Current Status of the Neutron Detector Prototypes for LAMPS at the RAON Facility

KPS Fall 2013 Daejeon

Thursday October 31

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Synopsis

- ❀ Brief Review of the LAMPS Systems at RAON
- ❀ Low-energy LAMPS at RAON
- ❀ Neutron Detector Prototype Module Terminal Objectives
- ❀ Assembly & Test of Block-type Neutron Detector Prototype Module with FTLG
- ❀ Assembly & Test of Block-type Neutron Detector Prototype Module with SFLG
- ❀ Test of Block-type Neutron Detector Prototype Module with SFLG at KIRAMS
- ❀ **Summary**

Brief Review of the LAMPS Systems at RAON

$LAMPS_H$

$LAMPS_L$

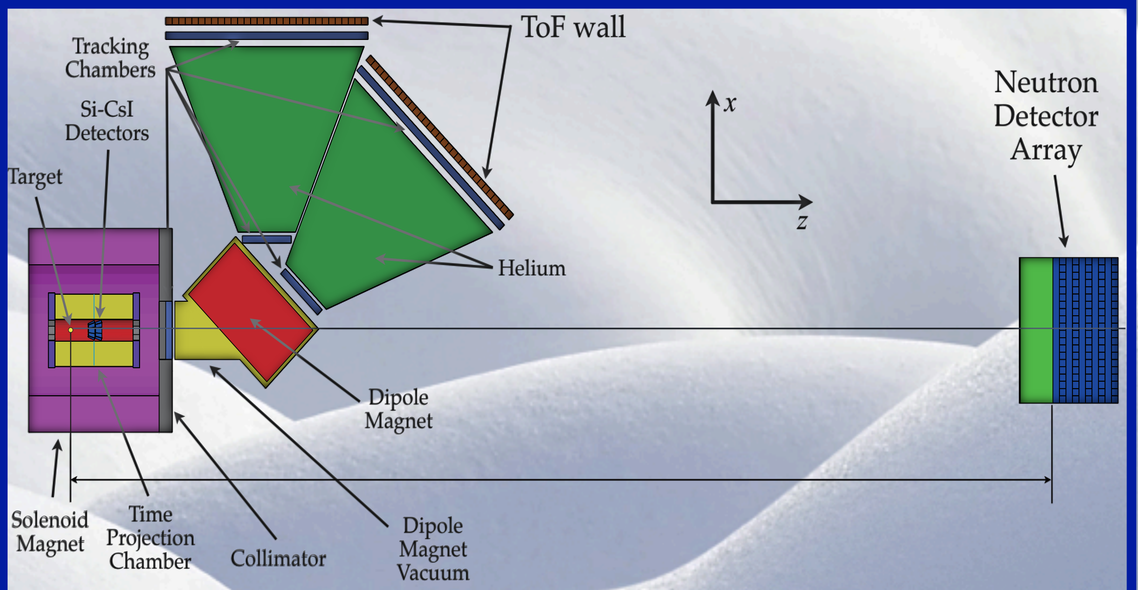
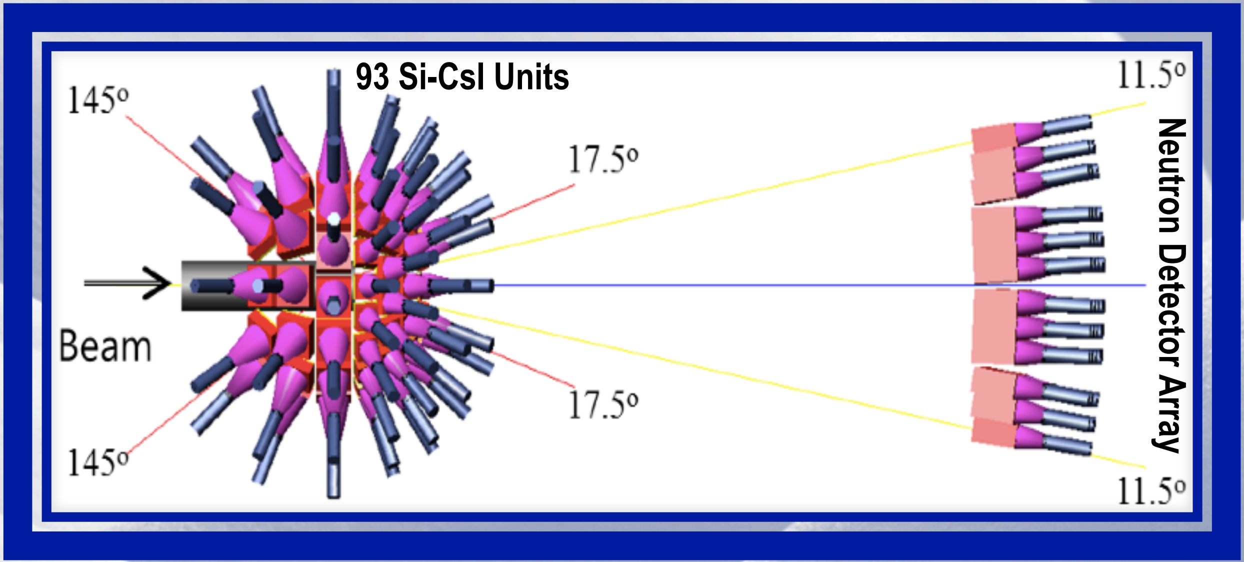


