

## China reaching the target gradient

A 1.3-gigahertz TESLA-type nine-cell niobium superconducting cavity, named PKU3, as the third nine-cell cavity fabricated by the superconducting radiofrequency (RF) group at Peking University, Beijing, China, achieved an accelerating gradient of 28.6 megavolts per metre (MV/m) at an unloaded quality factor of  $4 \times 10^9$  in its second vertical test at Jefferson Lab (JLab), USA on 9 August 2010. This cavity is the first nine-cell cavity with end group components in China reaching a gradient usable for the ILC.

The cavity is made of high-purity niobium from Orient Tantalum Industry Corp. (OTIC), Ningxia, China. The fabrication of the cavity was finished in the middle of 2009. After field flatness pre-tuning with the Peking University tuning facility, PKU3 was sent to JLab in April 2010 for performance evaluation.



PKU3, the first nine-cell cavity in China reaching a gradient usable for the ILC, in JLab clean room before vertical test.  
Image: Fumio Furuta



Superconducting cavities (including PKU3) fabricated by Peking University since 2005. Image: Peking University

After optical inspection of electron-beam welding seams, the cavity was ultra-sonic cleaned and etched for 10 micrometres of inner surface removal by buffered chemical polishing, followed by field flatness tuning in May. The flatness was 95.5 percent, which shows no degradation of cavity mechanical dimensions due to transportation. Successful bulk electropolishing of PKU3 was made on 15 June. Furnace vacuum heat treatment was applied to the cavity at 800 degrees Celsius for two hours on 23 June. After the field flatness was tuned to 97.9 percent, a light electropolishing of 25 micrometres was done on 13 July. After high-pressure rinsing and clean room assembly, the first RF test was done on 30 July. The maximum accelerating gradient was 20 MV/m at an unloaded quality factor of  $2.3 \times 10^9$ , limited by field emission. After partial disassembly, additional high-pressure

water rinsing was done, followed by the second RF test on 9 August. The maximum accelerating gradient reached 28.6 MV/m at an unloaded quality factor of  $4 \times 10^9$ , limited by RF cable heating. The observed decrease of quality factor versus the gradient (Q-slope) might be due to the field emission by the sharp edges in the iris electron-beam welding regions. The cavity will be re-inspected for further improvement.

The achievement of PKU3 is a major milestone in superconducting RF technology development in China. PKU started the R&D work on this technology from the late eighties in cooperation with JLab and Cornell University in the US, DESY in Germany, and KEK in Japan. The group has accumulated extensive experiences in the field of superconducting RF science and technology. In 1994, PKU produced the first Chinese niobium cavity. Since 2005, great efforts have been extended to develop high gradient superconducting cavities in close collaboration with DESY and JLab. PKU produced a series of superconducting cavities including single-cell, two-cell, 3.5-cell, five-cell and nine-cell cavities, using fine-grain and large-grain niobium from China. PKU has also signed a memorandum of understanding with Fermi Laboratory in the US for cooperation on superconducting RF technology. "The achievement of PKU3 is a great encouragement for the superconducting RF group at Peking University. More efforts have to be made on further development of high gradient nine-cell cavity in the future," said Jiaer Chen, academician of Chinese Academy of Science.

"The achievement of PKU3 is very exciting and it is a very important milestone to both of Chinese superconducting technology development and the global cooperation for ILC activities. We are very much impressed to hear of this exciting news and would send our sincere congratulation for the PKU team and the global cooperation", said Akira Yamamoto, on behalf of the ILC Global Design Effort Project Managers. Jie Gao, chair of Asia Linear Collider Steering Committee also indicated that: "It is very good news for the ILC Asian collaboration. Asia's participation and contribution to the ILC will be more and more balanced in the future".

-- Jiankui Hao, Peking University

