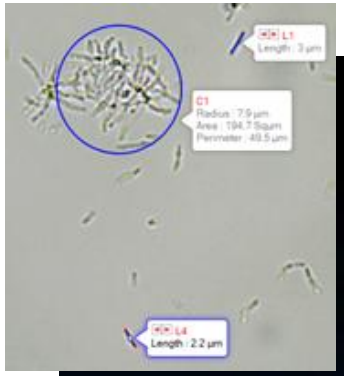
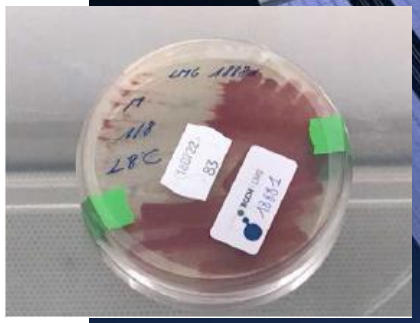
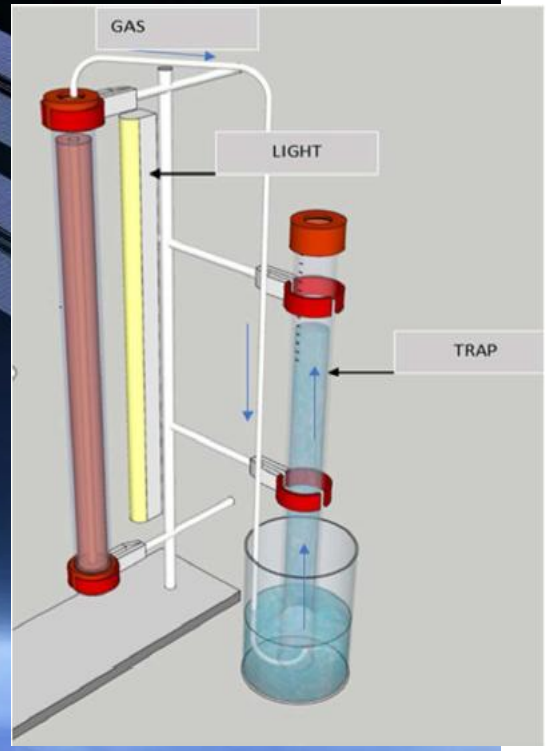
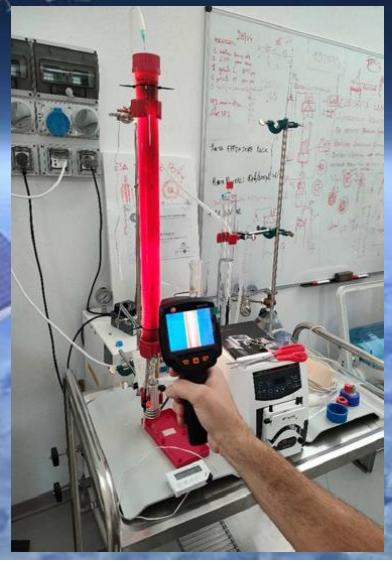
Purple-B **Project**

European Space Agency









BIO-ENERGIA VERITAS

BIO-ENERGIA VERITAS

GREENPROPULSIONLABORATORY

BIOMOON PROJECT

LUNAR GRAVITY BIOREFINERY PLATFORM

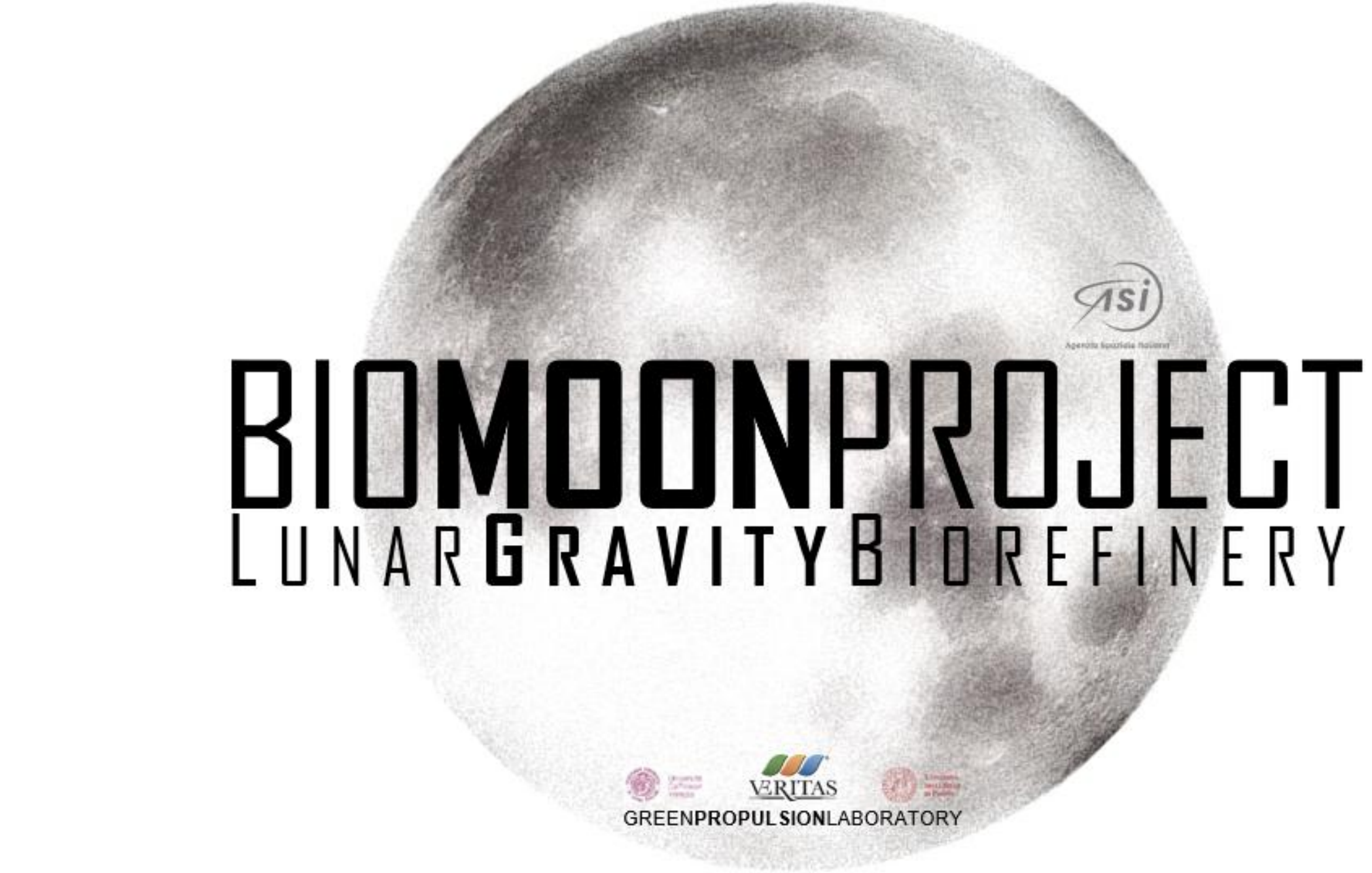
and

TOPICAL TEAM LIFE SCIENCE

Sustainable Low-Gravity Biorefinery Models for
Energy, Food and Chemicsl production in the
Space Missions

