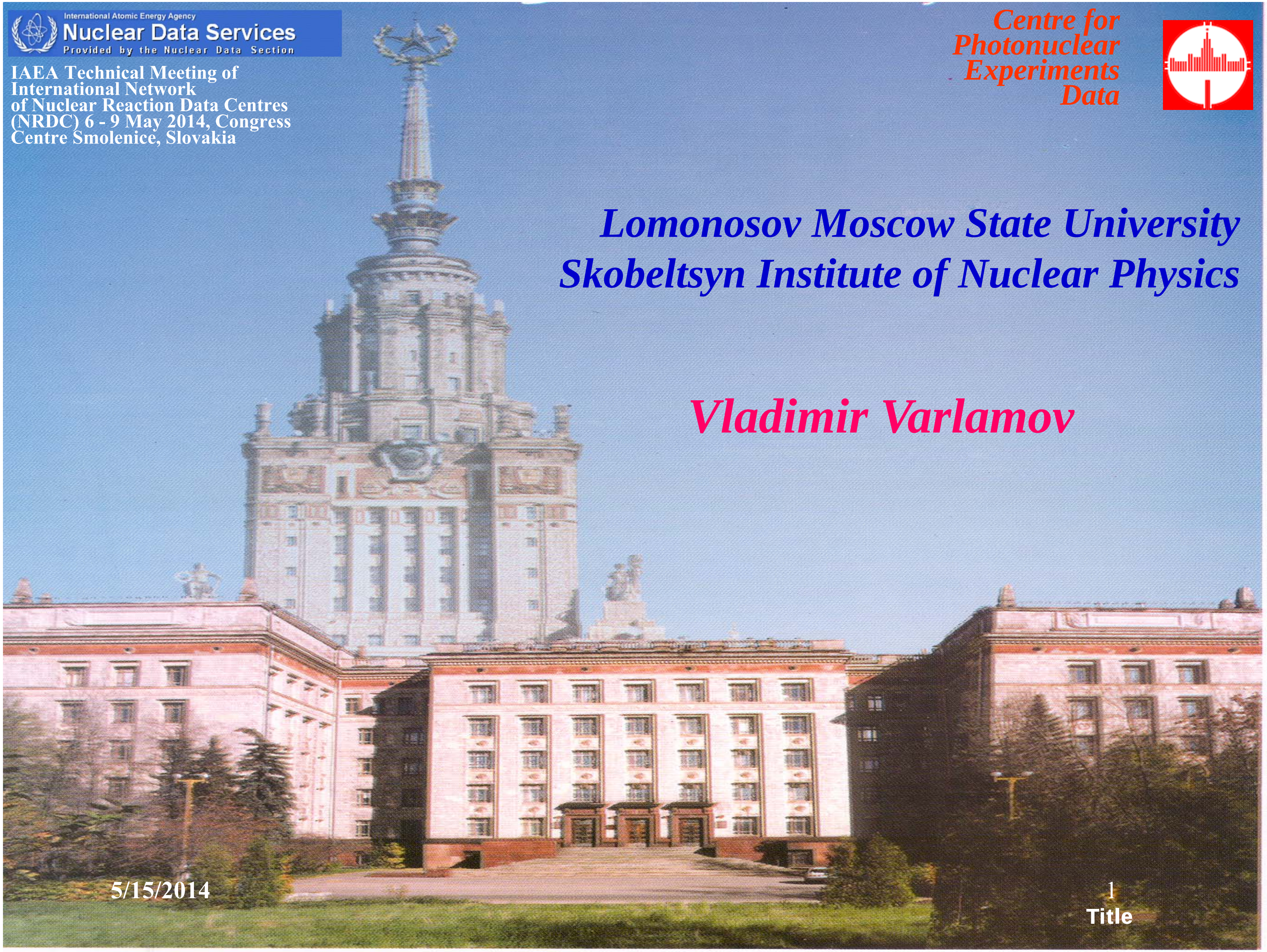

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IAEA Technical Meeting of International Network of Nuclear Reaction Data Centres (NRDC) 6 - 9 May 2014, Congress Centre Smolenice, Slovakia

Centre for Photonuclear Experiments Data

Lomonosov Moscow State University
Skobeltsyn Institute of Nuclear Physics

Vladimir Varlamov

The CDFE progress report on new photonuclear data compilations and old data corrections for 2013 - 2014

V.V.Varlamov, N.E.Gorskikh, S.Yu.Komarov, M.A.Makarov, N.N.Peskov, M.E.Stepanov

Progress Report to the IAEA Technical Meeting
on International Network of Nuclear Reaction Data Centres (NRDC)
6 –9 May 2014, Congress Centre Smolenice, Slovakia

The report contains short review of the main results obtained at the Centre for Photonuclear Experiments Data (Centr Dannykh Fotoyadernykh Eksperimentov – CDFE) of the Lomonosov Moscow State University Skobeltsyn Institute of Nuclear Physics (MSU SINP) concern nuclear data processing, analysis and evaluation for the period of time from the IAEA's Technical Meeting On International Network of Nuclear Reaction Data Centers" (NRDC), 23 – 25 April 2012, IAEA's Headquarters, Vienna, Austria till the spring of 2014.

General

The CDFE provides scientific and educational institutes and organizations of Russian Academy of Science with nuclear data for basic research, education and various applications. CDFE activities include the compilation, verification, evaluation and dissemination of modern international nuclear data. CDFE maintains several international and specially developed nuclear databases available through the CDFE Web-site – http://cdfe.sinp.msu.ru.

Organization

The CDFE has a status of laboratory (Nuclear Data Analysis Laboratory) within the MSU SINP. The total permanent stuff incudes 5 professional (the Centre head Vladimir Varlamov, Sergei Komarov, Nikolay Peskov, Mikhail Stepanov, Valery Viazovsky), 2 general service officers and several students of the MSU Physics Faculty.

Main fields of nuclear data activity

EXFOR Compilations

Photonuclear Data Evaluations

Nuclear Structure Data Evaluations

Nuclear Database Service

EXFOR Compilations

6 new CDFE EXFOR transes **TRANS.M067 - 072** have been produced and transmitted to the IAEA NDS. In the reported period of time all transes in addition to number of new ENTRYs contain primarily old ENTRYs corrected in accordance with the NRDC Network experts comments and recommendations.

The main subjects of corrections were:

- English translation additions for REFERENCE (YF <-> SNP, YF <-> PAN, ZET <-> JET, ZEP <-> JEL, IZV <-> BAS, DOK <-> SPD);
- REACTION SF8 corrections BRA <-> BRS;
- REACTION SF8 corrections ST2 <-> SN2;
- deleting of some ENTRYs because data duplications.

On the whole contents new CDFE trances have been produced in the reported period contain 164 corrected ENTRYs and 15 new ENTRYs.

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CDFE as participant of NRDC

Centre for Photonuclear Experiments Data

International Network of Nuclear Reaction Data Centres - Mozilla Firefox

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CDFE worldwide partners | International Network of Nuclear Reactio...

www-nds.iaea.org/nrdc/

CDFE НИИЯФ ИСТИНА МГУ РФФИ NRDC-Net NDS-cmpltn X4Cmpltn NDSX4 EXFOR-chex RapidShare Google Google Maps ND2013 "Ежедневный журна...

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Databases » EXFOR | ENDF | CINDA | IBANDL | Medical | PGAA | NGAtlas | RIPL | FENDL | IRDF-2002 | IRDFF

Databases
EXFOR
- What is EXFOR?
- EXFOR News
- Feedback
- Feedback (SG30)
- Articles in compilation
CINDA
- What is CINDA?
- Feedback
ENDF
- What is ENDF?
- ENDF Citation

NRDC Centres
NNDC (USA)
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CJD (Russia)
CNDC (China)
ATOMKI (Hungary)
NDPCI (India)
JAEA (Japan)
JCPRG (Japan)
KAERI (Korea)
CAJaD (Russia)
CDFE (Russia)
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Contacts
N.Otsuka
V.Semkova
S.Simakov
V.Zerkin

Links
NRDC
Nuclear Data Services
Nuclear Data Section

International Network of Nuclear Reaction Data Centres (NRDC)

(To previous NRDC Home / NRDC Internal Archive / Cite map)

What is NRDC?

The International Network of Nuclear Reaction Data Centres (NRDC) constitutes a worldwide cooperation of nuclear data centres under the auspices of the International Atomic Energy Agency. The Network was established to coordinate the world-wide collection, compilation and dissemination of nuclear reaction data.

Objectives and Tasks

The primary goal of the Network is the dissemination of nuclear reaction data and associated documentation to users. The following specific tasks must be carried out in order to accomplish this important aim:

- Compilation of relevant bibliographic information (CINDA),
- Compilation of experimental nuclear reaction data (EXFOR),
- Collection of evaluated nuclear reaction data (ENDF),
- Exchange of nuclear reaction data of all types,
- Promotion of the development of special purpose evaluated data files,
- Development of common formats for computerized exchange of nuclear data,
- Coordinated development of computer software for managing and disseminating nuclear data,
- Coordination of the development and dissemination of end user software for both on line and local access to nuclear data,
- Documentation of current and future data needs in order to be able to meet changing user demands.

Core Centres | **Specialized Centres** | Discontinued Centres

Regional, national and specialized data centres provide essential complementary functions to the core data centres by assuming particular responsibility for the collection and dissemination of data of a specialized type or application.

Country	Centre	Joined
China	Chinese Nuclear Data Center (CNDC) China Institute of Atomic Energy Beijing	1987
Hungary	Nuclear Data Group ATOMKI, Debrecen	1992
India	Nuclear Data Physics Centre of India BARC, Trombay, Mumbai	2008
Japan	Nuclear Data Center Japan Atomic Energy Agency, Tokai-mura, Naka-gun, Ibaraki	1991
Japan	Japan Nuclear Reaction Data Centre (JCPRG) Hokkaido University, Sapporo	1975
Korea	Nuclear Data Center Korea Atomic Energy Research Institute, Yuseong, Daejeon	2000
Russia	Nuclear Structure and Nuclear Reaction Data Centre (CAJaD) Kurchatov Institute, Moscow	1974
Russia	Centre for Experimental Photonuclear Data (CDFE) Moscow State University, Moscow	1982
Russia	Center for Nuclear Physics Data (CNPD) All Russian Scientific Research Institute of Experimental Physics, Sarov	1997
Ukraine	Ukrainian Nuclear Data Center (UkrNDC) Institute for Nuclear Research, Kyiv	1998

Documents
Network Document
EXFOR Basics (pdf)
EXFOR Basics (html)
EXFOR Formats
LEXFOR
Protocol
Dictionary
Short Guide
CINDA2001
ENDF-6 Formats
More Documents

Codes
Codes
Comments on ZCHEX

NRDC Meetings
2014 (Smolenice)
2013 (Vienna)
2012 (Paris)
2011 (Vienna)
2010 (Sapporo)
2009 (Vienna)
2008 (Obninsk)
2007 (Vienna)
2006 (Vienna)
2005 (Vienna)
2004 (Brookhaven)
2003 (Vienna)
2002 (Paris)
2001 (Vienna)
2000 (Obninsk)
1999 (Vienna)
All meetings

Other Events
Workshop 2013
Workshop 2011
Workshop 2010
Workshop 2003
More Meetings

Memos
4C-1 (NNDC)
4C-2 (NEA-DB)
4C-3 (NDS)
4C-4 (CJD)
CP-A (CAJaD)
CP-B (KaChaPaG)
CP-C (NNDC)
CP-D (NDS)
CP-E (JCPRG)
CP-F (CNPD)
CP-M (CDFE)
CP-N (NEA-DB)

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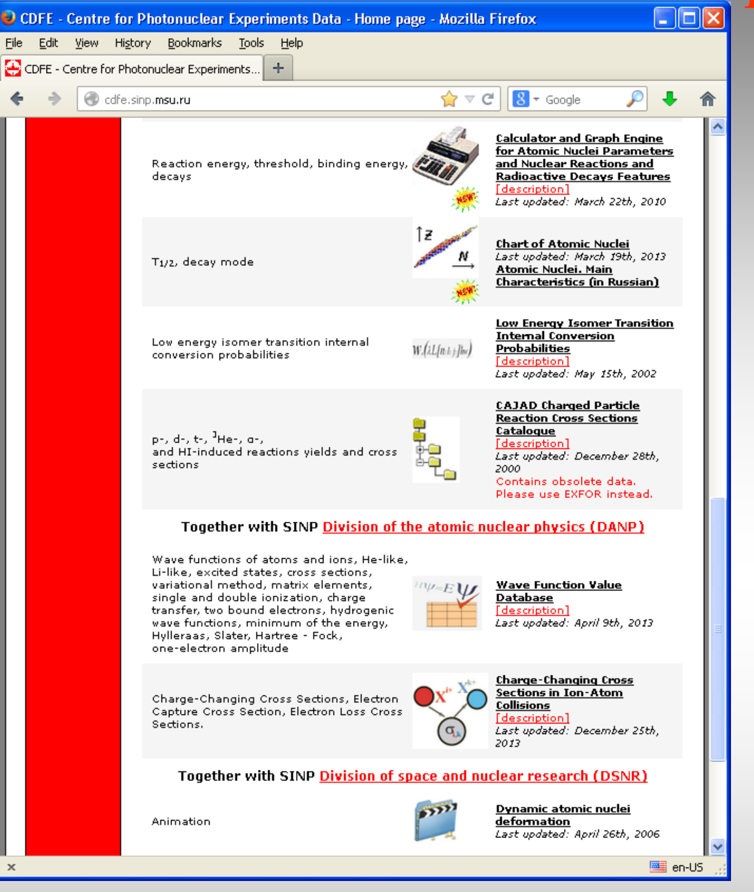
Centre for Photonuclear Experiments Data



3 CDFE databases (EXFOR, ENSDF, NSR) are based on the international data sources but have original Search Engines.

Other databases are based on the CDFE own data collections.

