



DEVELOPEMENT OF A NEUTRON COUNTER FOR MEASURING PROMPT NEUTRON MULTIPLICITY IN (N,F) AT THE LANSCE/WNR FACILITY

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⌋ EFNUDAT Fast Neutrons ⌋

Scientific workshop on neutron measurements, theory & applications

JRC-IRMM, Geel, Belgium - April 28-30, 2009

GOALS



- **Goals:** measurement of the number ν of prompt neutrons in (n,f) reaction with *LANSCE/WNR* neutron beam: **large energy range**

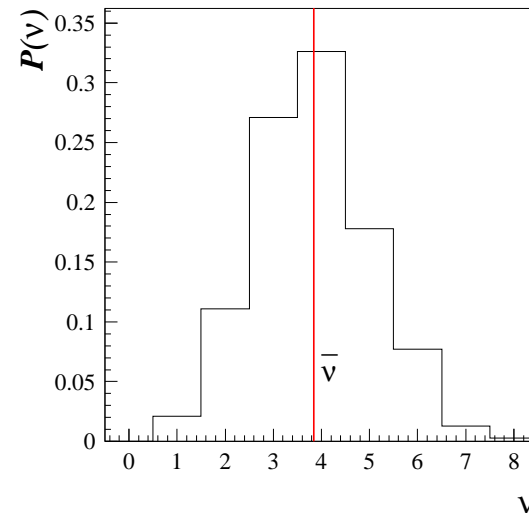
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→ measurement of $\bar{\nu}$ and $p(\nu)$ as a function of $E_{n_{inc}}$





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 - fission applications: nuclear data
 - fundamental observable: related to the excitation energy of the primary fragments and thus to the deformation energy



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- ▶ **More complex experiment to study the fission process:**
 - coincident measurement of the fragments' mass and KE



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 - extend the energy incident range



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 - good efficiency
 - BUT: γ sensitive, beam stopped after each fission event



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 - extend the energy incident range
- ▶ Liquid scintillator sphere
 - good efficiency
 - BUT: γ sensitive, beam stopped after each fission event
- ▶ *WNR*: not possible to the beam
 - background during neutron counting
 - dedicated setup

EXPERIMENTAL PRINCIPLE



► Fission chamber:

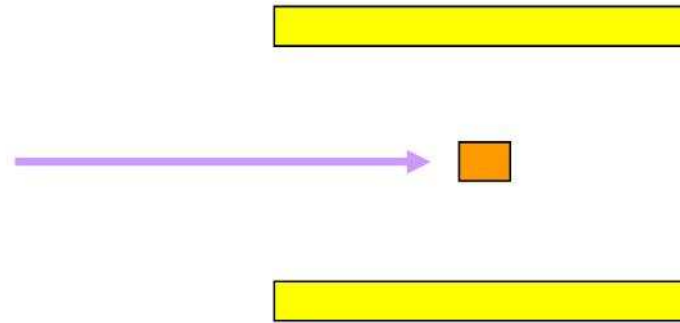


EXPERIMENTAL PRINCIPLE



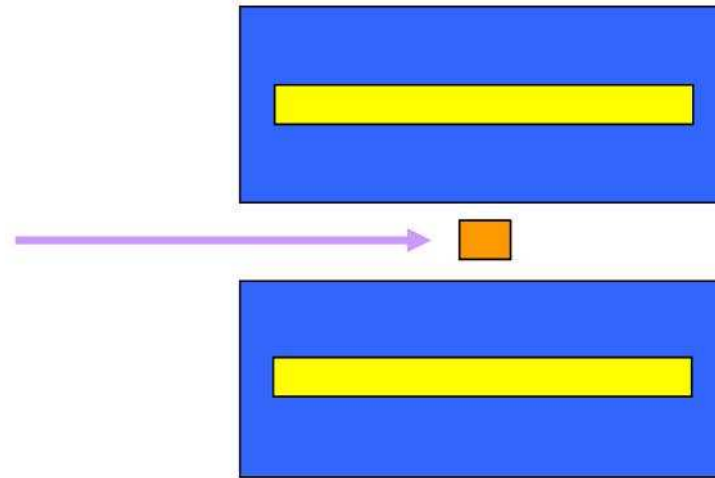
- ▶ Fission chamber: trigger, $E_{n_{inc}}$ (*ToF*) measurement
- ▶ Neutron beam: $E_{n_{inc}}$

EXPERIMENTAL PRINCIPLE



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- ▶ Neutron beam: $E_{n_{inc}}$
- ▶ ^3He detectors: $n + ^3\text{He} \longrightarrow p + t$
good efficiency to thermal neutrons

