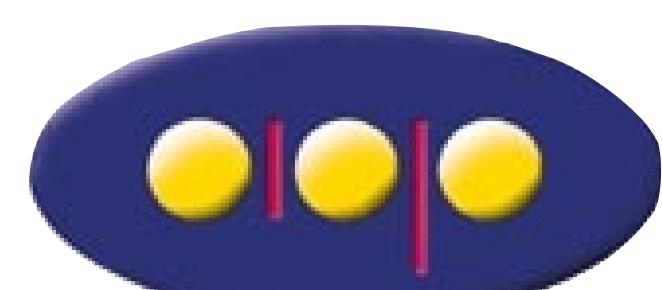


# Thermal Electron Emission from $\text{LaB}_6$ and $\text{BaO}$ in a Thermionic Set-Up



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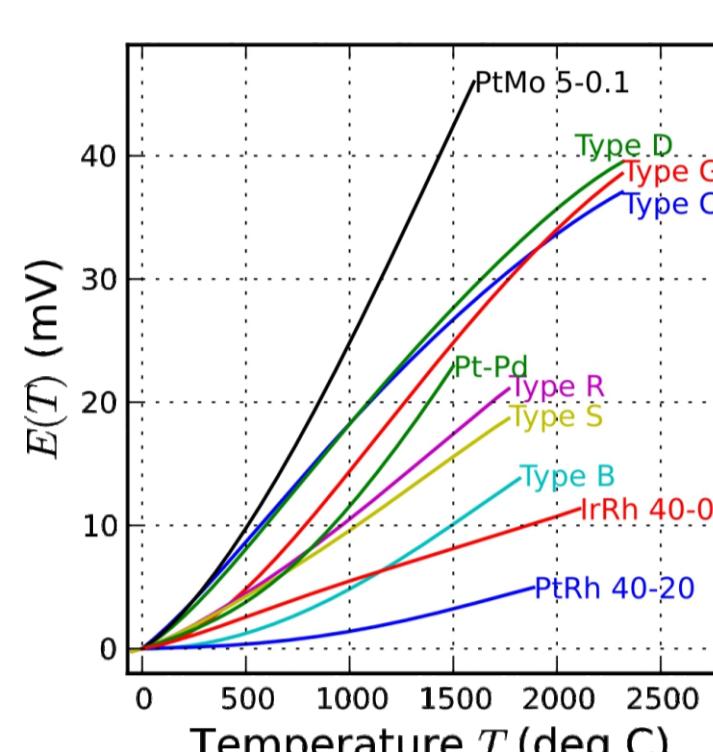
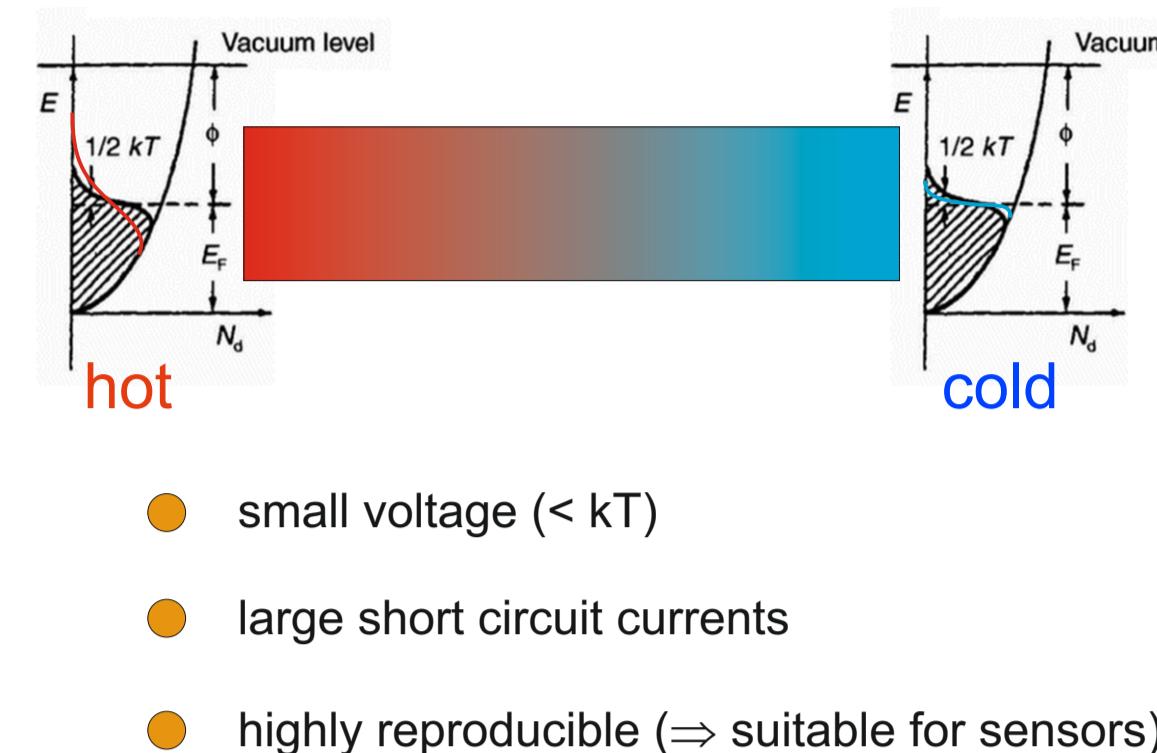


