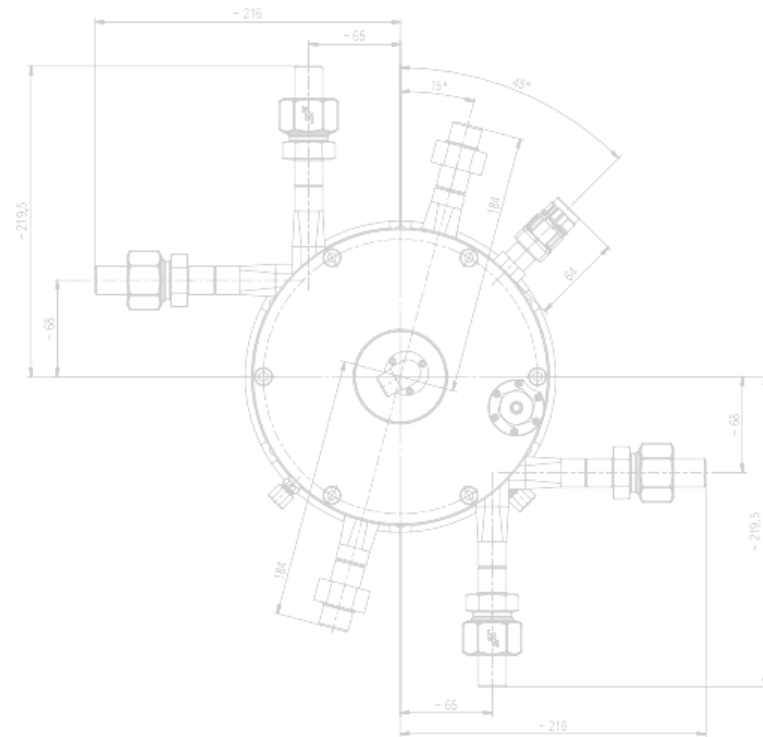
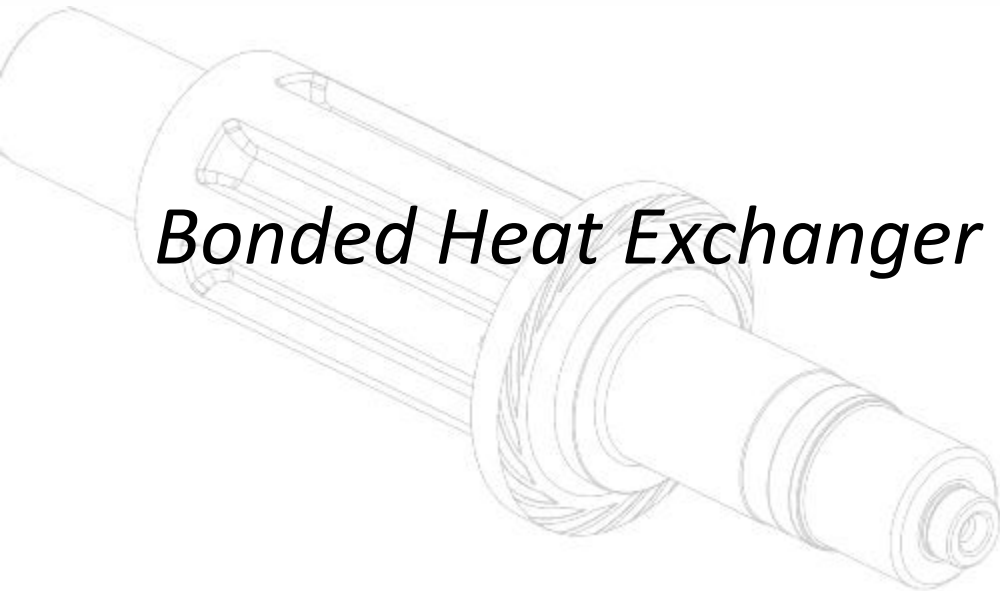


