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Differential Sensitivity of the CSC's to Neutrons in Function of Neutron Energy in the Range $0.1\text{eV} < E_n < 20$ MeV

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Abstract:

Investigation of the CSC's differential sensitivity to neutrons depending on neutron energy is proposed. The Gatchina time of flight neutron spectrometer (GNEIS) is planned to use to attain the following main goals:

- to investigate a response of the cathode strip chambers to neutrons in wide energy region 0.1 eV < E < 20 MeV with 10% neutron energy resolution;
- to analyze the time correlation between different chambers in stack;
- to measure the amplitude spectra of the chamber pulses;
- to investigate of the inner chamber processes contributing to the chamber output signal;
- to study influence of chosen construction materials on sensitivity of the chambers to neutron induced background.

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1. The response of CSC's to the very high neutron and gamma-ray background at GEM is the question of close attention now (GEM TN-92-199). We propose to perform detailed investigation of the CSC sensitivity to neutrons of different energies using the neutron time-of-flight spectrometer GNEIS at the Gatchina 1 GeV proton synchrocyclotron. The PNPI spallation pulsed neutron source has the next parameters:

- the integrated neutron yield from the lead target for internal proton current of about 3 μA $\sim 3 * 10^{14}$ n/sec;
- the neutron burst width ~5-7 nsec;
- an accelerator repetition rate 50Hz.

The general layout of the GNEIS facility is given in figure 1. Figures 2 and 3 show the energy spectrum of neutrons in two energy regions for a fixed energy resolution of DE/E=8.8*10^{-4} .The more detailed description of GNEIS is given in supplement to proposal (N.K.Abrosimov et al.,Nucl.Instrum.and Meth. A242 (1985) 121).

2. The main goals of these investigations are the measurement of the PNPI CSC prototype sensitivity to neutrons and to study the other CSC's prototypes constructed from specialized materials

and filled with different gas-mixtures for minimizing the chamber neutron sensitivity. The PNPI CSC prototype is shown in figure 4. It has practically the same design as investigated at BNL prototype tested at TTR. The chambers will be tested in the different neutron beams depending on the energy range choosen. The first beam originates from the lead target (E =0.1-20 MeV) and another beam is prodused by the polyethylene moderator (E =0.1-10^5 eV). For calibration measurements, we are planning to use the lithium-6 glass scintillation detector,the detector with boron-10 plate, the counter filled with helium-3 and the fission ionization chambers containing uranium-238 and thorium-232 for $E_n > 1$ MeV region.The types of the neutron reference detectors will depend on the neutron energy range.

3. The research program can be divided into several stages. At the first stage,the PNPI prototype response to neutrons will be studied in the wide energy region (0.1eV < E < 20 MeV) with energy resolution of about 10% using the multistop measurement procedure. The pulses from the all fast outputs (wires and stripes) of the prototype will be added in OR and used as STOP signals for the time of flight analysis. The START signal will be taken from the accelerator.The efficiency of the chamber stack as a whole can be calculated from the comparison of the chamber and reference detector counting rates.

4. In the second stage, the amplitude spectra of the chamber pulses will be recorded and the correlation between different chambers in stack will be analyzed.

5. The third stage will be devoted to investigation of the inner chamber processes contributing to the chamber output signal. The region of neutron resonances of the chamber constructional mate-

rials will be studied with the high neutron energy resolution to understand and to separate their relative influence on the neutron induced background. The nontrivial character of this problem can be illustrated by the figures 5,6,7 and 8 which show the very complex energy dependence of the total neutron cross-sections for some nuclei containing in the chamber constructional materials. The different materials and gas mixtures will be examined.

6. For the CSC efficiency to neutrons at the level of $10^{-4}-10^{-3}$ (GEM TN-92-199,Preprint LINP NB46 1987), the GNEIS neutron source parameters and for energy resolution of about 10%, one can evaluate the total counting rate as (2-20) counts/sec for irradiated area of 20 cm^2 and the energy E~1 MeV. It means that $2*10^5$ or $2*10^6$ events per day will be taken in this energy interval. The statistics for the neutron energies $E < 1$ MeV will be even better.

7. The investigation of the CSC sensitivity to californium source neutrons and to gamma quanta from various sources will be done in parallel to the main program. The CSC sensitivity to γ-rays of different energies can be measured with about 10radioactive sources with known activity. For example, one can use the ^{243}Am,^{57}Co,^{137}Cs,^{60}Co sources which have practically monoenergetic spectra (59 KeV, 130 KeV, 661 KeV, 1250 KeV). We want to investigate the sensitivity of different CSC parts to background gammas using the collimated gamma beams from the sources. The measurement of the CSC sensitivity to the Cf source neutrons will be done to check the result of the measurements (GEM TN-92-199) where strong sensitivity of CSC to neutrons has been observed.

