# Study of the Lead Evaporation from the Oven of the GTS-LHC Ion Source

T. Kövener[1], D. Küchler[1] and V. A. Toivanen[2]

[1]*European Organization for Nuclear Research (CERN), Geneva, Switzerland*

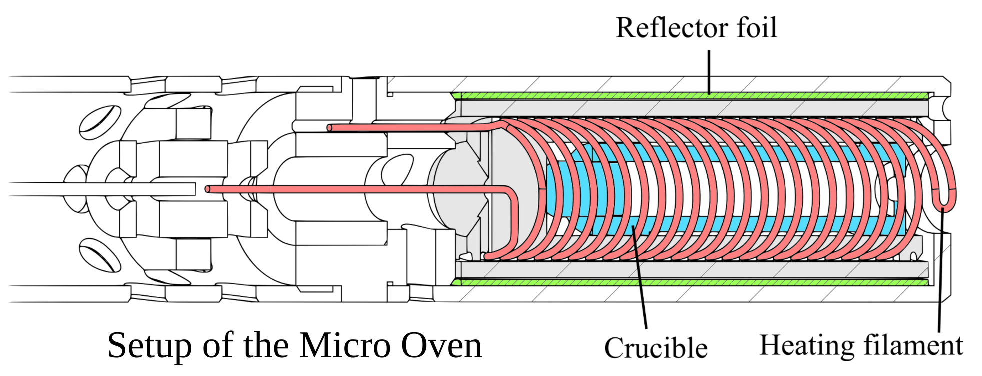
[2]*Grand Accélérateur National d'Ions Lourds (GANIL), F-14076 Caen Cedex 5, France*

## Introduction

Ovens at the GTS-LHC ECR ion source show instabilities and do not evaporate all lead in the crucibles.

➡ A dedicated study shall help to improve the oven performance.

