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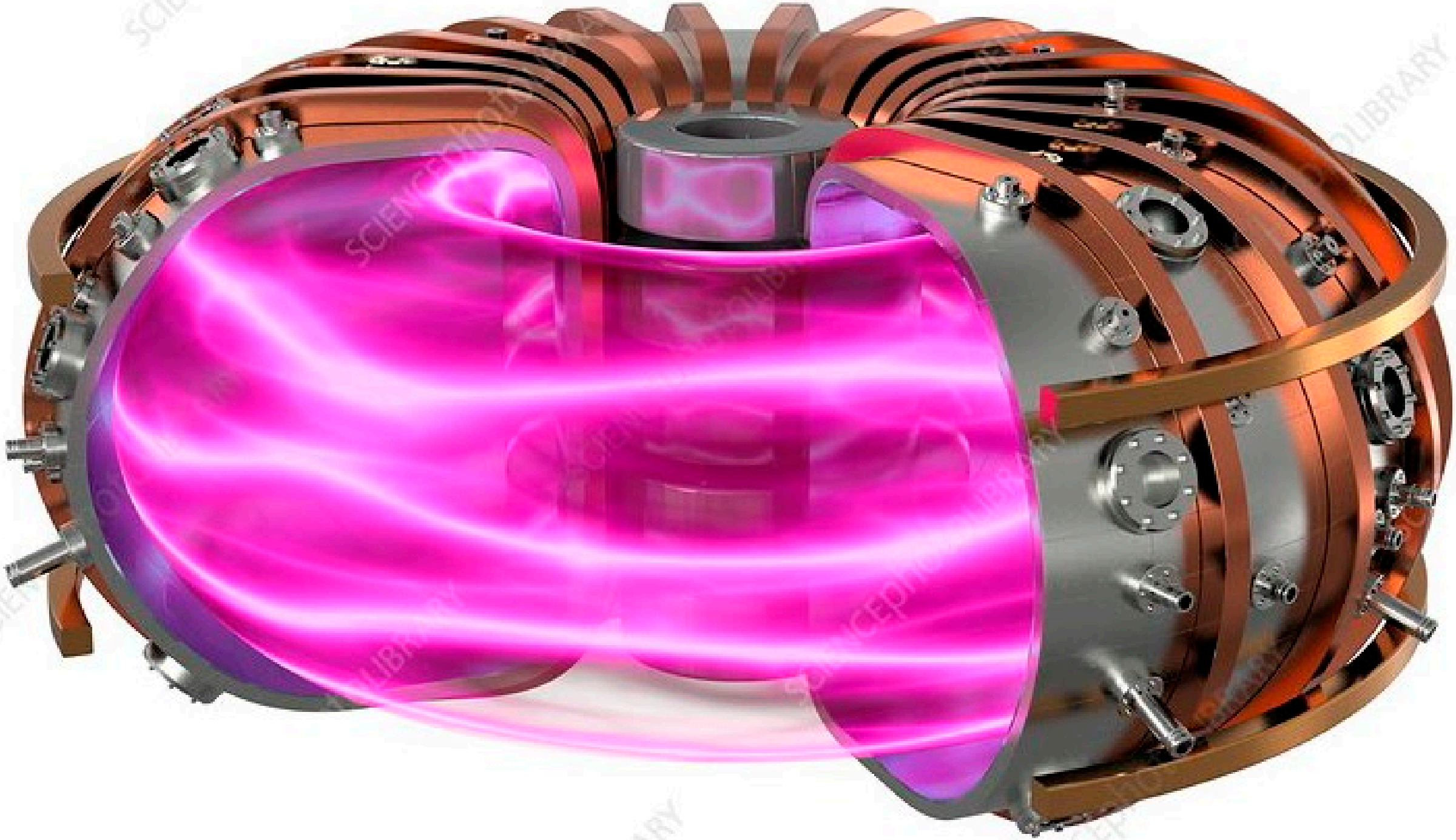
