ÖAW IWF

Tracking up to Geostationary Satellite

with 15uJ Laser and 70cm Astronomy Telescope

Georg Kirchner, Franz Koidl, Peiyuan Wang, Michael Steindorfer
Space Research Institute, Austrian Academy of Sciences

Egon Döberl, Martin Ploner, Philipp Keller, Mirco Taubenberger
ASA / Astrosysteme Austria

ÖAW IWF

OUTLINE

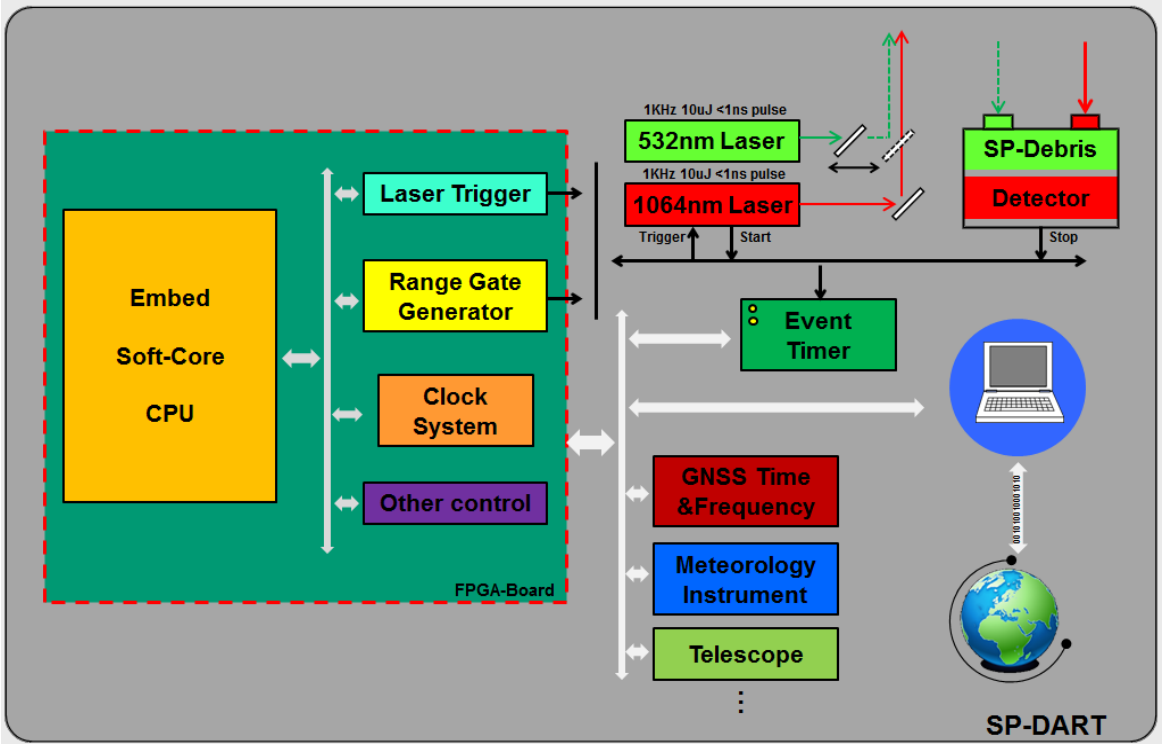
- Concept of SP-DART
- Experiment Setup
- ASA Telescope
- Results
- Conclusions and Outlook

