Design, development and evaluation of an orbital laser welding head

ORBITAL - Grant Agreement nº 262455 - FP7-SME-2010-1

Final publishable summary report

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Executive summary

Shell and tube heat exchangers are currently welded by the orbital TIG welding process, characterized by very high quality of the weld beads and good repeatability. This process was one of the major improvements introduced in this industrial sector in the 1980s. Even so, the cycle time of the welding process is still very high, typically around forty seconds.

The introduction of laser welding for the manufacturing of heat exchangers and steam generators can introduce some improvements in the manufacturing process such as the increase of the welding speed and therefore a reduction of production time. Furthermore due to the large number of welds to be done, the time between each operation is a critical point. The automation of the process, involving the use of the laser welding technology, would permit to reduce the time between welding operations.

The ORBITAL Project (titled Design, development and evaluation of an orbital laser welding head) started in January 2011 due to the interest of implementing the laser welding process in industrial applications where orbital welding is needed.

The ORBITAL system consists in a new laser welding head adapted to the specific requirements of the orbital welding process and tailored for tube-to-sheet joints used in the production of heat exchangers. Auto centering of the system to the tubes is performed to ensure high accuracy and repetitiveness from one weld to another. The system has been developed in order to enhance the characteristics of the laser welding process: high-speed welding, real-time control, easy automation, data exchange, accuracy.

Due to the important size of heat exchangers, production takes place in large warehouses where vibrations generated by production processes or pieces manipulation are very common. The ORBITAL laser welding system has been designed in order to satisfy the conditions of orbital welding applications: repeatable and robust positioning of the laser respect to the tubes to be welded thanks to a mechanical finger inserted in it.

The development of the ORBITAL system involved intensive work in mechanical design, in optical design and integration of the beam path into the mechanical design, and in the design of the control system.

Once manufactured and assembled, assessment of the prototype capacities have been performed. The prototype has been first tested and calibrated in laboratory environment in order to align the beam path and check the main functionalities such as accuracy of the trip or maximum possible speed. Finally the prototype has been integrated completely in a robotized cell and the system capacities have been evaluated by welding different joint configurations.

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 262455.

Summary description of project context and objectives

In the industrial area, the function of heat exchangers is to extract heat from one medium and transfer it to another. The structural design and flow configuration of this critical plant component are determined by the final use application. The materials used for these components also differ greatly depending of the application. Recuperative heat exchangers, such as shell and tube heat exchangers, are suitable for high-pressure or contaminated media. The main industrial sectors where this type of heat exchanger is used are: power steam generation, nuclear power, pharmaceutical plants, food processing, chemical and petrochemical plants, paper production, etc.

Figure 1: Example of heat exchanger manufactured by INTEGASA

European shell and tube exchangers market is undergoing a phase of cutthroat competition, which is adversely affecting the margin of domestic companies. Surging metal prices and energy costs are also having a direct impact on profitability of heat exchanger manufacturers in Europe. Although companies are devising strategies to sustain their markets, pricing pressure is expected to continue in future.

Productivity improvements in the heat exchangers manufacturing, in terms of enhanced efficiency, greater durability, lowered fouling and metal fiber-enabled integral cleaning, are set to revitalize the shell and tube exchangers market. Indeed, the welding process plays a significant role in order to reduce the production cycle time, and thus reducing the delivery time, especially in shell and tube heat exchangers, where thousands of tube to tube-sheet welded joints are required. The orbital arc welding process for welding tube to tube-sheet joints is well established for these components.

Orbital welding is a specialised area of welding whereby the arc is rotated mechanically through 360º around a static work piece in a continuous process. Since its beginnings, orbital welding has been carried out almost exclusively by the Tungsten Inert Gas (TIG) technique using non-consumable electrodes, with additional cold-wire feed where necessary.

The task of welding involves welding tubes to one another or welding tubes into tube sheets. In this last case, which corresponds to the type of joint used in shell and tube heat exchangers, the orbital GTAW equipment consist of orbital welding set up that uses a mandrel for the correct alignment with the tube to be welded. Once locked into position, a GTAW torch rotates automatically around the face of the tube and welds it to the tube sheet.

The orbital welding process is well established in different industrial sectors due to the high quality of the welded seams and the good repeatability of the process. Manufacturing of shell and tube heat exchangers is an example. TIG orbital welding is the standard method for welding tube to tube sheet joints in heat exchangers, especially those where thousands of tubes are welded, like heat exchangers used in power steam generation, nuclear power, pharmaceutical plants, food production, chemical and petrochemical plants, etc. Even so, the cycle time of the welding process is still very high, typically around forty seconds. As a consequence, a considerable amount of time is needed to manufacture one unit. As an example, welding of one of these heat exchangers of 16.000 tubes of 25mm diameter requires 32.000 welds. Accomplishing this task takes between seven to eight weeks, 24 hours a day, including positioning times. Time involved in the welding process is almost the half: three weeks.

