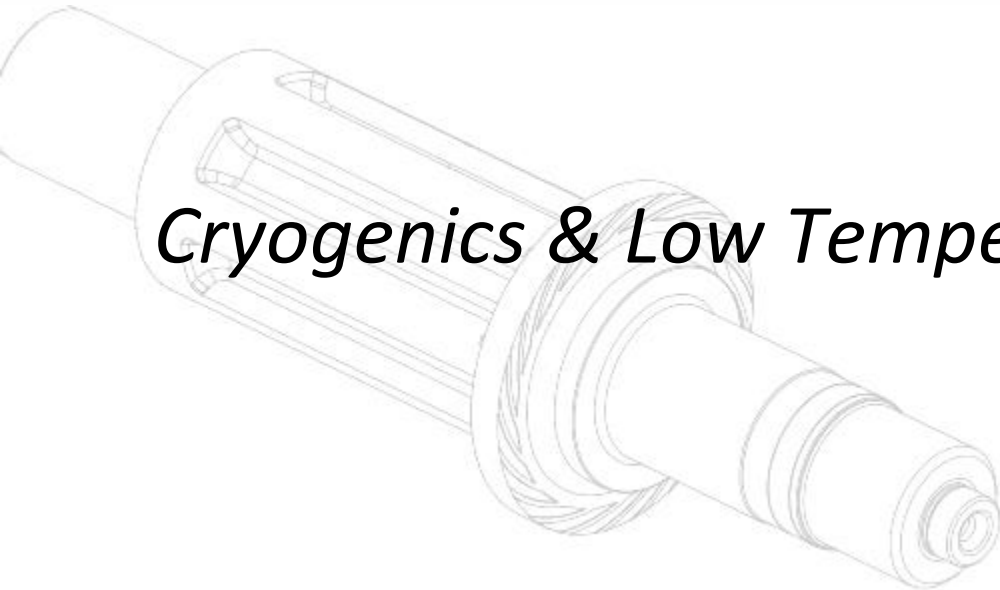
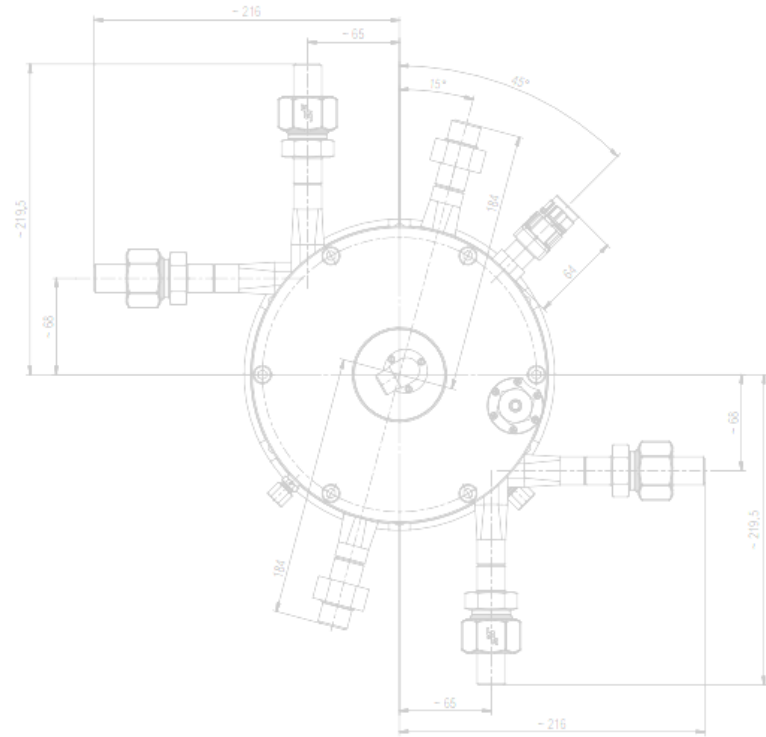


