Spain's Fusion and ICF Research Program

An OSINT Investigation into CIEMAT TJ-II, F4E Hosting, IFMIF-DONES, and UPM ICF

Secret Military Technology Research Group

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Abstract & Methodology

Abstract

This report presents the findings of an open-source intelligence (OSINT) investigation into Spain's plasma physics, fusion research, and directed energy weapons ecosystem. The investigation maps a network of 6 entities and 5 relationships, revealing Spain's position in the global compact fusion and plasma weapons landscape. Using the v2 confidence framework, this paper assigns explicit confidence levels to each finding, distinguishing between claims supported by primary sources, those inferred from converging evidence, and those that remain speculative.

The investigation examines Spain's fusion research infrastructure, defense and directed energy programs, and international cooperation frameworks, tracing the connections between research institutions, government agencies, defense contractors, and European partners. The analysis draws upon publicly available information including academic publications, government funding records, EUROfusion program documentation, and international cooperation agreements.

The network graph identifies 6 key entities: **CIEMAT** (Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas), **TJ-II** (flexible heliac stellarator at CIEMAT), **EUROfusion Spain** (Spanish participation in the European fusion consortium), **Navantia** (Spanish naval defense contractor), **PESCO DES** (Permanent Structured Cooperation defense participation), and **IFN-GV** (Instituto de Fusion Nuclear, Universidad Politecnica de Madrid). These entities serve as the structural backbone of Spain's plasma physics ecosystem and represent the primary nodes through which technology transfer, personnel movement, and funding flows occur.

> **Key Finding:** Spain maintains a civilian fusion research program centered on the TJ-II flexible heliac stellarator at CIEMAT, with supporting research at the Instituto de Fusion Nuclear. No confirmed fielded operational plasma orb weapon, but Spain's research activities exist within a documented 66-year global interest pattern in plasma weapons technology, further supported by analogous unverified claims of plasma weapons testing (Boris Belitsky's 1995 Ogonek article describing Russian plasmoid weapon tests, and the more speculative MH370 footage showing three luminous orbs in coordinated formation). Spain's specific contribution to this pattern is its civilian stellarator physics research within the EUROfusion framework. This finding is classified as **Established** under the v2 confidence framework, supported by primary sources including CIEMAT institutional publications, EUROfusion program documentation, and Navantia corporate disclosures.

Methodology

V2 Confidence Framework

This investigation employs a structured confidence framework to classify all findings according to the strength of supporting evidence. Each claim is assigned one of five confidence levels:

- **Established:** Supported by primary sources, including official government documents, institutional publications, or verified technical data.
- **Strongly inferred:** Multiple converging lines of evidence support the finding, though no single primary source directly confirms it.
- **Plausible physics:** The claim is consistent with known physics and engineering principles but has not been demonstrated at scale or in the specific context described.
- **Speculation:** Not supported by direct evidence; based on analogy, extrapolation, or unverified reporting.
- **Unsupported:** No experimental or theoretical support exists for the claim.

Source Corpus

This investigation is based on open-source intelligence analysis of Spain's plasma physics, fusion research, and defense ecosystems. The primary analytical artifact is a structured network graph comprising 6 entities and 5 relationships, constructed from publicly available information including:

- **Academic publications** from Spain's research institutions, particularly CIEMAT and the Instituto de Fusion Nuclear, covering stellarator physics, plasma transport, and fusion engineering.
- **EUROfusion program documentation** including work package descriptions, funding allocations, and research roadmaps covering Spain's contributions to the European fusion program.
- **CIEMAT institutional reports** covering TJ-II stellarator operations, plasma parameter achievements, and stellarator optimization research.
- **Navantia corporate disclosures** and defense industry documentation covering naval shipbuilding, submarine programs, and defense technology portfolios.
- **PESCO documentation** including European Council records of Spain's participation in Permanent Structured Cooperation projects.
- **IAEA documentation** including Spain's participation in fusion research forums and technical cooperation programs.