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metal

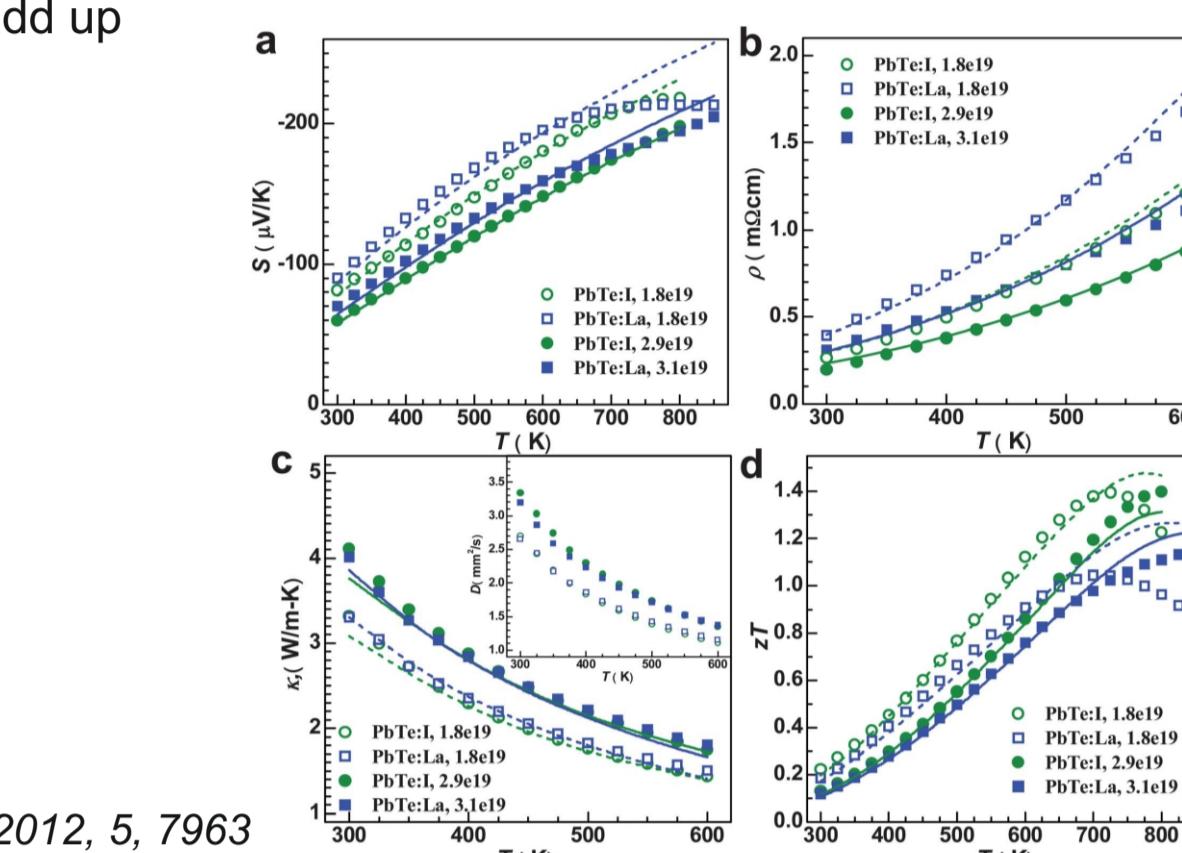
Thermoelectricity

doped semiconductor

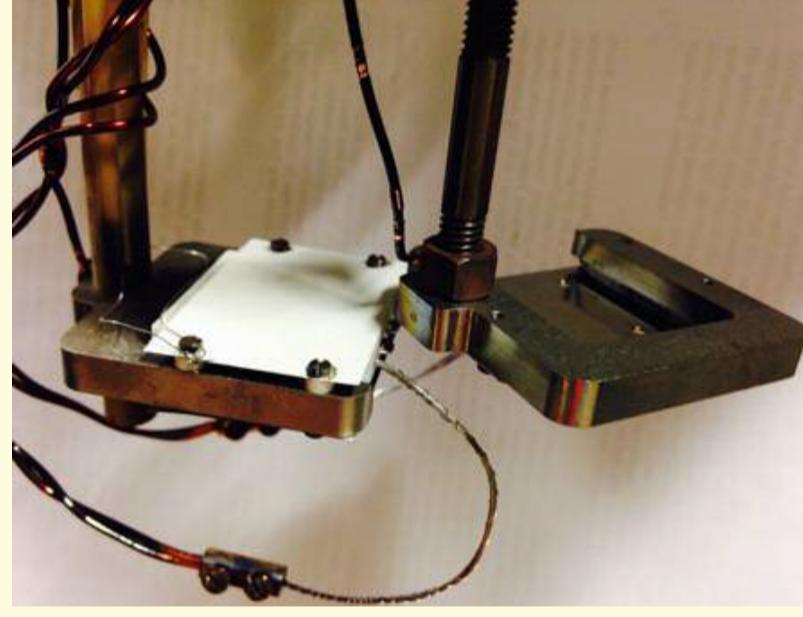
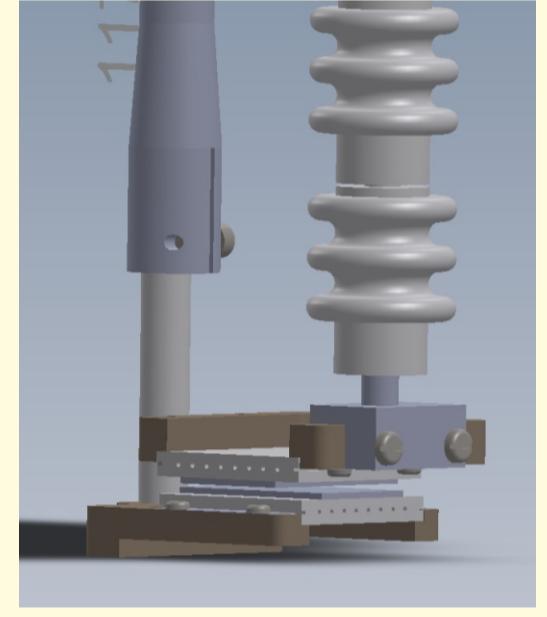


all solid state thermal electric generators have a large loss due to thermal conductivity!

