BOOSTING SCIENTIFIC KNOWLEDGE

About us

SET-UP IN 2006

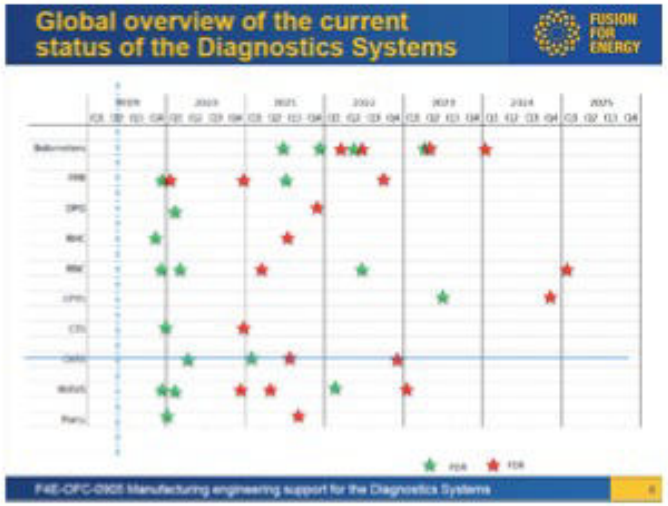
HIGHLY QUALIFIED PERSONNEL
(80% MSc, MEngs and PhDs)

TÜV CERTIFICATES
ISO 9001
EN 9100

+10.000 m² FACILITIES

MODELLING DETAILED-DESIGN ANALYSIS PROCUREMENT MANUFACTURING ASSEMBLY INTEGRATION TEST

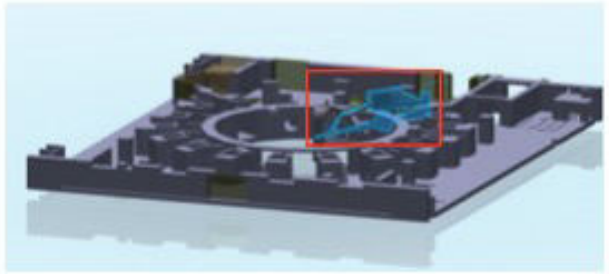
Engineering design services for ITER Diagnostics

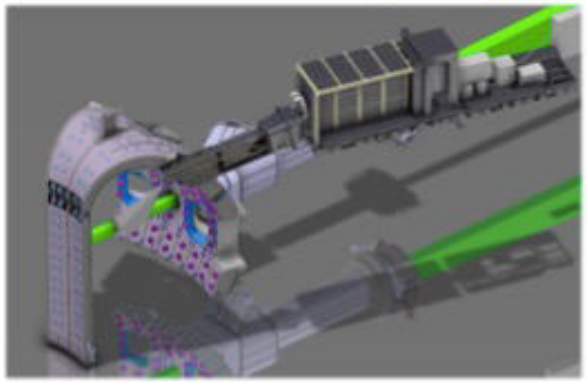


Colective Thomson Scatering
Radial Neutron Camera
Diagnostic Pressure Gauges
Wide Angle Viewing System
Bolometers...

CXRS design from PDR, FDR, BTP up to M. Specifications

ITER CXRS (charge-Exchange recomb. Spectroscopy)

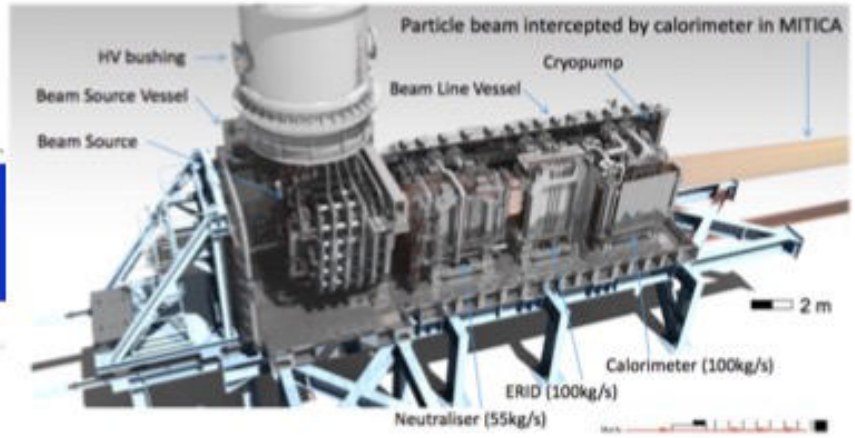


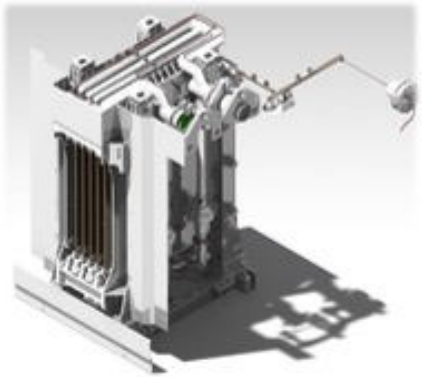


MITICA Beamlines: Heating an Earth's local Star

WORLD most powerful NBI System

P_{beam}	17 MW (33-40 MW)
I_{acc}	40-50 A
V_{acc}	1 MV
t_{pulse}	3600 s
Weight	50 T





Working with ITER Organization for more than 7 years

Worked on almost every in vessel diagnostic and component

Prototyping activities, procedures validation, series production…

- ITER Outer Vessel Steady State sensors OVSS
- ITER mechanical Looms
- ITER attachments/Clamps,
- ITER ECRH Sensors bolometers
- ITER Junction Boxes (Blanket Instrument., Blanket Rogowski, In-Port connector, Flux loops)
- ITER Fibre Optics current sensors FOCS
- ITER in-vessel diagnostic magnetic sensor platforms
- ITER magnetic flux loops mock-ups & tools
- ITER Mirnovs coils Inconel baseplates prototypes
- ITER FOCS' feedthroughs
- ITER Fiber bundle wall penetrations (Nuclear Safety Relevant)
- ITER Prototype testing mock-ups (…)

Others:

Tokamak Energy: Divertor Infrared – Visible endoscope

JET 16 channels Low noise Trans-Impedance Amplifier (for Fast Ions Losses KA3). CCFE-UK.

COMPASS D Slits and grids (IPP-CHZ)

Hall Sensor UVH instrument for **WEST Tokamak (CEA)**

[…]

FUSION FOR ENERGY

iter

tokamak energy

cea

CONSORZIO RFX
Ricerca Formazione Innovazione

CCFE
CULHAM CENTRE FOR FUSION ENERGY

ENEA

Ciemat

IPP Max Planck Institute for Plasma Physics

ISO 9001 EN 9100

avs

EMPRESARIOS AGRUPADOS

Advanced Projects Unit

General Presentation

Maria Teresa Dominguez
Advanced Projects Director

EMPRESARIOS AGRUPADOS

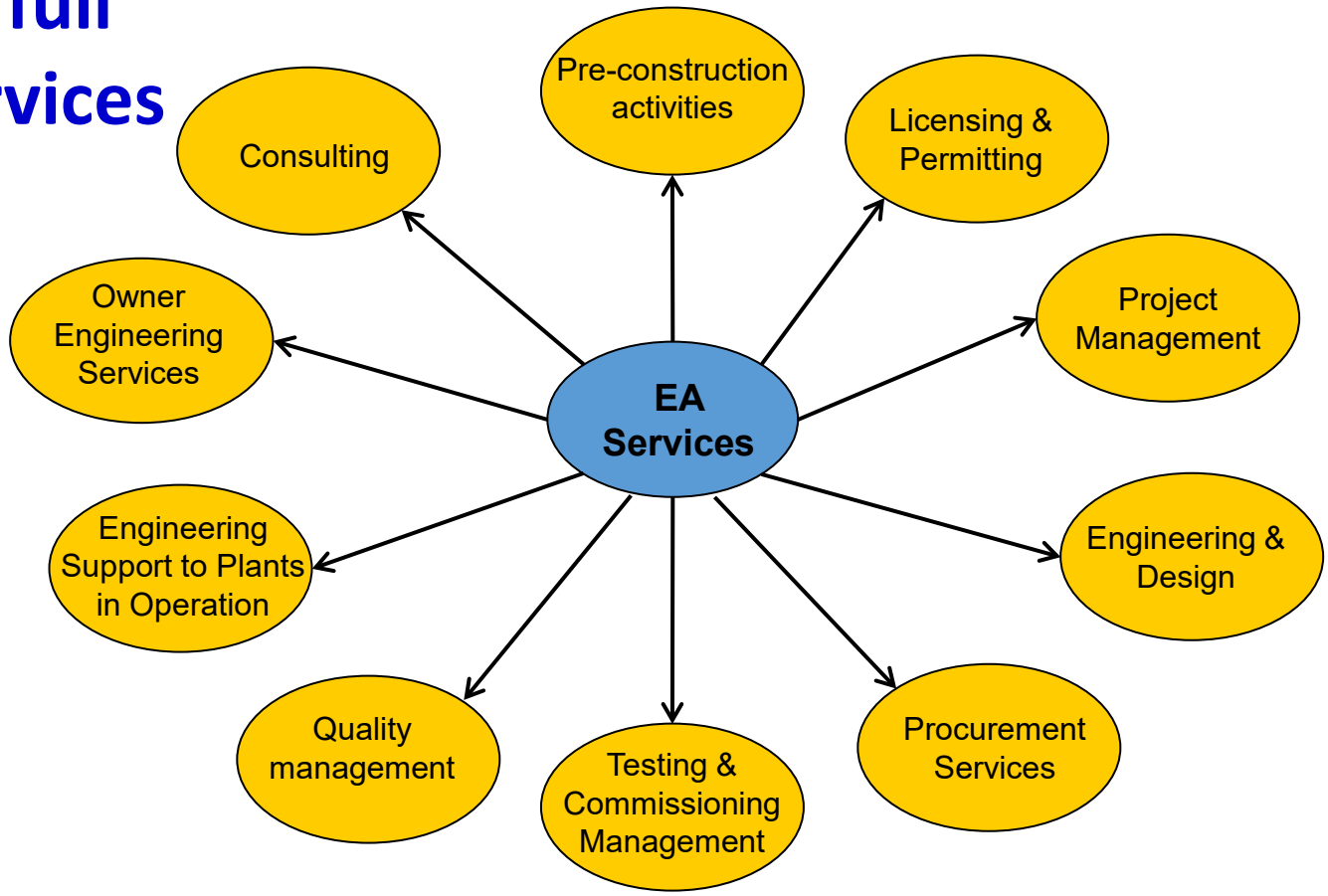
Company profile

- An Architect-Engineering and Construction Management Company
- Created in 1971
- Main focus: Power Generation, Transmission and Distribution Projects
- Leading engineering organization in Spain
- Project experience in more than 20 other countries
- Full range of engineering services provided to the electric power industry: from engineering studies to complete EPC turnkey projects.

