

CJD: Progress Report, 2008/2010

Summary of Nuclear Data activity by staff of the IPPE CJD

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IAEA NRDC Meeting

“The International Network of the Nuclear Reaction Data Centers”
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1. Staff

- 1.1. Total number of staff in the CJD is 9. This is divided into 6 professional staff and three support staff.
- 1.2. In the frame of the general re-organization of the IPPE six new staff numbers joined to CJD and in future they will be involved in the Nuclear Data activity. They are: four physics with a high level of qualification (3 Doctors in Physics and one Ph.D. in Physics), one technical staff and one post-graduate student.

2. Activity in a range of Nuclear Data Compilation

2.1. EXFOR compilation activity.

2.1.1 New and revised entries / subentries since the 2009 NRDC meeting

Exfor Transes 4146 – 4148 were transmitted to NDS as final.

Exfor Transes 4149 is transmitted as preliminary.

Compilation statistics

TRANS	Date/status	Entries	Entries	Entries	Subents	Subents	Subents
		Total	New	Revised	Total	New	Revised
4146	2009/07/22Final	47	0	47	465	35	430
4147	2009/12/11Final	31	4	27	106	17	89
4148	2009/02/09Final	66	5	61	469	22	447
4149	2010/ 03/29Prelim	25	8	17	162	36	126
Total		169	17	152	1202	110	1092

2.1.2. Computer and software matters. WEB-site service.

In processing of compilation the information for EXFOR library the CJD operates widely with next items:

The digitizing program of Sarov is used to digitize graphical data for EXFOR.

- New tool of web-service for compilers <http://nds121.iaea.org/exfor2/x4up1.htm> (developed by V.Zerkin) is used for trans checking.
- CHEX code and Janis checker system is used for checking of EXFOR entries.
- The information from NRDC web-sites:
 - http://www-nds.iaea.org/nrdc/error/exfor_err1.html,
 - http://www-nds.iaea.org/nrdc/error/exfor_err2.html,
 - http://www-nds.iaea.org/nrdc/error/exfor_err3.html is used for correction of the old Entries.
- <http://www-nds.iaea.org/exfor-master/x4compil/> - EXFOR status compilation web-page is used to found the articles for compilation.

2.2 Re-analysis of the IPPE's photofission experiments

In during of 30 years the IPPE performed a lot of measurements of photofission cross sections for 21 fissile systems. In some cases the measurements for the same nuclide were made few times with different conditions. CJD organized a process of re-analysing of experimental results using a modern mathematical methods for processing of initial experimental data to obtain the unified and self-consistent results in a complete photon energy range up to 11 MeV. A new compilation includes experimental data for integral photofission yield, photofission cross section, photofission cross section ratio to Np237(g,f) or U238(g,f) , new standard for Np237(g,f) and U238(g,f) and for six even-even nuclides were obtained differential photofission cross sections for fixed parity and states ($I^\pi=2^+$ ($K=0, 1, 2$) and $I^\pi=1^-$ ($K=0$ и 1)). This activity was ended in 2009 and their results will be published in J., YK-2010.

2.3. Compilation of measurements in high energy range.

CJD supported the activity of Yu.E.Titarenko's group to compile their experimental results as a unified set and help to publish that as a special issue of Journal "Yadernye Konstanty" -2009:

Yu.E.Titarenko et al. Detailed data on the threshold reaction rates outside and inside the 0.8 GeV protons-irradiated thick Pb target. J., YK, 2009, v.1-2, p.2-221.

The work presents the results of experimental determining the threshold reaction rates in 79 ^{209}Bi , $^{\text{nat}}\text{Pb}$, ^{197}Au , ^{181}Ta , ^{169}Tm , $^{\text{nat}}\text{In}$, ^{93}Nb , ^{64}Zn , ^{65}Cu , ^{63}Cu , ^{59}Co , ^{19}F , and ^{12}C samples and in 127 ^{27}Al samples. The samples are arranged along the proton beam axis inside and outside the collapsible 920-mm thick Pb target of 50-mm diameter. The target is assembled of 23 40-mm thick discs. The reaction rates are determined by direct γ -spectrometry techniques. The measurements are made using a GC-2518 detector of 1.8 keV resolution and a DGDК-60V detector of 2.9 keV resolution in ^{60}Co 1332 keV ^{60}Co γ -line. The γ -lines measured are processed by the GENIE2000 code system. In all, 1196 γ -spectra have been measured and processed, and about 2467 reaction rates determined (monitor reactions included).