- voltages  $\approx kT$  (dependant on donor / acceptor level)
- small short circuit currents (dependant on donor / acceptor concentrations)
- S for n- and p-type semiconductors has opposite sign  
 $\Rightarrow$  voltages add up



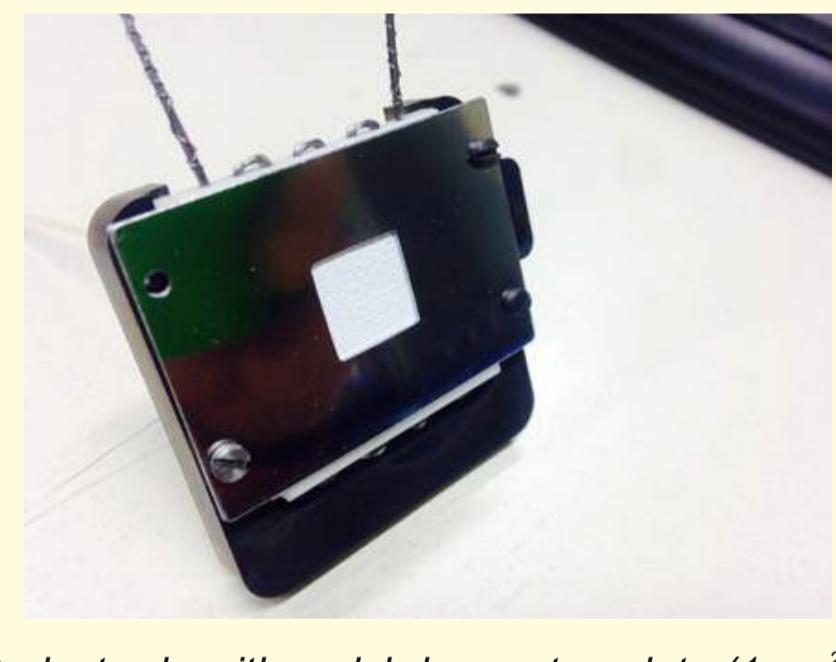
Experimental Set-Up



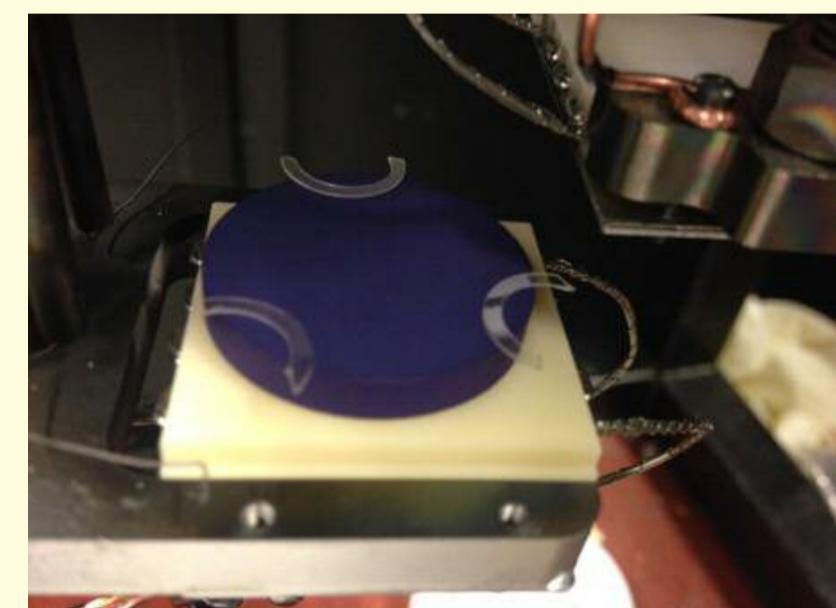
technical drawing of the manipulator

- coplanar surfaces
- adjustable distance down to 0.7 mm

- $\text{Al}_2\text{O}_3$  heating plates  
 $\Rightarrow$  cathode and anode can be heated up to 1600 K

