UNE Normalización Española

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UNIVERSIDAD POLITÉCNICA DE MADRID

Quantum Technologies Standardization

Workshop

October 2025

QuTechSpace

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under the project *"Quantum technology components for space communication"* *(QuTechSPace, grant agreement No 101135225)*

Spain's Quantum Technologies Strategy 2025-2030

Spanish Ecosystem on Quantum Technologies

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INTA
National Institute for Aerospace Technologies

October 29th, 2025
Madrid, Spain

- Explores the key points of the new Quantum Technologies Strategy.
- Constitutes the roadmap for consolidating the national quantum ecosystem, strengthening digital sovereignty, competitiveness, and sustainable development.
- It is a call for cooperation, dialogue, and coordinated action with other actors.
- Investment of 800 million euros.
- Vision: The development of these technologies support the digital sovereignty and economic security of the European Union and strengthens the position of Spain and the EU in this international race.
- There is potentialfor Spanish and European leadership in these technologies as one in four quantum SMEs worldwide is in Europe.

Spain's Quantum Technologies Strategy 2025-2030

- **Strategic Objectives**

to turn Spain and its quantum ecosystem into a European and international reference by 2030:

1. Strengthen research and R&D&I

   facilitating the transfer of knowledge and bringing quantum technologies research into the market.

2. Create a Spanish quantum market

   where quantum companies will be created and grow on demand, by means providing funding.

3. Prepare society for disruptive change

   ensuring security through post-quantum encryption and expanding on post-quantum privacy.

4. Consolidate the quantum ecosystem

   ensuring security through post-quantum encryption and expanding on post-quantum privacy.

Quantum Spain

- Spain's first quantum computing ecosystem
- Research centres:

  DIPC (Donostia International Physics Center)

  ICFO (Institut de Ciències Fotòniques).

  CSIC (Consejo Superior de Investigaciones Científicas).

Quantum Spain

- Nodes:
  - BSC (Barcelona Supercomputing Center).
  - CESGA (Centro de Supercomputación de Galicia).
  - SCAYLE (Centro de Supercomputación de Castilla y León).
  - NASERTIC (Navarra de Servicios y Tecnologías).
  - BIFI (Instituto de Biocomputación y Física de Sistemas Complejos de la Universidad de Zaragoza).
  - CSUC (Consorcio de Servicios Universitarios de Cataluña).
  - PIC (CIEMAT-IFAE) (Port d'Informació Científica de la Universidad de Barcelona).
  - UAM (Universidad Autónoma de Madrid).
  - COMPUTAEX.
  - UMA (Universidad de Málaga).
  - IAC (Instituto de Astrofísica de Canarias)

Quantum Spain

- Academia:
  - USC (Universidad de Santiago de Compostela).
  - UNIOVI (Universidad de Oviedo).
  - UNICAN (Universidad de Cantabria).
  - UPV/EHU (Universidad del País Vasco).
  - TECNUN (Universidad de Navarra).
  - UAB (Universidad Autónoma de Barcelona).
  - UB (Universidad de Barcelona).
  - UV (Universidad de Valencia).
  - UPV (Universidad Politécnica de Valencia).
  - UCM (Universidad Complutense de Madrid).
  - US (Universidad de Sevilla).
  - UGR (Universidad de Granada).
  - UIB (Universidad de Islas Baleares)

- Spanish Research Centres and Academia.

POLITÉCNICA

Polytechnique
University of Madrid

CCS

Center for Research in
Computational Simulation

INTA

General Subdirectorate
of Space

- Spanish Companies Ecosystem:

Quside: A Barcelona-based company specializing in quantum security.

Lux Quanta: Based in Barcelona, it focuses on quantum optical technology.

ITG (Technology Center of Galicia): Implemented the first quantum communications network in northwest Spain.

Telefónica: Has established a Center of Excellence dedicated to quantum technologies to boost research and development.

Qilimanjaro Quantum Tech: A Spanish startup developing quantum computers, including chips and algorithms.

MADQCI: A project collaborating with universities and research institutions to advance quantum communications.

INTA

- General Secretariat
- General Subdirectorate of Coordination and Plans
- Subdirectorate General of Space Systems
- Subdirectorate General of Aeronautical Systems
- General Subdirectorate of Land Systems
- Subdirectorate General of Naval Systems

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SDG

General Subdirectorate of Land Systems

CENTERS

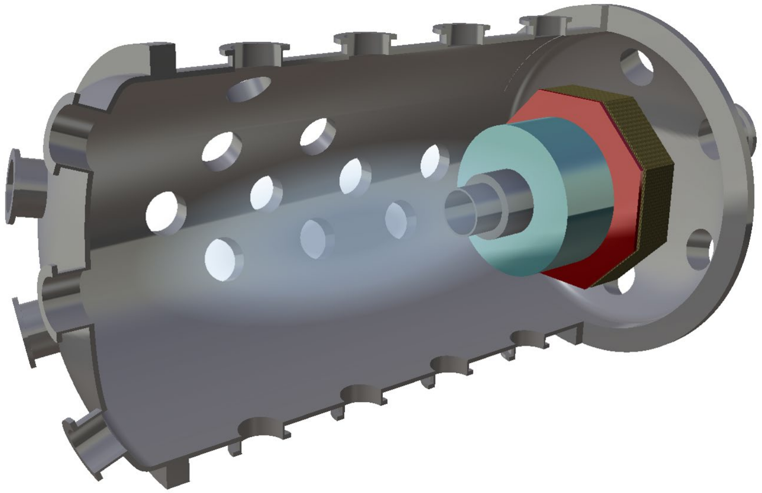
- Torregorda Test Center
- LABINGE (Engineering Laboratory, G. Marvá)

