



Welding tests thermal evaluation

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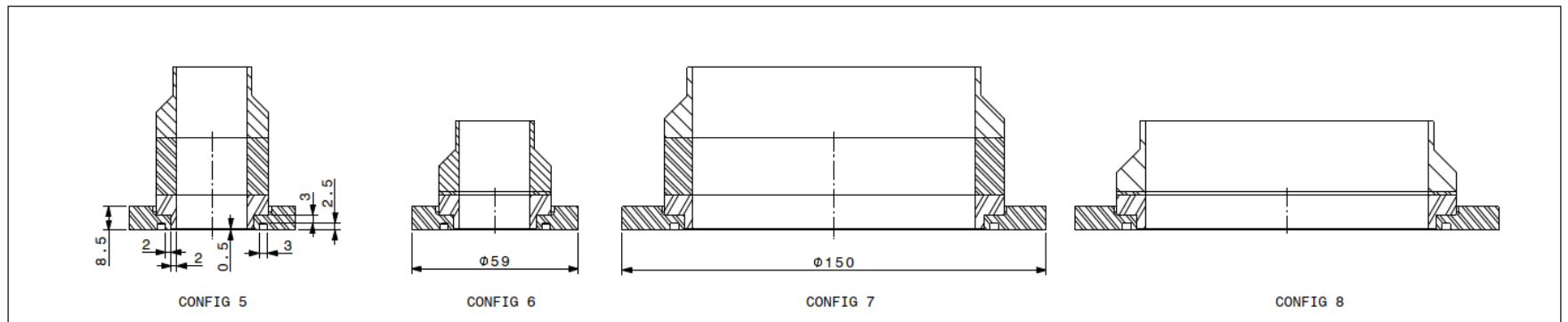
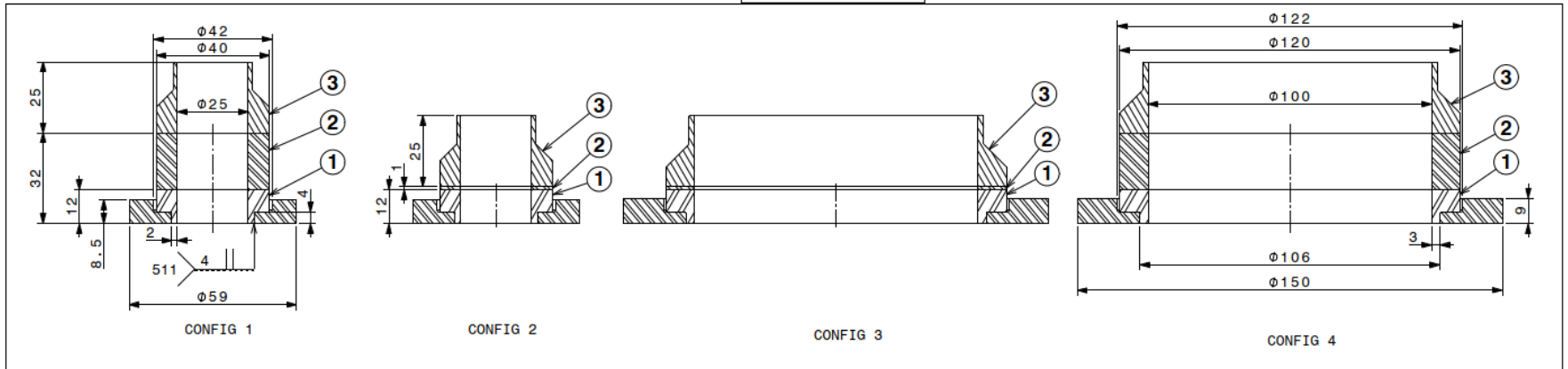
31/01/2019

Introduction

- 8 geometries tested – 4 for EBW and 4 for TIG welding

Baloon	Material Name
1	Titanium layer 1
2	Titanium layer 2
3	Stainless Steel

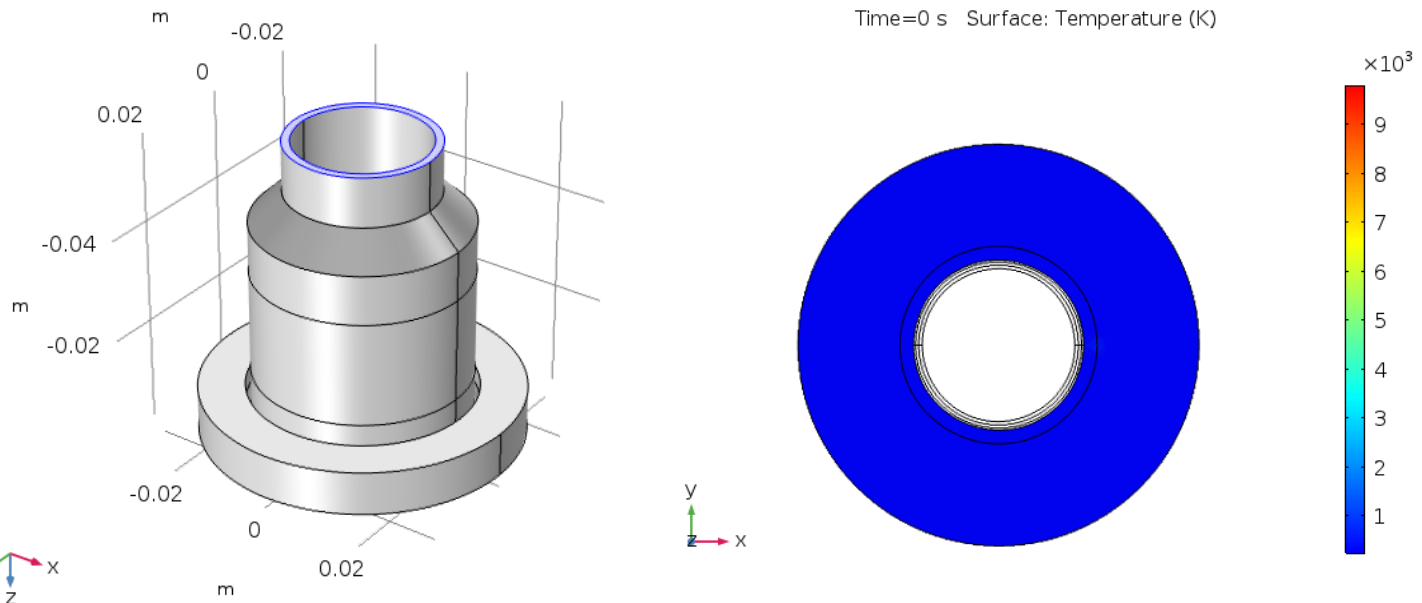
EB WELDING



TIG WELDING

EB welding

- Welding parameters
 - Power: 1500 W
 - Spot diameter: 1.5 mm
 - Welding speed: 17 mm/s
 - Radius of the welding surface = 14.5 mm (Configs 1 & 2), 53 mm (Configs 3 & 4)
 - Welding time = 5.36 s (Configs 1 & 2), 19.6 s (Configs 3 & 4)
- Boundary conditions
 - Weld spot in the boundary between the two components.
 - Weld spot presents a Gaussian heat distribution.
 - **No radiation**
 - **No convection** –Quite conservative – Tests with convection only for Configurations 6 and 8 (during the weekend)