Fig. 1: High energy LAMPS ($LAMPS_H$)

$LAMPS_H$
Is a composition of the:
- Solenoid spectrometer
- Dipole spectrometer
- Neutron detector array

JKPS, Volume 62, No. 9, May 2013, pp. 1227~1232

Low-energy LAMPS ($LAMPS_L$)



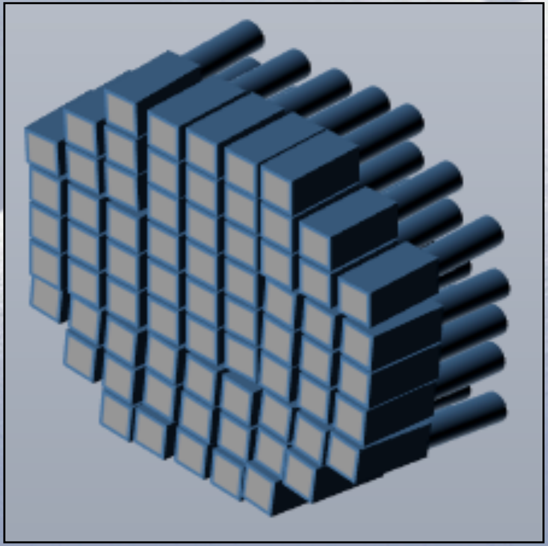
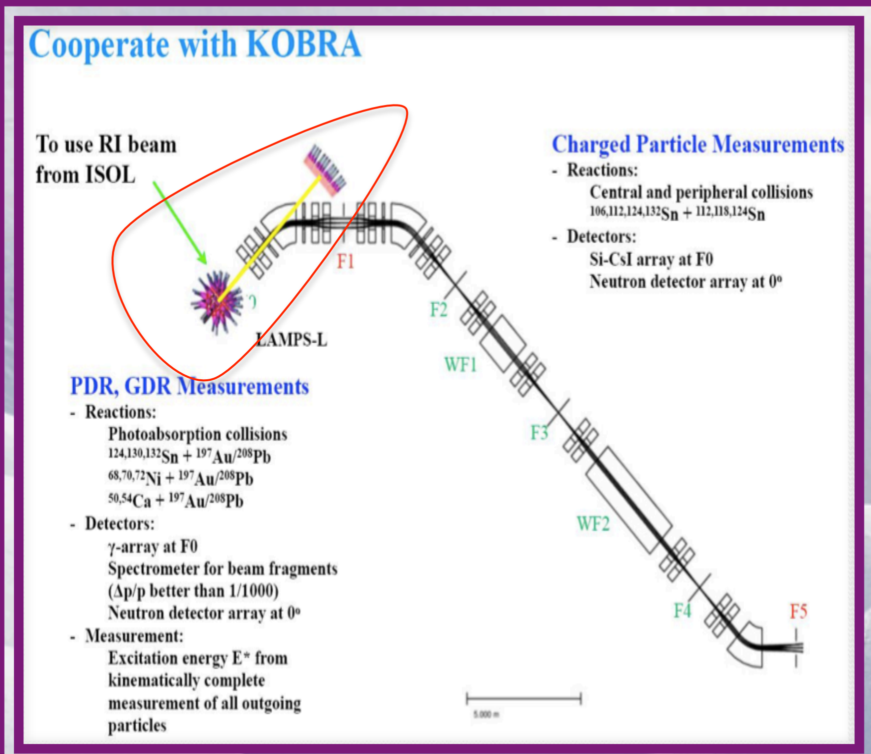


Fig. 2: A schematic diagram of $LAMPS_L$ (left) & a stack of block detectors (right)

Low-energy LAMPS (LAMPS$_L$)...............



