The New Control System for WLRS and TIGO: Getting Started

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Abstract

It is in the nature of a control system for laser ranging applications to have a high level of complexity. A variety of hardware components have to be controlled and synchronised. Some of them have real-time requirements. To overcome the complexity and to keep the control system compatible to different laser ranging systems as well as future upgrades, a modular structure has been chosen. Therefore controllers for every hardware component and defined interfaces to the main ranging program are necessary. As the main ranging program has no strict real-time requirements it can be based on a high level graphical language specialised on data acquisition. The modules requiring real-time are programmed for the operating system RT-Linux. The new control system is operating at the WLRS since the 12th of October 2000.

Keywords: laser-ranging, real-time-control, data-acquisition

1. Introduction

As the old control system at the WLRS has a complex and parallel programed structure, the problem arose, that a substitution of the MRCS event timer is not possible, without changing the whole controlling software. How should a control system look like to keep the possibility for upgrading one component?

Actual even three control systems were required, because TIGO and MTLRS did not work well, too. How should a control system look like to fit in different laser ranging systems?

The answer is: It has to be constructed in separate and autonomous modules with defined interfaces to communicate with each other. So a substitution of a hardware component only results in changing one module.

2. Modular Structure of the New Control System

The aspect of time is the first to be thought of when breaking a complex structure into parts. The whole ranging problem can be divided in three different steps: the preparation of the measurement, the ranging process itself and the analysis of the observation. In figure 1 the modules are assigned to the different steps.

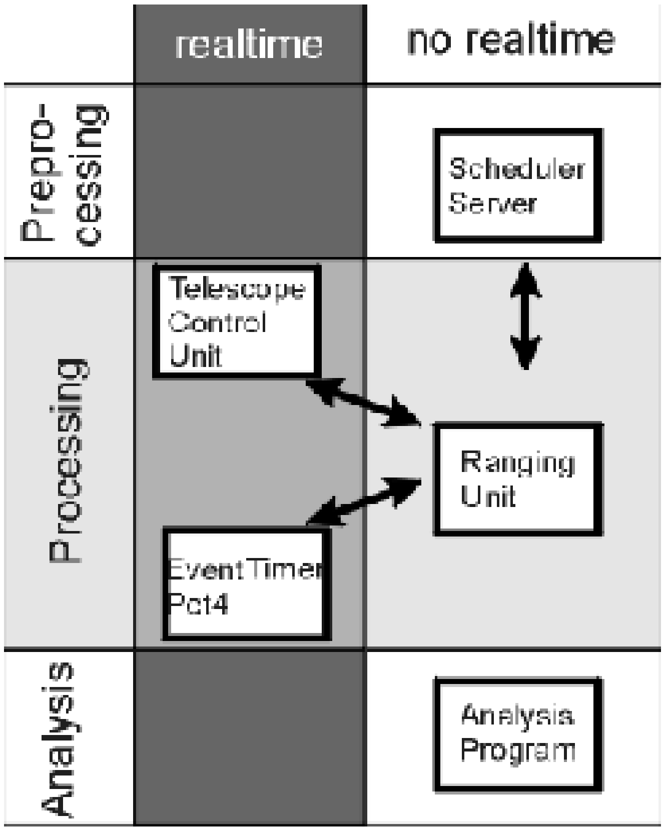

Figure 1: Modular structure of the new control system

Before any measurement can start the visibility of the satellites has to be calculated. That is done by the scheduler server, which puts an eight hours schedule at disposal or tells which satellites are above horizon at the moment.

In the processing step the modules of the hardware components needed for laser ranging are split from the main ranging unit: the telescope and the event timer. But another distinction is important, too: the requirement of real-time. Whereas driving the telescope, setting the range gate for the detectors and evaluating the event timer measurements need hard real-time conditions, switching the detectors and firing the laser are not time critical at all. This results in the fact that the PET4 not only has the job to realize the event timing but also has to set the range gates for the detectors. Everything that is not critical in time is done by the main ranging program.

