

WIR SCHAFFEN WISSEN – HEUTE FÜR MORGEN



Dr. Bertrand Blau :: Facility Manager SINQ & UCN :: Paul Scherrer Institut

Design and Performance of the Solid D₂ Moderator System of the UCN Facility at PSI

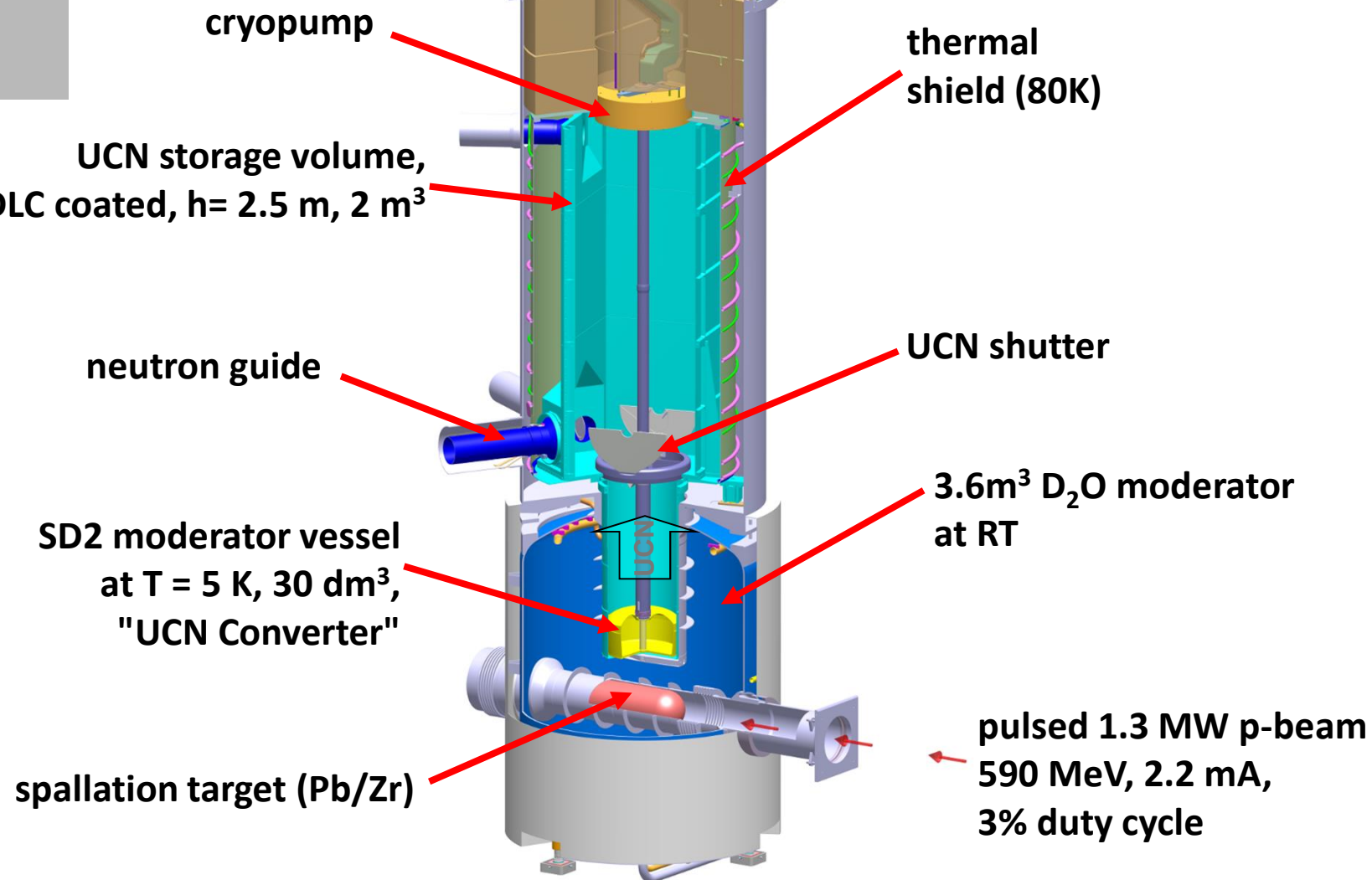
DENIM 2018

19th September 2018

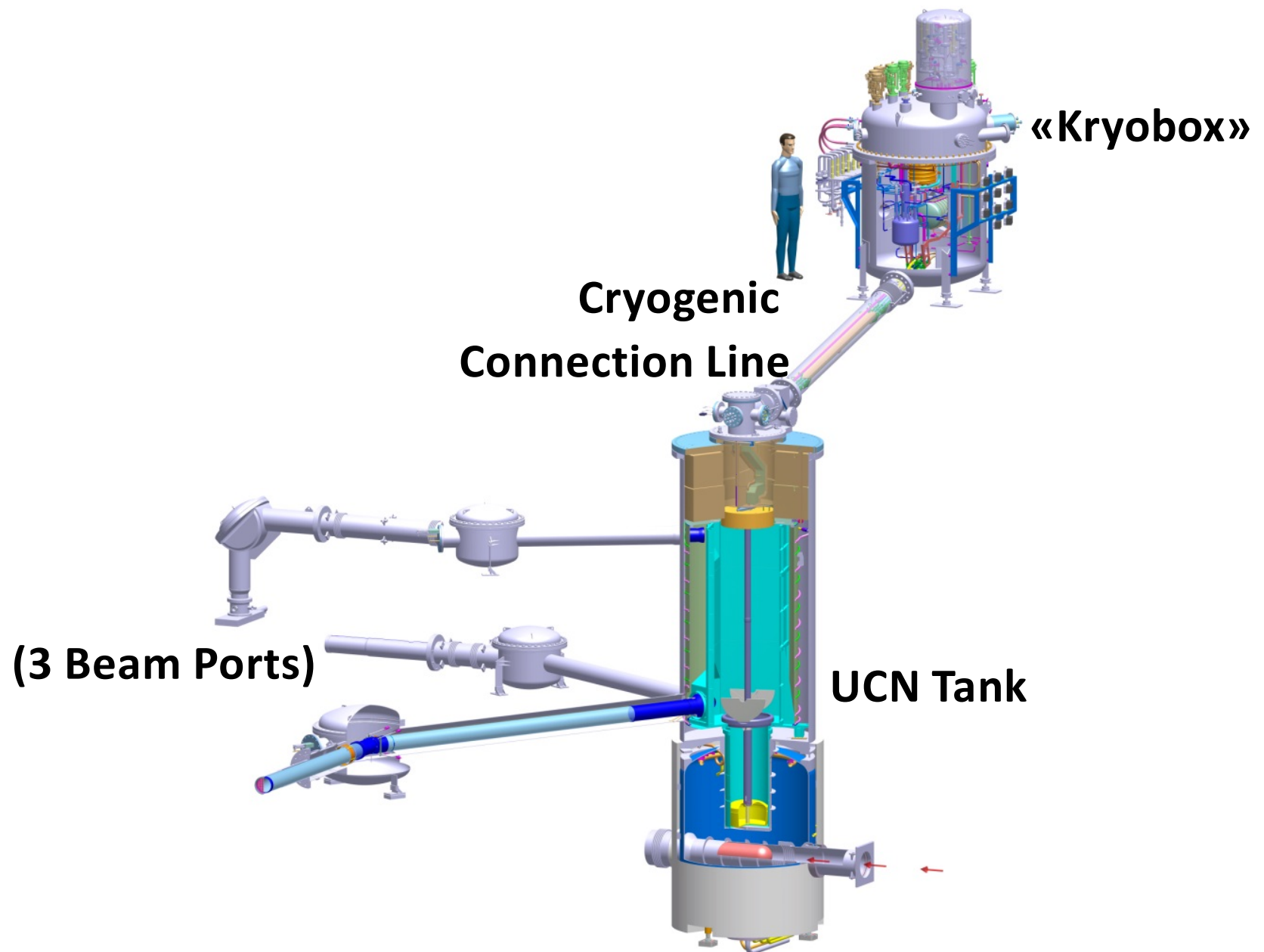
