Harmonically resonant cavity as a bunch-length monitor

Brock F. Roberts

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

Collaborators: Thomas Jefferson National Accelerator Facility (TJNAF). Continuous Beam Electron Accelerator Facility, (CBAF). Center for Injectors and Sources (CIS) and the University of New Mexico, Electrical Engineering Dept. Applied Electromagnetics group.

Publications: Physical review, accelerators and beams **19** ,052801 (2016) and **15**, 122802 (2012)

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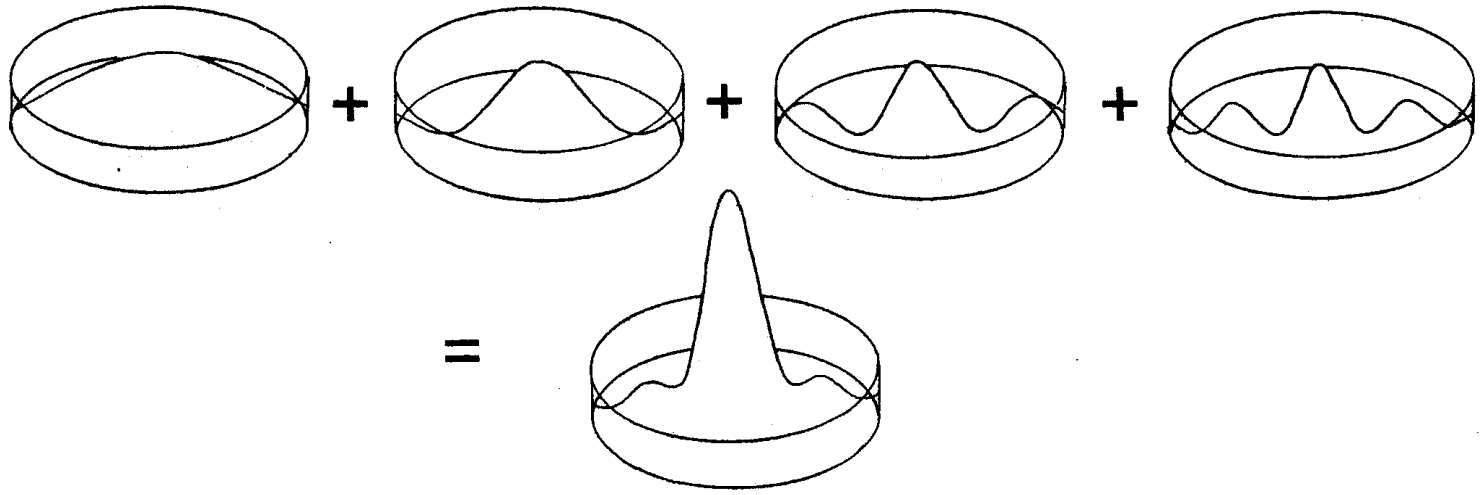
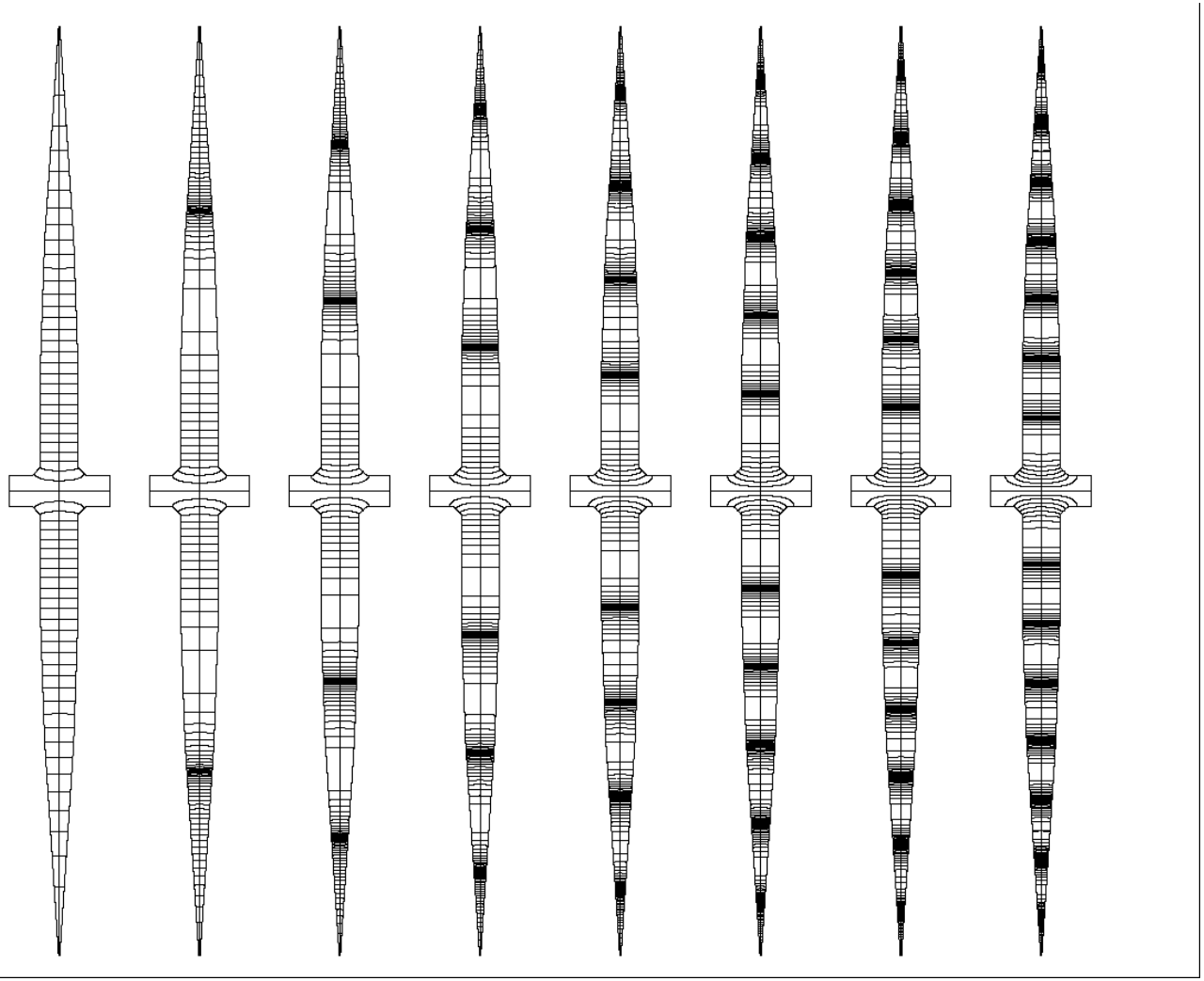
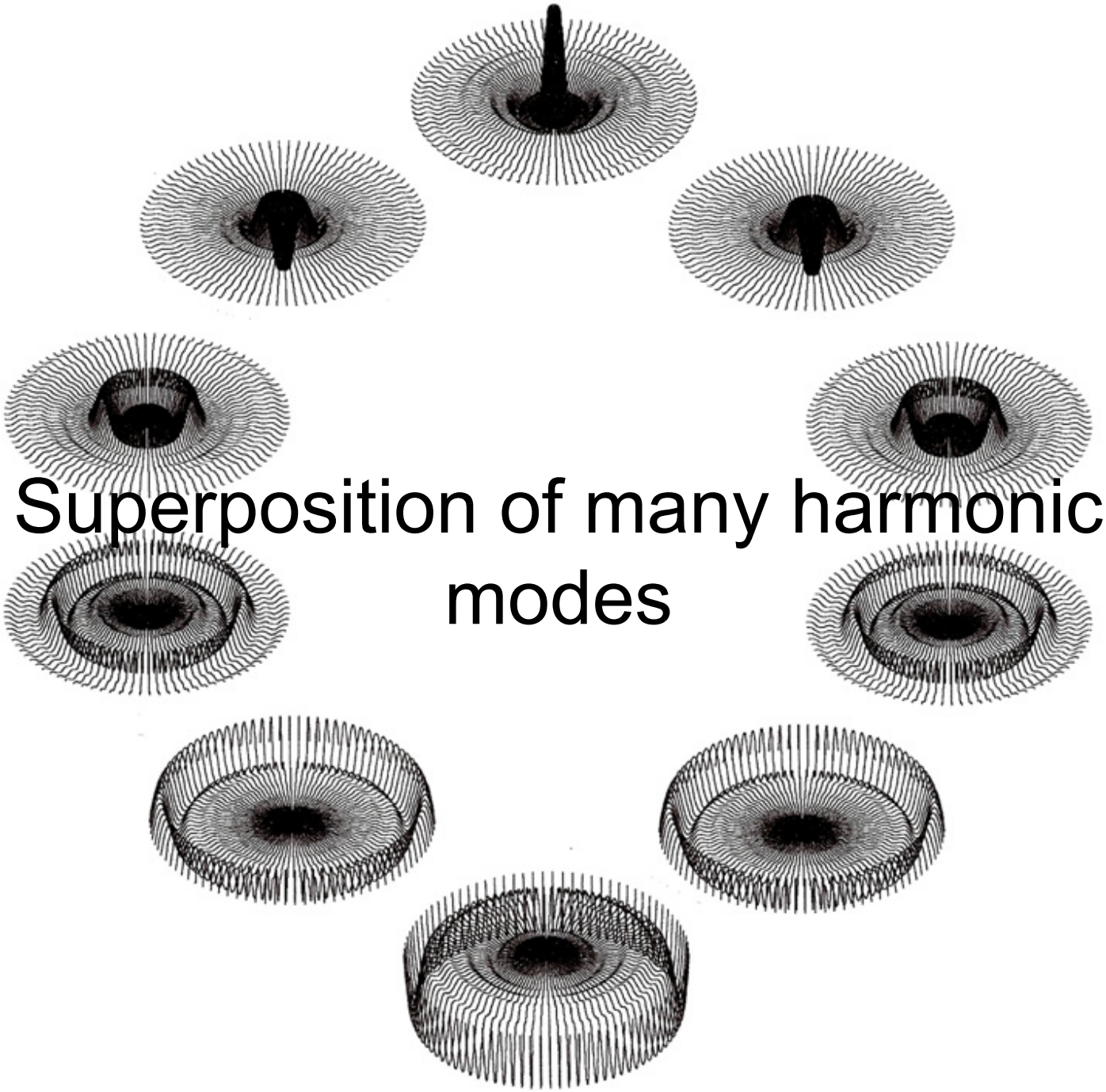
Can several harmonic TM_{0N0} modes be simultaneously superimposed?