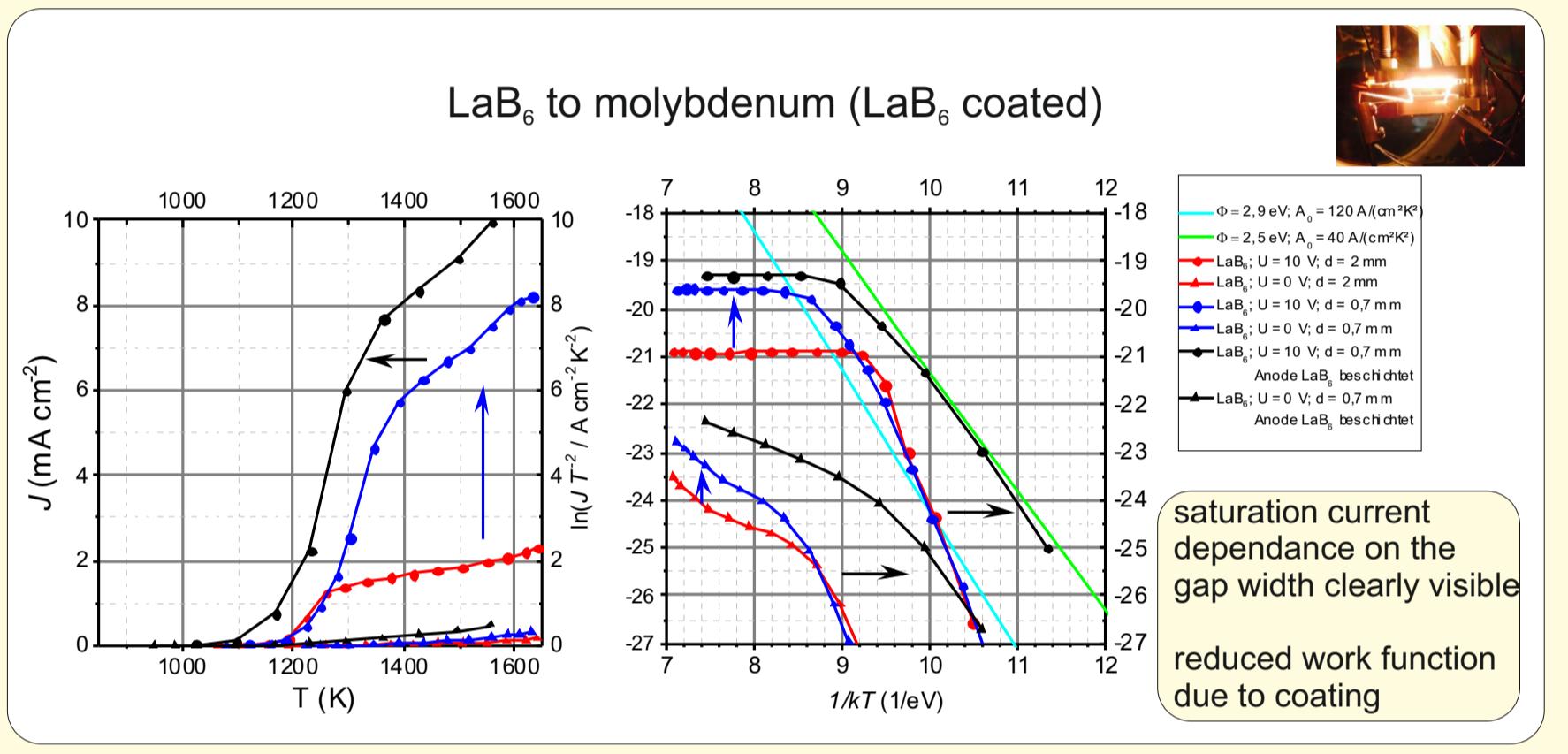


BaO electrode with molybdenum top plate (1 cm<sup>2</sup> aperture)

