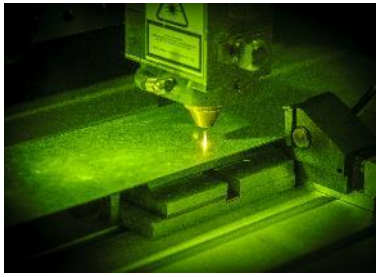
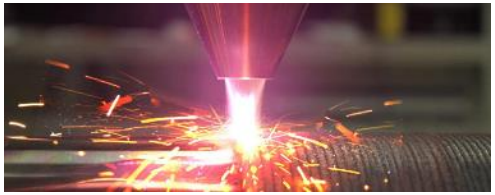
ModuLase
MODULAR LASER PROCESS HEAD

Development and Pilot Line Validation of a Modular Re-Configurable Laser Process Head





ModuLase Overview: Main Objectives vs. Achievements

17th June 2021

ModuLase Consortium

TWI SODECIA ULO Optics Q-Sys Graham CRF aimen EWF

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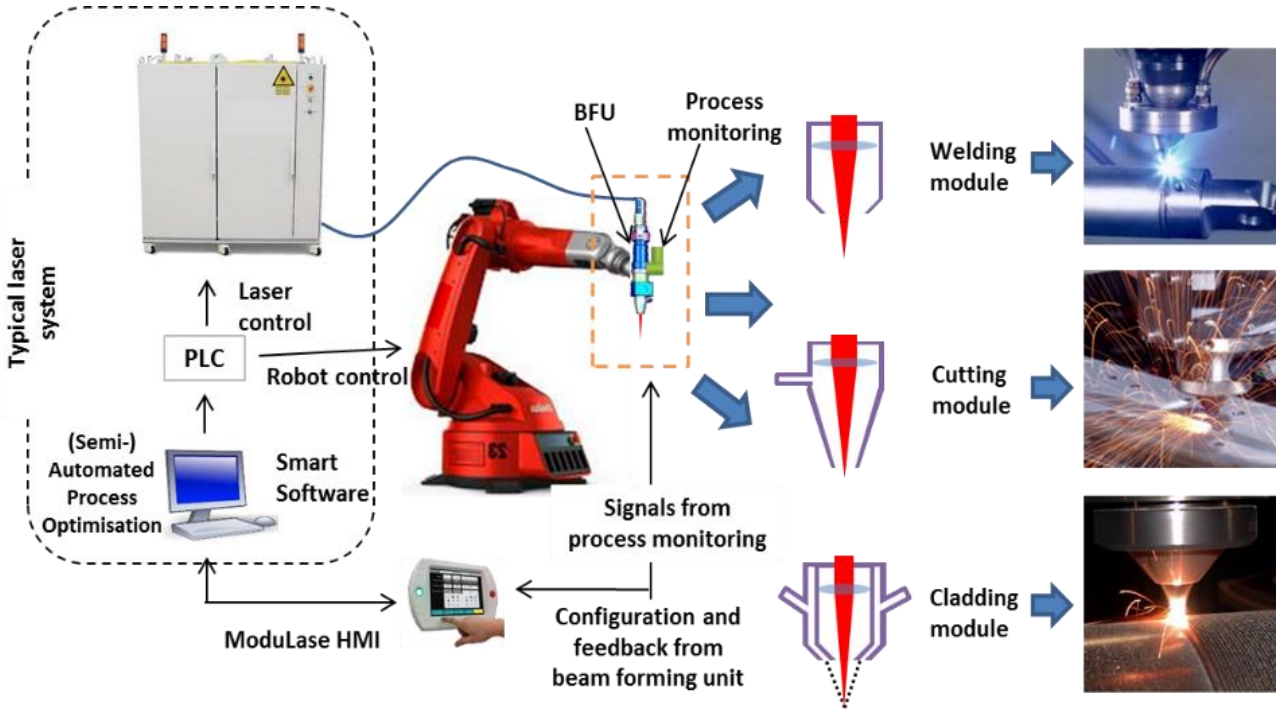
- Overview of the project
- Introduction of Consortium
- Scientific objectives
- Achievements for the project