The last step is the generation of normal points. As the analysis program gets an observation file which only contains returns from the satellite, no filtering of the data is necessary. The data only has to be corrected for the calibration (linear fit) and the meteorology.

An other new tool in the control system is the database. All information needed for the observations, e.g. interrange vectors of the satellites, and all ranging data are saved in a system of databases.

3. Realization of the Modules

This chapter introduces the individual modules. Their purpose and software realization will be explained and attention will be paid on the communication between the modules.

Telescope Control Unit (TCU). This module calculates the position of the satellites or stars (for the mount model) taking the meteorology and other corrections into account. It controls the pointing of the telescope according to the predictions. The interrange vectors needed for the calculation of the satellite position are taken from the database. This connection is via internet as well as the one to the ranging unit which informs the TCU about the satellite that should be tracked and all data which goes with it. The TCU is programed in the script language python based on C-libraries and is running on real-time-Linux.

Scheduler Server. An other python program running on Linux is the Scheduler Server. It has to manage the satellite passes and is the link between the ranging unit and the databases. The communication takes place via internet.

Ranging Program. The ranging program is split into two parts: the scheduler client and the tracking unit. The scheduler client has three independent loops. The first displays a list of satellites, which are above horizon at the moment. This list is updated every minute. The second loop waits until a double clicks on a satellite name was done by the observer and then starts the tracking unit. The third loop checks if satellites which are below horizon have been measured and makes the complete observation file in xml-format. The front penal of the scheduler client is shown in figure 2. The ranging unit is responsible for the firing of the laser, switching the detectors and rotating the mirror (transmit-receive-switch). The ranging unit is not only the interface to the observer but also is the center module communicating with the telescope control unit as well as with the PET4 and the radar. The seriell interface is used for the communication with the radar and PET4 and the internet to tell the telescope which satellite should be tracked. The front penal shown in figure 3 belongs to the ranging unit. The events registered by PET4 are not only displaid as ranging residuals but an automatic filtering of the satellite echo takes place and only these echos are saved in the observation file. As we make real time calibration they are although shown on the screen as an histogram. Every 2000th shot the histogram is fitted and only the results of the fit are saved in a file.

