BELGIUM
R-matrix theory of nuclear reactions

Anatoly Ignatyuk
Institute of Physics and Power Engineering, Obninsk, RUSSIAN FEDERATION
Evaluation of Nuclear Reaction Data

Giuseppe Palmiotti
Argonne National Laboratory, Chicago, USA
Sensitivity and Uncertainty Analysis
for the Neutronic Design of Advanced Nuclear Systems

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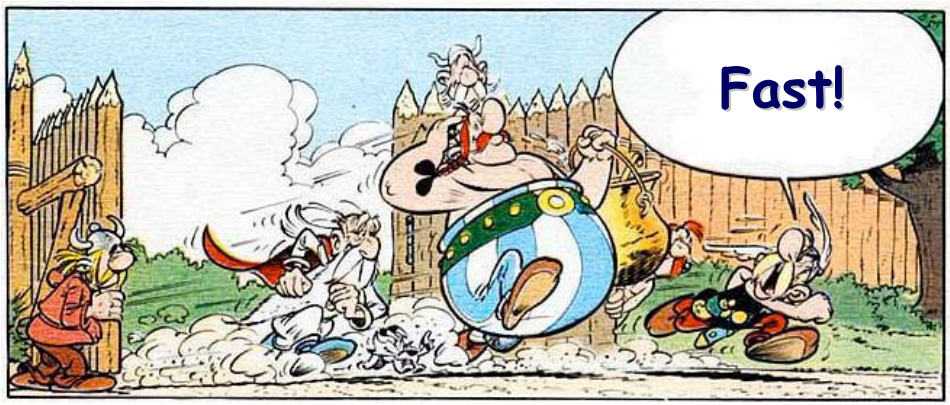
3. Applications: Advanced Reactor Systems

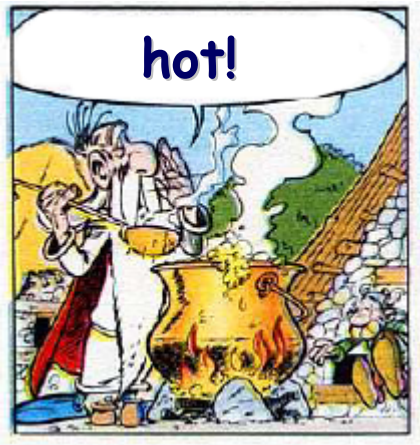
Alex Stanculescu
IAEA, Vienna, AUSTRIA
Advanced Fast Reactors



a.mengoni@iaea.org

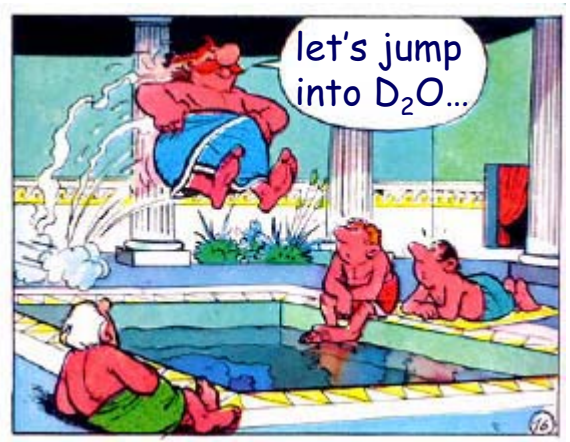
3. Applications: Advanced Reactor Systems

Jim Kendall
Global Virtual LLCC, Prescott, AZ, USA
High Temperature Advanced Reactors



