Good Morning!

A Novel Magnetic Bearing Using 2G Double Crossed Loops

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Abstract 2LO2-07

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1. Introduction

Research background

Motivations

Objectives

1.1. Background

Maglev Cobra is the Brazilian experimental SML vehicle

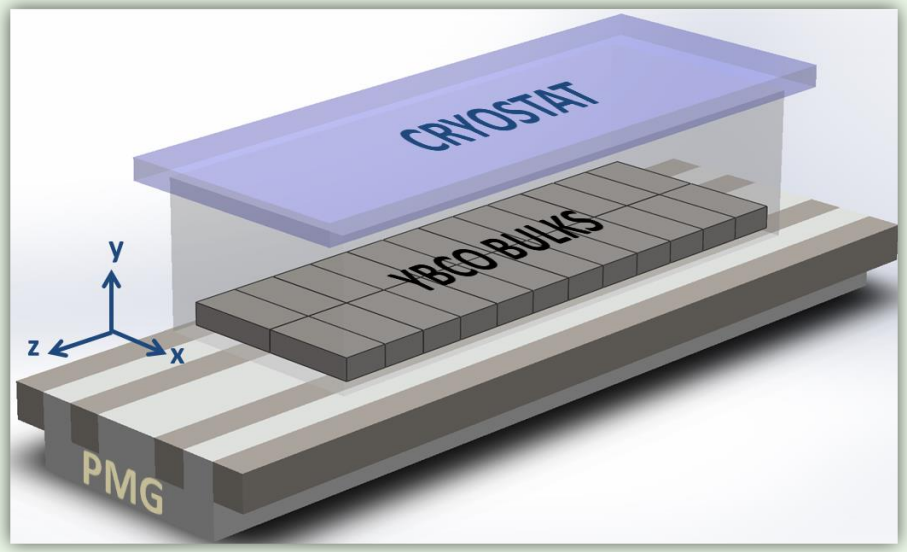
The first in the world to reach a full scale prototype status (2014)

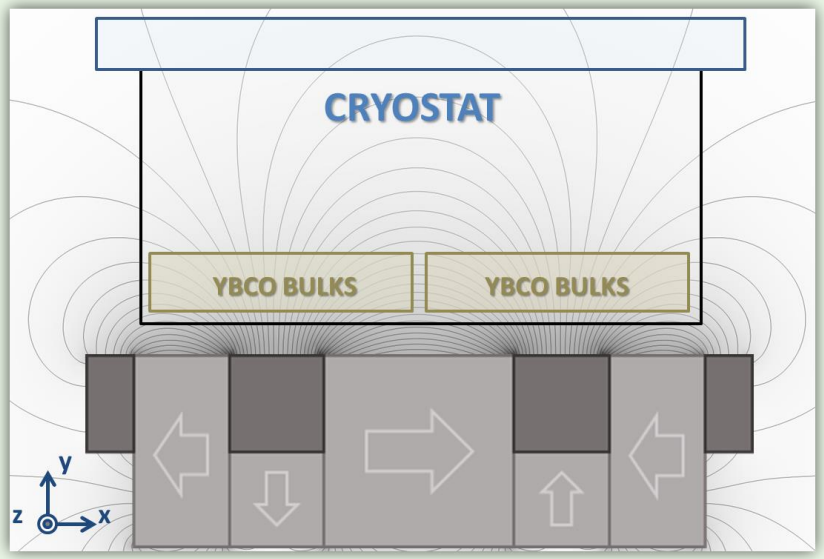
1.1. Background

Levitation is achieved by the interaction between **YBCO bulks** in cryostats and a **permanent magnet guideway** (PMG).

1.1. Background

The bottom of each cryostat contains two lines of **12 YBCO bulks** centered above the PMG **flux shapers.**





Cryostat manufacturer: **ATZ**

(Adelwitz Technologiezentrum GmbH)

1.2. Motivations

Maglev Cobra dependency to a single manufacturer motivates the search for **technological soveregnty** of its HTS levitation system!

Bulk YBCO technology **lacks** a quality-standard **large scale** production process.

2G Tapes on the other hand...

- Have various **large-scale manufacturers** worldwide
- Critical current densities have long **surpassed** bulks'

1.2. Motivations

We believe that the **future** of HTS application relies on 2G tapes.

Based on this, we propose a **novel** HTS magnetic bearing based on these **tapes** aiming to the replacement of the present bulks on the *Maglev Cobra*.

