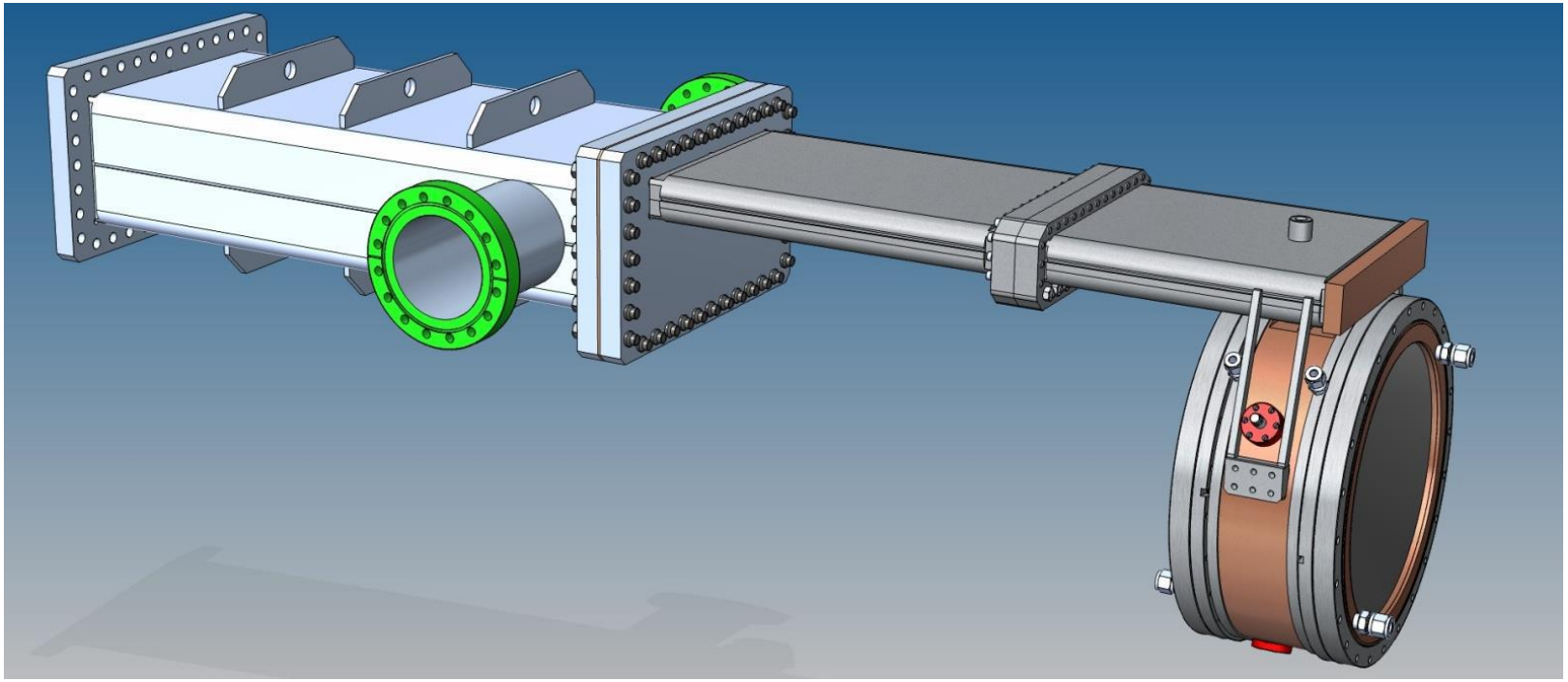
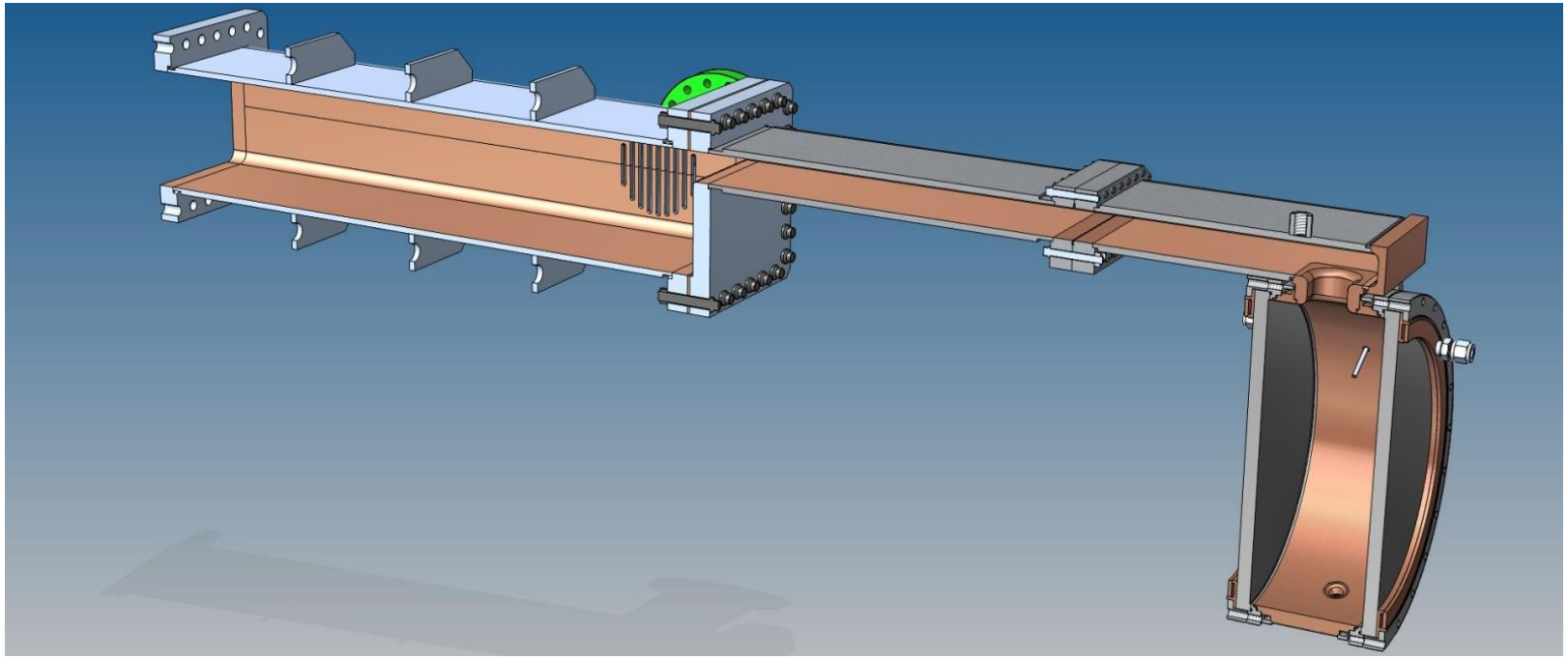
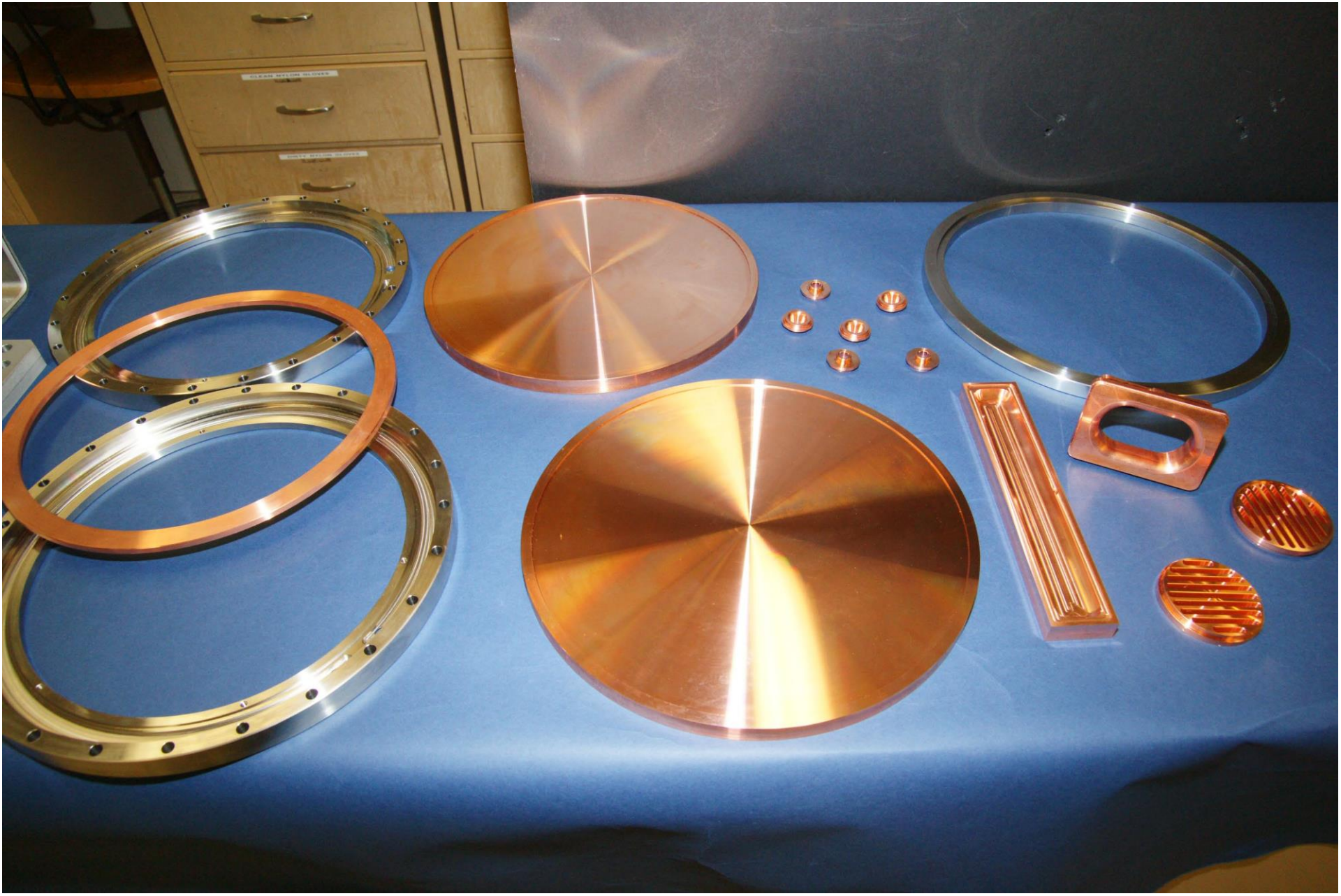
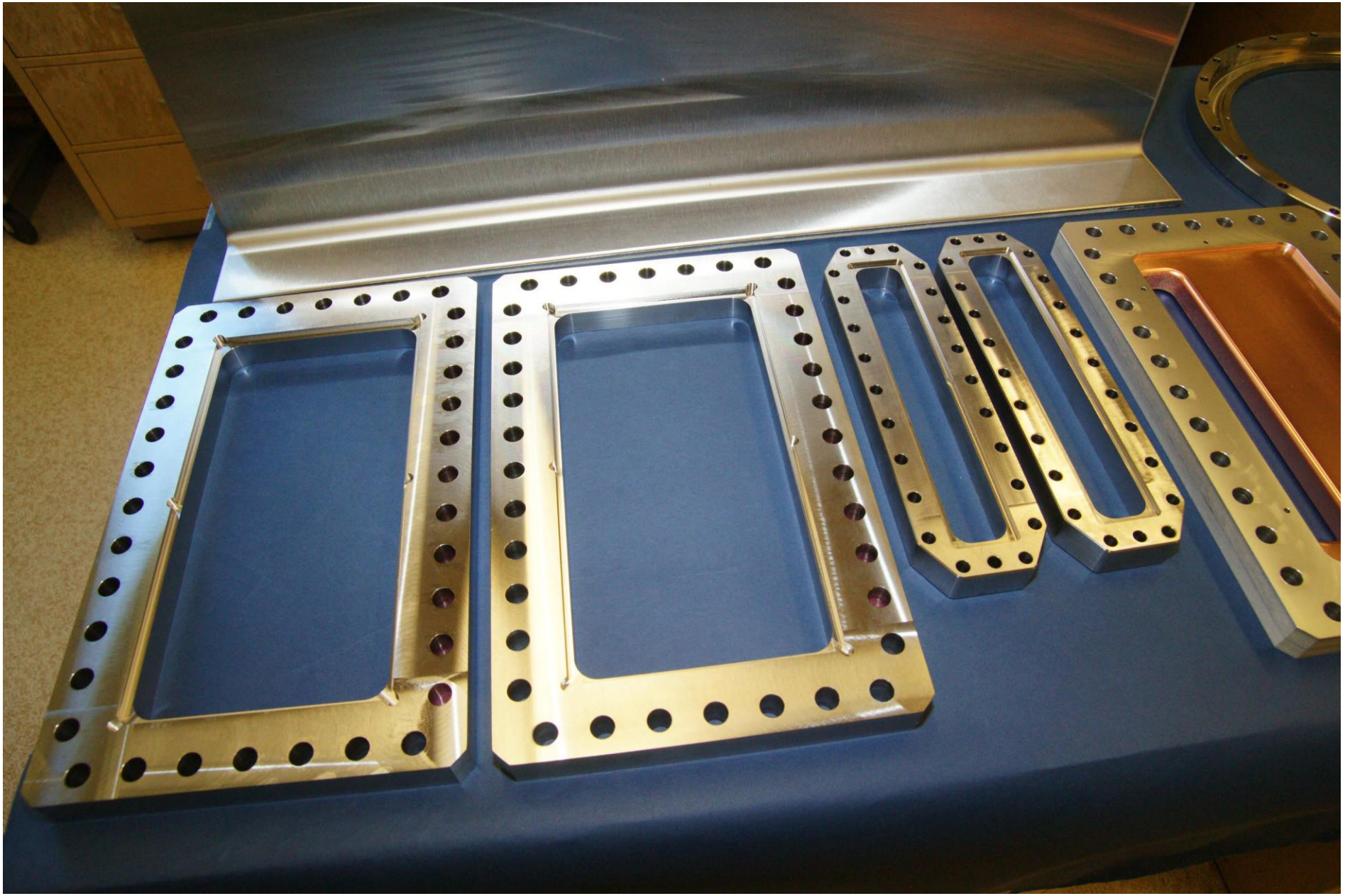
Modular Cavity Status

