TEST RESULTS OF DSA326 AND DSA101, 50 mm, APERTURE, 1.5 m LONG MODEL DIPOLES

TARIQ JAFFERY

FERMI NATIONAL ACCELERATOR LABORATORY

MSI MEETING AT FNAL, 29 OCTOBER 1991

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EXECUTIVE SUMMARY FOR TARIQ JAFFERY 10/28/91(MSIM AT FERMILAB)

TITLE: TEST RESULTS OF DSA326 AND DSA101, 50 mm APERTURE, 1.5 m LONG MODEL DIPOLES

-DSA326 IS THE FOURTH FERMILAB 50 mm APERTURE, 1.5 METER LONG MODEL DIPOLE THAT HAS BEEN COLD TESTED AT FERMILAB. THIS MAGNET HAS GONE THROUGH THREE THERMAL CYCLES. DURING THE FIRST TWO COOLDOWNS THE QUENCHES WERE ERRATIC AND SHOWED SOME TRAINING. DURING THIRD COOLDOWN THE MAGNET PLATEAUED ABOVE THE PREDICTED CURRENT AT EACH TEMPERATURE (i.e. 4.2, 4.3 AND 3.8 K) . ALL PLATEAU QUENCHES WERE IN THE UPPER INNER COIL POLE TURN (TURN 19 STRAIGHT SECTION) EITHER ON RAMP SPLICE SIDE OR NON RAMP SPLICE SIDE OF THE COIL. WHEREAS ALL, BUT ONE QUENCH IN THIRD COOLDOWN, WERE ON THE RAMP SPLICE SIDE OF THE COIL (STILL UPPER INNER POLE TURN STRAIGHT SECTION).

PLATEAU CURRENTS :

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| # quenche | S | _10 Qs | 34 Qs | 10 Q'S | ſ |
|------------|----------|--------|--------|--------|--------|
| | TEMP (K) | TC1 | TC2 | тсз | • |
| | 4.2 | 7673 A | 7586 A | 7656A | |
| | 4.35 | 7386A | 7412 A | 7404 A | DSA326 |
| | 3.8 | | 8087 A | 8105 A | |
| | 4.2 | 7783 A | | | DSA101 |
| | 4.35 | 7568 A | | | • |
| | 3.8 | | | | |
| # auenches | 5 | 12 Qs | | | |

quenches

- ON THE THIRD COOLDOWN THE END PRELOAD WAS INCREASED FROM 250 LBS (<30 in-lb torque) TO 4000 LBS (~37 社 b torque)PER BULLET. THE LEAD END SCREWS WERE ALSO TORQUED TO ~37 ft-lb/screw . THERE IS NO OBVIOUS CHANGE IN QUENCH PLATEAU CURRENT DUE TO INCREASE IN END PRELOAD.

- DSA101 SHOWED VERY LITTLE TRAINING AT 4.35 K AND 4.2 K AND PLATEAUED ABOVE THE PREDICTED QUENCH CURRENT. PLATEAU QUENCHES ARE IN LOWER INNER COIL POLE TURN (TURN 19 STRAIGHT SECTION) ON RAMP SPLICE SIDE OF THE COIL .

- THE END PRELOAD ON DSA101 WAS 500 LBS PER BULLET. -DSA101 HAS BEEN WARMED UP AND A SECOND COOLDOWN WILL START ON 10/30/91

THE QUENCH PROPAGATION VELOCITY, FOR BOTH MAGNETS, DURING A PLATEAU QUENCH (AT 16 A/S) IS ~85 m/s IN THE STRAIGHT SECTION OF THE HIGHEST FIELD REGION (POLE TURNS) . WHEREAS IN THE RAMP SPLICE THE QUENCH VELOCITY CAN BECOME AS SMALL AS ~33 m/s . ALL THE STANDARD PLATEAU QUENCHES WERE IN THE POLE TURN AND THE MAGNET PLATEAUED WELL ABOVE THE SSC OPERATING MARGIN.

TEST RESULTS OF DSA326 AND DSA101, 50 mm APERTURE, 1.5 m LONG MODEL DIPOLES

- I. INTRODUCTION
- **II. MECHANICAL BEHAVIOR**
- **III. QUENCH BEHAVIOR**
- **IV. HARMONICS**

DSA326

DSA101

ALUMINUM END CLAMPS S.S. END CLAMPS WITH AZIMUTHAL G10CR WITH AZIMUTHAL

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S.S. END CLAMPS WITH AZIMUTHAL G10CR (LIKE DSA321)

8 HEATERS

NO HEATERS

-DIFFERENT COIL PRESTRESS -BOTH HAVE VERTICALLY SPLIT YOKE -DSA101 IS FIRST SSC BUILT MODEL MAGNET -DSA326 IS FOURTH FERMILAB,1.5m MODEL, COLD TESTED IN LAB2 -DSA326 HAS NO SHIMS (LIKE DSA323)

- HIGH MANGANESE STEEL "FILLER " LAMINATIONS IN END REGIONS TO PREVENT THERMAL STRESSES IN SHELL



DSA326 Coil Stress Assembly History

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PRESTRESS CHANGE WITH COOLDOWN 1.5 m Long , 50 mm Aperture SSC Model Dipoles at Fermilab

| Magnet | Coil Stress (Inner Coil | Change (MPa) Outer Coil | End Force Change (kN) |
|------------|-----------------------------|----------------------------|--------------------------|
| DSA321 | -19 | -14 | -1 |
| DSA323 | -30 | -10 | 0 |
| DSA324 | -33 | -8 | 1 |
| DSA326 (TO | 1) -34 | -25 | 4.8 |
| DSA326 (TO | 2) -37 | -23 | 5 |
| DSA326 (TO | 3) -36 | -22 | -2.5 |
| DSA101 (TO | 1) -35 | -22 | |





End Force (kN)



THREE THERMAL CYCLES ON DSA326

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COOLDOWNS 1 &2- ERRATIC QUENCHES - SHOWED SOME TRAINING . THIRD COOLDOWN - MAGNET PLATEAUED ABOVE THE PREDICTED CURRENT AT 4.2, 4.3 AND 3.8 K . PLATEAU QUENCHES IN THE UI COIL POLE TURN (TURN 19 STRAIGHT SECTION) .

