



HZDR

**HELMHOLTZ
ZENTRUM DRESDEN
ROSSENDORF**

PTB

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CENBG
CENTRE NATIONAL
DE LA RECHERCHE
SCIENTIFIQUE
IN 2 P 3 C
RS



NPL
National Physical Laboratory



ERINDA Scientific Results: Transnational Access Activities Scientific Visits

F.-J. Hamsch
ERINDA Scientific coordinator

Joint
Research
Centre



 **JYVÄSKYLÄN YLIOPISTO**
University of Jyväskylä

2 500 supplementary data-taking hours in 3 years

25 experiments

TAA budget : 676 k€ ~ 67% of total ERINDA budget

Pool of facilities

- whole budget → Project Coordinator
- common call for proposals
- single PAC →

selects best experiments
allocates to best-suited facilities

User costs
User fees

Facilities in ERINDA



nELBE	40 MeV superconducting electron linac + neutron TOF facility D-T neutron generator	FZ Dresden (Germany)
GELINA and VdG	150 MeV electron linac + neutron TOF facility 7 MV Van de Graaff accelerator	IRMM Geel (Belgium)
n_TOF	20 GeV proton beam of the PS + spallation neutron source + neutron TOF facility	CERN Geneva (Switzerland/France)
AIFIRA	3.5 MV Van de Graaff accelerator	CENBG Bordeaux (France)
Tandem-ALTO	15 MV tandem and photo-fission source	IPN Orsay (France)
TSL	Cyclotron (180 MeV p)	UU-TSL Uppsala (Sweden)
PIAF	3.7 MV Van de Graaff accelerator Cyclotron (19 MeV p and d, α)	PTB Braunschweig (Germany)
NPI	Cyclotron (20 MeV p and d, α)	NPI Řež (Czech Republic)
BRR	10 MW research reactor	IKI Budapest (Hungary)
JYFL	130 MeV heavy ion cyclotron 30 MeV high intensity cyclotron + IGISOL	JYFL, Jyväskylä (Finland)
IFIN HH	9 MeV Tandem accelerator (p to Au)	IFIN HH, Bucharest (Romania)
NPL	3.5 MeV Tandem Van de Graaff accelerator	NPL, Teddington (Great Britain)
FRANZ	500 keV RFQ + proton linac	GUF, Frankfurt (Germany)
CEA	4 MV Van de Graaff accelerator 7 MV tandem accelerator	CEA Bruyères-le-Chatel (France)

Facility costs and real access hours



European
Commission

Facility	Unit cost per hour (€)	Fraction charged to the project	Access cost per hour (€)	Minimum quantity of access offered to the project (hours)	Quantity already allocated and requested
HZDR	433	0,8	346	270	320+200
n_TOF	3 409	0,08	273	270	300
CENBG	140	1	140	180	168
IPNO	500	0,5	250	180	200
UU-TSL	647	0,66	427	180	170
PTB	276	1	276	180	336
NPI	231	1	231	180	128
II HAS	114	1	114	270	840
JYU	208	1	208	180	100
IFIN-HH	98	1	98	180	96
NPL	278	1	278	180	0
CEA	271	0,83	225	250	100
TOTAL				2 500	3174

80 weeks in 3 years

SC budget : 71.2 k€ ~ 7% of total ERINDA budget

Direct support to scientists (travel and subsistence)

Benefit for host institutes (additional manpower)

Scientific visitors



PAC1:

A. Tudora at JRC-IRMM	6 weeks	
K.-H. Schmidt at CENBG	2 weeks	
M. Lantz at JYFL	6 weeks	14 weeks

PAC2:

N. Carjan at JRC-IRMM	8 weeks	
L. Benedik at JRC-IRMM	8 weeks	
A. Oberstedt at JRC-IRMM	8 weeks	24 weeks

PAC3:

A. Tudora at JRC-IRMM	6 weeks	
K.-H. Schmidt at CENBG	2 weeks	
P. Sauvan at PTB	2 weeks	
C. Lampoudis at JRC-IRMM	4 weeks	
S. Valenta at JRC-IRMM	6 weeks	
P. Archier at JRC-IRMM	4 weeks	24 weeks

