AUTOMATED FAST NEUTRON DOSIMETRY SYSTEM
FOR PERSONNEL MONITORING

Abstract

The Automated Fast Neutron Dosimetry System for Personnel Monitoring has been developed by S*ESSD, BARC* in association with *RP&AD, BARC*. This system is used to automate the process of neutron dose measurement (up to 5mSv) for personnel monitoring using an image analysis software.

Introduction

Personnel working in nuclear installations such as reactors, accelerators, spent fuel processing plants and those working in various industries such as oil refining, mining, ore processing, etc. need to be monitored for fast neutron exposures on quarterly basis. RP&AD of BARC is the only institution in India involved in monitoring of personnel working in neutron fields. Around 2800 workers from 70 institutes (DAE & non-DAE) are monitored on a quarterly basis. For fast neutron personnel dosimetry, CR-39 solid state track detectors are deployed which produce neutron tracks on irradiation. The tracks get enlarged after the detectors are subjected to electro-chemical etching in laboratory (Fig. 1a). These tracks are counted in an optical system to evaluate the effective fast neutron dose.

Automated Image Analysis System with Batch Processing Mode

An automated image analysis system has been developed by SESSD for automatic counting of the neutron tracks using image processing techniques. The image analysis system employs a 5M pixel B&W camera connected to a desktop computer through USB interface. A panel LED light is employed underneath the CR-39 detector to directly illuminate it in transmission imaging mode for better accuracy. The captured image is processed and analyzed using Blob Analysis Counting software package which was developed in-house (Fig. 1b). The net track count is converted to an equivalent dose employing a suitable calibration factor. Complete statistics of each detector including diameter of each track, counted/rejected tracks, roundness factor, overall track density are stored in the system for detailed analysis by the user.
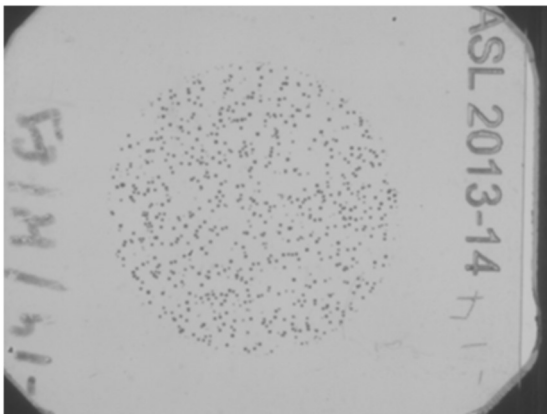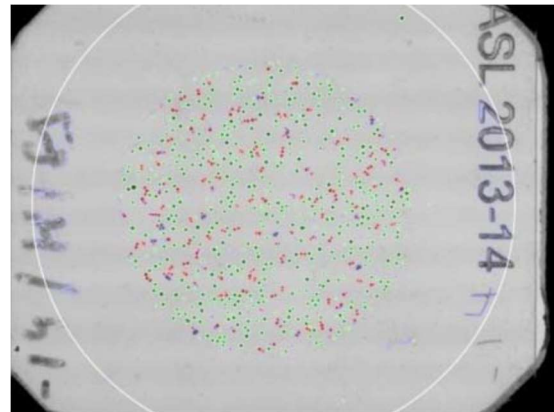

Fig.1a. Original image.

Fig.1b. Processed image (Green tracks are counted standalone tracks, red tracks are overlapping tracks resolved and counted separately, blue dots (rejected) corresponds to noise.

An automated pick & place based system (Fig. 2a, 2b) has been developed to handle a batch of detectors (up to 100 no) which are vertically arranged in input stack. The system consists of precision servo based X & Y linear motions for picking detectors from the input stack, placing them onto the imaging station & storing of the processed detectors in the

output stack. The system has a small foot print and can process up to 5 detectors/ minute. The image analysis software and pick & place system operate concurrently with minimal delay.

Fig. 2a. Automated system for batch processing. Fig.2b. Close-up view of the mechanism.

The complete system has been developed (including requirements gathering, design & development, procurement, fabrication & software development) over a time span of 7 months. This system is used by RPAD , HS&E Group for routine dosimetry of radiation workers in DAE and non DAE units.