3. Applications: Advanced Reactor Systems

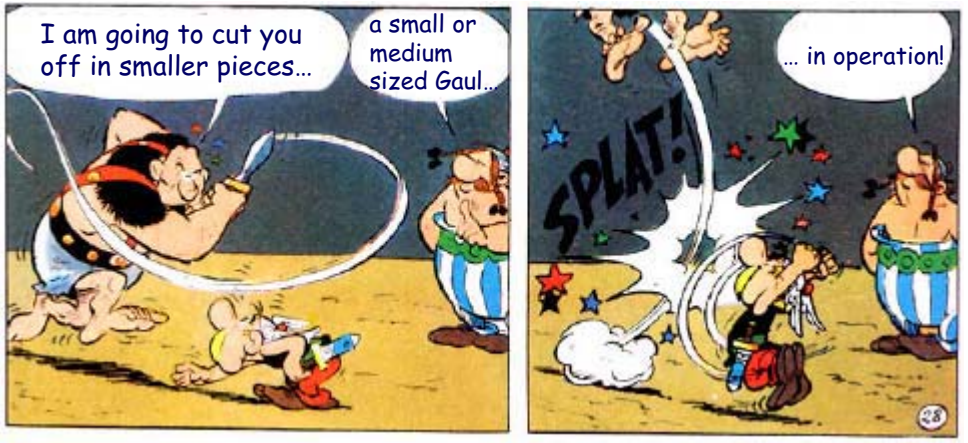
Blair Bromley
AECL, Deep River, ON, CANADA
Heavy Water Reactors



3. Applications: Advanced Reactor Systems

Vladimir Kuznetzov
IAEA, Vienna, AUSTRIA

Small and Medium Sized Advanced Reactors



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Joint IAEA-ICTP Workshop on

Nuclear Reaction Data for Advanced Reactor Technologies

PROGRAM layout

Week 1	Monday, 19	Tuesday, 20	Wednesday, 21	Thursday, 22	Friday, 23	Weekend
8:30 – 10:00	registration	P Schillebeeckx	P Schillebeeckx	TBA	TBA	
10:00 – 10:30	*Break*					
10:30 – 12:00	Welcome & Introduction	N Colonna	N Colonna	A Borella	F Gunsing	
12:00 – 14:00	*Lunch*					
14:00 – 15:30	A Stanculescu	J Kendall	J Kendall	V Kuznetsov	V Kuznetsov	
15:30 – 16:00	*Break*					
16:00 – 17:30	Introduction to computational facilities and computer software	exercise P Schillebeeckx	exercise P Schillebeeckx	exercise A Borella	exercise S Marrone	

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Joint IAEA-ICTP Workshop on

Nuclear Reaction Data for Advanced Reactor Technologies

PROGRAM layout

Week 2	Monday, 26	Tuesday, 27	Wednesday, 28	Thursday, 29	Friday, 30	Weekend
8:30 – 10:00	P Descouvemont	P Descouvemont	S Hilaire	S Hilaire	A Mengoni	
10:00 – 10:30	*Break*					
10:30 – 12:00	G Palmiotti	G Palmiotti	A Ignatyuk	A Ignatyuk	TBA	
12:00 – 14:00	*Lunch*					
14:00 – 15:30	BP Bromley	BP Bromley	Student's presentation	Student's presentations	Student's presentations	
15:30 – 16:00	*Break*					
16:00 – 17:30	exercise P Descouvemont	exercise P Descouvemont	exercise S Hilaire	exercise S Hilaire	Closing	

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Exercises

J. Grassberger / K. McLaughlin
ICTP, Trieste / IAEA, Vienna, Austria
Introduction to computational facilities and computer software

Student's presentations

- 2nd week: Wednesday, Thursday & Friday,
from 2:00PM to 3:30PM

- typically 20min for each presentation

Please sign up to make a presentation
on a topic (any), on which you are working!

Reception

Today, 19:00 hrs
Adriatico Cafeteria
in the terrace, ground floor
(or inside if bad weather…)

Practical Infos

DIRECTORS: office no. 4, tel.ext. 954

LECTURERS/SPEAKERS: United Nations Room, tel.ext. 643

SECRETARIAT: Mrs. Ave Lusenti, office no. 2, tel.ext. 544

MAIL BOX AND E-MAIL ACCOUNT: A mail box has been prepared for you on the Lower Level 1, near Eklund Informatics Laboratory, Adriatico Guest House. An ICTP e-mail account has been created. Your login information will be given to you in a sealed envelope during registration. During your stay please check your mail box and e-mail account regularly, as these are the main channels of communication within the Campus and the only means of notifying you of urgent messages or correspondence which may arrive during your stay

FOLDER & NAME BADGE: In the Mail Box you will receive a conference Folder, containing information on the activity, Upon registration you will also receive a Name Badge, which you are kindly requested to wear, and which is required to borrow books from the Library.