EB welding - Results

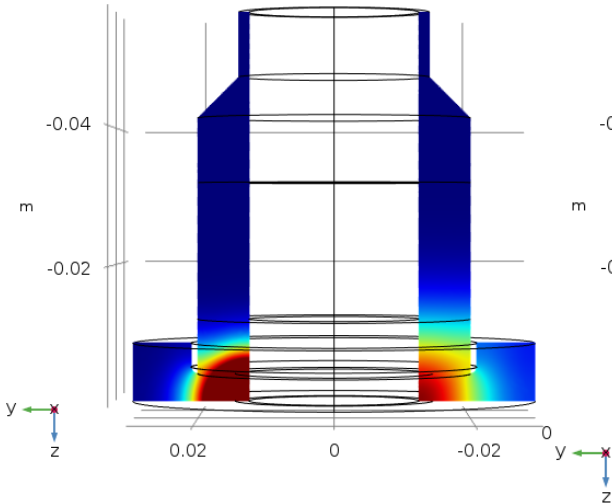
- Results for the different configurations, time normalized as a function of the welding time t_w .
Configurations 1 and 2

$t/t_w=1$

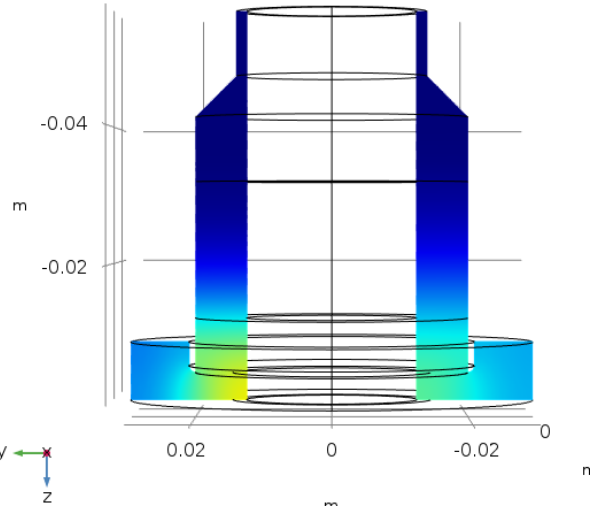
$t/t_w=2$

$t/t_w=10$

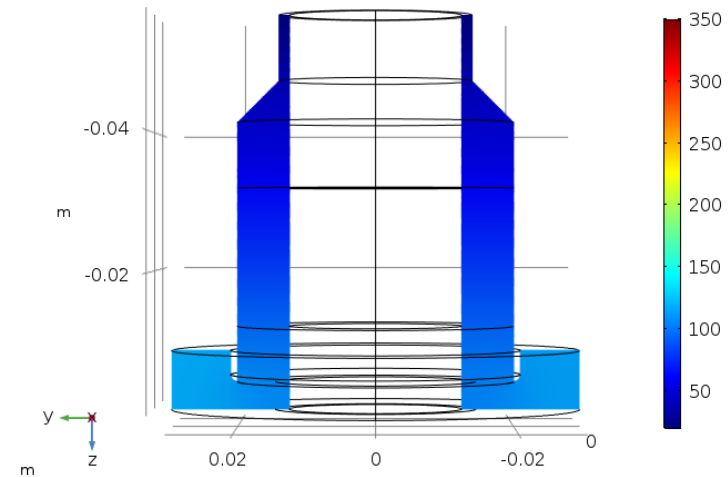
Time=5.35 s Slice: Temperature (degC)



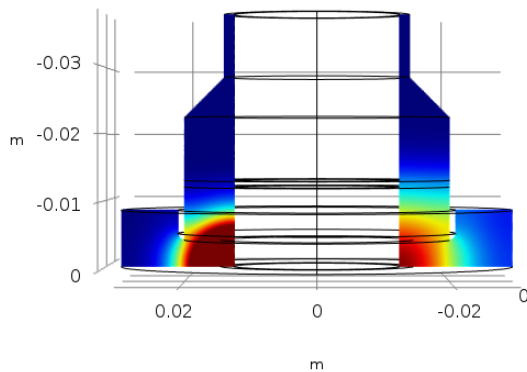
Time=10.7 s Slice: Temperature (degC)



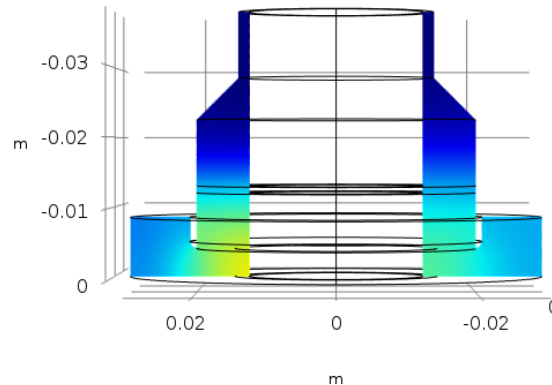
Time=53.5 s Slice: Temperature (degC)



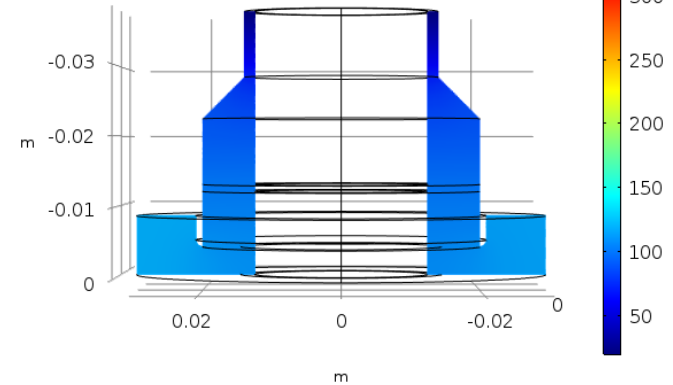
Time=5.35 s Slice: Temperature (degC)



Time=10.7 s Slice: Temperature (degC)



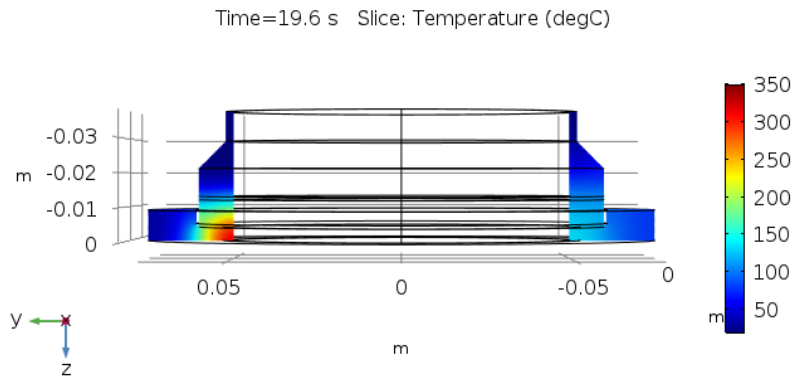
Time=53.5 s Slice: Temperature (degC)



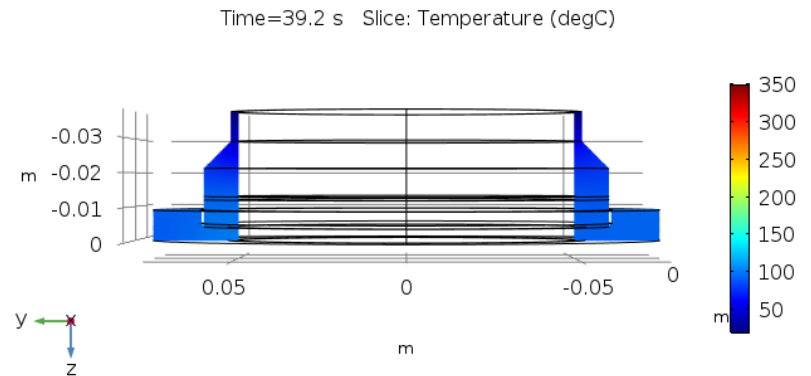
EB welding - Results

- Results for the different configurations, time normalized as a function of the welding time t_w . **Configurations 3 and 4**

