Section 11

Microgravity Environment of

Non-Orbital Flight Platforms

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Topics for Discussion

- **Non-orbital flight platforms**
  - **Terrier-Black Brant sounding rocket**
  - **KC-135 aircraft**
    - bolted-down conditions
    - free-float conditions

- **Accelerometer systems used to measure the environment**
  - **SAMS (Space Acceleration Measurement System)**
  - **SAMS-FF (SAMS-Free Flyer)**

Non-Orbital Flight Platforms

- **Terrier-Black Brant sounding rocket**
  - **Launched from White Sands, NM in support of the DARTFire experiment in September, 1997**
  - **Achieved approximately 500 seconds of flight with a reduced gravity environment**

- **KC-135 Aircraft**
  - **Operated by NASA Johnson Space Center**
  - **Achieves reduced gravity environment by flying parabolic trajectories**
  - **Parabolas provide 15-20 seconds of reduced gravity environment**
  - **Approximately 40-50 parabolas per flight (campaign)**

Accelerometer Systems

- **SAMS characteristics**
  - **Sampling rate and cut-off frequency are selected and fixed before the flight**
  - **For support of KC-135 flights, three SAMS heads were flown**
    - head A, f_s=250 and cut-off frequency of f_c=100
    - head B, f_s=500 and cut-off frequency of f_c=100
    - head C, f_s=25 and cut-off frequency of f_c=5
  - **SAMS unit has been retired from KC-135 service**

- **SAMS-FF characteristics**
  - **Sampling rate and cut-off frequency are selectable before the flight (either fixed or as adjustable during the flight)**
  - **DARTFire mission utilized a variable sampling rate**
  - **uSEG experiment utilized two sampling rates during KC-135 testing (f_s=800 and f_s = 100)**

Sounding Rocket Environment Characterization

- **Terrier-Black sounding rocket DARTFire flight timeline is shown in the graphic in Figure 11-1**

- **Figure 11-2 illustrates the acceleration vector magnitude for the time period when the sampling rate was 25 samples per second**
  - **environment measured at less than 30 μg root sum square (RSS) for the time interval analyzed**

- **Figure 11-3 is the RSS power spectral density for the time period when the sampling rate was 25 samples per second**
  - **frequency domain characteristics track known disturbance sources originating internal to the DARTFire equipment**
    - Intensified Multispectral Imager filter wheel operates at 5 Hz
    - Infrared Imager filter wheel operates at 1 Hz

KC-135 Environment Characterization

- **Figure 11-4 illustrates the KC-135 overall environment over multiple parabolas during a typical campaign as recorded by SAMS**

- **Figure 11-5 is a detailed plot of the KC-135 environment during the reduced gravity portion of the parabola as recorded by SAMS-FF**

- **Figure 11-6 is a plot of KC-135 parabola recorded in support of SAL experiment. Shows free-float of SAL test equipment and timelines the activity within the parabola**

