QUALITY OF FLIGHT RECORDER DATA
Filtered / Under sampled Data
and
Post Processing Errors/Limitations

SAE TOPTEC Vehicle Recorder Symposium

June 4-5 , 2003

Alexandria, VA

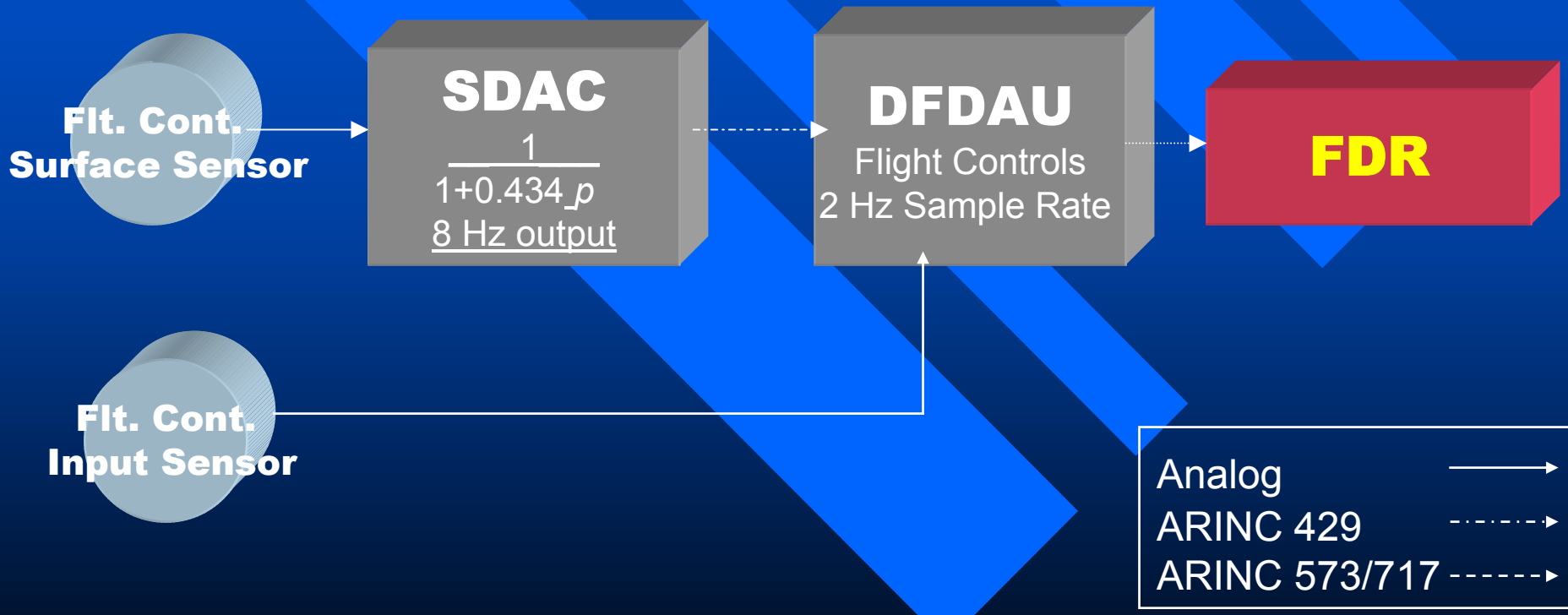
Overview

- Affects on Data Quality With Filtered Data and Regulatory non-compliance;
- Affects on Quality of Recorded Data When Source is Under Sampled and Regulatory non-compliance;
- Problems Associated with Post Processing No Regulatory Requirements.

Filtered FDR Data Background

- Use of Filtered Data as Input to FDR Identified in Early 90's on Boeing 757&767
- NTSB Recommendations - Eliminate filter
- FDR FAR's Revised in 1997 to Require Accuracy Under Static & Dynamic Conditions.
- Original FAA Survey – No Filtered Data
- Crash of American Airlines Flight 587
- AIRBUS Aircraft (A 300 & A310)Fitted with SDAC Supplying Filtered Flight Control Data to FDR

FDR System Configuration
A300 Flight Controls

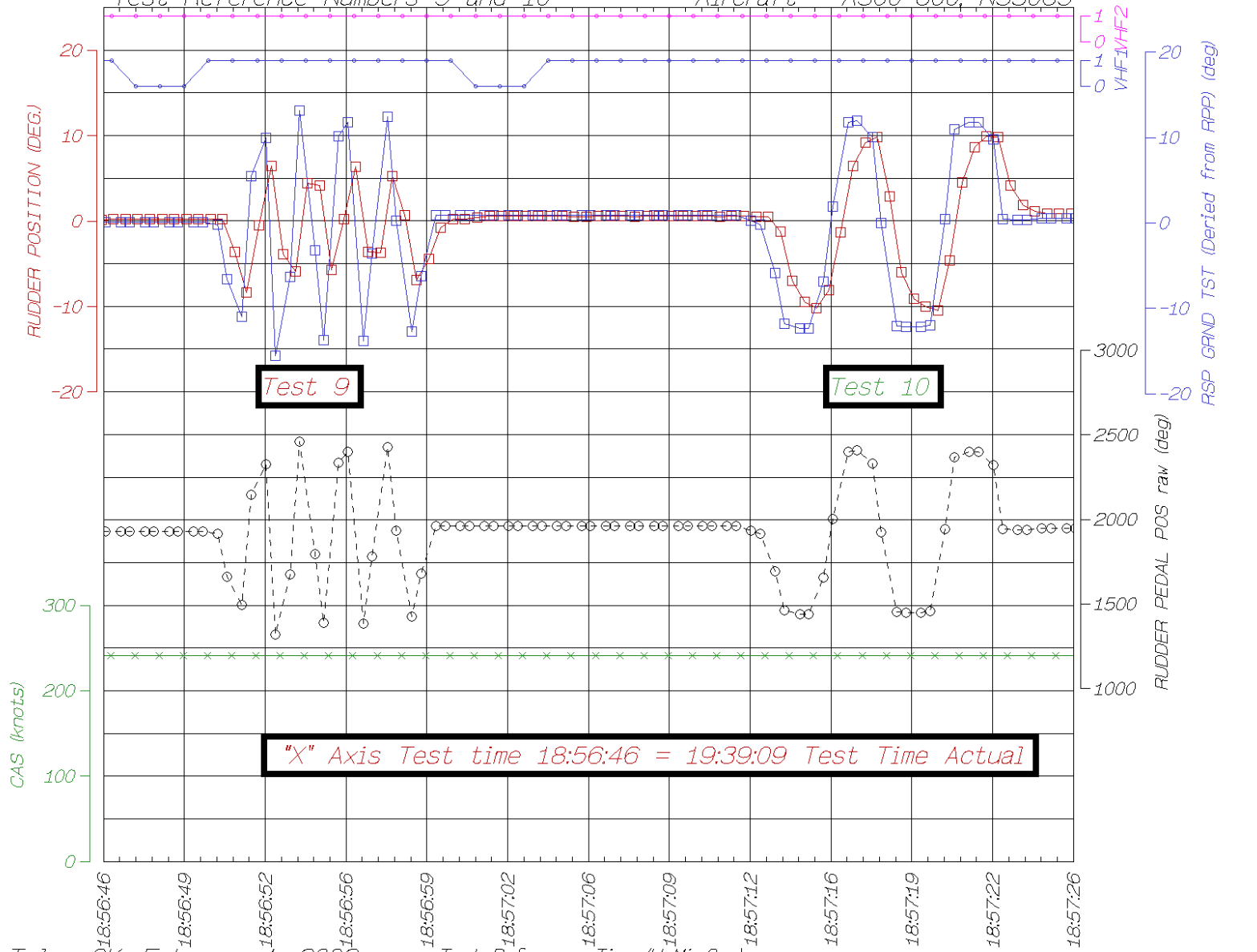


Determination of Flight Controls Sensor Characteristics

- Conducted Bench Test to Define Filter
- Conducted Aircraft Ground Test On AAL A300
  - Determine Characteristics of Rudder Surface Sensor
  - Determine Characteristics of Rudder Pedal Sensor
  - Determine Relationship of Rudder Surface and Pedal Data

