Observation of a Bean Model Limit – A Large Decrease in Required Applied Activation Field for TFMs

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Abstract – Experiments are reported on pulsed activation of zero-field-cooled trapped field magnets (TFMs) containing improved broken-columnar pinning centers (PCs). The YBCO TFMs have J_C ~50 kA/cm^2 and maximum trapped field, $B_{T,max}$ ~2.2 T at 77 K. Several results are in disagreement with the well-established Bean model. Essentially full activation is obtained with an applied field at the surface of $B_A \approx 1.0 \times B_{T,max}$. The Bean model predicts $B_A \geq 2 \times B_{T,max}$. Low points in activation are observed at radial sample coordinates $r \approx 0.5$ R, a result precluded by the model. Activation shows a discontinuous giant field leap, in disagreement with the smooth increase of $B_{T,max}$ vs. B_A predicted by the model. Results are compared to TFMs containing Y211 PCs, which are well described by the Bean model. E.g., for Y211 PCs, field at inner r is the last to rise. For columnar PCs it is the first to rise, an additional conflict with the model. Also, the Bean model predictions are independent of J_C, B_T, and PCs, whereas major differences exist experimentally. We speculate that with high J_C and B_T, the very large, centrally-directed Lorentz force causes a discontinuous shift of the fluxoid mesh toward $r = 0$.

Keywords (Index Terms) — REBCO coated conductors, PLD and TFA-MOD processing, BHO, BZO and BSO additions as artificial pinning centers (APC), in-field critical currents, M-PACC project