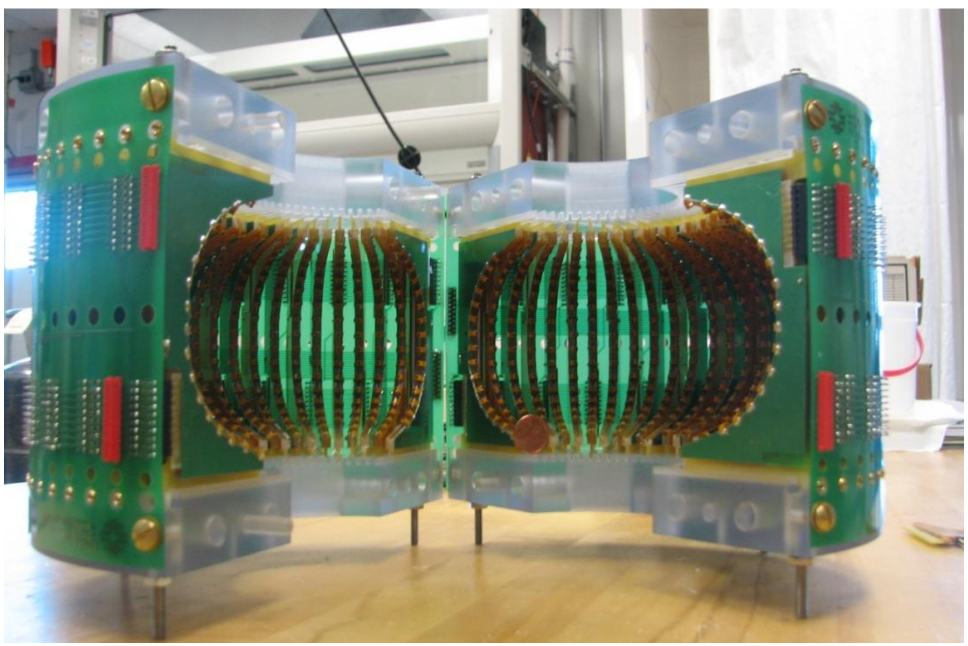
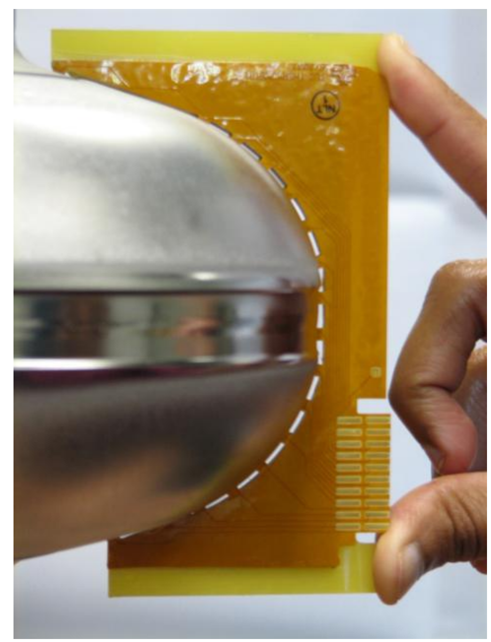
# Temperature Mapping

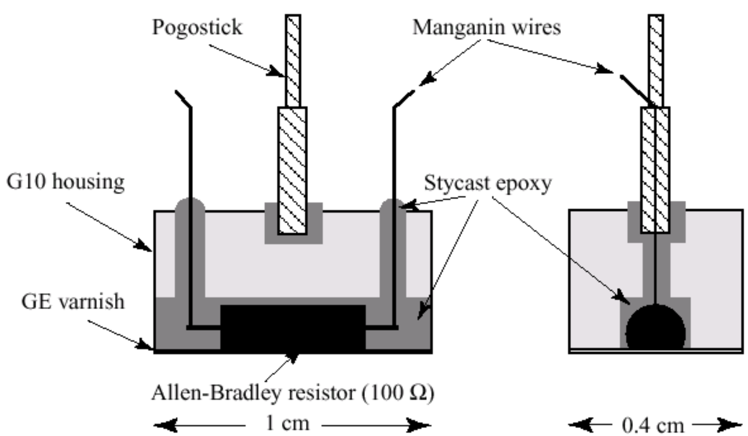
- Present Status
  - Construction
  - Calibration
  - Results
- Future plans
  - 4-way split of "shell"
  - Better sensor boards
  - Improved readout





