

Proposals for the new measurements for the IRDFF community and for inclusion in the NEA [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 ²⁵²Cf(s.f.) and ²³⁵U(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,α), 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), ¹¹⁷Sn(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), ¹¹⁷Sn(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. Point-wise cross sections (reaction excitation functions)

1. Low threshold reactions

The new reaction $^{117}\text{Sn}(n,n')^{117\text{m}}\text{Sn}$ was proposed for inclusion IRDFF by RCM-2:

available measurements for $^{117}\text{Sn}(n,n')^{117\text{m}}\text{Sn}$ [https://www-nds.iaea.org/IRDFFtest/Sn117\(n,n\)Sn117m.pdf](https://www-nds.iaea.org/IRDFFtest/Sn117(n,n)Sn117m.pdf)

(no one measurement on plateau so far !)

This dosimeter has been already experimentally tested employing the enriched Tin foil (93% at. ^{117}Sn) in different reactor spectra at CEA (see C. Destouches "Progress of the CEA contribution to IRDFF validation: experimental data and codes", [https://www-nds.iaea.org/publications/indc/INDC\(NDS\)-0682.pdf](https://www-nds.iaea.org/publications/indc/INDC(NDS)-0682.pdf), p. 29).

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.

It is known that a set of several reactions of the (n,xn) type on one of isotope do exist which produce residuals suitable for detection in dosimetry applications:



Due to this, already one foil can serve for the multiple neutron fluence monitoring and spectrum unfolding.

The figures illustrating the status of such reactions:

$^{209}\text{Bi}(n,3-8n)$	https://www-nds.iaea.org/IRDFFtest/Bi(n,xn).pdf
$^{89}\text{Y}(n,2-4n)$ & (n,p)	https://www-nds.iaea.org/IRDFFtest/Y89(n,xn).pdf
$^{59}\text{Co}(n,3-5n)$	https://www-nds.iaea.org/IRDFFtest/Co(n,xn).pdf
$^{197}\text{Au}(n,3-5n)$	https://www-nds.iaea.org/IRDFFtest/Au(n,xn).pdf
$^{175}\text{Lu}(n,2-4n)$	https://www-nds.iaea.org/IRDFFtest/Lu(n,xn).pdf
$^{169}\text{Tm}(n,2-3n)$	https://www-nds.iaea.org/IRDFFtest/Tm(n,xn).pdf
$^{93}\text{Nb}(n,3-4n)$	https://www-nds.iaea.org/IRDFFtest/Nb(n,xn).pdf
$^{54}\text{Fe}(n,2n)$	https://www-nds.iaea.org/IRDFFtest/Fe54n2n.pdf
$^{139}\text{La}(n,4-10n)$	will be prepared ...
$^{103}\text{Rh}(n,4-8n)$	will be prepared ...
$^{\text{nat}}\text{Fe}(n,x)$, ^{54}Mn , ^{51}Cr	will be prepared ...
$^{\text{nat}}\text{Ti}(n,x)$, ^{46}Sc , ^{47}Sc , ^{48}Sc	will be prepared ..

See additionally implemented applications and overviews:

F.Maekawa et al.: [INDC\(JPN\)-0185/U, 2000, p.226.](#)

S.Simakov, P.Bem et al.: [FED 82\(2007\)2510](#), ISRD-13 [Reactor Dosimetry State of the Art 2008, p.532](#),

V.Pronyaev RCM-1 (2013): <https://www-nds.iaea.org/IRDFFtest/RCM1/Pronyaev-nxn-high-en-dos.pdf>

III. Common Request for 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.