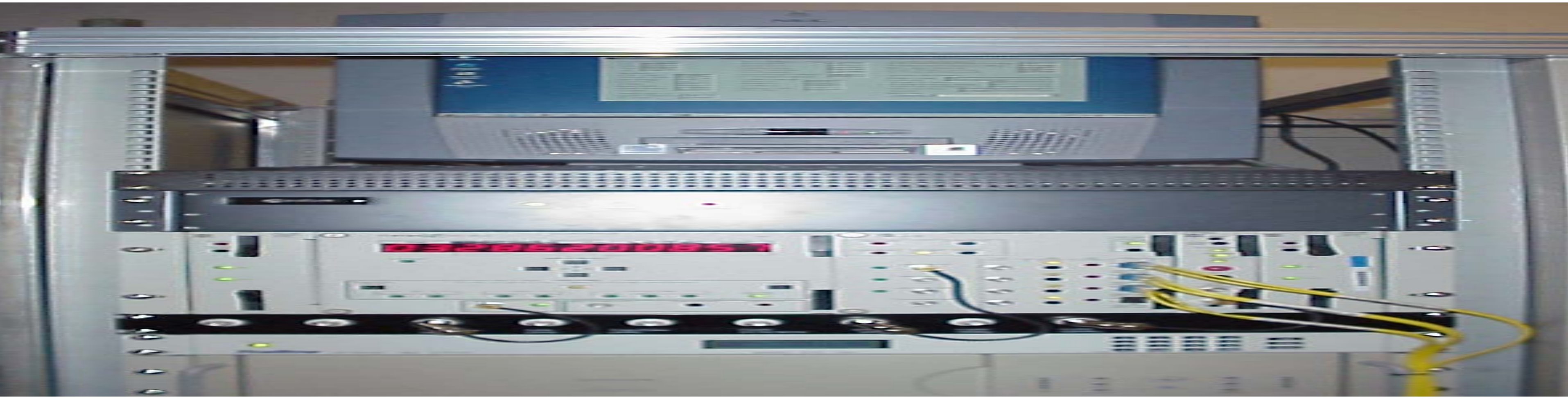
On detector timing: the dawn of S3

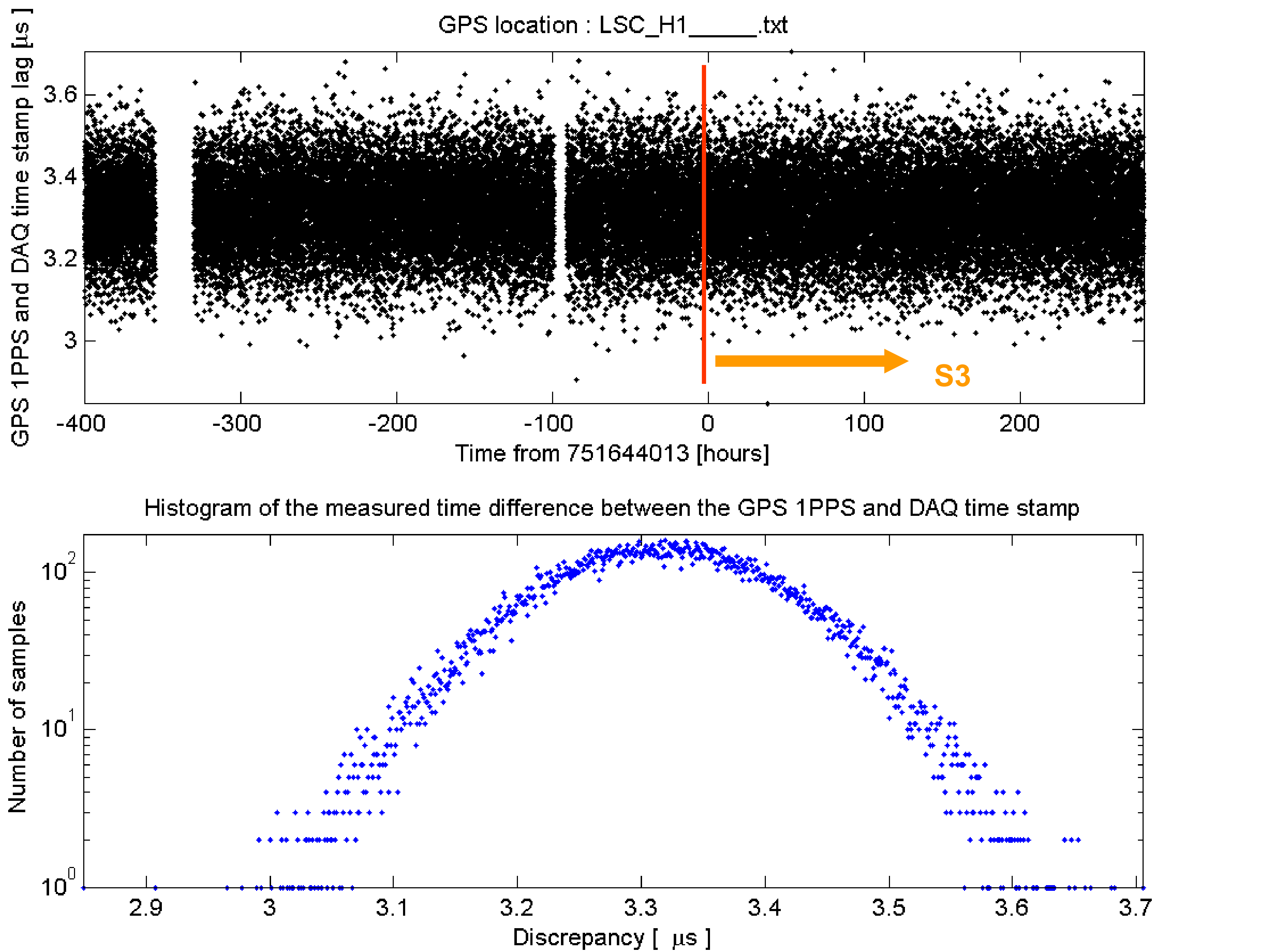


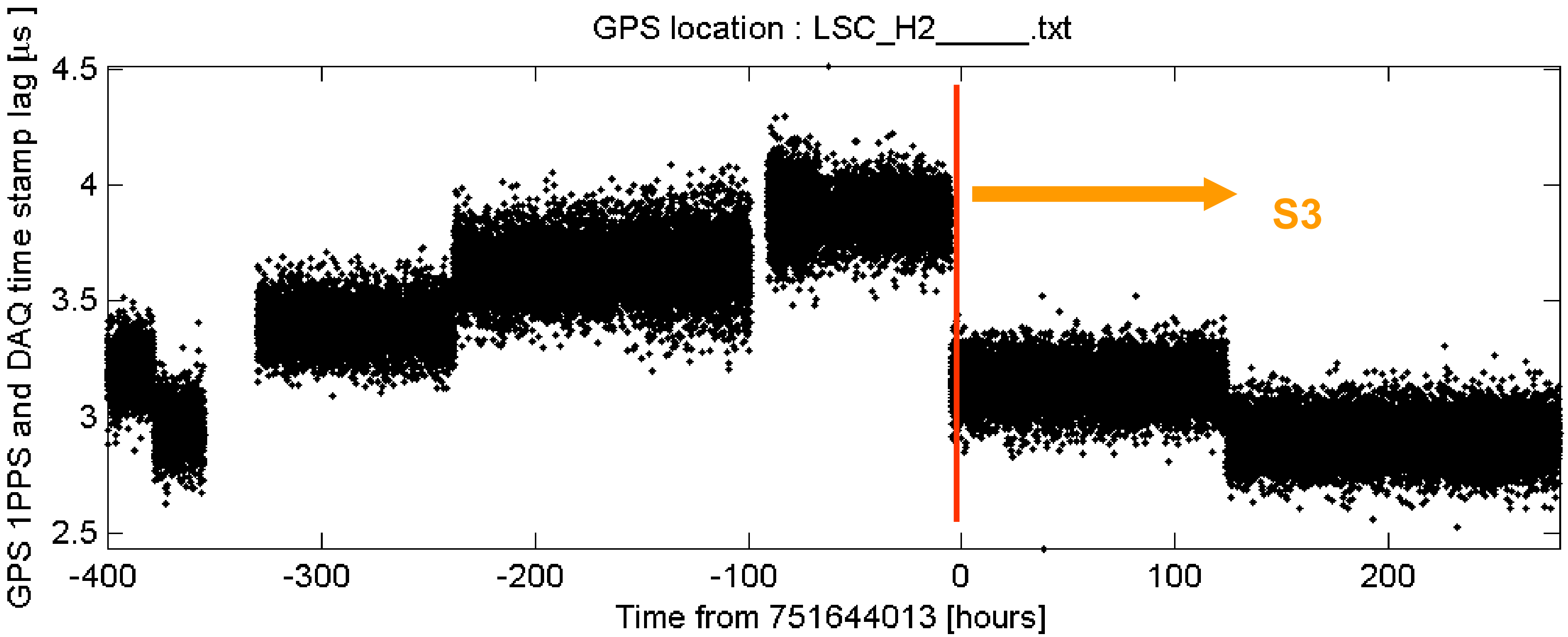
Szabolcs Márka, Daniel Sigg and Dave Barker

