Non- Invasive Bunch Length Monitor, Fast Kicker, Bunch Shaper, and Photogun.

Electrodynamic, DOE SBIR DE-SC0009509 SBIR Phase II, no cost extension.

PI: Brock F. Roberts

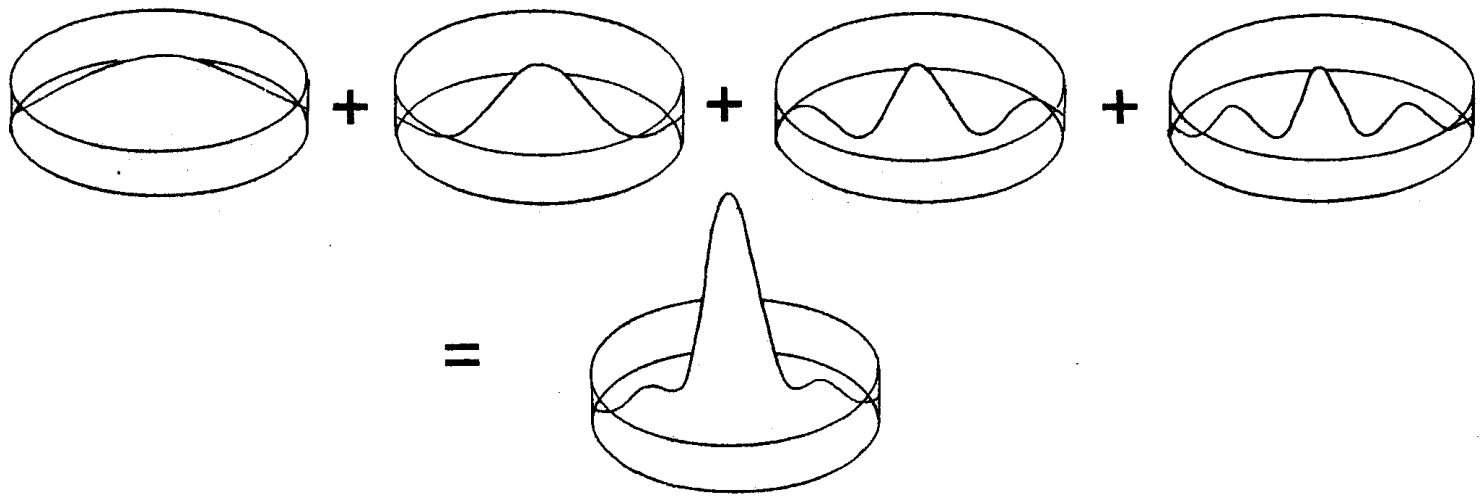
DOE Phase II SBIR Topic: 41G, Nuclear Physics Accelerator Technology, Accelerator Control and Diagnostics.

Collaborator: Thomas Jefferson National Accelerator Facility (TJNAF). Continuous Beam Electron Accelerator Facility, (CBAF). Center for Injectors and Sources (CIS)

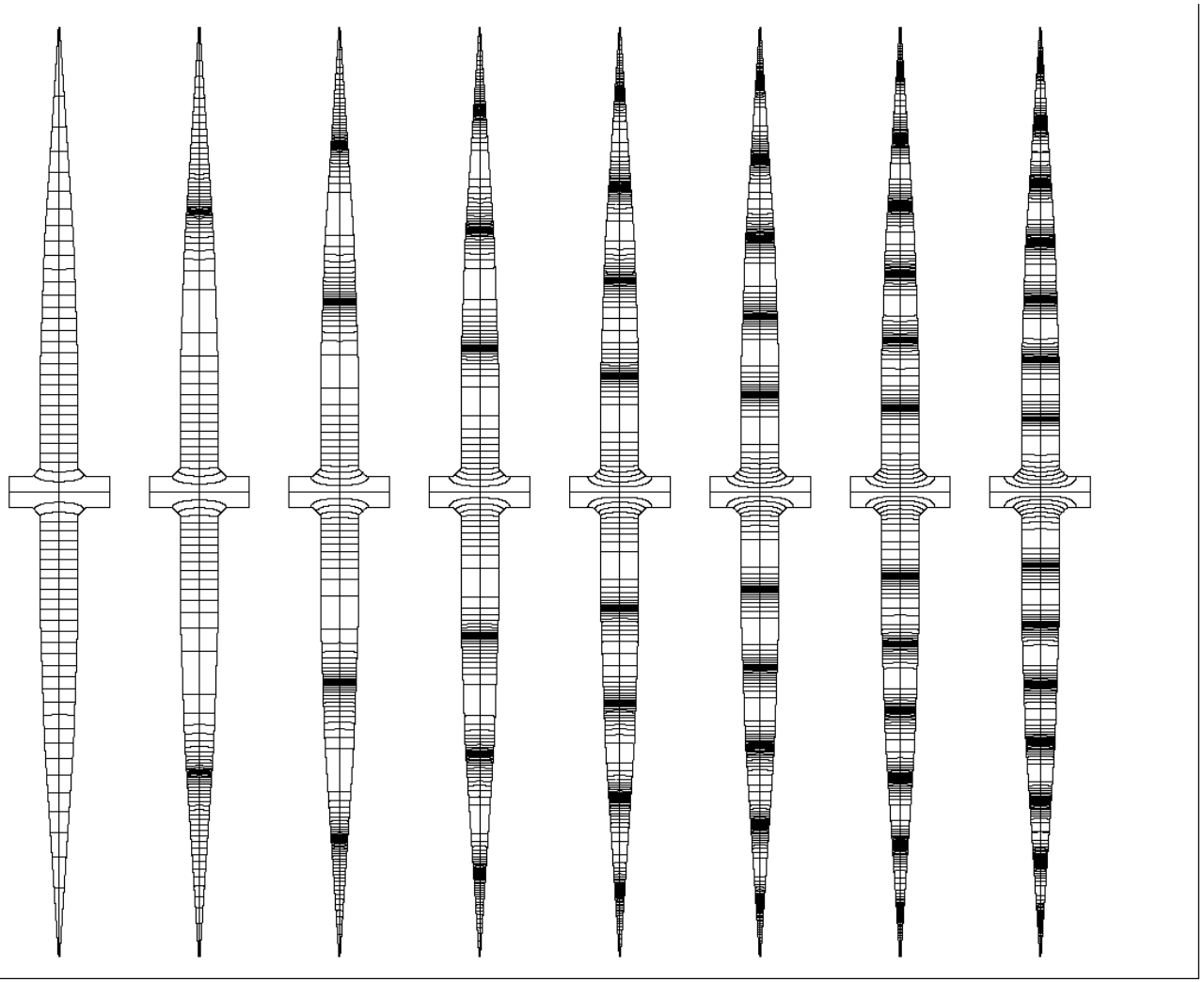
Contractor: University of New Mexico, Electrical Engineering Dept. Applied Electromagnetics group.

Electrodynamic : 4909 Paseo Del Norte suite D, Albuquerque, NM 87113 (505)-225-9279

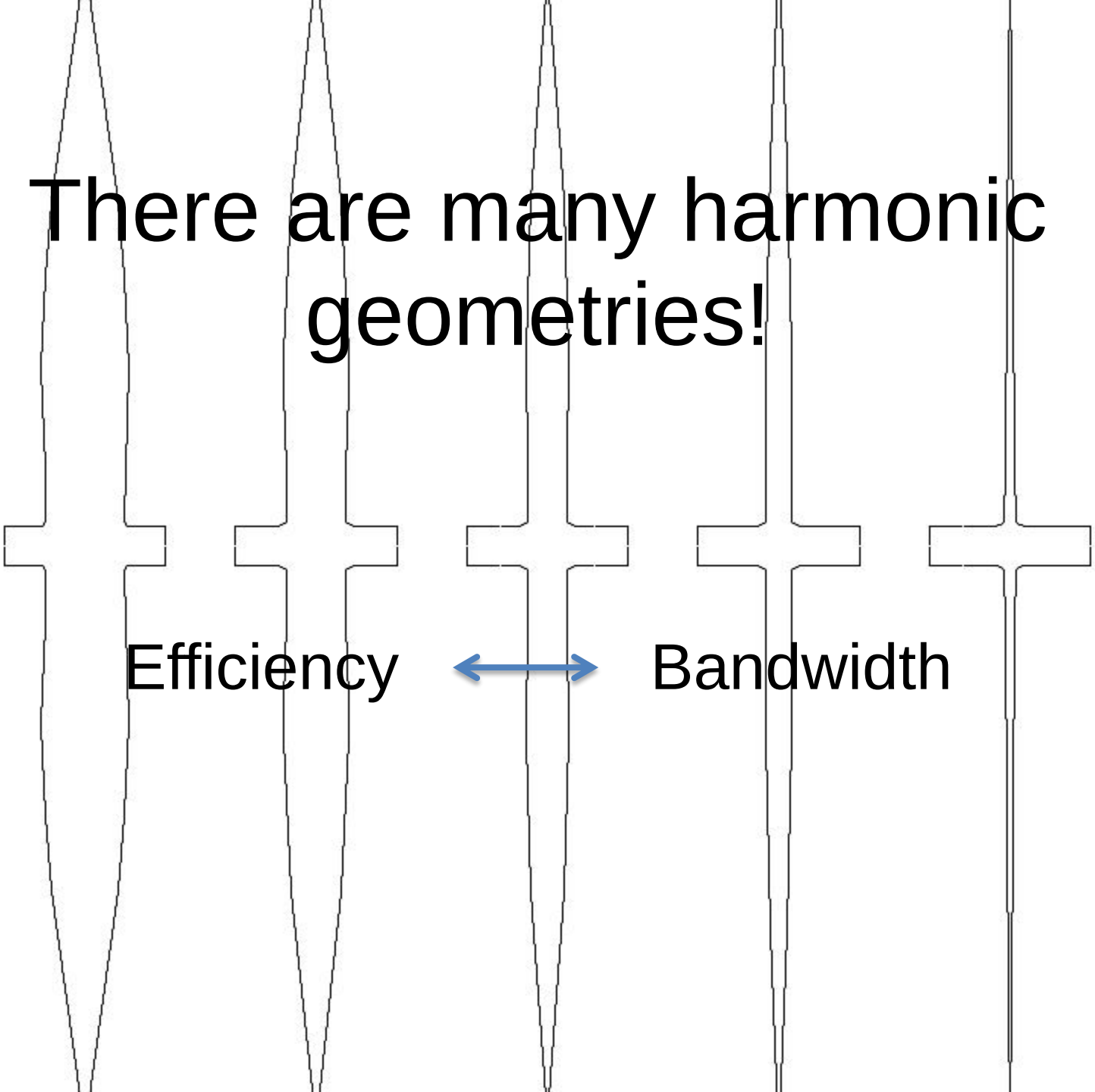
Can several harmonic TM_{0N0} modes be simultaneously superimposed?