PAC4:

A. Tudora at JRC-IRMM	8 weeks	
N. Carjan at JRC-IRMM	8 weeks	
K.-H. Schmidt at CENBG	2 weeks	
C. Rouki at JRC-IRMM	8 weeks	26 weeks

Extra:

N. Carjan at JRC-IRMM	8 weeks	
C. Rouki at JRC-IRMM	8 weeks	

Total available:

80 weeks (DoW)

Total supported:

88 (+ 16) weeks = 104 weeks



- **Kick-off meeting, Jan. 27-28, 2011, Dresden, Germany**
- **First scientific meeting, Jan. 16-18, Prague, 2012, Czech Republic**
- **Second scientific meeting, Jan. 9-11, 2013, Jyvaskyla, Finland**
- **Final scientific meeting, Oct. 1-3, 2013, CERN, Switzerland**

Scientific visitors: Publications



- "Sub-barrier resonance fission and its effects on fission fragment properties", **A. Tudora**, F.-J. Habsch, S. Oberstedt, Nucl. Phys. A 890-891 (2012) 77-101
- "Modelling of the total excitation energy partition including fragment deformation and excitation energies at scission", C. Morariu, **A. Tudora**, et al., J. Phys. G. 39 (2012) 055103
- "Possible reference method of total excitation energy partition between complementary fission fragments", C. Manailescu, **A. Tudora**, et al., Nucl. Phys. A 867 (2011) 12-40
- Model description of sub-barrier fission cross-section resonances and prompt neutron emission calculations for $^{234}\text{U}(n,f)$ ", **A. Tudora**, F.-J. Habsch, S. Oberstedt, submitted to Nucl. Phys. A
- "Cassini-oval description of the energy balance at scission during $^{235}\text{U}(nth, f)$ "
N. Carjan, F. A. Ivanyuk, V. V. Pashkevich, Physics Procedia 31 (2012) 66 – 77
- "Determination of resonance parameters and their covariances from neutron induced reaction cross section data", P. Schillebeeckx, B. Becker, Y. Danon, K. Guber, H. Harada, J. Heyse, A.R. Junghans, S. Kopecky, C. Massimi, M.C. Moxon, N. Otuka, **I. Sirakov** and K. Volev, Nuclear Data Sheets 2012
- "Inconsistencies in the description of pairing effects in nuclear level densities", **K.-H. Schmidt**, B. Jurado, Phys. Rev. C 86 (2012) 044322

