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Technical Laser Ranging Workshop Matera 2015

SP-DART

Single-Photon Detection, Alignment and Reference Tool

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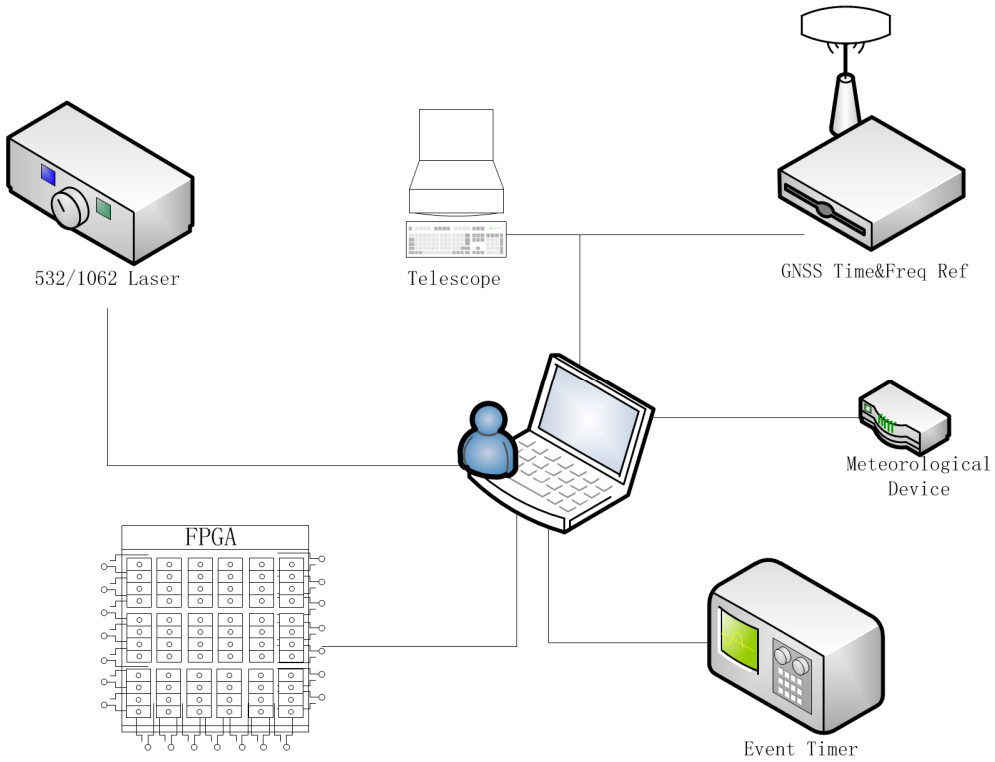
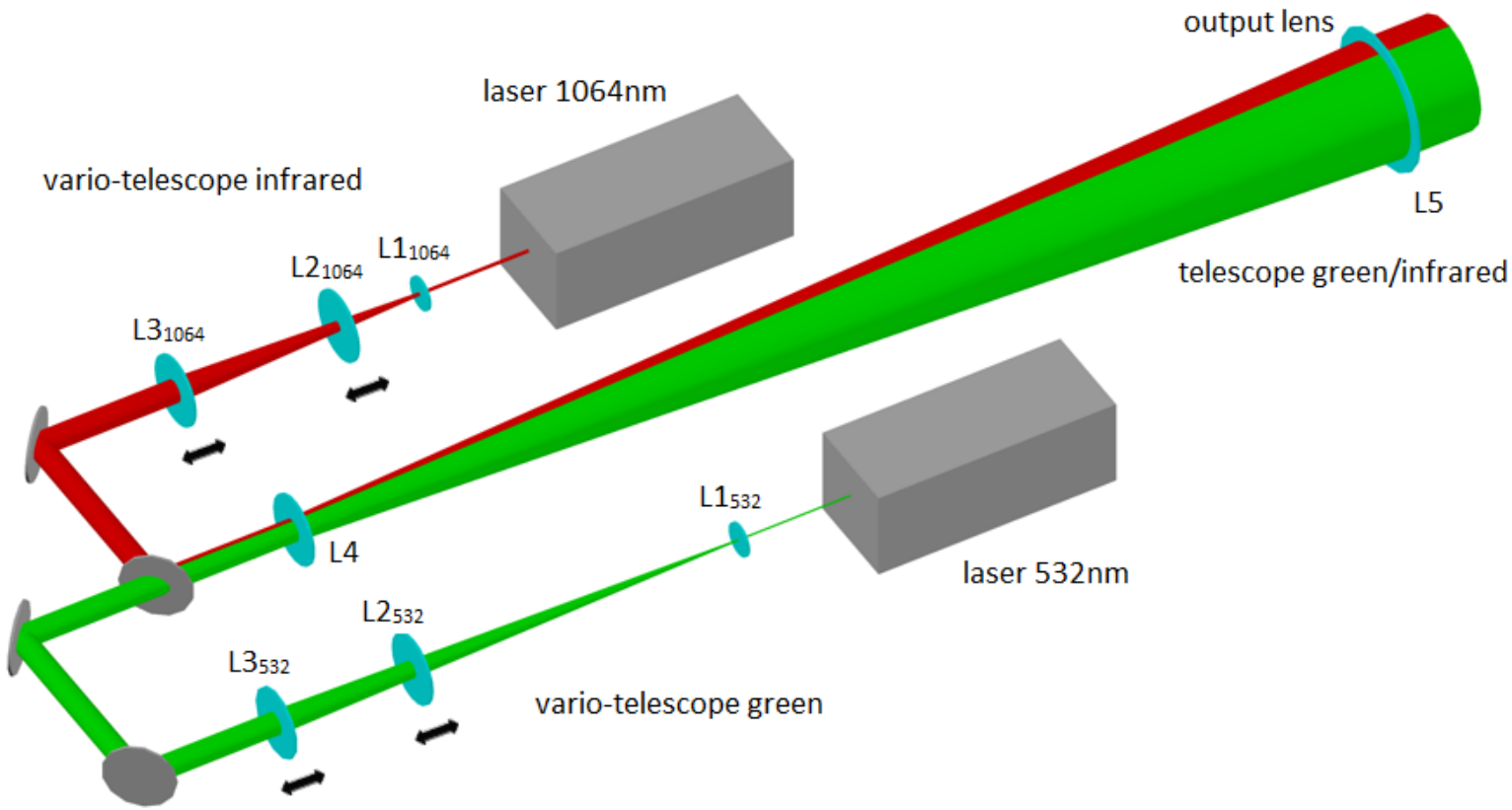
The basic configuration …



