The RF R&D Program

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Argonne

Muon Collaboration Meeting
Berkeley, Feb.. 12, 05

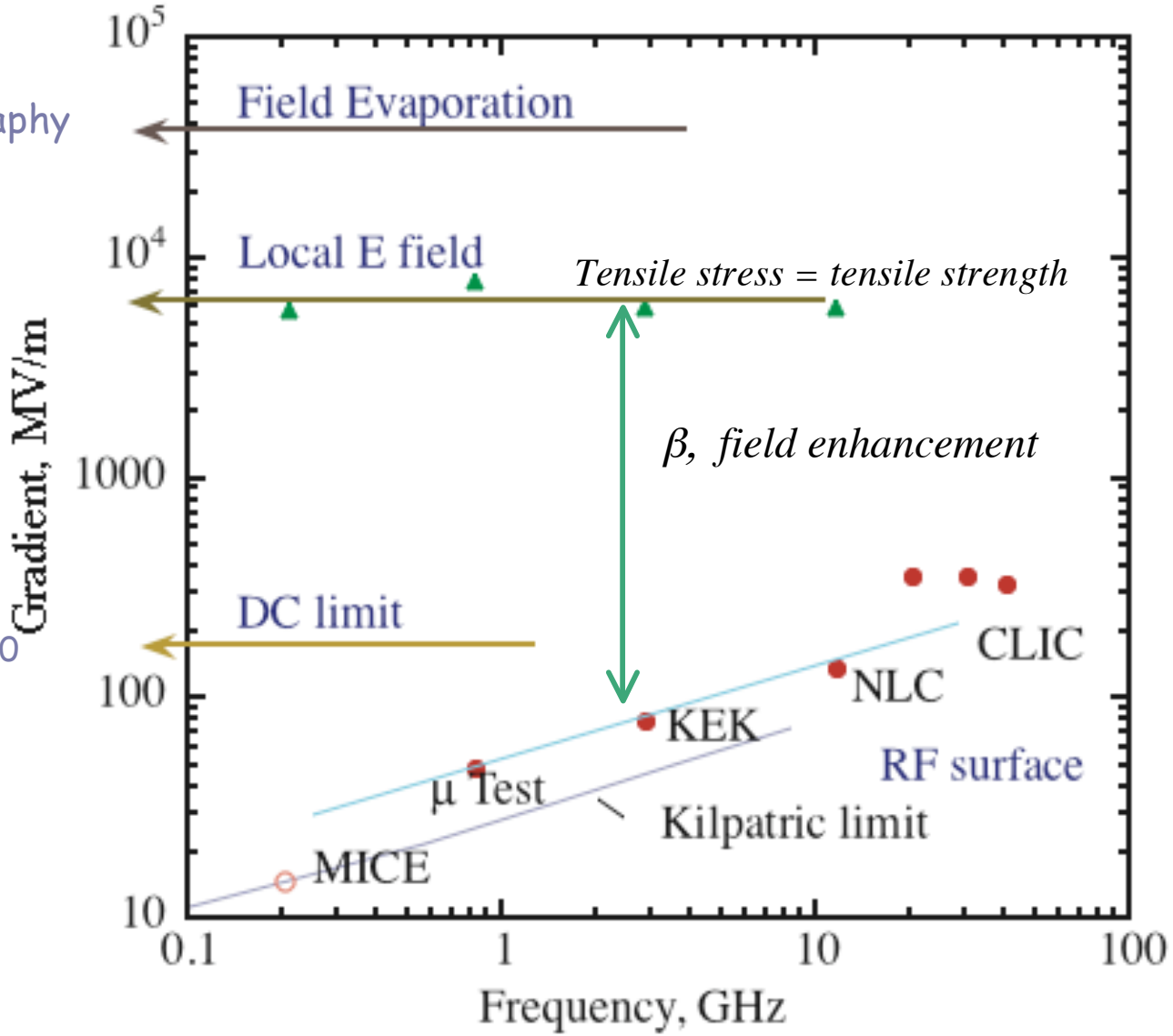
What are we trying to do?

- Physics gives limits.

