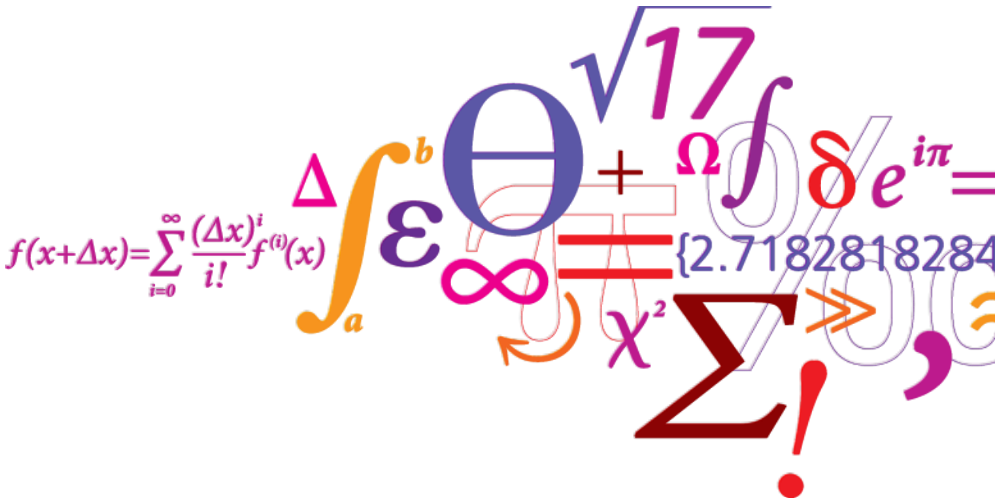
tTAC – October 2016 - ESS

Experimental study of Tungsten Target Halogen release

Mikael Jensen

Xiaolin Hou



Hevesy Lab

DTU Nutech

Center for Nuclear Technologies

AIM: Experimental confirmation that radioactive halogens stay inside the tungsten blocks

- Measurement of the **fractional release rates** at various temperatures (300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 900, and 1000°C) for the following elements:
  - **Halogens (I, Br)**
  - Noble gases (Kr, Xe, Ar)
  - Alkali metals (Cs, Rb, K, Na)
  - Others (Gd, Re, Ta, Hf, Yb, Lu)

Using "closest possible to real life" experiment.

Release factor

Fractional release rate (F): fraction of radionuclides released in unit time.

$$F = \frac{Amount\ of\ radionuclide\ released}{Total\ inventory\ of\ radionuclide\ \ in\ the\ target} \Big/ time\ of\ experiment\ time$$

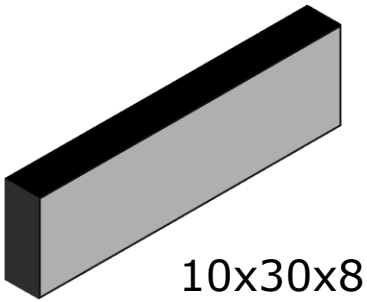
- Amount of radionuclide released
- Total inventory of radionuclide in the experimental target
- (I-125 1e8-1e9 Bq)
- Experiment time (hours at each temperature)

For iodine, the minimum sensitivity on the **fractional release rate** is **$10^{-13}\ s^{-1}$**. Minimum sensitivities for Br is to be derived.

Minimum accuracy on each measured value is **±50%.**

Two experimental approaches

- ”Main road”:
- Irradiate two tungsten blocks
- 1e18 protons at 1.4 GeV at CERN
- Decay for 2 weeks at CERN
- Transport from CERN to DTU-NUTECH
- Measure I-125 release as function of temperature



