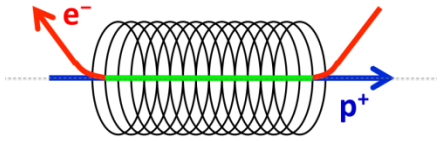
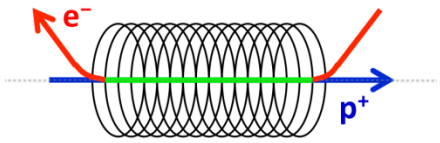


Electron Lens Superconducting Magnet Testing

Joseph F Muratore

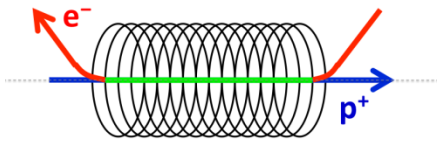
October 20, 2010

Outline



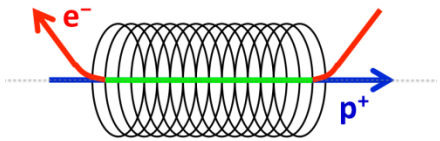
- Magnet Test Parameters
- Magnet Instrumentation
- Testing Conditions
- Quench Protection
- Test Plan

Magnet Test Parameters



COIL TYPE	Number of each	L (H)	I_{op} (A)	I_{max} (A)	E (kJ)
MAIN SOLENOID	1	14	460	500	1500
FRINGE SOLENOID	2	46	47	60	51
ANTI-FRINGE SOLENOID	2	3.7	33	50	2
LONG VERT CORRECTOR	2		34	40	
LONG HORIZ CORRECTOR	2		34	40	
SHORT VERT CORRECTOR	5		26	30	
SHORT HORIZ CORRECTOR	5		26	30	

Magnet Instrumentation



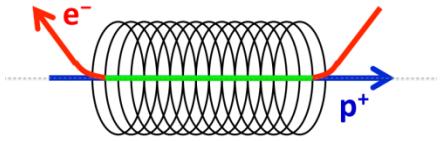
- **Power Supplies**

  17 independent power supplies (12 bipolar supplies)

- **Voltage Taps**
  1. coil voltages
  2. center taps
  3. each set of layers (segments with bypass diodes)
  4. superconducting leads
  5. copper leads

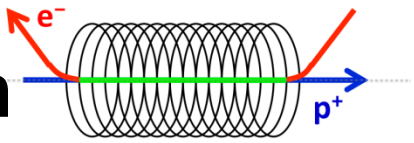
- **Temperature Sensors**
  1. silicon diodes at both top and bottom ends
  2. carbon-glass or cernox at leads

TESTING CONDITIONS



- 6 m deep vertical test dewar
- 1500 W helium refrigerator - 300 L / hr capacity
- All magnet instrumention & power leads use top plate feedthroughs
- Liquid helium bath at 4.5 K, 131 kPa

