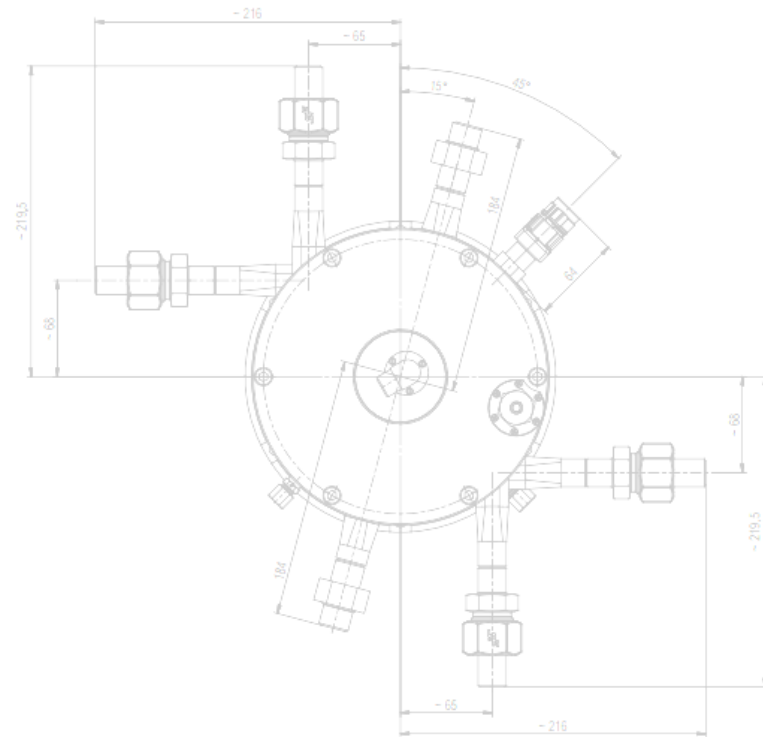
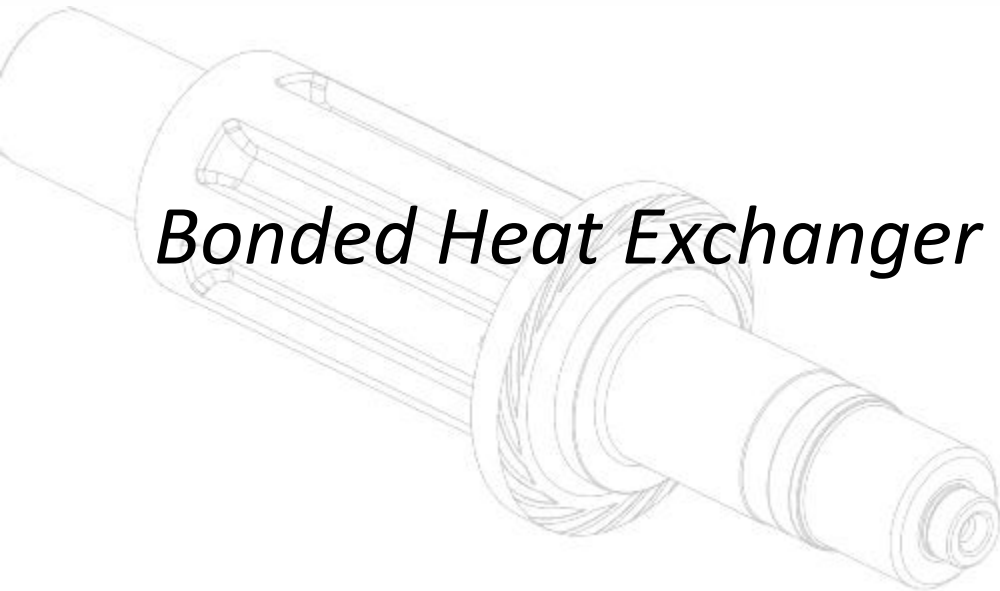


