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§2. Cool-down Test of the New Apparatus for Fuel Layering Experiments

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i) Introduction

FIREX targets have been developed under two layering strategies: foam shell and cone guide laser heating methods.[1,2] To date, basic studies have been conducted by the collaboration research between ILE and NIFS. The next stage requires the characterization of a layered solid fuel. The present system is at the disadvantage of optical observations. Therefore, a new apparatus is designed. In this report, its cool-down performance is described.

ii) Design of the new apparatus

The configuration of the new apparatus is shown in Fig. 1. The Gifford-McMahon (GM) cryocooler, RDK-415D (Sumitomo Heavy Industries, Ltd.) is used to cool the cryogenic system. The refrigeration capacity is 1.5 W at 4.2 K. Its disadvantage is generating low frequency vibrations. To compensate it, the cryocooler and the vacuum chamber with a target can are supported by individual structures with vibration control units. Flexible copper braids are also applied as thermal conductive links to mechanically insulate from each other. These should provide a low vibration environment.

Four viewing windows with a wide aperture are installed for an interferometer and a microscope. The shortest distance between the target centre and room temperature is designed to be 80 mm to apply the digital microscope VHX-100 (Keyence Corporation) with the long-distance zoom lens VH-Z50L (Keyence Corporation). For the characterization of a layered solid fuel from multiple angular views, a target rotation mechanism on the z-axis is equipped.

A quick target exchange mechanism has been developed to deal with different types of FIREX targets. A target holder is detachable from a main vacuum chamber. A metal gasket with not fixing bolts but a load of ~ thousand newtons on ensures GHe leak tightness for target cooling.

iii) Experiment

Cool-down performance was tested without a target. The target can is designed to be able to cool a target below 10.00 K. 10 hours were required to reach 10.00 K. The heat leak to the target can must be more than 1.5 W accoding to the specification of the cryocooler. Major heat leaks have been estimated to be via cryogenic supporting structures. The cool-down performance indecates that the new apparatus can provide a cryogenic environment for fuel layering demonstrations.

1) Iwamoto, A., et al., *J. Phys.: Conf. Ser.* **244** (2010) 032039.
2) Iwamoto, A., et al., *Nucl. Fusion* **53** (2013) 083009.

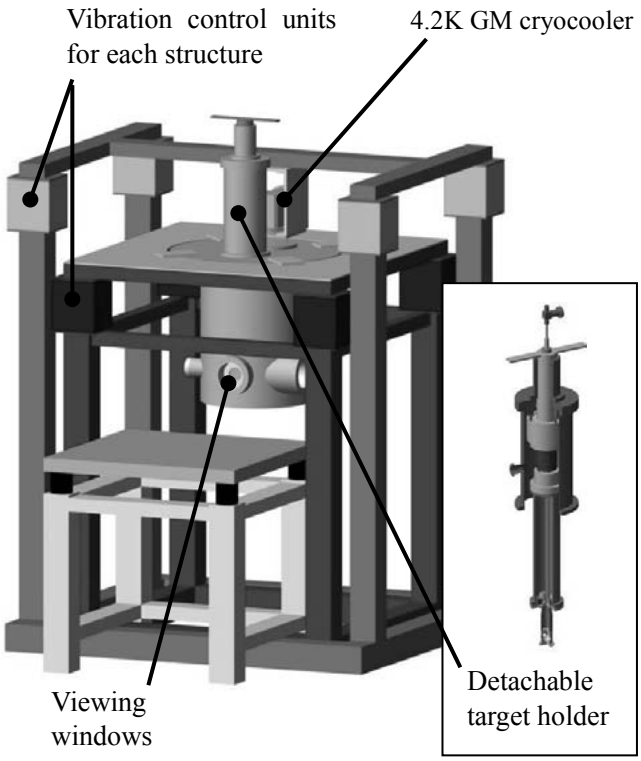

Fig. 1 Schematic of the new apparatus.