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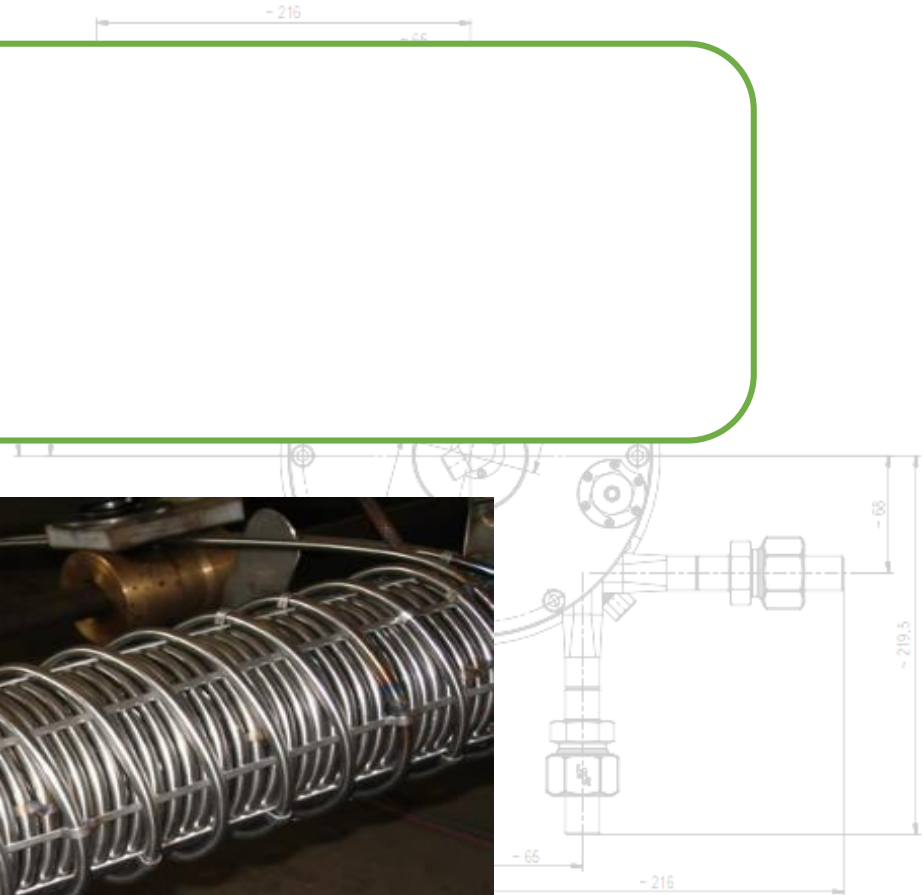
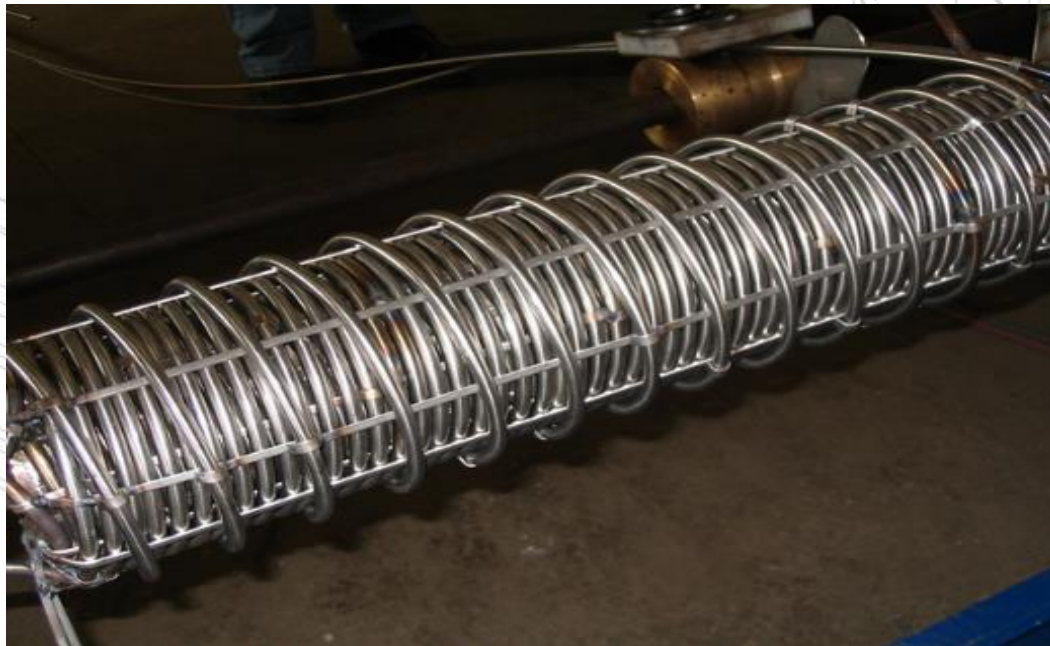
Cryogenics & Low Temperatures Equipment



