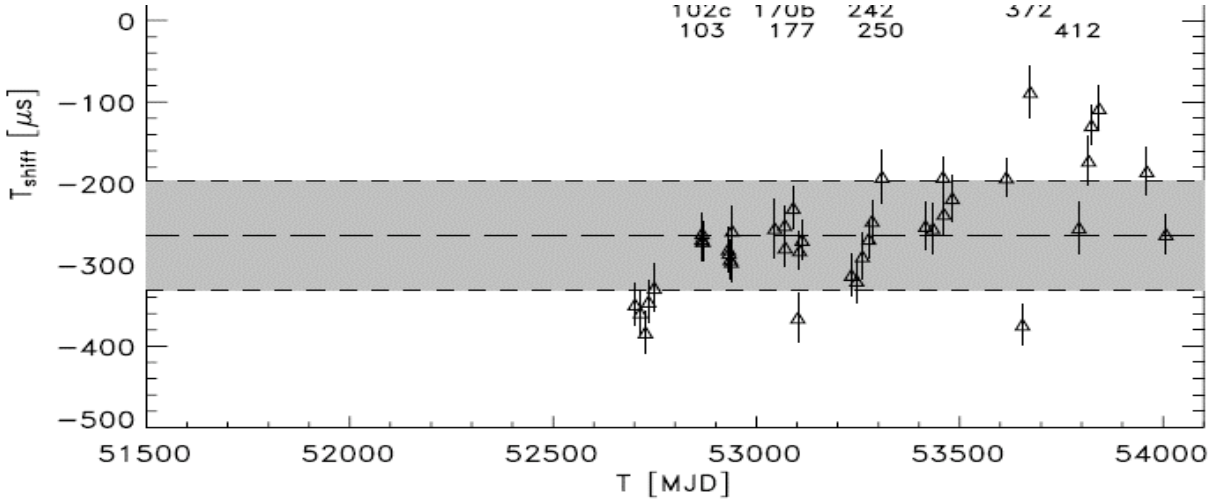
Integral time correlation error - Introduction.

- Requirements on ESOC.
  - Time Correlation Budget 50us.
- Time correlation calculation.
  - OBT correlation calculated from (ERT) – (sum of delays.)
  - Delays are:
    - On-board delay, fixed delay.
    - One way light time, variable depends on Satellite location and Ground Station use.
    - Antenna Delay, fixed but different for each Antenna in use.

Detection of the Problem by ISDC.

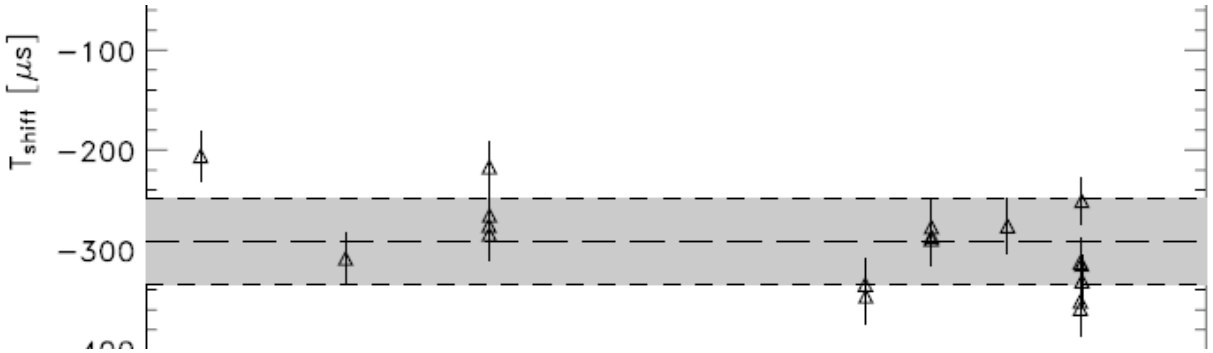
IBIS ISGRI:

Crab Absolute Timing



XMM-Newton:

Crab Absolute Timing

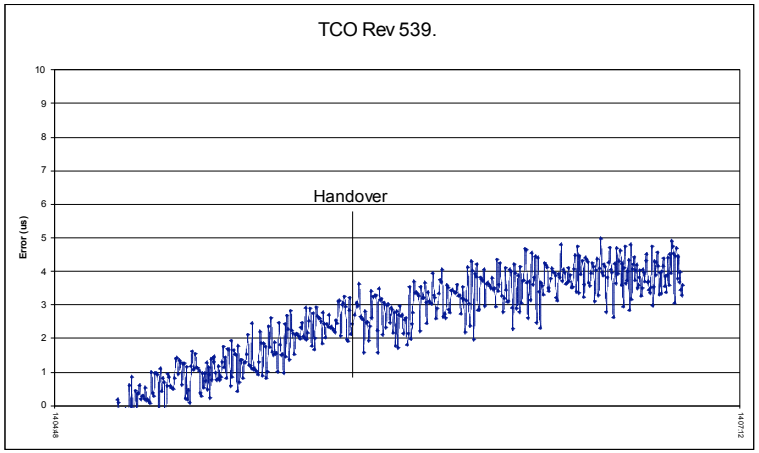


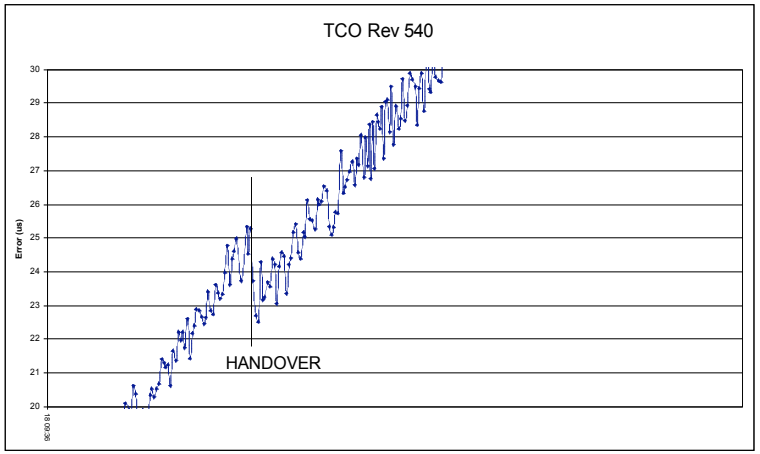
- Initial investigations revealed no problems.
- Detailed check of MCS TCO Functions and Config. files.
- Possible candidate: orbit prediction used to calculate transmission delay.
- Orbit file accuracy checked – OK.
- Transfer of Orbit file to MCS checked in logs – OK.
- Use of new orbit file by MCS – Possible problem!.
  - Message issued by MCS when new orbit file received not always seen when expected.
- Check of all updates since 1/1/2007 carried out.

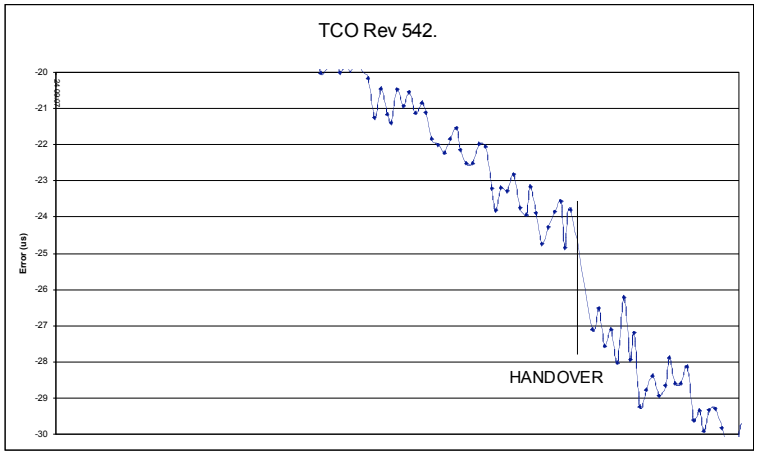
INTEGRAL Time Correlation Error.

