



# LAND OF THE CURIOUS





# TEST RIGS FOR DEMO IN LUT

HUAPENG WU

 Contents of presentation

- Introduce the facility of Mechanic department
- Laboratory of intelligent machines
- Test Rig for condition monitoring
- Test Rig for MPD

**LUT Mechanical Engineering** :an internationally renowned expert in mechanical and metal industry applications. Digitality and all of its manifestations represent a significant concept throughout the lifespan-oriented processes of LUT Mechanical Engineering.

#### Research groups and laboratories

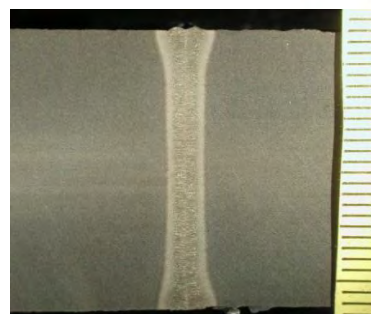
- COMPUTATIONAL MECHANICS
- WELDING TECHNOLOGY
- LASER PROCESSING AND ADDITIVE MANUFACTURING
- PACKAGING TECHNOLOGY
- MATERIALS MODELLING RESEARCH GROUP
- LABORATORY OF INTELLIGENT MACHINES
- STEEL STRUCTURES
- PRODUCTION AND SHEET METAL WORK TECHNOLOGY

# LUT LASE & AM

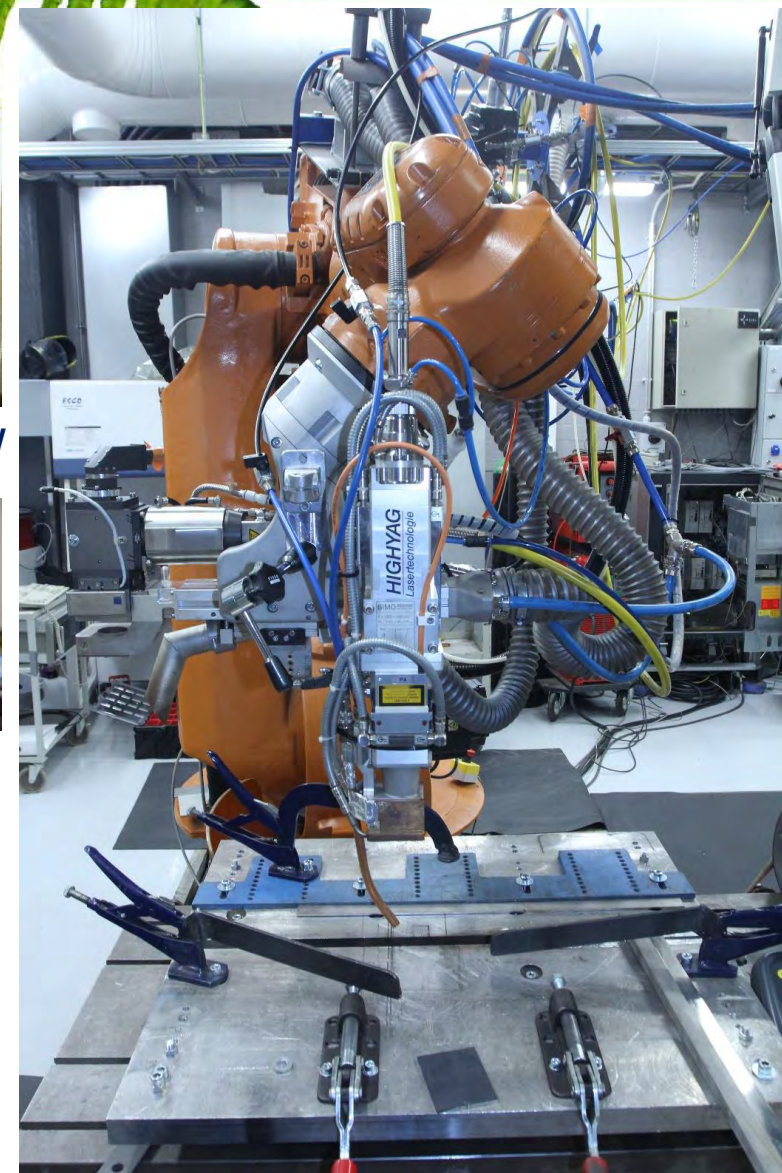
Experimental research since 1985  
 Teaching from 1990  
 Scale from micro to meters  
 Experience in CO<sub>2</sub>-, Fiber-, ND-YAG and diode lasers

## Research topics:

- Understanding of behaviour and features of Key-hole, filler wire, remote, and hybrid welding processes
- Process monitoring since 2000
- Product design for laser welding
- Additive Manufacturing (metal 3D printing)
- DED



