CURRICULUM VITAE

CARDELLA ANTONINO

Degrees: Dottore in Ingegneria Nucleare (Italy) - University degree in Nuclear Engineering, 14-4-1977
Professional Engineer Qualification (1980).
Italian University Professor (Ministero dell'Università e della ricerca scientifica 1992).
German Honorar Professor (Technische Universität München - School of Engineering and Design Department of Energy and Process Engineering, 18-10-2017), Dozent since April 2010.

Competences and Expertise:

- **43 years working experience**: 39 years on **nuclear fusion research** and 4 years on **nuclear fission power plants**.
- Direct experience in the **construction phase of Large Fusion Devices and Nuclear Power Plants**.
- On site representative for manufacturing, installation and commissioning of system and components
- Direct Experience in **Design** (from first concept to detailed manufacturing drawings)**, Manufacturing, Integration, Assembly, Quality Assurance and R&D of Thermonuclear Fusion components**:
  - **Vacuum and pressure Vessels with their Support System (7 in total)**
  - **Large Cryostats Vessels with their Supporting system (2 in total)**
  - **First Wall, Shielding and Breeding Blankets, Divertors, Limiter**,
  - **Supporting Structure and the Intercoil Structures of Superconducting Magnets,**
  - **Cryopumps,**
  - **Glow Discharge Electrodes, In-vessel Cooling Networks**
  - **Magnetic Diagnostics**.
- Experience in the **management** of **teams of professionals, designers and technicians**.
- Large experience in the **Project Management** of **large** (e.g. >50 million $) **International Projects**.
- Knowledge of **TOKAMAKS (ITER, JT-60SA)** and **STELLARATORS (WENDELSTEIN-7X) devices**.
- Large competence in **structural** and **thermo-mechanical analyses**, **complex transient thermal analyses** and **advanced thermo-hydraulics**.
- Long experience in mechanics and knowledge of **fabrication technologies and joining technologies.**
- Experience in **working** (including **negotiations and communication**) with **International Organizations**.
- Knowledge in relevant parts of nuclear codes and standards (e.g ASME, RCC-MR, DIN).

A. From 01-2-2018 to present: Consultant and Advisor (Self Empoyment) - Professor at the Technische Universität München.

1. **Consultant,** Advisor, **Lead Engineer for EUROfusion on IDTT and DEMO** (January-December 2021).
2. Member of **DTT Cost Review Committees and technical evaluations** for CREATE consortium (2018-2020)
3. **Consultant Field Engineer** at Belleli (Italy) for the manufacturing of the **ITER Vacuum Vessel** seconded by F4E (1.2.2018 – 31.1.2019).
4. **Teaches Nuclear Fusion Technology** at the **TUM School of Engineering and Design, Munich, Germany**

B. From 14-6-1982 to 01-2-2018 Scientific Officer of the European Commission (from 14.5.1982 to 1.8.1994 seconded by other Institutions)

1. **1-3-2013 to 31-1-2018, seconded to F4E for the JT-60-SA Tokamak built in Naka Japan and for the ITER VV** procurement (last 3 4 months)**:**

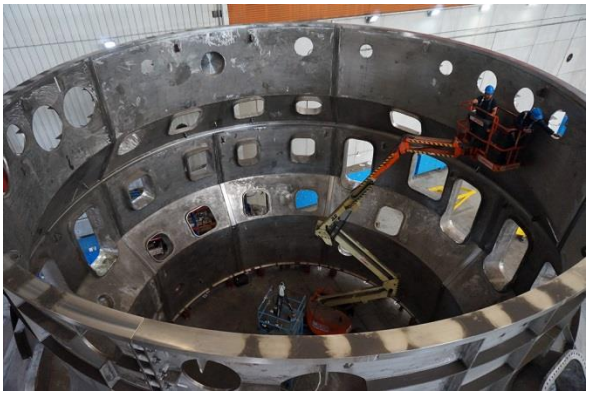
Main Responsibilities / Activities:

