Design of LAMPS-L

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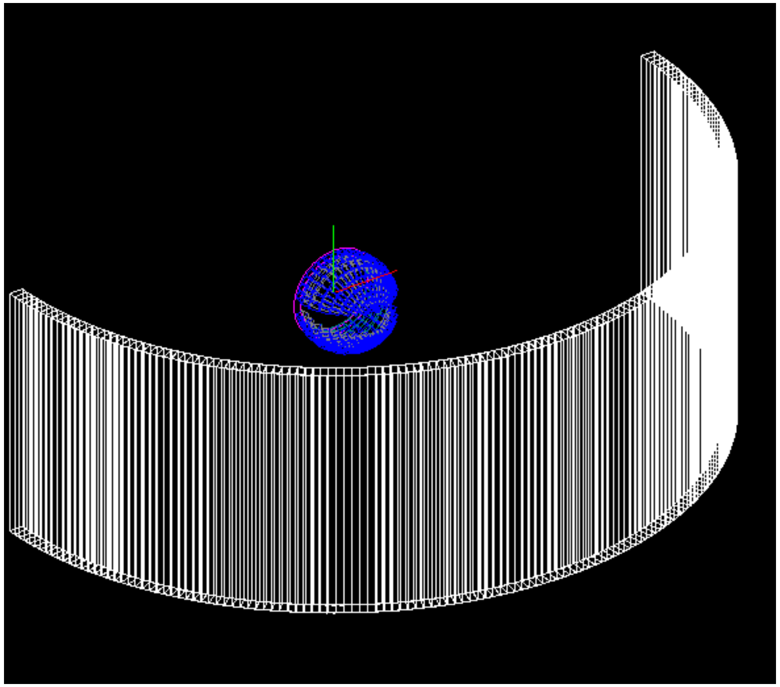
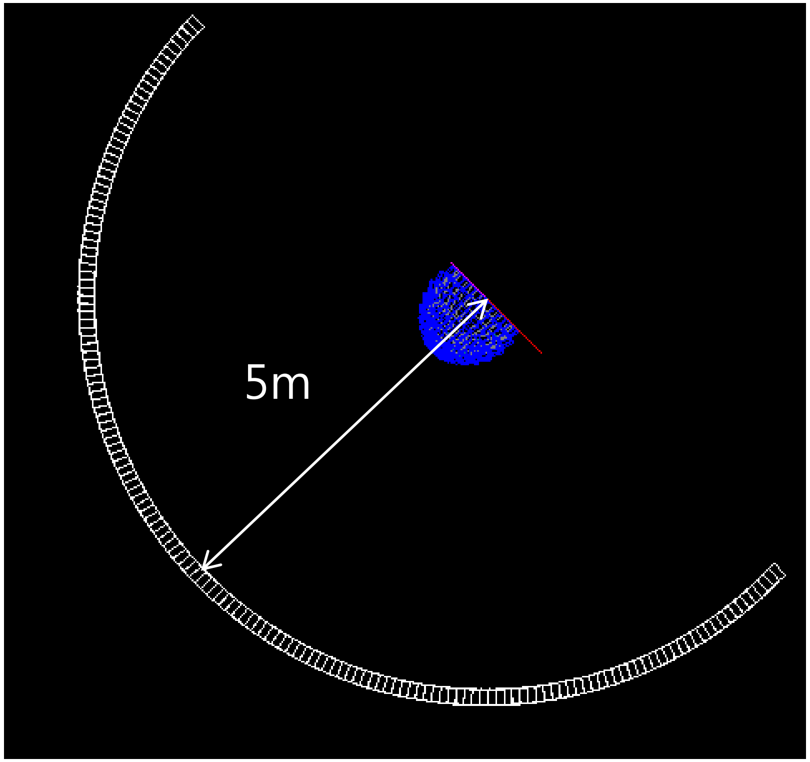
DayOne Design





Neutron Wall in GANIL

Using ToF to measure the energy of neutrons.

Neutron Wall (previous version of NEDA)

50 closely packed liquid scintillator detectors of three types: H1, H2, P.

Liquid: BC501A (xylene), total volume 150 litre.

Distance to target: 51 cm; detector thickness: 15 cm.