- **Figure 11-7 is a detailed plot of the free-float period of the parabola**

SAMS-FF DARTFire
RMS Values for Each TSH Sampling Rate

200 MILES									

TSH	x (µg)	y (µg)	z (µg)
RMS	11	5	4

	200 SAMPLES PER SECOND		

TSH	x (µg)	y (µg)	z (µg)
RMS	58	168	238

TSH	x (µg)	y (µg)	z (µg)
RMS	13	13	10

150 MILES

400 SAMPLES PER SECOND	TSH	x (µg)	y (µg)	z (µg)
	RMS	376	405	243

100 MILES

TSH	x (µg)	y (µg)	z (µg)
RMS	899	1375	822

50 MILES

0 MILES

Figure 11-1

MET Start at 000/00:02:05.027

Acceleration Vector Magnitude for Fs=25

DARTFire Mission
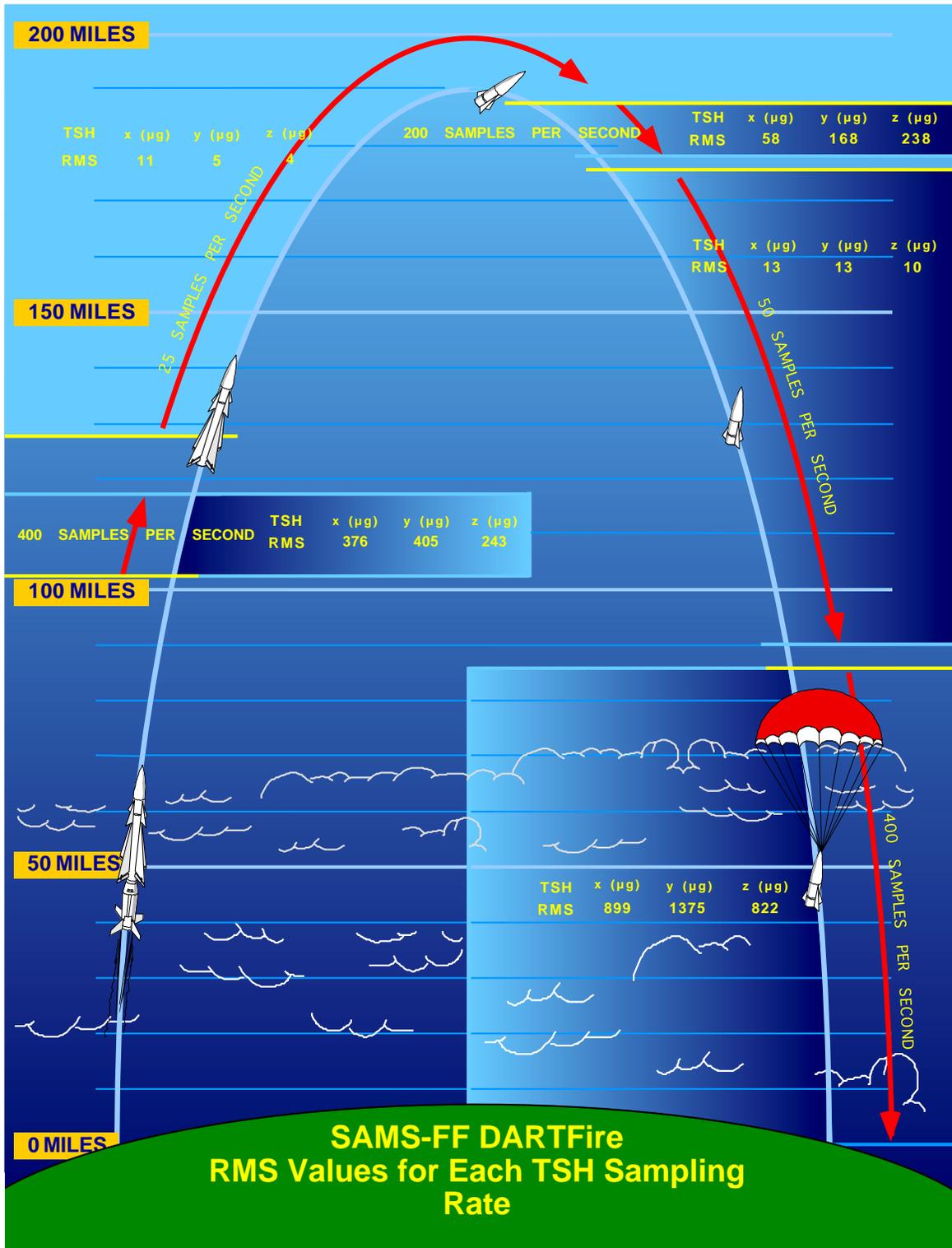
SAMS–FF Coordinates
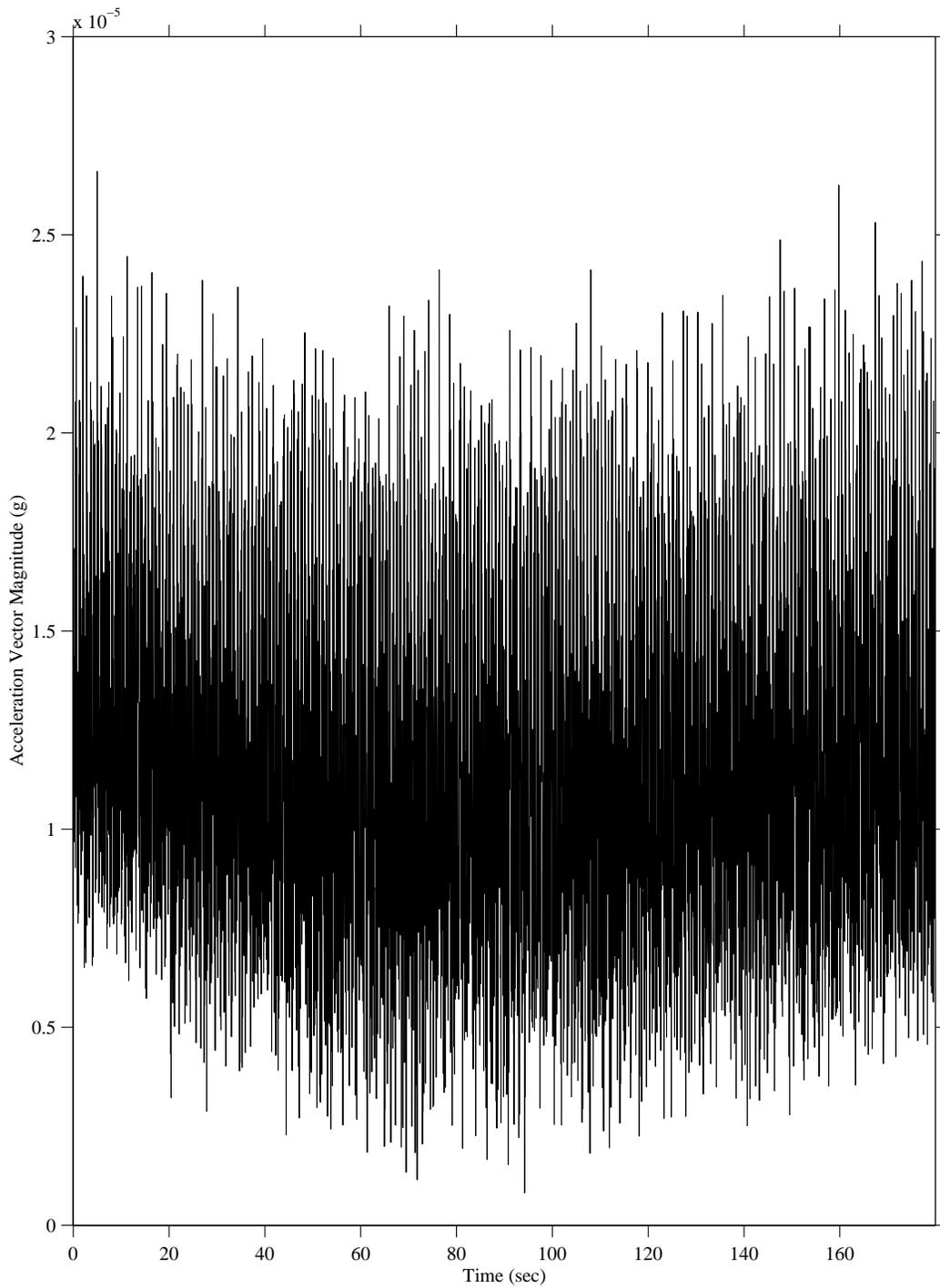
MATLAB: 11–Aug–1998, 06:02 pm