Cryogenics & Low Temperatures Technology Survey 1

Low Temperature Heat Exchangers

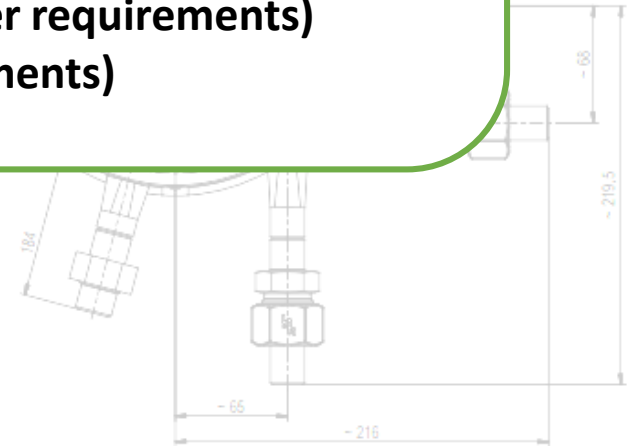
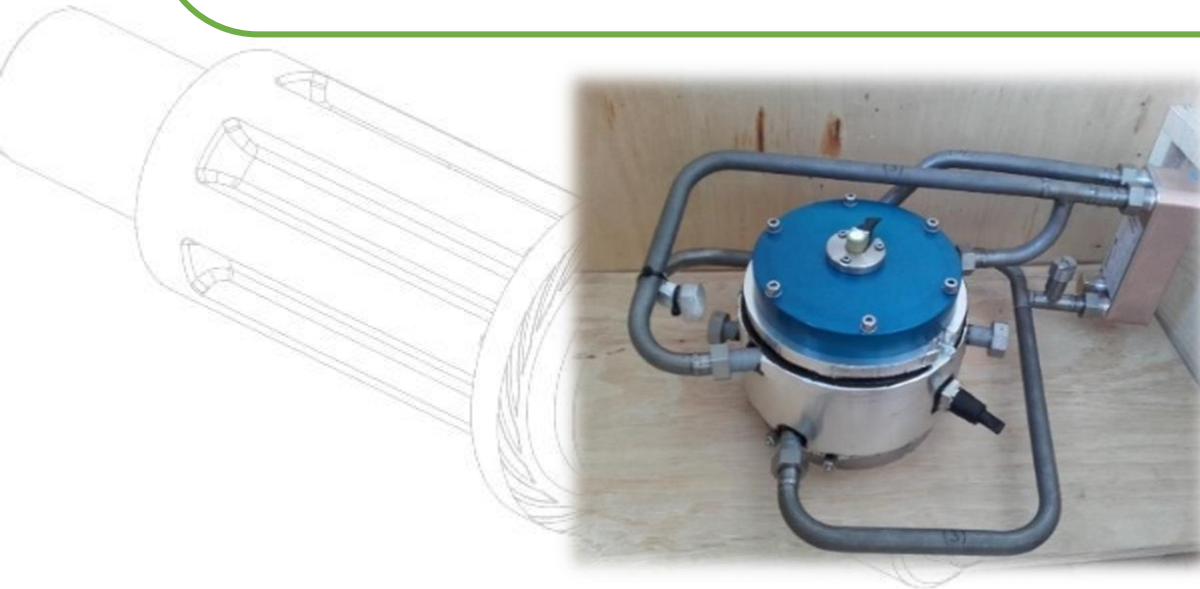
- **Spiral wound design**
- **Temperature:** up to 77 K
- **Pressure:** up to 1.6 MPa,g



Cryogenics & Low Temperatures Technology Survey 2

Helium Expansion Turbines (HET)