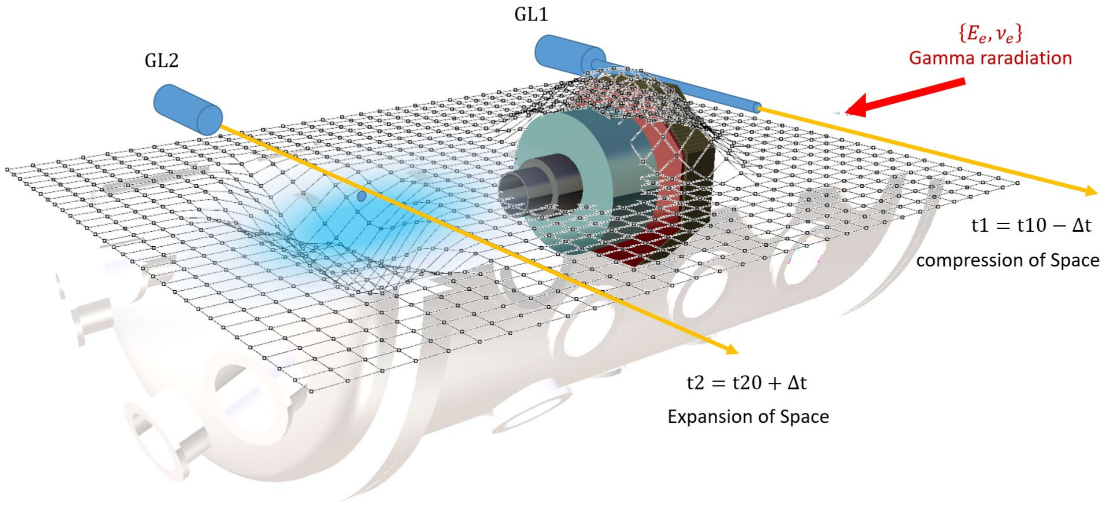
DEPARTMENTS / **SECTIONS**

- **Information, Communications and Simulation Technologies**
  - Control, Modeling and Simulation
  - Communications and Cybersecurity
- **Optoelectronics and Acoustics**
  - New Sensors
  - Optronics
  - Acoustics
- **Platforms and Land Vehicles**
  - Tecnologías Vehiculares
  - Motor y Medio Ambiente
  - Seguridad y Certificación
- **Weapons Systems and Ballistics**
  - Balística de Efectos y Detónica
  - Ensayos Balísticos y Ambientales
  - Materiales Energéticos
- **CBRN Defense Systems**
  - Defensa Biológica
  - Defensa Nuclear
  - Defensa Química

Harrowing results in the lab

In 2024, our partner, the Chinese Academy of Sciences, radiated a cryogenic quantum material with artificially produced space radiation in their Station of Extreme Light (SEL) in Shanghái, and they measured with two atomic clocks a compression of spacetime at the entry (advance of the impact of the geodesic laser) and an expansion at the exit (delay of the impact of the geodesic laser).





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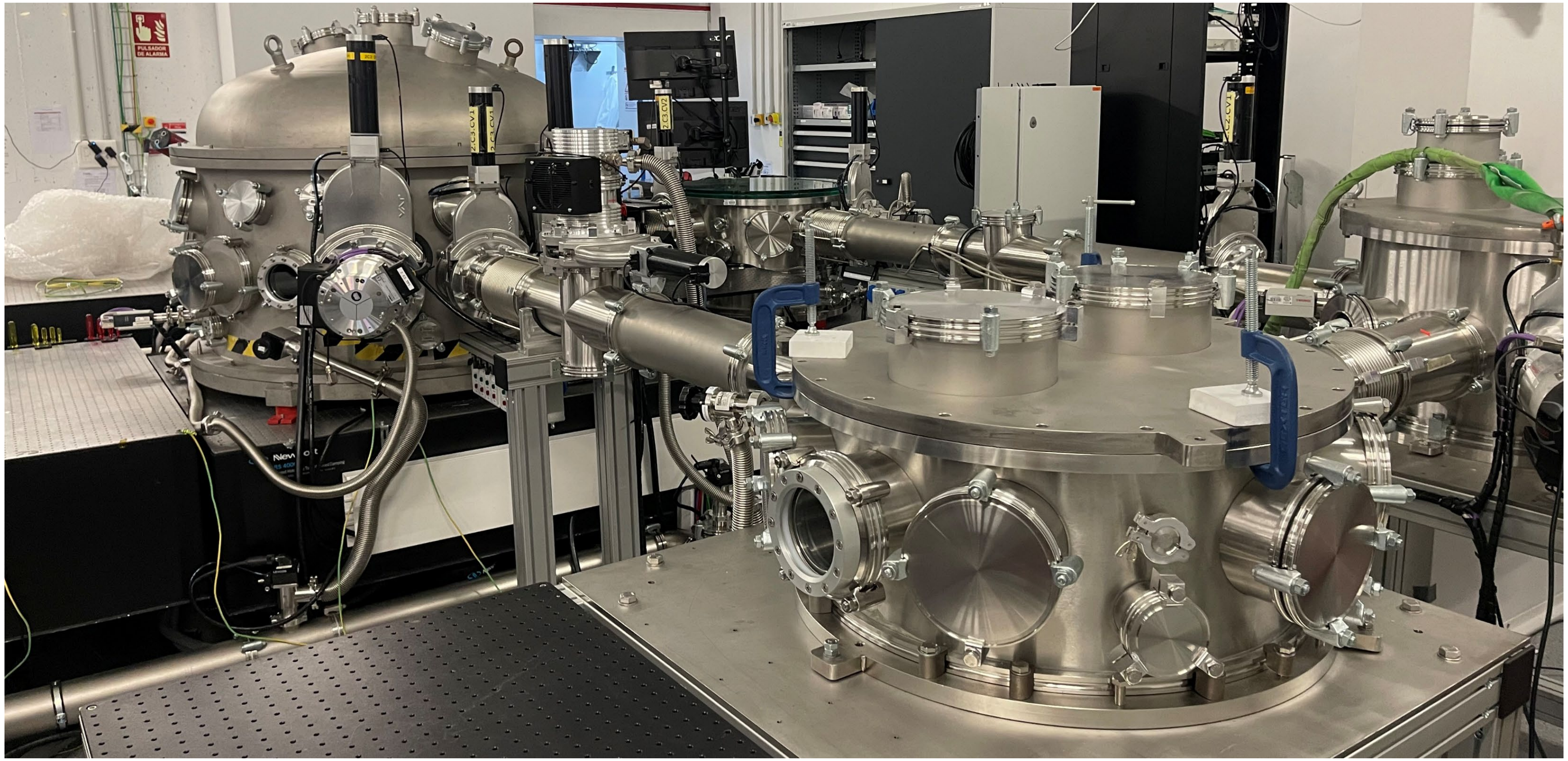
2027 in CLPU, Salamanca, Spain



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Juan José Navlet
Laboratory of New Sensors

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Quantum physics

Different definitions:

- The fundamental physical theory that describes the behavior of matter and of light.
- The study of matter and energy at the most fundamental level, describing the behavior of atoms, electrons, and photons.
- A model for elementary Physics by means of solving the Schrödinger equation.

Whatever the definition we chose, we can't deny that quantum physics is flying in circles around the Schrödinger equation and the QCD.

And yet, a question arises:

Is our kind able to come up anytime soon with anything better?

