

SINCE 1970



Icpe # SPACE PROGRAM

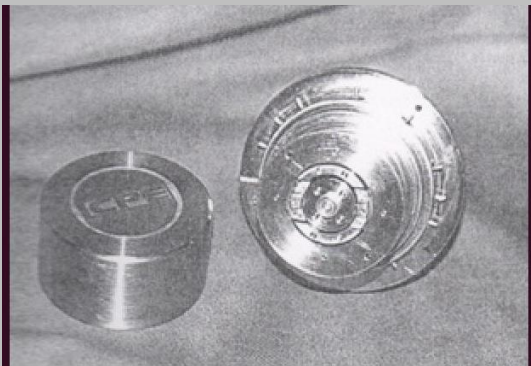
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Icpe SPACE PROGRAM

Airspace and even outer space technologies have been integrated in Icpe deep concerns since the 70s. Icpe has gained extensive experience in research, developing, producing and qualifying gyros and reaction control systems, based on a large expertise and super qualified teams, trained in harsh times and restrictive conditions.

Extraordinary complex electro-mechanical structures like three axes gyros, electronically assisted rate gyrosensors, Hook elastically supported dynamically tuned gyroscopes, reaction wheels and other inertial navigation systems had been developed and fabricated based on a large spectrum of small size electric machines: gyromotors, resolvers, thermal compensated selsyns/synchro devices, microsins, a.c. and d.c. torque motors, miniature step by step motors, micromotors.



DESIGN & MANUFACTURING



Today, Icpe offers a large spectrum of small size special electric machines like:

- servomotors
- resolvers
- microsyns, rvdts
- tachogenerators
- dc limited angle brushless torque motors
- dc brushed torque motors
- special dc brushed motors
- special dc brushless motors

DESIGN & MANUFACTURING



Since 1950 our company is well known for design capabilities of new products, customized production and unsurpassed quality. In order to keep our high production standards we developed a dedicated range of test stands.

Icpe also has special manufacturing capabilities (winding, mechanical processing, electroerosion etc.) that allows to respond fast to customers needs - even for small series - and constantly update the product range with the latest developments and market requirements (<http://www.icpe.ro/en/d/4/p/about>)

DESIGN INSTRUMENT SOFTWARE

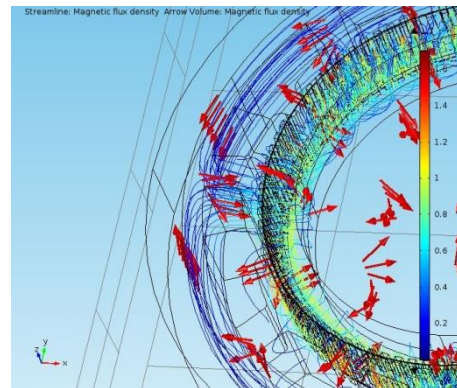
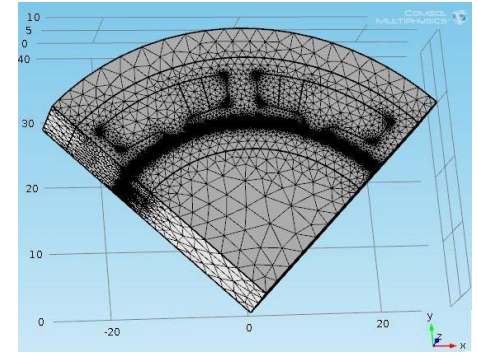
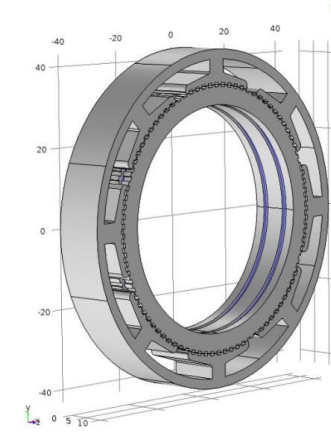
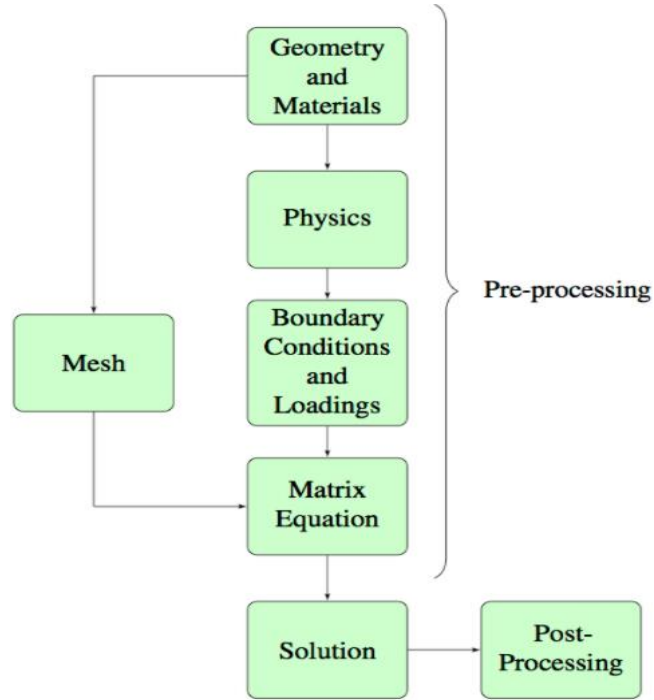


Autodesk® Inventor® 2018
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JMAG Designer 2D/3D magnetostatic
JMAG Express
Motor-Cad
LabVIEW Real-Time Module 2018
LabVIEW FPGA Module 2018
LabVIEW 2016 Prof. Development System
Comsol Multiphysics
Solid Works CAD 2018
Mathlab Multiphysics

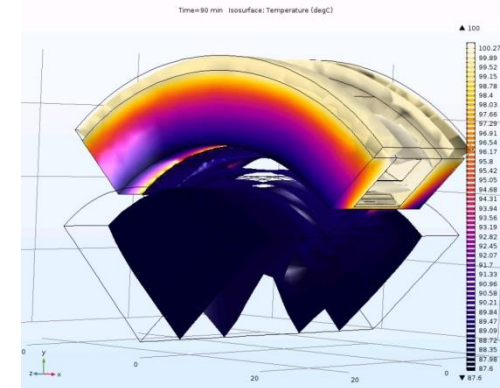
COMSOL Multiphysics

3D electromagnetic analysis

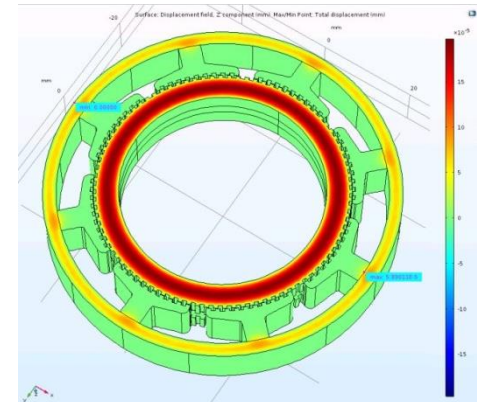
This soft minimizes the needs for physical prototypes, shorten product development times and achieve substantial savings in the development process.