1.3. Objectives

In this work we are going to:

- Present the novel magnetic bearing topology;
- Design and manufacture small scale prototypes;
- Test the prototypes by levitation force measurements;
- Simulate via FEM and compare to measurements

2. The Double Crossed Loops Concept

Previous works

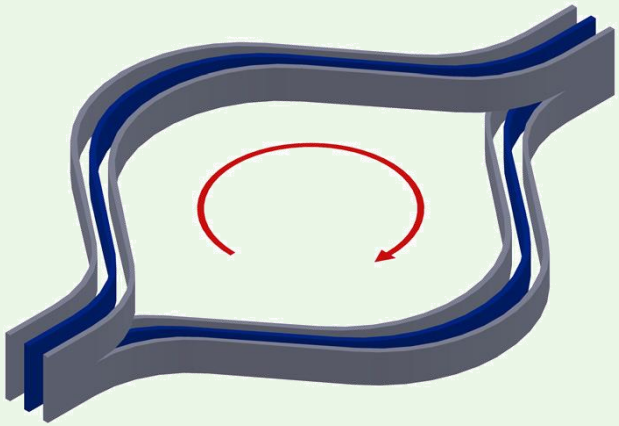
The DCL Coils

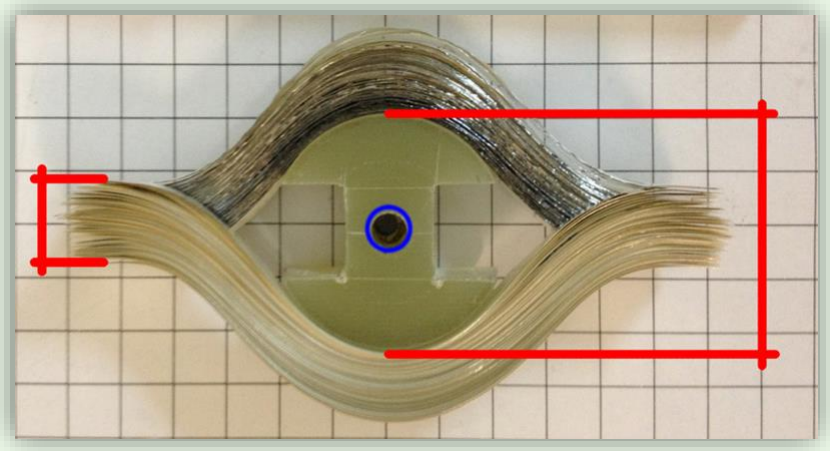
Prototype coils

2.1. Previous works

We introduced the *HTS Loops* (Single Loops) in 2015

Study on trapped magnetic field and levitation force



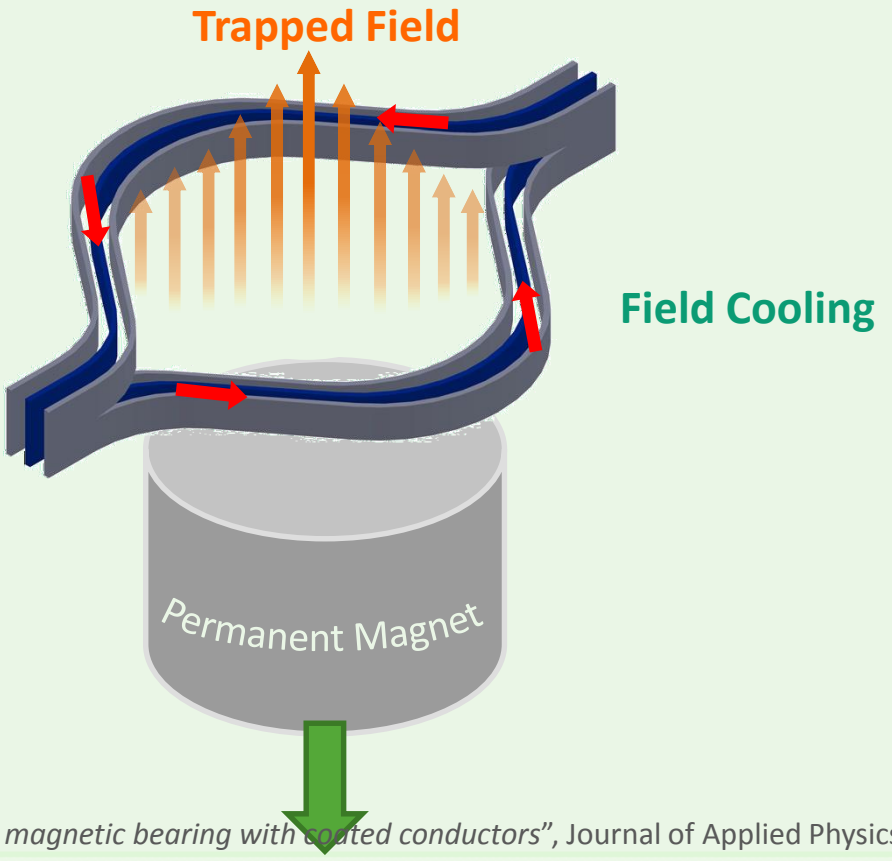


F. Sass, et al., "*Persistent currents in a magnetic bearing with coated conductors*", Journal of Applied Physics, v. 18, p. 203901, 2015.