A different perspective

Deconstructing Newton, Schrödinger and Feynman:

What happens before we have matter and energy?

Quoting Albert Einstein: "**Imagination is more important than knowledge. For knowledge is limited, while imagination encompasses the entire world**”.

In other words…**Where knowledge sinks mathematics still remains**.

Theory of Universal Order, a new paradigm in science:

Physical reality as a part of a wider frame founded on a non-physical reality where we can mathematically describe and control the behaviour of unknown entities.

A new paradigm in science

Physics fails to explain these phenomena because it is not meant to deal with entities which are previous to the existence of any particle, piece of matter or piece of energy. Conversely, the **Theory of Universal Order** is a set theory and algebraic topology construction that can perfectly handled and control anything pertaining to the unknowable foundation of reality, both physical and non-physical.

Domain $\mathbb{O}$ (non-physical reality)

Composed of unmeasurable elements

Space V^3 $\quad |\psi\rangle_{i,V^3,\mathbb{O}} = \{\nu_p, \nu_e, \nu_n\}$

Dark Space $\mathcal{O}$ $\quad m_i = \langle f|\psi\rangle_{i,V^3,\mathbb{O}}$

Domain $\mathbb{G}$ (physical reality)

Composed of measurable elements

Hilbert space $\mathcal{H}$ $\quad |\psi\rangle_{i,\mathcal{H}} = \{\hat{s}, \hat{E}, \hat{\vec{P}}, \hat{\vec{r}}\}$

Minkowski space $\mathcal{M}$ $\quad \mathcal{M} = (\mathbb{R}^4, \eta)$

Order space Ω $\quad \Omega = (\mathbb{R}^4_\Psi, g)$, $\quad e_i^\mu = \Psi_i\, e_{i-1}^\mu$

Domain $\mathbb{O}$ (non-physical reality)

Composed of unmeasurable elements

Space V^3

Three-dimensional Banach space

$$|\psi\rangle_{i,V^3} = \begin{Bmatrix} \nu_p \\ \nu_e \\ n \end{Bmatrix} \qquad \nu_e = \frac{E_e}{f_{af} \cdot h} \qquad \Delta m = f_{af} \frac{E_e}{c^2}$$

$$f: V^3 \longrightarrow \mathcal{O} \qquad \langle f| = \frac{h}{c^2}[1, f_{af}, 1]$$

Dark Space $\mathcal{O}$

One-dimensional Banach space

$$m_i = \langle f|\psi\rangle_{i,V^3}$$

$$|\psi\rangle_{i,\mathcal{H},\mathbb{G}} = O_t^{\mathsf{T}} |\psi\rangle_{i,V^3,\mathbb{O}}$$

$$O^{\mathsf{T}}: V^3 \longrightarrow \mathcal{H}$$

$$E_e$$

$$k_m = \frac{(\gamma - 1) m_e c^2}{k_e \frac{Ze^2}{r_o}}$$

$$\xi = \left(1 - \frac{x_3}{h_m}\right)$$

$$k_{\Phi,i+1} = \frac{e_i \cdot {\varepsilon_{0,i+1}}^{1/2}}{e_{i+1} \cdot {\varepsilon_{0,i}}^{1/2}} \sqrt{\frac{m_{e,i+1}}{m_{e,i}}}$$

$$m_{e,i} = M(m_{e,i-1})$$

Domain $\mathbb{G}$ (physical reality)

Composed of measurable elements

Hilbert space $\mathcal{H}$

$$\mathcal{H} = (\mathbb{R}^4, \|\cdot\|)$$

$$|\psi\rangle_{i,\mathcal{H}} = \begin{Bmatrix} \hat{S} \\ \hat{E} \\ \hat{\vec{P}} \\ \hat{\vec{r}} \end{Bmatrix} \qquad e_i^\mu = e_{i-1}^\mu \qquad |e_i^\mu| = 1 \quad \forall \mu, i$$

Minkowski space $\mathcal{M}$

$$\mathcal{M} = (\mathbb{R}^4, \eta)$$

$$R_{\mu\nu,\delta} - \frac{R}{2}\eta_{\mu\nu} + \Lambda\eta_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu} \qquad \eta_{\mu\nu} = \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \end{bmatrix}$$

$$\eta = \eta_{\mu\nu}\, dx^\mu \otimes dx^\nu = \eta_{\mu\nu}\, dx^\mu dx^\nu = ds^2$$

$$\eta = ds^2 = -c^2 dt^2 + dx^2 + dy^2 + dz^2$$

$$\Psi: \mathcal{M} \longrightarrow \Omega$$

Order space Ω

$$\Omega = (\mathbb{R}_\Psi^4, g)$$

$$\Psi: \mathbb{R}^4 \longrightarrow \mathbb{R}_\Psi^4 \qquad (e^\nu, \delta) \begin{bmatrix} e^\mu_{0,\mathbb{R}_\Psi^4} = e^\mu_{0,\mathbb{R}^4} \\ e_i^\mu = \Psi_i\, e_{i-1}^\mu \end{bmatrix}$$

$$g_{\mu\nu} = \Psi_{\mu\nu}\, \eta_{\mu\nu}$$

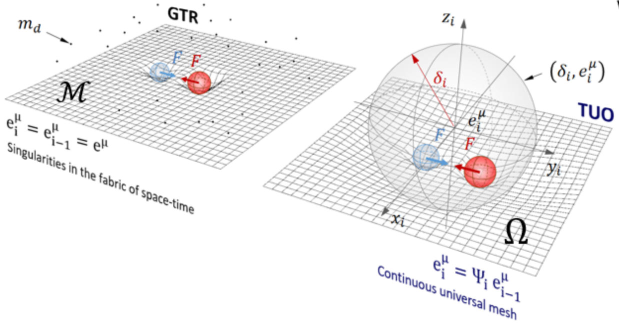
$$R_{\mu\nu,\delta} - \frac{R}{2} g_{\mu\nu,\delta} + \Lambda(e^\mu, \delta) g_{\mu\nu,\delta} = \frac{8\pi G}{c^4} T_{\mu\nu,\delta}$$

$$g = -c^2 k_\Phi dt^2 + k_m dx^2 + k_m dy^2 + k_m \xi dz^2$$

$$[\Psi] = \begin{bmatrix} k_\Phi & 0 & 0 & 0 \\ 0 & k_m & 0 & 0 \\ 0 & 0 & k_m & 0 \\ 0 & 0 & 0 & k_m\xi \end{bmatrix}$$

$$\Psi_{\delta,i-1} = \{k_{\Phi,\delta,i-1}, k_{m,\delta,i-1}, k_{m,\delta,i-1}, k_{m,\delta,i-1}\xi_{,\delta,i-1}\}$$

$$\Lambda(e^\mu, \delta) = \frac{12G \cdot m_d(e^\mu, \delta)}{{r_m}^2 \cdot {f_H}^2 \cdot h_m \cdot c^2}$$

