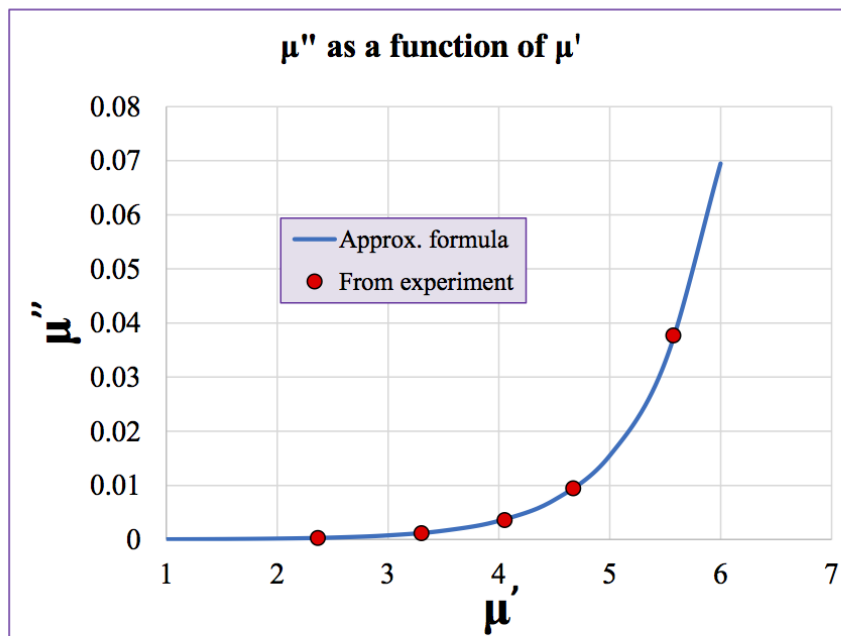# Summary of impedance, PA, and cathode resonator results with new AL800 μ measurements

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The new measurement

Function $\mu''=f(\mu')$ was derived from Robyn's measurements. It was assumed that $\tan\delta_E = 0.0001$, conductivity of copper $\sigma= 5.8\cdot10^7$ S/m, μ'' and μ' are averaged over garnet volume.
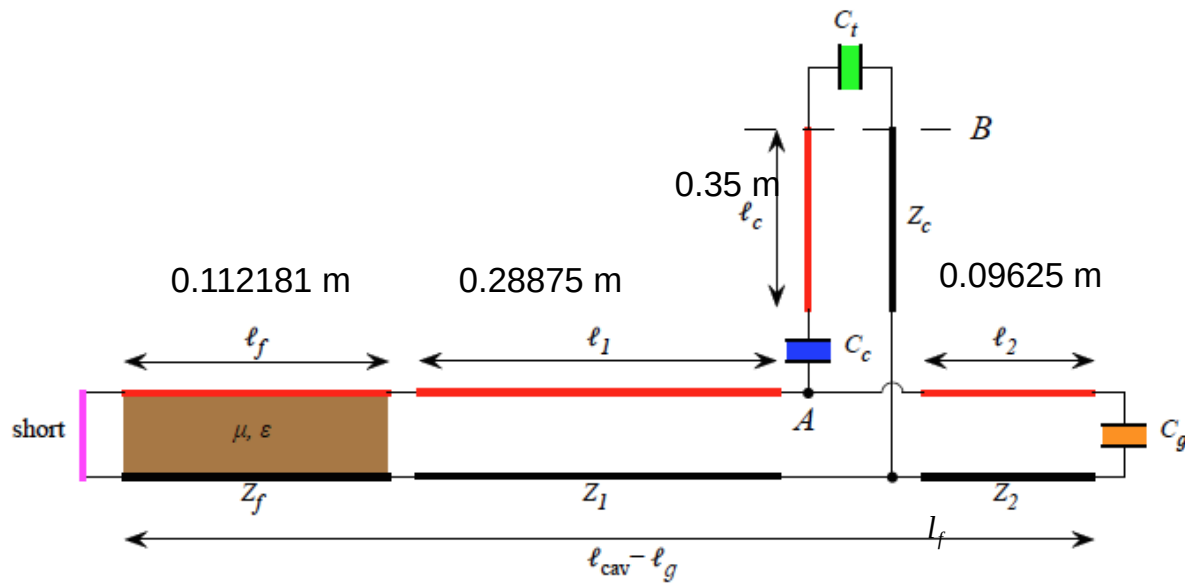

μ" as a function of μ'

The experimental data is well approximated by formula:

$$\mu'' = 8.572\cdot10^{-6}\cdot e^{1.5\mu'}$$

μ'	μ"
1	3.8417E-05
1.5	8.1329E-05
2	0.00017217
2.5	0.00036449
3	0.00077163
3.5	0.00163353
4	0.00345819
4.5	0.00732099
5	0.01549854
5.5	0.03281041
6	0.06945964

Summary of dimensions used in calculations

Parameter	value	comments
C_c	10 pF	Coupling capacitance
C_t	60 pF	Tube capacitance
C_g	3.4 pF	Gap capacitance
rfi	0.105 m	Inner radius of ferrite
rfo	0.170 m	Outer radius of ferrite

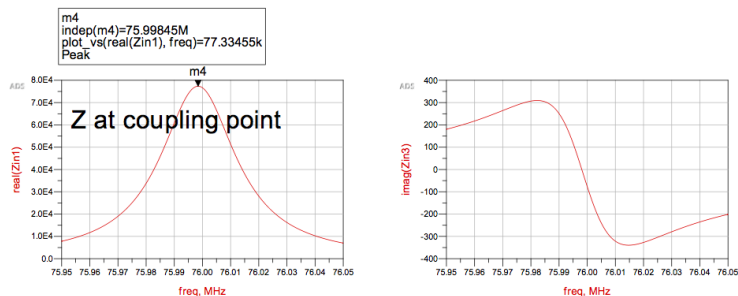| Parameter	value	comments
Z_1, Z_2	61.299 Ω	Non-ferrite characteristic impedance
Z_c	20.9269 Ω	Characteristic impedance of coupler