Electronic version of numerical data is stored in CJD.

2.4. Compilation of benchmark experiments

CJD participated in compilation of integral benchmark experiments performed in IPPE (see Appendix A). Some initial measurements were seriously modified. In future this compilation will be presented as a Handbook. Main task of a compilation is using in testing of evaluated nuclear data.

2.5. MEASUREMENT OF ACTIVATION IN VANADIUM AND V-ALLOYS IRRADIATED IN FAST REACTOR

CJD organized the measurements of radioactivity of targets irradiated in the BR-10 fast reactor (see Appendix B). These results were used for testing the activation data libraries BROND-3/ACTV and ACDAM. This work is in processing.

3. Publications

In during 2008 - 2009 two issues of the journal “Yadernye Konstanty” were prepared and printed. Some results concerning the BROND-3 library were presented in J., YK-2008.

4. Nuclear Data Services

The nuclear data services are provided through direct contact with the users from many Russian organizations. Mainly the compilation of the evaluated data of the different types are needed. That is why the requests obtained by the CJD in last time are needed in a specialist labour.

4. NUCLEAR DATA EVALUATION Activity

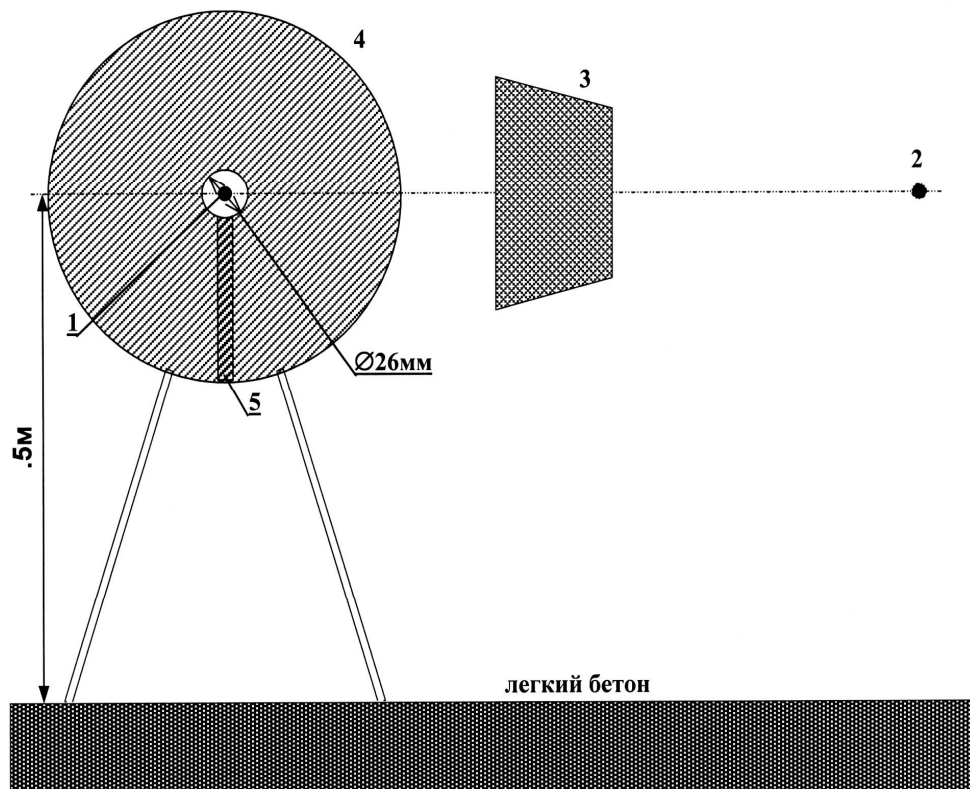
1. BROND-3/GN – processing and integral testing
2. BROND-3/FP-YLD (28 fissile nuclei for neutron and 3 for photofission)
3. BROND-3/STANDARD
4. BROND-3/RRDF
5. BROND-3/ACTV
6. BROND-3/Photonuclear data library for actinides
7. New data library ACDAM for the activation/damage calculations is compiled in the Russian Nuclear Data Center and consists from three parts:
 - *Activation/transmutation neutron cross-section base* (From the element H (A=1) to Po (A=210), in the neutron energy range 10^{-5} to 20- MeV and it includes 704 target isotopes with data presentation: in ENDF-6 format).
 - *Decay Data Library (DeDaL)*
 - *Damage Data Library (DDL)* (60 elements/isotopes in the neutron energy range 10^{-5} to 20- MeV. The data for main structural elements and basic impurities involved in alloys and steels are included in the DDL in ENDF-6 format.

