15 Early-Stage Researcher (ESR) 3-year PhD positions

GREAT - “Grating Reflectors Enabled laser Applications and Training”

ORGANISATION/COMPANY:	Institutions across Europe in the GREAT ITN network
RESEARCH FIELD:	Physics > Optics > Laser applications, Optical engineering, Metrology and measurement
RESEARCHER PROFILE:	First Stage Researcher (R1)
APPLICATION DEADLINE:	**01/03/2019 00:00 - CEST**
LOCATION:	Germany › Stuttgart
TYPE OF CONTRACT:	Temporary
JOB STATUS:	Full-time
HOURS PER WEEK:	35-40
OFFER STARTING DATE:	01/09/2019
EU RESEARCH FRAMEWORK PROGRAMME:	H2020 / Marie Skłodowska-Curie Actions MARIE CURIE (MSCA-ITN-ETN)
GRANT AGREEMENT NUMBER:	813159

We are pleased to advertise 15 Early-Stage Researcher (PhD) positions to begin in 2019, as part of the Innovative Training Network of the European Commission GREAT “Grating Reflectors Enabled laser Applications and Training". The positions will all last three years, and will allow all students to participate in an exciting programme comprising international schools, workshops, and secondments at academic as well as industrial partners (see the overview of the project below).

IMPORTANT: Please check out the webpages of the individual vacancies (via the IFSW website: http://www.ifsw.uni-stuttgart.de/) for details.

Overview of the project and of the training offered to all Early Stage Researchers of GREAT

The overall aim of the GREAT (Grating Reflectors Enabled laser Applications and Training) project is to train a cohort of 15 ESRs through the completion of interconnected individual projects which will deliver innovative approaches for development and use of Grating Waveguide Structures (GWS), from design to implementation in several laser systems. GWS results from the combination of sub-wavelength gratings and planar waveguides. This combination results, by means of an appropriate design of the overall GWS resonances, which are more efficient than current grating-only devices, unique optical components that are enabling for a range of applications. The GREAT projects encompass Photonics, Micro-Nano technologies, Advanced Materials as well as Nanotechnologies, which are among the Key Technologies defined within the H2020 framework, underpinning the competitiveness and renewal of European manufacturing. Moreover, Lasers, is identified as an important industrial sector, where the European Community is a key player, who aims to keep its competitive position (http://www.strategies-u.com/lasers-photonics.html).
The ESRs will be embedded within leading international institutions and trained to work collaboratively to deliver ground-breaking research solutions and novel systems, whilst responding to real-world problems. This is a crucial skill, particularly since there is an overall lack of qualified specialized personnel in this field, with a growing number of active companies worldwide. Critically, this lack of skilled workforce has been identified by the ETP Photonics21 (Photonics21 (2013), “Towards 2020 – Photonics driving economic growth in Europe-Multiannual Strategic Roadmap 2014 – 2020”), as a major challenge for the photonics community, but also highlighting a rich landscape for career progression.

Therefore, the GREAT network will provide each ESR with key learning opportunities along with project specific exposure to important modelling methods, world-leading fabrication tools, or systems development. These will be paramount for the realization of optics based upon GWS, leading to the consolidation and expansion of their use in several advanced application-themes in the field of Laser, such as pulse compression, spectral stabilization and wavelength multiplexing, as well as polarization shaping (generation of beams with radial and azimuthal polarization).
ESR positions will be hosted at the following institutions, with the project descriptions given under the associated ESR number:

- UNIVERSITAET STUTTGART (USTUTT): 4 PhD positions, ESR 1, 8, 12, 13
- UNIVERSITE JEAN MONNET SAINT-ETIENNE (LabHC): 1 PhD position, ESR 2
- ECOLE CENTRALE DE MARSEILLE (IF): 2 PhD positions, ESR 6 and ESR 10
- UNIVERSITY OF SOUTHAMPTON (ORC): 2 PhD positions, ESR 7 and ESR 9
- UNIVERSTIY OF EASTERN FINLAND (UEF): 2 PhD positions, ESR 4 and ESR 5
- GESELLSCHAFT FUR ANGEWANDTE MIKRO UND OPTOELEKTRONIK MIT BESCHRANKTER HAFTUNG AMO GMBH (AMO): 1 PhD position, ESR 3
- Dilas Diodenlaser GmbH (DILAS): 1 PhD position, ESR 15
- CENTRE TECHNOLOGIQUE ALPHANOV (ALPHA): 1 PhD position, ESR 11
- UNIVERSITE DE BORDEAUX (UBx): 1 PhD position, ESR 14

The GREAT consortium also includes academic partner organizations:

- RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN

plus private sector partners:

- FIBERCRYST SAS
- TRUMPF LASER GMBH
- MODUS RESEARCH AND INNOVATION LIMITED
- Novae
- AMPLITUDE SYSTEMES SA

Interested applicants are strongly encouraged to contact the scientists in charge of the projects as soon as possible.

Available projects:

Details of each project can be found below or via the IFSW website: http://www.ifsw.uni-stuttgart.de/.

Here we summarize the titles and host institutions for the 15 ESR positions:

ESR 1 (USTUTT, IFSW, Stuttgart):	Design and optical characterization of grating waveguide structures GWS.
ESR 2 (LabHC, Lyon):	Fabrication of GWS for spectral (and linear polarization) stabilization and wavelength multiplexing for 9xx nm, 1030 nm and 2000 nm wavelength range.
ESR 3 (AMO, Aachen):	Development and optimization of a Nanoimprint Lithography process for the fabrication of highly efficient GWS.
ESR 4 (UEF, Joensuu, Finland):	Fabrication and characterization grating waveguide structures for spectral shaping (stabilization and pulse compression) and wavelength multiplexing of high-power laser systems GWS.

ESR 5 (UEF, Joensuu, Finland):	Fabrication of GWS for radial and azimuthal polarization shaping in high-power lasers
ESR 6 (IF, Marseille):	Optical coatings for grating-waveguide structures.
ESR 7 (ORC, Southampton):	Crystalline Grating Waveguide Mirrors.
ESR 8 (USTUTT, ITO, Stuttgart):	Interference lithography (SBIL resp. SMILE) for the fabrication of circular and segmented GWS for the generation of beams with radial and azimuthal polarization.
ESR 9 (ORC, Southampton):	Developing processes for sub-wavelength structuring of crystals.
ESR 10 (IF, Marseille):	Laser damage resistance of materials and structures for grating-waveguide.
ESR 11 (ALPHA, Talence):	Highly efficient compressor for high average power and high-energy mid-IR femtosecond lasers.
ESR 12 (USTUTT, IFSW, Stuttgart):	Spectral stabilization, pulse compression and Wavelength multiplexing of high-power solid-state lasers emitting at 1030nm and 2000 nm.
ESR 13 (USTUTT, IFSW, Stuttgart):	Efficient intra-cavity and extra-cavity generation of beams radial and azimuthal polarization in high-power thin-disk lasers
ESR 14 (UBx, Bordeaux):	Picosecond and femtosecond high power Ytterbium fiber laser designed for optical parametric devices pumping.
ESR 15 (DILAS, Mainz):	Investigation of the fundamentals of both wavelength stabilization and dense wavelength multiplexing concepts for diode laser bars using GWS.

Additional information

The successful candidates will receive a 36 month, full-time employment contract as per Marie Skłodowska-Curie Actions (MSCA) regulations for early stage researchers. The monthly salary will be confirmed upon offer, paid in the currency of the host country, and with a correction factor applied to the host country. The approximate monthly salary before employer and statutory deductions is €3,783 (France); €3,172 (Germany); €3,950 (Finland); and €4,571 (UK) plus an additional mobility allowance of €600/month. Researchers may also qualify for a family allowance of €500/month depending on family situation at the time of recruitment. Please visit the EU MSCA website for further information.