Detector angles: from 0° to $\simeq 60^\circ$

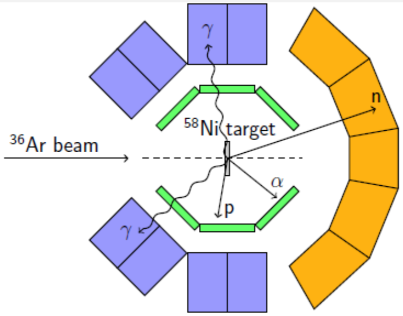
Neutron energy range: from $\simeq 0.5$ MeV to $\simeq 10$ MeV

Experiment at GANIL (2009)

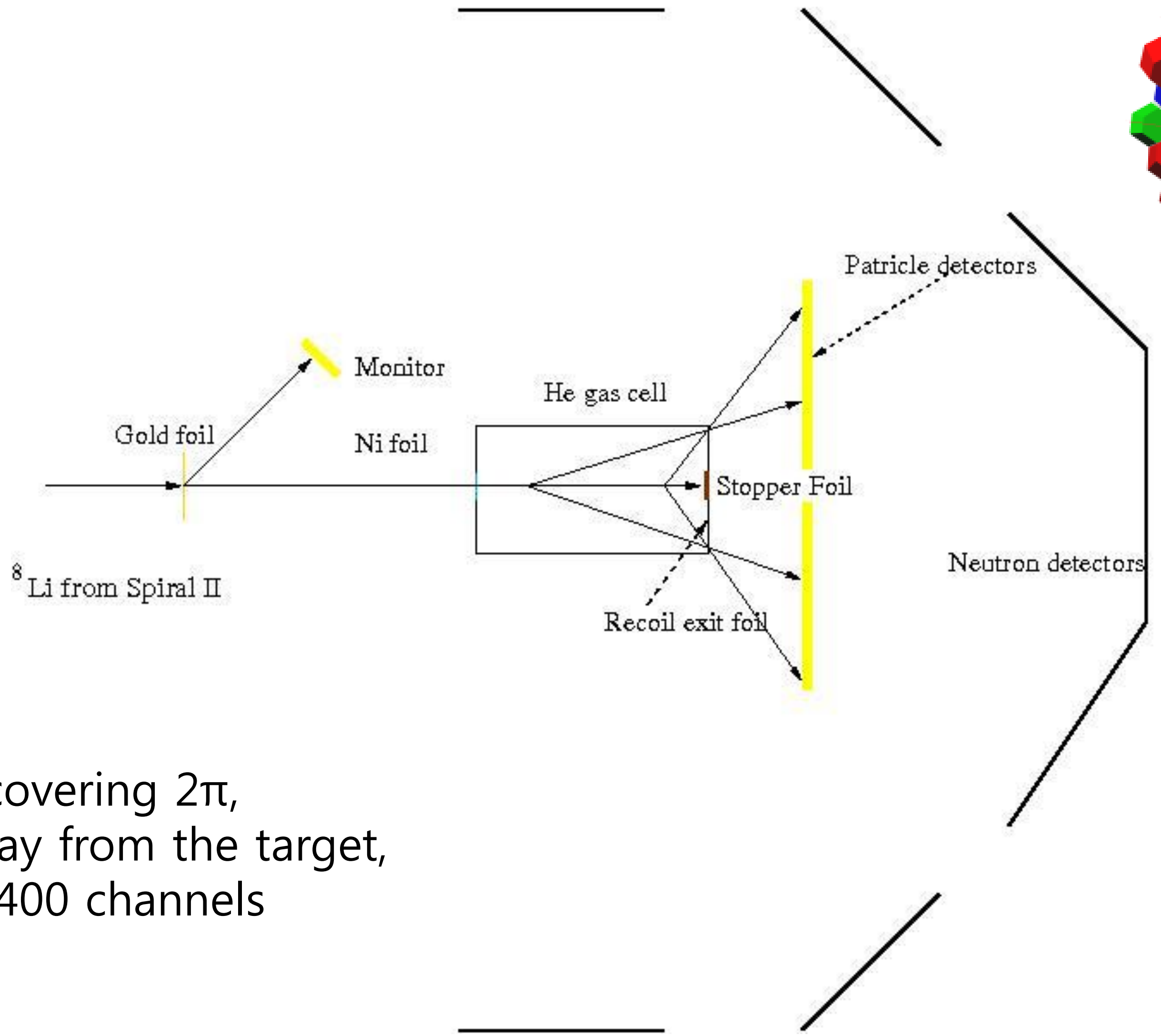
EXOGAM + DIAMANT + Neutron Wall

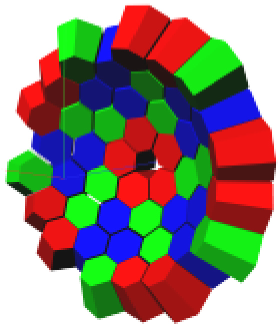
^{36}Ar (111 MeV) + ^{58}Ni $\rightarrow$ ^{92}Pd + 2 n

Cross section: $\sigma(^{92}\mathrm{Pd}) \simeq 1\mu$b, σ(fusion) $\simeq 0.2$ b,



NEDA(**Ne**utron **D**etector **A**rray) in GANIL