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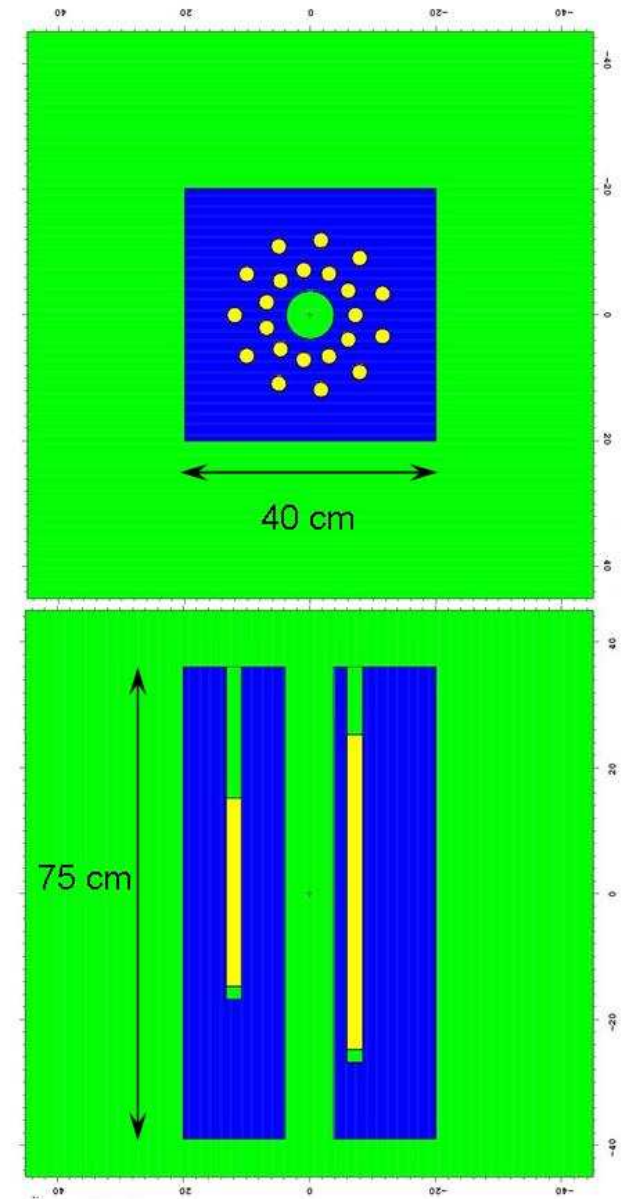


- ▶ Fission chamber: trigger, $E_{n_{inc}}$ (ToF) measurement
- ▶ Neutron beam: $E_{n_{inc}}$
- ▶ ^3He detectors: $n + ^3\text{He} \longrightarrow p + t$
 - good efficiency to thermal neutrons
- ▶ Block of polyethylene: neutron moderator



► MCNP Simulations

- geometry and dimensions
- 22 10 bars- ^3He tubes
- setup with two rings

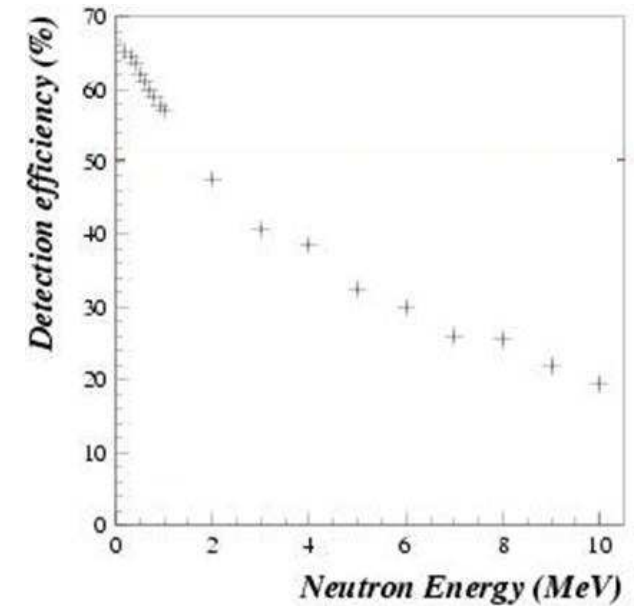




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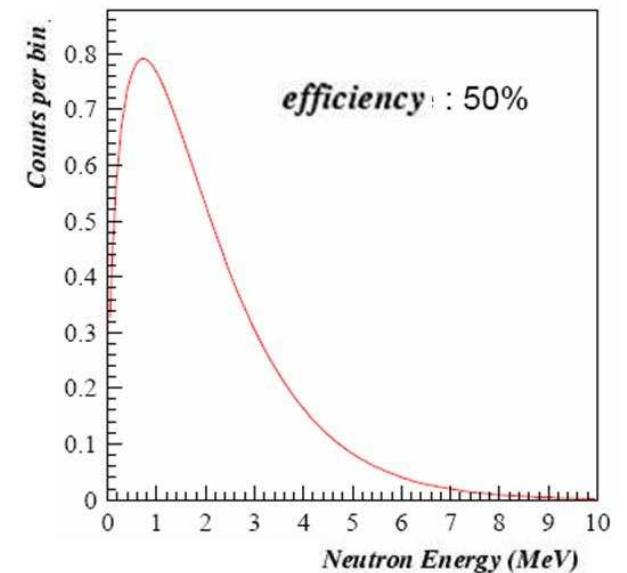
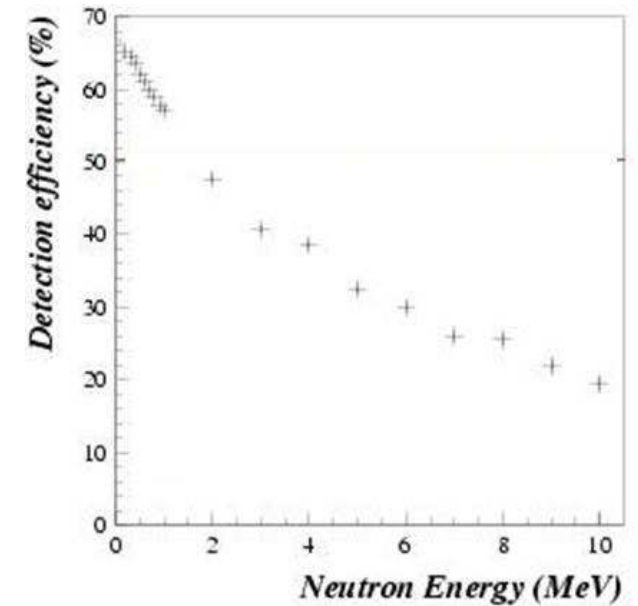


