Grant Agreement Number: 723945		
Project Title: Development and Pilot Line Validation of a Modular re-configurable Laser Process Head		
Project Acronym: ModuLase	**Funding Scheme:** Collaborative Project	
Date: October 2016	**Project Website Address:** www.modulase.eu	
EC Project Officer: Christoph HELMRATH	**Email:** Christoph.HELMRATH@ec.europa.eu	
Deliverable Number: 1.5	External training, workshops and seminars report	
Work Package Number:	1	
Date of Delivery: M57	**Actual:** M58	
Status	Draft ☐ Final x	
Nature	Prototype ☐ Report X Specification ☐ Tool ☐ Other ☐	
Distribution Type	Public x Restricted ☐ Consortium ☐	
Authoring Partner: EWF		
Contact Person: Rita Bola		
Email: rgbola@ewf.be	**Phone:** +351 914 044 390	**Fax:** NA
Abstract (for dissemination)	NA	
Keywords	NA	
Name of the Scientific Representative of the Project's Co-ordinator, Title and Organisation	**Name:** Paola De Bono **Tel:** +44 (0)1223 899000 **E-mail:** paola.debono@twi.co.uk	
Document reference:	**PDB.njp.D263.21**	

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1. Introduction

The ModuLase project developed a re-configurable highly flexible processing head system, capable of covering welding, cladding, and cutting, through the use of three modular end-effectors. The ModuLase process head system also includes intelligent sensor's technologies for quality assurance and semi-automated process parameter configuration. The ModuLase process head has unlocked the potential of greater flexibility of fibre-delivered laser sources and addresses a number of arising industrial challenges, including:

- The rising need for flexible manufacturing systems, to support an increasing variety of product mixes;
- The need to maximise equipment utilisation rates, by eliminating down-time associated with changing of laser, processing heads and equipment stoppages and reducing capital investment costs.

Training, knowledge transfer and raising awareness are key activities to ensure the uptake of new technologies, hardware, software, discoveries and outcomes by industry. In this respect, in order to raise awareness about the outcomes and results of ModuLase, a set of training activities took place in the course of the project. D1.5 'External training, workshops and seminars report' results from activities in Task 1.5. Main aim of the present report is to provide an overview of training activities carried out throughout the duration of the project. Table 1 summarises scope of Task 1.5 and D1.5.

Table 1 – Task 1.5 and D1.5 Descriptions (according to the GA 723945)

Task 1.5 – Training
This task targets the organization of training/dissemination workshops. For this purpose, a set of materials, like training manuals and guidelines will be developed and prepared. A database of videos and photos will also be created, with the assistance of all partners, to facilitate training. *The training workshops will be organised for two different targets, internal training (aimed at staff of the project partners) and external training. A set of external training workshops will be organised during the last three months of the project in different countries mainly aiming at engineers and engineering students. This will allow a wider dissemination of the project results.* *EWF will also introduce a training module related to the project results into their standard training packages for engineers. This will ensure that the necessary workforce receive training on the developed technology. The RTD performers, the end-users and EWF will organise technical seminars and events during which they will present the results of ModuLase.* *A final event will be organised, to gather all the industry stakeholders from several sectors and present the main results and expected gains of its deployment for the targeted markets, providing for a faster acceptance and integration of the project results in the value chain.*
D1.5 External training, workshops and seminars report (M57)
This deliverable results from activity in Task 1.5. This report will be submitted towards the end of the project and aims to capture the external training activity that has been on going in the project. A set of external training workshops will be organised during the last three months of the project in different countries mainly aiming at engineers and engineering students. This will allow a wider dissemination of the project results.

2. Training Materials and Manuals

A set of training materials were developed to complement and aid the training activities carried out throughout the timeframe of the project. These materials will be available, in the project's common repository, for the consortium to use where they see fit even after the end of the project.

Presentations

During the timeframe of the project's presentations were created to showcase project, share information and knowledge in an effective and didactic way.

At the start of the project, a presentation providing an overview of the project scope was produced, showcasing its goals and expected outcomes (Figure 1).

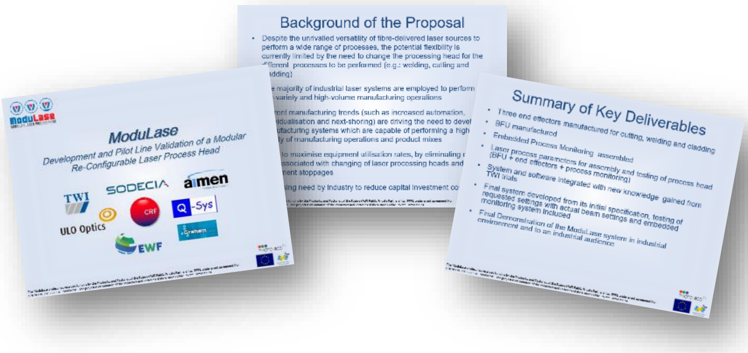


Figure 1 - Slides from the first presentation

The full presentation can be seen in Annex I – Initial Project Presentation.

