

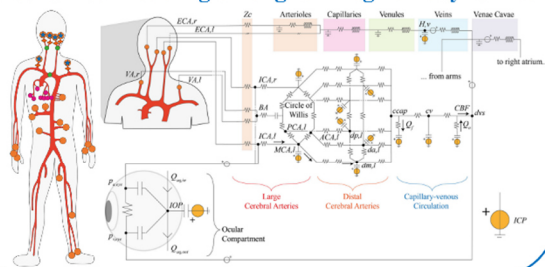
Risk map for the Spaceflight Associated Neuro-ocular Syndrome (SANS) through cardiovascular digital twins

Spaceflight Associated Neuro-ocular Syndrome (SANS) is a neuro-ocular disturb comprising a variety of ocular (optic disc edema, globe flattening, choroidal folds, hyperopic shifts) and cerebral (brain upward shift and increased brain ventricular volume) signs, yielding decreased near-visual acuity, visual scotomas and headaches [1, 2]. SANS is classified today among the major 'red' risks of the human space exploration as it represents a maladaptive 0g response, which can become irreversible after long-term spaceflights [3].

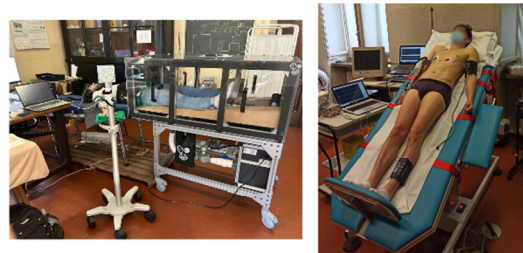
Although still under debate, there is growing evidence that cephalad fluid shift is the driving cause of SANS [4]. The complex interplay between long-term spaceflight cardiovascular deconditioning, intracranial pressure increase and fluid redistribution at cerebral-ocular level is actively being investigated but currently unknown [5, 6]. Moreover, even if 70% of astronauts experience inflight SANS signs and symptoms, the inter-subject response is heterogeneous: many astronauts only experience effects in 0g, while in some others changes may be permanent [7].

In this project we propose to build a validated multiscale and personalized digital twin, based on our existing computational framework, to investigate the cardiovascular and ocular hemodynamic response to long-term 0g [8-11]. The objectives are: (i) to understand the hemodynamic mechanisms underlying the onset of SANS in long-term spaceflights; and (ii) to develop a risk map to classify which are the most prone subjects to SANS. Present outcomes will lead to an accurate evaluation of the SANS risk on a wide, heterogeneous, and mixed-gender crew, and will have important implications on the astronaut recruitment and the development of personalized countermeasures. The project will also have a broader impact on the management of future space travelers tourism and for understanding on-Earth aging-associated diseases such as glaucoma, which is the leading cause of irreversible blindness [7, 12].

WP 1 Personalized modeling of long-term 0g hemodynamics



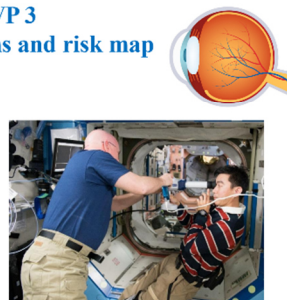
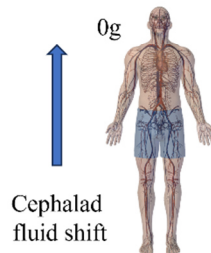
WP 2 In-vivo validation of cardiovascular digital twin



WP 3 SANS mechanisms and risk map

Research Question #1

Which are the hemodynamic mechanisms underlying the onset of SANS in long-term spaceflights?



Research Question #2

Can we develop a risk map to classify which are the most prone subjects to SANS?

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