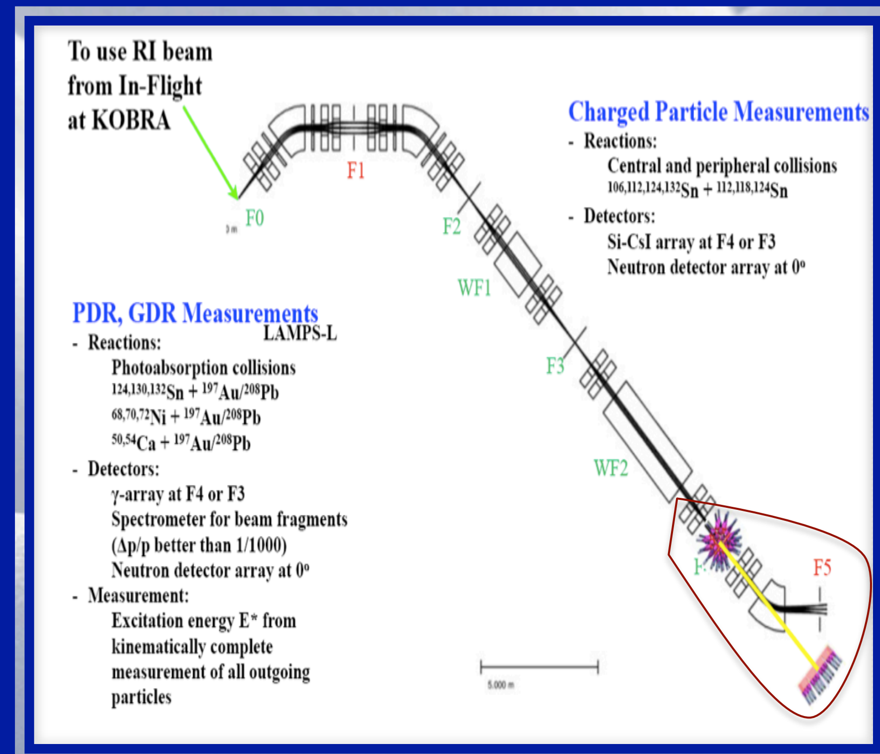


Fig. 3: LAMPS$_L$ in conjunction with KOBRA to allow use of RIB from ISOL (left) and IF (right)

Block-type Neutron Detector Prototype Single Module

Terminal objectives

Build prototypes for the low energy neutron measurements using:

- ❈ Fish-tail light guides (FTLG)
- ❈ Square frustum light guides (SFLG)

Construct:

- ❈ Time of Flight (ToF) distributions
- ❈ The kinetic energy spectra of the neutrons emitted from the spontaneous fission of the ^{252}Cf radiation source.

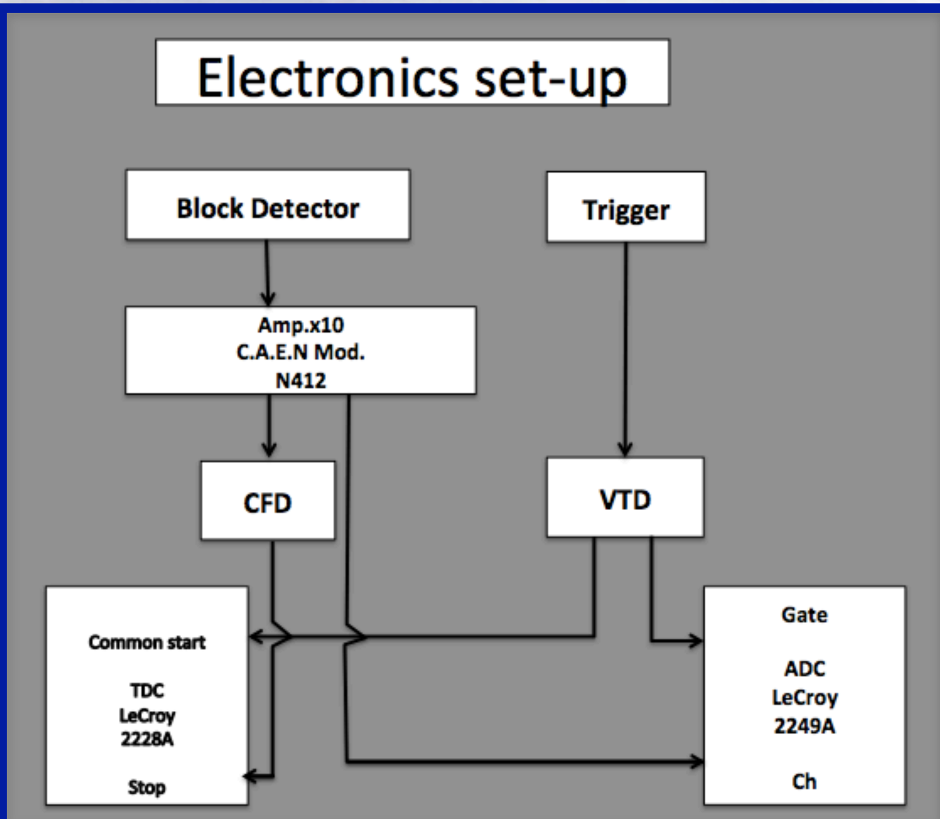
Assembly and Test of the Block-type Neutron Detector Prototype Single Module

