



**FUSION  
FOR  
ENERGY**

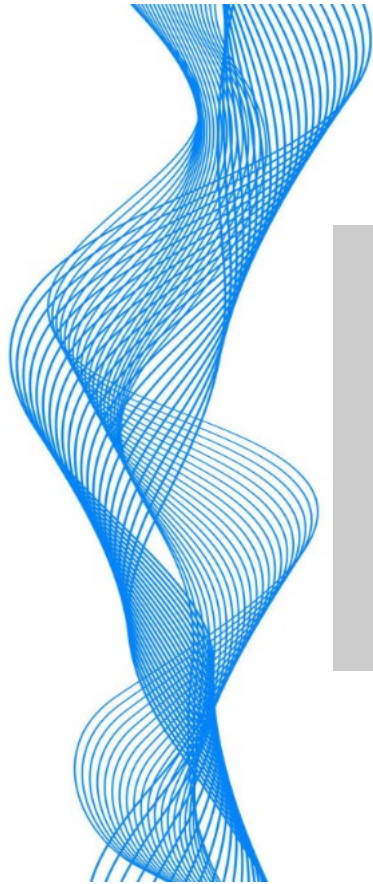
# F4E Technology Development Program (TDP) Pilots Info Day

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Fusion Technologies and Engineering  
Department**

**17<sup>th</sup> September 2024**



**Bringing  
the power  
of the sun  
to earth**



# CONTENT

01

INTRO TDP (WHY)

02

TDP CONCEPT & GOALS (WHAT)

03

WAY FORWARD (HOW, WHEN)

What is the **need** for a F4E Technology Development Program?

Formal answer i: Governing Board Mandate

Formal answer ii: F4E DIR Vision



*“We pave the way for a transition from the research to the industrial sector, and the creation of a **competitive** European industrial fusion sector”*

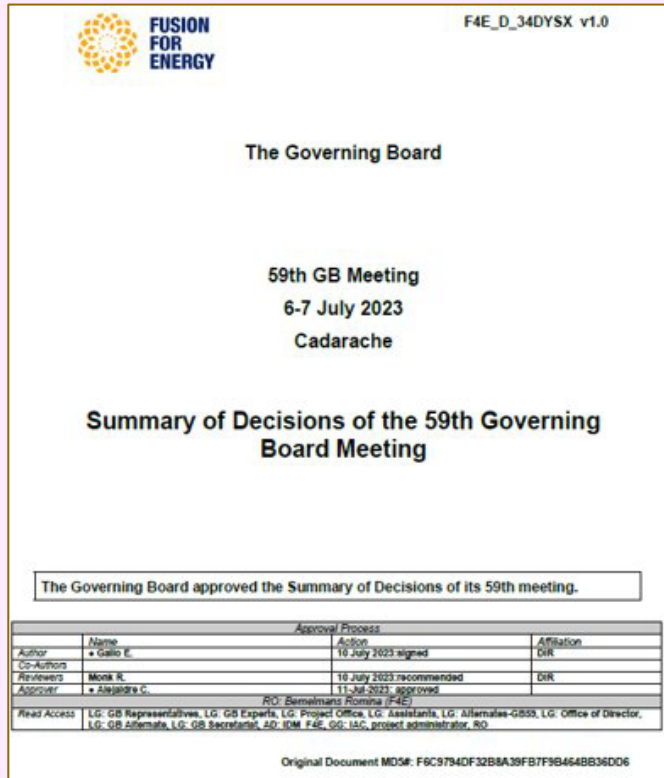
Other directions: European Union Focus on Innovation

*“EU benchmarking shows that Europe is exploiting only half of the **potential** power of innovation procurement, in particular in R&D procurement”.<sup>1</sup>*

*“Public buyers, acting as lead customer, will need to boost innovation procurement and help businesses to develop innovative solutions in **key industrial ecosystems**”.<sup>1</sup>*

