# Thermal simulations of couplers

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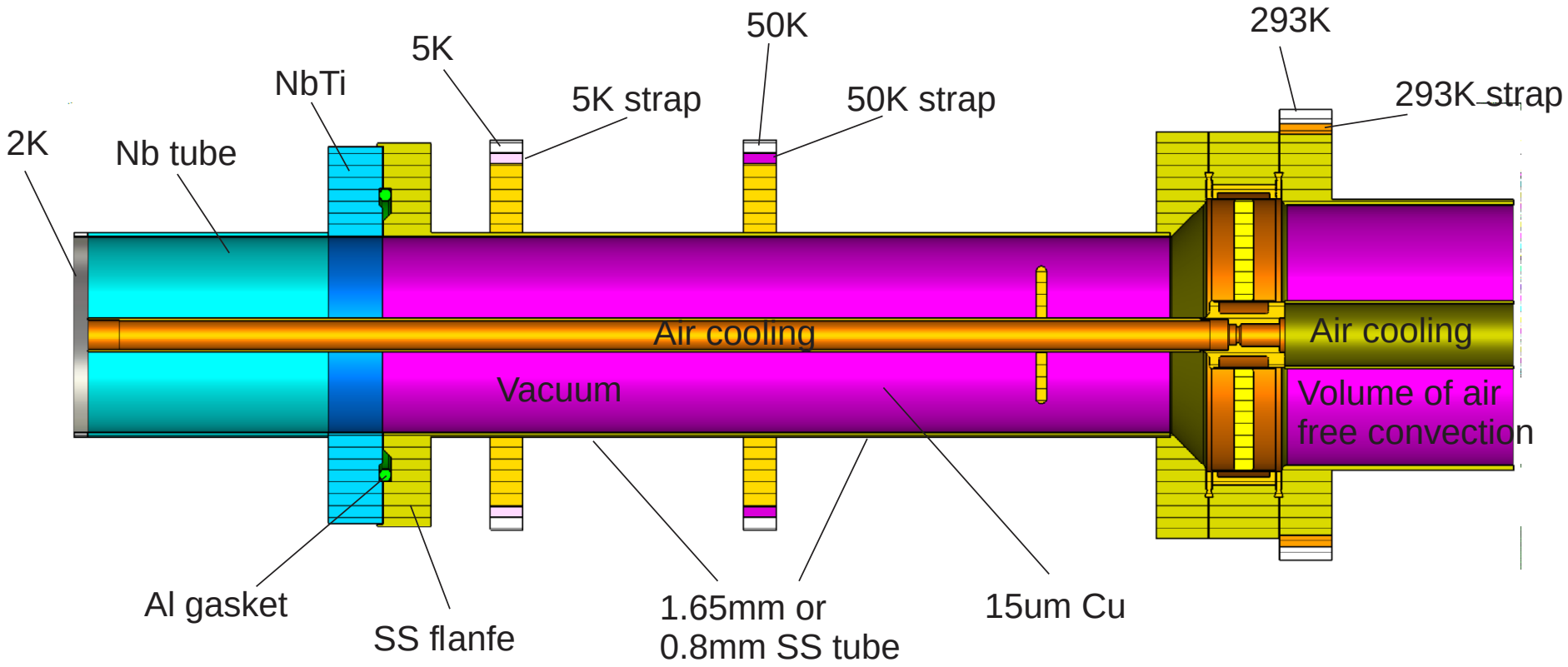
**Configuration of vacuum part of coupler for thermal simulations.**