## The GTS-LHC Micro Oven

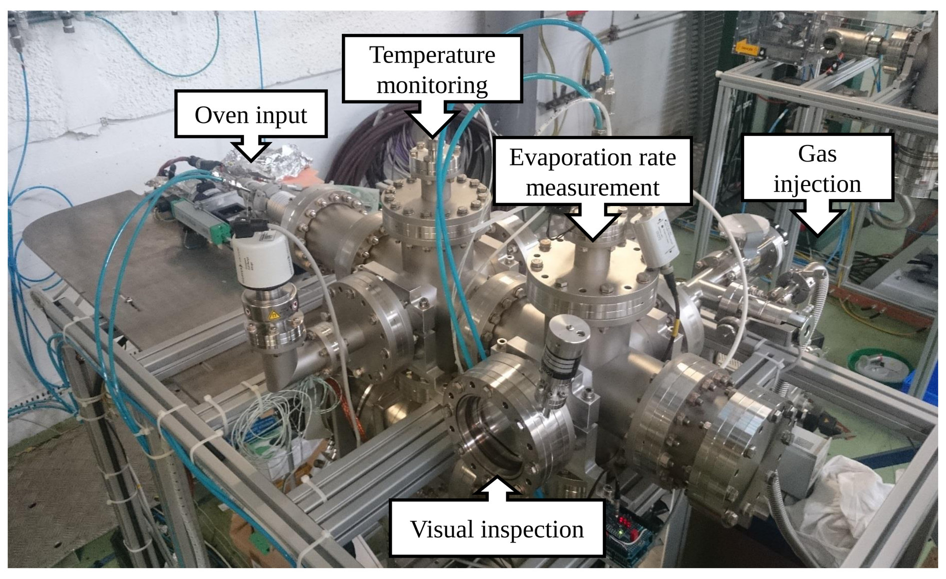


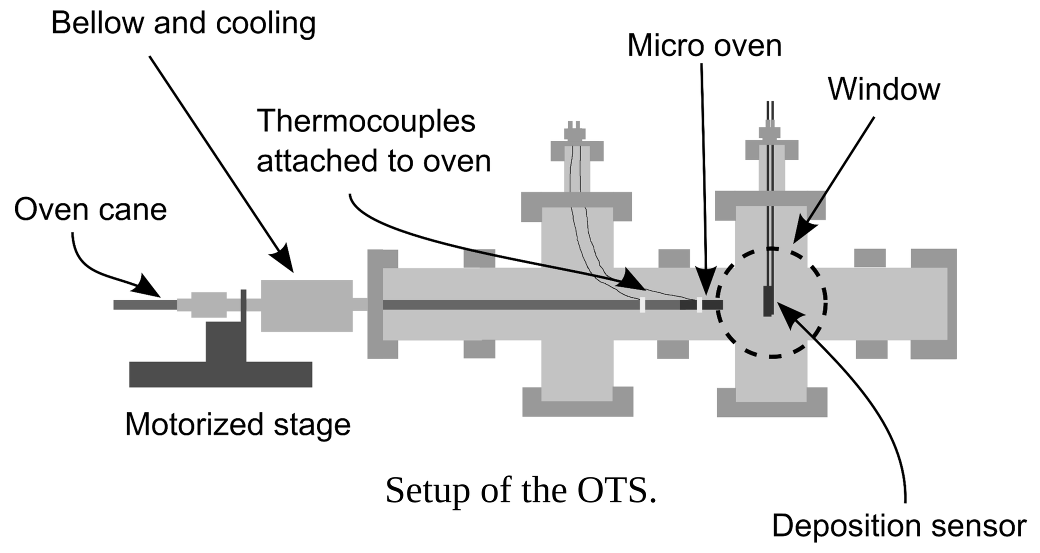

- Lead for evaporation is inside a manually filled crucible.
- Resistively heated with a tantalum filament wound as a double helix.
- Outside layers help to insulate and distribute heat evenly over the crucible.

**Problems :**

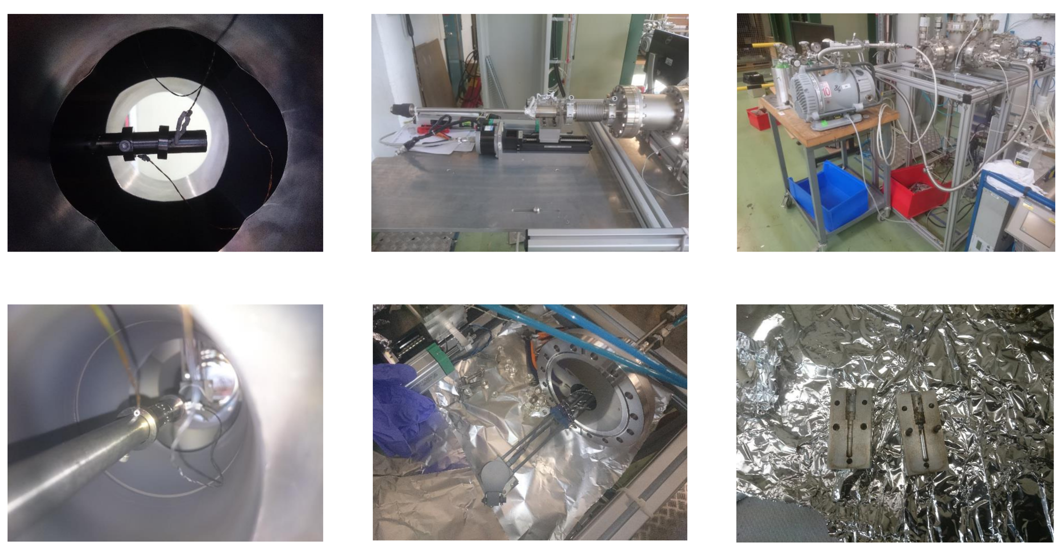
1. The oven seems to be a source of instabilities in the GTS-LHC ion source.
2. The crucible needs to be refilled even though there is still lead inside.