ÖAW IWF

Single-Photon Detection, Alignment and Reference Tool

SP-DART

SP-DART is a tiny SLR station, but uses a host mount/telescope

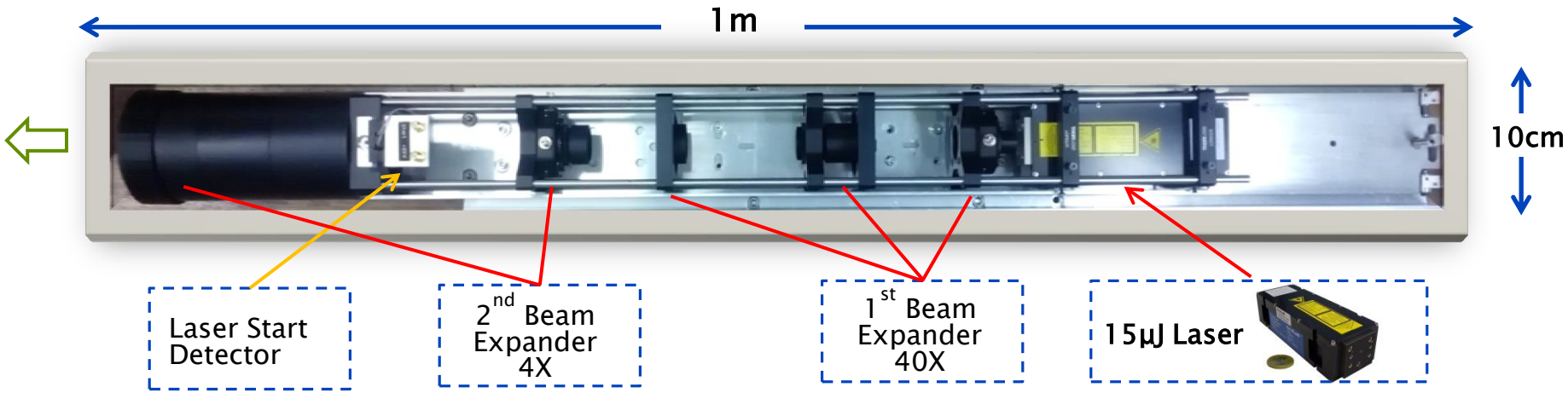


- Transmitting module (15uJ/1ns/2kHz)
- Detection package
- FPGA-based Control Unit
- Riga ET-A033
- Laptop
- Real-Time programs
- GNSS T&F Receiver
- P/T/H Device

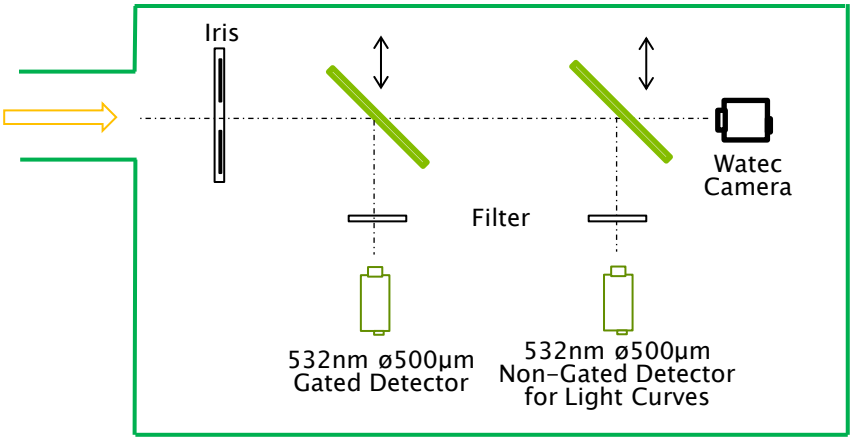
Kirchner, G., Koidl, F., Steindorfer, M., Wang, P., 2015. SP-DART: Single-Photon Detection, Alignment and Reference Tool. In: 2015 ILRS Technical Workshop.

ÖAW IWF

TRANSMITTING MODULE



DETECTION AND CONTROL MODULE



- 19'' Rack Box
  - -- FPGA for laser and RG
  - -- GPS Time & Freq. Unit
  - -- Latvia ET
  - -- P/T/H
- Laptop

