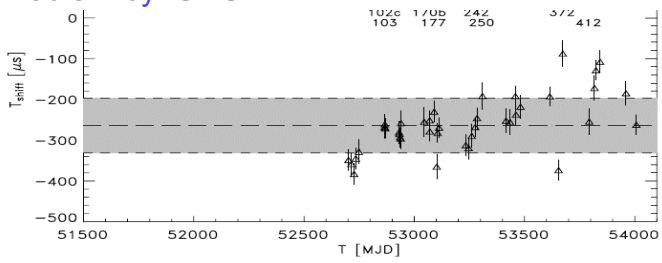
Integral time correlation error - Introduction.

- Requirements on ESOC.
  - Time Correlation Budget 50us.
- Time correlation calculation.
  - OBT sample time calculated from: (frame 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.

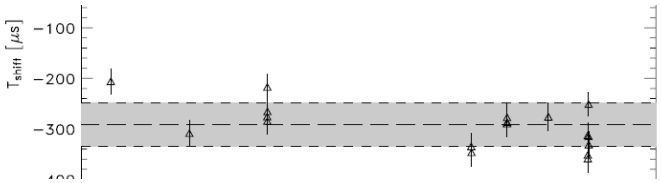
IBIS ISGRI:

Crab Absolute Timing



XMM-Newton:

Crab Absolute Timing



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Source of problem.

Use of new orbit file by MCS to calculate one way light time.

- Message issued by MCS when new orbit file received not always seen when expected.

- Check of all updates since 1/1/2007 carried out.
  - Several periods were noted when no update was flagged.
  - Longest period: revolution 539 to 545.
- Two independent checks:
  - Check of jump in station Handover during this time.
  - Check of difference between FD calculated delay and MCS calculated delay.

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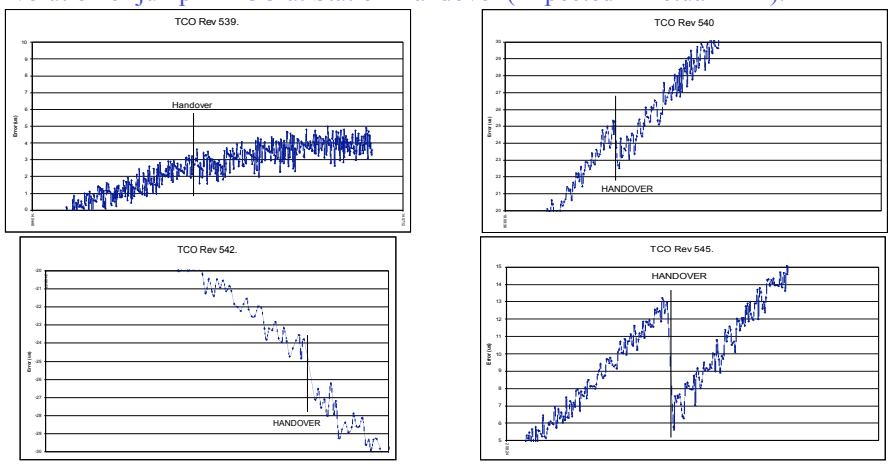
Evolution of jump in TCO at Station Handover (Expected – Actual ERT).



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

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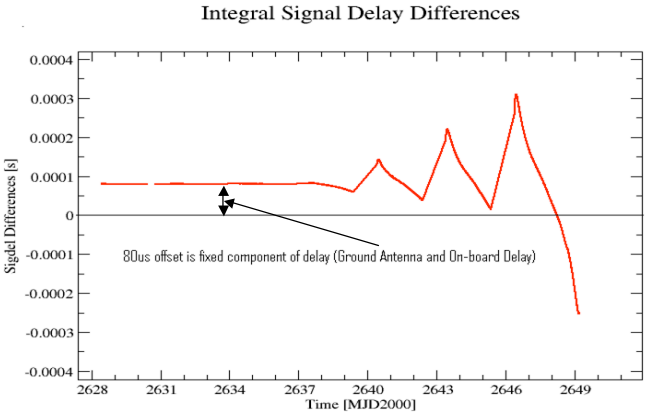
Difference between FD and MCS calculated delay, Revolutions 539 to 545.



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.

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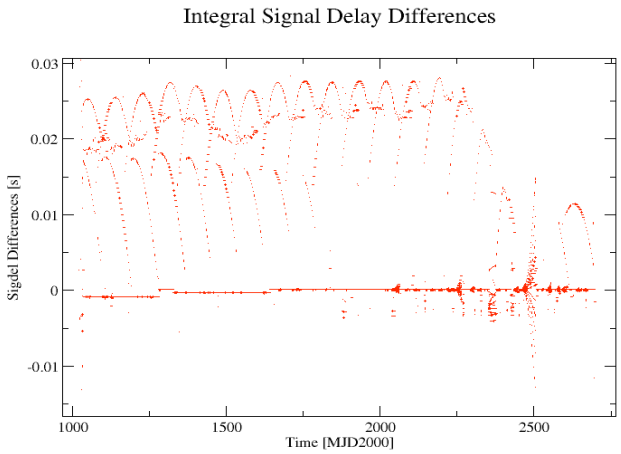
When did the problem first occur?.