Scientific visitors: Publications



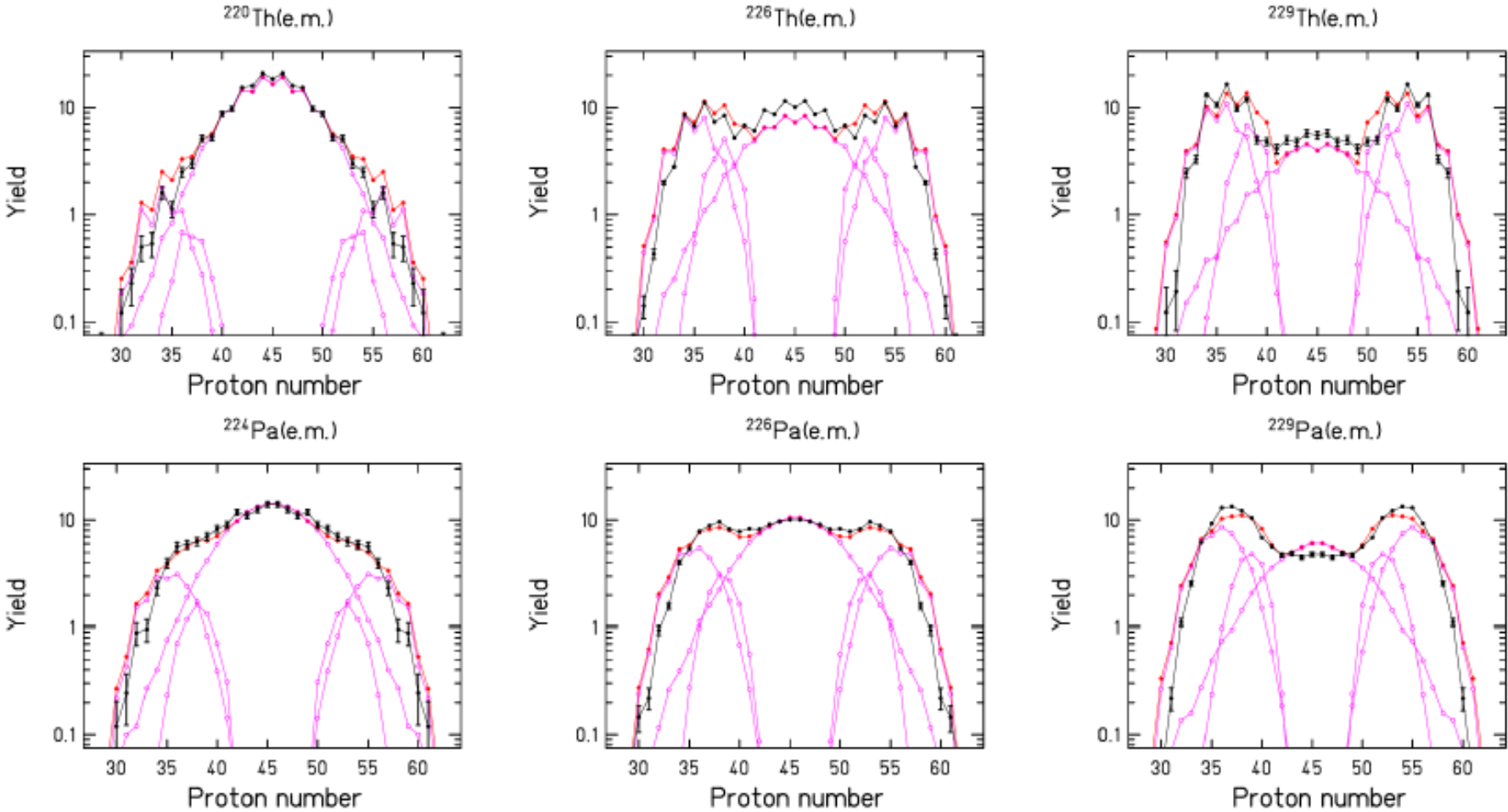
- "Modelling the width of the mass distribution in low-energy fission with the statistical approach", B. Jurado, **K.-H. Schmidt**, EPJ Web of Conferences **42**, 06005 (2013)
- "Final excitation energy of fission fragments", **K.-H. Schmidt**, B. Jurado, Phys. Rev. C 83 (2011) 060601
- "Entropy driven excitation energy sorting in superfluid fission dynamics", **K.-H. Schmidt**, B. Jurado, Phys. Rev. Lett. 104 (2010) 212501
- "Design of a neutron converter for fission studies at the IGISOL facility"
M. Lantz, et al., Phys. Scr. T150 (2012) 014020
- "Neutron measurements with lanthanum-bromide scintillation detectors - a first approach", **A. Oberstedt**, R. Billnert and S. Oberstedt, Nucl. Instr. Methods A708 (2013) 7-14
- "Evaluation of resonance parameters for neutron induced reactions in cadmium", K. Volev, ...**C. Lampoudis**, et al., Nucl. Instr. Methods B300 (2013) 11-29
- "Identification of prompt fission γ -rays with lanthanum-chloride scintillation detectors", **A. Oberstedt** et al. , Nucl. Instr. Methods A668 (2012) 14-20
- "Improved values for the characteristics of prompt-fission γ -ray spectra from the reaction $^{235}\text{U}(n_{\text{th}}, f)$ ", **A. Oberstedt** et al. , Phys. Rev. C **87**, 051602(R) (2013)
- "Recent Developments in the CONRAD Code regarding Experimental Corrections", **P. Archier** et al., EPJ Web of Conferences 42, 02004 (2013)