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1949 – 2020

Bonded Heat Exchanger

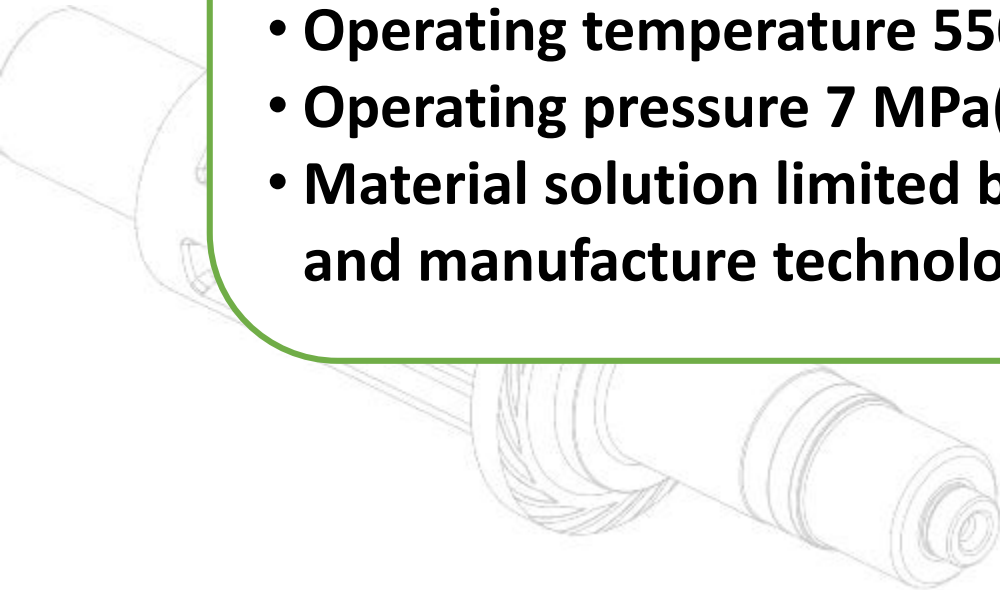
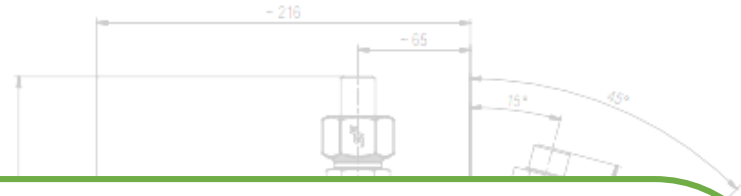


Bonded Heat Exchanger – Why

Reason For A New Technology Research:

Nuclear technology development:

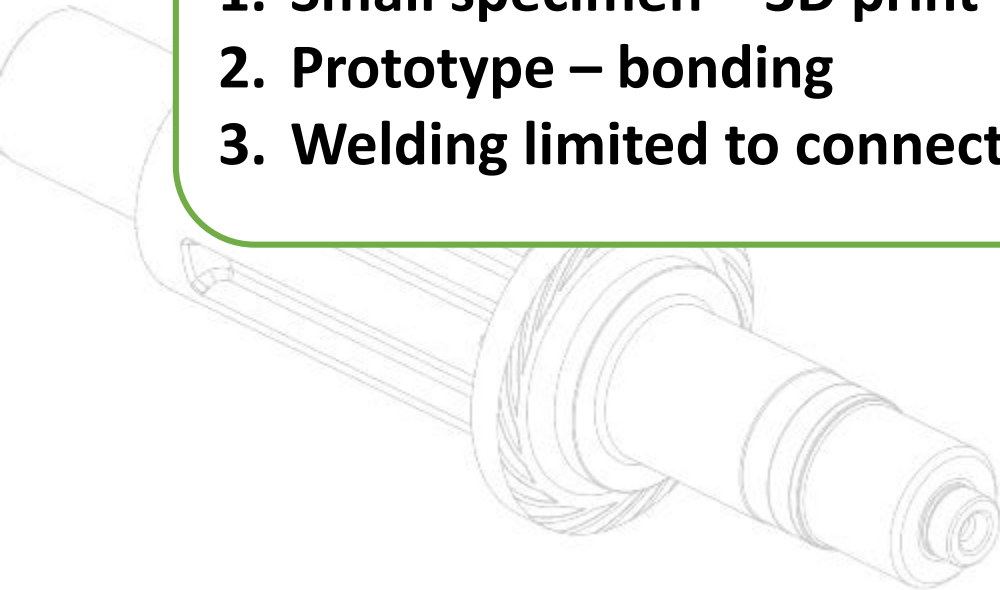
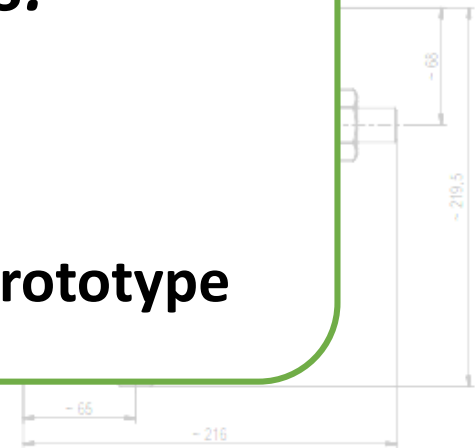
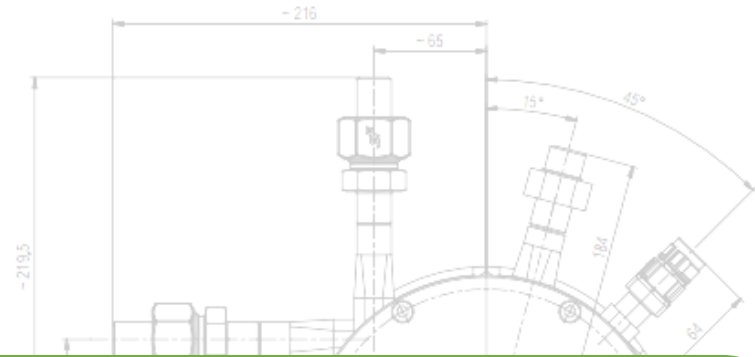
- Nuclear reactors, 4th generation
- Cooled by Helium
- Operating temperature 550 – 580 °C
- Operating pressure 7 MPa(g)
- Material solution limited by operating conditions and manufacture technology



