Progress of the klystron and cavity test stand for the FAIR proton linac

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In collaboration between the FAIR project, GSI, and CNRS, the IPNO lab provided the high power RF components at 325.224 MHz for the cavity and klystron test stand [1] in the experimental hall LBH. For initial operation of the 3 MW Thales TH2181 klystron, a high voltage modulator from CERN Linac 4 was received as a loan. The 45 kW amplifiers for the 3 buncher structures of the FAIR proton Linac were carefully checked at the test stand, and prepared for cavity test operation.

Klystron test preparation

The company that originally wanted to provide the high voltage modulator for the klystron faced technical problems and finally abandoned this project. Fortunately the operating voltage and current of the klystrons for the CERN Linac 4 are quite similar to the TH 2181 klystrons foreseen for the FAIR Proton Linac. The Linac 4 repetition rate of 2 Hz is lower, than the 5 Hz rate foreseen for the Proton Linac. The pulse length for the proton Linac is shorter, which provides enough margins for operating the borrowed Linac 4 high voltage modulator. Effort was put into modifying and upgrading the existing infrastructure.

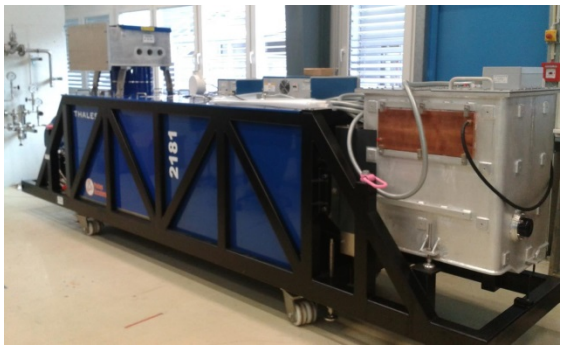

Figure 1: TH2181 Klystron in LBH test area.

The 3 phase electric supply connection was modified to provide sufficient margin for operating high voltage modulator and pulsed transistor amplifiers. At the former setup the auxiliaries were foreseen to be embedded into the modulator. Here we provided an additional rack containing the klystron filament power supply, the 3 solenoid power supplies and the two ion pump power supplies. The company who delivered the circulator for the klystron managed to adapt the cooling temperature range from 30+/-1°C to available 25°C. This allowed simplifying the cooling water distribution, which now can handle testing of klystron and transistor amplifiers.

The heater oil tank was prepared for the CERN modulator, and the filament power supply was tested with the goal to establish the power up and shutdown procedures. In operation of the solenoid power supplies in constant current mode, it was confirmed that they work as expected. The solenoids reach thermal steady state in two hours. The ion pump power supplies and the arc detection require fast acting interlocks. Accordingly the measurement & interlock rack was modified to process the additional signals. Careful checking of the interlock functionality and the signals processed by a PLC will ensure protection of the klystron according to the manufacturer specifications. The fastest response is handled by blanking the low level RF signal within microseconds.

First operation with the klystron will be without applying RF for commissioning and to understand the interaction with the modulator. As next steps, RF power will be send to a dummy load, and then the circulator will be included and measured by calibrated directional couplers. Finally we prepare to exercise the prototype CH cavity in the shielded area.

Transistor amplifier test

In autumn 2014 three 45 kW transistor amplifiers for the 3 (re-)bunchers of the Proton Linac were delivered. The alignment of the amplifiers and the RF output was improved for easier installation and the firmware was adjusted to the expected pulsed operation mode.

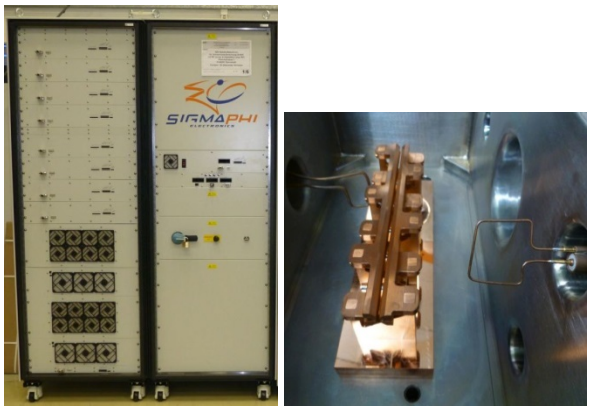

Figure 2: Amplifier (left) and RFQ test cavity structure.

Initial tests were conducted with a 50 Ohm power load at the amplifier output. The required 45 kW pulsed power was confirmed. From University of Frankfurt we received a compact 325 MHz test cavity structure and we prepare a site acceptance test of these amplifiers under pulsed conditions driving a resonant load.

References

[1] J. Lesrel, et. al. “RF Power Systems for the FAIR Proton Linac”, LINAC2014, Geneva, Sept. 2014, MOPP078

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