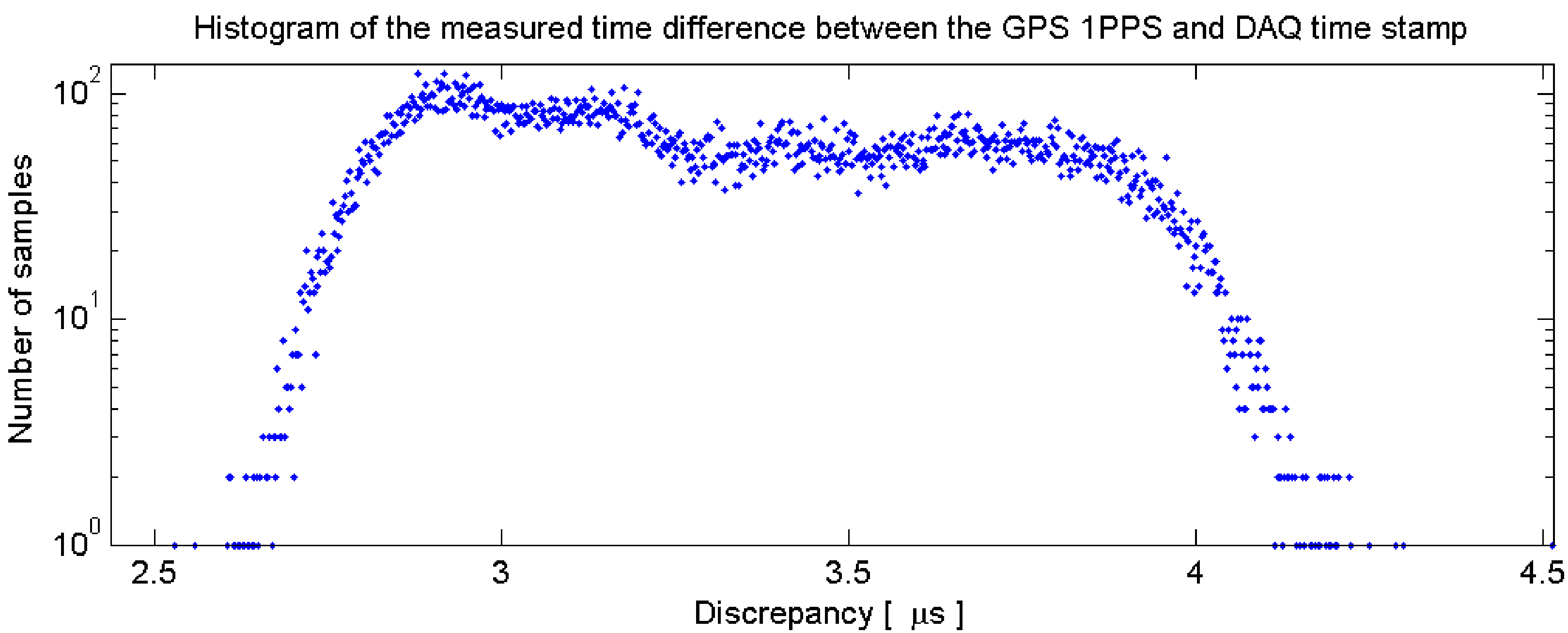
LSC meeting, November 2003, Hanford

Outline

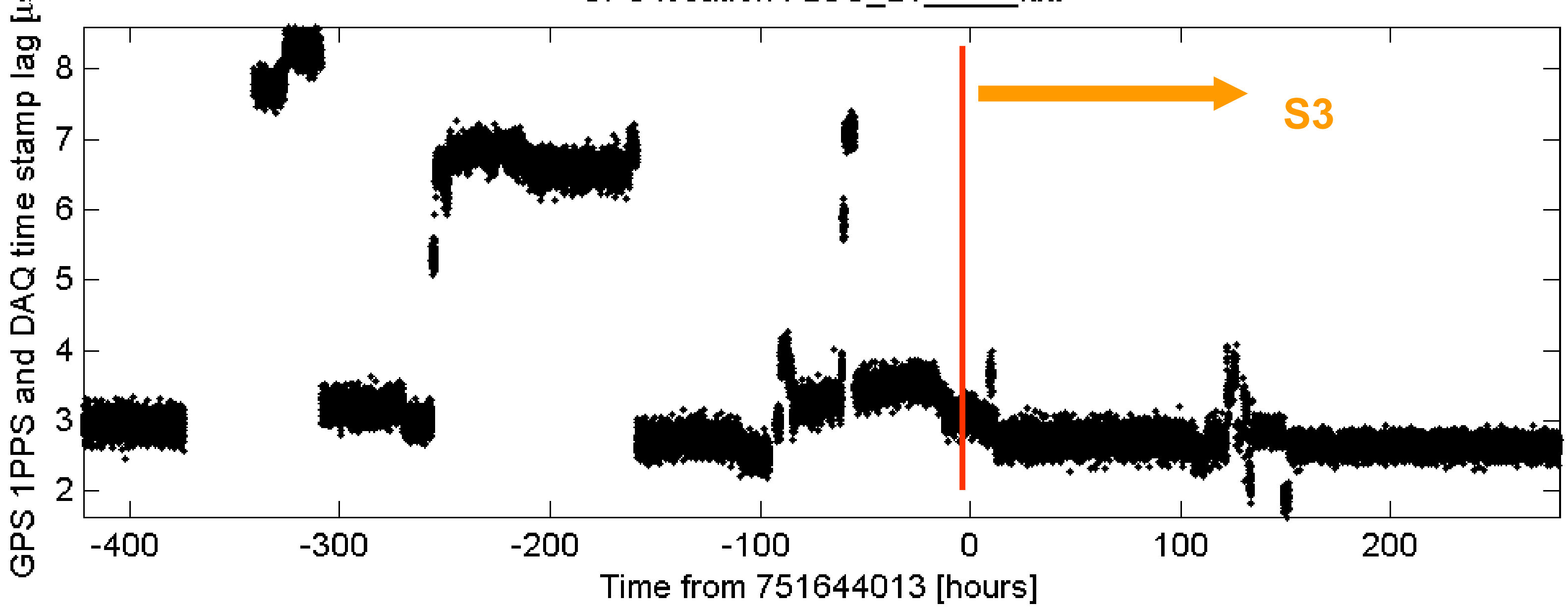
- DAQ timing measurements for the last 4 weeks
  - » LHO 4K
  - » LHO 2K
  - » LLO 4k
- Caesium clock based timing system
  - » Overview of instrumentation
  - » Status
  - » LLO problem identified and eliminated
  - » LHO results for all LVEs
- Summary


GPS location : LSC_H1_____.txt
GPS 1PPS and DAQ time stamp lag [µs]
3.6
3.4
3.2
3
-400
-300
-200
-100
0
100
200
S3
Time from 751644013 [hours]
Histogram of the measured time difference between the GPS 1PPS and DAQ time stamp
Number of samples
10^2
10^1
10^0
2.9
3
3.1
3.2
3.3
3.4
3.5
3.6
3.7
Discrepancy [µs]