Equivalent circuit in ADS
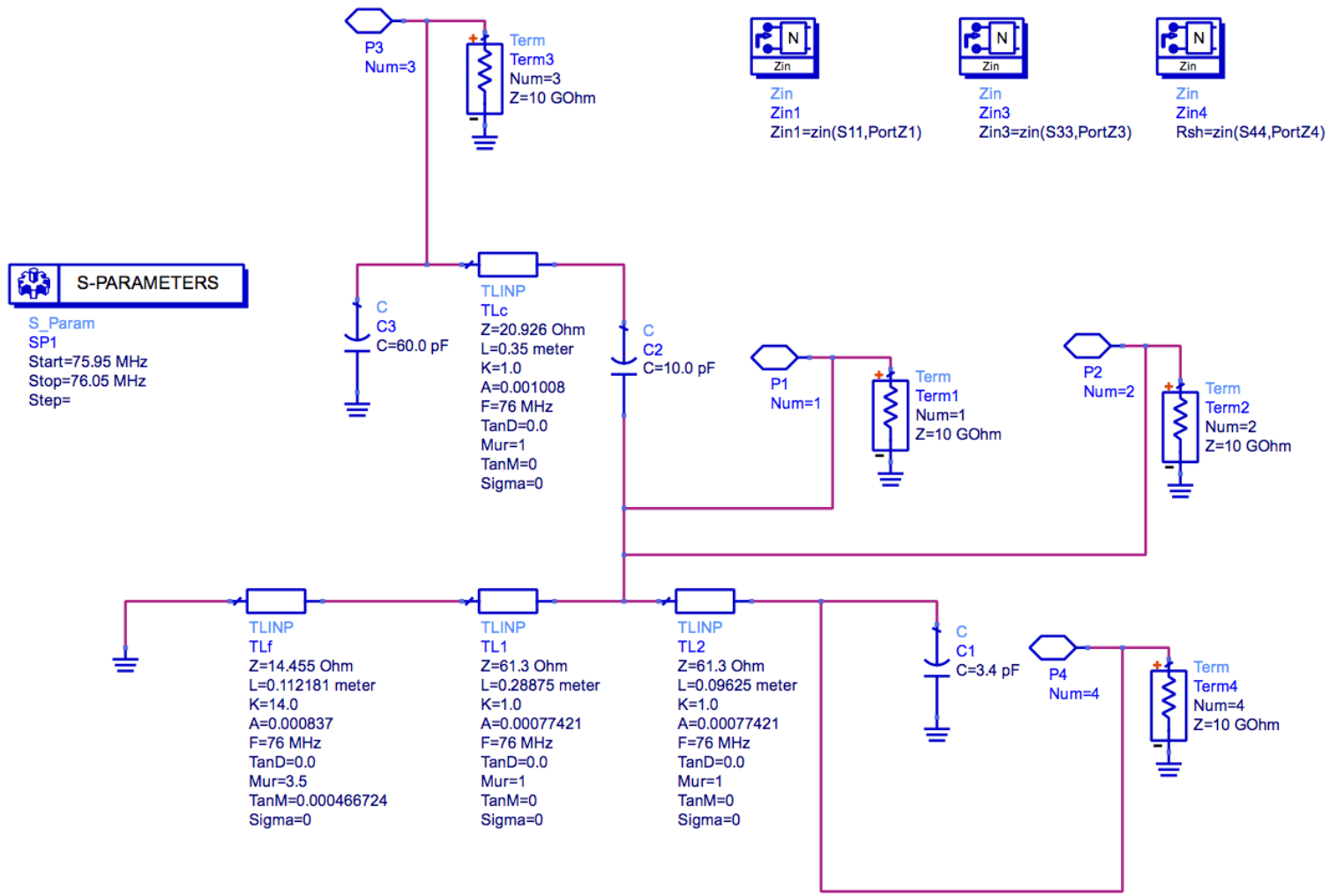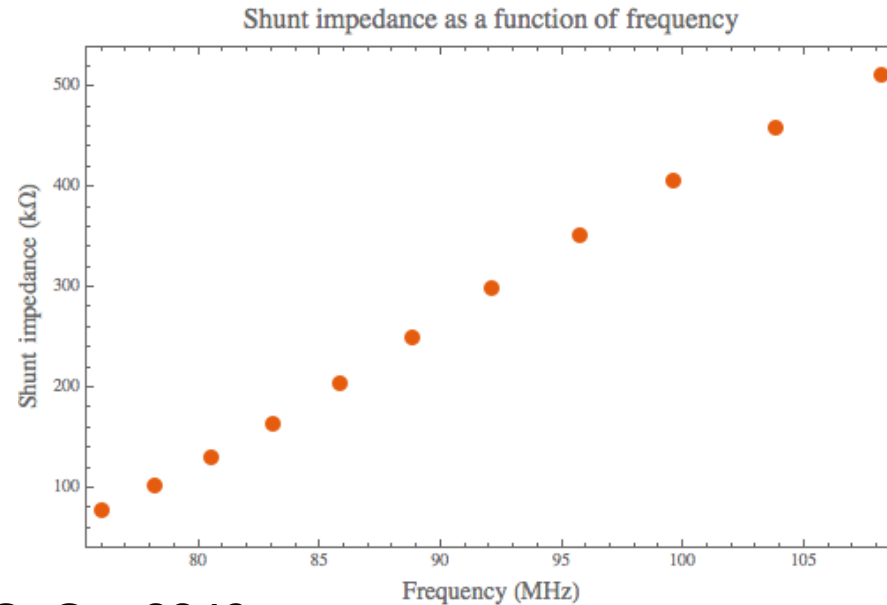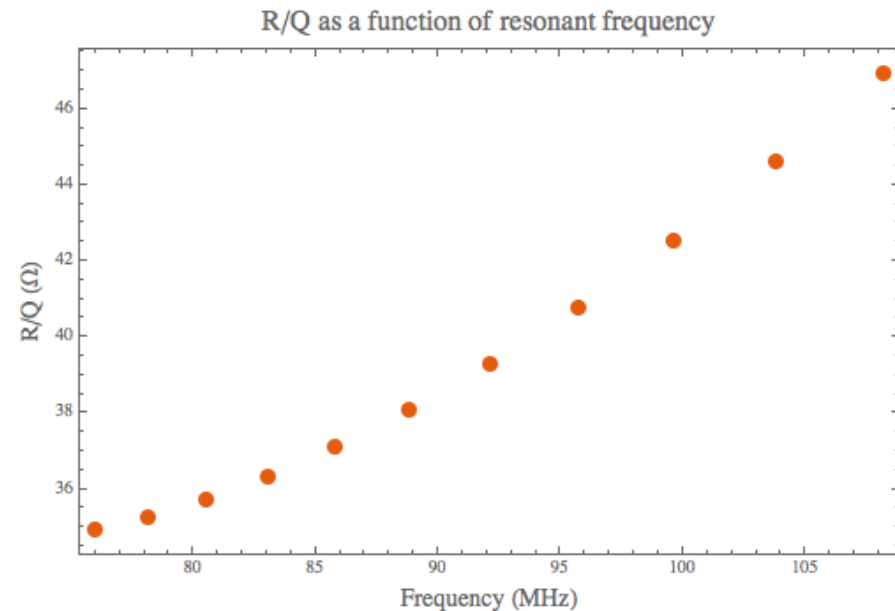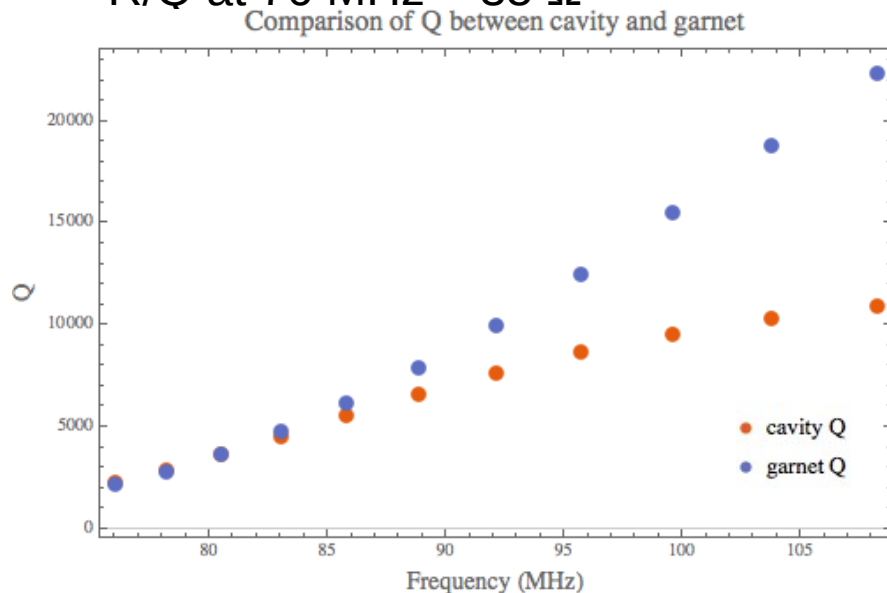
Example ADS results at 76 MHz
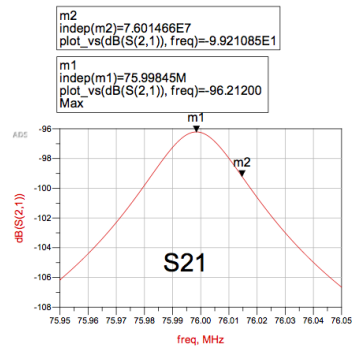
At 76 MHz:
Shunt impedance = 81.6 kΩ
R_{anode} = 649 Ω
Q = 2345
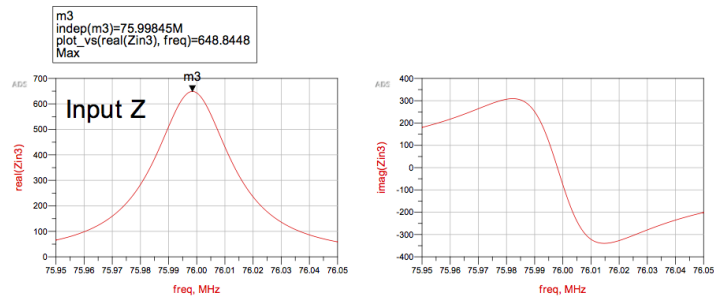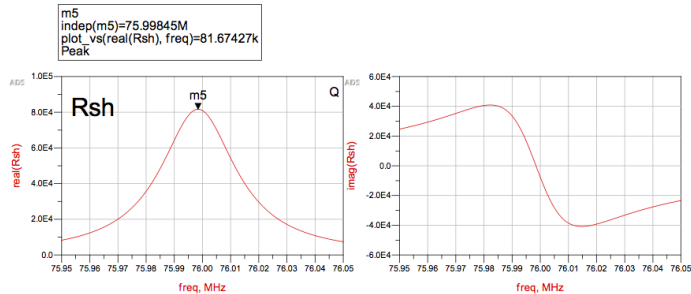
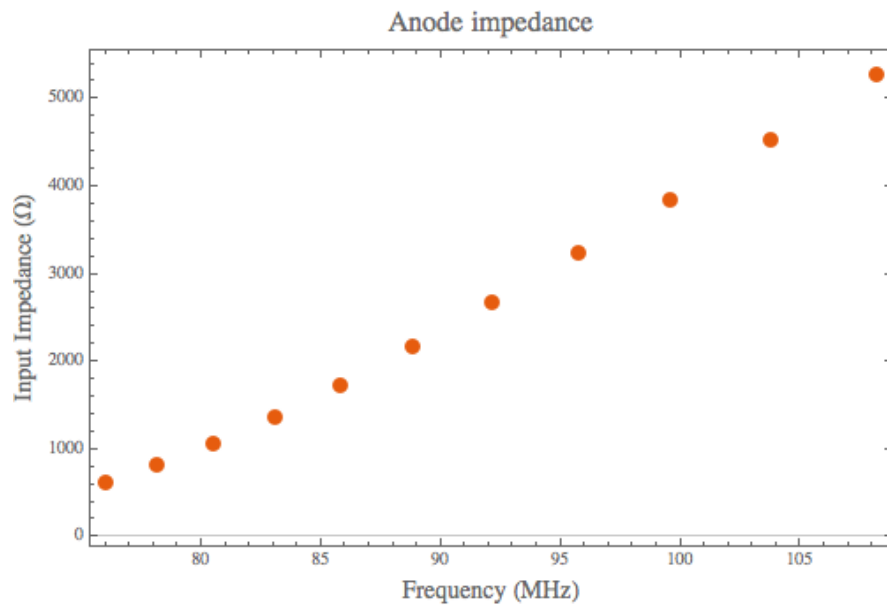# The following are results from Mathematica (essentially gives same results at 76 and 108 MHz with ADS)

