As part of an ongoing effort to develop and understand high-temperature superconductors (HTS), small quasi-crystal tiles (2 cm in diameter and 0.32 to 0.8 cm thick) of Y$_{1.7}$Ba$_2$Cu$_3$O$_{7-6}$Pt$_{0.01}$Y123 have been produced at the University of Houston, irradiated with 200-MeV protons at the Indiana University Cyclotron Facility to increase the maximum trappable field by the introduction of pinning centers, combined to form mini-magnets of four tiles, and activated at the NSF National High Magnetic Field Laboratory in Tallahassee. World-record trapped magnetic fields have been produced in this way and procedures developed that reduce the slow decay of the trapped field, creep, to practically zero.

In the early 1970's, persistent fields in low temperature superconductors were studied at Stanford. Record fields of 2.3 T were trapped at 4 K.\textsuperscript{1} We have studied trapped-field magnets using the newer high temperature superconductors (HTS).\textsuperscript{2-10} A variety of techniques have been used to produce materials with increased maximum trappable fields, $B_{t,max}$.\textsuperscript{11} Also operation at lower temperatures increases $B_{t,max}$.\textsuperscript{11} An early generation of these tiles produced in 1993 and 1994, trapped 4.0 T at 64.5 K,\textsuperscript{9} and 7.0 T at 55 K,\textsuperscript{8} and eclipsed the record field observed at Stanford 17 years earlier.

Progress has been rapid in the last year. A mini-magnet fabricated from four single-grained tiles of Y123 grown by top-seeded melt texturing and irradiation by 200-MeV protons to a fluence of about $2 \times 10^{16}$ p/cm$^2$ was studied using an applied field, $B_A$, of 13 T at the NHMFL. The mini-magnet was cooled to 54 K. $B_A$ was reduced to zero in 83 min, at which time the trapped field, $B_t$, was 8.34 T, a record field for a permanent magnet. Cooling the Y123 after $B_A$ reached zero was found to reduce creep greatly, by a factor of 197, as a result of post activation cooling by 4 K. These results were reported in June 21, 1995.\textsuperscript{11}

In recent studies performed in June, 1995, using tiles irradiated with 200-MeV protons at IUCF in late February, 1995, a 10.1 T field was trapped at about 42 K. This field is...
Figure 1. Maximum trapped magnetic fields achieved by Y123 samples produced by the Institute of Beam Particle Dynamics at the University of Houston as a function of time. While the samples are labelled by the temperature at which the fields were observed, the improvement in performance shown reflects a variety of improvements in fabrication techniques and the use of radiation exposure to introduce pinning centers. The 1977 record for low temperature superconductors (LTS) of 2.3 T and the goal for high temperature superconductors (HTS) of 10 T are plotted for comparison.

a world record for a permanent magnet ingot made of any material, and operated at any temperature. It is six times higher than fields achieved by electromagnets.

For this work, Roy Weinstein was presented with the “Material/Device Performance Award” in recognition of superior performance in the field of Trapped Field Magnets at the “1995 International Workshop on Superconductivity” held June 21, 1995 and sponsored jointly by the International Superconductivity Technology Center and the Materials Research Society.


