Development of a PVD-based manufacturing process of monolithic LEU irradiation targets for ^{99}Mo production

Forschung-Neutronenquelle Heinz Maier-Leibnitz (FRM II)
Technische Universität München

Tobias Hollmer
03.09.2015

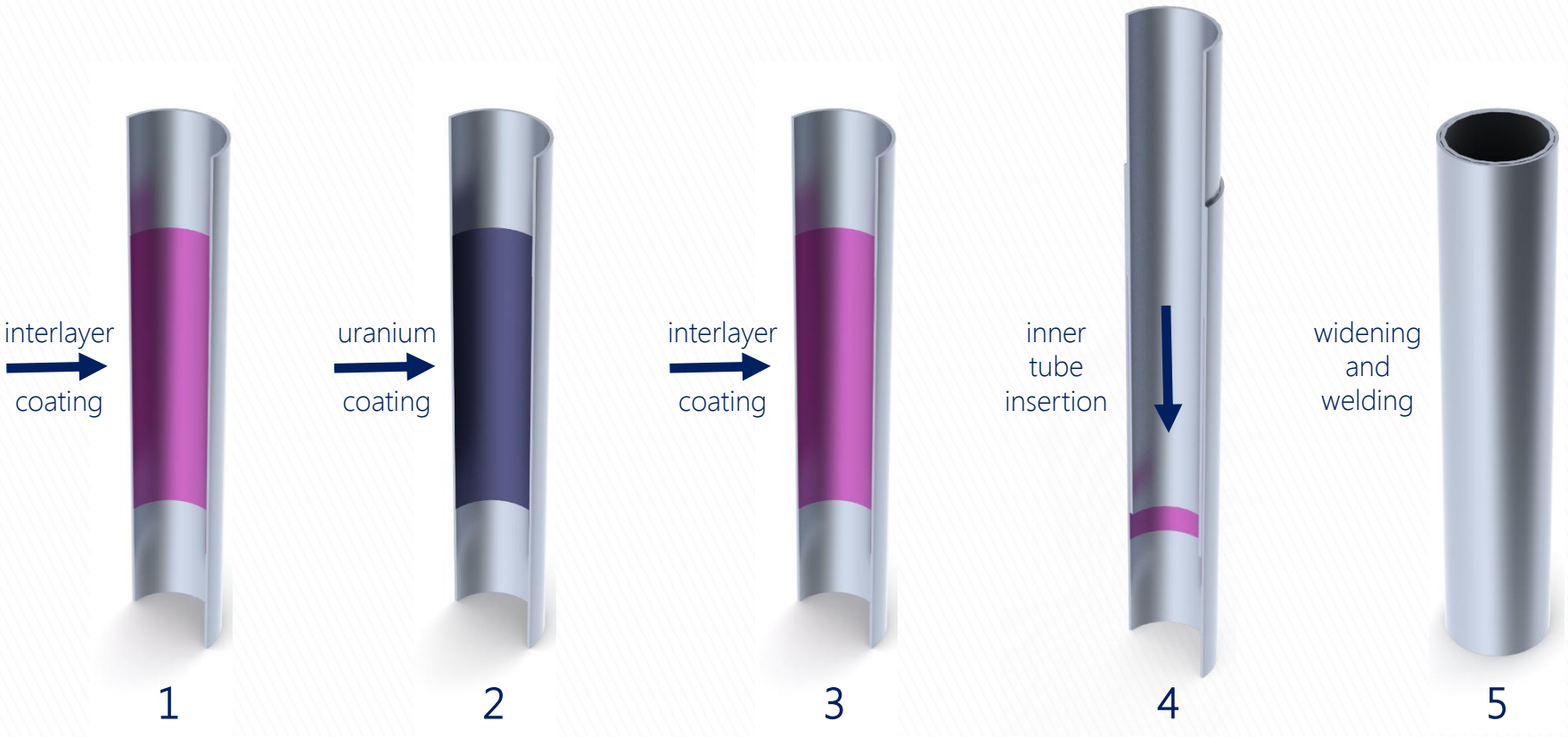
FRM II and ^{99}Mo production

- FRM II:
  - Commissioning: 2004
  - Power: 20 MW
  - Max. thermal neutron flux: $8 \cdot 10^{14} \frac{n}{cm^2 s}$
- Currently: installation of an irradiation facility for ^{99}Mo production
- Parallel: research on a next level irradiation target

