Why Geodesy needs Time!

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How to get along with the troposphere?
A new and old ranging technique

Now working in the Ku-Band
MWL and ELT

MWL

• All weather
• High availability
• High precision
• Easy to operate

ELT/SLR

• Low dispersion
• Single shot
• Accurate time tagging
• Used to calibrate MWL
Frequency stability for interplanetary ranging

\[ \langle \Delta R^2 \rangle \approx R^2 \left[ \frac{\langle \Delta f_A^2 \rangle}{f_c^2} + \frac{\langle \Delta f_B^2 \rangle}{f_c^2} \right] \]

and

\[ \langle \Delta \tau^2 \rangle = \left[ \frac{R}{2c \left( 1 + \frac{\dot{R}}{c} \right)} \right]^2 \left[ \frac{\langle \Delta f_A^2 \rangle}{f_c^2} + \frac{\langle \Delta f_B^2 \rangle}{f_c^2} \right] \]

Asynchronous transponders

Degnan 2002

transfer, the latter clock would introduce a timing jitter on the order of 250 ps (<4 cm). However, if both clocks were of maser quality (~1×10^{-15} over time intervals of several minutes), clock errors would introduce submillimeter errors over distances on the order of 1 AU and range accuracy would then be limited, as in conventional SLR to artificial satellites, at the sub-cm level by uncertainties in the atmospheric propagation paths.
Use of timing predictability for multi-static space debris

See poster Christoph Bamann
Transporting time information

Combined two-way, multistatic

multi-static

- time offset and drift of maser

- implement time information
Consider to buy a maser now and be part of ELT!

Thank you very much!