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Superconducting Accelerator Structures: An Historical Overview[1]

PERRY WILSON, SLAC, Stanford

In 1961 I began doing active research on RF superconducting cavities at the High Energy Physics Laboratory (HEPL) at Stanford University. At that time there were already nascent research programs exploring superconducting cavities at four other laboratories around the world, including the one at the Stanford physics department. However, all attempts to produce a substantial accelerating field in a superconducting cavity had failed. Since a cavity that is capable of acceleration always has a surface electric field, I decided that my first research effort would be to build and test a cavity with only a magnetic field at the surface. The frequency would need to be 2856 MHz, that of the electron linac at HEPL, so that available instrumentation could be used. In order to have only a magnetic field at the surface, the cavity would have to operate in the so-called TE mode. But there was a problem: at 2856 MHz such a cavity would be considerably larger than the single-cell accelerating mode cavities previously built at the Stanford physics department. In collaboration with the low temperature physics group in the Stanford physics department, a larger electroplating facility was built that was capable of handling the cylindrical cavity body and two end plates. The initial measurements gave stunning results: a Q factor of about 10^8 at 4°K for a lead-plated cavity was obtained, and there was no degradation in Q up to a surface magnetic field of about 10 mT, (limited by the oscillator power). The results were published in 1963. Experimentation on superconducting accelerator cavities increased rapidly in the decade or so following this initial success. Successful niobium TM-mode (accelerating mode) cavities were built with Q's of about 10^{11}. Within a few years the multipactor problem in accelerating cavities was solved by changing the shape of the outer boundary. The initial impetus for superconducting accelerator research at Stanford was to design and build a long pulse superconducting linac with an energy of about one GeV. Such a linac has still not been realized, but in the years from 1970 to 1990 there have been successful applications of RF superconducting structures to storage rings, rf separators, drive linacs for FEL's, and heavy ion accelerators. The evolution superconducting structures and their applications, as outlined above, will be discussed in more detail in my talk

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