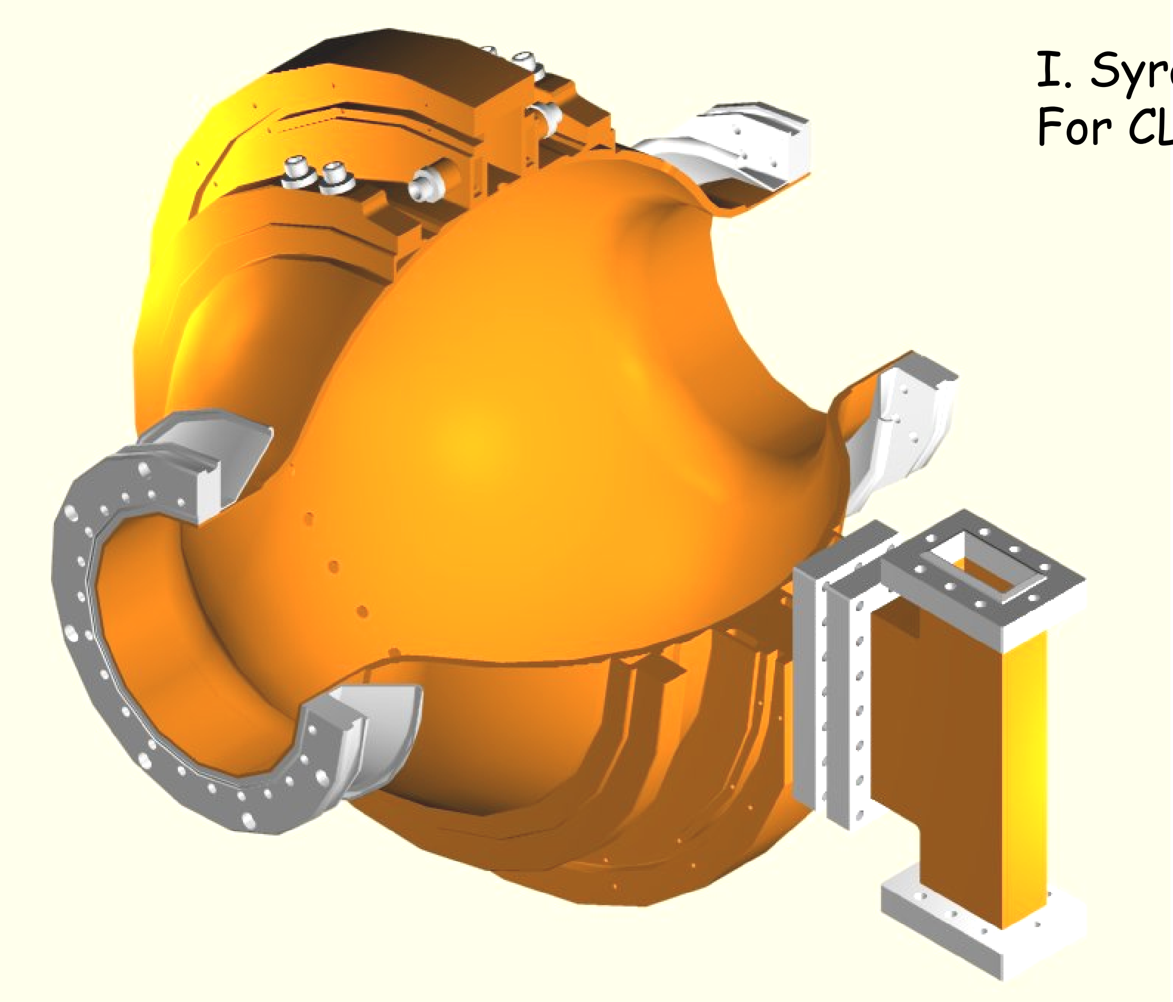
I. Syratchev
For CLIC team

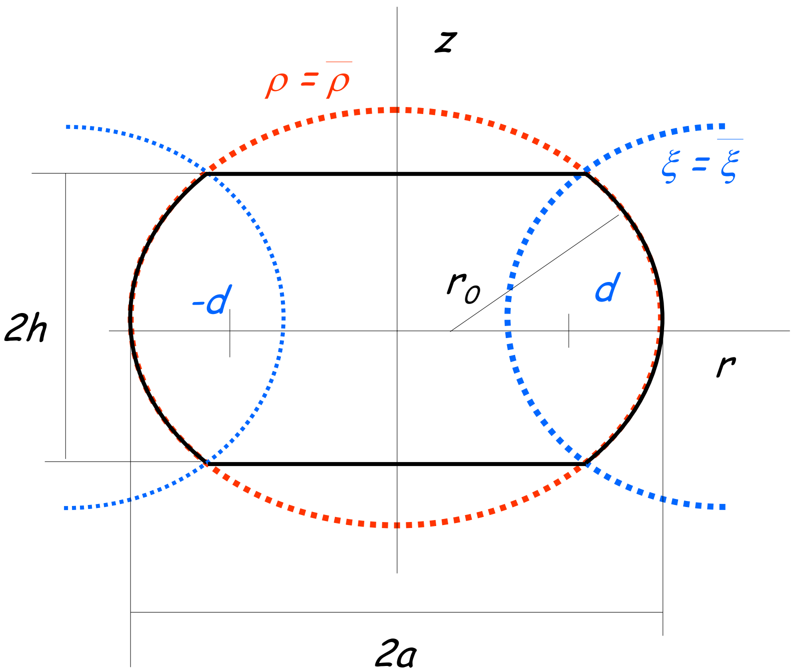


Barrel Open Cavity RF pulse compression system

Motivations

Another six 3 GHz RF pulse compression systems are required for CTF3 nominal operation.

Barrel cavity short theory.



Cavity profile

$$z = \sqrt{a r_0 \left\{ 1 - \left(\frac{r}{a} \right)^2 \right\}}$$

The eigen-frequency of the Barrel cavity with E_{mnq} oscillation is the solution of the next equation:

$$ka = \nu_{mn} + \frac{(q - 1/2)\alpha}{\sin\theta}$$

ν_{mn} is a root of the Bessel function that for the big *m* can be approximated as:

$$\nu^{o}_{mn} = m - \mu t^{0}_{n} \qquad (n = 1,2,\ldots),$$

$$-t^{0}_{n} = [(n - 0.25)1.5\pi]^{2/3}, \qquad \mu = \left(\frac{m}{2} \right)^{1/3}.$$

The optimal radius r_0, when the external caustic has the smallest height comes from: $r_0 = 2a\sin^2\theta$ where α and θ are derived from:

$$\sin\alpha = \sqrt{\frac{a}{r_0}}\sin\theta \qquad \cos\theta = \frac{m}{\nu_{mn}}$$