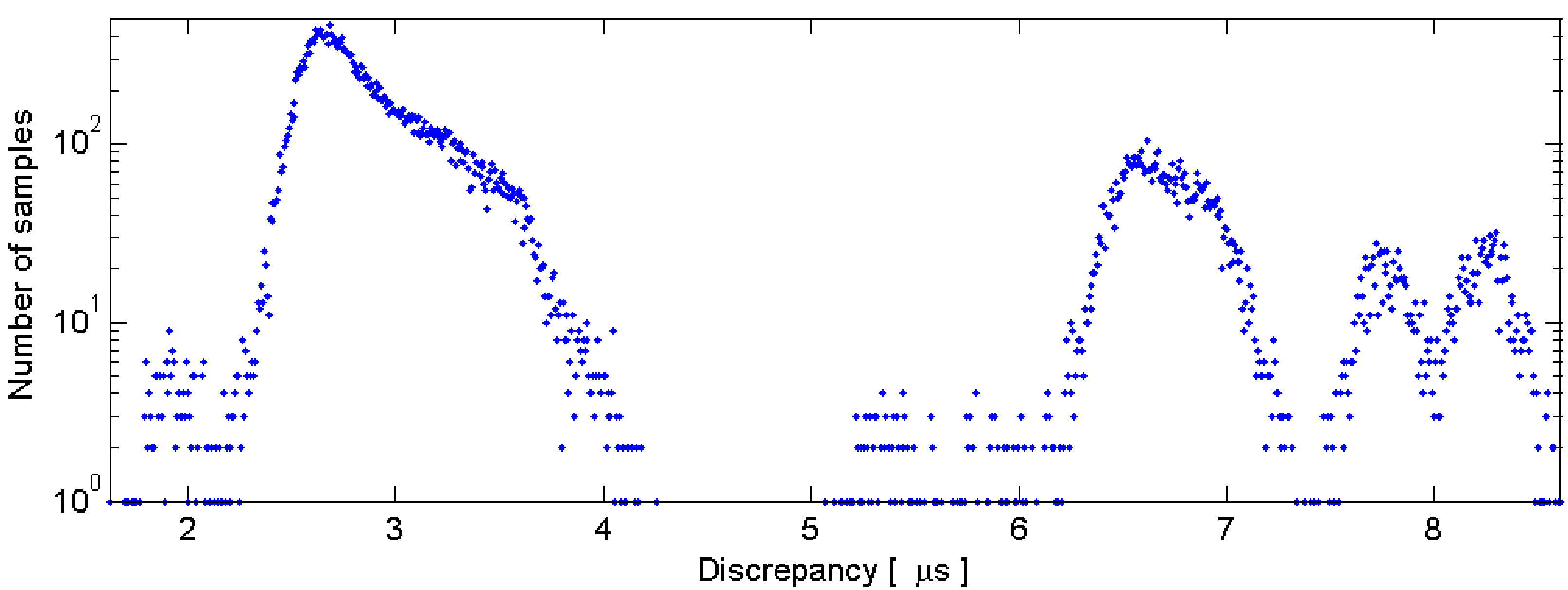

GPS location : LSC_H2______.txt
GPS 1PPS and DAQ time stamp lag [µs]
4.5
4
3.5
3
2.5
-400
-300
-200
-100
0
100
200
Time from 751644013 [hours]
S3


Histogram of the measured time difference between the GPS 1PPS and DAQ time stamp
Number of samples
10^2
10^1
10^0
2.5
3
3.5
4
4.5
Discrepancy [µs]

GPS location : LSC_L1_____.txt



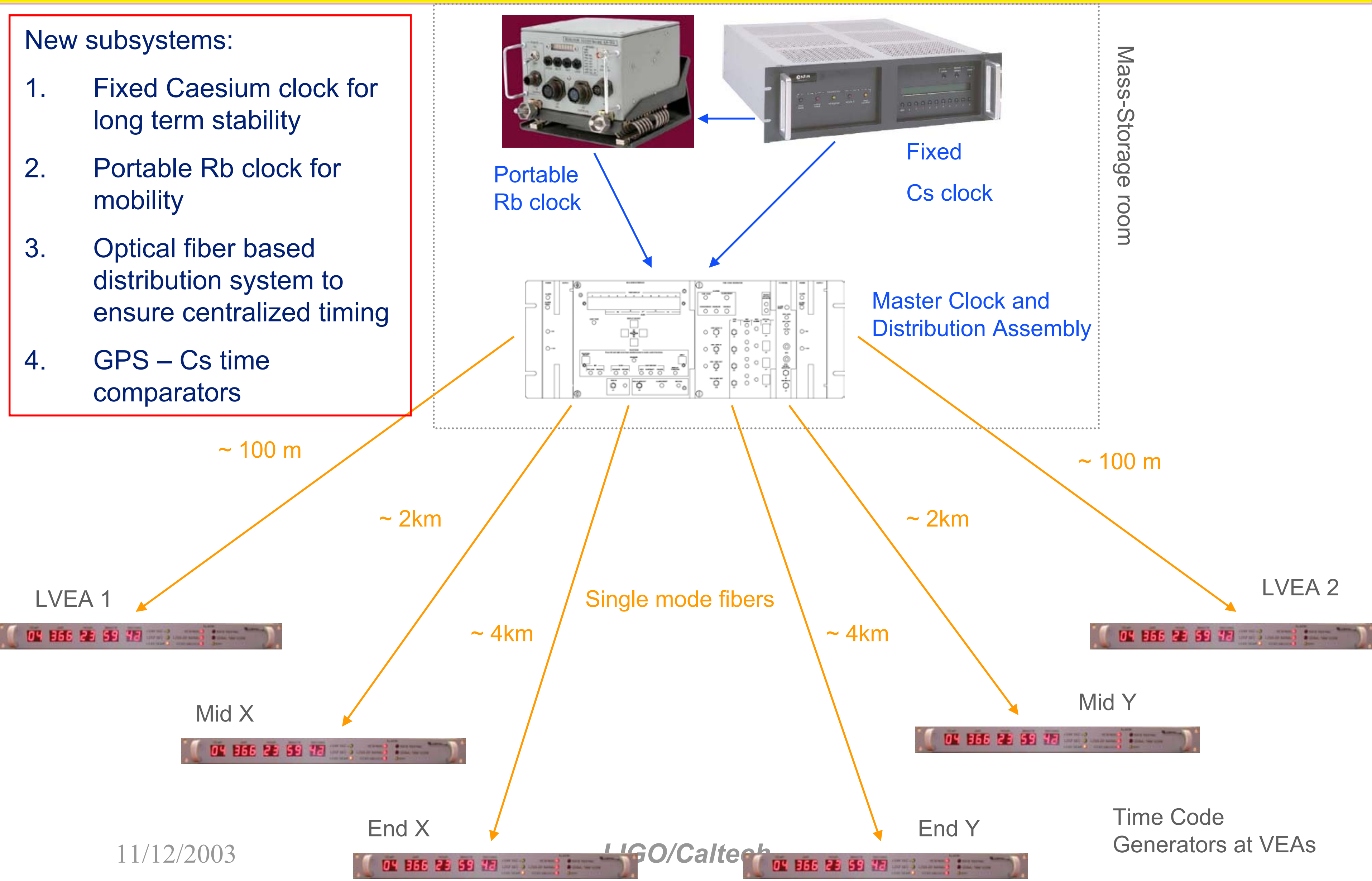
Histogram of the measured time difference between the GPS 1PPS and DAQ time stamp



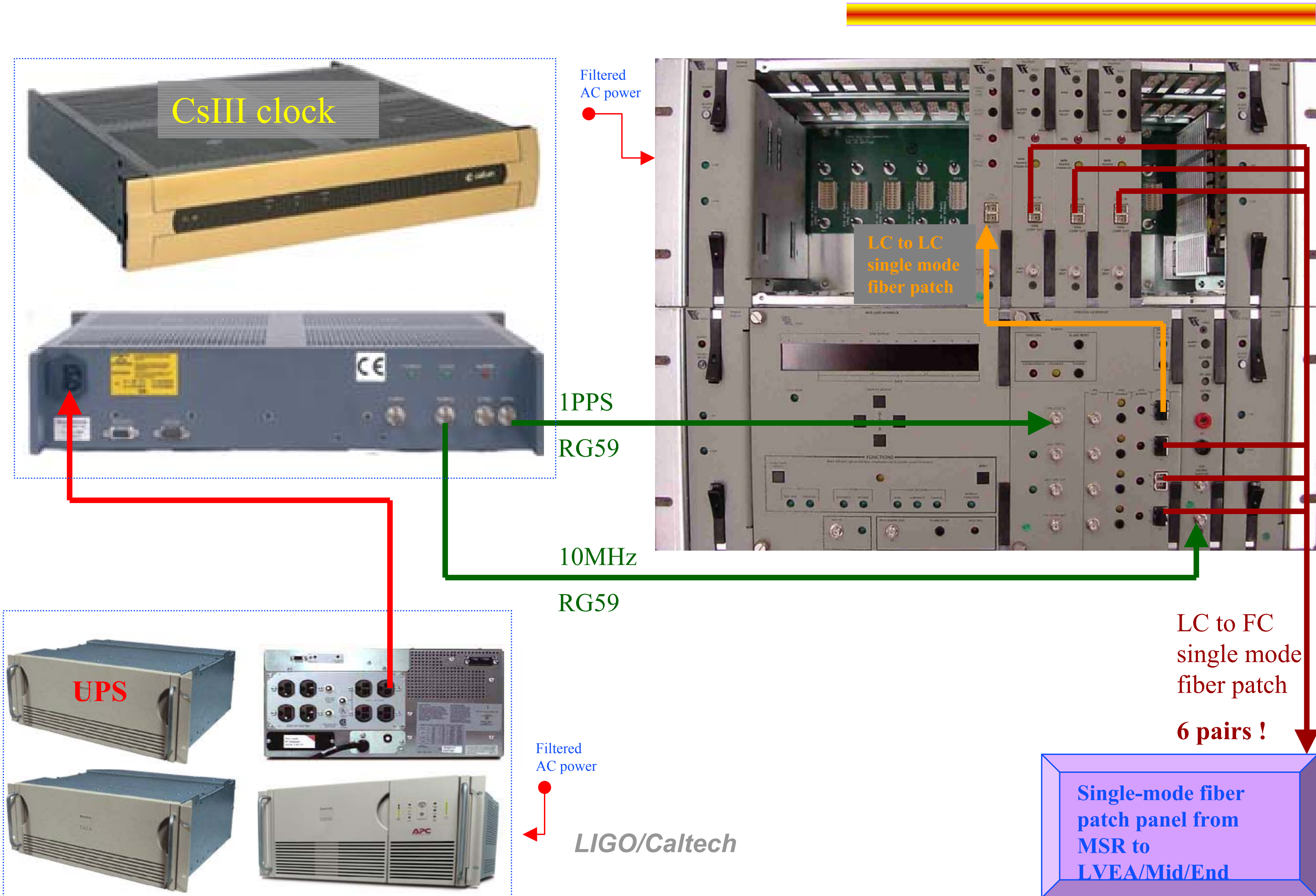
Timing distribution system geometry

New subsystems:

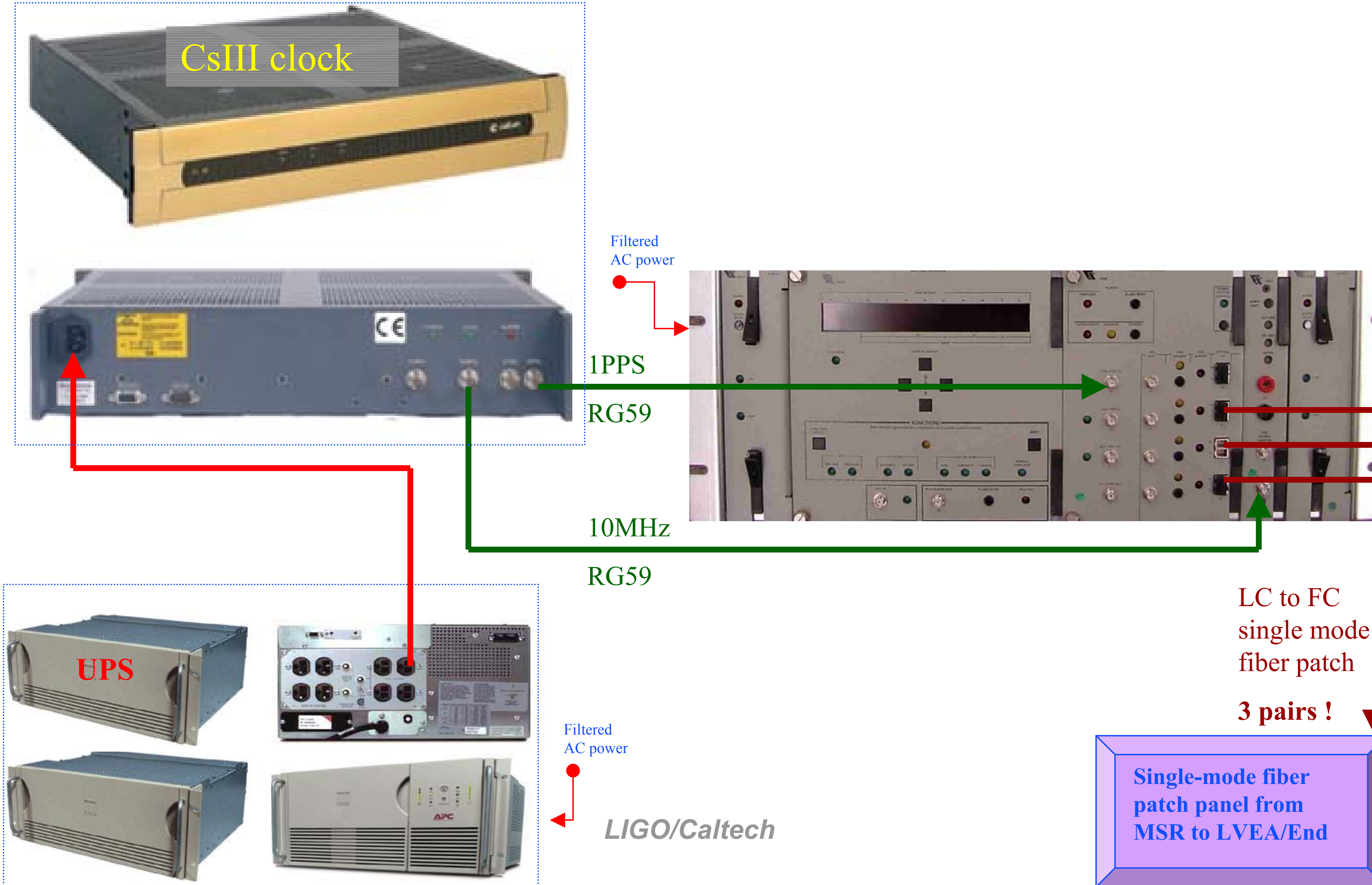
1. Fixed Caesium clock for long term stability
2. Portable Rb clock for mobility
3. Optical fiber based distribution system to ensure centralized timing
4. GPS – Cs time comparators



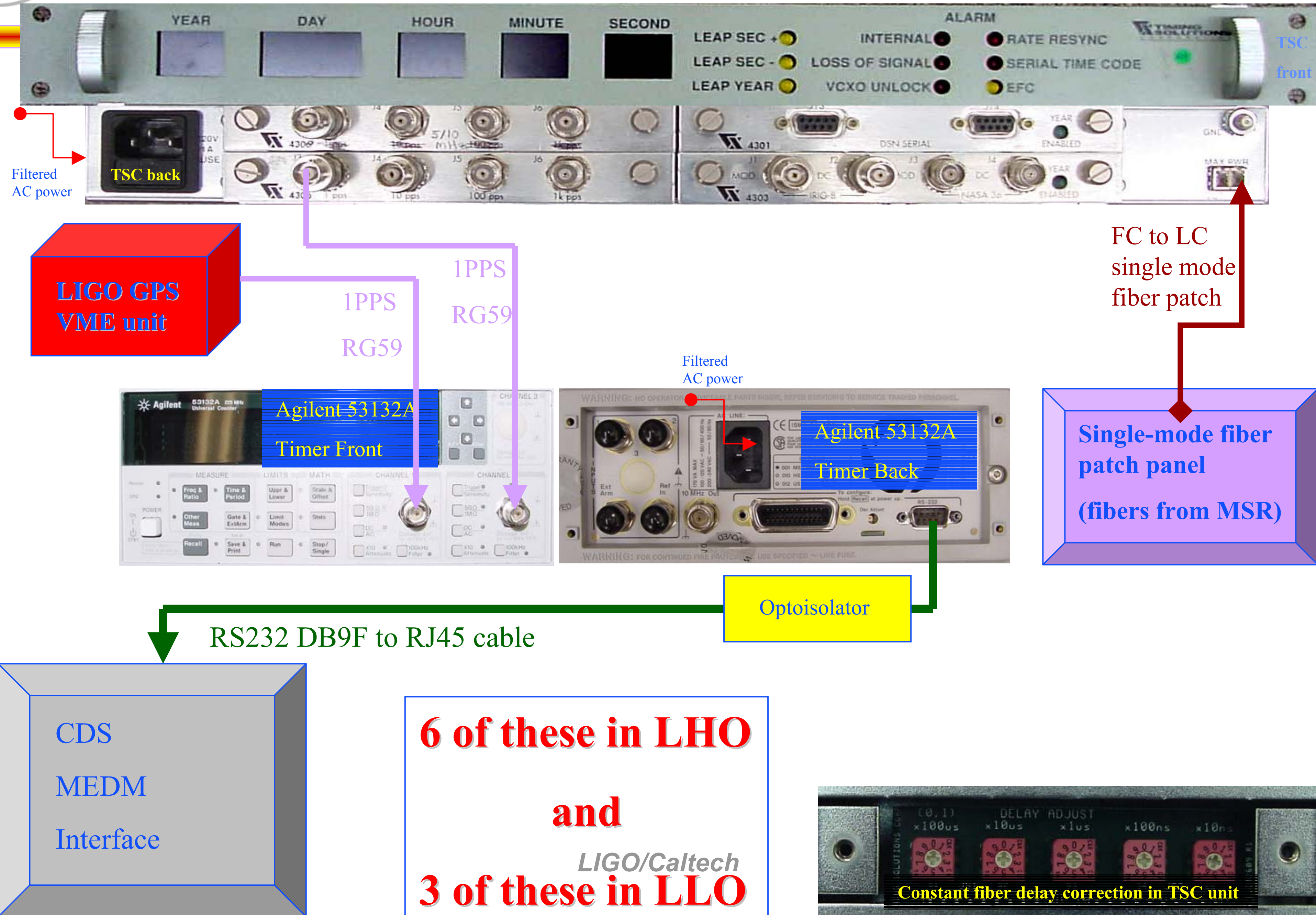
Timing distribution system components at MSR at LHO