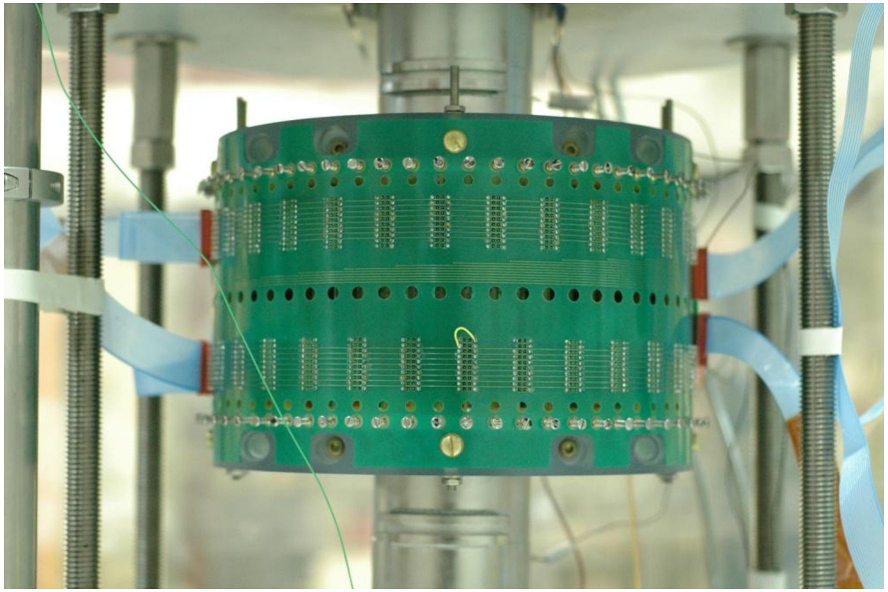
# Why not duplicate existing system?

- Goal was a 9-cell system
- Cabling for even a single cell is quite massive
- Turning resistors into sensor assembly is labor intensive




# Diodes

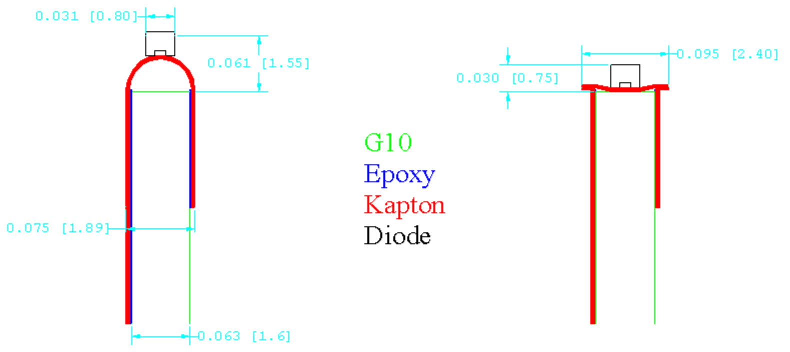
- Diodes multiplex. Read $32 \times 30 = 960$ sensors
  using
  $32+30 = 62$ lines

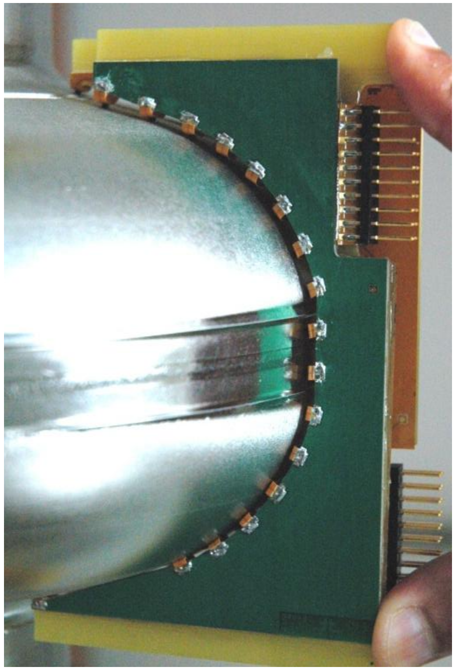


- Problems with diodes acceptable here
  - Calibration shifts with each thermal cycle
    *Only need $\Delta T$ due to RF power*
  - Noisy
    *Don't need precision for quench detection*
    *Long average for small temperature shift*

