^{206}Po sources for production and release studies relevant for high power spallation targets

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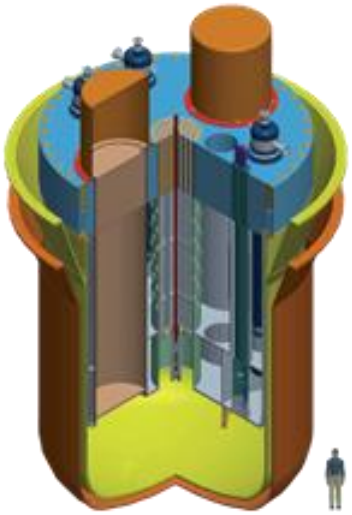
Lead Bismuth Eutectic (LBE)

LBE proposed as:

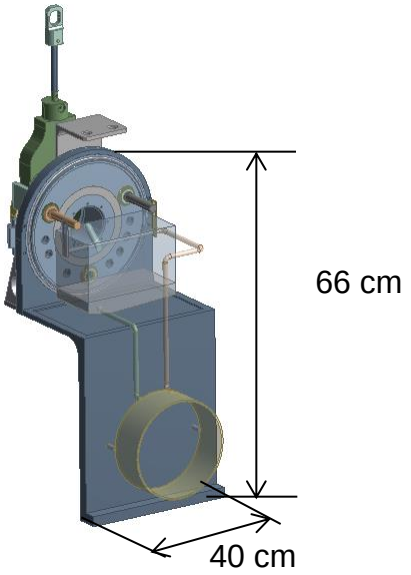
- spallation target material and/or reactor coolant for accelerator driven systems (ADS) – MYRRHA project
- target material for molten metal loop for EURISOL -LIEBE project

Release of polonium is a driving element for licensing and commissioning.



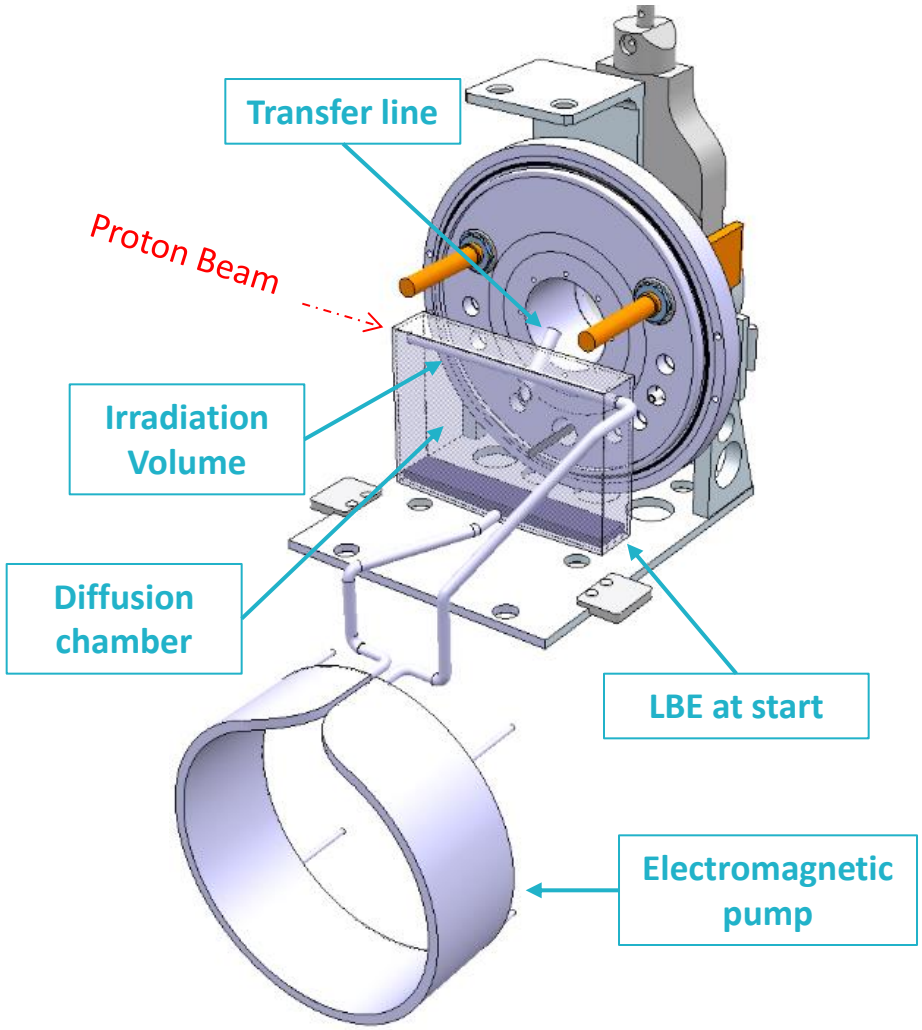
MYRRHA: Multi-purpose hybrid research reactor for high-tech applications