As the project evolved and results were achieved, a new presentation was created, focusing on the outcomes and providing a more technical overview of the work developed (Figure 2).

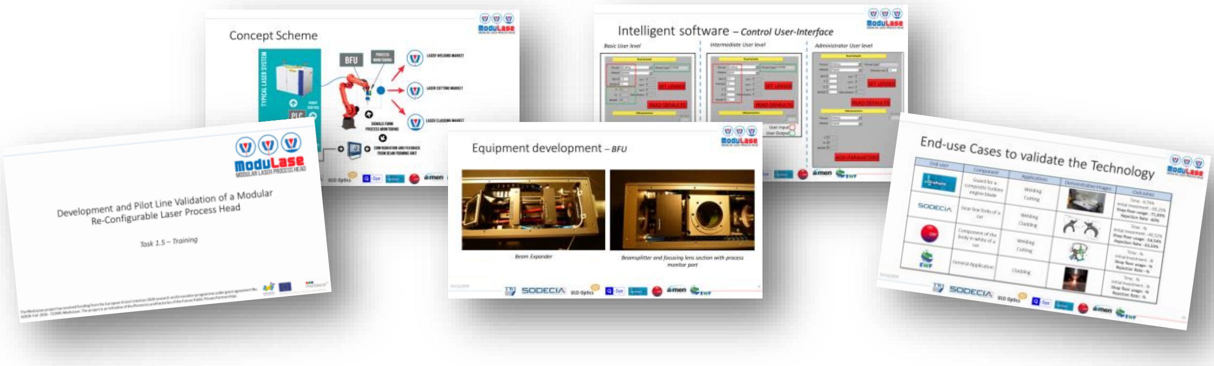


Figure 2 - Slides from the updated presentation

The full presentation can be seen in Annex II – Updated project presentation.

Additional presentations (to introduce the technology) are also available in the project website and covers the following topics:

- Basics of Laser technology; Laser beam cutting; Laser beam welding & Laser cladding;
- Basics of Process Monitoring and Control;
- ModuLase Key Technologies: Set-up, Capabilities and Processes.

In order to complement the ModuLase training activities, and for students to have a reference document and address any doubt they might have, the ModuLase consortium prepared a manual with the different steps needed to use the Control User-Interface (Figure 3). The full document can be seen in Annex III – ModuLase Software and Hardware Architecture Manual. The software developed ensures the adequate control of the hardware enabling the fast configuration of the machine to be adjusted to the work being done. All this is done through a user-friendly interface.

Figure 3 – Software and Hardware Architecture – Manual

Database of Photos and videos

Photos, videos and associated training materials to support delivery of training sessions to external entities are available on the project website in the Documents tab (Figure 4; https://www.modulase.eu/documents.html).