EMPRESARIOS AGRUPADOS

Services

Since 1971: full range of services



EMPRESARIOS AGRUPADOS

Fields of activity

Nuclear Projects

New-build nuclear power plants

Engineering support services to plants in operation

Decommissio-ning and Radioactive Waste Management

Research Reactors and Generation IV Reactors

ITER Fusion Reactor-Cadarache (France)

Thermal Power Plants

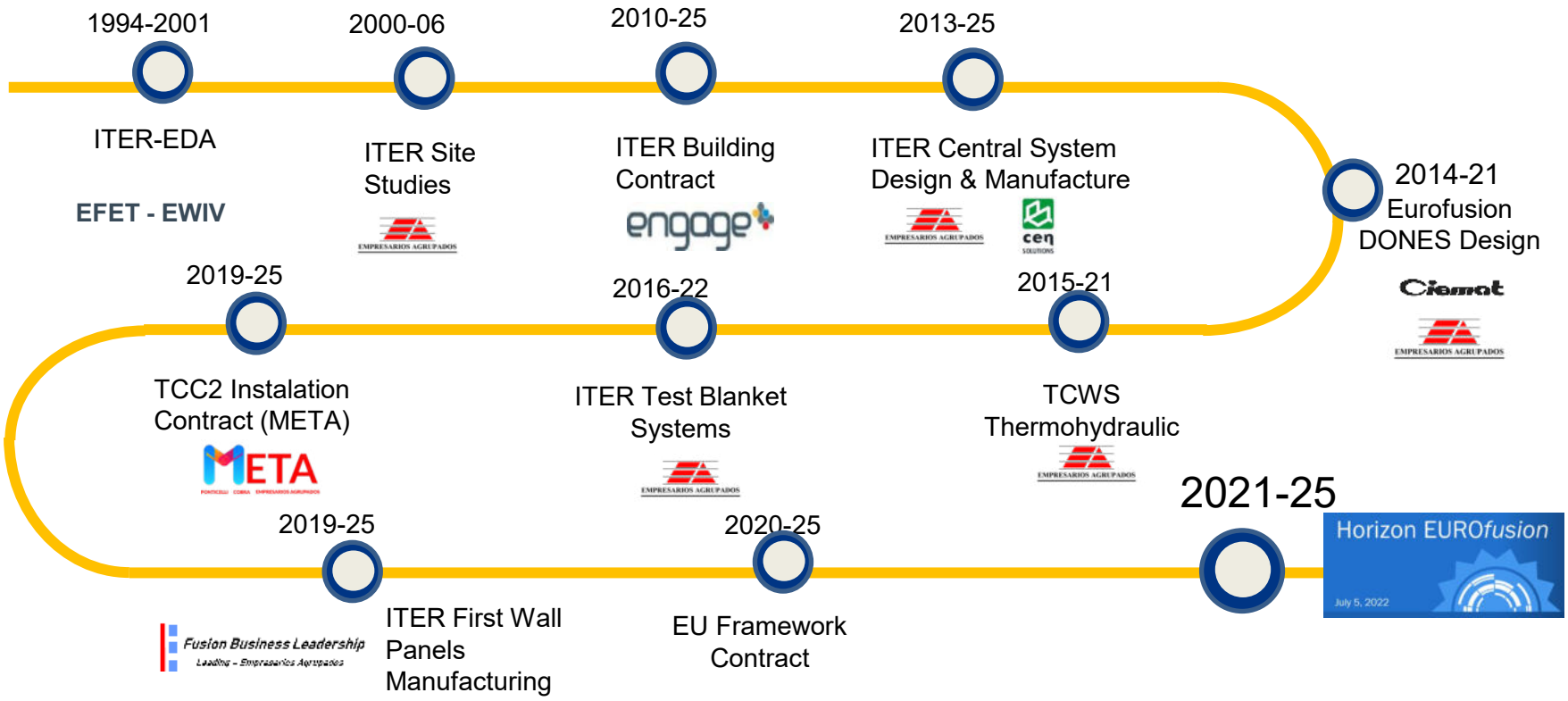
Combined-cycle thermal power plants

Coal and FO fired thermal power plants

Renewable energies

Solar and Biomass Thermal Power Plants

Fusion: Empresarios Agrupados major Contracts



EMPRESARIOS AGRUPADOS

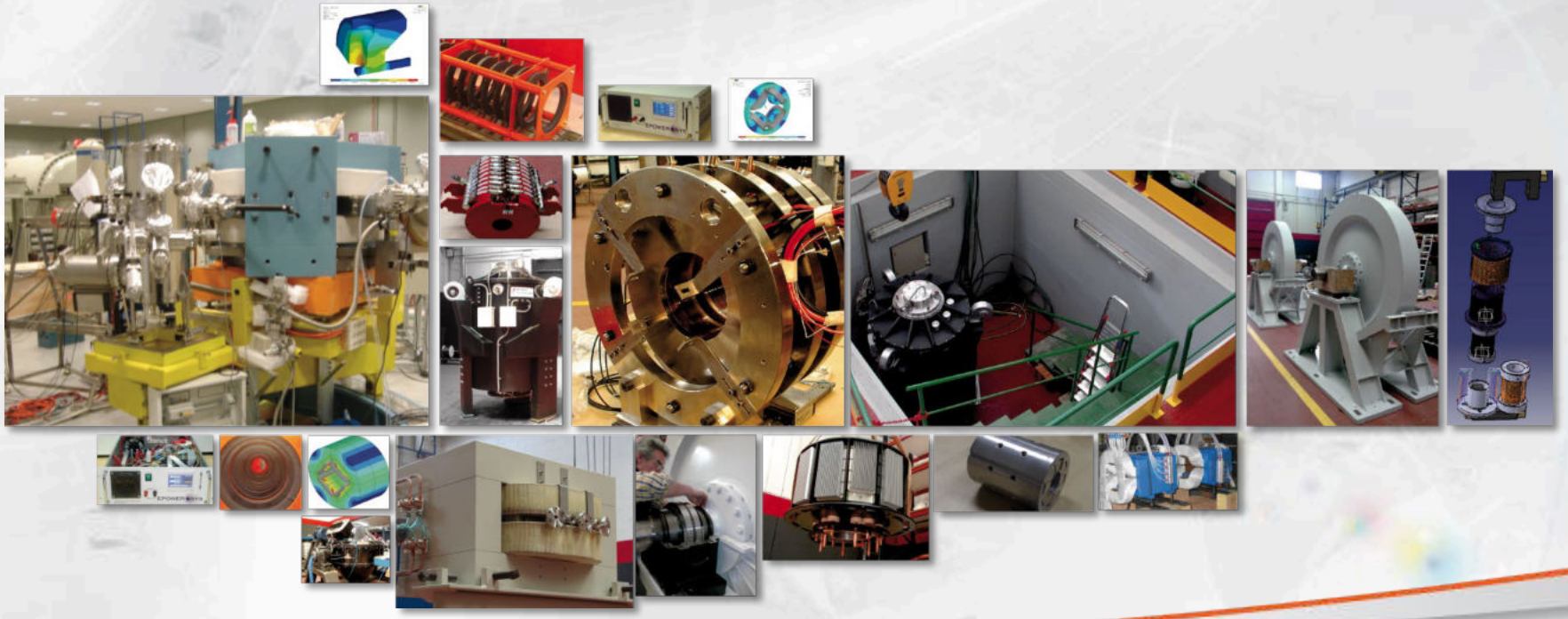
Thank you

Maria Teresa Dominguez
Advanced Projects Director
Tel.: +34913098022
Email: mtdominguez@empre.es

ELYTT ENERGY

Is an independent Spanish company composed by two business units:

ENGINEERING & MANUFACTURING



Calle Orense 11, 2 º B - 28020 Madrid - Spain - Phone: +34 91 411 09 63 - Fax: +34 91 411 09 64 - www.elytt.com

Location

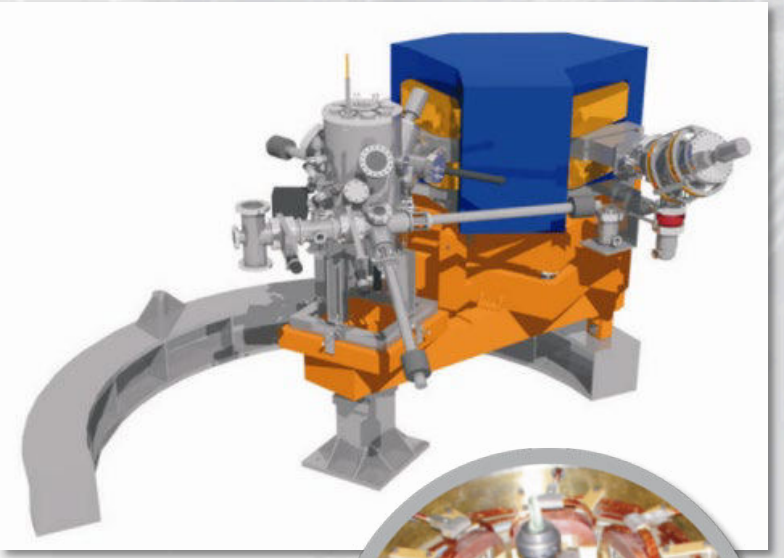
2 Manufacturing sites (Artea&Llodio)

Business & Engineering (Madrid)

MARKETS. what we do?

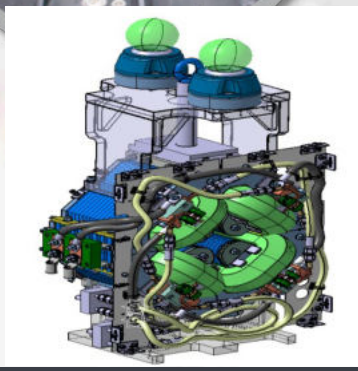
Engineering and Manufacturing Services:

- 2D and 3D FEM and analytical electromagnetic calculations.
- 2D and 3D FEM and analytical stress calculations.
- 2D and 3D FEM and analytical thermal calculations.
- Ray tracing.
- Vacuum calculations.
- Dynamics.
- Coil cooling calculations.
- Cryogenic calculations.
- Support frame calculations.



Sectors for engineering&manufacturing:

- Accelerators & Scientific investigation.
  - ***Design and manufacturing*** of warm and superconducting magnets (dipoles, quadrupoles, sextupoles, octupoles, undulators, septa…) for particle accelerators, spectrographs, magnet support frames, vacuum chamber design, cryogenics…
- Fusion Reactor.
  - ***Design*** of fusion reactor structural systems, design of superconducting magnets for material characterization, design of TF and PF coils…
- Electrical Machines.
  - Complete electrical machine design. ***Design and manufacturing***.



CLIENTS

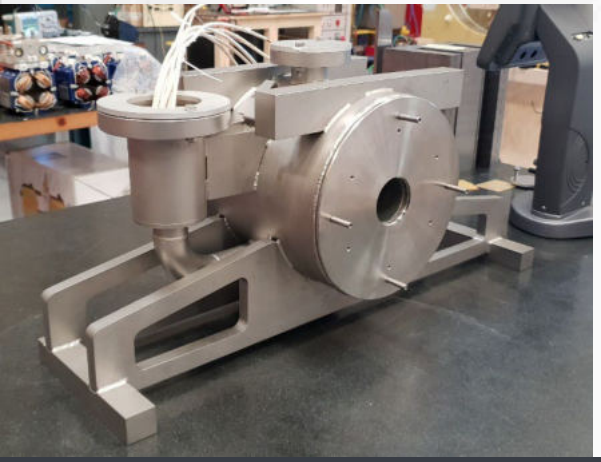
- **F4E/ITER/EFDA** *(Europe).*
- **CERN** *(Europe)*
- **CORNELL**(USA)
- **FAIR / GSI** (Germany).
- **CEA**(France).
- **ILL** (France)
- **CIEMAT** *(Spain).*
- **ESS Bilbao** *(Spain).*
- **CMAM** *(Madrid, Spain).*
- **DESY** *(Germany).*
- **BERKELEY** *(USA).*
- **JULICH** *(Germany).*
- **CPI** *(USA).*
- **PRINCETON** *(USA).*

Calculation, design and manufacturing 21 superferric superconducting Dipoles. SFRS FAIR-GSI

Calculation, design and manufacturing 1 superconducting Quadrupole. QUACO HILUMI CERN

Calculation, design and manufacturing 6 VPI stations for ITER PF coils.

