Project - Overview

Project: UDH

Optimization of an apparatus for creation and characterization of ultra-dense hydrogen
– UDH – (ultra dense hydrogen)“

Status as of: 10/2019

Customer – LENR Cars SA (Ecublens/Lausanne, CH):

- Background info / contact established in 06/2018
  http://www.lenr-cars.com/index.php

  https://memento.epfl.ch/event/creation-and-characterization-of-ultra-dense-hyd-2/

- General agreement on project collaboration reached – 2.7.2018
  - Development stage: experimental research, not-for-profit
  - Material & transportation costs: covered by LENR Cars
  - Design & manufacturing: LBS Bludenz
  - Project start: September 2018

LENR Cars
Power Generators for Electric Vehicles

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LENR

LENR or Low Energy Nuclear Reaction is a 3rd type of nuclear reaction (along with fission and fusion) based on atomic transmutations that was originally discovered in 1989 by scientists Martin Fleischmann and Stanley Pons. It used to be called "cold fusion" at that time. LENR covers a larger field of experiments and applications than cold fusion, although that may remain the most used name to characterize these reactions. LENR has also been called LANR, Fleischmann/Pons Effect, Anomalous Heat Effect, Quantum Fusion, CECR, LENT.

LENR has been shown to be far stronger than any known chemical reaction and up to 20'000'000 times the power density of today's combustion energy processes. The LENR technology can continually create large amounts of heat in a small sized reactor for several months using small amounts of low cost fuel and without producing any greenhouse gas like CO_2, any harmful nuclear waste or any dangerous radiation.

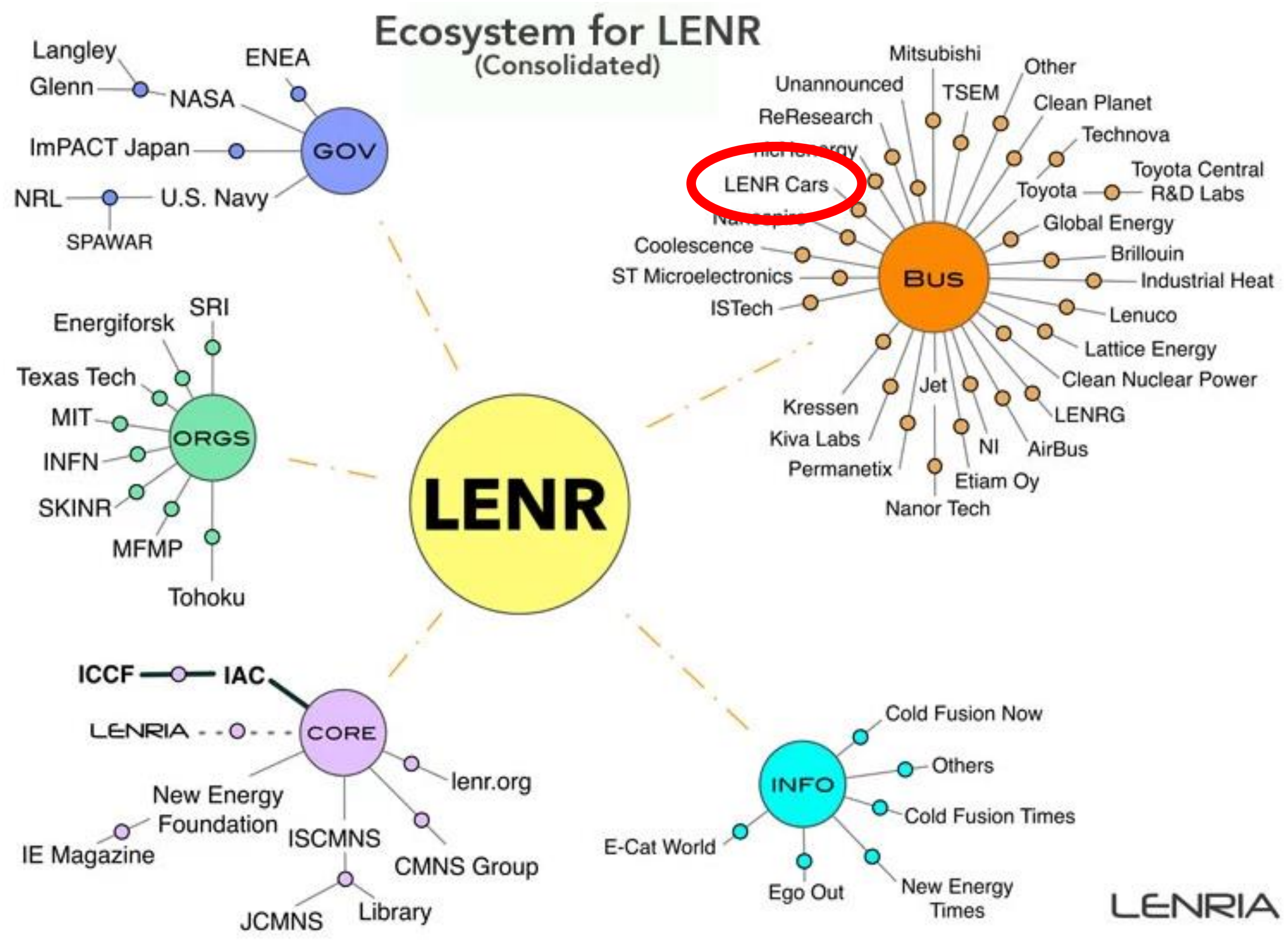
It is an extremely clean and safe way of producing energy.

