

J-PARC 50 GeV Proton Synchrotron

J-PARC E15/E17

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MEMORANDUM

Status report of liquid ^3He target for J-PARC E15/E17 experiments

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Abstract

A liquid ^3He target has been developed for J-PARC E15 experiment as the joint project between KEK and RIKEN. The development of the target for E15 is almost completed. Currently, we perform upgrading for J-PARC E17 in which x-ray detection device is installed inside the target. The target system for E17 will be completed in the end of March, 2009.

In this section, it is written result of cooling tests and development plan for E17 as status report.

1. Design of the liquid ^3He target

A liquid ^3He target has been developed for J-PARC E15 experiment as the joint project between KEK and RIKEN. Figure 1 shows the design of the liquid ^3He target. Basic design for the target system is based on the techniques developed for the superfluid ^4He target used by KEK-PS E471, E549 and E570. Liquid ^4He is supplied from a 1000 liter dewar placed outside to the separator ($\sim 4\text{ K}$) inside the target system by a transfer tube. From the separator, only liquid ^4He dropped into the evaporator which is placed under the Separator, then decompressed down to $\sim 1\text{ Torr}$, where the temperature inside is kept $\sim 1.3\text{ K}$. The ^3He gas is cooled down and liquefied in the heat exchanger which is placed under the evaporator and target cell and is filled with liquid ^3He , which is almost 1 m away from the ^3He heat exchanger.

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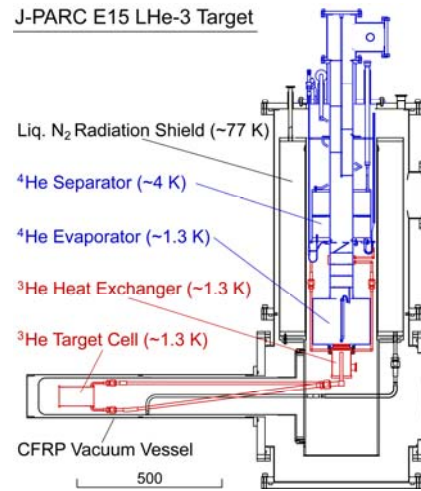