# ATEKO a.s.

1949 – 2019

*Bonded Heat Exchanger*

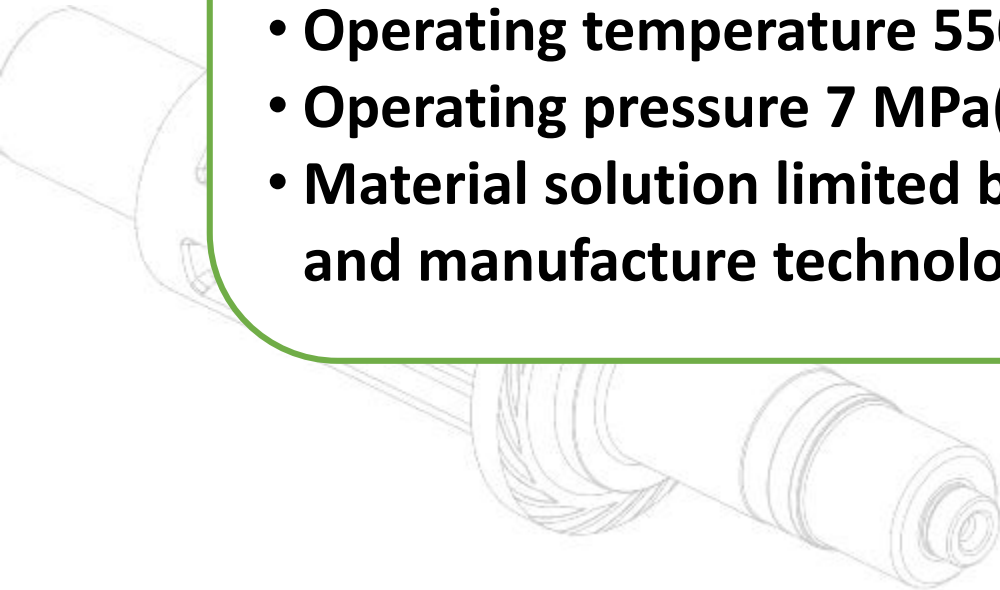
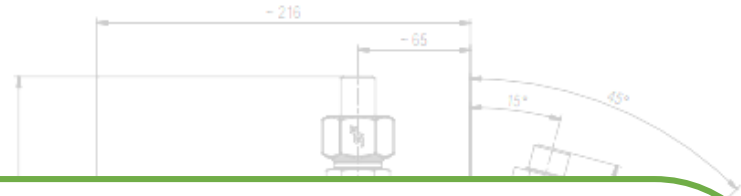


# Bonded Heat Exchanger – Why

## ***Reason For A New Technology Research:***

**Nuclear technology development :**

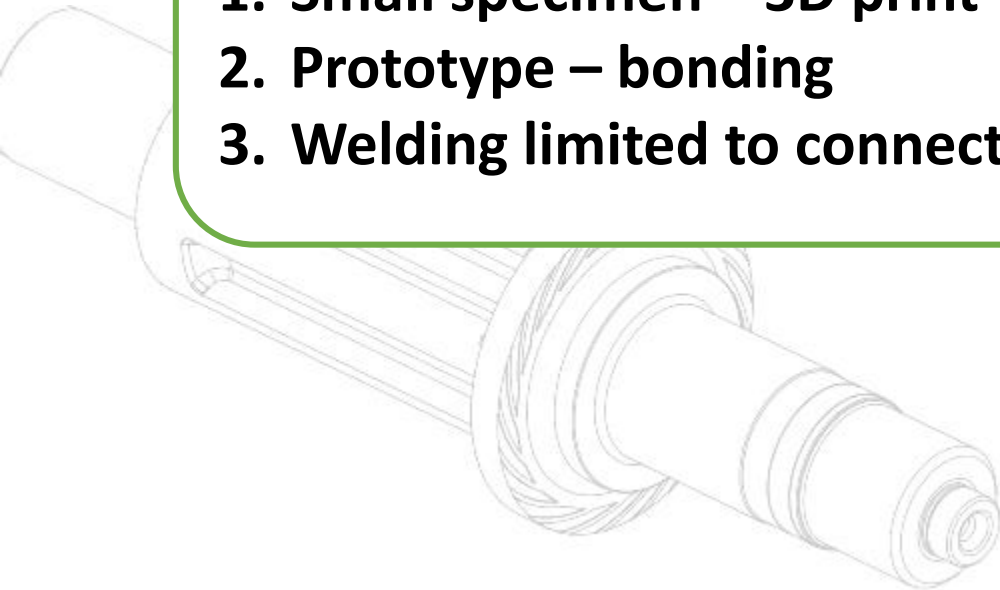
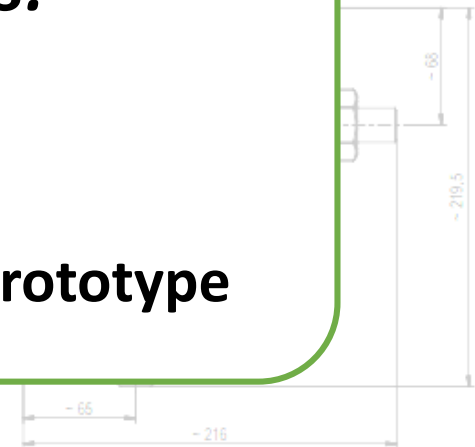
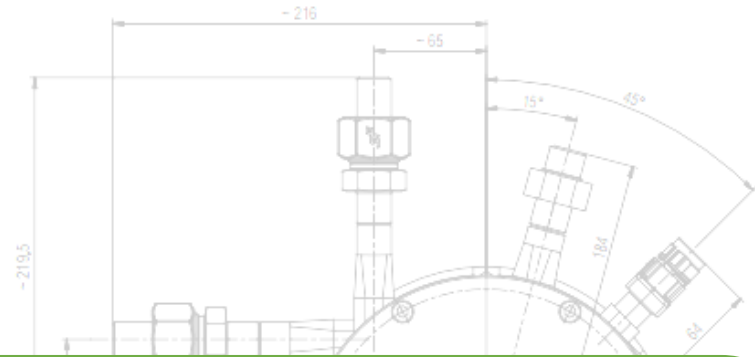
- Nuclear reactors, 4th generation
- Cooled by Helium
- Operating temperature 550 – 580 °C
- Operating pressure 7 MPa(g)
- Material solution limited by operating conditions and manufacture technology



