

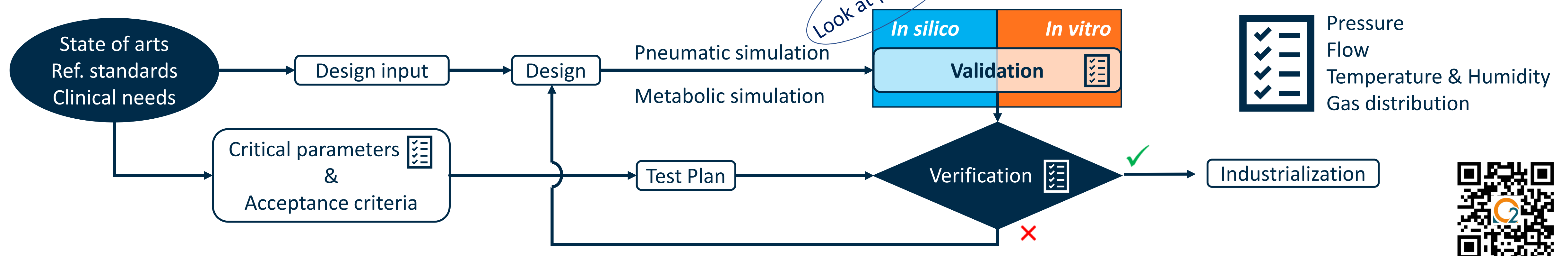
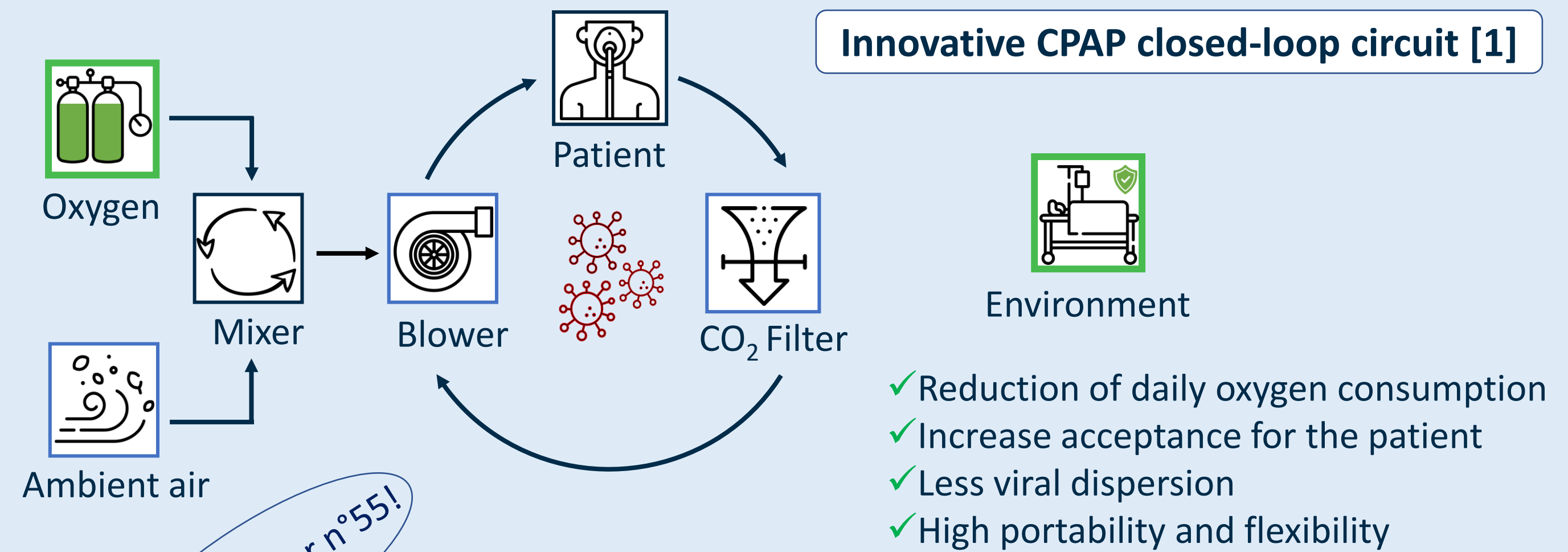
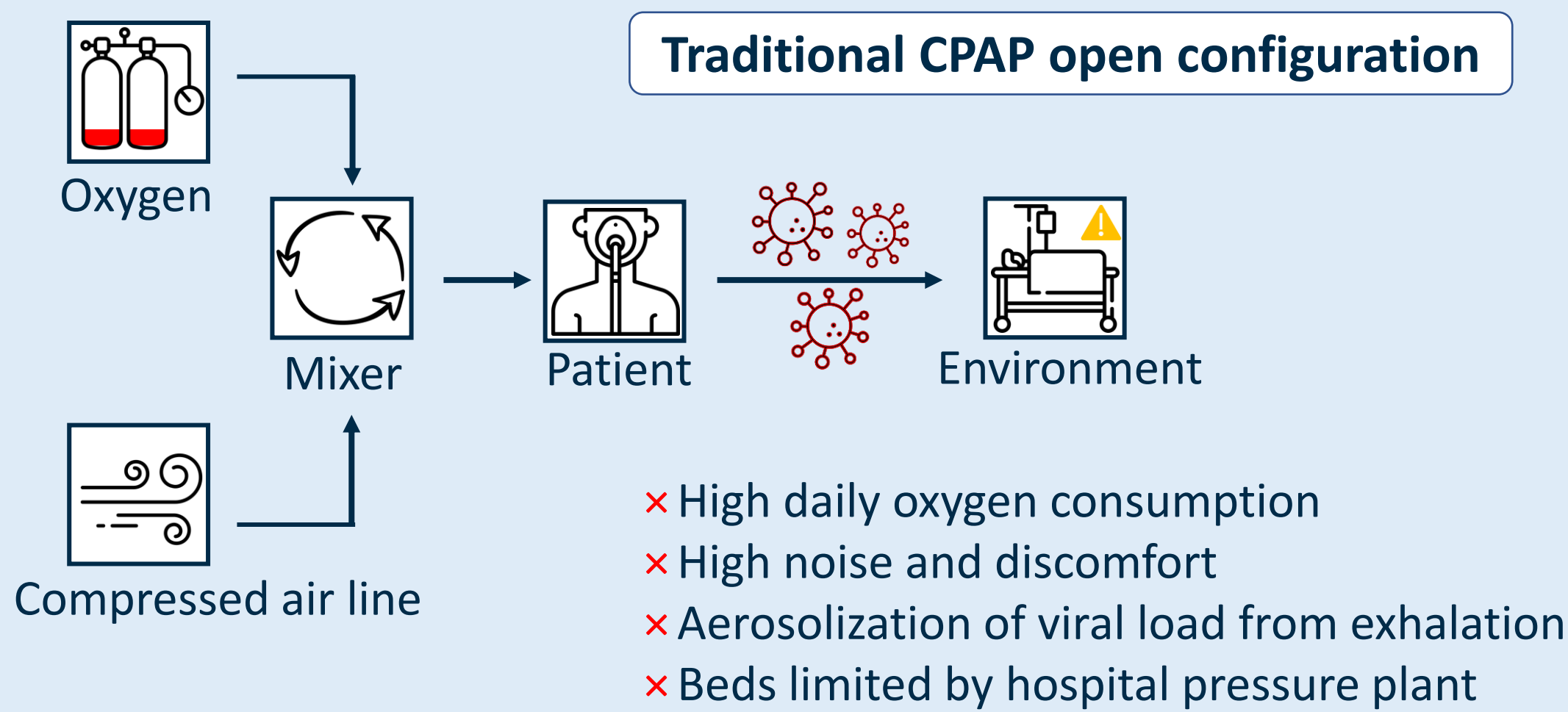
# Design, characterisation and development of an innovative low-oxygen mechanical lung ventilation system