UNIVERSITÀ DEGLI STUDI DI PADOVA

9-Tech



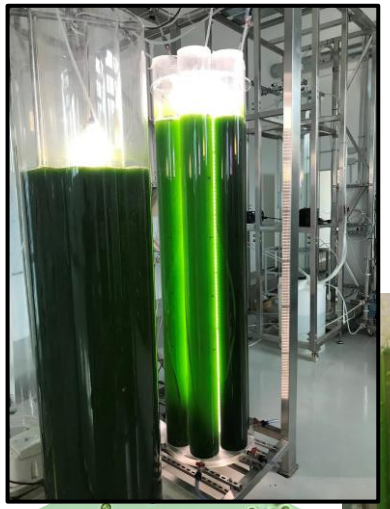
BIOMOONPROJECT

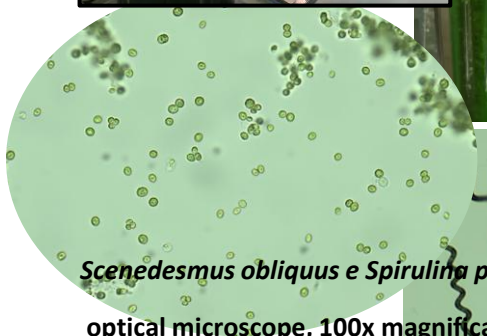
LUNAR GRAVITY BIOREFINERY

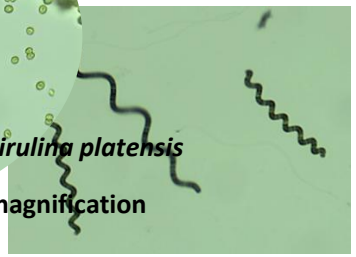
GREENPROPULSIONLABORATORY

GREENPROPULSIONLABORATORY

- FOTOAUTOTROFI



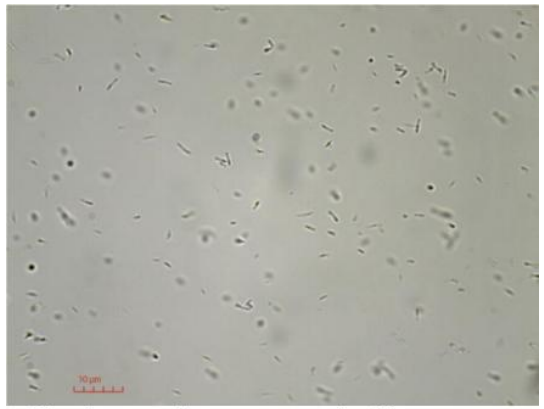




Scenedesmus obliquus e Spirulina platensis

optical microscope, 100x magnification

- FOTOETEROTROFI



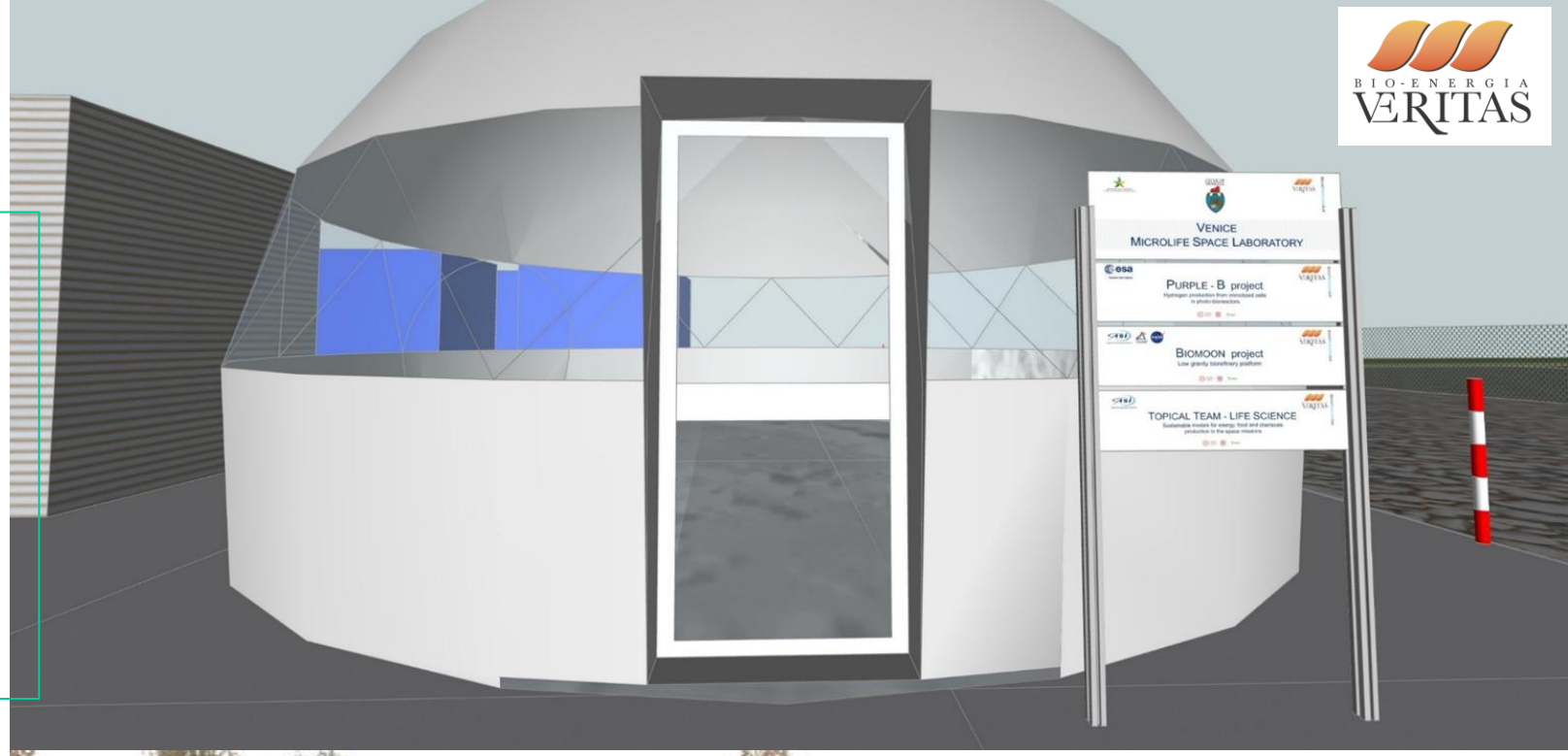
Rhodopseudomonans palustris
optical microscope, 100x magnification

- CHEMIOETEROTROFI-METANIGENI

Fanghi granulari anaerobici

VENICE MICROLIFE SPACE LABORATORY

GREENPROPULSIONLABORATORY



GPLab project proposal

VENICe - *fuels*

Aircraft advanced fuels by **bioH₂**
and **CO₂** from Venice incinerator plant

GREENPROPULSIONLABORATORY

Venice waste incinerator plant

Flue gas CO_2 (10% ca.)

