Development of a Full SLR Software Stack Based on Real Time Linux

and

a New Version of the Potsdam Range Gate

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19th International Workshop on
Laser Ranging

A Short History of SCOPE

- **SCOPE: SLR Control & Operation Software**

- In 2011 SpaceTech (STI) did a major redesign and re-implementation of operation software for SLR station in Potsdam/GFZ
  - Enhance performance & maintainability
  - Use of still existing expertise in upgrade process
  - State-of-the-art operating system with continuous long-term support
  - Efficiency improvement
- Since September 2012 system is in productive operation

→**Ensures operation for the next decades!**

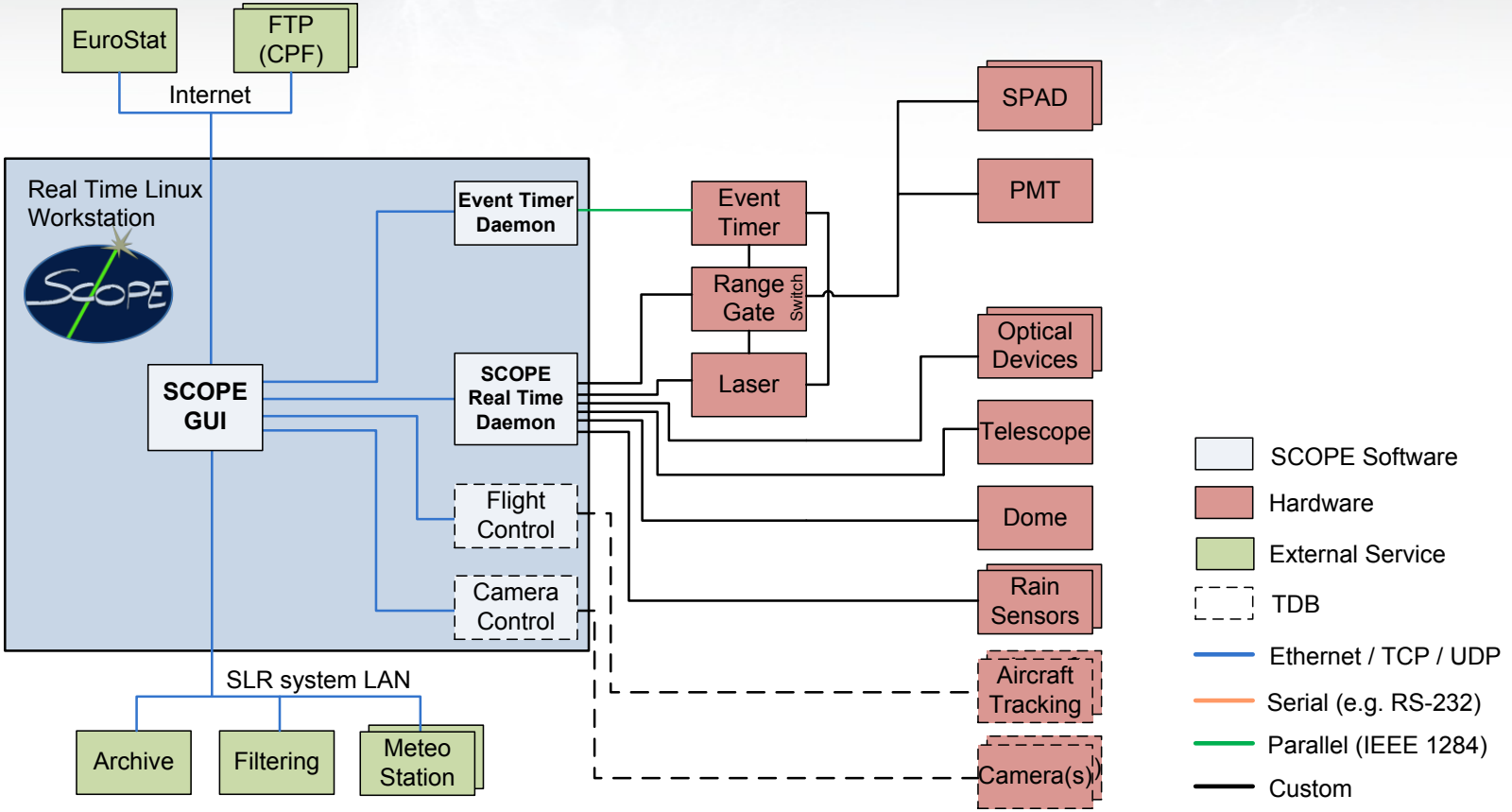
A Short History of SCOPE

- Following the successful upgrade approach at GFZ, STI was contracted by Finnish Geodetic Institute (FGI) for integration of its SLR software, Range Gate and operations support in 2014
- FGI currently builds a new kHz SLR system from scratch

