The Flex-Gen PRIN 2022 project

FLEX-GEN

Carlo Beatrice, Francesco Capuano, Clemente Capasso, Antonio Scarpa, Roberto Ianniello

Luigi Rubino

Raffaele Saviano

Giancarlo Dellora, Giuseppe Farina

Modeling

Integrated 1D-3D modeling of FPLG including control systems.

Experiments

Characterization of linear generators under FPLG operation.

Fuel

Efficiency maximization with low carbon energy carriers

FLEX-GEN aims to provide cutting-edge innovations in the FPLG technology, considered as mid- and long-term sustainable solution for power generations and power units for mobile applications

Main aim of **FLEX-GEN** is to develop new models, simulation tools and prototypes maximizing the sustainability of the FPLGs both for gen-set and mobility

The research flow has been divided into three main research areas as follows:

- Development of new mathematical models of all FPLG partes;
- Design, prototyping and testing of novel axial generators;
- Development of 1D and CFD multi-physic simulation tools to be used for pre-design and validation

Project Objectives

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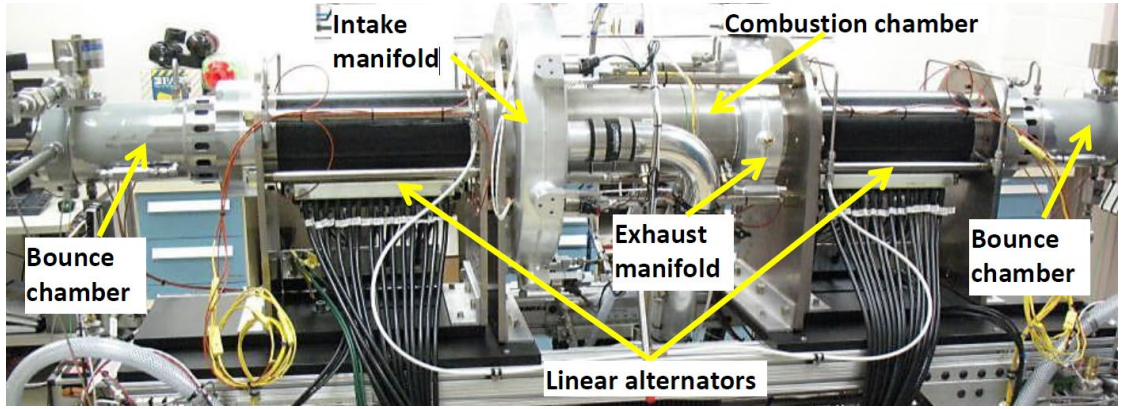
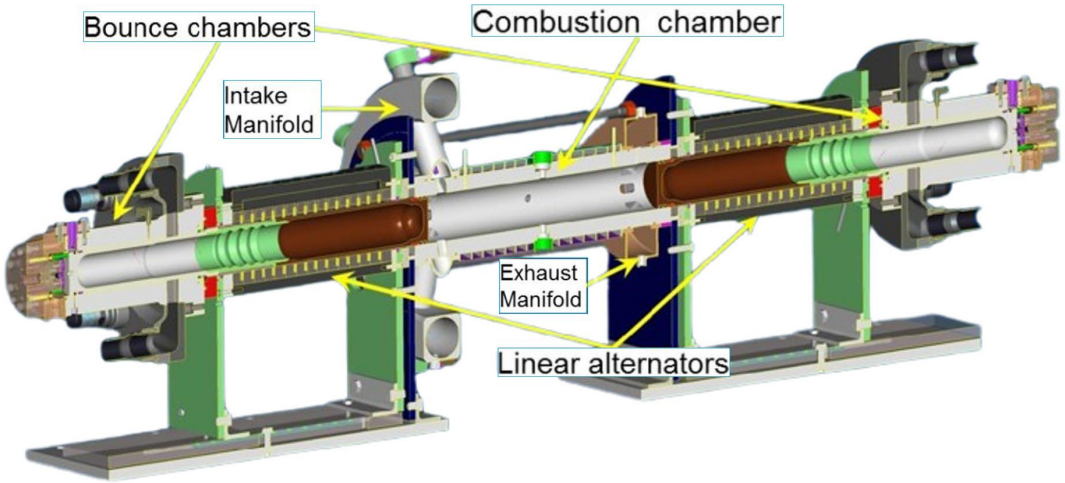
STEMS

Sandia National Laboratories





Mainspring

Easy, modular installation
High availability & low maintenance
Up to 25 MW per acre scalability

Each package contains two linear generator cores, operated in tandem.