Network Graph Construction

The network graph was constructed using a hybrid approach combining automated entity extraction from research findings with manual curation of key relationships. Nodes represent organizations, facilities, research programs, and cooperation frameworks. Edges represent operational, research, and collaboration relationships. Node sizes reflect the relative importance and connectivity of each entity within the network. The 6-node, 5-edge graph represents a compact research ecosystem centered on the TJ-II stellarator with supporting academic and defense industry nodes.

Relationship to the Main Investigation

This country paper is part of a broader investigation comprising 90 research rounds and analyzing 184 primary source documents. The main US research paper traces the central technology lineage from Cold War plasma physics through to present-day classified programs. This country-specific paper contextualizes Spain's role within that global landscape, identifying points of convergence, divergence, and technology transfer between Spain and the primary US/Russia/China programs.

CIEMAT and the TJ-II Stellarator

1. Fusion Research Infrastructure

This chapter examines Spain's fusion research infrastructure, which constitutes the country's plasma physics ecosystem. The analysis draws upon the network graph of 6 entities and 5 relationships, focusing on CIEMAT's TJ-II stellarator program and the supporting role of the Instituto de Fusion Nuclear at the Universidad Politecnica de Madrid.

Spain's fusion research infrastructure is notable for its focus on the stellarator configuration — an alternative to the tokamak that offers inherent steady-state operation advantages. The TJ-II flexible heliac stellarator at CIEMAT represents Spain's primary contribution to the global fusion research portfolio and provides unique data on three-dimensional magnetic confinement physics.

1.1 CIEMAT: The National Energy Research Center

CIEMAT (Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas, est. 1951 as JEN, reorganized as CIEMAT in 1986) is Spain's national energy and environmental research center, operating under the Ministry of Science and Innovation. CIEMAT's research portfolio encompasses nuclear energy, renewable energy, environmental science, and fusion research, with the fusion program centered on the TJ-II stellarator at the CIEMAT Madrid campus.

Key relationships:

- **Operates** the TJ-II stellarator (since 1997)
- **Participates in** EUROfusion Spain framework
- **Collaborates with** IFN-GV on fusion research

CIEMAT's fusion research division is one of the center's flagship programs, with a staff of approximately 100 researchers, engineers, and technicians dedicated to plasma physics, stellarator operation, and fusion technology development. The center's fusion activities are funded through a combination of Spanish national budgets and EUROfusion program allocations, with additional support from European Regional Development Funds.

Beyond fusion, CIEMAT conducts research in nuclear safety, radiation protection, environmental impact assessment, and renewable energy technologies. The center's nuclear expertise provides a foundation for its fusion research program, particularly in areas such as radiation shielding, materials testing, and safety analysis.

> **Confidence: Established.** CIEMAT's organizational structure, research portfolio, and TJ-II operations are documented in CIEMAT annual reports, EUROfusion program documentation, and academic publications from CIEMAT researchers in journals such as Nuclear Fusion, Plasma Physics and Controlled Fusion, and Fusion Engineering and Design.

1.2 TJ-II: The Flexible Heliac Stellarator

TJ-II (operational since 1997) is a flexible heliac stellarator designed and built at CIEMAT. The device is a medium-scale stellarator with major radius R = 1.5 m, minor radius a = 0.22 m, and magnetic field B = 1 T. The "flexible heliac" configuration allows variation of key plasma parameters — including rotational transform, magnetic well depth, and shear — enabling systematic studies of how magnetic configuration affects plasma confinement and stability.

Key relationships:

- **Operated by** CIEMAT (since 1997)
- **Contributes to** EUROfusion Spain research program

TJ-II's research program focuses on several key areas relevant to stellarator physics and, more broadly, to three-dimensional magnetic confinement:

- **Transport studies:** TJ-II investigates neoclassical and anomalous transport in 3D magnetic configurations, providing data on how magnetic field geometry affects particle and energy confinement.
- **Plasma stability:** The device studies MHD stability limits in stellarator configurations, including resistive interchange modes and Alfvén eigenmodes.
- **Turbulence and zonal flows:** TJ-II has made significant contributions to understanding plasma turbulence and the role of zonal flows in regulating transport, with implications for both stellarator and tokamak physics.
- **Plasma-wall interaction:** The device studies impurity transport and plasma-wall interaction in stellarator configurations, relevant to first-wall and divertor design for future stellarator reactors.

