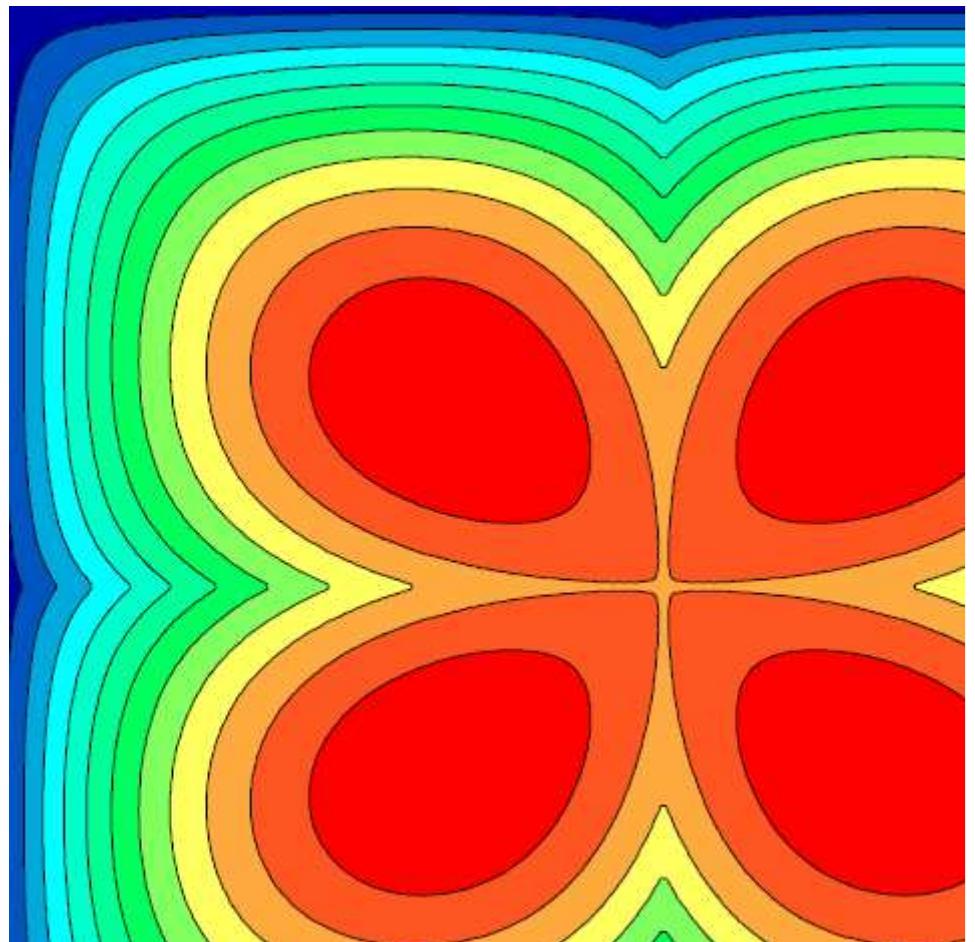


EDET thermal simulations

Munich, 30.4.2014

Contents:

- Single die simulations
 - Plain pane
 - Cross support
 - Cross support thick substrate
- Focal plane assembly (4 dies)

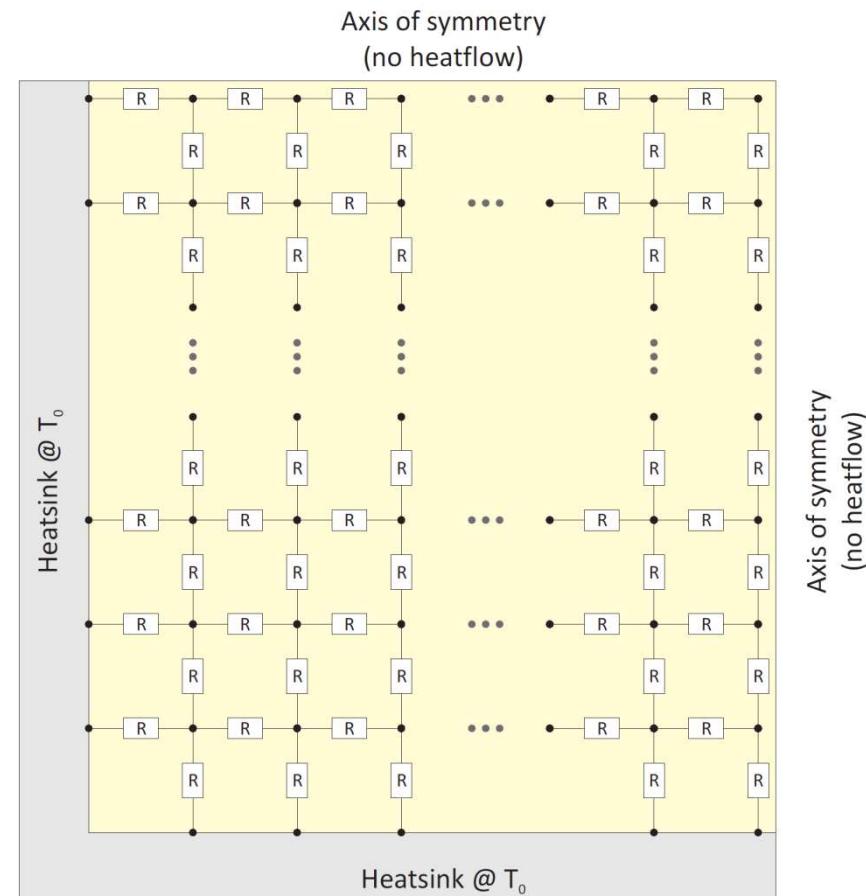


Simulation: Plain pane

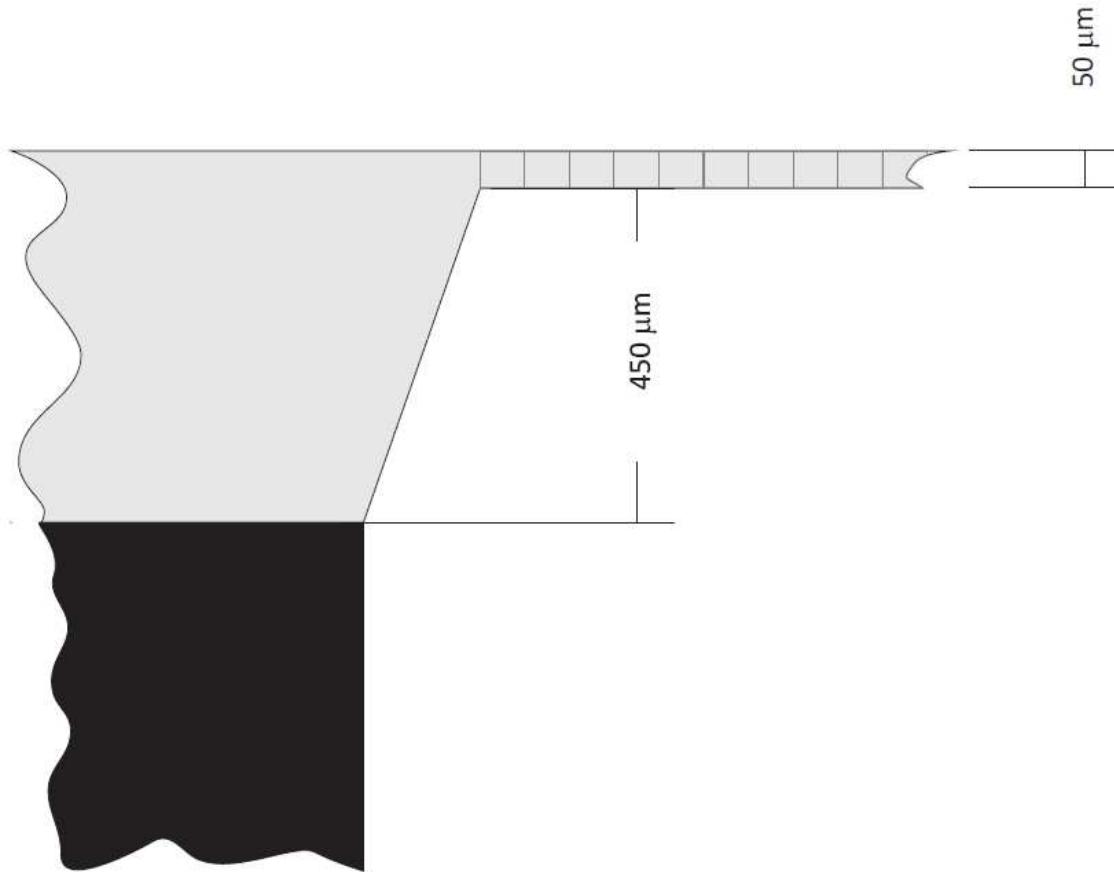
Study temperature gradient on single die

Method:

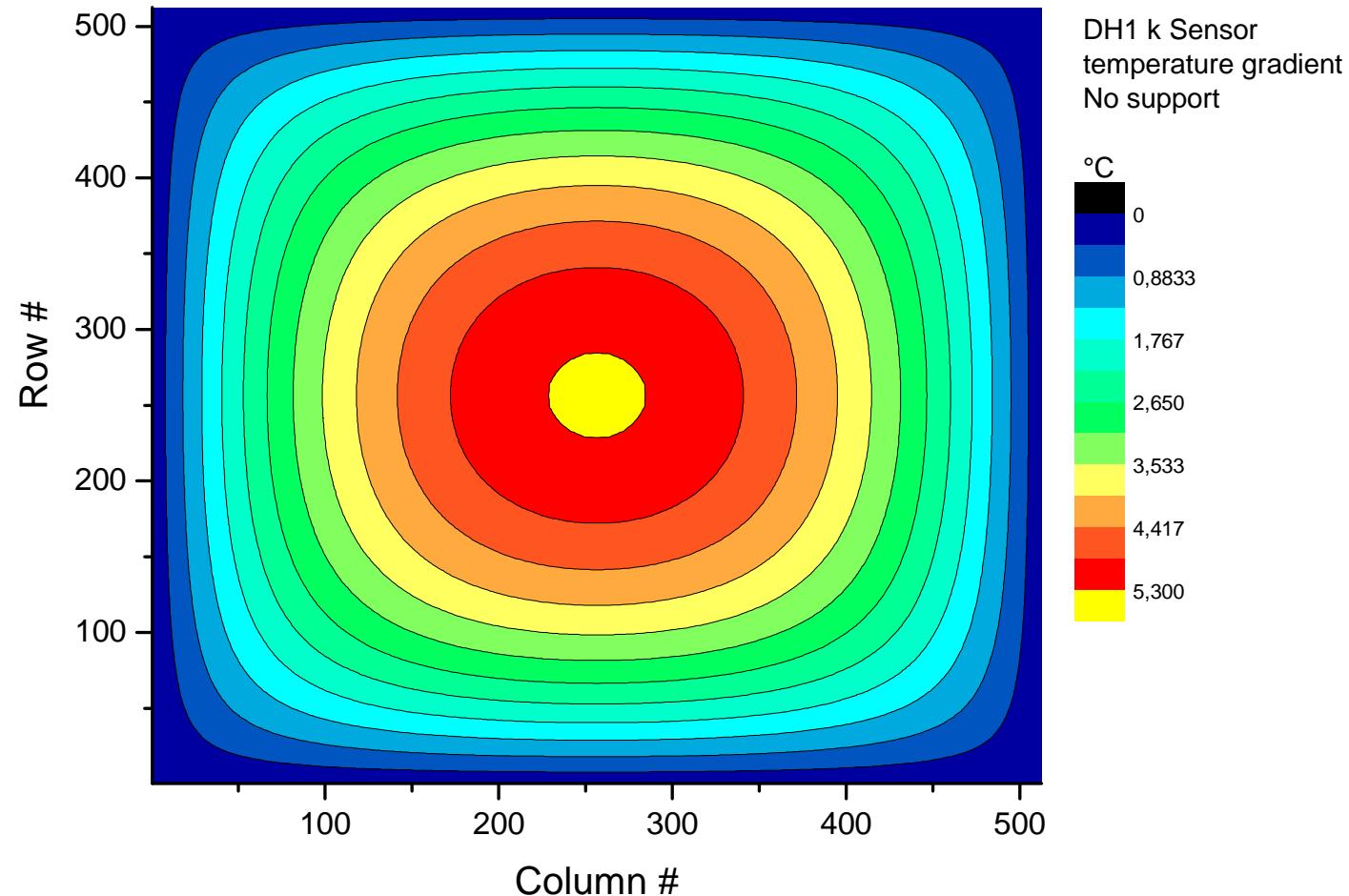
- Simulation of one quadrant of one die
- Network of thermal resistors
- Assuming rigid coupling to heatsink on lower and left edge
- Assuming symmetric conditions at top and right edge
- Baseline design DH1K (DH80K):
 - 512×512 pixels of $60 \times 60 \mu\text{m}^2$
 - 2 (4) fold readout
 - 0.5 mW of power consumption per pixel (100 μA @ 5 V)
- DH1K and DH80K of course have different timing



