# Development of neutron flux detectors for boron neutron capture therapy


Xingcai Guan[1], Isao Murata[2], Tieshan Wang[1]

[1] School of Nuclear Science and Technology, Lanzhou University, Tianshui South Road 222, Lanzhou, Gansu Province 730000, China

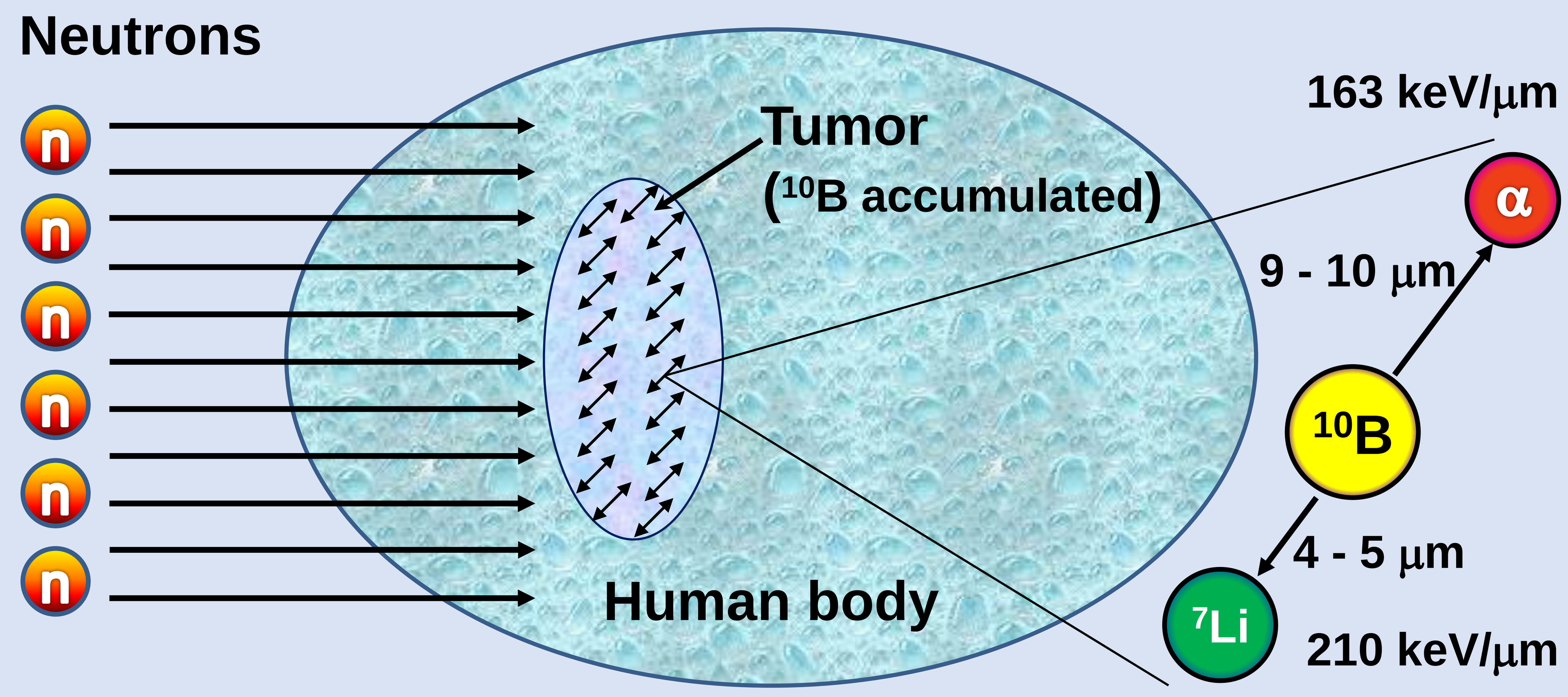
[2] Division of Sustainable Energy and Environmental Engineering, Graduate School of Engineering, Osaka University, Osaka 565-0871, Japan


## Abstract


Boron neutron capture therapy (BNCT) is a promising binary cancer radiotherapy which can selectively destroy tumor cells while sparing normal tissues. The neutron source is a key factor for BNCT. The epithermal neutron (0.5 eV ~ 10 keV) flux is one of basic characteristics for the BNCT neutron source. Therefore, the epithermal neutron flux measurement of a BNCT neutron source is very important for its quality assessment and developing the treatment planning system.