Fig. 1. Design of the Target for E15

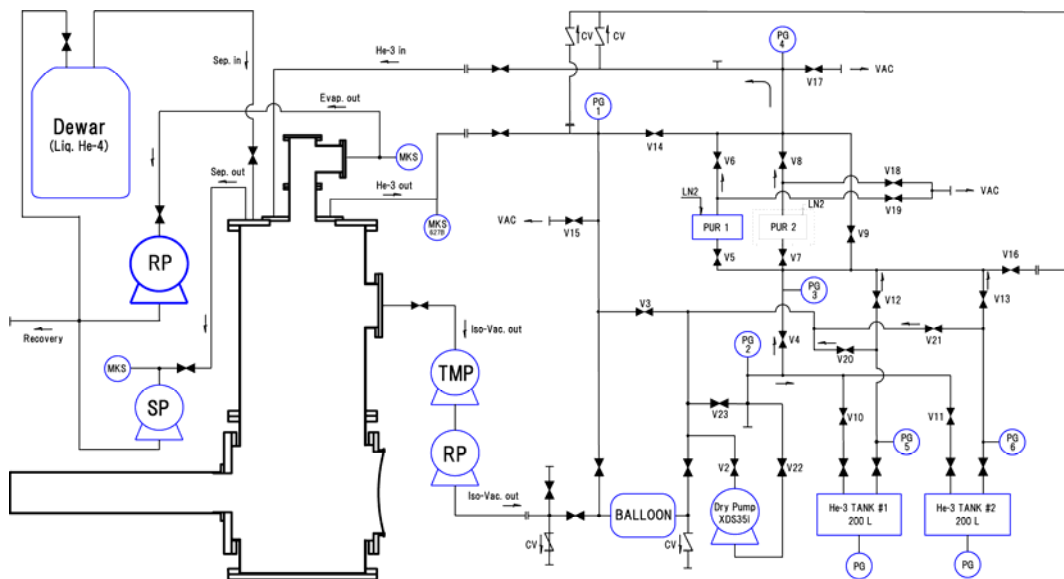


Fig. 2. Setup of the gas system

2. Results of cooling test by E15 setting

We performed cooling tests at K5 experimental area in KEK-PS north counter hall. The setup of cooling system was the almost same as production run setting for E15, and 250 liters ^3He gas was used as the target material on the test. The setup of gas system and the photograph of the target system under the cooling are shown in figure 2, 3 each. The temperature change just



Fig. 3. Photograph of the target system

after the liquid ^4He decompression cooling in the evaporator start is shown in figure 4. Where blue, red and green lines are described to temperature in the evaporator, heat exchanger and target cell. The temperatures of three parts hardly had a difference, and the target cell was cooled down to ~ 1.3 K for stability. In addition, since the pressure in the evaporator and cell is also measured at the same time, we were able to study the correlation of the pressure and temperature. The result is shown in figure 5. Where blue and red dots are correspond to the evaporator and cell. Although there are small shift by the error of the measuring device, the both measurements are good agreement with vapor pressure curve. It is clear that liquid ^3He exists in the target cell. In addition, the heat load to the 1K parts is 0.19 W, high-performance cooling system for E15 ^3He target was completed.

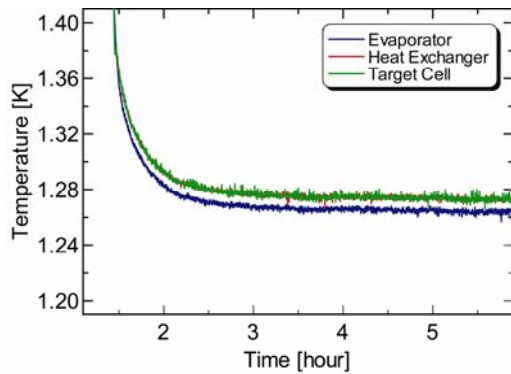


Fig. 4. Temperature change of 1K parts

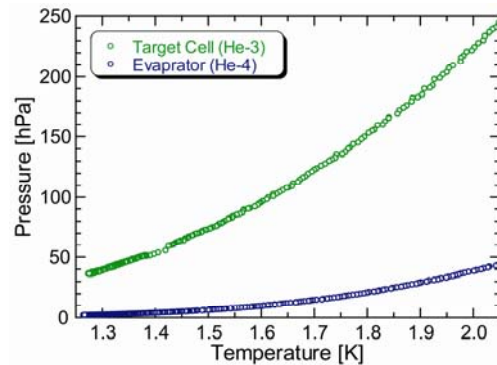


Fig. 5. correlation of the pressure and temperature

3. Upgrading plans for E17

In E17 experiment, the silicon drift x-ray detectors (SDD) are installed in the target system in consideration with kaonic atom x-rays transmission. Additionally, pre-Amplifiers for SDD are also attached in the target for the reduction of the noise and limitation of the place. Figure 6 shows a schematic view of the E17 experimental setup around the target cell. The SDDs are cooled down to ~ 80 K by direct heat contact with radiation shield which is cooled by liquid N_2 . It was confirmed that the

pre-Amplifier does not work well in 80 K temperature range by a test. It becomes the huge heat load to the target that the temperature of the pre-amplifier is high. Therefore we cover the pre-amplifiers with the 80 K shield. The pre-amplifier is attached to the shield by the material of the small thermal conductivity such as grass epoxies or steels steel, and it is controlled so that temperature does not decrease too much. Currently, the productions of the new radiation shield, vacuum chamber and target inside part for SDDs were finished, and they were delivered to KEK. A photograph of the inside part assembling is shown in figure 7. Development of the liquid target system including the X-rays detection device is completed in KEK by the end of December, 2008, and it starts installation in J-PARC hadron hall in next January. All the preparations for E17 about target are going to be completed in the end of March, 2009.