8. CJD was engaged in re-evaluation and preparation of evaluated neutron data for minor actinides and fission products for the ROSFOND-2008 Library which is a base for the ABBN group constant system for calculations of fast breeder reactor. The correction, processing and testing of modified evaluated data files is under way.

5. Our current publications concerning nuclear data

1. V.Pronyaev, E.Gai. RFS-2007: RUSSIAN FILE OF NEUTRON STANDARD CROSS SECTIONS WITH FULL COVARIANCE MATRIX OF UNCERTAINTIES. J., YK-2008, v1-2, p.
2. A.Blokhin et al. INTERCOMPARISON OF ACTINIDE NUCLEAR DATA FOR TRANSMUTATION. J., YK-2008, v1-2, p.
3. A.Ignatyuk, V.Manokhin, V.Pronyaev. COMPILATION OF FISSION PRODUCT DATA FILES FOR THE BROND-3 LIBRARY. J., YK-2008, v1-2, p.
4. Khorasanov G.L., Korobeynikov V.V., Ivanov A.P., Blokhin A.I. Minimization of an initial fast reactor uranium-plutonium load by using enriched lead-208 as a coolant. Nuclear Engineering and Design, 2009, v.239, No 9, pp. 1703-1707.
5. Khorasanov G.L., Korobeynikov V.V., Ivanov A.P., Blokhin A.I. MACROSCOPIC CROSS-SECTIONS OF NEUTRON RADIATION CAPTURE BY Pb-208, U-238 AND Tc-99 NUCLIDES IN THE ACCELERATOR DRIVEN SUBCRITICAL CORE COOLED WITH MOLTEN Pb-208. REPORT TO PHYSOR-2010
6. B. Jansky, Z. Turzik, E. Novak, M.Karac, L. A. Trykov, A. Blokhin. Neutron Spectra Measurement and Calculations Using Different Data Libraries in Iron Benchmark Assembly. Proceedings of the CANDIDE workshop "NEMEA-4: Neutron measurements, evaluations and applications", 16-18 October 2007, Prague, Czech Republic, edited by A. Plompen. Report EUR 23235 EN-2008, p.79-82.
7. B. Jansky, Z. Turzik, E. Novak, M.Karac, L. A. Trykov, A. Blokhin. Neutron Spectra Measurement and Calculations Using Different Data Libraries in Iron Benchmark Assembly. in Proceedings of the International Conference on Nuclear Data for Science and Technology, April 22-27, 2007, Nice, France, editors O.Bersillon, F.Gunsing, E.Bauge, R.Jacqmin, and S.Leray, EDP Sciences, 2008, vol.2, pp.961
8. A.I. Blokhin and A. S. Soldatov, Physics of Atomic Nuclei, 2009, Vol.72(6), pp.917-927, DOI [10.1134/S1063778809060039](https://doi.org/10.1134/S1063778809060039)

Appendix A. IPPE: Scheme of leakage n(g)-spectra measurement



Task: to prepare a review book with a compilation of experimental data which can be used for benchmark testing of evaluated data files for a fission reactor applications.

