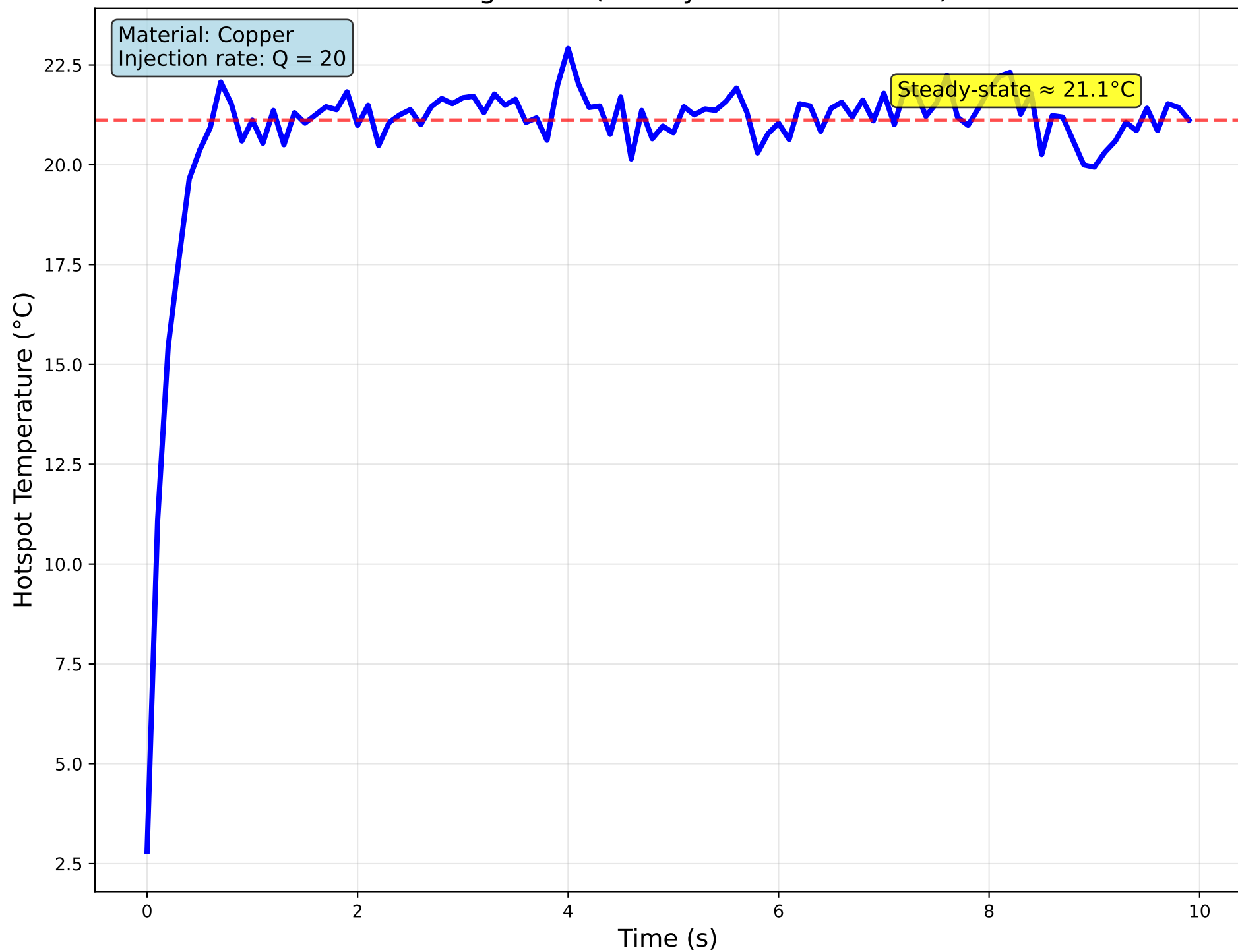
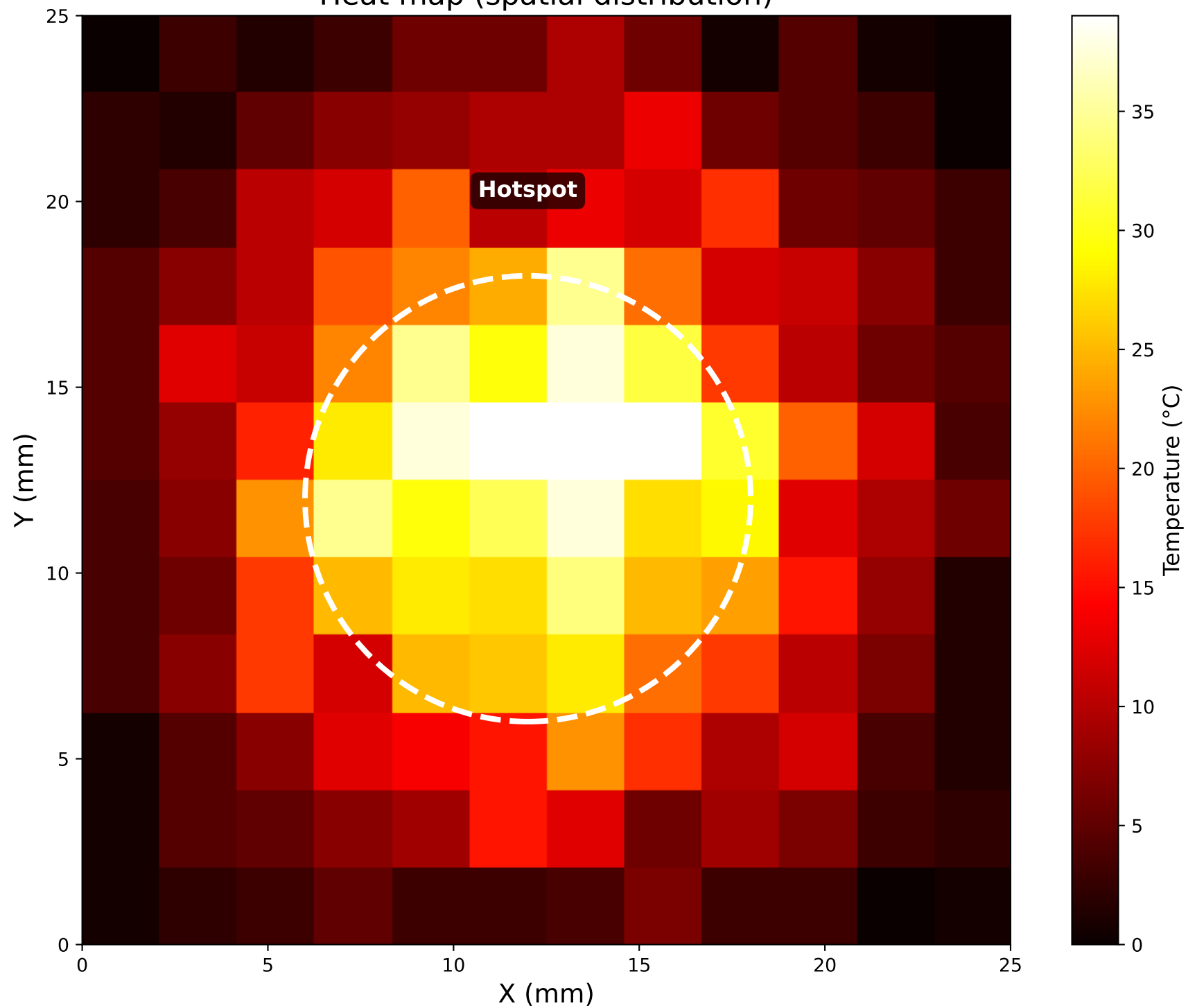