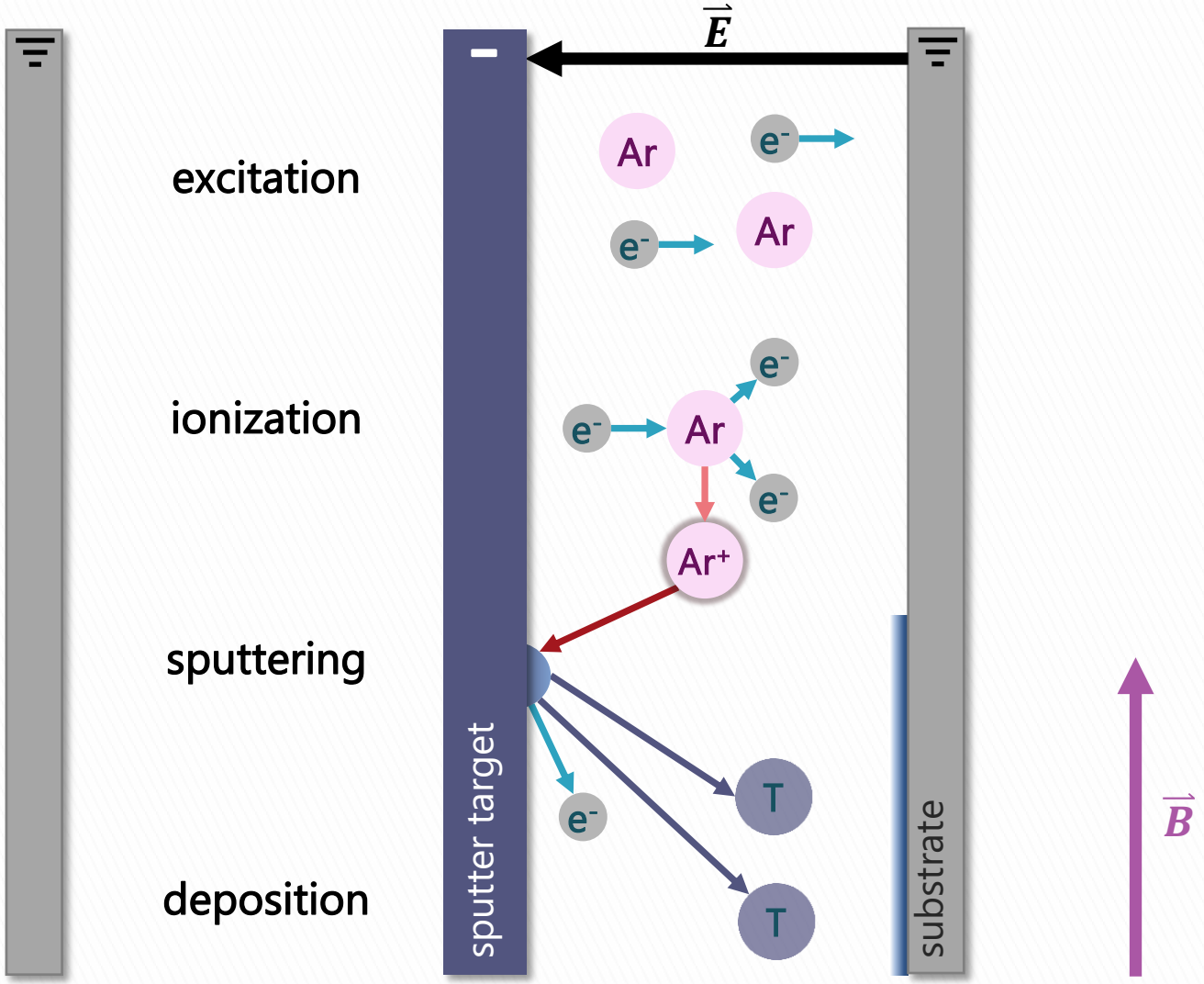
Monolithic LEU Target

- High uranium density (HEU → LEU)
- Separability of the uranium foil (reduction of HRLW)