Electromagnetic



Thermal

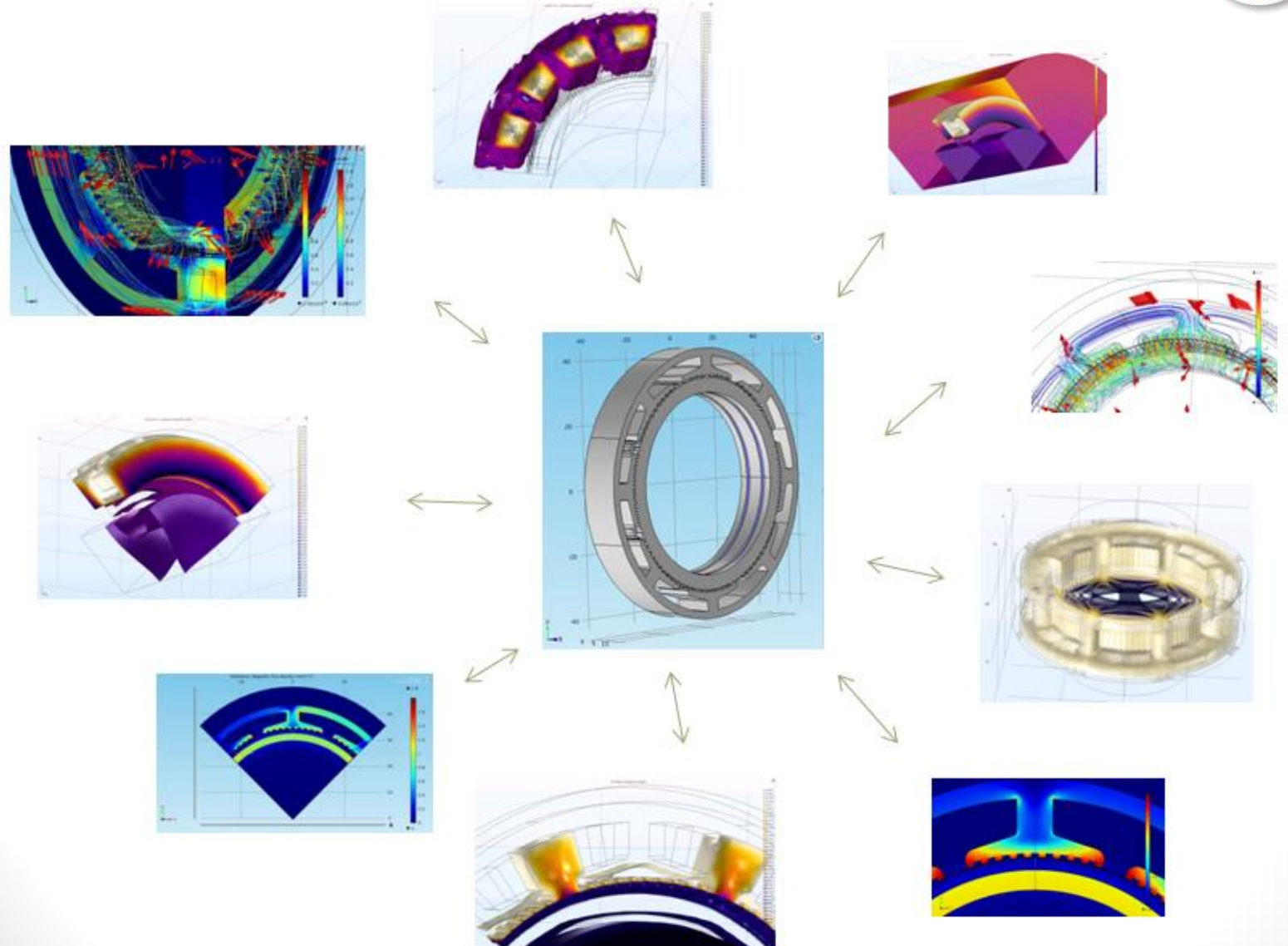


Mechanical

COMSOL

Multiphysics 3D

Thermal analysis

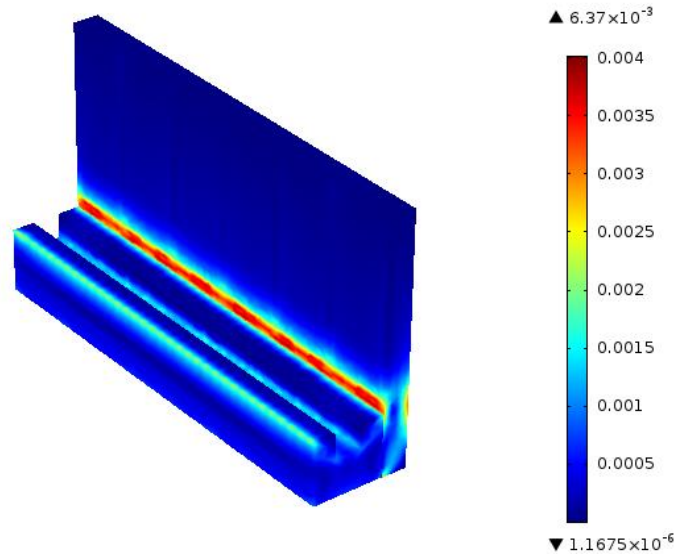


COMSOL

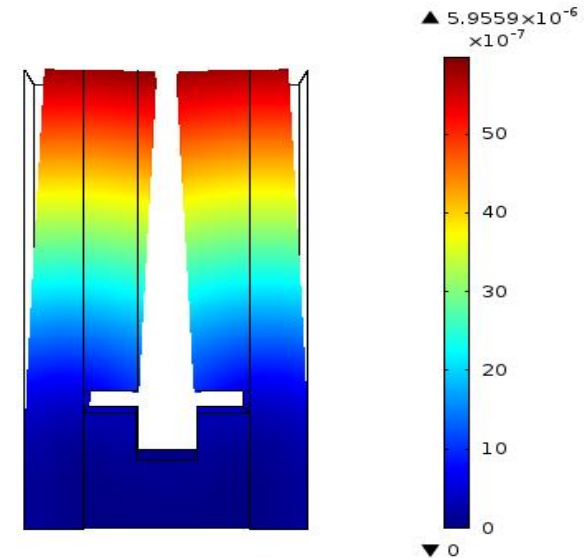
Multiphysics 3D

Mechanical analysis

Von Mises Stress distribution



Total displacement



MANUFACTURING CAPABILITIES

Mechanical facilities



An electro-erosion
machine type
AgieCharmilles
CUT 200 Sp



Machining Center
type DMG MORI
CLX 450



CNC 4 axes
milling machine
Mynx Daewoo Dosan



MANUFACTURING CAPABILITIES

Windings Capabilities



Windings Machines



Windings manufacturing area



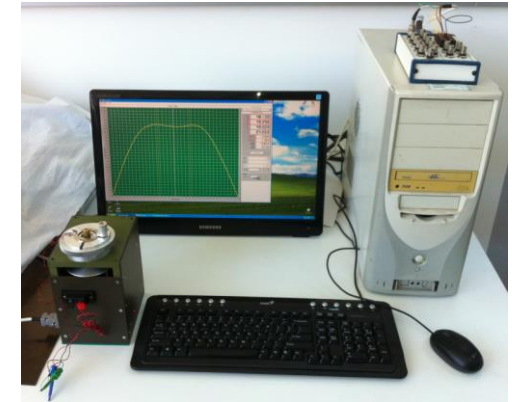
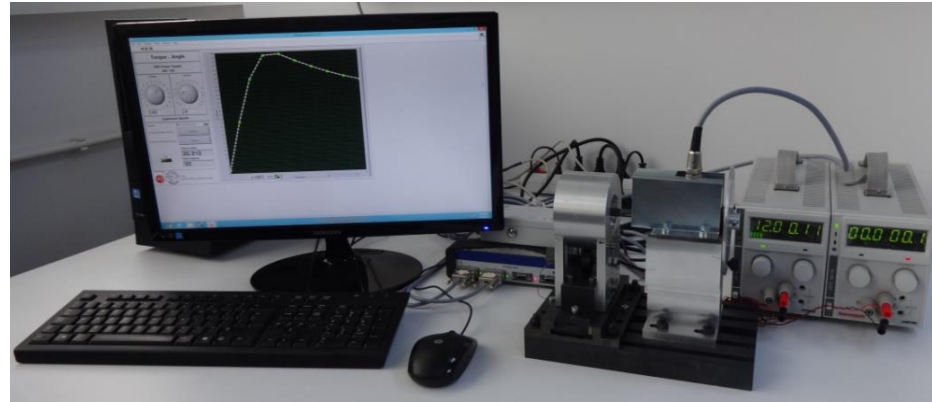
Windings for special electric machines



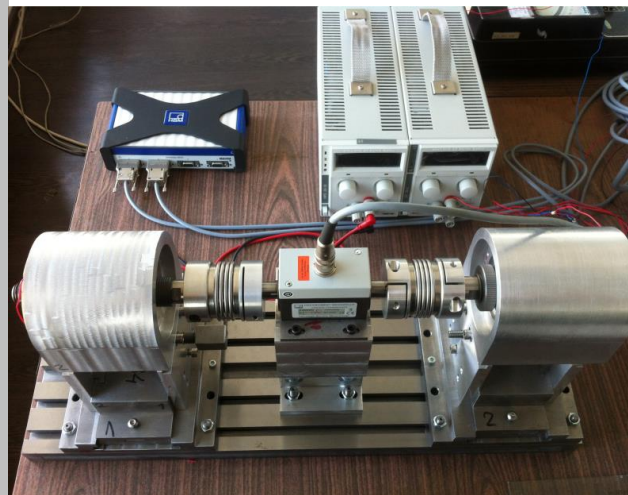
MANUFACTURING CAPABILITIES

Testing Facilities

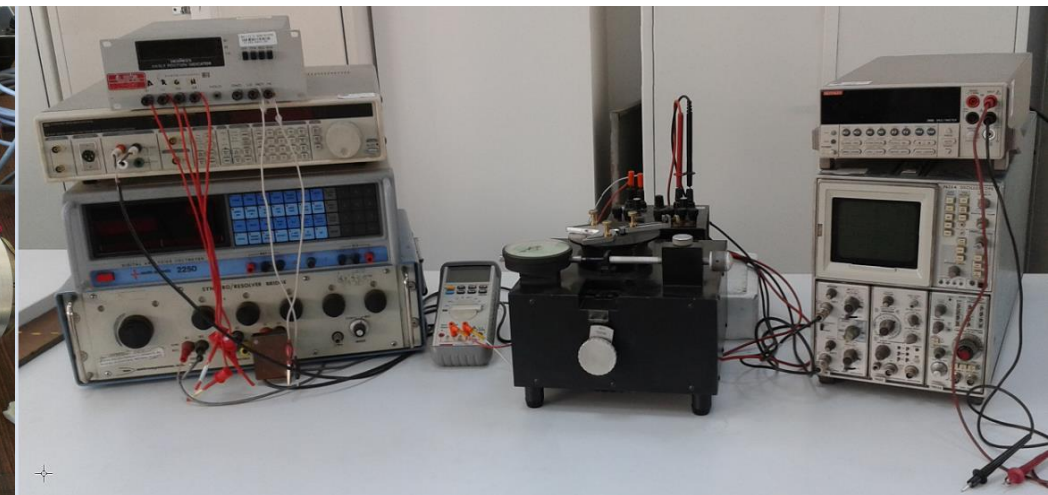
Test benches for limited angle torque motors



Test bench for
DC torque motors



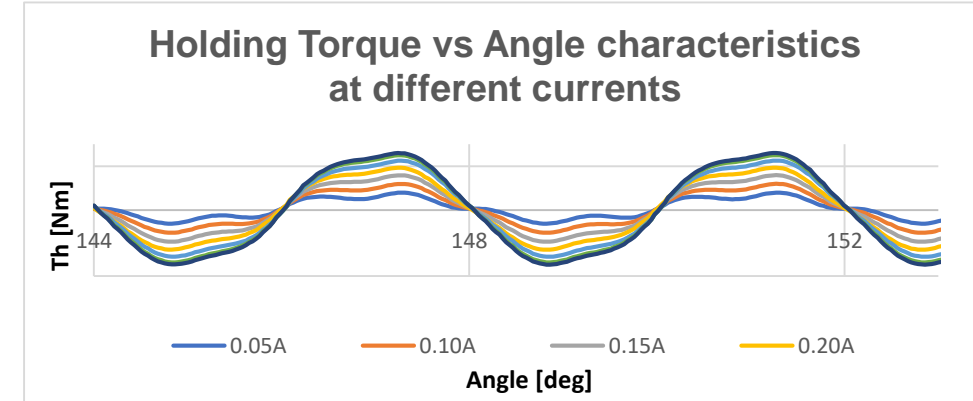
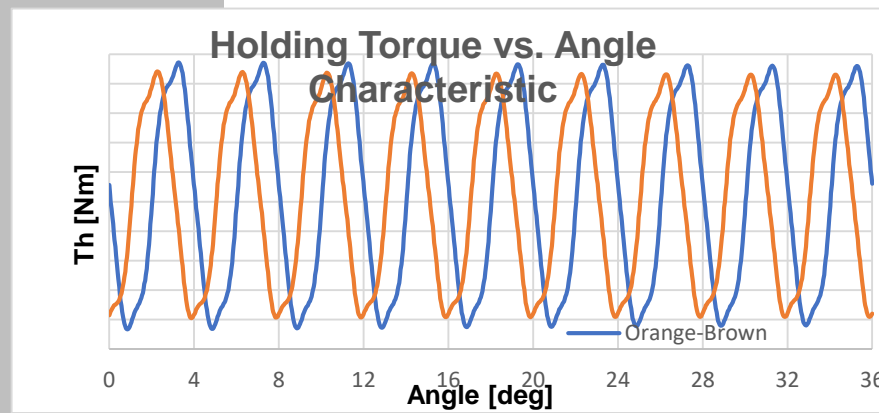
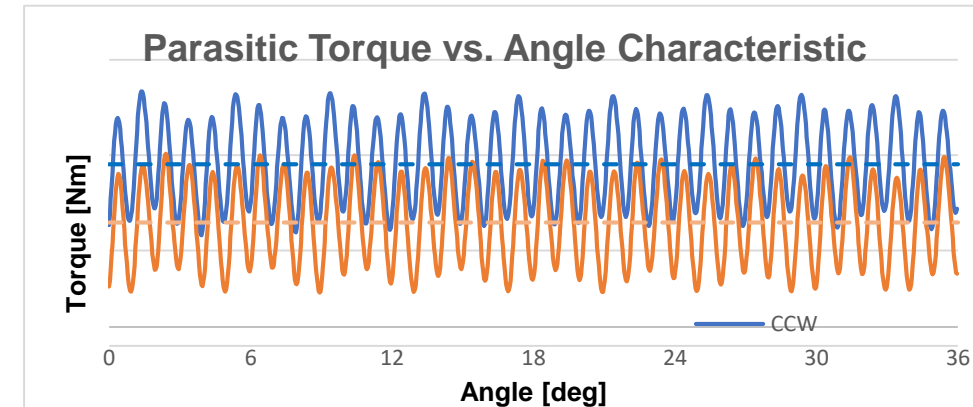
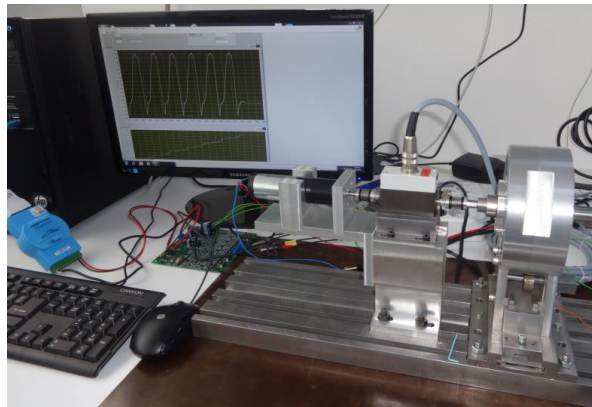
Test bench for resolvers



