



PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 40th cycle

**THEMATIC Research Field: TEMPORAL AND SPATIAL CONTROL OF BEAM SHAPING IN
LPBF WITH PHYSICS-BASED MODELLING FOR TAILORED PRODUCTS**

Monthly net income of PhDscholarship (max 36 months)

€ 1500.0

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 powder bed fusion (LPBF) is arguably the most widely used metal additive manufacturing process in the industry. Today several industries demand higher productivity, better precision, newer materials, and tailored properties to match with the component requirements. Laser beam shaping can provide several options to enhance the processing capabilities by controlling heating and cooling behaviour in a desired manner across larger areas. Contemporary fiber lasers enable flexible control over the power profile in time, while arbitrary beam shapes in space can be achieved in a digital manner by use of dynamic projection devices such as spatial light modulators. On the other hand, the hardware capabilities render only the process development lengthier from the perspective of parameter selection in a much wider space. Hence, efficient modelling tools are required to determine the ideal beam shape in time and space.

This PhD project will tackle the needs of next generation metal additive manufacturing with LPBF by integrating beam sources, beam control equipment, and modelling solutions in a single platform. The project foresees the use of a high brilliance laser source with fast temporal switching and ring/core beam shapes coupled to a spatial light modulator launched into a wide area dynamic scanner. The modelling tools foresee the use of multi-physics simulator to generate a database of different solutions. Artificial intelligence methods will be employed



	to shorten the modelling phase by efficient search algorithms as well as developing reduced models to design the most appropriate beam shapes. On-board sensors will be used to calibrate and validate the models. Case studies will concern hard to process materials such as Zn-alloys, FeSi soft magnets, and Cu-alloys.
Methods and techniques that will be developed and used to carry out the research	<ol style="list-style-type: none"> 1. Implementation of spatial and temporal beam shaping solutions with high power lasers and spatial light modulators. 2. Process monitoring with OCT in large area. 3. Process development for demanding materials in electric mobility, biomedical, and electronics applications. 4. Development of a multi-physics simulation solution in loop with the process hardware.
Educational objectives	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.
Job opportunities	<p>Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary, compared Master of Science holders in the same field.</p> <p>List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research: University of Stuttgart, ENSAM Paris, TU Munich, Optoprim, nLIGHT, Raylase</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 Gökhan Demir

Contacts

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<https://www.mecc.polimi.it/ricerca/sezioni/tecnologie-meccaniche-e-produzione/>
For questions about scholarship/support phd-dmec@polimi.it

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	750.0 €
By number of months	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 6.114,50. Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 750 euro/month- net amount). 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.