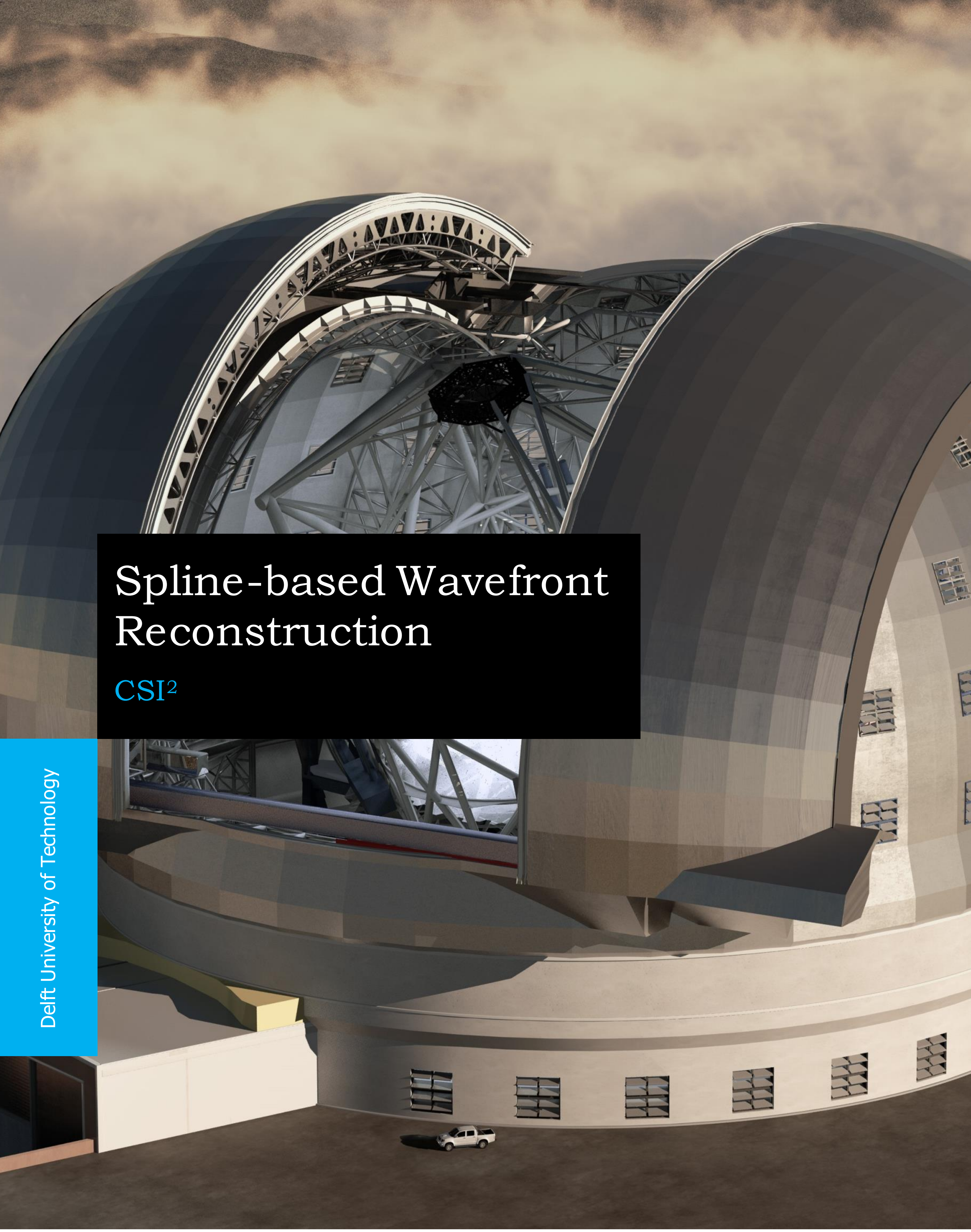