Yes, the cavities shape tunes the TM_{ONO} modes to be Harmonic

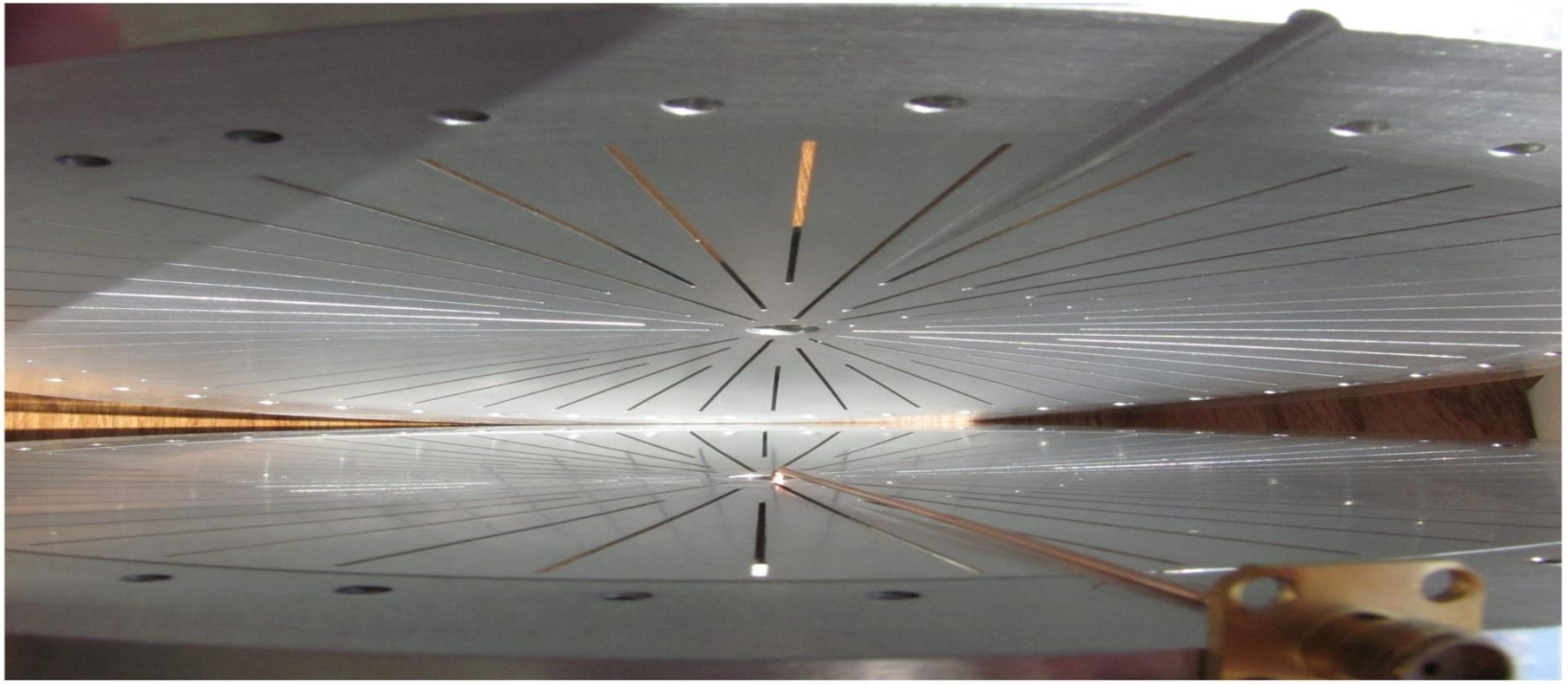


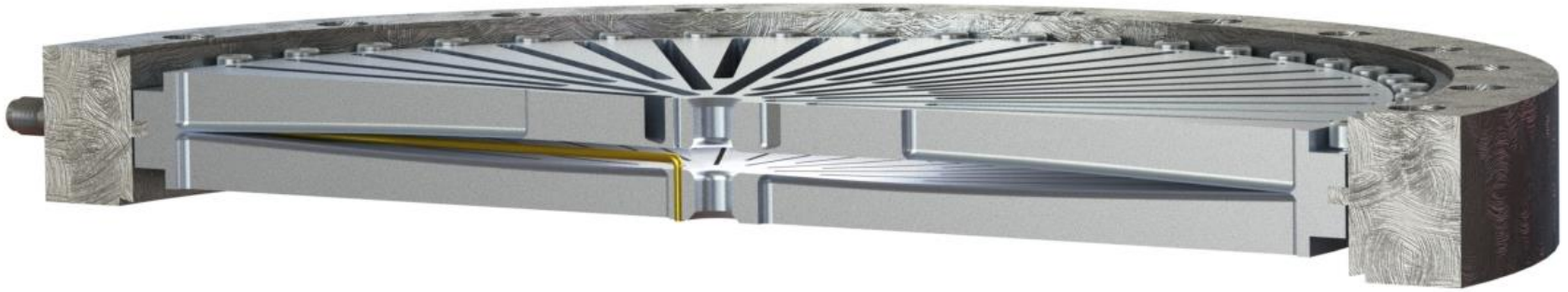
There are many harmonic geometries!