Resonant frequency as a function of permeability

Shunt impedance as a function of frequency
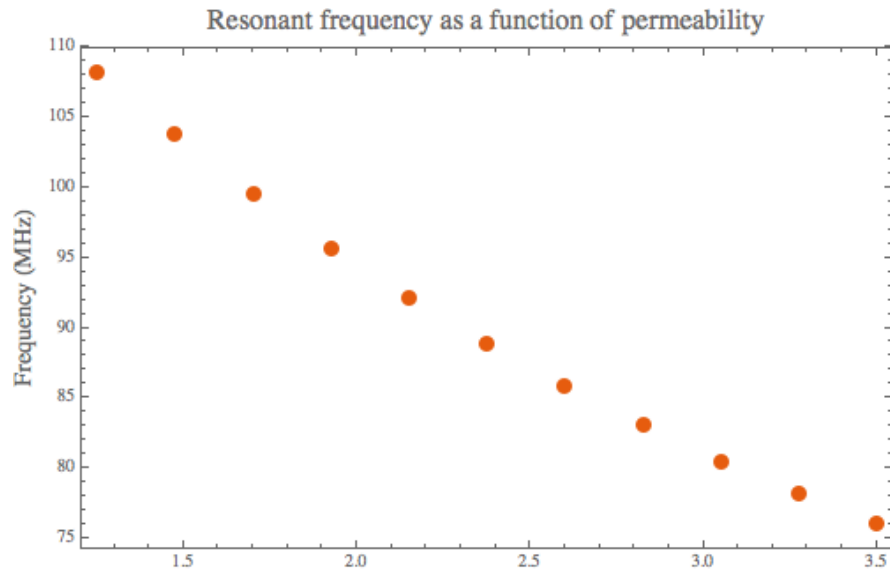
Shunt impedance at 76 MHz = 78.5 kΩ, Q = 2249
R/Q at 76 MHz = 35 Ω

