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7.8GHz Power Extractor Using Dielectric Loaded Waveguide

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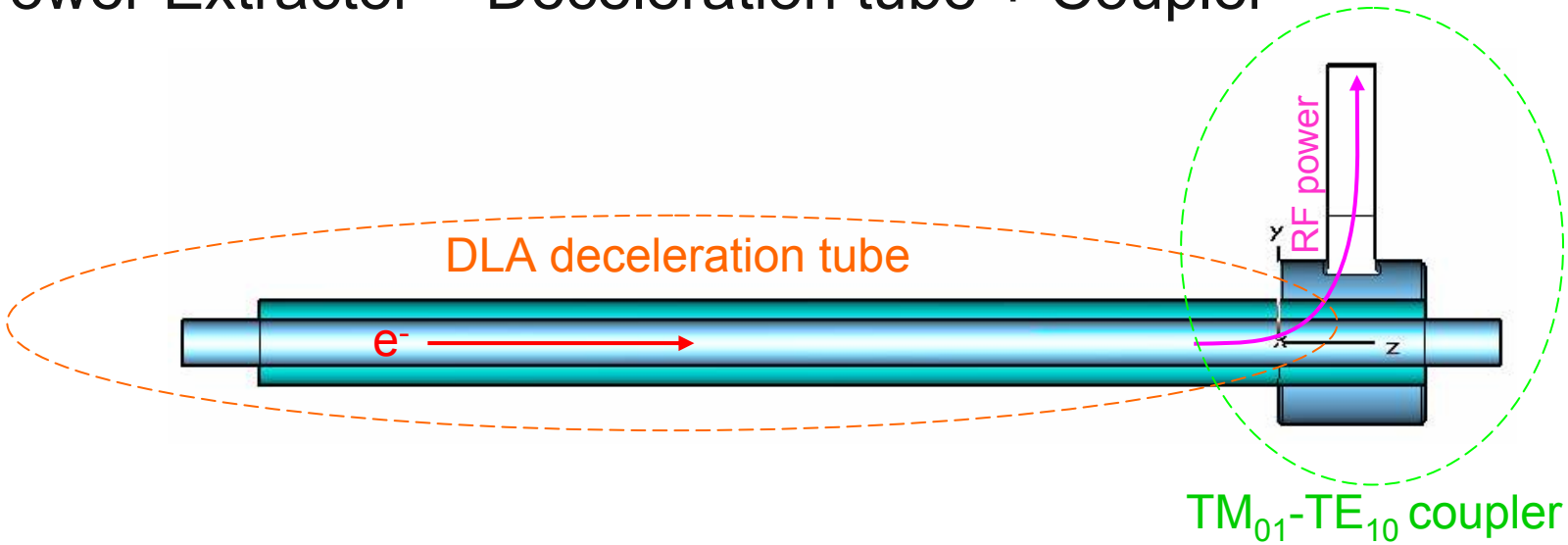
Introduction

- The 7.8GHz power extractor is the first stage of the AWA two beam acceleration (TBA) experiment
- The power extractor can also be used for other high power applications
- 7.8GHz is the 6th harmonic of the AWA linac frequency 1.3GHz

Power Extractor = Deceleration tube + Coupler



Specifications of the DLA deceleration tube

(f_{RF}–RF frequency, *ID* – inner diameter of the ceramic tube, *OD* – outer diameter of the ceramic tube, *L* – tube length, ε_r – relative permittivity of the ceramic, β_g – the fractional group velocity of the RF mode, t_d – drain time, δ_d – loss tangent of the ceramic, Q_w – wall Q, *Q* – total *Q*, [*r/Q*] – "*r* over *Q*" of the tube, r_{sh} – shunt impedance)

f_{RF} GHz	*ID* mm	*OD* mm	*L* mm	ε_r	β_g	t_d ns	δ_d 10^{-4}	Q_w	Q	[*r/Q*] KΩ/m	r_{sh} MΩ/m
7.8	12.04	22.34	266	4.6	0.23	2.9	5	8777	2745	6.09	16.7

Generated gradient and power by Gaussian bunch (σ_z = 2mm)