Efficiency ⟷ Bandwidth

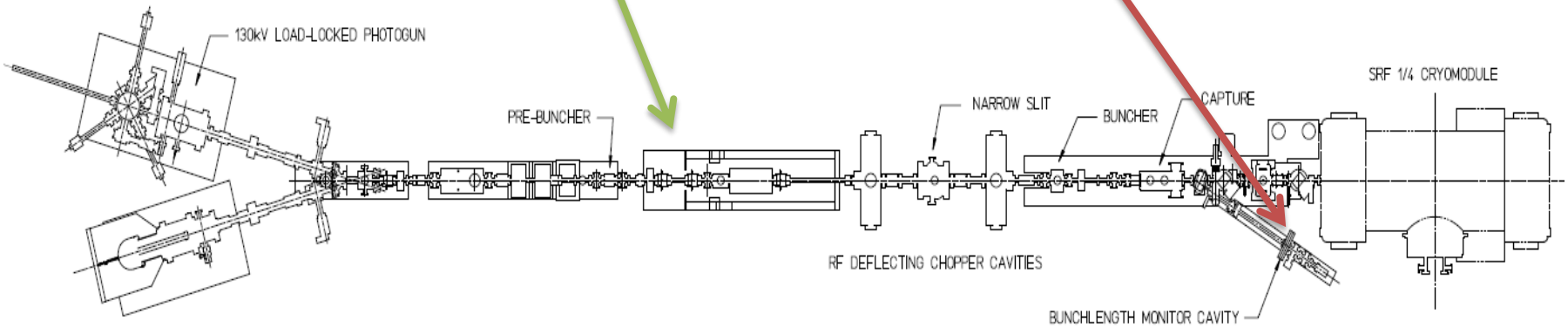
Wideband Antenna

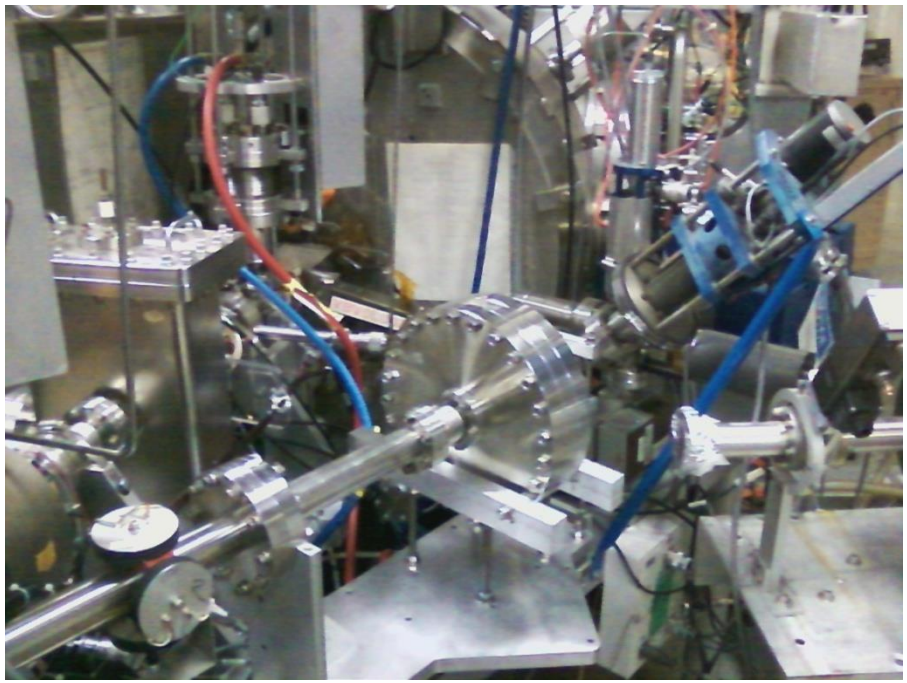





Beam Monitor

Beam Monitor Evaluation in CEBAF's injector



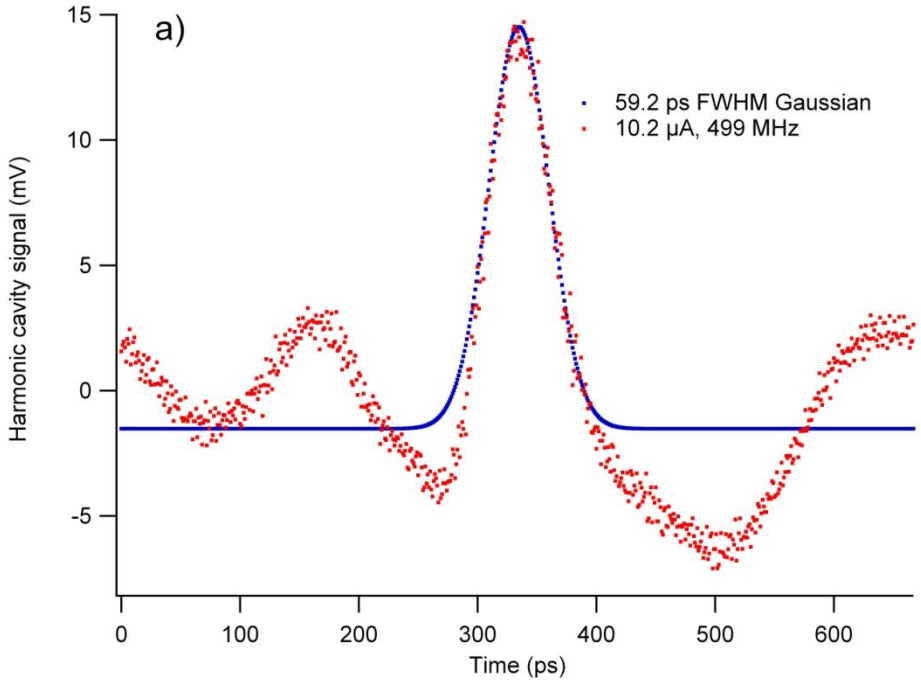


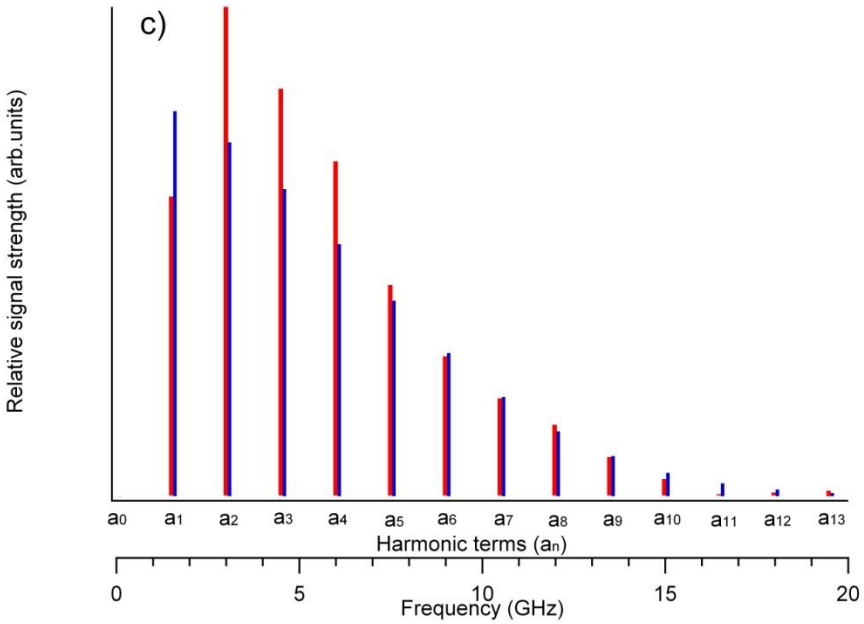
The detected waveform is the superposition of the cavity modes excited by the beam. The beam can be described in the same format; the compact trigonometric form of their Fourier series

$$F(v_{detected}(t)) = a_{TM_{010}} \cos(w_0 t + \theta_{010}) + a_{TM_{020}} \cos(2w_0 t + \theta_{020}) \ldots + a_{TM_{0n0}} \cos(nw_0 t + \theta_{0n0}).$$

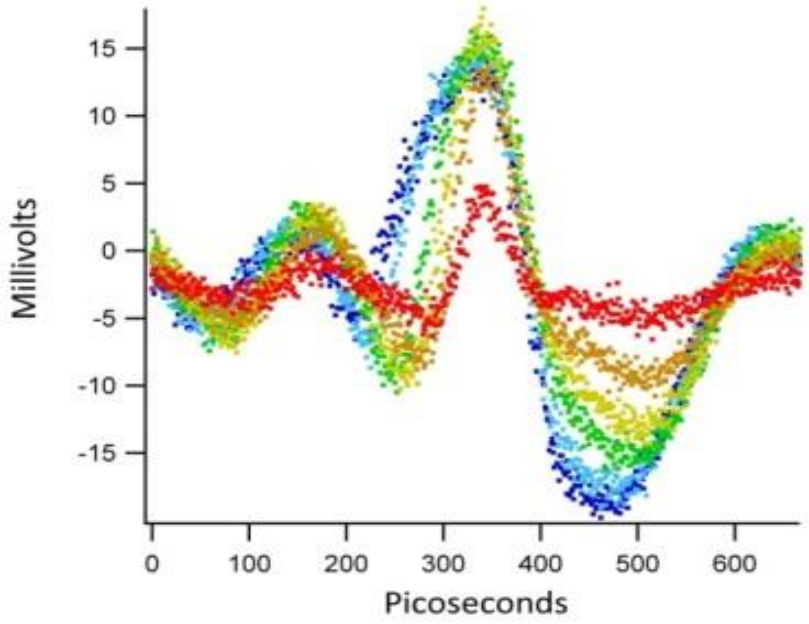
$$F(i_{beam}(t)) = a_1 \cos(w_o t + \theta_1) + a_2 \cos(2w_o t + \theta_2) \ldots + a_n \cos(nw_o t + \theta_n).$$

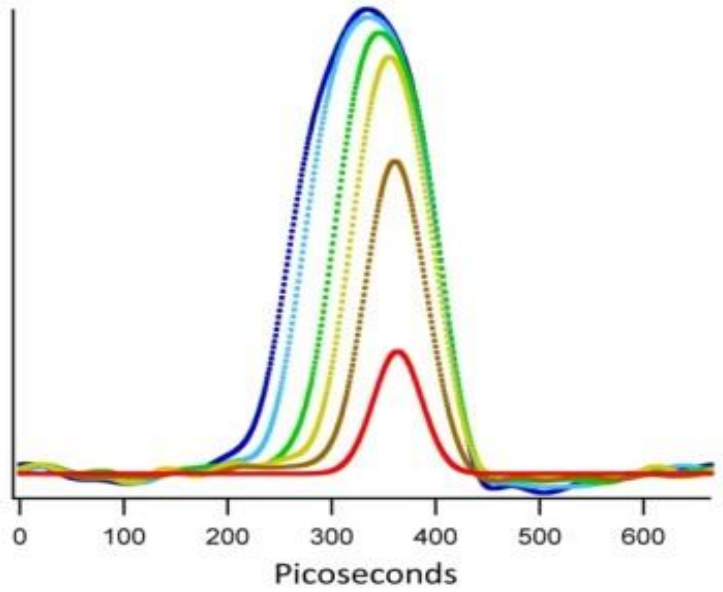
Harmonic Cavity Transfer Function



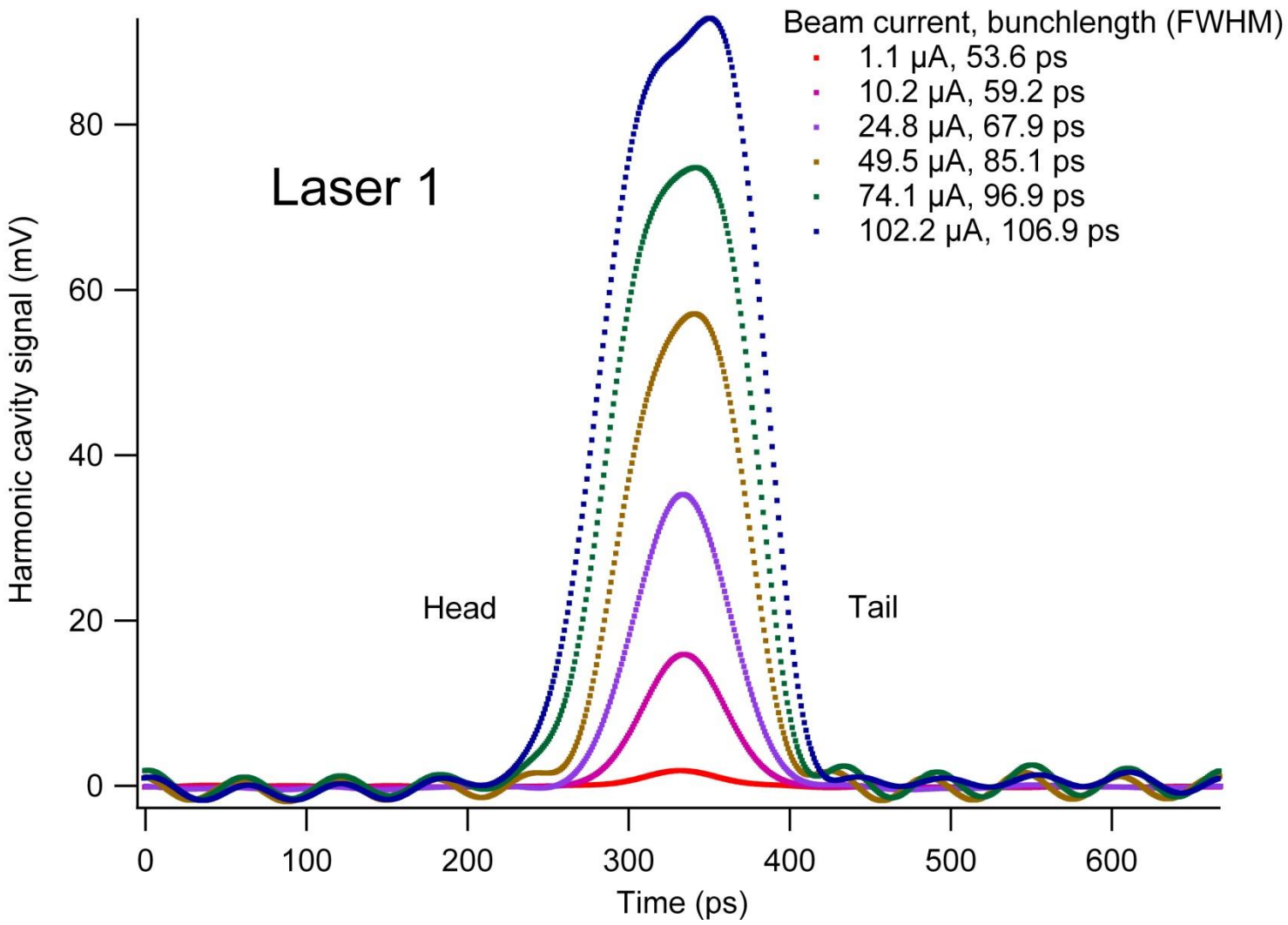


The ratio of these two series is the harmonic cavities transfer function. Once determined, the cavities transfer function can be used to un-distort subsequent data independent of new bunch shapes.