UCN-Source

PSI's 2nd target station

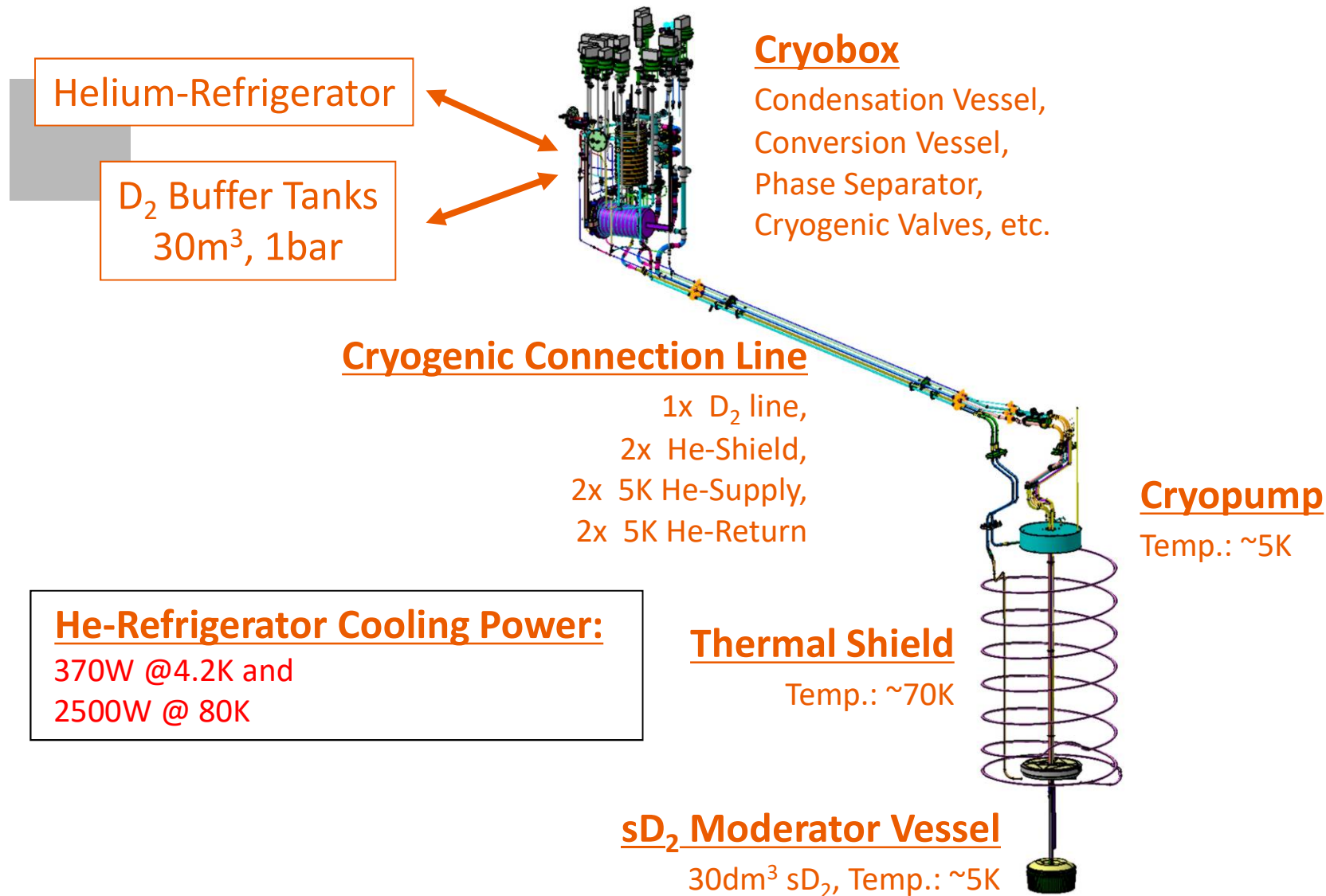
7 m



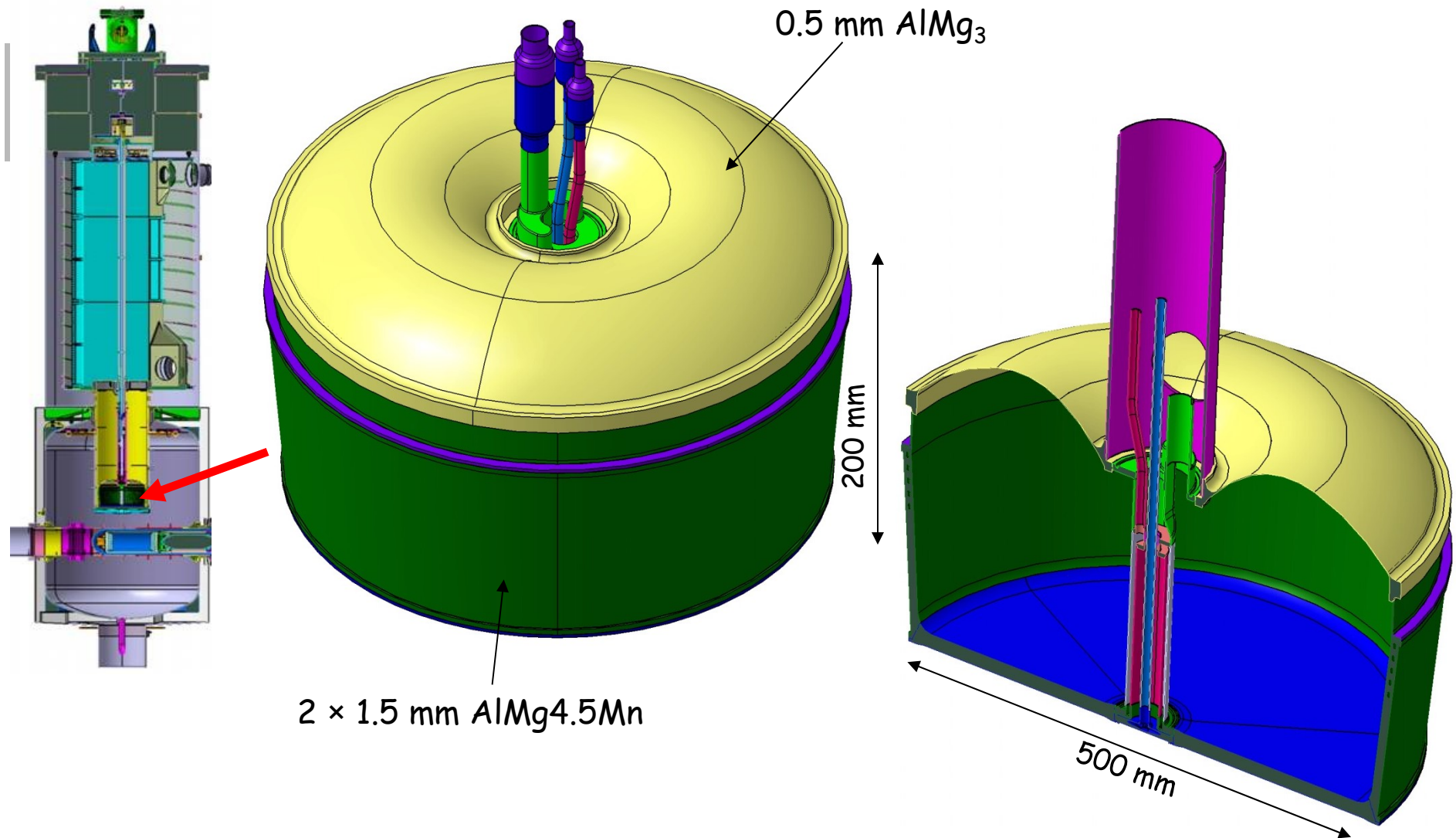
The Cryogenic System of the UCN Source



He and D₂ Cryogenic System



SD₂-Moderator Vessel

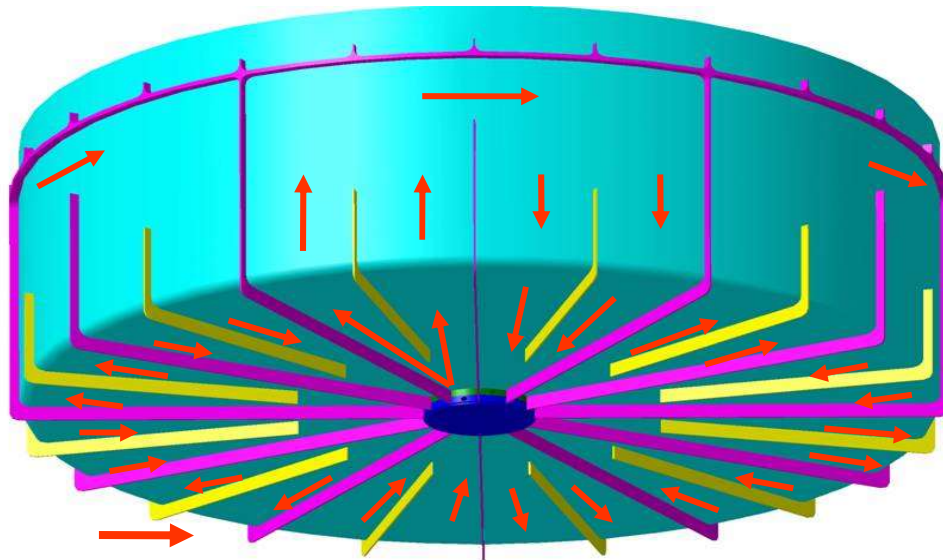
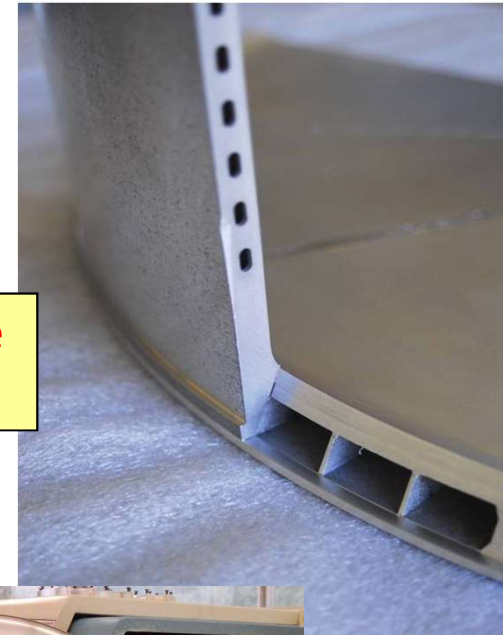