Comparison of Q between cavity and garnet

R/Q as a function of resonant frequency

Anode impedance

Z_{anode} at this point
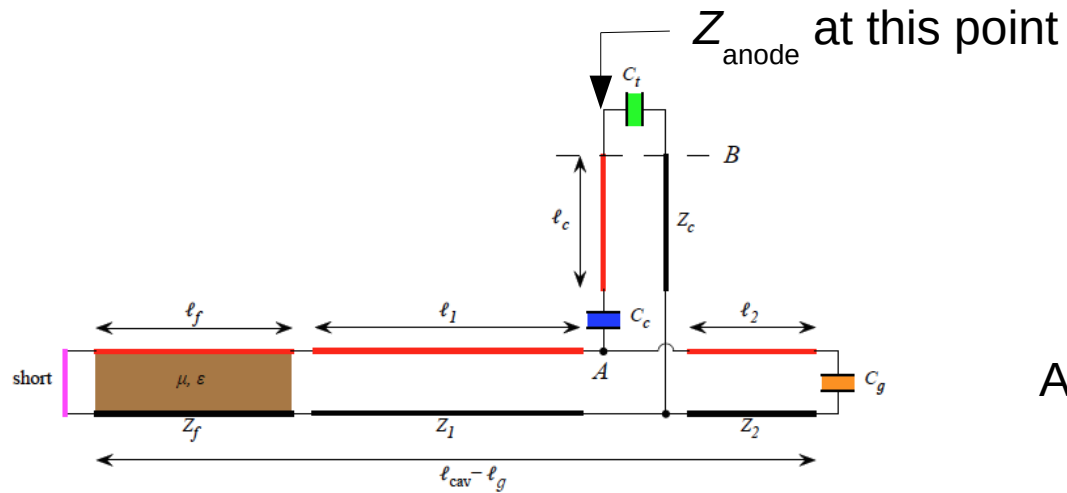
At 76 MHz = R_{anode} = 624 Ω

Anode impedance

Voltage along the cavity
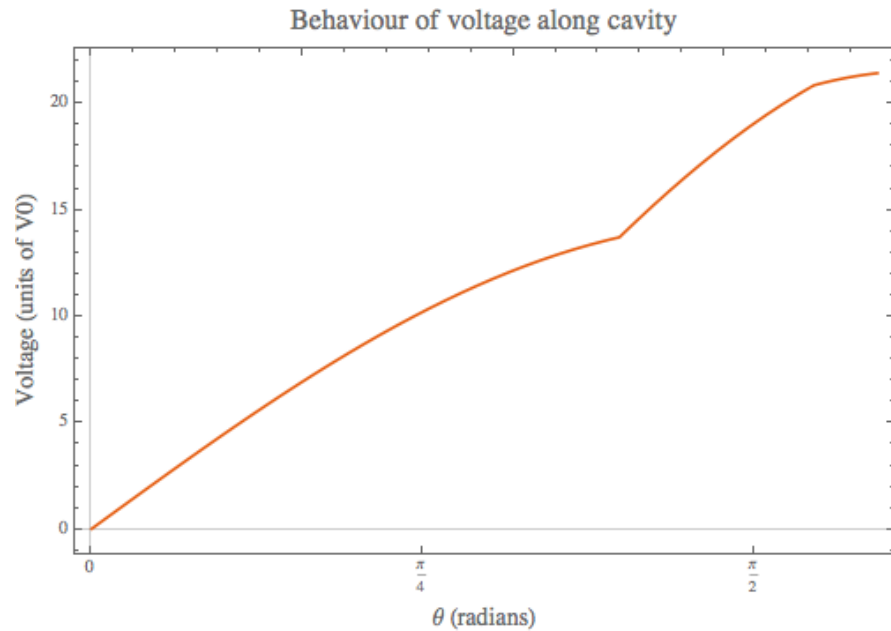
In terms of phase
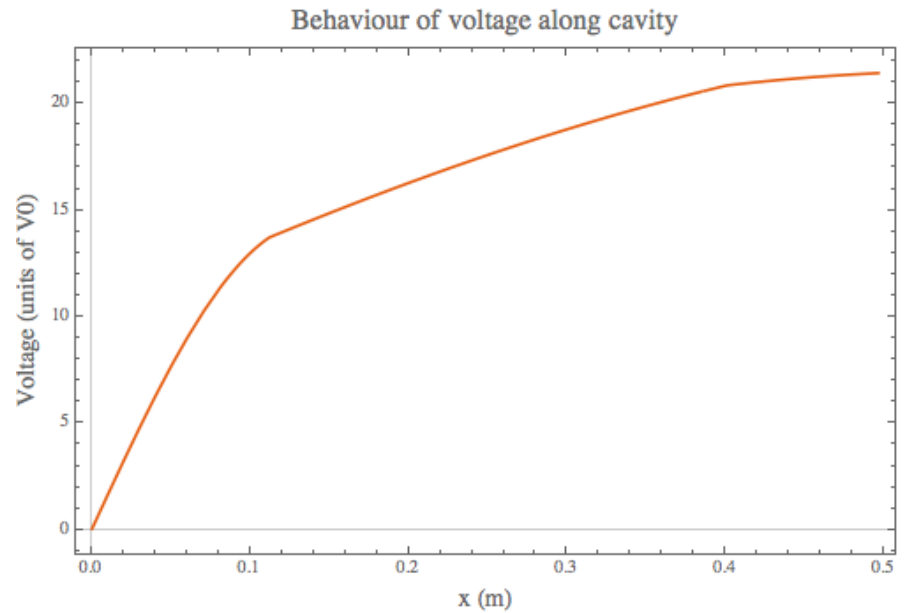
In terms of position