Atom Probe Tomography

DC breakdown

Millikan/Michelson 1900

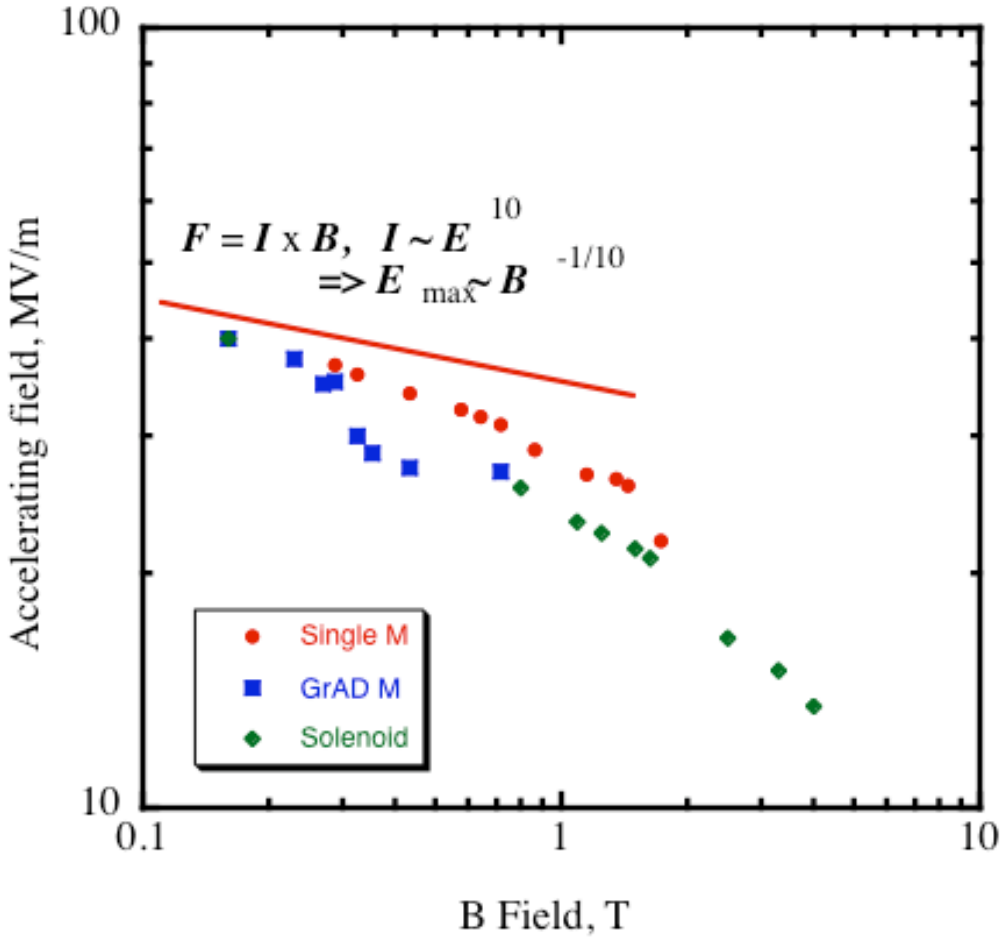


Magnetic field data is consistent with *J* x *B* effects.

- ***j*** x ***B*** forces are sensitive to current density.
- This gives:

$$E_{max} \sim B^{-1/10}$$

- Agreement ~good at low fields.
  Trouble conditioning at high fields.
- Some loose ends.



What have we learned?

- We have the best data on Field Emission in Cavities.
- This data was used to develop a model of breakdown.
- The model is consistent with data from other labs.
- The rf community cannot tell us much more.
- Material Scientists have relevant tools and experience.
- We have formed a collaboration with the Seidman group at NU, who are leaders in the field.

Muon Test Area Experimental Program

- 805 MHz cavity
  - Curved windows (the flat ones were unstable)
  - Button tests of different materials (damage in different materials)
  - Magnetic field studies (we need to operate at 5T)
  - High pressure cavities (high pressures may be good)

- 201 MHz cavity
  - Conditioning and breakdown studies (needed for MICE)
  - Magnetic field studies (Can we reach 16 MV/m?)

- Surface modification and control (Can we do better?)

RF in the MTA: the plan

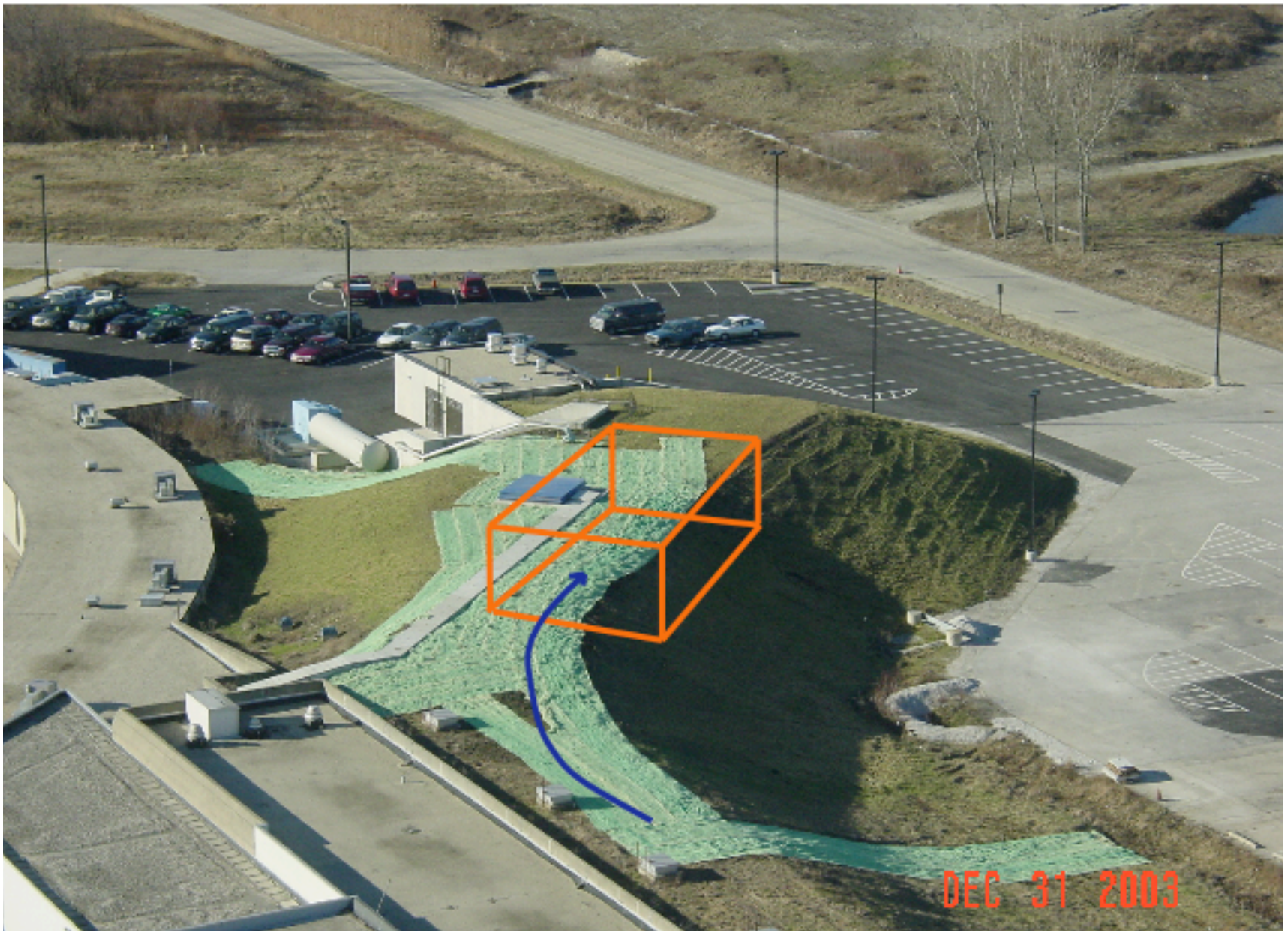
- Document underway (last edit Dec 21, 8 pages so far)
  Drafts are circulating, things change.

- Loose ends:
  Gridded window
  NAI detector
  How close to mount the cavities
  Windows on the 201 MHz vacuum plate
  Quench safety with the 201 MHz cavity
  Do they still make Polaroid Film?
  Status of mounts, windows, controls. etc.
  Interfacing with Muons Inc.
- When Rickard Sandstrom should come

- Final operating priorities

We have a new experimental area at Fermilab

The Muon Test Area (MTA)



The MTA.