In this work, neutron flux detectors are developed for BNCT to accurately measure the epithermal neutron flux of the BNCT neutron source. These detectors work well and they will be efficiently applicable in BNCT quality assurance.


## Basic principle of BNCT




## The epithermal neutron flux detectors

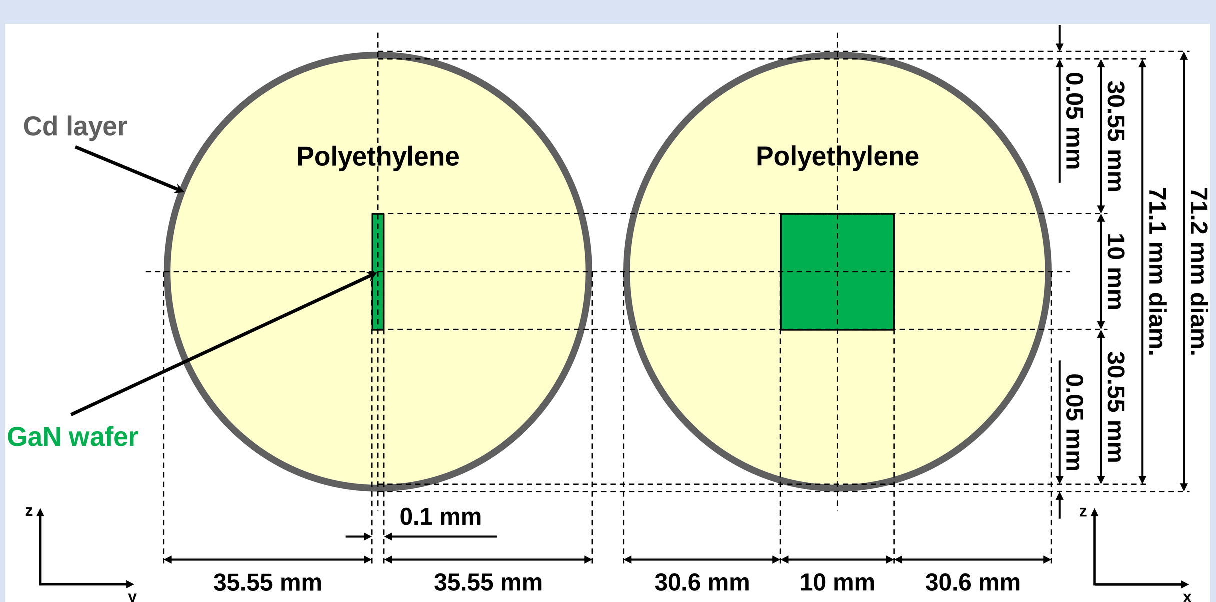



Fig. 1. Schematic view of the epithermal neutron flux detector using $^{71}$Ga(n,γ)$^{72}$Ga reaction developed for BNCT.

