stellarator news

Published by Fusion Energy Division, Oak Ridge National Laboratory
Building 5700 P.O. Box 2008 Oak Ridge, TN 37831-6169, USA

Editor: James A. Rome Issue 93 July 2004
E-Mail: jar@ornl.gov Phone (865) 482-5643
On the Web at *http://www.ornl.gov/sci/fed/stelnews*

Future home for QPS is taking shape at ORNL

A new building, the Multi-Program High Bay Facility is under construction at Oak Ridge National Laboratory to house Fusion Energy Division experimental programs, including the proposed Quasi-Poloidal Stellarator (QPS). Construction started in January (Fig. 1), and should be completed for beneficial occupancy in September. The building is 220 ft (67 m) long by 125 ft (38 m) wide. The full-length high bay area is 75 ft (23 m) wide. The high bay also features a 20-ton remote-controlled crane with a 30-ft (9-m) hook height. The south end of the building, which is reserved for experimental plasma physics experiments, features a 40 ft × 15 ft × 12 ft deep (12 × 5 × 4 m) pit (Fig. 2) with conduit connections to the adjacent control room and power supply areas. The pit walls and adjacent concrete floor will have nonmagnetic rebar to a radius of 25 ft (8 m). The overall floor plan of the building is shown in Fig. 3.

Fig. 1. The new fusion experimental facility is located at the former Experimental Gas-Cooled Reactor site on the banks of the Clinch River.

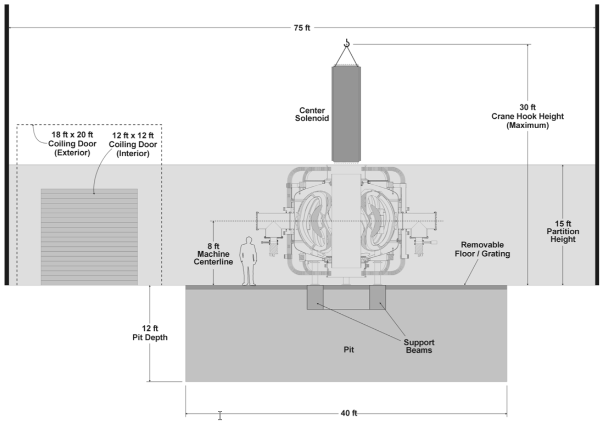
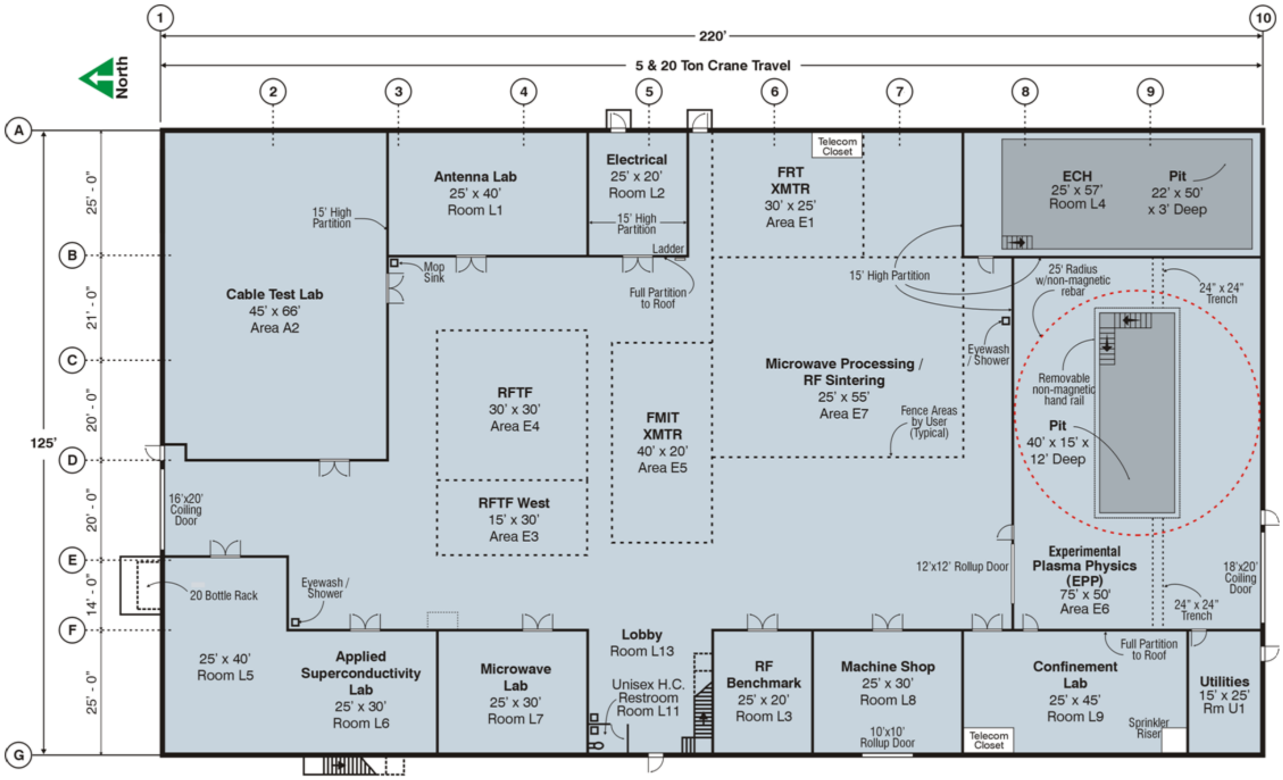