Introduction to the Project

- H2020-FOF-13-2016 call
- Factories of the Future: Photonics Laser-based production
- Start date: 1st September 2016
- Duration: 57 months
- Received EC funding: €2,458,465 (€2,184,565 Grant)
- Programme directly focused on “Rapid individualised laser-based production”

The ModuLase project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No. H2020–FoF-2016- 723945-ModuLase. The project is an initiative of the Photonics and Factories of the Future Public Private Partnerships’

Business Need



- Develop a processing head covering **welding, cladding and cutting**, through the use of three modular end-effectors and re-configurable optics
- Include **intelligent sensor technologies** for in-process monitoring
- Be linked to an intelligent user interface system, to achieve adaptive process control, quality assurance, and semi-automated process parameters configuration

Expected ModuLase Outputs

- **Reduced capital investment costs:**
  - End-users will save as much as 59% when installing the ModuLase head, compared to conventional laser processing without the developments made in this project (**1xprocess head with three end-effectors considered in this project**)
  - Higher savings possible for organisations adopting more end-effectors

- **Maximise laser equipment utilisation rates by reducing down-time:**
  - Anticipated changeover time of <1 minute for the proposed ModuLase process head
  - Improved utilisation rates

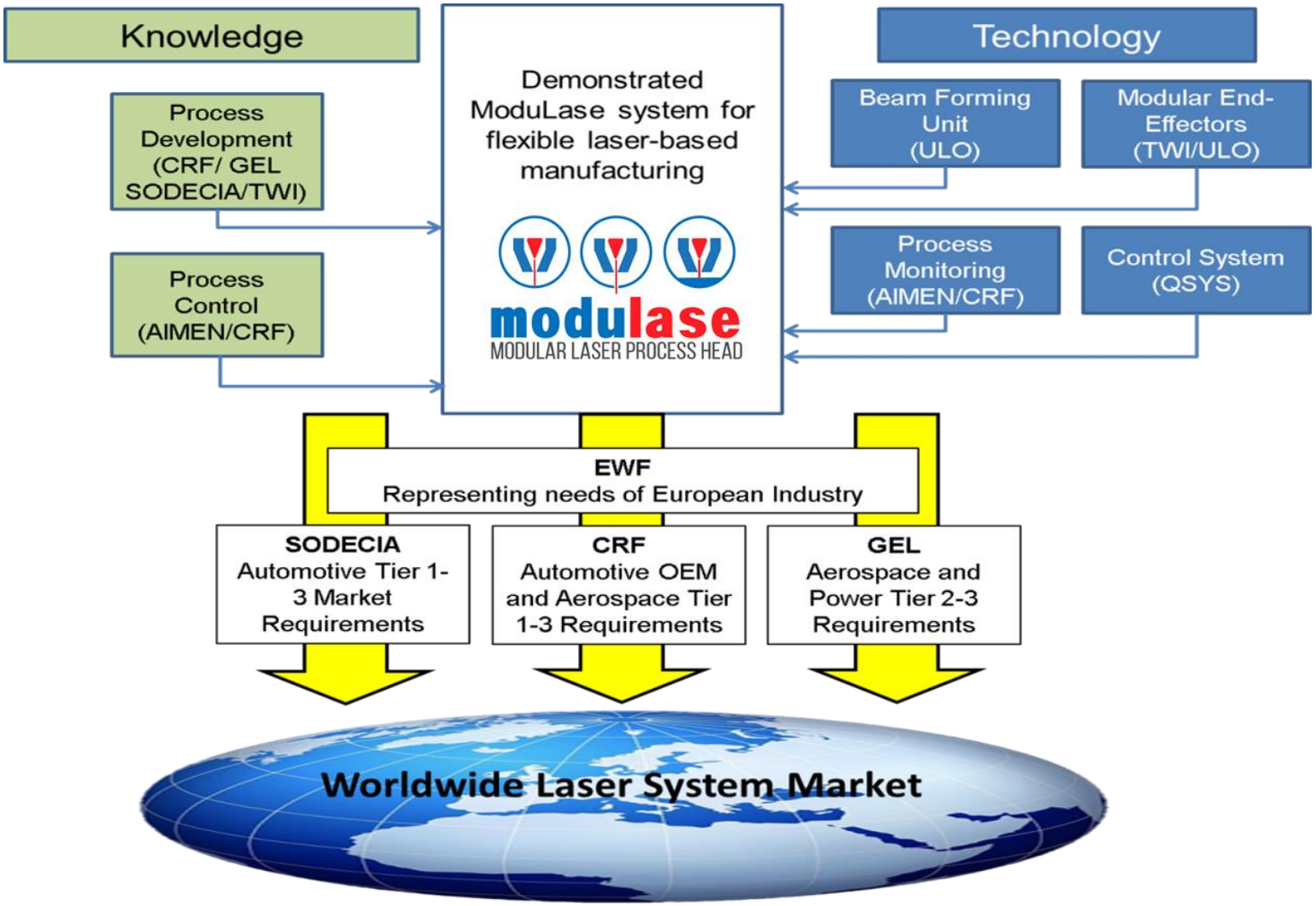
- **Reduced running costs:**
  - Reconfiguring the Beam Forming Unit (BFU) to match the required beam configuration will save time and cost
  - The integrated process control and monitoring system also helps minimise, if not eliminate, defects and therefore save on re-work or scrappage