FDR RUDDER PARAMETER GROUND TEST

Test Reference Numbers 9 and 10 Aircraft - A300-600, N33069



Tulsa OK, February 1, 2002
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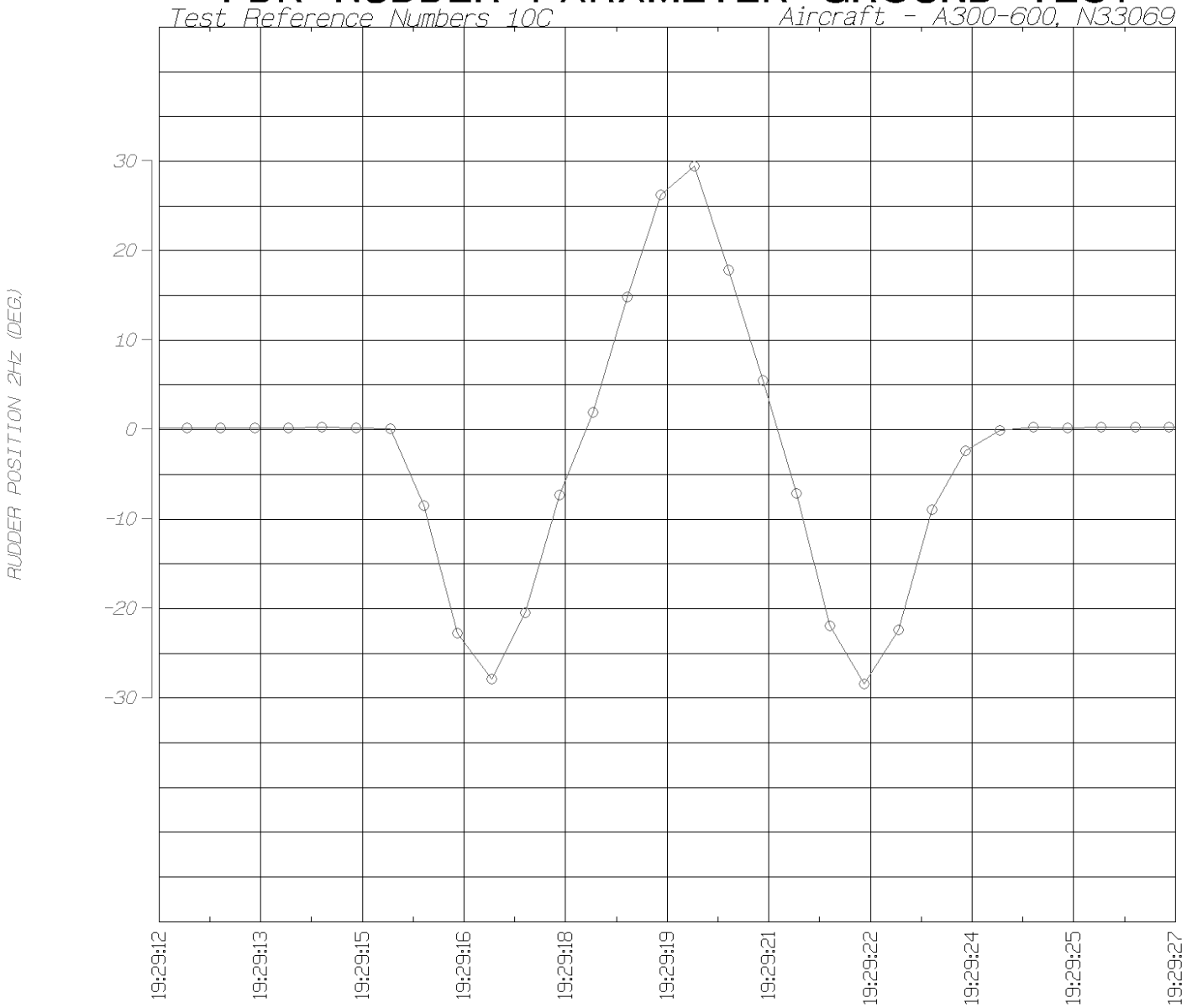
FDR RUDDER PARAMETER GROUND TEST



Tulsa OK, February 1, 2002
Created: March 07, 2002

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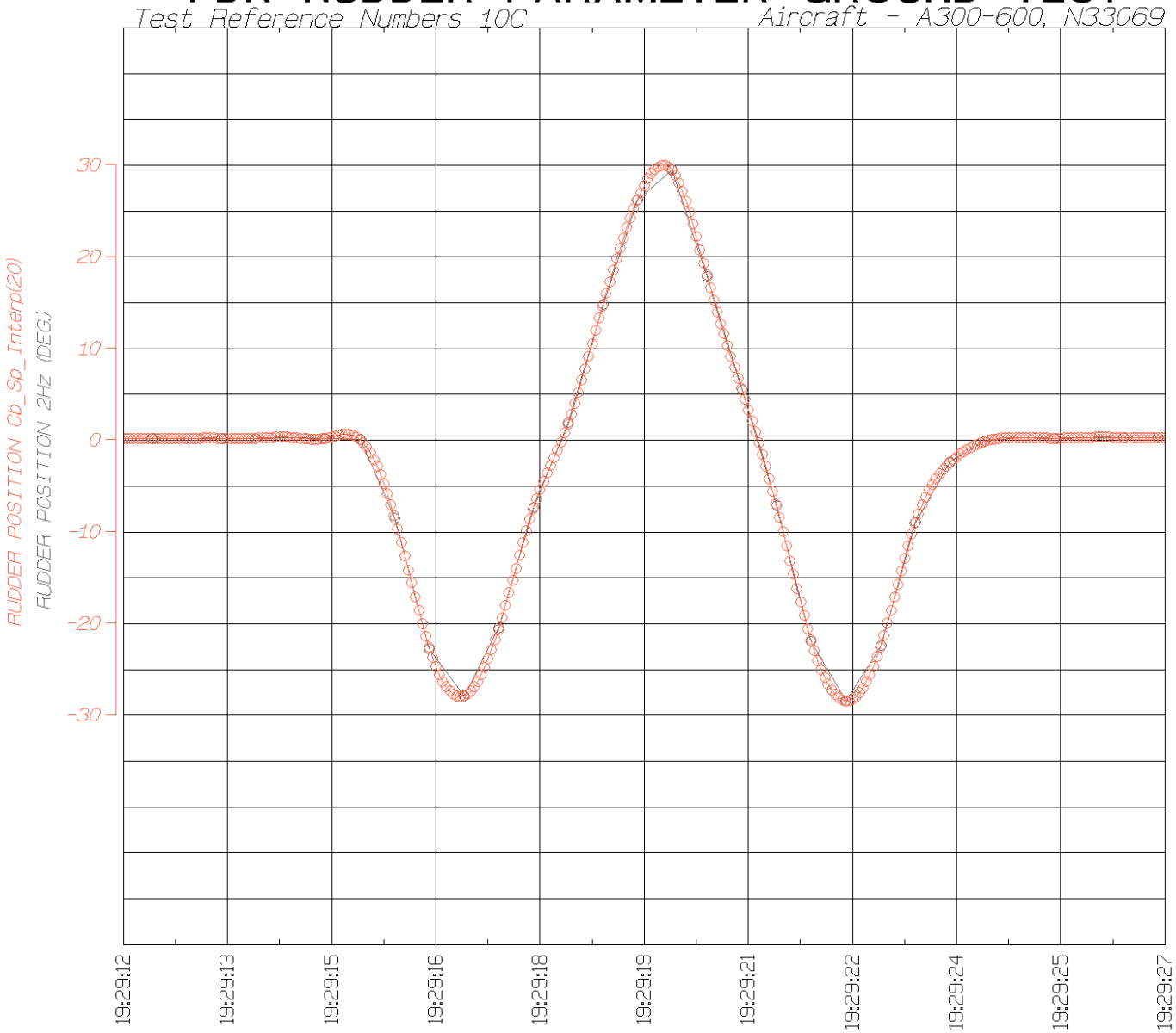
FDR RUDDER PARAMETER GROUND TEST



Tulsa OK, February 1, 2002
Created: March 07, 2002

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Data Analysis – RSP_20.wks

File Math Edit

	X	Y
Descriptor:	Time	RUDDER POSITION
Units:	(seconds)	(DEG.)
Type:		

Named Range ...

