

Engineering of advanced acoustic metamaterials made with additive manufacturing

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Introduction

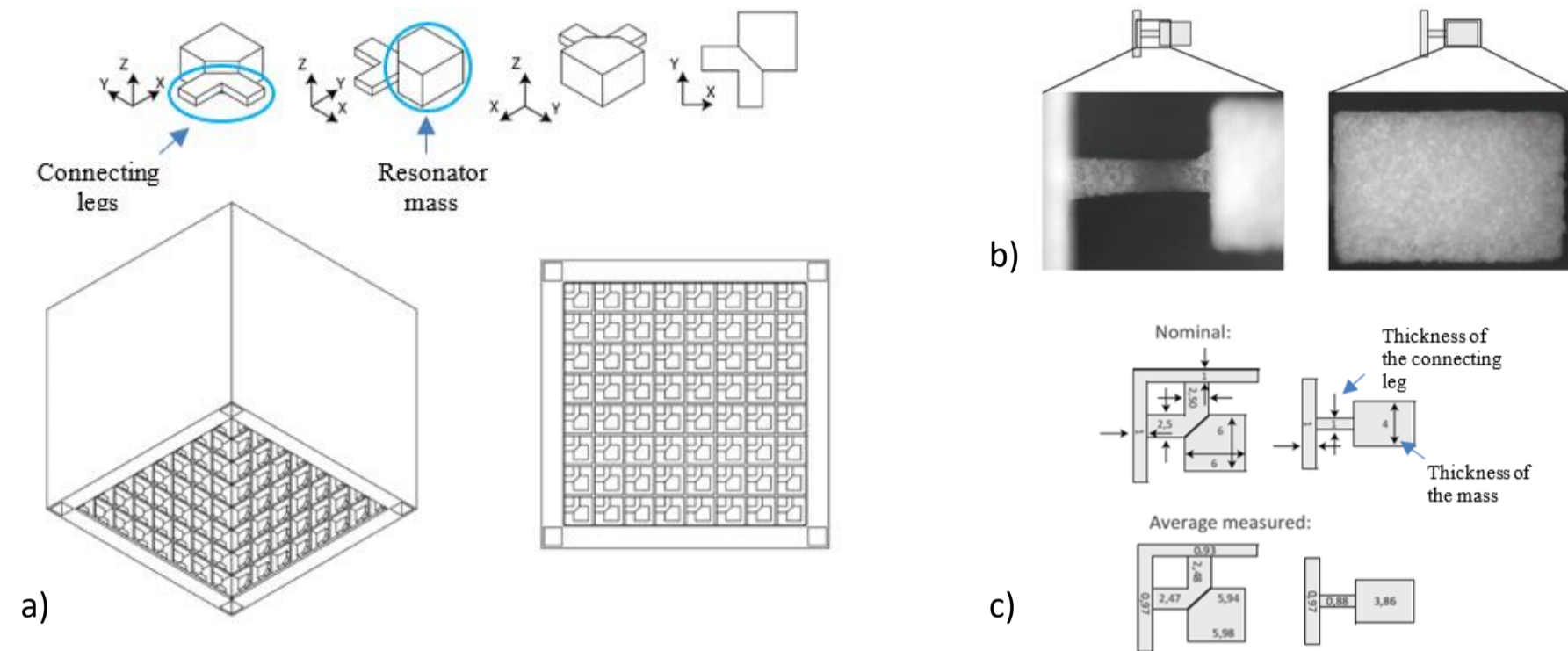


Figure 1. a) Structural resonator (top) and enclosure design (bottom). b) On the left we show one of the connecting legs, which was not straight, and on the right side we show a resonator mass. c) Characteristic dimensions from a strip of resonator cells. On the top the dimensions as defined in the CAD file are shown. The average measured distances for each resonator are depicted on the bottom*