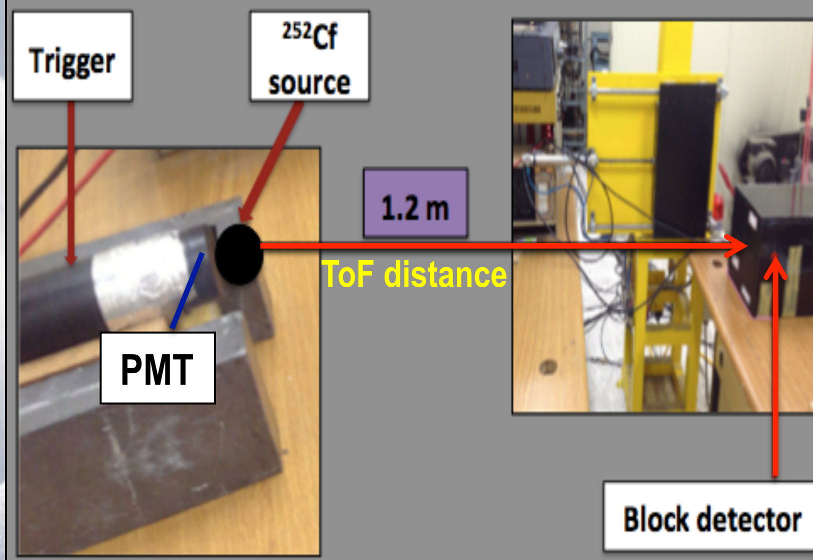
Block detector assembly

Using Fish-tail Light Guides (LG)

Fig. 4: Detector assembly process. Scintillator BC-408, fish-tail light guide and a photomultiplier tube used.

Electronic and Experimental Set-ups





Time of flight (ToF) distance = 1.2 m

Fig.5 : Data acquisition (DAQ) system (left) and experimental setup (right)