Upstream (last year)

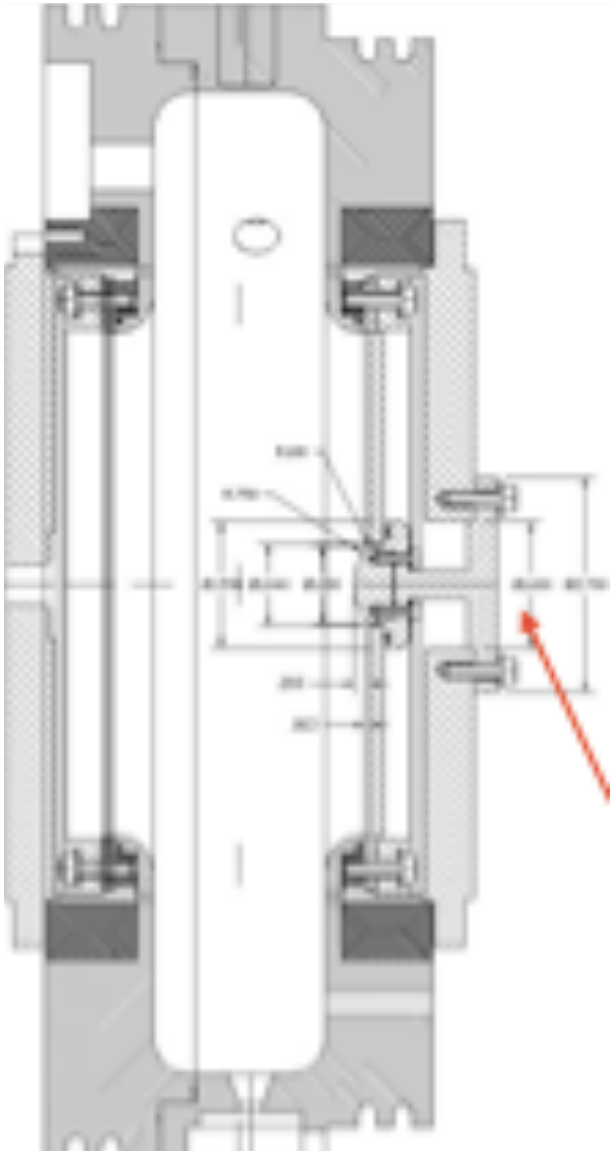
Downstream (last week)

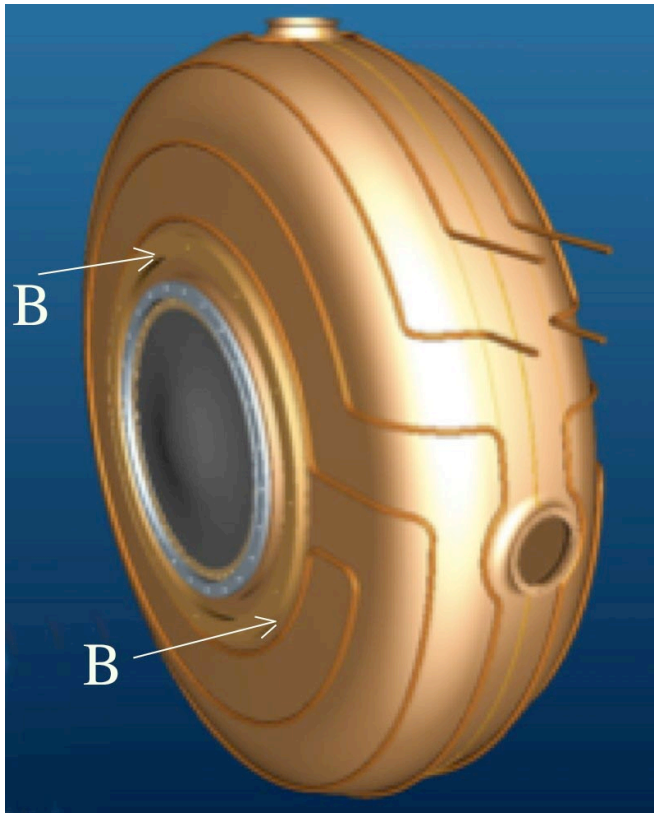
We expect to be taking data in March.

We are moving into the downstream end of the Linac Gallery.