## The Oven Test Stand (OTS)



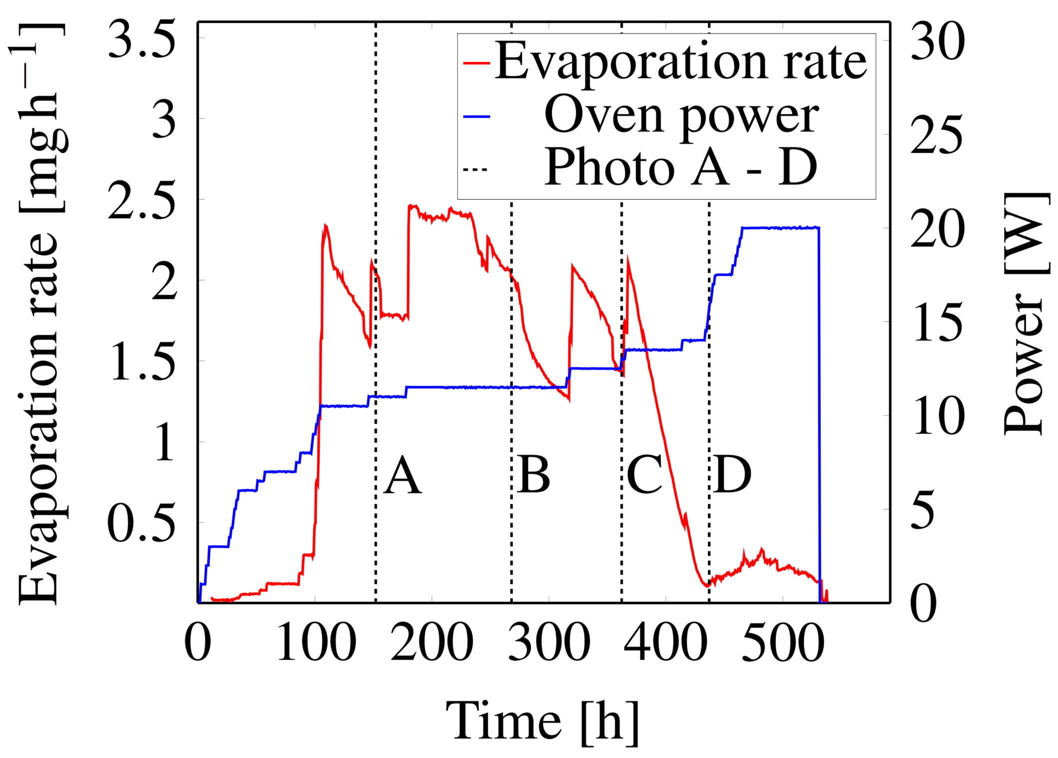

Setup of the OTS.

