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SLR Station Potsdam Software Upgrade based on a Linux Real Time System

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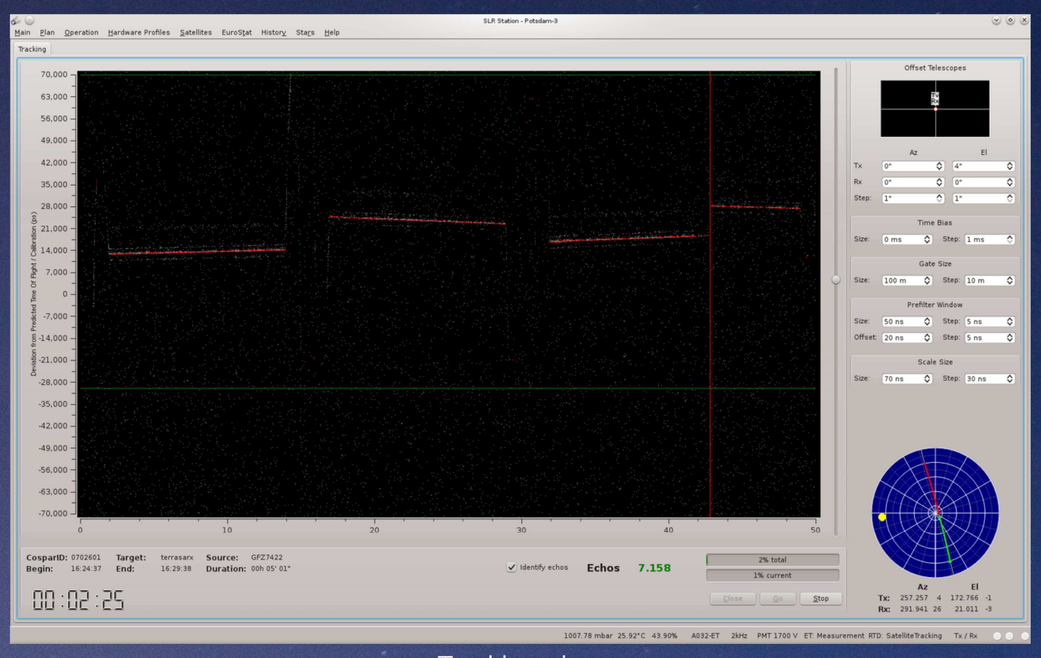
1. Initial Situation

Like in most of the older SLR stations there where a couple of computers and a various number of loosely coupled software components developed over decades. All software components where written in PowerBasic and the main control computer was still based on MS-DOS. This setup results in a number of limitations. To point out just a few:

- MS-DOS is no longer a maintained operating system and modern hardware is unsupported, therefore the control PC or components of this PC can't be easily replaced
- During the switch to a kHz system, the processing and visualisation of echos had to be outsourced to a second workstation running Windows & LabView
- PowerBasic is hardly known anymore, therefore it's nearly impossible to get support from in-house or external developers
- Also PowerBasic is a commercial product with uncertain future
- Many hardware and system specific parameters were hard-coded in the source code
- The workflow included a lot of manual steps, which made it hart to train new observer



Tracking view

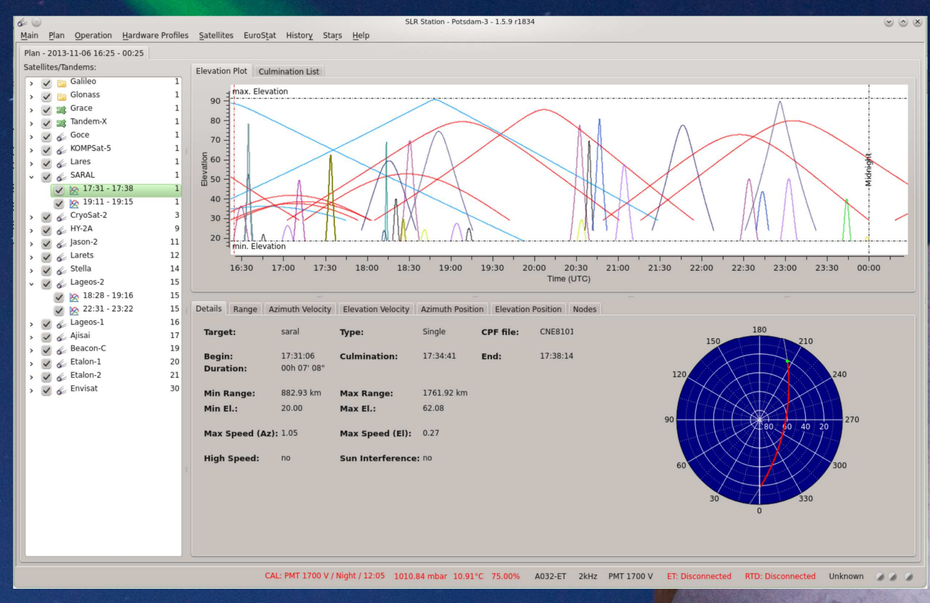
2. Requirements

To ensure the long-term maintainability and extensibility of the station GFZ contracted SpaceTech GmbH in 2011 for the redesign and implementation of a new SLR operation software. Some of the requirements which where found:

Hardware/Operating System:
- The old DOS based control PC must be replaced with modern hardware, preferable with "Commercial-Off-The-Shelf" hardware
- MS-DOS must be replaced with a modern Real Time operating system
- The operating system should not limit the hardware selection

