Block Detector Prototypes for Low-energy Neutron Measurement

LAMPS Meeting

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Daejeon

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Synopsis

1. Terminal objectives
2. Schedule
3. First test of the prototype block detector using tail-like fish light guides
4. Second test of the prototype block detector using square frustum light guides
5. Third test at KIRAMS
6. Summary

Terminal objectives

Build block detector prototypes for low energy neutron measurements using:

- Tail-like fish light guides
- Square frustum light guides

Examine:

- Time of Flight (ToF) distributions
- Range of neutron energies the prototypes can measure using ^{252}Cf radiation source and proton beam

Schedule

Assembly of the prototype block detector:

- ✓ *July, 2013. ("3 Bicron scintillators" module assembly using tail-like fish LG)*
- ✓ *July, 2013. ("3 Bicron scintillators" module assembly using square frustum LG)*

Tests for the prototypes:

- ✓ *Test 1: 2013/07/16 (tail-like fish LG)(using radiation source)*
- ✓ *Test 2: 2013/07/26 (square frustum LG)(using radiation source)*
- ✓ *Test 3: 2013/08/08 (square frustum LG) (KIRAMS test with p beam)*

First Test of the Prototype Block Detector for Low-energy Neutron Measurement [Using tail-like fish light guides]

Block detector assembly

Using tail-like fish light guides

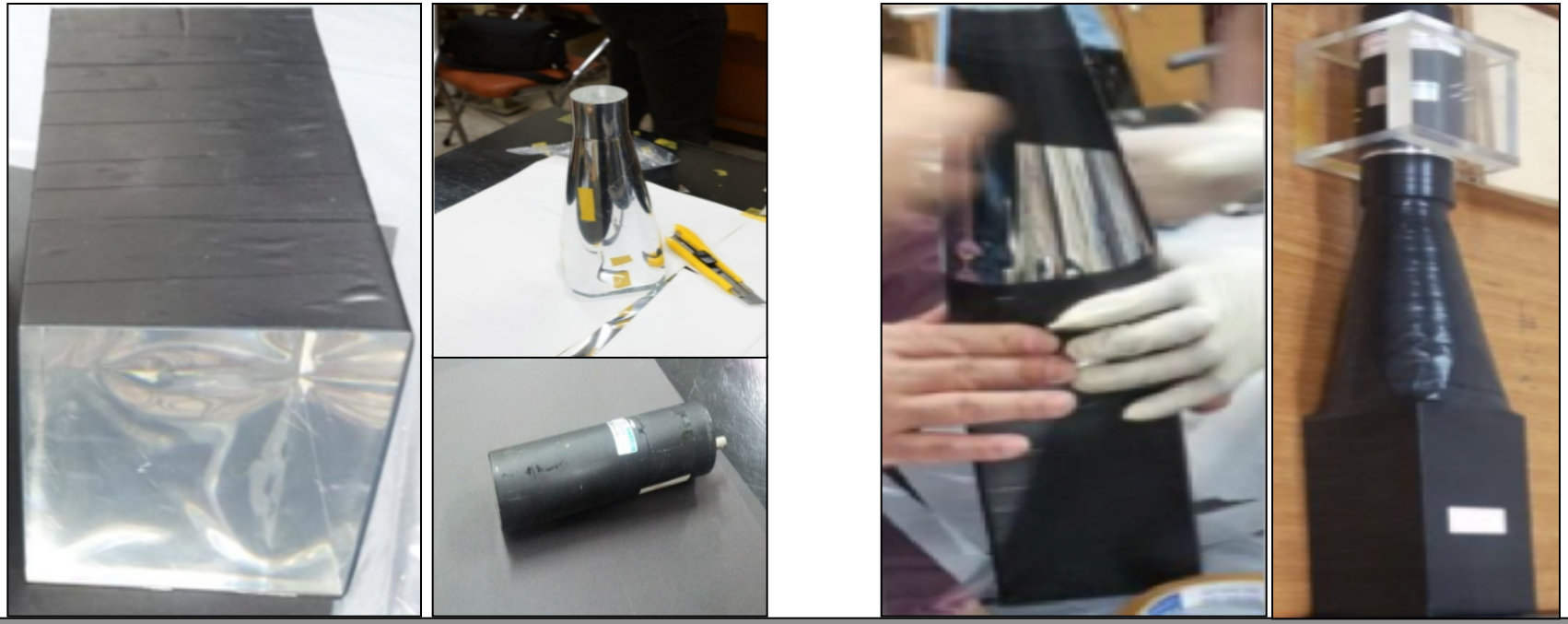


Fig. 1: Detector assembly process

Block detector assembly….

Module containing 3 Bicron scintillators.