ADMINISTRATIVE INFORMATION is posted on the notice boards situated in the reception areas of the Leonardo Building, Adriatico and Galileo Guest Houses. In-house information is sent through the Info Point by means of an automatic e-mail delivery service (ICTP Community Link Digest) available to all holders of an e-mail account at ICTP. There is also a mailing list (Trieste Scientific News Digest), which gives details of in-house scientific activities as well as those taking place in ICTP's neighbouring scientific institutes, like SISSA.

INFO POINT (**located to the left of the main entrance hall of the Leonardo da Vinci Building**) provides general information about the Centre, its activities and offices, as well as details about the city and its surroundings. Tel. Ext: 433; e-mail: info_pt@ictp.it

Practical Infos

ITALIAN PERMIT OF STAY: Your new ICTP e-mail account contains an important comprehensive message regarding the rules to be observed related to the permit of stay in Italy. The message is especially important to those whose stay exceeds 8 days and are not accommodated in the ICTP Guesthouses, and the deadlines mentioned are imperative! Questions on permit of stay issues can be raised with the ICTP Passport and Visa Information Office (room T4, E. Fermi Building 09:00 - 12:30 14:00 - 15:00).

MEAL COUPONS (*for participants whose subsistence costs are covered by the Centre*). Meal coupons are issued by the Operations Office (Fermi Building), upon presentation of the completed Registration form.

ICTP STAFF WORKING HOURS Monday to Friday, from 8.30 to 16.48

CERTIFICATES OF ATTENDANCE Unless already foreseen by the Activity itself, certificates can be requested via e-mail to the account: Attendance.Certificates@ictp.it Requests should be made well in advance of your departure date.

END OF STAY Only in exceptional cases of authorized anticipated departure and **always** for Associates and Affiliates the clearance is requested. For details please see the End-of-Stay Clearance Terms to be found on the last page of the Pre-arrival Information Booklet: http://www.ictp.it/pages/info/visiting.html

PLEASE SEE THE REVERSE SIDE FOR A SUMMARY OF INFORMATION ON ICTP OFFICES AND SERVICES
For more details, we draw your kind attention to the "**Visitor's Guide**" booklet, to be found in your conference folder. Special attention should be given to the sections regarding PASSPORTS AND VISAS and HEALTH INSURANCE.

Practical Infos

HOUSING OFFICE 08.30 - 12.00 and 13.30 - 14.30 (Mon - Fri)
E. Fermi Building - Rooms T1/T2 (ground floor).

OPERATIONS/TRAVEL CLAIMS OFFICE 08.30 - 12.00 and 13.30 - 14.30 (Mon-Fri)
E. Fermi Building - Room T17 (ground floor) - For daily allowances/travel reimbursements. *Note*: reimburse- ments of over Euro 200 are done via bank cheque, cashed at UniCredit Banca (see timetable below).

PASSPORT & VISA INFORMATION OFFICE 09.00 - 12.30 and 14.00 - 15.00 (Mon-Fri)
E. Fermi Building - Room T4 (ground floor)

BANK (UniCredit Banca) 08.30 - 12.30 (Mon-Fri)
E. Fermi Building - Main Entrance (ground floor) - Kindly note that for all banking transactions you are required to exhibit your **passport** (or equivalent valid identification document).

TRAVEL AGENCY (Carlson Wagonlit Travel) 08.30 - 12.30 and 13.00 - 15.00 (Mon-Fri)
E. Fermi Building - Main Entrance (ground floor) (Tel.ext. 584)

MEDICAL SERVICE 09.00 - 12.00 and 15.00 - 16.30 (Mon-Fri)
E. Fermi Building - Main Entrance (Room T9/T10 - ground floor) (**Tel. ext. 500 and 600**).
Appointments with the Doctor should be arranged through the Nurse.

