PRELIMINARY STUDY FOR AN ACTIVE 3rd HARMONIC SYSTEM FOR ALBA

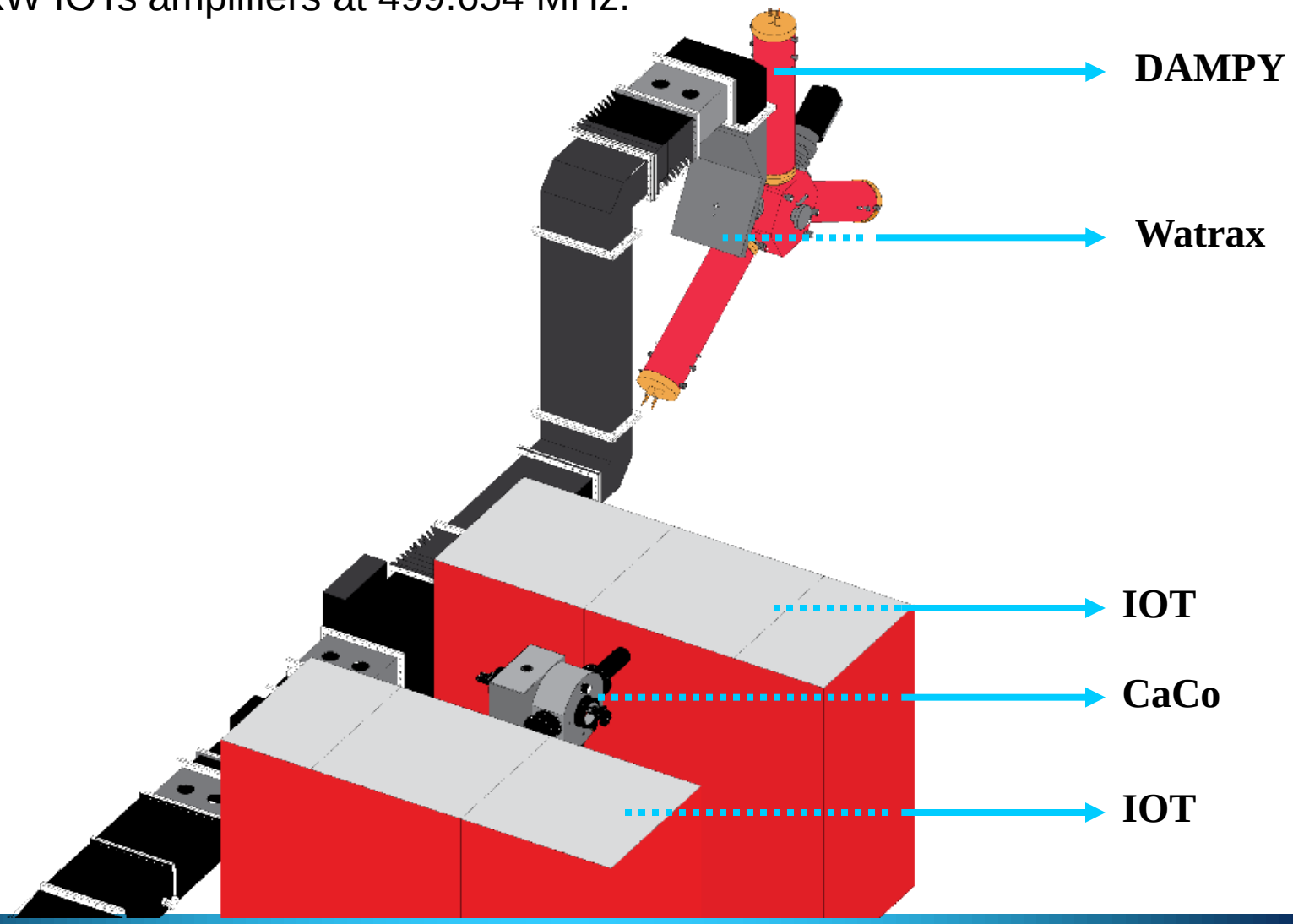
BEATRIZ BRAVO

OVERVIEW

- INTRODUCTION
- MOTIVATION
- THIRD HARMONIC CAVITIES
- PROPOSAL: THIRD HARMONIC SYSTEM
- CONCLUSIONS

INTRODUCTION

- The ALBA storage ring uses six room temperature cavities; each one is fed by two 80kW IOTs amplifiers at 499.654 MHz.



INTRODUCTION

- The ALBA storage ring uses six room temperature cavities; each one is fed by two 80kW IOTs amplifiers at 499.654 MHz.

