Novel Data Analysis Strategy at the SwissOGS Zimmerwald 7810

Julian Rodriguez-Villamizar, Pierre Lauber, Thomas Schildknecht

Astronomical Institute, University of Bern, Switzerland

22nd International Workshop on Laser Ranging
7-11 November
Yebes, Spain

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- Key Performance Indicators: Definition & Scope

- Relating KPIs to System Components

- New KPIs: Examples

- Summary

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KPIs: Definition & Scope

Julian Rodriguez-Villamizar, Pierre Lauber, Thomas Schildknecht:
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Definition: Quantitative measure of the performance, or quality, of an observable unit.

What for?
Operational or even strategic enhancement.

How will my SLR station profit from KPIs?
Observable unit $\rightarrow$ shows any anomalous behavior:

- Schedule unit-oriented technical sessions profiting e.g. from bad weather.

- Judge the readiness of the system for dedicated short-notice observation campaigns.

- To sleep good at night knowing that the system is up and running to the best of our knowledge.

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Timing Units:

- Synchronization of the station 1 PPS from the maser wrt 1 PPS provided by the reference timing unit (e.g. GPS receiver). IVS recommendations: avoid zero crossing & its drift rate $> 0 \rightarrow$ **KPI**: counter measures the offset between station 1 PPS & GPS 1 PPS.

- ToF timing unit & internal system delays. Compare measured range against a fiducial one (independent technique) plus internal system delays $\rightarrow$ **KPI**: statistical descriptors such as $E(\Delta\rho)$ & $D(\Delta\rho)$.

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Optical Unit (Tx/Rx):

All possible elements in Tx/Rx optical paths (mirror, lenses, variable neutral density filters, etc.) $\rightarrow$ **KPI**: element-wise transmission compared to nominal specifications.

Telescope and Beam Alignment Unit:

Mount model estimation after the observation of specific targets $\rightarrow$ includes the coudé-path $\rightarrow$ **KPI**: mean aposteriori error of unit weight.

Controlling Software Unit:

Changes in the controlling software $\rightarrow$ new developments, refactoring, different branches $\rightarrow$ **KPI**: Outcome of scoring functions measuring modularity, new functions, better algorithms, etc.

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New KPIs: Return Rates

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Target Selection: LAGEOS-1

- Avoids the use of a VND filter when the measured return rate is $> 10\%$.
- Available cross-section enables the computation of the theoretical return rates using the link equation
- Good visibility from 7810 & good predictions available $\rightarrow$ shorter range-gates $\rightarrow$ increase SNR $\rightarrow$ mitigates differences between day/night passes

Time Span of Historical Records: One Year

- Data from one year is expected to be a representative sample accounting for seasonal/monthly variabilities
- Feature extraction on a monthly basis based on binning of single passes

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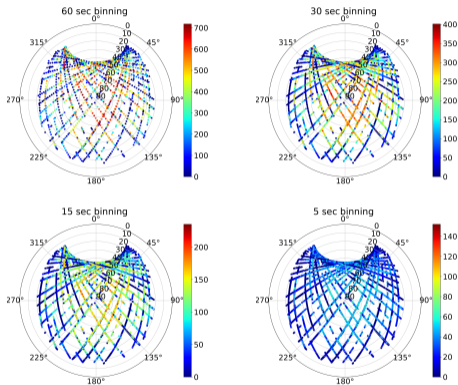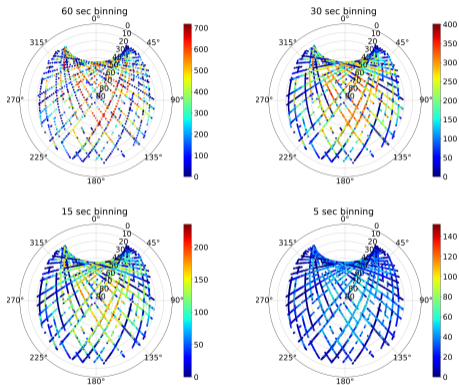## Example of return rates March 2020
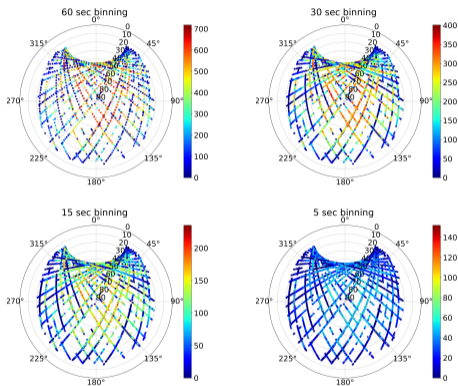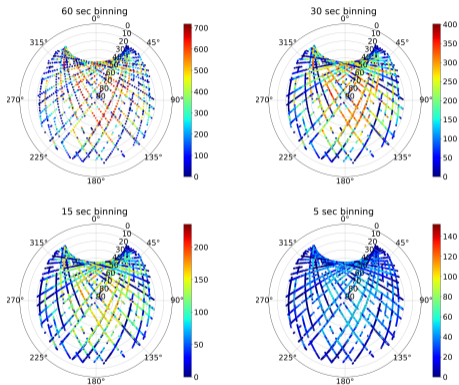
- Two-class feature space: (signal || noise)/bin → SNR
- Bin size > few minutes smooth the signal too much (limit 2 min)
- Fix binning size for all comparisons
- Extract the spatial distribution of the return rates → 2D-Fourier (2,2)