Architectures & Power Unit sizing

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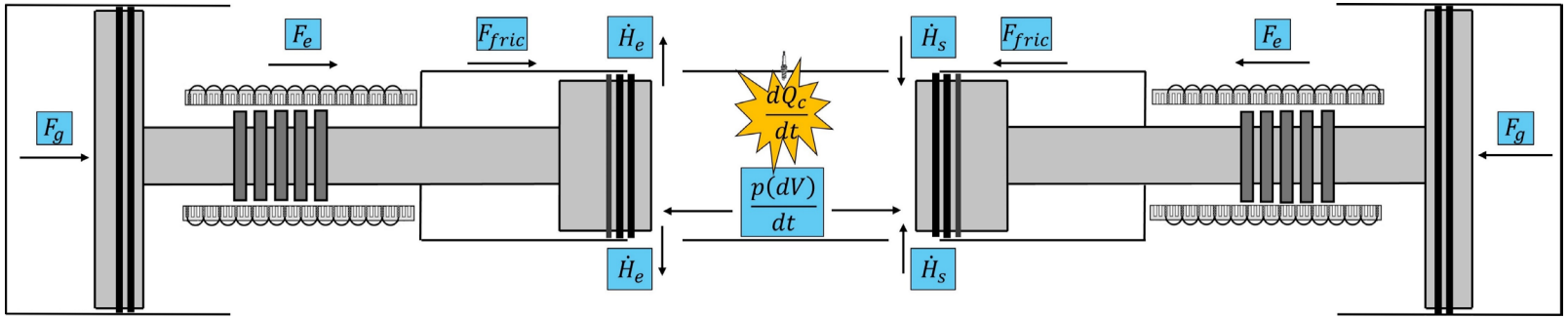
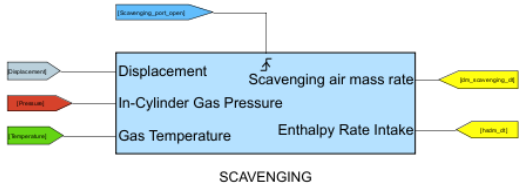
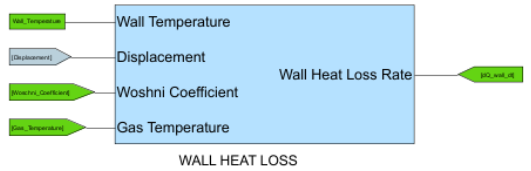
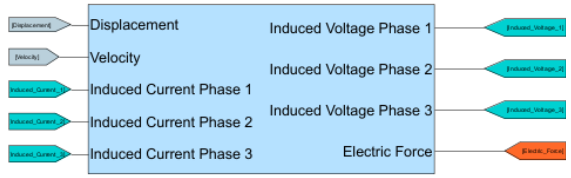
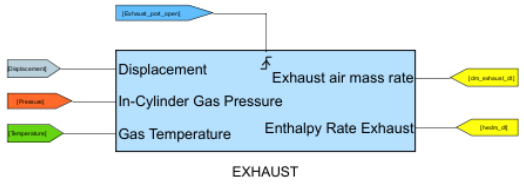


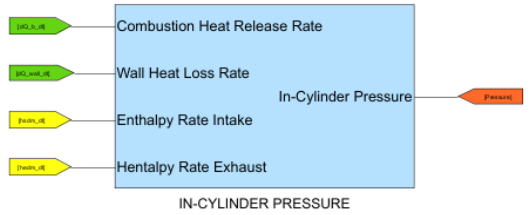
PARAMETRS	VALUE
Fuel	Gasoline
Bore	56.5 mm
Stroke	49.5 mm
Nominal CR	12.5
Air-Fuel ratio	14.57
Combustion Duration	3e-3 s
Combustion Efficiency	0.9