Calculation, design and manufacturing 17 superconducting solenoids. SARAF-CEA



Calculation, design and manufacturing 1 superconducting octupole. ILL

Calculation, design and manufacturing 168 normal conducting magnets. Cornell

10 ITER TF WP manufacturing Consortium members

ELYTT ENERGY

FOR FURTHER INFORMATION CONTACT:

Angel García
Sales Manager
Phone: +34 91 411 09 63
Fax: +34 91 411 09 64
Mobile: +34 619 039 199
Email: angel.garcia@elytt.com

GENERAL
PRESENTATION

2022

Diálogo en Innovación España – EE.UU

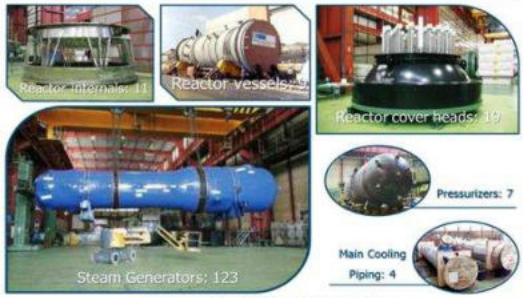
2022

ENSA NUTSHELL

Ensa more than 40 years supplying components for the Nuclear Power Plants.
Products & Services:

- Engineering – Products Design – Manufacturing
- Advanced Technology Centre
- Services at Plants – Fuel Management
- Decommissioning and Waste Management

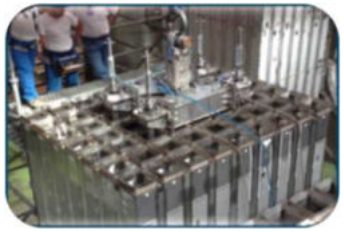
NSSS EXPERIENCE

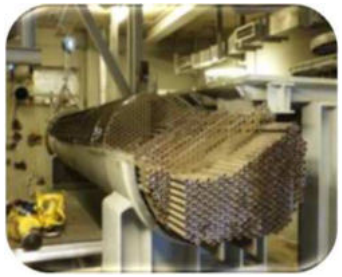


Total: 173 NSSS components

NSSS NON EXPERIENCE

Total: 156 Casks and Racks in 27 NPPs





ITER:

YOUR GLOBAL SUPPLIER

Nuclear Quality Standards:

ITER

DEVELOPMENT

Tools, techniques, processes and procedures qualification

PRE-PRODUCTION

Tools procurement and equipment preparation

PRODUCTION

Responsible for VV assembly activities on-site

MANUFACTURING

Supply of subassemblies
- PS1
- PS4

- Other experience Experimental Reactors

- **PRISM reactor**: we have cooperated with GEH in the feasibility study and cost assessment of the main components in 2014
  - Rotatable Plug, Reactor Closure, Containment Vessel and Reactor Vessel

- **ESFR** (European Sodium Fast Reactor): Ensa has collaborated in some specific areas (2008) within a consortium of companies (programaMarco)
  - Tube to tubesheet welding design
  - Design codes study
  - Selection of materials review

- Design of the HTR of the **PBMR** (South Africa)

- Involved in the **EM2** reactor of General Atomics (US)

- Performed detailed feasibility works and cost evaluation for the **Jules Horowitz Reactor** (France)

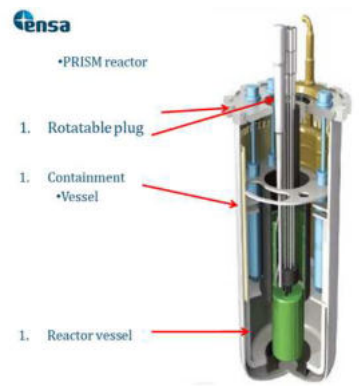
- **ITER** vacuum vessel assembly project and segments fabrication

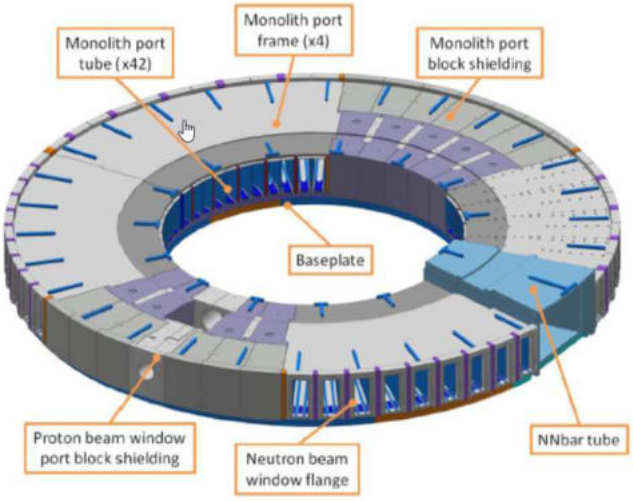
- **NuScale SMR**
  - Participated in manufacturability assessment, design review, RFI & RFP

- European Spalaion Source (**ESS**)
  - Manufacturing and Installation of Monolith Port Blocks

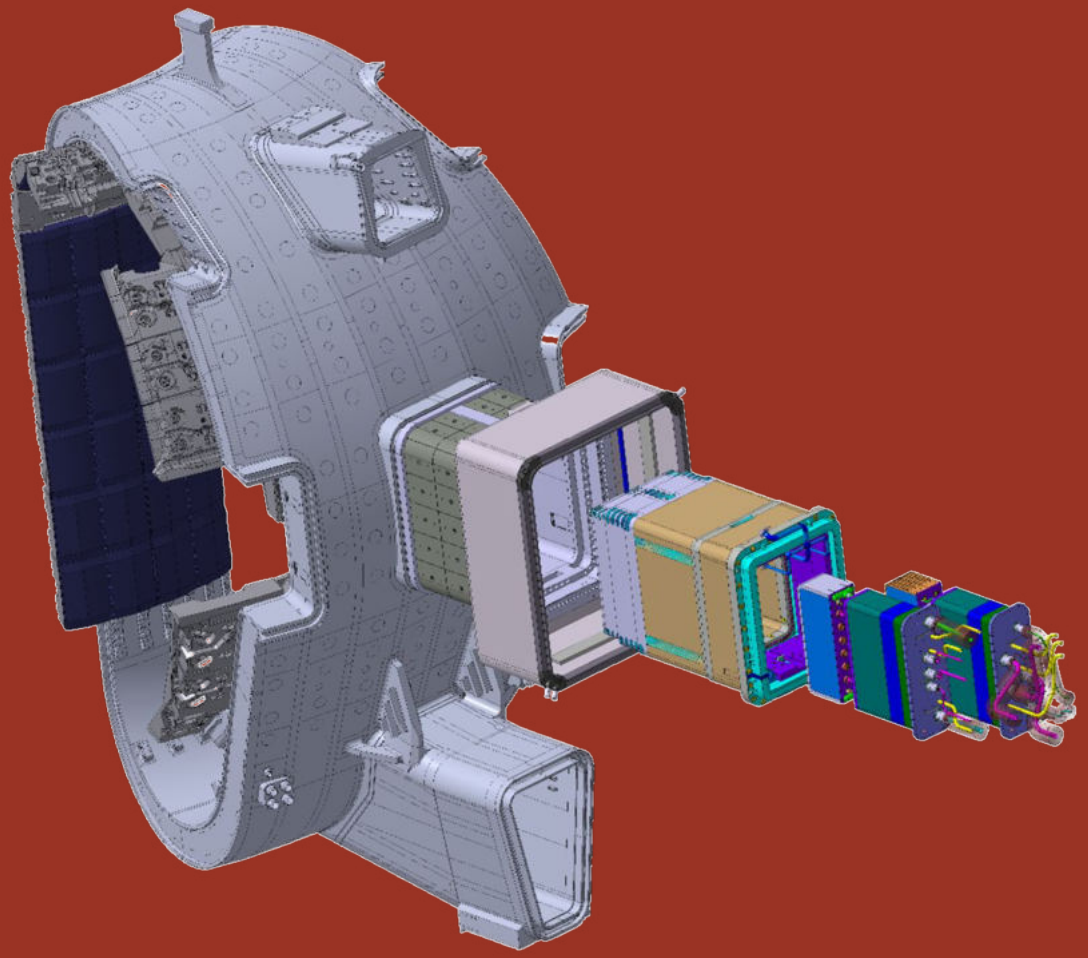
Typical steps in feasibility studies

- Confidentiality Agreement
- Request for Quotation & Technical information disclosure
  - Technical & commercial discusions
- Ensa Offer
- Customer Purchase Order – General Terms and Condition agreement
- Kick – Off meeting





Ensa participates in the construction of the most powerful neutron source in the world



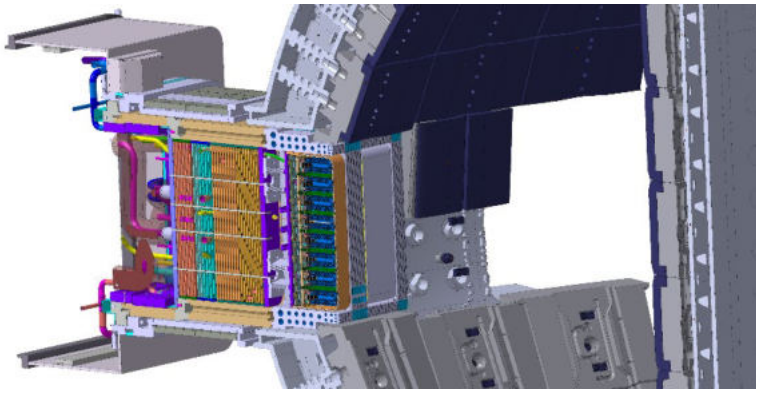
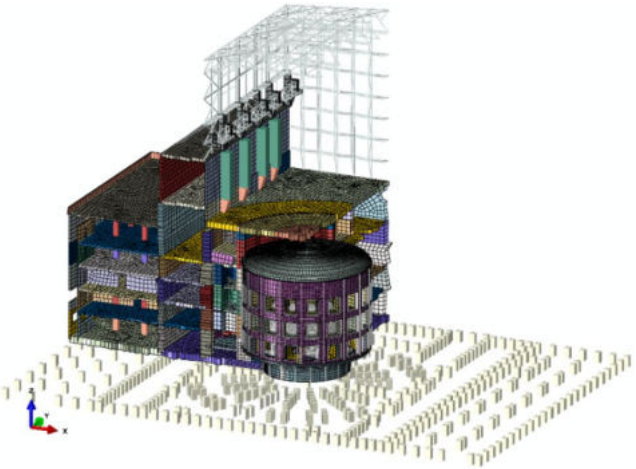
ESTEYCO Mechanics

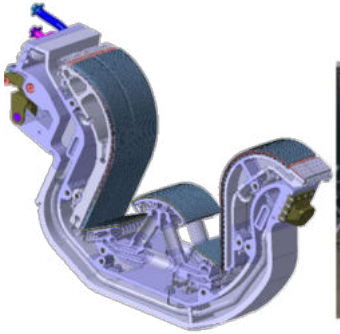
An overview of experience in fusion and two key strengths and development lines

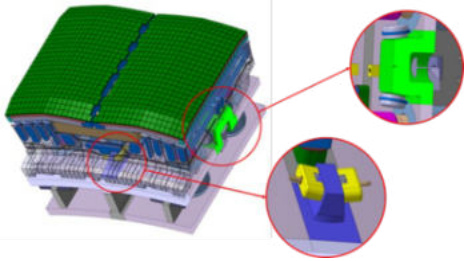
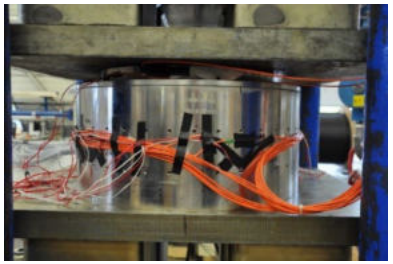
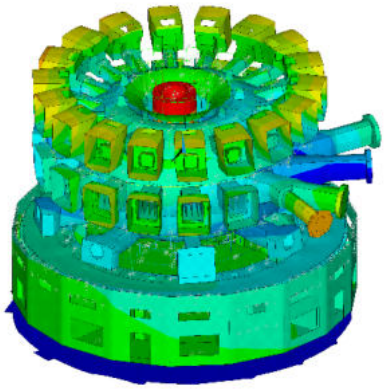
Experience in ITER

- **Intensively worked on many of the ITER main components since 2009:** VV, Magnets, Cryostat, Blanket Modules, Divertor, TBMs, NBIs, ICRH Antenna, Upper Launcher, etc.
  - **Systems Engineering**: Requirements (SRSs), Design (DDDs), Interface Sheets, Load Specs., Justification Reports, etc.
  - **Design & Analysis**: Specific advanced methodologies.