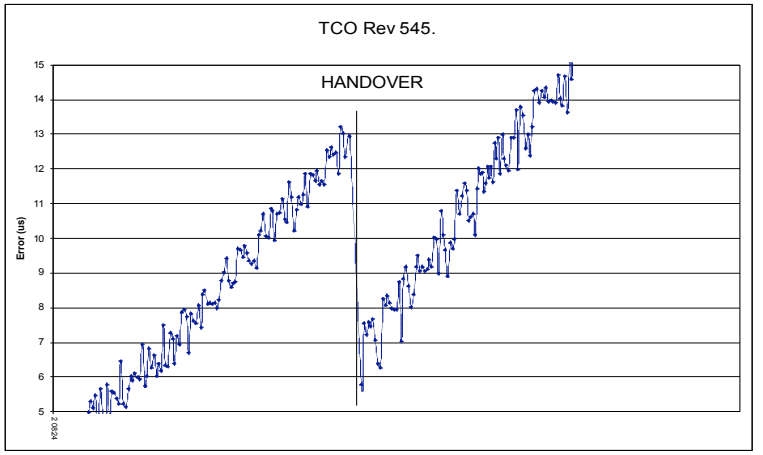
- Several periods were noted when no update was flagged.
- Longest period: revolution 539 to 545.
- Check of jump in station Handover during this time.
  - Quick check, indicative only.
- Check of difference between FD calculated delay and MCS calculated delay.

Evolution of jump in TCO at Station Handover (Expected – Actual ERT).



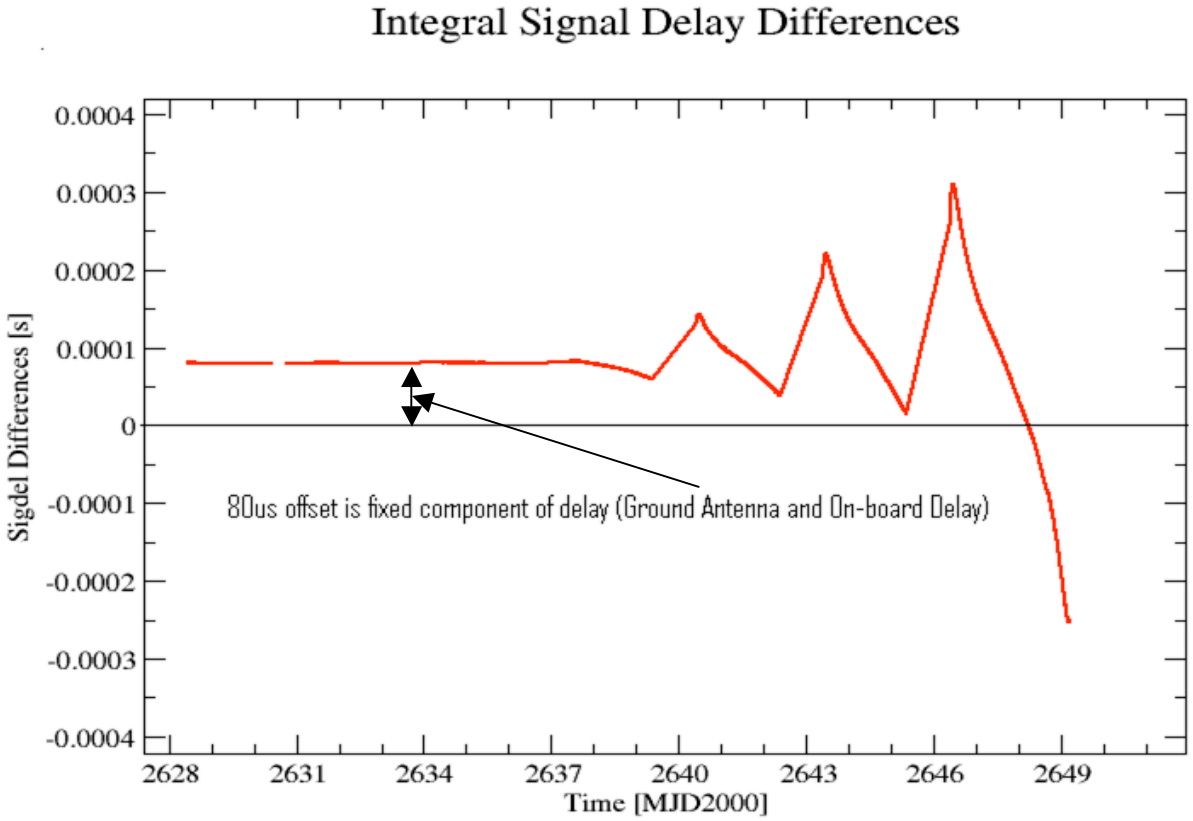






Jump in TCO at Station Handover evolves from 0us to about 7us after 19 days.

