9/23/82

FAA TECHNICAL CENTER LETTER REPORT

ENGINEERING FLIGHT TESTS

ON THE BENDIX SMALL COMMUNITY MLS,

RUNWAY 33, WASHINGTON NATIONAL AIRPORT

by

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SEPTEMBER 1982

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
TECHNICAL CENTER
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ENGINEERING FLIGHT TESTS ON THE BENDIX SMALL COMMUNITY MLS, RUNWAY 33, WASHINGTON NATIONAL AIRPORT

PURPOSE

The purpose of this project was to determine if the Bendix Small Community Microwave Landing System (SCMLS) installed to service Runway 33 at Washington National Airport meets the accuracy tolerances as outlined in FAA-ER-700-08C, Change 2, Microwave Landing System Signal Format and System Level Functional Requirements.

BACKGROUND

The system installed on runway 33 will be used during commuter flight operations by Ransome Airlines in conjunction with Runway 17 at Philadelphia International Airport to gain operational experience under visual flight rule (VFR) conditions and to collect operational data for the Federal Aviation Administration Service Test and Evaluation Program (STEP).

EQUIPMENT DESCRIPTION

The Bendix SCMLS consists of an azimuth (AZ) system, an elevation (EL) system and a Precision Distance Measuring Equipment (DME/P). The AZ system gives proportional horizontal guidance to $\pm$ 10° about the phase center of the antenna. From 10° to 40° on each side, there is a full fly left or fly right signal to direct the aircraft to the proportional guidance area. The EL system gives proportional vertical guidance from 1° to 15°. The DME/P is a Cardion Precision DME which measures the distance from the aircraft to the DME antenna. Although the DME/P was used during these tests and data was collected, this report does not address those results.

The azimuth antenna is installed at the runway 33 stop-end, 275 feet to the left of centerline (pilot's right). It is situated so the 0° azimuth angle is parallel to the runway centerline. A 2.0° left azimuth approach will intersect the runway centerline extended 2,663 feet outside the threshold. The elevation antenna is located 258 feet inside the threshold and 250 feet to the left of runway centerline (pilot's right). It is sited for a 35-foot threshold crossing height on a 6.0° glide path. The DME/P antenna is mounted on the top of the azimuth antenna enclosure. A diagram of the runway 33 installation is shown in figure 1.

TEST PROCEDURES

Bendix personnel installed the system in January 1981, performed preliminary checkout of the equipment by taking static data using one of the MLS instrumented test vans from the Technical Center. This was to assure that the system was properly aligned and operating before the start of the airborne data collection.

The airborne data collection was accomplished using the Technical Center's Convair 580 aircraft (N-49) and precision laser tracker. Three types of flight profiles were flown: level altitude radials, approaches, and partial orbits. Radials check all of the EL angles at one AZ angle; the orbits check all of the AZ angles at one EL angle; and the approaches check the primary areas where the system is used operationally. The primary receiver used in these tests was the Phase III receiver built by Bendix. Data was collected on two receivers which are designated System 1 and System 2 on the data plots. On the last three data collection flights (1/5/82, 2/8/82, and 3/2/82) the second receiver was one of the new STEP receivers which was under test. The results using the STEP receiver will be addressed at a later date and are not included in this report.

DATA PROCESSING

After each flight test, the tracker data was outliered, filtered and time synchronized merged with the airborne digital data in the Technical Center's Honeywell 66/60 computer. Raw error and diagnostic plots with a printout come directly from the merge output. The difference between the angle processed by the airborne receiver and the true angles as determined by the tracker (MLS minus Tracker) at the same instant in time is defined as the error. The errors fall into two categories: constant bias errors and cyclical errors of all frequencies. These errors interact with the flight control system in a variety of ways resulting in two general types of guidance errors: path following error (PFE) and control motion noise (CMN).

PFE includes the steady state bias and cyclical error components of low enough frequency for the aircraft to physically track and have a measurable effect in terms of deviations from the desired track. The azimuth and elevation PFE error may degrade with range, azimuth and elevation angle.

CMN encompasses the higher frequency error components in the 0.3 to 10 radians/second range for azimuth and 0.5 to 10 radians/second range for elevation. These errors are generally of a frequency too high for the aircraft to physically track, but low enough for the control system to respond to. This results in rapid small amplitude control surface wheel and column motions and is undesirable in that it diminishes flight crew confidence by presenting them with a "shaky stick". The elevation CMN error may degrade with range, azimuth and elevation angle. However, the azimuth CMN error may only degrade with range and azimuth angle. The elevation error specifications are shown in figure 2 and the azimuth error specifications are in figure 3.

DATA ANALYSIS

Inbound, level, 3000 foot (ft) radials were flown at AZ angles of 0°, $\pm 5^{\circ}$, $\pm 10^{\circ}$ and approaches were made at AZ angles of 0° and $+2^{\circ}$ at an EL angle of 6°. Partial orbits were flown $\pm 40^{\circ}$ at a distance of 7 nautical miles (nmi) from the azimuth site at altitudes of 3000 ft., 4000 ft., and 5000 ft., which corresponds to elevation angles of 4.5°, 5.4°, and 5.8°. At least two radials and four approaches were flown at each listed AZ angle. The partial orbits were flown twice in both the clockwise (CW) and counterclockwise (CCW) directions.

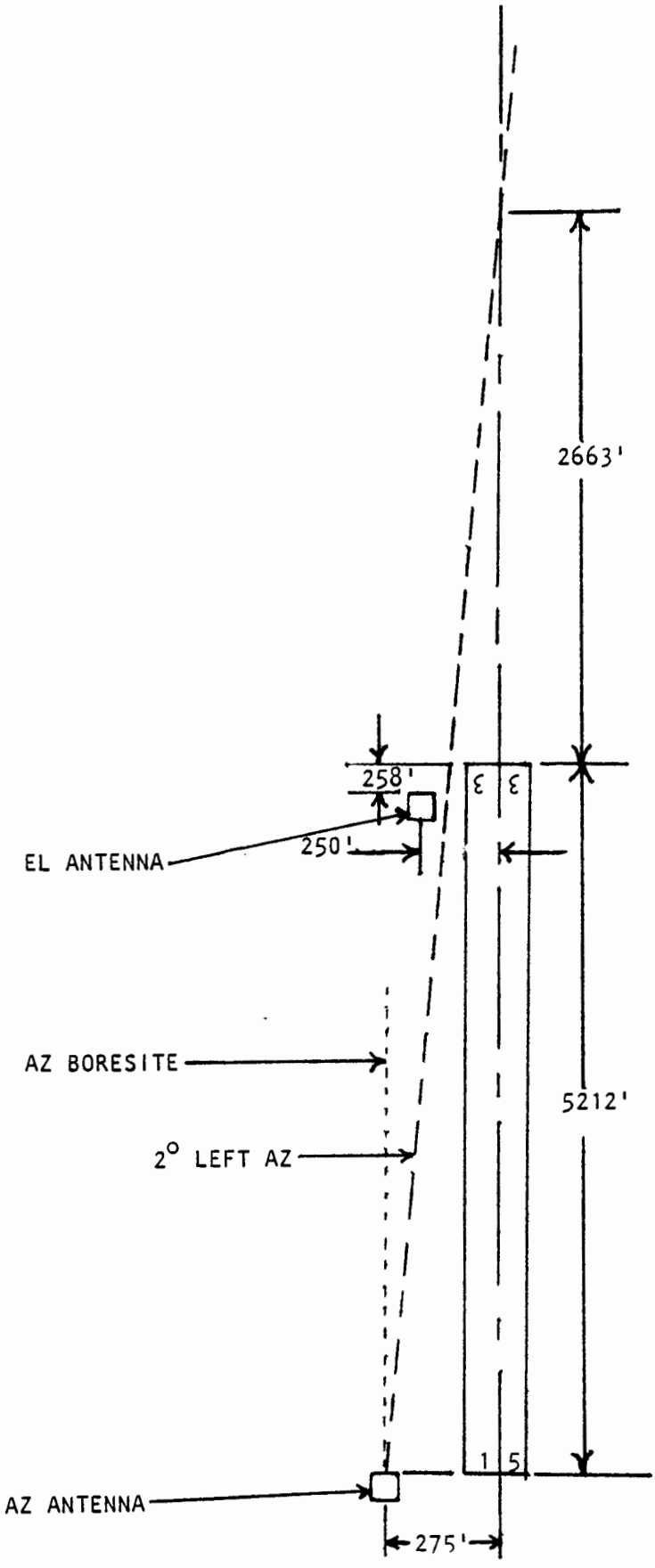


Figure 1. DCA Runway 33 MLS Siting Configuration

ERROR COMPONENT	SYSTEM ERROR(FT) (1)	DEGRADATION ALLOWANCES		
		WITH DISTANCE	WITH AZIMUTH ANGLE	WITH ELEVATION ANGLE (3)
PATH FOLLOWING ERROR (PFE)	2.0	0.2° maximum at 20 nmi (On the minimum glide path and 0° azimuth radial)	1.3:1 in angle from the reference datum to ±40°	2:1 in angle from minimum glide path to 15° 6:1 in angle from 60% of minimum glide path to lower coverage limit. Maximum allowed is 0.8°
CONTROL MOTION NOISE (CMN)	0.75	1.3:1 in angle from the reference datum to 10 nmi (2)	1.3:1 in angle from the reference datum to ±40°	2:1 in angle from minimum glide path to 15°. Maximum allowed above the reference datum is .27° 6:1 in angle from 60% of minimum glide path to lower coverage limit. Maximum allowed is 0.4°

NOTES:

Specifications are per FAA-ER-700-08C, Change #2 (dated 4/23/81)

1. At approach reference datum defined as the point on the minimum glide path at threshold.

2. The CMN is unspecified beyond 10 nmi.

3. Elevation equipment sited to provide a minimum glide path higher than 3° shall provide angular accuracies not less than those specified as if the equipment were sited for a 3° glide path.

Figure 2. Elevation Error Specifications

ERROR COMPONENT	SYSTEM ERROR(FT) (1)	DEGRADATION ALLOWANCES		
		WITH DISTANCE	WITH AZIMUTH ANGLE	WITH ELEVATION ANGLE
PATH FOLLOWING ERROR (PFE)	20	2:1 in angle from the reference datum to 20 nmi	1.5:1 in angle from the reference datum to ±40°	None to 9° 2:1 in angle from 9° to 20°
CONTROL MOTION NOISE (CMN)	10.5 (3)	1.3:1 in angle from the reference datum to 10 nmi (2)	1.3:1 in angle from the reference datum to ±40°	NONE

NOTES:

Specifications are per FAA-ER-700-08C, Change #2 (dated 4/23/81).

1. At approach reference datum defined as the point on the minimum glide path at threshold. For systems with colocated Az and El use 5000 feet distance to the approach reference datum.
2. The CMN is unspecified beyond 10 nmi
3. Maximum CMN at the reference datum is 0.1°.

Figure 3. Azimuth Error Specifications

A set of data plots that is representative of all the data obtained is shown in the appendix.

For each radial and approach, there is a diagnostic plot, which shows raw MLS (receiver output) and filtered tracker data, a PFE plot and a CMN plot. The EL orbits contain diagnostic, PFE and CMN plots. Only PFE and CMN plots are included for AZ orbits because the scale on the diagnostic plot is such that little if any useful diagnostic information is revealed. All of the data except for the EL CMN plots for the 2° left AZ, 6° EL approach (figure A-72) and the partial CW orbit at 3000' (figure A-35) is well within the tolerance limits. On the approach the trace does exceed the tolerance limits, but close examination of the diagnostic plot (figure A-70) indicates that as the aircraft approaches threshold it levels off resulting in a rapid change in elevation angles. The CMN filter is a high pass filter but rapid one direction changes in the data can still be passed and will show up as a bias on the CMN filtered plots. On the 1/5/82 run 7, data (figure A-72) in the area close to threshold the peak-to-peak value of the CMN is about $\pm .03^{\circ}$ but, because of the bias, the data range is from $+ .01^{\circ}$ to $-.06^{\circ}$ which exceeds the $-.05^{\circ}$ tolerance limit. This rapid, in close, change in elevation angle and the resulting CMN bias occurs on all of the approaches that were recorded. In some cases the trace exceeds the tolerance limit while in others it does not.

The partial orbit CMN trace (figure A-35) goes slightly above the tolerance limit in the area of -9.5°. This again appears to be caused by the filter. On the CW orbits, the filter is initialized at -10° and on the CCW orbits it is initialized at $+10^{\circ}$. Figures A-33 and A-38 are the diagnostic plots for CW and CCW partial orbits respectively, under the same conditions and the data is very similar for both runs. However, the CMN plots (figures A-35 and A-40) for these two runs show that in the area of the run where the filter is initialized, there is a bias which causes one of the runs to exceed the tolerance line. Examination of the data between 8° and 10° on both sides of centerline on both runs shows that the peak-to-peak amplitude of the trace is the same; however, there is a bias at the end of the run where filter initialization occurs because the filter is started by initializing all values to the first angular error difference measurement.

Several of the runs indicate a bias on the elevation system of between $.05^{\circ}$ and $.10^{\circ}$ which is well within the prescribed tolerance. The straight lines on some of the data plots indicate that no data was merged during those time periods because there was no tracker data. This lack of tracker data could be caused by the tracker unlocking from the retro or bad tracker data that was unusable.

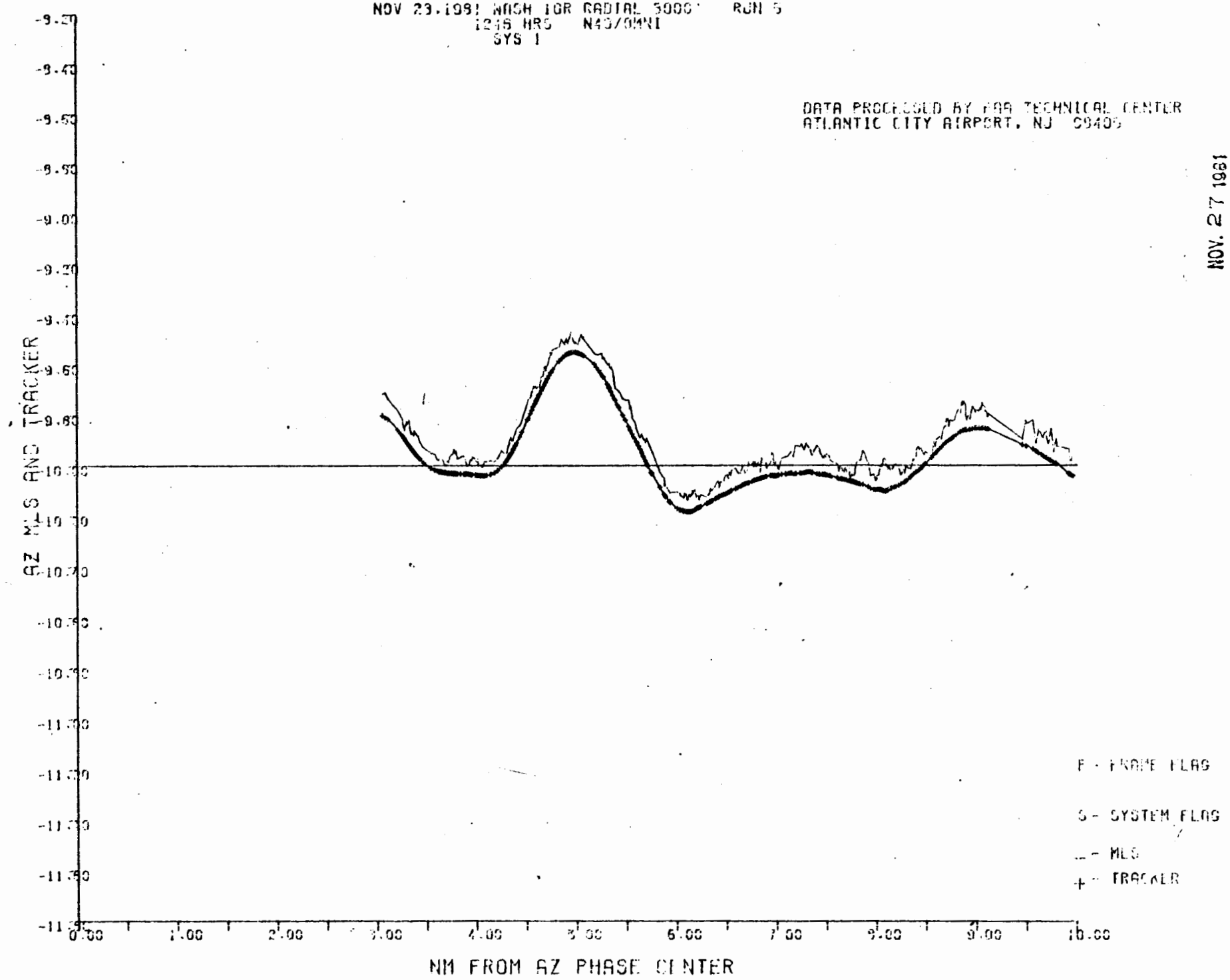
The azimuth CMN plots are noisier on the approaches that on the radials although they are still within tolerance. Testing performed since this data was collected indicates that reflections from the blades of the props on the CV-580 aircraft contributed to this noise and steps are being taken to minimize this problem.

The analog signals were checked with a full orbit and there are no abnormal flag conditions or false courses. In addition there is a usable signal out to 20 nautical miles down to at least 3000 ft. in altitude and up to at least 16,000 ft. in altitude across $\pm 40^{\circ}$ in azimuth.

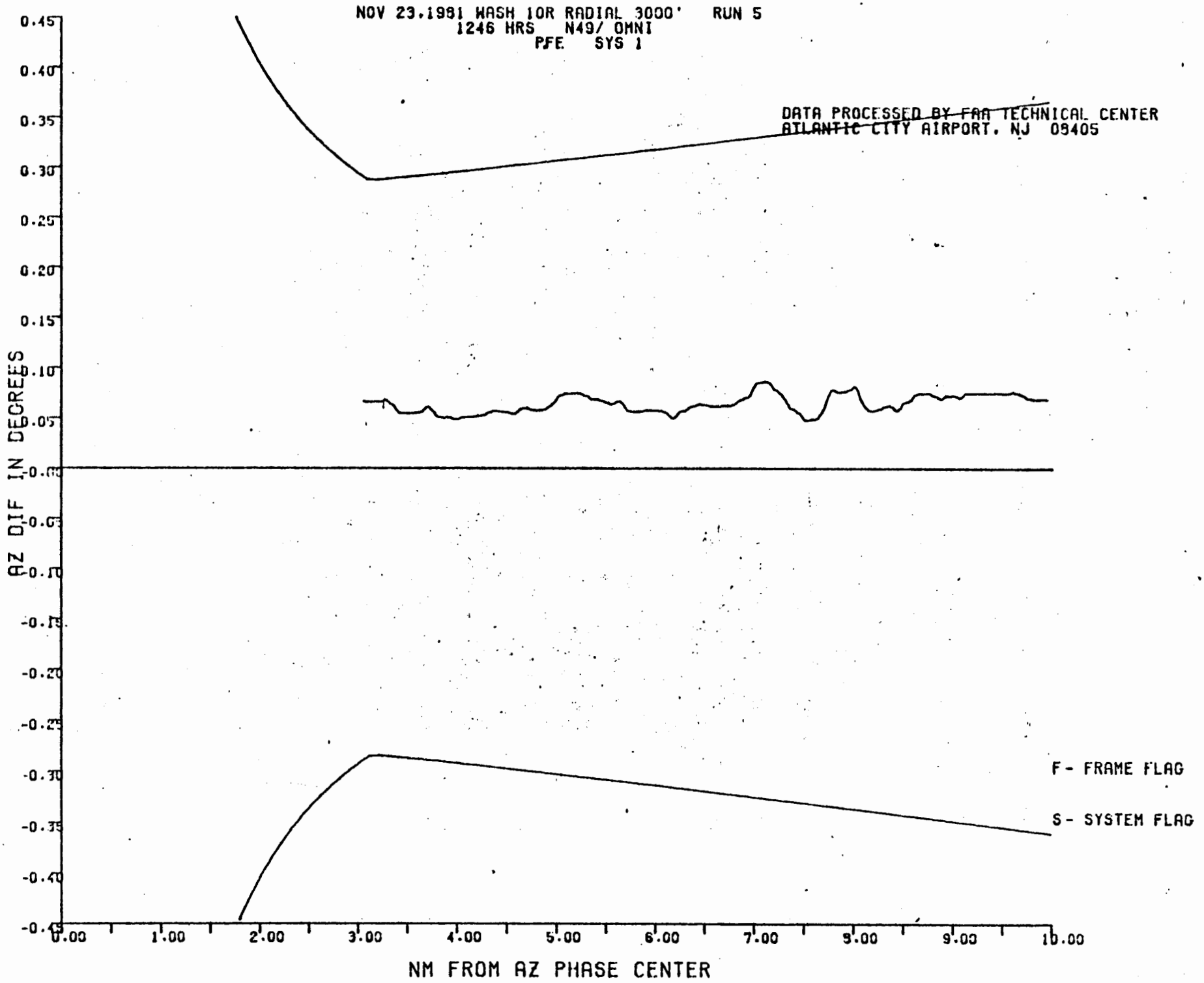
CONCLUSIONS AND RECOMMENDATIONS

The Bendix Small Community MLS AZ and EL guidance signals serving runway 33 at Washington National Airport were within specified accuracy tolerances in the areas that were checked. The signal in space is usable for collection of operational data.