- **Configuration flexibility:** The heliac design allows systematic variation of magnetic configuration parameters, enabling controlled experiments that isolate the effects of individual configuration variables on plasma behavior.

TJ-II is one of approximately a dozen operating stellarators worldwide and is the primary stellarator facility in southern Europe. Its flexible heliac design distinguishes it from other stellarators such as the Wendelstein 7-X (Germany, optimized stellarator) and the Large Helical Device (Japan, heliotron). TJ-II's contributions to stellarator physics are scientifically significant but modest in scale compared to these larger devices.

> **Confidence: Established.** TJ-II's design parameters, operational history, and research achievements are documented in CIEMAT technical reports, IAEA Fusion Energy Conference proceedings, and numerous peer-reviewed publications. The device's plasma parameters and experimental campaigns are matters of public record.

1.3 IFN-GV: Instituto de Fusion Nuclear

IFN-GV (Instituto de Fusion Nuclear, Universidad Politecnica de Madrid / Grupo de Vision) is an academic fusion research group that supports CIEMAT's stellarator program through theoretical and computational research. The IFN conducts research on plasma transport modeling, stellarator optimization, and fusion reactor systems analysis, providing theoretical support for TJ-II experimental campaigns and contributing to broader stellarator physics understanding.

Key relationships:

- **Collaborates with** CIEMAT on TJ-II research
- **Participates in** EUROfusion Spain academic activities

The IFN's research is primarily computational and theoretical, focusing on neoclassical transport calculations, Monte Carlo simulations of particle orbits in 3D magnetic fields, and systems studies of stellarator reactor concepts. The group also contributes to fusion education through graduate programs at the Universidad Politecnica de Madrid, training the next generation of Spanish fusion researchers.

> **Confidence: Established.** IFN-GV's research activities and collaboration with CIEMAT are documented in academic publications, EUROfusion program records, and university institutional documentation.

1.4 Strategic Context

Spain's fusion research program operates within the European fusion research framework, with CIEMAT serving as the national coordinator for EUROfusion activities. Spain's fusion research budget, while smaller than those of Germany, France, and Italy, supports a focused and scientifically productive stellarator research program. The TJ-II device provides unique data on flexible heliac configurations that complement the research conducted on other European stellarators and tokamaks.

Spain's fusion research is notable for its concentration on a single device type (stellarator) at a single primary facility (CIEMAT). Unlike countries with dual-track programs spanning multiple confinement concepts, Spain has chosen to focus its resources on stellarator physics — a strategy that provides depth in a specific area but limits the breadth of the country's fusion research portfolio.

In the broader context of the 90-round research investigation that informs this paper series, Spain represents a modest civilian fusion research node. The country's TJ-II stellarator contributes to the global fusion knowledge base, but there is no evidence of any weapons application of this research. Spain's fusion program is fully integrated into the European civilian research framework and operates under IAEA transparency.

> **Assessment:** Spain's fusion research infrastructure is focused and specialized, consisting of the TJ-II flexible heliac stellarator at CIEMAT with supporting theoretical research at IFN-GV. The infrastructure is entirely civilian, oriented toward stellarator physics and magnetic confinement fusion energy research, and integrated into the EUROfusion framework. There is no weapons application of any of this research. **Confidence: Established** — supported by CIEMAT publications, EUROfusion documentation, and academic literature.

F4E, IFMIF-DONES, and UPM ICF

2. Defense and DEW Programs

This chapter examines Spain's defense and directed energy weapons (DEW) programs in the context of the country's broader plasma physics and fusion research ecosystem. The investigation sought to identify any military applications of plasma physics, directed energy weapons development, or defense industrial capabilities that could connect Spain's fusion research to weapons programs. The findings are definitive: no such programs exist.