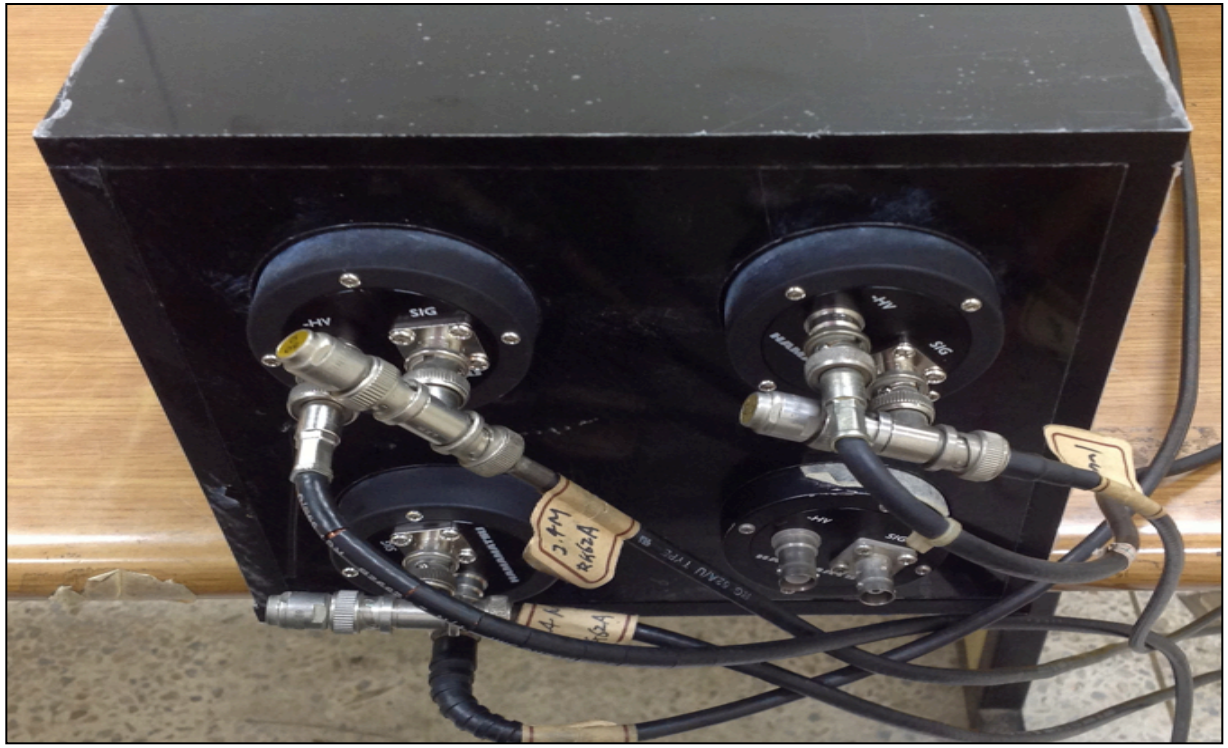


Fig.2 : Block detector assembly

Electronics set-up

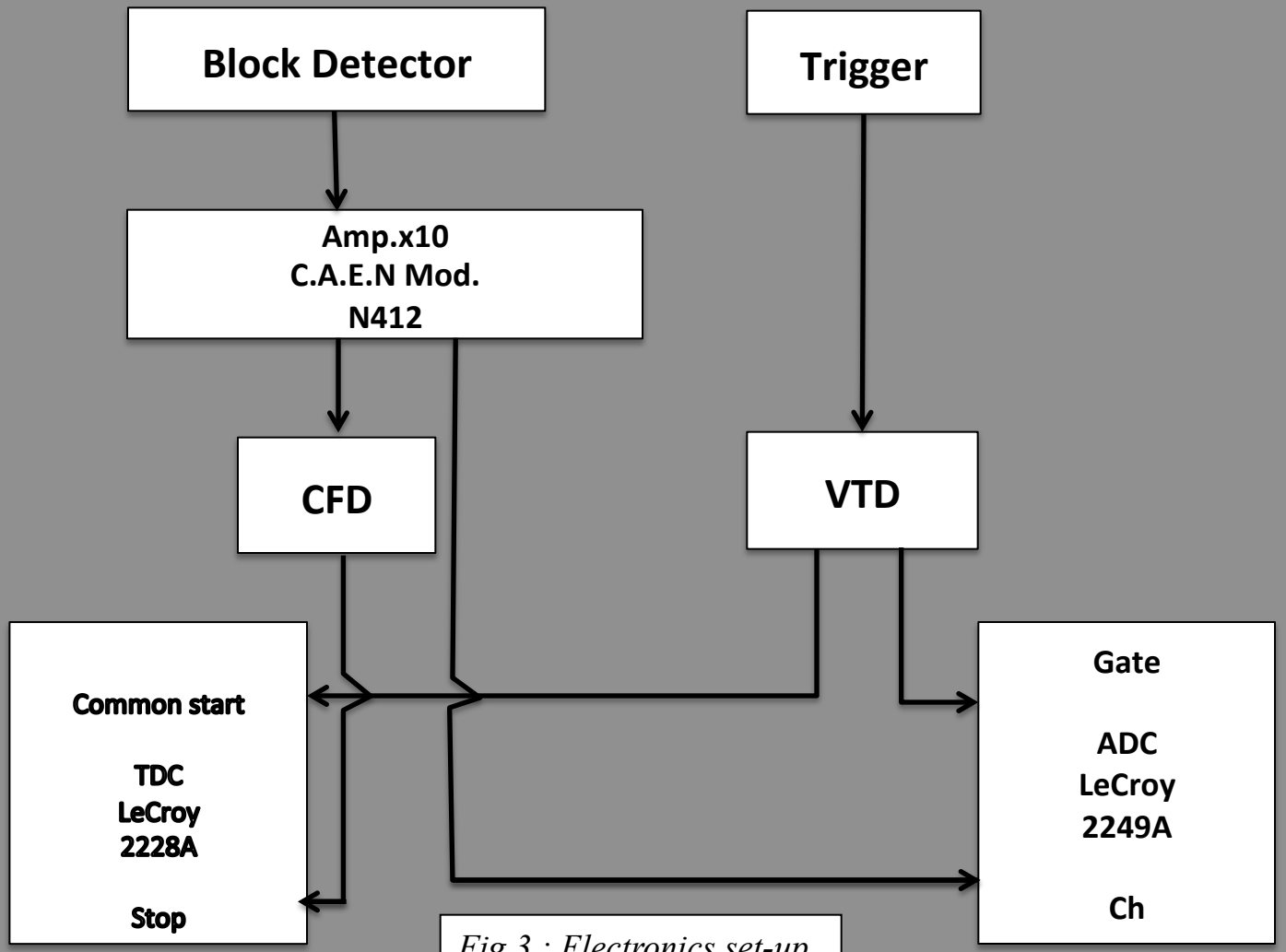


Fig.3 : Electronics set-up