2.1. Previous works

When field-cooled, a HTS loop will work as a jointless HTS coil.

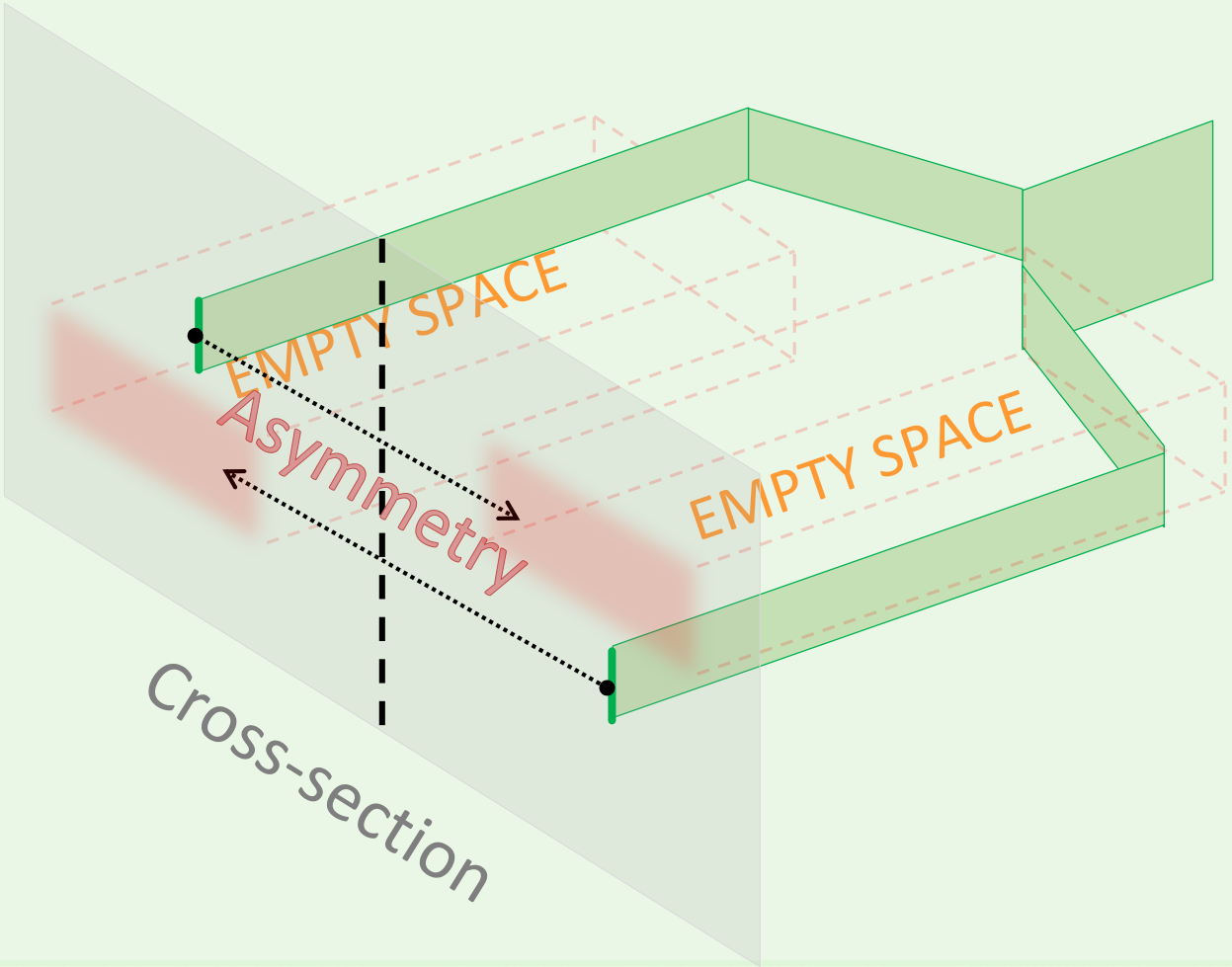
Persistent currents will oppose any magnetic field variation.



F. Sass, et al., "*Persistent currents in a magnetic bearing with coated conductors*", Journal of Applied Physics, v. 18, p. 203901, 2015.

