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Determination of Group Neutron Cross-Sections and their Integral Characteristics for Minor Actinides by GRUCON Code based on Estimated Data of ENDFB, JENDL, JEFF, BNAB

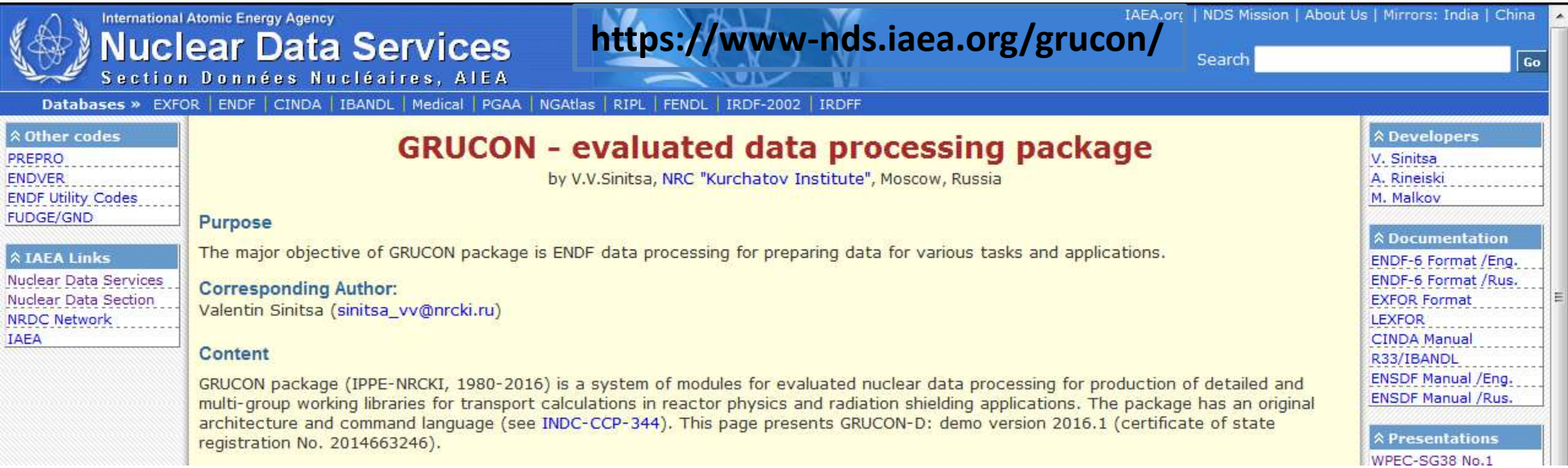
Abstract. Utilization of radioactive wastes of nuclear power engineering is one of the urgent tasks, because nowadays there are hundreds of tons of long-living fission fragments and minor actinides, which need to be kept in special radioactive waste storages or to be transmuted into short-living isotopes. In this connection it is necessary to elaborate the waste transmutation techniques and to solve complicated technical problems, in particular to create a database of necessary scientific and technical information of neutron and other nuclear-physics values. As for neutron constants, there are insufficiently known the neutron cross-sections of radiation capture of fission fragments and cross-sections of fission and capture of the lower minor actinides: isotopes of neptunium, americium, curium, thorium, plutonium and uranium. In this paper we suggest to measure the cross-sections of the isotopes by means of TOF and neutron time slowing-down technique in the energy range from 1 eV upto 200 keV by using the new fast fission chambers. To estimate the efficiency of measurement techniques the group neutron cross-sections of isotopes mentioned above by using GRUCON code based on estimated data of ENDFB, JENDL, JEFF, BNAB have been calculated. The calculated group cross-sections point out that there are large errors from 10 to 30% in cross-section values in resonance range.

Plan of the Talk

1. GRUCON Code and its Capabilities
2. DB and Experimental Data Estimations
3. Neutron Sources on Experimental Complex of INR RAS
4. TOF & Slowing-Down Technique on LSDS-100

GRUCON Code

The GRUCON code is a system of modules for evaluated nuclear data processing for production of detailed and multi-group working libraries for transport calculations in reactor physics and radiation shielding applications.



