Overview of future remote handling work

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Jorma Järvenpää
VTT Technical Research Centre of Finland
Content of the presentation

1. ITER RH - Remote handling
2. Divertor Test Platform – DTP2
3. Virtual prototyping
4. DEMO work
5. ITER Procurements
6. What in future?
Remote Handling Operations at ITER

23.01 Blanket RH (JA-DA)
23.02 In-vessel divertor maintenance (EU)
23.03 Transfer cask system (EU)
23.04: In-vessel Viewing System
23.05 Neutral Beam RH (EU)

© F4E
DTP2 work program

Tests
- Divertor maintenance – Test and Verification
- CMM – test drives
- Second Cassette Handling
- Robustness & Reliability

Control
- Control room and Operations
  - Virtual model & teleoperation with it
  - Viewing system
  - Condition monitoring
  - Operation management

Design
- Design, modifications and mock-ups
  - CMM modifications
  - Mock-up updates
  - In-vessel transporter
  - Cassette locking system
  - Other tests
Key Activities at DTP2

- **Virtual engineering**
  - From Req.Specs to Verification
  - Virtual model for task planning
  - Using virtual model for operation
  - ”Structural simulator”

- **Remote operation**
  - Developing tools for operator
  - VR&Camera integration (+AR)
  - Sensor fusion
  - Force feedback
  - ”Virtual rail”
  - Collision monitoring

- **Viewing system**
  - Camera image for seeing & measuring
  - Image enhancement
  - Model calibration
  - Visual servo

- **Condition monitoring**
  - Improve reliability
  - To minimize ”unexpected” failures
  - Remote diagnostics
  - Comparison to earlier data
  - Simulation based
  - Test sequences to verify
From: Virtual prototyping => To: Full scale tests

Integrating real life into virtual model

- Kinematics
- Dynamics
- Flexibility
- Control

Using the model all the lifetime

- Prototyping
- Control development
- Operator training
- Maintenance
- Device control
- ...

What:
- Manipulators, tools, methods
- Control, operator training
- Logistics, rescue scenarios
- Maintenance, maint. planning

Tools used:
- Virtual modeling
- Virtual prototyping
- Hardware-in-the-loop
- Testing in practice
DEMO work for EFDA

Reactor and maintenance design done in parallel

- Divertor remote handling operations and design
  - First Mover concept
  - Divertor rails in Vacuum vessel, cassette locking system and cassette pre tensioning between rails
  - Maintenance tunnel lay out design
  - Cooling pipe lay out design
  - Blanket handling and in vessel transporter design in co-operation with CCFE
RH Procurements for ITER

- **F4E** is coming to ask tenders about four ITER RH systems:
  - **LOT1** Divertor Maintenance ~70M€ VTT+TUT (involved)
  - **LOT2** Cask & Plug ~100M€ VTT+TUT (possible)
  - **LOT3** In-Vessel Viewing Syst ~40M€ VTT+TUT (little possible)
  - **LOT4** Neutral Beam ~80M€ open?

- **ITER** is responsible to purchase all what is needed in Hot Cell –
  - Hot Cell ~250M€ VTT+TUT (possible)
What in future?

- Engineering support and testing for ITER and F4E
  - Testing in DTP2 platform
  - Teaching operators
  - Develop RH control and management systems
  - Still lot to be done for Div RH before operation
- Join to consortium to tender other RH equipment to ITER and F4E
  - Obtained expertise for design work
  - Testing prototypes in DTP2
- Join deeper in DEMO RH work
- Apply learned RH technology in Finnish nuclear industry
  - Work together e.g. with FinNuclear
- Develop and apply Systems Engineering and requirements management to other industry areas (nuclear and machine industry).
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