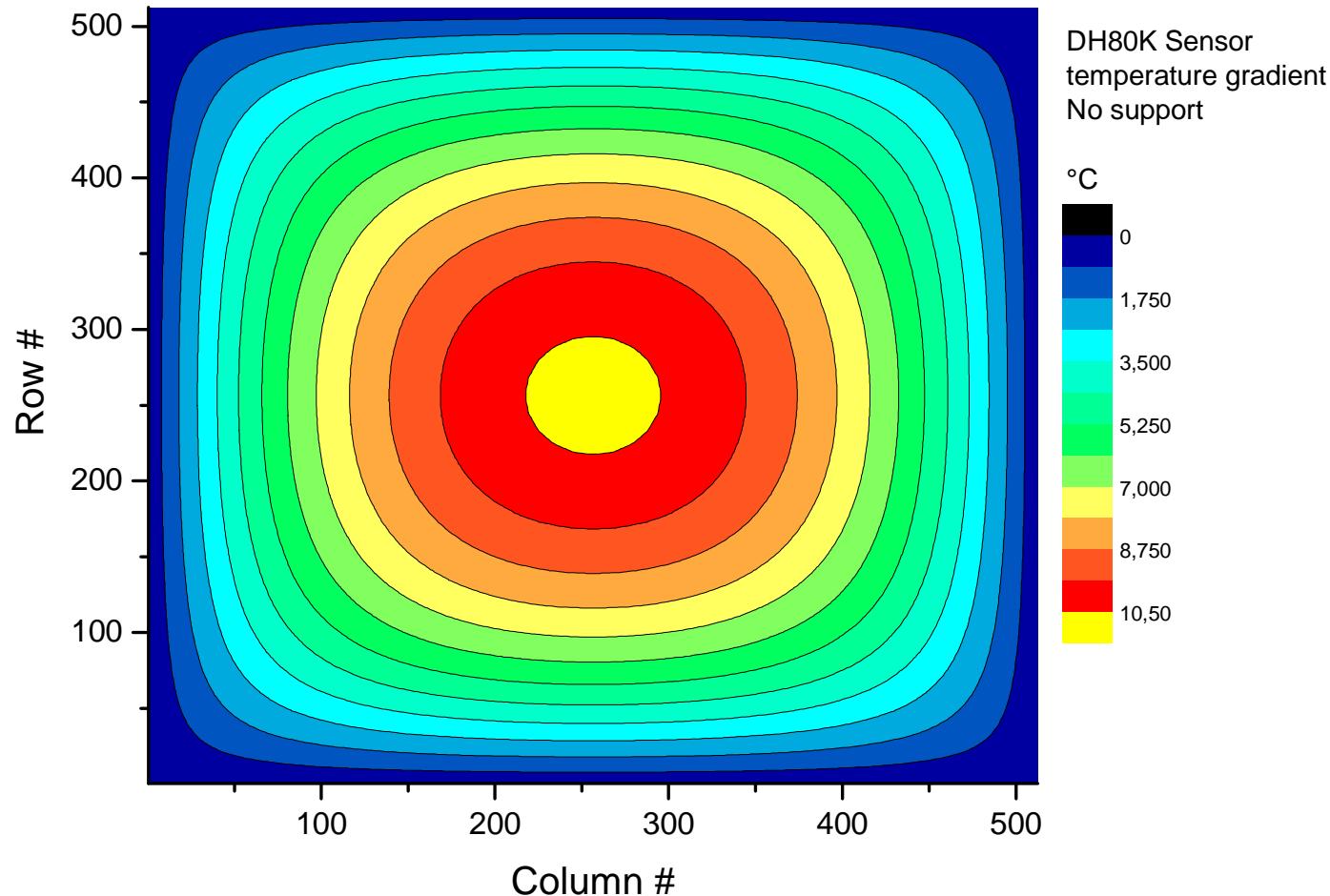
No support



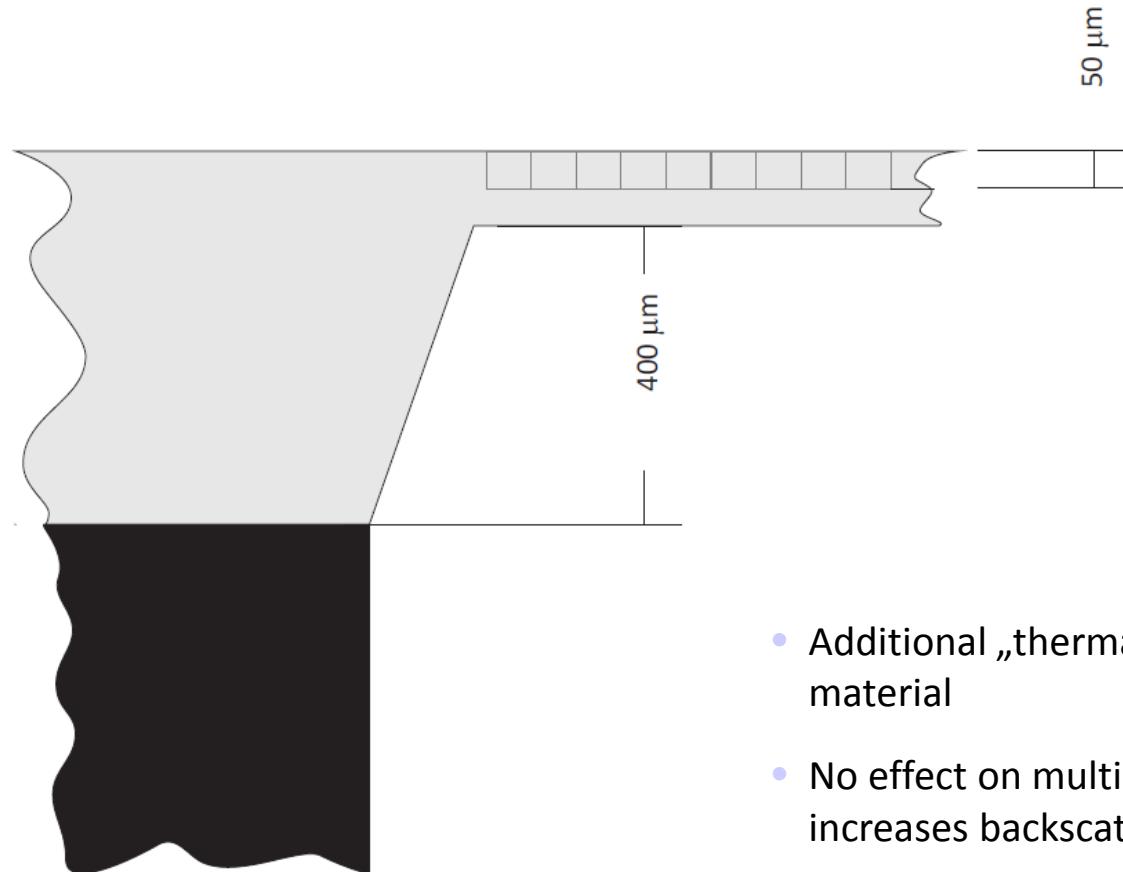
DH1K thermal profile



DH80K thermal profile

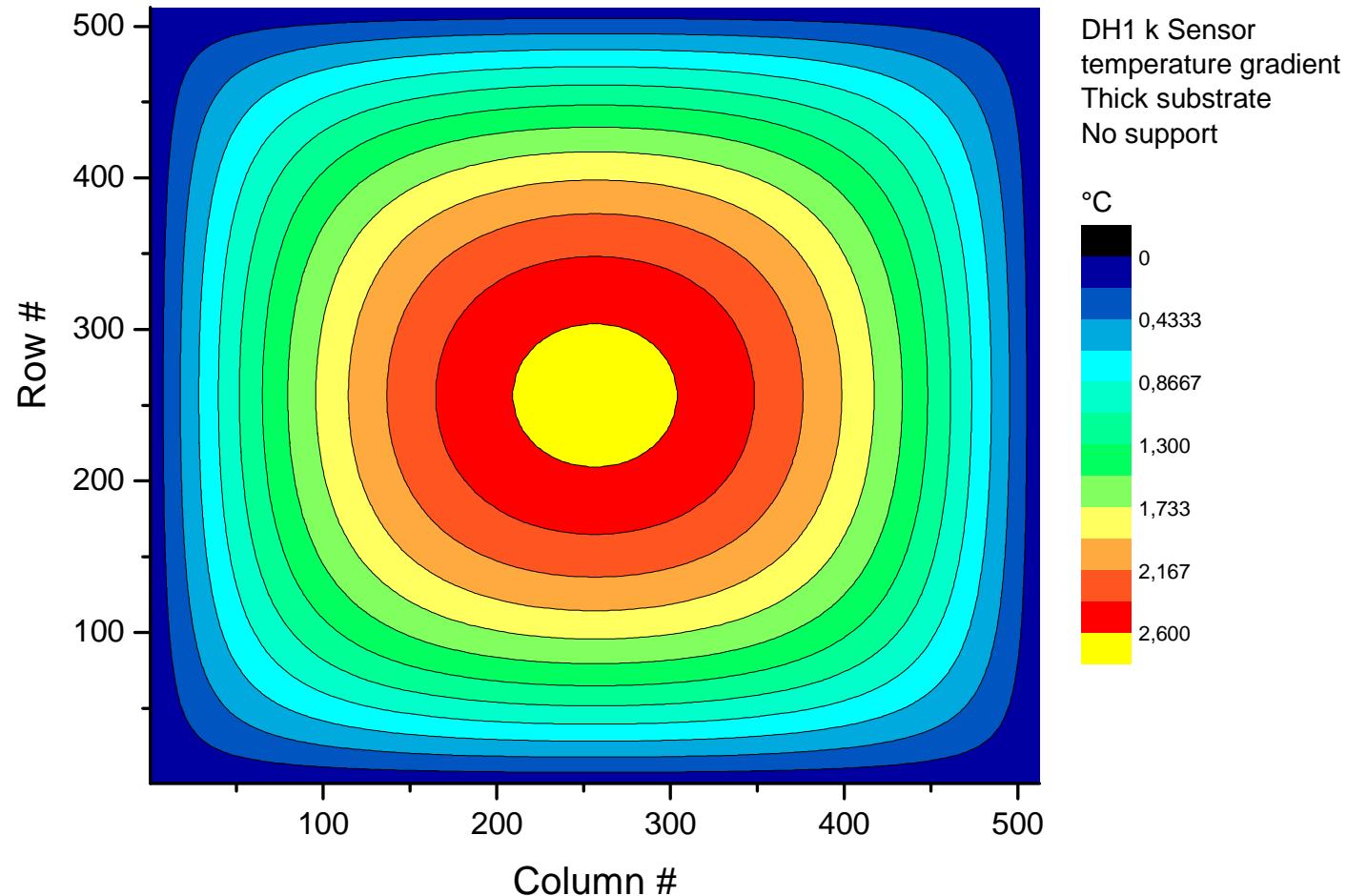


No support w/ thick substrate

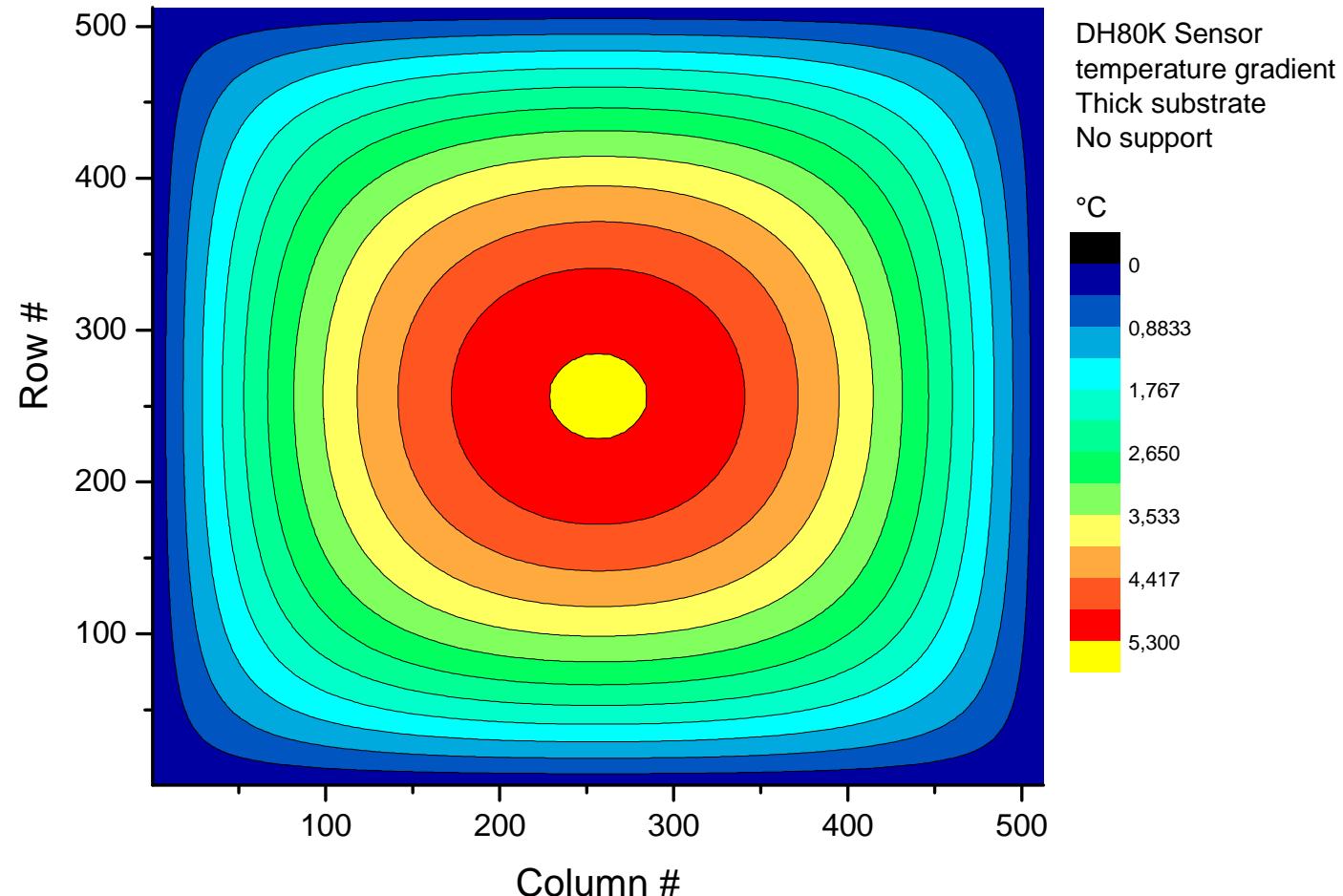