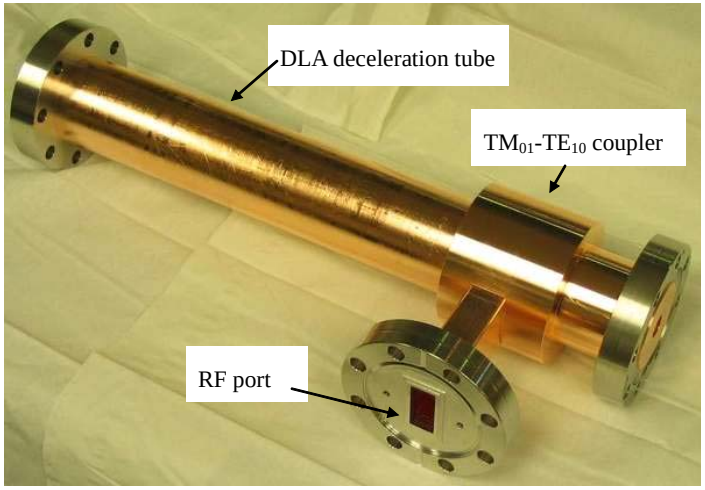
Single Bunch Excitation

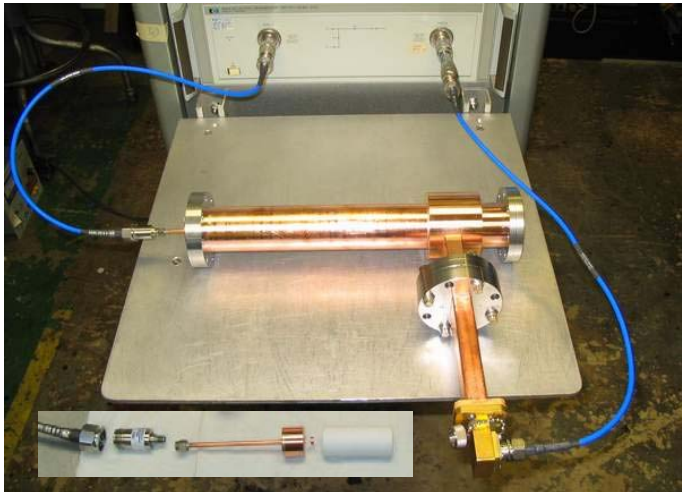
Single Bunch (q = 100nC)	
G_s (MV/m) ~ q	P_s (MW) ~ q^2
18	79

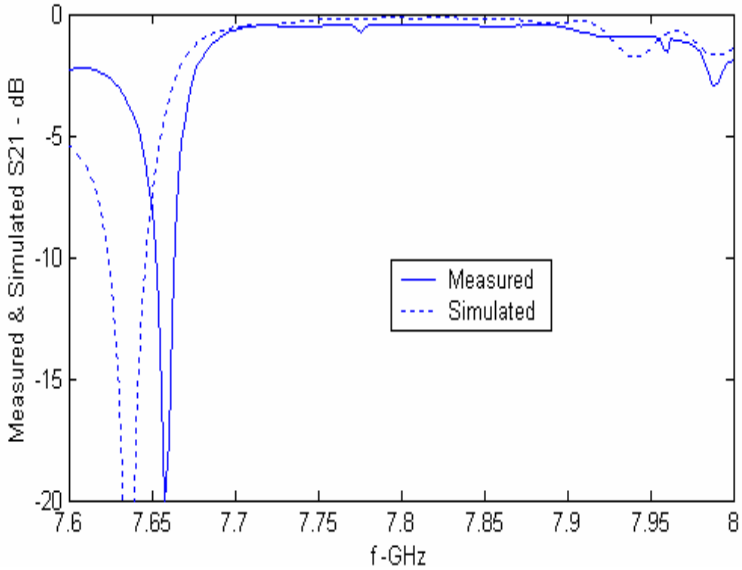
Bunch Train Excitation

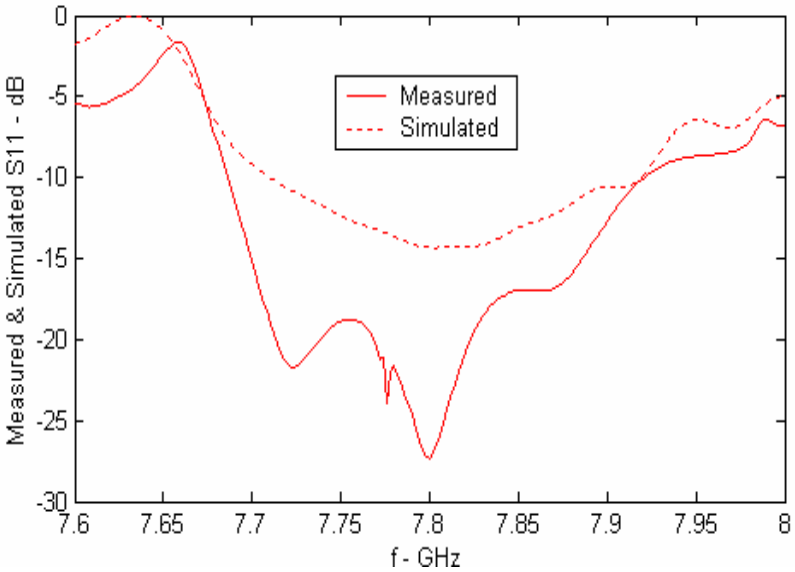
Bunch Train (q = 30nC per bunch f_b = 1.3GHz)	
G (MV/m) ~ q	P (MW) ~ q^2
20.7	101