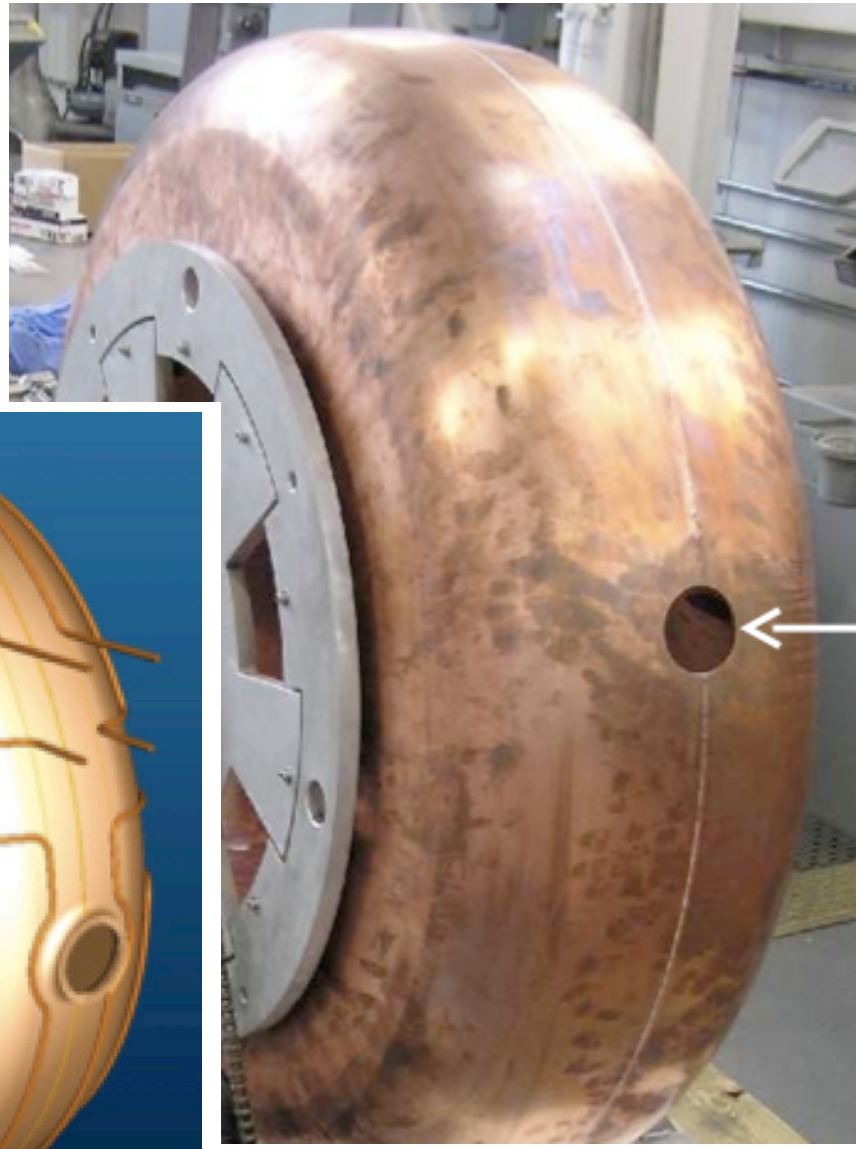
We will be studying two cavities

805 MHz





201 MHz



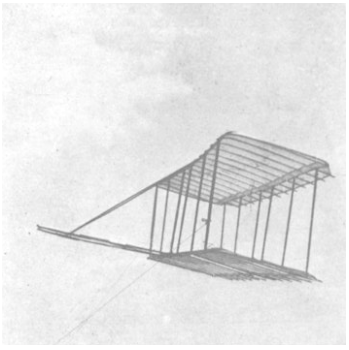
Breakdown studies

- Things haven't changed much since A. A. Michelson and R. A. Millikan.

Millikan

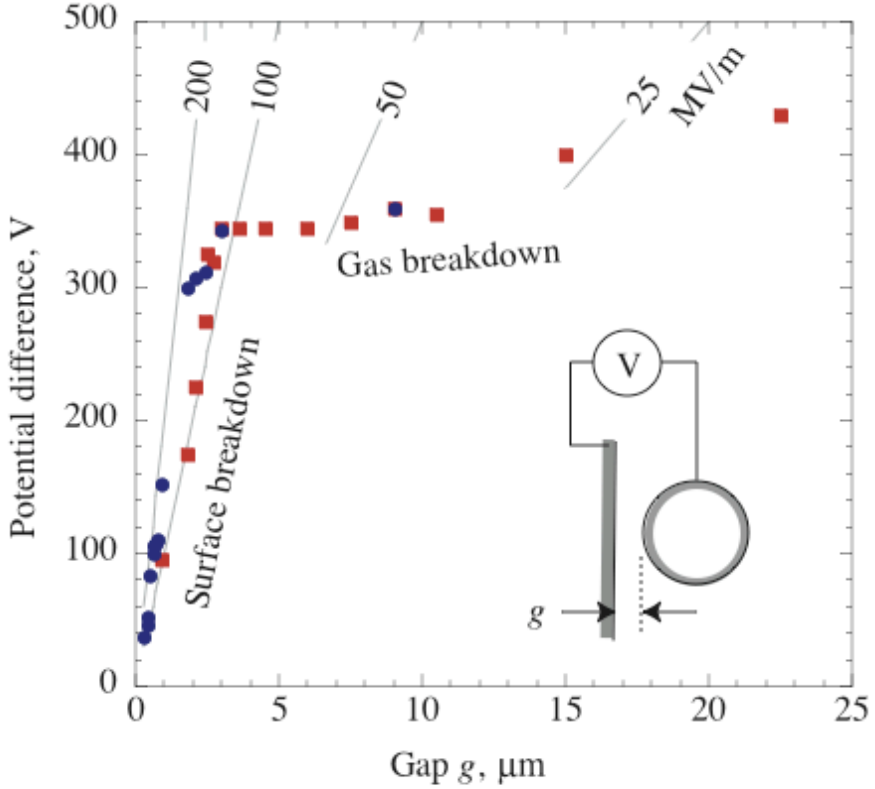
Michelson

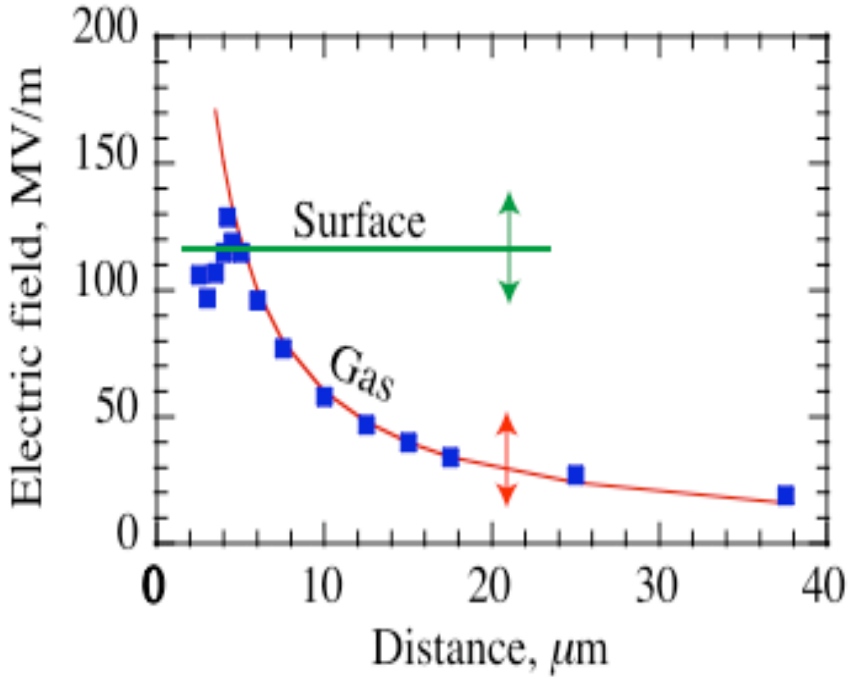
at the U of C in 1900.



The early data is still the best (not a good thing).