- SP-DART is a small SLR station, but without receive telescope: It uses a ***host*** mount/ telescope
- Low energy laser transmitters:
  - 532 nm / 2 kHz / 15 µJ / < 1 ns
  - 1064 nm / 2 kHz / 30 µJ / < 1 ns
- FGPA for Range Gate etc.
- Event Timer, GNSS Receiver, MET
- Laptop, Real-Time programs
- Uses a host mount/telescope …

The laser transmitter



Design Goal: Both beams at exit: 40 mm dia, minimum divergence (<25 µrad);

Both lasers operating parallel, no moving parts, pointing stability < 15 µrad

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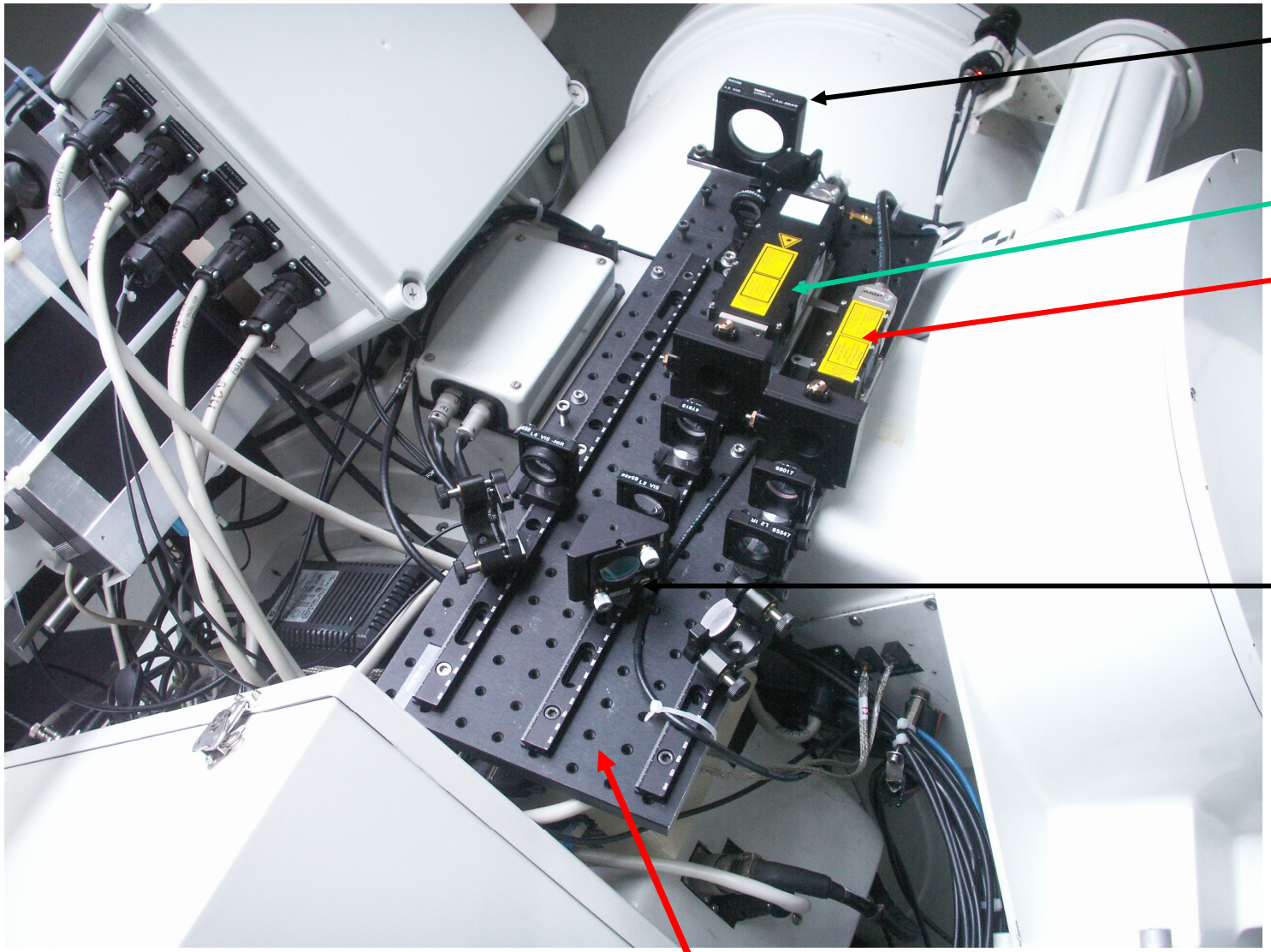
Laser bench, mounted on Graz telescope …



SP-DART in Graz: Tracking Galileo 101

HQ-Laser / 532 nm:

350 µJ / 2 kHz / 10 ps:

25° El: 0.6 % Ret Quote

65° El: 8.3 % Ret Quote

DART-Laser / 532 nm:

15 µJ / 2 kHz / < 1 ns

56° El: < 0.1 % Ret Quote

63° El: 1.1% Ret Quote

- With 15 µJ: Ranging to HEOs possible; needs Single-Photon Sensitivity of Receiver
- Return Quotes are varying due to weather conditions / elevation etc.
- With several passes: Reasonable statistics obtained