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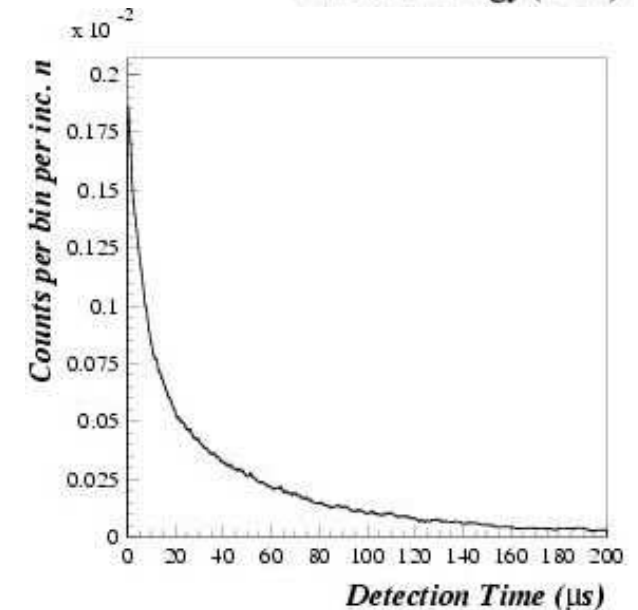
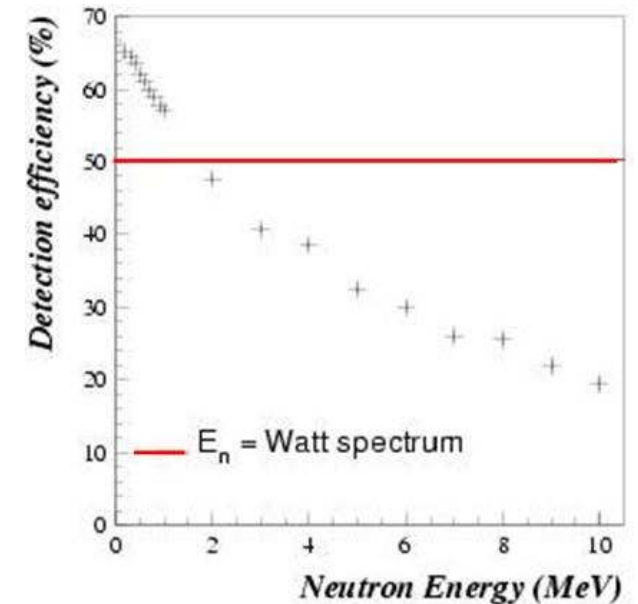
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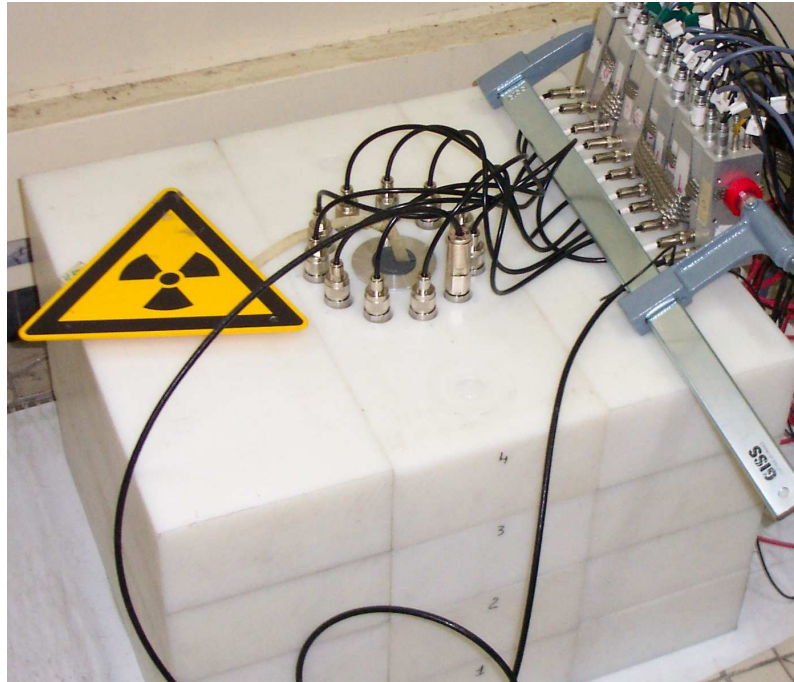
→ 50% efficiency simulated (Watt spectrum)

► 200 μs to collect neutrons

→ compatible with estimated fission rate (≈ 10 fissions/s)