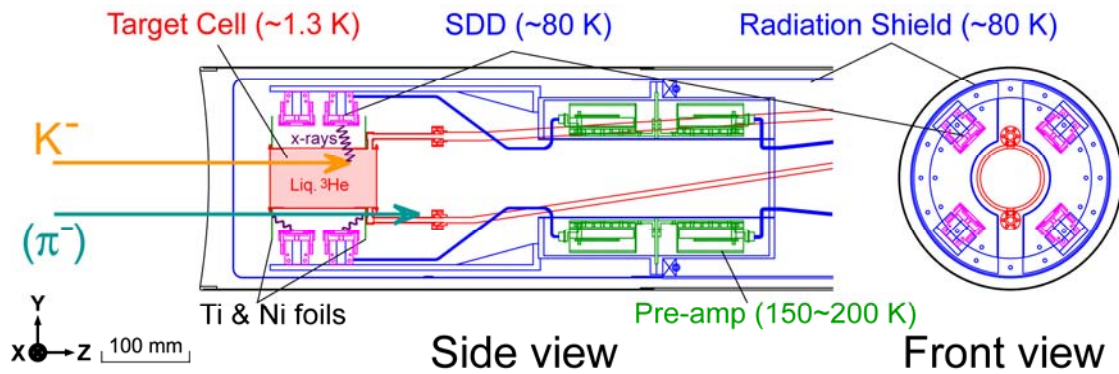


Fig. 6. Schematic view of the E17 setup

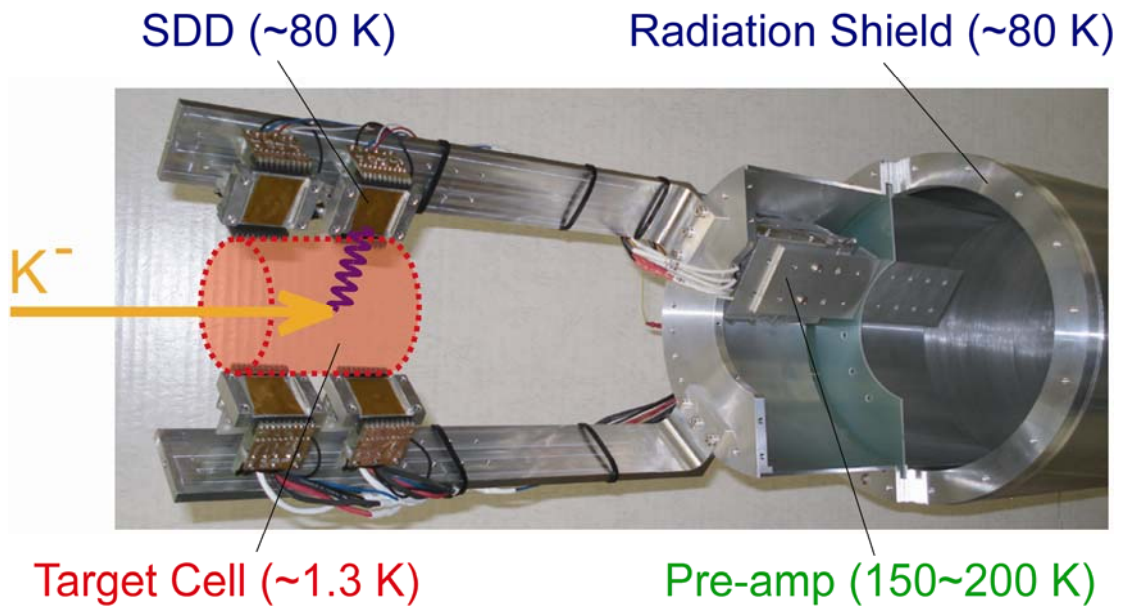


Fig. 7. photograph of the inside part assembling