Recent developments on LENR have led to a high increase in sustained power gain since the original experiments in 1989 which used Palladium and Deuterium electrolysis. Newer LENR reactors use processed Nickel and Hydrogen gas to achieve higher power gains, which appear to now be approaching commercial power generating levels.

LENR Cars is developing a patent pending technology producing electricity with mobile LENR generators that can be used to power electric vehicles such as cars, boats, trains or airplanes in a near future.

For more information about LENR, please visit LENRweb website.

What organisations are involved in LENR research:



https://www.lenria.org/ecosystem

„Iceberg-Theory“ (e.g. energy science)

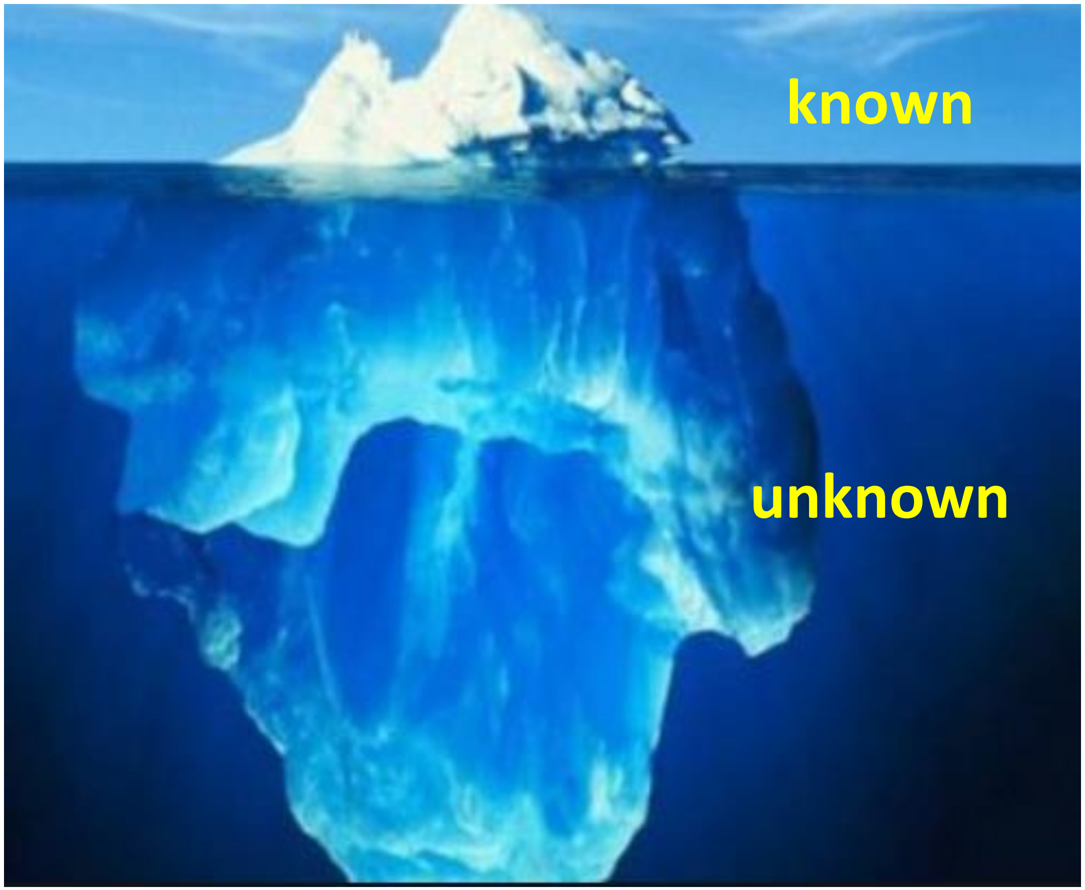


Fig.2: https://www.shutterstock.com/de/image-photo/melting-iceberg-huge-big-processing-definitely-1428494129