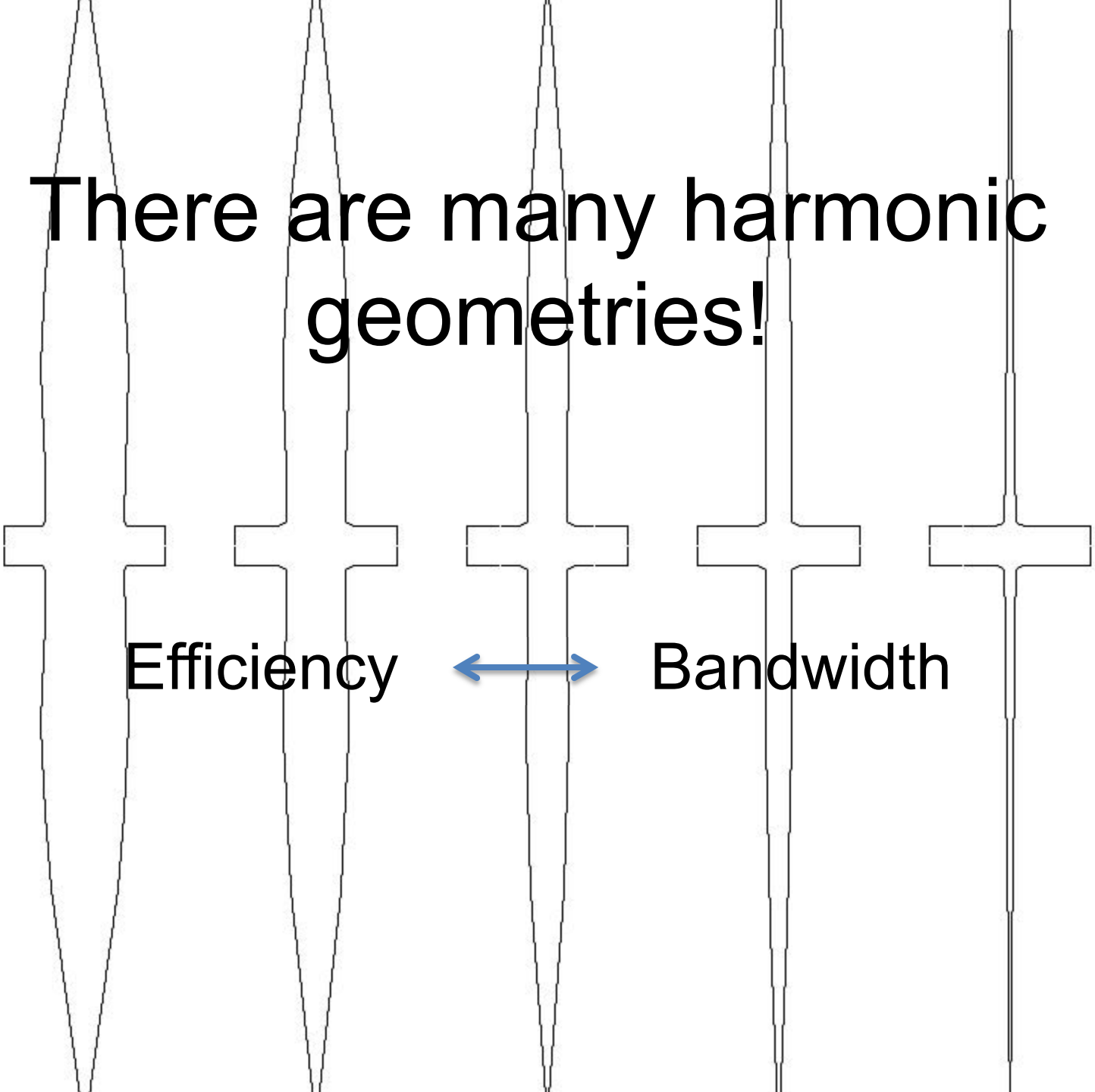


Yes, the cavities shape tunes the TM_{ONO} modes to be Harmonic





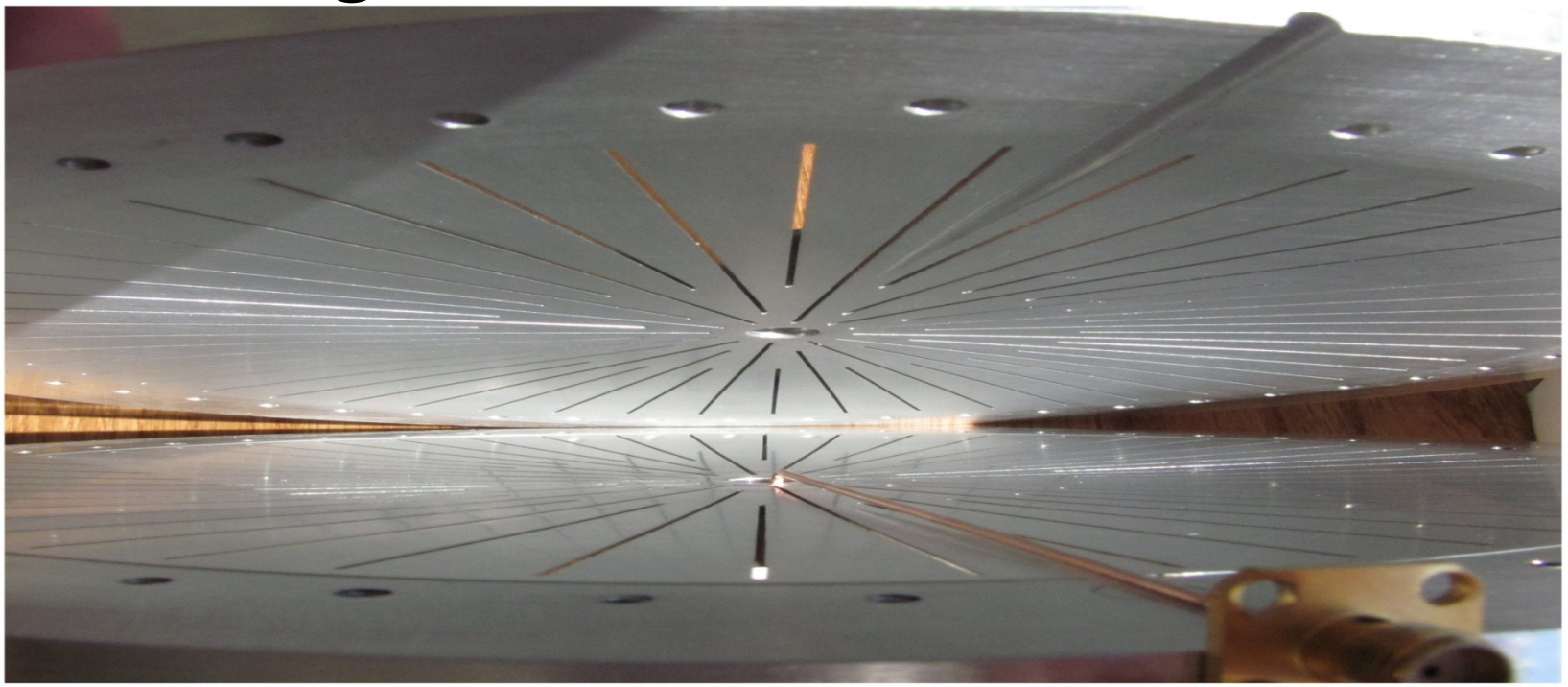
Superposition of many harmonic modes

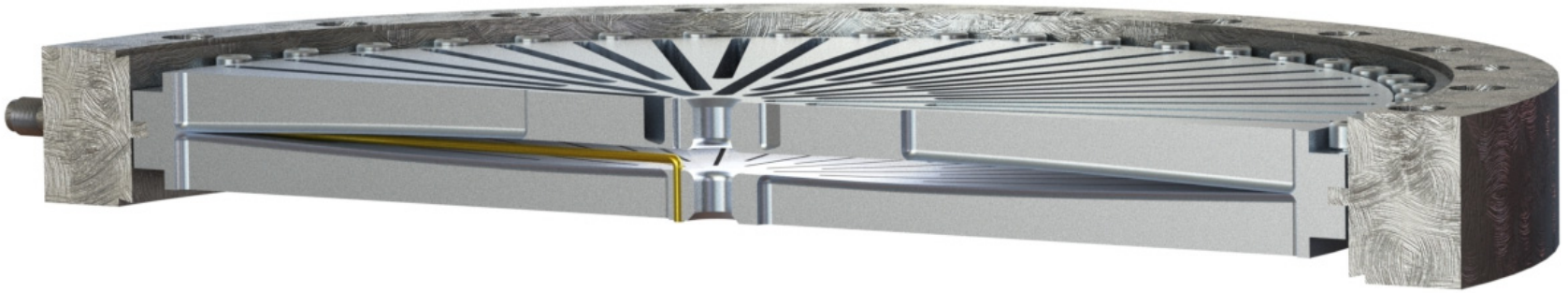


There are many harmonic geometries!

