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RICOTTI Convention Center, Tokai, Ibaraki, Japan

Recent Nuclear Data Needs from Innovative Reactor Design

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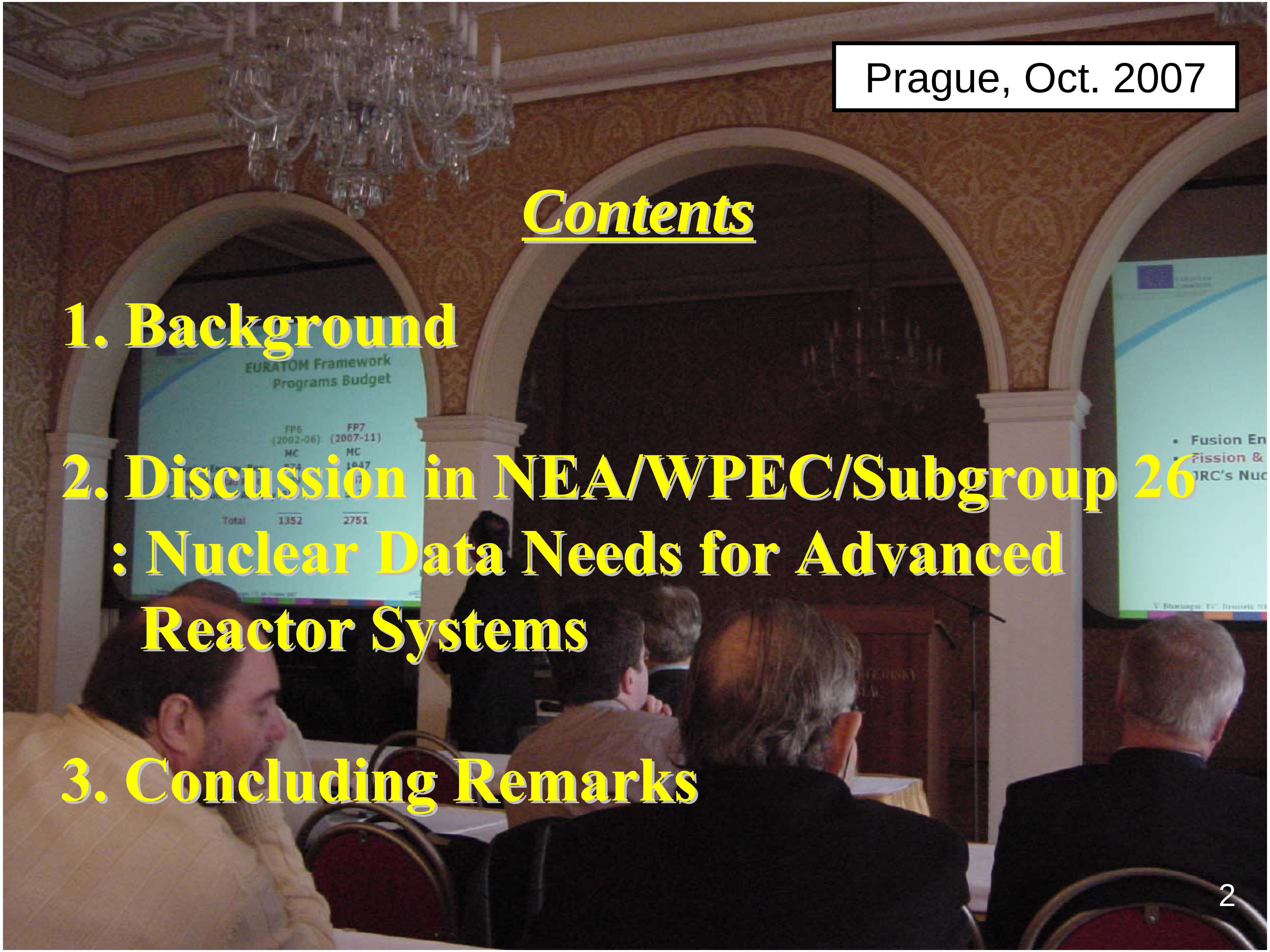
Japan Atomic Energy Agency (JAEA)



Prague, Oct. 2007

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1. Background

- ✓ **Gen-IV**
- ✓ **GNEP**
- ✓ **FS => FaCT**

Generation IV Nuclear Energy Systems

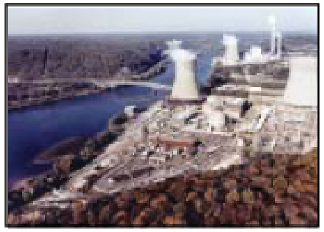
Advanced nuclear energy systems which can be introduced by ∼2030.

For deployment between
2010 and 2030
(G.Marcus, Feb.2003)

Deployable by
2030 or earlier
(W.Magwood, Aug.2003)

