Continuous temperature mapping for superconducting cavities

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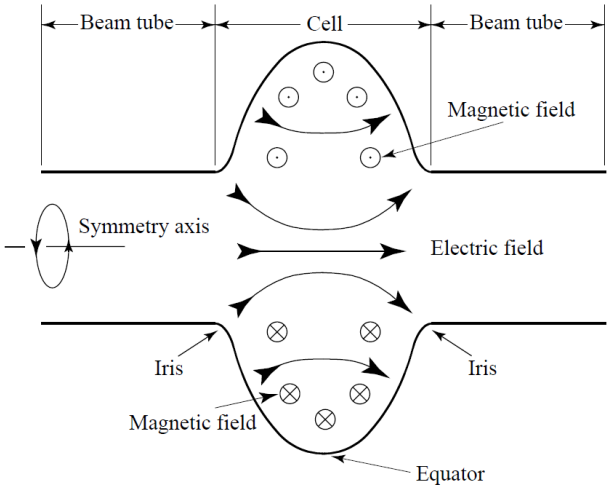
Acknowledgment: Pilipenko R., Sergatskov D.

Superconducting cavities

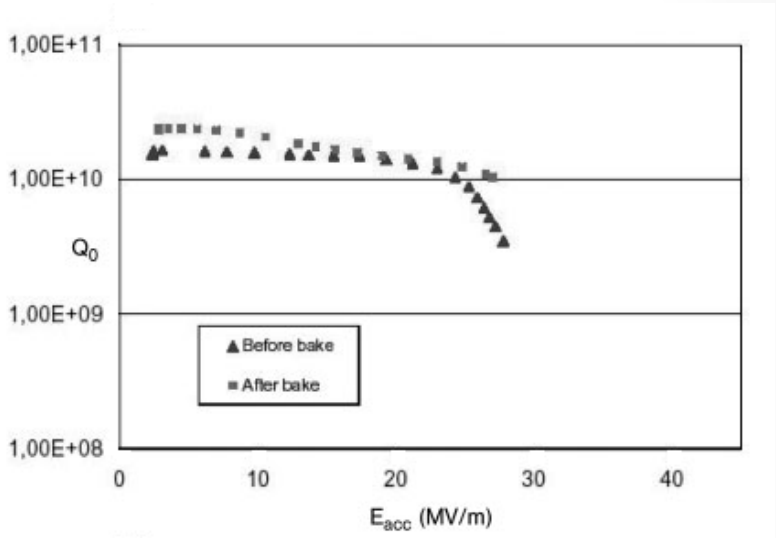
- Resonating cavity is a basic element of an accelerator
- Superconducting cavity is the next technological step
- One of the cavity main characteristics is the surface RF losses
- Losses may cause excessive heat dissipation and quench phenomena



1.3 GHz Single cell Nb cavity

Quench

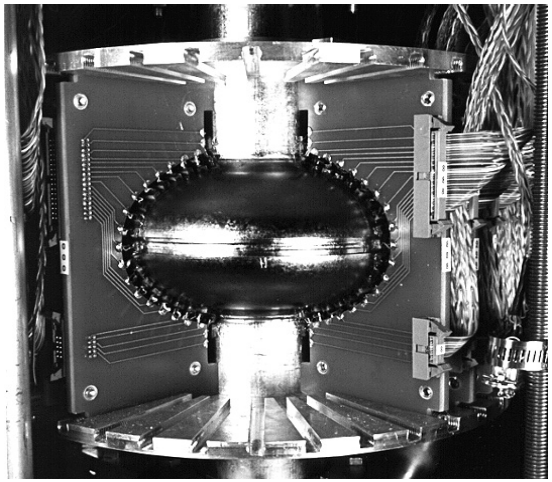
- Increasing the electrical field may cause thermal breakdown = quench
- Quench is a local phenomenon
- Quench is mainly caused by surface defects or impurities
- Breakdown is a quick process (order of several 10 ms), cavity recovers from the quench promptly