ALL, BUT ONE QUENCH IN THIRD COOLDOWN, WERE ON THE RAMP SPLICE SIDE OF THE COIL

THIRD COOLDOWN -INCREASED END PRELOAD FROM 250 LBS TO 4000 LBS PER BULLET. THE LEAD END SCREWS WERE ALSO TORQUED TO ~37 ft-lb/screw . THERE IS NO OBVIOUS CHANGE IN QUENCH PLATEAU CURRENT DUE TO INCREASED END PRELOAD .

- DSA101 SHOWED VERY LITTLE TRAINING AT 4.35 K AND 4.2 K AND PLATEAUED ABOVE THE PREDICTED QUENCH CURRENT. PLATEAU QUENCHES ARE IN LOWER INNER COIL POLE TURN (TURN 19 STRAIGHT SECTION) ON RAMP SPLICE SIDE OF THE COIL .

- THE END PRELOAD ON DSA101 WAS 500 LBS PER BULLET . -DSA101 HAS BEEN WARMED UP AND A SECOND COOLDOWN WILL START ON ~10/30/91

BOTH MAGNETS-ALL THE STANDARD PLATEAU QUENCHES WERE IN THE POLE TURN AND THE MAGNETS PLATEAUED WELL ABOVE THE SSC OPERATING MARGIN .

| DSA323 AND | DSA324 HAVE | E SAME INNER CABLE | | |
|------------------------|-----------------------|----------------------------|--|--|
| TEMP (K) | <u>lcritical (kA)</u> | | | |
| | ∗DSA326 | DSA101 | | |
| 4.22 | 7.47 | - | | |
| 4.35 | 7.31 | 7.53 MIKA (1. 11. | | |
| 3.8 | 7.96 | | | |
| SSC-3-S-00021 | | SSC-3-00024 | | |
| Ic =10,079 A at 7 | T, 4.22 K | IC=10917 A at 7 T, 4.22 K | | |
| *OUENOU OUDDENT DDEDIC | TED BY ODEEN DADAN | ACTRIZATION OF LET SUBEACE | | |

*QUENCH CURRENT PREDICTED BY GREEN PARAMETRIZATION OF J,B,T SURFACE PLATEAU CURRENTS :

| # quenche | s | _10 Qs | 34 Qs | 10 Q'S | |
|------------|----------|--------|--------|--------|--------|
| | TEMP (K) | TC1 | TC2 | тсз | |
| | 4.2 | 7673 A | 7586 A | 7656A | |
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| | 3.8 | | 8087 A | 8105 A | |
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| | 4.35 | 7568 A | | | 4 |
| | 3.8 | | | | |
| # auenches | 5 | 12 Qs | | | |

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DSA326 QUENCH HISTORY (Fermilab built 50 mm aperture, 1.5 m long SSC dipole)



All quenches are at 16 A/sec

QUENCH CURRENT (A)

QUENCH NUMBER

DSA326 Quench Current vs Temperature



Temperature (K)

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DSA101 QUENCH HISTORY

First SSC built 50 mm aperture, 1.5 m long dipole



QUENCH NUMBER

DSA101 Quench Curent vs Temperature

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ALLOWED HARMONICS; LAB2

18 INCH ACTIVE LENGTH MORGAN COIL PROBE AVERAGE VALUE AWAY FROM THE GAGE PACK

| | 5kA | | Yoked ± | <u>10 A</u> |
|--------|-----------------|------|---------|-------------|
| MAGNET | b2 | b4 | b2 | b4 |
| DSA323 | .91 | .23 | .91 | 0.23 . |
| DSA324 | 1.4 | .002 | 1.8 | 0.18 . |
| DSA326 | 2.0 ±.02 | 2 | 2.1 | 0.34 . |
| DSA101 | | | | |

TRANSFER FUNCTION FOR 50 mm MAGNETS (T/kA)

| | DSA321 | DSA323 | DSA324 | PREDICTED |
|--------------------------|--------|------------------|--------|-----------|
| Collared Coils ± 10 A | 0.795 | .794 | .794 | .795 |
| Yoked ± 10 A | 1.043 | 1.043 | 1.044 | 1.045 |
| Cold at 5 kA | 1.036 | $1.033 \pm .002$ | 1.037 | 1.044 |

| | DSA326 | DSA101 | PREDICTED |
|--------------------------|------------|--------------|-----------|
| Collared Coils ± 10 A | .793 | | .795 |
| Yoked ± 10 A | 1.042 | | 1.045 |
| Cold at 5 kA | 1.04 ±.002 | | 1.044 |
| Cold at 3 kA | | *1.047 ±.002 | 1.045 |

* measured with Rawson Lush fieldmeter (1/4 in rotating probe)



Distribution:

FNAL

- R. Bossert
- J. Carson
- S. Delchamps
- W. Koska
- M. Lamm
- P. Mantsch
- G. Pewitt
- J. Strait
- M. Wake

SSCL

- A. Devred
- J. Jayakumar

- J. Tompkins R. Wetterskog B. Williams (at FNAL)