



# Returning gas pressure stabilization system in ToF detector using a pump suspended on magnetic bearings.

Michał Gontarz

276704@pw.edu.pl
+48 607 733 560

# Introduction

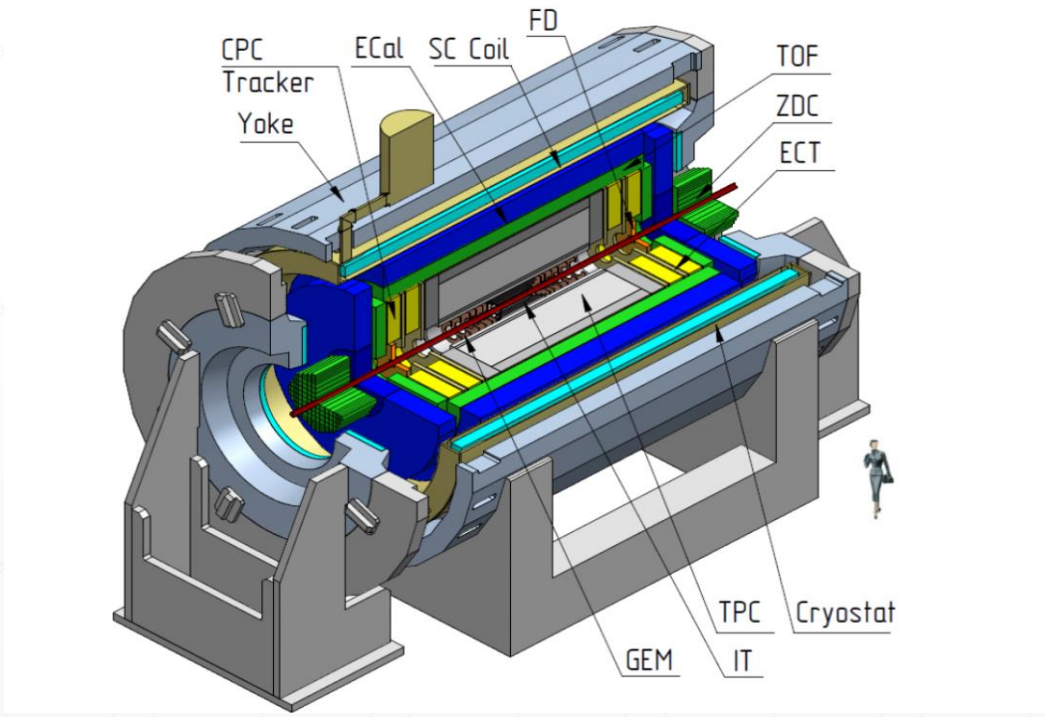
TeFeNICA 2018

# Presentation plan

1. Introduction and the theory
2. Initial work
3. Digital model of the pump
4. Future

# Introduction

Multi Purpose Detector

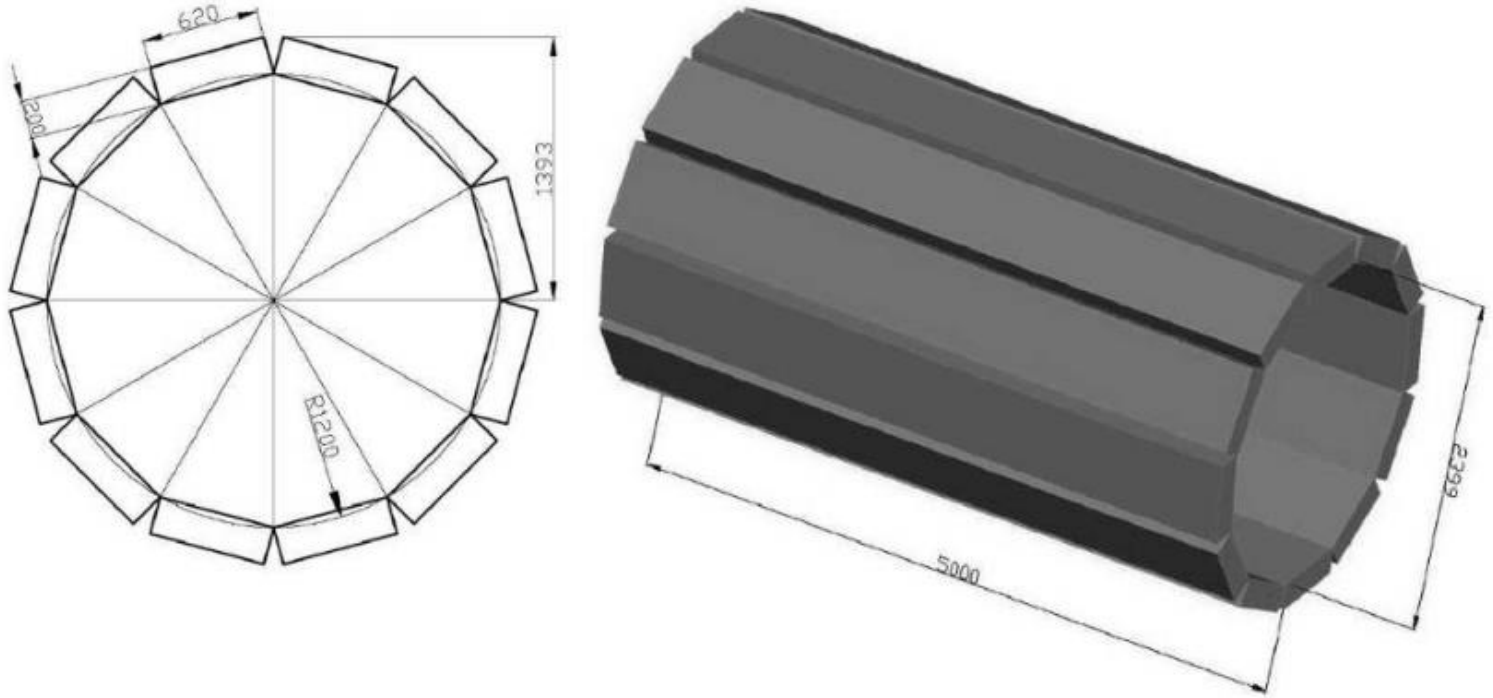



*Źródło: mpd.jinr.ru/mpd/*

# Time Of Flight Detector (ToF)

FFD Detector -> ‘start’ signal during collision

ToF Detector-> local ionization of gas -> ‘stop’ signal.



