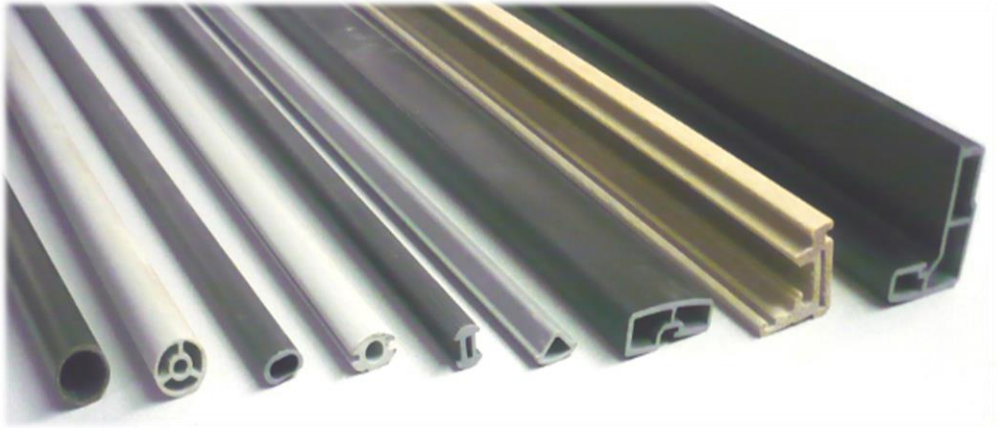
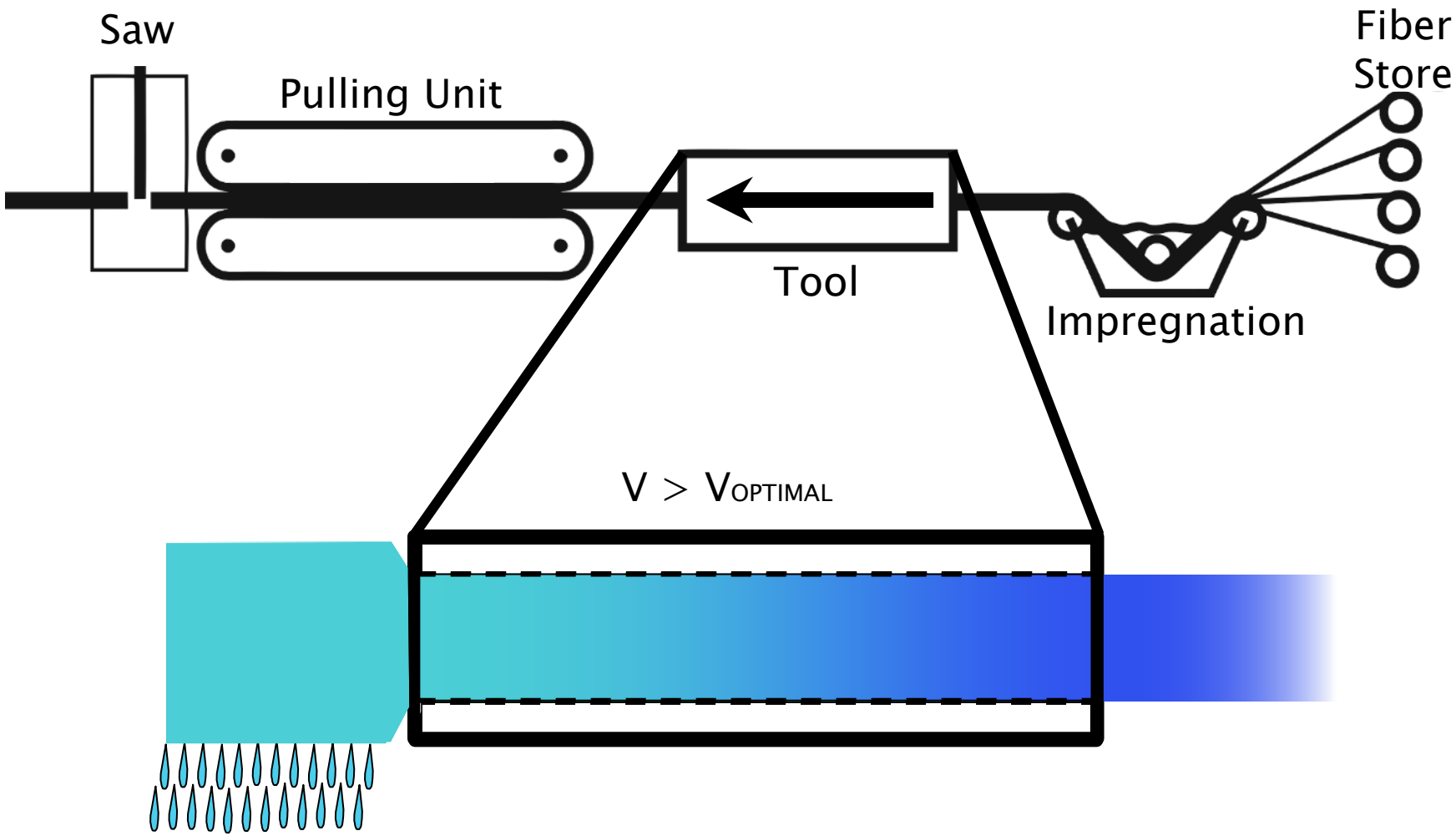
ULTRASONIC PULTRUSION IN-LINE CURE MONITORING

