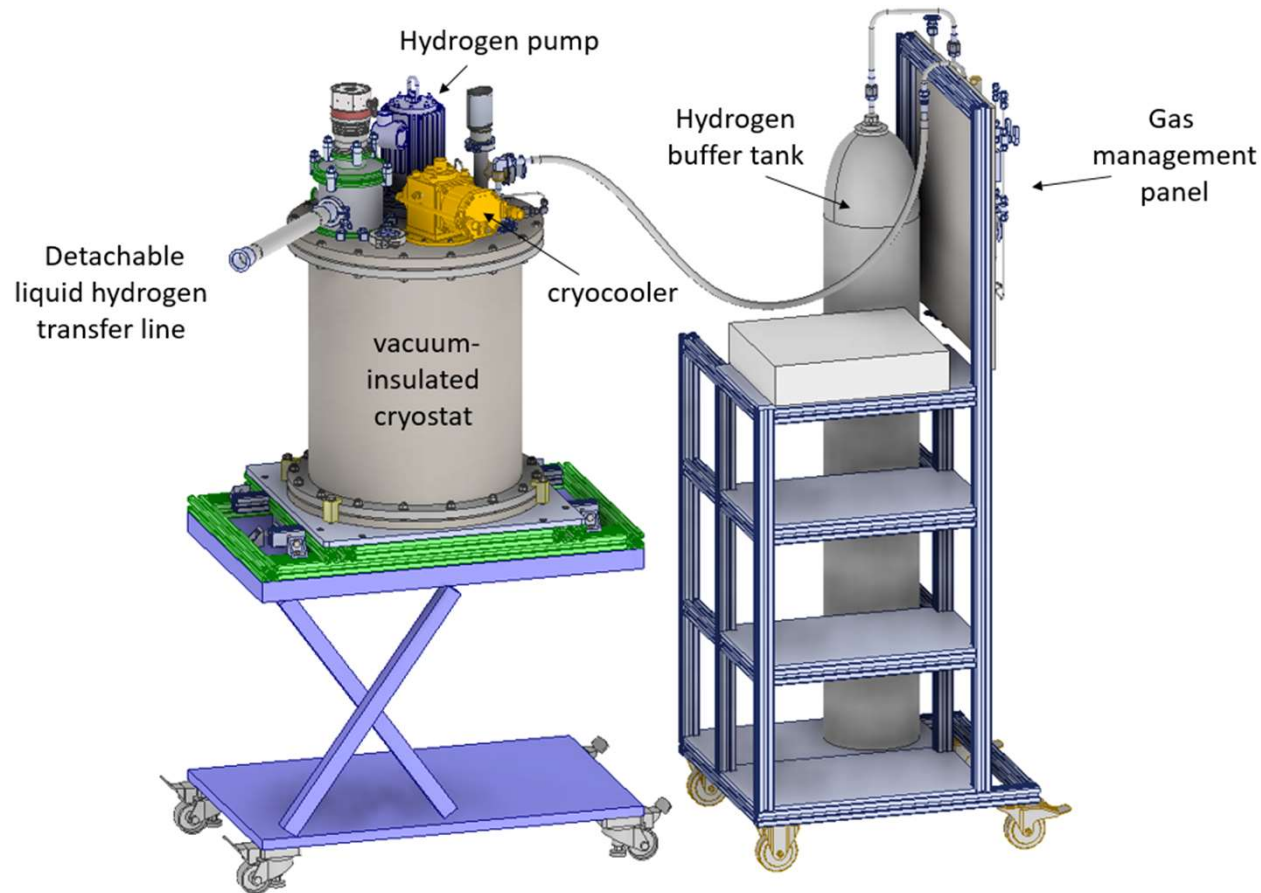


# First operation of the para-H<sub>2</sub> moderator at the JULIC Neutron Platform

U. Rücker, JCNS-HBS

Moderator workshop 17.04.2024

# Closed-loop para-H<sub>2</sub> moderator cryostat



Sealed-in hydrogen volume  
(800 bar l at room temperature)

Continuous operation

Liquid hydrogen is moderator  
and cooling medium

Infrastructure:  
3-ph AC 16 A power  
cooling water  
(computer network)

Idea: 2020

Realization: 2022-23

# Main components

Reservoir (at room temperature)

Main cryostat:

- Closed-cycle cryocooler
- Circulation pump
- Catalyst

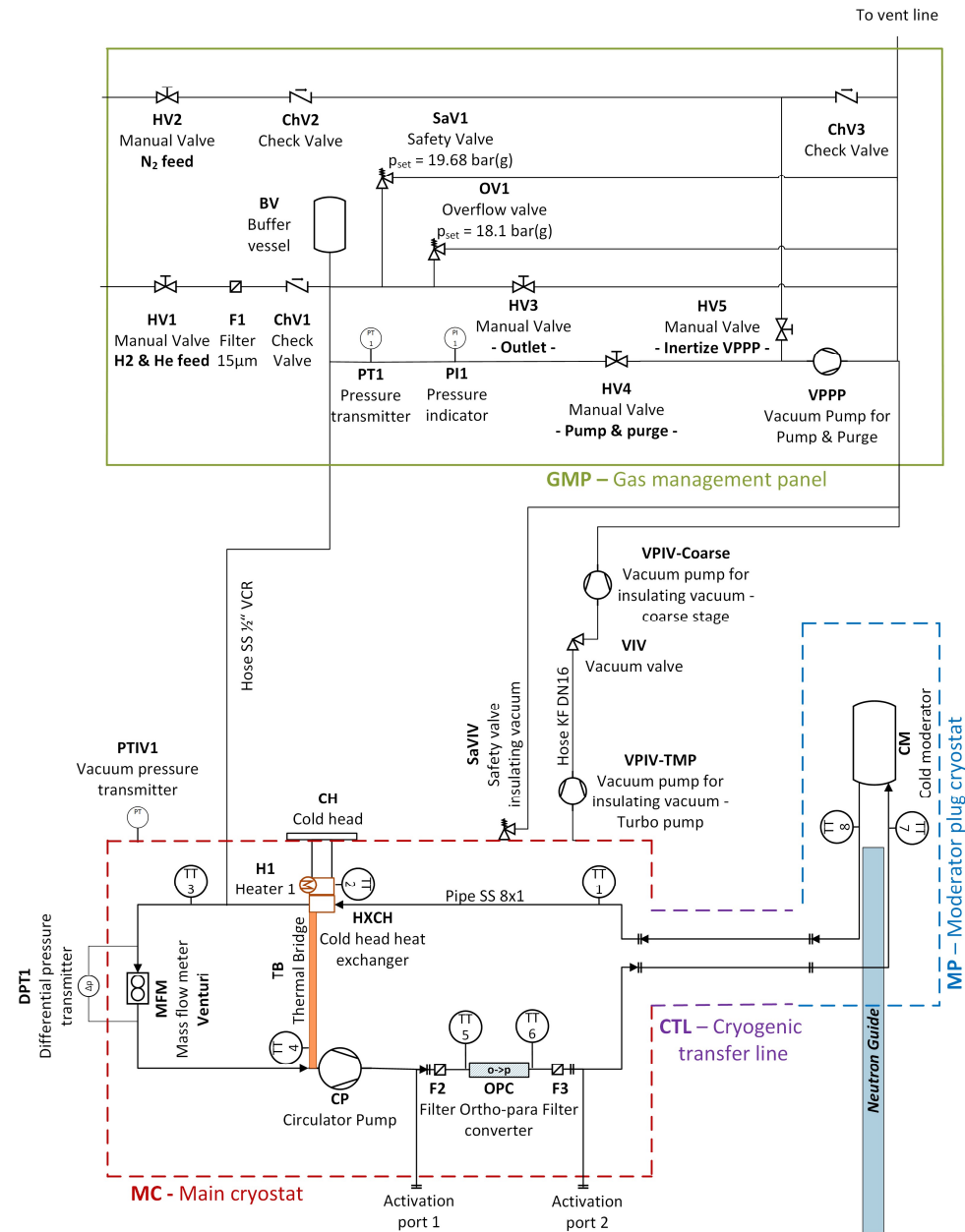
Outside the shielding block

Extension:

- Moderator vessel

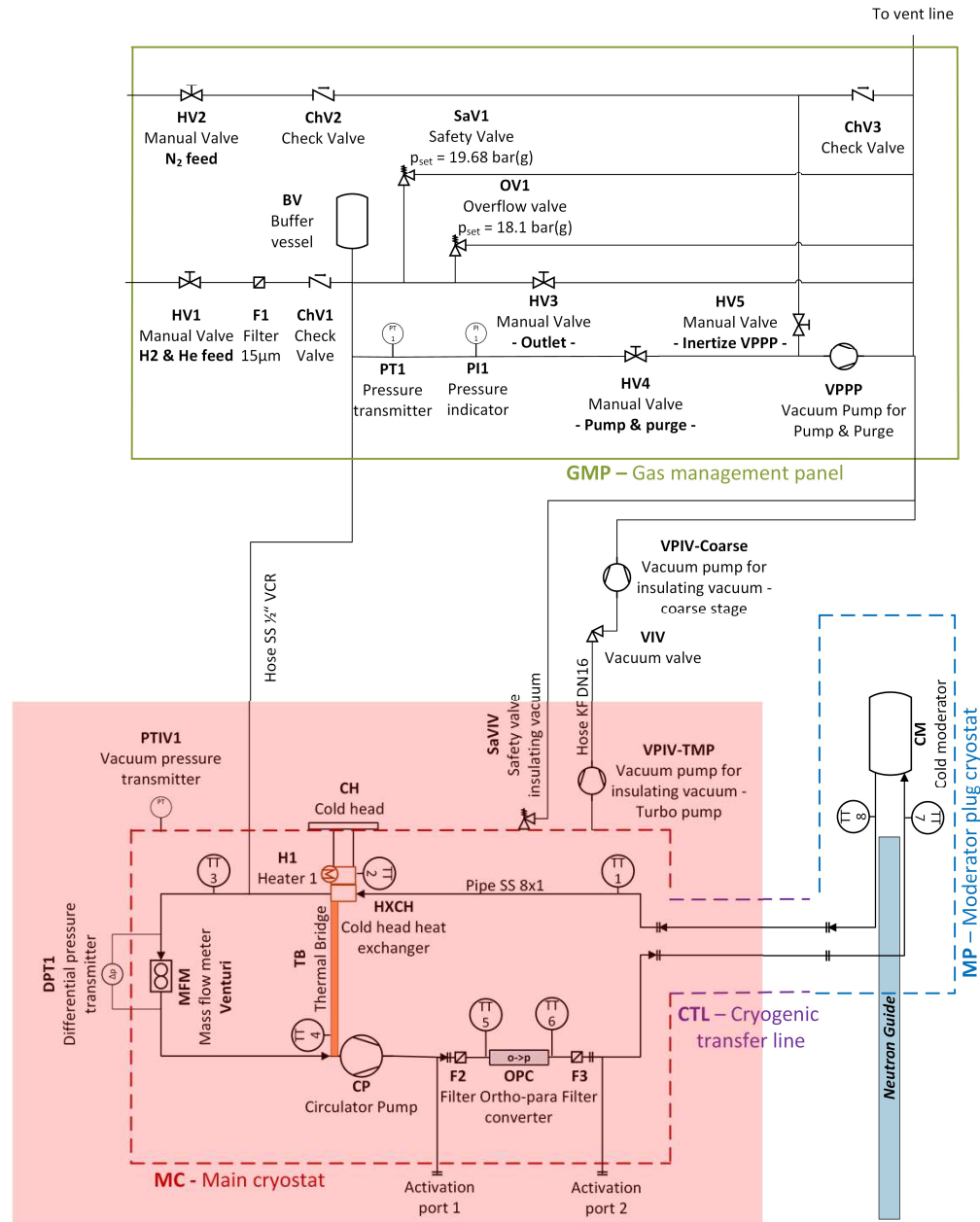
Embedded in the extraction plug

# Schematic





# Main cryostat

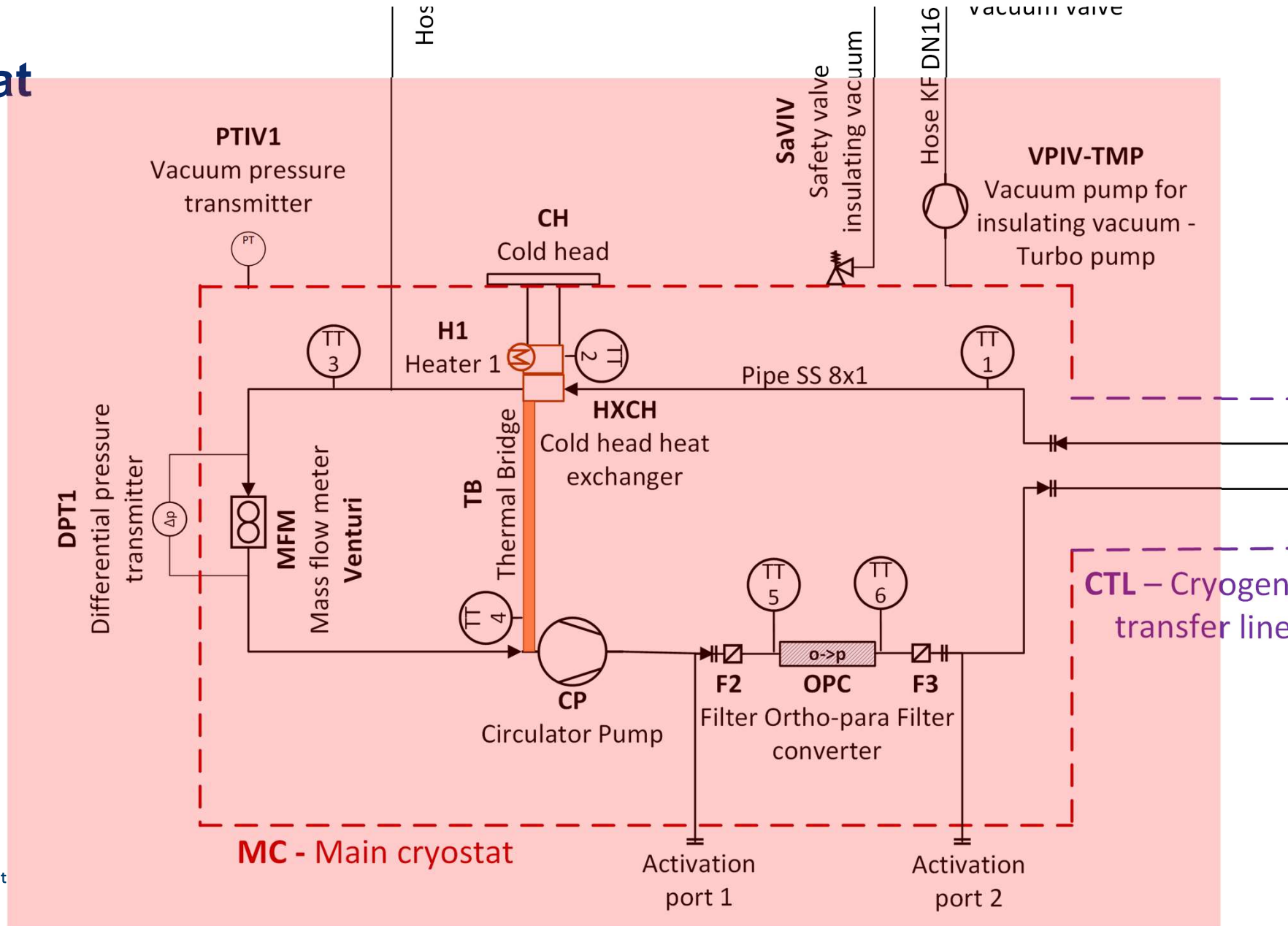


Mitglied der Helmholtz-Gemeinschaft

HIGH  
BRILLIANCE  
SOURCE

JÜLICH  
Forschungszentrum

# Main cryostat



# Main cryostat



Mitglied der Helmholtz-Gemeinschaft

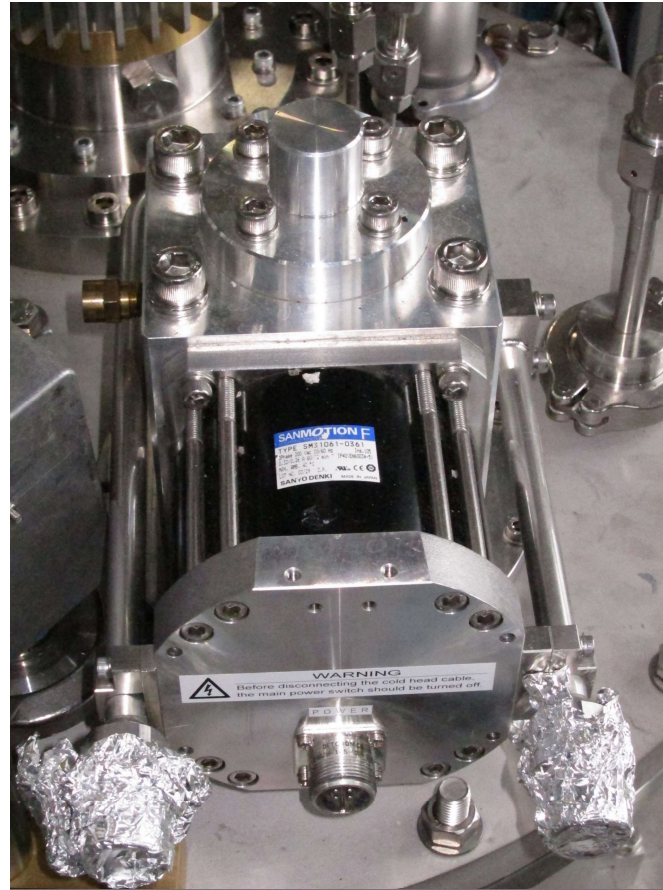


HIGH  
BRILLIANCE  
