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FIRST RESULTS FROM THE HIGH ENERGY TRANSFER SPECTROMETER HET AT THE SNS

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THE HET SPECTROMETER

The HET spectrometer [1] at the SNS is a direct geometry chopper spectrometer designed to study systems at high energy transfer ε with low associated momentum transfer Q and good resolution $\Delta\varepsilon$. The chopper [2], which spins at 600 Hz, has been successfully phased to the accelerator via a master clock. The burst time of the chopper is matched to the moderator pulse width and the spectrometer views the moderator at an angle of 27° to the normal to minimise the scan time contribution. Three chopper slit packages, optimised for 250 meV, 500 meV and 1000 meV are envisaged, but all commissioning to date has been done with the intermediate energy package.

The layout of the spectrometer is illustrated in Figure 1. The monochromating chopper is located at 10m and the primary flight path is

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11.8m. The low angle detector bank, covering 3° to 7°, has a secondary flight path of 4m. The detectors are 10 atmosphere ^{3}He tubes arranged in 5 banks with azimuthal symmetry. One bank is in the horizontal scattering plane for single crystal excitations and has an angular resolution of 0.25°. A bank of direct coupled scintillator detectors, again with azimuthal symmetry, covers scattering angles of 9° to 29° with 2° resolution. Currently 32 of the eventual 256 elements are available. A high resolution scintillator bank covering these angles with 0.5° resolution is located in the horizontal plane. The kinematic space covered by these banks is illustrated in Figure 2 for three values of incident energy. The difficulty of achieving high values of energy transfer subject to the constraint that $Q \leq 4\,\text{Å}^{-1}$ is illustrated in Figure 3. The chopper performance has been estimated using a Monte Carlo calculation and the resulting energy resolution, using the approach of reference [3], is given in Figure 4.

In addition the spectrometer has the capability of making measurements at high momentum transfer, an important region for the study of quantum fluids. For this purpose, a high angle bank, consisting of six scintillator elements at a secondary flight path of 4m, has been constructed, see Figure 1. Its scattering angle may be varied between 80° and 140°.

FIRST RESULTS

Excellent progress has been made with low intensity commissioning of the spectrometer. Beam profiles have been measured and show that B_4C collimation is extremely effective, see Figure 5. The bulk shield shutter position has been optimised for signal to noise. 126 detectors are being used and show good signal to noise, even at low scattering angles. With the chopper removed, timing and length calibrations have been carried out using resonance foils and Bragg diffraction.

Figure 6 shows the raw time-of-flight spectrum of ZrH_2 ($6\ 10^{21}$ H atoms/cm^2 with a beam area of 4 x 4 cm^2) taken with an incident energy of 526 meV. Data have been summed over all detectors between 3° and 7°. The total time to measure this spectrum was 6.9 μA-hr, which corresponds to 2 minutes at full SNS intensity. The measured elastic line at 1.6ms has a resolution of $\Delta E_o/E_o$ = 0.82% which compares well with the predicted value

of 0.79%. The inelastic features at 1.67ms, 1.79ms and 2.05ms correspond to the 140 meV, 280 meV and 420 meV simple harmonic oscillator transitions in ZrH_2. The momentum transfer associated with these features is 2.6Å^{-1}, 5.2Å^{-1} and 8.8Å^{-1} respectively. These data, transformed to an energy scale, but not corrected in any other way, are shown in Figure 7.

The user programme planned for HET includes experiments on the vibrational spectroscopy of metal hydrides, and hydrogen bonded systems, crystal field levels in actinide and rare earth metal systems, itinerant magnetism and momentum distributions in quantum systems. Data from a 26 μA-hr preliminary study of the ferroelastic KH_2PO_4 are shown in Figure 8.