Simulated and measured S_{21} and S_{11} of the TM_{01}-TE_{10} coupler

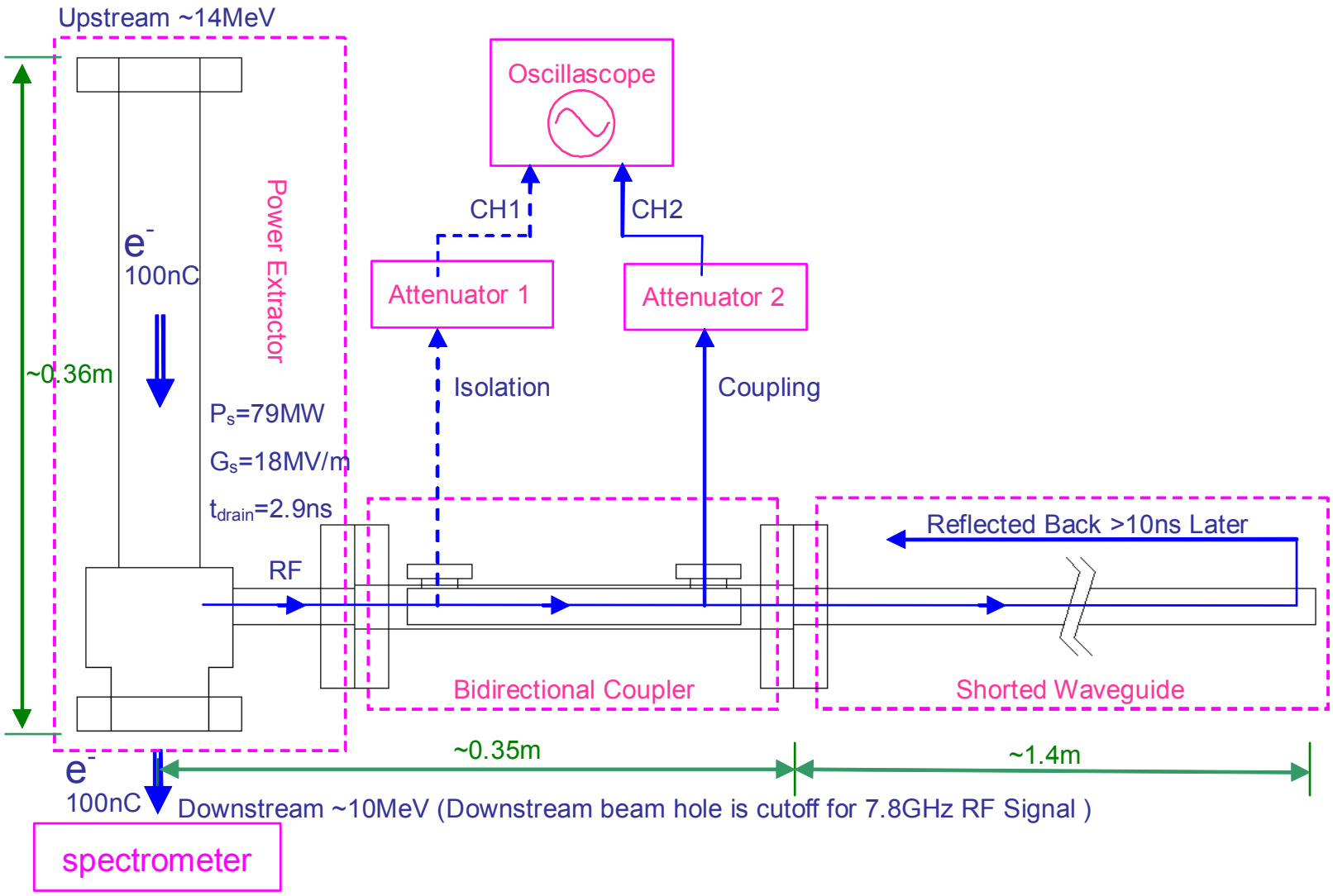




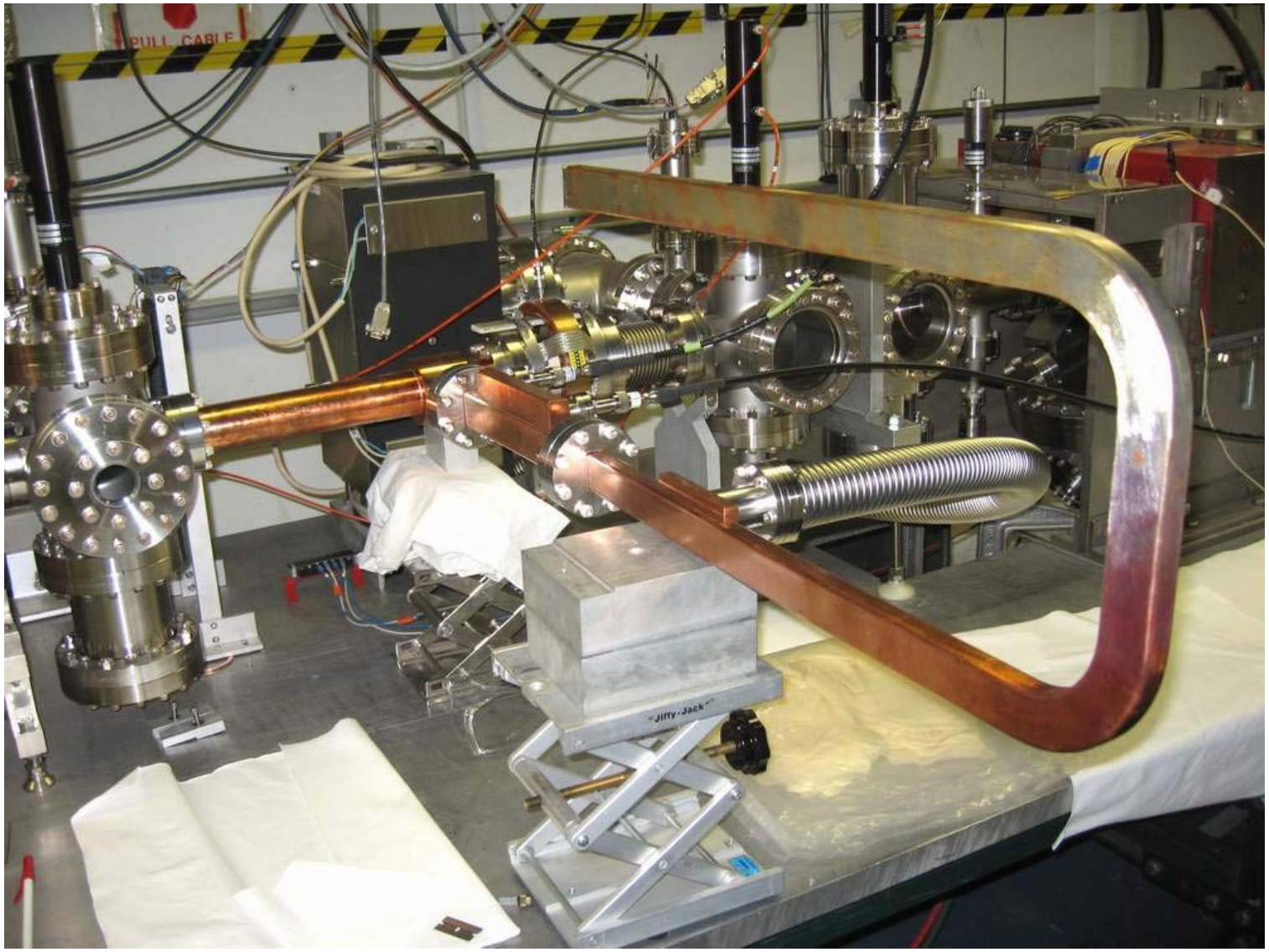




Experimental Scheme

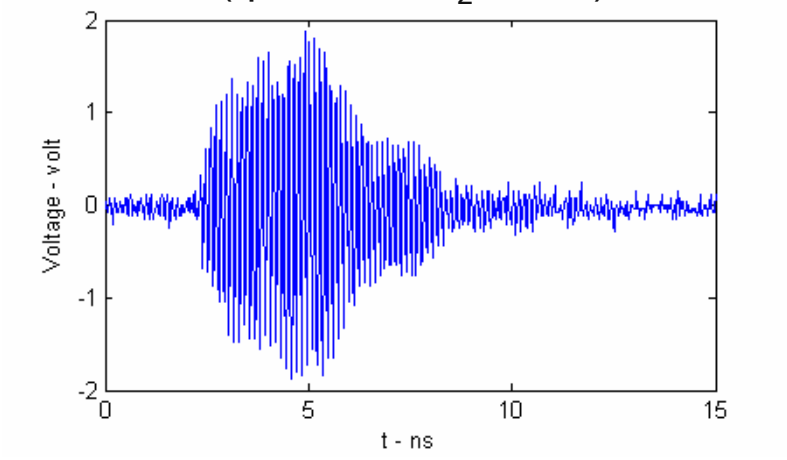


Power Extractor Under Test