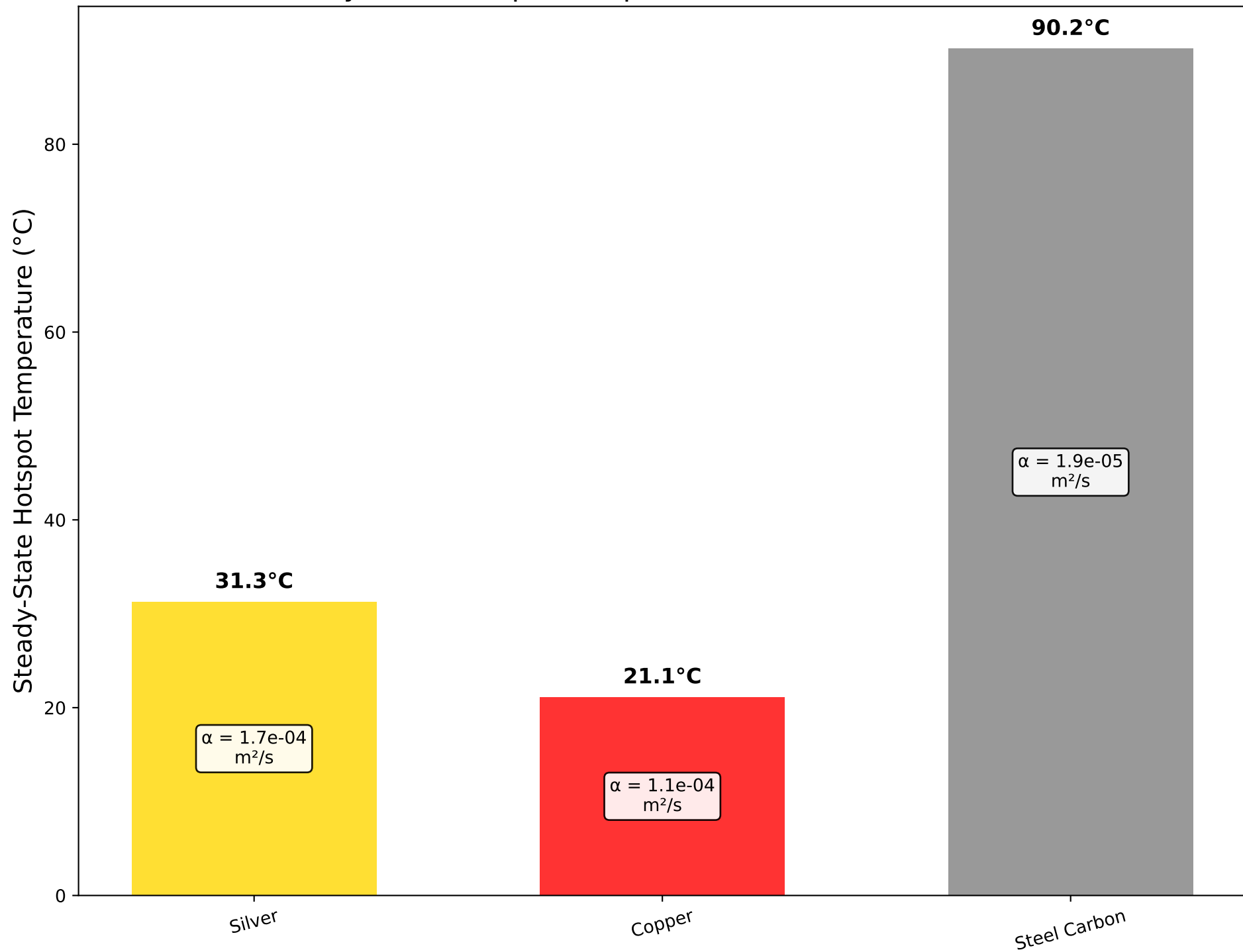
Heating curve (steady-state illustration)