The ModuLase Consortium

- 8 participants from 4 countries
- 50% RTO, 25%SMEs and 25%LEs
- End users within the power, aerospace and automotive sectors

Activities	Consortium
Beam Forming Unit	ULO Optics
End Effectors	TWI, SODECIA
Process monitoring and quality control	aimen, CRF
Laser processing development and validation	TWI
User friendly Operating/User interface	Q-Sys
Training, Dissemination & Exploitation	EWF
Automotive and Aerospace applications	CRF, Graham, SODECIA

ModuLase Technologies & Industry Focus



Objectives of the Project

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1. Develop a Beam Forming Unit (BFU) for Tailoring Laser Beam Energy Distribution

- Re-configurable collimating and focusing optics (by mounting them on automated drives) to allow tailored beam caustics to be produced for welding, cladding and cutting applications

2. Develop End-Effectors for Welding, Cladding and Cutting Applications

- A range of rapidly interchangeable end-effectors designed and built for welding, cladding and cutting
- Each having the same 'plug and play' connection method to the BFU
- End-effectors will provide the additional functionality for each process (for example, cutting assist-gas, wire/powder-feed and plume control)

Objectives of the Project

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3. Develop a Co-Axial In-Process Quality Assurance System

- Commercial in-process monitoring systems exist for laser cladding, welding and cutting applications
- However, the systems are not currently compatible for all three processes. In ModuLase, quality monitoring unit to be suitable for welding, cladding and cutting applications

4. Develop Software Package and Integrate with Process Head

- User-friendly software package required to interface with other parts of the wider laser processing system and for human interface

Objectives of the Project

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6. Validate the Flexibility of the ModuLase system for Welding, Cladding and Cutting at a Pilot Facility

- End-user applications targeted for the ModuLase system:

End-user	Application	Process(es)
SODECIA	Shift forks for automotive gearbox components, constructed from steel- based material	Welding, Cladding
GEL	Titanium aerospace parts (eg gas turbine components)	Welding, Cutting
CRF	Galvanized steel door frame parts	Welding, Cutting

Achievements

Beam Forming Unit (BFU)

- Adaptable optical elements capable of delivering a wide range of laser beam energy distributions, suitable for welding, cutting and cladding applications