# Bonded Heat Exchanger – How

## *Possible Manufacture Methods:*

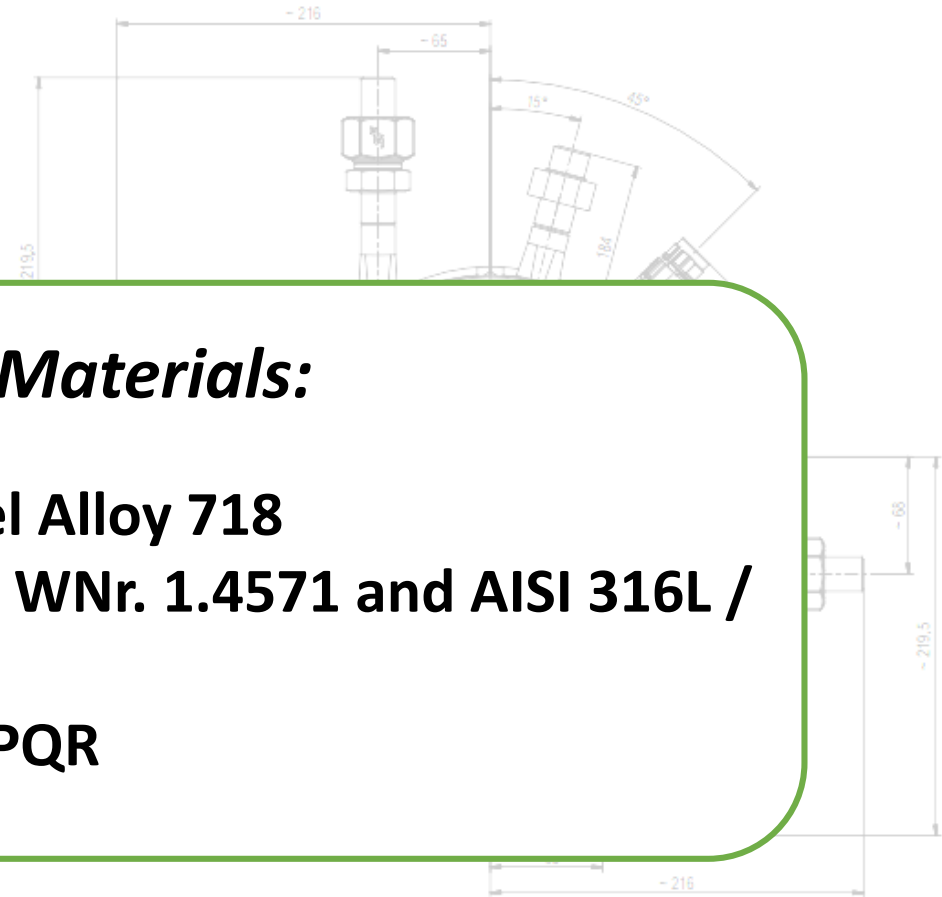
- 1. Small specimen – 3D print**
- 2. Prototype – bonding**
- 3. Welding limited to connecting flanges at prototype**



# Bonded Heat Exchanger – How

## *Possible Materials:*

1. Small specimen – Inconel Alloy 718
2. Prototype – AISI 316 Ti / WNr. 1.4571 and AISI 316L / WNr. 1.4404
3. Welding according to WPQR