Content:

1. Compilation of experimental data on neutron and photon transport in different targets obtained mainly in the IPPE. The IPPE has accumulated large experience of benchmark experiments in various geometries, the results of which will be placed into database of the benchmark experiments and calculations. Large attention has been paid recently to the study of secondary gamma-radiation for the materials used in reactor building, as far as in many cases calculated data differs greatly to those of experiments. Neutron and photon spectra leaking from the surface of different targets with neutron source in the centre were obtained.
2. Neutron sources: Cf-252, Pu-Be, Pu-B, 14-MeV.
3. Target: H₂O, H₂O+B, D₂O, Li, Be, Al, Na, Cr, Fe, Fe+H₂O, Ni, Cu, Zr, Nb, Mo, Pb, Bi, Th-232, U-235, U-238, CH₄, Graphite and so on. A total sum is ~70.

4. Geometry of Targets:
spherical shells of 20, 30, 40, 50, 60, 70, 100 cm in diameter;
slabs with a size up to 150 cm;
cylinders in a combination with spherical shells;
5. A review of neutron sources used in experiment (Cf-252, Pu-Be, Pu-B, 14-MeV).
6. A review of detectors and the response functions used in measurements.
7. Experimental data will be used for benchmarking of new evaluations of the neutron induced reaction cross sections and gamma-ray yields. Comparisons with the JEF-2.2, JEFF-3.0/1, ENDF-VI/VII and BROND-2.2/3 data files will be performed.

Appendix B. Measurements of induced radioactivity of vanadium and vanadium alloys irradiated in the BR-10 fast reactor.

№	Vanadium and vanadium alloys irradiated in BR-10 reactor
1	V – 100%
2	V – 100%
3	V – 4%Ti – 4%Cr
4	V – 9%Ti – 5%Cr
5	V – 5%Fe
6	V – 0,5%Fe
7	V – 0%Fe
8	V – 5%Ti – 5%Cr