Experimental setup with ^{252}Cf source

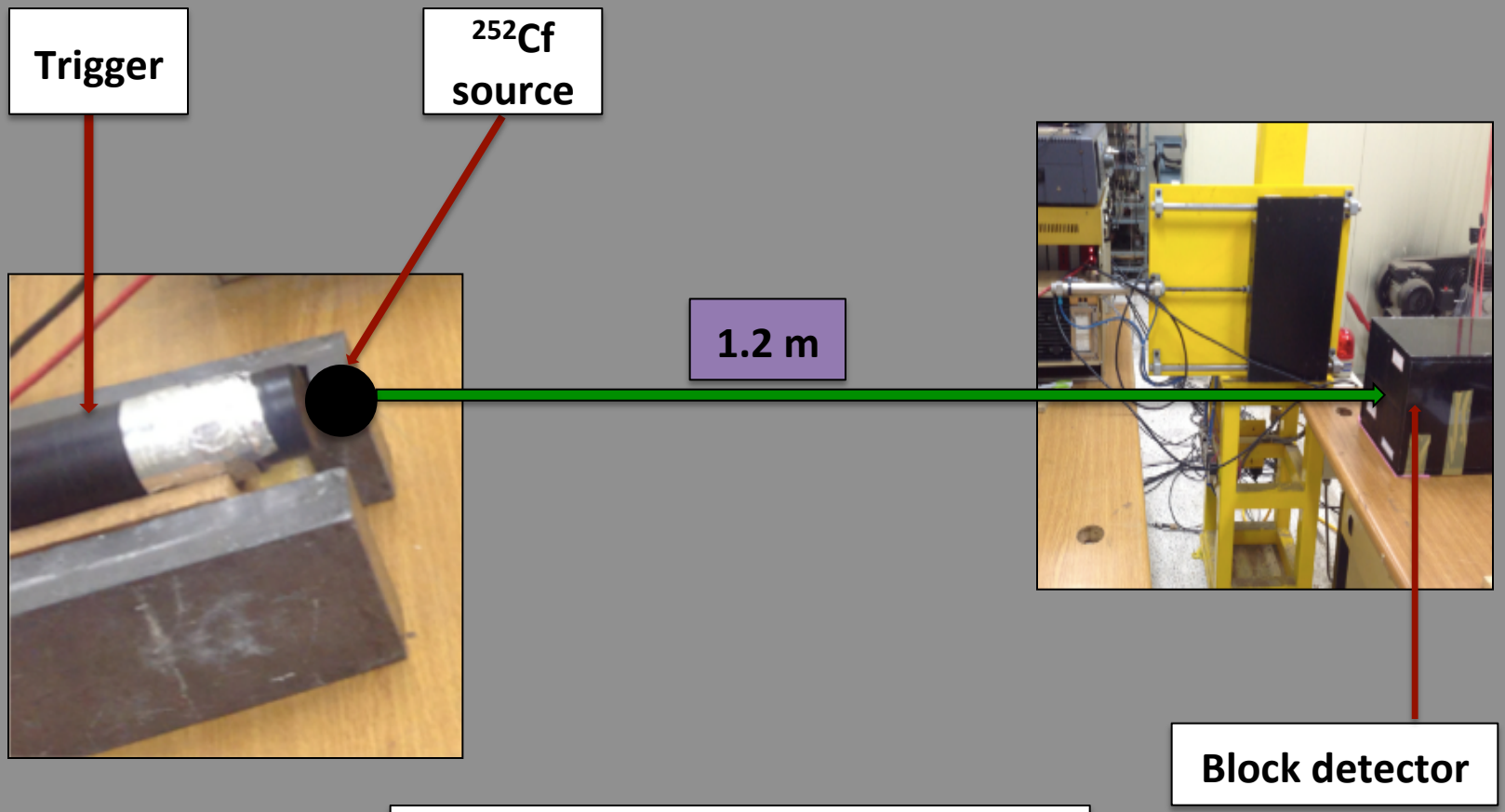
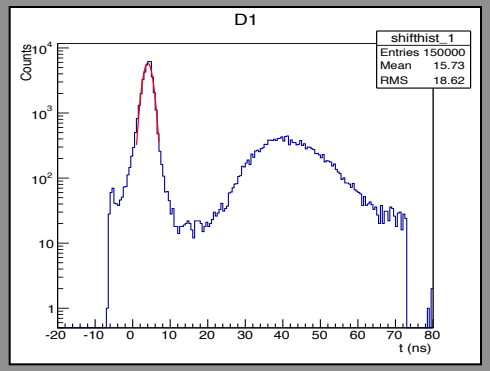
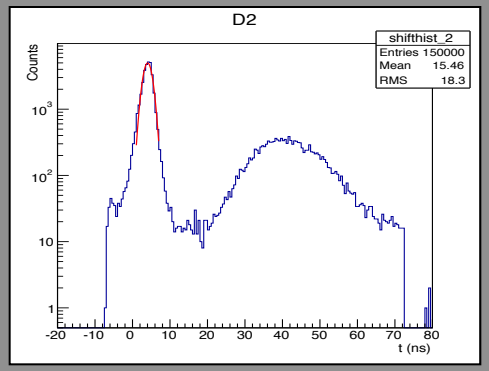