Green H_2 storage

CC&S

$CO_2 + H_2O$ (12% ca.)

$CO_2 + H_2O$ (12% ca.)

Anhydrous CO_2

Bio H_2

Bio CH_4

Bio CH_4

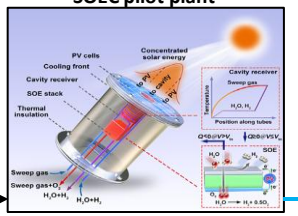
Bio H_2

CH_3OH

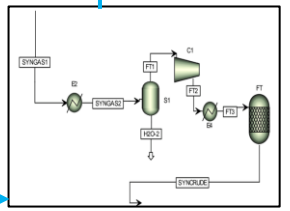
CH_3OH

Sabatier
methanation/methanol
production

SOEC pilot plant



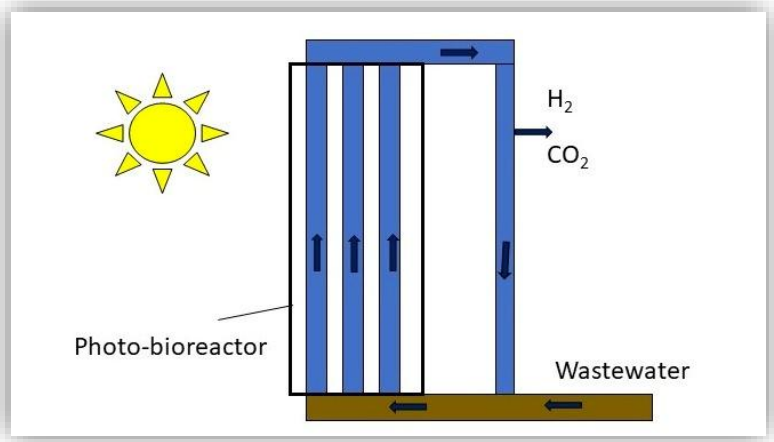
Fischer Tropsch



GreenPropulsionLab

Idea I-2021-01895

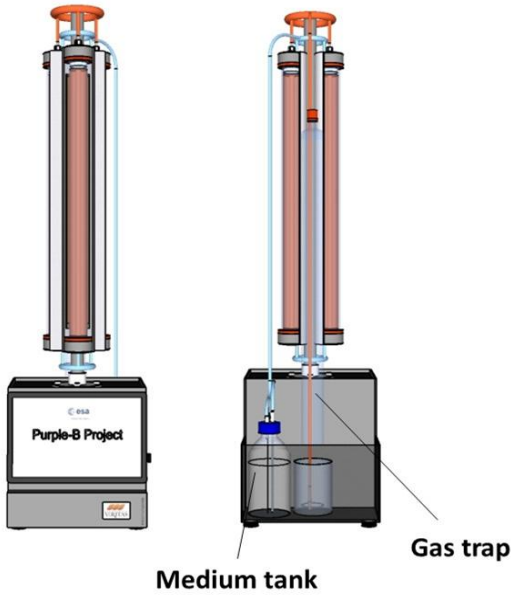
Purple-B: Hydrogen production from immobilized cells in photo-bioreactors



Subcontractors:

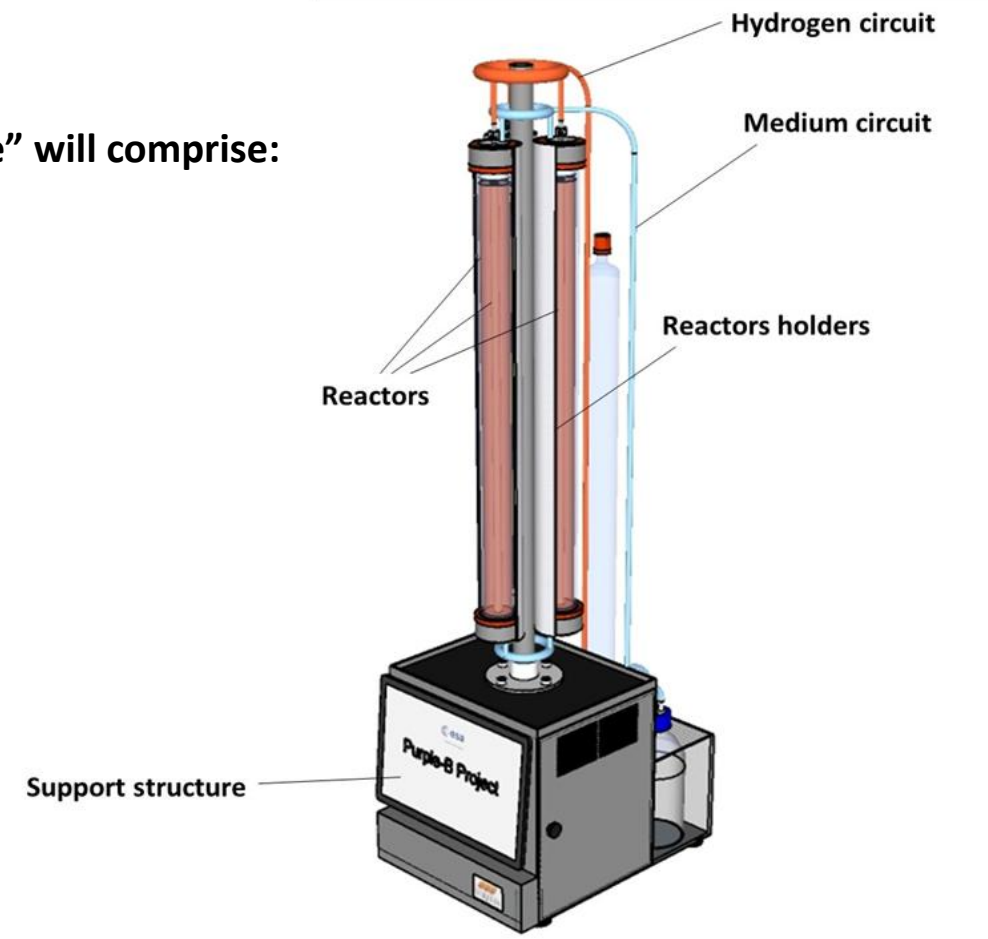
WP3 T 3.2 Realisation of the reactor and of the H2 capture system