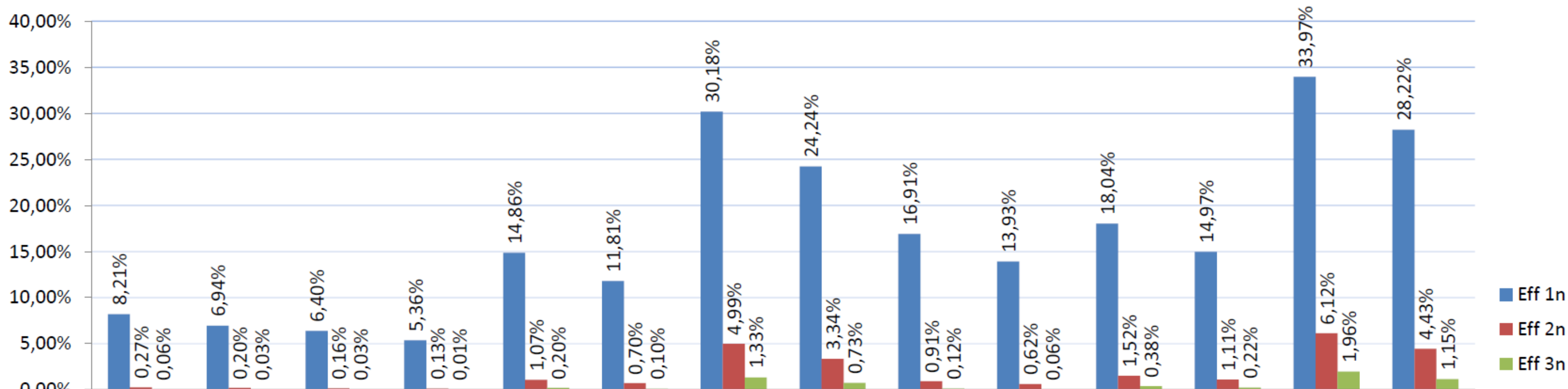




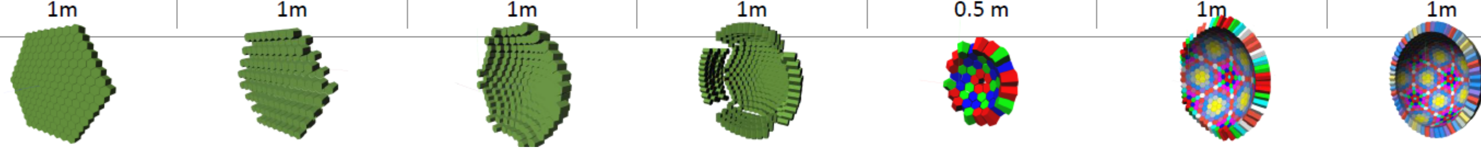
NEDA

Array covering 2π,
1m away from the target,
about 400 channels

NEDA Efficiencies from different geometries



Material	BC501A	BC537	BC501A	BC537	BC501A	BC537	BC501A	BC537	BC501A	BC537	BC501A	BC537	BC501A	BC537
Solid angle	0,52		0,45		0,92		1,88		1,00		1,00		2,00	
Cell vol.	3		3		3		3		4,5		2		2	
Total Vol.	507		507		489		1065		202,5		652		1212	
Modularity	169		169		163		355		45		326		606	
Dist./Foc.	1m		1m		1m		1m		0.5 m		1m		1m	



