Recent SLR tracking improvements at SGF Herstmonceux

Daytime GNSS tracking difficulties

- Intrinsic weak returns
- High noise rate
- Decreased transmission due to filters
- No nighttime camera
- Pointing
- Turbulence
Station parameter that captures (crudely) tracking capabilities:

- primary radius (m)
- average laser power (W)
- 2-way transmission for 30° slant range and clear conditions
• Stations significantly above or below the line indicate over- and under-performance relative to the expected values

• Reasons for this include scheduling priority differences
Past upgrades at SGF

- Dichroic mirror change
- Coude path optics
- Emitter optics (partial)
- Laser upgrade (0.4mJ@2KHz to 1.1mJ@1KHz)
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http://sgf.rgo.ac.uk/operations/laserenergy.html
Testing daytime filter transmission

Abysmal performance: ~12.5 % transmission
Better alternatives available?
• Extremely good on paper: high transmission, wide band blocking included
• Laser linewidth an issue?
• Manufacturer says: wait for measurement
• Dual blocking filter setup (~95% transmission each)
• Actual improvement much higher than expected: old filter underperforming (19-39% transmission)
• Current narrow filter underperforming, barely within spec (~33%)
Evidence for improved signal after filter change
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Noise...
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- Noise rate varies greatly with azimuth, elevation, atmospheric conditions and Sun position
- Doubling of noise rates at low elevations typical
- 1-4MHz noise rates fairly common with our setup
- Worse case scenario (really) much worse
Noise mitigation: temporal and spatial filtering
Worth ensuring optimal operation, especially for weak targets
Beware of arbitrary small range gates...

- Found 3 mm error with range gates below ~60 ns
- Must characterise your detector
“GLONASS retroreflector systems”, Victor Shargorodsky, May 2014:
Single pass Glonass-134: target signature

Tracking at higher incidence angles (low elevation) increases the apparent size of LRA resulting in shallower signal return distributions.
Single pass Glonass-134: target signature

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Single pass Glonass-134: target signature

Tracking at higher incidence angles (low elevation) increases the apparent size of LRA resulting in shallower signal return distributions.

At low elevation:
- higher air-mass
- longer distance
- higher noise
- shallower distribution
Productivity gains?
Coated vs uncoated GNSS tracking

Group A: coated GLONASS
Group B: uncoated GLONASS

NPs

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Low priority vs high priority GNSS tracking

Group A: uncoated GLONASS, low-priority
Group B: GLONASS 123, 125, 128, 129, 133, 134, GALILEO 101-4, COMPASS-M3

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Conclusions

• Unexpected performance gains may be hiding in your system (suspect everything)
• Best operational practice will help with most challenging targets
• System optimisation increases productivity without sacrificing coverage (there is spare capacity to be exploited)
• Accuracy issues at low elevation: single-photon SLR tracking of GNSS targets ensures centroid of NP distribution refers to nominal LRA offset
• Priority scheduling can make a difference to tracking density of selected S/C
Thank you