Heat source geometry – rule of thumb

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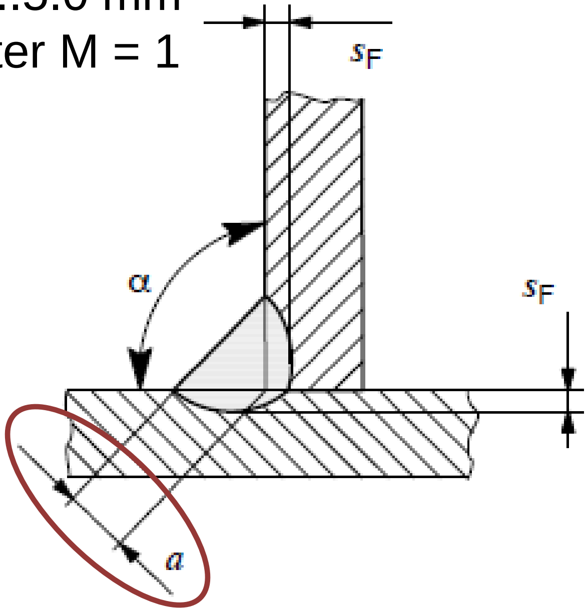
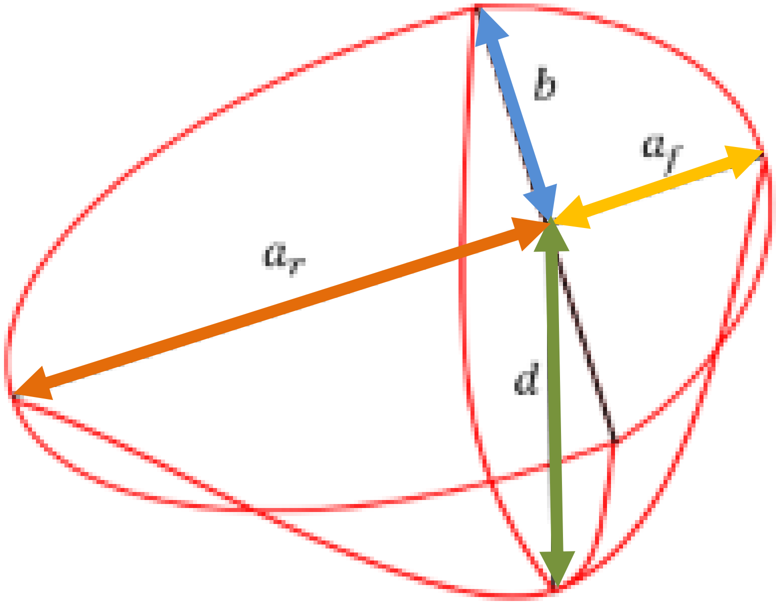
- Front length a_f = a … b
- Rear length a_r = 2 x a_f
- Width b = a + a/3
- Depth d = a + 2.0...5.0 mm
- Gaussian parameter M = 1



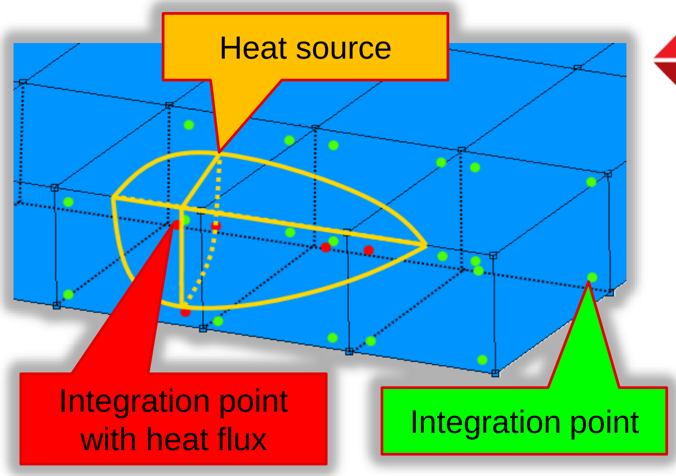


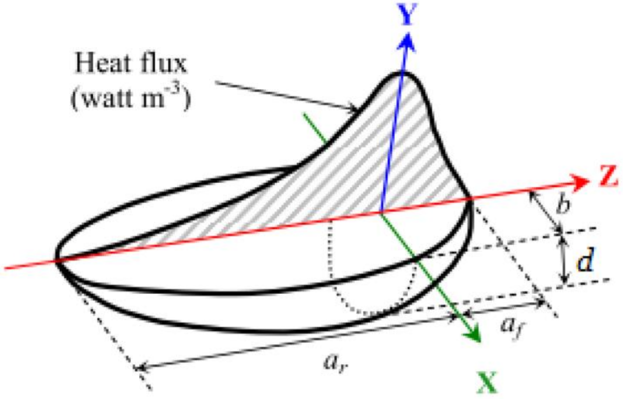
Gaussian parameter

What does the Gaussian parameter M do?