Timing distribution system components at MSR at LLO



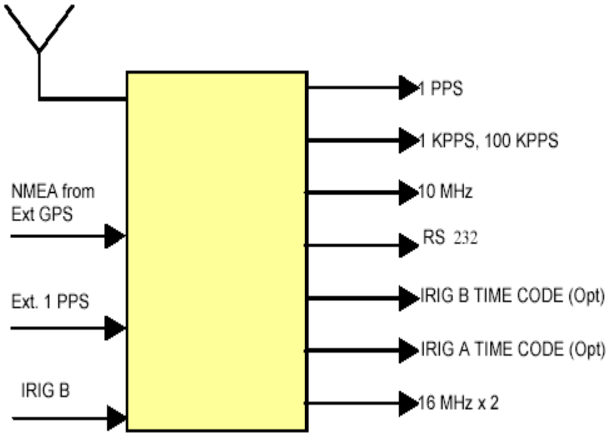
Timing distribution system components at LVEA/Mid/End stations



Preferred portable Rubidium clock

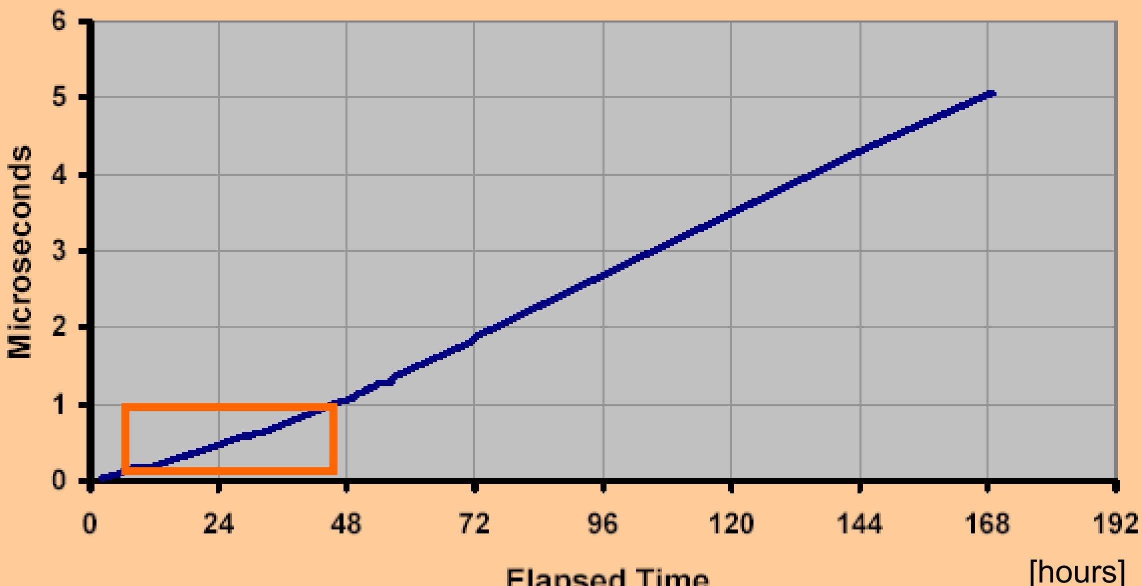
Main Features:

- GPS with Rubidium clock
- Outputs of 10MHz, 1PPS, IRIG B, RS232
- Inputs of 1 PPS, IRIG-B, 10MHz
- Time Accuracy: 1μs relative to UTC (std.)
  50ns relative to UTC (option)
- Frequency Accuracy: 2E-12
- Display of Time, Date, Status & BIT
- 1-hour Rechargeable Battery Back-up
- Built In Test - Up to 97%
- Operating Temperature: -20°C to +65°C (71°C for 30 min)
- Holdover (no GPS): 1μs/24hours, 5E-11/month
- Full MIL-STD Qualification for Mil. Applications.