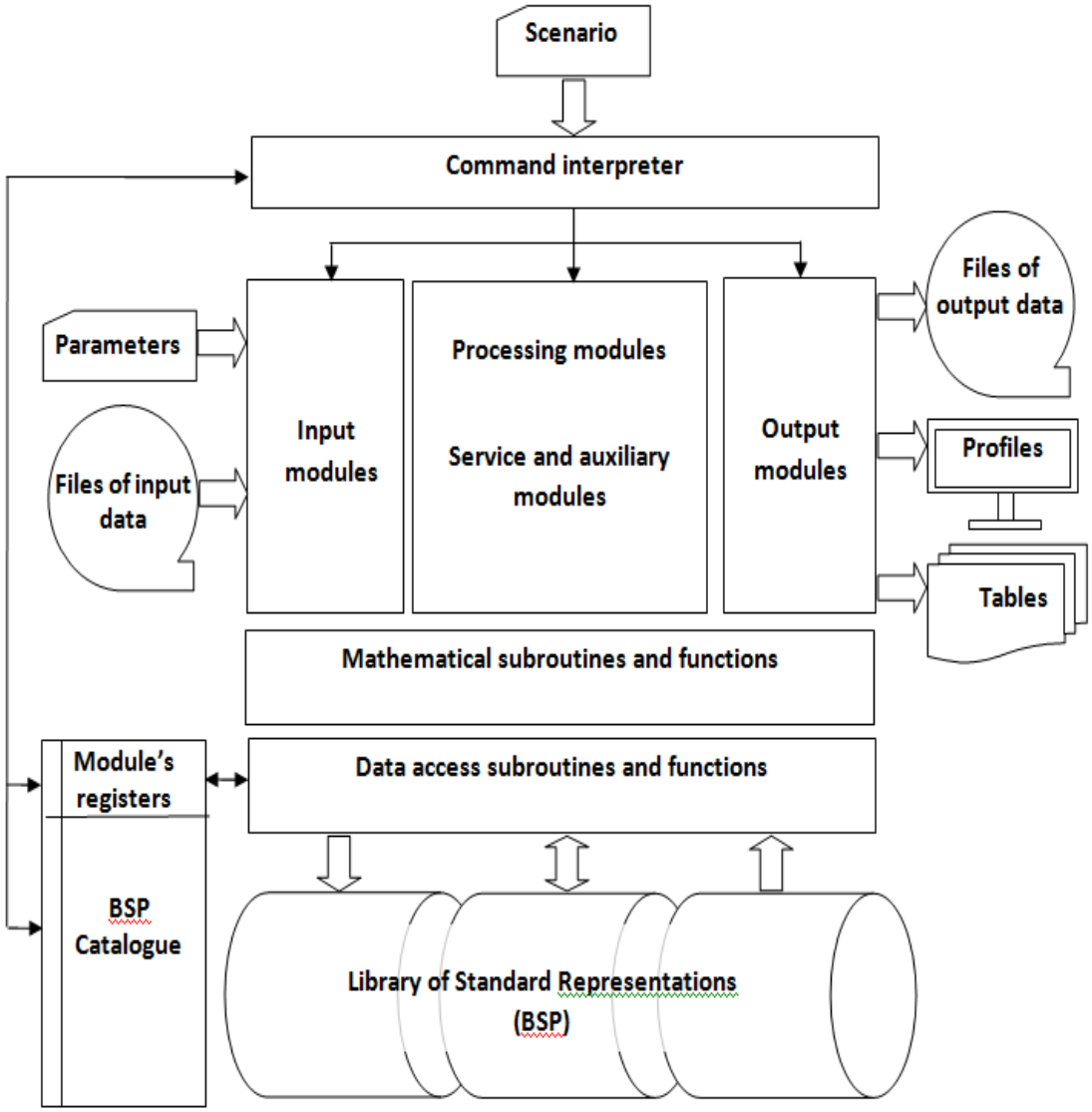
The package GRUCON-D includes modules allowing to:

- reconstruct cross sections in required energy range for given temperature;
- prepare generalized subgroup parameters with regard to correlations of cross sections of different materials, reactions, temperatures, and as result of collisions, to describe the resonance effects in neutron transport problems;
- calculate the energy-angular distributions of neutrons scattered on the resonances;
- prepare group cross sections and matrices from photo-atomic interaction data library;
- prepare group cross sections from activation data library.

GRUCON Code

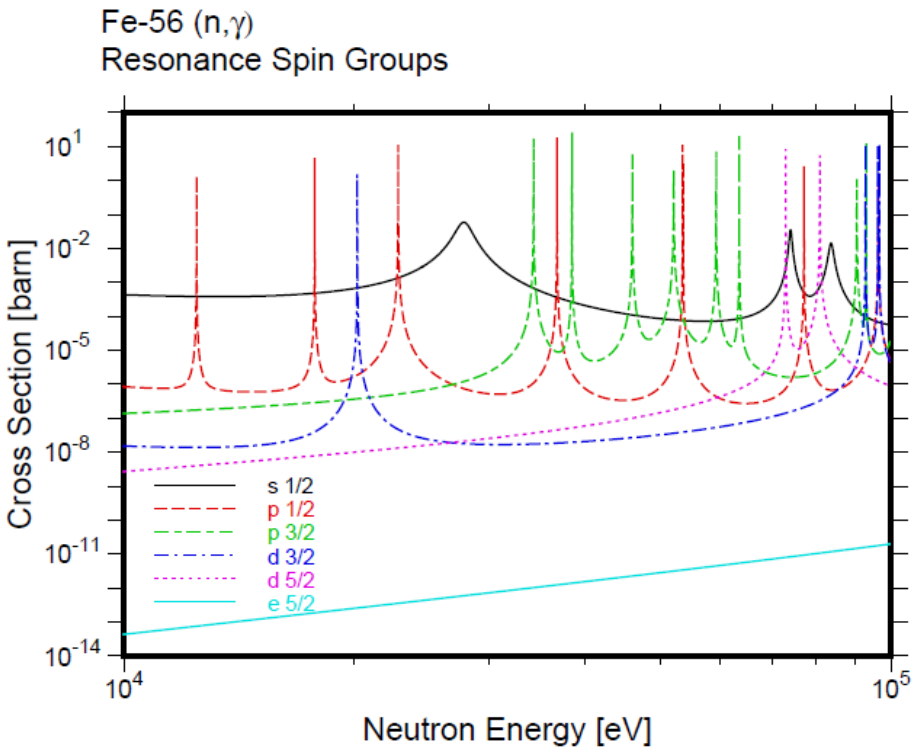
MAIN LIBRARIES

1) ENDF/B-VII.1 (USA,2011)
2) JEFF-3.2 (Europe,2014)
3) JENDL-4.0u2 (Japan,2012)
4) CENDL-3.1 (China,2009)
5) ROSFOND-2010 (Russia,2010)
6) BROND-2.2 (Russia,1992)