8. The first stage of this program can be started in the beginning of April. The whole program can be fulfilled by the end of 1993.

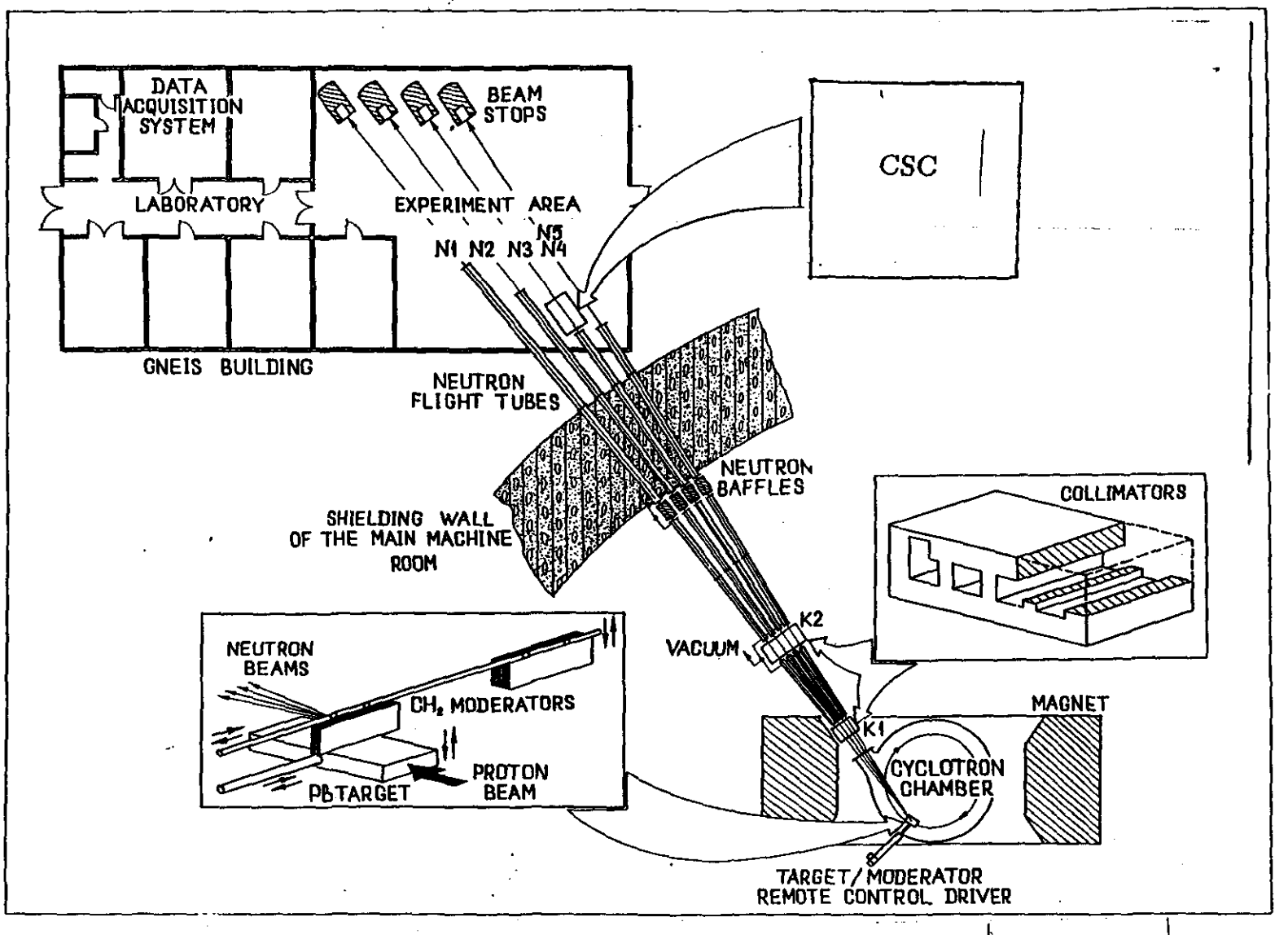


Fig. 1 General layout of the GNEIS facility.

