L. Some Recent Results and New Instruments at ZING P', J. M. Carpenter, ANL

Since its startup in late 1977, the performance of ZING P' has increased to its present level of about 8×10^{11} p/pulse, 8 n/p (estimated for the W target), and 10 Hz average repetition frequency. The Rapid Cycling Synchrotron (RCS) is operating from a stable oscillator and delivers pulses of ~ 100 ns duration. The target/moderator arrangement is shown in Fig. I-L.1. Two vertical beams are produced by two moderators, and three horizontal beams are produced by one moderator. A boron-containing vane above the moderator of beam V-2 prevents "cross-talk" with the horizontal-beam moderator. Instruments now operating are the Crystal Analyzer Spectrometer, the High Resolution Powder Diffractometer, and the Single Crystal Diffractometer. In place, but not yet operating, are the Chopper Spectrometer and the Ultracold Neutron Generator.

The Crystal Analyzer Spectrometer in beam V-2, is designed for chemical spectroscopy and is shown schematically in Fig. I-L.2. The distance from the source to the sample is ~ 4.0 m. Recent data on the scattering at 90° to 0.003 eV from ZrH_2 are shown in Fig. I-L.3 which gives the observed counts/channel vs time-of-flight. The elastic peak appears at channel 690. Elastically-scattered neutrons not removed by the Be filter (at room temperature in these measurements) and reflected by the pyrolytic graphite monochromator in second and third order appear at channels 320 and 220, respectively. Optic mode transitions in ZrH_2 are seen at channels 190 (138 meV, 1-2 transition), 162 (274 meV, 1-3 transition), and 152 (417 meV 1-4 transition). The instrument scientist is R. Kent Crawford.

The High Resolution Powder Diffractometer is now performing research measurements, and is shown schematically in Fig. I.L-4. The source-to-detector distance is ~ 20 m. The instrument is located in beam H-3. Calibration and profile parameters have been derived from scattering patterns of iron and silicon powders, which indicate $\Delta d/d \lesssim 0.3\%$ in the 160° detectors and $\Delta d/d \lesssim 0.5\%$ in the 90° detectors (constant with d). Data for Si are shown in Fig. I-L.5. Through the data points is the profile curve fitted to the reflections at positions indicated below the data. The residual of the fit shown below indicates the accuracy of the fit. A sample of $A\ell_2O_3$ (about 2 cm^3, two of the international standard samples used in diffractometer comparisons) was run for a period of about five days, and

provided the patterns shown in Fig. I-L.6. The profile refinement extends from d = 0.5 Å to d = 2.18 Å, and produced parameters in good agreement with data derived from other high resolution diffractometers. The instrument scientist is J. D. Jorgensen.

The Single Crystal Diffractometer operated for the first time on March 15, 1979. Figure I-L.7 shows the instrument schematically. The distance from the source to the sample is 8.5 m, in beam H-2. The chopper is not yet a part of the system. The 20 x 20 cm^2 multiwire gas proportional counter (built cooperatively by ORNL and ANL personnel) provides data to a remote computer which stores data as function of position (x,y) and time (wavelength). The computer remotely operates the twelve-inch Huber gonimeter and the detector positioning drive. A 5-mm-diam by 9-mm-high NaCℓ crystal was placed in the sample position. Intensity data (points above eight counts per element) are shown on an x-y map in Fig. I-L.8, for wavelengths between $1.11 \leq \lambda \leq 1.33$ Å, showing the 440 reflection. The same data are plotted as intensity per element vs position in Fig. I-L.9. The distribution of intensity roughly reproduces the image of the crystal, broadened by the detector resolution and by parallax. Figure I-L.10 shows data (counts > 10 per element, $0.5 < \lambda > 3.57$ Å) accumulated in 1 1/2 h, with the crystal oriented to place reflections in the center of the detector; the 200, 331, 331 families are shown. To our knowledge, this is the first demonstration of a pulsed source time-of-flight Laue camera. The instrument scientists are S. W. Peterson and A. H. Reis, Jr.

The Chopper Spectrometer is shown schematically in Fig. I-L.11. Seven groups of 7 He^3 detectors span scattering angles $2° < \theta < 90°$. The distance from the source to the chopper is 10 m. The instrument is located in beam H-1. The spectrometer will enable spectroscopy with incident energies up to 0.5 eV. The instrument has not yet operated, but will begin operation in May 1979, driven from the same oscillator that drives the accelerator. The instrument scientist is C. A. Pelizzari.

The Ultracold Neutron Generator is being installed for operation in May 1979. This is the first stage of a series of measurements leading to a measurement of the neutron electric dipole moment. The current goal is to produce ultracold neutrons ($v \lesssim 7$ m/s) and store them in a totally reflecting bottle. The experiment is shown in Fig. I-L.12. Neutrons from the source stream upward in beam V-1, to strike a mica crystal array (d ~ 20 Å), moving at 200 m/s and phased so as to be in reflecting position at the

time of arrival of 400 m/s neutrons. Neutrons are backscattered from the crystal to nearly zero velocity. The principle is illustrated in Fig. I-L.13 which shows the volume around 400 m/s in velocity space which is reflected by the crystal. After reflection, this volume, containing approximately the same phase space density of neutrons, is shifted to the origin ($v \approx 0$). A portion of this shifted volume is accepted by the bottle, which is connected through an intermittently-opening rotating valve, to the region of the source. The experiment will operate from the same stable oscillator as drives the accelerator. The leader of the experiment team, which involves personnel of three universities and three divisions of ANL, is T. W. Dombeck, Department of Physics and Astronomy, University of Maryland.

