LIEBE

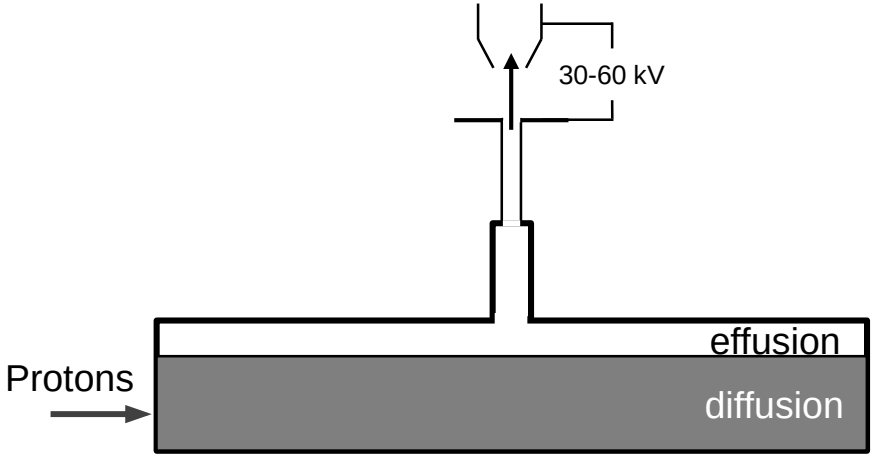
Design & optimisation of the irradiation & release chambers

Preliminary shock-wave calculation

Donald Houngbo (SCK•CEN)

Context; LIEBE Project

Current liquid targets at CERN-ISOLDE



- Slow release of Hg isotopes ~10 s
- Heat dissipation

  CERN-ISOLDE < 6 kW

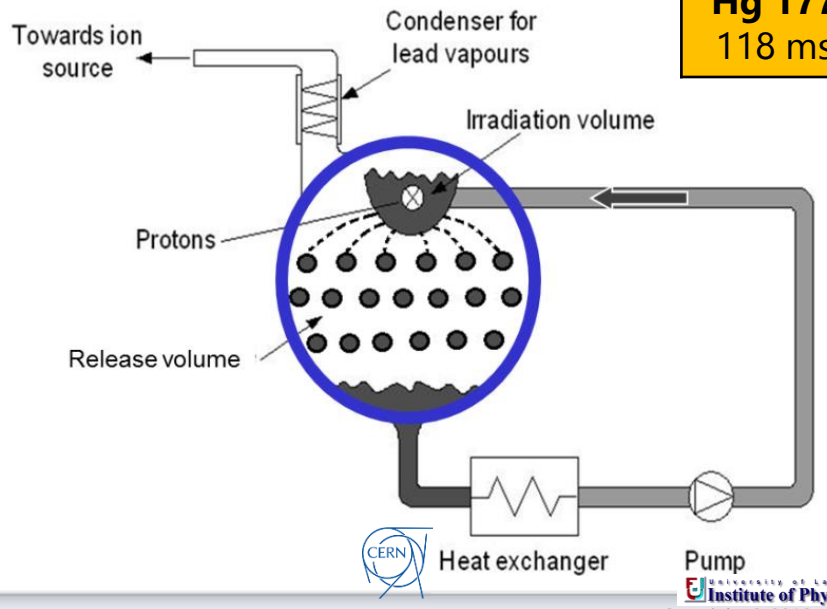
  EURISOL 100 kW

Motivation

...	^{172}Hg 231 µs	...	^{176}Hg 20.3 ms	^{177}Hg 118 ms	...	^{196}Hg STABLE	...