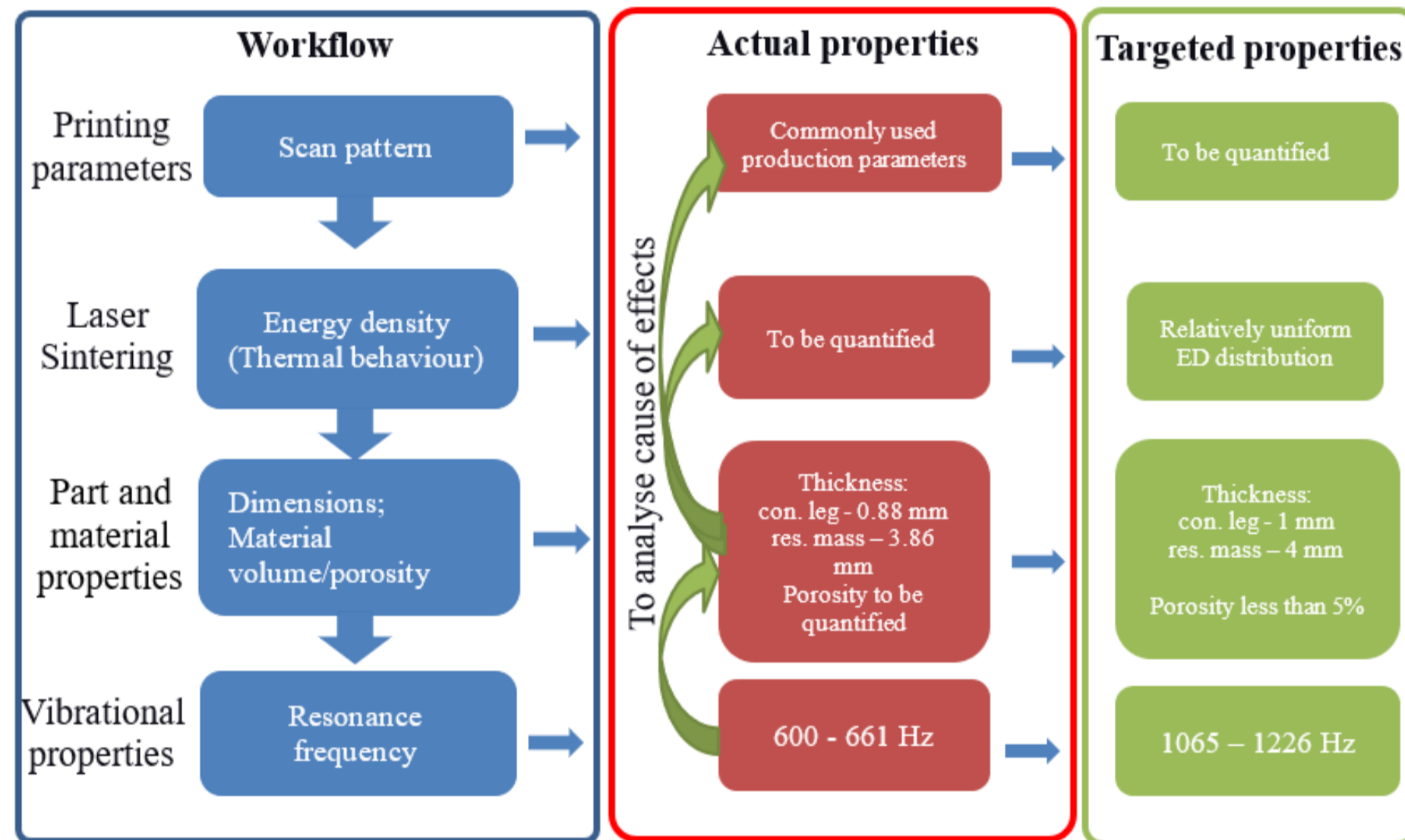


Figure 2. Workflow of production process optimization, interinfluence of the workflow blocks, actual and targeted performance of vibro-acoustic metamaterials