SOURCE

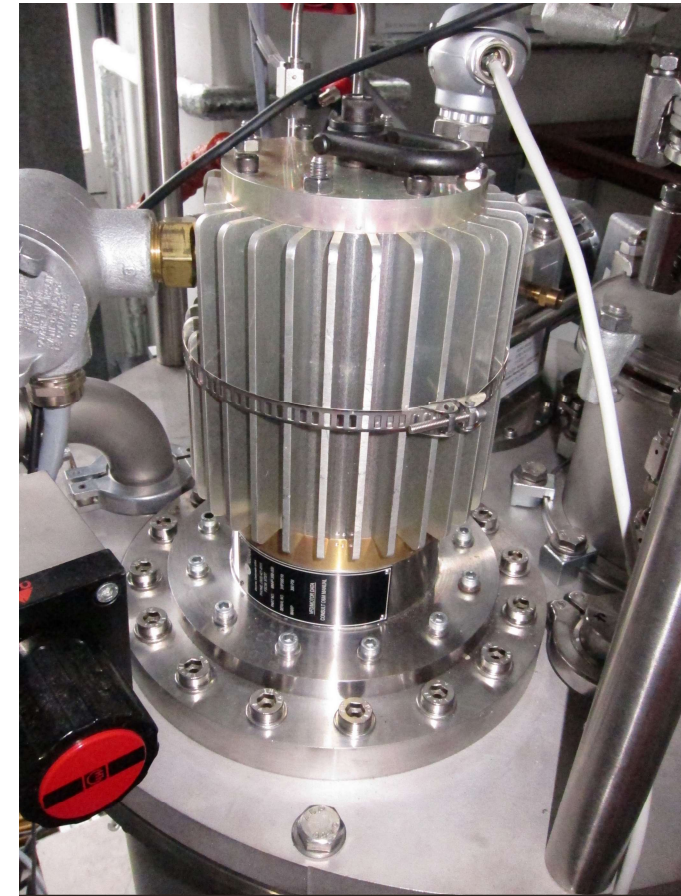




## Main cryostat



## BarberNichols liquid hydrogen pump



## Sumitomo SRDK-500B cryocooler

Mitglied der Helmholtz-Gemeinschaft



# Main cryostat

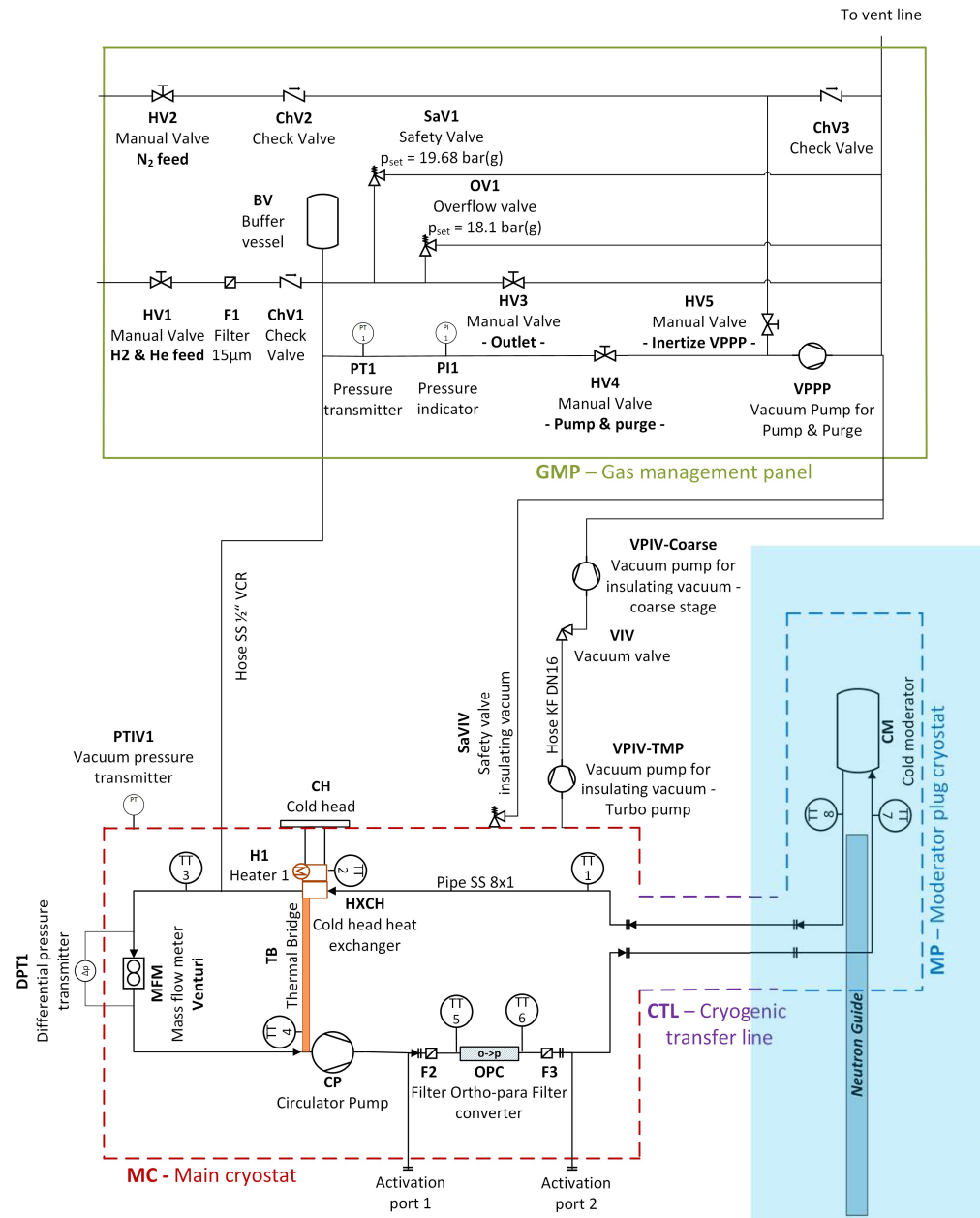


Mitglied der Helmholtz-Gemeinschaft

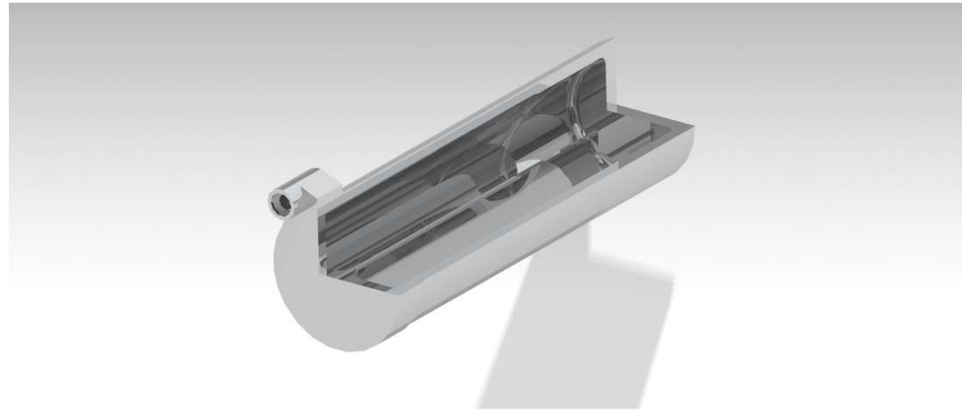
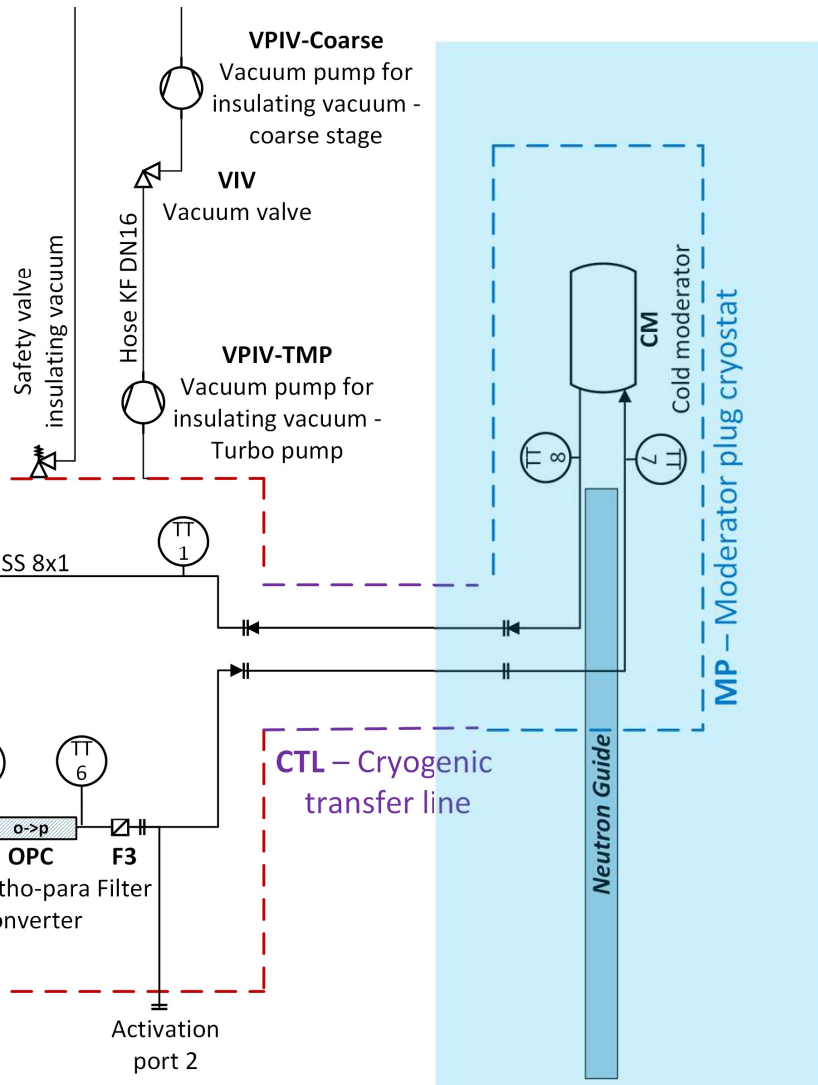
science  
HIGH  
BRILLIANCE  
SOURCE