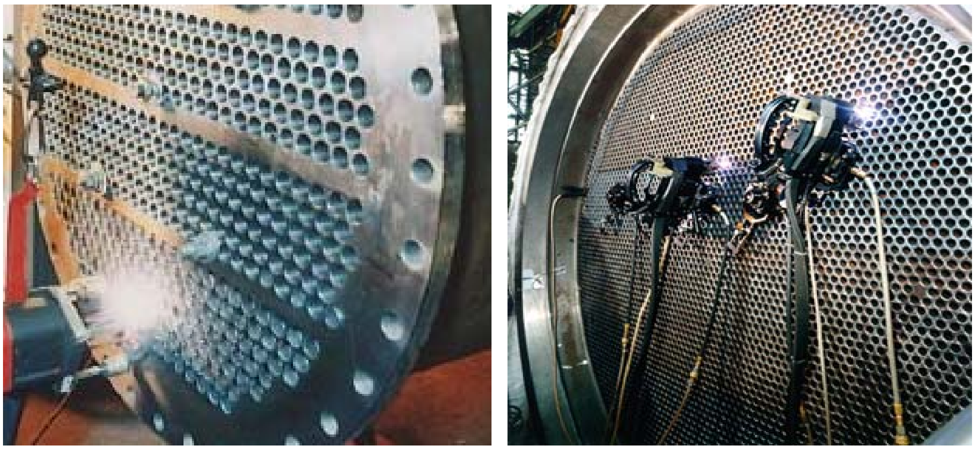

Figure 2: Examples of TIG Orbital welding in shell and tube heat exchanger manufacturing

The introduction of laser welding for the manufacturing of heat exchangers and steam generators can introduce some improvements in the manufacturing process. As an alternative to TIG welding process, laser welding is presented as the only welding process technically viable and capable of achieving welding speeds significantly higher. Furthermore, while the TIG welding process melts the whole tube thickness, the high energy focalization of the laser welding technology makes also possible a narrow weld seam, which would allow melting partial thickness of the tubes, improving the weld seam quality, avoiding reduction of the tube section that can have negative influence in flow circulation and cavitation.

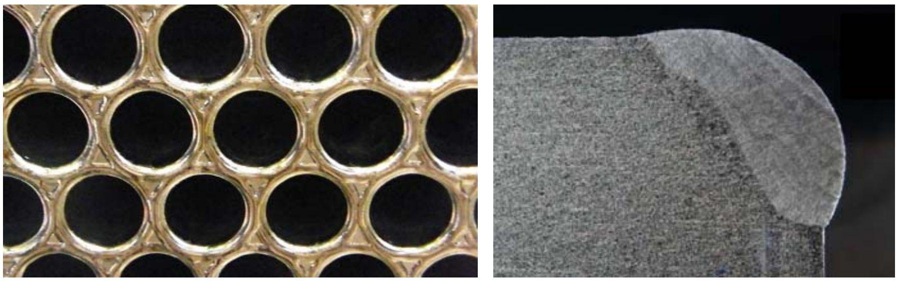

Figure 3: Photograph of TIG orbital seam and example of cross section

Laser welding also involves a reduction of heat input regarding to conventional TIG welding process. That means a different metallurgical behaviour, minimizing metallurgical defects in critical materials regarding welding behaviour. Finally, the automation of the process, in case of using laser welding technology, would minimize the time between each welding operation. Decreasing the overall duration of this stage would directly reduce production times, as well as the costs, and improve competitiveness and productivity of companies.

The ORBITAL Project, titled “Design, development and evaluation of an orbital laser welding head”, started in January 2011 due to the interest of implementing the laser welding process for orbital welding of tube to tube-sheet joints. The development of a welding system that enables the use of laser technology in an orbital welding process was considered a great technological breakthrough, since no device on the market using this technology was available.

The objective of the project was to design an ORBITAL laser welding system satisfying the specific requirements of the orbital welding process and tailored for tube-to-sheet joints used in the production of heat exchangers, providing a good shielding gas atmosphere and repeatable positioning of the laser respect to the tubes to be welded thanks to a mechanical finger inserted in it. Due to the important size of heat exchangers, production takes place in large warehouses where vibrations generated by production processes or pieces manipulation are very common. This ORBITAL system would avoid vibration problems that could affect the laser welding process which presents low tolerance to positioning thanks to the mechanical clamping to the work piece.

Summarizing, the development of the orbital laser welding head performed in this project will allow introducing laser welding technology in the shell and tube heat exchangers manufacturing, aiming at increasing productivity and competitiveness of heat exchanger manufacturers.

In order to obtain a specially adapted new system for tube to sheet welding, it was necessary to develop the three following technical aspects: an optical path in order to focus the laser on the workpiece, an electro-mechanical system in order to move and control the speed and path of laser beam around the tube circumference with a high positioning accuracy, and a control system able to control the different parameters of the welding head in order to perform the welding process.

The following five sub objectives were defined initially in order to reach the overall goal of the project:

1. Design and simulation of a compatible optical and mechanical system adapted to work conditions.

The main goal was to achieve a compact design of the orbital laser welding head that meets the specifications defined by working conditions.

2. Development of a control system to monitor the location and movement of the device designed.

One of the most critical points of the project was the control system development. It must control the internal movement of optical and mechanical systems and the whole movement of the welding head.

3. Manufacturing of a prototype of the orbital laser welding head

Once designed and approved the different parts of the ORBITAL laser welding system, they have been manufactured or purchased in order to build a prototype system. Final assembly has been achieved integrating the optical system, the mechanical structure and the control system developed.

4. Calibrating and testing the prototype in laboratory conditions

These tests were oriented to ensure the correct alignment between the optical elements of the system. Beam analysis and power measurements of the laser beam have been done to evaluate functionality of optical and opto-mechanical elements.

5. Testing of the orbital laser welding head under real work conditions

To validate the final prototype, welding tests have been performed in specimens of tube to tube-sheet applications. The welded joints have been subjected to different tests in order to check if they meet the standards applicable to shell and tube heat exchangers.