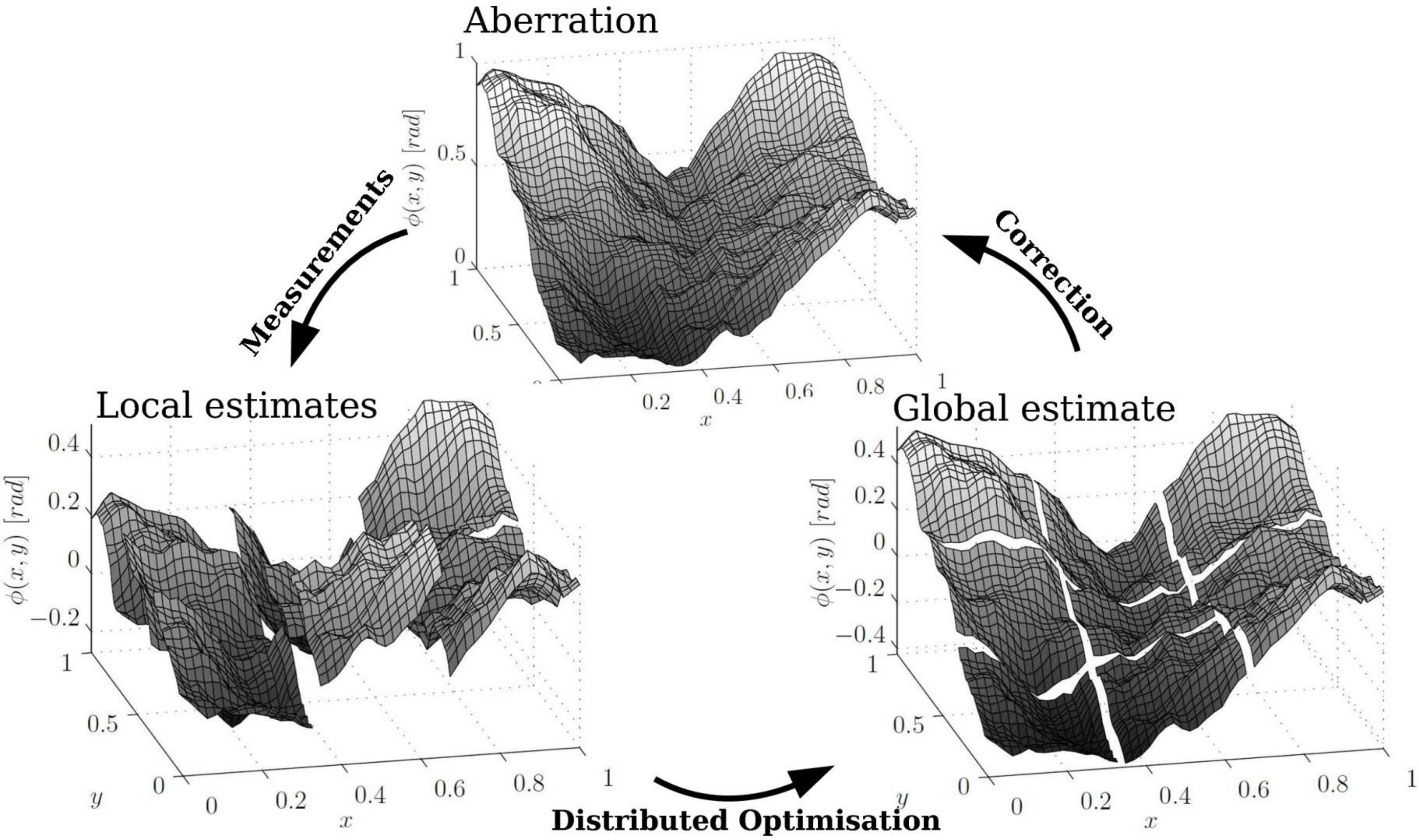