- Task Responsible Officer for F4E for **the Final Design, analyses and on time Procurement of the JT60-SA bolted Cryostat Vessel Body** (Ø 13.47 m x 15.85 m) **including its Integral Preassembly at factory, its Shipment, and Assembly Strategy); Procurement Association CIEMAT (E).**

- **Design and on time (12 months) Procurement of Six large Storage Helium Pressure Vessels (20m long x 4m ø, 73 t) for the JT-60SA cryogenic system, including their Shipment, Transport and Installation on Site.**
- F4E **RO, on site representative and safety officer delegate** for the **Cryogenic System** (F4E with CEA Association).

Examples:


JT-60SA Helium Storage Vessels Final Assembly

JT-60SA Cryostat Vessel Body Integral Preassembly at Factory

2. <u>1-5-2004 to 28-2-2013, seconded to the Wendelstein 7X project, a large Stellarator built at the Max Planck-Institut für Plasmaphysik in Greifswald, Germany:</u>

➢ **Head of the Cryostat Department & Deputy "Magnet and Kryostat" Division Head (2004-2007),**

Main Responsibilities / Activities:

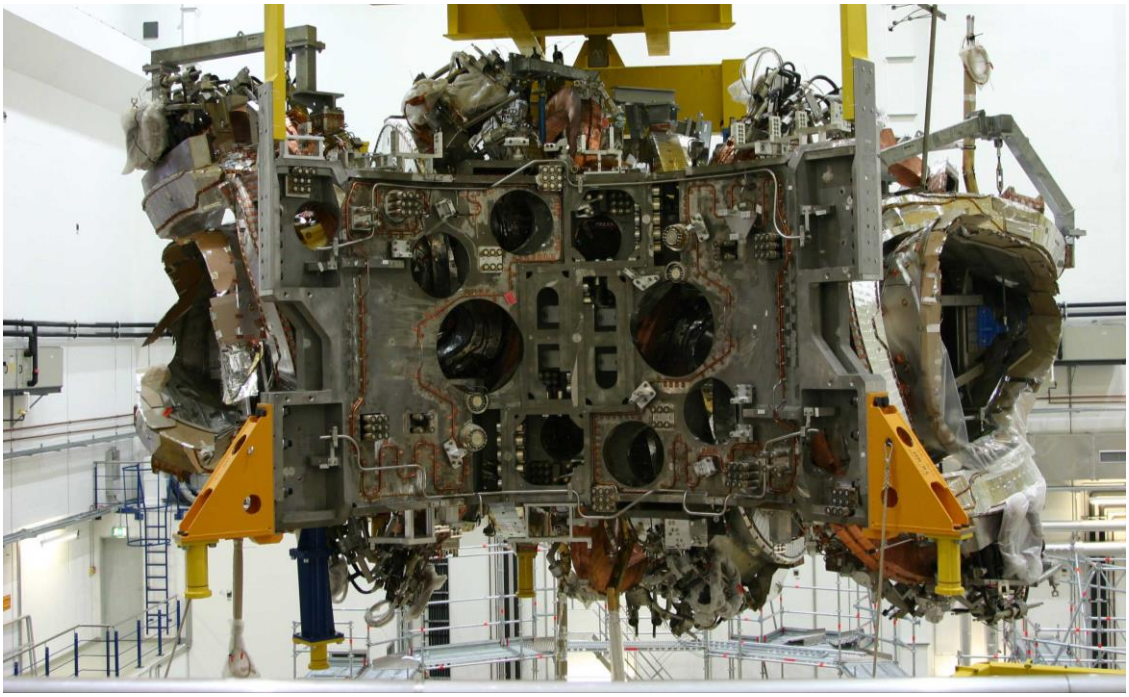
- **Department staff management** (15 professionals, 2 CAD designers and 3 temporary inspectors).
- Design, Construction, Integration and Support to the Assembly of the:
  - **Plasma Vacuum Vessel** (11m major, ~2.5 m minor diameter with complex 3D shape).
  - Adjustable Vacuum Vessel Vertical **Supports and Centring System**.
  - **Cryostat** (11 m major, 4.2 m minor diameters).
  - Superconducting-Coil **Support Ring Structure** (10 m diam, 2.5m high) and its cryo-legs.
  - 299 **Vacuum Vessel Ports**.
  - **Intercoil Support Structures**.