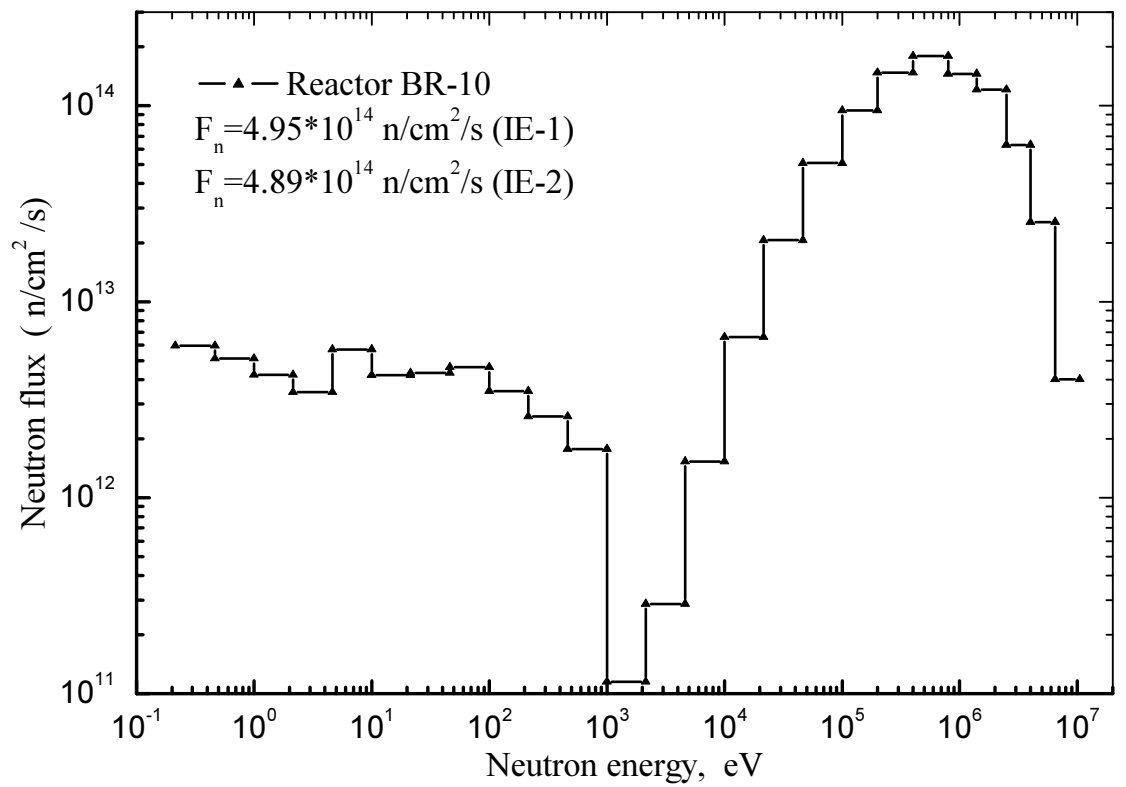


Figure 1. Neutron spectrum for the experimental channel in BR-10

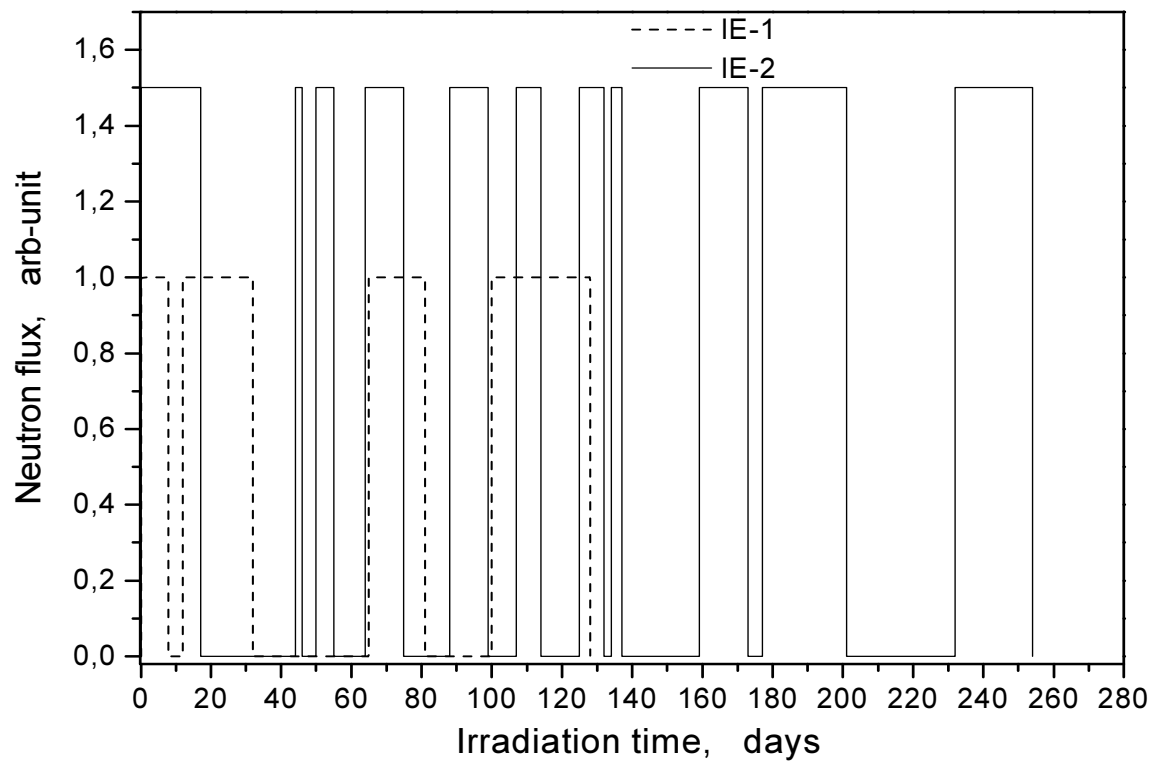