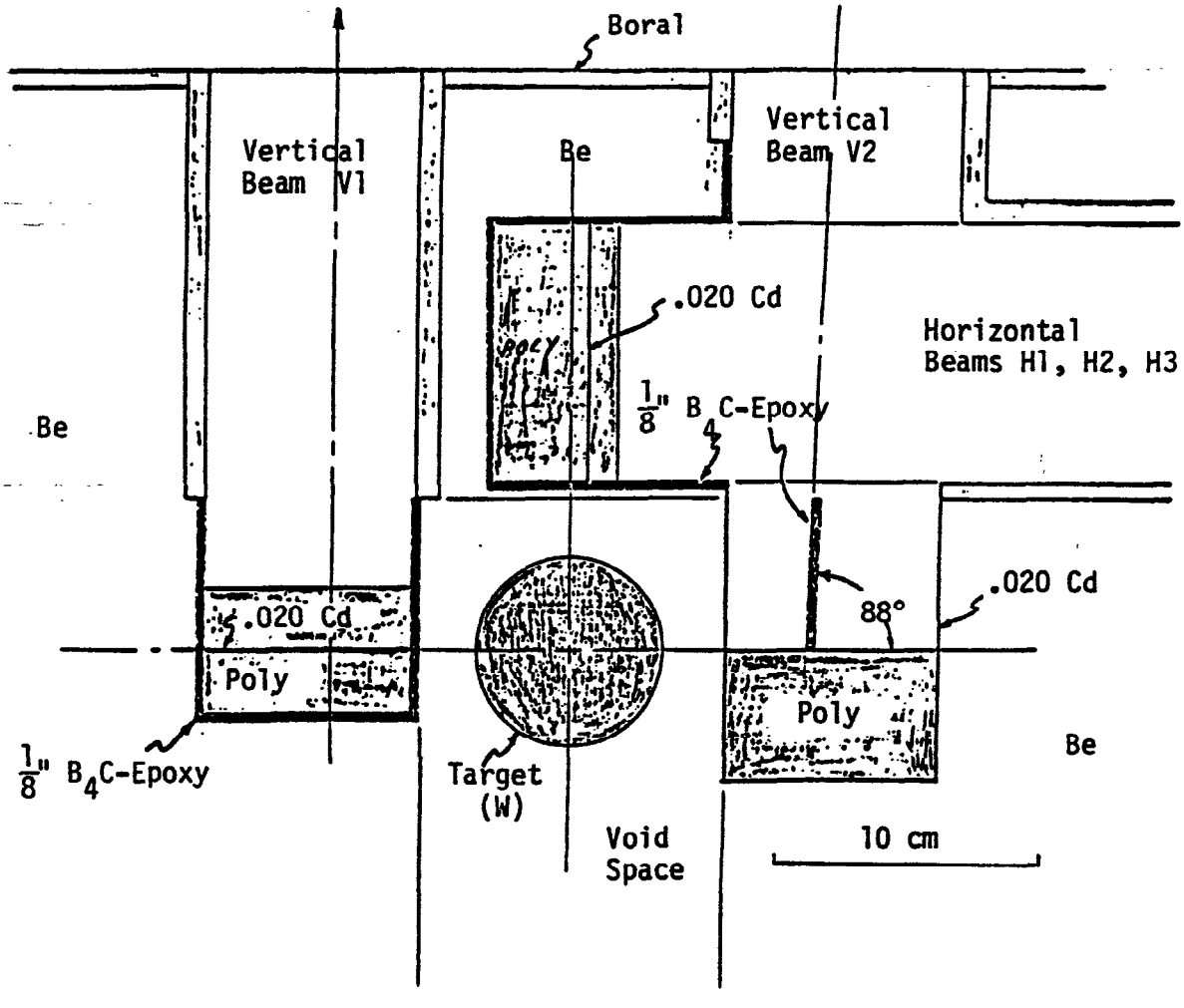

Fig. I-L.1. ZING-P' target/moderator arrangement.

ZING - P'

CRYSTAL ANALYZER SPECTROMETER

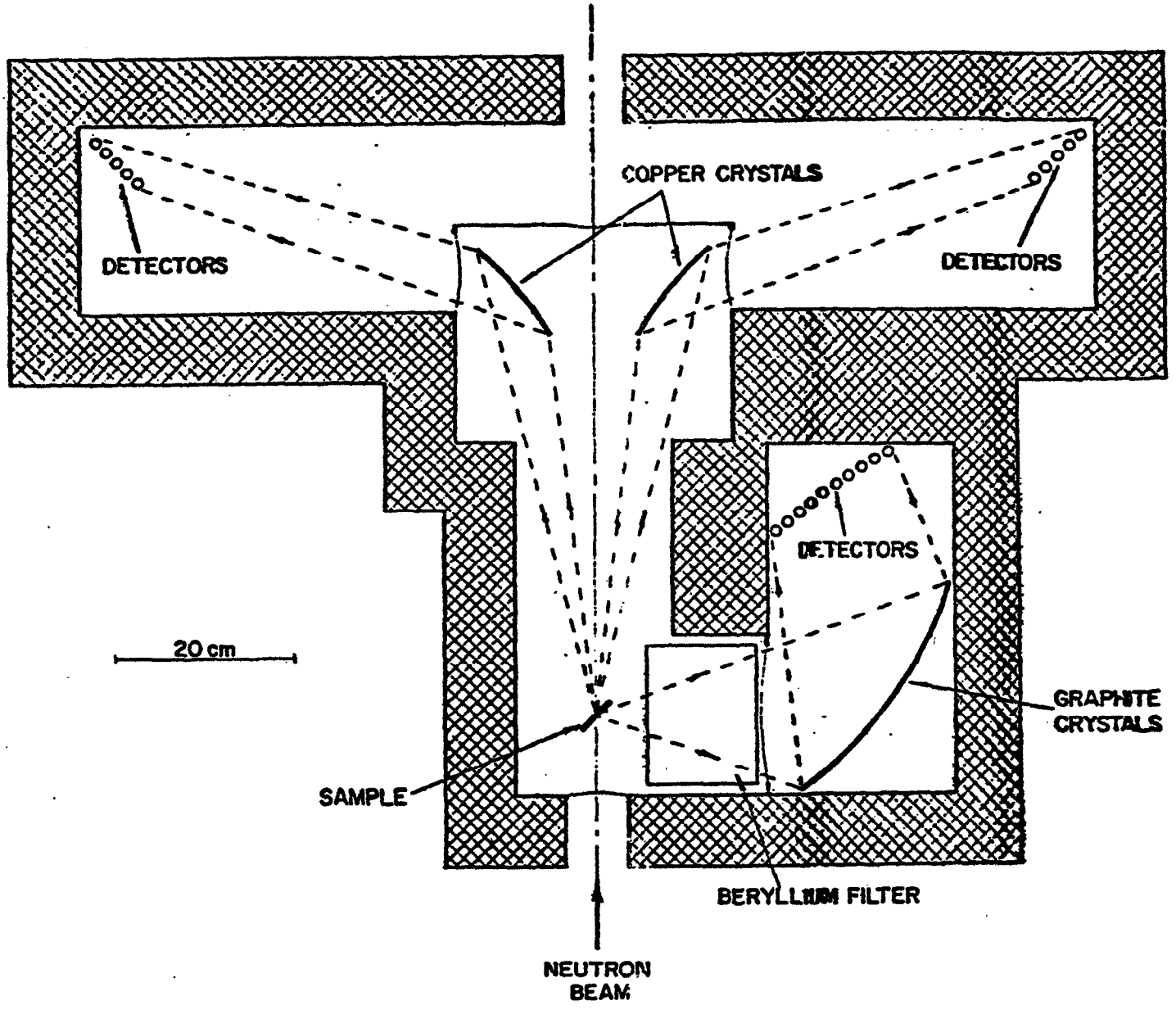

Fig. I-L.2. Crystal analyzer spectrometer.