→SpaceTech supports system design/engineering and provides experience about all details of SLR

SCOPE – SLR Control & Operation Software

- **Providing complete software stack for SLR operations**
  - SCOPE (GUI, Real Time & Event Timer Daemon)
  - SLR filter software
  - SLR station simulator



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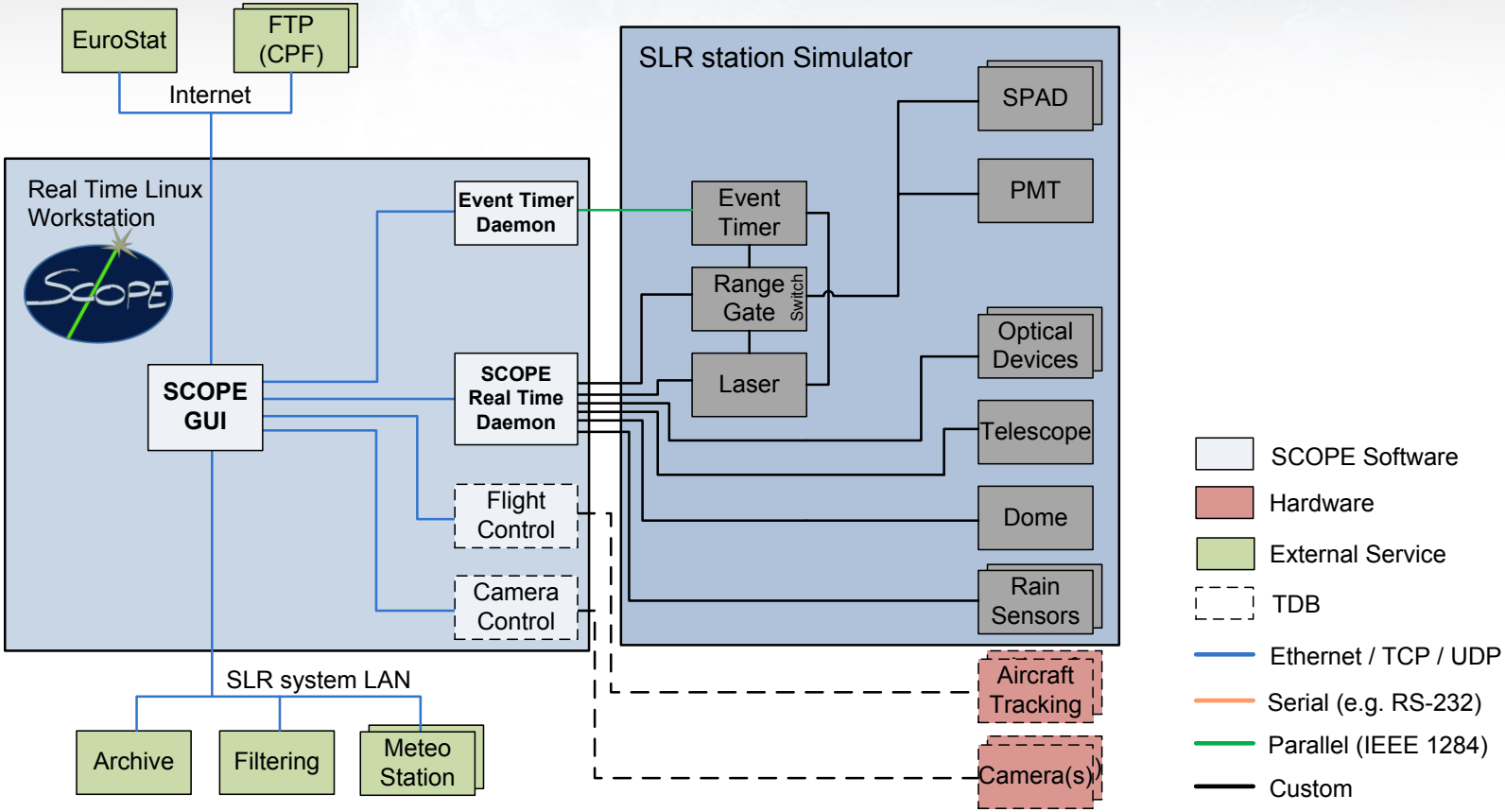


