On the use of W-Cu laminate pipes as a heat sink

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WP13-MAT-HHFM-05-01 ; working period: - July 2013

INSTITUTE FOR APPLIED MATERIALS, APPLIED MATERIALS PHYSICS

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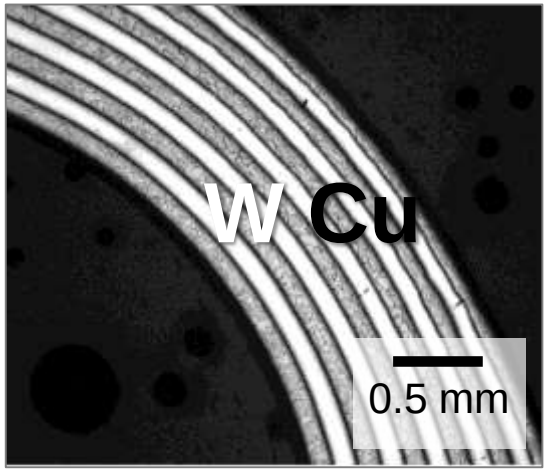
- W-laminates used as an interlayer → steel divertor
  - HHF tests in GLADIS, IPP (H. Greuner)
- W-laminate pipes → pipe concept

Deep drawing of W-laminate plates

- W-Cu laminates, thickness 1 mm, 600°C
  - W-foil as-received → NO!
  - W-foil rxx → YES!

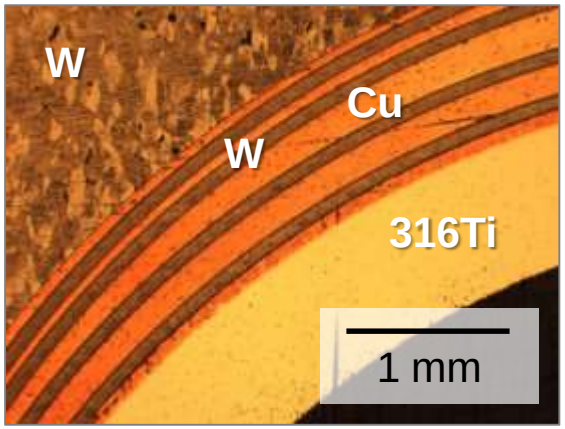


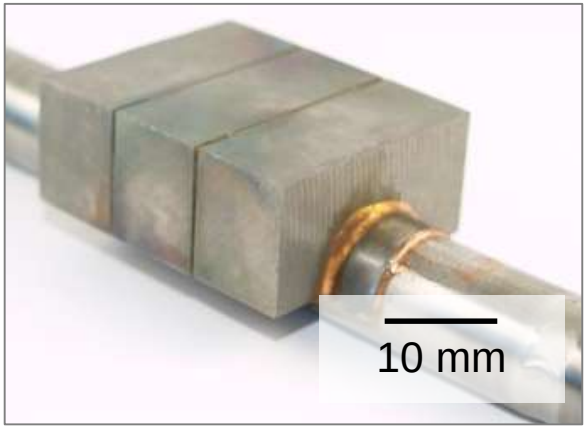
W-laminates used as an interlayer

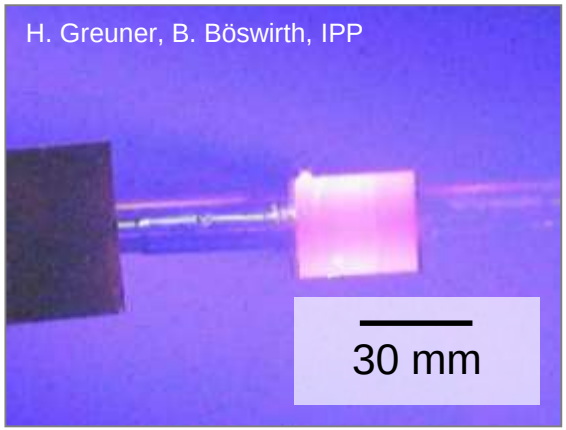
- Mockup, tests, results
  - pipe: austenitic steel (316Ti, 1.4571)
  - coolant: water, 20°C, 10 bar, 10 m/s, 1.13 l/s
  - beam: 20 s on, 40 s off
  - 6 MW/m^2, 100 cycles → no damage
  - 7 MW/m^2, 100 cycles → increase of saddle temp.