Efficiency ⟷ Bandwidth

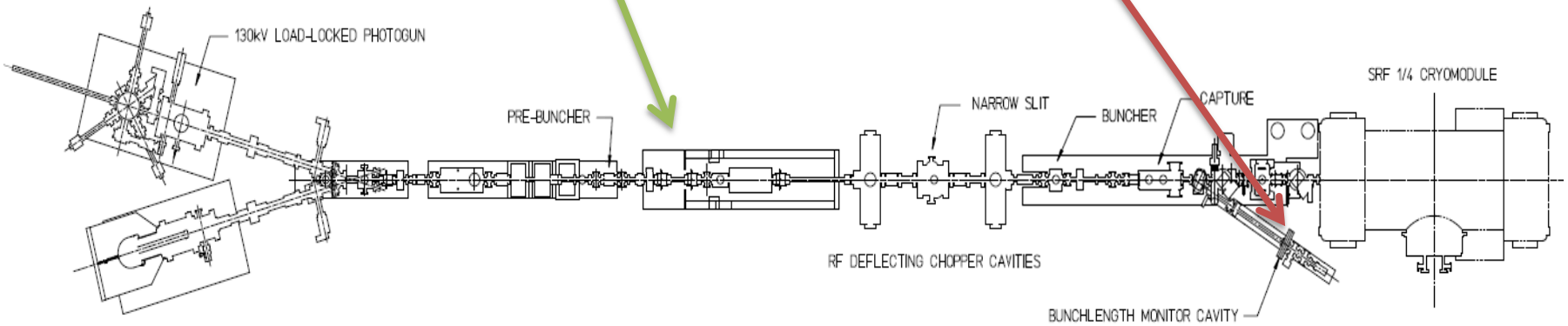
A single wideband antenna

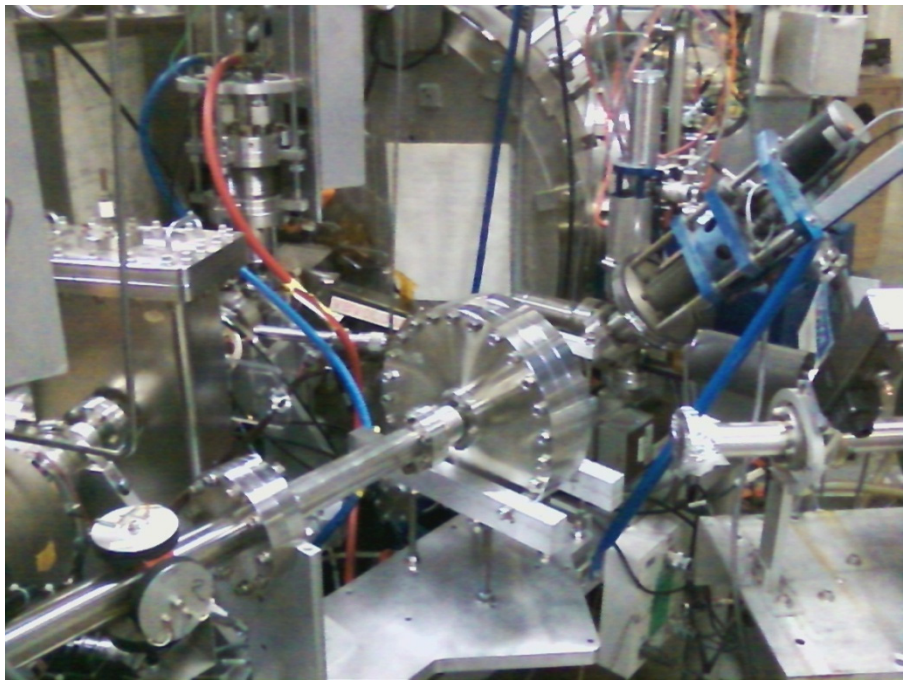





Beam Monitor

Beam Monitor Evaluation in CEBAF's injector



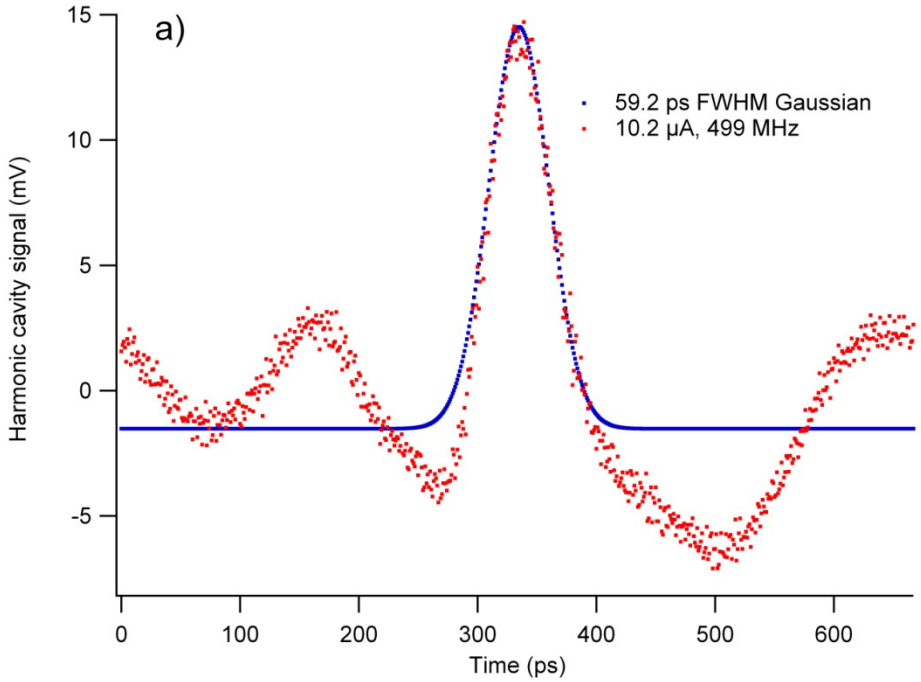


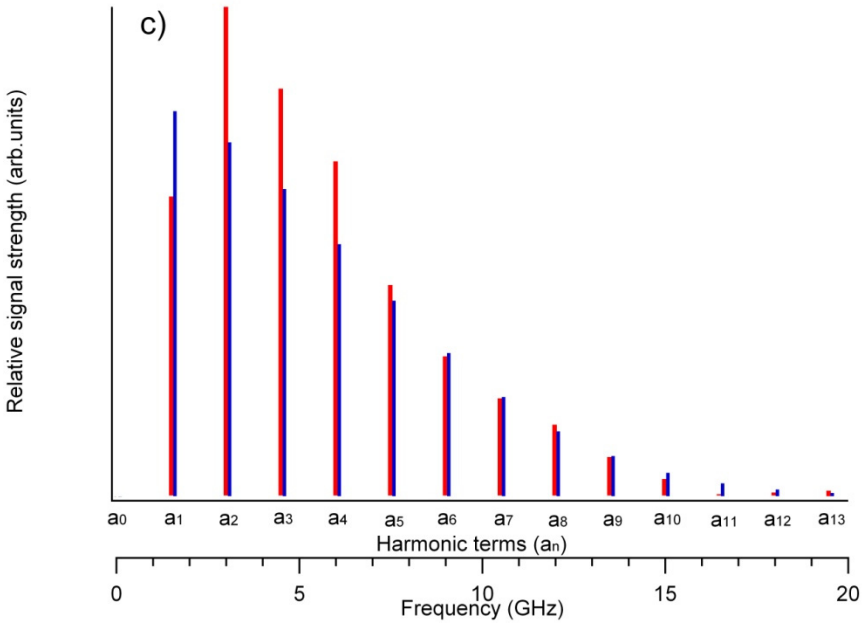
The detected waveform is the superposition of the cavity modes excited by the beam. The beam can be described in the same format; the compact trigonometric form of their Fourier series