Hardware - BFU

Cover glass

Focusing lens

Beam splitter

Beam expander lenses

Collimator

Achievements - BFU

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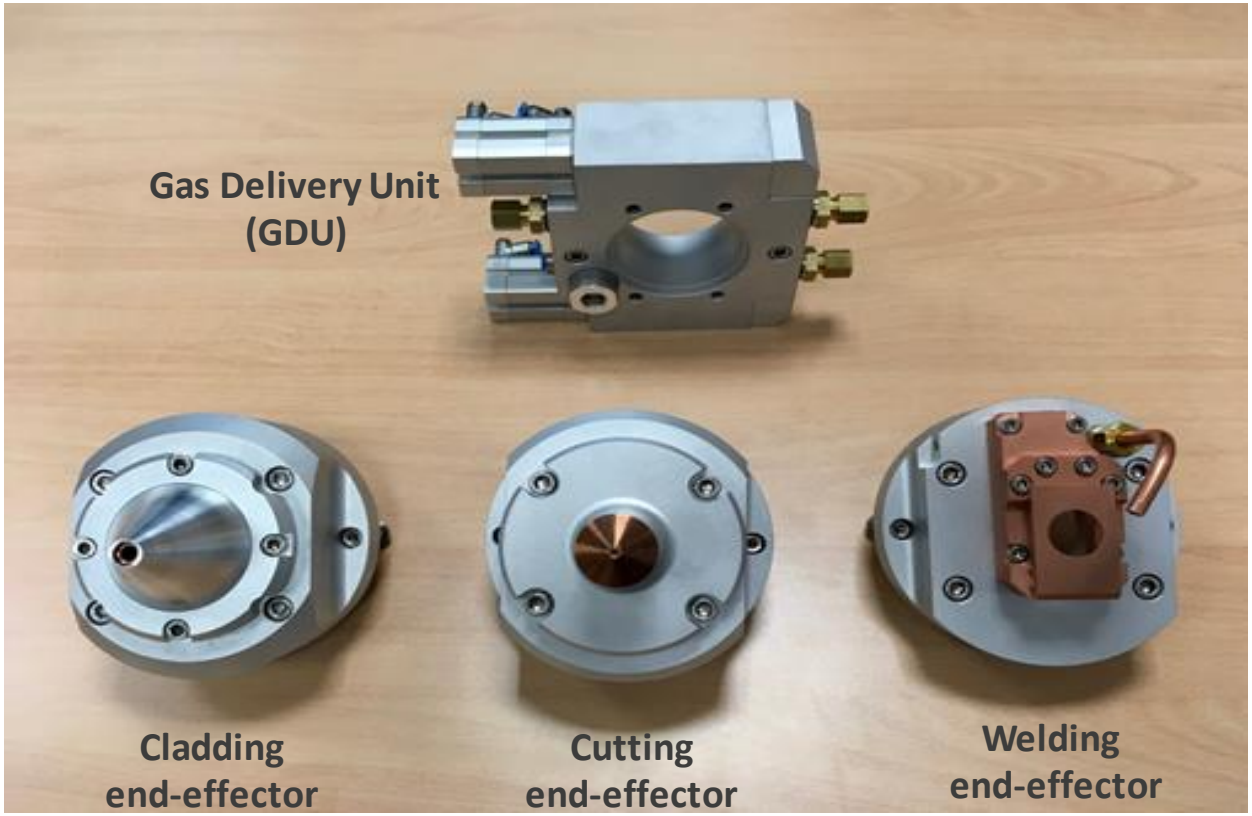
- Power handling capability up to 10kW, and compatible with 1µm wavelength laser sources
- Capable of providing focus spot sizes varied by a factor of 3 (fibre diameter is benchmark)
- Reduce optical configuration changeover from current 1-2 hours to <1 minute, minimising down-time.
- Positional accuracy of 0.05mm of optical component drives, to ensure accurate beam caustics
- Optical compatibility with co-axial process monitoring technology