# Flex Board

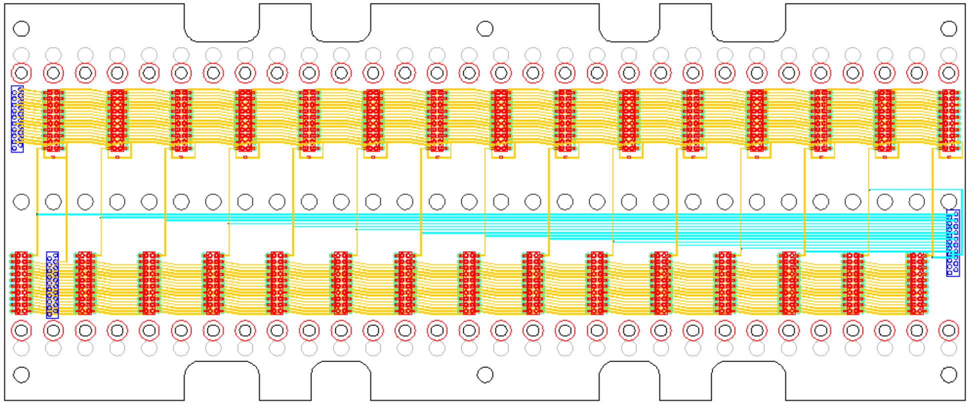
- Use Kapton loop as both the spring and the electrical connection
- Diodes mounted with flex board flat … allows standard assembly techniques

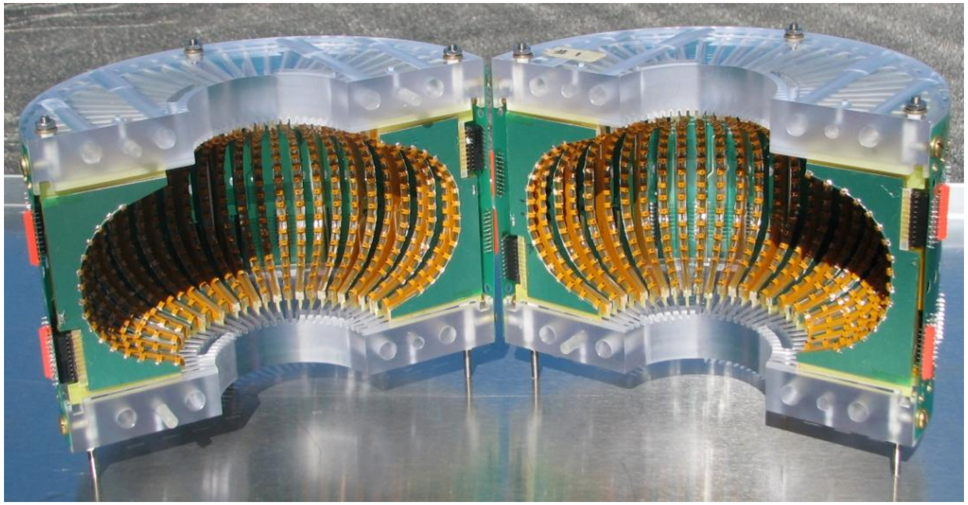


# Pre-assembled "Shell"

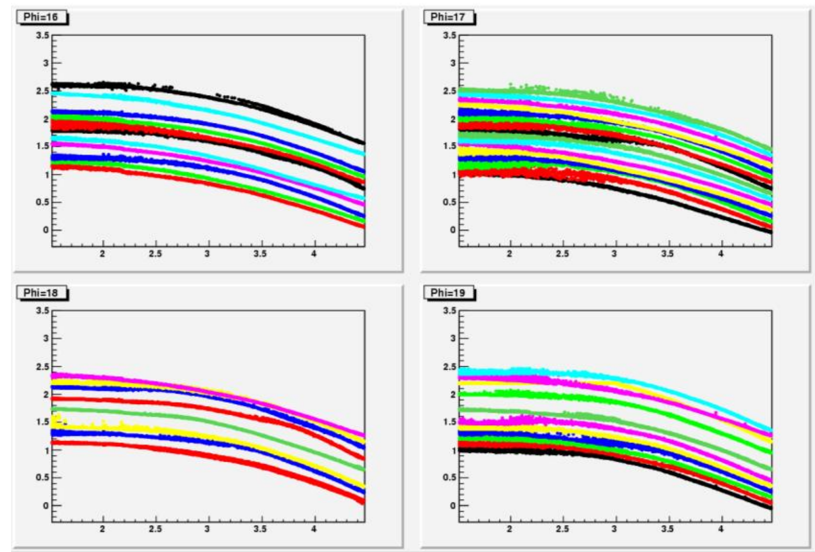
- Backplane to do most of the connections
- Flexible enough to wrap onto top and bottom plate
- Assembly:
  - Bolt halves together
  - Plug in four cables
- Takes ~15 minutes