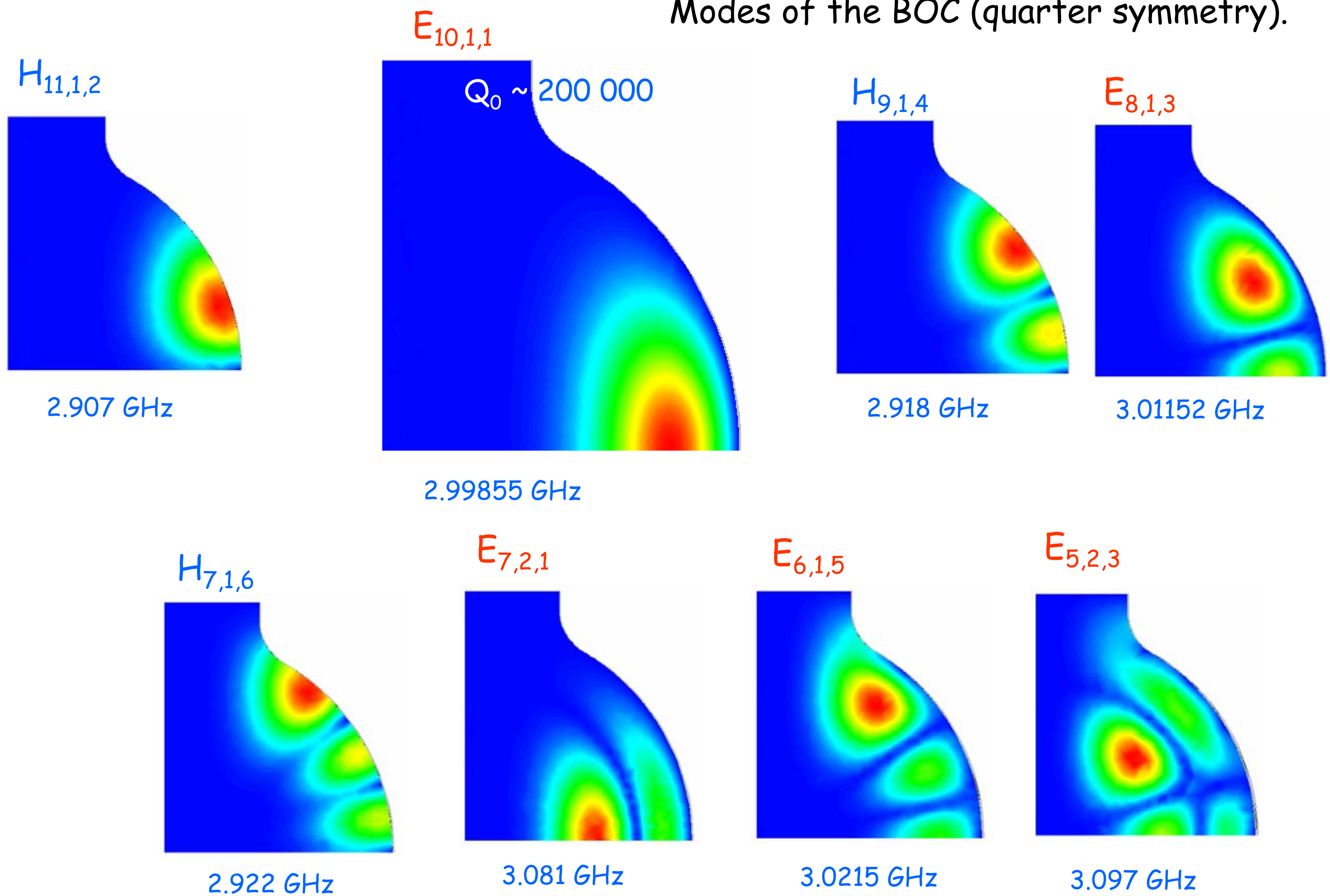
Finally the height of the external caustic and Q-factor of the cavity are:

$$z_{q-1} = 2\sqrt{(q - 1/2)\frac{a\sin\theta}{k\sin 2\alpha}}$$

$$Q_E = \frac{a}{\sigma_s}$$

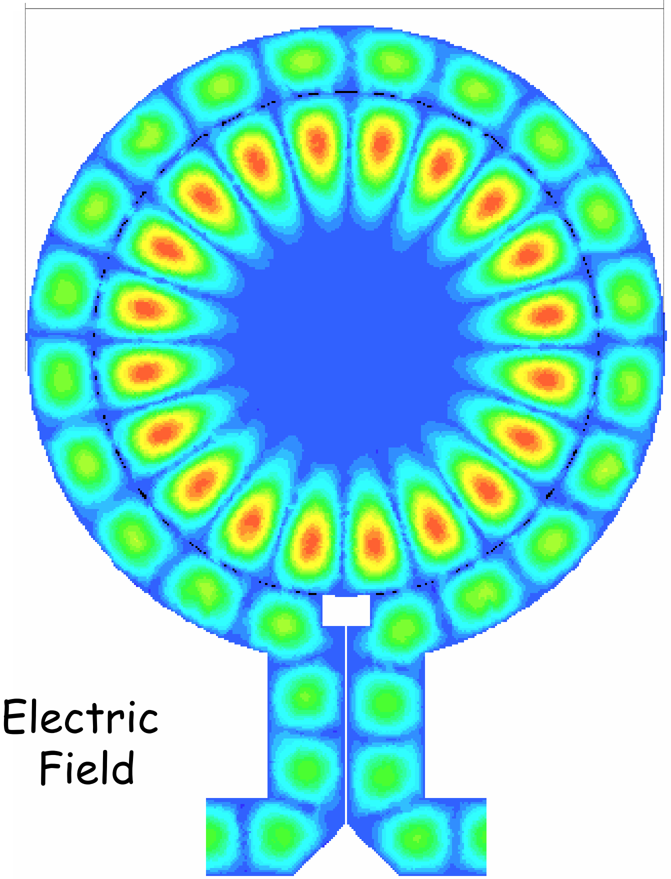
3 GHz BOC RF pulse compressor

Modes of the BOC (quarter symmetry).