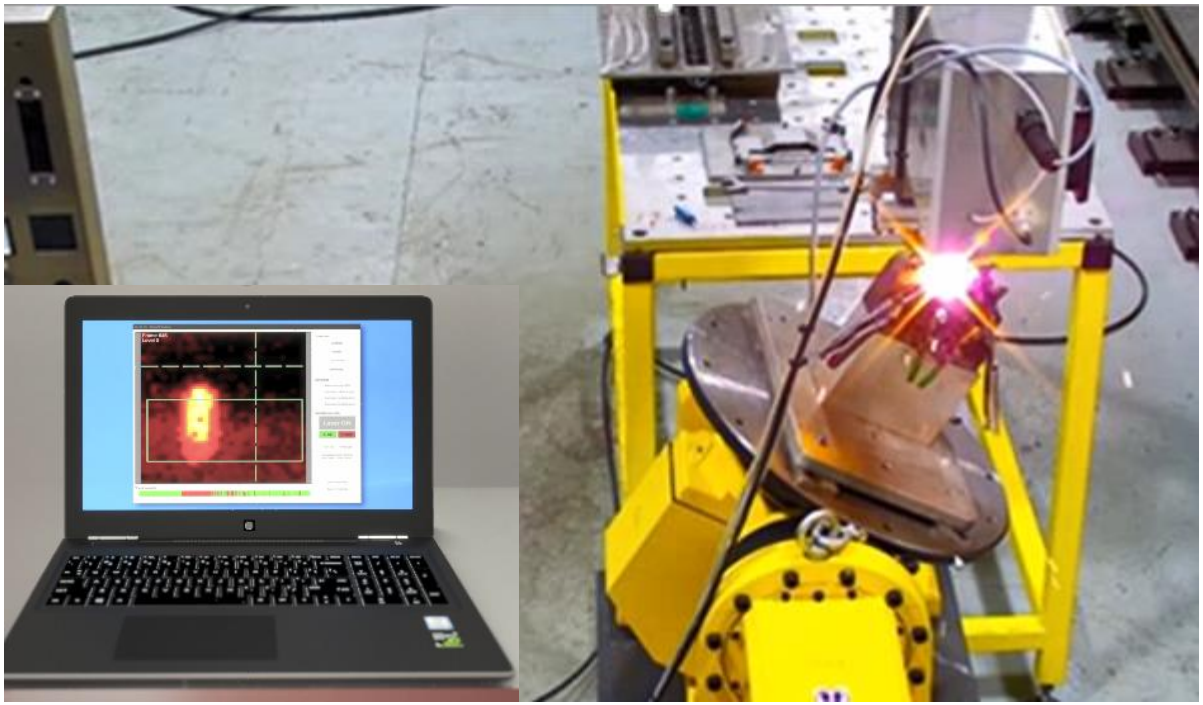
Achievements – End Effectors

- Three rapidly interchangeable end-effectors to cover welding, cutting and cladding applications
- Plug and play system to allow them to be changed on the end of the process head within a time of 1minute



