High Flux Isotope Reactor

WAND & NRSF-2 Experiments at 1000C in a 5T Cryomagnet

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The Science Driving the Sample Environment

- **Previous Experiments at the NHFML**
  - Shown a potential shift in the equilibrium phase transformation temperatures in the application of high magnetic fields on Fe-C binary alloys.
  - Challenge arose in that experiments could be performed before & after the application of the high magnetic fields (30T) in which it was inferred that this transformation was taking place.
    - BUT, in-situ measurements using neutron diffraction had not yet been attempted.
    - In order to validate the predictions, a means of achieving 1000C at 5 Tesla on the WAND had to be devised.

An Extreme Request for an Unusual Venture

The Normal Conversation between Scientist & Sample Environment Team:

"We would like to stick a 1000C furnace in your 5T Cryomagnet"

"That doesn't sound too safe, are you sure?"

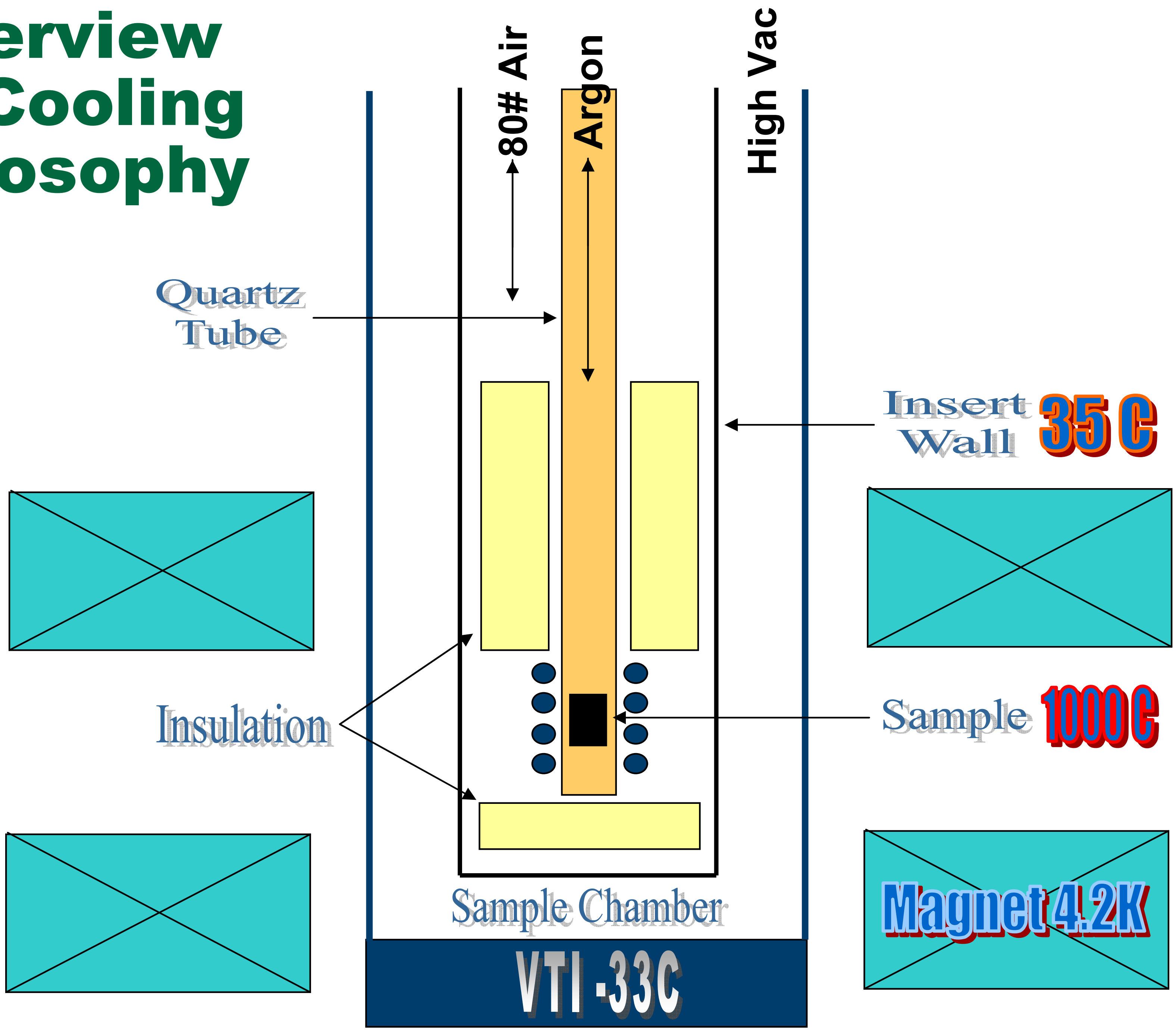
"Of Course It's SAFE! Trust Me"

Challenge:

-Build an insert capable of reaching temperatures of 1000C
-Put that into our OI Spectromag, 5T Vertical Field Magnet
-Run time-resolved experiments at the WAND & NRSF-2