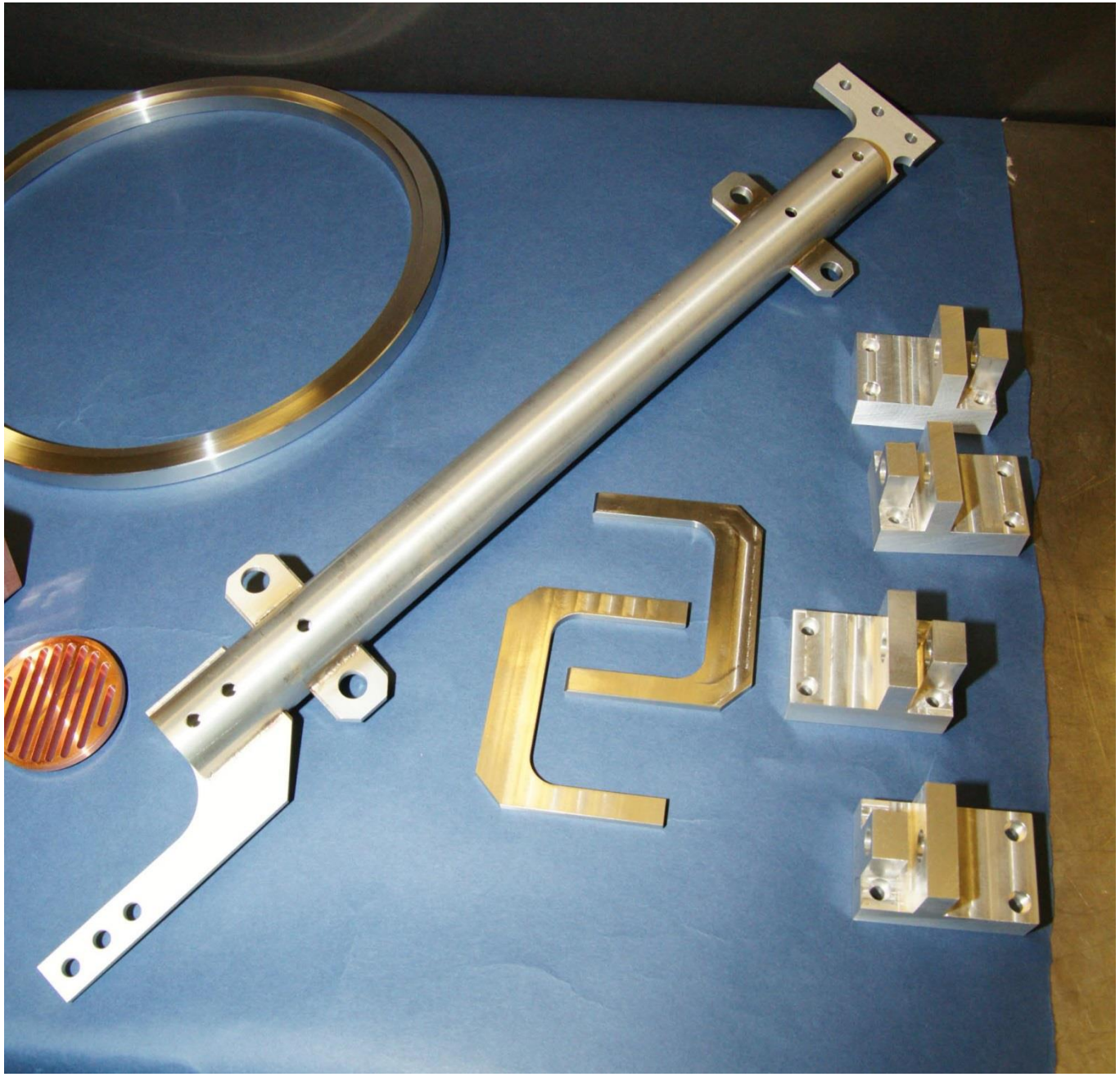
- 168 k$ of the 229 k$ estimated cost has been spent
- Only major parts still in fab are the waveguide channels and main body
- Expect to be on budget and meet the Sept 30 completion date.
- Daniel Bowring coordinating FNAL/SLAC interface