Bonded Heat Exchanger – How

Possible Manufacture Methods:

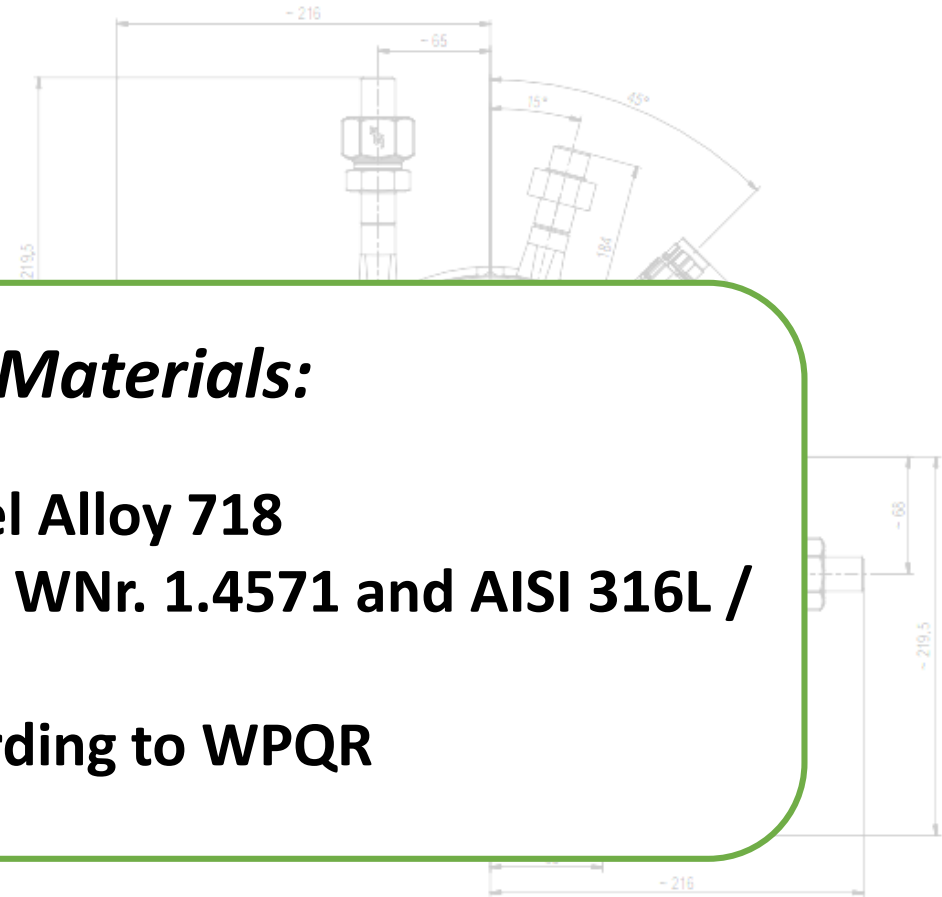
- 1. Small specimen – 3D print**
- 2. Prototype – bonding**
- 3. Welding limited to connecting flanges at prototype**



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 of flanges according to WPQR