Main Activities:

- ✓ Successful completion of the critical **Design Review** of the main components.
- ✓ Completion of the **manufacturing of all the Vacuum Vessel** modules and **all the 299 vessel ports on time**.
- ✓ Completion of the design and preparation for the manufacturing of the **vacuum vessel supporting system**
- ✓ Development and qualification together with the supplier of a **successful weld procedure** for field joining the vessel sectors and half-modules.

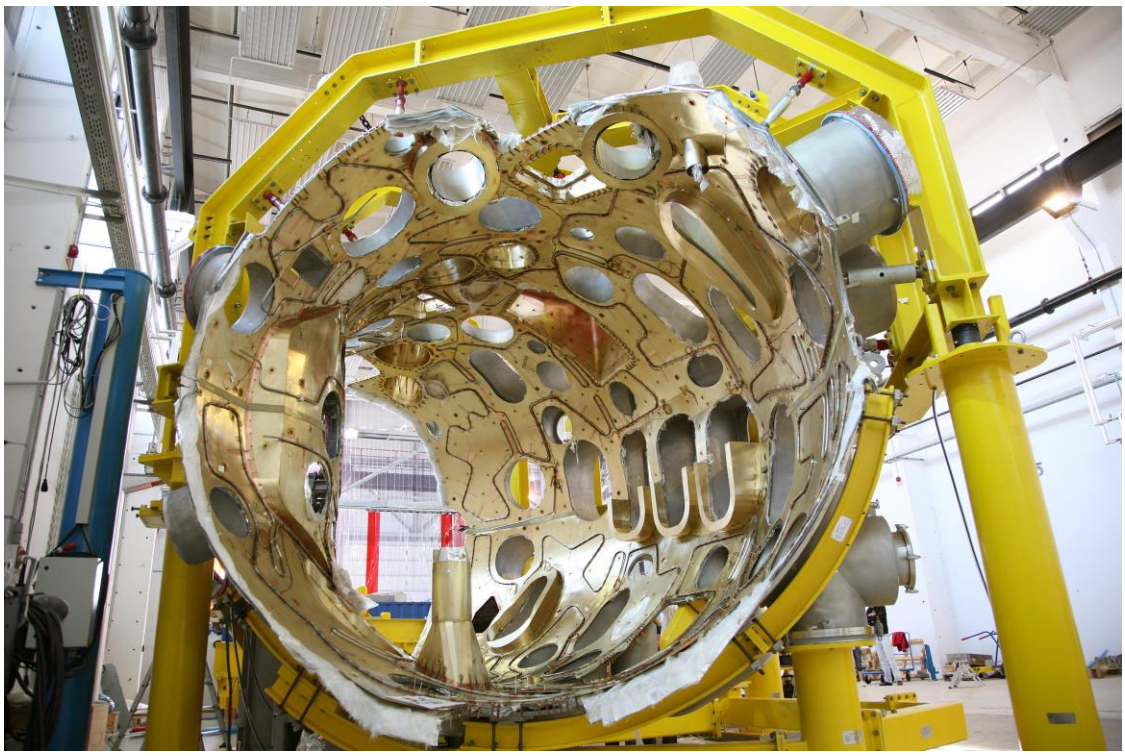
- ✓ Completion of the **manufacturing of the first three modules of the Cryostat** with their domes (total number of the Cryostat domes: 524, some with multiple openings) and advanced manufacturing status of the remaining two modules.
- ✓ Completion of the **manufacturing of the first two modules of the Coil Support Ring Structure** with very stringent manufacturing (+/- 0.1mm at relevant locations).and assembly tolerances (+/- 1mm). Each module consisted of two anti-symmetric semi-modules. Each semi-module was successfully assembled matching precisely all 7 preassembled corresponding coils.
- ✓ Completion of the **engineering design** of the **Intercoil Structures** (advanced status of manufacturing).
- ✓ Successful **solution of severe engineering problems** encountered during manufacturing (e.g. due to design changes or non-conformities of interfacing components, very strict tolerances, etc.).