*“The fifth freedom” to enhance research, innovation and education. The fifth freedom would entail embedding **research and innovation** drivers at the core of the Single Market”<sup>2</sup>.*

1. Guidance on Innovation Procurement. EC. C(2021) 4320 final; 2. Much more than a Market. Enrico Letta. April 2024



## Procurement Process

1) Strategic procurement

2) SME-targeted recommendations

## Early involvement of EU Industry

3) Implementation of a Technology Development Program (TDP)

4) Better articulation of F4E-EUROfusion collaboration & enhanced involvement of European Fusion Labs (EFLs) expertise

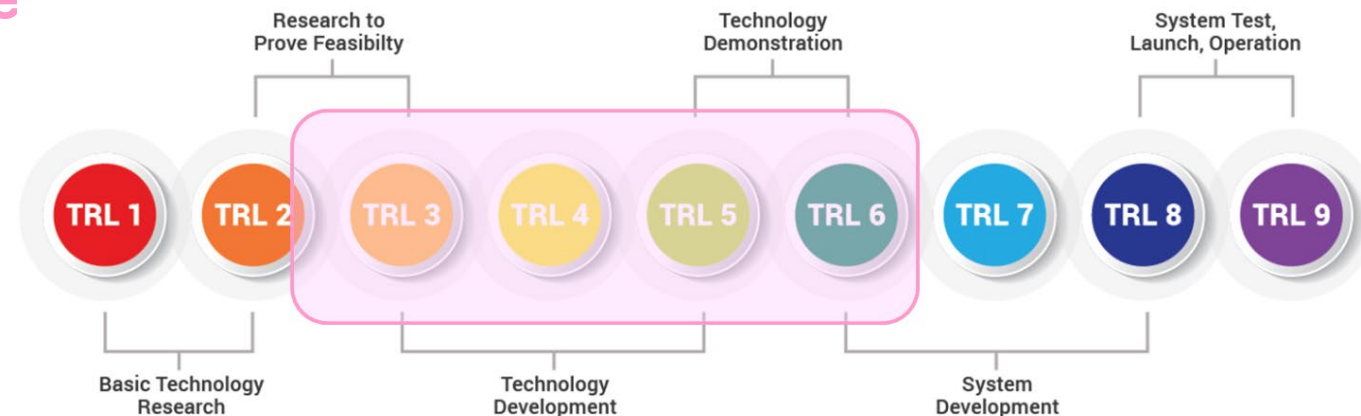
Support **R&D activities** on advanced technological capabilities.

Explore the feasibility and suitability of **cutting-edge technologies**.

Ease availability of fusion **key enabling technologies** (right technologies at the right time!)

Promote strategical technology actions for future-proofing the **competitiveness of European industry**.

Address critical technologies gaps for European fusion technology **non-dependence**

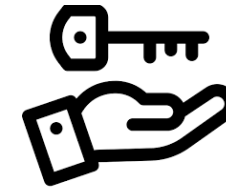




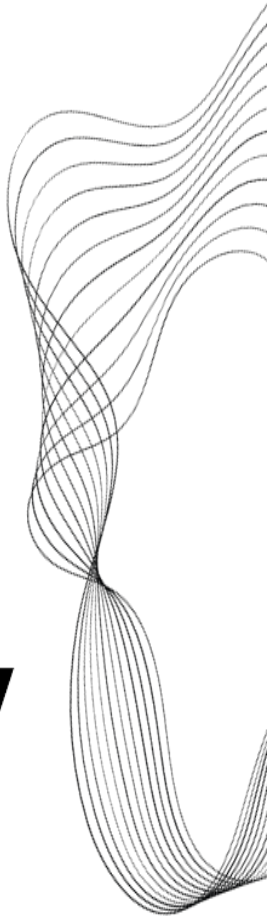
## ADVANTAGES

- R&D activities fully financed by F4E **100%**
- In support of a competitive European Fusion Supply Chain
- Ownership by the company of IP rights generated
- Work based on Best Effort approach
- Simplified Technical Specifications (functional requirements)
- Ad hoc simplified Specific Contract terms
- Ad hoc simplified Tender Provisions
- Quick Procurement Lead Times

