Gas detector with solid Boron-10 converter for UCN time-of-flight spectrometry

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TOF experiments with UCN

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Diffraction of ultracold neutrons on a moving grating and neutron focusing in time

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NUCLEI
Experiment

Effect of Accelerated Matter in Neutron Optics

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New Experiment on the Observation of the Effect of Accelerating Matter in Neutron Optics

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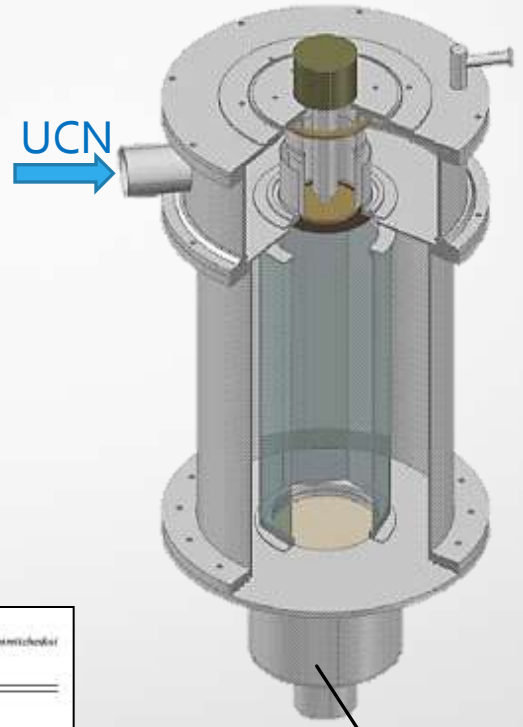
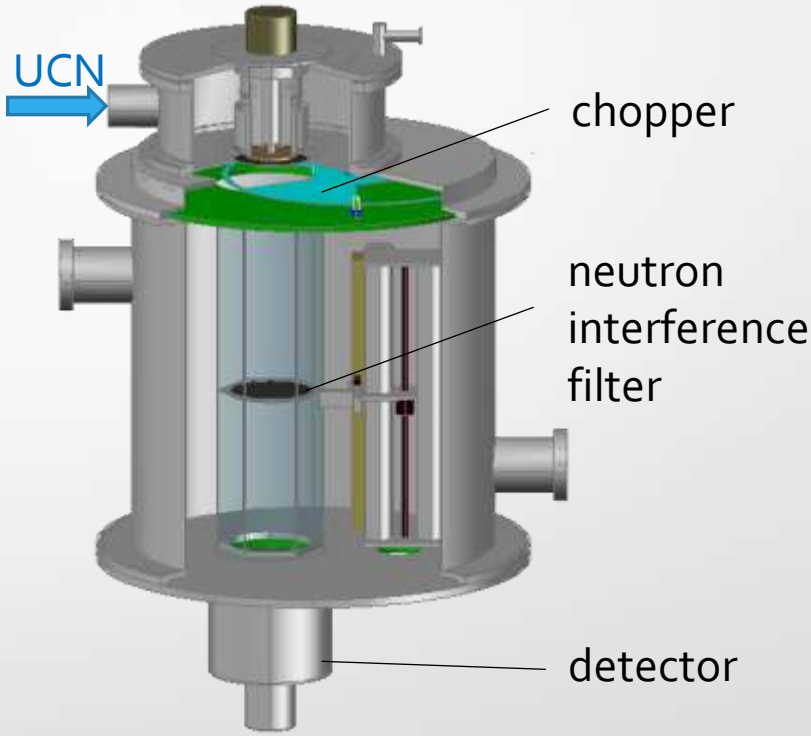