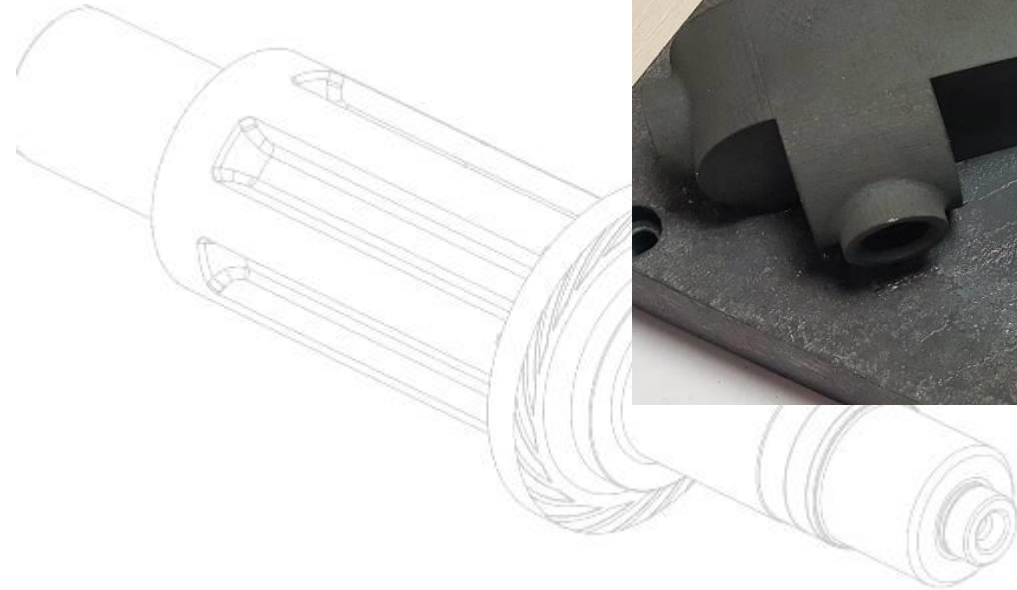
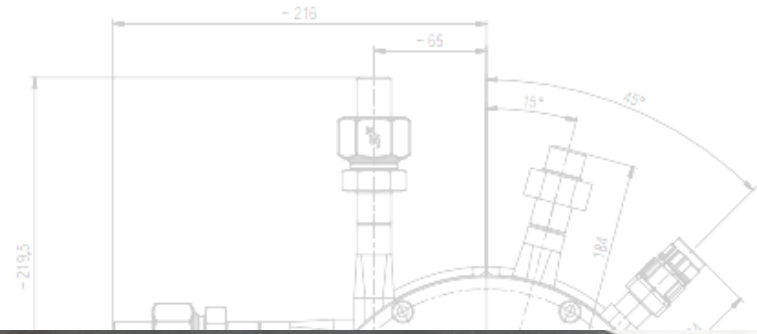


Bonded Heat Exchanger – Small Specimen

3D Print

Microchannells 2 mm x 1 mm

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

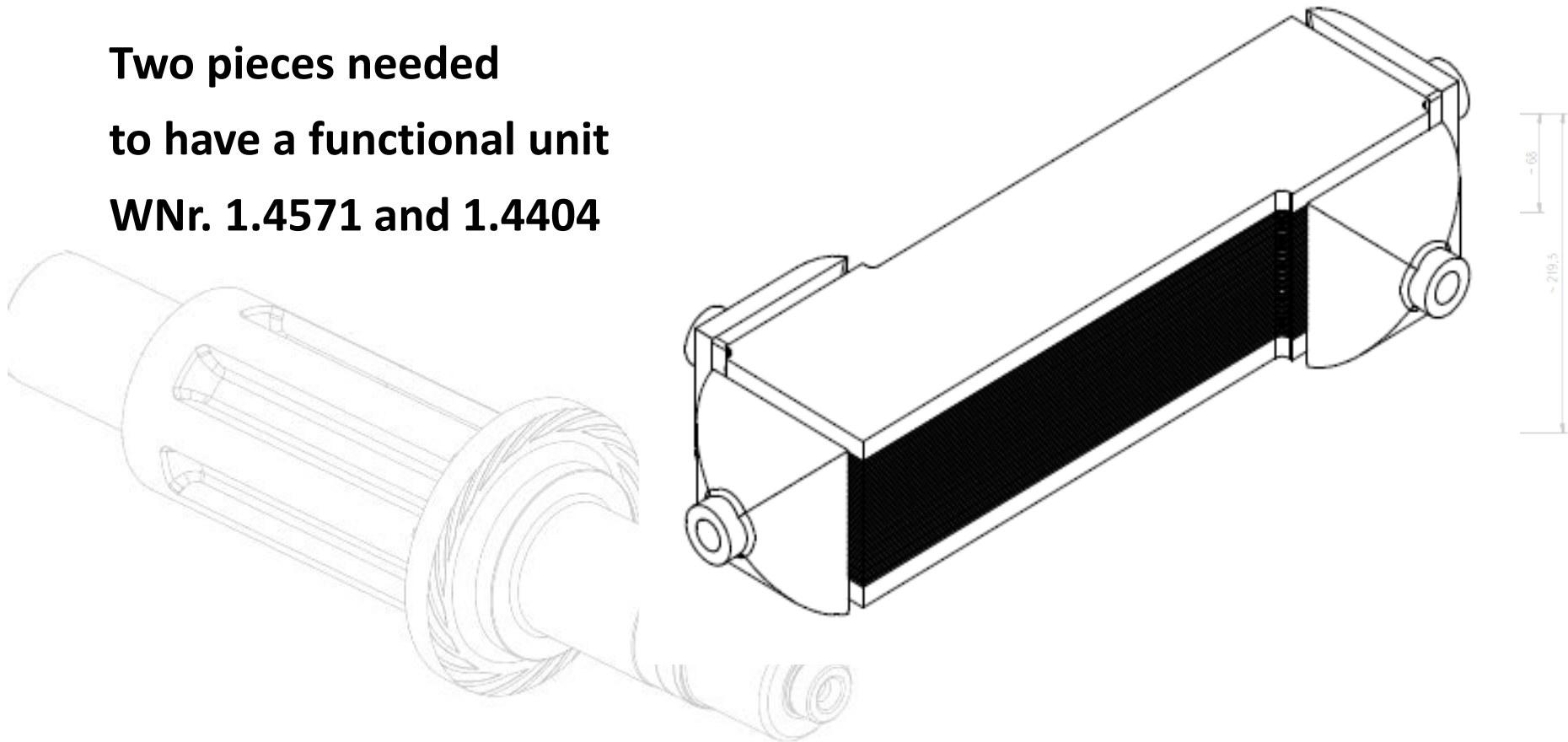
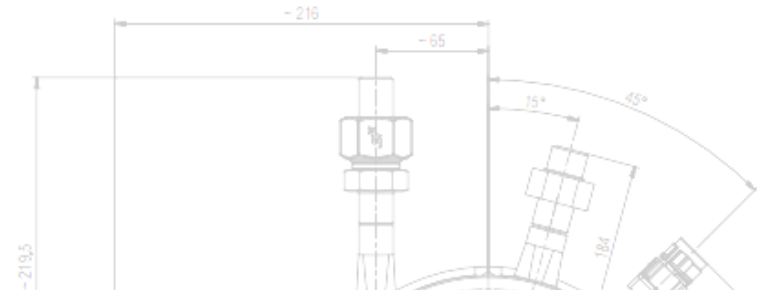