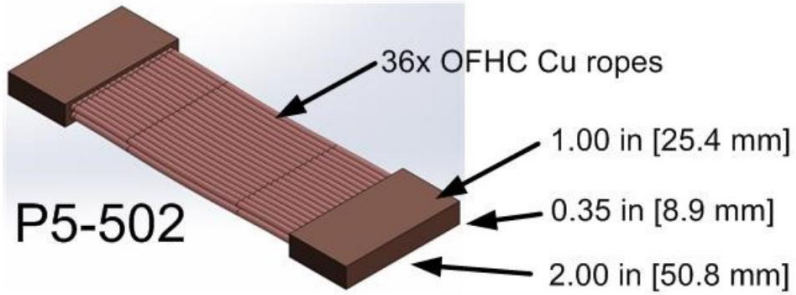

**Convection coefficients:**

| | |
|---|---|
| Inside antenna | h = 72+85.4*Air_rate (g/s). |
| Inside inner conductor | h = 11.6*Air_rate. |
| Inside inner sleeve | h = 20*Air_rate. |
| Free convection | h = 3 W/m2/K. |

# Simulations were based at copper straps properties:

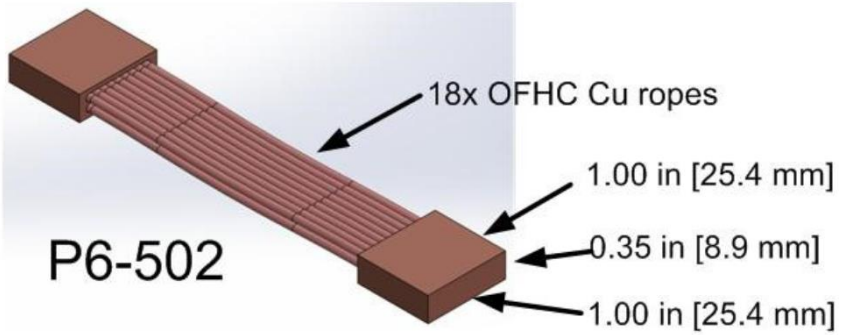
**Performance Data & Mass**
*(at braid length = 10 cm):*