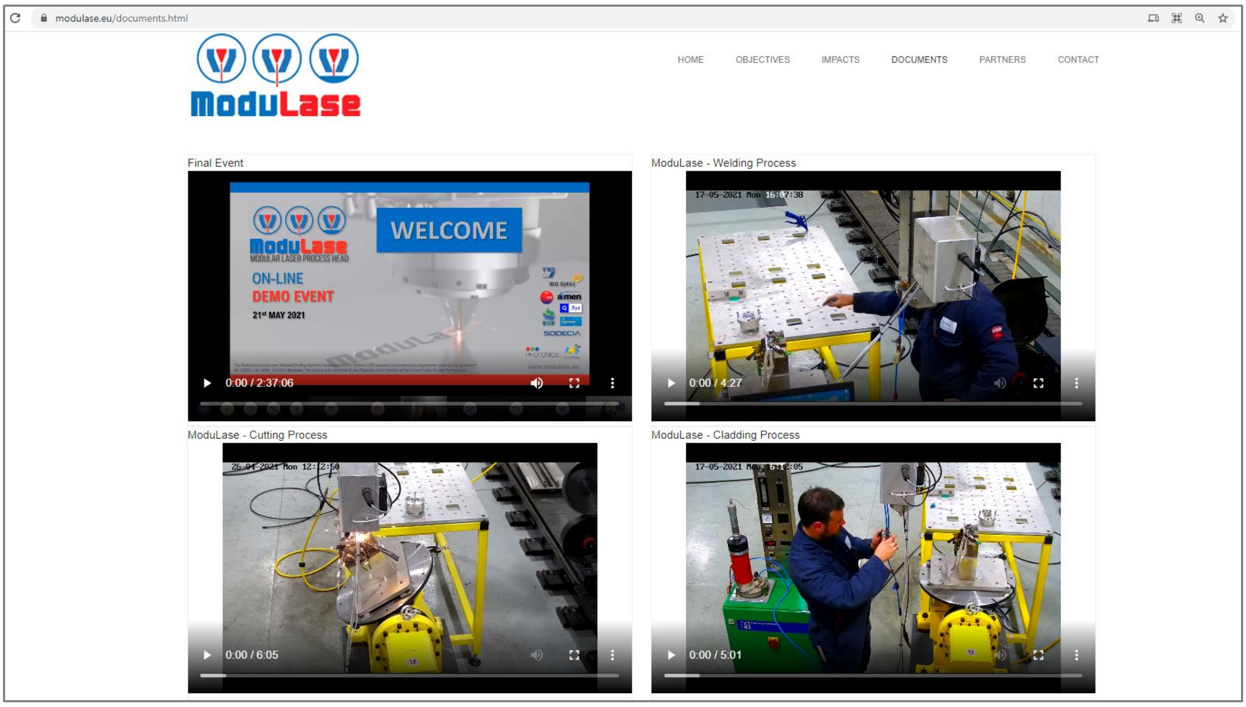


Figure 4 – Evidence of database of ModuLase Training Materials

3. External Training, workshops and seminars

Within the timeframe of the project a set of activities were carried out, targeting not only engineering students but also engineers and operators. The activities targeting engineers and operators were carried out directly to industry, enabling the raise awareness regarding the ModuLase system. During delivery of the training sessions, it was ensured that personnel needing to acquire knowledge on the operational aspects of the ModuLase system was involved.

Moreover, the workshops organized toward engineering students were a great opportunity to showcase a new industrial approach for laser processing to the future work force. Delivered training activities are summarised in Table 2.

Table 2 – Summary of External Training Activities deployed

Activity	Place	Date	Audience Type	Attendees	Notes
Training at VET Centre	Oeiras PT	28 September 2018	EWE Course Engineers & Engineering students	24	Evidences In the subsections here-after
Seminar at University	Lisbon PT	03 December 2018	Mechanical and Materials Engineering Students	34	
Training at Industry	Ovar PT	19 December 2018	Automotive Sector Company	16	
Training at Industry	Ovar PT	04 – 08 February 2019	Automotive Sector Company	9	
Training at Industry	Ovar PT	27 – 29 February 2019	Automotive Sector Company	5	
Training at VET Centre	Grijó PT	28 September 2019	EWE Course Engineers & Engineering students	18	
Training at VET Centre	On-line	11 July 2020	EWE Course Engineers & Engineering students	15	
Seminar at University	On-line	23 March 2021	Mechanical and Materials Engineering Students	20	

Figures 5 to 13 report evidence of all external training activities delivered in the course of the ModuLase project.

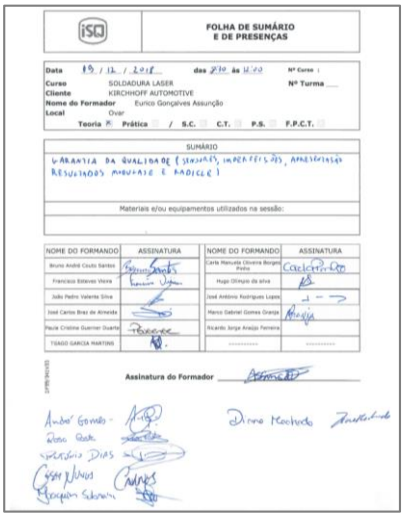
VET Centre – EWE Course – ISQ Oeiras – 28th September 2018

Figure 5 – EWE Course presence list

Seminar at University – IST – 3rd December 2018

Figure 6 – Evidence of Training at IST Engineering Students

Training at Industry – Automotive Sector – Kirchhoff 1st Edition – 19th December 2018



FOLHA DE SUMÁRIO E DE PRESENÇAS

Data 19 / 12 / 2018 **das** 9:30 **às** 12:00 **Nº Curso** :
Curso SOLDADURA LASER **Nº Turma** ___
Cliente KIRCHHOFF AUTOMOTIVE
Nome do Formador Eurico Gonçalves Assunção
Local Ovar
Teoria ☒ **Prática** ☐ / **S.C.** ☐ **C.T.** ☐ **P.S.** ☐ **F.P.C.T.** ☐

