EUROPEAN UNION

Structural Instruments 2014-2020

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Extreme Light Infrastructure-Nuclear Physics (ELI-NP) - Phase II

nuclear physics

IFIN-HH

Partial photoneutron cross section measurements on ^{209}Bi

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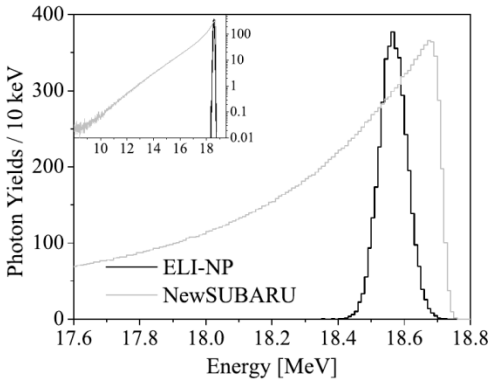
Total and partial photoneutron cross section measurements for the GDR at ELI-NP

Laser photons – relativistic electrons Compton scattering
Yb:YAG ***100 Hz ps Collision Laser*** (200 mJ, 2.3 eV, 3.5 ps)
Low emittance warm electron RF Linac (720MeV, 100 Hz RF)
Very brilliant γ-ray source

- 0.2 to 19.5 MeV
- relative energy resolution 0.5% FWHM
- ~ 10^8 photons/s in FWHM bandwidth



Gamma
Above
Neutron
Threshold

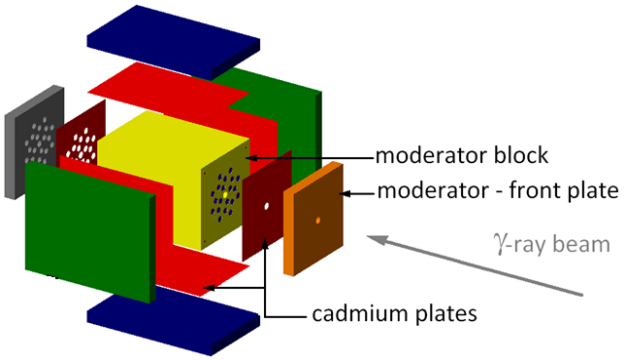
Four Physics Cases

P-process Nucleosynthesis	New Compilation of (γ,xn) CS
Nuclear Structure of GDR	Nuclear Structure of PDR and MDR

New Direct Neutron Multiplicity (DNM) sorting technique based on a flat efficiency neutron detection system. Pioneering experiments currently performed at the NewSUBARU gamma beam line facility.

Photoneutron cross section measurements on ^{209}Bi

205	206	207	208	209	
(g,4n) Sn=29.4 MeV 15.31 days	(g,3n) Sn=22.45 MeV 6.243 days	(g,2n) Sn=14.35MeV 31.55 years	(g,1n) Sn=7.46 MeV 3.68E5 years	STABLE	Bi



7.4 – 42.5 MeV maximum energy LCS γ-ray beams

(g,1n) – (g,4n) reactions

^{209}Bi monoisotopic target placed in beam

Neutrons recorded with 4π neutron detection system

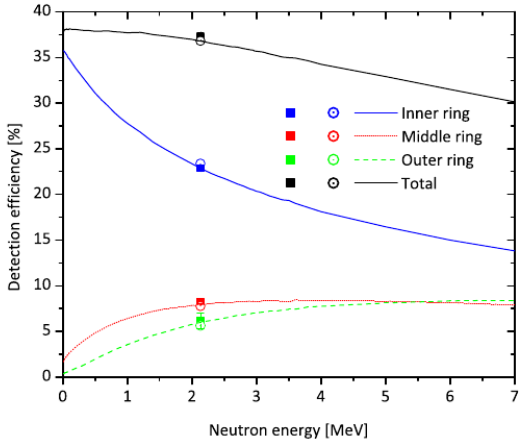
- ^{3}He counters embedded in moderator
- Flat efficiency neutron detector
  - 38.0 - 35.7 % over 0 - 3 MeV
  - 38.0 - 32.9 % over 0 - 5 MeV
- DNM sorting method (H. Ustunomiya I480)

