PREPARATION AND CHARACTERIZATION OF HOPG-BACKED TARGETS FOR THE NUMEN PROJECT

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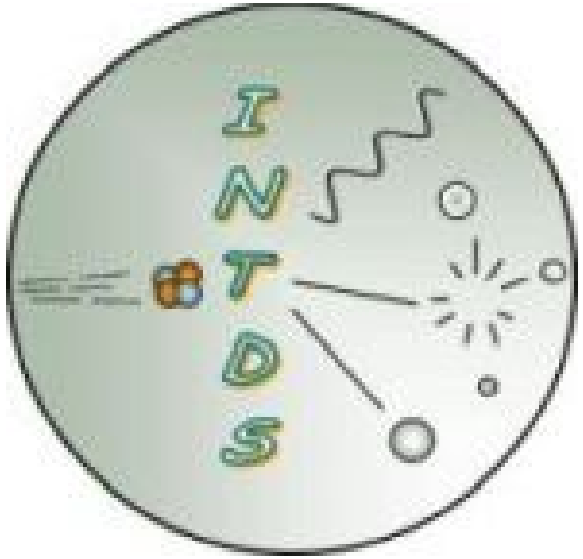

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PRESENTATION LAYOUT

- Overview of the LNS target laboratory
- The new target measurement system and its characterization
- Mo target production
- Cd target production
- Conclusions

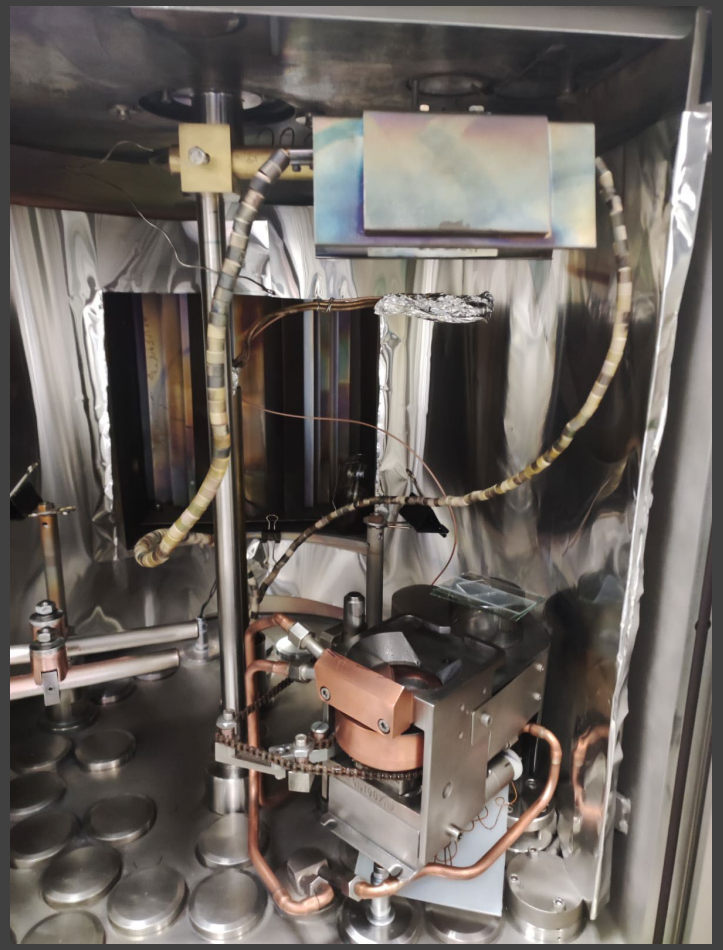
Bell Jar Thermal evaporator system - L300

- Two resistive sources
- A probe to monitor the backing temperature
- A quartz crystal micro balances