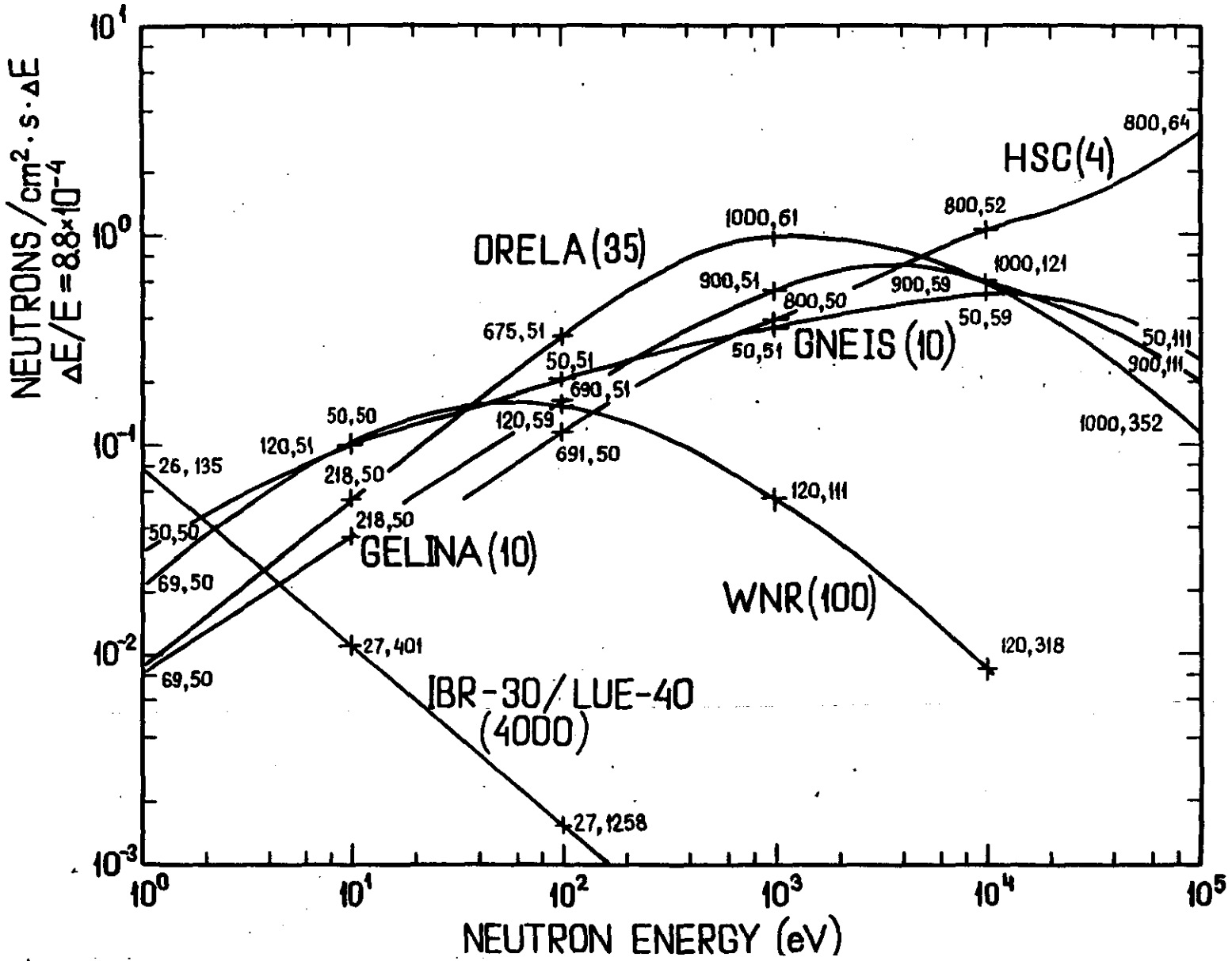


Fig. 2 Neutron spectra of GNEIS in 1-10⁵ eV energy range.

