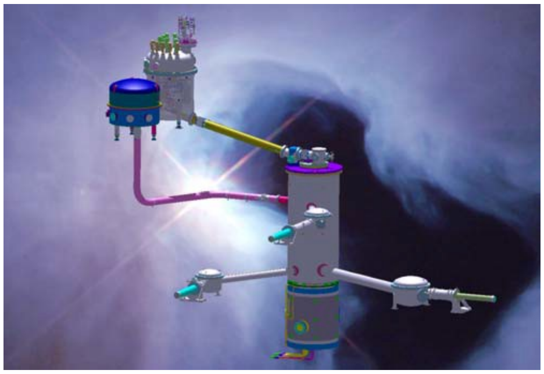
Components of the PSI UCN Source



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The PSI UCN Source is in routine operation since 2011. Here a short historical summary of the milestones.

1) Proton beam

(i) A test beam dump has been installed for testing the performance of the proton beam while the UCN area was in the build-up process, see Figure 1. From September 2007 on, proton beam test with intensities up to 2 mA and duration of a 10 ms have been performed during accelerator beam development. It was demonstrated that the beam position monitors (BPM) of the proton beam, necessary for the correct beam transport, are able to monitor the beam position along the total beam line within 5 ms.

(ii) The array of collimators in the beam line, necessary in the past to reduce the losses during splitter operation is not necessary for the UCN operation and was removed.

(iii) PSI's new source for ultracold neutrons was tested with the high intensity proton beam for the first time on December 15th 2009. Short pulses of proton beam with 5ms duration were sent onto the UCN target. The proton beam was ready for commissioning and UCN operation.

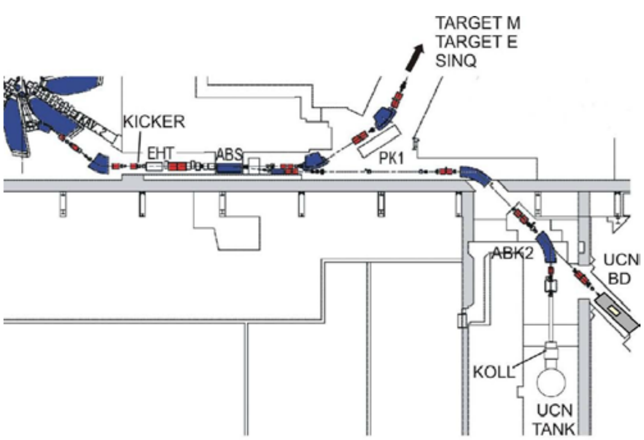

Figure 1: Layout of the proton beam from the cyclotron to the UCN facility and the test beam dump (UCN BD).

2) Neutron spallation target

The neutron spallation target has been manufactured and was ready to be inserted, see Figure 2.

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Figure 2: Neutron spallation target, ready for installation and operation.

3) UCN tank system

The UCN tank system, see Figure 3, was installed. It contains the heavy water tank, the cold solid deuterium converter and the UCN storage volume.

The UCN storage containment was ready, see Figure 4. Several test have been performed to demonstrate the storage properties of the storage volume coating for the optimal storage of UCN. The storage volume was ready for production. The UCN guides have been constructed. For the optimal transport of UCN from the storage volume to the experiment, three conditions have to be fulfilled, (a) high optical potential of the wall material which must be high for the optimal transport of UCN. (b) The coating must consist of a
non-depolarizing material. For the first generation of UCN guides, we use Ni/Mo coating. (c) The surface roughness of the UCN guides must be very low in order to minimize diffuse reflection per wall collision. We use cylindrical pipes made of float glass with a surface roughness of a few nanometer.

