IHEP 1.3 GHZ SCRF TECHNOLOGY R&D PROGRESS

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Abstract

IHEP has started the "1.3 GHz SCRF Accelerating Unit and Horizontal Test Stand Project" since early 2009. The SCRF Accelerating Unit contains a 9-cell 1.3 GHz superconducting cavity, a short cryomodule, a high power input coupler, a tuner, a low level RF system and a high power RF source, etc. This unit will also serve as a Horizontal Test Stand (HTS) for new components R&D. Recent progress of the components R&D is presented, as well as the key SCRF facilities design and commissioning, i.e. the CBP machine, pre-tuning machine and BCP facility for 9-cell cavities.

INTRODUCTION

In order to develop and demonstrate the key technology for China's future XFEL and ERL projects as well as the ILC, IHEP has started the "1.3 GHz SCRF Accelerating Unit and Horizontal Test Stand Project" since early 2009 [1].

The "SCRF Accelerating Unit" is a 2-meter-long short cryomodule containing one 9-cell cavity, one high power coupler, one tuner, and the corresponding low level RF (LLRF), high level RF (HLRF) and cryogenic systems (Fig. 1). The components will be designed, fabricated and commissioned with reference to the existing designs worldwide which meet the ILC RDR specifications. This unit will also serve as a Horizontal Test Stand (HTS) for new components R&D (e.g. cavity packages, input couplers, tuners, LLRF systems, cryomodule cold mass structures, etc.).

Constructing and commissioning SCRF infrastructures and facilities is an important part of this program, which will allow sustainable SCRF technology development in IHEP and China.

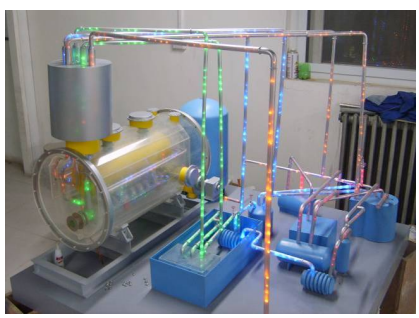

Figure 1: Mockup of the IHEP 1.3 GHz SCRF Accelerating Unit

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R&D PROGRESS

Large Grain 9-cell Cavity

A low-loss shape bare tube 9-cell cavity using Ningxia large grain niobium is being fabricated at IHEP. EBW of 13 dumbbells with stiffening rings was finished. We are now tuning the dumbbells by reshaping and trimming. For details, refer to [2].

Figure 2: Half cells and dumbells of the IHEP large grain 9-cell cavity

The low-loss 9-cell cavity with full end groups is also under development. The end cell shape, the HOM couplers and the end plate will be optimized to damp higher order modes and reduce high field Lorentz force detuning according to ILC requirements.

High Power Input Coupler and Tuner

The high power input coupler is designed with reference to the KEK STF-baseline input coupler. RF design [1], thermal and multipacting simulation and mechanical design (Fig. 3) are on going. We will fabricate two input couplers in 2010.

We chose the KEK slide jack tuner as the baseline design (Fig. 4). Fabrication and low temperature test will be done next year.

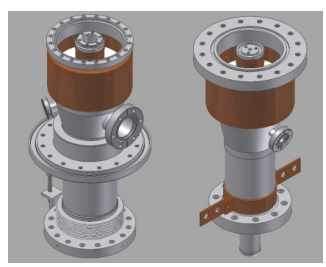

Figure 3: Structure design of the warm and cold coaxial parts of the high power input coupler

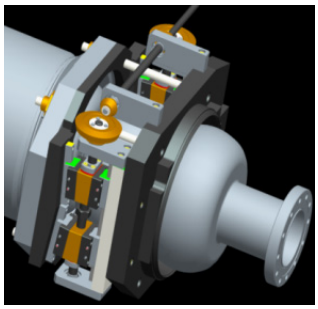

Figure 4: Structure design of the slide jack tuner

Cryomodule

The structure design (Fig. 5), thermal and mechanical simulation of the short cryomodule containing one 9-cell cavity has been finished. The short cryomodule will be fabricated next year.