Test results with ^{252}Cf source

Time of flight distribution fitted data results

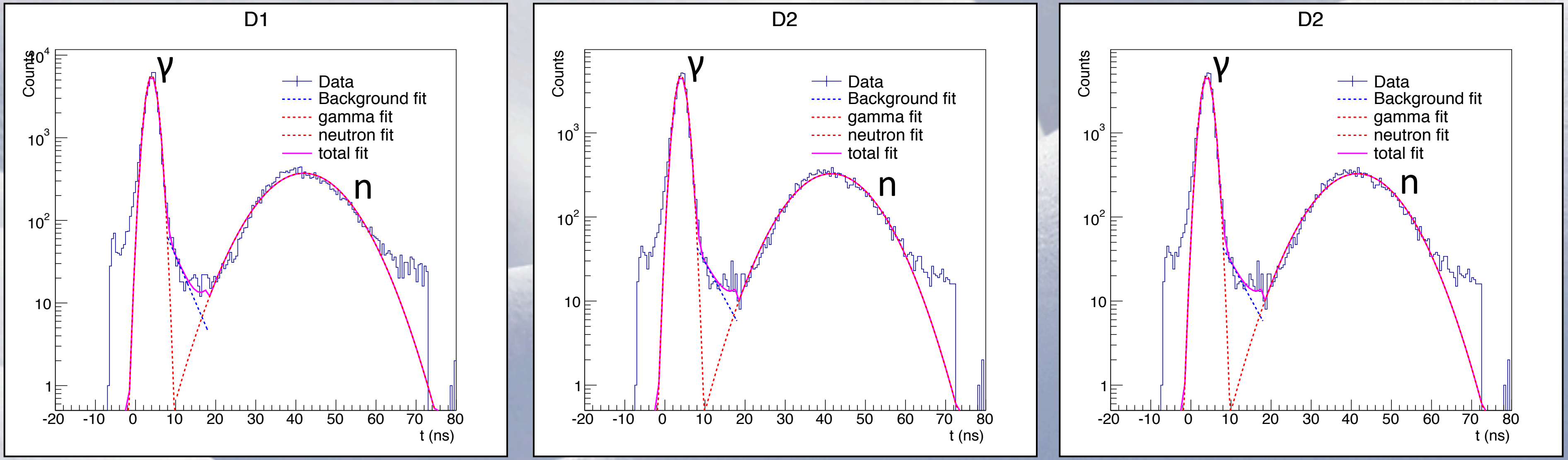


Fig.6 : Average time of flight distribution data results for detectors D1, D2 and D3 respectively.

Test results with ^{252}Cf source…

Kinetic Energy Spectra of the Fission Neutrons

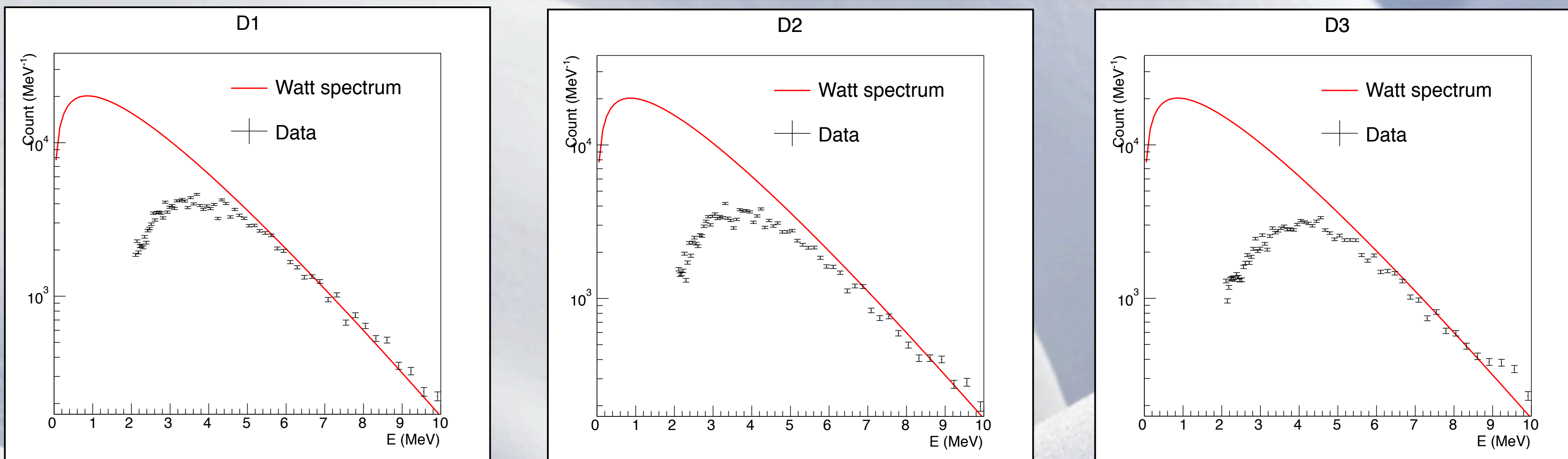


Fig.7 : Kinetic energy spectra results for detectors D1, D2 and D3 respectively. Energy spectra well reconstructed from 3.4 MeV to about 10 MeV.

$$E_k = \frac{m_n c^2}{\sqrt{1 - v^2 / c^2}} \quad \text{.................................}(1)$$

Here, m_n is the **neutron mass**

$$\frac{dN}{dE} \propto e^{-\eta E} \sinh\left[\sqrt{\xi E}\right], \quad \text{.................................}(2)$$

Where ‘η’ & ‘ξ’ are **free fitting parameters** with $\eta = 0.88\ \mathrm{MeV}^{-1}$ and $\xi = 2.0\ \mathrm{MeV}^{-1}$

Assembly and Test of the Block-type Neutron Detector Prototype Single Module

Prototype block detector assembly

Using Square Frustum Light Guides (SFLG)

