Federal Agency for
Cartography and Geodesy

Recent achievements in mono-static, high repetition rate ranging at the WLRS

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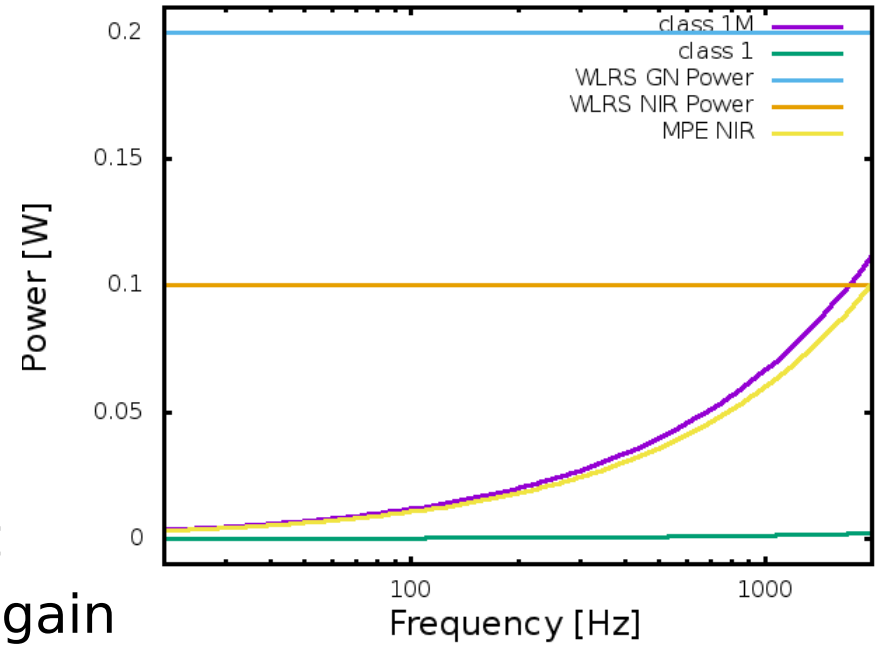
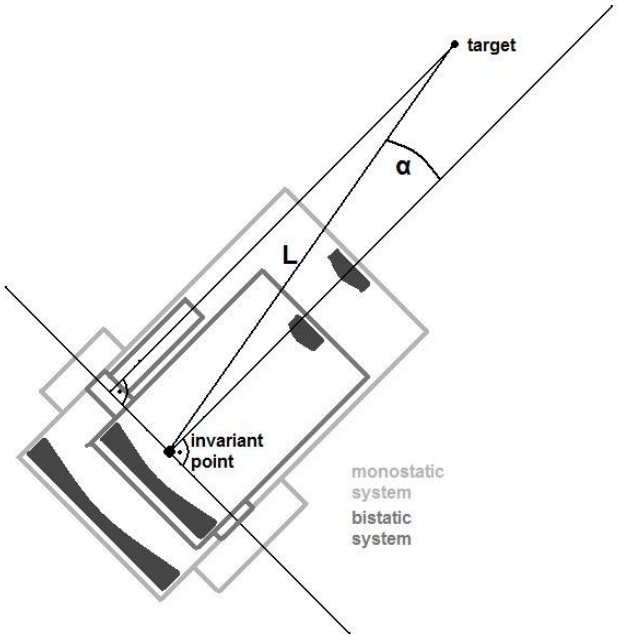
Motivation

