Interface Phenomena for a Multifunctional Air-Water Micro-Particle Collecting and Filtering System

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Introduction: A new device concept of a multifunctional particle collector was designed to meet the strict regulations of clean rooms and medical-biological environment. The device is meant to assist the existing installations on achieving better performances or to offer an alternative to costly equipments.

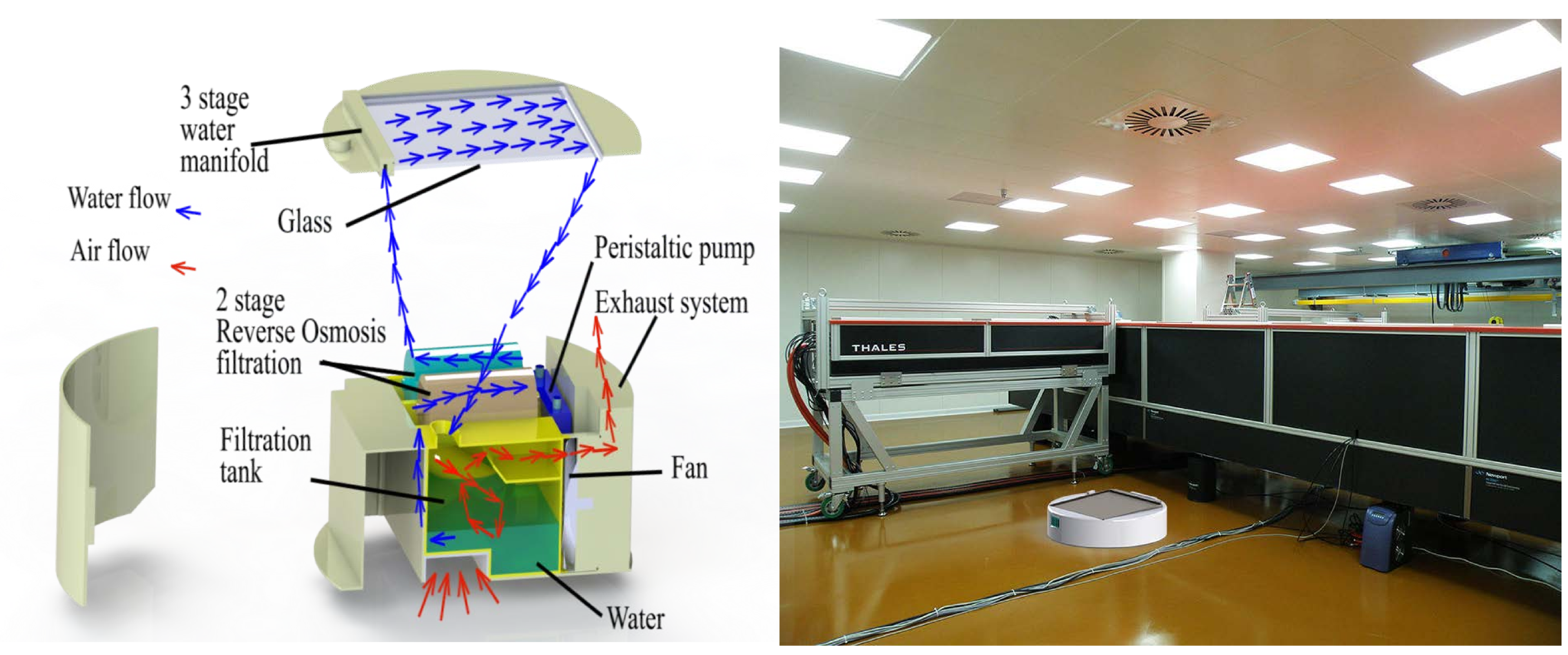

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Figure 1. (a) the first elaborated model; (b) CETAL clean room [1] with the Multifunctional Air-Water Particle Collector (µC3)