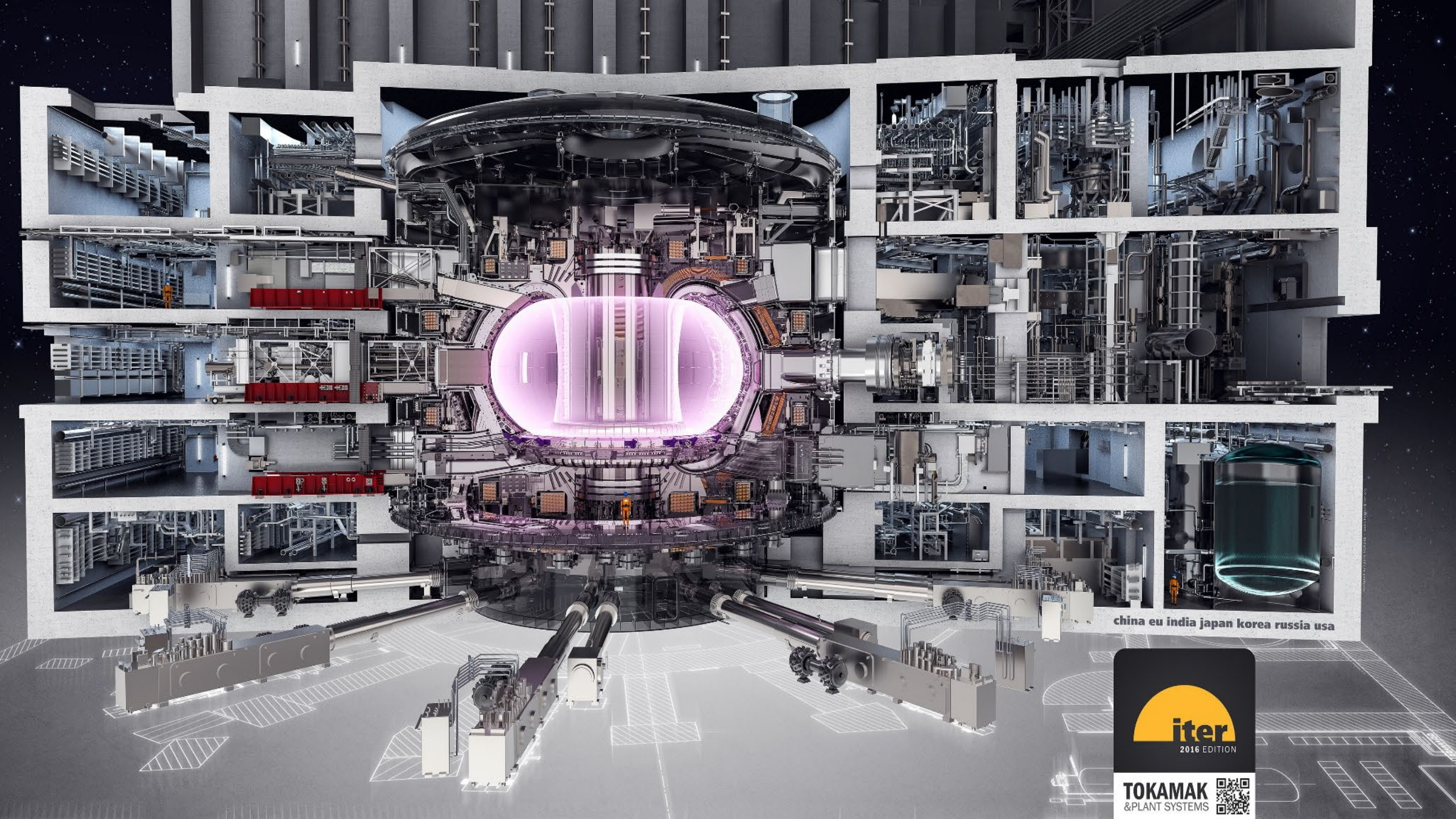
Dutch Institute for
Fundamental Energy Research