Design presented in last meeting

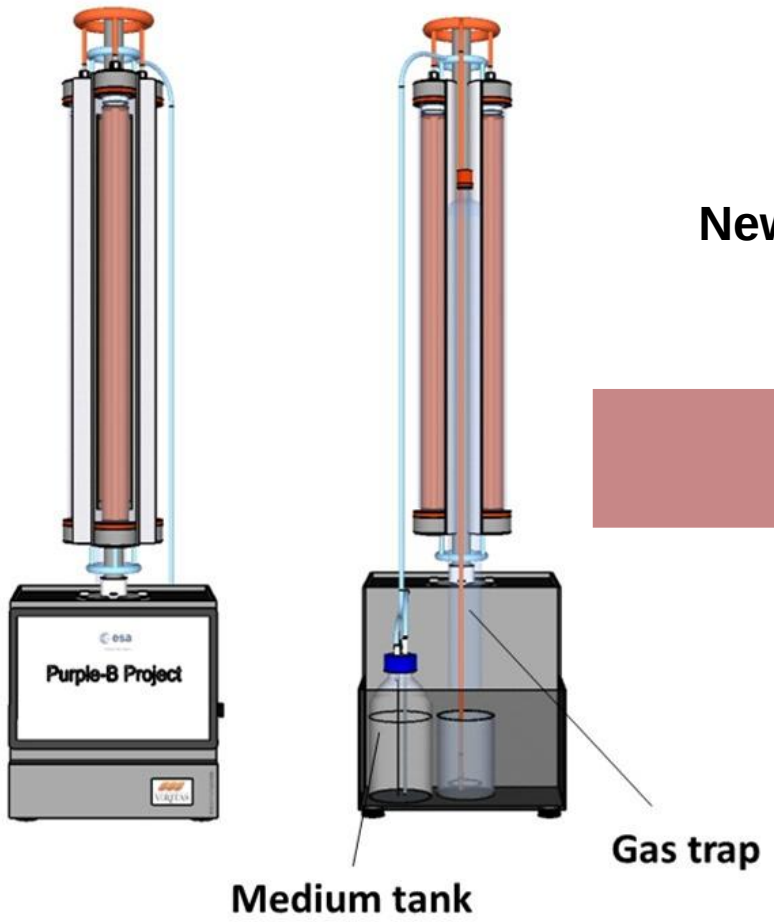


The "Purple-B module" will comprise:

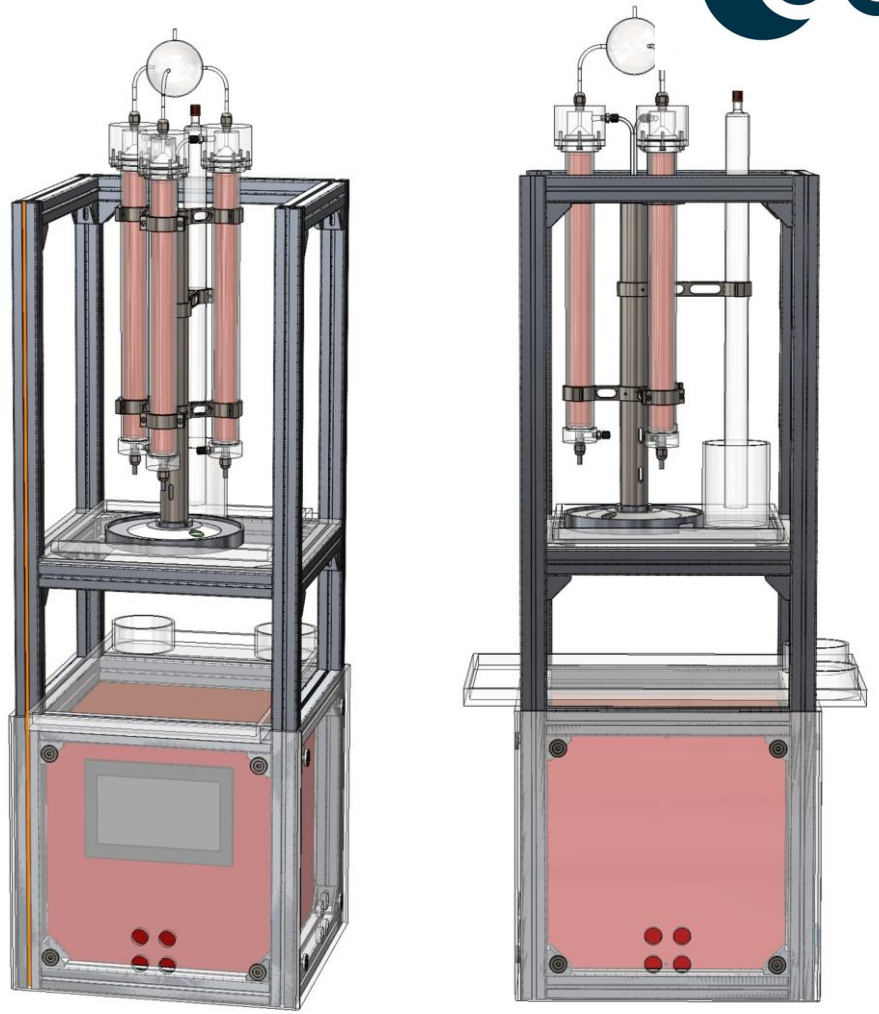
1. **3 Reactors**
2. **Support structure**
3. **Reactor holders**
4. **Medium tank**
5. **Gas trap**
6. **Medium circuit**
7. **Hydrogen circuit**
8. **Sensors**