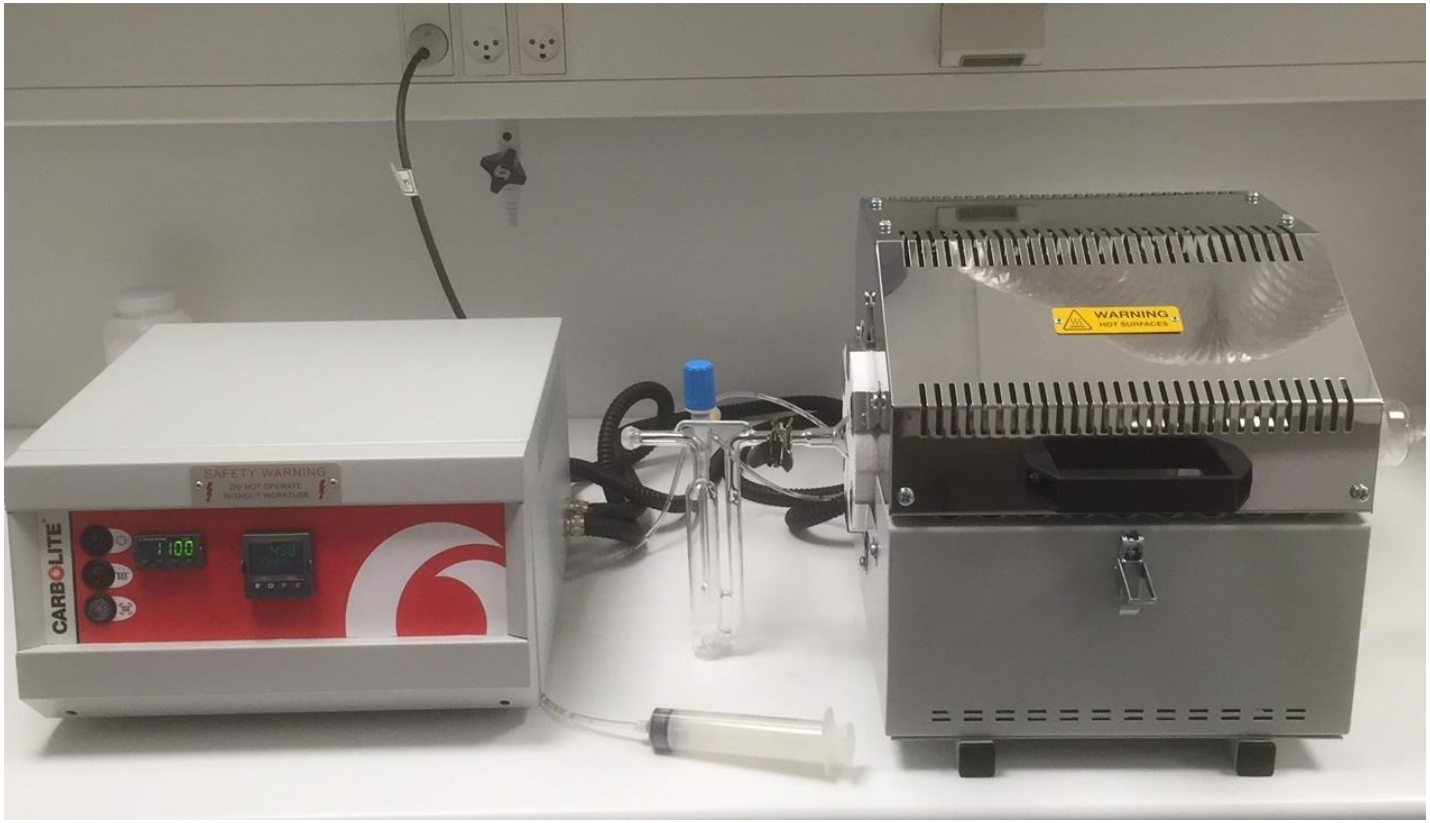
10x30x80 mm

Identical to blocks mounted at ESS Bilbao – same batch

- ”pilot experiment”:
- Load a tungsten tube with 50 MBq I-131
- Plug the tube with tungsten wire
- Seal the tungsten tube against tungsten
- Measure I-131 release as function of temperature

o.d. 1.6 mm
i.d. 0.6 mm
Wall = 0.5 mm

Experimental setup for measurement of the release factors of iodine in tungsten target
A Quartz Tube Furnace with helium flow