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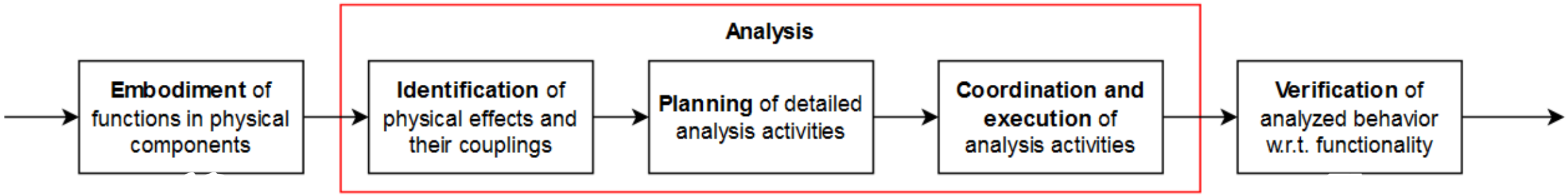
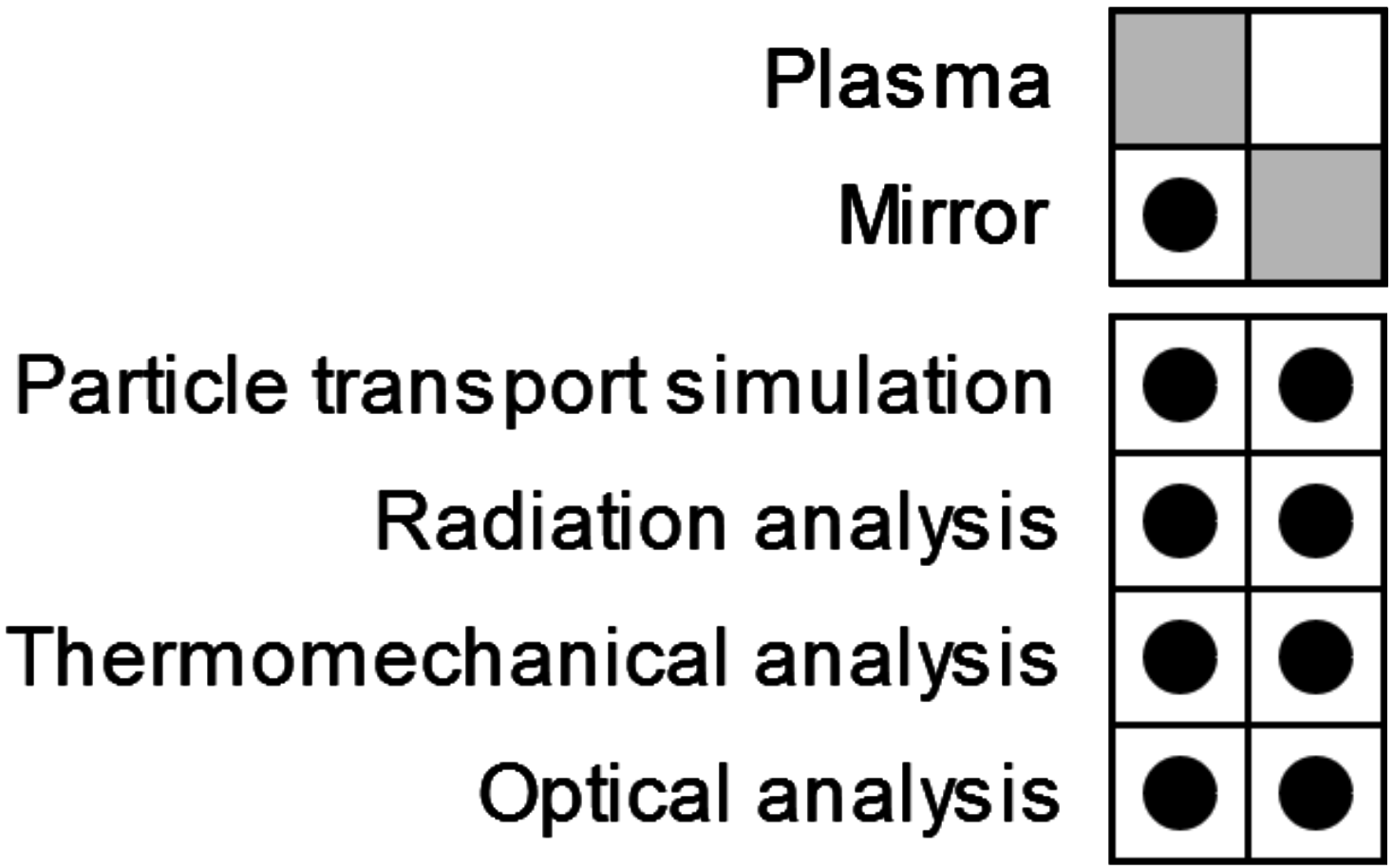
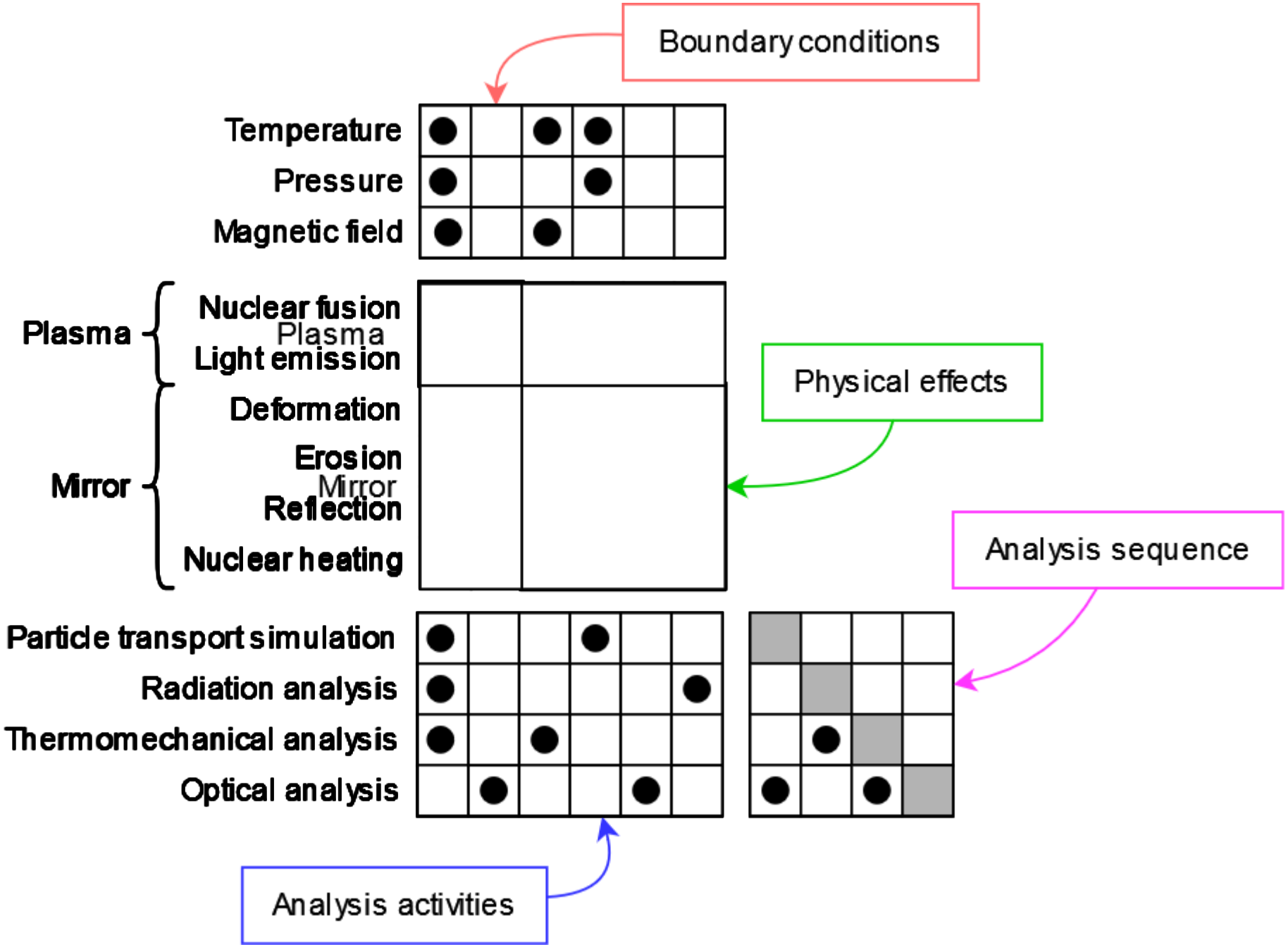
