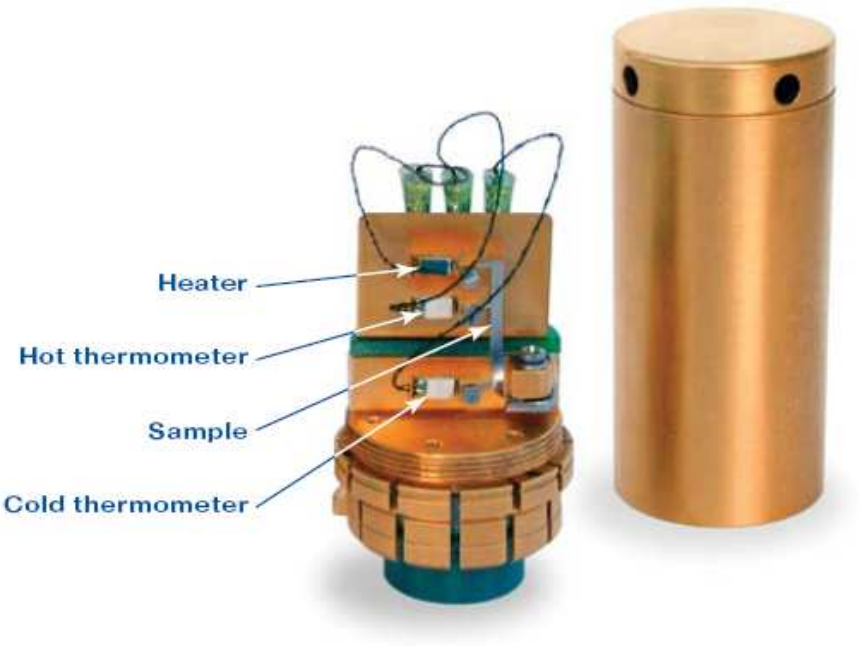
Thermal and electrical measurements (λ,α,ρ,κ)

Hardware-

-Quantum Design introduced Thermal transport option



➤ *Thermal Transport sample puck with radiation shield*

THERMAL CONDUCTANCE *(K)*

Typical Accuracy:

- ± 5 % or ± 2 μW/K, whichever is greater, for T < 15 K
- ± 5 % or ± 20 μW/K, whichever is greater, for 15 K < T < 200 K
- ± 5 % or ± 0.5 mW/K, whichever is greater, for 200 K < T < 300 K
- ± 5 % or ± 1 mW/K, whichever is greater, for T > 300 K

SEEBECK COEFFICIENT *(S)*

Typical Accuracy:

- Error in S = ± 5 % or,
- Error in S = ± 0.5 μV/K or,
- Error in V = ± 2 μV, whichever is greater

SPEED OF ACQUISITION:

Typically temperature slew rate:

