

# TRUE ROCKET SCIENCE

Neutron Radiography is an imaging technique that provides images similar to X-ray radiography. X-ray attenuation (loss of intensity), which provides the contrast in radiography images, is directly dependent on the atomic number, that is, attenuation increases with the weight of the atoms. Attenuation of neutrons however, is very strong for specific elements like hydrogen. This means that organic materials or water are clearly visible in neutron radiographs because of their high hydrogen content, whereas many structural materials such as aluminum or steel, are much more transparent. This is an advantage when for example, organic compounds have to be detected in materials with high x-ray attenuation and x-ray radiography is therefore not feasible.

French Dassault Aviation designed and produced pyrotechnics components for the Ariane 5\* rocket program. Before launch, every single device had to be thoroughly tested for sufficient density and homogeneity of the explosive. A method of analysis that is non destructive, i.e. will not damage nor alter the components, is mandatory when analyzing these explosive devices, and this is where neutron radiography comes into the picture.

## Neutron radiography non-destructive testing

Approximately 800 different pyrotechnical devices have to be installed for the launch of Ariane 5. The components included the booster rockets and fuel tanks, initiators and capsules that contain modern explosives (Hexogen), as well as items as cable cutters for steel ropes of up to 10 mm thickness.



High density and homogeneity of explosives onboard, for example within the capsule or the initiator, were essential for all pyrotechnical devices in order to guarantee a safe and hustle-free operation when in orbit.

Due to the method's large penetration depth and good contrast for light elements, especially with hydrogen rich materials such as explosives, neutron radiography is by far, the best choice for analyzing such items. Neutron Radiography is one of the main techniques that satisfy the quality-control requirements of explosive devices used in space programs. The measurements for Ariane 5 were performed at the Helmholtz-Zentrum Geesthacht facility in Germany.

\*Ariane 5 is, as a part of Ariane rocket family, an expendable launch system used to deliver payloads into geostationary transfer orbit (GTO) or low Earth orbit (LEO). Ariane 5 rockets are manufactured under the authority of the European Space Agency (ESA) and the Centre National d'Etudes Spatiales (CNES). Source: Wikipedia

## Figure NUMBER ONE

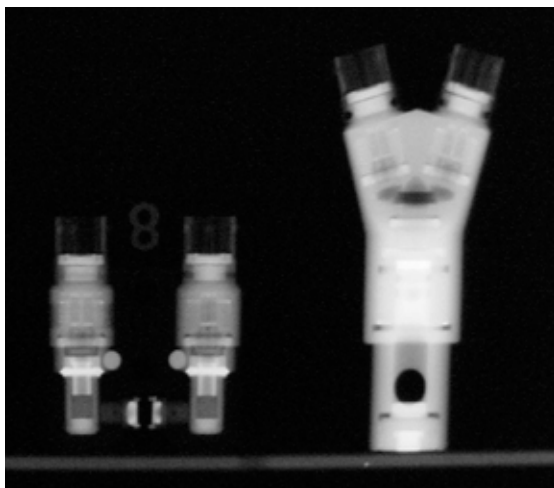


Figure 1 Radiographs of components, left initiators and cable cutter

Science Link is a network between leading research facilities of photon and neutron sources and its users. The project aims to support and encourage innovation and entrepreneurship in the Baltic Sea Region. Apart from the research facilities, the network also includes scientific institutes, universities and regional organisations that serve as service and promoting units. Science Link is part-financed by the European Union (Baltic Sea Region Programme) and involves 20 partners from 9 countries during the project period 2012 to 2014.

## Figure NUMBER TWO



Figure 2 Pyrotechnical components, Ariane 5

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