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Expected neutron energy and distribution (from simulation)

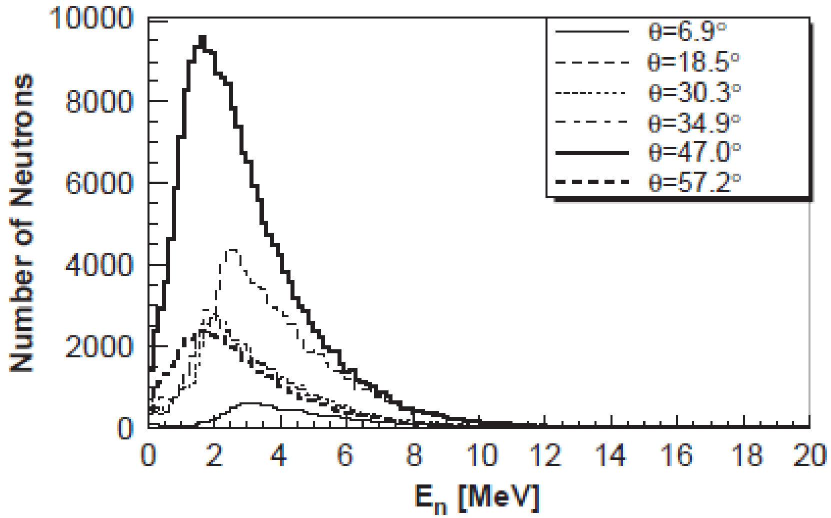
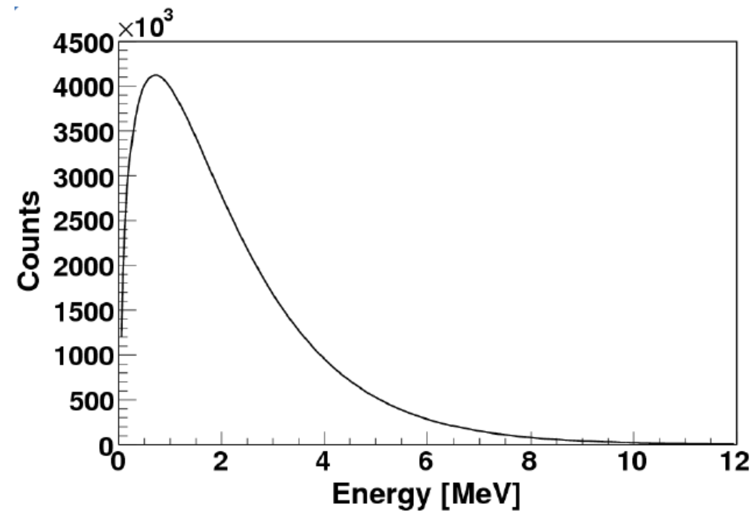


Fig. 2. Simulated energy distributions of neutrons in the laboratory system as obtained by evapOR and GEANT4 using the reaction ^{58}Ni(220 MeV) + ^{56}Fe(10 mg/cm^2). The shown curves correspond to hits in the different groups of detector segments, with their central position angles indicated in the legend. The detector segments at $\theta = 46.8°$ and 47.2° are shown together as the $\theta = 47.0°$ curve. The total number of neutrons emitted in 4π was 10^6 in this simulation. The scale on the y-axis shows the number of neutrons emitted in each angular group.



Neutron deficient nuclei up to the region of ^{100}Sn, fusion-evaporation reaction

Simulation result is similar to the energy distribution of neutron from ^{252}Cf source

