High Temperature Furnace for Fission Target Investigation

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The ^{235}U fission target of the Munich fission fragment accelerator consists of uranium carbide distributed homogeniously in a porous graphite matrix, similar to the target of the PIAFE project [1]. It has the shape of a cylinder with a narrow coaxial blind ended channel. The target is surrounded by a rhenium container, which has an aperture of 2 mm diameter in its front face opposite to the open end of the channel. During operation, the target has to be maintained at a temperature of more than 2000 °C to allow the fission fragments to diffuse rapidly into the channel, from where they are extracted through the aperture in the rhenium container. This container is an important part of the target assembly. Besides providing mechanical support, it prevents the uranium and the fission fragments from escaping through the periphery of the graphite matrix, as well as excessive sublimation of graphite. The target has to stand at least one reactor cycle of approximatly 1000 h. Its long term behaviour at elevated temperatures has to be studied to get approval for the ion source operation by the reactor safety authorities (TÜV Süddeutschland). Several detrimental phenomena may arise:

- Diffusion of uranium, resulting in possible reduction of the yield and embrittlement of the container
- Diffusion of carbon, resulting in possible short circuits across insulators outside the target assembly
- Fatigue of the container material, including the formation of pores
- Change of the emissivity of the container material, leading to a destabilization of the temperture equilibrium.

To perform these investigations, a vacuum furnace with a useful volume of 80 mm diam. x 160 mm is under construction, which is capable to produce a temperature of up to 2 500 °C for the required period (fig.1). The hot zone is manufactured by Plansee AG in Reutte, Austria, and consists of a tungsten mesh heater surrounded by a set of heat shields made of tungsten and molybdenum. It is installed in a jacketed stainless steel vacuum chamber of 600 mm diam. x 600 mm, which is water cooled during furnace operation. A turbomolecular pump with a speed of 300 ls^{-1} is provided to produce a working pressure of 10^{-7} mbar. Temperature control is performed either by a W5W26/Re thermocouple or, at temperatures above 2000 °C, by an IR pyrometer. A computer controlled power supply allows to run temperature-time programs according to the required heat treatment procedure for the sample. A power of 40 kW is needed to produce a temperature of 2500 °C. The furnace will be brought into service shortly.

References

[1] PIAFE Collaboration, Technical Report, Institut des Sciences Nucléaires de Grenoble, ISN 97-52, July 1997

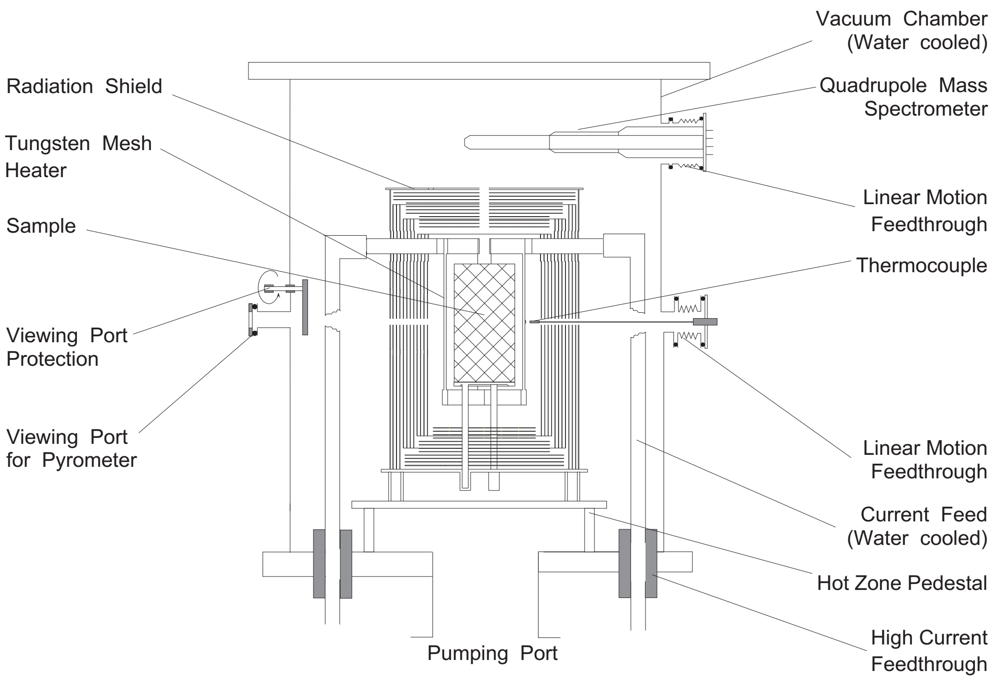

Fig. 1: Schematic of the High Vacuum Furnace