- Two mechanisms of breakdown were easily seen in 1900.





- Millikan and Michelson liked the "hot sparks", bought a vacuum pump and invented vacuum ultraviolet spectroscopy.

- We need better data to understand the problems..

Northwestern Atom Probe Microscopy

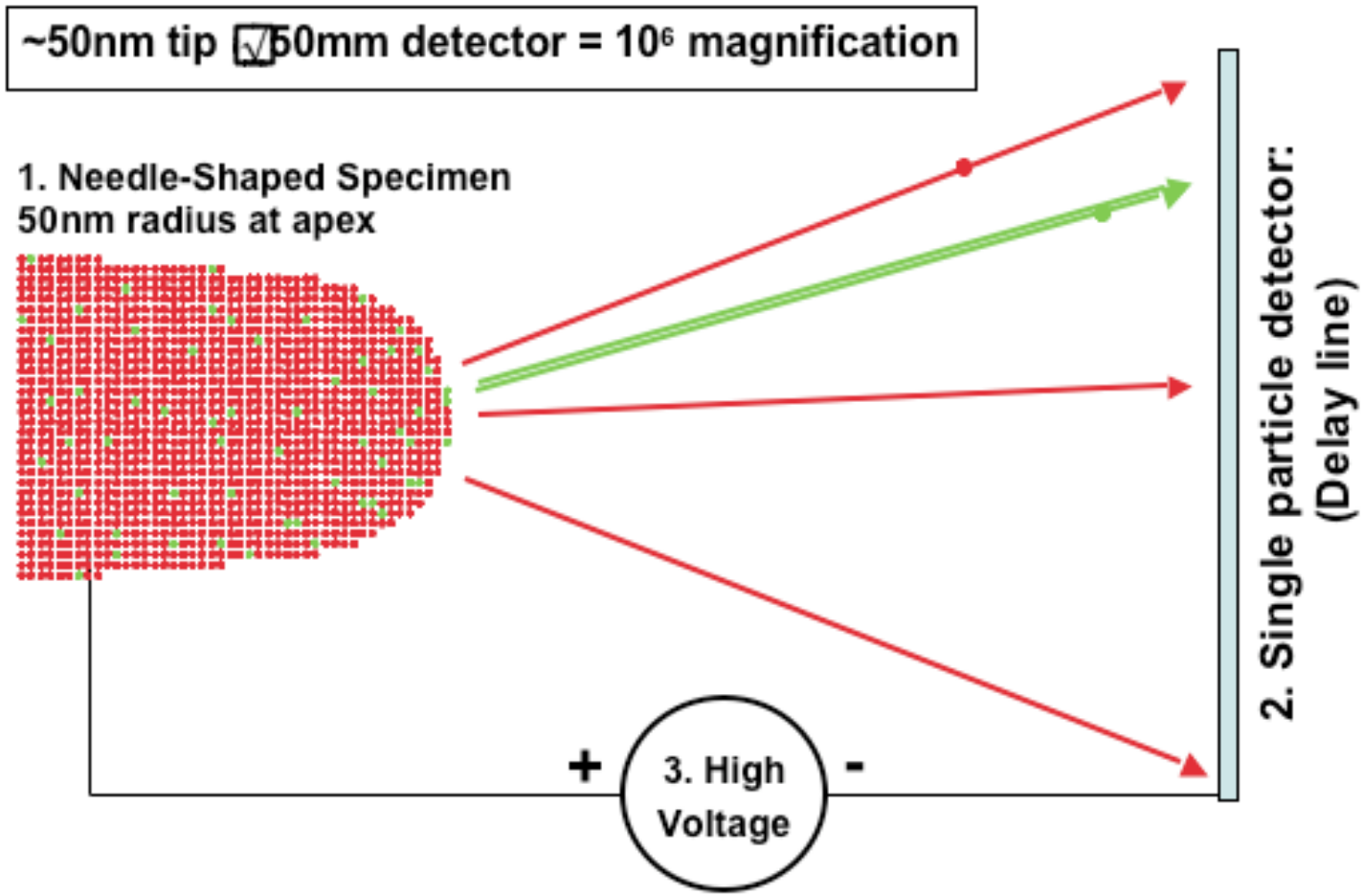
- The physics of Atom probe samples and field emitter/breakdown sites is similar.

- This physics is almost impossible to work with in cavities.

- Atom Probe Tomography systems can tell us exactly what we need to know – with fantastically good instrumentation.