Description of the main S&T results/foregrounds

The following results have been reached during the project development, permitting the achievement of the main objective:

-Optical design of the laser welding head:
A combination of mirrors and lenses permits to guide the laser beam from the optic fibre end to the workpiece. The definition of specifications and development of a concept of optical path for its integration into the mechanical design have been performed. The optical path has been designed in parallel to the mechanical architecture of the Orbital head in order to ensure the viability of concept. It has been designed for a laser output power up to 2kW, and reaching spot size under 0,5mm on the workpiece by using industrial standard commercial fiber and disc lasers. In order to guarantee good seam geometry, the beam path has been designed to work with perpendicular incidence of the beam onto the workpiece. For the optimization of the optical design, simulation of the optical path using ZEMAX software has been performed. Laboratory tests on the optical elements were also performed in particular to confirm that no relevant focal shift would occur during real welding process.

-Opto-mechanical design of the ORBITAL laser welding head:
A mechanical design adapted to the process requirements and including the integration of the optical elements from the beam path has been developed. The idea is to implement the Orbital system onto an industrial robot or CNC system in order to automate the whole welding cycle. The conception of the head includes the following parts:

- Coupling system: an interface between the robot or CNC and the orbital part. These elements permit linear movements between the ORBITAL head and the robot in vertical and horizontal, as well as tilting. These freedom degrees permit the autocentering of the welding head when it enters into the tube to weld. Furthermore, vibrations from the workshop would not be transmitted through the robot to the welding head.

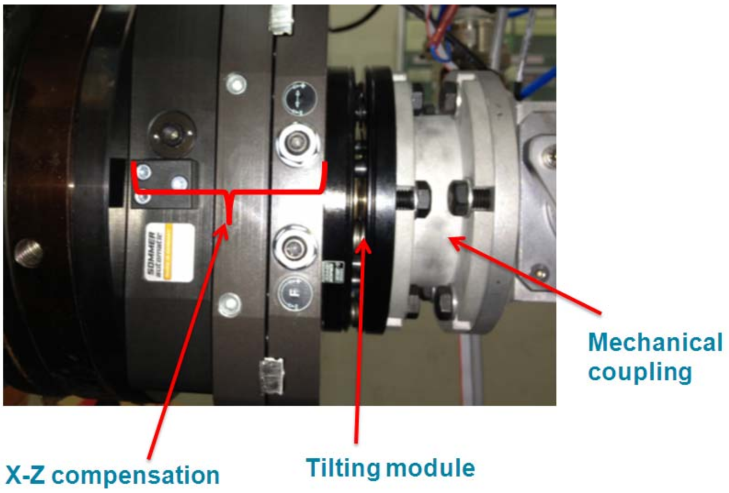

Figure 4: Modules for the coupling between the robot and the ORBITAL head

- Beam shaping: this part of the processing head is composed by the lenses needed for the collimation and focusing of the beam onto the workpiece.

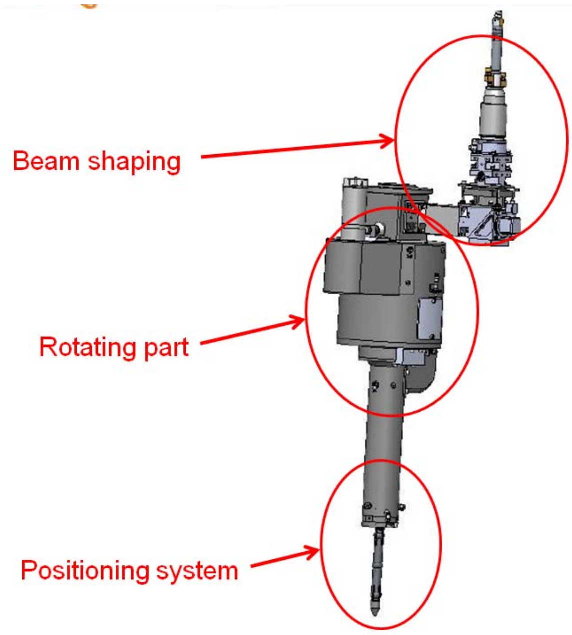

Figure 5: General sketch of the ORBITAL prototype head

- Rotating part: it permits to generate the circular movement of the beam, to follow the joint path to be welded.

- Position system: it ensures precision positioning of the head regarding the tube to be welded. A mechanical finger enters into the tube to be welded to position the laser beam respect to the joint. Furthermore, the head needs to touch the workpiece in order to be able to activate the laser beam. This strategy permits to work in a safer way, but also to ensure good positioning of the workpiece regarding focal position of the laser. This ORBITAL system will avoid vibration problems that could affect the laser welding process in industrial applications: the head mounted onto a positioning system (for example a robot) is clamped into the workpiece while welding, at the same time clever mechanical coupling as explained earlier permits to avoid transmission of vibrations from the robot to the welding head.

- Cover system: it was designed mainly for safety purpose. The metallic cover includes different windows in order to access to some internal parts of the head and sensors to be sure that these windows are closed during operation.

-Development of a control system:

The axle control system was developed based on a FPGA solution using a CompactRIO hardware architecture from National Instruments. It ensures high accuracy, high speed processing and Real-Time control. Besides, a high level control system was also developed. It includes a graphical user interface permitting the setting of parameters and the visualisation of the process state, so the operator has an easy control over the process. The high level control system interacts with the rest of the laser installation for example by sending the process settings to the laser and the robot, or informing the robot when a tube is welded in order to start moving to the following one. The main welding parameters that can be changed from the ORBITAL interface system are laser power, welding speed and rotation angle in order to control the start/stop welding operation. It is also possible to ramp the rotation speed and the laser power. Finally, it is also possible to load the pipe distribution into the control system so the user interface can show to the operator the welding state of each pipes (welded, not welded, or problem during welding).