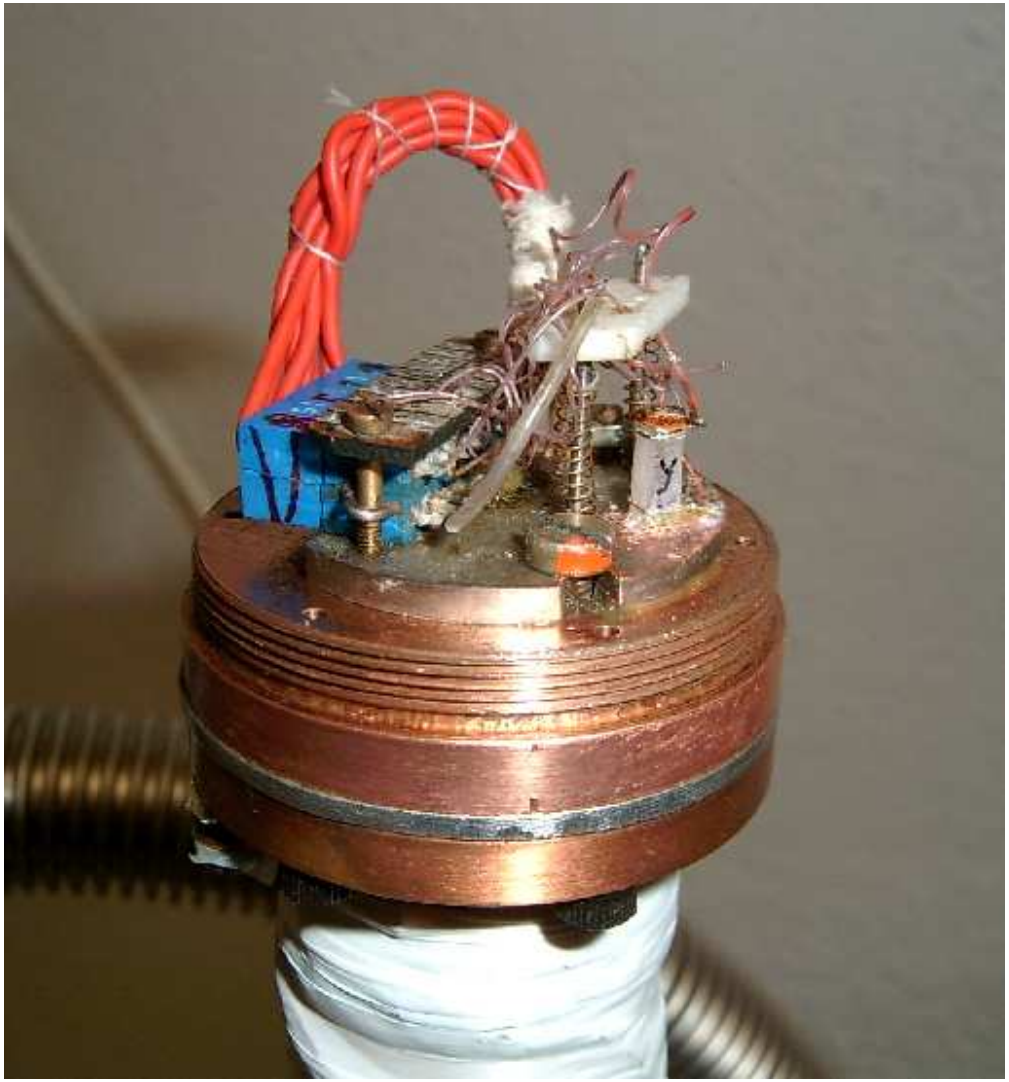
± 0.5 K/min, T > 20 K
± 0.2 K/min, T < 20 K
14 hour run from 390 to 1.9 K

Software-

-PPMS delivered, dynamic regime

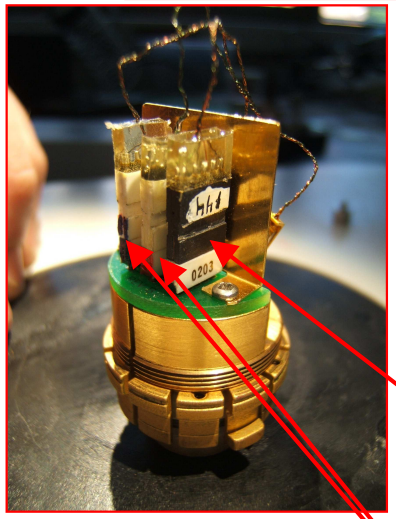
Home made- thermal and electrical measurements ($\lambda,\alpha,\rho,\kappa,c_v$)

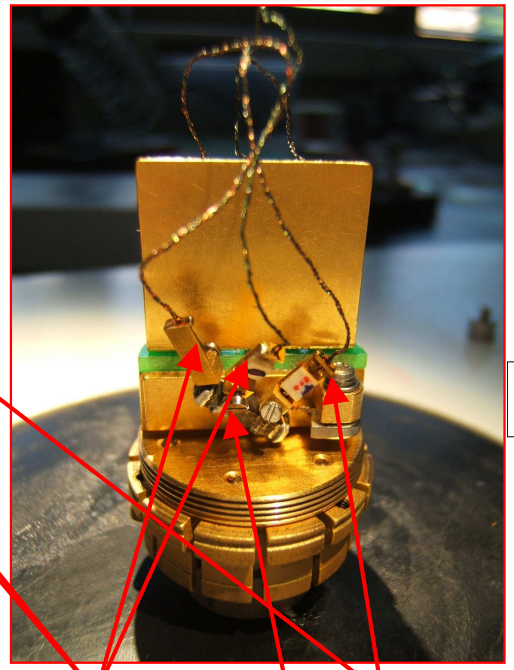
Low temperature 4-point cell
Close cycle He-cryostat (3.5-300K)

