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Laser based Neutron Sources as a Tool for Material Analysis

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In recent years the demand for small sized neutron sources has immensely grown, which is caused by several factors. On one side, as technology advances, structures become more complex and an in-situ diagnostic is required that promises a sensitivity to small material variations while maintaining a high transmission range. On the other side the potential thread of undiscovered sensitive fissile material, explosives or contraband crossing borders is of great concern to our civilization.

Neutrons are able to solve both problems since they are capable of penetrating deep into samples since they do not interact electromagnetically and they are highly sensitive to variations in the isotopic number inside the probed object. This can not only be used to identify materials but also to trace them back to their origin since isotopic compositions vary strongly depending on geographic composition.

While conventional neutron sources are large in size, expensive and produce strong background radiation with large pulse widths, it is more desirable for this purpose to have additional sources, that are smaller, transportable with short pulse lengths and which require less shielding.

With laser based neutron sources this advantage can be achieved and with the current development of lasers, the amount of neutron per pulse is increasing drastically as well as the repetition rate of future laser systems . This will soon lead to a point where laser based neutron sources will become a serious competitor to existing sources as they provide capabilities and opportunities where the conventional sources have their limits.

The international center for nuclear photonics was recently founded by the LOEWE initiative for excellence at the institute of nuclear physics at the TU Darmstadt and aims for the development of a laser driven neutron source. In line with this efforts first experiments were conducted that proved the applicability of these sources for neutron resonance spectroscopy as well as for thermal neutron radiography.

Primary author: Mr ZIMMER, Marc (Technische Universität(TUDA))

Presenter: Mr ZIMMER, Marc (Technische Universität(TUDA))

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