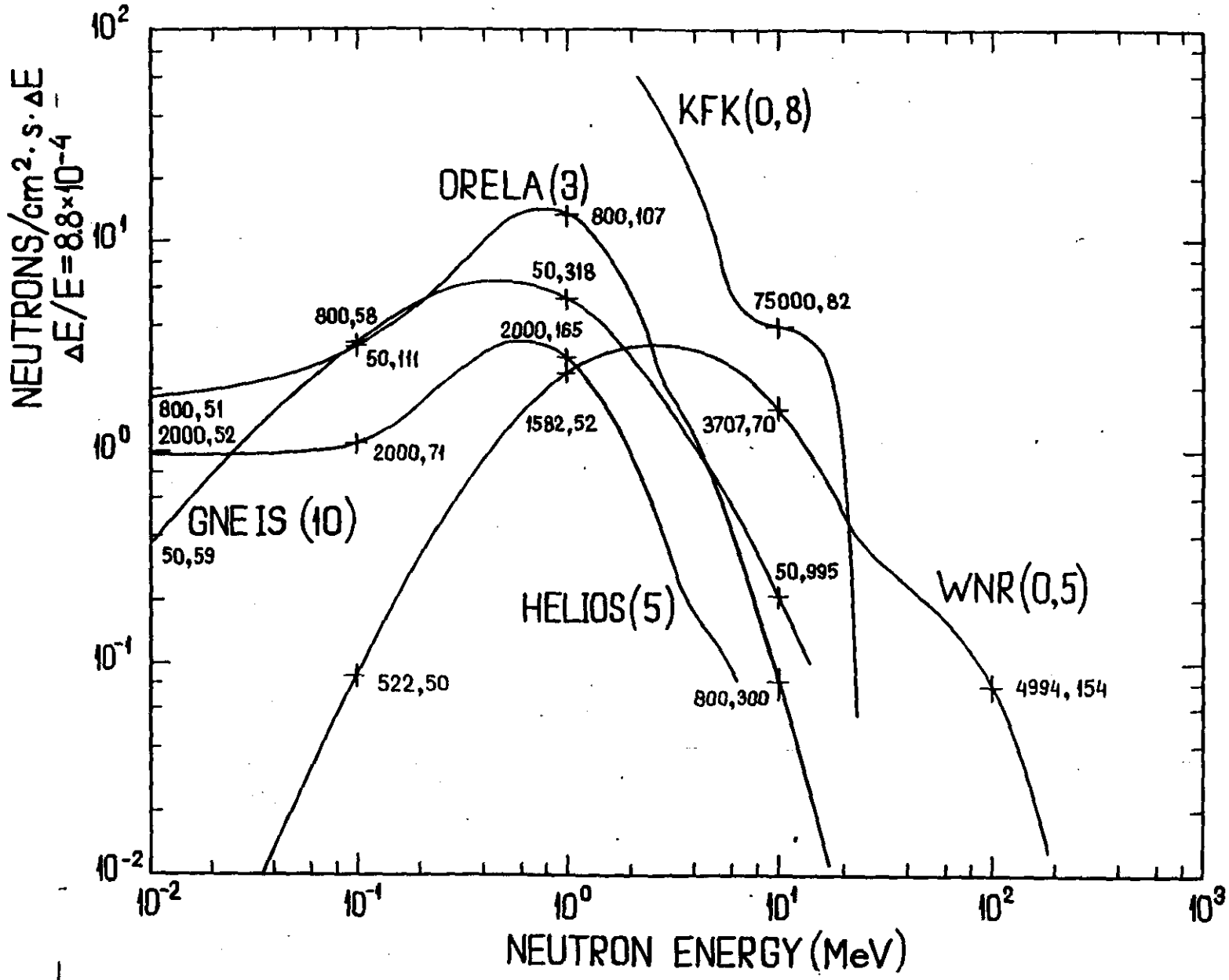


Fig. 3 Neutron spectra of GNEIS in $10^{-2}-10^{3}$ MeV energy range.