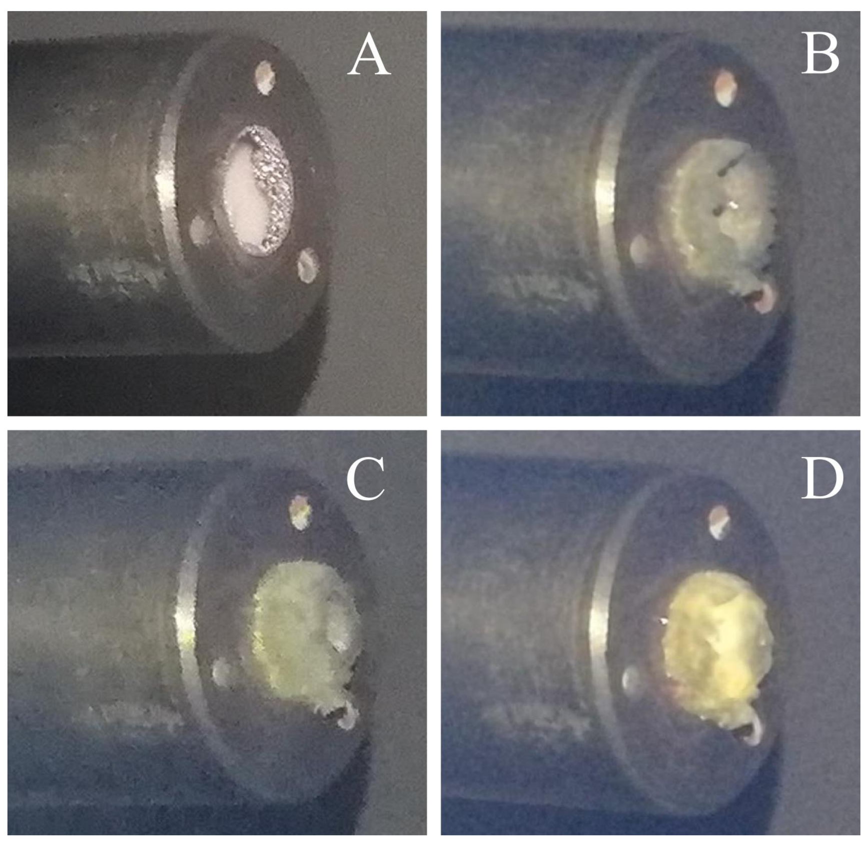


## Lead Oxide Blockages

- Oxygen is used as a buffer gas in the GTS-LHC ion source.
- Lead oxide formations at the oven tip can be regularly observed at the Linac3 ion source. They are believed to be a possible failure mechanism of the oven.
- Measurements at the test stand in vacuum or with a nitrogen atmosphere showed no oxide formation.

- Injecting oxygen at the OTS could recreate the formation of oxide blockages.