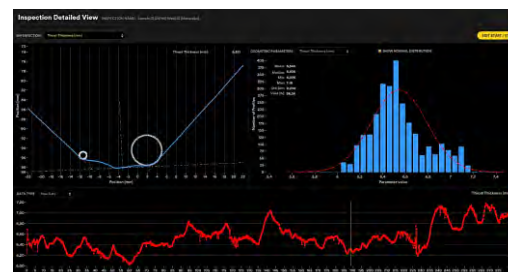
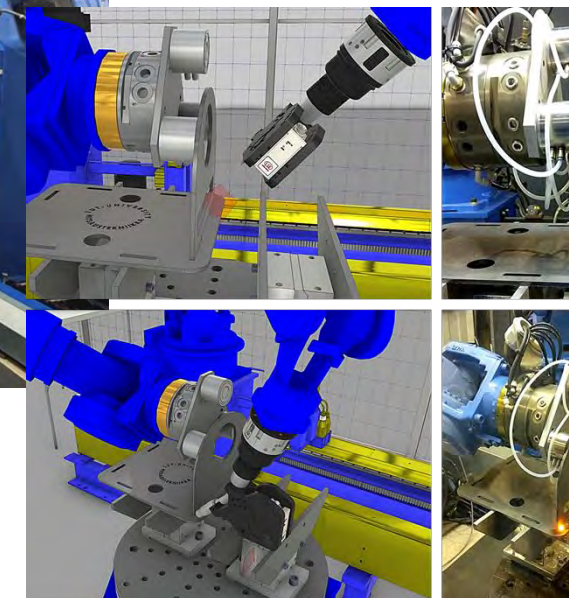
25 mm – 27 kW