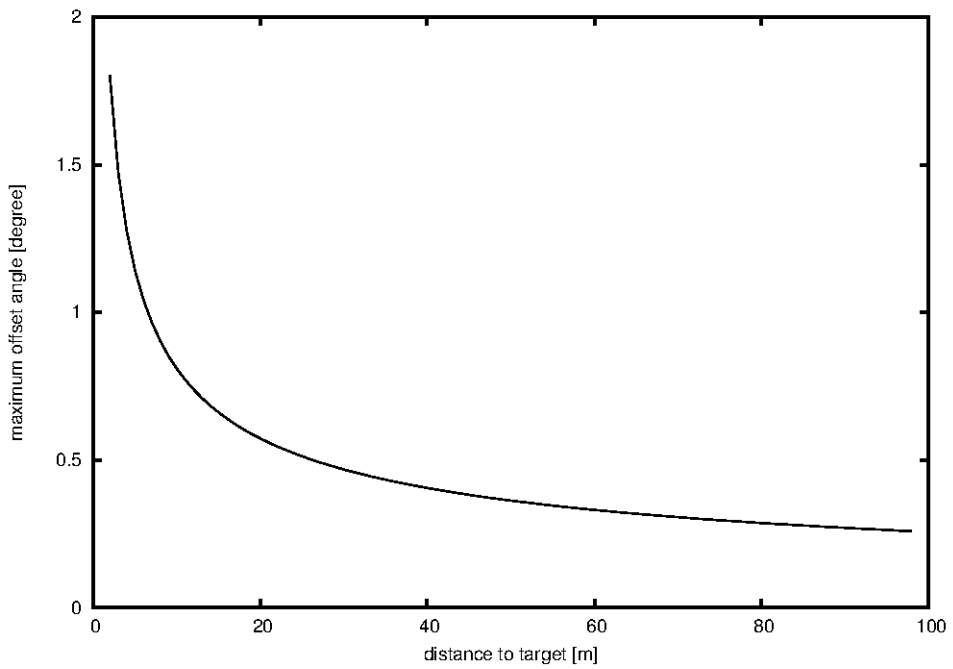
- Reduce Systematics & increase data yield
  - single photon ranging, high repetition rate
- Reduce Maintainance
  - Flash lamp pumped post amplifier needed for high energy experiments only
- ELT Time Transfer
  - free laser trigger
  - use 100 Hz
- Step towards autonomous SLR
  - eyesave ranging in NIR @ 50 µJ, 2 kHz
  - Increase feedback gain



Motivation

- Still be able to simple monitor the geometry of system delay using corner cube calibration targets, even on short distances
- Hint: Regard geometry bias !!!