Generation I

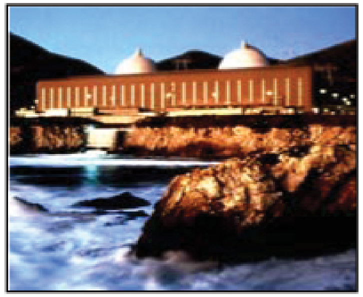
Early Prototype Reactors



- Shippingport
- Dresden, Fermi I
- Magnox

Generation II

Commercial Power Reactors



- LWR-PWR, BWR
- CANDU
- AGR

Generation III

Advanced LWRs

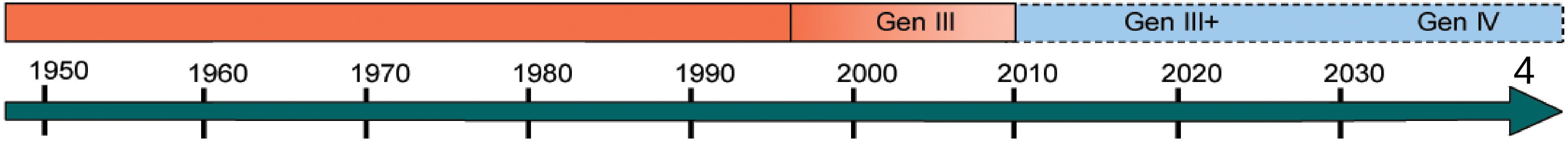
- ABWR
- System 80+

Generation III +

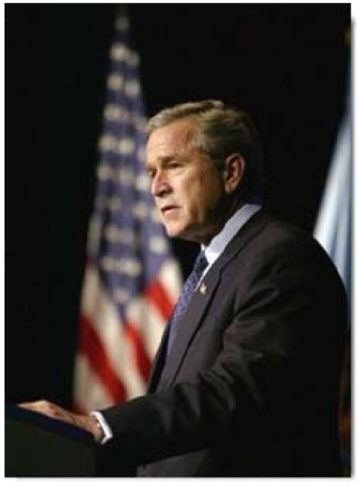
Evolutionary Designs Offering Improved Economics for Near-Term Deployment

Generation IV

- Highly Economical
- Enhanced Safety
- Minimal Waste
- Proliferation Resistant



What is GNEP?



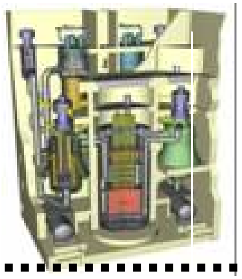
This morning, I want to speak to you about one part of this initiative: our plans to expand the use of safe and clean nuclear power. Nuclear power generates large amounts of low-cost electricity without emitting air pollution or greenhouse gases.

….my Administration has announced a bold new proposal called the **Global Nuclear Energy Partnership**. Under this partnership, America will work with nations that have advanced civilian nuclear energy programs, such as France, Japan, and Russia. Together, we will develop and deploy innovative, advanced reactors and new methods to recycle spent nuclear fuel. This will allow us to produce more energy, while dramatically reducing the amount of nuclear waste and eliminating the nuclear byproducts that unstable regimes or terrorists could use to make weapons.

President George W. Bush
Radio Address: February 18, 2006

Fast Reactor Development Strategy in Japan

Commercialized FR



~2045 ***Commercial***

2025 ***Demonstration***

2015

Innovative Technology for Economics and Reliability

FaCT Project ***since Oct. 2006***

Fast Reactor Cycle Technology Developments Project

Prototype

Monju

- **Verification of Reliability**
- **Establishment of Sodium Handling Technology**

1994～
Power : 714MWt / 280MWe
Temperature : 529℃

Experimental

Joyo

- **Confirmation of FR's Fundamentals**
- **Verification of Safe and Stable Operation**

1977～	MK–I	MK–II	MK–III
Power :	50MWt →	100MWt →	140MWt
Temperature :	435℃ →	500℃ →	500℃

System Development as Electricity Generation

Outline of NEA/WPEC/Subgroup 26 : Nuclear Data Needs for Advanced Reactor Systems

Proposal : to WPEC by P.Finck (ANL) and R.Jacqmin (CEA) in April, 2005

Objectives :

-Compilation of **an agreed set target accuracies** on relevant design parameters for the Gen-IV concepts. Required target accuracies should be justified in terms of impact on different phases of a specific design (feasibility, preconceptual and conceptual design etc.)

-Definition of **a set of data uncertainties and covariance data**. These data should be as complete as possible. At this stage, it is not expected to have a "final" set, in particular of covariance data, but an agreed "first iteration" set.

-Production of **a set of quantitative data needs by isotope, reaction type, energy range**.

-Proposal for **an approach to meet the needs** and relative timeframe.

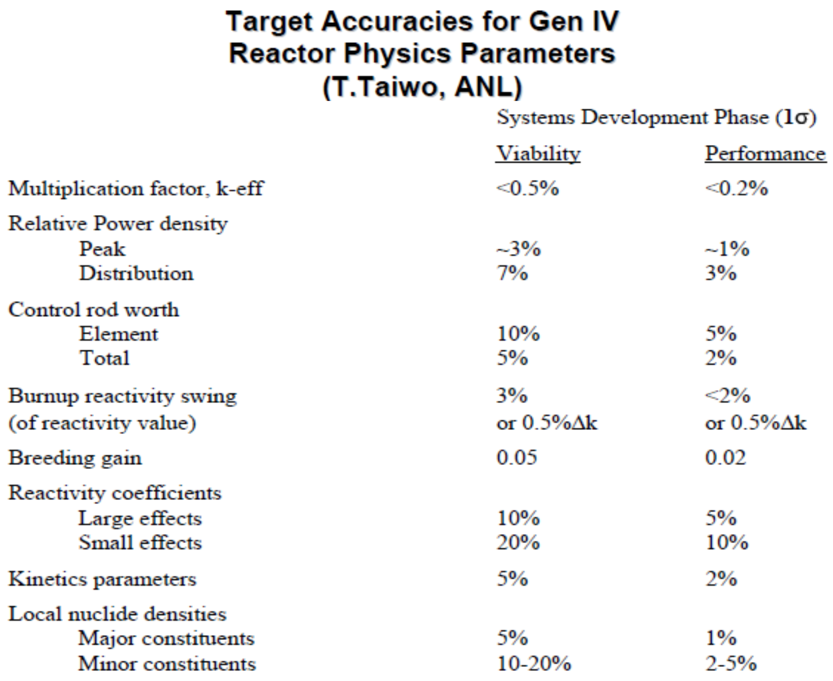
Period : Sep. 2005 – Mar. 2008 (Report submission to WPEC.)