Fig.4: Experimental set-up with ^{252}Cf source

Test results with ^{252}Cf source

Zero base correction for gammas





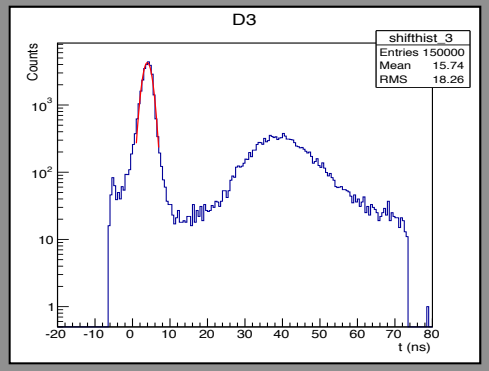
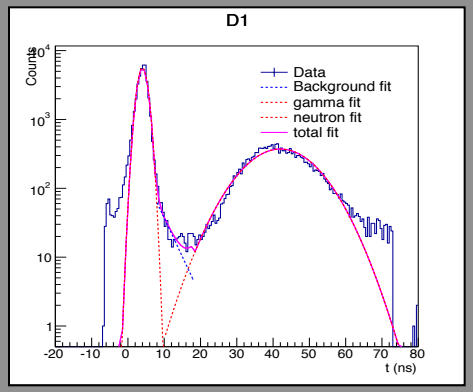
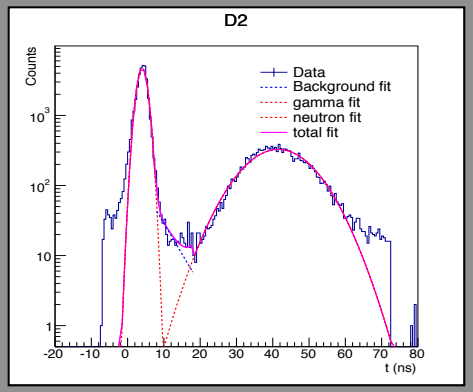


Fig. 5: Time of flight distribution data results for detectors 1, 2 and 3 respectively.

Test results with ^{252}Cf source…

Time of flight distribution fitted data results





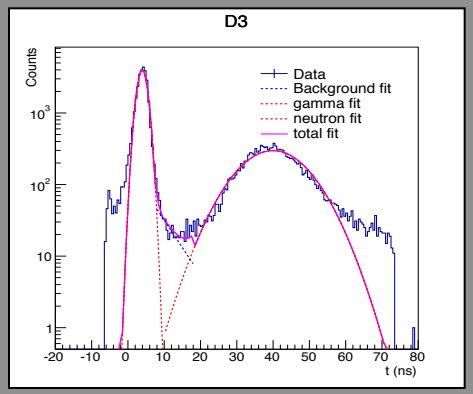
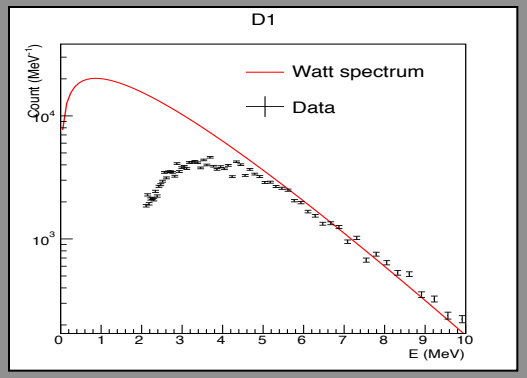
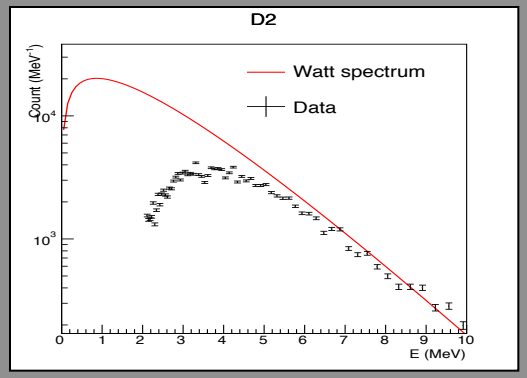


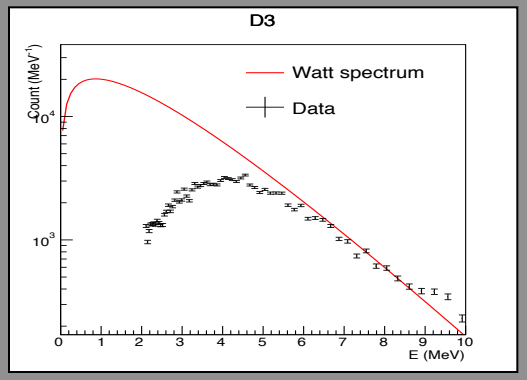
Fig.6 : Time of flight distribution fitted data results for detectors 1, 2 and 3 respectively.

Test results with ^{252}Cf source…

Neutron energy data results







- Well re-constructed about 3.5 MeV
- Minimum measurable energy was ~ 2 MeV

Fig.7 : Final neutron energy data results for detectors 1, 2 and 3 respectively.