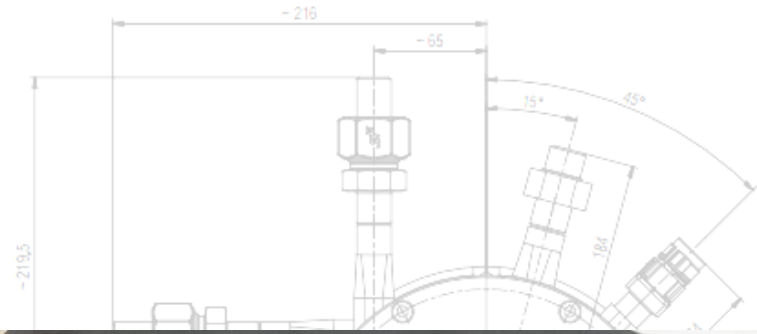


# Bonded Heat Exchanger – Small Specimen

## ***3D Print***

**Microchannells 2 mm x 1 mm**

**Several pieces  
needed to have  
a functional unit**

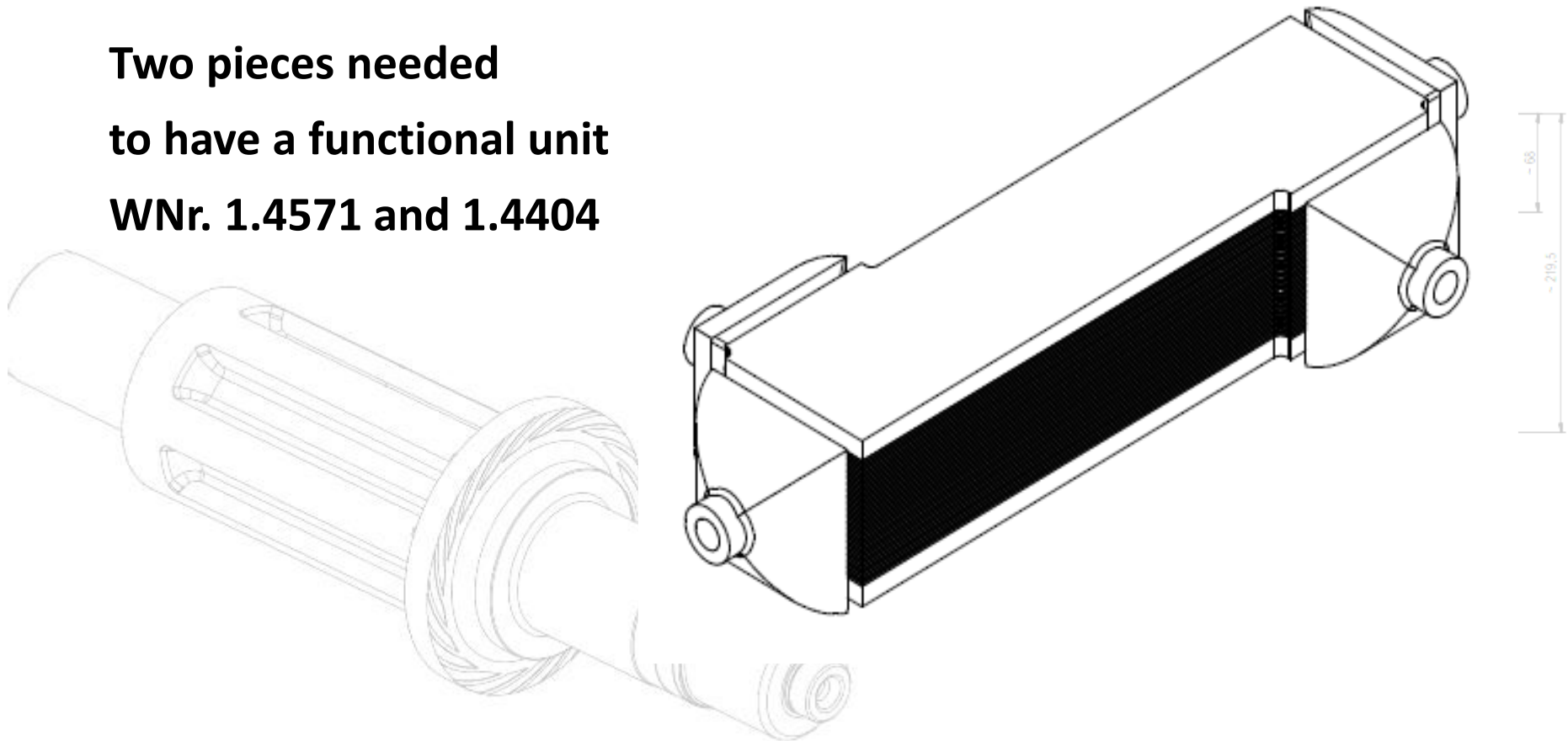
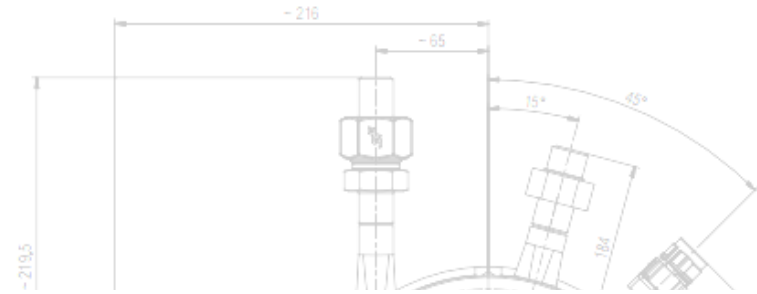


