KCS Main Waveguide Testing

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LCWS12

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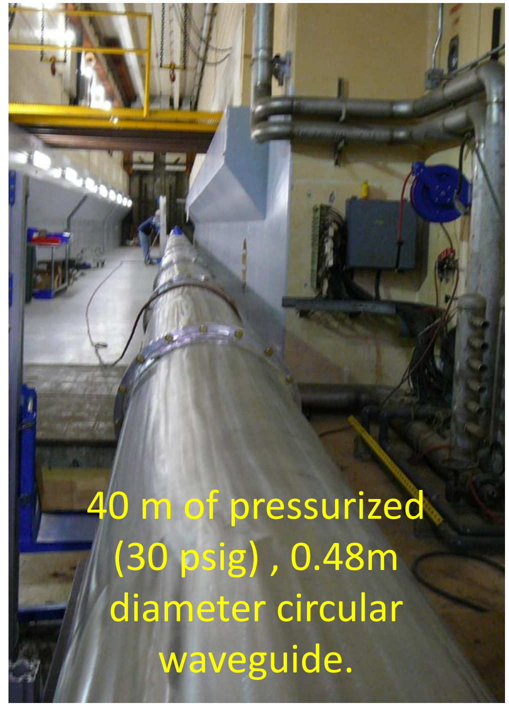
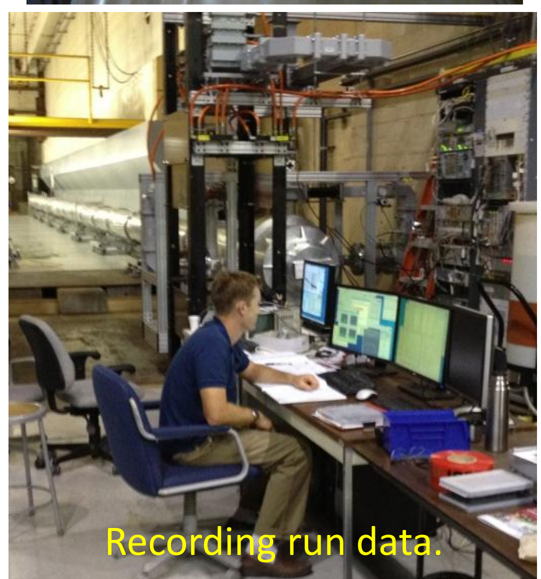
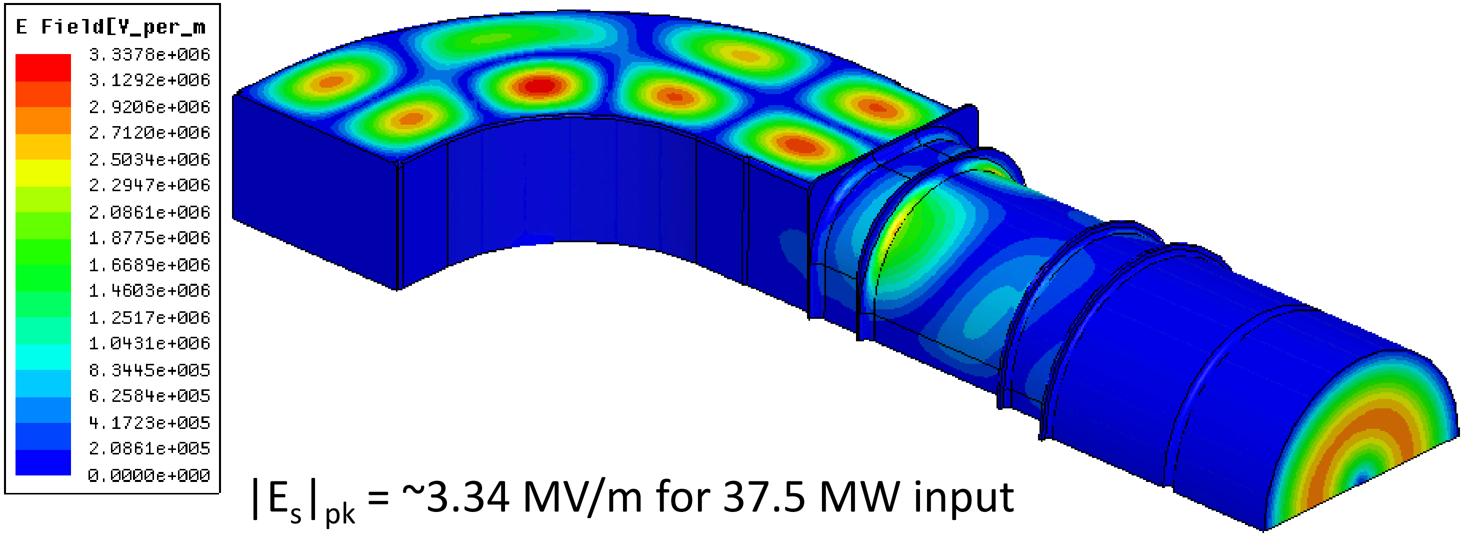