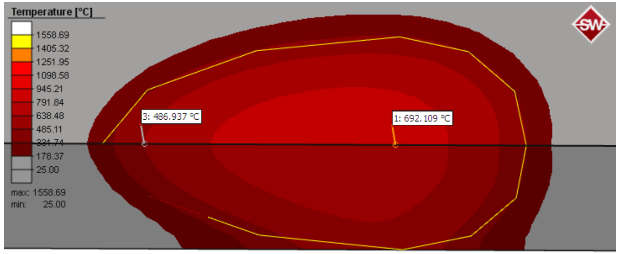
For transient approach:

- A heat flux based on the power, velocity & Δs will be insert into the model
- All integration points who captured by the geometry of the heat source will get a part of the heat flux
- How big this heat flux will be, is based on the relative position of the integration point to the center of the heat source because of the Gaussian distribution

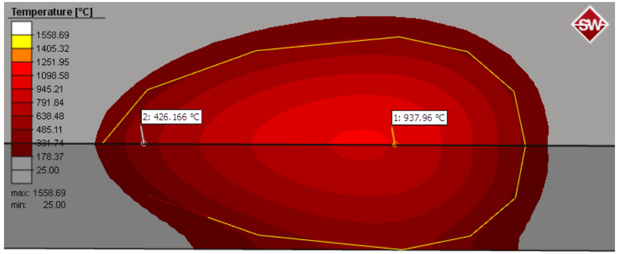




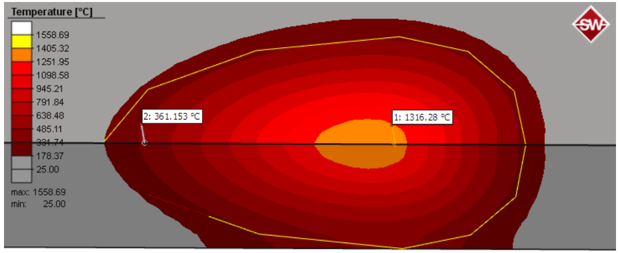
Influence of Gaussian parameter after 0.2 s & 0.6 s