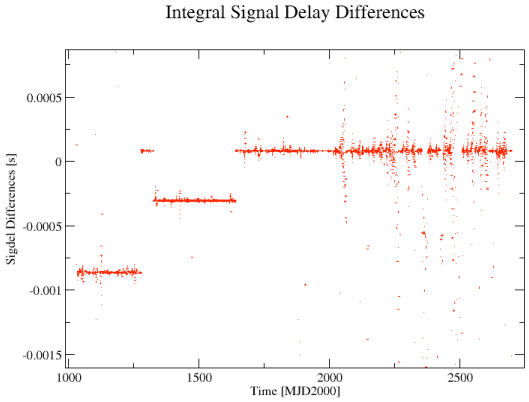


Difference between MCS calculated Delay and FD calculated delay, assuming all data is from REDU.

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

INTEGRAL Time Correlation Error.

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 known problems / changes:

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

- June 2005: infrastructure software used by MCS was upgraded.
  - Change in the way internally generated variable values were Broadcast to users.

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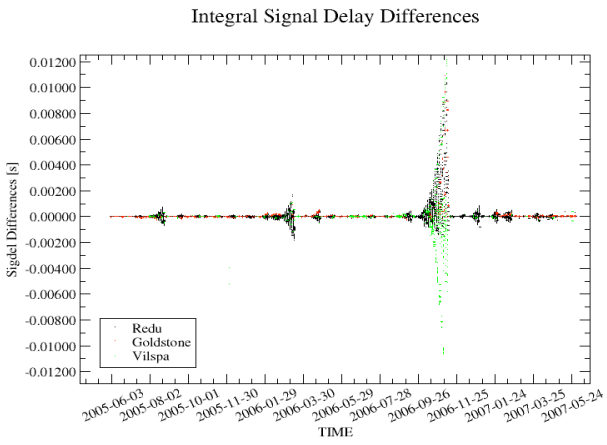
Magnitude of Errors and affected Periods.



- Errors Since June 2005 to July 2007.
- Worst case approximately 15ms after 50 days without update of orbit file.
- Worst errors are seen at perigee.

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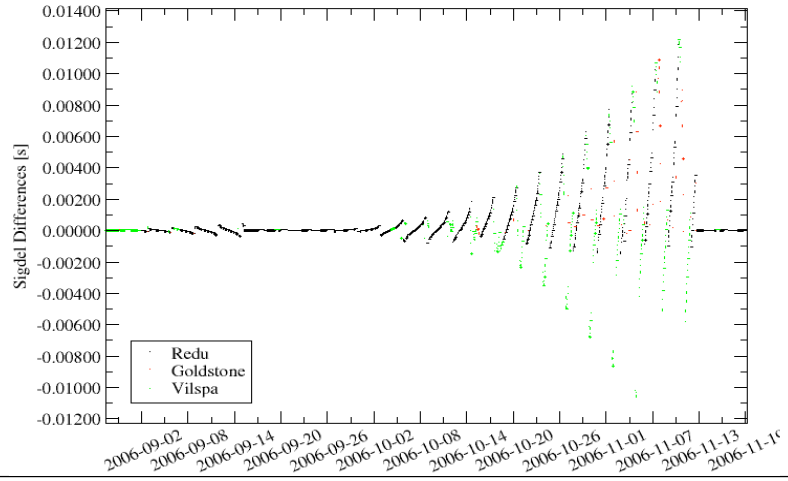
Details of worst Affected Period.



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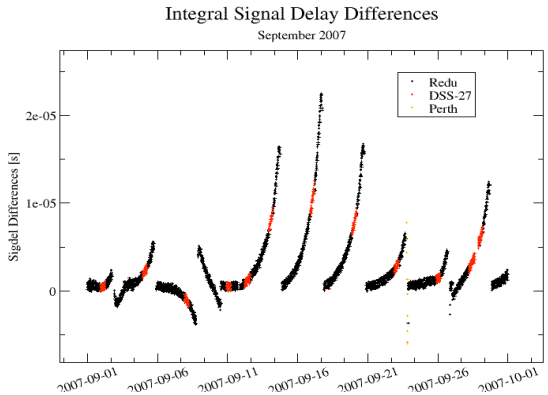
- Fix is to force a read of the orbit file at every transfer.
  - In use since June 2007.
- Monthly comparison of MCS and FD calculated delays.



September 2007, Maximum Observed Error: 23us

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Reprocessing of historical data.

- Reprocess all data from launch.
- Use reconstituted orbit data => slightly more accurate than using predictions.
- Regenerate all OLFs from launch.
- 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
  - Occasional Station timing problems.

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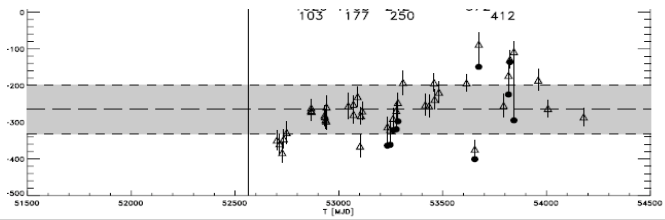
Reprocessing of historical data.

- Test batch of recreated OLFs generated, revolutions: 225, 229, 234, 239, 242, 365, 372, 420, 422, 428.
- Results show in general an improvement.
  - Old: Δ, New:●
  - Some corrections are the wrong way.
  - Some corrections smaller than expected



INTEGRAL Time Correlation Error.

Reprocessing of historical data.

- Agreed to recreate OLFs, for all CRAB revolutions.
- Forwarded to ISDC, early September
- Revolutions: 47, 51, 55, 58, 63, 102, 103, 123, 124, 125, 126, 127, 162, 170, 177, 181, 182, 184, 250, 286, 292, 300, 301, 308, 352, 412, 468, 483, 541.
- Feedback awaited.