Examples:



W7-X Superconducting Magnet Central Structure Sector

W7-X Vacuum Vessel Sector



W7-X Cryostat Sector

- **Responsible for the detailed design completion and Final manufacturing of the Cryopumps**, (2008-March 2010).

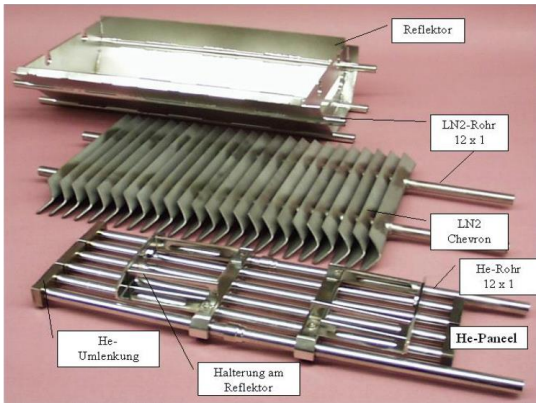
- **Responsible for complex In-Vessel Components Cooling Circuit Network** and **Glow Discharge Electrodes** (2008-March 2010).

- **Head of the Diagnostic Engineering Department of W-7X.** (2 physicists 18 engineers and technicians). Final design, Completion of the R&D **and manufacturing of the W7-X diagnostics** (Apr.2010-Feb.2013).

- **Member of the Technical Advisory Panel of Fusion For Energy, ITER EU DA** (July2011-Feb. 2013).

Examples:

W7-X Foldable Diamagnetic Loop



W7-X Cryopump Parts

3. **<u>21-7-2001 to 30-4-2004, seconded to EFDA CSU international organization in Garching, Germany:</u>**

- **Responsible for the Breeding Blanket Research Area (budget ~6 Million Euro/year).**
  Main Responsibilities:
  - **Head of EU delegation** to the TBWG (testing Blanket Working Group) committee for ITER.
  - Development of the **ITER Testing Blanket Modules.**

- **Definition, Implementation and coordination** of the Design and **R&D tasks and contracts**.
- Direct contribution to the definition of the **R&D Strategies**, and the **required Budget and Work-program** to be submitted to the relevant fusion committee.
- Technical and scientific support to projects.

4. <u>1-8-1994 - 21-7-2001, ITER Member at the Joint Central Site in Garching, Germany:</u>

➢ **Project Manager, Responsible Officer.**

Main Responsibilities:

- **Project Management of the Large Project** 'Nuclear Shielding Blanket' (original budget ~50 million dollar, value 1989) and **Work Area Officer of**: Materials and Joints, Neutronics, Attachment & Connections, Primary Module & Water Chemistry, Baffle, Manifolds & Assembly, Limiter.
- **Responsible for the Design and development of the ITER First Wall, Shielding Blanket, Limiter**.

Main Activities:

✓ **Successful development** of all the key technologies for the **shielding blanket and its First Wall**. **Several mock-ups** up to **full scale prototypes of the blanket system** have been **designed,** successfully **manufactured and tested**.
✓ **Materials** have been selected and characterized.
✓ **Blanket Assembly Tests** using remote handling facilities have proven the assembly feasibility.
✓ **Remote, cut and re-welding** of pipes through small holes have been developed.
✓ Has **originated and defined** (in 1994 together with Prof. R. Parker MIT, former ITER Head of Garching site) the **main architecture of the ITER Blanket system** in exchangeable modules.
✓ Starting from first concept has developed the **ITER first wall** and the **Limiter** designs.
✓ Has been **Supervisor of two Marie Curie Grants with PhD students**.

