RF Studies: a Two Part Program

1) MTA Work (starting May 15+)
   805 MHz
   Grid (Mohammad's Thesis)
   Domed window - Tests stability of thin window
   High Pressure cavity - Measures high pressure breakdown
   Button tests - Look at different materials
   201MHz (under construction)
   Conditioning - How fast, how much radiation produced
   Dark current measurements - How can we improve the running conditions

2) Surface Studies Proposal - material, plasma and surface physics, ANL/Northwestern
   Simulations - What triggers breakdown? What parameters are variables?
   High Electric Field Tests - How do solids fragment? What does the process look like?
   High Current density - What is the limiting current density? (CLIC seems close.)
   RF cavity tests - After we understand the process, how much real control?
   Submitted to DOE Apr 16.
   Planning submission to EPRI and perhaps NSF
We have a model of rf breakdown and dark currents

Talks at
High Gradient Workshop
Fermilab, Northwestern, Argonne, SLAC, (U of Chicago Monday)
Muon Collaboration meetings

The model assumes:
Cavities break down at field emission sites when high fields fragment the surface.
fragments are heated by field emission \( (P = 0.1 \text{ W}) / (V = 5 \mu m * 5 \mu m * 1 \text{ nm}) \)
The model says the surface matters.

The model is relevant to
Normal conducting Linear Colliders (NLC, GLC, JLC, CLIC)
Superconducting Linear Colliders (TESLA)
Synchrotron rf
Linacs
Power distribution
Klystron design
MICE rf is based on extrapolations.

We could still have some surprises with backgrounds.
These would be expensive in time and money, (and programmatically)
rf continues to need a high priority

The best option is to use high workfunction coatings. Huge gains are possible.
We don't understand B fields, but $I_{\text{Field Emitt}} \times B$ forces must be bad, lower currents good.
Surface studies should help MICE.

The breakdown and dark current studies aim directly at MICE. We need a systematic look at high work function materials for 201 MHz. Tests with the 201 MHz cavity are expensive, time consuming and risky.

Using an APFIM, we can experimentally measure how well we can control the surface Procedure

1) Produce field emitter from any metal
2) Clean ( or dirty it )
3) Measure the Field Emission
4) Coat it in-situ ( with monolayer, multilayer coatings )
5) Re measure the Field Emission
6) Measure how well the coating sticks to the substrate ( removing it atom by atom )
7) Remove coating, go to 2)

A single pumpdown can do ( 6 substrates ) x ( 4 coating materials ) = 24 expts. plus multi-layers

Unfortunately, for fast results
The material science people are busy doing other things.
The deposition system costs ~20k$
People, money and time are in demand
Materials science people are interested in programs, not single measurements
Some of the equipment is complex.

The Quad Evaporator costs about 20 k.

**QUAD-EV-S/C**

Simpler tests with existing equipment are possible, and we are pursuing the options.

We have funding from an Argonne LDRD for this.

We will also be looking at breakdown issues in the surface program.
Summary

The programs at the MTA and the ANL/Northwestern surface studies are complementary. They are relevant to MICE and MUCCOL. They should have a high priority.