Final members : **Salvatores** (Coordinator, ANL, CEA, FZK), Palmiotti (INL), Aliberti, Taiwo, McKnight, Don Smith (ANL), Oblozinsky (BNL), Dunn, Leal (ORNL), Kawano, Talou (LANL), Mills, Zimmerman (Nexiasolutions), Jacqmin, Rimpault (CEA), Ignatyuk (IPPE), Hogenbirk, Koning (NRG), Plompen (JRC), Ishikawa (JAEA), Kodeli, Rugama (NEA)

1. Design Target Accuracy

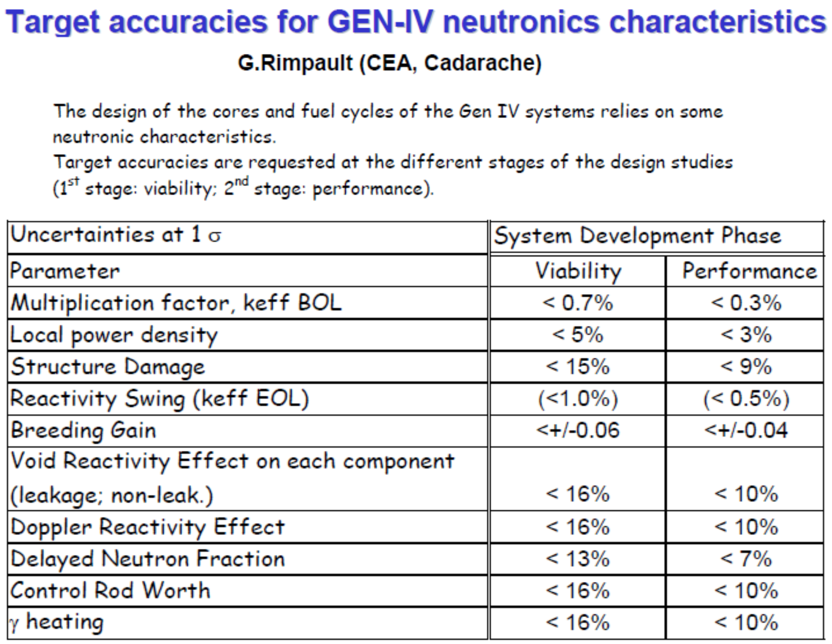
Design Target Accuracy proposed by SG members

Mar. 2006



Target Accuracies for Gen IV Reactor Physics Parameters
(T.Taiwo, ANL)

	Systems Development Phase (1σ)	
	Viability	Performance
Multiplication factor, k-eff	<0.5%	<0.2%
Relative Power density		
Peak	~3%	~1%
Distribution	7%	3%
Control rod worth		
Element	10%	5%
Total	5%	2%
Burnup reactivity swing (of reactivity value)	3% or 0.5%Δk	<2% or 0.5%Δk
Breeding gain	0.05	0.02
Reactivity coefficients		
Large effects	10%	5%
Small effects	20%	10%
Kinetics parameters	5%	2%
Local nuclide densities		
Major constituents	5%	1%
Minor constituents	10-20%	2-5%



Target accuracies for GEN-IV neutronics characteristics
G.Rimpault (CEA, Cadarache)

The design of the cores and fuel cycles of the Gen IV systems relies on some neutronic characteristics.
Target accuracies are requested at the different stages of the design studies (1st stage: viability; 2nd stage: performance).

Uncertainties at 1 σ	System Development Phase	
Parameter	Viability	Performance
Multiplication factor, keff BOL	< 0.7%	< 0.3%
Local power density	< 5%	< 3%
Structure Damage	< 15%	< 9%
Reactivity Swing (keff EOL)	(<1.0%)	(< 0.5%)
Breeding Gain	<+/-0.06	<+/-0.04
Void Reactivity Effect on each component (leakage; non-leak.)	< 16%	< 10%
Doppler Reactivity Effect	< 16%	< 10%
Delayed Neutron Fraction	< 13%	< 7%
Control Rod Worth	< 16%	< 10%
γ heating	< 16%	< 10%

Target Accuracy of FBR Core Design
M.Ishikawa (JAEA)

Criticality□ Target□ → ±0.3%Δk□1σ□

Traditional design error□0.5□1.0%Δk → These error values correspond to the number of peripheral fuel S/As of 10 – 20. This results the costly design due to heavy control rod system, or change of Pu enrichment, etc.

Power distribution□ Target → ±3%□2σ□

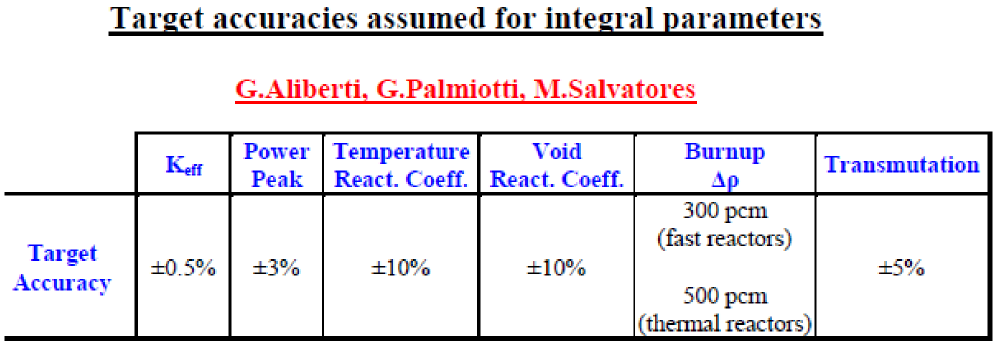
Traditional design error□5% → This forces to set allowance of 20 W/cm for the maximum linear power rate, which severely affects the design criteria of non-melting fuel. This results too much safety guard system, or too low fuel linear power rate, that is, too large core sizes, or too many fuel pin numbers.

Doppler Reactivity : Target□ → ±14%□2σ□

Traditional design error□20□30% → Since it is most fast and effective negative feedback in the accident condition, the error value directly affects the requirement of response time of the detector and control system.