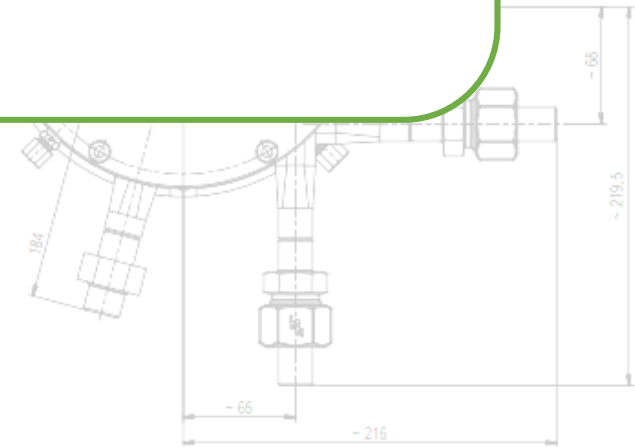
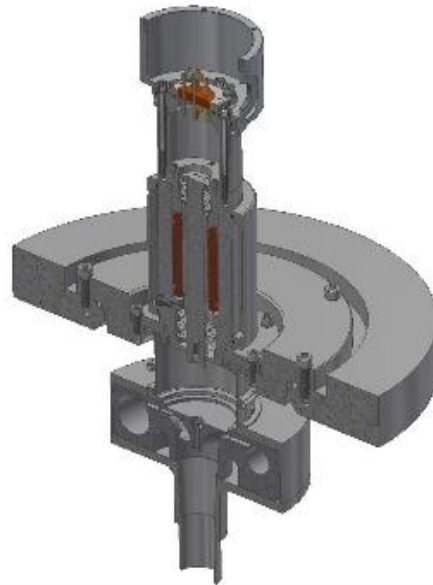
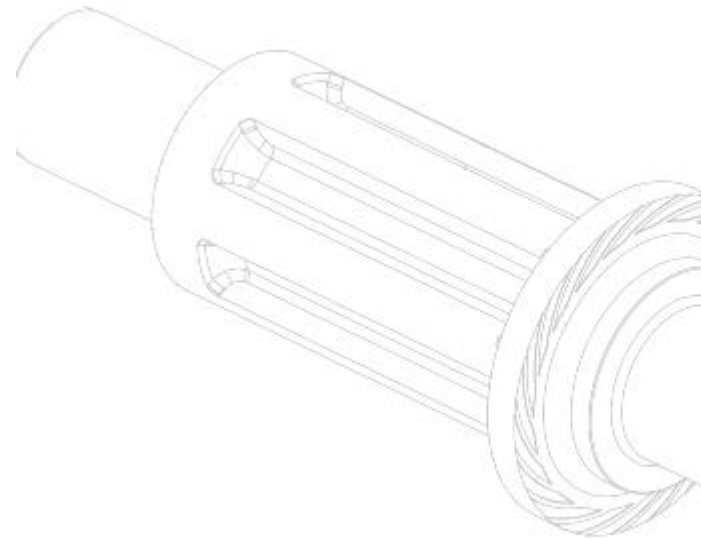
- A single shaft high-speed cryogenic machine braked by eddy current brake
- Designed as a one stage expansion of He or other gases (N_2 , Ar, CO_2 , CH_4 etc.)
- Up to 300 000 rpm
- HET 2 – 10 kW, HEXT 0.1 – 2 kW
- Inlet temperature: from approx. 5 K (or by customer requirements)
- Pressure: up to 2.5 MPa,a (or by customer requirements)



Cryogenics & Low Temperatures Technology Survey 3

Cold Compressors (CC)

- A single shaft high-speed machine
- Designed as a one stage compression of cryogenic Helium
- Up to 54 000 rpm (or higher according operating param. and customer requirements)
- 0.1 - 10 kW
- Temperature from approx 2.5 K
- Pressure from: 3 kPa (or lower or higher)



Cryogenics & Low Temperatures Technology Survey 4

Turbo-Expander Circulator (TEC) – Cryogenic Cooling System Brayton (CSB)

- A cryogenic cooling system Brayton
- 250 000 rpm
- Cooling power: 0.1 - 20 kW
- Temperature: 170 - 5 K
- Pressure: 2.5 Mpa,a (or higher according to customer requirements)



Cryogenics & Low Temperatures Technology Survey 5

International Underground Laboratories - Radon Removal Systems

Laboratories:

- Modane, France, 2004,
- Gran Sasso, Italy, 2011-12,
- Y2L, Korea, 2015
- LSC, Spain, 2015
- SURF, USA, 2017
- Jin Ping, China, 2019

Technical data:

Air flow 120 – 300 m³/h

Input radon concentration 20 - 100 bq/m³

Reduction of radon concentration 1000

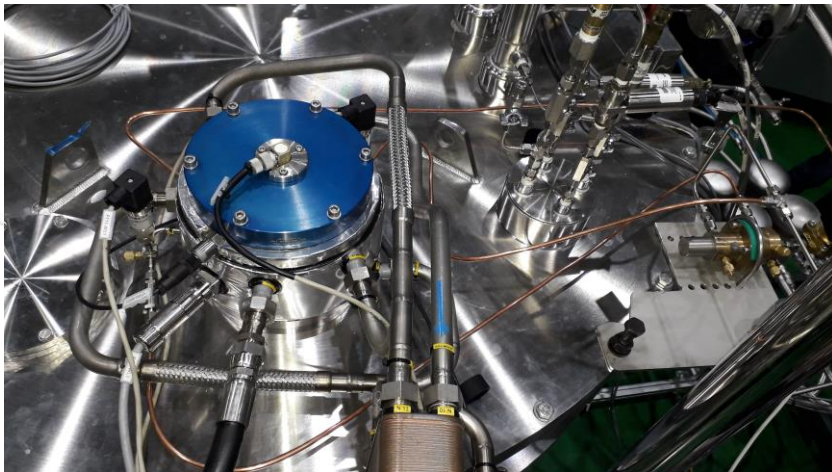
Output air humidity -70°C



Cryogenics & Low Temperatures Main Projects 2019

KIMM – Korea Institute of Machinery and Materials, Korea

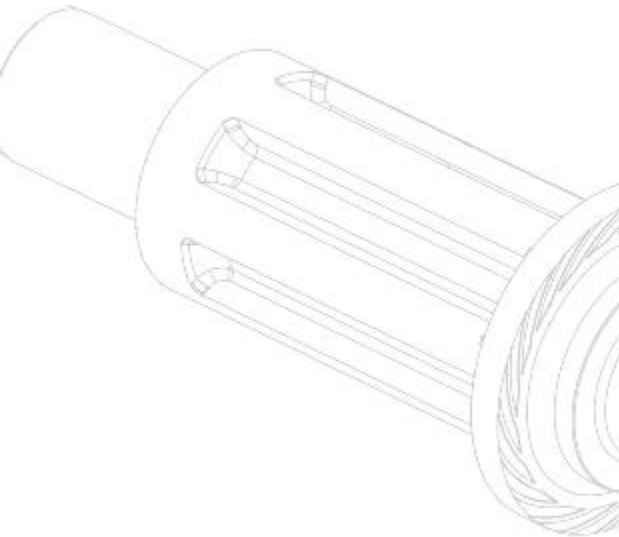
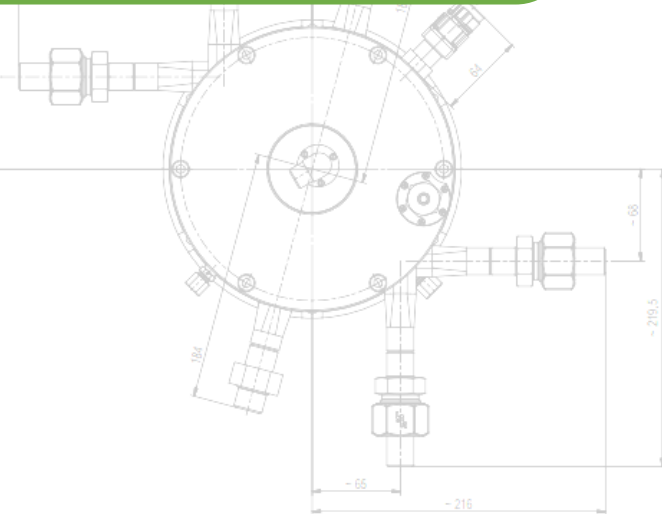
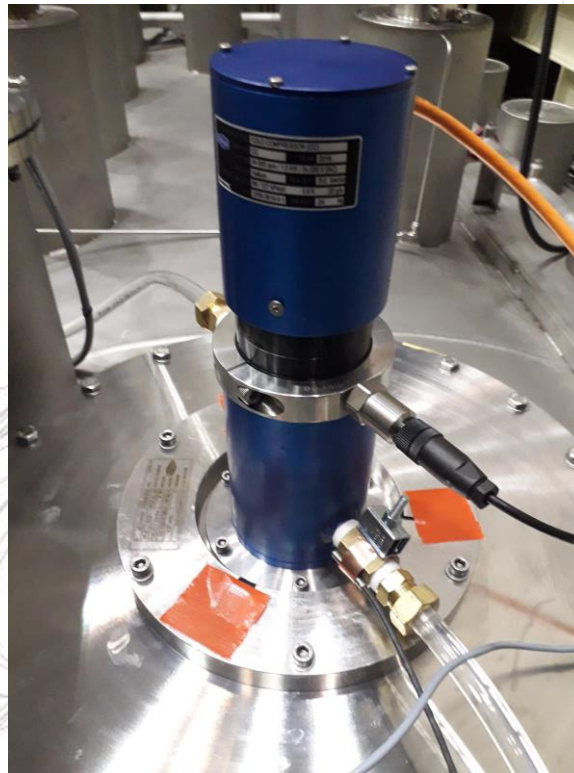
- **Neon Turbo Expander**
- **Brayton Cycle Test Circuit**
- **Design and delivery**