Production Process



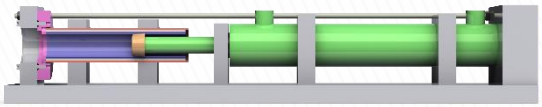
Physical vapor deposition



Process steps

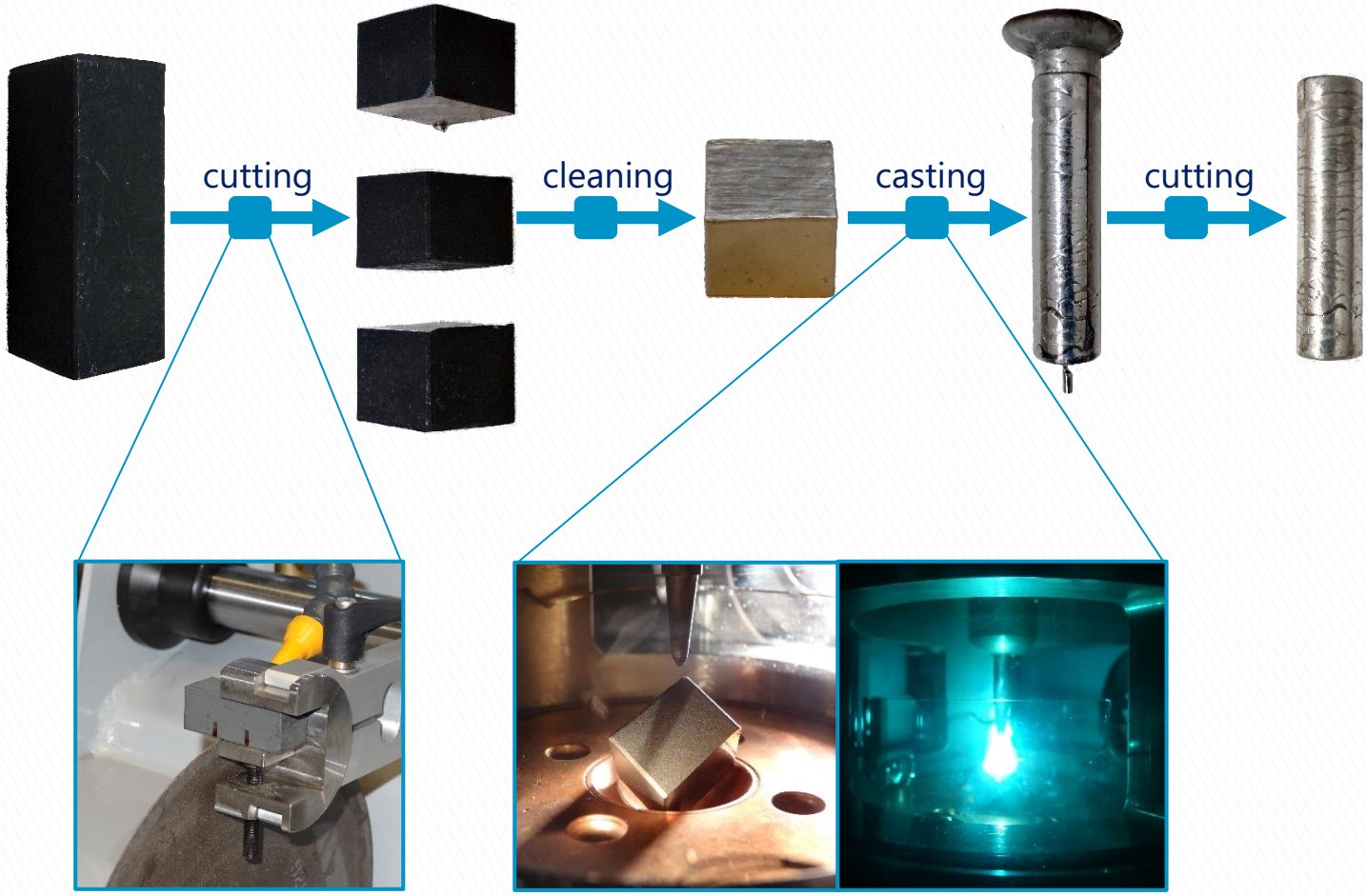
1. Sputter target production

2. Coating



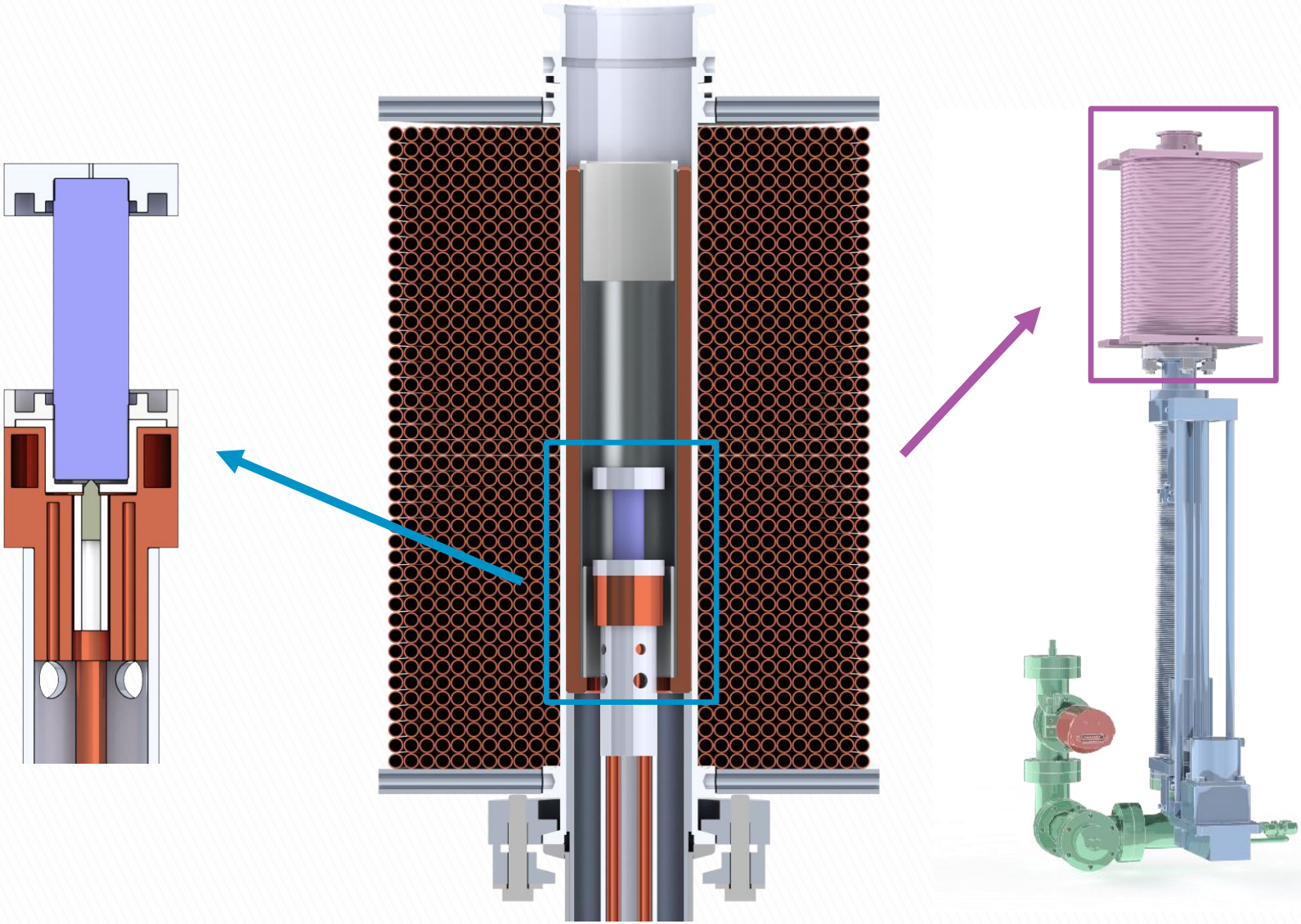