# Bonded Heat Exchanger – Prototype

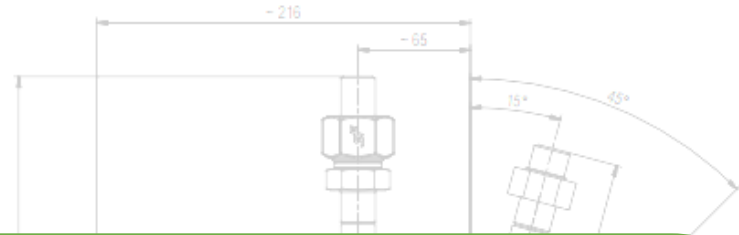
## *Diffusion Bonding*

**Microchannells 3 mm x 2 mm**

**Two pieces needed  
to have a functional unit  
WNr. 1.4571 and 1.4404**



# Bonded Heat Exchanger – Bonding



## ***Diffusion Bonding:***

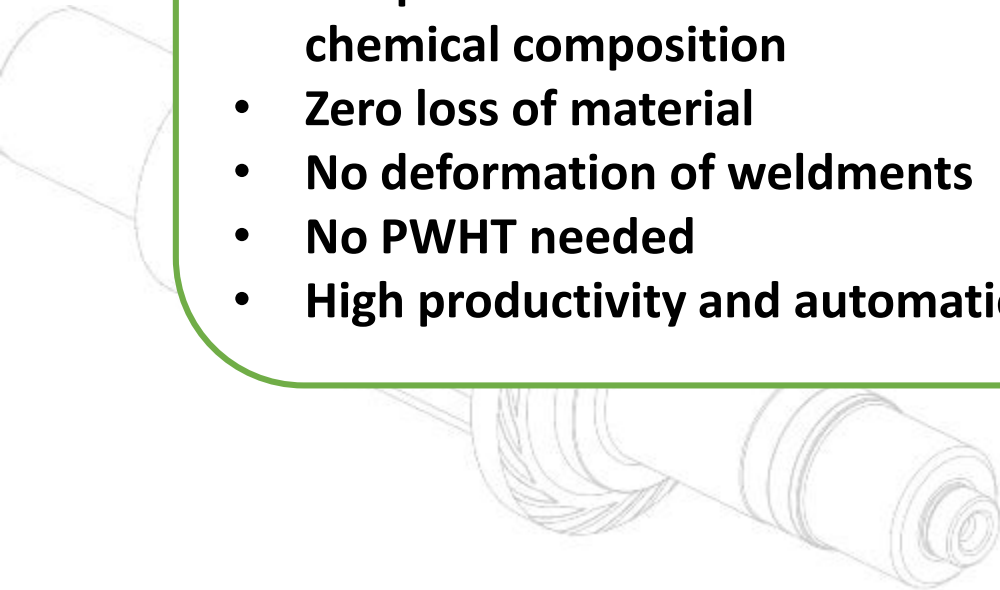
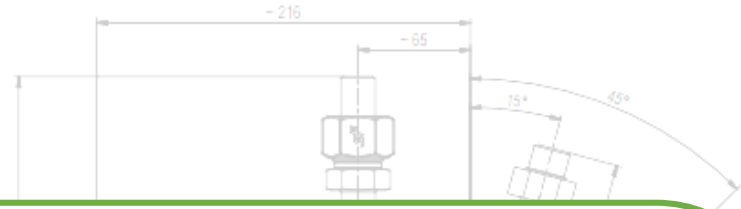
**Solid-state diffusion welding of materials is a method of obtaining a monolithic bond, which is based on the formation of atomic bonds resulting from the maximum approximation of the surfaces to be joined and local plastic deformation at elevated temperature. This ensures diffusion in the surface layers of the joined materials**



# Bonded Heat Exchanger – Bonding

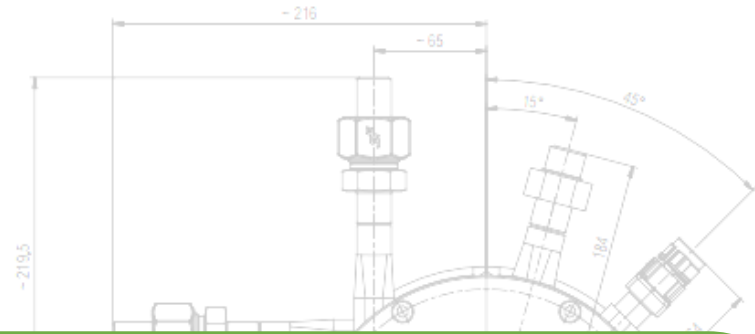
## ***Diffusion Bonding Pros:***

- **No welding consumables**
- **It is possible to weld thin-walled and thick-walled materials**
- **It is possible to weld materials of the same or different chemical composition**
- **Zero loss of material**
- **No deformation of weldments**
- **No PWHT needed**
- **High productivity and automation application**



