Measurement of the neutron capture cross section of ^{232}Th at the CERN-nTOF facility

Gaëlle Aerts[1], Frank Gunsing[1], The n_TOF Collaboration[2]

[1] *CEA/Saclay*
[2] *The n_TOF Collaboration*

The interest in high resolution neutron capture cross section data has gained much interest in recent years due to the development of new activities related to nuclear energy, like the transmutation of nuclear waste, the thorium-based nuclear fuel cycle and accelerator driven systems (ADS).

The amount of nuclear waste, notably the higher actinides, can be reduced by using a fuel cycle based on ^{232}Th. The isotope ^{232}Th by itself is not fissile but after neutron capture followed by β-decay, the fissile isotope ^{233}U is formed. The build-up of the higher actinides, especially americium and curium, is strongly suppressed due to the lower atomic and mass number of thorium.

The recent renewed interest in the nuclear fuel cycle based on ^{232}Th/^{233}U has made clear that the existing knowledge of reaction cross sections for many of the relevant isotopes is still rather poor. For an optimized design of a thorium-cycle based accelerator driven system (ADS) an improved knowledge of these isotopes is crucial.

We have measured the neutron capture cross section of ^{232}Th at the newly constructed neutron time-of-flight facility at CERN. Neutrons are created by spallation reactions induced by a pulsed, 6 ns wide, 20 GeV/c proton beam with up to 7×10^{12} protons per pulse, impinging on a 80x80x60 cm^3 lead target. A 5 cm water slab surrounding the lead target serves as a coolant and at the same time as a moderator of the initially fast neutron spectrum, providing a wide energy spectrum from 0.1 eV to about 250 MeV with a nearly $1/E$ flux dependence between 1 eV and 1 MeV.

The high instantaneous neutron flux, high resolution and low background make this facility well suited for high quality neutron cross section measurements. In particular neutron capture measurements on radioactive isotopes or low mass samples take advantage of the enhanced signal to background ratio as compared to other existing facilities.

The main characteristics of the facility will be described as well as the used capture setup with C_6D_6-based gamma-ray detectors associated with a pulse height weighting technique. The measured reaction yield has been analyzed within the R-matrix modelization of the reaction and the resonance parameters have been extracted up to a few keV. From the resonance information the level density information, including a missing-level correction, has been extracted. Above this energy in the unresolved resonance region the capture cross section is presented as point-wise data up to about 500 keV and the neutron strength functions have been fitted from the data.

Email: aerts@cea.fr, gunsing@cea.fr