REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
23-03-2007

2. REPORT TYPE
Final Report

3. DATES COVERED *(From - To)*
01-10-2004 to 30-11-2006

4. TITLE AND SUBTITLE
Development of a Flow-Through SQUID System for Non-Destructive Evaluation of MRI Wire

5a. CONTRACT NUMBER
FA95500510028

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Frederick C. Wellstood

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Department of Physics
University of Maryland
College Park, Maryland,
20742-4111

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFOSR/PKC (ATTN: Wendy Veon)
875 North Randolph Street
Suite 325, Room 3112
Arlington, VA 22203-1768.
Dr Harold

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

AFRL-SR-AR-TR-07-0123

13. SUPPLEMENTARY NOTES

14. ABSTRACT: This project developed techniques to detect small defects in NbTi magnet wire at room-temperature using a flow-through high-transition temperature (T_c) superconducting quantum interference device (SQUID) system. The ability to detect small defects in km-long sections of NbTi magnet wire could improve the production yield of high-field magnets for power and medical applications. Such magnets are wound from continuous sections of wire up to 1 km long, and a single small defect in the wire can limit the field the magnet produces, making it unsuitable. It is highly desirable to be able to locate defects in wire using non-destructive evaluation (NDE) of the wire before the magnet is wound. Ideally, the NDE system must be able to detect small buried defects due to yields (wire stretched beyond elastic limit) and occlusions (non-conducting impurity grain introduced into the wire). Such defects have proven to be difficult to find using visual inspection or conventional eddy current detection, and better techniques are needed.

15. SUBJECT TERMS
NDE, Superconducting, SQUID, Magnet

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON / 19b. TELEPHONE NUMBER (include area code)
				3	301-405-7649

Final Performance Report for

Development of a Flow-Through SQUID System
for
Non-Destructive Evaluation of MRI Wire

AFOSR Award Number FA95500510028

University of Maryland FRS # 01-5-28399

From: Fred Wellstood
Center for Superconductivity Research
Department of Physics
University of Maryland
College Park, Maryland 20742-4111
Phone 301-405-7649, well@squid.umd.edu

To: Air Force Office of Scientific Research
ATTN:Wendy M Veon -PKC
875 North Randolph Street
Suite 325 , Room 3112
Arlington , VA 22203-1768

Date: March 23, 2007

Cc: Cleopatra White, Center for Superconductivity Research;
Hasti Mehta, Compliance Coordinator,
Office of Research Administration and Advancement, UMD

The objective of this project was to develop techniques to detect small defects in km-long sections of NbTi magnet wire at room-temperature using a flow-through high-transition temperature (T_c) superconducting quantum interference device (SQUID) system. The ability to detect small defects in km-long sections of NbTi magnet wire could improve the production yield of high-field magnets for Medical Resonance Imaging (MRI) and power applications. Such magnets are wound from continuous sections of wire up to 1 km long, and a single small defect in the wire can limit the field the magnet produces, making it unsuitable. Ideally, the NDE system must be able to detect small buried defects due to yields (wire stretched beyond elastic limit) and occlusions (non-conducting impurity grain introduced into the wire). Such defects have proven to be difficult to find using visual inspection or conventional eddy current detection, and better technique are needed.

During the two years of this project, the main tasks we accomplished were:

(1) Built a stepper motor controlled wire feed system and tested it on a cryo-cooled flow-through high-T_c SQUID system;

(2) Used the system to measure ac magnetic signals from intentional defects (small through holes) in 6 ft long 2 mm diameter brass rod driven at up to 20 cm/s;

(3) Developed a simple automatic detection scheme using high pass filter and threshold detection to reliably detect through holes down to 300 μm diameter;

(4) Rebuilt SQUID tip and electronics for higher bandwidth (about 20 kHz) and tested the complete system;

(5) Developed a simple model of the defect signal, compared observed signals to the model, and developed estimates for minimum defect size observable with a given level of injection current;

(5) Considered two designs for alternative detection schemes. The aim of the first scheme was to improve the detection of smaller holes by using a coaxial return current path that would produce a field that would cancel the background field from the average current through the wire under test. The aim of the second techniques was to remove the need for making connections to the wire by using a pair of anti-Helmholtz coils to produce a large field gradient that the wire would then be swept through.