Difference between FD and MCS calculated delay, Revolutions 539 to 545.



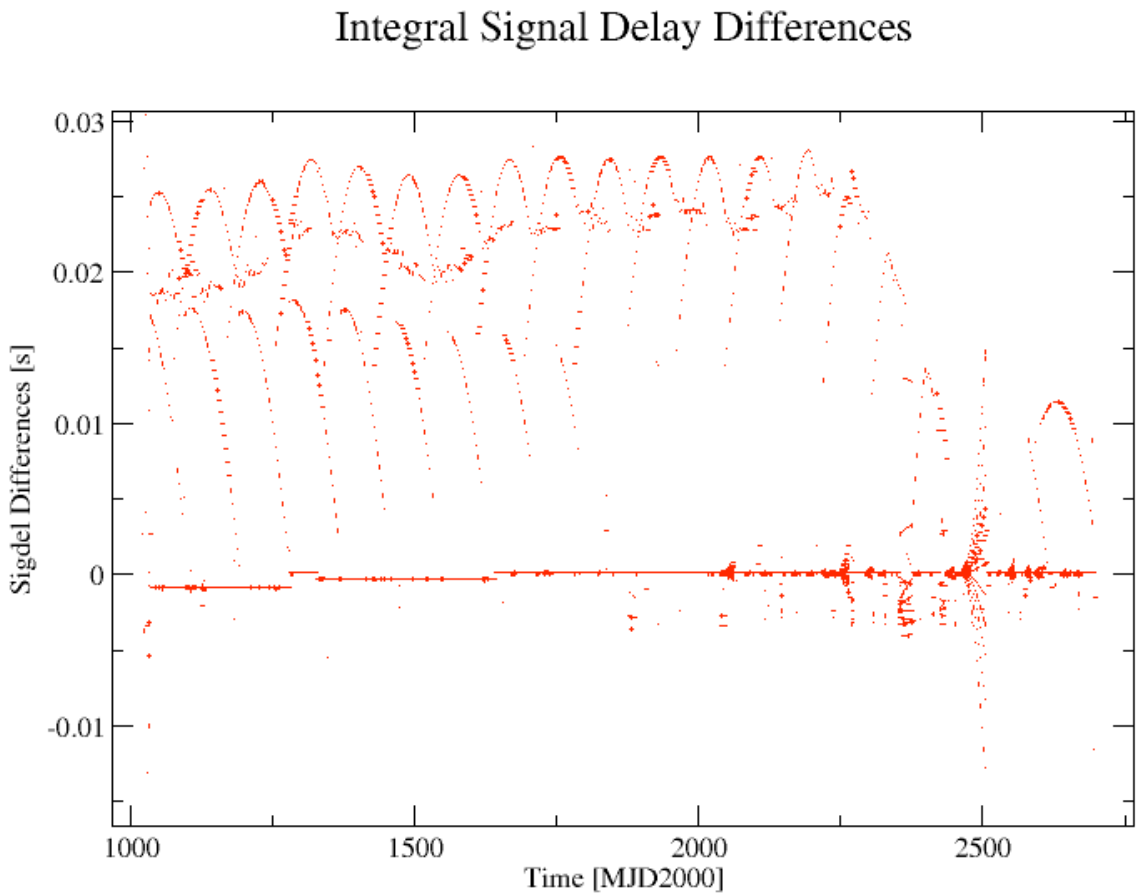
REDU Data only.

Effect is dependant on time since last update. Up to 3 revolutions – negligible.

After 3 revolutions maximum effect increases rapidly.

Maximum error 6 revolutions after Update of Orbit file is about 350us.