e.g. fusion, LION battery technology

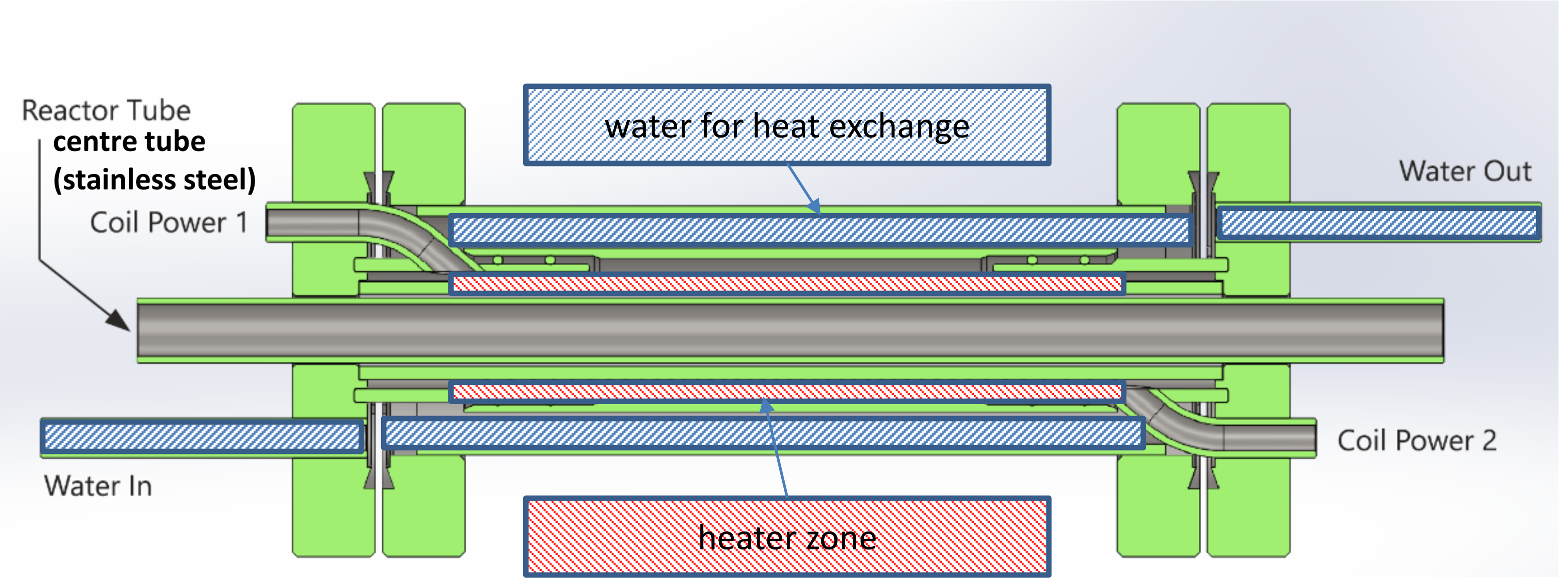
- publicly known that science and development happens
- significant amounts of public and private investments in science

e.g. “cold fusion” or LENR technology (Low Energy Nuclear Reactions)
https://coldfusionnow.org/crew/edmund-storms/

- publicly not well known that science and development happens
- insignificant amounts of public and private investments in research, because LENR science doesn’t provide a good scientific reputation.
- refer to “Fleischmann-Pons Exp.” https://en.wikipedia.org/wiki/Fleischmann%E2%80%93Pons_experiment

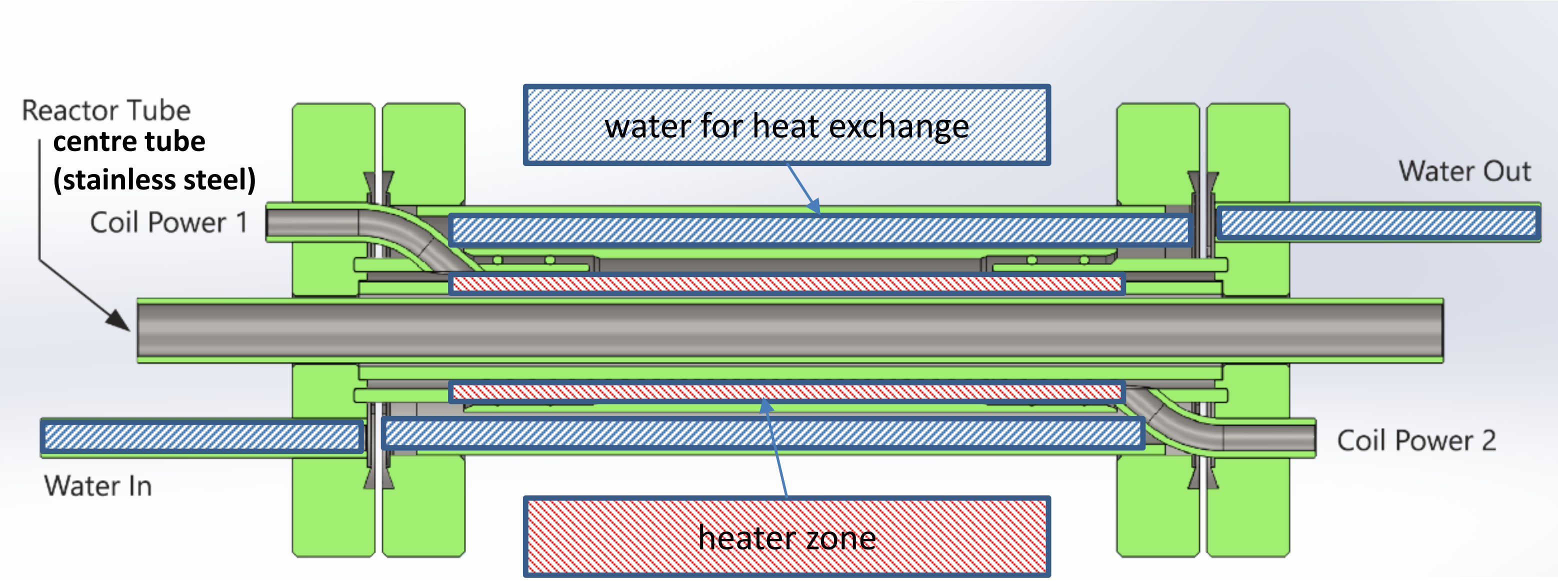
Reactor – principle of operation:

- reaction is occurring inside the 10 mm diameter stainless steel tube in the centre
- centre tube is connected to a thermocouple (temperature sensor) on one side and to gas system on the other side (pressure transducer, vacuum transducer, vacuum pump, multiple gas atmosphere options).
- around this tube is an alumina tube with a coiled Kanthal wire (heater wire).
- Kanthal wire is embedded in Alumina powder for better protection against corrosion
- there are two stainless tubes within each other allowing water to circulate between them to cool down the reactor.



