



PhD in FISICA / PHYSICS - 38th cycle

PNRR_352 Research Field: WIRELESS TRANSMISSION OF ENERGY BASED ON HIGH-POWER LASERS FOR SPACE APPLICATIONS.

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	<p>Several small and larger scale studies and experiments have been performed around the world in order to mature the concept of wireless energy transmission based on lasers further, however, the idea still needs to be put on a larger industrial scale, and the general concept of abundant, virtually CO2 emission-free power generated in orbit, and transmitted through a high-power laser beam to where needed has always attracted large interest. This scholarship concentrates on investigation and potential development of laser technologies for long-distance wireless power transmission for space applications. Specific field of application is foreseen on the moon surface where the power generated by a Power plant needs to be distributed wireless to specific users. Radio frequency and laser systems are envisaged as possible candidates for this application that has to be designed to operate in a harsh environment</p> <p>This PhD scholarship is compliant with the 4th mission "Education and Research" of the National Recovery and Resilience Plan, specifically the component "From Research to Business"; indeed, it aims at creating a solid collaboration between Politecnico di Milano and Thales Alenia Space Italia, ultimately enhancing technology transfer mechanisms from academy to industry.</p>
Methods and techniques that will be developed and used to carry out the research	Lasers generate phase-coherent electromagnetic radiation at optical and infrared frequencies from external energy sources by preferentially pumping excited states of



	<p>a ?lasant? to create an inversion in the normal distribution of energy states. Direct solar-pumping laser generation has a major advantage over conventional solid state or gas lasers, which rely on the use of electrical energy to generate laser oscillation since the generation of electricity in space implies automatically a system level efficiency loss of roughly 60%. To generate a laser beam by direct solar pumping, solar energy needs to be concentrated before being injected into the laser medium. The required concentration ratio is dependent on the size of the laser medium, the energy absorption ratio and the thermal shock parameter (weakness of the material to internal stress caused by a thermal gradient). The main parameters for system design are the efficiency of the laser generation process and the efficiency of the absorption and laser-to-electric conversion processes. Applications in space or from space to Earth add additional constraints regarding:</p> <ul style="list-style-type: none"> • laser generation system mass; • laser generation temperature requirements (preference for very high temperature operations); • absence of ?consumables? and other potential waste products; • high laser beam quality to avoid the use of lenses and achieve small receiving surfaces; • control of the phase (arrays of matrices of different laser, possibly used in order to form virtual, large apertures). • Selection of components, techniques and design rules compliant with space standards (ECSS) The activities related to this PhD scholarship will be carried out at the Physics Dept. of Politecnico di Milano and at the main Thales Alenia Space Italia site in Turin and an international research center.
<p>Educational objectives</p>	<p>The main educational objectives are: 1) consolidate background on laser physics and photonics;</p>



	2) develop experimental know-how on photonics devices and optics; 3) achieve multidisciplinary skills for space applications; 4) achieve soft skills particularly related to technology transfer and entrepreneurship.
Job opportunities	Job opportunities in: 1) established companies in the fields of photonics and aerospace 2) space agencies (national and international, public and private); 3) startups in the field of photonics and laser physics; 4) research institutes in Italy or abroad;
Composition of the research group	4 Full Professors 5 Associated Professors 5 Assistant Professors 10 PhD Students
Name of the research directors	Nicola Coluccelli

Contacts	
nicola.coluccelli@polimi.it, 0223996183	

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)	Thales Alenia Space
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	to be defined
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information



Educational activities:

Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): financial aid per PhD student per 3 years: max **5.707,13** euros per student.

Teaching assistantship:

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.

Computer availability: individual use

Desk availability: shared use

Other Information about Industrial Partner

Drawing on over 40 years of experience and a unique combination of skills, expertise and cultures, Thales Alenia Space delivers cost-effective solutions for telecommunications, navigation, Earth observation, environmental management, exploration, science and orbital infrastructures. Governments and private industry alike count on Thales Alenia Space to design satellite-based systems that provide anytime, anywhere connections and positioning, monitor our planet, enhance management of its resources, and explore our Solar System and beyond. Thales Alenia Space sees space as a new horizon, helping to build a better, more sustainable life on Earth. A joint venture between Thales (67%) and Leonardo (33%), Thales Alenia Space also teams up with Telespazio to form the parent companies, Space Alliance, which offers a complete range of services. Thales Alenia Space posted consolidated revenues of approximately 1.850 billion euros in 2020 and has around 7,700 employees in ten countries.