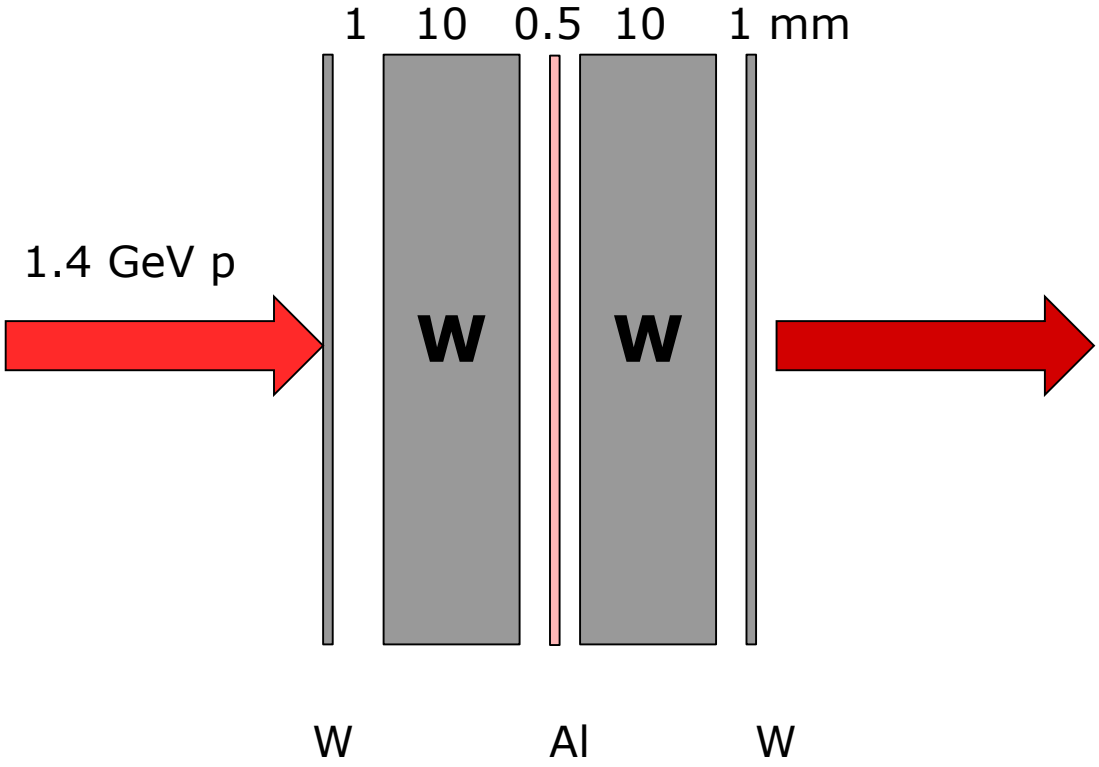


Mounted and operated inside 100 mm Pb shielded hot-cell

Temperatures, °C:
2-8 h of each point

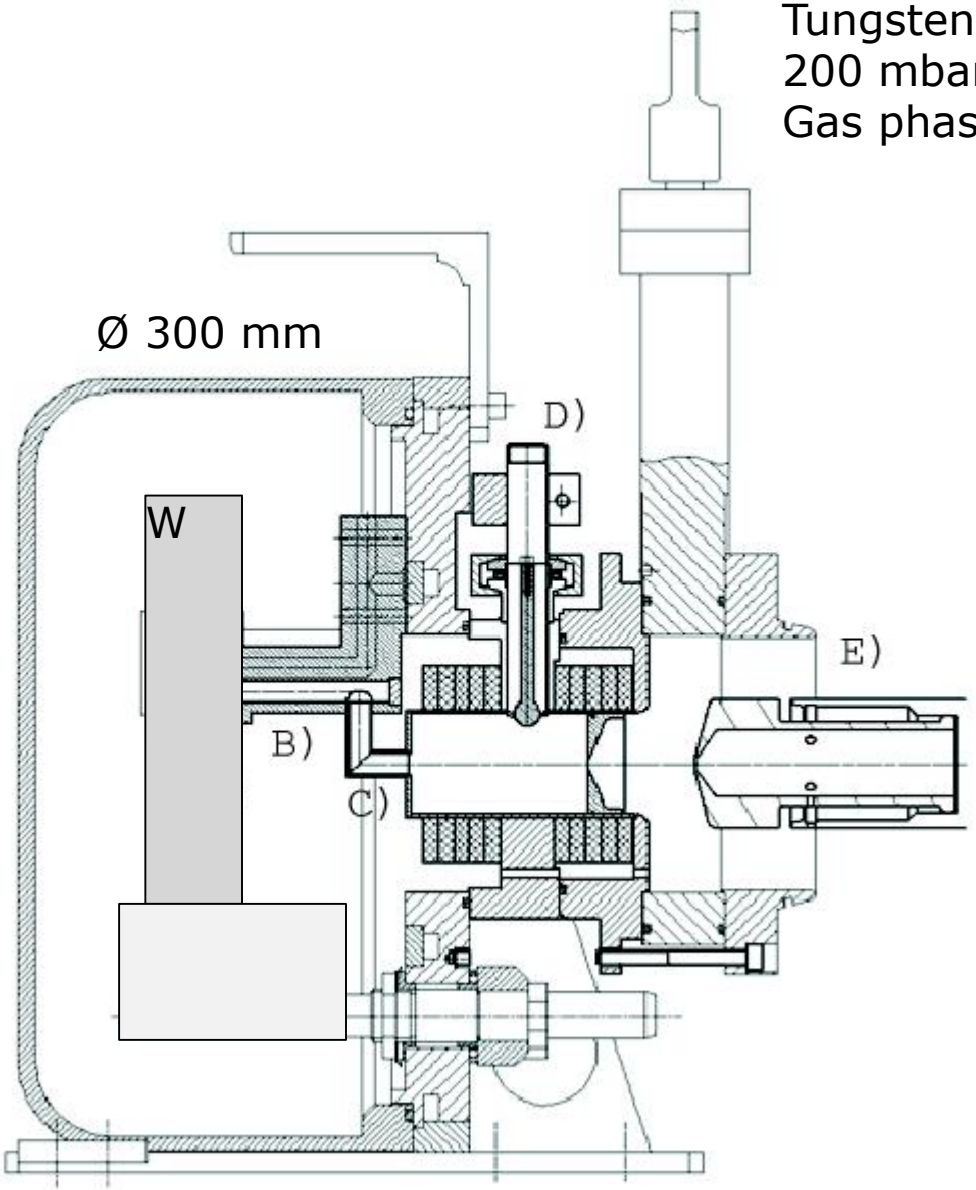
RT
250, 300
350, 400
450, 500
550, 600
650, 700
750, 800
850,900
950, 1000 °C

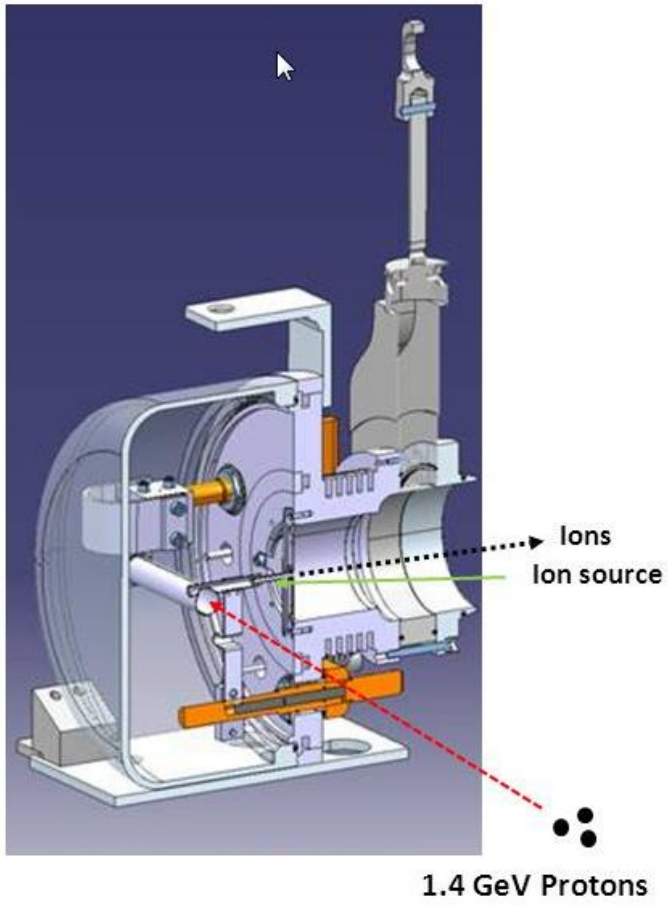
The experimental SANDWICH



Isolde ion source assembly

Tungsten cooled during irradiation T<50 deg C
200 mbar Helium atmosphere absolute
Gas phase analysed upon receipt at Hevesy Lab