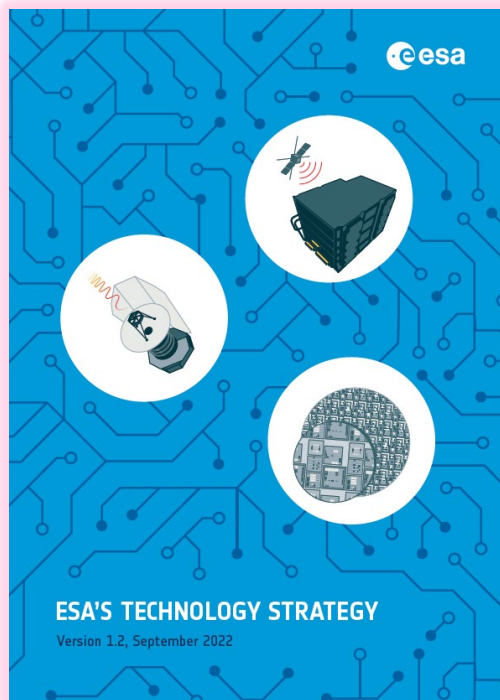
**BEST  
EFFORT**



**Simplify**



## ESA Technology Development Program as the Reference Model



## TEC PEOPLE

FROM LAB EXPERIMENTS TO INDUSTRIAL PROTOTYPES, FROM DAZZLING IDEAS TO RELIABLE INSTRUMENTS, IMAGINATION AND DEDICATION DRIVE OUR INNOVATION

