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Towards a preliminary design of the ITER plasma control system architecture

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HIGHLIGHTS

- ITER control requirements and use scenarios for initial plasma operation have been analysed.
- Basic choices from conceptual design could be confirmed.
- Architectural design considers dynamic structure changes.
- All PCS components are integrated in an exception handling hierarchy.

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ABSTRACT

Design of the ITER plasma control system is proceeding towards its next – preliminary design – stage. During the conceptual design in 2013 an overall assessment of high-level control tasks and their relationships has been conducted. The goal of the preliminary design is to show, that a reasonable implementation of the proposed concepts exists which fulfills the high-level requirements and is suitable for realistic use cases. This verification is conducted with focus on the concrete use cases of early operation and first plasma, since these phases are mandatory for ITER startup.

In particular, detailed control requirements and functions for commissioning and first plasma operation including breakdown, burn-through and ramp-up in L-mode, as well as for planned or exceptional shutdown are identified. Control functions related to those operational phases and the underlying control system architecture are modeled. The goal is to check whether the flexibility of the conceptual architectural approach is adequate also in consideration of the more elaborate definitions for control functions and their interactions. In addition, architecture shall already be prepared for extension to H-mode operation and burn-control, even if the related control functions are only roughly defined at the moment. As a consequence, the architectural design is amended where necessary and converted into base components and infrastructure services allowing to deploy control and exception handling algorithms for the concrete first-plasma operation.

1. Introduction

One of today's big challenges in thermonuclear fusion research is the design and construction of ITER, an international, next-generation tokamak device. It will be the most complex installation of this kind targeted on exploring control of a burning plasma and scaling from smaller present-day devices to a future self-sustaining

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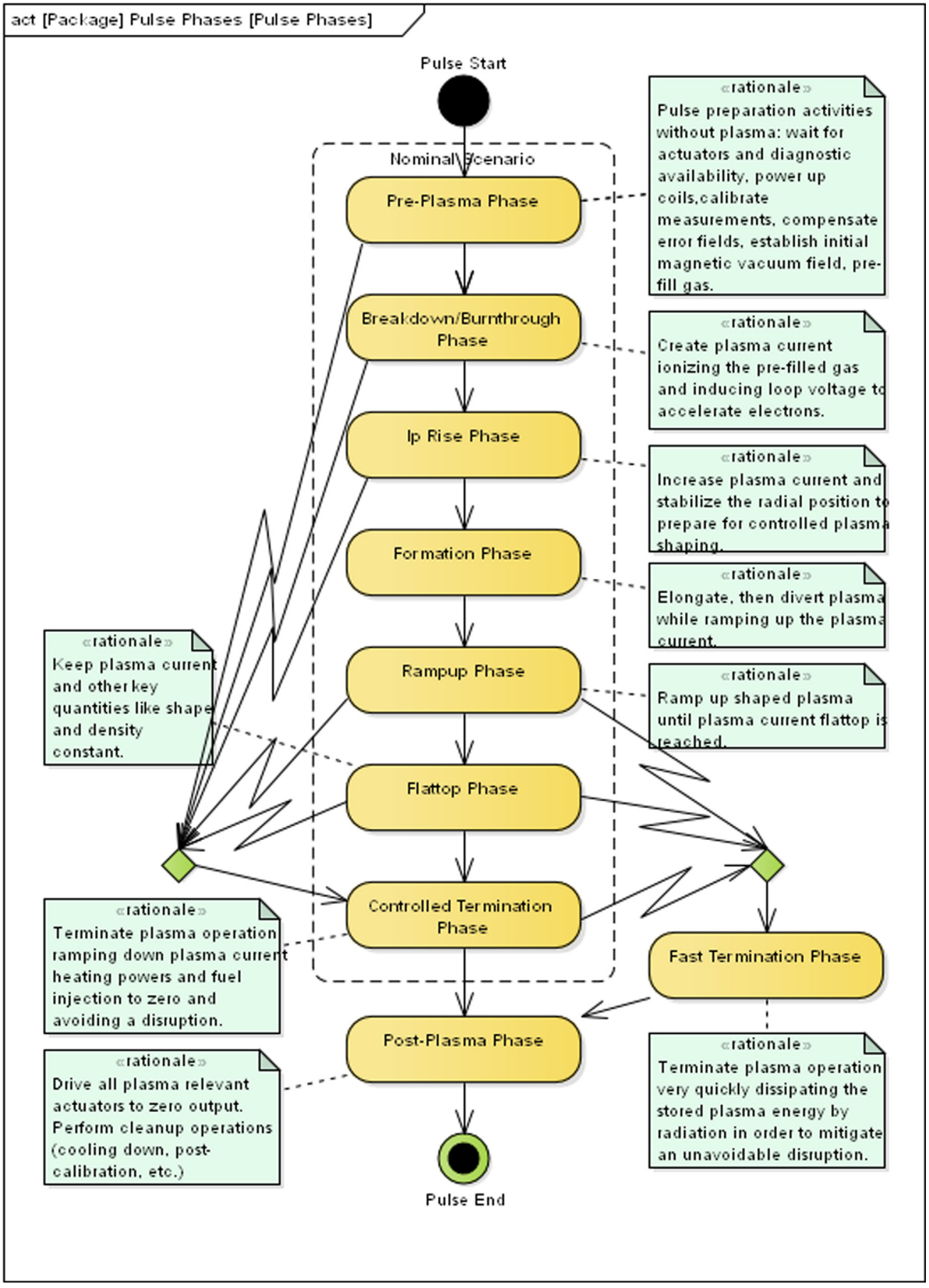

Fig. 1. Pulse phases with goals.

fusion reactor. Hundreds of subsystems, coordinated by the Plasma Control System (PCS), will be employed to eventually generate Deuterium-Tritium plasmas, tailor their properties and observe plasma behavior, but also to counteract instabilities and plant system faults in order to ensure safe operation. The PCS design must not only account for the novel physical targets and the unprece-