MOTIVATION

FOR A USER, **LIFETIME** IS ONE OF THE MOST IMPORTANT ASPECTS OF A SYNCHROTRON LIGHT

PROBLEM	SOLUTION
High brightness synchrotron like ALBA are lifetime limited from Touschek scattering.	Stretch the bunch using a secondary RF system (3HC).

$$\frac{1}{\tau_{Touschek}} = \frac{r_e^2 cq}{8\pi\varepsilon\gamma^3\sigma_s}\cdot\frac{1}{C}\cdot\oint_C \frac{F\left(\left(\delta_{acc}(s)/\gamma\sigma_{x'}(s)\right)^2\right)}{\sigma_x(s)\sigma_z(s)\sigma_s(s)\delta_{acc}^2(s)}ds$$

Optimized brilliance for 3rd generation sources: => lower $\tau_{Touschek}$

Bunch lengthening:
=> increases $\tau_{Touschek}$

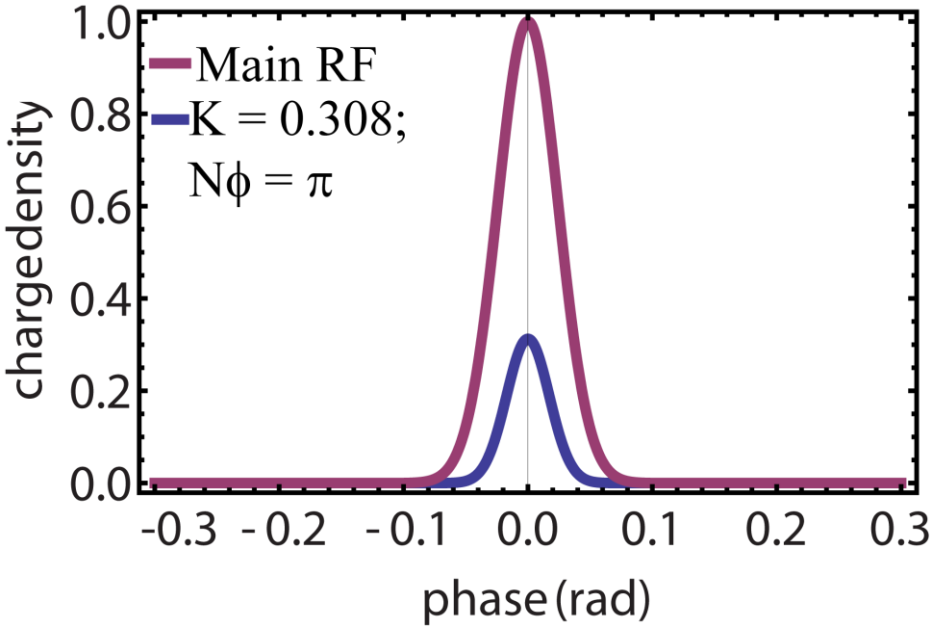
RF or dynamic acceptance:
=> limits $\tau_{Touschek}$

THIRD HARMONIC CAVITY

The combined voltage from the main and harmonic RF system is given by:

$$V(\phi) = V_{rf} \cdot \sin(\phi + \phi_s) + V_h \cdot \sin(n(\phi + \phi_h))$$

Depending on the Vh and the phase the bunch can stretch, shorten, overstretch.



New Beam size

$$\sigma_z(V_{rf+harm}) = 0.5\ \sigma_z(V_{rf})$$

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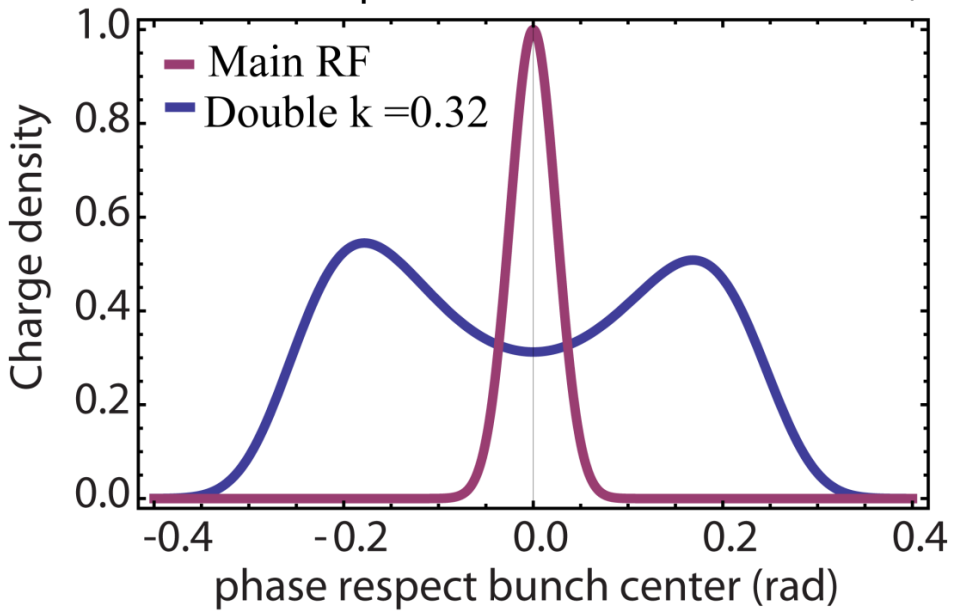