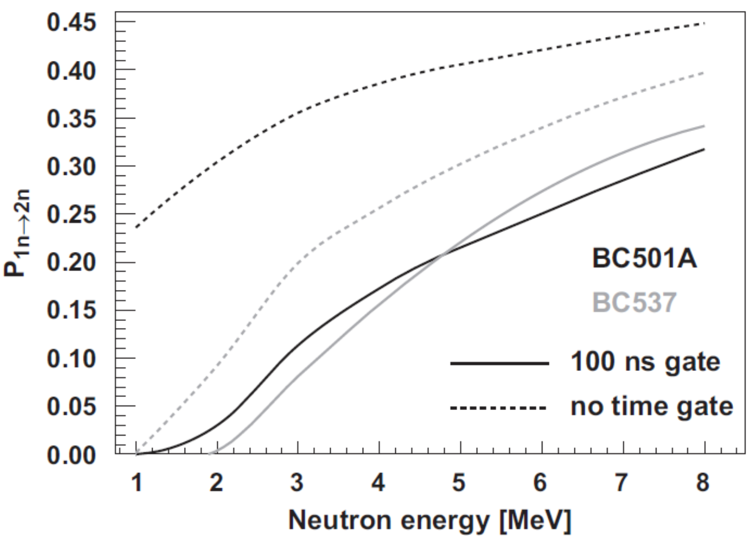
Neutrons were isotropically emitted in 4π

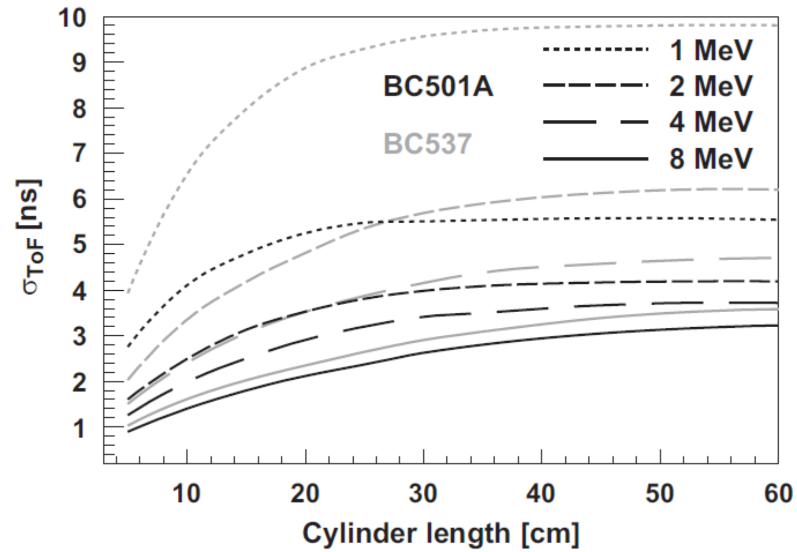
Neutron wall simulation

NEDA simulation

NEDA output
(from Geant4 simulation)

BC537 : C_6D_6, BC501A : C_8H_{10}





$$P_{1n\rightarrow 2n} = N^{1n}_{d\geq 2}/N^{1n}_{d\geq 1}$$

where $N^{1n}_{d\geq 2}$ is the number of events in which 1 neutron was emitted and at least 2 detector fired. In the following discussion $P_{1n\rightarrow 2n}$ is referred to as *cross-talk*.