Surface Electric Field in Installed Shorted 90 Degree Bend



$|E_s|_{pk}$ = ~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 !

Theoretical Calculations for 40 m Shorted KCS Waveguide + 90 Bend

Round trip loss: .98806*.99653*.99991 = 0.984545 → 1.545%, field atten. factor: 0.99224

Round trip delay time: 357.1 ns

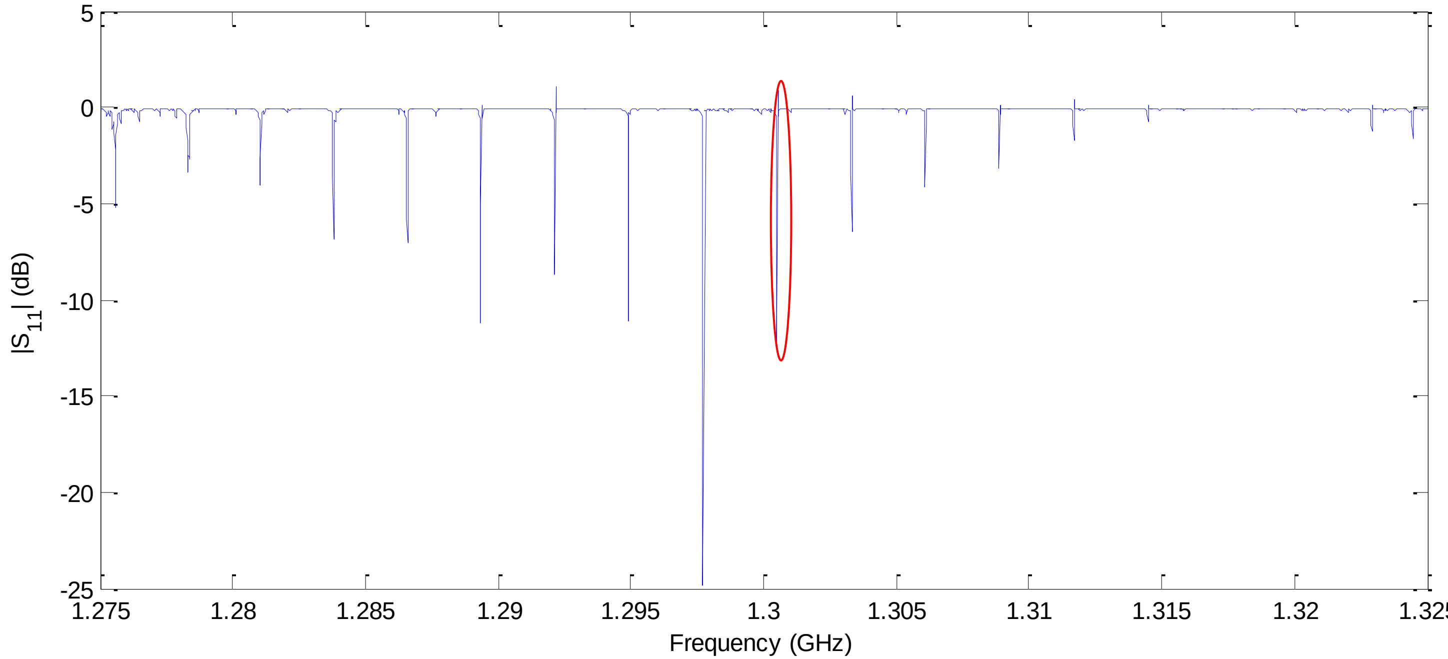
$\exp(-t_{rt}/T_{c0}) = 0.99224$ → $T_{c0} = 45.8\ \mu s$ → $Q_0 = \omega T_{c0}/2 = 187{,}230$