**Conductance** (*at 300K*): 0.43 W/K
**Projected Conductance** (at 20K): 1.80 W/K
**Approximate Weight**: 260g




**Performance Data & Mass**
*(at braid length = 10 cm):*

**Conductance** (*at 300K*): 0.21 W/K
**Projected Conductance** (at 20K): 0.93 W/K
**Approximate Weight**: 130g

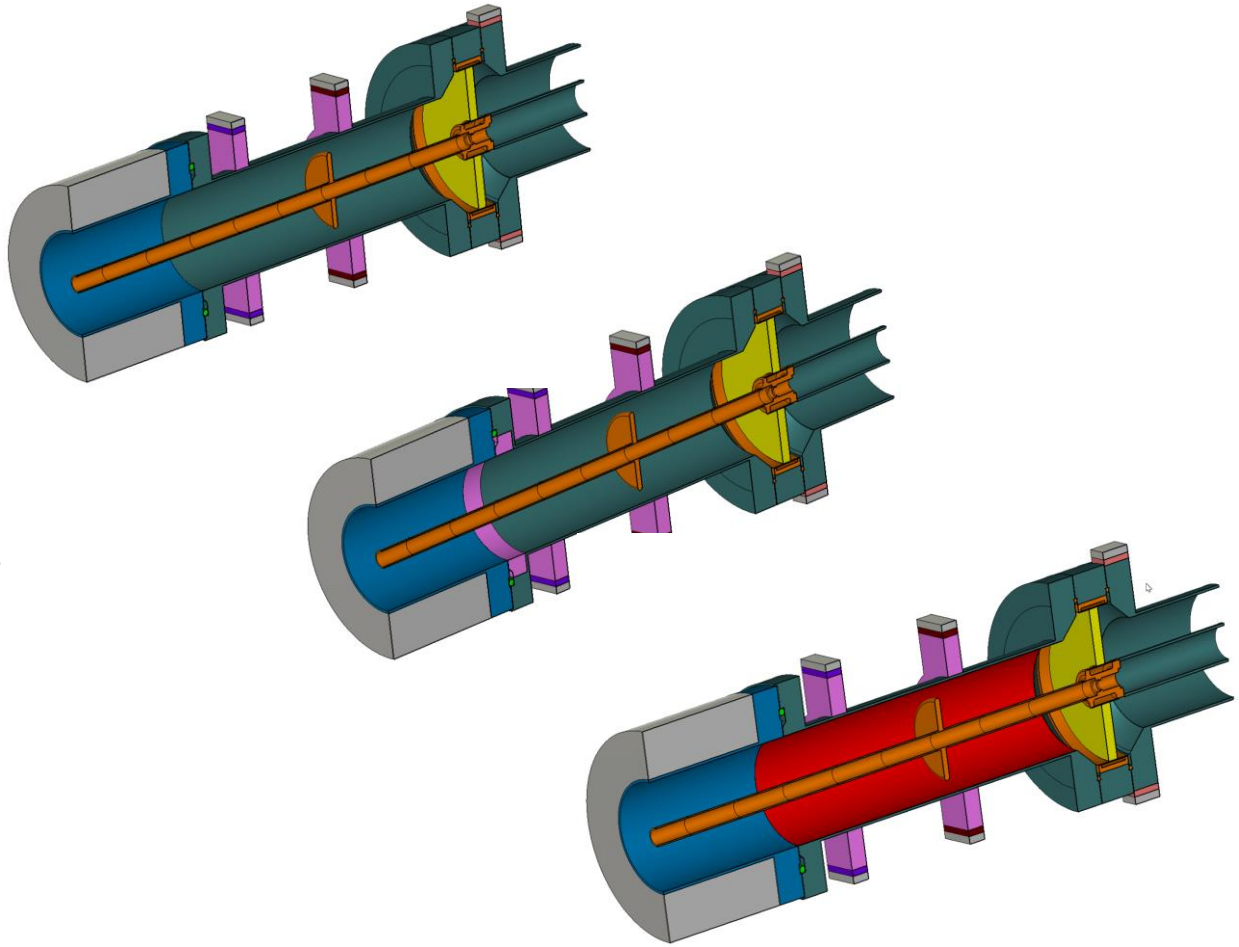



- Thermal conductance of “293K” straps of air part simulation is equivalent to 4 x350mm of double 2’’ straps or 4 x 170mm double 1’’ straps
- Thermal conductance of “5K” straps is 0.33 W/K. Simulated configuration is equivalent to 2 x 180 mm double 2’’ straps at ~ 7K.
- Thermal conductance of “50K” straps is 0.6W/K. Simulated configuration is equivalent to 2 x 370 mm double 2’’ or 2 x 190mm straps at ~ 60K.

# Thermal properties

**Material properties for thermal simulation:**

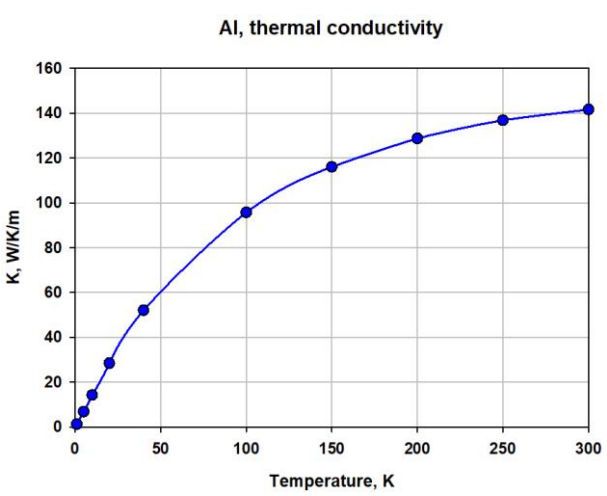
- Perfect thermal conductor, K = ∞, boundary cond. For 2K, 5K, 50K, 293K.
- Al, non-linear
- “Cu”, non-linear
- Cu, non-linear
- Nb, non-linear
- T. cond. C = 0.33 W/K, 2pc.
- T. cond. C = 0.60 W/K, 2pc.
- T. cond. C = 0.124 W/K, 4pc.
- SS, non-linear
- Cu, K = 401 W/K/m
- Ceramics, 26 W/K/m

