The Graz SMART-TT: Smart Transmit Telescope

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Basic transmit telescope (Coudé Path System)

- Our >10 m long Coudé path has a diameter of 5 cm; needs 3“ diameter mirrors
- Our transmit telescope has a final diameter of 10 cm
- However, we can allow only for a 7 cm beam diameter maximum:
  - Long (10 m) Coudé path, low stability etc; the rotating beam needs space …
  - Our min. beam divergence is ≈ 5“ (25 µrad) FWHM (meas. with LAGEOS SLR)
  - With usual atmospheric seeings in Graz of several arcsecs, this is okay…

Basic transmit telescope: From 5 cm input to 10 cm output (maximum);
Graz values: ≈ 3.5 cm input beam Ø; ≈ 7 cm output beam Ø
Basic Transmit Telescope, as used in Graz (Coudé Path System)

Splitting the diverging lens, relaxes the position accuracy requirements
(© Contraves USA – they produced our mount / telescope >40 years ago 😊)
Transmit telescope design, without Coudé path:
Laser mounted on an ASA receive telescope

- The Transmit telescope design allows easy adaption to available space

The long collimated part allows to add additional optical systems

75 mm Ø lenses are COTS

70 mm Ø beam allows a minimum divergence of 25 µrad (5“): Sufficient for low power SLR to GEOs
The long collimated part allows various options

- A rotatable $\lambda/2$ waveplate plus a polarizing beam splitter (PBS) allows continuous attenuation of the laser beam energy: From 100% to $\approx 0\%$ (e.g. to maintain single photon receiving)

- It can be used also for simple laser beam energy measuring:
  
  => To check laser operation
  => To monitor output energy during ranging etc.
Smart Transmit Telescope: Use it as a LIDAR!
The basic principle:
LIDAR integrated into the Transmit Telescope

Each counter counts the # of photons coming from a certain 15 m interval (100 ns) 
Max distance with 4096 counters (in FPGA) thus is > 61 km 
With 1 kHz rep rate, we get good averages within << 1 s
LIDAR Real Time Display / 'Cloud Bit'

- Real-Time display of a cloud in a distance of 3117 m, in 1453 m MSL
- For Graz SLR: Nice enhancement for the human observers 😊

- For any automatic SLR system this allows a reliable check for clouds
- Without this: Any automatics will start a (useless) search procedure 😞

- LIDAR data points, showing a thin cloud in counter # 156 (~2350 m)
- Cloud Altitude: 2340 m (calculated from distance and elevation angle)
Combining LIDAR + Attenuation + Energy measurements into the Transmit Telescope

Perfect info [„cloud / no cloud bit“] for autonomous SLR systems
Thank you!

http://www.youtube.com/watch?v=5o6OtPJKRJ8
Video of Graz SLR station ranging to ILRS satellites