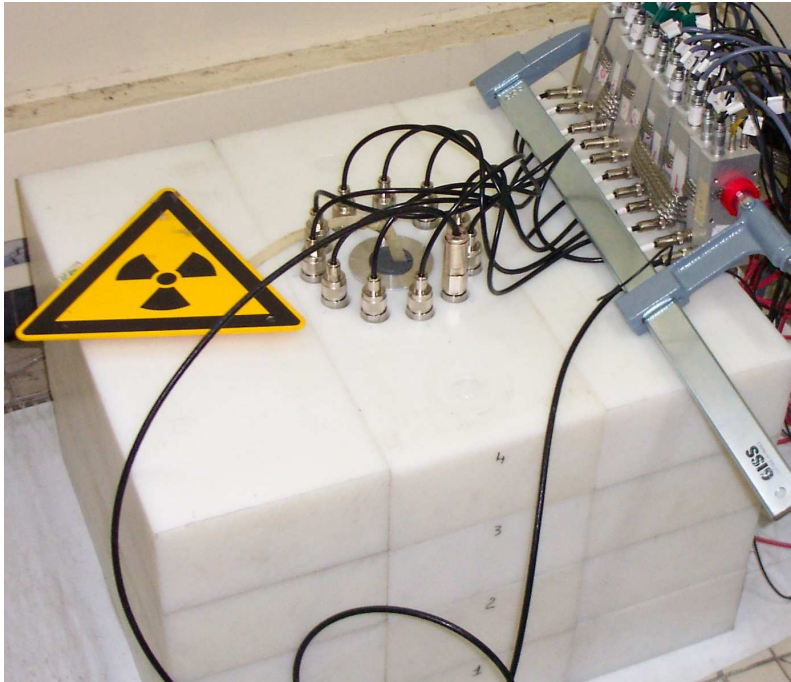
PROTOTYPE SETUP TESTS



► Prototype construction

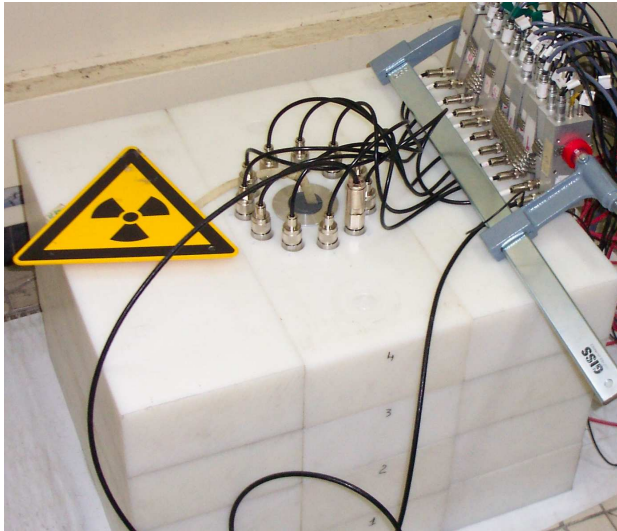
→ 11 *30cm length* tubes

PROTOTYPE SETUP TESTS



- ▶ Prototype construction
 - 11 *30cm length* tubes
- ▶ Tests with ^{252}Cf source
 - spontaneous fission

PROTOTYPE SETUP TESTS



- ▶ **Prototype construction**

 - 11 *30cm length* tubes

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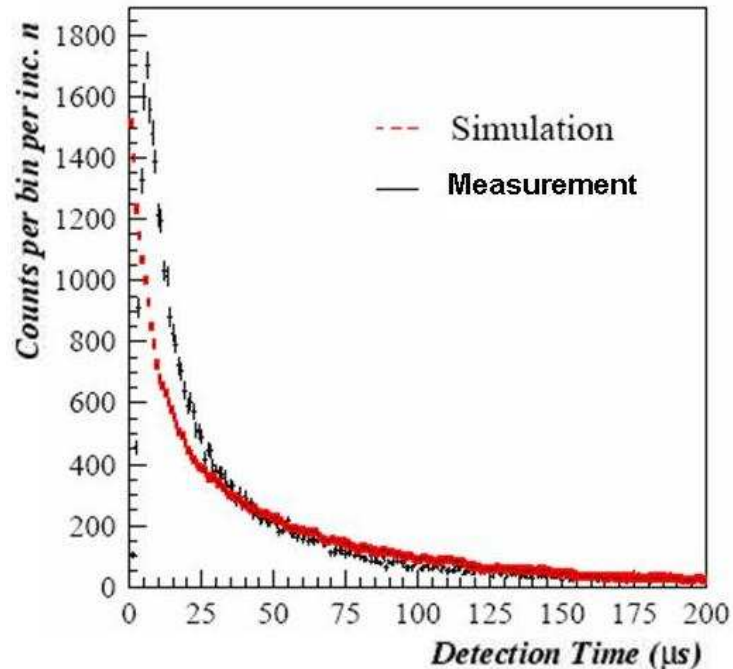
 - spontaneous fission

- ▶ **Simulations validated**

 - efficiency:

 - 30% simulated, 30% measurement**

 - time of collection





▶ **Background** sources:

- ▷ external: beam halo, room scattering, other beam lines, cosmics

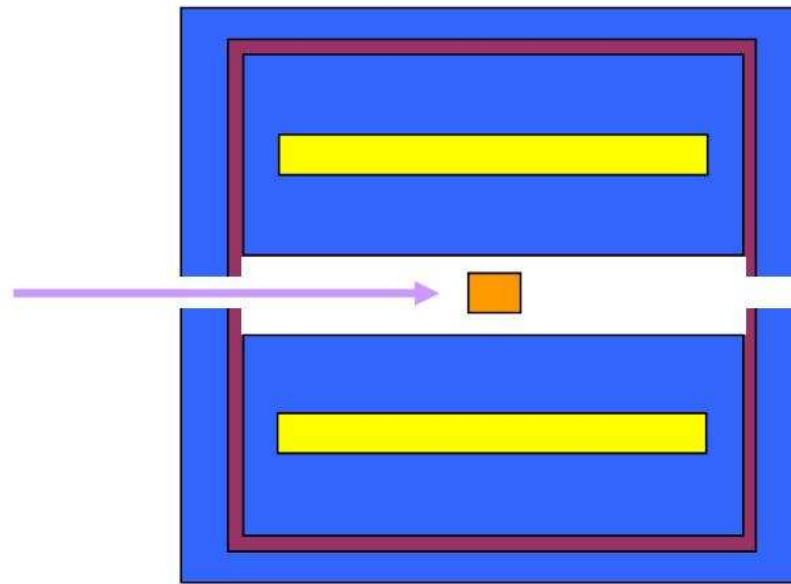
NEUTRON BACKGROUND



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→ shielding: **polyethylene (moderation)** et **B₄C (absorption)**