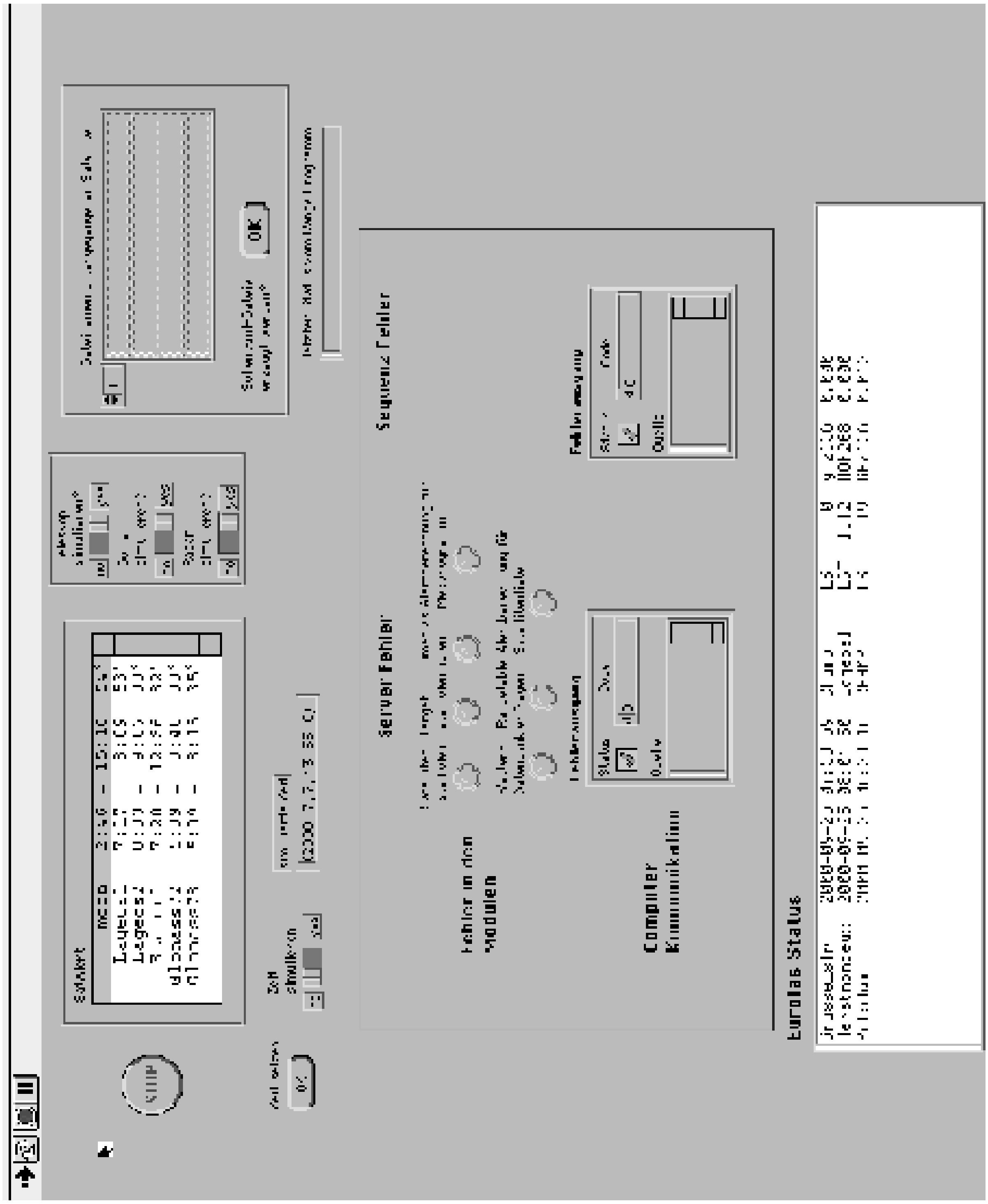

Figure2: Front penal of the scheduler server. The list of satellites above horizon is shown on the left side on top. The observer starts the tracking unit by a double click on the name of the satellite which should be tracked. The buttom on the right side on top starts the generation of the complete observation file in xml format of the sattelites which are below horizon and are listed above the button. A control field of possible errors is located in the middle and the EUROLAS exchange at the bottom.