http://myrrha.sckcen.be/

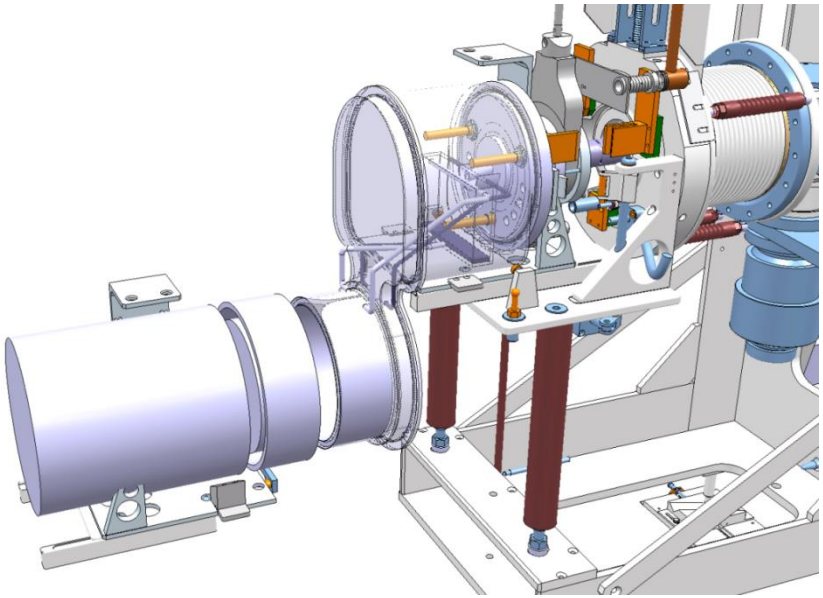


LIEBE: Liquid eutectic Pb/Bi loop for EURISOL

Liquid eutectic Pb/Bi loop for EURISOL – LIEBE project



View at the front-end



Production of polonium in irradiated LBE

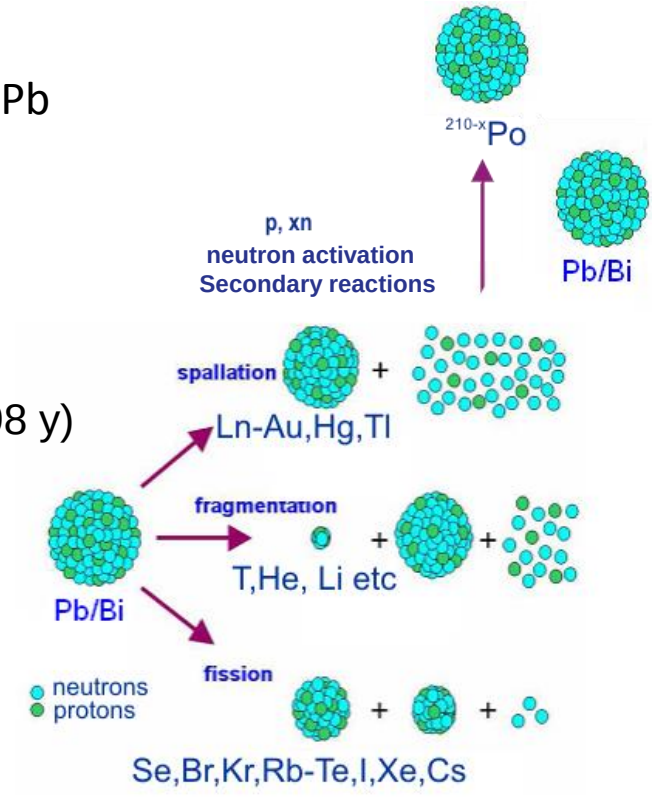
Production of Polonium

- Direct production via (p,xn) reactions on ^{209}Bi
- β-decay from ^{210}Bi produced by neutron activation
- Secondary helium-induced (alpha) reactions in Bi and Pb