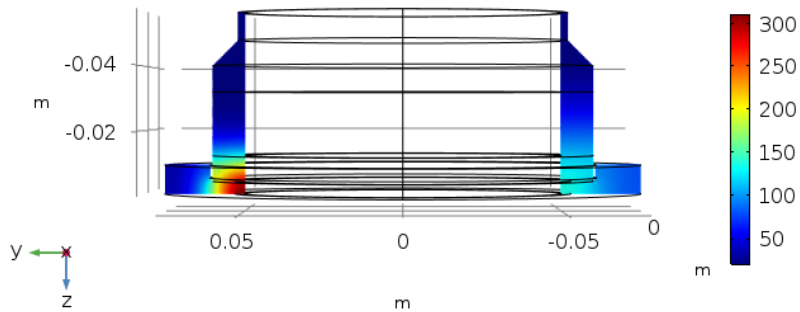
$t/t_w=1$



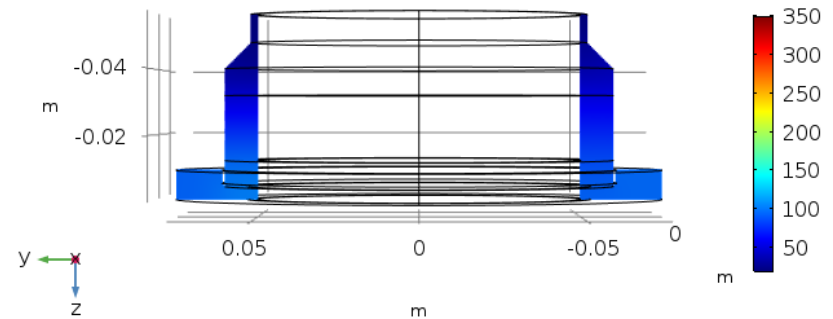
$t/t_w=2$



Time=19.6 s Slice: Temperature (degC)



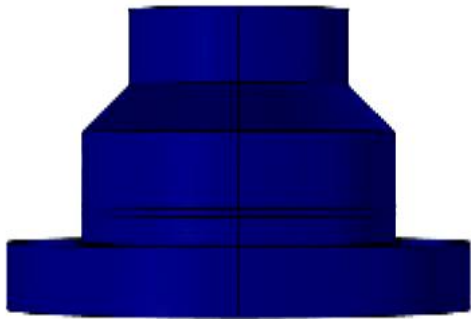
Time=39.2 s Slice: Temperature (degC)



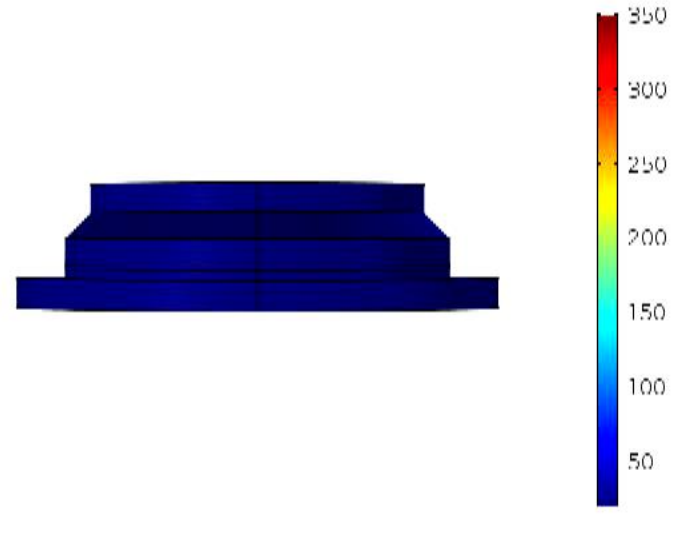
EB welding - Results

- Visual comparison between configurations 2 and 3.

Time=0 s Surface: Temperature (degC)

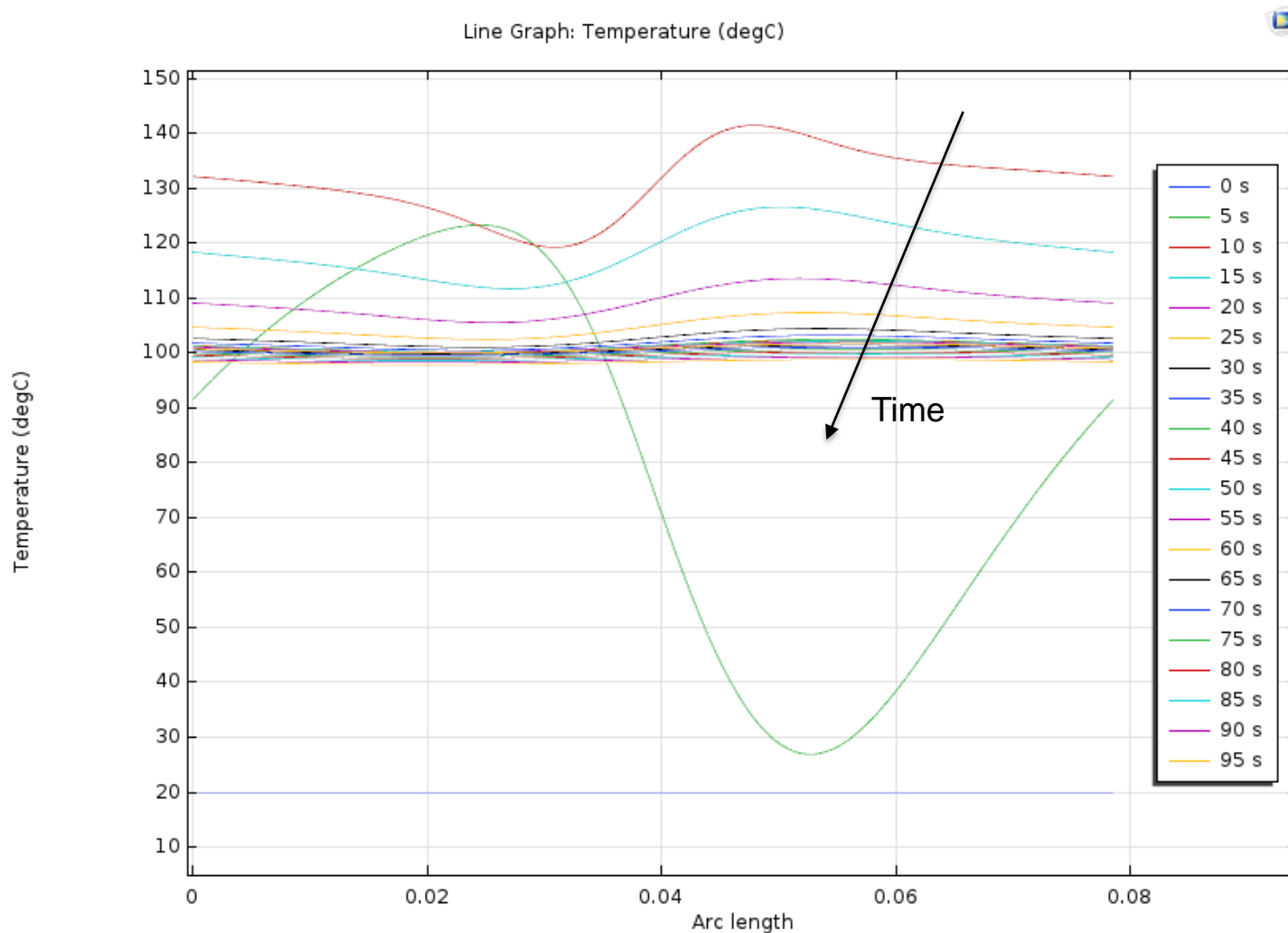


Time=0 s Surface: Temperature (degC)