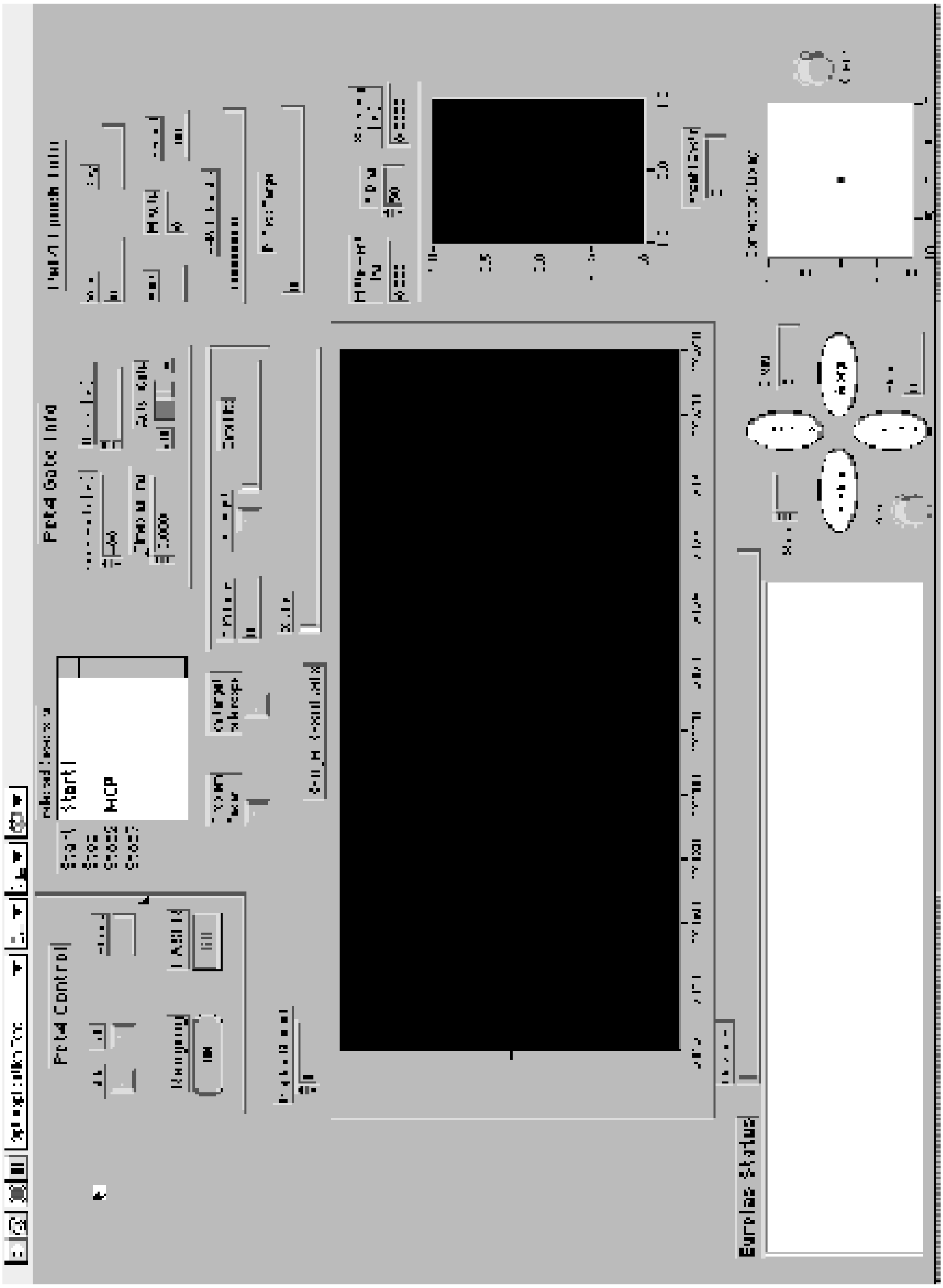

Figure3: Front penal of the ranging unit. In the upper part the adjustments of PET4 event timer are displaid. In the middle the ranging residuals and the real-time calibrations are shown. The Eurolas Status Report is on the bottom of the screen and on the right the offsets along and across the satellite pass can be entered.

PET4. As the new event timer was introduced before [1] only a short description will be given here. The PET4 consists of four Dassault-modules for the event timing, signal converters from NIM to ECL and the TTL range gate generator for activating the detectors. Via the seriell port the ranging unit can upload the range table of a satellite or can read out the FIFO of the event timer.

Analysis Program. The analysis program gets a file in xml format that is readable by an internet browser. The observation file contains all information needed for normal point generation. The analysis can be started from an internet browser which runs an cgi-bin script written in python and the results are plotted on the screen. The evolution in time of the calibration and the satellite echo with the achieved normal points are plotted. The pass is send to the analysis centers by pushing the appropriate button.

Databases. The information necessary for laser ranging is saved in a system of databases. This system consists of three parts: the database for the meteorology, one for the local survey and the slr database. They are written in SQL language with the program Postgres.