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## INTRODUCTION

The aim of this PhD project is the design, development and future industrialization of an innovative device for non-invasive ventilation. The device will deliver CPAP therapy (continuous positive airway pressure), indicated for patient with hypoxemic respiratory failure (e.g. COVID-19).



## TEST PLAN

The device is designed as an **INNOVATIVE** closed-loop circuit that delivers CPAP therapy. There is no single reference standard for performance and safety evaluation. Were analysed:

BS EN ISO 80601-2-70

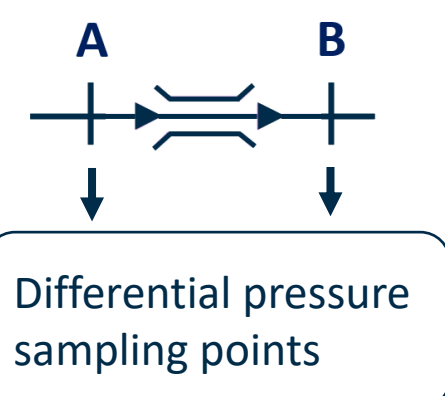
BS EN ISO 80601-2-12

Test family	Mechanical safety & Performance characterisation	Software evaluation
		Usability
	Electrical safety & Electromagnetic compatibility	Cleaning, sterilization and contamination