Loop-type target concept proposed in EURISOL DS

Hg 177
118 ms



Irradiation volume

Hg 177
118 ms

Objectives

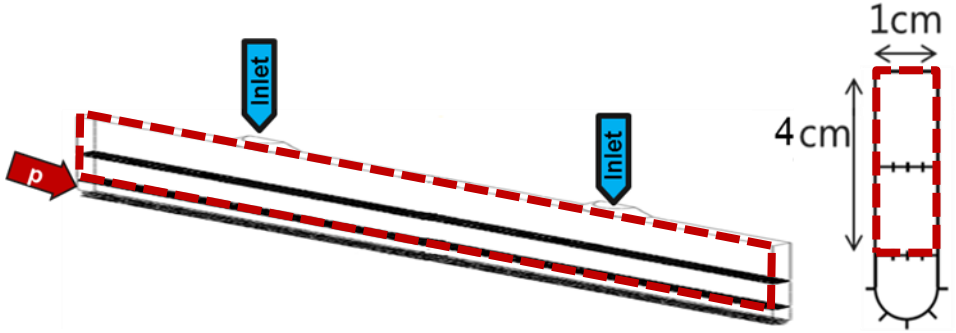
- Complete evacuation of the irradiated LBE into droplets within 100 ms
- Uniform distribution of droplet formation along the length of the target
- Formation of small droplets (r ~ 100 µm)

Methodology

- Initial basic geometries
- CFD analysis LBE flow in irradiation volume
- Progressive geometrical adjustments

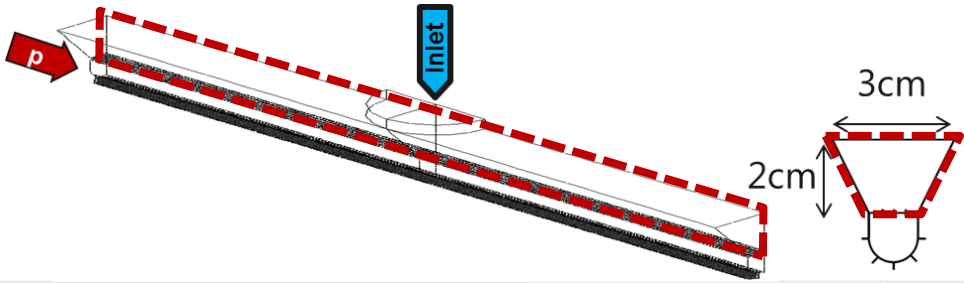
Results

- Parallelepiped-shape feeder volume



D. Houngbo et al., NIMA 777 (2015) 202-210

- Prism-shape feeder volume



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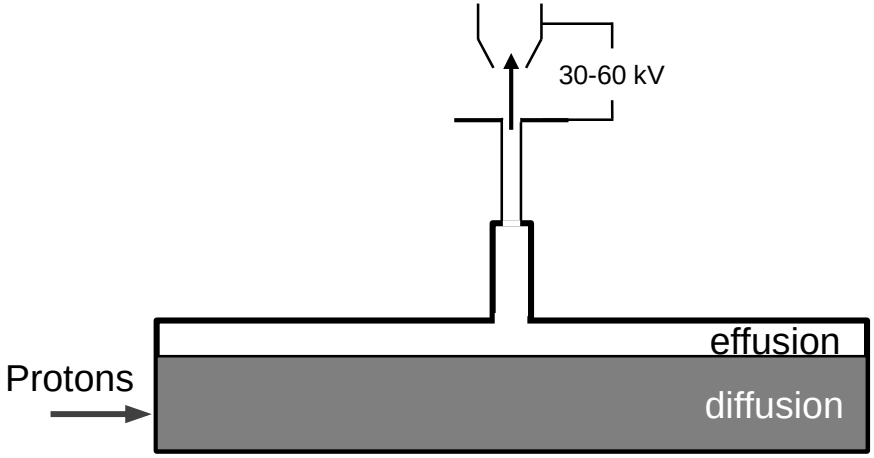