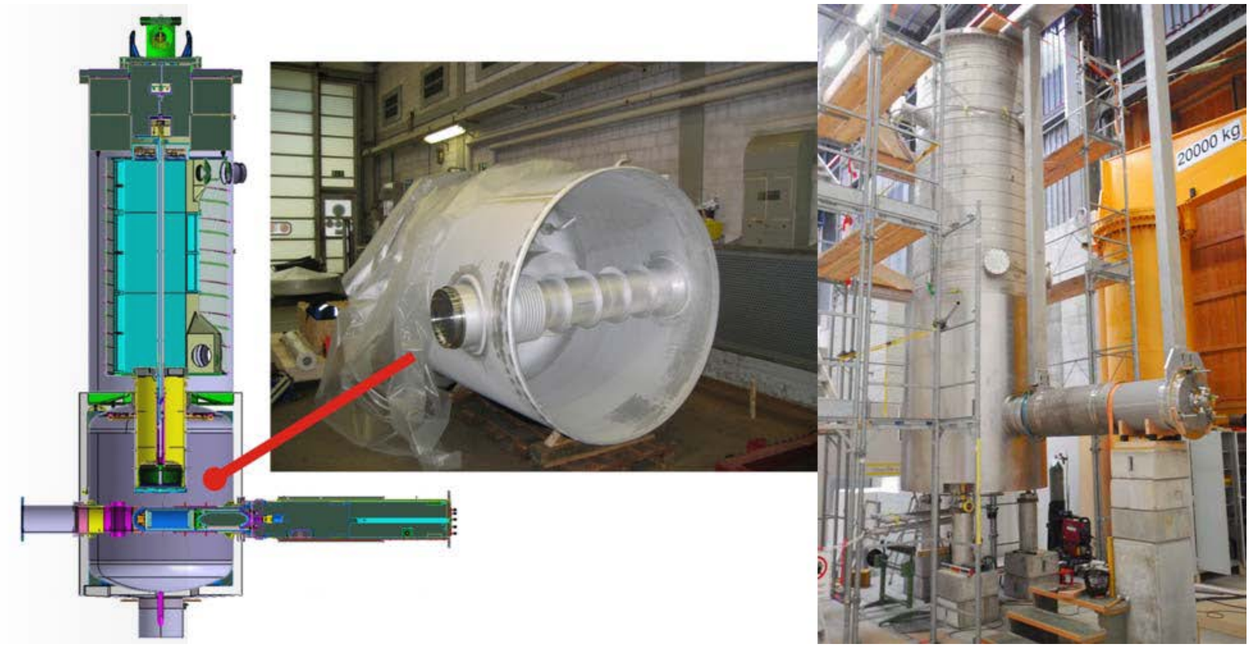

Figure 3: The UCN tank system including the heavy water containment in the manufacturing process. Right: tank system January 2009

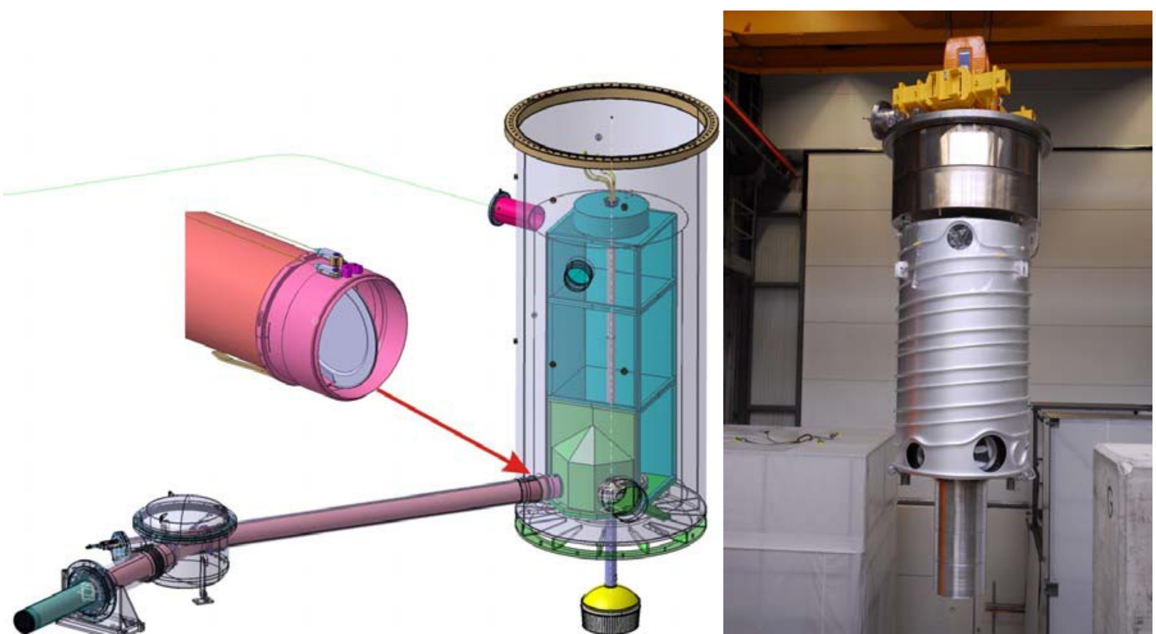

Figure 4: Design of the UCN storage volume and UCN guides including shutter at the outlet of the storage volume. Right: Storage volume