Nuclear Database Service

Some of the CDFE DB that are available through the CDFE Web-site (http://cdfe.sinp.msu.ru) were based on the international sources and founds of data produced and maintained by Nuclear Reaction Data Centres Network and by USA NNDC and NSDD:

- **“Nuclear Reaction Database (EXFOR)”:** many data for reactions induced by photons, neutrons, charge particles and heavy ions;

- **“Complete Nuclear Spectroscopy Database “Relational ENSDF”** contains many nuclear spectroscopy data for all known (~3200) nuclides from the well-known international fund ENSDF (Evaluated Nuclear Structure Data File);

- **“Nuclear Physics Publications (“NSR” Database”** is the really relational DB based on the data fund of NSR (Nuclear Science References).

Those databases used international sources of information but CDFE-developed powerful and flexible original Search Engines.

Other databases are CDFE-produced and maintained:

- digital **"Chart of Giant Dipole Resonance Main Parameters"** contains data on main parameters (energy position, amplitude, width, integrated cross section) of GDR for many nuclei;

- digital **"Chart of Nucleus Shape and Size Parameters"** contains data on quadrupole moments, parameters of quadrupole deformation and charge radii for many nuclei;

- **"Nucleus Ground and Isomeric State Parameters"** combines many useful information on the nucleus as whole and its ground and isomeric states properties (masses, binding energy, nucleon separation energy, decay mode, energy of various decays, etc);

- **"Calculator and Graph Engine for Atomic Nuclei Parameters and Nuclear Reactions and Radiative Decays Features** combines many useful data for "Nucleus Binding Energies", "Nucleons and Nuclei Separation Energies", "Decays Energies", "Decays Energies", "Nuclei fission".

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EXFOR Database

Centre for Photonuclear Experiments Data

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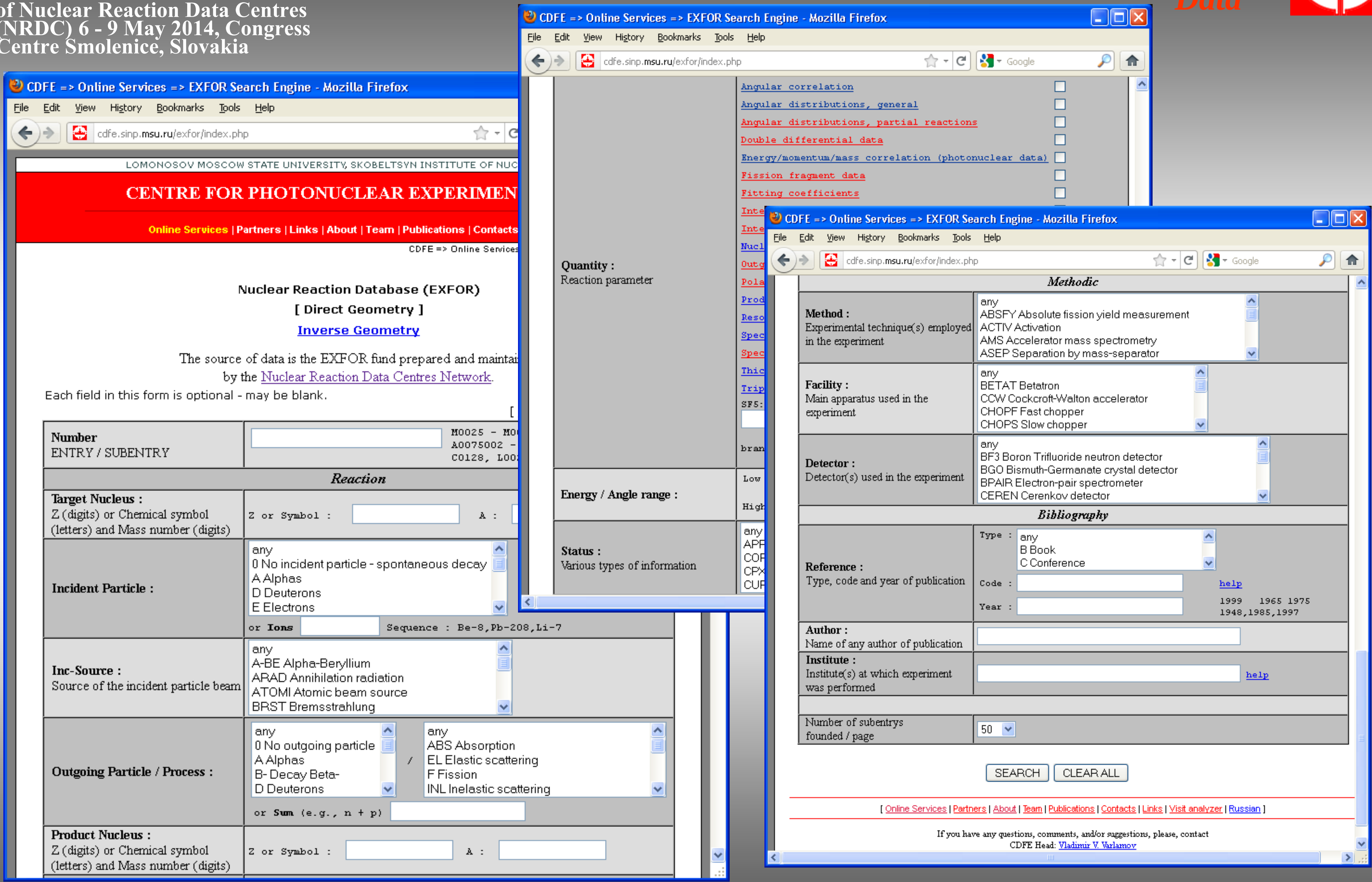

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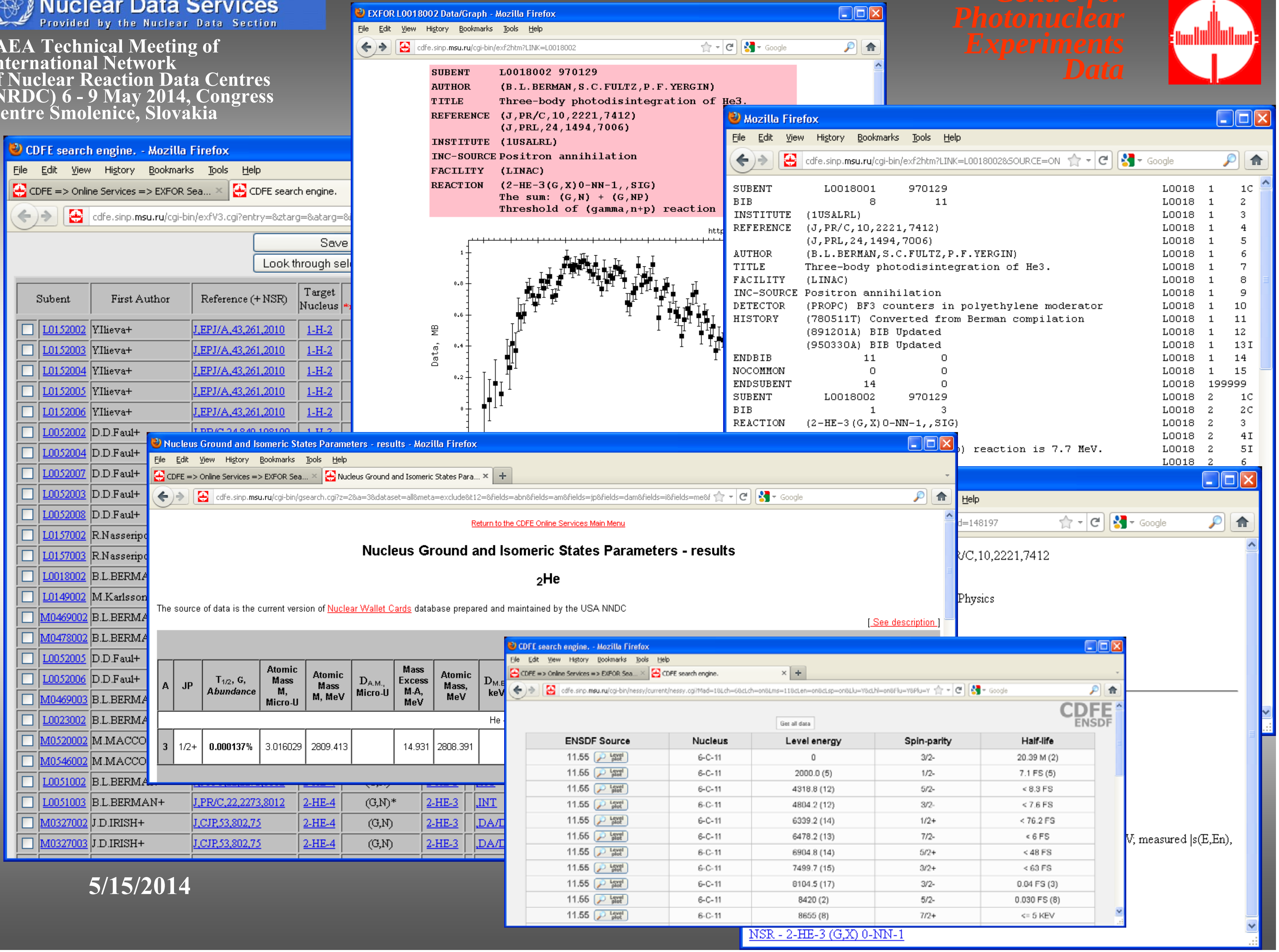


5/15/2014

Photonuclear Data Evaluations

Main direction:

investigations of reliability and authenticity of data for partial photonuclear reaction cross sections

Main results:

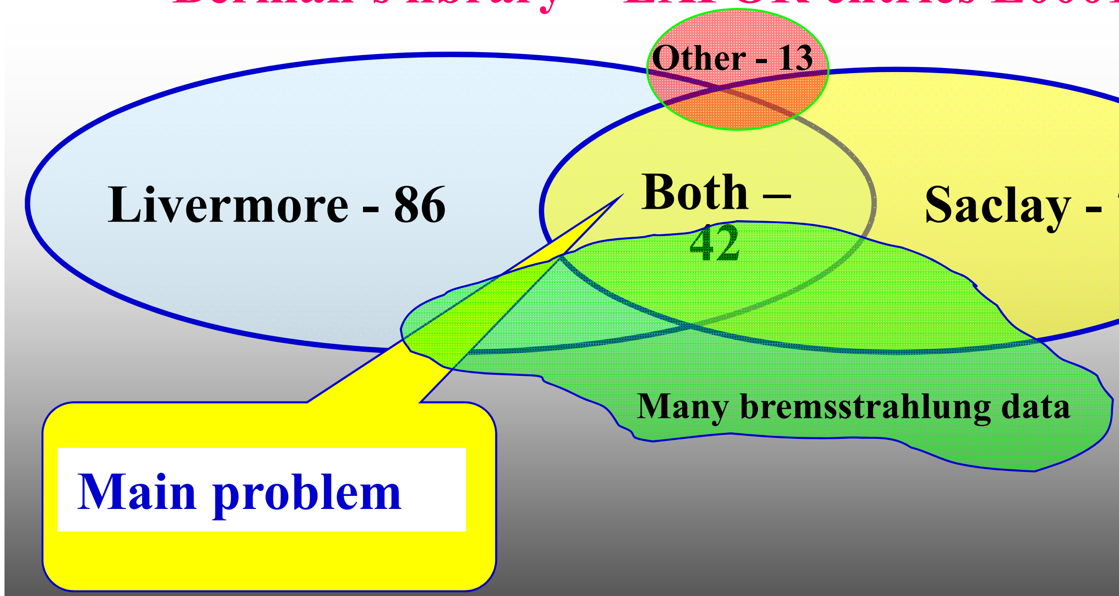
- **many experimental data data for partial photonuclear reaction cross sections from various experiments were analyzed;**
- **new simple objective and absolute criteria were found out for investigation of data reliability and authenticity;**
- **that was shown that majority of experimental data on partial photonuclear reaction cross section data are not reliable and authentic;**
- **new method for evaluation of reliable and authentic data were proposed**
- **many new data were evaluated**

Main problem:

• many experimental data data for partial photonuclear reaction cross sections are published (majority was obtained at Livermore and Saclay):

Atlas of Photoneutron cross sections obtained with monoenergetic photons (S.S.Dietrich, B.L.Berman. Atom. Data and Nucl. Data Tables, 38 (1988) 199;

Berman's library - EXFOR entries L0001 – L0059 (~ 180 nuclei sets)



For each nucleus – cross sections:

(γ,3n)

(γ,2n)

(γ,n)

(γ,sn) = + (γ,n) + (γ,2n) + (γ,3n)

γ,xn) = + (γ,n) + 2(γ,2n) + 3(γ,3n)