300 MW equiv. field max → P = 75 MW, traveling power (fwd.&bkwd)

Stored energy: U = 26.8 J

Input power for beta = 1: $P_d = 1.17$ MW

Big Long Pipe w/ Bend* Resonant Cold Test

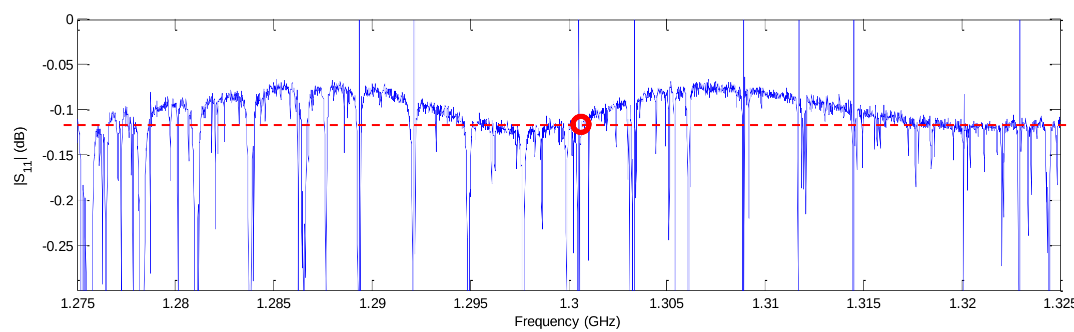


Resonances:

f_r (GHz)	Δf_r (MHz)
1.27559	
1.27831	
1.28105	
1.28380	
1.28657	
1.28934	
1.29214	2.80
1.29492	2.78
1.29772	2.80
1.300516	2.80
1.30331	2.79
1.30609	2.78
1.30889	2.80
1.31169	2.80
1.31448	