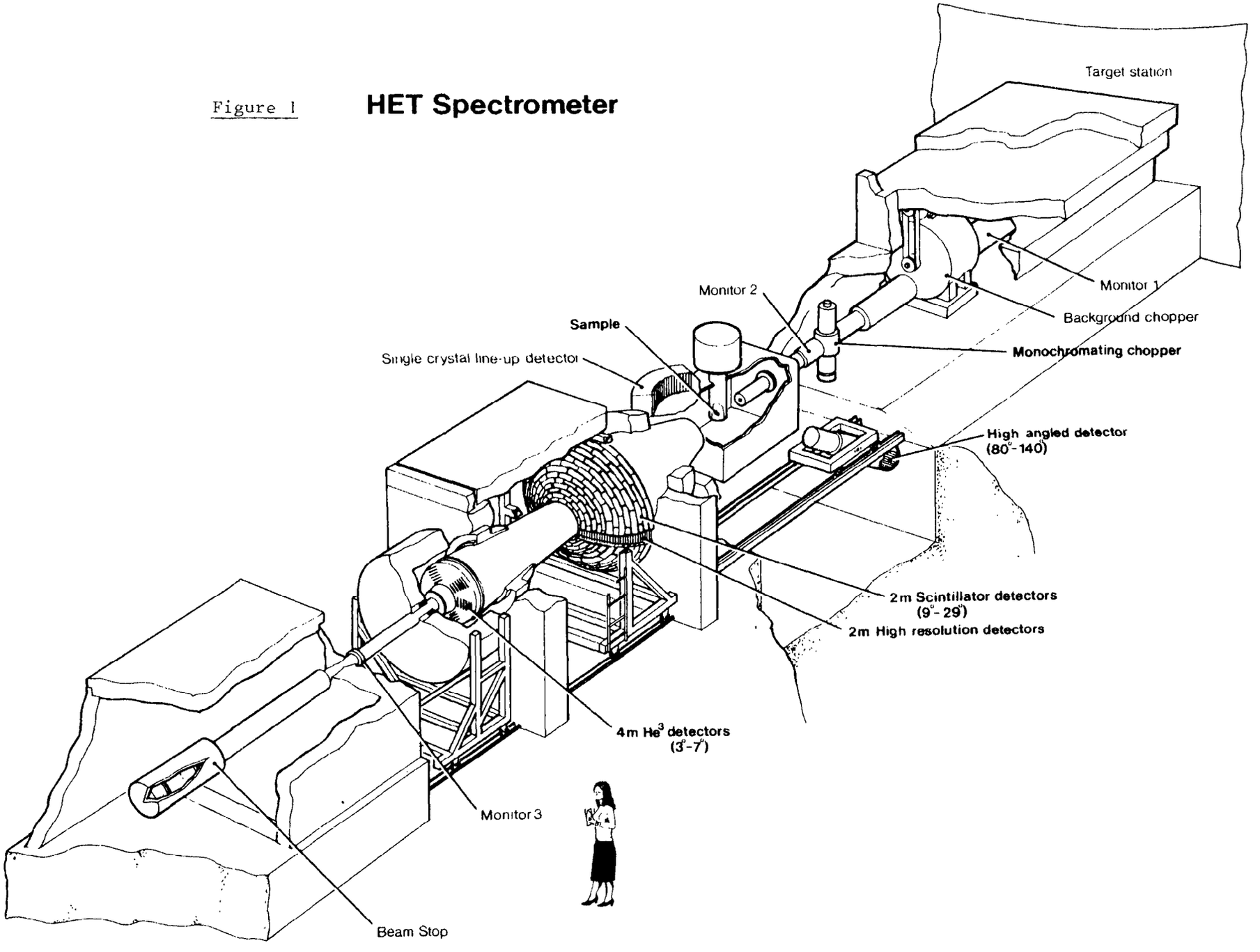
REFERENCES

[1] B C Boland, 'High Energy Inelastic Spectrometer' in 'Proceedings of ICANS-IV, October 1980', published as KENS Report II (1981).

[2] T J L Jones, J H Parker, J K Fremerey, K Bowden and I Davidson, 'Experience with the KFA-Julich Magnetic Bearing System on an SNS Neutron Chopper', these proceedings.

[3] C J Carlile, A D Taylor and W G Williams, 'MARS - A Multi-Angle Rotor Spectrometer for the SNS', Rutherford Appleton Laboratory Report RAL-85-052 (1985).