ÖAW IWF

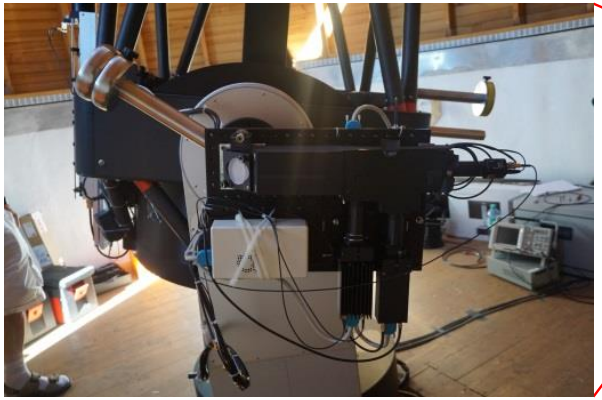
EXPERIMENT SETUP

Telescope was remotely controlled by Dr. Martin Ploner in Switzerland

ÖAW IWF

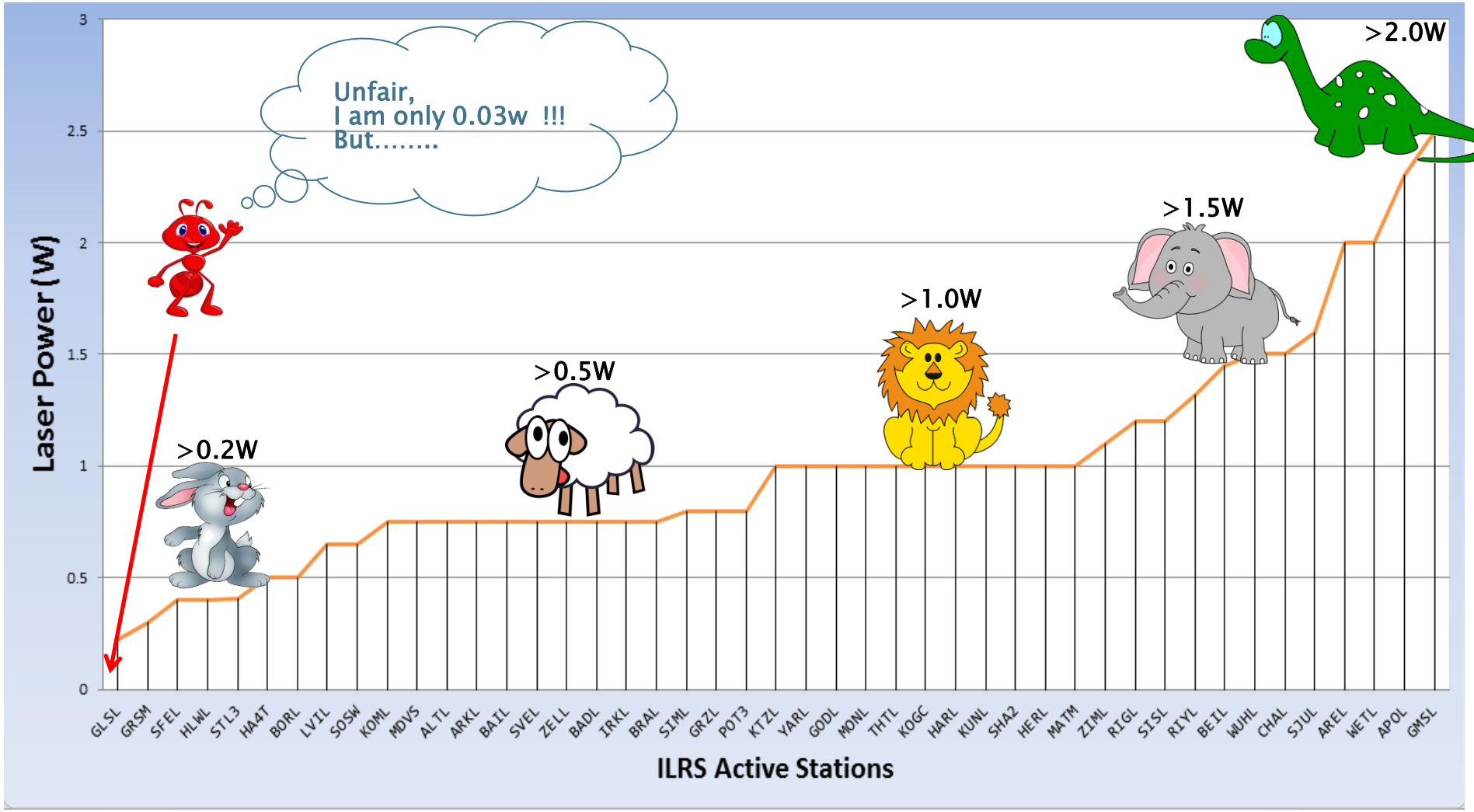
THE SANDL TELESCOPE

- Altazimuth Ritchey Chretien
- Aperture: 70 cm
- Focal length: 6.3 m
- Two hyperbolic mirrors -> abberation correction
- Nazmyth style Outcoupling in Elevation axis Rotatable 45° mirror