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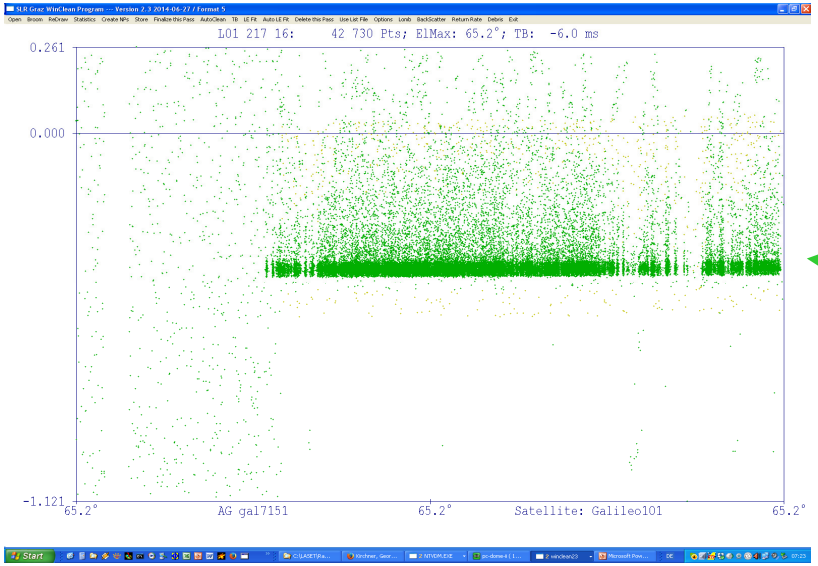
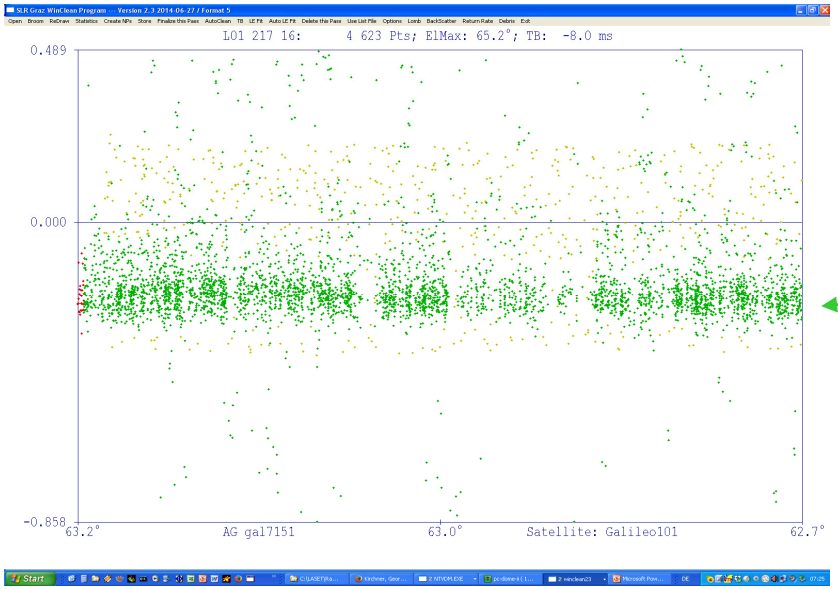
Details of tracking Galileo 101