Figure 11-2

MET Start at 000/00:02:05.027, Hanning k=8

RSS Power Spectral Density for Fs=25
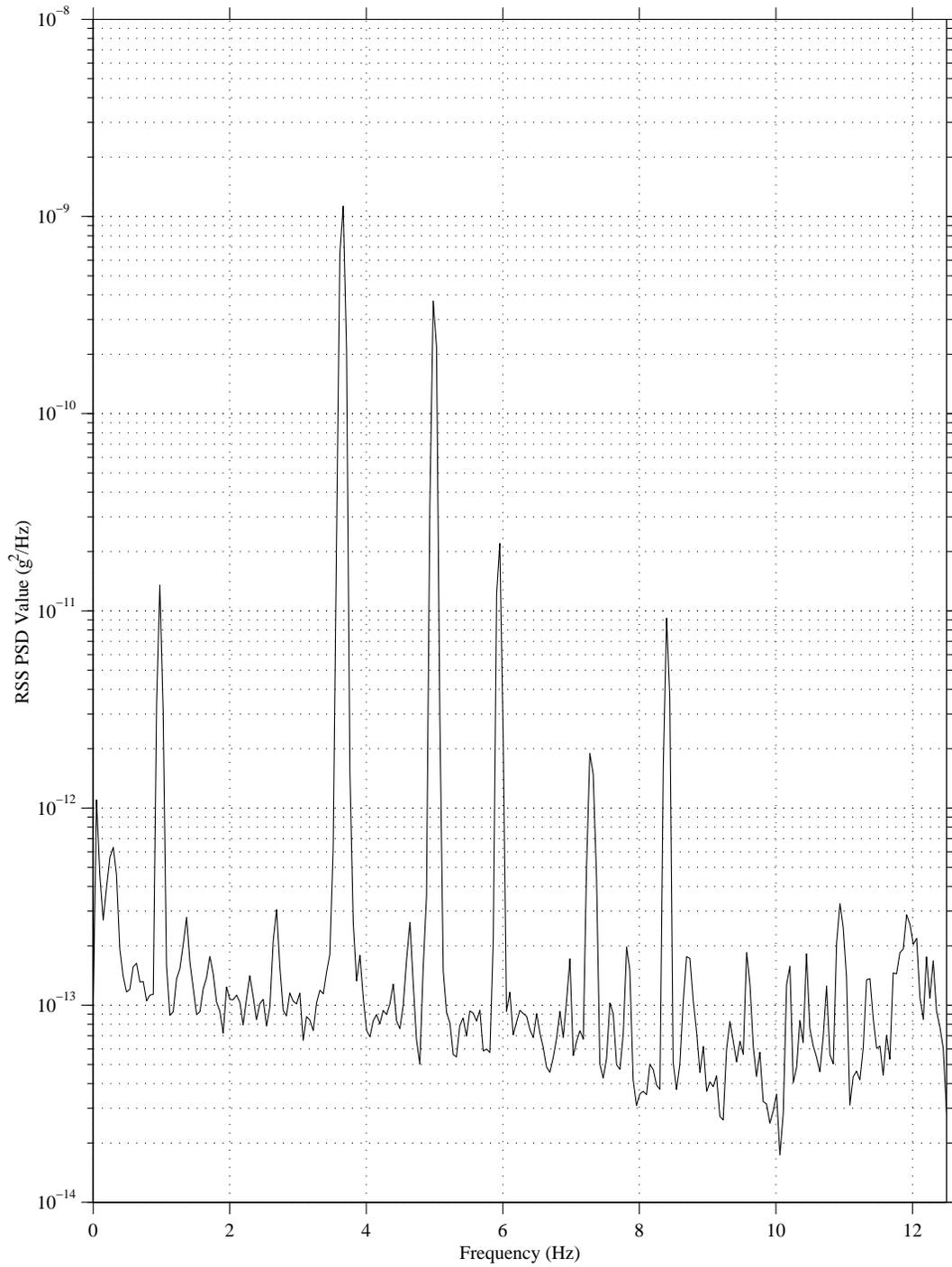
MATLAB: 11–Aug–1998, 06:05 pm