→ **Final result:** W-Cu laminate can be used an interlayer

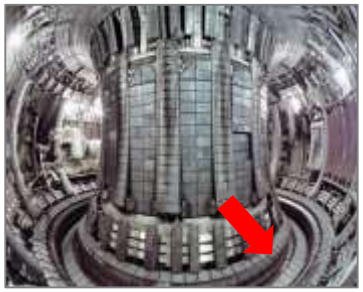
Thanks to Mr. Greuner



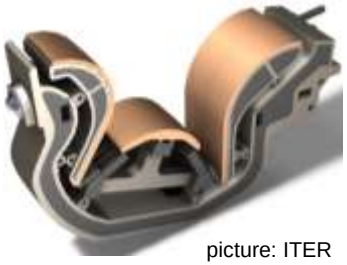




W-laminate pipes: He-cooled divertor



Tokamak fusion reactor

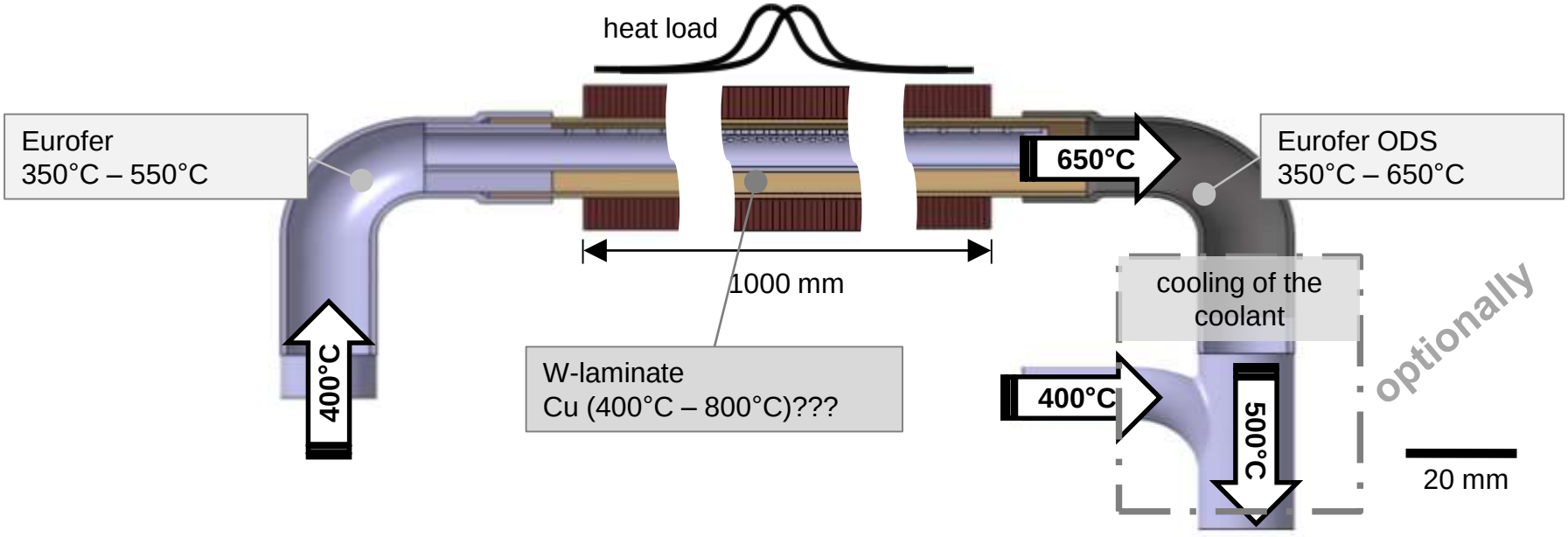


picture: ITER

Divertor cassette:
inner/outer vertical target, dome

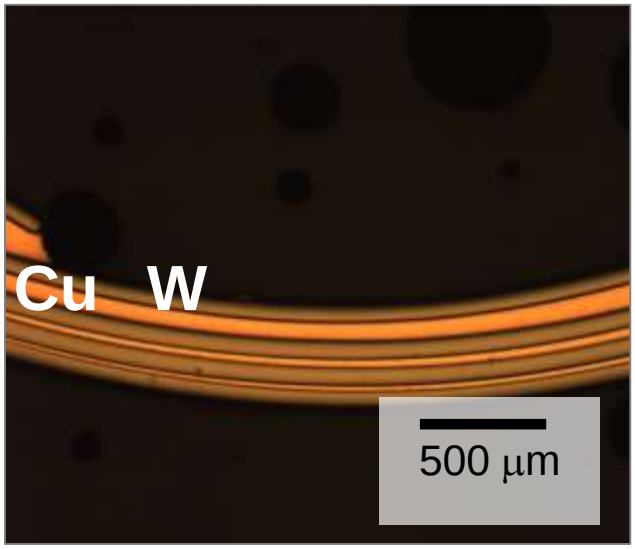
picture: PLANSEE SE

inner/outer vertical target



W-laminate pipes: He-cooled divertor

- Thermal conductivity (TC), k
  - W-Cu laminate: high TC through plane, even higher in plane