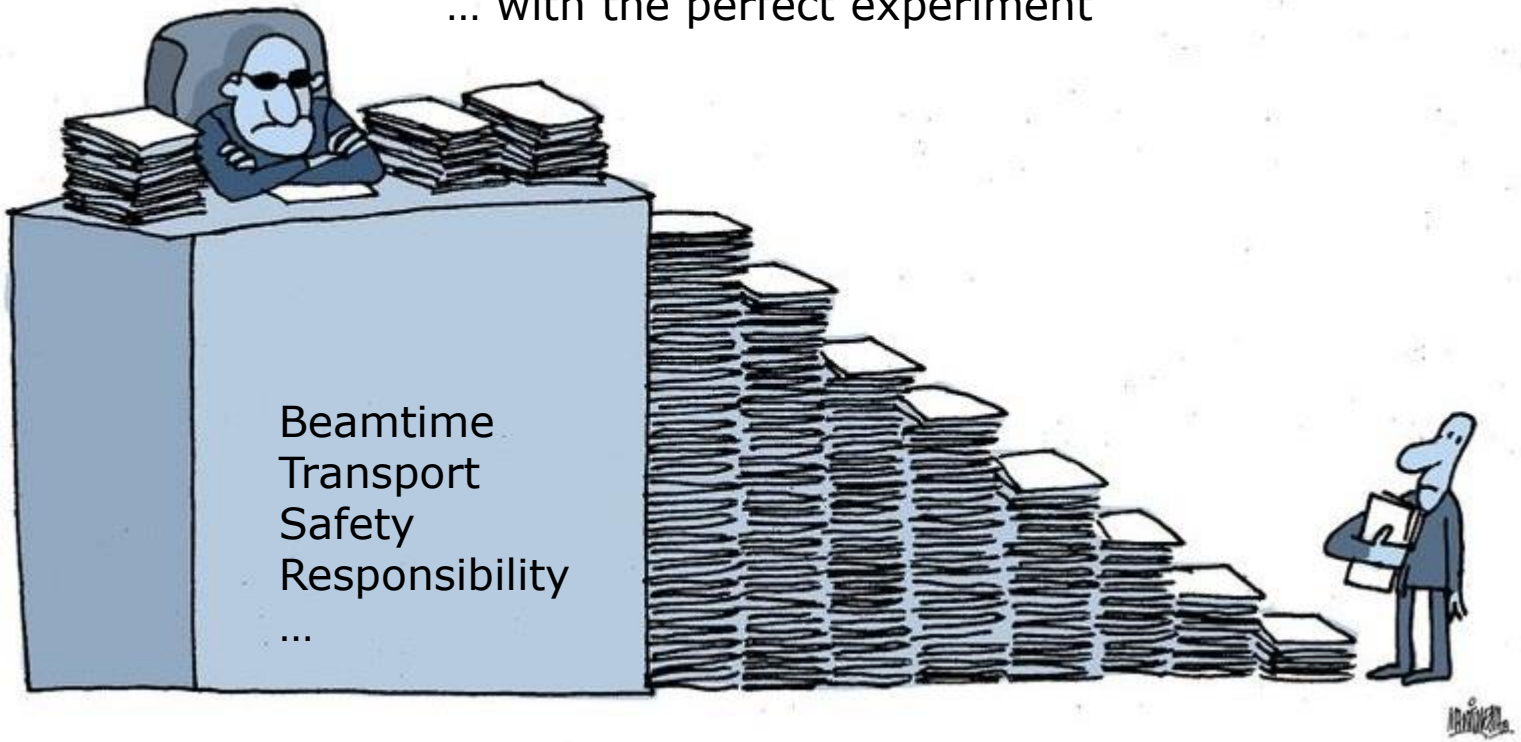




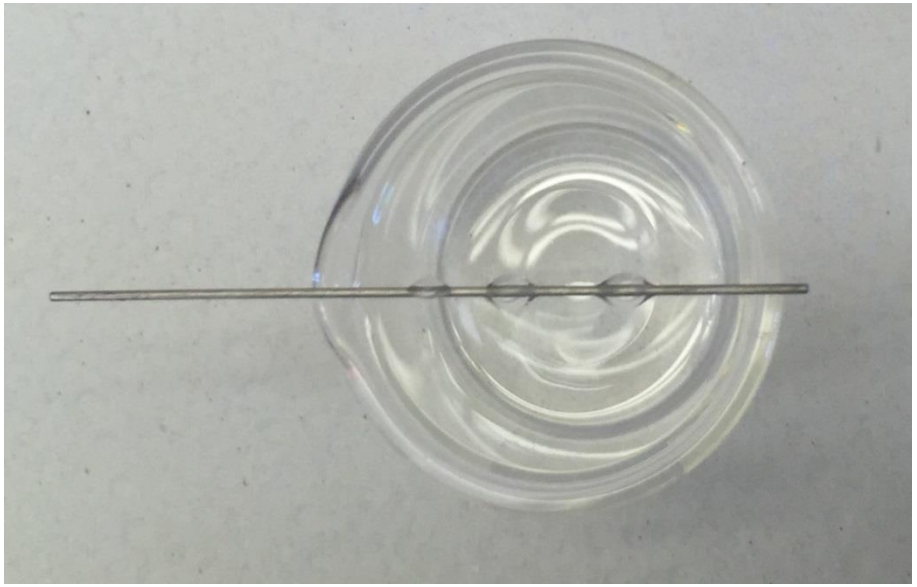
Waiting to be bombarded……

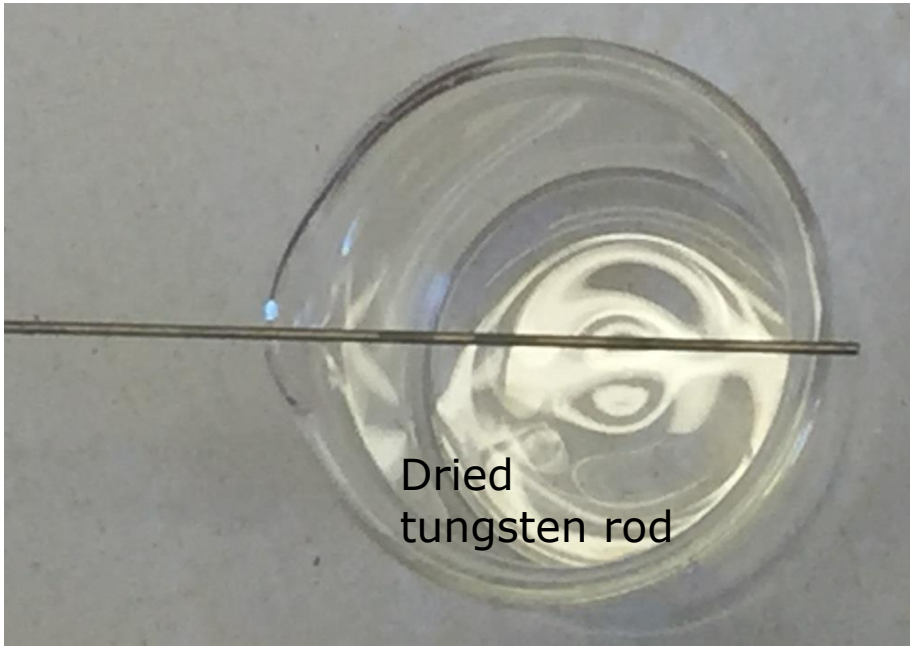
Target is assembled at Isolde. Time slot mid october.
Was delayed by INTC approval, then change in size of tungsten blocks

But anyway, many thanks to CERN and ISOLDE –
They allow me to sit close to the feeder chain of the LHC
… with the perfect experiment