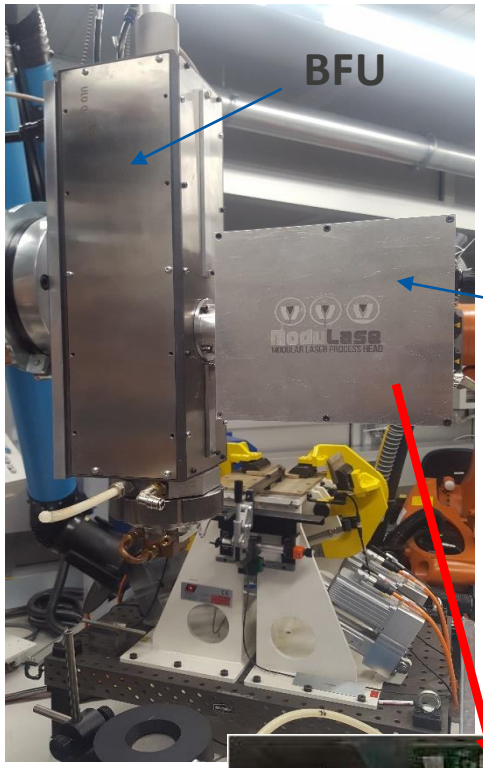
Achievements – Quality Assurance

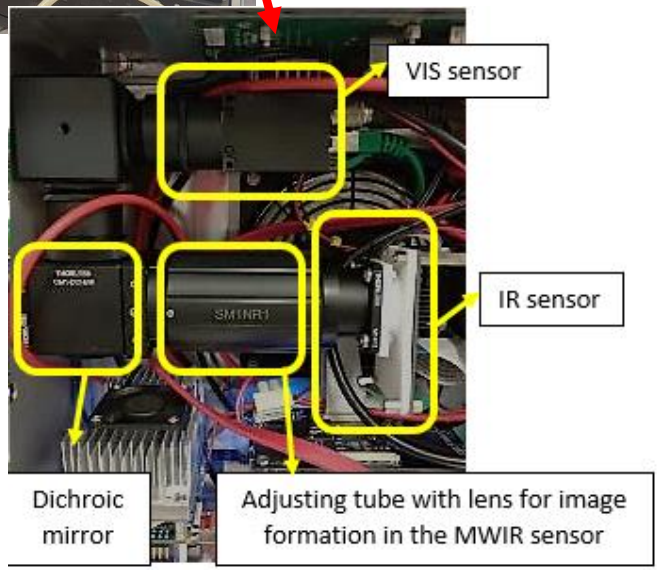
- A process monitoring system suitable for welding, cladding and cutting processes developed
- Embedded into the ModuLase system, in order to assure process stability, reduce scrap rate, enabling to reduce additional time and costs involved in the process



Achievements
Quality assurance

- ✓ Effective and compatible with the three different laser processes
- ✓ Arrangement includes camera-based sensors which cover different spectral bands from visible (VS) to infrared (IR) embedded electronics and optical components
- ✓ Molten pool is monitored in real time
- ✓ Deviations from stable reference conditions are captured, localized and identified as anomalies of the process



