Design of the BPM button for ALBA II

L. Torino, U. Iriso, O. Traver

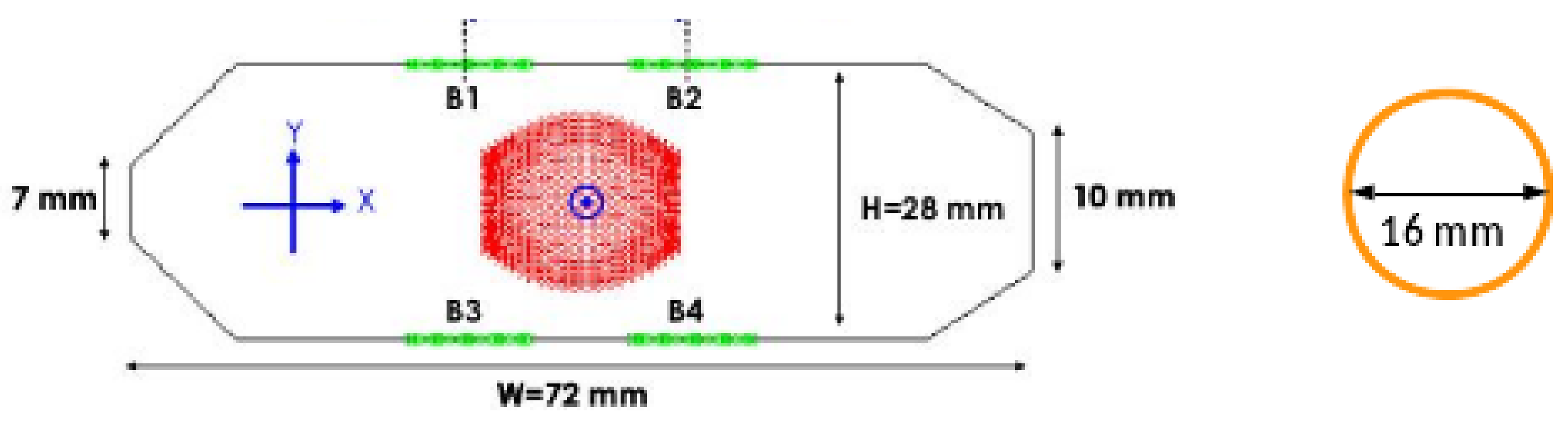
ALBA-CELLS, Cerdanyola del Vallès, Barcelona, Spain

Abstract

As many other light sources, ALBA is also going through an upgrade phase leading to ALBA II. In this context, new Beam Position Monitors (BPMs) have to be designed to fit the reduced vacuum chamber. The buttons and the block were designed to be as compact as possible minimizing the impedance to avoid overheat and maintaining a good signal level. Different shapes and materials were simulated and the best were selected to be produced as prototype. In this proceeding, we present the process and the simulations that lead to the ALBA II BPM button design.

Alba Vs ALBA II

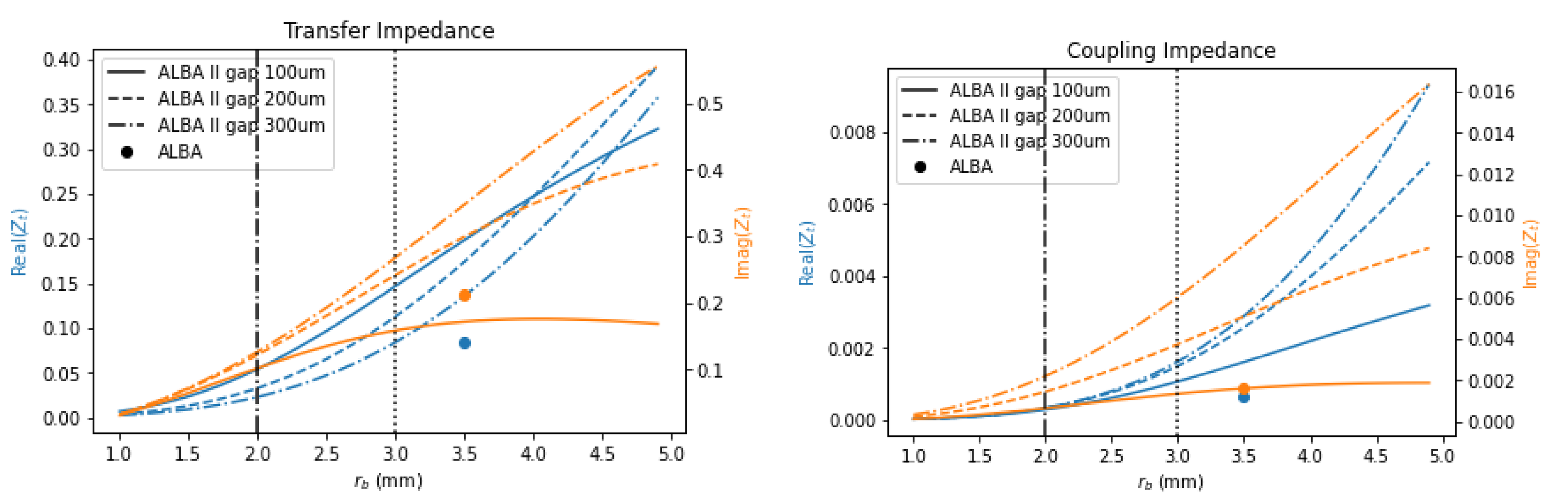
Comparison in scale of ALBA and ALBA II vacuum chamber