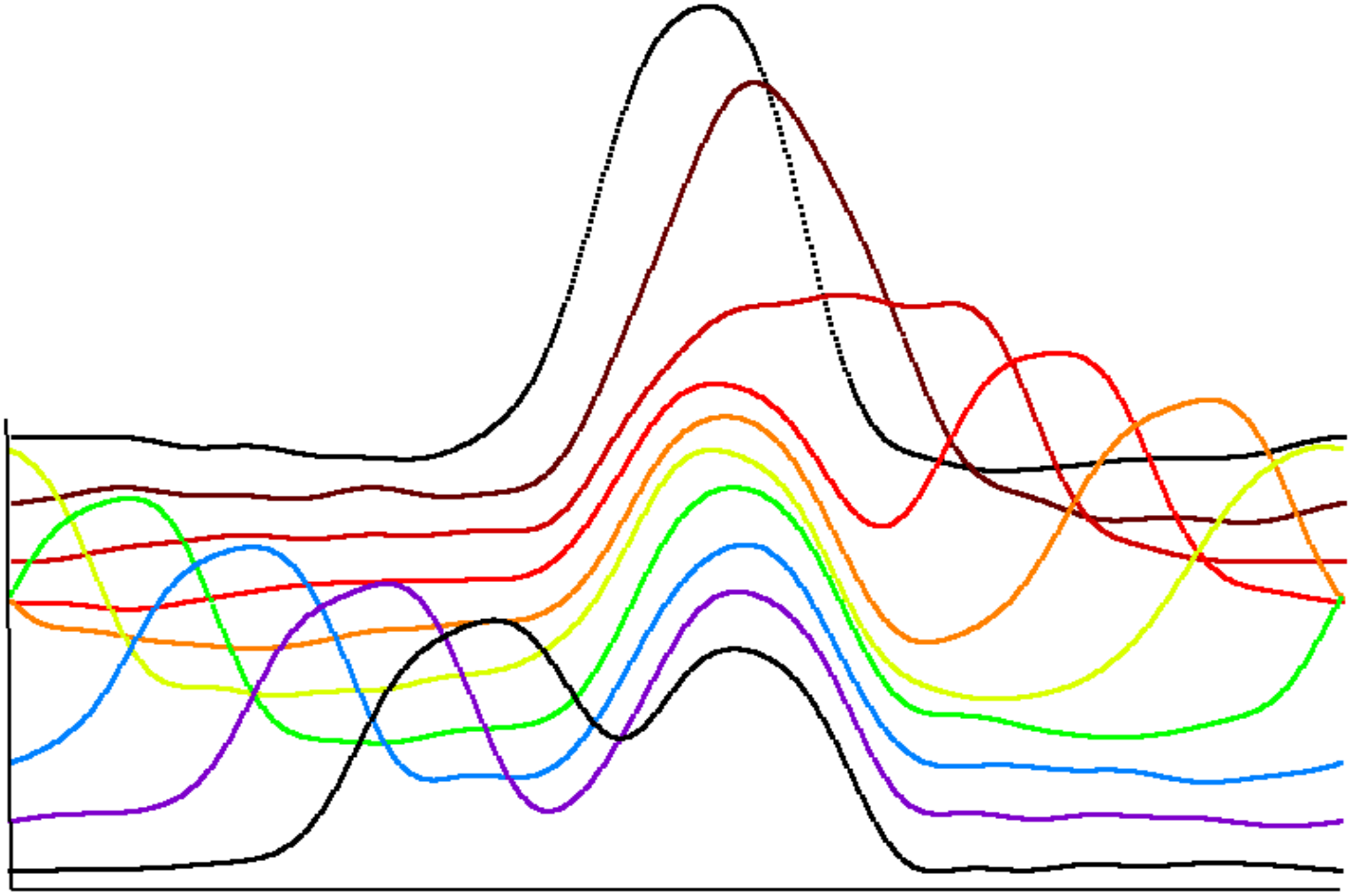




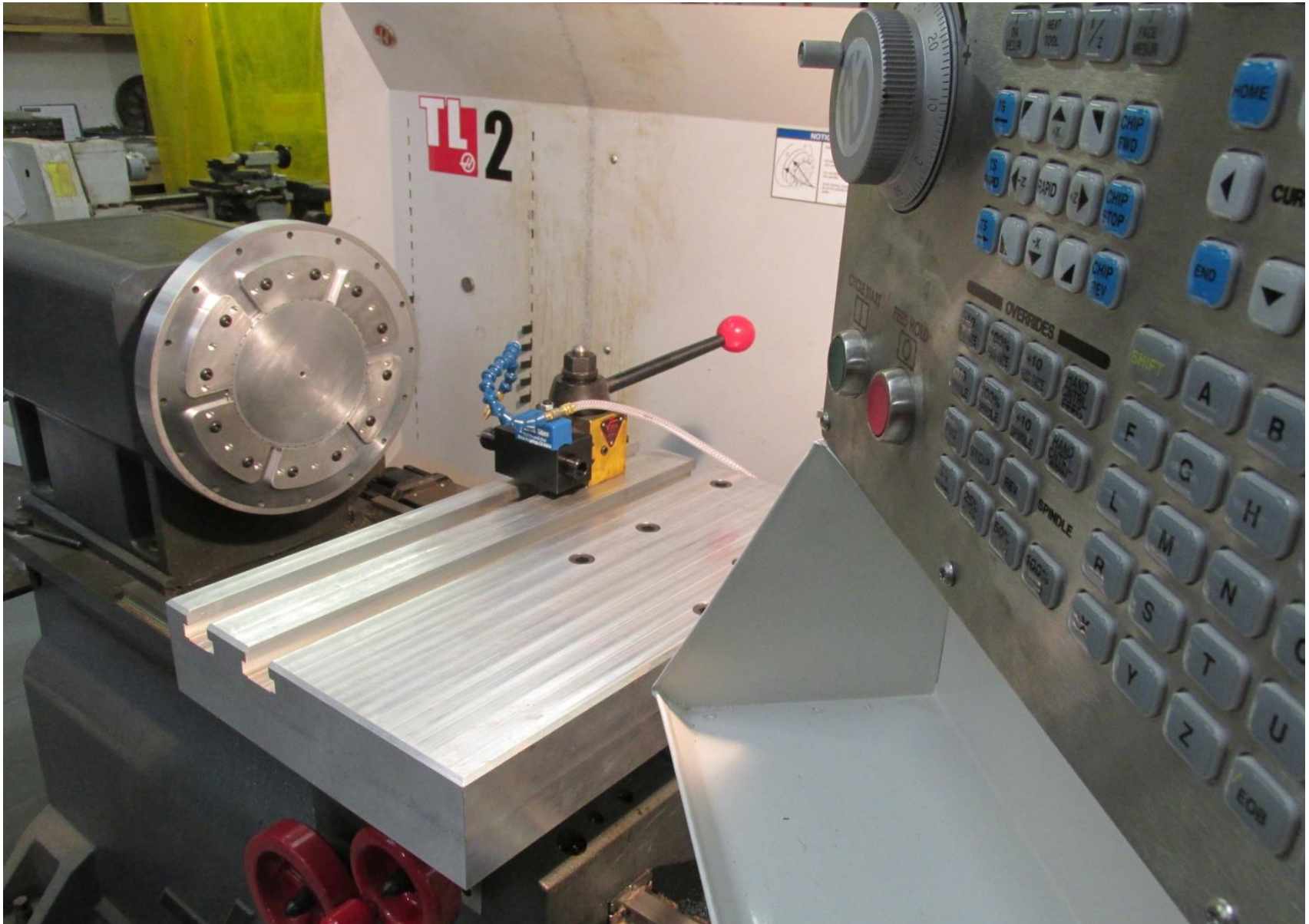
Bunch Width Measurement

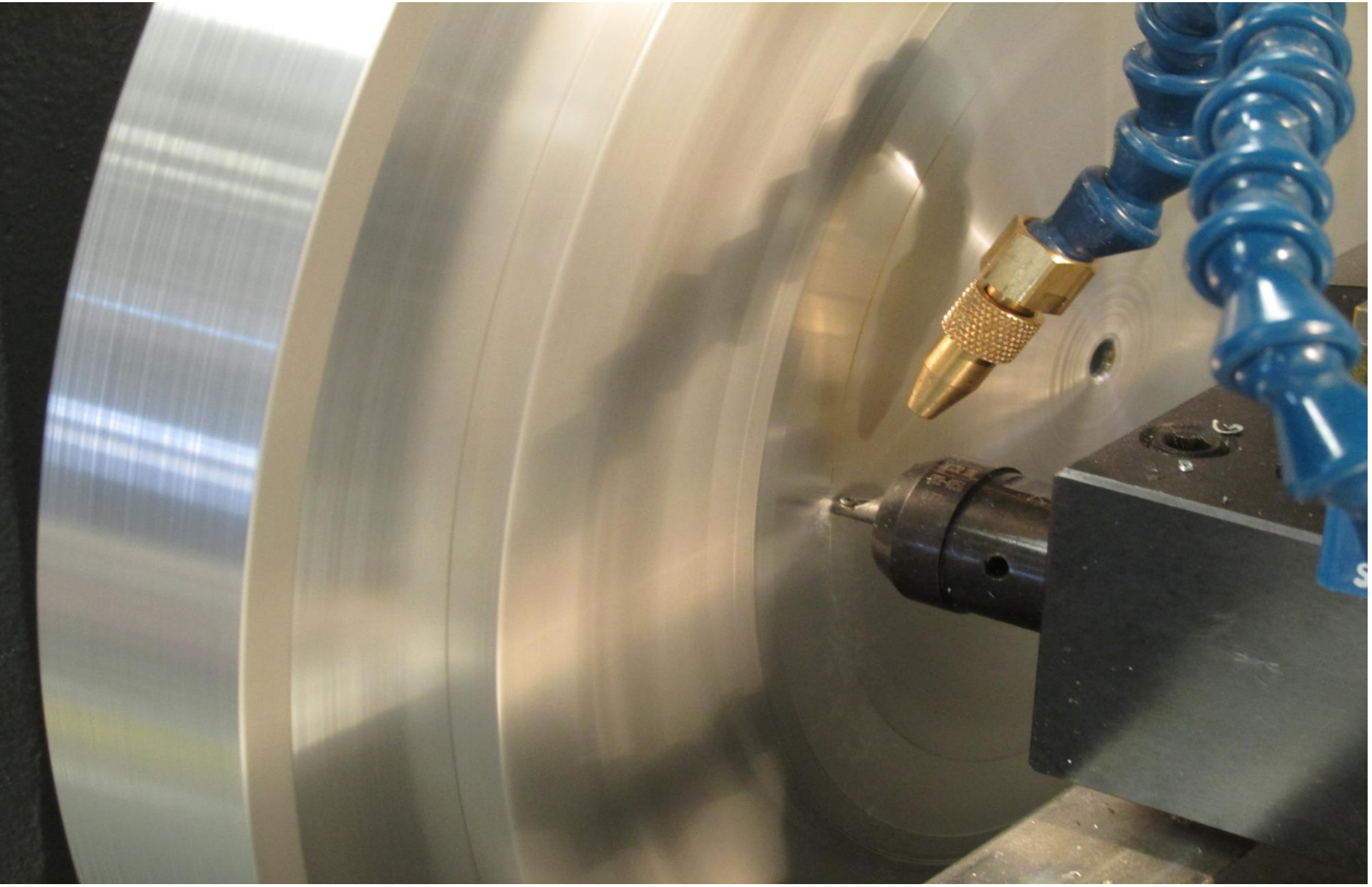


Measurement of Two Interleaved 499 MHz beams.