Figure 11-3

Multiple KC−135 Parabolas Without De−Meaning
MET Start at 055/15:09:59.992

Original Mean=−5.27e−02 g
RMS Value=5.27e−02 g

Original Mean=6.83e−03 g
RMS Value=9.71e−03 g

Original Mean=1.09e+00 g
RMS Value=8.06e−01 g

MATLAB: 13−Aug−1998, 10:35 am

Figure 11-4

uSEG Mission: Reduced Gravity Portion of KC–135 Parabola Without De–Meaning

MATLAB: 15–Jun–1998, 04:41 pm
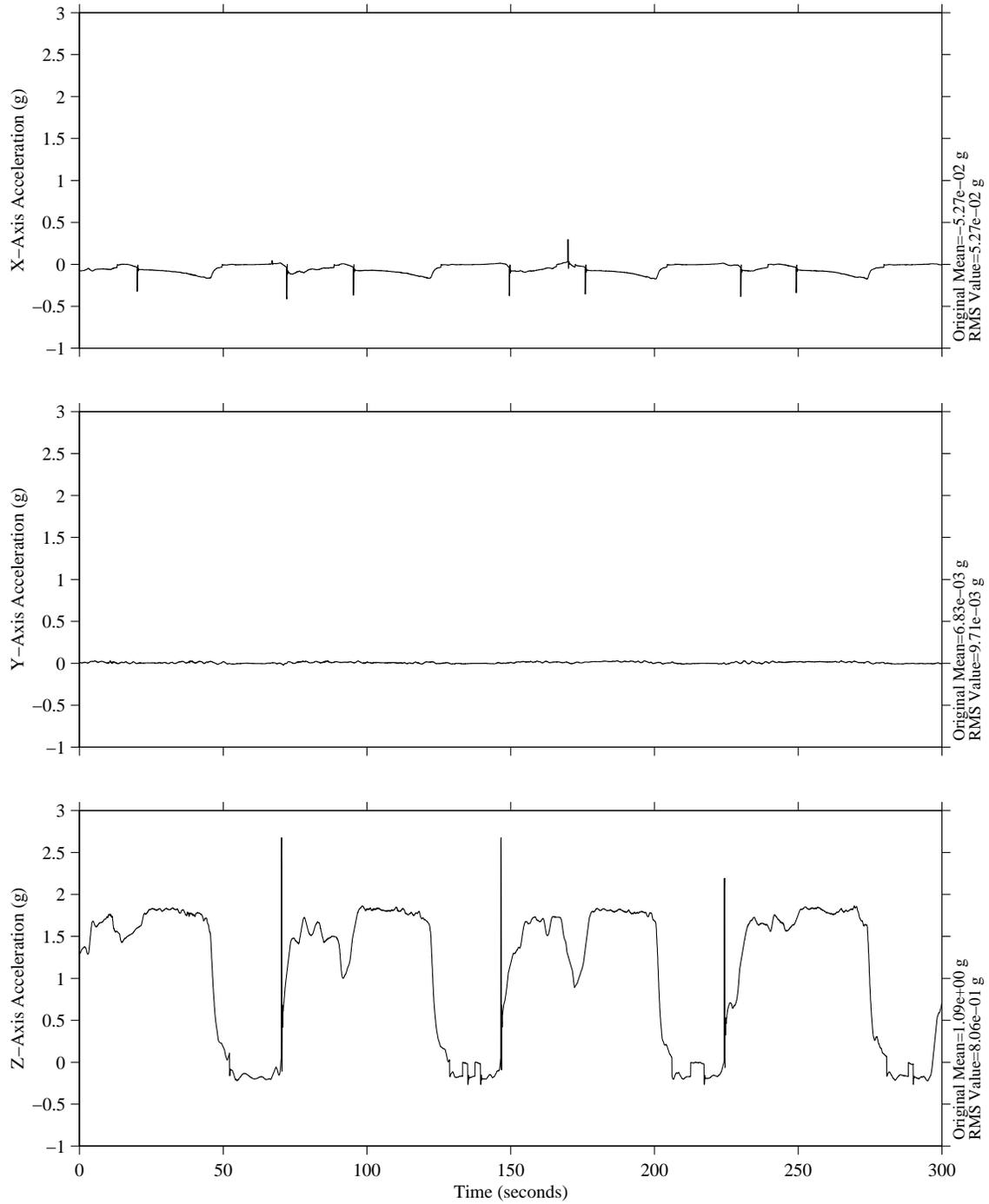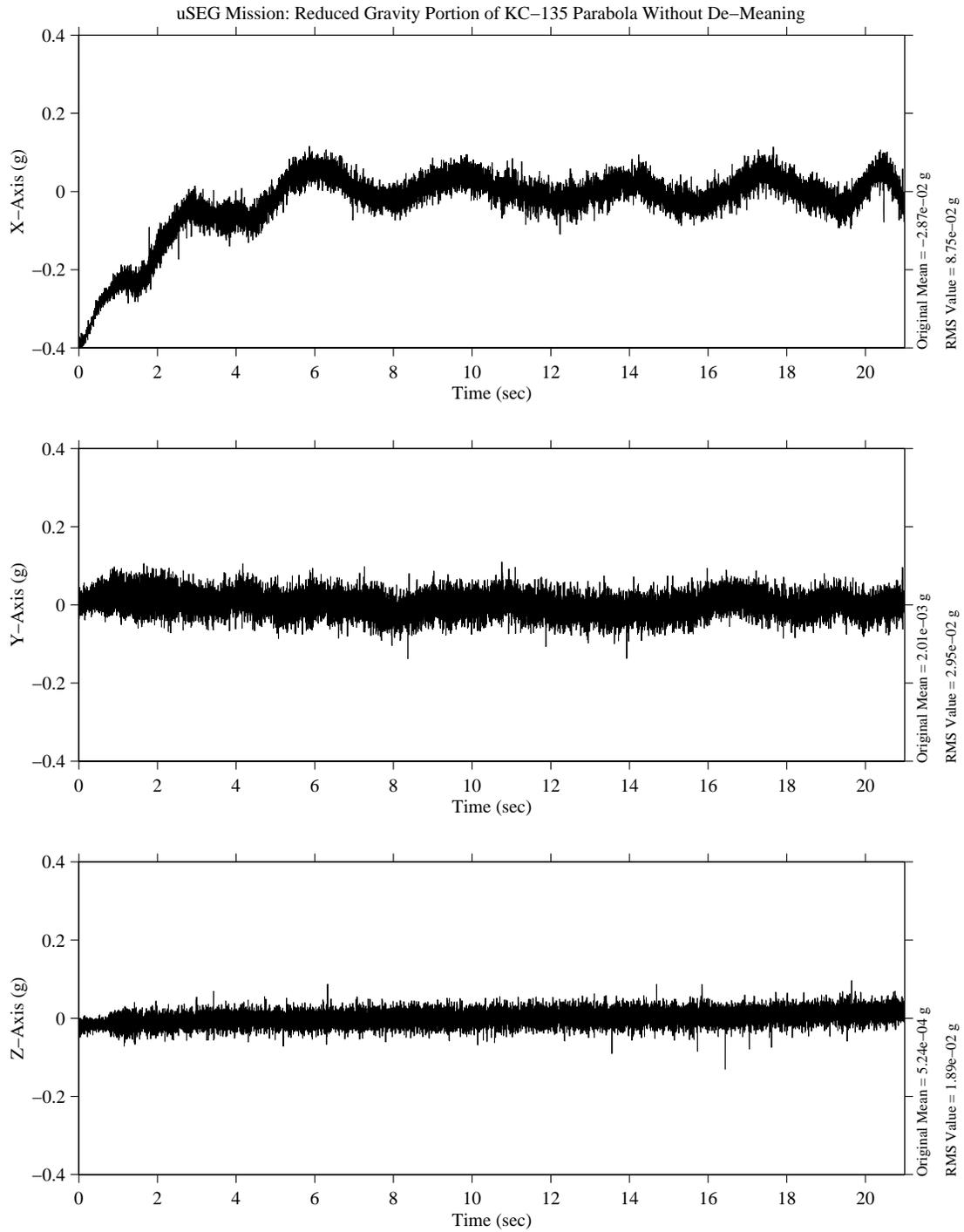
Figure 11-5