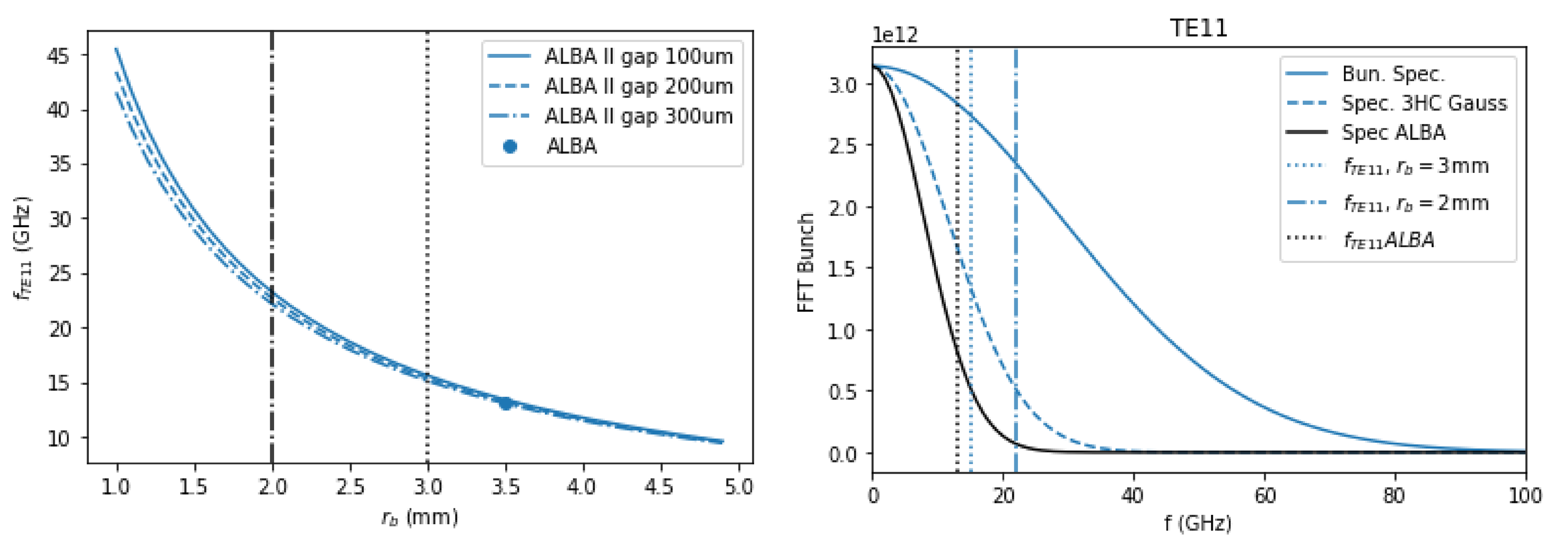
	ALBA	ALBA II
Chamber radius a (mm)	14	8
BPM radius r_b (mm)	3.5	1-5
Gap g (μm)	300	100, 200, 300

Impedances and Resonance Plots

Impedance button radius for different gaps (different line-style) fixing $T = 3\,\mathrm{mm}$ (left). The dot represent current ALBA BPM button transfer impedance. Real (blue) and imaginary part (orange).