New UCN TOF spectrometer

It is necessary to build new detector for new UCN TOF spectrometer

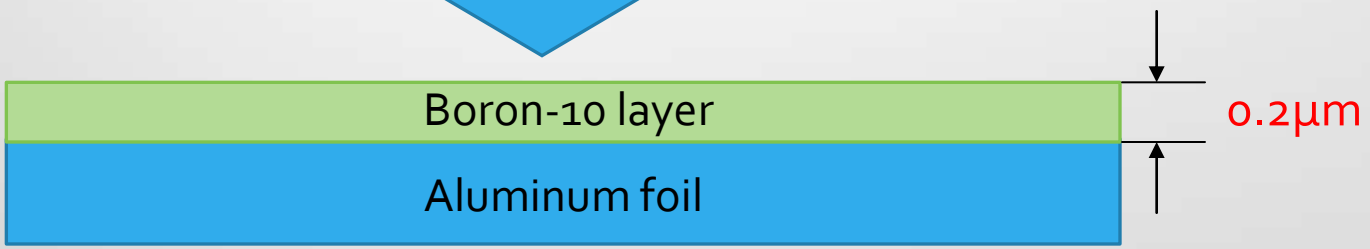


UCN TOF spectrometer

Solid boron-10 neutron converter

- The accuracy of time-of-flight measurement what we need is about 10μsec
- Typical UCN energy is about 100neV. It corresponds to 4.5m/sec velocity.

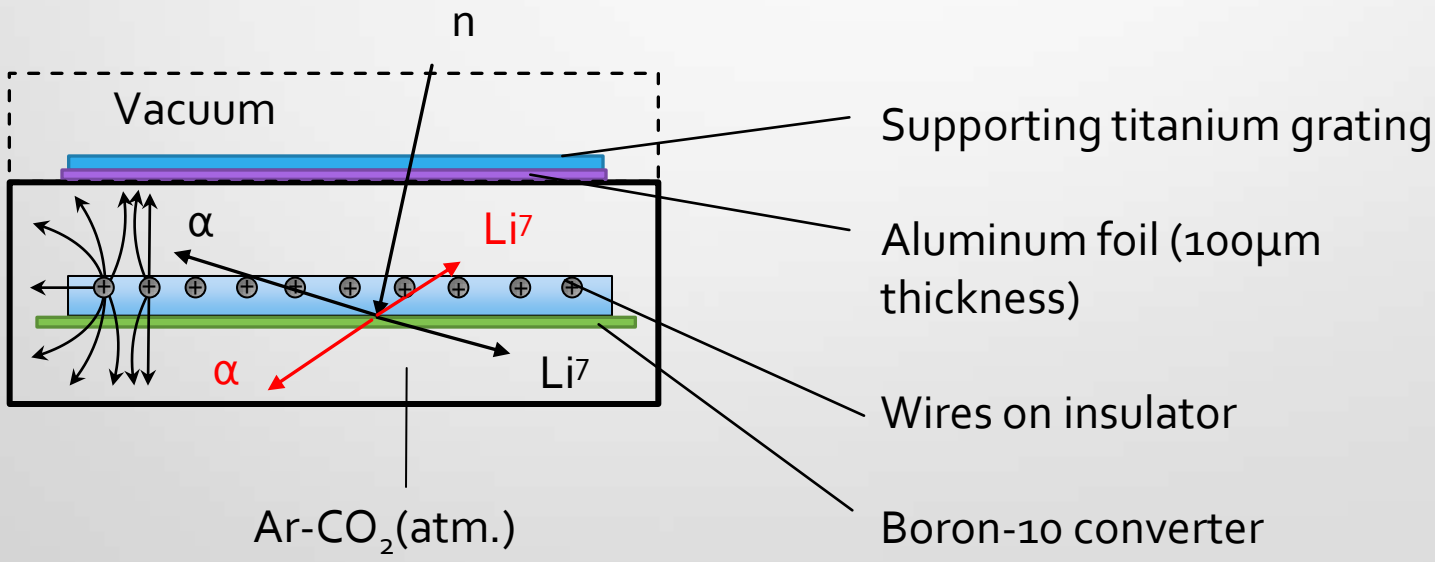
- The maximum thickness of the neutron converter should be about 45μm