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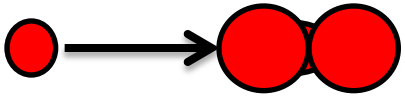
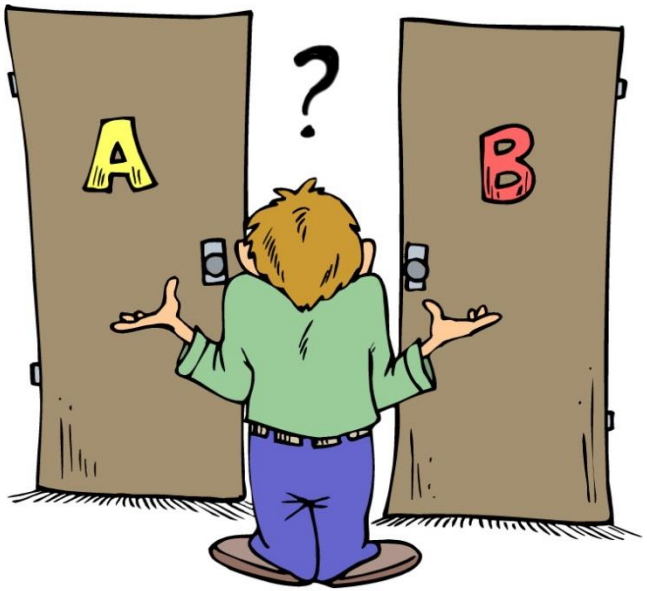


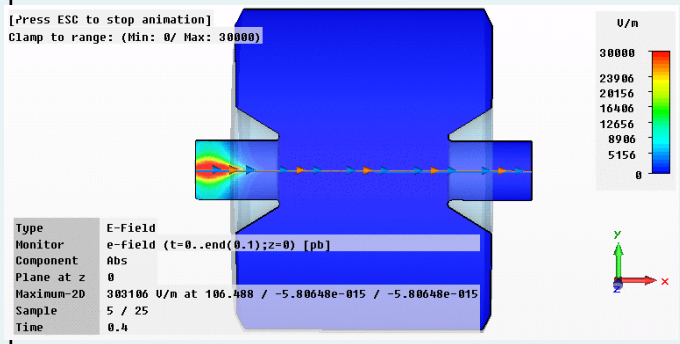
- Optimum values FOR ALBA at 400 mA and Vrf = 3,6 MeV:

Vh =1 MeV; k = Vh/Vrf =0,308 $N\phi_h = -8.4\,\mathrm{deg}\,rees$

WHICH CAVITY IS THE BEST OPTION FOR ALBA?



THIRD HARMONIC CAVITY

	SC passive	NC active HOM damped
External generator and waveguide distribution system	No 	Yes 
Possibility of adjust Vh and phase	No	Yes. VIA DLLRF.
Filling pattern	It is important due to beam loading.	It is not a concern
Problems with HOMs	Is detuned on the unstable Robinson criterion,	No
Cooling	Criogenetics	Water cooling