WP3 T 3.2 Realisation of the reactor and of the H2 capture system



New design

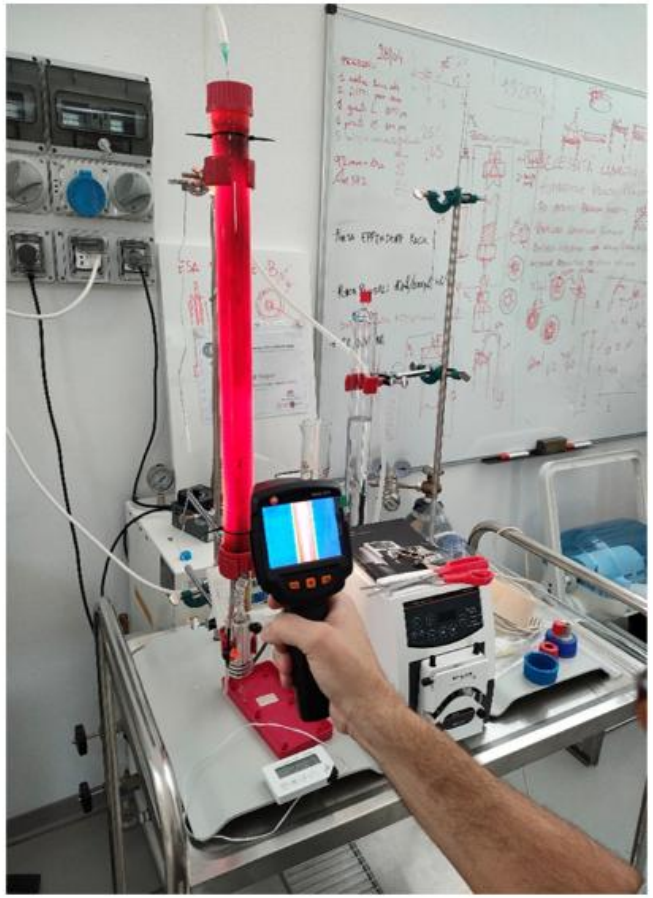


Energy model

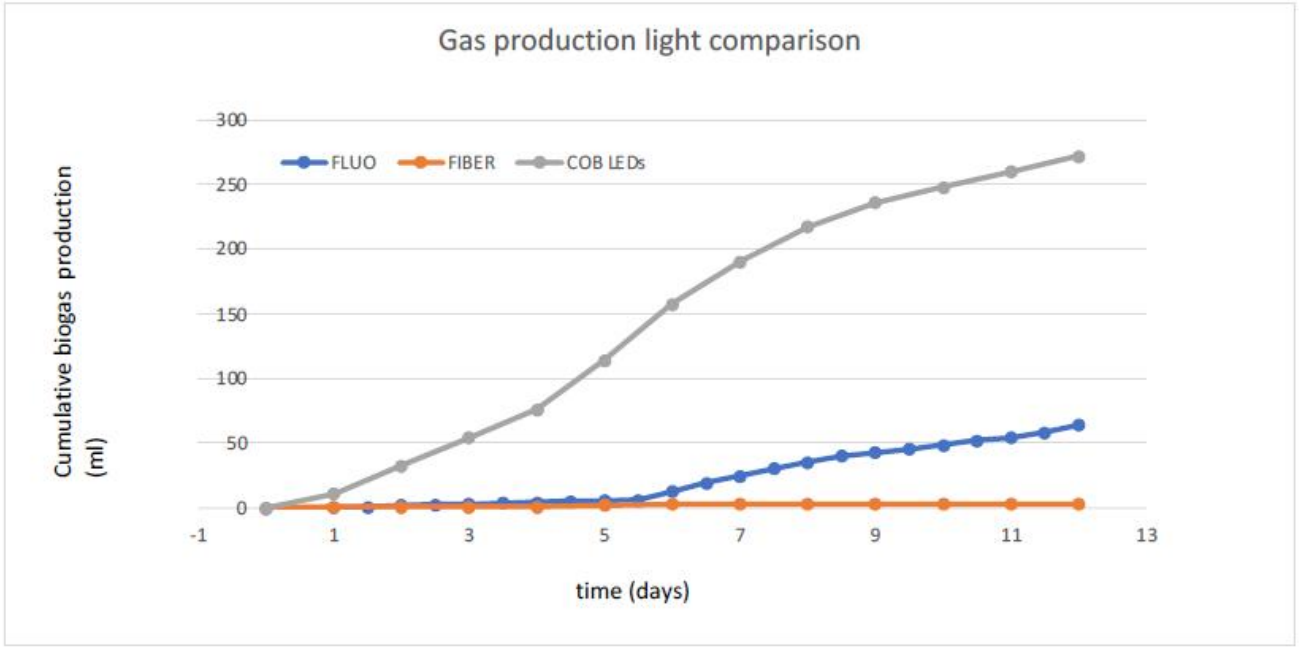
- The model of the Purple-B module will be performed, and its operation evaluated over some days
- The goal is the quantification of the the overall system energy performances (energy efficiency, primary energy consumption)
- The operation under different conditions (e.g, different light management, external temperatures, flow rate, …) will be studied and compared
- Data coming from wp will be used to validate the model

Purple-b photo-bioreactor

WP1-T 1.3 --> Analysis and evaluation of the H2 evolution efficiency with continuous or pulsed light

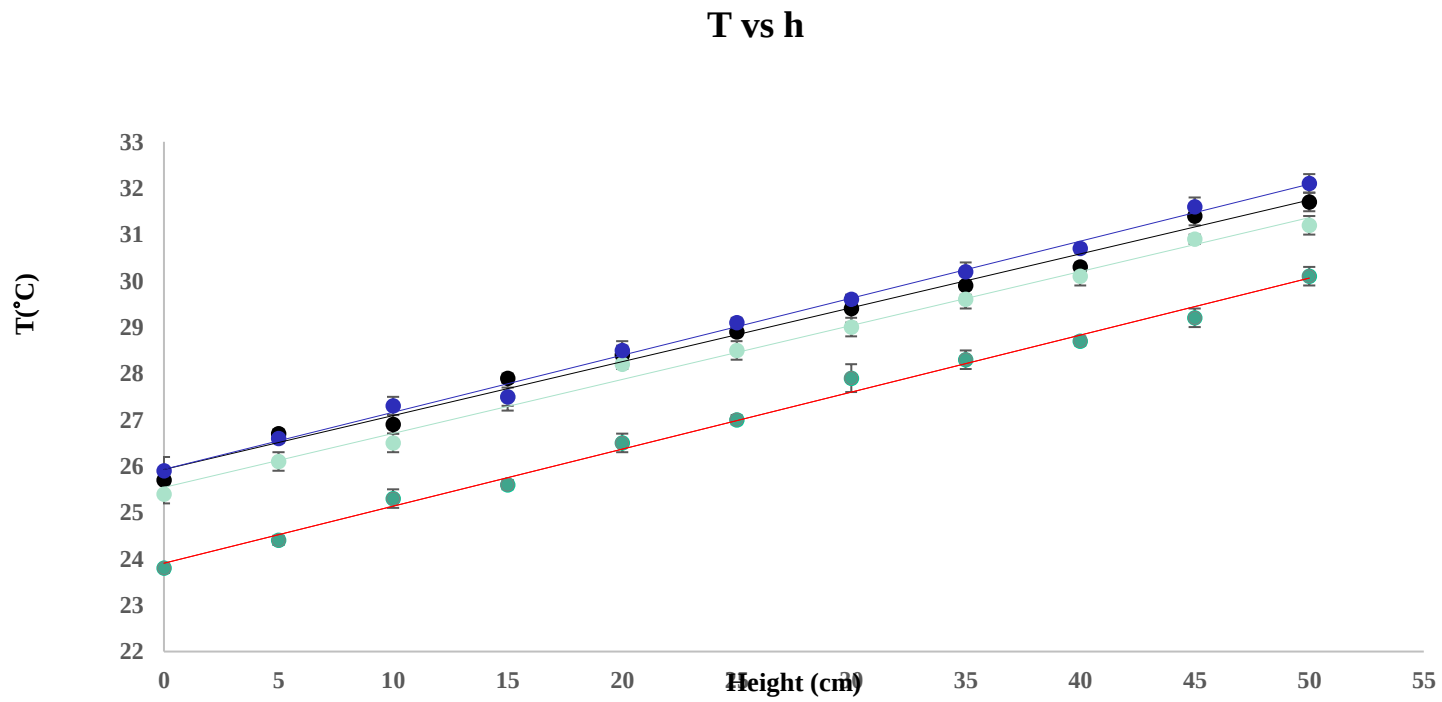


COB LED gave excellent results, such as a stable hydrogen production without damaging the photosystem I of the bacteria. Thanks to the COB LED the temperature monitored was uniformely distributed (28-33 °C).



