High Gradients + Radiation in Dielectrics

Bringing Beam to the MTA is expensive. Is there an easier way?

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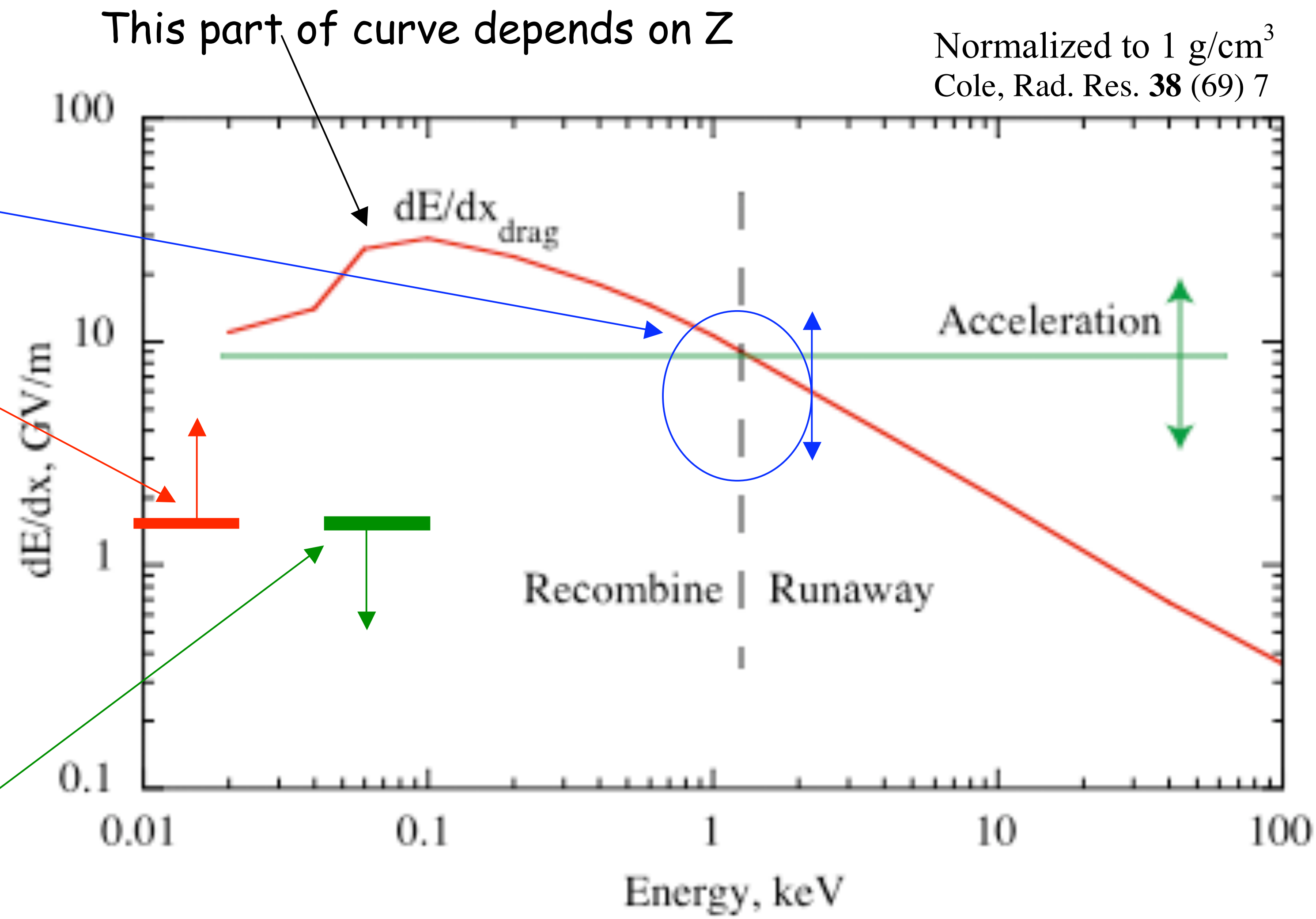
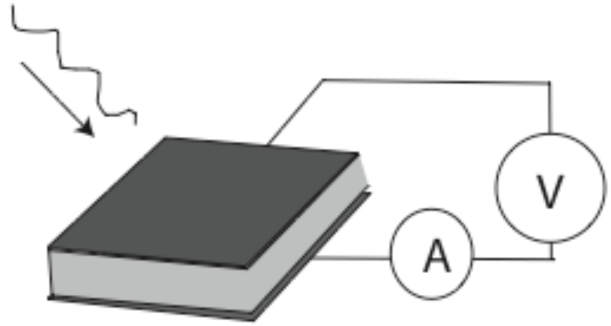
How does runaway model compare with other work?

