Karlsruhe Institute of Technology

Institute for Neutron Physics and Reactor Technology (INR)

Long Range Optical Distance Sensor for Liquid Metal Free Surface Detection

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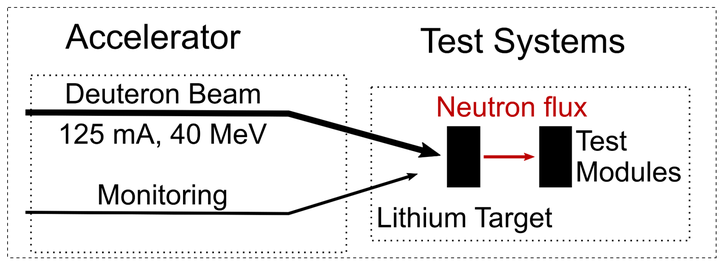
DONES (DEMOnstration fusion power plant Oriented NEutron Source)

- Irradiation Facility for fusion materials

➡ Characterisation of irradiated structural materials



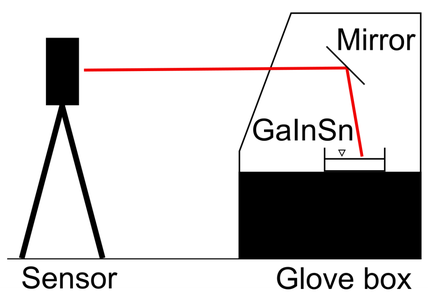
Motivation

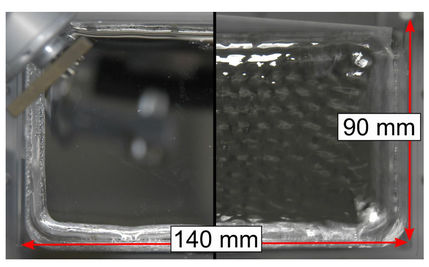
- Preselected potential optical sensors for DONES
  - Triangulation, Chromatic Confocal, Time of Flight and Phase
- Specular surface detection from long ranges (> 7 m)

➡ Validation of selected sensors

Experimental Setup

- Sensor: ATS600 [HEXAGON] (Laser Radar)
- GaInSn pod with vibration motor to induce waves
- Measurement distances were 4.3 m and 7.4 m
- Argon atmosphere (< 5 ppm O_2, < 1ppm H_2O) to slow down surface oxidation
- Alternated measurement on flat and wavy surface



