Measurement of the fission cross-section of ^{232}Th with quasi-monoenergetic neutron beams at NCSR "Demokritos" with Micromegas detectors

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Motivation

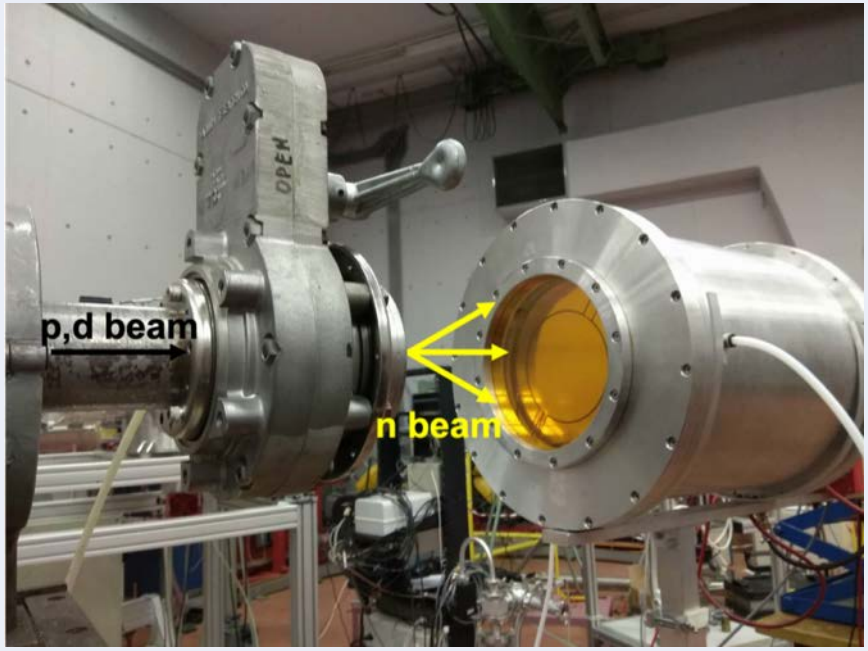
- Cross-section data on neutron induced reactions are of considerable importance for **the design of advanced nuclear systems**
- **^{232}Th is the main isotope in the thorium cycle**, where it is converted into the fissile ^{233}U after neutron capture followed by two β^- decays
- In addition, fission cross-section data play an important role in the **theoretical study of the fission process**
- More specifically, in the thorium isotopes, fine structures appear in the threshold region, known as the '**thorium anomaly'**
- The data of this work aim to **resolve the discrepancies of previous datasets** in literature, with measurements covering the **fast neutron energy region**

Neutron sources

The experiments were performed in the **neutron beam facility of the National Centre for Scientific Research "Demokritos"**, using the 5.5 MV Van de Graaff Tandem accelerator

Twelve irradiations were carried out, while the neutrons were produced via:

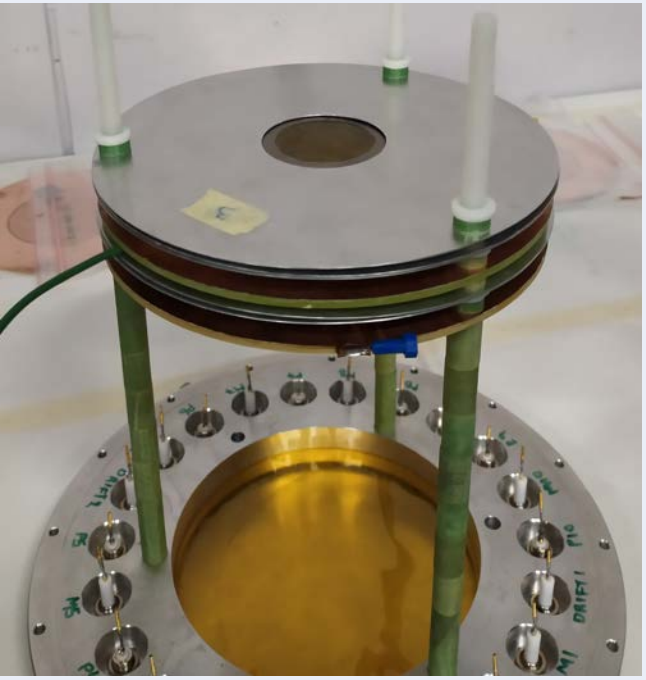
- The **^{3}H(p,n)** reaction for the neutron energy range **2.0 – 5.3 MeV**
- The **^{2}H(d,n)** reaction for the neutron energy at **9.9 MeV**
- The **^{3}H(d,n)** reaction for the neutron energy range **14.8 – 17.8 MeV**



The charged particle beam impinges on the target for the production of the neutron source