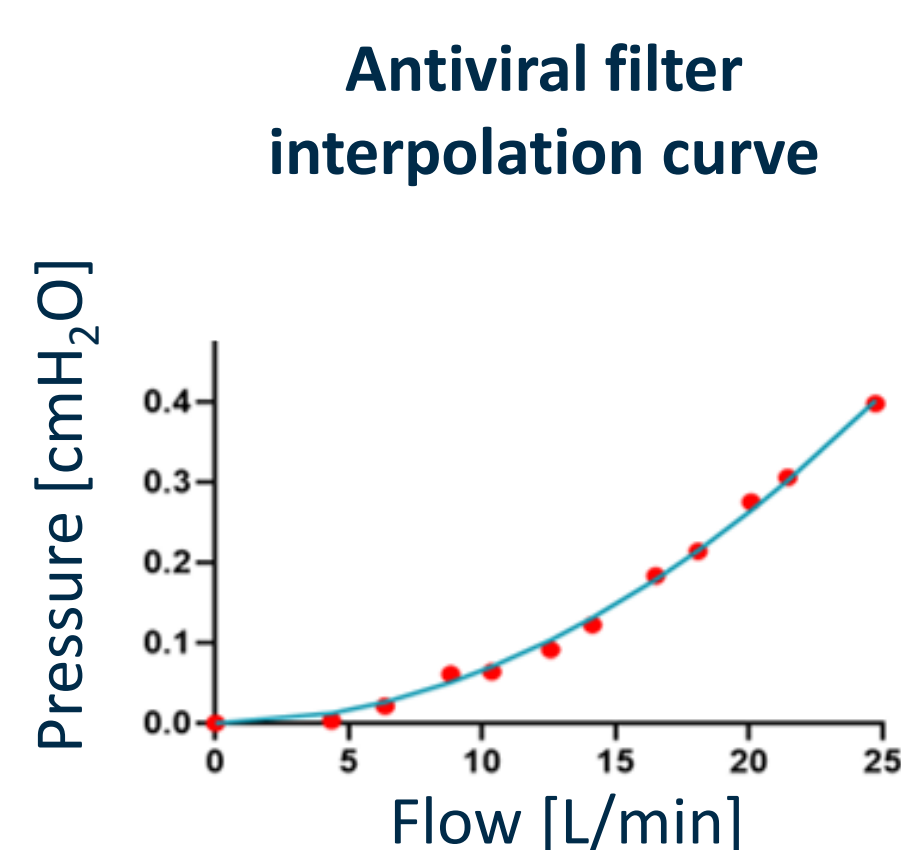
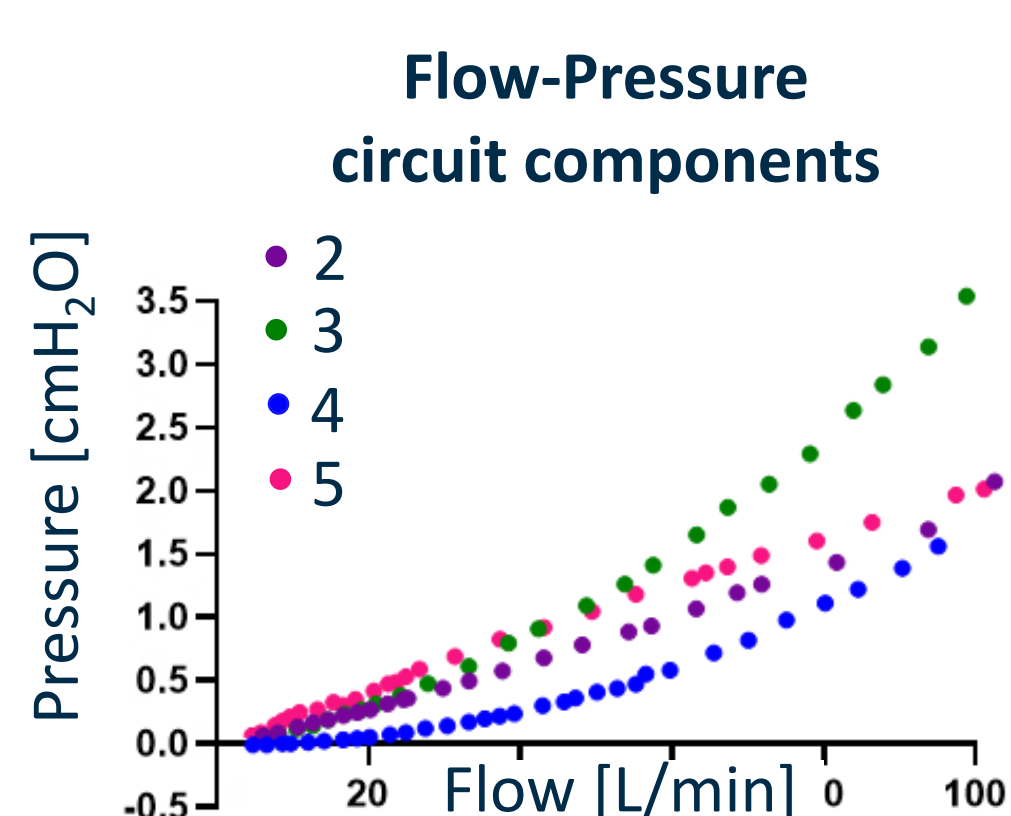
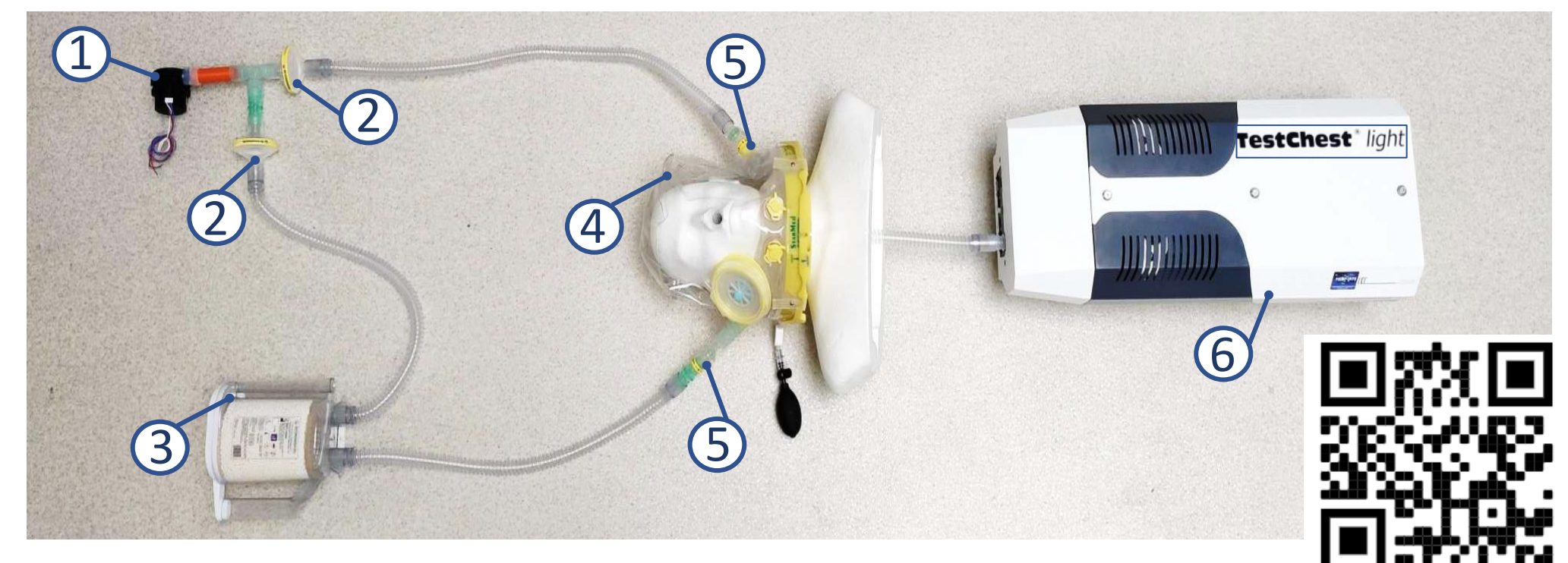
## IN VITRO PNEUMATIC SIMULATION

### → Flow-pressure characterisation of the circuit components

- ❖ Pressure drop evaluation: at the ends of the circuit components, we measured the pressure as a function of flow variation.