THIRD HARMONIC CAVITY

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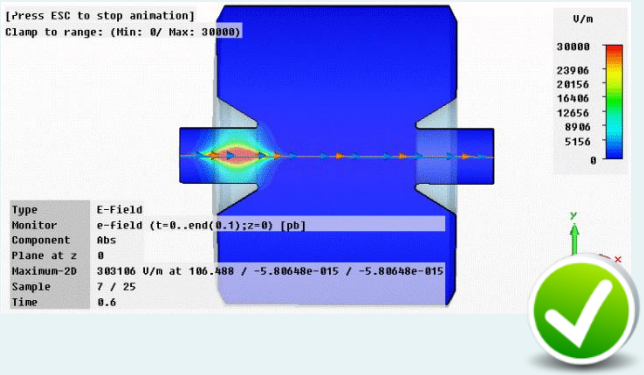
External generator and waveguide distribution system	No 	Yes  
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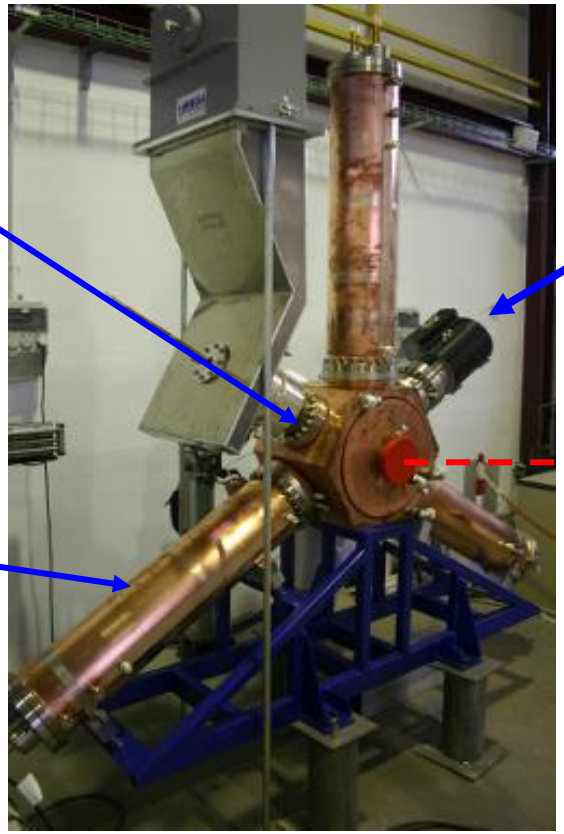
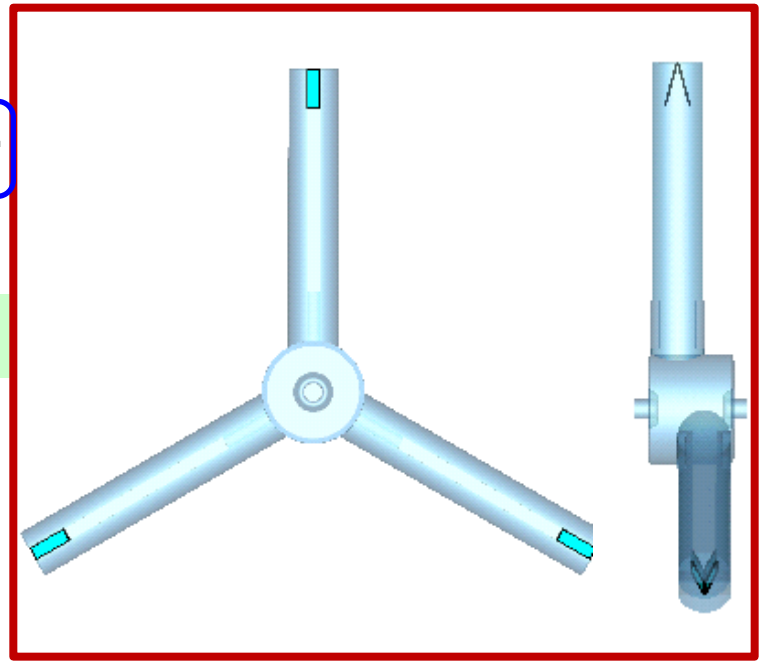
PROPOSAL: SCALED HOM DAMPED CAVITY

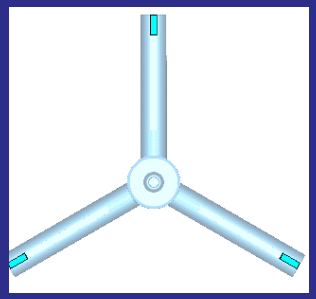
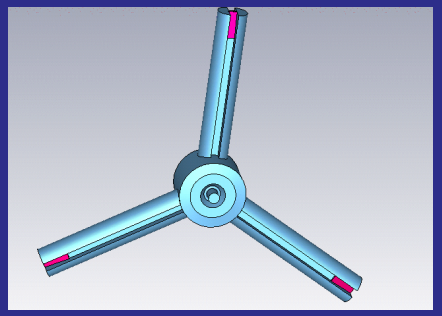
DAMPY CAVITY