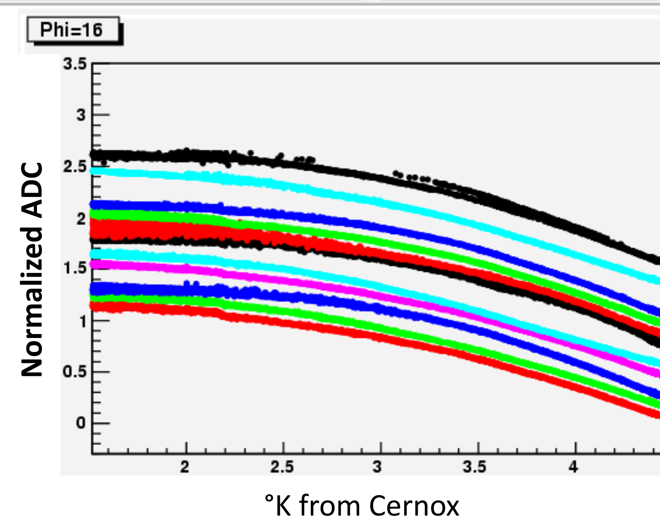




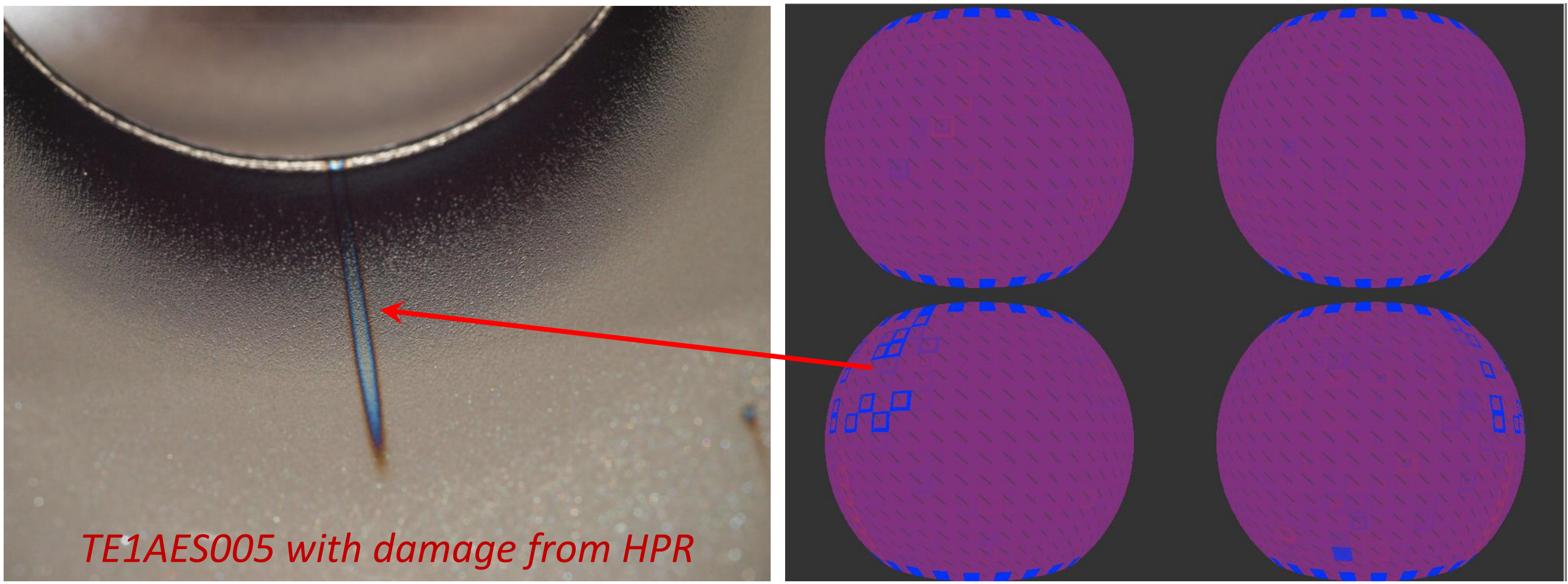
# Calibration

- Can calibrate all sensors at each cool-down
- Sensitivity near 2°K not great
  - Excitation current chosen for best $\sigma_V/\Delta V$ for 2°K $\rightarrow$ 4°K
  - Scan excitation current for better sensitivity near 2°K