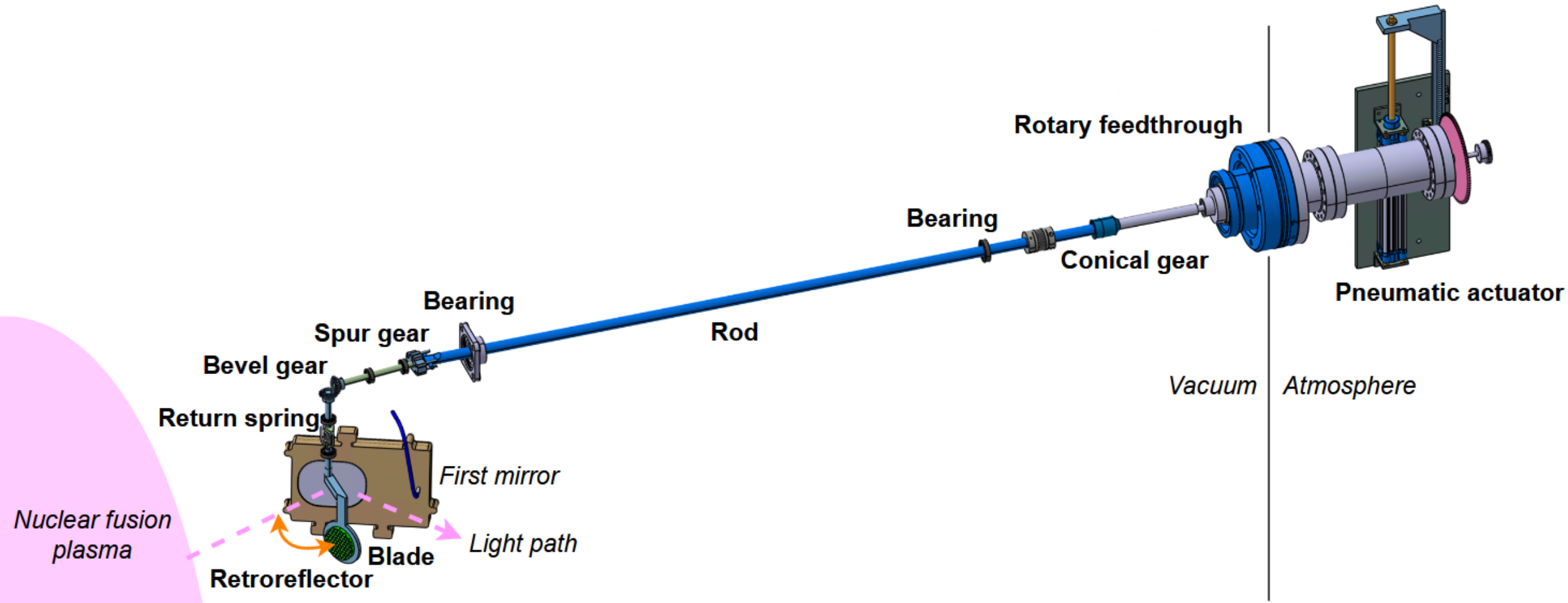
2016 EDITION
TOKAMAK
&PLANT SYSTEMS