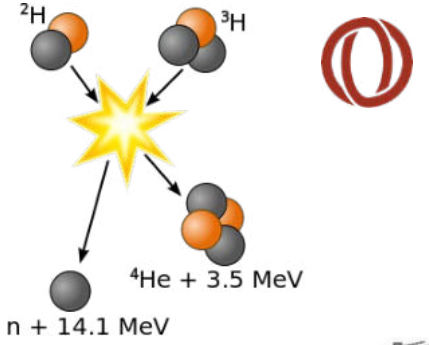
- **Two relevant lines** of activities may be relevant for MIT **-> In charge of** the development of the:
  - **European Test Blanket Modules for tritium generation** to be tested in ITER.
  - **Tokamak Systems Monitor** for electromagnetic, hydraulic, thermal & mechanical monitoring of main Tokamak Systems.

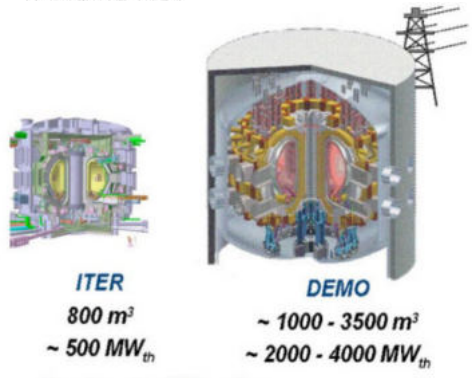



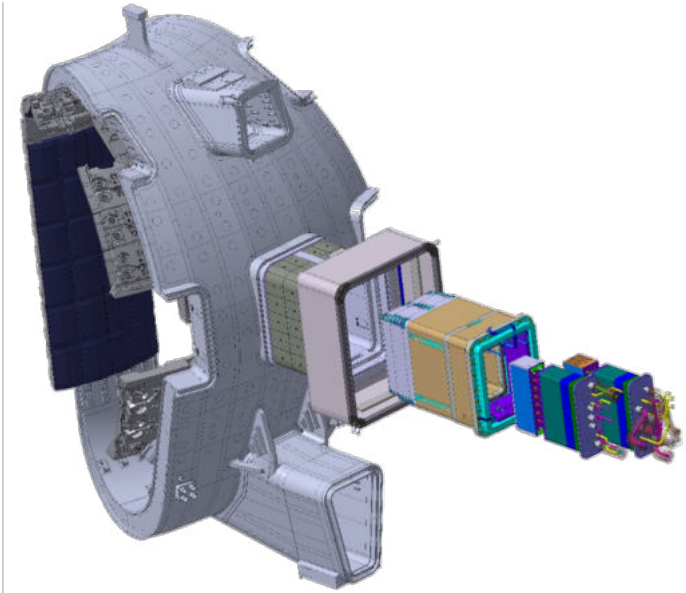





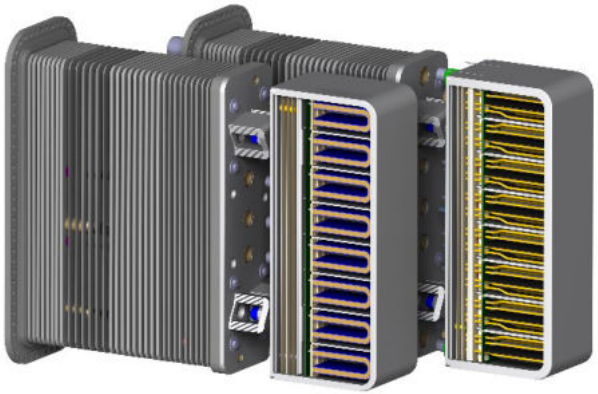
Experience in TBM/BB (tritium generation)

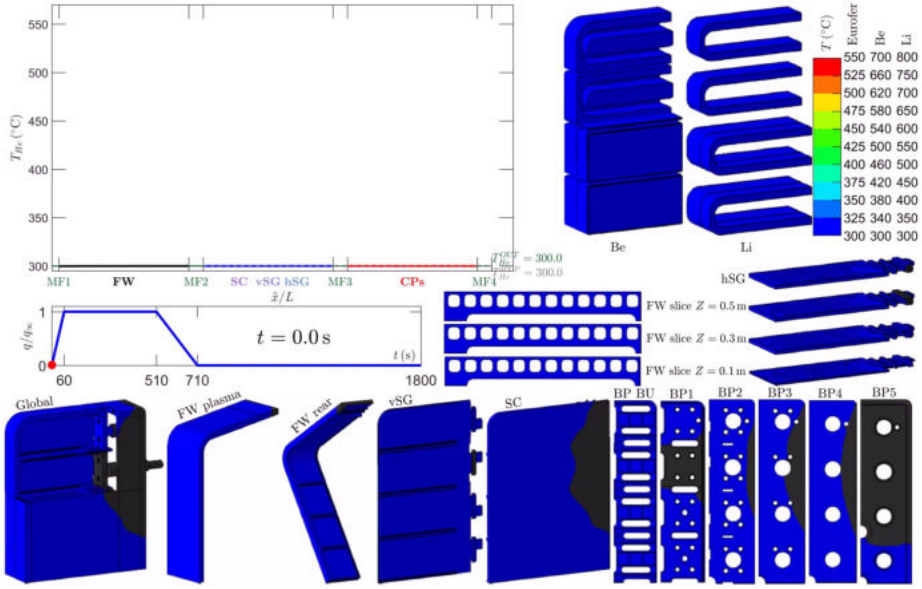


- **Currently in charge of the HCPB & WCLL TBM set designs** for F4E through FWC:
  - Design optimization accounting for manufacturing and nuclear regulatory constraints.
  - Detailed assessment of thermal and structural performance under the pulsed ITER operation.
- **Additional TBM-related** work:
  - Team in charge of first industrial design & analysis support of the EU-TBM program in 2011.
  - Team in charge of the engineering activities for the HCLL & HCPB TBM-Sets presented at CDR.
  - Leadership in analysis activities towards CDR for the WCLL TBM design (supporting CEA).
- Supporting EUROfusion in the **development of the DEMO Breeding Blankets since 2015** (involved in four concepts: WCLL -ENEA-, HCPB -KIT-, HCLL -CEA-, DCLL -CIEMAT-)
- Preliminary **support to UKAEA** in the development of conceptual designs for **Breeder Blankets in STEP**.







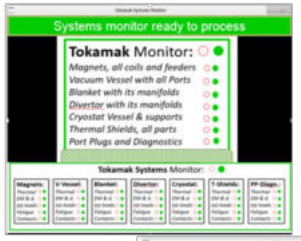


Experience in ITER Diagnostics

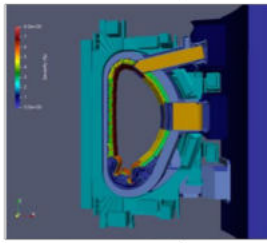
- **In charge of the development of the ITER "Tokamak Systems Monitor (TSM)",** a specifically designed **software** which will make **use** of the **available instrumentation to provide an integrated view of the real overall mechanical response of the Tokamak** in near real time, with delays generally below one second:
  - The sensors information can be used **directly** (e.g. the calculation of electromagnetic loads based on measured currents and magnetic fields) **or indirectly, through the resolution of ill-posed, inverse problems**.
  - The **outputs** of the TSM **will be made available in the control room so the operator can react** if necessary. **Moreover**, within minutes, more detailed information will be provided **to engineers and scientists** so that they can make the necessary adjustments between plasma pulses