Figure 1 **HET Spectrometer**



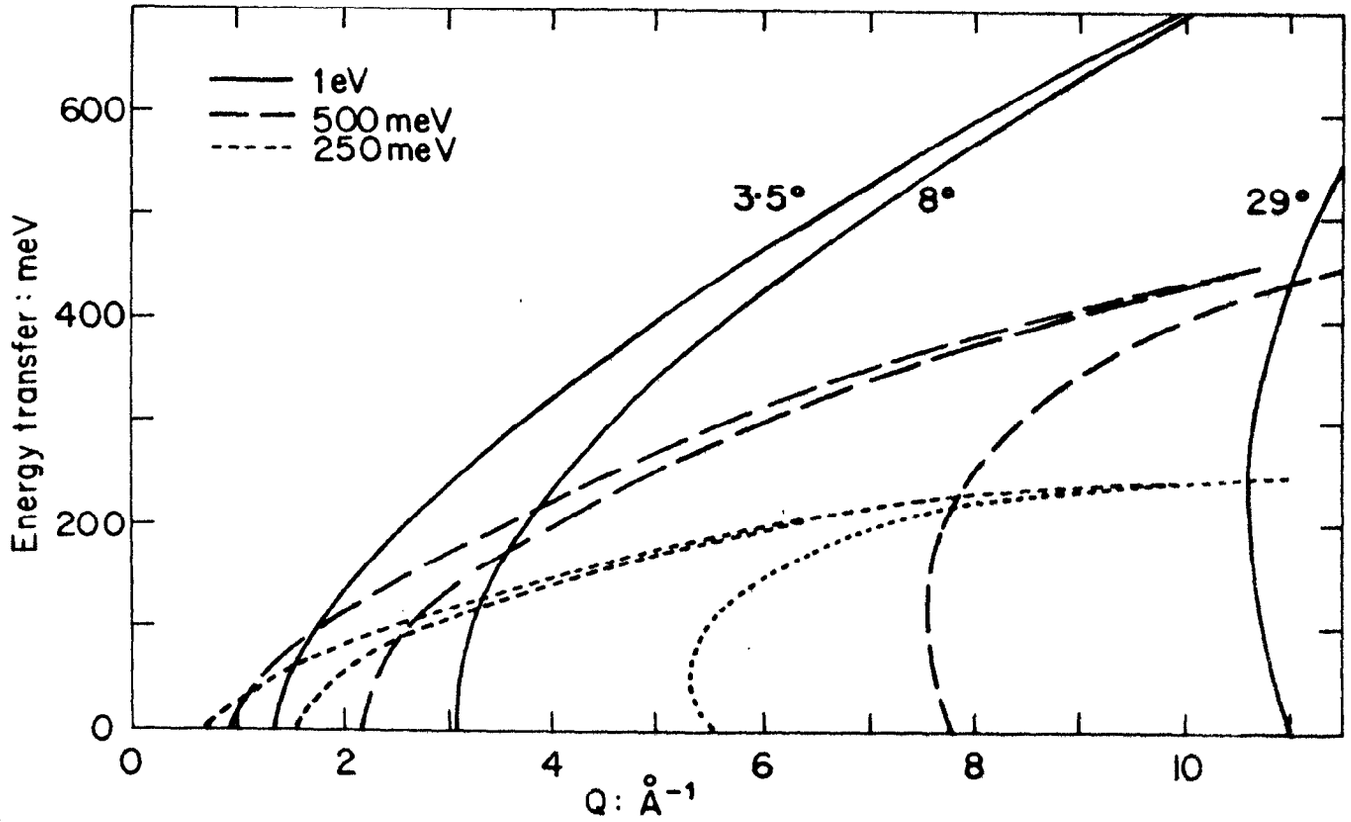


Figure 2 Kinematic space accessible by the 4m bank (3.5°-8°) and the 2m bank (8°-29°) for three values of incident energy