- Additional „thermal layer“ of dead material
- No effect on multiple scattering, but increases backscattering

DH1K thermal profile



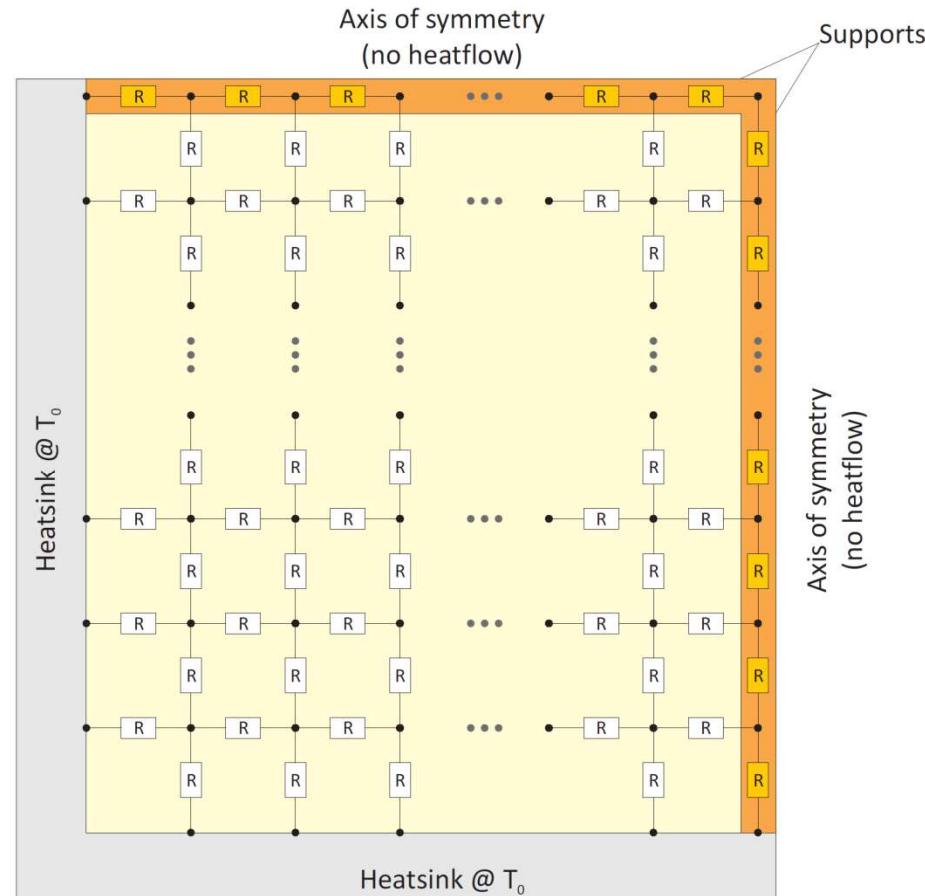
DH80K thermal profile



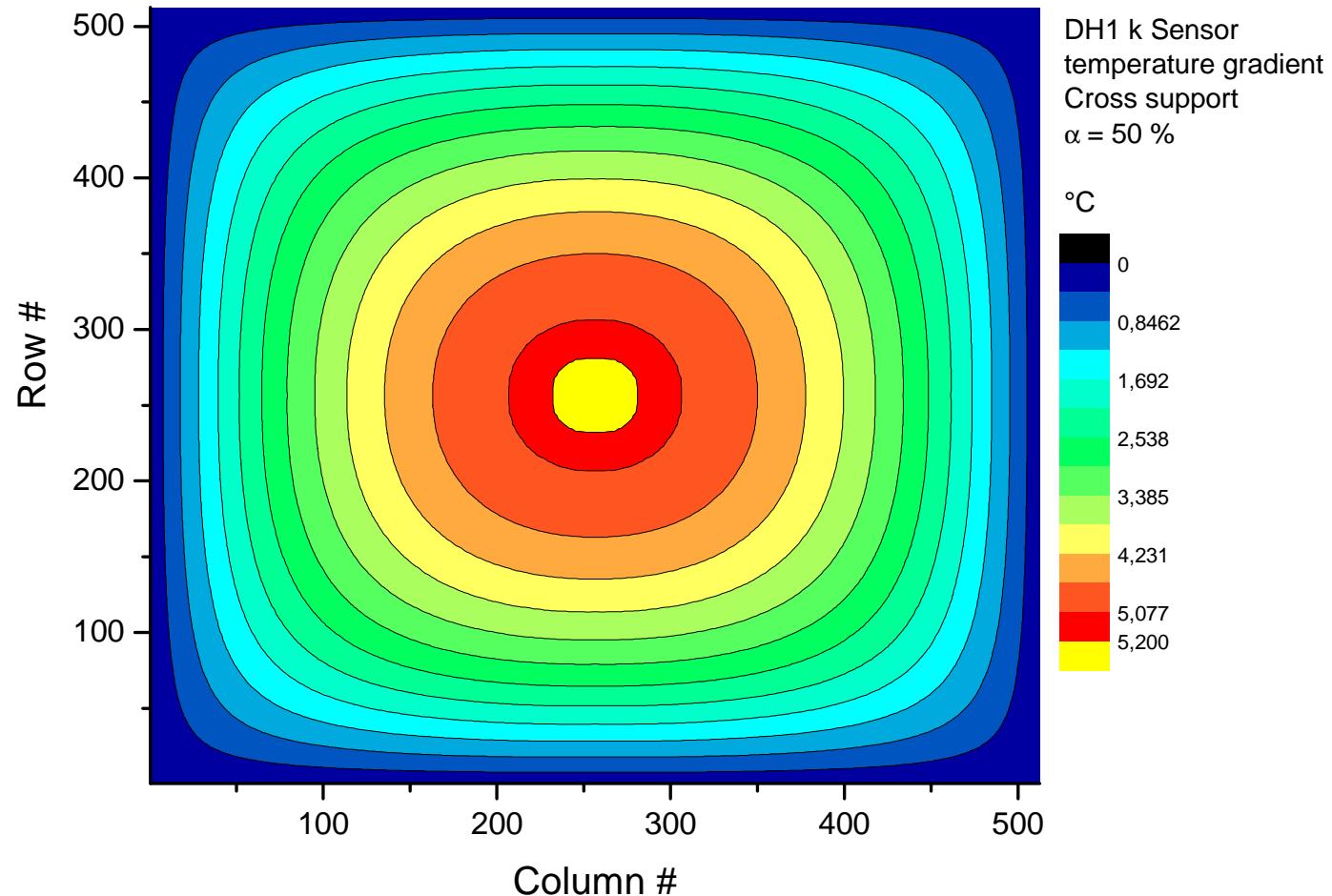
Simulation: Minimal support

Method:

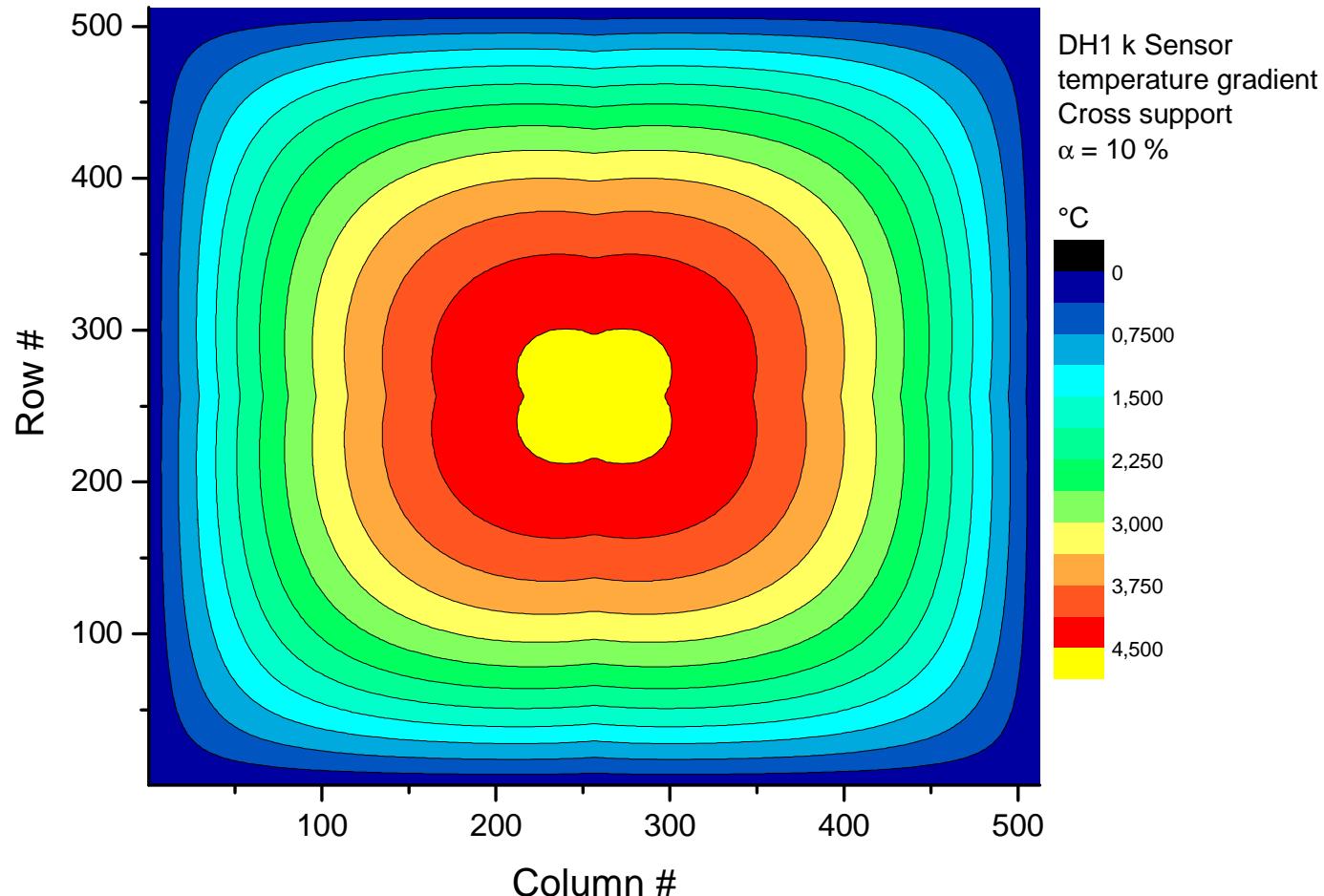
- Simulation of one quadrant only
- Simulation of supports by modifying thermal coupling at the top and right edges of the die
- Supports in the middle of detector dies
- Still assuming rigid coupling to heatsink on lower and left edge
- Ratio of „normal“ thermal resistance to modified thermal resistance is used as parameter α



