Date: Dec 2013 - Mar 2015 *back to CRP-web*

Proposals for new measurements for IRDFF community and HPRL.

I. Spectrum Averaged (SPA) cross sections

Following the action of 1st RCM (see Report INDC(NDS)-0639, page 15) and analysing the available SPA data measured in fields:

Cf-252(s.f.) - available measured data and C/E plots
U-235(n_{th},f) - available measured data and C/E plots
MACS(30 keV) - available measured data and C/E plots

we formulate a list of Not-Measured, Outliers or "Discrepant" data for IRDFF community and for submission to HPRL:

NB.1. Since it is difficult to measure the (n,γ) cross sections due to impact of room and set-up returned neutrons, only the threshold reactions from Not-Measured (marked as **bold)**, Outliers and Discrepant reactions we primarily recommend to measure and to include in HPRL.

NB.2. SPA for **high threshold (above ≈ 10 MeV) dosimetry reactions**, which may serve to "measure" the unknown high energy part of ^{252}Cf(s.f.) and ^{235}U(n_{th},f) spectra, will require intensive source and probably new detection techniques (e.g. AMS) alternative to the conventional activation one. For more details see proper information .

1. SPA in Cf-252(s.f.) field

Not Measured yet (26 reactions):

Sc-45(n,γ), Li-6(n,t)He-4, Nb-93(n,γ), Fe-58(n, γ), Ag-109(n, γ), U-235(n, γ), B-10(n,a), U-238(n, γ), W-186(n, γ), **Am-241(n,f), P-31(n,p), Zn-67(n,p), Fe-54(n,α), In-115(n,2n), Pr-141(n,2n), As-75(n,2n), Y-89(n,2n), Cr-52(n,2n), Ti-47(n,np), Na-23(n,2n), Ti-49(n,np), Ti-48(n,np), Fe-54(n,2n), Bi-209(n,3n), Tm-169(n,3n), Co-59(n,3n), ^{117}Sn(n,n')^{117m}Sn**

Outliers (4 reactions):

Co-59(n,γ), Mo-92(n,p), Ni-60(n,p), Ti-46(n,2n)

Large Discrepancies or Uncertainties (2 reactions):

Th-232(n,f), U-238(n,2n)

2. SPA in U-235(n_{th},f) field

Not Measured yet (22 reactions):

Sc-45(n,γ), Nb-93(n,γ), Fe-58(n, γ), Ag-109(n,γ), U-235(n,γ), Ta-181(n,γ), Th-232(n,γ), W-186(n,γ), **Am-241(n,f), In-115(n,2n), Pr-141(n,2n), Cu-65(n,2n), Cr-52(n,2n), Ti-47(n,np), Na-23(n,2n), Ti-49(n,np), Ti-48(n,np), Ti-46(n,2n), Fe-54(n,2n), Bi-209(n,3n), Tm-169(n,3n), Co-59(n,3n), ^{117}Sn(n,n')^{117m}Sn**

Outliers (5 reactions):

Mn-55(n,γ), U-238(n, γ), La-139(n, γ), P-31(n,p), U-238(n,2n)

P.S.: Li-6(n,t)He-4, B-10(n,α)Li-7 are not outliers due to ≈30-20% contribution from (n,n'α) and (n,t2α)

Large Discrepancies or Uncertainties (6 reactions):

Rh-103(n,n'), U-238(n,γ), Cu-63(n,γ), Tm-169(n,2n), Mn-55(n,2n), Ni-58(n,2n)

3. MACS (30 keV) field

Not Measured yet (4 reactions):

Ag-109(n,γ)Ag-110m, Th-232(n,γ)Th-233, U-235(n,γ)U-236, U-238(n,γ)U-239

II. Mono-energy cross sections

1. Low threshold reactions

The new reaction ^{117}Sn(n,n')^{117m}Sn was proposed for inclusion IRDFF by RCM-2 (no one measurement on plateau !)

^{117}Sn(n,n')^{117m}Sn https://www-nds.iaea.org/IRDFFtest/Sn117(n,n)Sn117m.pdf

This dosimeter has been already experimentally tested (irradiated) employing the inreached Tin foil (93% at. ^{117}Sn) in different reactor spectra at CEA. However, the microscopic nuclear data for this reaction suffer of lack measurements on plateau (5 - 10 MeV), discrepancies between library evaluations, lack of uncertainties … prevent this reaction to be used.

2. High threshold (n,xn) reactions (point and energy-integrated cross sections)

CRP strives to evaluate and eventually add to the IRDFF library the high threshold reactions with cross section plateaus located between 20 and 100-200 MeV to meet the requirements of the high neutron energy accelerator driven sources such as ADS.
Often it happens to be a set of several reactions of (n,xn) type on one of isotope: ^{89}Y, ^{59}Co, ^{169}Tm, ^{197}Au, ^{209}Bi, ^{175}Lu, ^{169}Tm, ^{139}La, ^{139}Rh, ^{63}Cu, ^{93}Nb .... Due to this, already one foil can serve for neutron fluence monitoring and spectrum unfolding.