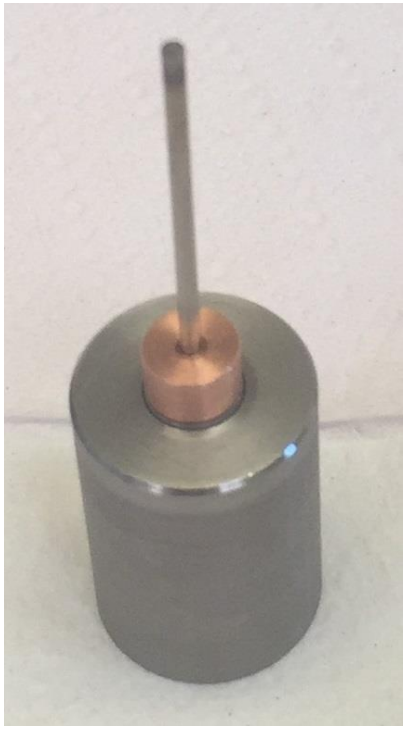
Meanwhile, the experimentalist at play…





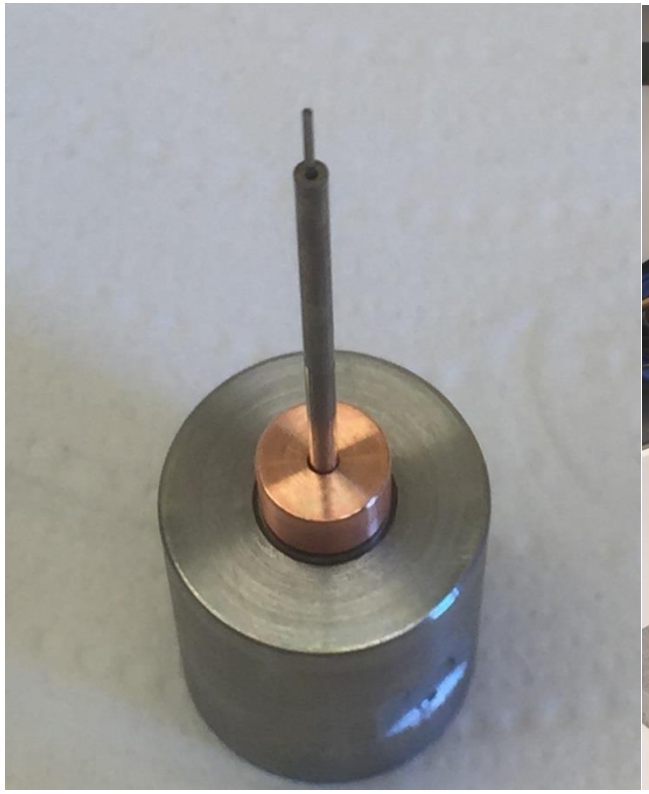
9 µl ^{131}I loaded on the tungsten rod (0.5mm)
50 MBq ^{131}I loaded

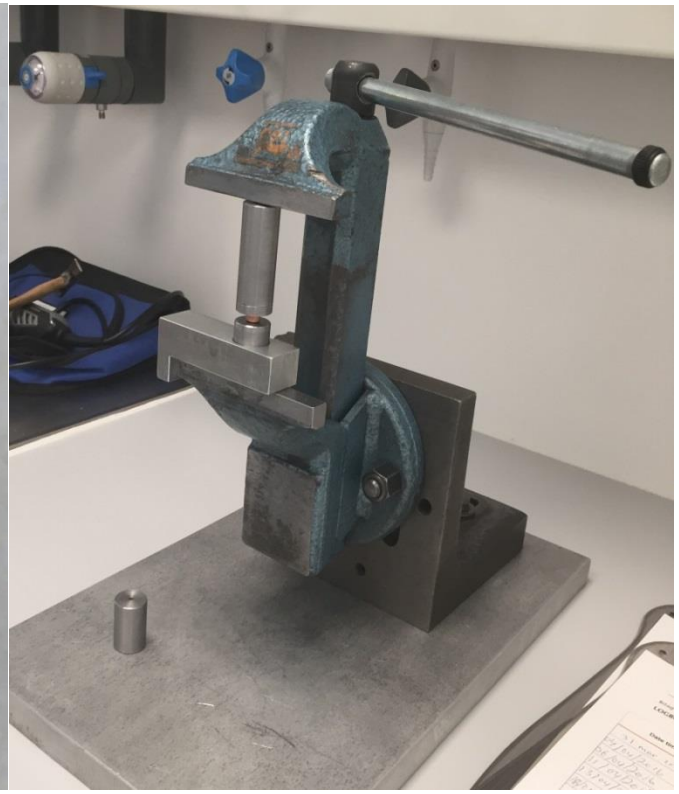
Inserted
into
Tungsten tube
0.6 mm i.d.
1.6 mm o.d.
0.5 mm wall

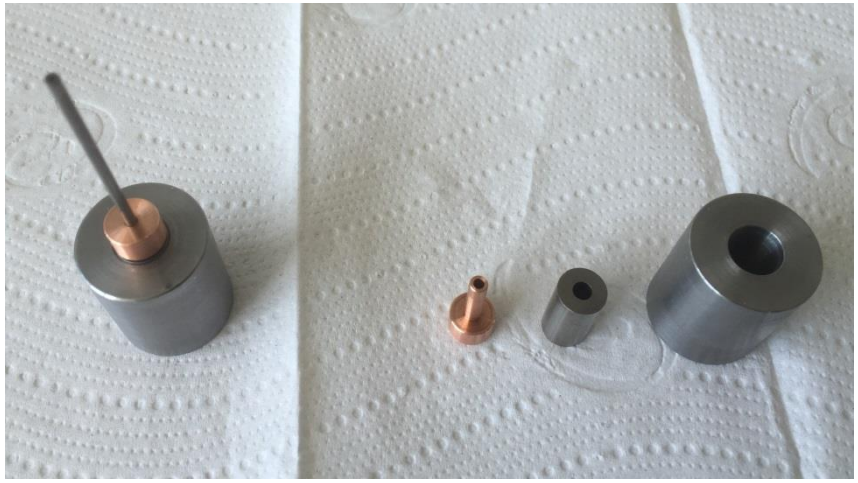


(from Goooooodfellow, who else)