I NEVER DOUBTED

Overview of Cooling Philosophy

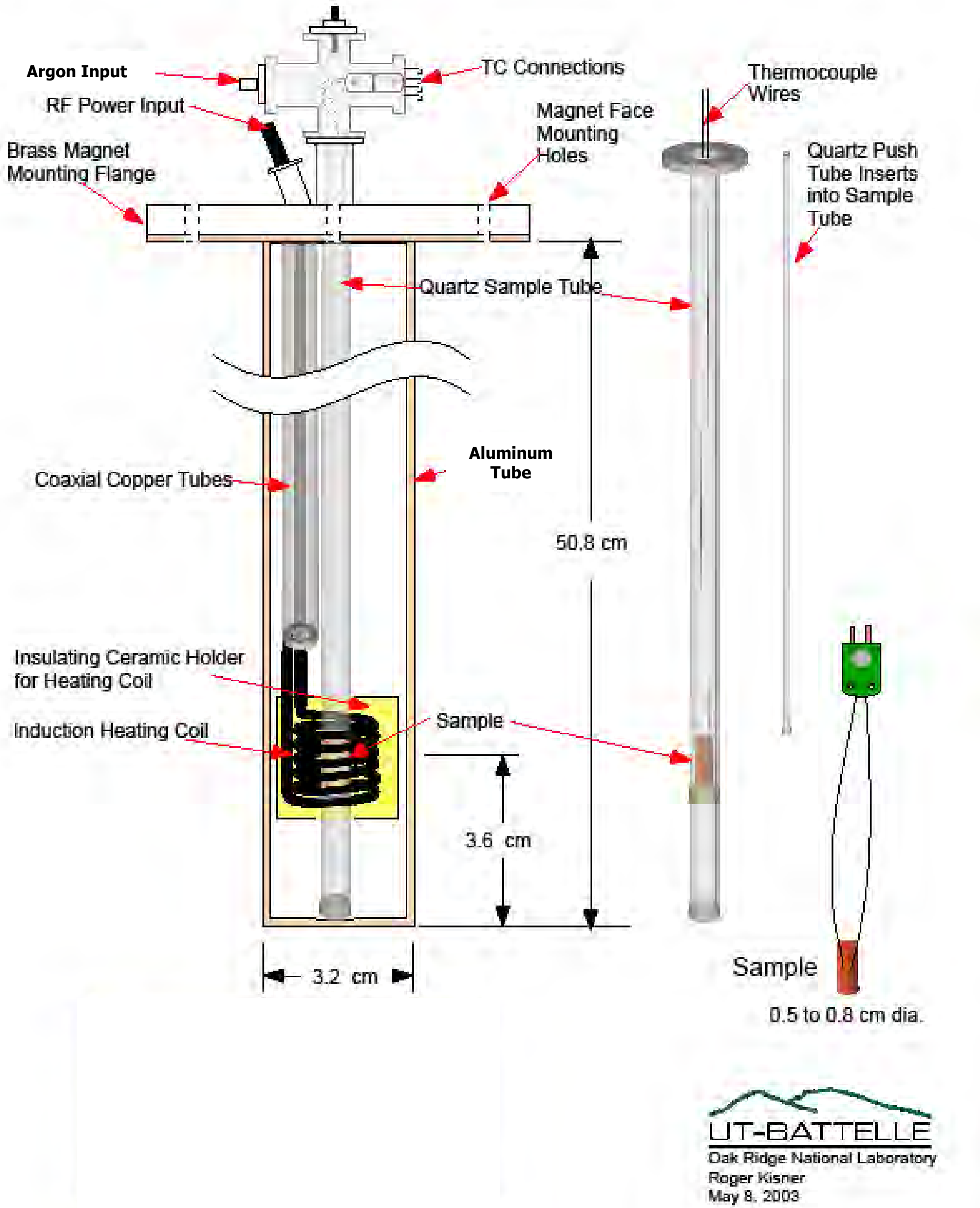


Initial Design Concerns

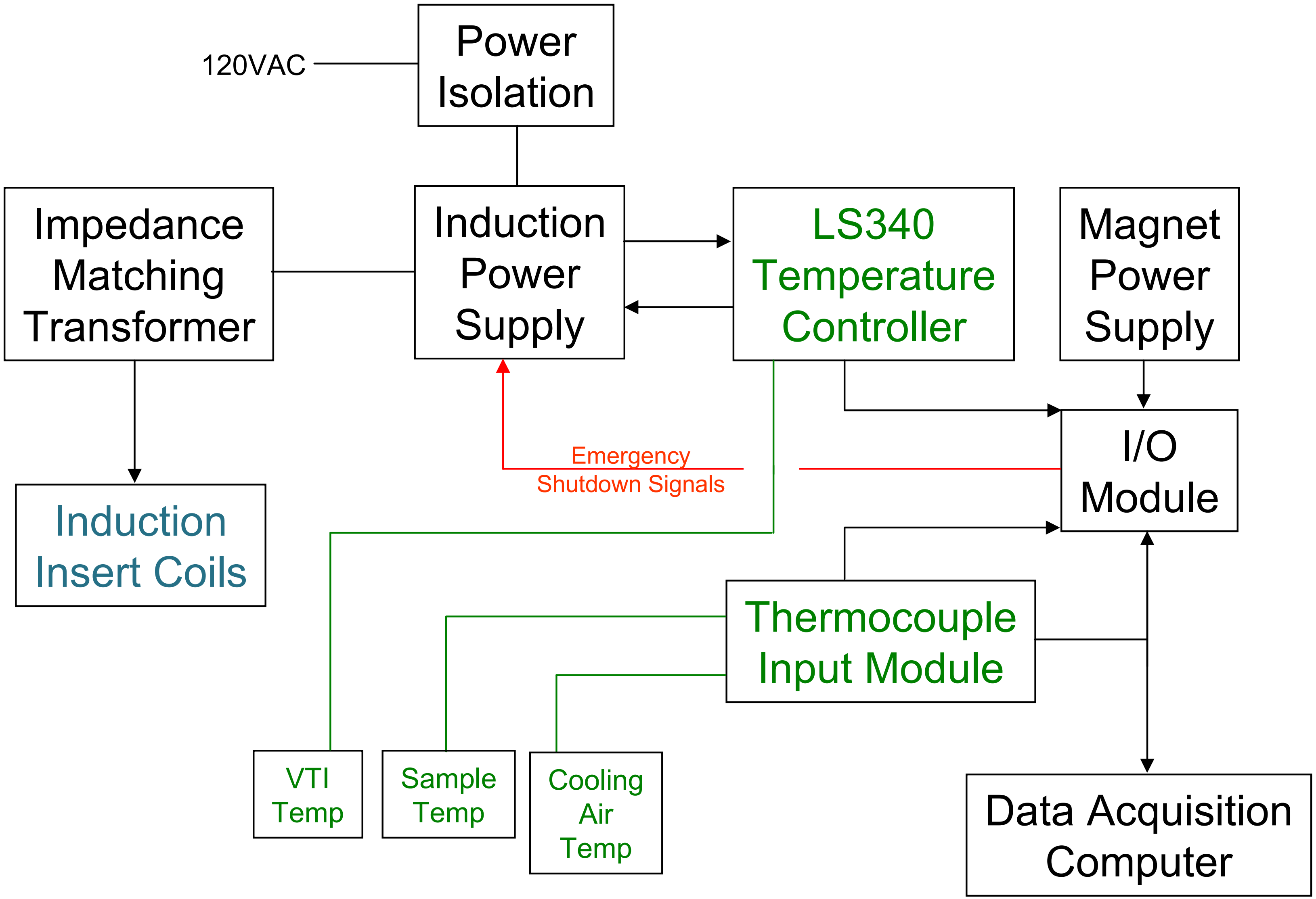
- Bore Size (50mm)– No similar insert had been built that small.
- Insert Height– Vertically limited by overhead interferences in the Beam Room.
