



Mikko Siuko Matti Paljakka





# VTT – beyond the obvious

VTT is one of the leading research, development and innovation organizations in Europe. We help our customers and society to grow and renew through applied research. The business sector and the entire society get the best benefit from VTT when we solve challenges that require world-class know-how together and translate them into business opportunities.

Our vision

A brighter future is created through science-based innovations.

Customers and society grow and renew through applied research.

Impact through scientific and technological excellence.

Established in

1942

Ministry of **Economic** Affairs and 268 M€

Net turnover and other operating income (VTT **Group 2018)** 

Total of personnel (VTT Group 31.12.2018)

Owned by

**Employment** 

**Doctorates and** 

Licentiates (VTT Group 2018)

31%

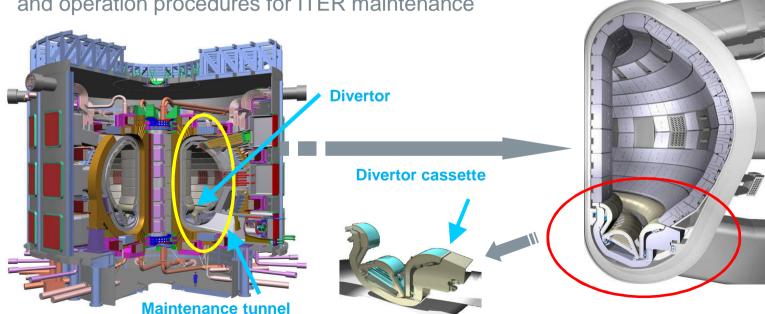
44% From the net turnover abroad (VTT Group 2018)



### **ITER - Divertor Maintenance**

- DTP2 the planned divertor maintenance operations to be verified
  - Cassette locking, cleaning, transportation

 DTP2 is necessary for developing and testing devices, sequences and operation procedures for ITER maintenance



### ITER Divertor Test Platform – DTP2

DRM - Divertor Region Mock-up



CMM - Cassette Multifunctional Mover



**Divertor Cassette Mock-up** 



**Control Software** 



Water Hydraulic Manipulator



+ Manipulator tools for maintenance operations

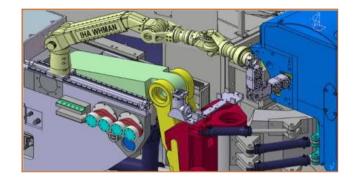
**Cassette transportation** 







### **Controlroom**







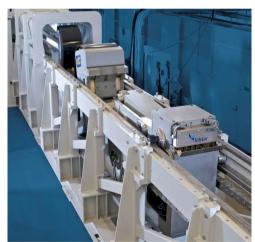




# ITER Remote Handling experience

#### **Divertor Test Platform at VTT**

- Divertor Test Platform the planned divertor maintenance operations to be verified
  - Cassette locking and transportation
  - Second and central cassette operations
  - Full scale test platform at VTT Tampere, Finland
- Heavy components, space very limited
  - Developing and testing devices, sequences and operation procedures for ITER maintenance
  - Ability to reach 2-3mm accuracy
- Control system development and testing





# **Remote Operation of Machines**

#### References 1/3

- ITER divertor second and central cassette operation development and testing (2005-2017, partner TUT)
  - Mechanical design
  - Control system development
  - Operation planning
  - Full scale testing
  - Systems engineering
  - Cassette and manipulator cooperation
  - Cassette locking system development and testing





## **Remote Operation of Machines**

#### References 2/3

- ITER divertor remote handling connector development and testing 2017-2019)
  - Mechanical design, operation planning and testing, cable selections and testing, environmental conditions calculations, requirements management
- ITER remote handling control system development (2018-2020, partner TUT)
  - Development and integration of 3D Machine Vision, High Level Control System modules and GENROBOT robot controller
  - Virtual Reality and Remote Diagnostics Application to become standard components of F4E RH procurement packages and be included in the IO Standard Components catalogue

21.11.2019 VTT – beyond the obvious



## **Remote Operation of Machines**

#### References 3/3

- DEMO fusion reactor divertor RH operations and equipment concept design (several projects 2011-)
- ITER divertor Remote Handling procurement to F4E in Assystems consortium (2017-)
- Automatic control of hydraulic boom (Finnish machine industry)
  - Kinematic and control algorithm development
  - Simulation, implementation and testing
- Remote Operation of Machinery Over 5G Radio
  - Pilot system for remote machine operations using the 5G radio and a Hardware-in-the-Loop development environment

21.11.2019 VTT – beyond the obvious



### **Conclusions**

### From the point of view of building up good consortia

- Plan based on evaluation criteria
- Cover the whole scope
- Define good roles
- Start from references
- Build trust
- Consortium within consortium to secure a scope
- Make yourself known
- Local presence is a benefit

21.11.2019 VTT – beyond the obvious