Fig. 2. The QPS experimental area.

The current plan calls for installation of QPS-related equipment to begin in 2006.

Brad E. Nelson
Oak Ridge National Laboratory
MS 6169, P. O. Box 2008
Oak Ridge, TN 37831-6169, USA
E-mail: nelsonbe@ornl.gov

In this issue . . .



Main Level Floor Plan

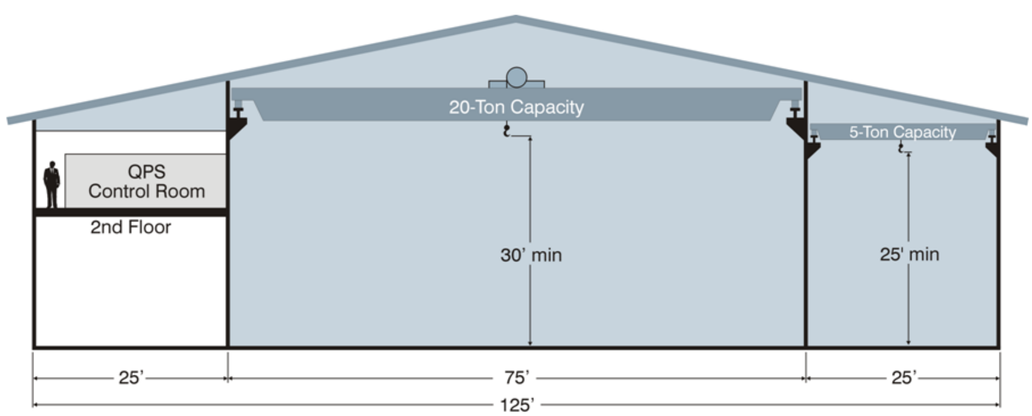


Fig. 3. Floor plan and elevation view of the new ORNL Multi-Program High Bay Facility.

Extended abstracts

Surface temperature measurements of carbon materials in fusion devices

Presented at the 16th International Conference on Plasma Surface Interactions in Controlled Fusion Devices, Portland, Maine, May 2004; to appear in the *Journal of Nuclear Materials*

Thermographic measurements using radiation with a wavelength between 0.5 and 5 µm have been made on all significant magnetic fusion devices in order to monitor and diagnose the power loading of plasma-facing components with a spatial resolution of some millimeters. Two- and three-dimensional numerical codes (e.g., THERM) were developed to derive power fluxes arriving at the internal components from the temporal evolution of the measured surface temperature distribution.

