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Status of Fast Neutron Imaging Research at ETH/PSI

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In collaboration between ETH Zurich (Laboratory of Nuclear Energy Systems) and the Paul Scherrer Institute in Switzerland, fast neutron imaging techniques are actively developed. This includes a custom D-D fast neutron generator with a small emitting spot (~2 mm) and an output of about 3E7 neutrons/s. It is equipped with a rotating beam target in order to manage high power density at the emitting spot. Ongoing source upgrades include changing from an RF-driven to a microwave-driven ion source in order to reduce operating pressure and enable higher acceleration voltage. This is expected to bring the output to about 3E8 neutrons/s. A custom array of plastic scintillator detectors is used for fan-beam tomography, including research on energy-selective techniques where tomography data is collected at different source emission angles, corresponding to a quasi-monoenergetic range of about 2.2-2.8 MeV. By combining images at multiple angles, because elements have uniquely energy-dependent cross-sections in the case of neutrons (unlike X-rays), element sensitivity can be achieved. Feasibility studies using homogeneous samples were successful, and the technique is now being tested with more realistic, heterogeneous samples. Development of a gamma-blind, high efficiency, high-resolution 2D fast neutron imaging detector is also ongoing. The concept uses wavelength shifting fibers embedded in a ZnS(Ag)-epoxy mixture with SiPM readout of the light collected. A single channel prototype was developed and tested for characterization of spent nuclear fuel, and by segmenting the fiber readout it is expected that roughly 0.5 mm resolution can be achieved. That status and outlook of all of these efforts will be presented.

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