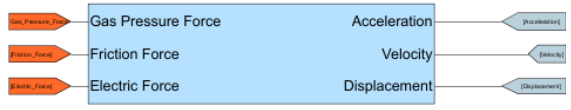


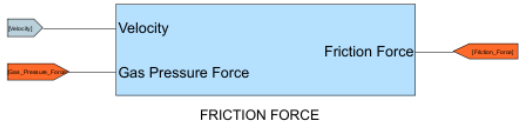


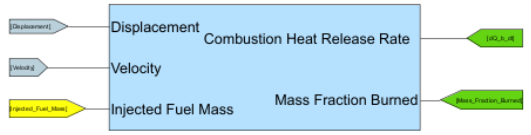


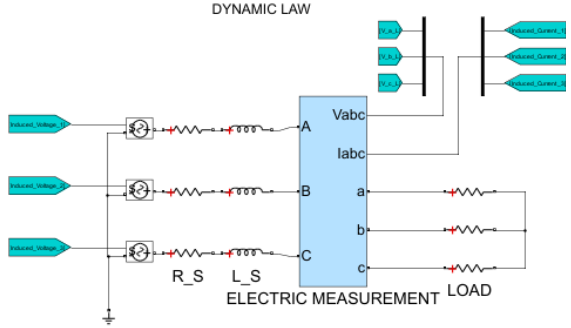












0D FPLG Matlab&Simulink Model And Main Parameters

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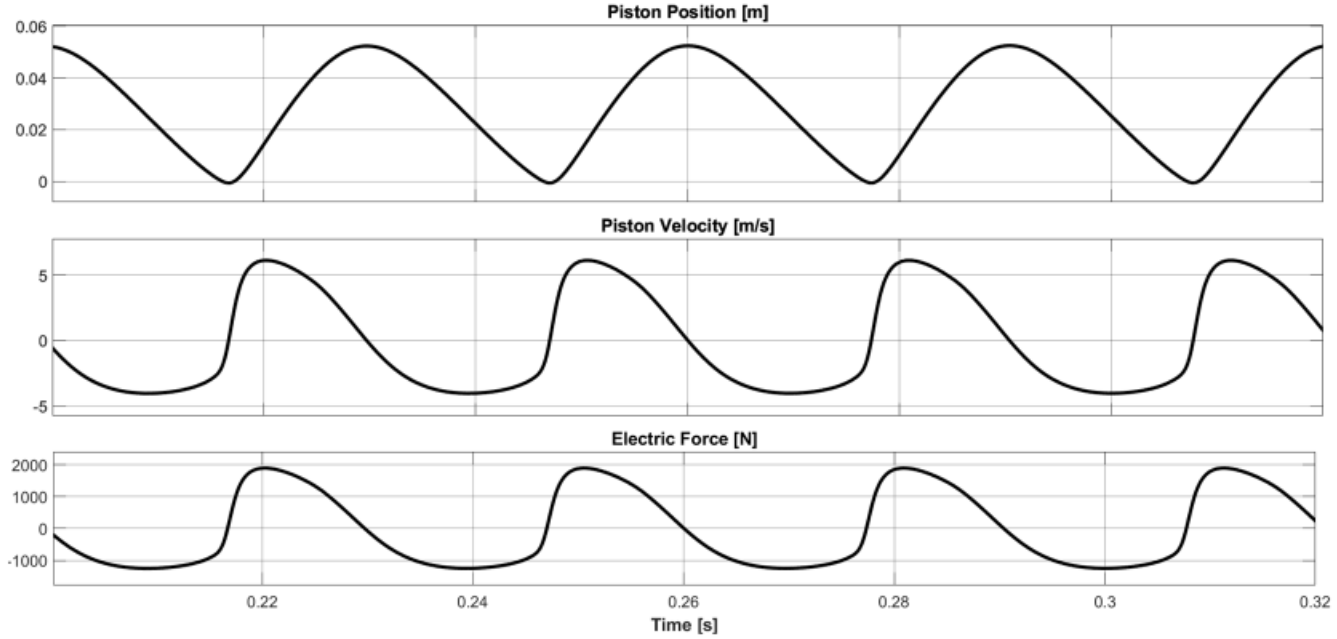
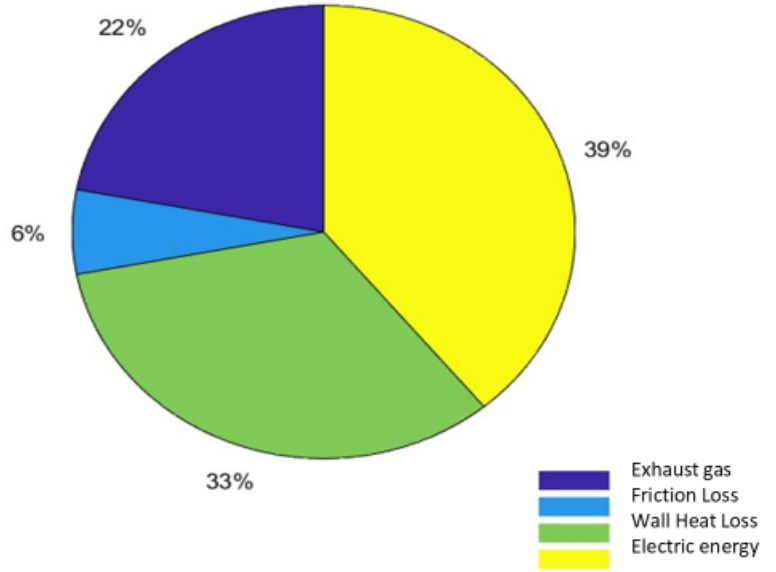
By developing a 0D model in a simulink environment, we tried to evaluate the overall efficiency of the technology for an 'Opposed Piston' application