Bonded Heat Exchanger – Prototype

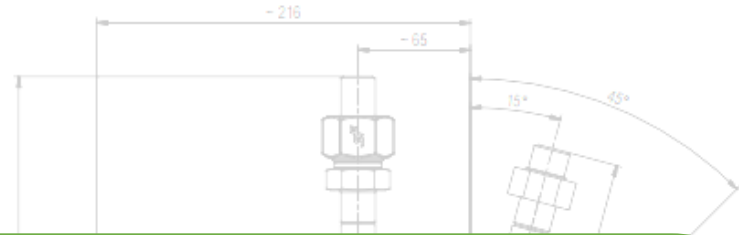
Diffusion Bonding

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:

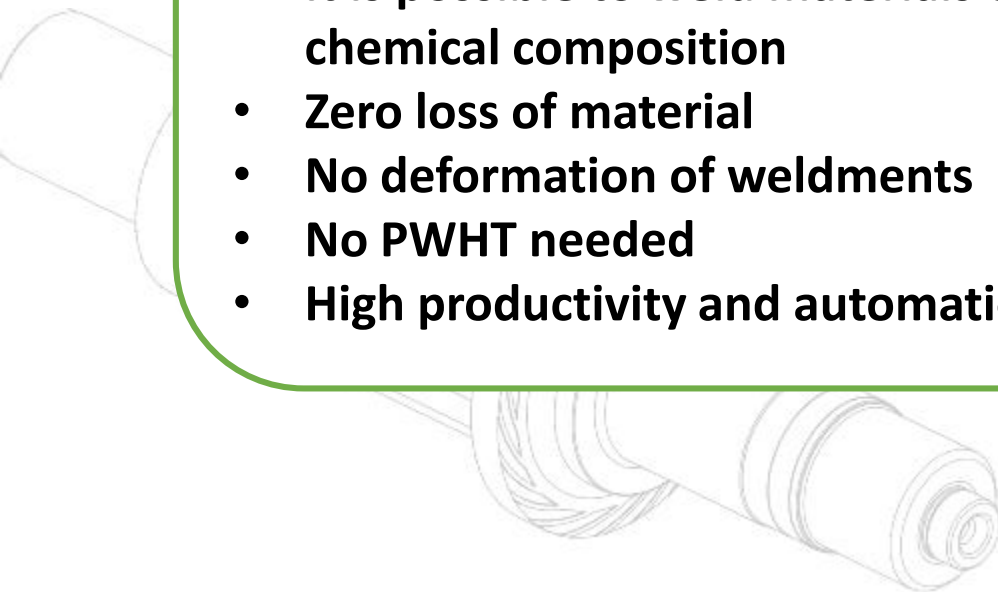
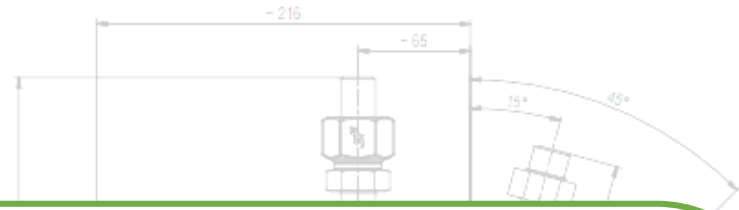
Solid-state diffusion welding of materials is a method of obtaining a monolithic bond, which is based on the formation of atomic bonds resulting from the maximum approximation of the surfaces to be joined and local plastic deformation at elevated temperature. This ensures diffusion in the surface layers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