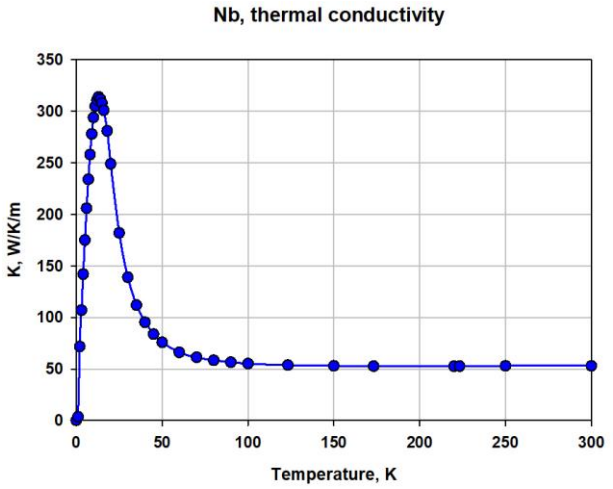


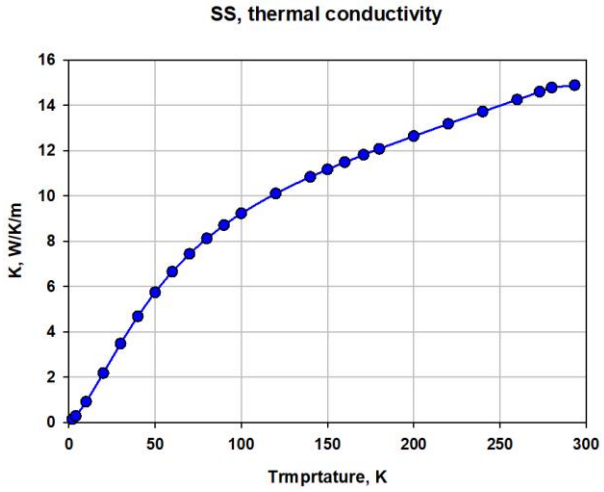
Charge # 1b

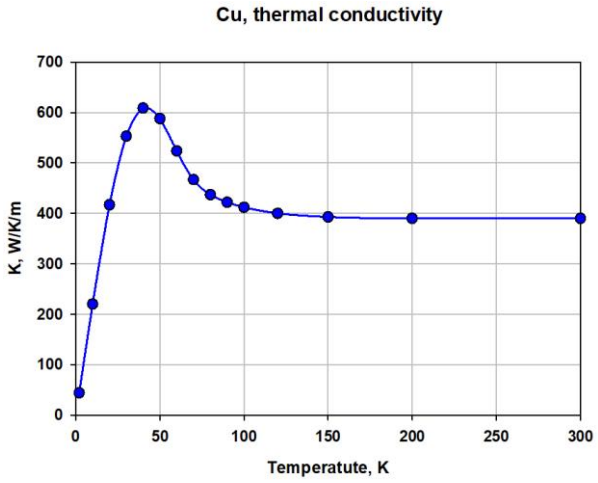
# Thermal properties

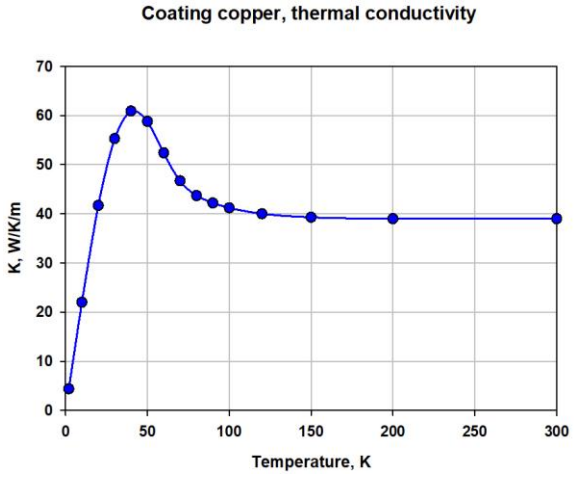
## Thermal conductivities of non-linear materials