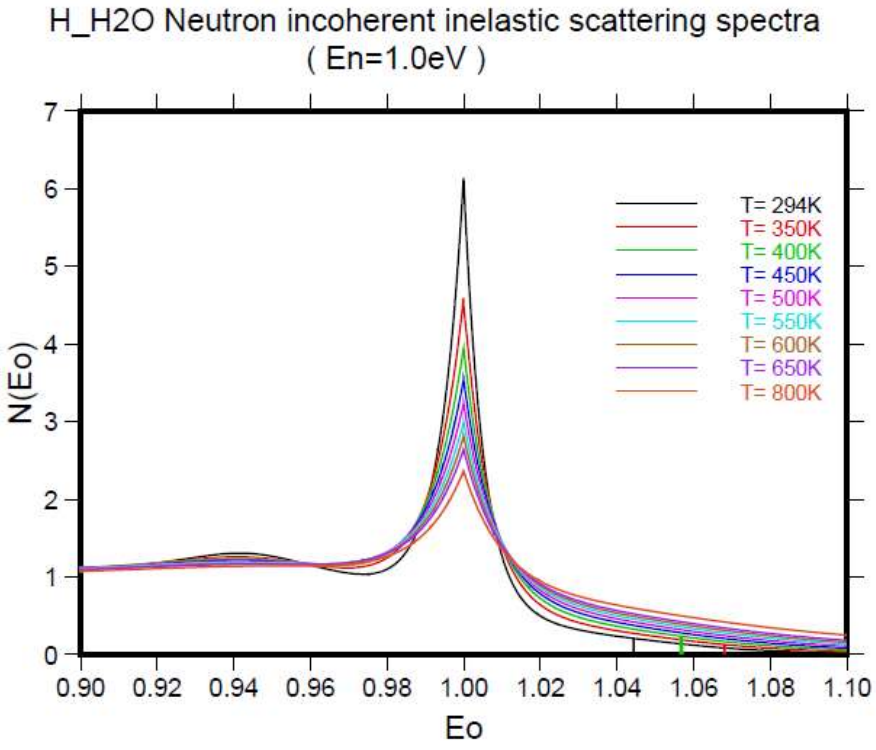


Specific computational capabilities of GRUCON

Separate calculation of resonance component for each spin group

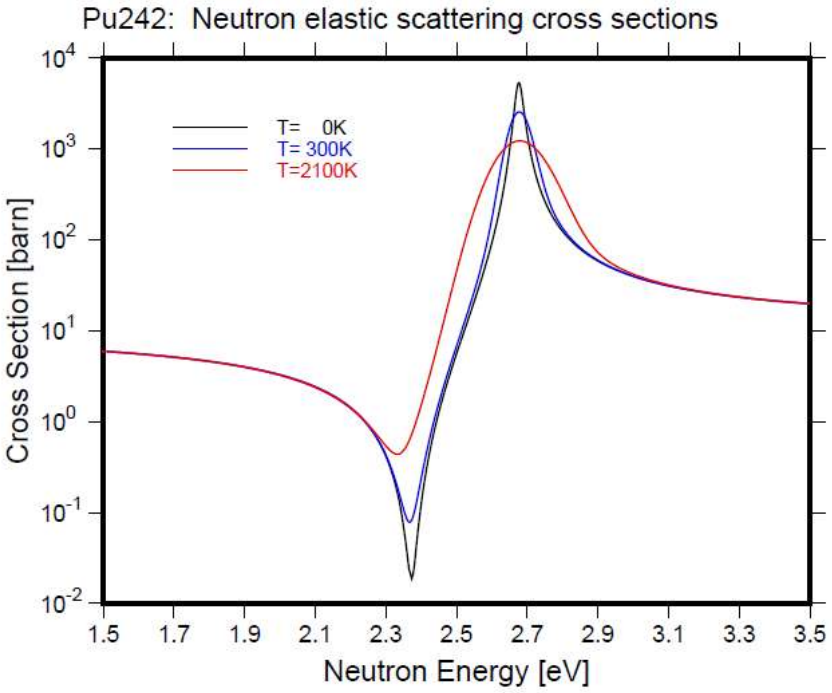


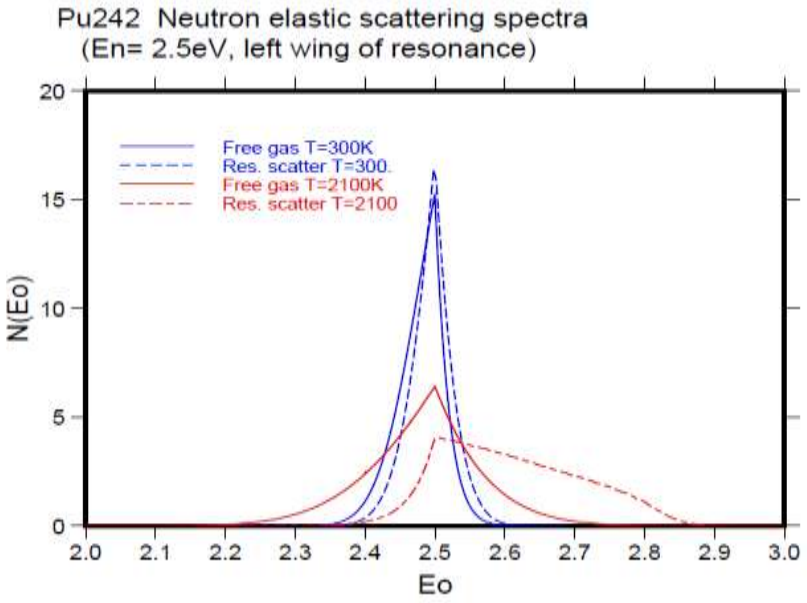
Neutron spectra for scattering on hydrogen in water