Stepup ratio

Step up ratio from tube to gap
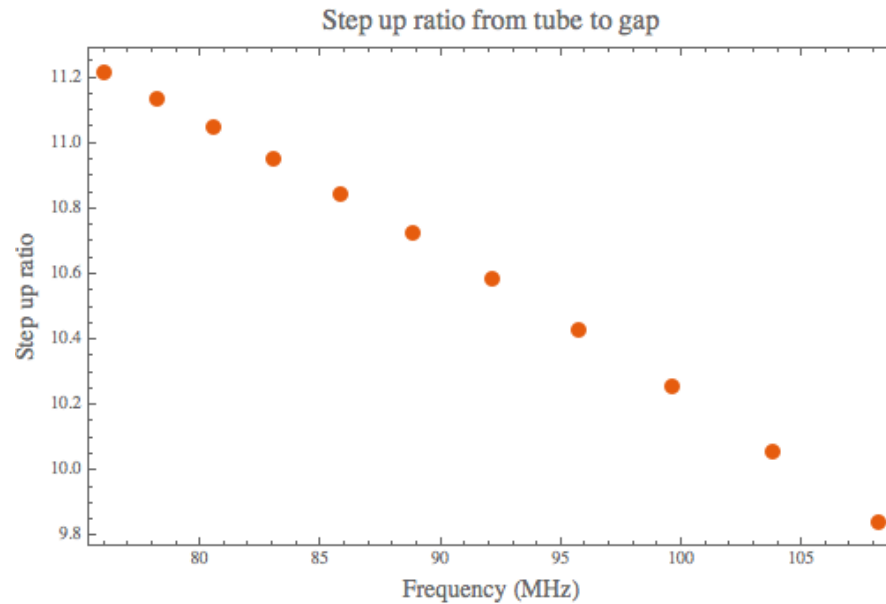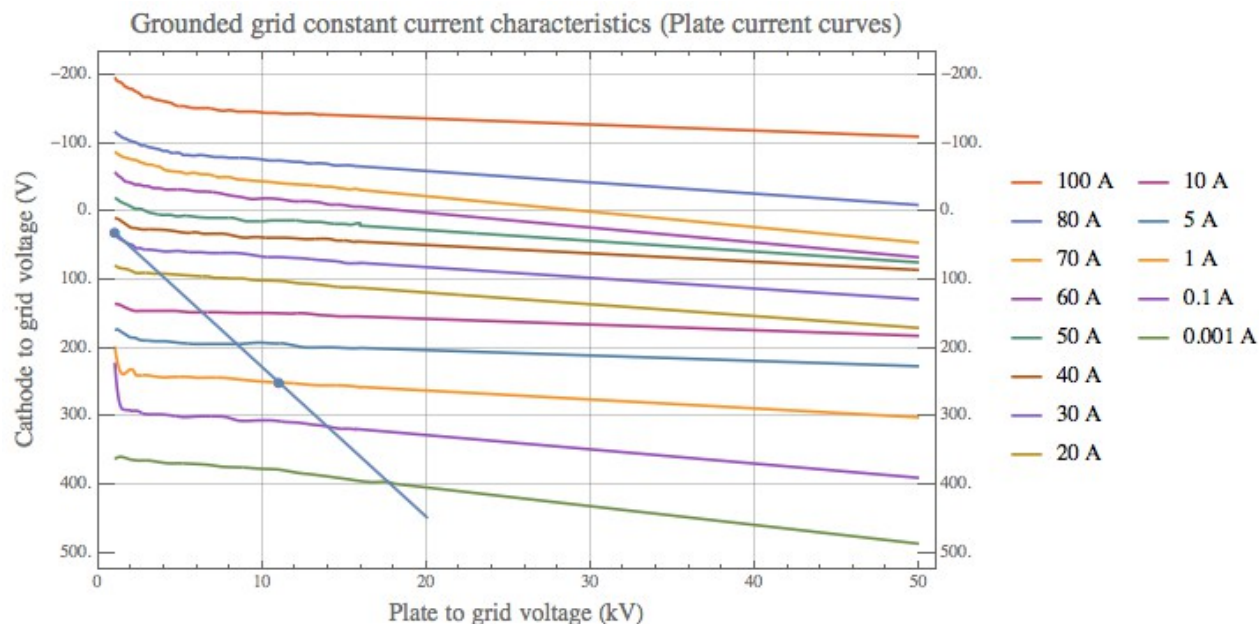

This is highly dependent on the coupling capacitance that we have chosen. Can be changed later.

Assume stepup is 10 for now.

Y567 Grounded Grid Load line

Grounded grid constant current characteristics (Plate current curves)

The two points that were chosen are:
Right hand point (Vanode = 11 kV – assuming stepup of 10, 1 kV
screen voltage, and Vcathode = 250 V cathode to grid bias)
Left hand point (Vanode = 1.025 kV – screen to grid bias,
I peak = 4 * I0 = 31 A)

I0 = takes into account the inefficiency of class B operation, Vgap =
100 kV and Rshunt = 78.5 kΩ.