Details of sD₂-Moderator Vessel



all parts
EB welded

cooling channels made
by wire erosion



Helium-flow direction

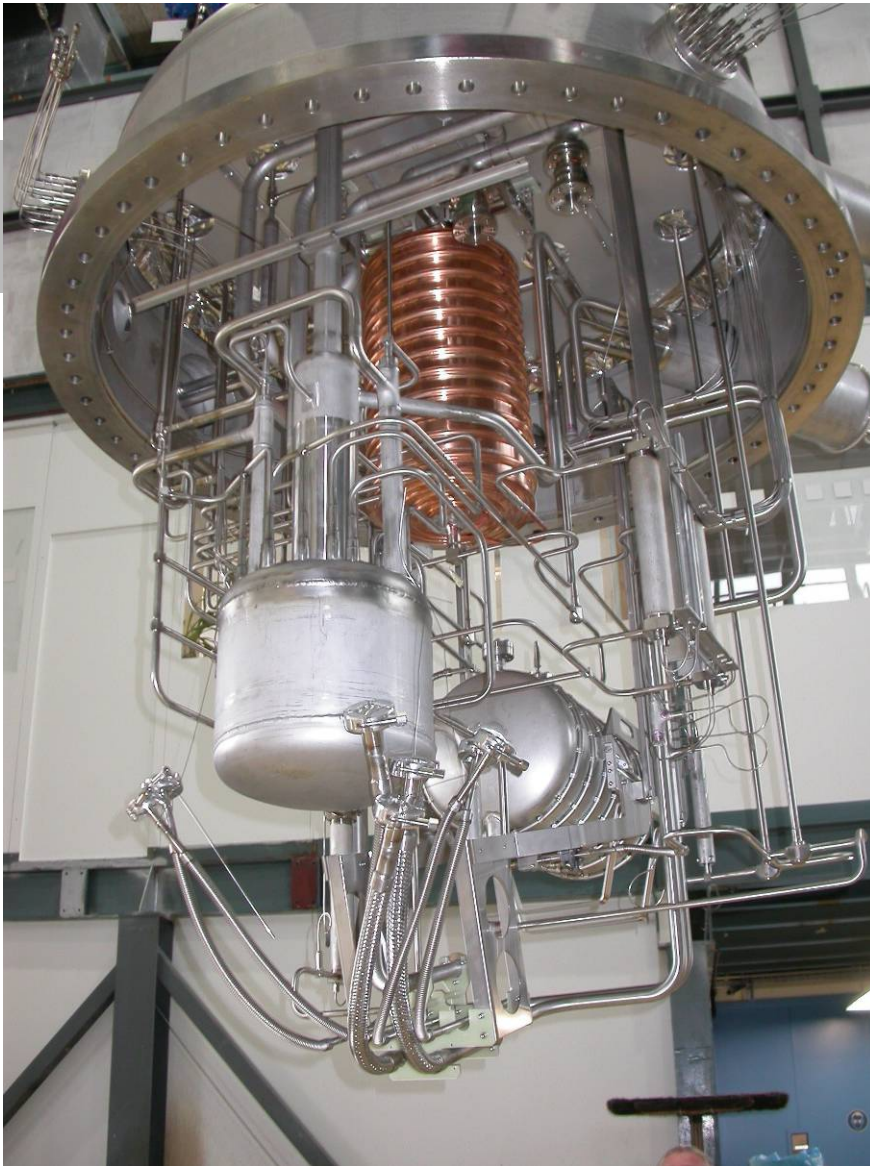
DENIM 2018



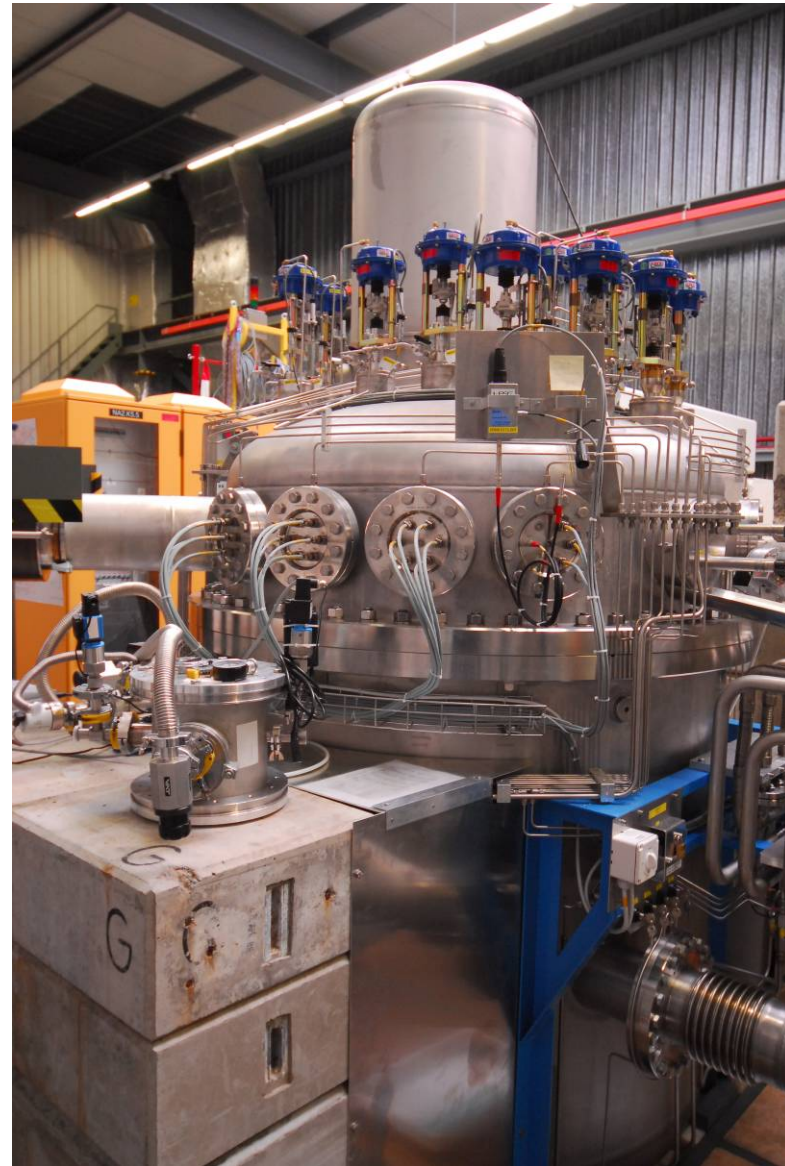
Toroidal calotte: $500 \pm 50 \mu\text{m}$ thickness

no plastic deformation for -1 ... +3 bar

Cryobox (= Coldbox for D₂ Handling)

