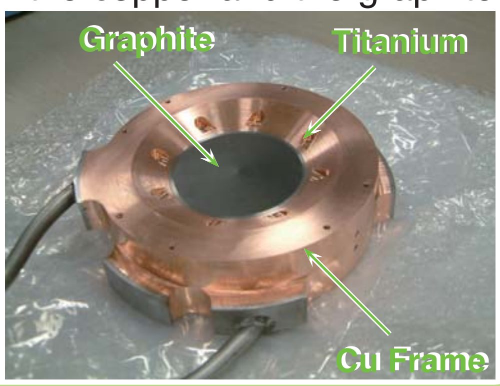
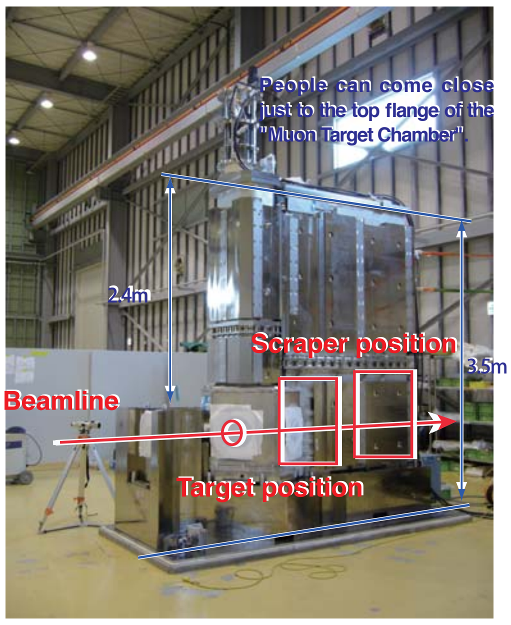
Muon Target

Muon Target

The "Muons", which are utilized in our experiments, are produced by a proton beam hitting the "Muon Target". An isotropic graphite is adopted as the target material, which has a thickness of 20 mm and a diameter of 70 mm. When the proton beam goes through the "Muon Target", 4 kW of heat will be generated. Therefore, a copper frame, in which a stainless-steel water piping is embedded, is surrounding the graphite. However, because the copper and the graphite have different thermal expansion coefficients, which means how much the materials expand according to the temperature, it is predicted that a large stress will take place at the interface between the copper and the graphite through a computer simulation. To relieve the stress, titanium, which has a thermal expansion coefficient just in between graphite and copper, is adopted as an intermediate material. Also, though the graphite is known to be difficult to braze, it was successfully bonded by a special brazing material and method. In MUSE, the "Muon Target" was fabricated through an evaluation by computer simulations and trial tests for the fabrication.



Muon Target Chamber



The "Muon Target" is located directly on the proton beam line, which must be kept under vacuum. Therefore the "Muon Target" is set in a "Target Chamber", which is a huge vacuum vessel with a height of 3.5 m, and a length of 3.5 m. To protect the downstream apparatuses from scattered protons, there are two "Scrapers" located just after the "Muon Target". The "Scraper" is made of a copper block with a thickness of 80 cm, and has a hole in it with a size so that the primary proton beam can go through. The materials of the "Target Chamber" were well-considered and their characteristics were measured in order to acquire a high vacuum. While the "Muon Target" must be replaced twice in a year, people cannot come closed to the target because of high radiation. Therefore, the reproducibility of the "Muon Target" location in the beam through a remote control system was also considered in the design of the "Target Chamber".

Target Replacement

We cannot come closed to the "Muon Target" for maintenance because of very high radiation. Therefore the "Muon Target" must be transferred to a remote controlled room, the "Hot cell" in the MLF building. For transportation, the "Muon Target" is remotely and automatically brought into a shielding vessel, which is called the "Muon Transfer Cask". In the "Hot cell", the used "Muon Target" is replaced with a new "Muon Target" through remote handling apparatuses. The used "Muon Target" is cut into pieces, thrown away into a dedicated storage container and kept under control.

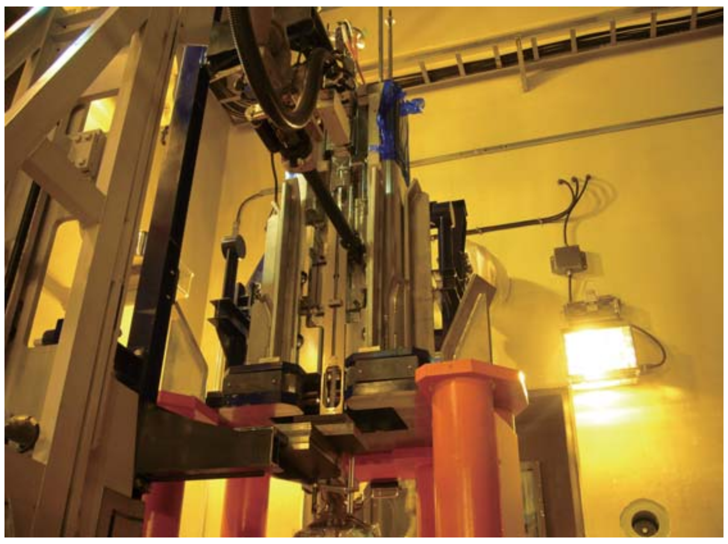
Muon Target Replacement by remote handling

Muon Target Replacement

The "Muon Target" in its current design must be replaced once every half a year through computer simulations, when the intensity of the proton beam is 1 MW. However, because the "Muon Target" is located on the high intensity proton beam line and is highly irradiated, people cannot come closed to the "Muon Target". Therefore the "Muon Target" must be remotely replaced in the "Hot Cell". People cannot enter the "Hot Cell" when the irradiated "Muon Target" is there. The replacement of the "Muon Target" is viewed through thick lead-glass windows and a remote controlled camera.

Remotely Controlled Replacement

When the "Muon Target" is replaced, a support apparatus called the "Muon Attachment" is mounted to the exchange device, which gives up-down motion, left-right motion, forward-backward motion, and rotation. Then a rod, onto which the "Muon Target" is fixed, is held by the "Muon Attachment". Four fixing screws are loosened by a power-manipulator, which has a function of handling the screws for remote handling. It is difficult to know the precise position of the "Muon Attachment" from the outside of the "Hot Cell". Therefore, the loads of each motion are measured to monitor any unusual circumstances such as sticking out of an alignment pin and so on.



Transportation of the "Muon Attachment" by crane

During the remote handling operation, it is difficult to perform a detailed work as people can do. For example, when the "Muon Attachment" is transported by crane, it is not possible to manually adjust the length of the hanging wire or rope in order to keep the balance. Also, the "Muon Attachment" must have two hanging positions with a precise alignment, because it has two weight centers, one with the "Muon Target" and another without. Furthermore, because a manual guidance against the swing or the rotation of the "Muon Attachment" is impossible, a definitive and careful crane operation is required. The precise position of the crane can be known outside through an encoder device.