The ESRs will be enrolled in an exciting PhD programme of leading academic and industrial researchers. In addition to their individual scientific projects, all ESRs will benefit from a dedicated training program comprising an integrated curriculum of local and intensive network courses, schools, workshops and engagement with cutting-edge research.

Eligibility criteria

There are strict eligibility requirements within Marie Skłodowska-Curie Innovative Training Networks. At the time of appointment, applicants must not have resided or carried out their main activity (work, studies) in the country for more than 12 months in the 3 years immediately before their appointment; AND shall also be in the first four years of their research careers at the time of appointment and have not been awarded a doctoral degree.

Offer Requirements, Skills and Qualifications

- Must have Master (or equivalent) degree in Mechanical Engineering, Mathematics, Physics or Photonics with solid knowledge of optics and its applications.
- Must be in the first 4 years of his/her career, measured from the date of graduation (MSc degree or equivalent).
- Should not hold a PhD degree.
- Should not have resided or carried out their main activity (work, studies) in the country of their appointment for more than 12 months in the 3 years immediately before their appointment. For refugees under the Geneva Convention, the refugee procedure (i.e. before refugee status is conferred) will not be counted as 'period of residence/activity in the country of the beneficiary'.
- Must be able to communicate fluently in English, in oral and written form.

IMPORTANT: Please check out the pages of the individual vacancies for specific details. These are accessible from the IFSW website: http://www.ifsw.uni-stuttgart.de/

Selection process

Applicants will need to submit, for each application:

- Brief description of why the applicant wishes to become a PhD student within GREAT (Letter of motivation).
- Copy of transcripts and of their degree, and a copy of master's thesis and any other publications (if available).
- Curriculum vitae of three pages maximum.
- Two written recommendation letters (e.g. one by the former Master thesis supervisor and their referees contact details).

PLEASE SEND YOUR FULL APPLICATIONS TO THE FOLLOWING E-MAIL ADRESS: great@ifsw.uni-stuttgart.de

Job descriptions

ESR 1 (USTUTT, IFSW, Stuttgart):

Design and optical characterization of grating waveguide structures GWS.

Development of design tools for precise modelling of important parameters of the GWS for the different applications (pulse compression, spectral stabilization and wavelength multiplexing, radial/azimuthal polarization shaping). Accomplishment of precise measurement of the refractive indices of coated dielectric layers using grating-based M-lines spectroscopy. Results shall be used in design routine to align simulations and experiments. Accomplishment of precise characterization results for the measurement of the polarization and wavelength dependent reflectivity, diffraction efficiencies, absorption and scattering losses of the different GWS developed in the project. Accomplishment of LIDT measurement in CW operation and @ 1030 nm.

Specific requirements: Basic knowledge in programming or simulation tools (e.g. MATLAB, python or C), basic experiences in handling of optics, fundamentals in laser physics.

ESR 2 (LabHC, Lyon):

Fabrication of GWS for spectral (and linear polarization) stabilization and wavelength multiplexing for 9xx nm, 1030 nm and 2000 nm wavelength range.

Implementation of existing modelling codes and participation in the development of new methods for the analysis, design and optimization of GWS. Ellipsometry measurements for the characterization of thin-film layers. Use of laser interference lithography (LIL) and etching processes (Ta_2O_5, HfO_2, SiO_2) for the fabrication of GWS for spectral and linear polarization stabilization of high-power lasers at 1030 nm and 2000 nm, as well as GWS for wavelength multiplexing of high-power lasers diodes (9xx nm), Yb:YAG thin disk lasers (1030 nm) and Tm-fiber lasers (2000 nm). Topological characterization (AFM, SEM) of the GWS as well as optical characterization (spectrally and angularly resolved reflection and transmission measurements, diffraction efficiencies).

Specific requirements: Basic knowledge in programming (e.g. MATLAB, python or C++) required. Experience in optical simulation tools (wave-optical methods RCWA, FDTD, etc.) is a plus. Basic skills in handling of table top optical experiments (lasers, lenses, basic optical components, etc.) and basic knowledge of fabrication processes of optical components (lithography, dry etching processes, etc.) required, clean-room experience is a plus.