Problem description / customer requirements:

- **main customer requirements (design issues / areas of improvement)**
  - actual design needs improvement to easily assemble / disassemble
  - water flow (water for heat exchange) is not perfectly watertight
  - Kanthal wire (heater wire) electrical insulation could be improved



Other customer requirements:

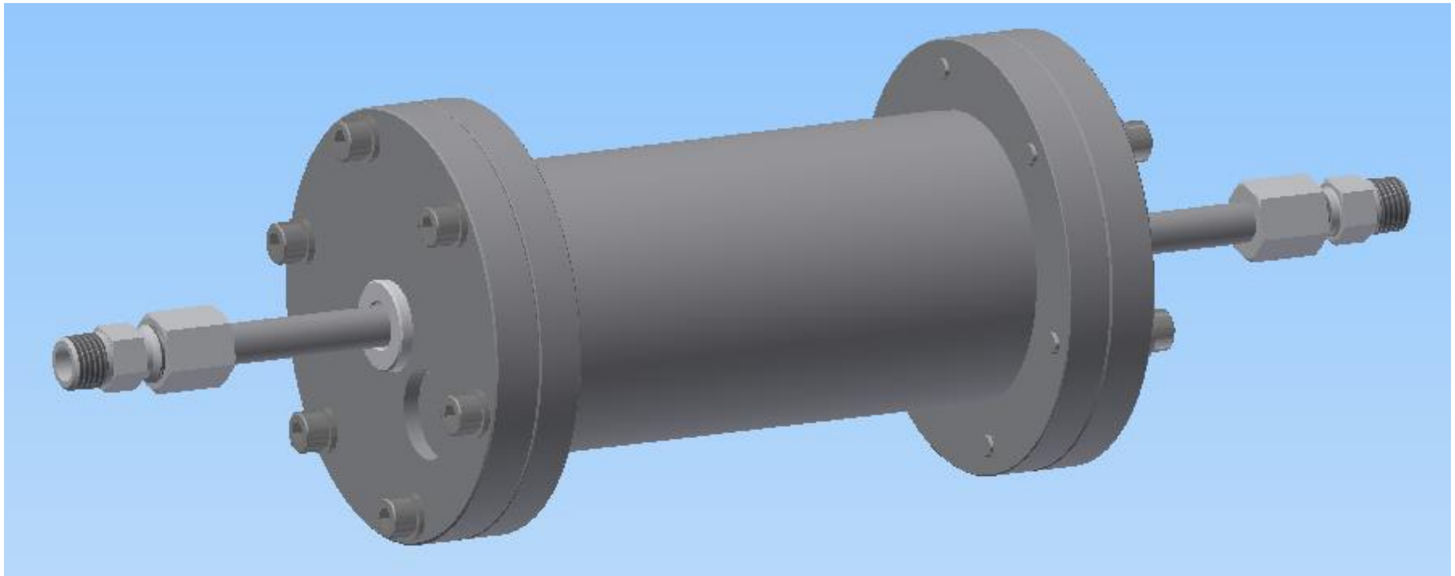
- design should be modular and each part should be easily replaceable
- centre stainless steel tube will be replaced often (fast and easy replacement necessary – optimized "waves-hub-connection necessary")
- centre stainless steel tube should be able to be heated / cooled down quickly (performant heat exchanger)
- replacement of material for centre tube needs to be considered
  Alumina tube instead of stainless steel tube
- centre stainless steel tube can sometimes be deformed due to heat and pressure
- **3D model of current design is available!**

Important working conditions:

- Working temperature: ~ 900°C
- Coil max temperature: ~ 1200 °C (KANTHAL A1, 16AWG)
- Centre stainless steel tube pressure
  from min: 1 mbars to max: 6 bars
  we plan to test low and medium pressure conditions (but no deep vacuum, no high pressure)
- Heat Coil Area Pressure: 1 atm
- Argon Atmosphere around Coil (two design options)
  Not planned, but it can be a good idea.
  Currently the coil is protected by an alumina powder layer.
- Power Input: 40V @ 40A DC
  This is the limitation of the power supply we currently use