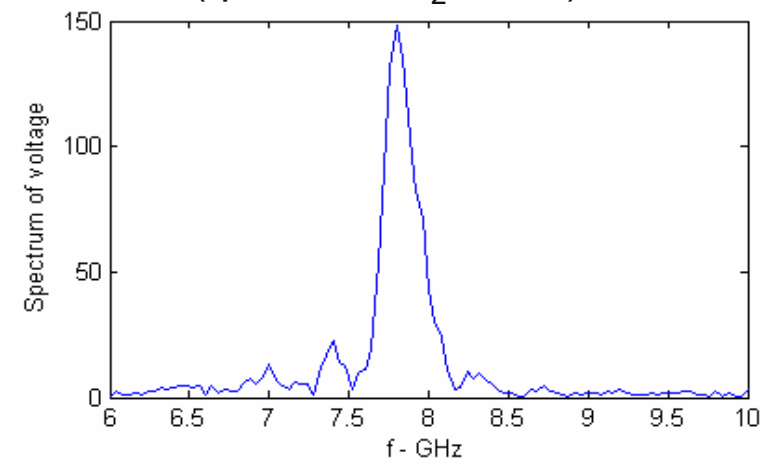


Initial Signal Analysis

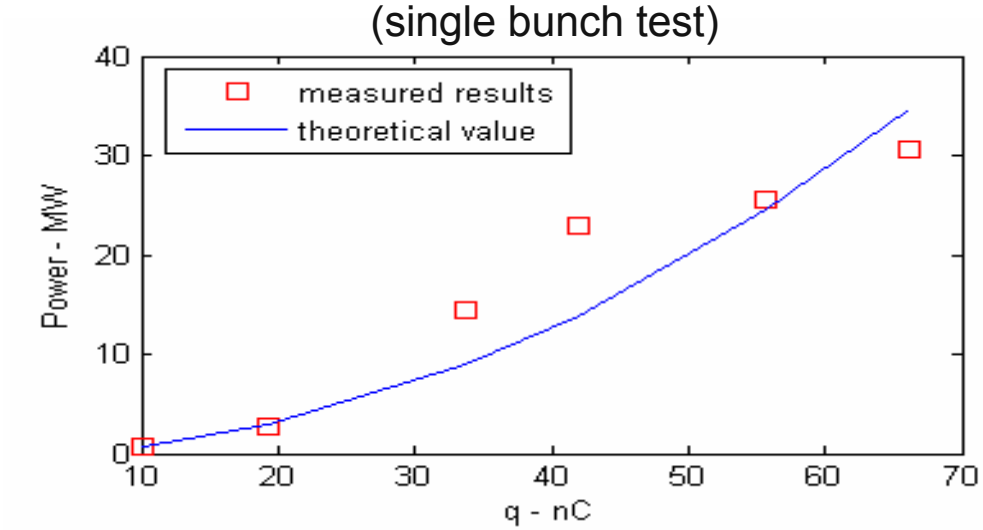
Detected voltage signal
(q = 66nC, σ_z=2mm)



Spectrum of the voltage
(q = 66nC, σ_z=2mm)



Generated power v.s. charge
(single bunch test)



Future work

1. Improve charge transmission:
   Send 100nC charge through the tube to generate 80MW of power;

2. Bunch train test:
   Use 4 bunches (10nC per bunch) to demonstrate field superposition. This should generate 11MW of power.