Second Test of the Prototype Block Detector for Low Energy Neutron Measurements
[Using square frustum light guides]

Prototype block detector assembly

- Using square frustum light guides

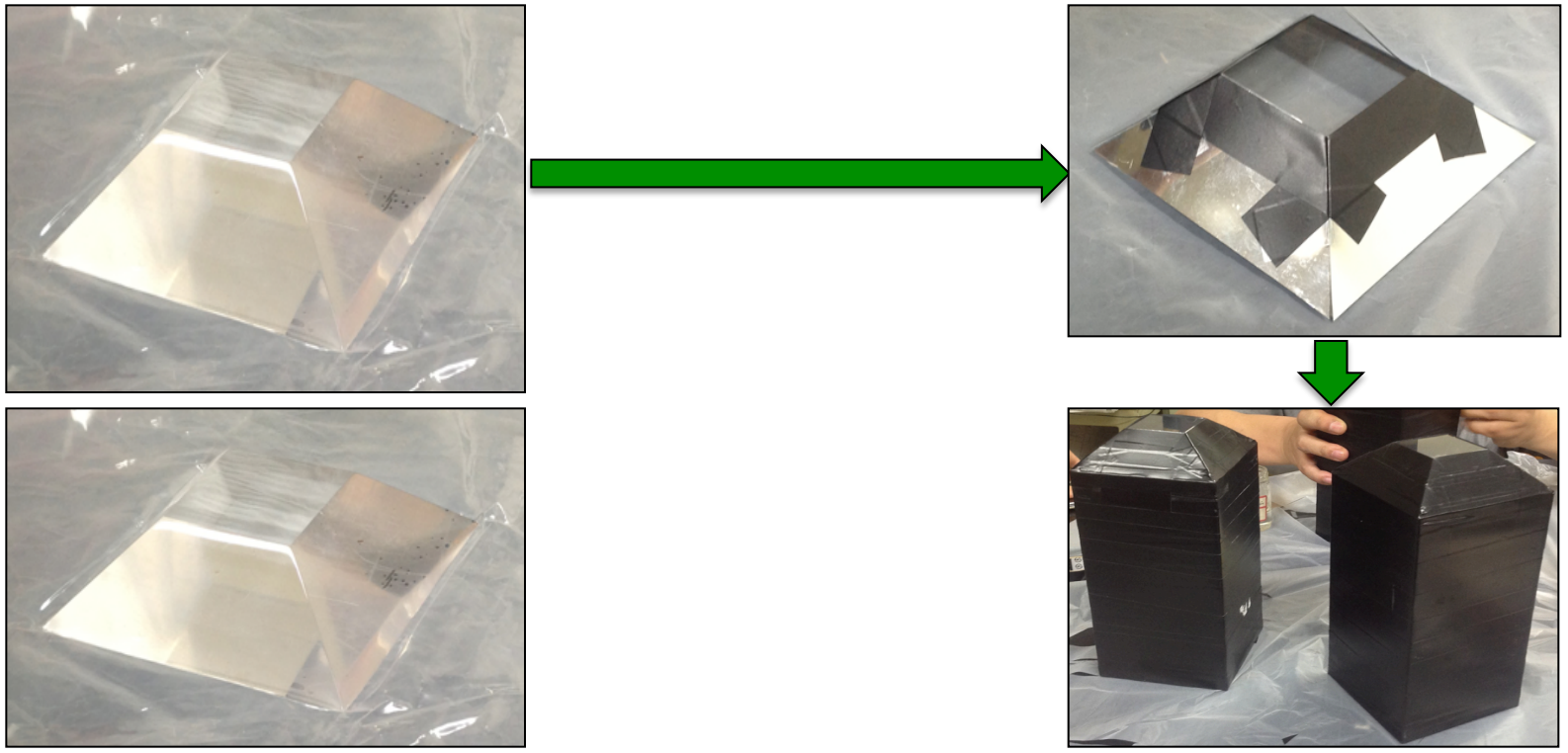
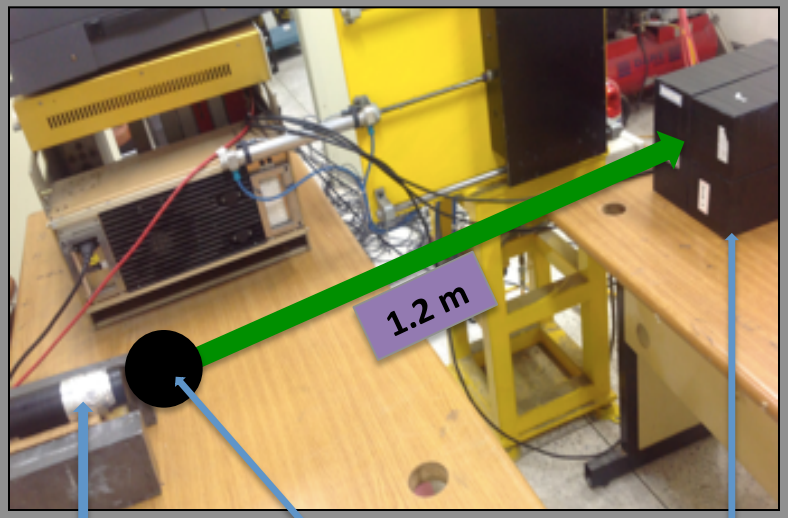