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

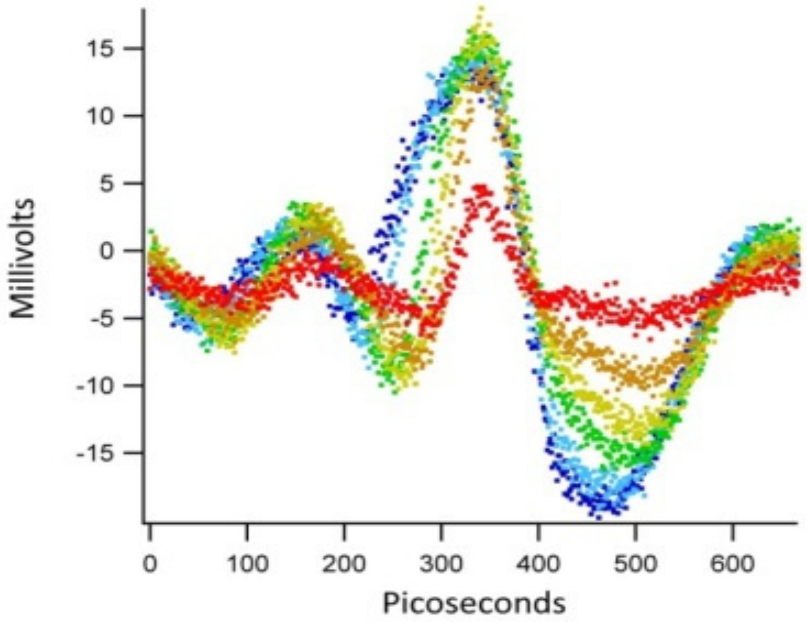
$$i_{beam}(t) = a_1 \cos(w_o t + \theta_1) + a_2 \cos(2w_o t + \theta_2) \ldots$$
$$+ a_n \cos(nw_o t + \theta_n).$$

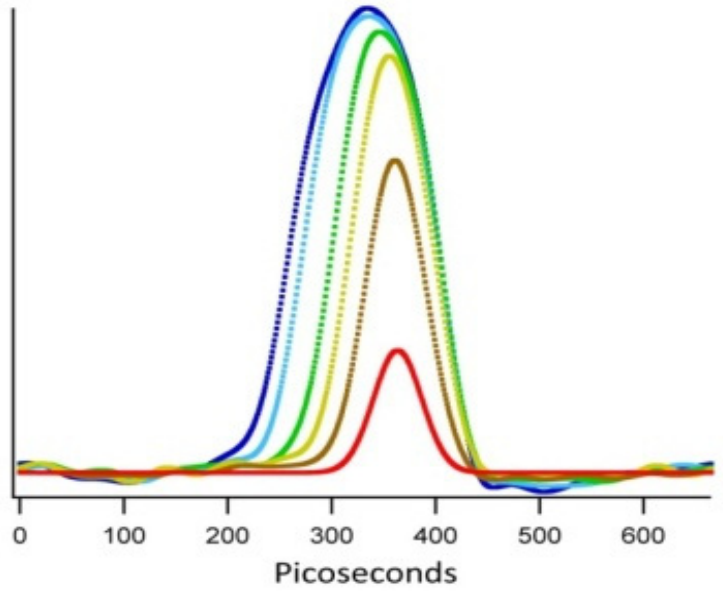
Harmonic Cavity Transfer Function



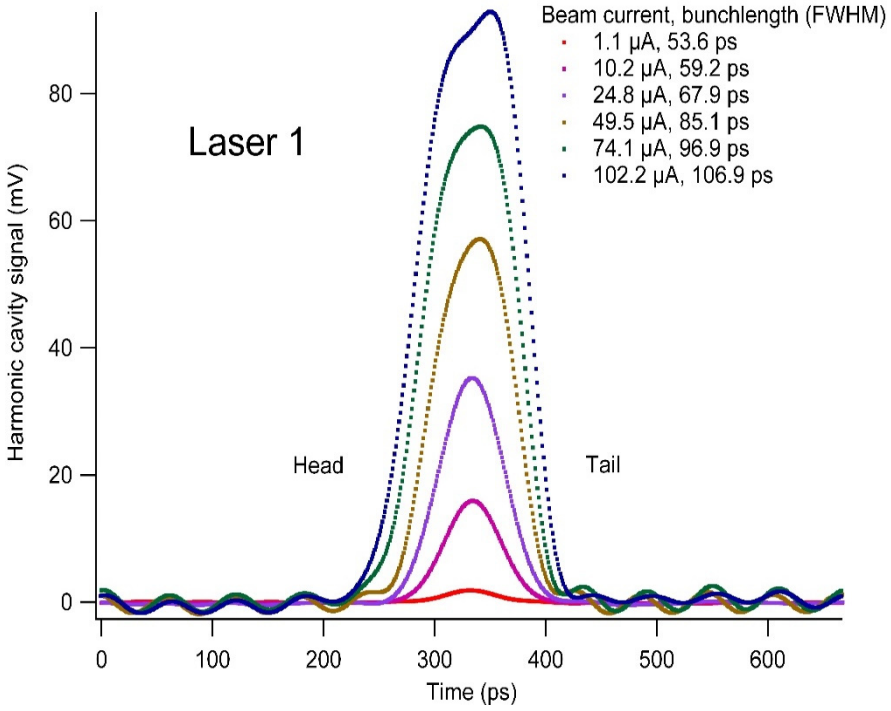


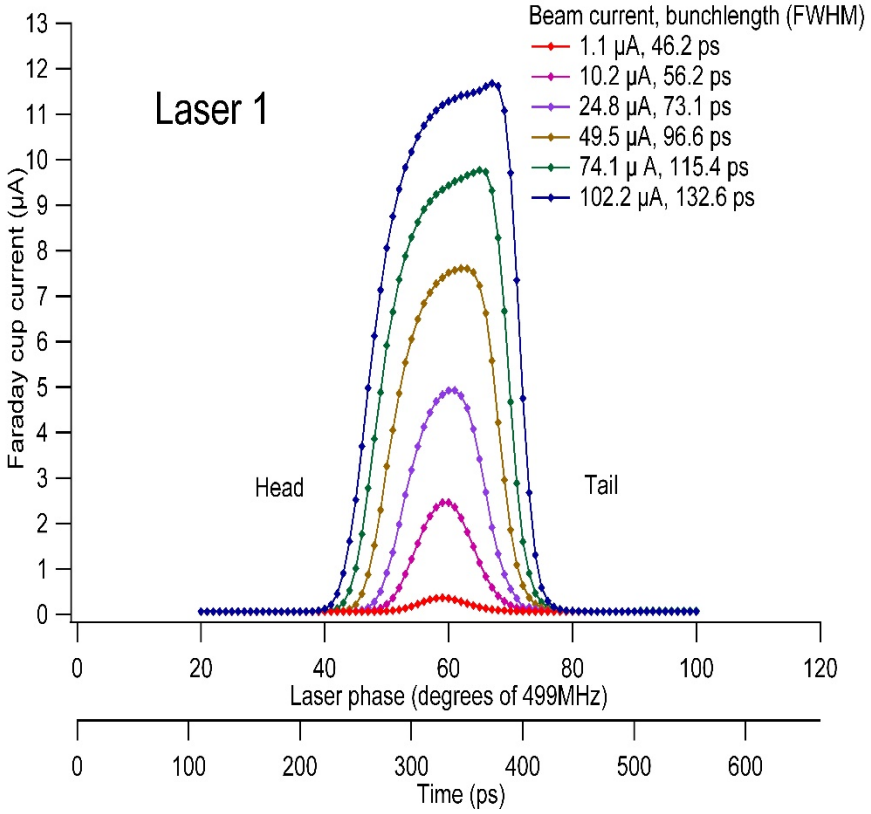
The ratio of these two series is the harmonic cavities transfer function. Once determined, the cavities transfer function can be used to un-distort subsequent data independent of new bunch shapes.