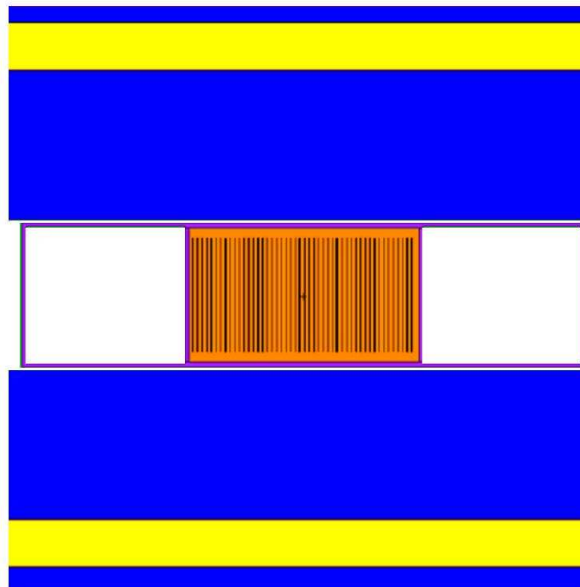
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trigger «**pulser**», decorrelated from fissions



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▷ internal: neutron scattering in fission chamber

→ fission chamber studies: scattering simulations

→ background **on-line monitoring**:

trigger «**pulser**», decorrelated from fissions

→ acquisition started:

Trigger = **fission**: neutrons fission + neutrons scattered

Trigger = **pulser**: neutrons scattered



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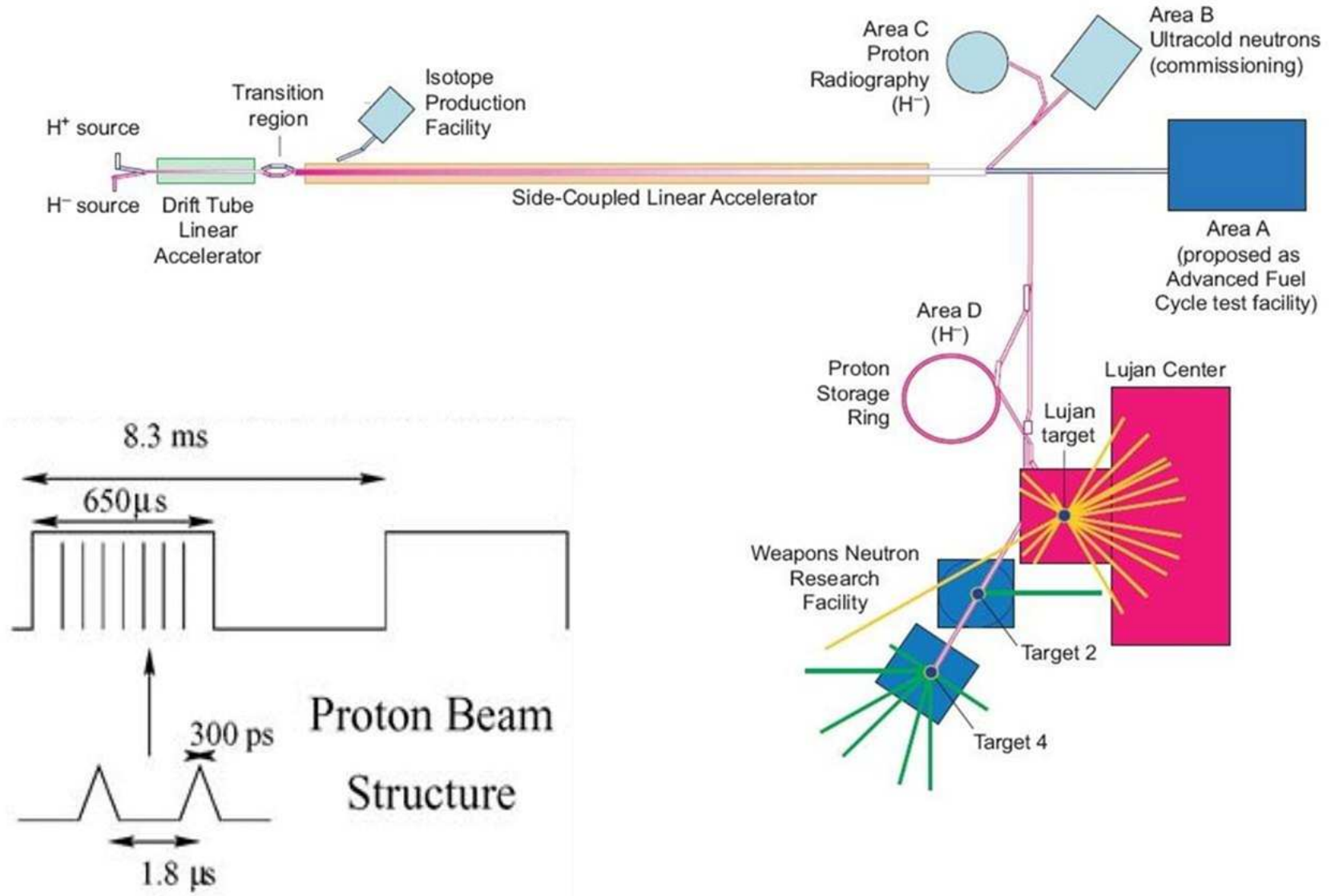