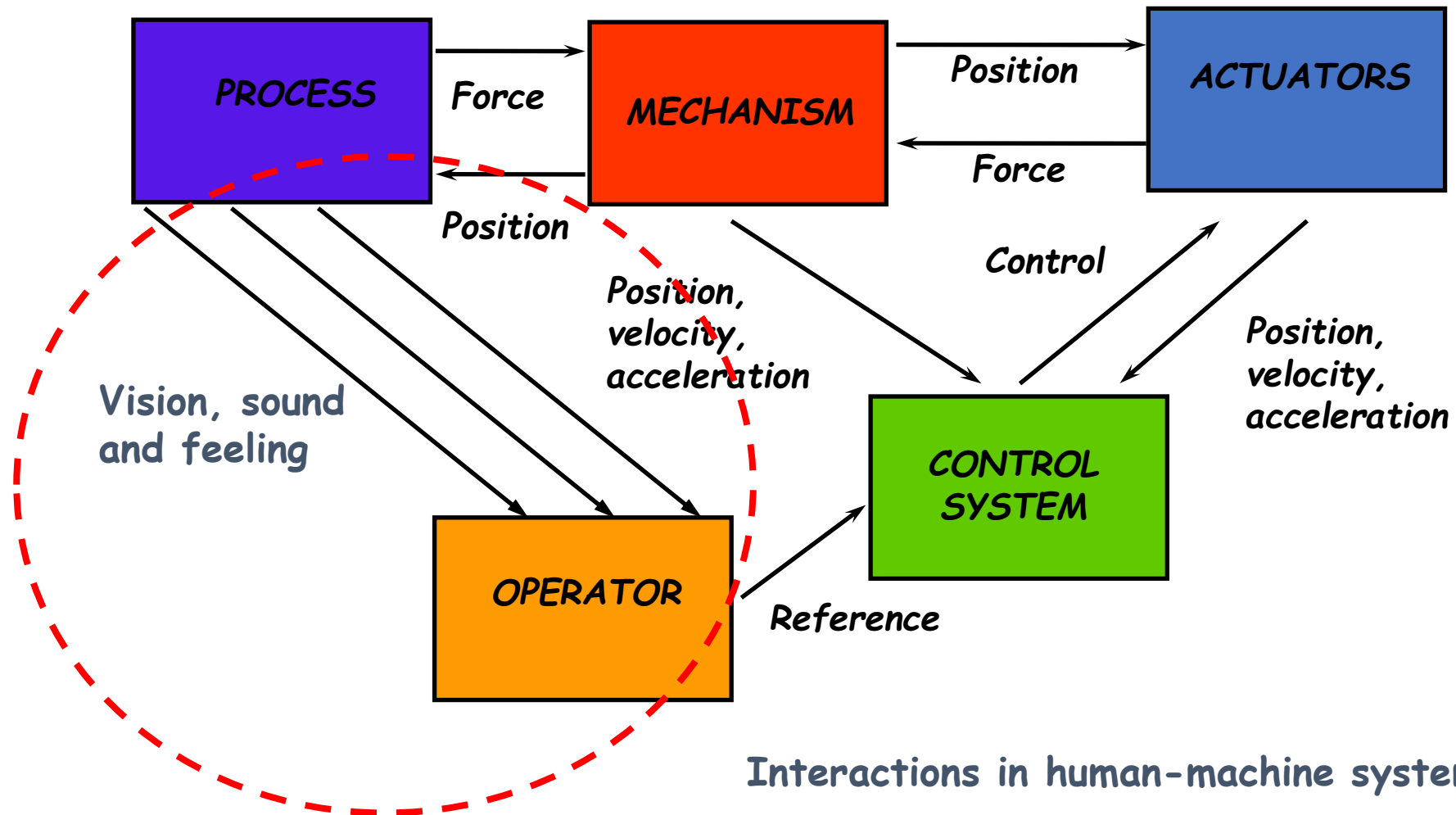
# LUT WELDING TECHNOLOGY



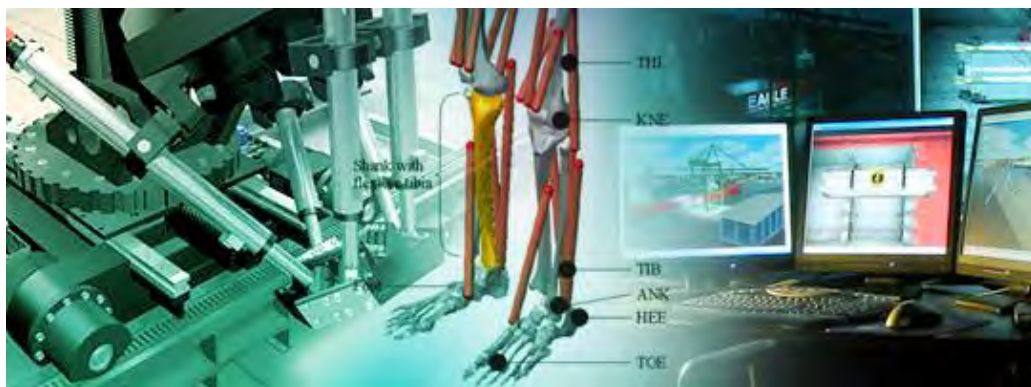
- Digitized welding and welding production
  - adaptivity, VR applications, design-manufacturing chain, etc.
- Advanced welding processes and equipment
  - arc, hybrid and arc-DED applications
- Mechanization and robotization of welding, including sensing
- Programming and modeling (off-line) of robot welding
- Quality management and assurance of welding production and weld joints
  - NDT, DT, quality - lead time
- Welding productivity and economy
- Welding metallurgy and weldability of metal materials
  - structural and stainless steels, aluminum, other ferrous and non-ferrous metals