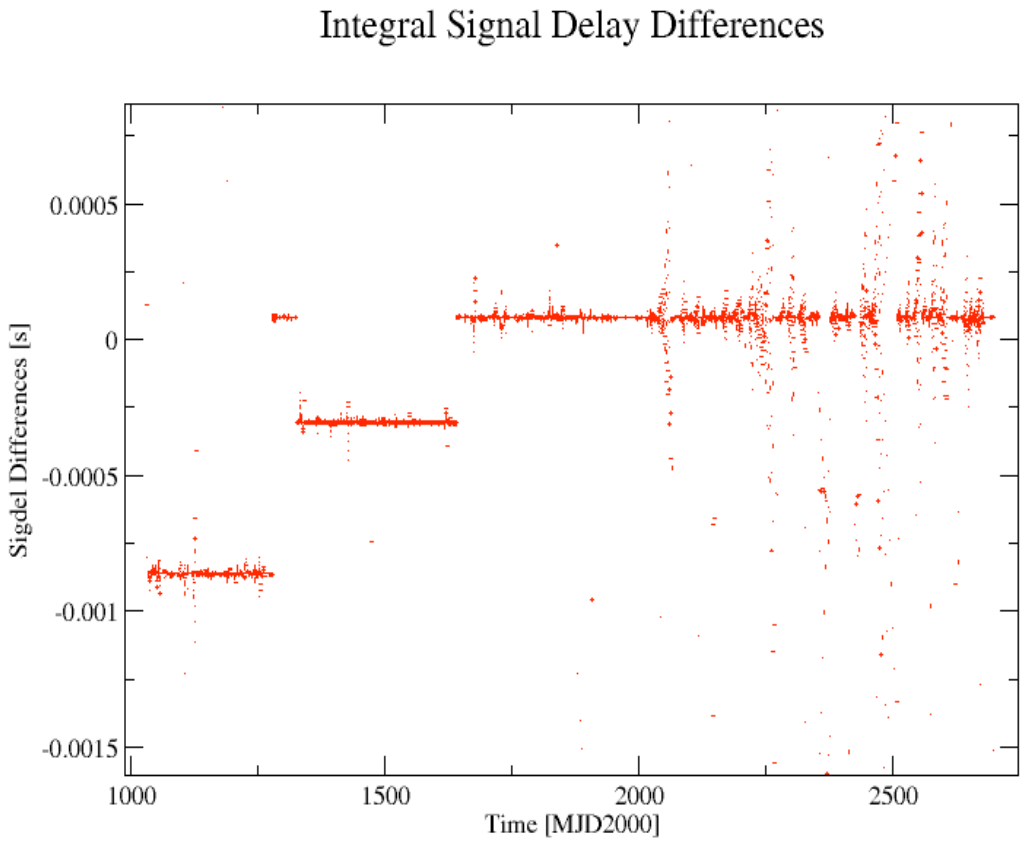
When did the problem first occur?.



Difference between MCS calculated Delay and FD calculated delay, assuming all data is from REDU.

- Parabolas are DSN data.
- Horizontal line is REDU data.

Detail of Previous Plot – REDU only.



Noise seems to start in June 2005.

This corresponds to plots from ISDC.