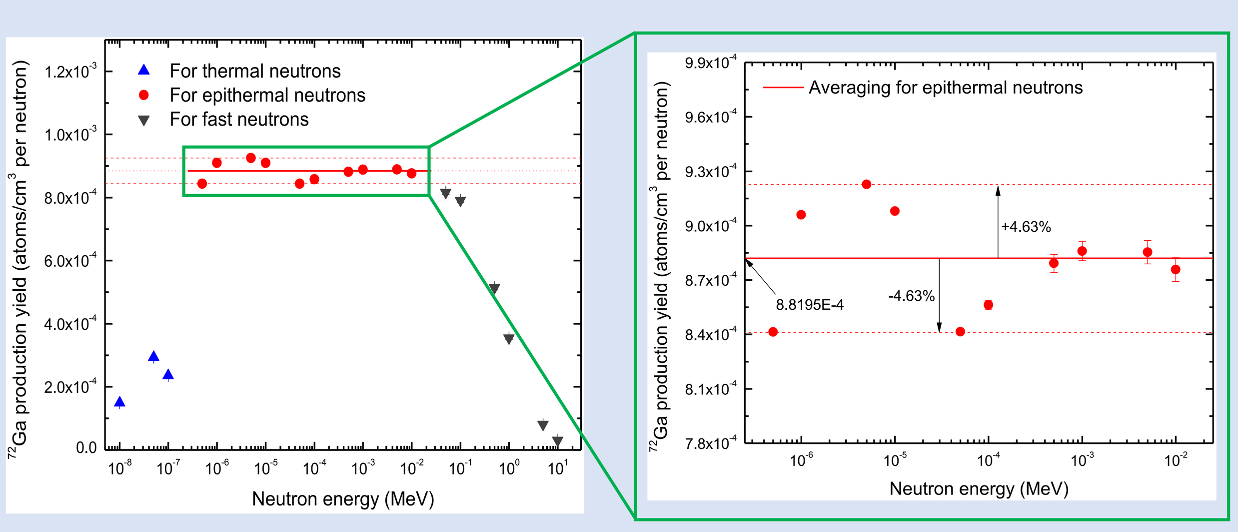



Fig. 2. Sensitivities of the epithermal neutron flux detector using $^{71}$Ga(n,γ)$^{72}$Ga reaction developed for BNCT.

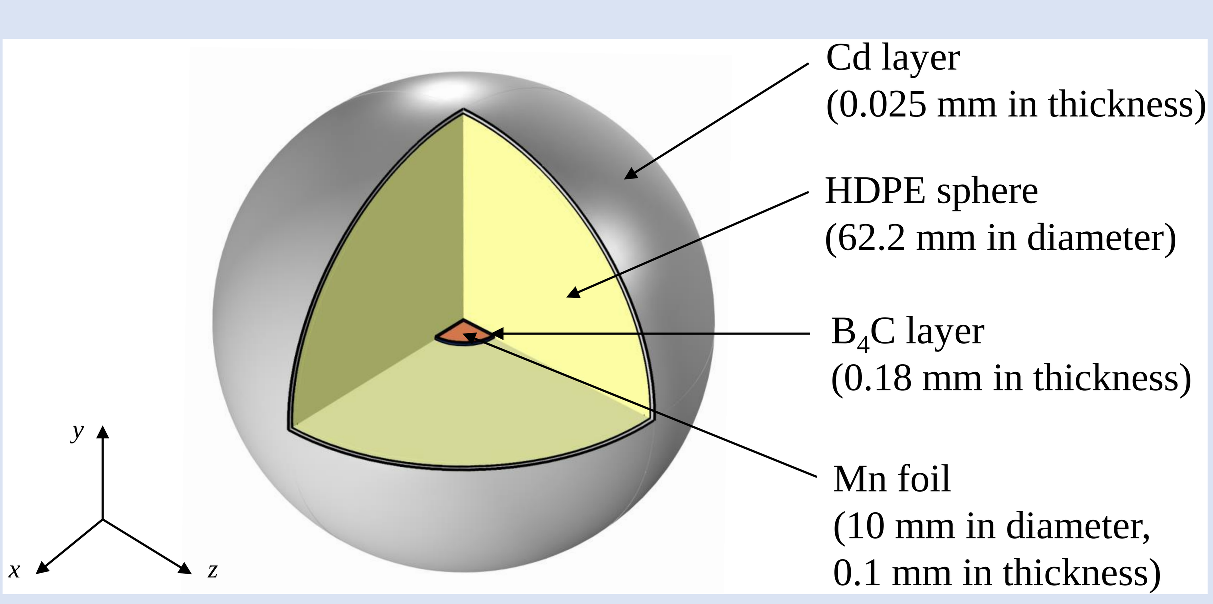



Fig. 3. Schematic view of the epithermal neutron flux detector using $^{55}$Mn(n,γ)$^{56}$Mn reaction developed for BNCT.