ÖAW IWF

15 µJ @ 2 KHz = 0.03 W

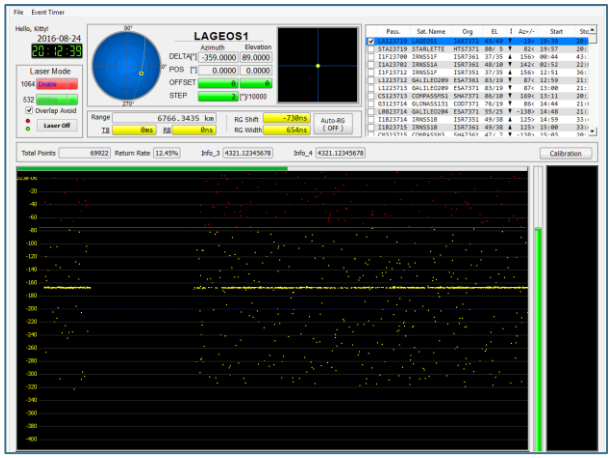


*c.f. http://ilrs.gsfc.nasa.gov/network/stations/active/index.html, Sep. 2016
**Exclude: 1) MDOL, because of 15w power
2) MAIL, because of laser Info. N/A
3) METL, because of too low repetition rate

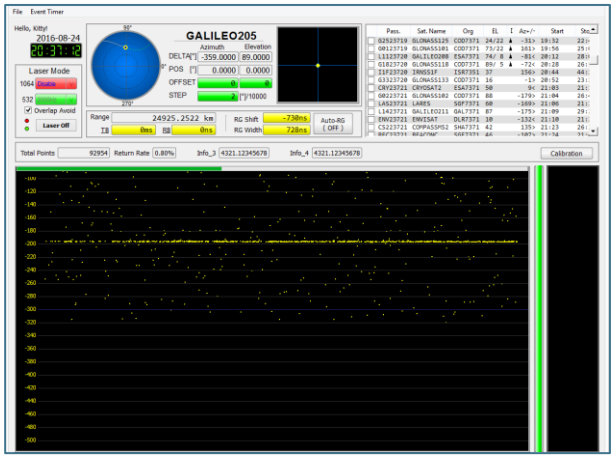
ÖAW IWF

RANGING RESULTS

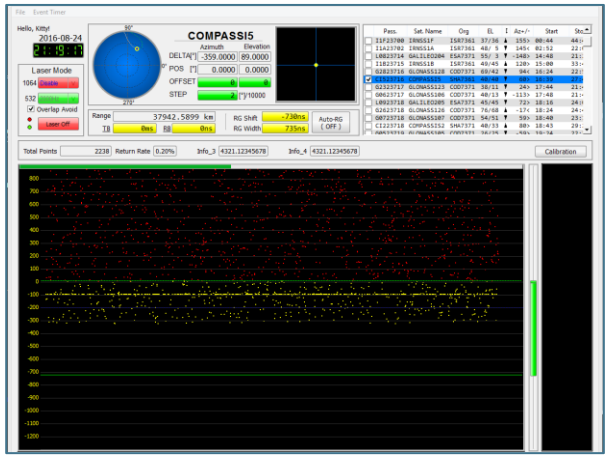
- In total, 17 passes from LEO up to GEO
- **Only 6 hours** setup, the first pass was tracked successfully



Lagoes1



Galileo



COMPASS IGSO5

Elevation:~40° Perigee: 35,604 km

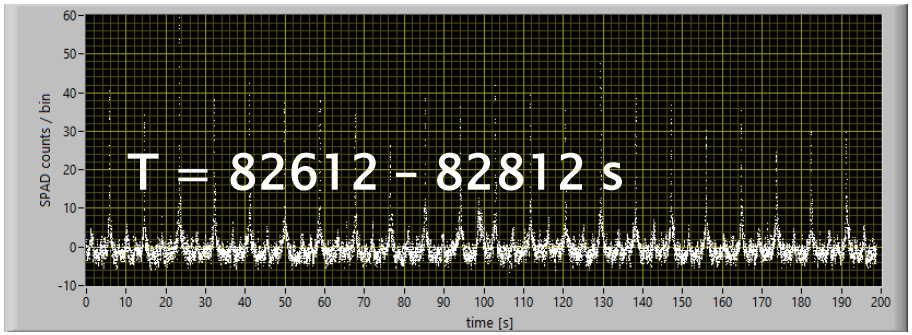
	Passes	Max. Return Rate
GEO (Compass I5) Elevation:~40°	1	~0.2%
GNSS	6	~2.6%
Lageos	3	~12.5%
LEO	7	>30%