When sound hits a window

NDT in Canada
NDTiC 2018
Canada's NDT Conference
June 19 - 21
Halifax Convention Centre
Halifax, Nova Scotia

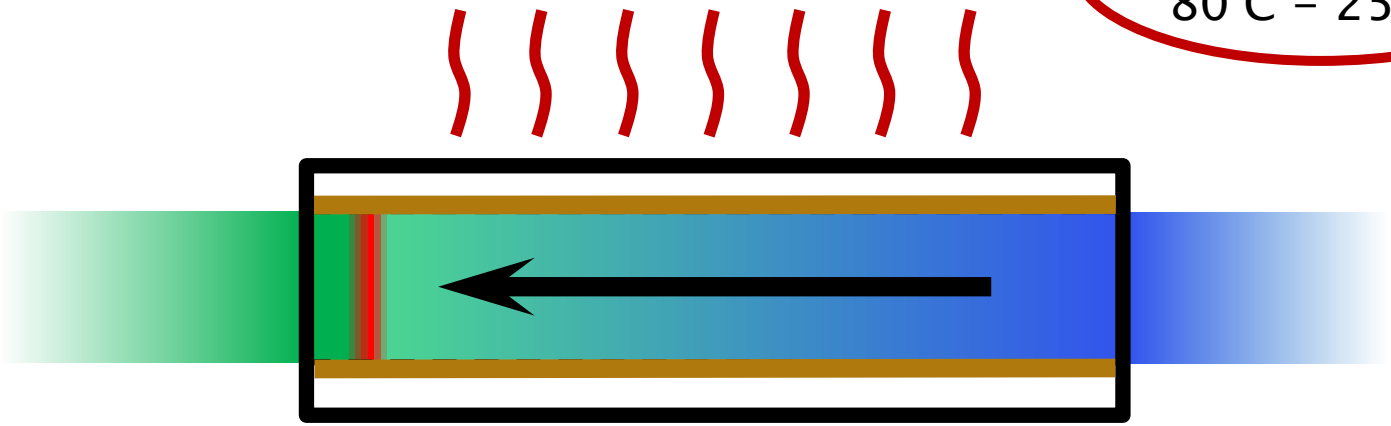



Pultrusionsforschungsanlage
Säge
Abzug
Werkzeug
Tränkung
Faserrollen


Saw
Pulling Unit
Fiber
Store
Tool
Impregnation