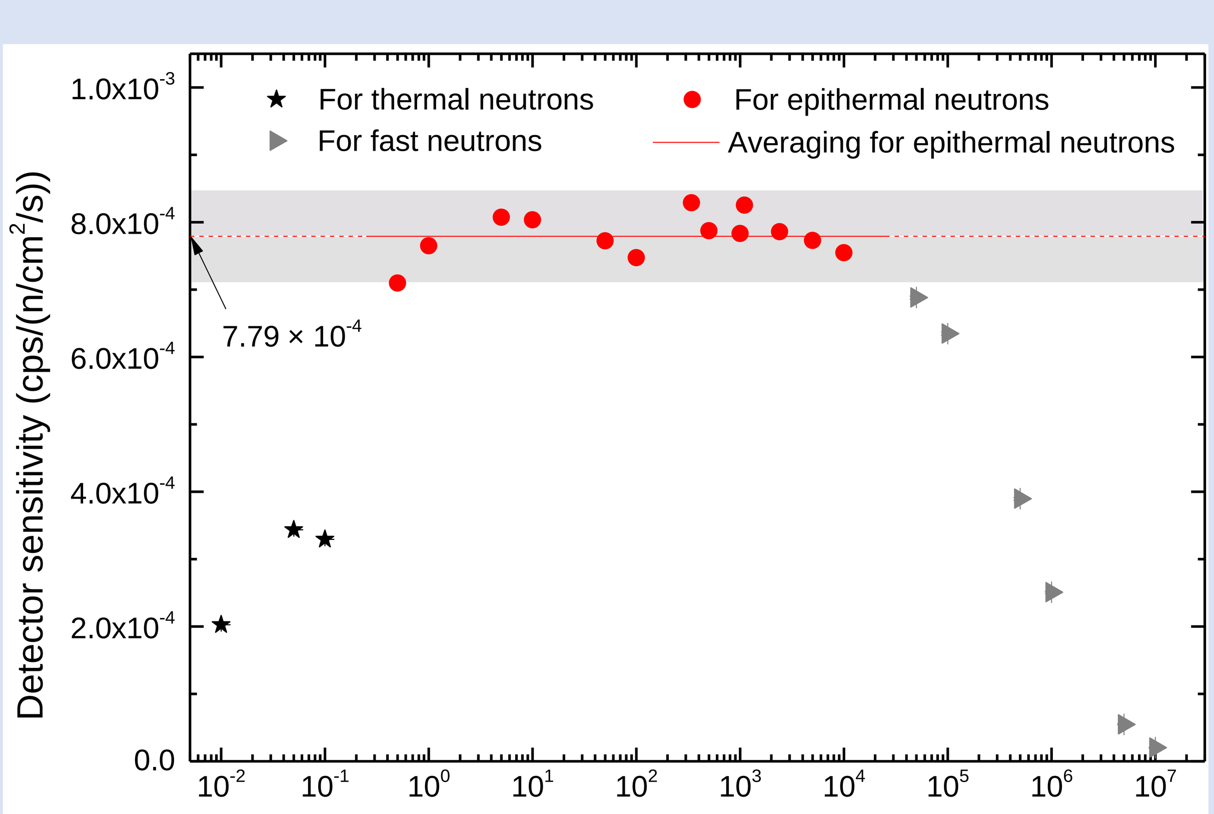



Fig. 4. Sensitivities of the epithermal neutron flux detector using $^{55}$Mn(n,γ)$^{56}$Mn reaction developed for BNCT.