IHEP fabricated the first prototype cryomodule for Euro-XFEL (PXFEL1) in 2009 (Fig.6&7). This cryomodule was successfully tested at CMTB of DESY and will be installed in FLASH to increase the energy to 1.2 GeV.

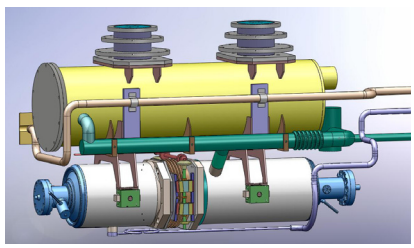

Figure 5: Cold mass design of the short cryomodule

Figure 6: Coldmass of the PXFEL1 cryomodule

Figure 7: PXFEL1 cryomodule

Marx Modulator

The solid-state Marx modulator (Fig.8) is under development at IHEP with ILC baseline specifications, supported by innovation funds of the Chinese Academy of Sciences. The key component 12 kV solid switch has been developed and one 12 kV cell module was demonstrated successfully.

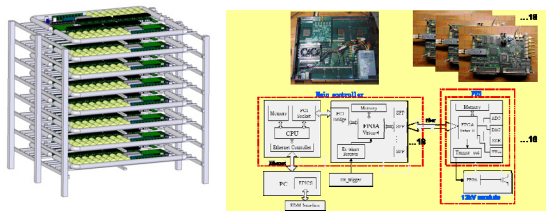

Figure 8: Marx modulator components.

SCRF Facilities

The 1.3 GHz SCRF program will significantly improve the IHEP SCRF infrastructures and facilities to meet the 9-cell cavity requirement for surface preparation and vertical tests. Several SCRF facilities have been fabricated or installed and will be commissioned soon:

- CBP (tumbling) machine for 9-cell cavities (Fig. 9)
- BCP facility for 9-cell cavities (Fig. 10)
- Pretuning machine (Fig. 11)
- Manually vertical pretuning device (Fig. 12)

Figure 9: CBP machine for the 9-cell cavity. Normal rotating speed is 100 rpm.

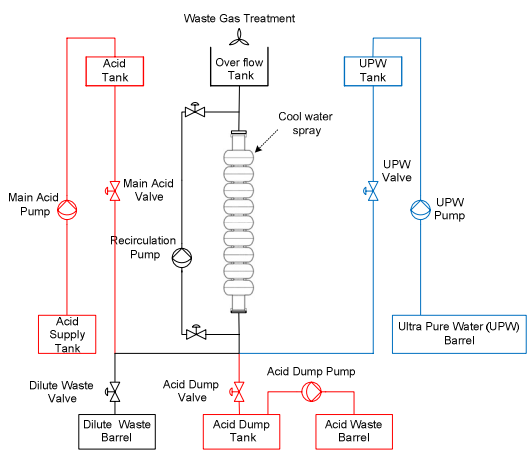

Figure 10: Scheme of the automatic closed loop buffered chemical polishing (BCP) facility. The cooling system can remove up to 2 kW heat during the process. The maximum acid flow is 2 tons / hour.

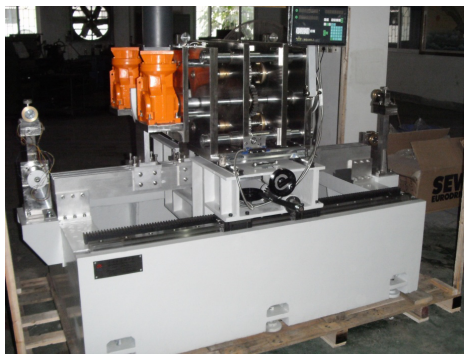

Figure 11: Pretuning machine for the 9-cell cavity. Longitudinal precision 2 μm, maximum force 10 kN (1000 kgf) , maximum movement 6 mm.