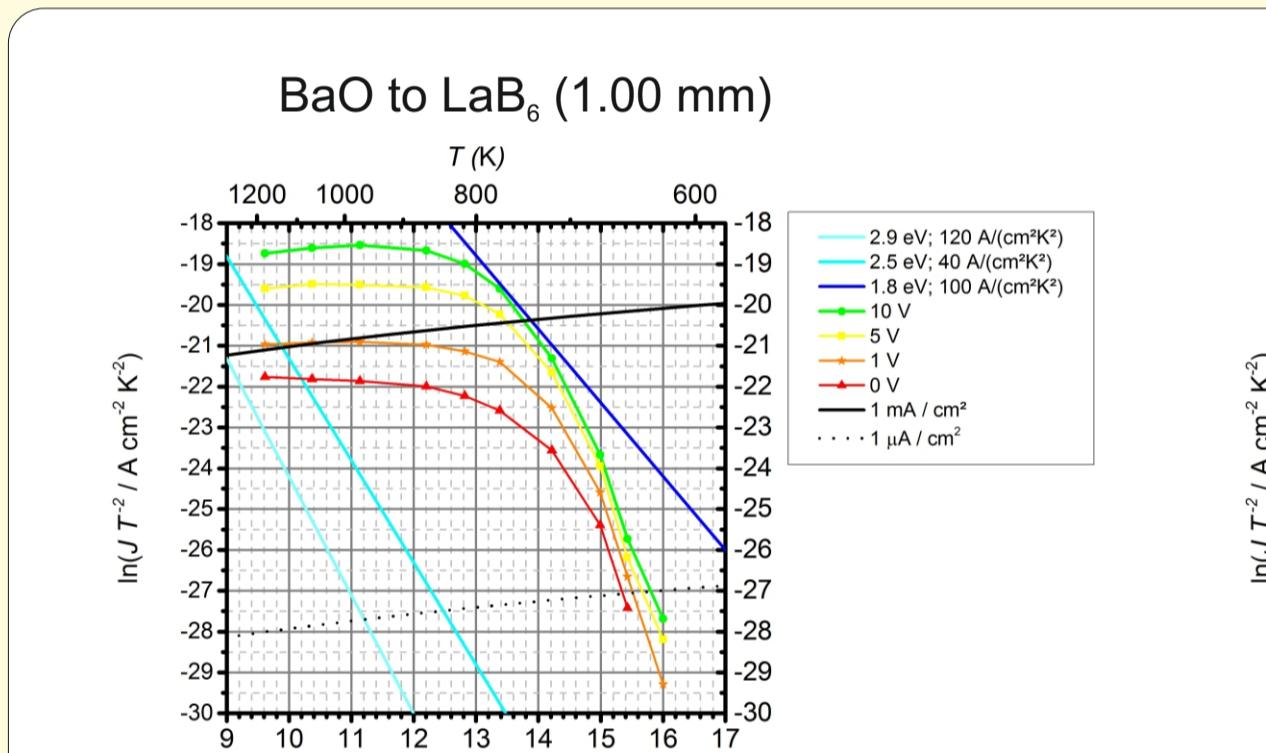


Modified set-up for small cathode-anode gaps  
(two LaB<sub>6</sub> tablets with 0.25 mm sapphire distance holders)

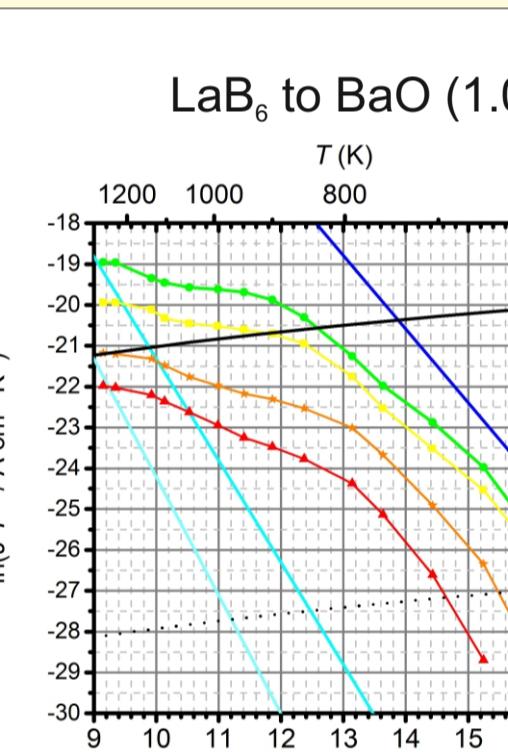
LaB<sub>6</sub> to molybdenum (LaB<sub>6</sub> coated)



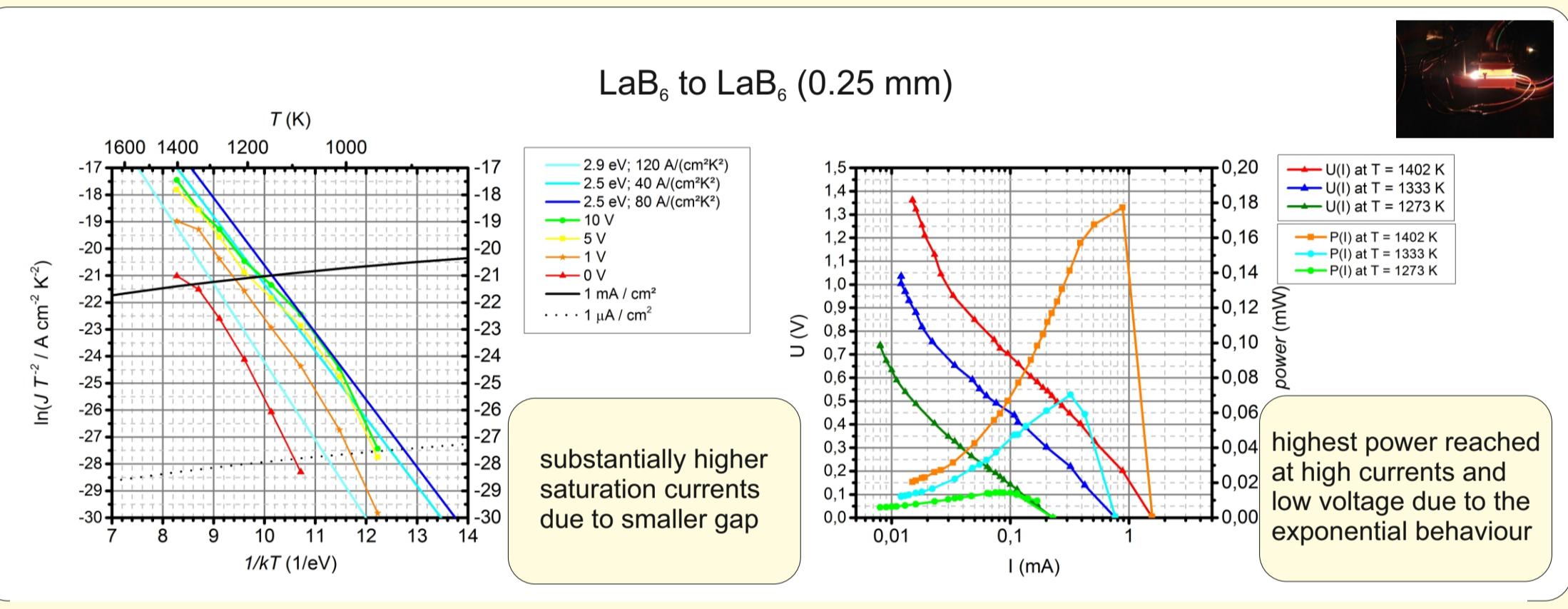
BaO to LaB<sub>6</sub> (1.00 mm)



