

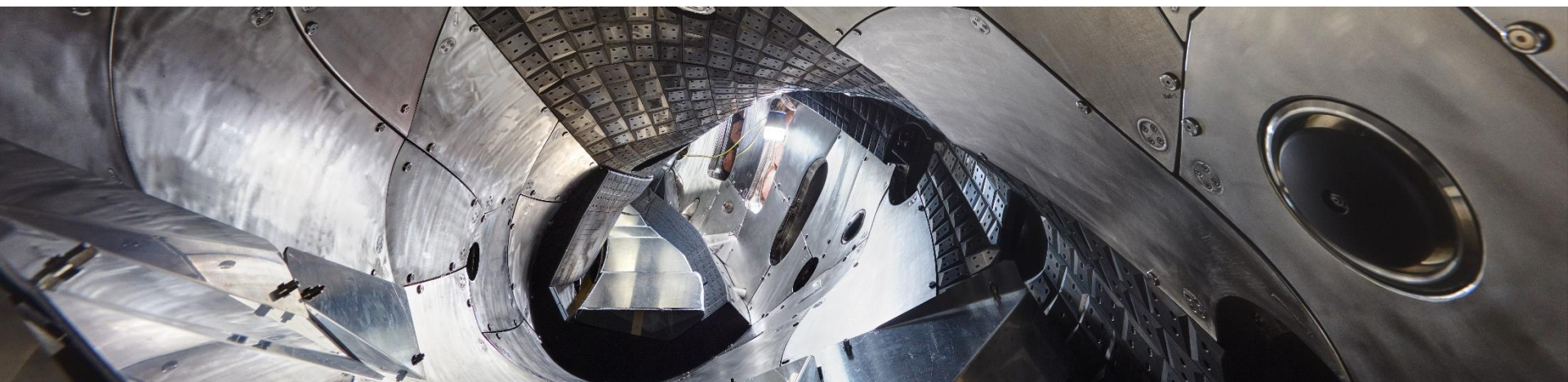
Realization of the requirements for a safe operation of Wendelstein 7-X

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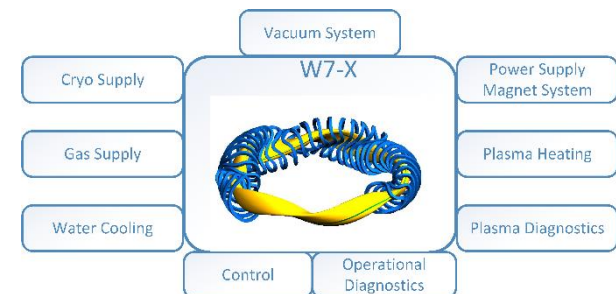
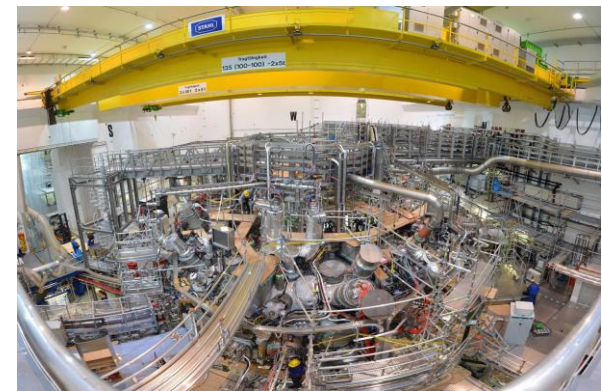
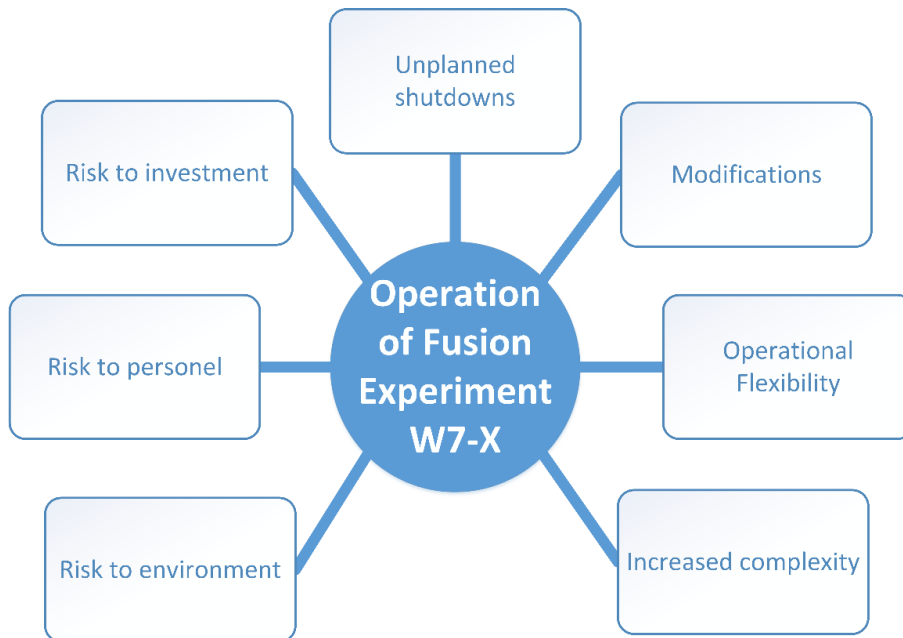
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 **EUROfusion**