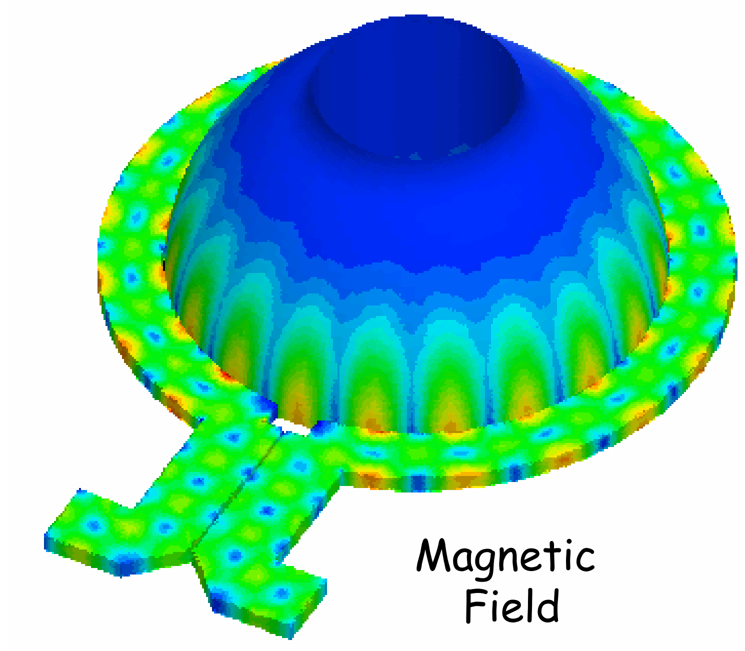


Whispering Gallery Mode Fields patterns

~ 0.6 m



Electric Field



Magnetic Field

Whispering Gallery Mode: $TM_{10,1,1}$
Q_0 = 197 800 (calculated with HFSS)
F = 2.9985 GHz
$\beta = 6$