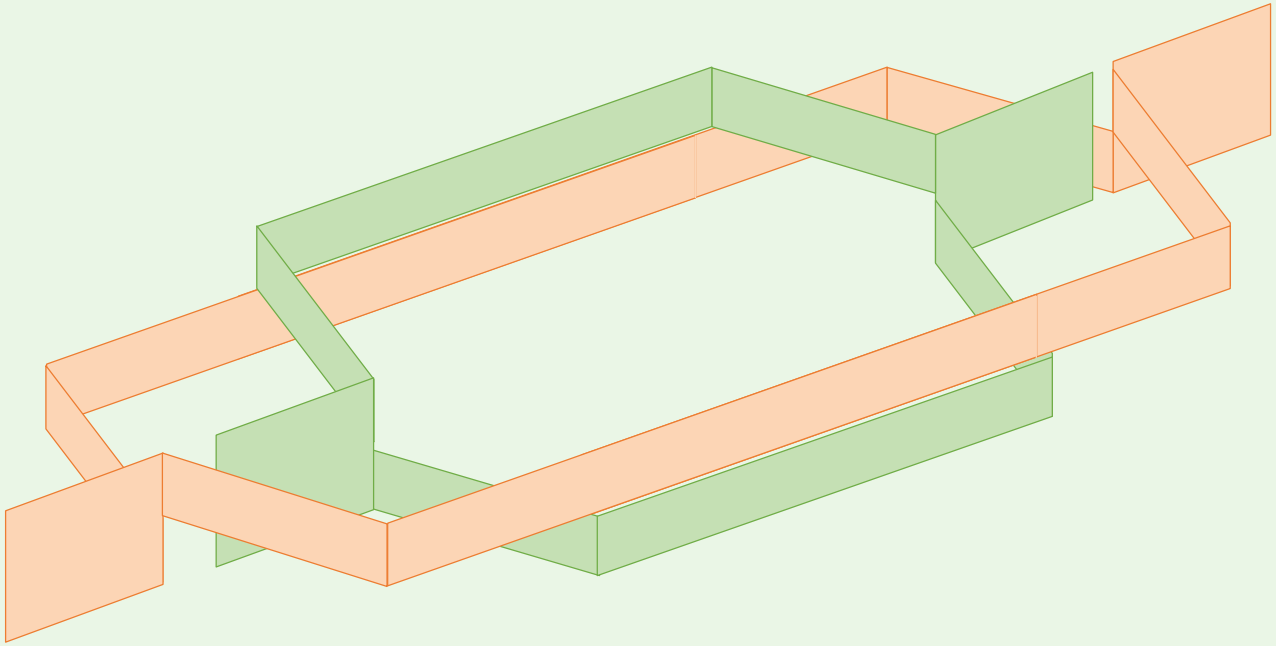
2.1. Previous works

Problem of volume **usage** and **assimetry:**



2.2. The DCL Coils

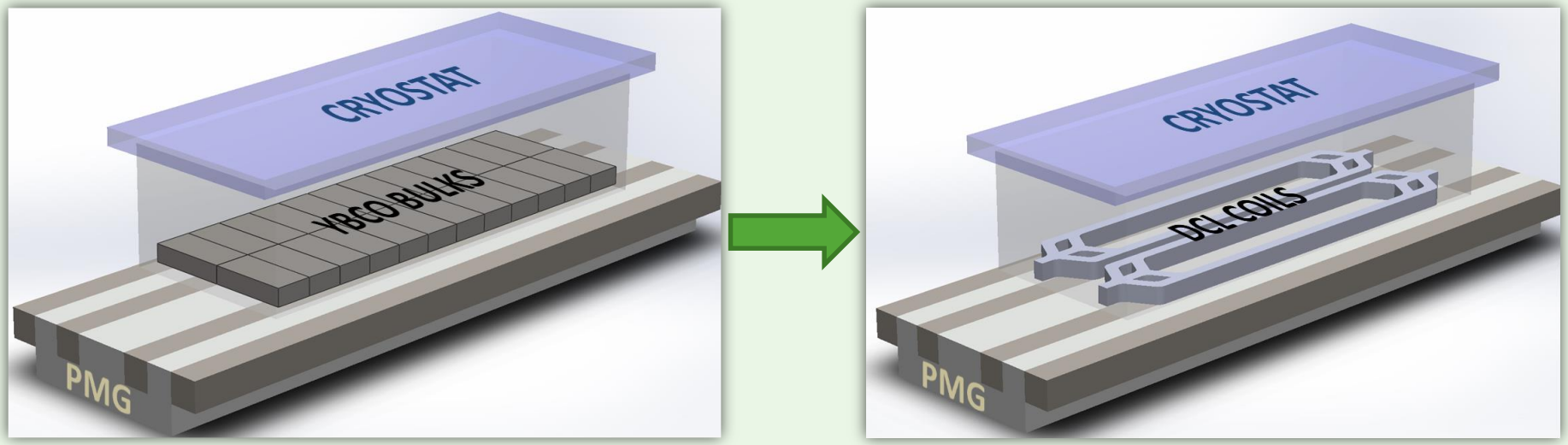
A simple, yet efficient solution: **The Double Crossed Loop** (DCL)