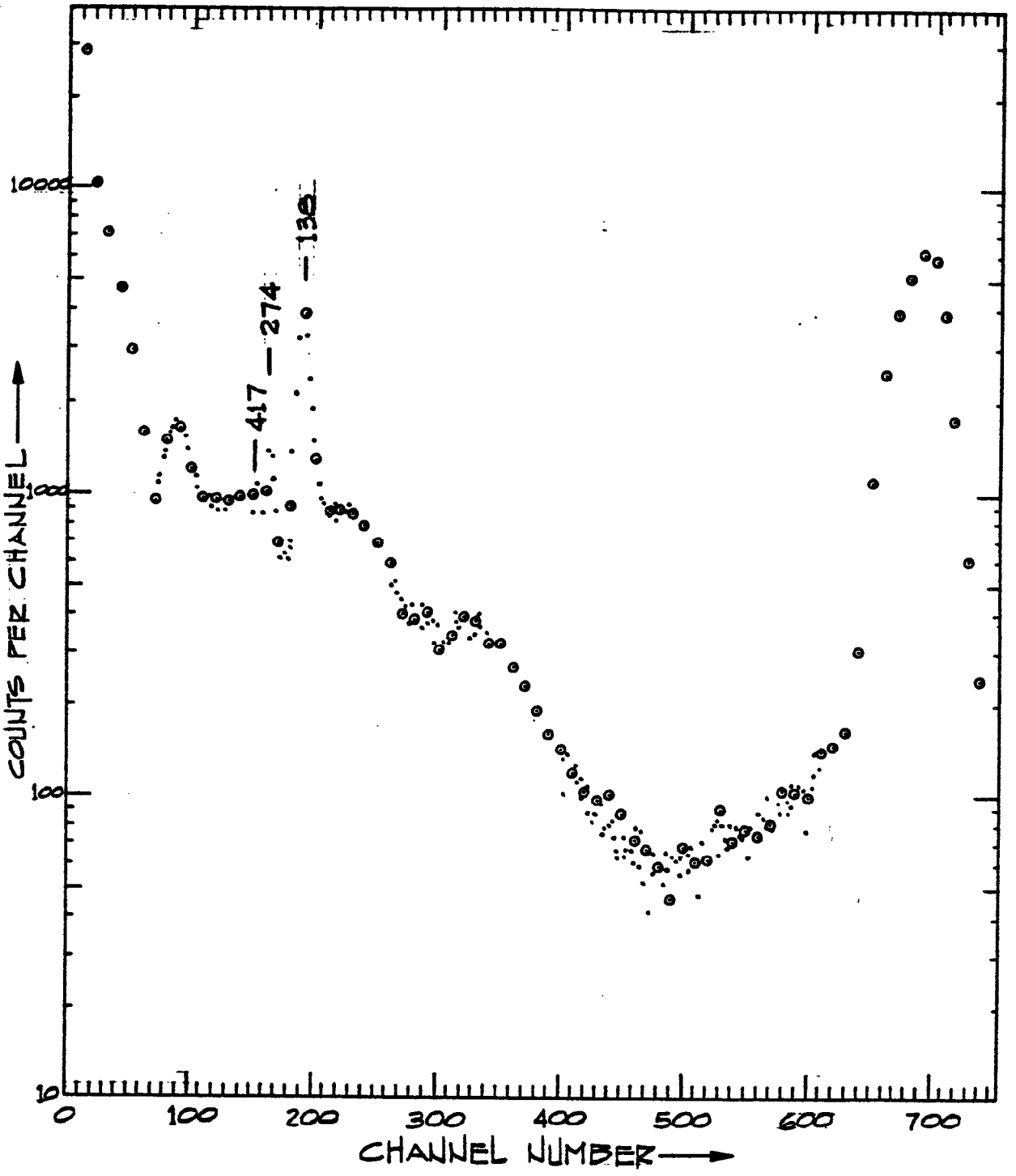

Fig. I-L.3. Neutron scattering at 90° from ZrH_2 using crystal analyzer spectrometer.

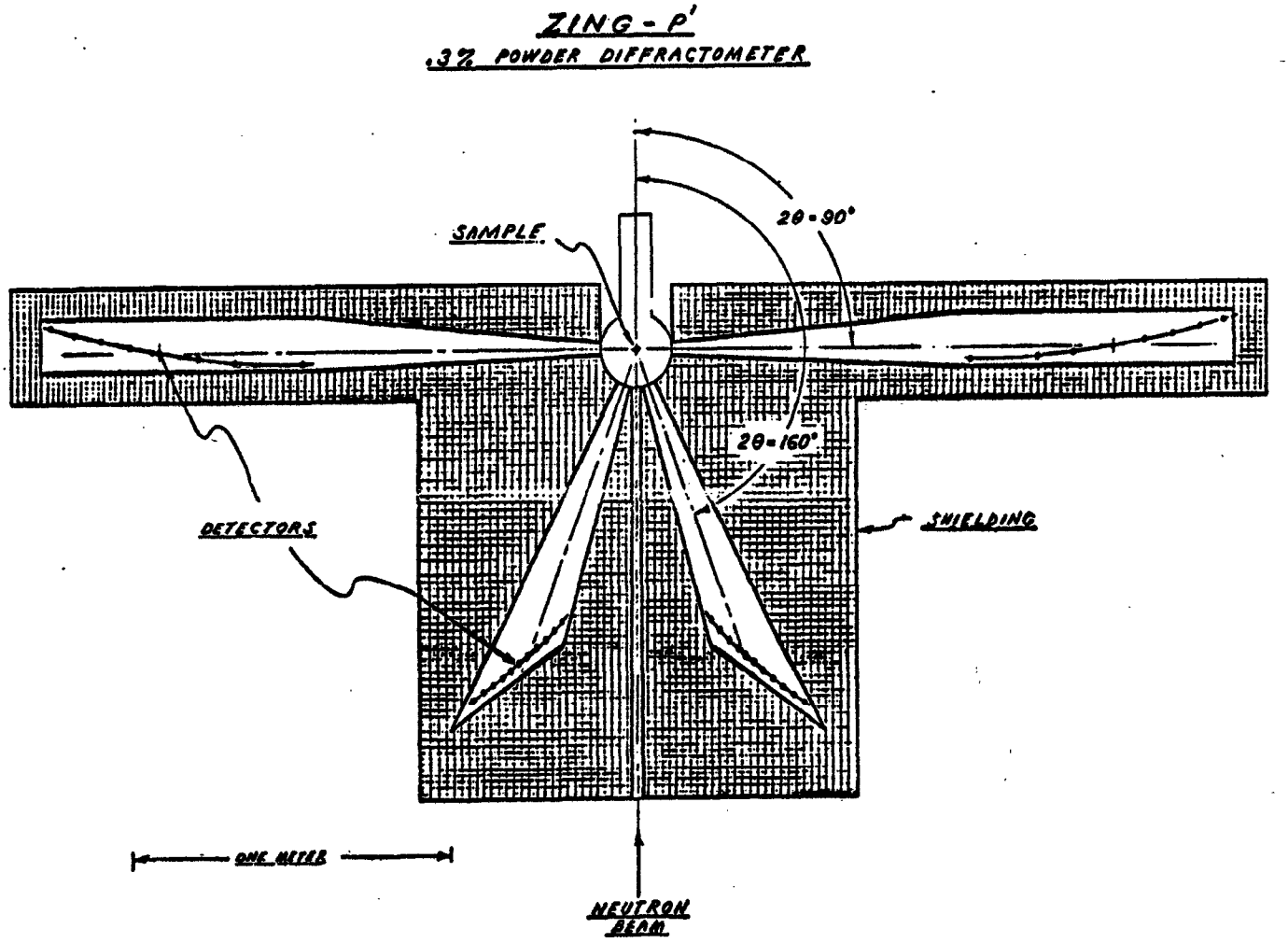

Fig. I-L.4. High resolution powder diffractometer.