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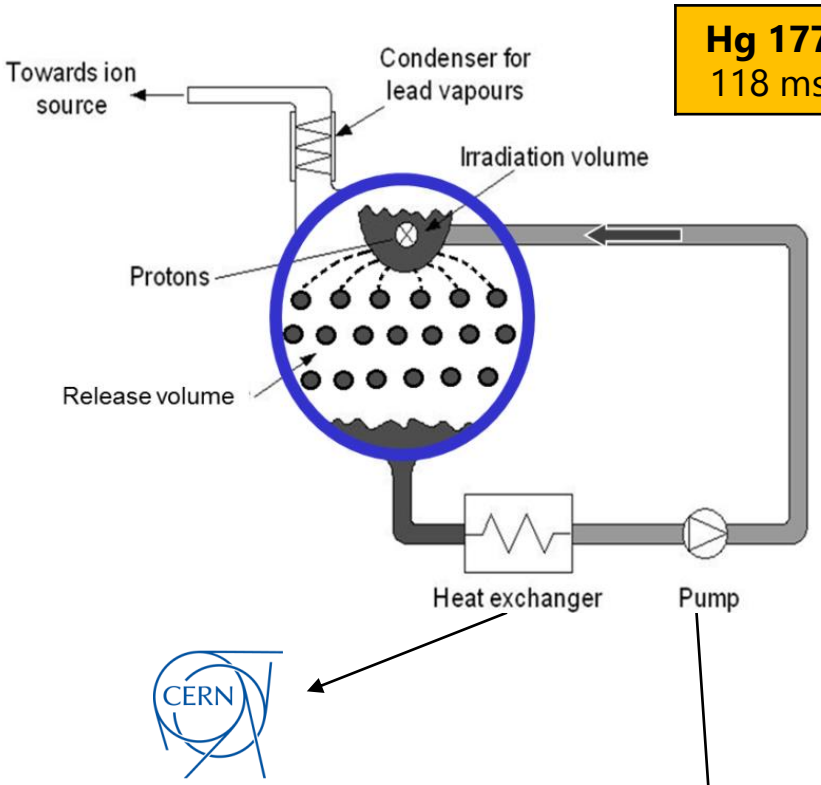
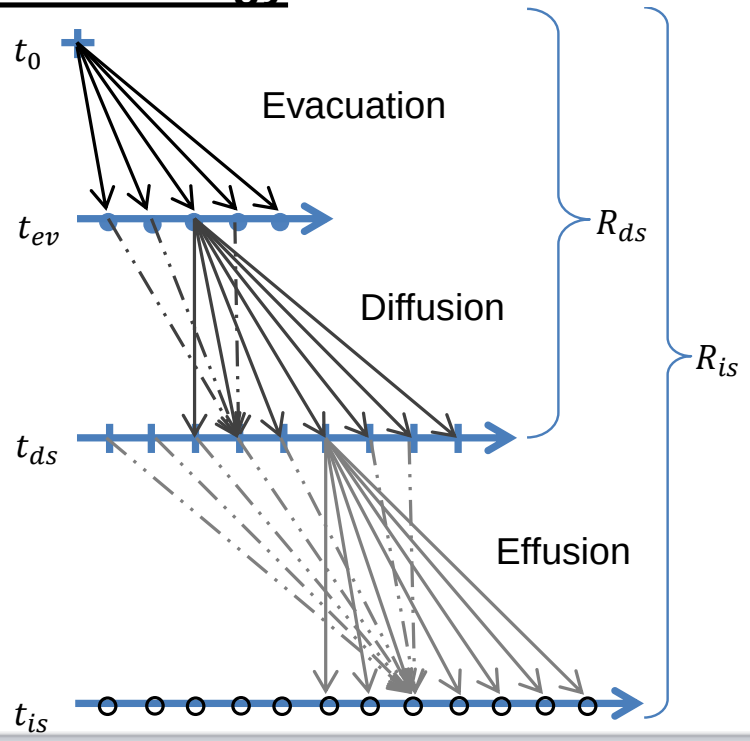