Δf_r = ~2.794 MHz

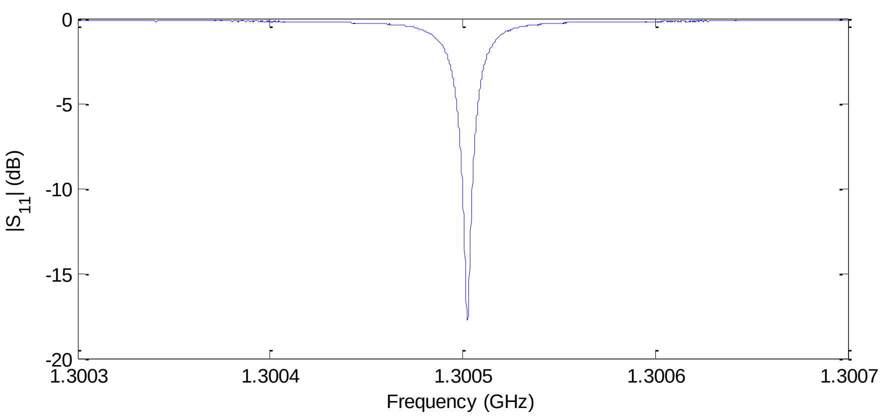
n = ~340

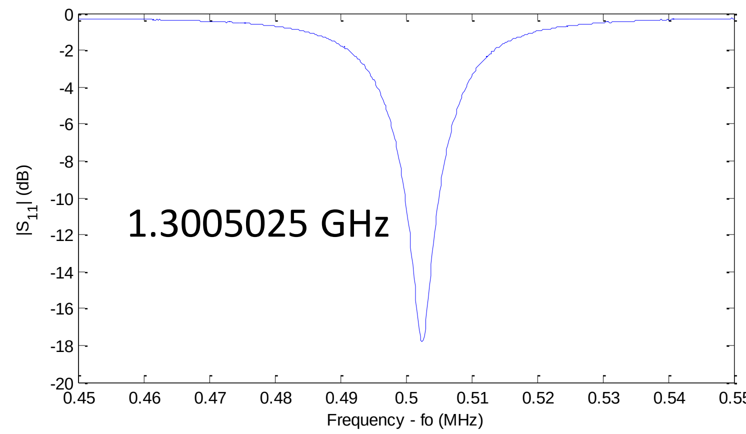


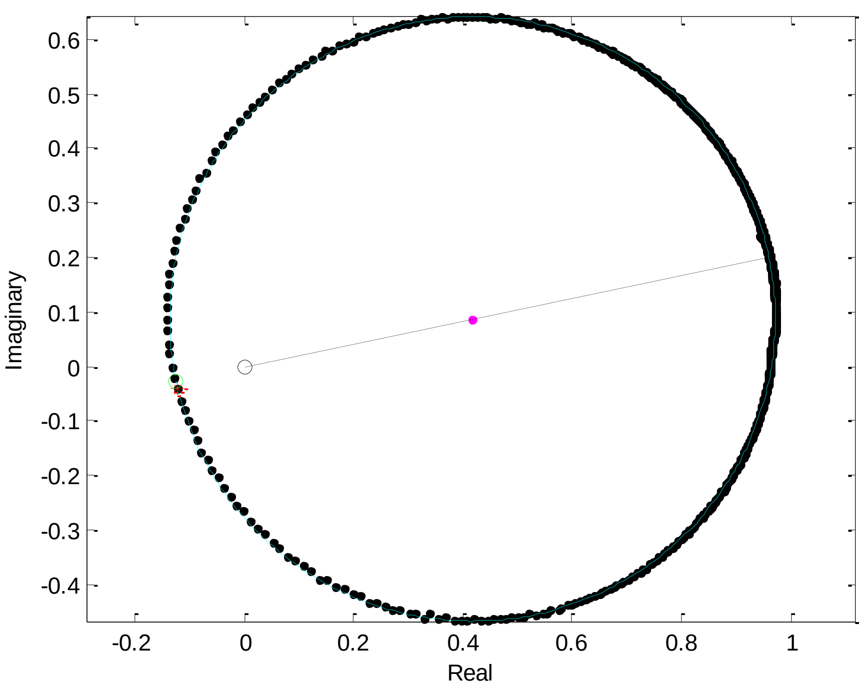
Approximately 0.12 dB input loss at operating resonance.

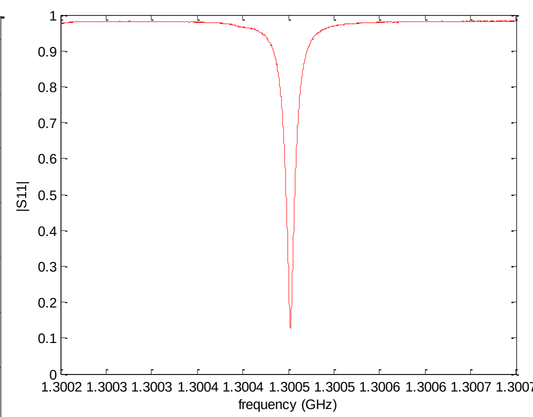
* minus second transition

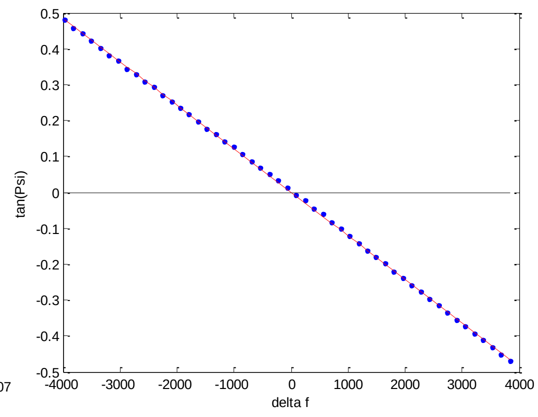
Analysis of Nearest Resonance











f_r = 1.300502 GHz (cold, unpress.)
Q_L = 78,839
β = 1.2997
Q_0 = 181,310

Combining Measurements with Calculations

Input Power (beta =1) : $P_d = \omega U/Q_0$ = 1.17 MW

for 75 MW resonant power (300MW TW equiv.)