- Heat Load on the Cryostat
  - Delta T of at least 1000C over 2 cm.
    - Potential for catastrophic damage was huge.
  - Magnet VTI was a dynamic flow system
    - Needed cooling power, but also needed vacuum

The Design Takes Shape

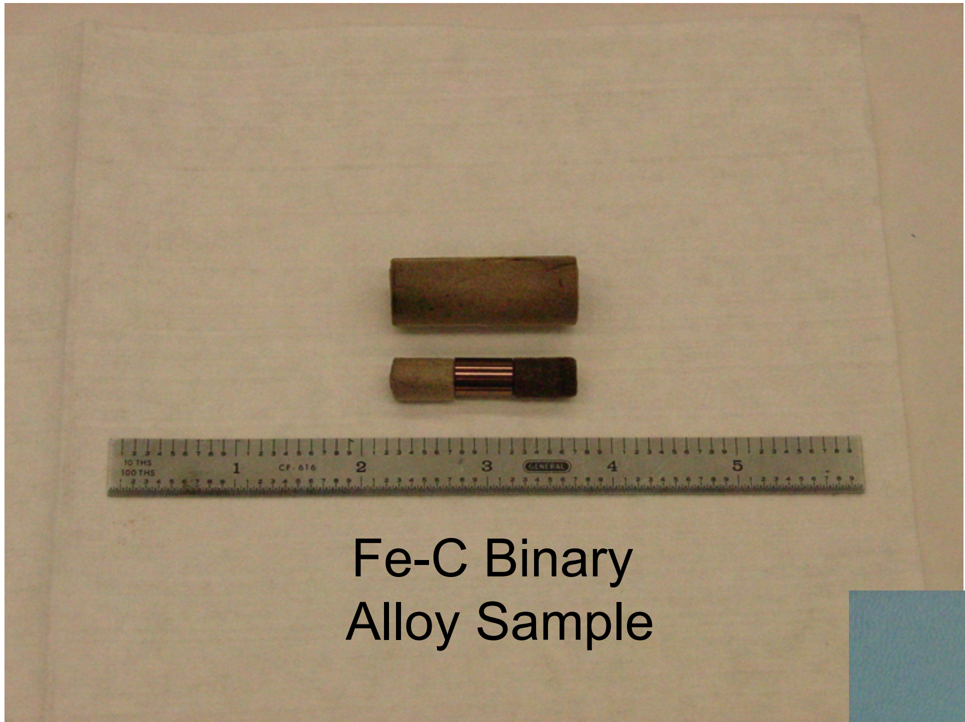
(Note: Some Dimensions are from Early Iterations)