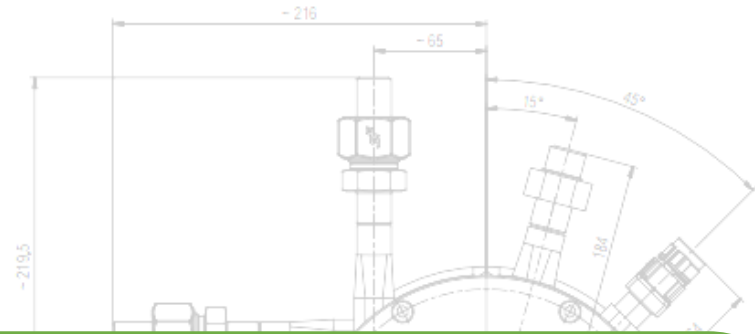
Bonded Heat Exchanger – Bonding

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**

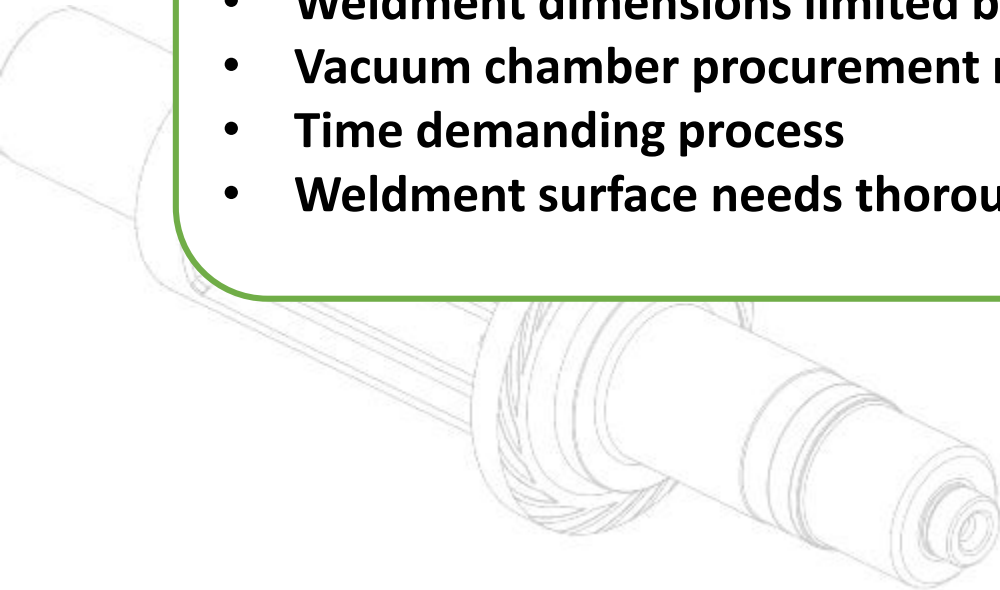


Bonded Heat Exchanger – Bonding



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