Use of COMSOL Multiphysics: After analyzing the clean room parameters, a SolidWorks model (Fig.1.a) has been elaborated and imported in COMSOL Multiphysics. Using COMSOL Fluid Flow Interface the micro-particle collector design (µC3) and the exhaust system impact on the clean room airflow were studied. The flow velocity simulations are solutions of the Navier-Stokes equations derived from the Cauchy momentum equation:

$$\frac{\partial}{\partial t}(\rho \boldsymbol{u}) + \nabla \cdot (\rho \boldsymbol{u} \otimes \boldsymbol{u} + p\boldsymbol{I}) = \nabla \cdot \tau + \rho g$$

To fully describe the fluid flow a statement of the conservation of mass is generally necessary. This is achived through the mass continuity equation, given in its most general form as:

$$\frac{\partial p}{\partial t} + \nabla \cdot (\rho \boldsymbol{u}) = 0$$

Results: The effective design of the active elements has been readdressed based on COMSOL simulation results (Fig. 2, 3) thus the efficiency of the device parts modeling being correlated (Fig. 4.a,b).

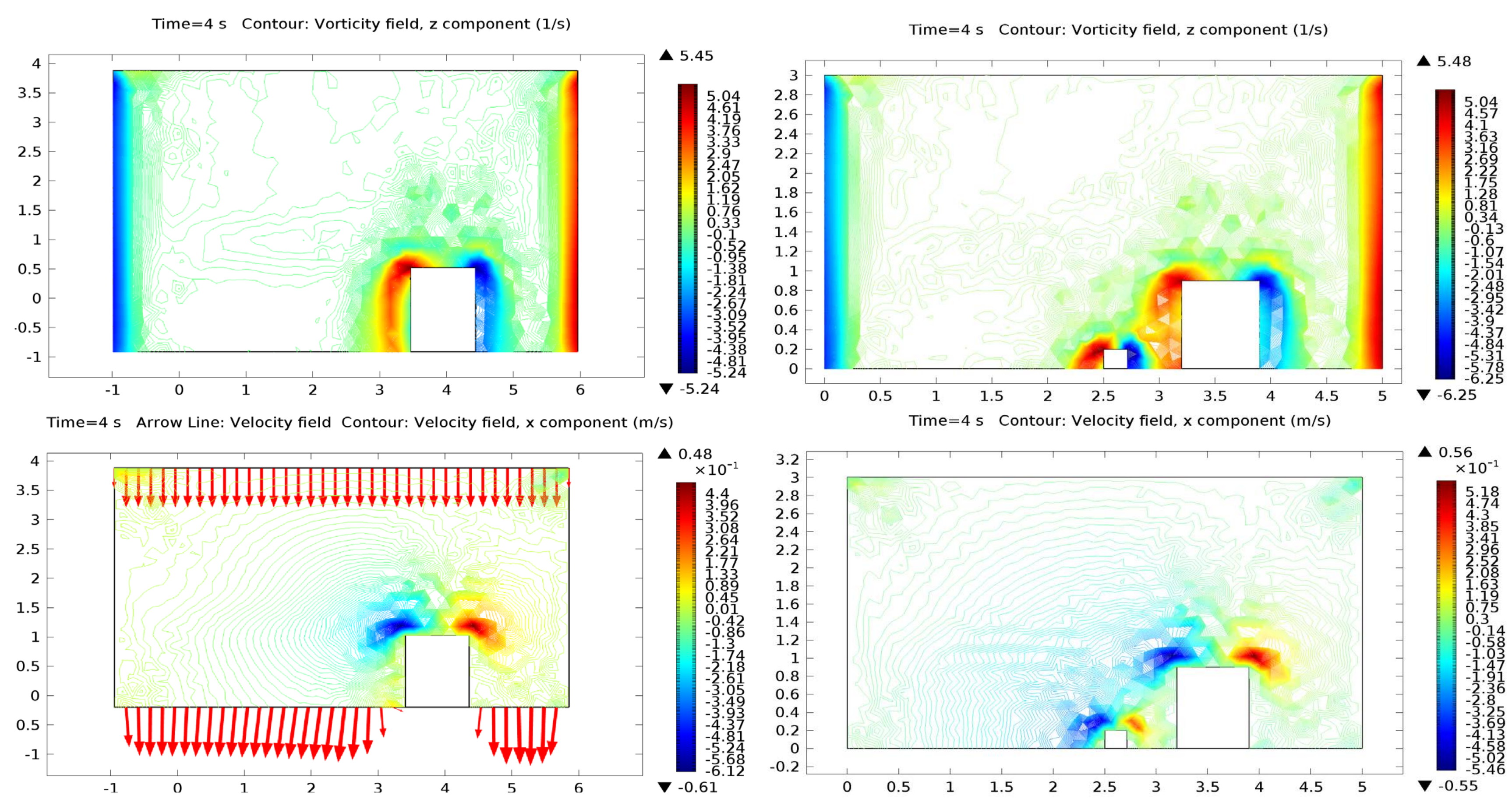

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Figure 2. Laminar fluid flow simulation inside a clean room (a) during a working hours; (b) depicting the impact of the µC3 on the clean room airflow;