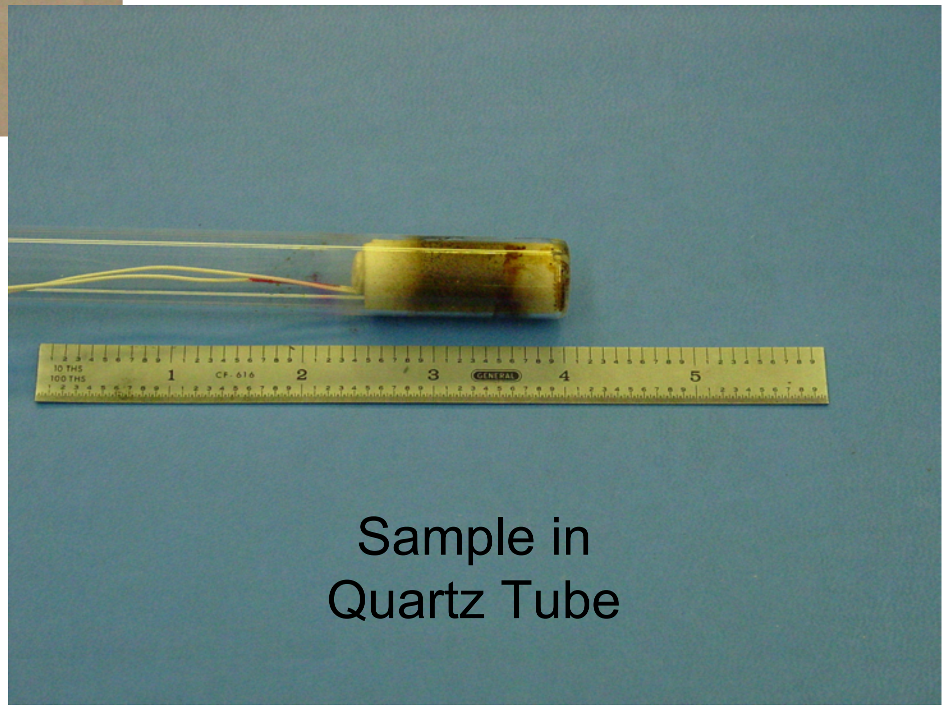


Induction Insert Control Systems

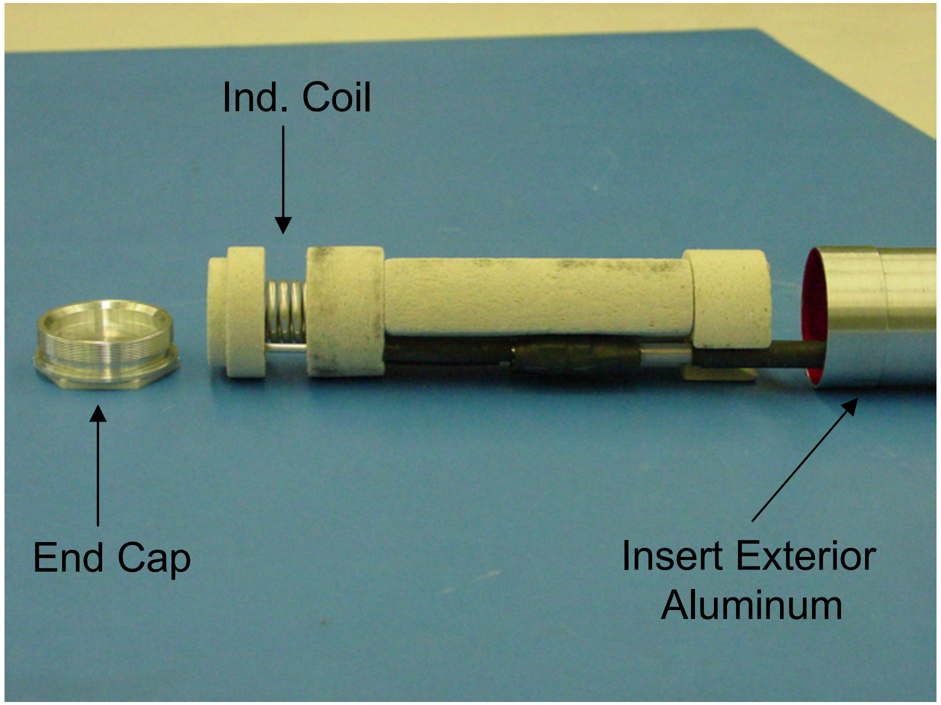


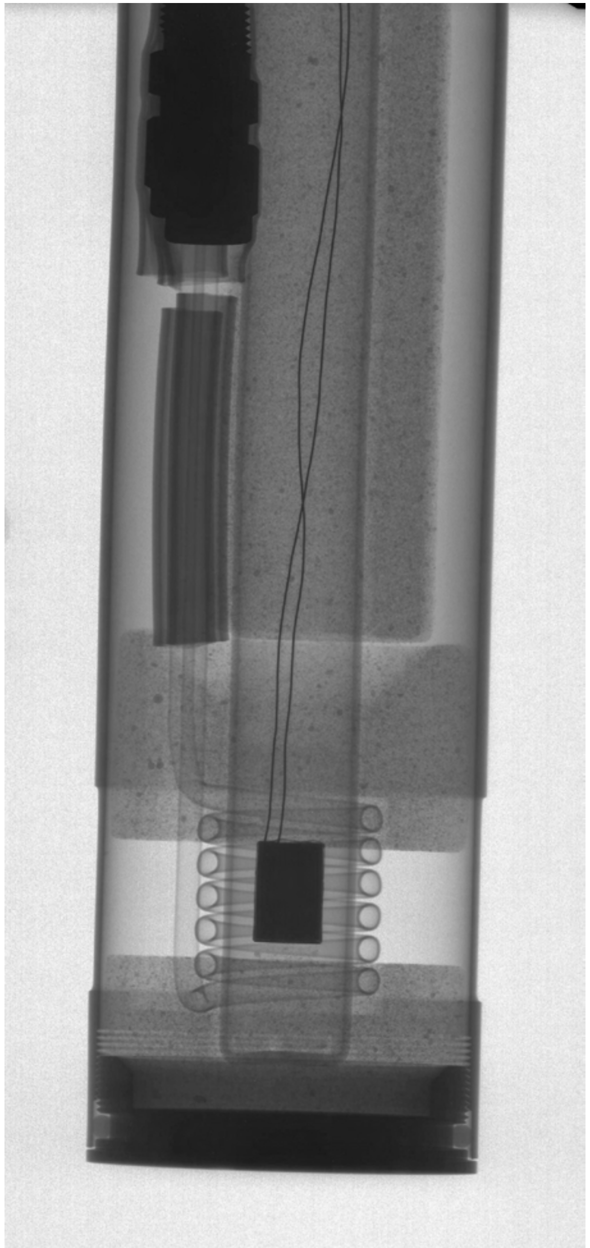
The Sample & Quartz Tube





Induction Insert





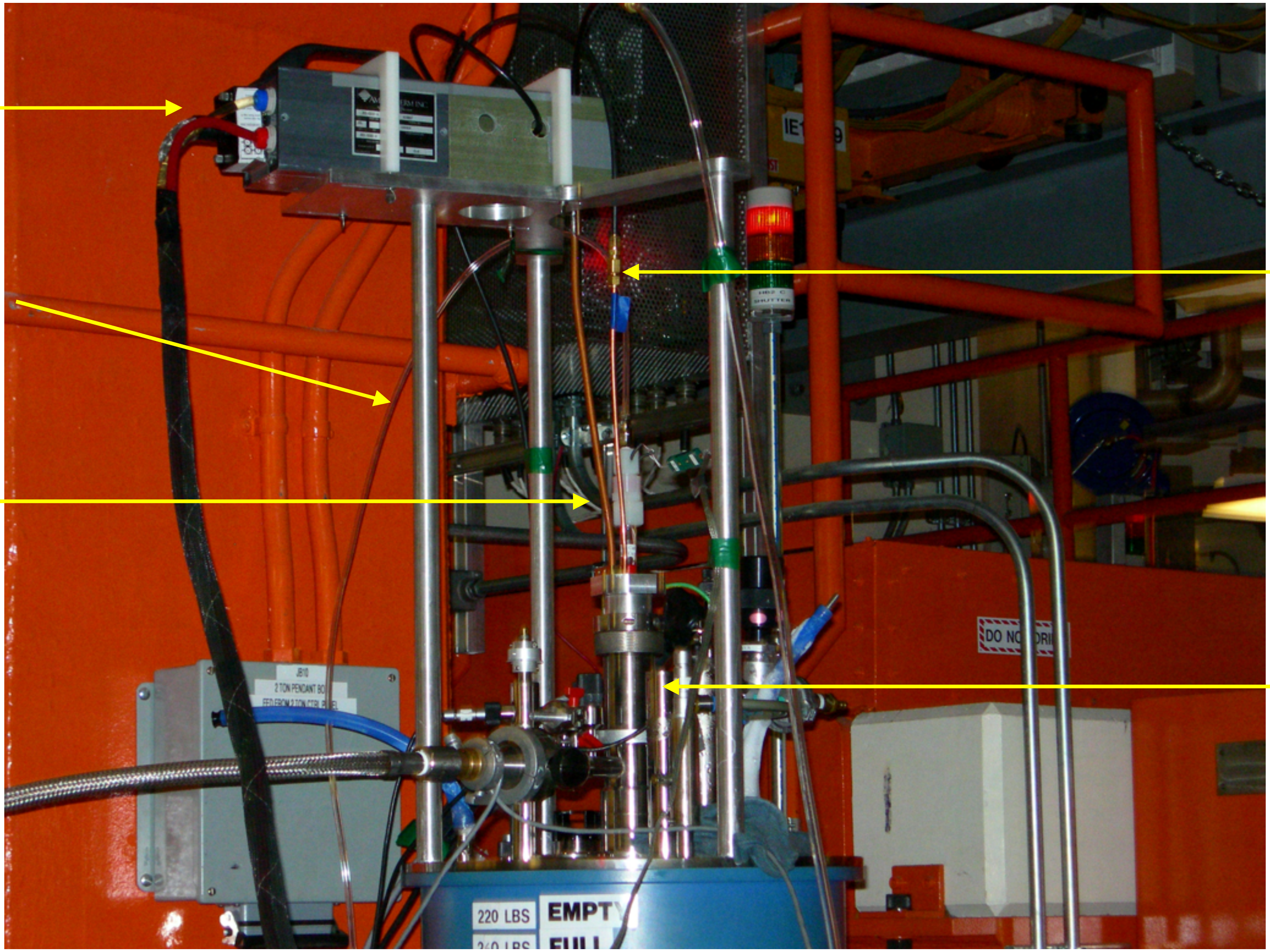
X-Ray of
Induction
Insert

Entire Assembly at the WAND

Transformer (Water Cooled)

Argon Flow Inside Quartz Tube

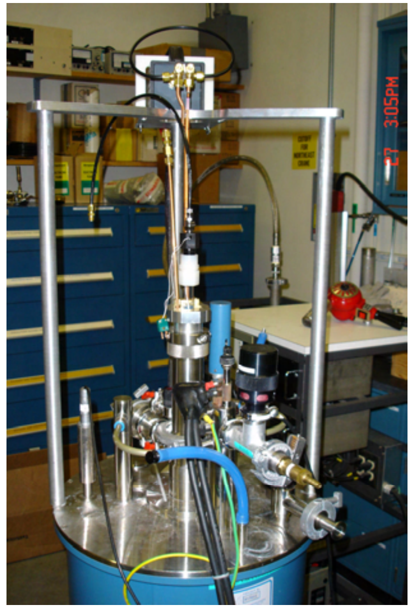
Coaxial Copper Leads to Coil



Air Cooling Inside Insert

Insert

Problems in the Test Phase



- Successfully ran at 5T & 1000C