V > VOPTIMAL

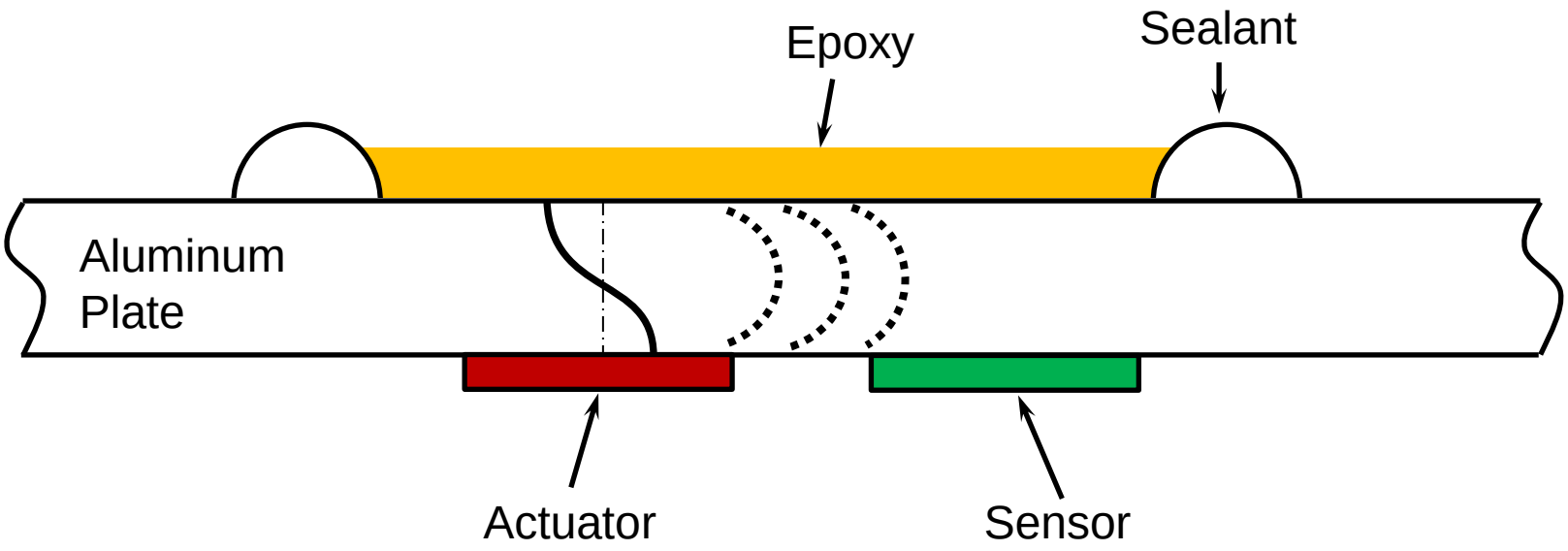
Low cost

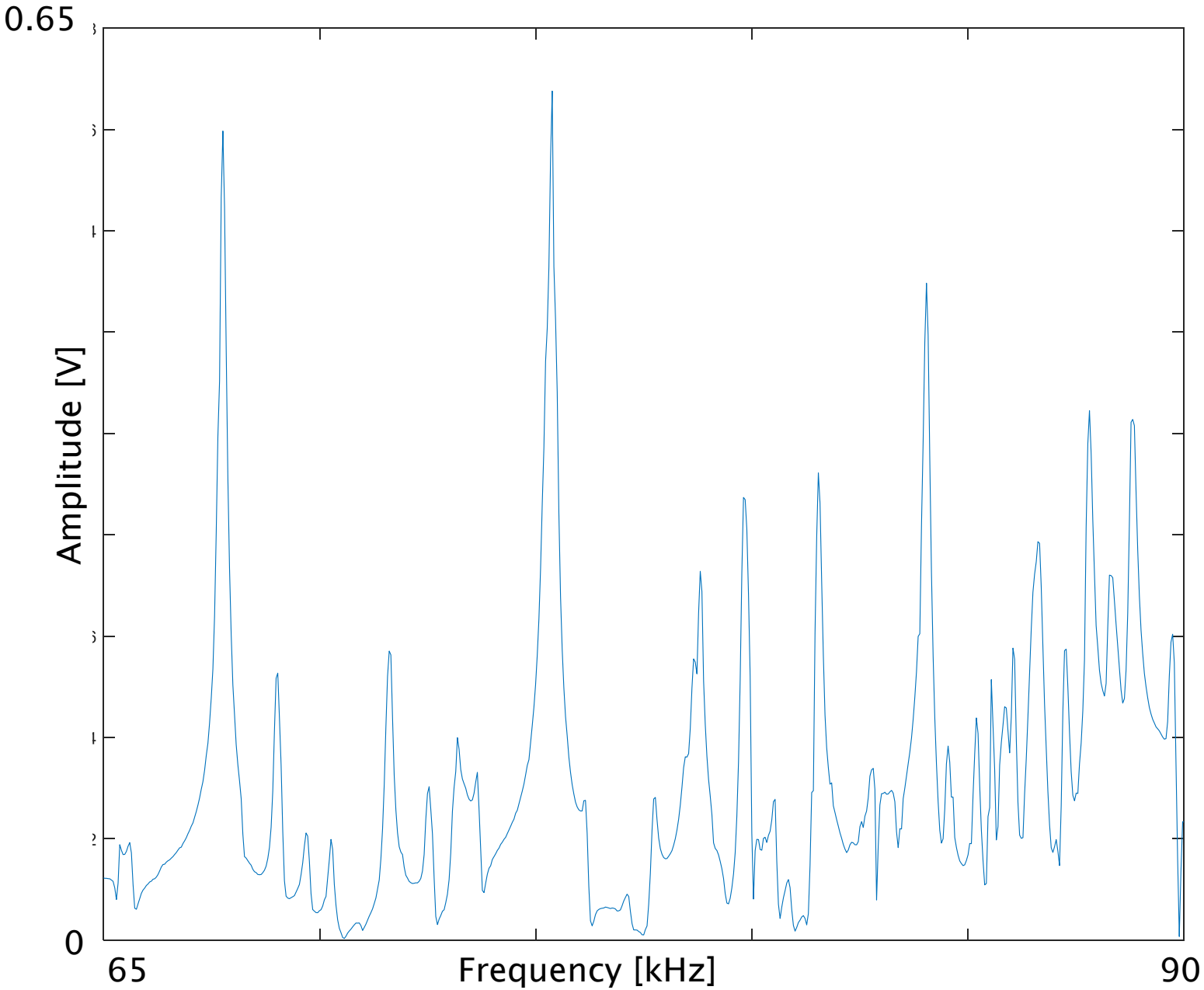
High temperature
80°C – 250°C

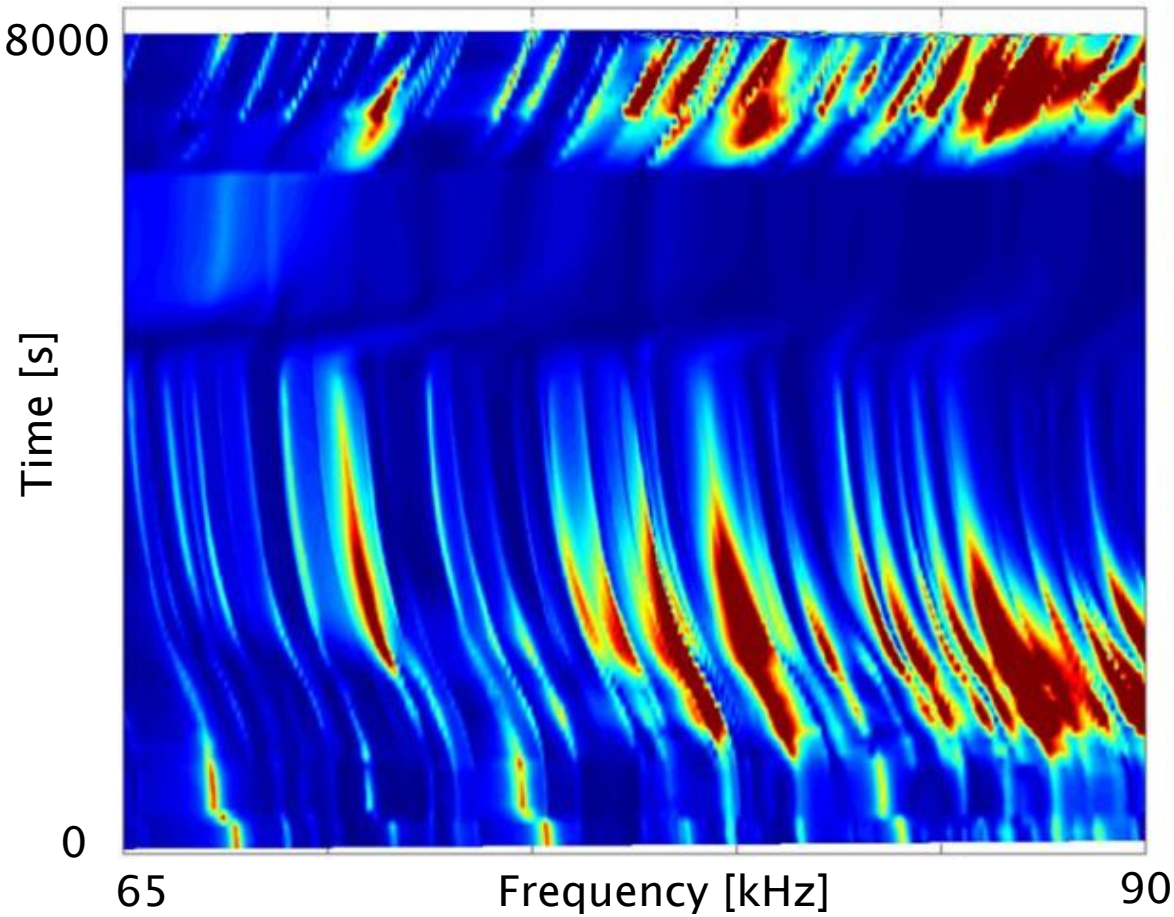


Different Geometries
Hollow structures
Slender structures
Complex profiles

High abrasion
Sandpaper like abrasion
Long production cycles