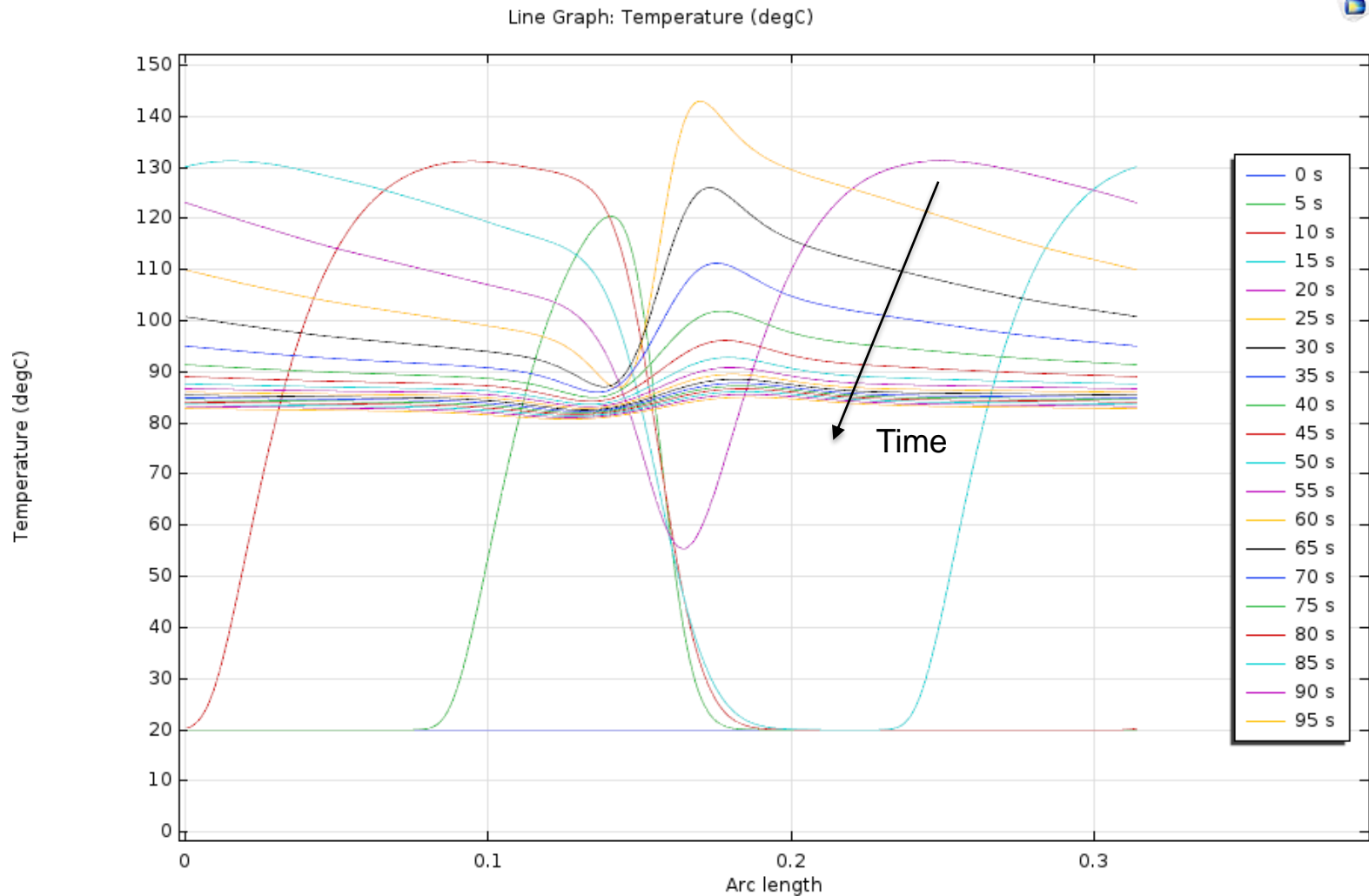
TIG welding - Results

- Evolution of the temperature along the first Ti-Ti boundary for Configuration 2.



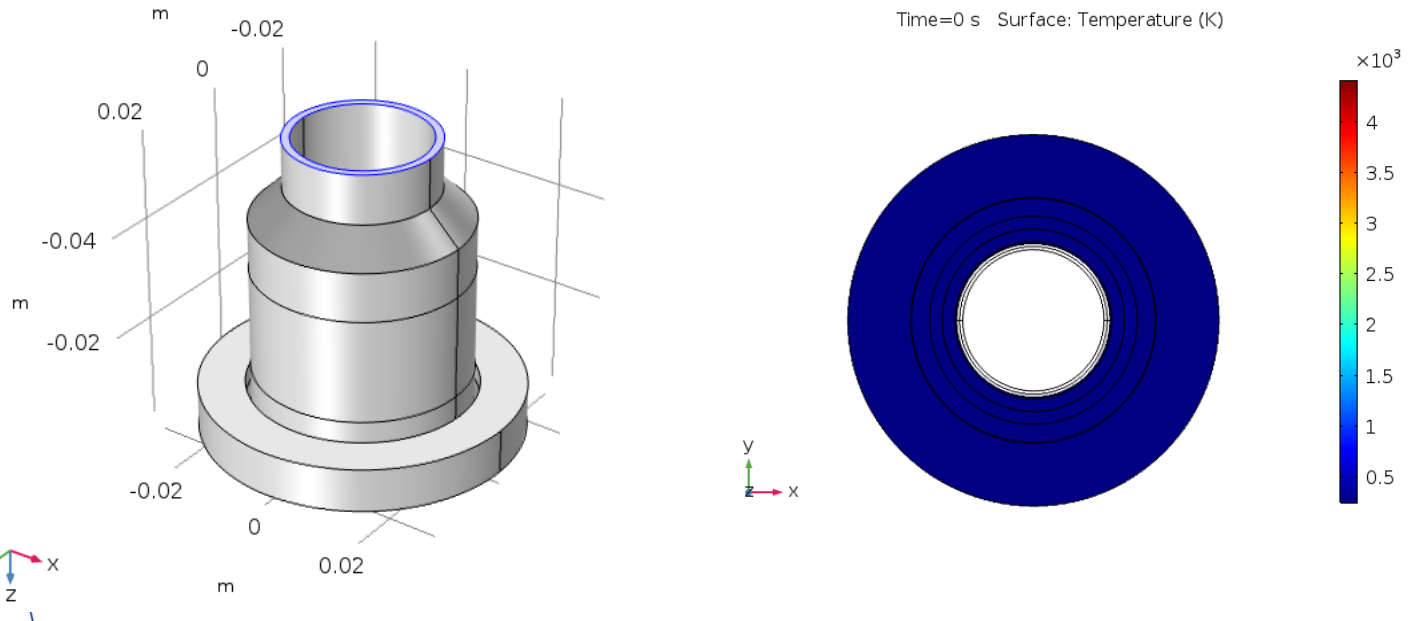
TIG welding - Results

- Evolution of the temperature along the first Ti-Ti boundary for Configuration 3.