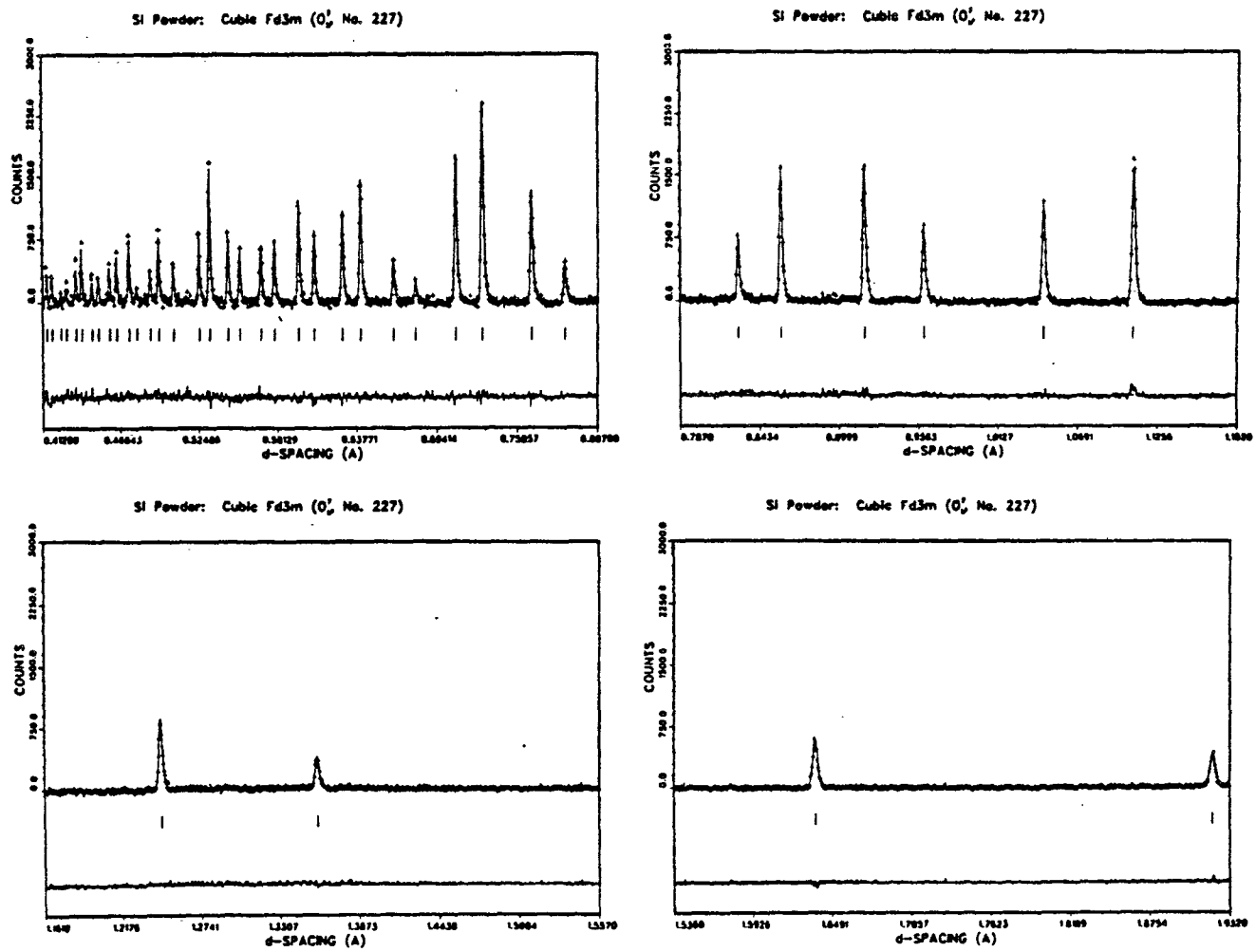

Fig. I-L.5. Data for Si using high resolution powder diffractometer.