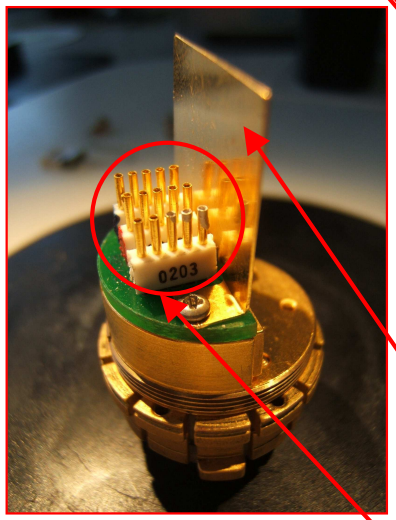


Thermal and electrical measurements **COMPARE** PPMS-Cryocooled (λ,α,ρ,κ)

PPMS sample topology







2 Cernox chip thermometers

Heater chip resistance

sample

Protection for radiation

Heater

Thermometer up

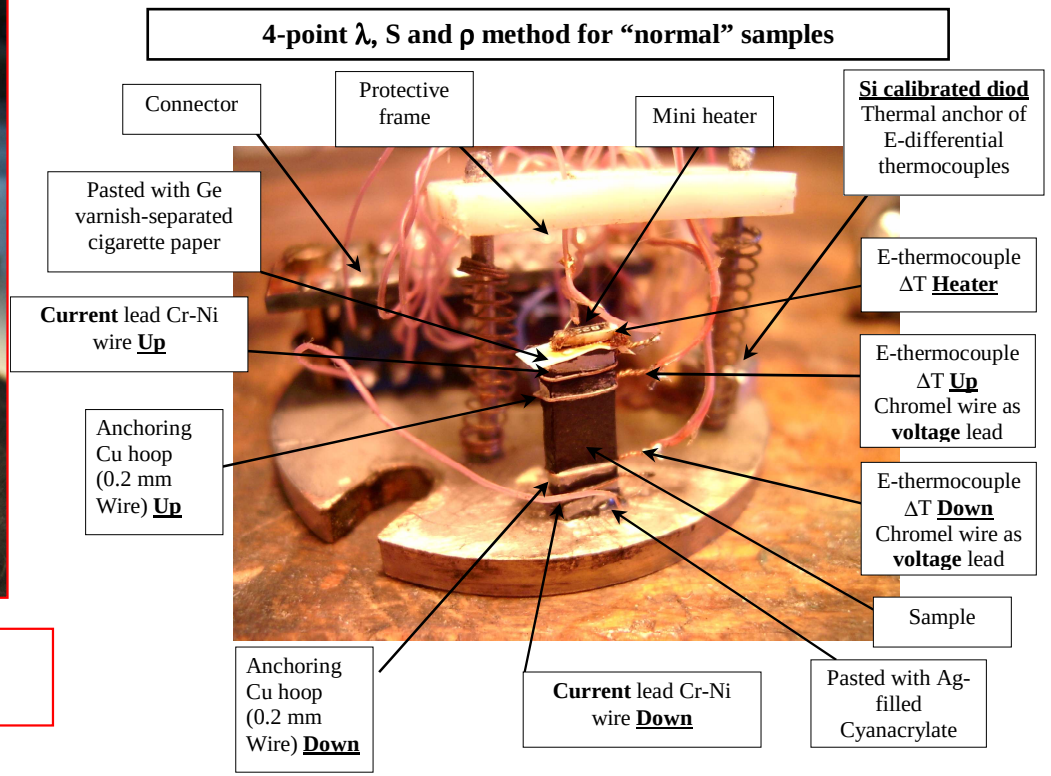
Thermometer down

2 for I_{heater} and 1 for I_{sample}

