

The Delft Center for Systems and Control of the Delft University of Technology, The Netherlands, announces

2 Ph.D. positions on

*Metrology and Control for adaptive optics in lithography systems*

### [Mechanical, Maritime and Materials Engineering](#)

The 3ME Faculty trains committed engineering students and PhD candidates in groundbreaking scientific research in the fields of mechanical, maritime and materials engineering. 3ME is the epitome of a dynamic, innovative faculty, with a European scope that contributes demonstrable economic and social benefits.

### [Precision and Microsystems Engineering](#)

The Precision and Microsystems Engineering (PME) department plays a key role in the faculty of 3mE. We supply research and education in the field of “the small world”. Our pride lies with mechanical engineering at the microscale (both the study of the micro-devices themselves, as well as the study of the tools required to create them). Within our four research groups we cover mechanical engineering disciplines such as statics, dynamics, basic manufacturing and design techniques, but also advanced numerical analysis methods, material characterization and system (mechatronic) design. Each of the research groups focuses on different aspect of the precision and microsystem world. The four groups are Fundamentals of MicroSystems (FMS), Engineering Dynamics (ED), Mechatronic System Design (MSD) and Precision Manufacturing & Assembly (PMA). As a department, we educate in a joint effort on the Bachelor, Master and PhD level.

### [Delft Centre for Systems and Control](#)

The Delft Centre for Systems and Control (DCSC) coordinates the education and research activities in systems and control at Delft University of Technology. The Centre’s research mission is to conduct fundamental research in systems dynamics and control, involving dynamic modelling, advanced control theory, optimization and signal analysis. The research is motivated by advanced technology development in mechatronics and microsystems, sustainable industrial processes, transportation and automotive systems, and physical imaging systems. The group actively participates in the Dutch Institute of Systems and Control (DISC).

### [Job description](#)

The semiconductor industry continuously strives to reduce feature size of Integrated Circuits (IC). Optical aberrations due to misalignment, vibrations, and heat generation, etc., limit the accuracy in photolithography. A specific key enabling technology to improve the accuracy in photolithography is Adaptive Optics. This project specifically focuses on the development of adaptive optics for image-to-wafer plane conformity in optical lithography systems, and is part of the [Smart Optics Systems](#) (SOS) programme sponsored by the Dutch National Science Foundation STW. The PhD students, one located at PME and one at DCSC, will work together at the university and the industrial contributor ASML.

### **Position 1: PhD student on *metrology for adaptive optics* (at PME)**

This activity involves research and development of a metrology system architecture for Adaptive Optics. Specifically, you will look into real time measurement techniques to identify and characterize the shape of the optical element in relation to the wavefront of the projected image.

The obtained information will serve as input for the AO control action. Due to the dynamic nature of the lithography process, you will need to tackle a number of challenges when developing the measurement technology. Examples of these challenges are the choice of metrology principle, speed of measurement, accuracy, resolution, alignment, development of electronics and data processing. In order to validate the developed methods and technologies, you will have the opportunity to develop demonstrator models. Furthermore, you will work closely with the other PhD's of the IMWACOL project, especially the PhD who is researching system identification and control technologies.

#### Requirements

We are looking for a candidate with a MSc degree in Mechatronic design, Control engineering, (Applied) Physics or equivalent with a strong interest in all aspects of metrology. The candidate is expected to work together in a project while being responsible for his/her own research track.

#### **Position 2: PhD student on *identification and control for adaptive optics* (at DCSC)**

This project concerns the development of efficient and fast real-time algorithms for (closed-loop) identification and control of adaptive optics systems for lithography. Specifically, you will be responsible for the development of a multivariable system identification method, such as a recursive Kalman filter or subspace identification method, that can diagnose automatically whether or not the data contains time-varying trends and/or non-linearities. The challenges that you will need to face are how to make these methods efficient, real-time and adaptive in the kHz frequency range so that they can be applied to industrial problems. Your second challenge will be to implement the developed real-time disturbance models into a predictive controller. Finally, you will tailor the real-time disturbance modeling insights and predictive controller methodology into a feasible real-time control architecture. In order to validate the developed techniques, you will be able to apply them an industrial benchmark. In addition, you will work closely with the metrology PhD and industry during the development of the identification and control methods.

#### Requirements

We are looking for a candidate with a MSc degree in Systems and Control engineering, Mechatronic design, (Applied) Physics or equivalent with a strong interest in algorithm development for system identification and control. The candidate is expected to work together in a project while being responsible for his/her own research track.

#### Conditions of employment

TU Delft offers an attractive benefits package, including a flexible work week, free high-speed Internet access from home, and the option of assembling a customized compensation and benefits package (the 'IKA'). Salary and benefits are in accordance with the Collective Labour Agreement for Dutch Universities.

#### Information and application

For more information about the PhD position on metrology, please contact prof. R. Munnig Schmidt, phone: +31 (0)15 2786663, e-mail: [r.h.munnigschmidt@tudelft.nl](mailto:r.h.munnigschmidt@tudelft.nl), for the PhD position on control, please contact dr. P.R. Fraanje, phone: +31 (0)15-2785189 or +31 (0)6 439 27 159, e-mail: [p.r.fraanje@tudelft.nl](mailto:p.r.fraanje@tudelft.nl)

To apply, please e-mail i) a detailed CV, ii) a letter of application, iii) your grades, iv) a summary of your MSc thesis and list of publications (if any), and v) the names and contact data of two professional reference persons, written in the English language and mentioning the vacancy number 3ME09.02 to: [Application-3mE@tudelft.nl](mailto:Application-3mE@tudelft.nl).

The position will remain open until filled. However, interviewing of candidates will start in early April 2009.