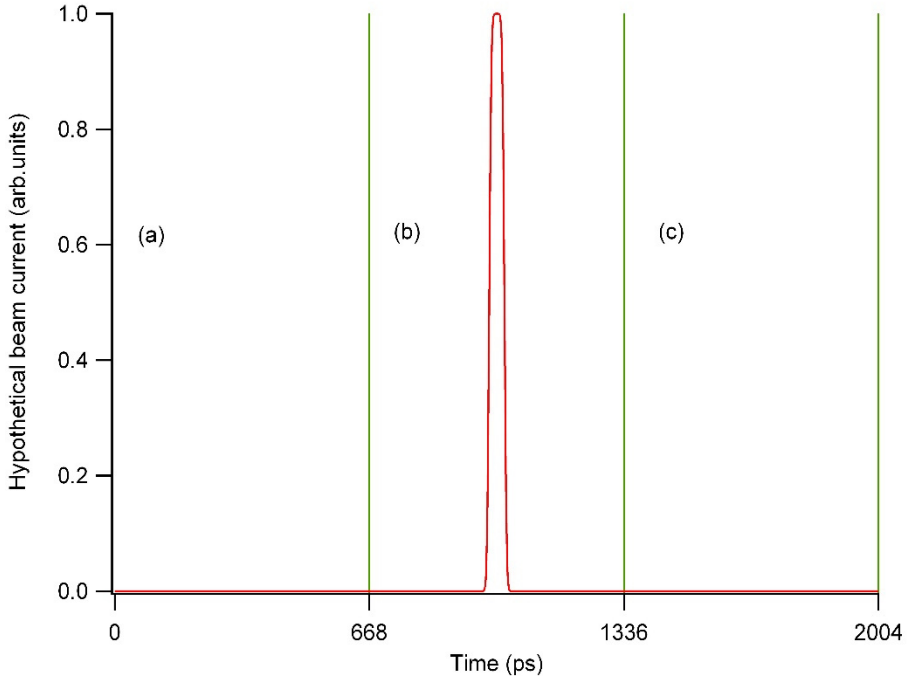


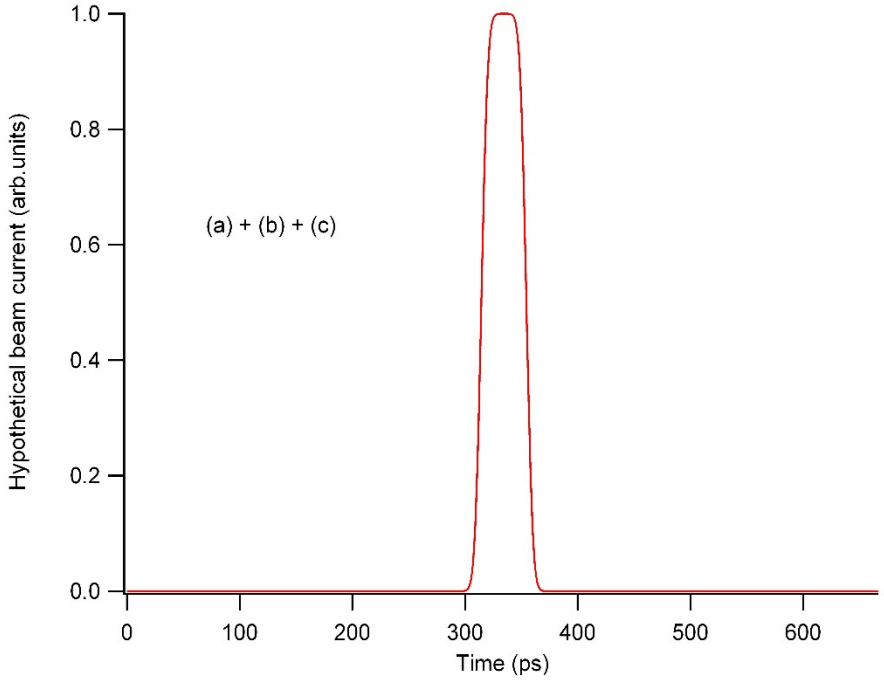
Comparison: Harmonic cavity vs. RF-deflection cavity techniques.



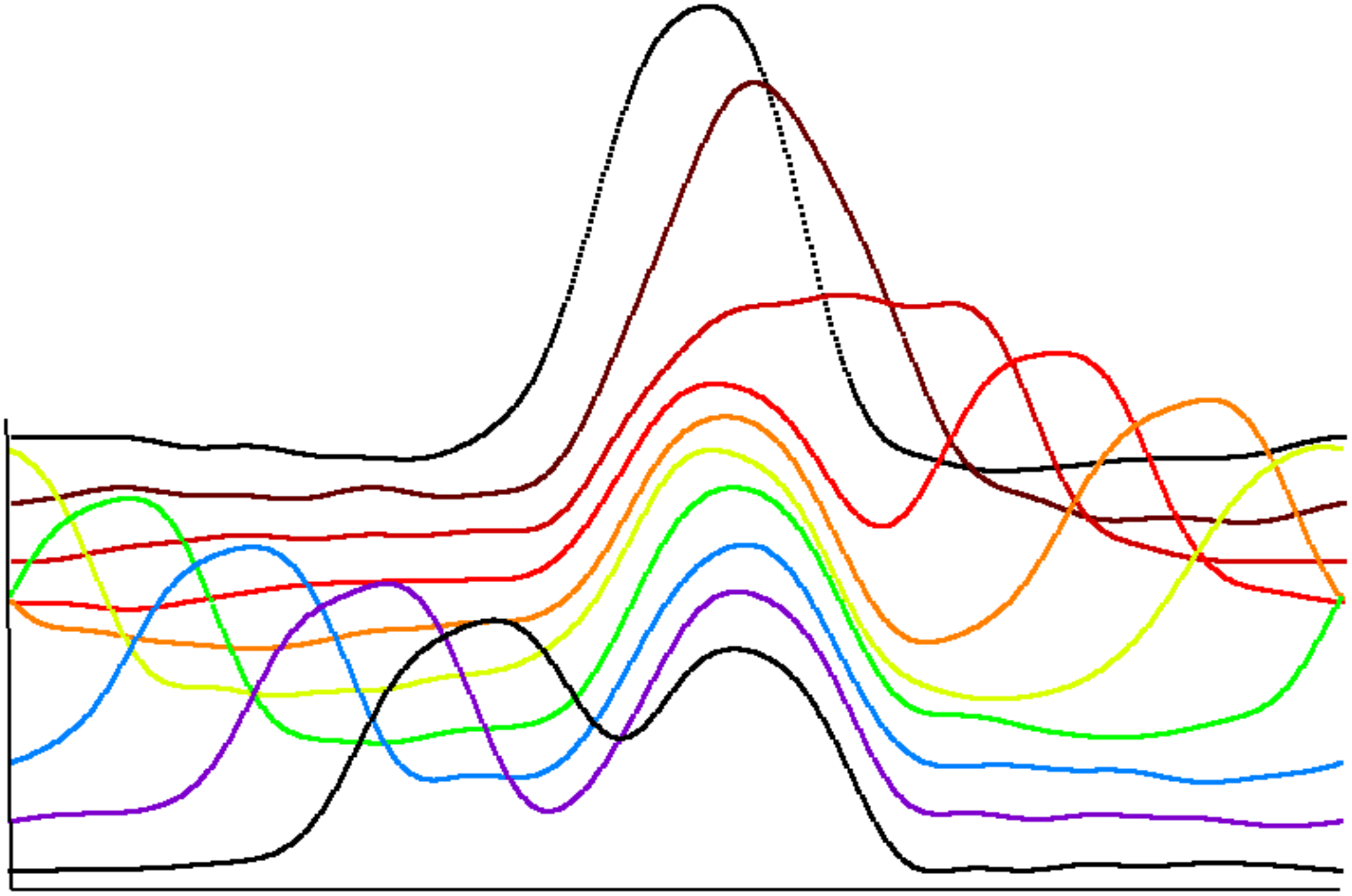


Measuring 499 MHz and 249.5 MHz beams with a 1497 MHz harmonic cavity.