SCOPE Adaptation Approach for FGI

1. **Engineering activities of identifying and specifying necessary interface adaptations and software extensions**
2. **SLR station Simulator for system development & verification**

→Minimized risk of damaging hardware (e.g. allows damage “free” error injection)

→Validation of timing behavior and low level hardware access without available hardware

→Optimal tool to test special cases (over-mid-night and high-speed tracking, sun avoidance)

→Replay of observations for e.g. testing different algorithms & parameters (e.g. echo detection, automatic angle/time bias correction, etc.)

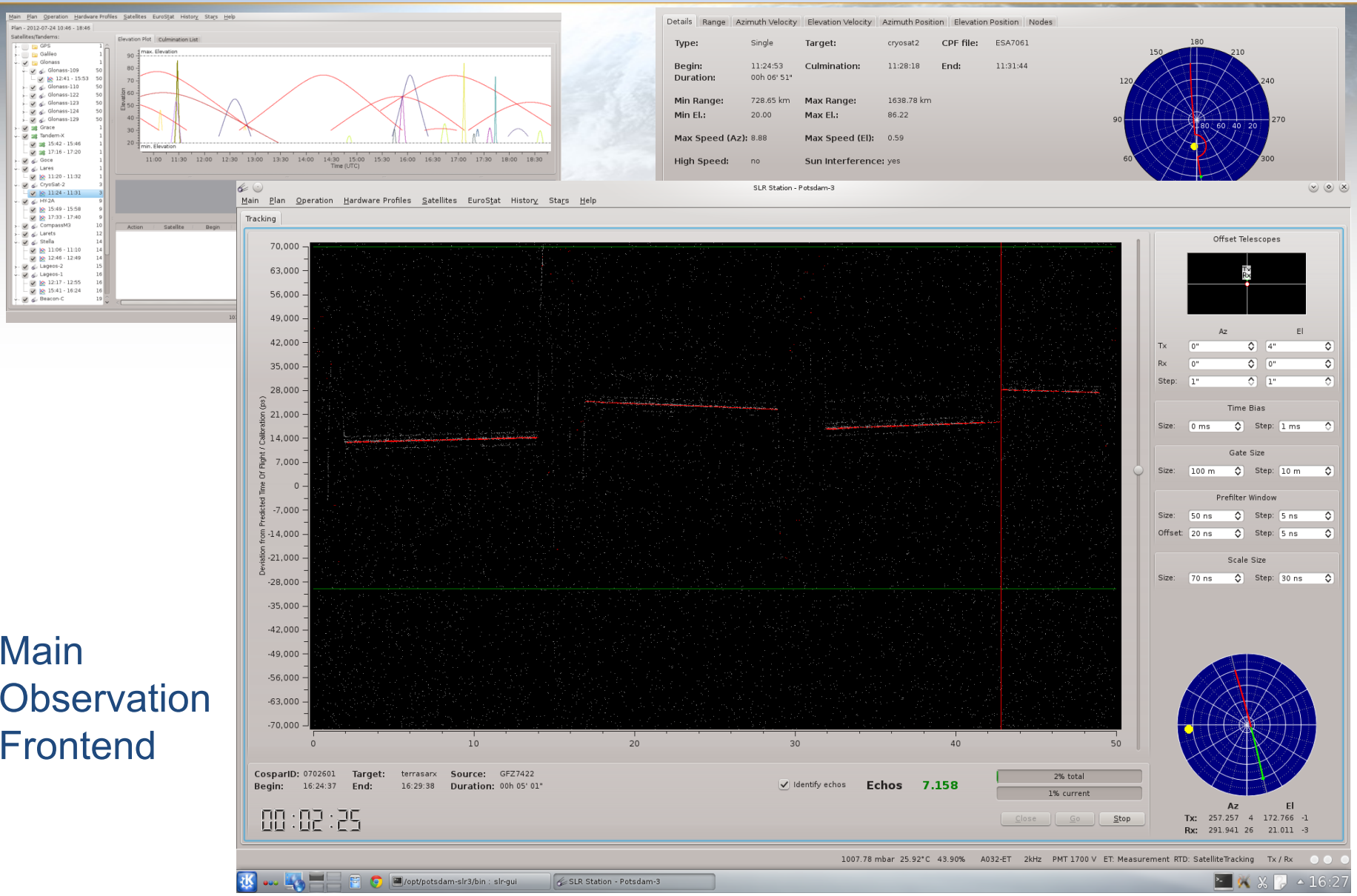
→Gradual exchange of simulated hardware modules by real hardware