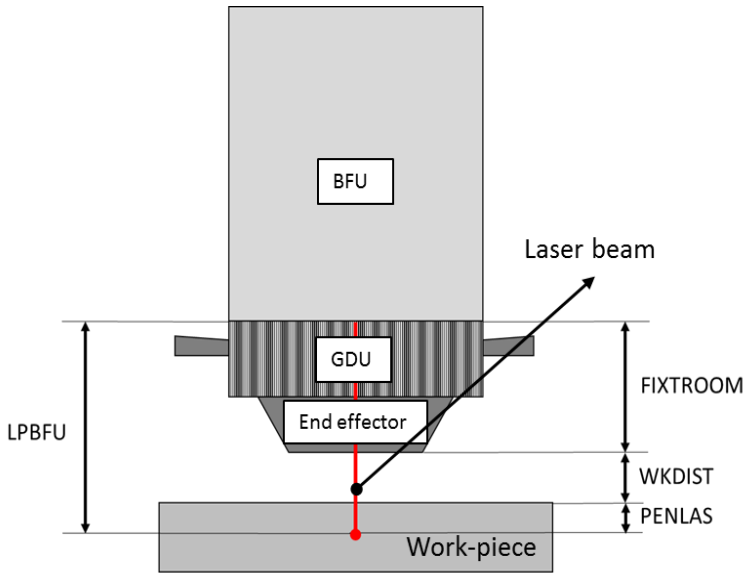


Achievements - Friendly User-interface

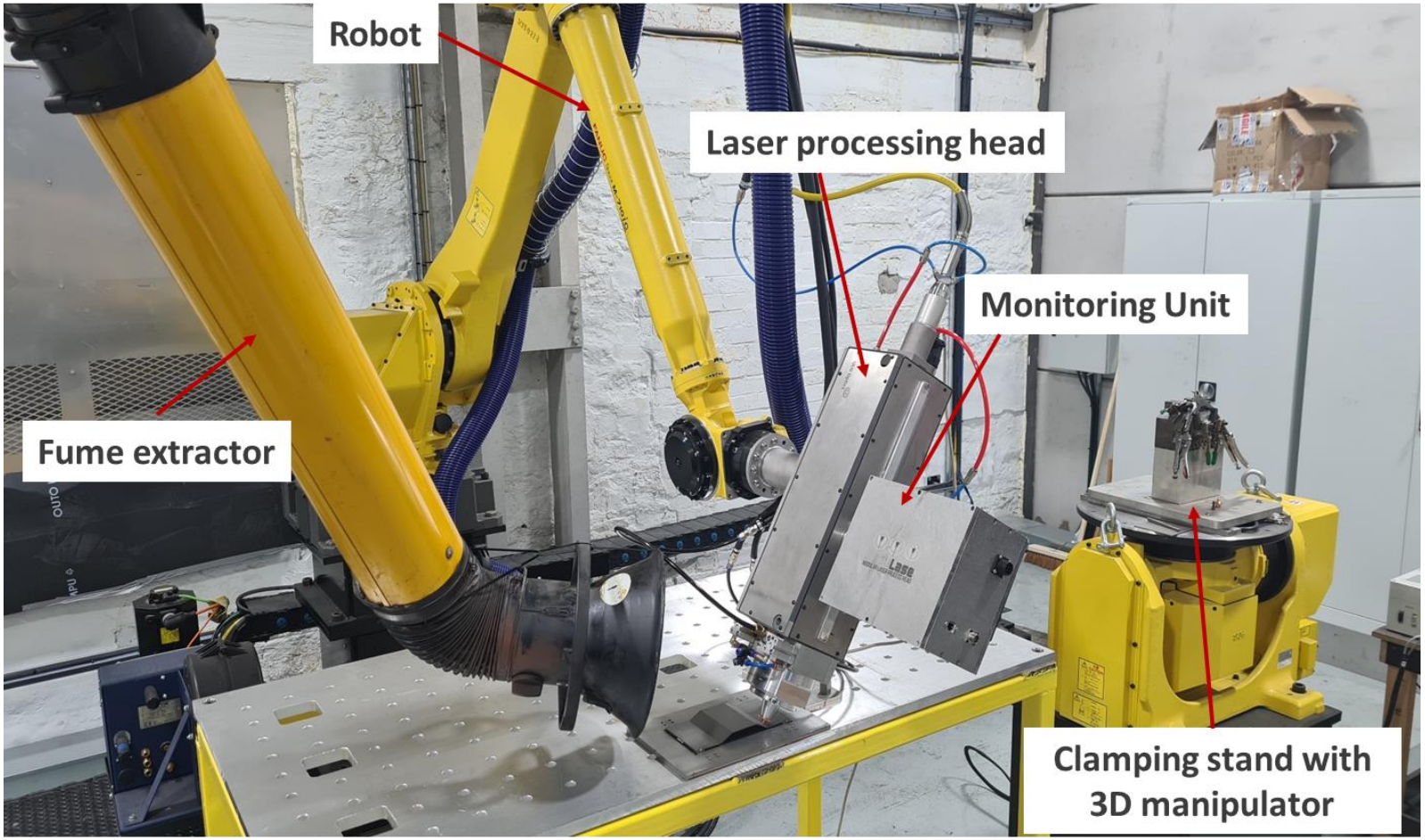
- User friendly Human Machine Interface (HMI) interface, enabling to input the material grade, its thickness and the laser process required
- Both the Quality Assurance System and BFU shall adjust vision and optical configurations and deliver the beam accordingly with minimal user contact

✓ Quick process configuration

✓ Reducing the expertise required to optimise the laser processes



System Set-up and Validated at GEL Pilot Cell



Check https://www.modulase.eu/documents.html for project videos!