3. Assembly

Casting

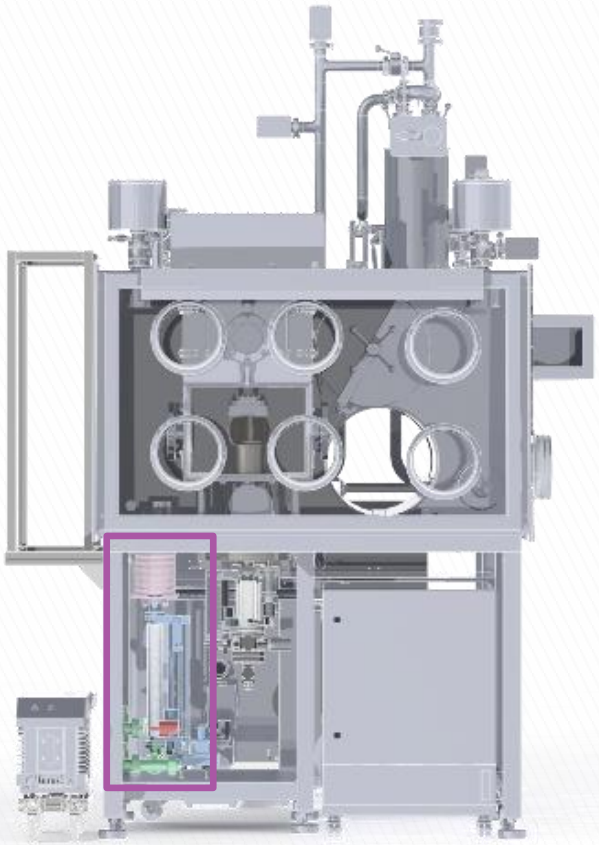


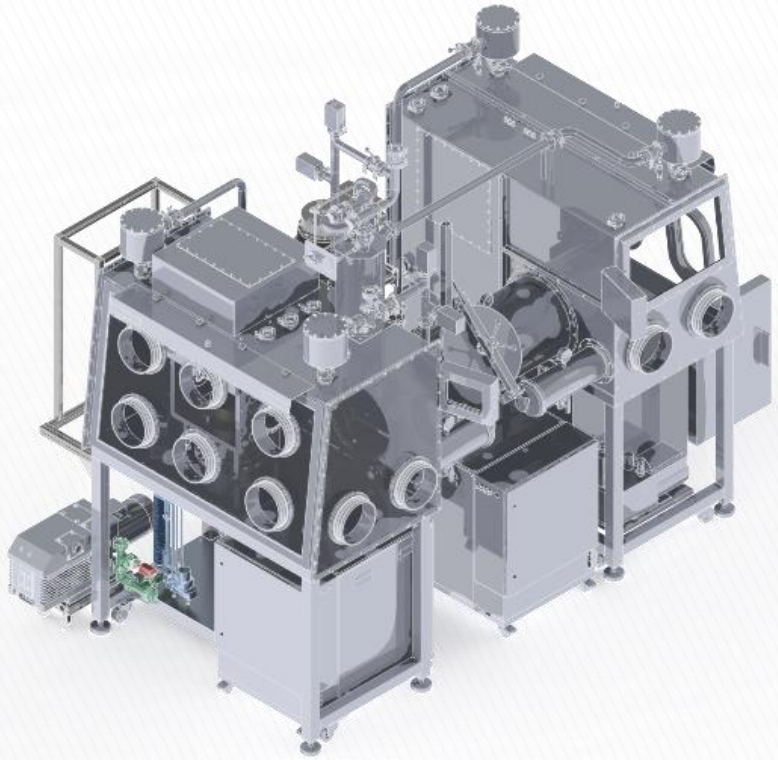
Coating apparatus

1. Sputter target production
2. Coating
3. Assembly

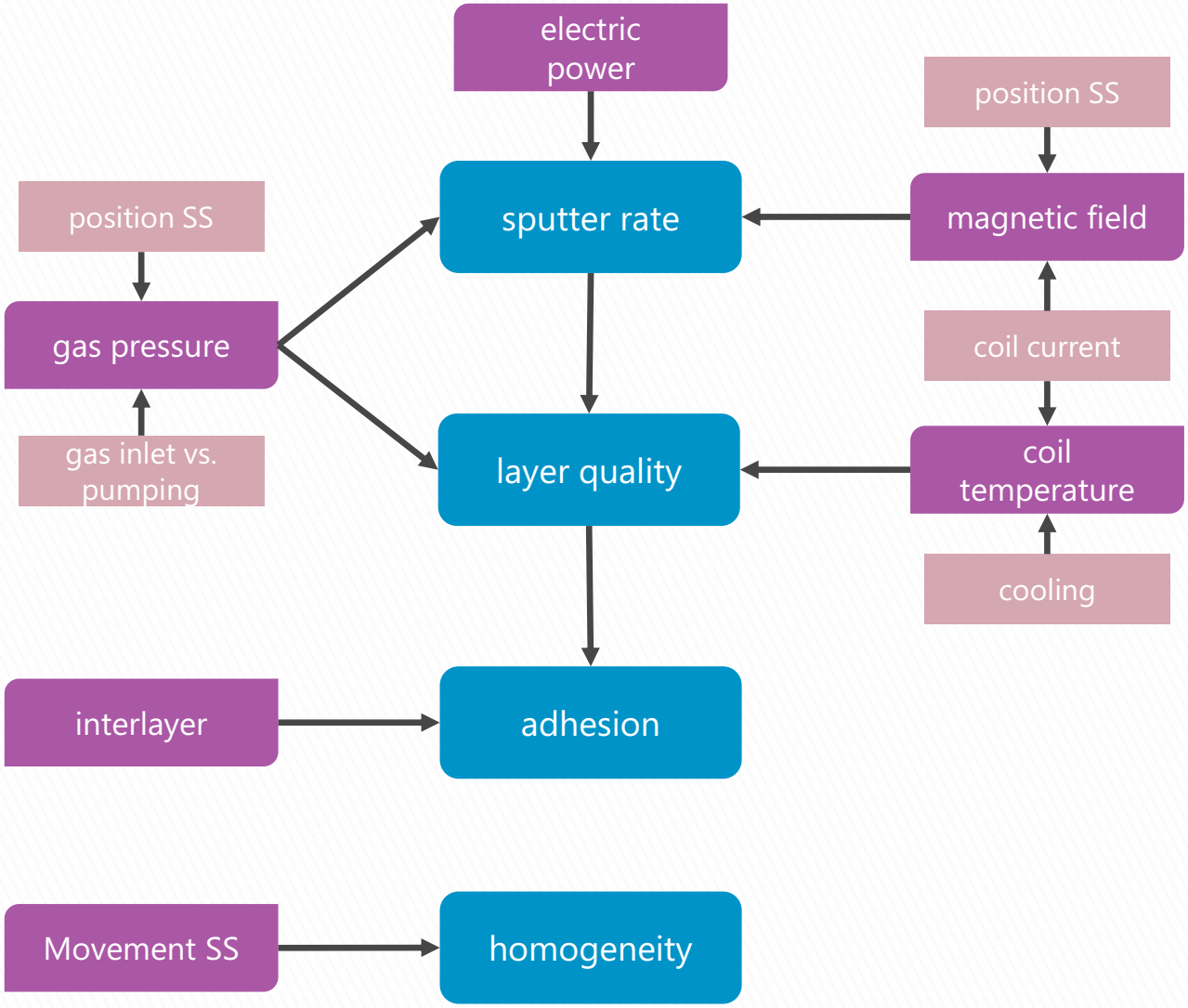


Glovebox system