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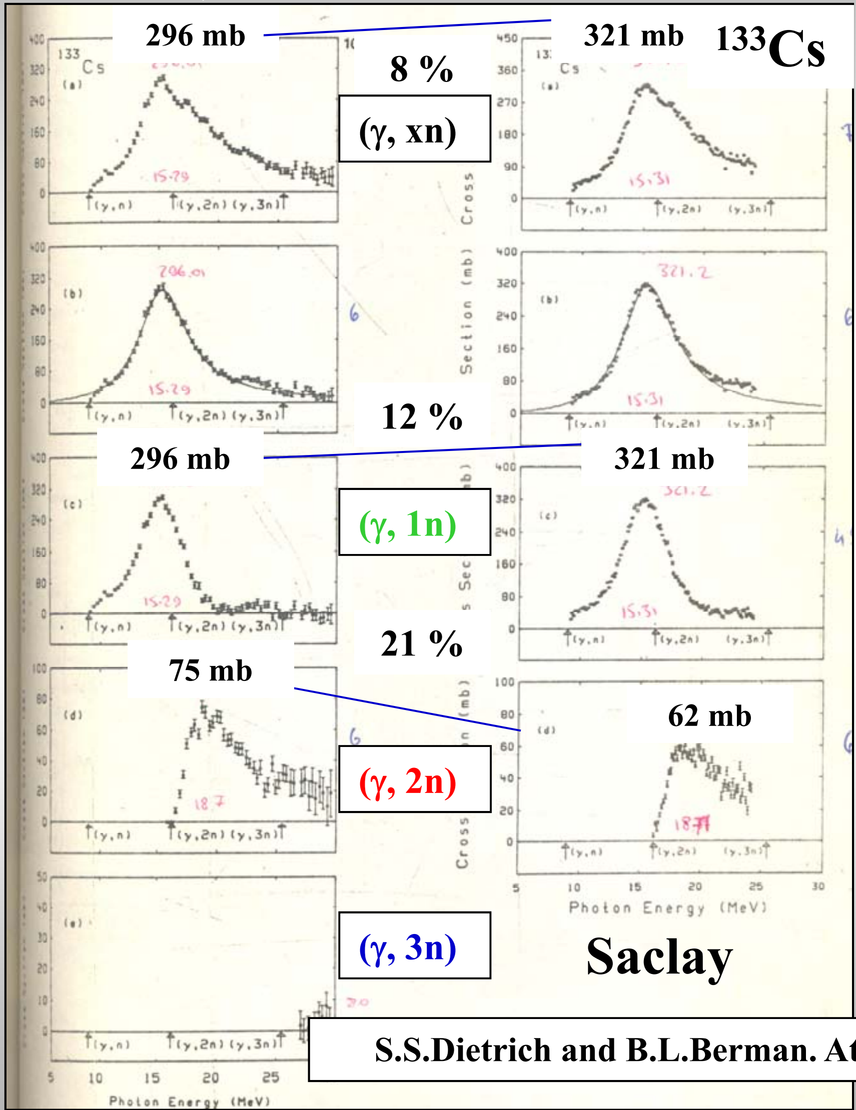
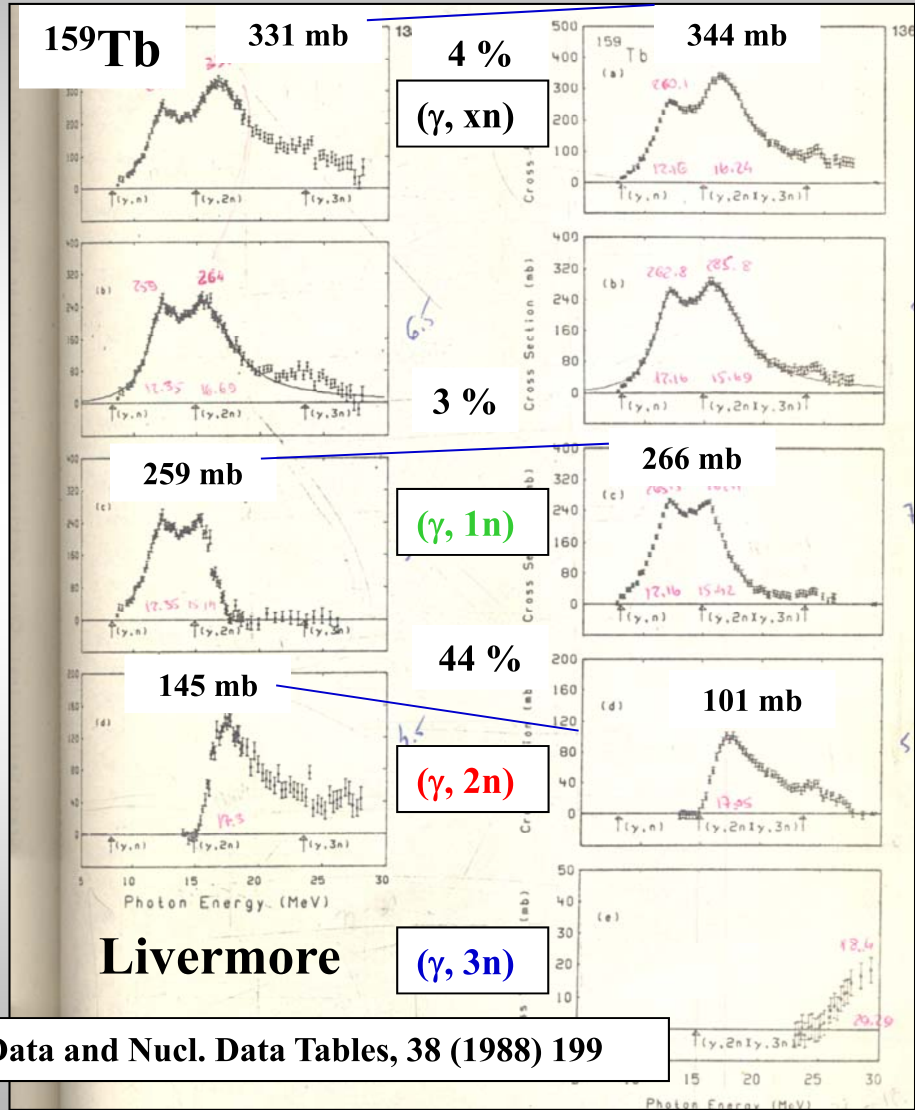


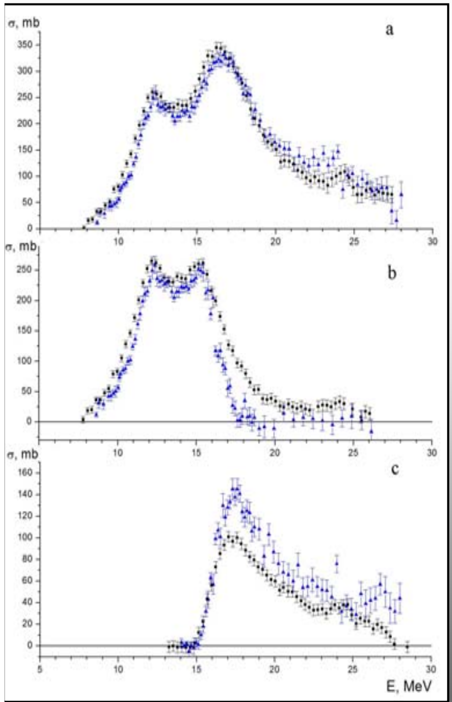


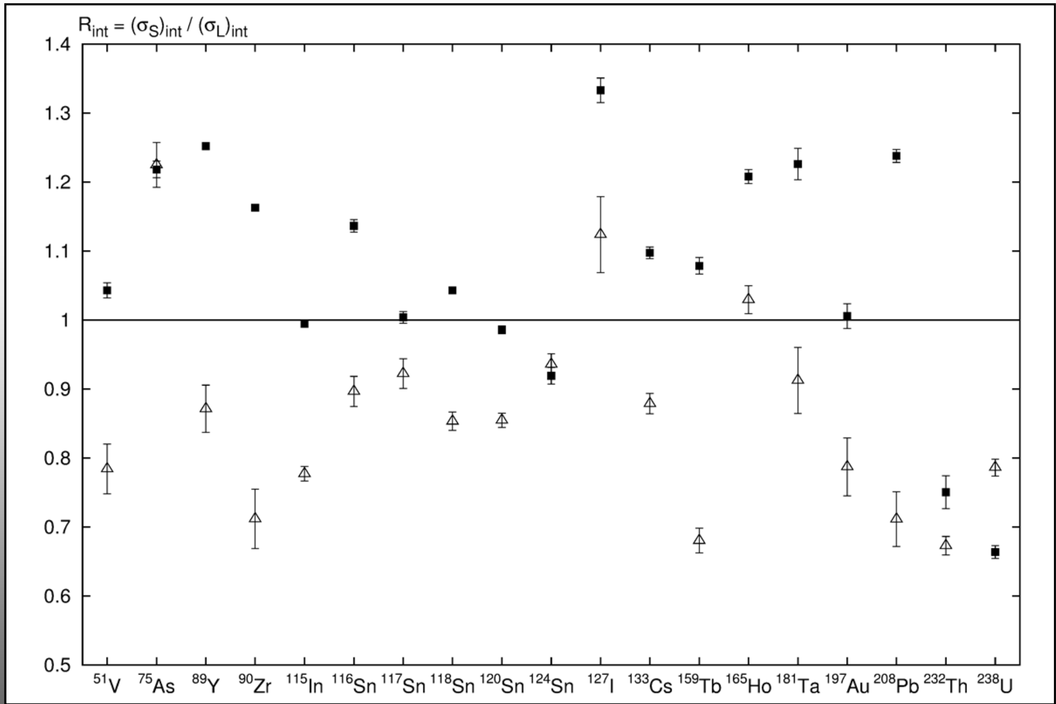
S.S.Dietrich and B.L.Berman. Atom. Data and Nucl. Data Tables, 38 (1988) 199

Main problem: many significant (till 100 %!) disagreements were found out between data from two laboratories;

(γ,n) – (γ,2n) disagreements between Saclay and Livermore data – ratios of integrated cross sections

^{159}Tb



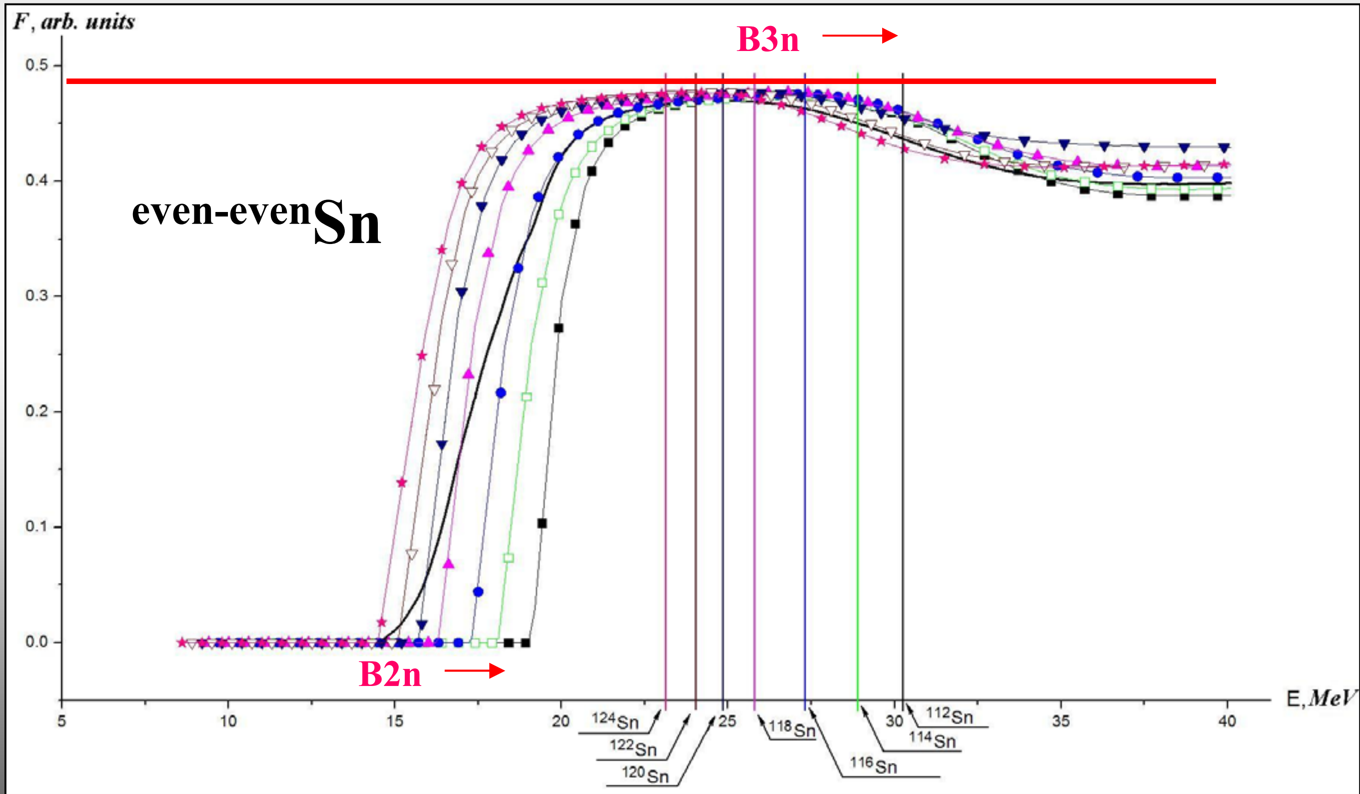


Squares - ■ - ratios for (γ,n) reactions – are larger than 1.0

Triangles - △ - ratios for (γ,2n) reactions – are smaller than 1.0.