Obs. #	X
1	38638.000000
2	38638.050781
3	38638.101562
4	38638.148438
5	38638.199219
6	38638.250000
7	38638.300781
8	38638.351562
9	38638.398438
10	38638.449219
11	38638.500000
12	38638.550781

History:

RUDDER POSITION:
Loaded from frame data.
Date: March 07, 2002, 08:02:29
Clamping: OFF
Data Access: CONVERTED

Cubic spline interpolation performed:
X-Evaluation: Start: 38638, End: 38738, Increment: 0.05

Functions

File

Project Functions
Site Functions
AIRBUS_SDAC
Airbus_SDAC_Filter
Airbus_SDAC_Inv
Raps Functions
Flight Path Functions

Airbus_SDAC_Inv()

Recorded FDR parameter, filtered for instrument
Current Workspace Data

Time increment of parameter
0.05

Output, using filter to reconstitute original
/users_obiwan/2002/A300_AAL_N33069_Grnd_Tst_2-2-02/recovery/

Source: Workspace File

NULL
Current Workspace Data
Workspace File

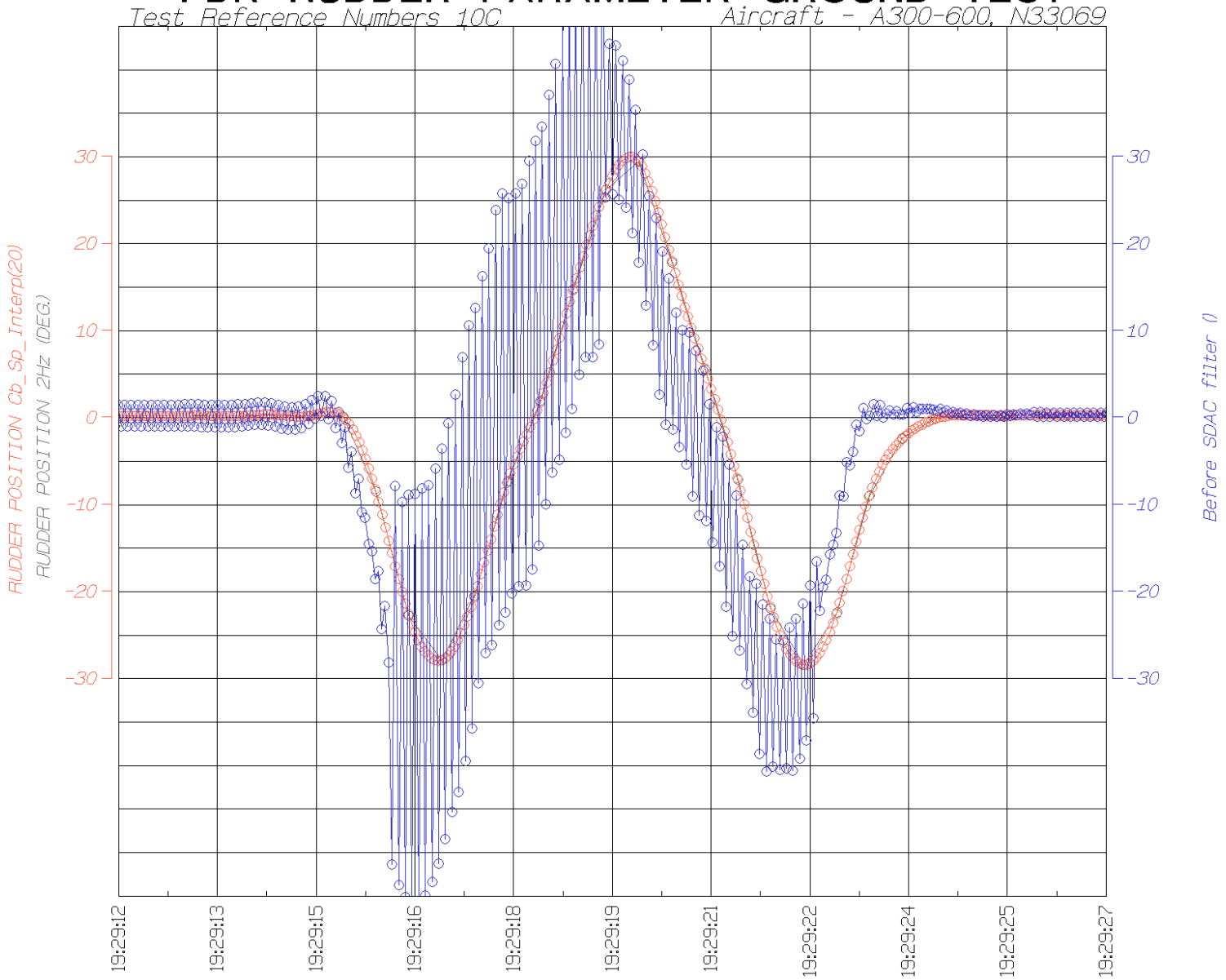
OK Cancel

grod
Digital_M
dtterm

Jun 17

One Two Three Four EXIT

FDR RUDDER PARAMETER GROUND TEST



Tulsa OK, February 1, 2002
Created: March 07, 2002

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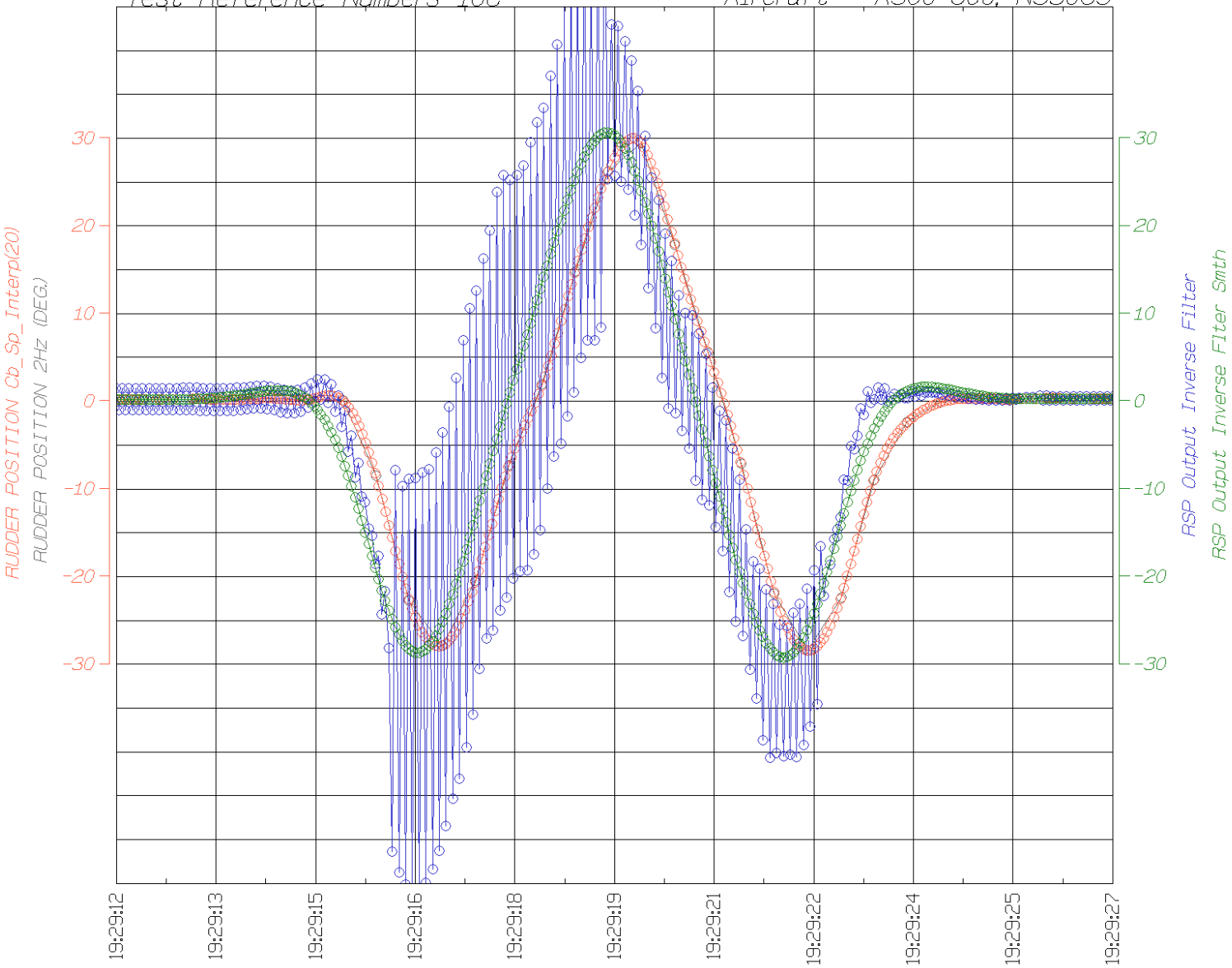
FDR RUDDER PARAMETER GROUND TEST