MANUFACTURING CAPABILITIES

Testing Facilities

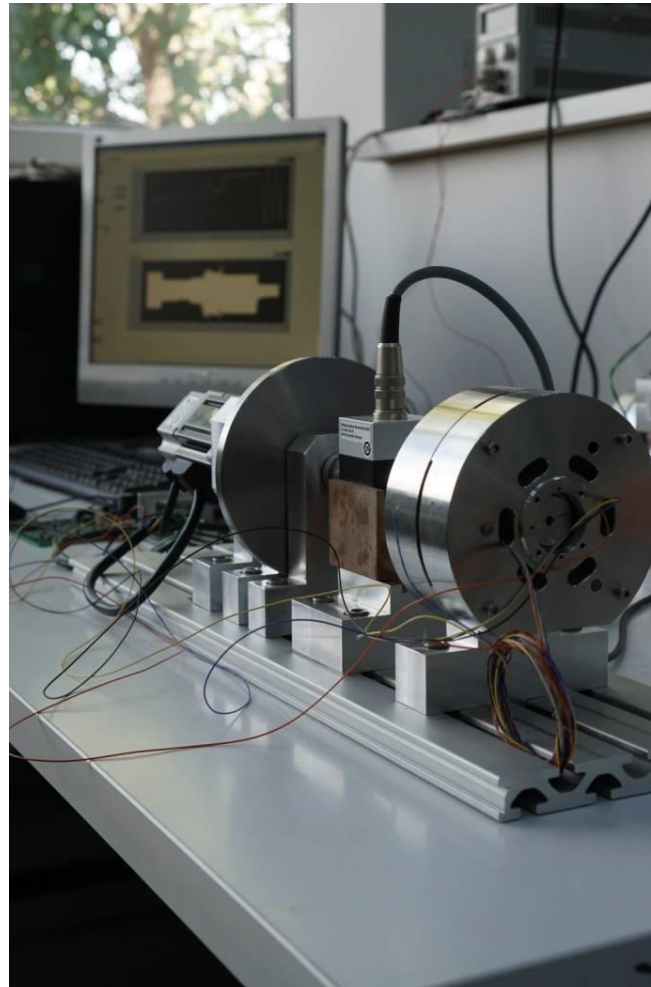
Steppers test bench for parasitic and holding torque measurements



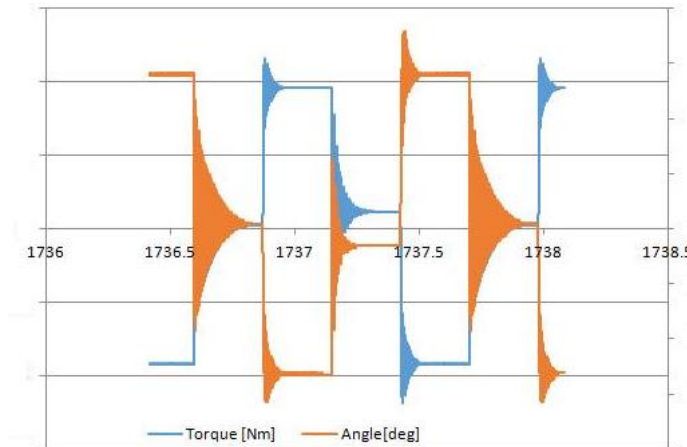
MANUFACTURING CAPABILITIES

Testing Facilities

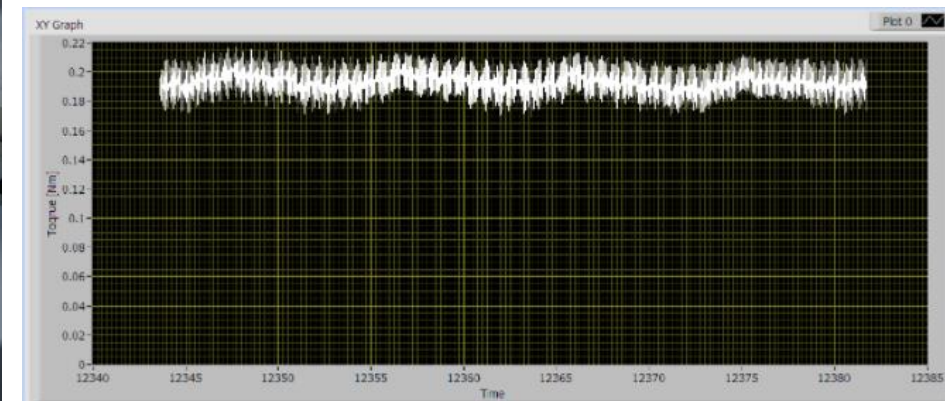
Steppers test bench for on-load torque measurements



Blocked output torque



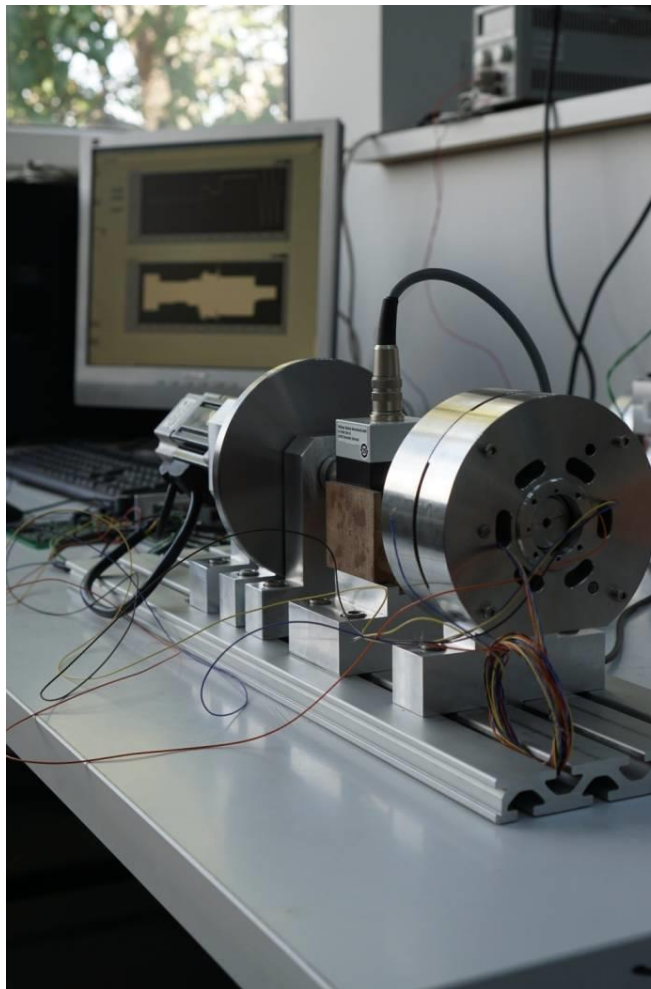
On-load torque



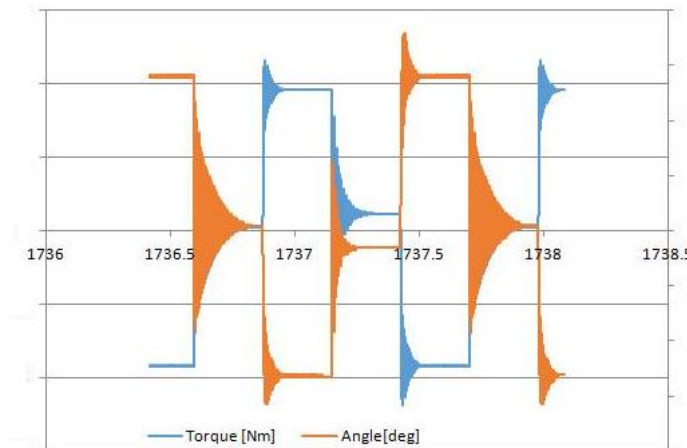
MANUFACTURING CAPABILITIES

Testing Facilities

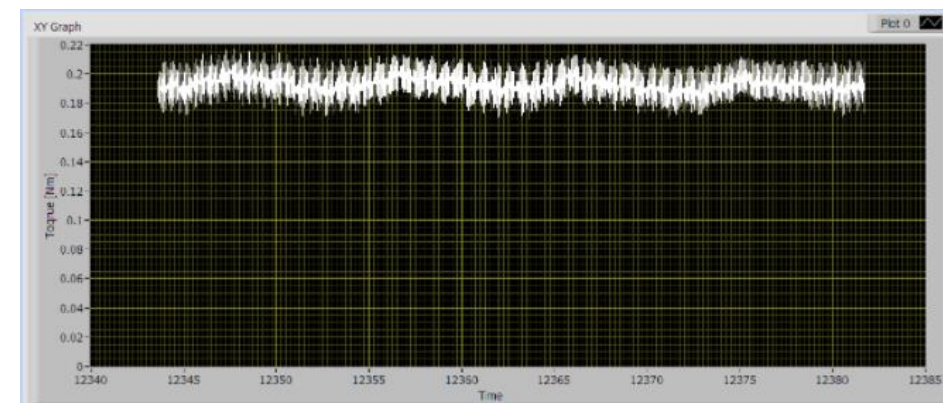
Steppers test bench for on-load torque measurements



