High-Speed Neutron Tomography at the Australian Centre for Neutron Scattering

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Summary: Short summary of maximum 4 lines

1. INTRODUCTION

Commercial and academic demand for time-resolved non-destructive 3D imagining of dynamic systems has resulted in the implementation of numerous acquisition strategies and software protocols for processing time-evolving tomographic data. These advancements have naturally been led by the medical and industrial X-ray user communities, resulting in the availability of bespoke 4D CT scanners.

Neutron tomography, 3D imaging based upon the attenuation of subatomic particles, is increasingly becoming available with neutron beam imaging capabilities located at fixed nuclear reactor and spallation sources, and more recently, with portable neutron source units. Relative to X-ray technologies, low neutron flux and long exposure times have inhibited the development of temporal neutron CT.

The DINGO neutron imaging facility at the OPAL nuclear research reactor operates with a high-flux ($1 - 4.75 \times 10^7 n/cm^2/s$), quasi-parallel thermal neutron beam (L/D = 500 or 1,000) and with a number of detectors enabling a range of true spatial resolution (7 – 200 micrometres). The recent implementation of CMOS detectors and other physical upgrades has enabled us to follow the lead of ILL, PSI and HZB to achieve “continuous streaming” or “on-the-fly” neutron tomography. Previous continuous streaming nCT have focussed on achieving ultra-fast CT with a reduction in number of projections and subsequent loss of spatial resolution, or the use of a golden-ratio sampling.

Here we present our efforts and outcomes in optimising the physical systems on DINGO to achieve a reduction in full CT scan times from ~24 h to just under 5 min, albeit with limited dynamic range, but maintaining spatial resolution to observe changes in a dynamic system - the ordering of granular materials under controlled flow (Figure 1), and for the high-throughput scanning of geological and sensitive samples. Also to be discussed are our next steps in offering 4D-neutron CT available to the broader user community.

2. EXPERIMENTAL METHOD

The experiments were performed at the Dingo thermal-neutron radiography/tomography/imaging instrument at the OPAL nuclear research reactor, Australian Centre for Neutron Scattering (ACNS), ANSTO.

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3. RESULTS

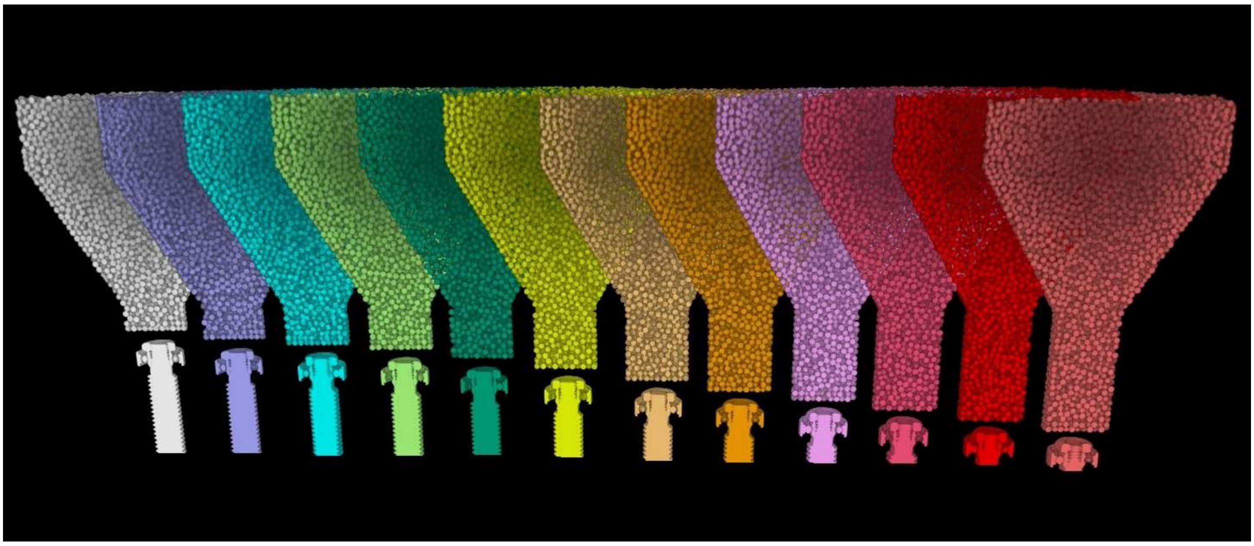

Figure 1: The results shown above are the first series of rapid-neutron tomographic reconstructions achieved using the DINGO neutron imaging instrument at ANSTO and illustrate bulk granular flow of model particles.