HEALTH INSURANCE (Lloyd Adriatico Ins. Co.) 08.30 - 12.30 (Tuesday and Thursday)
E. Fermi Building - Main Entrance (ground floor)

Practical Infos

COMPUTERS Computers are located in the Leonardo da Vinci Building (1S level) and the Adriatico (Lower Level 1) and Galileo (near reception) guesthouses, running Windows XP and Linux. As mentioned before, your login information will be given to you in a sealed envelope during registration. It is also needed for our wireless network. For more information, please see http://icts.ictp.it/. Computer help is available on workdays 10:30-12:00 and 13:30-15:00 in the Leonardo Building, Information and Communication Technology Section (ICTS), entrance level, room 2, or via internal phone 999. Diskettes, CD-Rs, network cables and printer transparencies can be bought at the Mail Counters (see below). Network cables can also be bought from the vending machines at the Adriatico and Galileo Guesthouses at the same price as at the Mail Counters (Euro 4.50)

STATIONERY and MAIL COUNTERS (Photographic services: **only** E. Fermi Bldg, Mail Office counter).

Leonardo Building - (IS Level, right-hand side)	13.30 - 15.30 (Mon-Fri)
E. Fermi Building - (Lower Level)	08.30 - 12.00 (Mon-Fri)

Basic stationery is included in the conference folder. Additional items can be requested from the above offices.

PHOTOCOPYING (SELF-SERVICE) Five self-service photocopying machines are available: two inside the ICTP Library, one at the AGH (Lower Level, inside the Eklund Informatic Lab.), one at the Galileo GH, one at the Enrico Fermi Building (outside the Associate area). The machines are operated by magnetic cards, obtainable from an automatic distributor outside the Library entrance, at a cost of Euro 1 (deposit for the card + 10 copies). These cards may be re-charged at Euro 0,03 per copy. The deposit (Euro 0,80) will be reimbursed if the card is returned, undamaged, to the mail counters. Exceptionally, cards are also available from the Mail Counters and at weekends from the AGH Reception.

TYPEWRITERS Available for the use of Visitors at: ***E. Fermi Building*** Lower Level, corridor.
Leonardo Building: right-hand side, Level 2S

TELEFAX	Private messages can be sent, on payment, through:
Leonardo Building:	Reception Desk (08.30 - 16.00, Mon-Fri)
Adriatico G.H.:	Reception Desk
E. Fermi Building:	Mail Counter (08.30 - 12.00, Mon-Fri)

LIBRARY	08.30 - 20.00 (Mon-Fri)	09.00 - 20.00 (Sat & Sun)
Leonardo Building	first floor All first-time users must register at the loan desk.	

Practical Infos

SHUTTLE BUS SERVICE:.

08:30 Galileo/Fermi	08.35 Leonardo Building	08:40 Adriatico	08:45 Galileo/Fermi
08:50 Galileo/Fermi	08:55 Leonardo Building	09:00 Adriatico	09:05 Galileo/Fermi
10:00 Galileo/Fermi	10:05 Leonardo Building	10:10 Adriatico	10:15 Galileo/Fermi
11:55 Galileo/Fermi	12:00 Leonardo Building	12:05 Adriatico	12:10 Galileo/Fermi
12:15 Galileo/Fermi	12:20 Leonardo Building	12:25 Adriatico	12:30 Galileo/Fermi
13:00 Galileo/Fermi	13:05 Leonardo Building	13:10 Adriatico	13:15 Galileo/Fermi
13:40 Galileo/Fermi	13:45 Leonardo Building	13:50 Adriatico	13:55 Galileo/Fermi
15:00 Galileo/Fermi	15:05 Leonardo Building	15:10 Adriatico	15:15 Galileo/Fermi
16:30 Galileo/Fermi	16:35 Leonardo Building	16:40 Adriatico	16:45 Galileo/Fermi

Joint IAEA-ICTP Workshop on

Nuclear Reaction Data for Advanced Reactor Technologies

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Title

to cover:

-information on the location
-exercises
-student's presentations

Fast neutrons!