Blocked output torque



On-load torque



RESEARCH & DEVELOPMENT

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SERVO CONTROL

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ELECTRIC VEHICLES AND
E-MOBILITY

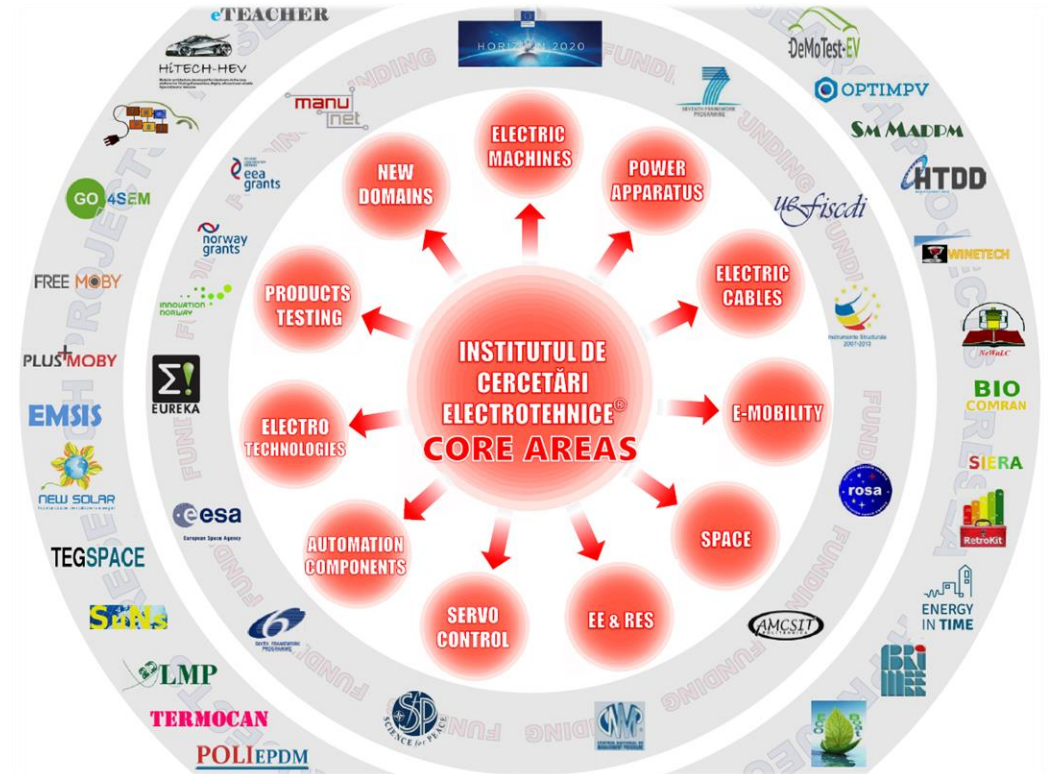
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RENEWABLE ENERGY SOURCES

AUTOMATION COMPONENTS

ELECTRO TECHNOLOGIES

PRODUCTS TESTING

NEW EMERGENT DOMAINS



BEING AN ACTIVE PRESENCE IN THE SCIENTIFIC COMMUNITY EVER SINCE ITS FOUNDATION IN 1950 **INSTITUTUL DE CERCETĂRI ELECTROTEHNICE REMUS RĂDULEȚ®** CONTINUOUSLY PURSUED THE DEVELOPMENT OF NEW RESEARCH PATHS.

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INTERACT

End-users Tools to Empower and rise
Awareness of Behavioural Change ...



ETEACHER

End-users Tools to Empower and rise
Awareness of Behavioural Change ...



RWSAC

Reaction wheel for spacecraft attitude
control



STRAUSS

Advanced solar thermal propulsion system
for increasing satellite operational life



TERMOCAN

Thermal sensing bra used for breast
cancer detection and locating



SM MADPM

Stepper Motor for Multimedia Antenna
deployment - ESA Programme ...



SMC4SERVO

Brushless servo-motors series utilizing soft
magnetic composite materials ...



OPTIMPV

Complex Informatic Solution for
Optimizing the Operational Procedures ...



ISMACH

High performance polymeric insulation for



DEVELOPMENT OF A NEW REACTIO...

A new reaction wheel using up-to-date



BRIMEE

Cost-effective and sustainable Bio-



EMSI

Electric motor spin into space - ESA



EUREKA
Doing business
through technology



RESEARCH & DEVELOPMENT FOR SPACE

THE FIRST STEP. STAR PROGRAM

**STAR - Space Technology and Advanced Research - for the period 2012-2019,
was the first step in the new "space"**



Icpe

RESEARCH PROJECTS IN SPACE FIELD

Based on The Romanian Space Agency — ROSA constant effort to establish cooperation agreements with international organizations such as the European Space Agency — ESA, starting from 22 December 2011, Romania became the 19' State Member of the European Space Agency.



This affiliation opened an excellent opportunity for us to enter new R&D fields and to valorize the long term expertise in this field of excellence.

Inside ROSA mandatory programs Icpe has succeeded in some fields, carrying on researches in the following projects:



Subsystems for Nanosatellites - SuNs

The project targets the development of a micro-motor and a telemeter dedicated for use on nanosatellites with the purpose of augmenting the existing capabilities toward precise attitude control and inter-satellite range determination in the context of close orbital formations. The project includes the development of an experimental set-up and the on ground tests of the proposed subsystems. The subsystems were designed and developed to the specifications of the spacecraft and the launch environment.

High efficiency thermoelectric generator with non-steady state operation TegSpace

The project aims to develop a new thermoelectric generator and customized operating regime yielding significant improvements in power/volume, cost/performance and energy efficiency over conventional limitations, based on traditionally thermoelectric materials and a new design of thermoelectric unit and pulse (Non Steady-State) operation.

We propose to use solar energy for heating and passive radiator for cooling, and in that manner the thermoelectric generator being possible to use in the space as power source.

ONGOING PROJECTS



Reaction wheel for spacecraft attitude control– RWSAC

*Partners: COMOTI – National Research and Development Institute for Gas Turbines
National Institute for Lasers Plasma and Radiation Physics – Institute for
Space Sciences*

The project RWSAC aims the development of a reaction wheel assembly for attitude control in spacecrafts by spinning-in proven technologies towards space applications. Although having a relative simple operating principle, reaction wheels are intrinsically complex due to special restrictions imposed by their applicability to space missions: high reliability requirements, close to 100% duty cycle, mechanical wear, provisions for lubrication in vacuum, high precision for balancing at high rotational speed, mitigation of potential defects at launch etc. Tackling this problems will increase the know how in the consortium beyond the product being developed, while expanding the existing abilities, skills, qualifications and methodologies applicable to most of the space related activities of the entities involved.

ONGOING PROJECTS



Advanced solar thermal propulsion system for increasing satellite operational life – STRAUSS

*Partner: COMOTI – National Research and Development Institute for Gas Turbines
Universitatea Politehnica București*

The main objectives of this project is to research, design, manufacture and test an advanced/ original solar thermal propulsion system for increasing of operational life of satellites by 2.5 times. The main objective will be reached through achievement of three secondary objectives: R&D of Special Equipment for Focusing of Solar Light (SEFSR), R&D of a high performance/ultra-light solenoid micro-valve and nozzles.



ONGOING PROJECTS



Stepper Motor for Multimedia Antenna deployment - SM MADPM

Partner: TAS - Thales Alenia Space (France)

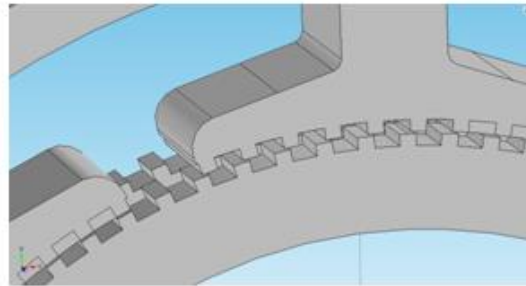
This project aims to develop a stepper motor for the second generation mechanism used in motion applications for antennas and solar panels manufactured by Thales for Arienne6 program.

TEST RESULTS

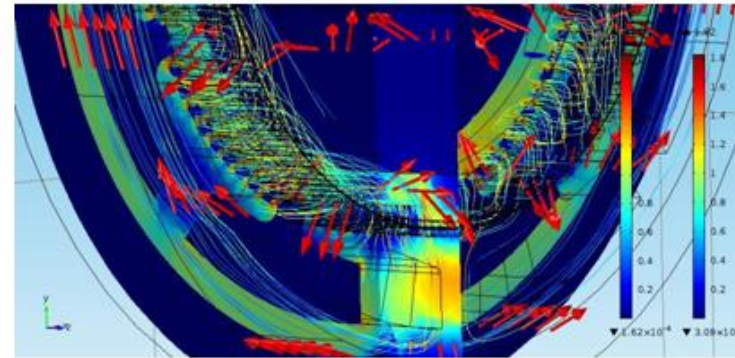
- *Breadboarding process had two stages. BB2 results fulfill main Technical Specification Requirements. Therefore, the next stage in stepper motor development is Engineering Model.*
- *With the new test bench manufactured for this stepper motor type, were measured the new characteristics and parameters which were not required in the previous project (EMSIS).*

Design process

Five numerical models were developed.