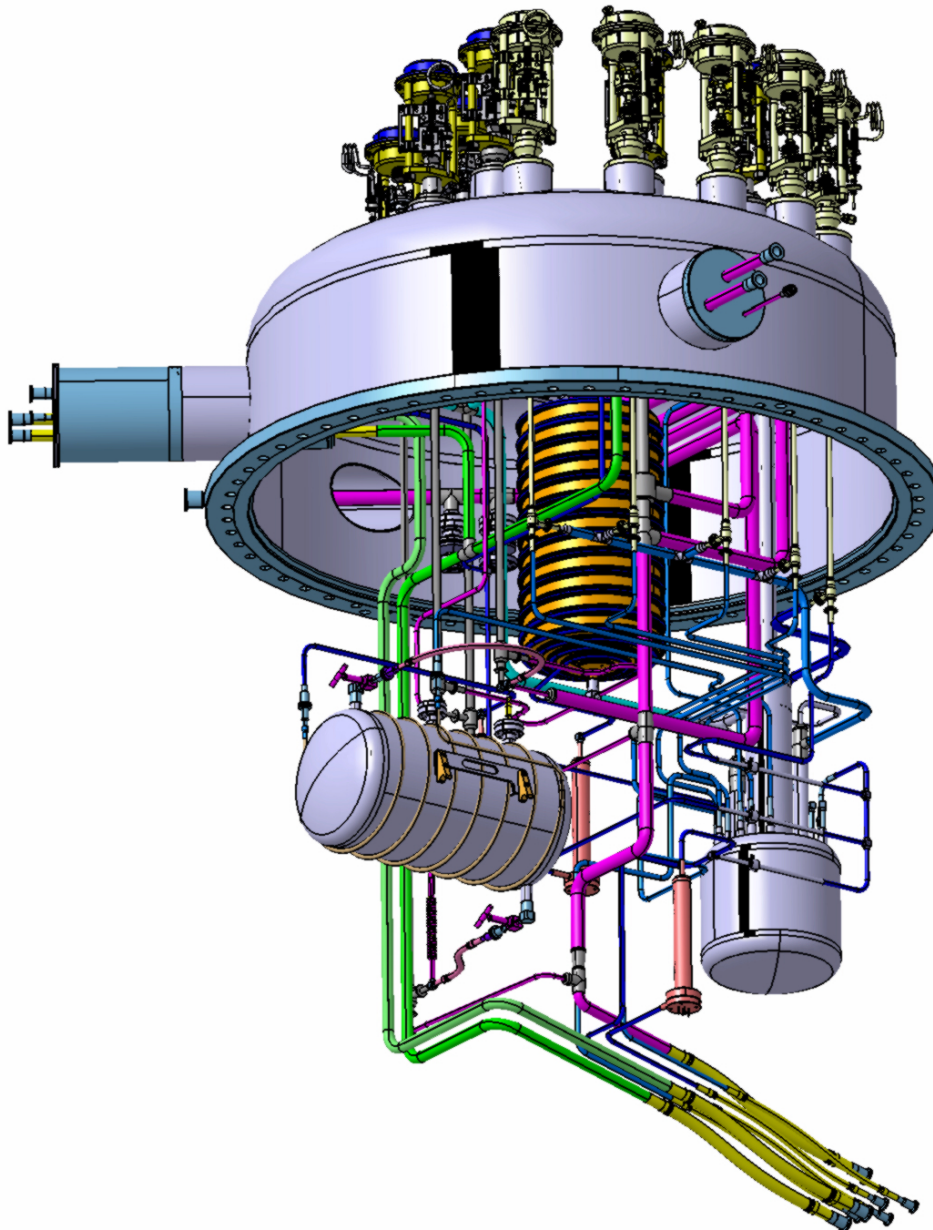


interior of cryobox without superinsulation

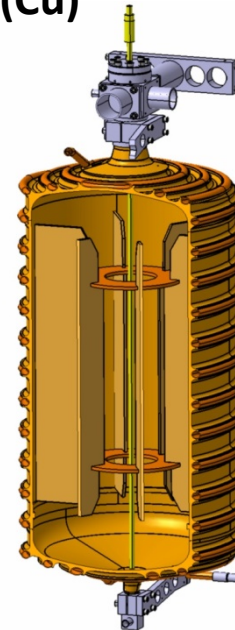


cryobox in operation

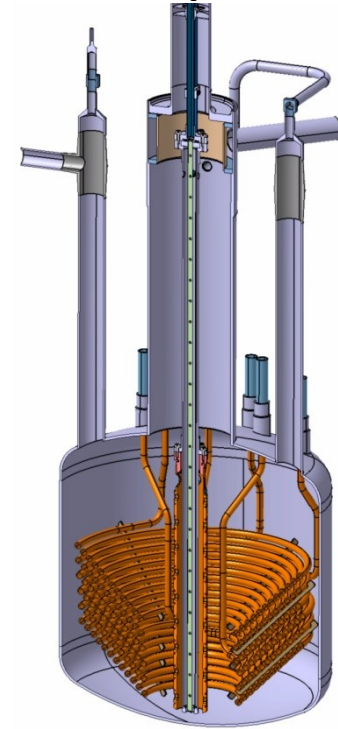
Cryobox Details



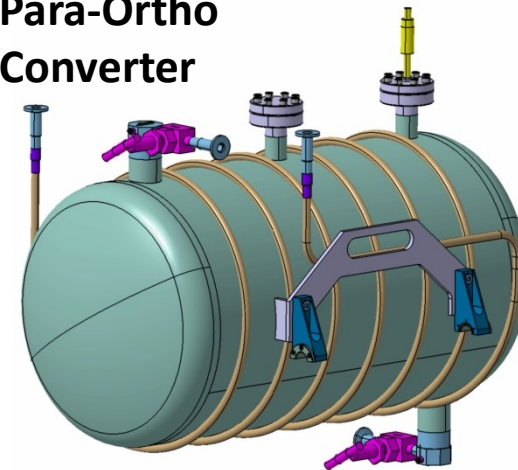
Condenser
(Cu)