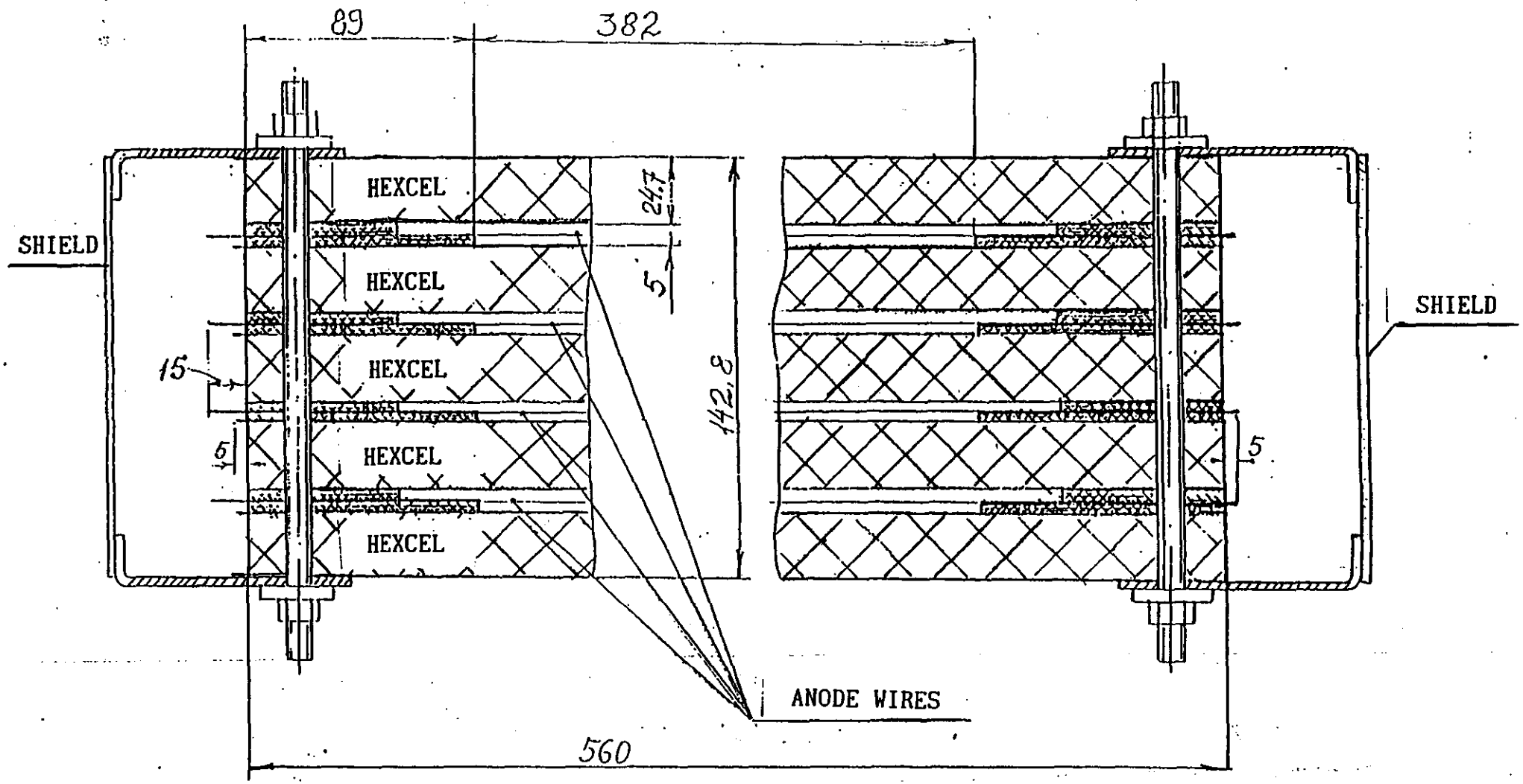
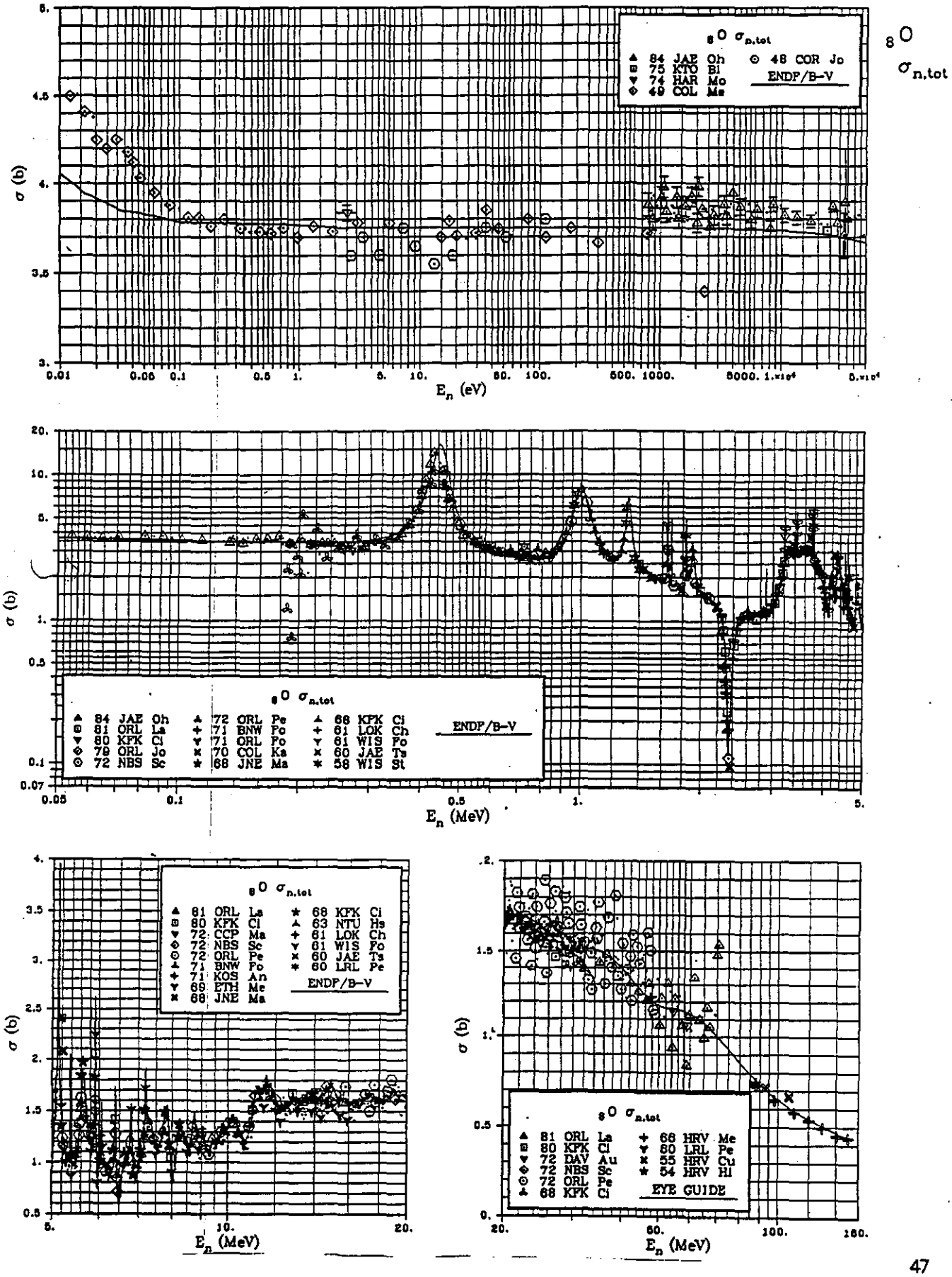