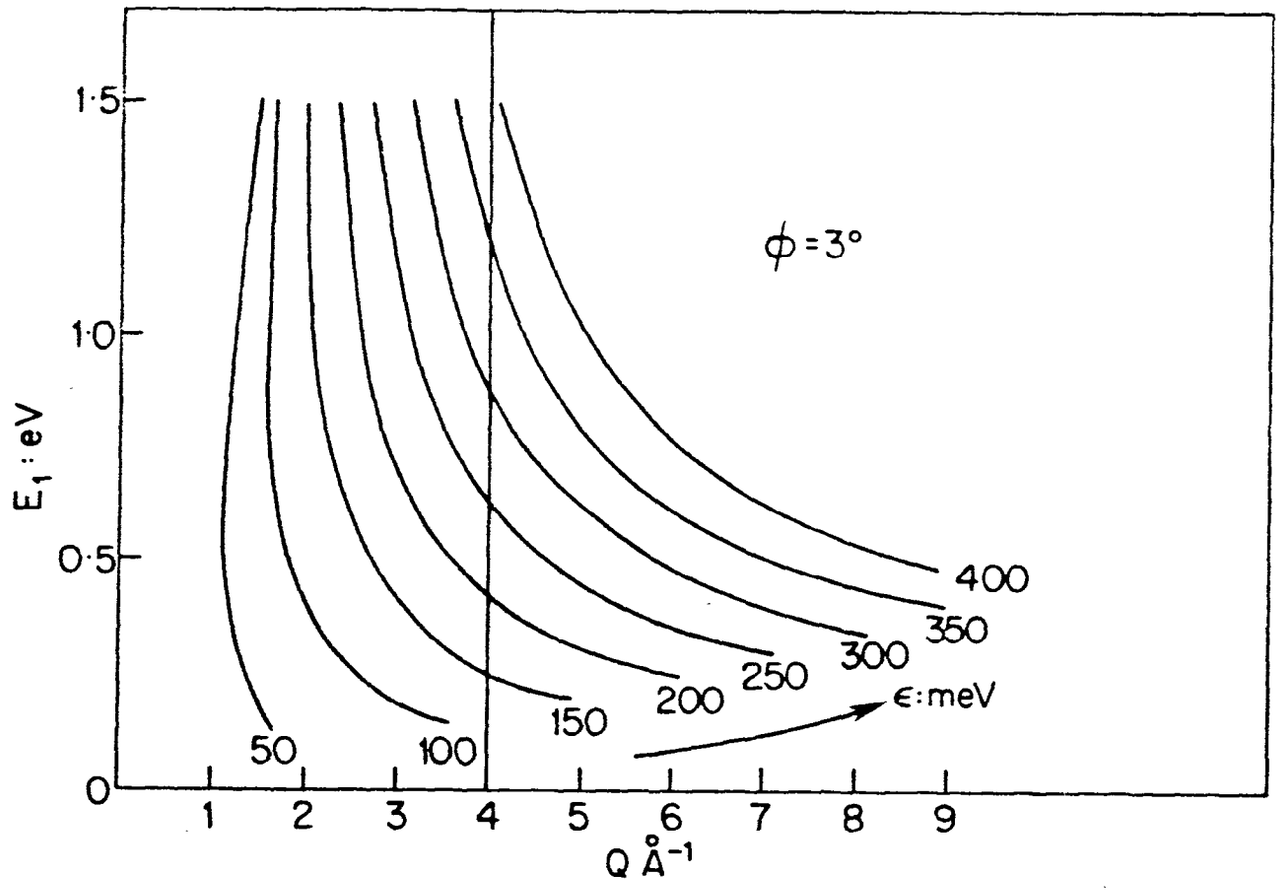


Figure 3 Plot of incident energy against momentum transfer for the lowest scattering angle illustrating the incident energies required to achieve a given energy transfer subject to the condition $Q \leqslant 4Å^{-1}$