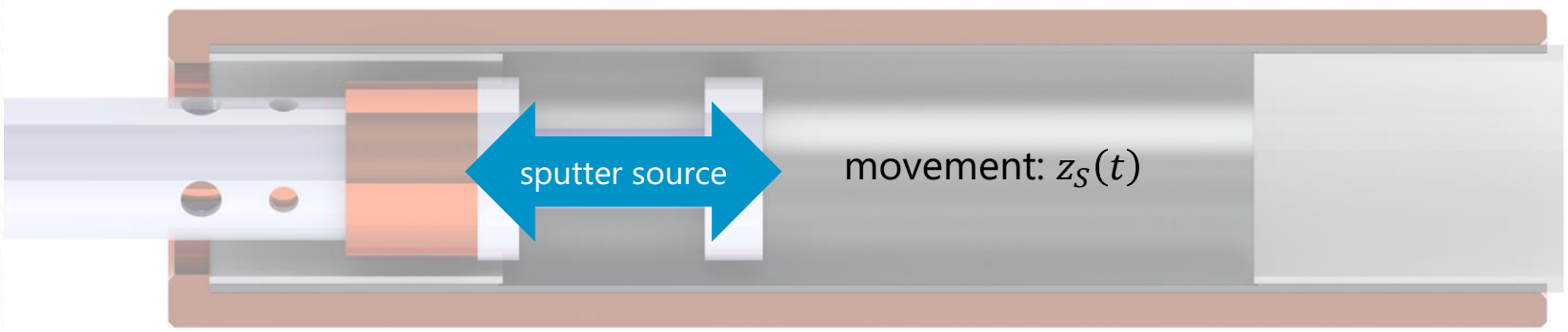




Process parameters

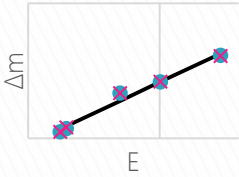


Homogeneity

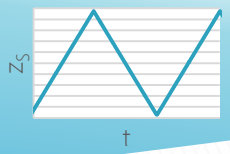


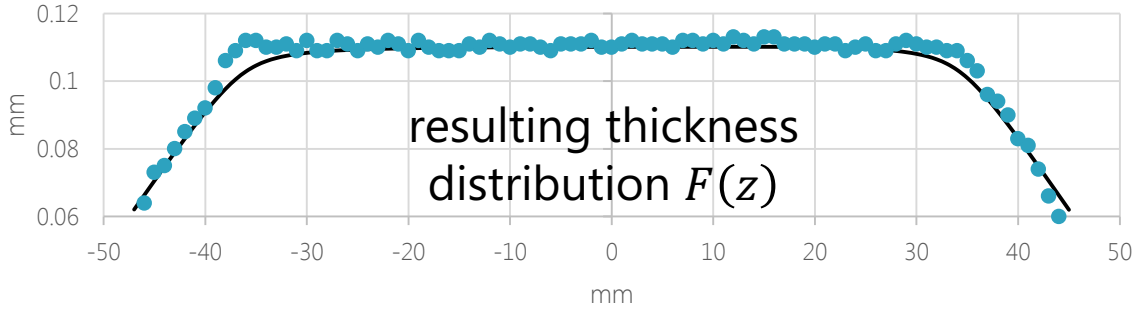
deposition characteristics:
$f(z, z_S(t), Material)$

sputter rate:
$R(P(t), I(t), material)$



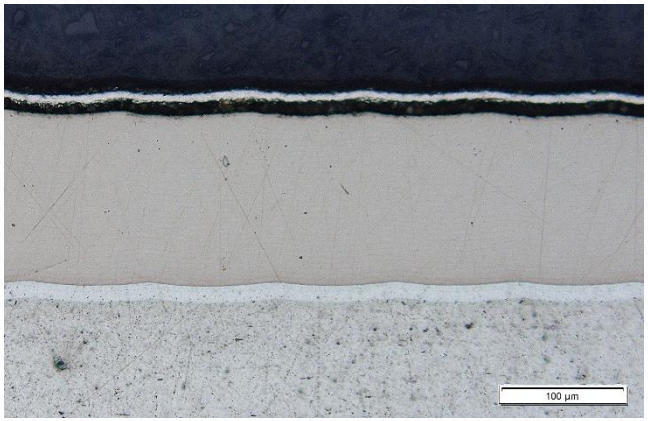
coating process:
$F(z) = C \int_0^T f\left(z, z_S(t)\right) R(t)\, dt$

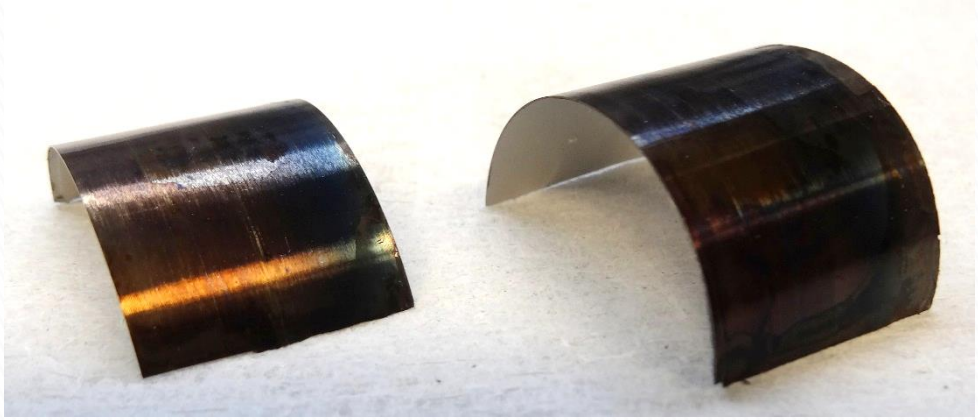


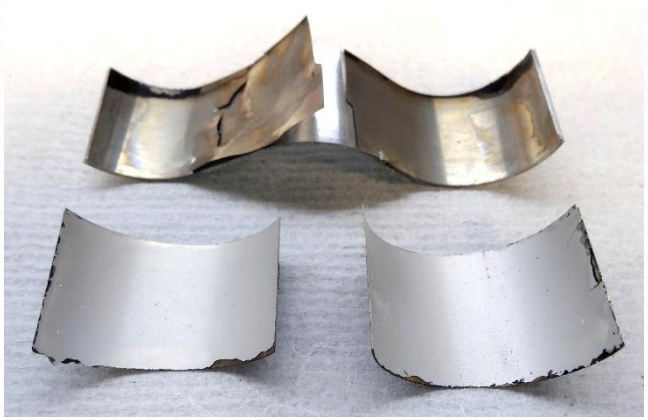


Layer quality and adhesion

- High mechanical strength when applying high substrate temperatures
  (coil temperature + sputter power)
- Foils easily removable when using interlayers like graphite or aluminum