  ((α,Bi) ⟶ At and (α,Pb) ⟶ Po)

$$^{209}Bi \xrightarrow{(n,\gamma)} {}^{210}Bi \xrightarrow{(\beta^-)} {}^{210}Po \ (T_{1/2}=138\ d)$$

$$^{209}Bi \xrightarrow{(p,xn)} {}^{210-x}Po \quad (^{209}Po:\ T_{1/2}=102\ y,\ ^{208}Po:\ T_{1/2}=2.898\ y)$$



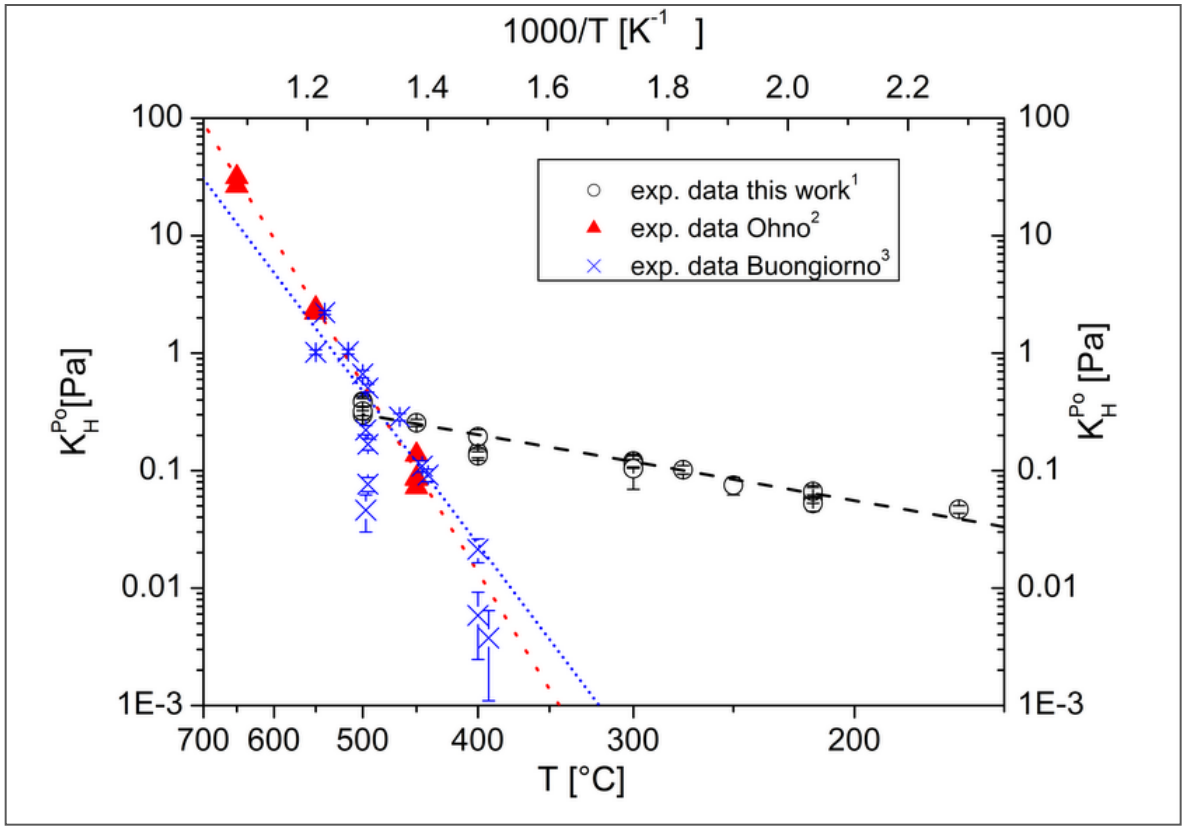
Key element for safety assessment

radiotoxicity (alpha emitter) and volatility

Chemical behaviour

- Moderately volatile in elemental state
- Volatility in presence of moisture and/or hydrogen

