Task: Stellarator Power Plant Studies in WP-PRD
- Status and link to WP-W7X -

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September 13, 2021

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

SPPS Goals

Background:
ELMs unacceptable for DEMO (and thus classical H-mode); needs current drive (recirc. power), pulsed operation (load cycling), instabilities (disruption)
→ DEMO now: physics gaps and additional complications in engineering that the stellarator design could help ease

EUROfusion Roadmap:
„… review and decision point around 2030 on how to progress with a next-step stellarator device (such as a burning-plasma device)“

→ Develop engineering basis for a next-step stellarator device
→ Analysis of key design drivers and stellartor-specific engineering issues
→ Down-selection of attractive options for a next-step stellarator device

SPPS Research Strategy in a Nutshell

1) **Systems Studies for design space exploration**

2) **Parametric (CAD) modelling for fast design iteration**

3) **3D Multi-physics assessment to solve stellarator-specific engineering challenges**

Magnetic configuration and physics scenarios as input from WP-W7X and TSVV

Required effort

Hierarchy of models with different fidelity

Improvement of predictive capability

SPPS Tasks in 2021

- **Systems Studies**
  - IPP – New generation of models that can treat any type of configuration
- **Stellarator Neutronics**
  - CIEMAT/Aalto – benchmark of MCNP and Serpent2 (KIT from 2022)
- **Magnet System (HTS for Stellarators)**
  - KIT – coil curvature limitation due to bending strain
- **Blanket**
  - U. Palermo – Multi-physics modelling
  - CCFE – Remote Maintenance

Link to WP-W7X

- **Identification of reactor-relevant physics gaps, operation scenarios, and engineering constraints**

  - Stellarator has to demonstrate risk free & reliable operation
  - Avoid “dead-end” scenarios
    (detachment control, core-edge compatibility, accidental re-attachement, avoidance of transients), etc.

- **Discussion started in the Topical Group “Scenario Development”**
- **Next step:**
  - Development of pragmatic experimental proposals with experts; and implementation into the W7-X experimental programme

General issues

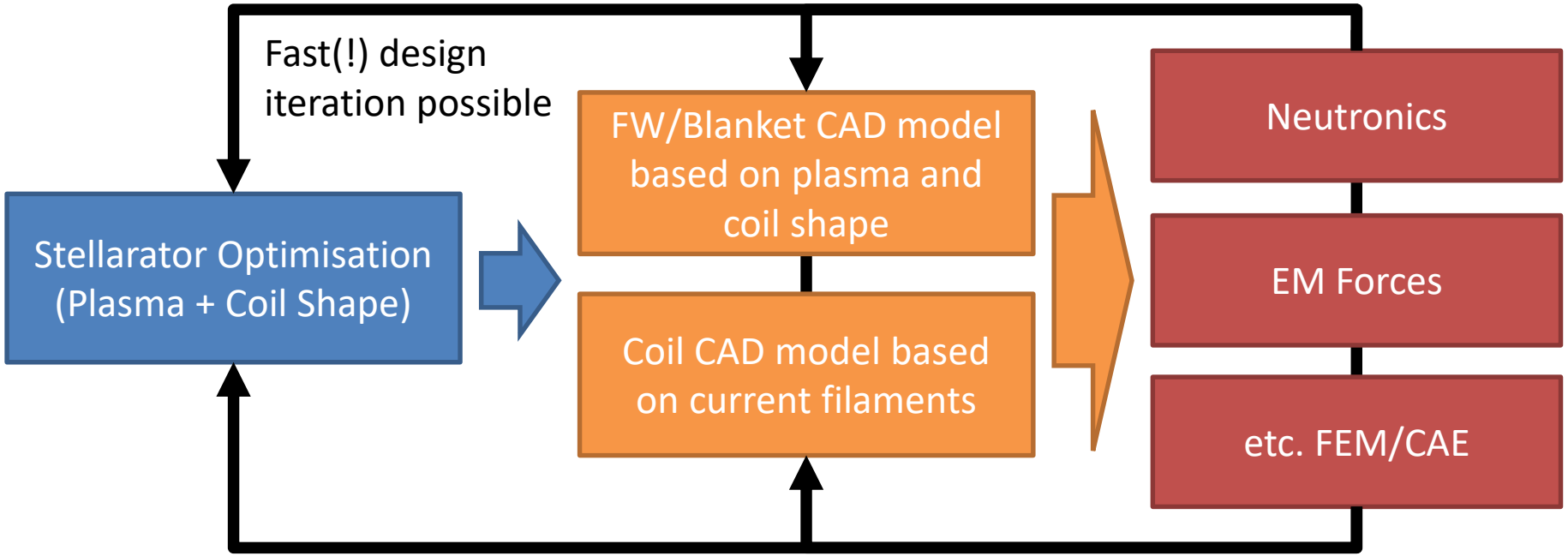
- **Status of resources**
  - 2x ~50% cut, from 12ppy expected to now 4ppy/year

- **Lack of key expertise**
  - Examples: loss of KIT neutronics expert; severe CAD bottleneck (see strategy)
  - So far relying on DEMO experts (Stellarator Engineering Experts do not exist)
  - resources don't seem to be enough to incentivise PhD projects

- **Possible Countermeasures:**
  - EEG Grants (have not been considered 3rd year in a row)

- **Risk: At the current level, the goal of the EUROfusion Roadmap for 2030 to discuss a next-step stellarator device will lack sufficient engineering input**

Why is parametric CAD modelling a bottleneck?



- Reduce time consuming manual work for the complex 3D geometry
- Enable high-fidelity multi-physics/CAE analysis of the 3D components
- Allow fast design iterations and optimisation within reasonable time & resources