Sodium Void Reactivity□ Target□ → ±20%□2σ□

Traditional design error□40□50% → The ULOF evaluation of Monju was OK, but the large FBR core expects more severe results.
□Ref: FBR R&D Committee under STA, Japan□Core, Fuel□□April, 1996□



Target accuracies assumed for integral parameters
G.Aliberti, G.Palmiotti, M.Salvatores

	K_{eff}	Power Peak	Temperature React. Coeff.	Void React. Coeff.	Burnup Δρ	Transmutation
Target Accuracy	±0.5%	±3%	±10%	±10%	300 pcm (fast reactors) 500 pcm (thermal reactors)	±5%

A review of current and targeted uncertainties for some SFR design parameters (from G.Palmiotti)

Neutronics: Core

Oct. 2007

Parameter	Current Uncertainty (SFR)		Targeted Uncertainty
	Input data origin (a priori)	Modeling origin	
Multiplication factor, K_{eff} ($\Delta k/k$)	1%	0.5%	0.3%
Power peak	1%	3%	2%
Power distribution[d)]	1%	6%	3%
Conversion ratio (absolute value in %)	5%	2%	2%
Control rod worth: Total	5%	4%	2%
Burnup reactivity swing ($\Delta k/k$)	0.7%	0.5%	0.3%
Reactivity coefficients: total	7%	15%	7%

2. Covariance Data

First Proposal by Salvatores, Palmiotti, etc.

Nov. 2005

<u>Definition of a "first iteration" set of data uncertainty values</u>.

Here comes the most difficult point. Suggestions on how to proceed are very welcome. As you will see, in paper A we used "**educated guesses**", mostly to stimulate more systematic and scientifically based work in that domain and to underline its relevance.

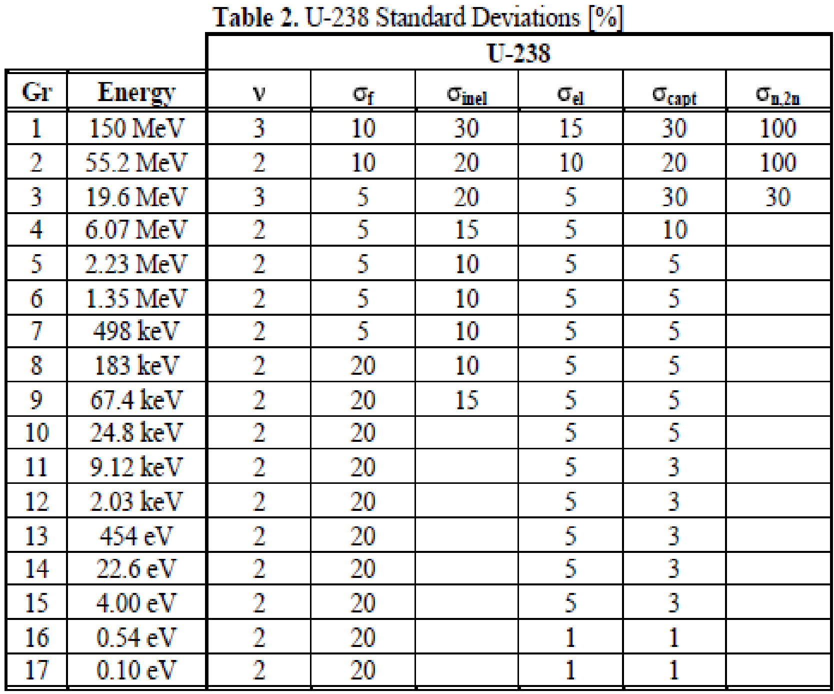


Table 2. U-238 Standard Deviations [%]

		U-238					
Gr	**Energy**	ν	σ_f	σ_{inel}	σ_{el}	σ_{capt}	$\sigma_{n,2n}$
1	150 MeV	3	10	30	15	30	100
2	55.2 MeV	2	10	20	10	20	100
3	19.6 MeV	3	5	20	5	30	30
4	6.07 MeV	2	5	15	5	10	
5	2.23 MeV	2	5	10	5	5	
6	1.35 MeV	2	5	10	5	5	
7	498 keV	2	5	10	5	5	
8	183 keV	2	20	10	5	5	
9	67.4 keV	2	20	15	5	5	
10	24.8 keV	2	20		5	5	
11	9.12 keV	2	20		5	3	
12	2.03 keV	2	20		5	3	
13	454 eV	2	20		5	3	
14	22.6 eV	2	20		5	3	
15	4.00 eV	2	20		5	3	
16	0.54 eV	2	20		1	1	
17	0.10 eV	2	20		1	1	

<u>Many Objections</u>

From LANL: we (T-16, LANL) will provide covariance data for U235, U238 and Pu239 reactions by September 2006, …by using our nuclear reaction code **McGNASH and the KALMAN** code by Kawano. Finally, these matrices will be processed through **NJOY and ERRORJ** to produce energy-grouped covariance matrices.

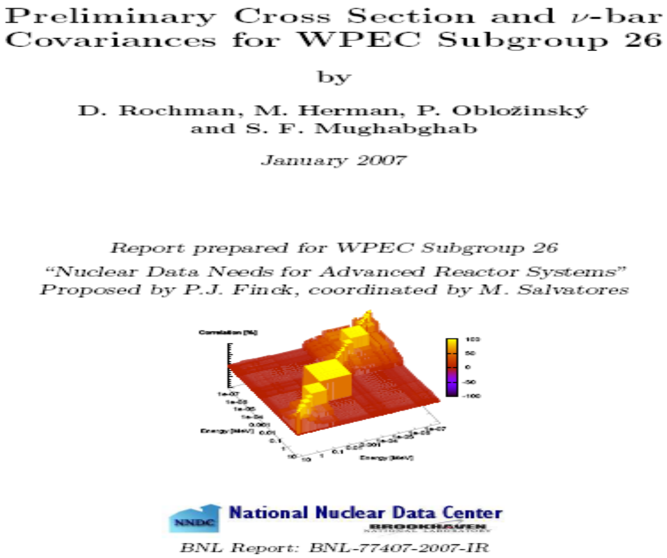
From BNL: I would like to mention that at NNDC we are doing calculations of covariances in the fast region with the **EMPIRE-KALMAN** codes, for other nuclei than actinides. We are following the same methodology than at T-16, but with EMPIRE-2 instead of McGnash.