Cryogenics & Low Temperatures Main Projects 2019

NFRI – National Fusion Research Institute, Daejeon, Korea

- **Cold Compressor**
- **Delivery and on-site commissioning**
- **Helium vapours - 3,8 K Working Temperature**



Cryogenics & Low Temperatures Main Projects 2019

Shanghai Jiao Tong University, Jin Ping, China

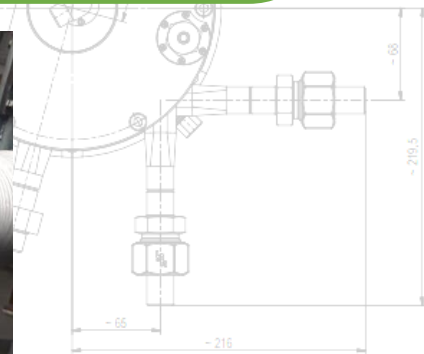
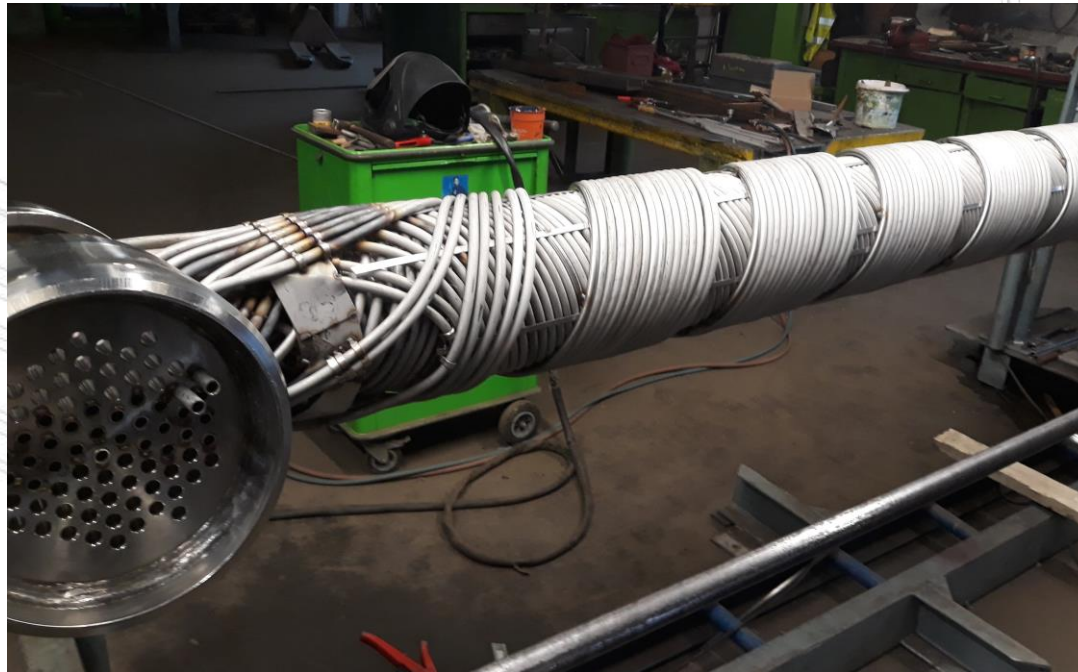
- **Radon Removal System**
- **Delivery 2018, on-site commissioning 2019**
- **220 m³ / hour**
- **Reduction of Radon concentration: 1000**