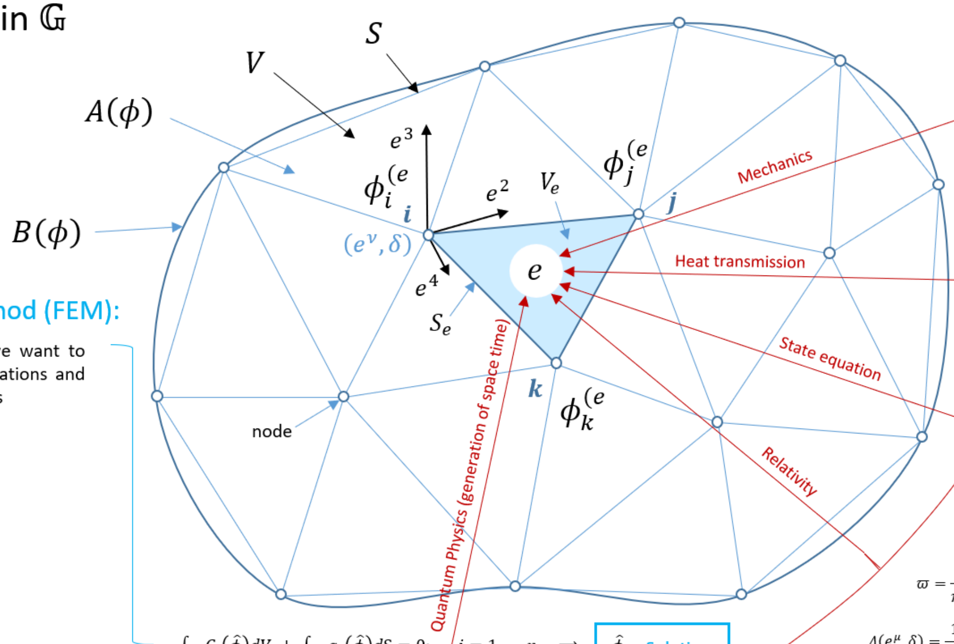


Where:

- $\mathbb{G}_U$: Whole universe
- (δ, e^μ): sphere in $\mathbb{G}_u$ centred in e^μ with radius δ
- $\mathbb{G}_\mu$: Visible universe in e^μ
- m_d: all dark mass in $\mathbb{G}_U$
- m'_d: all dark mass in $\mathbb{G}_\mu$
- r_m: Mean radius of $\mathbb{G}_U$
- h_m: dwindled height of $\mathbb{G}_u$
- $m_d(e^\mu, \delta)$: dark mass in (e^μ, δ)

Juan José Navlet
Laboratory of New Sensors

Physical Domain $\mathbb{G}$



Finite Element Method (FEM):

For each variable ϕ that we want to solve we need n $A(\phi)$ equations and m $B(\phi)$ boundary conditions

$$A(\phi) = \begin{Bmatrix} A_1(\phi) \\ A_2(\phi) \\ \vdots \\ A_n(\phi) \end{Bmatrix} = 0$$

$$B(\phi) = \begin{Bmatrix} B_1(\phi) \\ B_2(\phi) \\ \vdots \\ B_m(\phi) \end{Bmatrix} = 0$$

$$\phi \approx \hat{\phi} = \sum_{i=1}^{n} N_i a_i = Na \qquad \text{Interpolation}$$

$$\phi^{(e}(ct, x, y, z) = \beta_1^{(e} ct + \beta_2^{(e} x + \beta_3^{(e} y + \beta_4^{(e} z$$

$$\phi^{(e}(ct, x, y, z) = \sum_{e=1}^{m} \sum_{j=1}^{r} N_j^{(e} \boldsymbol{\phi}_j$$

$$\Pi(\phi) = \sum_{e=1}^{m} \Pi^{(e}(\phi^{(e})$$

$$\delta\Pi(\phi) = \sum_{i=1}^{n} \frac{\partial \Pi}{\partial \phi_i} \delta\phi_i = 0$$

Solving variational principle

$$\int_V G_j(\hat{\phi}) dV + \int_S g_j(\hat{\phi}) dS = 0; \quad j = 1, \dots, n \quad \Rightarrow \quad \boxed{\hat{\phi} \quad \text{Solution}}$$

Functions $A^{(e}(\phi_\mu)$ of ϕ_μ variables of element e:

$$\{F\}^q = [K]_{pq}^{(e} \{\bar{\delta}\}^q = \{F_0\}^q + \{F_B\}^q + \{F_T\}^q$$

$$[K]_{pq}^{(e} = \iiint_{V^{(e}} [B]_q^{T^{(e}} [C]^{(e} [B]_q^{(e} dV^{(e} = [B]_q^{T^{(e}} [C][B]_q^{(e} V$$

$$[C]\left\{\frac{dT}{dt}\right\} + [[K_c] + [K_h] + [K_r]]\{T\} = \{R_T\} + \{R_Q\} + \{R_q\} + \{R_h\} + \{R_r\}$$

$$\int_{V^{(e}} \rho c \frac{\partial T}{\partial t} N_i dV - \int_V \begin{bmatrix} \frac{\partial N_i}{\partial x} & \frac{\partial N_i}{\partial y} & \frac{\partial N_i}{\partial z} \end{bmatrix} \begin{Bmatrix} q_x \\ q_y \\ q_z \end{Bmatrix} dS =$$

$$= \int_V Q N_i dV - \int_{S_1} (q \cdot \vec{n}) N_i dS + \int_{S_2} q_s N_i dS - \int_{S_3} h(T_s - T_e) N_i dS -$$

$$- \int_{S_4} (\sigma \epsilon T_s{}^4 - \alpha q_r) N_i dS \quad i = 1, 2, \dots r$$

$$\nabla \cdot (\rho V) = 0 \qquad \frac{1}{2} V^2 + \int \frac{dP}{\rho} = cte$$

$$E_{m_d} = \beta_{m_d} \cdot E_c \implies \Delta m = f_{af} \frac{E_{m_d}}{c^2} \implies E_d = -f_c \cdot E_{m_d}$$

$$w_b = \frac{H_0 \cdot r_b}{c}$$

$$\varpi = \frac{3 \cdot h \cdot f_{af}}{\pi \cdot r_m{}^2 \cdot f_H{}^2 \cdot h_m}$$

$$\Lambda(e^\mu, \delta) = \frac{12G \cdot m_d(e^\mu, \delta)}{r_m{}^2 \cdot f_H{}^2 \cdot h_m \cdot c^2}$$

$$R_{\mu\nu,\delta} - \frac{R}{2} g_{\mu\nu,o} + \Lambda(e^\mu, \delta) g_{\mu\nu,o} = \frac{8\pi G}{c^4} T_{\mu\nu,\delta}$$