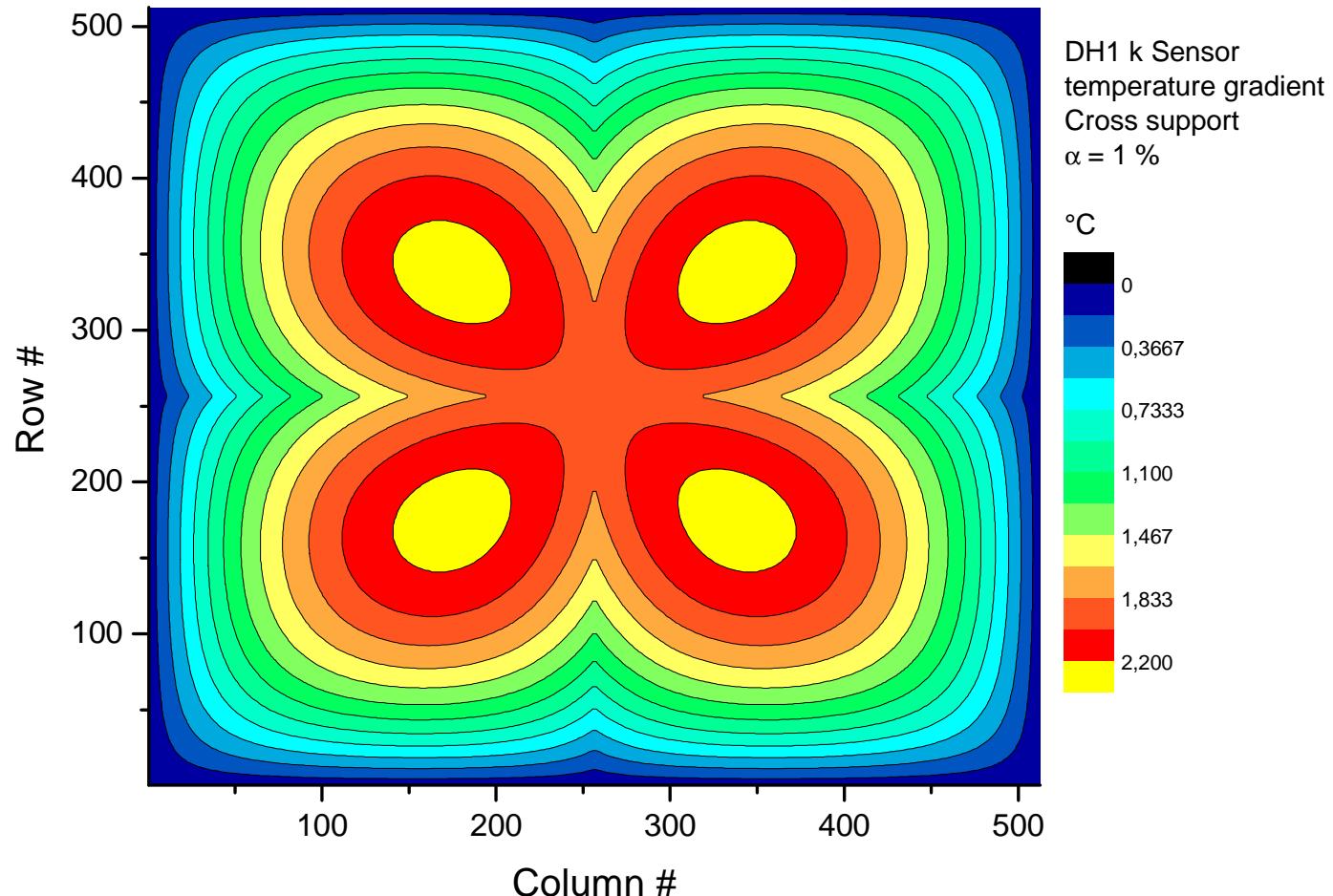
Examples



Examples



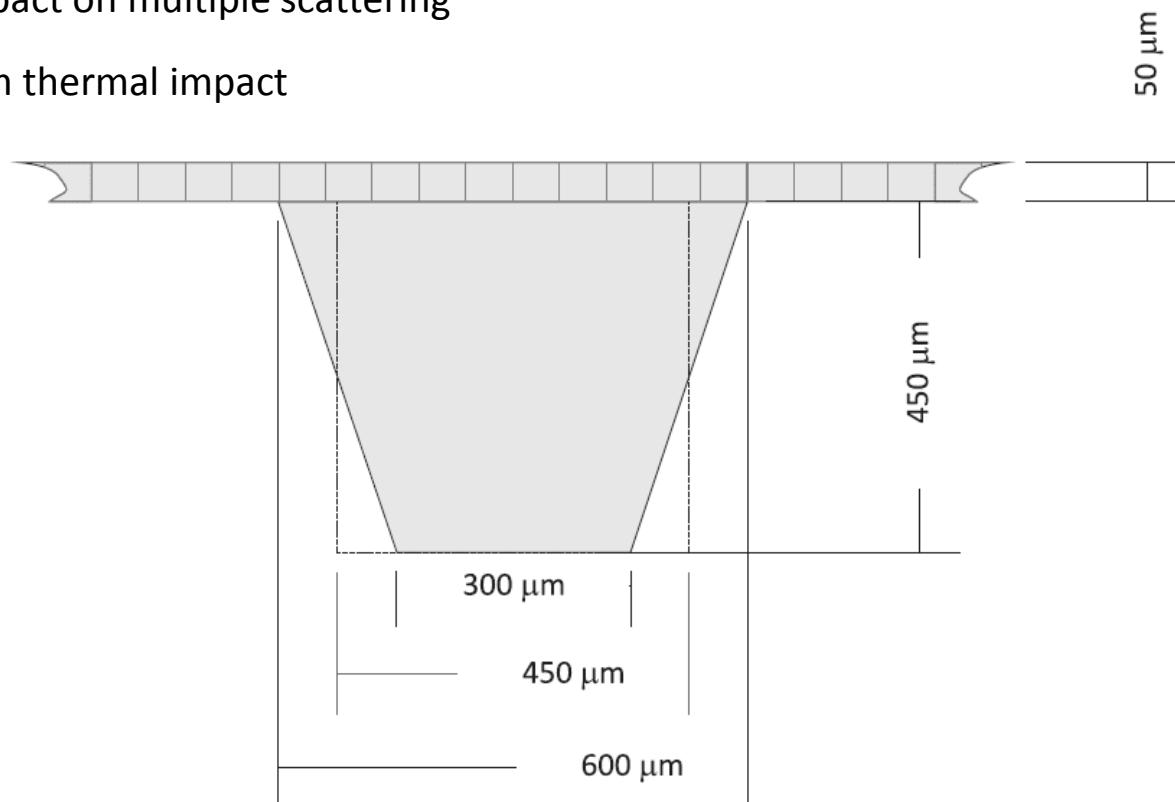
Examples



Minimal support

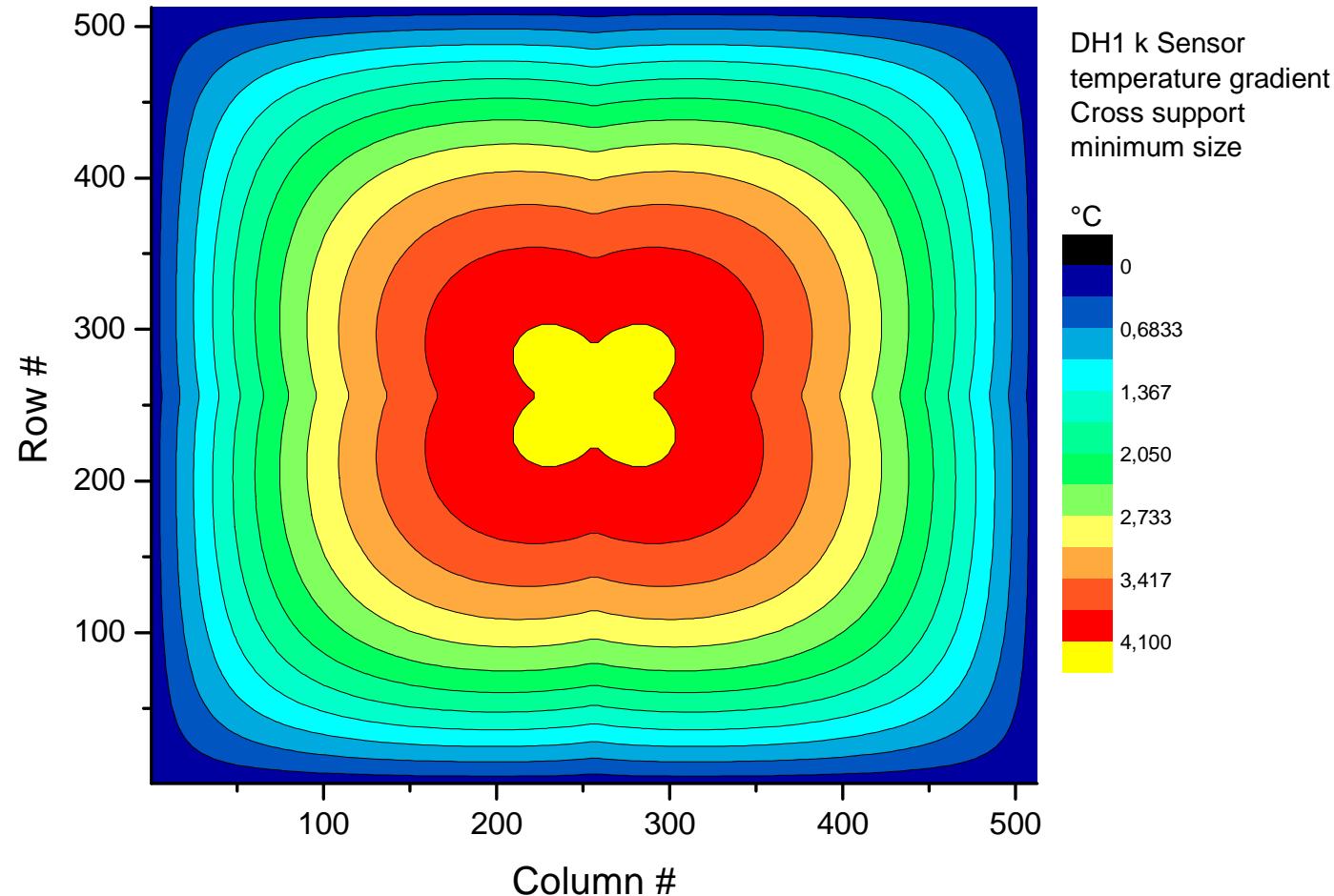
What is a practicable value for α ?

