Magnetic Center Measurements for NLC Quadrupoles: 
Micron Magnetic Center Measurements using a Rotating Coil *

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Invited talk presented at 13th International Magnetic Measurement Workshop
Stanford, California
May 19-22, 2003
Magnetic Center Measurements for NLC Quadrupoles

Micron Magnetic Center Measurements using a Rotating Coil

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SLAC Magnetic Measurements
May 21, 2003
Contributions

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• Dave Jensen
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• Jerry Yocky
• Cherrill Spencer
Motivation for Apparatus

- NLC Quadrupole BBA requirement magnetic center change < 1 µm when field strength is changed by 20%.

- Study effect of temperature on magnetic center stability, especially for hybrid permanent magnet designs.
BBA Runs, 20% Strength Change

NLC Prototype Electromagnetic Quad

Measurement Number, each data pt takes ~8 minutes
Magnetic Center Statistical Errors

- 0.05 µm for individual measurements
- 0.1 µm for length of NLC 20% change measurement (35 min - 1 hr)
  - BBA measurement requirement can be determined
- 1.0 µm for 24 hr stability studies.
  - How often do magnets have to be moved for center correction.
Rotating Coil

- 3.8 mm radius, 43 cm length G-10 rod
- 2 coil windings, in plane, center to outer radius, opposite each other.
- Coil windings can be wired for several purposes.
- Coil ends Rulon PTFE cups met to SS ball and shaft turning precision bearings.
- One end has a sliding translation stage, for thermal expansion.
Coil Windings Wiring

- Two Coils in Series, outer radius to outer radius
  - Field Strength, immunity to coil flex
- Single Coil
  - Main Harmonic (Quad) is dominate, other harmonics too.
- Two Coils Bucking
  - Quad term is zeroed. Even Harmonics too.
  - Dipole and other odd Harmonics measured.
Coil Measurements

• Coil rotates 13 times CW then CCW.
  – Middle 8 rotations each direction are used for measurements.

• Coil Voltages
  – Sent through mercury wetted slip rings
  – Multiplexer, coil wirings switched on the fly
  – To Metrolab digital integrator.

• TCs and Heidenhains

• Lab Windows DAQ software
Measurement Stand

• Granite Table on rubber isolation pads
• All parts are aluminum or SS plates, flat on granite blocks or on shims. All parts clamped or tied down.
• Room temperature controlled to 0.2 °C
• Magnet Cooling water temperature controlled to 0.1 °C
• Cooling fan on Motor/Encoder plate
Latest Magnetic Measurement Setup

- Translation Stage w/ Ball and Cone Coupling
- Flexible Bellows Coupling
- Encoder
- Motor
- Fermilab Wedge Magnet with Tunable Rods
- Heidenhain 0.5 μm Indicator
Environment Effects

- Temperature fluctuations
  - Cooling Water Temperature
  - Ambient Room Temperature
  - Motor Heating
- RH %
Cooling Water Before Regulation

NLC Prototype EM1 Overnight Run

Water Temp (°C)

0 100 200 300 400 500 600 700

y-position (µm)

0 100 200 300 400 500 600 700

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SLAC Magnetic Measurements
Cooling Water Effect on Y Center

NLC Prototype EM1-1
Overnight Run

1.5 µm/C

MagSteel(near pole)(C) vs y-position(um)
Plot 1 Regr

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X Center, Expansion no shift

NLC Prototype EM1
Overnight Run

x-position (um)

9.2 9.4 9.6 9.8 10.0 10.2

time (each bin = 8 minutes)

100 200 300 400 500 600 700
NLC Prototype Linac Quad in Magnetic Measurement Set-Up
(early version)
Ambient Temperature

NLC Electromagnet

Ambient Temperature (°C)

Measurement Number (Each bin = 8 Mins)
X Center, Ambient Effect

NLC Electromagnet

Measurement Number (Each bin = 8 mins)