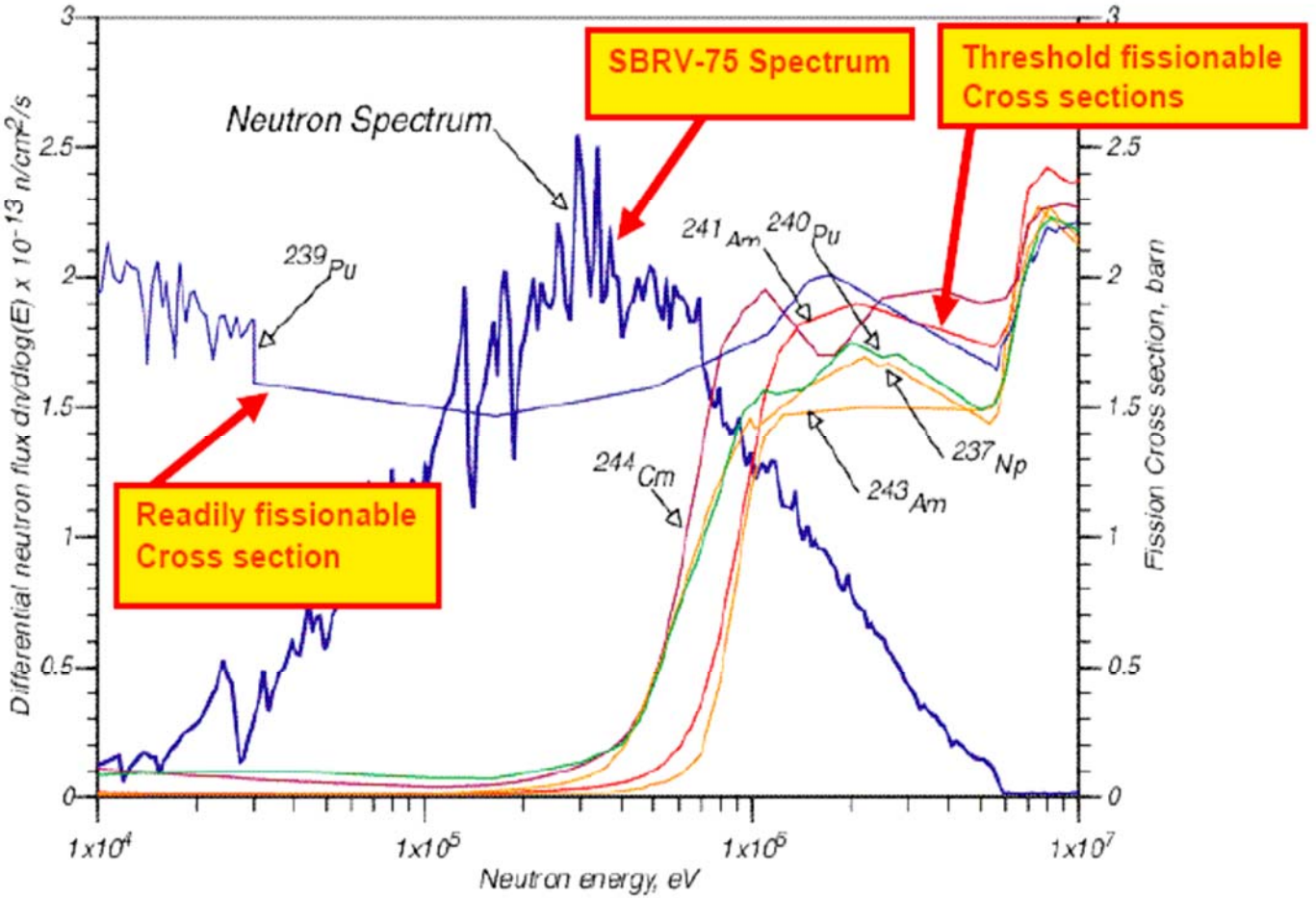

Figure 1: Simulation of the neutron spectrum in the SBRV-75 reactor [2], loaded with the Spiro MA fuel mixture (1/2 of ^{241}Am, 1/4 of ^{243}Am and 1/4 of equal amount of ^{244}Cm and ^{237}Np). The fission cross sections of several MA in consideration here are shown. The fission cross section of ^{239}Pu is also shown for a direct comparison with a non-threshold fission case.

source: C Rubbia

Neutron cross sections data are needed!

^{243}Am(n,f)