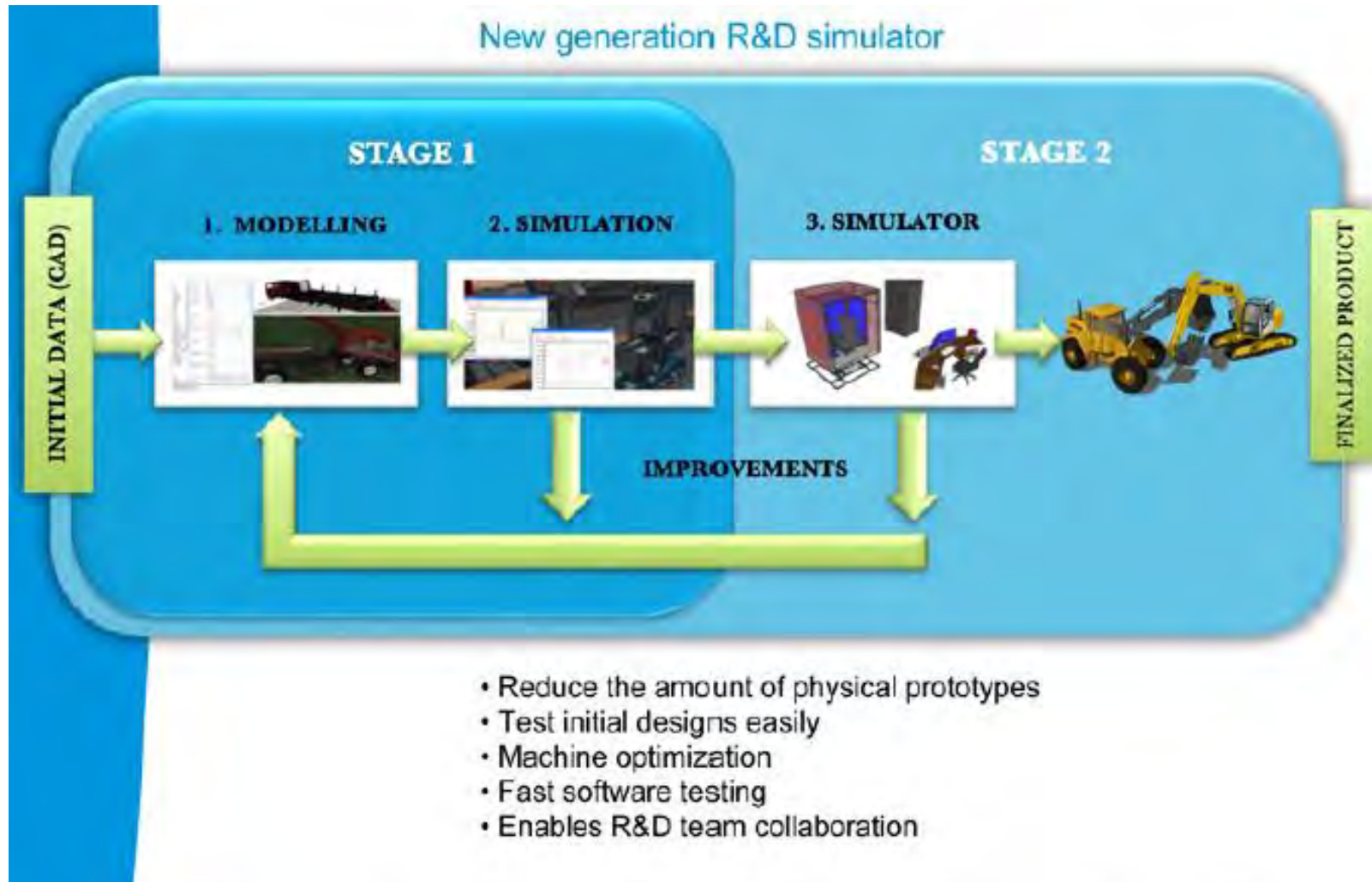
## 1. Virtual reality



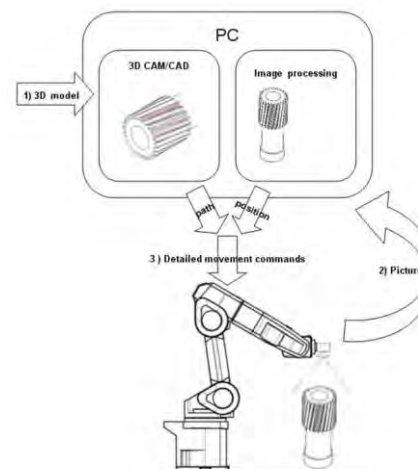
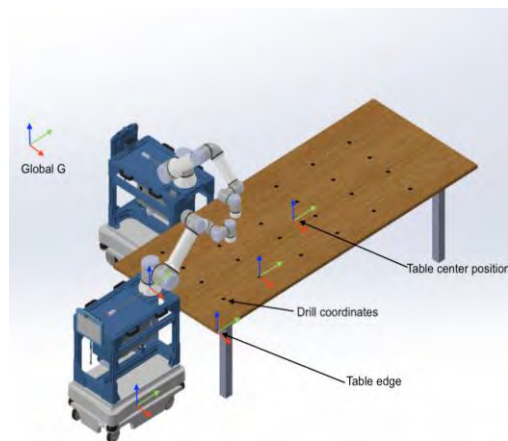
# METHODS FOR REACHING GOALS



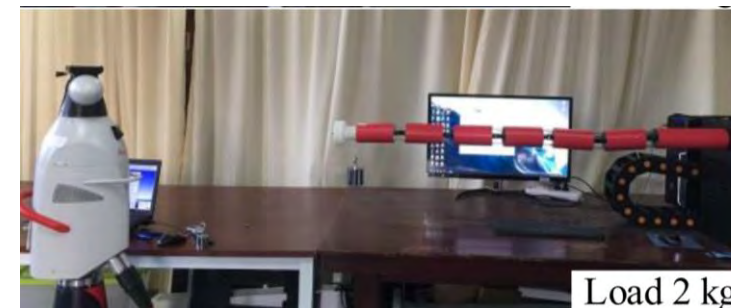
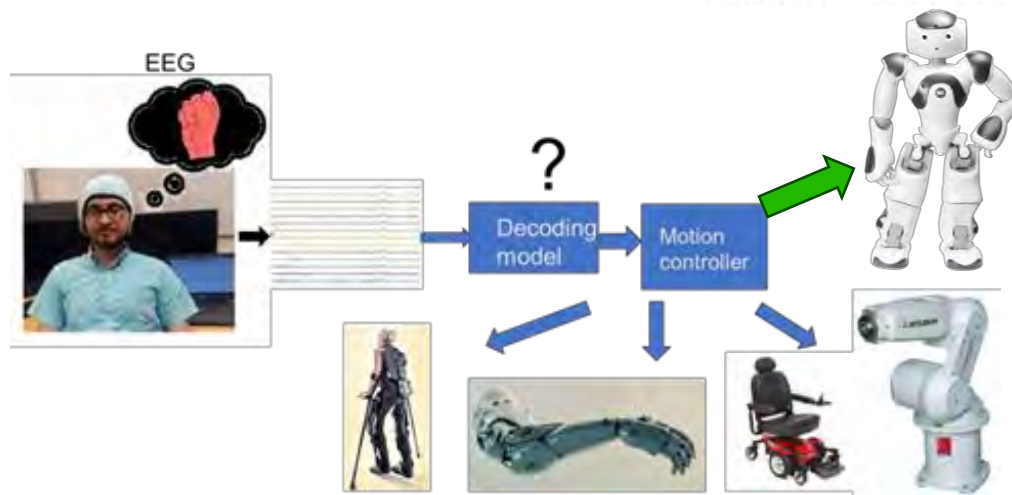
# ITERATIVE R&D THROUGH HIL-SIMULATION