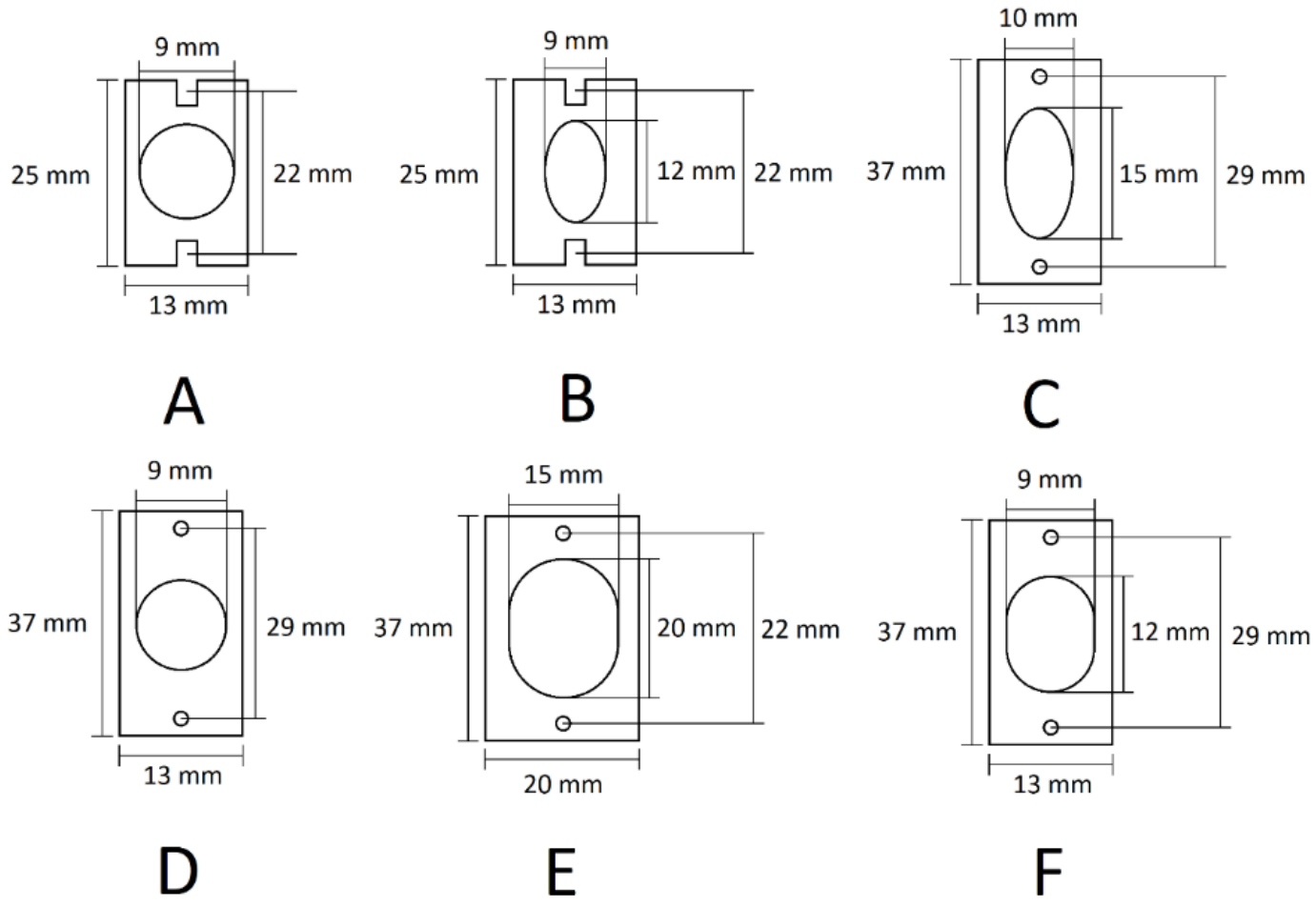
Vacuum thermal Evaporator - LEYBOLD HERAEUS 560