TIG welding

- Welding parameters
 - Power: 800 W
 - Spot diameter: 4 mm
 - Welding speed: 1 mm/s
 - Radius of the welding surface = 14.5 mm (Configs 5 & 6), 53 mm (Configs 7 & 8)
 - Welding time = 91.1 s (Configs 5 & 6), 333 s (Configs 7 & 8)
- Boundary conditions
 - Weld spot in the boundary between the two components.
 - Weld spot presents a Gaussian heat distribution – Causes the spot not to be fully contained in the geometry.
 - **No radiation**
 - Extremity of the component assumed at room temperature

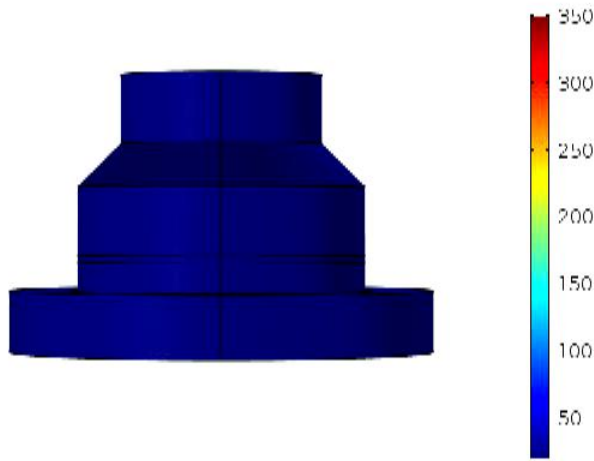


TIG welding - Results

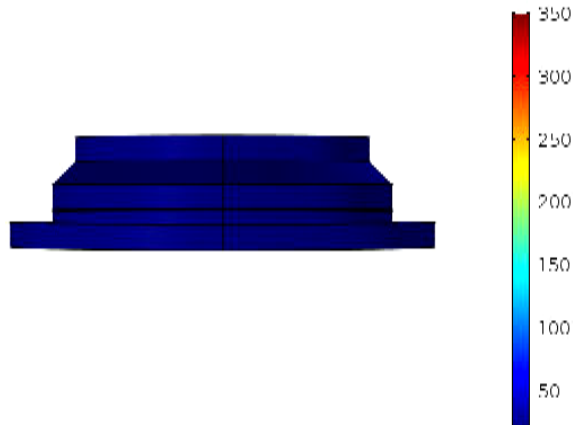
- Configurations 6 and 8 were identified as the most critical.
- Visual comparison between configurations 6 and 8.

No convection

Time=0 s - Surface: Temperature (degC)

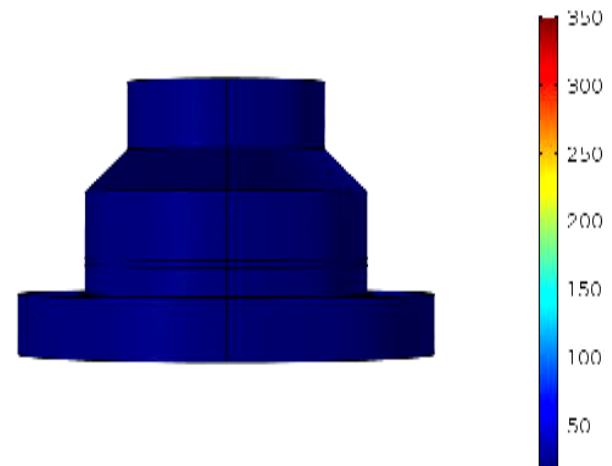


Time=0 s - Surface: Temperature (degC)

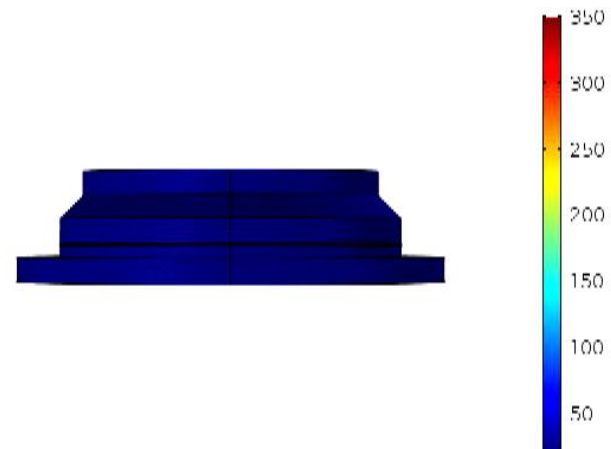


Convection

Time=0 s - Surface: Temperature (degC)

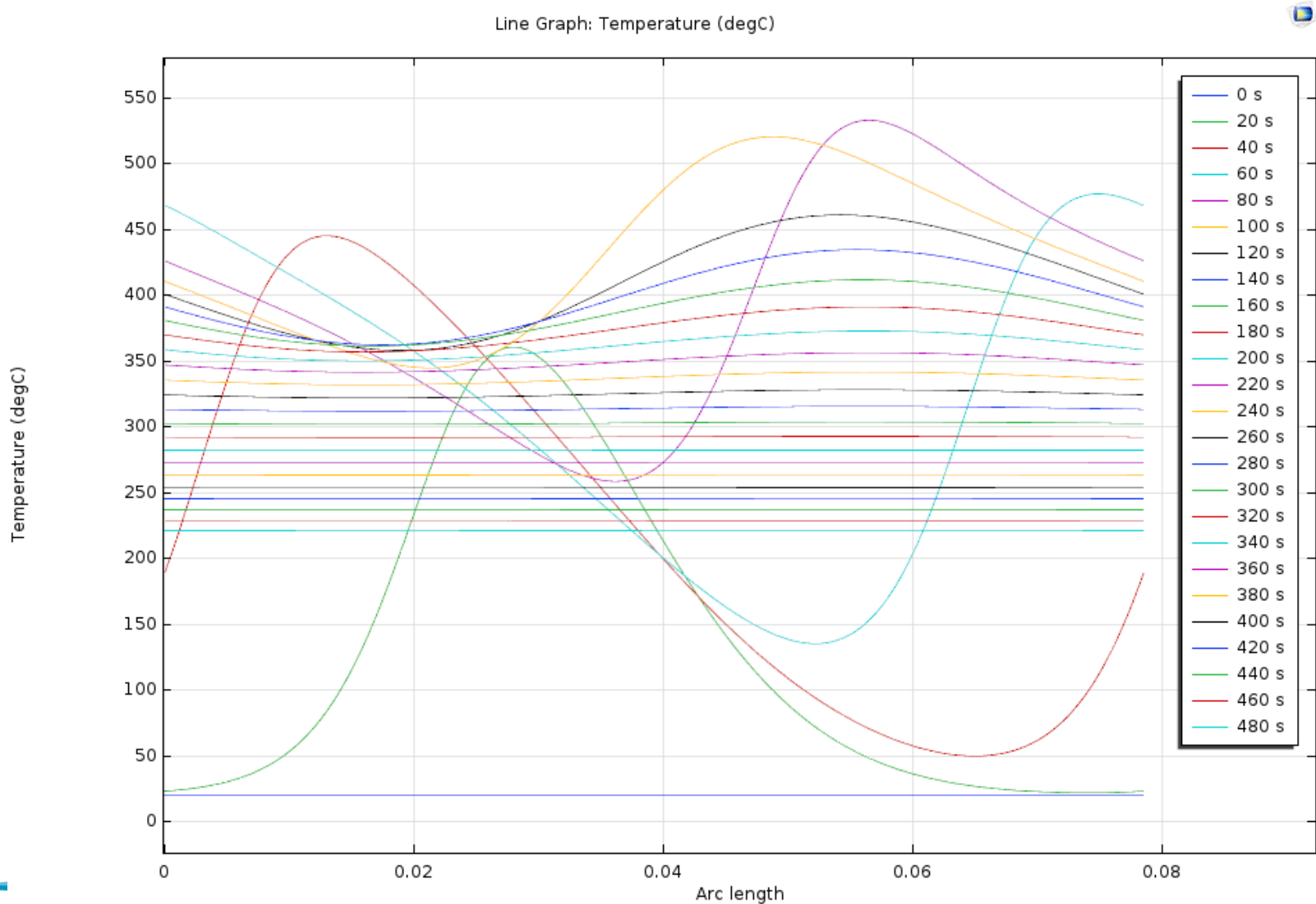


Time=0 s - Surface: Temperature (degC)