SCOPE Adaptation Approach for FGI

- STI's system expertise for future commissioning of complete SLR system

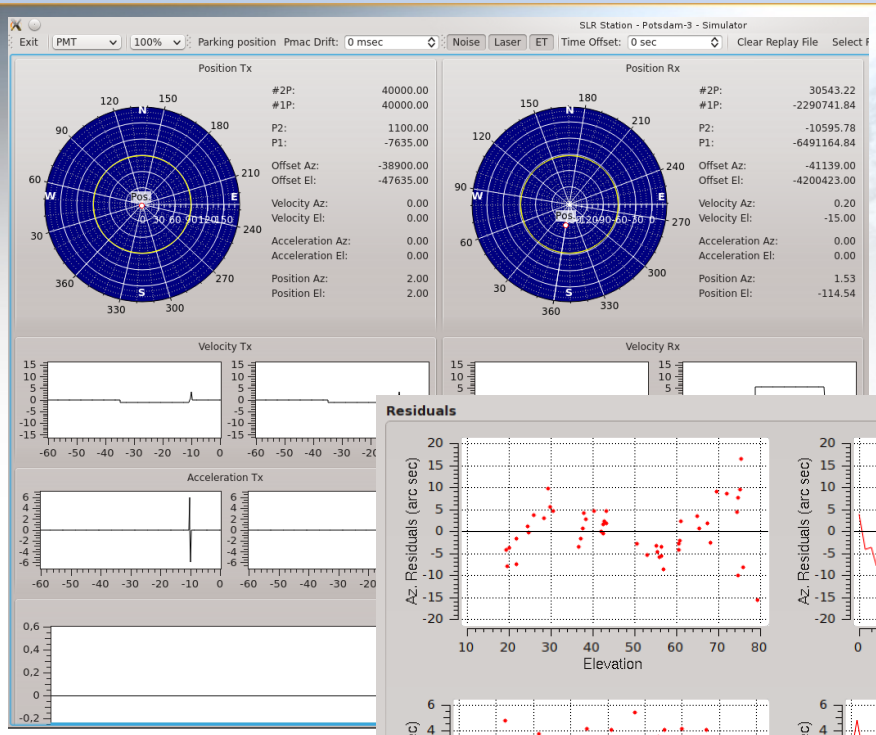
- **GFZ and FGI will share the same software code base**
  →Easier integration of new modules e.g. for space debris tracking!
  →Both SLR systems benefit from software updates and improvements
  →Easier exchange of operational knowledge, add-on software