Modelling mass distributions: GEF

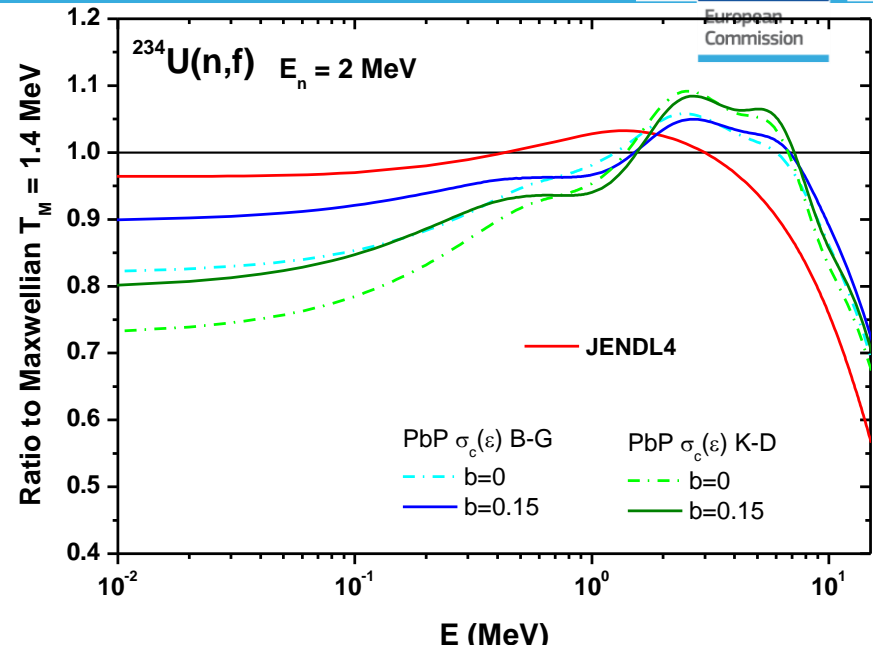
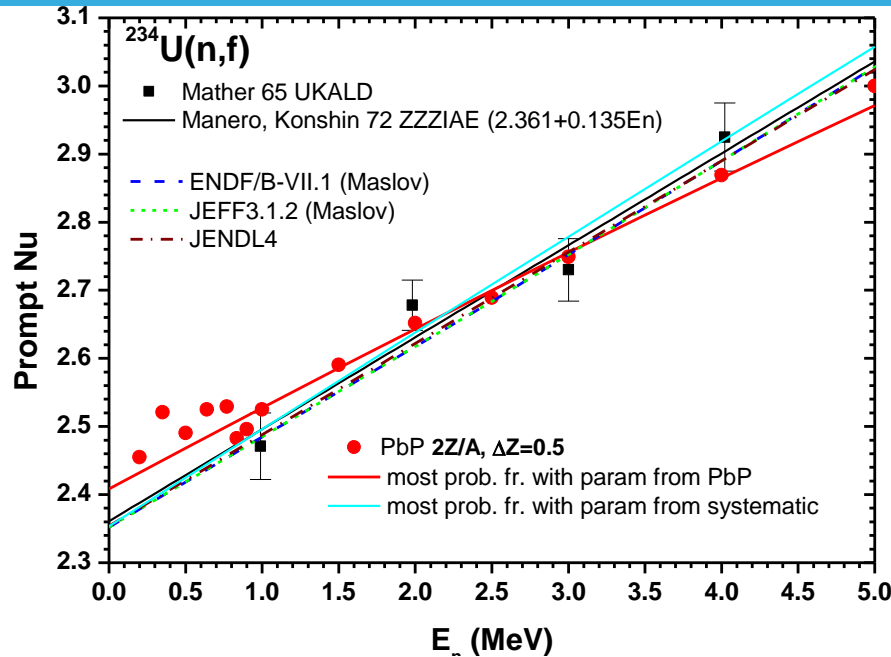


European Commission

Transition from symmetric to asymmetric fission around A=226



Prompt neutron emission in $^{234}\text{U}(n,f)$



- Calculations based on first complete experimental data measured at JRC-IRMM (mass and TKE distributions)
- Prompt neutron multiplicity and spectrum deduced from experimental mass and TKE distributions