All Angle Cavity

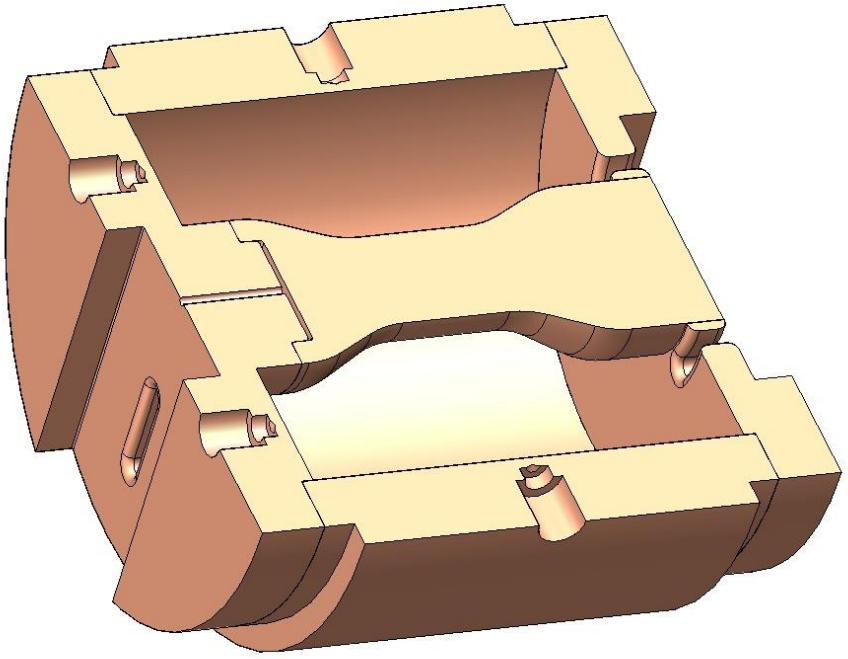
- Build an 805 MHz coaxial cavity such that E_rf is at all angles relative to the applied external magnetic field, H_ext
- Map azimuthal breakdown dependence to assess E_rf x H_ext effects

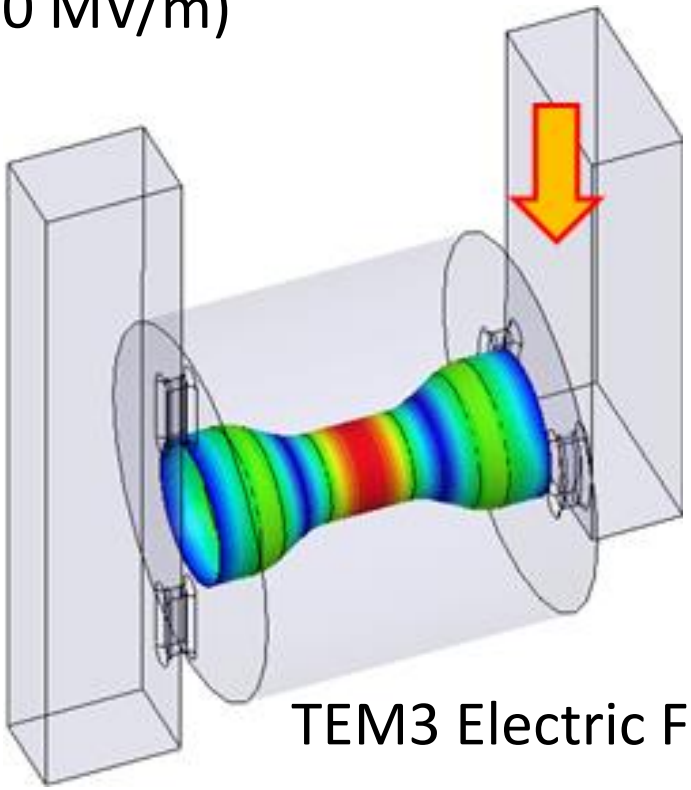
Chris Adolphsen, Chris Nantista and Faya Wang

SLAC

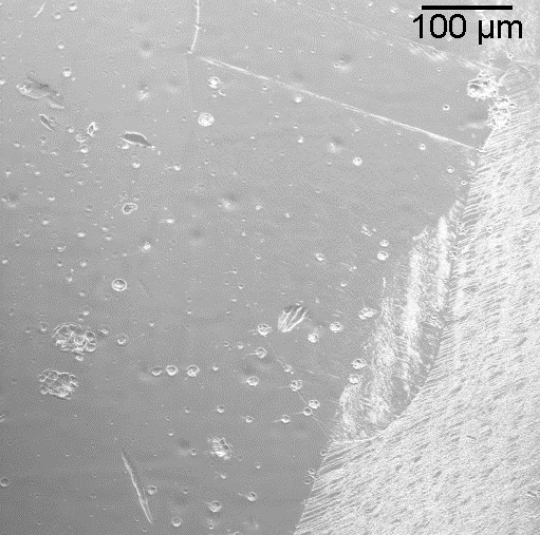
Inspired by Our X-band (11.4 GHz) Dual Mode Cavity

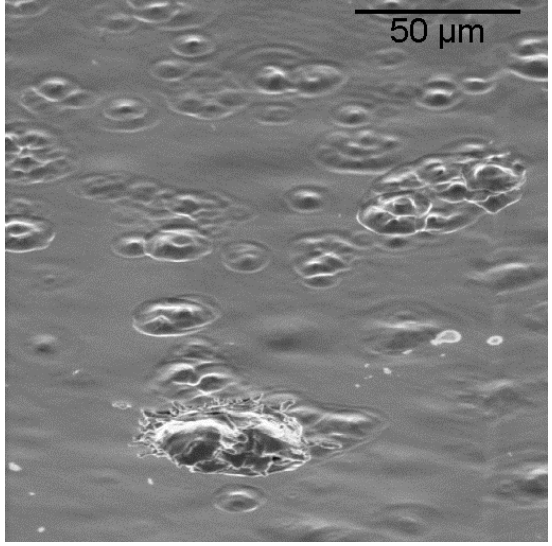
Designed to study effect of pulse heating on breakdown rate – excite two modes, TE011 (H only) and TEM3 (E and H) through two ports to vary the pulse surface heating for a fixed surface electric field (~ 200 MV/m)