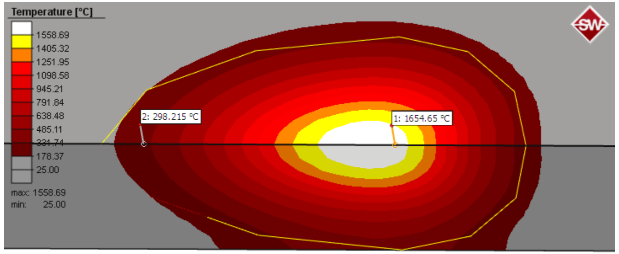
M = 0 → Rear: 487 °C & Center: 692 °C



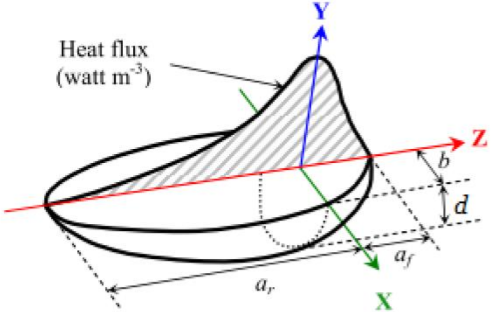
M = 1 → Rear: 426 °C & Center: 938 °C

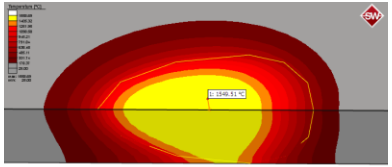


M = 2 → Rear: 361 °C & Center: 1316 °C

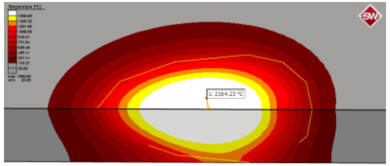


M = 3 → Rear: 298 °C & Center: 1655 °C

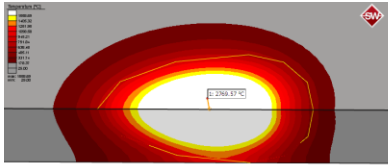




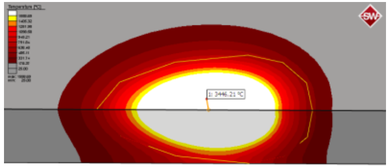
M = 0 → 1550 °C



M = 1 → 2164 °C



M = 2 → 2770 °C

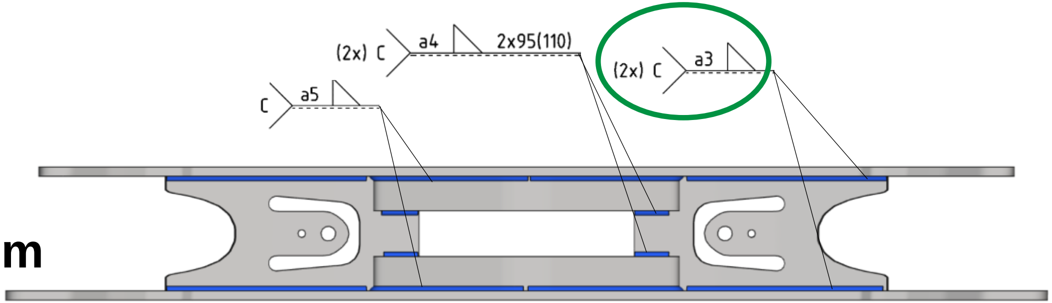


M = 3 → 3446 °C

Define the heat source geometry

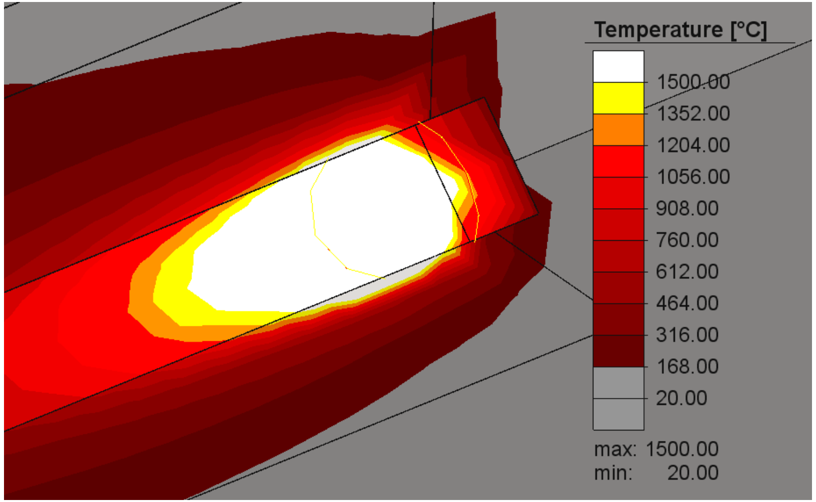
Heat source geometry – first try:

- **Front length a_f** = a … b → **3 mm**
- **Rear length a_r** = 2 x a_f → **6 mm**
- **Width b** = a + a/3 → **4 mm**
- **Depth d** = a + 2.0...5.0 mm → **5 mm**
- Gaussian parameter M = **1**



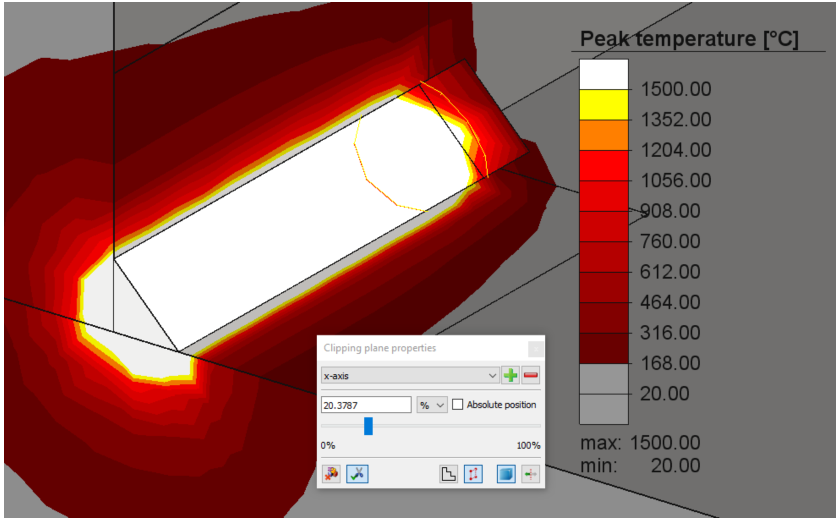
Welding parameter (lower limits)

- Movement speed: 300 mm/min
- Current: 260 A
- Voltage: 28.5 V
- Efficiency: 0.7