ESR 3 (AMO, Aachen):

Development and optimization of a Nanoimprint Lithography process for the fabrication of highly efficient GWS.

Accomplishment of development and optimization of master/mold fabrication processes using LIL and reactive ion etching for cost-efficient fabrication of high quality GWS structures. Accomplishment of development and optimization of suitable NIL processes for pattern transfer onto the target substrates. Accomplishment of development and optimization of processes for pattern transfer into the target substrate by means of reactive ion etching. Accomplishment of development of suitable metrology techniques for both efficient process optimization and quality control for fabricated devices. Generation of detailed understanding of fabrication limits and establishment of a low cost fabrication technology for GWS structures.

Specific requirements: Basic experiences in semiconductor technology fabrication processes (lithography, etching process), basic knowledge of the application of those processes for optical component fabrication, basic experiences in handling of optics.

ESR 4 (UEF, Joensuu, Finland):

Fabrication and characterization grating waveguide structures for spectral shaping (stabilization and pulse compression) and wavelength multiplexing of high-power laser systems GWS.

Accomplishment of finding of suitable materials for GWS structures, development of fabrication processes with EBL and NIL, fabrication and characterization of designed GWS. Accomplishment of fabrication of master templates, which will be used in NIL process for spectral stabilization, pulse compression and wavelength multiplexing. Accomplishment of testing structures for pulse compression (at 1030 nm, 1070 nm and 2000 nm) and for spectral stabilization and wavelength multiplexing at 9xx nm, 1030 nm and 2000 nm. Master templates for all targeted GWS to be delivered to partners for NIL process.

Specific requirements: Basic experiences in production processes of optical components (lithography, etching process), basic experiences in handling of optics.

ESR 5 (UEF, Joensuu, Finland):

Fabrication of GWS for radial and azimuthal polarization shaping in high-power lasers.

Accomplishment of fabrication of circular and segmented GWS using electron beam lithography for intra-cavity generation and extra-cavity conversion of beams with radial and azimuthal polarization, reactive ion etching and nanoimprint lithography. Accomplishment of fabrication of polarizing GWS for intra-cavity generation of beams with radial and/or azimuthal polarization, extra-cavity conversion of beams from linear to radial or azimuthal polarization for $\lambda \sim 1$ µm wavelength. Accomplishment of

fabrication of master templates for radial/azimuthal polarizing GWS produced and delivered to partners for NIL process evaluation. Accomplishment of NIL process tested in house.

Specific requirements: Basic experiences in production processes of optical components (lithography, etching process).

ESR 6 (IF, Marseille):

Optical coatings for grating-waveguide structures.

Accomplishment of designing, manufacturing and characterization of coatings that will be the basis for the fabrication of the GWS for high power laser applications. This work includes the material selection, stack design, deposition strategy and process choices, in close collaboration with partners for design and end-users. Accomplishment of manufacturing of low-loss, low defect densities coatings with state-of-the-art deposition techniques and precise control of the manufacturing process. Accomplishment of characterization of optical properties of the coatings and the GWS.

Specific requirements: Experience and/or knowledge in optics, vacuum technology, optical coatings and laser.

ESR 7 (ORC, Southampton):

Crystalline Grating Waveguide Mirrors.

Development of crystalline mirrors and crystalline waveguide mirrors fabricated via Pulsed Laser Deposition (PLD). Achieved through enhanced functionality obtained by refining the PLD process and multilayer structures with nm-scale precision. Working in collaboration with ESR 9 and other network partners, to create Crystalline Grating Waveguide Structures (CGWS) and Crystalline Mirrors (CM). Performance evaluation, and refinement of PLD films and nano-structures, for CM and CGWS components; characterization of intra-cavity CM and CWGS in high-power diode- and Thin-Disk Laser (TDL); determination of CM/CGWS Laser Induced Damage Threshold LIDT. Key outcomes will include first utilization of CM in TDL; demonstrating the first CGWS; and demonstration of the first polarization selective CGWS.