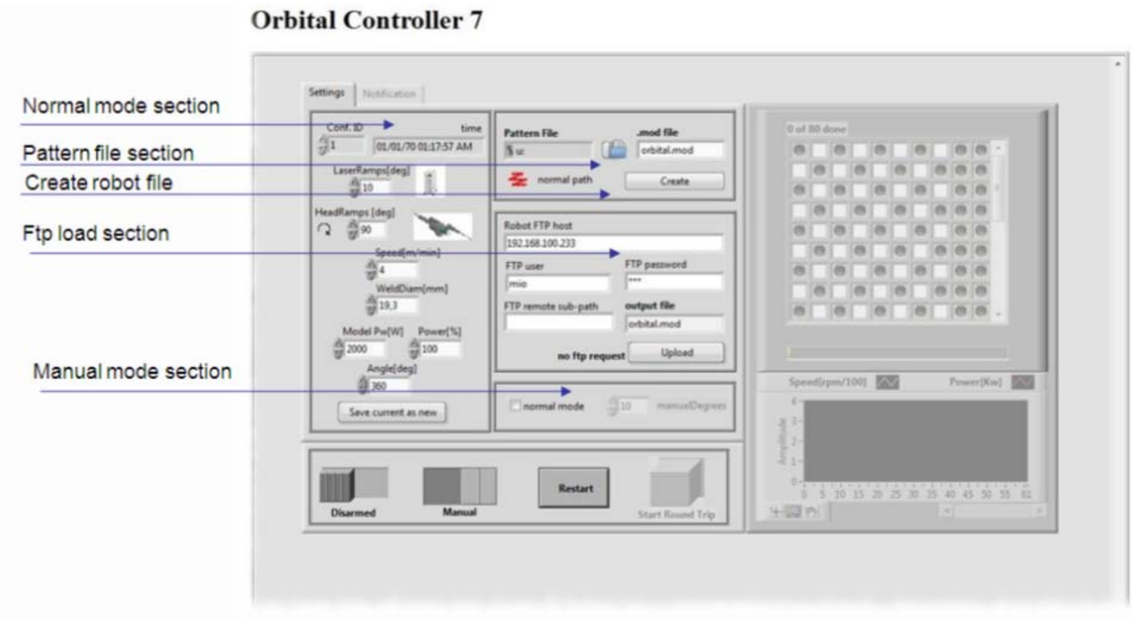

Figure 6: Graphical user interface, setting of welding parameters and workpiece geometry

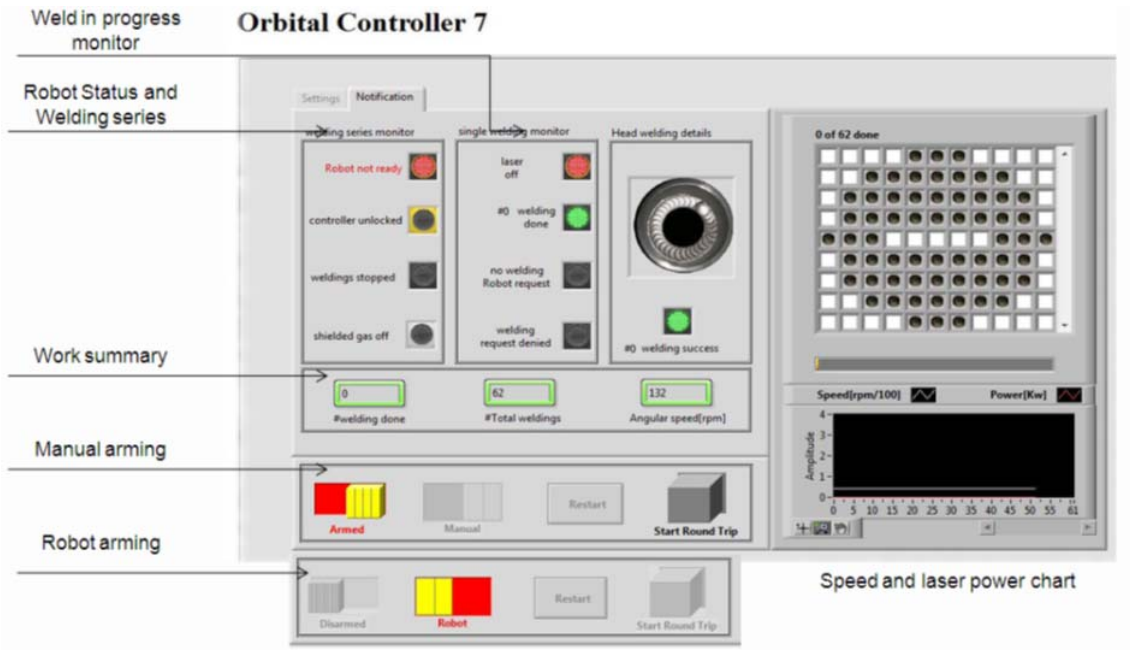

Figure 7: Graphical user interface, status of the system during welding operation

-ORBITAL prototype:

A prototype was developed and assembled in accordance with the design and specifications produced in the previous activities of the project. This comprises opto-mechanical and electronic hardware, but also the control software.