Spline-based Wavefront Reconstruction

CSI^2

Delft University of Technology



Implementation of a spline based wavefront reconstruction method for extremely large telescopes on graphic processing units

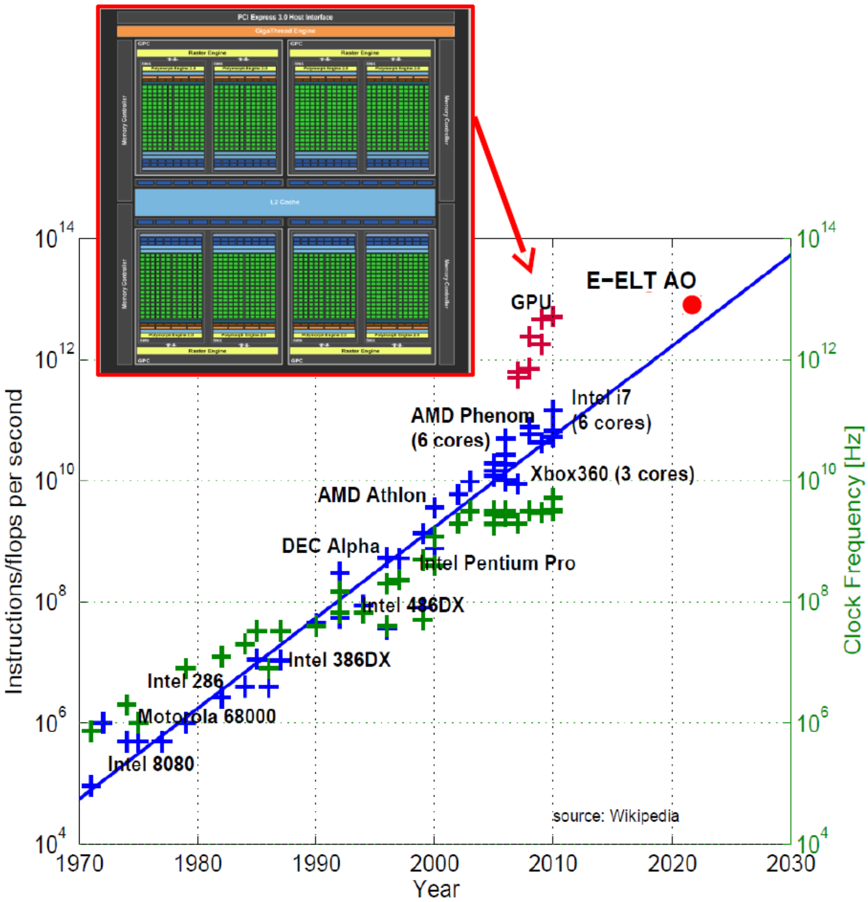
ir. Elisabeth Brunner & Prof. Michel Verhaegen

Room Number	34 C-1-270
Email	E.Brunner@tudelft.nl
Project Term	2014-15
Keywords	Adaptive Optics, Astronomy, Imaging
Level	Master's

Introduction

A new generation of extremely large-scale telescopes (ELTs) is under construction to advance major science goals in astronomy which require large collecting areas, as detection of earth-like exo-planets or the study of high-redshift galaxies. The optical resolution of ground-based telescopes is limited by perturbations introduced by the Earth's atmosphere. Adaptive optics (AO) is a technology that was developed to overcome these limitations [1] which become staggering for the new systems with primary mirrors of up to 39m for the European Extremely Large Telescope (E-ELT, Figure1).

The increasing dimensions of Adaptive optics (AO) systems raise new challenges as the development of fast high-performance algorithms for AO reconstruction of the atmospheric perturbation and its correction using deformable mirrors [1,2]. The AO systems have to cope with a huge number of degrees of freedom such that the computational complexity of the controller prohibits an (unstructured) centralized implementation. The disadvantage of classical wavefront reconstruction methods is that they are essentially incompatible with parallel processing architectures.



Research Question

At the Delft Center for Systems and Control (DCSC) a new distributed wavefront reconstruction method for Shack-Hartmann gradient measurements based on multivariate simplex B-splines, the Distributed Spline Based Aberration Reconstruction [3] (D-SABRE) method has been developed. D-SABRE is proven to be infinitely scalable and designed for operation on massively parallel computing architectures. D-SABRE provides arbitrary partitioning of the area on which the perturbation has to be reconstructed as shown in Figure 2. The goal of this project is to implement and validate the method on multi-core off-the-shelf hardware. This includes a thorough analysis of the computational load performed per processor and of the necessary communication between the partitions. The method will be demonstrated on simulated E-ELT turbulence wavefronts and compared with standard wavefront reconstruction methods. We are looking for a student with a strong background in programming; skills in parallel computation and C-programming would be of great advantage. With an implementation of D-SABRE for a graphics processing unit (GPU) with the parallel computing platform NVIDIA CUDA the student would contribute a significant step towards on-site application of this innovative method.

Literature

[1] F. Roddier. Adaptive Optics in Astronomy. Cambridge University Press, Reading, MA, 1999.
[2] M. Verhaegen. Control for High resolution Imaging, TU Delft, 2013. (Course notes)
[3] C. C. de Visser, M. Verhaege. On Distributed Wavefront Reconstruction for Large Scale Adaptive Optics Systems, OSA, 2013. (in review)