Oblective absolute criterium of "correct" reliable data

$$F_2 = \frac{\sigma(\gamma,2n)}{\sigma(\gamma,n) + 2\sigma(\gamma,2n) + 3\sigma(\gamma,3n) + \ldots} < 0.5\ (!)$$



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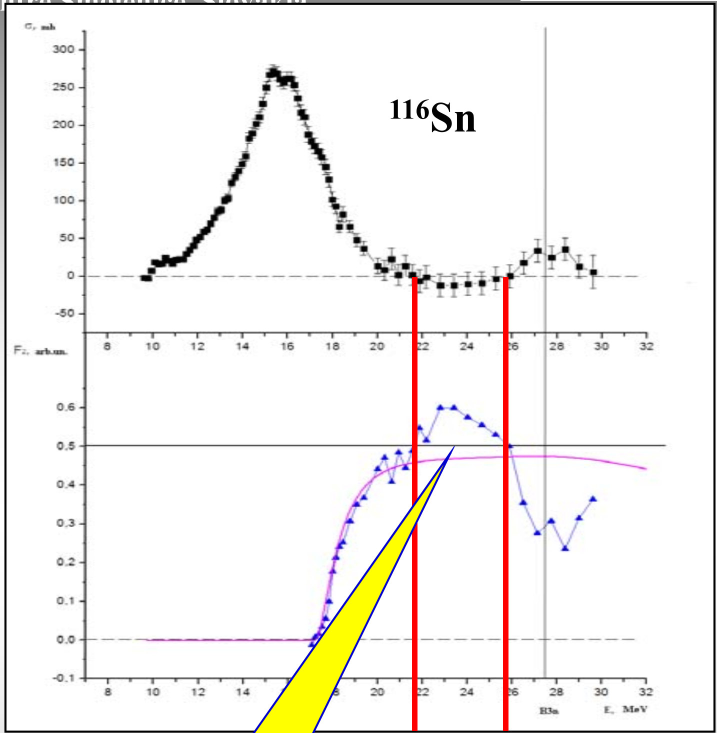
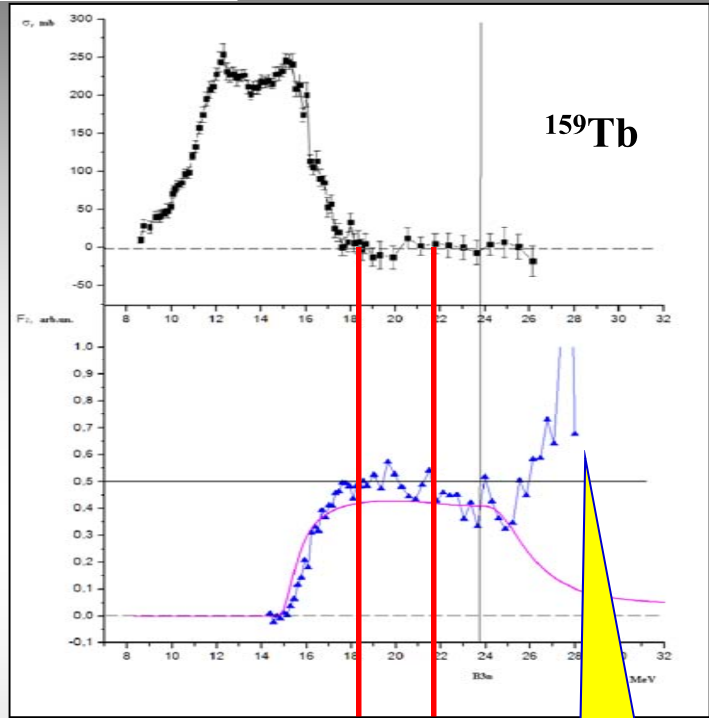
Some examples of "correct" Livermore data



σ(γ,n)

F_2



Dramatic disagreements: $F_2 > 0.5$!

$$F_2 = \frac{\sigma(\gamma,2n)}{\sigma(\gamma,n) + 2\sigma(\gamma,2n) + 3\sigma(\gamma,3n) + \ldots} < 0.5\ (!)$$

Dramatic disagreements: $F_2 = 1.5 – 2.0$!

But physically not reliable negative cross section values are correlated with physically forbidden values $F_2 > 0.5$

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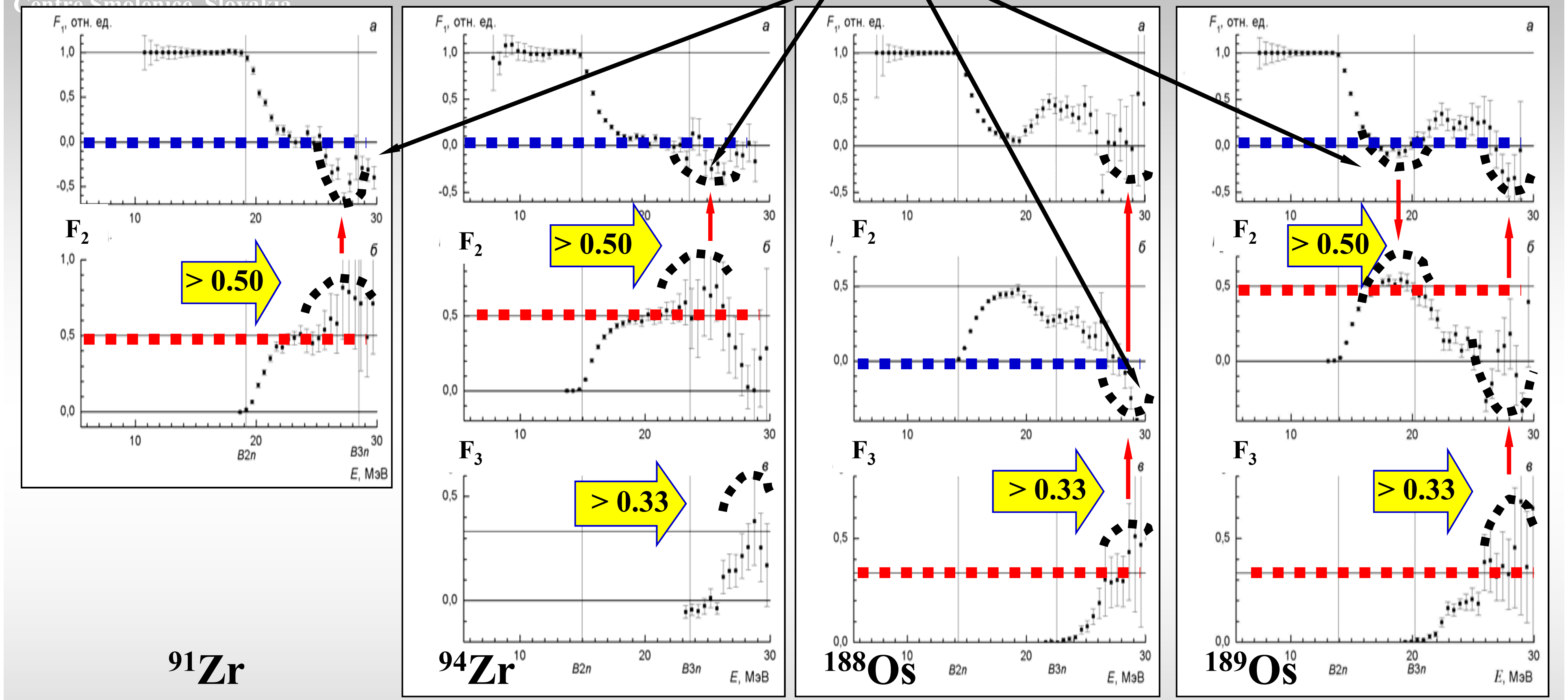
Physically forbidden negative values



The reliability of many data is doubtful.

Many data should be reanalyzed and reevaluated!

There are additional physically natural criteria:

$F_1 = \sigma(\gamma, 1n) \;/\; \sigma(\gamma, xn) < 1.00$

$F_3 = \sigma(\gamma, 3n) \;/\; \sigma(\gamma, xn) < 0.33$ etc.

New experimentally-theoretical method of evaluation

using modern model of photonuclear reactions:

- initial data – experimental (γ,xn) reaction cross section;

- sorting neutrons for multiplicity based on theoretical model.

Theoretically calculated transitional multiplicity functions

$$F_i^{theor} = \sigma^{theor}(\gamma,in)/\sigma^{theor}(\gamma,xn)$$

are used for cross section evaluation by following way

$$\sigma^{eval}(\gamma,in) = F_i^{theor}(\gamma,in) \bullet \sigma^{exp}(\gamma,xn).$$

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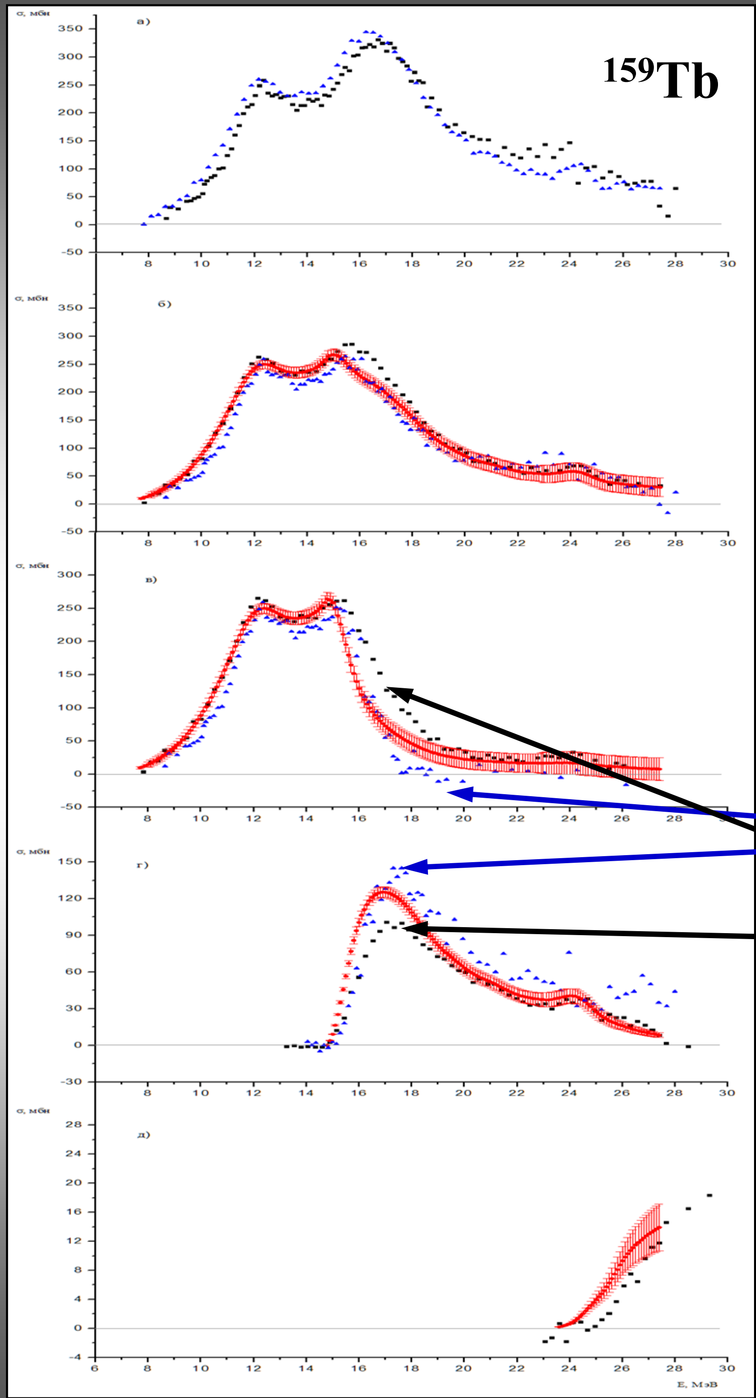
σ(γ,xn)

σ(γ,sn)

σ(γ,n)

σ(γ,2n)

σ(γ,3n)



^{63}Cu, ^{89}Y, ^{90}Zr, ^{115}In, ^{112,114,116,117,118,119,120,122,124}Sn, ^{165}Ho, ^{197}Au, ^{181}Ta, ^{208}Pb

Livermore data are “bad”

Saclay data are “bad”