 **JÜLICH**  
Forschungszentrum

# Moderator plug

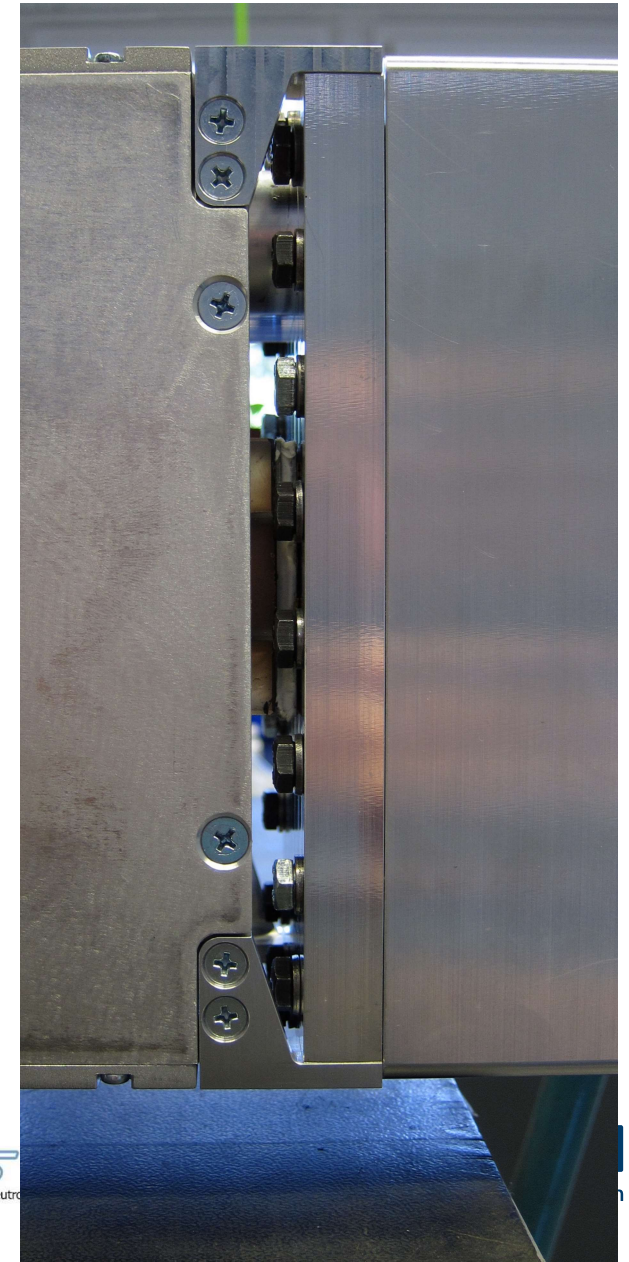


# Moderator plug

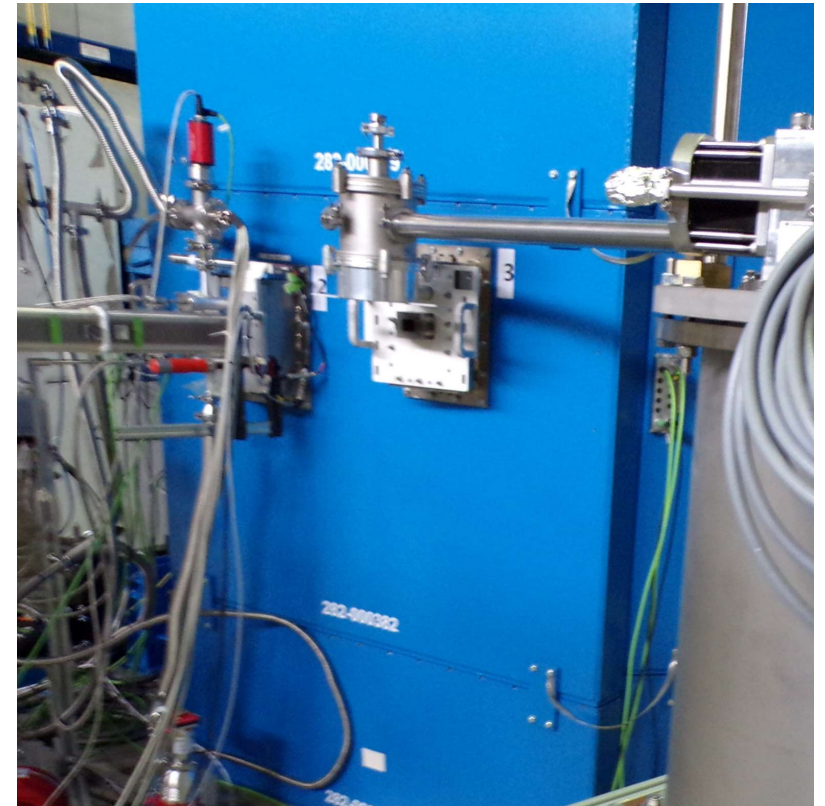
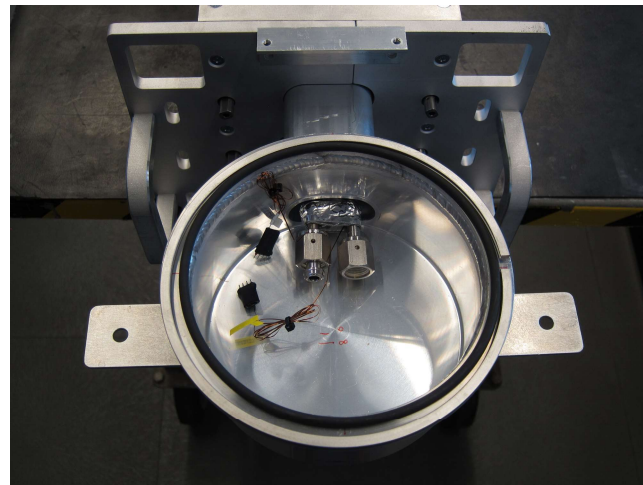
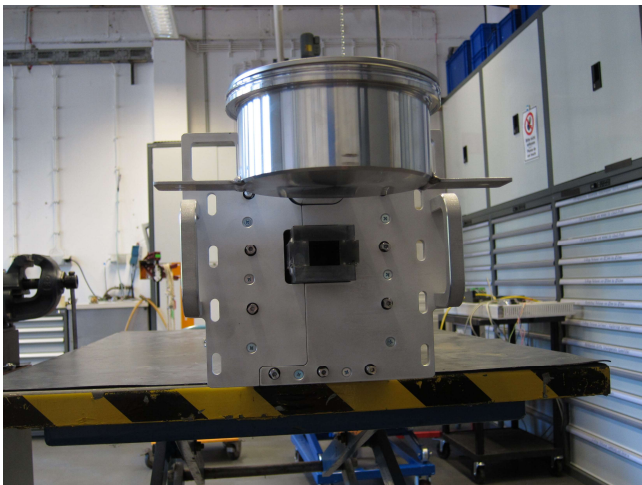




# Moderator plug

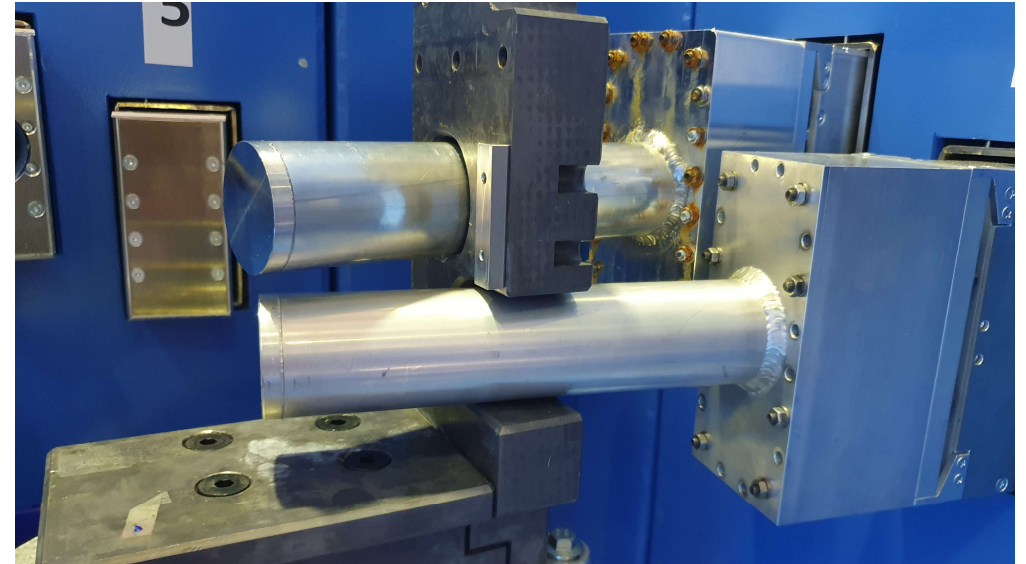
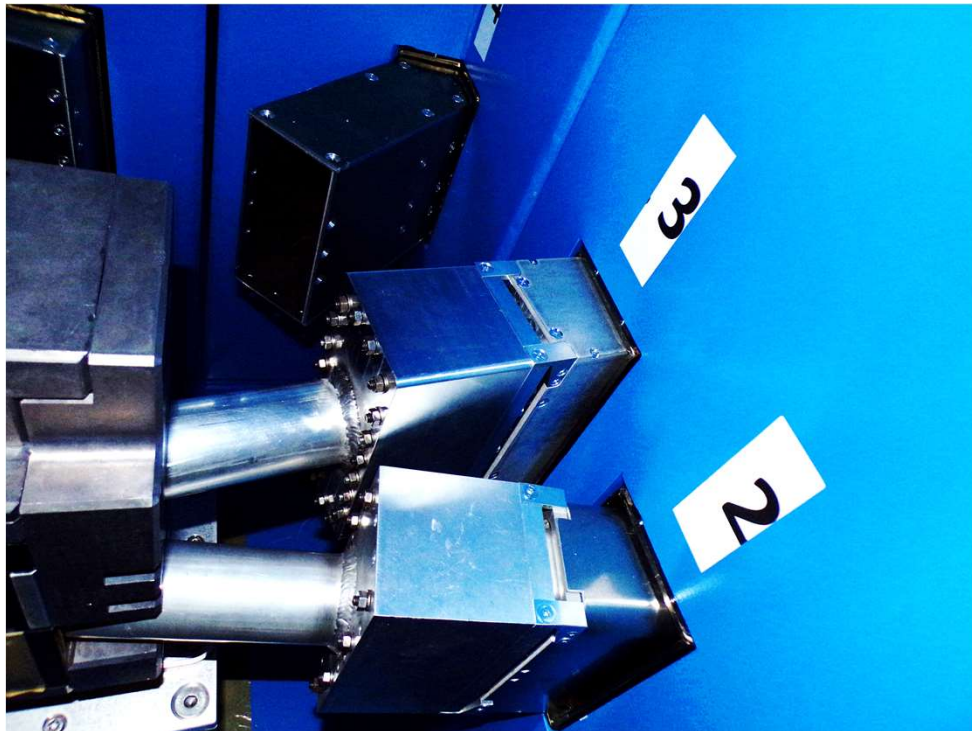