SUMÁRIO

GARANTIA DA QUALIDADE (SENSORES, IMPERFEIÇÕES, APRESENTAÇÃO RESULTADOS MODULASE E RADICLE)

Materiais e/ou equipamentos utilizados na sessão:

NOME DO FORMANDO	ASSINATURA	NOME DO FORMANDO	ASSINATURA
Bruno André Couto Santos		Carla Manuela Oliveira Borges Pinho	
Francisco Esteves Vieira		Hugo Olímpio da silva	
João Pedro Valente Silva		José António Rodrigues Lopes	
José Carlos Braz de Almeida		Marco Gabriel Gomes Granja	
Paula Cristina Guerner Duarte		Ricardo Jorge Araújo Ferreira	
TIAGO GARCIA MARTINS		----------	----------

Assinatura do Formador

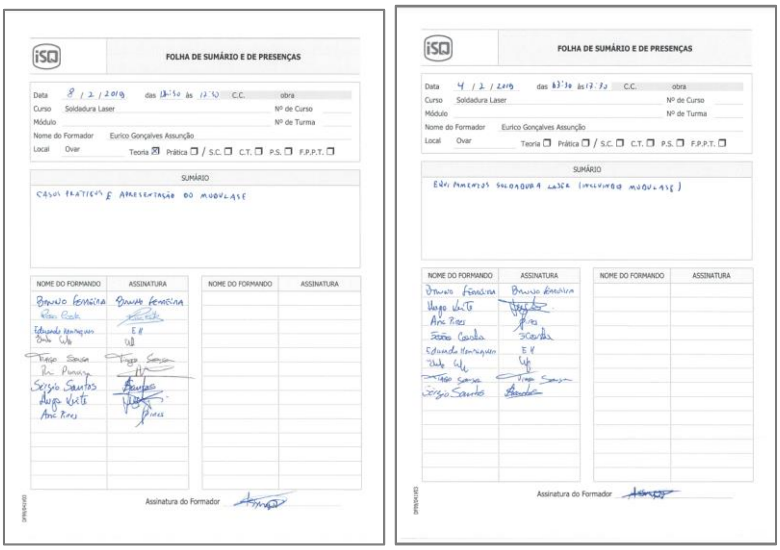
Figure 7 – Kirchhoff 1st Edition Course presence list

Training at Industry – Automotive Sector – Kirchhoff 2nd Edition – 4th to 8th February 2019


FOLHA DE SUMÁRIO E DE PRESENÇAS

Figure 8 – Kirchhoff 2nd Edition course presence list

Training at Industry – Automotive Sector – Kirchhoff 3rd Edition – 27th to 29th February 2019


FOLHA DE SUMÁRIO E DE PRESENÇAS

Data 8 / 2 / 2019 das 13:30 às 17:30 C.C. obra
Curso Soldadura Laser Nº de Curso
Módulo Nº de Turma
Nome do Formador Eurico Gonçalves Assunção
Local Ovar Teoria ☒ Prática ☐ / S.C. ☐ C.T. ☐ P.S. ☐ F.P.P.T. ☐

SUMÁRIO
CASOS PRÁTICOS E APRESENTAÇÃO DO MODULASE

NOME DO FORMANDO	ASSINATURA	NOME DO FORMANDO	ASSINATURA

Assinatura do Formador

FOLHA DE SUMÁRIO E DE PRESENÇAS

Data 4 / 2 / 2019 das 13:30 às 17:30 C.C. obra
Curso Soldadura Laser Nº de Curso
Módulo Nº de Turma
Nome do Formador Eurico Gonçalves Assunção
Local Ovar Teoria ☐ Prática ☐ / S.C. ☐ C.T. ☐ P.S. ☐ F.P.P.T. ☐

SUMÁRIO
EQUIPAMENTOS SOLDADURA LASER (INCLUINDO MODULASE)