# Gas reversing system

The gas mixture in the detector: 90% $C_2H_2F_4$ + 5% i-$C_4H_{10}$ + 5% $SF_6$.

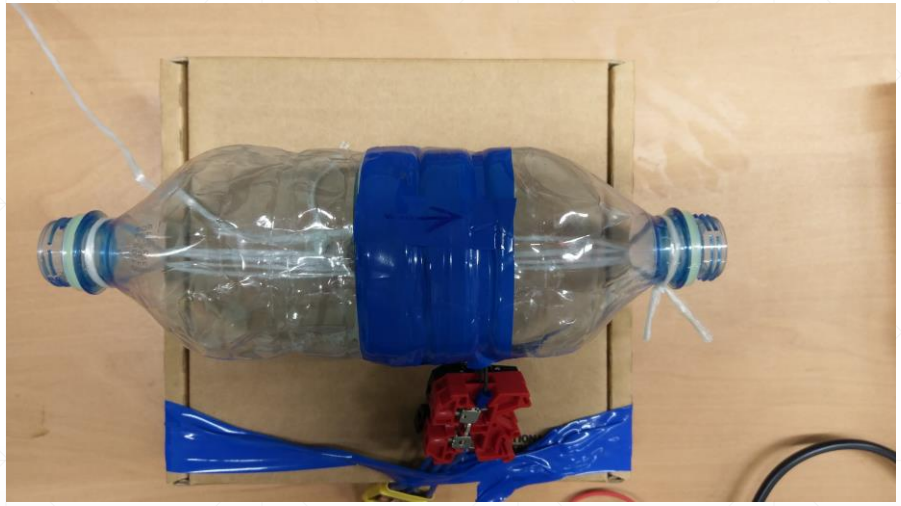
The $C_2H_2F_4$ gas is widely considered as hazardous to the environment. It means that it cannot be released into the atmosphere.

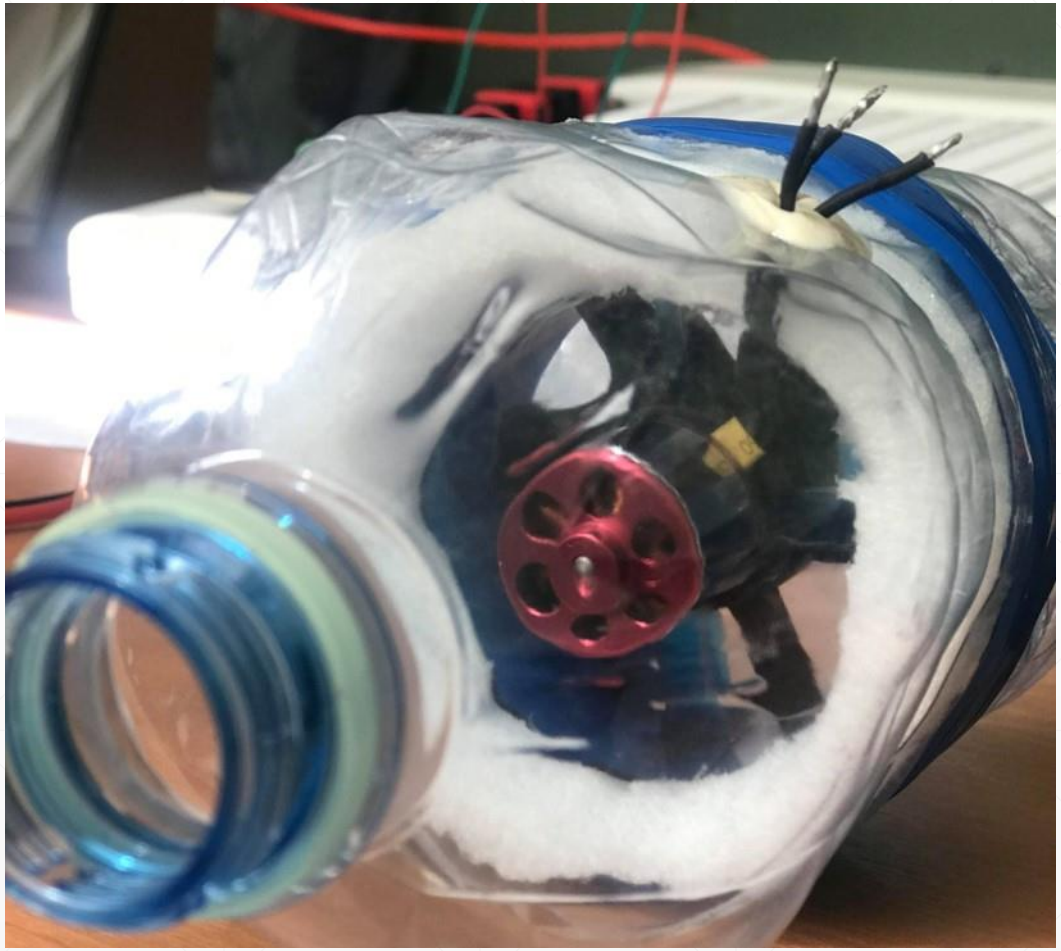
The need for returning the gas to the ToF system arises, thus the need for a pump, which can operate without any lubricants, friction or other sources, that could pollute the gas mixture.