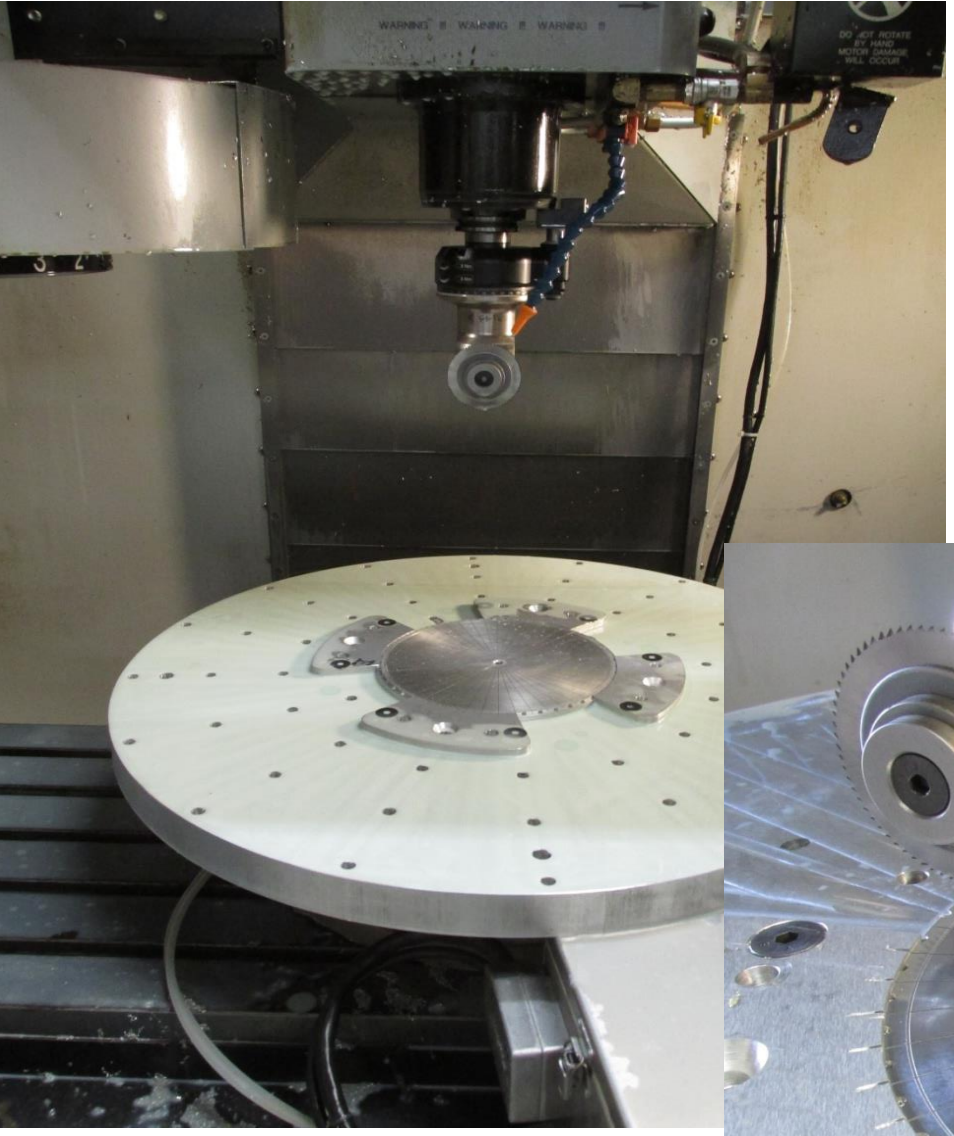


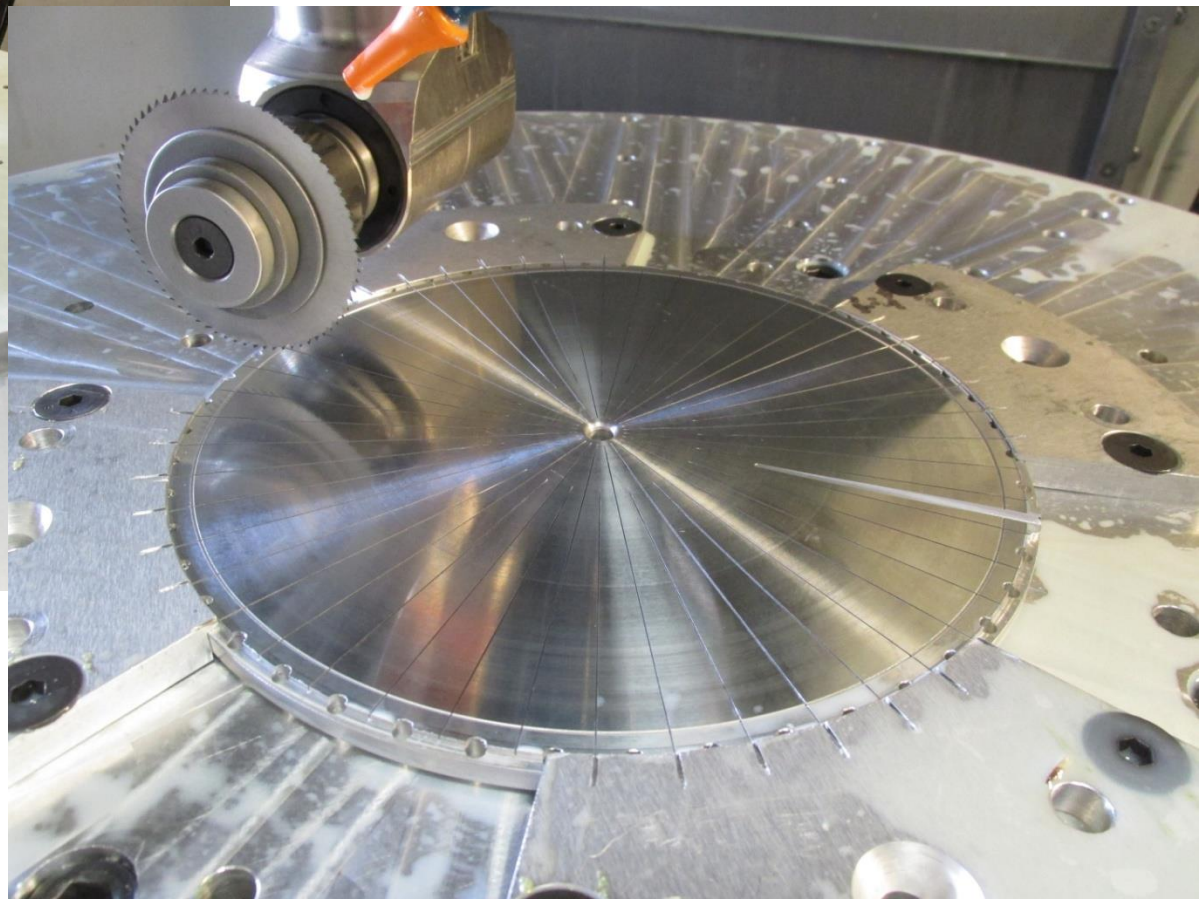
CNC Lathe and Vacuum Chuck



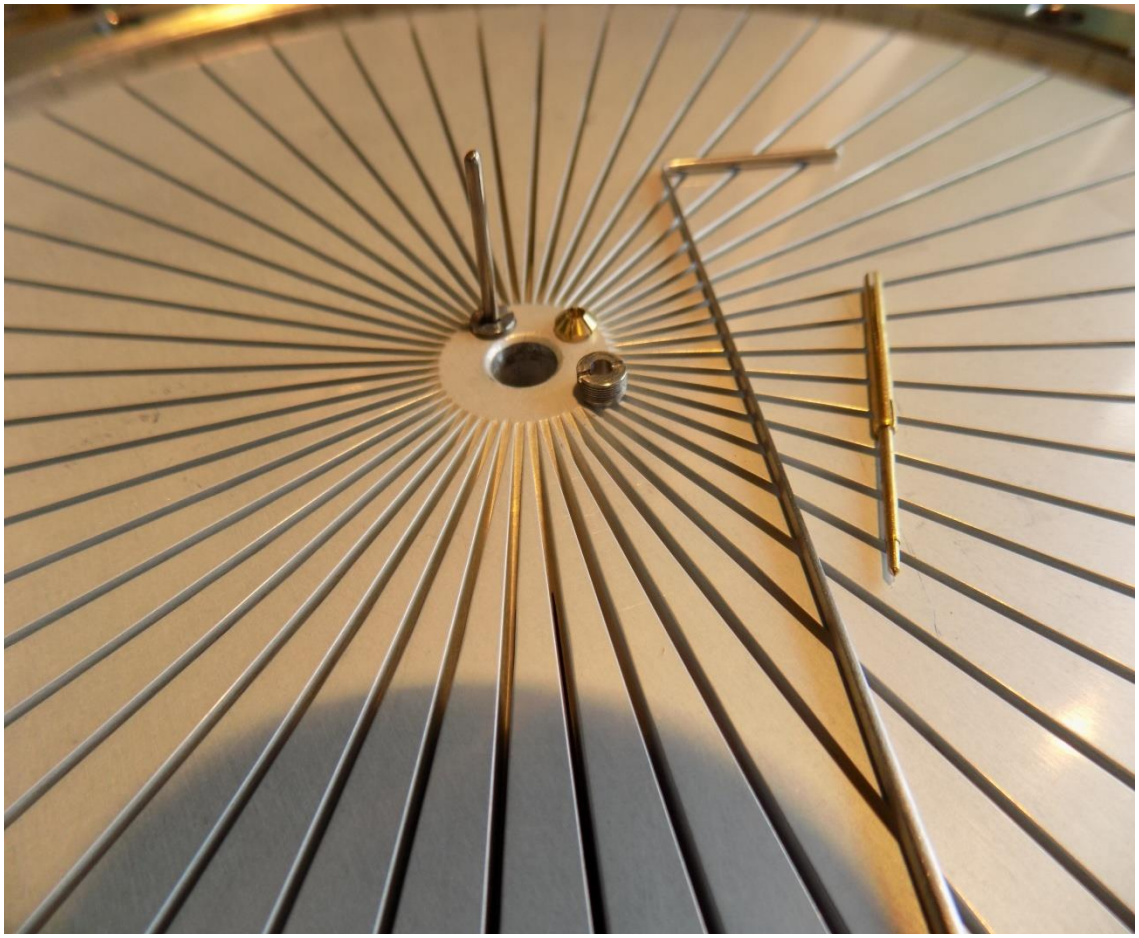


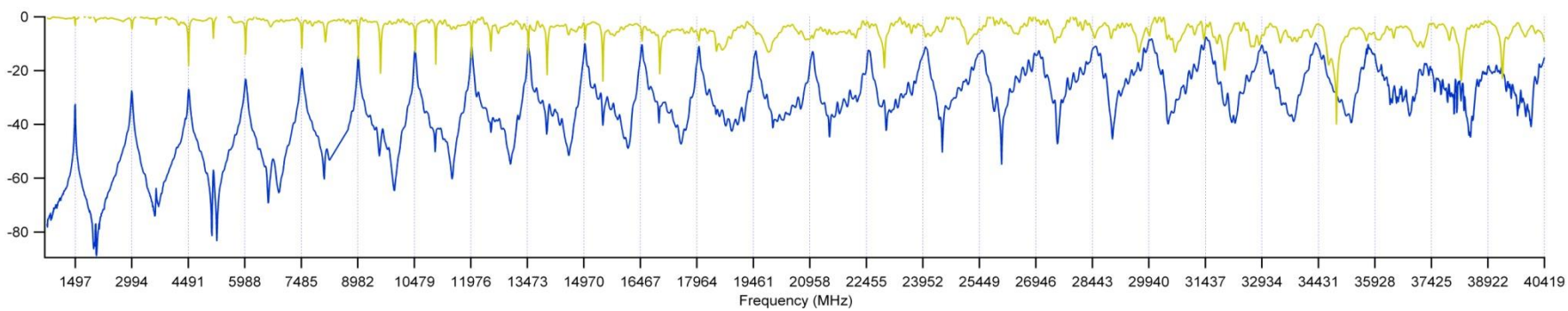
Slitting Saw on CNC Mill with 26” rotary