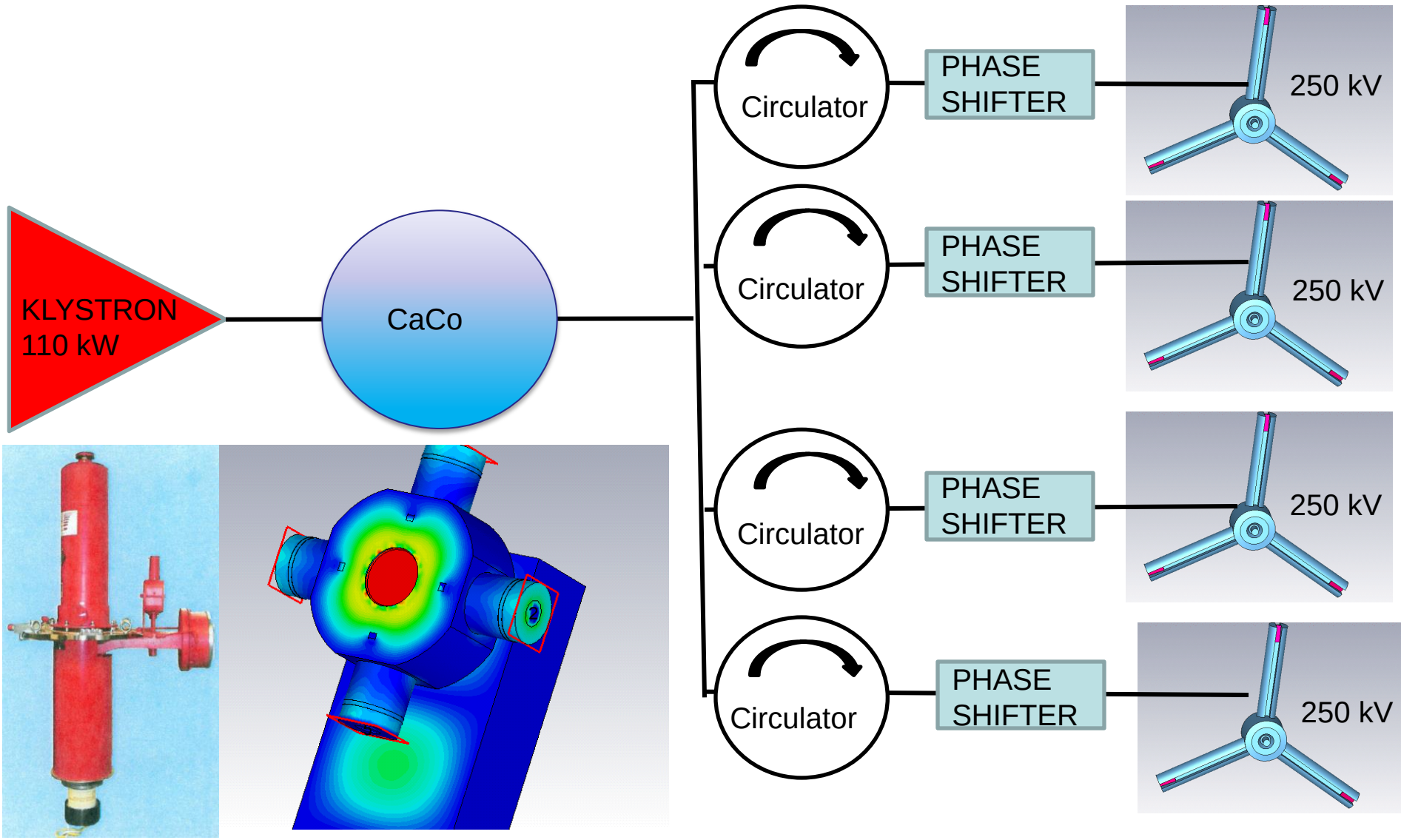
CST MWS model



PROPOSAL: SCALED HOM DAMPY CAVITY

Dampy (measurements)	Scaled Dampy (MWS)	OPTIMIZED SCALED DAMPY (MWS)
		
f_r = 499.654 MHz	f_r =1499 MHz	f_r =1499 MHz
Q_0 = 29500	Q_0 = 17705	Q_0 = 20000
R_s = 3.3 MΩ	R_s = 1.866 MΩ	R_s = 2.5 MΩ
R/Q = 119	R/Q =106.5	R/Q =125

PROPOSAL: 3rd HARMONIC SYSTEM



PROPOSAL: 3rd HARMONIC SYSTEM

Straight section where the cavities will be installed.