# Moderator plug



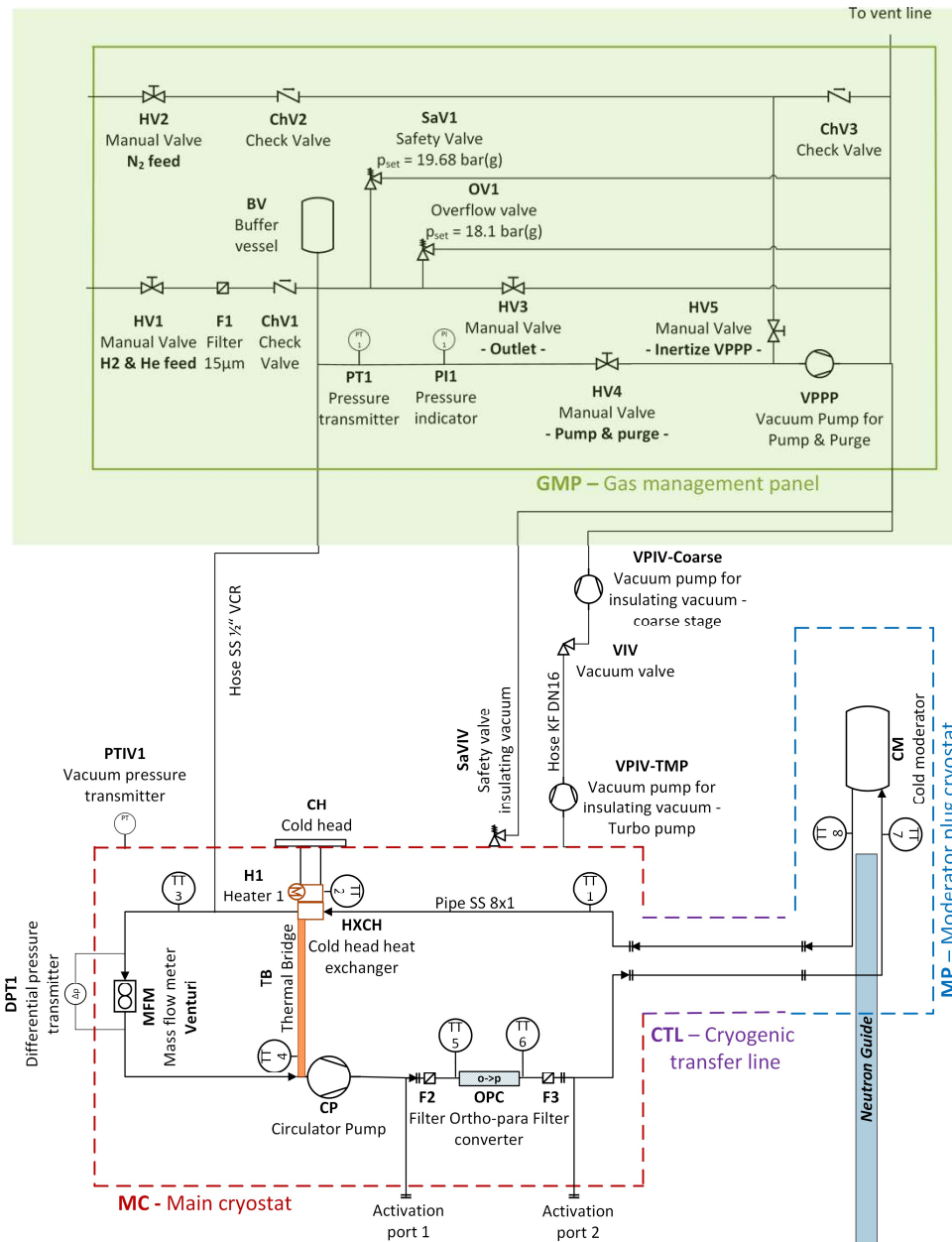


# Moderator plug



Mitglied der Helmholtz-Gemeinschaft

# Gas management panel

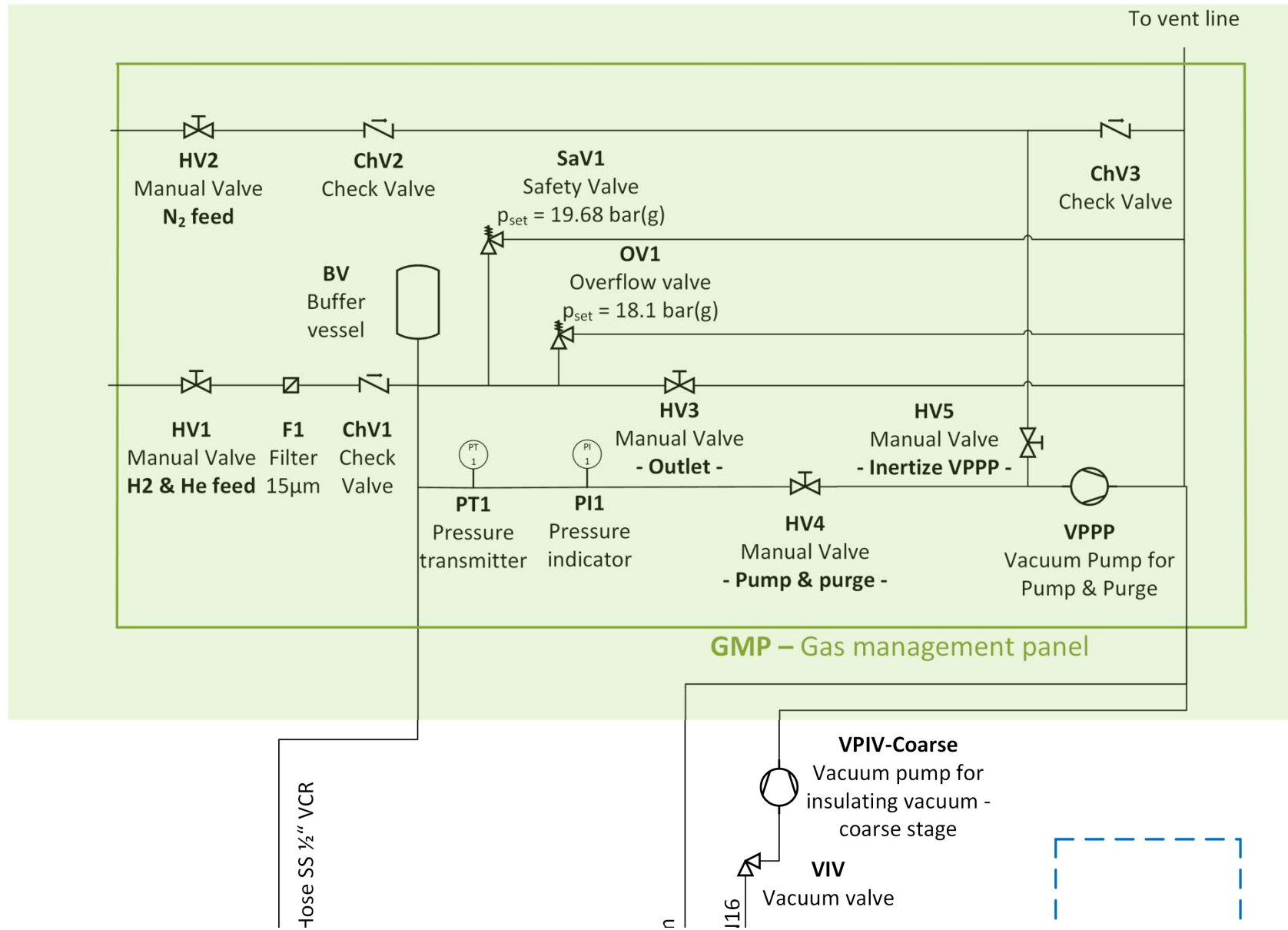


# Gas management panel

50 l buffer cylinder

Safety valves

Manually operated





# Gas management panel

50 l buffer cylinder

Safety valves

Manually operated



# All together installed at the JULIC neutron platform



Mitglied der Helmholtz-Gemeinschaft



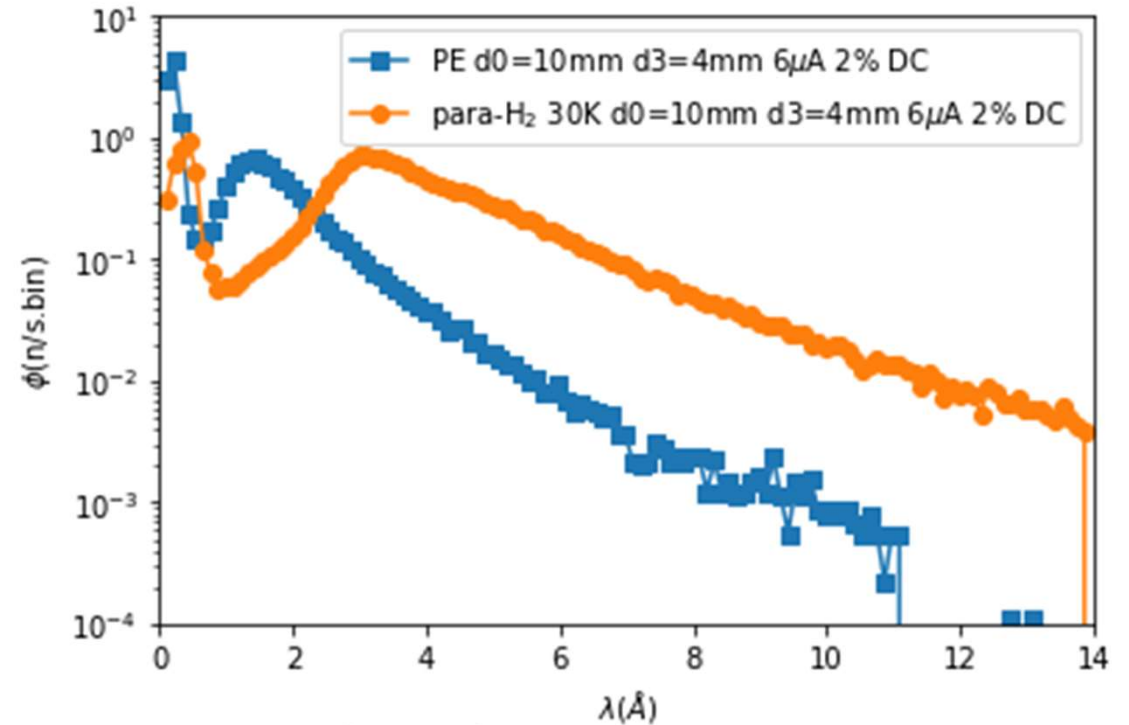
HIGH  
BRILLIANCE  
SOURCE





# It works: Neutrons for HERMES

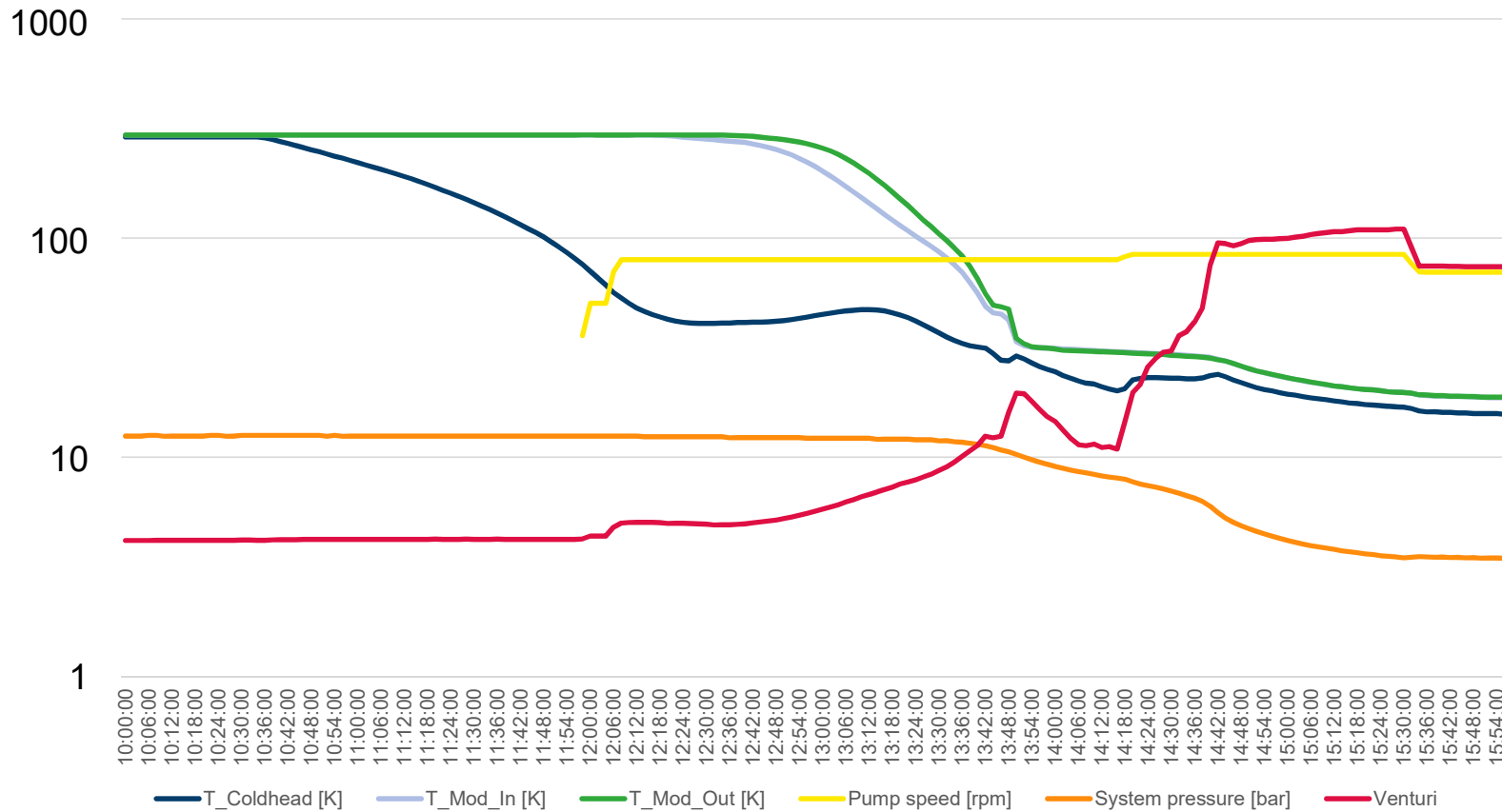
Continuous operation @ 11 bar, 26 K  
for 10 days