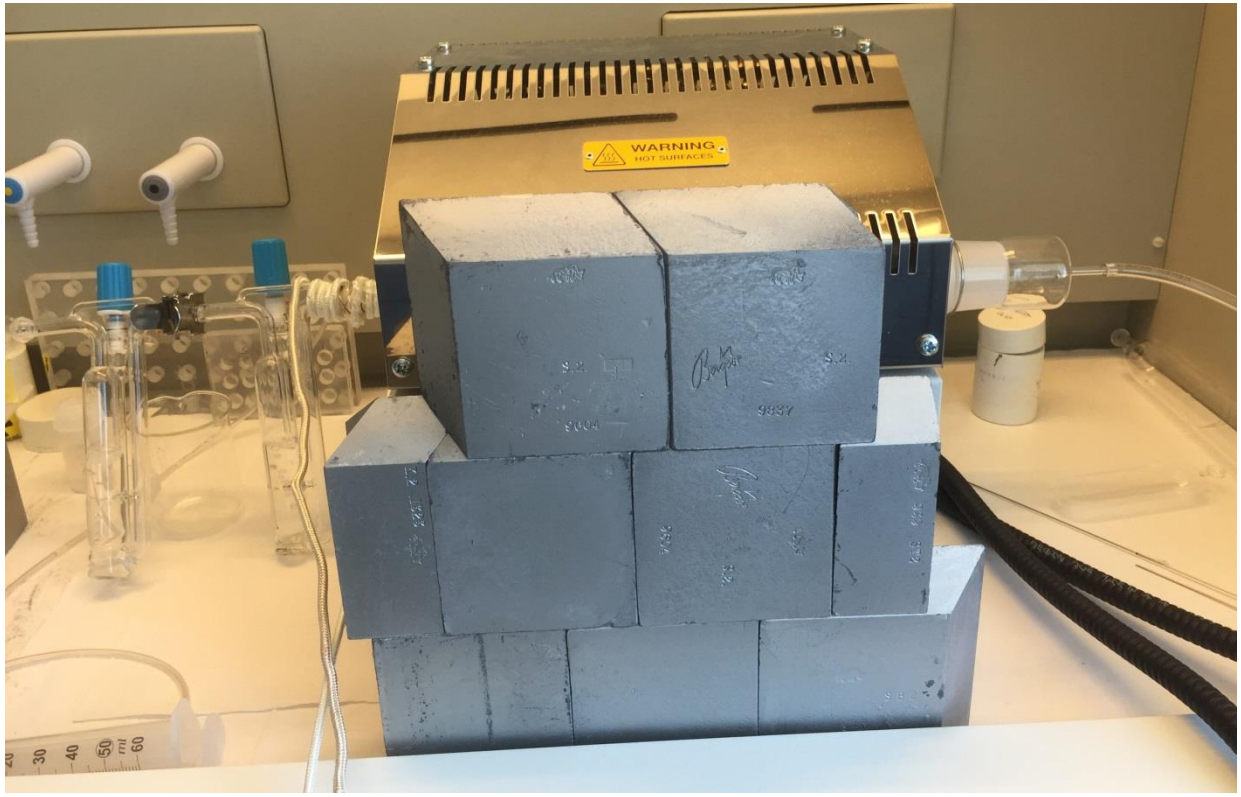
Tungsten tube Assembly for ^{131}I release experiment