# Initial work

TeFeNICA 2018

# Pump composed of a plastic bottle and a 12V DC engine.

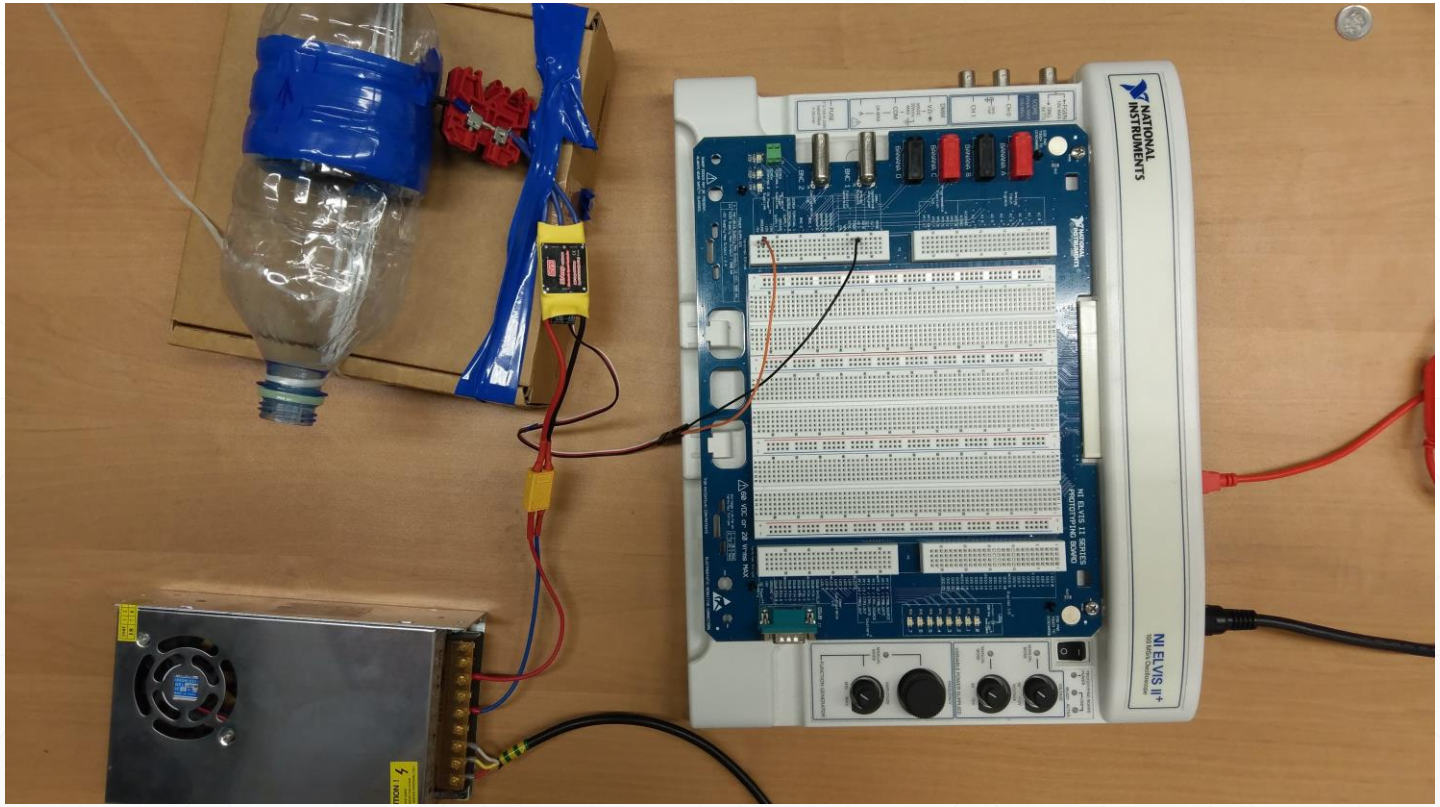




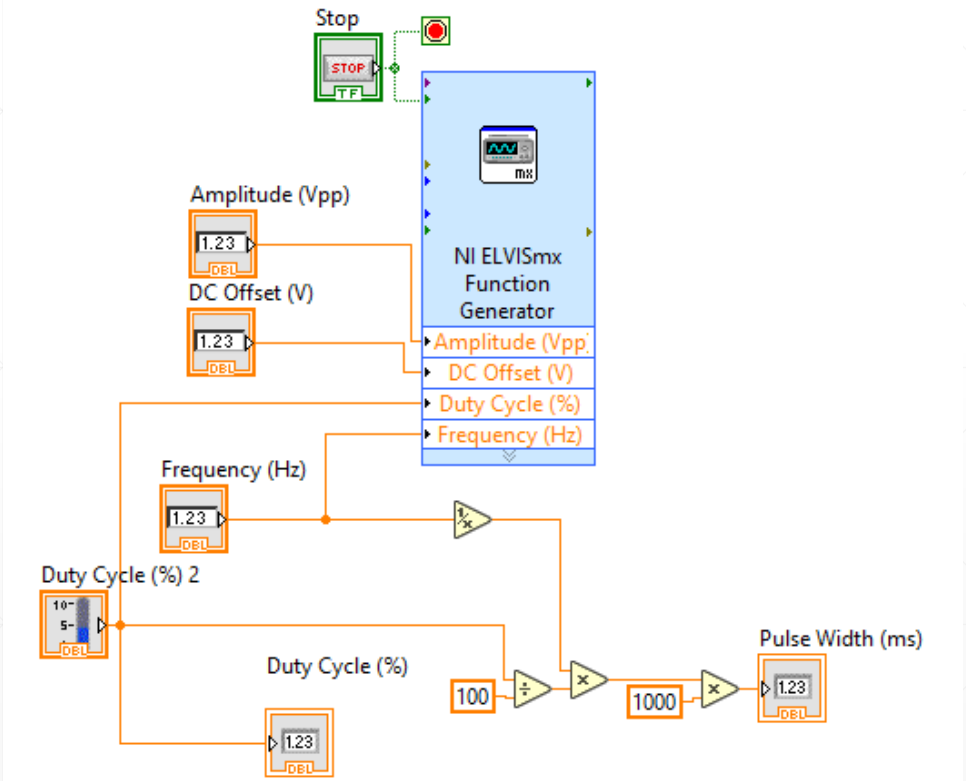
# First Project

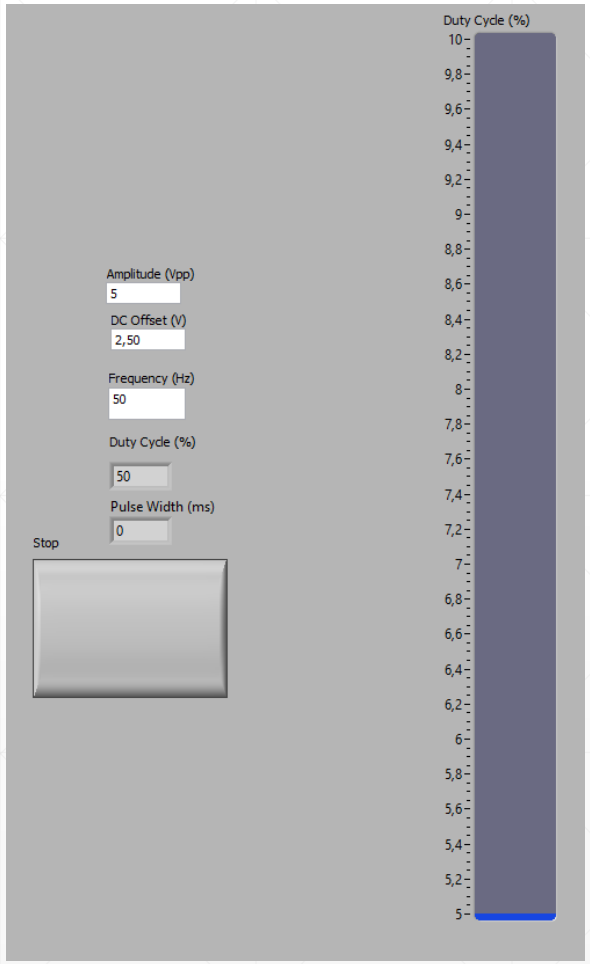
- 12V engine from an RC plane
- Controlled with an ESC (Electronic Speed Controller) DYS 30031 – 30A
- 12 V, 30 A power supply.
- Controlling signal PWM originating from the NI Elvis system, connected and programmed using NI LabVIEW.
