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Development of kfps bright flash neutron imaging for rapid, transient processes

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The speed of thermal/cold neutron radiography is limited by the available flux even on the strongest spallation sources. The flux limitation can be alleviated using phase-lock, ensemble averaging techniques for periodic, repeating processes as it has been demonstrated on several samples like engines, pumps etc. However capturing rapid, transient, non-periodic processes by neutron imaging remains difficult. Recently we have demonstrated 800 fps cold neutron imaging [1] at the ICON beam line of the SINQ continuous spallation source utilizing the highest available flux of that beam line. Opposed to spallation sources, TRIGA reactors have the capability due to their special fuel composition to produce extremely bright neutron pulses for a short duration. This opens the possibility to image short, very rapid transient processes at very high rates. We develop bright flash thermal neutron radiography at the beam line of the 1 MW Penn State Breazeale research reactor. This TRIGA type reactor is able to produce pulses up to 1 GW with a FWHM of around 20 milliseconds. We have achieved bright flash radiography up to 4000 fps on a field of view (FOV) of around 15 square centimeters and at a spatial resolution of about 0.5 mm, however higher frame rates and FOV is feasible. The detector used is a CMOS camera based system featuring a 400 um thick LiF/ZnS converter screen. We demonstrate the method on air-water two-phase flow in a bubbler as simple, non-periodic dynamic process.
[1] R. Zboray, P. Tritk, “800 fps neutron radiography of air-water two-phase flow”, MethodsX, 5, pp. 96-102 (2018).

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