Quench Protection – Quench Detection

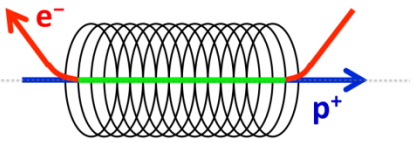


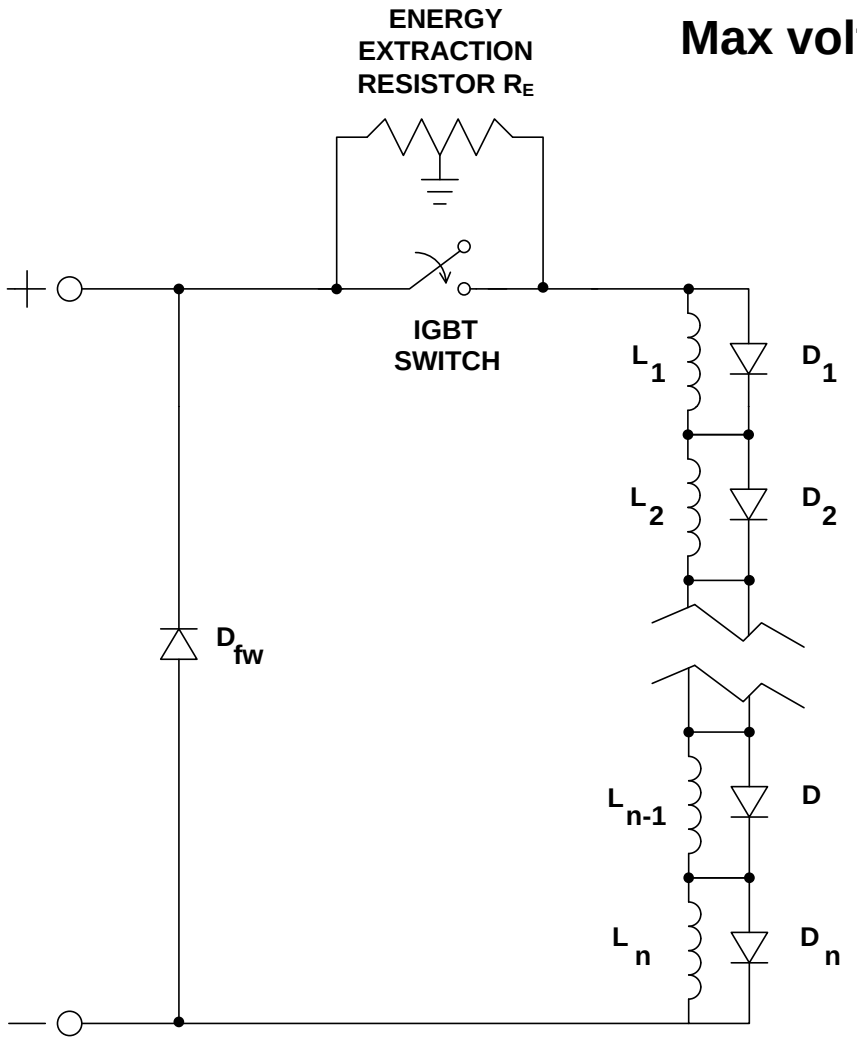
Two quench detection schemes are used.

- **coil difference quench detectors** – uses center tap and monitors the voltage difference between matched coils or matched coil halves

- **current derivative quench detectors** – monitors difference of current derivative voltage and coil total voltage – in case of simultaneous quenches

Quench Protection – Energy Extraction





Max voltage to ground limited to Vmax= ±300 V

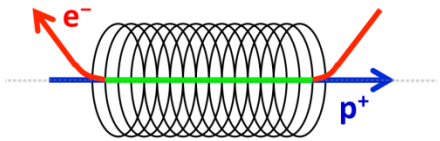
Number of Cold Diodes Needed:

Main Solenoid: n = 11

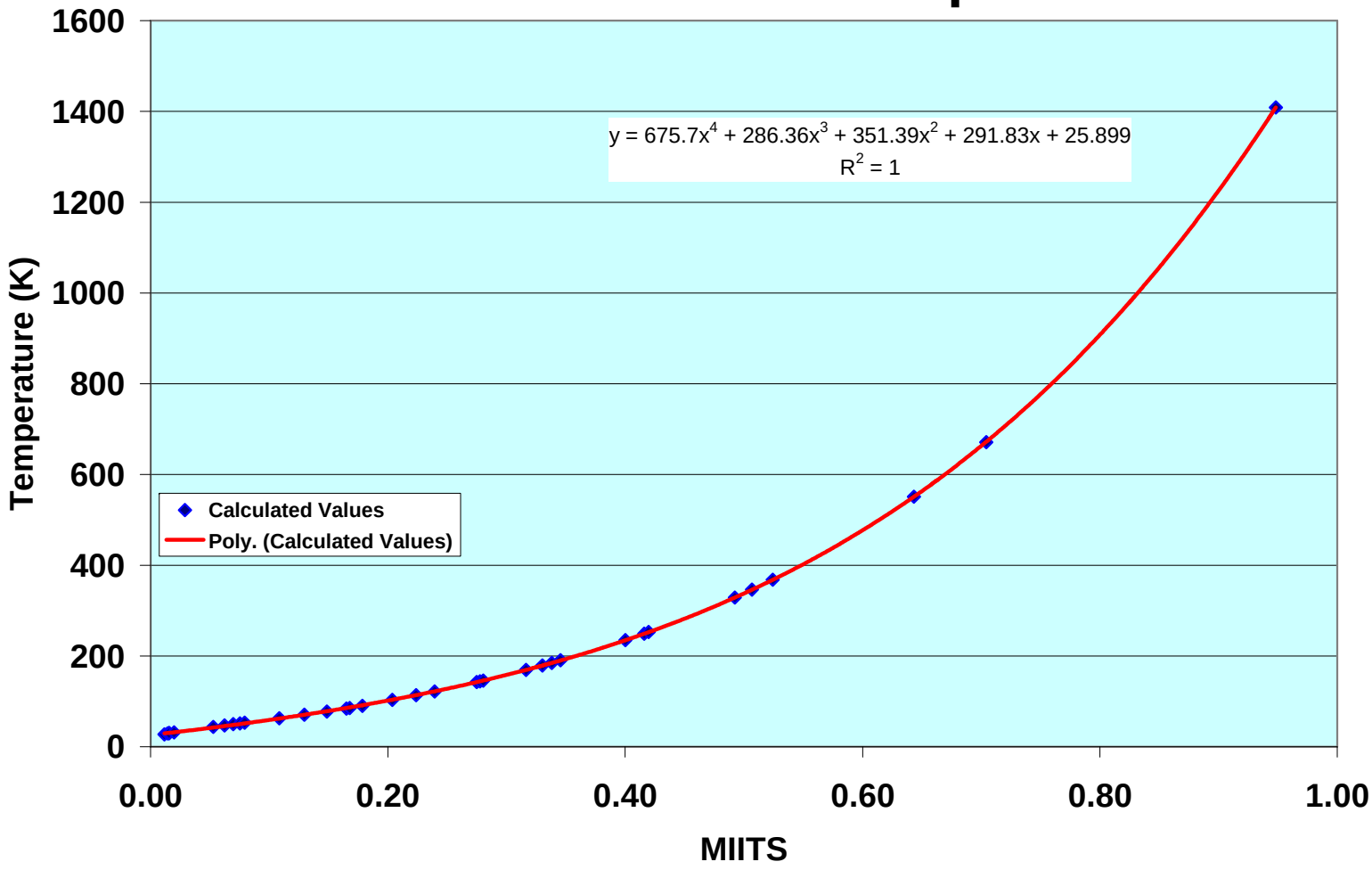
Fringe Field Solenoid: n = 11

Anti-Fringe Field Solenoid: n = TBD

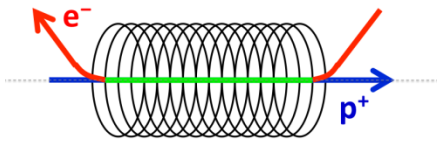
Temperature – MIITS Correlation



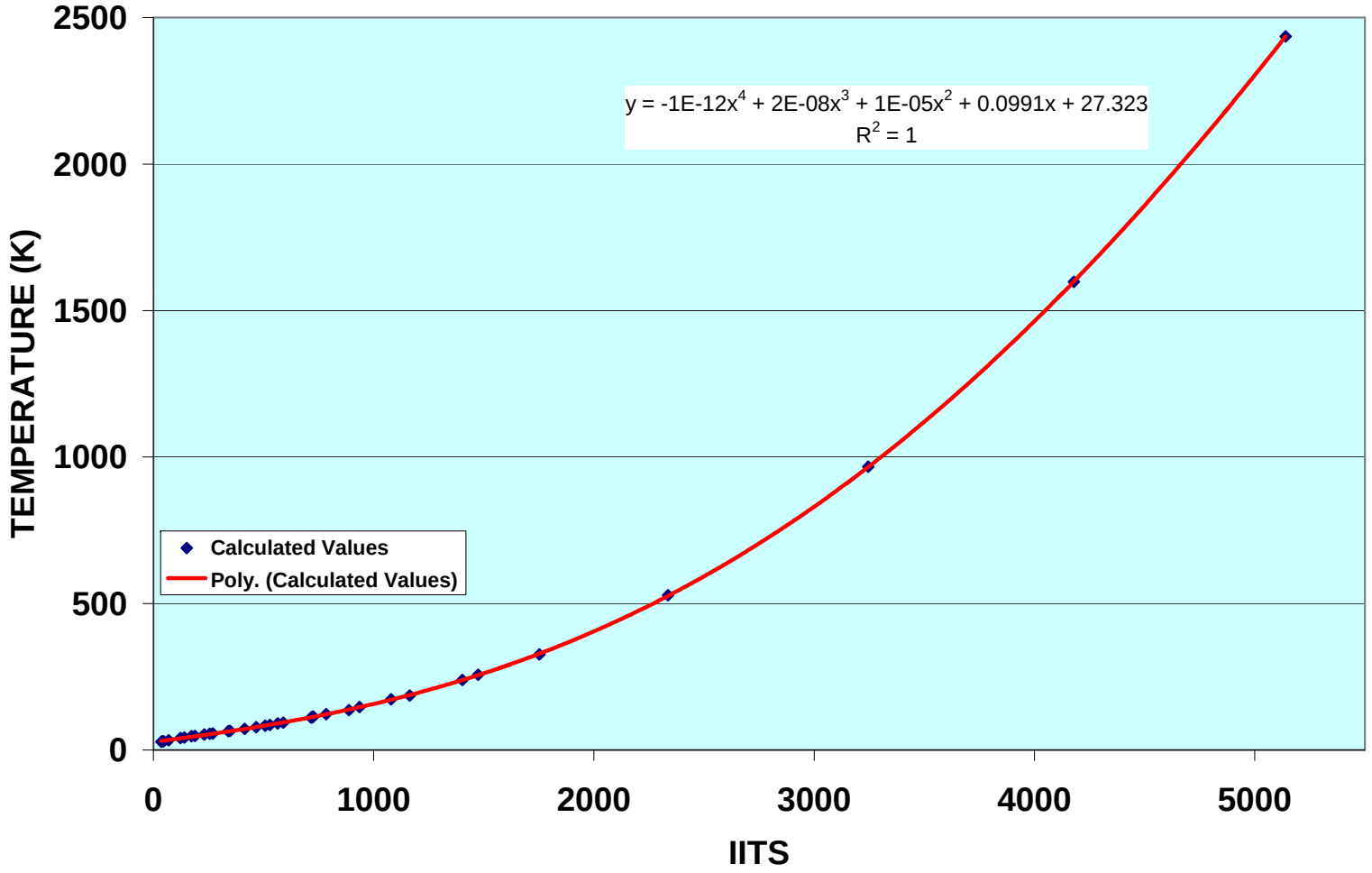
E-Lens Main Solenoid Temp vs MIITS



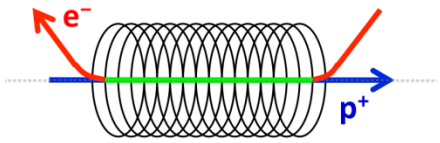
Temperature – MIITS Correlation



E-Lens Fringe Field Solenoid Temp vs IITS

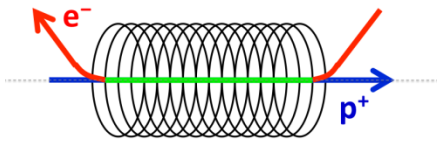


TEST PROCEDURES



- **Vertical testing of cold mass**
- **Electrical checkout at 4.5 K**
  - Coil resistances to ground
  - Voltage tap continuity checks
  - Hipots of coils
  - AC voltage coil measurements
  - Power supply shutoffs (manual QD trips)
- **Main solenoid 5 cycles to 500 A at 5 A/s**
- **Fringe field solenoids to 60 A at 1 A/s**
- **Anti Fringe Field solenoids to -50 A at 1 A/s**
- **Long correctors cycled to ±40 A at 1 A/s**
- **Short correctors cycled to ±30 A at 1 A/s**
- **Simultaneous power cycles of coils**
- **No magnetic field measurements during vertical testing**

TEST PROCEDURES

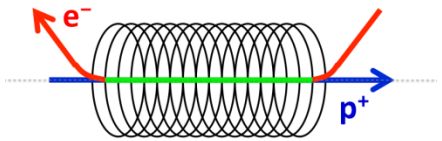


- **Horizontal test of magnet in cryostat**
- **Horizontal testing in liquid helium bath at 4.5 K**
- **Repeat of power cycle tests done in vertical**
- **Magnetic field measurements**

  Vibrating Wire

  Hall probe

SUMMARY



- **15 - 17 independent circuits and power supplies**
- **Vertical testing of cold mass only**
- **Quench voltages limited to ±300 V to ground**
- **Power cycle testing only, no deliberate quenches**
- **No magnetic field measurements during vertical testing**
- **Field measurements (vibrating wire and Hall probe) during horizontal testing**