Figure 8: Opto-mechanical assembly of the prototype

-Laboratory validation of the prototype:

The manufactured prototype was first tested and calibrated in laboratory environment in order to align the beam path and check the main functionalities such as accuracy of the trip, maximum possible speed, laser power on work piece and beam profile. The knowledge regarding the alignment of the beam path revealed to be very important to ensure good set up of the system before each application. The maximum welding speed reached is 5m/min. Useful functions for welding such as ramping of the speed and ramping of the laser power were also tested. The exact angle for each ramping as well as for welding at constant speed and power can be selected by the operator, making possible a weld overlap (welding more than 360º) to ensure tightness of the welds.

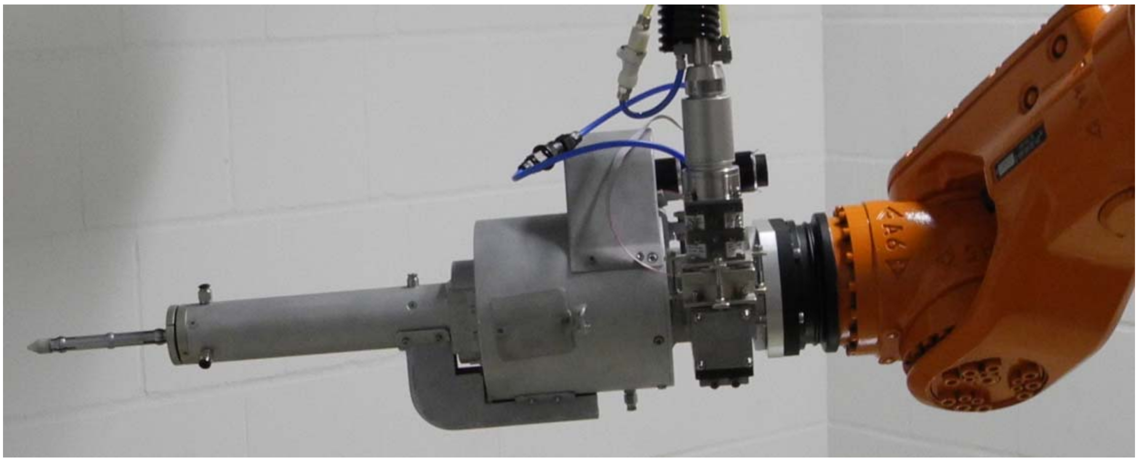

Figure 9: ORBITAL head mounted for laboratory validation

Figure 10: Demonstration sample welded after alignment and calibration of the ORBITAL head

-Industrial validation of the prototype:

Finally the prototype was integrated completely in a robotized cell in a pre-industrial environment. The system has been integrated in order to work in automatic mode and perform welding trials on different type of joints to evaluate its capacities. The safety sensors, checking that the system is positioned onto the workpiece, were connected and the mechanical couplings between the robot and the head permitting x-z linear movements and angular tilting were installed for the validation of the auto centering concept. The studied laser welding parameters were: laser power, welding speed, and shielding gas. As there are no examination requirements for laser welded tube to tube-sheet joints, requirements for TIG welds were used. Regarding to metallographic examination, weld beads must fulfil specific penetration and internal porosity requirements. Weld seams were subjected to several examination tests, to evaluate their quality: visual inspection, macrograph examinations, dye penetrant inspection and radiograph testing. Small size demonstrators of different materials were welded using welding speeds up to 2m/min.

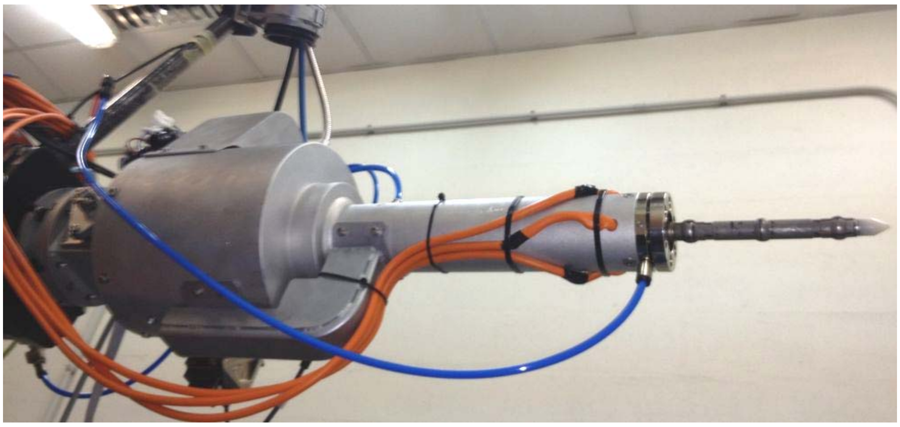

Figure 11: ORBITAL prototype head integrated onto a robot

Two possible configurations resulting from the welding parameters are possible for this type of joint: complete or partial fusion of the tube thickness. In both cases, the laser is applied perpendicularly to the work piece surface. The difference of the final shape of the seam relies on the welding parameters.

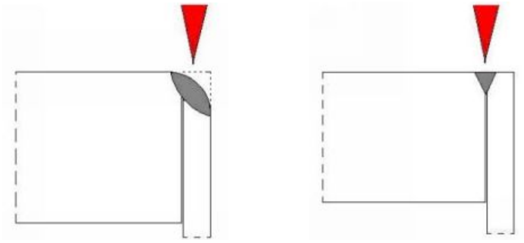

Figure 12: Complete fusion of tube thickness (left) and partial fusion of tube thickness (right)

Figure 13: Cross section of nickel joint welded at 2m/min (left) and at 1,5m/min (right)

The joining of tube to tube sheet is a complex process and requires very good tuning. A fundamental aspect to take into consideration is the good centering of the welding path. Deviations of tenths of millimeter are enough to reduce the leak path in a drastic way. One of the big improvements of the ORBITAL system when welding tube to sheet joints compared to standard commercial laser heads is the repetitiveness of the process. Once performed the tuning of centering of the beam path with the tube, the positioning of the beam onto the tubes is always the same thanks to the auto centering design.

