



PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 39th cycle

**PNRR 117 Research Field: DEFECT-FREE ROBOTIC REMOTE LASER WELDING WITH
NOVEL TEMPORAL AND SPATIAL LASER BEAM SHAPING APPROACHES**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

**Motivation and objectives of the research
in this field**

Laser welding has demonstrated its capacity to generate high quality seams for highly demanding applications such as aerospace, aviation, automotive, and e-mobility. Both remote and proximity welding operations have been applied to robotic and cartesian systems seam types such as butt, lap and t-joint. The processed materials, thicknesses, joint configurations, and gaps can vary within the operation of a flexible welding system. This rises the necessity to control energy input both in spatial and temporal domains. Laser beam shaping with high brilliance solid state fiber lasers is a key ability that allows to form the power distribution of the beam with optical and electronical control means. The use of unconventional beam shapes such (eg. ring, flat-top, combined Gaussians), as well as beam oscillations on demand allow new parameter spaces to be explored and used. The PhD project is developed together with the BLM Group, leader in tube machinery and laser based machine tools. The project aims to study the novel beam shaping solutions in a remote welding configuration to have a greater control over the heat input during the welding operations. The candidate will use high-end monitoring devices such as low coherence tomography to investigate the weld quality inline.

**Methods and techniques that will be
developed and used to carry out the
research**

1. Implementation of in-source beam shaping solutions and the dedicated scanner in a flexible robotic laser



	<p>welding system. Beam temporal and spatial characterization;</p> <p>2. Experimental analysis and in-process diagnostics with high speed imaging, 2D and 3D coaxial imaging methods. Characterization of the welds and model validation;</p> <p>3. Inline monitoring of the weld quality via multiple sensors through the use of low coherence tomography. The use of monitoring data to generate process feasibility database and parameter selection.</p>
Educational objectives	<p>We provide doctoral candidates with high-level scientific training, fostering and refining research and problem solving abilities by focusing on both theoretical and experimental skills. A PhD in Mechanical Engineering will be able to layout, draft and carry on original research, by leading a research group or working in a team.</p>
Job opportunities	<p>Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary, compared to Master of Science holders in the same field.</p> <p>Further companies and Universities collaborating in the research are: Adige - BLM Group, University of Cambridge, TU Munich, University of Twente, Cranfield University.</p>
Composition of the research group	<p>1 Full Professors 1 Associated Professors 1 Assistant Professors 5 PhD Students</p>
Name of the research directors	Prof. Ali Gokhan Demir

Contacts
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	BLM Group - Adige S.p.A.
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	University of Stuttgart
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 5.707, 13. Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.