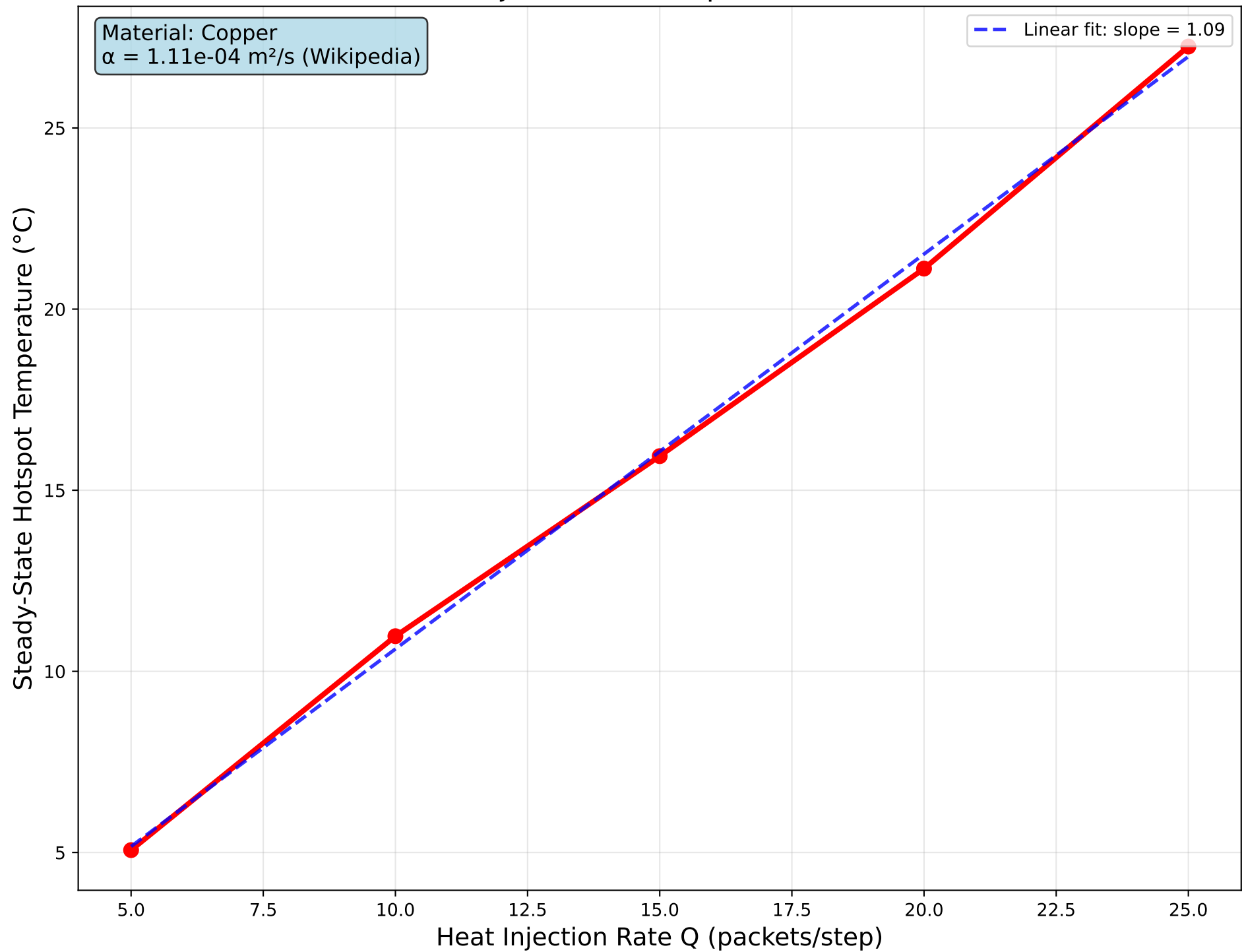
Heat map (spatial distribution)