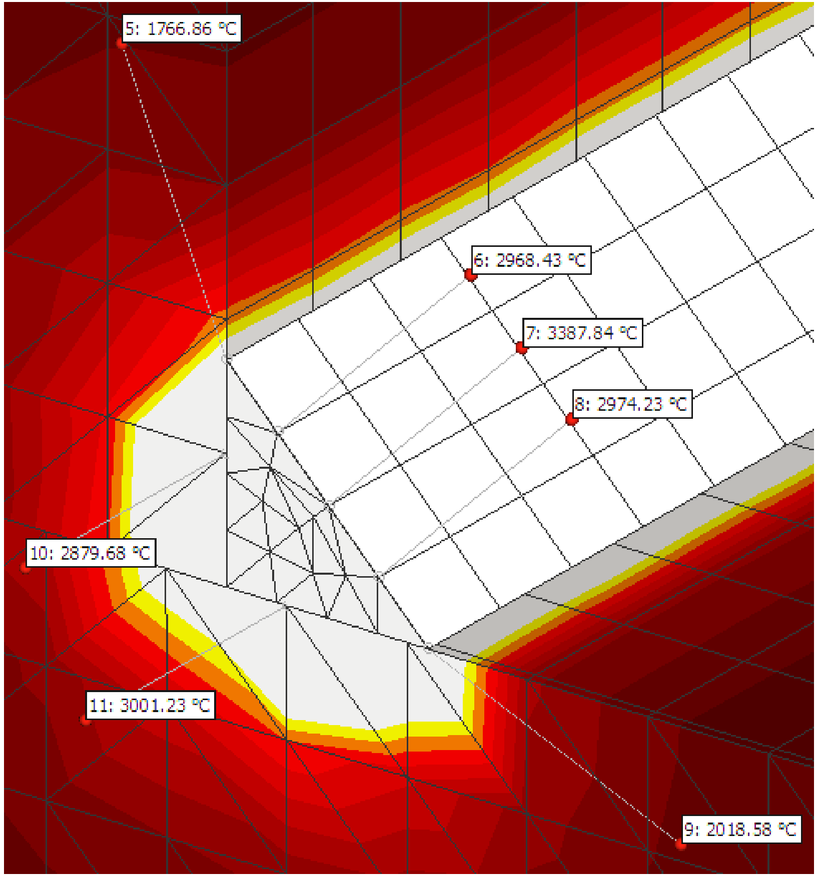


→ Looks ok at the first view, but is it really??

Qualify the heat source



Check the cross section with peak temperature to qualify the joint → is everything melted?



Check the peak temperature to qualify the heat source → is temperature to high?
boiling temperature steel ~2730°C

Calibrating the heat source

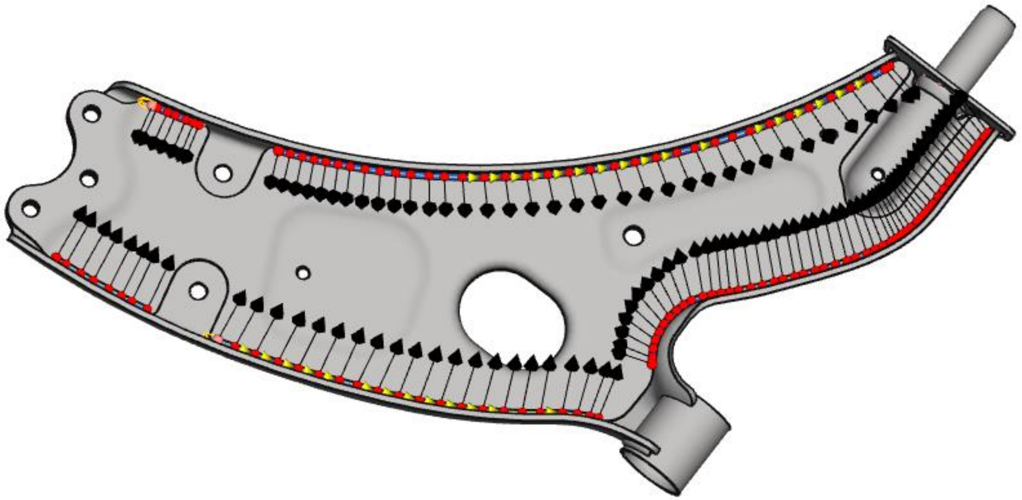
With a cross section

Example: suspension arm

Input data (1of2)

- CAD-Data (assembly & clamping)
- Material
- Weld paths (position & length)
- Welding parameter
- RPS data