From JAEA: My serious concerns are how he would make the "**transparency, accountability or traceability**" of those covariance data. As you may know, JENDL people including Dr.Kawano or Dr.Shibata, has made a lot of efforts to establish the methodology to evaluate the nuclear data covariance based on the mechanistic way, and they succeeded it. The results are included in the recent **JENDL-3.3** library.

Covariance Data

by Salvatores, Oct. 2007

For current studies, all the available BNL data have been used:



Preliminary Cross Section and ν-bar
Covariances for WPEC Subgroup 26

by

D. Rochman, M. Herman, P. Obložinský
and S. F. Mughabghab

January 2007

Report prepared for WPEC Subgroup 26
"Nuclear Data Needs for Advanced Reactor Systems"
Proposed by P.J. Finck, coordinated by M. Salvatores

National Nuclear Data Center

BNL Report: BNL-77407-2007-IR

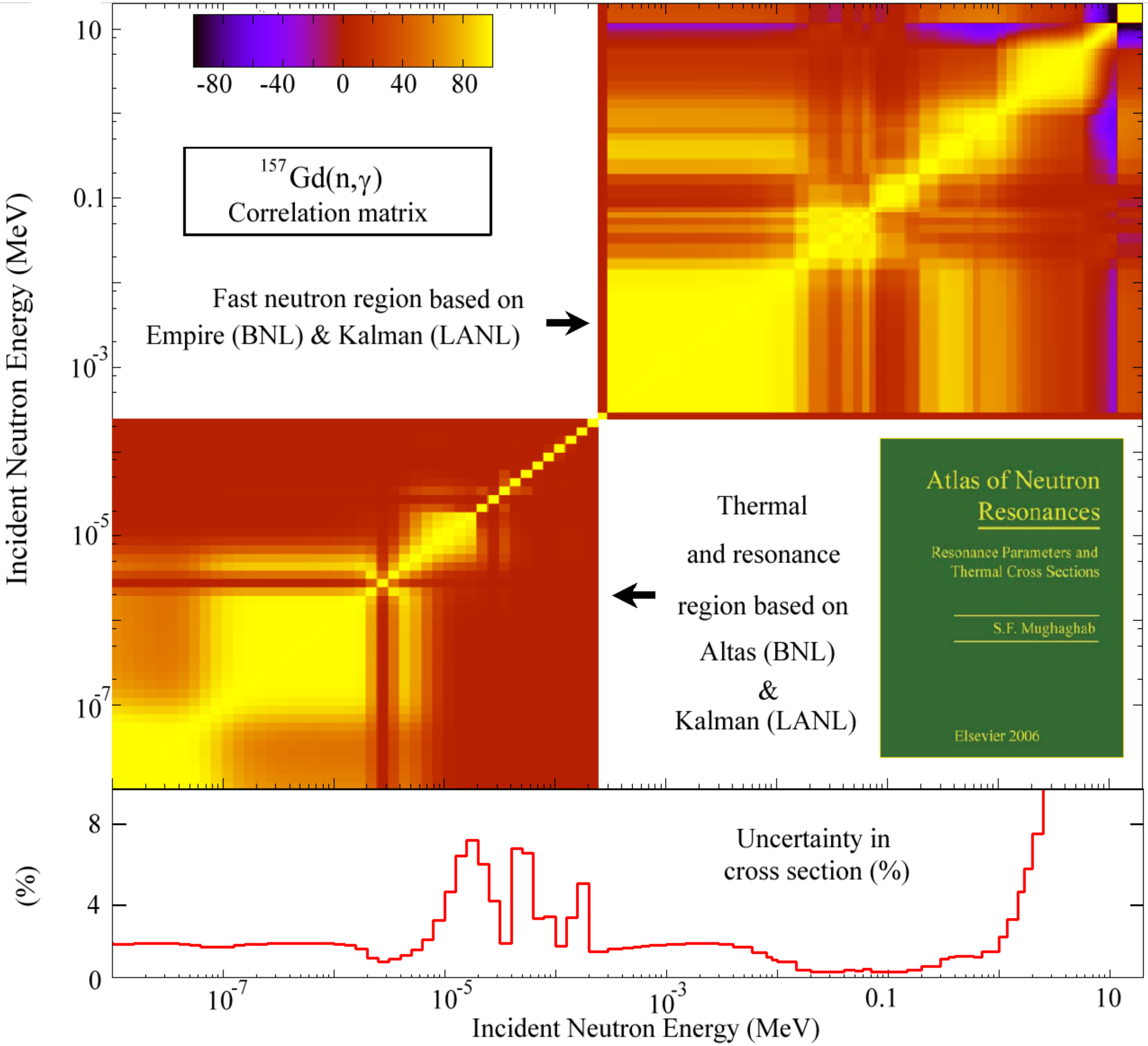
BOLNA Covariance

- except the U-235, U-238 and Pu-239 data, which have been taken from the combined **LANL/ORNL** evaluation,
- and the Pb isotope data, taken from the **NRG** evaluation.
- Missing data have been taken from the **ANL** estimated covariance data

Energy correlations have been used, but practically no reaction cross-correlations

Covariance methodology

Atlas-EMPIRE-KALMAN



by Oblozinsky,

Oct. 2007

Covariance methodology

Fast neutron region

EMPIRE

Nuclear Reaction Model Code

1. Cross sections calculated with EMPIRE to reproduce ENDF/B-VII.0 as much as reasonably possible.
2. Sensitivity matrices calculated for input model parameters (OM, level densities, preequilibrium strength, …)
    - Parameter uncertainties propagated to covariances by KALMAN
    - Can be limited to basic parameters (18 used in low fidelity)
    - Ultimately a complete set of parameters should be used
3. Experimental data incorporated using KALMAN and cross section covariances produced (MF33)
    - Can be skipped (low fidelity covariances)
    - Can be done approximately (preliminary covariances for SG26)
    - Robust procedure must be developed in future
4. MF33 merged with low energies (either MF33 or MF32), processed with NJOY (PUFF, ERORRJ) and multigroup data produced.