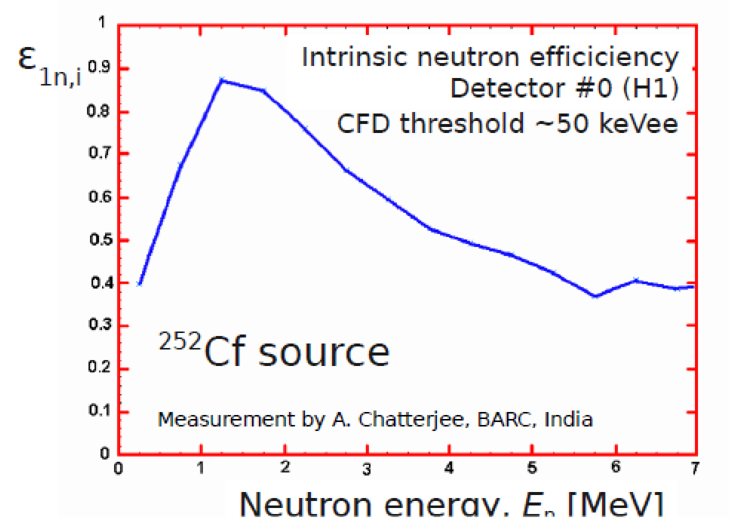
Efficiency and energy resolution

Efficiency

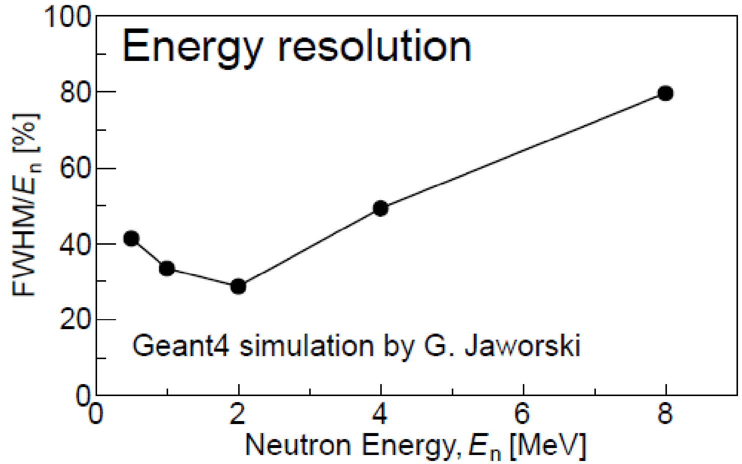
Intrinsic neutron efficiency at $E_n = 2$ MeV: $\varepsilon_{1n,i} \simeq 80\%$

Total Neutron Wall efficiency for symmetric fusion evaporation reactions:

- One-neutron efficiency: $\varepsilon_{1n} = 20\text{-}25\%$
- Two-neutron efficiency: $\varepsilon_{2n} = 1\text{-}3\%$

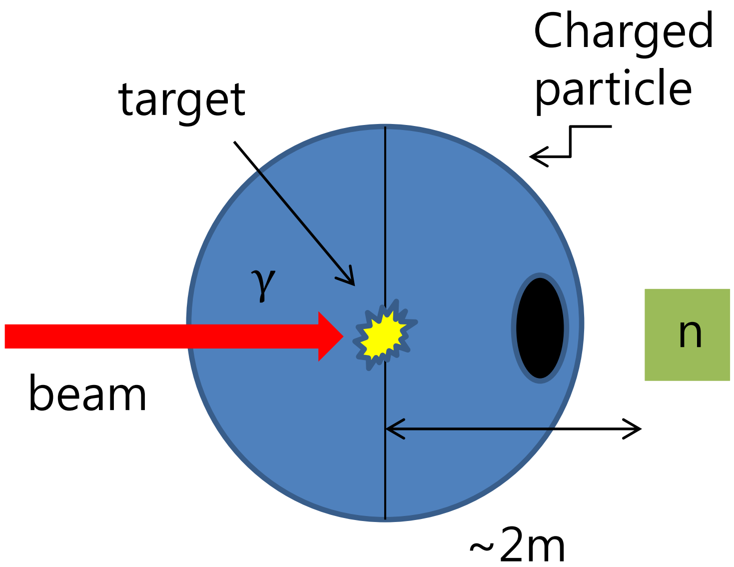


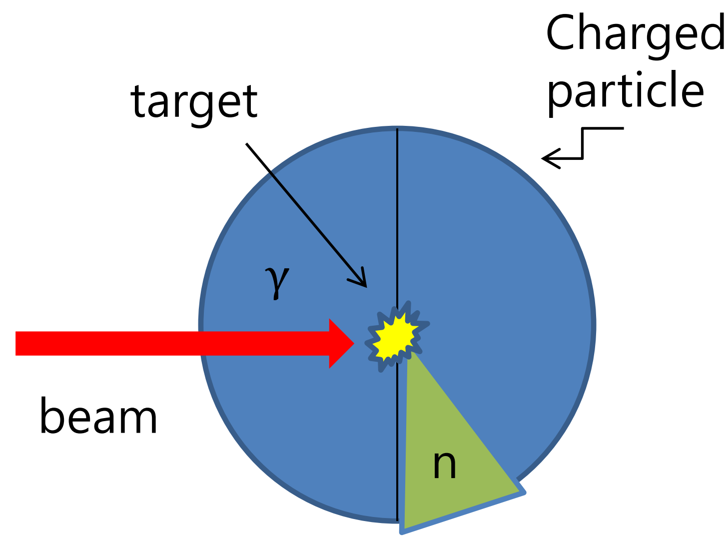
Energy resolution (Time-of-Flight)