Equations of the D-Drive:

$$\Delta T_{\mu\nu,\delta_b,bow} = \frac{1}{\kappa} \Delta\Lambda(e^\mu, \delta_b) g_{\mu\nu,o} = \frac{\varpi \cdot v_r}{2} g_{\mu\nu,o}$$

$$\Delta T_{\mu\nu,\delta_b,,stern} = -\frac{1}{\kappa} \Delta\Lambda(e^\mu, \delta_b) g_{\mu\nu,o} = -\frac{\varpi \cdot v_r}{w_b{}^2} g_{\mu\nu,o}$$

Lagrange

$$x(t) = \Psi_{(e^\nu,\delta),i}\, \varphi(X_0, t)$$

$$X(t) = \left(\Psi_{(e^\nu,\delta),i} X(t_0)\right) \circ \varphi^{-1}$$

$$dv = J(\Psi_{(e^\nu,\delta),i} X, t)\, dV$$

Euler

$$\frac{dM}{dt} = -\int_S \rho(\vec{v} \cdot \vec{n}) dS$$

$$e^\mu_{(e^\nu,\delta),i} = \Psi_{(e^\nu,\delta),i}\, e^\mu_{(e^\nu,\delta),i-1}$$

$$e^1_{(e^\nu,\delta),i} = \Psi_{(e^\nu,\delta),i}\, e^1_{(e^\nu,\delta),i-1} = t_{(e^\nu,\delta),i-1} + \Delta t_{(e^\nu,\delta)}$$

$$e^2_{(e^\nu,\delta),i} = \Psi_{(e^\nu,\delta),i}\, e^2_{(e^\nu,\delta),i-1} = x_{(e^\nu,\delta),i}$$

$$e^3_{(e^\nu,\delta),i} = \Psi_{(e^\nu,\delta),i}\, e^3_{(e^\nu,\delta),i-1} = y_{(e^\nu,\delta),i}$$

$$e^4_{(e^\nu,\delta),i} = \Psi_{(e^\nu,\delta),i}\, e^4_{(e^\nu,\delta),i-1} = z_{(e^\nu,\delta),i}$$

$$[\Psi] = \begin{bmatrix} k_\Phi & 0 & 0 & 0 \\ 0 & k_m & 0 & 0 \\ 0 & 0 & k_m & 0 \\ 0 & 0 & 0 & k_m \xi \end{bmatrix}$$

$$k_m = \frac{(\gamma - 1) m_e c^2}{k_e \frac{Z e^2}{r_o}}$$

$$\xi = \left(1 - \frac{x_3}{h_m}\right)$$

$$k_{\Phi,i+1} = \frac{e_i \cdot \varepsilon_{0,i+1}{}^{1/2}}{e_{i+1} \cdot \varepsilon_{0,i}{}^{1/2}} \sqrt{\frac{m_{e,i+1}}{m_{e,i}}}$$

$$m_{e,i} = M(m_{e,i-1})$$

A new paradigm in science

As harrowing as warping space-time in a vacuum chamber at a temperature close to the one of the BEC, it is the existence of an elementary spectrum of vibrations that produce the quanta in the non-physical reality $\mathbb{O}$ to bundle into hadrons that pop up in the physical reality $\mathbb{G}$ according to a matter inception algorithm, which creates space and time in a single step.

It is most remarkable because, as all quanta inside nucleons vibrate in the dark space $\mathcal{O} \in \mathbb{O}$, those vibrating in the same frequency ν_p share the same quantum noise. As an arbitrary electromagnetic signal ν_e can be transferred with the appropriate apparatus from one quanta to another, and some crystals contain up to 10^{21} atoms vibrating in the same frequency, it is possible to share instantaneously a transmission signal at an arbitrary distance and amplify it to the threshold of detection.

Funded by the European Union

To projects on the edge of reality

In the laboratory of new sensors of INTA we have created two projects with their own researching ecosystems to test these two harrowing phenomena.

DESS

Development of Elementary Spectrum Sensors

INTA, UPM, DHV, UAH, Chinese Academy of Sciences, CLPU, UMA, Fraunhofer IOF and IZM, HTW Berlin, ALI, SOPHIA, ePROINN, ACIES, COMAT, EZUS - Cristal Innov, LMS, i46, SEL