Fig 4. PNPI prototype of CSCs



$_8$O

$\sigma_{n,tot}$

Fig. 5 Total neutron crossection for $_8$O.

$_{14}$Si

$\sigma_{n,tot}$

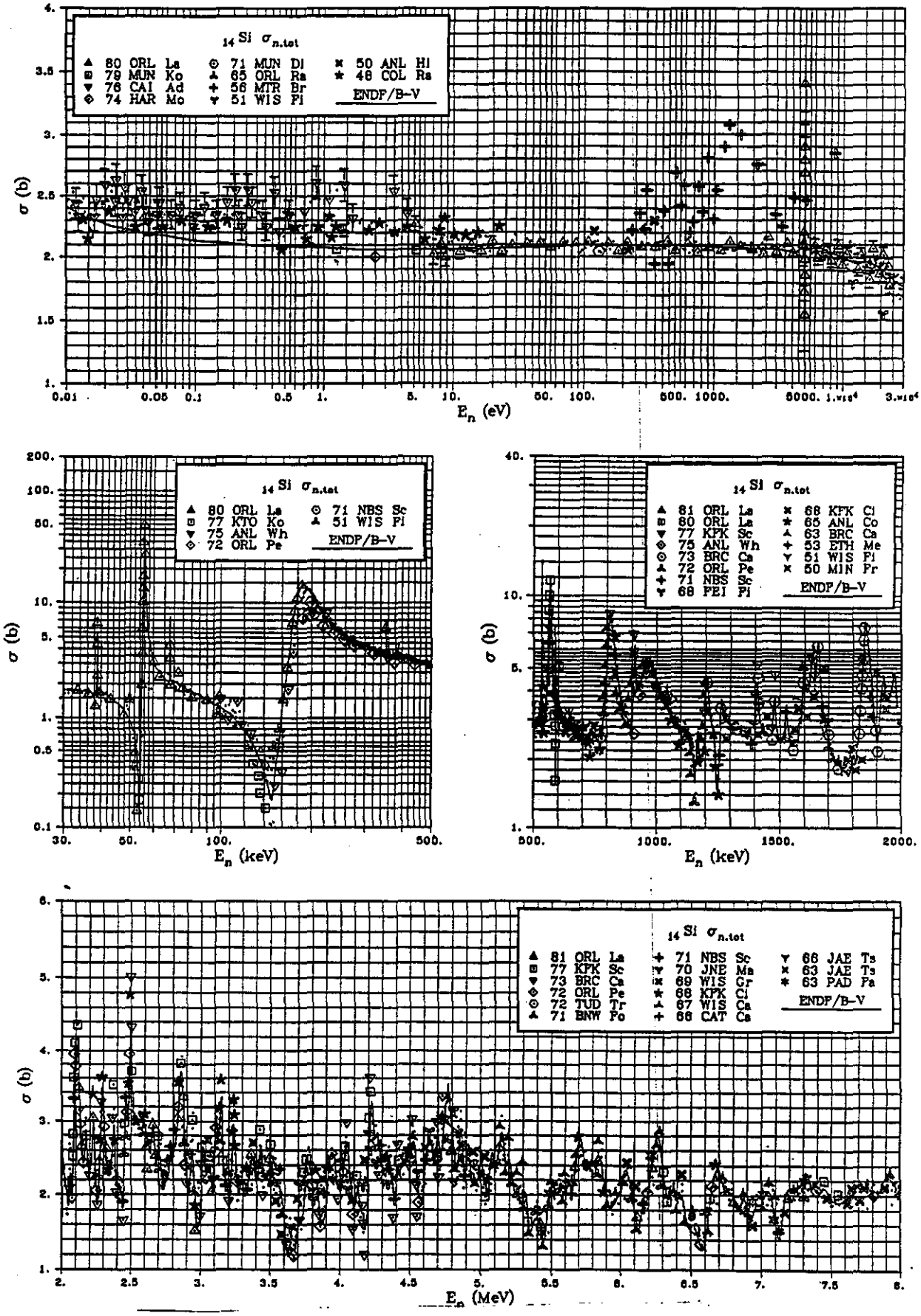
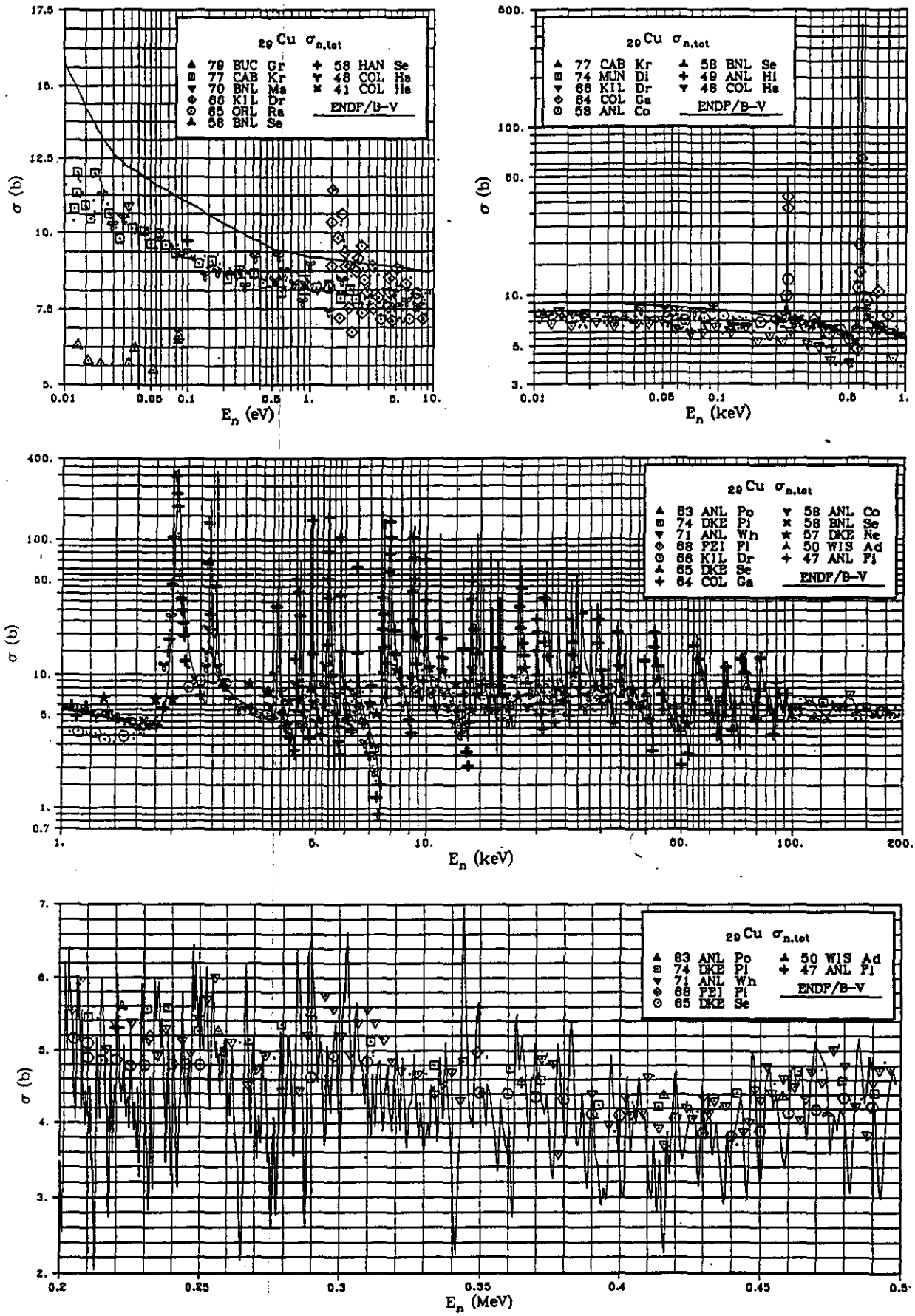