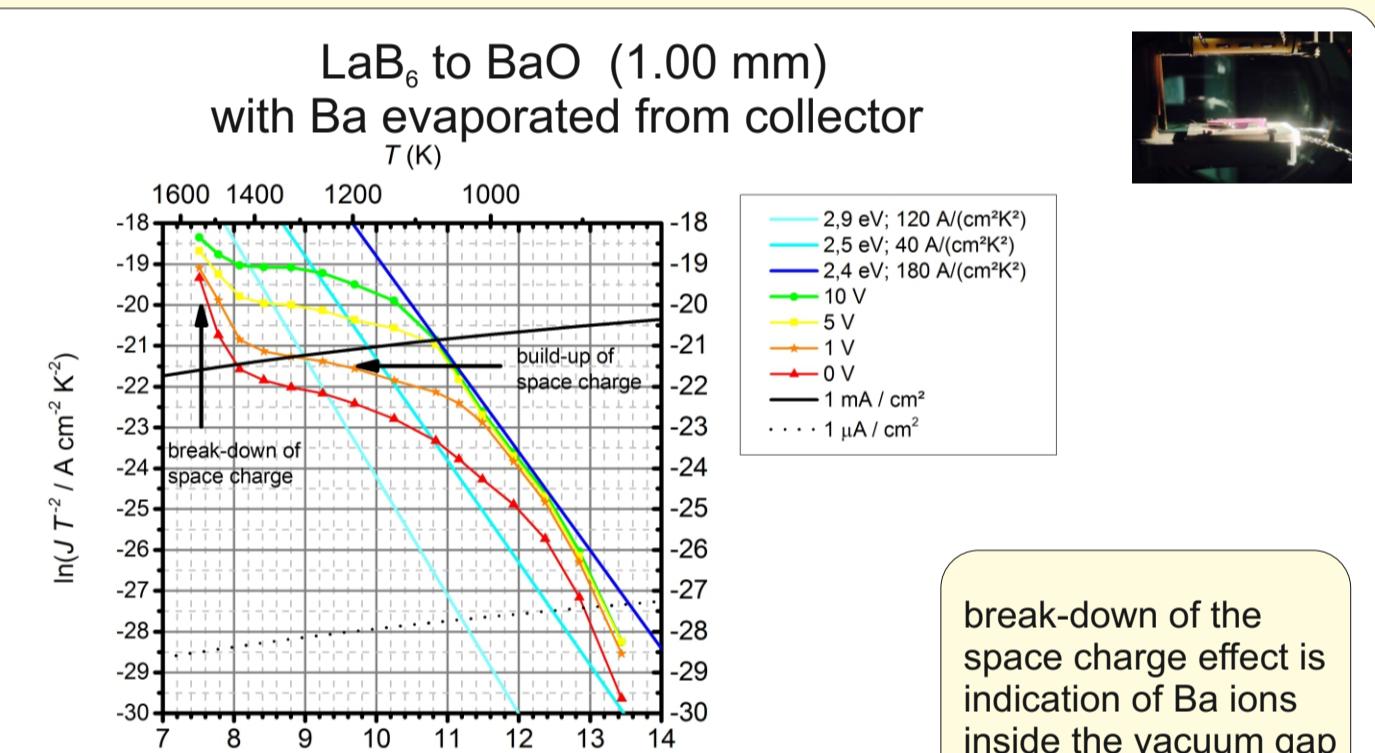
LaB<sub>6</sub> to BaO (1.00 mm)



LaB<sub>6</sub> to LaB<sub>6</sub> (0.25 mm)

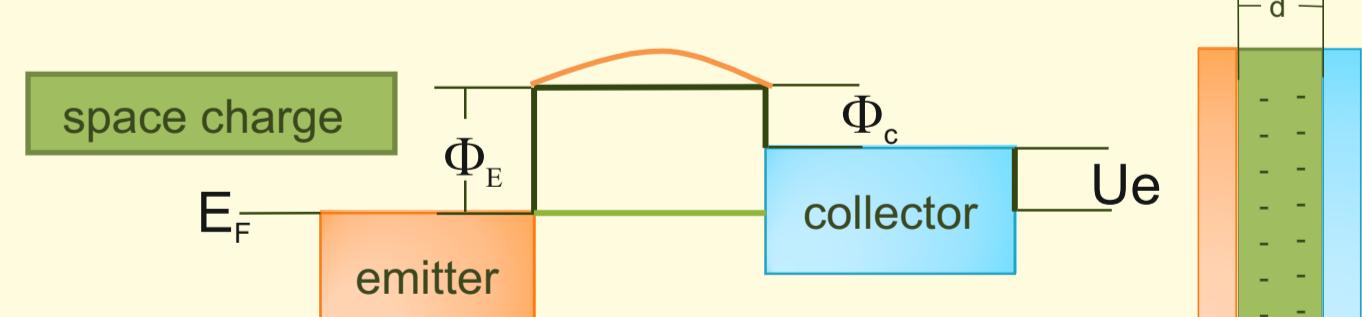


LaB<sub>6</sub> to BaO (1.00 mm)  
with Ba evaporated from collector



Simple Model

(estimation of the space charge effect)