-> **Obvious discrepancies between the present calculations and evaluated neutron data libraries**

- "Measurement of thermal neutron capture cross sections of ^{237}Np and ^{242}Pu using prompt gamma neutron activation", C. Genreith, M. Rossbach, et al., J. Radioanal Nucl Chem (2012) DOI: 10.1007/s10967-012-2080-8
- "Neutron measurements with lanthanum-bromide scintillation detectors - a first approach", A. Oberstedt, R. Billnert and S. Oberstedt, Nucl. Instr. and Meth. A 708 (2013) 7
- "Improved values for prompt fission gamma-ray spectra characteristics from the reaction $^{235}\text{U}(n, f)$ ", A. Oberstedt, et al., Phys. Rev. C 87 (2013) 051602(R)
- "Determination of resonance parameters and their covariances from neutron induced reaction cross section data", P. Schillebeeckx, B. Becker, Y. Danon, K. Guber, H. Harada, J. Heyse, A.R. Junghans, S. Kopecky, C. Massimi, M.C. Moxon, N. Otuka, I. Sirakov and K. Volev, Nuclear Data Sheets 113 (2012) 3054–3100
- "Data Reduction and Uncertainty Propagation of Time-of-Flight Spectra with AGS", B. Becker, C. Bastian, F. Emiliani, F. Gunsing, J. Heyse, K. Kauwenberghs, S. Kopecky, C. Lampoudis, C. Massimi, N. Otuka, P. Schillebeeckx, and I. Sirakov, 2012 JINST 7 P11002
- "The extrapolated-efficiency method, a new technique to determine the γ -cascade detection efficiency in experiments based on the surrogate-reaction method", G. Boutoux, B. Jurado, et al., Nucl. Instr. and Meth. A (article in press)

- "Study of the surrogate-reaction method applied to neutron-induced capture cross sections", G. Boutoux, B. Jurado, et al., *Physics Letters B* 712 (2012) 319–325
- "²⁴³Am neutron-induced fission cross section in the fast neutron energy range", G. Kessedjian, et al., *PHYSICAL REVIEW C* **85**, 044613 (2012)
- "Measurement of ²³⁵U(*n,nγ*) and ²³⁵U(*n,2nγ*) reaction cross sections", M. Kerveno et al., *PHYSICAL REVIEW C* **87**, 024609 (2013)
- "Neutron resonance spectroscopy for the characterization of materials and objects", P. Schillebeeckx et al., *J. of Instrumentation* 7 (2012) C03009
- Results of total cross section measurements for ¹⁹⁷Au in the neutron energy region from 4 to 108 keV at GELINA, I. Sirakov et al. submitted to EPJ