Analysis
Embodiment of functions in physical components
Identification of physical effects and their couplings
Planning of detailed analysis activities
Coordination and execution of analysis activities
Verification of analyzed behavior w.r.t. functionality


Plasma
Mirror
Particle transport simulation
Radiation analysis
Thermomechanical analysis
Optical analysis


Boundary conditions
Temperature
Pressure
Magnetic field
Plasma
Nuclear fusion Plasma
Light emission
Mirror
Deformation
Erosion Mirror
Reflection
Nuclear heating
Physical effects
Analysis sequence
Particle transport simulation
Radiation analysis
Thermomechanical analysis
Optical analysis
Analysis activities


Rotary feedthrough
Bearing
Conical gear
Pneumatic actuator
Bearing
Spur gear
Rod
Bevel gear
Return spring
Vacuum
Atmosphere
First mirror
Nuclear fusion plasma
Light path
Blade
Retroreflector

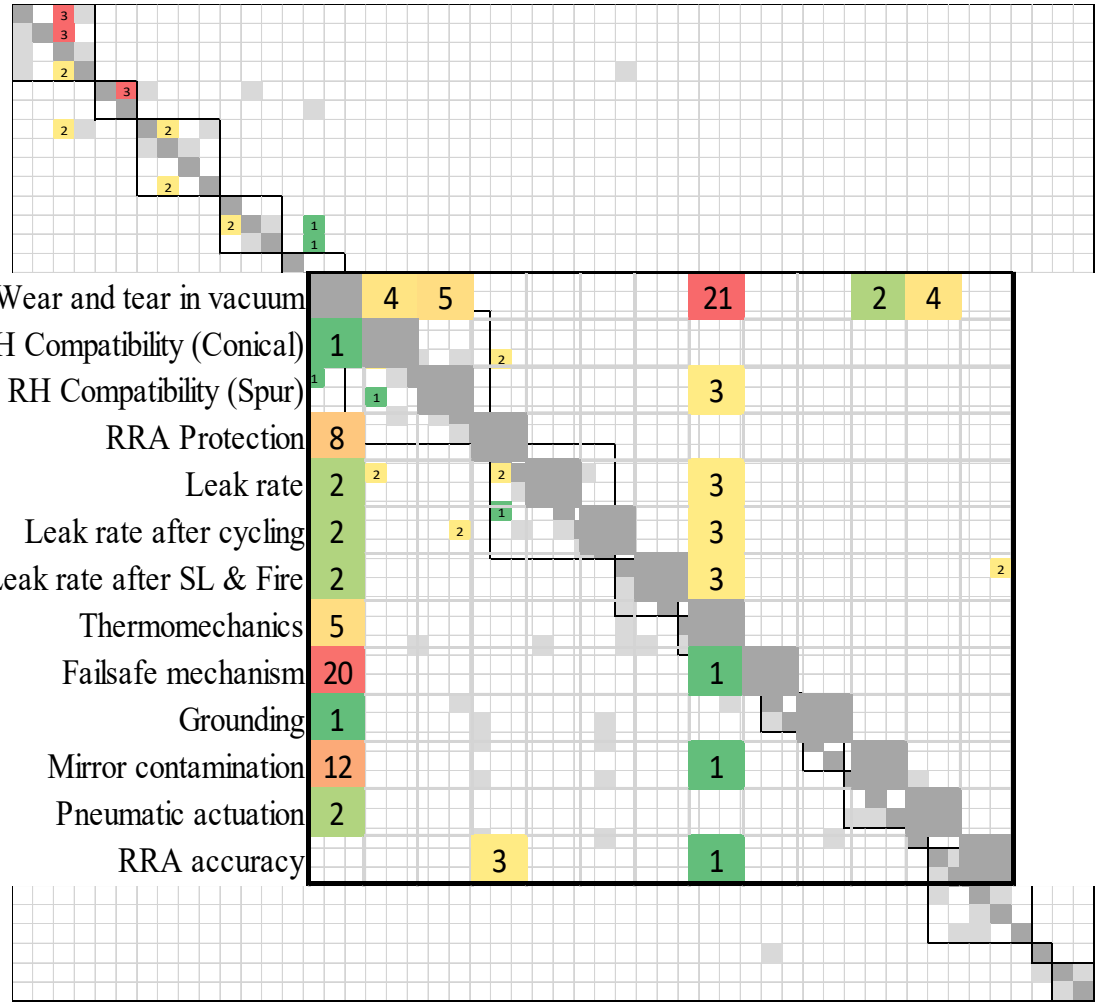
ENVIRONMENT

- Dust
- Vacuum
- Cleaning plasma
- Temperature
- Mechanical loads
- Radiation
- Magnetic field

FUNCTION	COMPONENT	PHYSICAL EFFECT
Transport motion to vacuum	Rotary feedthrough	Friction
		Sealing
		Alignment
		Torque transfer
Transport motion to FMU	Rod	Torque transfer
		Bending
Connect rod to feedthrough	Conical gear	Torque transfer
		Alignment
		Engagement
		Cold welding
Support rod	Bearings	Stiffness
		Friction
		Wear and tear
Fix component position	Frame	Thermal expansion
		Alignment
		Stress
Connect rod to mirror box	Spur gear	Engagement
		Alignment
		Wear and tear
		Friction
		Cold welding
		Torque transfer
		Particle generation
Turn rotation axis	Bevel gear	Alignment
		Wear and tear
		Friction
		Cold welding
		Torque transfer
		Particle generation
Generate rotation	Pneumatic actuator	Motion
		Friction
		Leakage
Return shutter to open state	Return spring	Stiffness
		Motion
Limit motion	End stops	Cold welding
		Grounding
Block particles	Blade	Motion
		Particle blocking
Reflect light	First mirror	Deposition
		Erosion
Return calibration light	Retroreflector	Degradation
		Alignment
		Reflection
Protect reflector	Garage	Particle blocking
Control pneumatic actuator	Piezo valve	Mechanics
		Actuation
		Pneumatics
		Pressure loss
		Motion
Detect state	Limit switch	Electrical contact
Pass electrical signals to vacuum	Signal feedthrough	Conduction
		Isolation