- the electrons stay for a time  $t$  between emitter and collector  
( $t = 5 \text{ ns}$  at 1500 K for  $d = 1 \text{ mm}$ )

$$d\varphi = \frac{\sigma_{2D}}{2\varepsilon_0 d} |x| dx$$

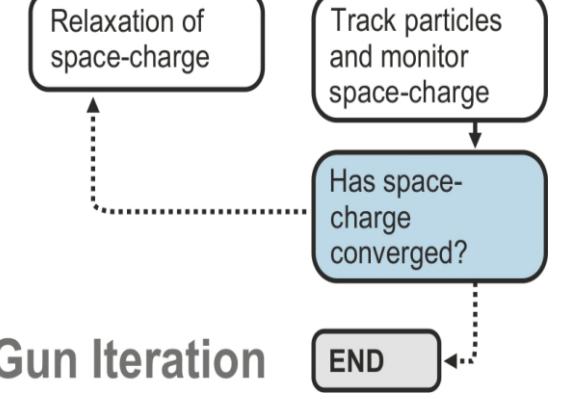
$$\Rightarrow \varphi_M - \varphi_R = \frac{\sigma_{2D}}{8\varepsilon_0 d}$$

CST-Simulations

simulation work-flow

applied solvers

- stationary current solver
- electrostatics fields solver
- magnetostatics fields solver
- thermal solver
- particle tracking solver



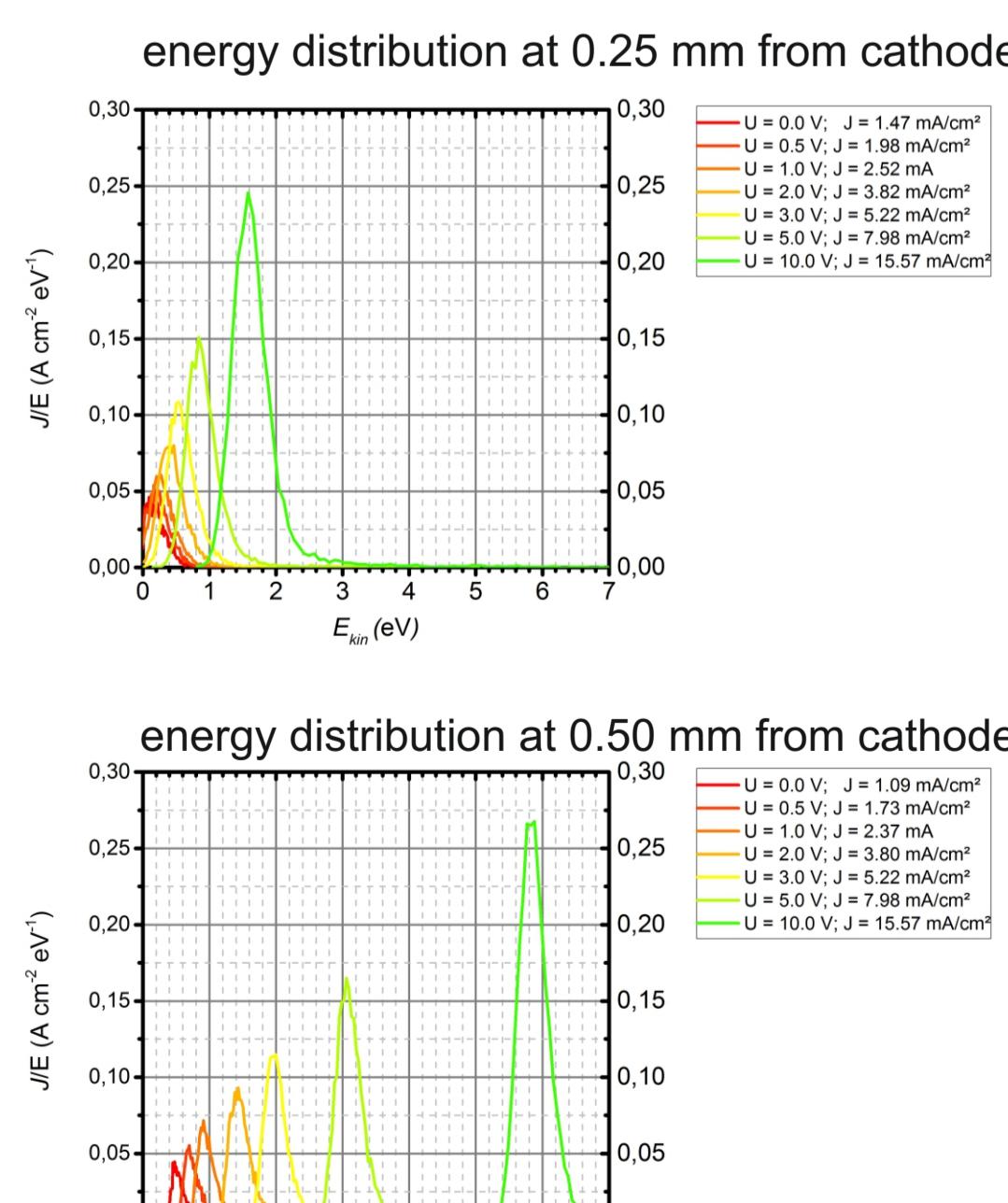
CST-simulation of the influence of the magnetic field caused by the heater