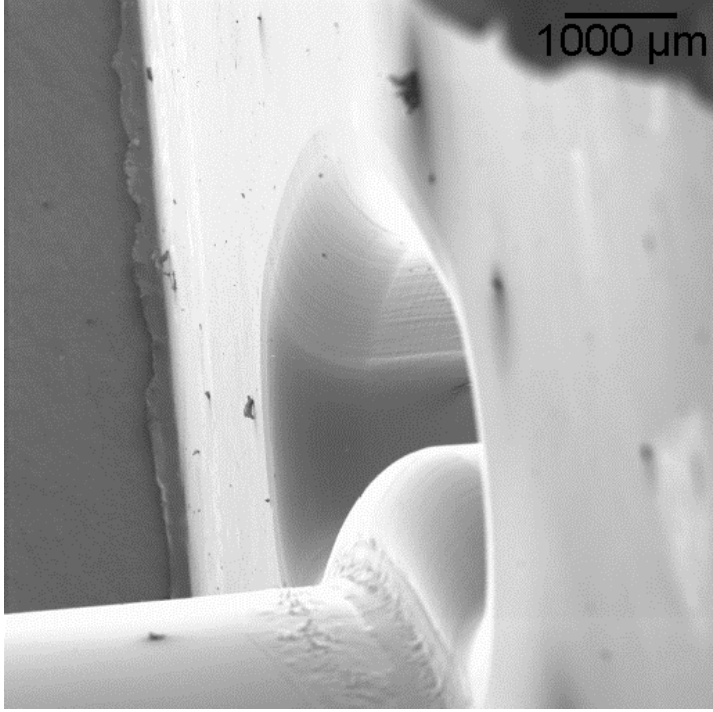


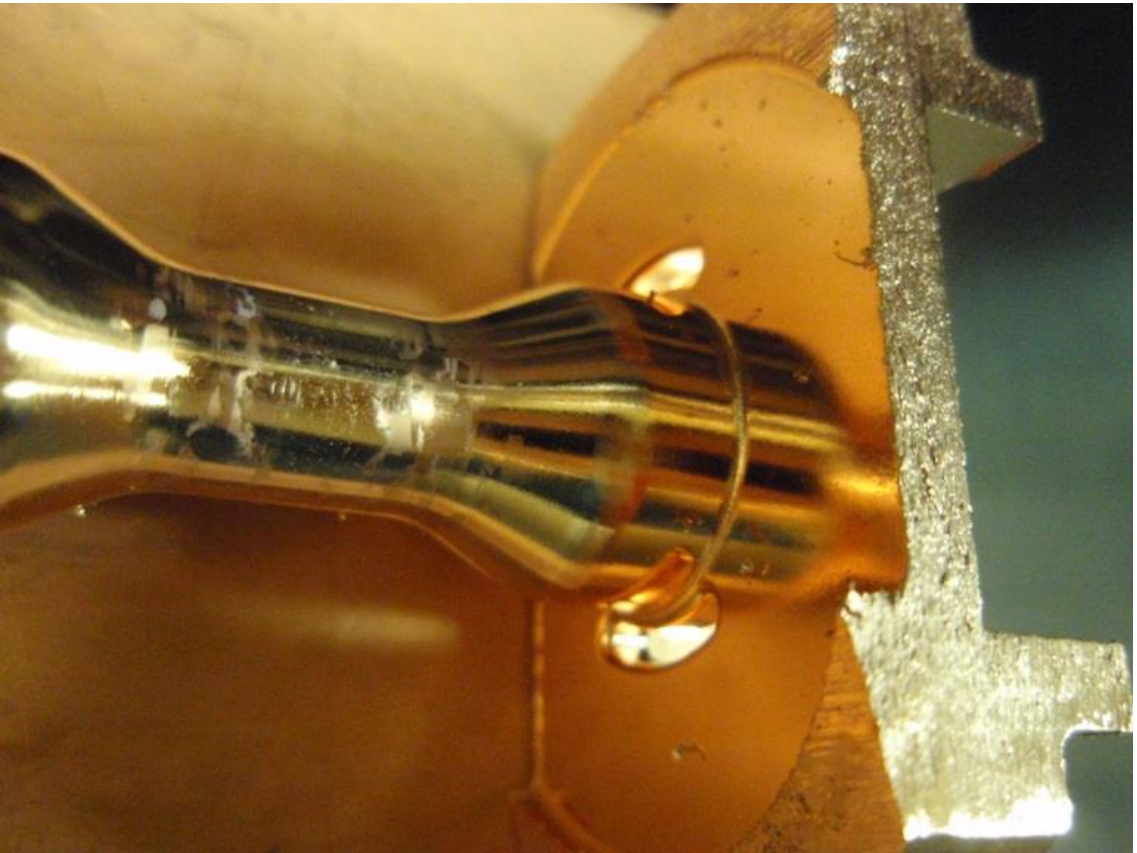


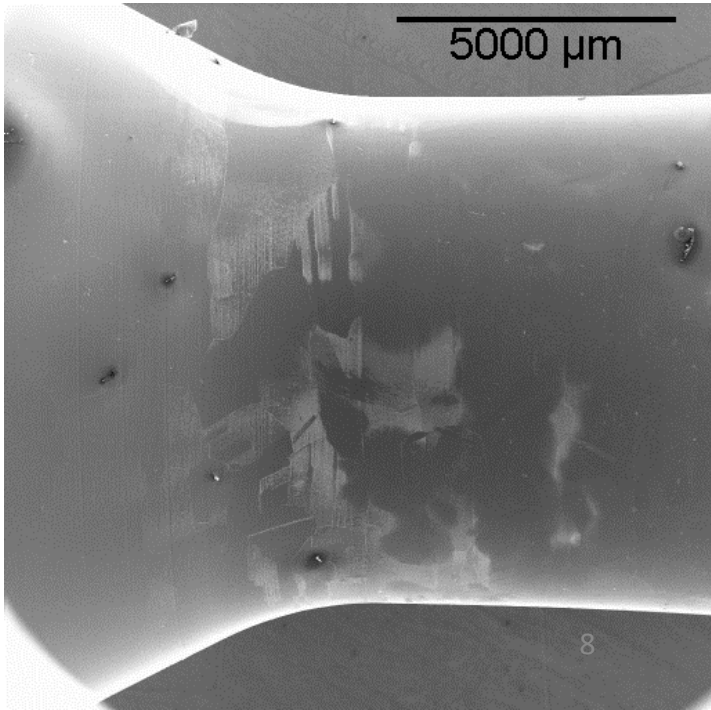
TEM3 Electric Field

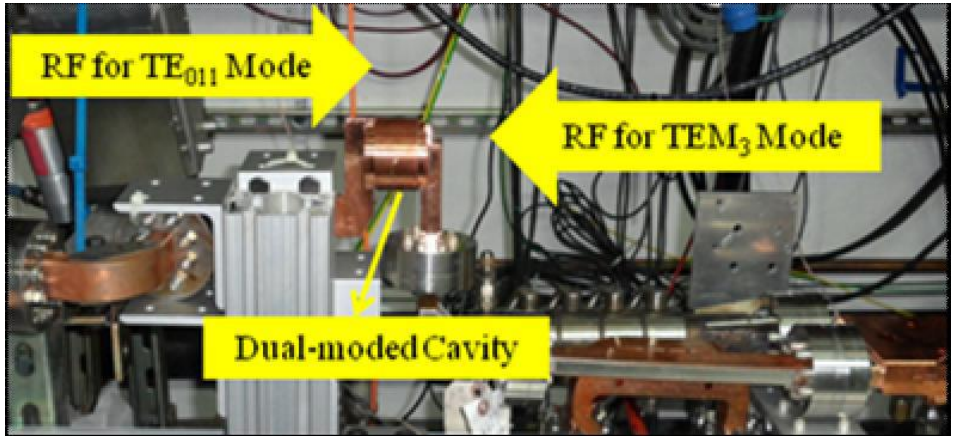

100 µm

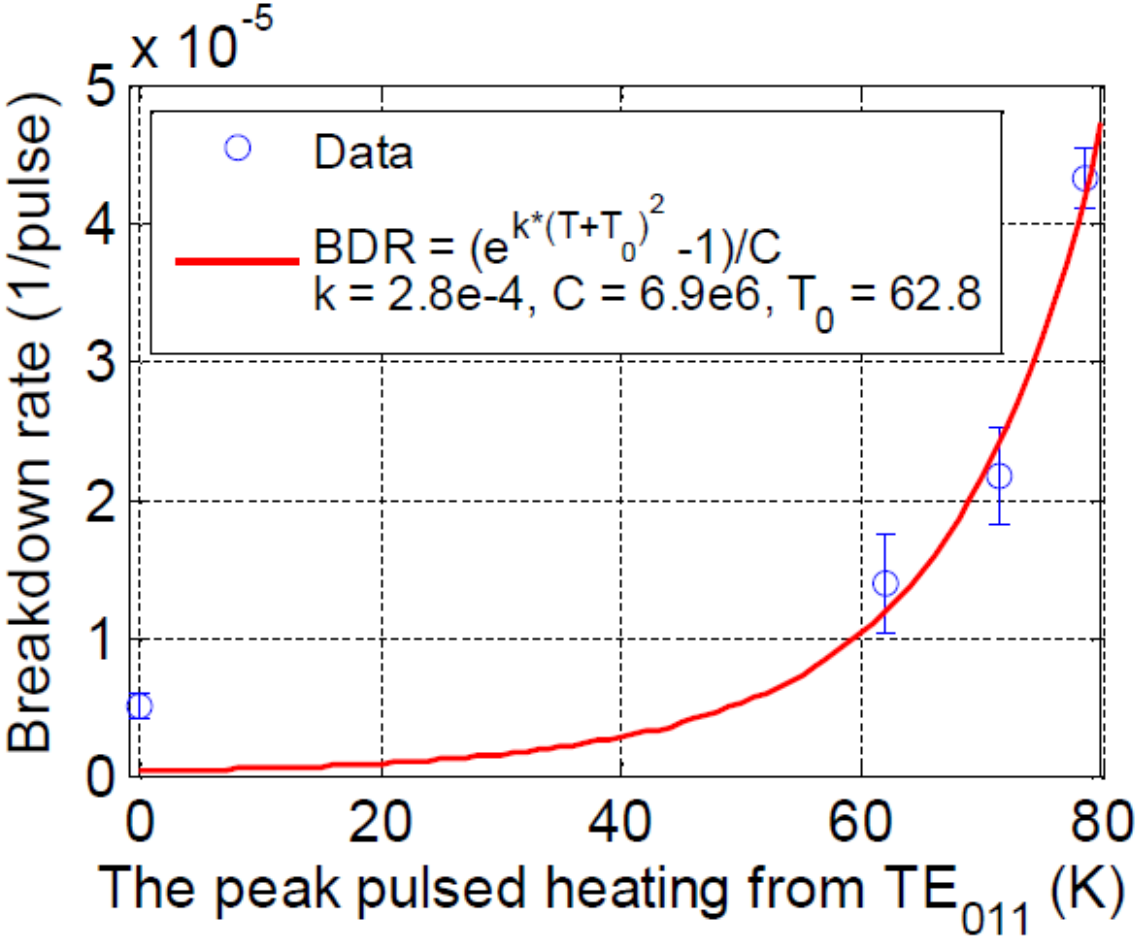

50 µm


1000 µm

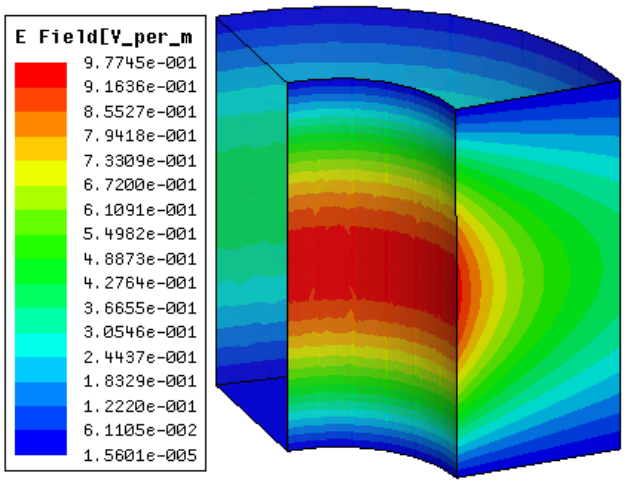



5000 µm


RF for TE_{011} Mode
RF for TEM_3 Mode
Dual-moded Cavity

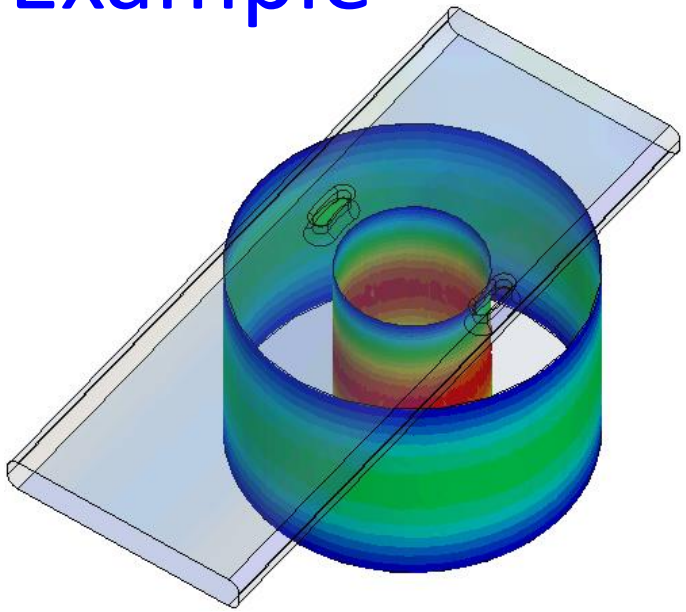

x 10^-5
Data
BDR = (e^k*(T+T0)^2 -1)/C
k = 2.8e-4, C = 6.9e6, T0 = 62.8
Breakdown rate (1/pulse)
The peak pulsed heating from TE011 (K)