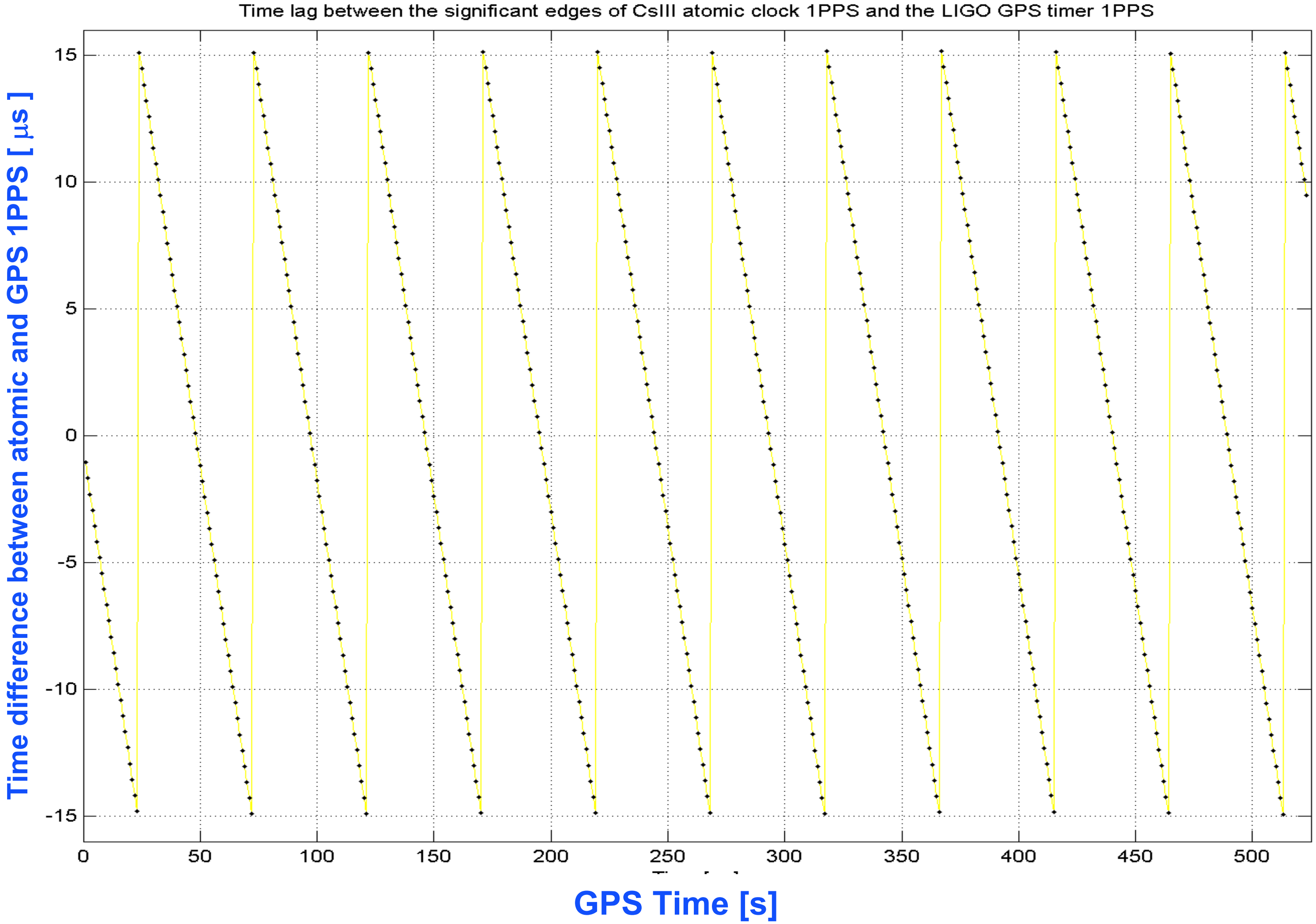


AR-51A Inputs / Outputs

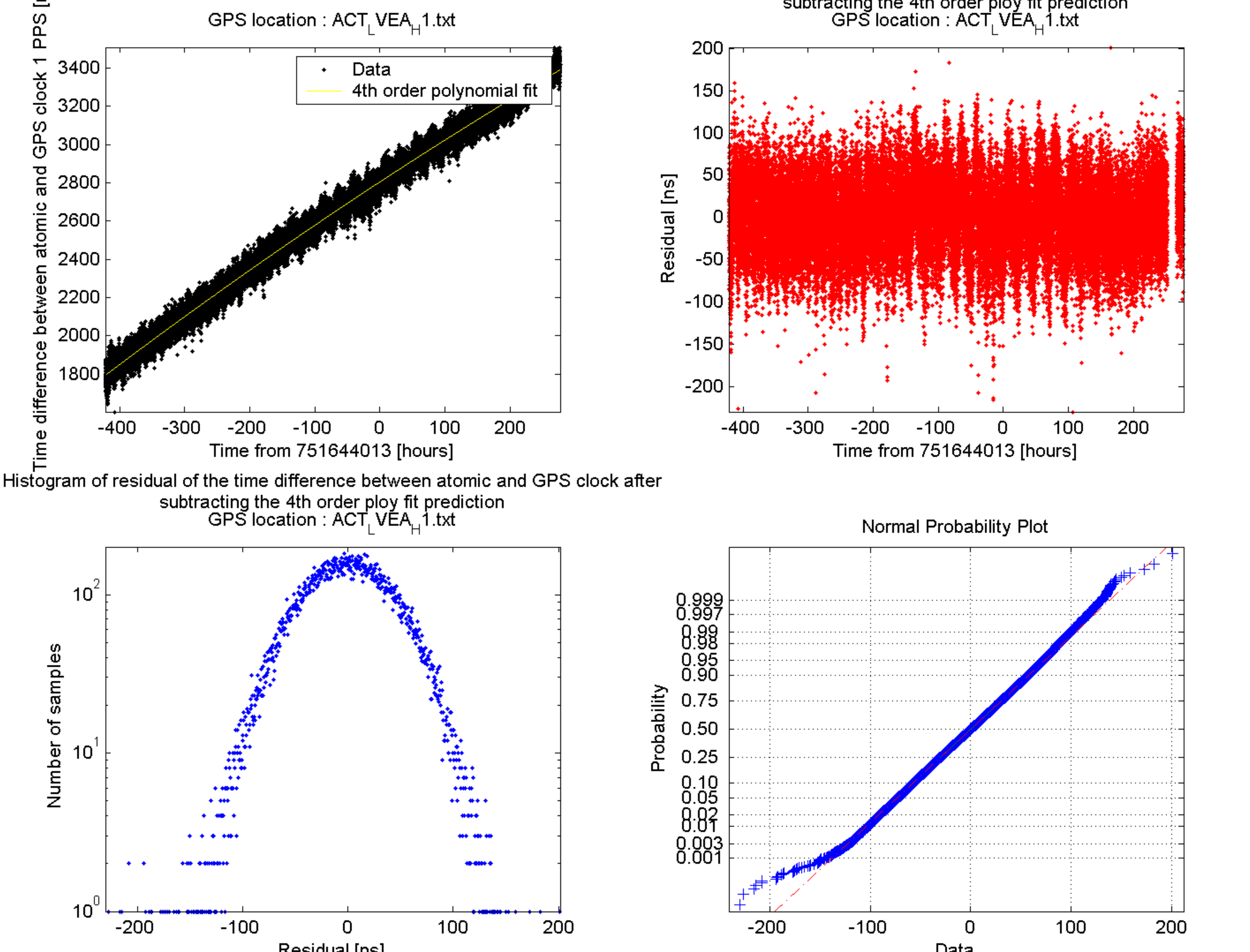
Typical Time Error in Holdover

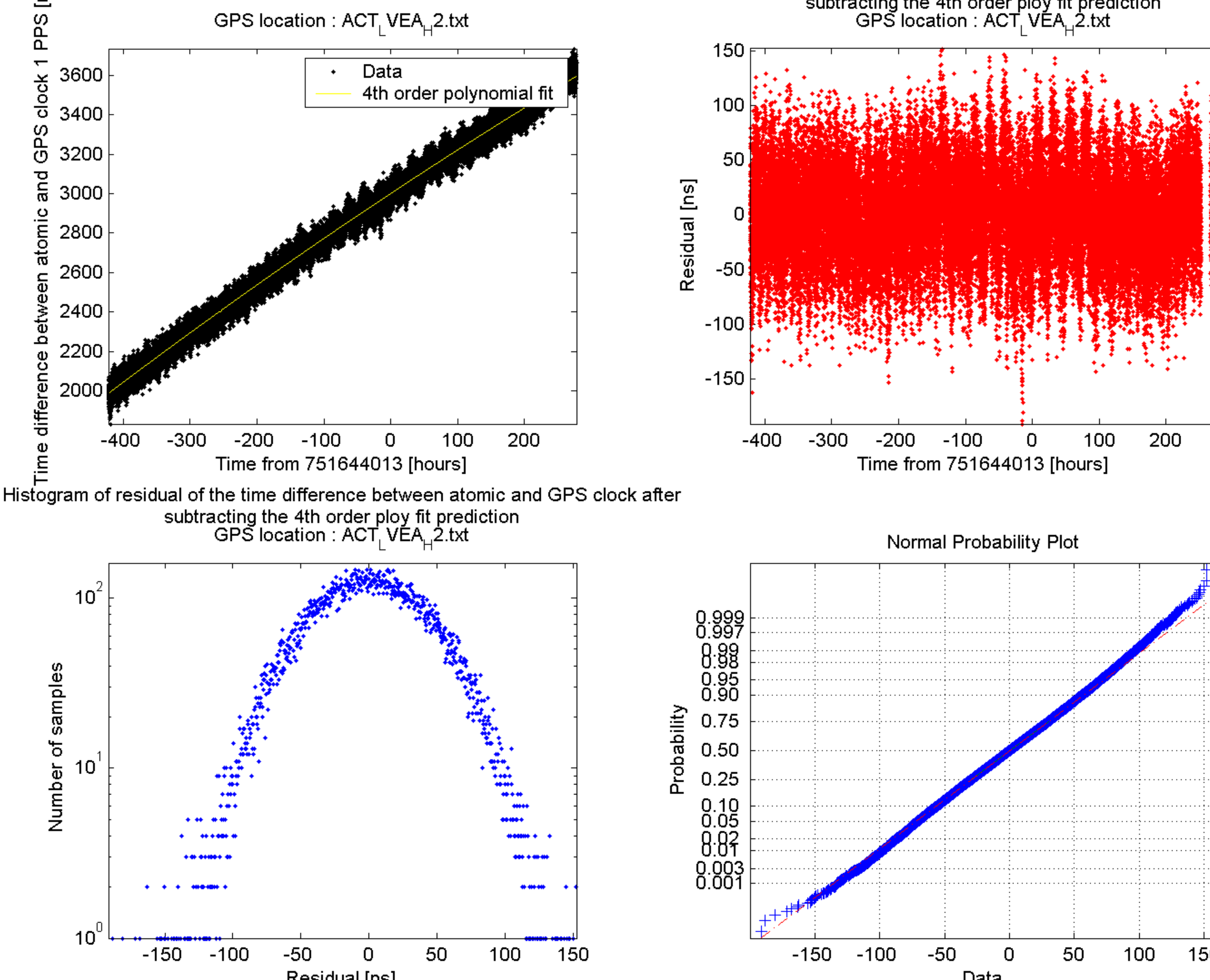


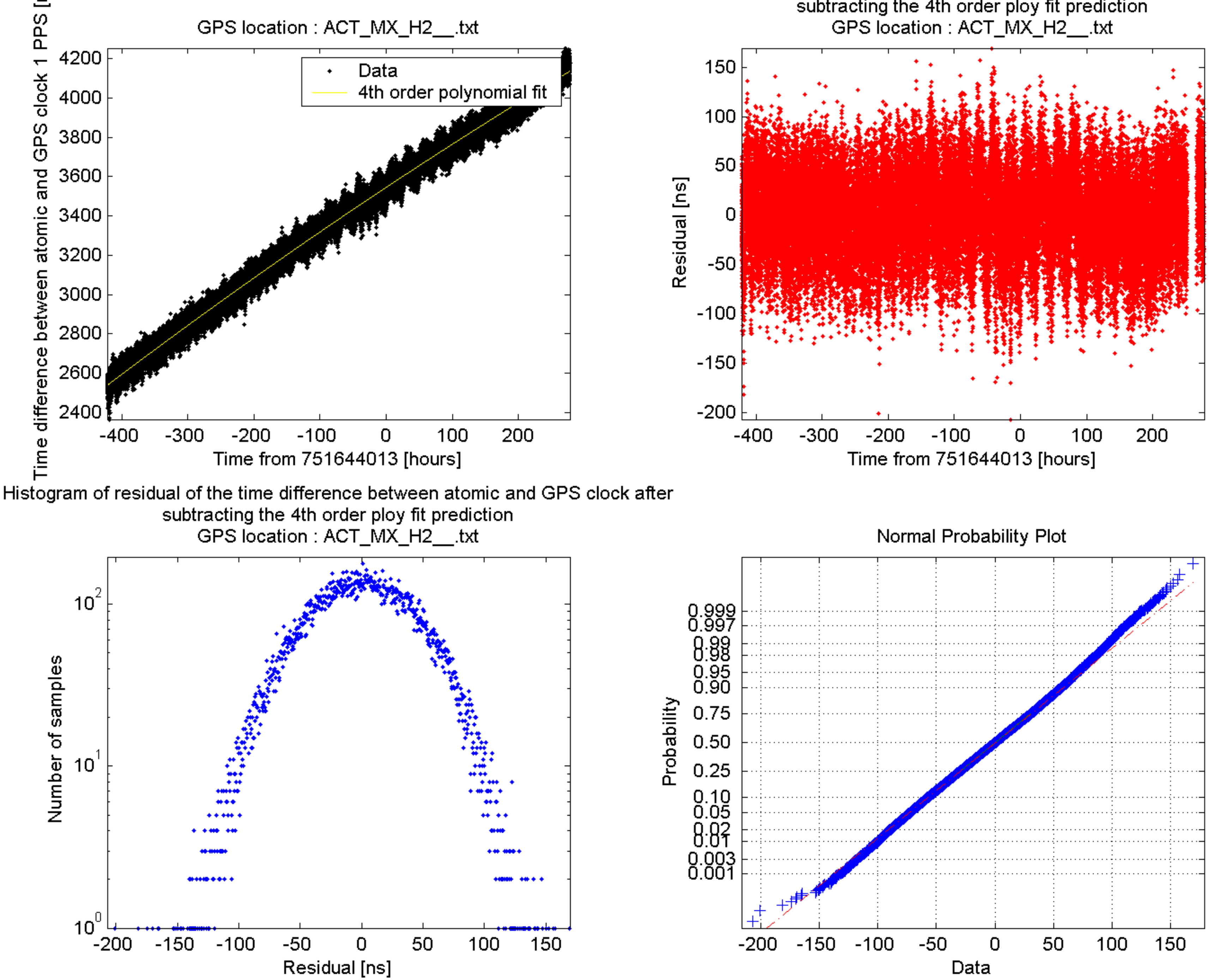