Test Reference Numbers 10C

Aircraft - A300-600, N33069



Tulsa OK, February 1, 2002
Created: March 07, 2002

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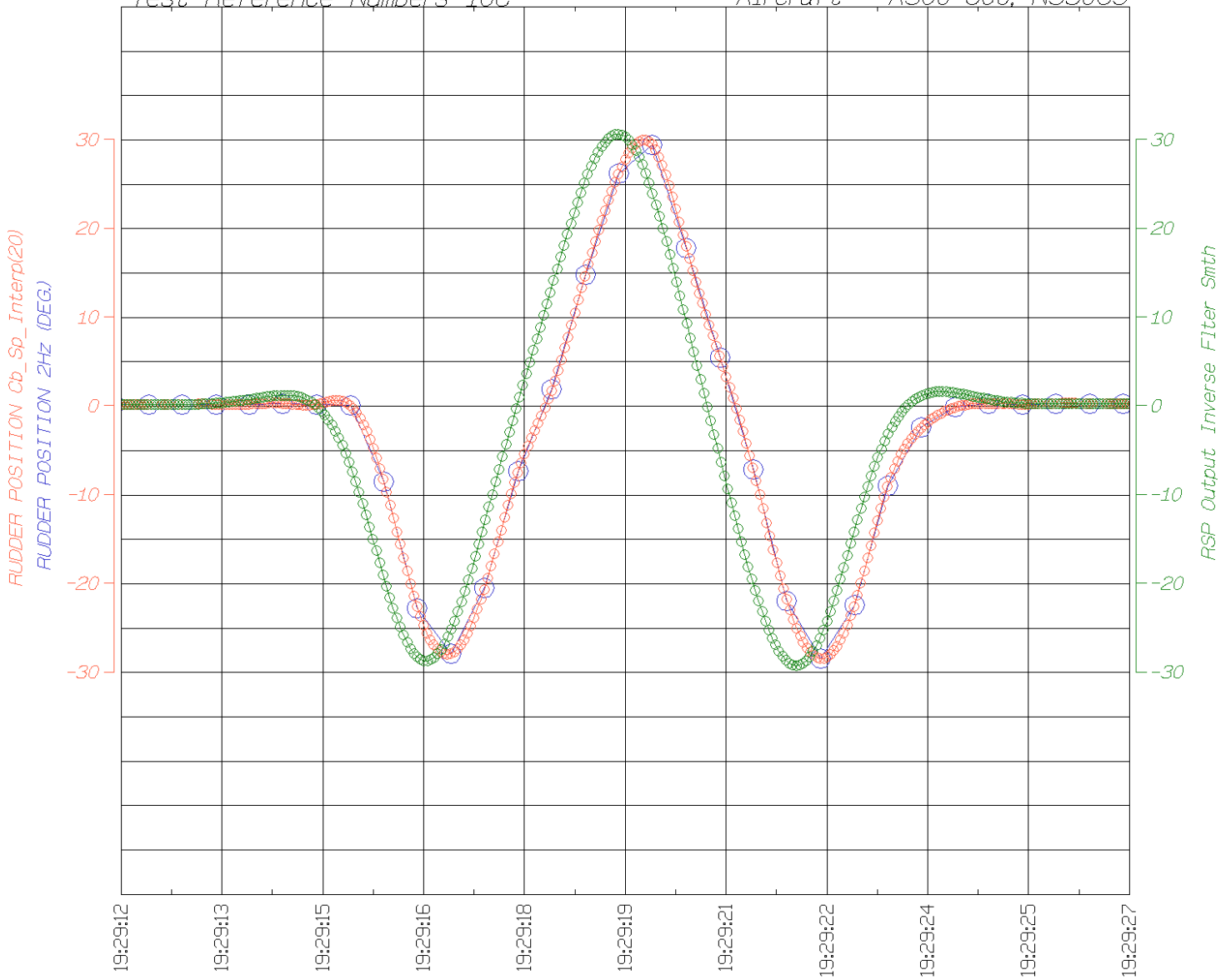
FDR RUDDER PARAMETER GROUND TEST

Test Reference Numbers 10C

Aircraft - A300-600, N33069



Tulsa OK, February 1, 2002
Created: March 07, 2002

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Data Analysis – RSP_20.wks

File Math Edit

	X	Y
Descriptor:	Time	RUDDER POSITION
Units:	(seconds)	(DEG.)
Type:		

Named Range ...

Obs. #	X	Y
1	38638.000000	0.175824
2	38638.050781	0.175824
3	38638.101562	0.175824
4	38638.148438	0.175824
5	38638.199219	0.175824
6	38638.250000	0.175824
7	38638.300781	0.175824
8	38638.351562	0.175824
9	38638.398438	0.175824
10	38638.449219	0.175824
11	38638.500000	0.175824
12	38638.550781	0.175824

History:

RUDDER POSITION:
Loaded from frame data.
Date: March 07, 2002, 08:02:29
Clamping: OFF
Data Access: CONVERTED

Functions

File

- Project Functions
- Site Functions
  - AIRBUS_SDAC
    - Airbus_SDAC_Filter
    - Airbus_SDAC_Inv
- Raps Functions
  - Flight Path Functions
  - Speed Conversions
  - Temperature Conversions

tmp
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dtterm

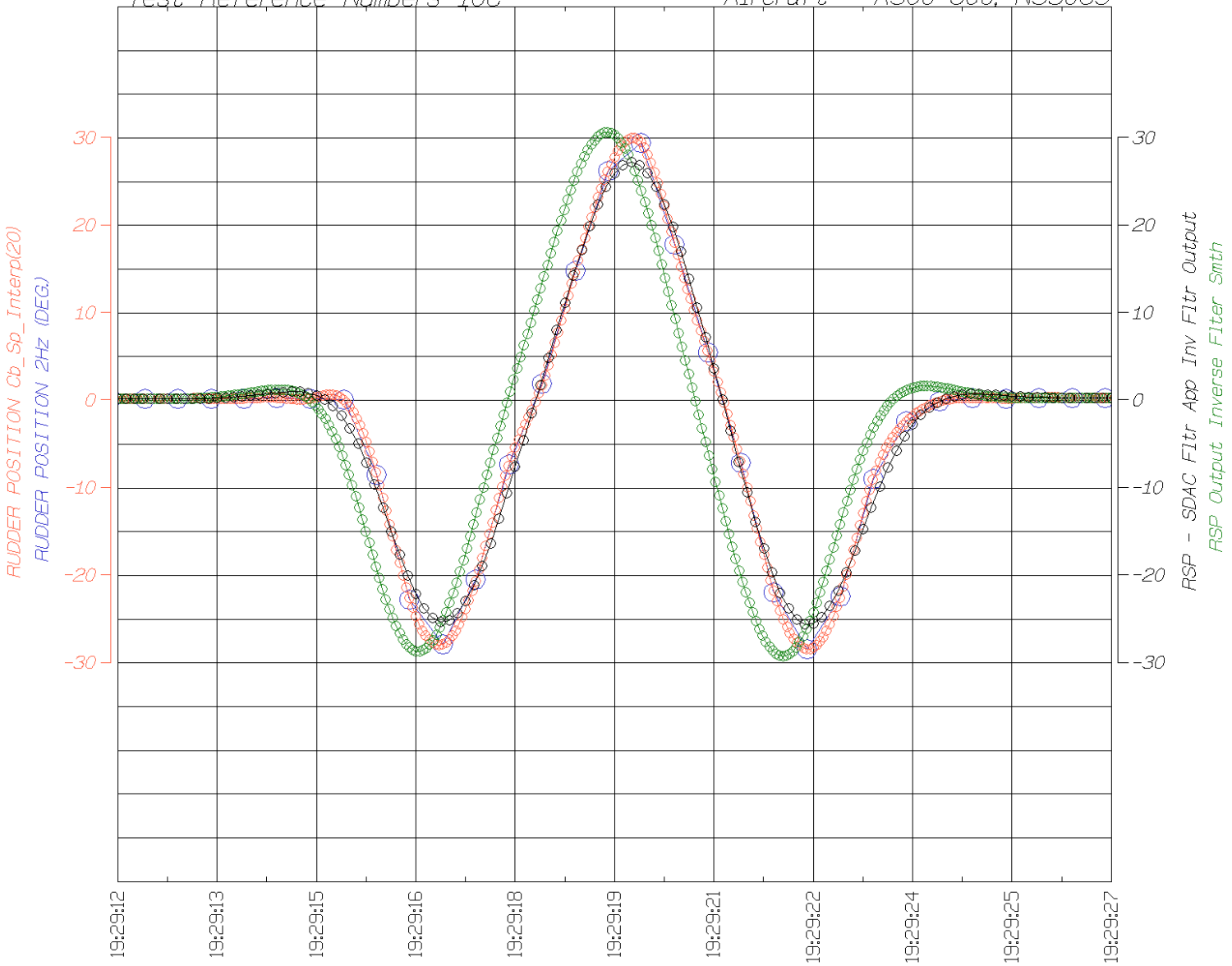
Jun 17

One Two Three Four EXIT

FDR RUDDER PARAMETER GROUND TEST

Test Reference Numbers 10C

Aircraft - A300-600, N33069



Tulsa OK, February 1, 2002
Created: March 07, 2002

Test Reference Time (Hr:Min:Sec)