CONCLUSIONS

THIRD HARMONIC CAVITY

- Can Stretch, shorten, overstretch the bunch, just depends on the Vh and the phase.
- Optimum values at 400 mA and Vrf = 3,6 MeV:

Vh =1 MeV	$N\phi_h = -8.4\,\mathrm{deg}\,rees$

- Proposal for ALBA:
  - 4 HOM damped cavities normal conducting.
  - A klystron of 110 kW.
  - A Cavity splitter

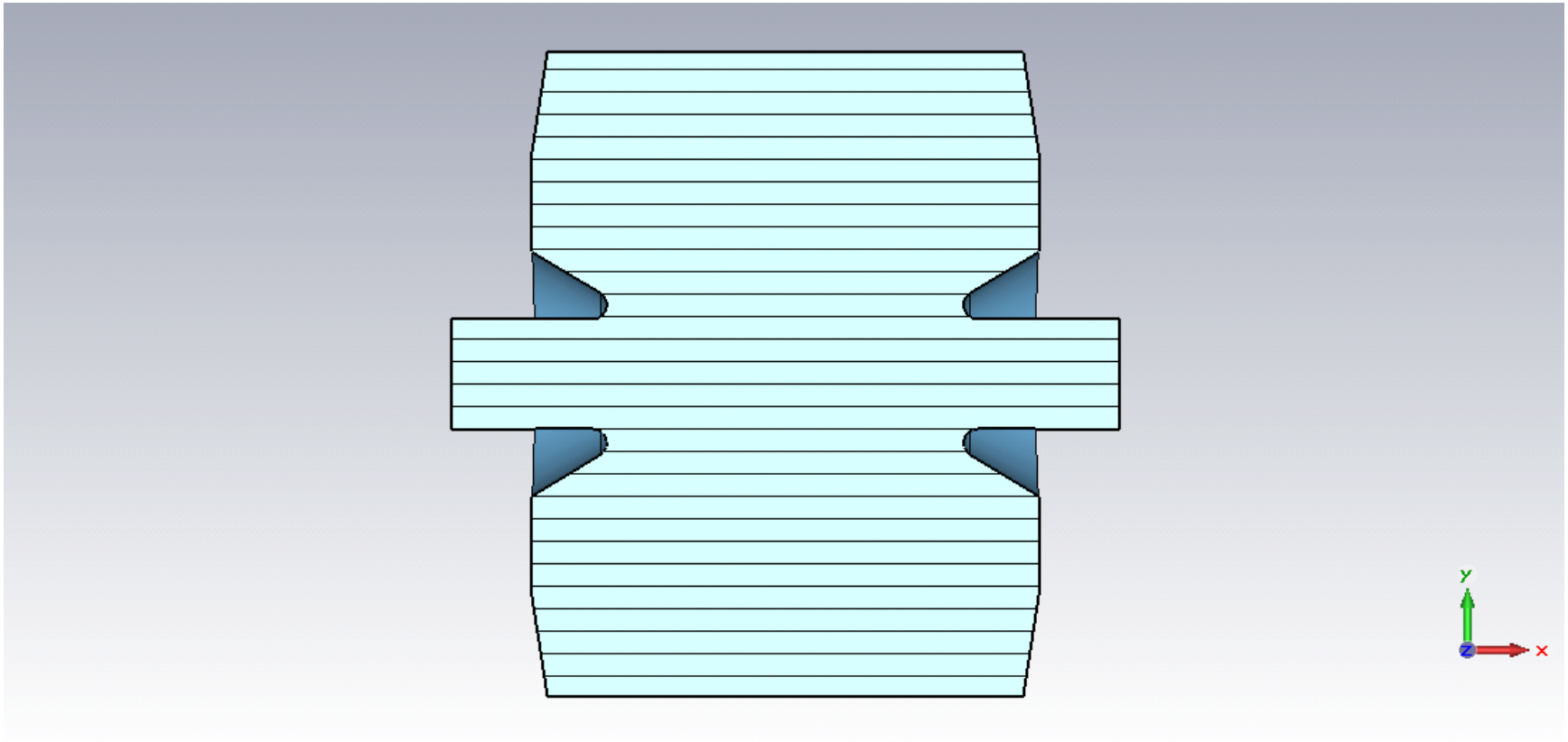
THANK YOU FOR YOUR ATTENTION

SPARE SLIDES

BODY OPTIMIZATION

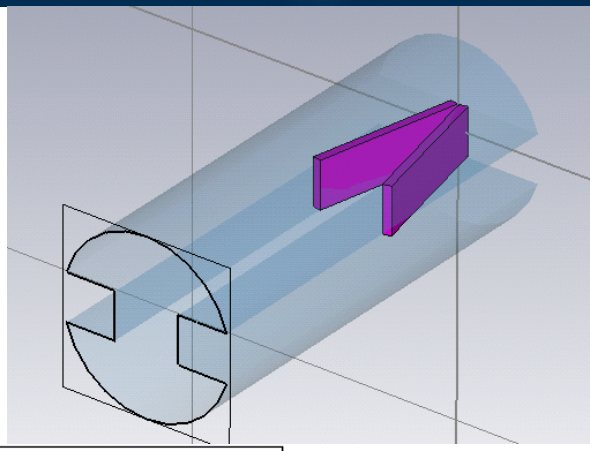
FIX BEAM PIPE standar gasket 25 mm => beam pipe 23 mm.
Cutoff frequency of the first monopole mode 10GHz