BOC fabrication procedure

Half-cell

EBW: Half-cell to cooling-ring

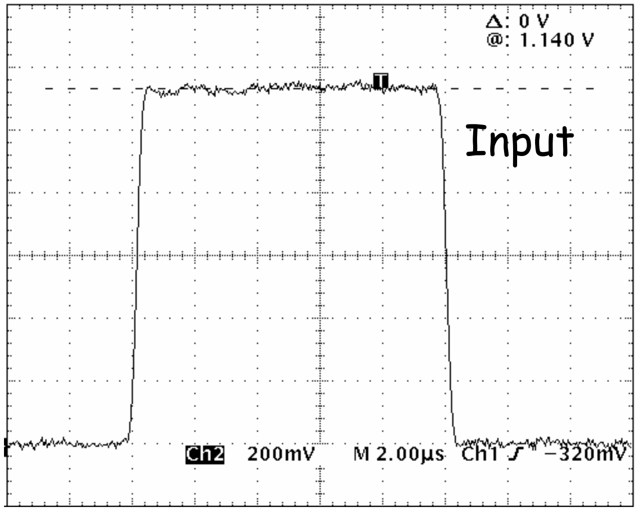
EBW: Half-cell to virole

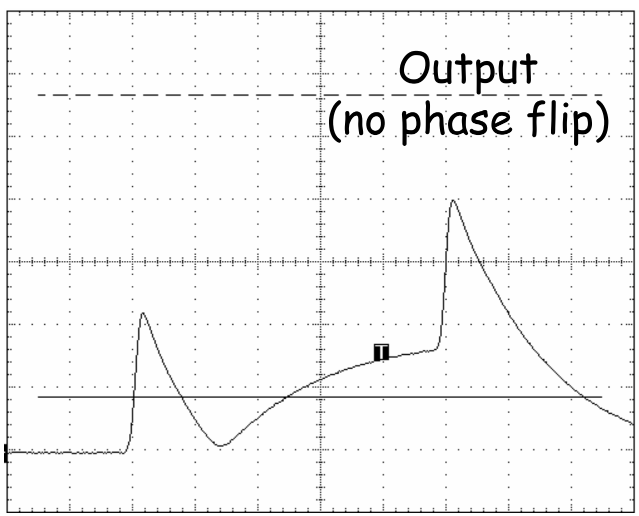
Waveguide: T-section

Cavity body assembly

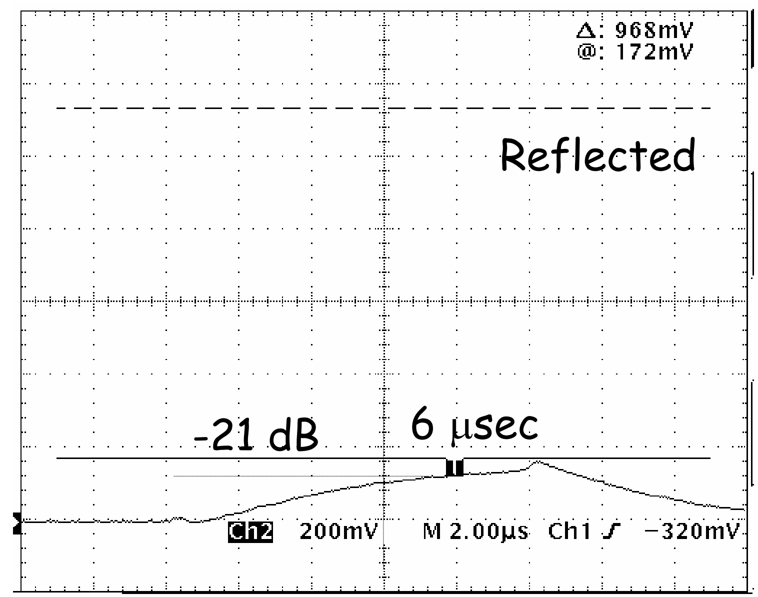
Turning: Half-cell and main-ring