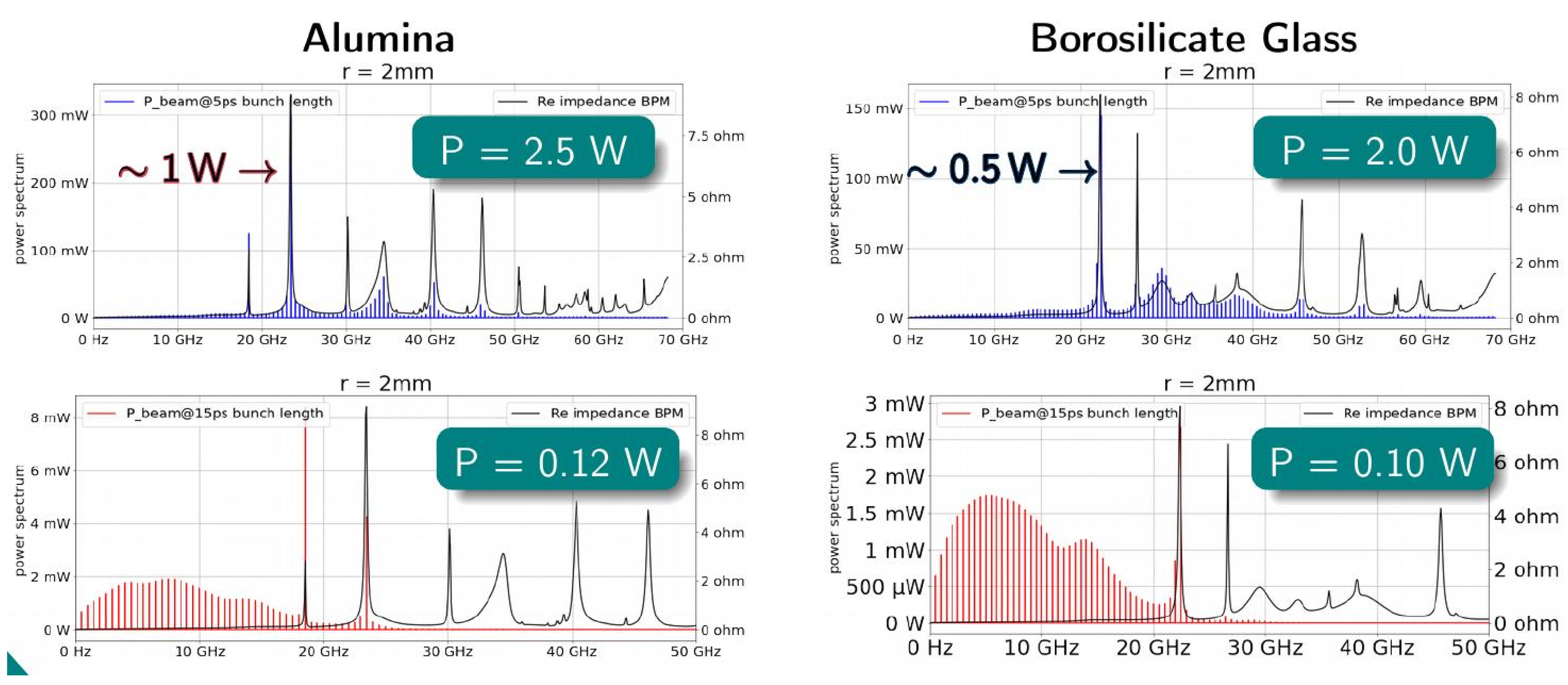


TE11 mode for different button radius (left), and superposition with bunch spectrum (right).