0
1
2
3
4
5
0
20
40
60
80

All Angle Cavity Design Example



Eigenmode	Frequency (GHz)	Q
Mode 1	0.804962 +j 2.28993e-...	17576.2

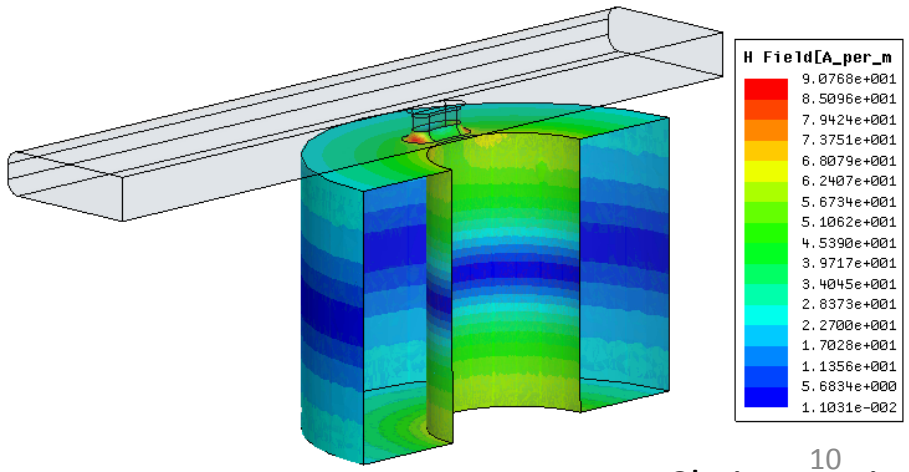
Q_0
(theor. 17,585)



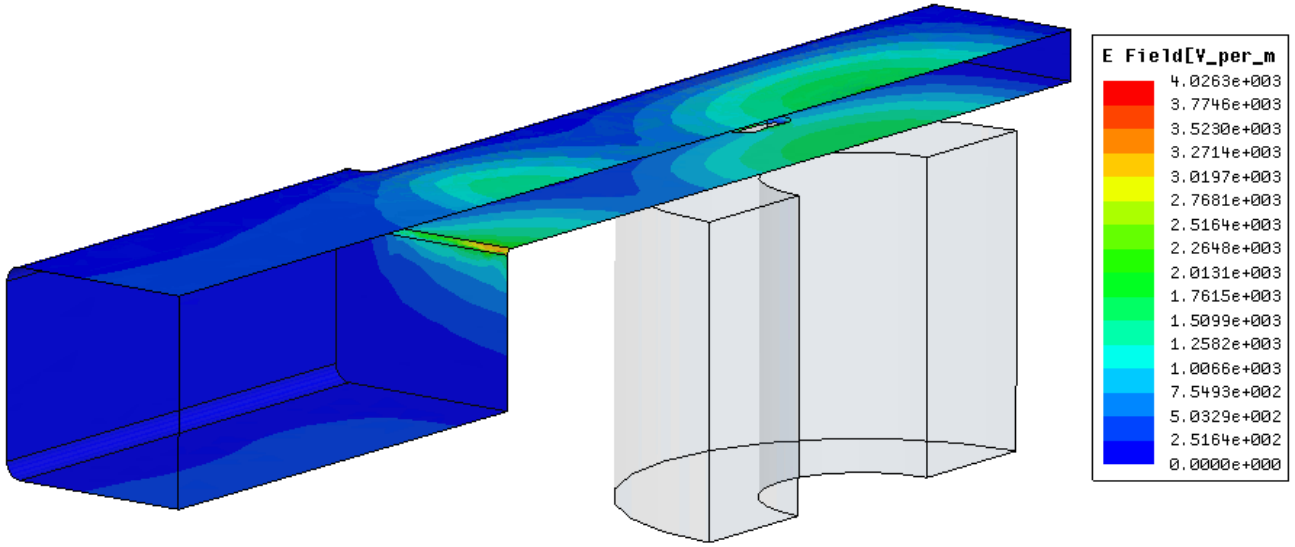
Eigenmode	Frequency (GHz)	Q
Mode 1	0.805008 +j 2.99721e-...	13429.3

Q_L

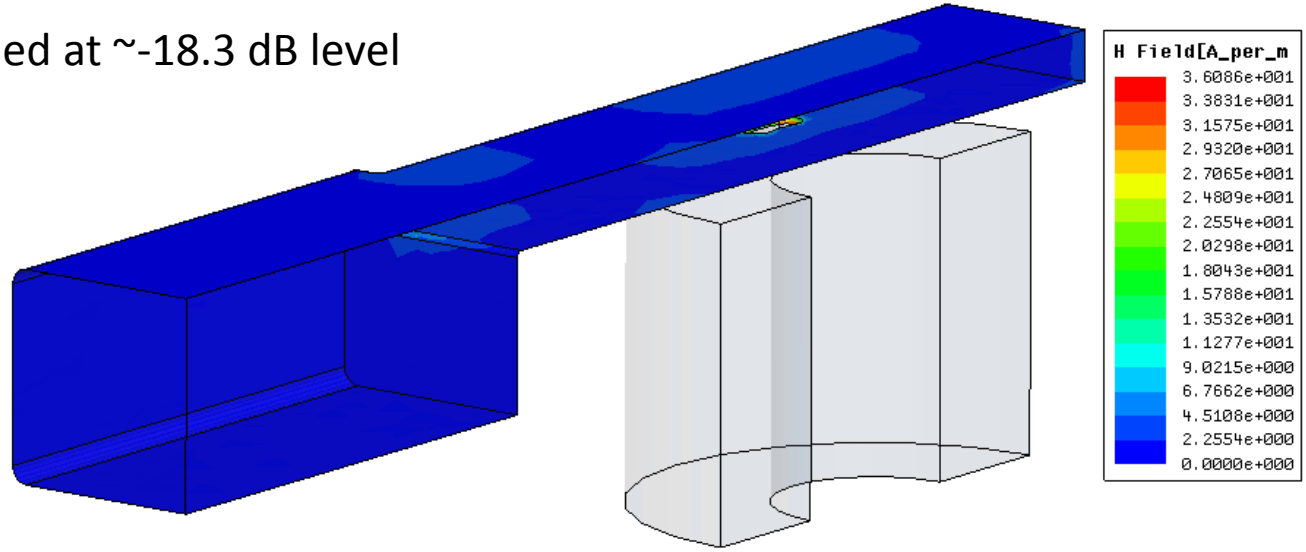
In this case, choose inner radius, r1 = 2.34 in and outer radius, r2 =5.6 in so have same stored energy as Modular Cavity and same 805 MHz frequency



Match to Existing Waveguide (Beta ~ 1)