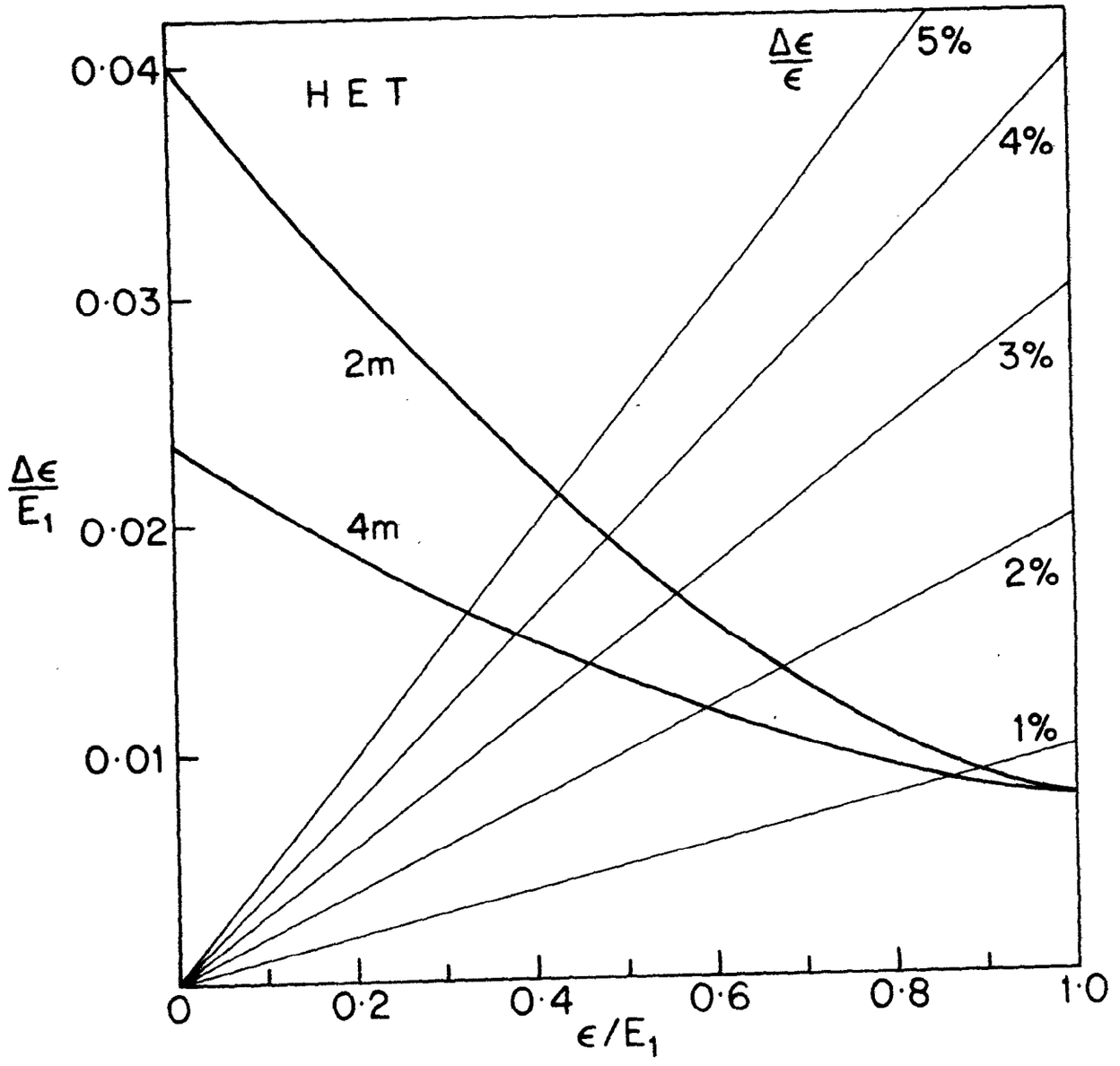


Figure 4 The energy transfer resolution of the HET 2m and 4m banks in reduced units. Fractional energy transfer resolutions are also indicated