Fig.8: Block detector assembly process

Module with three Bicron scintillators

Fig. 9: Module with three Bicron scintillators

Experimental setup with ^{252}Cf source



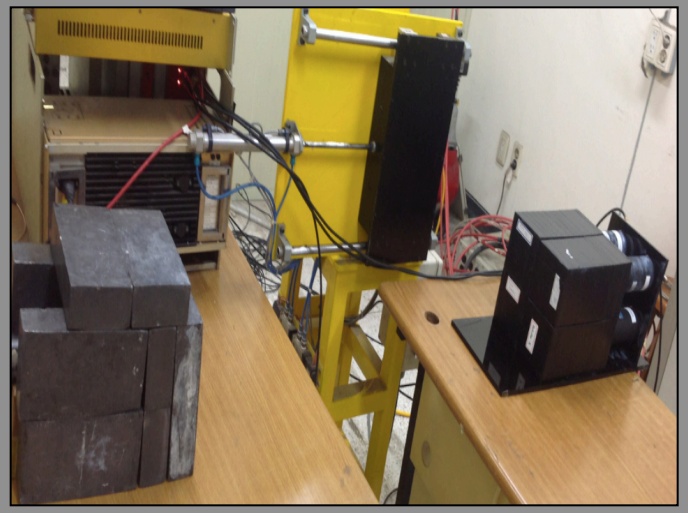
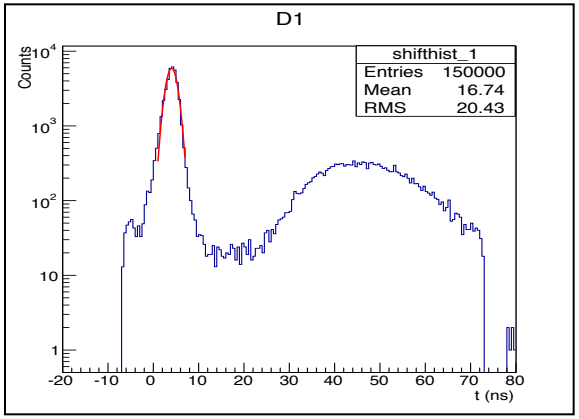
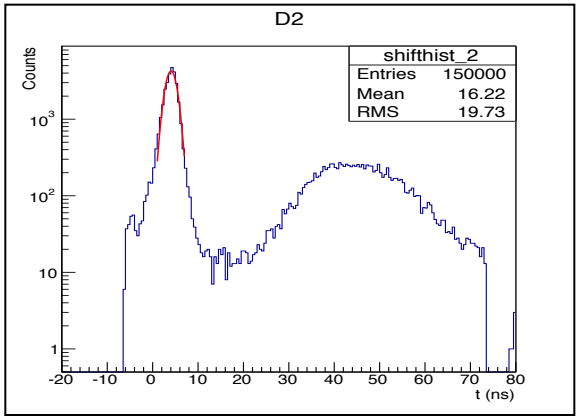


Fig. 10: Neutron and pedestal data collection on the left and right panels respectively

Test results with ^{252}Cf source...

- Zero base correction





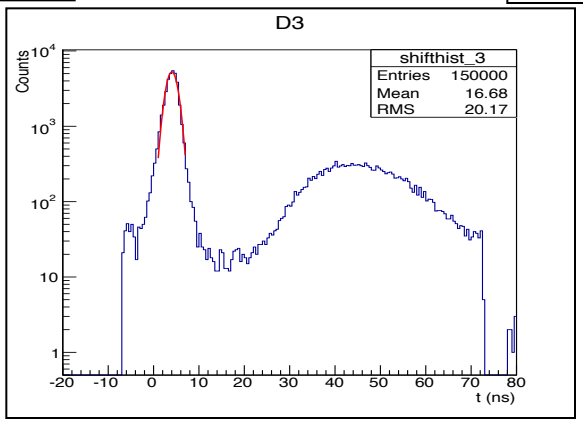
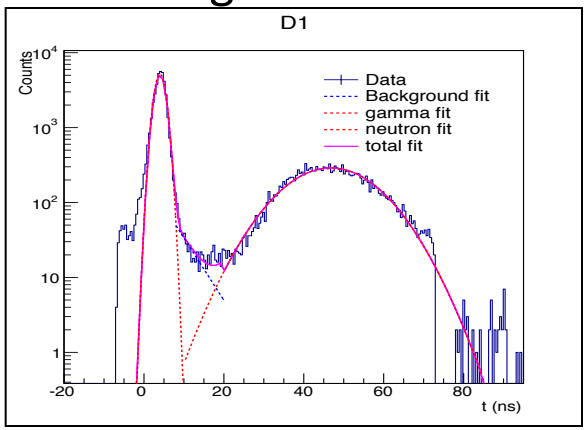
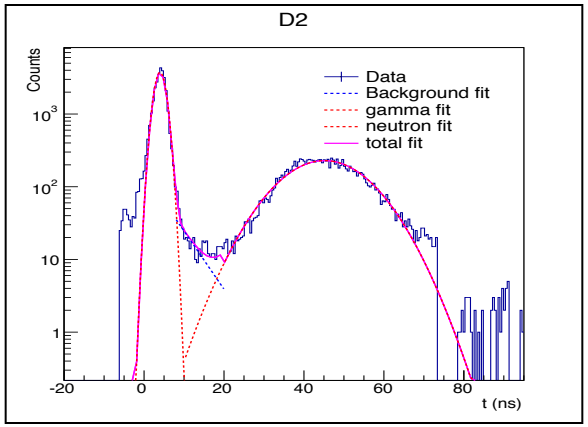


Fig. 11: Time of flight distribution data results for detectors 1, 2 and 3 respectively.