Epoxy
Sealant
Aluminum
Plate
Actuator
Sensor


0.65
0
Amplitude [V]
65
Frequency [kHz]
90

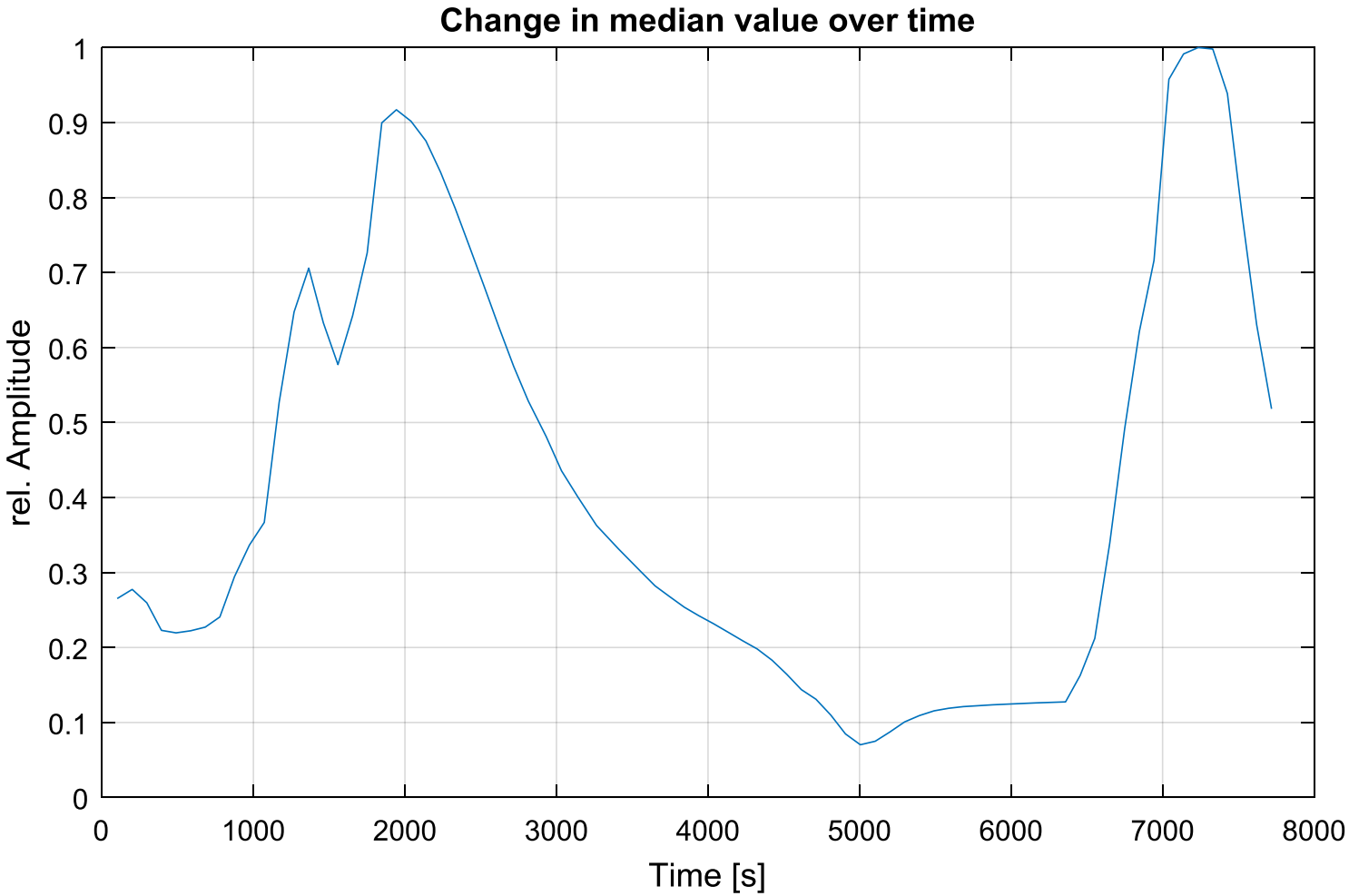


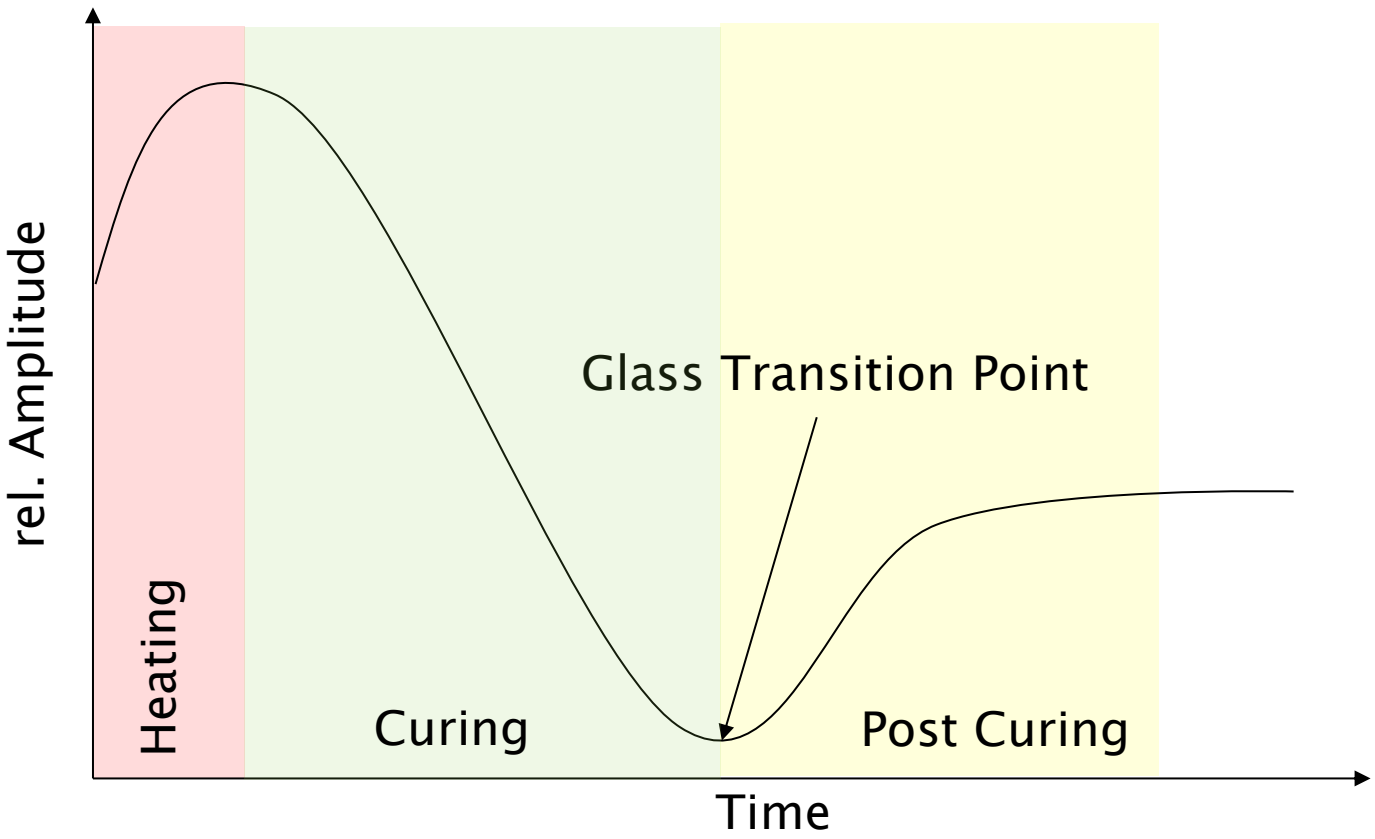
Glass transition

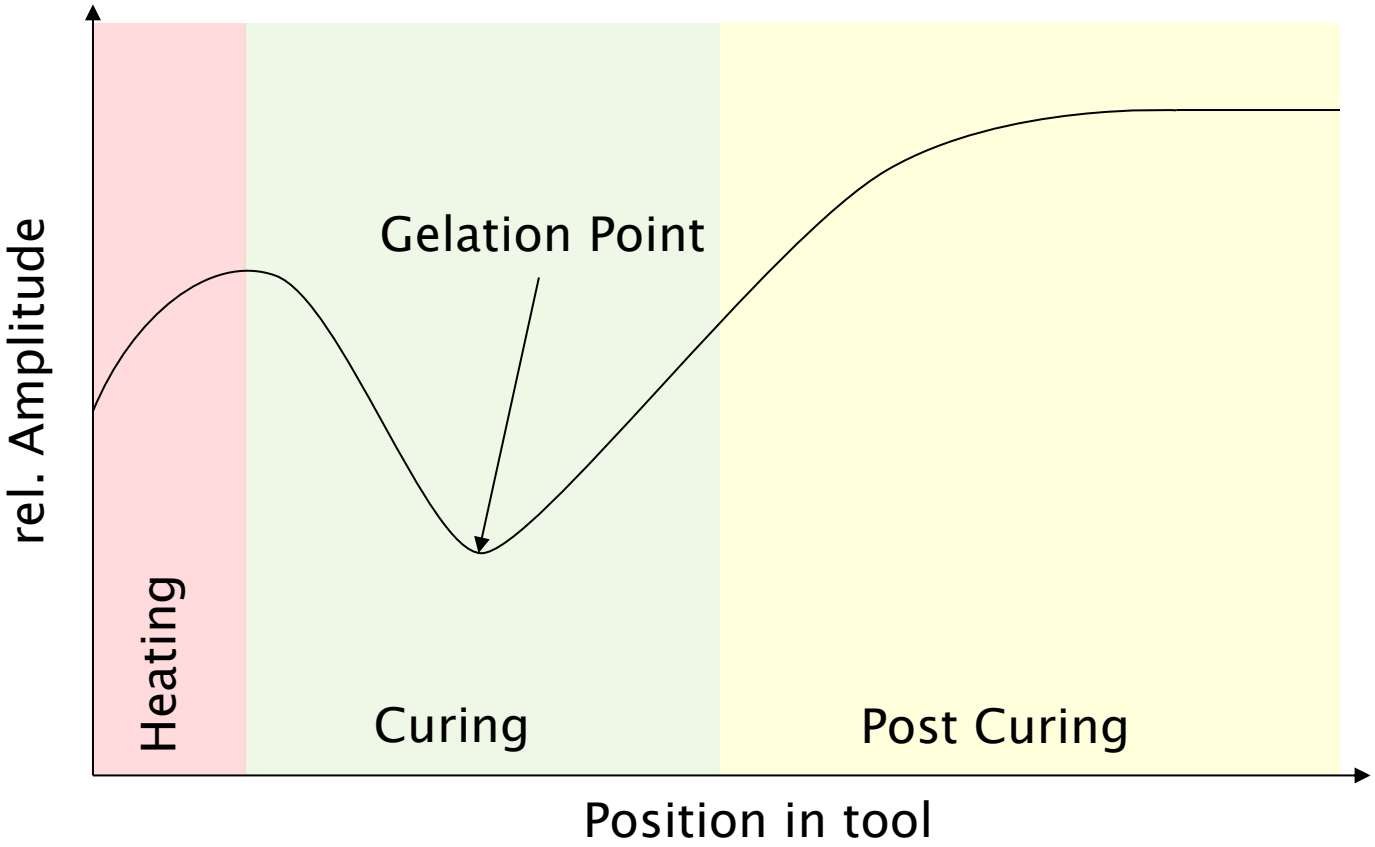
Shrinkage

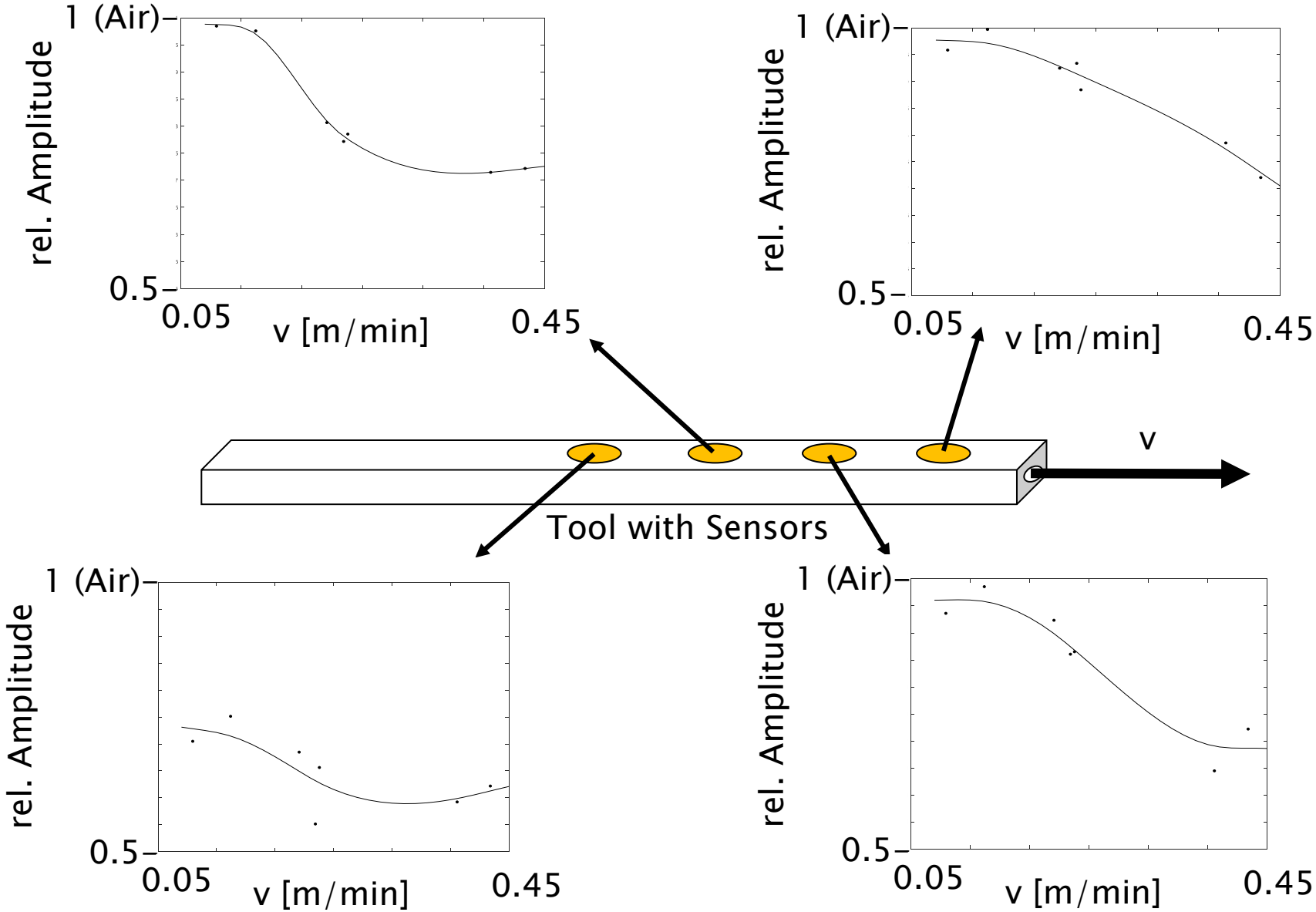
Warming