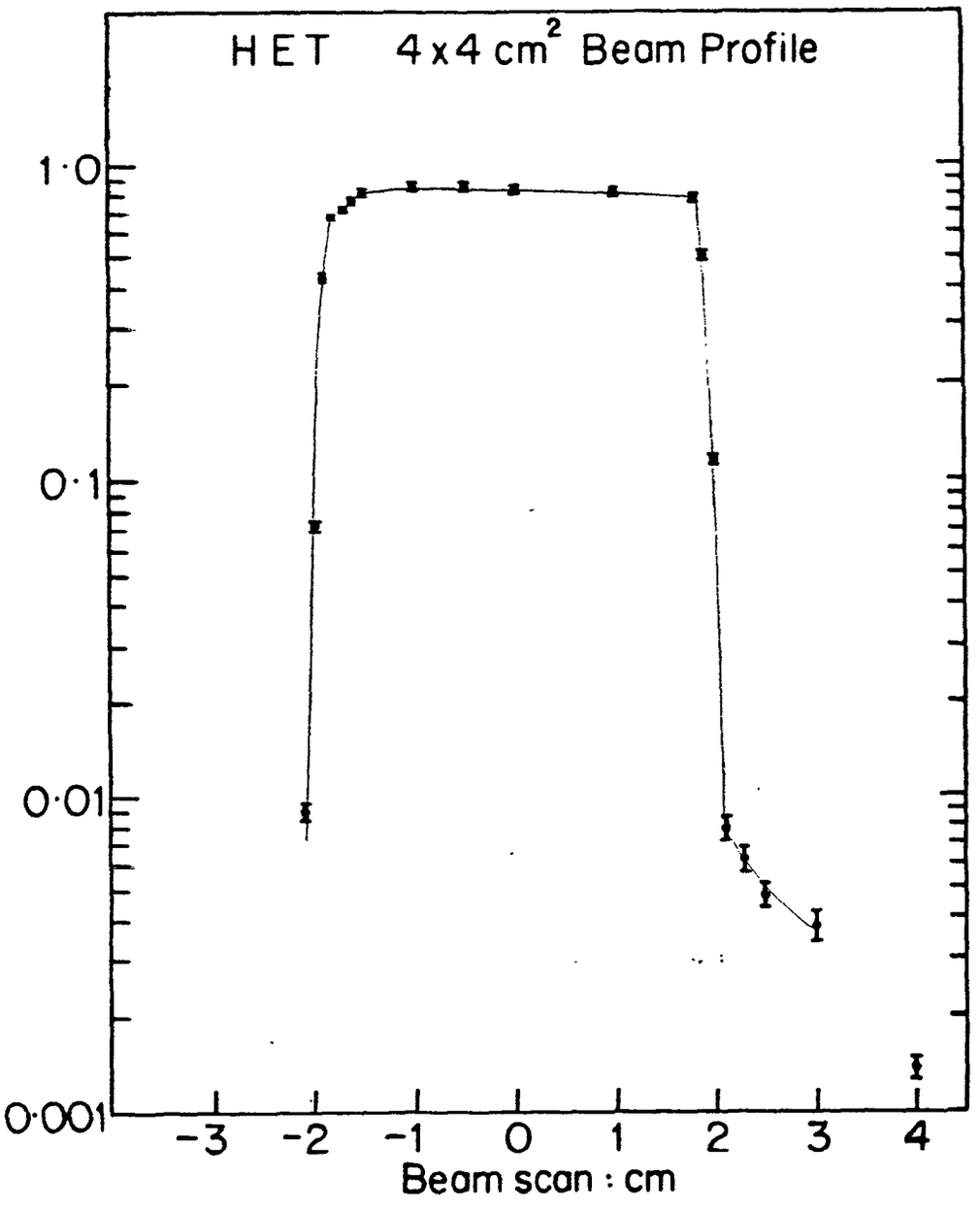


Figure 5 The measured HET beam profile at the sample position

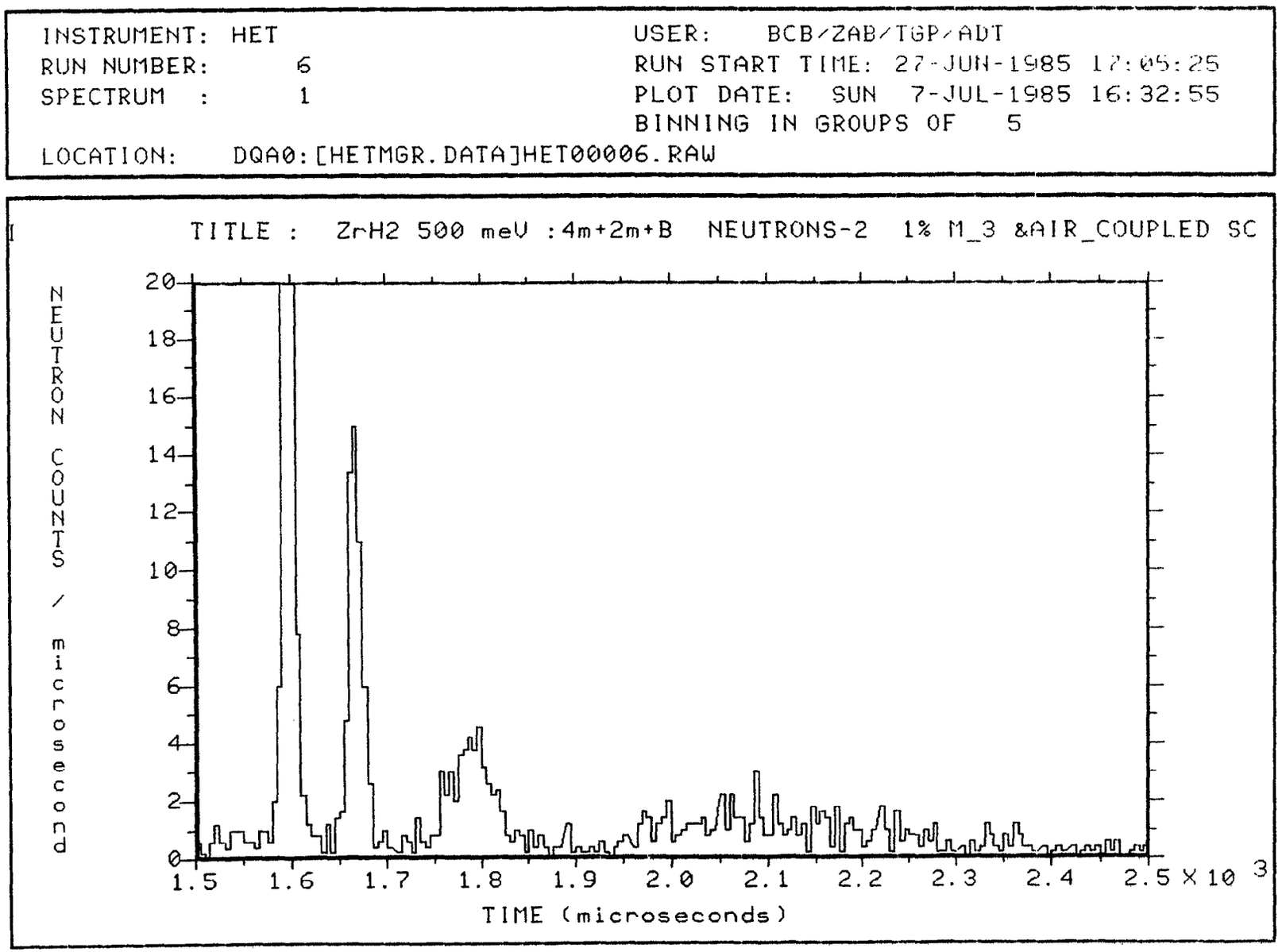


Figure 6 The raw time-of-flight spectrum of ZrH_2 taken in 6.9 μA-hr with an incident energy of 520 meV