The release model

Objective

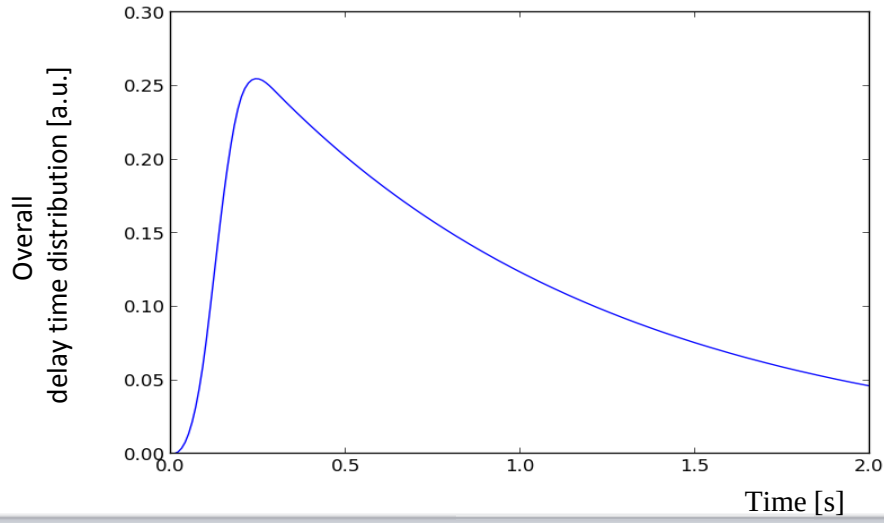
- Assessment of the release efficiency for short lived Hg isotopes

Methodology



Results

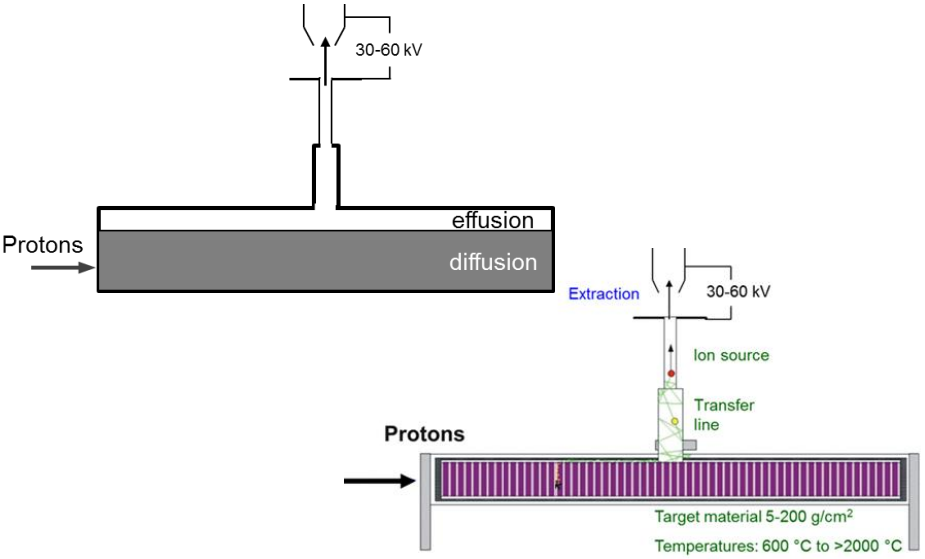
- Effusion model developed
  - Simplifications required to deal with the complex geometry
- Analytical release model developed
  - Validated on ISOLDE data (static-bath targets)



The release model – Method validation

Objective

- Validation of the methodology used to derive the release model
- Comparison between computed and experimental results