- Distance source to detector front face: 51 cm
- Thickness of detectors: 14.8 cm
- Time resolution of detectors: FWHM = 1.5 ns

possible designs



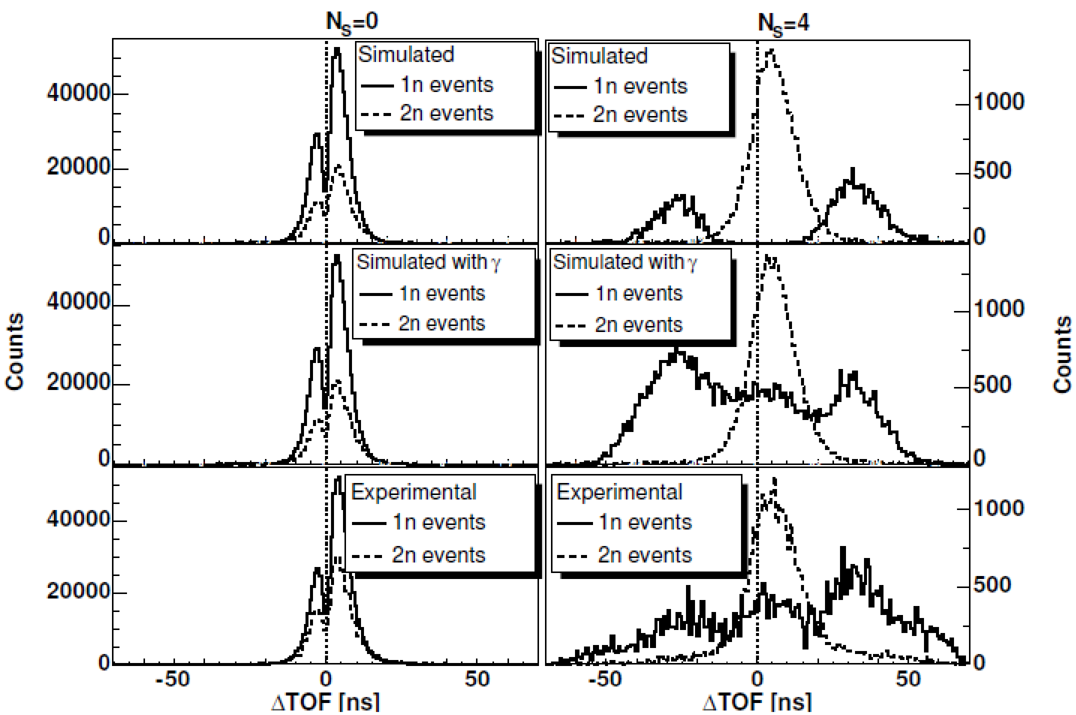


Back up

Neutron scattering

Probability of 1 neutron giving a signal in 2 or more detectors $\simeq 10\%$.

Serious problem in searches for weakly populated $\geq$ 2n reaction channels: scattered neutrons from much stronger 1n channels are mis-identified as being due to 2n, 3n, . . . channels.



J. Ljungvall et al. NIM A528 (2004) 741

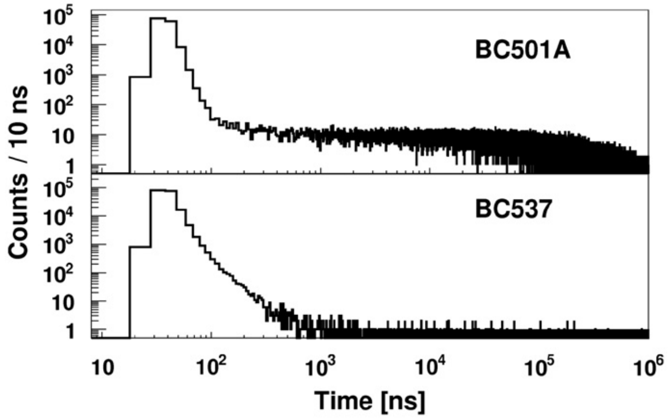
Methods to detect scattered neutrons:

- Neighbor rejection.
- ΔToF. J.Cederkäll et al. NIM A385 (1997) 166.

Small amounts of γ rays mis-identified as neutrons reduces dramatically the quality of the neutron scattering reduction

At 1m,
20 MeV ToF = 17 ns
10 MeV ToF = 23.5 ns

20cm deep



50 keV_{ee} threshold is applied for the light output