# Dimensional metrology measurements of targets relevant to the geometry of the IFMIF-DONES lithium target

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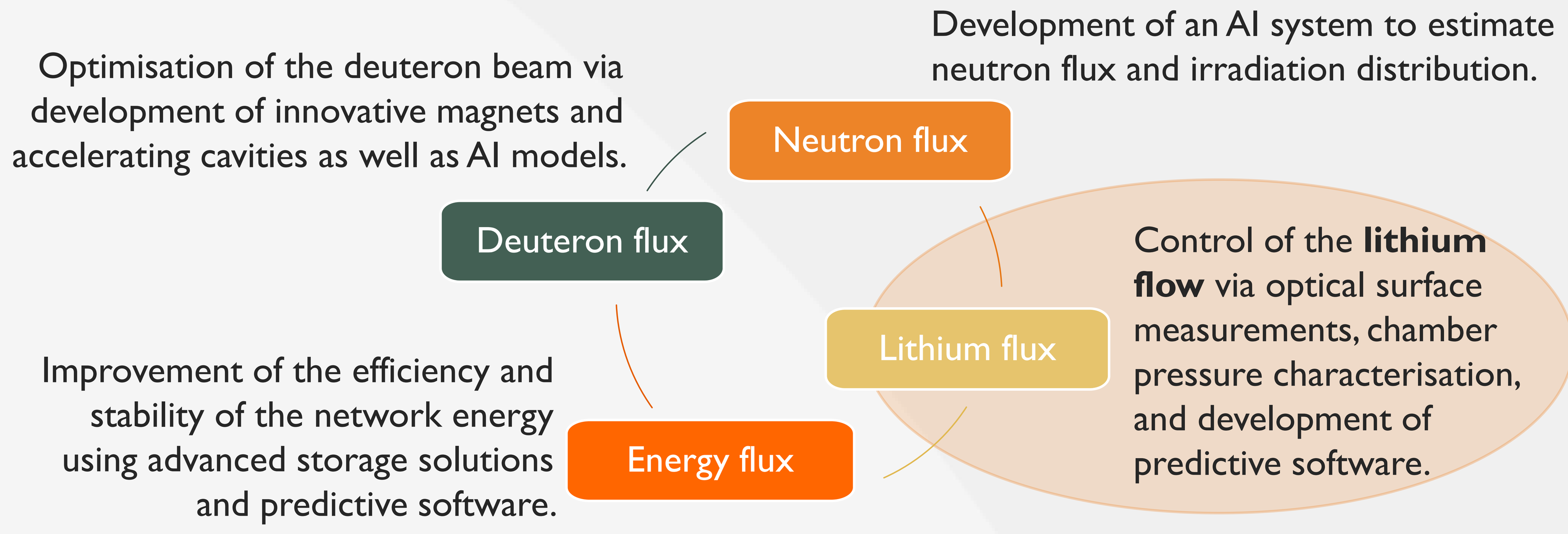
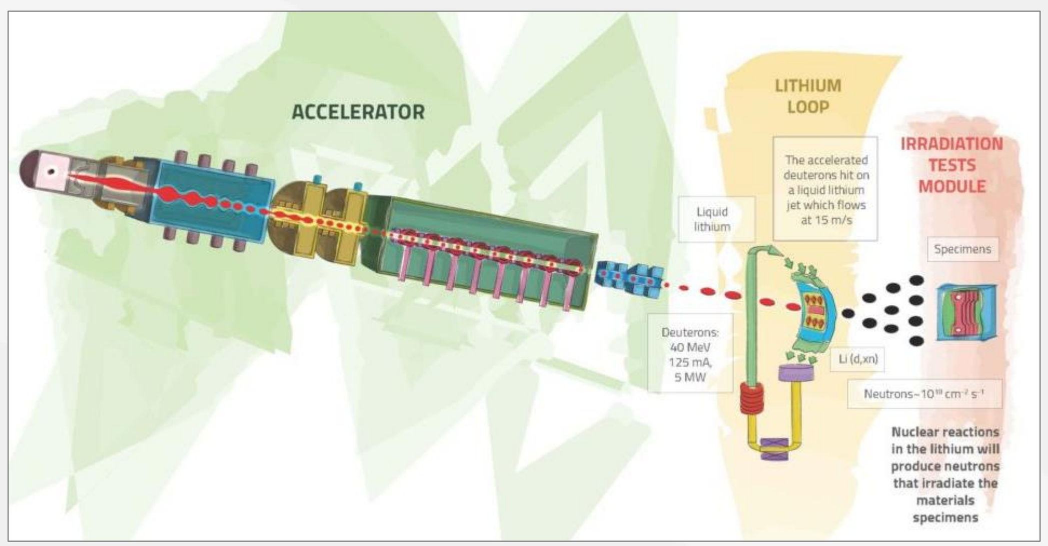
## The DONES-Flux project