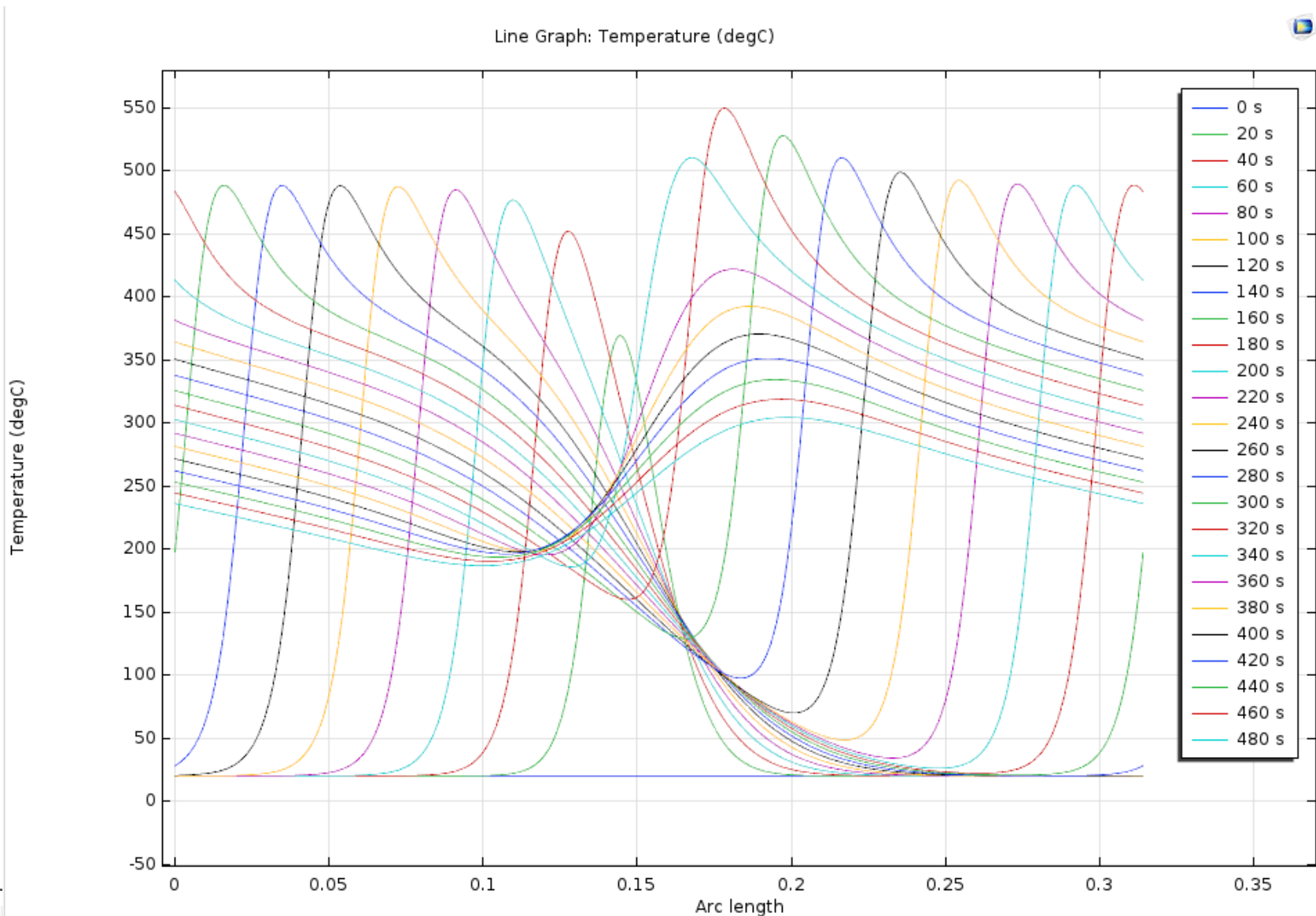
TIG welding - Results

- Evolution of the temperature along the first Ti-Ti boundary for Configuration 6.



TIG welding - Results

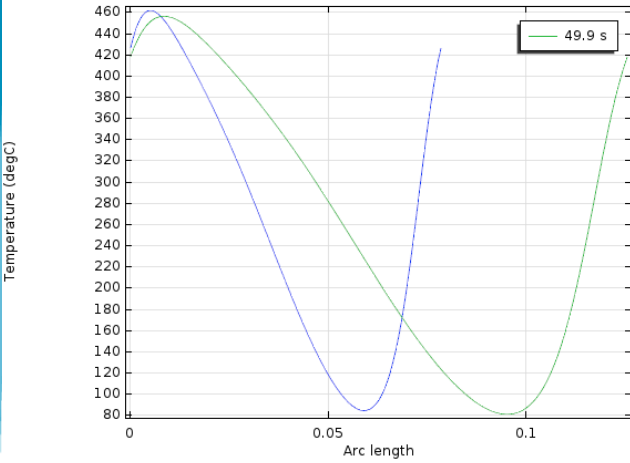
- Evolution of the temperature along the first Ti-Ti boundary for Configuration 8.



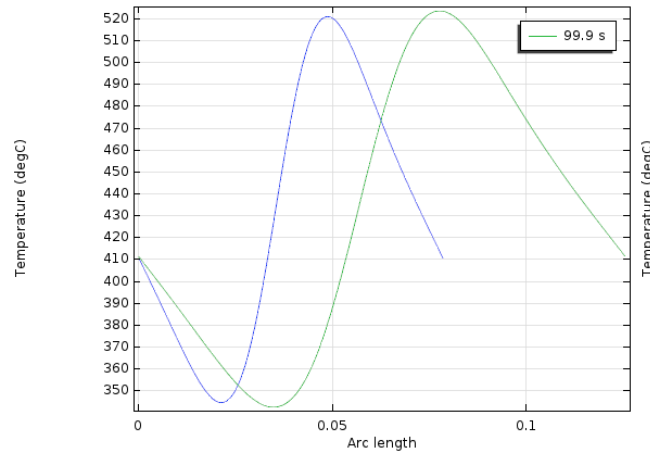
TIG welding – Measuring inside or outside?

Configuration 6

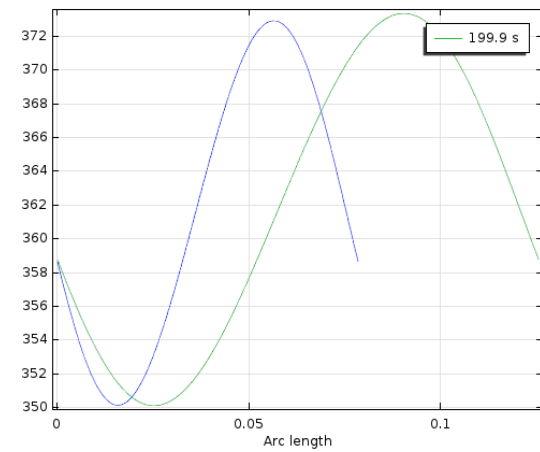
Line Graph: Temperature (degC) Line Graph: Temperature (degC)



Line Graph: Temperature (degC) Line Graph: Temperature (degC)

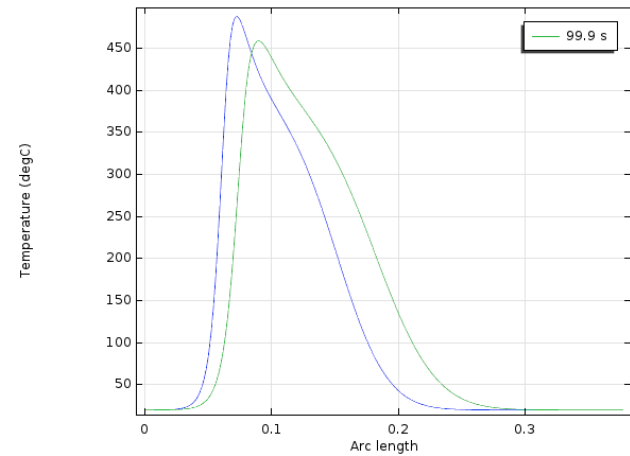


Line Graph: Temperature (degC) Line Graph: Temperature (degC)