- Two directions:
  - Study of coatings
  - Study of particle emission

The Atom Probe Tomography concept



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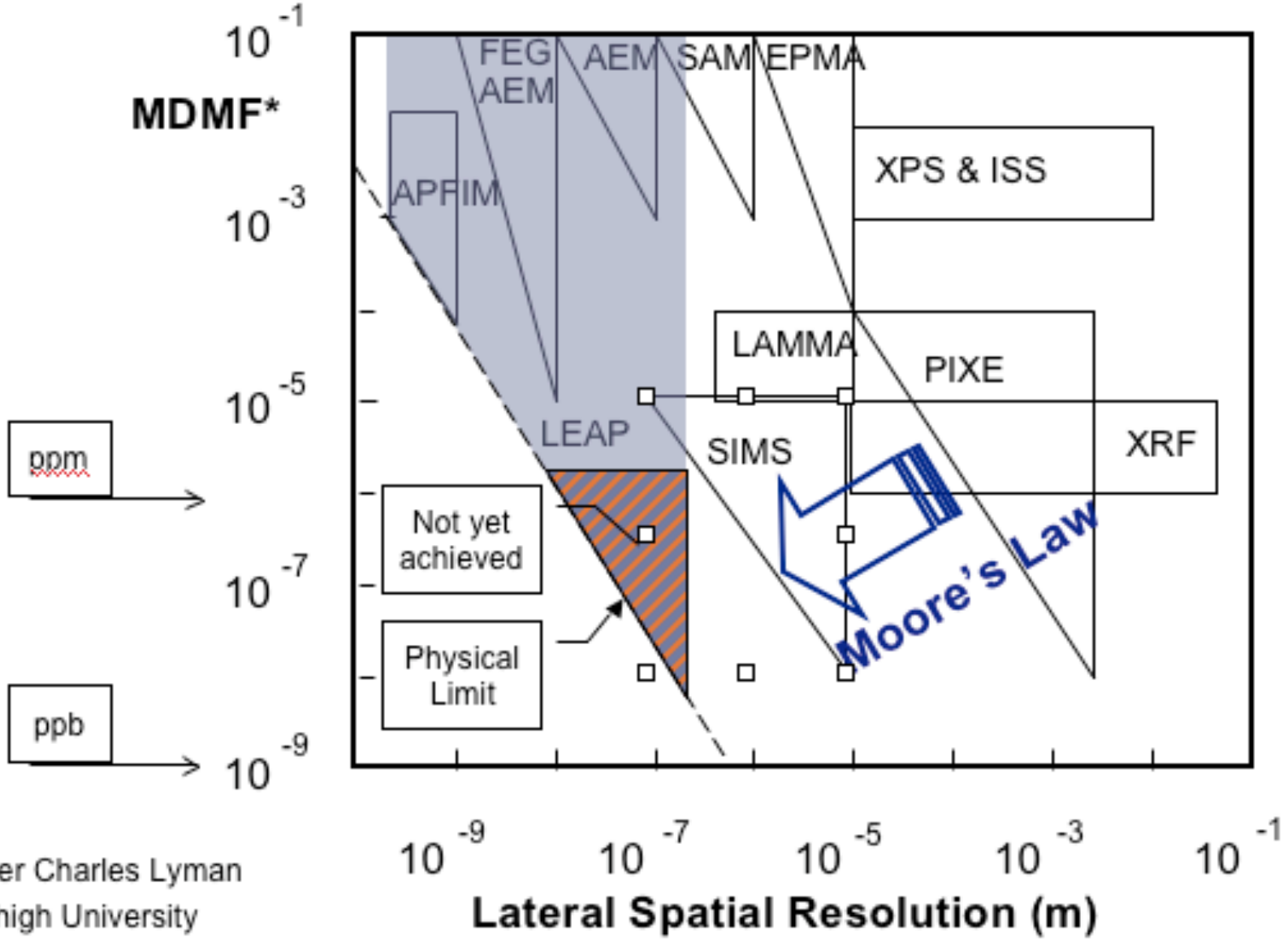
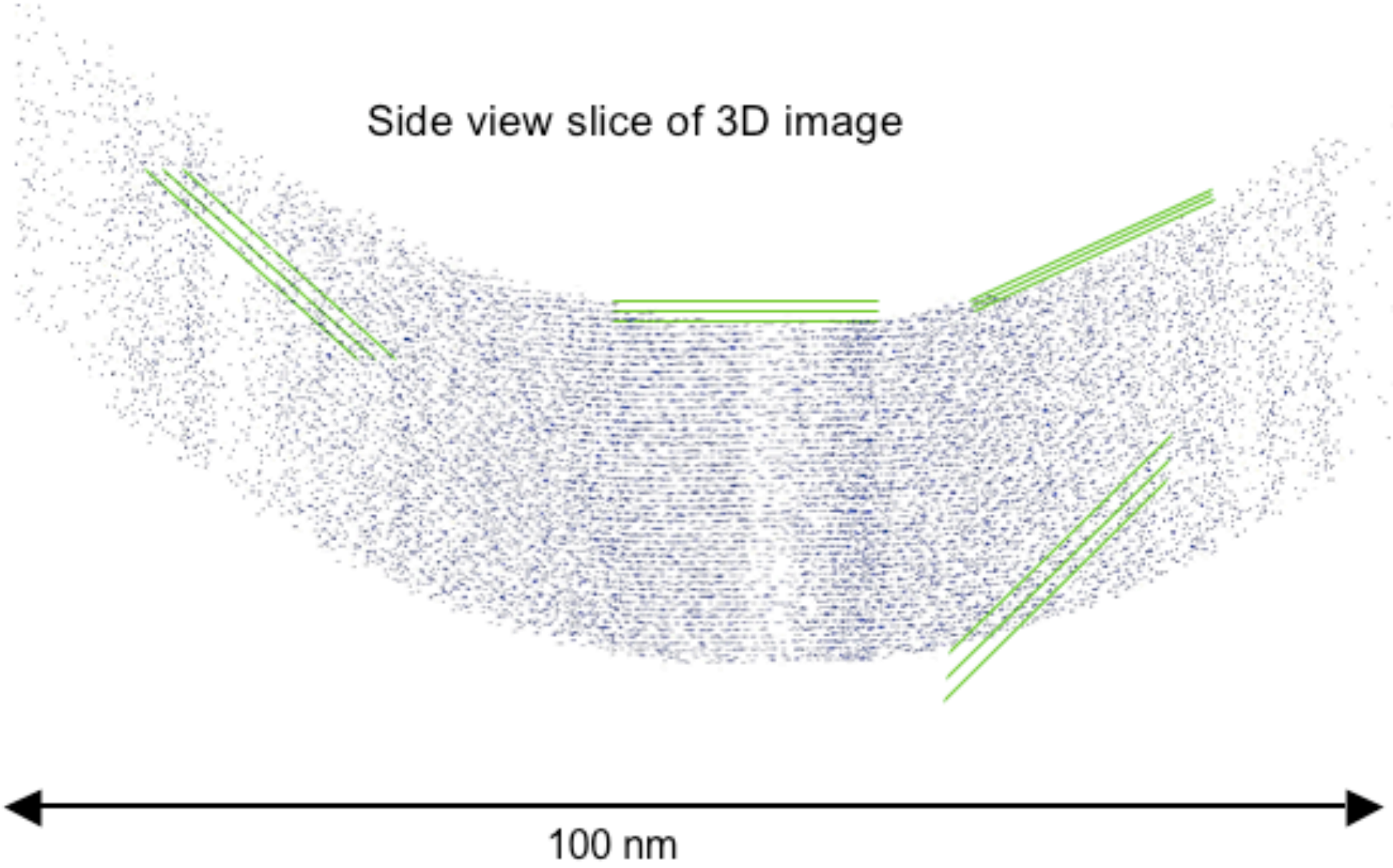