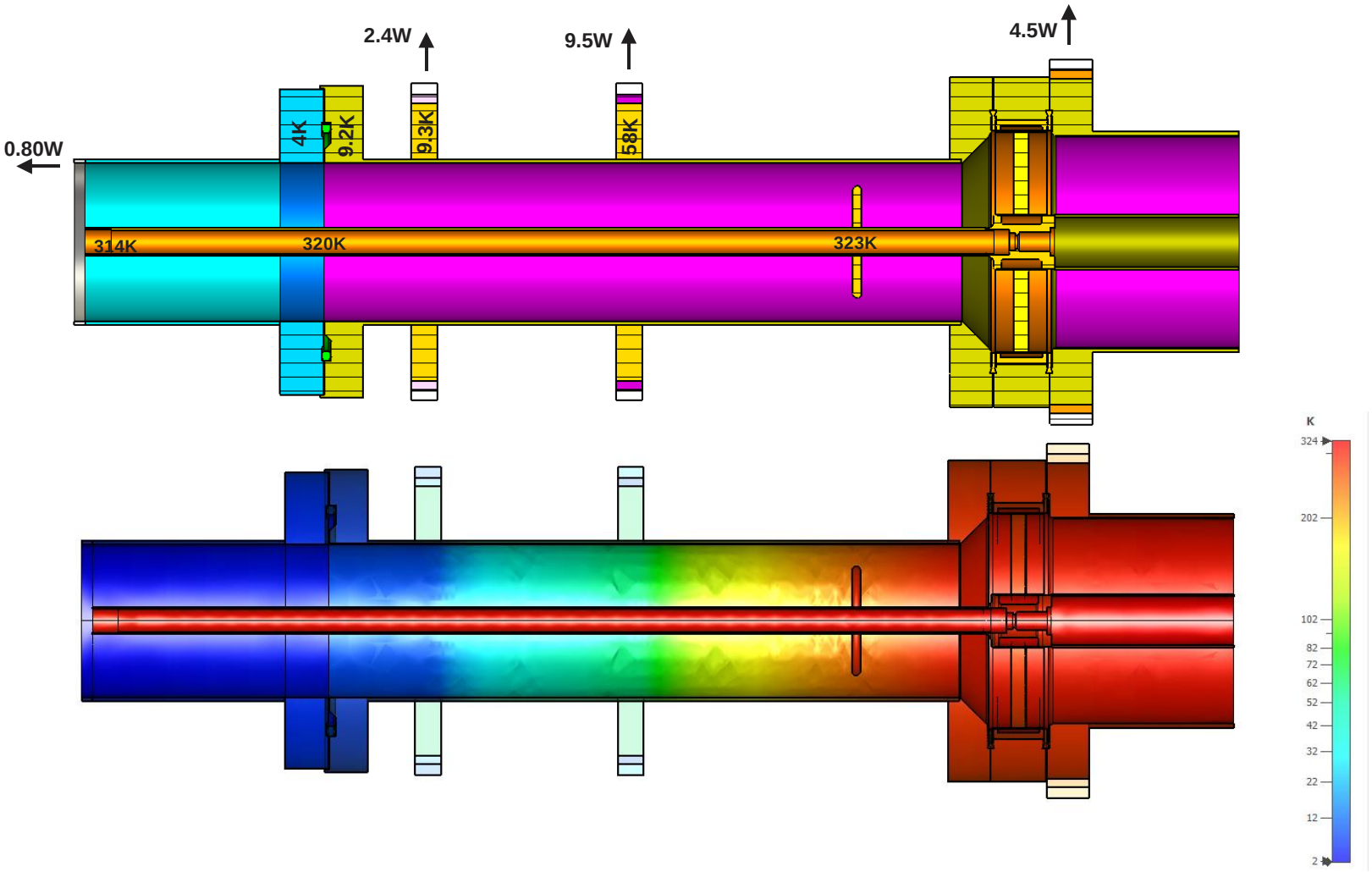

Thickness of Cu layer is 10 times lager, 150um.
Thermal conductivity of Cu layer is 10 times smaller.