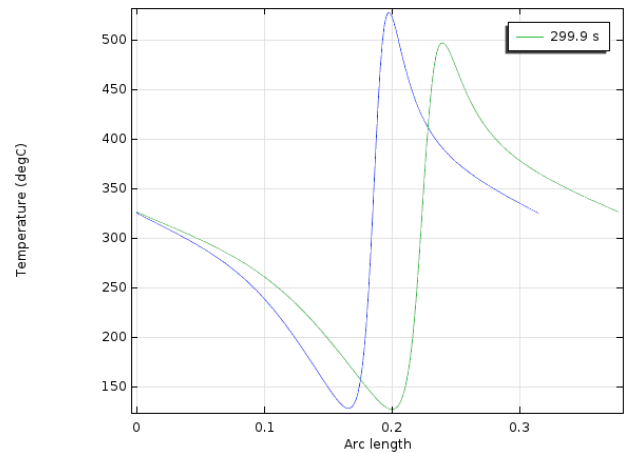


Configuration 8

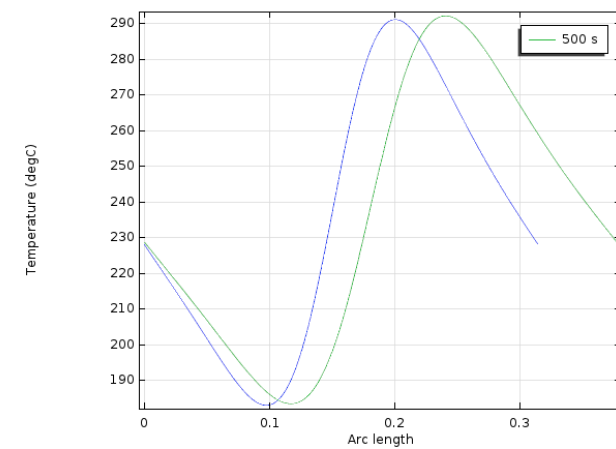
Line Graph: Temperature (degC) Line Graph: Temperature (degC)



Line Graph: Temperature (degC) Line Graph: Temperature (degC)



Line Graph: Temperature (degC) Line Graph: Temperature (degC)



Some words

- The calculations could be further optimized, but they provide a preliminary good approach.
- Longer simulation times will be needed (run during the weekend).
- For EB, the total welding energy is relatively low: 8000 J & 30000 J for the different configurations.
- The heat will be mainly dissipated by conduction within the Titanium and the temperature reached at the Ti-Ti and Ti-SS boundaries will be low regardless of the configuration.
- For TIG, the total welding energy increases by a factor larger than 5 which largely increases the temperature in the system.
- The most critical configurations are the **short** ones.
- **Configuration 8** (large diameter for TIG) **takes longer to stabilize its temperature.**
- **The times the Ti-Ti and SS-Ti boundaries present $T > 350$ °C are expected to be <30 min for all the configurations.**
- **Anyway, some boundaries reach large temperatures, is there any limitation on the maximum temperature on them?**



Thank you for your attention!

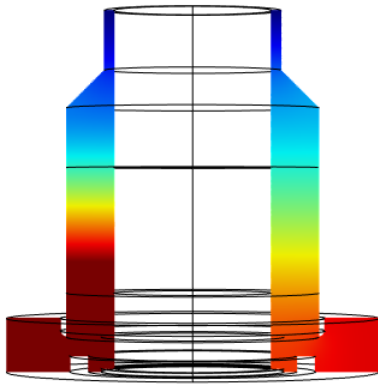


TIG welding - Results

- Results for the different configurations, time normalized as a function of the welding time t_w .
Configurations 5 and 6. $t_w=91.1$ s

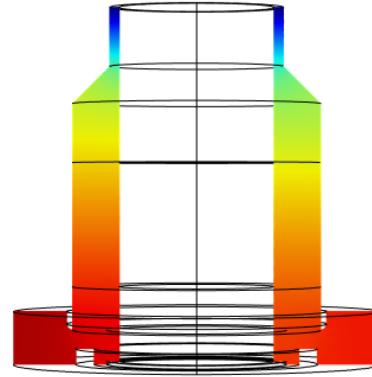
$t/t_w=1$

Time=90 s Slice: Temperature (degC)



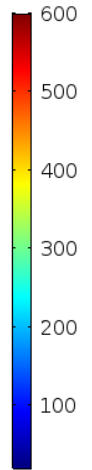
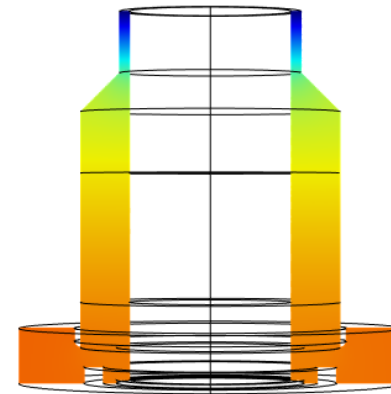
$t/t_w=2$

Time=180 s Slice: Temperature (degC)

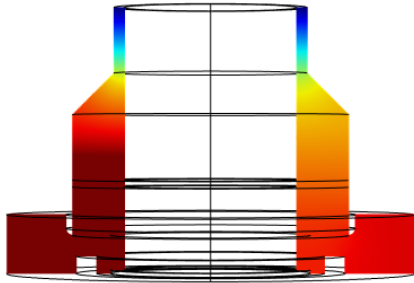


$t/t_w=3$

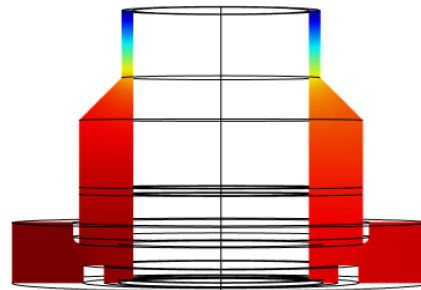
Time=270 s Slice: Temperature (degC)



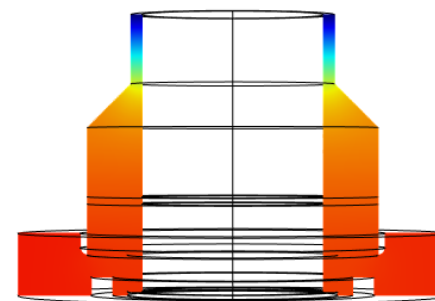
Time=90 s Slice: Temperature (degC)



Time=180 s Slice: Temperature (degC)



Time=270 s Slice: Temperature (degC)