NOME DO FORMANDO	ASSINATURA	NOME DO FORMANDO	ASSINATURA

Assinatura do Formador

Figure 9 – Kirchhoff 3rd Edition course presence list

Figure 10 – Eurico Assunção presenting the Modulase System at Kirchhoff

VET Centre – EWE Course – ISQ Norte – 28th September 2019

Figure 11 – ISQ Norte – Training workshop presence list and classroom

VET Centre – EWE Course – ISQ Norte – 11th July 2020

Figure 12 – On-line presentation of ModuLase to ISQ students

Seminar at University – IST – 23rd March 2021

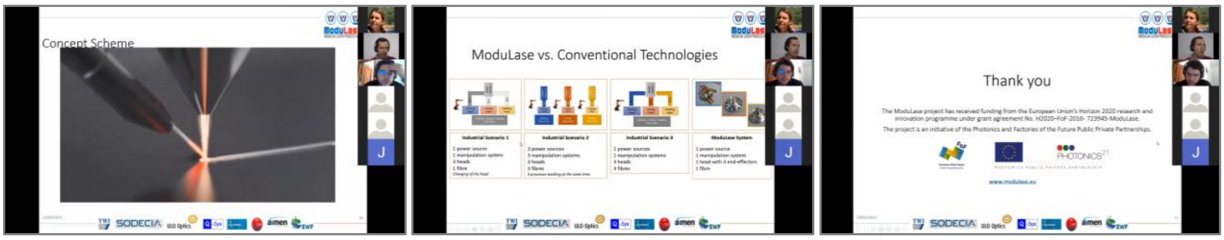


Figure 13 – Evidence of Training at IST Engineering Students

4. Conclusions

This report compiles all training materials and external training activities that took place during the duration of the project. Target groups initially identified at proposal stage, both internal and external, were reached (although this deliverable reports only the external activities, there have been also internal ones – reported under D1.13 – Training, workshops and seminar reports). The training activities carried out, targeted not only industry experts but also undergraduate engineering students as well as the industry in which the ModuLase concept was showcased, increasing more the coverage of the project, including to potential end-users.

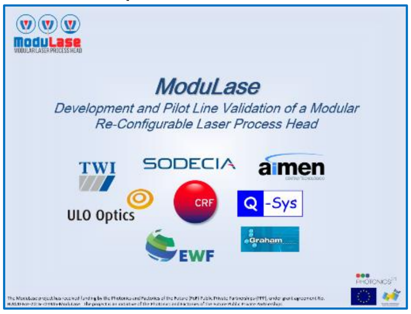
A database is available on the project website, containing training materials, from presentations, manuals, photos and videos and will be maintained available and accessible after the end of the project, so that partners will be able to use in post-project activities, as appropriate.

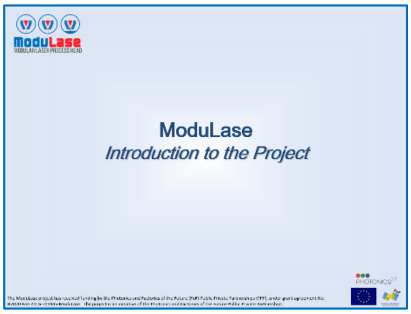
It is planned to have further training and knowledge sharing activities also beyond project completion, proving that the results and outcomes of the project are of added value to possible end-users.

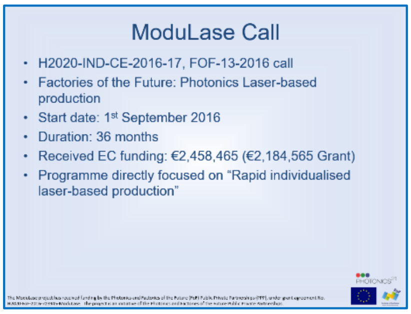
5. Annexes

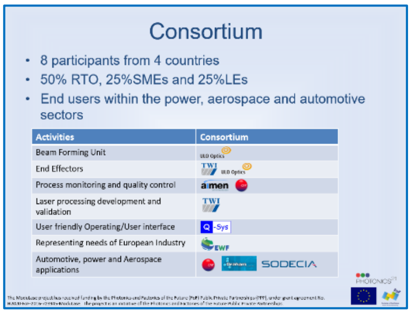
Annex I – Initial Project Presentation

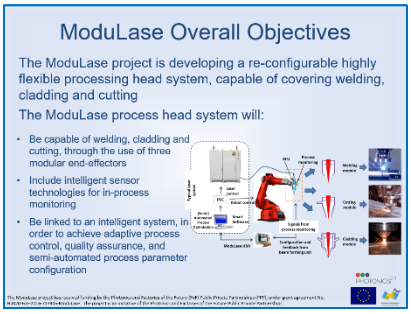
The below presentation is accessible at: www.modulase.eu/documents.html