- Little impact on multiple scattering
- Optimum thermal impact

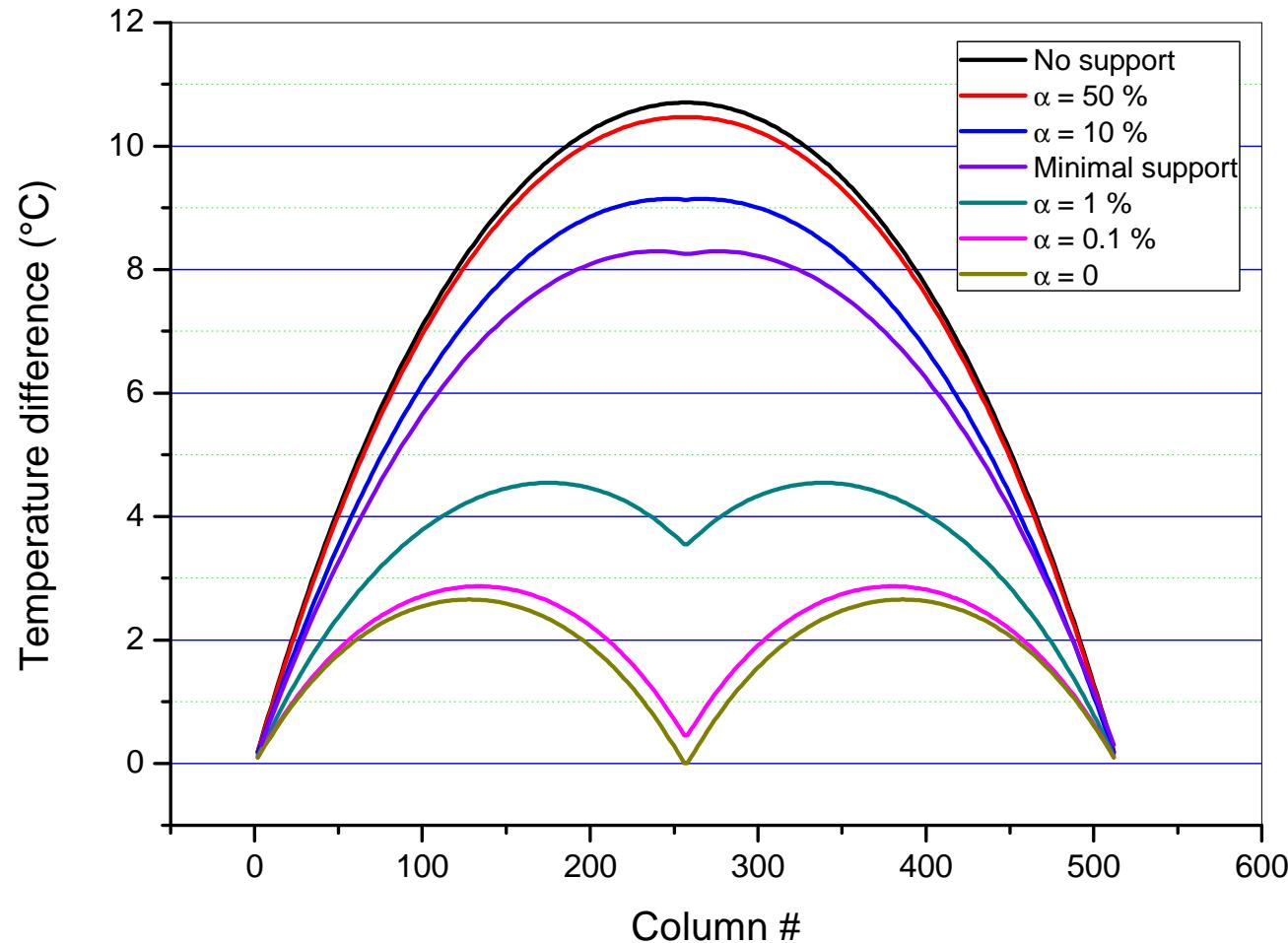


- Effective $\alpha = 8 \%$

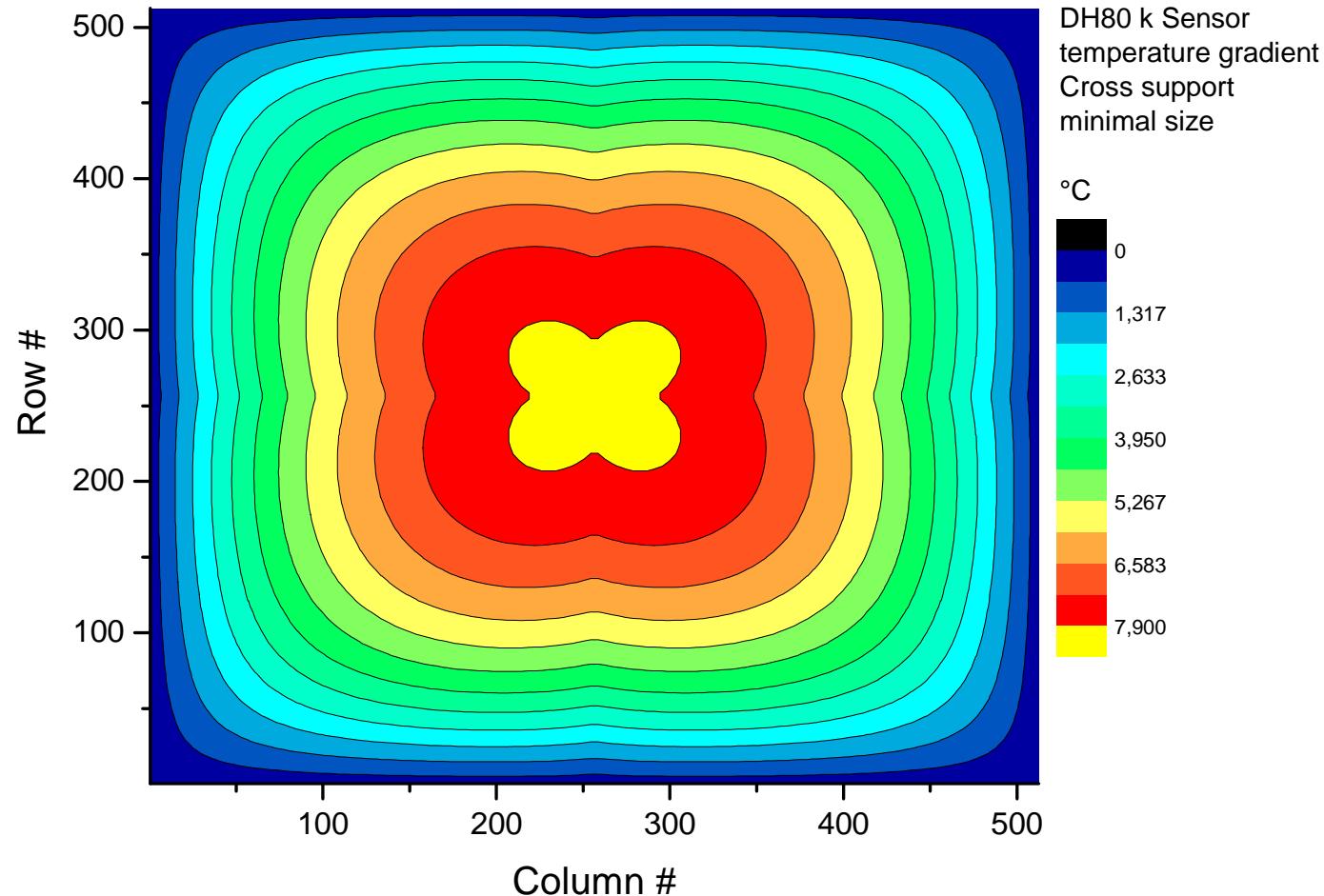
DH1K thermal profile



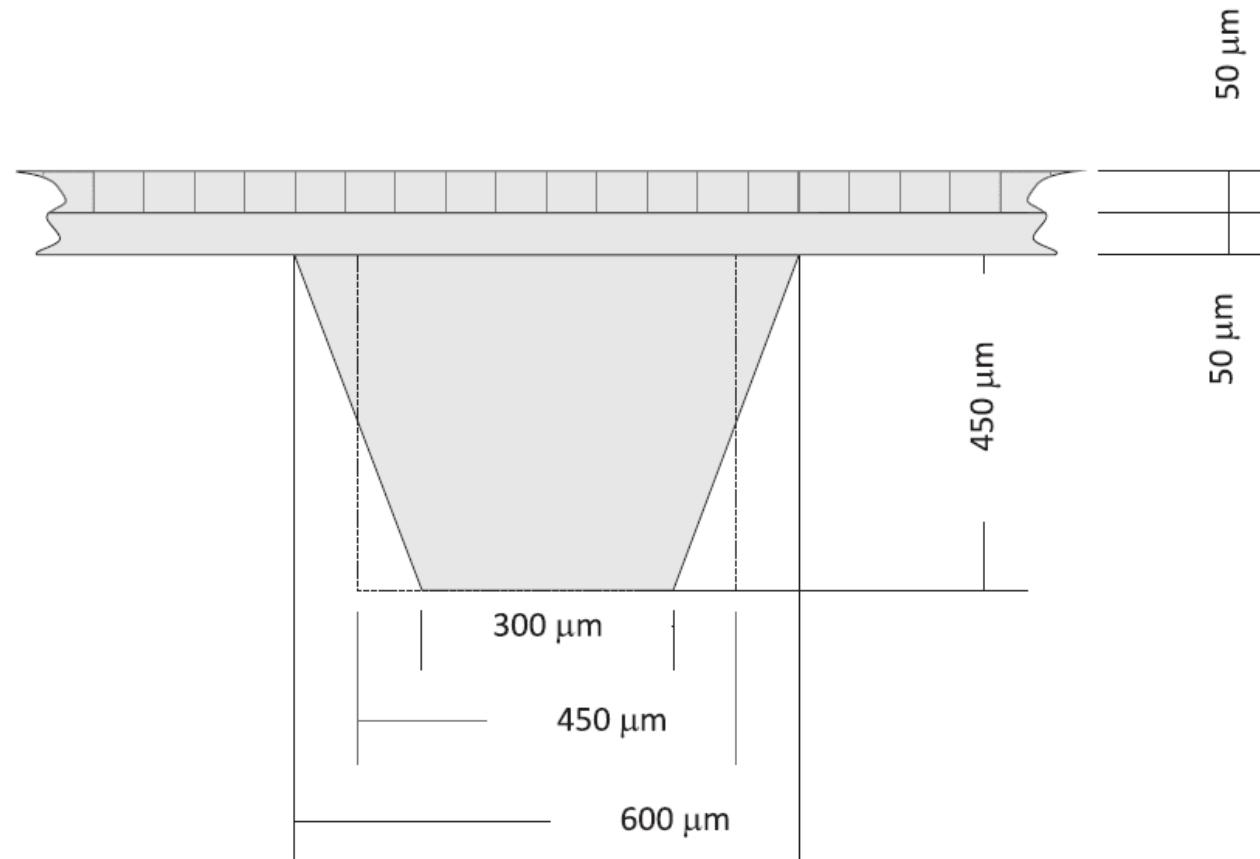
Comparison



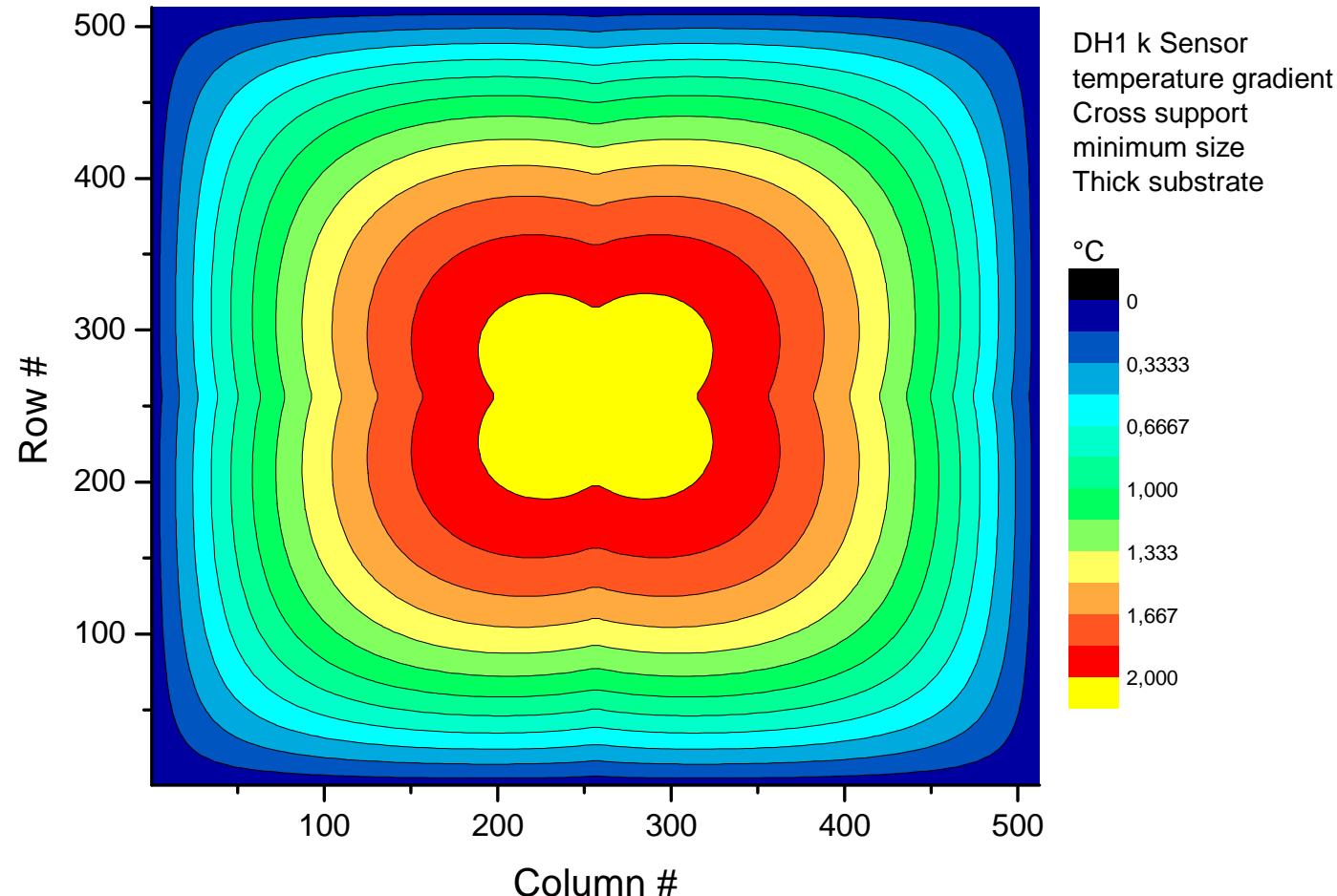
DH80K thermal profile



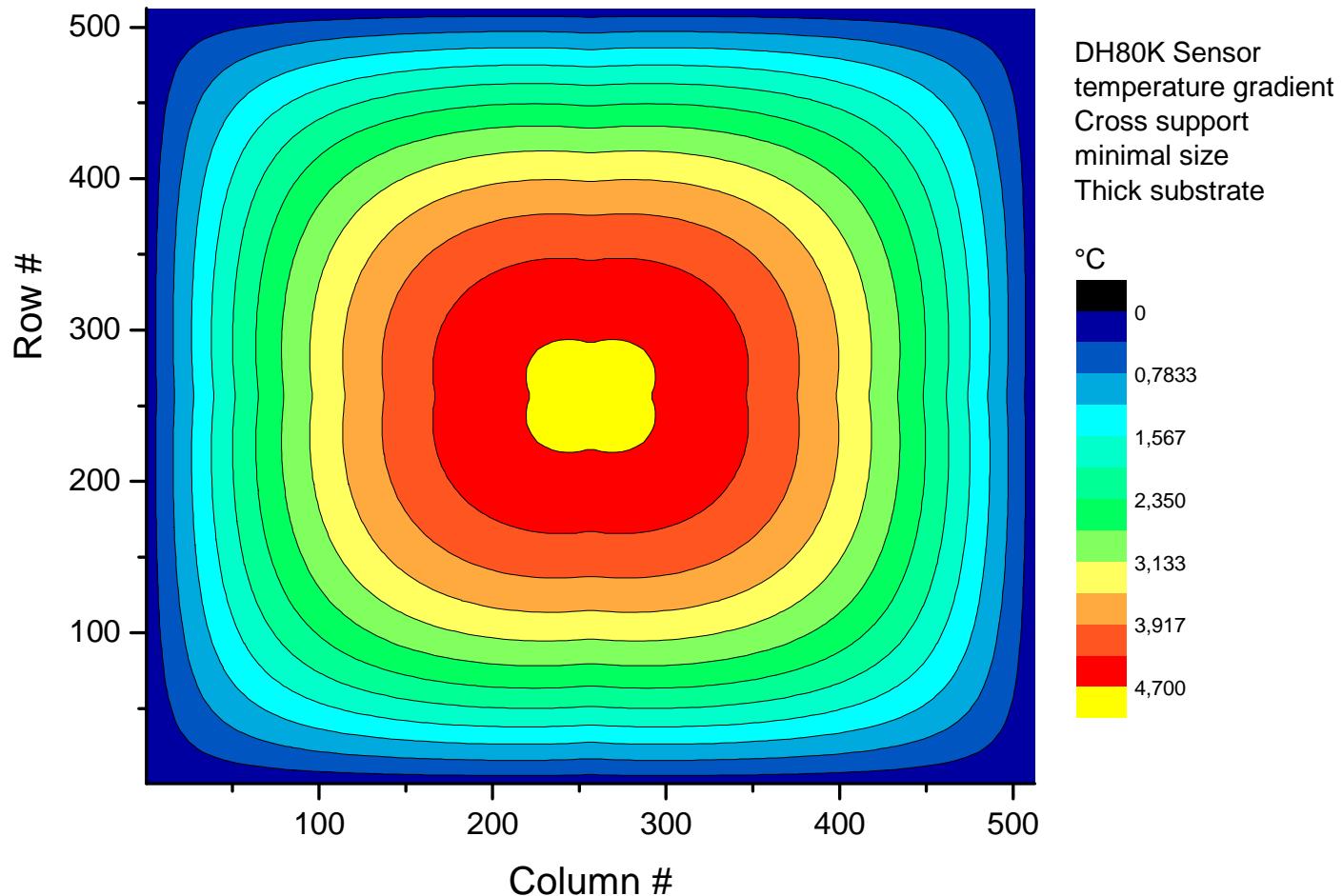
Minimal support w/ thick substrate



DH1K thermal profile



DH80K thick substrate



Summary (single dies)