Evaporation by
- e-beam heating source
- resistive heating source

- quartz crystal micro balance
- halogen heating elements to fix temperature

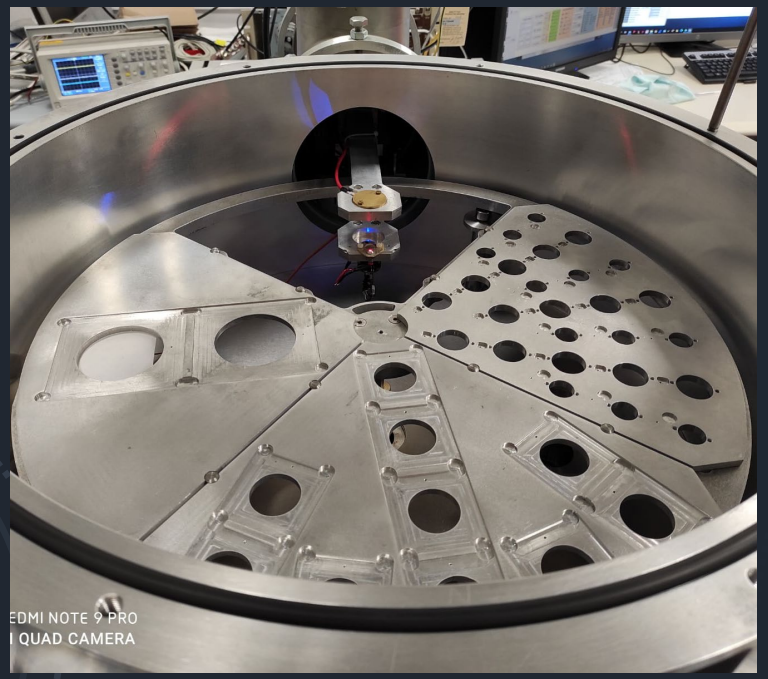


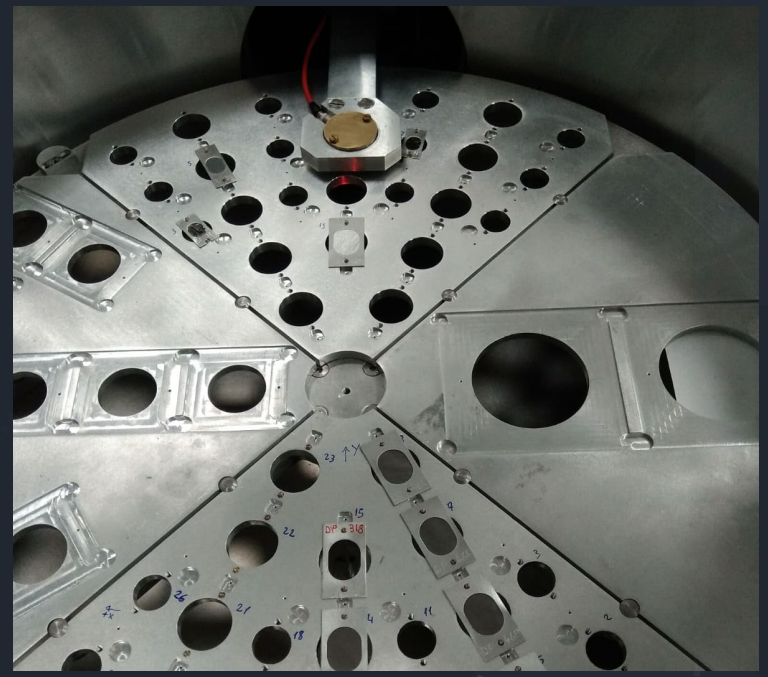
STANDARD TARGET FRAMES @ LNS



It is possible to manufacture target also on different frames !

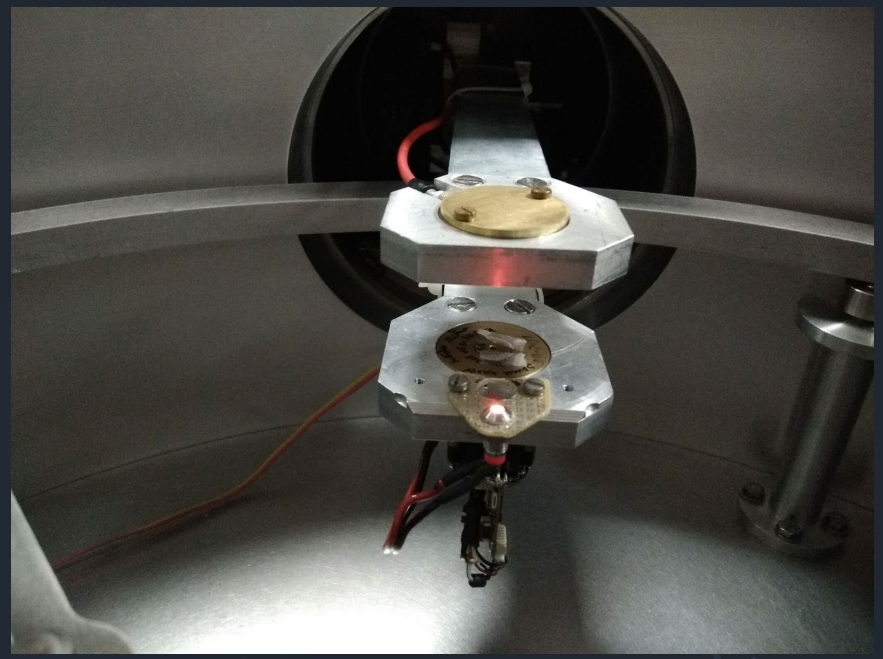
New system for target thickness measurement and characterization