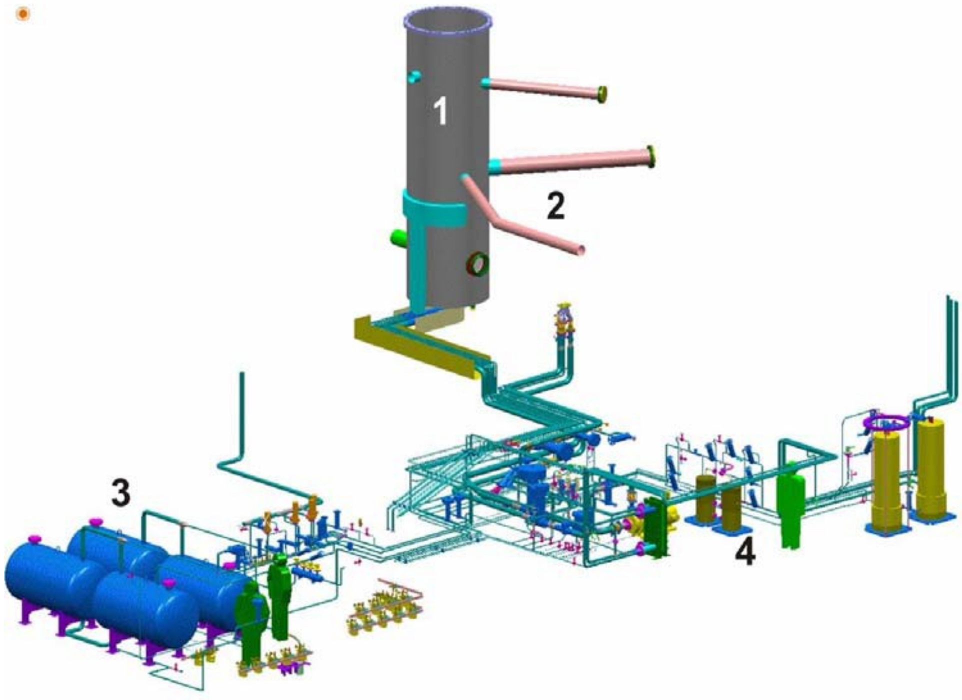

Figure 5: Design of the heavy water system for the moderation of the spallation neutrons. 1: UCN tank system with heavy water moderator vessel (lower part) and UCN storage tank (upper part). 2: UCN guides; 3: Heavy water storage and leakage tanks; 4: heavy water pumping system with pump (25 liter/s), ion exchangers, filters etc.

The heavy water loop was installed as in Figure 5. All components (water storage and leakage tanks, see Figure 6) have been installed, all pumps, valves, filters, ion exchangers etc. are operational. The water cooling the neutron spallation target with 20 liter/s has to be delayed in order to avoid a too high radioactivity in the pumping station. For this purpose a delay volume of 1200 liter has been built, see Figure 7.

Figure 6: Storage and leakage tanks for the heavy water circuit (in total $8m^3$) have been installed.

Figure 7: Delay volume. The heavy water from the spallation target is delayed by about 60 s in order to allow the short-lived radioactive isotopes, created by neutron spallation in the heavy water, to decay before reaching the pumping station. Right: The cooling system.

4. Deuterium system

The warm part of the deuterium system including the gast tans with a volume of 30 m^3 , the valve box and the collector box have been built and tested. The whole gas system was enclosed by a helium gas blanket of 1.3 bar overpressure to avoid leakage of air into the deuterium system. The cold part of the deuterium system (including the heat exchanger with condensation vessel and para-to-ortho converter) was constructed.

Figure 8: Storage tanks for the deuterium gas system (in total 30 m^3).