## 2. Robotics



Basic principle of the machine vision and CAM integration.

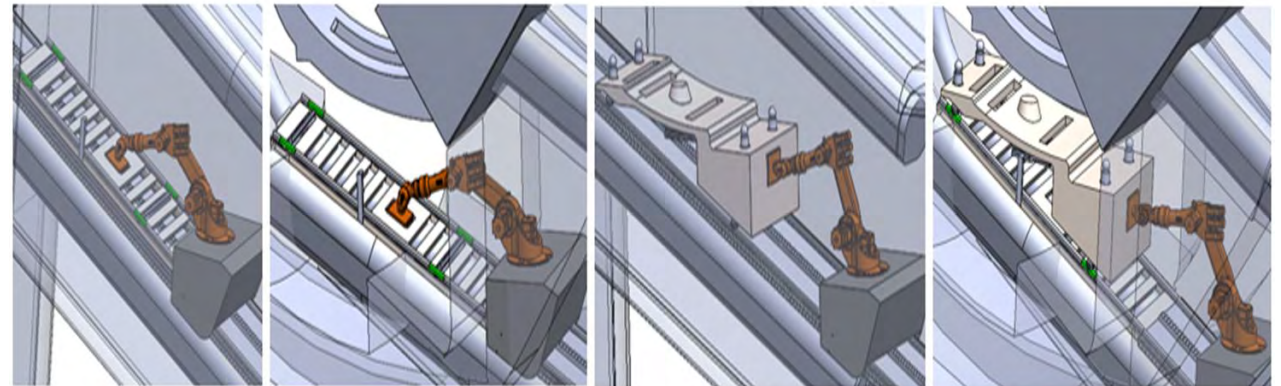


### 3. Remote handling machines for Fusion application

LUT participated fusion research since 2002 develop welding/cutting robot, laser technology of welding, and NDT testing for ITER assembly and maintenance, dynamic modeling and simulation for the remote system for ITER( 2002-2010) . Involved DEMO research 2018



welding/cutting robot



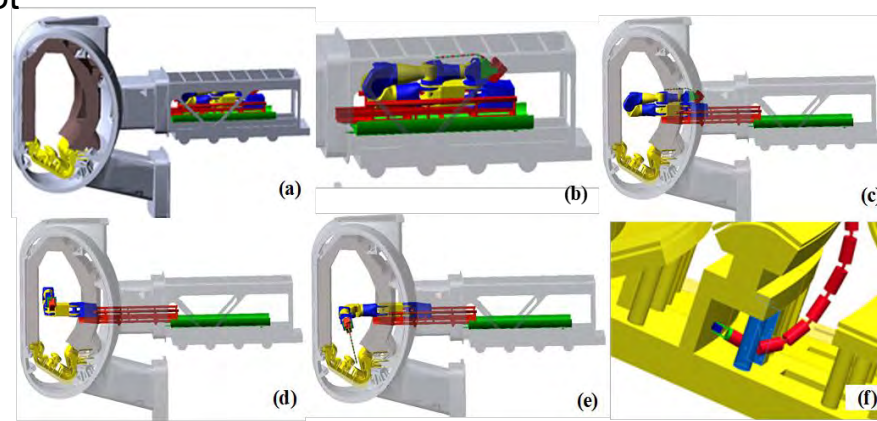
(a)

(b)

(c)

(d)

Concept design for DEMO divertor Remote handling bottom up to avoid cantilever beam



(a)

(b)

(c)

(d)

(e)