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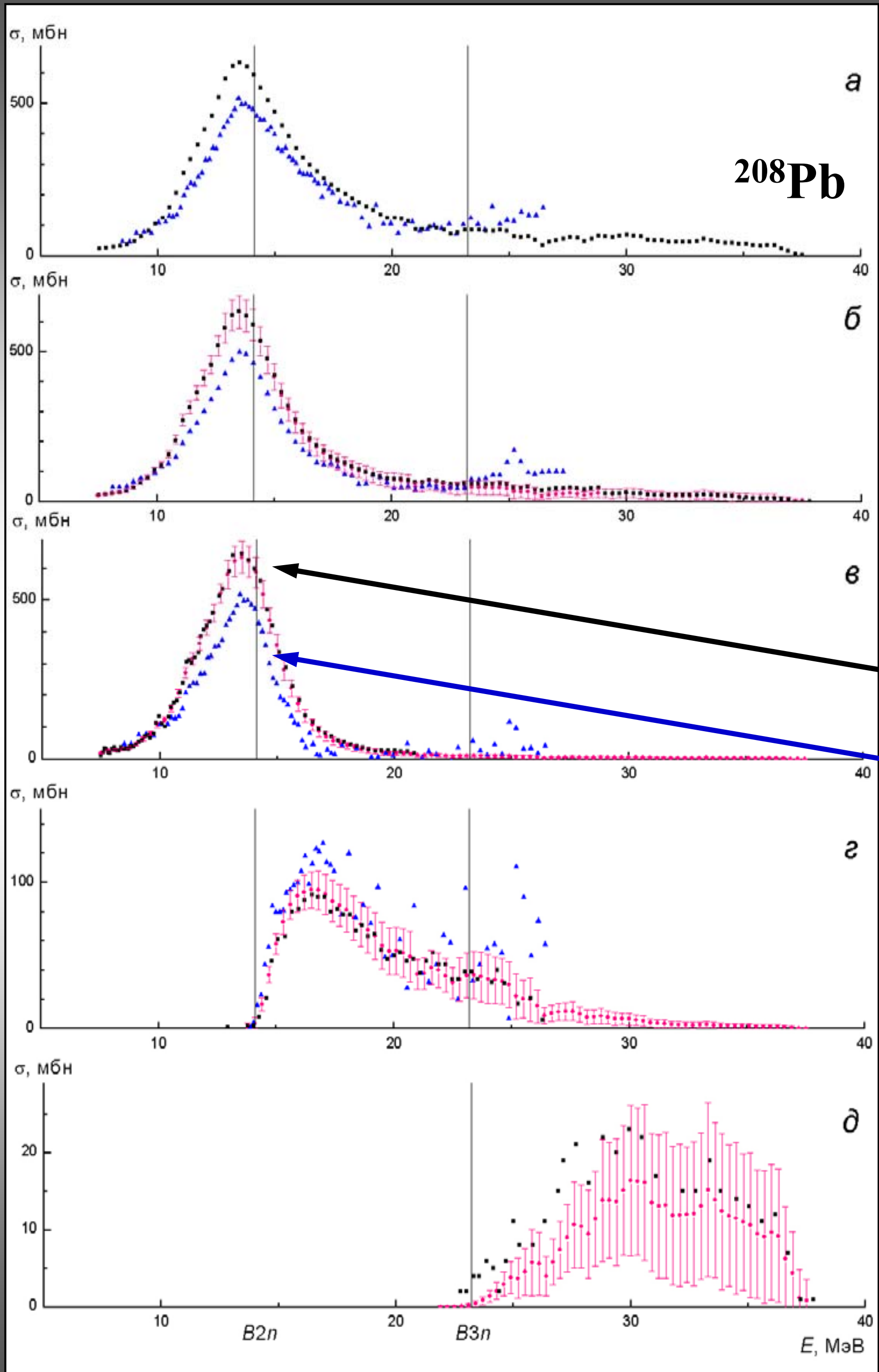
σ(γ,xn)

σ(γ,sn)

σ(γ,n)

σ(γ,2n)

σ(γ,3n)



Saclay data are "good"

Livermore data are "bad"

xn-sn-n-2n-3n

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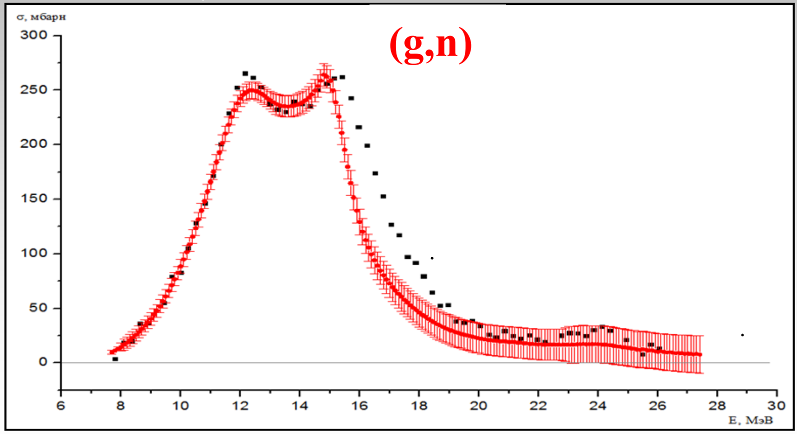

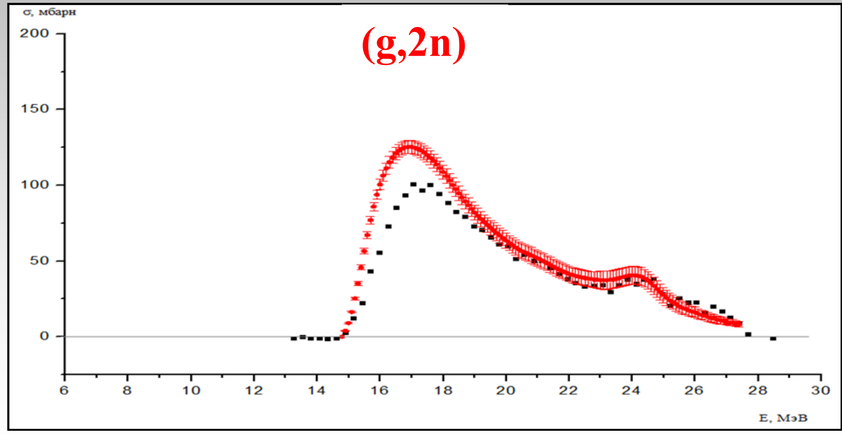

^{159}Tb

Reaction	Center of gravity $E^{c.g.}$, MeV	Integrated cross section σ^{int}, MeV•mb	Integrated cross section σ^{int}, MeV•mb	Center of gravity $E^{c.g.}$, MeV
	New evaluated data		Saclay data	
(γ,xn) *)	16.84	3200	3200	16.84
(γ,sn)	15.78	2383 <	2557	
(γ,n)	14.04	1642 <	1950	14.6
(γ,2n)	19.04	714 >	610	19.9
(γ,3n)	26.29	26	16	26.8

$\sigma^{int}(\gamma,2n)/\sigma^{int}(\gamma,n)$ decreased for 27 %.

Decrease for 9 %!

Decrease for 19 %!

Increase for 15 %!

*) Initial Saclay data

GEANT, TALYS, EMPIRE,…corrections?

^{181}Ta

Ratios	Experiments			Evaluation
	Saclay	Livermore	Activity	$F_{1,2,3}$
of cross sections σ(γ,2n)/σ(γ,n)	0.36 (797.4/2189.5)	0.67 (887.0/1315.7)		0.49 (958.3/1956.3)
of yields Y(γ,2n)/Y(γ,n)	**0.24**	**0.42**	**0.34 ± 0.07**	**0.33 *)**
of cross sections σ(γ,3n)/σ(γ,n)	0.063 (137.4/2189.5)			0.055 (107.3/1956.3)
of yields Y(γ,3n)/Y(γ,n)	0.02		0.023 – 0.025**)	0.018*)

Photonuclear Data Evaluations

In accordance with CDFE program of investigation of reliability of experimental data for photonuclear total and partial reaction cross sections obtained using various methods the correspondent analysis and evaluations were continued. Using specially proposed objective criteria of data reliability and new experimental-theoretical method for evaluation many new reliable and data for neutron yield reaction (γ,xn) = (γ,n) + 2(γ,2n) + 3(γ,3n), total photoneutron reaction (γ,sn) = (γ,n) + (γ,2n) + (γ,3n) and partial (γ,n), (γ,2n), (γ,3n) reactions cross sections were obtained for many nuclei (^{63,65}Cu, ^{91,94}Zr, ^{186,188,189,190,192}Os, ^{207}Pb) in addition to those investigated before (^{89}Y, ^{90}Zr, ^{115}In, ^{116,117,118,119,120,122,124}Sn, ^{159}Tb, ^{165}Ho, ^{181}Ta, ^{197}Au, ^{208}Pb). New reliable evaluated data were presented at the International Meetings on Nuclear Spectroscopy and Nuclear Structure (NUCLEUS 2013 and NUCLEUS 2014) and included into the EXFOR database.

Short-term (2013/2014) Program

The main items of CDFE (2013/2014) program, main priorities and most important tasks are traditional and the following:

- continuation of photonuclear data compilation using EXFOR format, new TRANSes (M073, M074, etc.) production;
- correction of old ENTRYs in accordance with new EXFOR coding rule changes and the NRDC Network experts comments and recommendations;
- continuation of joint analysis and evaluation of total and partial photonuclear reaction cross sections obtained using various methods in experiments with quasimonoenergetic annihilation and bremsstrahlung photons;
- upgrading (corrections and additions) of all databases put upon the CDFE Web-site (http://cdfe.sinp.msu.ru).

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Centre for Photonuclear Experiments Data

Vladimir Varlamov

THANKS A LOT

FOR ATTENTION!

Thanks!

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CDFE services statistics: January 2012

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Statistics for cdfe.sinp.msu.ru (2012-01) - main - Mozilla Firefox

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cdfe.sinp.msu.ru/cgi-bin/awstats/awstats.pl

Statistics for: cdfe.sinp.msu.ru

Summary
When:
Monthly history
Days of month
Days of week
Hours
Who:
Countries
- Full list

Hosts
- Full list
- Last visit
- Unresolved IP Address

Robots/Spiders visitors
- Full list
- Last visit

Worm/Virus attacks
Navigation:
Visits duration
File type
Viewed
- Full list
- Entry
- Exit

Operating Systems
- Versions
- Unknown

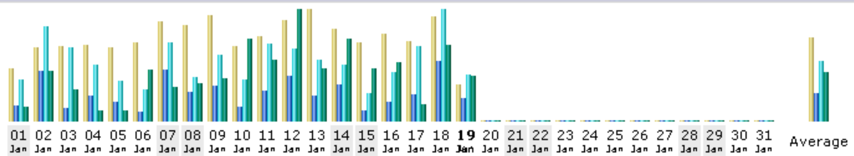
Browsers
- Versions
- Unknown

Referrers:
Origin
- Referring search engines
- Referring sites

Search
- Search Keyphrases
- Search Keywords

Others:
Web compression
Miscellaneous
HTTP Status codes
- Pages not found

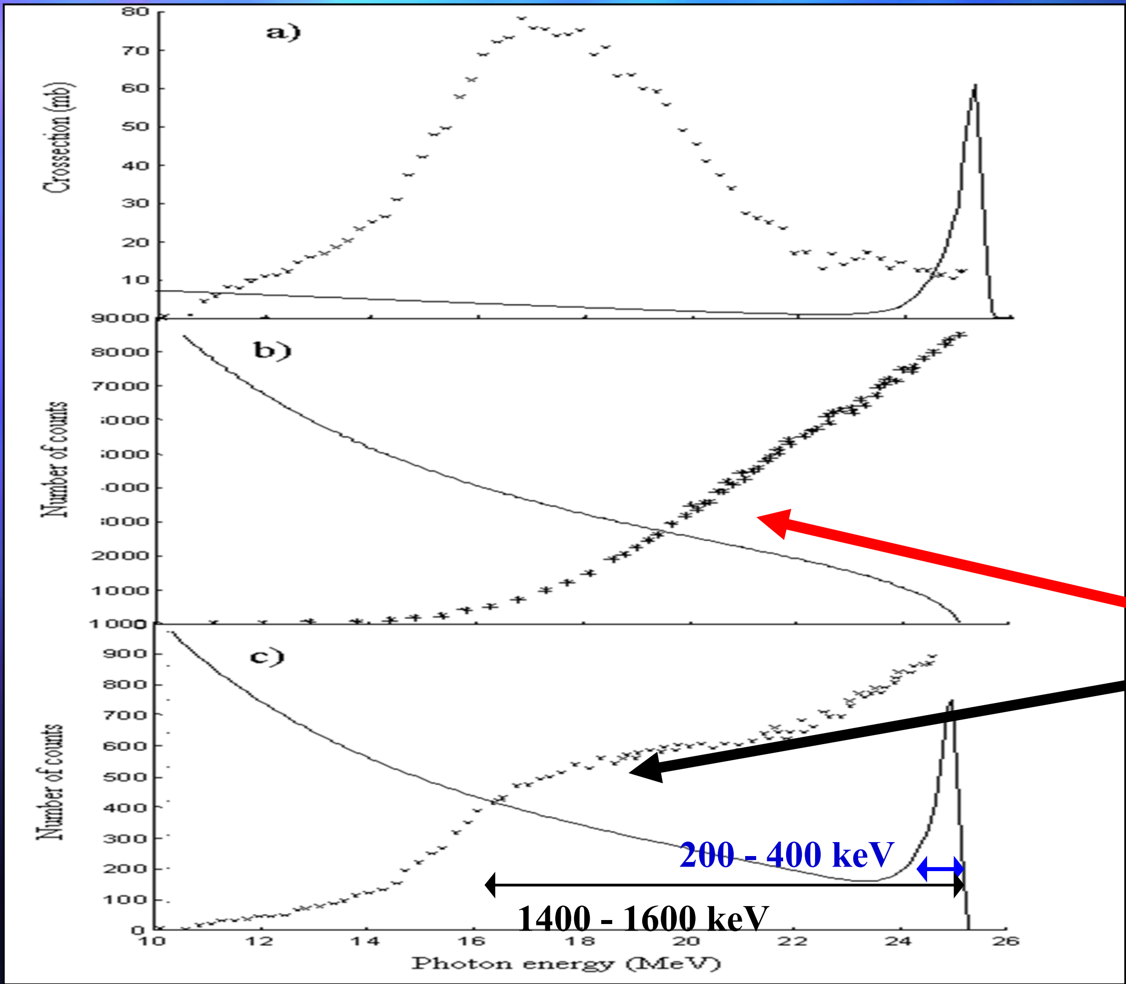
Days of month



Statistics for cdfe.sinp.msu.ru (2012-01) - main - Mozilla Firefox

Countries (Top 20) - Full list

	Countries		Pages	Hits	Bandwidth
	Russian Federation	ru	1841	4080	323.01 MB
	Ukraine	ua	338	563	20.10 MB
	United States	us	325	431	47.87 MB
	Kazakhstan	kz	101	437	4.50 MB
	Germany	de	74	108	3.60 MB
	China	cn	67	100	2.23 MB
	Japan	jp	66	163	2.76 MB
	Poland	pl	65	71	964.64 KB
	Canada	ca	41	73	3.02 MB
	South Korea	kr	37	37	3.59 MB
	Vietnam	vn	35	103	515.38 KB
	Iraq	iq	31	55	4.41 MB
	India	in	30	111	15.89 MB
	Great Britain	gb	28	97	17.99 MB
	France	fr	27	35	12.03 MB
	Belgium	be	25	27	72.76 KB
	Netherlands	nl	22	25	1.35 MB
	Italy	it	20	21	1.61 MB
	Turkey	tr	16	55	843.44 KB
	Thailand	th	16	39	456.50 KB
	Others		124	425	40.92 MB



Simple subtraction QMA-procedure gives to one possibility to delete bremsstrahlung tale but does not - to obtain higher energy resolution!