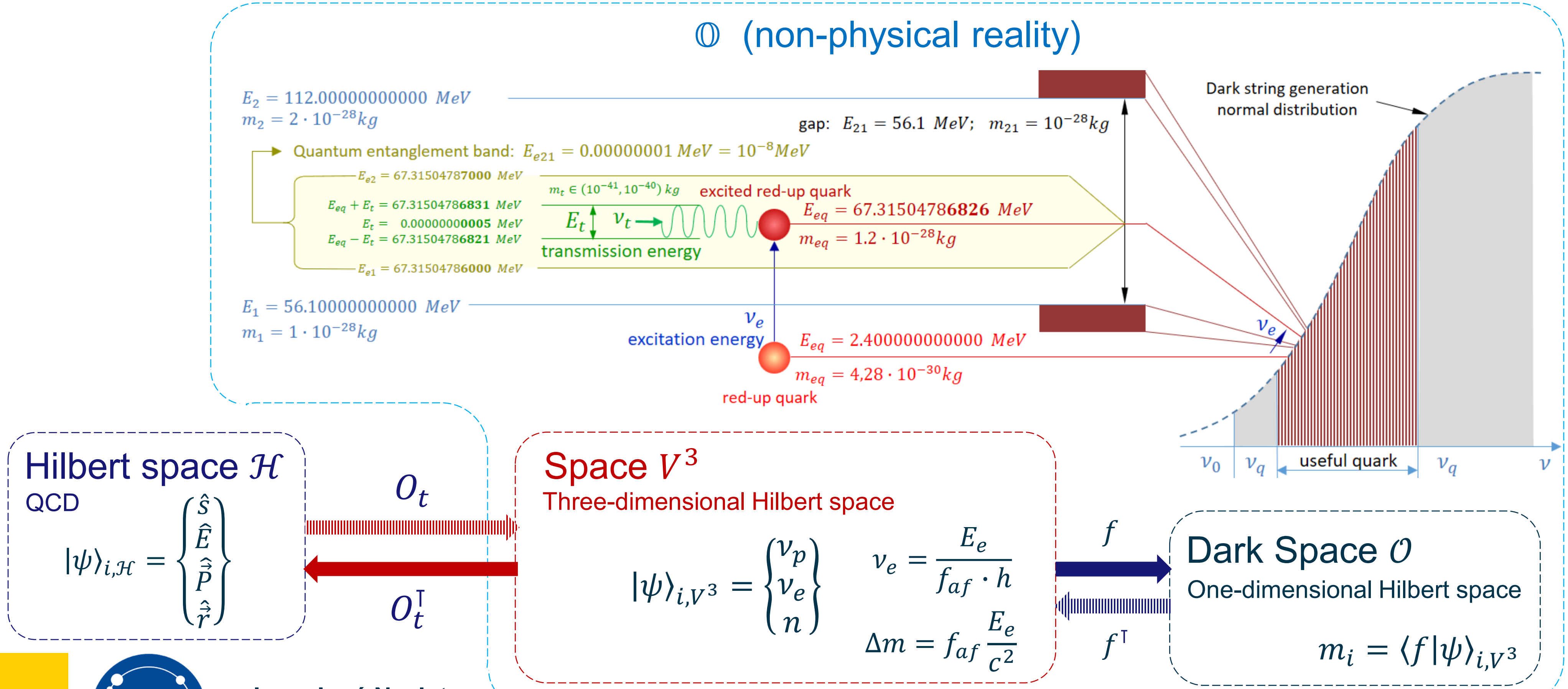
COLUMBUS

INTA, UPM, SAFT (Total Energies), DHV, UAH, Chinese Academy of Sciences,CLPU, UMA, ALI, SOPHIA, ePROINN, ARCEON, COMAT

Development of Elementary Spectrum Sensors

DESS

Domain $\mathbb{G}$ (physical reality)



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Development of Elementary Spectrum Sensors

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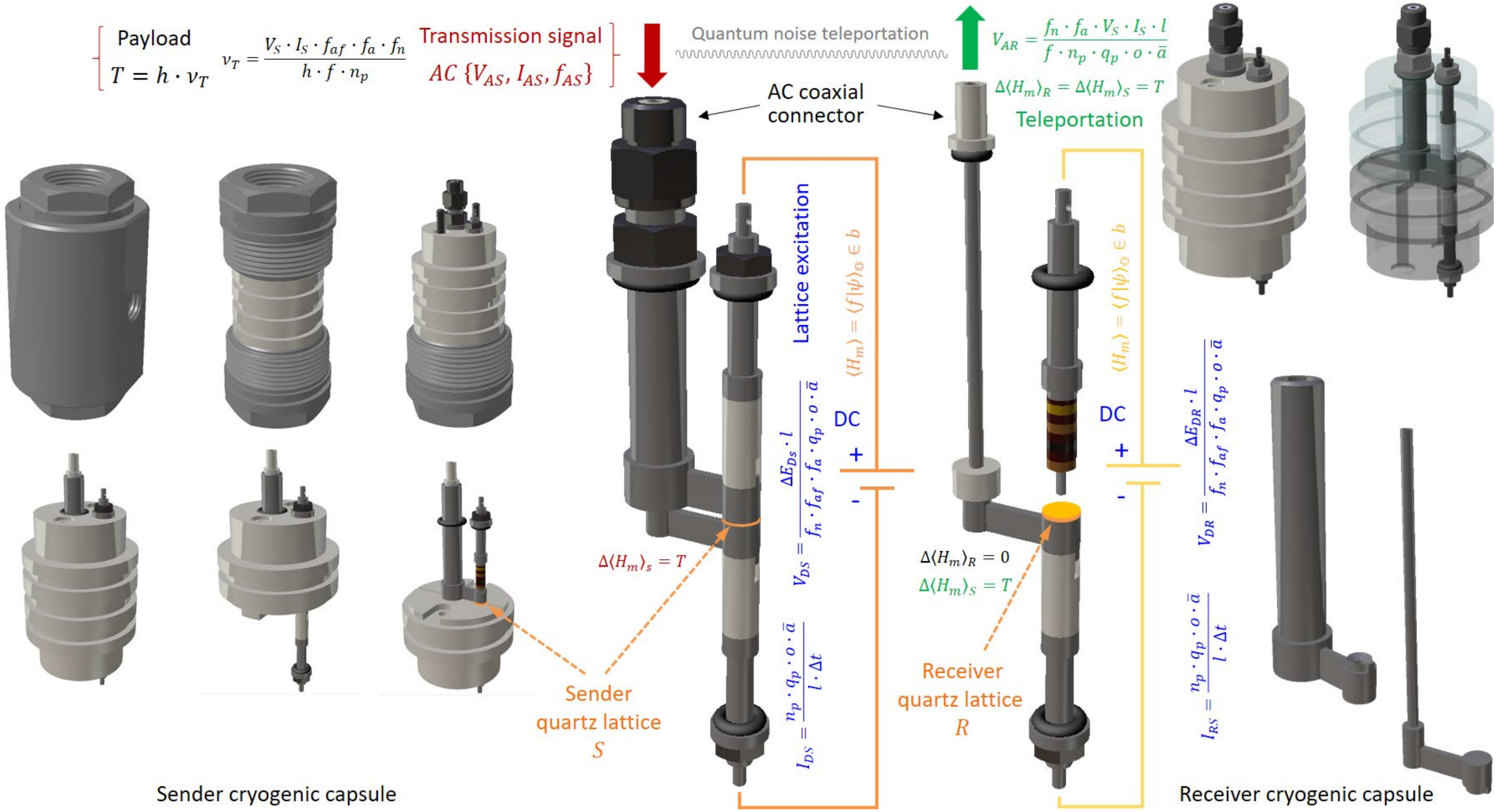
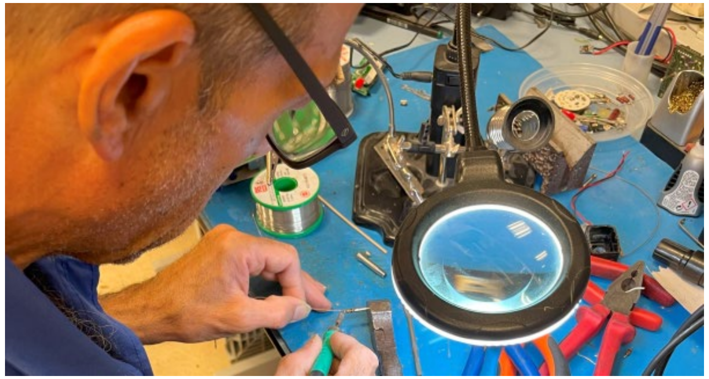