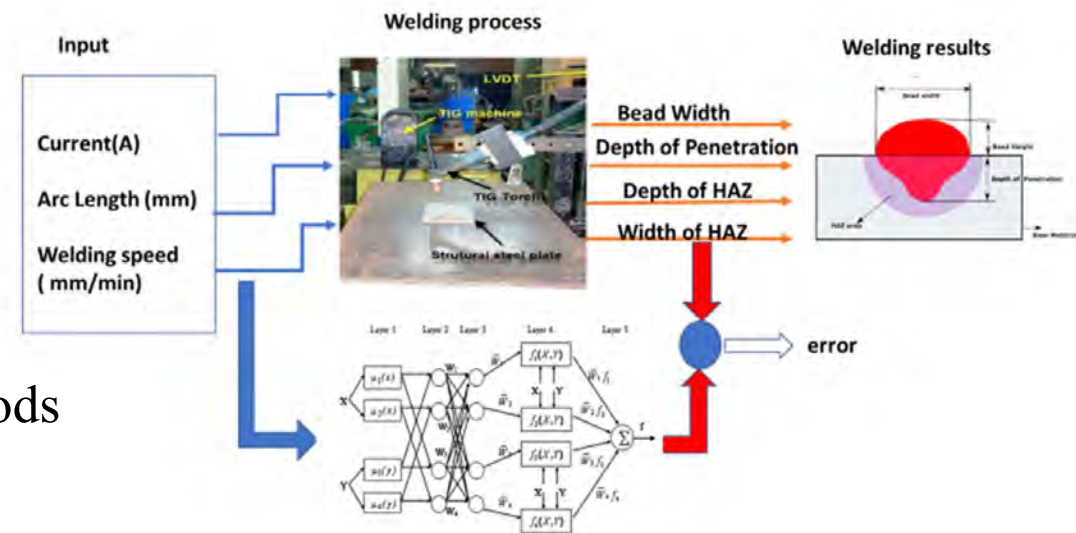
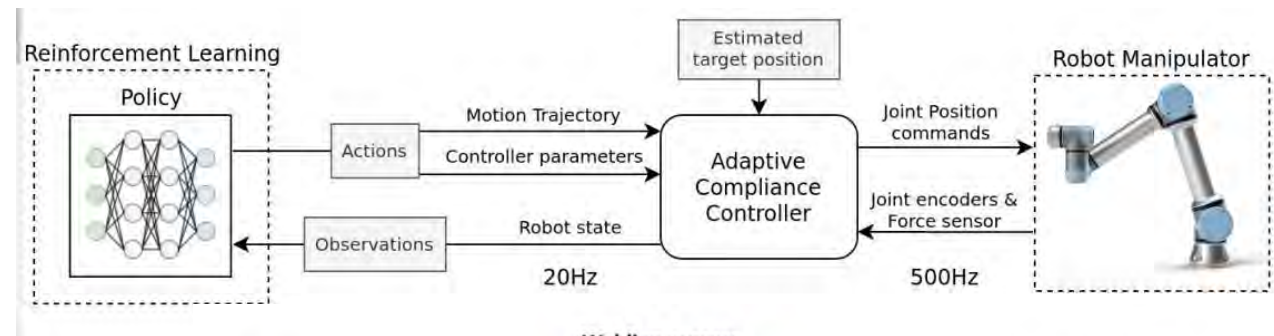
(f)