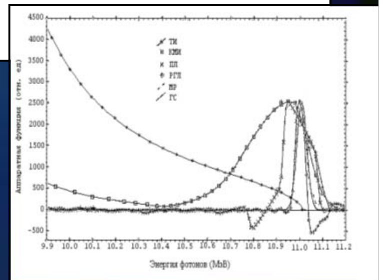
Difference of the yields is not cross section but only yield again:

$$\int W_1 \sigma dE - \int W_2 \sigma dE = \int (W_1 - W_2) \sigma dE$$

only for $\sigma = const$!

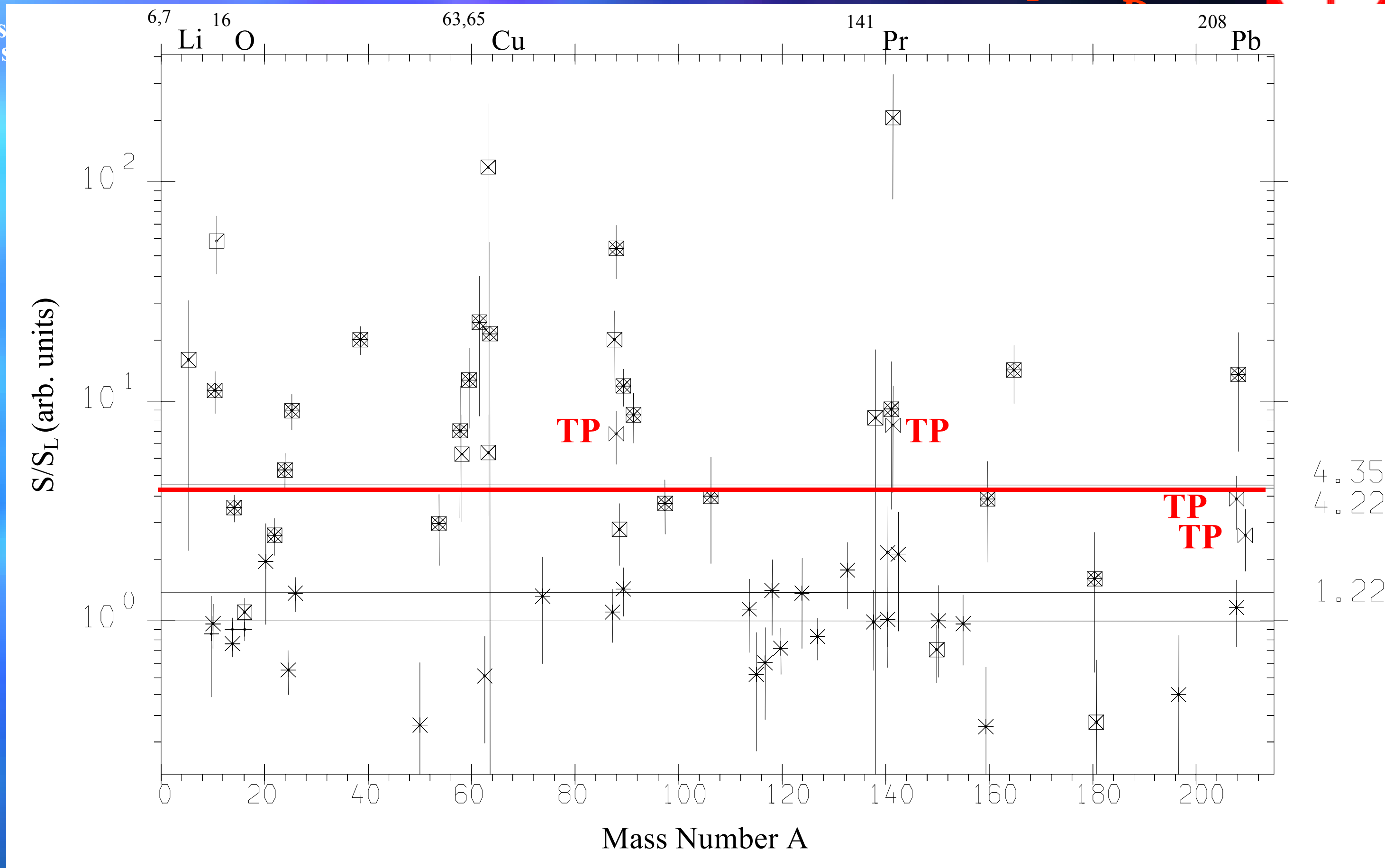
That procedure is subtraction of result obtained with very bad resolution from the result obtained with bad resolution!

Additional processing for real photon spectrum is needed.



$$S = \frac{1}{N}\sum_{i=1}^{N}\frac{(\sigma_i - <\sigma_i>)^2}{<<\sigma>>^2}$$

S/S_l are presented, where S were calculated for various laboratories data and S_l - for Livermore QMA-data.

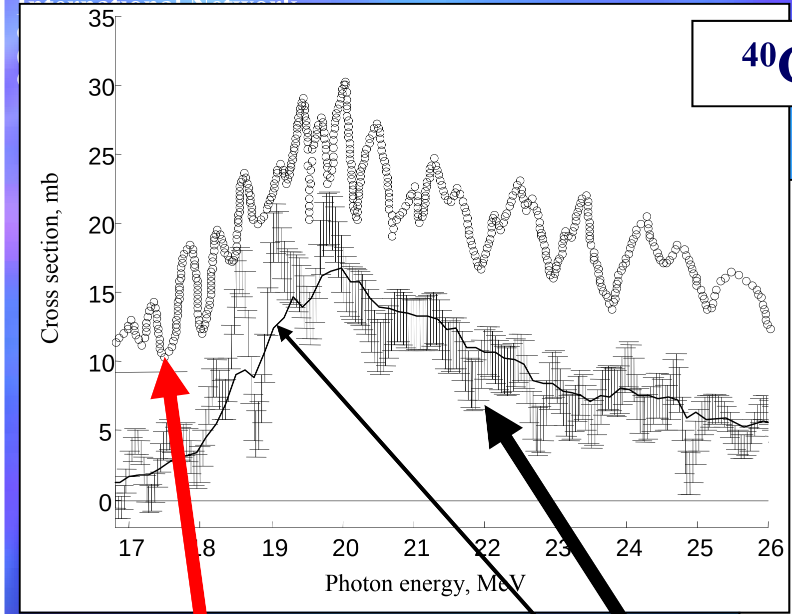


"Structurenes" S/S_l ratios for (γ,xn) reaction cross section data:

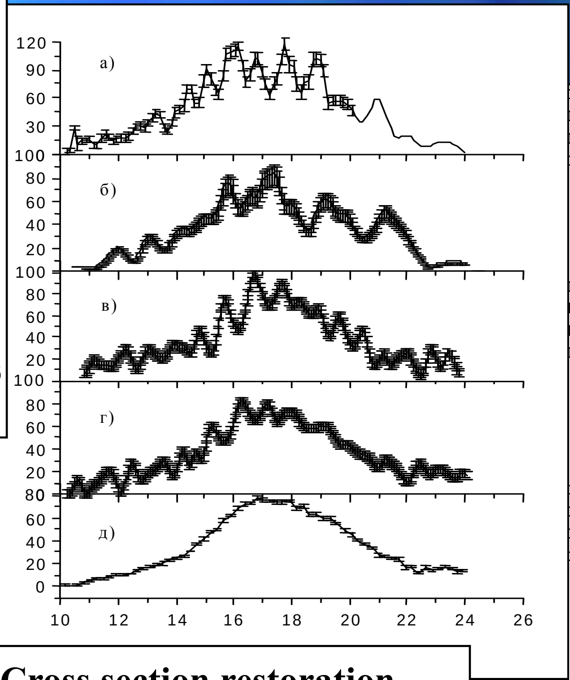
- **squares - BR-data (Moscow, Melbourne (Australia), other) - $< S/S_l> = 4.35$;**
- **crosses - QMA-data (Saclay (France), Giessen (Germany), other) - $< S/S_l> = 1.22$;**
- **bows - Tagged Photons-data (Illinois (USA)) - $< S/S_l> = 4.22$.**

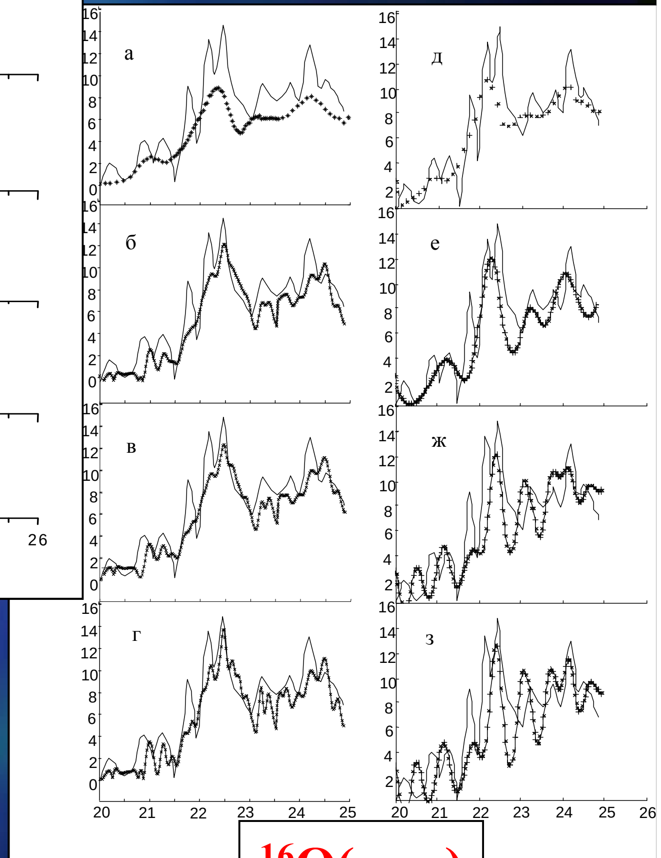
Structure systematic

$^{40}Ca(\gamma,n)^{39}Ca$



$^{63}Cu(\gamma,n)^{62}Cu$





$^{16}O(\gamma,xn)$

Result of bremsstrahlung experiment

Cross section restoration from QMA-experiment result

Real energy resolution of QMA-experiments is 4 - 6 times worse in comparison to its estimation based upon calculated photon spectrum annihilation line width.

Well-known data under discussion:

E.G.Fuller, H.Gerstenberg. Photonuclear Data - Abstracts Sheets 1955 - 1982. NBSIR 83-2742. U.S.A. National Bureau of Standards, 1986.

S.S.Dietrich, B.L.Berman. Atlas of Photoneutron Cross Sections Obtained with Monoenergetic Photons. Atomic Data and Nuclear Data Tables, 38 (1988) 199.

A.V.Varlamov, V.V.Varlamov, D.S.Rudenko, M.E.Stepanov. Atlas of Giant Dipole Resonances. Parameters and Graphs of Photonuclear Reaction Cross Sections. INDC(NDS)-394, IAEA NDS, Vienna, Austria, 1999.

V.V.Varlamov, V.V.Sapunenko, M.E.Stepanov. Photonuclear Data 1976 - 1995. Index. Moscow State University. Moscow, 1996 (bibliographic database URL (http://depni.sinp.msu.ru/cdfe/services/pnisearch.html).

International nuclear (including photonuclear) reaction data relational database (EXFOR):

I.N.Boboshin, V.V.Varlamov, E.M.Ivanov, S.V.Ivanov, N.N.Peskov, M.E.Stepanov, V.V.Chesnokov. Relational Nuclear Databases Upon the MSU INP CDFE Web-site and Nuclear Data Centres Network CDFE Activities. Report on the IAEA Consultant's Meeting on the Co-ordination of Nuclear Reaction Data Centres (Technical Aspects), 28 – 30 May 2001, Vienna, Austria. INDC(NDS)-427, IAEA NDS, Vienna, Austria, 2001, p. 49.