  - → reduction of the temp. gradient → reduction of thermal stresses



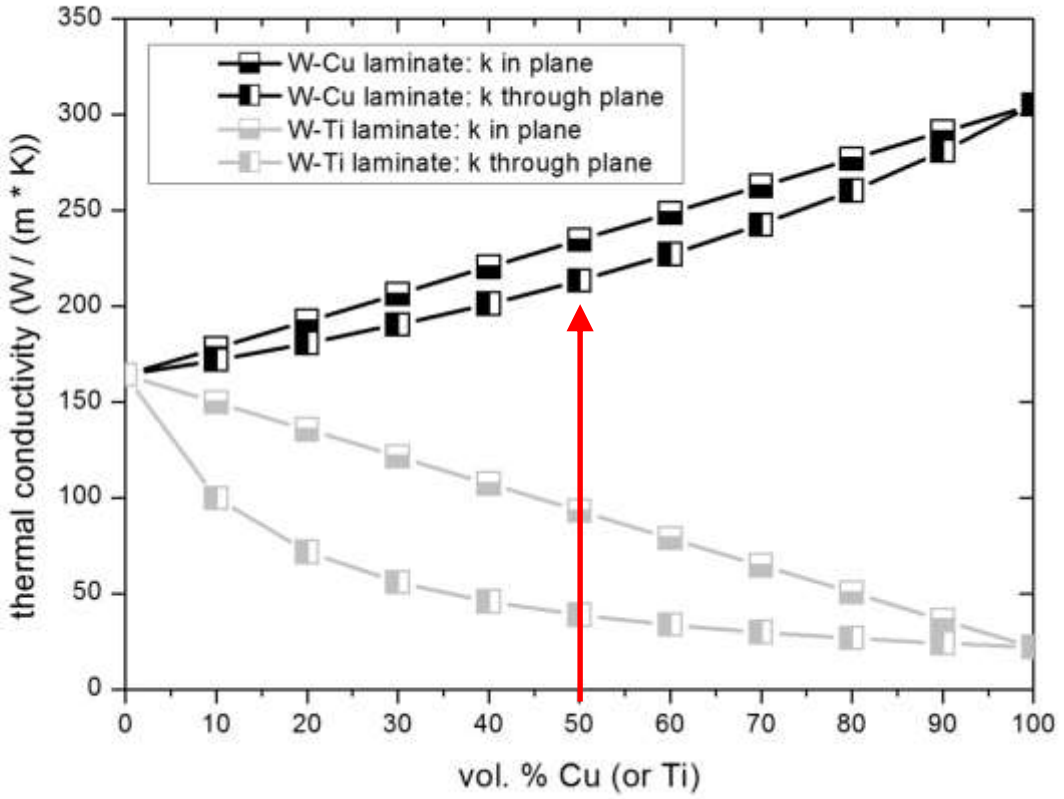
W-laminate pipes: He-cooled divertor

- TC in [W/(mK)]

$$\dot{q} = -k\frac{T_1 - T_2}{t} \quad (1D)$$

$$k_{\text{total}}^{\text{through}} = \frac{t_{\text{total}}}{\sum_i \frac{t_i}{k_i}}$$

$$k_{\text{total}}^{\text{in}} = \frac{\sum_i k_i t_i}{t_{\text{total}}}$$



W-laminate pipes: He-cooled divertor

- Plans in 2013: HELOKA test sample

Thank you for your attention

The authors are grateful to

EFDA
EUROPEAN FUSION DEVELOPMENT AGREEMENT

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