POZ: Monitoring of TSM, configuration and execution

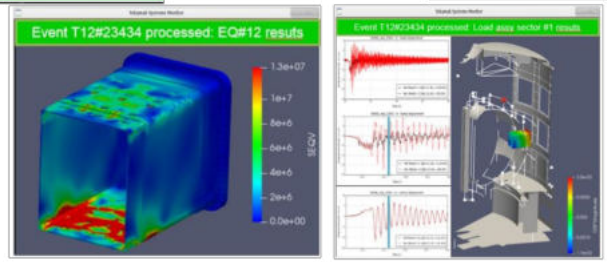
XPOZ L1: Tokamak Summary

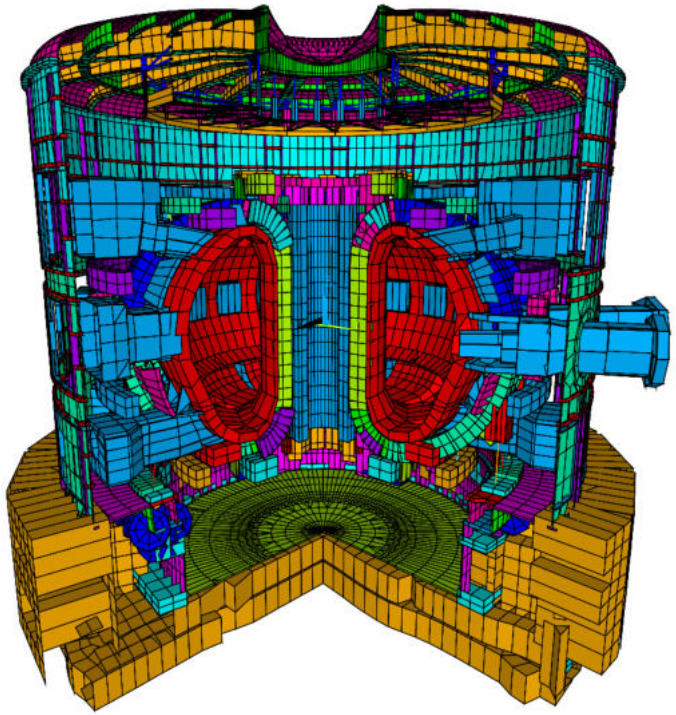


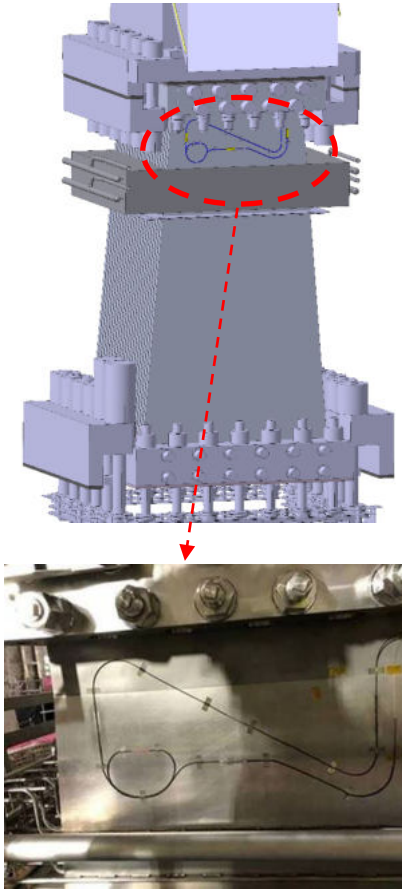
XPOZ L2: Tokamak Subsystem Status



XPOZ L3: Tokamak Subsystem Component Analysis

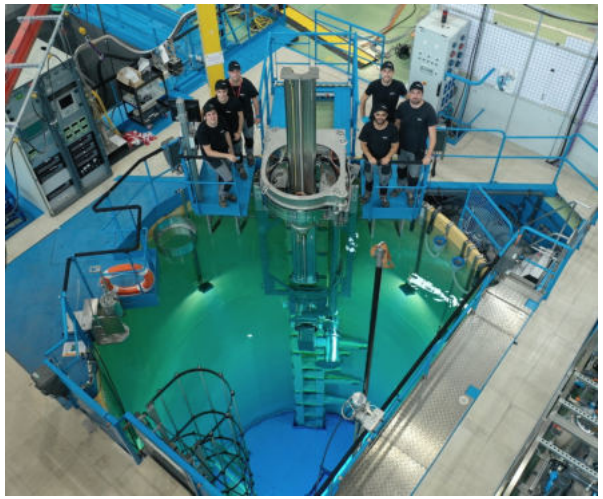




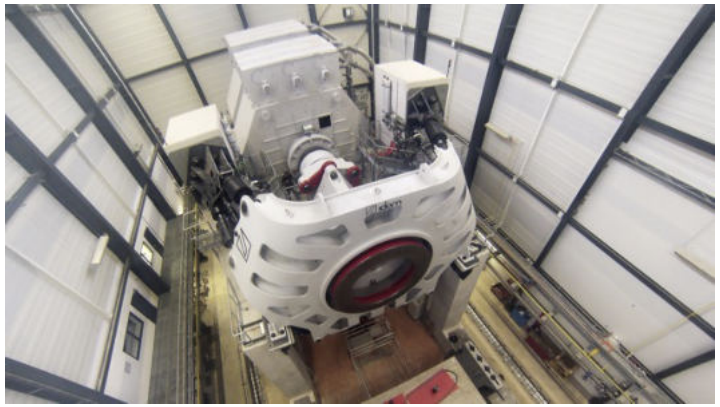


Science and Technology

IDOM PROFILE



JHR Underwater X-Ray Tomography and Gammametry Bench



Dynalab Wind Turbine Testing Facility

IDOM ADA (IDOM's Advanced & Analysis Design Division) is devoted to create and deliver bespoke advanced instruments and systems for Science and Technology.

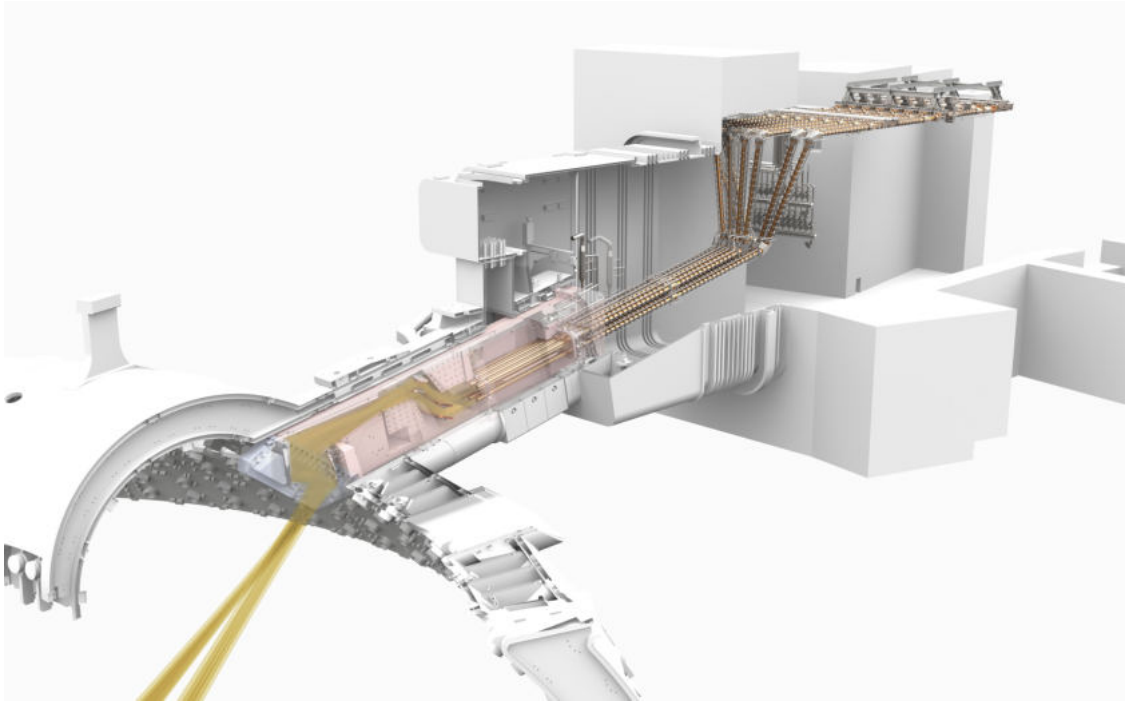
IDOM ADA operates from Bilbao IDOM Headquarters (Spain) –where the bulk of people and our integration facilities are located- and IDOM's US branch in Minneapolis (MN, US), and delivers its products and services to the best research institutions in the world.

We master mechanical design, mechatronics, optical design, opto-mechanics, systems engineering, full range of analysis and simulation capabilities (solid and fluid mechanics, system dynamics, radiation transport and neutronics, electromagnetics, complex phenomena, multiphysics), prototype and testing, systems integration.

In addition to IDOM ADA, IDOM operates globally in areas such as power generation, oil & gas, renewable and alternative energies, manufacturing industry, cilivil infrastructures, nuclear plants, architecture and unique challenging engineering projects.

4300 Professionals	Since 1957	920 Partners	125 Countries

PROJECTS – SCIENCE & TECHNOLOGY



One of the 4 ITER Electron Cyclotron Upper Launchers

Fusion Technology - Design, qualification and supply of instruments and other systems for ITER.

- Design and Supply of the ITER Electron-Cyclotron Upper Launchers
- Design and Integration of ITER European Diagnostic Ports
- Design and qualification of the Core Plasma Thompson Scattering diagnostic for ITER
- Design and qualification of ITER first confinement barrier water, gas and electrical feedthroughs.
- Design and qualification of ITER Divertor Remote Handable electrical connectors

Some projects in other fields:

- Design and supply of Gammametry and X-Ray tomography benches and collimators – JHR materials research nuclear reactor, France.
- Design and prototyping of Tungsten rotary target concepts for SNS (ORNL, US) and ESS (Europe)
- Design and supply of the European ELT Pre-Focal Stations and a Local Coherencer (patented)
- Design, prototype and sea testing of a Wave Energy Converter (WEC) – with a grant from the US DOE
- Design and supply of the DKIST (Daniel K. Inouye Solar Telescope) enclosure (AURA, US)

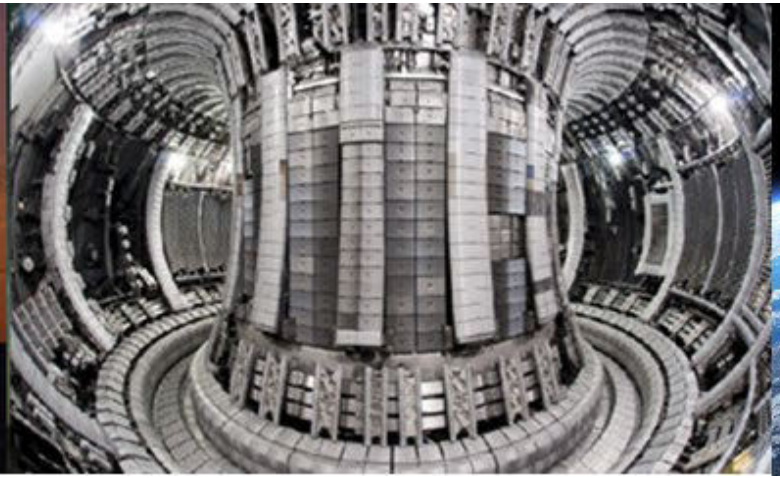
IDOM is very interested in exploring potential collaborations with the MIT in Fusion Technologies and others. Topics of interest (tentatively):

- Gyrotrons
- Railgun to launch space objects
- Others


IDOM

LEADING
METAL-MECHANIC SOLUTIONS
Evolving With You

Experience in Fusion Technologies
L E A D I N G G R O U P


Management
Project Management
Supply Chain Management (SCM)
Quality Assurance Management (ISO 9001)
Safety Management (ISO 45001)
Continuous Improvement Process (CIP)
Environmental Management (ISO 14001)
Total Productive Maintenance (TPM)

Standards Management
Nuclear Standards (RCC-Mx and ASME)
Military standards,
ISO, ASTM, PED, ESP/ESPN

Product engineering
3D Modelling & FEM
Mechanical Engineering
Control of Electromechanical Systems
CAM (Computer-Aided-Machining)
Casting
Welding

Innovation
Business Innovation
Product Innovation

Machining Technologies:
Precision Machining of Exotic Materials: Duplex, Inconel, Hastelloy, Titanium….
Beryllium Machining

Joining Technologies
Welding Machines: GTAW, SMAW, GMAW, SAW
Orbital Welding Laser Welding System
Canning for HIP Process

Coatings
PVD

Assemblies
Assembly in a Clean Room under Controlled Conditions of Humidity and Temperature

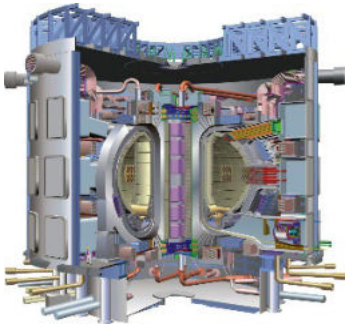
FAT Testing
Metrology
Leak Testing
Pressure Test
Hot Helium Leak Test Chamber
Ultrasonic Testing

Facilities

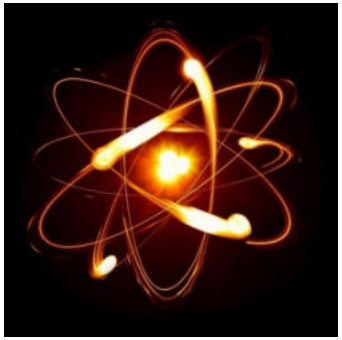
1.Headquarters, Engineering, R&D
2.Machining Workshop
3.Special Materials Workshop
4.Joining Technics Workshop
5.Cleaning Rooms Area
6.Coatings Area
7.FAT Area
8.On-Site Services
9.Warehouse

LEADING´s REFERENCES
Science Large Contracts

NUCLEAR FUSION



F4E-OMF-0900 - Series Production of the Normal Heat Flux (NHF) ITER Blanket First Wall (FW) Panels – F4E (2020-)
F4E-OPE-1060 – Manufacture of Welded Support Mock-up – F4E (2020)
ITER ASSEMBLY TAC2 – ITER (2019-)
Manufacturing design of the FWP (DNO #23991) – F4E (2018-)
ITER Blankets Alternative Design Mock-up (DNO #10336) – F4E (2018-)
Tokamak Assembly Preparation Building Engineering (IO/17/CFT/10015153/ABN) – TRACTEBEL (2018)
Manufacturing of Prototypes of the Supports of the Blanket Cooling Manifold System and Application of Coatings on Different Items (F4E-OPE-0833) – F4E (2018-2019)
Sub-assemblies for ITER Vacuum Vessel – AMW (Ansaldo Nucleare & S.p.A, Mangiarotti S.p.A) (2017-2018)
F4E-OPE-0805 - Splice Plate Custom Machining for the JT-60SA Magnet – F4E (2016-2018)
F4E-OPE-443 IV-PT - Manufacturing of the Full-Scale Prototype ITER FIRST WALL PANELS – F4E (2014-)
Manufacturing of the Semi-Prototype ITER FIRST WALL PANELS (F4E-OPE-394) – F4E (2012)
F4E-2008-OPE-17 - ITER Engineering Support – F4E (2009)