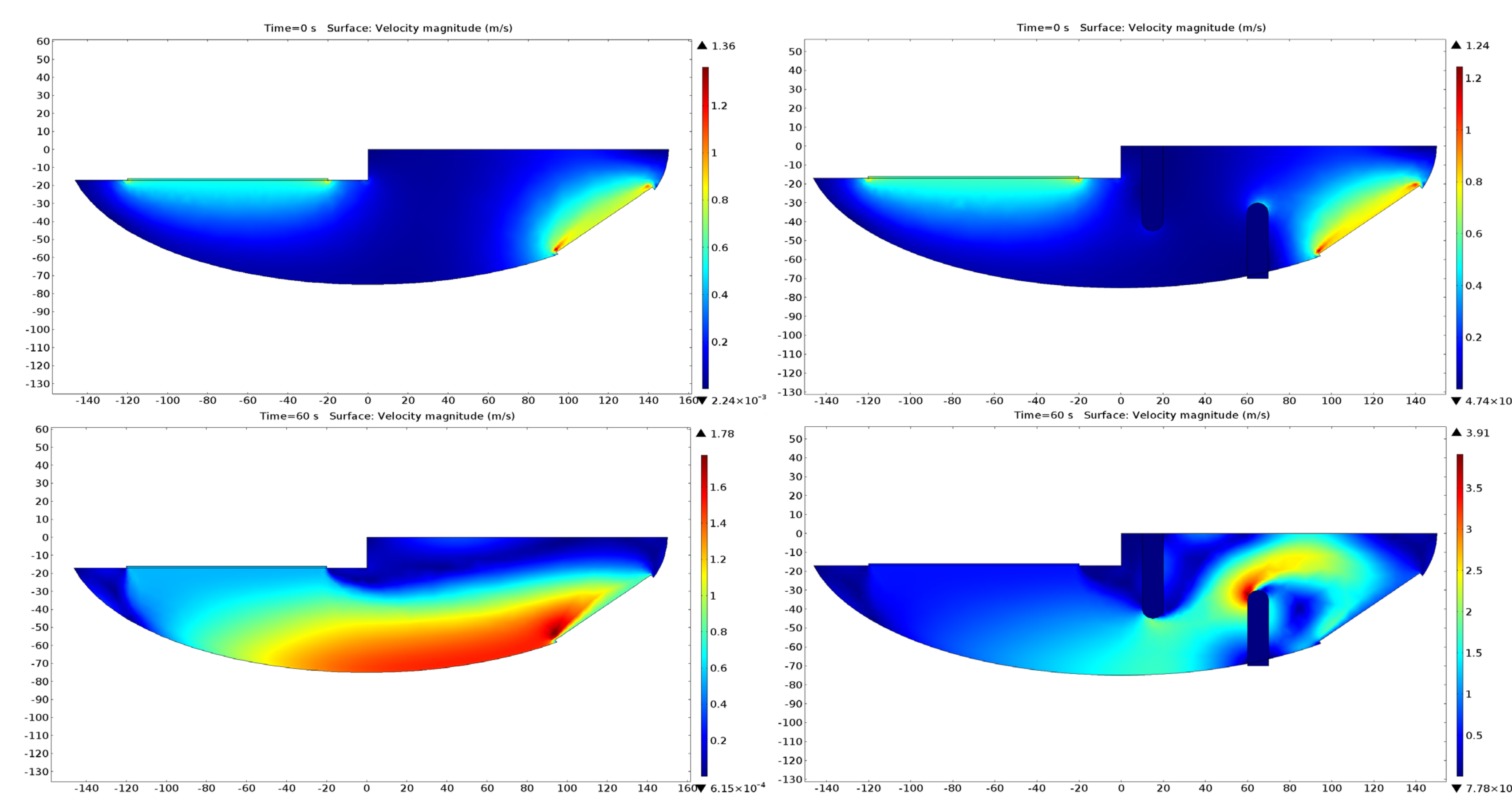

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Figure 3. Fluid flow simulation inside (a) the first elaborated model exhaust system; (b) redesigned exhaust system after COMSOL simulation analysis;

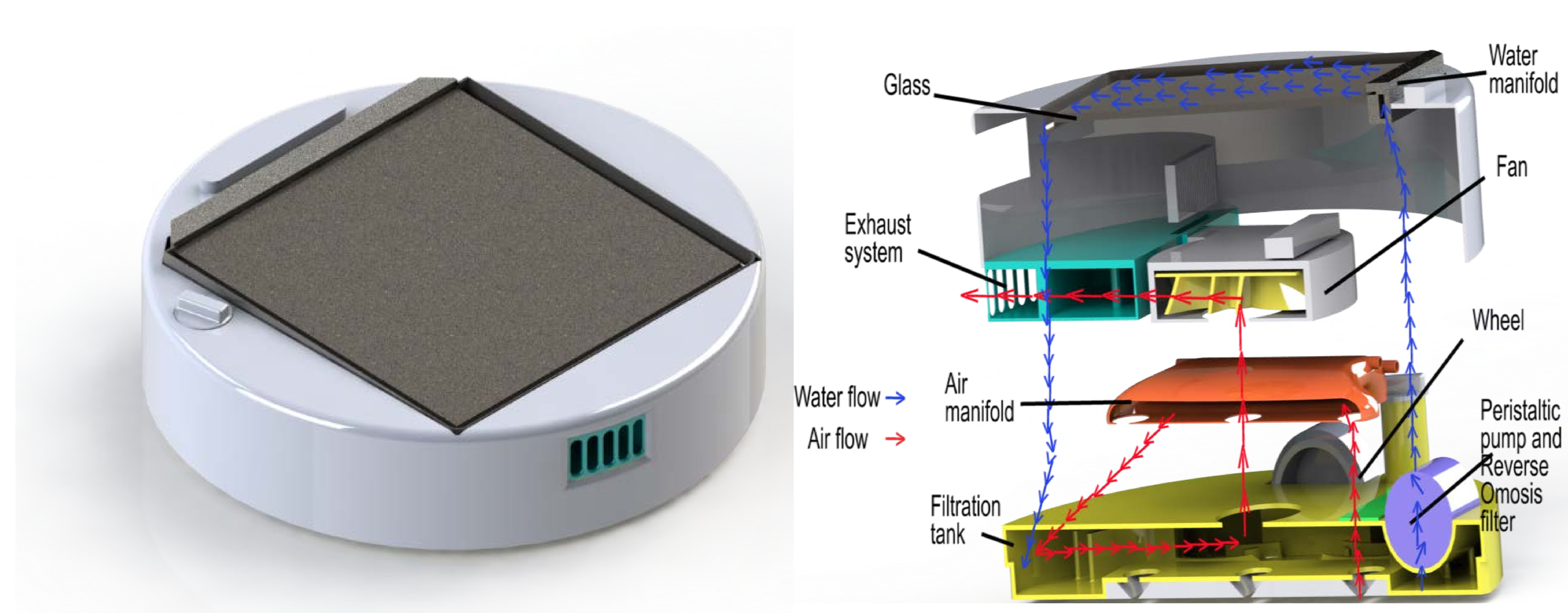

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Figure 4. (a) rendered picture of the redesigned model ; (b) redesigned model after COMSOL simulation analysis ;

Conclusions: The effects of the model geometry and exhaust system on the clean room air flow were controlled through the redesign of the device parts and through interface process variables monitoring.

References:

1. http://pw.cetal.inflpr.ro/