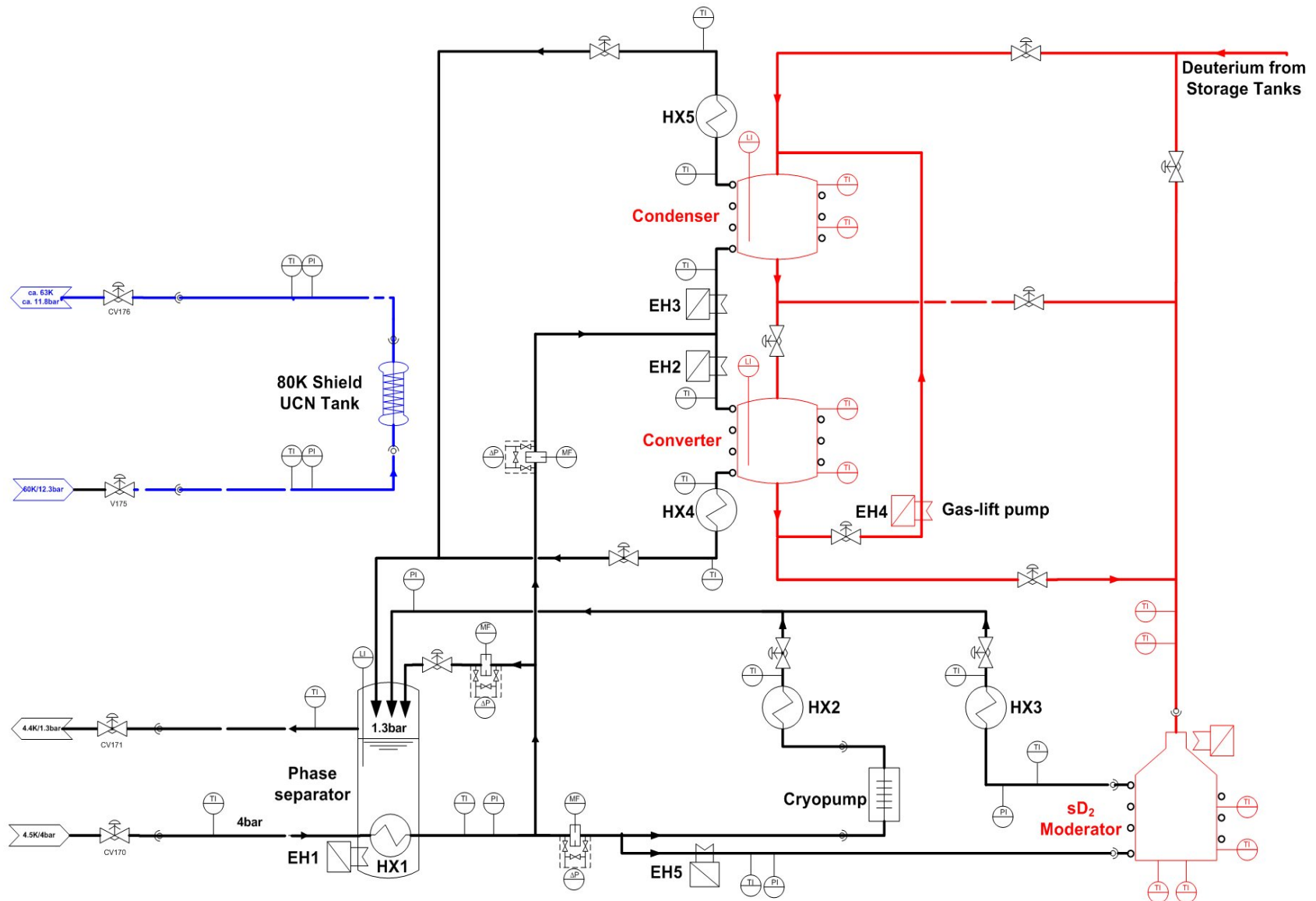
Phase Separator



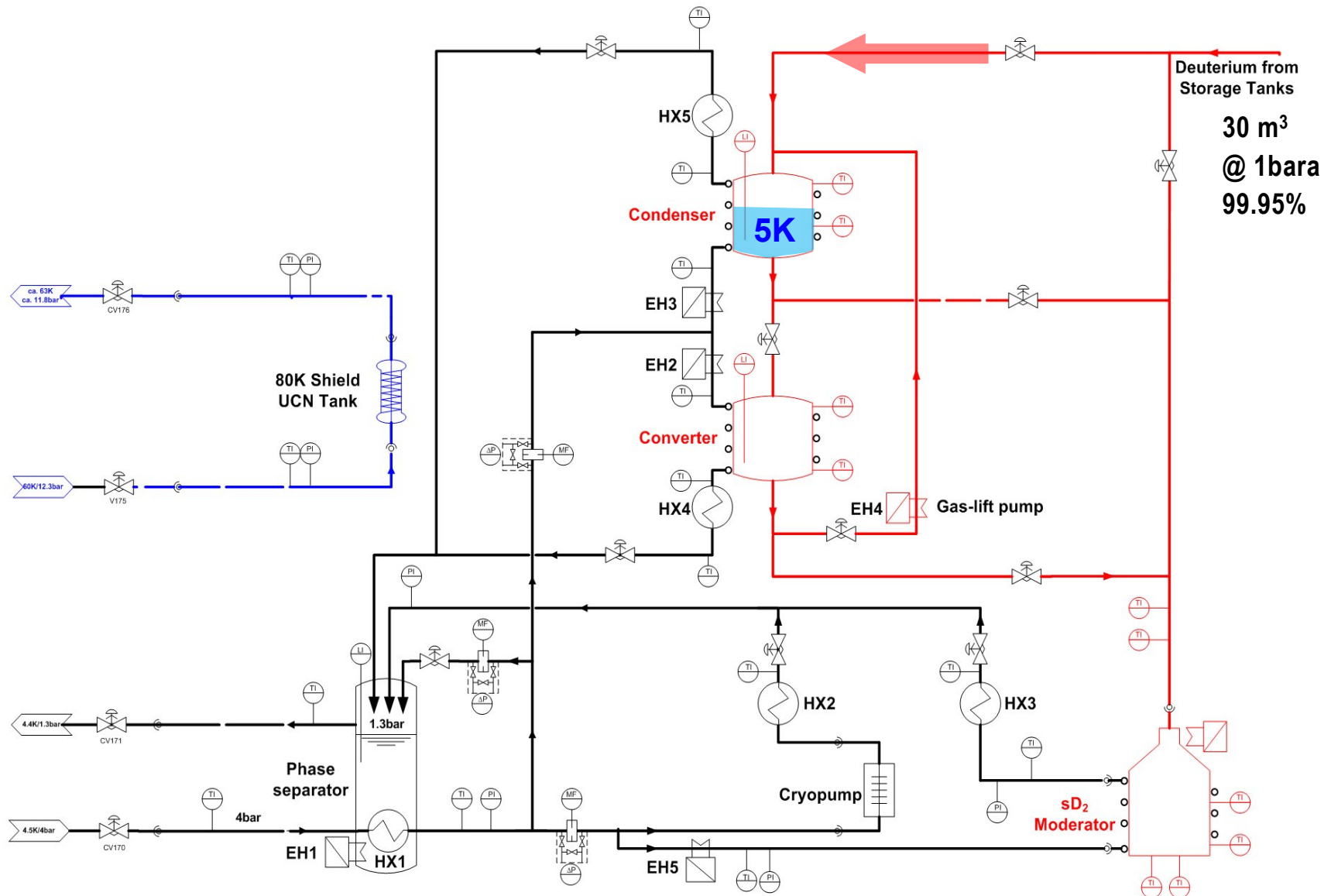
Para-Ortho
Converter



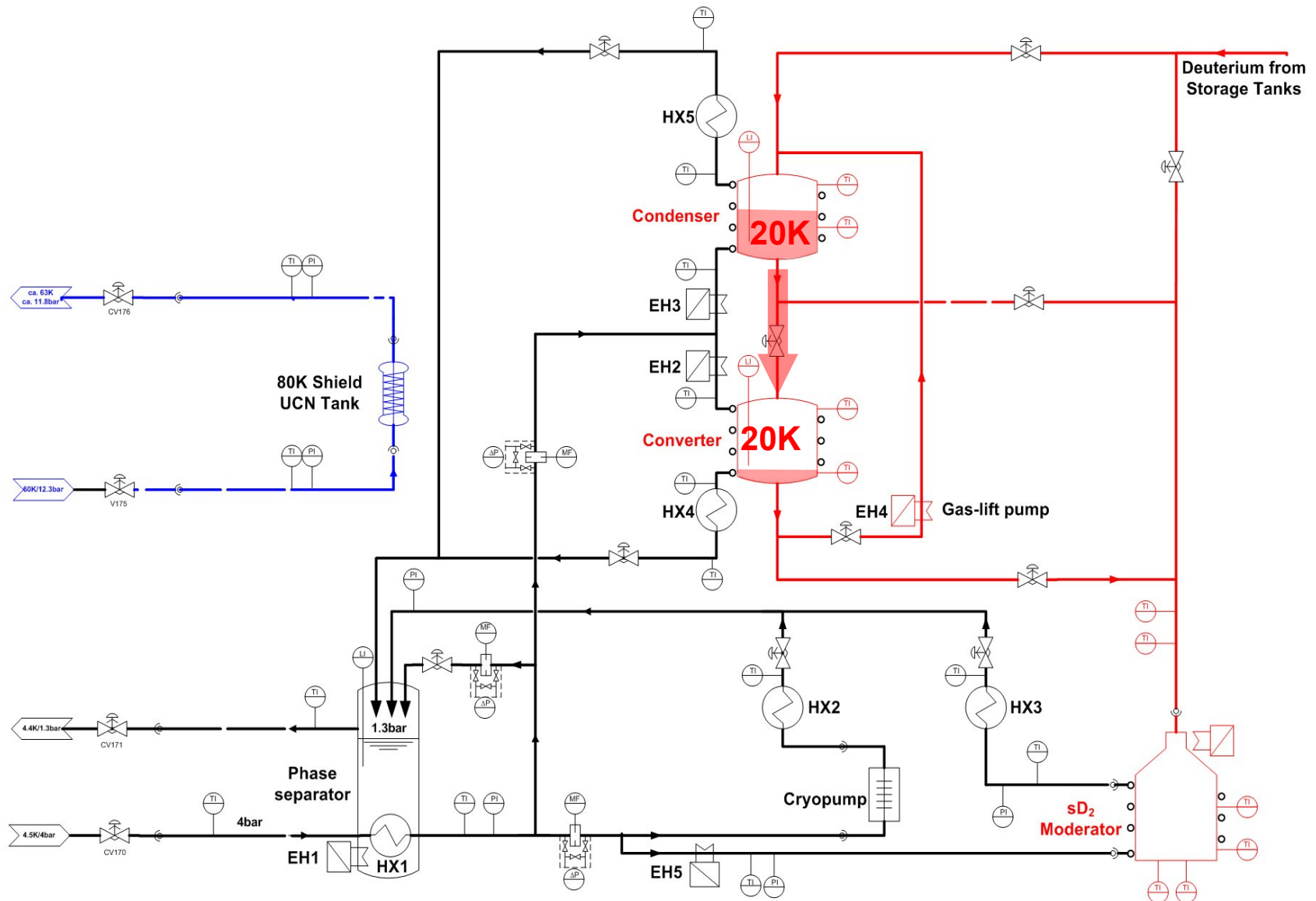
Simplified Cooling Scheme



Condensation from Storage Tanks