Fourier components

Anode current waveform
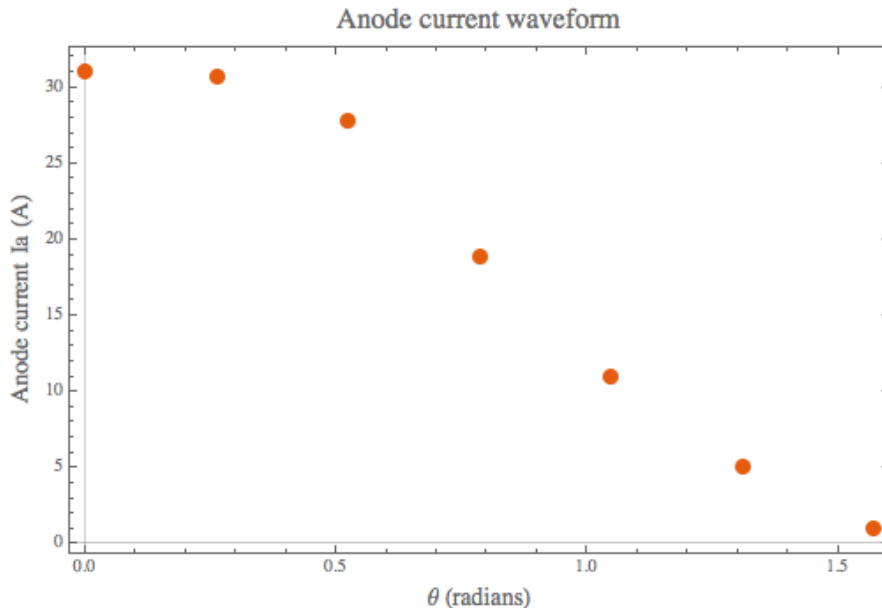
Idc = 8.8 A, and thus DC input power Vanode = 11 kV => Pdc = 96 kW.
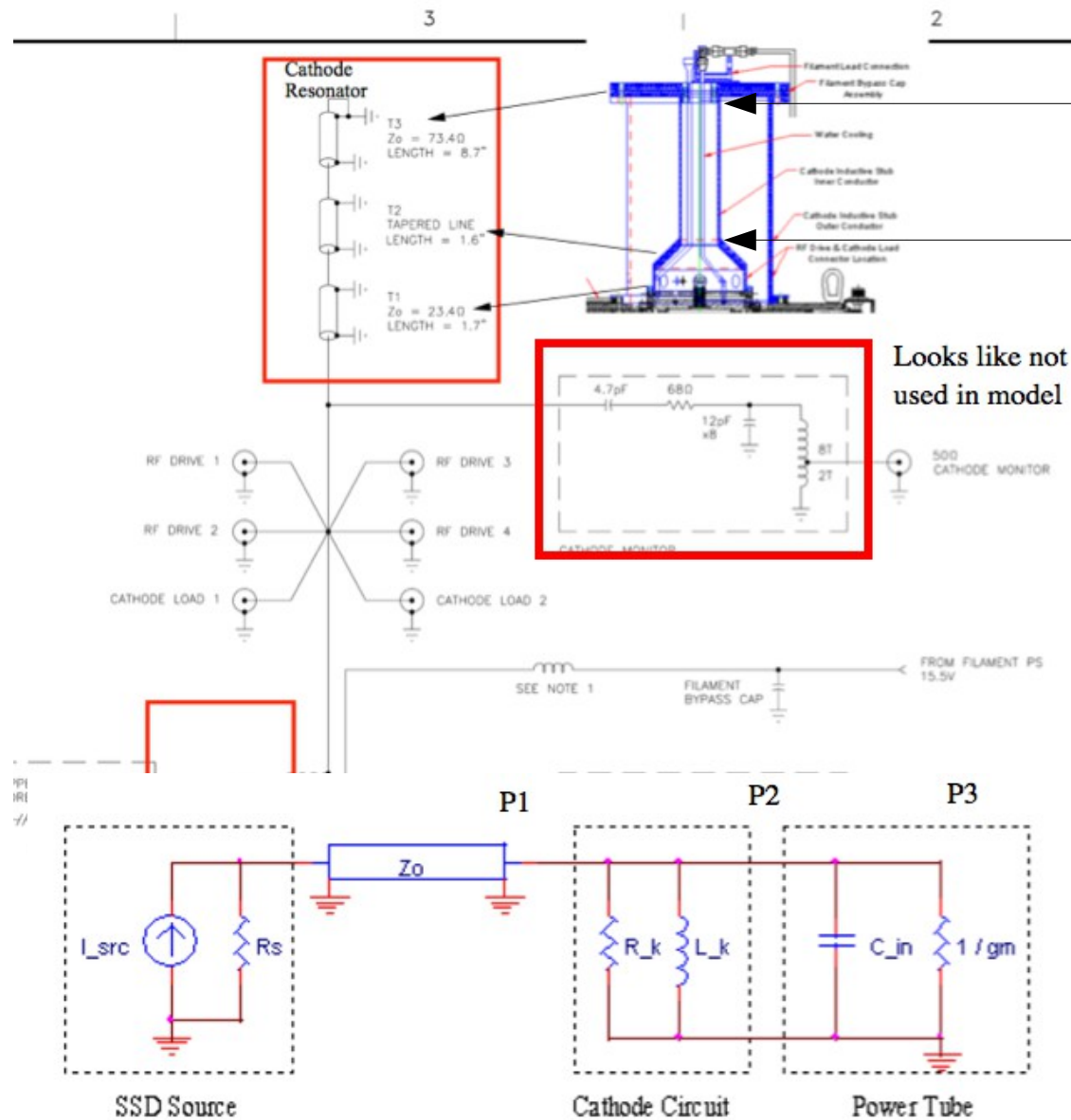
I@76 MHz = 14.2A gives Prf = 71.3 kW

Efficiency = 0.74

The load resistance (which I assume is the anode resistance) = 698 Ω

This number is consistent with the anode resistance calculated earlier = 624 Ω
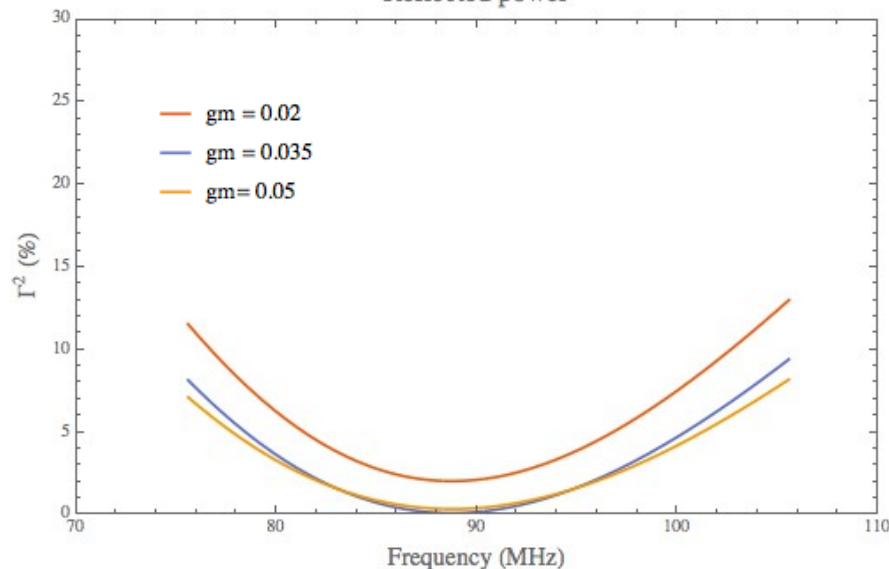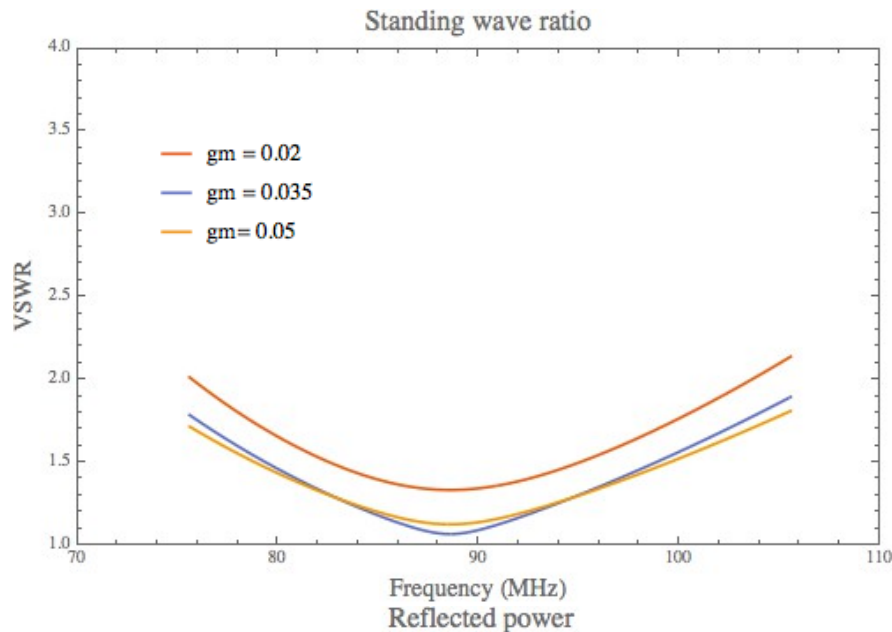
Cathode side of the tube

To get the cathode resonator to resonate between 76 MHz to 106 MHz, the length of this transmission line has been reduced from 22.1 cm to < 3.3 cm.