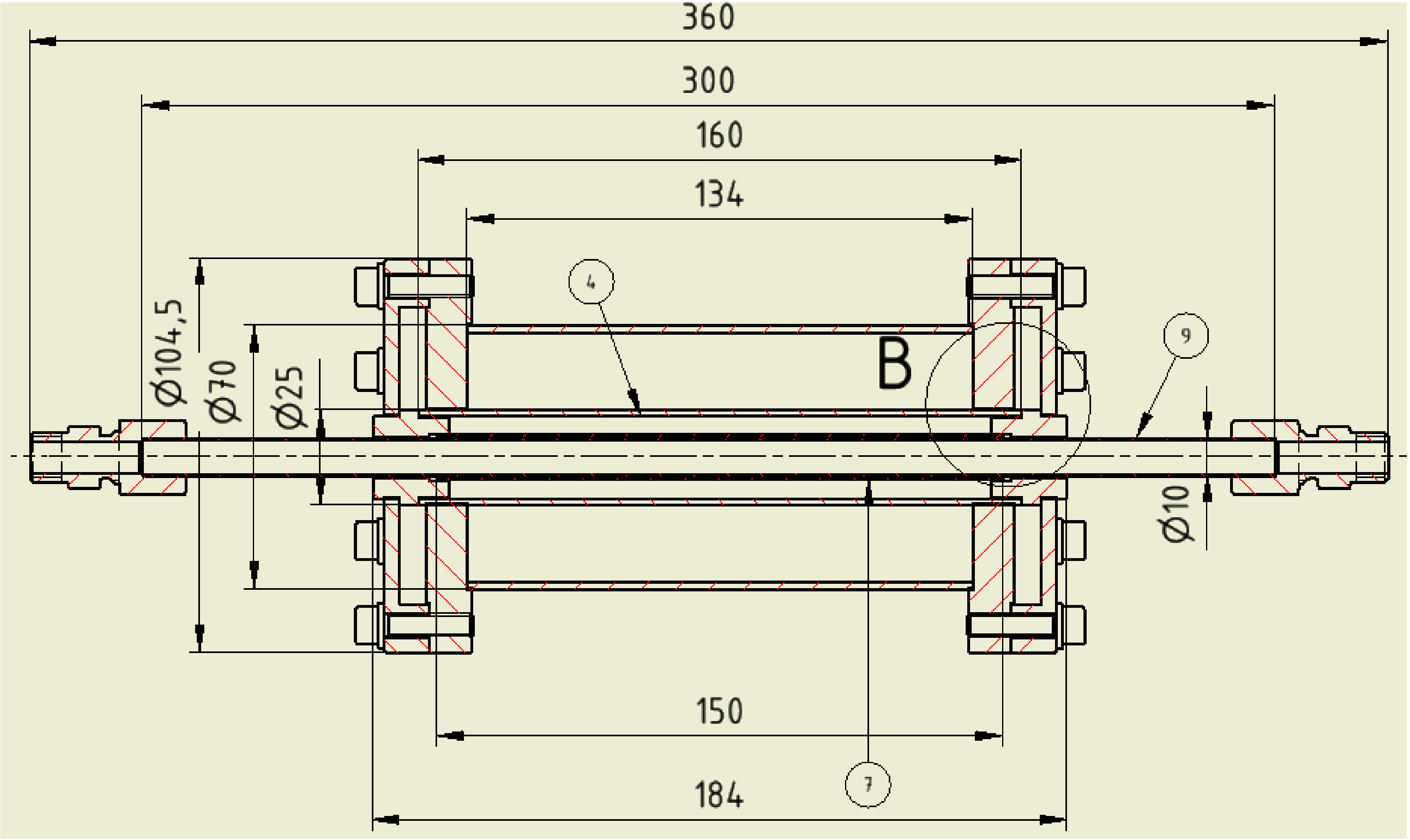
our proposed solution:

- after modelling and design of several solution variants by students **one design concept** has been selected for further detailing



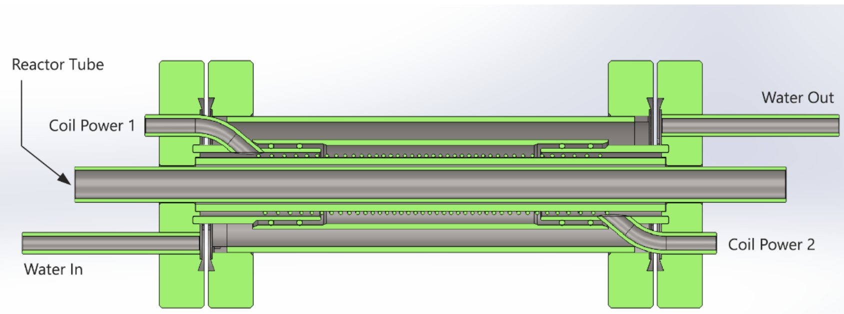
  - **Improvement of water tightness** – TIG welded heat exchanger
  - **Easier to assemble** – fewer parts, alternative pipe fittings (not represented in this figure)
  - **Improvement of electrical connection**– use of MACOR as an electrical **and** heat insulator (two functions with **one** part)
  - **Improvement of temperature durability** – use of heat resistant stainless steel (1.4841 temperature resistant in air up to 1150°C)

Overview - assembly:



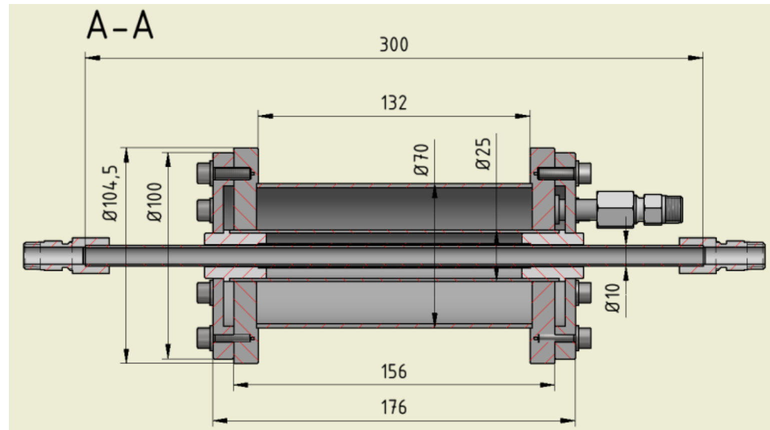
Comparison – existing design to new design