by Oblozinsky, Oct. 2007

Preliminary covariances for SG26

36 materials produced by BNL

Rochman, Herman, Oblozinsky, Mughabghab "*Preliminary cross section and nubar covariances for WPEC Subgroup 26*", Report BNL-77407-2007-IR, Jan 2007; Remaining nubars in Suppl.1, Feb 2007

Reports include data for 45 materials out of 53 requested

- **36 materials (15 actinides, 21 structural) are our own estimates**
- 6 materials from ENDF/B-VII.0; 3 from JENDL-3.3; light nuclei not provided

15 actinides: (n,g), (n,el), (n,inl), (n,2n), (n,f), ν-bars

- ^{237}Np, ^{240,241}Pu, ^{241,242m,243}Am
- ^{233,234,236}U, ^{238,242}Pu, ^{242,243,244,245}Cm
- Nubars
  - ν-bar energy dependence approximated by a linear function
  - Thermal and higher energy data considered, propagated with KALMAN

21 structural materials: (n,g), (n,el), (n,inl), (n,2n)

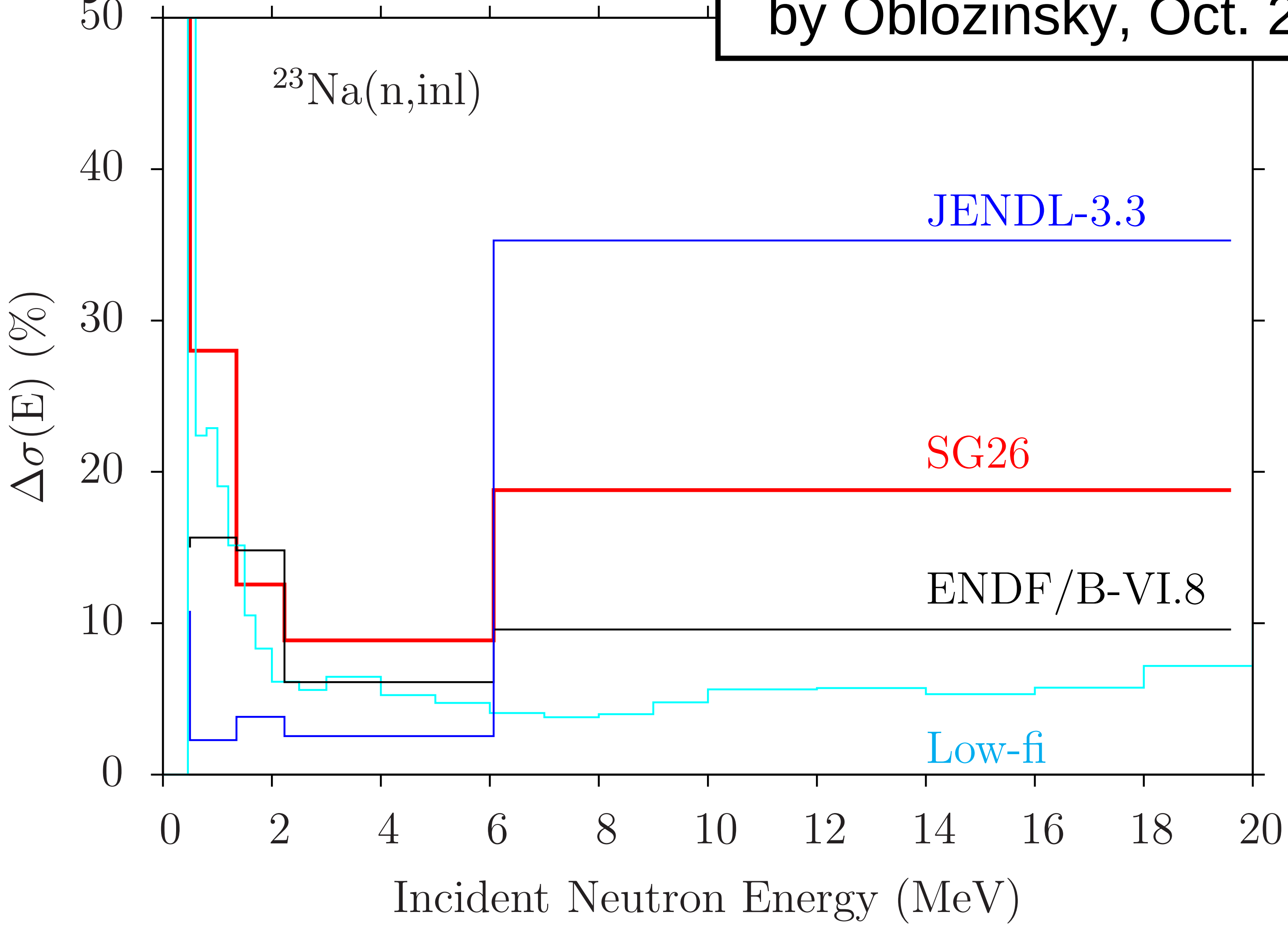
- ^{16}O, ^{23}Na, ^{52}Cr, ^{58}Ni; ^{28}Si, ^{90,91,92,94}Zr, ^{206,207,208}Pb, ^{209}Bi
- ^{19}F, ^{27}Al, ^{56}Fe, ^{57}Fe, ^{166,167,168,170}Er

by Oblozinsky, Oct. 2007

SG26: Results and discussion

Inelastic for ^{56}Fe, ^{28}Si and ^{23}Na particularly important

by Oblozinsky, Oct. 2007



3. Quantitative Data Needs by Isotope, Reaction Type, Energy Range

by Aliberti, Oct. 2007

Target Accuracy

To establish priorities and target accuracies on data uncertainty reduction, a formal approach can be adopted by defining target accuracies on design parameters and finding out the required accuracy on cross-section data.
The unknown uncertainty data requirements d_i can be obtained by solving the following minimization problem:

$$\sum_i \lambda_i / d_i^2 = \min \quad i = 1 \dots I$$

(I is the total number of parameters) with the following constraints:

$$\sum_i S_{ni}^2 d_i^2 < \left(R_n^T\right)^2 \qquad n = 1 \dots N$$

(N is the total number of integral design parameters) where S_{ni} are the sensitivity coefficients for the integral parameter R_n, and R_n^T are the target accuracies on the N integral parameters.
λ_i are “cost” parameters related to each σ_i and should give a relative figure of merit of the difficulty of improving that parameter (e.g., reducing uncertainties with an appropriate experiment).