LLO EY GPS problem identified and fixed

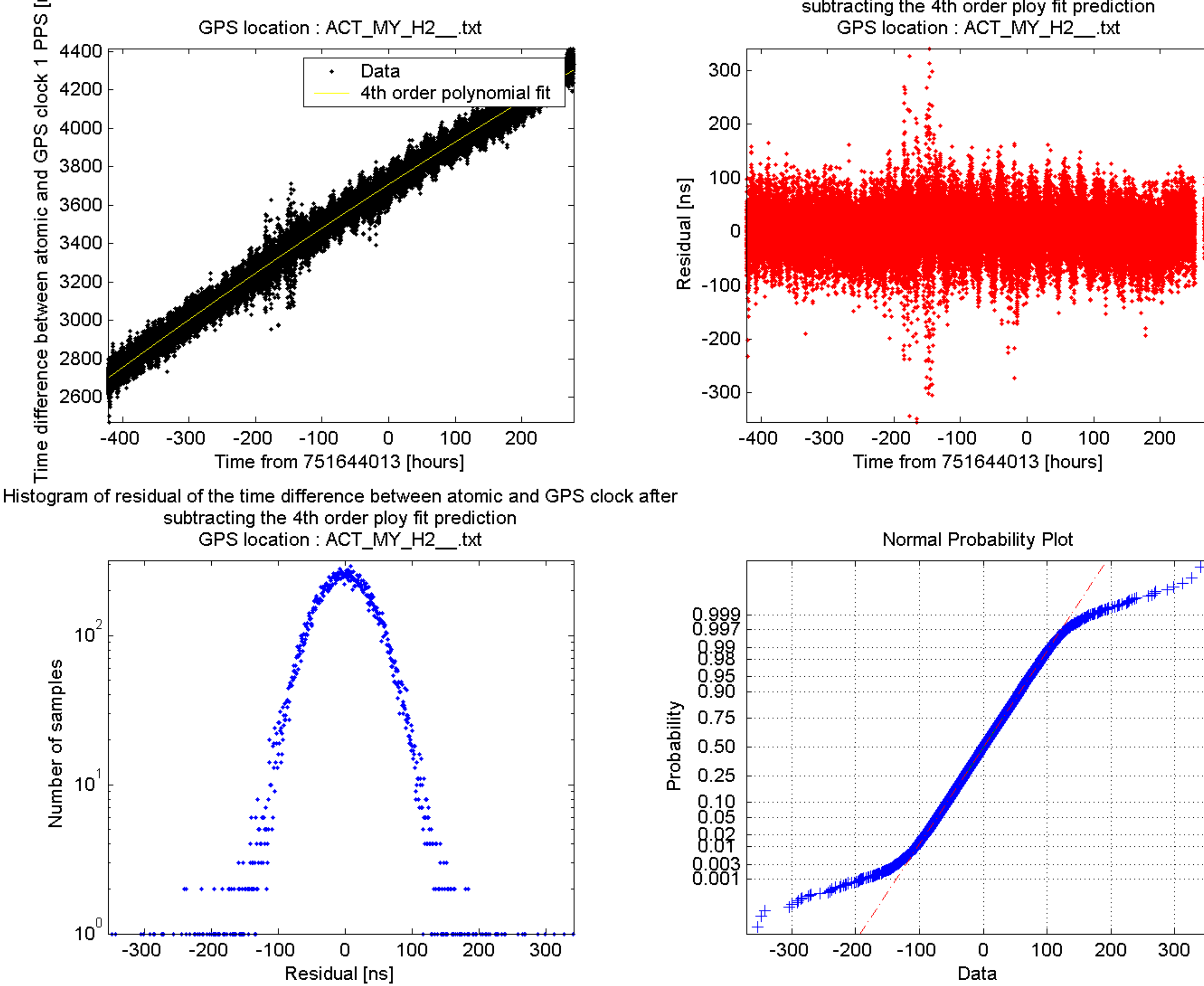


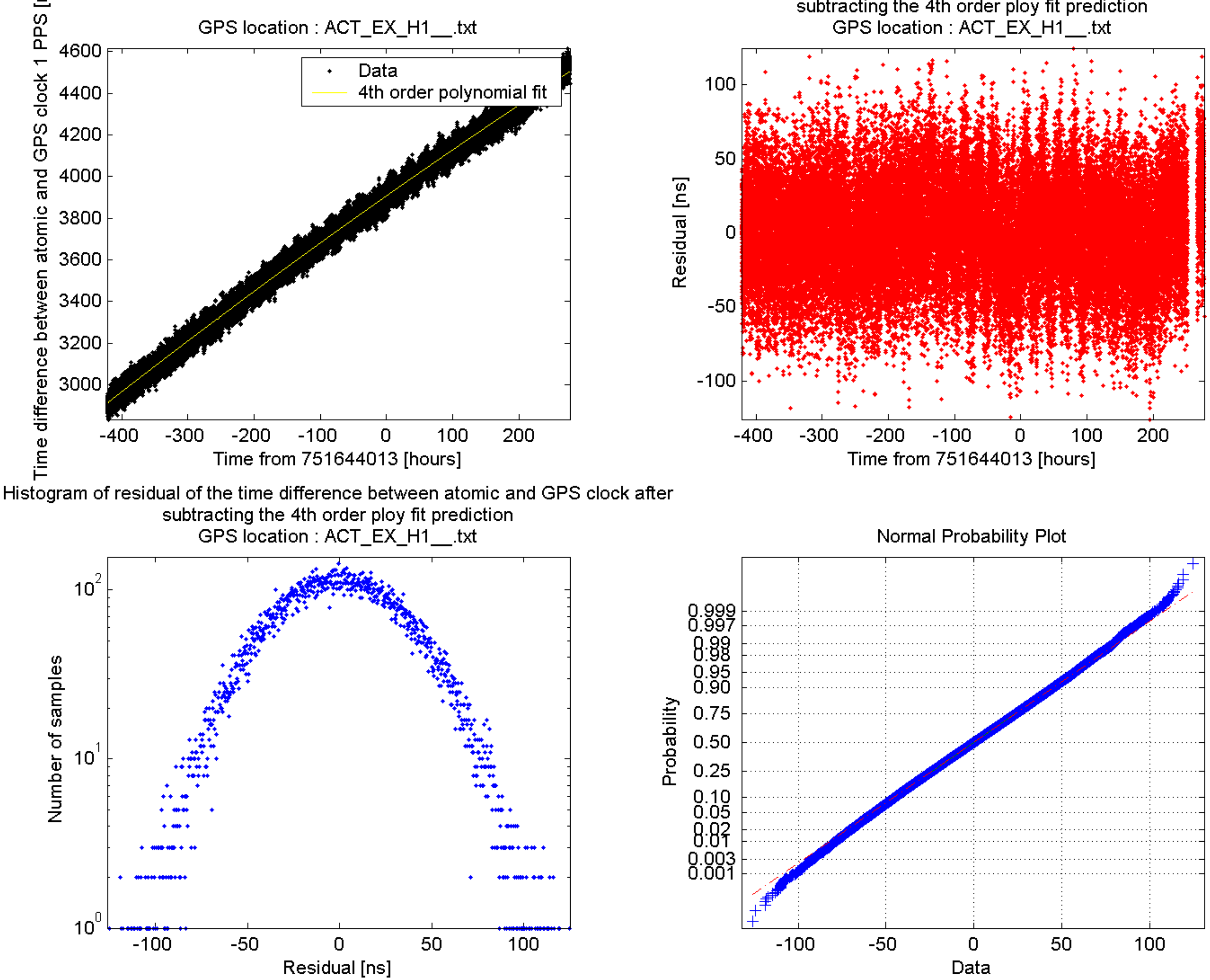
http://www.ligo-la.caltech.edu/ilog/pub/ilog.cgi?group=detector&date_to_view=10/15/2003&anchor_to_scroll_to=2003:10:15:18:08:41-smarka