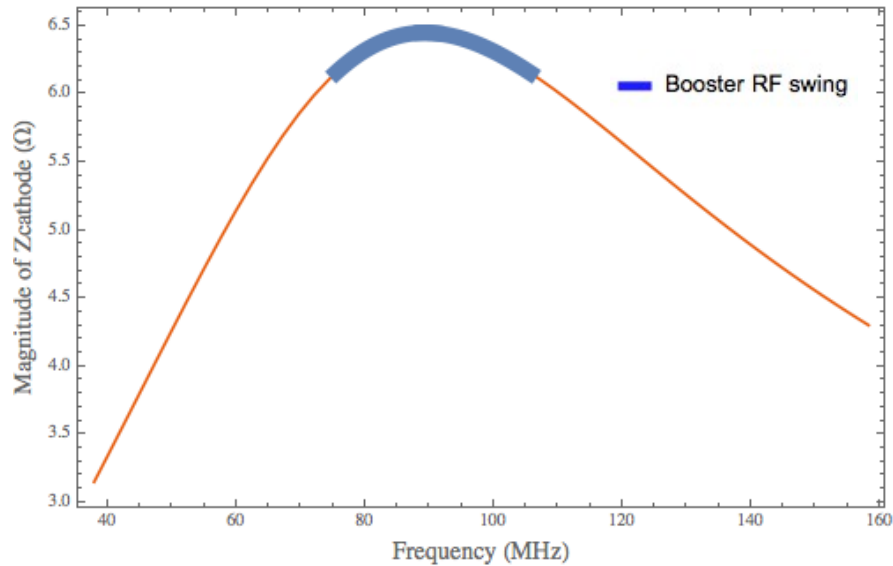# Optimize to make VSWR more symmetric about frequency range

I reduced the length of L03 from 3.3 cm to 1.3 cm and reflections got a lot better across the frequency range. However, it is **worse** at 76 MHz. Although using gm=0.035, the power reflected is < 10%.
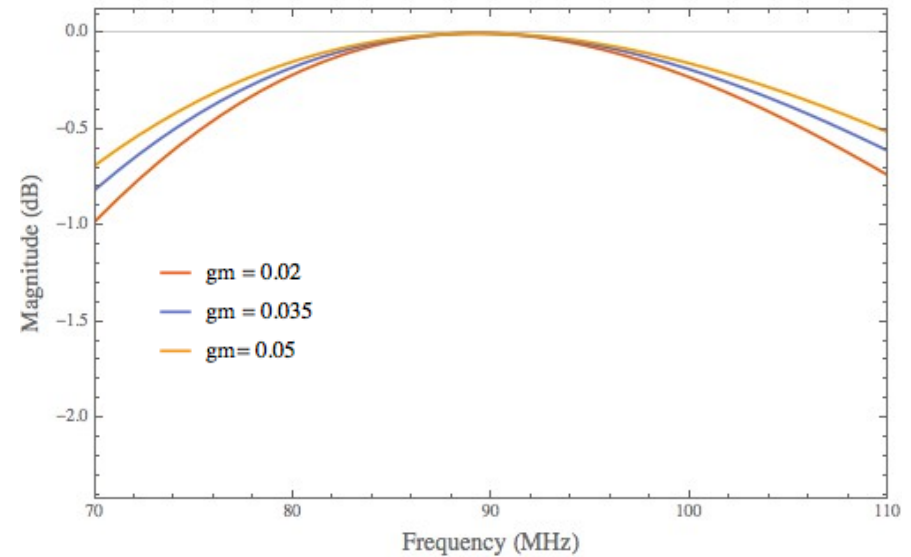
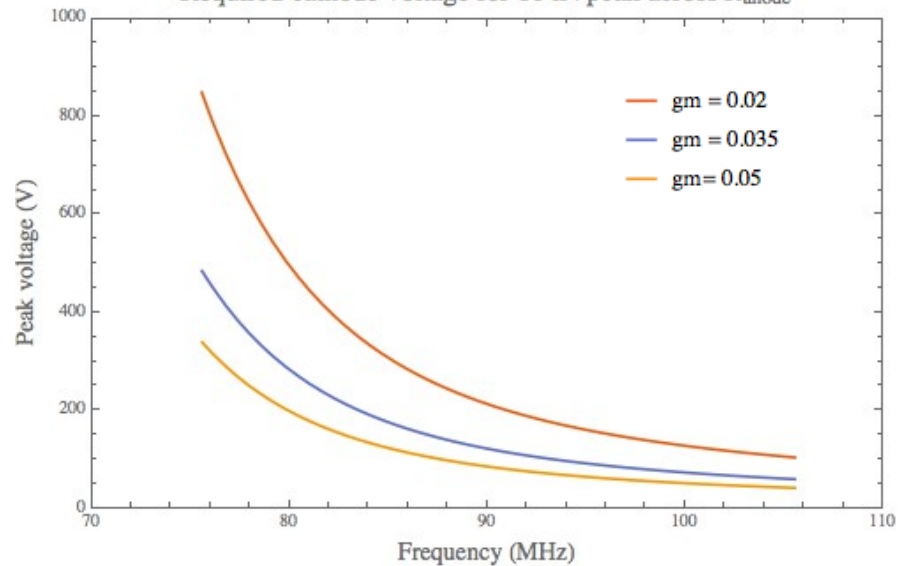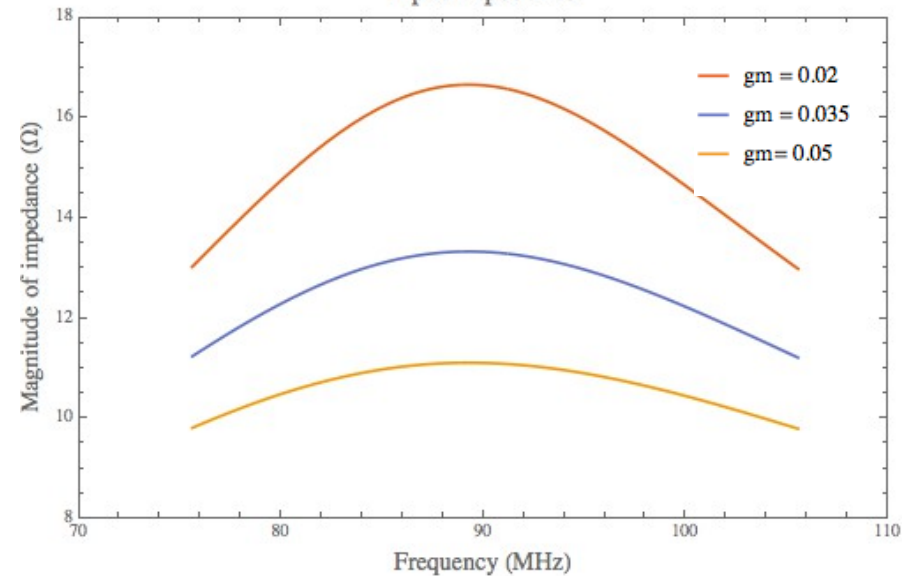VSWR is now < 2 everywhere and reflected power < 12%.