Gap	Ampere [A]	Voltage [V]	Weld speed [mm/min]	Joints
1 - 1.5 mm	**270**	**20**	**800**	**Group1**
	250	**20**	**650**	**Group2**
	270	**20**	**800**	**Group3**

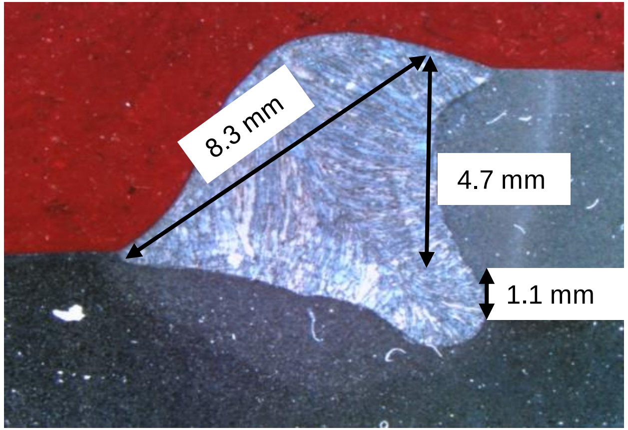


Example: suspension arm

Input data (2of2)

Fillet geometry:

- Roughly orientate the dimensions by the cross section
- Consider the gap
- Don't get to close to the sheet edge
- Get the throat dimension (a = ~5.55 mm)



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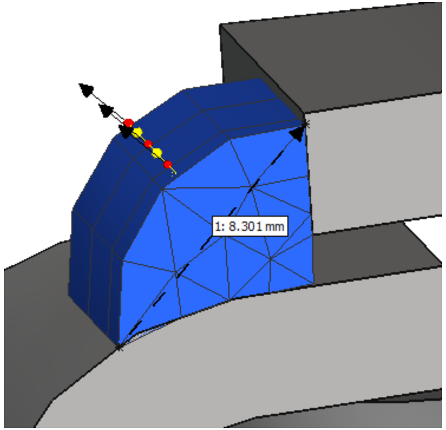
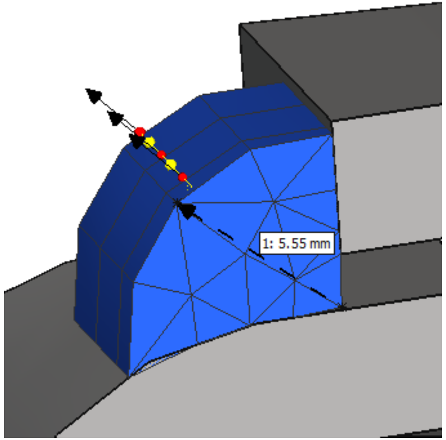
Note: simplification – not the real cross section



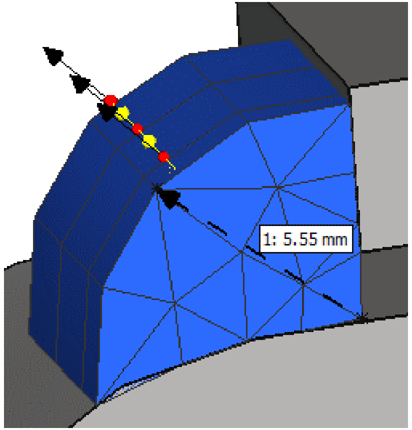


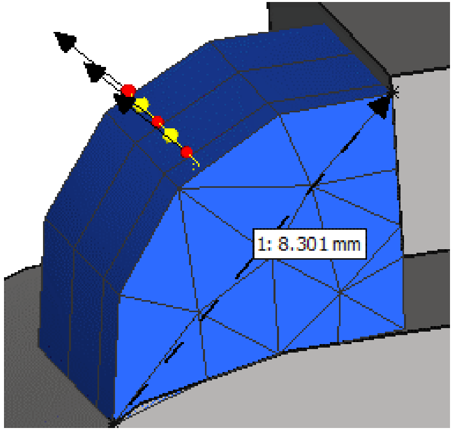
Heat source geometry – “new” rule of thumb

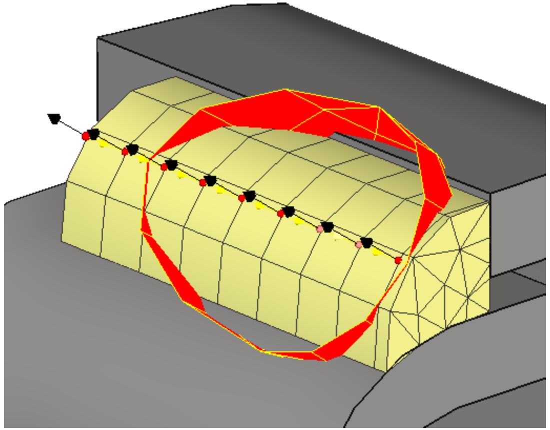
Heat source geometry – rule of thumb:

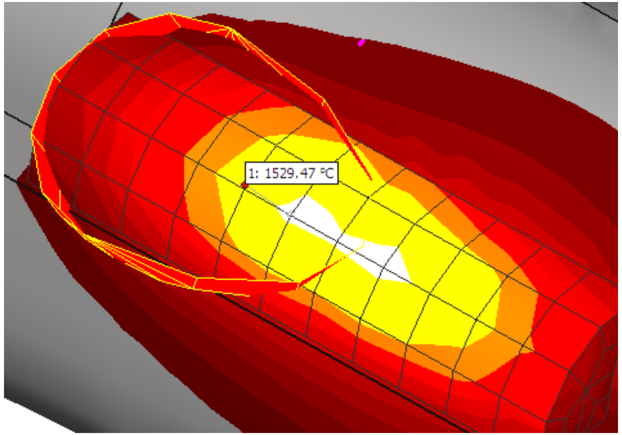
- Front length a_f = a … b → 5.5 mm
- Rear length a_r = 2 x a_f → 11 mm
- Width b = a ~~+ a/3~~ → 5.5 mm
- Depth d = a + 2.0...5.0 mm → 7.5 mm
- Gaussian parameter M = 1

a = ~5.5 mm

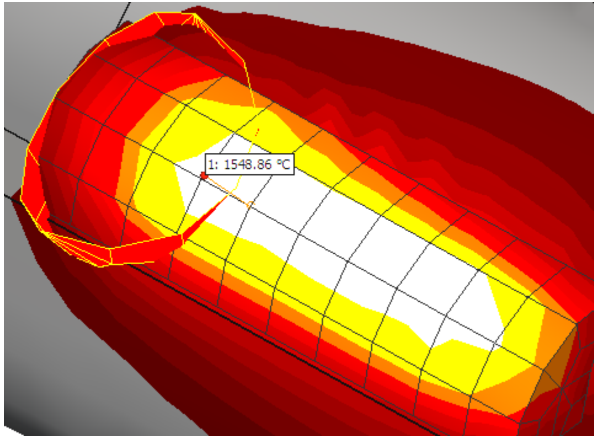


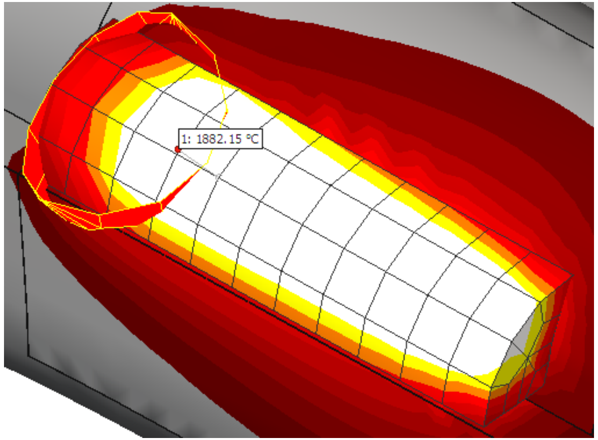






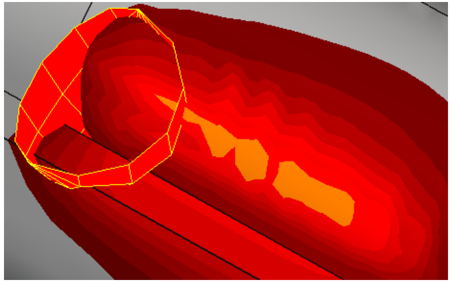
Heat source geometry – calibration

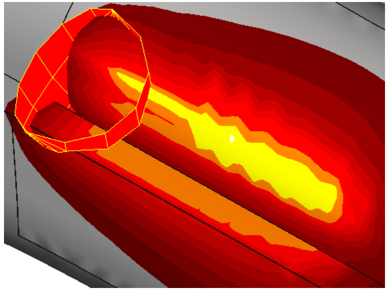




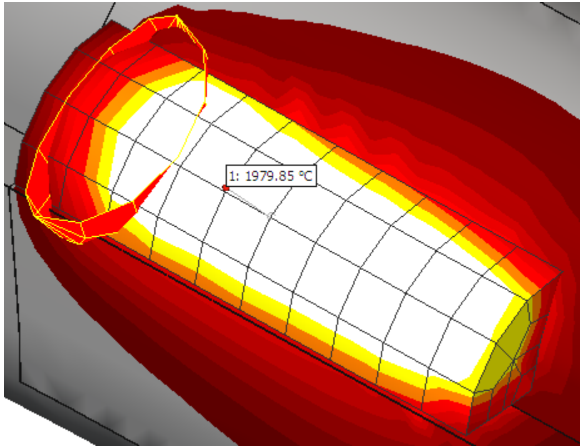
- Front length a_f = a … b → 3 mm
- Rear length $a_r = 2 \times a_f$ → 6 mm