ACTIVITIES

- Wear and tear in vacuum
- RH Compatibility (Conical)
- RH Compatibility (Spur)
- RRA Protection
- Leak rate
- Leak rate after cycling
- Leak rate after SL & Fire
- Thermomechanics
- Failsafe mechanism
- Grounding
- Mirror contamination
- Pneumatic actuation
- RRA accuracy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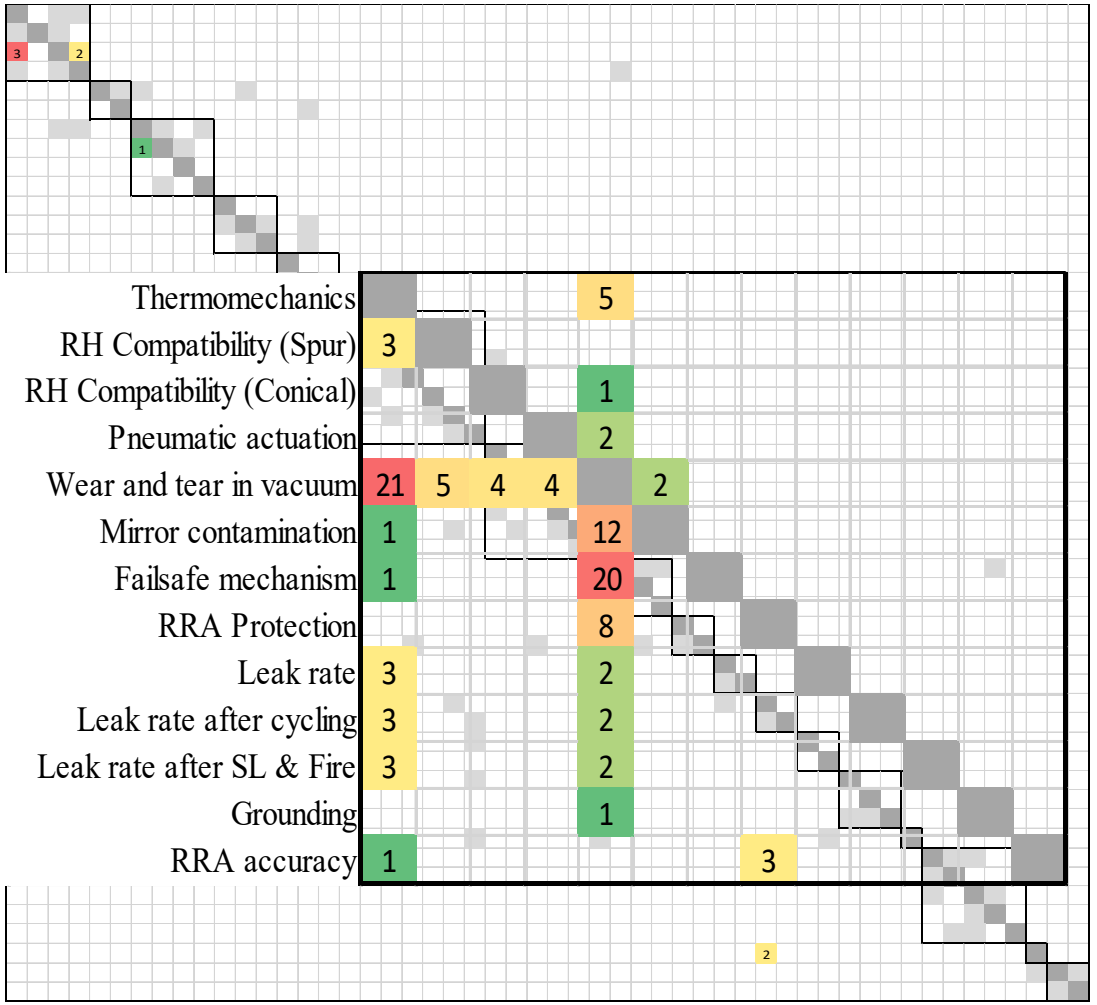
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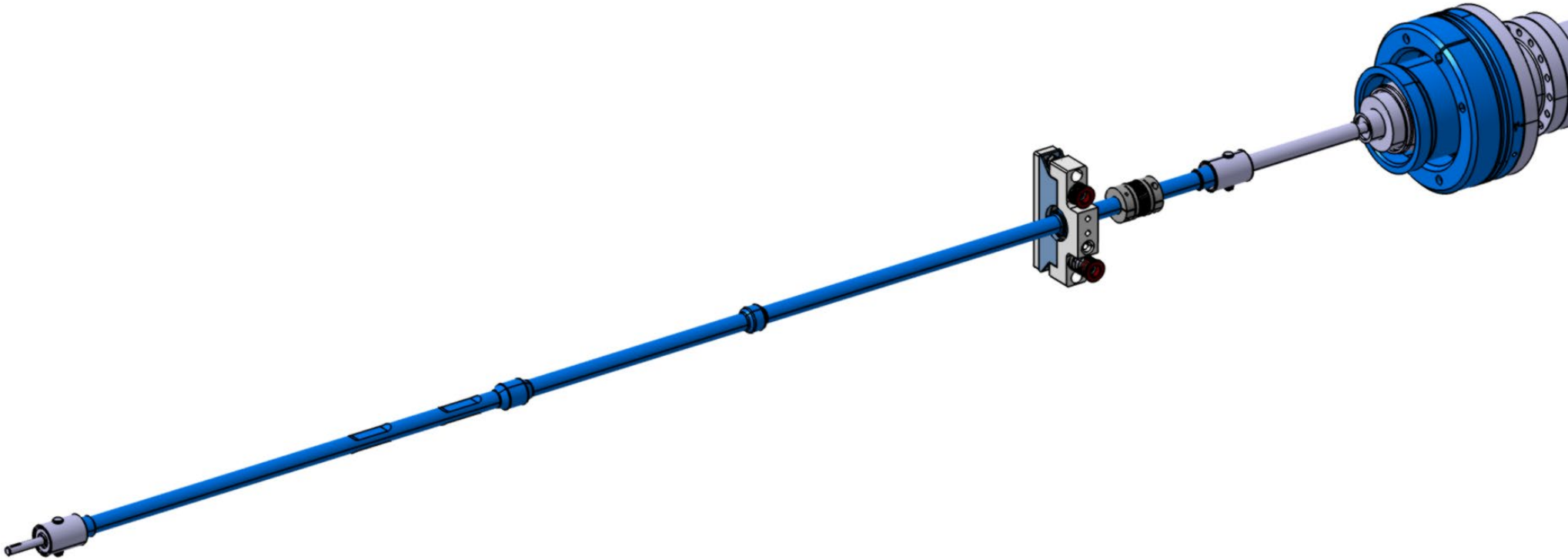