ANSALDO s.p.a., Genova, Italy, and **the University of Palermo** Italy. ***Seconded to the European Commission at the ITER Central Team and NET Team Garching, Germany.***

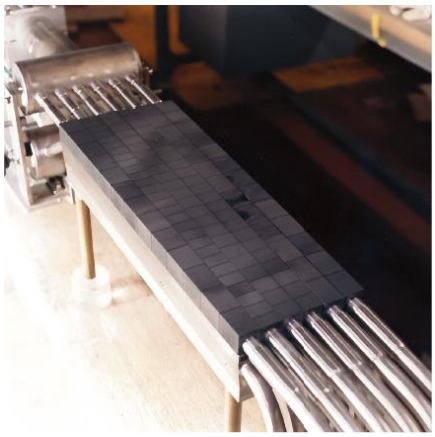
Main Responsibilities:

- Design, Analysis and R&D of the **NET (Next European Torus project) and ITER Divertor System. In charge of the ITER Shielding Blanket Design.**
- Design and Analysis of the NET Breeding Blankets. Development of the NET LiPb water cooled liquid metal blanket and the helium cooled pebble bed breeder out-of-tube solid blanket.

Highlights:

✓ Has been the **inventor** (together with a colleague) and **developer** (manufacturing and testing of mock-ups and prototypical component) of the innovative **divertor target** design named **"Monoblock Concept",** which had **achieved records of heat flux performances** for fusion devices **(> 15 MW/m^2)**. The concept is still today the reference engineering design for ITER.

Examples



NET/ITER-CDA Monoblock Divertor Prototype

ITER EDA Large Project 4 Blanket Module (EU)

✓ Has been **Responsible Officer** for the construction of the **200 kW electron beam facility FE200** in Le Creusot, France.
✓ Has **initially defined and supervised the thermo-hydraulic R&D** for advanced cooling techniques such as the **subcooled boiling with and without turbulence promoters** and the **hypervapotron**.

C. <u>Previous Employer (from 14-June-1982 to 30-September-1984)</u>: NIRA s.p.a., Seconded to the Joint Research Center of Ispra, Italy.

Main Responsibilities:

- Design and Engineering of the **First Wall, Breeding and Shielding Blanket for INTOR and NET Reactors.**
- Contribution to the design of the INTOR and NET divertor
- Contribution to the Design Architecture of the INTOR reactor.
- Thermal and Stress Analyses

D. Previous Employer (from 3-April-1978 to 14-6-1982): **Carlo Gavazzi** s.p.a., Marcallo, Milano, Italy.

Main Responsibilities:

- **Stress analysis and Qualification Group Leader** (from 1980),
- **Project Engineer** in the construction phase of Nuclear Fission power plants.

Highlights:

- ✓ Design and assistance to manufacturing of the **Control Rod Drive System of Nuclear Boiling Water Reactors** in Europe and in USA. In particular **"Leibstadt' nuclear power plant in Switzerland** (~1100 MW net electric power). In 1979 has been seconded to the firm Reactor Control Incorporation (6 months in San Jose, USA).
- ✓ Design of the instrumentation of the tanks of the Italian experimental fast breeder reactor P.E.C.
- ✓ **The control rod drive system of the Leibstadt nuclear power plant has been successfully working for now more than 2 decades.** The reactor has produced more than 160 billion Kwh.

E. Other Nominations, Activities.

- **From 2012 to 2017 he has member of the W7-X Project Council (Projektrat).**
- **For 10 years (starting 2001) he has been Member of the International Organizing Committee** of the SOFT, Symposium on Fusion Technology (last symposiums about 1000 participants).
- **Member of the ITER design review working group on vacuum vessel in 2007**.
- **Chairman of the ITER IO Design Review Committees on the Vacuum Vessel Pressure Suppression System (2013)**.
- Has participated in support of F4E to the **ITER Shielding Blanket Conceptual Design Review** in February 2010.
- Author of many publications. A list can be sent upon request.