- Efficiency = 0.99





Heat source geometry – calibration



???

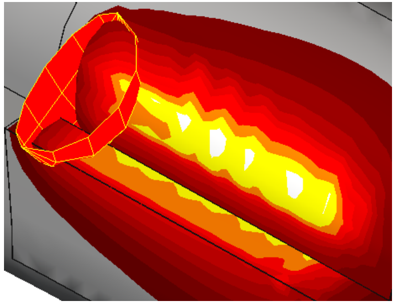
What to do?

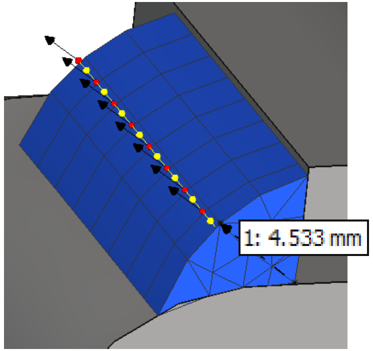
- Double check the welding parameter (welding method) with the prospect

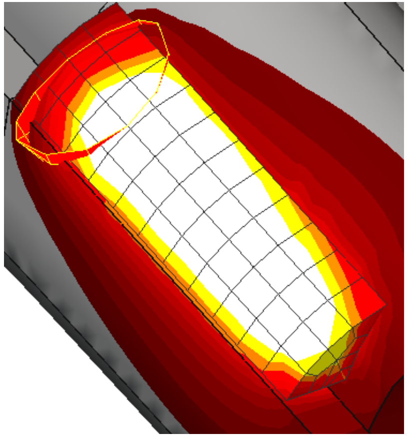
→ DON'T change the welding parameter (power / velocity) by yourself

- Reduce the volume of the fillet
- Use thermal cycle

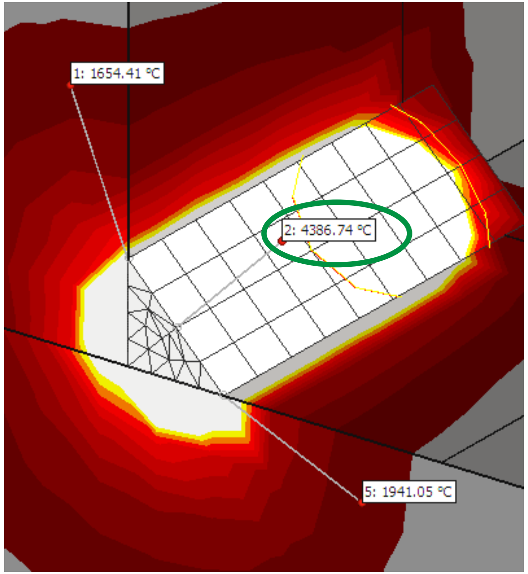
- Front length a_f = a … b → 2 mm
- Rear length a_r = 2 x a_f → 4 mm