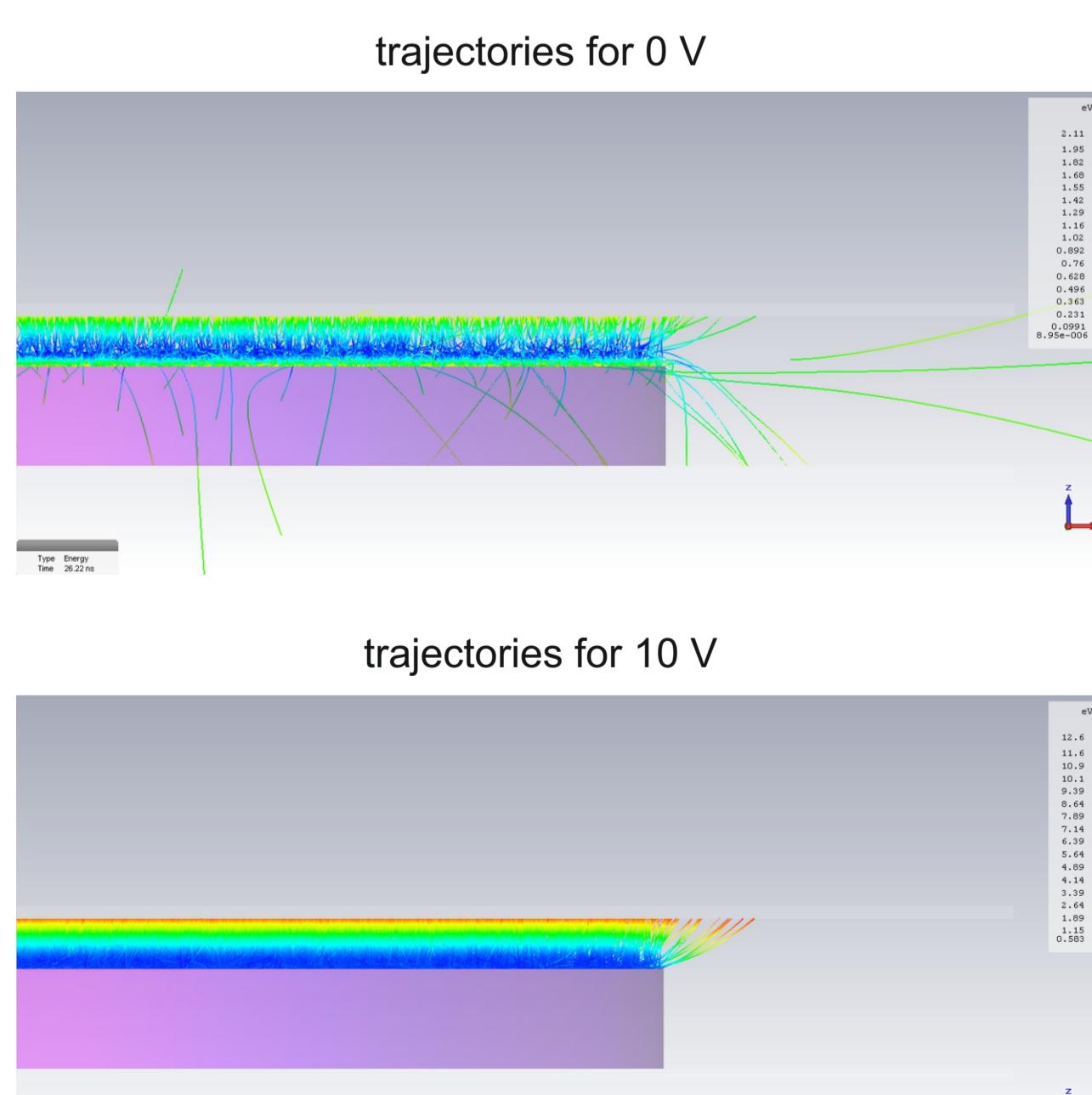
CST-simulation of the influence of the sample geometry



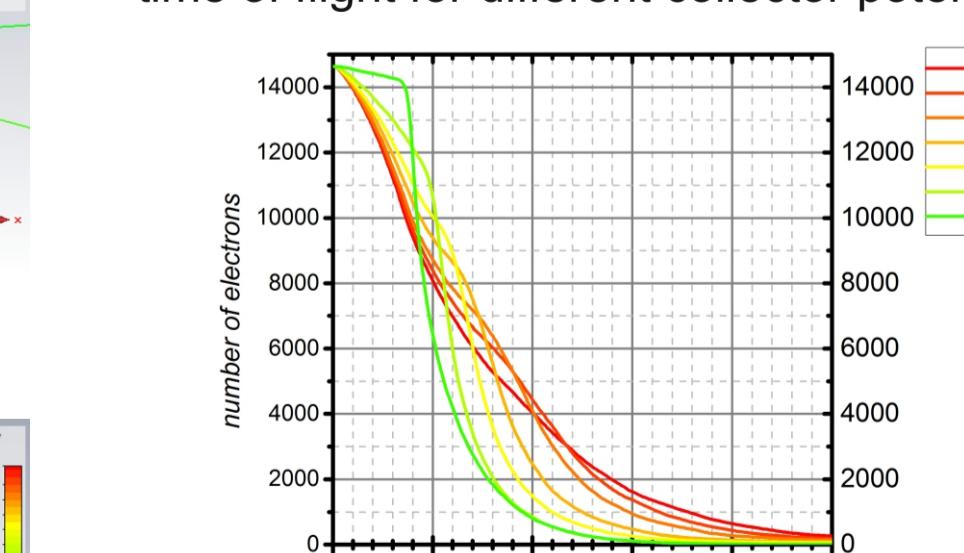
energy distribution at 0.25 mm from cathode



trajectories for 0 V



time of flight for different collector potentials



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