The potential use of fast neutrons to perform computed tomographic imaging

The technique of producing tomographic 2D and 3D images of the interior of objects using x-rays is now very well developed and extremely useful. It is widely used in many diverse fields such as nuclear medicine, archaeology, materials testing, etc. and won its inventors Cormack and Hounsfield the 1979 Nobel prize.

However, the limitations of using x-rays are their lack of penetration into dense objects. Another possibility is therefore to use fast neutrons to perform tomographic imaging. Neutrons have absorption properties which are highly complementary to photons. While thick high-Z materials are capable of strongly absorbing both, x-rays and gamma rays, they are much more transparent to fast neutrons. Vice versa, organic materials containing large amounts of hydrogen are well penetrated by photons, but easily scatter neutrons. This property of being easily absorbed by light elements such as hydrogen makes them ideal for imaging certain things: for example the distribution of water within a specimen or the detection of explosives in a suitcase. In addition, fast neutrons can gain additional information about the interior structure of objects by provoking the emission of secondary particles such as gamma rays and neutrons, via the nuclear reactions that they induced (e.g. inelastic scattering or (n,2n). The detection of these secondary particles may lead to some unique advantages for fast neutrons over x-rays.

Our first attempts to make tomographic reconstructed images using the LICORNE neutron source based at the ALTO facility of the IPN Orsay will be presented. In addition, the potential to use the very intense neutrons from the proposed IFMIF/ELAMAT facility will be shown. Such an intense source of fast neutrons would require its dedicated detection systems, and some ideas as to what could potentially be achieved and what applications might benefit from such a setup will be presented.