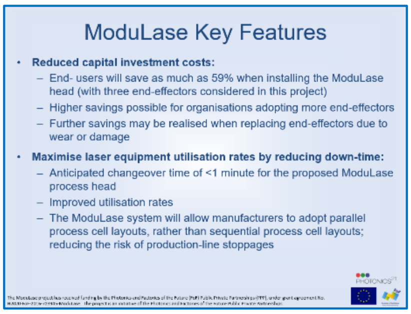


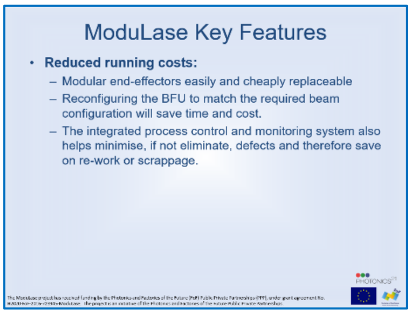


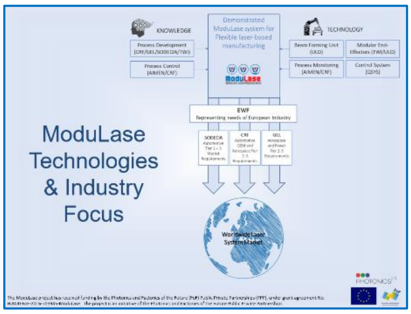


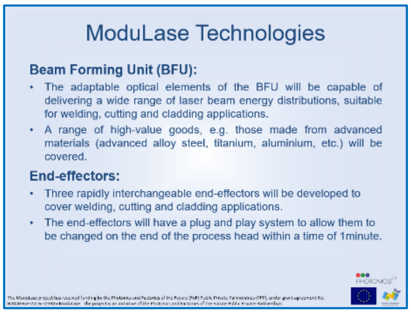


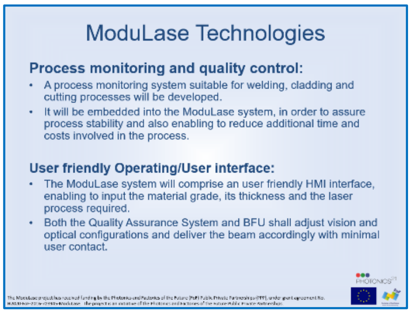


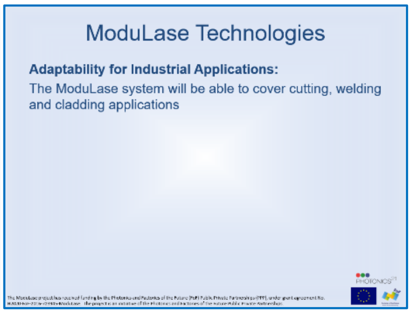


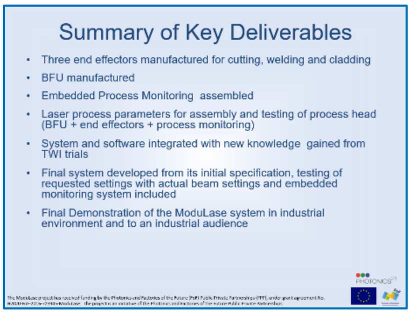






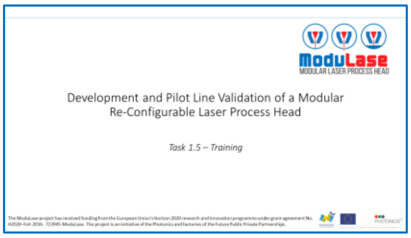


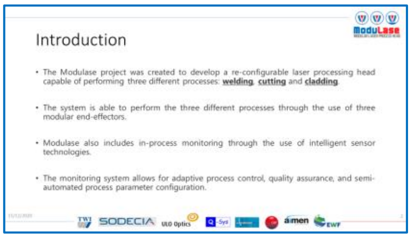


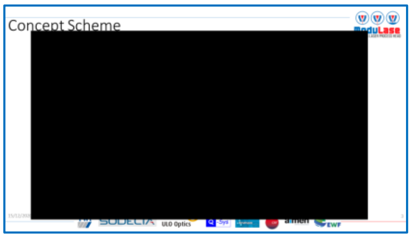


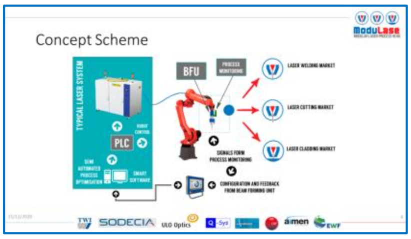
Annex II – Updated Project's Presentation

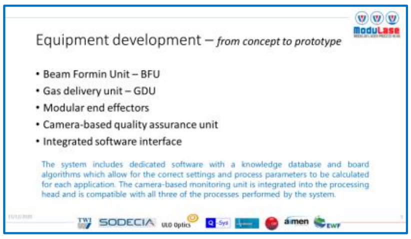
The below presentation is accessible at: www.modulase.eu/documents.html