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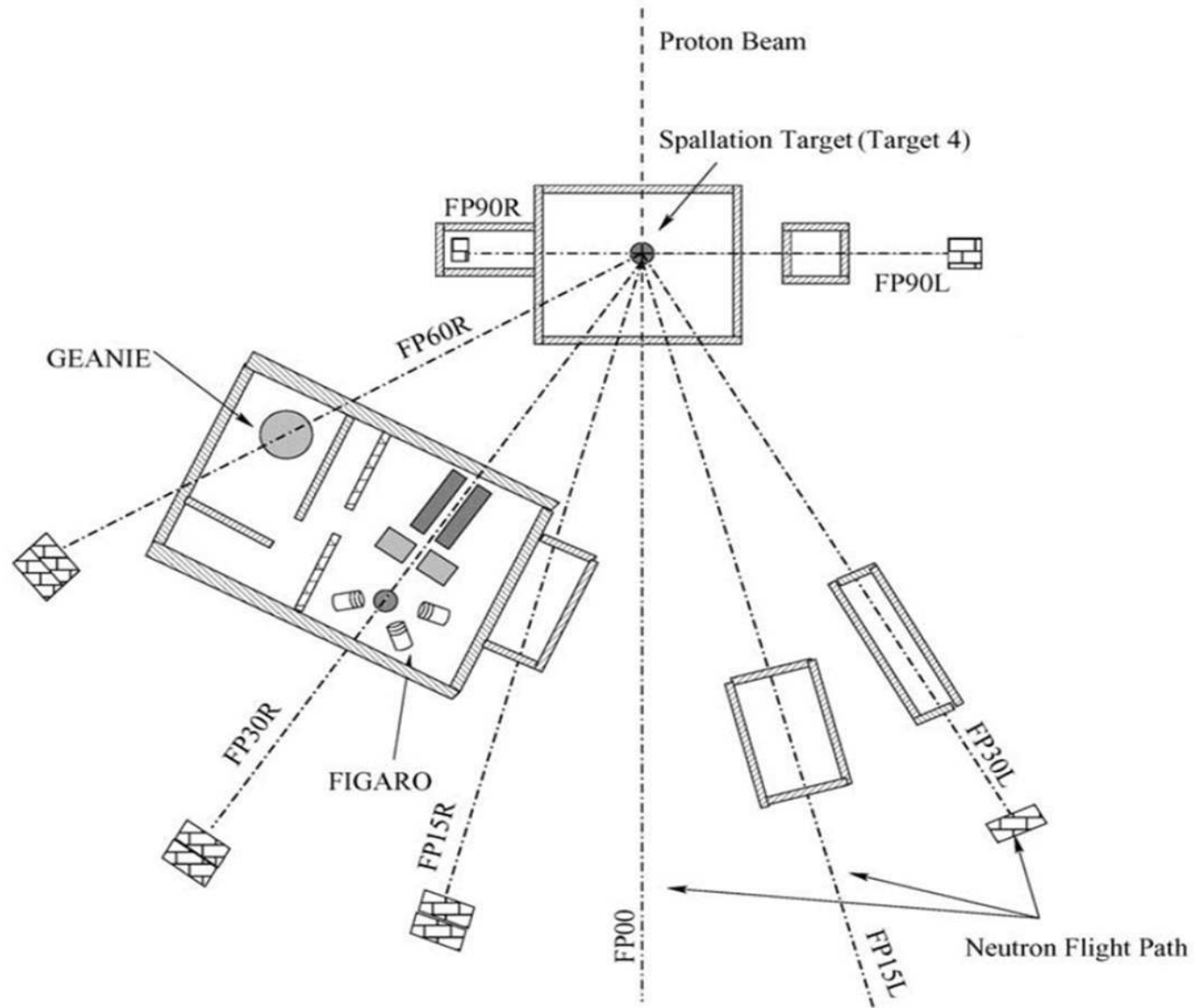
- ▶ **Experiment at LANSCE:** multiplate fission chamber containing ^{239}Pu at *WNR/FIGARO* beam line
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- ▷ **Pulsed neutron beam with large energy range**
 - high intensity flux between 1 and 200 MeV