Experiment @ IKI, Budapest

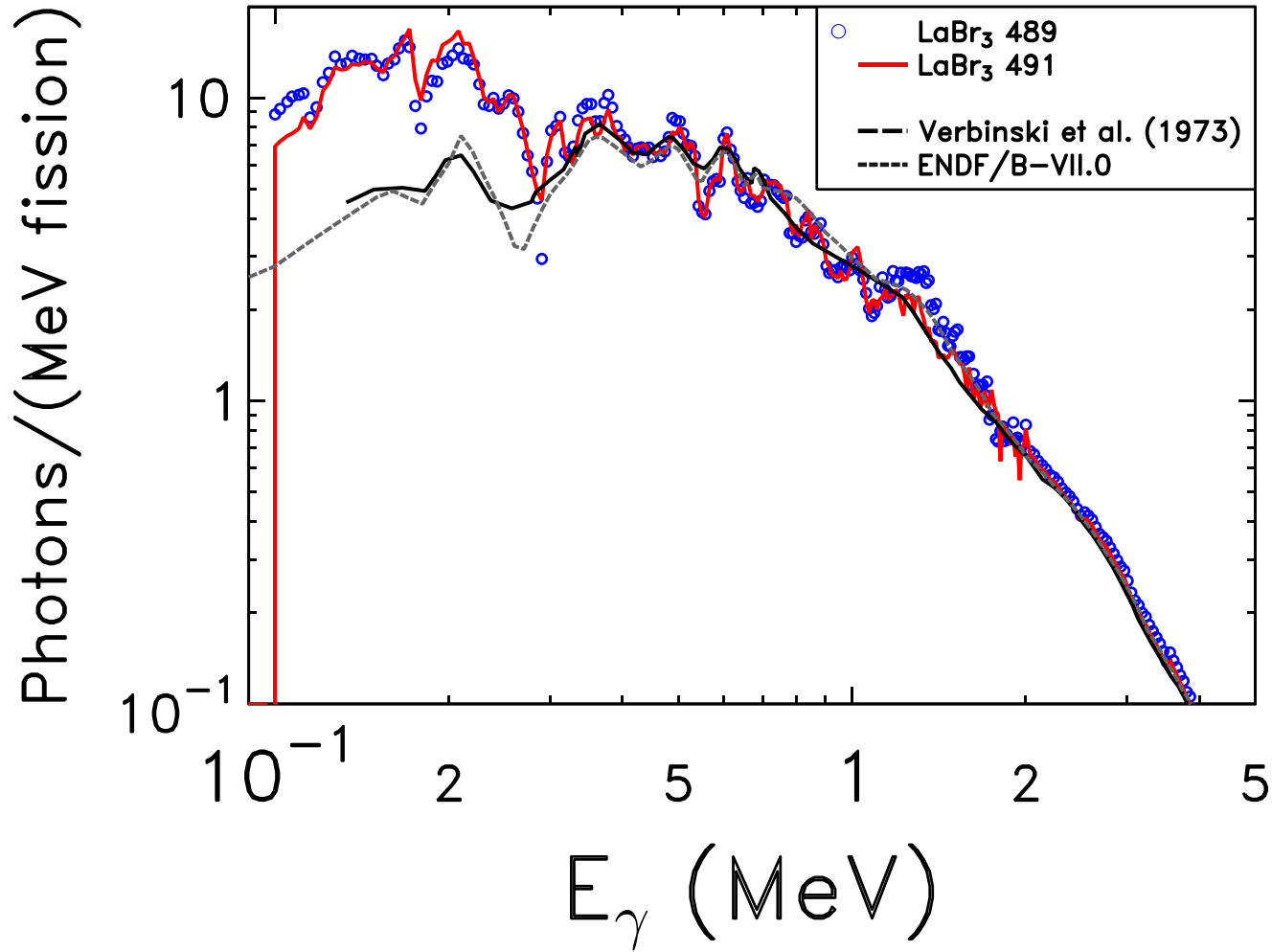
$^{235}\text{U}(n_{\text{th}},f)$ prompt fission γ -ray spectrum



Twin Frisch-grid ionization chamber



$^{235}\text{U}(n_{\text{th}},f)$: all detectors



PhD thesis work of R. Billnert

- ♥ This work was supported by the EFNUDAT programme of the European Commission (agreement number 31027)
- ♥ This work was supported by the ERINDA programme of the European Commission (agreement number 269499)

Comparison



Reference	year	ν_γ (per fission)	ϵ_γ (MeV)	$E_{\gamma,tot}$ (MeV)
average over all detectors	this work	7.60(7)	0.88 (2)	6.87(9)
Verbinski	1973	6.7(5)	0.97(3)	6.5(3)
ENDF/B-VII.1	2012	6.72	0.975	6.55

Threshold energy E_{\ominus} = 140 keV

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- **Final project report due November 2013**
- **Information needed from all partners on level of support, publications in refereed journals and under preparation.**
- **Publications published under other TAA schemes e.g. NUDAME, EUFRAT, ERINDA**

Future -> CHANDA



CHANDA = solving CHallenges in Nuclear DAta

Large project combining all the nuclear data activities
(EUFRAT, ERINDA, ANDES)

Start: 1. Dec. 2013 (48 month)

Total budget: 5.4 M€

30 partners

- 1) Programming Activities
- 2) TA to relevant facilities and Scientific Visitors
- 3) Upgrades of selected facilities
- 4) Collaborative R&D activities
- 5) Training, Education and Dissemination

-> **see presentation E. Gonzalez**

THANK YOU FOR YOUR ATTENTION