This paper presents experiments investigating the accuracy of heat fluxes derived from thermographic measurements of various materials to be applied in the Wendelstein 7-X (W7-X) project. Carbon target materials were studied, including fine-grained graphite and carbon fiber composites (CFCs) of different surface roughness and surface impurity contamination as they are obtained after plasma exposure. For these studies, well-defined heat pulses with densities up to 100 MW/m^2 and duration up to 20 ms were applied by laser radiation. The surface temperature excursion during and after the laser heat pulse was measured by three different cameras operating in the wavelength region between 0.4 and 1 µm (Si sensor), 3–5 µm (InSb sensor) or 8–15 µm (VOx microbolometer). In order to validate the accuracy of the measured surface temperature evolutions, they are compared with analytic and numerical solutions of the three-dimensional heat diffusion equation.

In particular, in the shorter wavelength regions (0.4–1 µm and 3–5 µm), significant deviations between the experimentally observed and the calculated evolutions of the surface temperature are found already on samples having original surface roughness (i.e., prior to plasma exposure). Measurements with improved spatial resolution show an extremely nonuniform heating of the surface correlated with its morphology. This effect causes an overestimate of the averaged temperature measured with lower spatial resolution at shorter wavelengths. Although temperature measurements with insufficient spatial or temporal resolution are more accurate in the longer wavelength region (8–15 µm), they still demonstrate a substantial deviation from the calculated behavior for both materials, the CFC material and the fine-grained graphite, indicating a much lower mean value of the thermal conductivity at the surface than in the bulk material.

In addition, the experiments demonstrate that the measured temperature excursion is strongly changed after surface modification by erosion and deposition processes occurring during plasma exposure. Even contamination layers with a thickness smaller than 300 nm influence the measured temperature.

These uncertainties make it difficult to monitor plasma-facing components such as divertor target plates in real time and can lead to unrealistic power flux densities obtained by the evaluation of thermographic measurements.

D. Hildebrandt, D. Naujoks, D. Sünder
EURATOM Association Max-Planck-Institut für Plasmaphysik, Bereich Plasmadiagnostik,
Mohrenstraße 41, D-10117 Berlin, Germany
E-mail: Dieter.Hildebrandt@ipp.mpg.de

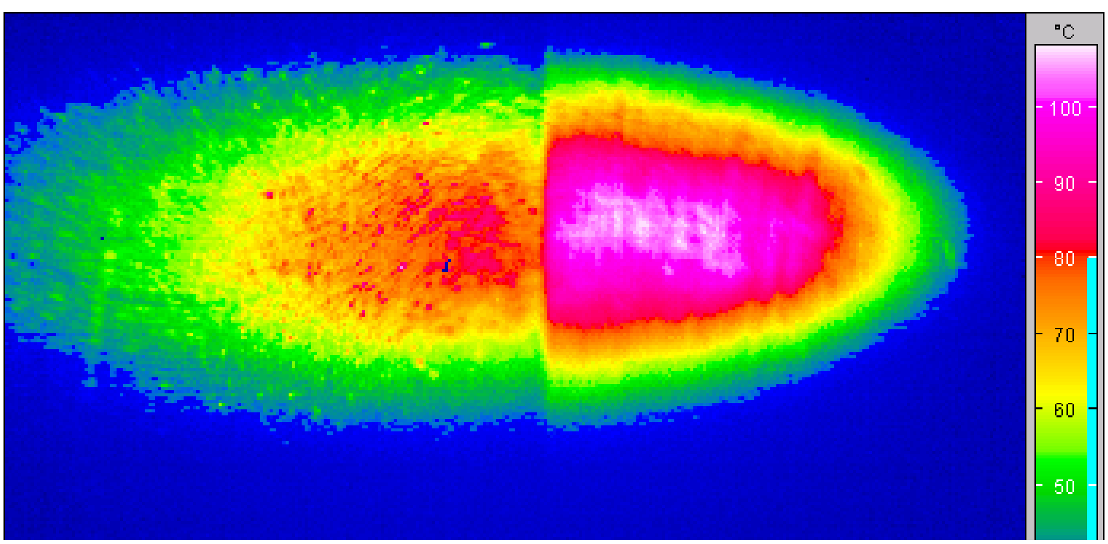


Fig. 1. Surface temperature of a divertor tile after a laser pulse. The tile was used in ASDEX Upgrade, and the 1.5-µm-thick deposited layer consists of a mixture of C, B, H, and D. On the left side of the sample this layer has been removed.