## The neutron flux detectors from 20 keV to 1 MeV

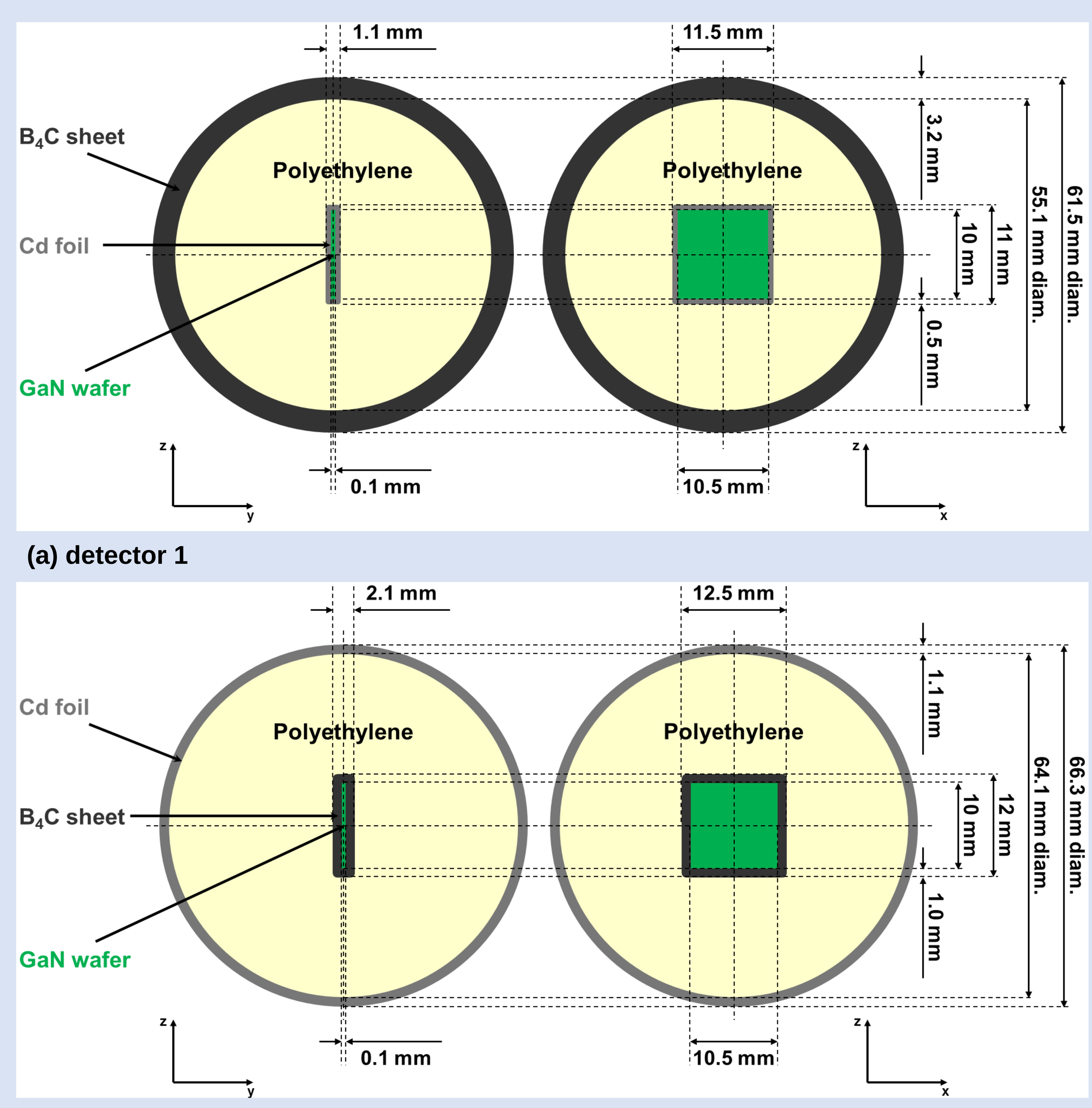



Fig. 5. Schematic views of the neutron flux detectors from 20 keV to 1 MeV developed for BNCT. (a) is for detector 1 and (b) is for detector 2.

