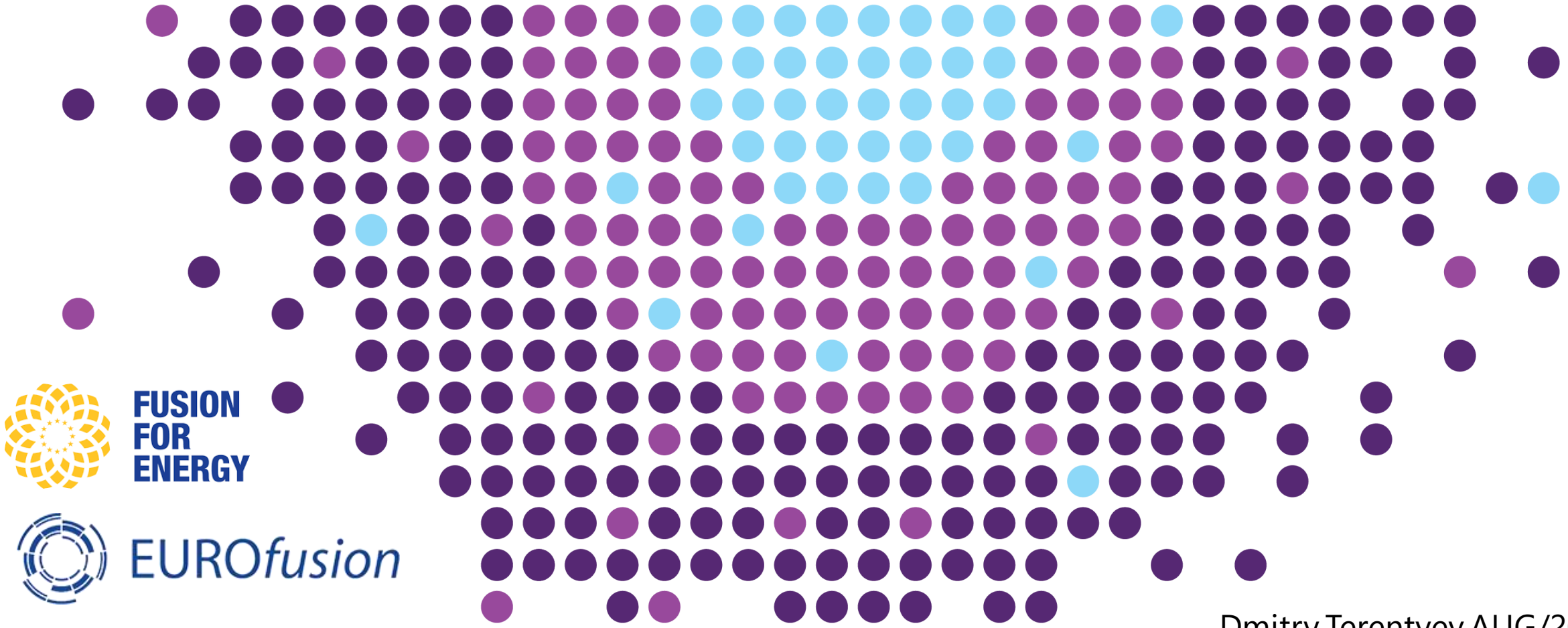


FUSION FOR ENERGY

EUROfusion

Dmitry Terentyev AUG/2022

SCK CEN
Belgian Nuclear Research Centre

Qualification of EUROFER97 for TBM: contribution of the EUROfusion project within 2021-2025

Gerald Pintsuk, Giacomo Aiello, Edgar Leon, Marta Serrano, Pierre Lamagnere, Véronique Lezaud-Chaillioux, Cristel Caës, Jérémy Hure, Grégory Perez, Alexander Zinovev, Yiqiang Wang, M. Carrington, Mario Walter, Jarir Aktaa, Dirk Radloff, Ermile Gaganidze, Davide Bernardi, Enrico Perelli Cippo, Szenthe Ildiko, Yann Carin, Zmitko Milan; Vallory Joelle, Poitevin Yves