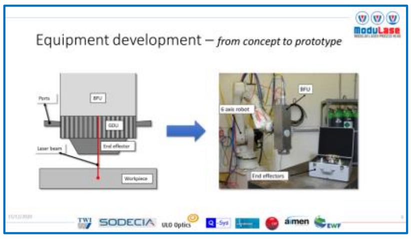


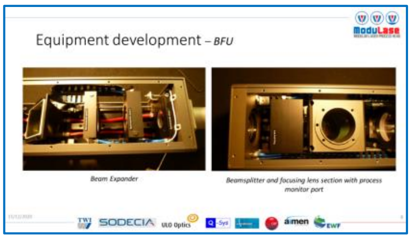


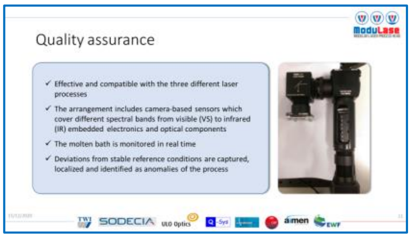


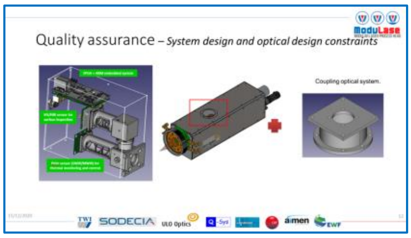


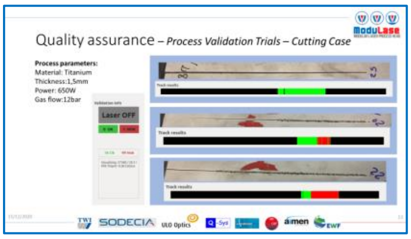


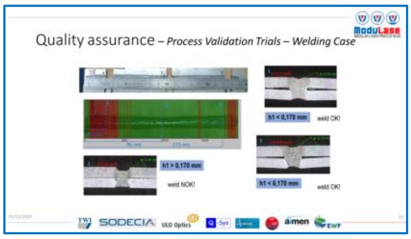


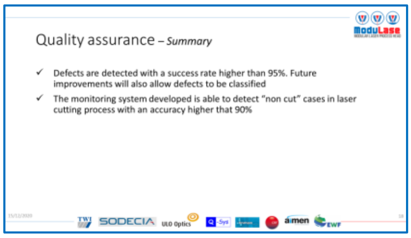


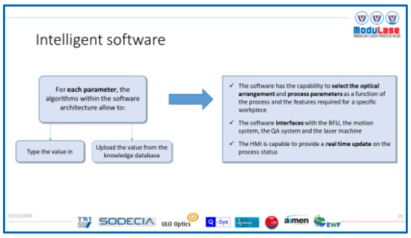


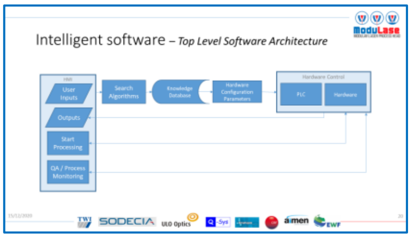


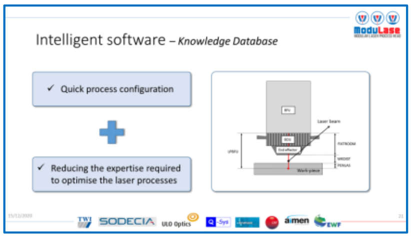


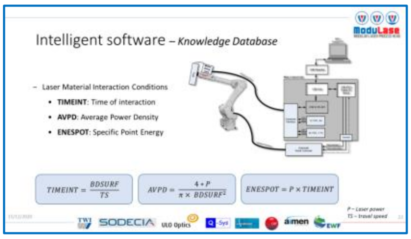


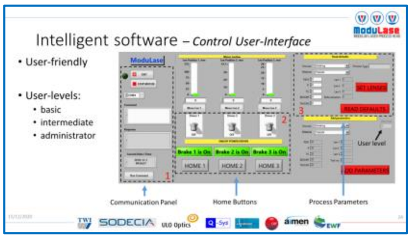


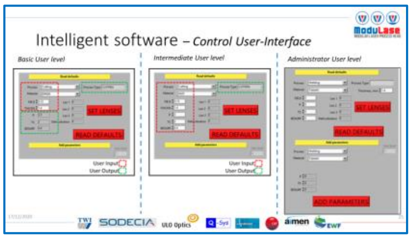

Intelligent software
For each parameter, the algorithms within the software architecture allow to:
Type the value in
Upload the value from the knowledge database
The software has the capability to select the optical arrangement and process parameters as a function of the process and the features required for a specific workpiece
The software interfaces with the BFU, the motion system, the QA system and the laser machine
The HMI is capable to provide a real time update on the process status