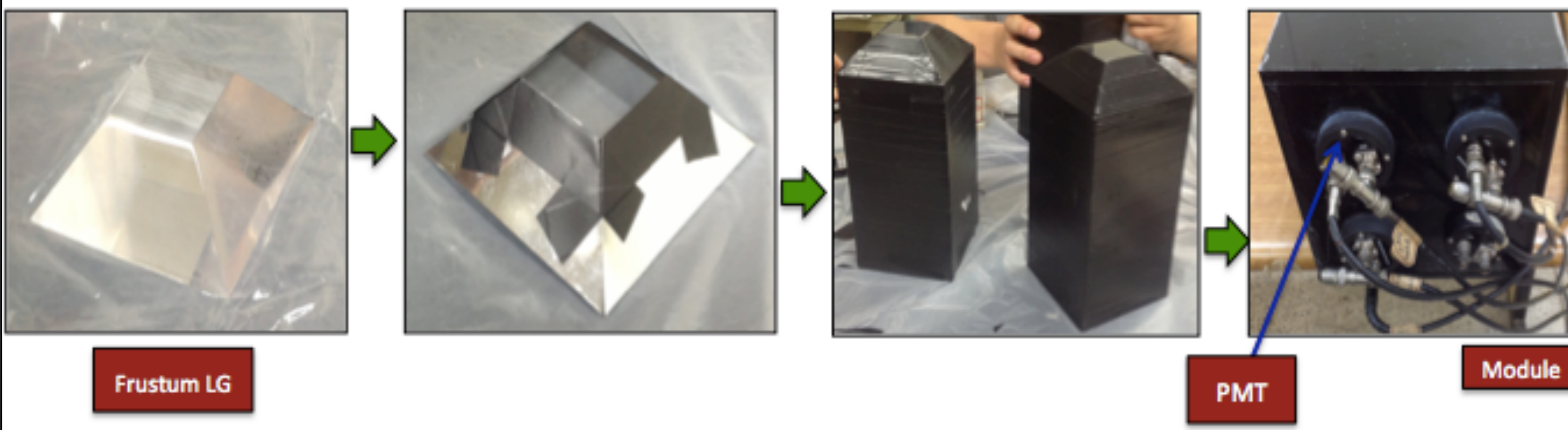


Fig.8: Block detector assembly process

Test results with ^{252}Cf source

Time of flight distribution fitted data results

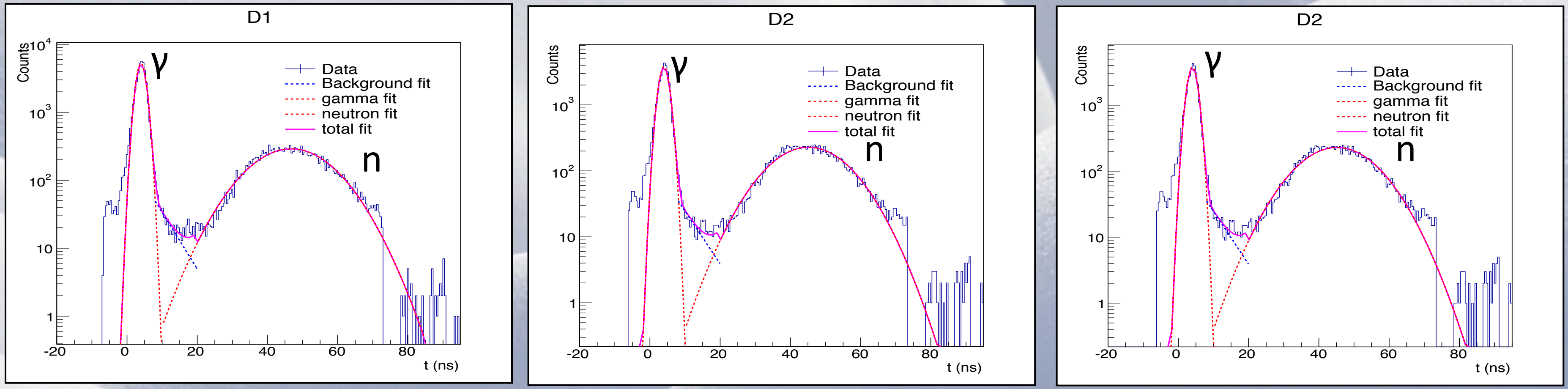


Fig.9 : Time of flight distribution data results for detectors D1, D2 and D3 respectively.

Test results with ^{252}Cf source….