NEUTRONS SCIENCE

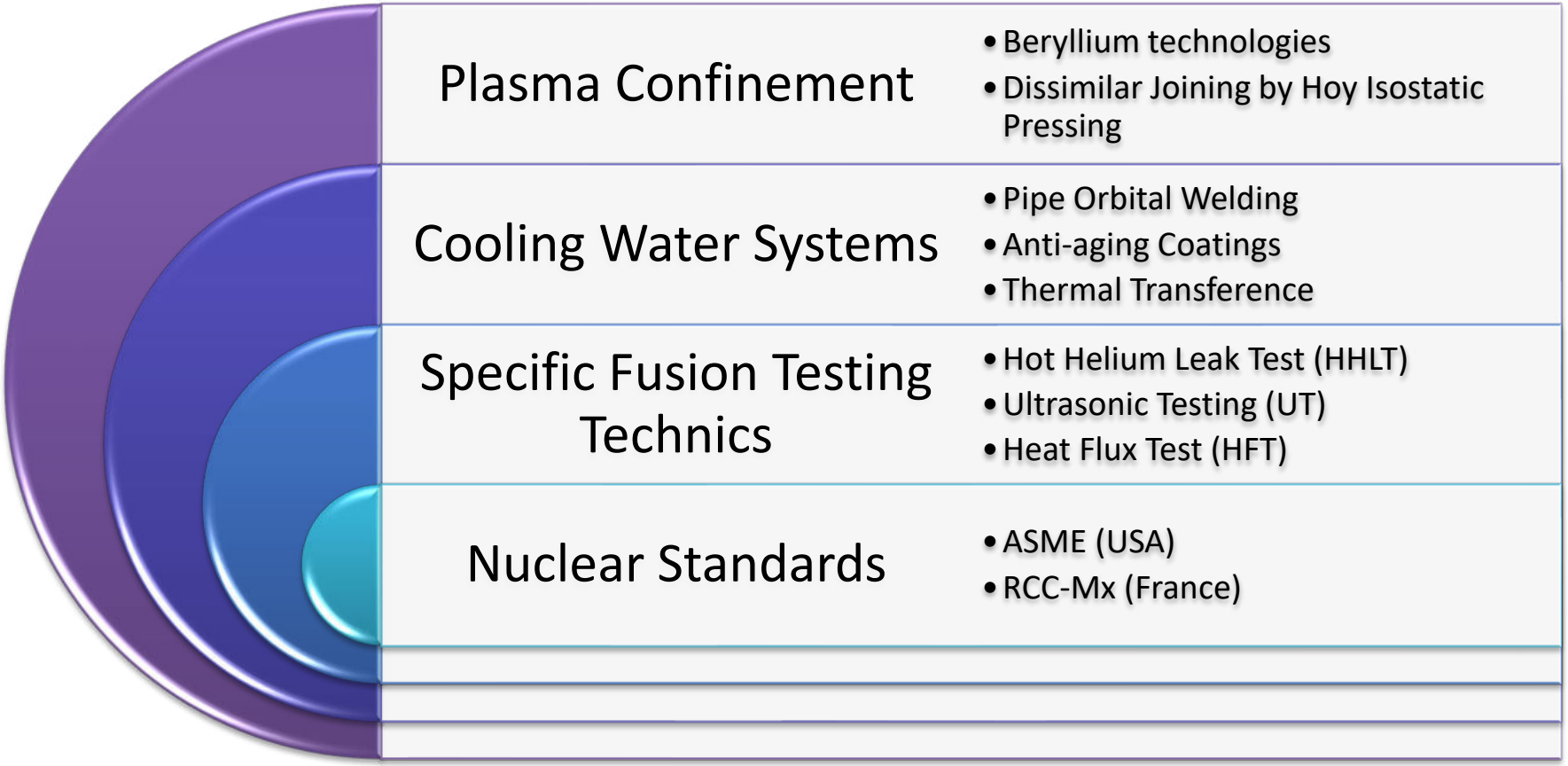
Manufacturing 1St Prototype Target Cassette – ESS Lund (2015)
Manufacturing 2nd Prototype Target Cassette – ESS Lund (2016)
Target Shaft Engineering Design – ESS Lund (2016)
Target Bricks Manufacturing – ESS Lund (2016)
Target Dummies Manufacturing – ESS Lund (2016)
Manufacturing 36 Series Target Cassettes – ESS Lund (2016-2018)
Target Monolith Vessel Engineering Design – ESS Lund (2016-2017)
3 x Proton Beam Window Prototypes – ESS Lund (2018-2019)
Aluminum blades for XTREMED detector project – ILL (2018)
TS1 Beryllium Reflector – ISIS (2018-2019)

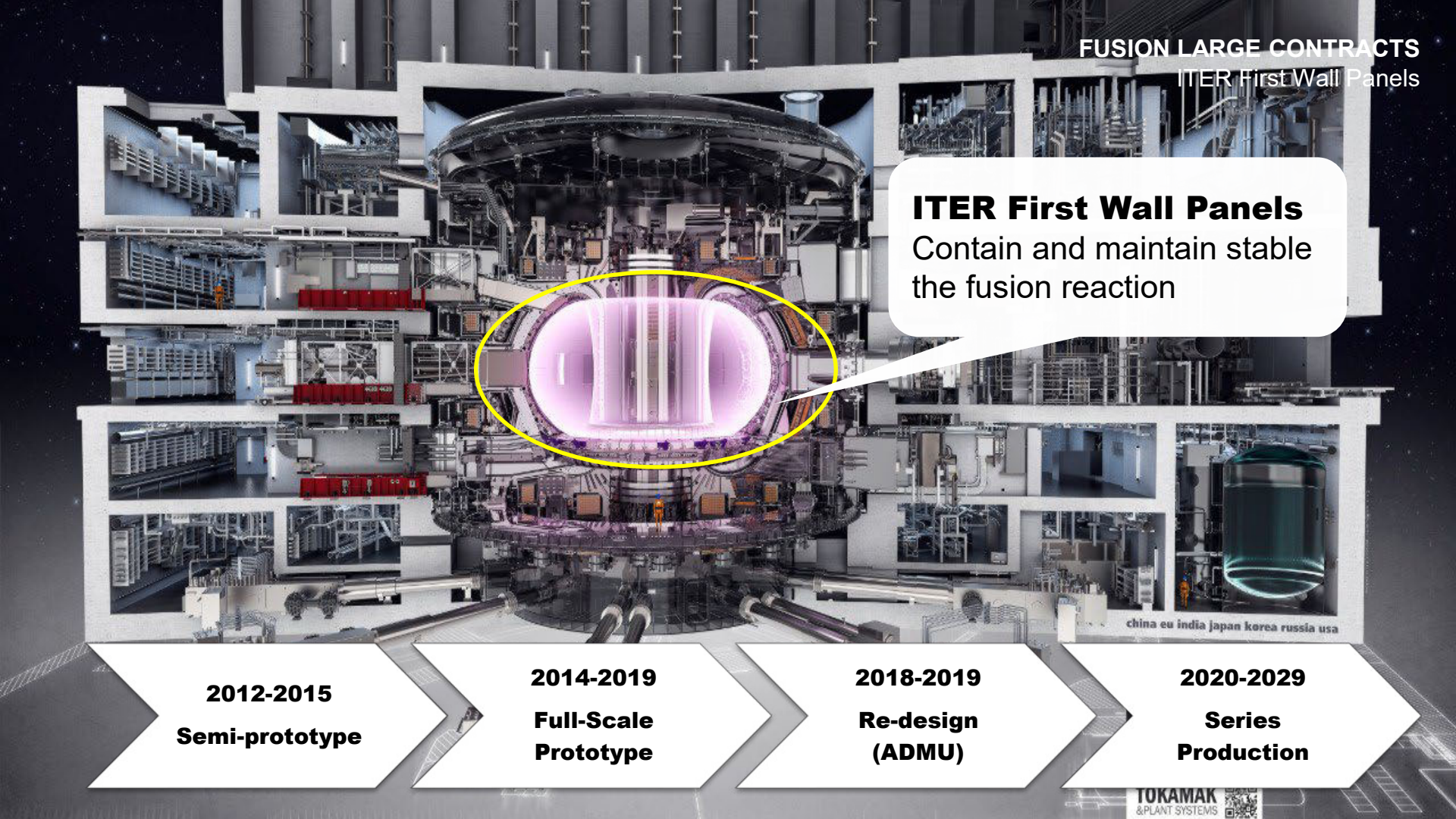
NUCLEAR REACTORS

Jules Horowitz Reactor (JHR) Manufacturing Design – AREVA (2016)
NRG Beryllium Reflectors – NRG (2021)

ASTRONOMY

ESO Alignment Tool – ESO (2009)


Plasma Confinement
• Beryllium technologies
• Dissimilar Joining by Hoy Isostatic Pressing
Cooling Water Systems
• Pipe Orbital Welding
• Anti-aging Coatings
• Thermal Transference
Specific Fusion Testing Technics
• Hot Helium Leak Test (HHLT)
• Ultrasonic Testing (UT)
• Heat Flux Test (HFT)
Nuclear Standards
• ASME (USA)
• RCC-Mx (France)



ITER First Wall Panels

Contain and maintain stable the fusion reaction

2012-2015
Semi-prototype

2014-2019
Full-Scale Prototype

2018-2019
Re-design (ADMU)

2020-2029
Series Production

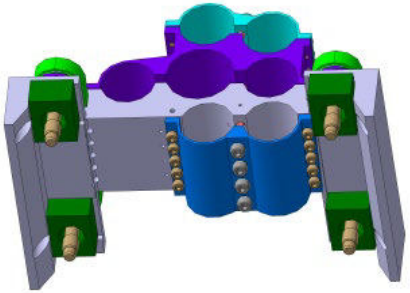
DYNAMIC

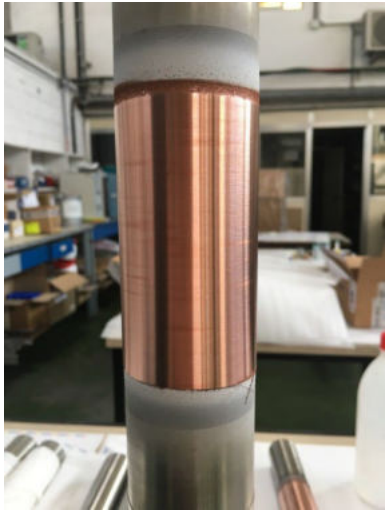
The company DYNAMIC SNC (société en nom collectif owned by ENGIE (France), ANSALDO ENERGIA (Italy), ORTEC GROUP (France), SIMIC (Italy) and LEADING (Spain) is in charge of the assembly, installation and commissioning of the Tokamak ITER Machine Assembly in Cadarache (France) during the Assembly Phase 1 which covers the major part of the assembly work for the Tokamak Machine. The ITER Tokamak Assembly is one of the major ITER contracts in terms of resources and complexity.

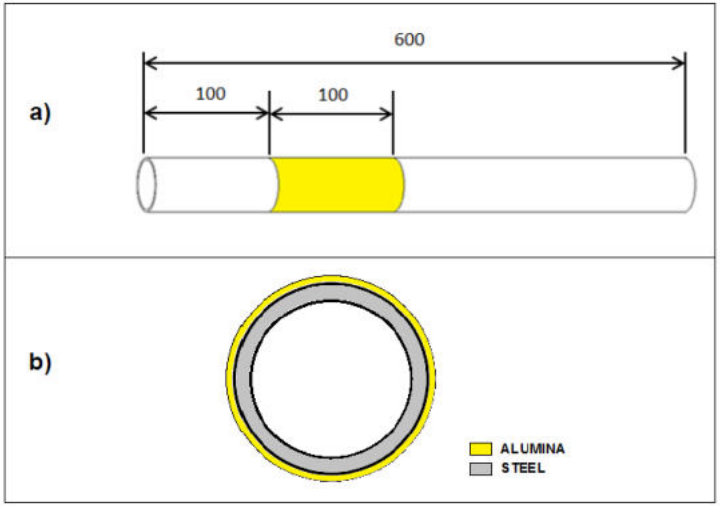
The contract includes the assembly of basic Tokamak machine with systems essential for First Plasma operation; the installations comprise permanent hardware, temporary equipment, replacing permanent hardware, such as the main in-vessel components, and captive components that cannot be installed in later assembly phases.