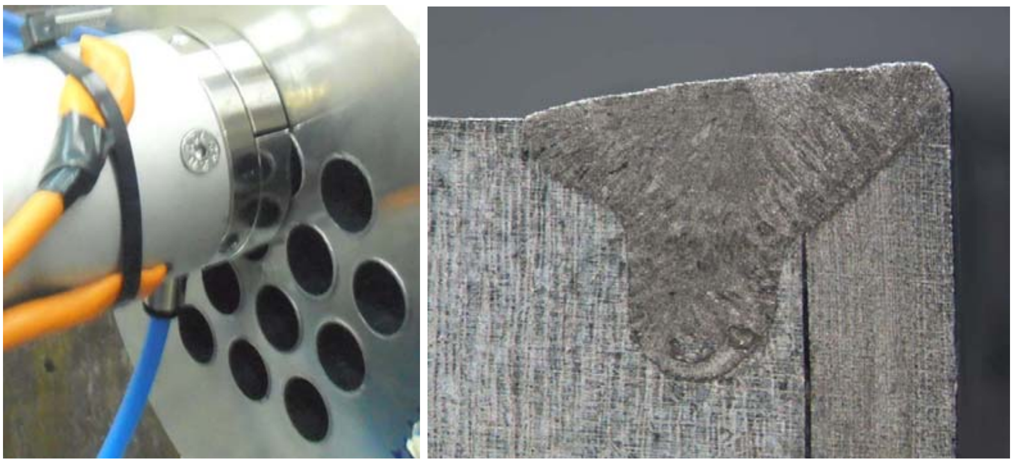

Figure 14: Positioning of the ORBITAL head onto a specimen (left) and cross section of a joint with deviation of the beam path positioning (right)

So, the work performed permitted to achieve repetitive good positioning of the seam respect to the joint and adequate penetration levels have been reached with welding speeds up to 2m/min, onto steel, stainless steel and nickel alloy joints. Different tube diameters were welded within the range permitted by the prototype which goes from 13mm to 22mm. It was possible to obtained seams with no defects observed by neither non destructive testing (radiographs and dye penetrant) nor metallographic cuts. However in some cases some pores were present in the weld seam, in acceptable levels. The results have been compared with orbital TIG welding. The use of orbital laser welding permits to decrease the section reduction typical when using TIG welding. However, the visual aspect of the joints obtained by laser welding is not as smooth as when using TIG orbital welding even for welds fulfilling all the quality criteria.

Figure 15: Metallographic cuts of Stainless steel samples welded by LASER (left) and TIG (right)

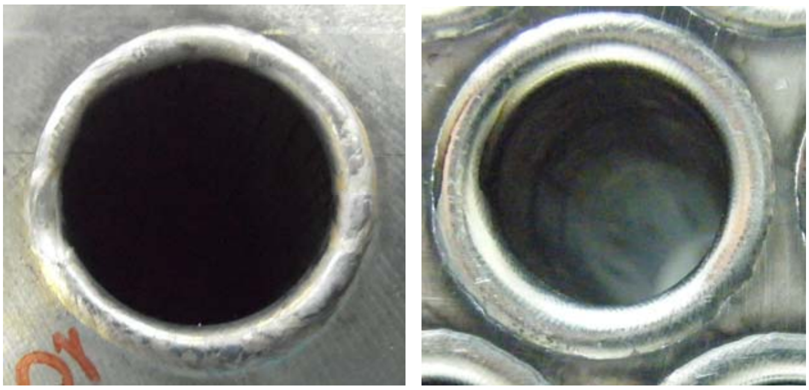

Figure 16: Photograph of Nickel samples welded by LASER (left) and TIG (right)

Summarizing, a prototype laser welding head adapted to the specific requirements of the orbital welding process and tailored for tube-to-sheet joints used in the production of heat exchangers has been developed. The functionality of the ORBITAL system has been demonstrated: a circular movement of the laser beam over the joint is performed with high accuracy, a speed up to 5m/min, and real time control. The head is fixed onto the workpiece while welding, and so independent of any unpredictable movements or vibrations from the robot. The system also comprises a control software and a graphical user interface to select the welding parameters and check the status of the system during operation.

The welding results obtained during the project were very promising. Good penetrated free of defect welds were achieved for the different tested materials. The welding head permitted to achieve repetitive results in the positioning of the laser to the joint. The use of laser welding for the joining of tube to sheet joints was demonstrated to be possible. However, the tuning of each application must be performed carefully in order to ensure good weld geometry and precise positioning.

The potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and exploitation of results

Potential impact

Actually there are a lot of commercial laser welding devices available in the market, but there are no specific solutions for the case of orbital welding applications where, commercial scanner or X-Y systems could be used but are not offering enough robustness to guarantee a perfect quality joint for each of the thousands of tubes that has to be welded in the same component.