All data for quasimonoenergetic photons and many data for bremsstrahlung are included: URL (http://depni.sinp.msu.ru/cdfe/exfor/index.php):

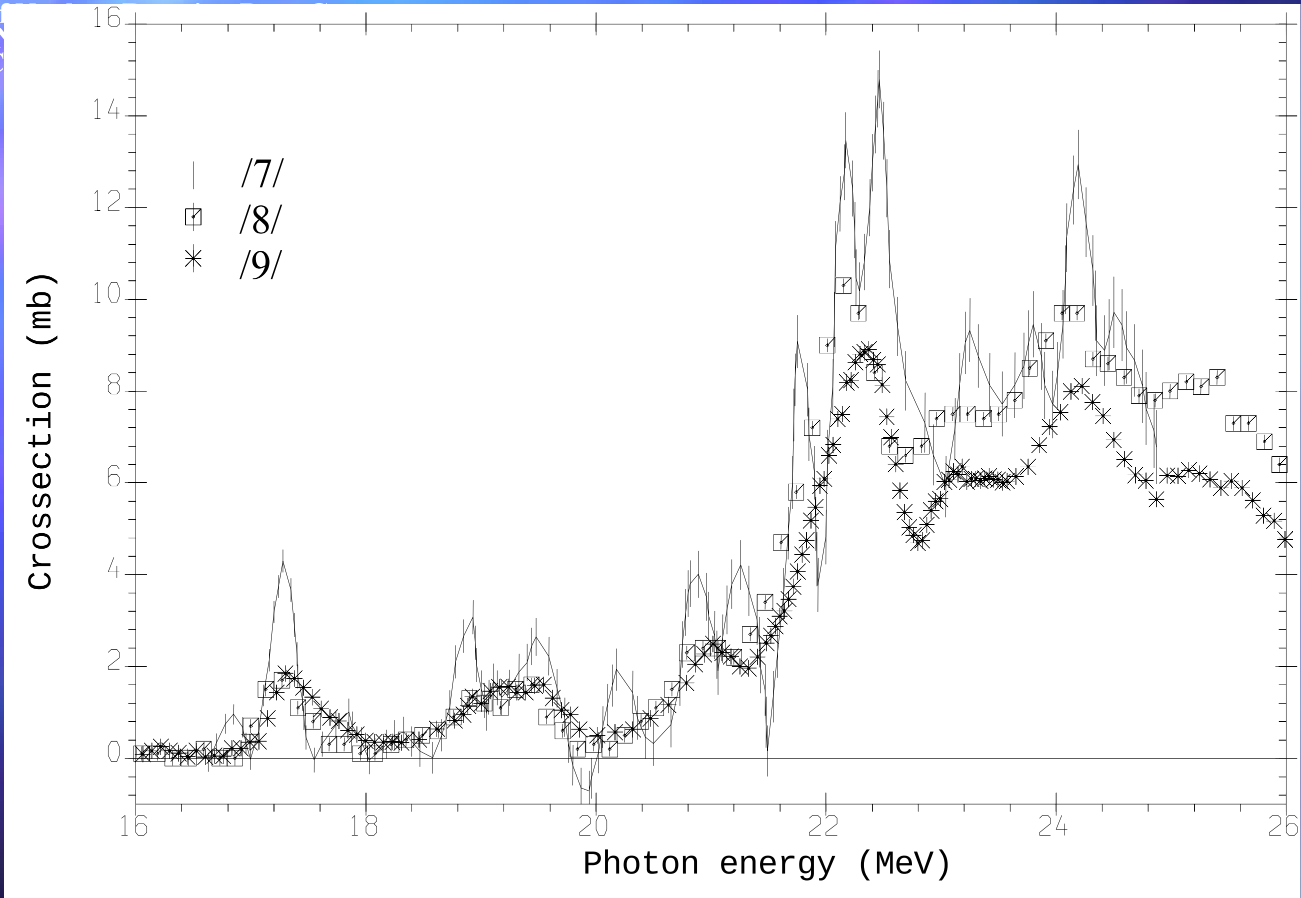
EXFOR database

International Atomic Energy Agency
Nuclear Data Services
Provided by the Nuclear Data Section

IAEA Technical Meeting of
International Network
of

Centre for Photonuclear Experiments Data

$^{16}O(\gamma,xn)$



In detailes:

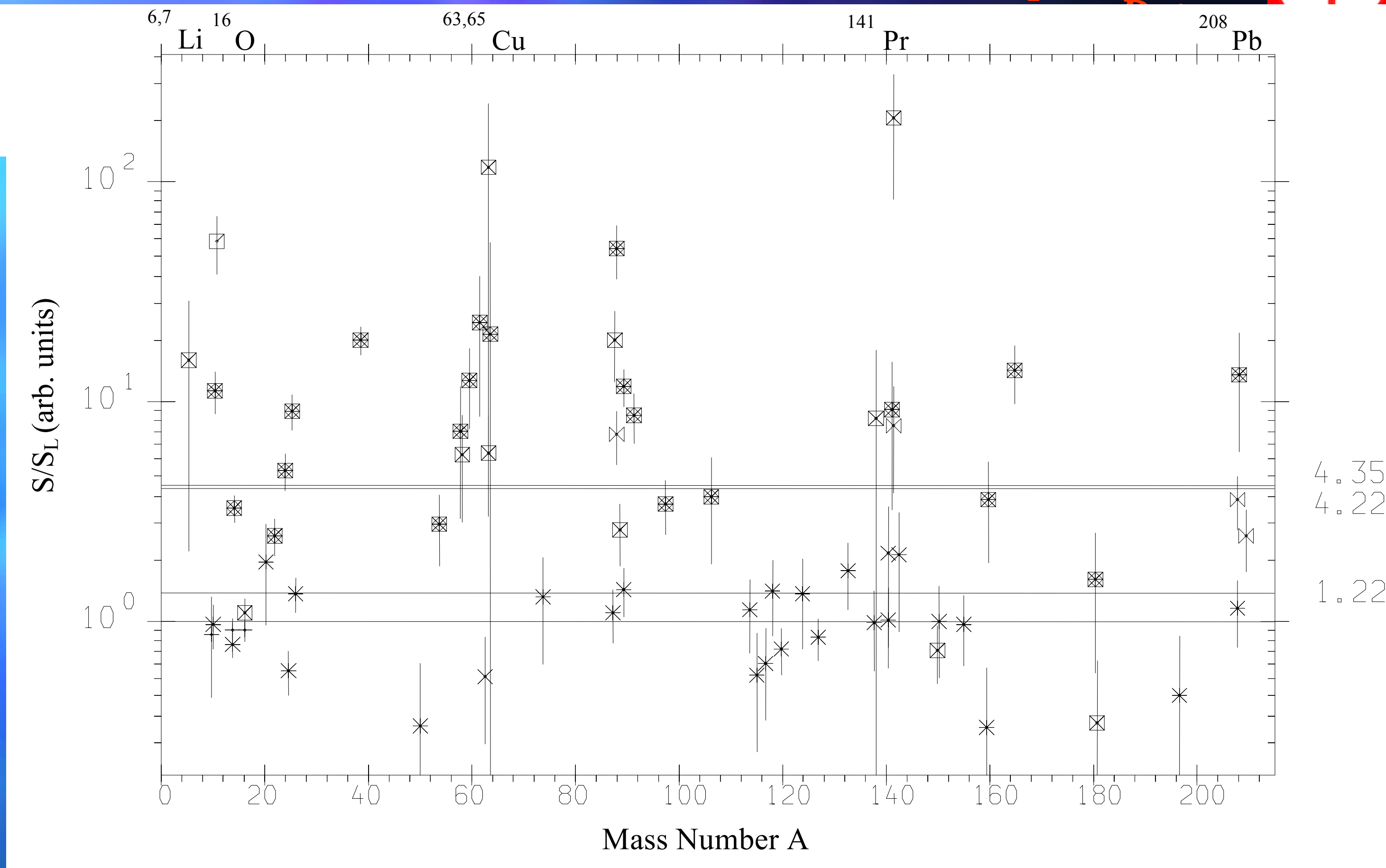
quasimonoenergetic data look like smoothed bremsstrahlung ones.

σ^{int}_{BR} (MSU -	error bars) =	36.9	MeV•mb
σ^{int}_{QMA} (Saclay -	squares) =	34.6	MeV•mb
σ^{int}_{QMA} (Livermore -	crosses) =	32.1 (27.6 • *1.12*)	MeV•mb

BR –QMA

$$S = \frac{1}{N}\sum_{i=1}^{N}\frac{(\sigma_i - <\sigma_i>)^2}{<<\sigma>>^2}$$

S/S_l are presented, where S were calculated for various laboratories data and S_l - for Livermore QMA-data.



"Structurenes" S/S_l ratios for (γ,xn) reaction cross section data:

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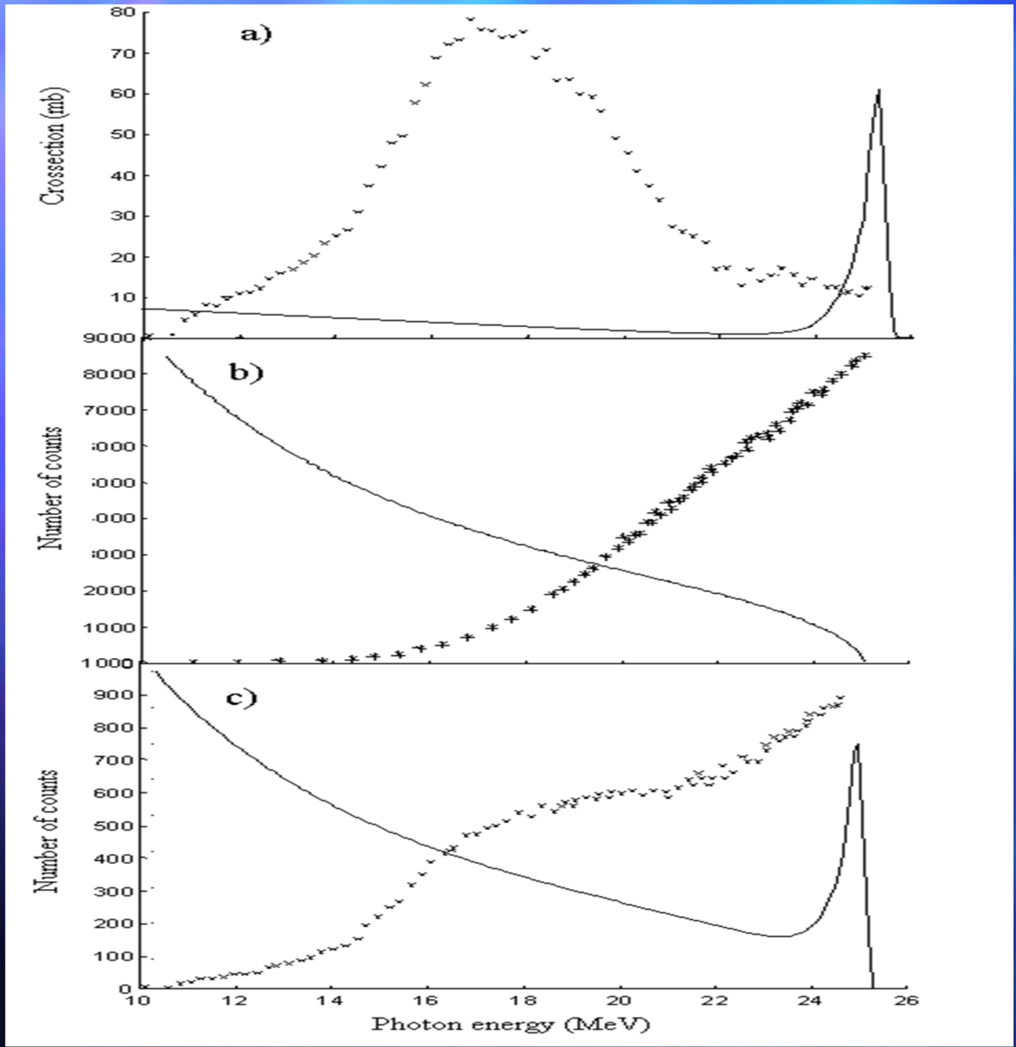
- **bows TP-data (Illinois (USA)) - $< S/S_l > = 4.22$.**

Structure systematic

Once more $^{63}Cu(\gamma,n)^{62}Cu$ reaction cross section in 3 steps QMA-experiment



a) $\sigma(k) \approx Y(E_j) = Y_{e+}(E_j) - Y_{e-}(E_j)$; must be additionally processed taking into account real apparatus function is needed ;

b) $Y_{e-}(E_j)$ measured using electron bremsstrahlung must be processes by one of methods traditional for BR-experiments;

c) $Y_{e+}(E_j)$ measured using photons from sum of positrons annihilation and bremsstrahlung must be processed also using appropriate apparatus function.