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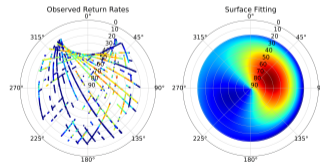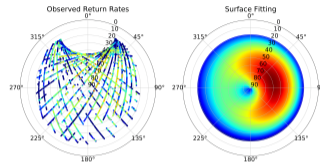**Example of return rates March 2020**

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LAGEOS-1. **Unit colorbars: photoelect/sec**

– Good agreement with theoretical
  return rate (7.1 photoelec/sec @ 45°)

– Several passes with bins without signal
  (!)

– Azimuth dependencies not considered
  by theoretical link

– Optimization: Higher elevation mask?
  Cloud detection algorithm?

– Analysis: RMS of NP f (return rates)
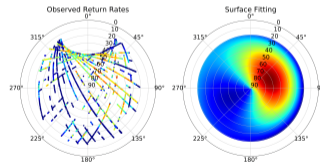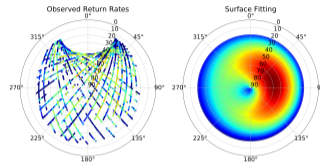 (!)

Jan-20(Top) Jan-19(Bot)

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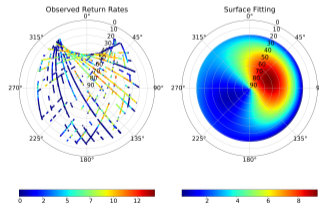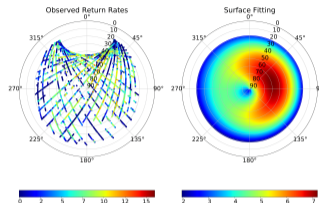
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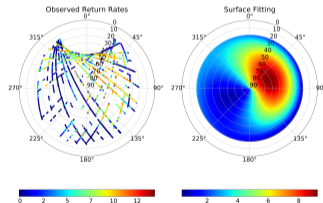
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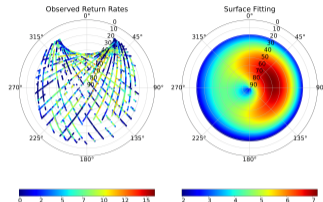Astronomical Institute, University of Bern **AIUB**

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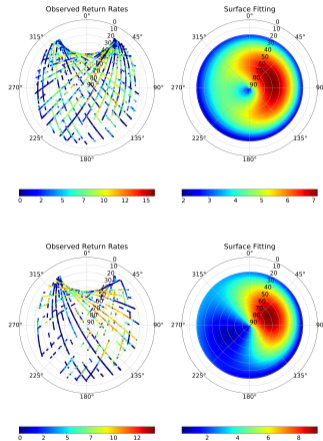– Analysis: RMS of NP f (return rates) (!)
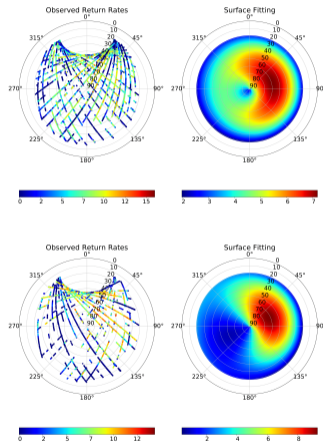
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Further extraction of features: Box-plots →from bottom to top: minimum, 1st quartile, median, 3rd quartile and maximum.
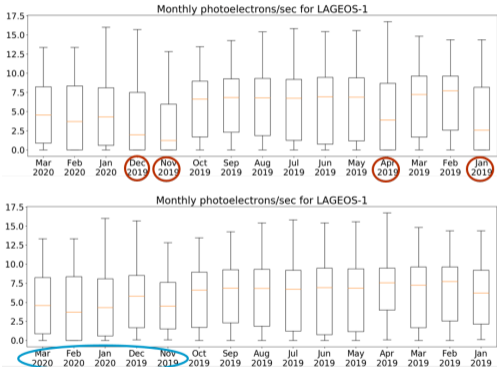
Monthly estimation affected by the reduced number of good passes.

Decreased power output → from the power meter: 7.8, 6.7, 5.4 mJ

Estimates using only good observations RTF & SCR

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Key Points

– KPIs may help to spot system flaws related to specific system components.

– Analysis of observed return rates provided:

  • Potential optimization of observations.

  • Information about the overall performance of the system over time.

  • Enabled a comparison against the theoretical return rates using nominal specifications.

  • Variability of the system may impact the quality of the normal points and all information derived thereof.

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