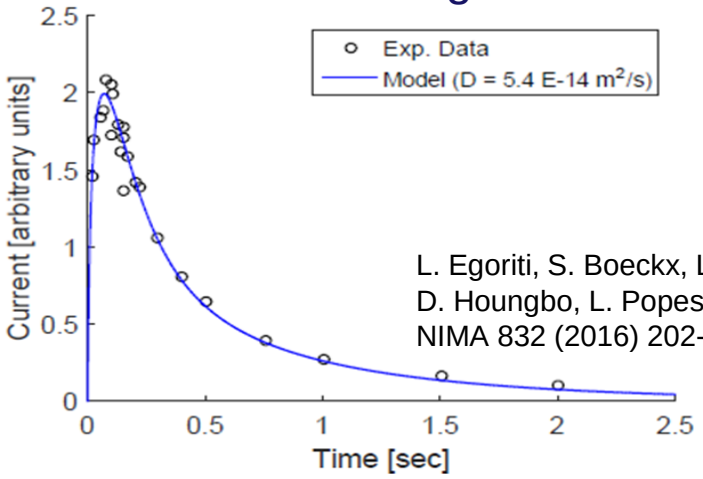


Results

- Hg out of a liquid Pb bath target

	Normalized Efficiencies	
	Experimental (*)	Computed
^{190}Hg	100.00%	100.00%
^{180}Hg	6.20%	5.46%
^{179}Hg	2.69%	3.05%
^{178}Hg	0.62%	0.81%
^{177}Hg	0.41%	0.49%

- Li out of a solid Ta target



L. Egoriti, S. Boeckx, L. Ghys, D. Houngbo, L. Popescu, NIMA 832 (2016) 202-207

Release volume - Optimization

Objectives

- Study of the influence of several design parameters on this release efficiency
- Identification of more efficient designs for the release volume

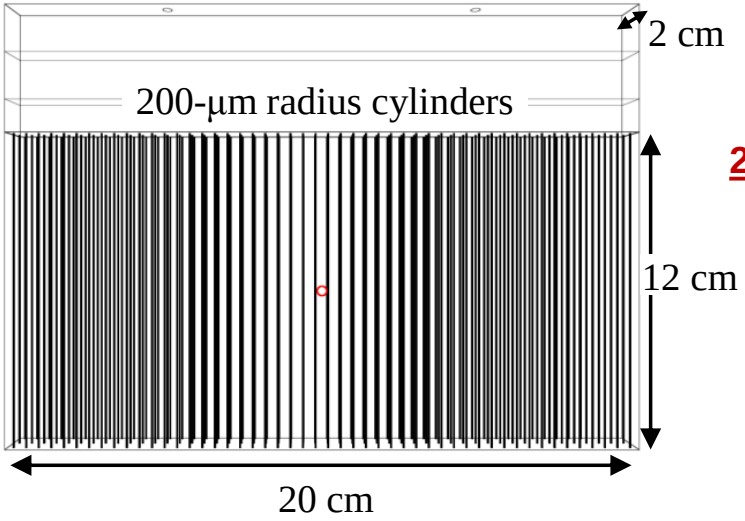
Methodology

- Application of the model to predict release efficiencies of ^{177,178}Hg in initial geometry
- Study separately the geometrical design parameters
- Application of the model to the resulting geometry