$^{63}Cu(\gamma,n)^{62}Cu$

Disagreements (Saclay/Livermore) of amplitudes – absolute values – integrated cross sections

5 clear cases (from “Atlas…” of S.S.Dietrich and B.L.Berman, Atomic Data and Nuclear Data Tables, 38 (1988) 199) of σ^{int} disagreements for appropriate integration energy limits E_γ^{max} :

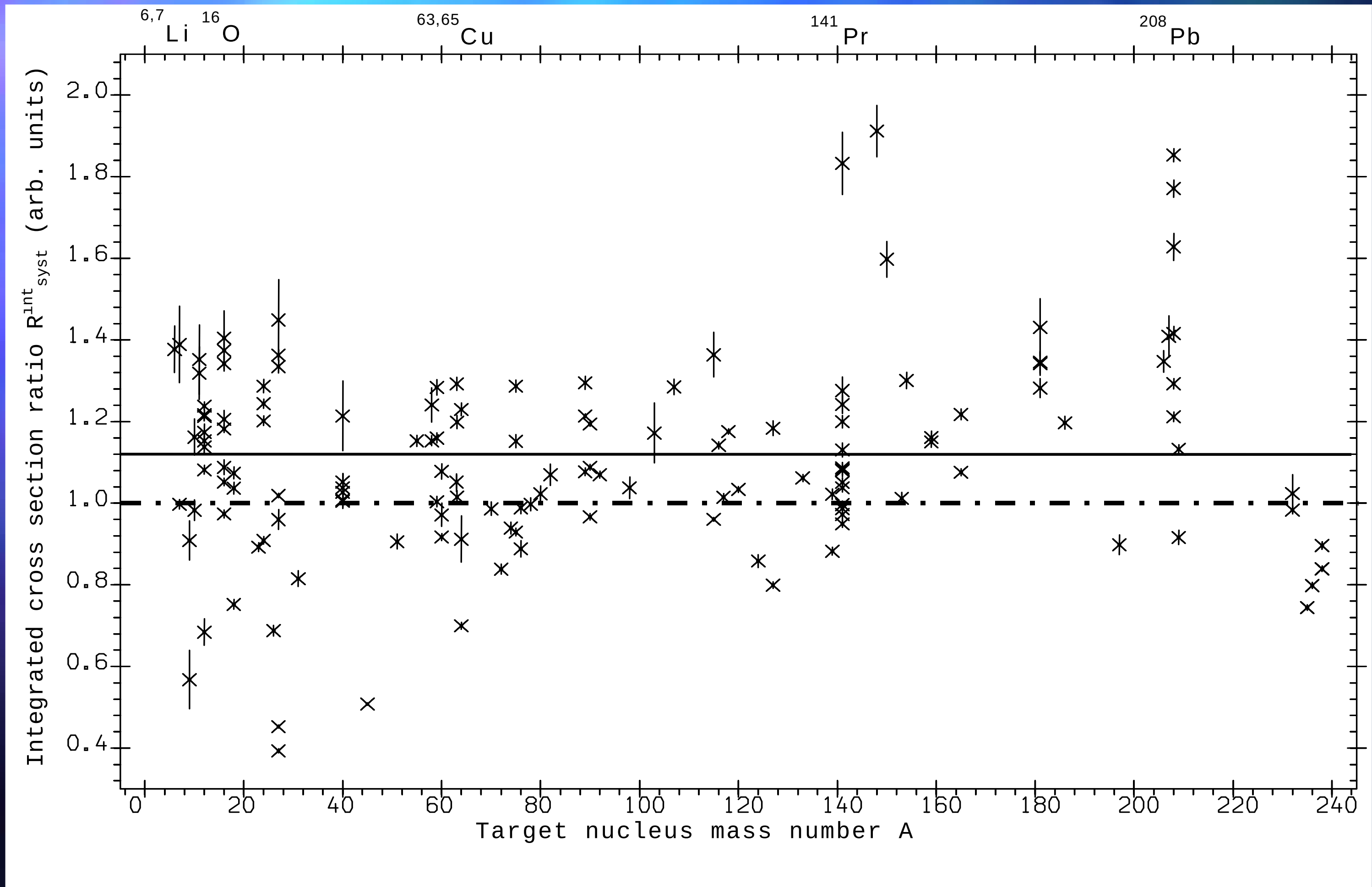
Nucleus	^{51}V	^{75}As	^{90}Zr	^{133}Cs	^{165}Ho
$E_\gamma^{int\text{-}max}$ (MeV)	27.8 27.8	26.2 29.5	25.9 27.6	*24.2* *29.5*	26.8 28.9
$\sigma^{int}{}_S/\sigma^{int.}{}_L$	689/654 = 1.06	1306/1130 ≥ 1.16	1309/1158 ≥ 1.13	2484/2505 ≈ *1*	3667/3385 ≥ 1.08

The values obtained at Saclay are higher than that obtained at Livermore for about 6 – 16 %.

Explanation of the reasons (B.L.Berman, et al., Phys.Rev., C36 (1987) 1286): “… an Livermore experiments error either in the photon flux determination or in the neutron detection efficiency or in both”.

5 nuclei “S/L”

Systematic of integrated cross section ratios "All other/Livermore" for about 500 total photoneutron reaction (γ,xn) cross sections.



$R^{int}_{syst} = 1.12$

Int. cross. sect. ratios

Significant disagreements for partial reaction (γ,n) and (γ,2n) cross section between Saclay and Livermore data (integrated cross section ratios are presented).

Nucleus	*n* $\sigma^{int}_{S}(\gamma,n)/\sigma^{int}_{L}(\gamma,n)$, /1, 25/ (= arb. units)	*2n* $\sigma^{int}_{S}(\gamma,2n)/\sigma^{int}_{S}(\gamma,2n)$, /1, 25/ (= arb. units)	*xn* $R^{int}(\gamma,xn)$ /25/ (arb. units)	$\sigma^{int}_{S}(\gamma,n)/\sigma^{int}_{L}(\gamma,n)$, /26/ (arb. units)	$\sigma^{int}_{S}(\gamma,2n)/\sigma^{int}_{S}(\gamma,2n)$, /26/ (arb. units)	$R^{int}(\gamma,xn)$ /26/ (arb. units)
^{51}V				1.07	0.79	1.07
^{75}As				1.21	1.22	1.21
^{89}Y	1279/960 = 1.33	74/99 = 0.75	1.26	1.25	0.87	1.25
^{90}Zr				1.26	0.73	1.26
^{115}In	1470/1354 = 1.09	278/508 = 0.55	0.94	0.97	0.76	0.97
^{116}Sn				1.10	0.92	1.10
^{117}Sn	1334/1380 = 0.97	220/476 = 0.46	1.01	1.02	0.93	1.02
^{118}Sn	1377/1302 = 1.06	258/531 = 0.59	1.06	1.07	0.86	1.07
^{120}Sn	1371/1389= 0.98	399/673 = 0.75	0.99	1.00	0.86	1.00
^{124}Sn	1056/1285 = 0.82	502/670 = 0.75	0.93	0.93	0.94	0.93
^{127}I				1.34	1.07	1.34
^{133}Cs	1828/1475 = 1.24	328/503 = 0.65	1.11	1.10	0.88	1.10
^{159}Tb	1936/1413 = 1.37	605/887 = 0.68	1.06	1.07	0.71	1.07
^{165}Ho	2090/1735 = 1.20	766/744 = 1.03	1.14	1.20	1.05	1.20
^{181}Ta	2180/1300 = 1.68	790/881 = 0.90	1.22	1.25	0.89	1.25
^{197}Au	2588/2190 = 1.18	479/777 = 0.62	1.00	1.00	0.69	1.00
^{208}Pb	2731/1776 = 1.54	328/860 = 0.38	1.30	1.21	0.77	1.21
^{232}Th				0.84	0.69	0.84
^{238}U				0.76	0.79	0.76

more higher *more lover* *<R> ≈ 1.12*

While (γ,n) Saclay data are more higher than those from Livermore,

(γ,2n) data are, vise versa, more lower.

“(γ,n) – (γ,2n)” discrepancies

Important results:

- clear data discrepancies force one to use data existed strongly individually;
- quasimonoenergetic photons-data are strongly (3 – 4 times) over-smoothed and must be additionally reprocessed to take into account real shape of apparatus function (effective photon spectrum);
- Livermore total photoneutron reaction (γ,xn) cross sections have in general absolute values smaller then that obtained at various other laboratories; the reason: "… an Livermore experiments error either in the photon flux determination or in the neutron detection efficiency or in both"; therefore Livermore (γ,xn) cross sections data of for 19 nuclei studied specially must be multiplied by appropriate coefficients R^{int}(γ,xn) and for others – by $\langle R^{int}_{syst} \rangle = 1.12$ at least;
- Saclay partial photoneutron reactions (γ,n) and (γ,2n) cross sections are not correct and consistent each other because of incorrect neutron multiplicity sorting procedure used and must be recalculated;
- Livermore neutron multiplicity sorting procedure at the same time is correct and therefore Livermore (γ,n) and (γ,2n) cross sections are in consistence with each other and with (γ,xn) cross sections and both can be used but again only multiplied by coefficients R^{int}(γ,xn) or $\langle R^{int}_{syst} \rangle$.

3 important physical consequences:

- GDR structure (resonances with width ~ hundreds of keV) exists; BR-data look like preferable for GDR structure detailed study because QMA-data are strongly over-smoothed;
- E1 GDR decays dominantly statistically - Saclay interpretation of high-energy tails of (γ,n) reaction cross sections as contributions of high-energy neutrons from GDR nonstatictical direct decay (those contributions evaluated to be about 17 - 30 %) because of small decreasing of (γ,n) reaction cross sections for energies higher than (γ,2n) reaction threshold B(2n) looks like as very doubtful; Saclay (γ,n) data corrections described decrease those and put them into accordance with Livermore data: direct decay contributions are not more than 10 - 12 %;
- big extra integrated cross section σ^{int}(γ,abs) ≈ 1.3 – 1.5 60NZ/A (MeV•mb) became doubtfully being all due to effective mass of nucleon changing because of the effect of exchange forces; Saclay data correction described affects photoabsorption cross section evaluation using cross section data combinations (γ,abs) = (γ,sn) + (γ,p) and (γ,sn) = (γ,xn) - (γ,2n); mistake in (γ,2n) reaction data produces the mistakes in both (γ,sn) and (γ,abs) reaction data; correction described do them noticeably smaller.

Neutron multiplicity sorting procedure test:

Twice measurement of $^{181}Ta(e,2n)^{180}Ta$ cross section s(e,2n) = ½(s(e,xn) - s(e,n)):

1. $\sigma_1(e,n)$ – neutron multiplicity sorting measurement;
2. $\sigma_2(e,n)$ – measurement of induced activity (decay $^{180}Ta \rightarrow {}^{180}Hf$, 93.3 keV, Ge-Li).

Mean-square ratio $\langle\sigma_1(e,n)/\sigma_2(e,n)\rangle = 1.057 \pm 0.023$ means high reliability of multiplicity sorting procedure.

Comparison of (e,n) and (γ,n) data show that Saclay data for (γ,2n) reaction are underestimated and correspondingly that for (γ,n) reaction – vise versa overestimated.

Nucleus	$\sigma^{int}{}_S(\gamma,n)/\sigma^{int}{}_L(\gamma,n)$, both – MeV*mb		$\sigma^{int}{}_S(\gamma,2n)/\sigma^{int}{}_L(\gamma,2n)$, both – MeV*mb	
	Before [6]	After	Before [6]	After
^{89}Y	1279/960 = 1.33	1205.3/1206.1 = 1.00	74/99 = 0.75	112.6/107.3 = 1.05
^{115}In	1470/1354 = 1.09	1298.0/1298.2 = 1.00	278/508 = 0.55	364.6/358.3 = 1.02
^{117}Sn	1334/1380 = 0.97	1261.6/1261.4 = 1.00	220/476 = 0.46	234.1/243.6 = 0.96
^{118}Sn	1377/1302 = 1.06	1281.3/1281.4 = 1.00	258/531 = 0.49	298.9/320.4 = 0.93
^{120}Sn	1371/1389 = 0.99	1282.7/1282.6 = 1.00	399/673 = 0.59	444.5/460.2 = 0.97
^{124}Sn	1056/1285 = 0.82	1042.5/1042.4 = 1.00	502/670 = 0.75	511.5/502.6 = 1.02
^{133}Cs	1828/1475 = 1.24	1619.5/1618.5 = 1.00	328/503 = 0.65	431.8/413.7 = 1.04
^{159}Tb	1936/1413 = 1.37	1485.3/1485.4 = 1.00	605/887 = 0.68	633.9/675.7 = 0.94
^{165}Ho	2090/1735 = 1.20	2040.7/2040.7 = 1.00	766/744 = 1.03	825.6/803.4 = 1.03
^{181}Ta	2180/1300 = 1.68	1616.4/1615.7 = 1.00	790/881 = 0.90	520.1/559.9 = 0.93
^{197}Au	2588/2190 = 1.18	2144.6/2142.4 = 1.00	479/777 = 0.62	367.0/345.0 = 1.06
^{208}Pb	2731/1776 = 1.54	2274.5/2273.8 = 1.00	328/860 = 0.38	611.0/626.0 = 0.98

The effect of joint Saclay and Livermore data correction:
agreement for both (γ,n) and (γ,2n) reaction cross sections is quite well.

Correction (table)

Nucleus	Laboratory	Factor F /23/ (arb. units)	Factor 1/F (arb. units)
^{nat}Rb	S	0.85 ± 0.03	
^{nat}Sr	S	0.85 ± 0.03	1.18
^{89}Y	S	0.82	1.22
^{89}Y	L	1.0	
^{90}Zr	S	0.88	1.14
^{90}Zr	L	1.0	
^{91}Zr	L	1.0	
^{92}Zr	L	1.0	
^{93}Nb	S	0.85 ± 0.03	1.18
^{94}Zr	L	1.0	
^{127}I	S	0.80	1.25
^{197}Au	S	0.93	1.08
^{206}Pb	L	1.22	
^{207}Pb	L	1.22	
^{208}Pb	L	1.22	
^{208}Pb	S	0.93	1.08
^{208}Bi	L	1.22	

Factor “F”