The DONES-Flux Project is an industrial technology research project that aims to **optimise the efficiency** of large scientific installations such as IFMIF-DONES to limit risks in operation and maintenance. It takes a global view of the optimisation of the different energy, matter or information flows within IFMIF-DONES.

Web:




## The lithium jet thickness monitoring system




*IFMIF-DONES – Functioning Scheme (https://ifmif-dones.es/ )*

| Key parameters | Requirement |
|---|---|
| Entry port distance | 8 m ± 0.120 m |
| Depth accuracy | < 0.3 mm |
| Lateral resolution | < 5.0 mm |
| Measurement area | 200 mm x 50 mm |
| Measurement time over line | < 100 ms |
| Environment | radiation, vacuum, high temp. |

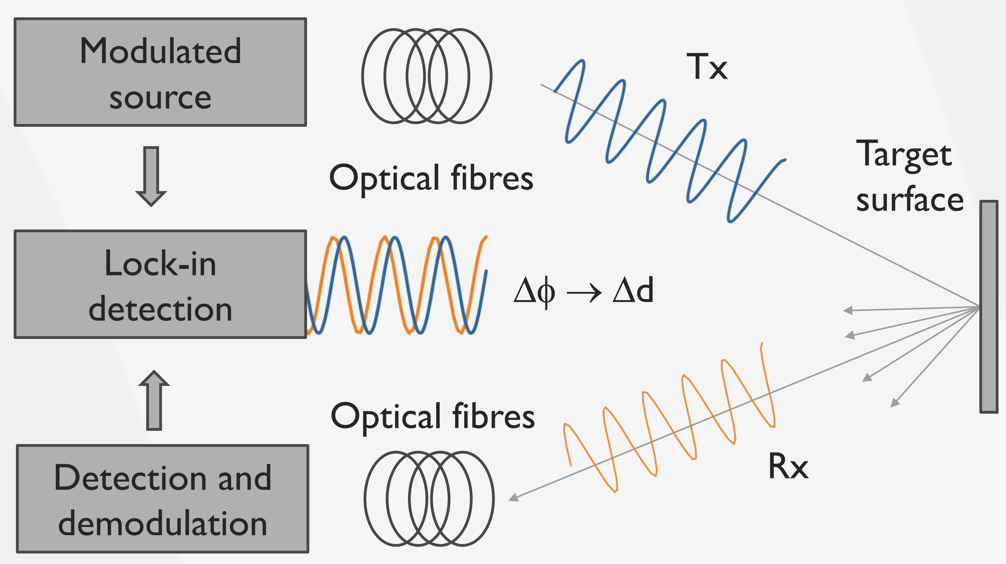
Operation of **IFMIF** relies on the bombardment of a sheet of liquid lithium with accelerated deuterium ions, resulting in neutron emission. Safe operation of the source requires **stability in the lithium target**, and characterisation of the position and spatial distribution of the flowing liquid lithium is required.