Qualification of EUROFER97: NEEDS & APPROACH

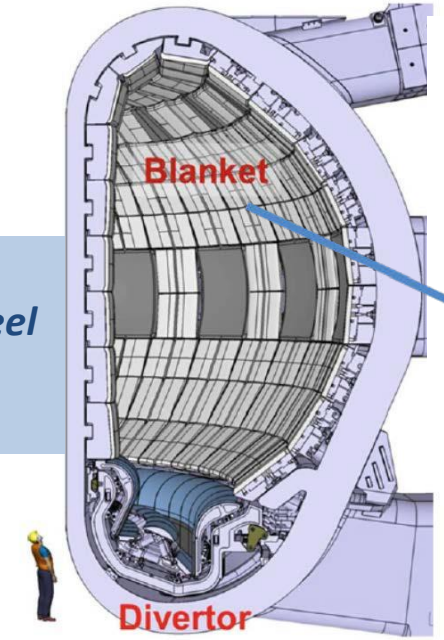
Component Design
- Loads
- Performance
- Safety

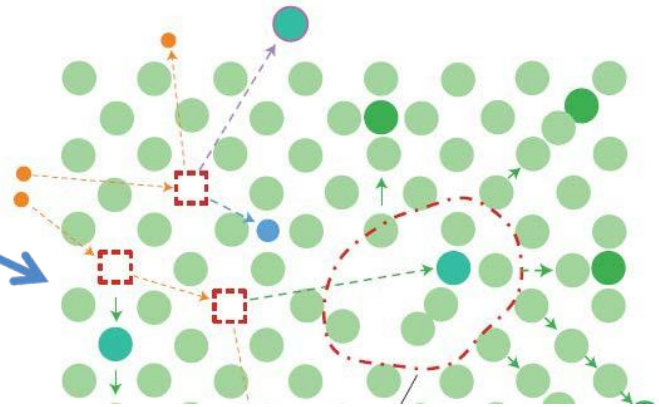
Operational conditions
- Temperature
- Stresses
- Displacement damage

Material Characterization
- Mechanical
- Physical
- Chemical

Codification
- Property Handbook
- Design Rules
- Code Update

Ferritic-Martensitic *Steel*
Li-Ceramic
(*Breeder*)





High temperature, mechanical loads and irradiation damage

Damage in materials
- Embrittlement
- Creep
- Fatigue
- Combination of damage modes

Severity of irradiation damage measured by dpa
- **ITER ~ 2 dpa**
- **DEMO 20-50 dpa**

1. Qualification of EUROFER97 ***to cover ITER TBM needs***: existing gaps, update RCC-MRx, validate Design Rules
2. Qualification of EUROFER97 ***beyond ITER TBM needs***: high dpa, possible update/development of Design Rules

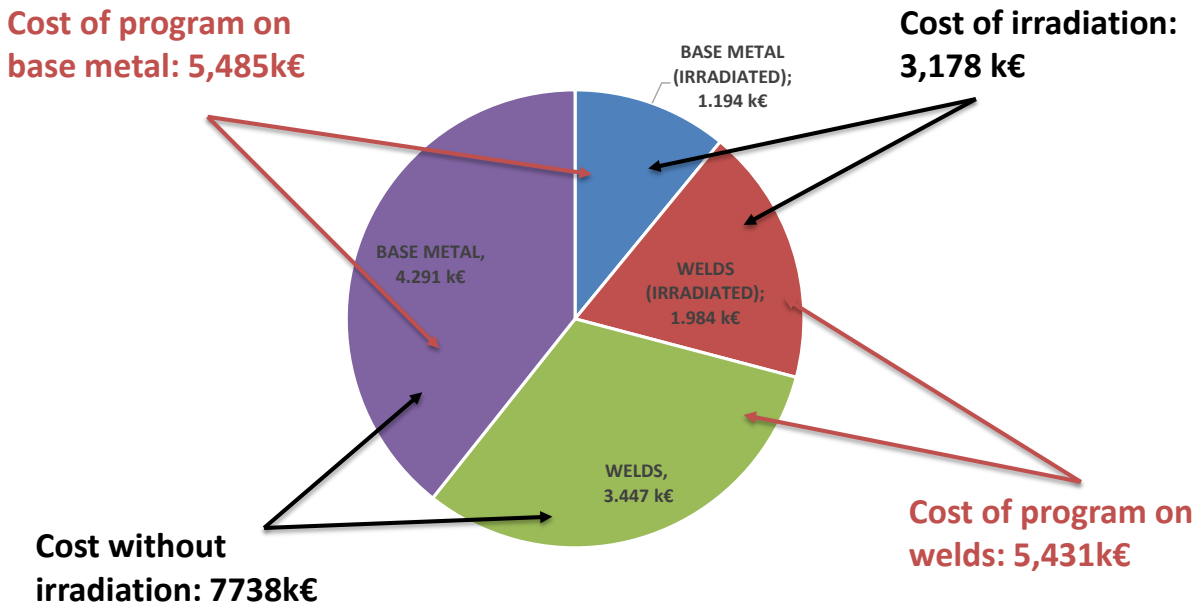
*Non-irradiated base metal: ratcheting, IPFL, fatigue, fracture toughness, creep (partial), creep-fatigue (partial). Partial properties for welded joints and irradiated base metal