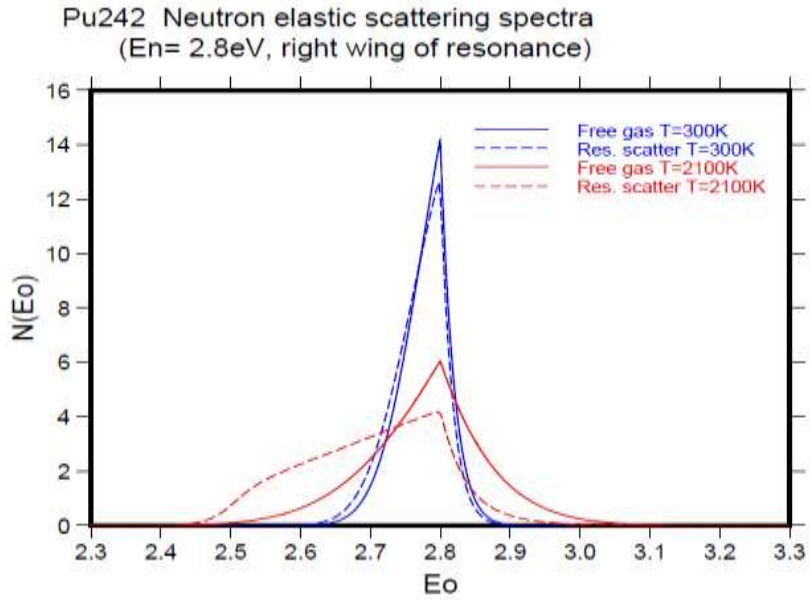


Specific computational capabilities of GRUCON

Neutron scattering on resonances: Pu242 elastic cross sections (below) and spectra on the left (right up) and right (right down) wings of resonance in the free gas and resonant scattering approaches