Design and principle of work

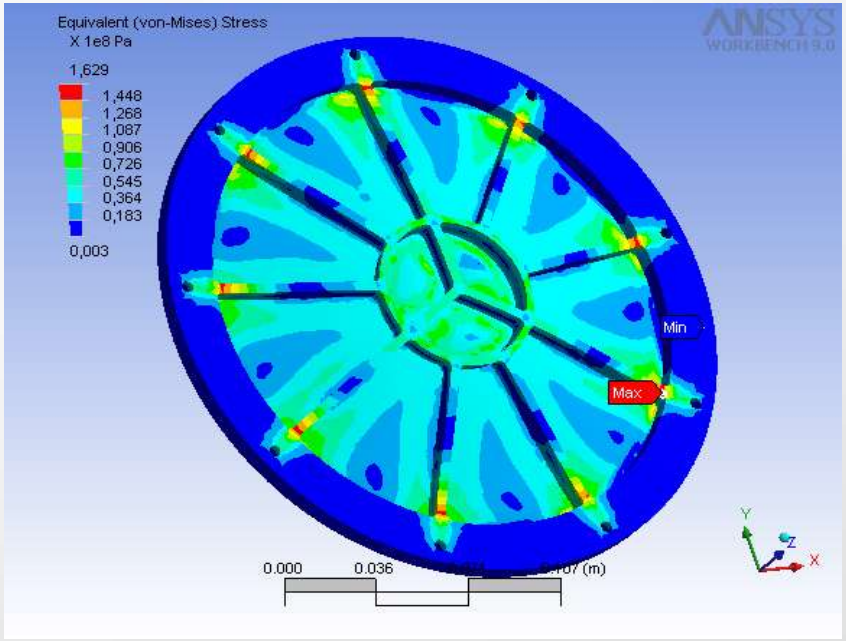
The detector registers neutrons by means of charged Li^7 or α particles born in reaction