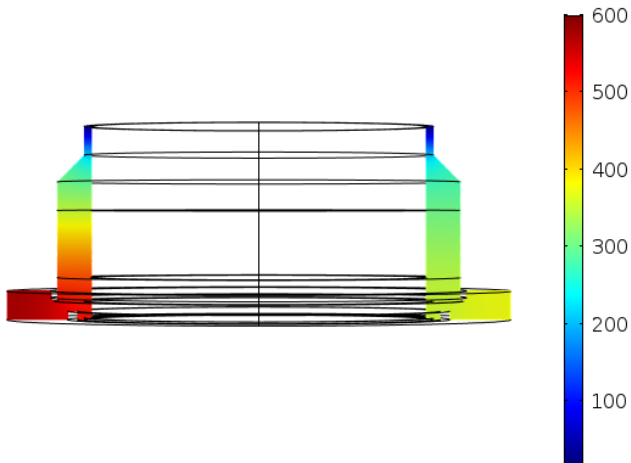


TIG welding - Results

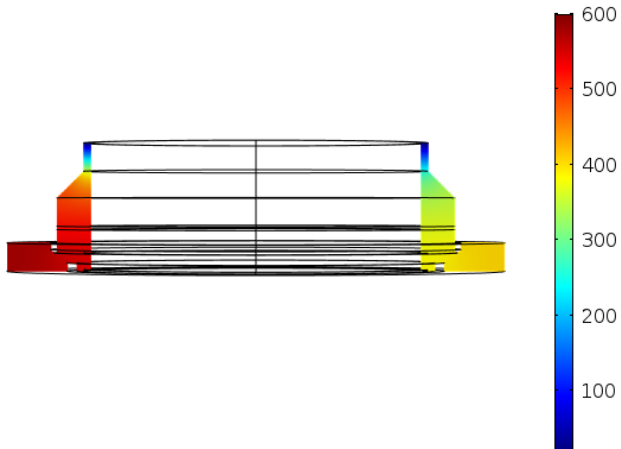
- Results for the different configurations, time normalized as a function of the welding time t_w . **Configurations 7 and 8.** $t_w=333$ s

$t/t_w=1$

Time=333 s Slice: Temperature (degC)

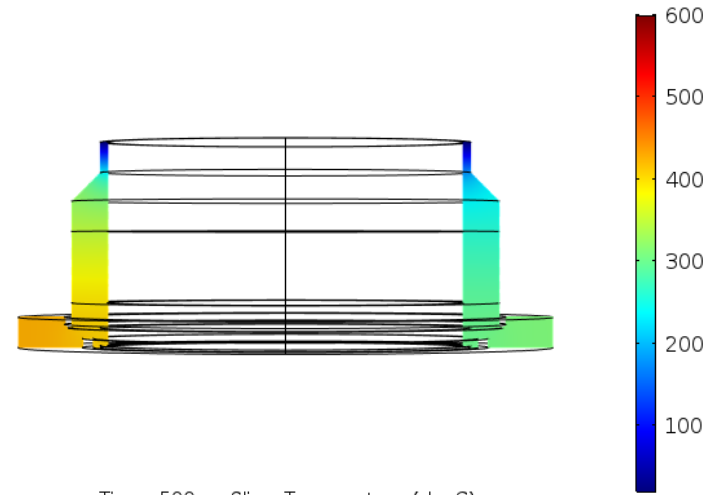


Time=333 s Slice: Temperature (degC)

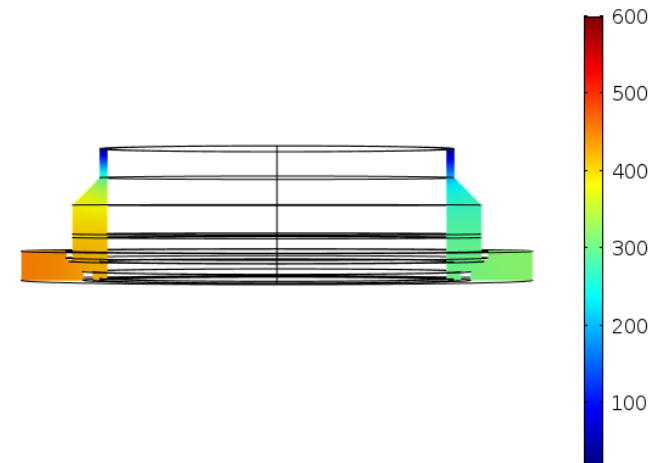


$t/t_w=1.5$

Time=500 s Slice: Temperature (degC)

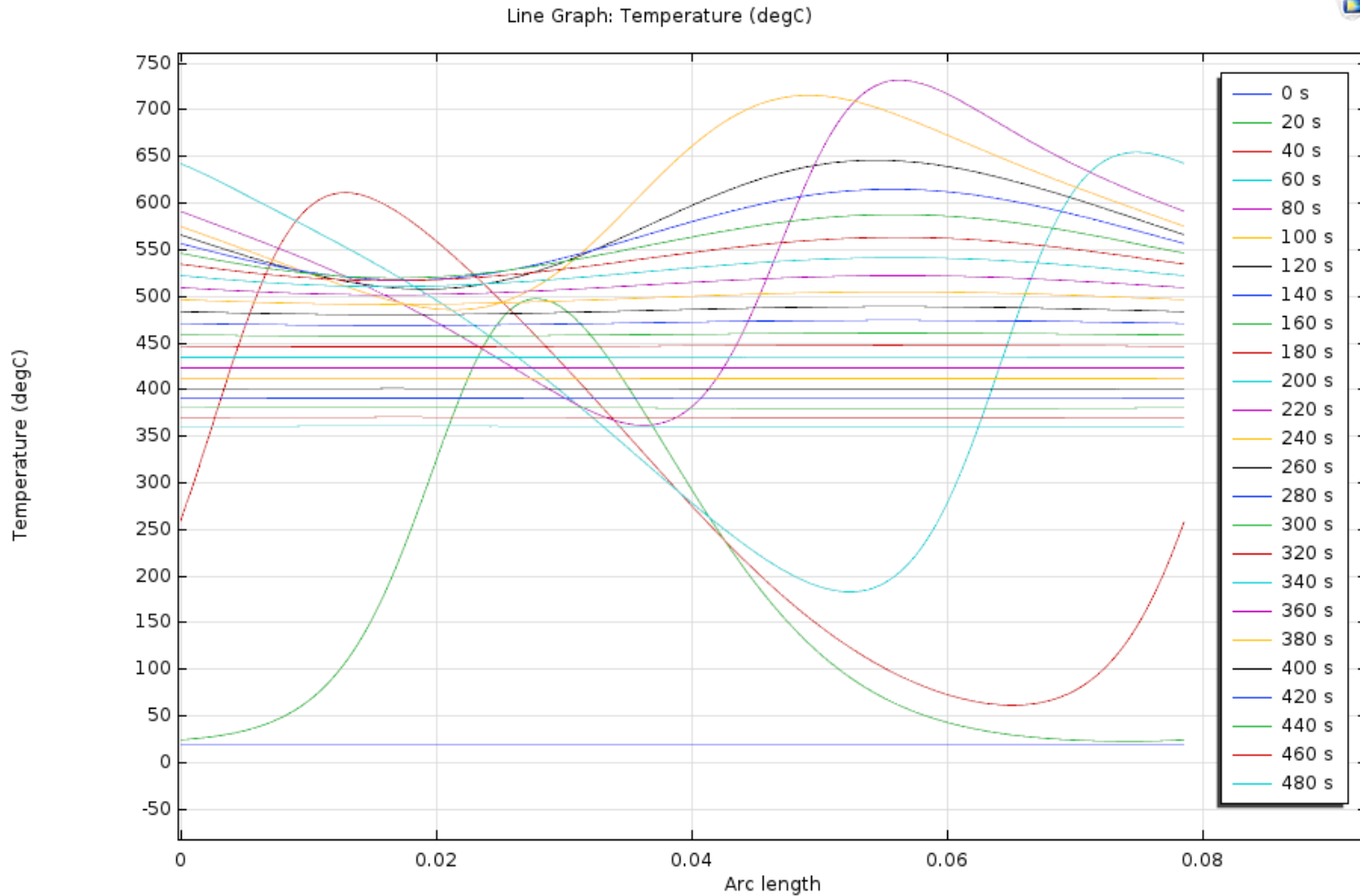


Time=500 s Slice: Temperature (degC)



TIG welding - Results

- Evolution of the temperature along the first Ti-Ti boundary for Configuration 6.



TIG welding - Results

- Evolution of the temperature along the first Ti-Ti boundary for Configuration 8.