Optimization of the production process for 3D printed acoustic metamaterial

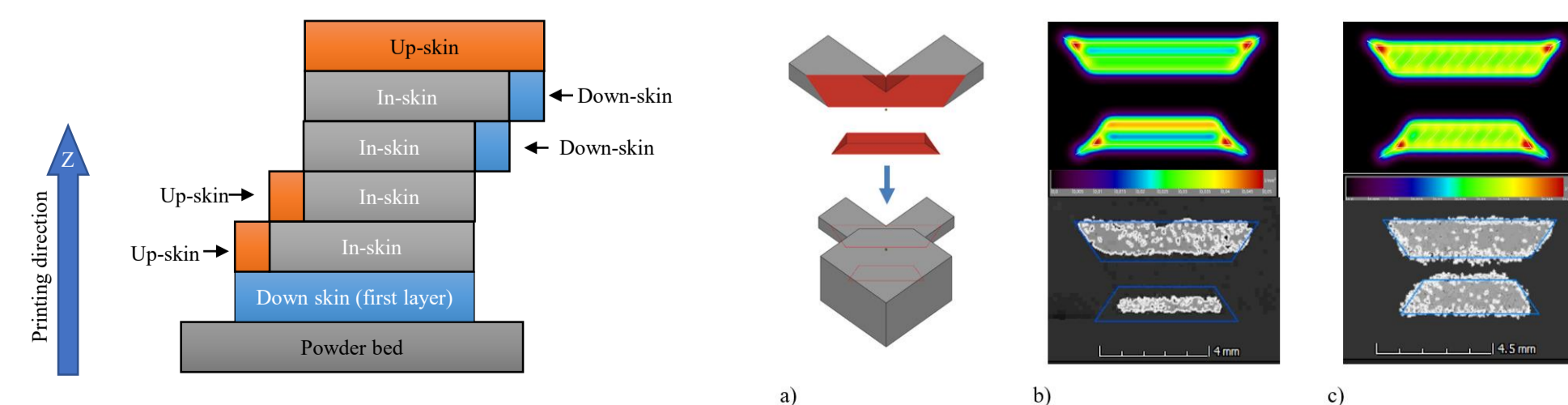


Figure 3. Schematic view of up-skin and down-skin layers.

Figure 4. Before and after optimization: a) Cross-section of a resonator. b,c) ED map and CT image of reference sample and optimized scan pattern respectively.