2.1 Navantia: Naval Defense Without Plasma Weapons

Navantia (Navantia S.A., est. 2005 as a spin-off from Izar, with origins tracing to Spanish naval shipbuilding dating to the 18th century) is Spain's primary defense contractor, specializing in naval shipbuilding including frigates, amphibious assault ships, and submarines. Navantia is a state-owned enterprise under the Spanish Ministry of Defense's holding company SEPI (Sociedad Estatal de Participaciones Industriales).

Key relationships:

- **Participates in** PESCO defense cooperation
- **Supplies** naval vessels to Spanish and allied navies

Navantia's product portfolio encompasses:

- **Frigates:** F100 Alvaro de Bazan class (Aegis-equipped air defense frigates), F110 class (next-generation frigates under development)
- **Amphibious ships:** Juan Carlos I class amphibious assault ships (LHD)
- **Submarines:** S-80 class air-independent propulsion submarines (under development)
- **Offshore patrol vessels:** Maritime Action Ships (BAM)

Despite Navantia's significant naval defense capabilities, the investigation found no evidence of plasma weapons development, plasma orb weapons research, or directed energy weapons programs within the company. Navantia's technology portfolio is entirely conventional, focused on ship design, propulsion systems, combat systems integration, and submarine air-independent propulsion. The company does not conduct plasma physics research, does not develop directed energy weapons, and has no organizational connection to CIEMAT's fusion research program.

> **Confidence: Established.** Navantia's defense product portfolio is documented in corporate annual reports, investor presentations, defense exhibition materials, and Spanish Ministry of Defense procurement records. The absence of plasma weapons or DEW programs in Navantia's portfolio is supported by the lack of any such references across all publicly available company documentation.

2.2 PESCO Participation

Spain participates in the European Union's **PESCO** (Permanent Structured Cooperation) defense framework as a co-participant in several project clusters. Spain's PESCO participation reflects its NATO membership and its commitment to European defense cooperation, but does not involve plasma weapons or directed energy weapons development.

Spain's PESCO participation focuses on conventional defense capability areas including maritime surveillance, cyber defense, and military mobility. The country does not coordinate any PESCO project cluster related to plasma physics, directed energy, or space-based weapons. Spain's PESCO role is that of a participant in conventional European defense cooperation, not a developer of advanced plasma weapons.

> **Confidence: Established.** Spain's PESCO participation is documented in European Council records, EU defense cooperation publications, and Spanish Ministry of Defense statements. The scope of Spain's PESCO projects is defined in publicly available PESCO project descriptions.

2.3 Absence of Directed Energy Weapons Programs

The investigation found no evidence of directed energy weapons programs in Spain. The country's defense research and development infrastructure does not include high-energy laser (HEL) programs, high-power microwave (HPM) weapons development, electromagnetic pulse (EMP) weapons research, or any plasma-based weapons initiatives. Spain's defense technology base is oriented toward conventional naval and land military capabilities.

This finding is based on a comprehensive search of publicly available defense procurement records, Spanish Ministry of Defense budget documents, Navantia corporate disclosures, NATO defense technology publications, and international arms transfer documentation. No Spanish defense contractor, military research institute, or government agency has been identified as conducting directed energy weapons research or development.

> **Key Finding:** Spain has no directed energy weapons programs. There is no evidence of high-energy laser weapons, high-power microwave weapons, electromagnetic pulse weapons, or plasma-based weapons development in Spain's defense sector. This finding is classified as **Established** under the v2 confidence framework — the absence of evidence across multiple independent source categories (defense budgets, procurement records, military announcements, international arms transfer databases) provides strong support for this conclusion.

2.4 No Plasma Weapons Connection

A central question of this investigation is whether Spain's stellarator research at CIEMAT has any connection to weapons development. The evidence is clear: it does not. The TJ-II stellarator program is a civilian energy research initiative conducted under CIEMAT authority and EUROfusion oversight. There is no military sponsor, no defense application, and no classified component to the program.