- Katsuya
  GEANT
  >1 KeV runaways
- Muons Inc.
  no gas BD
- Rosenzweig et. al.
  4 GV/m => BD
  Solid dielectrics



What happens in solids during high fields and radiation?



- Since solids are denser, the effects we are looking for would occur at much higher gradients. At a density of 5 g/cm^3 the required fields would be 10's of GV/m.

- The dielectric strength of the best dielectrics is much less than this.
  Tables list the dielectric strength of mylar ~ 280 MV/m
  Other effects seem to limit dielectrics: Defects etc. ?

- It is hard to measure electrical properties with accelerator beams.
  - Beams are pulsed.
  - RF instrumentation (network analyzers) is CW.
  - Synchrotron beams produce very low energy secondary electrons.

Radiation Effects in Dielectrics

- The fusion community is interested in this. Power reactors require insulators in high radiation environments.
- Two radiation components: 1) Atomic displacements, 2) Ionization effects
- A relevant experiment was done by Goulding et al. J. App. Phys, **79** (96) 2920, to measure radiation effects in a fission reactor

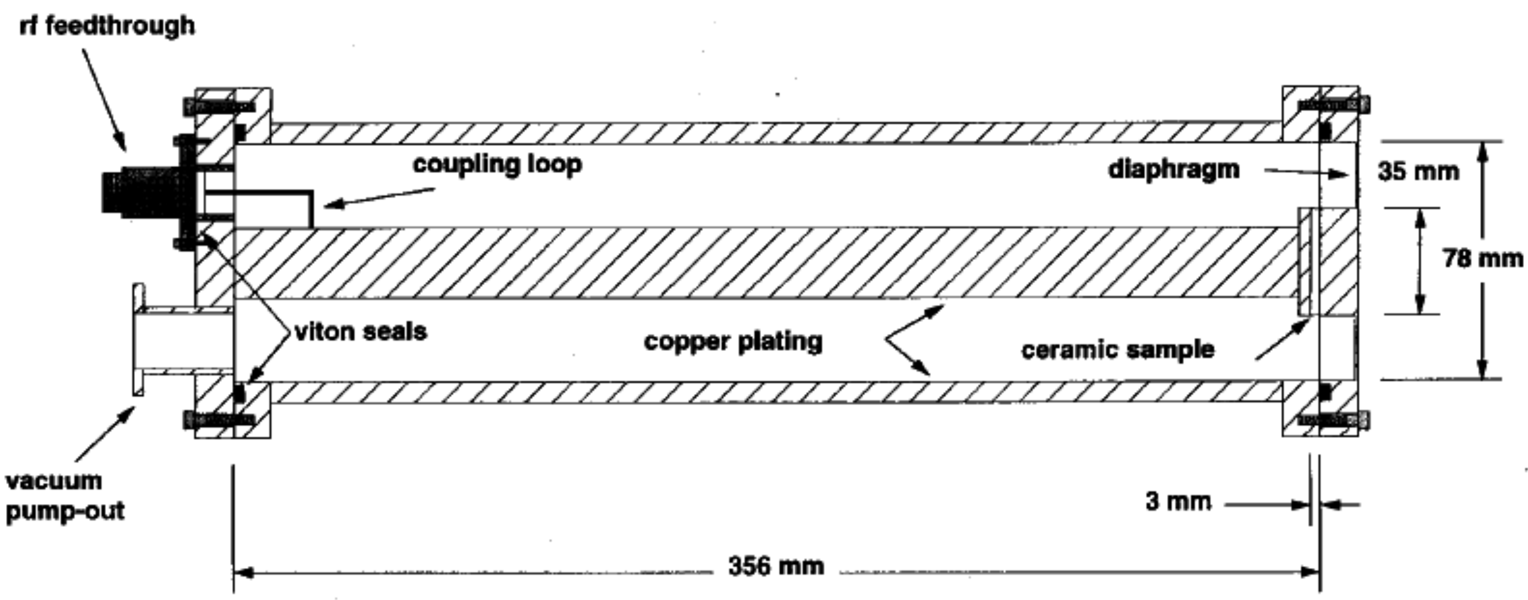
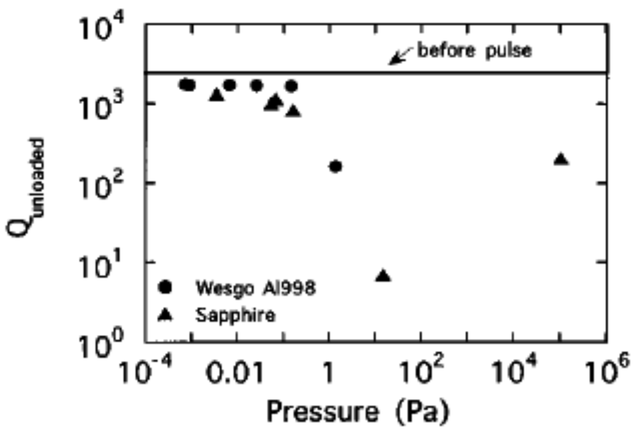