Intelligent software – Top Level Software Architecture
User Inputs
Outputs
Start Processing
QA / Process Monitoring
Search Algorithms
Knowledge Database
Hardware Configuration Parameters
Hardware Control
PLC
Hardware

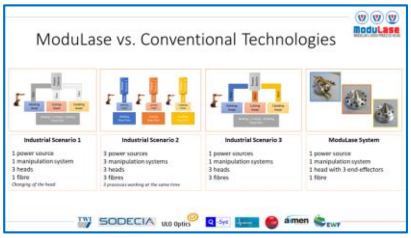

Intelligent software – Knowledge Database
Quick process configuration
Reducing the expertise required to optimise the laser processes
Laser beam
Work-piece

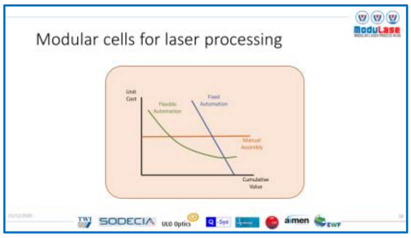

Intelligent software – Knowledge Database
Laser Material Interaction Conditions
TIMEINT: Time of interaction
AVPD: Average Power Density
ENESPOT: Specific Point Energy
TIMEINT = BDSURF / TS
AVPD = 4 * P / π × BDSURF²
ENESPOT = P × TIMEINT
P – Laser power
TS – travel speed

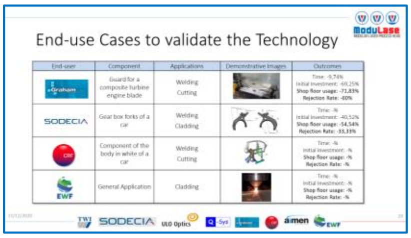

Intelligent software – Control User-Interface
User-friendly
User-levels:
basic
intermediate
administrator
ModuLase
SET LENSES
READ DEFAULTS
Brake 1 is On
Brake 2 is On
Brake 3 is On
HOME 1
HOME 2
HOME 3
User level
ADD PARAMETERS
Communication Panel
Home Buttons
Process Parameters

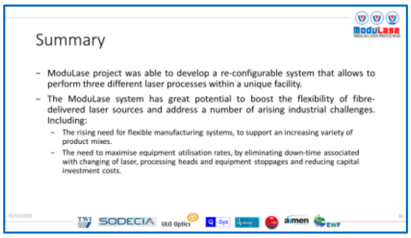

Intelligent software – Control User-Interface
Basic User level
Intermediate User level
Administrator User level
SET LENSES
READ DEFAULTS
User Input
User Output
ADD PARAMETERS


Modular cells for laser processing
Market Flexibility
Uptime Output
Safety
ADVANTAGES
Location Flexibility
Investment Flexibility


ModuLase vs. Conventional Technologies
Industrial Scenario 1
1 power source
1 manipulation system
3 heads
1 fibre
Changing of the head
Industrial Scenario 2
3 power sources
3 manipulation systems
3 heads
3 fibres
3 processes working at the same time
Industrial Scenario 3
1 power sources
1 manipulation systems
3 heads
3 fibres
ModuLase System
1 power source
1 manipulation system
1 head with 3 end-effectors
1 fibre


Modular cells for laser processing
Unit Cost
Flexible Automation
Fixed Automation
Manual Assembly
Cumulative Value


End-use Cases to validate the Technology
End-user
Component
Applications
Demonstrative images
Outcomes
Guard for a composite turbine engine blade
Welding
Cutting
Time: -9,74%
Initial investment: -69,25%
Shop floor usage: -71,83%
Rejection Rate: -60%
SODECIA
Gear box forks of a car
Welding
Cladding
Time: -%
Initial investment: -40,52%
Shop floor usage: -54,54%
Rejection Rate: -33,33%
Component of the body in white of a car
Welding
Cutting
Time: -%
Initial investment: -%
Shop floor usage: -%
Rejection Rate: -%
EWF
General Application
Cladding
Time: -%
Initial investment: -%
Shop floor usage: -%
Rejection Rate: -%


Summary
ModuLase project was able to develop a re-configurable system that allows to perform three different laser processes within a unique facility.
The ModuLase system has great potential to boost the flexibility of fibre-delivered laser sources and address a number of arising industrial challenges. Including:
The rising need for flexible manufacturing systems, to support an increasing variety of product mixes.
The need to maximise equipment utilisation rates, by eliminating down-time associated with changing of laser, processing heads and equipment stoppages and reducing capital investment costs.


Thank you
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Annex III – ModuLase Software and Hardware Architecture Manual

The below document is accessible at: www.modulase.eu/documents.html