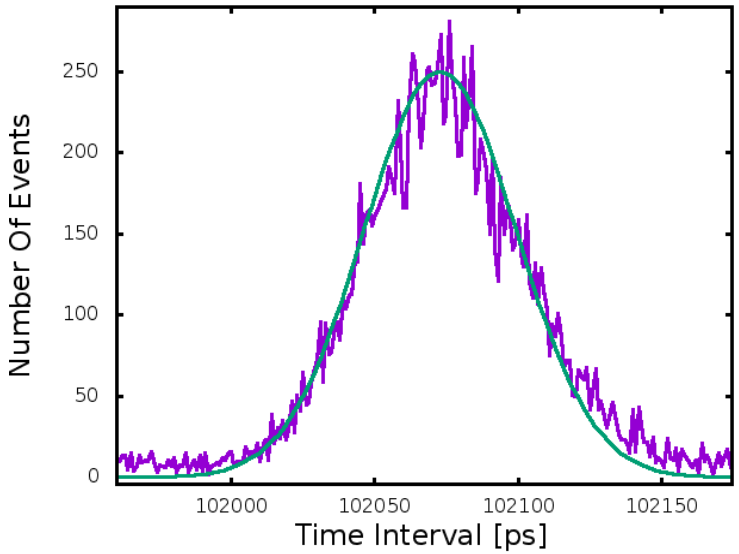


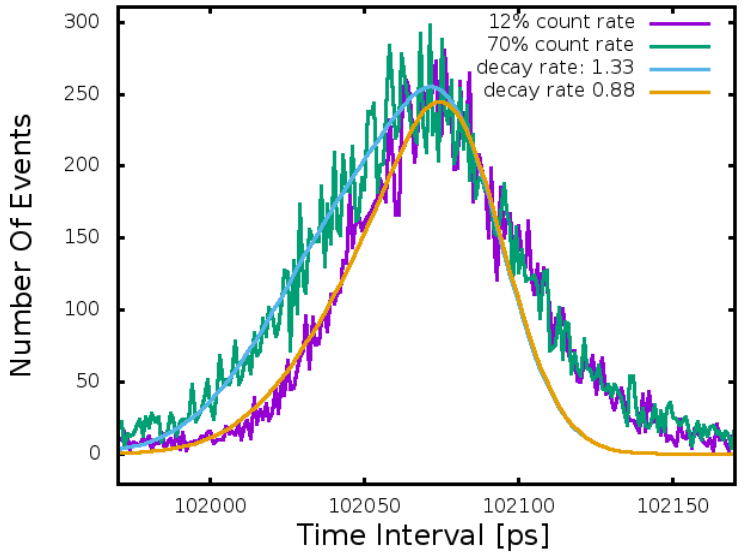
TODO - List

- Reinstall IR Detector
  - From test setup to permanent
- Eventtimer upgrade
  - kHz support
  - improved SetTime precision (ELT)
- Optics & T/R upgrade
  - Post amplifier bypass
  - T/R without mechanical components

NIR Receiver
- Timing -

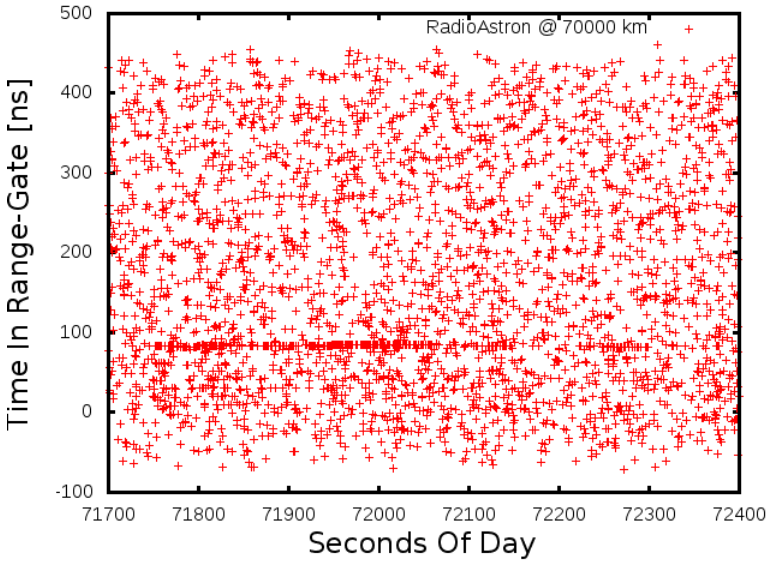
- PGA-284 Princeton Lightwave SPAD
- 80 µm active area
- FoV ~ 18 arcsec
- Single photoelectron timing RMS 29 ps @ -250mV