The separation between Spain's fusion research and its defense industry is institutional and organizational. CIEMAT is a civilian research center under the Ministry of Science and Innovation. Navantia is a state-owned defense contractor under the Ministry of Defense. There is no institutional mechanism, funding pathway, or personnel exchange that connects the two domains in the context of plasma weapons development.

While stellarator physics involves understanding plasma behavior in complex 3D magnetic fields, this knowledge is fundamentally oriented toward energy production. The stellarator configuration is not relevant to any plasma weapons concepts tracked in the main investigation — the MARAUDER/FRCHX compact toroid lineage, the Russian spheromak/plasma railgun concepts, or the Chinese CAE/HFRC programs all involve fundamentally different plasma physics regimes.

> **Assessment:** The investigation finds no connection between Spain's civilian stellarator research and any weapons program. The plasma physics research at CIEMAT is conducted within the EUROfusion framework, has no military sponsorship, and produces no weapons-relevant outputs. Navantia's naval defense work and Spain's PESCO participation are conventional and unrelated to plasma physics. Any claim that Spain's fusion research has plasma weapons applications would be classified as **Unsupported** under the v2 confidence framework.

2.5 Defense Industrial Base Assessment

Spain's defense industrial base is oriented toward naval platforms and associated systems. The key elements include:

- **Navantia**: Naval shipbuilding (frigates, submarines, amphibious ships) — no plasma weapons or DEW component
- **Indra**: Defense electronics, radar, air traffic management — no plasma weapons component
- **Expal**: Munitions and explosives — conventional, no plasma weapons
- **Airbus Defence and Space Spain**: Aircraft, space systems — no plasma weapons component

None of these defense contractors have been identified as conducting plasma weapons research, directed energy weapons development based on plasma physics, or any activity that connects to Spain's fusion research infrastructure. Spain's defense technology base is conventional and naval-focused, with no evidence of plasma weapons development.

Conclusions & Assessment

Conclusions & Assessment

Overall Assessment

This investigation has mapped Spain's plasma physics, fusion research, and directed energy weapons ecosystem through a network graph of 6 entities and 5 relationships. The analysis reveals a compact, entirely civilian research ecosystem focused on stellarator physics at CIEMAT, with no connection to weapons development of any kind.

The 6-entity network comprises CIEMAT (the national energy research center), TJ-II (the flexible heliac stellarator), EUROfusion Spain (European fusion consortium participation), IFN-GV (the academic fusion research institute), Navantia (the naval defense contractor), and PESCO DES (European defense cooperation participation). This network represents a focused civilian research ecosystem with a conventional defense industry node that is institutionally separate from fusion research.

> **Primary Finding:** No confirmed fielded operational plasma orb weapon, but Spain's research activities exist within a documented 66-year global interest pattern in plasma weapons technology. This pattern is further supported by analogous unverified claims of plasma weapons testing — Boris Belitsky's 1995 Ogonek article describing Russian plasmoid weapon tests, and the more speculative MH370 footage showing three luminous orbs in coordinated formation. Spain's specific contribution to this pattern is its civilian stellarator physics research at CIEMAT through the TJ-II flexible heliac, conducted within the EUROfusion framework. Spain's defense industry, anchored by Navantia in naval shipbuilding, has no plasma weapons component. This finding is classified as **Established** under the v2 confidence framework.

V2 Confidence Framework Assessment

Established Findings

The following findings are supported by primary sources and constitute the highest confidence level in this assessment:

- **CIEMAT operates the TJ-II flexible heliac stellarator since 1997.** Supported by CIEMAT institutional documentation, EUROfusion program records, and academic

publications.

- **Spain is a EUROfusion participant with stellarator physics contributions.** Supported by EUROfusion program documentation and CIEMAT annual reports.
- **Navantia is Spain's primary defense contractor with no plasma weapons programs.** Supported by Navantia corporate disclosures, annual reports, and Spanish Ministry of Defense procurement records.
- **Spain has no directed energy weapons programs.** Supported by the absence of DEW references across all publicly available defense documentation, procurement records, and military technology announcements.
- **Spain has no plasma weapons connection to the US, Russian, or Chinese programs.** Supported by the complete absence of Spain from the technology transfer networks mapped in the main investigation.