- Based on alpha transmission measurements
- A cylindrical chamber of about 1 m
- 4 plates to host different type of target frame

Handling system



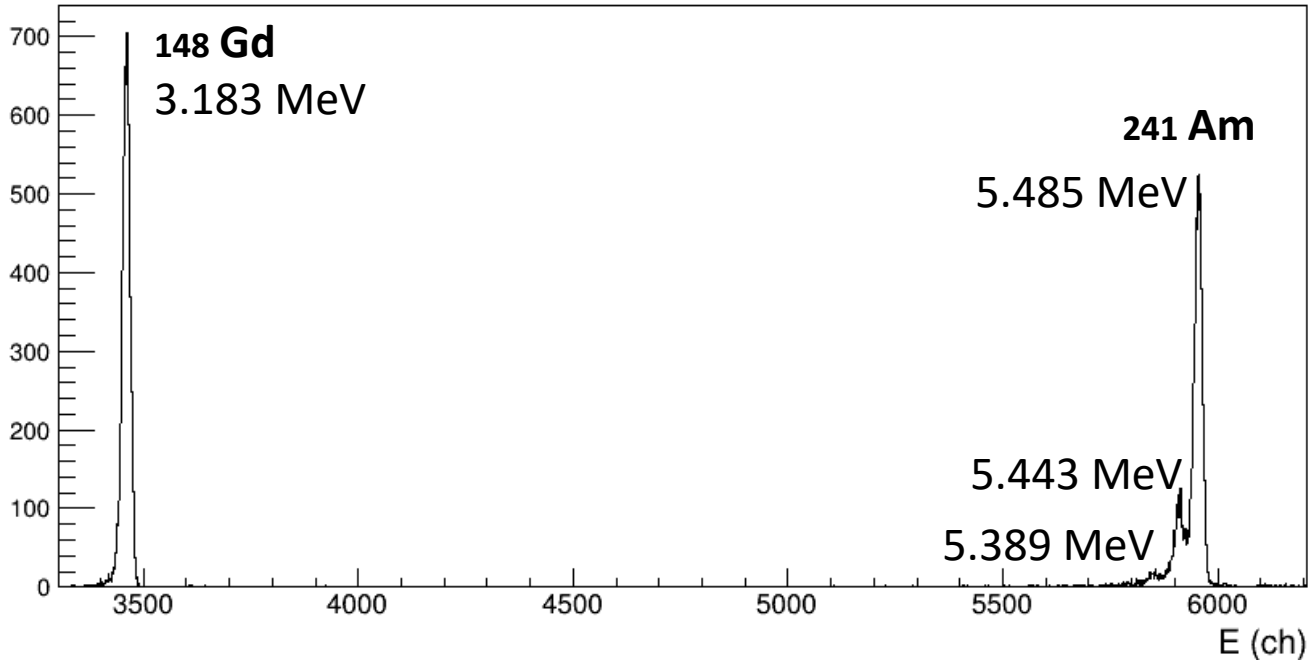
Pinpoint scanning sensor

- A moving arm splitted in two part hostes an ^{241}Am alpha source and a Si detector
- Designed to scan all target surface with a precision of 1 mm thanks to a rotational system and a video camera
- The user can set how many and which points scan

High precision target uniformity study

Calibration of the Si detector

- 2 alpha sources used to perform the detector calibration in the range of interest



Mo and Cd TARGETS FOR THE NUMEN PROJECT @LNS

The NUMEN Target must have:

- thin (200-500 μg/cm^2) and uniform;
- deposited on **H**ighly **O**riented **P**yrolytic **G**raphite (450 μg/cm^2 - 2 μm with ρ = 2.253 g/cm^2)

Why HOPG ?