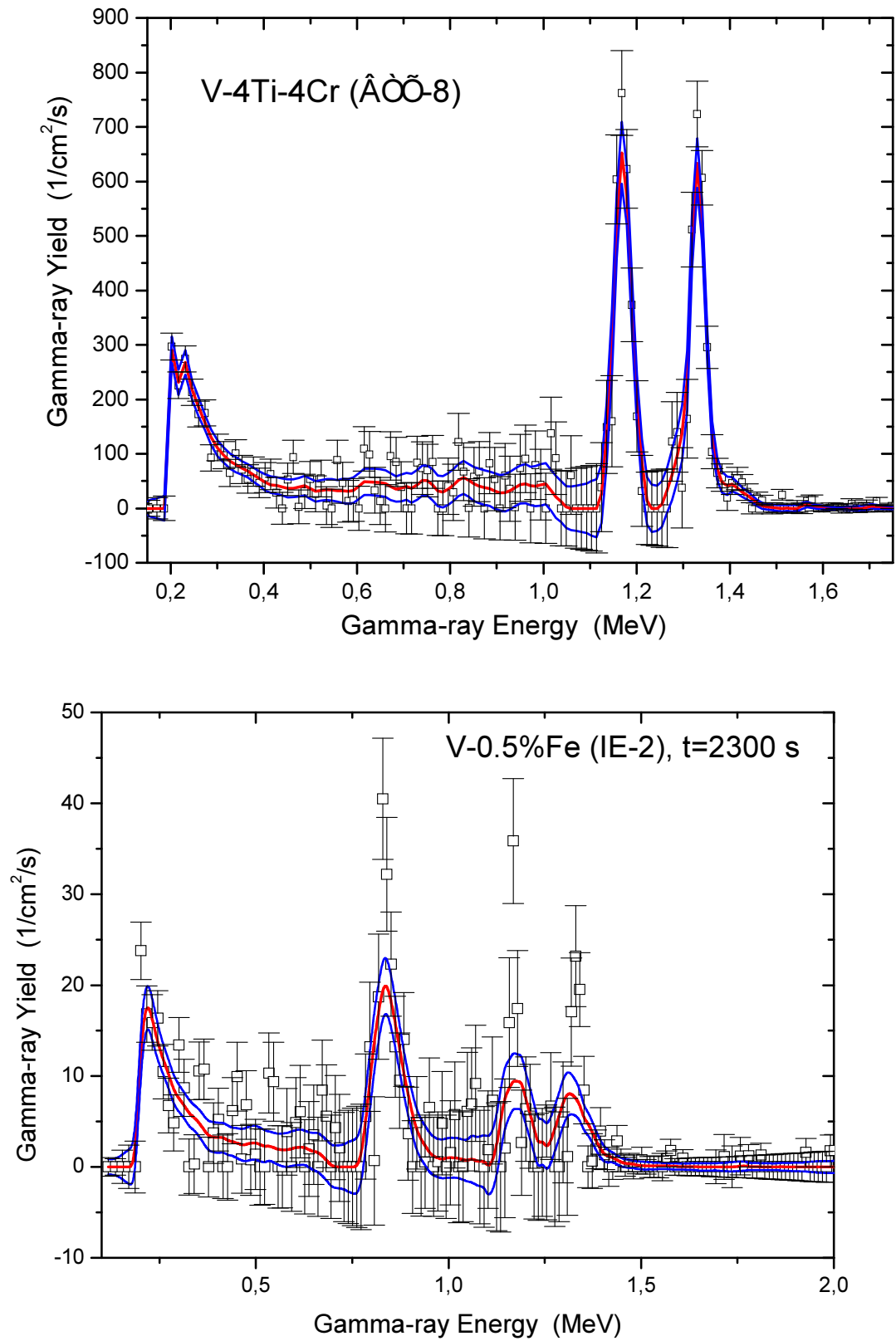


Figure 2. Time schedule for irradiation of targets in BR-10



Figures 3, 4. Examples of measured gamma-rays spectra of irradiated targets