1000 PEOPLE

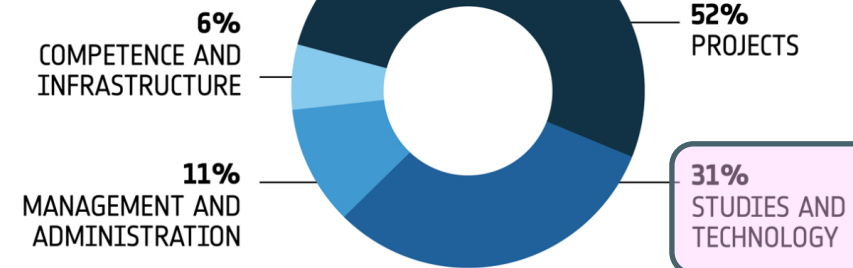
Total ESA Staff 2700

€1.1B€ OVERALL EUROPEAN SPACE TECHNOLOGY R&D BUDGET IN 2022

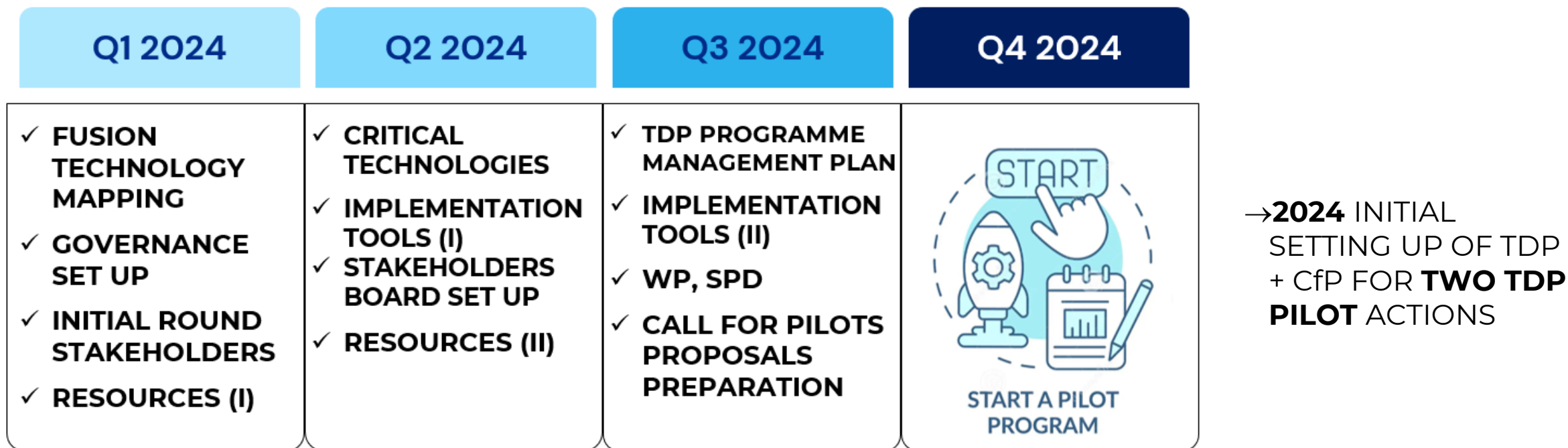
€651M€ ESA'S SPACE TECHNOLOGY R&D BUDGET IN 2022



WORKFORCE FULLY DEPLOYED ON AGENCY PRIORITIES



# WAY FORWARD (HOW, WHEN)



**2025** Full setting up of TDP  
CfP for “n” TDP actions (10 M€ BUDGET) following systematic proposal and selection process  
Pilot on European Fusion Technology Domains Harmonization & Strategy Workshops

**2026+** Steady State, about 30M€ yearly for TDP expenditure

DIMENSION OF PROGRAMME LINKED TO  $\propto$  RESOURCES



**Year 2024:** Launch of two TDP Pilot actions, via Pre-Commercial procurement-based tool

## TDP Pilot Action 1:



Subject: Characterization of Gradient joints on Tungsten/CuCrZr materials

Scope: R&D effort to specify, manufacture and test a series of Tungsten gradient joints samples for a systematic material properties characterization.

Cost Estimate:  $\approx 0,9$  M€, based on assuming three competing companies at stage one, two for later stages of testing and engineering analysis.

Duration: 15 months

## TDP Pilot Action 2:



Subject: Real-time personal monitor for Tritiated water vapor in air.

Scope: R&D effort to develop the design of a real time personal monitor for Tritium vapor. Prototyping and testing of such a design. Redesign and further prototyping and testing as needed.

Cost Estimate:  $\approx 0,7$  M€, based on assuming two competing companies throughout all stages, including prototyping and testing.

Duration: 24 months

- COMPETENCE DOMAIN
- KEY ENABLING TECHNOLOGY
- FUSION CRITICALITY
- STRATEGIC PROCUREMENT
- NEED HARMONIZATION
- CURRENT TRL
- CURRENT SRL
- STATE OF THE ART / TECH STATUS / GAPS
- COMPETITION
- EUROPEAN INDUSTRY COMPETENCES
- STRATEGIC INTEREST / NON-DEPENDENCE
- SPIN OFF PROBABILITY
- ITER/DEMO SCOPE RELEVANT
- ITER OPPORTUNITY
- RELEVANT FOR FPP
- PRIORITY

