Introduction

A prototype 65T magnet assembly failed after 470 full field science shots. The fault was traced to the inner “A” coil inside the nested two coil assembly. The construction of the inner “A” coil assembly is based upon the poly-layer assembly technique developed for the 100T insert program. The fault was unique in that the entire magnet assembly was intact save for the winding layer that failed. (See Fig. 1) Inspection and analysis of the assembly presented an opportunity to examine all internal interfaces to evaluate structural performance of components after long term service. Such inspection and design review is critical to the practical improvement of pulsed magnets. More importantly the inspection of the assembly allows direct evaluation of the structures used in the poly-layer assembly planned for the 100T insert magnets.

Observations

The first operational fault was located in the mid-plane of layer one in the “A” coil insert winding. (See Fig. 2) There is evidence of extreme heat as ~ ½ of two turns were vaporized. The metal vapor burned through the layer-one zylon reinforcement and MP35N metal reinforcement. Atomized metal particles were observed to be condensed upon the internal radius of the layer two windings. There was no evidence an electrical fault to layer two.

Electrical insulation structures and lead structures were intact and functioning as designed with no evidence of degradation after long term operation. Geometrical measurements were made on each layer at the winding diameter and the inside diameter of the metal reinforcement. No deformation was observed. Measured dimensions were essentially as constructed.

Summary

The hypothesis after gross morphological examination is that the kapton™ wire insulation failed via mechanical compression. The two mid-plane turns short circuited initiating an electrical arc. The arc burned insulation and conductor between the turns progressively ablating metal from both wires. The temperature of the shorted turns increased rapidly due to heating from the plasma and the magnet current. It is interesting to note that the axial magnetic field in the mid-plane region will focus a plasma discharge concentrating the heating in one location. The pulsed conductor insulation has since been upgraded to a zylon-kapton system that can take cyclic compression associated with high field operation.