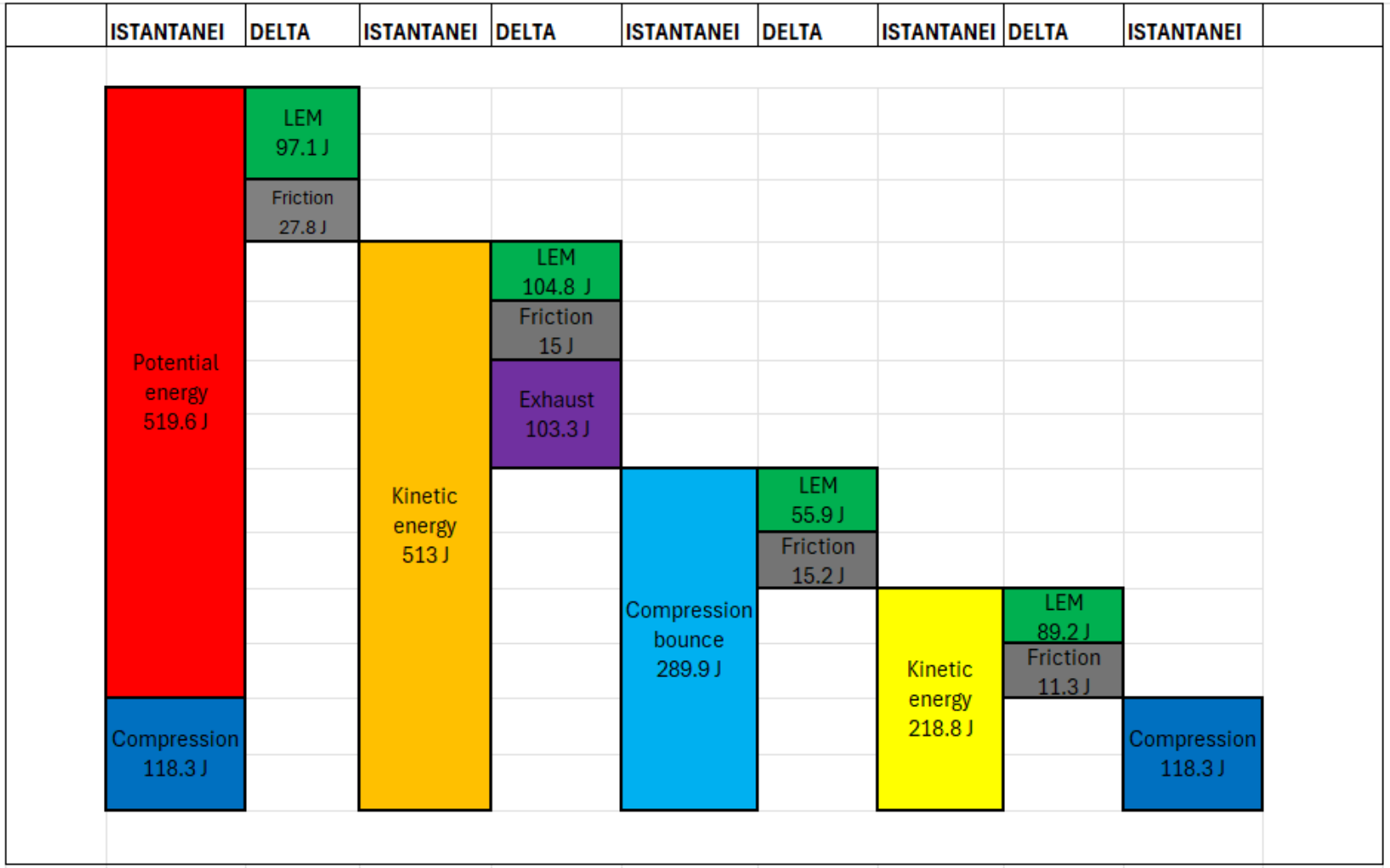
In order to simulate correct operating condition, the following sub-models have been modelled: combustion, scavenging process, friction loss, heat wall loss, linear electric machine