  - Frequency 50Hz, pulse width 1 – 2 ms, amplitude 5V.

# PWM Control schematic



# PWM Control schematic



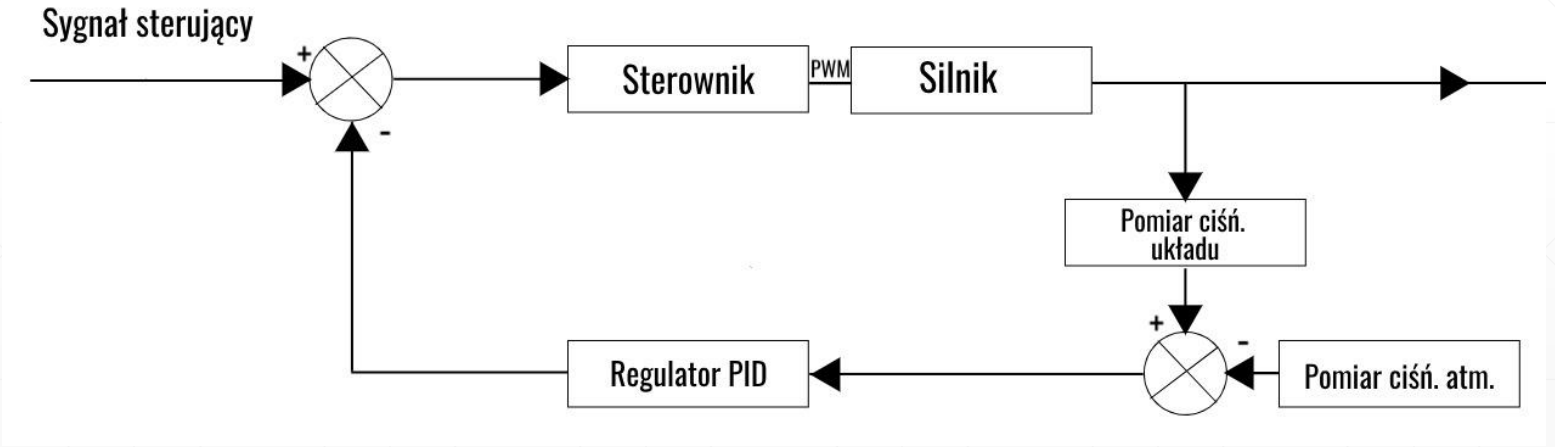



# Reading pressure values

- YF-S201C flow sensors.
- PWM signal generation,read by NI ELVIS Oscilloscope.
- Frequency [Hz] -> Flow (L/h) (conversion rate from the product’s data sheet).
- Converting the value into air speed [m/s], and then into dynamic pressure [Pa].