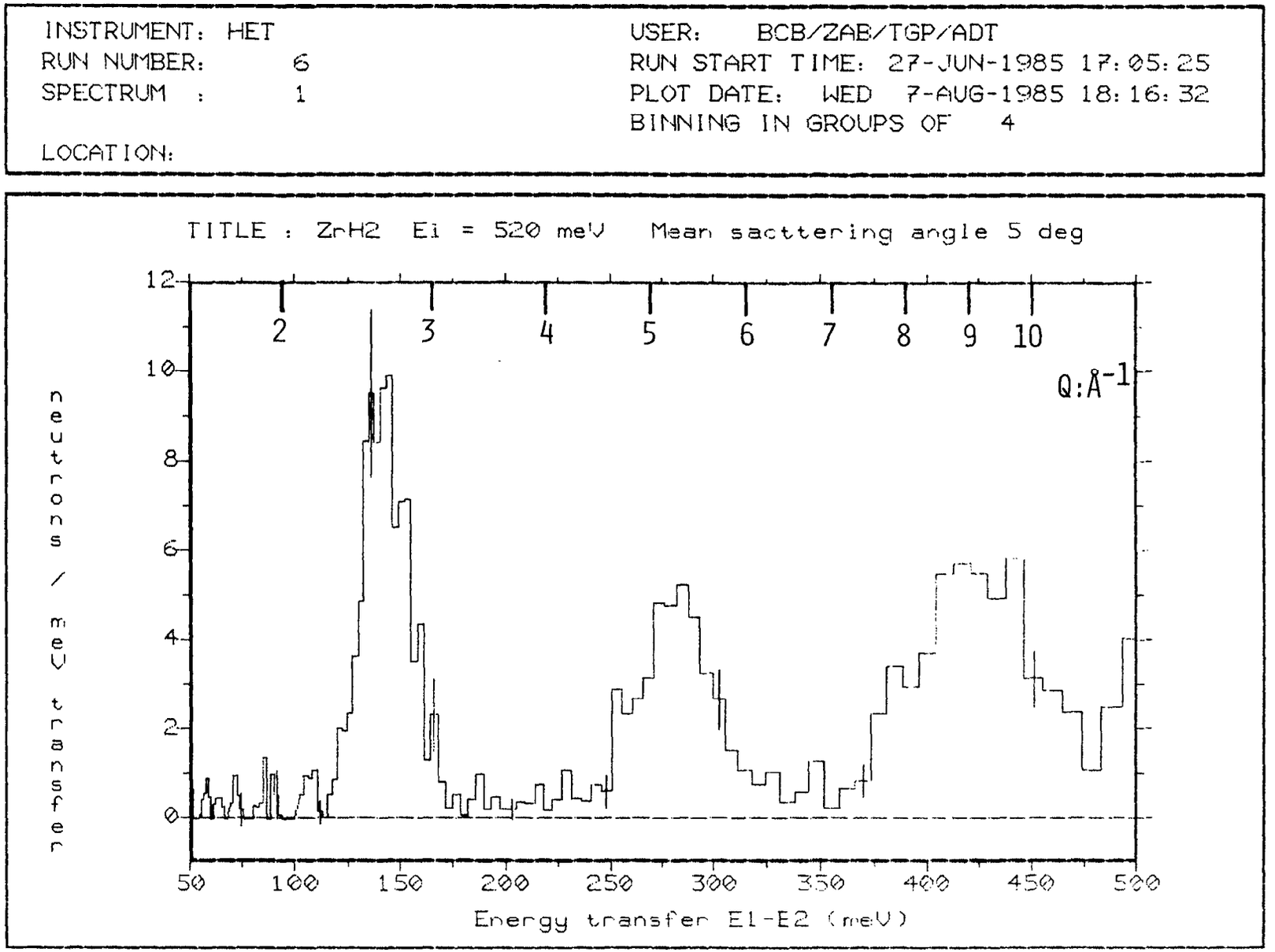


Figure 7 The data of Figure 6 converted to an energy transfer scale