Filling


Change in median value over time
rel. Amplitude
Time [s]
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
1000
2000
3000
4000
5000
6000
7000
8000


rel. Amplitude
Heating
Curing
Glass Transition Point
Post Curing
Time


rel. Amplitude
Gelation Point
Heating
Curing
Post Curing
Position in tool


1 (Air)
0.5
rel. Amplitude
0.05
v [m/min]
0.45
v
Tool with Sensors

Resonant ultrasonic spectroscopy has a number of advantages against other methods:

- Minimal invasive (by using pressed-in instead of glued sensors)
- No direct contact between tool and sensor (no abrasion)
- Highly temperature resistant
- No high speed digital to analog converters necessary

Future concepts:

- Further reducing the system size
- Stabilizing the measurements
- Optimizing control algorithms

Questions?

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Thank you for your attention!

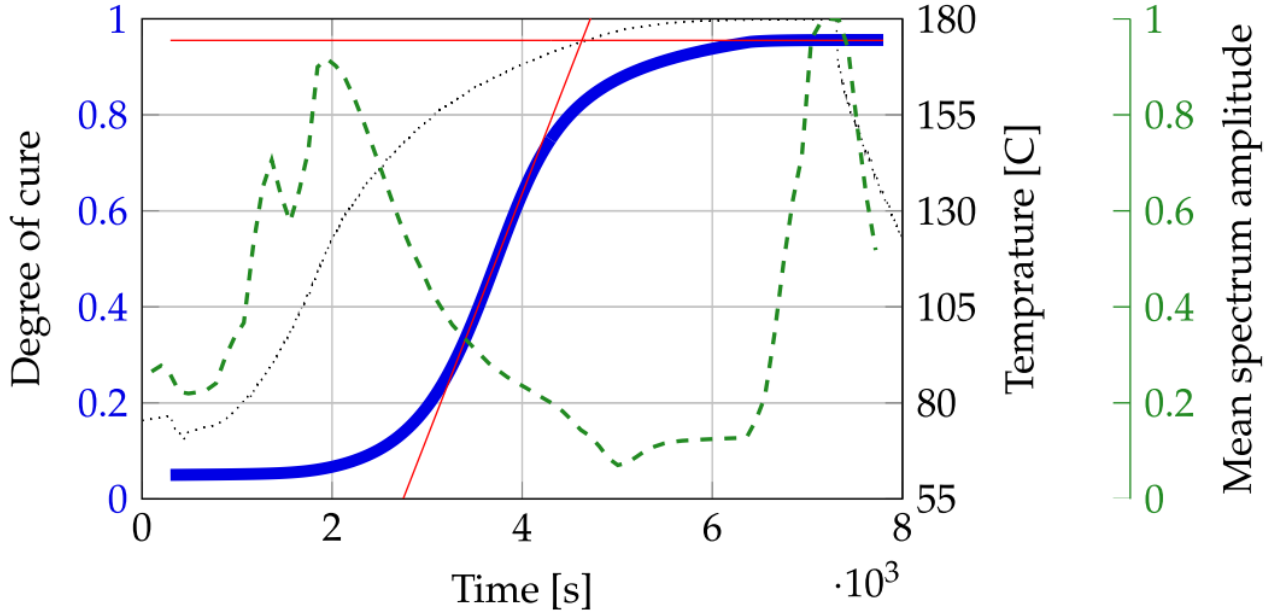

Figure 4. Measured temperature (black-dotted line) and calculated degree of cure (blue line) of the epoxy during the experiment with added support lines (in red) to determine the glass transition point (intersection). The mean spectrum amplitude of Figure 3 is shown in the green-dashed line.