- 3 Major Issues Discovered

1- We could not keep VTI temperature stable

- Problem was the inability to align the insert so that no touch occurred in the lower sections.
- Solution: Made a controlled touch by attaching a 5-point (Pentagon= 49mm) Macor piece to the lower end of insert.

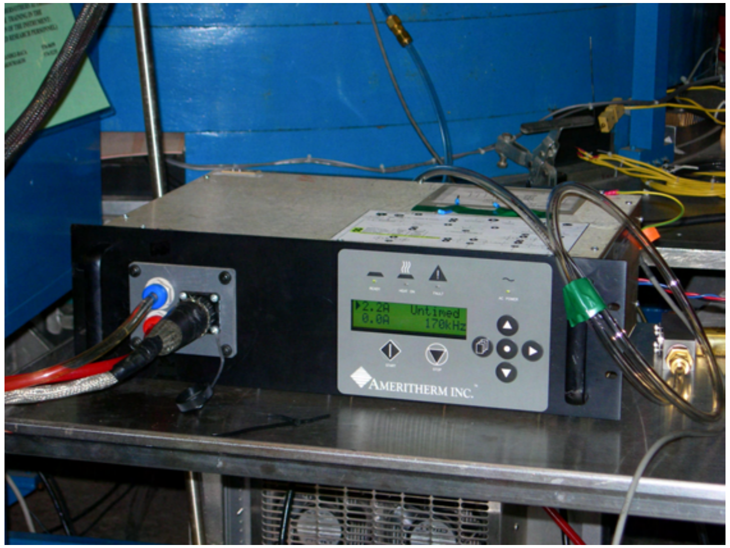
2- Air flow vs. cooling was not a linear issue

- We had to find an optimum pressure, as too much or too little proved to be counter-productive in insert efficiency

3- Could not maintain vacuum in the VTI

- A better end cap had to be designed for HVAC

Finally– Neutrons!
Now the REAL Trouble Begins



EMI Troubles– The incredible interference from the HotShot reeked havoc in the Beam Room:

- Sensors were noted (on the VTI) to offset up to 18K when the Insert was at 25 Amps. Of course, the offset made it look colder!
Example: T_{actual}=258K while $T_{display}$=240K

- Found we couldn't ramp the magnet if the insert was powered on. *Proved to be quite difficult when the scientist not only wanted to do temperature scans, but also magnetic field scans.*