Specific requirements: Basic experience in production processes of deposition; basic experience in handling of optics and laser-matter-interaction, fundamentals in laser physics.

ESR 8 (USTUTT, ITO, Stuttgart):

Interference lithography (SBIL resp. SMILE) for the fabrication of circular and segmented GWS for the generation of beams with radial and azimuthal polarization.

Support in design of GWS. Accomplishment of development of cost efficient, flexible and high-quality fabrication processes of intra-cavity and extra-cavity polarization shaping GWS. Accomplishment of fabrication and characterization (AFM, SEM) of large areas (> 15 mm in diameter) GWS as cavity end-mirrors and output coupler for 1030 nm wavelength. Accomplishment of fabrication and characterization (AFM, SEM) of large area (> 20 mm in diameter) GWS as extra-cavity polarization converters for 1030 nm wavelength. More specific:

- Development of dedicated Interference lithography setups including its automation.
- Development of process parameters for high quality elements.
- Development of circular GWS with diameter > 15 mm produced and made available for partners for evaluation in high-power laser cavities (CW, ps and fs).
- Development of segmented GWS as polarization converter produced for partners for evaluation in high-power laser systems (CW, ps, fs).
- Development of large area (> 20 mm in diameter) GWS as extra-cavity polarization converters for 1030 nm wavelength.

Specific requirements: Basic knowledge in programming (e.g. MATLAB, python or C++) required. Basic experiences in production processes of optical components (lithography, etching process), basic experiences in handling of optics.

ESR 9 (ORC, Southampton):

Developing processes for sub-wavelength structuring of crystals.

Tasked with creating sub-wavelength structures in crystalline materials, and in particular crystalline films fabricated by Pulsed Laser Deposition (PLD). This project aims to enhance functionality of GWS, through sub-wavelength modification of critical layers in collaboration with ESR 7 and other network partners working on nano-structuring techniques. Development of designs and etching recipes for crystalline grating structures and CGWS; evaluation of sub-wavelength structuring of substrate and laser deposited crystals for the development amorphous dielectric GWS on patterned crystalline substrates; determination of power handling capabilities and LIDT of GWS. Key outcomes will include first realization of grating structures in PLD films; first demonstration of GWS on structured crystal substrates; and first realization of polarization selective GWS in crystals.

Specific requirements: Basic experience in production processes of optical components (lithography, etching process), basic experiences in handling of optics and laser-matter-interaction, fundamentals in laser physics.

ESR 10 (IF, Marseille):

Laser damage resistance of materials and structures for grating-waveguide.

Definition of relevant methodologies and development of testing systems for evaluation of the laser damage resistance of optical components. Development and assessment of non-destructive methods to evaluate absorption and defects that can be the cause of reduced laser damage resistance and implementation of robust laser damage metrology based on raster scanning methods. Accomplishment of measurement of the laser damage resistance of components manufactured by partners in GREAT and development of understanding the physical and technological limitations for improving the laser-induced damage threshold. Experimental system and methods for evaluation of laser damage resistance shall be used as a support for the GREAT partners. Investigation of technological and physical limitations of the power handling capabilities of GWS.

Specific requirements: Basic experiences in handling of optics and lasers, fundamentals in laser-matter-interaction.

ESR 11 (ALPHA, Talence):

Highly efficient compressor for high average power and high-energy mid-IR femtosecond lasers.

Accomplishment of demonstration of low-energy, low power mid-IR compression with overall compression efficiency (4-passes) exceeding 95%. Accomplishment of CPA amplification in the mid-IR using fiber amplifiers with compressed output > 20 µJ, > 30 W of average power and pulse duration below 300 fs. Accomplishment of demonstration of CPA fiber laser compression with ultrashort 2 µm pulses, i.e. with compressed output > 40 µJ, > 100 W of average power and pulse duration below 150 fs. Accomplishment of scaling of CPA 2 µm fiber amplifier to state of the art high energy, high average power, ultrashort pulse compression. Demonstration of pulse compression to > 1 mJ, sub-ps regime using a regenerative amplifier.