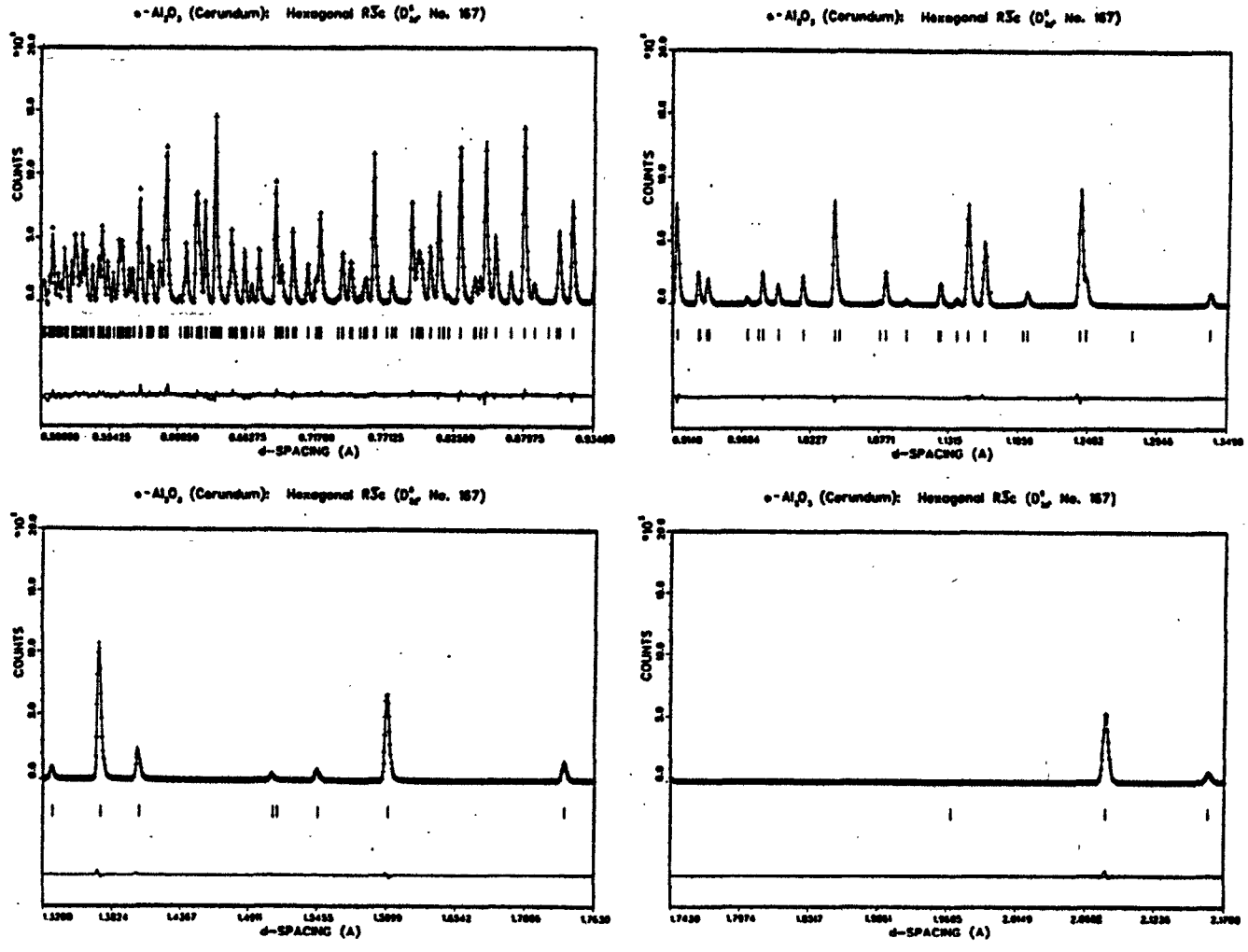

Fig. I-L.6. Data for Al_2O_3 using high resolution powder diffractometer.

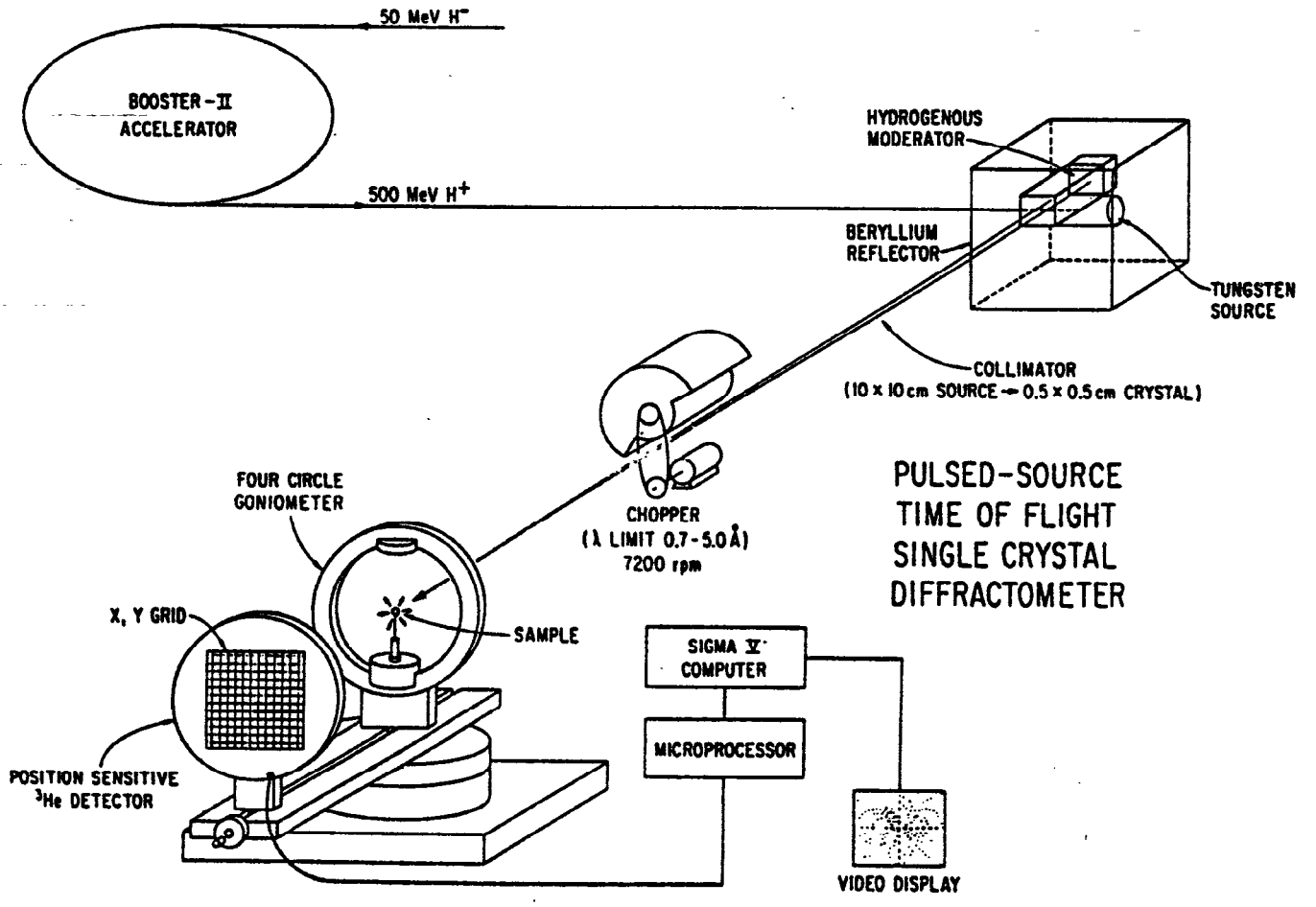

Fig. I-L.7. Single crystal diffractometer.