Wake Impedance – CST

Wake impedance of the BPM block using a $1\,\mathrm{nC}$ particle beam with a bunch length of $1.5\,\mathrm{mm}$, using different insulator material



Theoretical Consideration

- Maximize Transfer Impedance:
  $Z_t = \frac{R}{1+i\omega RC}\frac{r_b^2}{2ac}i\omega$
- Minimize Coupling Impedance:
  $Re(Z_l) = \frac{1}{c^2}\left(\frac{r_b^2}{2a}\right)^2 R\omega_c^2 \frac{\left(\frac{\omega}{\omega_c}\right)^2}{1+\left(\frac{\omega}{\omega_c}\right)^2}$
  $Im(Z_l) = \frac{1}{c^2}\left(\frac{r_b^2}{2a}\right)^2 R\omega_c^2 \frac{\left(\frac{\omega}{\omega_c}\right)}{1+\left(\frac{\omega}{\omega_c}\right)^2}$
- Avoid TE11 resonance:
  $f_1 = \frac{c}{\pi(r_h+r_b)}$,

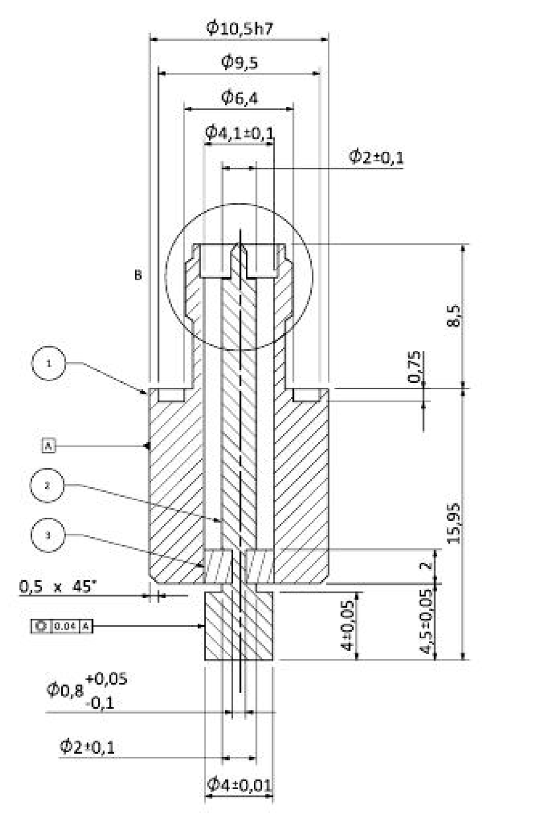
$R = 50\,\mathrm{Ohm}$

C is the capacitance between the button and the block

ω_c cutoff frequency of equivalent RC circuit

$r_h = r_b + g$

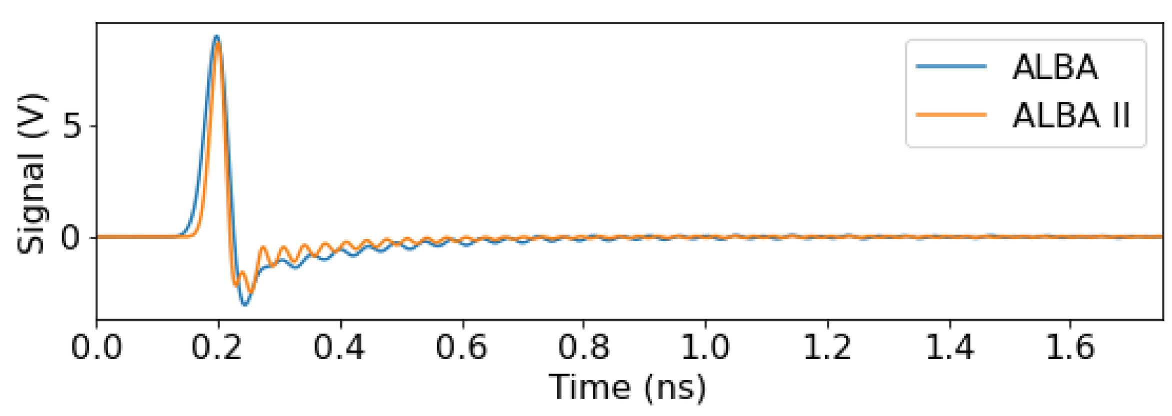
Button Design



- Chamber diameter: 16 mm
- Button diameter: 4 mm
- Gap: 200 μm
- Insulator diameter: 4.4 mm
- No "skirt"
- Block thickness: 12 mm
- Block Material: Stainless Steel 316LN
- Button Material: Molybdenum
- Insulator Material: Borosilicate Glass