# Feedback loop to control the pump speed.

- Atmospheric pressure measurement with a BMP180 sensor.
- Required pressure = atmospheric pressure + 3 mbar.



# Digital model of the pump suspended on neodymium bearings.

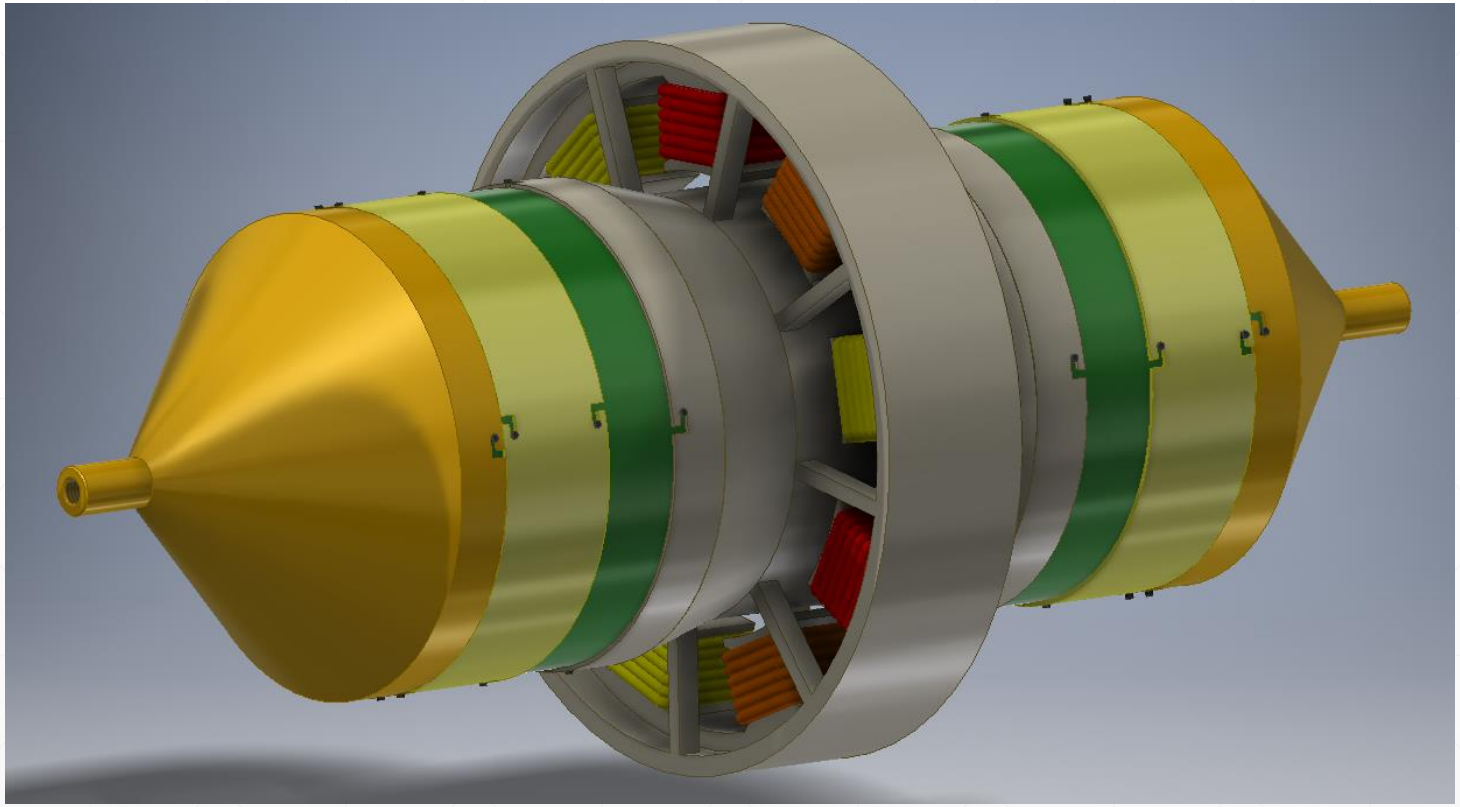
TeFeNICA 2018

# Software

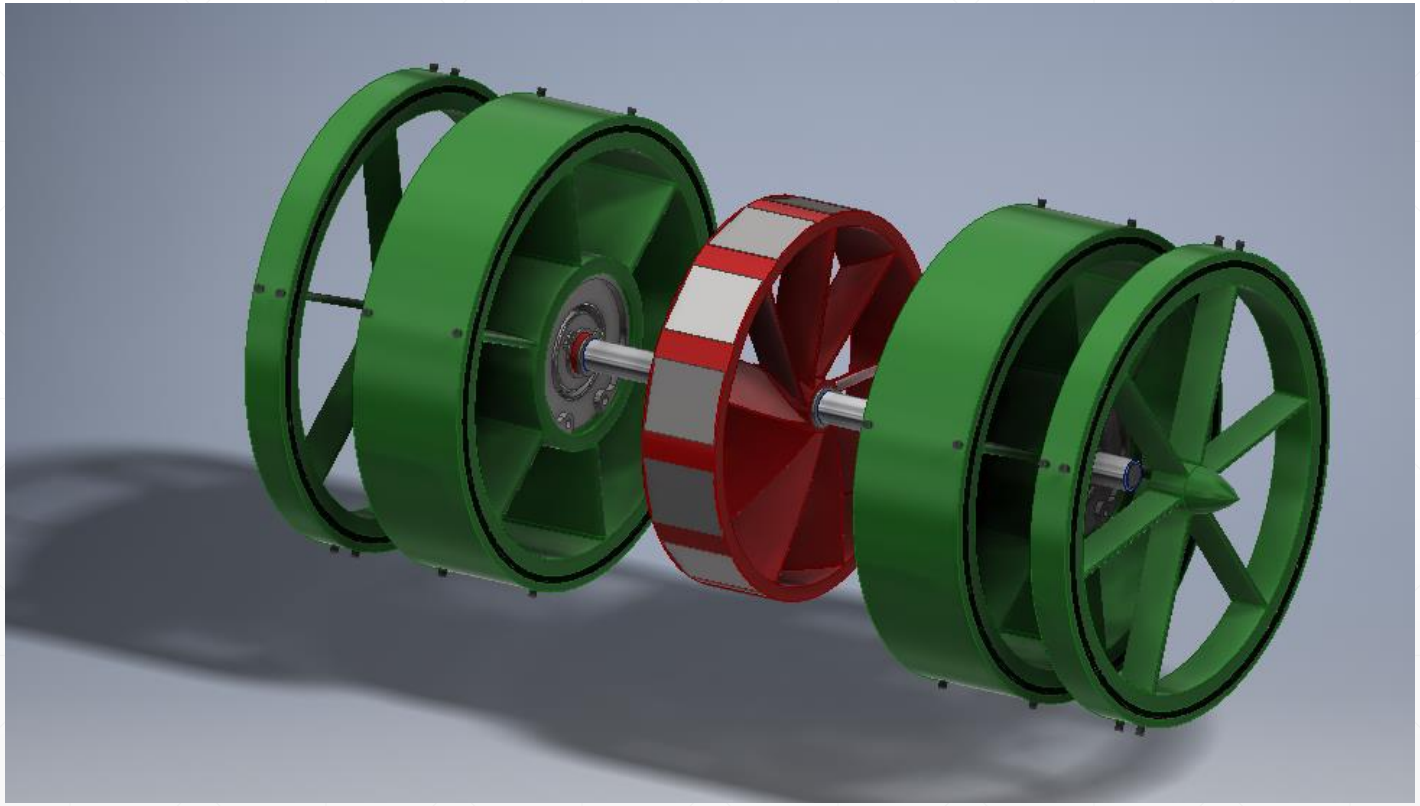
- The model was done in Autodesk Inventor.


- Planned flow simulations using Autodesk CFD, and magnetic simulations of the bearings using EMWorks.