First BOC measurements and Blank hole #40

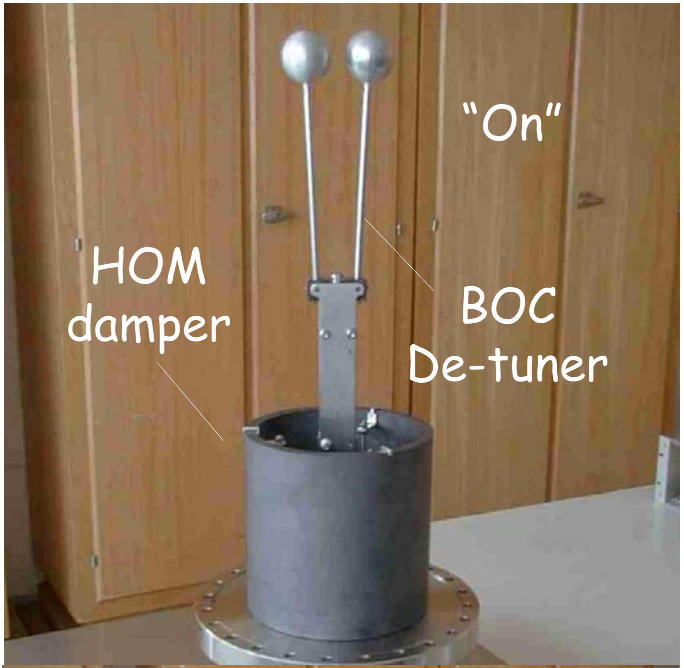




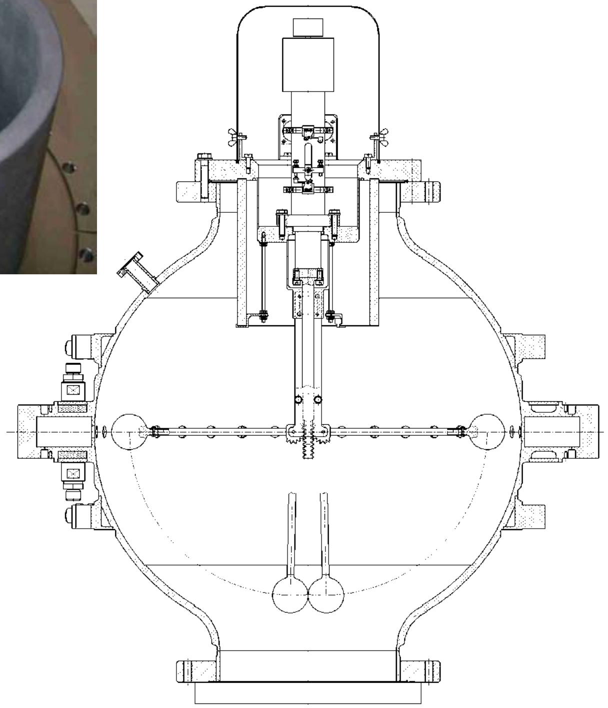
The blank hole #40 was machined, keeping the same diameter as others. The hole depth was optimised to minimize reflection, Finally -21 dB reflection after 6 μsec was achieved.