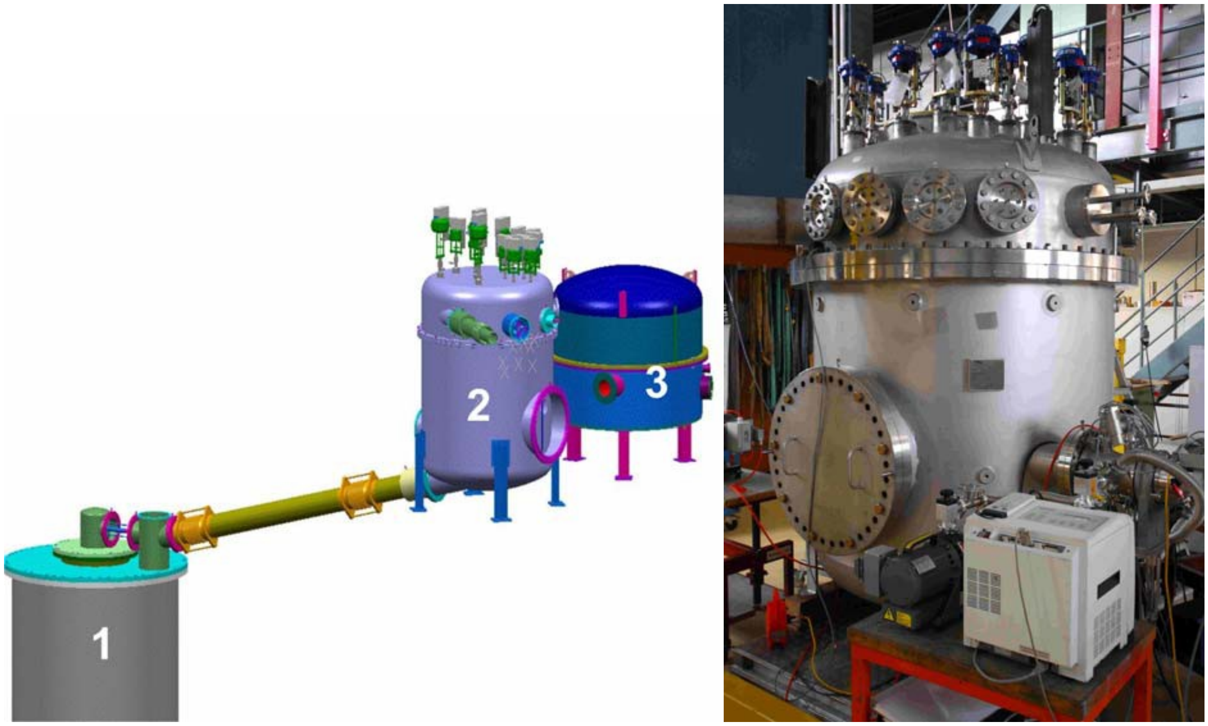

Figure 9: Layout of the cold deuterium system: 1 - UCN tank, 2 - heat exchanger box, 3 - vacuum box. Right: heat exchanger

