Validation of the fine guidance system for the PLATO-Mission

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Abstract

abstract test

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Chapter 1

Introduction

The PLATO–Mission from the European Space Agency (ESA) is the successor of the Kepler and Corrol missons and aims to find more planets outside our solar system. Therefore the satellite will carry several cameras, which are pointed on as many stars as possible. Over a period of time, the luminosity of each star will be measured and saved. This data can be used to create light curves of single stars. Periodic peaks in those curves indicate that there are planets around the corrisponding stars. This is called the transit method and will be explained later in greater detail.
The success of the mission is highly dependant on a stable position of the satellite in space. Disturbances have to be countered with thrusters. For the exact control of those thrusters, a fine guidance system (FGS) is developed by the DLR Berlin. This is an optical system which will depend on the optical input of the onboard cameras of the satellite. It will ensure that the satellite will be in place over a long period of time with neglectable deviation.
It's not easy to test such applications, since it is not feasable to build and launch a prototype of the mission. On the other hand, it is of utmost importance to ensure before the start of the mission, that all systems and especially the fine guidance system work as they should. Therefore simulators are needed, which generate data approximated with all known sources of disturbance. For the FGS there are two simulators used at the time the parallel developed DLR simulator, tailored for this exact task and the more general and more independantly developed PLATOSim simulator by the the KU Leuven.
Goal of this report is the summary of all steps taken to test the fgs and make sure all requirements for the mission ahead are met. Within this document the planned methods for detecting exoplanets and the according hardware of the PLATO–Mission are described. Next, the effects and probable sources of disturbances, as well as their possible influence is discussed. The third chapter deals with the used simulators. Their architecture and their meth-

ods of tackling the problem are described. The fourth chapter is about the generation of output data using the simulators and their use for the fgs. Strengths and weaknesses are discussed. The last Chapter is a summary of the work done and a prospect on the future testing of the fine guidance system.

Chapter 2

The PLATO–Mission

In this chapter the specifications and requirements of the Plato–Mission in general and its fine guidance system in detail are presented.

2.1 Goals

PLATO pursues the objective of detecting and characterizing exoplanetary systems, including both the planets and their host srars, reaching down to small, terrestial planets in the habitable zone. Furthermore the host stars will be characterized via asteroseismic analysis, which will provide the masses, radii and ages of the host stars, from which the characteristics of hypothetical planets can be derived. Promising planetary systems will be the target of further analysis in later missions.

2.2 The payload

Here, the used hardware is described.

2.3 The means

Key to the detection of exoplanets with PLATO is the transit method, which is, up to now, the most succesfull way to detect planets in other solar systems. Approximately 80% of all known exoplanets were found with this method.

At the current state of the art, there is no way to watch a planet, which orbits a star thausends of lightyears away. To prove its existence, the corresponding star itself is watched over a long period of time and its luminosity is recorded. This data is captured in light curves. A reappearing dent in this light curve can indicate an object which orbits the star and periodically obstructs the line of sight of the telescope/camera. This is clarified in figure ... . To

exclude the possibility of a coincidence, this change in the luminosity of the star has to be detected three times with the same time interval. Other than proving the existence of an exoplanet, more information can be derived from the course of the light curve. It is possible to calculate for example the planets radius, its inclination and its distance to the star. Through spectral analysis, statements about the atmospheric composition, the temperature and the albedo of the planet can be made.
This indirect method is dependent on the planets orbit crossing the line between telescope and star. The chance of this happening is only around 1%. PLATO will counter this problem by watching thousands of stars at once over years. Statistically it will have discovered ... stars by the end of the mission.

It is an indirect technique, hence the planet is not watched directly, but the changing luminosity of its star.

2.4 The fine guidance System

The requirements for the fine guidance system are described here.

Chapter 3

Validation tools

Chapter 4

Summary

This is the summary of the work done to validate the FGS for PLATO.