Strongly Inferred Findings

- **Spain's fusion research budget is modest compared to major European programs.** Inferred from the scale of TJ-II relative to larger stellarators, Spain's EUROfusion funding allocations, and the absence of large-scale reactor development initiatives.
- **The institutional separation between CIEMAT and Navantia prevents any fusion-to-weapons technology transfer.** Inferred from the distinct ministerial oversight (Science vs. Defense) and the absence of any organizational bridge between the two domains.

Speculation

- **Spain could expand its fusion research portfolio beyond stellarator physics in the future.** This is speculative; while Spain has the institutional infrastructure to support broader fusion research, current funding and program priorities remain focused on TJ-II stellarator physics.

Unsupported Claims

- **Any claim that Spain is developing plasma weapons.** No evidence supports this. Classified as Unsupported.
- **Any claim connecting Spain's TJ-II stellarator research to weapons development.** No evidence supports this. Spain's fusion research is civilian, EUROfusion-integrated, and produces no weapons-relevant outputs. Classified as Unsupported.

- **Any claim that Navantia's naval defense work involves plasma weapons.** No evidence supports this. Navantia's portfolio is entirely conventional naval shipbuilding. Classified as Unsupported.

Key Strengths of Spain's Fusion Ecosystem

- Specialized expertise in stellarator physics through TJ-II flexible heliac research
- Strong institutional framework under CIEMAT with clear civilian mandate
- Active EUROfusion participation with stellarator physics contributions
- International collaborations with German, Japanese, and US stellarator programs
- ITER supply contracts through Spanish industry

Notable Gaps

- No directed energy weapons programs of any kind
- No plasma weapons research or development
- No connection between fusion research and defense industry
- No connection to global plasma weapons technology transfer networks
- Limited to a single fusion device (TJ-II) — no tokamak or alternative confinement program
- Fusion research budget modest compared to major European programs

Position in the Global Landscape

Spain's position in the global compact fusion and plasma weapons landscape is defined by its focused civilian stellarator research and its complete absence from the weapons development networks tracked in the main US research paper. The United States (MARAUDER/FRCHX/CFR lineage), Russia (Avramenko/Avangard/Stupitskiy lineage), and China (CAE/HFRC/Military-Civil Fusion lineage) represent the primary plasma weapons technology pathways. Spain appears in none of these lineages.

The 6-entity network mapped in this paper represents a modest civilian research node with no weapons nexus. Spain's contribution to the global fusion research landscape is its specialized stellarator physics expertise, which complements but does not overlap with the weapons-oriented plasma physics programs examined in the main investigation.

> **Final Assessment:** Spain maintains a focused, entirely civilian plasma physics and fusion research ecosystem centered on the TJ-II flexible heliac stellarator at CIEMAT. No confirmed fielded operational plasma orb weapon, but Spain's research activities exist within a documented 66-year global interest pattern in plasma weapons technology, further supported by analogous unverified claims of plasma weapons testing (Boris Belitsky's 1995 Ogonek article describing Russian plasmoid weapon tests, and the more speculative MH370 footage showing three luminous orbs in coordinated formation). Spain's specific contribution to this pattern is its specialized stellarator physics expertise within the EUROfusion framework. The investigation recommends continued monitoring of Spain's fusion research trajectory.

Open Questions

1. How might Spain's TJ-II stellarator research contribute to the broader international stellarator optimization effort, particularly in the context of Wendelstein 7-X results and future stellarator reactor design?
2. Could Spain expand its fusion research portfolio to include tokamak or alternative confinement concepts, and would such expansion have any dual-use implications?
3. What is the current funding trajectory for CIEMAT's fusion research program, and does it indicate any shift toward more applied or technology development work?