The lithium sheet is a **metallic liquid flowing** between 10 and 20 m/s in a vacuum of $10^{-3}$ Pa, with a jet thickness that must remain within 25 mm ±1 mm.

The measurement system must quickly **detect sub-mm changes in height** in the target surface under extremely high radiation conditions, via an instrumentation port with clear line of sight at 9° from 8 m away.

## AM- continuous-wave lidar

The light output of a laser source is **modulated in time** and send towards the surface of interest. The returned scattered signal is coupled into a **fast APD** connected to a **lock-in amplifier** to extract the amplitude and phase of the return signal. The relative distance between surfaces is calculated from the **phase difference** via the modulation frequency and speed of light.

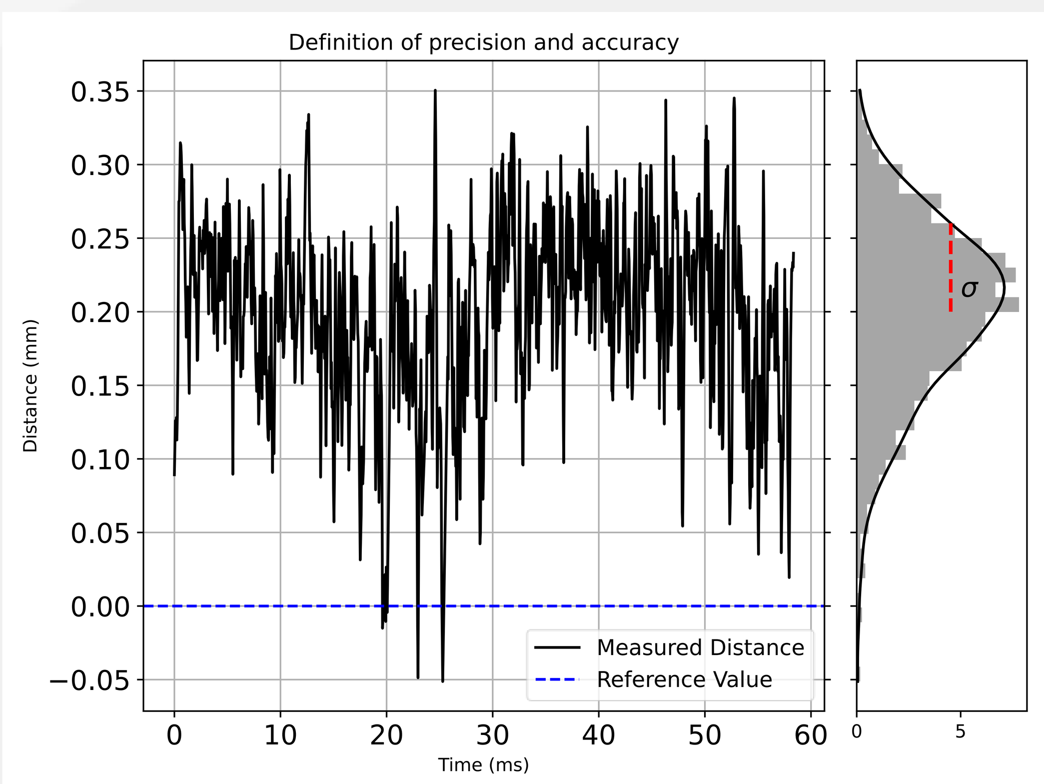



## Characterization of the AM-LIDAR metrology system

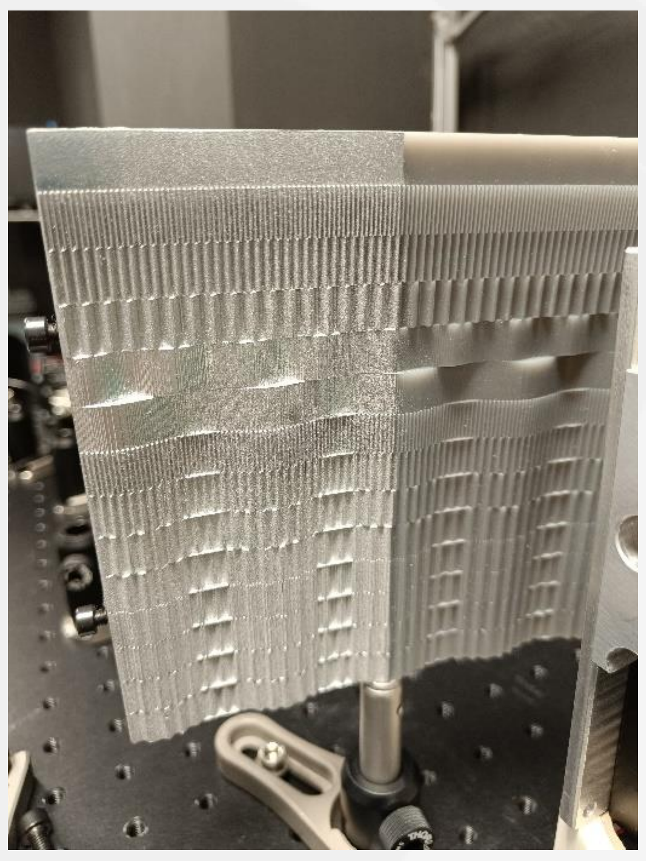
The precision and accuracy attainable from the AM LiDaR system was characterised using static targets:

Precision is obtained by scanning the beam across a planar target and calculating the standard deviation of the measured distance (black line below) from a perfect plane, dotted red line in the plot below.

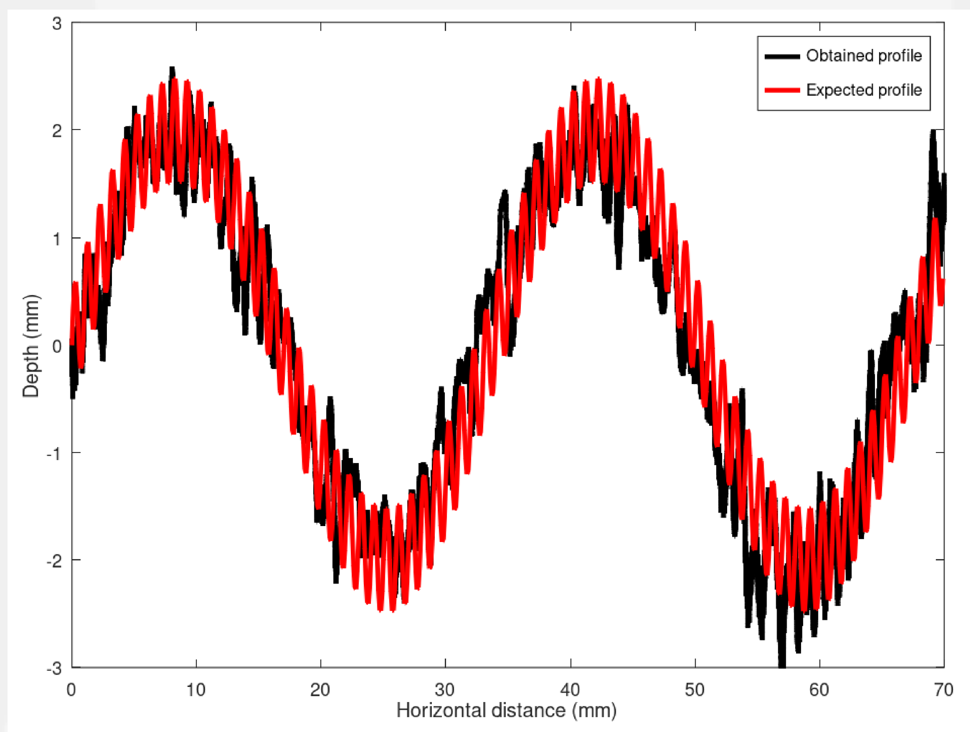
The accuracy is measured by scanning across a sequence of steps separated by a calibrated distance. The accuracy is defined by the difference between the measured distance (black continuous line of the plot) and the reference value (blue discontinuous line of the plot).