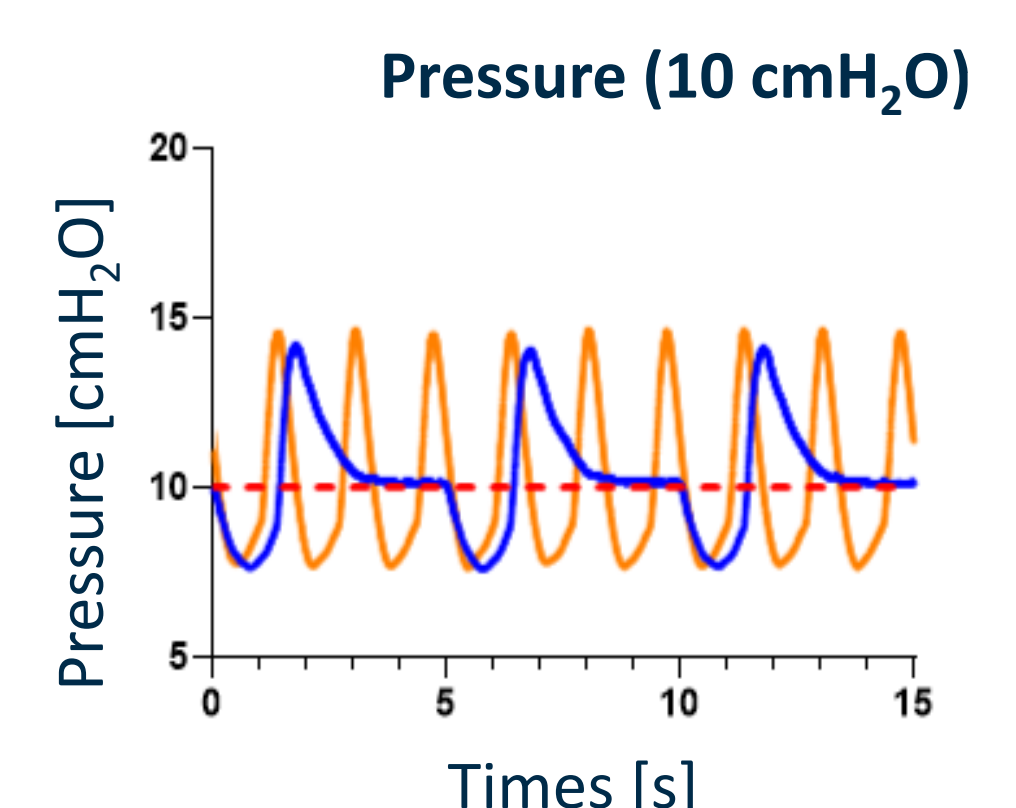
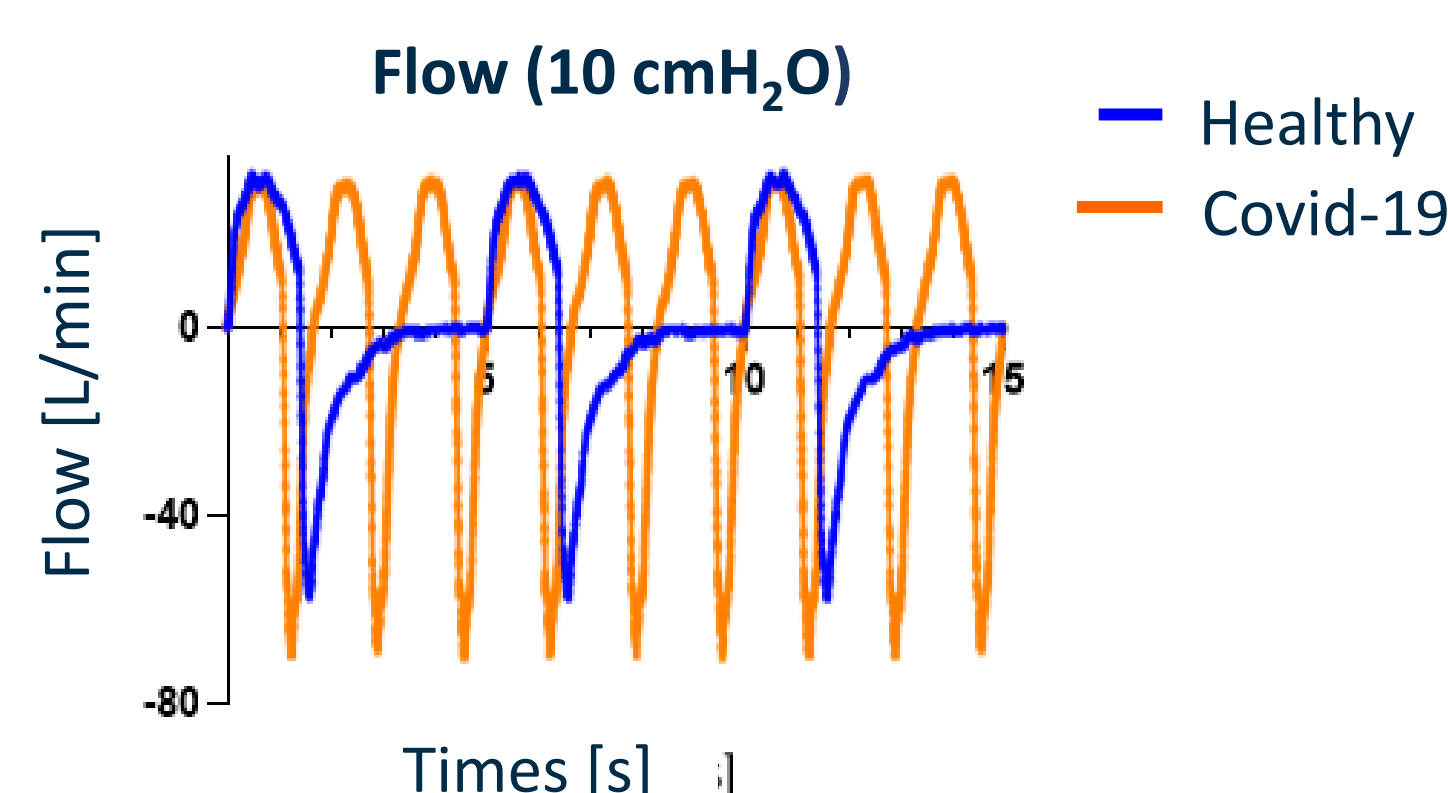
1. Blower
2. Antiviral filters
3. CO<sub>2</sub> absorber
4. Helmet
5. Unidirectional valves
6. Lung simulator