Heating experiment for ^{131}I release from sealed tungsten tube

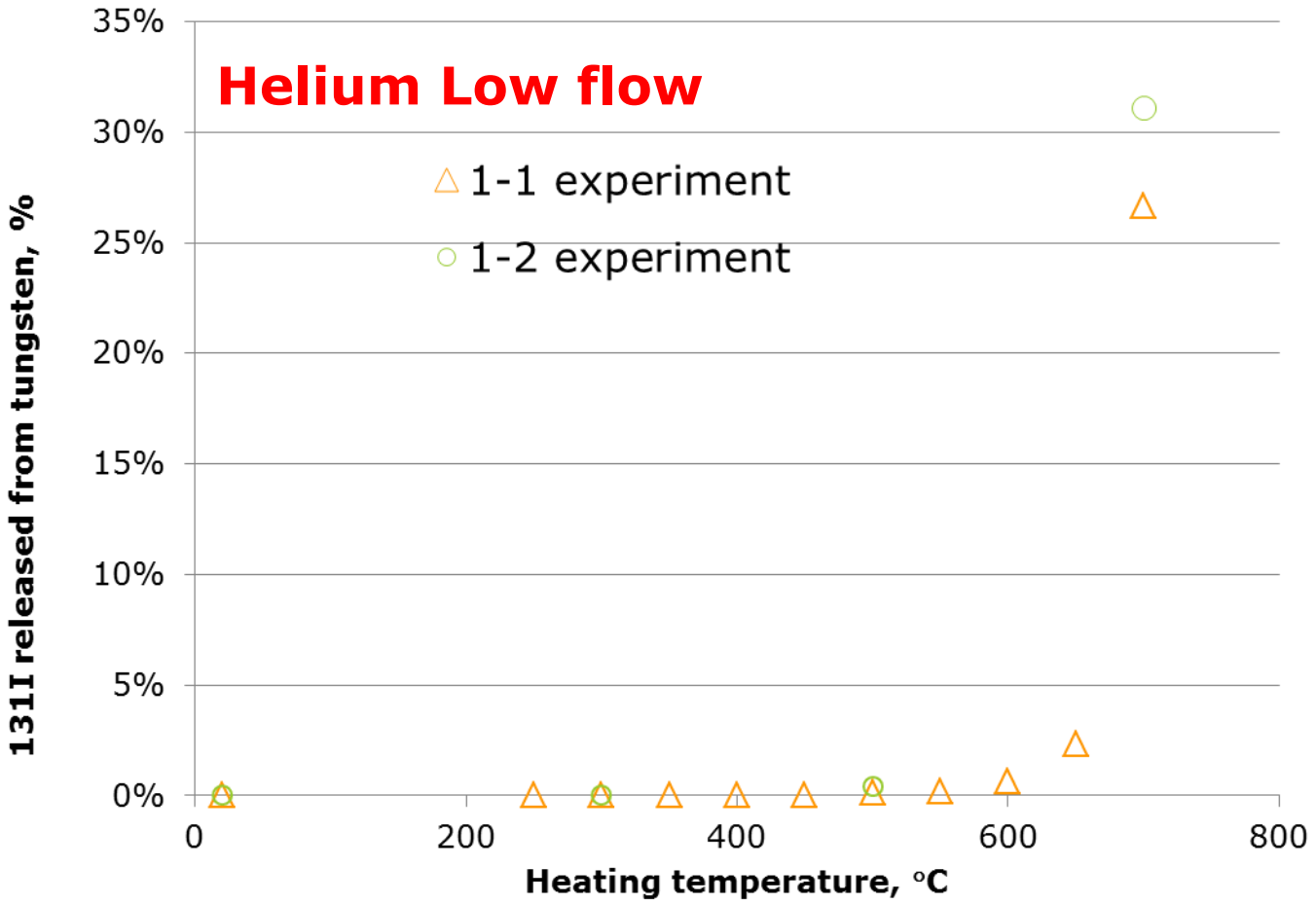


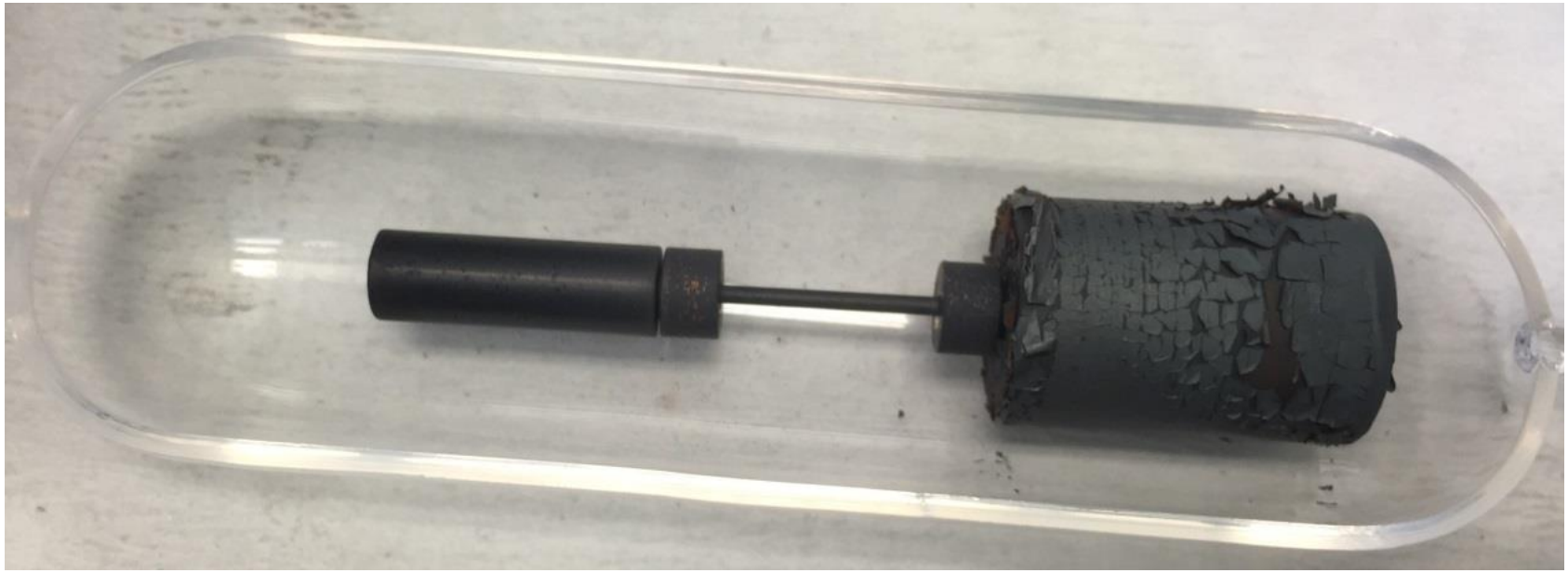
Experiment :

- Temperature: RT - 950°C
- He flow: 30-80 ml/min
- Trap solution: 0.5M NaOH-0.05M $NaHSO_3$
- Duringation: 2-15 h per temperature segment

- Change for each temperature segment
- All 30 ml trap solution is used for gamma measurement
- The bubbler is washed with H_2O every time

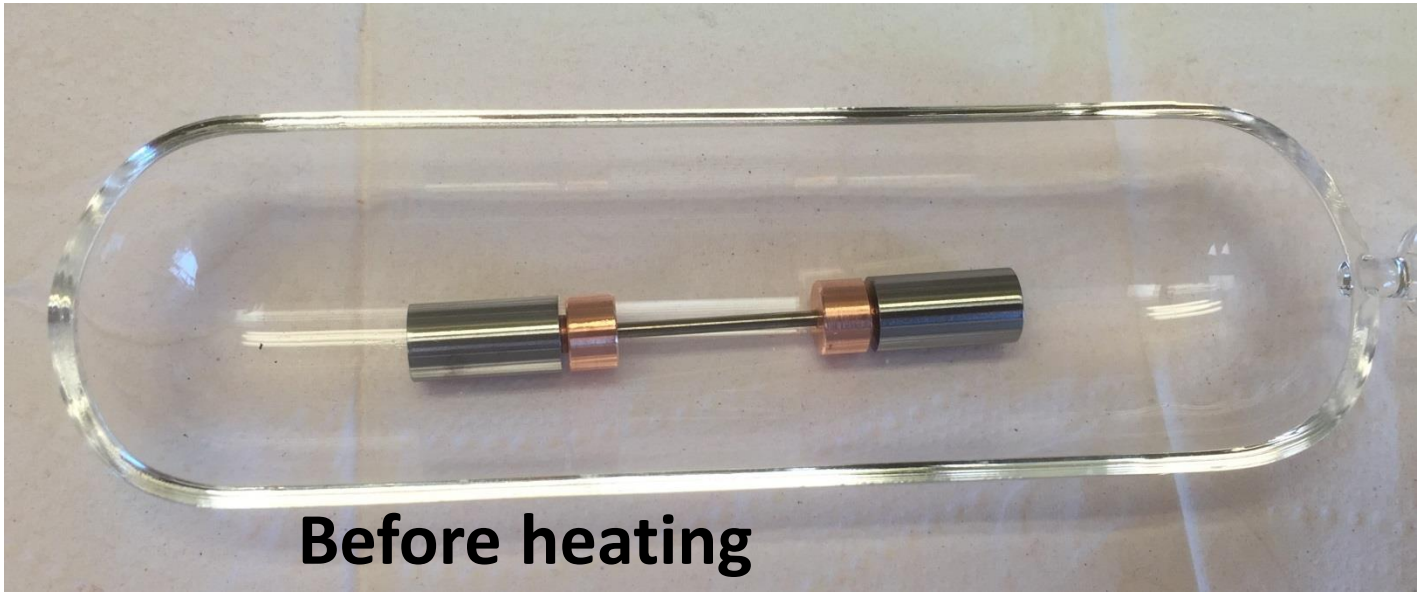
Result of the first experiment for ^{131}I release from sealed tungsten tube