The net electric global efficiency reached is about 40 % and this value can be improved upon with the support of 1D 3D simulation tools, thanks to which the thermofluid-dynamic processes involved in the cycle will be refined





0D FPLG Matlab&Simulink Model Results



EXPANSION WORK

COMPRESSION CYL ENERGY

ENERGY FROM LEM

FRICTION LOSS

KINETIC ENERGY

KINETIC ENERGY

EXHAUST ENERGY

COMPRESSION RD ENERGY

0D FPLG Matlab&simulink Model Results

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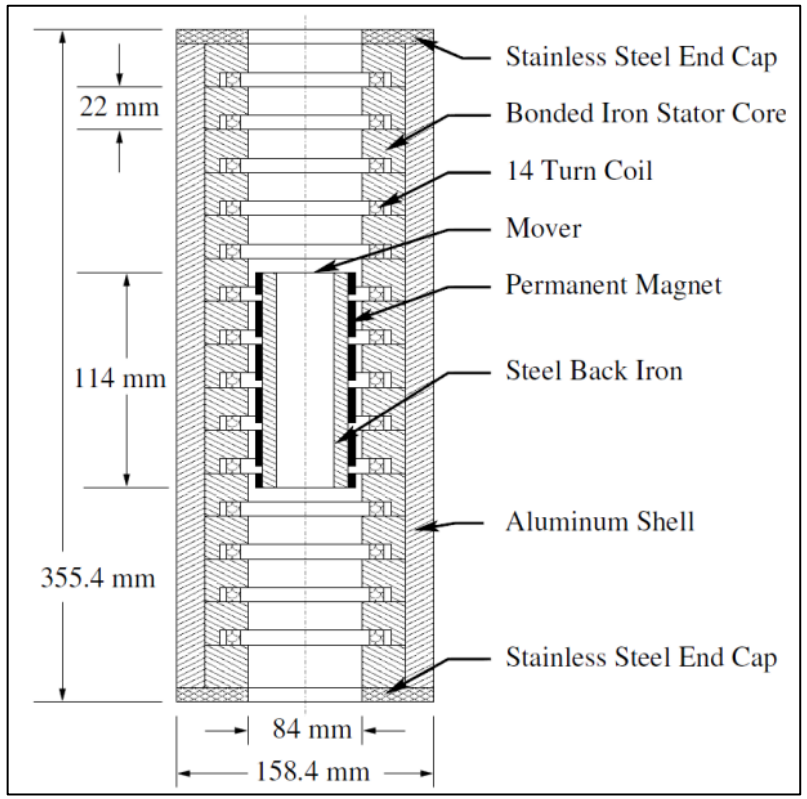