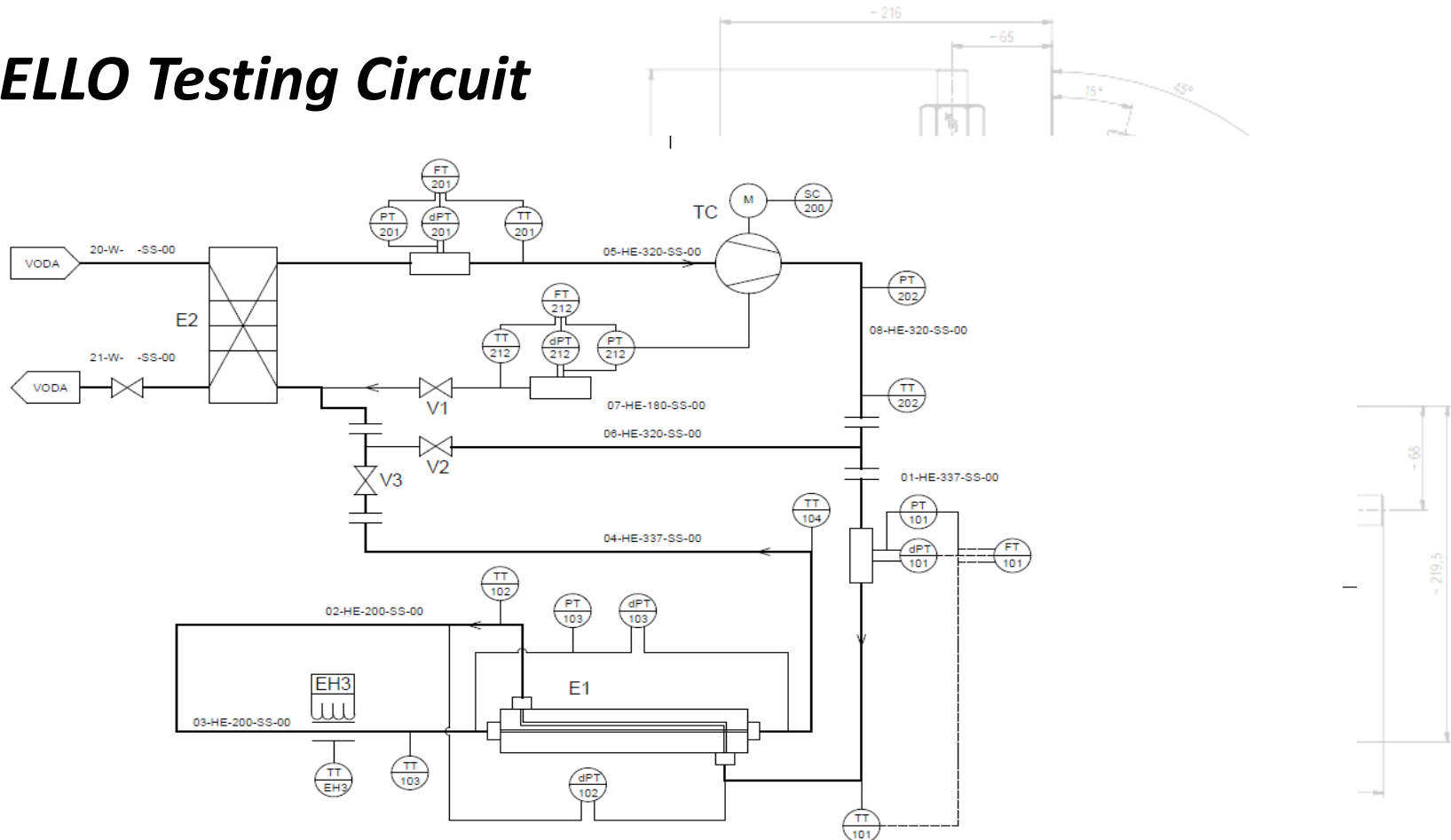
2nd Prototype pre-testing washing

WNr. 1.4404 Steel



Bonded Heat Exchanger – Testing Circuit

AHELLO Testing Circuit



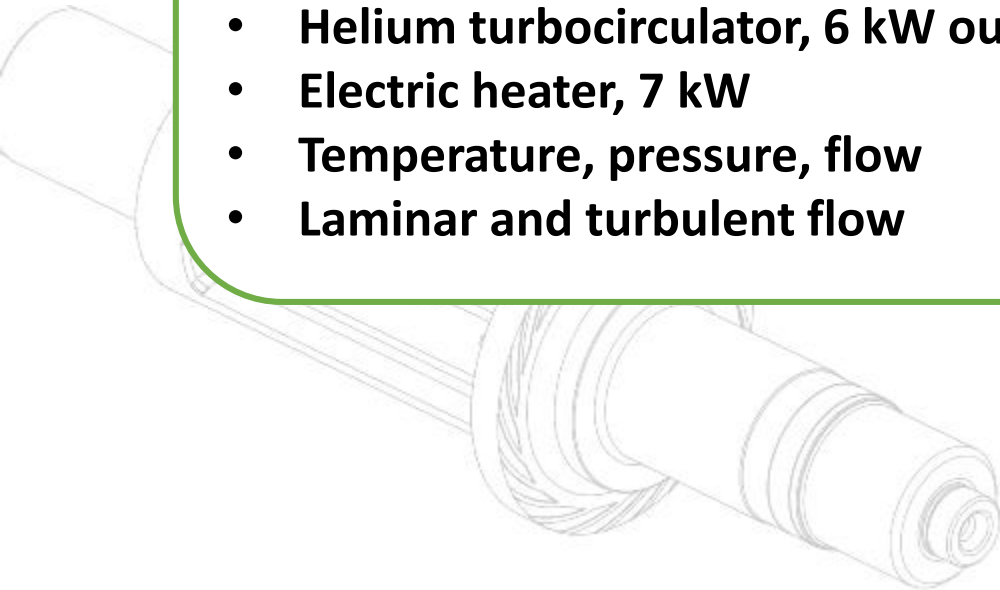
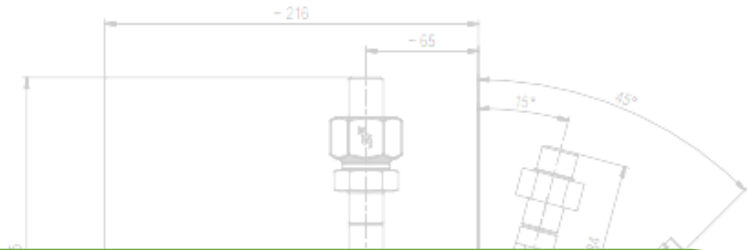
ZAPOJENÍ PRO TÍŠTĚNÝ VÝMĚNÍK