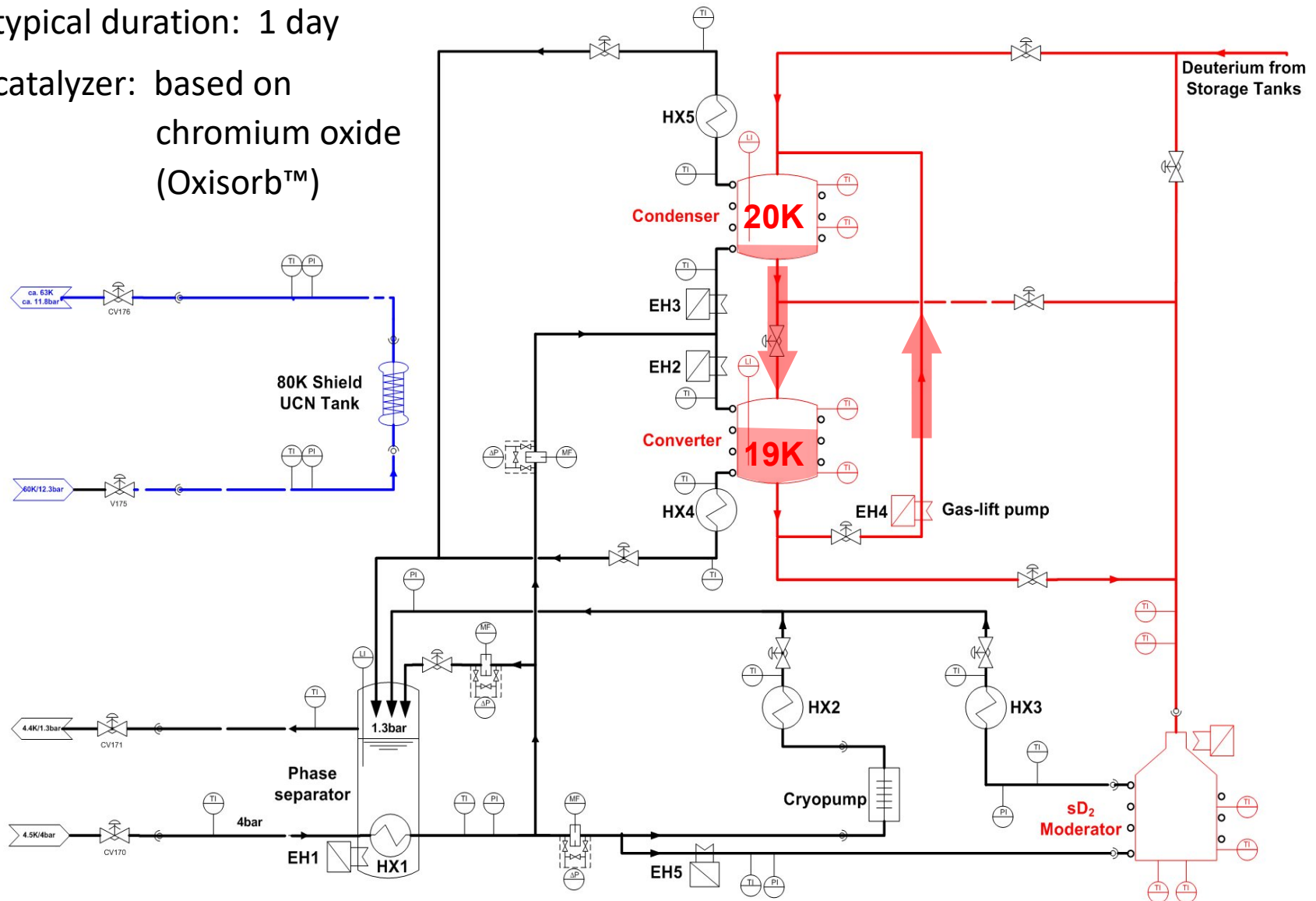
Melting and Transfer at ~20K



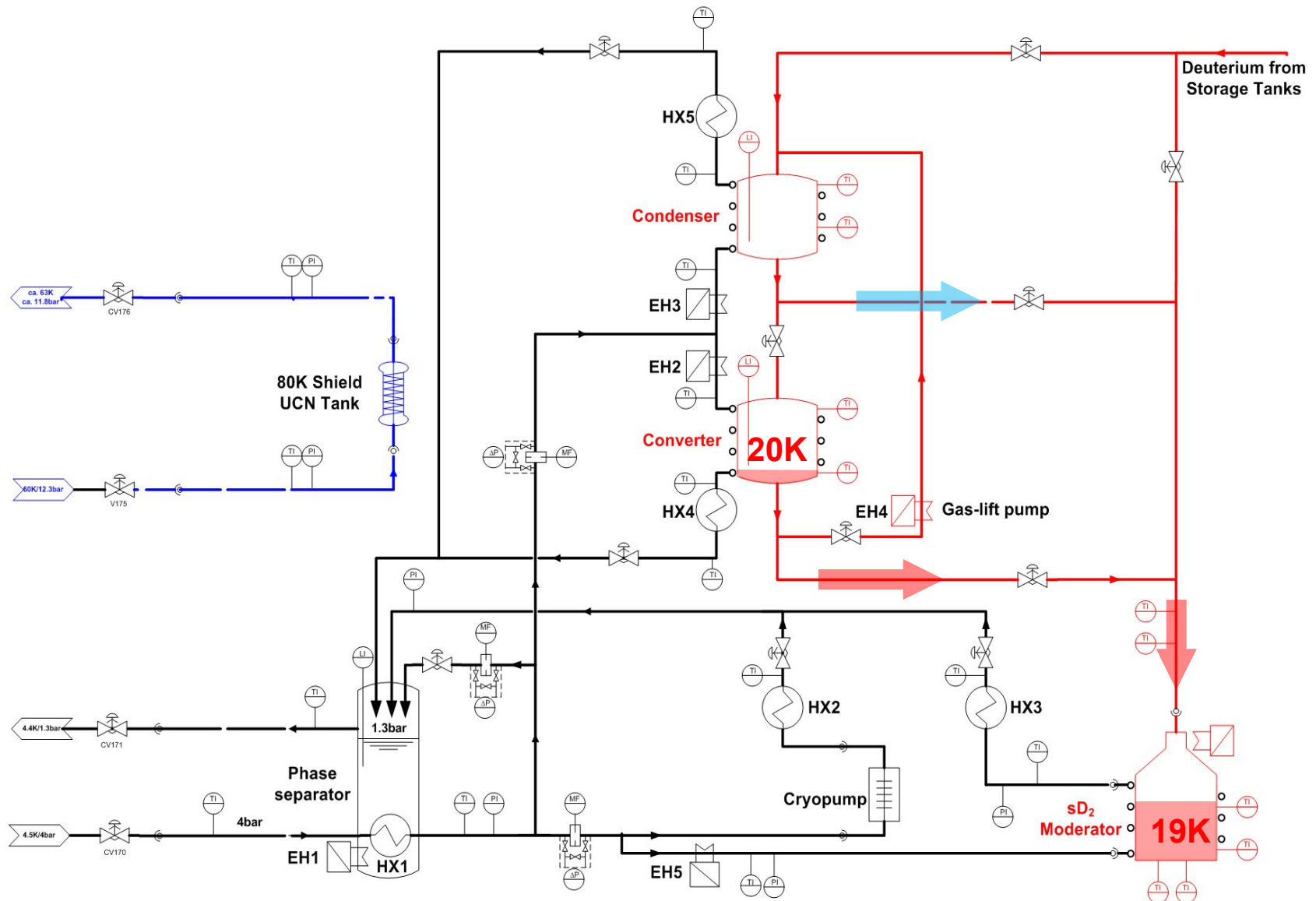
Para/Ortho Conversion

typical duration: 1 day

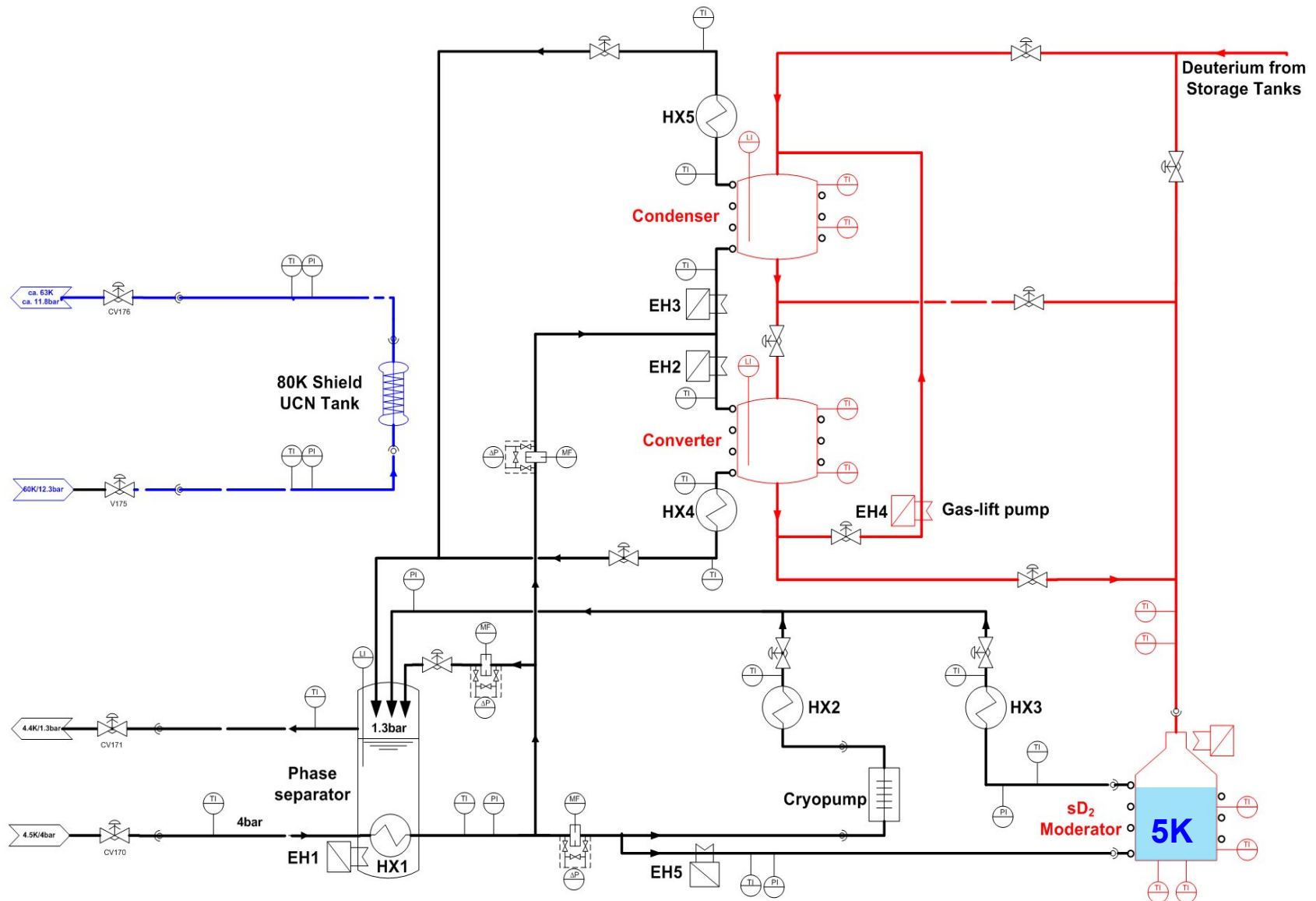
catalyzer: based on
chromium oxide
(Oxisorb™)