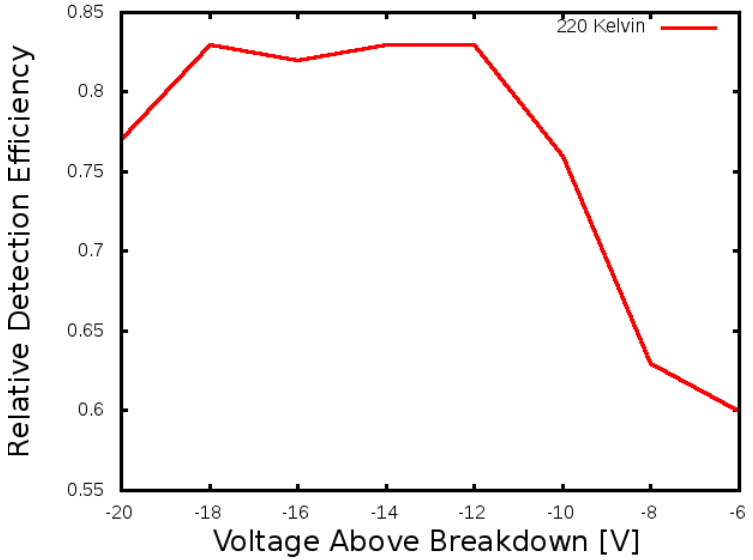




NIR Receiver
- Efficiency -

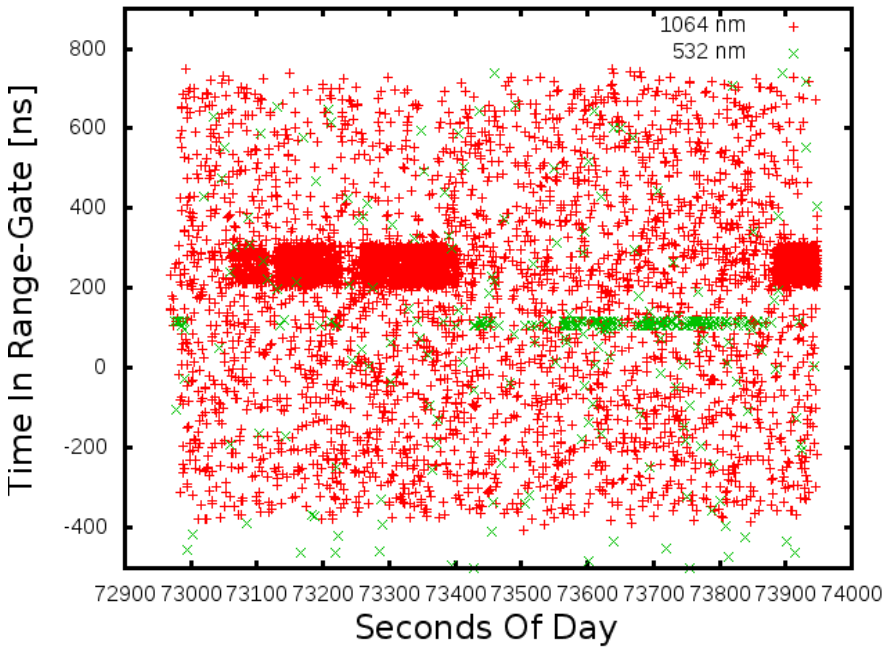
- DCR ~180 kHz @ -14 V above breakdown
- Ranging RadioAstron:
  - 25 mJ Pulse Energy, 20 Hz
  - 70000 km, Nighttime
  - Cirrostratus clouds
  - Up to 15 % Return Rate





NIR Efficiency
- Compared to Green -

- Ranging IRNSS1B
- Adjust Laser Energy $E_{NIR} = E_{GN}$
- Alternate and optimise (1064 – 532 -1064)
- Max RR NIR ~50%
- Max RR GN ~5%



Eventtimer
- Overview -

GENERAL:

- Thales Event Timing Modules
- Analog Input Board (CTU, Prag)
- ZEDBOARD

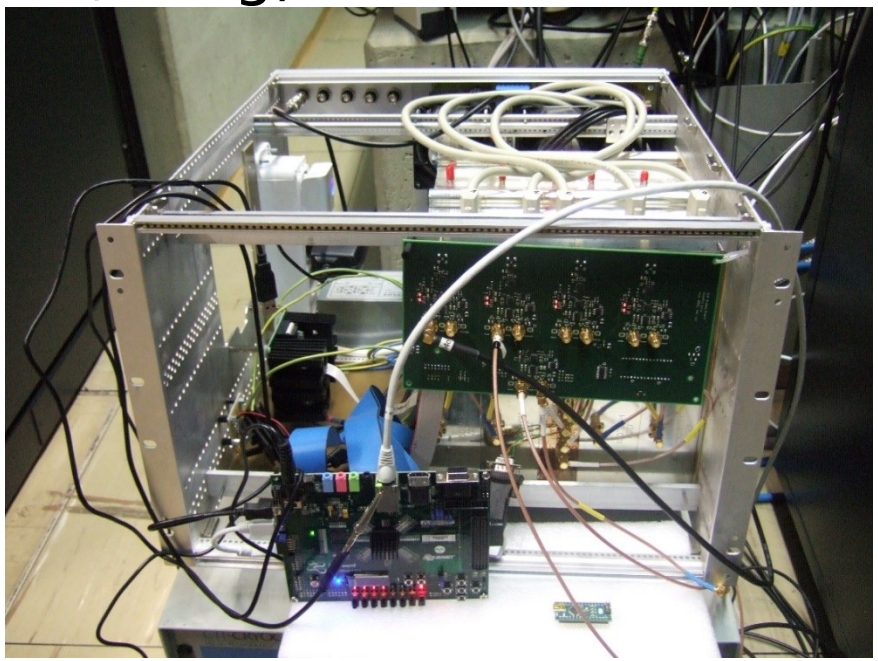
XILINX ZYNQ

(FPGA-ARM)

- Homemade SDK

via idl2rpc-interface

(Ethernet)



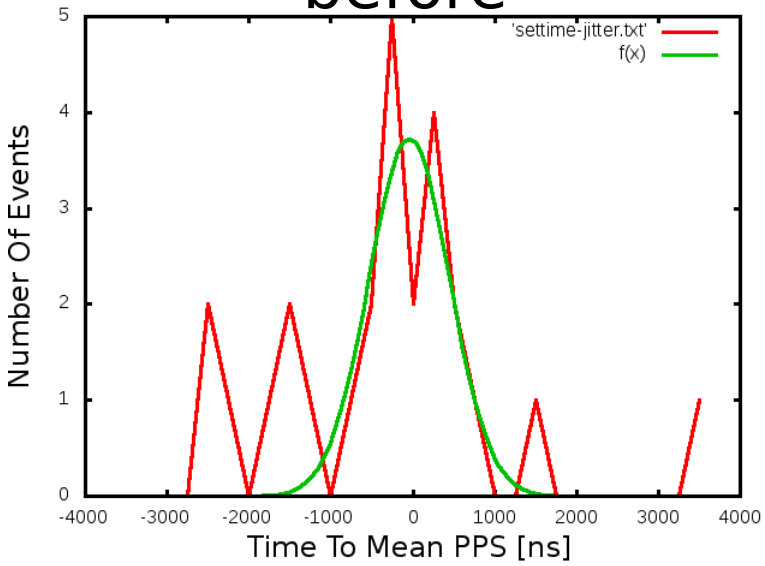
FEATURES:

- Shot by shot Hitdetection & NP finished indicator (NP precision)

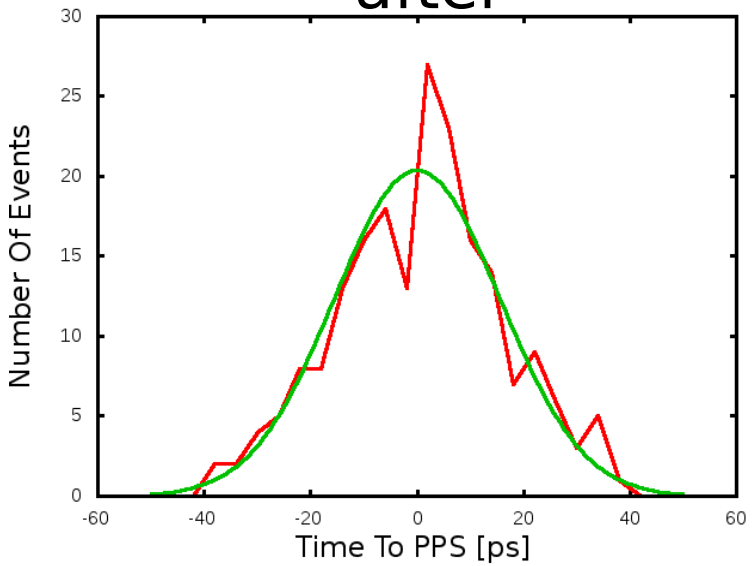
Eventtimer
- Performance -

- Set Time RMS ~ 16 ps (Time System Technology, INC. Model 6460 input)
- Repeated Measurement of Channel Offset ~ 1.9 ps RMS