Matched at ~-18.3 dB level

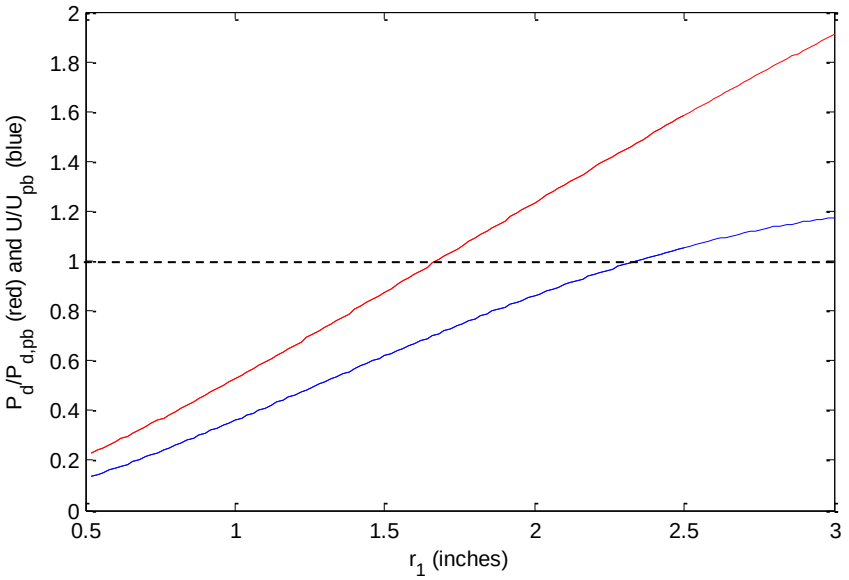


Coaxial Cavity Design Options

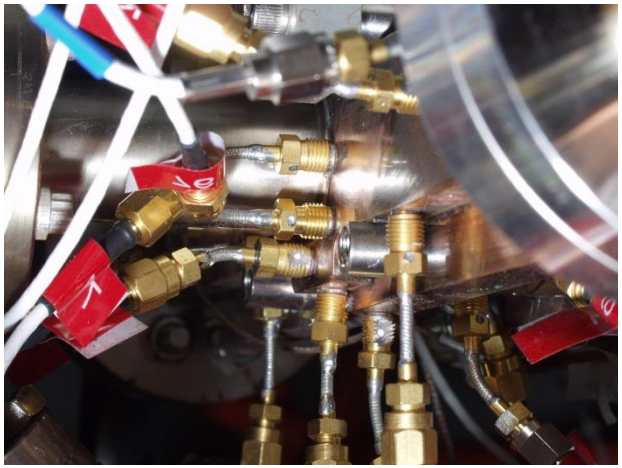
r_2 = 5.600” (fixed for size constraints)
l = 7.331” (½-wavelength)

	r_1	$U/U_{pillbox}$	$P_d/P_{d,\ pillbox}$	Q_0	$E(r_2)/E(r_1)$
initial choice:	1.000”	0.360	0.527	17,735	0.179
fix dissipated power:	1.674”	0.708	1	18,355	0.299
fix stored energy:	2.342”	1	1.475	17,585	0.418

@ common $|E_s|_m$



Use Acoustic Sensors to Map Azimuthal Breakdown Distribution



Acoustic Emission Sensor:

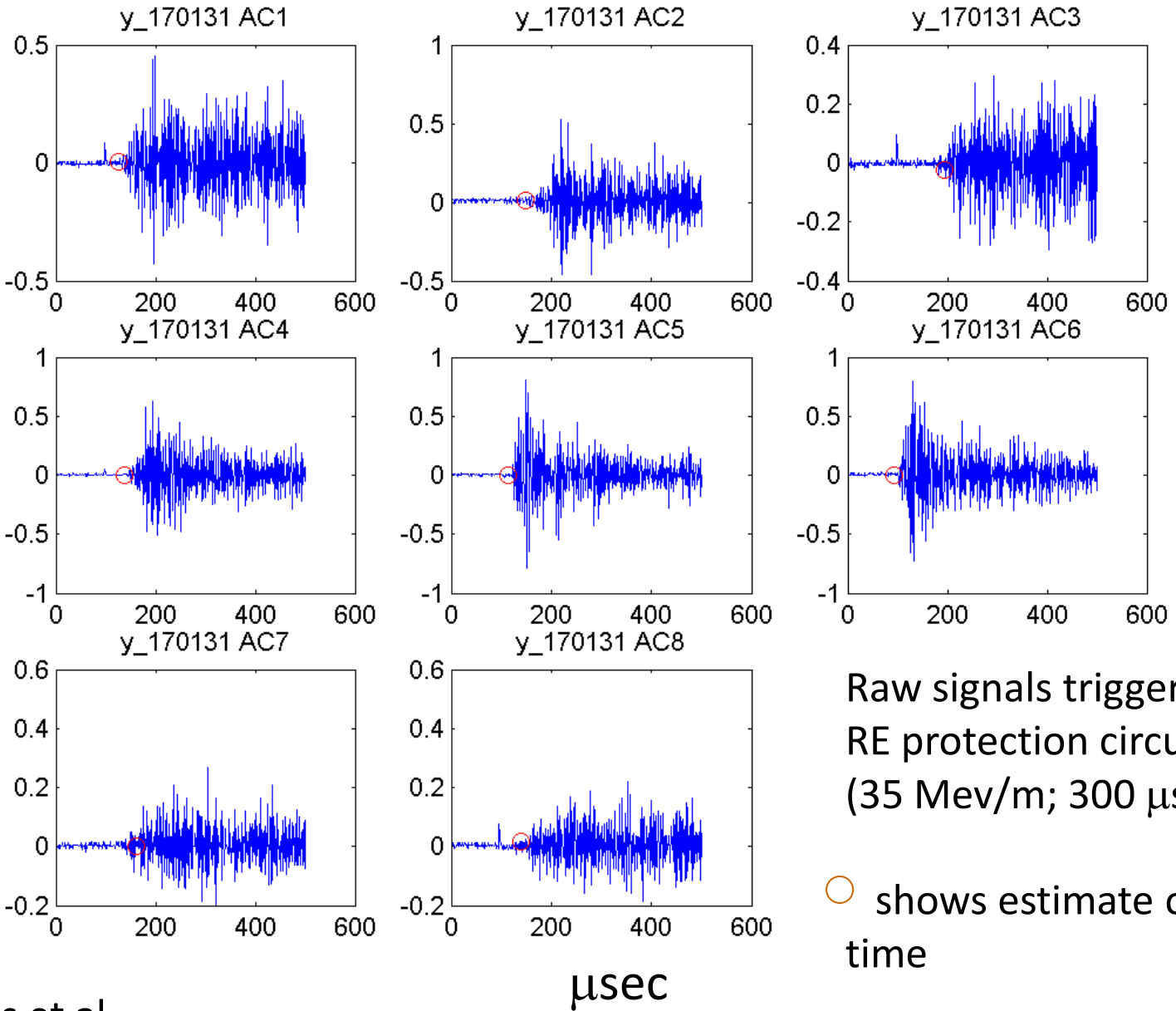
100 KHz – 1 MHz (speed is 3 mm/us)
Non-directional

SLAC-built
PZT piezo

SMA connector

Doug McCormick

TTF RF Gun Breakdown Localization



Raw signals triggered by RE protection circuit (35 Mev/m; 300 µs)

○ shows estimate of start time

M Ross et al

RF Breakdown in Gas Filled Cavities

Chris Adolphsen and Faya Wang

SLAC

Muon HPRF Cavity N2 Breakdown Threshold

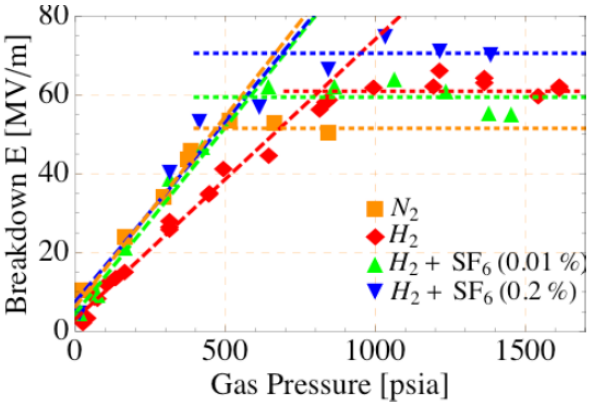


Figure 2: Observed breakdown as a function of gas pressure in copper electrodes with various gases.