Optimized results

Optimized results (cont'd)

Input impedance

RMS source power required for 10 kVpeak across R_{anode}

RMS Power dissipated in Rk for 10 kVpeak across R_{anode}
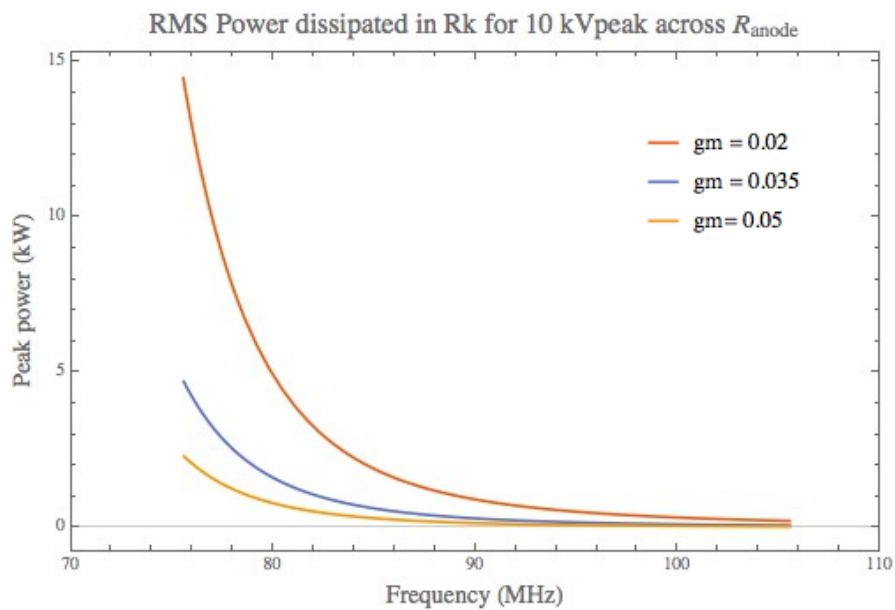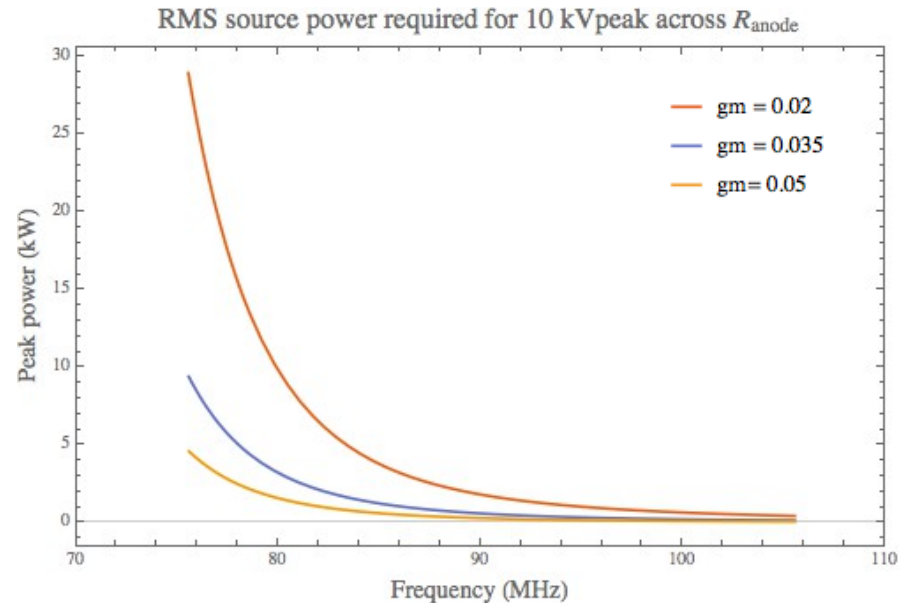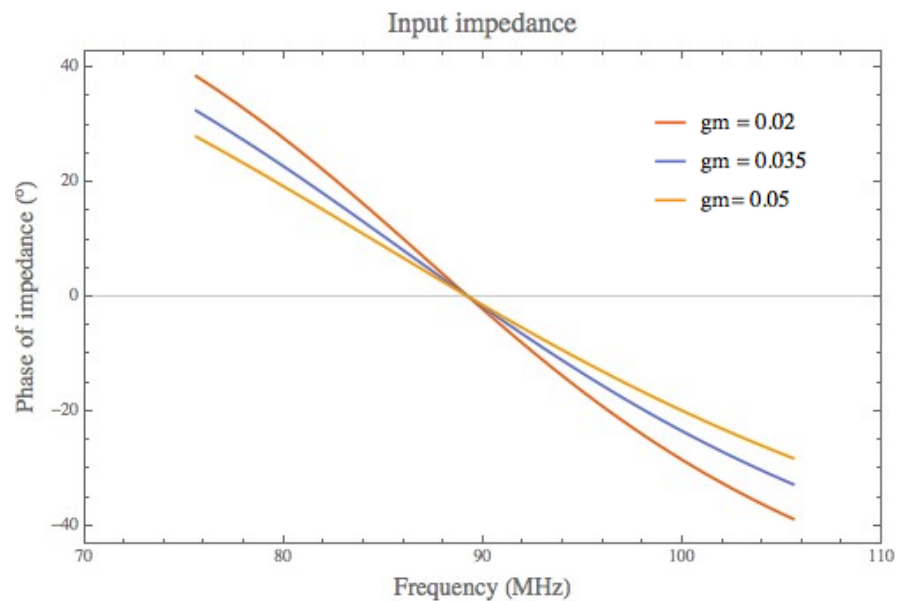
Summary

- No power reflection calculation because we had a wrong idea about the tube resistance being fixed at 1.4 kΩ.
  - Mismatch of PA to cavity comes from the tube not working completely in class B.

- Power requirements ~96 kW are reasonable for 100 kV gap voltage.

- Modifying cathode resonator does not seem to be too difficult.
  - Essentially one part of the present cathode resonator needs to be reduced in length to nearly zero length.
  - Need to build a test station with 76 – 106 MHz to show that the Y567 tube can supply the required power.