3 GHz BOC RF pulse compressor



BOC detuning and HOM damping



3 GHz BOC RF pulse compressor

Final assembly

Internal view
of coupling holes

3 GHz RF Pulse Compressors Gallery

LIPS
(XX century)

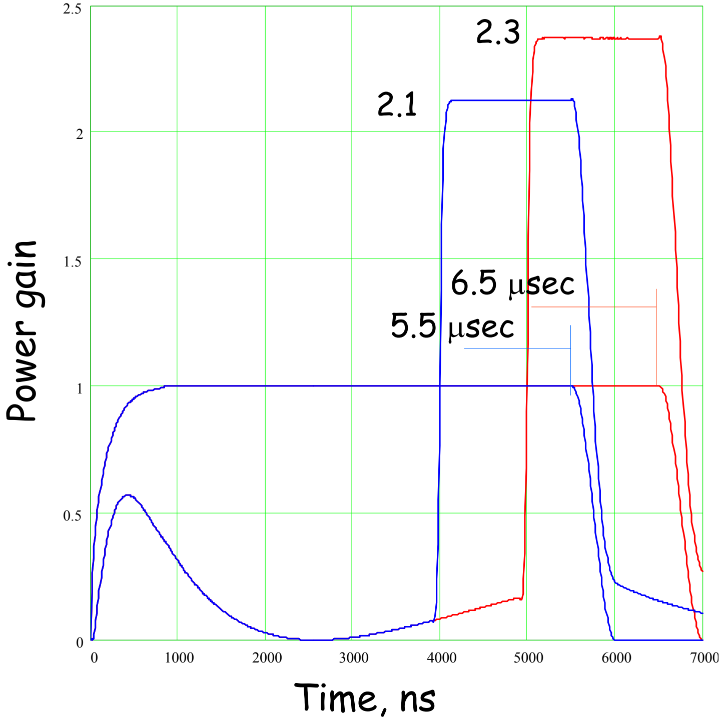
BOC
(XXI century)

Future plans …

Flat top compressed pulse with special RF phase modulation

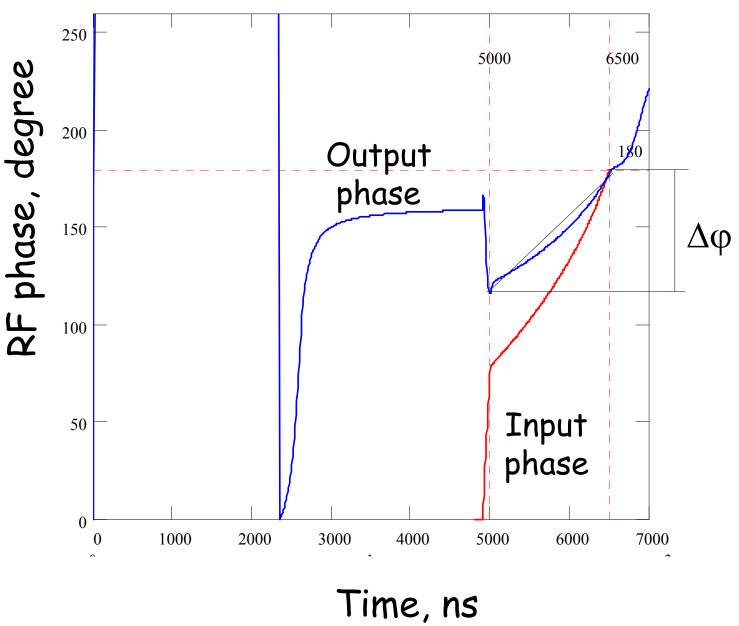
Simulations:

Cavity: $Q_0 = 1.8\times10^5$, $\beta=6$



The linear part of the phase slop will be compensated with the frequency shift:

$$\pm\Delta\omega T_{out} = \pm\Delta\varphi$$

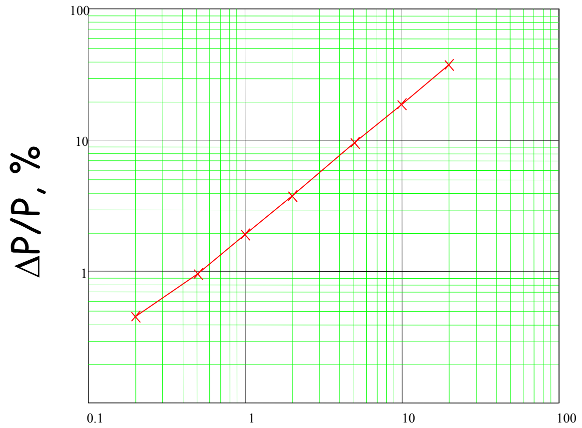


System operation stability issues.

<u>Because of the energy spread, the demand on the compressed pulse flatness is: $\Delta P/P < 2\%$</u>

The main sources of instability:

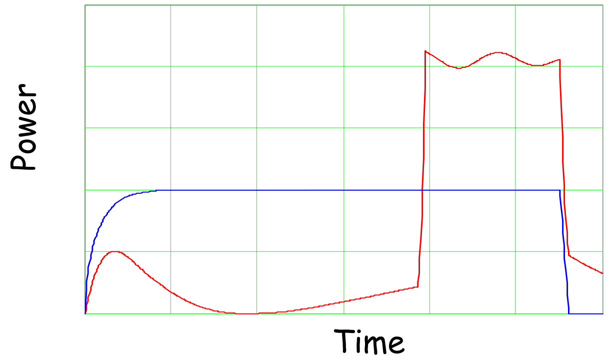
1. Klystron RF phase and amplitude jitter as result of HV supply instability.



Klystron's RF phase ripples (p-to-p), degree.

The examples of the compressed RF pulse distortion due to the klystron RF phase ripples.

a) RF Phase modulation. Klystron RF phase ripples 3^0 peak-to-peak.

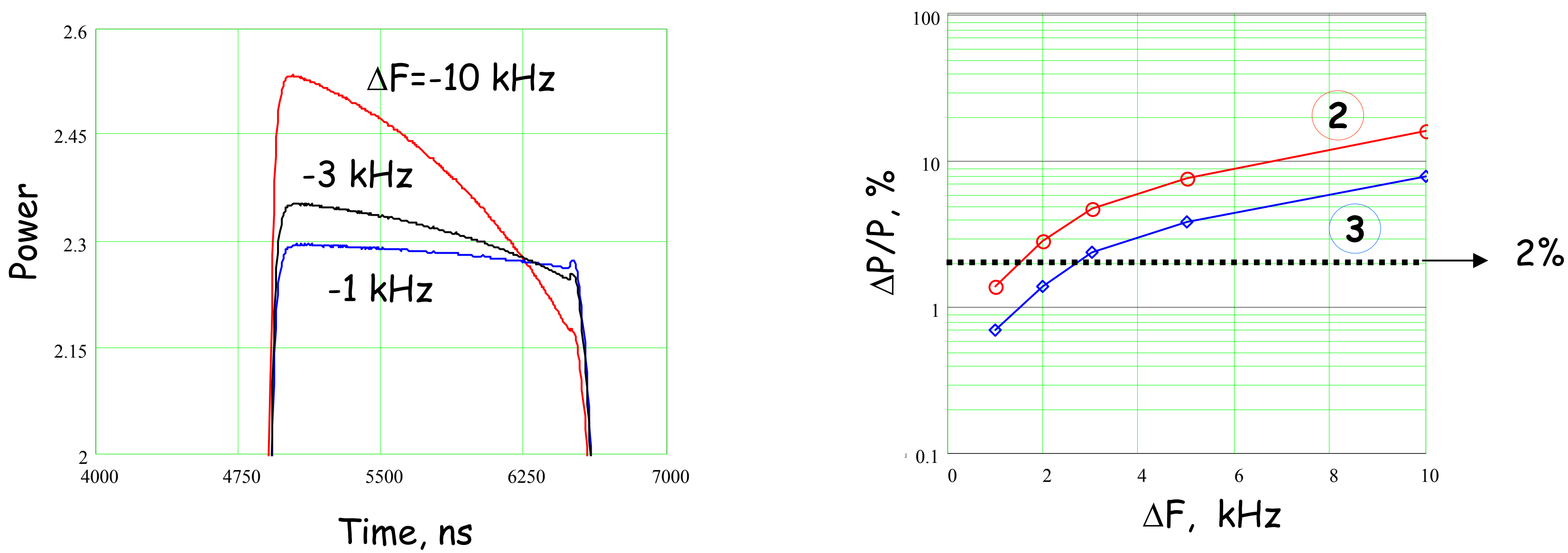


The klystron RF ripples were successfully compensated with RF phase correction of the drive signal.