Results

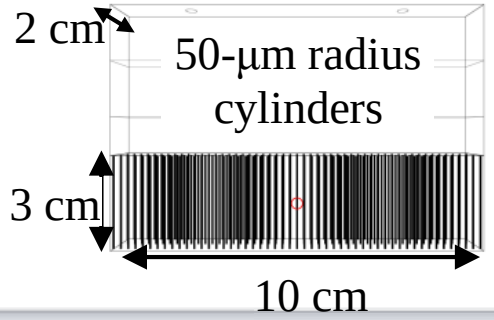
Hg 177
118 ms

Initial Geometry



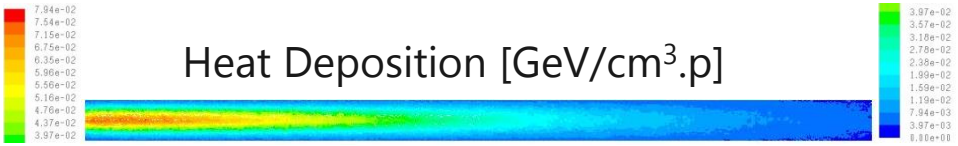
2.02 %

Compact Geometry

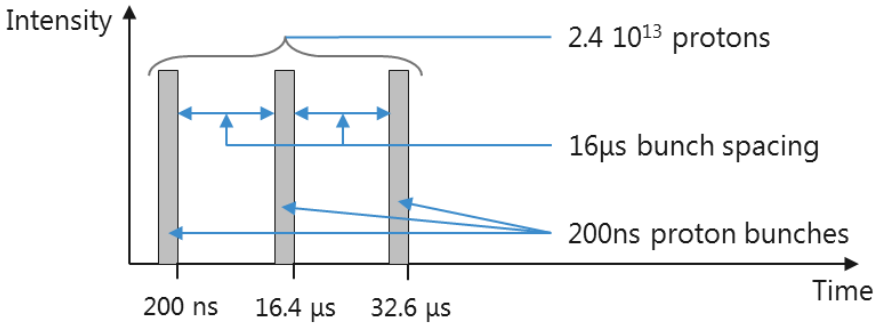


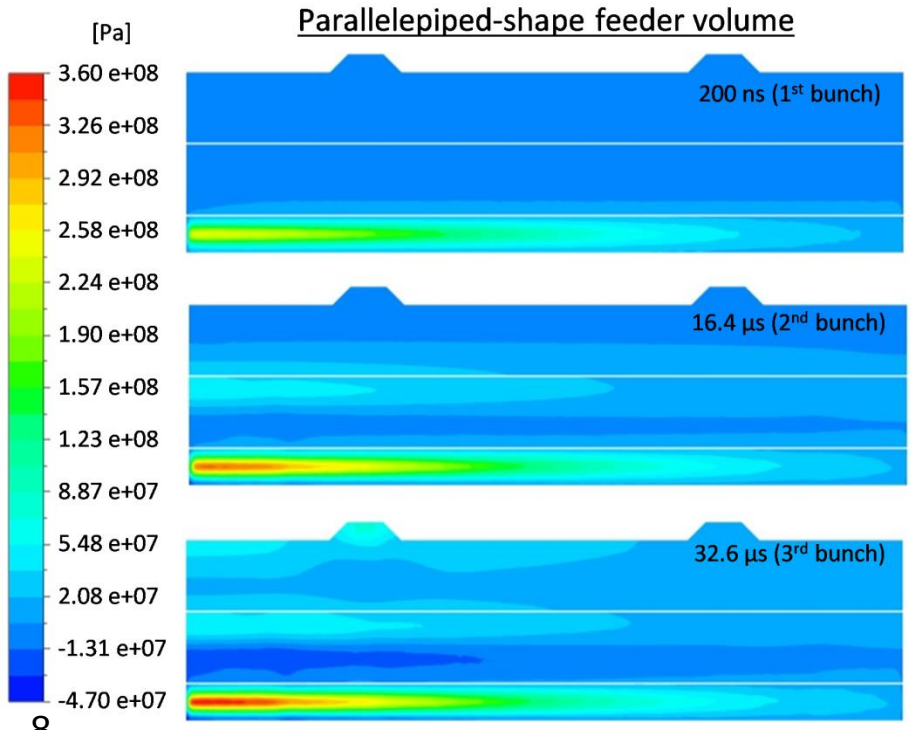
9.6 %

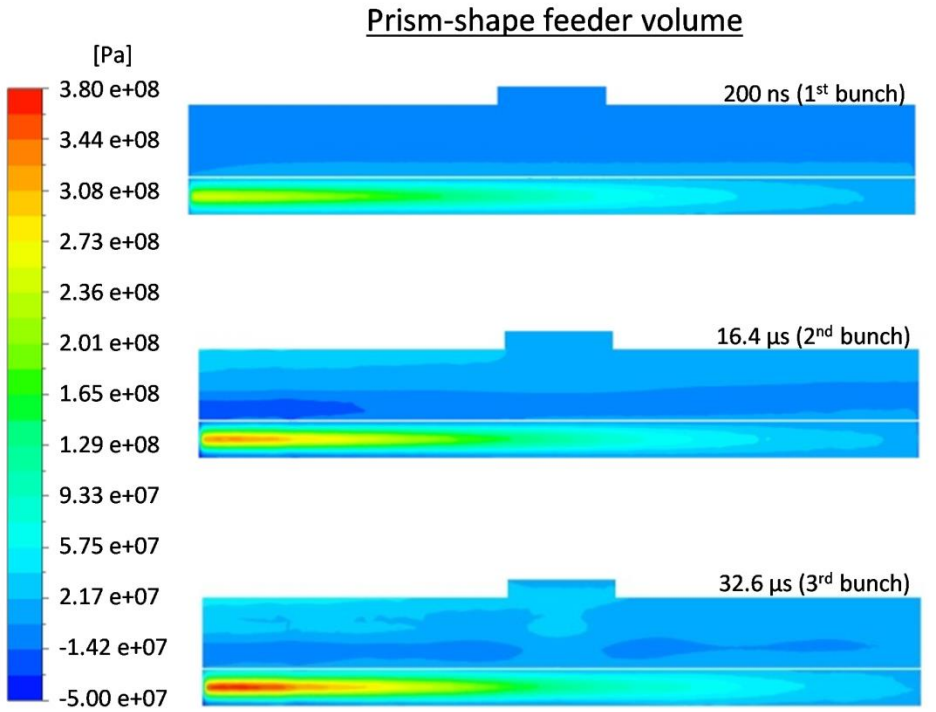
Shock-wave analysis



Max ΔT ~ 60 K