Test results with ^{252}Cf source…

- Time of flight distributions





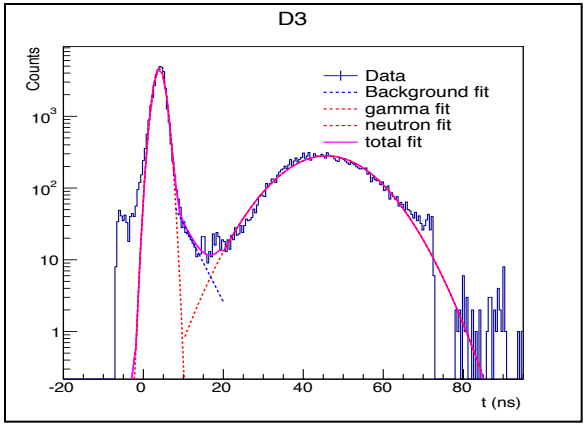
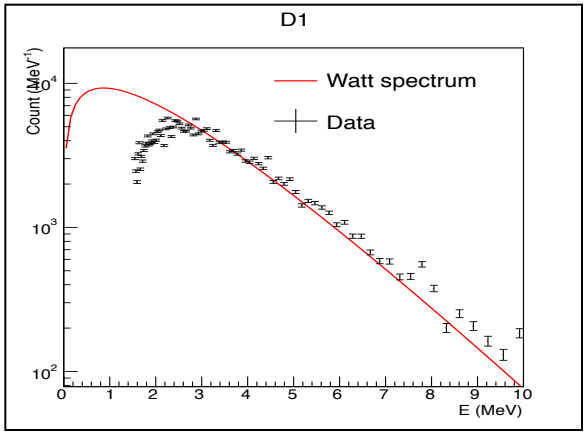
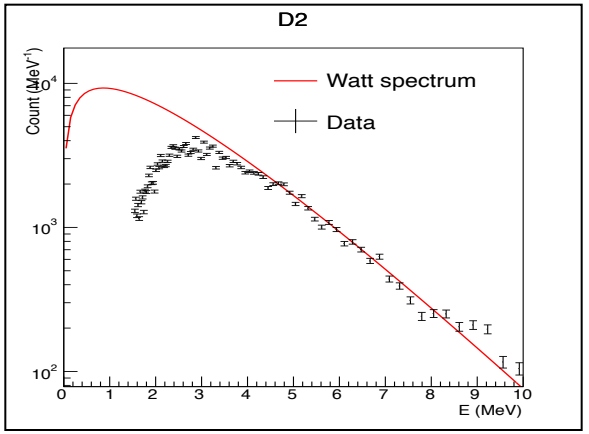


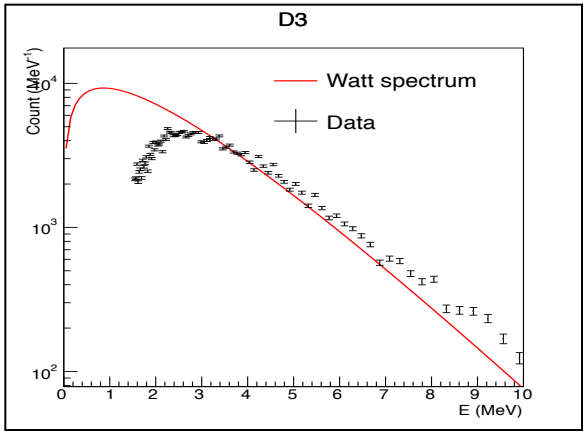
Fig.12 : Time of flight distribution fitted data results for detectors 1, 2 and 3 respectively.

Test results with ^{252}Cf source

- Final neutron energy







- *Well re-constructed about 2.4 MeV*
- *Minimum measurable energy being ~ 1.5 MeV*

Fig.13 : Final neutron energy data results for detectors 1, 2 and 3 respectively.

Third Test of the Prototype Block Detector for Low Energy Neutrons at KIRAMS
[Using square frustum light guides]