Figure 1 - Assembly Phases

The support selected is for seven pipes. It includes a “bridge” spanning between four anchor points, three profiled straps pressed onto the pipes by means of preloaded high strength bolts, four sleeves and spacers located between the legs of the bridge and the anchor points, and electrical grounding in the form of spiral springs.



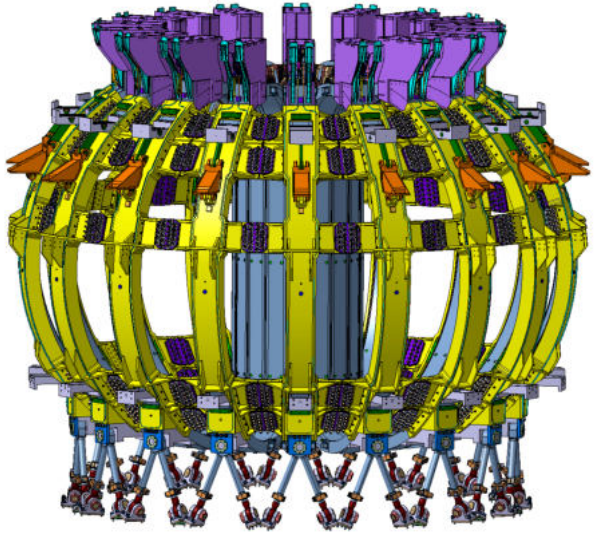




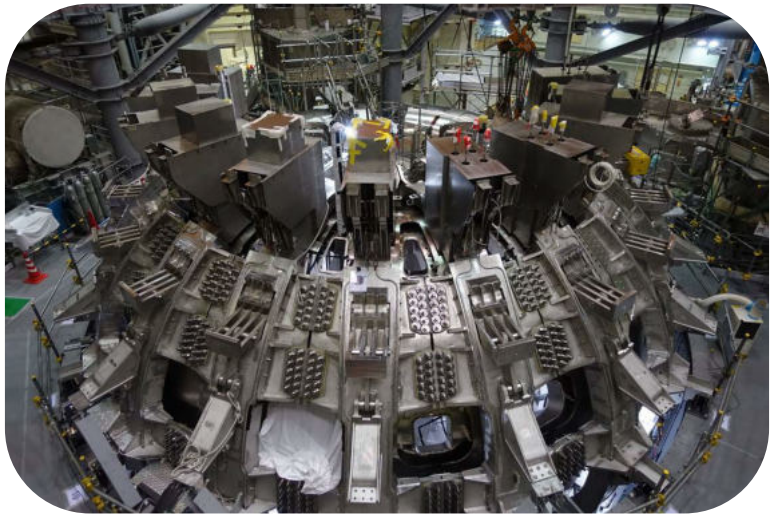
An alumina coating was applied **by a High Velocity Oxygen Fuel process**. The detailed description of the process (including critical parameters and their values, inspection, packaging and delivery) was part of the deliverables.

SPLICE PLATES

F4E must supply the toroidal field (TF) magnet for the JT-60SA tokamak. This will be made up of 18 large D-shaped superconducting coils. Each coil will be delivered to the assembly site already pre-assembled with its Outer Intercoil Structure (OIS). During the installation of the coils, at the outer radius of the tokamak each sector of the OIS must be bolted to its neighbours using splice plates. Each pair of coils is joined by 5 pairs of splice plates.



Toroidal field (TF) magnet



Splice Plates In TOKAMAK
Naka (Japan)

OIL & GAS
HAYWARD TYLER
DRESSER RAND (NO)
FREUDENBERG OIL & GAS TECHNOLOGIES (NO)
FAURE HERMAN (FR)
TECNICAS REUNIDAS (SP)

AEROSPACE & DEFENCE
MBDA (GER)
NEXTER (FR
ARQUUS (FR)
NAVANTIA (SP)
INDRA (SP)
AIRBUS (EU)
ROLLS-ROYCE (UK)
MSI (UK)

NUCLEAR
ITER ORGANIZATION (WW)
FUSION FOR ENERGY (EU)
FRAMATOME (FR)
ANSALDO NUCLEARE (IT)
NRG (ND)
IBERDROLA (SP)
ENSA (SP)

NEUTRONS SCIENCE
ESS LUND (EU)
CERN (EU)
ISIS (UK)

"MAKING THE SMALL PROFITABLE"

nanoker

ADVANCED CERAMICS-BASED SOLUTIONS COMPANY

EXECUTIVE SUMMARY

Nanoker Research is an European (Spanish) SME company that manufactures technical ceramic components, starting from powder and producing the finished part. Nanoker is a ceramist company (material, processing, sintering and finishing are activities covered by the company.)

23 People

30% of the employees are highly skilled, and devoted to the development of new materials and products

Turnover: 2,5 M€ 2019

EBITDA >1 M€ en 2019. After the COVID period, the company has developed a business plan to reach a turnover of 5 M€ in Europe in 2025.

6 patents under exploitation

The patents are exclusive of CINN-CSIC, and they are licensed to Nanoker.

STRATEGIC SECTORS

Nanoker is specialized in **three market niches**

Industry

Nanoker is producing mechanical components of complex shapes. Ceramics are used where properties of high hardness, low roughness, high mechanical strength, corrosion resistance, and high refractoriness are required.

Product Examples:

- Nozzles
- Extruding dies
- Welding pins

Medical devices

The company is specialized in the production of high precision microcomponents with specific features in biocompatible materials (3Y-TZP, ATZ). Nanoker is working under ISO 13485 and ISO 13356 standards.

Product Examples:

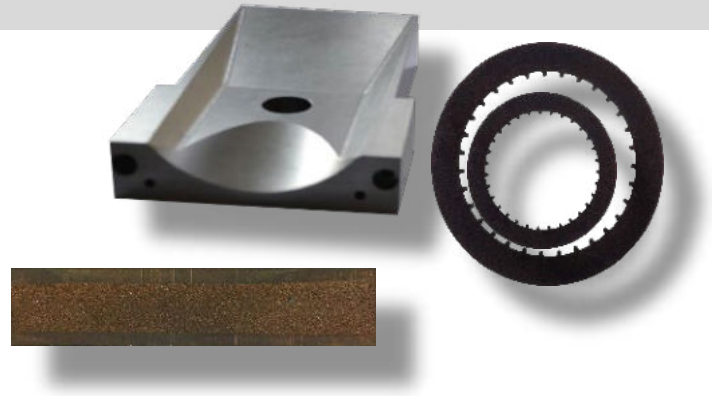
- Screws
- Dental abutments
- Tips for ablation surgery

Big science

Nanoker has developed special materials for thermal management under extreme environments in large research infrastructures, such as CERN, ITER, ILL, XFEL, ISS.

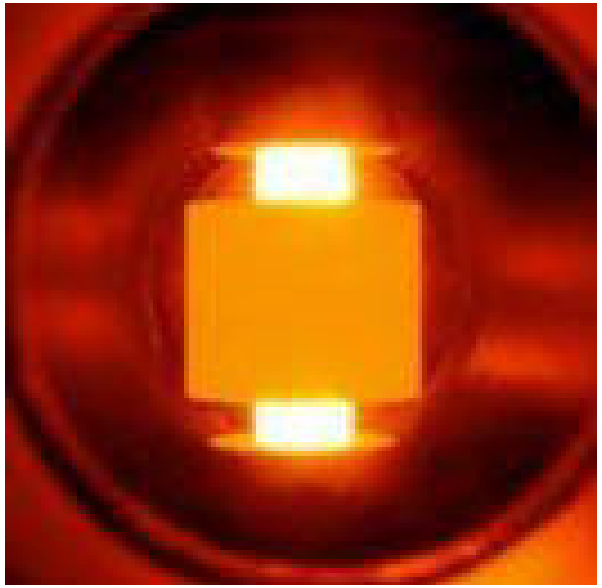
Product Examples:

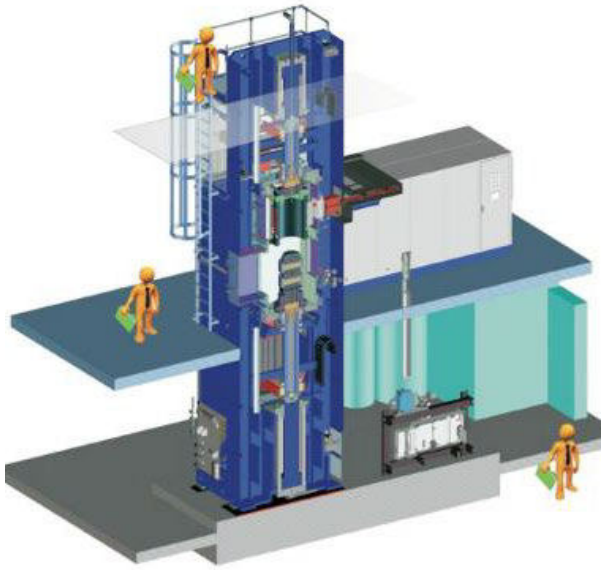
- Heat sinks
- Absorbers for collimators.
- Insulation components for magnets.

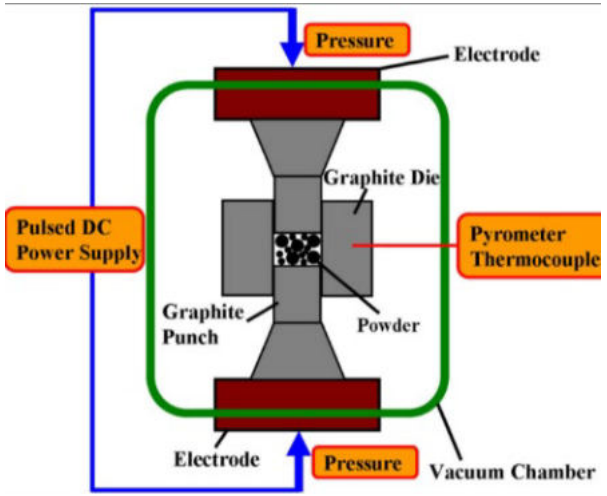


SPARK PLASMA SINTERING

(OUR TECHNOLOGY FOR SPECIAL MATERIALS)

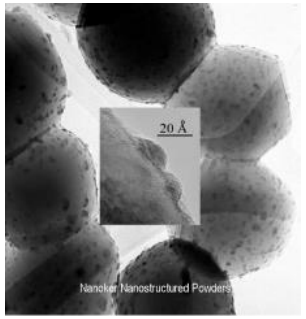






EXPERIENCE WITH SILICON CARBIDE

Ballistic protection



RAW MATERIALS MIXING AND CONDITIONING

LP-SiC

91%SiC-5,5%Al_2O_3-3,5%Y_2O_3

Ø230 mm, thickness ~8,5 mm

Density: 3,24g/cm^3
Hardness: *24 GPa*
Toughness: *~4,1 MPa·$m^{1/2}$*

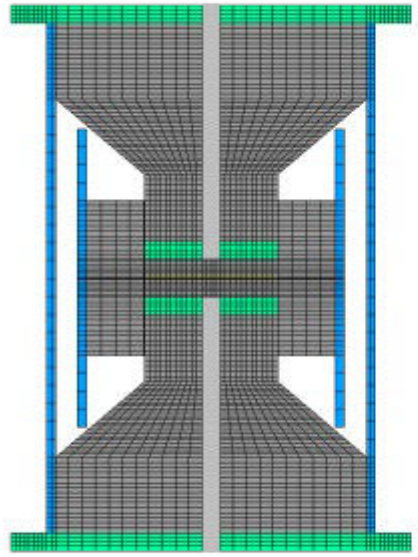
PRODUCTION OF BLANKS BY SPS

BODY ARMOUR MADE OF SiC

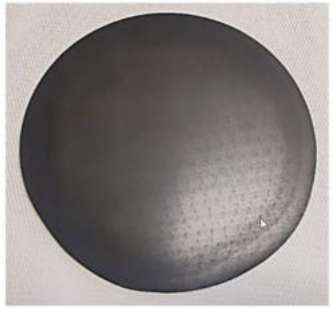
EXPERIENCE WITH SILICON CARBIDE

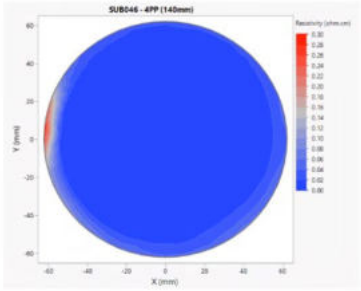
Semiconductor industry

SLIP CASTED GREEN BODIES



OPTIMIZED SINTERING PARAMETERS





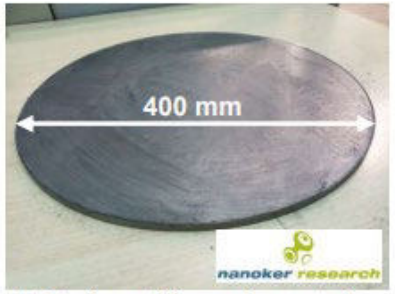
6H-SiC wafer substrate (6 inch)