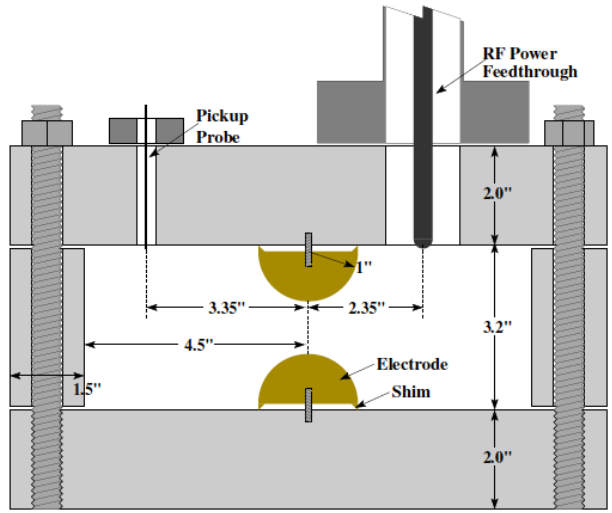
E/p ~ 20 V/cmTorr, E = E_p/sqrt(2)

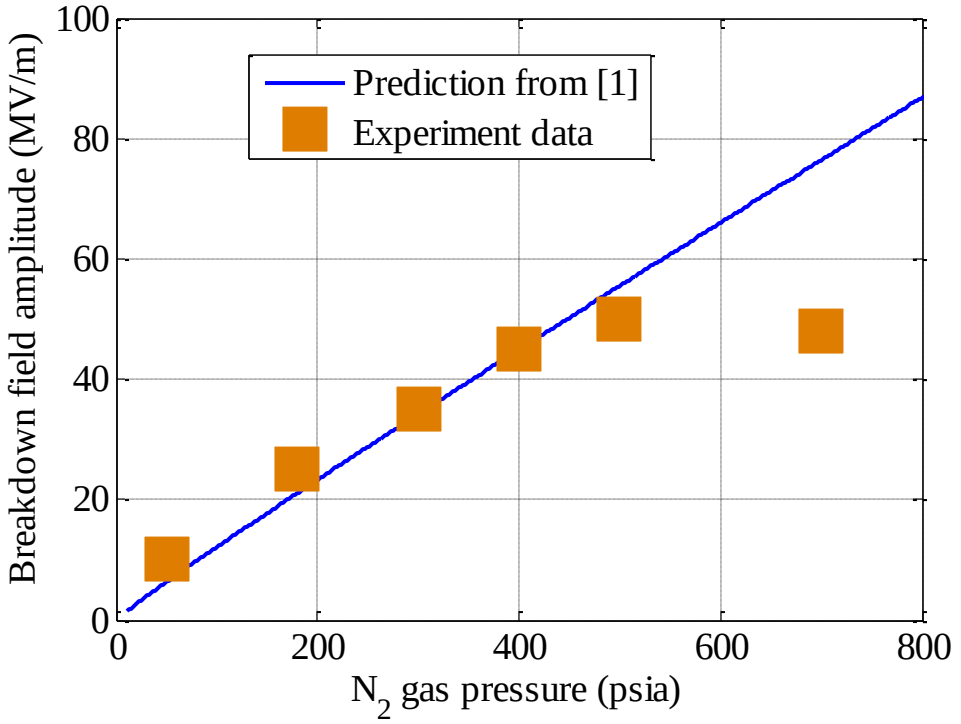
$$\alpha = 8.8\exp(-275\,p/E)$$

$$\nu_c = 4.05e9\,p$$

$$\nu_i = 4.35e5\alpha$$ Ionization rate

At pulsed breakdown threshold, diffusion loss rate << ionization rate





[1] A. D. MacDonald, "Microwave Breakdown in Gases", John Wiley & Sons, Inc., 1966.

Faya Wang

Muon HPRF Cavity H2 Breakdown Threshold

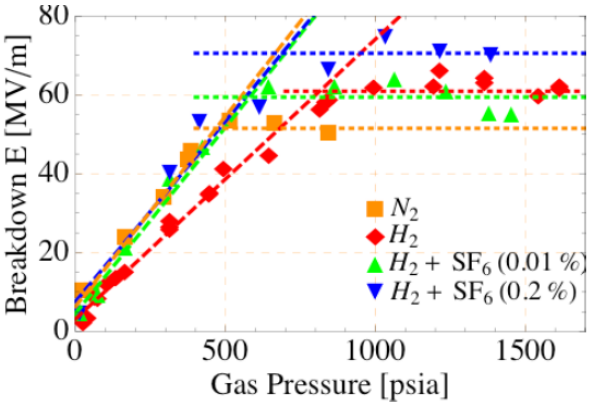
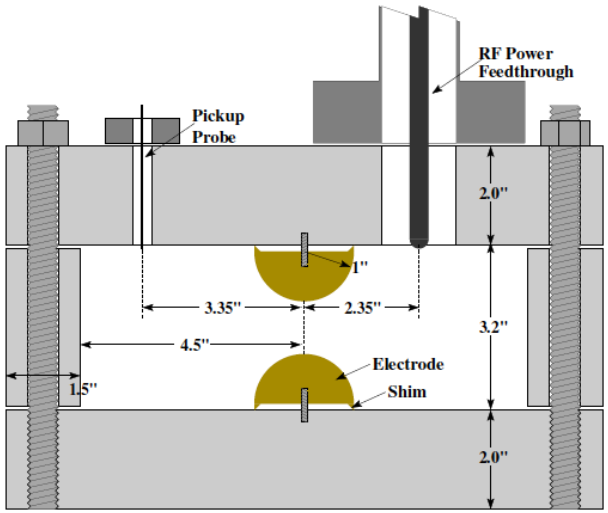


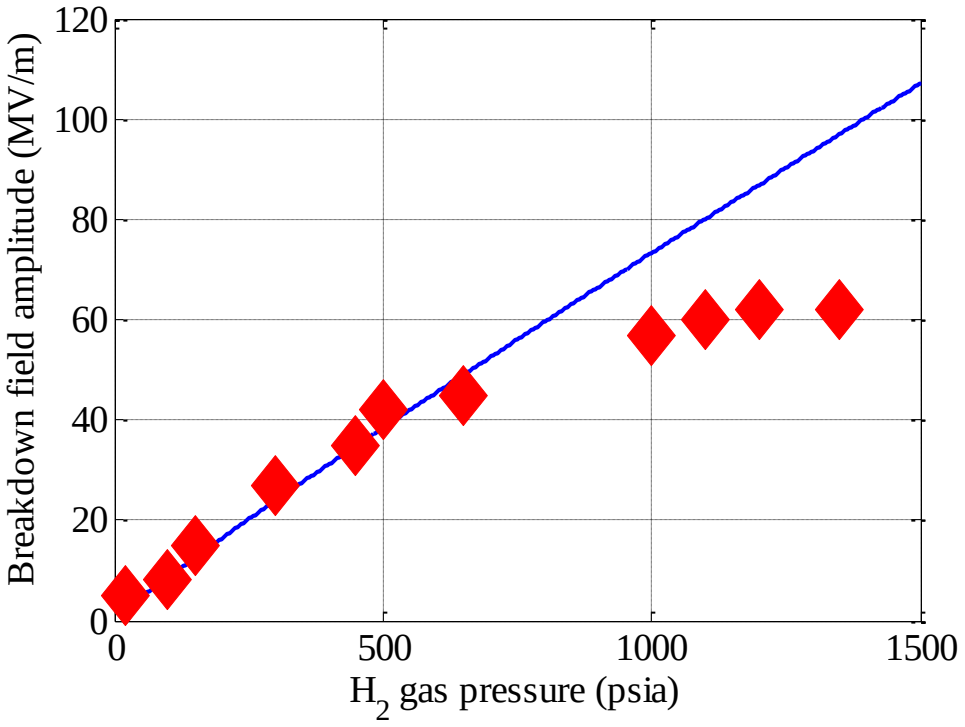
Figure 2: Observed breakdown as a function of gas pressure in copper electrodes with various gases.

E/p ~ 20 V/cmTorr, E = E_p/sqrt(2)

$$\alpha = 5.1\exp\left(-139\, p/E\right)$$

At pulsed breakdown threshold, diffusion loss rate << ionization rate



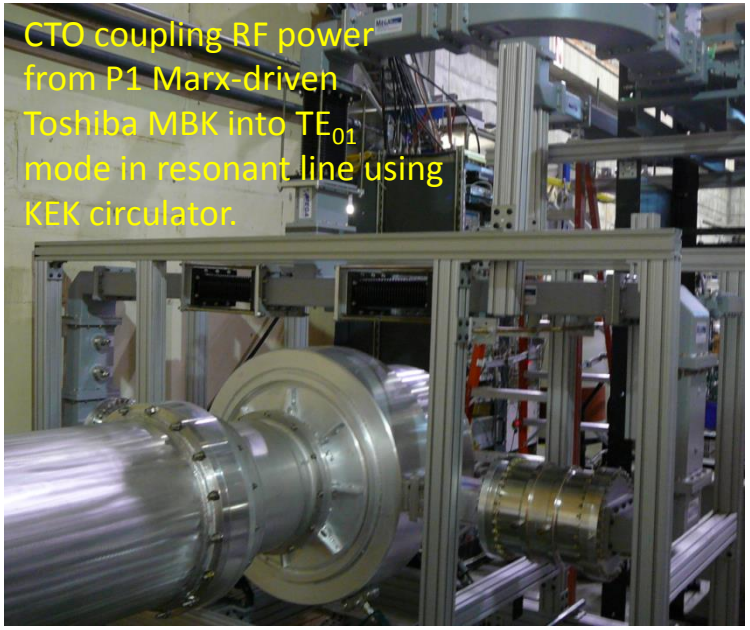


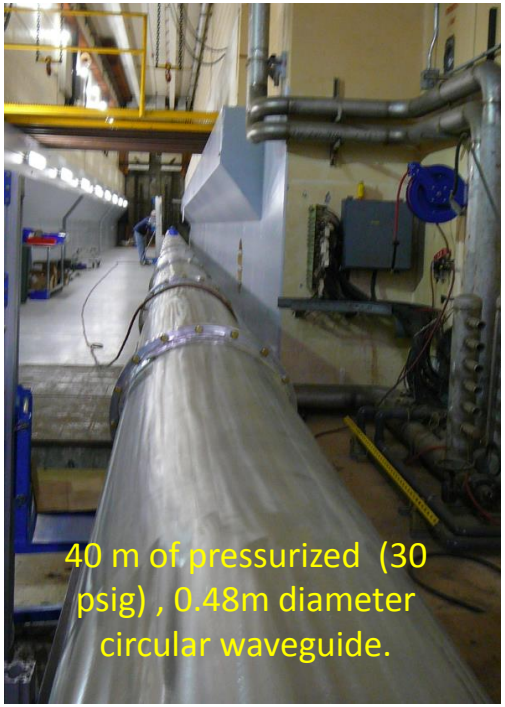
[1] A. D. MacDonald, "Microwave Breakdown in Gases", John Wiley & Sons, Inc., 1966.