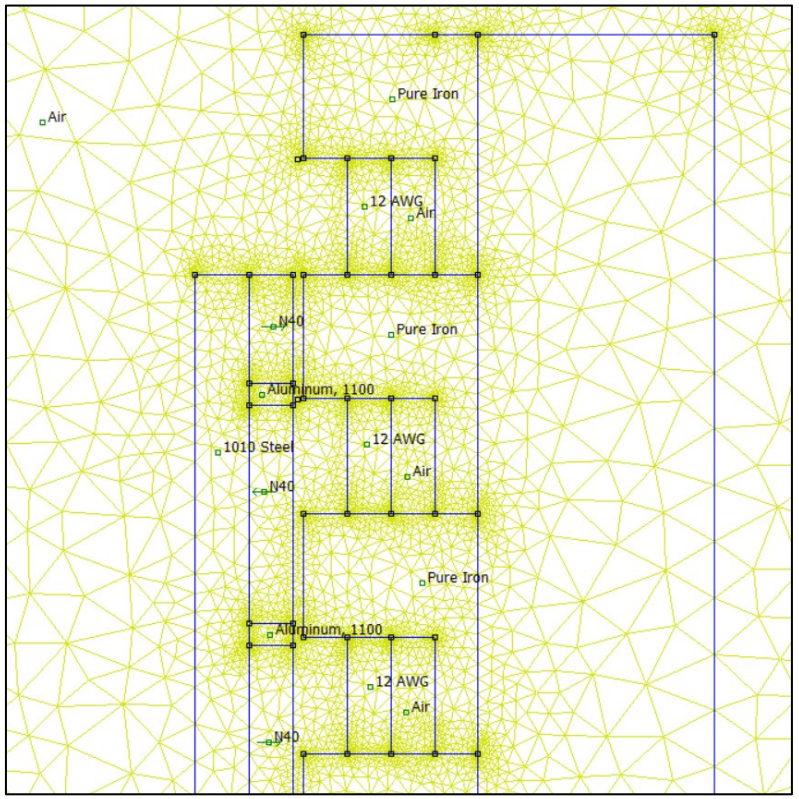

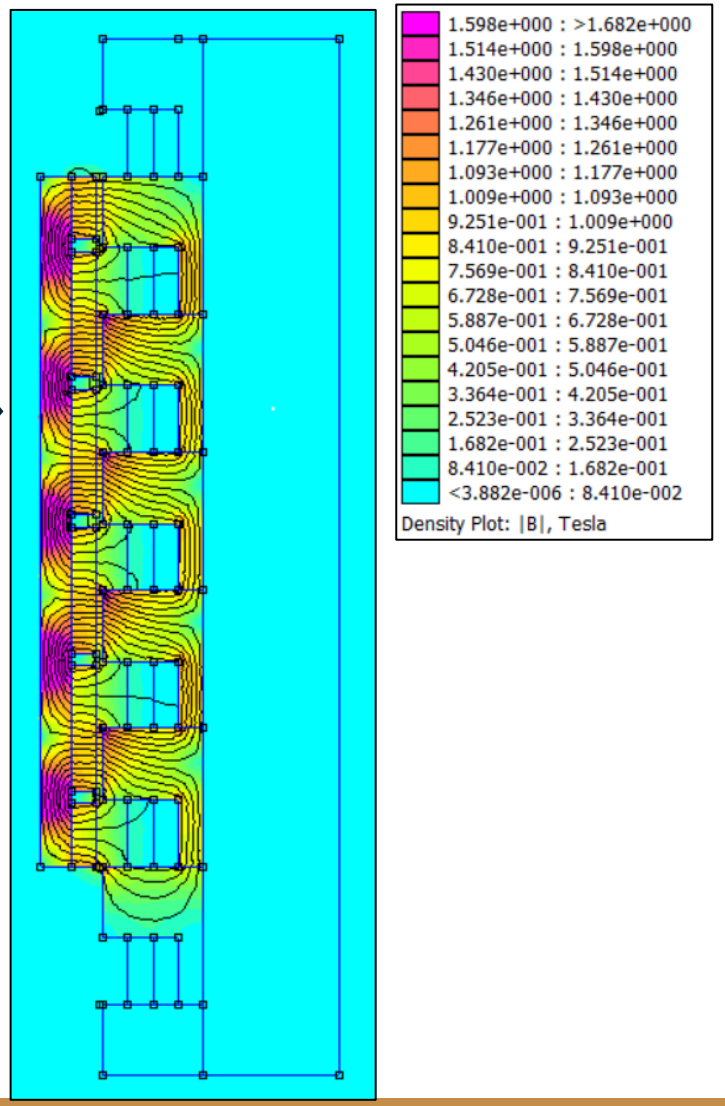

Università degli Studi della Campania *Luigi Vanvitelli*

UNIVERSITÀ DEGLI STUDI DEL SANNIO Benevento

[1] SAE Technical Paper 2016-01-0677, 2016.