NT. Only the diagonal values of the BOLNA covariance matrix have been object of the present Target Accuracy study.

by Aliberti, Oct. 2007

Integral Parameter Uncertainties (%) with Initial and Required Cross-Section Uncertainties

		ABTR	**SFR**	**EFR**	**GFR**	**LFR**	**ADS**	**Required Accuracy**
k_{eff} BOC [pcm]	**With initial uncertainties**	643	1108	877	1270	890	1882	300 pcm
	With required uncertainties	291	348	322	326	320	279	
Power Peak BOC	**With initial uncertainties**	0.32	0.31	0.81	1.18	0.45	14.22	2%
	With required uncertainties	0.20	0.13	0.34	0.26	0.18	2.17	
Doppler BOC	**With initial uncertainties**	2.86	3.62	2.46	3.62	2.85	-	7 %
	With required uncertainties	1.41	1.66	1.12	1.38	1.43	-	
Void	**With initial uncertainties**	5.11	15.66	6.68	5.46	4.97	13.11	7 %
	With required uncertainties	2.84	6.05	3.26	3.14	1.92	3.50	
Burnup [pcm]	**With initial uncertainties**	-37.4	-152.1	-584.9	254.2	-127.7	-602.9	300 pcm
	With required uncertainties	-14.5	-45.2	-201.2	91.9	-45.4	-207.1	

ABTR, SFR, EFR, GFR, LFR, ADS: Uncertainty Reduction Requirements Needed to Meet Integral Parameter Target Accuracies

Isotope	Cross-Section	Energy Range	Uncertainty (%)	
			Initial	Required
U238	σ_{capt}	24.8 - 9.12 keV	9.4	1.8
		9.12 - 2.03 keV	3.1	1.8
U238	σ_{inel}	19.6 - 6.07 MeV	29.3	9.0
		6.07 - 2.23 MeV	19.8	2.0
		2.23 - 1.35 MeV	20.6	2.1
		1.35 - 0.498 MeV	11.6	2.3
		498 - 183 keV	4.2	3.8
		183 - 67.4 keV	11.0	4.2
Pu239	σ_{capt}	1.35 - 0.498 MeV	18.2	6.6
		498 - 183 keV	11.6	4.4
		183 - 67.4 keV	9.0	4.0
		67.4 - 24.8 keV	10.1	4.2
		24.8 - 9.12 keV	7.4	3.8
		9.12 - 2.03 keV	15.5	3.2
Pu240	σ_{fiss}	6.07 - 2.23 MeV	4.8	2.9
		2.23 - 1.35 MeV	5.7	2.6
		1.35 - 0.498 MeV	5.8	1.6
		498 - 183 keV	3.9	3.7
		2.03 - 0.454 keV	21.6	11.8
Pu241	σ_{fiss}	6.07 - 2.23 MeV	14.2	5.0
		2.23 - 1.35 MeV	21.3	3.9
		1.35 - 0.498 MeV	16.6	2.1
		498 - 183 keV	13.5	1.7
		183 - 67.4 keV	19.9	1.7
		67.4 - 24.8 keV	8.7	1.9
		24.8 - 9.12 keV	11.3	2.0
		9.12 - 2.03 keV	10.4	2.1
		2.03 - 0.454 keV	12.7	2.7
		454 - 22.6 eV	19.4	5.4

Isotope	Cross-Section	Energy Range	Uncertainty (%)	
			Initial	Required
Am242m	σ_{fiss}	1.35 - 0.498 MeV	23.4	21.4
		498 - 183 keV	16.5	6.3
		183 - 67.4 keV	16.6	4.7
		67.4 - 24.8 keV	16.6	4.8
		24.8 - 9.12 keV	14.4	5.6
		2.04 - 0.454 keV	11.8	5.9
Am243	σ_{fiss}	6.07 - 2.23 MeV	11.0	2.3
		2.23 - 1.35 MeV	6.0	1.9
		1.35 - 0.498 MeV	9.2	1.7
Am243	σ_{inel}	6.07 - 2.23 MeV	17.9	4.9
		2.23 - 1.35 MeV	35.3	3.9
		1.35 - 0.498 MeV	42.2	2.3
		498 - 183 keV	41.0	3.7
		183 - 67.4 keV	79.5	3.7
		67.4 - 24.8 keV	80.8	12.4
Cm244	σ_{fiss}	6.07 - 2.23 MeV	31.3	3.0
		2.23 - 1.35 MeV	43.8	2.6
		1.35 - 0.498 MeV	50.0	1.5
		498 - 183 keV	36.5	4.0
		183 - 67.4 keV	47.6	7.3

by Aliberti, Oct. 2007

4. Approach to Meet the Needs

The statistical adjustment method can provide a powerful and robust tool to improve uncertainties in key design parameters. The method makes use of:

by Salvatores, Oct. 2007

- **“a priori” nuclear data covariance information,**
- **integral experiments analysis to define C/E values**
- **integral experiment uncertainties**

in order to:

- 🟥 **evaluate „a priori“ uncertainties on reference design performance parameters**
- 🟥 **reduce these uncertainties using integral experiments („a posteriori“ uncertainties on performance parameters)**
- 🟥 **define „adjusted“ nuclear data and associated „a posteriori“ covariances**

Then, it is needed:

by Salvatores, Oct. 2007

- selection of a set of relevant experiments (more on that later),
- sensitivity analysis of selected configurations including reference design configurations for a wide range of integral parameters related to the core performances (critical mass, reactivity coefficients, control rod worth, power distributions etc), and fuel cycle parameters (reactivity loss/cycle, decay heat, transmutation rates, neutron sources and doses of spent fuel etc)

(pink-colored by Ishikawa.)