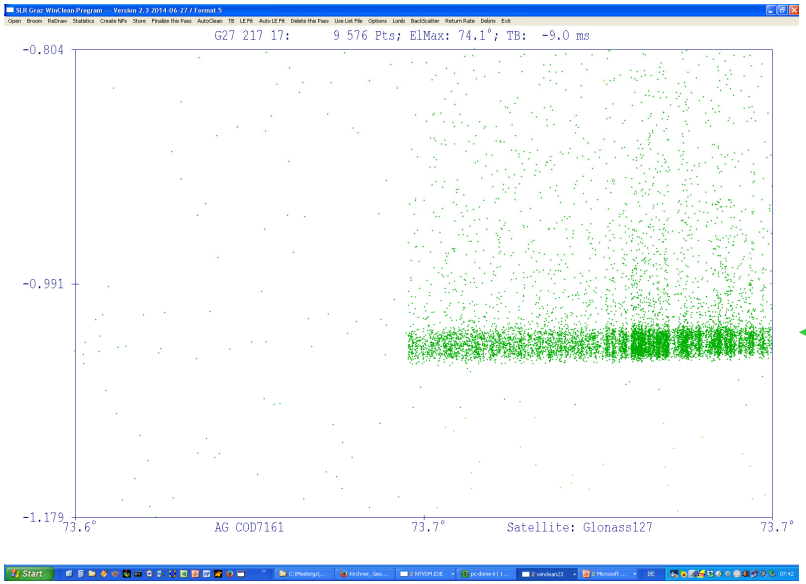


HQ-Laser: 350 µJ / 2 kHz / 10 ps / 532 nm:
@ 65° El: 8.3 % Return Quote

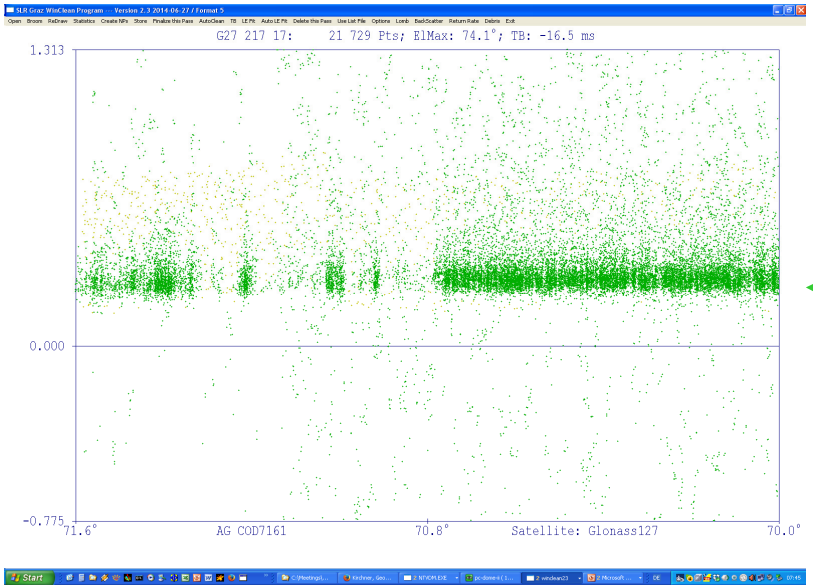


DART-Laser: 15 µJ / 2 kHz / 1 ns / 532 nm:
@ 63° El: 1.1% Return Quote

SP-DART in Graz: Tracking Glonass 127

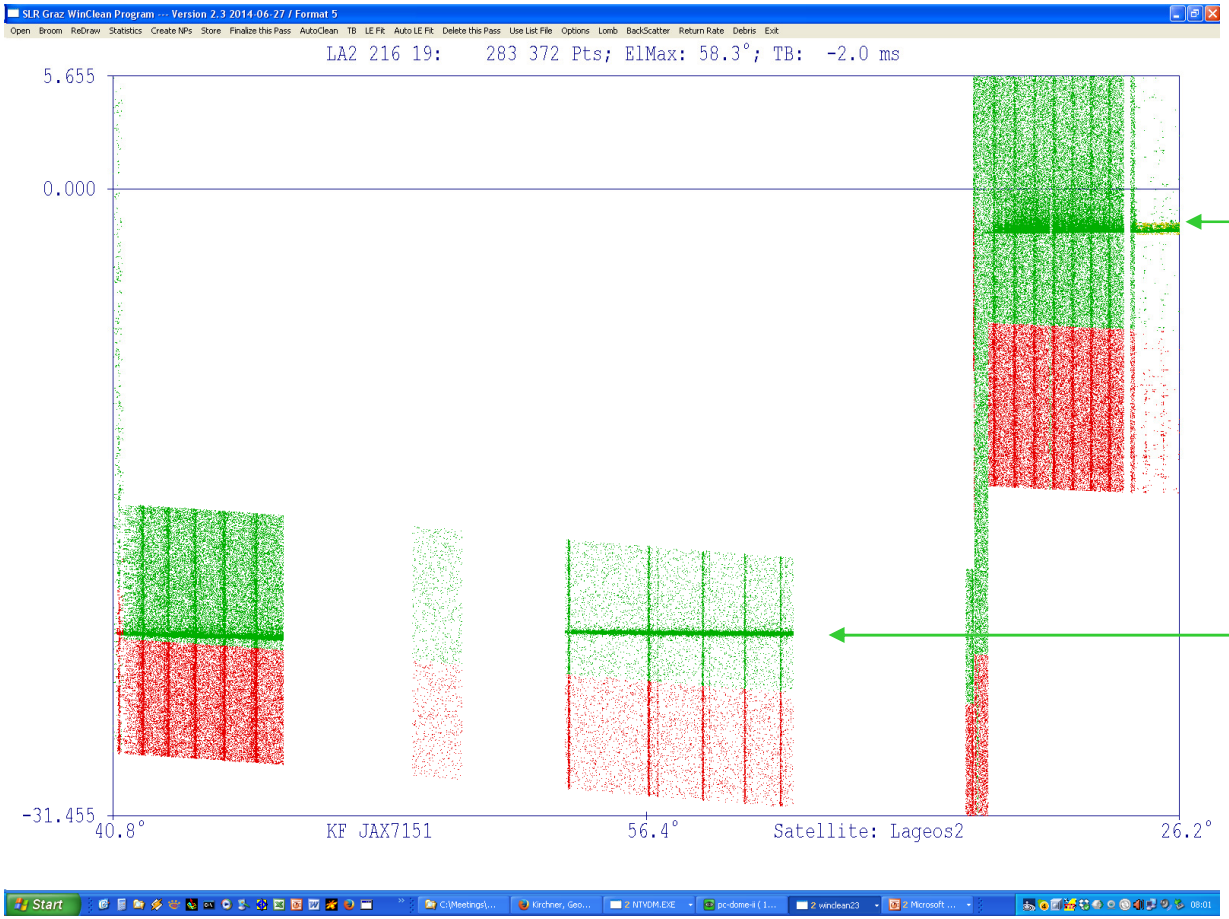


HQ-Laser: 350 µJ / 2 kHz / 10 ps / 532 nm:
@ 73° El: 11.9 % Return Quote