4 for T_{up} and 1 for U_{up}

4 for T_{down} and 1 for U_{down}

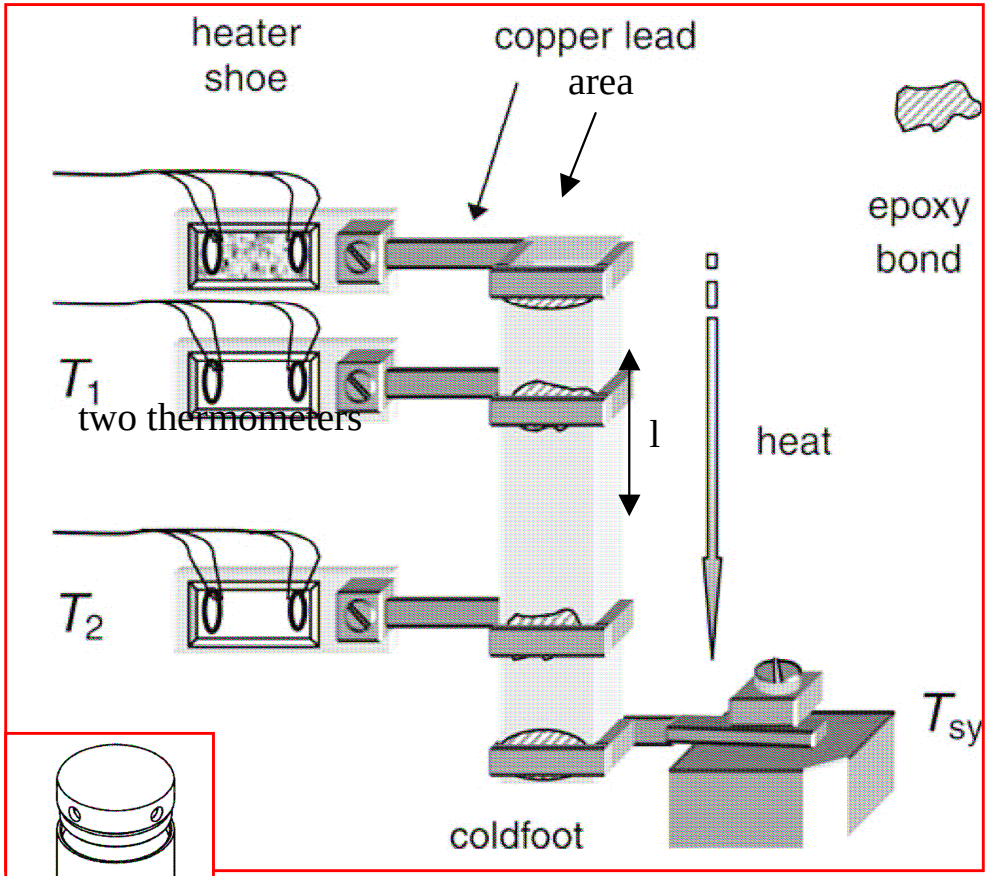
Cryo cooled sample topology

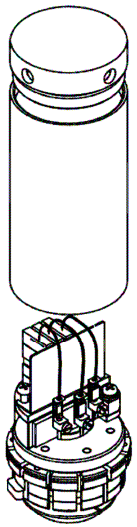


Arrangement of home-made 4-point thermal and transport measurement λ, S and ρ.

Thermal and electrical measurements **COMPARE** PPMS-Cryocooled (λ,α,ρ,κ)

