Ultra-high field HTS flux-pumped magnets

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Introduction

Flux pumped ultra-high field magnets have the potential to produce fields which surpass the nearly 20 year old record of 45 T in a DC field Bitter magnet in a relatively cost effective manner. These higher fields will undoubtedly require superconducting cables capable of carrying thousands of amps and the means to deliver those very high currents. Current leads could be used but at currents in the 10s of thousands of amps they represent a very high cost and heating overhead. Higher currents mean lower conductor cost, lower magnet inducances shorter charging times and lower quench voltages. Flux pump technology and the latest dynamic bridge switching method will be key to providing these high currents with minimal heat loads and minimal infrastructure in comparison to expensive high-current power supplies and warm-to-cold current leads. The resultant effect is that the purchase and running costs of high-field magnets will decrease substantially. Crucially also infra-structure costs will be slashed. A flux pumped HTS magnet does not require high current power supplies and current leads neither does it require copious amounts of water cooling to dissipate the waste heat. Thus it is realistic to expect HTS flux pumped magnets to be available which could be installed in any UK (or international) university enabling a radical sea change in the use of high field magnets to support research. Further down the line it is conceivable that HTS flux pumped magnets could enable the creation of practical fusion devices a goal which has eluded us for many years.

Dynamic Bridge Flux Pumps

Field Distribution and achieved voltages

Here we show a model of the system constructed in Comsol. A transport current is induced in the superconductor by the centrally placed EM. Two further coils either side of the magnet are used to simulate the bridge.

Experimental Results

Sample trace showing 100 cycles. The load was 1 micro-Henry and the flux change per cycle is 20 nWb.

References