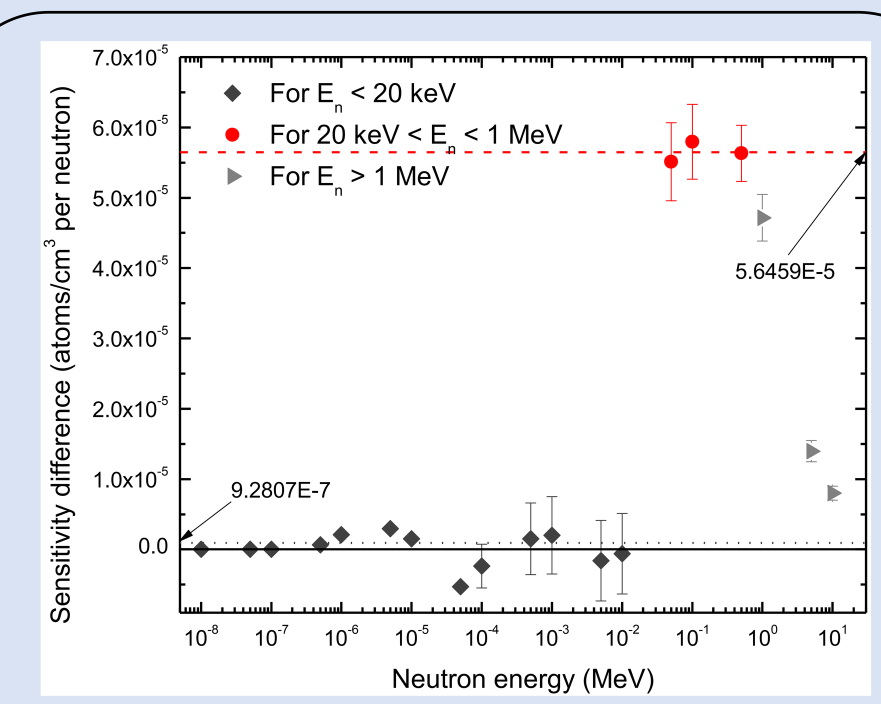
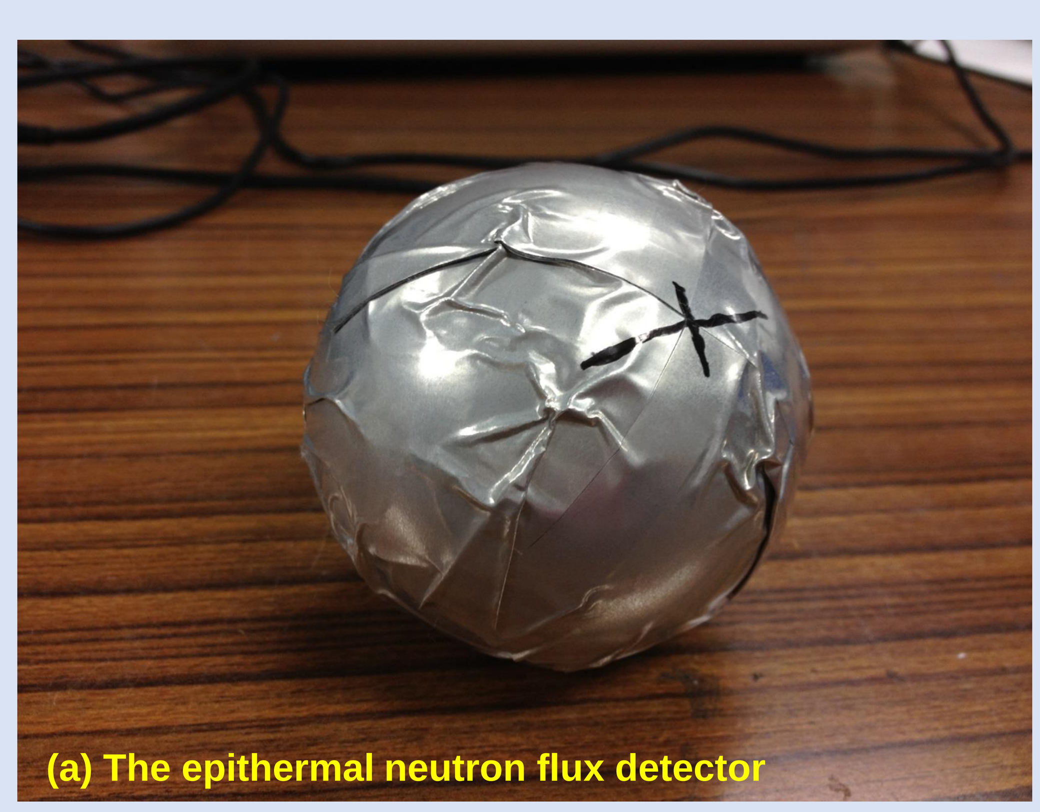