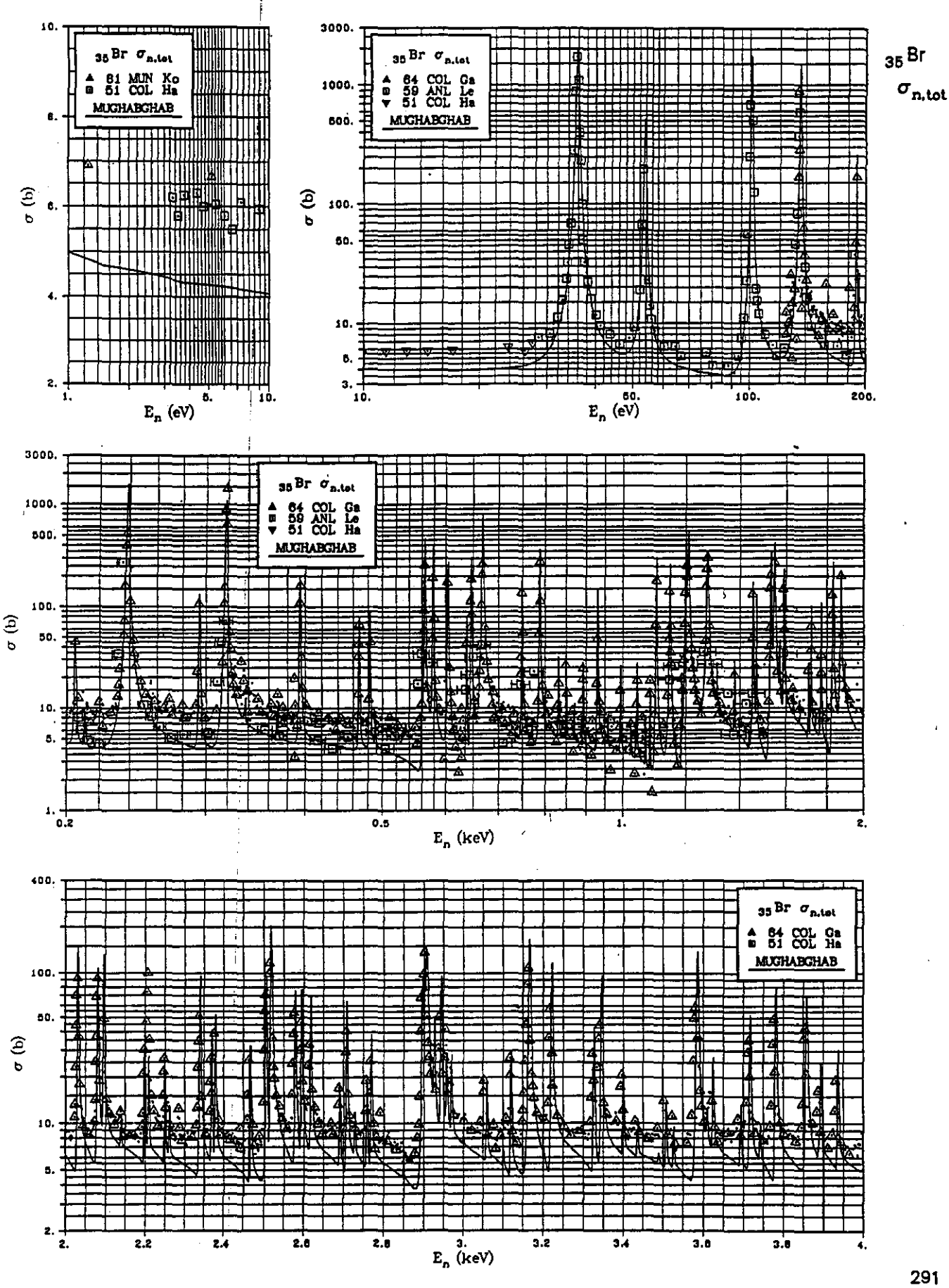
Fig. 6 Total neutron crossection for $_{14}$Si.



29Cu
σn,tot

233

Fig. 7 Total neutron crossection for $_{29}$Cu.



35 Br
$\sigma_{n,tot}$

Fig. 8 Total neutron crossection for $_{35}$Br.