4. Conclusions

The new control system is working now since the 12th of October at the WLRS. First of all it could be recognized that the rms of the calibrations got smaller. For the avalanche photodiode it decreased from approximately 2.5 cm to 1.5 cm and for the MCP detector from about 1.5 cm to 1 cm. This is due to the better resolution of the PET4 in contrast to the old MRCS timer.

But the new event timer has not only a better resolution, but also a better stability. And that is the reason why the scatter of our range bias is better with the new control system. Figure 4 shows the range bias of the Lageos passes according to the Texas report of the WLRS with the old control system for September (a) and with the new one since the 13th of October (b) for comparison. The scatter in the range bias of Lageos has deceased from 6 cm or more to about 2 cm.

As a summarize it can be stressed out that the new control system at the WLRS is doing a good job and is ready to be taken over to the TIGO system.

References

[1] U.Schreiber, K.Haufe, and I.Procházka, „Concept of a pet4/labview- control system“ in *Proc. 11th Workshop on Laser Ranging* (W.Schlüter, U.Schreiber and R. Dassing, eds.), no 11 in Mitteilungen des Bundesamtes für Kartographie und Geodäsie, (Frankfurt am Main), pp 413-420, Verlag des Bundesamtes für Kartographie und Geodäsie, 1999.

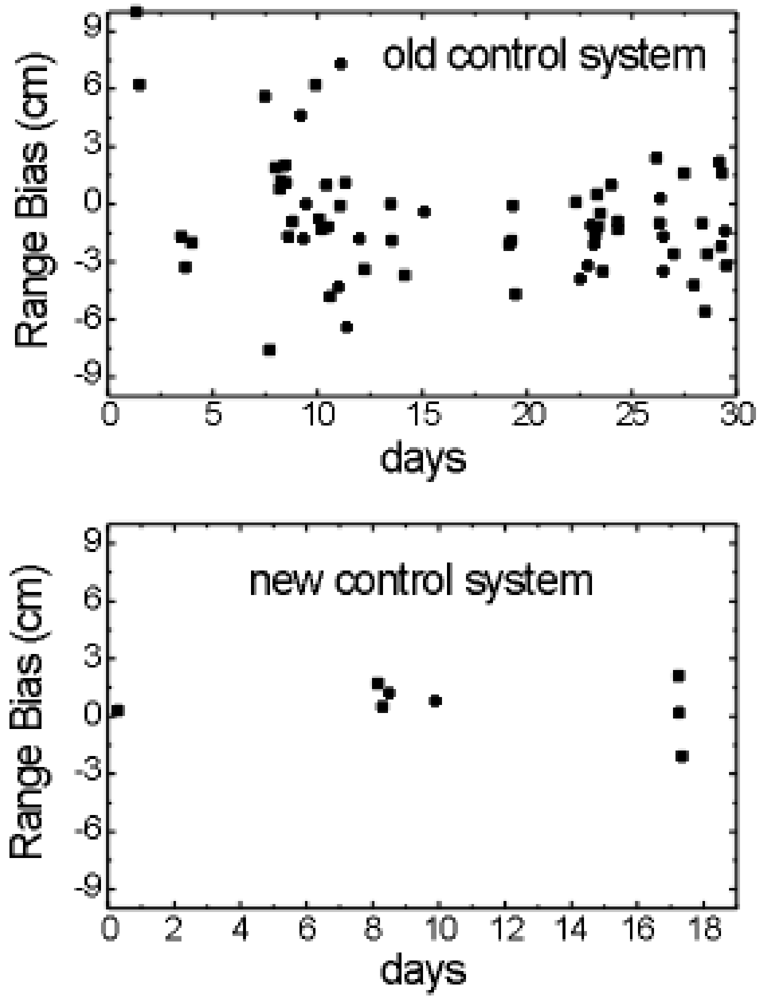

Figure4: For comparison the range bias of the Lageos passes according to the Texas report of the WLRS with the old control system for September (a) and with the new one since the 13th of October (b).