# Digital model of the pump suspended on neodymium bearings.

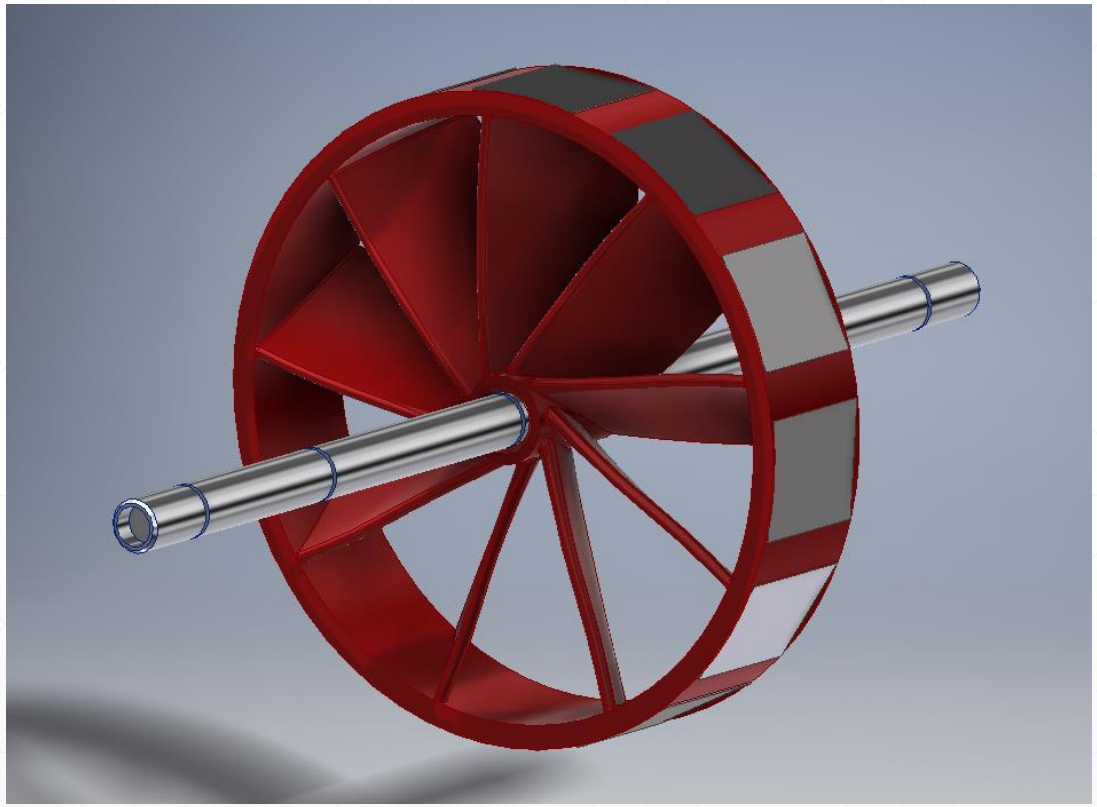


# Digital model of the pump suspended on neodymium bearings.



# Rotor

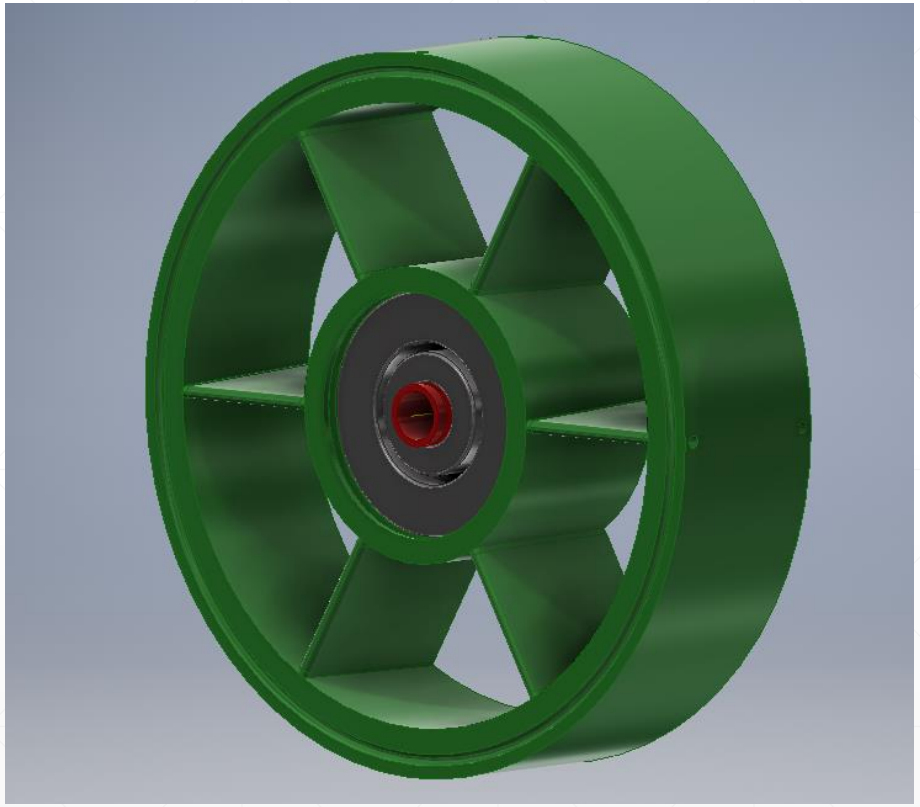
- 9 blades.
- 12 plate neodymium magnets (NdFeB) - 20x18x5 mm.



# Passive magnetic bearing

There are two magnetic bearings in the model which compose of two sets of 4 ring magnets 40x23x6 mm (outer) and 20x10x6 mm (inner).

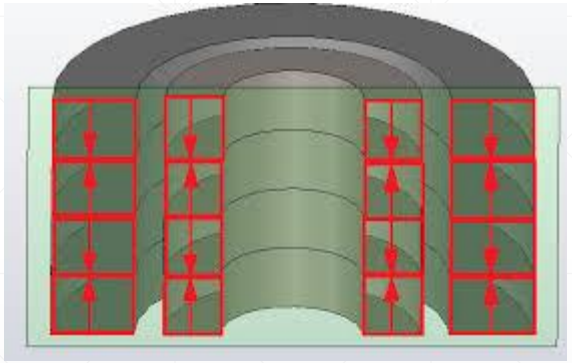
Magnets are fixed to the rotating and static elements using Seger rings.



# Magnetic bearing

The ring magnets are arranged in a  Hallbach array.