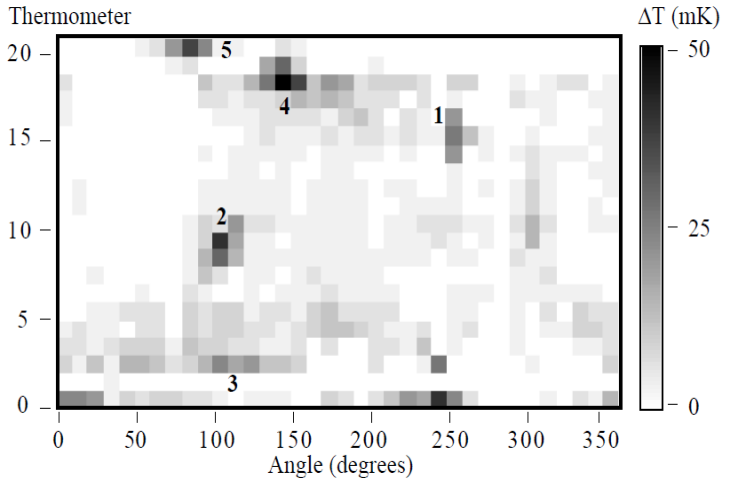


The cavity RF losses may be described by Q-factor vs accelerating gradient curve

T-map technique

- 36 PCBs, each with 16 carbon resistor thermometers
- 2 SCXI crates, 9 modules in each, acquire data from PCBs
- The data acquisition is driven by LabVIEW program
- T-maps are measured discretely (it takes about 150ms to get T-map)





Idea of continuous T-map

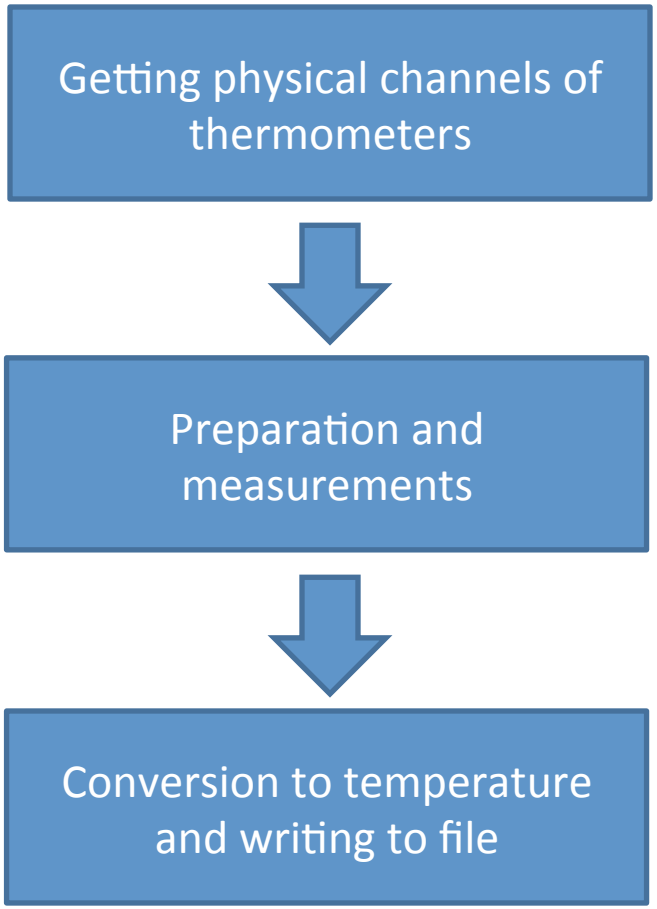
- Quench is a local phenomenon
- Quench happens quicker than we measure the whole T-map

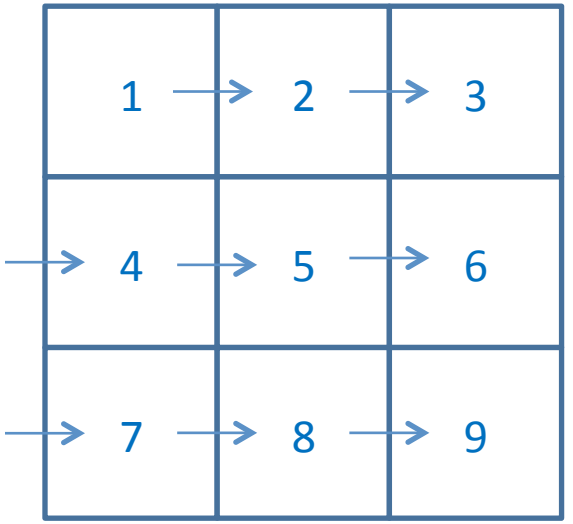
- Why don't we measure small part of the whole T-map as fast as hardware allows?