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Figure 1. Aliasing example: Sampling a 4 Hz sawtooth wave at 2 Hz

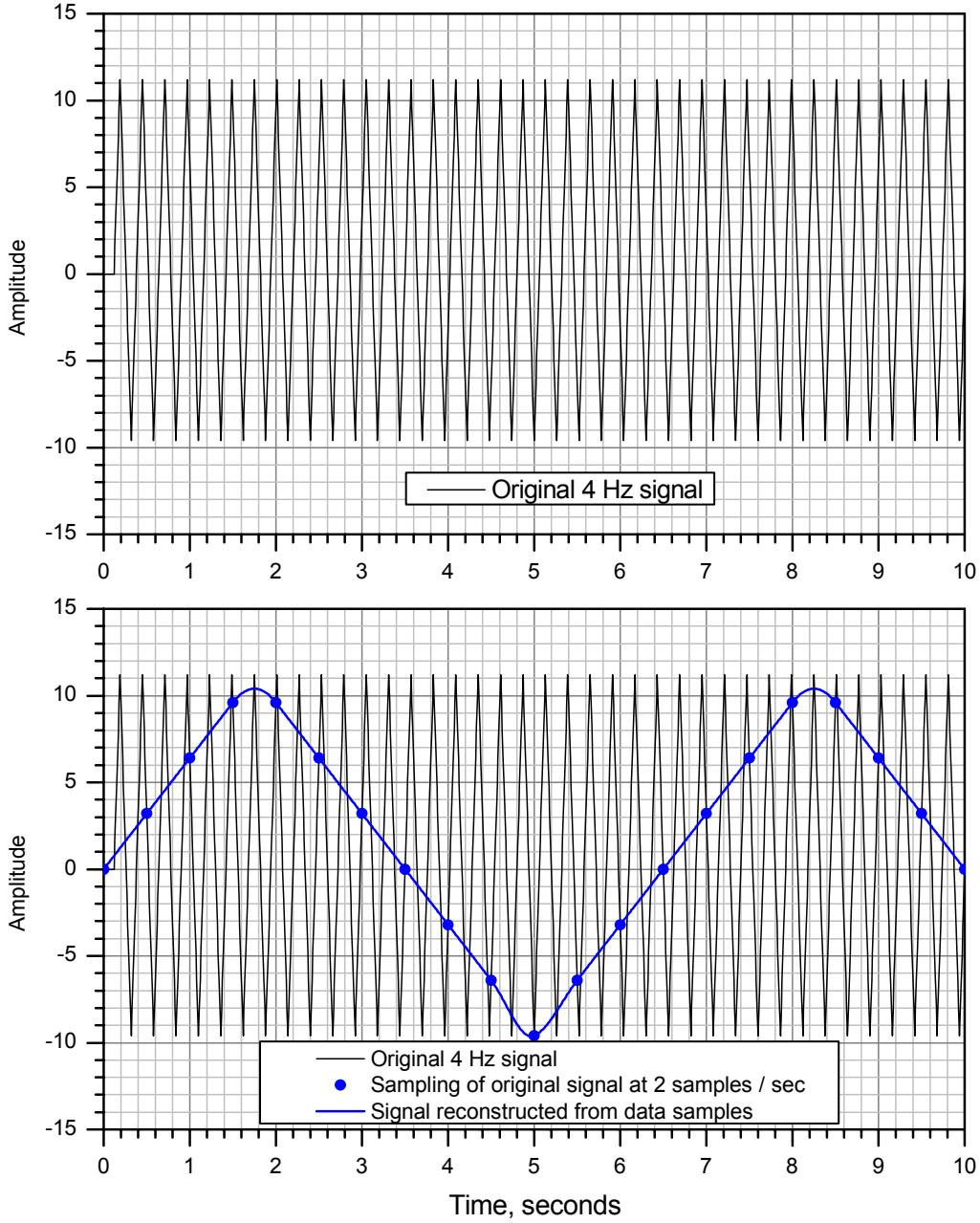
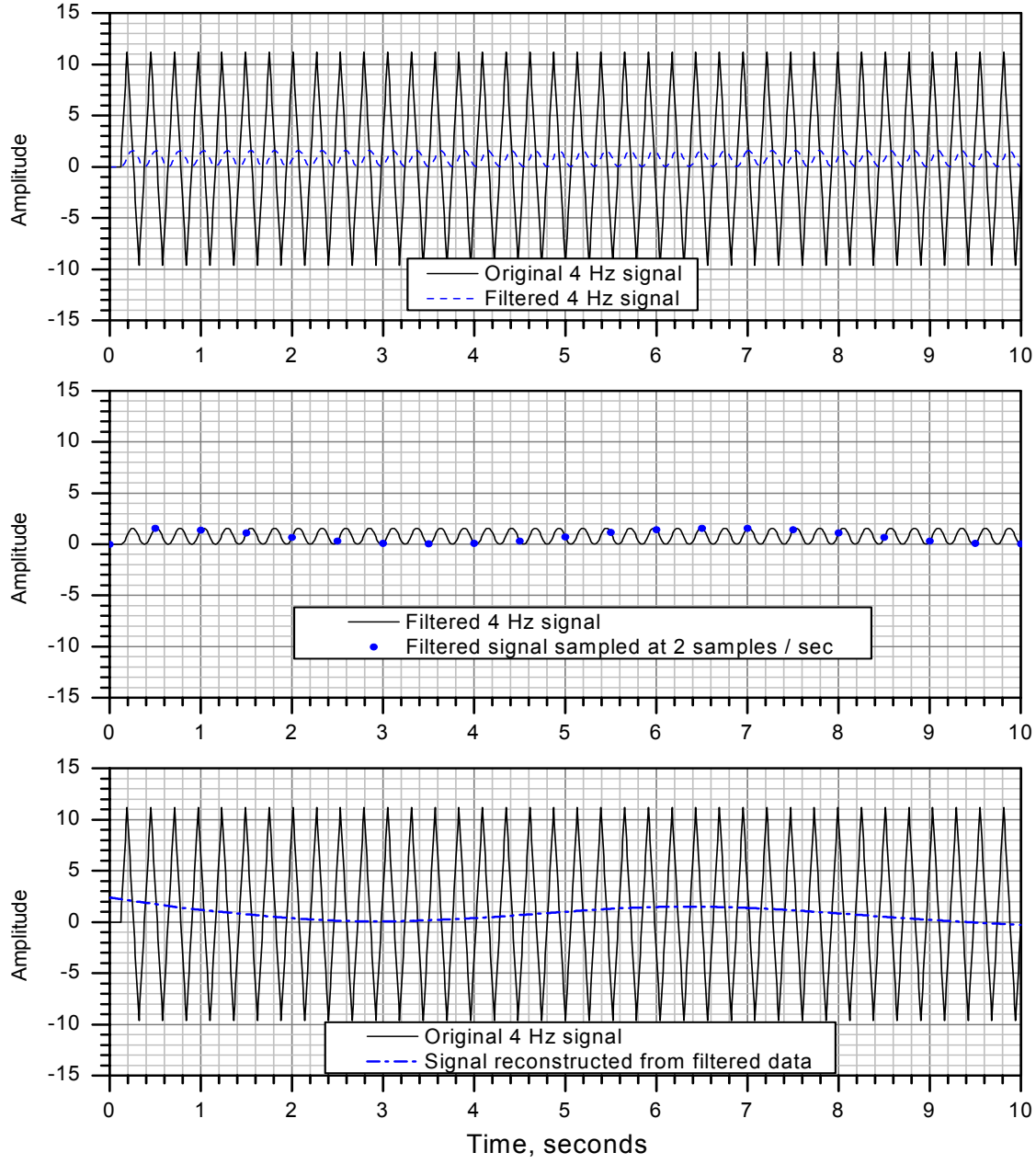


Figure 2. Effect of filter on aliasing and signal reconstruction



Problems With Filtered Data

- Filtering removes high frequency component of data that may not be fully recoverable;
- Highly dynamic parameters (e.g., flight controls) will be distorted by filtering;
- Filtering will introduce data latency that may vary as a function of sensor activity.