Figures/materials illustrating the status of such reactions:

^{209}Bi(n,3-8n)	https://www-nds.iaea.org/IRDFFtest/Bi(n,xn).pdf
^{89}Y(n,2-4n) & (n,p)	https://www-nds.iaea.org/IRDFFtest/Y89(n,xn).pdf
^{59}Co(n,3-5n)	https://www-nds.iaea.org/IRDFFtest/Co(n,xn).pdf
^{197}Au(n,3-5n)	https://www-nds.iaea.org/IRDFFtest/Au(n,xn).pdf
^{175}Lu(n,2-4n)	https://www-nds.iaea.org/IRDFFtest/Lu(n,xn).pdf
^{169}Tm(n,2-3n)	https://www-nds.iaea.org/IRDFFtest/Tm(n,xn).pdf
^{54}Fe(n,2n)	https://www-nds.iaea.org/IRDFFtest/Fe54n2n.pdf
^{139}La(n,4-10n)	…...
^{103}Rh(n,4-8n)	……
^{nat}Fe(n,x)^{54}Mn	……
^{nat}Ti(n,x)^{46}Sc, ^{47}Sc, ^{48}Sc	……..

see also on of the overview https://www-nds.iaea.org/IRDFFtest/RCM1/Pronyaev-nxn-high-en-dos.pdf

III. Common Request on experimental UNCERTAINTIES for reactions listed above

The new measurements should make effort **to reach uncertainty 2-5% ($E_{50\%}$ < 15 MeV) or 5-10% ($E_{50\%}$ > 15 MeV)**, as in the best previous experiments.

Simakov requests translated to request form

Example: 45Sc(n,g) in the 252Cf(SF) SPA.

- In reality this example needs to be repeated 32 times for Cf252 SPA, 32 times for 235U(n,f) SPA, 4 times for 30 keV MACS.
- For 117Sn(n,n')117mSn the request is for the first measurements at the cross section plateau, i.e. from 5 to 10 MeV (*de facto - requested by C. Destouches, CEA)* .
- For 20-100 MeV the request is for any good data on (n,3-6n) reactions on 197Au, 169Tm, 209Bi, 59Co, 63Cu, 89Y, 93Nb, 139La, 103Rh, 175Lu, natFe(n,x)54Mn, natTi(n,x)46,47,48Sc.

Main messages:

1. we need IT support to start with SPQ,
2. we need secretarial support with the Simakov requests, once (After 1 is completed).

Example request form

(form field names left, form entries right, additions SG-C in purple, to do in red)**:**

Requester details	
Name	Simakov
Email	s.simakov@iaea.org
Organisation	IAEA
Country or international organization	IAEA
Measurement details (this field should be **Request details, action NEA**)	
Target Z	Sc
Target A	45
Reaction/process	(n,g)
Quantity	SPA
Incident energy range	FNS 252Cf(SF)
Secondary energy (eV) or angle	NA
Covariance information	Y
Type of request	SPQ
Field (application areas)	Reactor Dosimetry (to be defined)
Subfield	Validation
Notes	
Impact documentation	IRDFF webpage https://www-nds.iaea.org/IRDFF/ IRDFF test CRP page https://www-nds.iaea.org/IRDFFtest/ <link to pdf proposal of Simakov, action NEA> <link to pdfs refs in the proposal of Simakov, action NEA>
Requested Accuracy	New measurements must make an effort to reach 2-5% uncertainty for E50%<15 MeV or 5-10% for E50%>15 MeV).
Justification documentation	As impact documentation.
General comments	The International Reactor Dosimetry and Fusion File aims at providing validated evaluated neutron dosimetry reactions for all applications in reactors and fusion technology development. Spectrum averaged cross sections in well characterized fields such as the 252Cf(SF), 235U(n-th,f) fission neutron spectra and the quasi-maxwellian 30 keV spectrum are essential to validation of the proposed cross sections in fields that are close to the interest in applications.
Attached files:	Proposal Simakov and the documents referred in his text.

Reviewer comment:

Reactions without threshold measured in fast spectra such as the ^{252}Cf(SF) and ^{235}U(n-th,f) spectrum tend to have their spectrum averaged cross section dominated by scattering contributions and 'room-return' neutrons.
In all cases experiments should be careful to minimize these contributions and maximize the reaction rate of the target spectrum. For new experiments best estimates must be provided by detailed Monte Carlo calculation of the spectrum realized in the experiment and the Monte Carlo model must be made available to IRDFF to facilitate validation of new proposals for the cross section. In all cases it is advised to publish both the fully corrected SPA and the measured reaction rates of the primary reaction and the monitor reactions used for normalization and validation of the model. The measured reaction rates must be provided with a full covariance matrix.