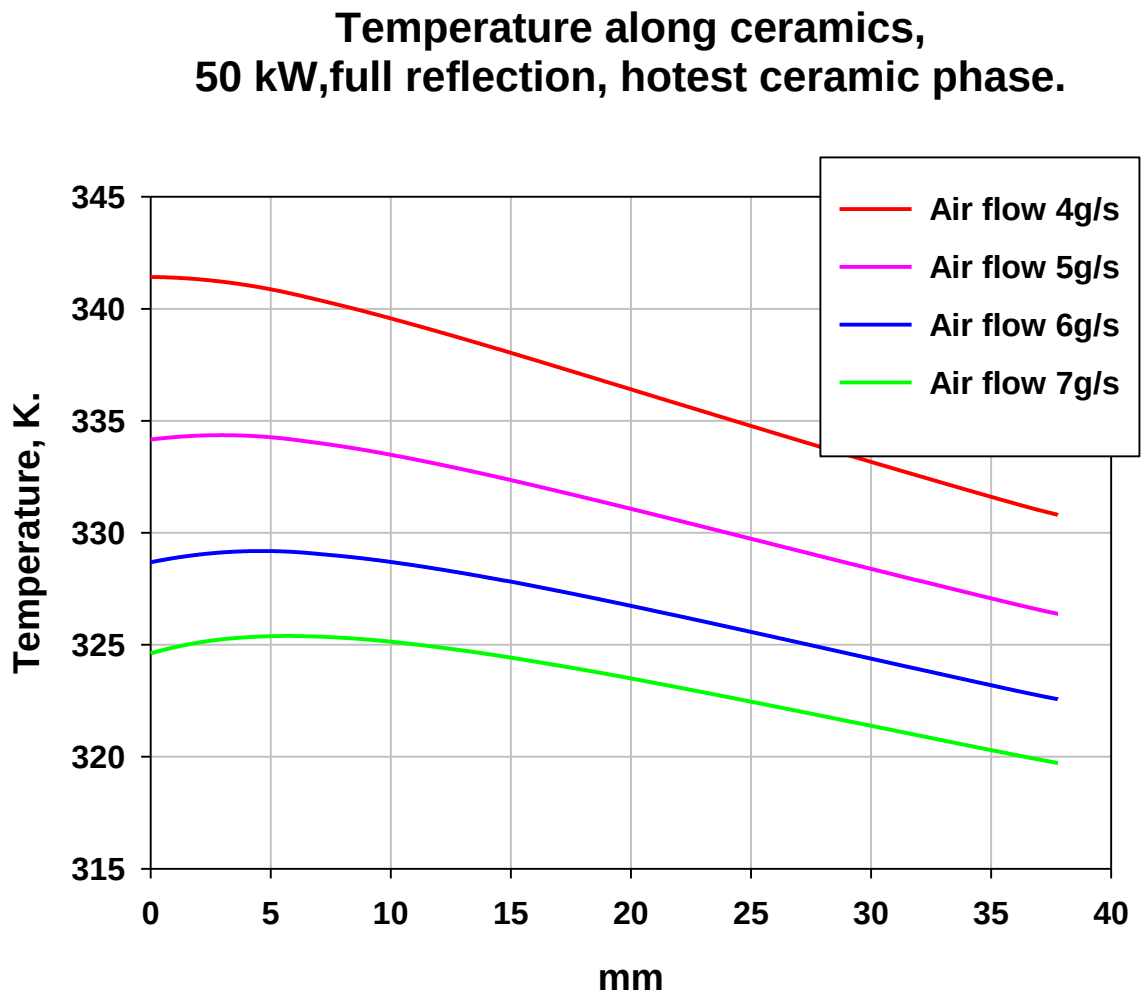
**50 kW, CW + 20% reflection**, worst cryogenic phase (highest magnetic field near cavity flange)

Total RF losses **70.6W,** losses in ceramics (loss tangent 1e-4) **7.7w**

**Air takes ~ 54W,** air temperature rise ~ **14C (flow rate 4g/s,** temperature rise **~ 10C** in air part, total rise **~ 25C).**

**SS wall thickness 1.65mm**






(Max. temperature of ceramics for 4g/s ~ **70C**)