Record Rate Higher than the Source Update Rate (Background)

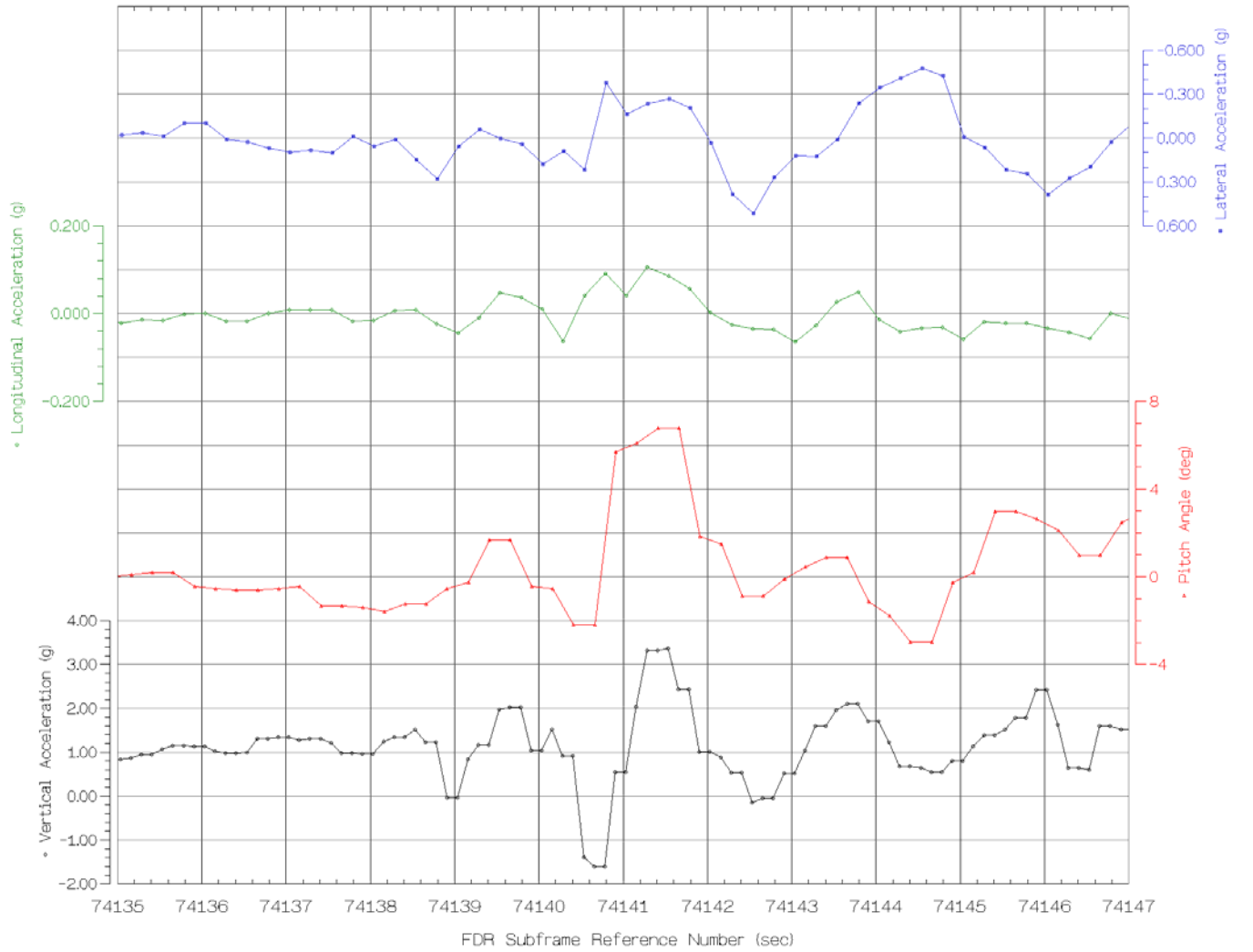
- UK Air Accident Investigation Branch first identified existence of repetitious FDR data during Sept. 01, EMB-145, accident investigation.
- Recommendations (2002-01 thru 04), which call for:

1. CTA of Brazil to determine nature and extent of anomalies, correct anomalies on existing and future A/C and demonstrate FDR data time history faithfully recorded.
2. CAA UK ensure FDR installations meet regulations
3. CTA alert other authorities of problem.
4. CAA ensure other UK reg. A/C do not have similar problem.

NTSB - Repetitious FDR data on Regional Jets

- NTSB review of the Regional Jet FDR data revealed similar problems on Dornier 328, Canadair CL-600 and EMB 135 and 145s.
- Recommendations (A-03-15 and A-03-16)
- Require aircraft to be modified to meet FAR sampling rate, accuracy and range requirements.
- FAA surveys fleet to determine if problem exists on other aircraft.