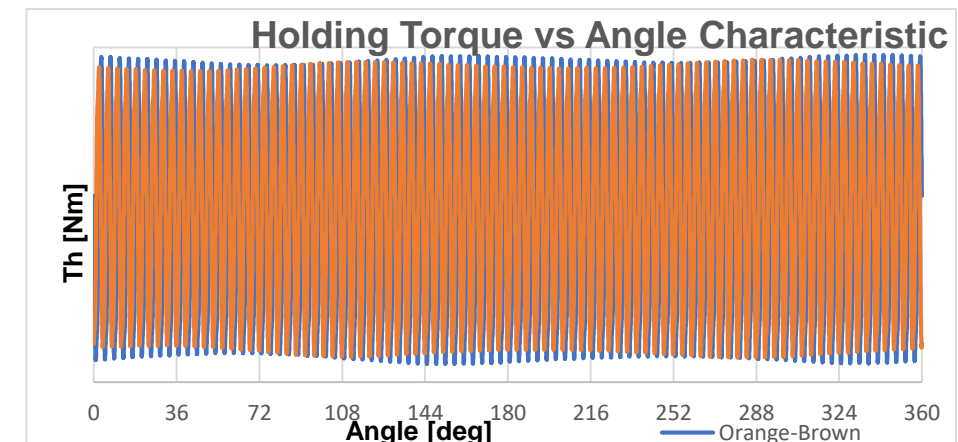
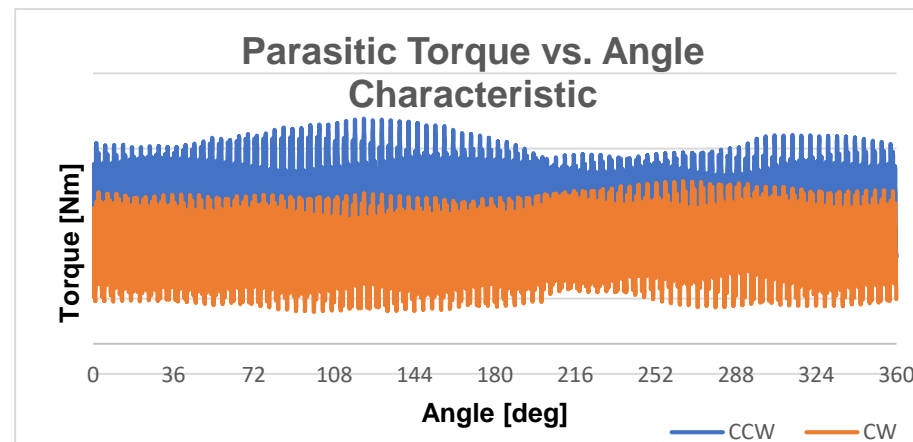
Detail of Stepper Motor model



The magnetic flux density



Stepper Motor - BB





ONGOING PROJECTS



Limited Angle Torque Motors for LLTVAS system of the Ariane 6 Launchers

Partner: S.A.B.C.A. (Belgium)

The lower central stage of the Ariane 6 launcher is powered by the Vulcain 2.1 engine. The LL-TVAS (Low Liquid Thrust Vector Actuation System) is the actuation system that allows gimbaling the engine nozzle according to the Guidance and Navigation Control requirements. Due to the specificity of the Vulcain engine, a hydraulic actuation system with direct drive servo-valve has been selected.

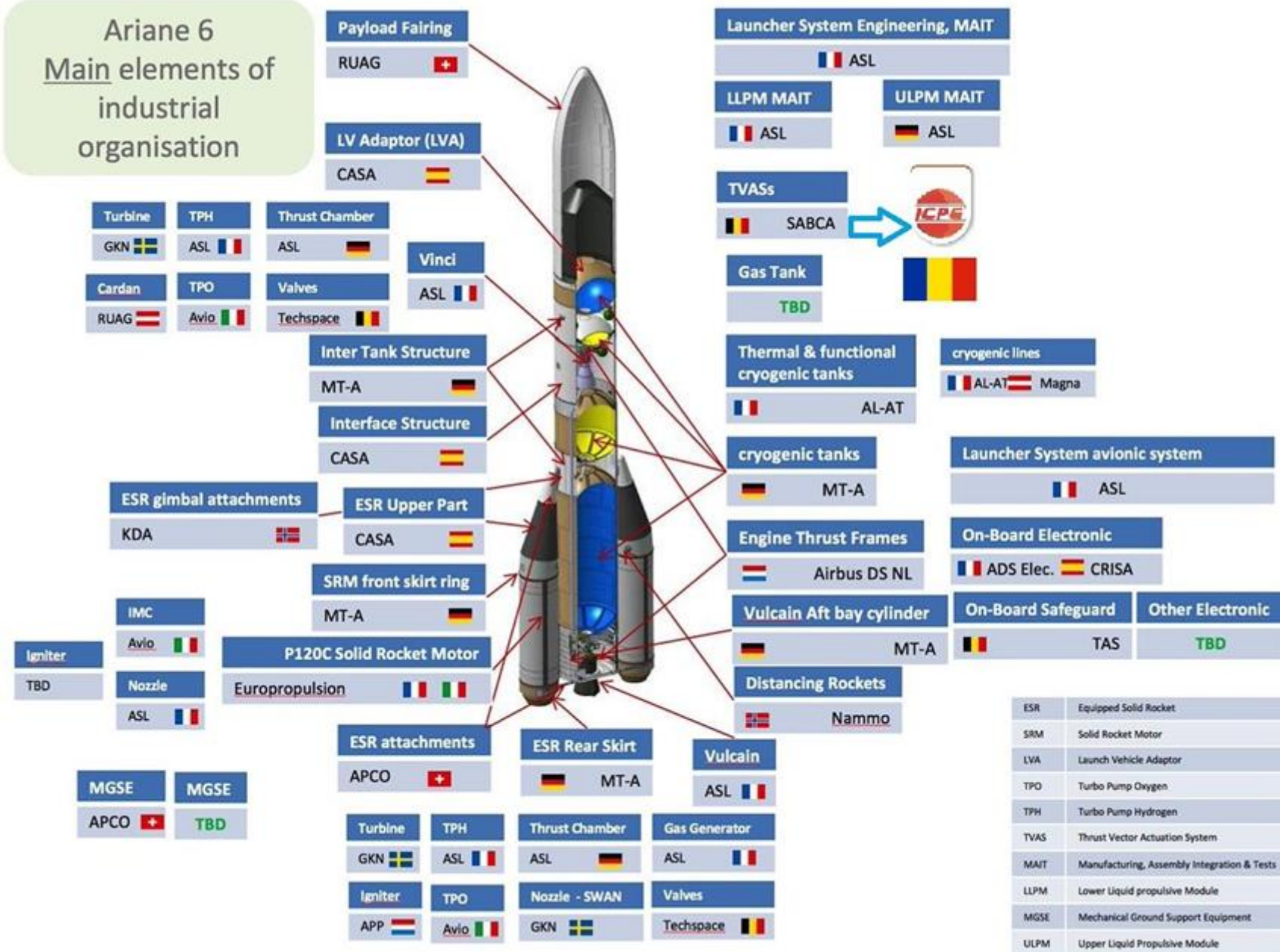
This direct drive servovalve is to be driven by a LAT (Limited Angle Torque) motor with flooded rotor and accurate electrical and mechanical characteristics necessary for the open loop control of the valve (no position sensor on the spool).

Beside the need for Ariane 6 and other future potential launcher developments, this type of motor for a direct drive valve is also used by SABCA for aeronautic applications.

The organization driving the technical objective is Icpe, a manufacturer of special electric motors with proven experience at an international level, currently adapting for space its portfolio of electric motors under two ESA contract awarded as part of the new member state scheme. The proposal also involves SABCA, who will be focusing on the technical requirements, on the requirements definition, test plan and test activities.

Icpe has the opportunity in frame of this proposed work to develop a product needed in the space mechanism market and start in this first step a cooperation with SABCA – Belgium Company one of the supplier of space launchers systems for Ariane 6 and Vega.

Ariane 6 Main elements of industrial organisation





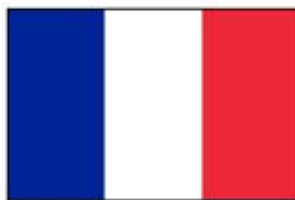
LLTVAS System



Limited Angle Torque
brushless motor



Vulcain II



ONGOING PROJECTS

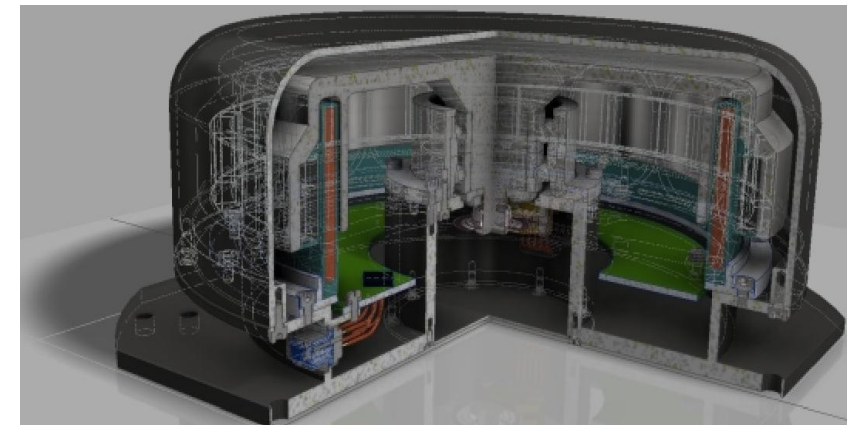


Development of a new reaction wheel using up-to-date technologies

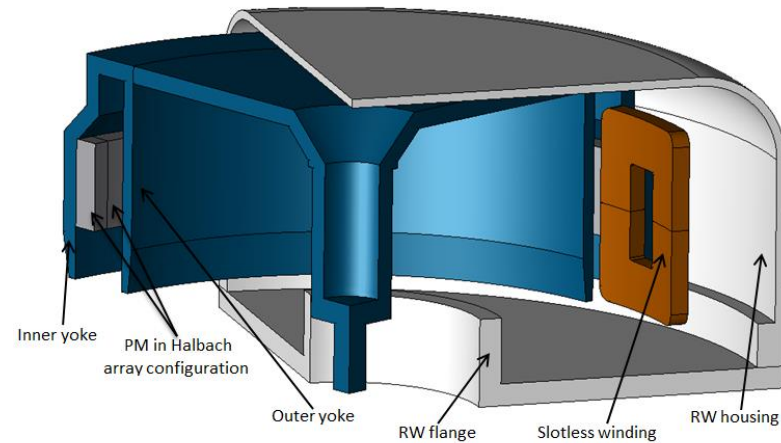
Partner: TAS - Thales Alenia Space (France)

The main technical objective of this project is to perform a preliminary conception of a reaction wheel that will take maximum benefit of new technologies, and to establish a detailed development plan for such product.