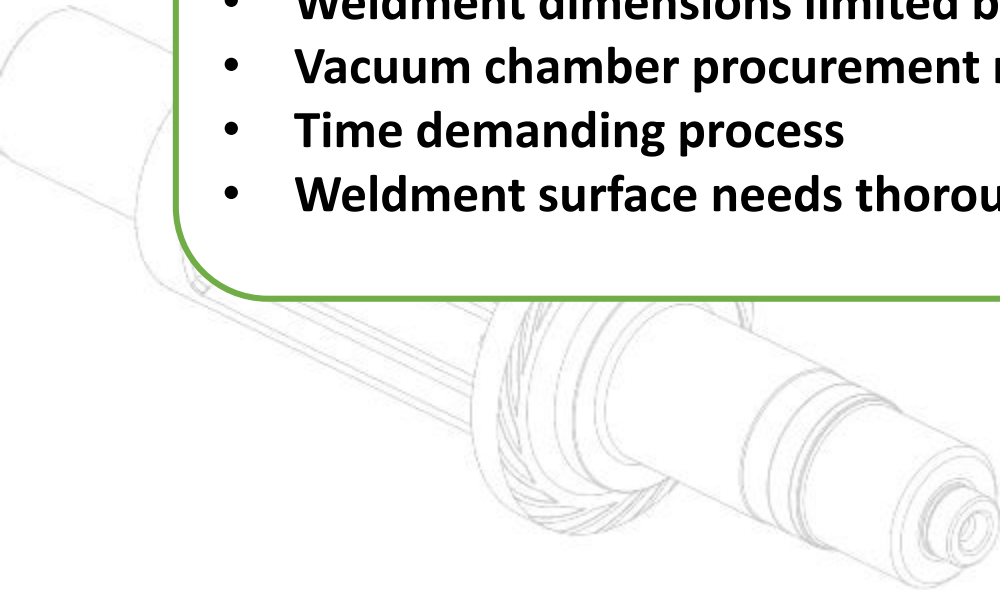


# Bonded Heat Exchanger – Bonding



## ***Diffusion Bonding Cons:***

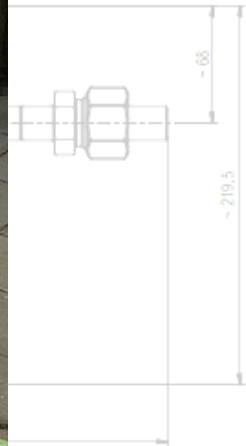
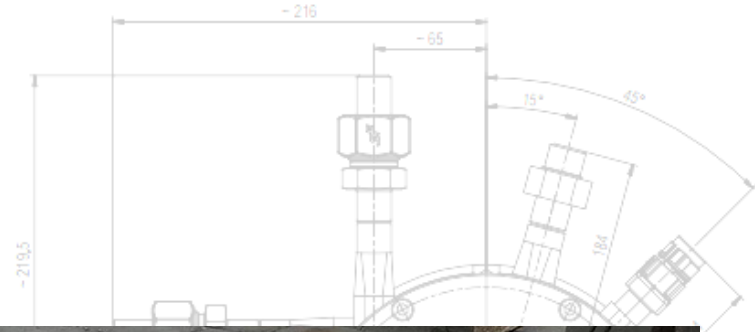
- **Weldment dimensions limited by vacuum chamber dimensions**
- **Vacuum chamber procurement requires costly investment**
- **Time demanding process**
- **Weldment surface needs thorough preparation**