Under Sampled Data FDR Data



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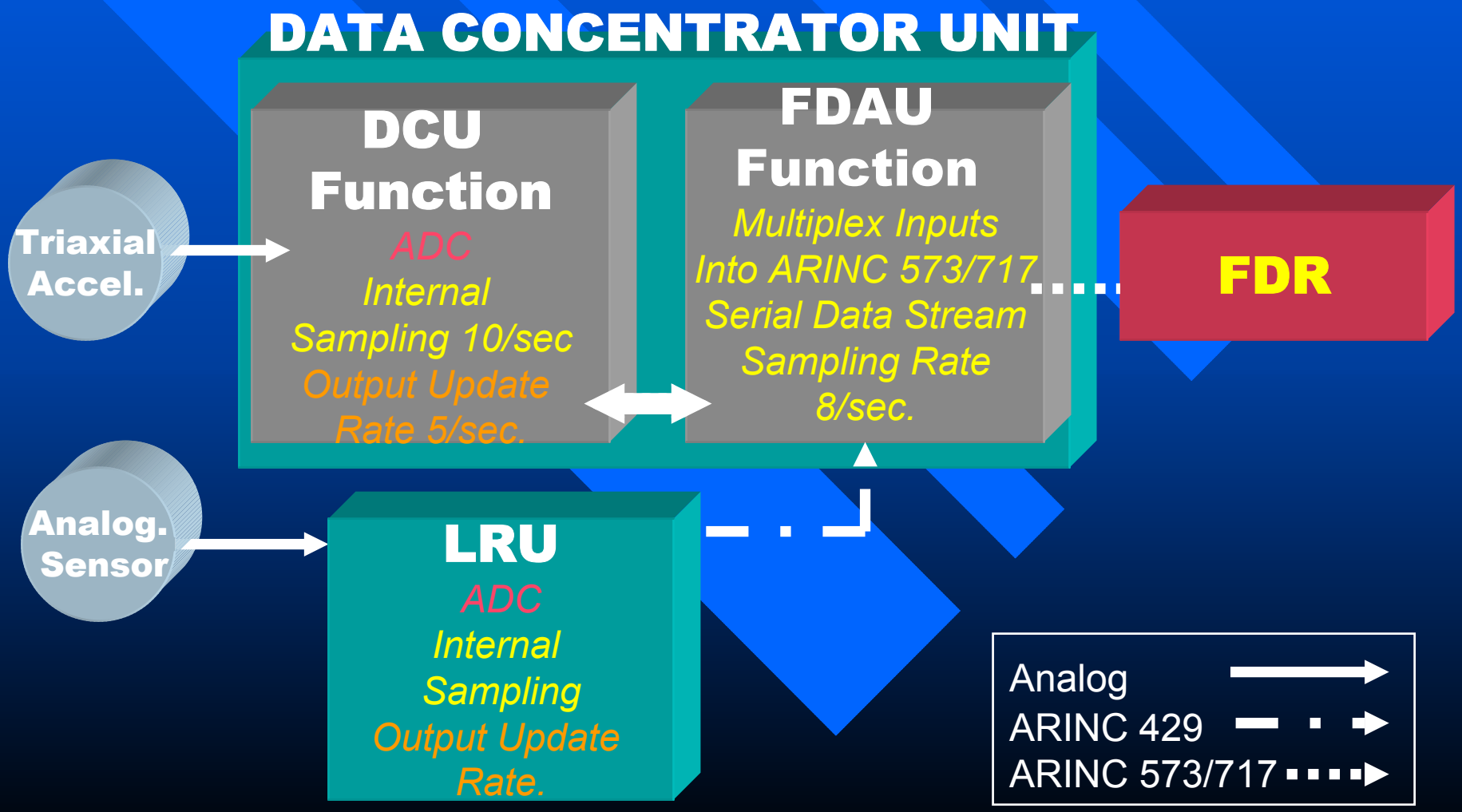
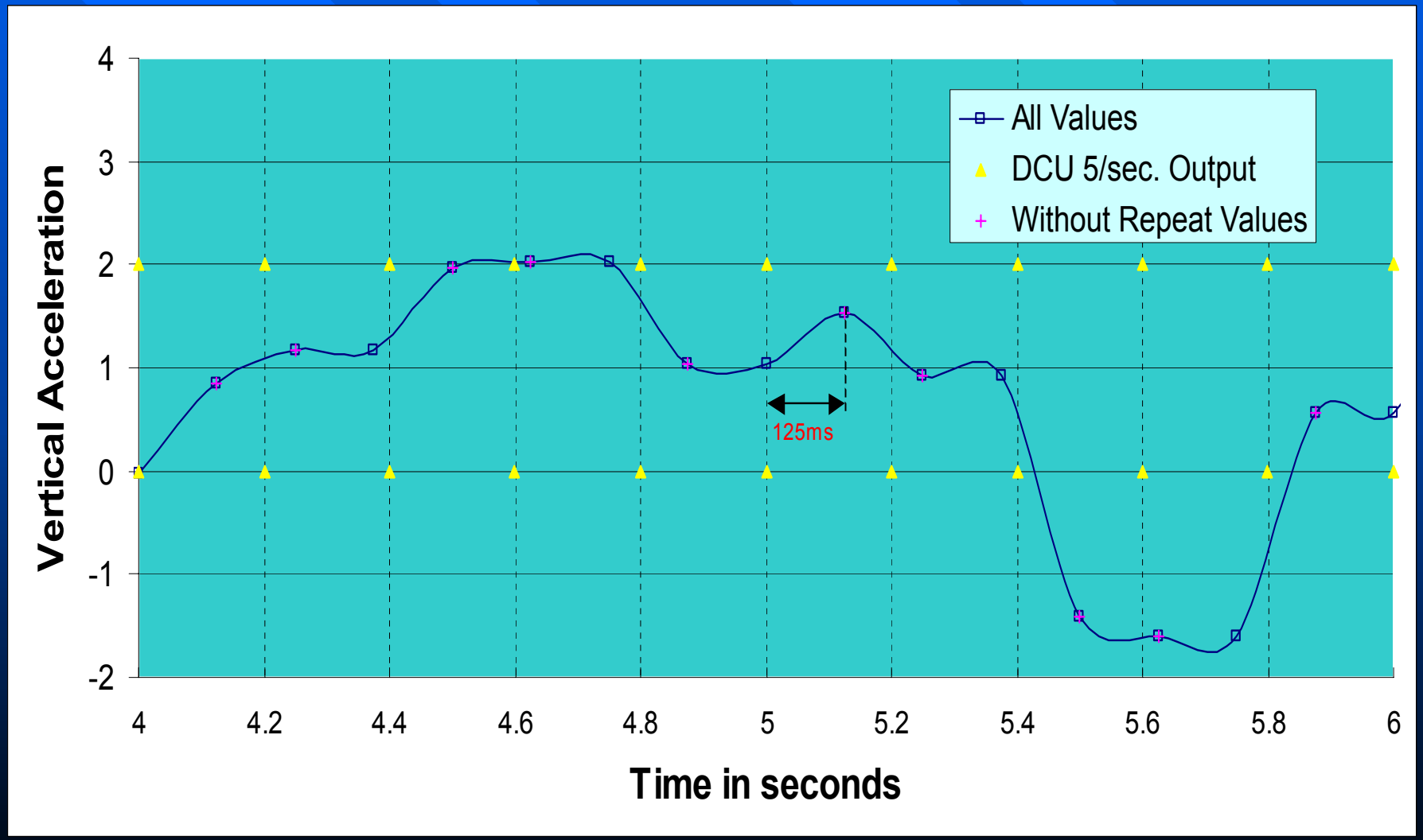
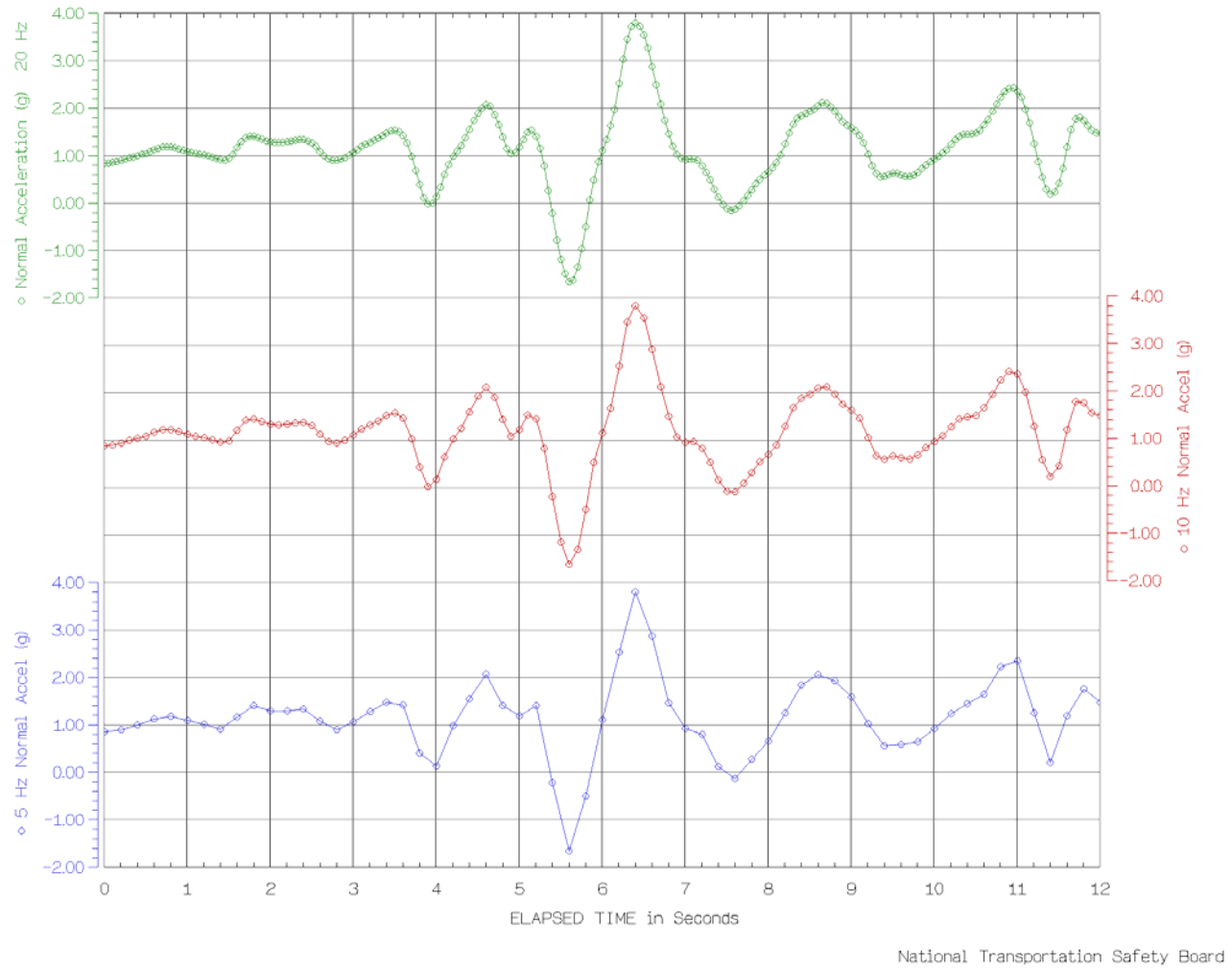
RJ FDR Recording Systems
(Simplified Block Diagram)