FACILITIES



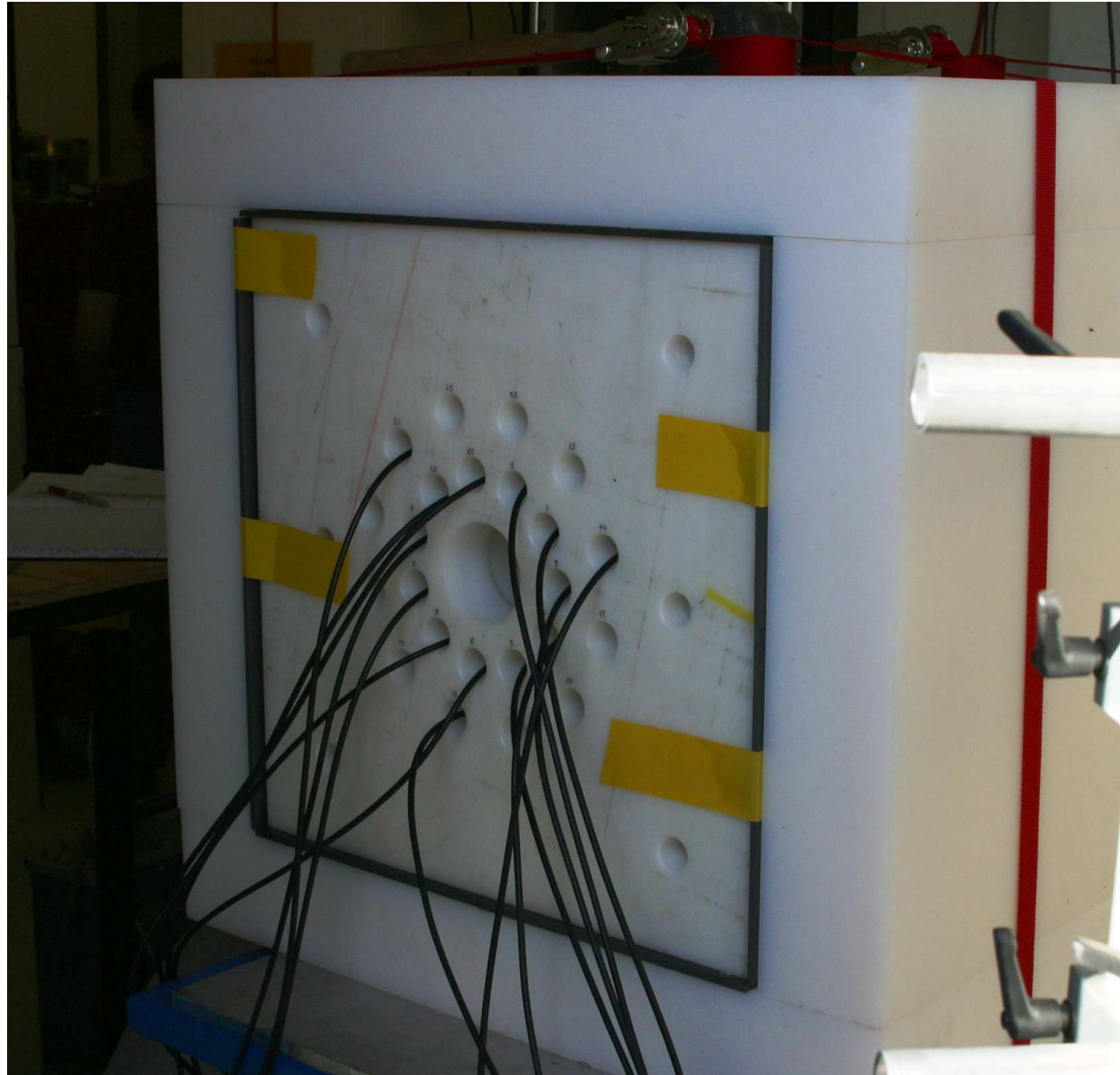
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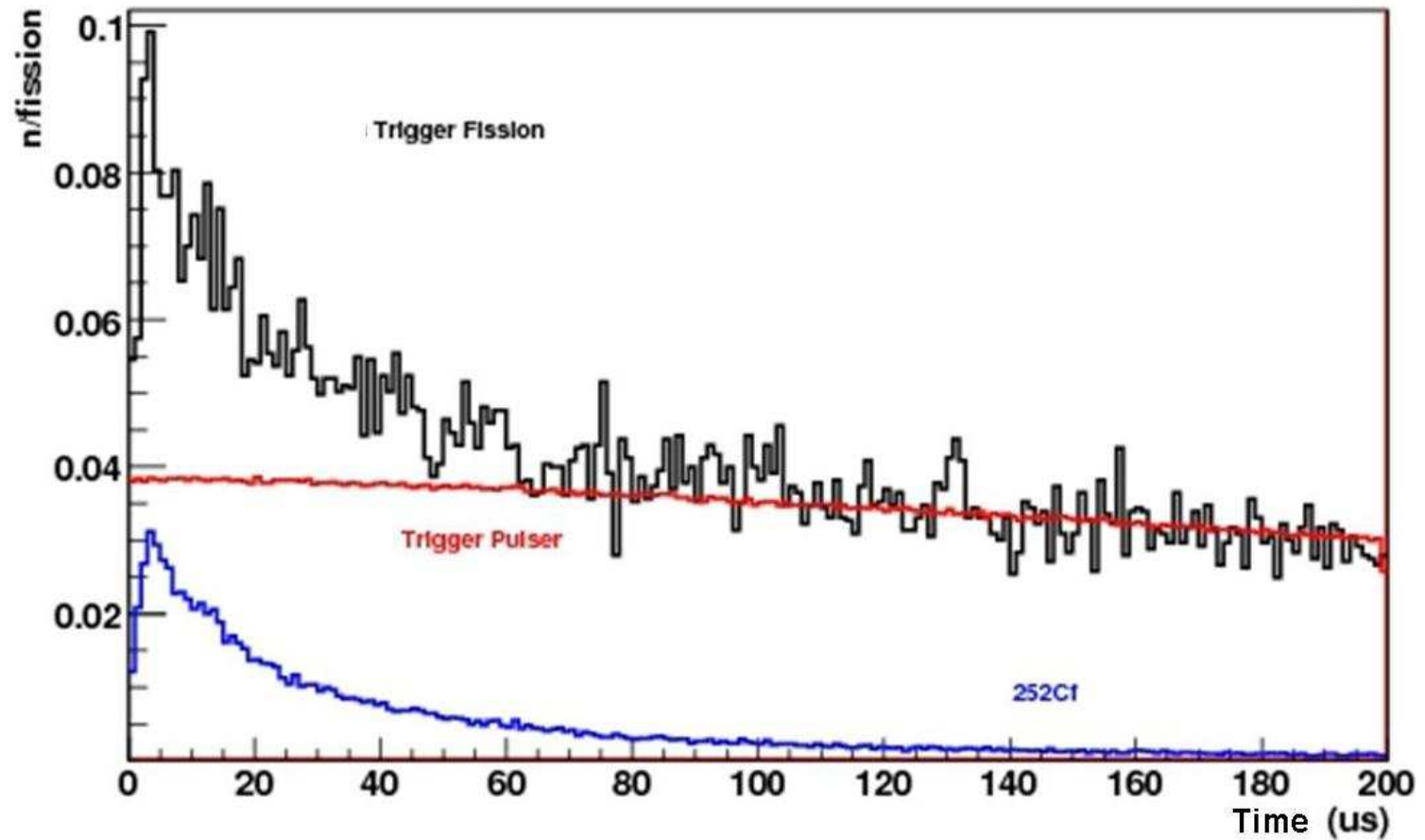