Specific requirements: Basic experiences in handling of fiber optics, laser alignment, and fundamentals of laser physics. Knowledge of ultrafast optics phenomena (femtosecond) would be ideal

ESR 12 (USTUTT, IFSW, Stuttgart):

Spectral stabilization, pulse compression and wavelength multiplexing of high-power solid-state lasers emitting at 1030 nm and 2000 nm.

Accomplishment of development of spectrally stabilized high-power thin-disk laser emitting at around 1030 nm in CW operation emitting more than 1kW output power at a narrow spectral bandwidth (< 0.2 nm). Demonstration of high spectral and polarization selectivity in a high-power thin-disk laser. Intra-cavity second harmonic generation in a continuous wave thin-disk laser with a green to pump

power efficiency > 40 %. Demonstration of high conversion efficiency at high average power. Spectral shaping and wavelength multiplexing of high-power Tm-doped fiber lasers. Accomplishment of integration and qualification of GWS fs pulse compressor in high-power lasers systems emitting at around 1030 nm with overall compression efficiency (4-passes) > 95 %.

Specific requirements: Basic experiences in handling of optics, fundamentals in laser physics.

ESR 13 (USTUTT, IFSW, Stuttgart):

Efficient intra-cavity and extra-cavity generation of beams radial and azimuthal polarization in high-power thin-disk lasers

Accomplishment of implementation and qualification of highly efficient grating waveguide structures developed within GREAT for the generation of CW beams with radial and azimuthal polarization in high-power thin-disk lasers at an average power higher than 1 kW with high optical efficiency (> 50 %). Implementation of GWS for the generation of beams with radial/azimuthal polarization in mode-locked thin-disk lasers (> 50 W). Accomplishment of demonstration of power capability of the developed GWS within the experimental investigations. Thermal analysis of the GWS at high-average power. Implementation of GWS as extra-cavity polarization converter in the beam path of CW, ps, and fs lasers.

Specific requirements: Basic experiences in handling of optics, fundamentals in laser physics.

ESR 14 (UBx, Bordeaux):

Picosecond and femtosecond high power Ytterbium fiber laser designed for optical parametric devices pumping.

Accomplishment of implementation of picosecond high power (> 50 W) rod-type Yb fiber laser for pumping of optical parametric oscillator. Comparison of working conditions compression between conventional and GWS filtering within the laser. Accomplishment of recompression of the pulses generated by the Yb fibre laser using GWS gratings and generation of high energy pulse at high repletion rate (~1 µJ, at 50 MHz) and pulse duration lower than 150 fs. Demonstration of pumping ability of an optical parametric oscillator and amplifier using the designed laser to generate tunable (1.3 - 4.5 µm) picoseconds and femtosecond pulses.

Specific requirements: Basic experiences in handling of optics, fundamentals in laser physics. Knowledge of ultrafast optics phenomena (femtosecond) and nonlinear optics would be ideal.

ESR 15 (DILAS, Mainz):

Investigation of the fundamentals of both wavelength stabilization and dense wavelength multiplexing concepts for diode laser bars using GWS.

Accomplishment of definition of specifications for grating structures needed for wavelength stabilization and multiplexing. Demonstration of wavelength stabilization and narrowing the spectral width of diode laser bars and investigation of power scaling laws and limitations for multi-kW high diode laser modules with high brightness. Accomplishment of performance comparison with commercially available Volume Bragg Gratings regarding efficiency, long-term stability, thermal drift and costs. Wavelength stabilization of diode bars (distance of separation: 2-3 nm). Accomplishment of efficient wavelength coupling of diode modules with separated wavelengths into a single beam.

Specific requirements: Basic experiences in handling of optics, fundamentals in laser physics.