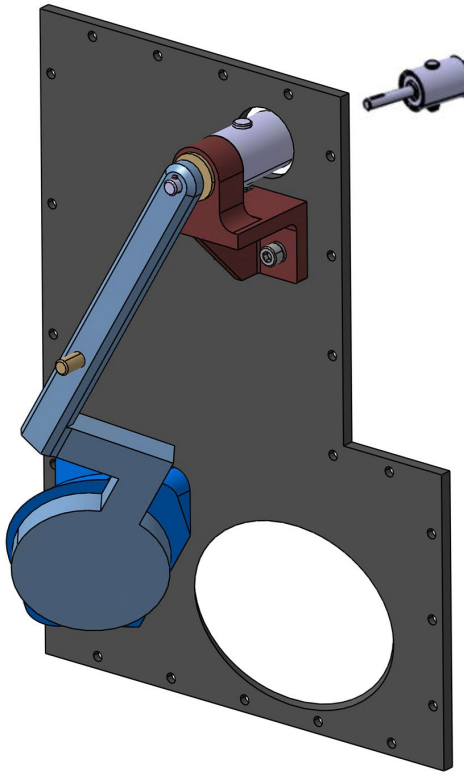

Simple design
Simple analysis

From Physics to Project Management

A Multi-Domain Matrix Model for the Distributed Analysis of Nuclear Fusion Systems

Torben Beernaert, Ad Verlaan, Pascal Etman, Peter Giesen, Erik van Beekum, Mariana Ribeiro, Ines Bola, Lucas Moser, Maarten de Bock, Ivo Classen, Marco de Baar

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