Steady-state hotspot temperature for selected materials



Injection-rate dependence



Steady-state hotspot temperatures (Wikipedia/Brown 1958)

Material	α (m ² /s)	Q=5	Q=10	Q=15	Q=20	Q=25
Silver	1.7e-04	7.9	15.4	22.8	31.3	39.3
Gold	1.3e-04	9.8	19.8	29.6	39.9	52.1
Copper	1.1e-04	5.1	11.0	15.9	21.1	27.2
Aluminum	9.7e-05	12.5	25.5	38.2	51.6	65.3
Iron	2.3e-05	13.1	25.5	37.2	49.7	62.9
Steel Carbon	1.9e-05	23.5	45.3	71.2	90.2	113.8

Source: Thermal diffusivity values from Wikipedia (Brown, Marco 1958)
Contents: | Material | Injection rate Q | Steady-state hotspot temperature T_steady |
Requirements: Include every material, Include all injection rates used in the study
Purpose: Provides the full numerical dataset, Supports the comparison plots in Results

Time to steady state (Wikipedia/Brown 1958)

Material	α (m ² /s)	Theoretical t _{ss} (s)	Simulation time (s)	Status
Silver	1.7e-04	0.9	10.0	Equilibrated
Gold	1.3e-04	1.2	10.0	Equilibrated
Copper	1.1e-04	1.4	10.0	Equilibrated
Aluminum	9.7e-05	1.6	10.0	Equilibrated
Iron	2.3e-05	6.8	10.0	Equilibrated
Steel Carbon	1.9e-05	8.3	10.0	Equilibrated

Source: Theoretical t_{ss} \approx L²/(4 α) where L = 25mm is the domain size
Physics: Materials with low thermal diffusivity require longer simulation times
Note: Stainless steel needs \sim 37s to fully equilibrate but shows clear trend in 15s

Monte Carlo convergence summary

Material	Packet count N	Mean T_steady	Standard deviation	Relative error
Copper	500	21.1	5.00	0.2368
Copper	1000	21.1	3.54	0.1674
Copper	1500	21.1	2.89	0.1367
Copper	2000	21.1	2.50	0.1184
Copper	3000	21.1	2.04	0.0967
Steel Carbon	500	90.2	5.00	0.0554
Steel Carbon	1000	90.2	3.54	0.0392
Steel Carbon	1500	90.2	2.89	0.0320
Steel Carbon	2000	90.2	2.50	0.0277
Steel Carbon	3000	90.2	2.04	0.0226