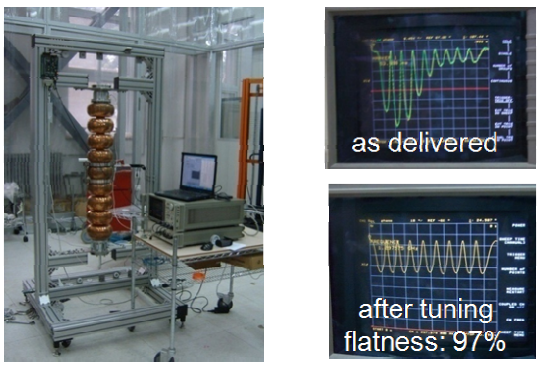

Figure 12: Manually vertical pretuning device for the 9-cell cavity. An Ichiro copper cavity was tuned to 97 % field flatness with this device.

A closed loop cryogenic system for vertical and horizontal test is also designed and proposed (Fig. 13).

SUMMARY

IHEP 1.3 GHz SCRF R&D is ongoing well including the SCRF facilities upgrade. Most of the components will be fabricated next year. The whole accelerating unit will be integrated and horizontally tested in 2011.

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REFERENCES

[1] J. Gao, Y.L. Chi, J.Y. Zhai et al, “ILC 1.3 GHz Superconducting RF Technology Development Program at IHEP”, PAC09, Vancouver, Canada, 2009

[2] J. Gao, Y.L. Chi, J.Y. Zhai et al, “Dumbbell Fabrication and Tuning of the IHEP Large Grain 9-cell Cavity”, THPPO067, this proceeding

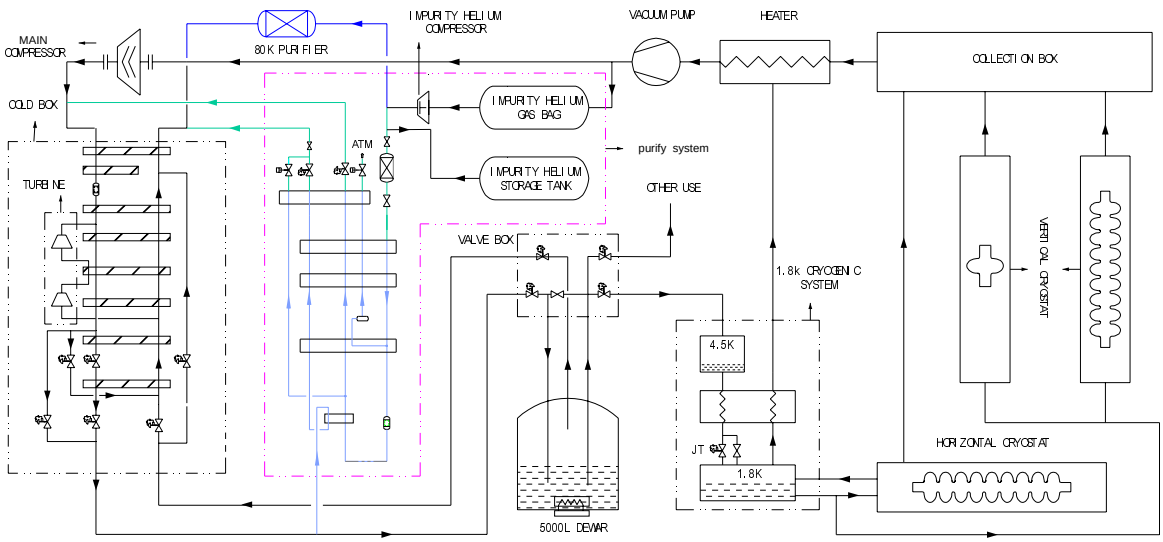

Figure 13: Cryogenic flow diagram for vertical and horizontal tests.