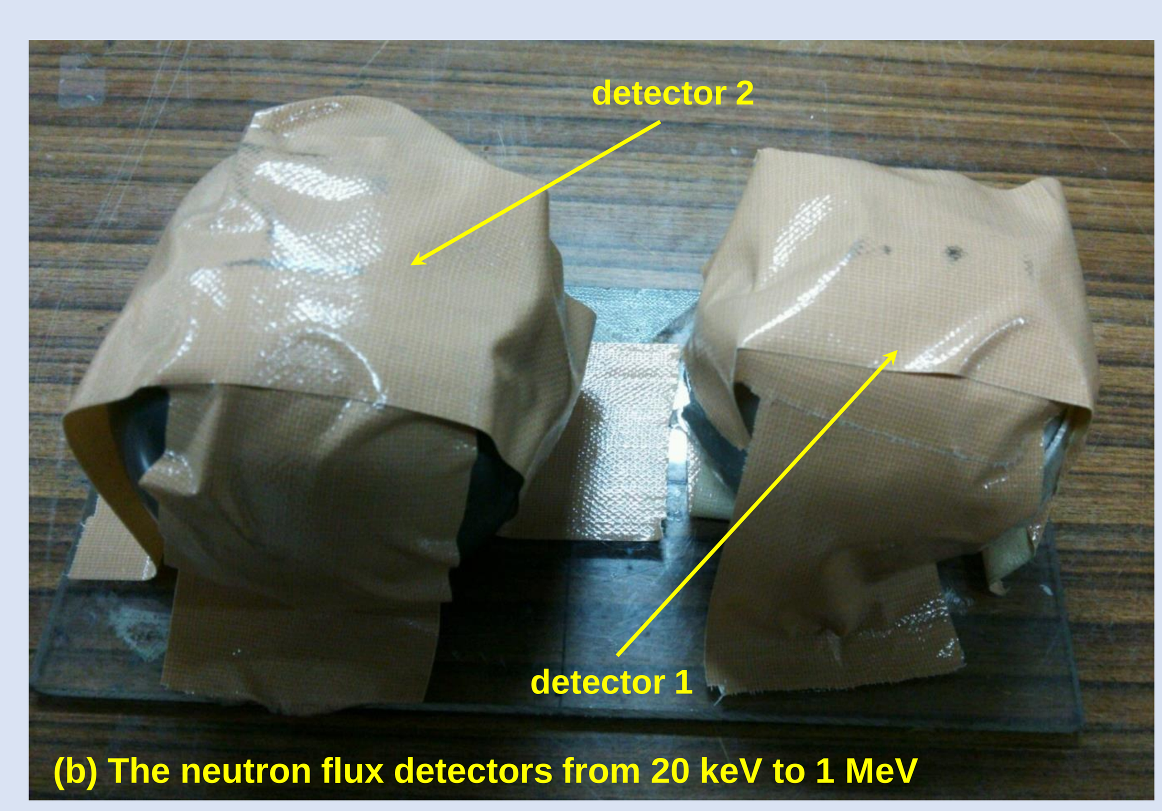

Fig. 6. Sensitivity difference between detector 1 and detector 2. The solid line represents the value of zero; the dotted and dashed lines represent the mean values of the $^{72}$Ga yields produced by neutrons below 20 keV (solid rhombi) and neutrons from 20 keV to 1 MeV (solid circles), respectively.

Table 1. Specification of the materials used in the neutron flux detectors.

| Material | Description | Role |
|---|---|---|
| GaN | Gallium nitride | Activation material |
| Mn | Manganese | Activation material |
| Cd | Cadmium | Thermal neutron absorber |
| $B_4C$ | Boron carbide | Thermal/epithermal neutron absorber |
| PE | Polyethylene | Neutron moderator |

## Photos of the neutron flux detectors


(a) The epithermal neutron flux detector



(b) The neutron flux detectors from 20 keV to 1 MeV

## Acknowledgements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## References


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