Cryogenics & Low Temperatures Survey Main Projects 2018

Wounded Heat Exchanger, customer in Russia via Germany

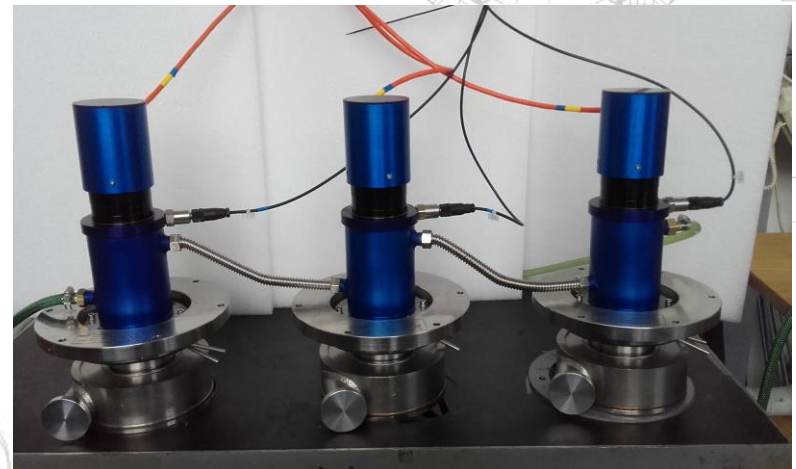
- Total heat area of heat exchanger is approx. 42,6 m².
- Design pressure (for all spaces) 5 MPa,g
- Design temperature (for all spaces) -90°C - +50°C
- Working medium - mixture of: Hydrogen, Ethane, Ethylene, Propane, Propylene, Nitrogen
- ASME Sect. VIII, Div.1 without U-stamp, EAC (TR TS 032/2013, TR TS 010/201)



Cryogenics & Low Temperatures Main Projects 2018

TIPC, China

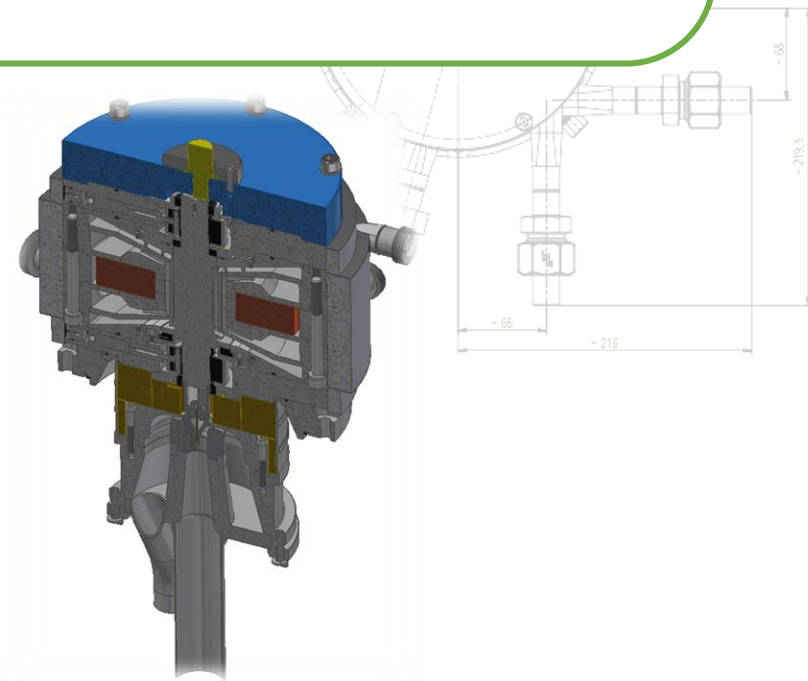
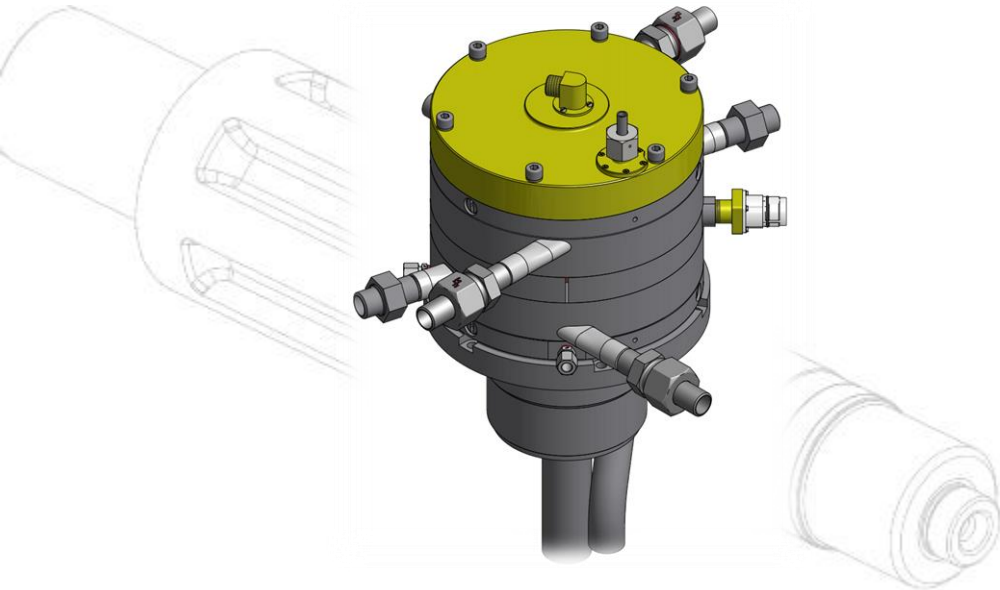
- 3 pcs.
- Cold compressors
- Including control system
- Delivered and on-site tested
- Inlet pressure 3 – 25 kPa,a
- Max. 43 000 rpm