POZN.	70077 Vysokotepelní výměníky		CELKOVÁ ČISTÁ VÁHA / kg				
MĚŘÍTKO	KRESLIL	Hušek		ZMĚNA	DATUM	POPS	INDEX
	PREZKOUSEL	Stoček					
	SCHVALIL	Víns					
	KOORDINÁTOR	Dostálová					
	DNE	11.05.2018					
			NAZEV	CÍSLO VÝKRESU			
			PID MĚŘÍCÍ TRATĚ AHELLO 2	3-PI-4053-2			
			1	LISTO			
				LIST 1			

Bonded Heat Exchanger – Testing Circuit

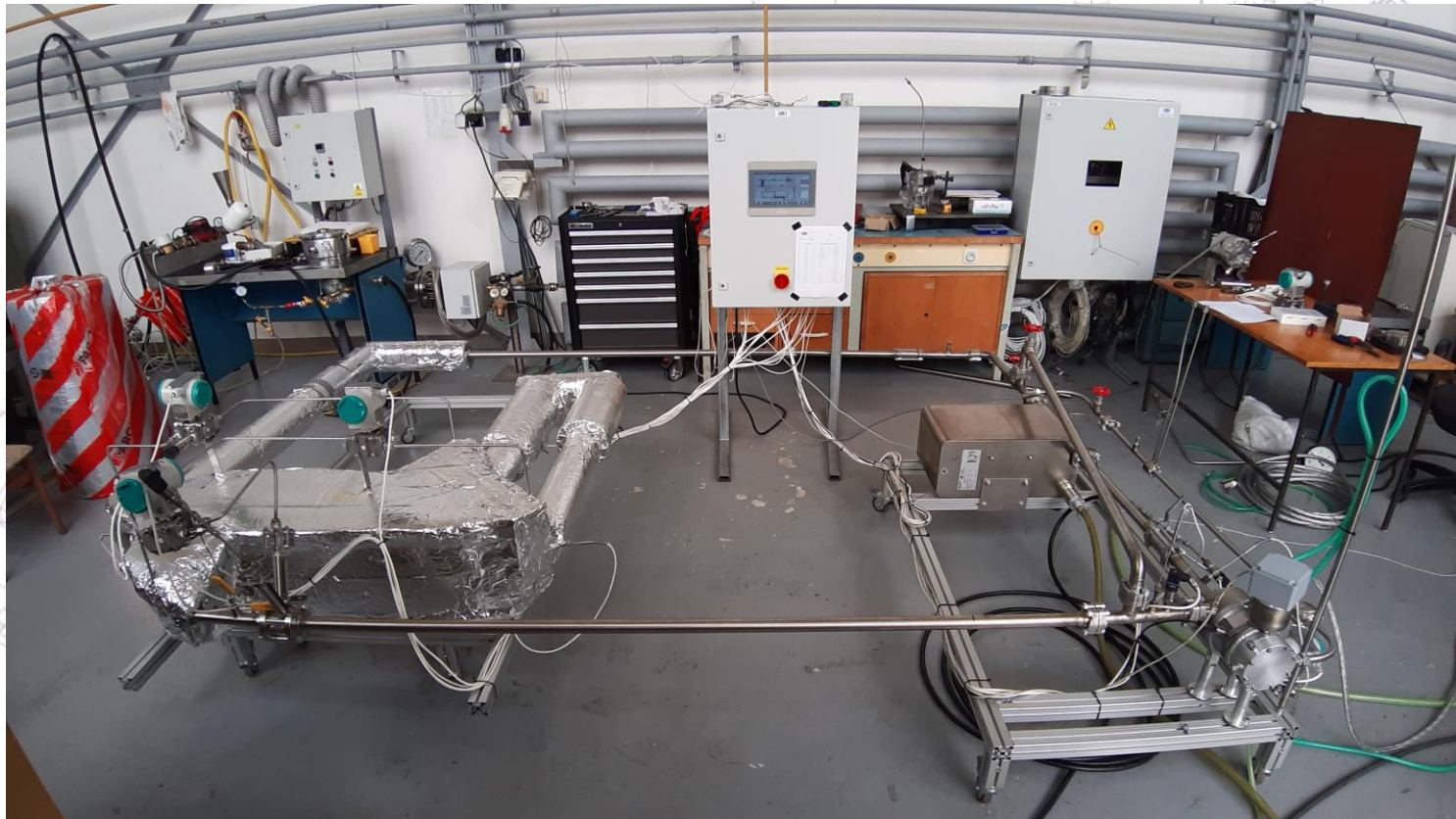
AHELLO Testing Circuit:

- **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

<http://www.ateko.cz>

ateko@ateko.cz