Low resistivity (<10 mOhm·cm)

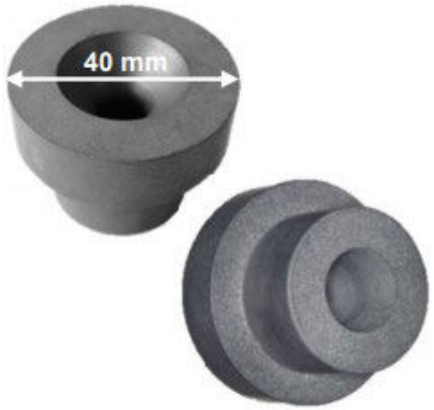
EXPERIENCE WITH SILICON CARBIDE

UHTCMC

Ultra-High temperature ceramic composites: ZrB_2 – Cf - SiC



UHTC piece (40 cm diameter). Piece fabricated at NANOKER



Subscale nozzles machined after sintering. Both EDM and conventional machining are possible.

Property	Value	Comment
Vol % of fibers	up to 50%	Conventional ceramic processing enables to incorporate high amount of short fibers
Density (kg/m³)	3.9 - 4.2	Variation of porosity and fiber volume fraction impact on the final density
Fracture toughness (RT)	4 - 5	The presence of the fibers improves the damage tolerance of the UHTC matrix
CTE (10^{-6} K^{-1}) (20-1500 °C)	4.7 – 5.5	CTE is reduced as compared to the UHTC matrix
Thermal conductivity (W/m·K), 20-1500°C	50-33	Efficient heat dissipation is guaranteed by high thermal conductivity up to high temperatures
Thermal diffusivity (mm²/s) (20-1950°C)	22-7	Measured close to 2000°C. Material is completely stable up to this temperature
Bending strength (MPa)	130-140	This value depends on fiber amount and length.

Next generation ceramic composites for combustion harsh environments and space.

Applications:

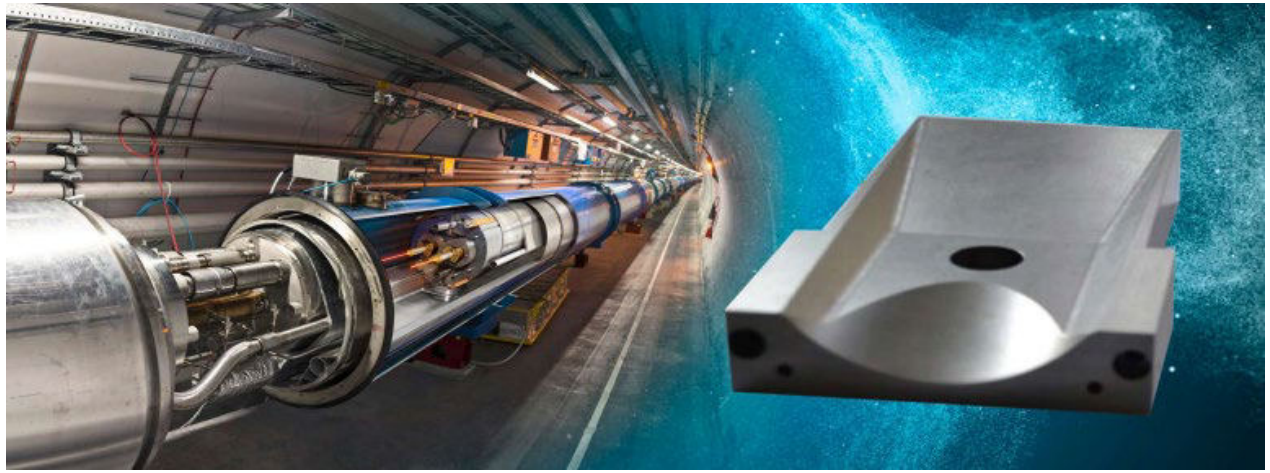
TPS – Tiles

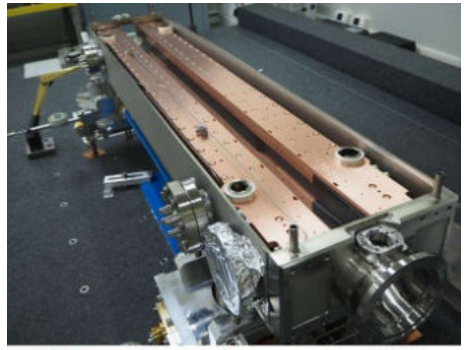
Thermal protection systems of hypersonic vehicles that should resist stresses during launch and re-entry

Rocket Nozzles

To survive harsh environments produced by high performance solid propellants during launch

GRAPHITE-METAL CARBIDE COMPOSITES

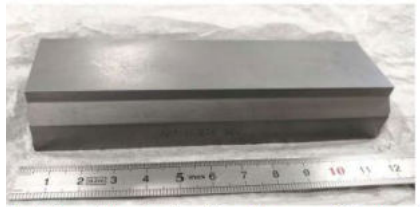




Primary collimator. Picture courtesy of CERN

Special insert (CTE-matching with Si)

Through hole of D1.6 mm ; thickness - 1 mm



Block for collimator (position tolerance of 5 micron)

Physical properties		
Parameters	Units	X,Y | Z *1
Density	g/cm³	2.57
Flexural Strength	MPa	102.1 | 16.9
Flexural Strain to rupture	µm/m	2580 | 5900
Young Modulus	GPa	69.7 | 5.5
Thermal conductivity (@20°C/300°C)	W/m·k	650/310 | 45/23
Thermal Diffusivity (@20°C/300°C)	mm²/s	390/110 | 27/8
CTE average (20-1000°C)	$10^{-6}K^{-1}$	6.5
CTE *2 (20-1000°C)	$10^{-6}K^{-1}$	2.4 | 14.7
Specific heat	J/g·K	0.65
Electrical conductivity	MS/m	0.8
Dimensional stability	%	0 | 0.1

All properties measured at 20°C unless otherwise stated

*1 XY - Parallel to the grain direction; Z - Perpendicular to the grain direction

*2 CTE adjustability according to chemical composition

Graphite-Metal carbide composites

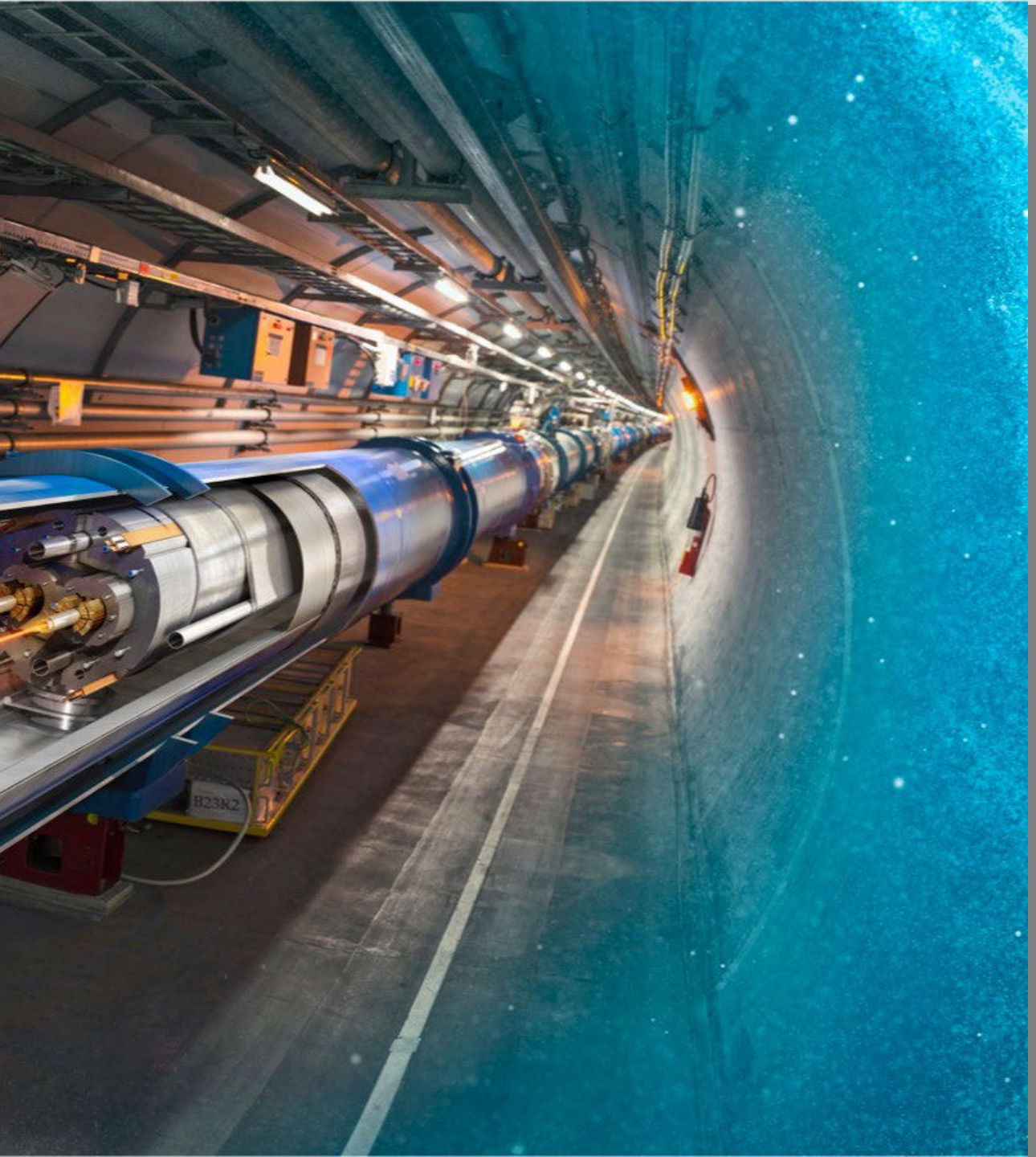
The new family of materials with extreme capacity of heat dissipation as well as improved mechanical properties (strength and hardness) compared to isostatically-pressed graphite.

The material selected by the CERN to collimate the beam halo.

Other applications:

Heat sinks for electronics

Thermal dissipation with a CTE-matched with Si, SiC, GaN, and low density.



THANKS

Phone :
+34 985 20 76 13

Address :
Polígono de Olloniego Parcela 22A,
Nave 5, 33660, Oviedo, Asturias, Spain

Website :
https://www.nanoker.com

Email :
info@nanoker.com