CFD Analysis

- A simplified model of the reactor will be build using a commercial CFD code
- A simulation will be done able to find the thermal behaviour



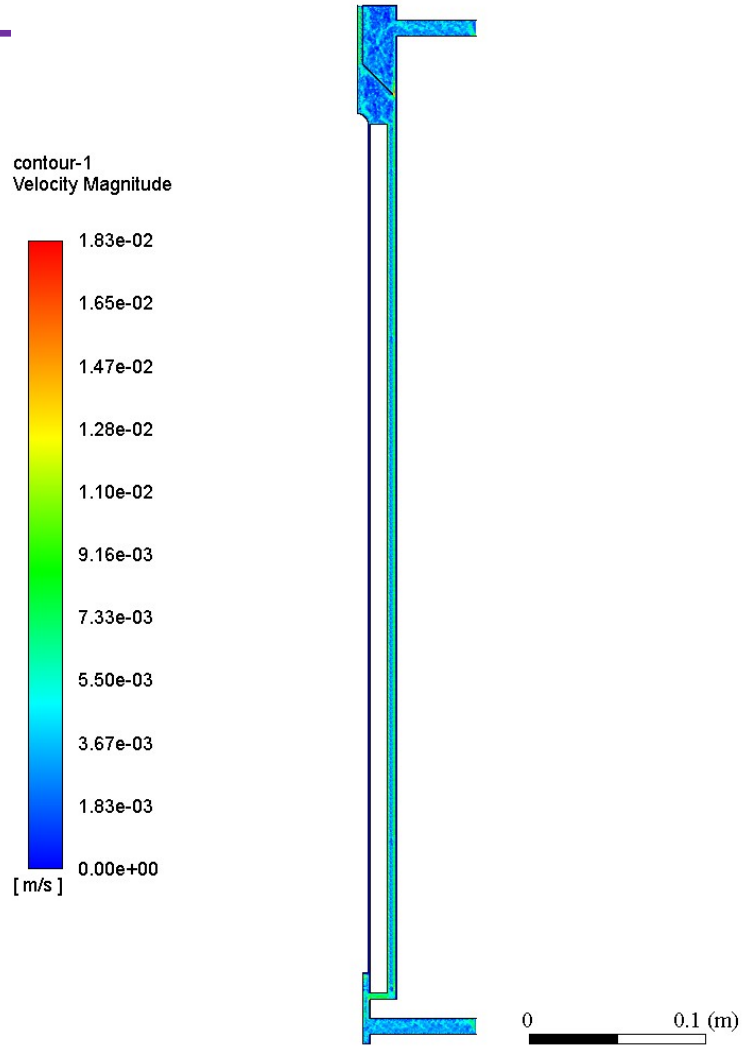
Fluid-dynamic model and simulation

Ansys Fluent software has been used to simulate the system.
The first simulations were aimed at reproducing the system operation and finding the main important boundary conditions for the simulation.
The velocity and pressure trends were found.

To simply the problem, a 2-D geometry has been implemented for now.

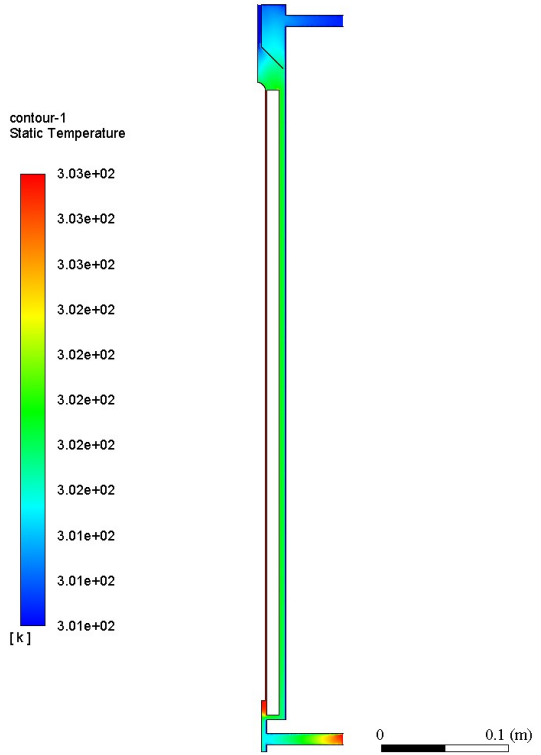
Some experimental tests were carried out for the correct modeling of the agar and some data were collected from literature.