Kinetic Energy Spectra of the Fission Neutrons

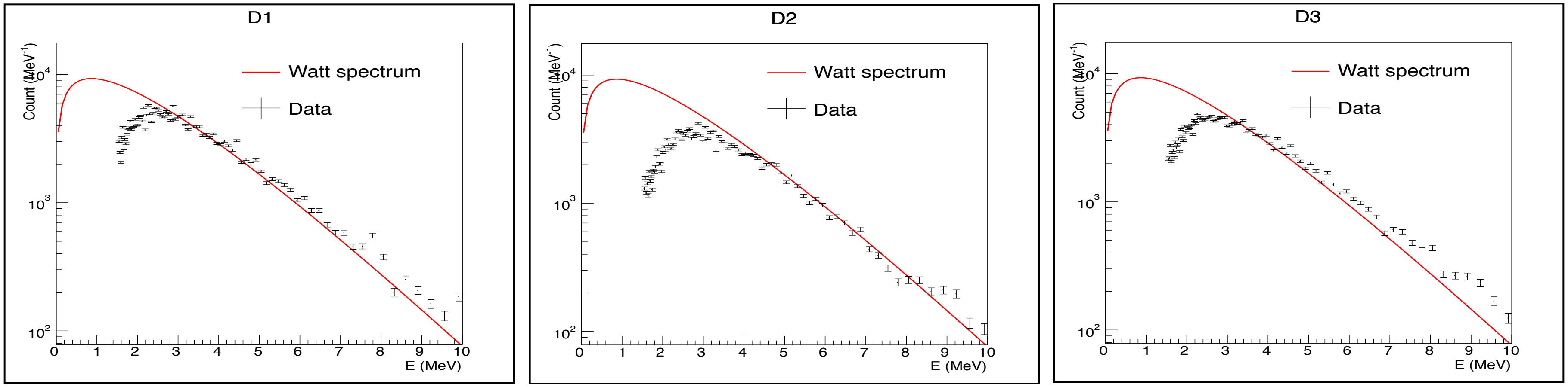


Fig.10 : Final neutron energy data results for detectors 1, 2 and 3 respectively. Energy spectra well reconstructed from 2.4 MeV and above.

Test of the Block-type Neutron Detector Prototypes with SFLG at KIRAMS using a 43 MeV, 1nA proton beam