In the ORBITAL project, a laser system prototype for laser orbital welding of tube to tube sheet has been developed, especially for shell and tube heat exchangers manufacturing. Thus, laser welding technology will be inserted in a new market that is actually growing and is expected to growth further in the future. Overall, it is estimated that the European heat exchanger market is growing at a rate of 10% annually, driven by high demand from the chemicals, fuel processing, power generation, pulp and paper, petrochemicals and oil and gas sectors. These are the most important sectors for the future and are predicted to drive consumption. The key to this growth is the commissioning of major oil projects and higher demands for power from a general growth in industrialisation. Rising energy prices are also expected to be among the major drivers of heat exchanger market growth in the near future.

For the time being, the main competitive differentiation in the heat exchangers market revolves around manufacturer reputation. Many customers will direct business to companies that have been able to establish a reputation for technical expertise, quality and performance in specific areas. The customer base is also focused on directing orders to manufacturers that can offer value-added in terms of systems construction.

Another key competitive issue in the market is price. All manufacturers need to follow flexible pricing strategies to ensure that they offer competitively priced heat exchangers, and maintain a competitive edge against a backdrop of continued change in the market environment and intensifying presence of suppliers from other regions.

According to the Strategic Multi-annual Roadmap of the Factories of the Future Public Private Partnership, a successful strategic development of high added value technology should consider the following strategic sub-domains:

- Sustainable Manufacturing
- ICT enabled intelligent manufacturing
- High performance manufacturing
- Exploiting new materials through manufacturing

The research activities under “High performance manufacturing” area aim at enhancing European leadership in product engineering and manufacturing systems development. A key factor of competitive advantage will be the capacity to achieve cost efficiency, performance and robustness of manufacturing systems, with the constraint of increasing product variants and highly variable production volumes.

In this way, the implantation of the orbital laser welding system will have an impact on final users, and shell and tube heat exchangers manufacturers:

- Increasing the welding speed in shell and tube heat exchangers manufacturing. Welding a heat exchanger with 32,000 tube to tube sheet joints using conventional orbital welding process involves three weeks, only for welding time. Laser welding would involve a welding time of less than 35 hours. The welding time will be approximately decreased by 90%.

- Increasing the automation of the welding process. Although conventional TIG orbital welding process is an automatic welding process, the positioning system of the welding device is, usually, manual. Laser welding is a fully automated process and it is estimated that the process automation would reduce the time between welding operations by 50% compared to manual positioning.

- Decreasing the welding cycle time regarding the actual welding process, and so reduce the whole delivery time. This will improve significantly the productivity of the heat exchangers manufacturers increasing their competitiveness.

- Improving the working conditions of welders

- Improving the weld seams quality and decreasing the reworking tasks. The high power focus of laser technology allows achieving precise and narrow seam welds. Heat input will decrease drastically, reducing distortion of the work piece.

- Laser welding technology will be introduced in an industrial sector, heat exchanger manufacturing that is dominated by conventional welding processes and where laser welding is an almost unknown process. The implementation of such a new process in a traditional sector will permit to enhance innovation and future improvements thanks to the implementation of new knowledge in a sector which is called to grow in years to come as energy demand will increase strongly in next decades in spite of the actual global economic situation. According to the document “MANUFUTURE- a vision to 2020” it is necessary to change the traditional structure of manufacturing industries towards a new structure, founded on knowledge and capital. The transition will depend on adoption of new attitudes towards the continued acquisition, deployment, protection and funding of new knowledge. The exploitation of the ORBITAL system will set a precedent in the development of applications of laser welding technology for heat exchangers manufacturing industry and it will open the way for future development of new applications. On the other hand, the knowledge gained by the companies will encourage their interest in new processing technologies.

Exploitation of the orbital laser welding head will contribute to achieve several benefits. Next to marketable benefits like reduced manufacturing time, better performance and enhanced quality, work and health conditions would also be improved as well as the environmental impact minimized.

The laser welding system developed includes local safety protections in order to orient its design toward achievement of class 1 laser safety system for industrial environment. The fully automated, ORBITAL system, will contribute to improve the working conditions in the following ways:

- Eliminate the tedious and monotonous nature of the job, creating greater job satisfaction. Furthermore, the working conditions would be improved as the operator would not need to displace the welding head from one tube to another, so the operator would not need to be close to the welding process during the tube to sheet welding, avoiding at the same time contact with fumes or heated atmosphere.

- The currently TIG welding process employed is carried out semi-automatically (positioning the welding device is made manually), is highly monotonous and carries certain risk level, like ergonomic problems. It is necessary to consider that, given the size of the heat exchangers, it is not always possible to guarantee the necessary means for operators to enable them to perform their work (monitoring the welding process and change the system's orbital TIG tube to another) in good conditions. The automated nature of the system developed in the project will improve aspects related to ergonomics of the process.

- A better balanced allocation of function between human operator and automation will be implemented thanks to the developed system. The operator will get information from the control system regarding specific problems during production, making easier the posterior quality control.

- Laser welding is a highly technical technology. The project consecution will contribute to the enhancement of human manufacturing skills and help retain expertise and application of these technological processes in the EU.

Main dissemination activities

The dissemination activities have been addressed to different **types of audience** such as:

- Scientific audience, including researchers in laser applications and automated process development.
- Technical audience meaning standardization organisations and engineering consultants.
- Industry Audience, potential clients of ORBITAL systems such as heat exchanger and steam generators manufacturers and industry associations.
- Public in general.

The selected **channels for dissemination** included:

- The Internet through a Project website and Partners' websites.