Acceleration History
Data Set #31
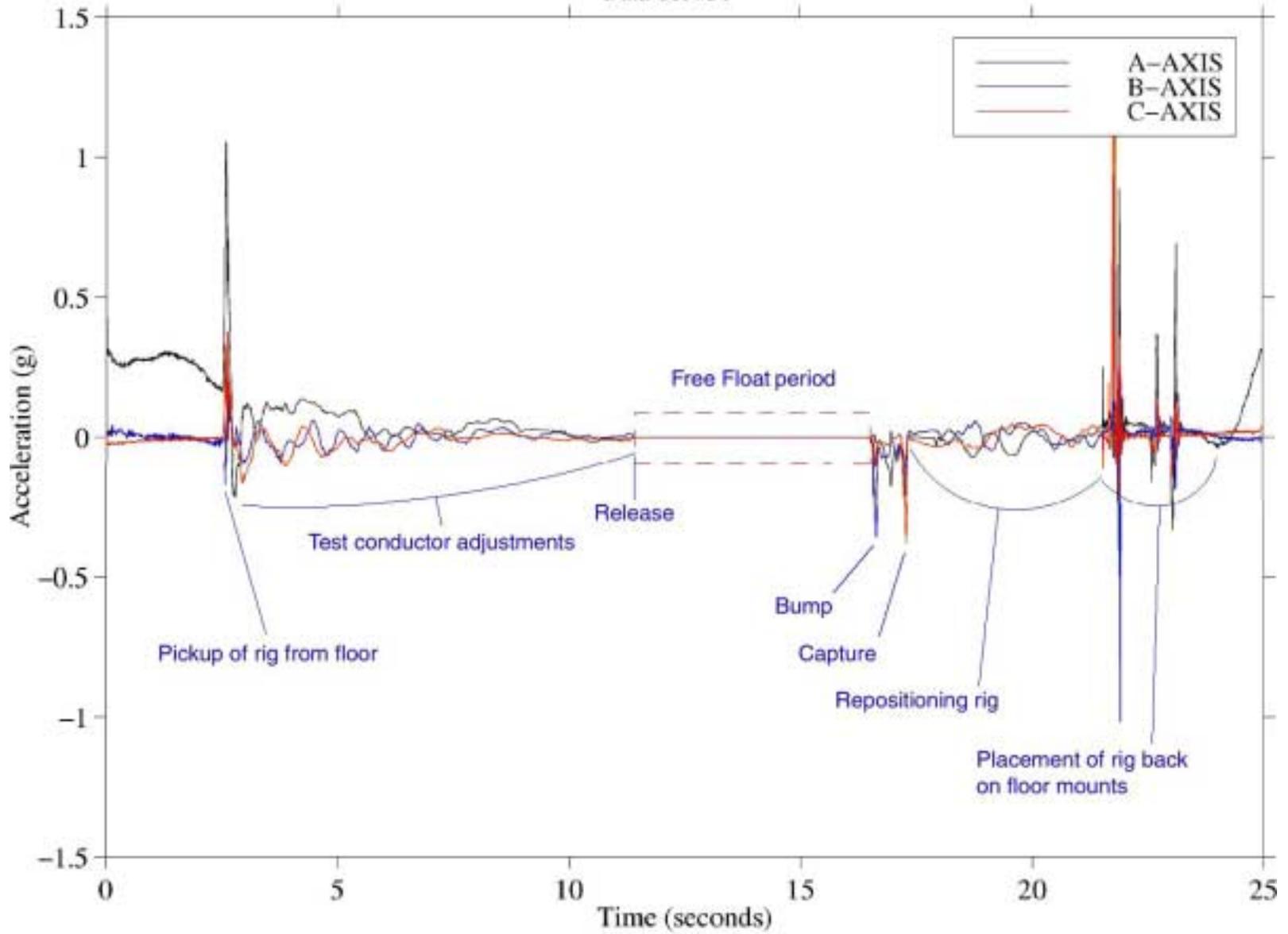
Figure 11-6