# Bonded Heat Exchanger - Result

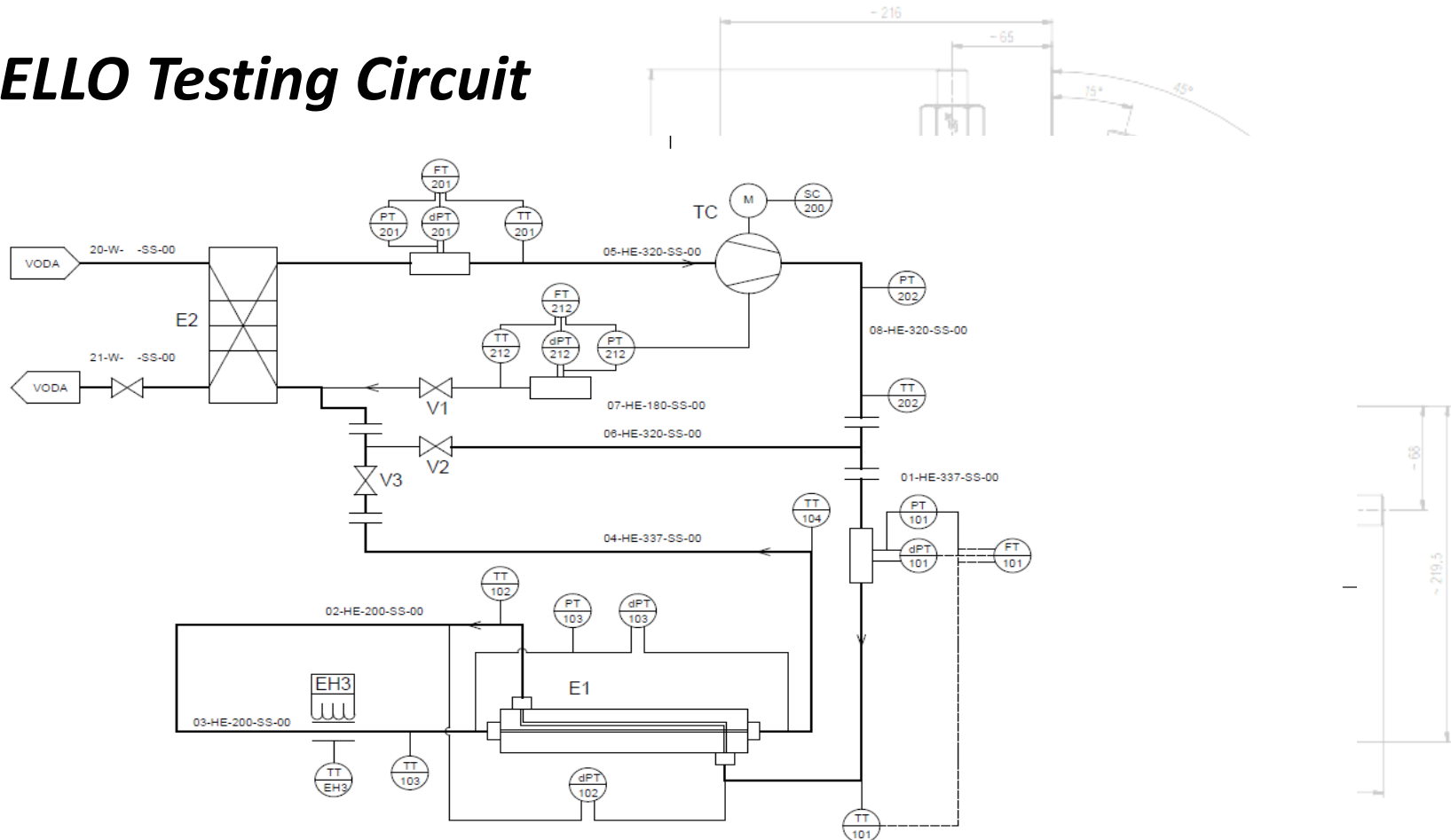
***2nd Prototype pre-testing washing***

**WNr. 1.4404 Steel**



# Bonded Heat Exchanger – Testing Circuit

## AHELLO Testing Circuit



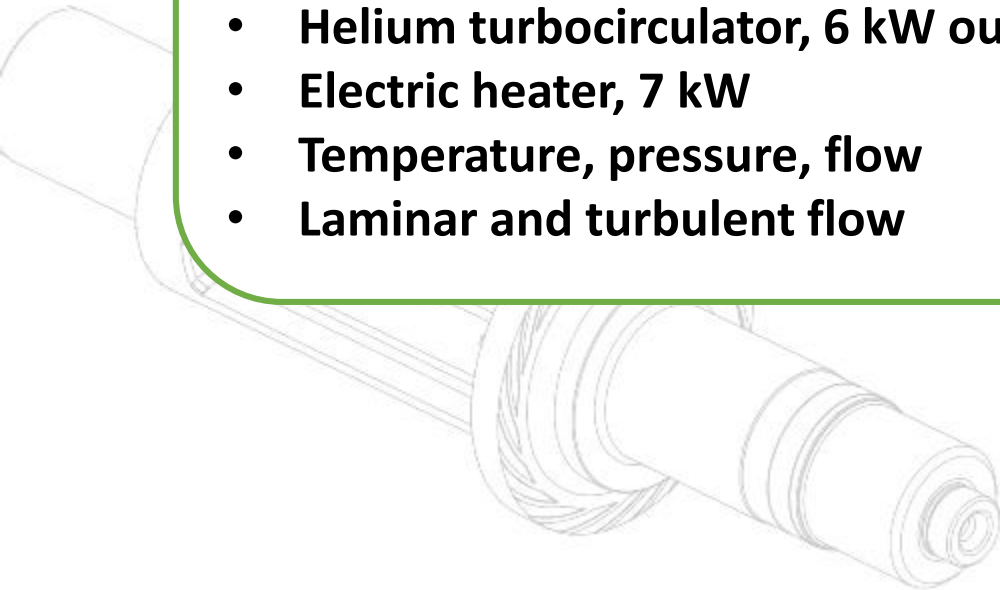
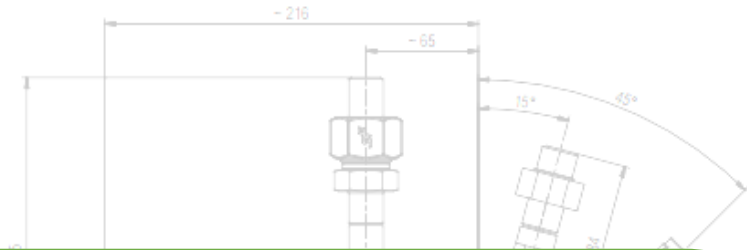
ZAPOJENÍ PRO TÍŠTĚNÝ VÝMĚNÍK

POZN.	70077 Vysokotepelný výměník		CELKOVÁ ČISTÁ VÁHA / kg				
MĚŘITKO	KRESLIL	Hušek		ZMĚNA	DATUM	POPS	INDEX
	PREZKOUSEL	Stoček					
	SCHVALIL	Víns					
	KOORDINÁTOR	Dostálová					
	DNE	11.05.2018					
			NAZEV		ČÍSLO VÝKRESU		
			PID MĚŘICÍ TRATĚ AHELLO 2		3-PI-4053-2		
			1		LISTO		
					LIST 1		