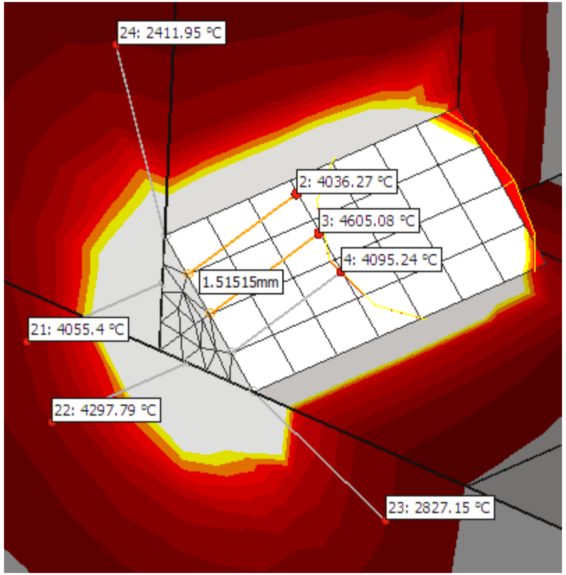


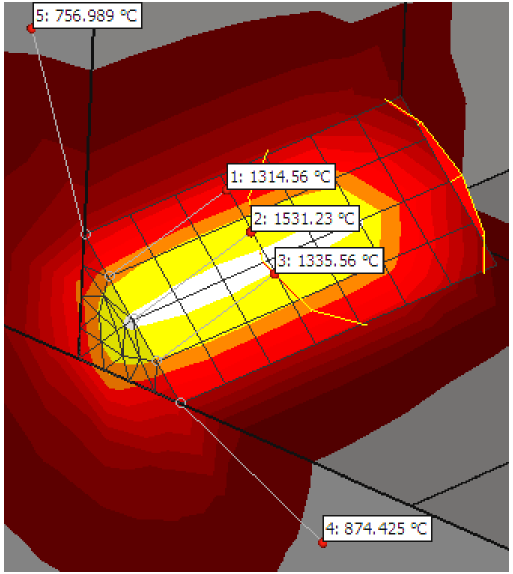




Melting pool is bad – what to do?





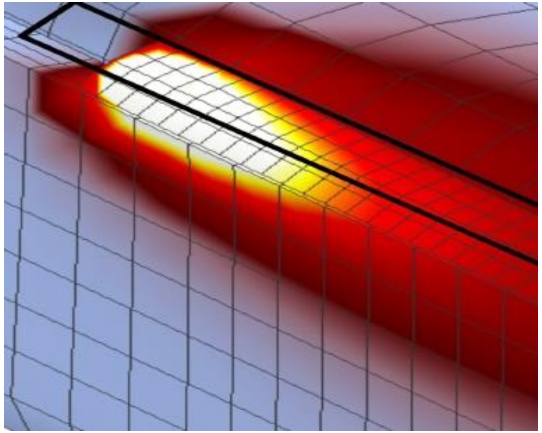


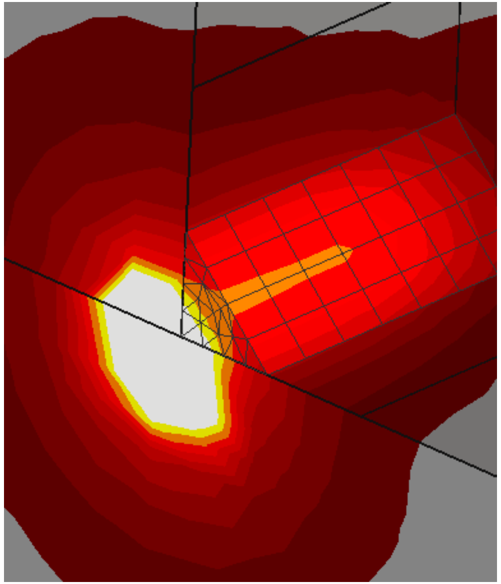
Peak temperature in the center is to high; the rest is ok
→ Change the Gaussian parameter to M = 1

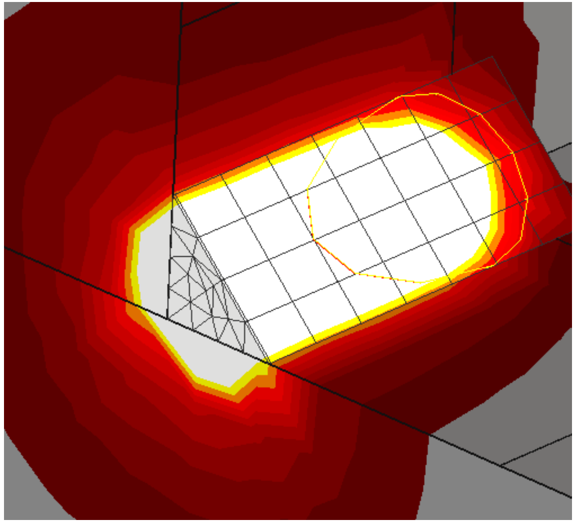
Peak temperature over all is to high
→ lower the efficiency OR BETTER increase the length of the heat source (this will increase the step size for an increment and speed up the calculation!

Peak temperature is overall to low
→ Increase the efficiency or reduce the length of the heat source (if efficiency reached 1)

Melting pool is bad – what to do?







Asymmetric weld pool
→ Check the mesh to get the same number of elements on both sides of the fillet

Fillet don’t heat up
→ Check the cross section to figure out if at least something is heated up. Check the position of the trajectory after generate the fillet.

Melt pool is to small
→ Adjust the size of the heat source (key an eye on the peak temperature which can drop because the heat flux in input in a bigger volume