Scope/Cost/Time of TBM programme

- **Objectives:**

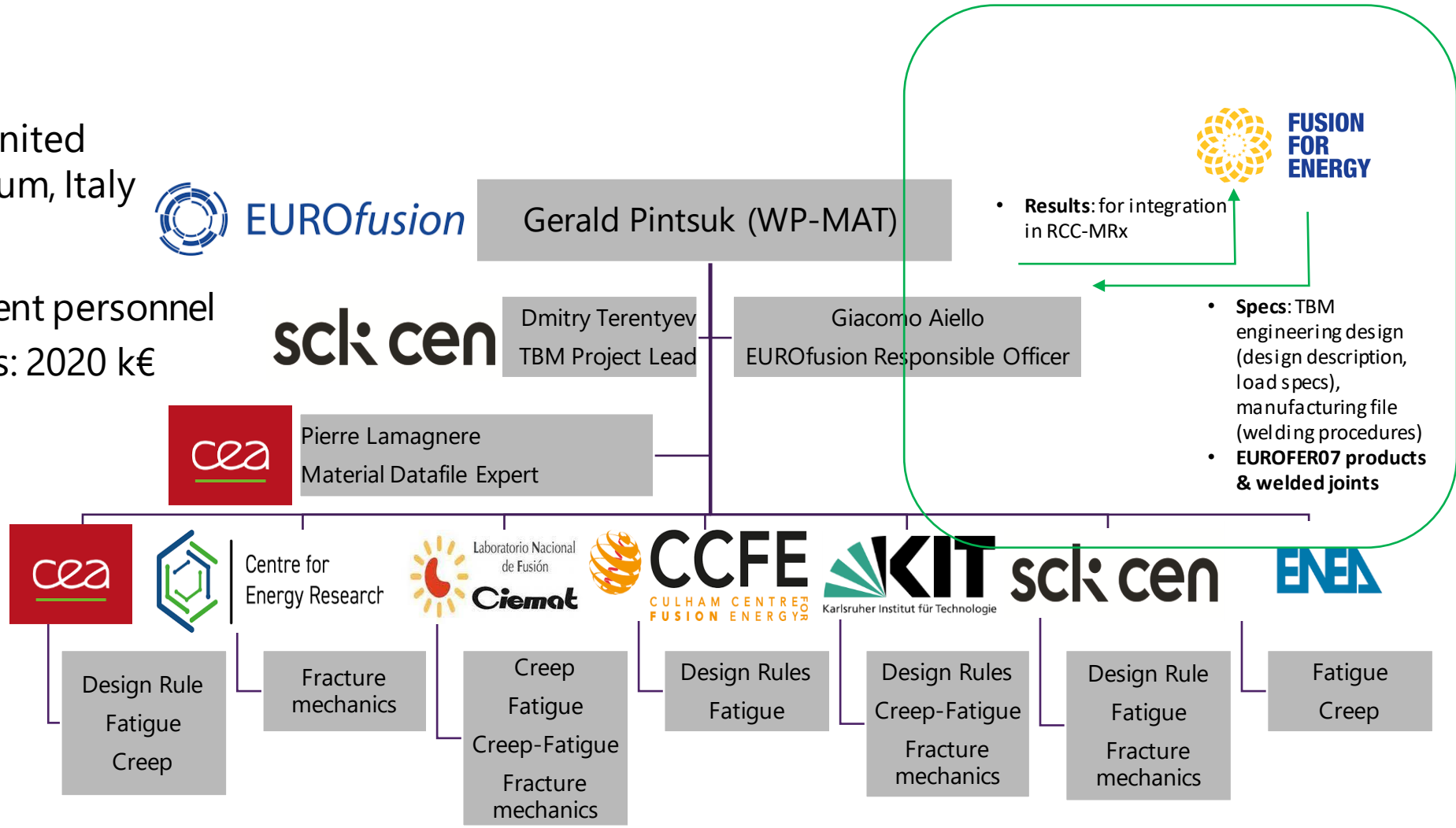
Objective	Scope Description	Priority	Deadline
Start-up TBM	Mechanical properties for preliminary design of the two TBMs for ITER within normal operation*	Highest	DEC 2023
Full TBM	Extended characterization of base metal and welds (non-irr.) required to design and assess the operational domain of TBM outside normal operation	High	DEC 2025
Beyond ITER TBM	Extended integration of EUROFER97 in RCC-MRx for all damage modes (incl. irradiation). Possibly part of properties relevant to DEMO conditions	Medium	2029