SANDIA Permanent Magnet Linear Generator Prototype (PMLG)

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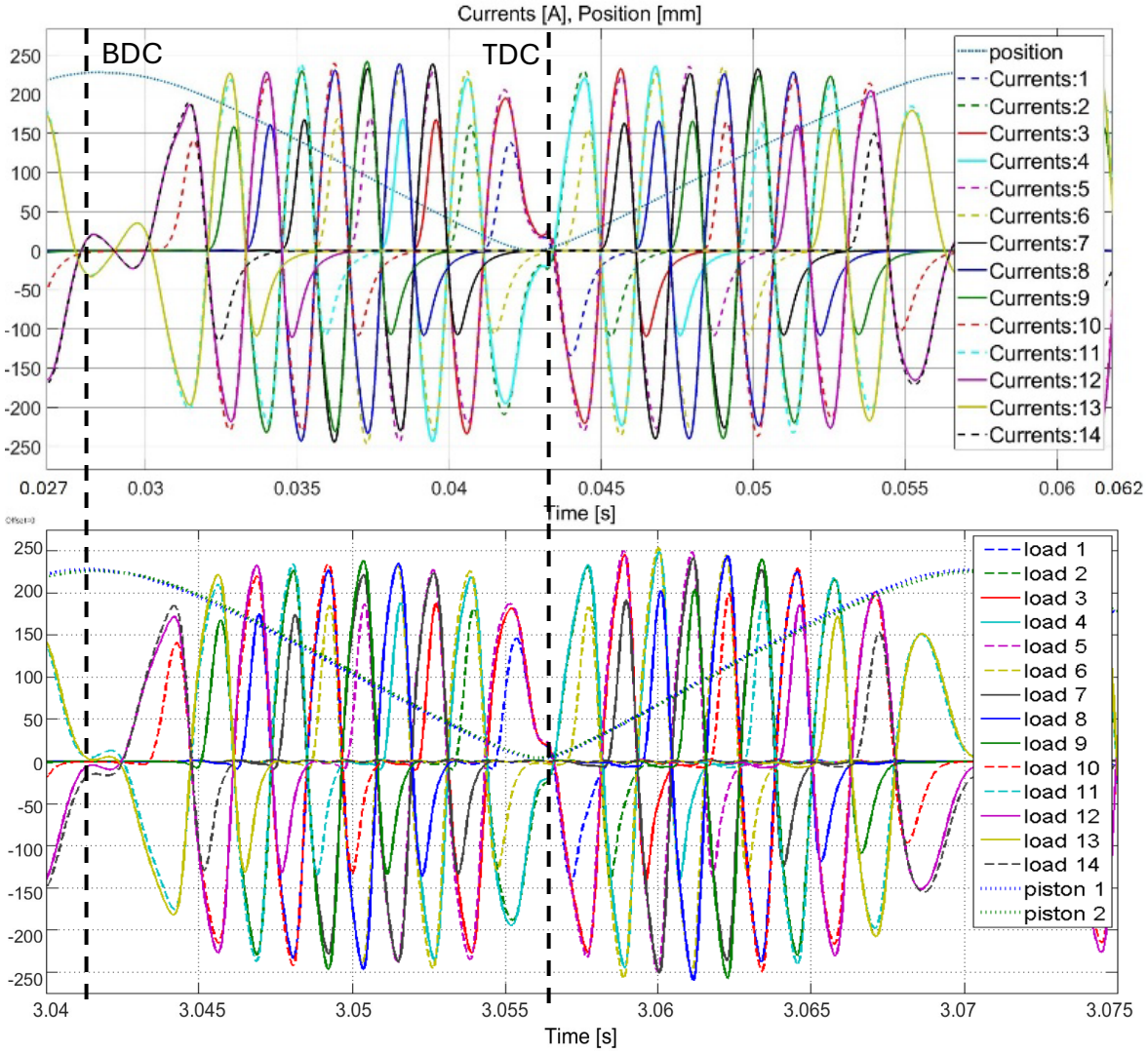
FEMM/Simulink simulation