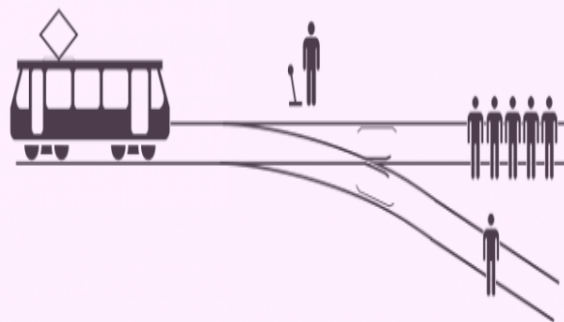
COMPETENCE DOMAIN	KEY ENABLING TECHNOLOGY
HIGH TECH MATERIALS	
	<b>FUSION MATERIALS CHARACTERIZATION</b>
	Novel fusion materials
	Advanced materials (e.g., SiC composites) with high heat resistance (up to 1000°C) and low activation
	Porous SiC with tailored porosity production
	Fusion structural materials (e.g. reduced activation steels)
	Creep resistance materials under influence of irradiation (embrittlement and swelling) and high temperature
	Reduced-activation ferritic/martensitic steels (RAFM): EUROFER, F82H
	High-strength steels e.g., Nitronic 50/XM-19 characterization and testing
	Oxide Dispersion Strengthened RAFM steel (ODS RAFMS)
	Rare earth metals for allows properties improvement
	First wall materials
	Self-passivating Metal Alloys with Reduced Thermo-oxidation (SMART)
	Cu / CuCrZr alloys (alternative heat sink combinations)
	YPb2 / Zr5Pb3 pebble/block fabrication and thermal cycling
	YPb2 / Zr5Pb3 EUROFER corrosion compatibility
	Advanced ceramics (e.g. Zerodur, Si, Al, Li oxide)
	SiC/SiC composites
	Beryllium / Beryllium Alloy
	Vanadium alloys
	Nanostructure alloy
<i>To be moved to "3D PRINTING / MANUFACTURING"</i>	<b>Functionally Graded Materials (FGMs) for transition between two materials with different properties</b>
<i>To be moved to "TESTING"</i>	<b>Irradiation of materials for neutron flux simulation</b>
	Coolant media above 500 C and compatibility of coolant interface materials (synergies with next generation fission)
	<b>TUNGSTEN CHARACTERIZATION</b>
	Tungsten for Plasma Facing Components (PFC)
	Tungsten fibre-reinforced composites (Wf /W) for high T applications (PFC)
	Tungsten fibre-reinforced copper composites (Wf-Cu) for high T and high heat flux applications
	Tungsten self-passivating (oxidation resistant) based alloys for high temperature application
	Tungsten-based laminated semi-finished products for plates, pipes or foils



F4E HUB

Innovation Procurement  
Pre-Commercial Procurement

Industry concerns about **bureaucracy** and repetition of **'heavy'** ITER style procedures and F4E culture



## Steady State

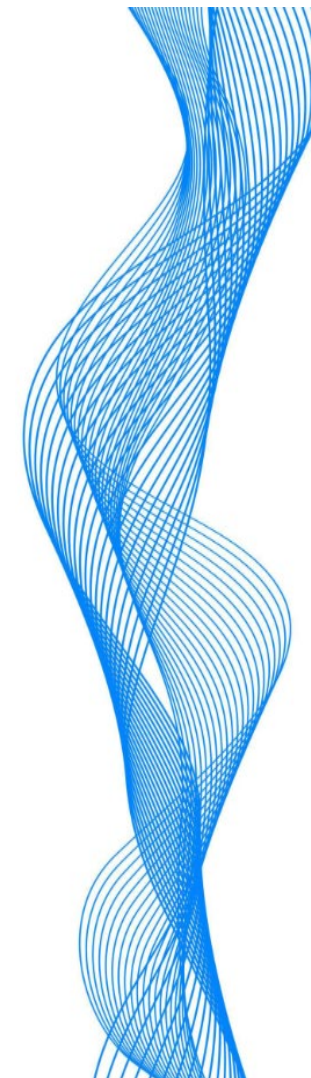
Typ. 30+ contracts per year 30 M€/year  
≈ 1M€ / 18-24 months duration

**RESOURCES**



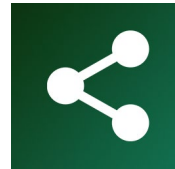
## Pilot

Typ. 2 contracts (<2 M€ in total)  
R&D-type Model Contract (simplified)