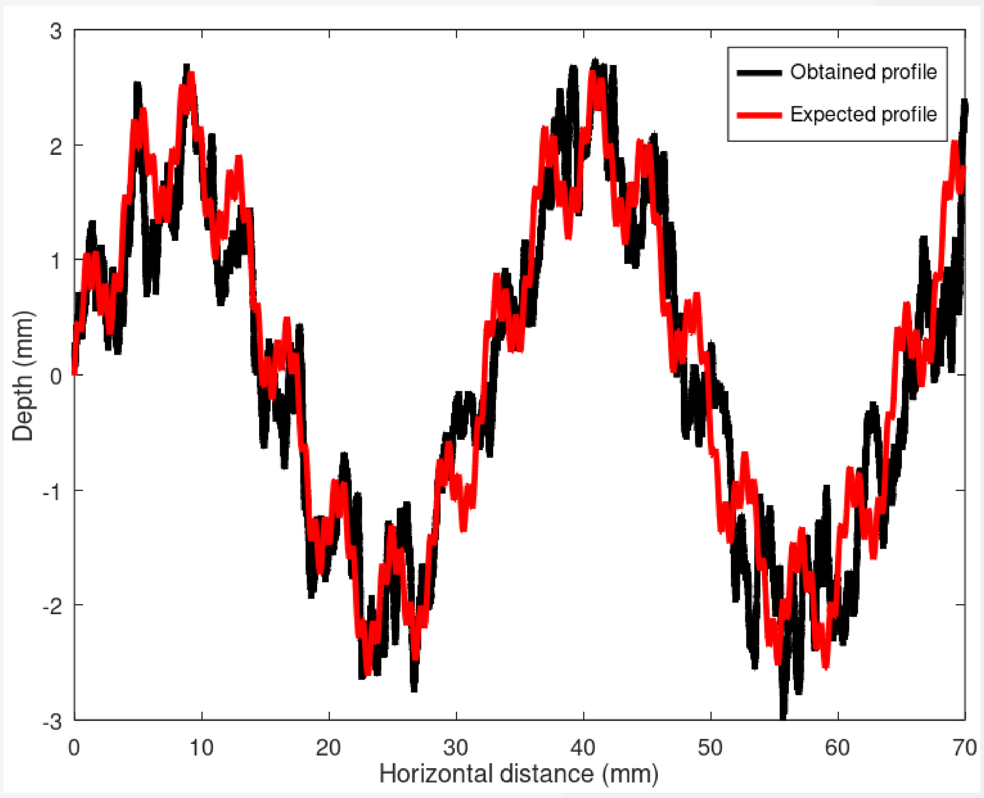

| Precision σ : 0.1 mm | |
|---|---|
| Measured distance (mm) | Accuracy (mm) |
| 51.10 | 0.1 |
| 80.03 | 0.07 |
| 125.16 | 0.08 |



**AM-LIDAR reconstruction of 3D printed wave targets generated from the sum of sinusoids of period T and amplitude A *:**




T1 = 32 mm, A1 = 4 mm ; T2 = 1 mm, A2 = 1 mm




T1 = 32 mm, A1 = 4 mm ; T2 = 4 mm, A2 = 1 mm, T3 = 2mm, A3 = 0.4 mm

* x-axis was not calibrated for these measurements.

A flowing GaInSn jet is being implemented at ASE's facilities through collaborative work with CEA-Saclay. This will enable the validation of the measurement system in a flowing liquid metal.

**Acknowledgements**

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