Development of Elementary Spectrum Sensors

DESS

Development of Elementary Spectrum Sensors

DESS



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$$\Psi(1s) = R(1s)Y(1s) = \left(\frac{1}{4\pi}\right)^{1/2} 2\left(\frac{Z}{a_0}\right)^{3/2} e^{-\sigma/2}$$

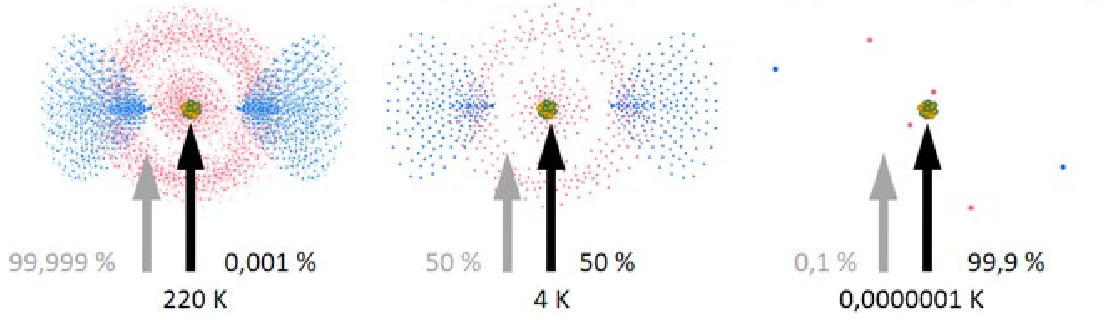
$$\Psi(2s) = R(2s)Y(2s) = \left(\frac{1}{4\pi}\right)^{1/2} \frac{1}{2\sqrt{2}}\left(\frac{Z}{a_0}\right)^{3/2} (2-\sigma)e^{-\sigma/2}$$

$$\Psi(2p) = R(2p)\{Y(p_x), Y(p_y), Y(p_z)\} = \frac{1}{2\sqrt{6}}\left(\frac{Z}{a_0}\right)^{3/2} \sigma e^{-\sigma/2}\left\{\left(\frac{3}{4\pi}\right)^{1/2} \sin\theta\cos\phi, \left(\frac{3}{4\pi}\right)^{1/2} \sin\theta\sin\phi, \left(\frac{3}{4\pi}\right)^{1/2} \cos\theta\right\}$$

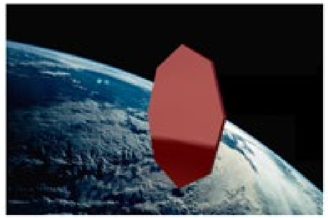
Fermi energy:

$$f(E) = \frac{1}{e^{(E-E_f)/kT} + 1}$$

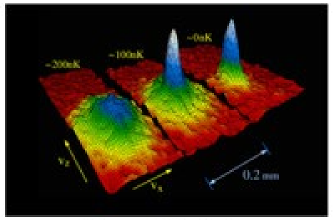
$$\sigma = \Phi(T)$$



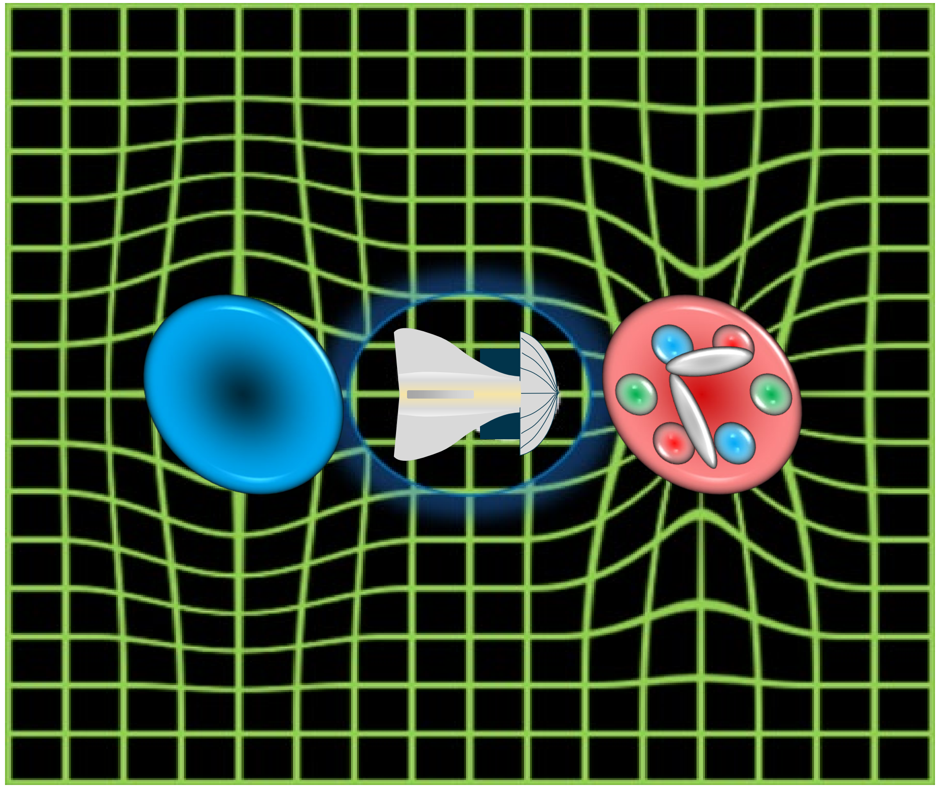
Artic ice



QG-S



Bose–Einstein condensate



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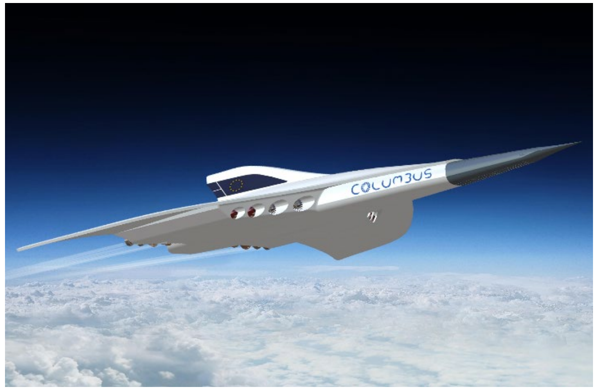