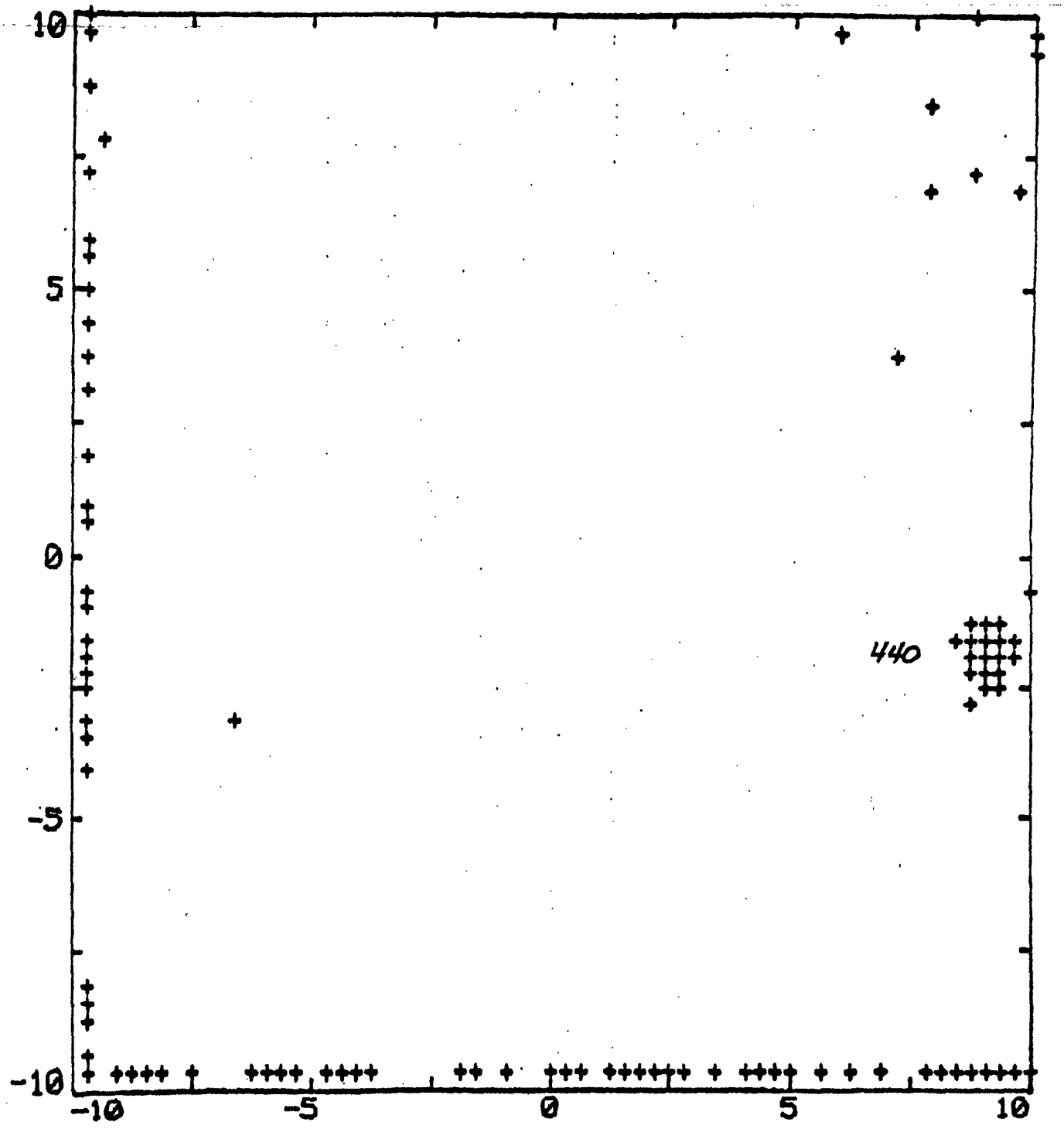

Fig. I-L.8. Intensity data on x-y map for 20 x 20 cm^2 multiwire gas proportional counter.

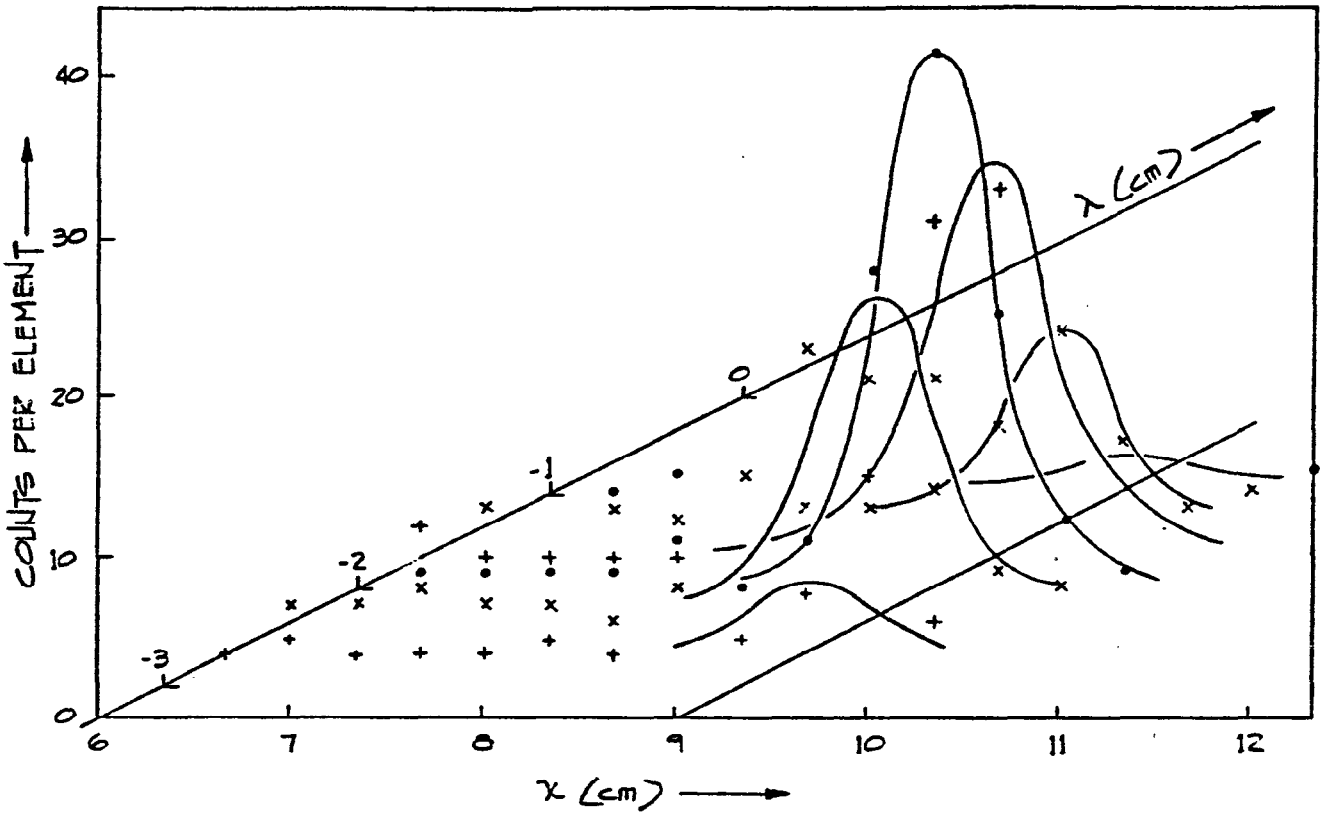

Fig. I-L.9. Intensity per element vs position for 20 x 20 cm^2 multiwire gas proportional counter.