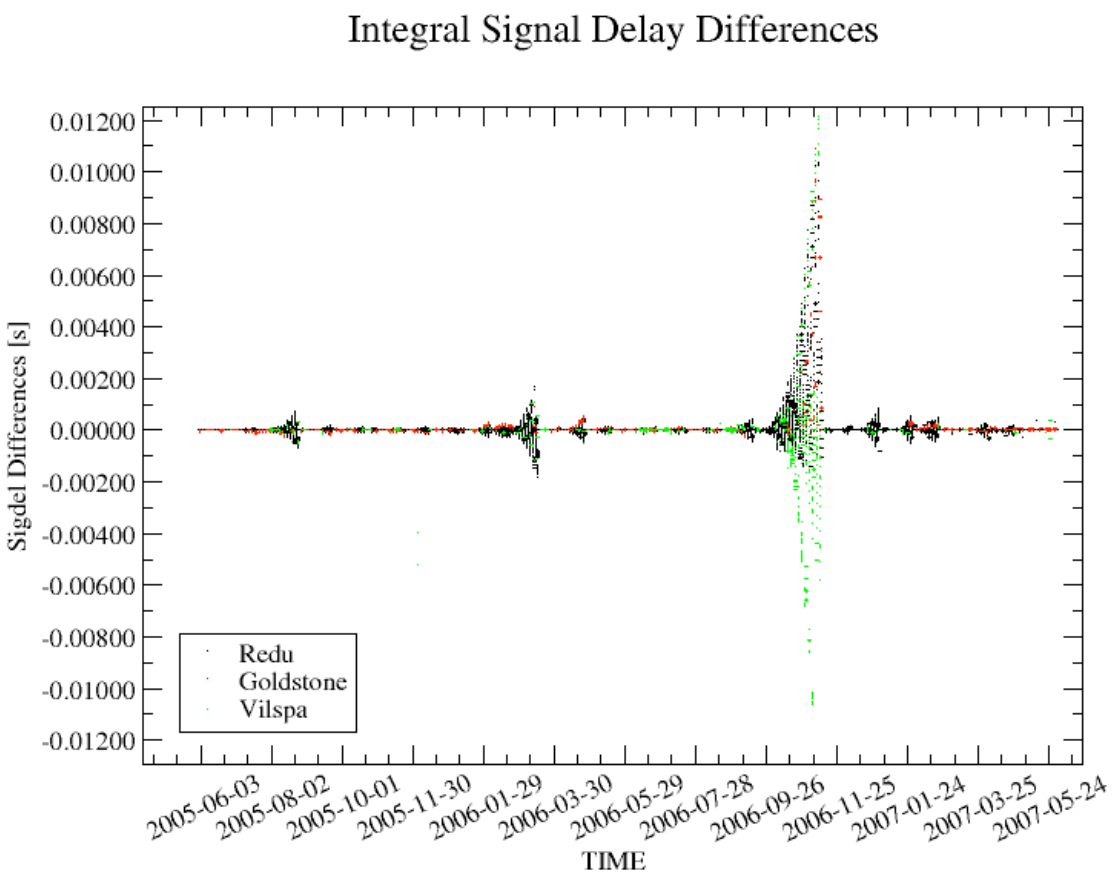
Steps in curve are due to:

- Switch to High Bit Rate.
- On-board Delay commented out in MCS Configuration File.
- On-board Delay restored in MCS Configuration File.

INTEGRAL Time Correlation Error.

- In June 2005 the infrastructure software used by MCS was upgraded.
- Change in the way internally generated variable values were Broadcast to users.
- XMM affected identically.
  - XMM SOC generate also TCO Data, hence only MOC affected.

Magnitude of Errors and affected Periods.



- Errors Since June 2005 to present.
- Worst case approximately 15ms after 50 days without update of orbit file.

Magnitude of Errors and affected Periods.

All Points - Number of Points: 16851

- 0 to 50 us: 13085 data points 77.65%
- 50 to 100us: 1343 data points 7.97%
- 100 to 300us: 1227 data points 7.28%
- >300sus: 1196 data points 7.10%