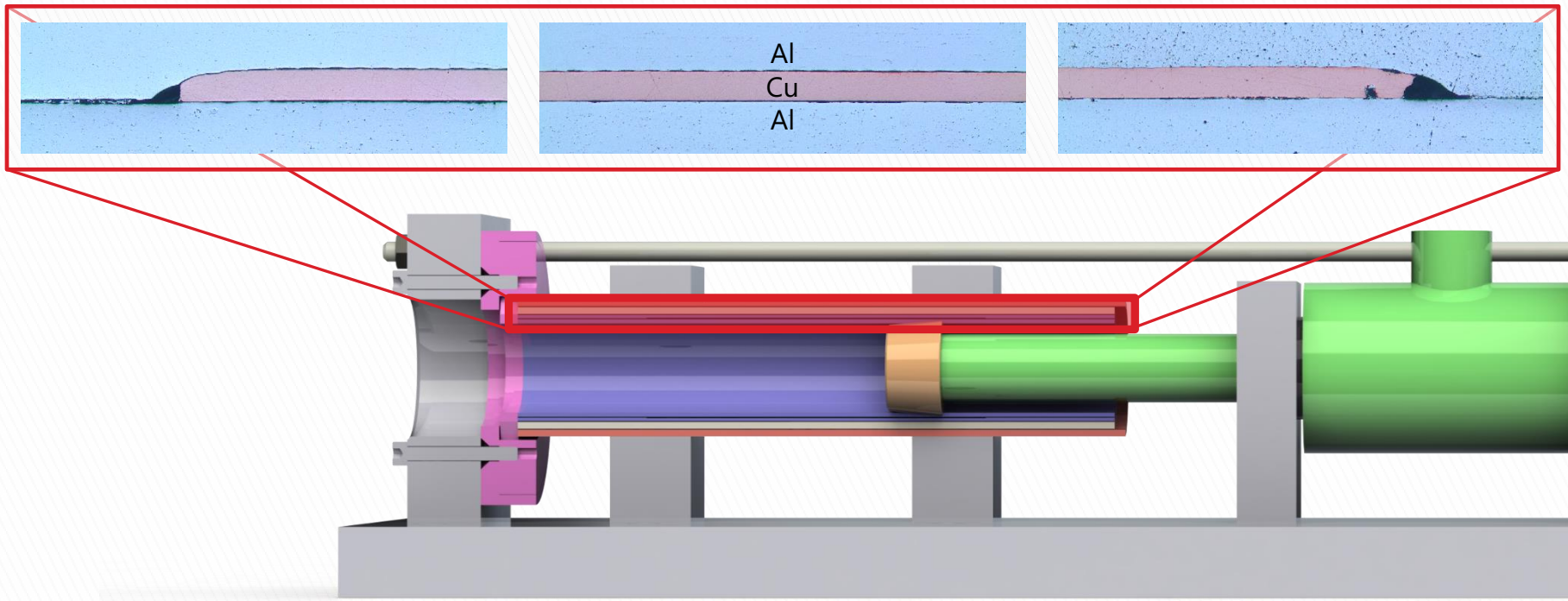






Forming

- Investigation of two different forming techniques: electromagnetic forming and hydraulic forming
- Successful demonstration of forming irradiation targets with sputtered foils



Summary

1. Sputter target production
2. Coating
3. Assembly

uranium ingot

casting

ε ≈ 95%

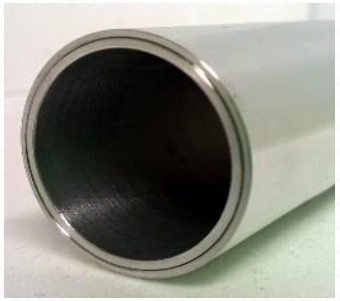
cast pin

coating

ε ≈ 92%

sputtered uranium layer

forming



assembled irradiation target

welding

complete irradiation target

Thank you for your attention!