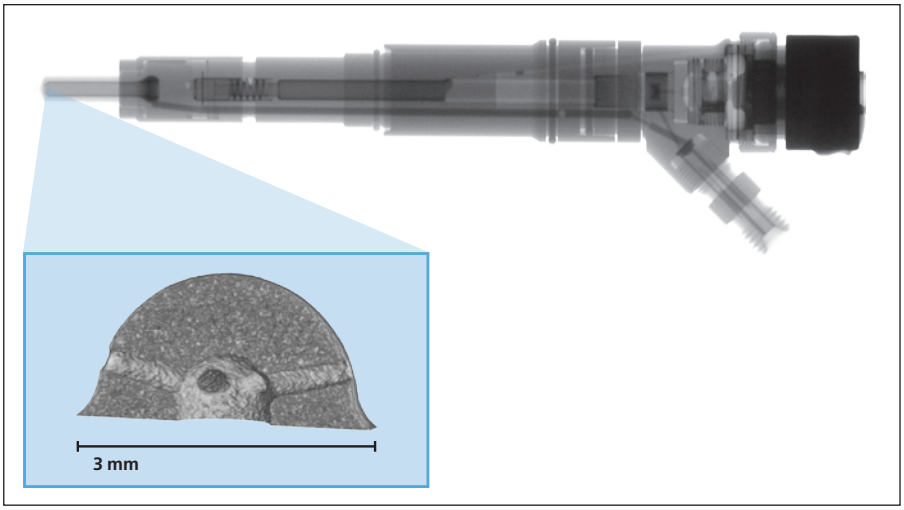
Neutron Imaging

A powerful non-destructive testing method

Introduction

The neutron imaging instruments at PSI belong to the top facilities in the world for neutron imaging[1]. PSI activities are focused on radiography and tomography neutron experiments with a large field of view (up to 30 cm in diameter), high spatial resolution (up to 10 µm), and real-time imaging for dynamic processes.



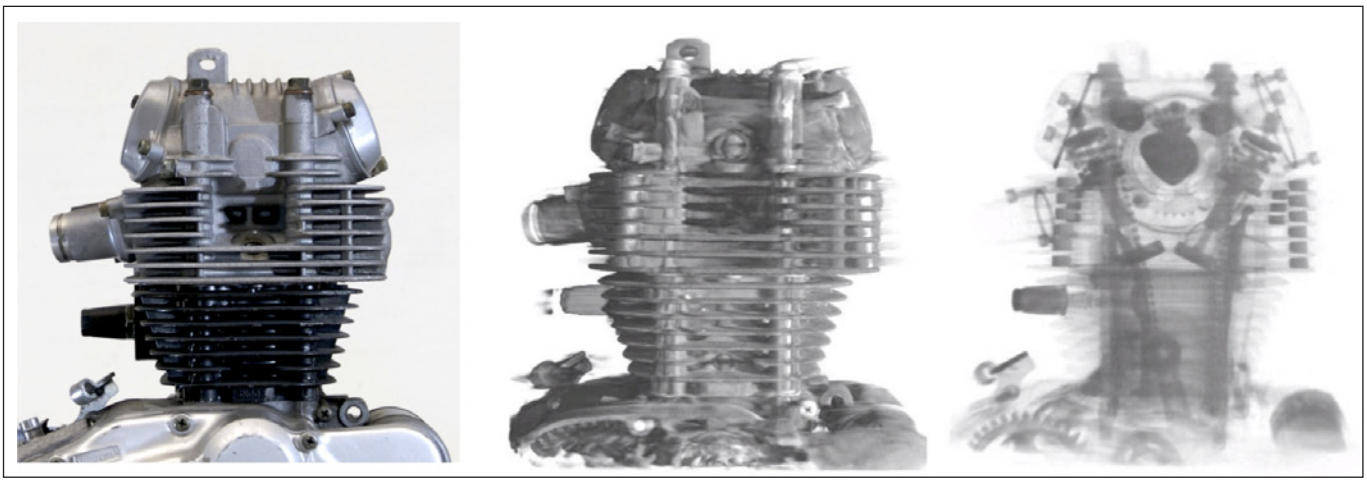
Example 2: **Diesel Injector Liquid can be visualized within the metallic structure of the nozzle body, as neutrons provide good contrast. The tip of the nozzle, containing channels of 0.15 mm diameter, is accessible with neutron microtomography through non-destructive analysis, providing virtual sectioning of the assembly.**