before

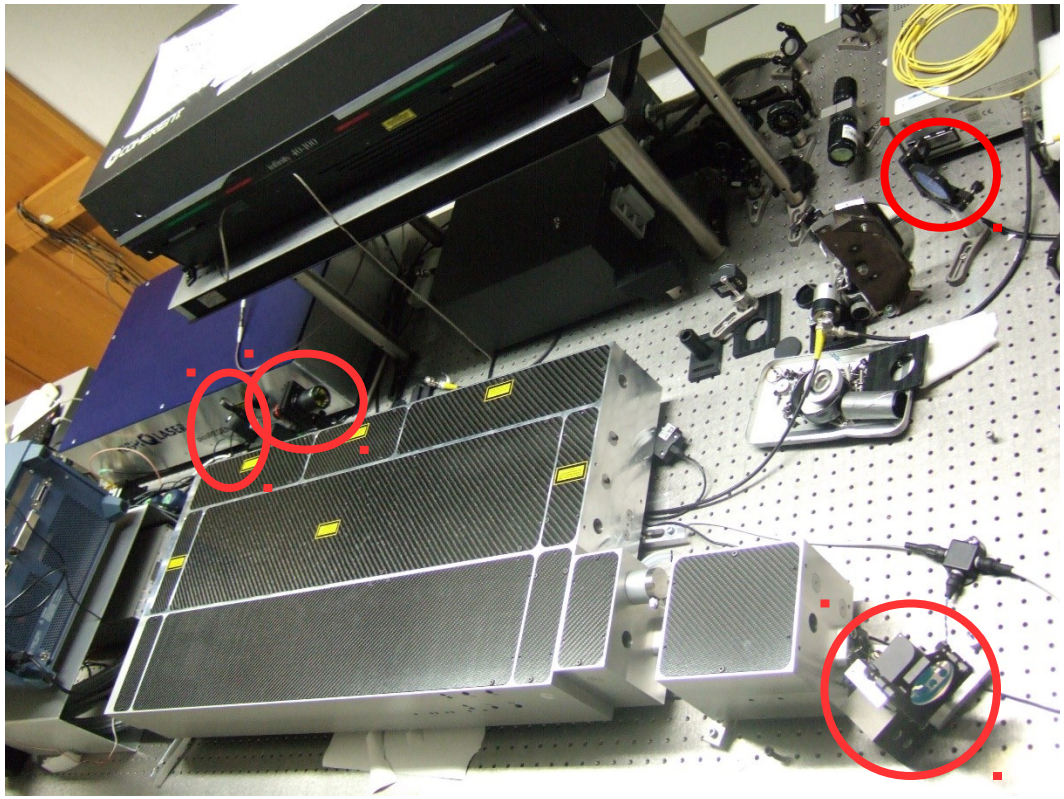


after



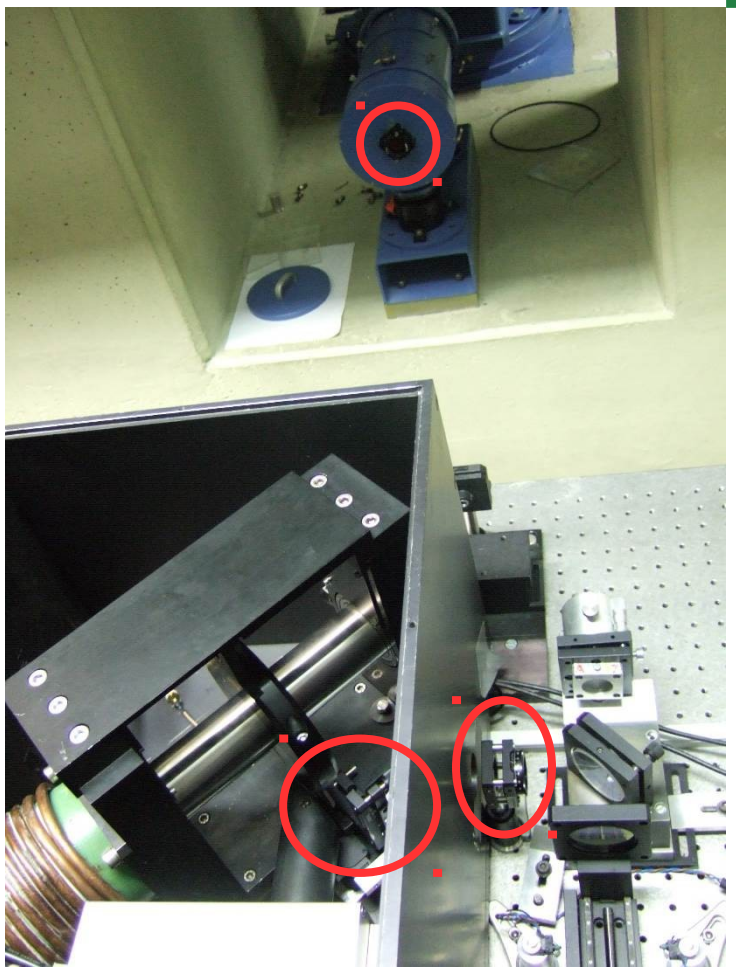
Optics & T/R
- Amplifier Bypass -

- Bypass of INNOLAS post-amplifier
- No SHG at the moment → NIR only
- Motorized Flip Mounts (Thorlabs)



Optics & T/R
- T/R switch -

- Designed for 532 & 1064
- Half wave plate
- Polarizer
- Quarter wave plate
- Possibility to switch to high pulse energy mode (motorized flip mount)



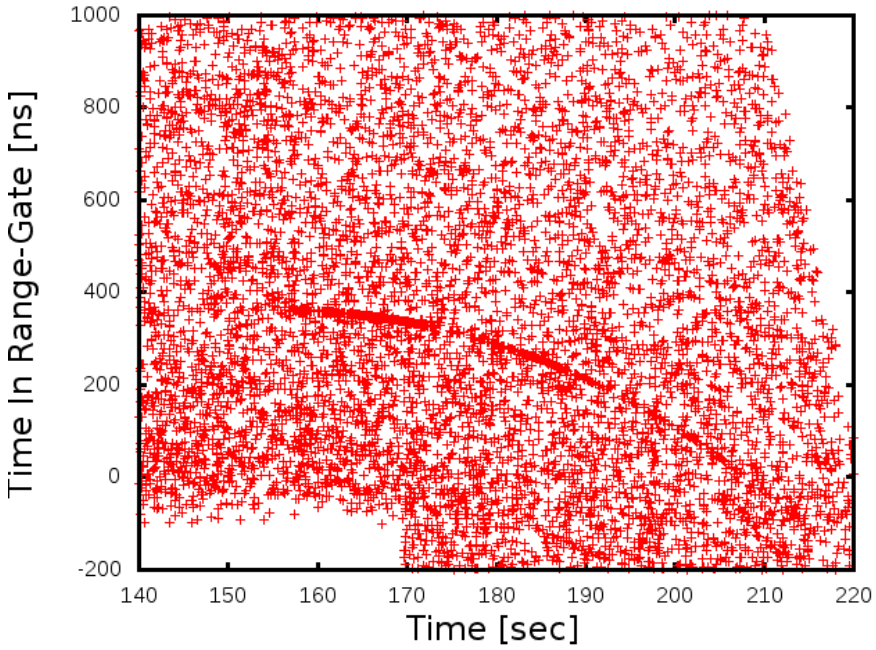
- Critical: backscatter from polarizer causes afterpulsing, no damage to the receiver !!!

→ Still need mechanical beam block, not installed, yet

Results

- First light from AJISAI (of course ;-))
- Nighttime, reduced pulse energy ~ 1µJ
- RR up to 40%, found Time-Bias of 1 sec

→ Need to check Eventtimer (wrong PPS)



Conclusion

- First results with new T/R switch
- Performance of Eventtimer-upgrade verified
- ELT ranging in green without additional mechanics feasible

- Unfortunately, to reach our goal a factor of 50 is still missing in the output energy.