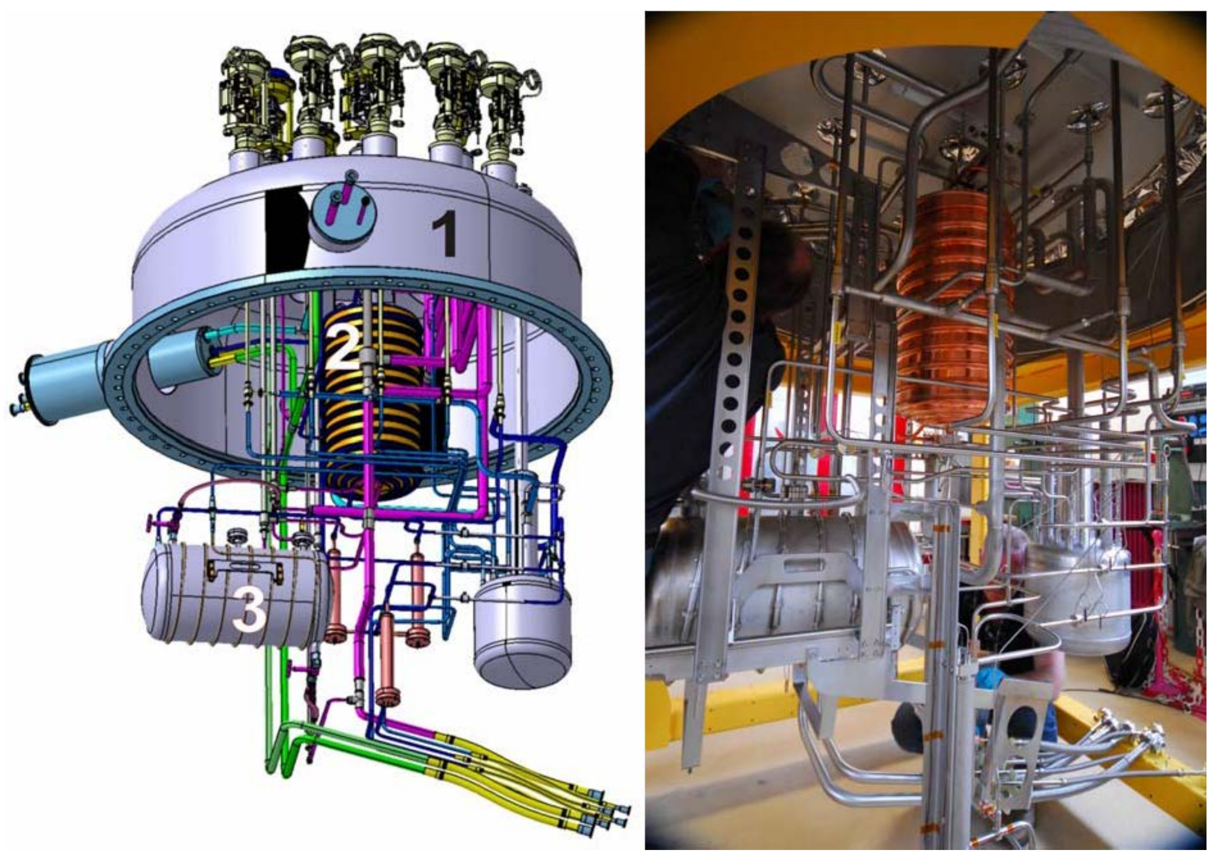

Figure 10: Heat exchanger components. 1: upper part of vacuum box, 2: condensation vessel for freezing the deuterium, 3: para-to-ortho deuterium converter.

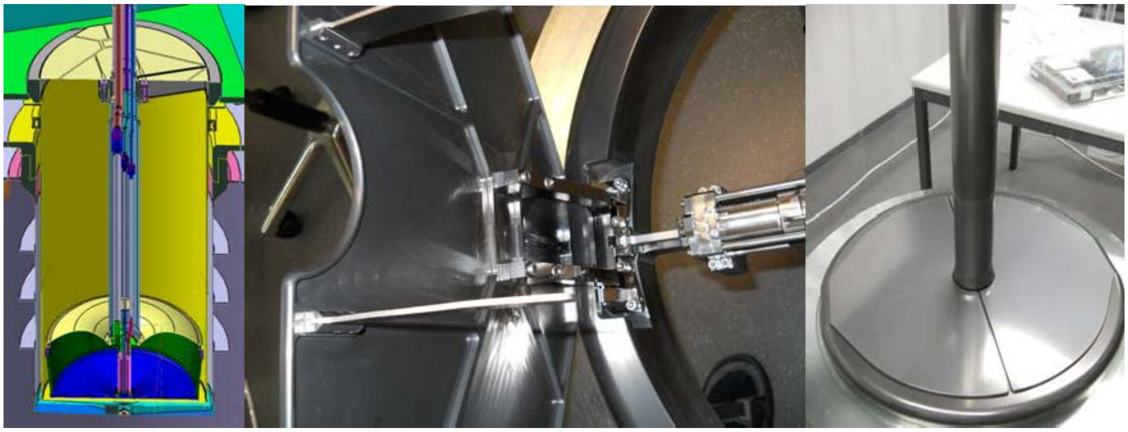

Figure 11: The solid deuterium vessel and vertical guide. Right: main shutter system

5.UCN guide system

All three ultracold neutron guides have been mounted.

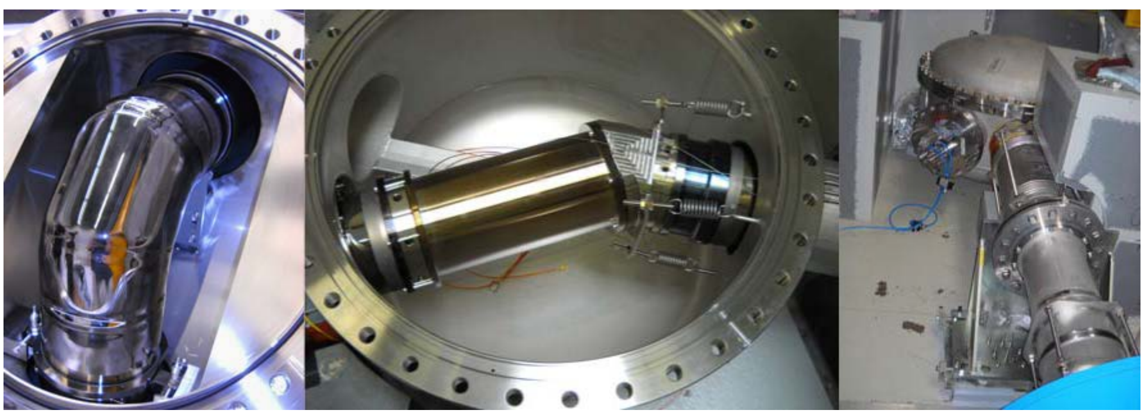

Figure 12: Details of the guide system