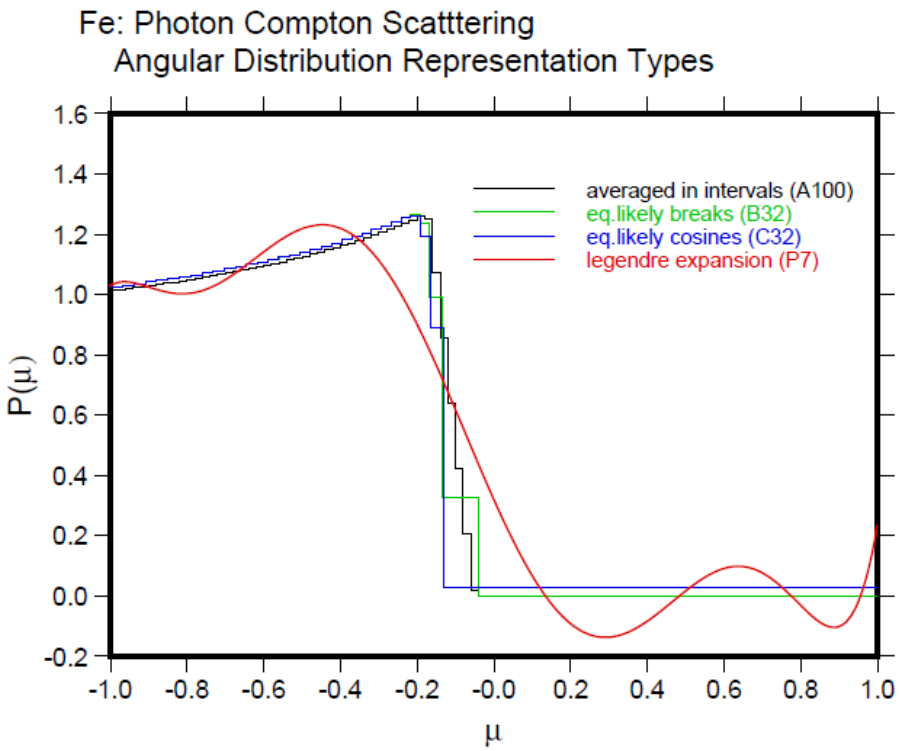






Specific computational capabilities of GRUCON

Four types of parametrization of angular distributions



and many other capabilities…

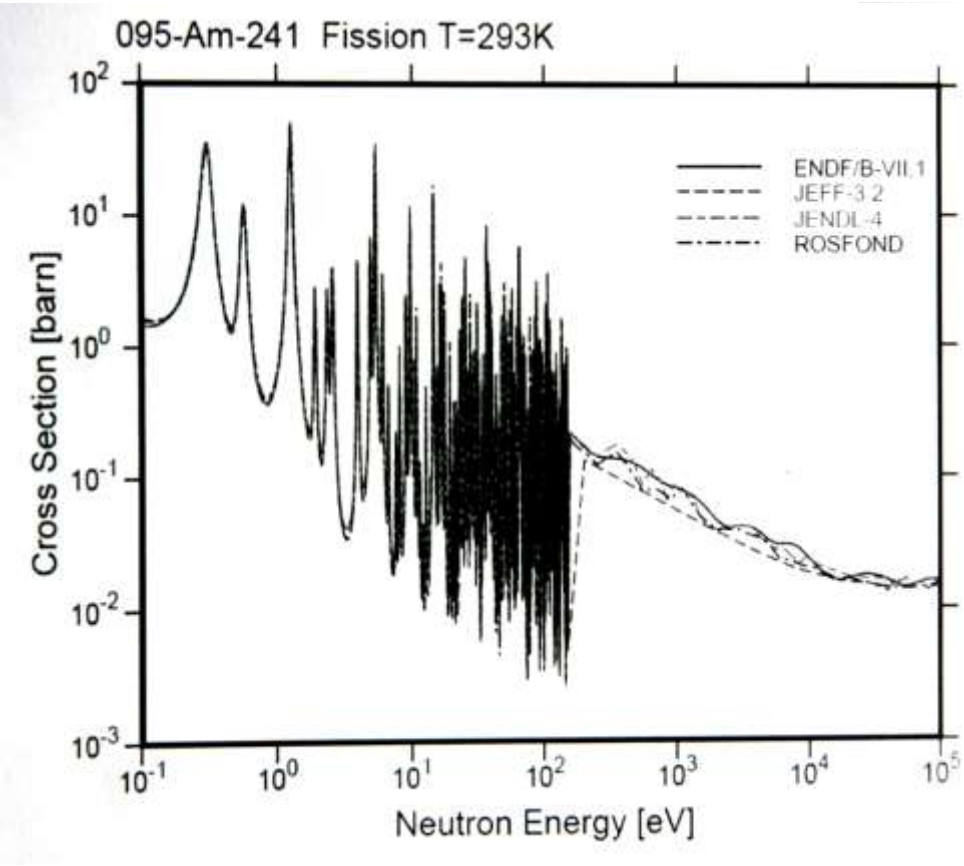
https://www-nds.iaea.org/grucon/

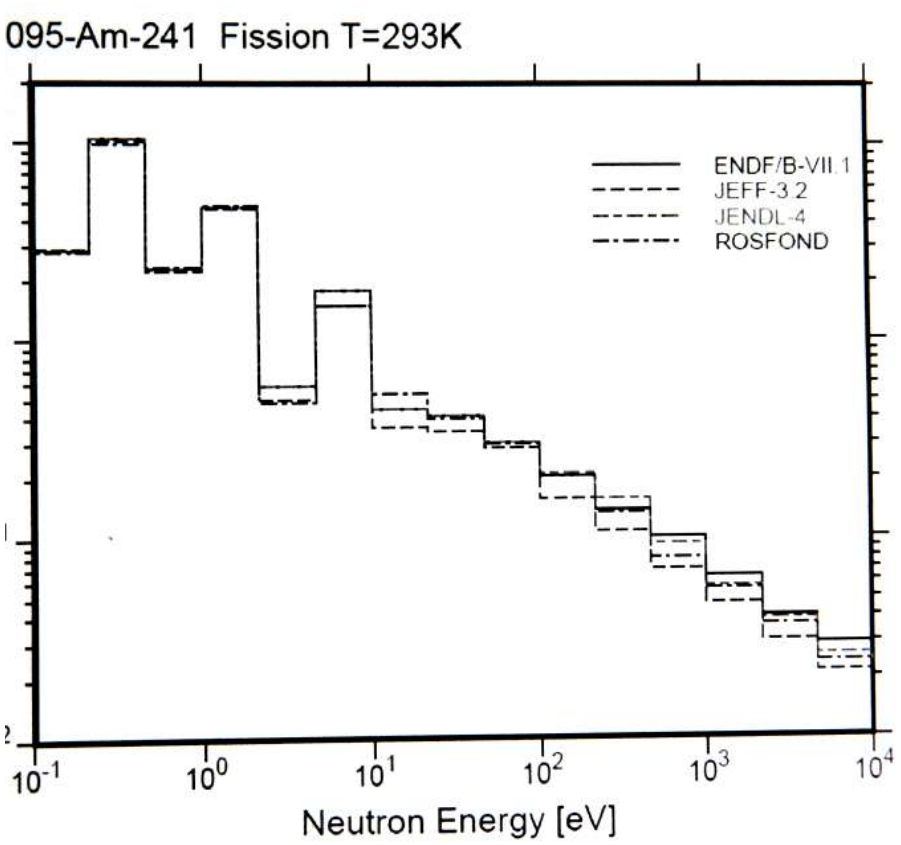
Download

#	Date	Title	Link
1	2016-03-03	Executables (32 and 64-bit) for Linux and Windows, tests and documentation	zip (79Mb)
2	2016-03-02	User's Manual (English)	pdf (2.5Mb)
3	2016-03-02	User's Manual (Russian)	pdf (2.7Mb)

Request source code: by [e-mail]