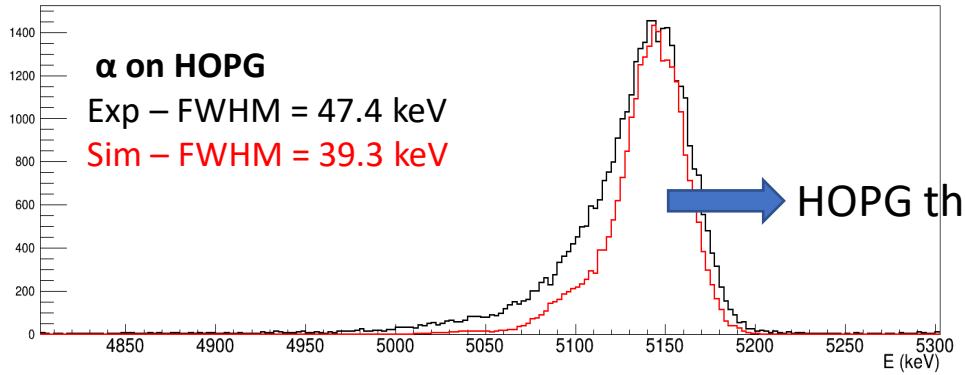
The high thermal conductivity is the main feature of HOPG, so it is able to dissipate the heat produced by the intense (up to 10^{13} pps) ^{18}O or ^{20}Ne ion beam on the target.

Mo and Cd studies were performed by natural elements, to avoid the wasting of isotopes materials

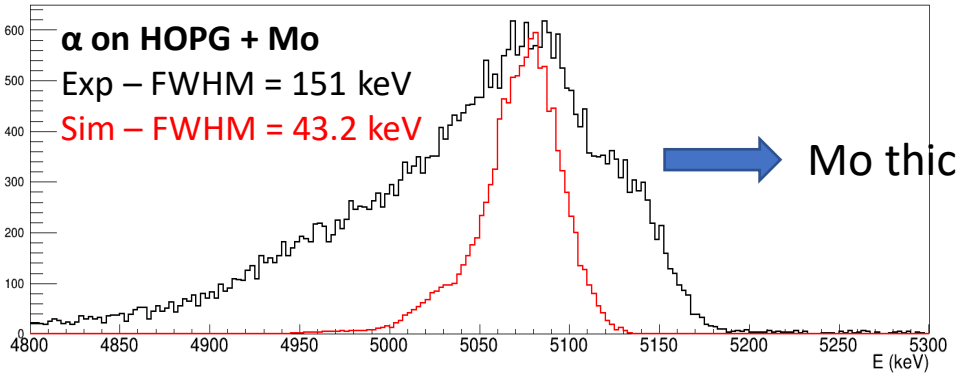
Molybdenum (250 µg/cm^2) on HOPG (450 µg/cm^2)

@ LEYBOLD HERAEUS 560 (e-beam)

- 1 g Mo powder deposited on pellet of Φ = 10 mm.
- Distance source - backing = 200 mm
- Evaporation rate = 0.3 – 0.4 Å/s
- 600 mg of Mo used
- Thickness @ the quartz : 240 µg/cm^2