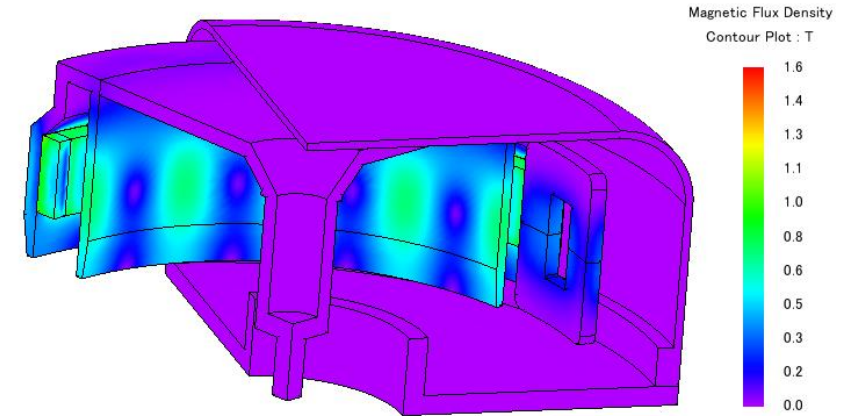
Using Icpe and TAS experiences to widely re-open the trade-offs driving an optimized wheel concept may lead to a very interesting solution that could satisfy most of the market needs. Many of the existing wheels designs are based on relatively old concepts and it is the right time to readdress the concept versus the today needs.



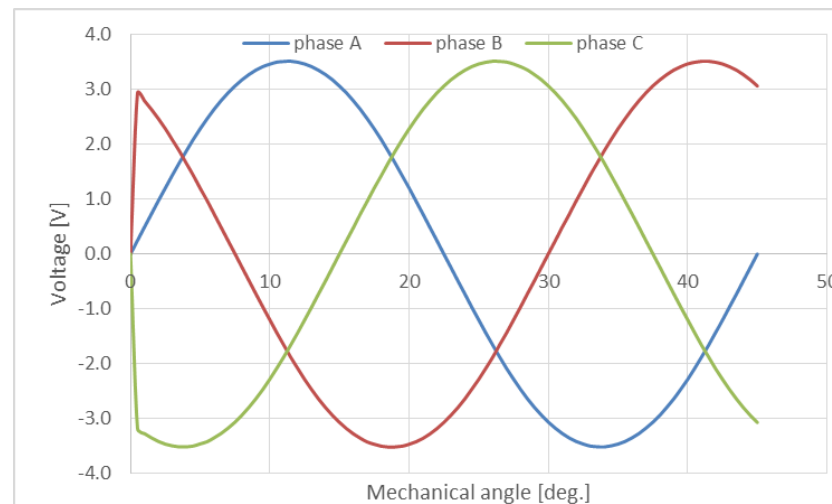
Configuration of the PM synchronous motor



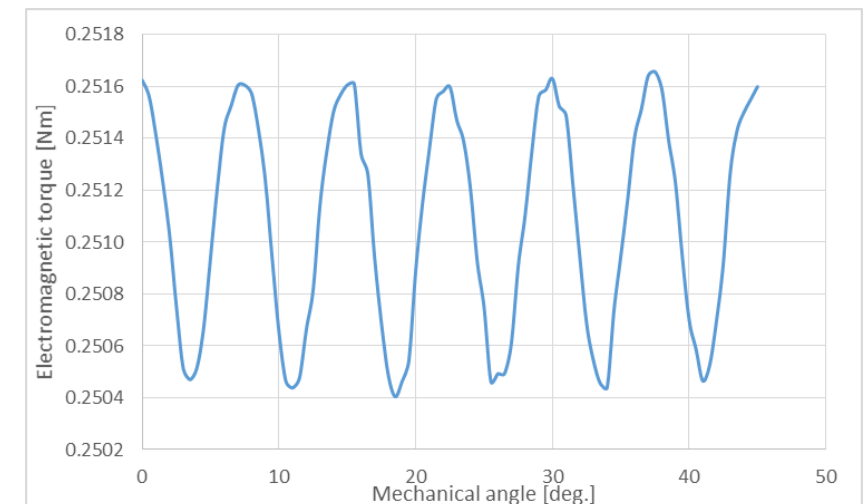
Magnetic flux density distribution



Phase Electromotive Force @ 1000 rpm



Electromagnetic torque



Objectives:

- preliminary concept of a reaction wheel (RW) that will take maximum benefit of new technologies
- preliminary validation of most critical issues
- establish a detailed development plan



ONGOING PROJECTS



Electric motor spin into space – EMSIS

Partner: ISS - Institutul de Stiinte Spatiale (Romania)

This project involves developing a stepper motor, used in over 90% of space applications that require controlled movement.

The main focus of the project was developing a product for operations in space.

ICPE run a technology survey to identify specific needs for primes and/or end users. The answers related all to SMs and seem to indicate a need for high detent torque. The usage scenario most likely involves actuators for deployment and pointing of various equipments.

EMSIS stepper motors – Breadboarding process

Accordingly to the conclusions of the survey report, a Permanent Magnet (PM) or a Hybrid Stepper Motor (H-SM) were chosen to be developed in the EMSIS project, supplied in a frameless configuration (rotor and stator separately), in order to integrate them within space mechanism applications.

Three breadboarding (BBs) stages and an engineering model (EM) were considered. In the first breadboarding stage (BB1), both PM and H-SM variants were realized.

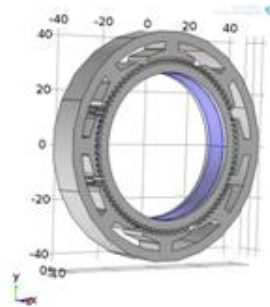
EMSIS

BB1

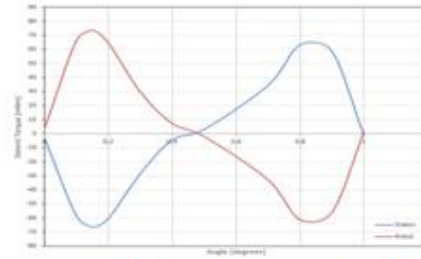
*Three BBs were manufactured,
two with Neodymium – Iron –
Boron magnets and one with
Samarium-Cobalt PMs.*

The H-SM variant was chosen.

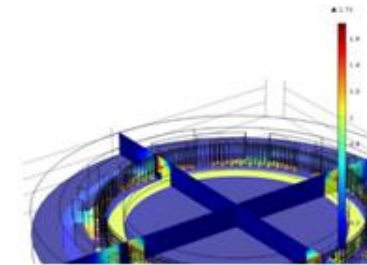
Results of numerical modeling



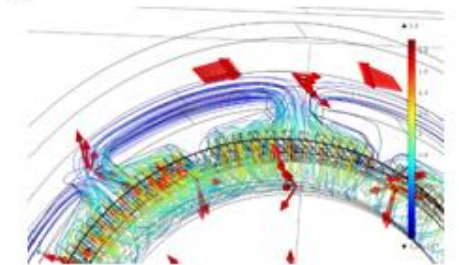
The magnetic circuit of the motor



Calculated T_D – angle
characteristic over 1 step



Magnetic flux density



Hybrid Stepper Motor – BB 1

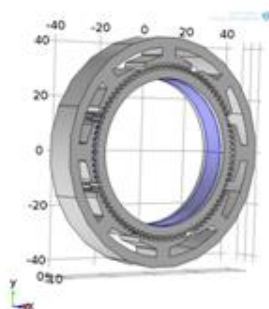


EMSIS

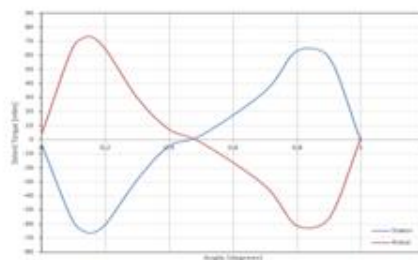
BB2

In the second breadboarding (BB2) stage, a new version for H-SM, different from the material and geometric point of view, was realized.

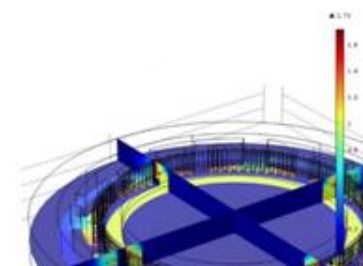
Results of numerical modeling



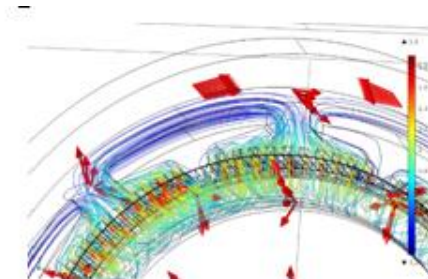
The magnetic circuit of the motor



Calculated T_D – angle characteristic over 1 step



Magnetic flux density



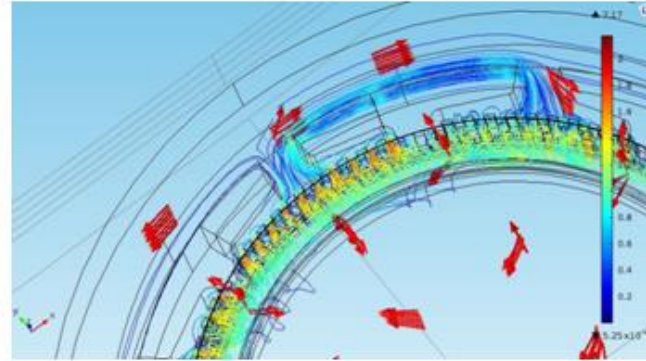
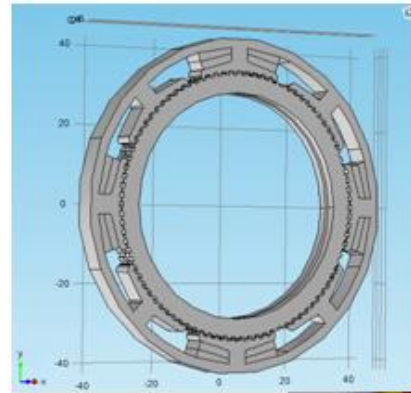
Hybrid Stepper Motor – BB 1



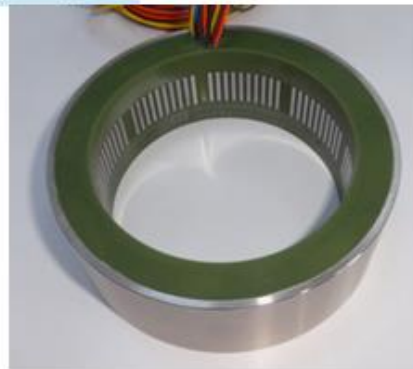
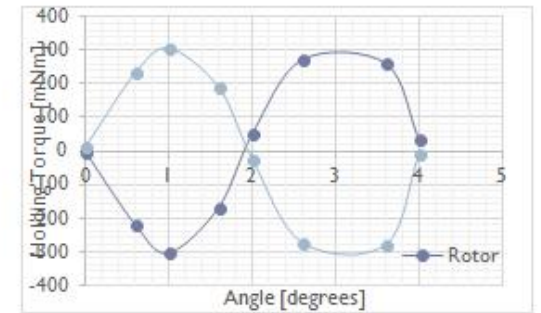
EMSIS BB3 & Engineering Model