Estimation of NR DB Data

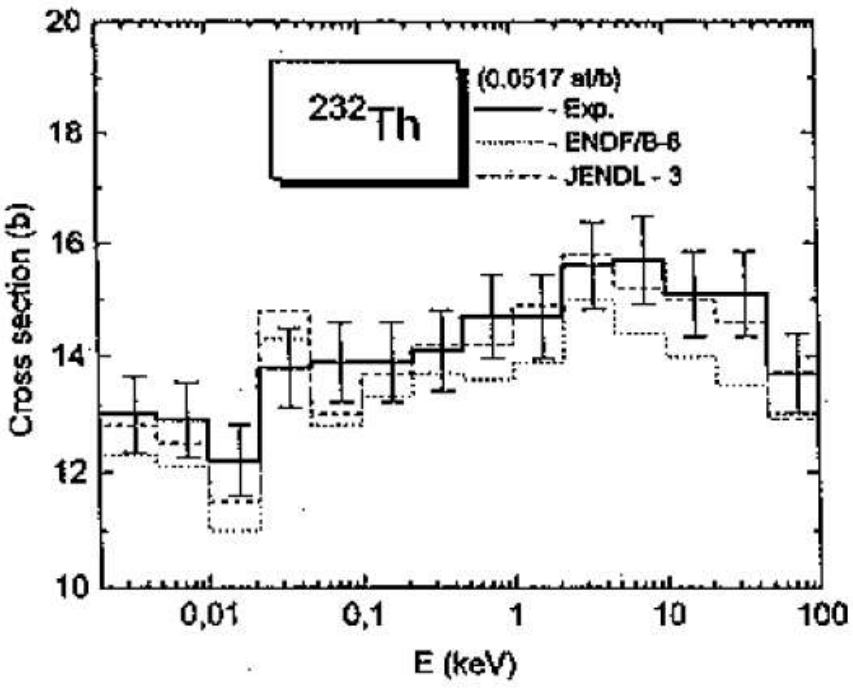


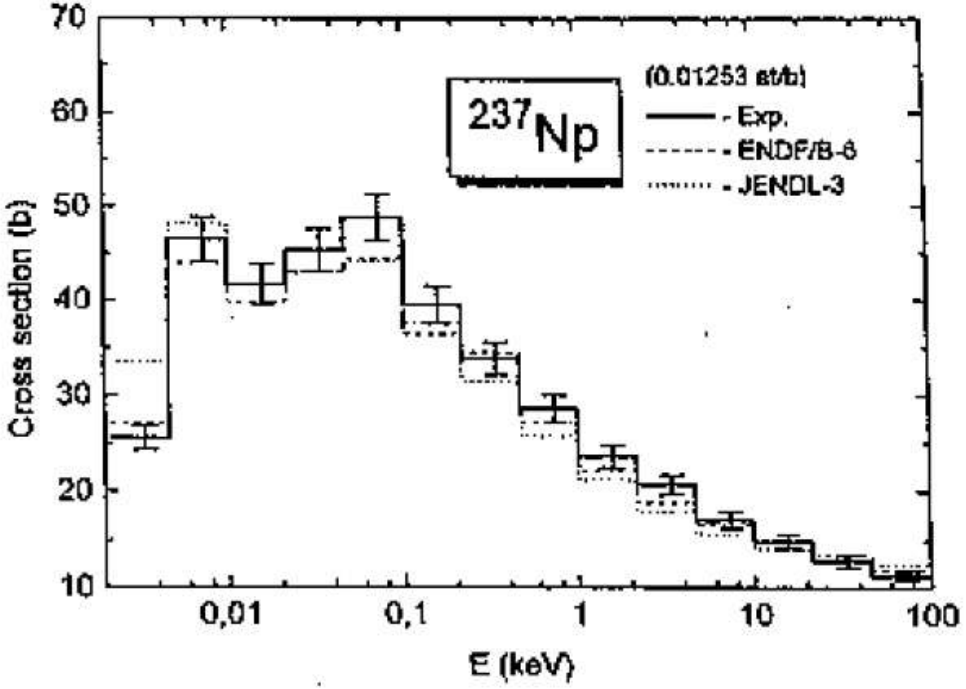


1) ENDF/B-VII.1 (USA,2011)
2) JEFF-3.2 (Europe,2014)
3) JENDL-4.0u2 (Japan,2012)
4) ROSFOND-2010 (Russia,2010)

DB Data errors: 10 - 30 % !