# Results




- Works well for locating quench

  - *Blue is "hot"*
  - *Top and bottom is sensors missing as part of design*
  - *Too many dead sensors!*

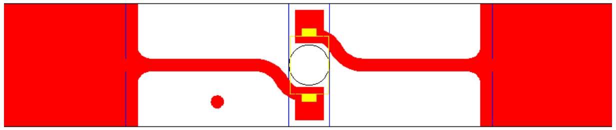
# New Shell for “1-of-9” tests

- Split into 4 (to fit in cage)
  - Can’t just cut these in half. Needs more longitudinal support
- Needed for 9-cell, but also good for single cell
  - Expect will have similar supports to mount single-cell in the future
  - Lot of damage on sensors at end boards from sliding over cavity
- Plates are too thick to fit between cells
- Need to go thinner 1″ $\rightarrow$ ½″ (or less)
- End cells are special … needs a different cage
- **Need a designer to work on this**

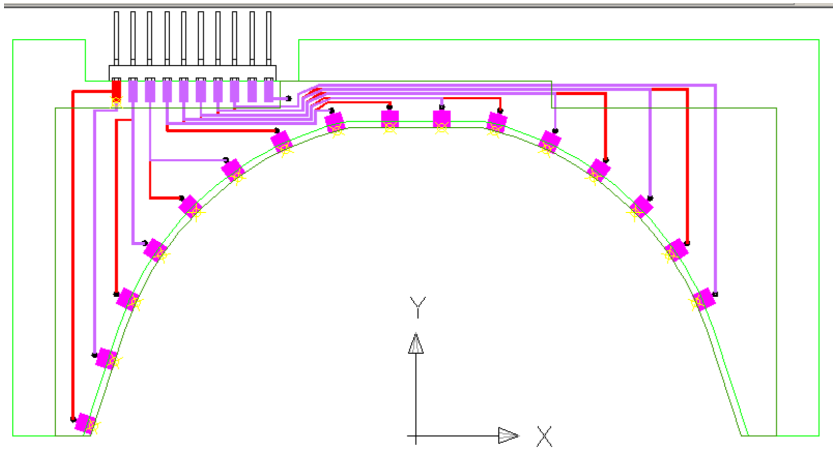
# New Sensor Boards

- Problems with existing boards:
  - Too much labor laminating boards
  - Solder connections to base (G10) board difficult to do, and breaks easily
  - Many diodes themselves break
  - Impossible to replace single diodes

- Use single-diode "board"

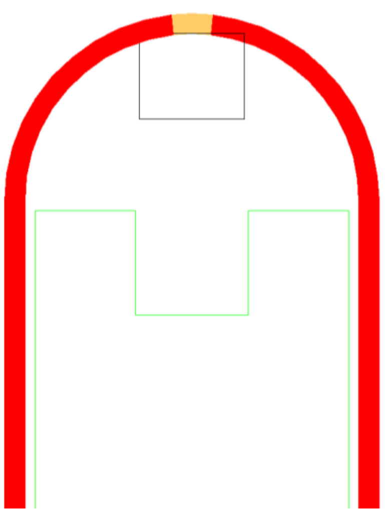


mounted on a G10 base



# New Sensor Boards

- Pad moved to make solder connections reliable
- Can replace single diodes



- Move diode away from cavity to avoid excess stress
- Also improves thermal contact to silicon (closer to “bottom” of package)
- Status:
  - Boards designed
  - Flex boards loaded with diodes
  - G10 boards should arrive this week

# Readout

- Original design had a number of problems
  - Did not allow for sensor failures … a single shorted sensor could (and did) ruin the board
  - Not well designed for prototyping … hard to modify
- Currently using a hand-wired system
  - Single analog low-pass filter
  - Short integration (~10$\mu$s) to avoid “remembering” past measurements
  - 10-bit ADC
- ~3Hz readout, fairly noisy, cannot cover 2°K$\rightarrow$4°K for all sensors

# Readout

- Analog front-end a separate, small (1″×1″) board
- 32 analog channels
- Active reset on integrator
- Can do 30Hz readout with ~1ms integration

- Status
  - Analog front-end board and parts ordered
    - Should be arriving this week
    - Expect first boards ready to test early next week
  - Need to design “mother board”
  - Will start with commercial MCU board for testing