Total counts<sub>PE</sub> (1.0Å - 12.0Å) = 69255 in 9000 s  
Total counts<sub>para-H<sub>2</sub></sub> (1.0Å - 12.0Å) = 79784 in 4500 s

# Easy operation: Cooldown within 6 hours

Cooldown diagram (over 6 hours)



T Coldhead [K]

T Mod In [K]

T Mod Out [K]

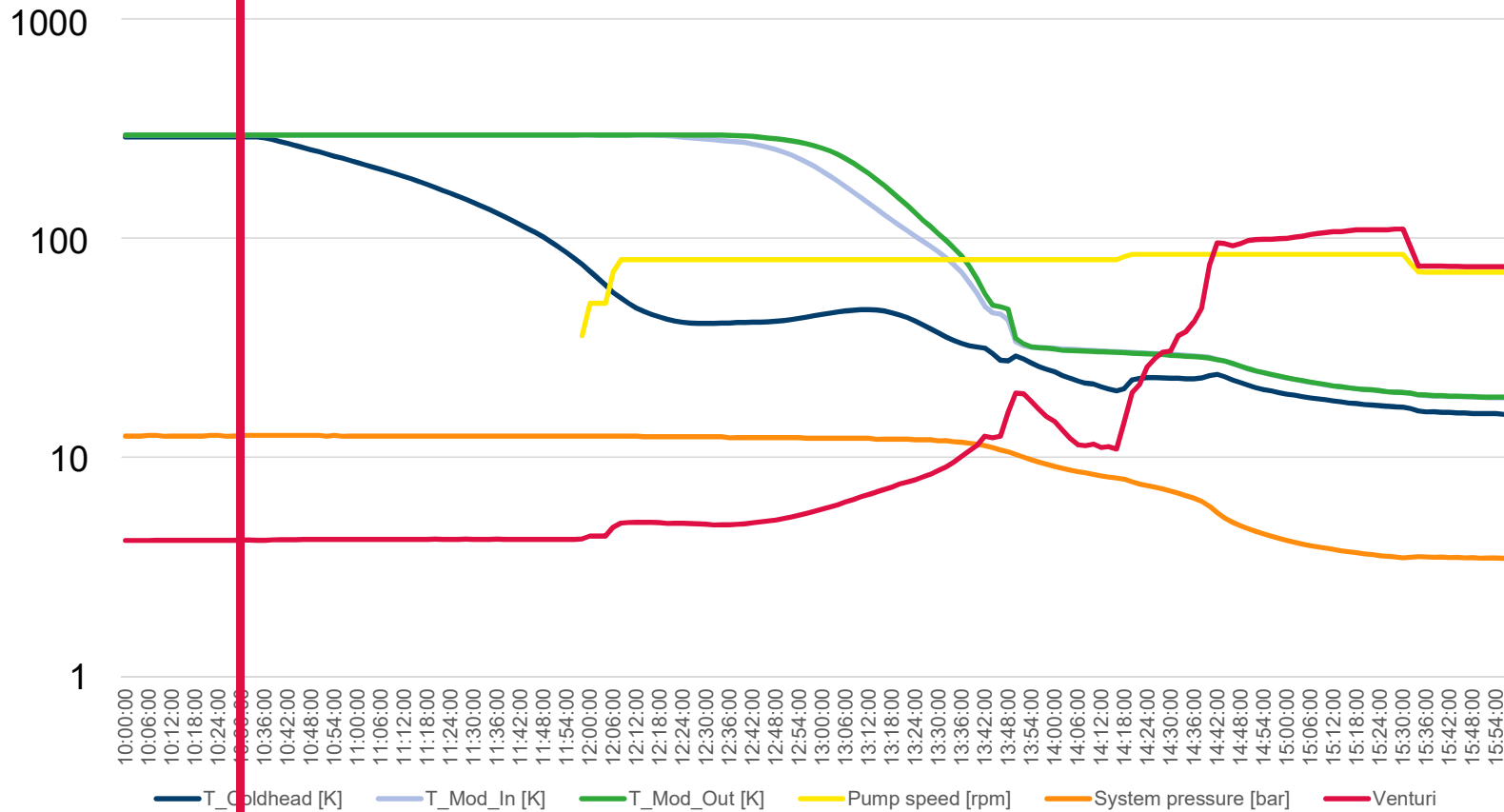
Pump speed [rpm]

Gas pressure [bar]

Mass flow

# Start of cryocooler @ 10:30h

Cooldown diagram (over 6 hours)



T Coldhead [K]

T Mod In [K]

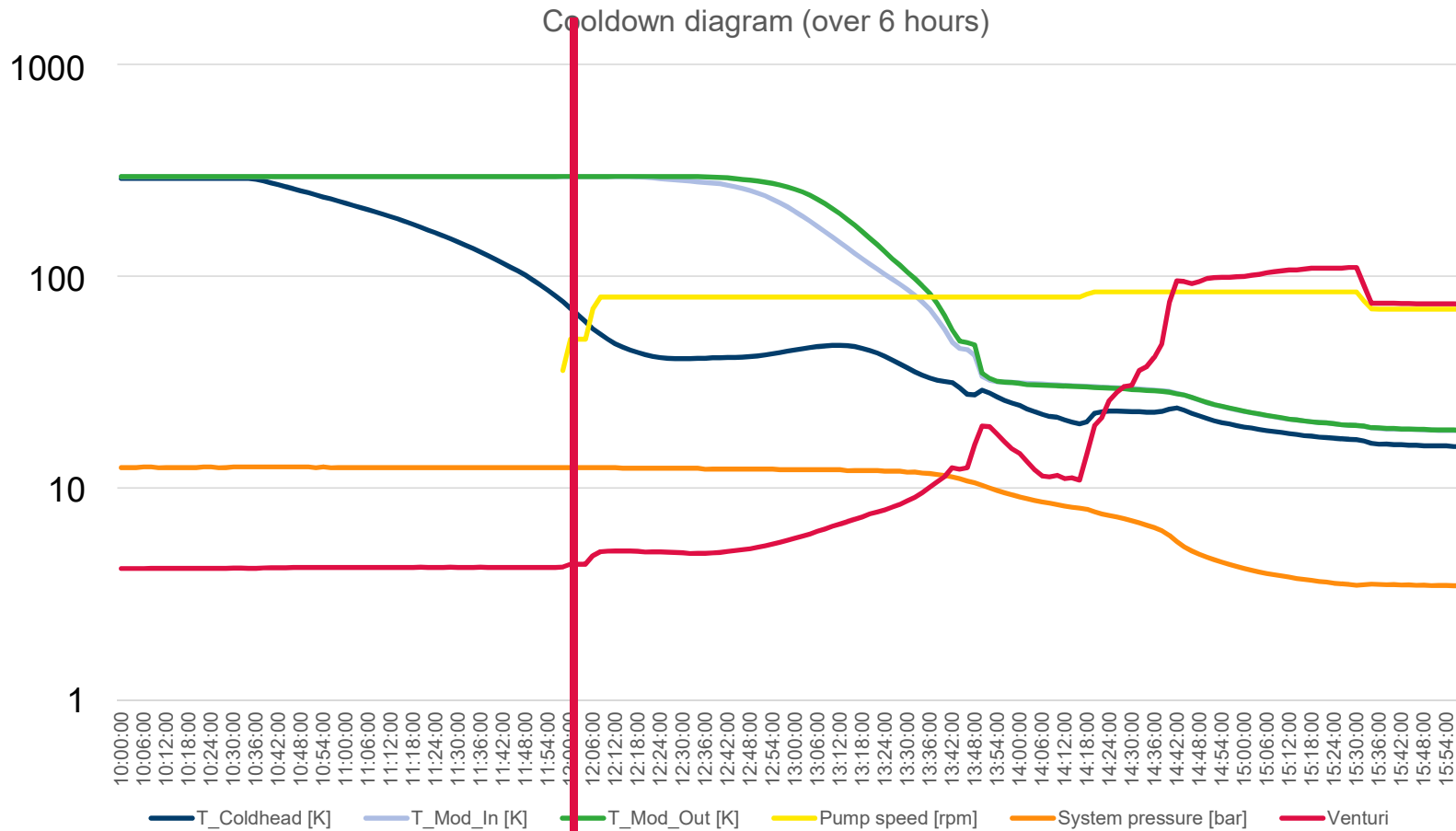
T Mod Out [K]

Pump speed [rpm]

Gas pressure [bar]

Mass flow

# Start of circulation @ 80 K after 1:30 h



T Coldhead [K]

T Mod In [K]

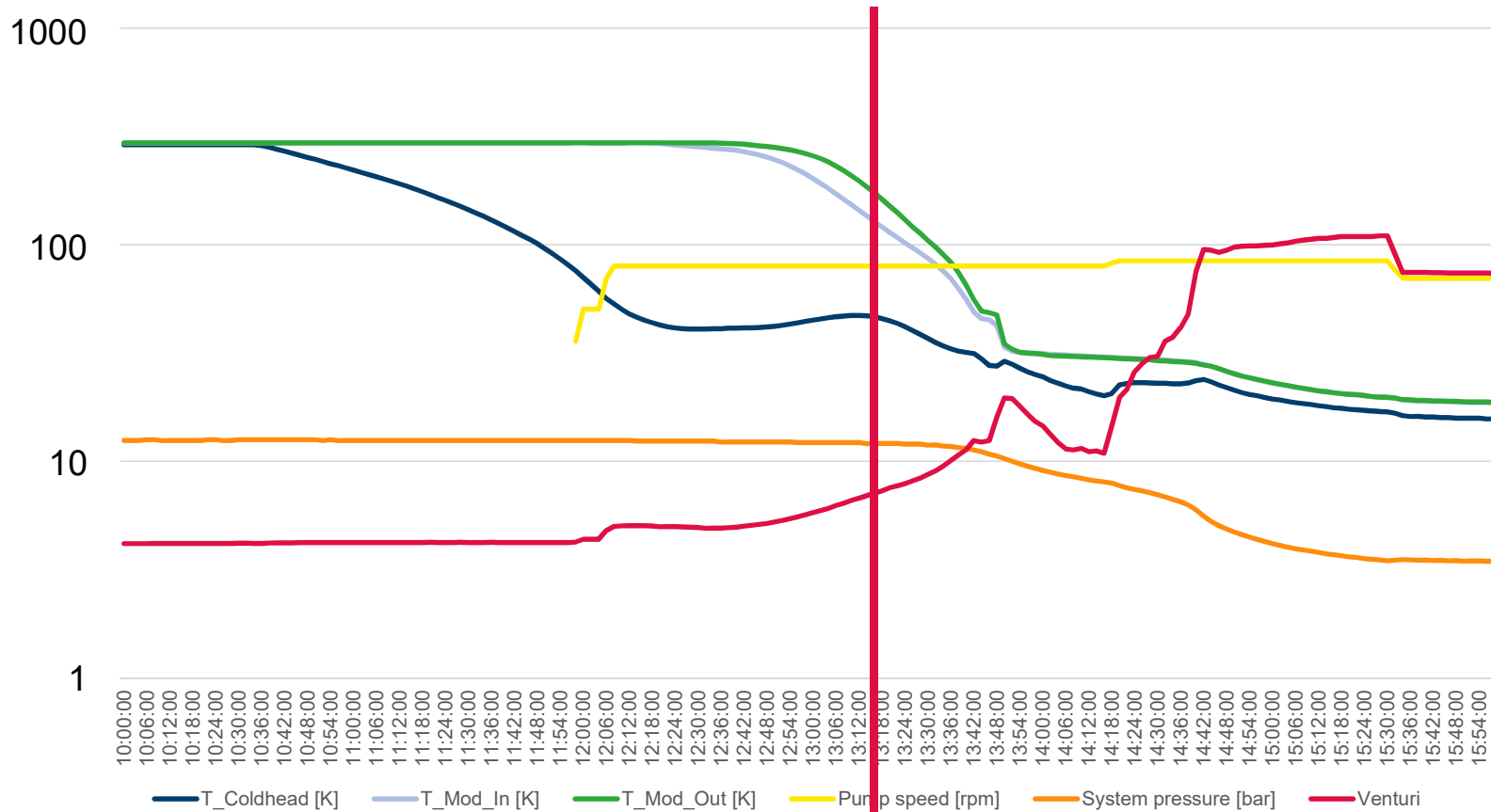
T Mod Out [K]