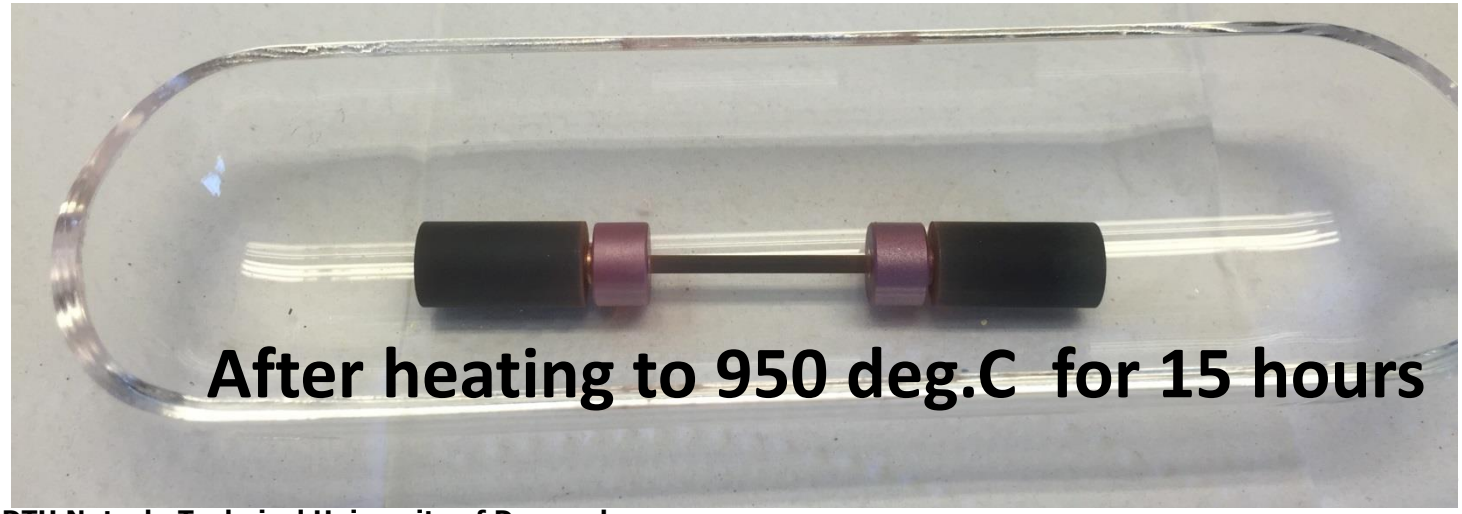




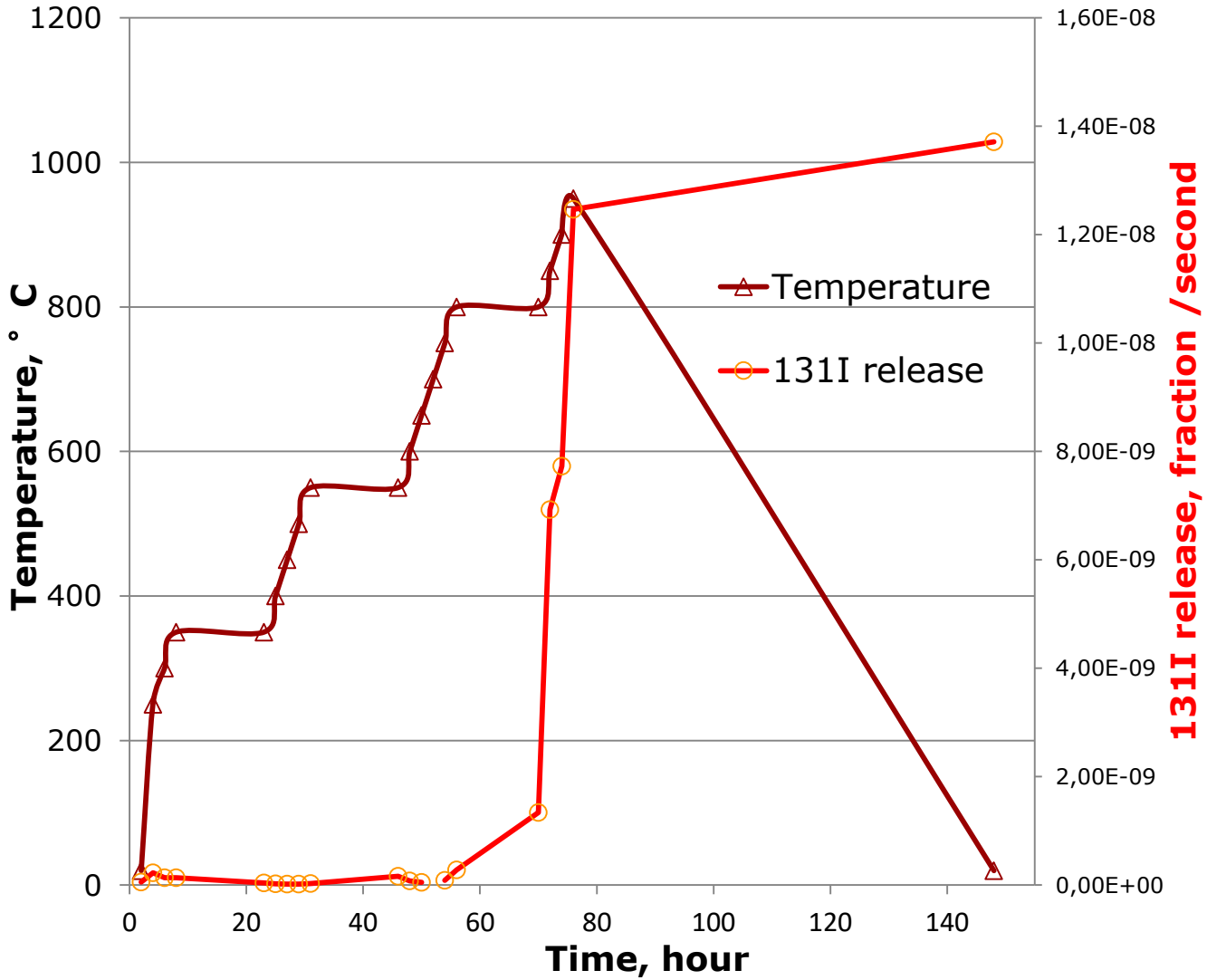
Then we did higher helium flow.
Oxygen not wellcome

The helium atmosphere - purity is not trivial ! -





The cliff-hanger data – thin wall tube



Waiting anxiously for the real block experiments