

# Quality Control of Nuclear Fusion Targets

Master Thesis: Computational Refraction-Corrected Optical Coherence Tomography



Nano- and Microfluidics

**Inertial-confinement fusion** (ICF) is a promising technology for sustainable power generation, using lasers to trigger fusion in small, spherical targets consisting of a shell and a fuel-filled core. For the implosion to be efficient, the targets must be almost perfect spheres with a homogeneous shell thickness. A promising manufacturing approach employs microfluidic chips to produce double-emulsion droplets with curable shells. But before curing, each droplet must be inspected for sphericity and concentricity so that production can be scaled up economically. **Optical-coherence tomography** (OCT) is well suited for this inspection, as it can image internal interfaces through transparent, layered materials. However, the curved droplet surfaces bend the light, which systematically distorts the OCT image and makes direct dimensional measurements unreliable.

The aim of this thesis is to develop a **refraction-correction model**. The correction is formulated as an inverse problem: from a measured OCT image we wish to recover the true droplet geometry. To this end we construct a forward model that predicts how refraction distorts the OCT signal by employing different **light-propagation models**. By comparing the predictions of models with varying fidelity to synthetic (computer-generated) OCT data, we will determine the level of physical detail required to satisfy the strict manufacturing tolerances.

The project will comprise the following tasks:

- 1) Acquire a solid understanding of OCT operation.
- 2) Review the literature on optical imaging of spherical objects and inverse problems in metrology.
- 3) Design the inverse-problem framework and outline a modular code architecture.
- 4) Implement different light propagation models
- 5) Validate against synthetic data.
- 6) Finally, apply the pipeline to experimental data

Key facts:

- Master thesis
- Metrology
- Computational image correction
- light propagation at interfaces

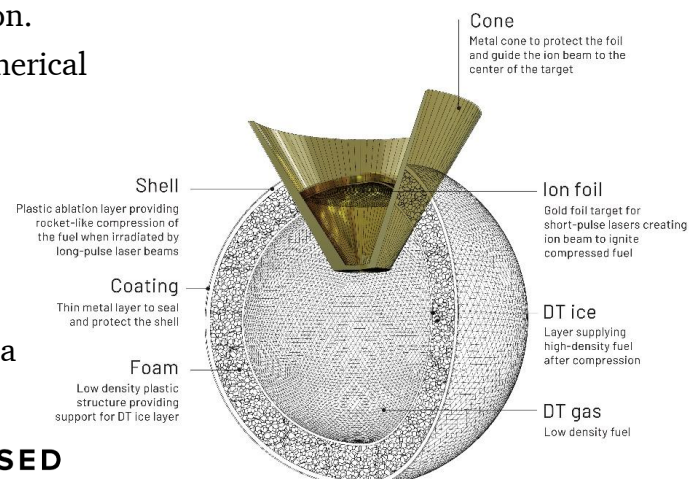
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Lisa



This thesis will be graded by Henning Bonart.



In collaboration with the Start-up



FOCUSED