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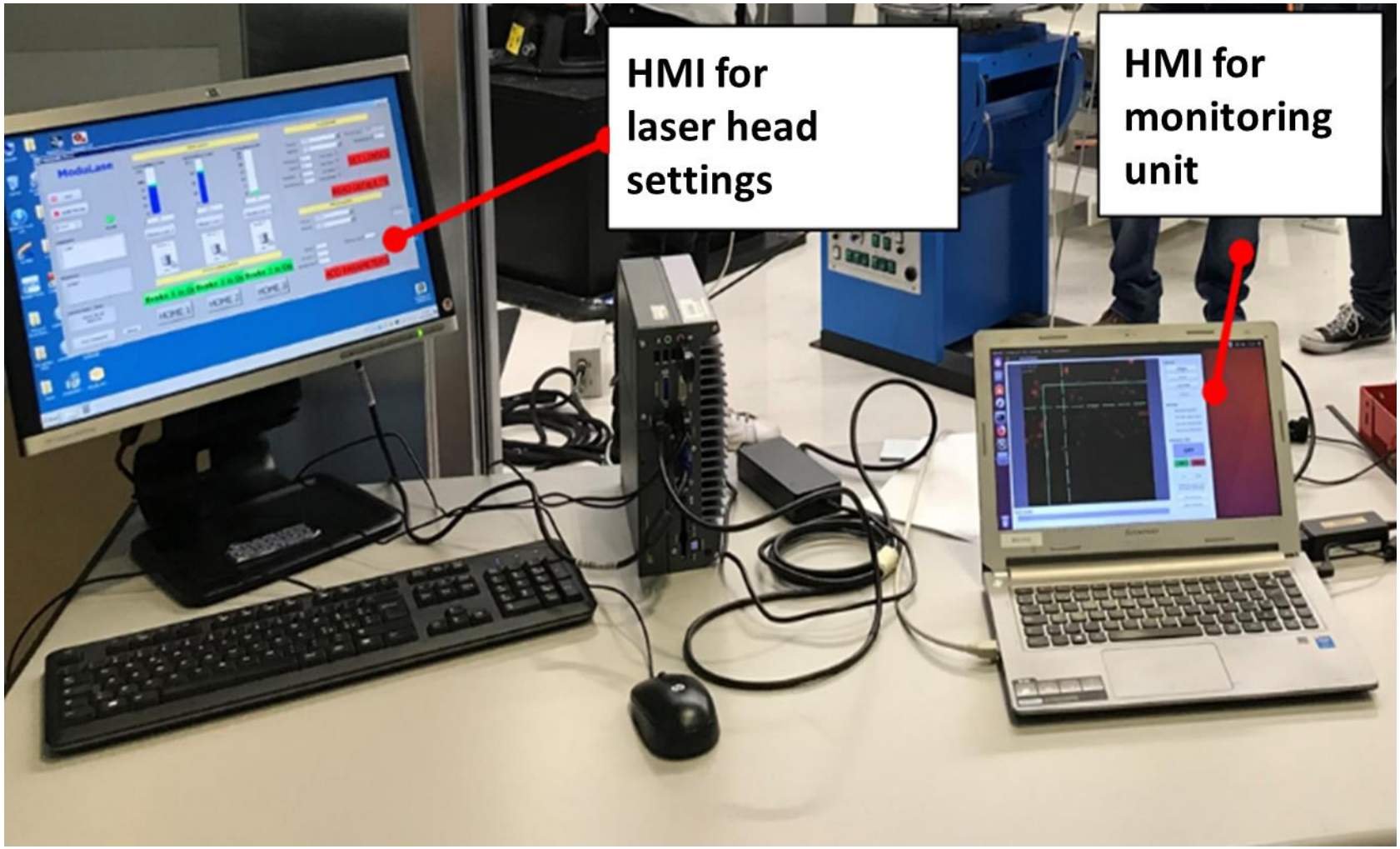

Summary

- The Modulase system has been designed and manufactured to:
  - Be flexible and accommodate three different laser processes -welding, cutting and cladding
  - Comprise monitoring unit and embedded intelligent algorithms for setting the optical configuration and help the user in the selection of process parameters
- By analysing results reached during the validation stage, it was possible to verify that proposal claims have been reached, meeting objectives of the project

Summary

- The following benefits were achieved from the use of the ModuLase system (compared to conventional laser processing without the developments made in this project):
  - 40% Equipment investment saving (1xBFU)
  - Up to 40% Space saving
  - Up to 20% Production time saving
  - < 1 min changeover of end effector

Contact

Further information available at:
http://www.modulase.eu/

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