Conclusion:

- Provided that the operation temperature can be chosen low enough (e.g. -20°C), the temperature gradients on the sensors can be accommodated for the assumed baseline values (0.5 mA 7 pixel)
- Impact of temperature gradient wrt. resolution in the presence of radiation damage will be studied
- Cross support is ineffective from thermal point of view, can be omitted if not needed for sake of stability
- Thick substrate is more effective, but how large is impact of backscattering on instrument resolution?

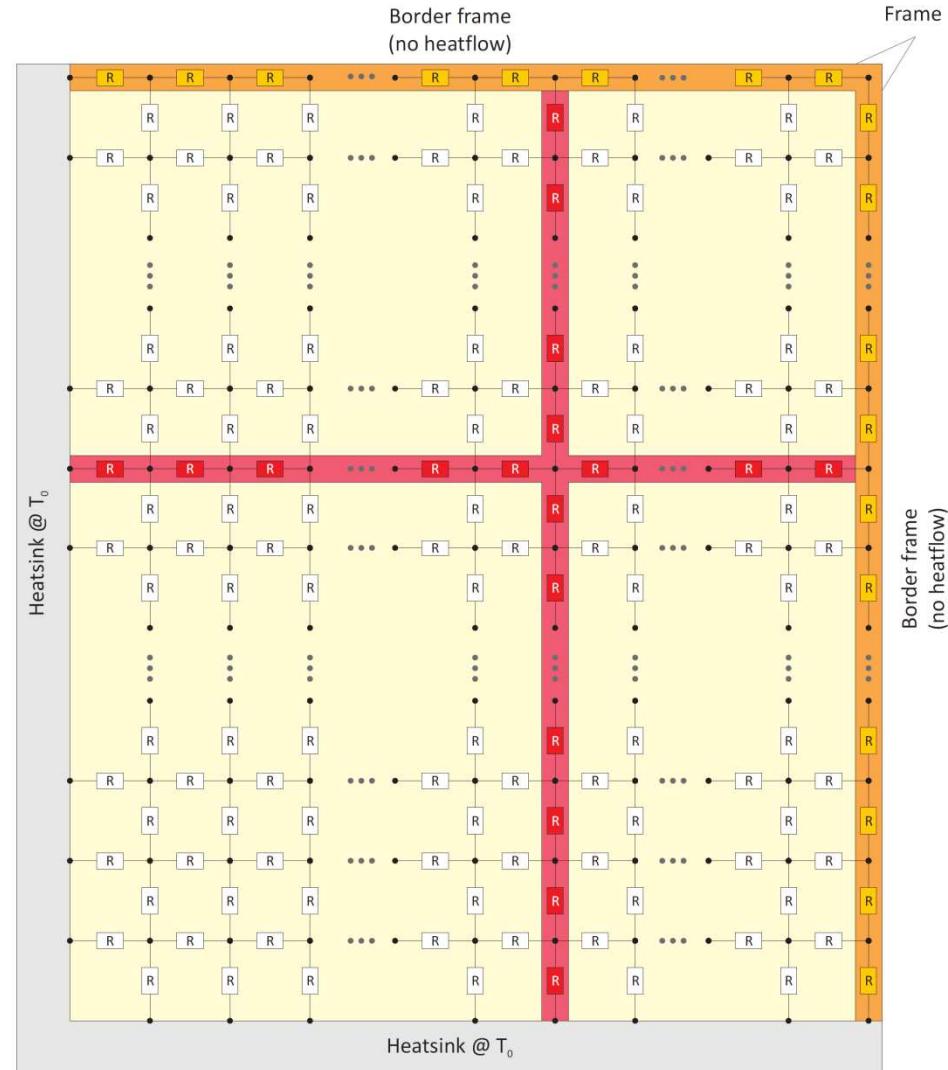
	DH1K (°C)	DH80K (°C)
Plain pane	5.4	10.8
Thick substrate	2.7	5.4
Cross support	4.1	8.2
Thick substrate & cross support	2.3	4.8

Simulation

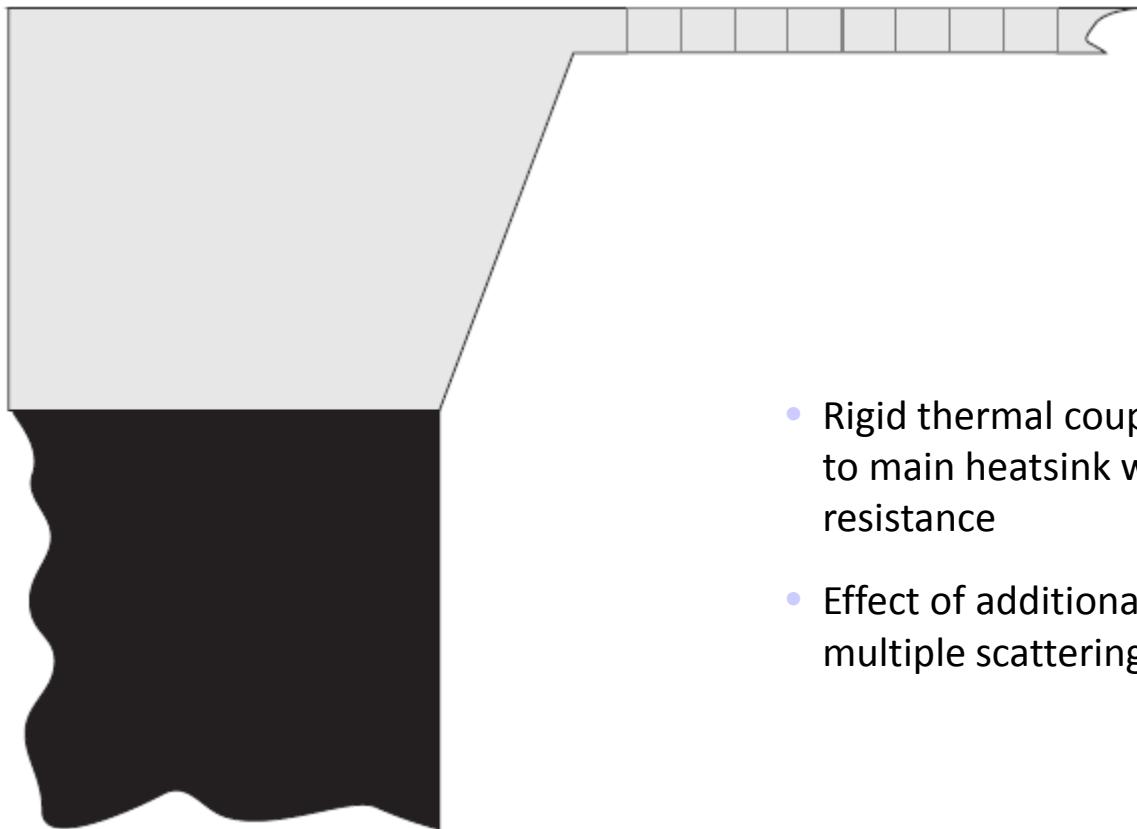
Study temperature gradient on FPA

Method:

- Simulation of entire die with passive support
- Still assuming rigid coupling to heatsink on lower and left edge
- „Softer“ coupling of upper and right edges
- Ratio of „normal“ thermal resistance to modified thermal resistance at the supports is used as parameter α
- Ratio of „normal“ thermal resistance to modified thermal resistance at the frame is used as parameter β

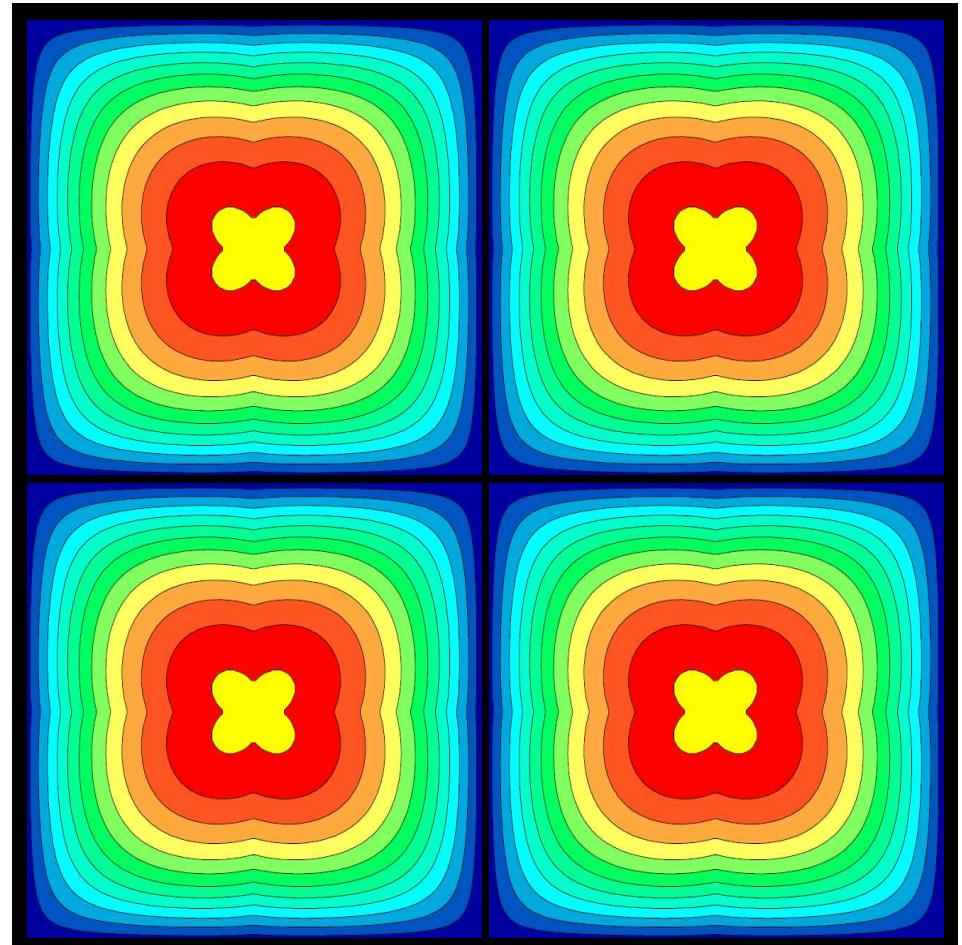


Best case

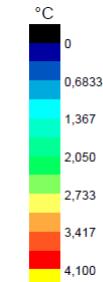


- Rigid thermal coupling of narrow rim to main heatsink w/ near zero thermal resistance
- Effect of additional material to multiple scattering?