Measured (cold test) β = 1.300 $\rightarrow$ $P_i = \frac{(1+\beta)^2}{4\beta} P_d$ = 1.19 MW

Or, using measured Q_0 (181,310): $P_d = \omega U/Q_0$ = 1.2067 MW $\rightarrow$ P_d = 1.23 MW

(3.2% lower than predicted)

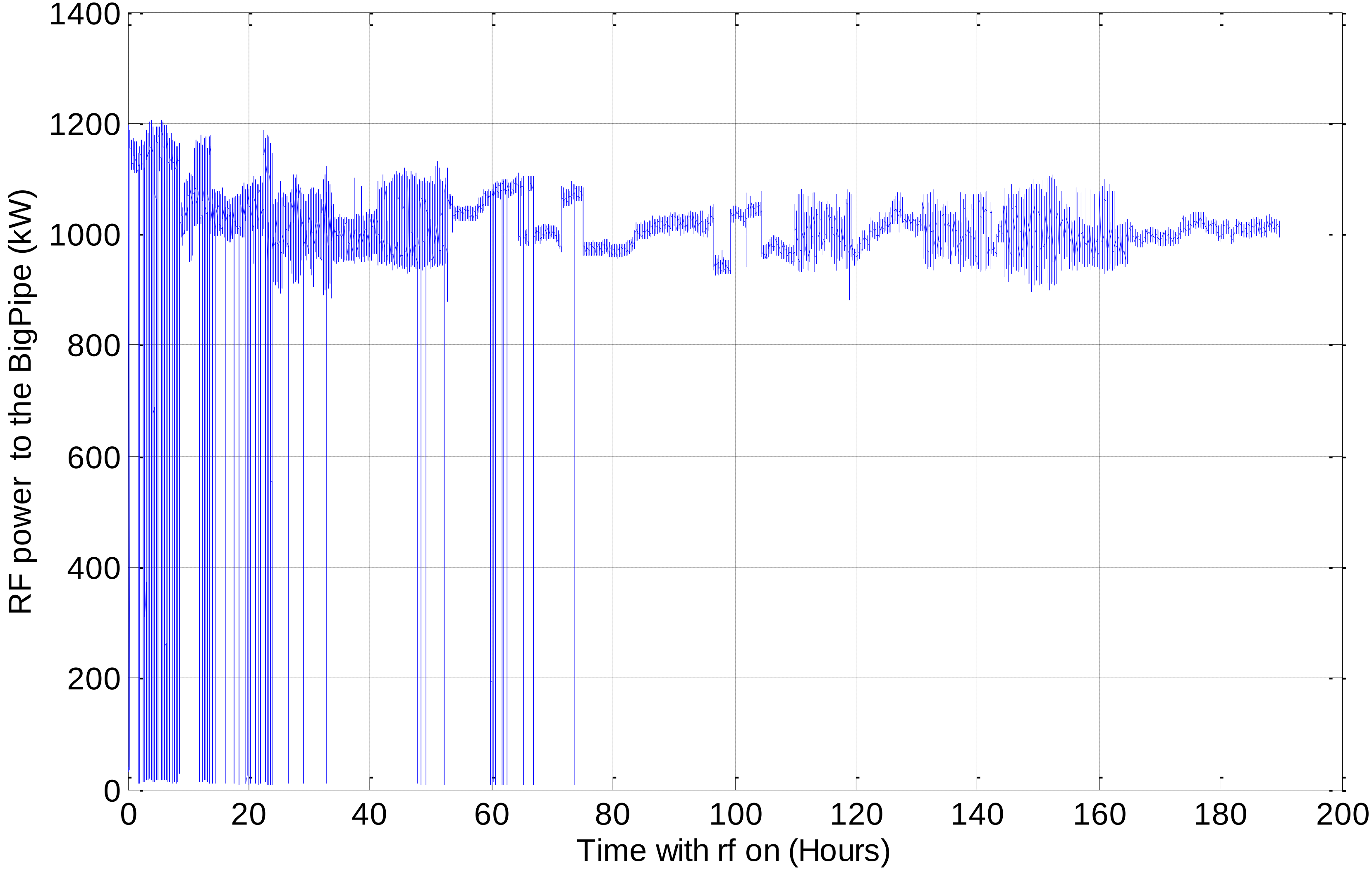
Faya's high power measurement:

At input power of 320 kW, the reflection is 2 kW from hp power meter.