existing design



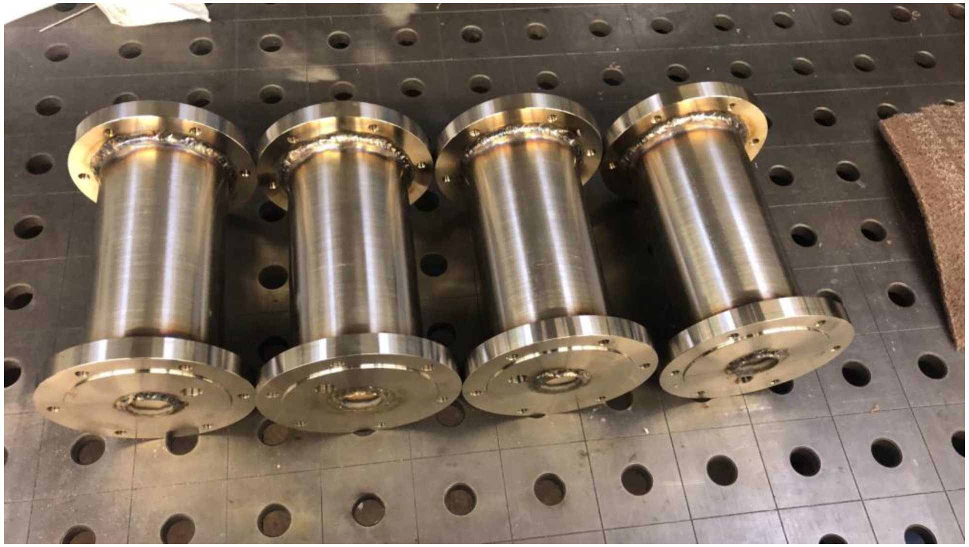
- reactor consists 11 parts
  -> assembly more complex
- heat exchanger – assembly
  -> issues with water tightness
- operational temperature: ~ 900°C
  (with limitations due to use of gaskets)

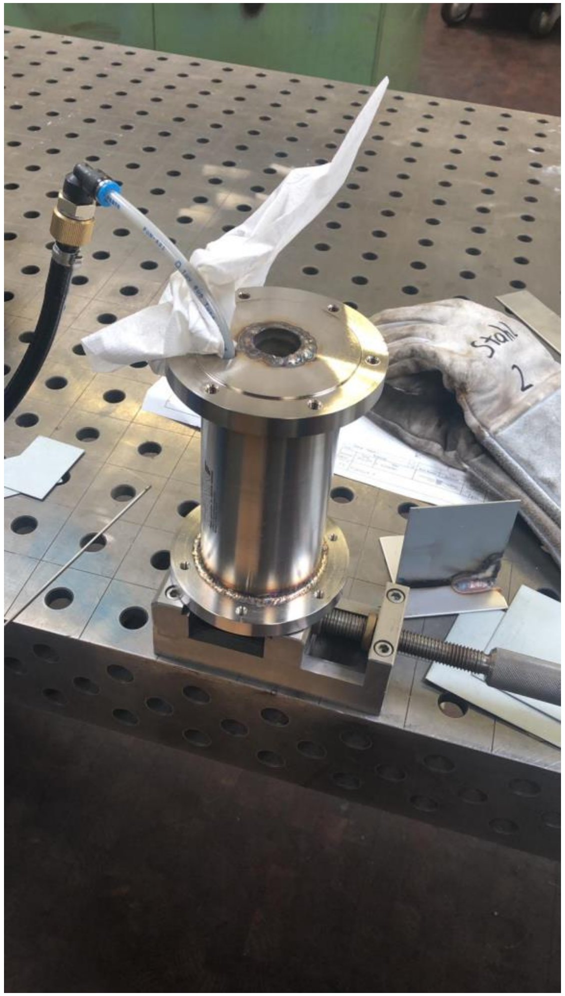
new design



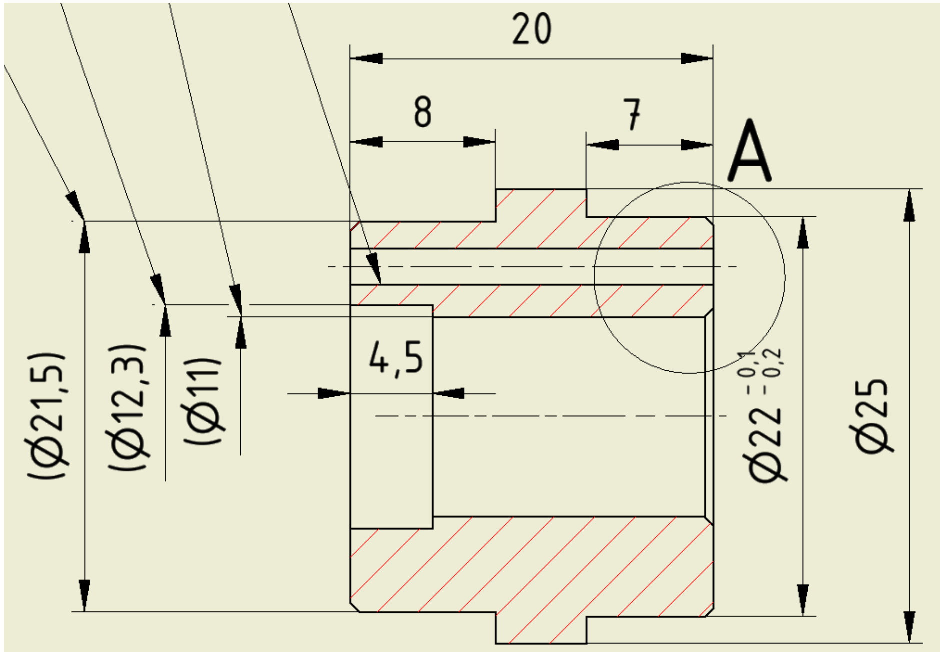
- reactor consists of 5 parts
  -> easy and quick assembly
- heat exchanger – one single part
  -> water tight
- operational temperature: ~ 1000°C
- enhanced thermal insulation for heating unit by use of MACOR sealing plugs **(machineable ceramic)**
- SERTO fittings to avoid cutting of centre pipe, when disassembled