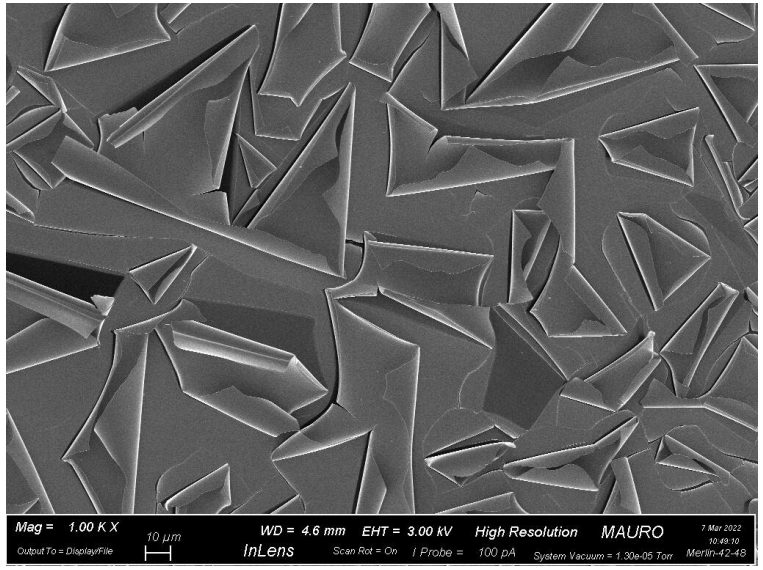


HOPG thickness = 450 µg/cm^2



Mo thickness = 245 µg/cm^2

FESEM @ Politecnico di Torino



- Thicknesses obtained by the alpha measurement close to one measured by the quartz, but a **strong local non uniformity** could be deduced by the energy residual spectra
- A very rough surface of the Mo it could be expected !!
- The Mo surface was analysed by colleagues of Politecnico di Torino by using a Fesem measurement

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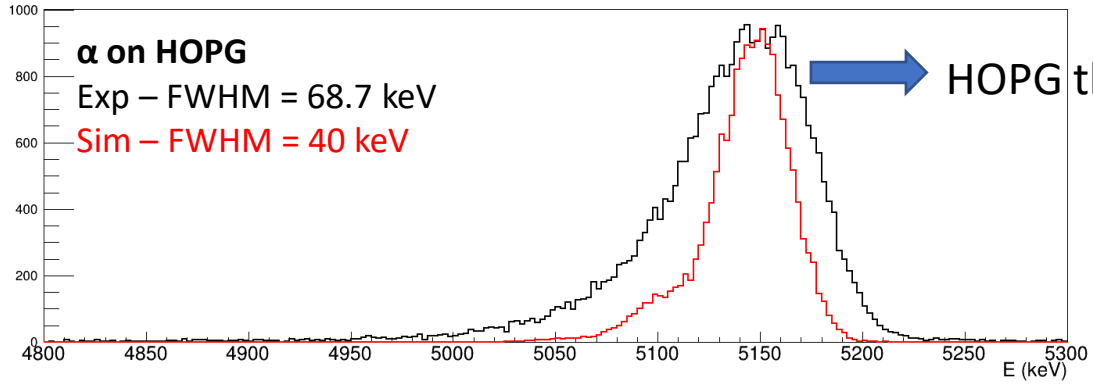
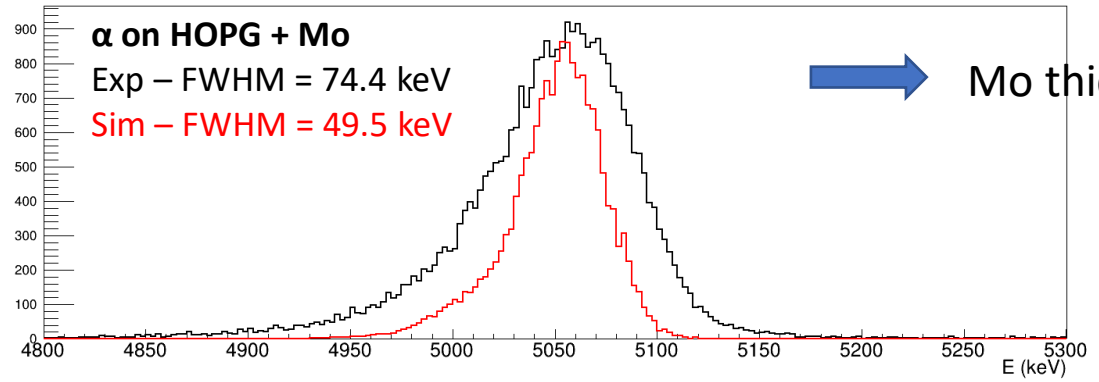
- Thickness @ the quartz : 240 µg/cm^2

- **Backing heated at 300°C**



HOPG thickness = 428 µg/cm^2



Mo thickness = 250 µg/cm^2

- The Mo seems quite uniform.
- New analysis will be performed to confirm this result.