MPD development for CFETR



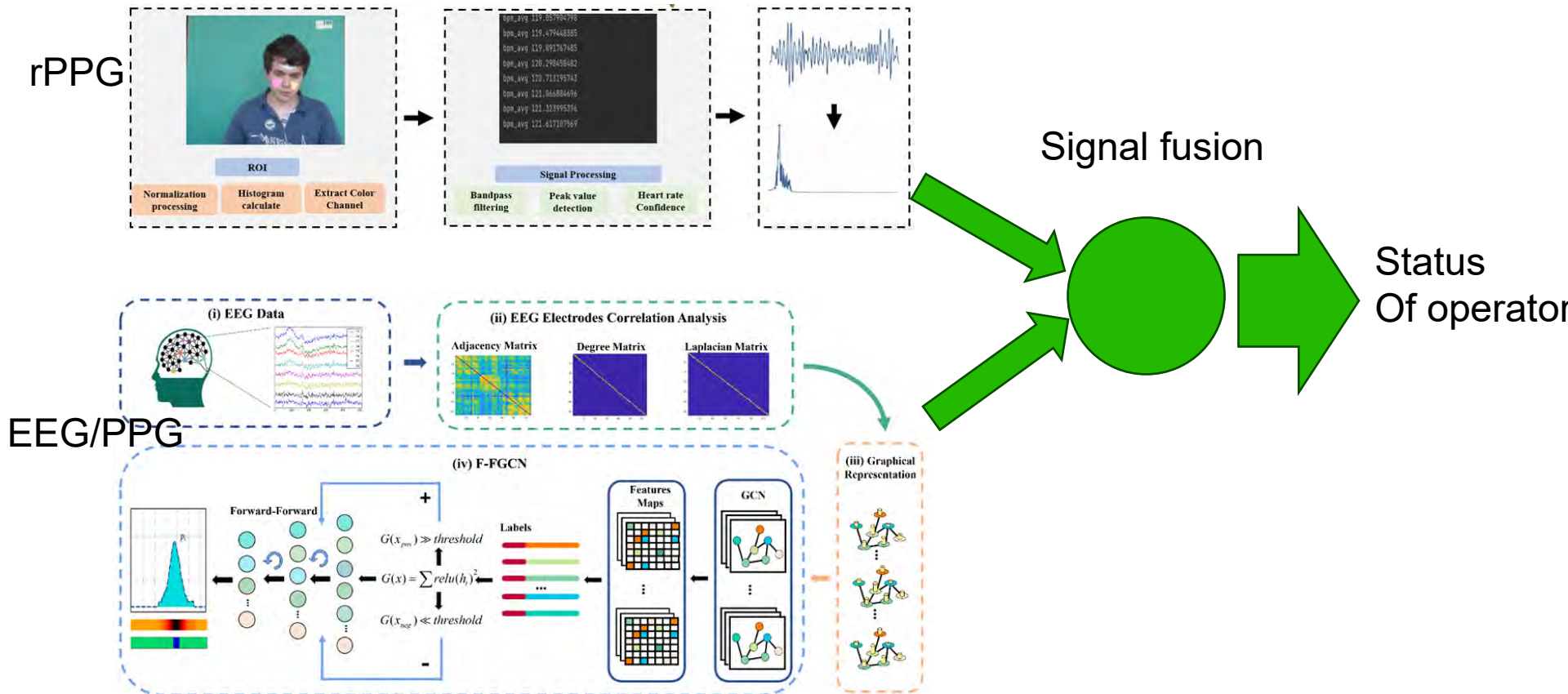
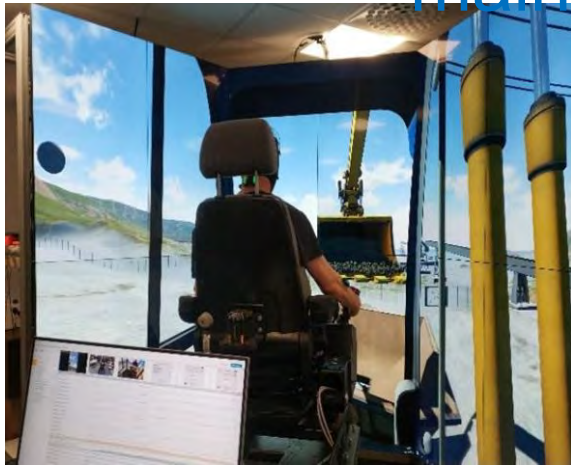
## 4. AI algorithms for modeling and control

- 1). Reinforce leaning for robotic assembly
- 2). Intelligent method for robotic welding
- 3). Model based predication control for high nonlinear system
- 4). Surrogate model-based cognitive digital twin for remote maintenance robot system
- 5). Stochastic modelling unitizing deep learning methods