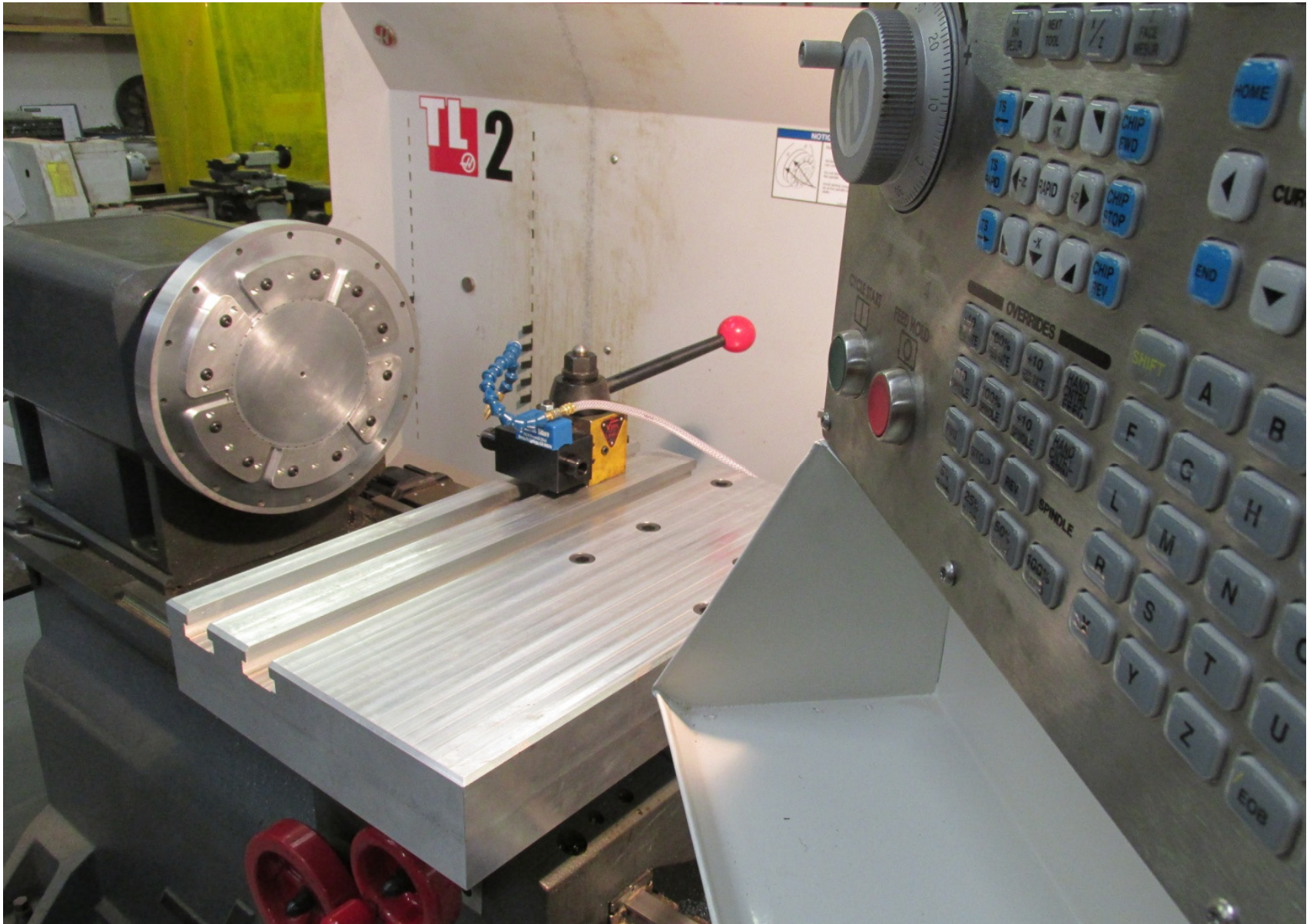




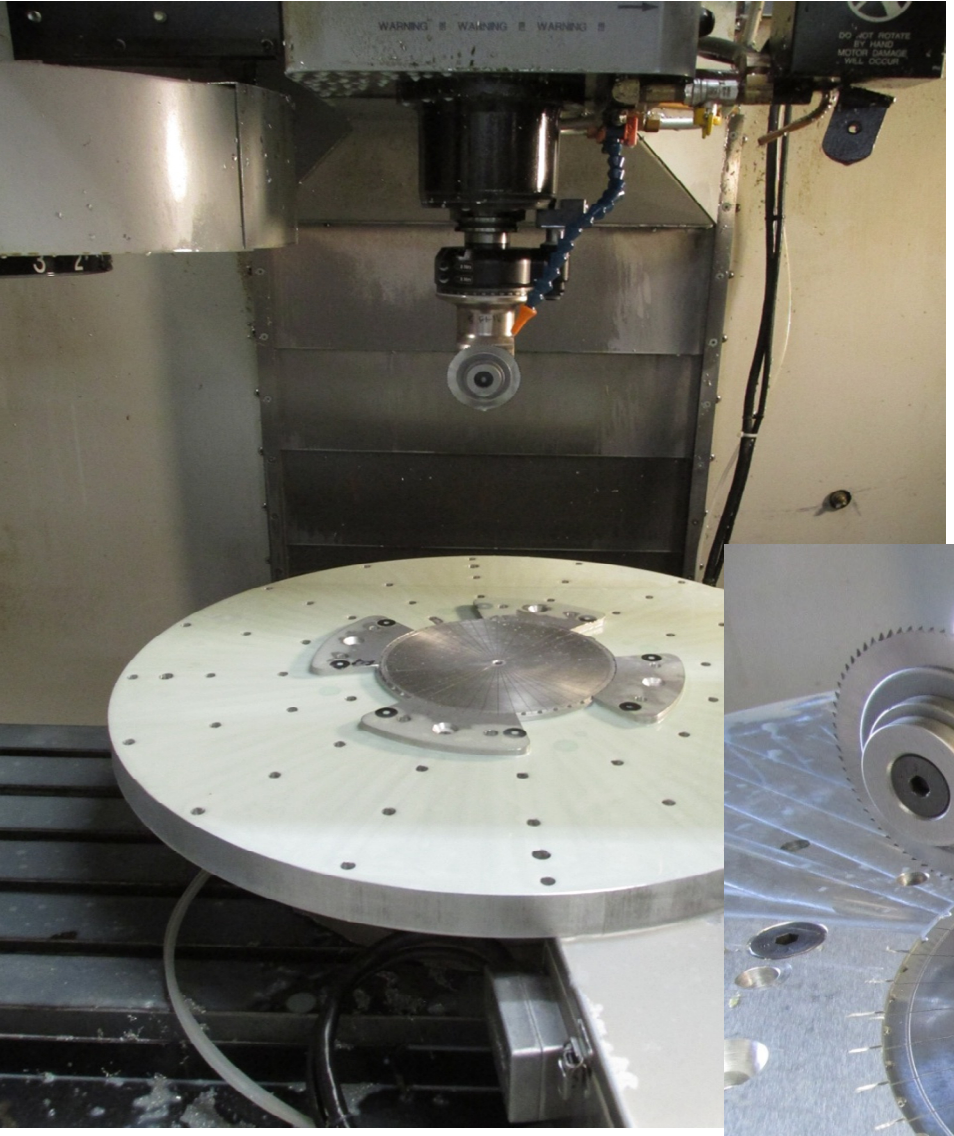
Measurement of two interleaved 499 MHz beams.