# Bonded Heat Exchanger – Testing Circuit

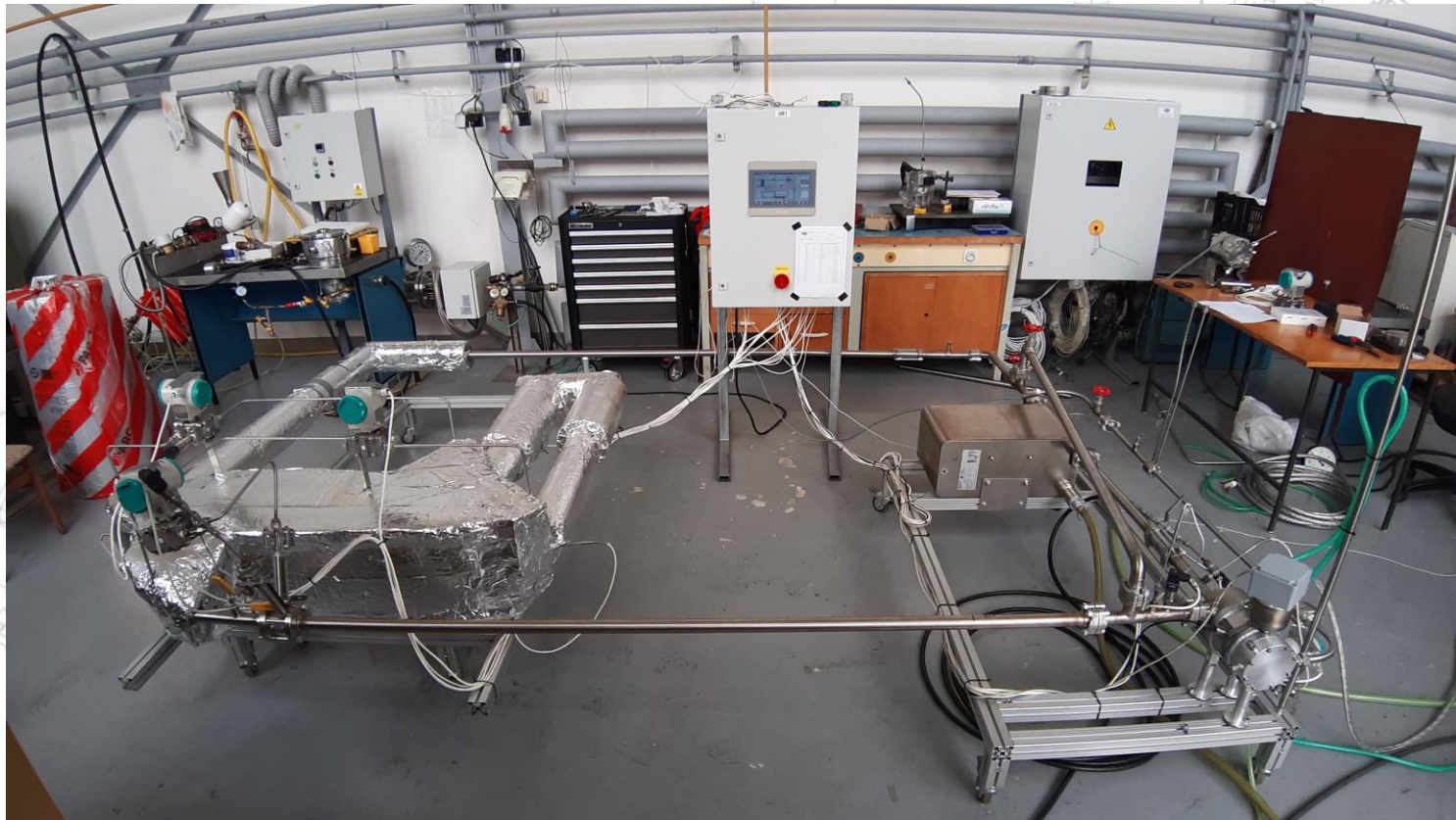
## ***AHELLO Testing Circuit:***

- **Gas-to-gas heat exchanger**
- **Water-to-gas plate heat exchanger**
- **Helium turbocirculator, 6 kW output**
- **Electric heater, 7 kW**
- **Temperature, pressure, flow**
- **Laminar and turbulent flow**



# Bonded Heat Exchanger – Testing Circuit

## AHELLO Testing Circuit with Bonded Heat Exchanger



# Bonded Heat Exchanger – Results

## ***Overall Results:***

- **Both of 3D printed specimen and bonded prototype heat exchangers manufactured and tested**
- **Design process and manufacture technology verified**
- **Teoretical models verified by real measurement**
- **Applied materials tested on mechanical qualities**
- **Compact solution of gas-to-gas heat exchanger**
- **Ready for serial production by both of 3D print and bonded welding**
- **Ready for use in Helium cooled circuits**



*Thank you for your attention*

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