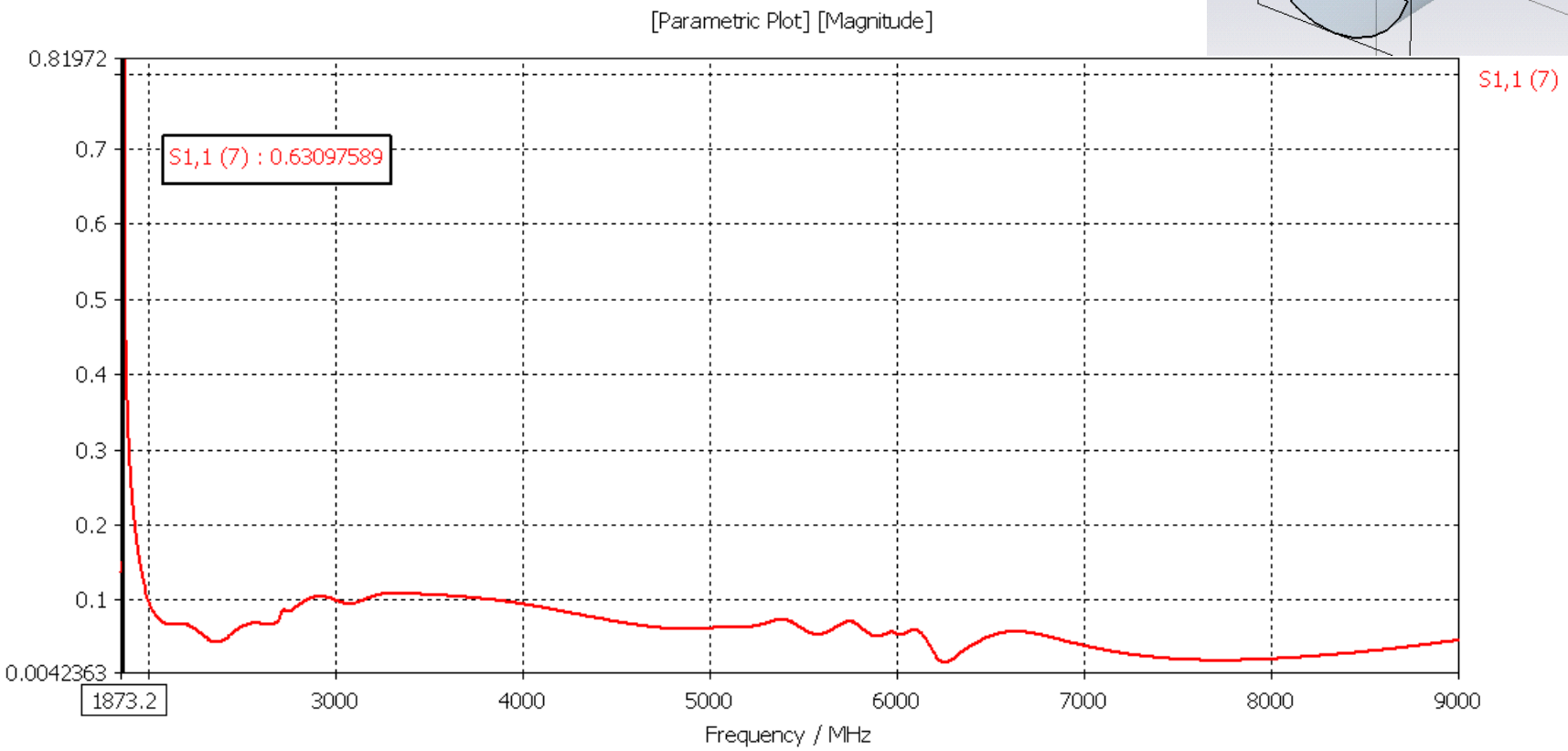
MAGNETIC LOSSES reduces as much as possible.