- use of science based covariance data for uncertainty evaluation and target accuracy assessment,
- analysis of experiments using the best methods available, with some redundancy to avoid systematic errors,
- use of calculation/experiment discrepancies (and associated uncertainties) in a statistical adjustment

A warning: the credibility of an adjustment is dependent on the credibility of the experimental uncertainties!

The adjustment method

by Salvatores, Oct. 2007

If B_p is the "a priori" nuclear data covariance matrix, S_B the sensitivity matrix of the performance parameters B (B=1…..BTOT) to the J nuclear data, the "a priori" covariance matrix of the performance parameters is given by:

$$B_B = S_B^T B_p S_B$$

It can be shown that, using a set of I integral experiments A, characterized by a sensitivity matrix S_A, besides a set of statistically adjusted cross-section data, a new ("a posteriori") covariance matrix can be obtained:

$$\tilde{B}_p = B_p - B_p S_A \left(S_A^T B_p S_A + B_A \right)^{-1} S_A^T B_p$$

where B_A is the integral experiment uncertainty matrix.

Integral experiments

by Salvatores, Oct. 2007

- **Integral experiments have been performed in large number in the past. Future experiments only on a few installations and at a later date (case of MASURCA)**

- **Some of the most representative (and „clean“) are being collected within the NEA-NSC projet IRPHEP.**

- **Experiment selected to cover different fuel types (e.g. oxide and metal), different Pu vectors, different Pu content and reactor size (different leakage), different reflector effects etc.**

- **A crucial point is the availability and share of power reactor experiments**
  - **Physics experiments at start-up (e.g. SUPERPHENIX)**
  - **Operation experiments (e.g. EBR-II, FFTF, PHENIX, JOYO)**
  - **New experiments (e.g. at the future MONJU start-up)**
  - **Irradiation experiments (e.g. PROFIL in PHENIX)**

A first proposal of integral experiments to be used in a global adjustment for GNEP/Gen-IV fast neutron systems.

Assembly	Doc. Availability	Experiments to be analyzed				MC Model	Determ. Model
		Critical mass	React. Rates	React. Coeff.	Irrad. Exp.		
GODIVA	IHECSBE	Yes	Yes	-	-	Yes	Yes
JEZEBEL^{239}	IHECSBE	Yes	Yes	-	-	Yes	Yes
JEZEBEL^{240}	IHECSBE	Yes	Yes	-	-	Yes	Yes
Np Sphere	IHECSBE	Yes	-	-	-	Yes	Yes
ZPR-6/6-7	IHECSBE	Yes	Yes	Yes		Yes	Yes
ZPR-3/53-54	ANL	Yes	Yes	-	-	-	Yes[a]
ZPPR-2	ANL	Yes	Yes	Yes	-	-	-
ZPPR-9	ANL	Yes	Yes	Yes	-	-	-
ZPPR-10A	IRPHEP	Yes	Yes	Yes	-	-	Yes
ZPPR-13A[b]	-	-	-	-	-	-	-
ZPPR-15	ANL	Yes	Yes	Yes		Yes	Yes
ZPPR-19B	ANL	Yes	Yes	Yes		-	-
MUSE/COSMO	NEA (benchm.)	Yes	Yes	-	-	Yes	Yes
CIRANO	CEA[c]	Yes	Yes	-	-	-[d]	Yes[d]
ZEBRA/CAD.	IRPHEP	Yes	Yes	-	-	Yes	Yes
SNEAK-6 -7	IRPHEP[e]	Yes	Yes	Yes	-	-	-
JOYO	IRPHEP	Yes	Yes	Yes	-[f]	-	Yes
EBR-II[g]	ANL	Yes	-		Yes		
FFTF	-	-	-	-	-	-	-
PROFIL	CEA[c]	-	-	-	Yes	-	Yes
TRAPU	CEA[c]	-	-	-	Yes	-	Yes
MONJU	-[i]	-	-	-	-	-	-

by Salvatores, Oct. 2007

Issues and perspectives

by Salvatores, Oct. 2007

- « Smart » choice of integral experiments
  - Separate effects
  - Energy effects
  - Space effects
- Need for integral experiments uncertainty and correlations
- Increased role of power reactor integral experiments
- Need for flexible sensitivity methods
- Improved covariance data and cross correlations
- Redundant/independent reference calculation routes
- Use of adjusted libraries and feedback to evaluators
- Bias factors and uncertainties for design parameters
- A new goal: basic parameters and datafile adjustment (consistent adjustment method)
- Need for new integral/differential experiments?

Next Steps

It is proposed to WPEC to consider the setting-up of ***two new subgroups***:

- A new specific Subgroup on "Methods and issues for the combined use of integral experiments and covariance data". Participation of evaluators (to account for feedbacks to files) and a close link to related activities like the ones coordinated at the Uncertainty Analysis of Criticality Safety Assessment Expert Group (WPNCS) should be clearly established.
- A Subgroup that should organize the work needed to meet the requirements as they have been pointed out: share of work on different installations and different projects, evaluation etc.

Final Report of NEA/WPEC/SG26

The present draft has been compiled by G. Aliberti and sent out by Y. Rugama (available on the NEA website http://www.nea.fr/html/science/wpec/meeting2007/SG26/):
The next version of the Report will be assembled by January 30, 2008. This version will be finalized by March 2008 and submitted to WPEC.

5. Concluding Remarks

- **Design Target Accuracy**

  → ***Suitable as rough reference values.***

- **Covariance Data**

  → ***Finally, took the right methodology.***

- **Quantitative data needs by isotope, etc.**

  → ***Only useful to demonstrate the needs of integral information.***

- **Approach to Meet the Needs**

  → ***Finally, the same direction with that of Japan. NEA is preparing two new WPEC/SGs for this topic.***