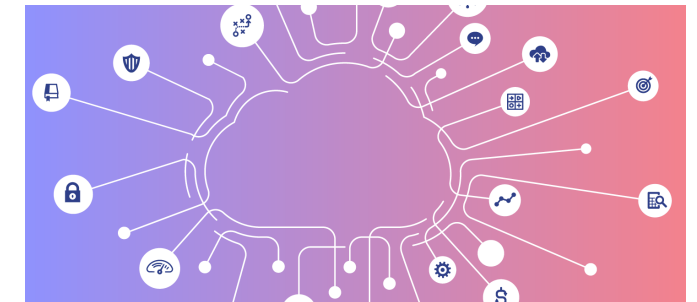


## Steady State

COMPETENCE DOMAIN	KEY ENABLING TECHNOLOGY
1	
2	
3	
4	<b>HIGH TECH MATERIALS</b> <i>Initial Review on 27th February</i>
5	<b>FUSION MATERIALS CHARACTERIZATION</b>
6	Novel fusion materials
7	Advanced materials (e.g., SiC composites) with high heat resistance (up to 1000°C) and low activation
8	Porous SiC with tailored porosity production
9	Fusion structural materials (e.g. reduced activation steels)
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12	High-strength steels e.g., Nitronic 50/XM-19 characterization and testing
13	Oxide Dispersion Strengthened RAFM steel (ODS RAFMS)
14	Rare earth metals for alloys properties improvement
15	First wall materials
16	Self-passivating Metal Alloys with Reduced Thermo-oxidation (SMART)
17	Cu / CuZr alloys (alternative heat sink combinations)
18	YPb2 / ZrSPb3 pebble/block fabrication and thermal cycling
19	YPb2 / ZrSPb3 EUROFER corrosion compatibility
20	Advanced ceramics (e.g. Zerodur, Si, Al, Li oxide)
21	SiC/SiC composites
22	Low activation and induced creep materials exposed to neutrons
23	Nanostructure alloy



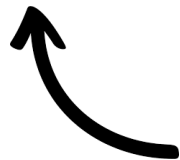
## Consolidated



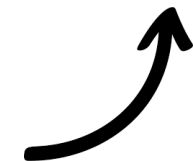
Critical Technologies Mapping  
(F4E expertise)

Sharing with external  
Stakeholders

Consolidated Tech Mapping

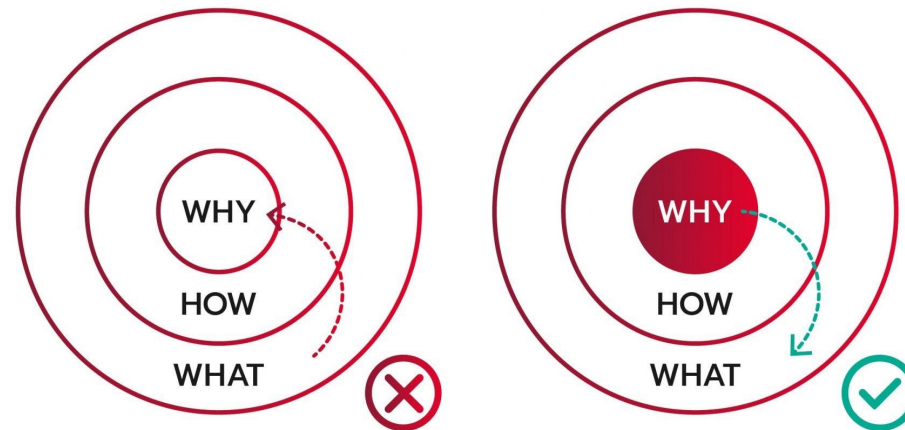


Definition of assessment  
parameters and priorities



*we believe*

in supporting **European industry** ambitions for accelerating fusion  
in making F4E a (great) **Fusion Technology Hub / Cluster**





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FOR  
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# Thank you for your attention

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