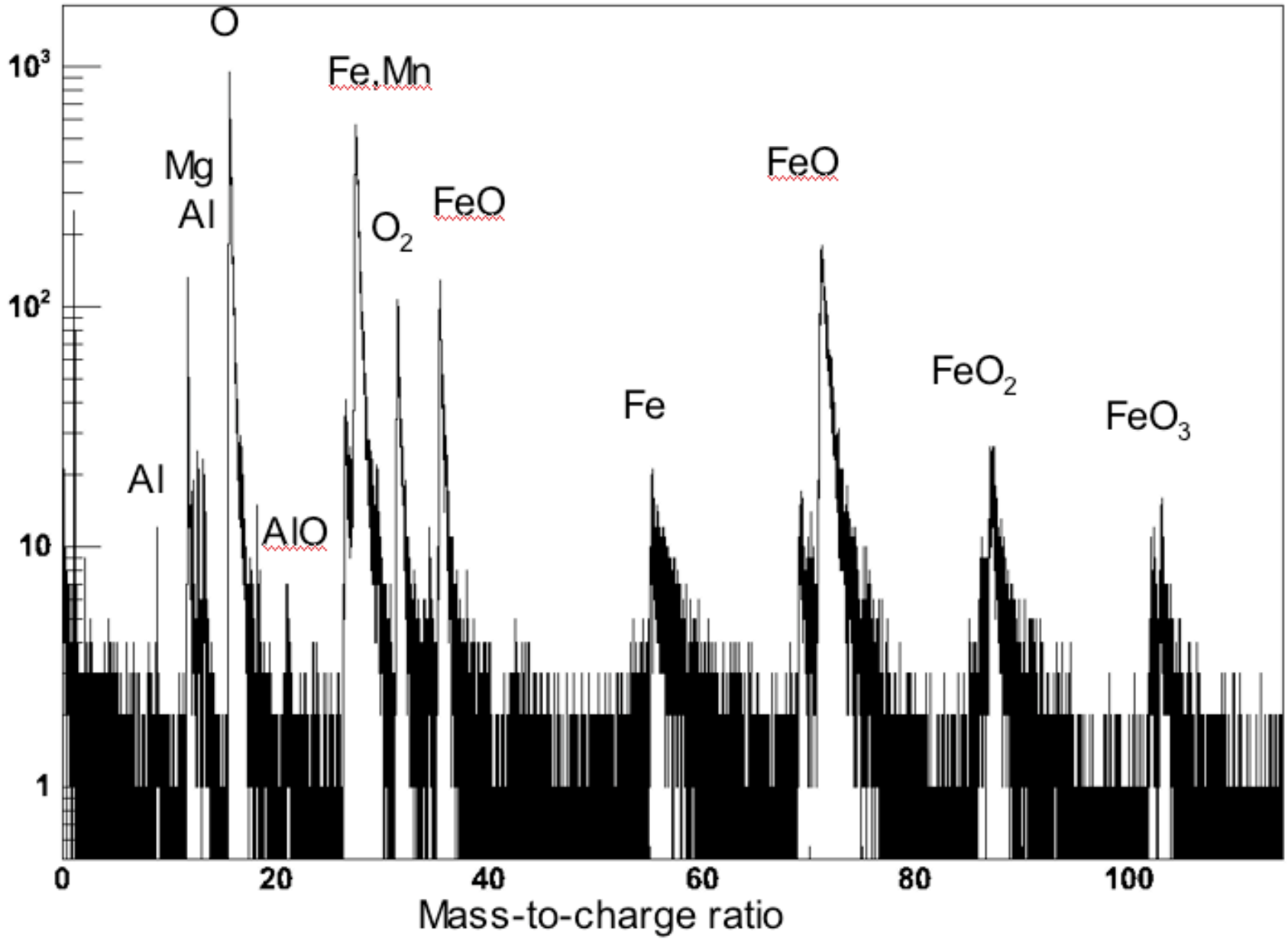
After Charles Lyman
Lehigh University

*MDMF = minimum detectable mass fraction (analytical sensitivity)

.. plus high statistics and great graphics.

