Design and Fabrication of Normal Conducting Accelerator Sections

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Abstract

Since more than ten years we are supplying cavities for various accelerators all over the world. The scope of supply ranges from 350 MHz multicell cavities for storage-rings and synchrotrons (CERN/LEP, ESRF, ANL/APS) over 500 MHz multicell and single cell cavities (Cornell/CESR, LBL/ALS) to S-Band injector systems for Free Electron Lasers (FOM/FELIX). Following R&D and a product development phase now also turn key Linear Accelerators are offered e. g. for FEL application or as injectors for synchrotron radiation sources. The scope of activities as well as the status of our projects is presented.

1. Projects at Siemens

1.1 Advanced Light Source

For the Advanced Light Source ALS at the Lawrence Berkeley Laboratory 4 single cell 500 MHz cavities have been designed, fabricated and delivered. Those cavities have been designed for an increased power handling capability of 70 kW rf heat load compared to operational experience with cavities of similar design.

The water cooling system is an electroformed jacket providing highly turbulent flow in narrow channels covering the whole cavity surface.

The high power rf-windows consist of tubular Al_2O_3ceramics of diameter 150 mm and length of 450 mm and have brazed copper-flanges with integrated cooling water channels.

After fabrication the ceramic windows have been titanium coated at CERN according to the CERN developed procedure for high power rf windows. Meanwhile one prototype window has passed high power test with up to 70 kW cw rf power [1]. The remaining windows are under production.

RF conditioning of cavity and coupler window went very smooth, full power being attainable after only about 10 hours of conditioning. The temperature rise of the cavity body due to rf power was below 1 °C thus prooving the previously calculated temperature stability of ± 1° C. The Ti-coating of the coupler window turned out to be very effective to surpress multipactoring.

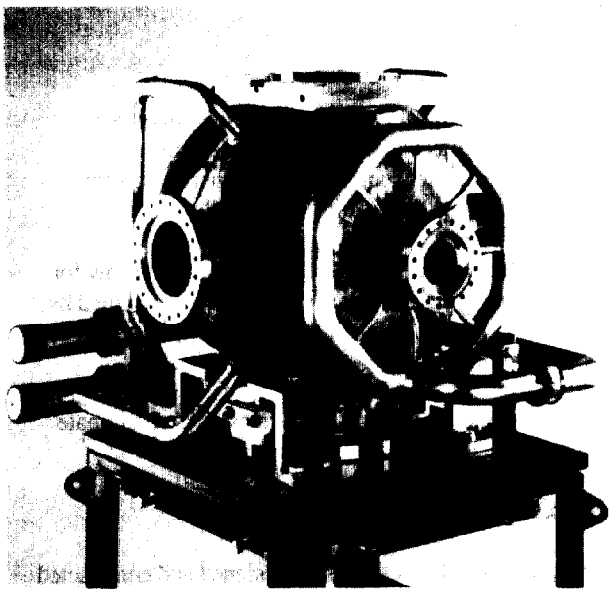

Figure 1: The 500 MHz Single Cell Cavity with completed cooling water distribution system. The upper rectangular flange holds the high power input window.

1.2 350 MHz Storage-Ring Cavities (ESRF; ANL)

Starting with the supply of 128 LEP cavities which are successfully operating in the LEP storage ring at CERN since several years we meanwhile have supplied 7 cavities of this type for ESRF (3/91) and another 5 cavities for the Advanced Photon Source at Argonne National Laboratory (end of 1991).

In the ESRF 2 cavities are used in the injector synchrotron and 4 cavities in the storage ring.

During the fabrication intense rf measurements were performed in order to achieve the following guaranteed values:

frequency:	352,20 MHz ± 50 kHz
field flatness:	± 5 %

After completion cavities and components are baked for UHV conditioning. The values below are guaranteed to the customer:

leak rate:	$< 10^{-10}$ mbar l/s
ultimate pressure:	$< 10^{-10}$ mbar

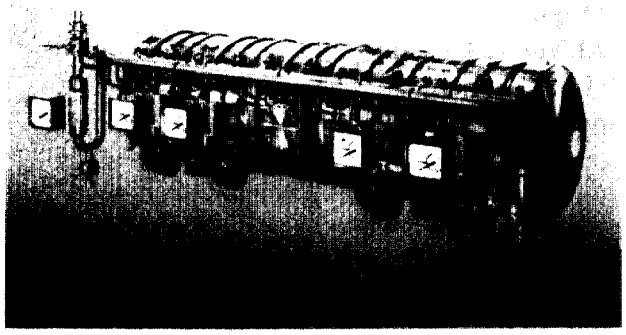

Figure 2: 352 MHz Five-Cell Cavity with flow rate instrumentation. The cavity is delivered completely equipped with tuners, couplers, field probes and instrumentation.

After delivery the cavities have been tested and show for example during high power rf conditioning performed by ESRF the capability of handling 85 kW cw power and 150 kW pulse power.[2]

After installation in the ring all cavities reached ultimate pressure of $< 10^{-10}$ mbar without problems [2].

1.3 Accelerator Sections and Systems

A complete buncher section was designed and constructed for the electron injector for the FEL-project at FOM, Netherlands. It comprises the 1 GHz prebuncher cavity, the 3 GHz 2π/3 travelling wave buncher which accelerates the beam to about 4 MeV and the focussing coil system. In the meanwhile this injector section has been commissioned and a pulse length of more than 15 μsec has been obtained at full power of 20 MW. [3]

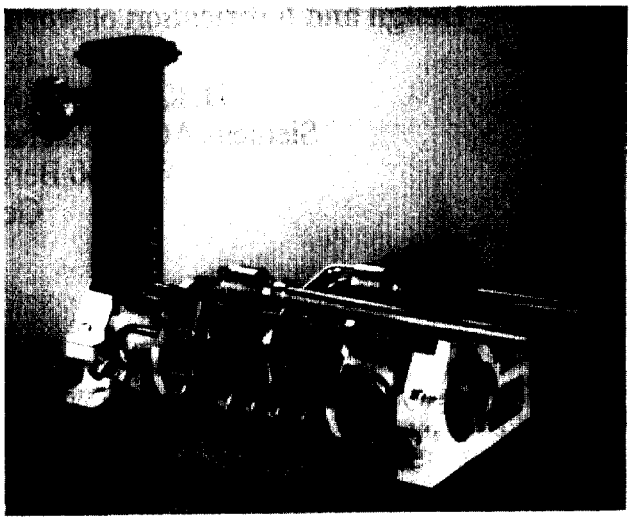

Figure 3: The 3 GHz 14-cell buncher with input and output waveguide

For future storage ring injection and Free Electron Laser application system design studies of turnkey pulsed and cw linear accelerators based on normal and superconducting technology are performed.

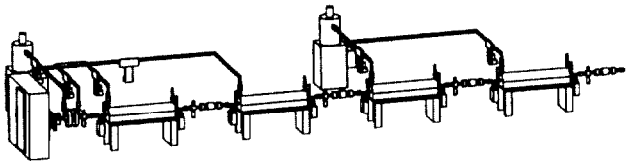

Figure 4: System Design of a 100 MeV S-Band Linac for longpulse FEL operation

References

[1] Brian Taylor, Lawrence Berkeley Laboraty, private communication

[2] J. Jacob, "Commissioning and operation of one Booster and two Storage Ring Acceleration Units at the ESRF", this conference.

[3] P. W. v. Amersfoort, "Lasing with FELIX", this conference