APPENDIX



A-1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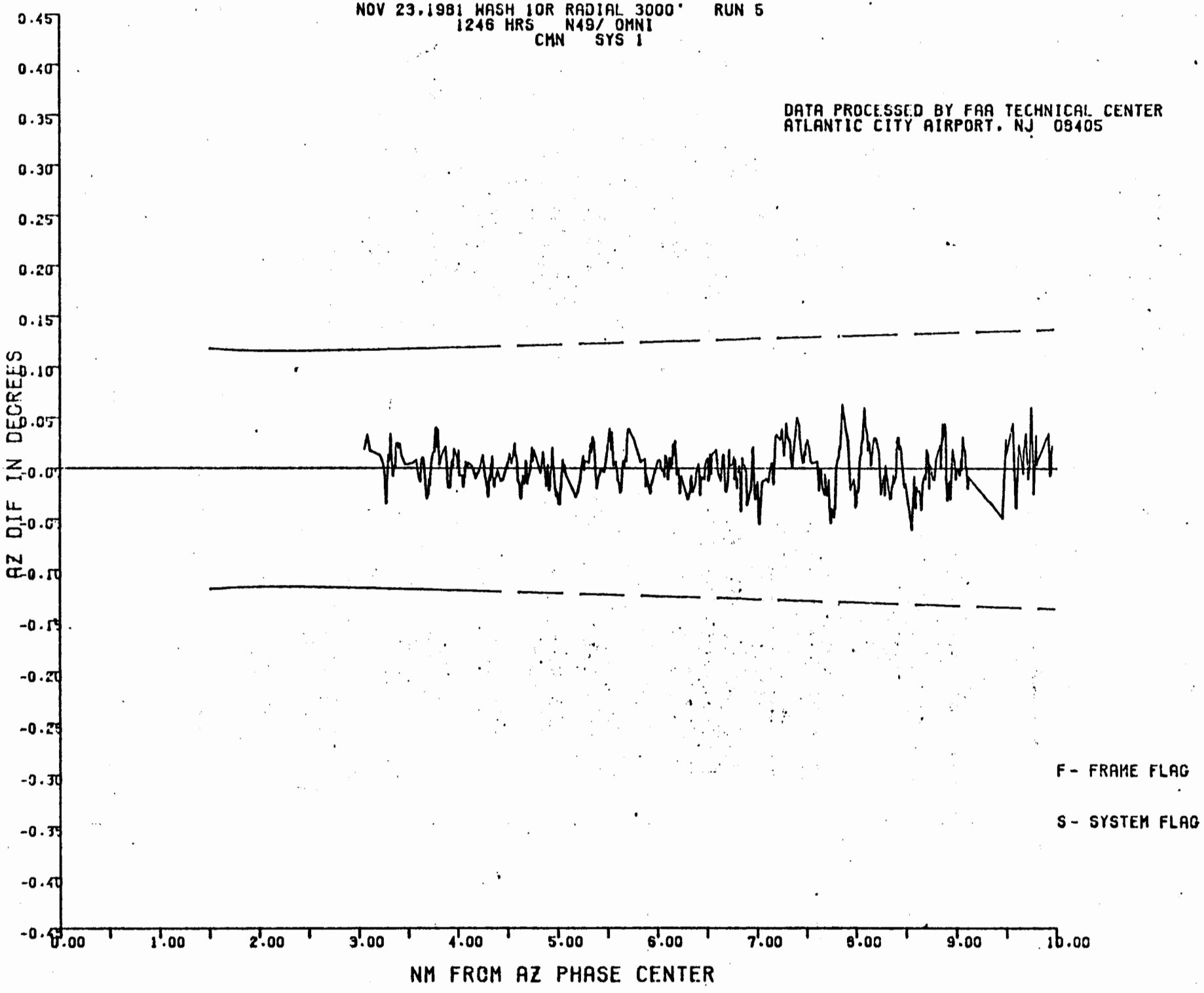
S - SYSTEM FLAG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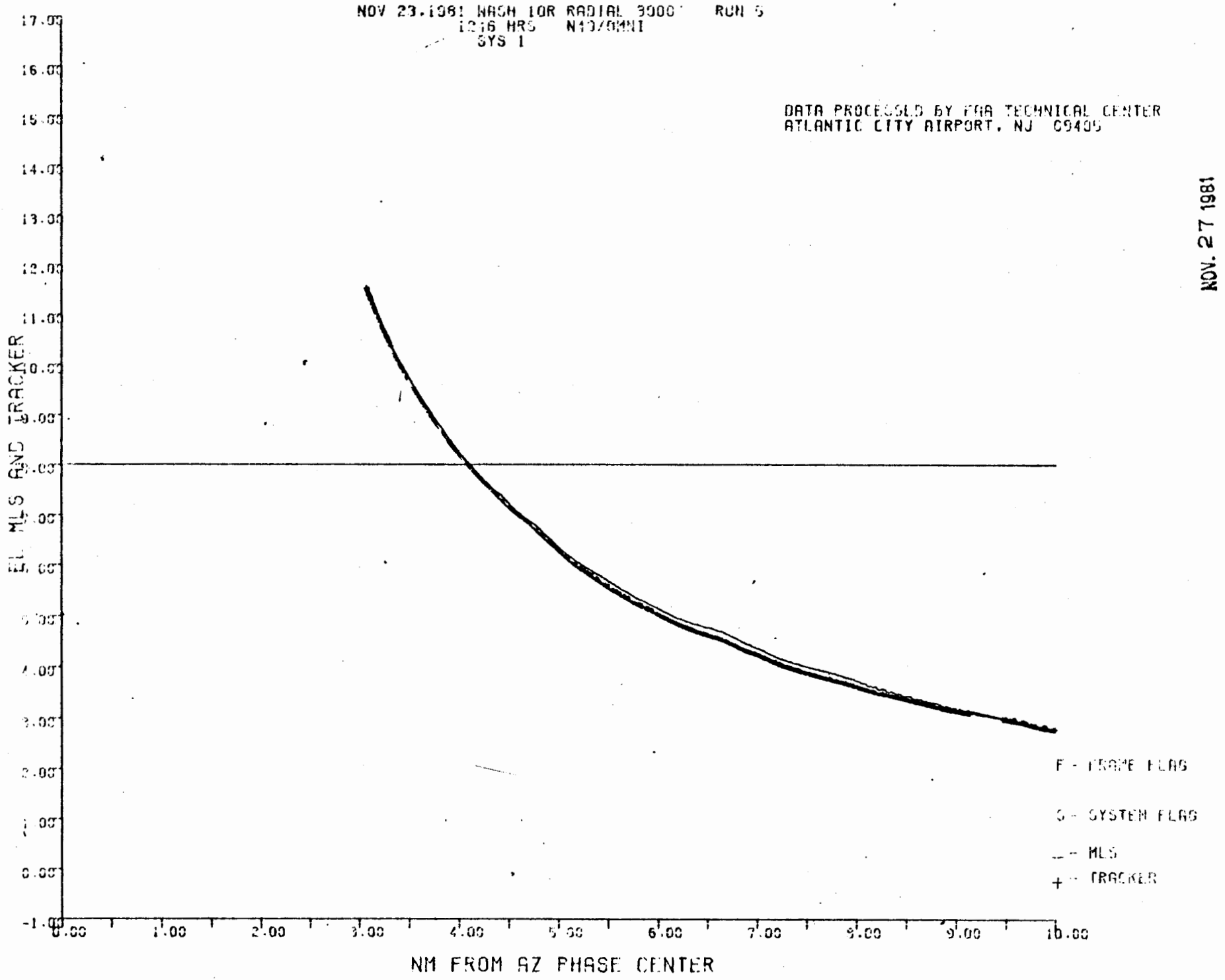
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13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
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3.00
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1.00
0.00
-1.00
0.00
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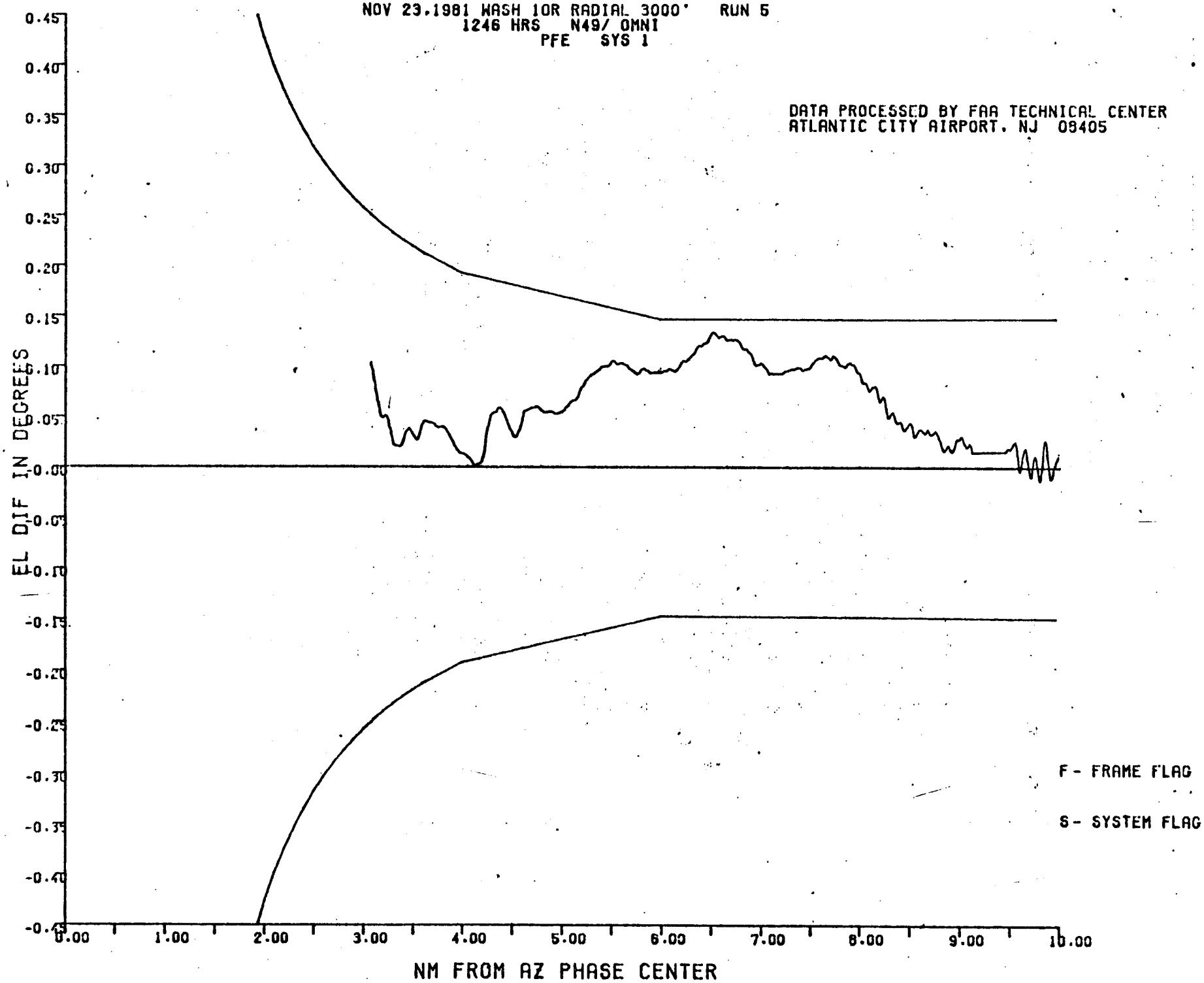
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0.20
0.15
0.10
0.05
0.00
-0.20
-0.40
0.00
1.00
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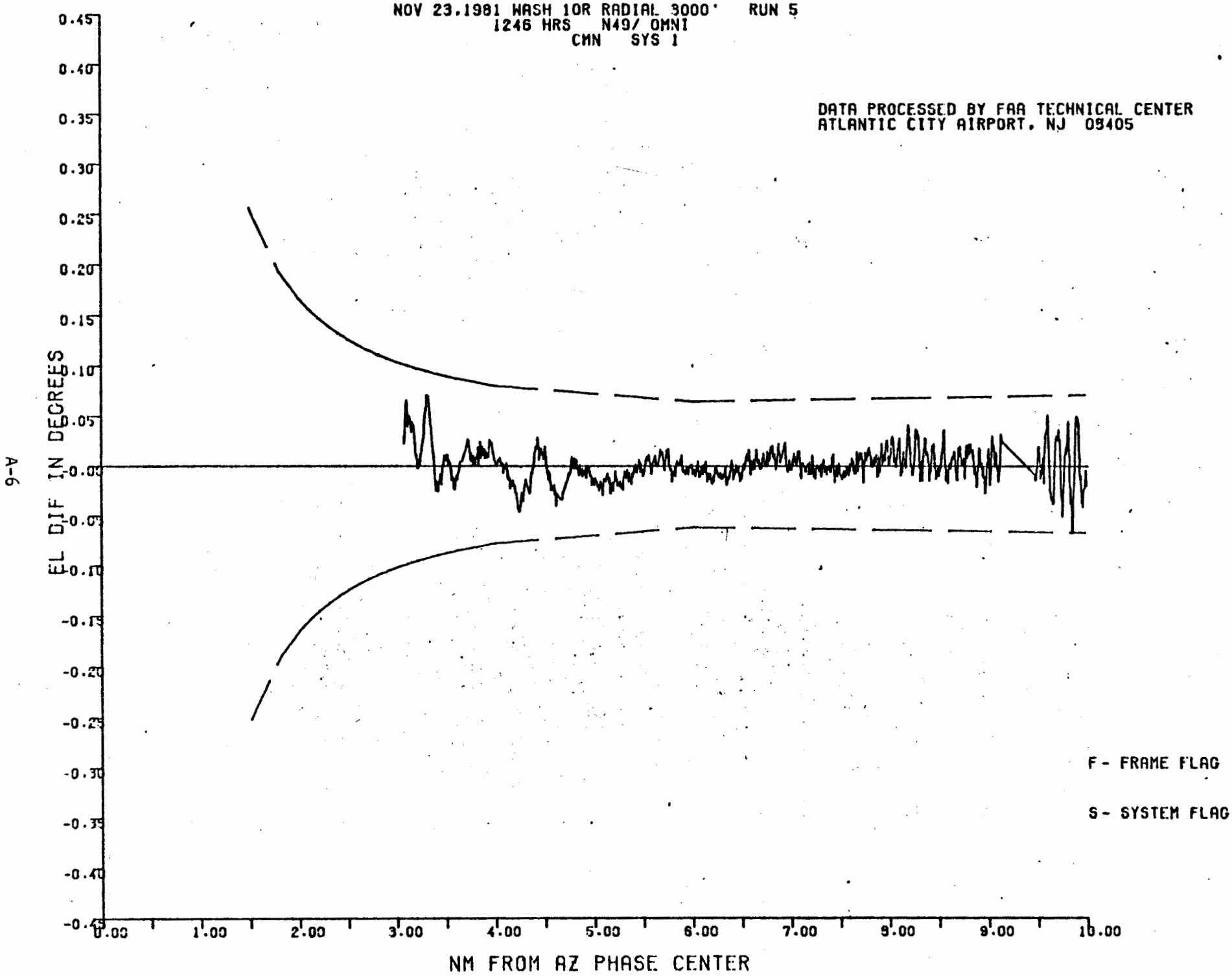