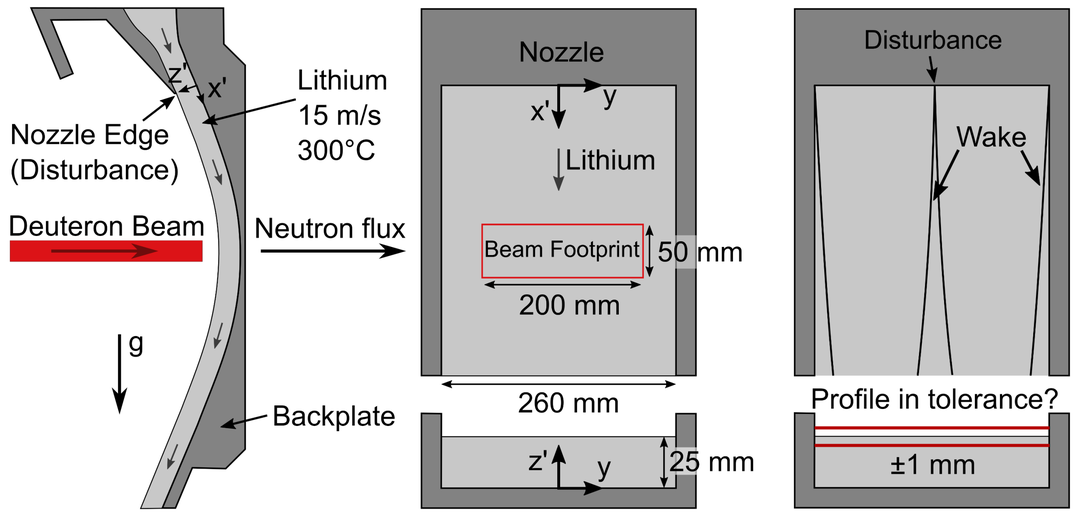


Liquid Lithium Target

- Neutron flux production and Heat removal

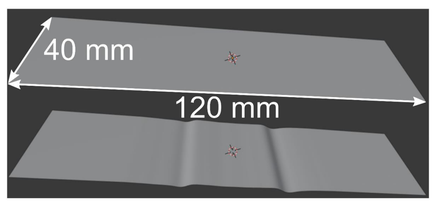
➡ Stable film thickness crucial

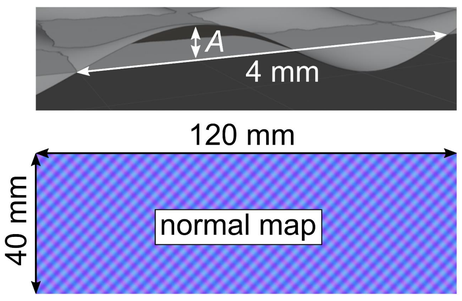
➡ Monitoring the free surface height necessary



Simulation Setup

- Sensor: ITER In Vessel Viewing System (IVVS) [F4E] (“Frequency Modulated lidar”)
- Software Blender 2.82a + F4E Add-on
- Ray Tracing on flat surface / idealized wake
- Ashikhmin-Shirley model
  - Bidirectional Reflectance Distribution Function (BRDF)
- Waviness implemented as normal map
- Variation of wave amplitude *A* and reflectivity





Results

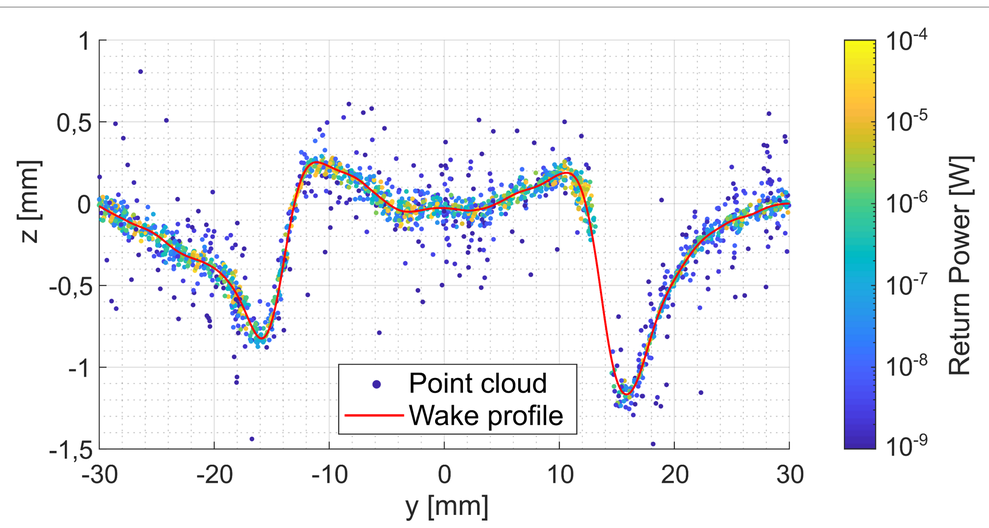
- Flat specular surface not detected
- Wavy specular surface detectable

➡ Threshold value for the reflected power necessary

➡ Standard deviation < 0.35 mm

- Amount of detected points depended strongly on the waviness
  - 36 – 56% points in comparison to a diffuse surface

➡ Simulation had a peak of detected points at *A* = 0.13 mm amplitude.



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EUROfusion

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