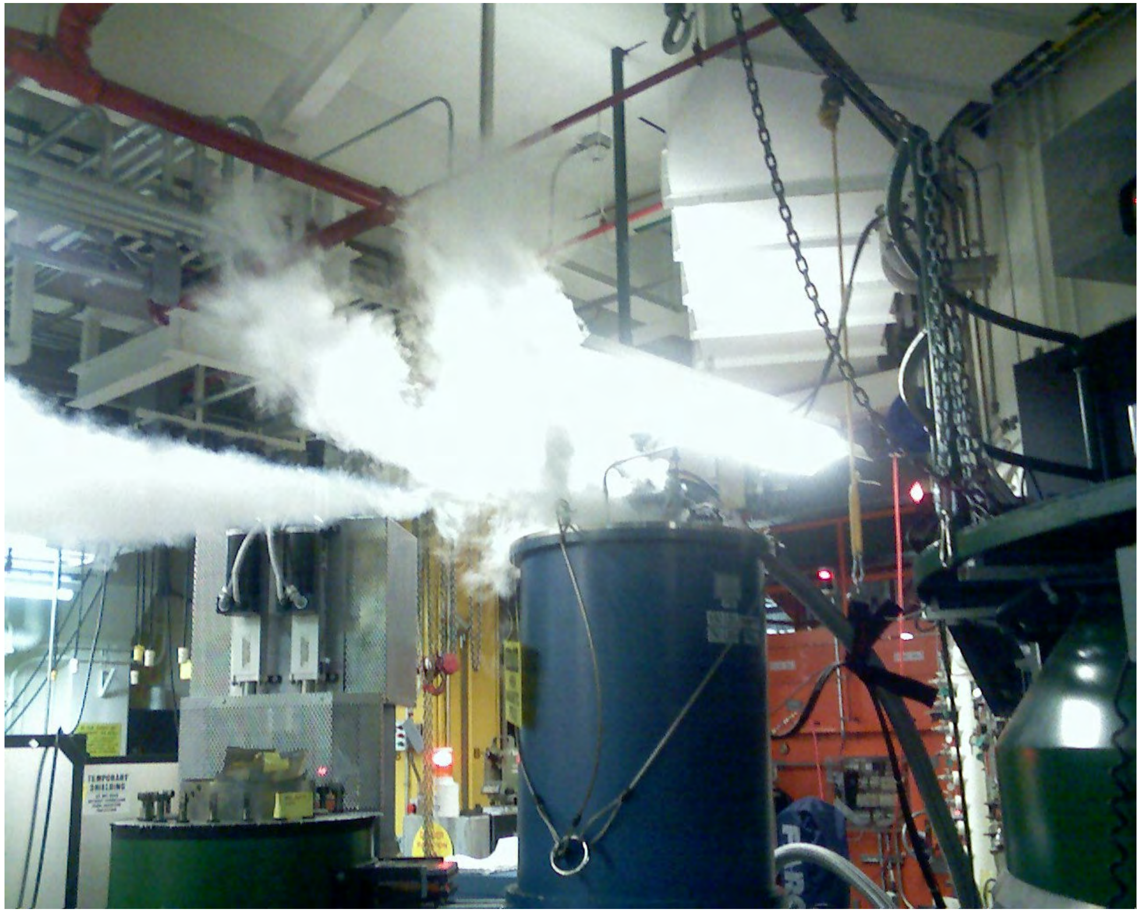
- It also caused multiple 'Virtual Quenches'. *New to us: Magnet stayed at 5T, but the power supply detects & indicates a quench.*

Solutions?

Virtually everything that could be grounded was strapped to building grounds. Ferrite clamps were used by the boxful. Brought power to the HotShot thru a line filter

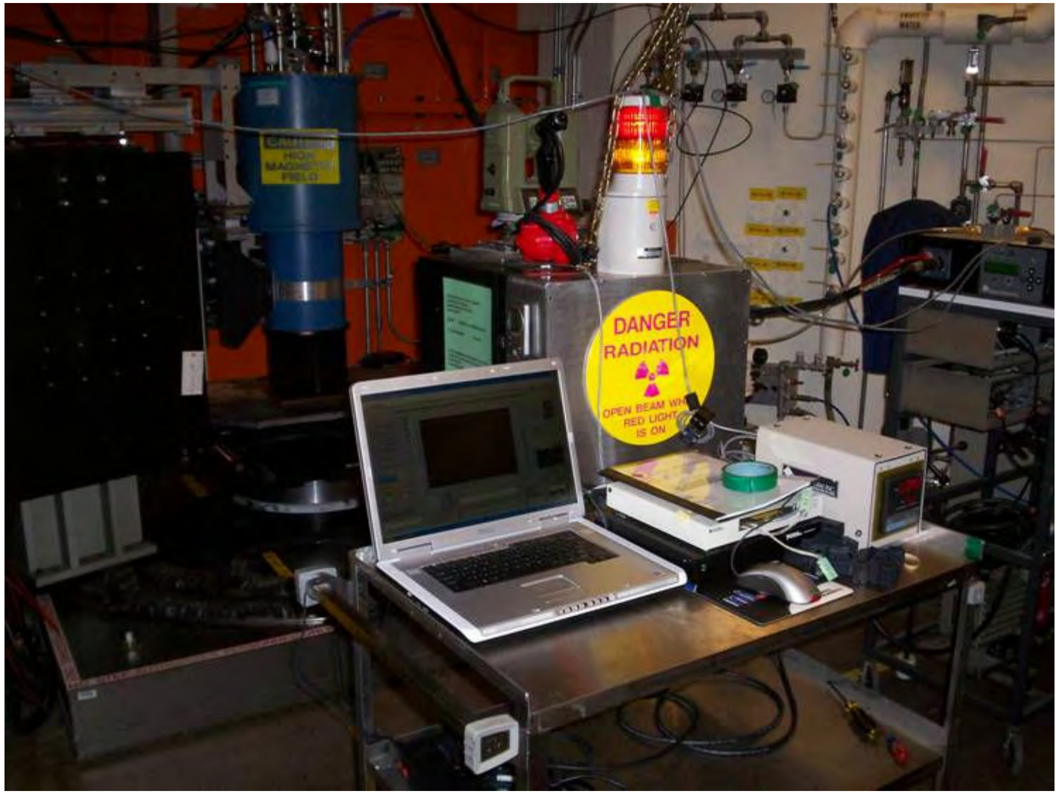
Finally– Neutrons!
Now the REAL Trouble Continues