PPMS sample topology

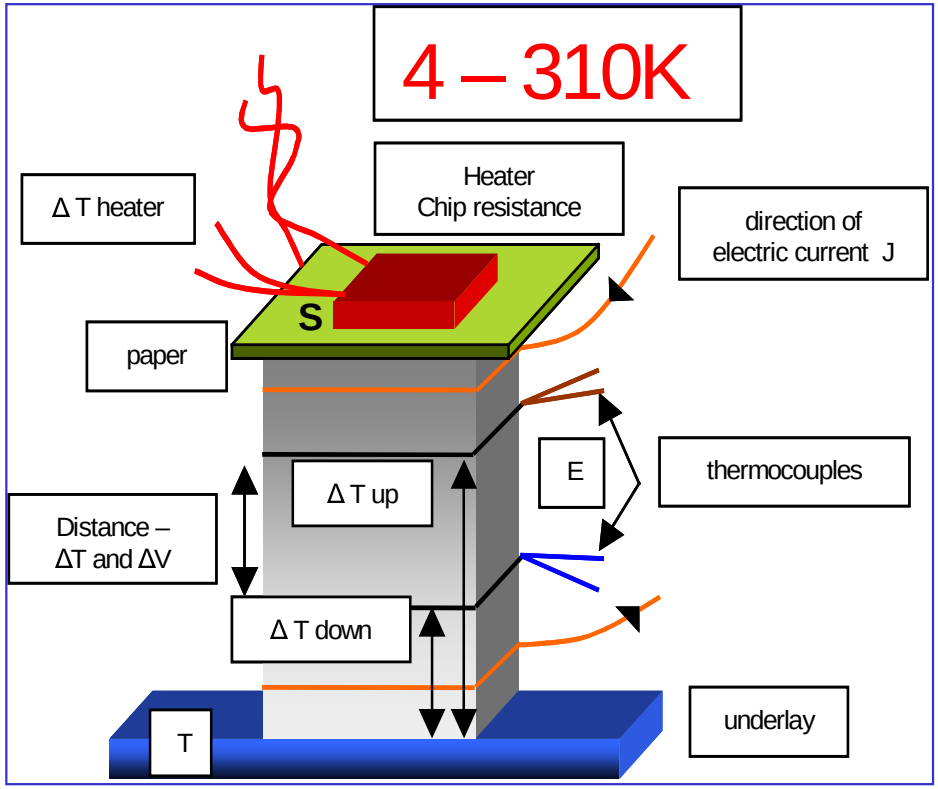




Not steady state method

ΔT calculated on a base τ_1,τ_2

Cryo-cooled sample topology



$$S = \frac{\Delta V}{\Delta T}$$

$$\lambda = F * \frac{Power}{\Delta T}$$

$$F = \frac{l}{area}$$

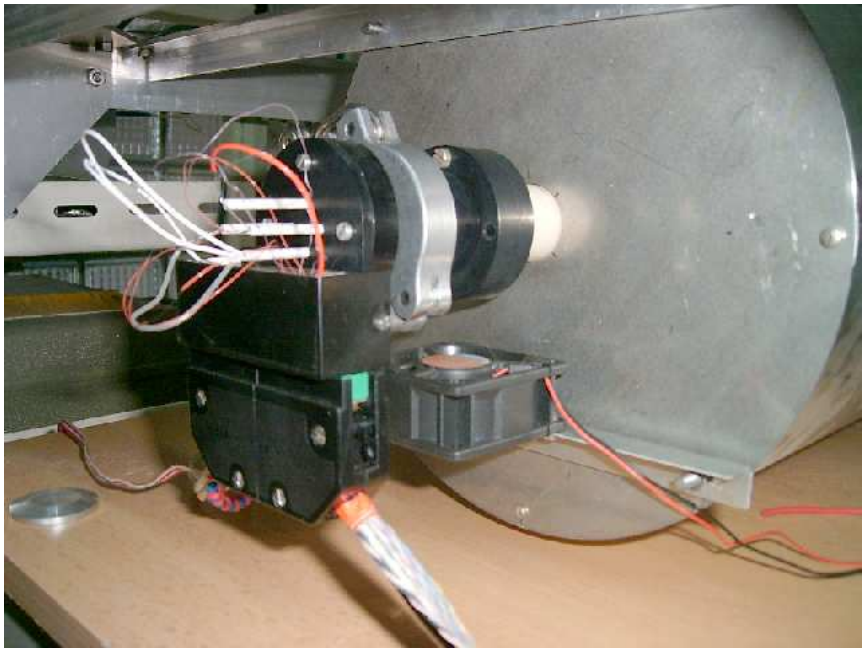
$$\Delta T = T_1 - T_2$$