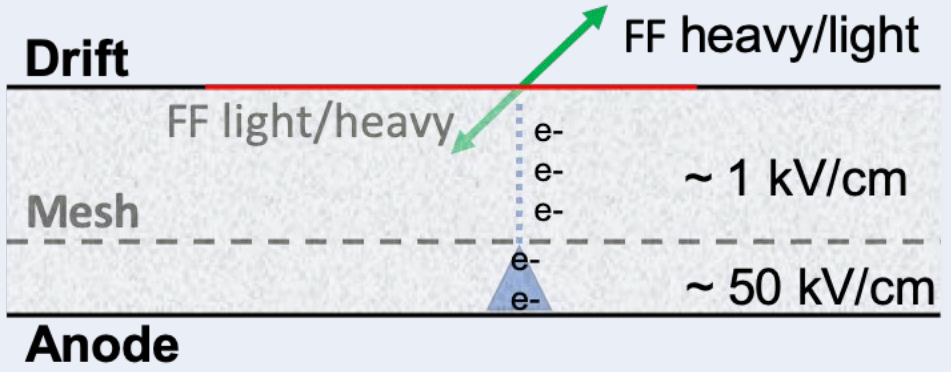
Experimental setup

- **Two ^{232}Th samples** were used for the measurements, while **^{238}U and ^{235}U targets were used as references**
- **Micromegas detectors** were used for the detection of the fission fragments



The sample-Micromegas assembly

The fission fragments upon entering the detector gas create **secondary electrons** → **The signal is collected from the mesh electrode**, after multiplication through avalanches in the mesh region

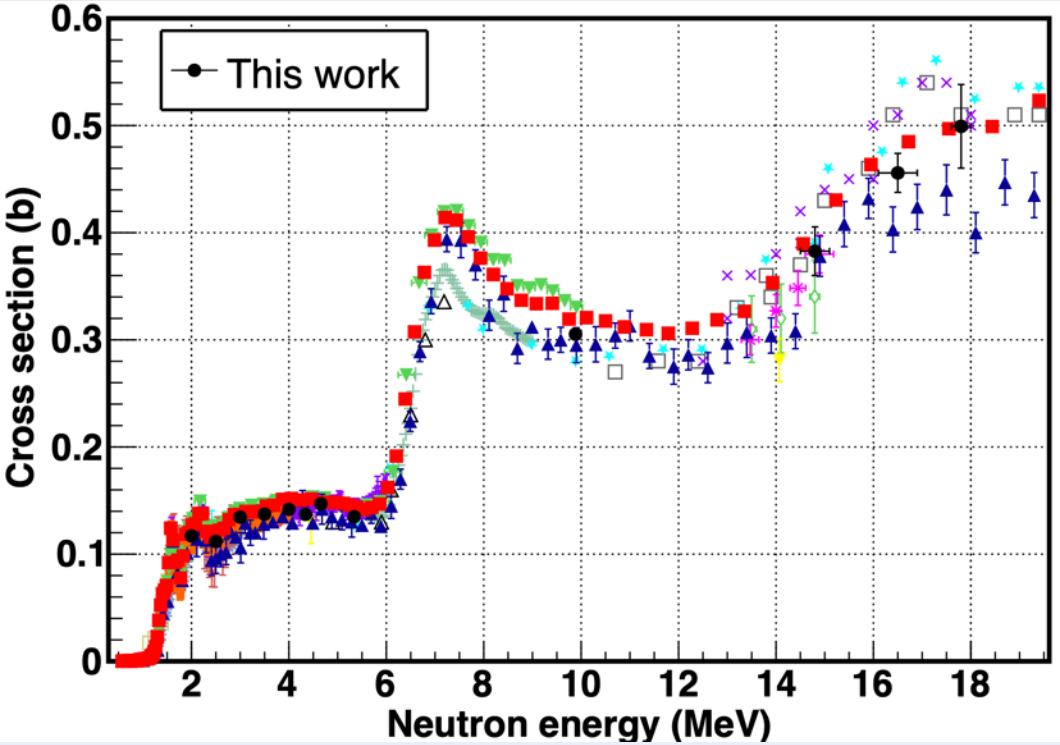


Schematic representation of the Micromegas detector

Data analysis

- **The fission cross-section is estimated relative to reference samples (^{238}U and ^{235}U)**
- **Extensive MC calculations, combining NeusDesc and MCNP 6.1** can reveal the detailed energy distribution of the neutron flux and permit (along with experimental reference data and evaluated libraries) the control of parasitic neutrons
- **GEF + FLUKA** are used for corrections in the Micromegas efficiency for low energy depositing fission fragments
- **<u>For the ^{232}Th case (high energy threshold), ^{238}U proved to be an excellent reference target for fission cross-section measurements</u>**

Results



Cross-section results of this work (black circle) along with the available experimental data in the EXFOR library

- Very good agreement with certain experimental datasets
- The presented results cover a broad energy range

Conclusions – Future perspectives

- The cross section measurements of ^{232}Th(n,f) at the neutron beam facility “Demokritos” will provide **precise data in the fast neutron energy region**
- The measurement was performed with **quasi-monoenergetic neutron beams** and without any complementary time-of-flight system for the characterization of the neutron beam and the parasitic neutrons, highlighting the capability of obtaining **accurate results** with this analysis procedure, when a careful and detailed consideration of all the experimental details is carried out
- *Several (n,f) cases (mainly threshold) can be studied in the near future using the same setup and analysis technique!*