Zentralabteilung Forschungstechnik
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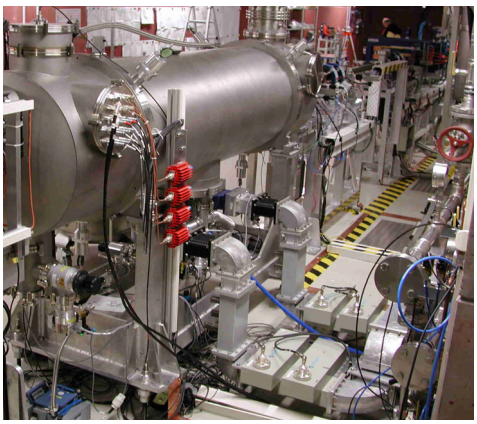
RF WINDOW DIAGNOSIS AND TRAINING FOR THE ELBE SUPERCONDUCTING ACCELERATOR

RF Windows at ELBE

The ELBE accelerator operates with 10 kW klystrons per superconducting cavity in true CW operation. The main intended use is FEL operation, but several other nuclear physics facilities with different beam requirements are also built [1]. Two cavities are used in one cryomodule.

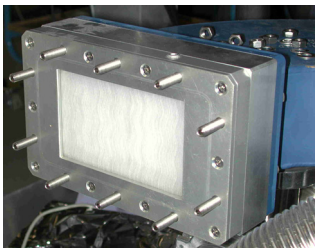


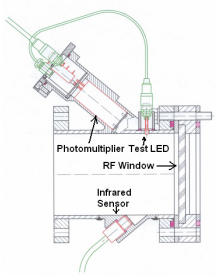
The warm window is made from polystyrene (Rexolite®) which is not very common as RF window material in accelerators. The window is a standard microwave part for WR650 waveguides. This gives a mechanically very simple and cost effective window design compared to ceramic windows.

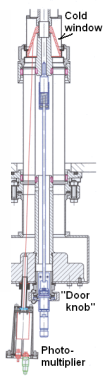
The RF coupler is based on a development by HEPL at Stanford, which used a design by Mark Champion [2]. The coupler has a conical ceramic window.

Window Diagnosis

The warm window diagnosis consists of window temperature monitoring, vacuum monitoring and monitoring for light flashes.
The window temperature measurement is done by an infrared sensor. The resolution is 0.1° C. The sensor works from 8 µm till 14 µm.
For vacuum measurement measuring gauges were used. An extra vacuum pump improved the window vacuum marked.
The detection of light is done by a photomultiplier and a modul from DESY, which amplifies and monitors the signal. Temperature and vacuum monitoring are intrinsically safe, light monitoring is not. Therefore a test LED was built in, which produces a light signal of 0.5 lux.
The position of the minimum of the standing wave for full reflection was chosen as window position. At low beam currents and with the use of the macro pulser the full reflection is the most common RF operating mode.



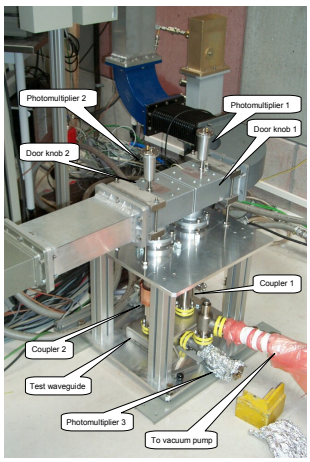




The same light monitoring was also realized for the cold windows. The vacuum is approximately the same as for the warm windows.

Window Training

A special teststand was built with a hardware interlock system and a PC based data acquisition. The window training was automated by software. Temperature, vacuum and light flashes were monitored. The RF power and phase could be adjusted. The maximum power at window position was 40 kW. Pulsed operation started from 1 ms to 1 sec in 10 %-steps. CW operation was also possible. Till now 2 warm windows and 2 couplers were trained.
For warm window training 2 windows were used to separate the vacuum. The windows are electrically $\lambda / 4$ distant to monitor and train only one window.
Warm window training showed no vacuum or light events. Only a heating with a thermal time constant of 10 minutes could be observed. This limits the maximum power for CW operation to 13 / 18 kW for a maximum window temperature of 70° C.



For coupler training a special test waveguide was used. The couplers were trained at room temperature with full reflection for all phases (4 steps with 30° step width). Only the antenna side was in vacuum.
Several 100 interlocks occurred by vacuum, temperature and light flashes in the test waveguide. No light flashes could be observed from the door knob side. Without the liquid nitrogen cooling as in the accelerator a strong heating occurred. It was possible to train the couplers till full power in pulsed mode.

Experiences

The warm windows with the diagnosis are used in the accelerator without problems. Before the window training and diagnosis were done two window breakdowns occured. Till now the accelerator was not operating with full CW power so the window heating was very low. In opposition to the window training light flashes occur in the accelerator which is not understood.
The trained couplers are not yet used. The couplers used till now were trained under different conditions. Together with the diagnosis they operate without problems. Light flashes occur by strong RF changes. The machine interlock system prevents any damages.

References

[1] A. Büchner, F. Gabriel, E. Grosse, P. Michel, W. Seidel, J. Voigtländer: „The ELBE-Project at Dresden-Rossendorf" EPAC2000, Vienna, June 2000.

[2] M. Champion: „Design, Performance and Production of the Fermilab TESLA RF Input Couplers" LINAC96, Geneva, August 1996

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