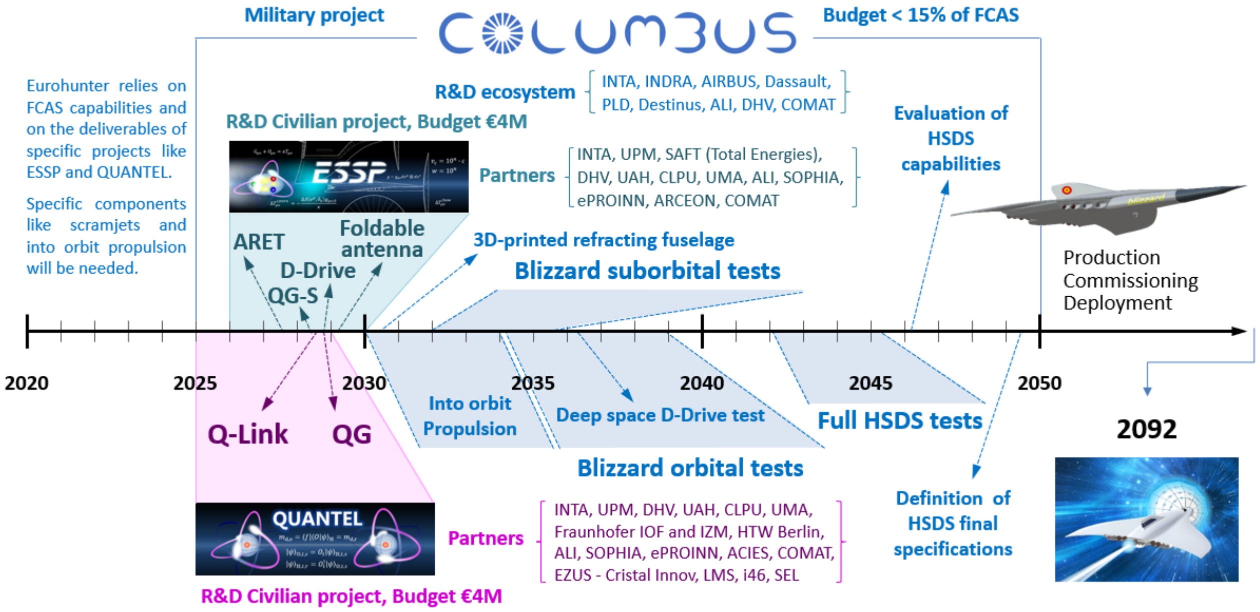

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Spanish Ecosystem on Quantum Technologies

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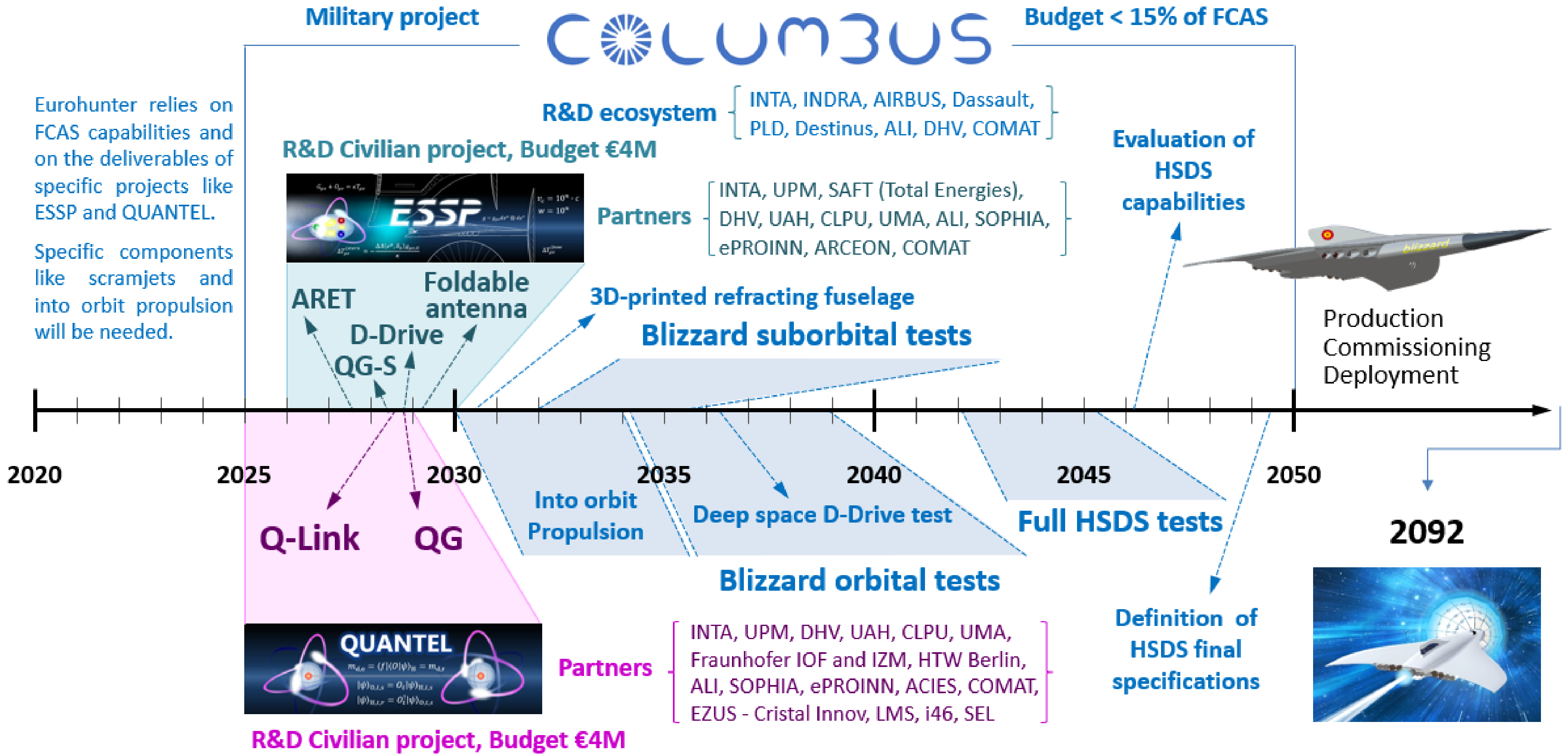

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Thank you for your attention

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