→ The results of the experimental tests performed on the circuit components were then used to define components of *in silico* model (interpolation with parabolic curve:  $\Delta p = \xi \dot{m}^2 / 2\rho S^2$ )

### → Experimental curves comparing CPAP therapy in healthy and Covid-19 patients [2] [3]

Flow through the patient's airway and pressure at the patient interface were analyzed in the case of a healthy patient and a patient with Covid-19, imposing a CPAP of 5, 10 and 15 cmH<sub>2</sub>O.



✓ The pressure values oscillate around 10 cmH<sub>2</sub>O (CPAP therapy imposed). This confirms correct delivery of therapy

## ACTIVITIES CARRIED OUT IN THE COMPANY

In the context of this project, we collaborate with the APR srl company. For the **commercialisation**, must ensure:



General Product Safety Directive (2001/95/EC)



EU declaration of conformity and CE marking

The primary objective of the company is to **certify** the company's quality management system according to **BS EN ISO 13485**.

## REFERENCES

- [1] M. Cavaglià et al., Artif Organs, 2021
- [2] J.M. Arnal et al., Respir. Care, 2018
- [3] L. Gattinoni et al., Am. J. Respir. Crit. Care Med, 2020

## HARD SKILLS

- ❖ **Application of multibody systems:** application of Multibody codes (Adams and Simpack) in the study of kinematics and dynamics of mechanical systems
- ❖ **Principles, materials and applications of robotics in biomedicine:** introduction to robotic history, overview of new multifunctional material systems used in surgical tools, potential applications of robotic surgery and actual limitation

## SOFT SKILLS

- ❖ Public speaking
- ❖ Research integrity
- ❖ Responsible research and innovation, the impact on social challenges
- ❖ The new Internet Society: entering the black-box of digital innovations
- ❖ Thinking out of the box
- ❖ Communication
- ❖ Entrepreneurial Finance
- ❖ Personal branding
- ❖ Time management
- ❖ Project management
- ❖ Navigating the hiring process: CV, tests, interview