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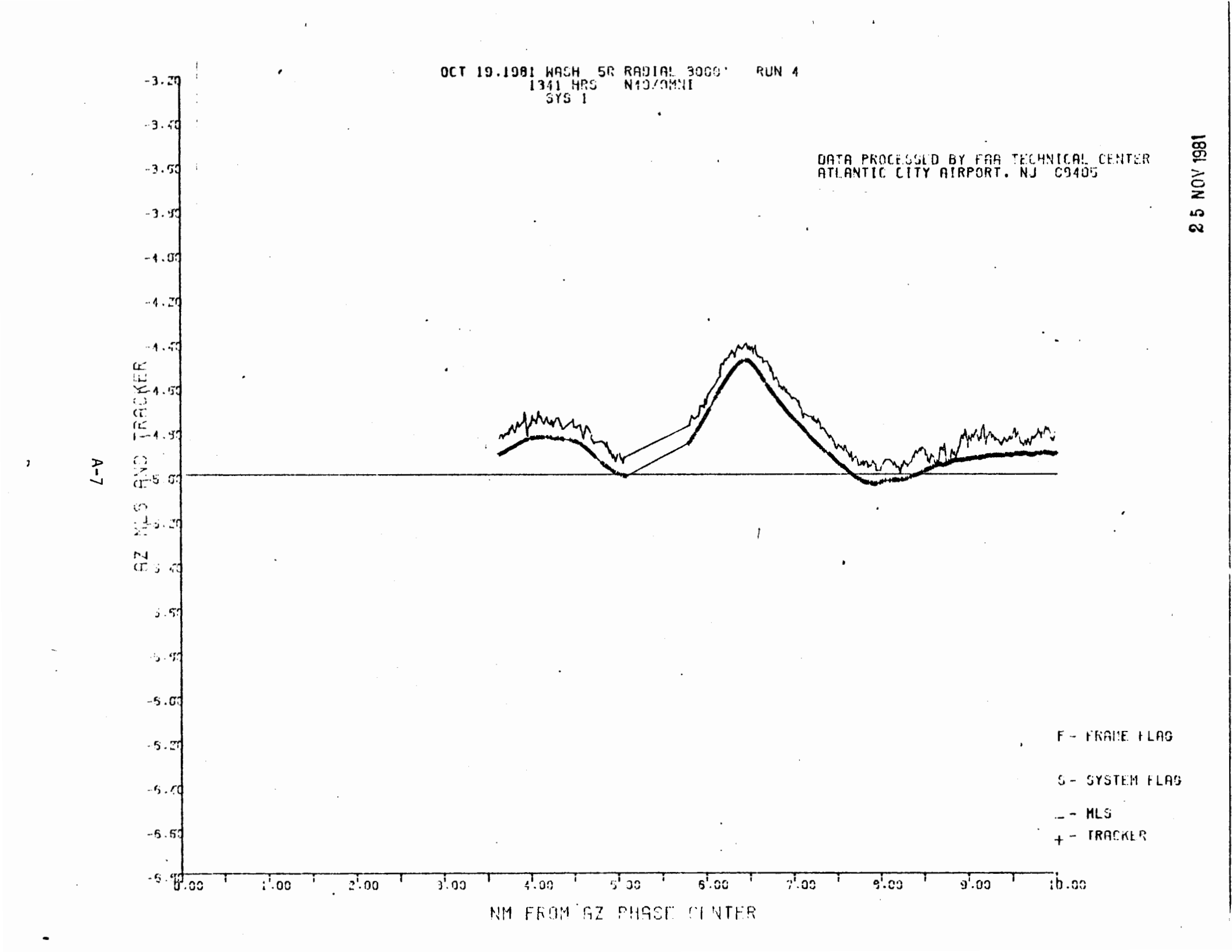
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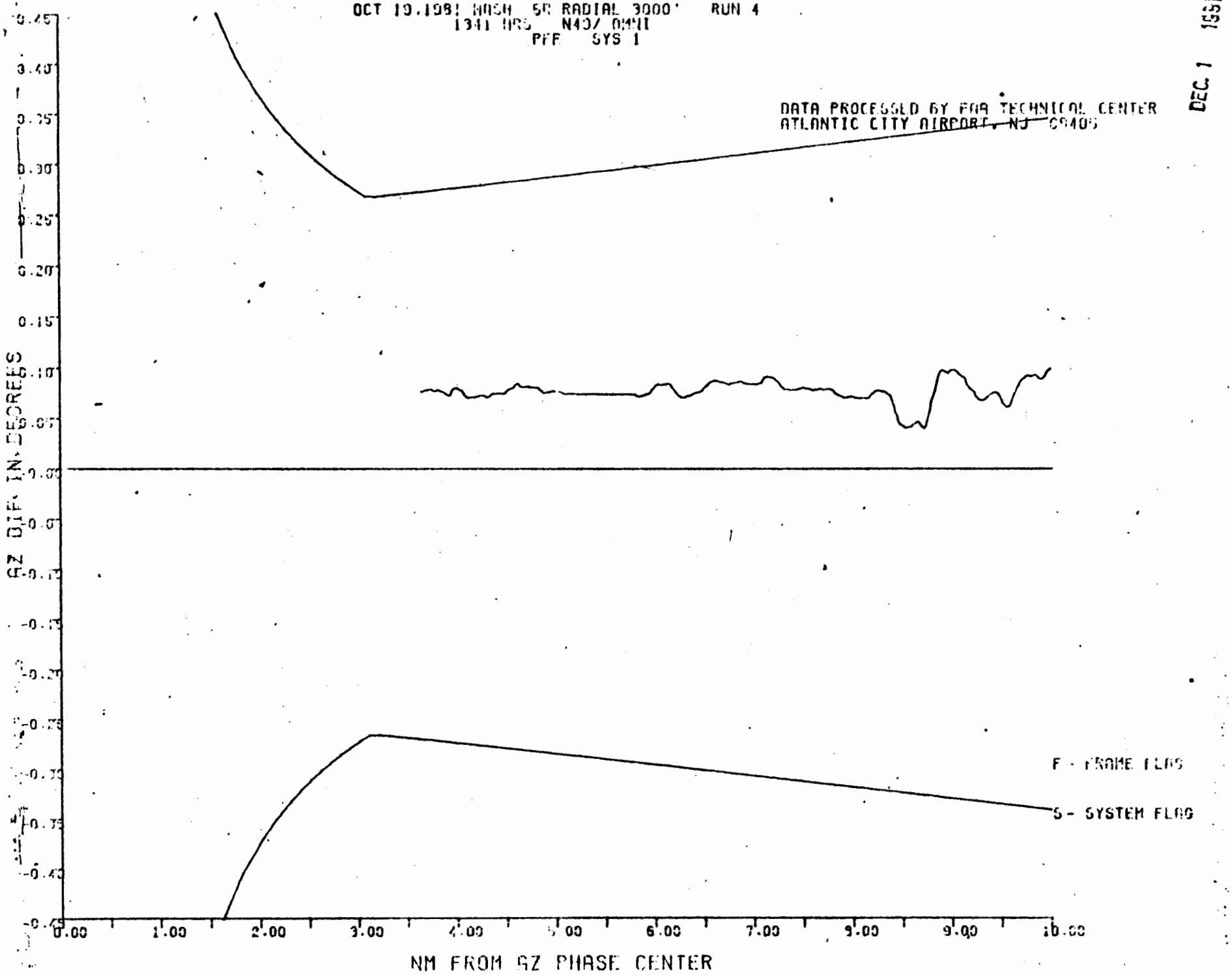
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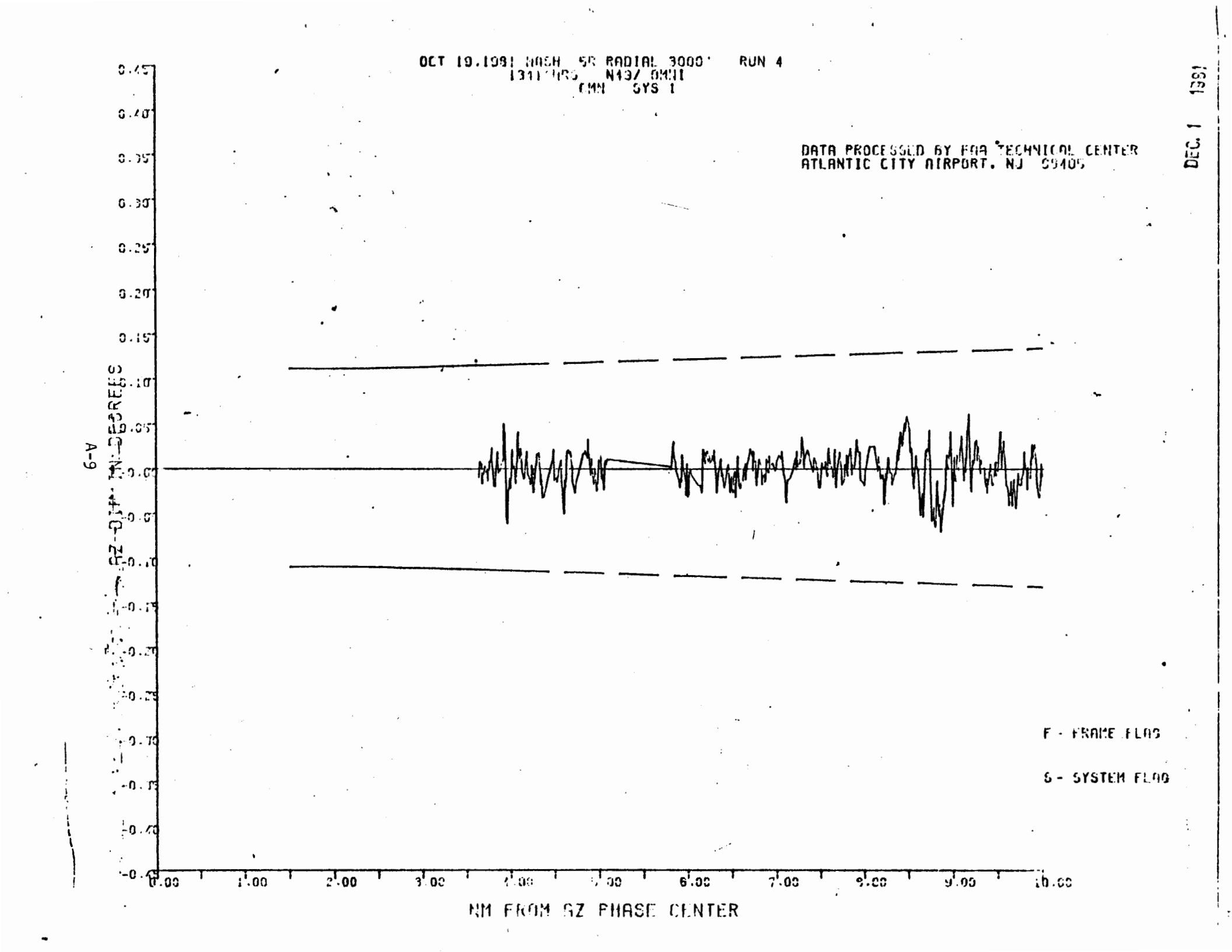
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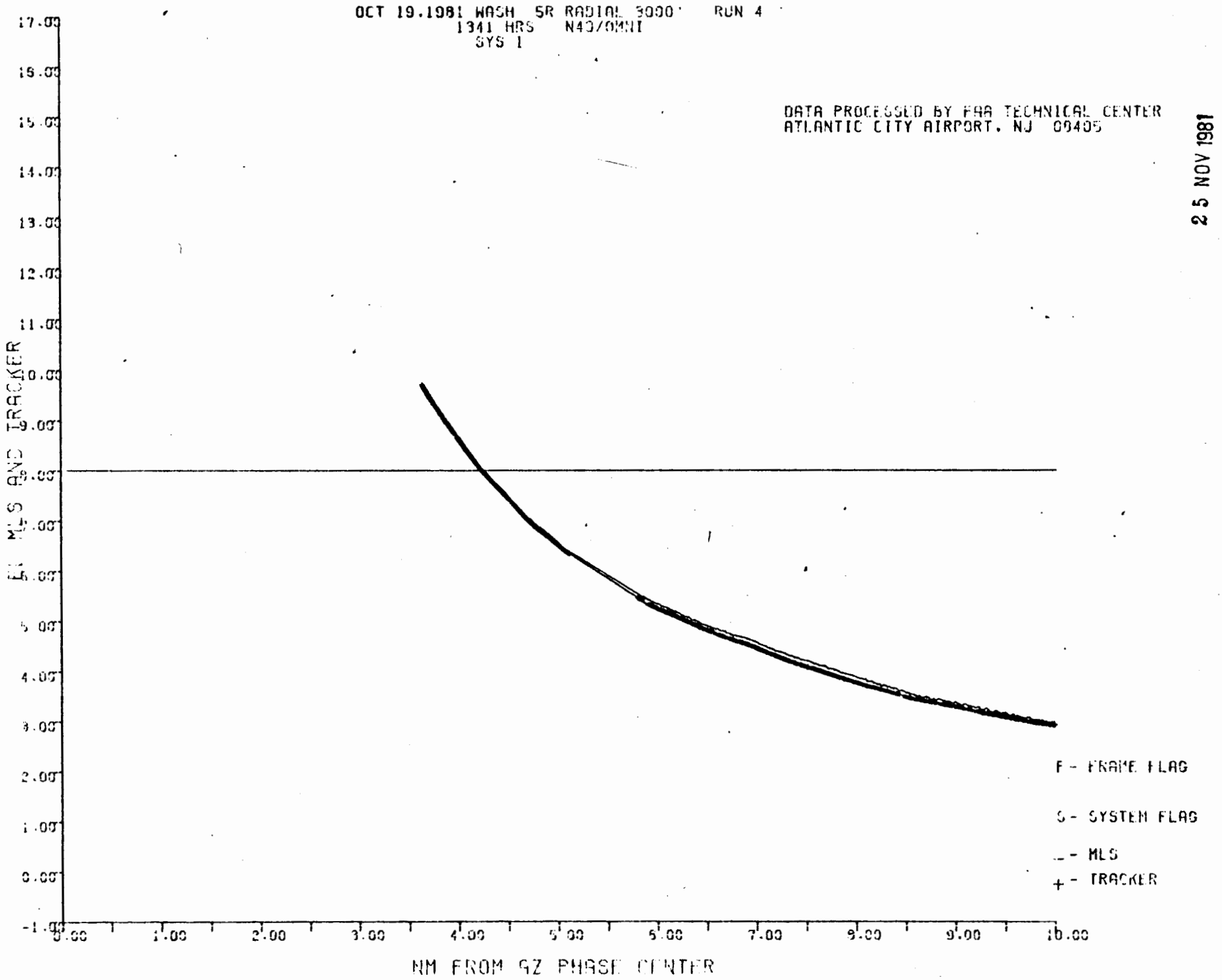
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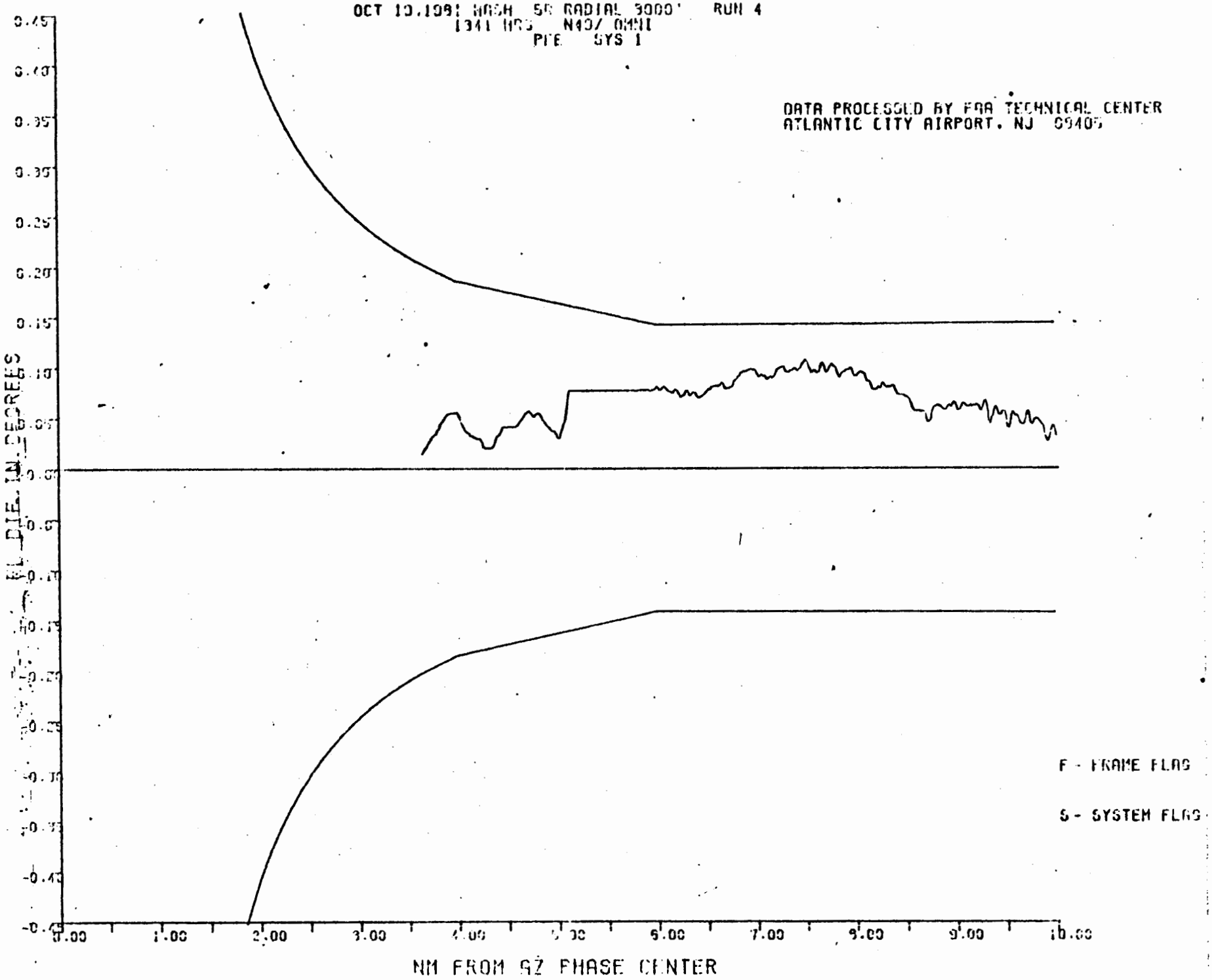
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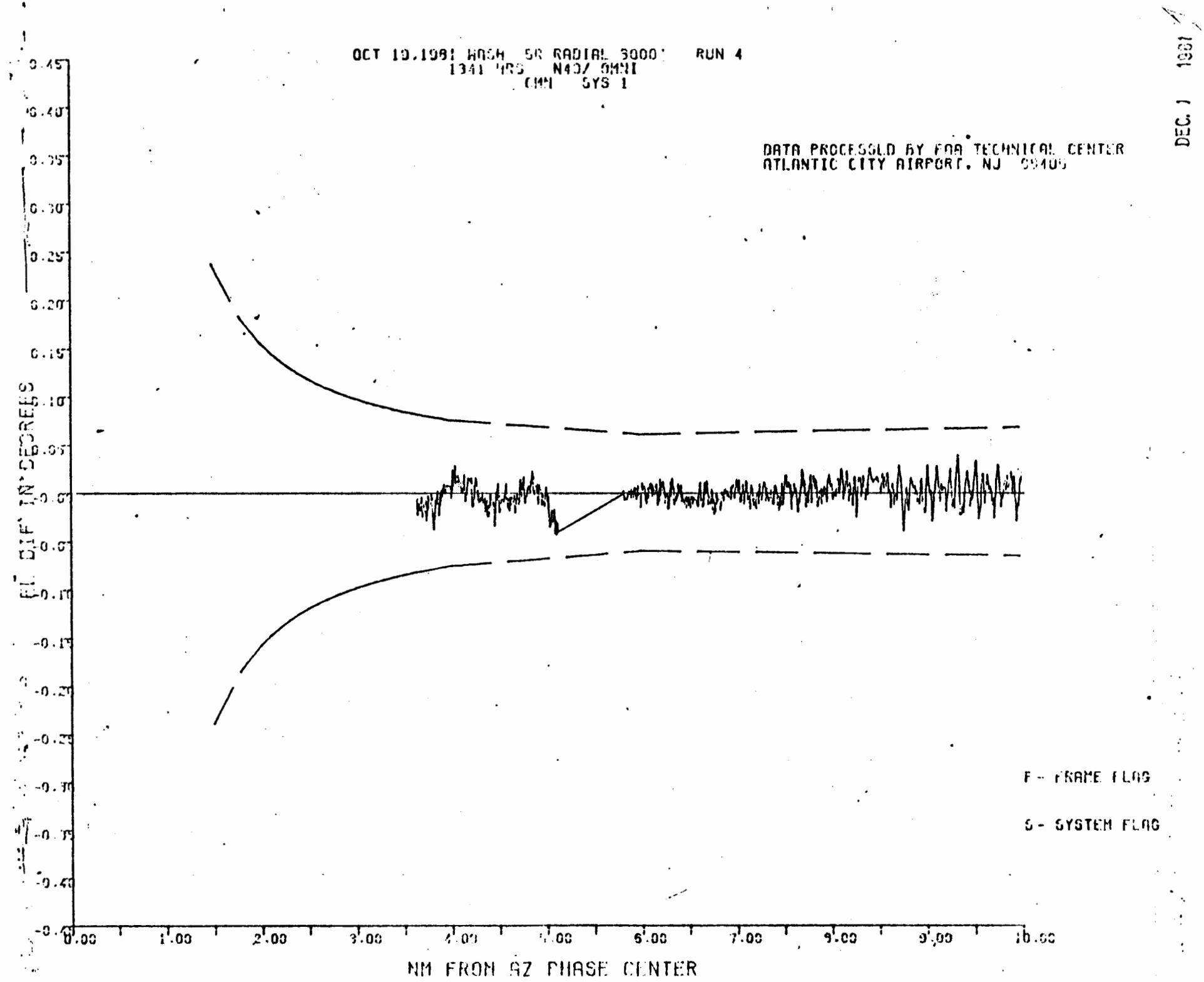
F - FRAME FLAG
S - SYSTEM FLAG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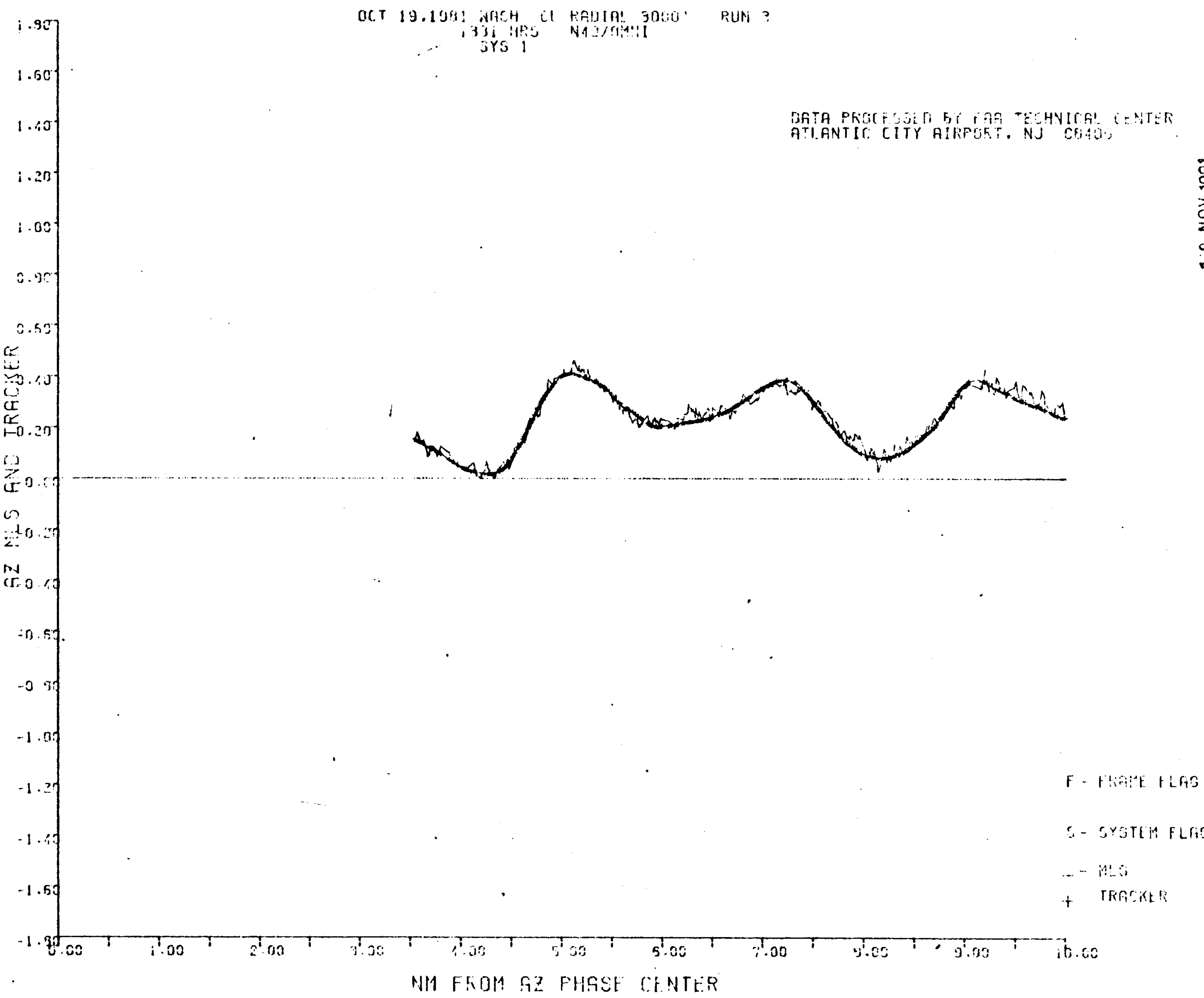
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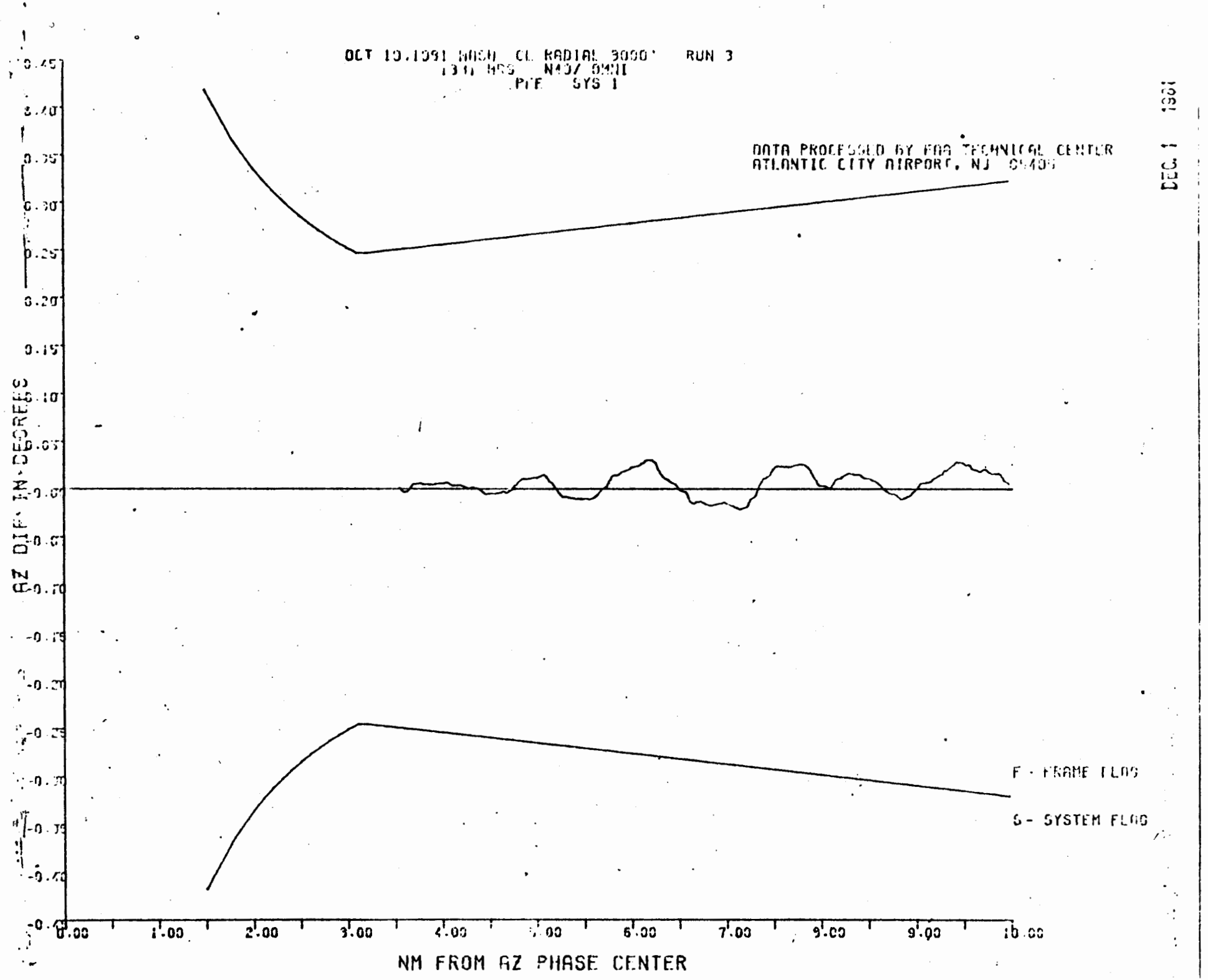