DART-Laser: 15 µJ / 2 kHz / 1 ns / 532 nm:
@ 70° El: 3.2 % Return Quote

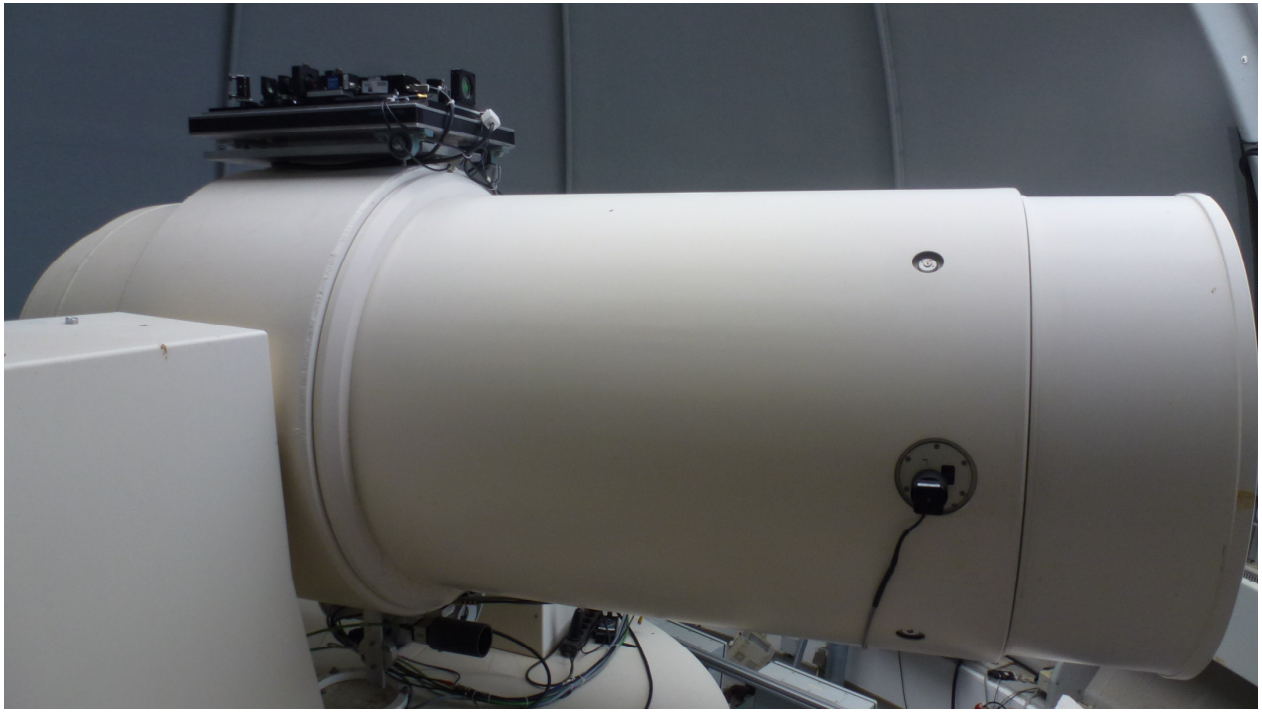
SP-DART in Graz: Tracking LAGEOS-2



HQ-Laser / 532 nm:
350 µJ / 2 kHz / 10 ps
23° El: 10.3 % Ret Quote

DART-Laser / 532 nm:
15 µJ / 2 kHz / 1 ns
46° El: 1.3 % Ret Quote
55° El: 1.7 % Ret Quote

SP-DART Transmitter mounted on Wettzell WLRS Telescope (30.Sept.2015)