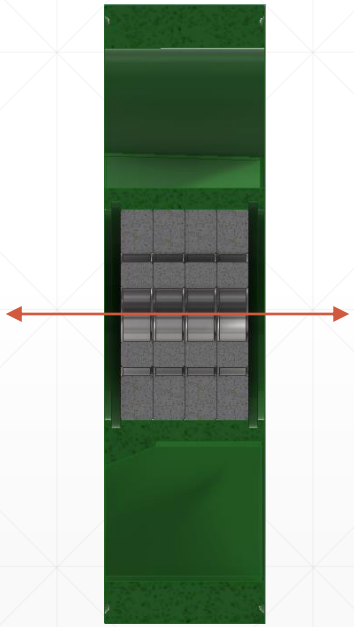
This placement helps obtain the desired magnetic flux and provides bigger stability than other ways.



A. MYSTKOWSKI , L. AMBROZIAK *„INVESTIGATION OF PASSIVE MAGNETIC BEARING WITH HALBACH-ARRAY”*

# Axial shift

One of the main issues with the concept is the axial shift.

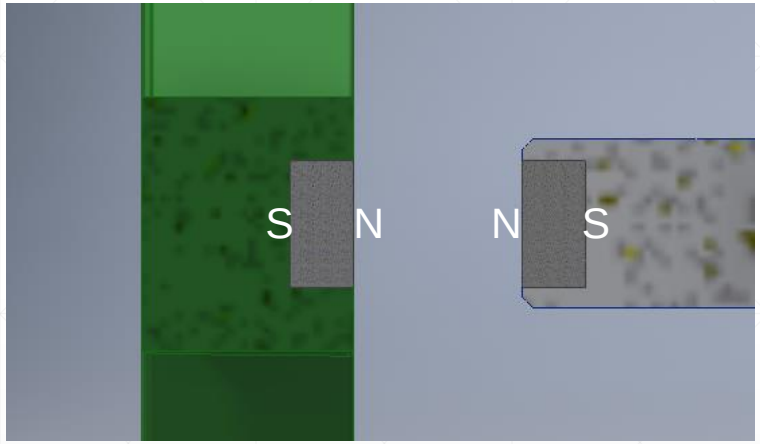


Magnetic bearing
cross-section.

# Axial stabilization

Primary solution – Placing two cylindrical magnets NdFeB 6x3 mm in two stators at both sides of the axis, as well as in the axis ends.

The magnets are directed to each other with magnetic poles of the same name, which mean slight repulsion.