Advantages

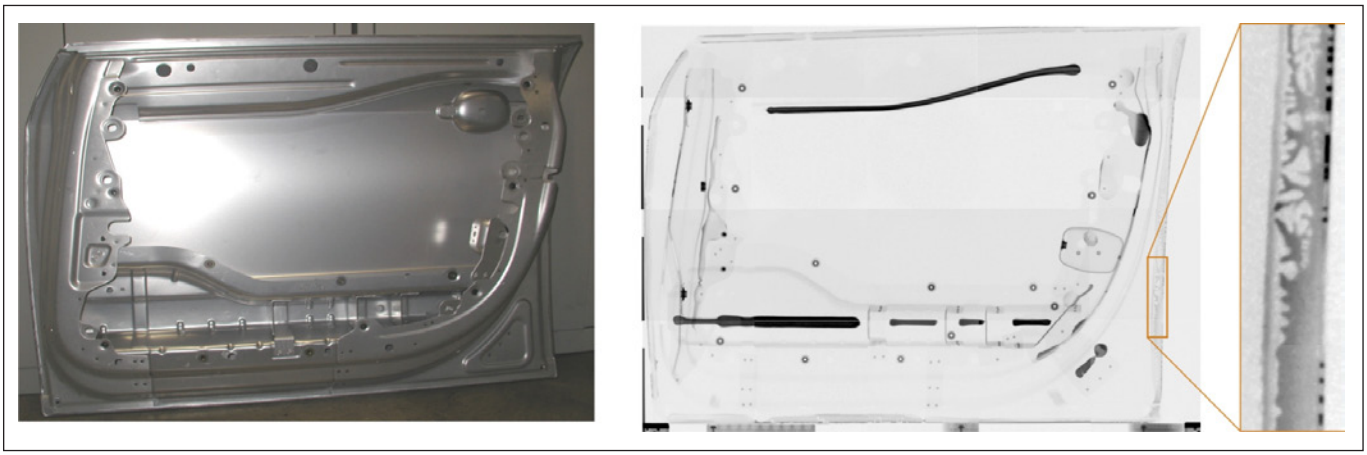
Neutron imaging (NI) operates similarly to X-ray imaging as a technique for non-destructive testing. Due to the different interaction mechanism of neutrons and X-rays with matter, NI delivers complementary information to X-rays of an object's internal structure. At PSI, both methods can be combined at the same beamline by complementary means.

Neutron imaging results provide information about the composition of matter: the amount and structure of the sample and changes in them. Defects in the material, such as pores, cracks or inclusions, can also be detected.

Contrary to X-rays, neutrons provide high contrast for light elements, such as hydrogen, lithium or boron, and often allow better penetration of metallic materials, imparting information not available from conventional X-ray radiography.



Example 1: **Motorcycle engine: Left: Photograph. Middle: 3D neutron data from tomography rendering. Right: Neutrons allow a non-destructive insight into the engine.**



Example 3: **Assembly of a car door: Left: Photograph; Right: Neutron radiography, showing the quality of the adhesives layer.**

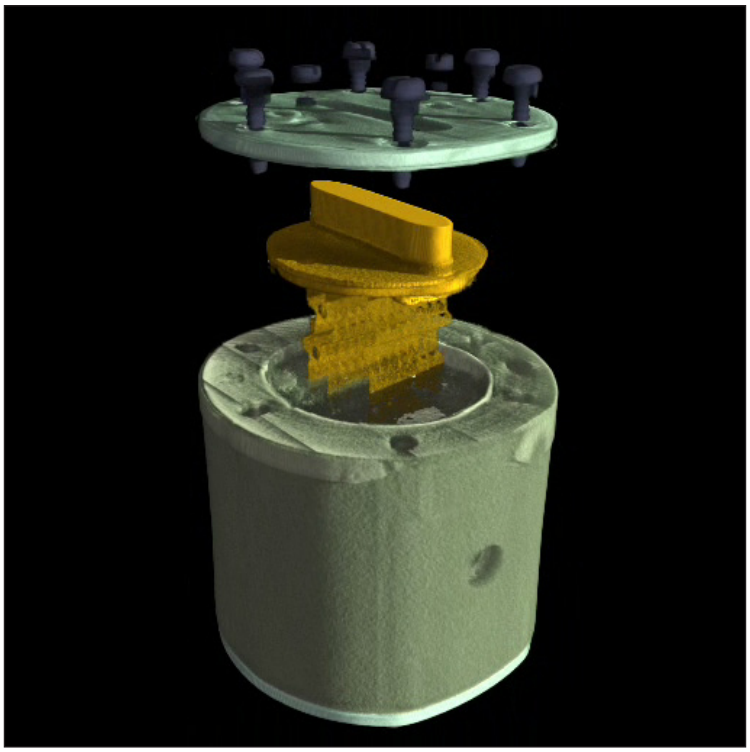
Tomography data can be obtained with the same setup. Using the principles of computed tomography, a full 3D animation of any object can be gained from a series of parallel 2D projections. The object is placed on a rotating base and turned in small incremental angular steps over 180°, to be irradiated from many different directions.

The neutron radiography equipment allows real-time imaging to be performed, to study dynamic processes such as the flow of a small amount of hydrogenated liquid in metallic structures, lubricant distribution in a running engine, or water uptake in concrete or soil. Experiments are performed by sequentially recording images at short time intervals, with a frame rate up to 20 kHz.

Typical applications of non-destructive NI testing

- Assemblies of cast metal components with internal organic layers, e.g. adhesive seals, lubricating films, and water or steam flows
- Investigation of defects in materials (pores, voids, cracks or inclusions)
- Characterization of welds and soldered joints
- Visualization of the distribution of water in fuel cells
- Absorption characteristics of particle filters
- Oil distribution in running engines
- Timber research and root growth

[1] http://neutra.web.psi.ch/



Example 4: **Neutron tomography image of a high-current fuse made of copper/ceramic, 8 cm in diameter, showing the predetermined breaking point layer inside.**

Contact
Dr. Christian Grünzweig
Manager Industrial Contacts NIAG
Tel. +41 (0)56 310 46 62
Email: christian.gruenzweig@psi.ch

Technology Transfer PSI
Tel. +41 (0)56 310 27 22
techtransfer@psi.ch

Paul Scherrer Institut
5232 Villigen PSI, Switzerland
Tel. +41 (0)56 310 21 11
www.psi.ch

NUM-F01-A-10, 10.2010