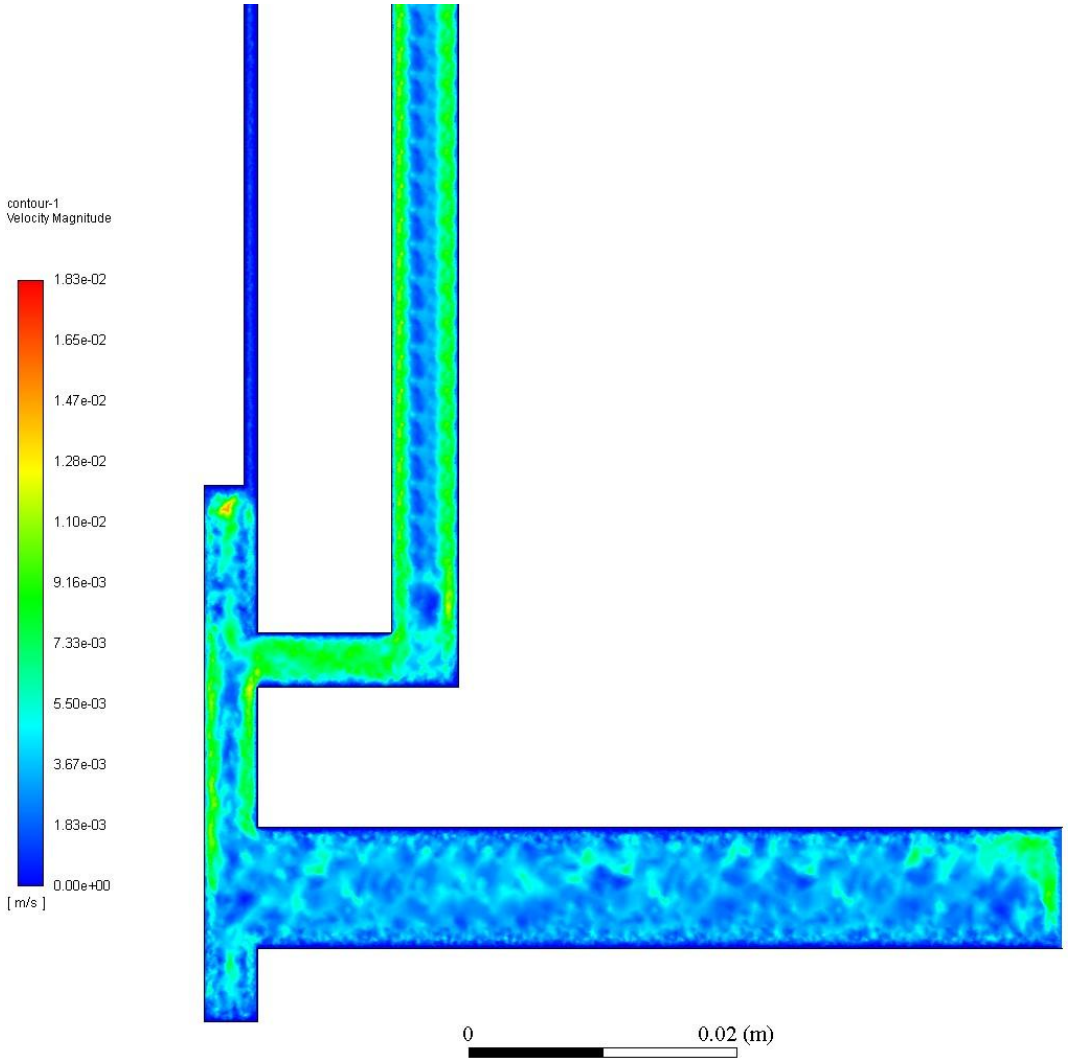
Velocity field

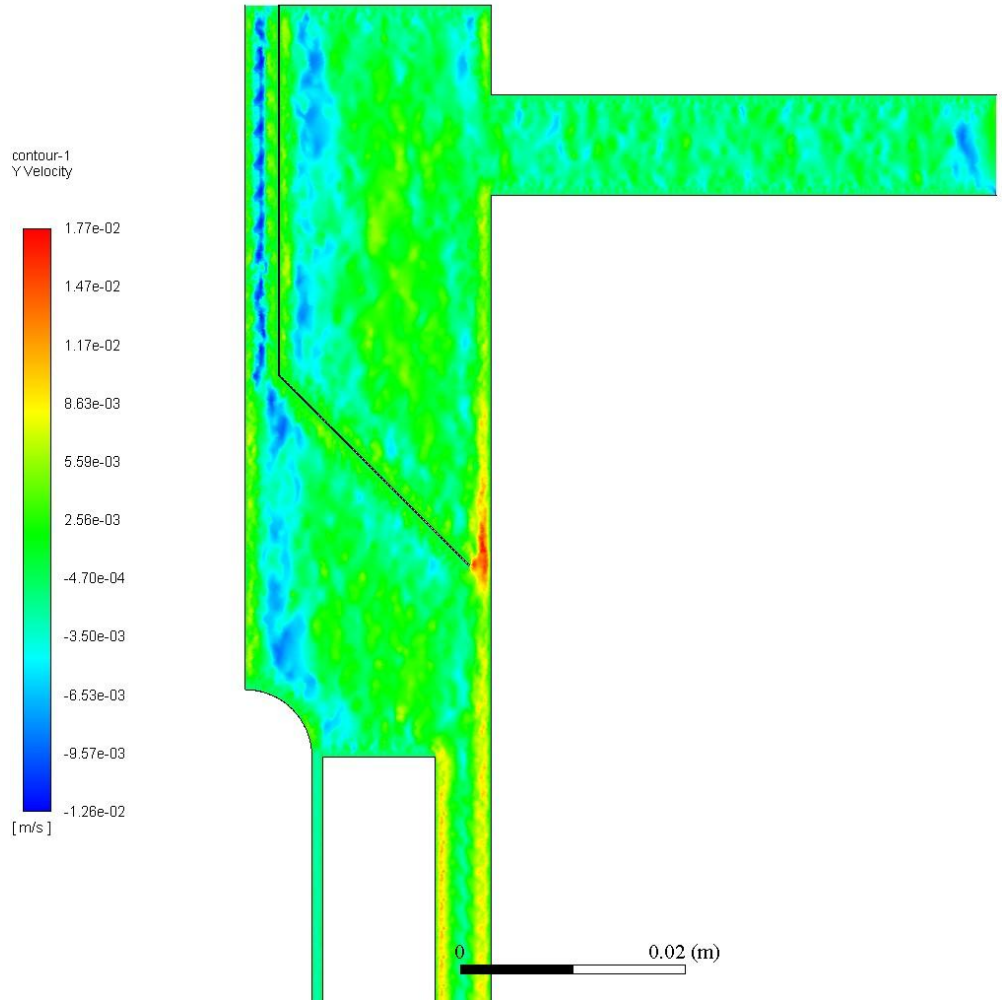


Thermo fluid dynamic model

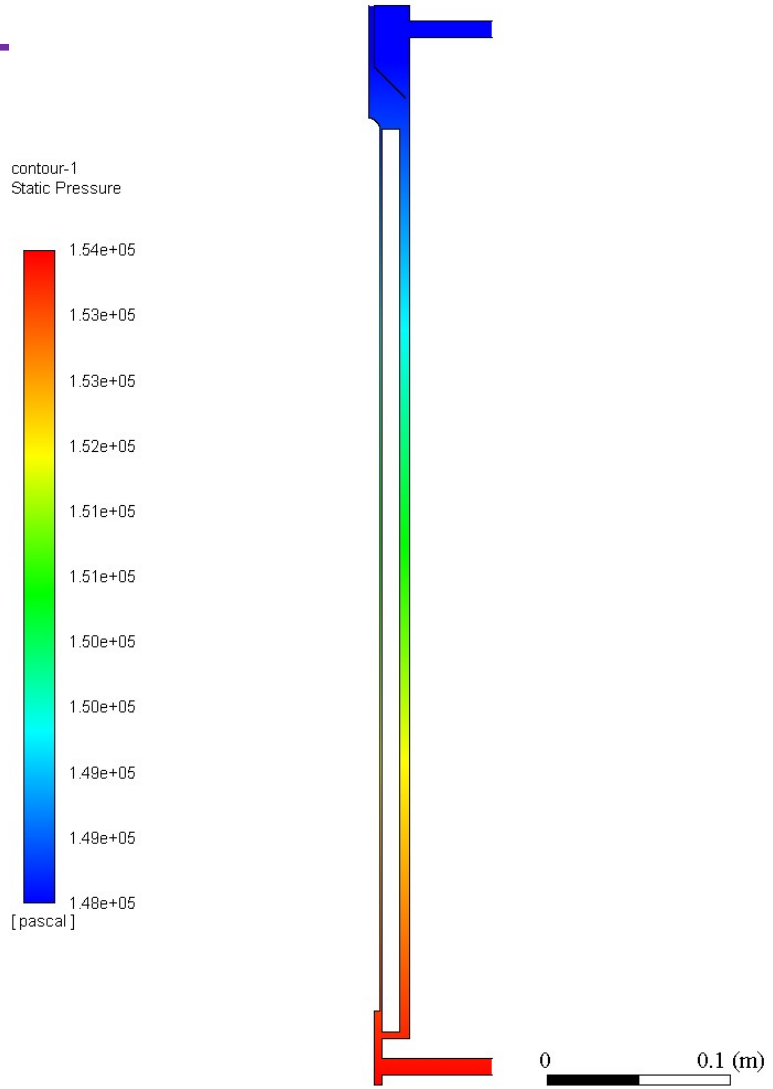
- The presence of the lamp has been considered.
- The water enters at 30°C.