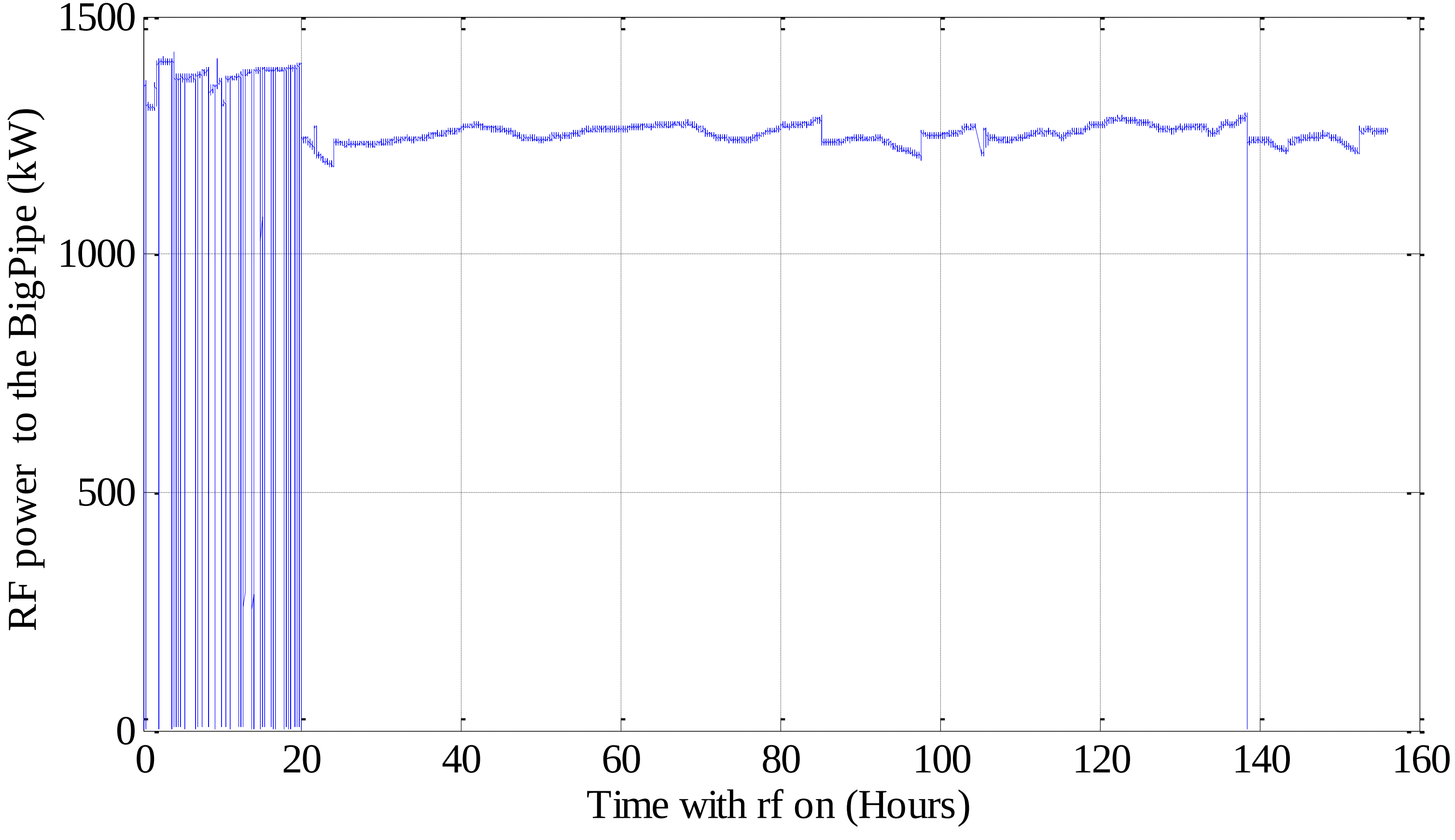
Therefore, the β = ~1.17.