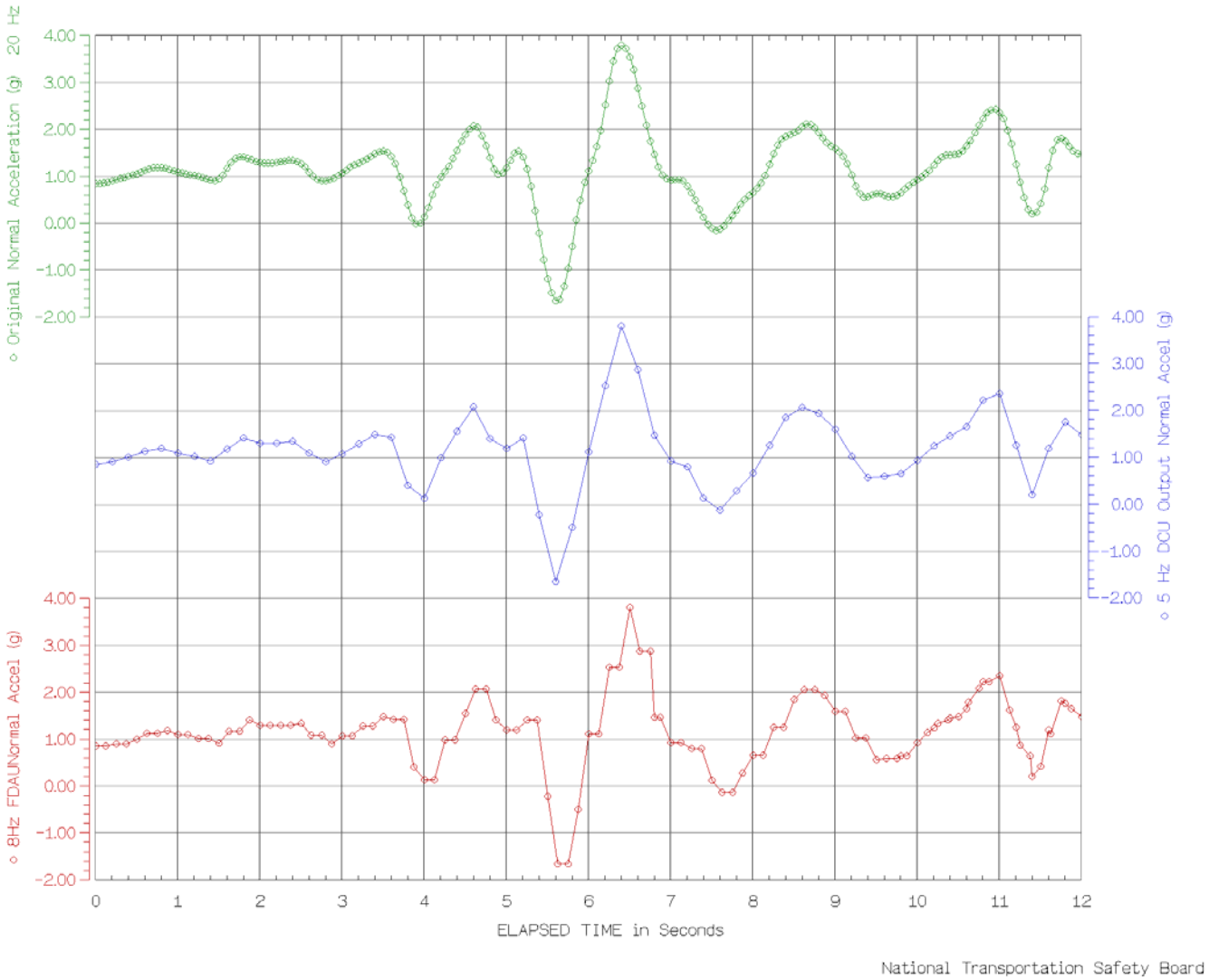
Data Latency & Repeat Values



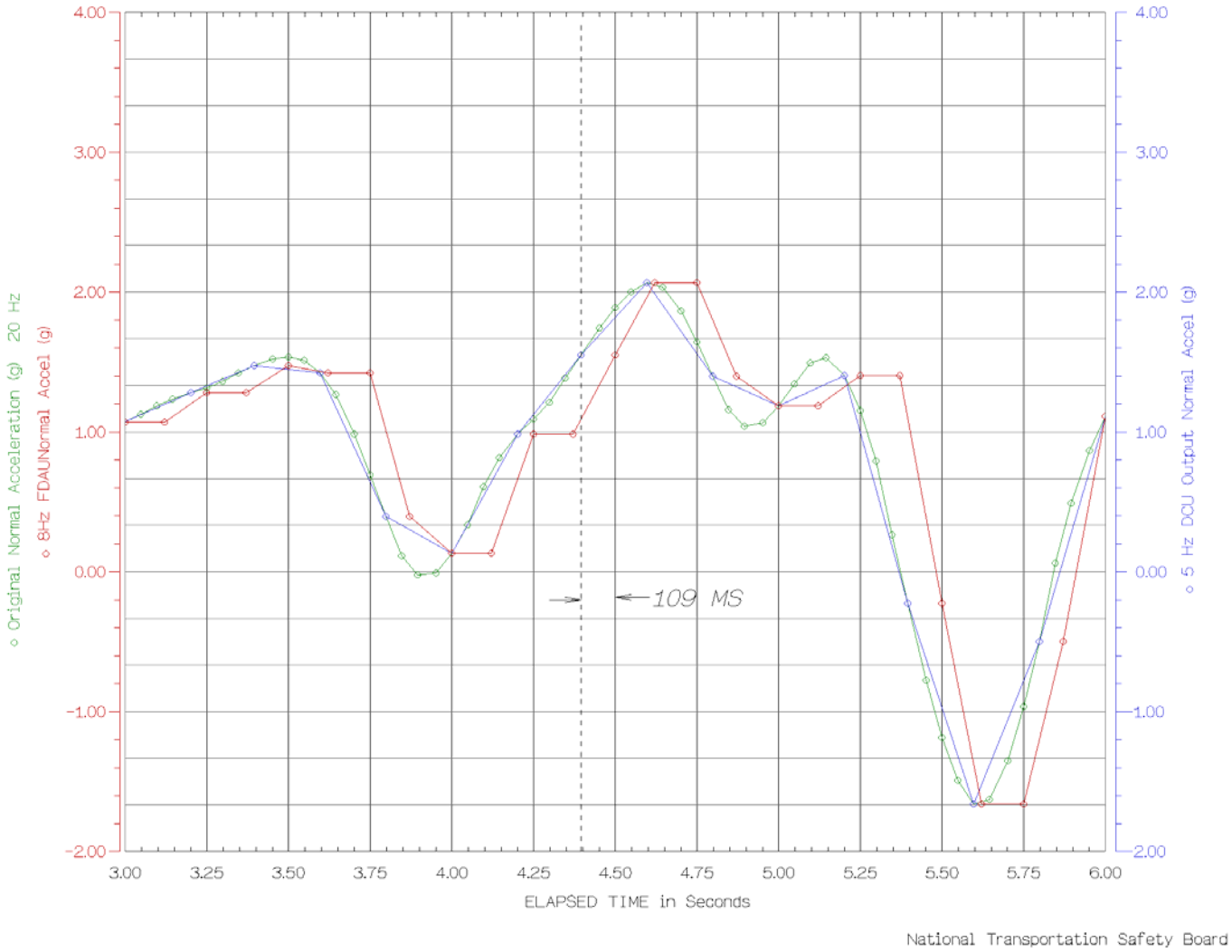
Evolution of DCU 5 Hz Signal



Comparison of Original 20 Hz DCU 5Hz and FDAU 8Hz Data



Original, 5 Hz DCU and 8 Hz (FDAU) (Expanded Time Scale)



Problems When Data Source is Updated at Slower Rate than the Record Rate

- Data does not meet minimum FAR sampling rate requirements.
- Data may not meet accuracy requirements under certain conditions;
- Data latency (variable)
- Repetitious data point must be identified and removed

Processing of Recorded Data

- Ground Readout Facility Validation
  - Invalid Readout Software can lead to invalid conclusions
  - Certification of FOQA/MOQA Ground Readout Systems??
- FDR System Documentation Standard
  - Advisory Circular 20-141, FRCS
  - Vendor Documentation
  - Aircraft Manufacturer Documentation.