Impressions – SCOPE screenshots

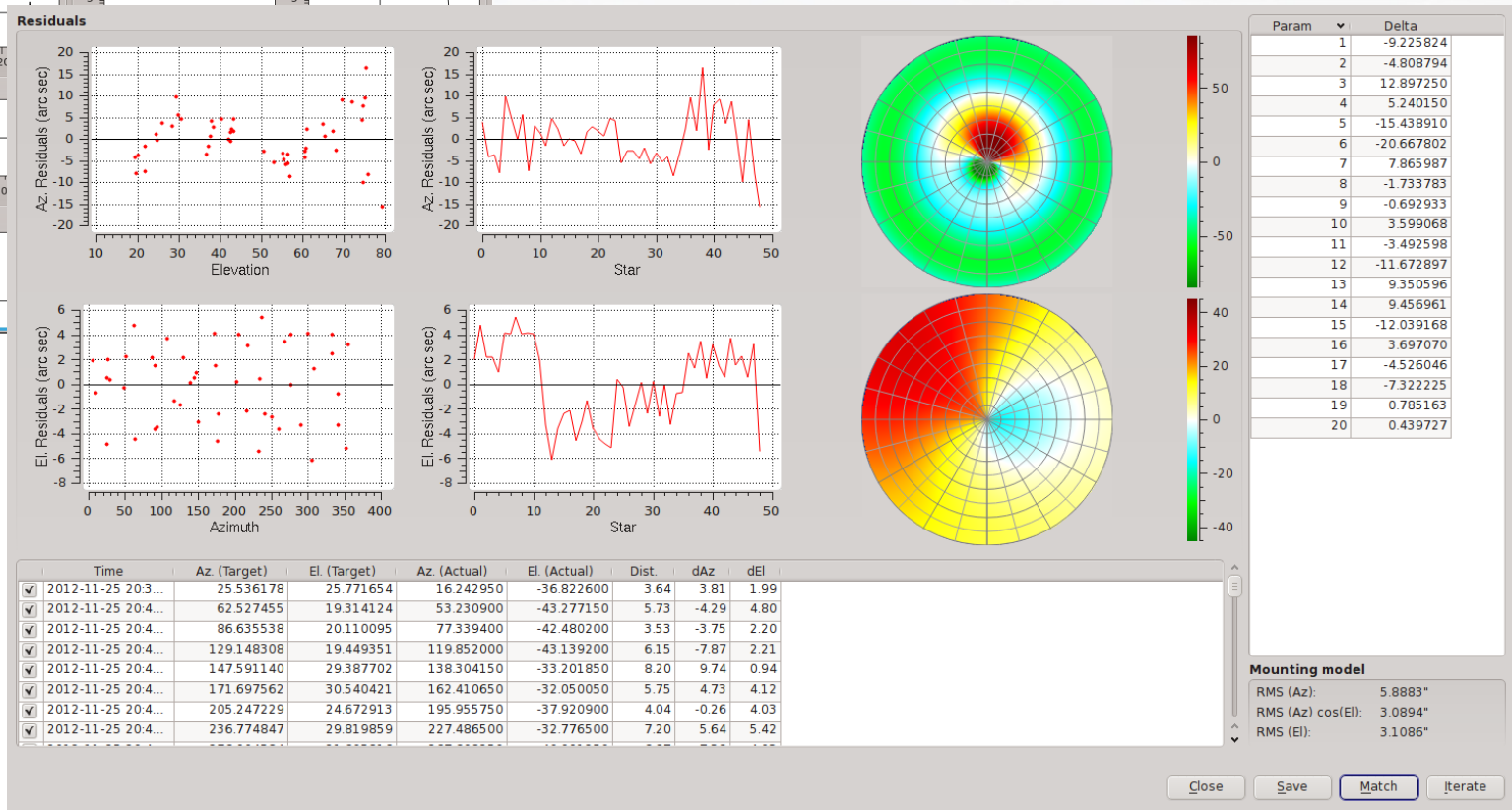


Main Observation Frontend

Impressions – SCOPE screenshots



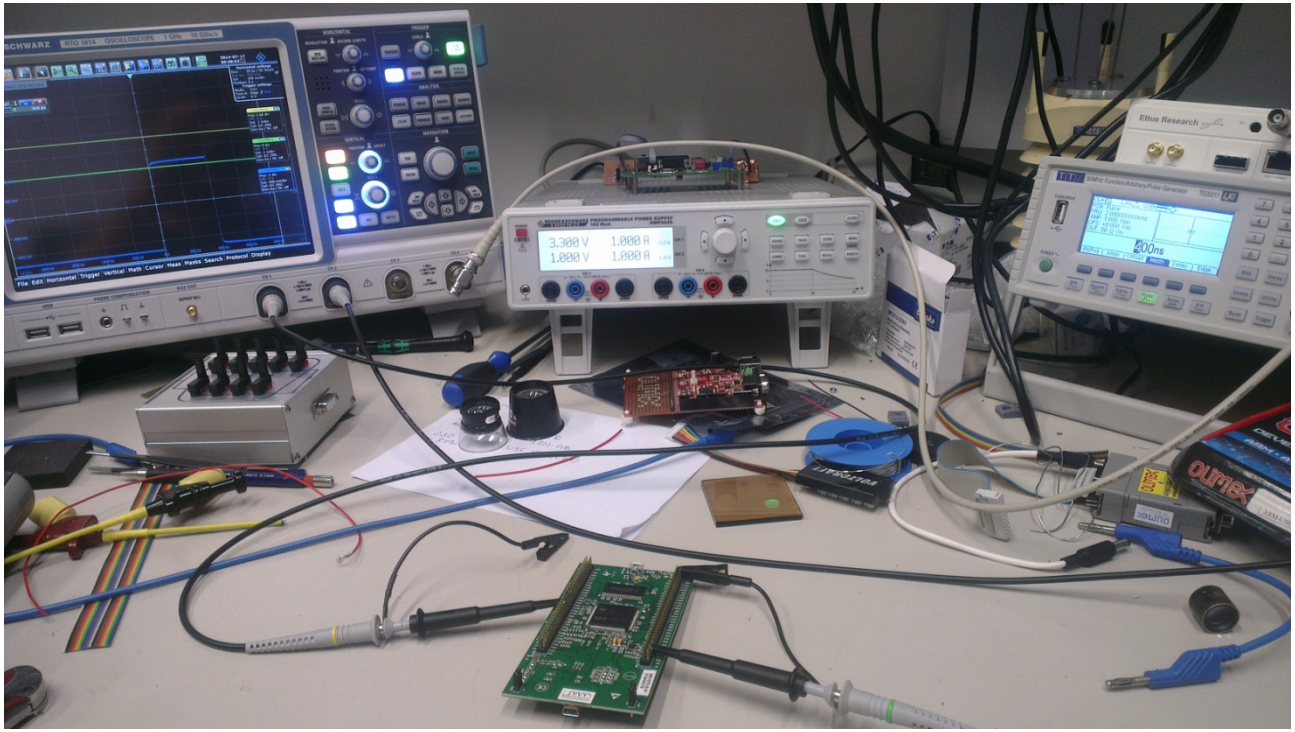
SLR station Simulator



Mount Model Calculations

Enhancements of SCOPE & new Range Gate

- Current enhancements for FGI/Metsähovi
  - Support for automatic dome control
  - Single telescope operation mode (two separate telescopes at GFZ)
  - New software interfaces and drivers for meteo, time synchronization / GPS receiver, filter/shutter, …
  - Improved range gate & newer event timer A033-ET from Riga