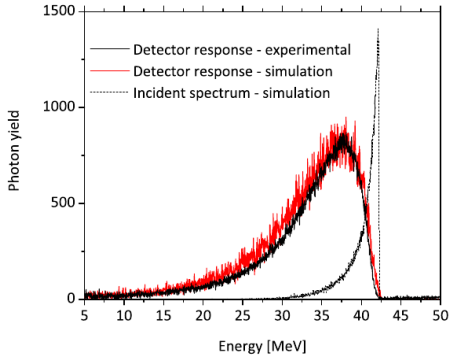
Photon flux – 100 % efficiency NaI detector

- "pile-up method"
- ~ 10^5 photons/s

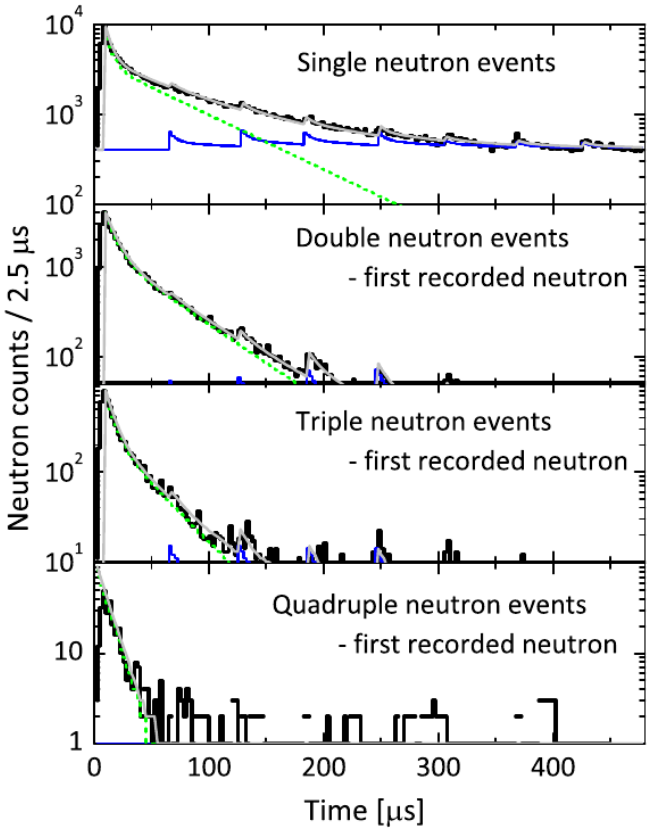
Incident photon spectra

- $LaBr_3$:Ce detector placed in beam
- ~ 2% energy resolution FWHM





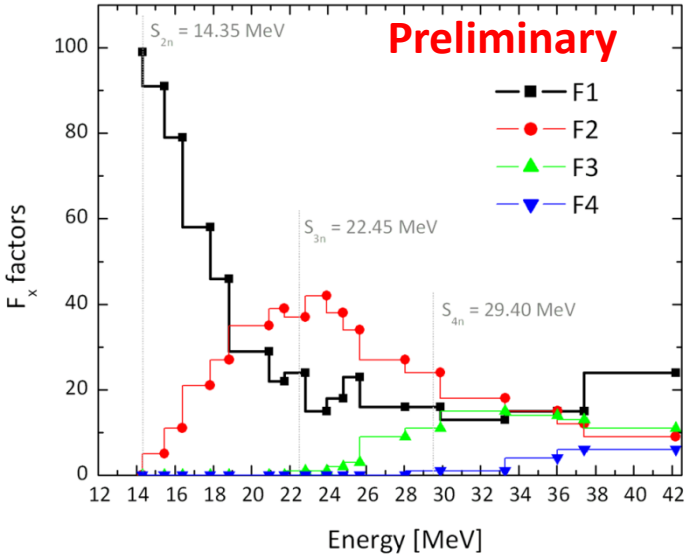
Photoneutron cross section measurements on ^{209}Bi



Recorded neutron coincidence events:

- Single events
- Double coincidences
- Triple coincidences
- Quadruple coincidences

480 us time range



$$\mathrm{F_x} = \sigma(\gamma, \mathrm{x}\,n)/\sigma(\gamma, \mathrm{Sn})$$
$$= \sigma(\gamma, \mathrm{x}\,n)/[\sigma(\gamma, 1n) + 2\sigma(\gamma, 2n) + 3\sigma(\gamma, 3n) + \ldots]$$