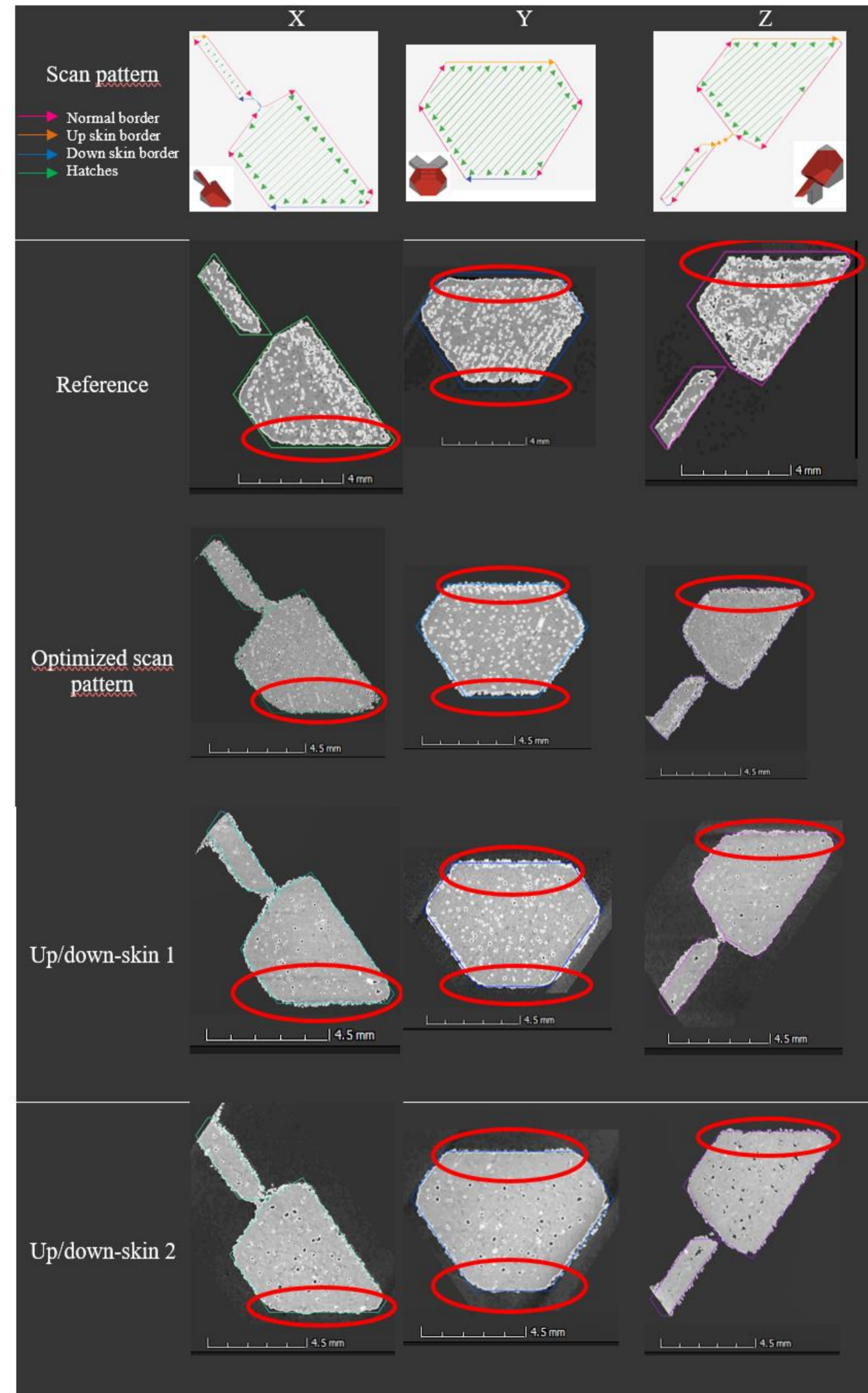


Figure 5. Comparison of scan pattern with CT slice for all scanning strategies. Samples of X, Y, Z-directions are best-fit aligned to the surface thresholded CT datasets.

Table 1. Average measured thickness of connection legs and resonator mass, average volume and porosity, and vibroacoustic measurements of a single resonator.

	Orientation	Thickness of connecting leg		Thickness of mass		Average volume of single resonator [mm ³]	Average porosity [%]	Resonance frequency	
		Average [mm]	Std. dev.	Average [mm]	Std. dev.			Average [Hz]	Std. dev.
Reference	X	0.79	0.027	3.76	0.013	112.8	15.44	628.58	30.1
	Y	0.81	0.017	3.78	0.004			660.88	18.35
	Z	0.77	0.006	3.75	0.006			599.83	11.46
Optimized scan pattern	X	1.03	0.042	3.97	0.021	133.59	8.21	826.39	30.35
	Y	1.00	0.037	3.92	0.061			798.02	42.43
	Z	1.05	0.025	4.00	0.028			835.98	30.1
Up/down-skin strategy 1	X	1.09	0.017	4.02	0.007	157.21	2.75	1174.62	26.78
	Y	0.99	0.026	3.97	0.012			999.76	14.06
	Z	1.08	0.008	4.02	0.004			1172.39	33.33
Up/down-skin strategy 2	X	1.09	0.018	4.03	0.009	155.46	3.02	1198.44	12.87
	Y	1.06	0.016	4.04	0.007			1130.94	6.69
	Z	1.08	0.019	4.04	0.003			1183.69	10.43