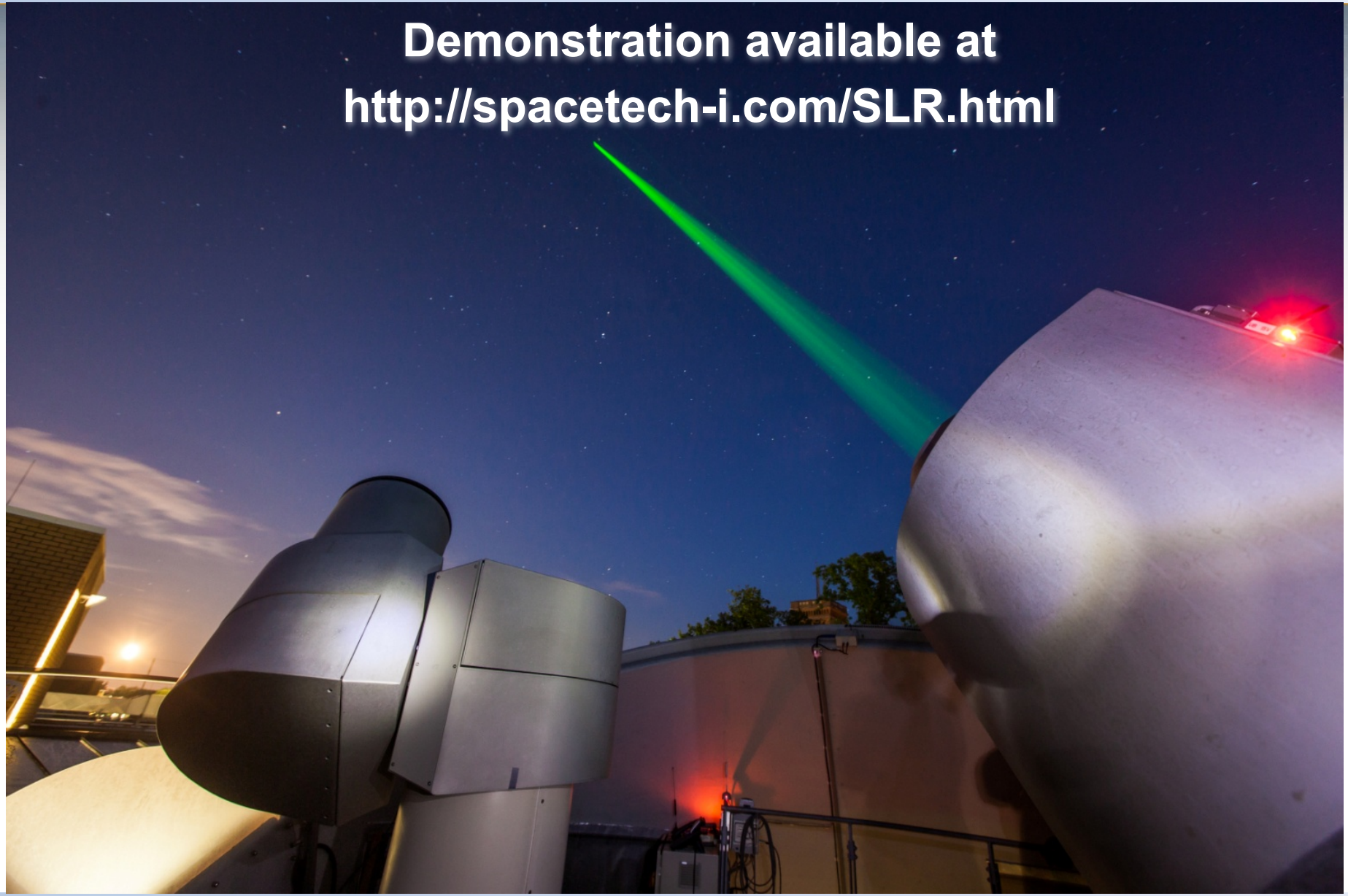


Range Gate Development based on ARM Cortex-M4

Enhancements of SCOPE

- Future goals and planned software upgrades
  - Space debris tracking as “joint tracking” together with other SLR stations
  - All-sky camera support for cloud monitoring
  - Automatic star observation for mount model generation (beta status)
  - Integration of automatic aircraft flight safety
  - **Full & semi-autonomous operation** of SLR system (track scheduling, tracking, advanced monitoring of status/environmental data, filtering, reporting, …)
  - Laser communication

SCOPE Demonstration Video



SCOPE – Features

- Support for ≥ 2KHz Laser firing frequency
- Consistent frontend for all tasks
  - System initialization, calibration procedure, all observation modes including sun avoidance, high-speed tracking, tandem, interleaving, re-attaching to running track, etc.)
  - Planning (preparation of prediction data)
  - Star observation for creating mounting models
- Interfaces to telescopes, event timer, range gate, optics control, meteo data, GPS time reference (synchronisation) by 1PPS signal , filter, shutter, post-processing of measurements, etc. (profiles for different configurations)
- Automatic retrieval of orbit predictions (CPFs)
- Time / elevation plot of satellite tracks for an arbitrary time frame including Keplerian elements calculation
- Configurable tracking profiles for single satellites and tandem satellites; simple switching between satellites
- Support for interleaving tracking (e.g. TanDEM-X & TerraSAR-X) and night-only tracking
- Automatic sun avoidance for telescope movement
- Automatic split of high speed tracks alt-azimuth telescopes

→ **This slide ends here, but the features list don't**