Pump speed [rpm]

Gas pressure [bar]

Mass flow

# Density increasing → Flow increasing, cooling of the moderator part after 2:45 h



T Coldhead [K]

T Mod In [K]

T Mod Out [K]

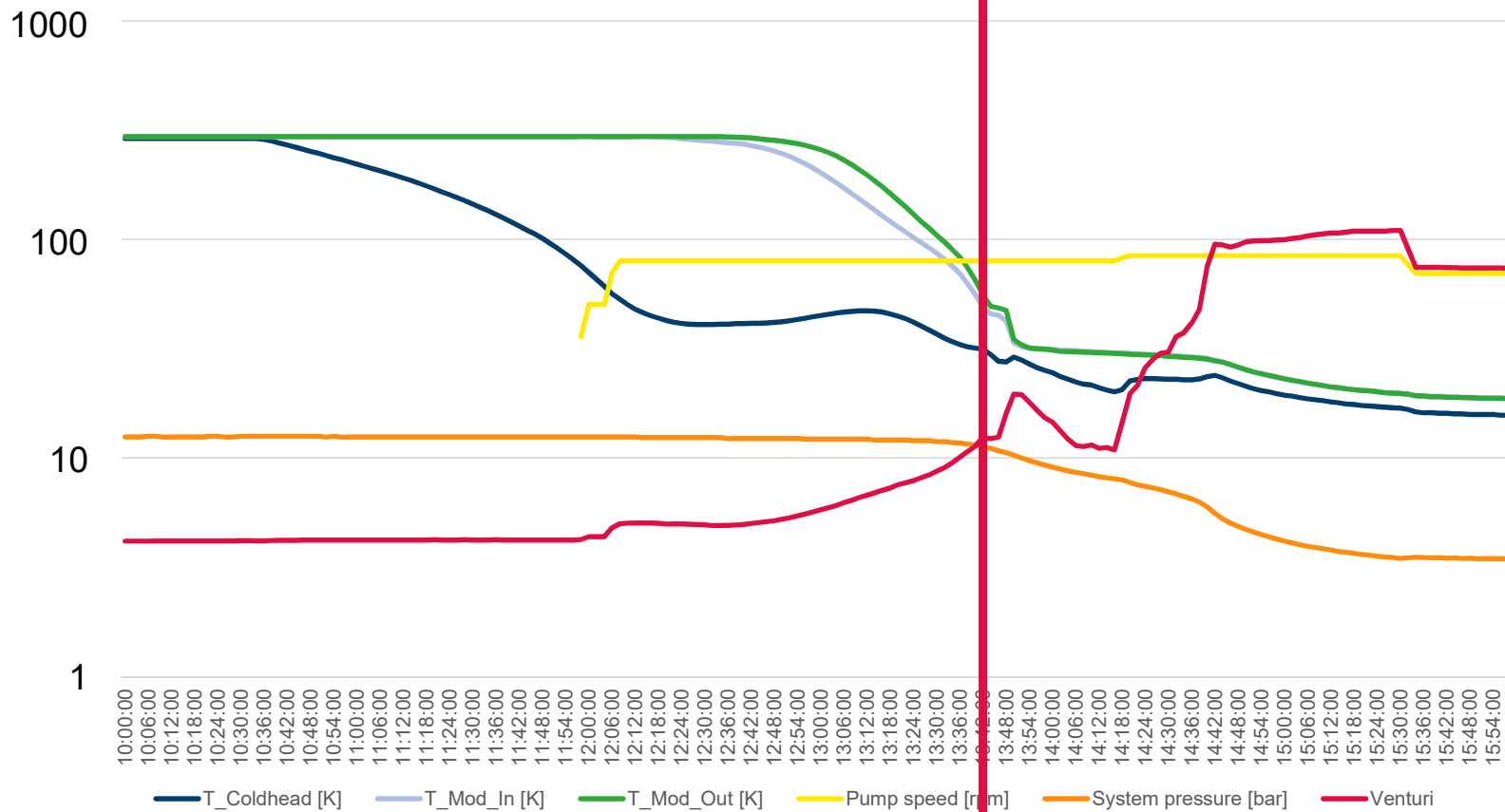
Pump speed [rpm]

Gas pressure [bar]

Mass flow

# Condensation after 3:10 h

Cooldown diagram (over 6 hours)



T Coldhead [K]

T Mod In [K]

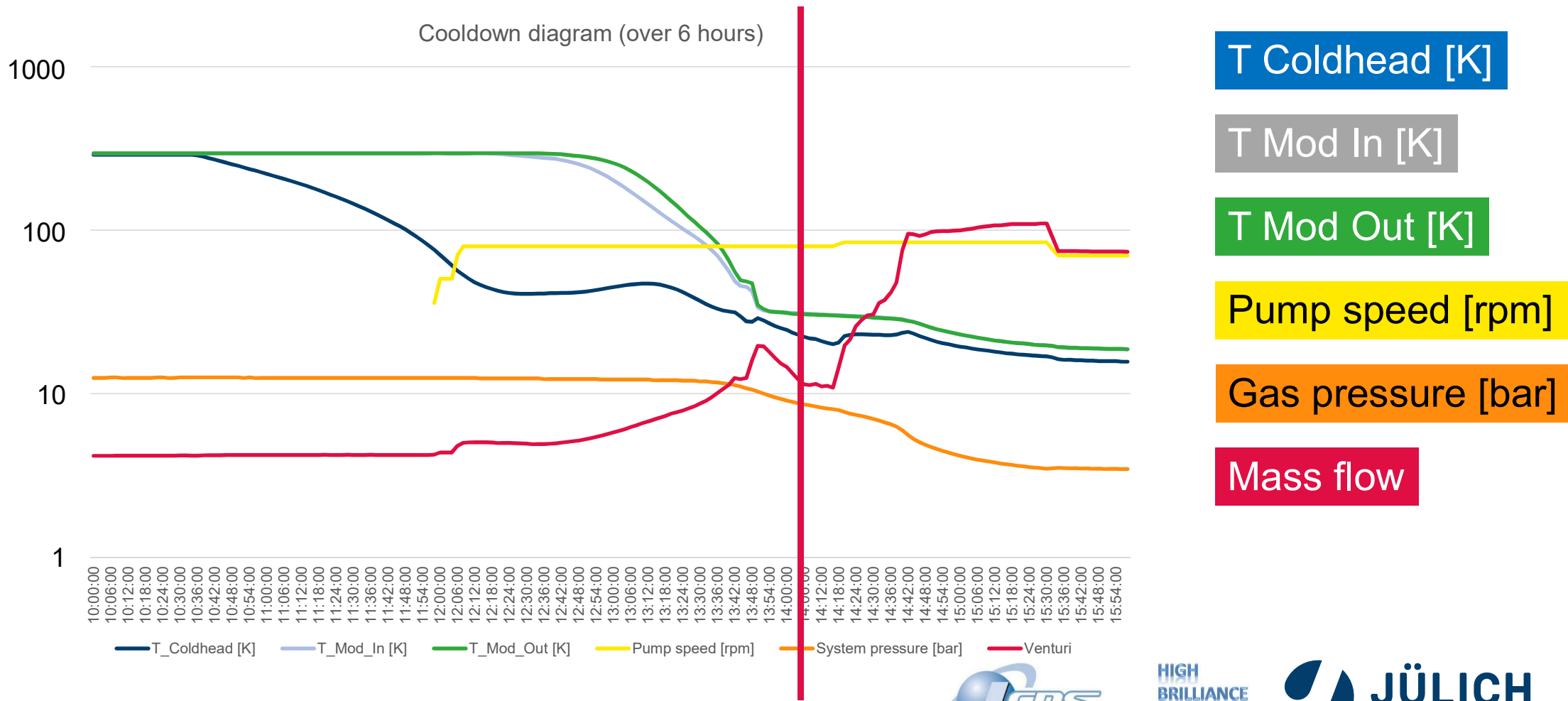
T Mod Out [K]

Pump speed [rpm]

Gas pressure [bar]