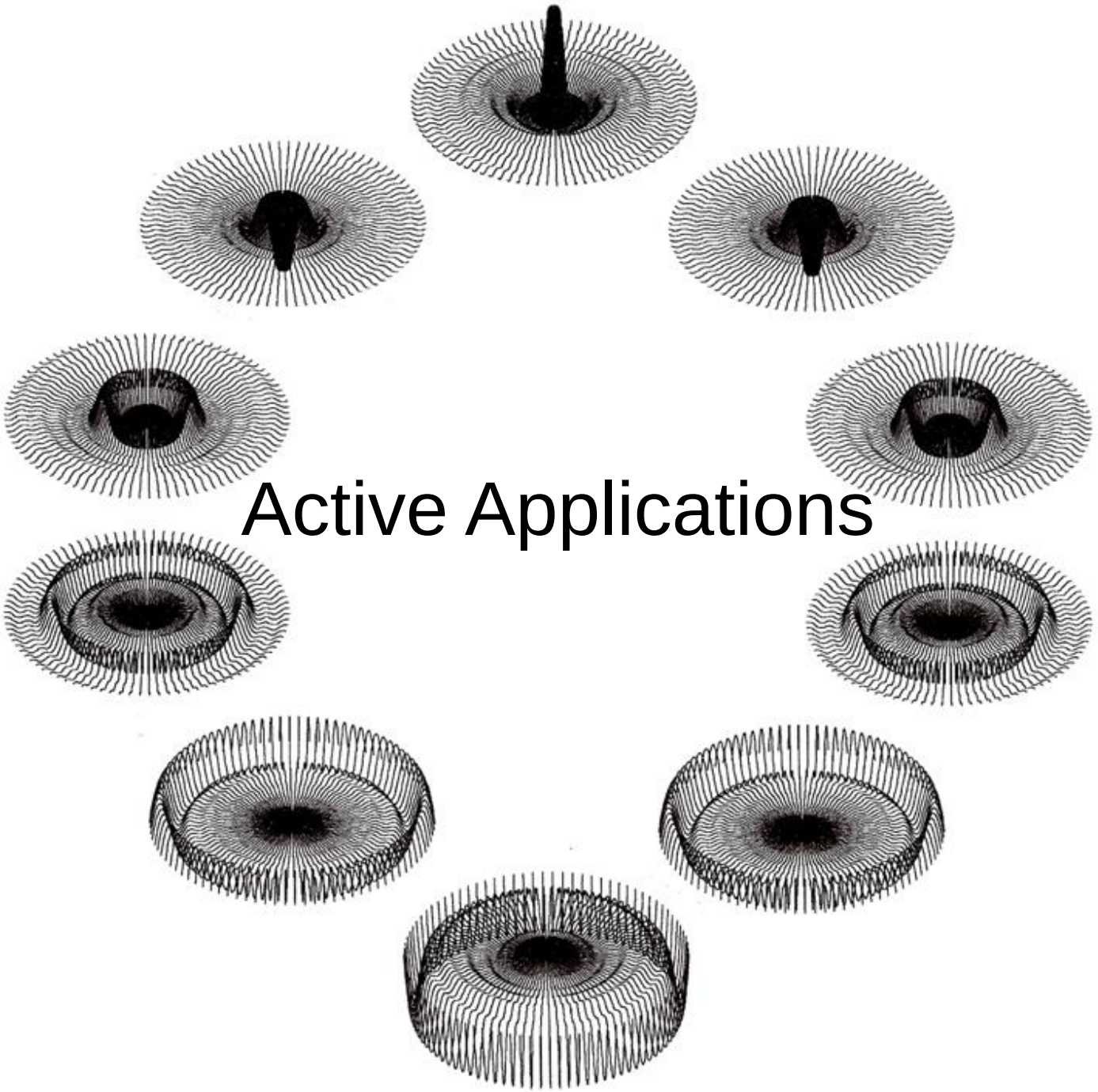


Brazing in Argon Gas




0
-20
-40
-60
-80
1497
2994
4491
5988
7485
8982
10479
11976
13473
14970
16467
17964
19461
20958
22455
23952
25449
26946
28443
29940
31437
32934
34431
35928
37425
38922
40419
Frequency (MHz)