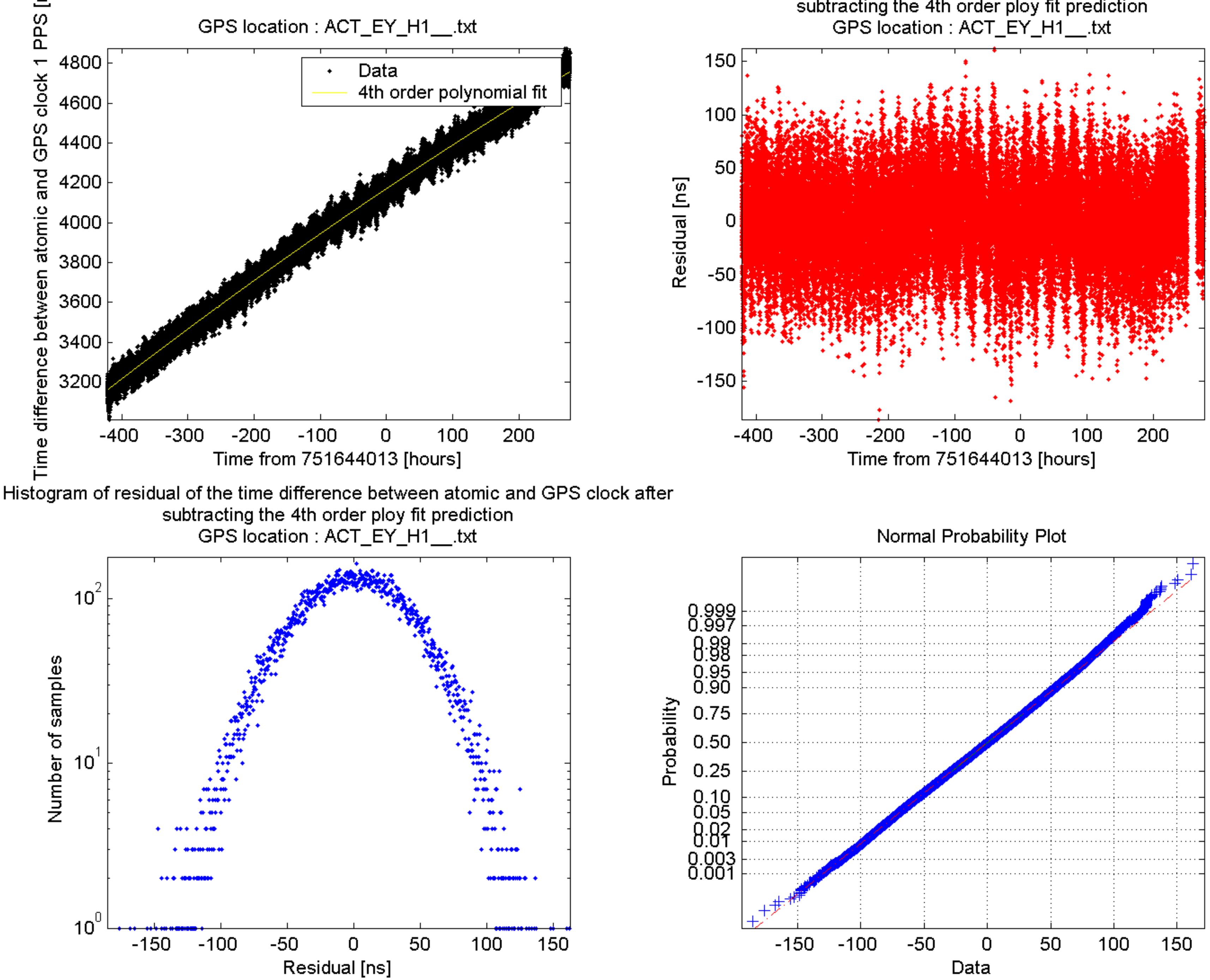

GPS location : ACT_L VEA_H 1.txt
Time difference between atomic and GPS clock 1 PPS [
Data
4th order polynomial fit
Time from 751644013 [hours]
subtracting the 4th order ploy fit prediction
GPS location : ACT_L VEA_H 1.txt
Residual [ns]
Time from 751644013 [hours]
Histogram of residual of the time difference between atomic and GPS clock after
subtracting the 4th order ploy fit prediction
GPS location : ACT_L VEA_H 1.txt
Number of samples
Residual [ns]
Normal Probability Plot
Probability
Data


GPS location : ACT_L VEA_H 2.txt
Time difference between atomic and GPS clock 1 PPS [
Data
4th order polynomial fit
Time from 751644013 [hours]
subtracting the 4th order ploy fit prediction
GPS location : ACT_L VEA_H 2.txt
Residual [ns]
Time from 751644013 [hours]
Histogram of residual of the time difference between atomic and GPS clock after
subtracting the 4th order ploy fit prediction
GPS location : ACT_L VEA_H 2.txt
Number of samples
Residual [ns]
Normal Probability Plot
Probability
Data


GPS location : ACT_MX_H2__.txt
Time difference between atomic and GPS clock 1 PPS [
Time from 751644013 [hours]
Data
4th order polynomial fit
subtracting the 4th order ploy fit prediction
GPS location : ACT_MX_H2__.txt
Residual [ns]
Time from 751644013 [hours]
Histogram of residual of the time difference between atomic and GPS clock after
subtracting the 4th order ploy fit prediction
GPS location : ACT_MX_H2__.txt
Number of samples
Residual [ns]
Normal Probability Plot
Probability
Data


GPS location : ACT_MY_H2__.txt
Data
4th order polynomial fit
Time difference between atomic and GPS clock 1 PPS [
Time from 751644013 [hours]
subtracting the 4th order ploy fit prediction
GPS location : ACT_MY_H2__.txt
Residual [ns]
Time from 751644013 [hours]
Histogram of residual of the time difference between atomic and GPS clock after
subtracting the 4th order ploy fit prediction
GPS location : ACT_MY_H2__.txt
Number of samples
Residual [ns]
Normal Probability Plot
Probability
Data


GPS location : ACT_EX_H1__.txt
Time difference between atomic and GPS clock 1 PPS [
Data
4th order polynomial fit
Time from 751644013 [hours]
subtracting the 4th order ploy fit prediction
GPS location : ACT_EX_H1__.txt
Residual [ns]
Time from 751644013 [hours]
Histogram of residual of the time difference between atomic and GPS clock after
subtracting the 4th order ploy fit prediction
GPS location : ACT_EX_H1__.txt
Number of samples
Residual [ns]
Normal Probability Plot
Probability
Data



GPS location : ACT_EY_H1__.txt
Data
4th order polynomial fit
Time difference between atomic and GPS clock 1 PPS [
Time from 751644013 [hours]
subtracting the 4th order ploy fit prediction
GPS location : ACT_EY_H1__.txt
Residual [ns]
Time from 751644013 [hours]
Histogram of residual of the time difference between atomic and GPS clock after
subtracting the 4th order ploy fit prediction
GPS location : ACT_EY_H1__.txt
Number of samples
Residual [ns]
Normal Probability Plot
Probability
Data

Summary

- **DAQ timing measurements indicate acceptable DAQ timing performance at all LIGO LSCs**
  - » **Still some jumping during pre-run periods**
- **Caesium clock based timing system is successfully installed in record time**
  - » **LHO has a nearly full featured system**
    - – Calibration, fiber delay measurements are post S3 activities
    - – System works without supervision
  - » **LLO has new timing hardware installed**
    - – Serius and hidden problem was identified via the help of the new system
    - – Administrative resistance inhibited pre S3 epics integration
      - • *No trend generation for S3 in LLO*
    - – Integration, calibration, fiber delay measurements are post S3 activities
- **Timing looks good for S3 and the new timing system is a pleasure to work with**