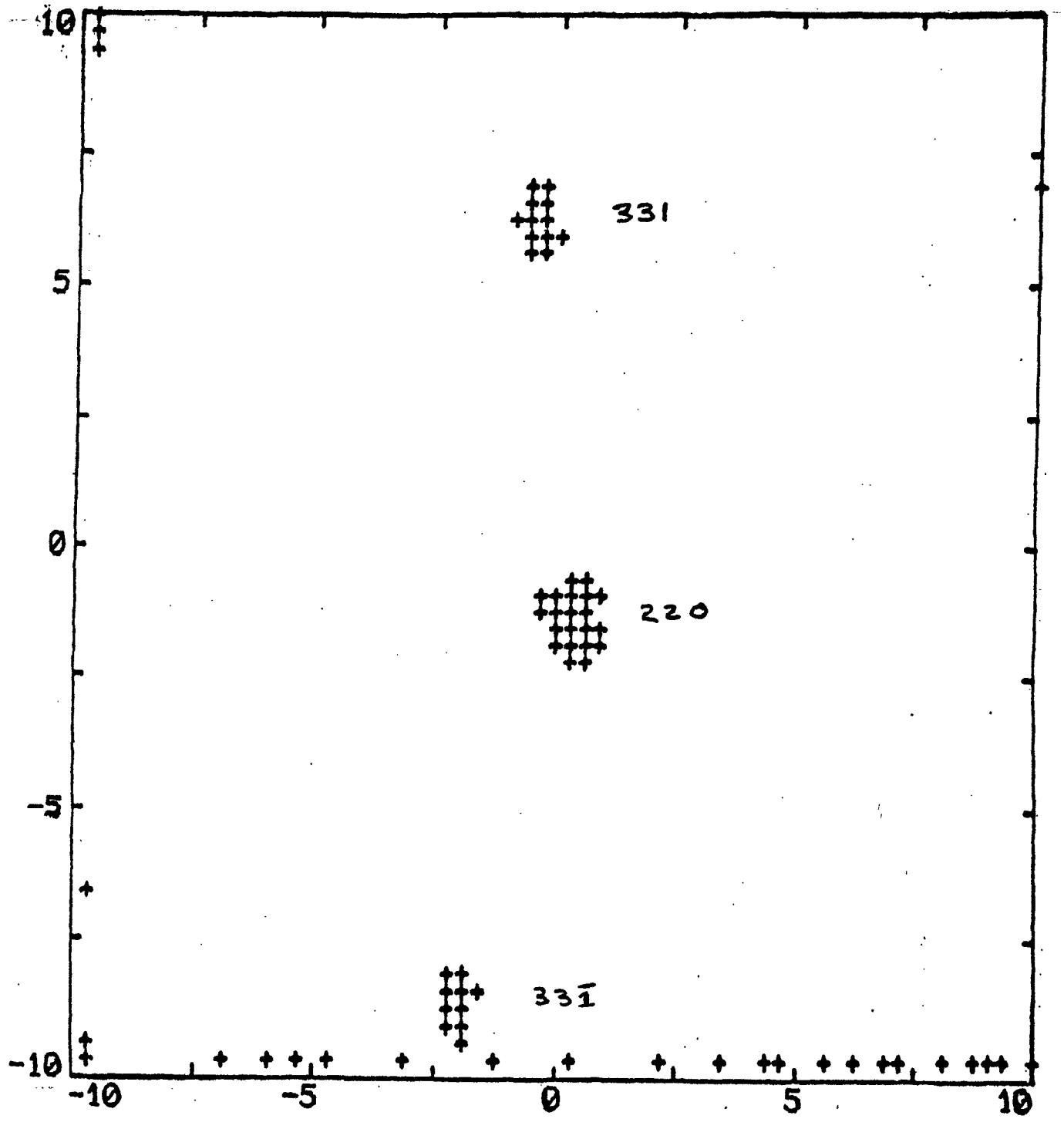

Fig. I-L.10. Illustration of a pulsed source time-of-flight Laue camera.

ZING-P' CHOPPER
SPECTROMETER

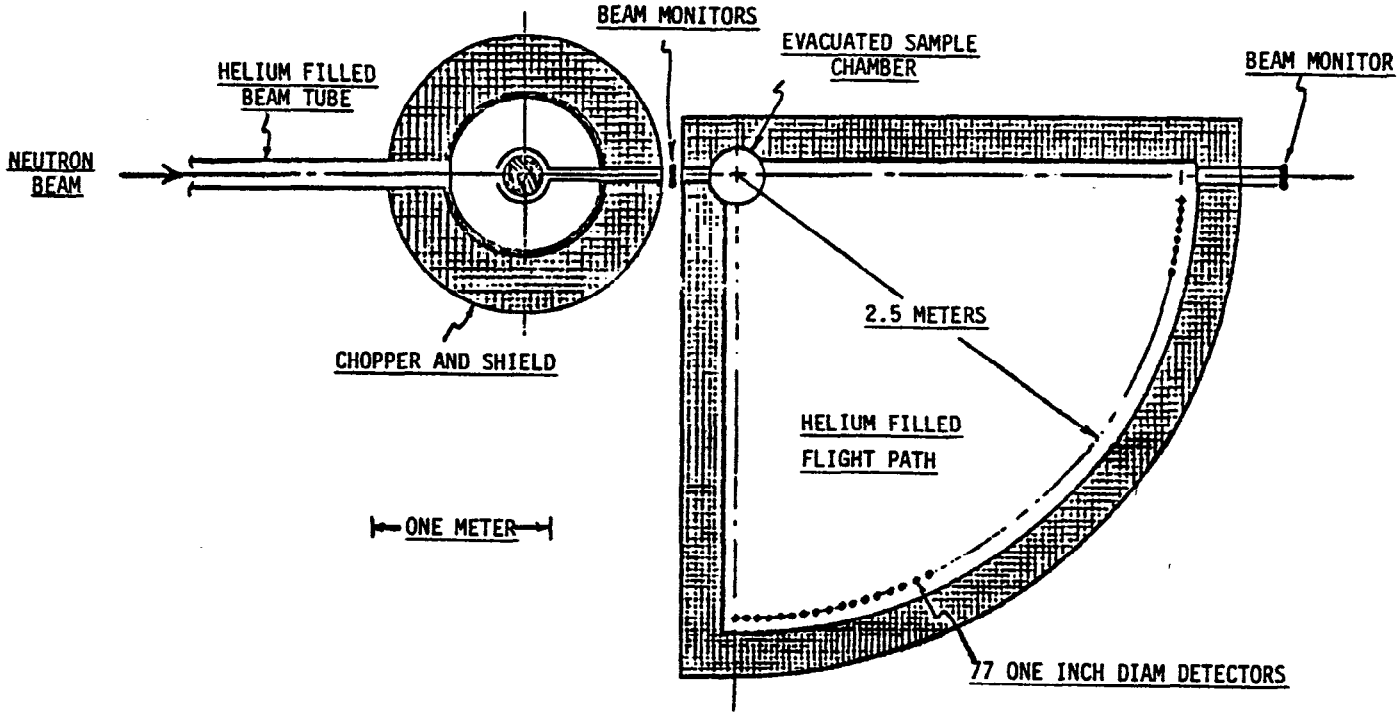

Fig. I-L.11. Chopper spectrometer.