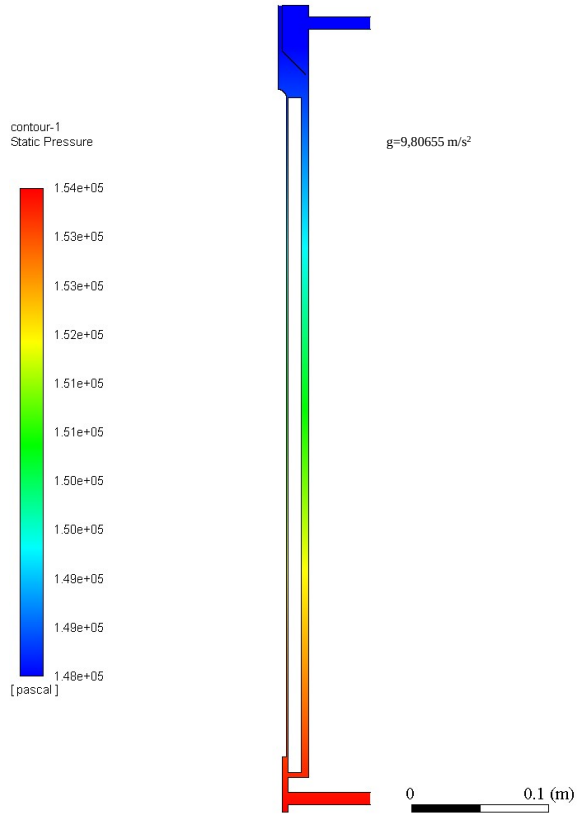

contour-1
Velocity Magnitude
1.83e-02
1.65e-02
1.47e-02
1.28e-02
1.10e-02
9.16e-03
7.33e-03
5.50e-03
3.67e-03
1.83e-03
0.00e+00
[m/s]
0
0.02 (m)

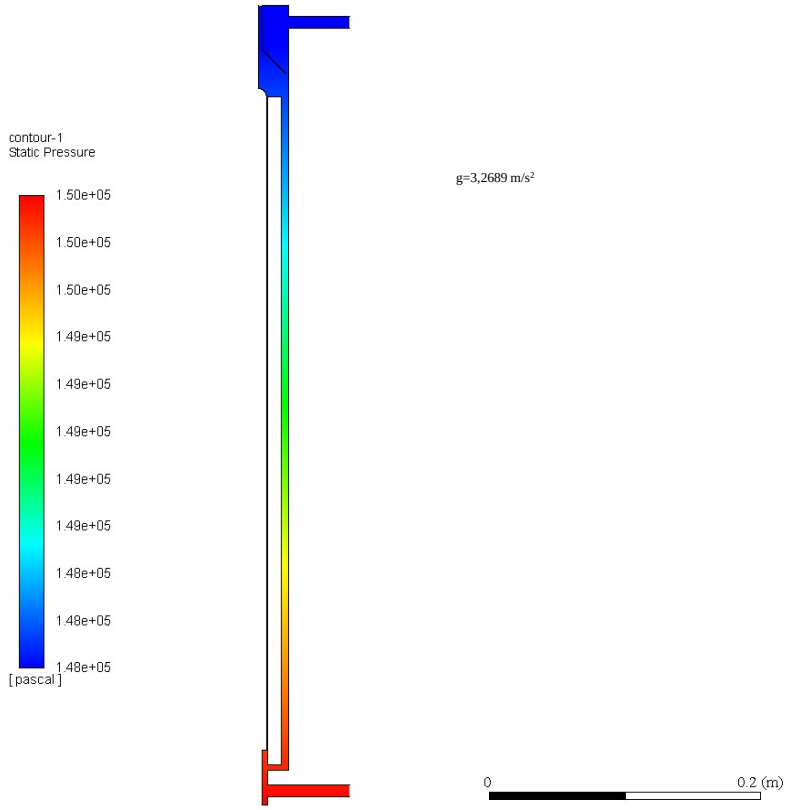

contour-1
Y Velocity
1.77e-02
1.47e-02
1.17e-02
8.63e-03
5.59e-03
2.56e-03
-4.70e-04
-3.50e-03
-6.53e-03
-9.57e-03
-1.26e-02
[m/s]
0
0.02 (m)

Static pressure field

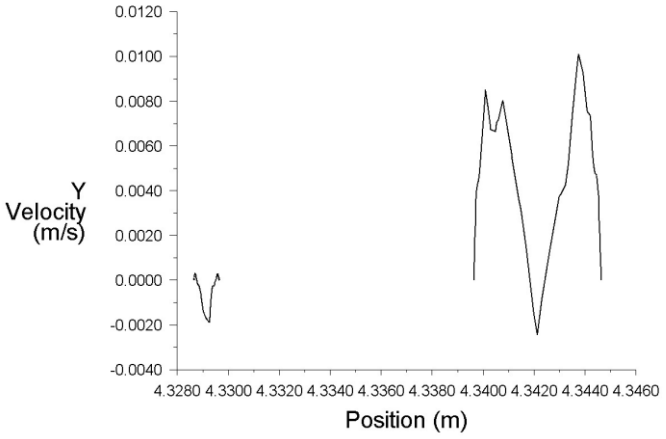


Preliminary test on the influence of gravity

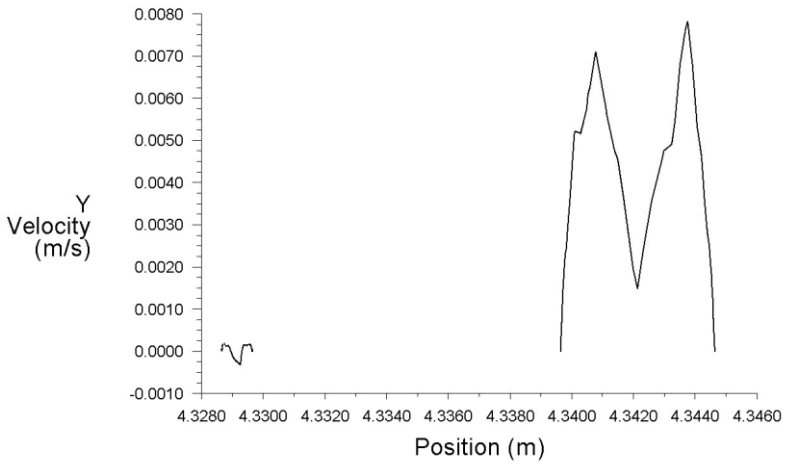




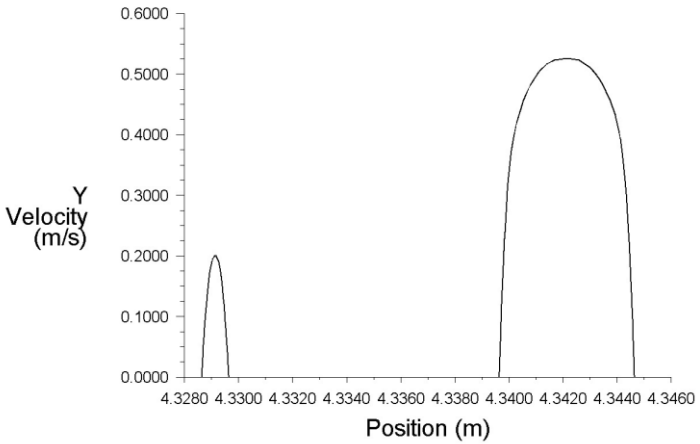
Preliminary test on the influence of gravity



g=9,80655 m/s²



g=3,2689 m/s²



g=9,80655 m/s²
$v >> v_{reactor}$

Piano Nazionale di Ripresa e Resilienza (PNRR)
Realizzazione di impianti di produzione di idrogeno rinnovabile in aree industriali dismesse

HYDROGEN**VALLEY**VENEZIA

5 MW - 750 t/y – 18 Mln di euro

- Industrial flue gas decarbonization (CC&S) and CO2 energy conversion using green H2 (CCUS/P2G)
- Use of green H2 in advanced green chemistry processes
- H2 production from renewable sources (e.g., biohydrogen from waste)
- New H2/CO2-based materials and fuels