Evaporation characteristics of polonium



Comparison of Henry constant data of Po over liquid LBE under inert gas atmosphere and corresponding functions according to refs. 1, 2 and 3.

- First own results show deviation from extrapolation of literature data – Po evaporated as PbPo?
- Chemical composition of volatile species and formation conditions unclear.
- Additional systematic experiments under different chemical conditions are necessary.

[1] M. Rizzi et al., Unpublished results

[2] S. Ohno et al., J. Nucl. Sci. Tech., 43 (2006) 1359-1369

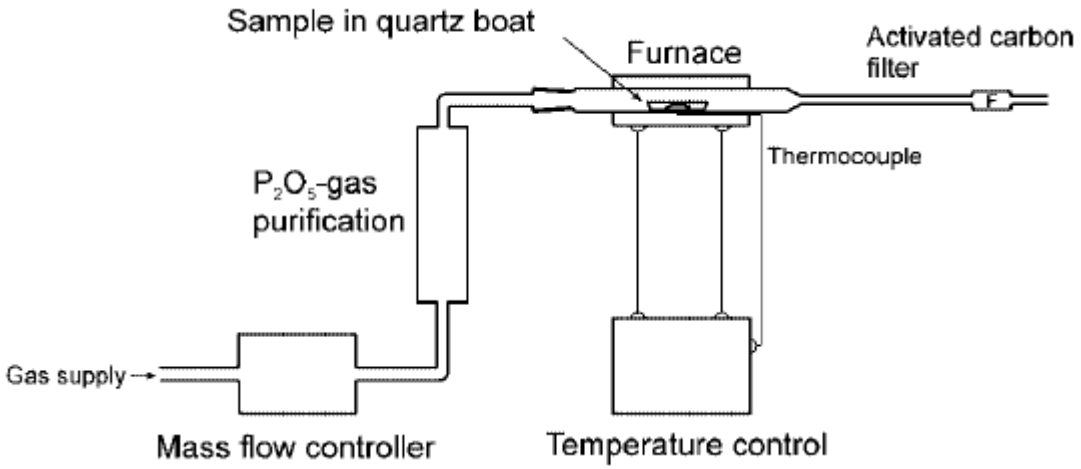
[3] J. Buongiorno et al., Radiochim. Acta 91 (2003) 153-158

Evaporation experiments: Materials and methods

- LBE samples (10x5x1.5 mm^3) containing ^{206}Po ($T_{1/2}$= 8.8 d)
  short-lived Po isotope: simplified handling of activity and measurement

<u>Transpiration method</u>

- Sample placed in quartz boat inside tube in furnace
- Tube flushed with gas mixture and annealed
- γ-ray spectrosopy measurements after each annealing step – fractional release of Po



Beam time request

- ^{206}Po obtained by implanting precursor ^{210}Fr ($T_{1/2}$=3.18 min)
- ^{210}Fr beams produced from UC_x target with tungsten surface ionizer (intensity: 1x10^8 ions/s)
- Implantations performed on GLM beam line

- Implanted dose up to 1x10^{12} atoms – 1 MBq

  ISOLDE and PSI laboratories allowance: 100LA=1 MBq ^{206}Po
- Opening of GLM chamber after implantation in the presence of Radioprotection officers
- Shipping to PSI up to 1 MBq allowed

- Beam time request: A total of 12 shifts (split into 4 runs over two years).

Swiss Ordinance:

Activity used per operation and per day: RS 814.501 Article 69

http://www.admin.ch/opc/fr/classified-compilation/19940157/index.html#app3

Thank you for the attention