- Specialized congress and Technical Seminars. The following activities were performed during the project:
  - Paper and oral presentation at the Annual meeting of the Spanish Nuclear Society (SNE) on October 19th 2012.
  - Poster at the French National Workshop on Laser Processes for Industry (JNPLI), on November 28-29th 2012.
  - Presentation of the ORBITAL prototype at the workshops “Industry@Fraunhofer - Innovation evening of German SME’s”, “ORBITALUM TOOLS” and in the congresses Tailored Joining and FiSC organized at Fraunhofer IWS from October 16th to 19th 2012.
  - Abstract sent for the congress Laser in Manufacturing that will take place in May 2013.
  - Presentation of ORBITAL poster at LANE congress on November 12th to 15th 2012, and ICALEO on September 23rd to 27th 2012.
- Professional magazines and newspapers. Information about the project was published in:
  - AIMEN Technology Bulletin, June 2012
  - SILLOPTICS Newsletter, July 2012
  - Laser Magazine, July 2012
  - Euro Laser Magazine, July 2012
  - Laser Magazin, July 2012
- Trade fairs. General information about the project was disseminated in the following events by one partner (in some cases two or three partners):
  - TUBE: from March 26th to 30th 2012
  - INDUSTRIE Paris: from March 26th to 30th 2012
  - LASYS: from June 12th to 14th 2012
  - BIEMH: from May 28th to June 2nd 2012
  - METALLOOBRABOTKA: from May 28th to June 1st 2012
  - MECANICA: from May 22nd to May 26th 2012
  - AKL: from May 9th to 11th 2012
  - LAMIERA: from May 9th to 12th 2012
  - EUROBLECH: from October 23rd to 27th 2012
  - FABTECH: from November 12th to 14th 2012
- Regional & National Newspapers

The **dissemination tools** developed by the partners included:

- Project website: www.orbitalproject.eu
- Project Brochure

Figure 17: Project brochure outside part

Figure 18: Project brochure inside part

- Articles, both technical and for general dissemination
- Project Poster

Figure 19: Project poster

- Project video
- Project Public Deliverables:
    - D1.1: Project website
    - D5.1: Construction of the ORBITAL prototype system
    - D7.2: Public report on ORBITAL system capabilities
    - D8.3: Proceedings of the final meeting, dossier with all the publication made during the project

Some dissemination activities have already been performed in January and February 2013:

- A technical article explaining briefly the architecture of the control system has been prepared in order to be published by National Instrument Italy

- The abstract sent to the "Laser In Manufacturing" congress has been accepted, a paper has been prepared and sent to the organisers. The oral presentation will take place in May 2013 in Munich.
- The workshop: "Advanced technologies for the Galician metal mechanic sector", took place at AIMEN on January 31st, 2013. An oral presentation has been performed, and the prototype presented.
- The "IX Workshop on material processing with laser technology" has been organized by AIMEN on February 21st and 22nd 2013. An oral presentation has been performed, and the prototype presented.

Further dissemination activities are already planned for 2013:

- Presentation of the prototype in the fair "World of Photonics" in Munich, May 2013. This event takes place in parallel to the "Laser In Manufacturing" congress where an oral presentation will also be realized. Fraunhofer IWS will prepare a place on its booth in order to present the prototype.
- Presentation of the prototype in the fair "Welding and Cutting" in Essen, September 2013. Fraunhofer IWS will prepare a place on its booth in order to present the prototype.
- Presentation of the projects results at Tailored Joining conference, organised by Fraunhofer IWS on November 5th and 6th 2013.

Exploitation of results

The consortium taking part in the ORBITAL project was very well balanced regarding tasked to be performed. Each SME involved in the project was actually working in the same field of activity as the main tasks assigned to it in the project. Furthermore, as their main business is complementary (manufacturers of components, system builder, system seller and installer…), their interests regarding exploitation of the project results are also complementary. Direct implication of SME partners in this project provided them new or improved knowledge. This knowledge is also considered as a competitiveness improvement in terms of increasing their know-how on laser welding applications.

The ORBITAL prototype presentations to industrial companies performed during the project were very positive, and the welding results encouraging. Welding trials will go on during 2013 to demonstrate the system capabilities to end users. The direct exploitation of the ORBITAL system will depend directly on end user acceptance.

ORBITAL system exploitation would affect directly on SME partners competitiveness, providing them new market options that is working with new industry sectors or improving experience on new technologies as laser welding technology. The long-term competitiveness of the SMEs would be improved by diversifying their product portfolios by including the ORBITAL system or components thereof. Each SME expects to increase its market share, introducing their products in a new industrial sector, the heat exchanger manufacturing sector, which presents a huge potential increase in the next years.

Project public website address
www.orbitalproject.eu

List of partners
The ORBITAL list of participant and their contact details is as follows:

Participant Number	Beneficiary name	Contact person
1 (coordinator)	Aimen Technology Center	Ambroise Vandewynckèle ambroise@aimen.es
2	Fraunhofer Institute for Material and Beam Technology (IWS)	Patrick Herwig Patrick.Herwig@iws.fraunhofer.de
3	LABOR S.R.L.	Alessandro Mascioletti a.mascioletti@labor-roma.it
4	Precisgal Utillaje S.L.	Xabier Barra comercial@precisgalgroup.com
5	Equipos Nucleares S.A.	Pedro Veron veron@ensa.es
6	Industrias Técnicas de Galicia S.A.	Juan Carlos Rodríguez Macías jmacias@integasa.com
7	SillOptics GmbH&Co KG	Günter Toesko guenter.toesko@silloptics.de
8	Precitec Optronik GmbH	Markus Kogel-Hollacher m.kogel-hollacher@precitec.de
9	CMF	Philippe Gendraud philippe.gendraud@cmf.fr