Welding process Fuzzy network training process

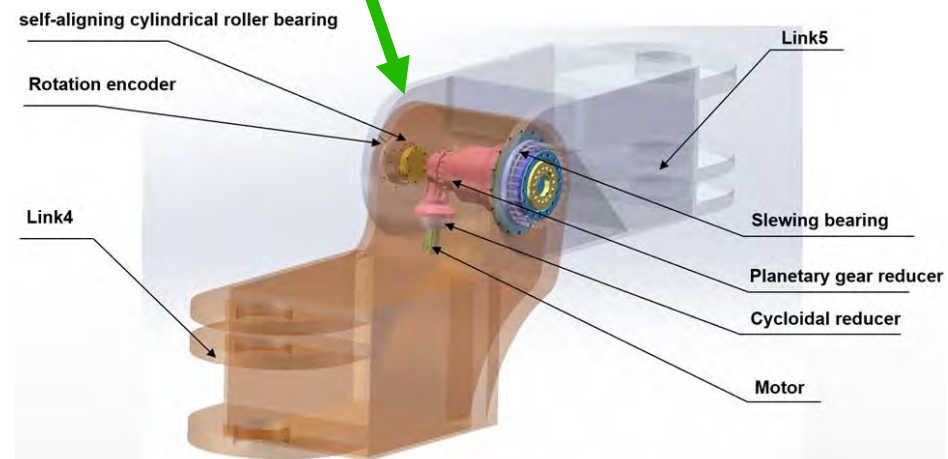
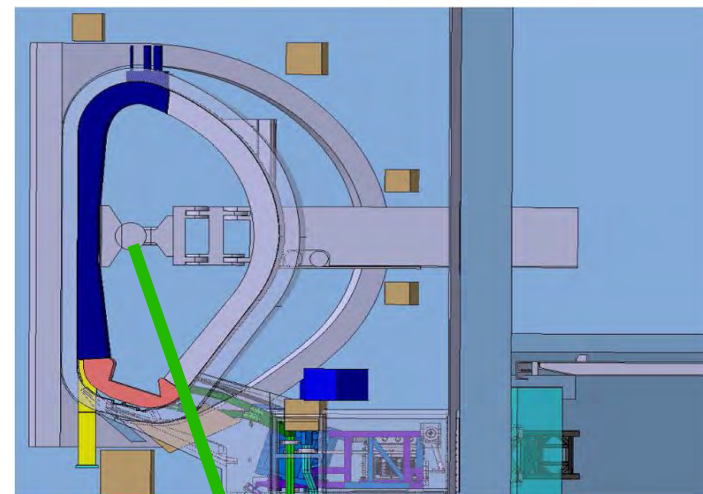
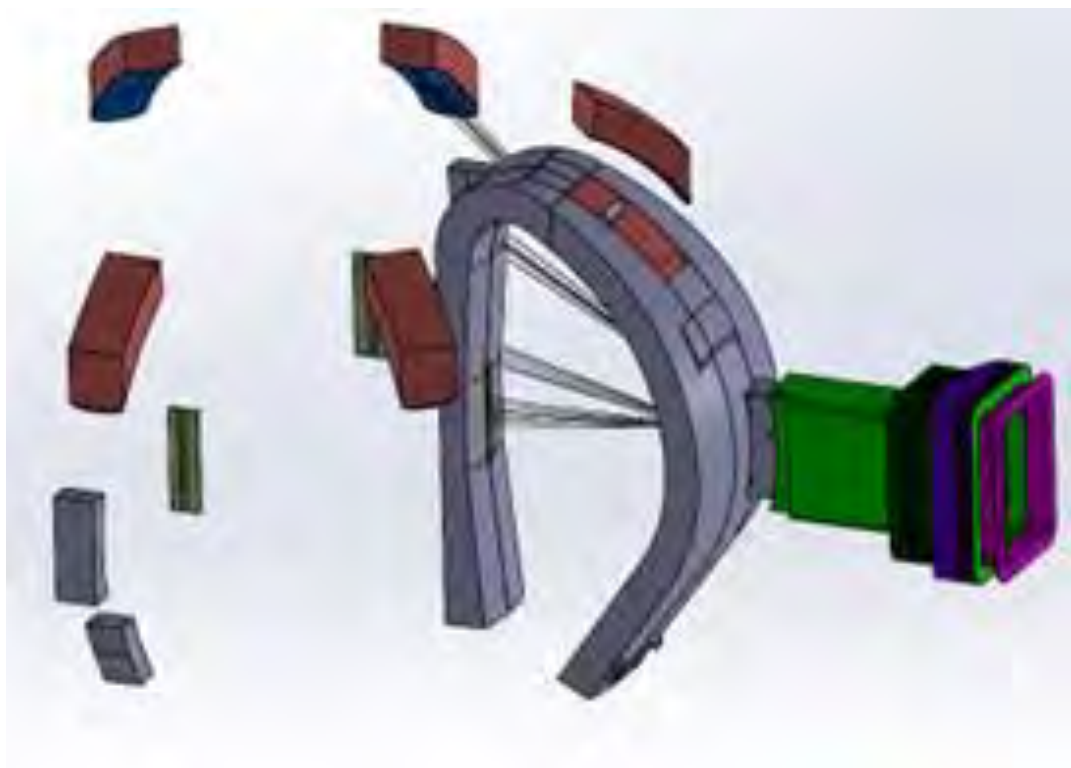
# Test Rig of condition monitoring of human in loop remote maintenance system



## — ➤➤ Test Rig of condition monitoring of human in loop system

- 1) Study EEG based PPG algorithm estimating the operator 's condition
- 2) Study rPPG ,EEG based PPG algorithm estimating the operator 's condition
- 3) Study integration methods with human factors
- 4) Validate the methods with simulator and test rig.

# Test Rig of MPD



## — Test rig of MPD

### 1)The payload capability

Optimizing design of key joint , test the payload capability up to 6000kg of a limiter

### 2)deflection

Test the real deflection to build up an accuracy deflection compunction model .

### 3)Dynamic

Study stochastic modeling methods for the digital twin , estimating the parameters change and correction the dynamic model in digital twin .

### 4)control algorithm.

Develop advanced control algorithm , improve the performance of robot arm .

**THANK YOU FOR YOUR ATTENTION**



**Master Chef welcomes you to Lappeenranta**