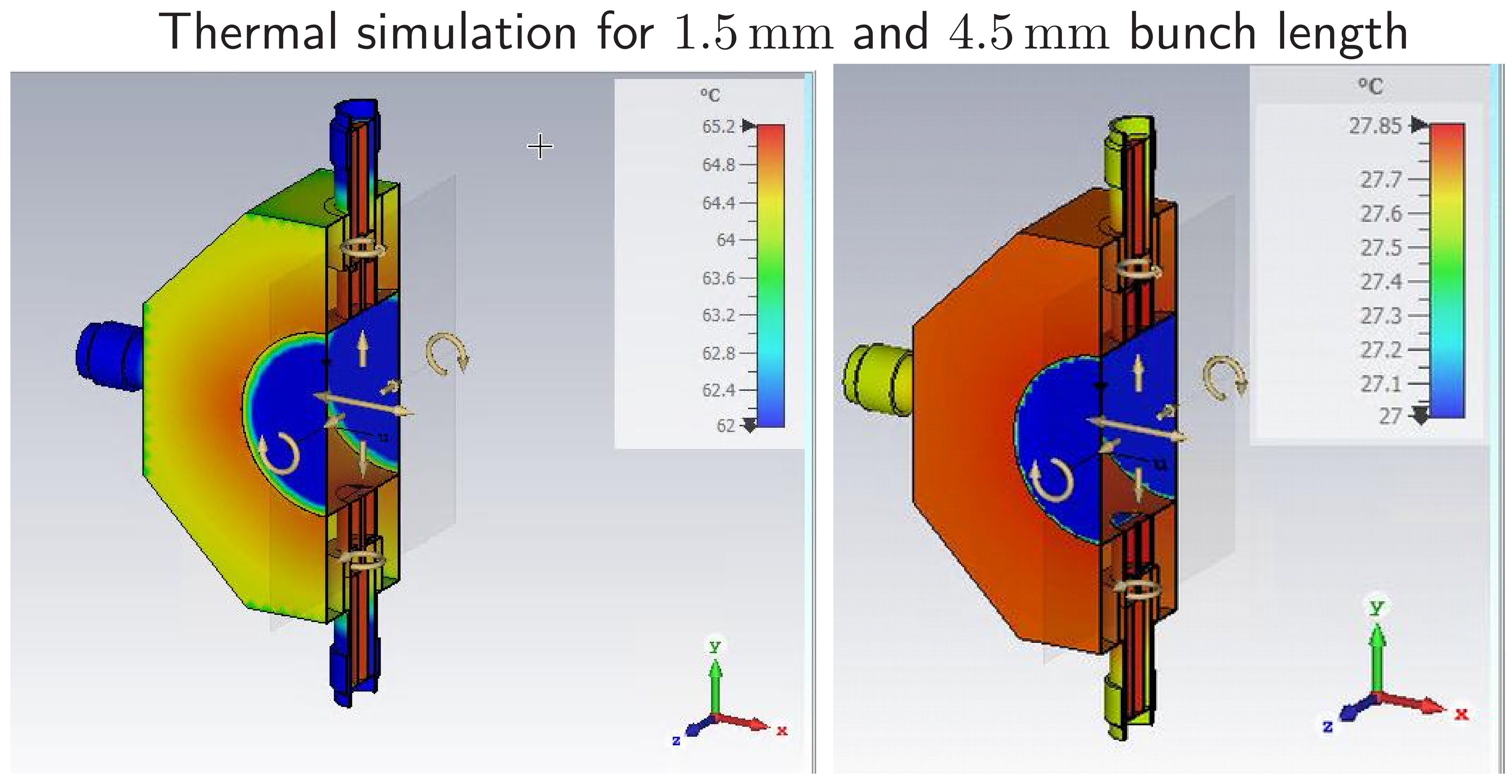
Signal – CST

Output signal for ALBA and ALBA II BPMs block simulated in CST using a bunch of $1\,\mathrm{nC}$ of charge and $15\,\mathrm{ps}$ of bunch length



Thermal Simulation – CST

Thermal simulation for $1.5\,\mathrm{mm}$ and $4.5\,\mathrm{mm}$ bunch length



Conclusions

After some iteration, we are going to prototype two batches of 20 button BPM each from two different manufacturer. Both of the batches will have borosilicate glass as an insulator, but one of the manufacturer proposed to change the material of the button from Molybdenum to Hastelloy. CST simulations were re-run and comparable results were obtained.