All Points apart from really poor 50 Days - Number of Points: 15703

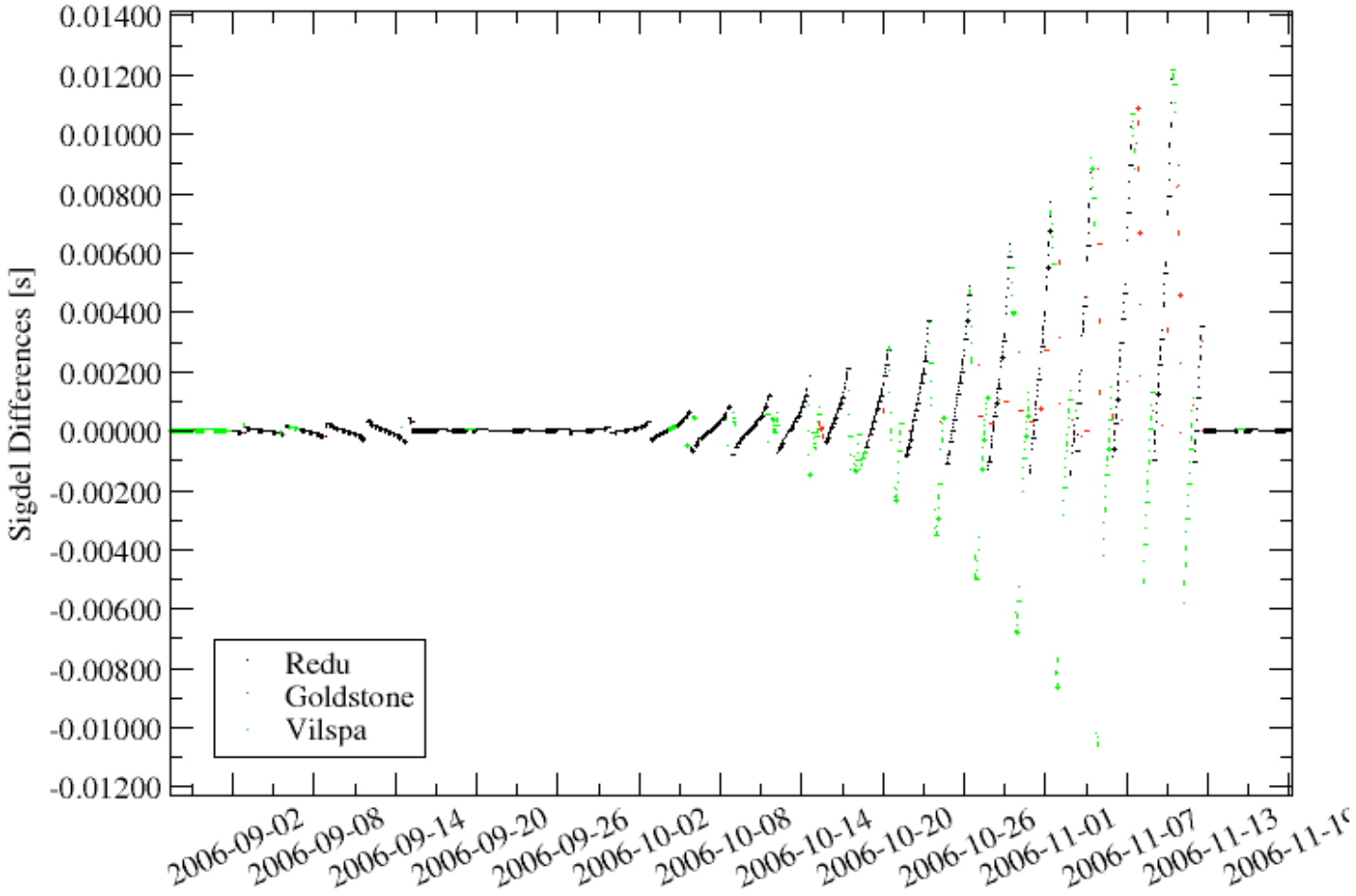
- 0 to 50 us: 12820 data points 81.64%
- 50 to 100us: 1268 data points 8.07%
- 100 to 300us: 1063 data points 6.77%
- >300sus: 552 data points 3.52%

Really poor 50 Days (DOY 2455 to 2505) - Number of Points: 1148

- 0 to 50 us: 265 data points 23.08%
- 50 to 100us: 75 data points 6.53%
- 100 to 300us: 164 data points 14.29 %
- >300sus: 644 data points 56.10%

Statistics:
June 2005 to present.
Time between samples = 1 hour.

Details of worst Affected Period.



Fix for problem.

- Fix is to force a read of the orbit file at every transfer.
  - Fix is developed and currently under test.
  - Fix will be deployed before end of June.
- Current (successful) workaround, is to manually restart TCO calculation after every transfer.
  - Maximum error observed with this method using REDU is about 12us, probably due to difference between predicted orbit used on MCS and reconstituted orbit used in FD calculation.
- Periodic (monthly) manual comparison of MCS and FD calculated delays for each REDU and DSN.
- ESOC will investigate the possibility of a check on the jump in TCO at station Handover – possibility of false error detection if threshold set too low.

Reprocessing of historical data.

- Option 1:.
  - Reprocess all data from June 2005.
  - Use reconstituted orbit data => slightly more accurate than using predictions.
  - Regenerate all OLFs from June 2005 – TCO data only!.
  - Compensate for incorrect Station Delay of 47us – tbc by ISDC
  - Complete by End of June.
- Option 2.
  - Reprocess all data from launch.
  - Use reconstituted orbit data => slightly more accurate than using predictions.
  - Regenerate all OLFs from launch – TCO data only!.
  - Complete by tbd (end 2007?).
  - Fixes all other TCO problems:
    - Incorrect Station delay, launch until now – magnitude 47us
    - Incorrect On-board delay, launch until July 2003 – magnitude 867us.
    - Incorrect On-board delay 20/8/2003 until 28/6/2004 – magnitude 385us