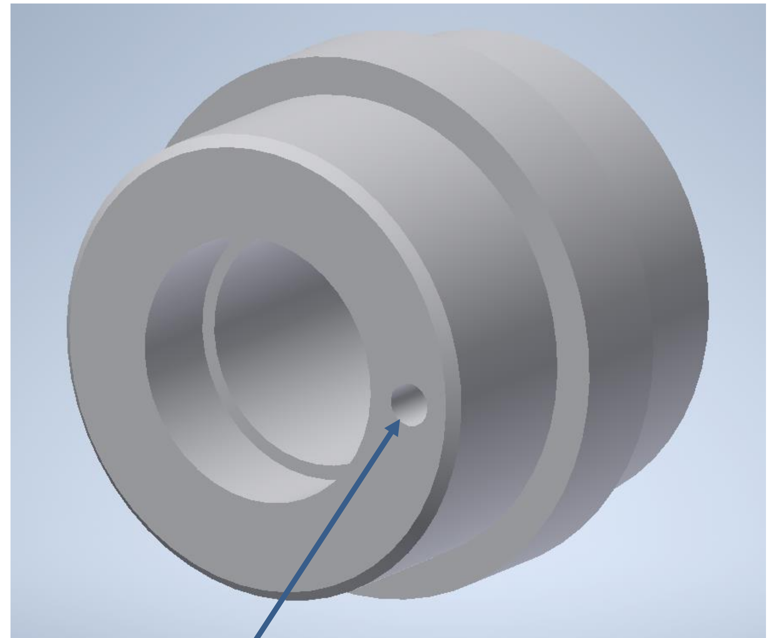
TIG welded heat exchangers (material: 1.4841) with fixture and Argon filling prior to welding:





Application of MACOR (machineable glass ceramics):

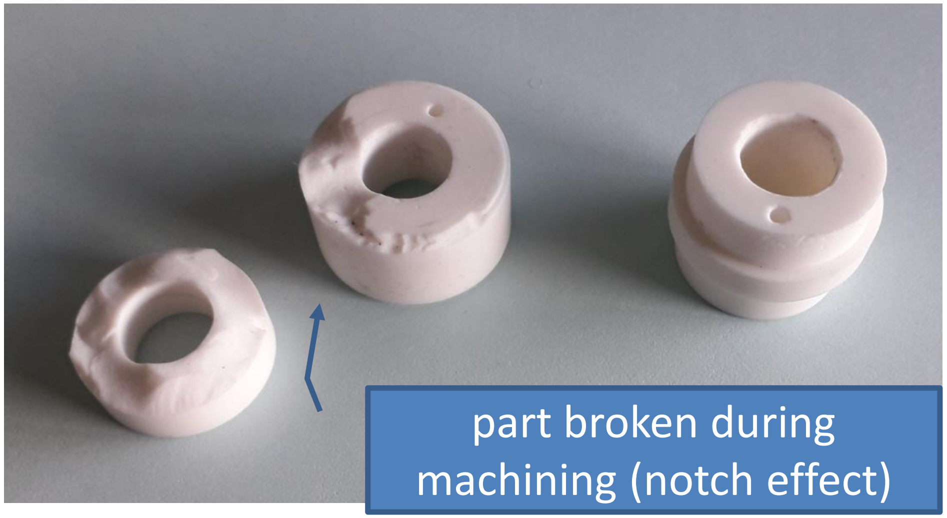


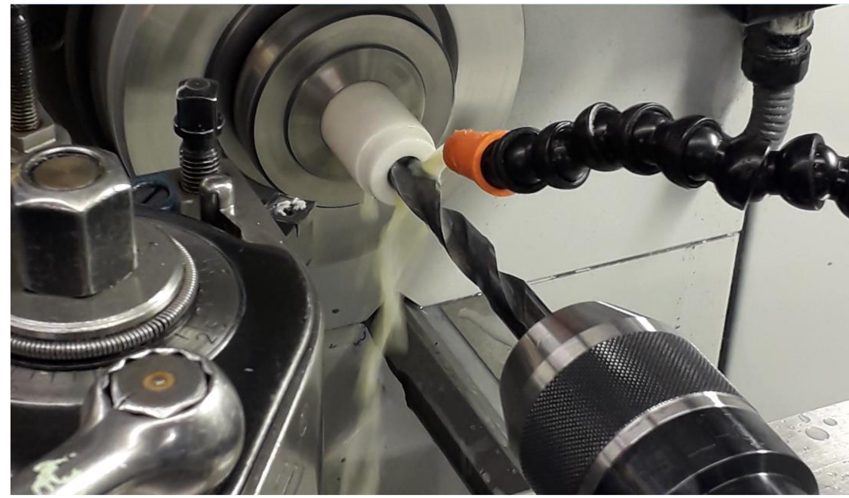


electrical feed through Ø2mm

- machineable with standard cutting tools
- high temperature stability (up to ca. 1000°C stable)
- good heat insulator
- very good electrical insulator (ceramics)
  refer to: https://en.wikipedia.org/wiki/Macor