Mass flow

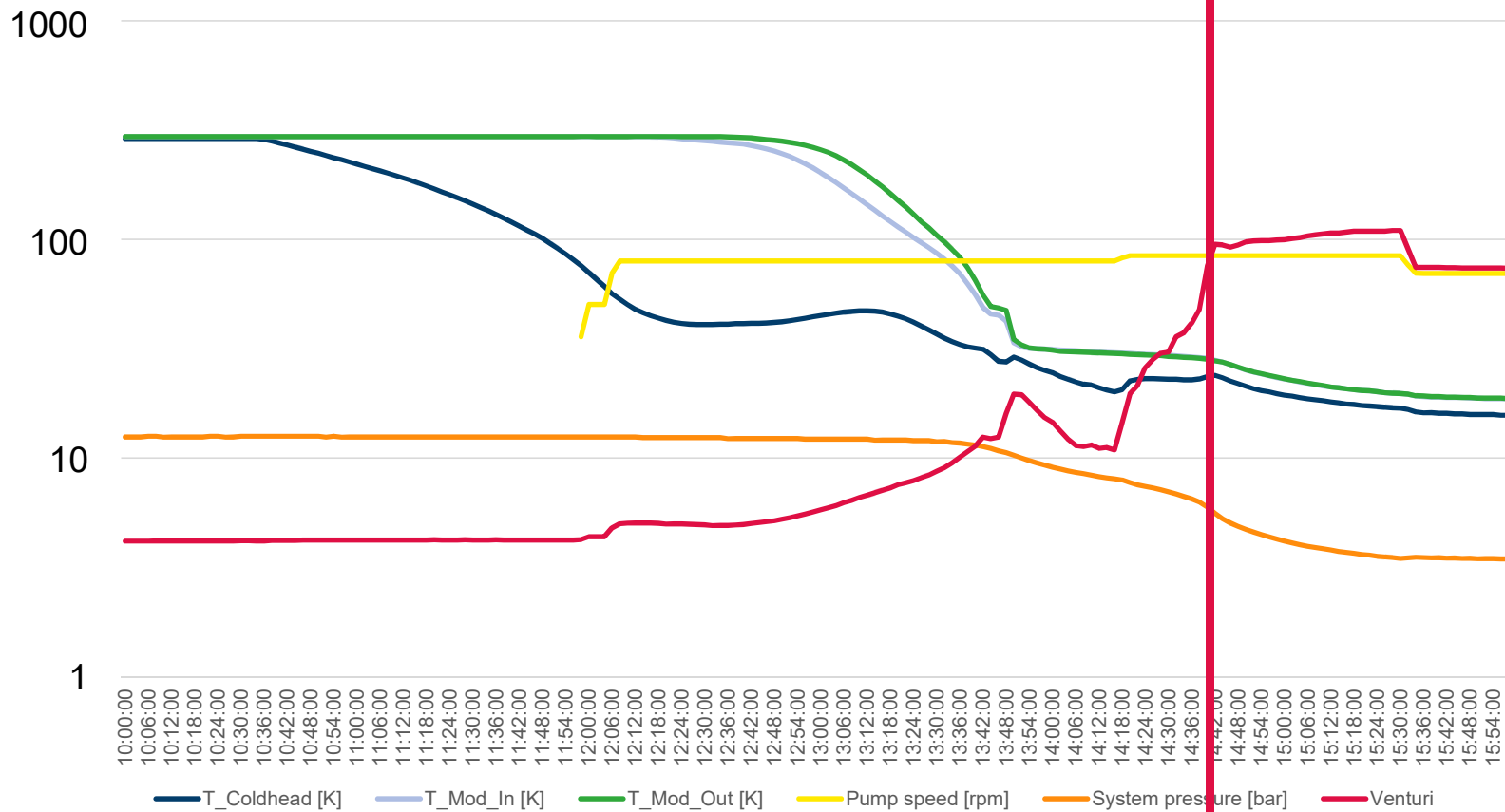
# Filling of moderator volume after 3:45 h





# Moderator full of liquid after 4:10 h

Cooldown diagram (over 6 hours)



T Coldhead [K]

T Mod In [K]

T Mod Out [K]

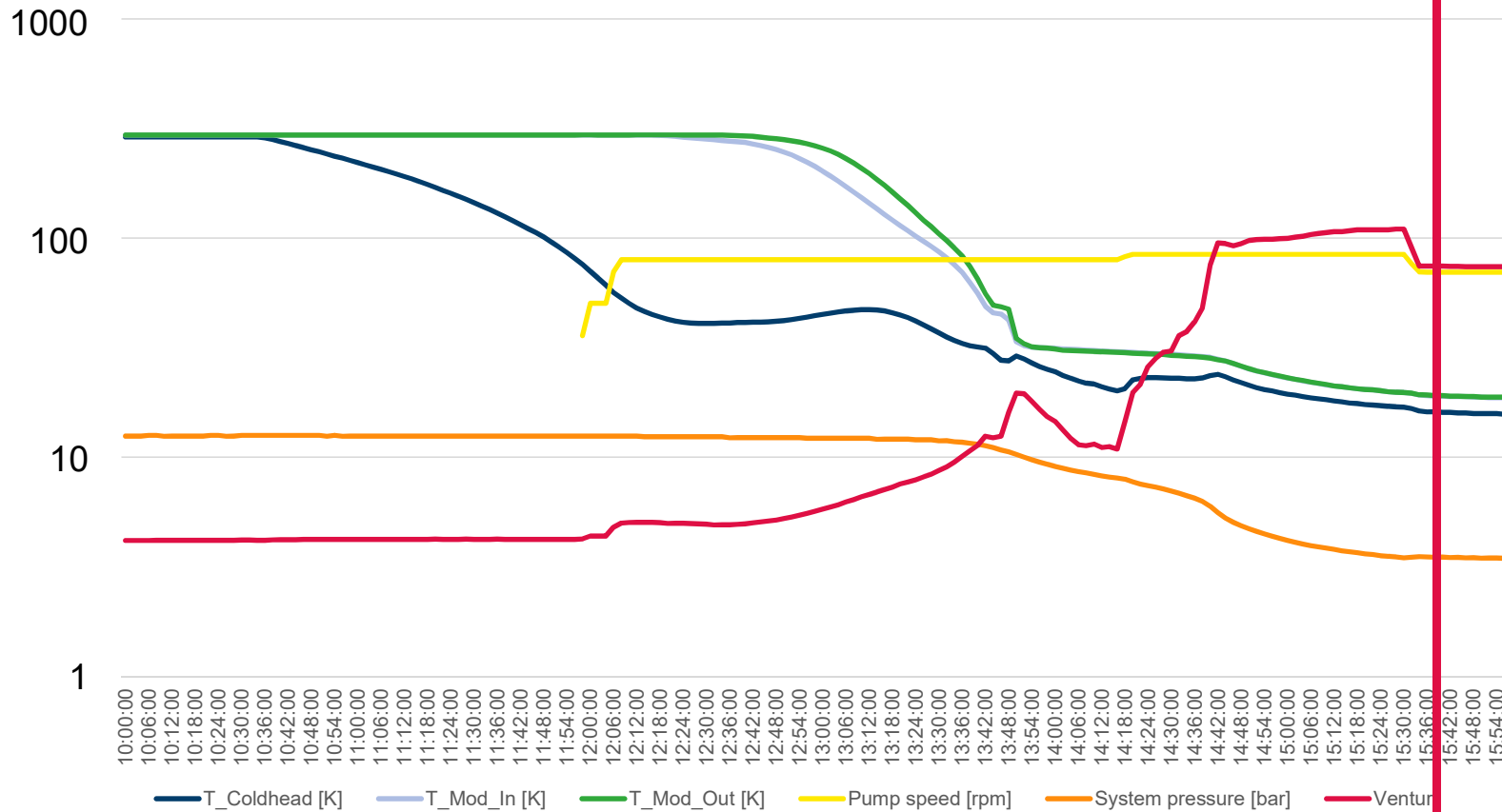
Pump speed [rpm]

Gas pressure [bar]

Mass flow

# Temperature stable after 5:15 h:

## 18.8 K moderator temp. 3.5 bar H<sub>2</sub> pressure



T Coldhead [K]

T Mod In [K]

T Mod Out [K]

Pump speed [rpm]

Gas pressure [bar]

Mass flow

## Team:

Design (Main cryostat): S. Eisenhut, TU Dresden

Design (Moderator plug): A. Schwab, J. Baggemann, JCNS-HBS

Main components borrowed: Y. Beßler, ZEA-1

Manufacturing, assembly: JCNS workshop, esp. S. Pistel, N. Bernard

Project management: F. Suxdorf, JCNS instrument technology

Commissioning: M. Hannot, R. Rings, E. Rosenthal, ZEA-1

Neutron measurements: M.-A. Paulin, LLB Saclay

# HBS Team



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 Th. Brückel  
 J. Chen  
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 T. Cronert (†)  
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 P.-E. Doege  
 M. El Barbari  
 T. Gutberlet  
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 J. Li  
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 U. Rücker  
 N. Schmidt  
 A. Schwab  
 D. Shabani  
 E. Vezhlev  
 J. Voigt  
 P. Zakalek

**- Design, verification, instrumentation**



## ZEA-1:

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 M. Hannot  
 F. Löchte  
 E. Rosenthal  
 R. Rings

**- Engineering**

## IKP-4:

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 R. Gebel  
 A. Lehrach  
 M. Rimmler

**- Nuclear physics**

## INM-5:

B. Neumaier

**- Radio isotopes**



S. Böhm  
 R. Nabbi

**- Nuclear simul.**



Ch. Haberstroh  
 M. Klaus  
 S. Eisenhut  
 C. Lange

**- Liquid H<sub>2</sub>, AKR-2**



H. Podlech  
 O. Meusel

**- Accelerator**



W. Barth

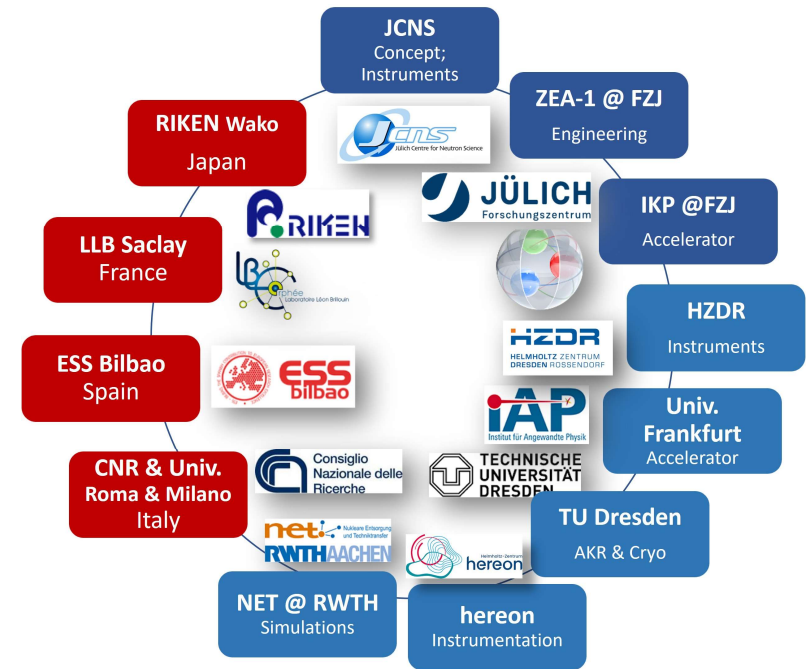
**- Accelerator**



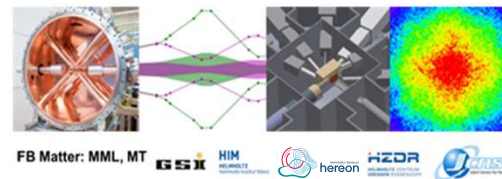
J. Fenske

**- Instrumentation**

Mitglied der Helmholtz-Gemeinschaft



## HBS Innovationpool Project



@hbsneutron

<https://hbs.fz-juelich.de/>