$B^{10}(n, \alpha) Li^7$



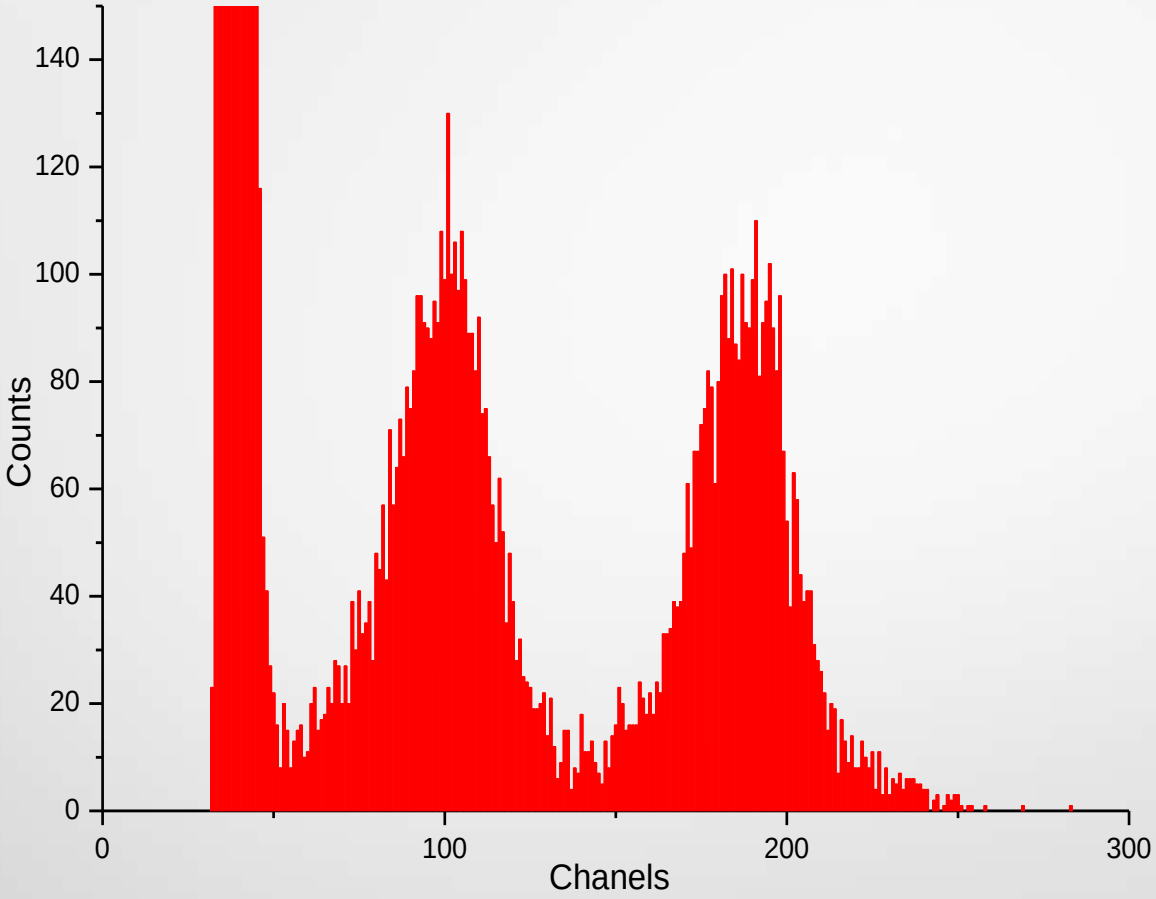
Design and principle of work

Boron-10 detector



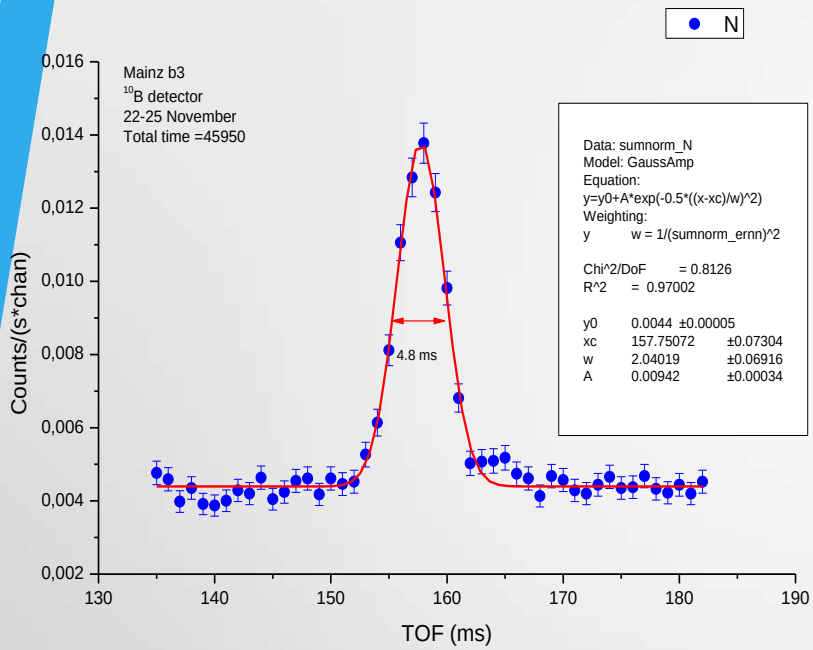
Stress calculation of supporting grating in ANSYS program. 84% of detector window area is open.

Results



Amplitude spectrum of the detector measured on PF2 UCN beam in ILL(Grenoble)

Results



TOF spectrum of monochromatic neutrons passed through neutron interference filter. Chopping frequency is 20 Hz.