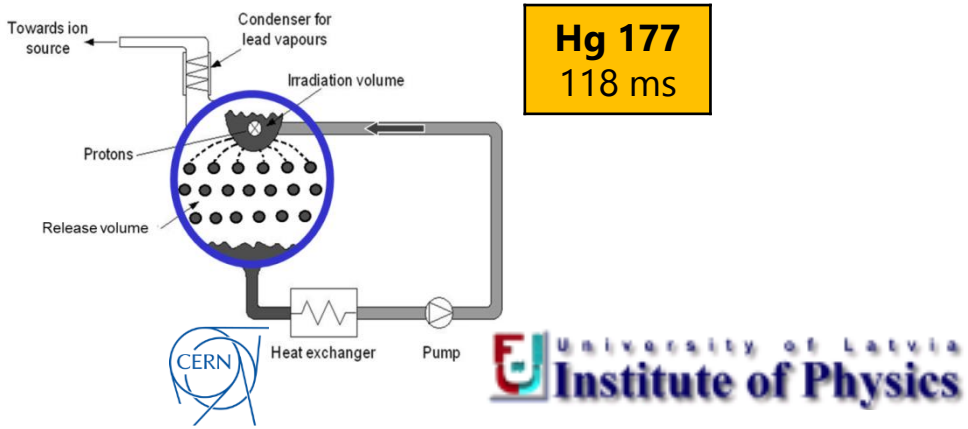






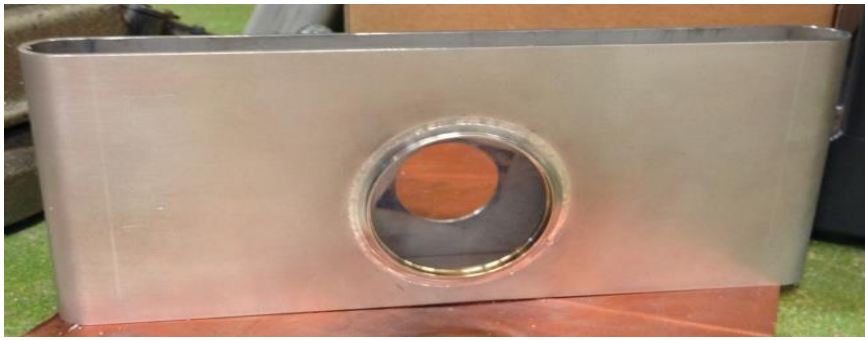
Summary

- Optimized geometries for irradiation & release volume



- Some of the findings incorporated in the LIEBE prototype

Irradiation volume



Release volume

- Prototype under offline testing at CERN-ISOLDE

Thank you for your attention