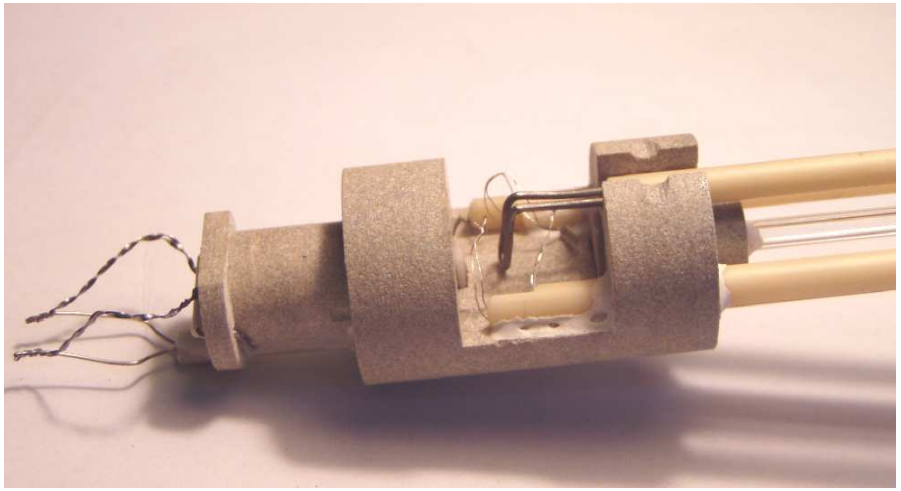
Steady state method **ΔT** measured

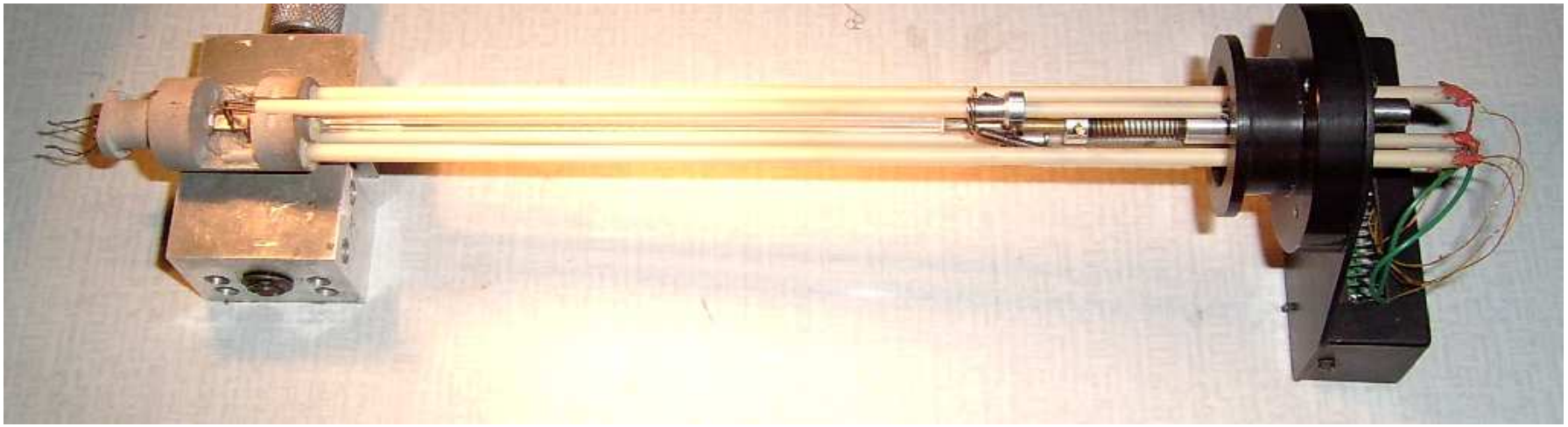
Arrangement of home-made thermal and transport measurement

Thermal and electrical measurements

High temperature 4-point cell (300 – 1200 K), Thermoelectric power and electrical resistivity

