Status of the European Laser Timing ELT Detector package

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Laser Time Transfer in Space

- Time and frequency transfer using ps laser pulses in space
- Relying on available technology and ground segment Satellite Laser Ranging
- Superb precision and accuracy
- Navigation, deep-space, fundamental physics...

- LTT – China since April 2007
  China Compass-M1 / Beidou
- T2L2 CNES - France since June 2008
  JASON-2
- LTT – China, August 1, 2010,
  CompassM2 Beidou, IGSO

European Laser Time Transfer
History review

- “H maser in space”, ’94, France + Russia + Prague canceled

- LTT China + Prague
  Compass M1 Beidou, (operational since Aug. 2007)

- T2L2 E. Samain et al
  ACES -> Miriade -> Jason 2 (operational since June 2008)

- ELT proposed by CTU Prague and TU Munich, June 2008

- Investigators Working Group established Dec. 2008

- Ground tests (Prague, Munich) started Dec. 2008
ELT Principal participants and contributors

- Luigi Cacciapuoti, ESTEC, The Netherlands
  ESA coordination

- Urs Hugentobler, Tech. Univ. Munich, Germany
  space geodesy

- Pierre Lauber, TU Munich, Germany
  Satellite Laser Station Wettzell

- Ivan Prochazka, Czech Tech. University in Prague
  Instrument Science coordinator

- Wolfgang Schaefer, TimeTech, Germany
  timing devices

- Ulrich Schreiber, Tech.Univ. Munich & BKG Germany
  Data Analysis Coordinator

- Anja Schlicht, Tech.Univ. Munich
  Data Analysis Center

Ground demonstration of the Wettzell ground demonstration experiment

December 2008 – May 2009

Ground demonstration of the entire timing performance via a space target and SLR combined

Diagram:

- Laser
- WLRS Timer
- MCP
- ELT Timer
- SPAD
- Satellite CCR

Proposed space segment

Progress in ELT project

Prague group ELT activities

- Detector design & construction
  - electronics
  - optics
  - mechanical

- Functional testing and test procedures
  Prague labs, Graz SLR

- Development of procedure for internal delay measuring

- Calibration of receiver Attenuation / sensitivity

- Radiation tests

Electronic mechanical design

direct “follow – on” of the previous versions

CSRC Brno

All space qualified components
Except of ADCMP 553
fast comparator, see later

Optical design

Input optics
Wavelength selection, attenuation, FoV
Flat diffuse, Cylinder, Hemisphere, etc

Flat diffuse + shield

- Simple optical design
- No technology problems
- Signal strength well within 1 order of mag. for 10-60 deg.
- No impact on timing properties
- "Macrolon" input window


Entire chain stability ~ 200 fs / hours, +/- 2 K

ELT delays measurement

Ground + Space segments SIMULTANEOUS REFERENCING

Both GROUND & SPACE “absolute delays” will be characterised by a single calibration value / station.

The ELT Engineering Model will be used to detect and time tag in a local time scale

Calibration value computed from - epoch dif. \( (E2-E1) \)
- geometry distance \( L \)

Calibration campaigns – will be organised by TUM and CTU (2014?) in cooperation with ILRS (Transponder Working Group)

presented at IWG#32 Paris April 2010

Conclusion

- European Laser Timing ELT construction is in progress
- We are looking for the participating SLR stations
  on-site H maser
  laser fire +/- 100 ns
- SLR sites calibration campaigns prior / just after the launch