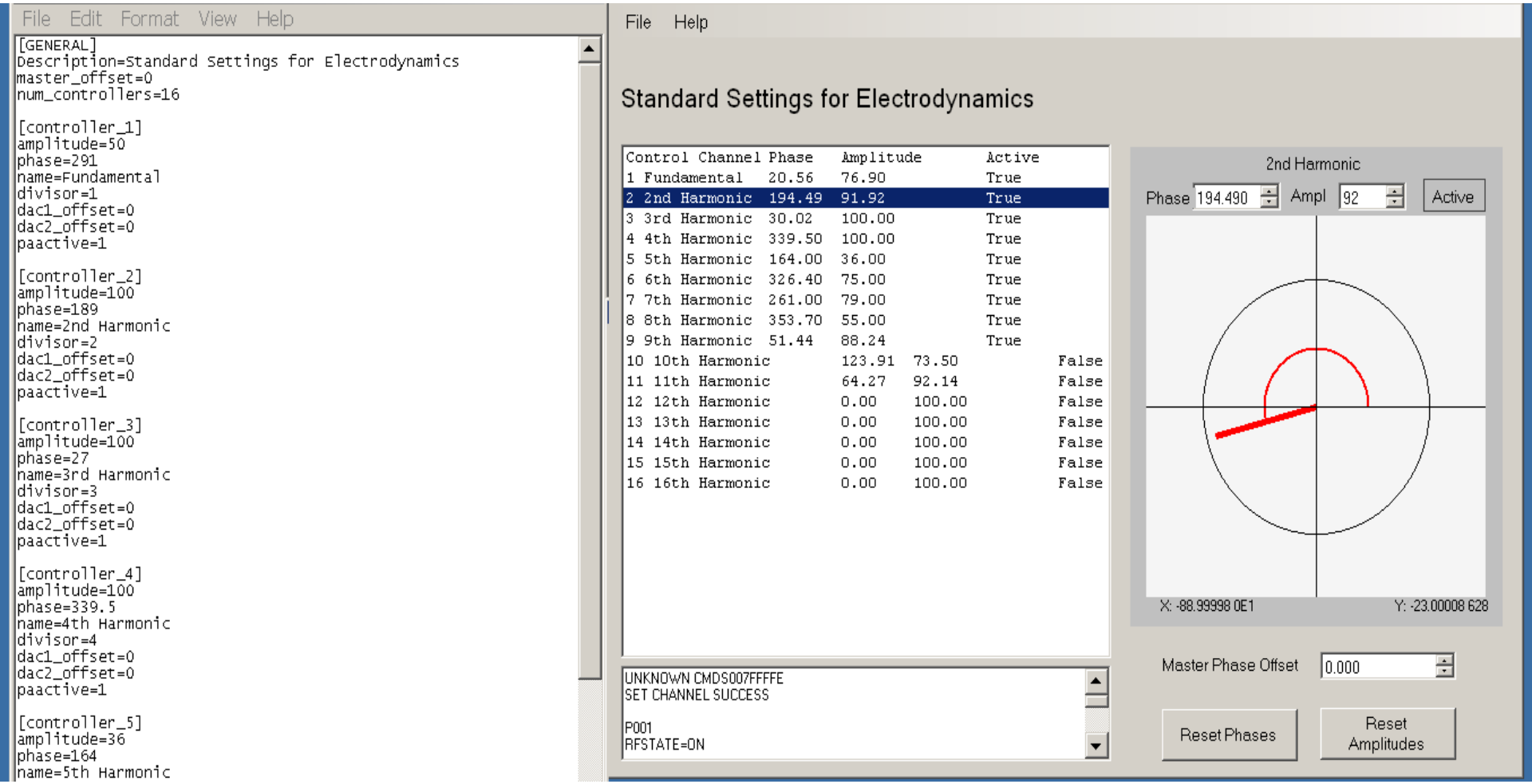
Phase II Beam Monitors



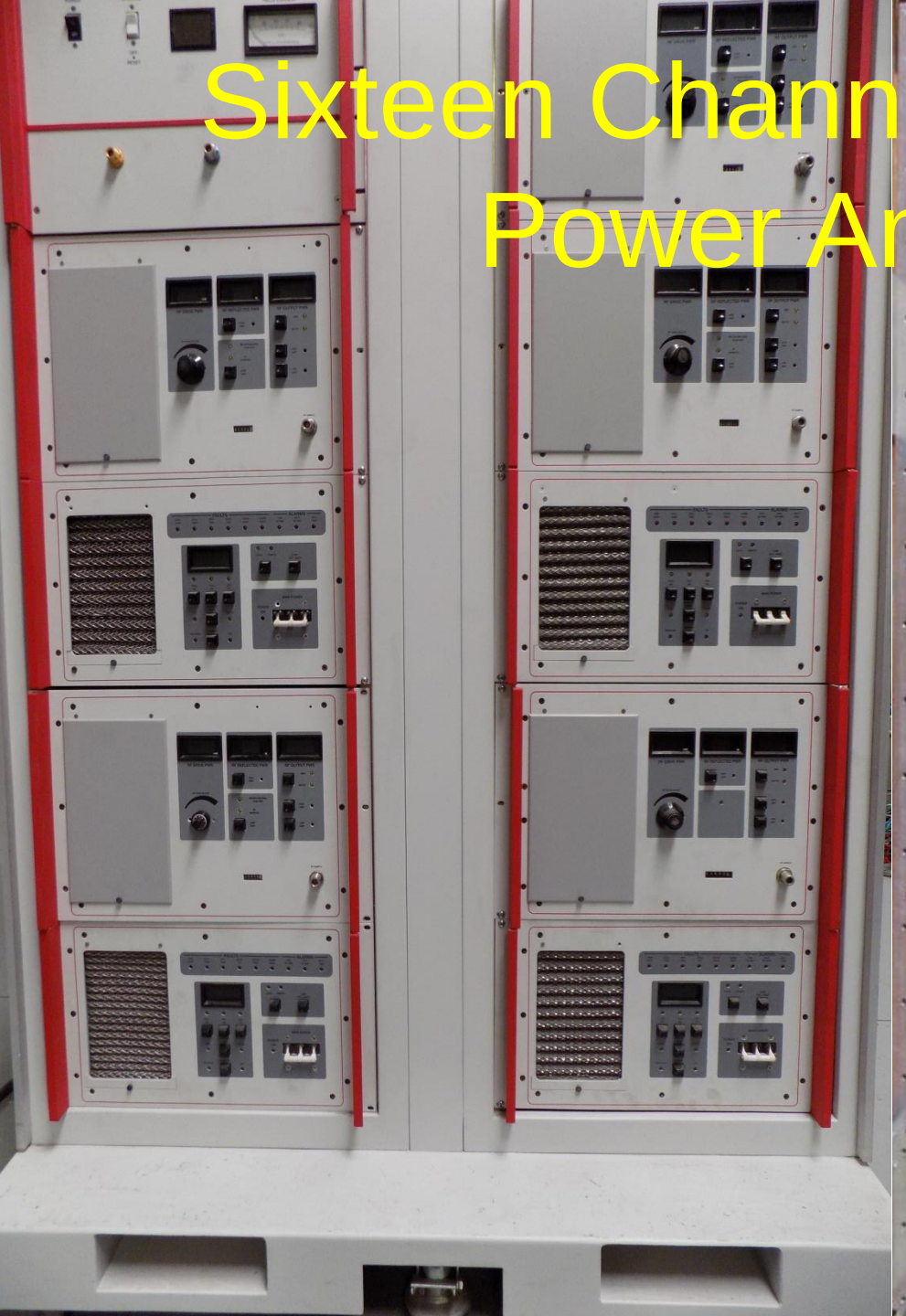
Active Applications

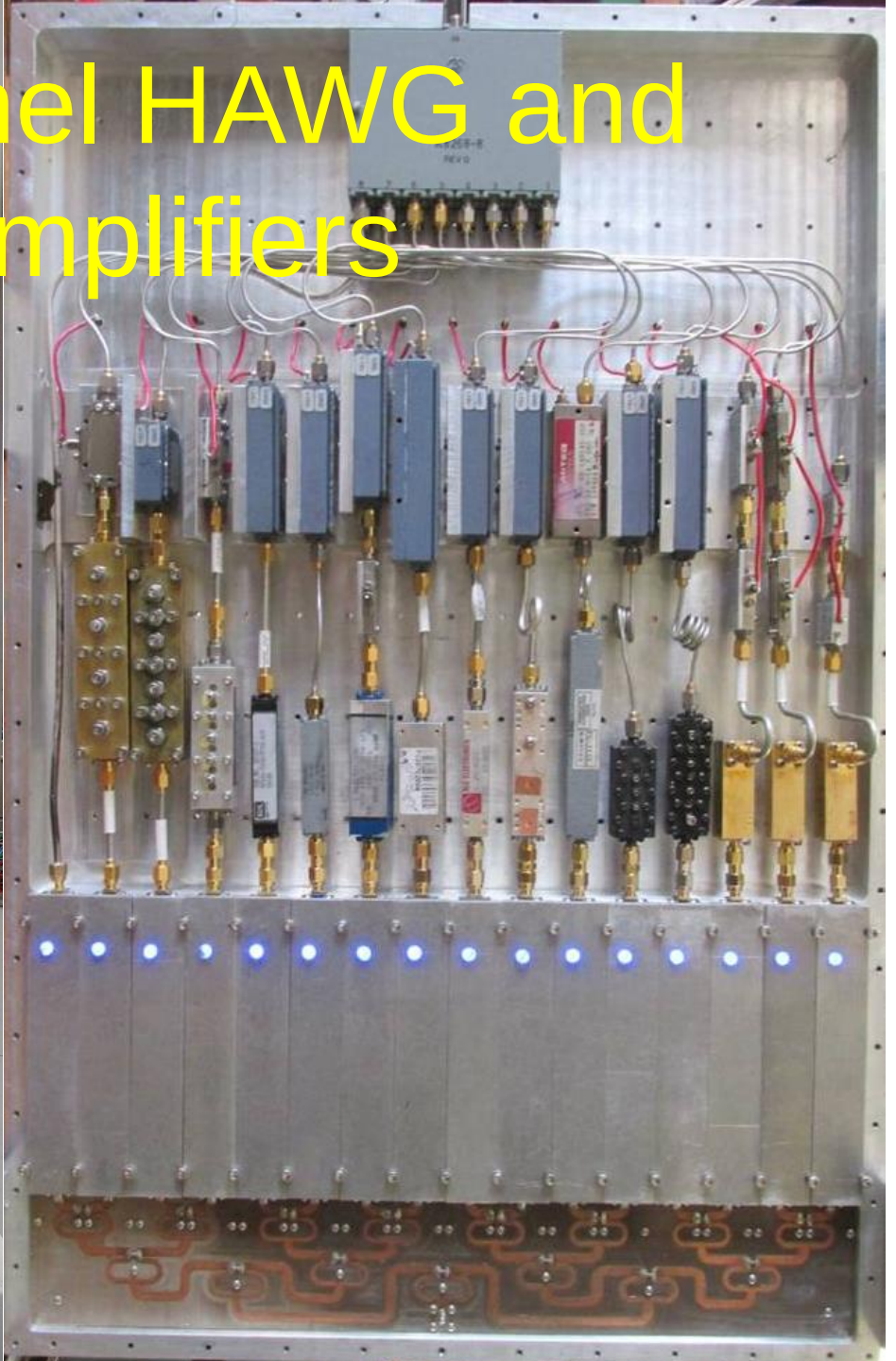
Harmonic Arbitrary Waveform Generator (HAWG)