Completion for all TBMs design justification	Base metal	Weldments
Basic (non-irrad.) characterization	2019-2024 (except creep)	2023-2026
Neutron irradiation	2019-2023	2023-2026
Post-irradiation characterization	2021-2025	2026-2027



Roles & Responsibilities within TBM programme (EUROFER97)

- Implementing Consortium:
  - France, Hungary, Spain, United Kingdom, Germany, Belgium, Italy
- Resources:
  - 873 PM Full Time Equivalent personnel
  - Hardware & Consumables: 2020 k€
  - Irradiation & PIE: 2350 k€
- F4E
  - Supply of EUROFER97
  - Review & Validation



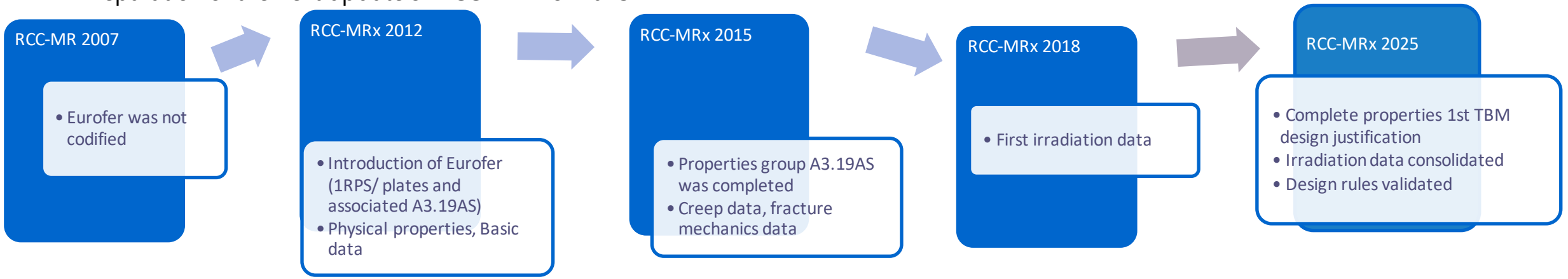
Current Status & Next Steps

Status on AUG 2022:

- Base metal characterization: Work Breakdown Structure (WBS) is defined, Material is distributed, Tests are ongoing, RCC-MRx update is planned for 2025
- Base metal irradiation: WBS is defined, irradiation programmes are launched (Belgium and Hungary), PIE is under preparation
- Weldments characterization: WBS is under preparation, Fabrication is in progress, Tests & Irradiation will be launched in 2023

Next Steps (for 2022-2025):

- Development of Fusion-dedicated standard for the Small Specimen Test Techniques (SSTT) → critical for mining material properties in irradiated state
- Preparation of the next update of RCC-MRx for 2025



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