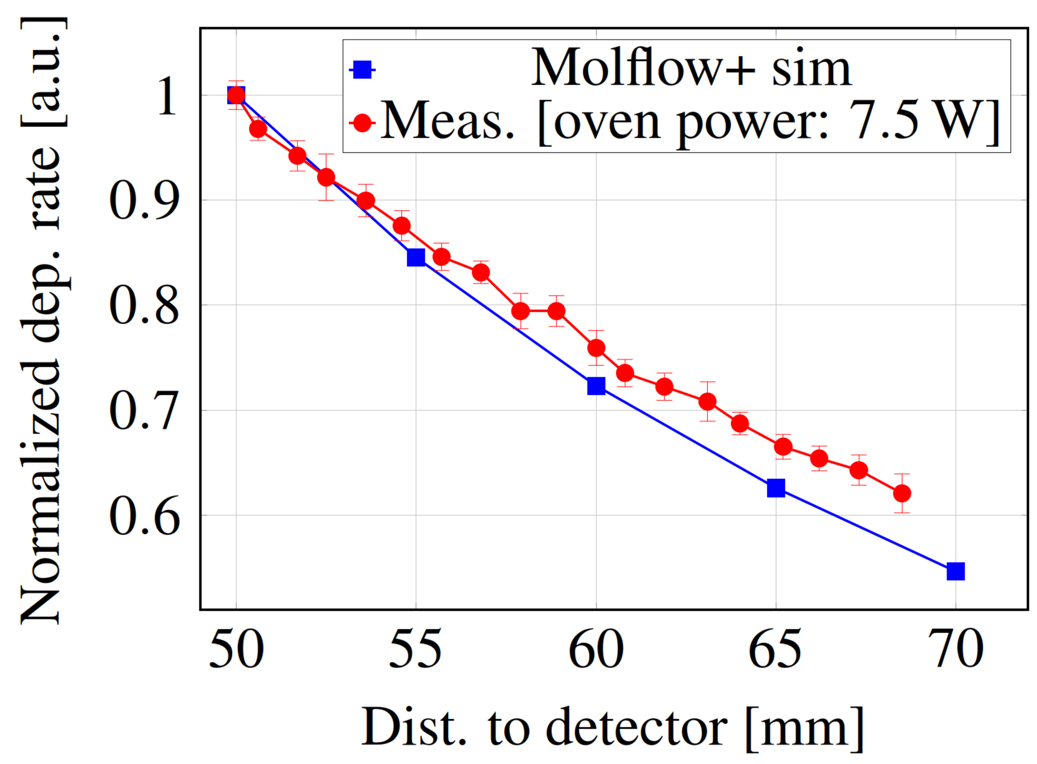


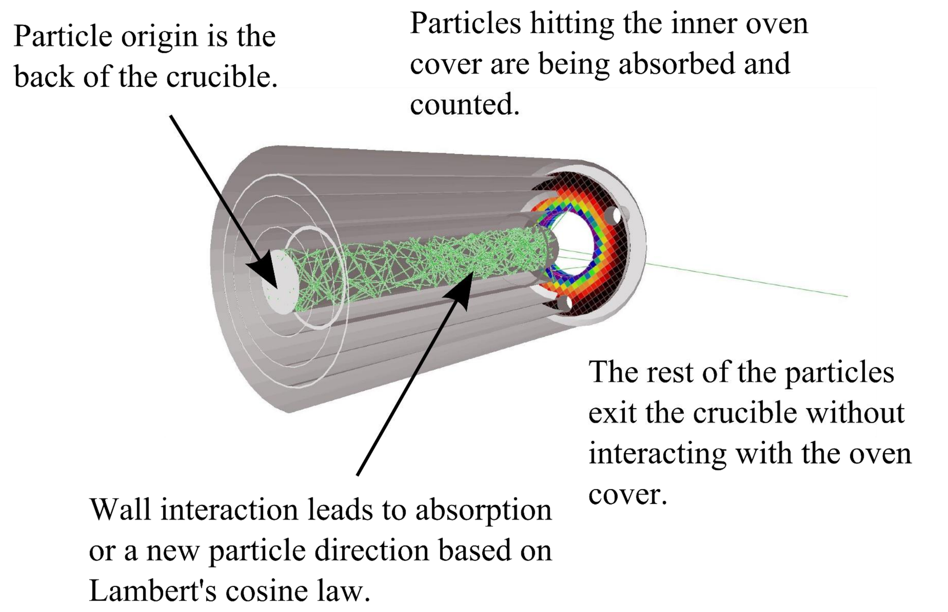

- A thermovalve stabilized the OTS pressure at 1.E-05 mbar.
- The oven power was adjusted manually to try to keep the evaporation rate stable.
- A blockage is forming that finally blocks the oven completely.
- The final decrease in the evaporation rate is most likely due to the lead oxide blockage.
- But clearly the first decrease in evaporation rate is not caused by the blockage, this has other reasons like uneven temperature in the crucible.

## Molflow+ Simulations

- The pressure is low enough to assume molecular flow regime outside of the crucible.
- Therefore the gas jet geometry can be simulated without knowing the exact pressures in the system.
- Molflow+ predicts the signal reduction on the deposition sensor when the oven is moved away from the detector at a stable evaporation rate. This can be tested:




- The simulation can be used to study the deposition of lead on the inner oven cover.




- It shows that approximately 50 % of the particles exiting the crucible hit the inner oven cover instead of propagating freely out of it.
- Lead deposition and condensation is believed to be the cause of the lead oxide blockages.

## Conclusion and Outlook

- Lead oxide blockages are a possible failure mechanism of the Linac3 ion source oven.
- Simulations show that a big part of the gas that exits the crucible hits the inner oven cover. This might lead to condensation and oxide formation.
- Another reason for instable evaporation could be an inhomogeneous thermal distribution in the crucible. This is being studied using ANSYS simulations.