*In Breadboard 3 (BB3) and
Engineering Model (EM), the
redundancy solution was
changed.*

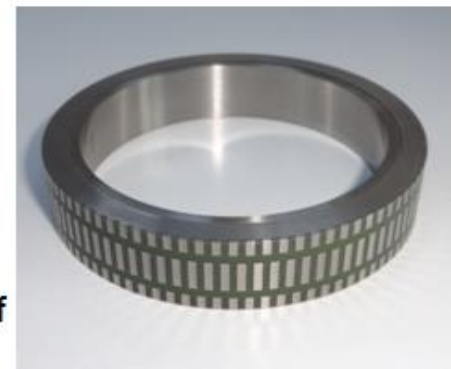
The constructive elements of the motor



Numerical modeling results for BB3 T_H model



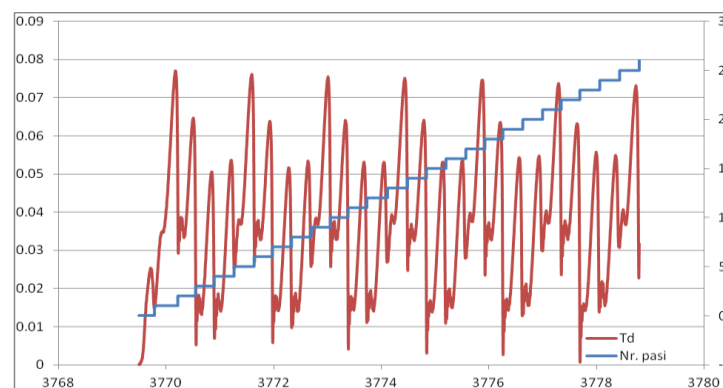
The magnetic circuit of
the motor



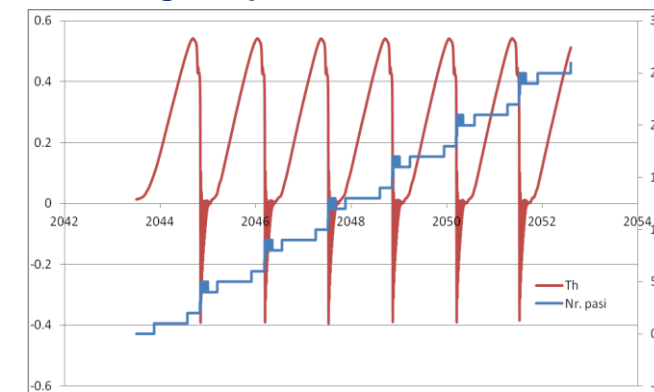
EMSIS Hybrid stepper tests

The measurement method for TD and TH uses a torque transducer. The motor's rotor is rotated with a motoreducer and with the torque transducer is registered the torque values and the step number at the motor shaft.

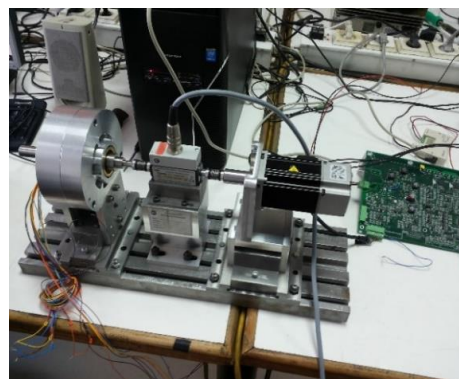
Detent Torque



Holding Torque

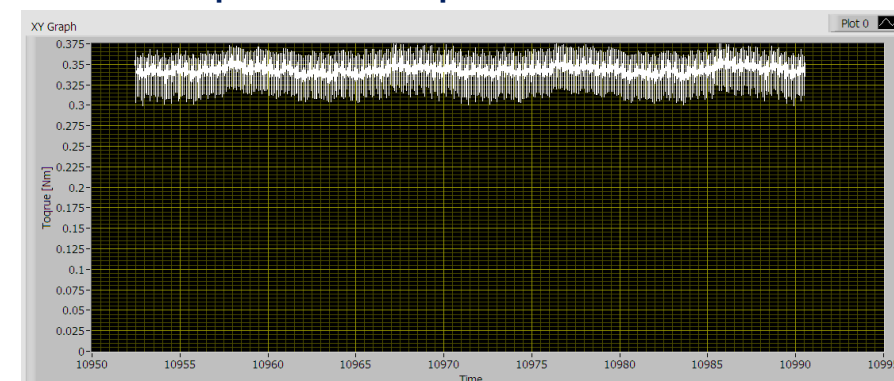


**Measurement
device for on load torque**



The measurement device for TL (a brushless AC motor controlled in torque, working like a brake) and the measured diagram are presented. This method allows us to measure the pull-in and pull-out torque.

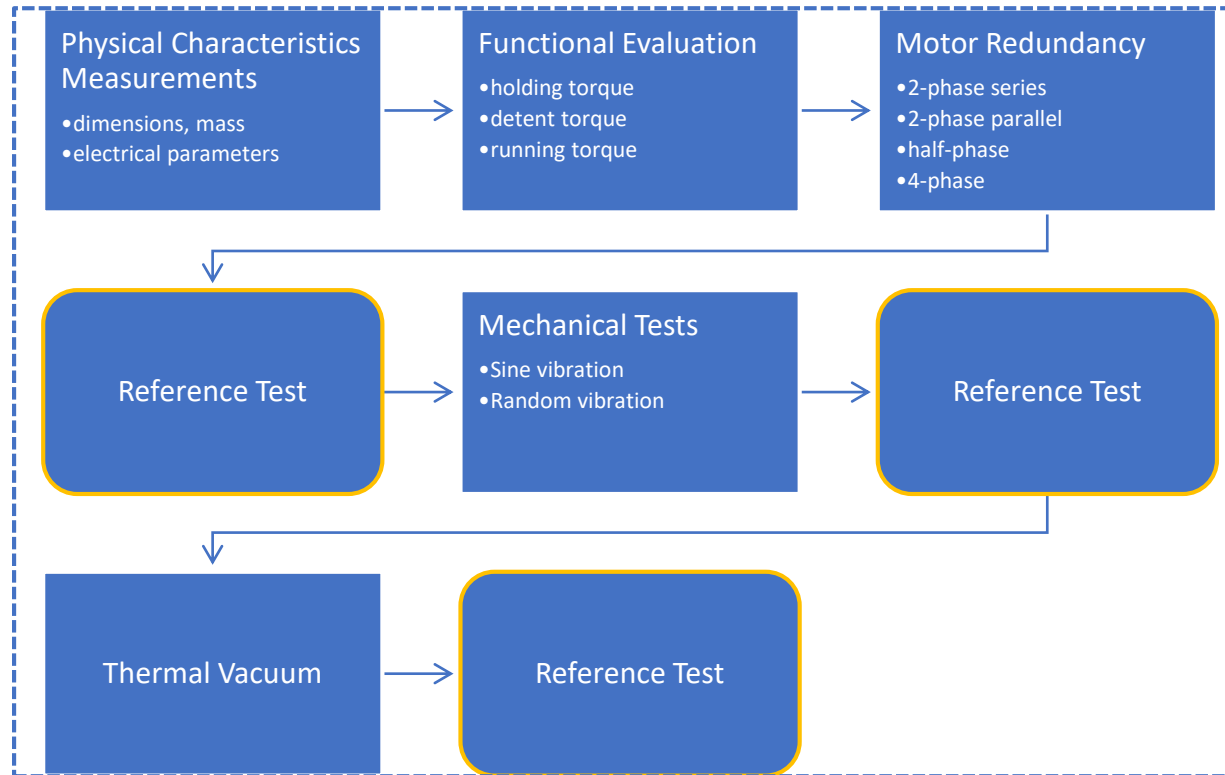
On load Torque – Parallel option



EMSIS

Motor tests – Environmental Test Campaign

The last objective of EMSIS project is a test campaign which includes the activity presented in the following flowchart. The entire program of EMSIS project was completed, except TV tests on the EM.

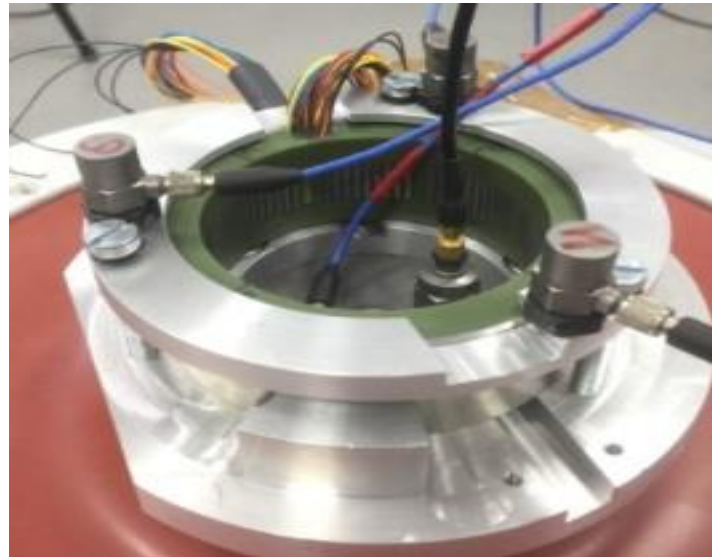


Environmental Test

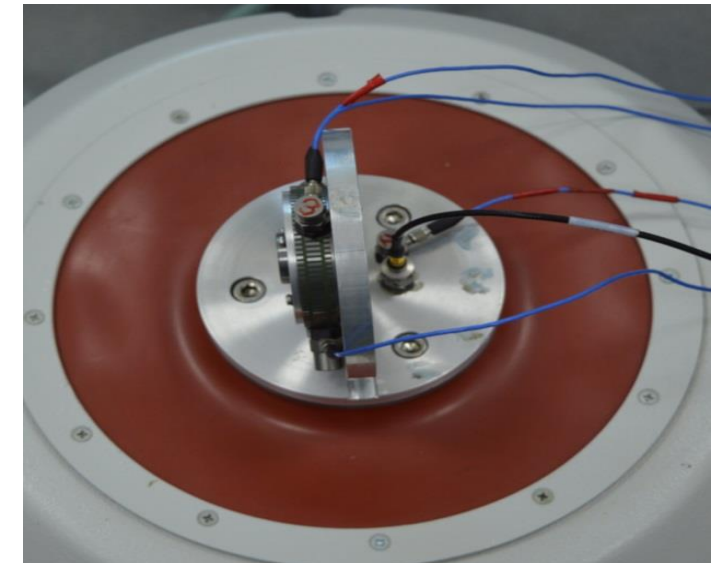
Mechanical tests

Vibration tests

- *The motor is in a frameless configuration.*
- *Rotor and stator mounting adapters to shaker mounting interface were made.*
- *The vibration test was conducted in accordance with Motor Test Procedure at a Romanian company, Research & Development Institute of Gas Turbines - COMOTI.*
- *The tests results and conclusions have been included in Motor Mechanical Test Report.*