Software Environment/Architecture:
- PowerBasic should be replaced with a widely supported programing language
- A version control system, build system and test environment is needed
- Presentation, application logic and hardware access should be separated
- Also components with weak and hard timing constraints should be separated
- It should be easy to replace or integrate new hardware components

Functionality:
- All system parameters should be changeable without modifying source code
- Support for all operation aspects like telescope initialisation, system calibration, satellite tracking, star tracking, ...
- Support for more than 2 kHz
- Support for different tracking setups (e.g. switching detector/laser profile)
- Clear and intuitional user interface



Planning view

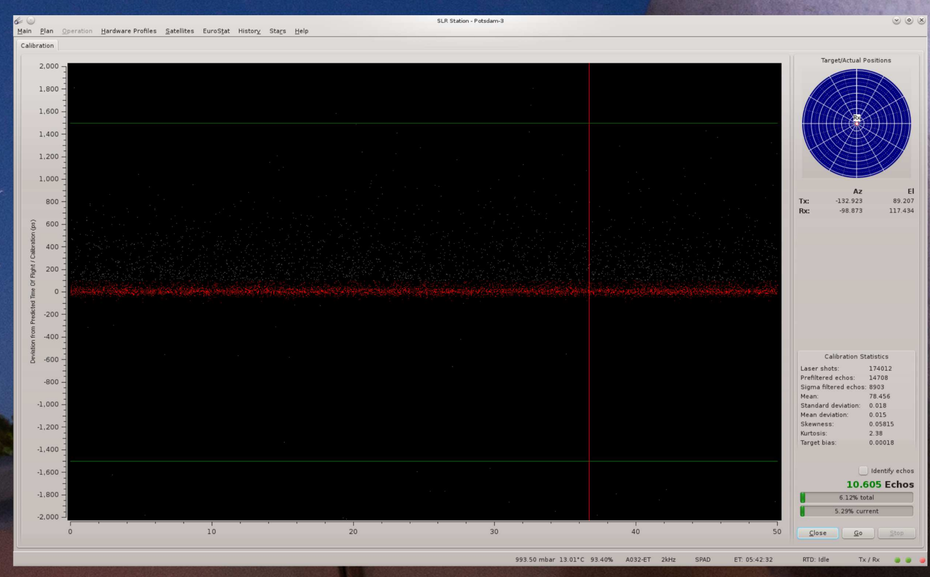
3. Realisation

Hardware/Operating System
- Dell Quad-core workstation
- 64 Bit Gentoo Linux with RT-Kernel (PREEMPT_RT Patch)

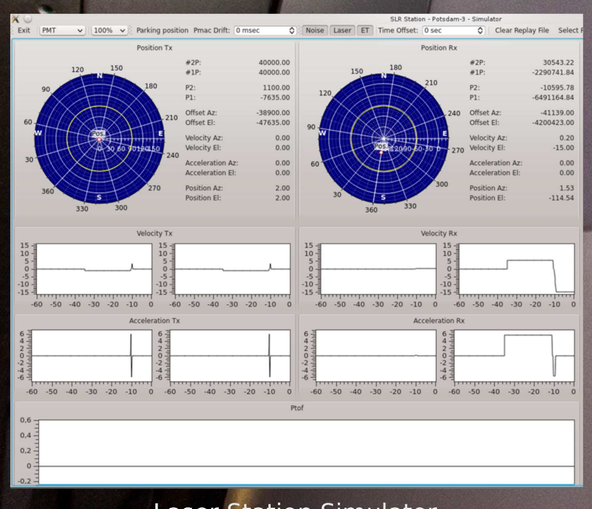
Software Environment
- Eclipse as IDE and GNU tools for C/C++
- Qt, Qwt and QwtPolar for visualization
- CMake as build system and SVN for version control
- GnuPlot and R for analyzing data

Simulator/Test Environment
- Qt program that can replace real hardware components
- Supports verification of SLR control software
- Simulates timing behavour of all hardware components
- Allows switching between different detectors and laser fire rate
- Simulation of noise, HW failures, time bias, etc.
- Supports recording and replay of satellite passes at any time

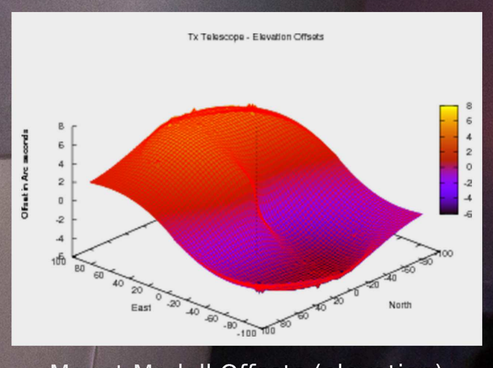
Architecture
- One common Qt based graphical user interface
- EventTimer Daemon for EventTimer read out, ported from Windows to Linux
- RealTime Daemon for controlling hardware
- Abstract device interfaces and hardware drivers



Calibration view



Laser Station Simulator



Mount Modell Offsets (elevation)

4. Results

The newly developed SLR control software is used at GFZ since September 2012. Only minor patches and extensions had to be included since.

- All software components are running again on a single workstation
- But if nessesary the GUI can run on a remote workstation

- Only open source software was used (LGPL, BSD), no additional license costs
- Linux Real Time kernel provides sufficient performance on standard workstation hardware

- New hardware components like a test C-SPAD could be integrated just by changing the configuration

- Observations are now more efficient; e.g. through easy to use GUI, integrated workflow and support of fast switching between different satellite passes
- Training of observers took only a few days

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