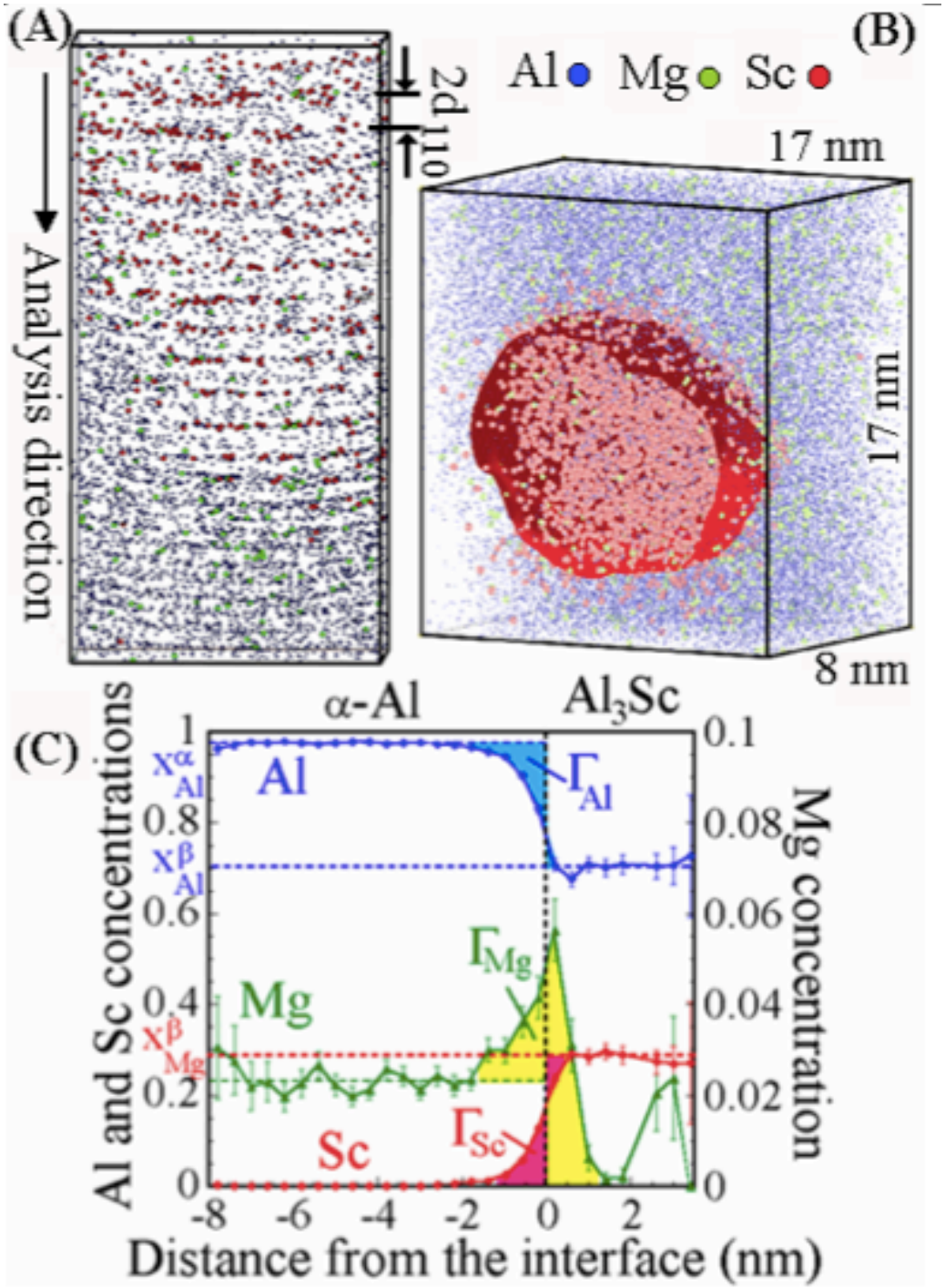


LEAP Time of Flight



Atom Probe data

- E. Marquis D.N.Seidman PRL 2003



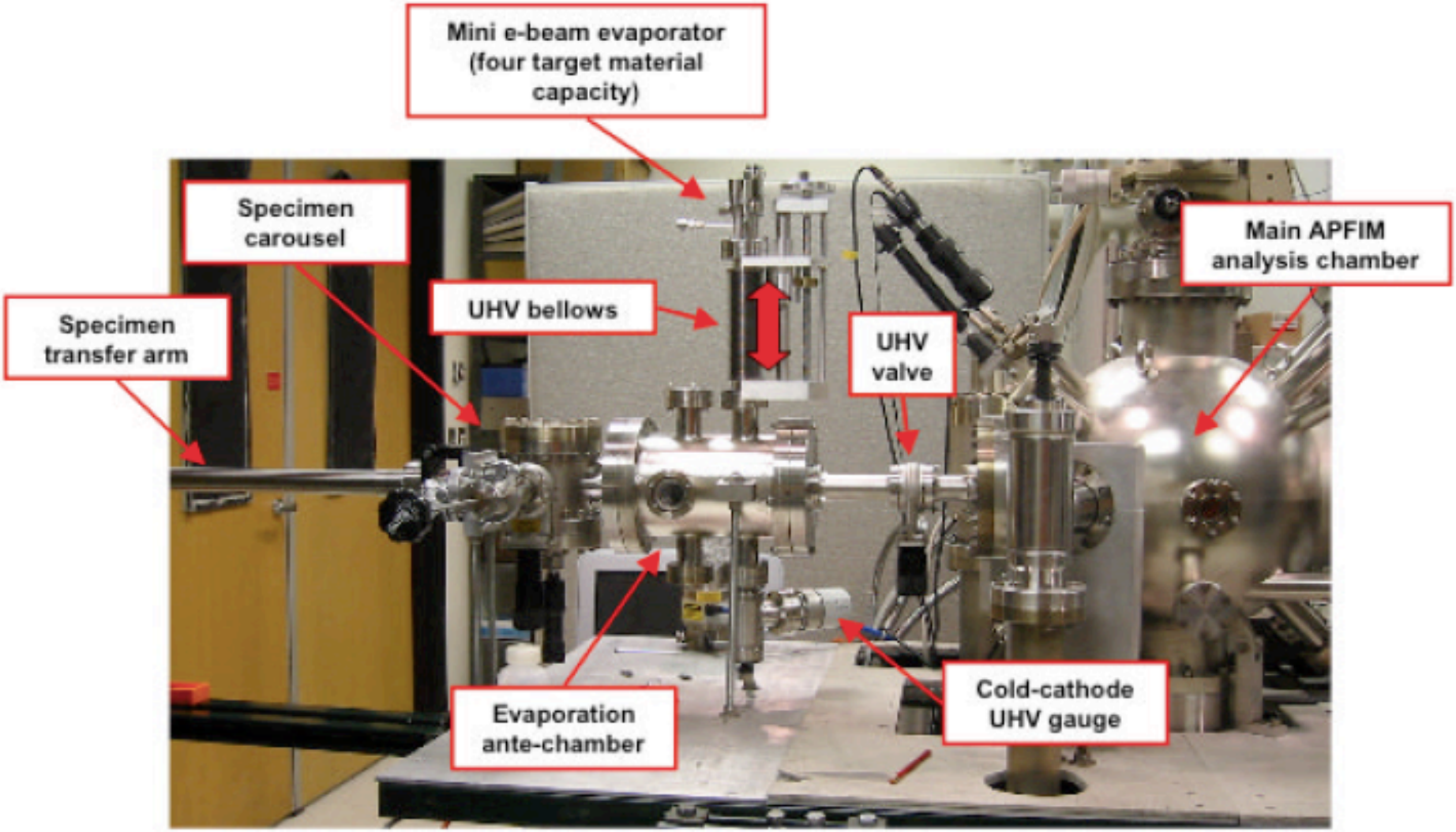
(A) 3D reconstruction of an Al3Sc precipitate with a slice taken through it showing the (110) planes.

(B) 3D reconstruction of an analyzed volume from a specimen aged at 300°C for 1040 hours showing the isoconcentration surface used to delineate the Al/Al3Sc interface. Sc (Mg) atoms are in pink-red (light green), and Al is in blue.

(C) Proximity histogram showing Al, Mg, and Sc concentrations with respect to distance from the interface, which is an average for many precipitates

NW Activities

- A coating test assembly will test small samples.



Summary

- We want to reach high E fields with low backgrounds - in a solenoid.
- Our experimental program has produced the best data and models in the community.
- We are trying to proceed with a balanced program of experiment and modeling, with
  - MTA Experiments
  - Modeling
  - Small sample tests with Atom Probe Tomography.
- We are developing a productive interaction with the SCRF community.
- We will have more data soon.