Theoretical degree of monochromatisation($\Delta t/t$) is about 0,02–0,03

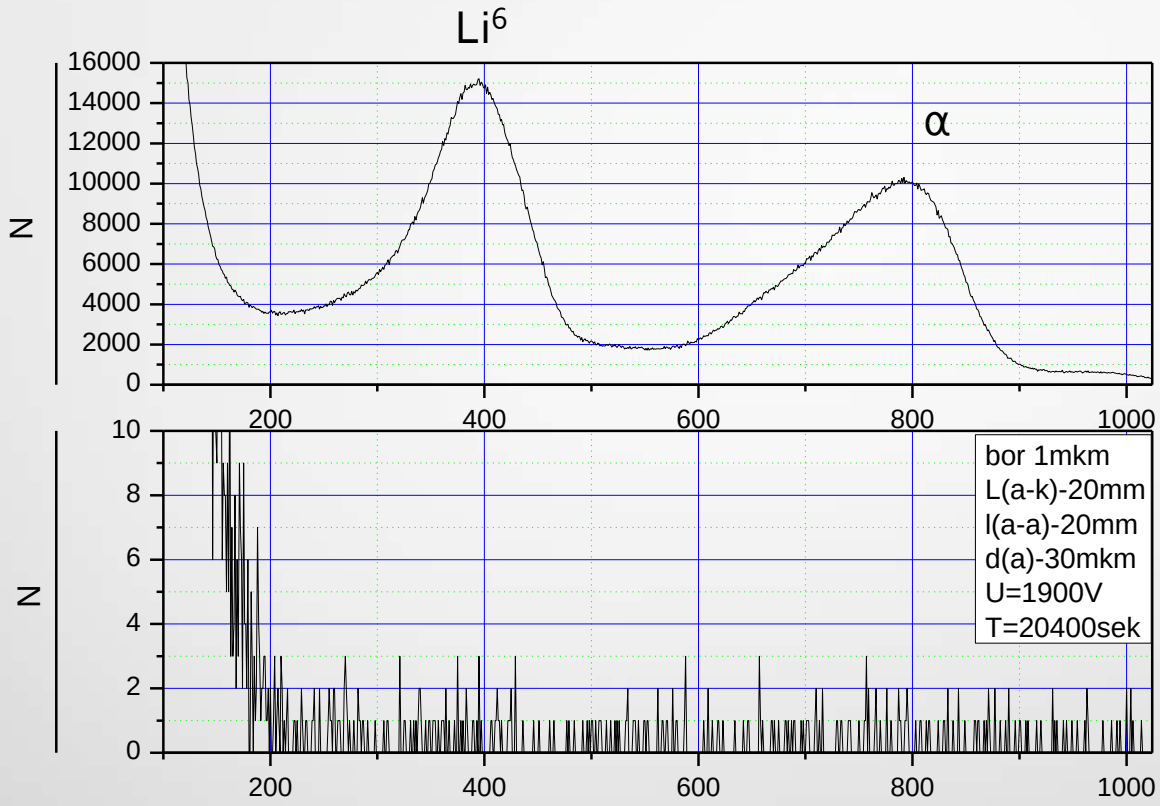
$$W_{tot} = \sqrt{W_f^2 + W_{ch}^2 + W_{res}^2}$$

FWHM of chopper burst (W_{ch}) is 2.8msec

$$\frac{\Delta t}{t} \approx \frac{\sqrt{W_f^2 + W_{res}^2}}{TOF} = 0{,}025$$

One window rotor. Time of opening window is 1/18 of the period.

Results



Amplitude spectrum of the B^{10} detector from Pu-Be neutron source(above) and background spectrum(below)

Summary

- Boron-10 detector with large sensitive area is cheaper than scintillation detector
- Aluminum window of boron-10 detector has less critical velocity than one of scintillation detector
- Efficiency of the boron-10 detector is the same as scintillation detector's one
- Time resolution of the new detector fulfils requirements of TOF UCN spectrometry

Thank you for your attention!!!