19 NOV 1981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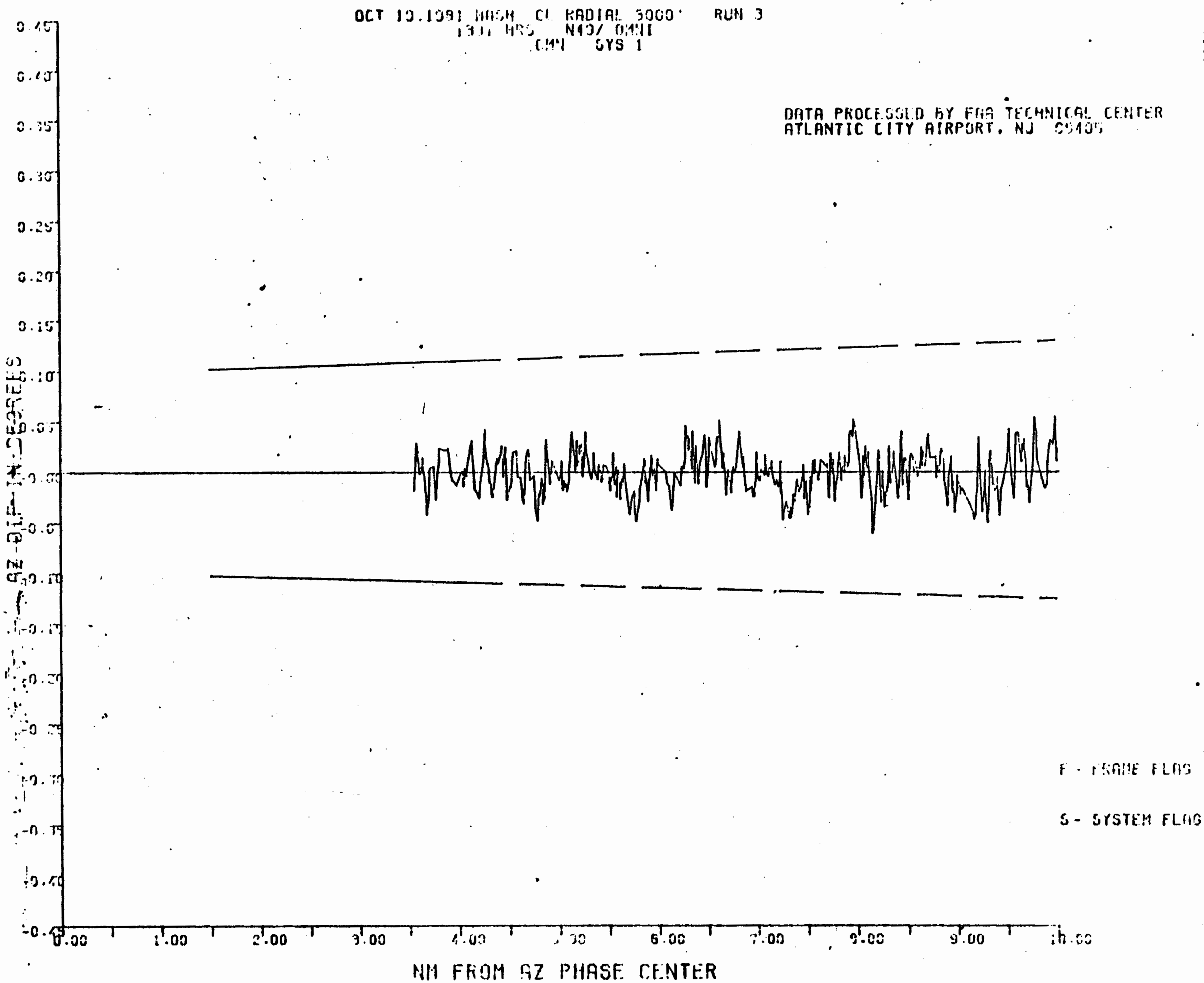
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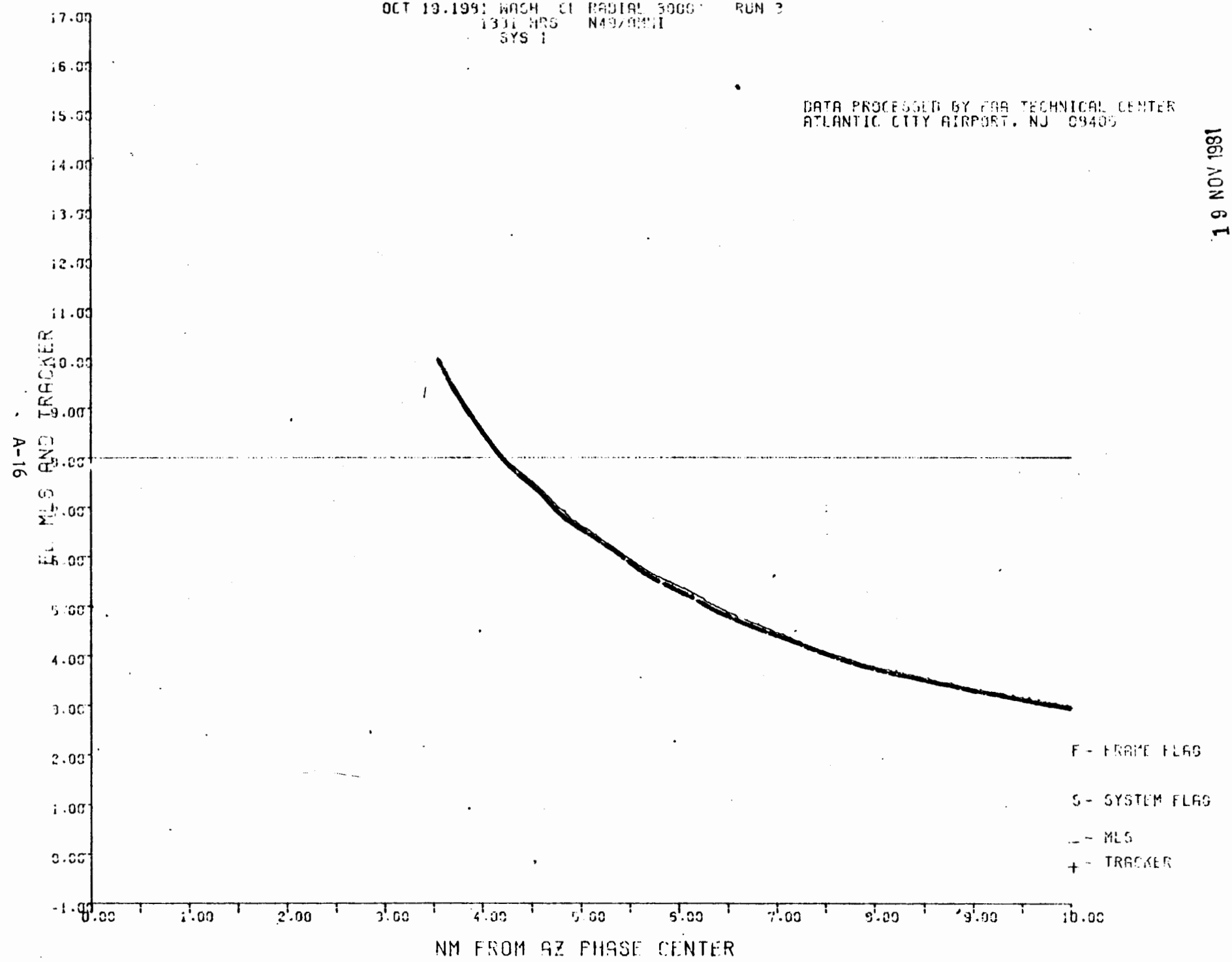
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S - SYSTEM FLAG
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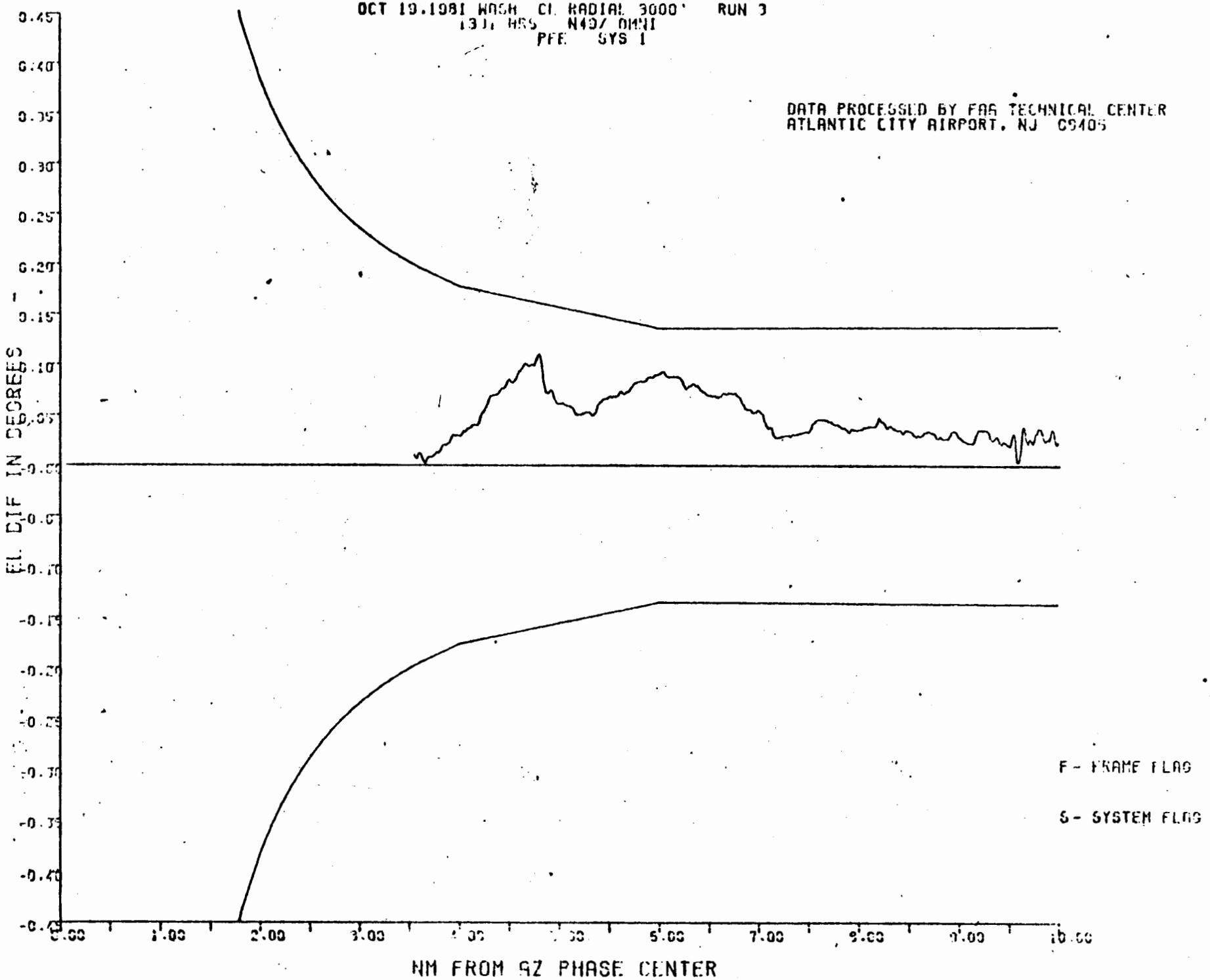
A-16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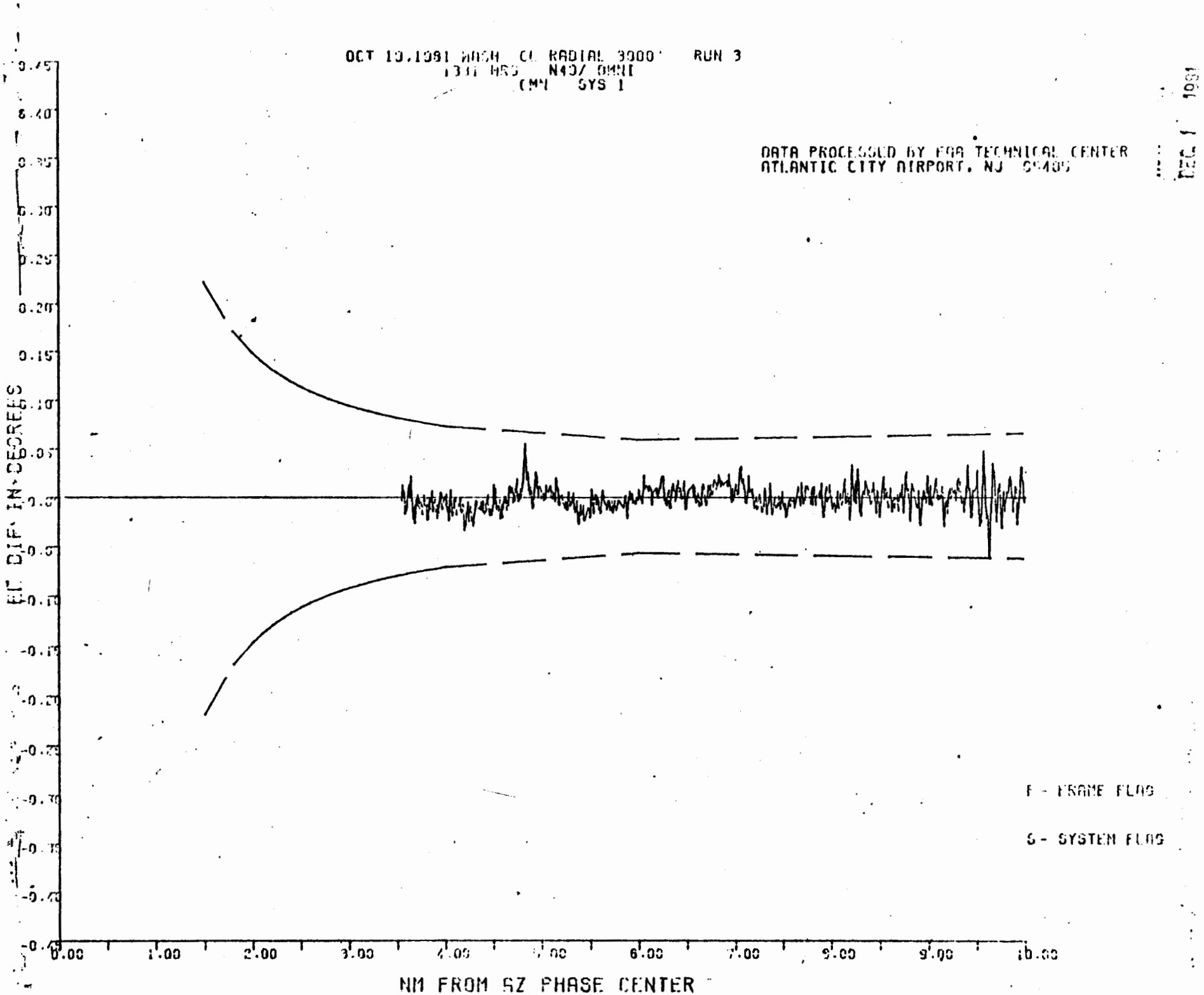
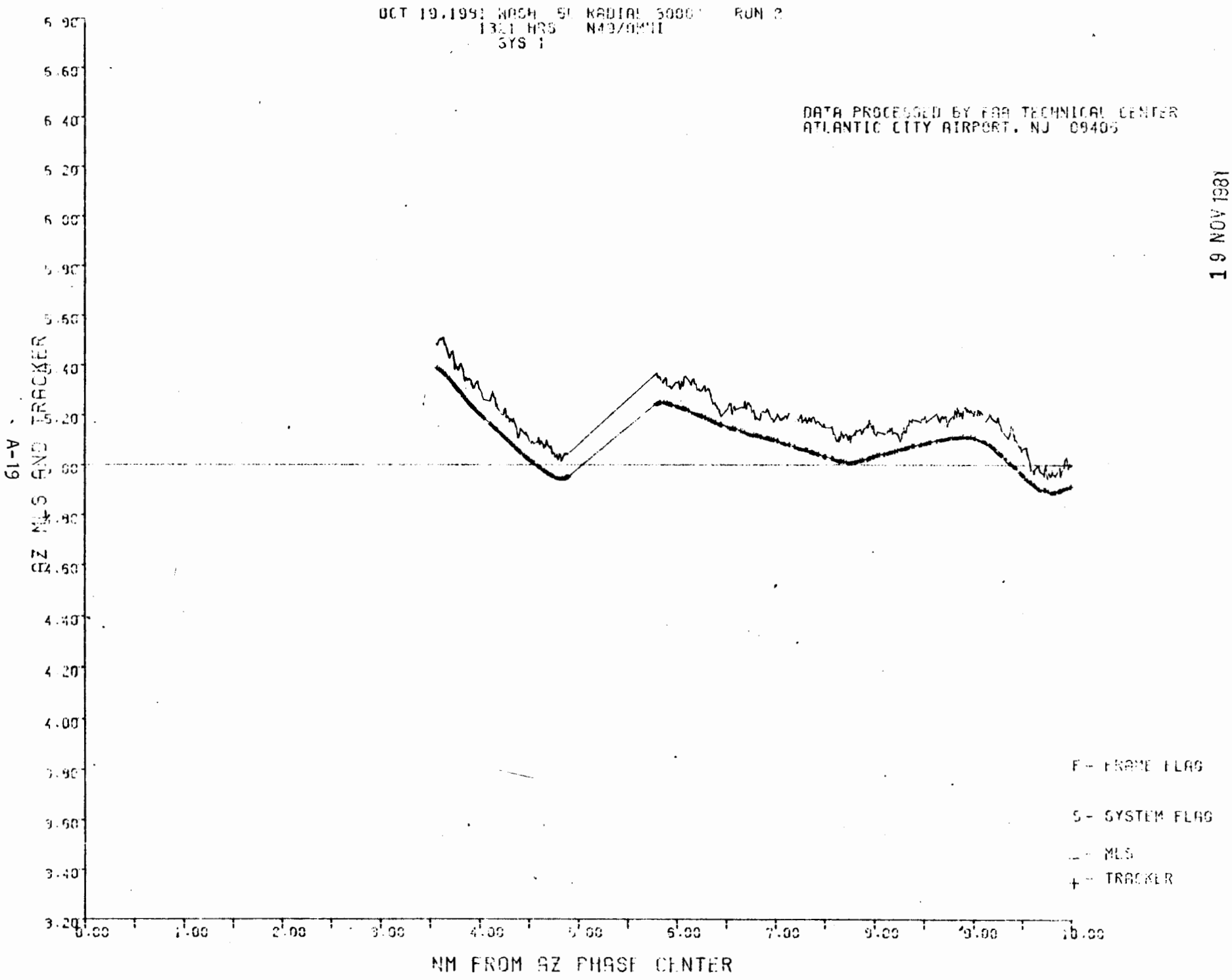
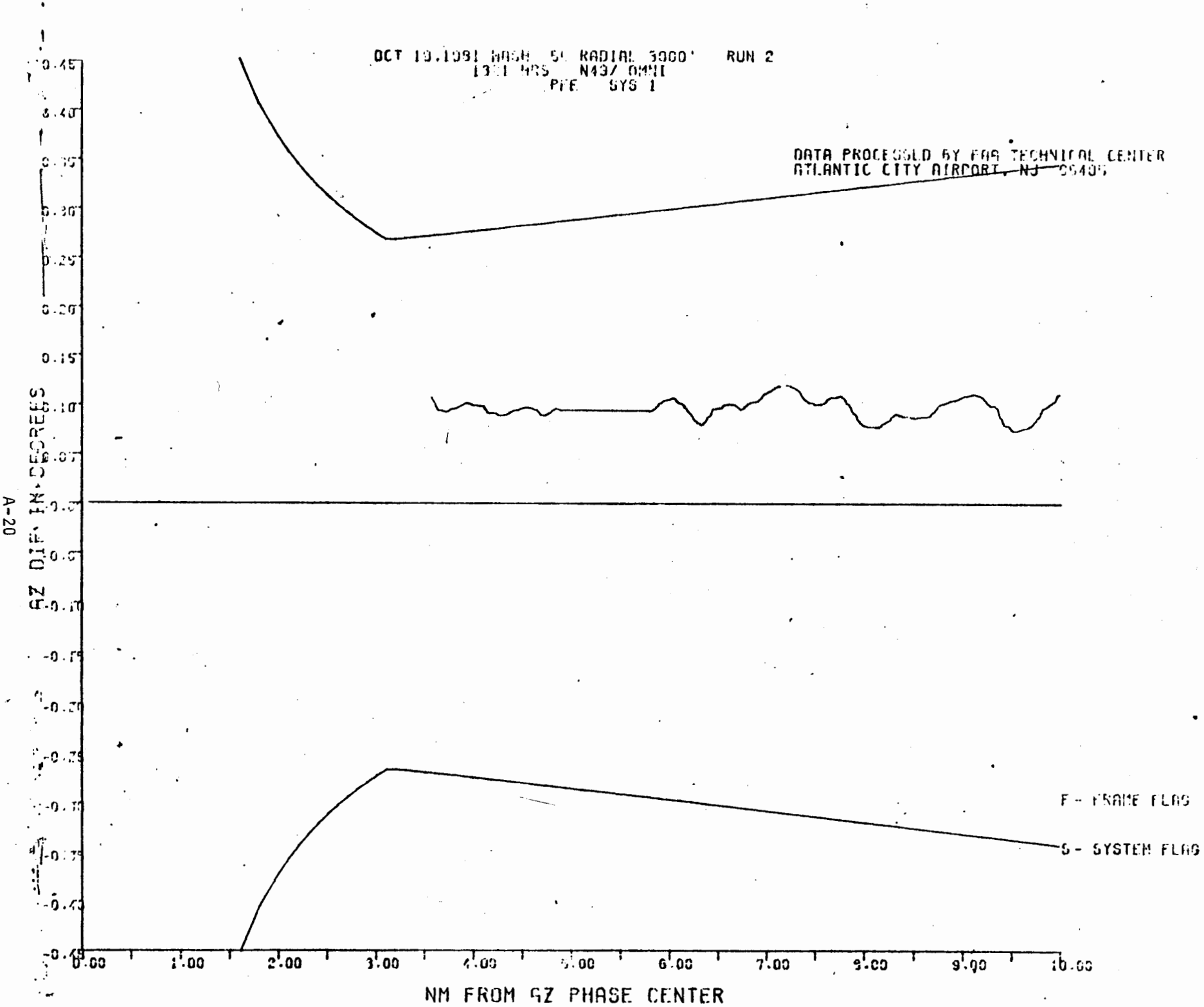
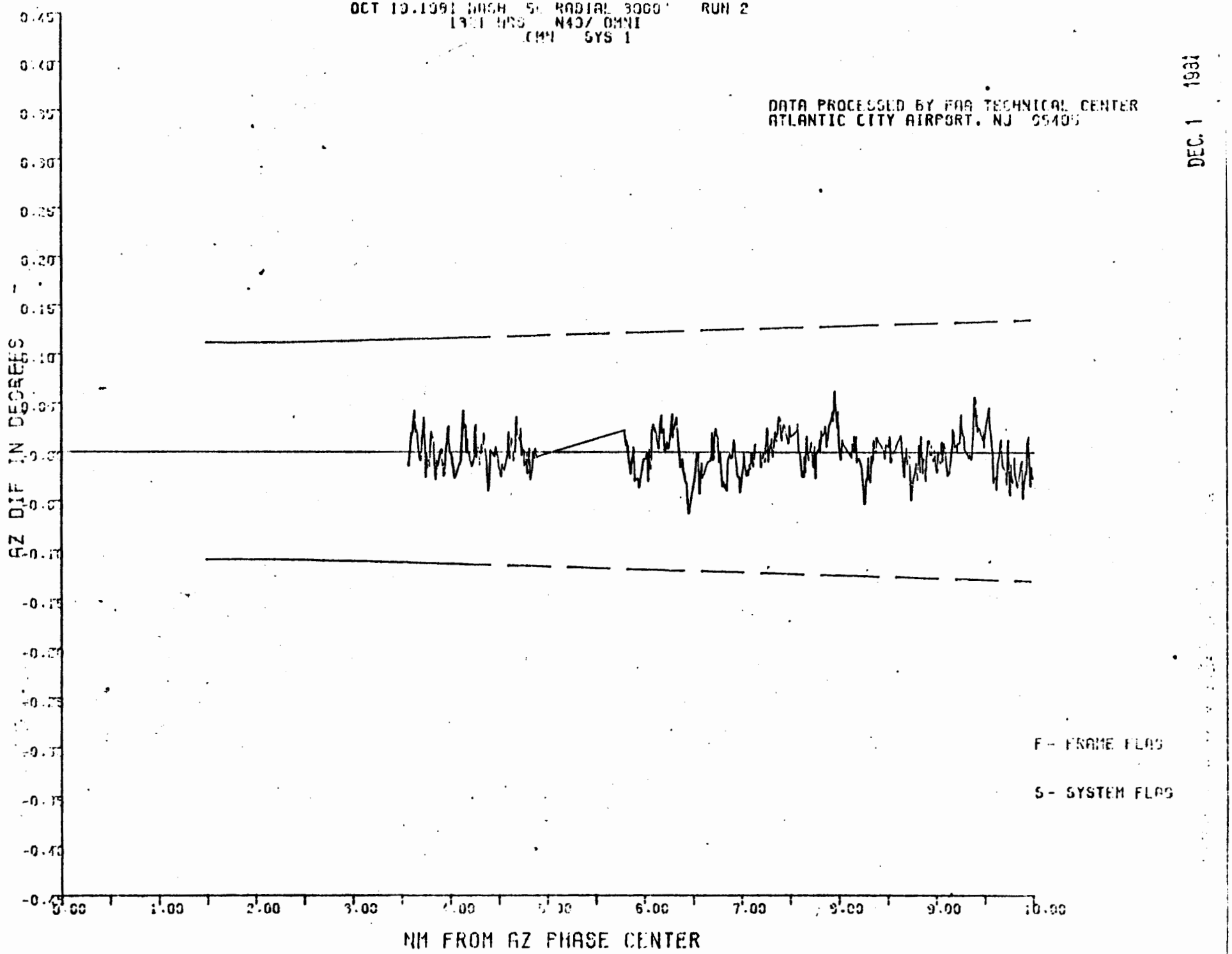
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
7.00
9.00
11.00
NM FROM GZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG

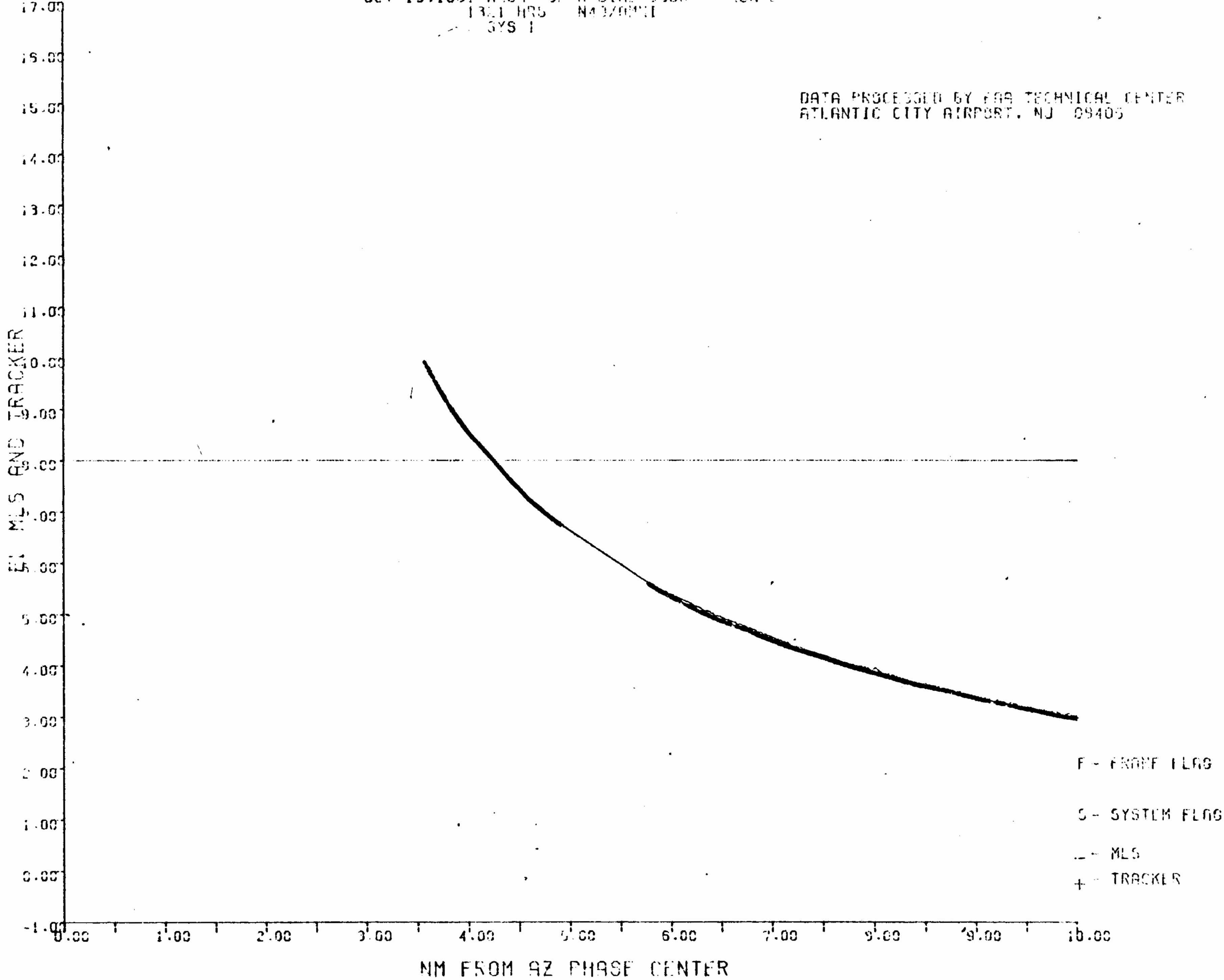

OCT 13,1981 WASH CL RADIAL 3900' RUN 3
N43/ OMNI
SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ
F - FRAME FLAG
S - SYSTEM FLAG
FT DIF IN DEGREES
NM FROM SZ PHASE CENTER
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00


OCT 19,1981 NOSH 9L RADIAL 3080' RUN 2
1321 HRS N43/08MII
SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
19 NOV 1981
A-19
GZ MLS AND TRACKER
6.80
6.60
6.40
6.20
6.00
5.80
5.60
5.40
5.20
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM GZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG
_ - MLS
+ - TRACKER


OCT 19,1981 WASH 5L RADIAL 3000' RUN 2
PFE SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
DEC 1 1981
GZ DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM GZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG

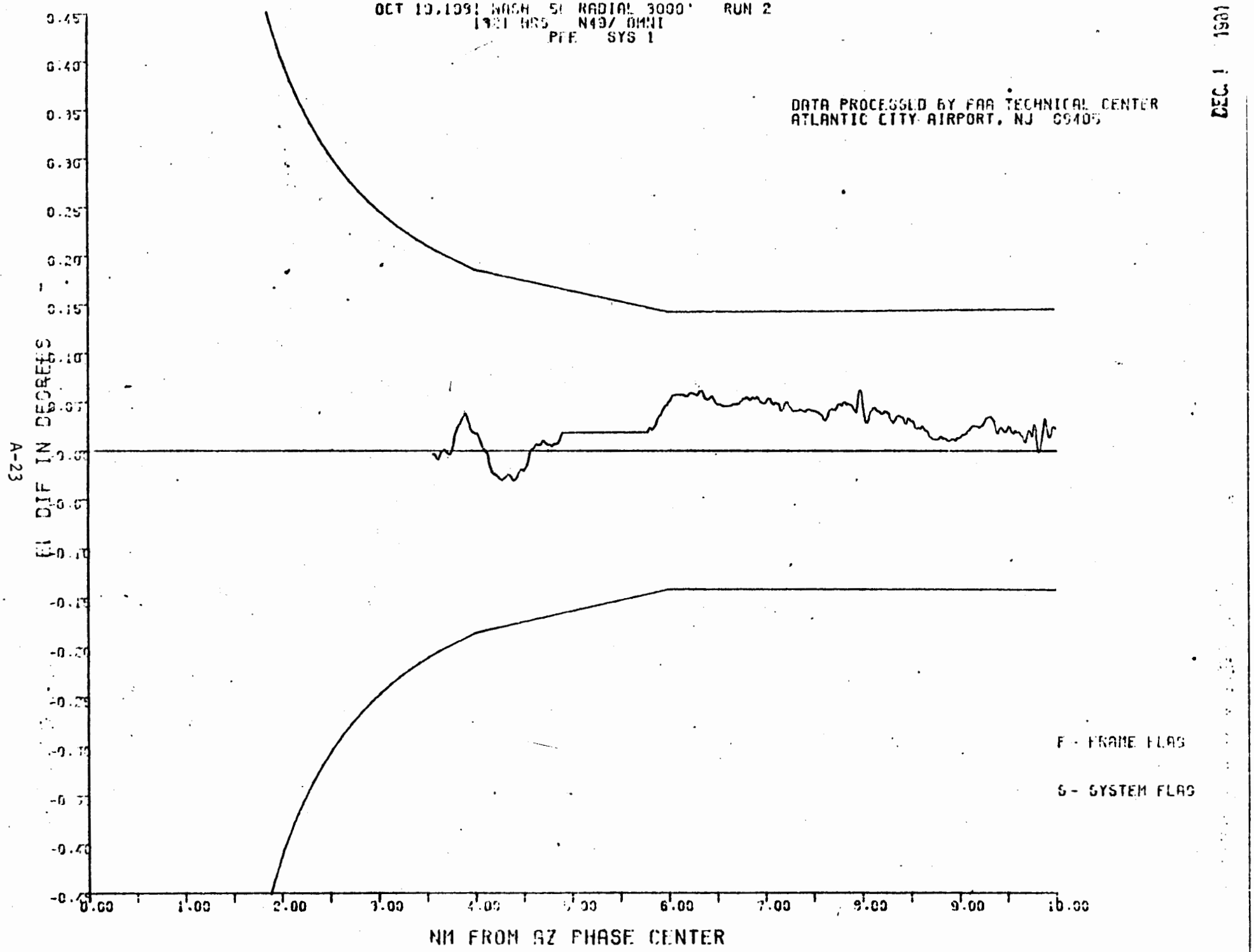

OCT 19.1981 BOSH 5° RADIAL 3000' RUN 2
N43/ OMNI
SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
DEC 1 1981
AZ DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
-0.15
-0.40
-0.45
0.00
1.00
2.00
3.00
6.00
7.00
9.00
10.00
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG

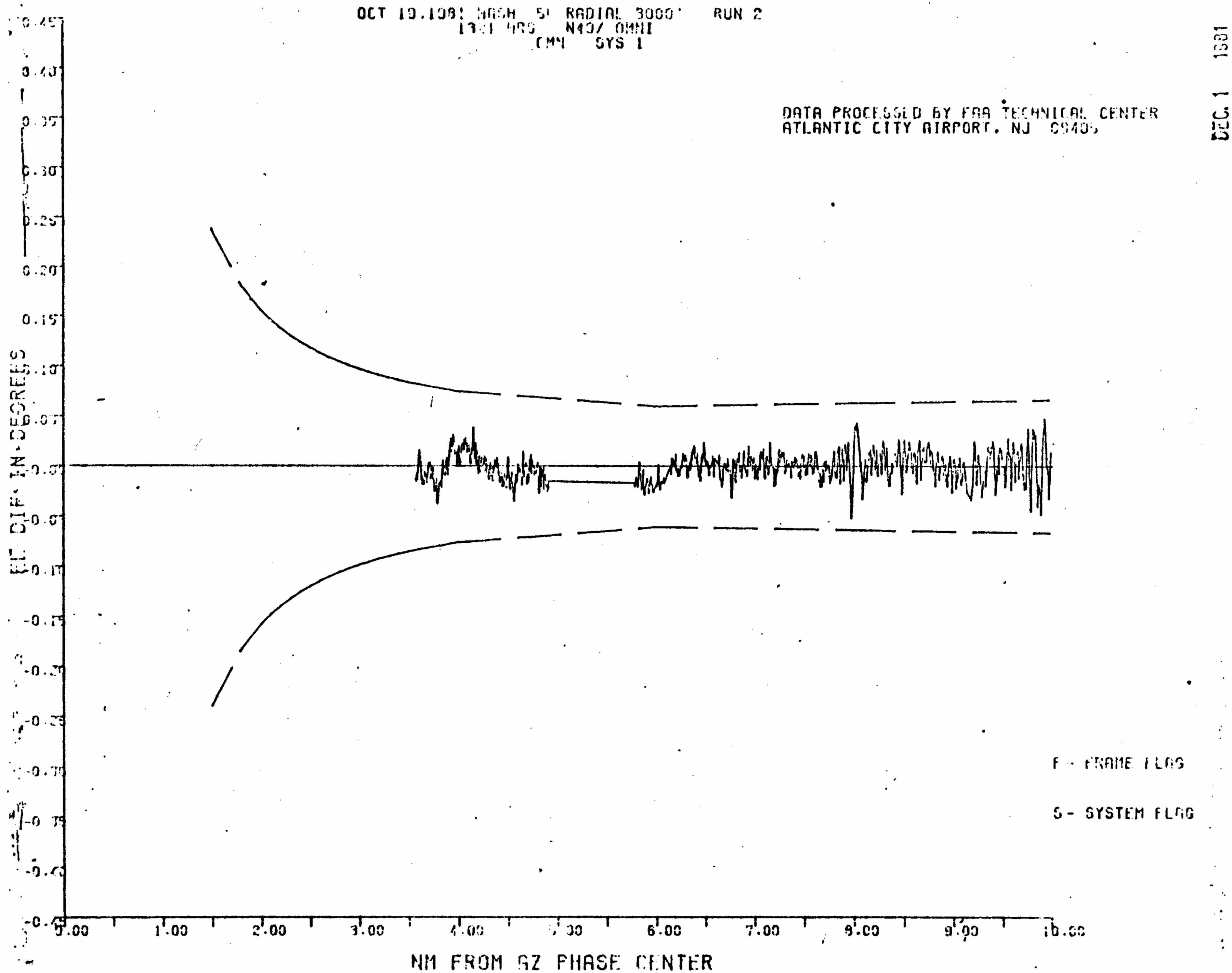
OCT 19,1981 WASH 5I RADIAL 3000'   RUN 2
1321 HRS   N43/00MI
SYS 1

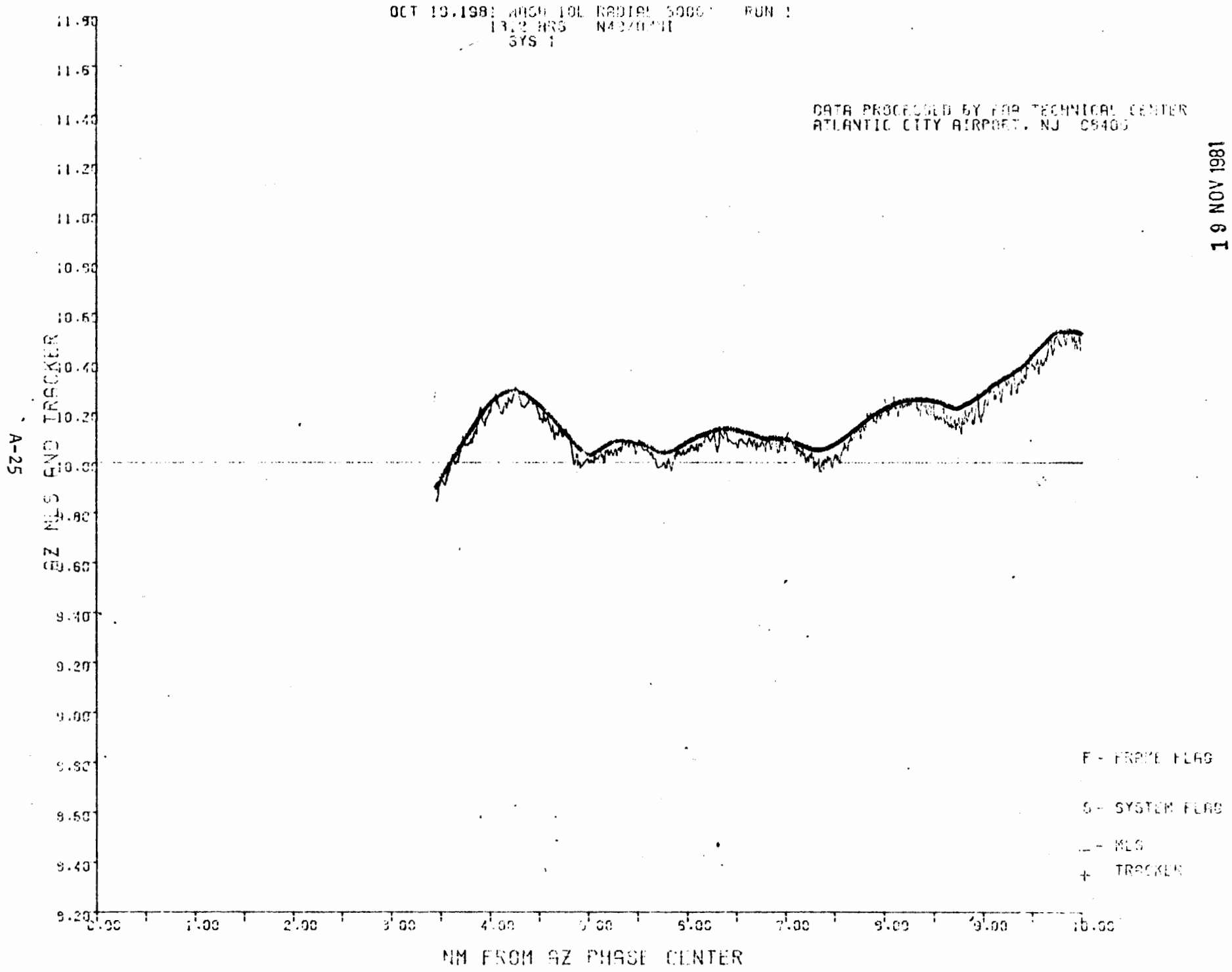


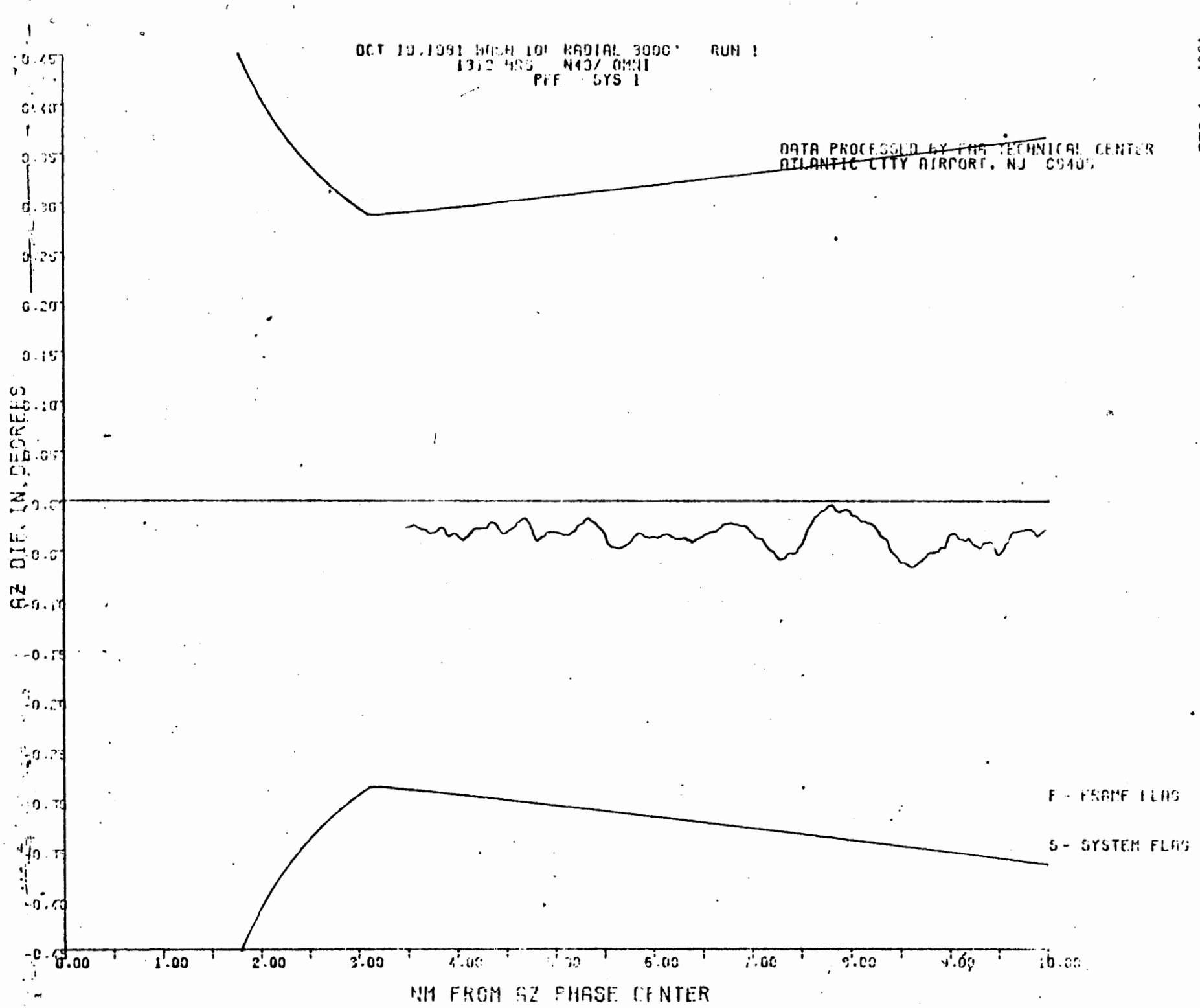
19 NOV 1981

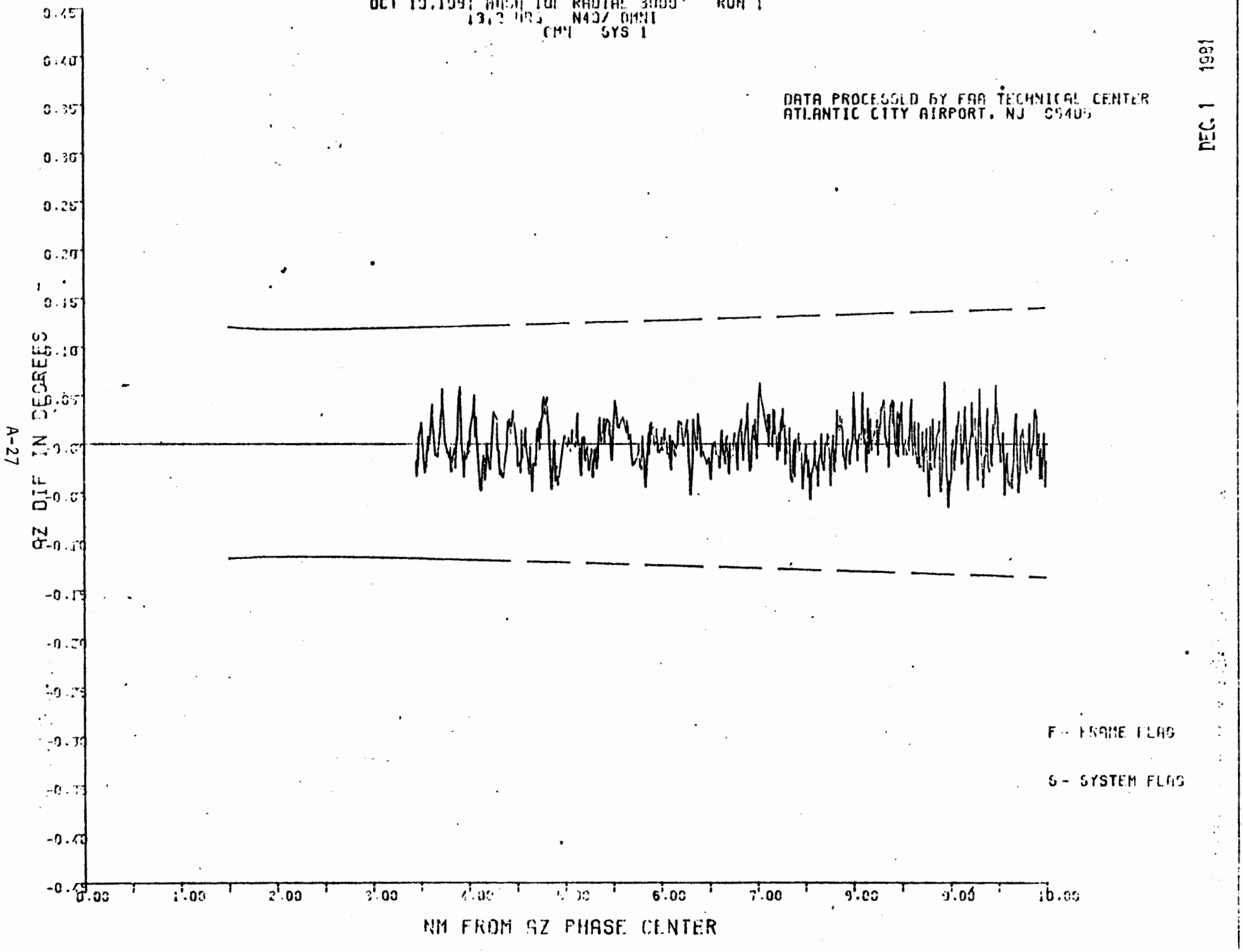
A-22

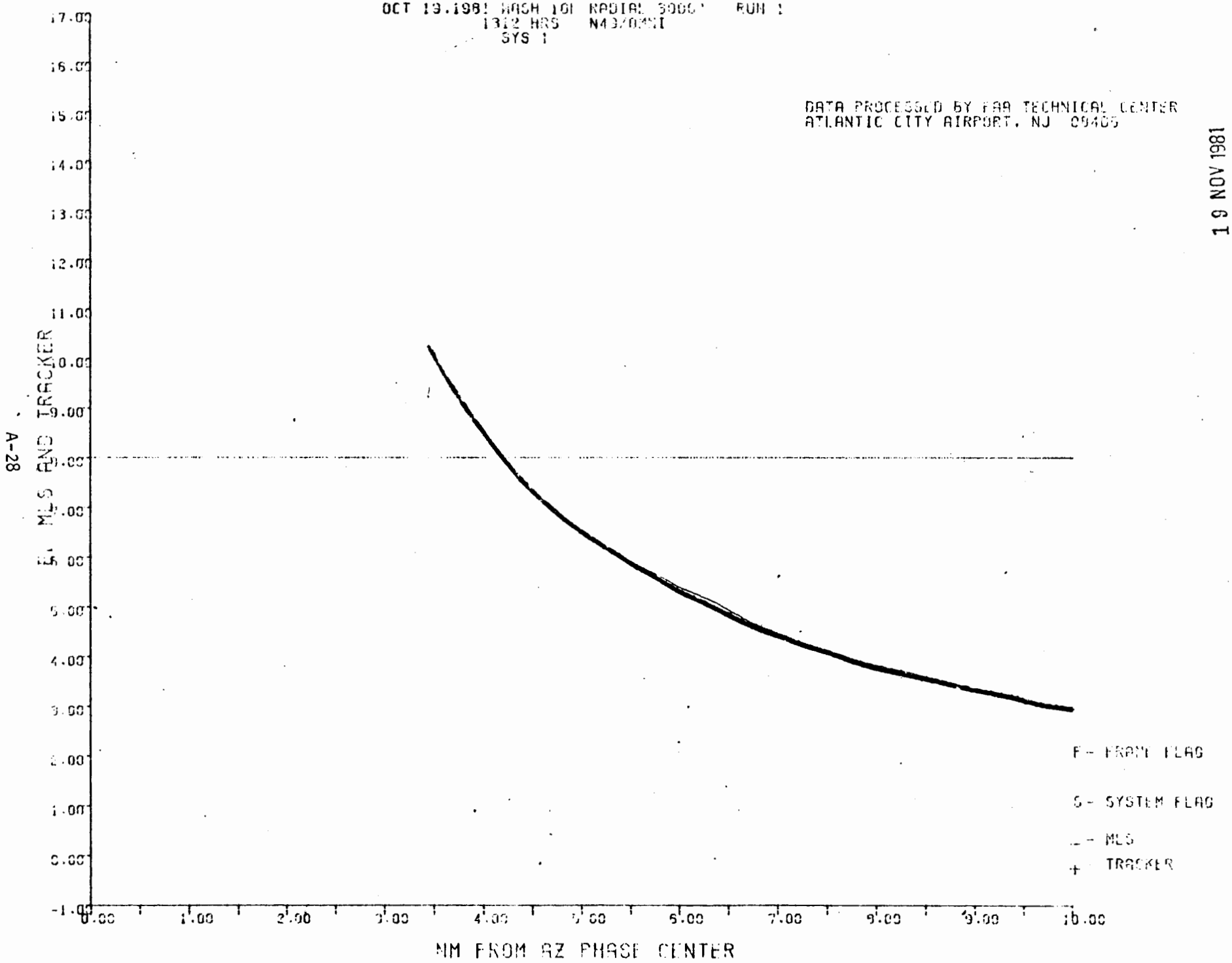

OCT 19,1991 WASH 5(RADIAL 3000' RUN 2
1921 HRS N49/ OMNI
PFE SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
DEC 1 1991
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG

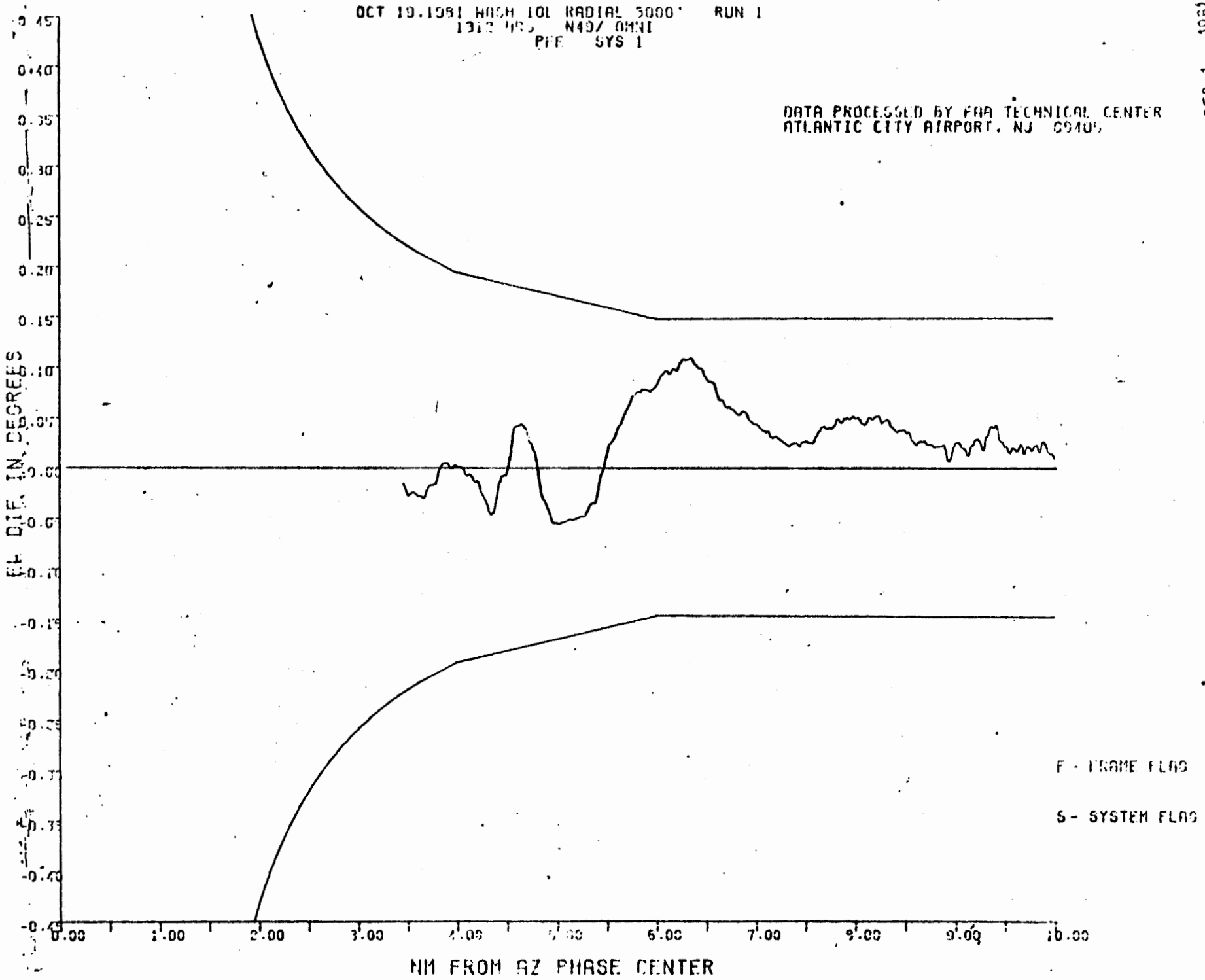

OCT 19,1981 WASH 5° RADIAL 3000' RUN 2
1331 HRS N40/ OMNI
CMN SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
EL DIF IN DEGREES
NM FROM GZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG
DEC 1 1981