Cadmium (500 µg/cm^2) on HOPG (450 µg/cm^2)

@ L300

- 1.5 – 2 g Cd deposited on Mo boat.
- Distance source - backing = 250 mm
- Evaporation rate = 0.2 Å/s
- 1 g of Cd used
- Thickness @ the quartz : 500 µg/cm^2

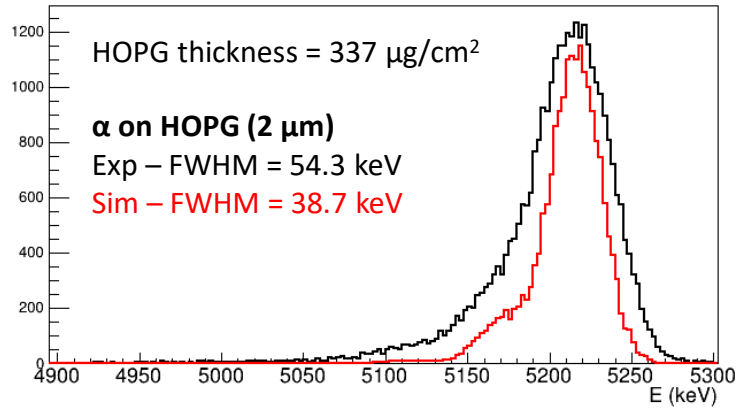
- **To promote adhesion of Cd on the backing a 100 Å of Bi is deposited on HOPG substrate before Cd evaporation**

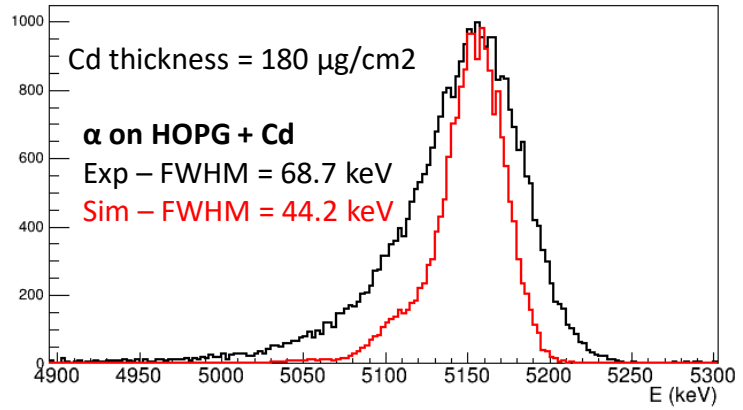
PRELIMINARY

- A good working condition is to evaporate Cd on a cooled backing.
- In our lab we do not have a cooling system for backing
- To overcome this limit, the evaporation process was performed in 2 steps: first half of the required thickness is evaporated, the substrate is expected to reach room temperature, evaporates until the required thickness is reached

Cadmium (500 µg/cm^2) on HOPG (450 µg/cm^2)
Results

	Backing	Average Cd thickness
1 step evaporation	HOPG (450 µg/cm^2)	170 µg/cm^2 😕 😕
	C (70 µg/cm^2)	300 µg/cm^2 😕
2 steps evaporation	**HOPG (450 µg/cm^2)**	**140 µg/cm^2 😕 😕**
	C (70 µg/cm^2)	**473 µg/cm^2 🙂**
	HOPG (2.25 mg/cm^2)	**370 µg/cm^2 😐**





- Reported the average value of the target thickness obtained in the two step process and for comparison the result obtained by performing a one step process
- Not only the 2 µm HOPG was used as backing, but also amorphous C and 10 µm HOPG

The surface of foil plays an important role in the evaporation process

PRELIMINARY

Conclusions

- **Target laboratory** available at **INFN-LNS** for users
- Development, production and characterization of **evaporated foils on HOPG** for the NUMEN project
- Two cases of interest for NUMEN:
  - **Mo** target: uniformity improved by substrate heating
  - **Cd** target: evaporation response depending on substrate properties (amorfous C or HOPG) to be further explored

- LNS target laboratory is part of **EURO-LABS** – WP 2.5 «Service Improvements» – Subtask «Targets»

Fostering the **connection between different nuclear physics institutions** in Europe and associated countries with the aim to create and maintain a **distributed infrastructure** for target development, production, and characterization.