MACOR – manufacturing “tips and tricks”

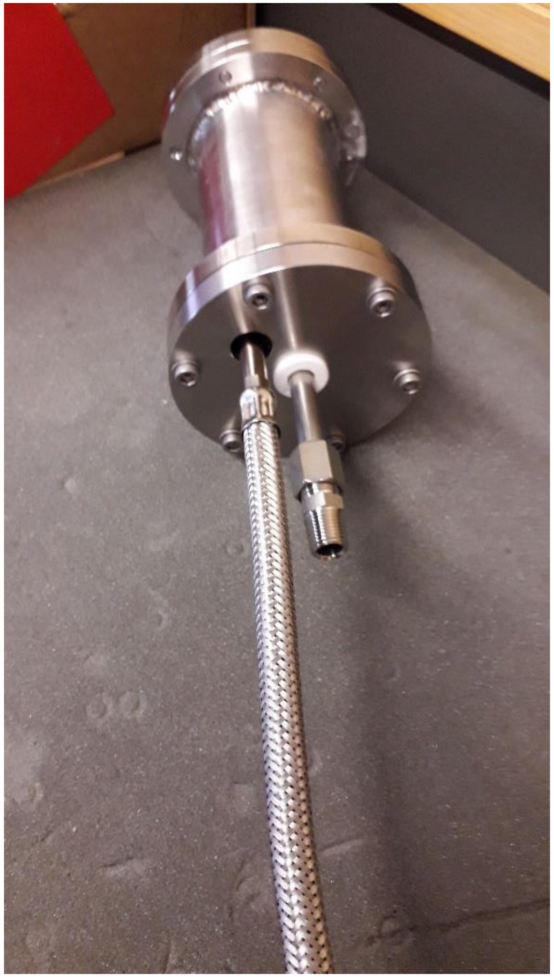


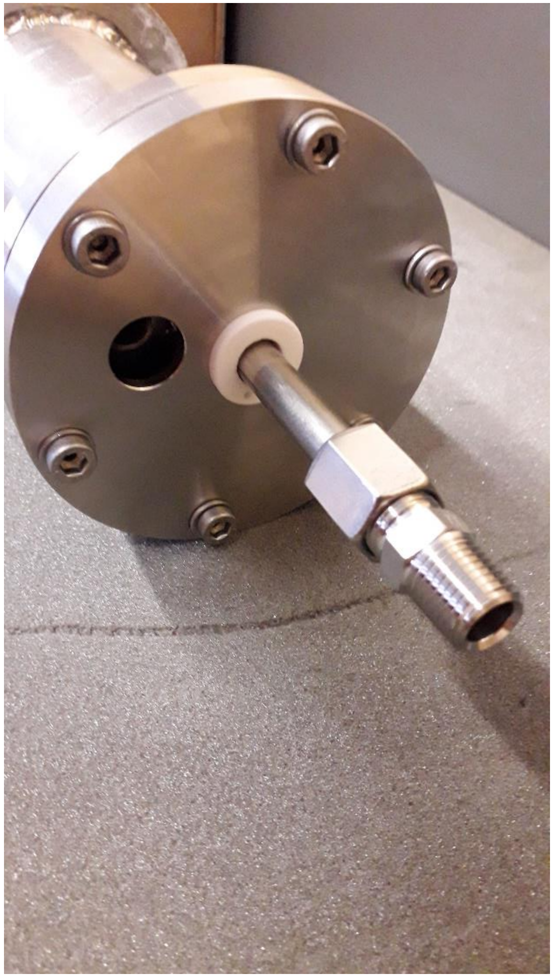


- machineable with tool steel or indexing tip
- especially flushing with cooling liquid necessary, while boring!!
- use of a collet chuck recommended to equally distribute the chucking force
- recommended manufacturing sequence: (1)outer-, (2)inner-contur machined, (3) cutting-off part

LENR Cars logo – engraved by laser

Heat exchanger assembly with water inlet, MACOR insulation and center reactor tube with pipe connector





Customer requirement fulfilment / project feedback:

Feedback from Nicolas CHAUVIN (CEO LENR Cars SA) as of 21.10.2019

- Q: Have your requirements been fulfilled?
- A: Yes. The main goals where:
  - improved water cooling system that can support relatively high temperature variation without leaking.
  - improved way to replace parts in the design (e.g. central reactor tube)

  These 2 goals have been fulfilled perfectly.

- Q: Water tightness?
- A: So far we have only done some preliminary tests with water at low pressure and ambient temperature. So far, water tightness has been good.

- Q: Temperature capability?
- A: We did not run high temperature tests yet. However, we feel confident that the design will support the temperature constrains.

- Q: Is the assembly process really simpler or do you see still room for improvement?
- A: The assembly process, as well as the flexibility of the proposed design is a great improvement. We have the possibility to use a glow plug as an internal heater and a thermocouple between the hot tube and the water cooling system. Or use the design as planned, with a thermocouple inside the hot tube and a Kanthal coil between the hot tube and the water cooling system. The flexibility is really useful for our research.

- Q: Any other interesting info regarding the design?
- A: Our goal is to have a design with multiple standard parts that can be re-ordered and replaced easily in case of wear or failure. This design is a good improvement toward that goal.