- Highest sampling rate of SCXI modules we use is 15 kSmpl/s

- It takes 66 µs to acquire data from a single thermometer

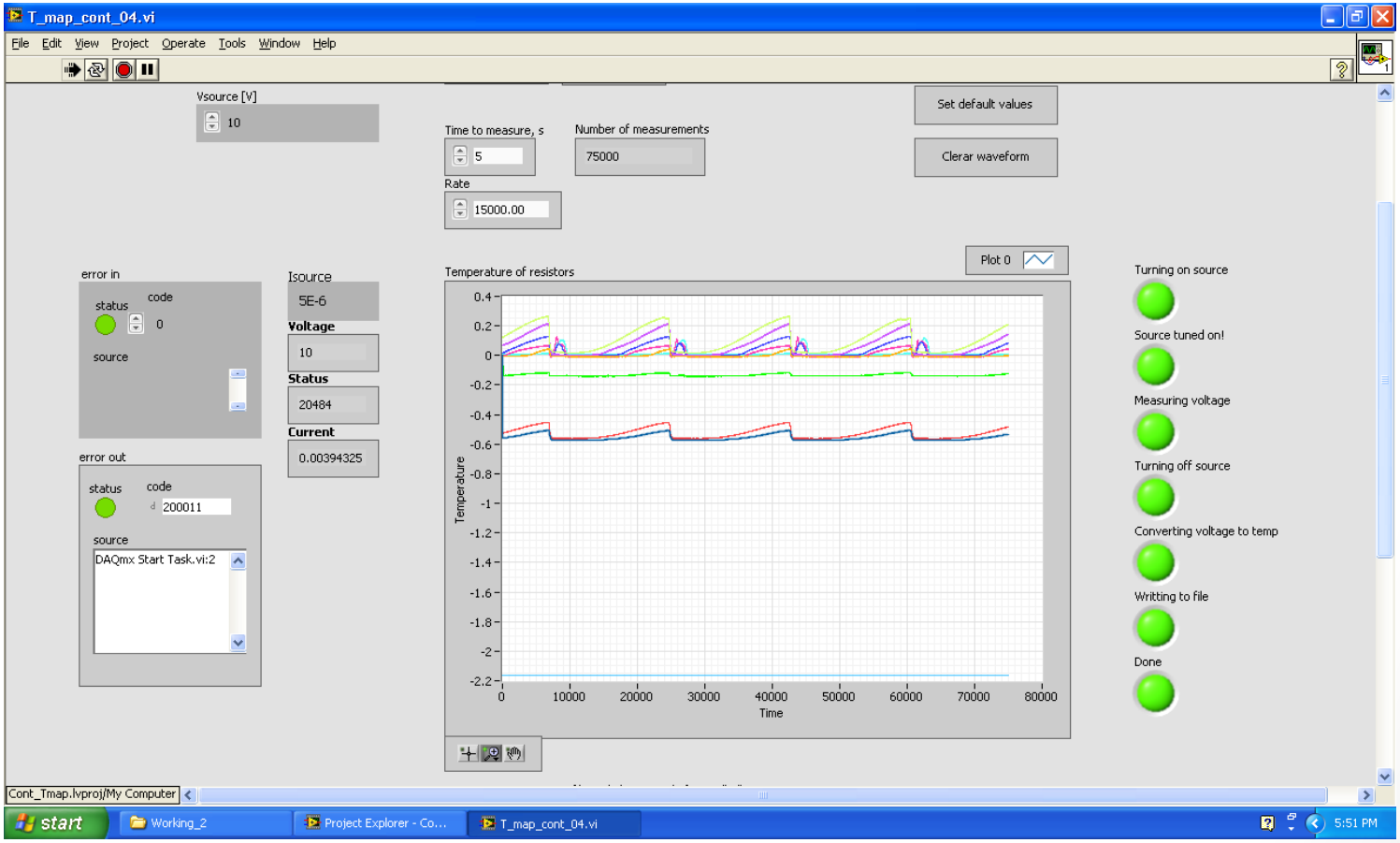
Architecture of the program



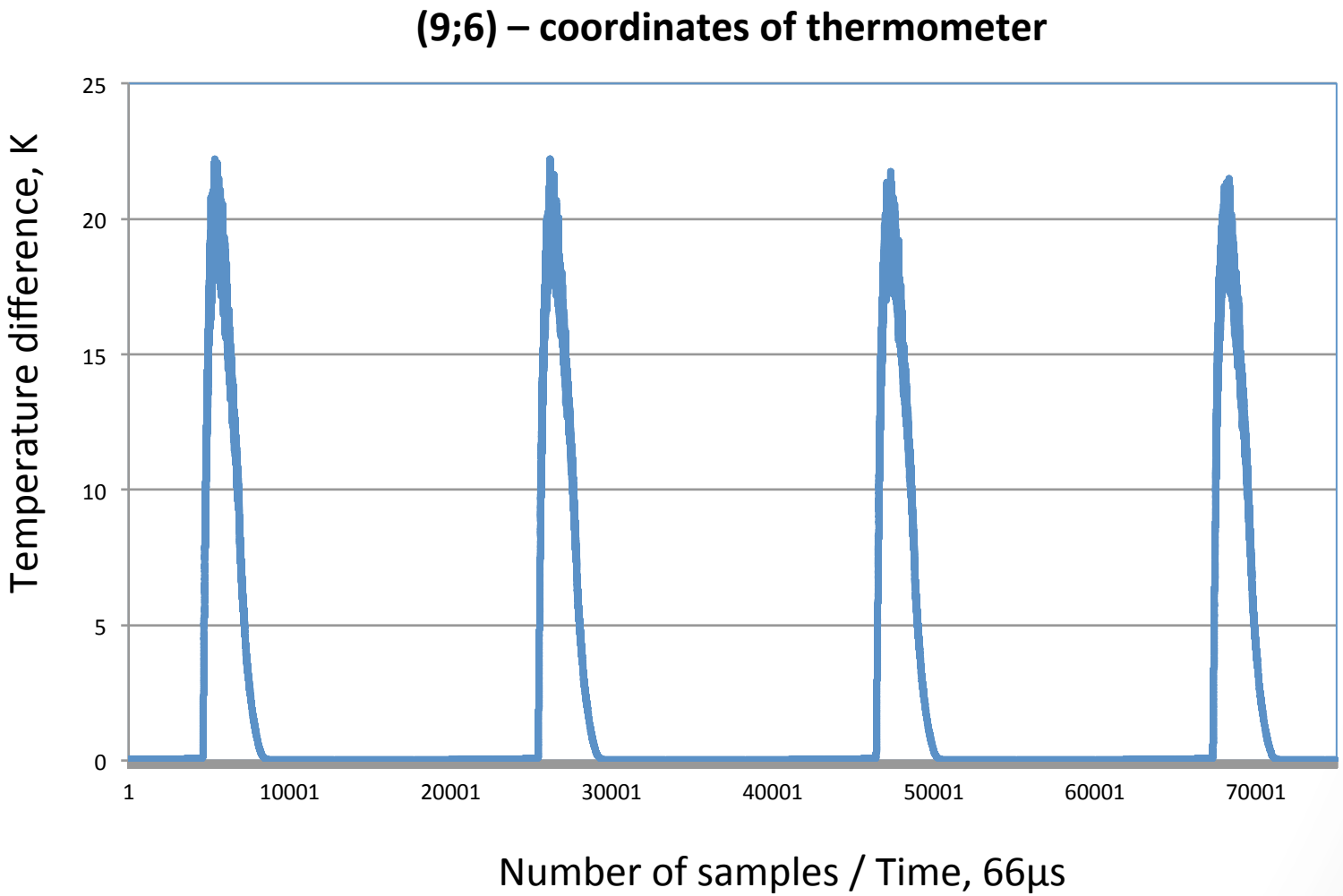


Implementation on LabVIEW

- Program is written on LabVIEW 2011
- DAQmx drivers for PXI modules were used



Experimental results



Analysis

- Places of quench found by original T-map are also found by continuous T-map technique
- Highest temperature measured is about 20K – 30K
- Typical time for quench to occur – 50ms – 70ms
- Typical time the system recovers – 150ms – 250ms
- Typical time between quenches – 1s – 1,5s

Results and perspectives

- New technique of continuous T-map was developed
- Unique data of quench dynamic are already obtained

- Various data processing may be carried out
- The quench dynamic and origin are to be studied
- Better synchronization may be realized in the program
- Better hardware (SCXI crates and modules) can provide higher sampling rate

Thank you for attention!

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