2.2. The DCL Coils

The idea is to replace the YBCO bulks by DCL coils in the

Maglev Cobra cryostats:



2.3. The Prototype Coils

Three **20 loop** coils were produced for this work:

one SL coil and two DCL coils

HTS 2G Tape: *SuperPower* SF12050 (2012)

Impregnation: Eutectic alloy (melting point < 100 °C)

2.3. The Prototype Coils

Three **20 loop** coils were produced for this work:

3. Results and Discussions

Experimental Rig Setup

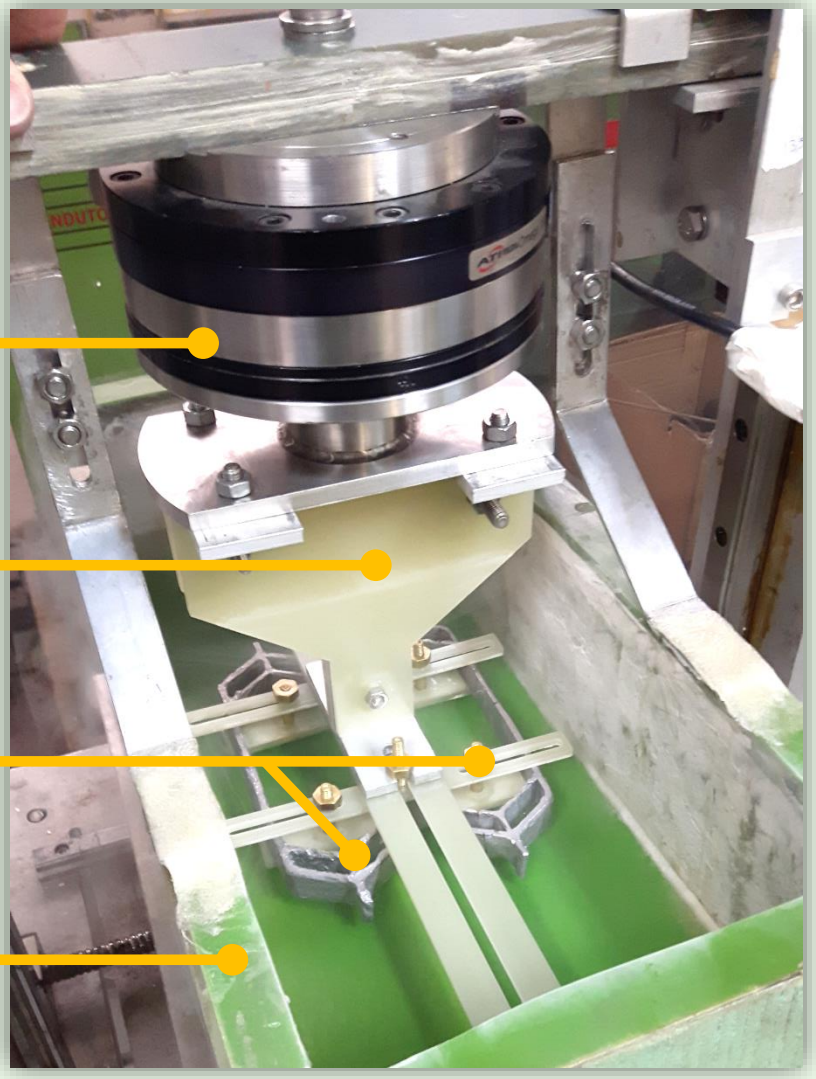
Coils ZFC Characterization

Prototype Bearing Tests

Simulations

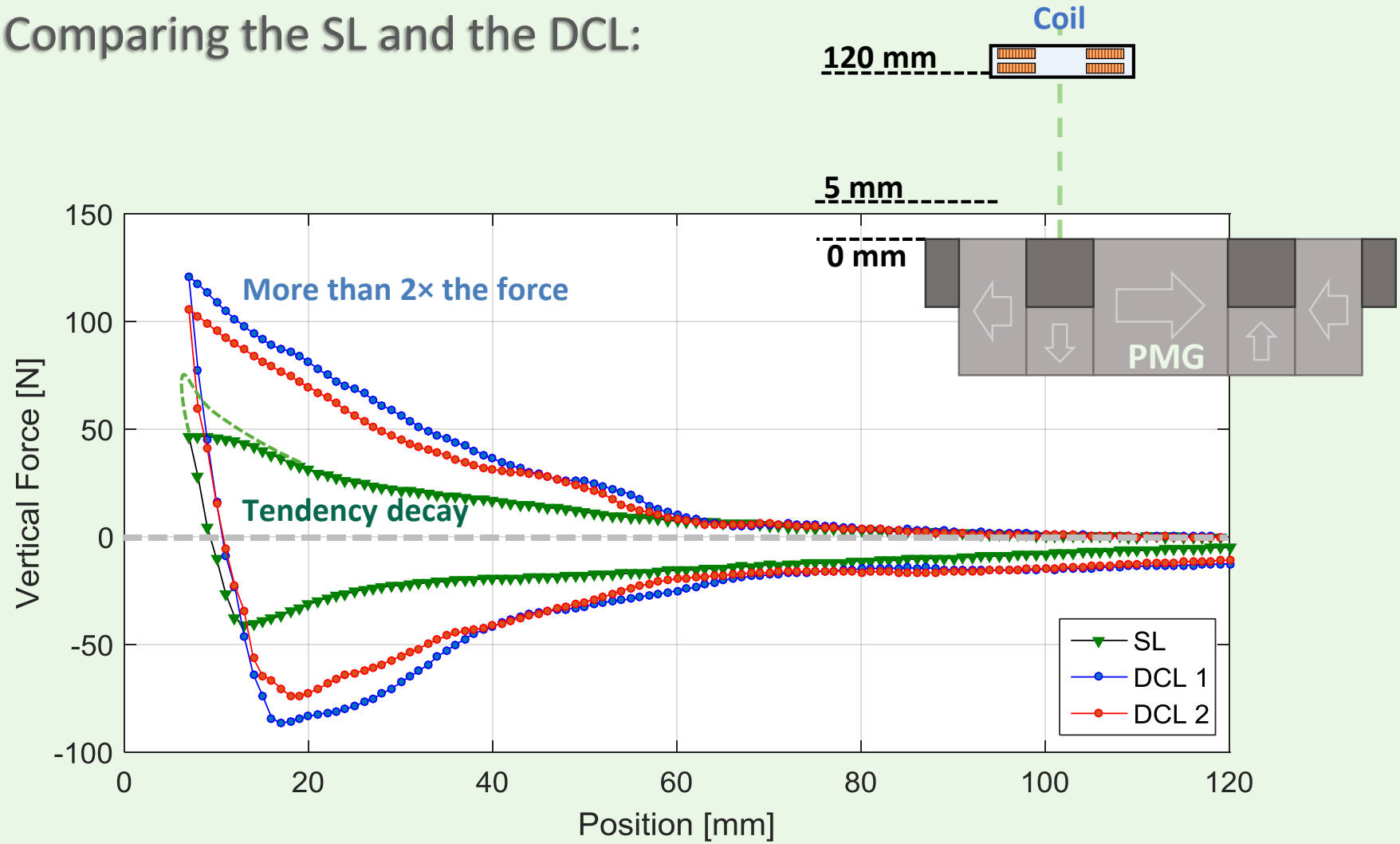
Comparisons

3.1. Experimental Rig Setup



3.2. Coils Characterization

Comparing the SL and the DCL:



3.3. Prototype Tests

EUCAS 2017

Testing different cooling points:

120 mm
85 mm
50 mm

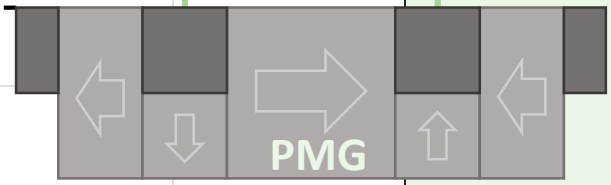
Maglev Cobra standard FC height

Maglev Cobra operational height

20 mm

0 mm

Prototype SML Bearing

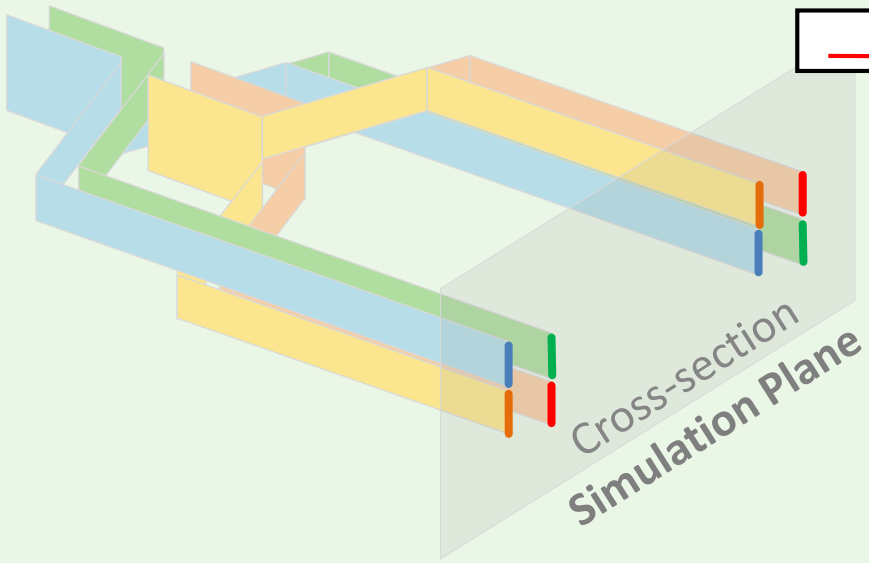


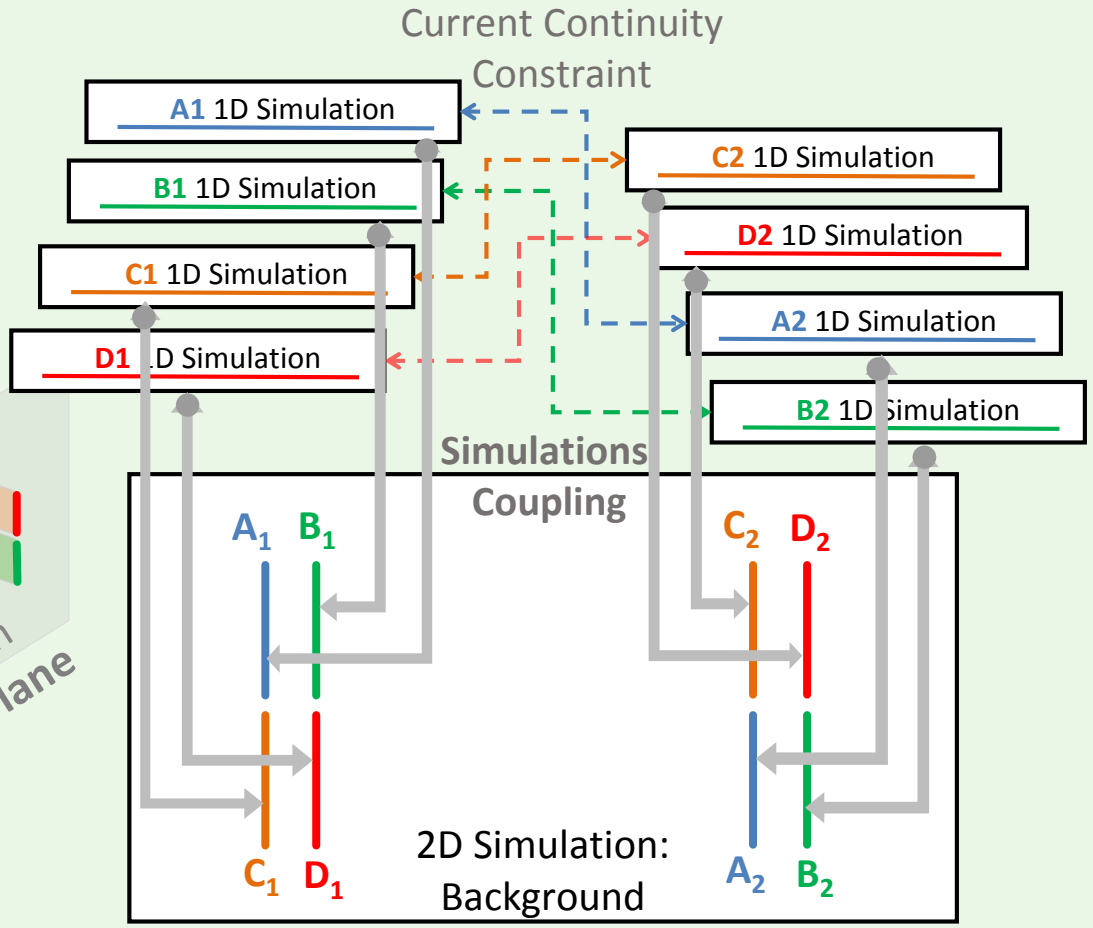
3.4. Simulations

Integral Equations (IE) solved by Finite Elements (FE) method

1D and 2D coupling:

Drawback:
neglects coil head effects

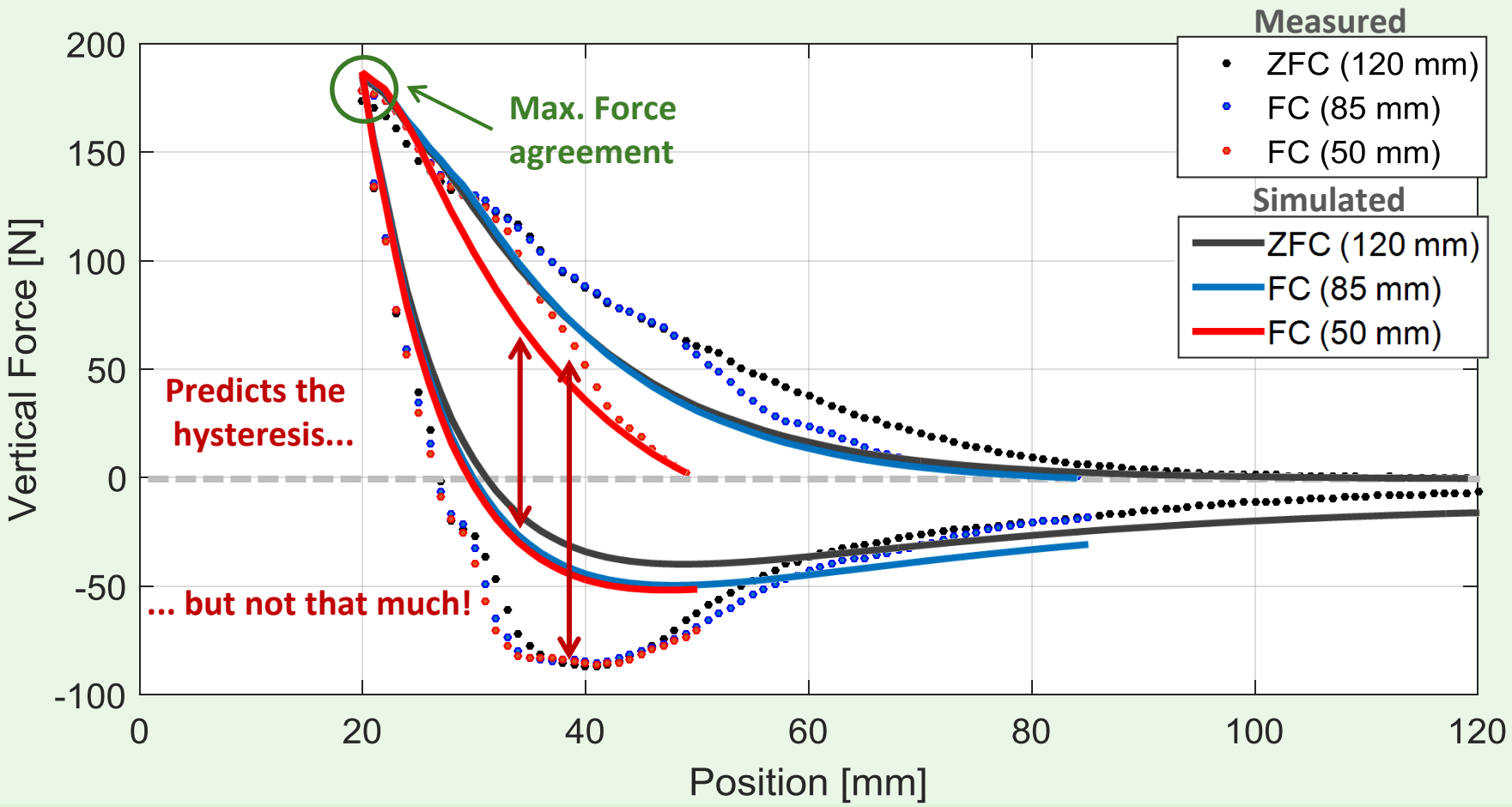




F. Grilli, et al., "*Current Density Distribution in Multiple YBCO Coated Conductors by Coupled Integral Equations*", IEEE Trans. App. Supercond., 2009

3.4. Simulations

Comparing measurements to simulations:



3.5. Comparisons

Levitation force / material consumption ratio:

- Previous works with stacked 2G tape segments: 1.71 N/m
- This work with DCLs: 10.70 N/m

Should be noted that the tape is an old version (2012) and the geometry is not optimized for this application.

There is plenty room for improvement!

4. Conclusions

4. Conclusions

A new SML bearing topology using 2G tapes was proposed.

Small scale prototypes were produced and sucessfully tested as a proof of concept.

Simulations were able to partially predict the bearing behavior but needs improvement. Deviations could be due to desconsidered coil heads border effects.

4. Conclusions

There are many possibilities yet to be studied in order to improve and optimize this new bearing proposal:

- Variations in geometry (stacking factor, flux linkage area, coil heads bending angle, etc...)
- Lateral force stability tests (indispensable for the bearing)
- Variations on the magnetic field topology
- Improve the simulation model

Thank you for your atention!

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