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# A NEUTRON-SENSITIVE IMAGE INTENSIFIER-TELEVISION SYSTEM

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# A NEUTRON-SENSITIVE IMAGE INTENSIFIER-TELEVISION SYSTEM

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Key words: neutron-sensitive, TV system, image intensifier, real time, transportable

## ABSTRACT

A neutron-sensitive, image intensifier-digital television system has been developed for area recording of weak patterns in neutron scattering studies. It can also be used as a low resolution neutron radiography instrument.

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## INTRODUCTION

A neutron-sensitive image intensifier-television system has been assembled that incorporates a larger screen (300 mm vs. 150 mm) and more modern instrumentation (digitizer and memory) than was available when our older systems were built.[1,2] Our goal was to build a portable system which could be readily moved among the various beam holes at the Oak Ridge High Flux Isotope Reactor (HFIR) and which would have some image processing capabilities using a personal computer. The latest system is shown diagrammatically in Fig. 1.

## DESCRIPTION

Neutrons diffracted or scattered by the sample, interact with a thin $^{6}$LiF-ZnS phosphor[3] whose output is focussed by a fast lens (f/0.95) onto a microchannel-plate image intensifier.[4] The output of the intensifier is coupled by fiber optics to a secondary electron conduction (SEC) television tube[5] installed in a modified vidicon camera.[6] An ordinary television monitor displays the real-time images which can also be stored on a video recorder for editing and replay. Because the images are generally too weak for real-time imaging and processing (except for large samples with simple crystal structures) a means of storing and integrating the

signals is highly desirable. In this system, a digital television image processor[7] is coupled between the intensifier camera and an IBM-PC-AT computer equipped with two 20 Mb hard disks. The IEEE-488 instrument bus is used between the processor and the computer. The image processor has an 8-bit analog to digital converter and storage for 640X482 sixteen bit words (pixel values). In the integration mode of the processor, continuous integration can be selected or a digitally selected number of television frames (1–999) can be summed. A previously stored image (background, for example) can be continuously subtracted from an incoming image. Images can be stored and retrieved using the computer's hard disk memory. This mode permits the difference of two images to be stored and displayed. This is a useful function when data is collected at two temperatures, pressures or magnetic field intensities.

The image processor has an odd-even field feature which can be used to effectively divide the memory and store two, separate half-resolution images. The two images can be individually or separately displayed. The processor can be controlled from the computer or from its own small keyboard attached by a 2-meter cable.

As mentioned above, in many experiments, particularly those using monochromatic beams, there are often not enough scattered or diffracted neutrons to give an instantaneous, interpretable image. It is then necessary to integrate the signal in memory until a meaningful image is obtained. The present system has been designed to have a counting mode in which each detected neutron is stored. The intensifier and camera gains are raised above those required for analog images (high counting rates) so that the scintillations from single events can be detected above the system noise and stored in the processor memory. In this counting mode, the 16-bit words act as counters allotted to each pixel in the image.

Industrial versions of the PC-AT and its hard disk drives are used. These are more robust and less prone to problems from dust and vibration than the office versions. The system is mounted on large casters for easy transport on the reactor floor or to another reactor.

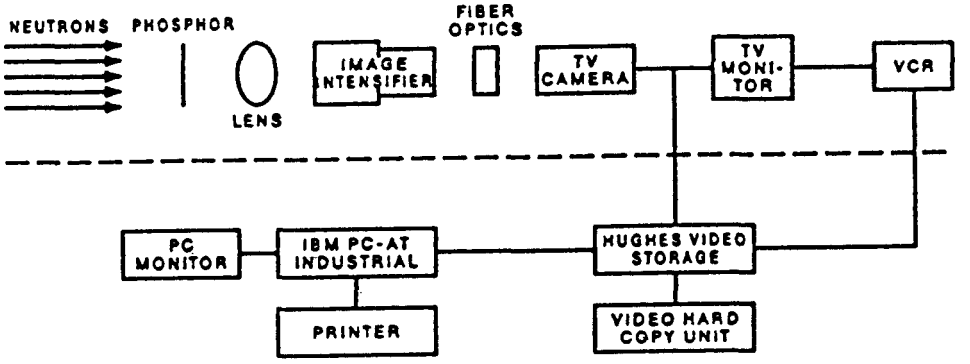


Fig. 1 Schematic diagram of neutron-sensitive TV image intensifier system.

Although the system is intended as an area detector in neutron scattering experiments, such as diffuse scattering, powder diffraction, small angle scattering, etc., it can be used at reduced gain as a low resolution (i.e. ≅ 0.5 mm) directly-viewed radiographic instrument for rapid alignment of samples mounted in cryostats and furnaces. Much time and effort can be saved over the instant-film methods often used.

A useful application which combines diffraction and radiographic techniques is diffraction tomography.[8] A large crystal or partially crystalline sample, such as a directionally solidified turbine blade, can be oriented in a narrow, knife-like monochromatic beam to give a Bragg reflection from a distinct "slice" of the sample. A series of such tomograms taken by successive translations of the sample across the beam provides three-dimensional information nondestructively.

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