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Control and acquisition system for a radar-based IFMIF-DONES lithium target diagnostic

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The IFMIF-DONES (International Fusion Materials Irradiation Facility –DEMO Oriented Neutron Source) will irradiate materials for fusion reactors with an accelerator-driven neutron source based on a 125 mA, 40 MeV deuteron beam impinging on a liquid lithium target. This is a jet flowing at 15 m/s and heated at 300ºC that must stop the 5 MW beam safely over a distributed beam footprint of 200 mm x 50 mm, while keeping its thickness within 25 ± 1 mm to avoid damages.

Monitoring lithium thickness in real time is essential to ensure safe operation under harsh environment conditions: intense radiation, high temperature and evaporated lithium. The proposed radar-based solution operates in the millimeter-wave range (mmWave). In case of thickness instabilities, it sends an alarm to Machine Protection System (MPS) with minimum latency.

The best-suited type of radar is Frequency-Modulated Continuous-Wave radar (FMCW). Specific to this diagnostic is that rough distance is fixed, but small variations have to be measured with accuracy below 1 millimeter.

The control and acquisition system shown in this contribution operates the radar by generating a sawtooth signal to modulate frequency, and digitizing received Intermediate Frequency (IF) signal with tight synchronization.

Digitizer has an FPGA to process signal and calculate range in real time with algorithms to improve accuracy beyond resolution. Experimental Physics and Industrial Control System (EPICS) is used for machine integration.

Footnotes

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