HAWG Graphical User Interface

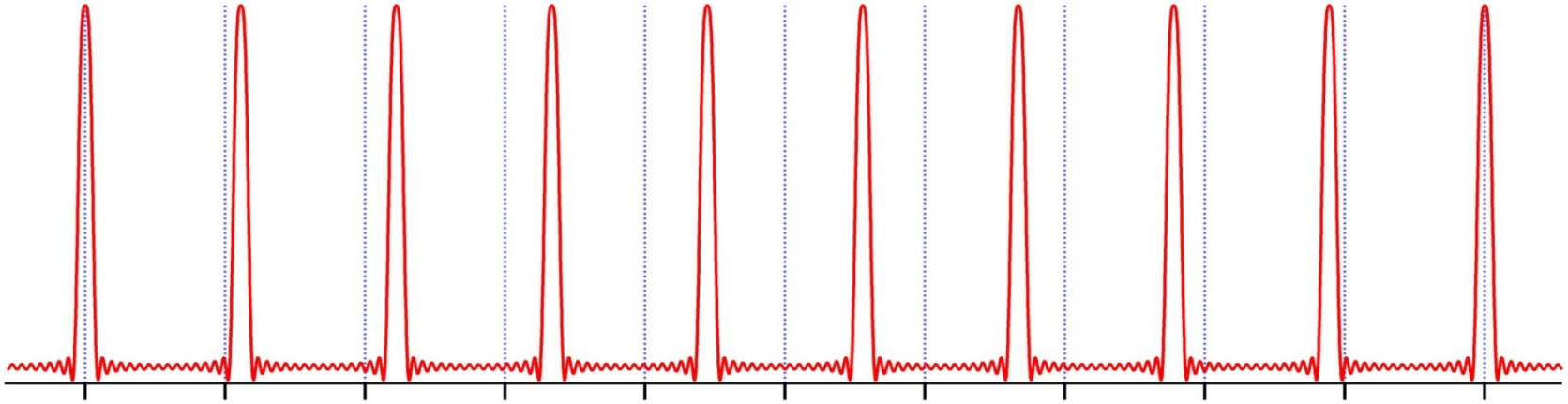


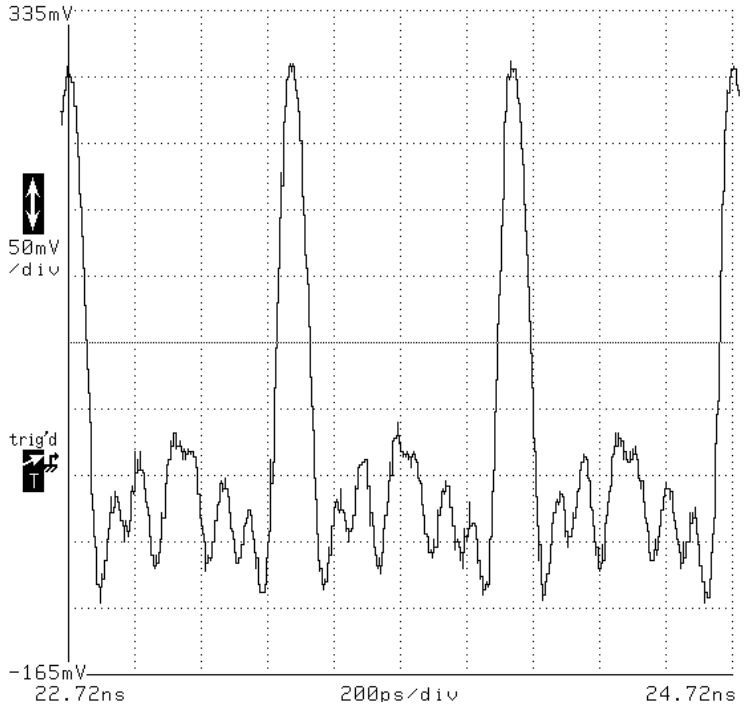
Sixteen Channel HAWG and Power Amplifiers

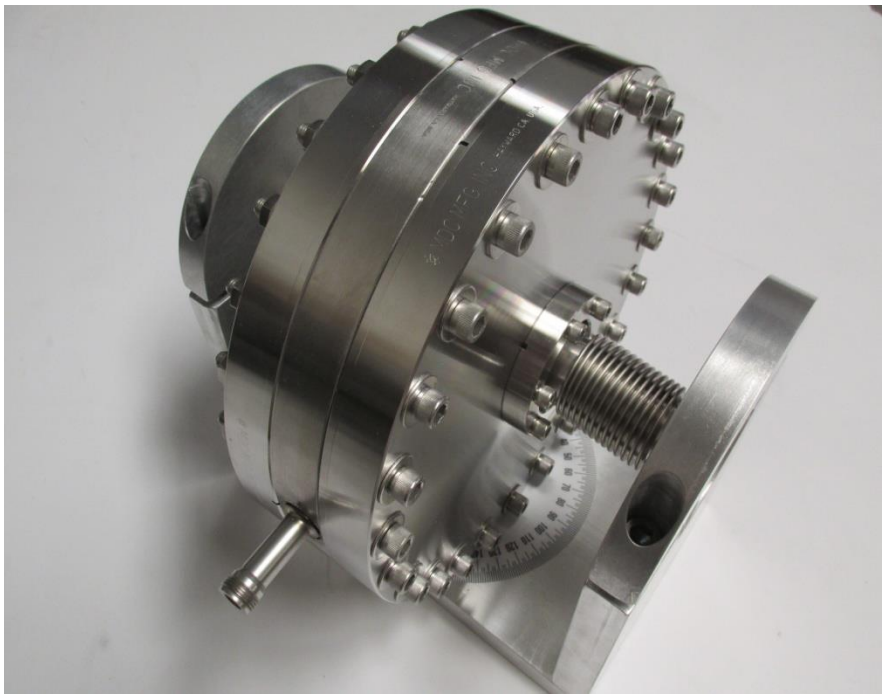




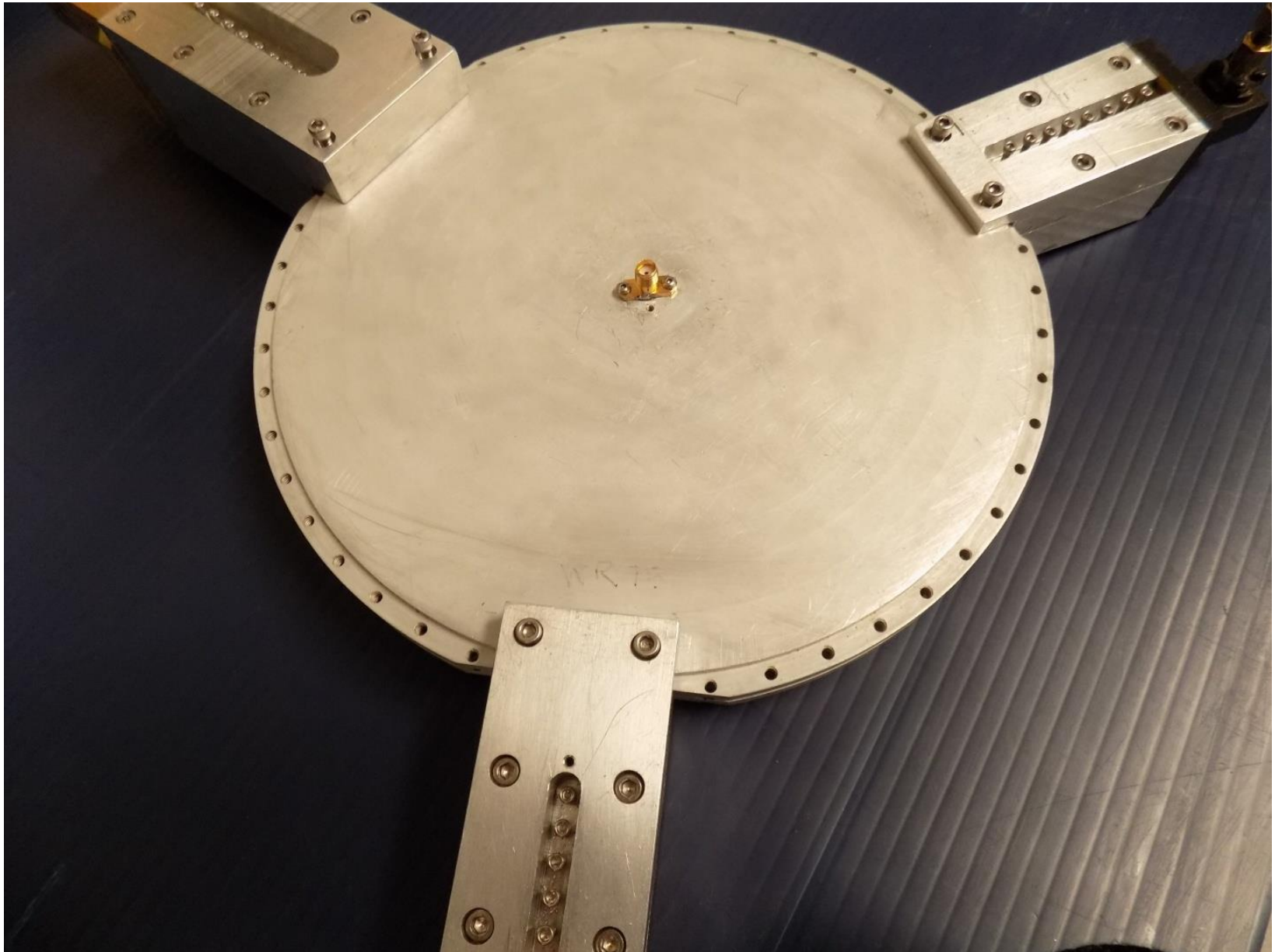
Fractionally Interleaved Kicking







High Power Waveguide Coupling.



CNC Lathe/Mill hybrid can now machine harmonic cavities up to 8 ft. in diameter.

Thank you for supporting the SBIR Program

- Better harmonic cavities with greater bandwidth will equip CEBAF with high resolution beam monitors.
- Upcoming kicking and bunch shaping experiments will evaluate fractionally interleaved kicking, and a bunch shaping photogun.
- Electrodynamic has won the International Beam Instrumentation Conference's (IBIC) 2016 Faraday Cup award.