3 GHz BOC RF pulse compressor

2 The frequency deviation of the storage cavity, mainly because of the temperature variation.

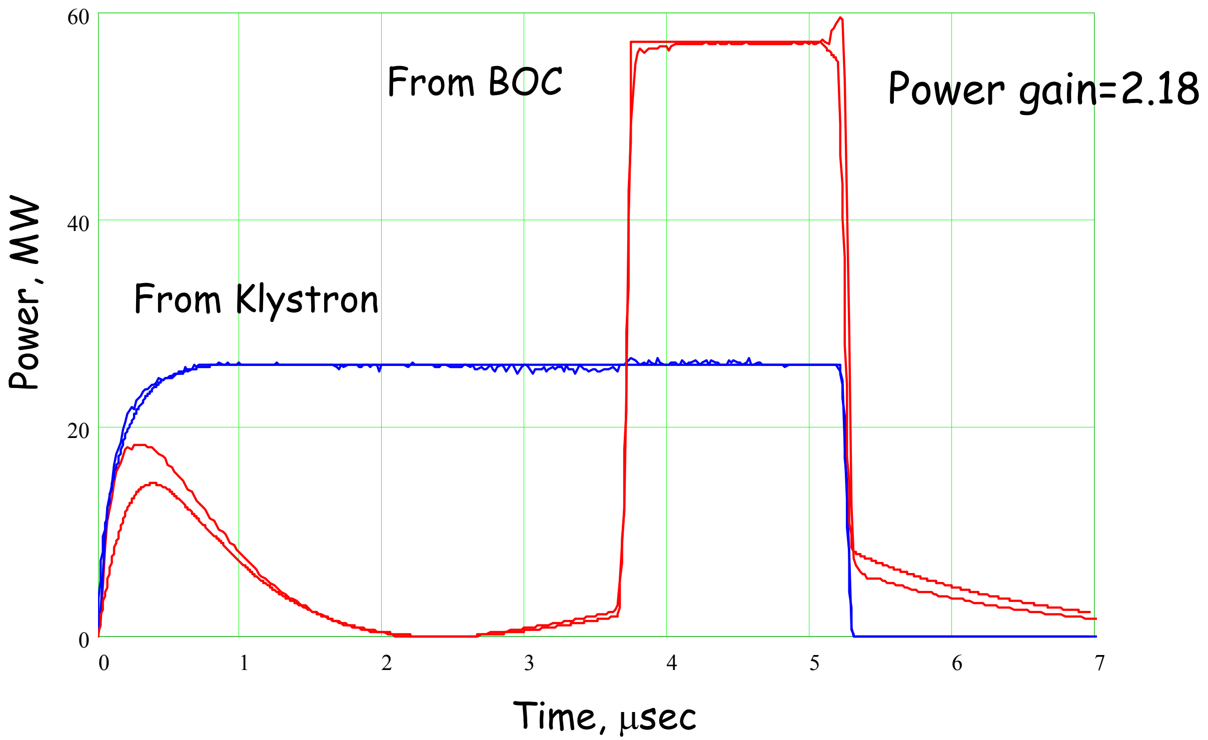
3 The identity of the LIPS cavities resonant frequencies.



$$\Delta T_s = \frac{\Delta F}{F\alpha}, \quad \alpha = 1.661\times10^{-5}\frac{1}{^oC}, \quad \Delta F = 1.5kHz \qquad \Delta T_s = \pm 0.03\ ^oC$$

To keep the flatness of the compressed pulse within specified ΔP/P, the temperature stabilization of the cavity must be $\Delta T < \pm 0.03\ ^0C$.

BOC high power tests with RF phase modulation.



Solid line – measurements, broken simulations. Data for simulations (Q-factor, coupling) were taken from BOC cold measurements.