Experimental setup

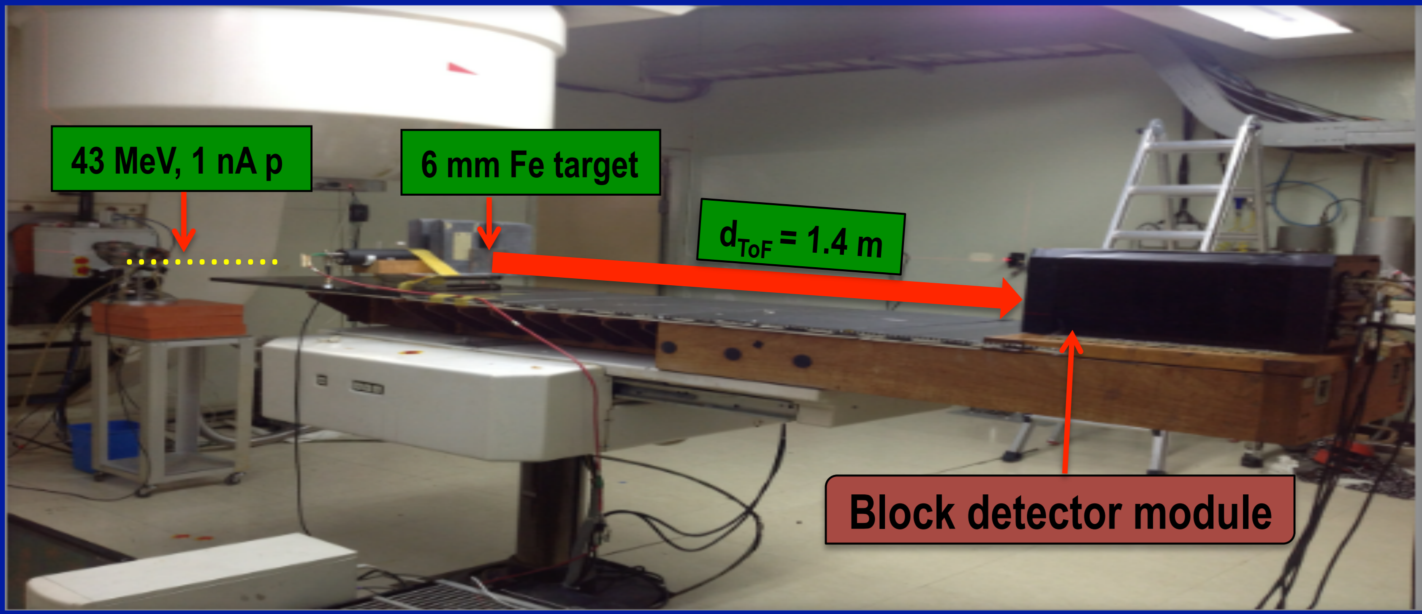


Fig.11: Experimental set-up for data collection at KIRAMS-Seoul, South Korea

Test results at KIRAMS using a 43 MeV, 1 nA Proton Beam

- Time of flight distributions **Kinetic energy spectrum of neutrons

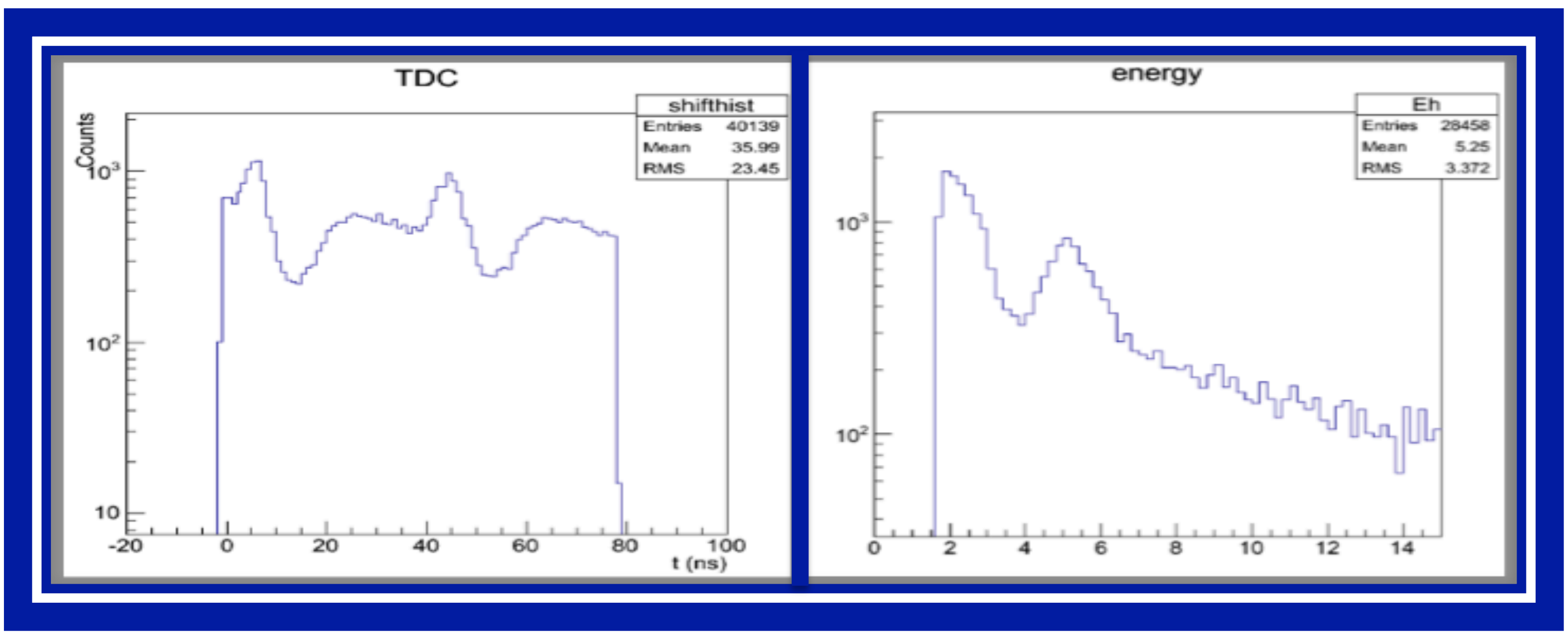


Fig.12 : Time of flight distributions (left panel) and neutron energy spectra (right panel) respectively.

Summary

☞ Low-energy LAMPS' neutron detector prototypes have been built.

☞ With the FTLG, the prototypes can measure fission neutron energies

$3.4 \leq E_k \leq 10$ MeV.

☞ With the SFLG, the prototypes can measure fission neutron energies

$2.4 \leq E_k \leq 10$ MeV.

☞ Possible measurable energy by the block detector with SFLG is

$1.5 \leq E_k \leq 14$ MeV for neutrons produced when a high-energy p beam is irradiated on an Fe target.

Prospect

✂ Deal with multi-hit events by performing clusterization using a module containing at least 7 prototypes.

THANK YOU


Jilin
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Shenyang
Tong Hua
Anshan
Dalian
북한
Pyongyang
동해
Seoul
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서해
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Daegu
Kwangju
Busan
일본