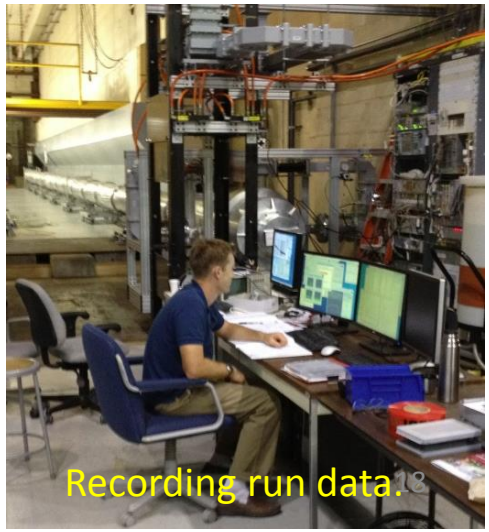
Faya Wang

Forty Meter ‘Big Pipe’ Test Setup

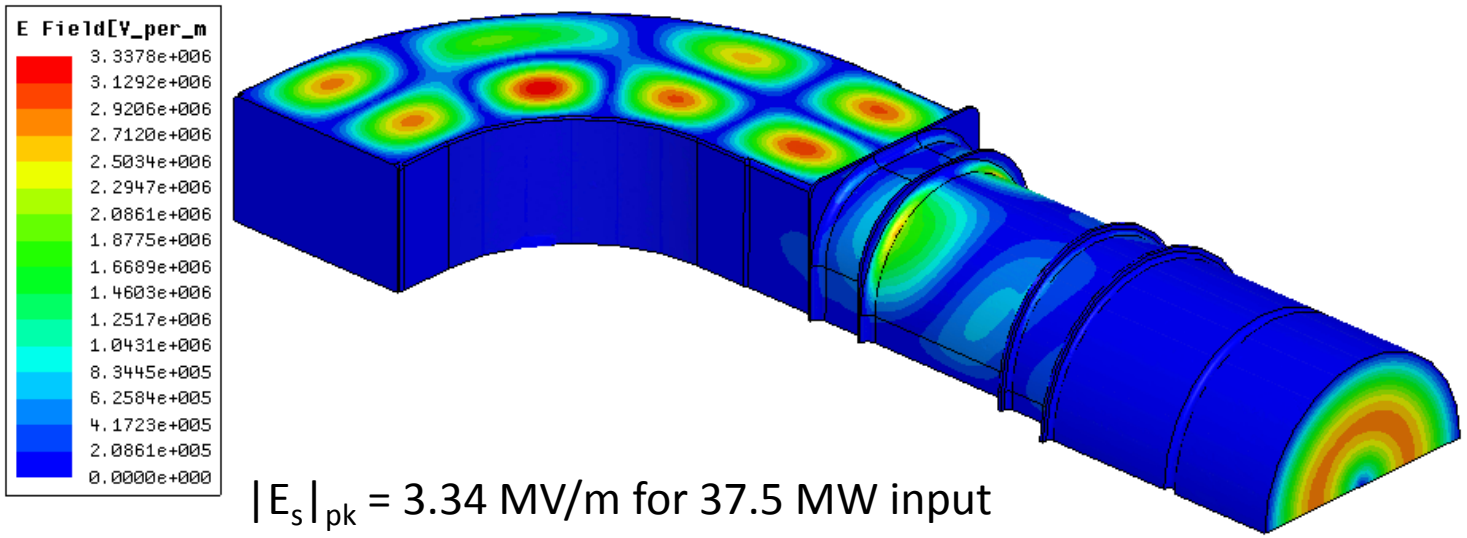
Operated 100+ hours breakdown free at field levels that would be seen in the ILC KCS with the beam current upgrade







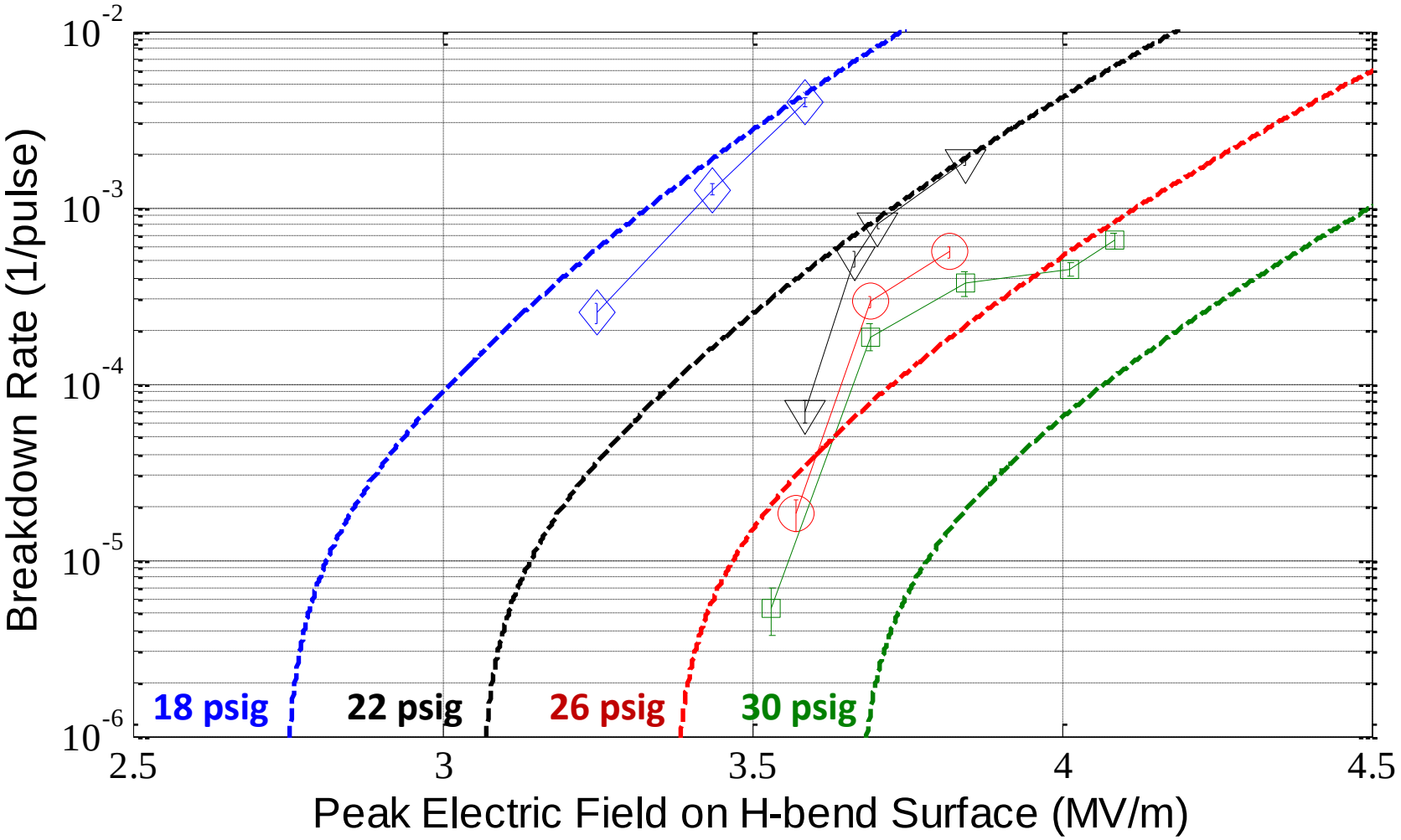
Surface Electric Field in 90 Degree Bend



$|E_s|_{pk}$ = 3.34 MV/m for 37.5 MW input
(= 75 MW full geometry → 300 MW TW equiv. at SW anti-nodes)

Equivalent to 72 MW TW in WR650 !

Breakdown Rate at Various N_2 Pressures



Dotted lines: Predicted electron growth rate in the gas normalized to the 18 psig data

Faya Wang