Experimental SANDIA Results



Model/Experimantal Results Comparison

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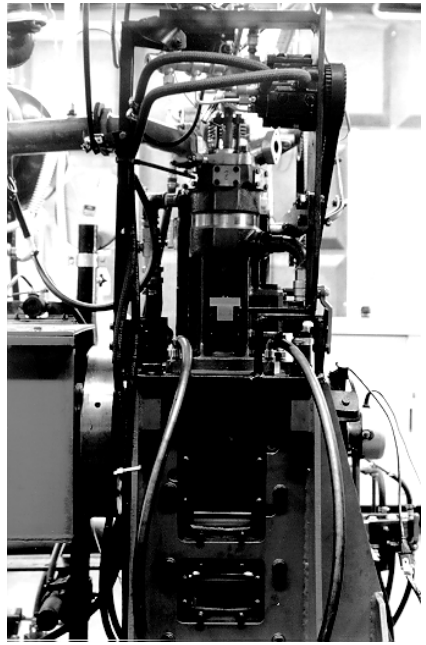
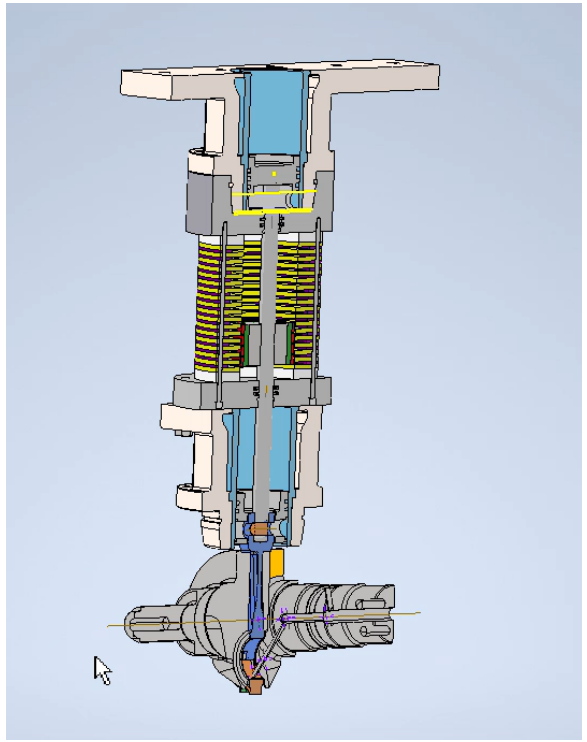
Current SCE



Updated SCE with axial generator



To design and validate the ax-GEN, a SCE will be exploited.

This process will be crucial for the characterization of the waveforms (induced voltages and currents) generated by the ax-GEN and its validation.

BEING AHEAD STC

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This study has been partially carried out within the **MOST – Sustainable Mobility Center** and received funding from the **European Union Next-GenerationEU (PIANO NAZIONALE DI RIPRESA E RESILIENZA (PNRR)** – MISSIONE 4 COMPONENTE 2, INVESTIMENTO 1.4 – D.D. 1033 17/06/2022, CN00000023).

This study has been also partially carried out within the project "**FLEXi-fuel high-efficiency linear piston engine for future power GENerators (FLEX-GEN)**" funded by **MUR** within the "Fondo per il Programma Nazionale di Ricerca e Progetti di Rilevante Interesse Nazionale (PRIN)"**PRIN 2022", project number PRIN 2022 2022988F33_PE8**.

This study has been also partially carried out within the project "**HEFFYMAXGEN - High EFficiency** hYdrogen Motor Axial GENerator

Finally, this study has been also partially carried out within the PhD research program of **Raffaele Saviano** carrying out within the **Industrial PhD program of University of Naples "Parthenope"** funded by the **MUR** and **STC Srl** through the Ministerial decree DM 117/2023. The PhD program received funding by **PNRR, Missione 4, Componente 2, Investimento 3.3**.

Aknowledgements