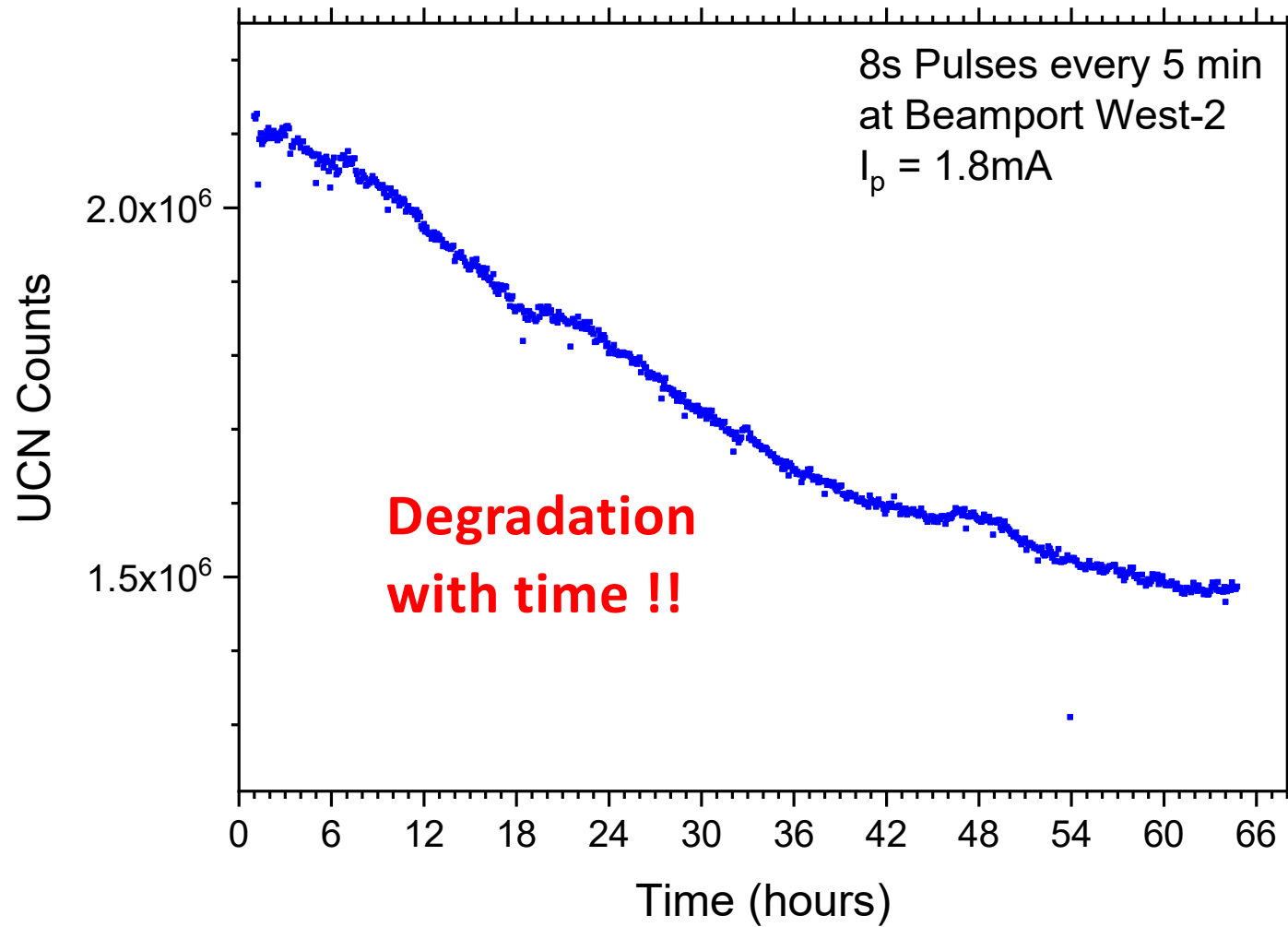
Transfer of Ortho-D₂ to Moderator



Freezing of Liquid oD₂ in Moderator & Operation

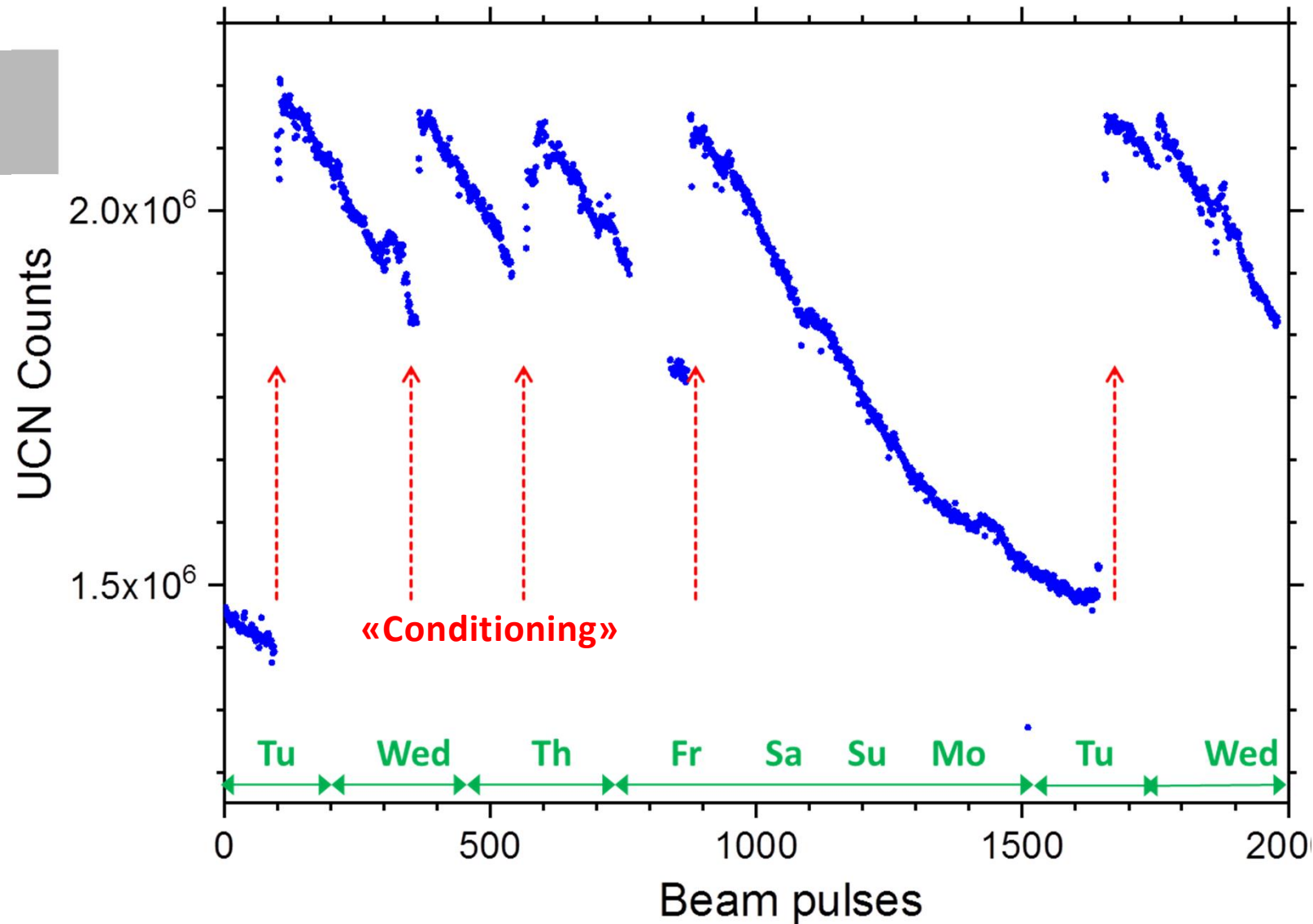


UCN Yield vs. Time



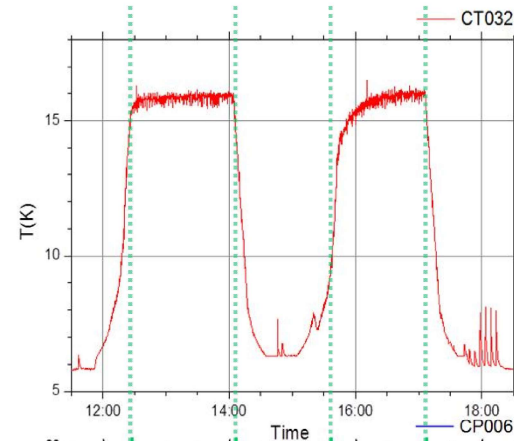
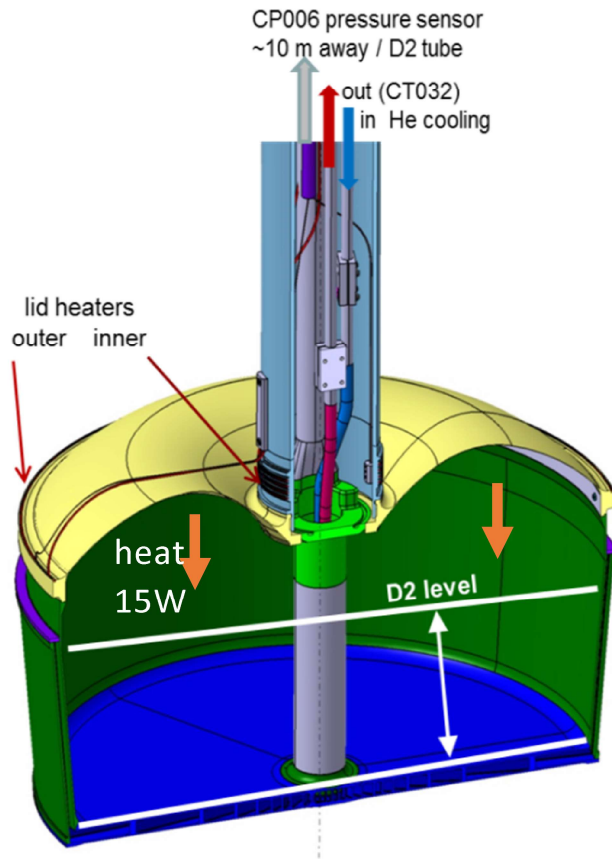
Regaining Full UCN Yield