SP-DART µJ laser mounted on Wettzell WLRS telescope

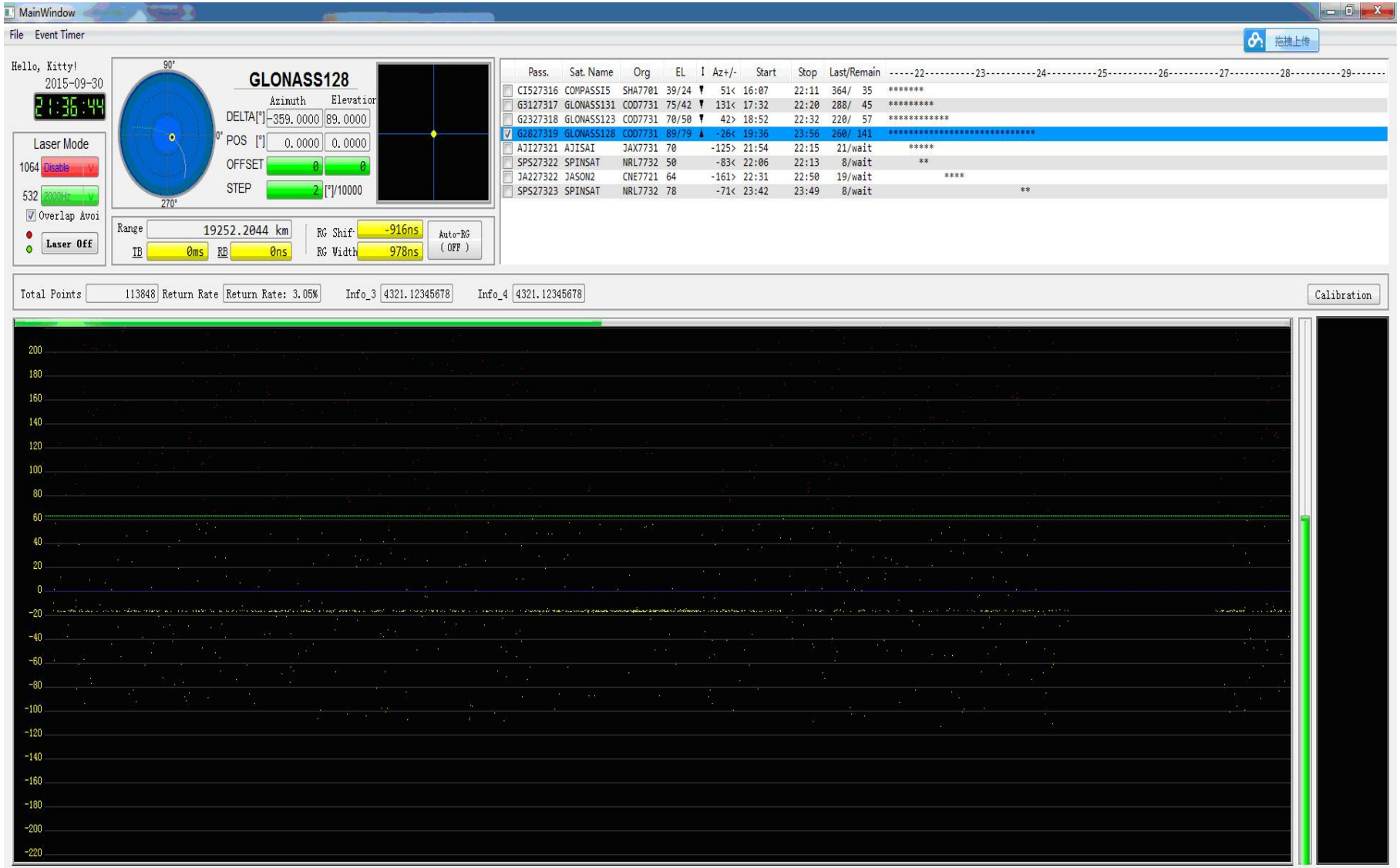
Graz SP-DART electronics box with GPS T&F receiver, Riga USB-ET, FPGA, …

Graz supplied: 15 µJ laser => start pulses, ET, FPGA / Range Gate, Laptop + program;