Cryogenics & Low Temperatures Main Projects 2016

ASIPP, China

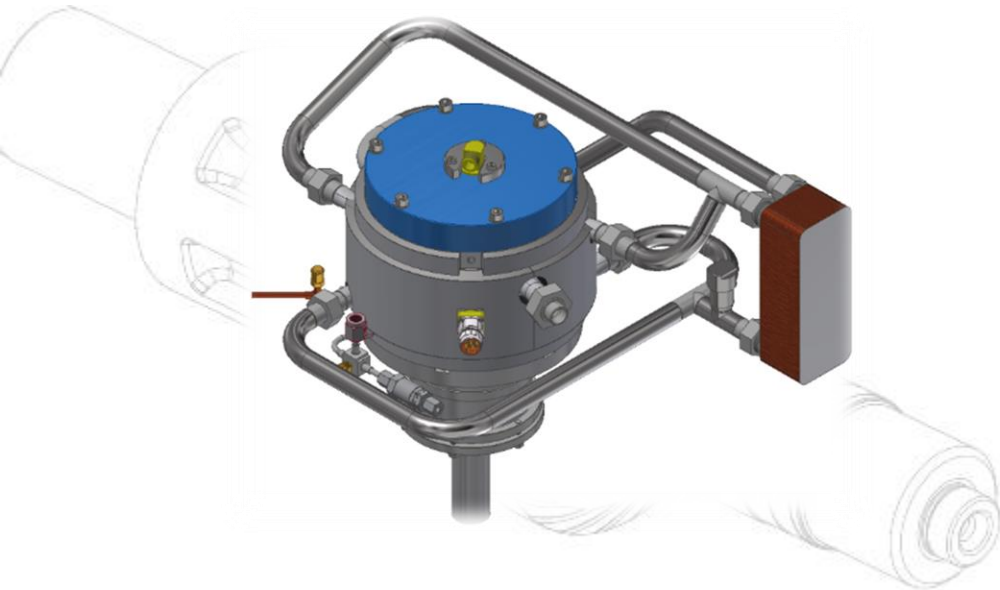
- Helium turbo-expanders
- Cooling power: 500 - 10 000 W
- Inlet temperature 14 K – 80 K
- Inlet pressure 0.5 – 2.0 MPa,a
- Max. 250 000 rpm
- 2 types (HET and HEXT)
- 9 pieces – 5x HET, 4x HEXT



Cryogenics & Low Temperatures Main Projects 2015

TIPC, China

- Helium turbo-expanders
- Cooling power: 500 - 10 000 W
- Inlet temperature 14 K – 45 K
- Inlet pressure 0.5 – 1.8 MPa,a
- max. 250 000 rpm
- 5 pieces – 1x HET, 4x HEXT



Cryogenics & Low Temperatures Main Projects 2015

ELI Beamlines

- AV CR, 2014 - 2015, Czech Republic
- Cooling System Brayton
- 1x Helium turbo-expander-circulator, 1x Turbo-circulator
- Cooling power: 300 W
- Cooling temperature 150 K
- Design pressure 1.2 MPa,a
- 120 000 rpm



Cryogenics & Low Temperatures Main Projects 2015

Low temperature spiral wound heat exchanger, Lukoil Stavrolen, Russia

- 1 pc., Hydrogen and Hydrocarbons
- ASME VIII Div. 1



Thank you for your attention

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