... due to special 2h thermal treatment of D₂ crystal

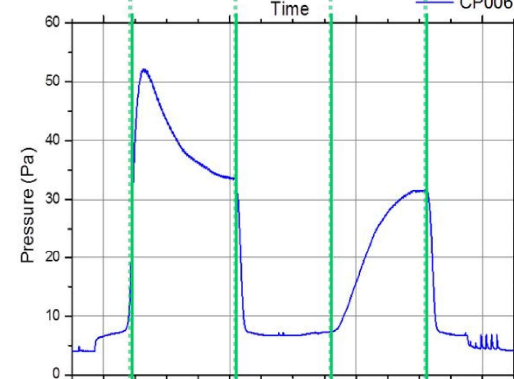


Thermal Cycle: Conditioning

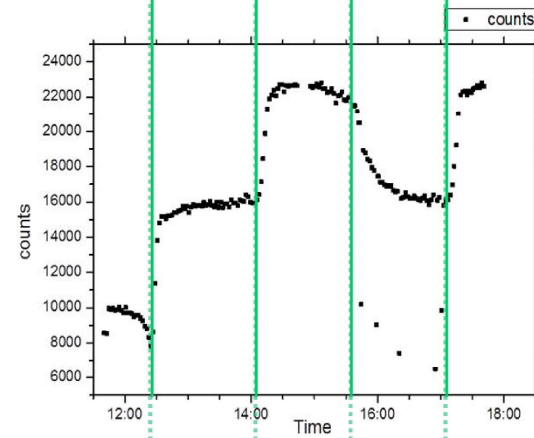
2x Conditioning



He-temperature
in coolant return line

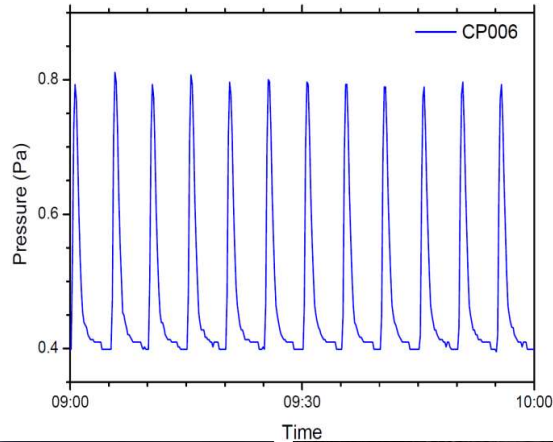


D₂ pressure
moderator



UCN counts
(100ms pulse every 2min)

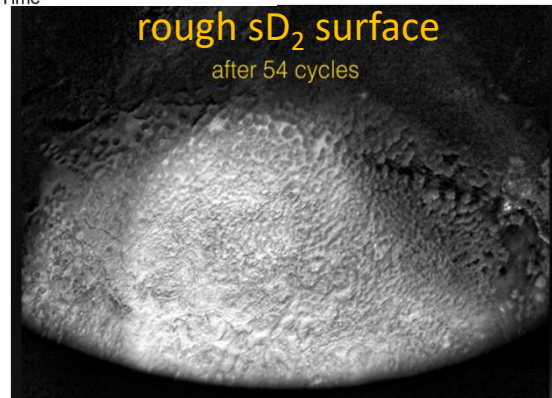
Surface Degradation due to D_2 «frost» layer build-up



sD_2 pressure
during pulsing
→ thermal cycling



smooth sD_2 surface
Before heat pulsing

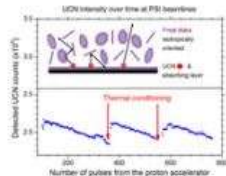


rough sD_2 surface
after 54 cycles

Photos courtesy E. Korobkina, NC State University, UCN source at PULSTAR reactor

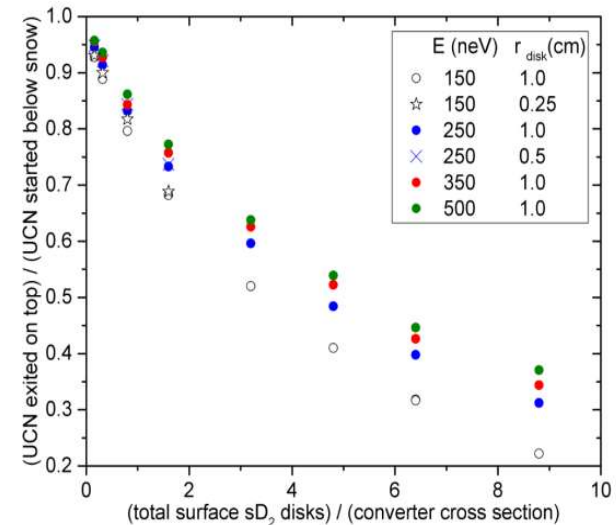
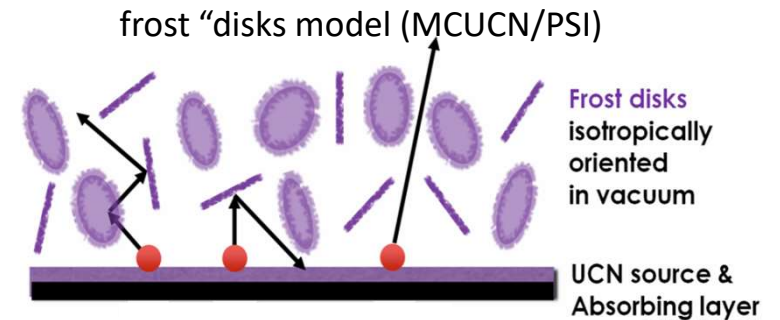
EPJ A Highlight - Solid deuterium surface degradation at ultracold neutron sources

Published on 11 September 2018



Highest intensities of ultracold neutrons (UCN) are in worldwide demand for fundamental physics experiments. Tests of the Standard Model of particle physics and searches for physics beyond it are performed with UCN.

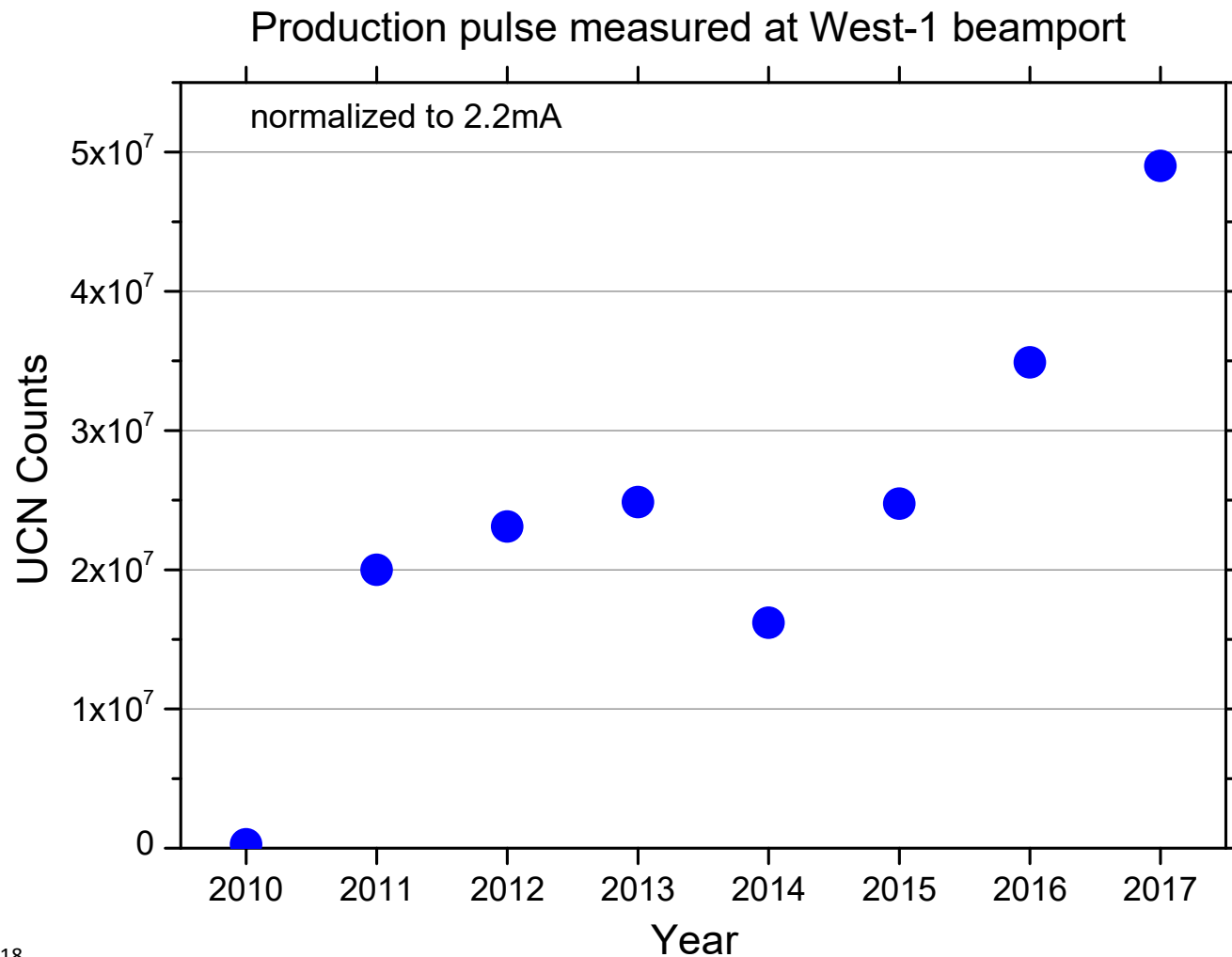
Two of the leading UCN sources, at PSI and at LANL, are based on solid deuterium (sD_2) at temperatures around 5 K. Here, together with NCSU they joined forces to understand UCN intensity decreases observed during pulsed neutron production. The study shows that the



Simulation of surface layer of small D_2 discs
(by G. Zsigmond, PSI)

Improvement of Maximum UCN Yield over Years

Highest yearly number of UCN delivered by a single pulse to beamport West-1





Thank you for your attention