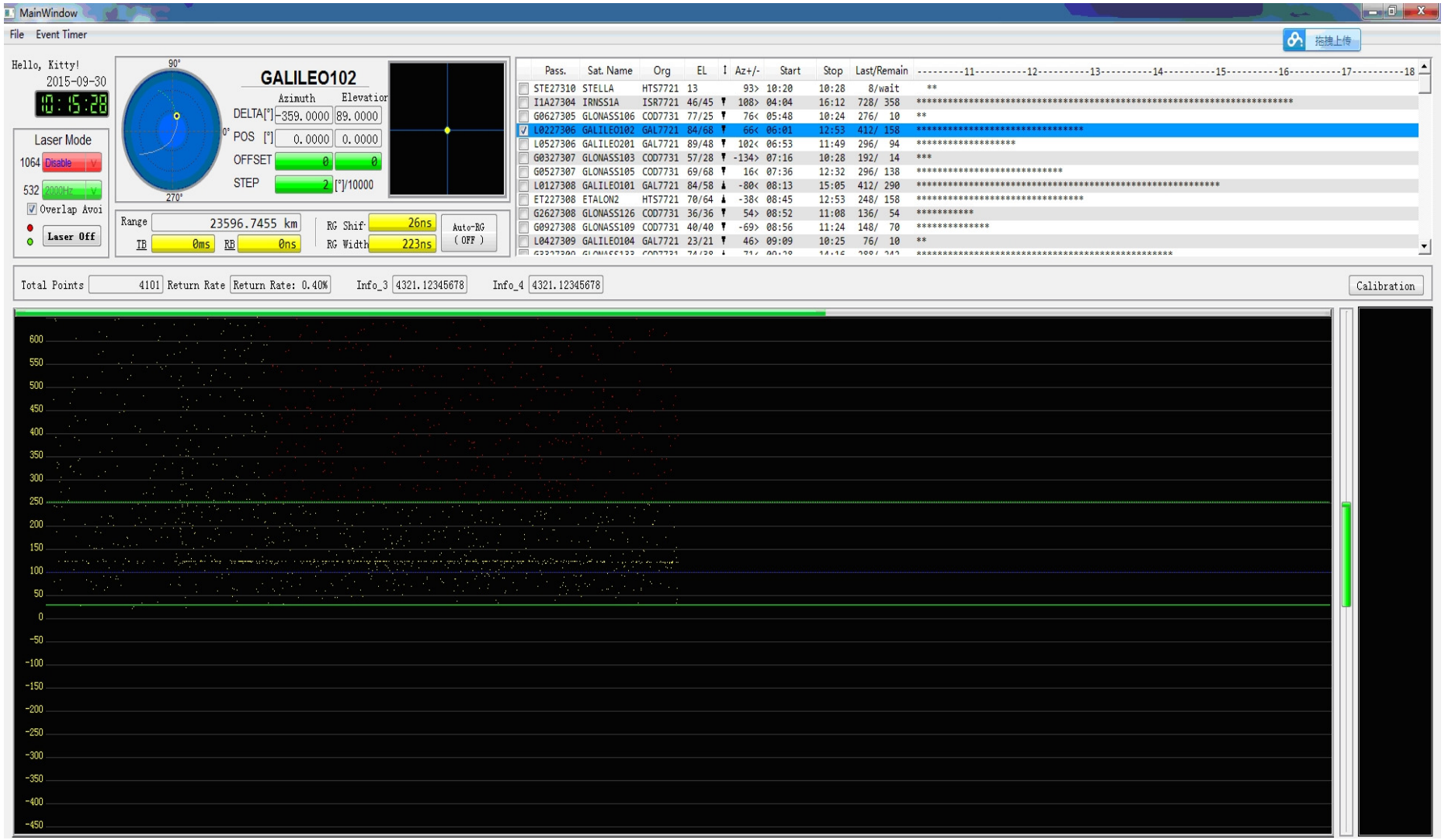
Wettzell supplied: Mount / telescope / tracking; SPAD detector => stop pulses

Satellites tracked: ENVISAT, AJISAI, LAGEOS-2, Glonass-128, Galileo-102

SP-DART in Wettzell: Tracking Glonass 128; Return Rate: ≈ 3% (≈ 60 returns/sec with 15 µJ / pulse)



SP-DART in Wettzell: Tracking Galileo 102; Return Rate: ≈3% (≈ 60 returns/sec with 15 µJ / pulse)



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SP-DART Applications …

- SP-DART ranging in Graz: Establishes a reference:
  - e.g. 1% to 3% return quote with 15 µJ from GNSS satellites

- Comparing this with other SLR stations: Allows independent test of receive channel
  - Wettzell: Done at end of September 2015: About 3% return rates for HEOs
  - Zimmerwald: Scheduled for mid of November 2015; anybody else interested ???

- Alignment & Setup Tests on standard astronomy telescopes / installing a SPAD:
  - Testing such setups for later bi-static Debris Ranging:
  - Villach / Astronomy telescope / 40 cm / 16”: Tests scheduled for 2016
  - Kefallonia / Greece: 1.2 m telescope in 1400 m: Testing for bi-static ranging

- Adding a 15 µJ / ps / kHz laser head: => Pico-DART ☺
  - To be mounted on any astronomy telescope;
  - Results in a simple, small kHz SLR station, with ps accuracy up to GNSS ☺

- Upgrades: Adding Retro-Reflector + CCD for easy alignment parallel to host system

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We are slowly approaching our ultimate goal:

The small, handheld SLR station ☺

Thank you !

http://www.youtube.com/watch?v=5o6OtPJKRJ8

Video of Graz SLR station ranging to ILRS satellites