Experimental setup

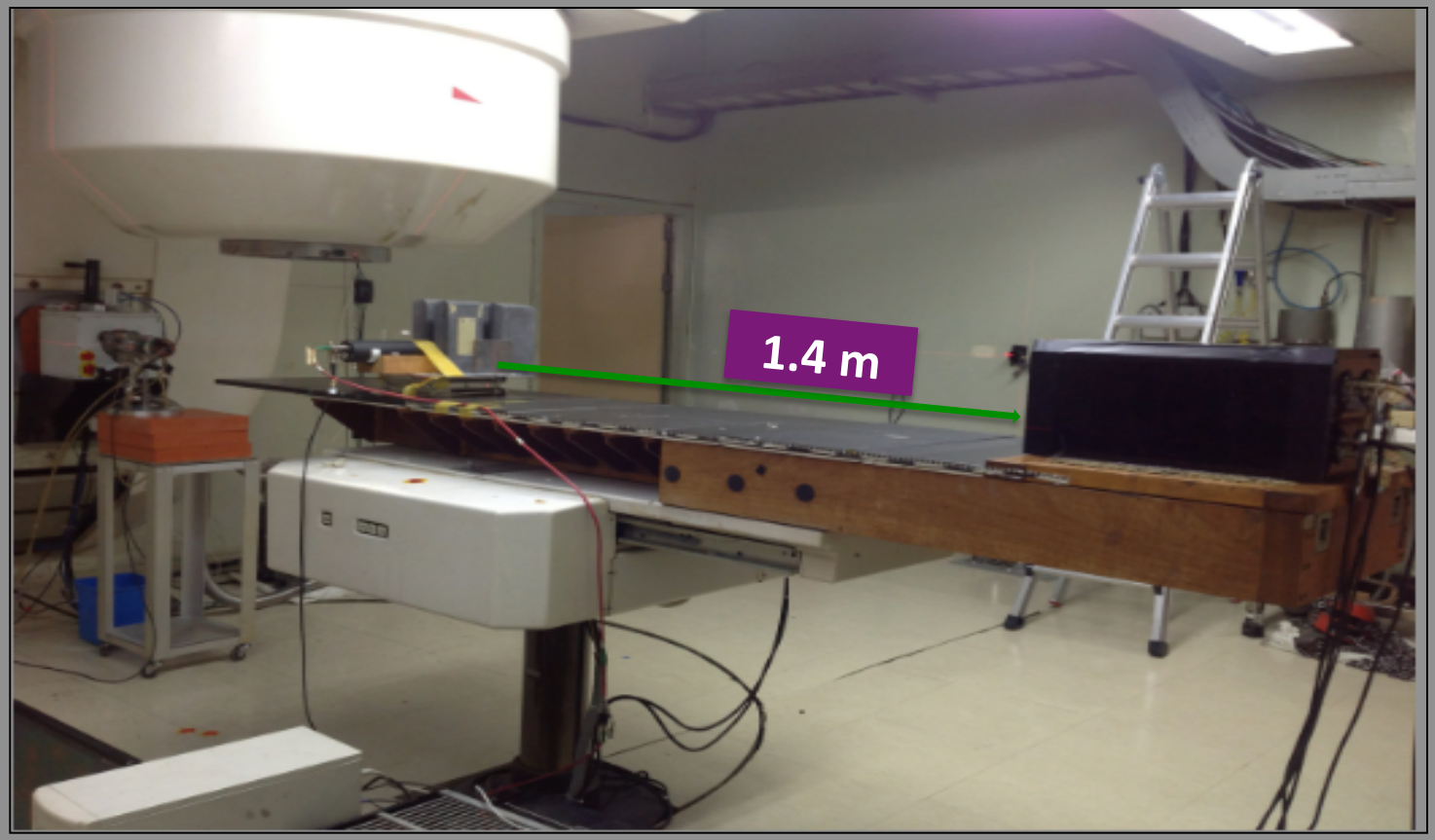


Fig.14: Experimental set-up for data collection at KIRAMS-Seoul, South Korea

Test results at KIRAMS

- Time of flight distributions * Final neutron energy

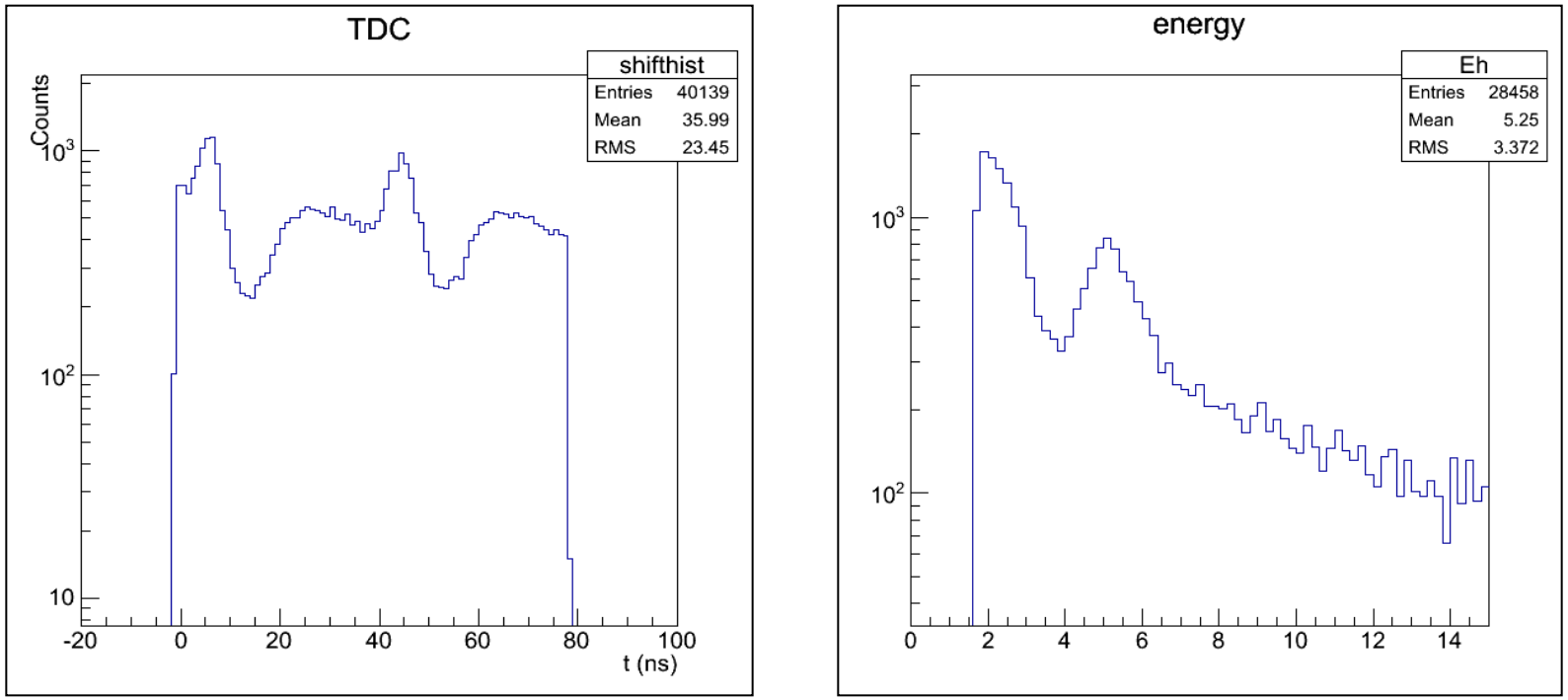


Fig.15 : Time of flight distributions (left panel) and final neutron energy (right panel) respectively.

Summary

- Low-energy LAMPS neutron detector prototypes built.
- Using tail-like fish LG, minimum measurable neutron energy by block detector is ~ 2 MeV.
- Using square frustum LG, minimum measurable neutron energy by block detector is ~ 1.5 MeV.
- Minimum detectable energy by block detector made from square frustum LG is ~ 1.5 MeV for neutrons produced when a high-energy proton bean incidences on an iron target.

Prospect

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