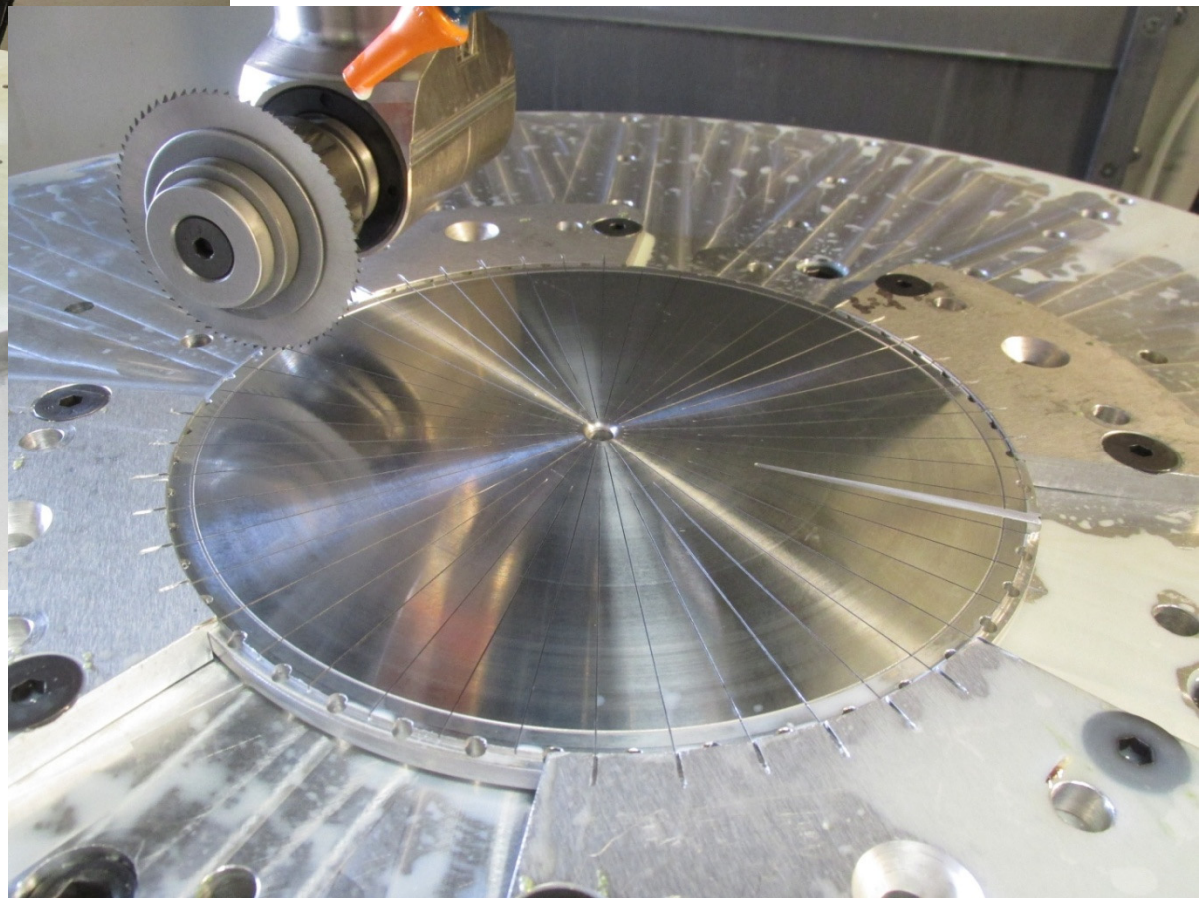


CNC Lathe and Vacuum Chuck

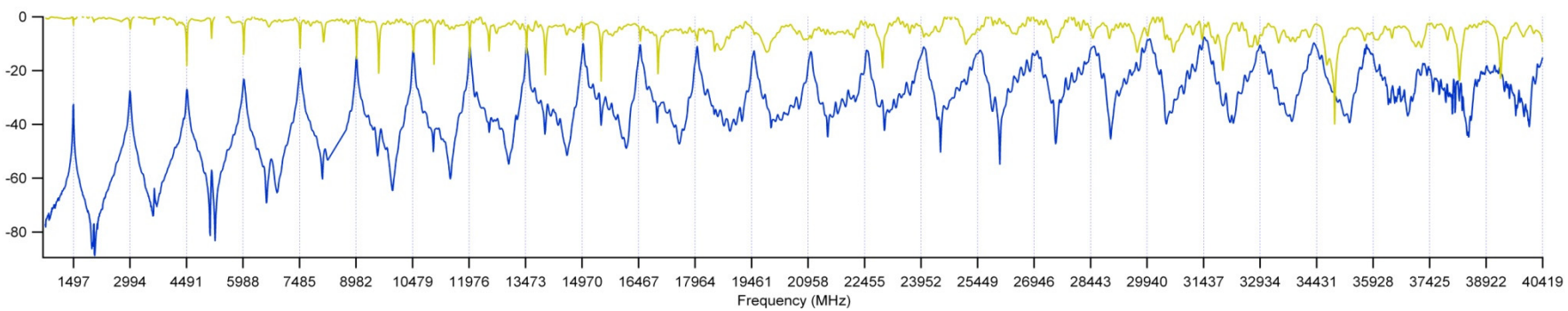


Slitting Saw on CNC Mill with 26” rotary





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)

Generation 3 Beam Monitors ready for installation!

Thank you IBIC 2016 and Bergoz!

We are excited to test the new higher bandwidth harmonic cavities and equip CEBAF with high resolution beam monitors.

We hope to demonstrate the use of harmonic cavities in driven applications; fast kickers and bunch modifiers.

Does your accelerator need a non-invasive beam monitor?