- A safe and reliable operation of the fusion experiment W7-X is a fundamental requirement for the successful execution of research programs.
- During the completion phase CP2 of W7-X, the safety control systems will be modified to be ready for the upcoming operational phase OP2.0.



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Realization of the requirements for a safe operation of Wendelstein 7-X (W7-X)



J. Schacht¹, D. Naujoks¹, S. Pingel¹, A. Wöhr¹, U. Herbst¹, S. Degenkolbe¹, R. Vilbrandt¹, H.-S. Bosch¹, A. Winter¹ and the W7-X Team

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Motivation

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- During the completion phase CP2 of W7-X, the safety control systems will be modified to be ready for the upcoming operational phase OP2.0.

W7-X operation

Wendelstein 7-X operation

Risk analysis:

- Identification and analysis of potential hazards for personnel, for the W7-X device and for the environment.

Examples for hazards of W7-X:

- Operation with high voltages and high currents in ranges of kV/6A.
- Certain working gas types are explosive and / or toxic.
- Plasma heating systems produce radio waves (ECRH: 2 MW), microwaves (ECRH: 10 MW) or high energy particles (NBI: 5 MW).
- Some diagnostics use laser systems with high laser beam power (laser class 4).
- The superconducting coils of magnet systems uses 4K Helium as coolant.
- Production of fast neutrons during Deuterium plasma discharges.

Safety life cycle, Risk mitigation



Safety lifecycle

Legal Requirements for W7-X operation:

- Industrial safety regulation,
- German occupational safety and health act,
- Product safety act,
- European harmonized standards, and
- Technical Standards e.g. Functional safety (EN 61508, EN 61511).

State for status of the safety management and setup of the Safety Instrumented System (SIS) for W7-X.

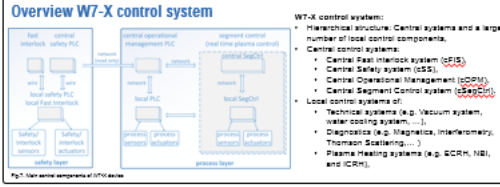
Measures for risk mitigation

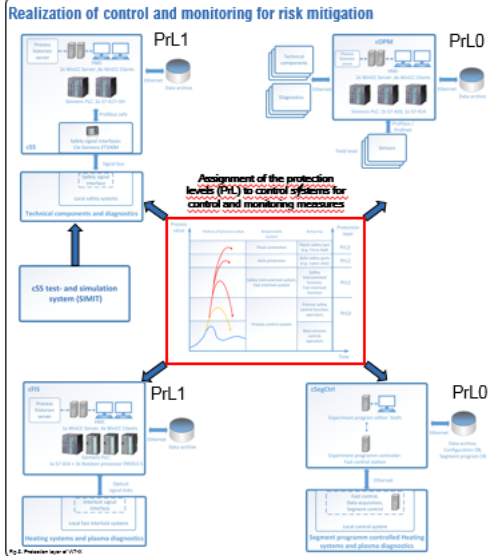
Special features of W7-X operation:

- W7-X an experiment being modified for every new operational phase. As a result, existing safety requirements or new requirements must be taken into account.
- A fusion experiment is a very complex technical system with a high potential of risks.
- Not all of the required Safety Instrumented Functions can be realized with the required Safety Integrity Level (SIL), since plasma diagnostic which are providing signals used as sensors and also some actuators used in the safety systems are usually not certified according to EN 61508 / EN 61511.

W7-X control system overview



W7-X control system overview



Status safety relevant control systems

Status safety relevant control systems (operational phase OP1.2b):

- CRIS:** 29 Safety Instrumented Functions for occupational safety and 14 Safety Instrumented Functions for device safety.
- Safety related function:**
 - Control of safety areas of W7-X,
 - Gas clearing system,
 - Access control system of radiation protection area and radiation protection system,
 - Signaling system,
 - Standard safety signalization status (Emergency Stop, enable signals, status signals), ...
- COM:** 50 Process Supervision Functions.
- CRIS:** 10 Interlock-Safety Functions:
 - Plasma density interlock,
 - Temperature supervision of plasma facing components,
 - Shut isolation interlock,
 - Plasma heating interlocks.

Thanks for attention!

Please contact me during the poster session!

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