What would any strange magnetic experience be without at least 1 'real' quench?



SUCCESS!!!

Setup at NRSF-2



Success at the WAND

Run Statistics

- 1000C using >50W Inductive Heating Power
- 5 Tesla Persistent but ramped frequently for sample changes.
- VTI Temperature with sample at 1000C stabilized at ~240K. LHe consumption averaged 2% per hour.
- Typical (T_c) curie temp was around 760C
- Other Trivial Stats
  - Cooling Air= 80psi
  - Argon= 200cc/min at 5psi regulated pressure
  - VTI Vacuum was maintained at 3E-6Torr

Acknowledgments

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    - Jaime Fernandez-Baca

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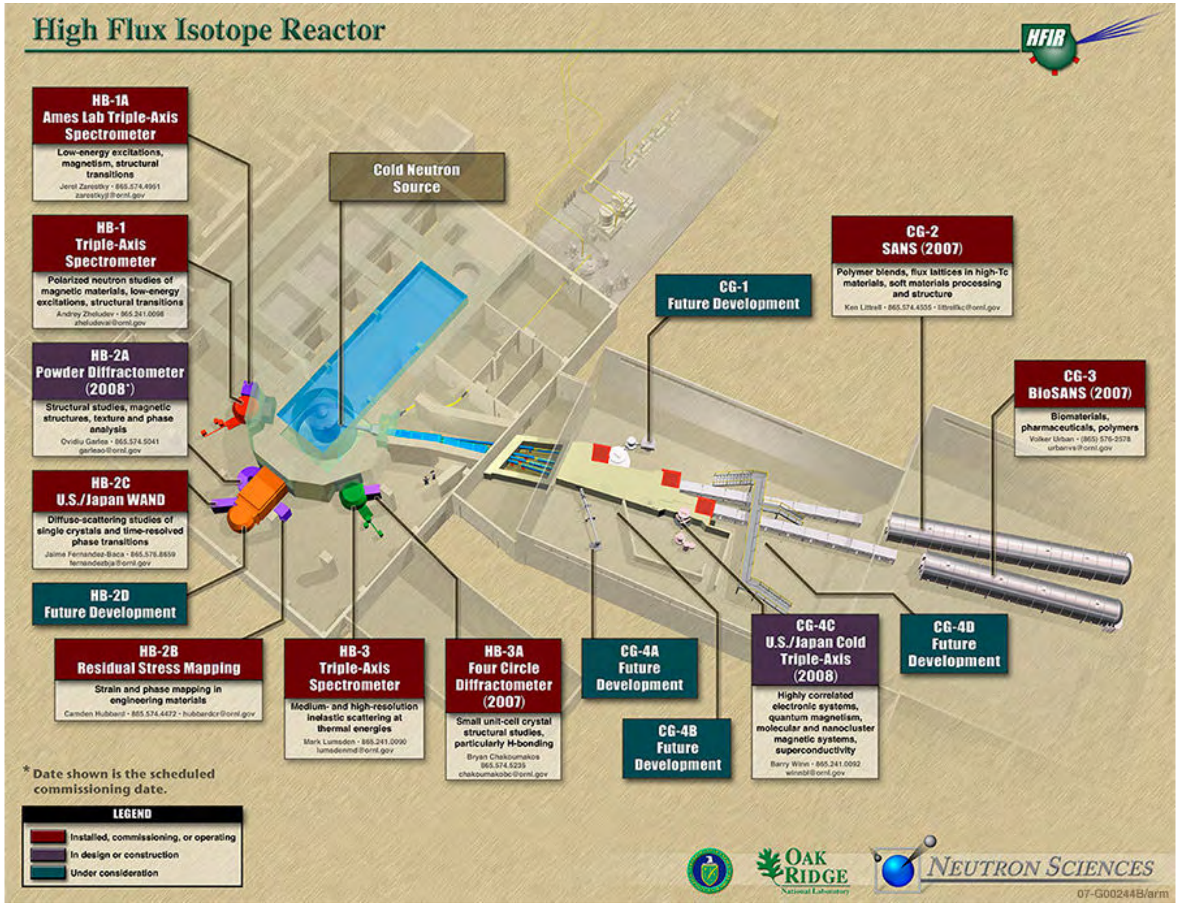
  - David Reass
  - Erik Stringfellow

Any Questions?



Life is Good in the USA!!! Hey Chap?