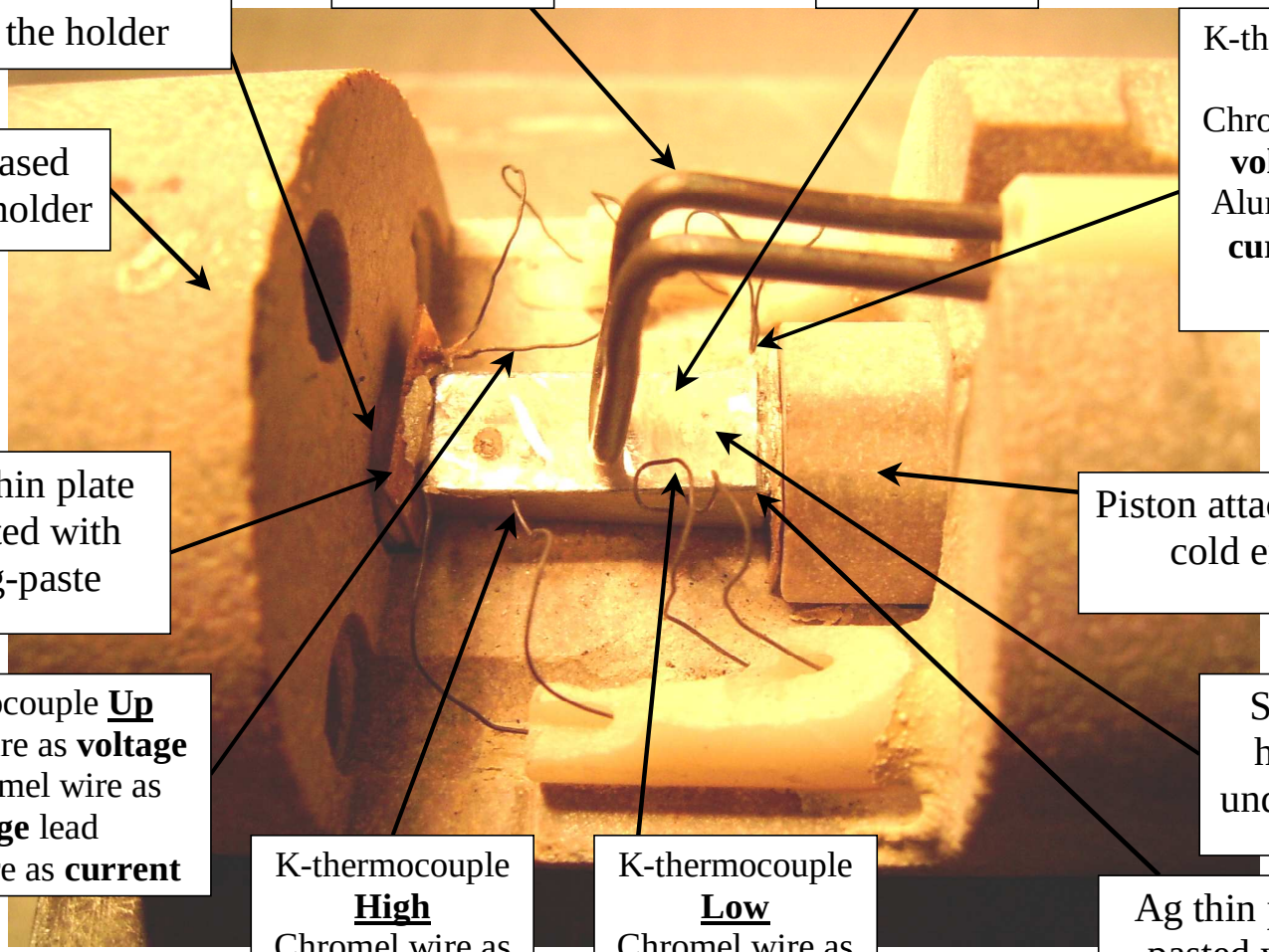




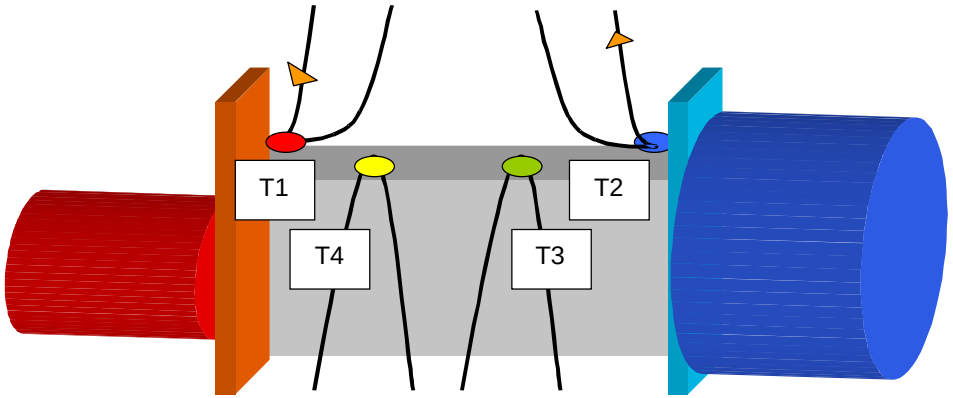


Thermal and electrical measurements

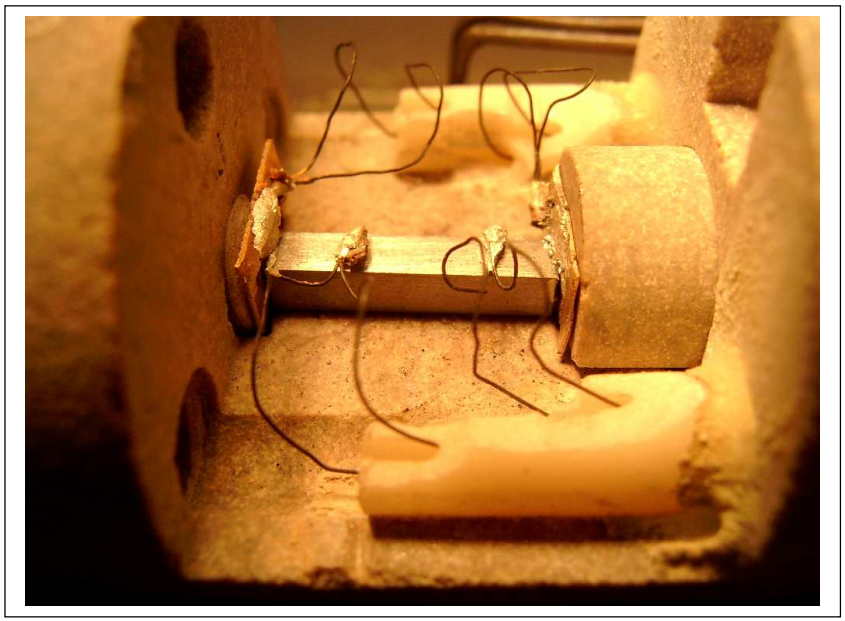
High temperature cell



Thermal and electrical measurements



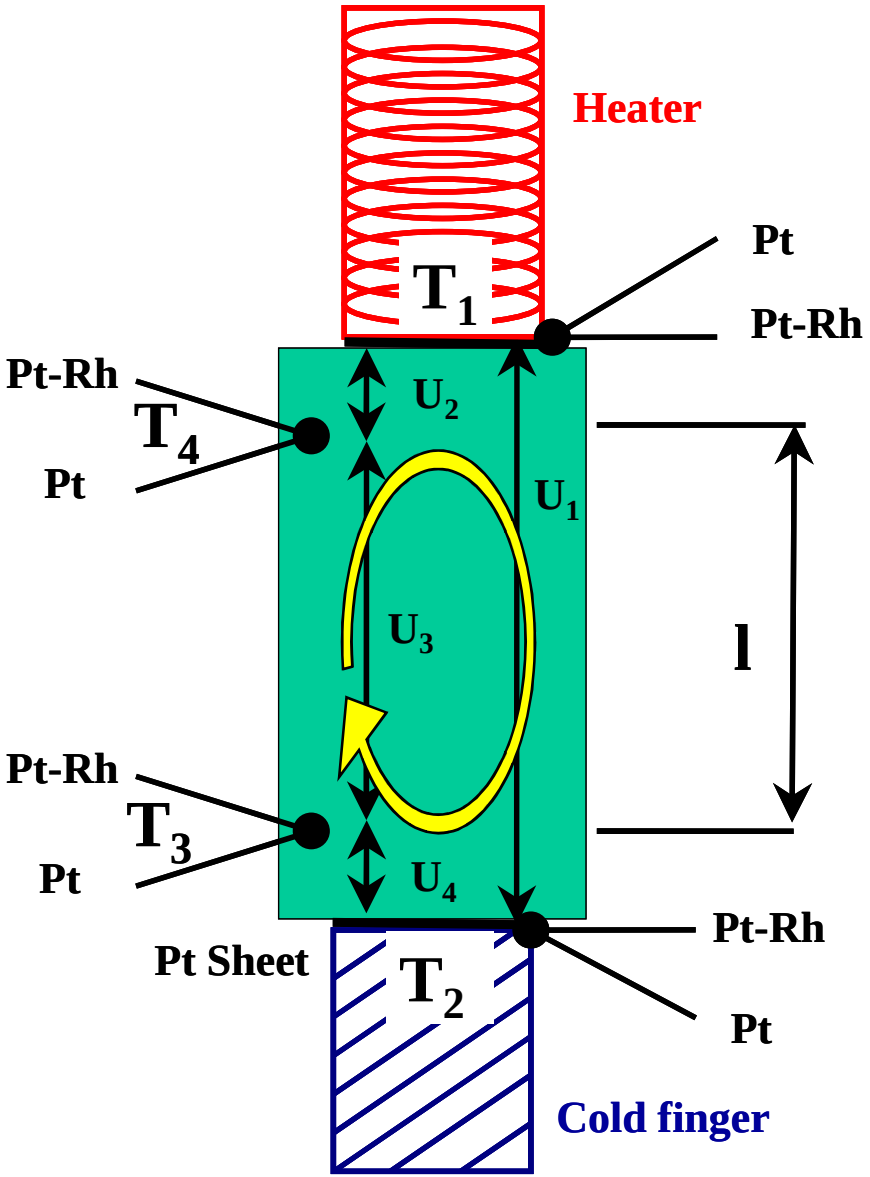
High temperature cell



TEP4points : $\Delta V(T_4\text{-}T_3) / (T_4\text{-}T_3)$

TEP3points : $\Delta V(T_4\text{-}T_2) / (T_4\text{-}T_2)$

TEP2points : $\Delta V(T_1\text{-}T_2) / (T_1\text{-}T_2)$



High temperature cell

Stability:

$$\Sigma U = U_1+U_4+U_3+U_2 = 0$$

$$T_1>T_4>T_3>T_2$$