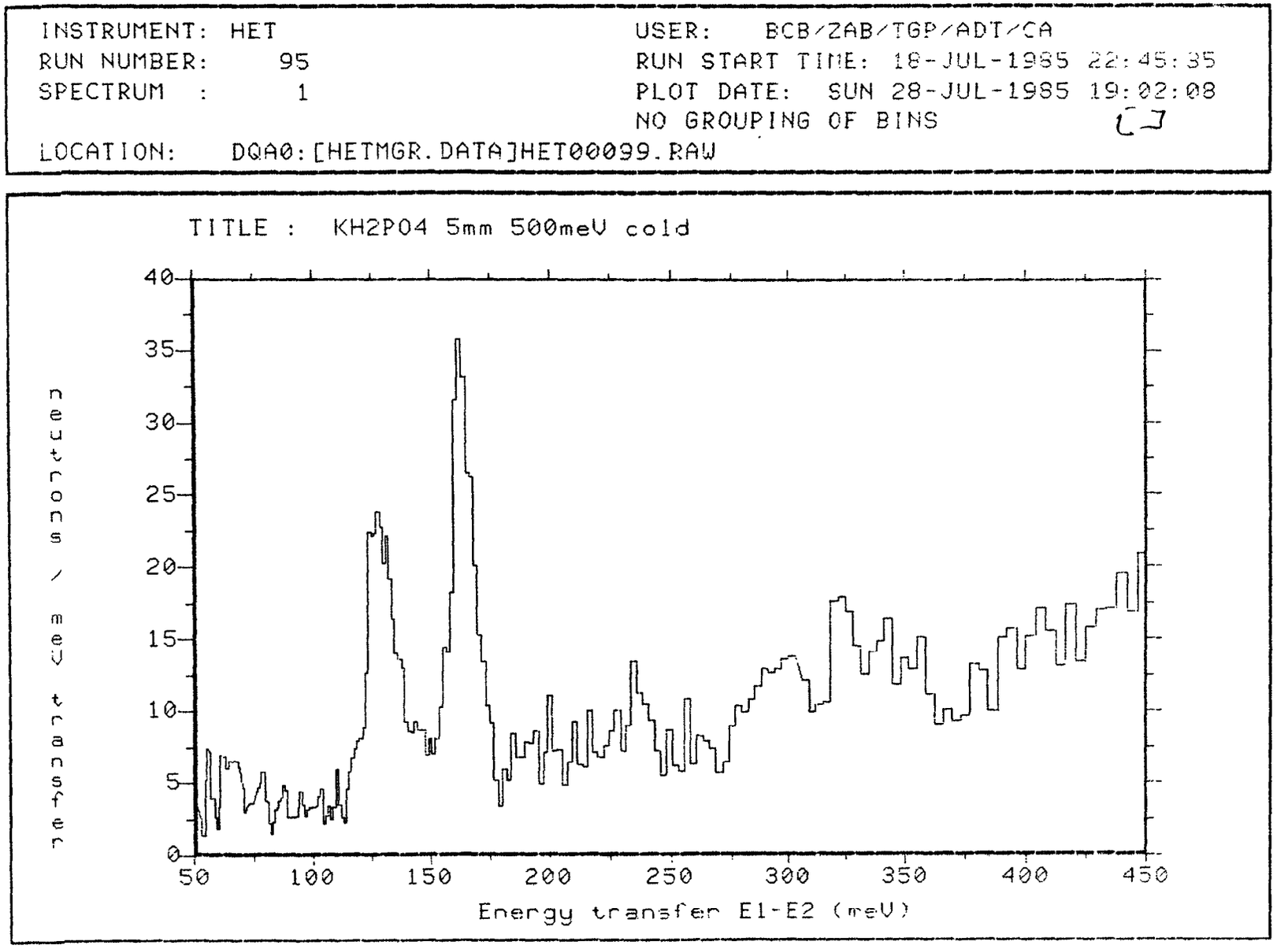


Figure 8 Data on KH_2PO_4 taken in 26 μA-hr with an incident energy of 495 meV