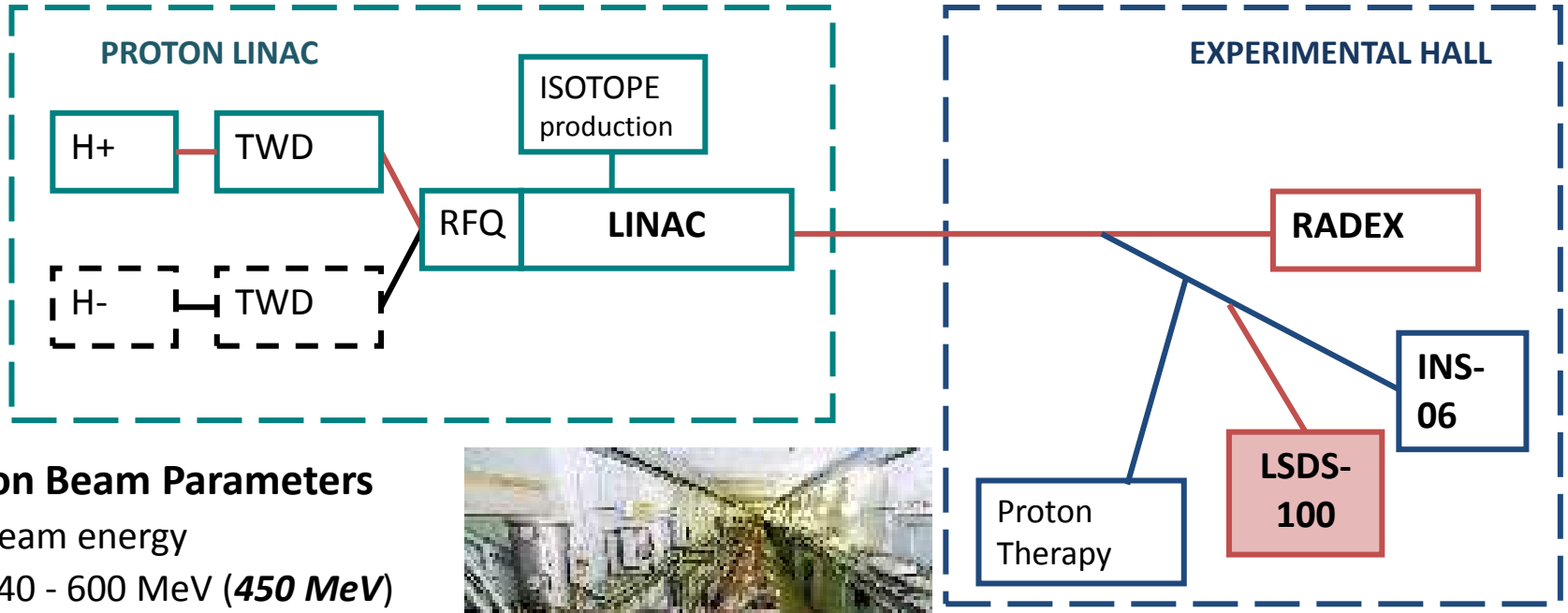
Estimation of Experimental & DB Data





Grigoriev Yu.V., Sinitsa V.V., Gundorin N.A., Popov Yu.P. **Investigations of the Resonance Structure of Neutron Cross-Sections for Thorium-232 and Neptunium-237 in the 2 eV-100 keV Energy Region.** – VANT, Nucl.Data, 1, p.9, 1998.

Linac and Experimental Complex of INR RAS



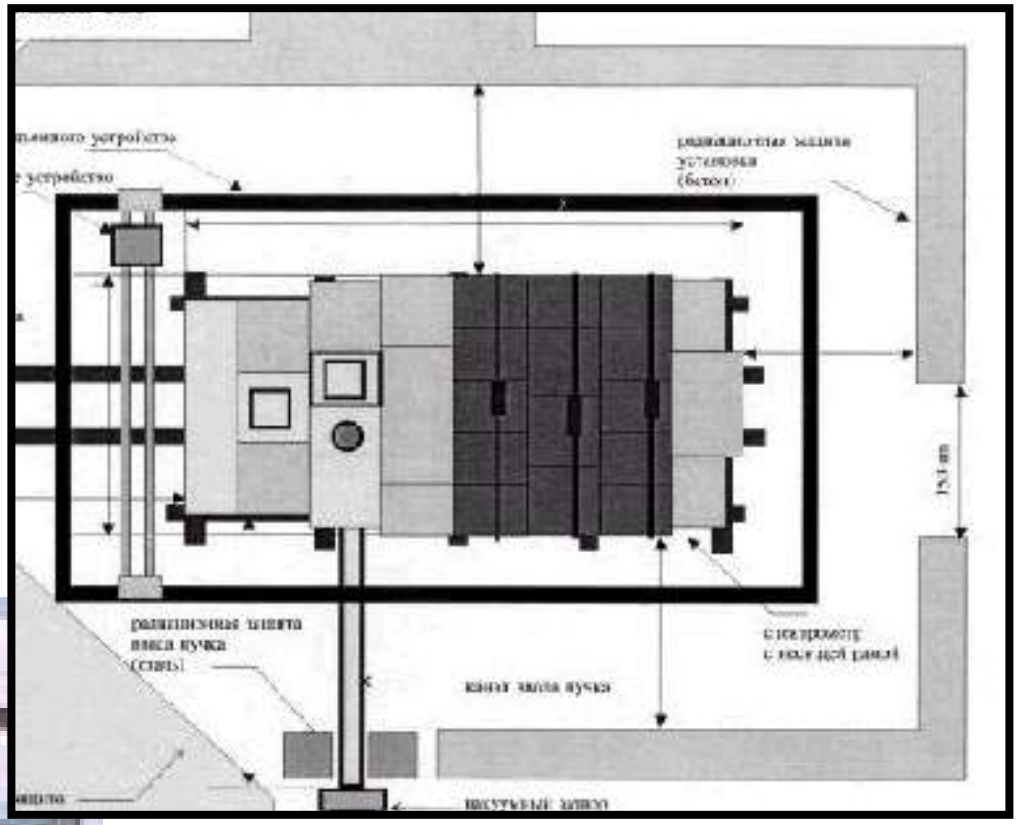
Proton Beam Parameters

- Beam energy
  140 - 600 MeV (***450 MeV***)
- Beam current
  0.1 nA - 0.5 mA (***0.1 mA***)
- Beam pulse duration (TWD)
  0.25 - 180 mks
- Pulse frequency
  1 - 100 Hz (***50 Hz***)