Stator on shaker (axial)

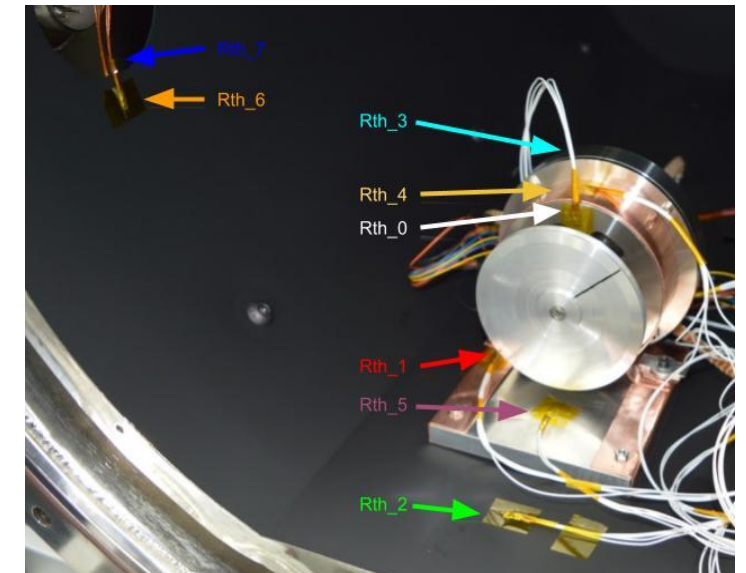
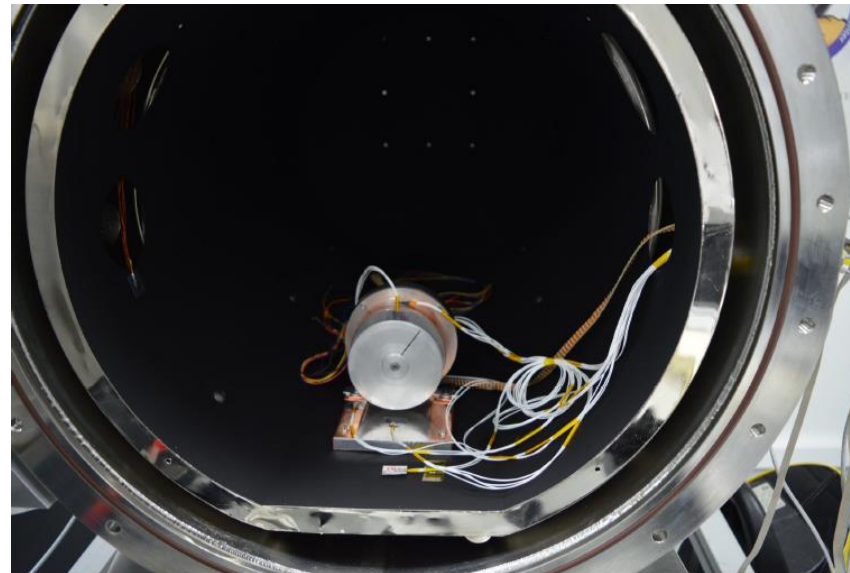


Rotor on shaker (radial)

Environmental Test

TVAC tests

- *Thermal – vacuum (TV) cycling tests were conducted in accordance with Motor Test Procedure.*
- *These tests were performed at a Romanian institute, Institute of Space Science - ISS.*
- *The stepper has demonstrated functionality after the test campaign and is considered suitable for environmental conditions (there were no degradation of motor performances).*
- *In this project, the stepper reached an EM level, up to a TRL 4-5.*



Stepper in TVAC chamber

Electric Motor Technology Spin Into Space

Contractor(s): ICPE (RO) Sub-Contractor: Institute of Space Science (RO)				ESA Budget:	197,350 k€
				Co-funded Budget:	0,000 k€
AO/1-7557/13/NL/SC -Contract :4000111083/14/NL/CBi			YoC: 2018	TO: Claudia Allegranza(TEC-MSM)	
TRL	Initial: 3-4	Achieved: 5-6	Target TRL: 8 Date: Q4 2019		

Background and justification:

ICPE, as a manufacturer of electric motors at an international level, is in a position of entering this new market with harmonization of the existing electric motor technology with the standard required for the space applications, since its portfolio already serves a wide range of applications in aeronautics and defense, fields with similar technological and product/quality assurance requirements.

Objective(s):

Survey the space qualified dc motors market and identify niches/needs; research and characterize the space and launch environments; spin-in the existing motor manufacturing technologies into the space components market; certify the new motor and the new driver electronics manufacturing technology for space applications.

Achievements and status:

The project foreseen deliverables are: Survey Report; System Requirements Document; Technological Modification Report; Motor Design Documentation including CAD model; Motor Engineering model; Driver electronics design documentation including CAD model; Driver electronic engineering model; Motor environment test procedure; Driver electronics test procedure; Environmental Analysis Report; Test Campaign Report; Final Report.

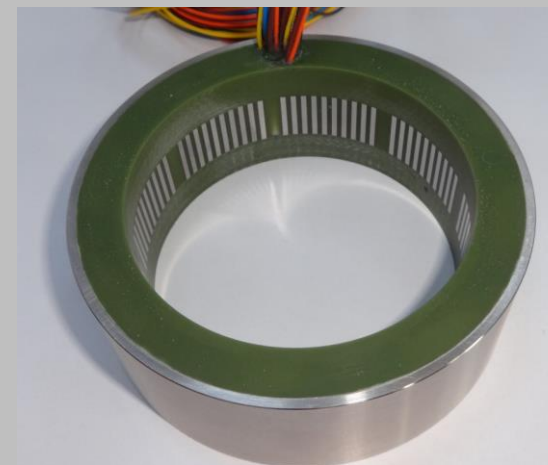
All the technical deliverables were completed.

Benefits:

In this project, the stepper reached an EM level. When it will reach a QM level, the motor can be used for operations in space, with applications directed towards LEO or GEO orbits.

Next steps:

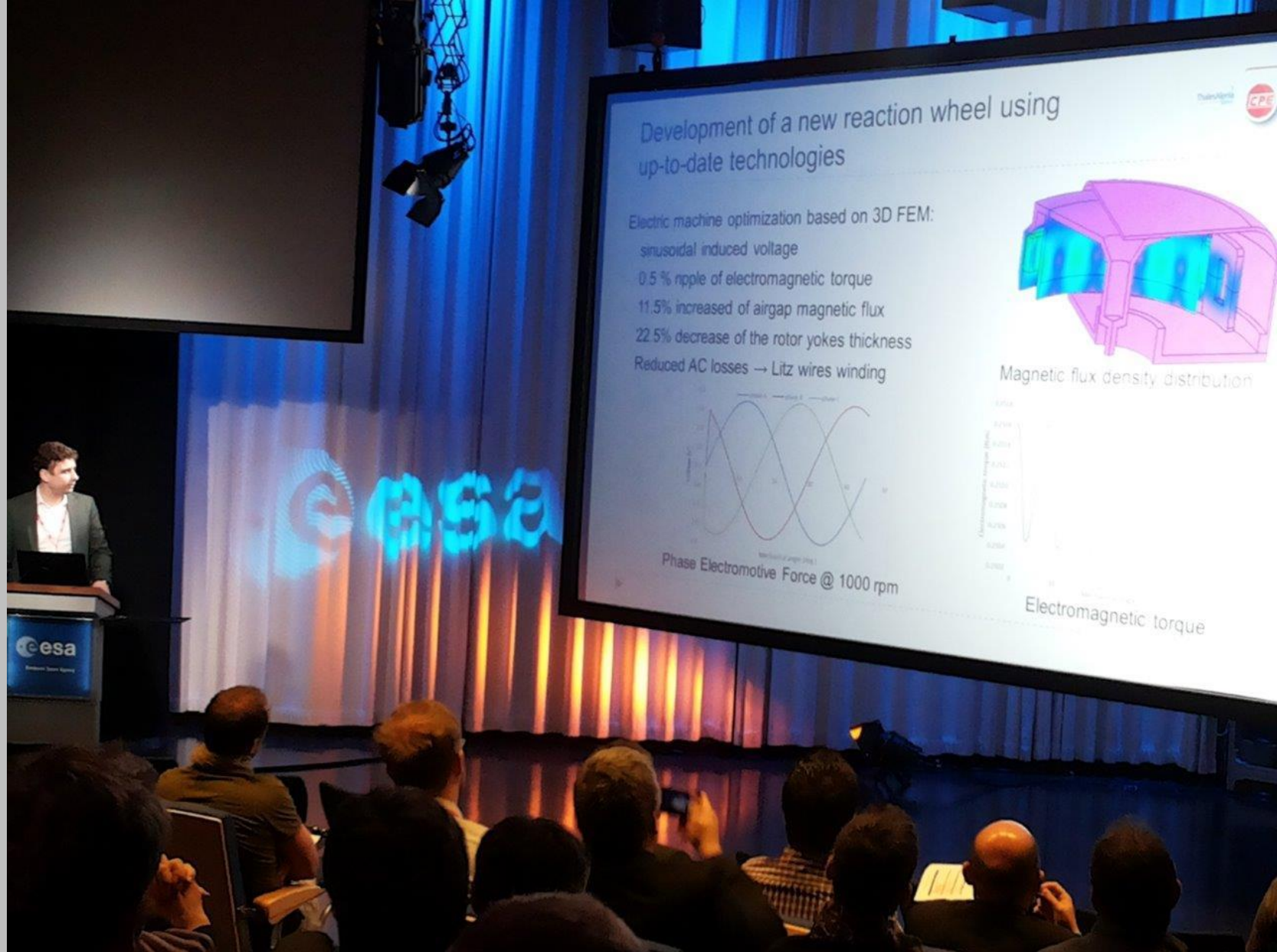
Currently, is an ongoing ESA project no. 4000117518/16/NL/Cbi, in which will be developed a new stepper motor at EM level for ESA space applications till the end of 2018. In the same time, the product can be a second source for Thales Alenia Space France applications. The next step is reaching QM level with this stepper, till Q4 2019.



RELATED EVENTS

MECHANISMS WORKSHOP AND
FINAL PRESENTATION DAY

*12 to 15 February 2019,
Noordwijk, The Netherlands*



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