FIG. 1. Cavity for measurement of rf parameters of ceramics during irradiation.

Transient ionization lowered the Q.

- Vacuum dependence - not relevant to high p, since λ_e ~ cell dimensions @ 1 Pa



- Radiation Dependence

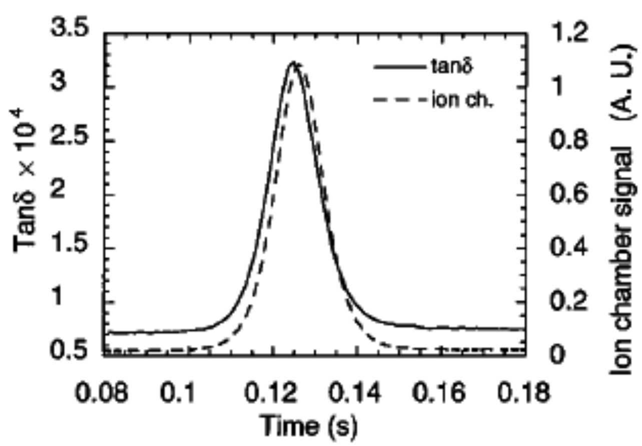


FIG. 11. Loss tangent vs time for Wesgo AL998, $3.00 pulse, with reactor power signal measured by an ion chamber overlaid.