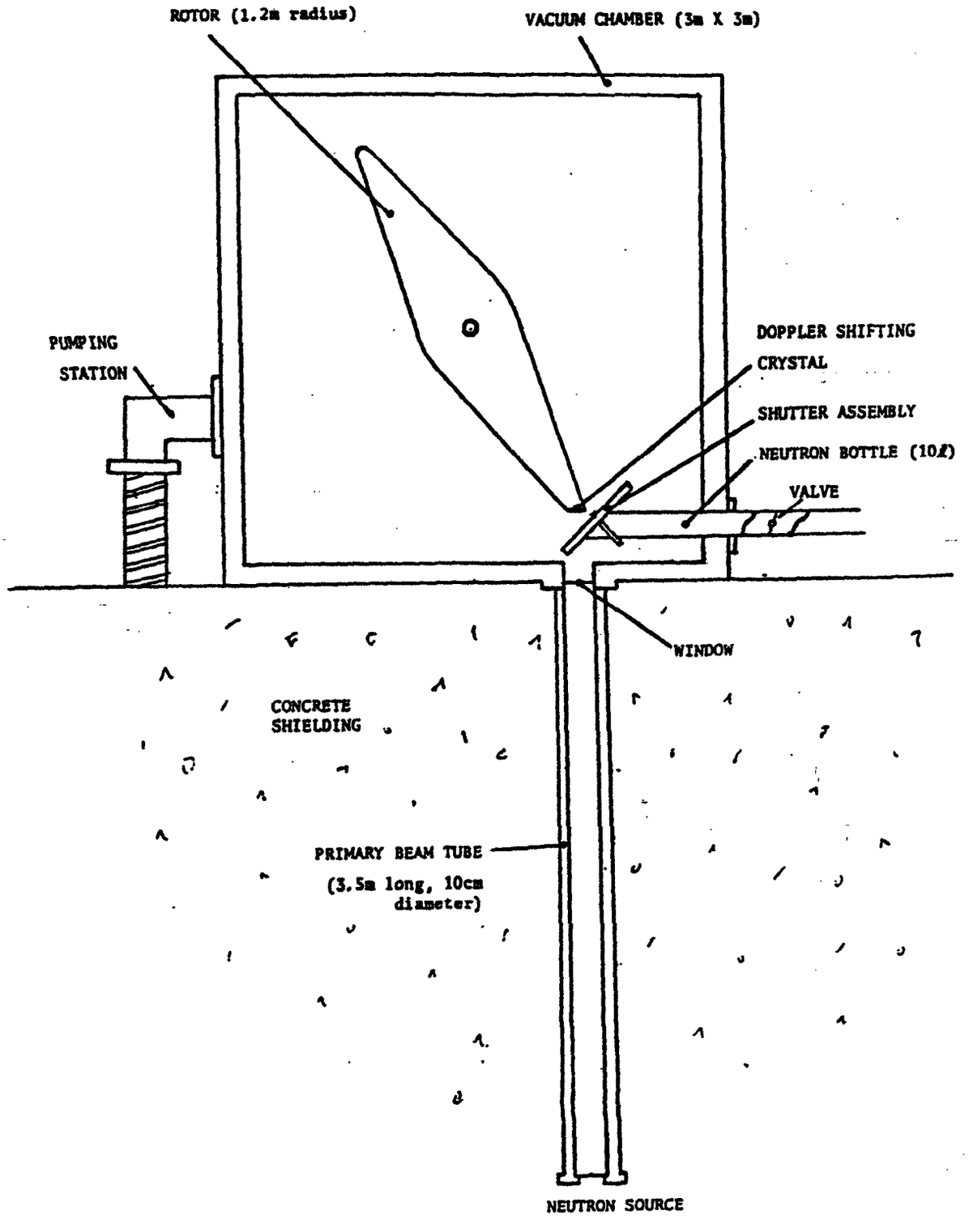

Fig. I-L.12. Ultracold neutron generator.

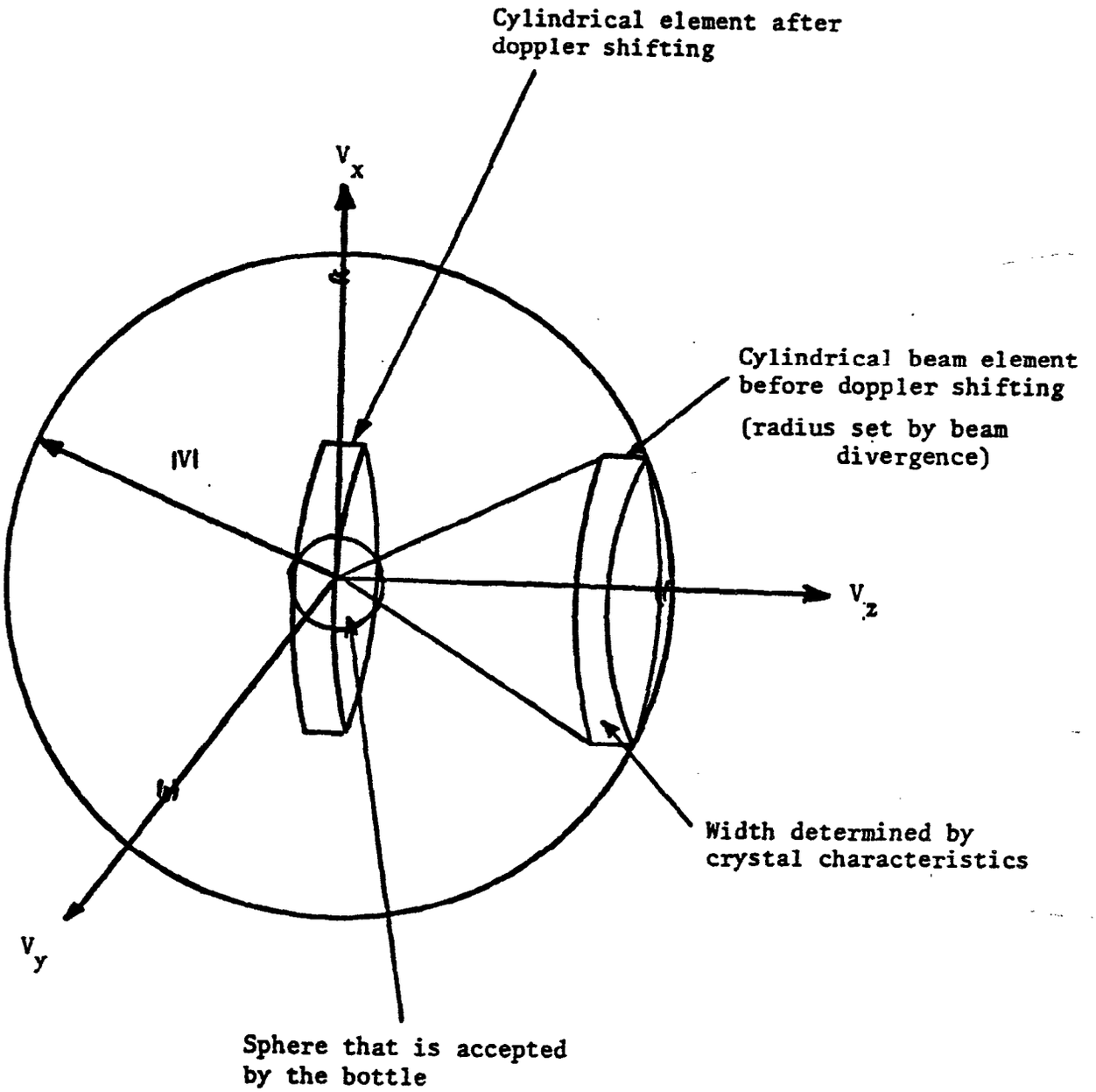

Fig. I-L.13. Principle of ultracold neutron generator.