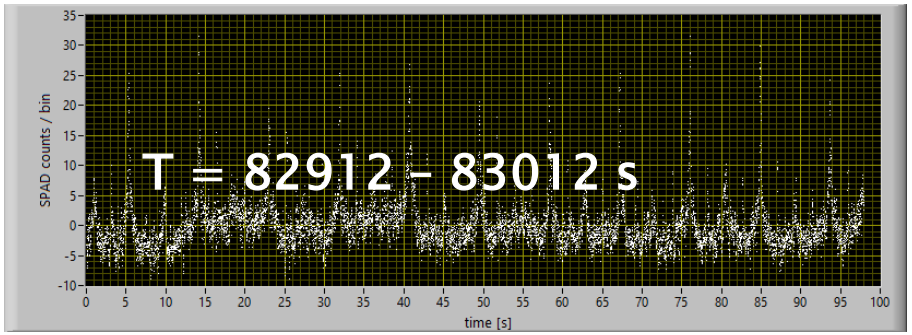
Date	Days of Year	Passes
2016-08-22	235	3
2016-08-23	236	6
2016-08-24	237	8

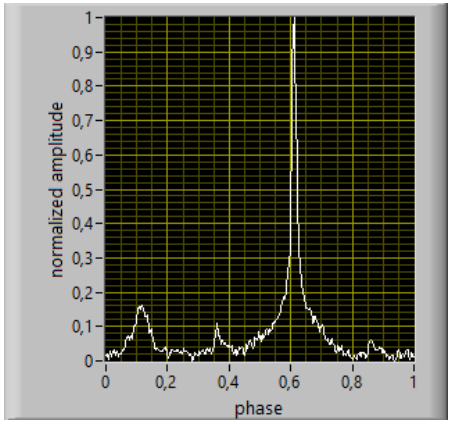
ÖAW IWF

LIGHT CURVES

- An non-gated un-gated detector was installed for parallel light curves
- GLONASS041, T_{spin} = 8.84 s, 4 sides of satellites visible

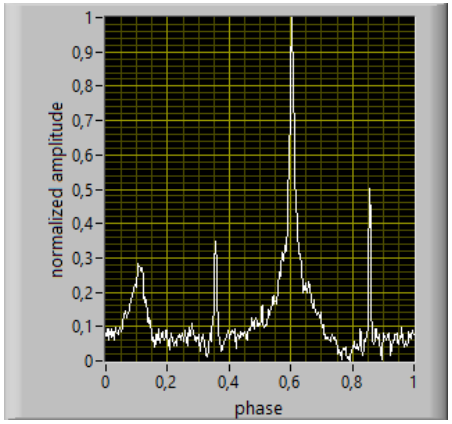






Signal

Light curves



Kirchner, G., Koidl, F., Steindorfer, M., Wang, P., 2015. Light Curve Measurements with Single Photon Counters at Graz SLR. In: 2015 ILRS Technical Workshop.

ÖAW IWF

CONCLUSIONS AND OUTLOOK

- *TINY, Transportable, Easy, Efficient*
  - --Tiny: <10 kg mounted on telescope; <30kg in total
  - --Transportable: easily loaded into a car
  - --Easy: 6 hours setup time, then get ready
  - --Efficient: up to GEO target with 15 μJ laser

- SP-DART could be used for
  - --Calibrate/Evaluate system
  - --Upgrade astronomical telescope to bi/multi-static ranging
  - --Full automatic HEOs ranging system
    (4 cm single-shot RMS, sufficient for EOP
    calculated by Toshimichi Otsubo)

- This project is supported ESA (4000112211/14/D/SR)
- Thanks for colleagues from ASA and remote operator from CH

A problem has been detected and windows has been shutdown to prevent damage to your computer.

If this is the first time you've seen this stop error screen, restart your computer, If this screen appears again, follow these steps:

Check to
hardware

If proble
as cachin
press F8

Technical

*** gv3.s

Beginning

Physical

Contact y

our

ns such

r,