Figure 11-6: SAMS-FF Data Recorded in Support of SAL Experiment Showing Free-Float Interval

Figure 11-7

Head SAMS–FF, 50 Hz
fs=100 samples per second

Enhancement of Free Float Interval for Z–Axis
Data Set #31

KC–135 Free Float
April 27, 1999
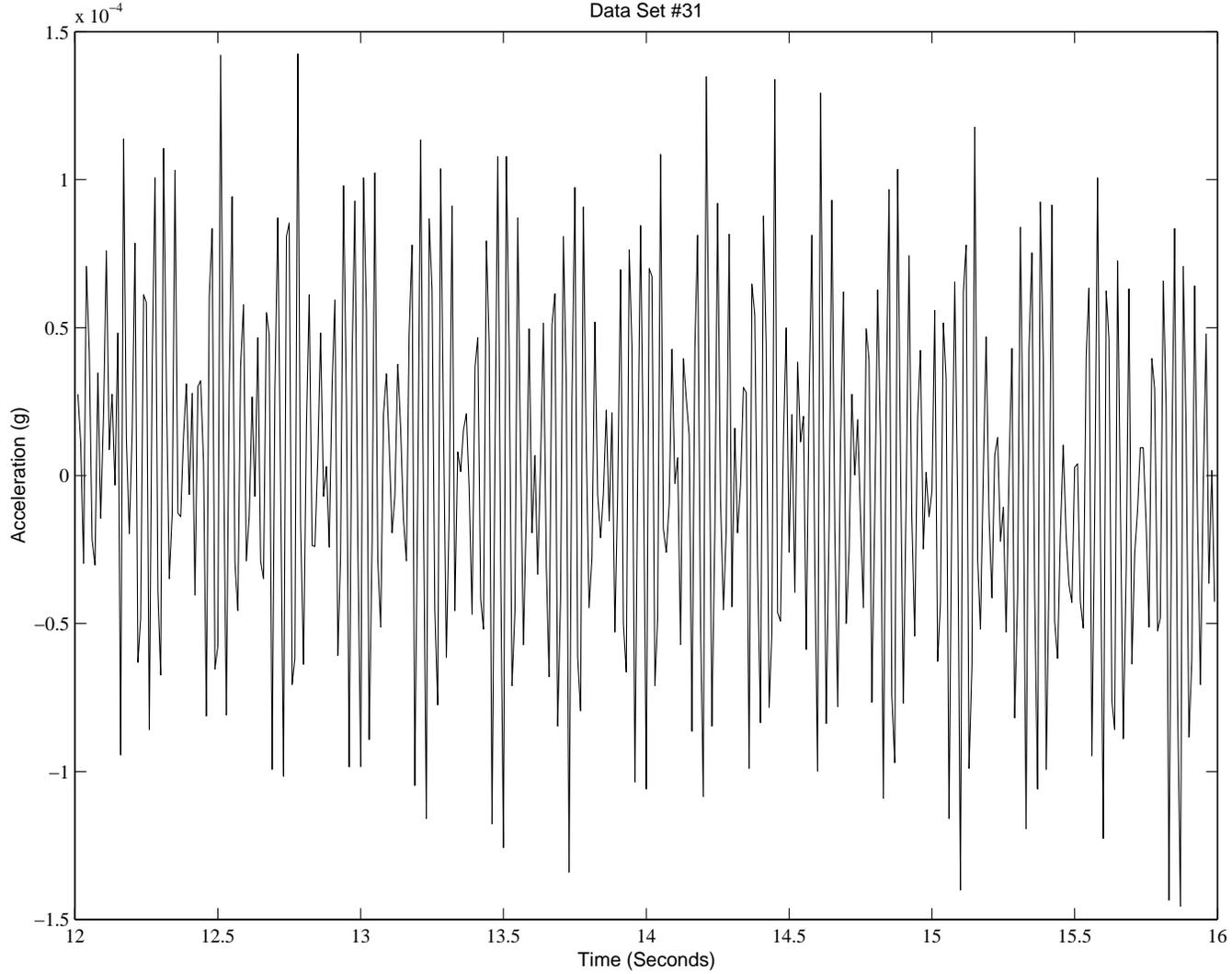
Figure 8–7: Enhancement of the Free Float Period for the Z–Axis