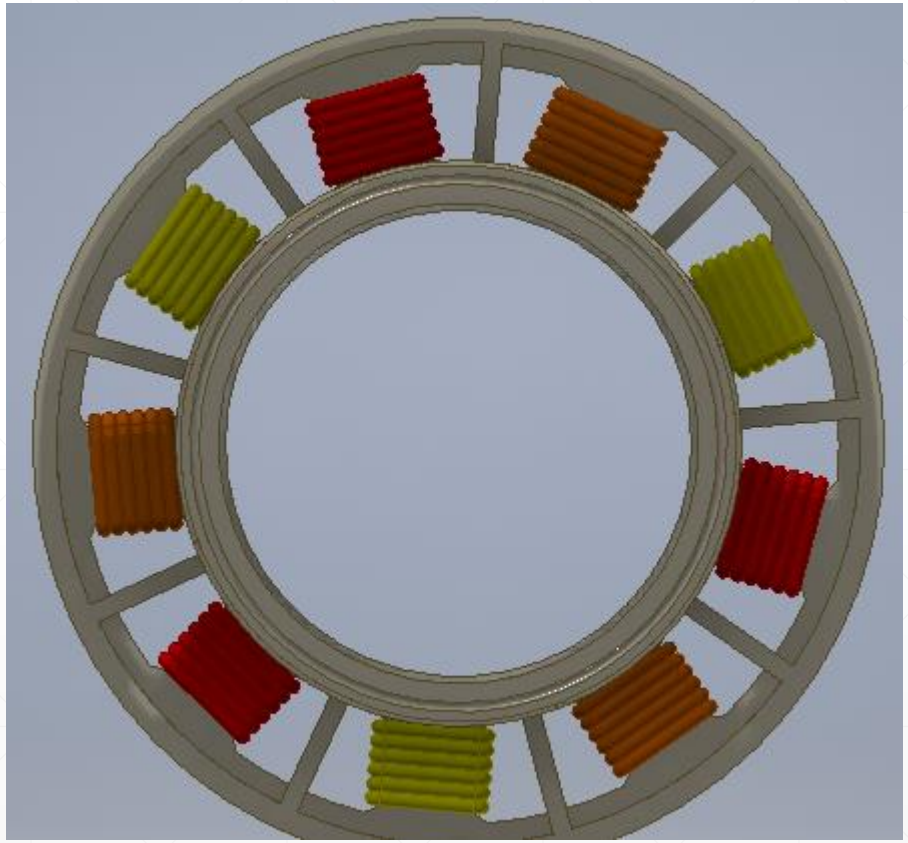


# Driving the rotor

BLDC – **B**rush**L**ess **D**irect **C**urrent powered with 3 phase current, controlled by a computer programmed PWM signal.

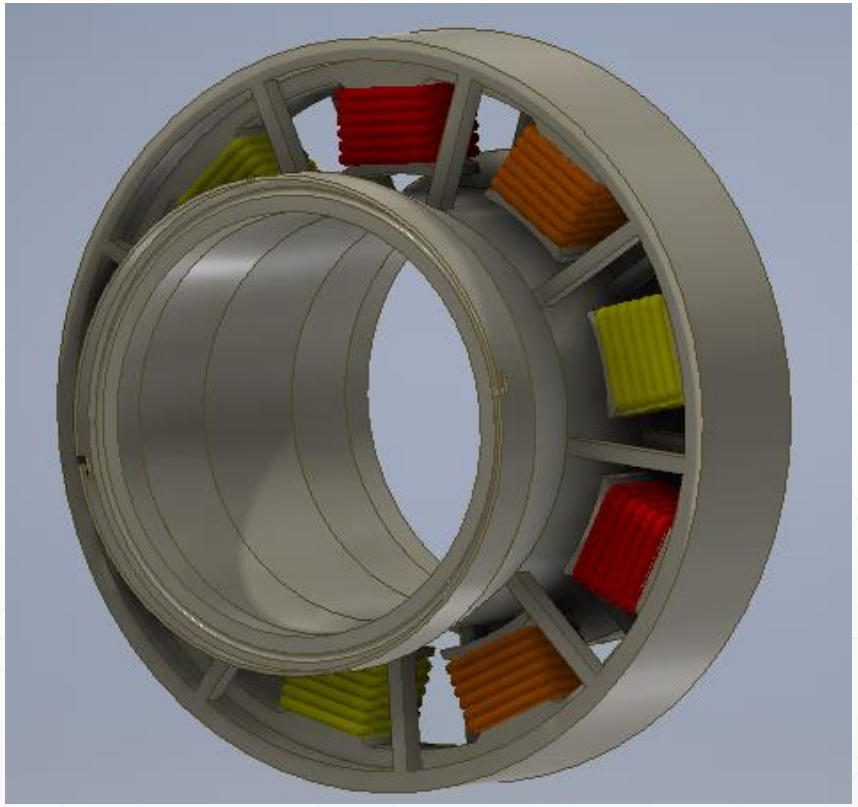
9 coils outside of the system, connected according to the ABCABCABC configuration (colour red, yellow and orange)

The inducted magnetic flux of the coils causes the attraction and repulsion of the magnets on the rotor, causing its rotation.



# Driving the rotor

The coils integrated as a part of the outer shell, which provides ease of mounting and better temperature management.



# Assembly

All designed elements will be 3D printed.

The moving elements (rotors and magnets) are mounted using Seger rings.

Outer elements of the shell and the stators are mounted using bayonet mountings.

# Future of the project

TeFeNICA 2018

# Future

Further developing and finishing the feedback loop system to operate the pump.

Performing electromagnetic and flow simulations.

Adjusting the model accordingly.

Printing and assembly.

# Thank You.

TeFeNICA 2018