- ▶ **First use** of a high efficiency counter with a “white“ neutron source
- ▶ **New counter**
- ▶ **Acquisition system design**
 - using an universel logic module



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- ▶ **New counter**
- ▶ **Acquisition system design**
 - using an universel logic module
- ▶ **Experimental principle validated**
 - background can be subtracted

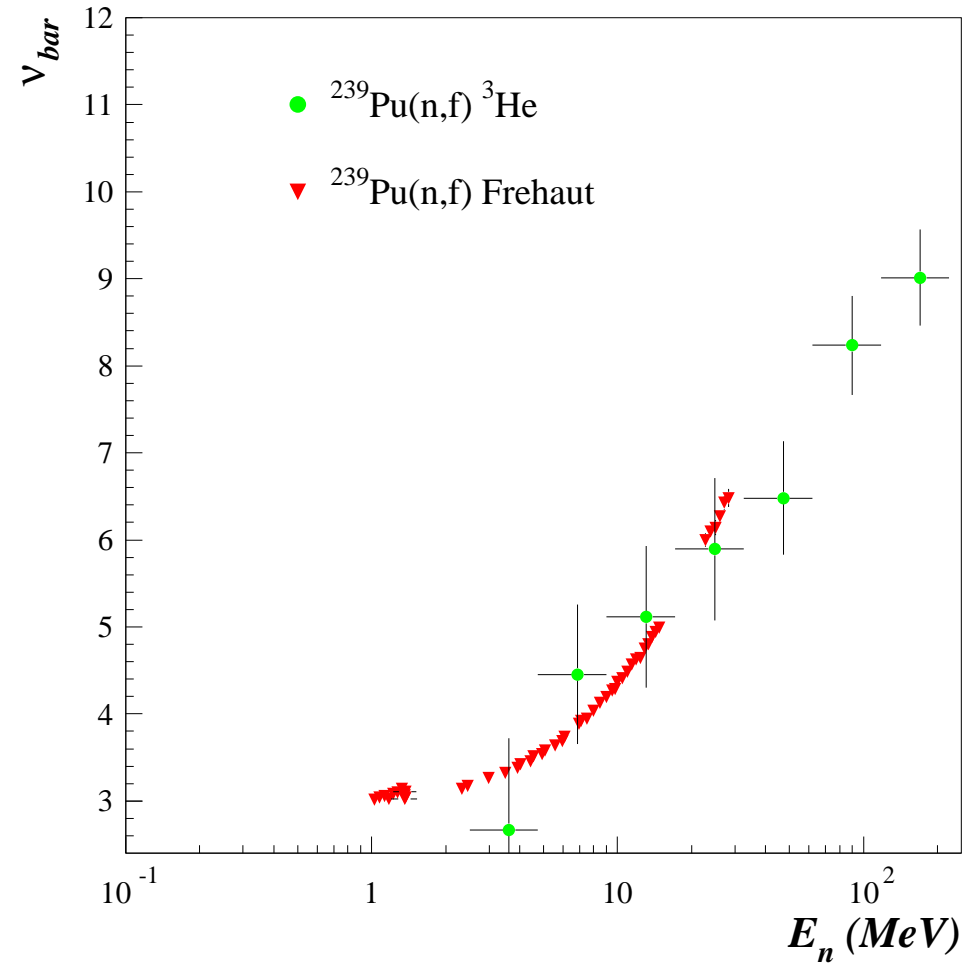
PRELIMINARY RESULTS



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► Very preliminary results from data subsample





- ▶ Short-term:
 - ▷ End of analysis
 - $\bar{\nu}$, $p(\nu)$
 - ▷ Technical publication



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▷ End of analysis

→ $\bar{\nu}$, $p(\nu)$

▷ Technical publication

► Future investigations:

▷ improve neutron counter efficiency

→ accuracy measurement of $\bar{\nu}$ and $p(\nu)$

▷ measurements of the fragment mass distribution in (n,f) of major actinides as a function of E_n from 1 to 200 MeV

→ IRMM/CEA collaboration : [twin ion chamber](#)

→ experiment in 2009 at LANSCE: fragment-neutron coincidence, fragment mass distribution