DAMPERS

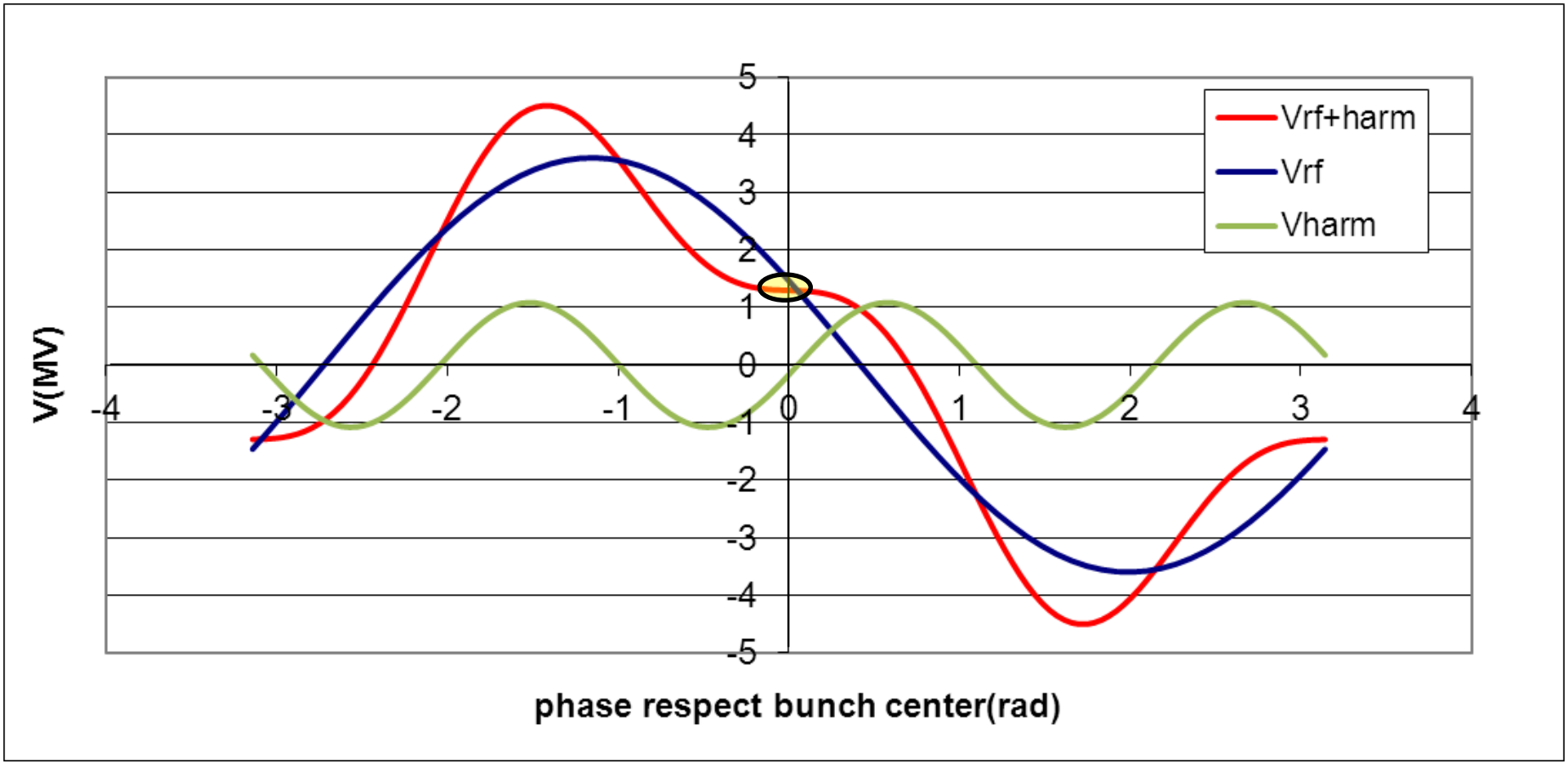
- GOAL: |S11| < 0,3 till 10 GHz.
- Gasket standar 64 mm.
- Ridgets optimize to reduce the cutoff frequency to 1880 MHz.
- Length of the ridges optimize to do not couple the fundamental mode.
- Width and shape of the ferrites C48 optimize to absorbe the HOM.
- There is No Gap between ridge-Damper





LONGITUDINAL BEAM DYNAMICS WITH A 3HC

- To leghthen the bunch: the Vh and $N\phi_h$ should be adjusted to cancel the slope of the rf voltage at the bunch center. The potential and its first two derivatives are zero.
- **Lenghtening mode** $K = \frac{V_{har}}{V_{rf}} = 0.308;\ N\phi_h = -8.4\,\mathrm{deg}\,rees$



LONGITUDINAL BEAM DYNAMICS WITH A 3HC

- **Shortening mode**