Design of metamaterial lamp and production

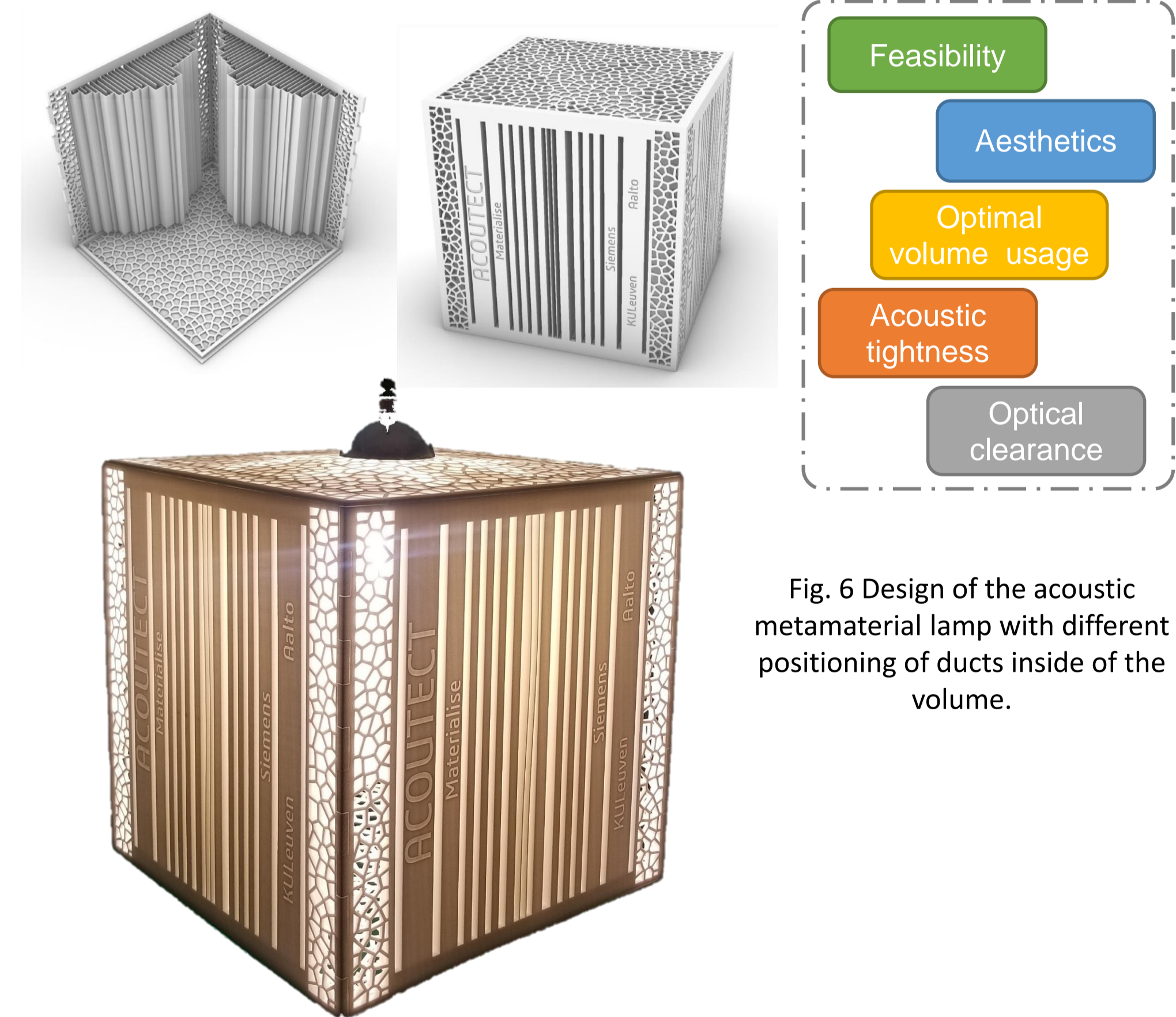


Fig. 6 Design of the acoustic metamaterial lamp with different positioning of ducts inside of the volume.