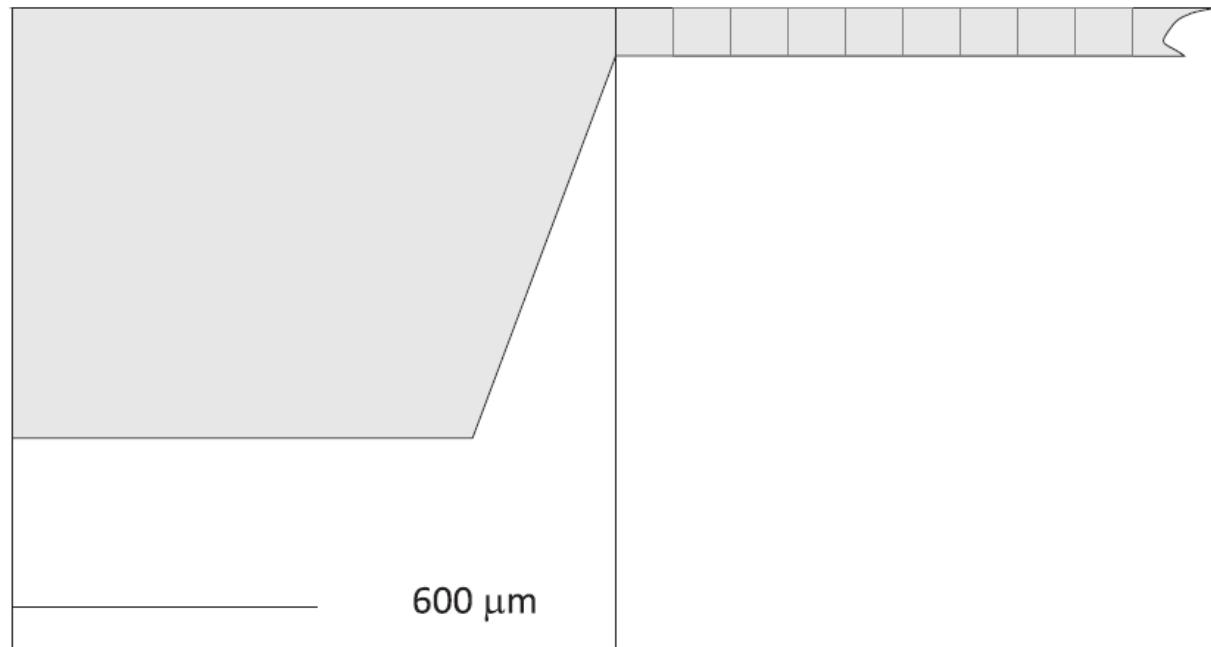
Temperature profile full FPA



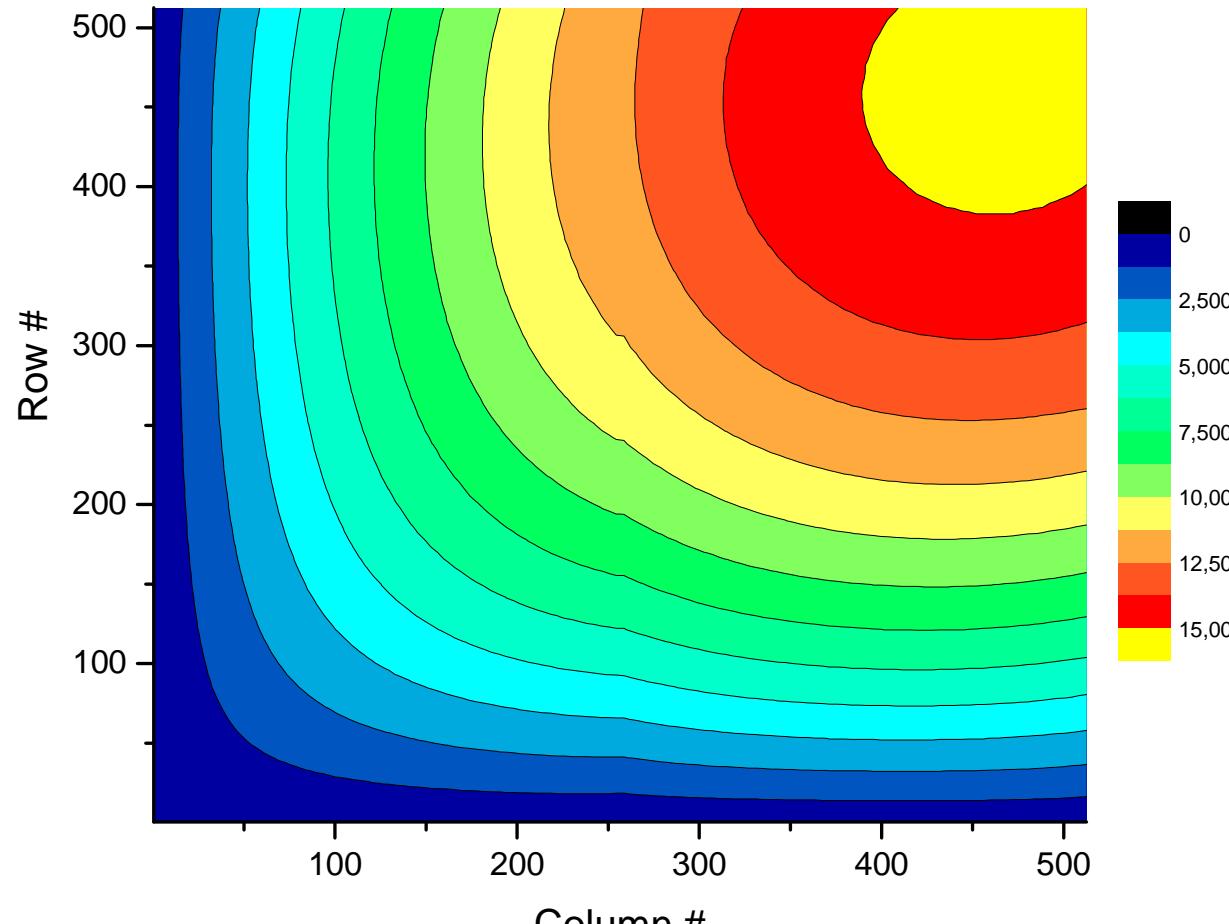
DH1 K Sensor
temperature gradient
Cross support
minimum size



Worst case

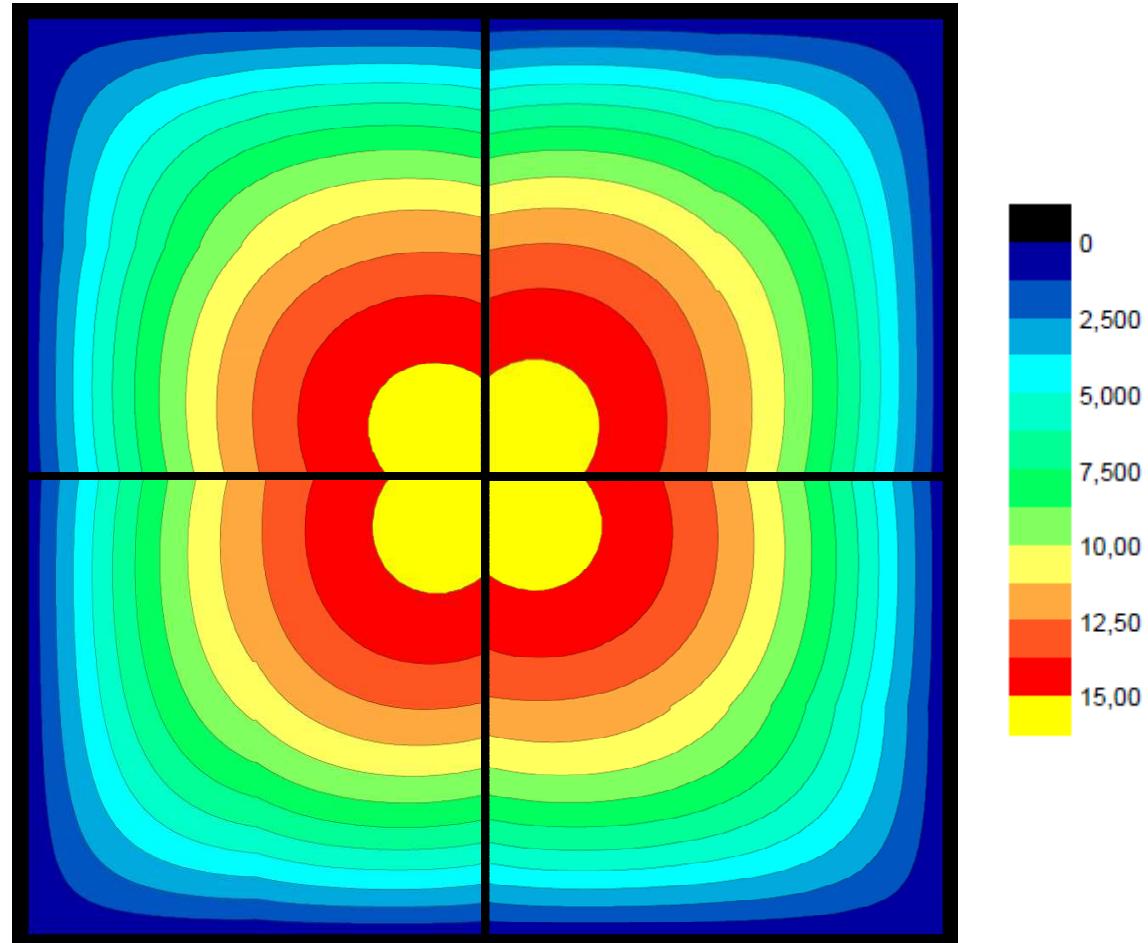


Temperature profile full FPA



Preliminary!

Temperature profile full FPA



Preliminary!

Conclusion



Sensor quadrant support and heatsink interface:

- Thermal coupling at sensor rim has big impact on overall thermal gradient
- How much material can be provided below for heatsink between quadrants?
- Impact on overall FPA system design
- Impact on sensitivity gap
- Will be studied more in detail
- Input concerning constraints is required!