Shape Controller Upgrades for the JET ITER-like Wall

Overview
- Real-time system
  - MIMO controller
- Controls:
  - Current in poloidal field circuits
  - Plasma current
  - Plasma shape

JET Circuits
- 10 Poloidal field circuits
  - 9 controlled by shape controller
  - First line of defence against faults and limits implemented in SC

Control mode selection
- Control modes and values dynamically assigned
  - Pre-programmed time windows
  - Stopping event

Protection of the ITER Like Wall (PIW) Stopping Strategy
- JET upgraded to a new all metal wall
- Previously, upon the detection of a problem:
  - Set of global responses
    - Invariant with the experimental phase
    - Designed to maximise the likelihood of a safe plasma landing
    - mitigate conflict with the requirement of avoiding localised heat fluxes in the wall components
- Upgraded system capable of dynamically adapting its response behaviour:
  - Accordingly to the experimental conditions at the time of the stop request
  - During the termination itself
  - Capable of switching to alternative experimental sequence if resources not available
- Triggered by the new Real-time Protection Sequencer (RTPS)
  - Responds to alarm requests from the Vessel Thermal Map (VTM)
  - Communicates using the ATM real-time data network

PFX On Early Task (POET)
- PFGC P1E generates and controls plasma current
  - 400 MW fly-wheel generator
    - Hardware switches (s1 and s4) enable current in both directions
  - PFX drives current in central pancakes windings
    - Reduce stray fields
    - More D shaped plasma
  - Current in PFX inhibited by shape controller...
    - While current in P1E is of opposite sign
    - Electromechanical modelling effort concluded that the old limits are too stringent
  - POET operation space allows limited PFX current with P1E current in the opposite direction

Current Limit Avoidance
- extreme Shape Controller (XSC) algorithm enables the control of the full plasma boundary
  - System is no longer limited to the accurate control of only a few gaps
  - All the circuits in shape controller are set to proportional current control
  - Current references provided by the XSC algorithm
  - Algorithm is valid only around a given equilibrium
  - Plasma must be driven into the reference conditions using shape controller
  - Current Limit Avoidance (CLA) uses the redundancy of the PF coil system
  - Automatically obtains almost the same plasma reference shape
  - With a different combination of currents in the PF coils
  - In the presence of severe disturbances
    - tries to avoid the current saturations
    - By relaxing the plasma shape constraints

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