➡ We need to run the shorted waveguide on resonance with 1.18 MW input power.

First Run: 1 MW input (255 MW field equivalent – ILC needs only 190 MW initially), no breakdown in 120 hours with 1.6 ms pulses at 3 Hz

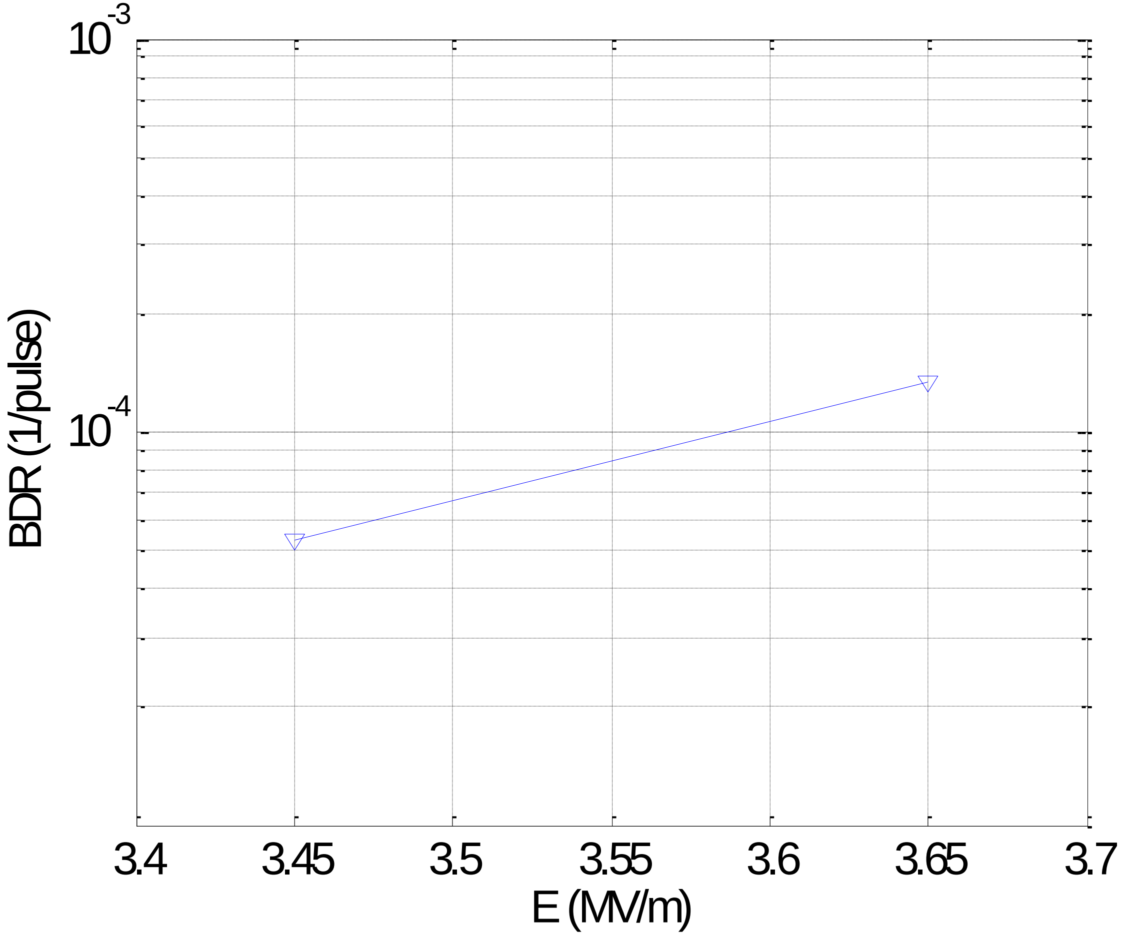


Second Run: 1.25 MW input (313 MW field equivalent – ILC needs only 190 MW initially), one breakdown in 140 hours with 1.6 ms pulses at 3 Hz



1. Coupling coefficient β = 1.17
2. Power needed for equivalent field of 300 MW, Pin = 1.18 MW.

Breakdown Rate vs E-field (at 30 psig, 200 us)



Breakdown Rate vs Pulse width (at 30 psig)