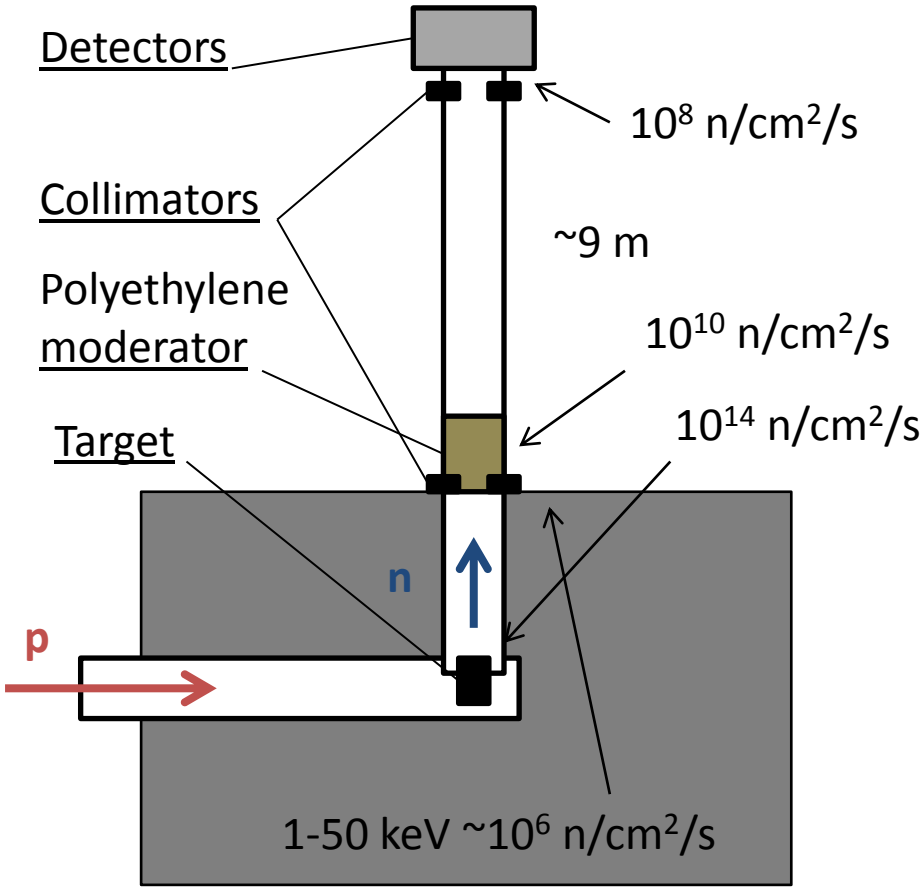
Experimental Complex of INR RAS

LSDS-100

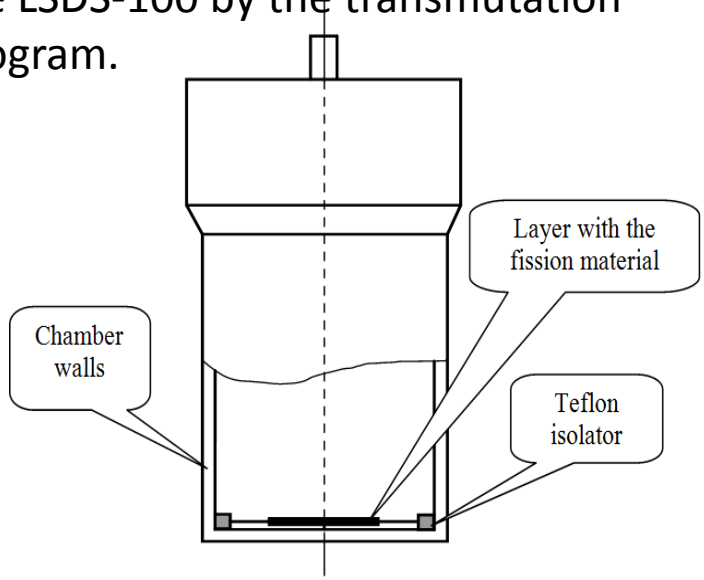
- LSDS-100 Spectrometer
  100 ton Pb cube, C prism
- Neutron energy: 1 eV - 50 keV.
- Neutron intensity
  ~10^6 n/cm^2/s near the cube surface with ~1 mkA proton beam current
- Beam pulse duration 0.25-180 mks
- Frequency 1-100 Hz



TOF & Slowing-Down Techniques on LSDS-100



Fast ionized fission chambers (Institute of Physics and Power Engineering) with thin layers of minor actinides are supposed to use for measurements the neutron fission cross-sections of minor actinides at the LSDS-100 by the transmutation program.



Alekseev A.A., Grigoriev Yu.V., Dulin V.A., Libanova O.N., Novikov-Borodin A.V., Matushko V.L., Mezentseva Zh.V., Ryabov Yu.V. **The TOF method for the LSDS-100 spectrometer**. – Proc. Int. Seminar ISINN-23, Dubna, JINR, 2016.

Acknowledgements

Dedicated to memory of Prof. Yu.V.Grigoriev,
who was a leader and an inspirer of this project

Thank You for Attention