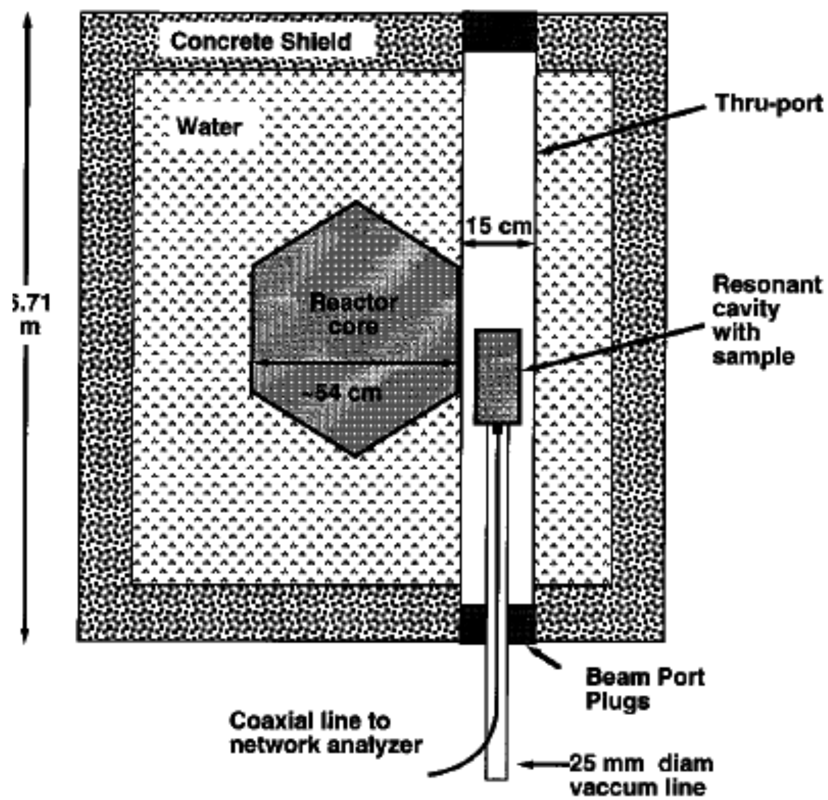
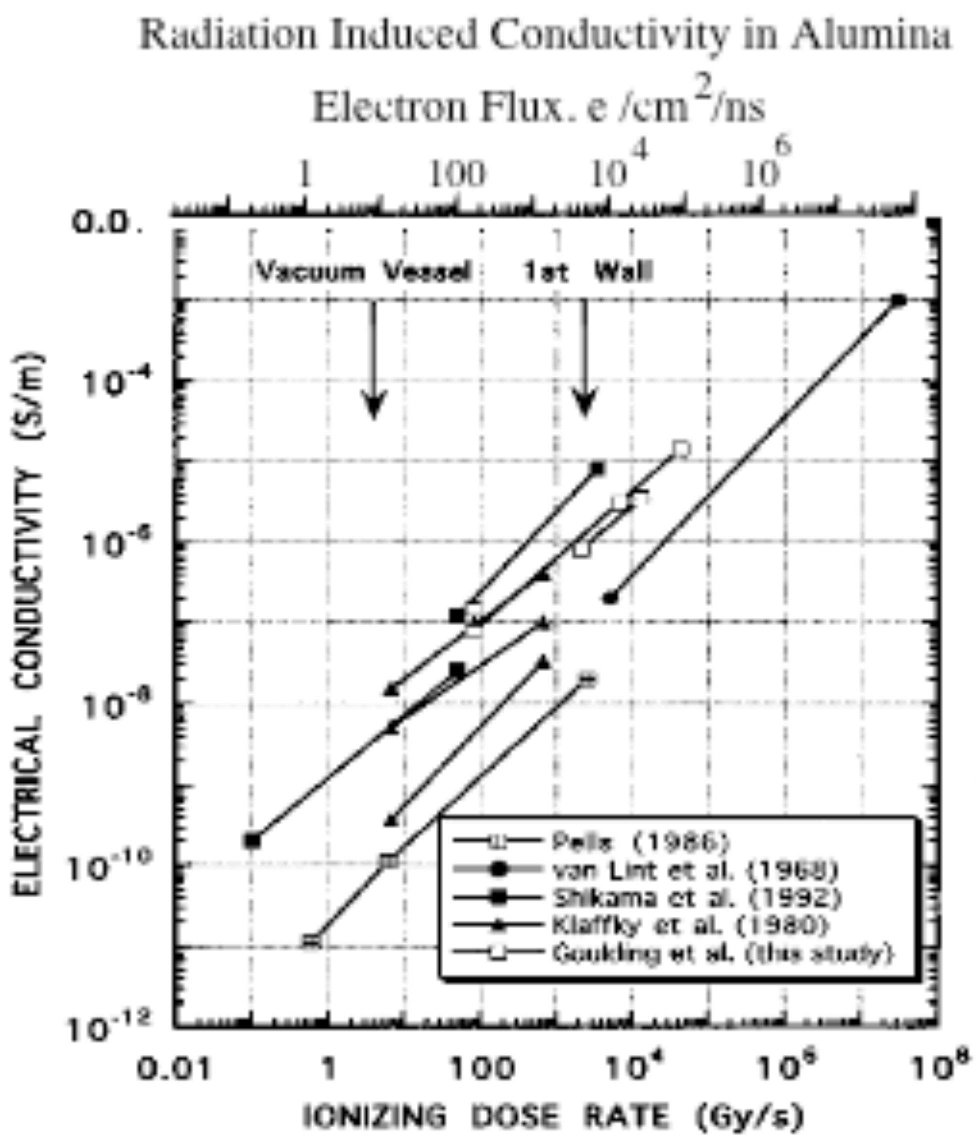


FIG. 2. Plan view of the University of Illinois TRIGA reactor.

Conclusions of this paper

- Ionization effects can be measured in reactors.
- Conductivity is proportional to ionization.



Summary

- Gasses are better dielectrics than solids.
- It is hard to design a relevant experiment with solids. We can't get high enough gradients to test the physics of high pressure rf.
- Both solids and gases exhibit radiation induced conductivity in reactor experiments.
- The gradient limits in solids seem to be due to radiation induced conductivity.