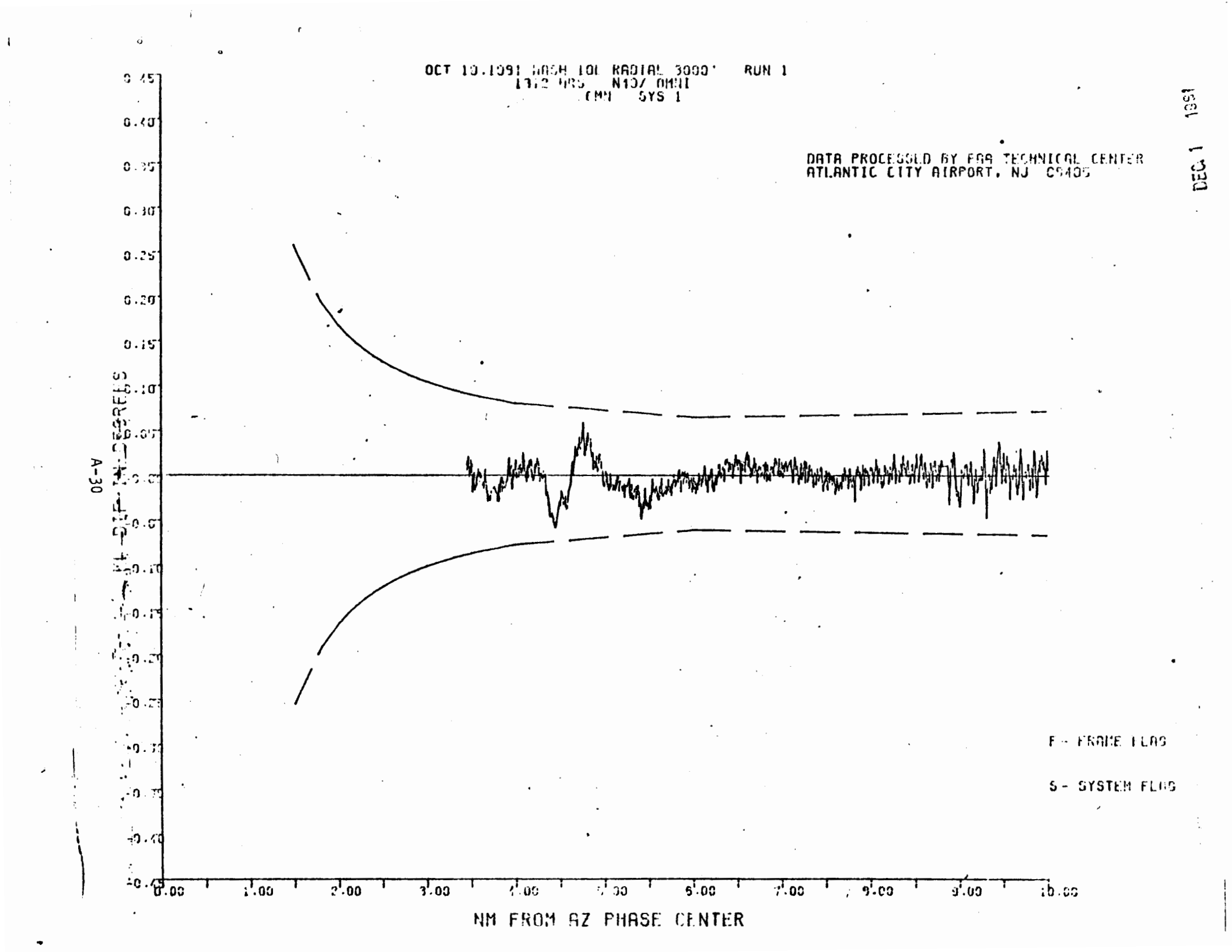

OCT 19,1981 MRSH ILL RADIAL 3000' RUN 1
SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
19 NOV 1981
GZ MLS AND TRACKER
NM FROM GZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG
_ - MLS
+ TRACKER

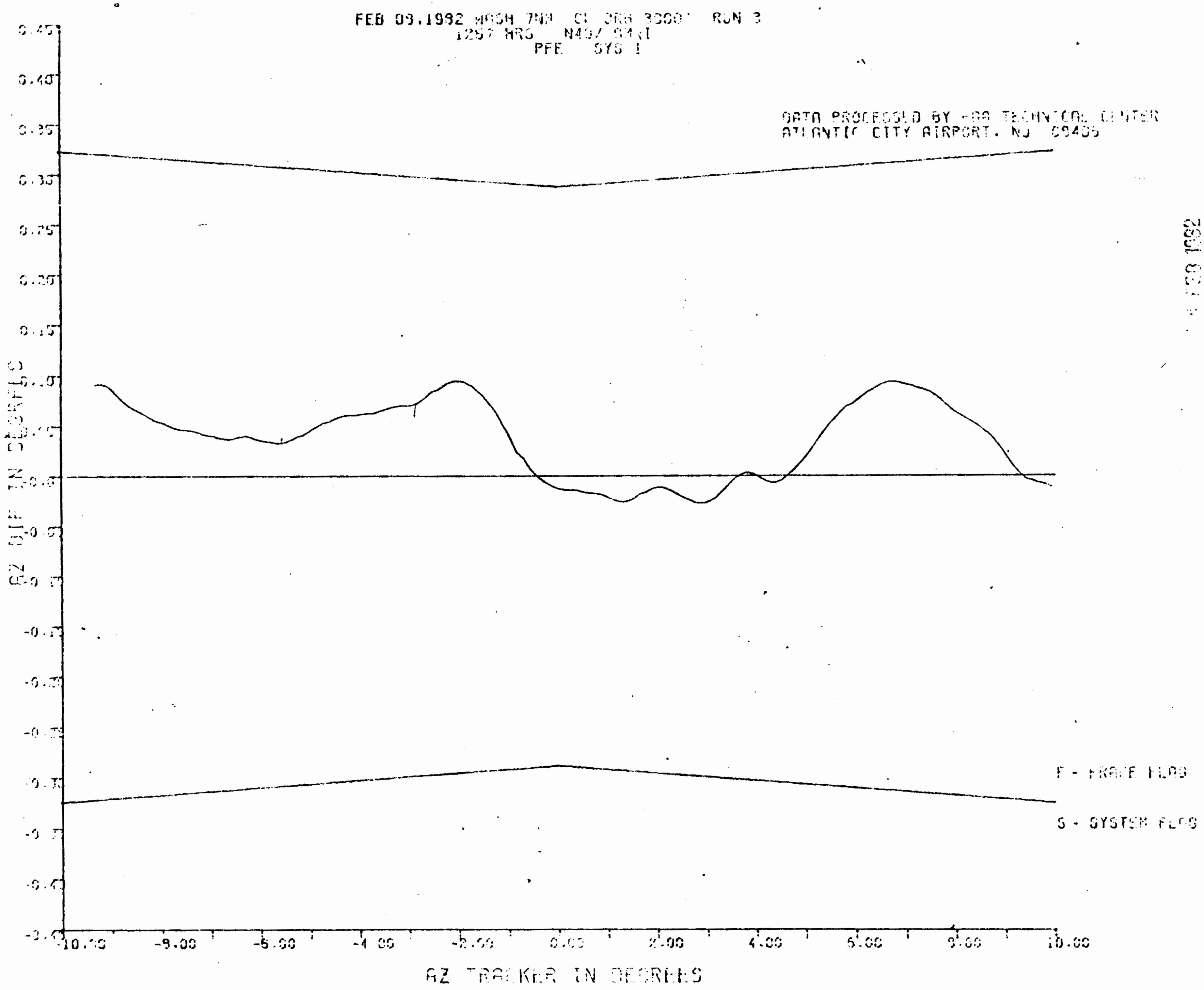

OCT 19,1981 SOUTH LOC RADIAL 300° RUN 1
1312 HRS N40/ OMNI
PFF SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
DEC 1 1981
SZ DIF. IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM SZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG

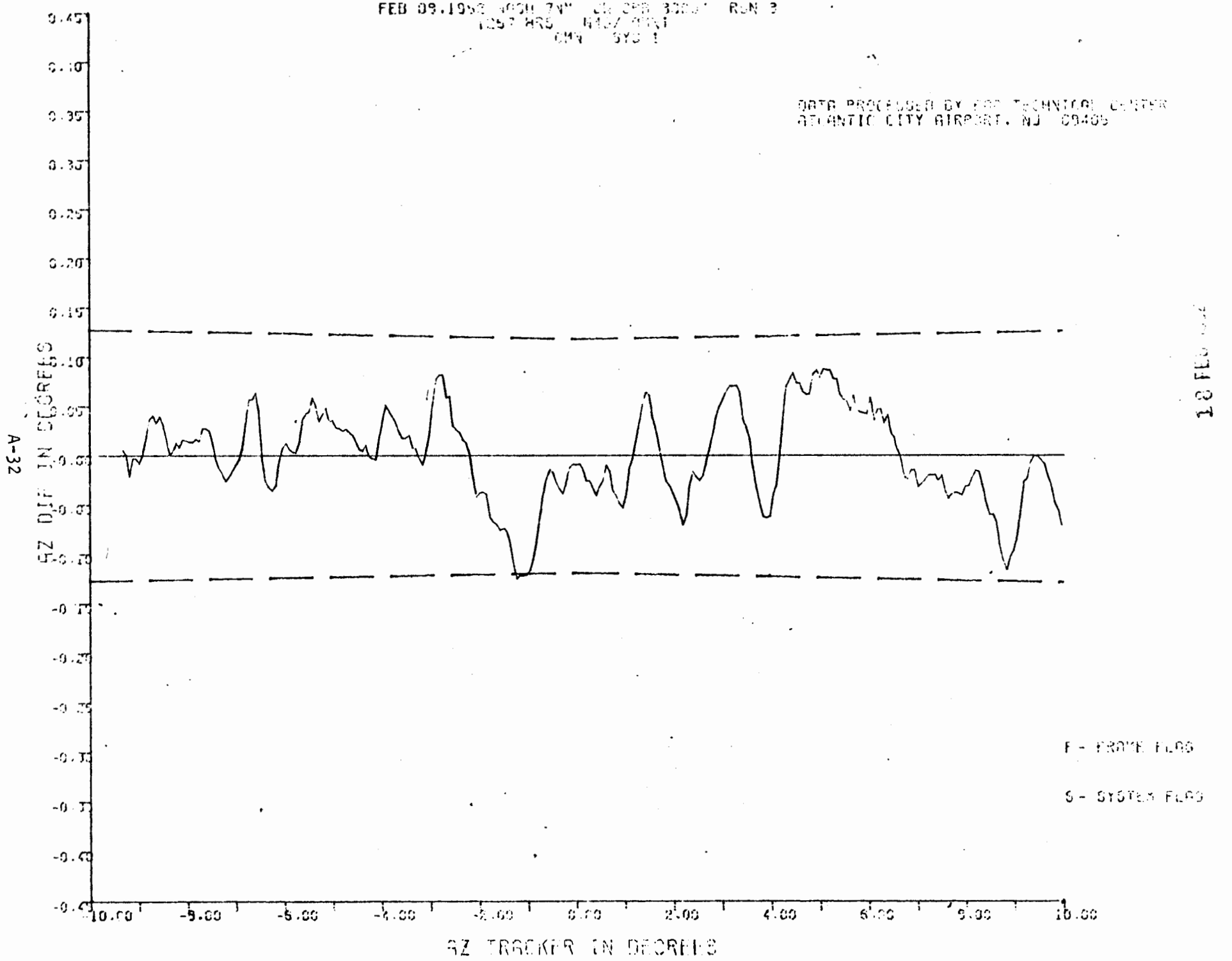

OCT 10,1991 HIGH IQI RADIAL 3000' RUN 1
N43/ OMNI
CMN SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
DEC 1 1991
AZ DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG

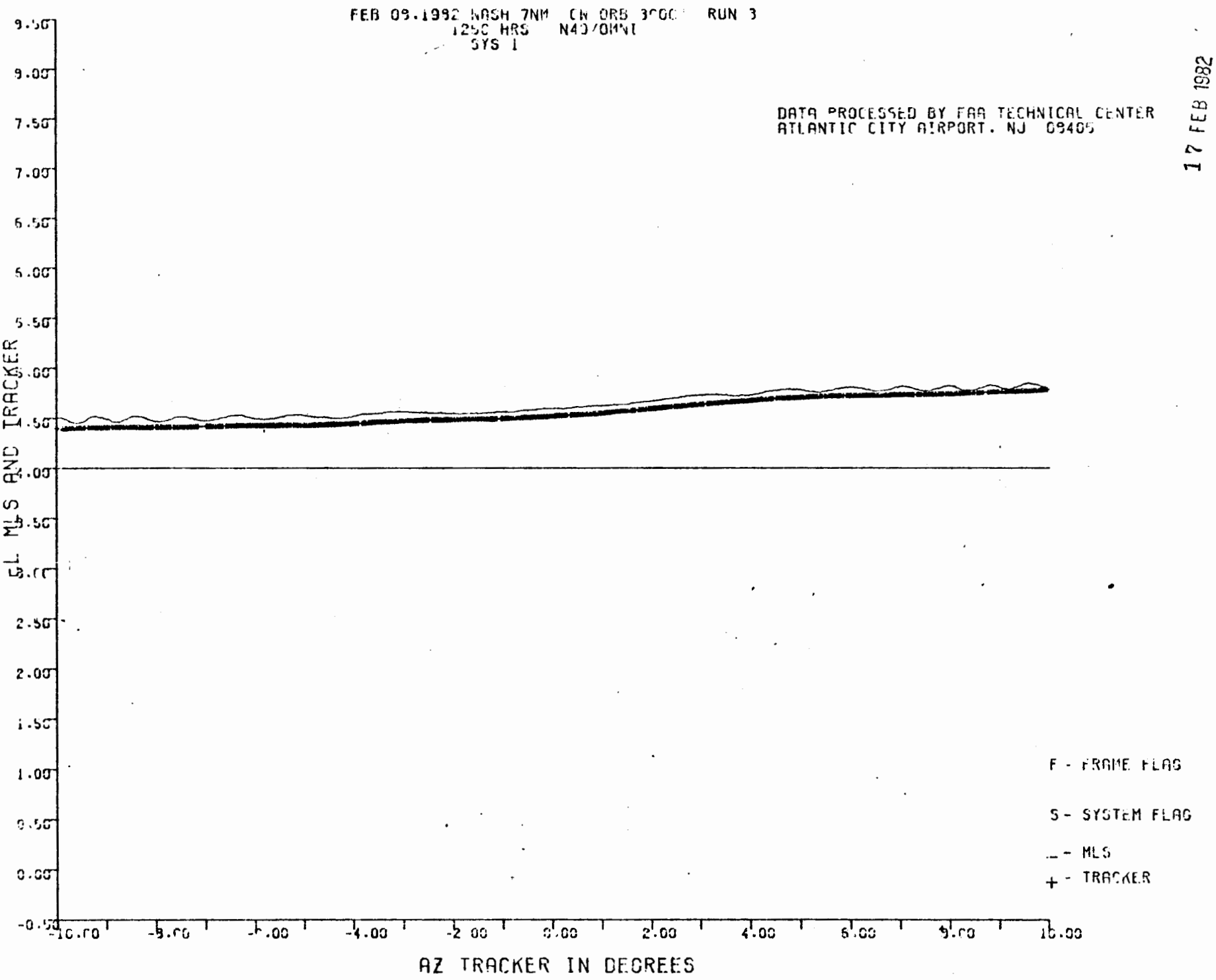

OCT 19,1981 WASH IGI RADIAL 3000' RUN 1
1312 HRS N43/04NI
SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
19 NOV 1981
FT MLS AND TRACKER
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
5.00
4.00
1.00
0.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM RZ PHASE CENTER
F - FRONT FLAG
S - SYSTEM FLAG
_ - MLS
+ TRACKER

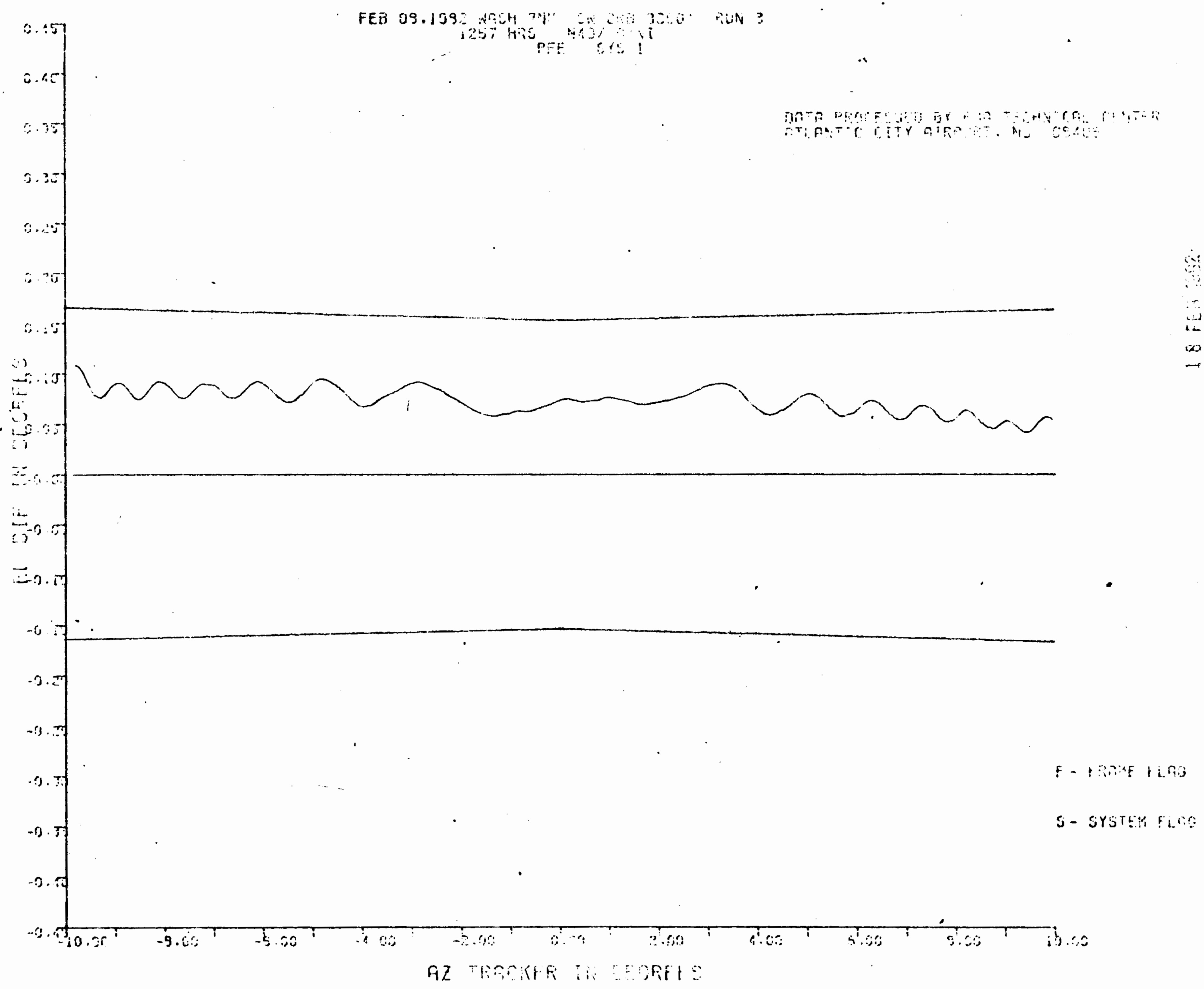

OCT 19.1981 WASH IOL RADIAL 3000' RUN 1
N49/ OMNI
PFE SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
DEC 1 1981
EL DIF. IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM GZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG

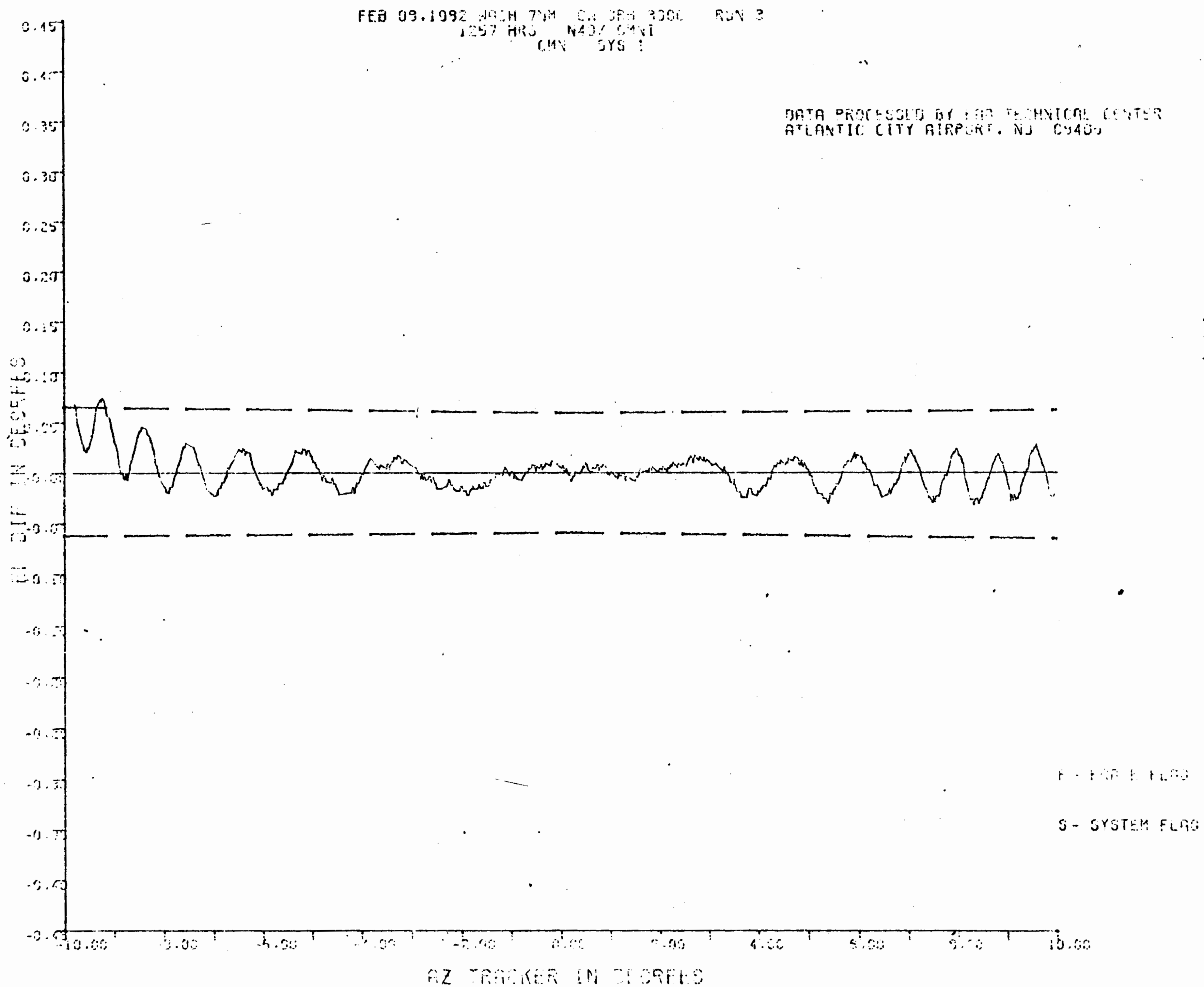

OCT 10.1991 WASH IOL RADIAL 3000' RUN 1
N10/ OMNI
CMN SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
DEC 1 1991
A-30
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG

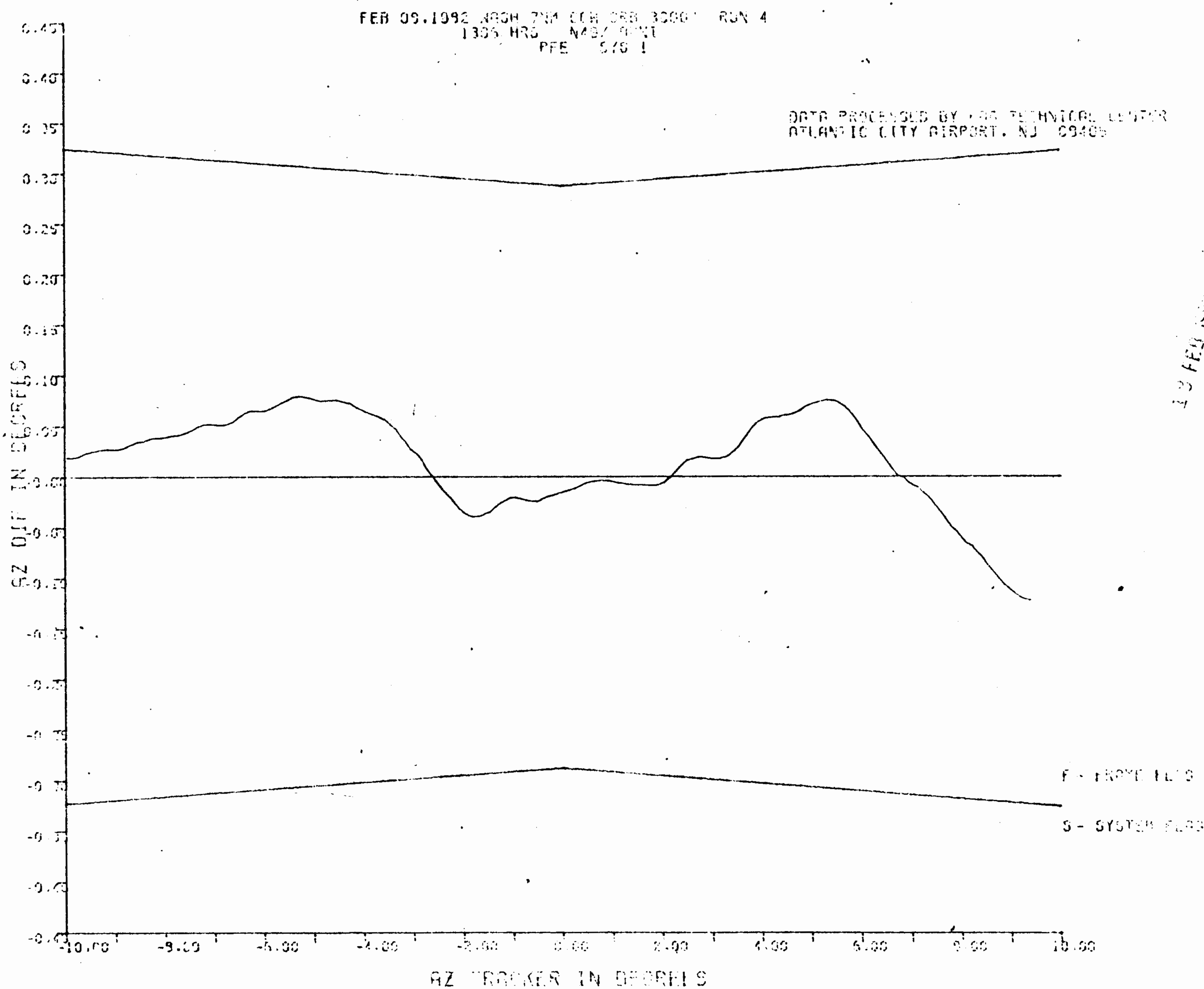

FEB 09,1982 WASH 7NM RUN 3
1257 HRS
PFE SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
F - FRAME FLAG
S - SYSTEM FLAG
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES

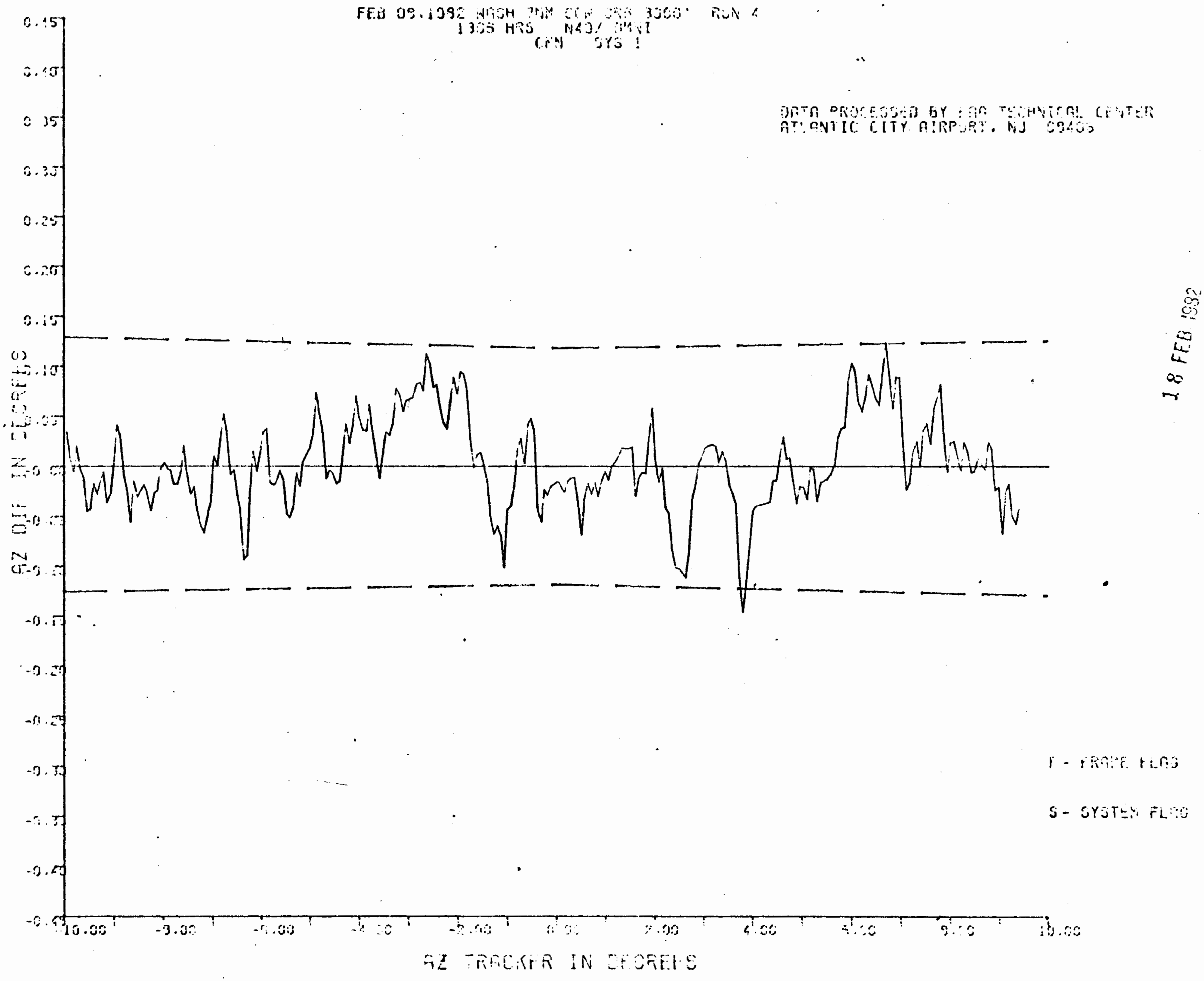

FEB 09,19[illegible] RUN 3
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
AZ DIFF IN DEGREES
AZ TRACKER IN DEGREES
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
F - FRAME FLAG
S - SYSTEM FLAG

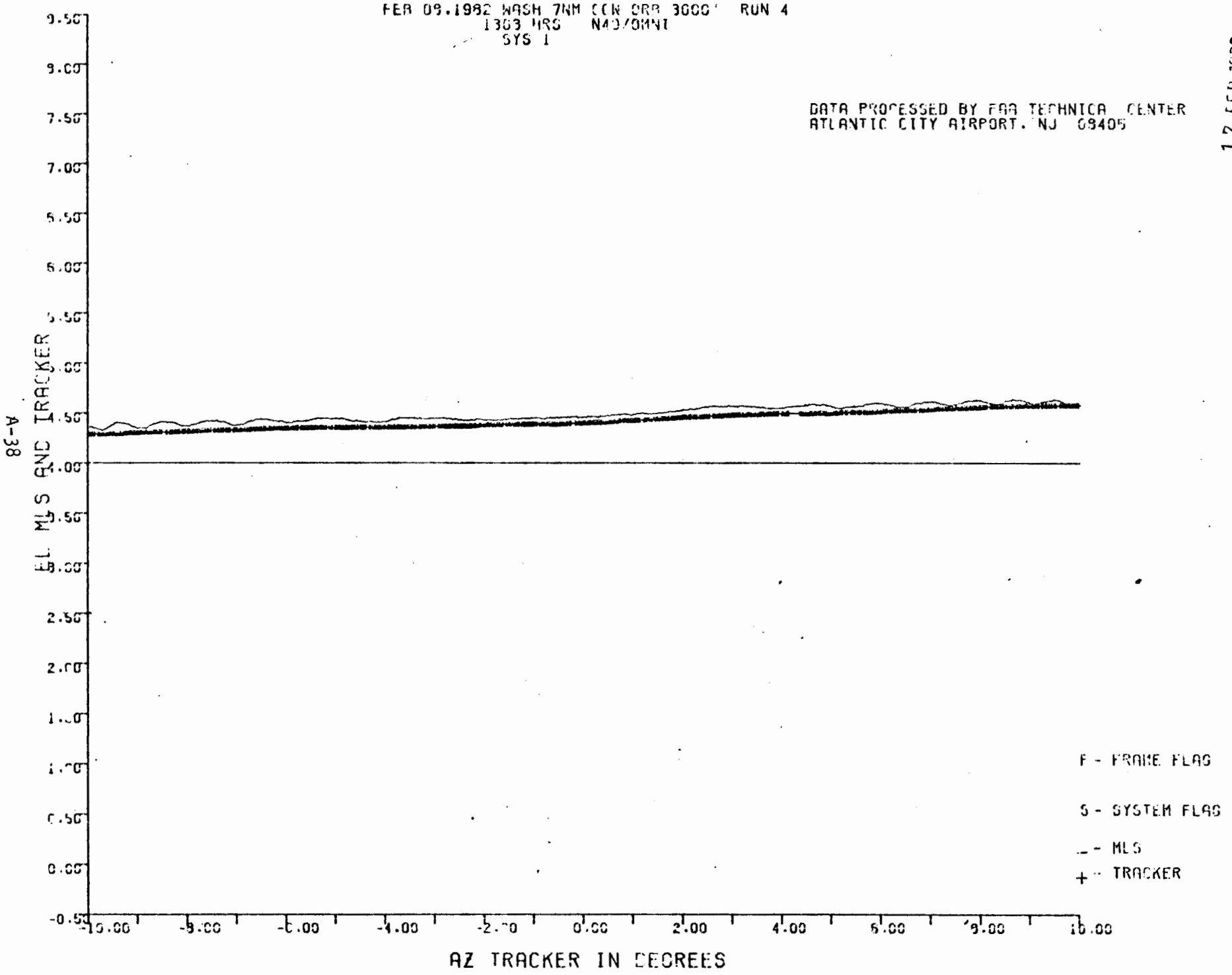

FEB 09.1982 WASH 7NM CW ORB 3°OC RUN 3
1250 HRS N40/OMNI
SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
17 FEB 1982
EL MLS AND TRACKER
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG
_ - MLS
+ - TRACKER

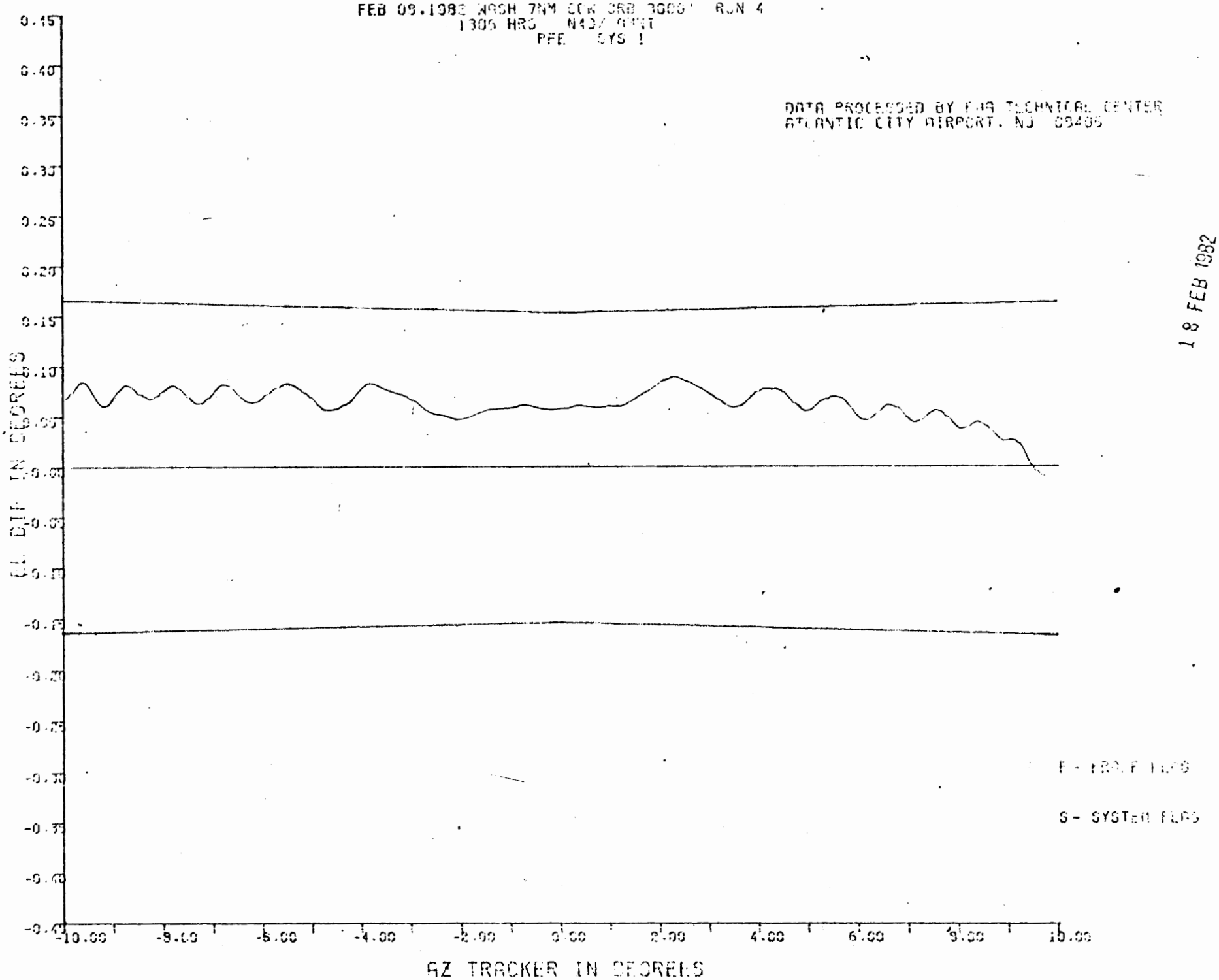

FEB 09.1992
RUN 3
1257 HRS
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ
F - FRAME FLAG
S - SYSTEM FLAG
AZ TRACKER IN DEGREES

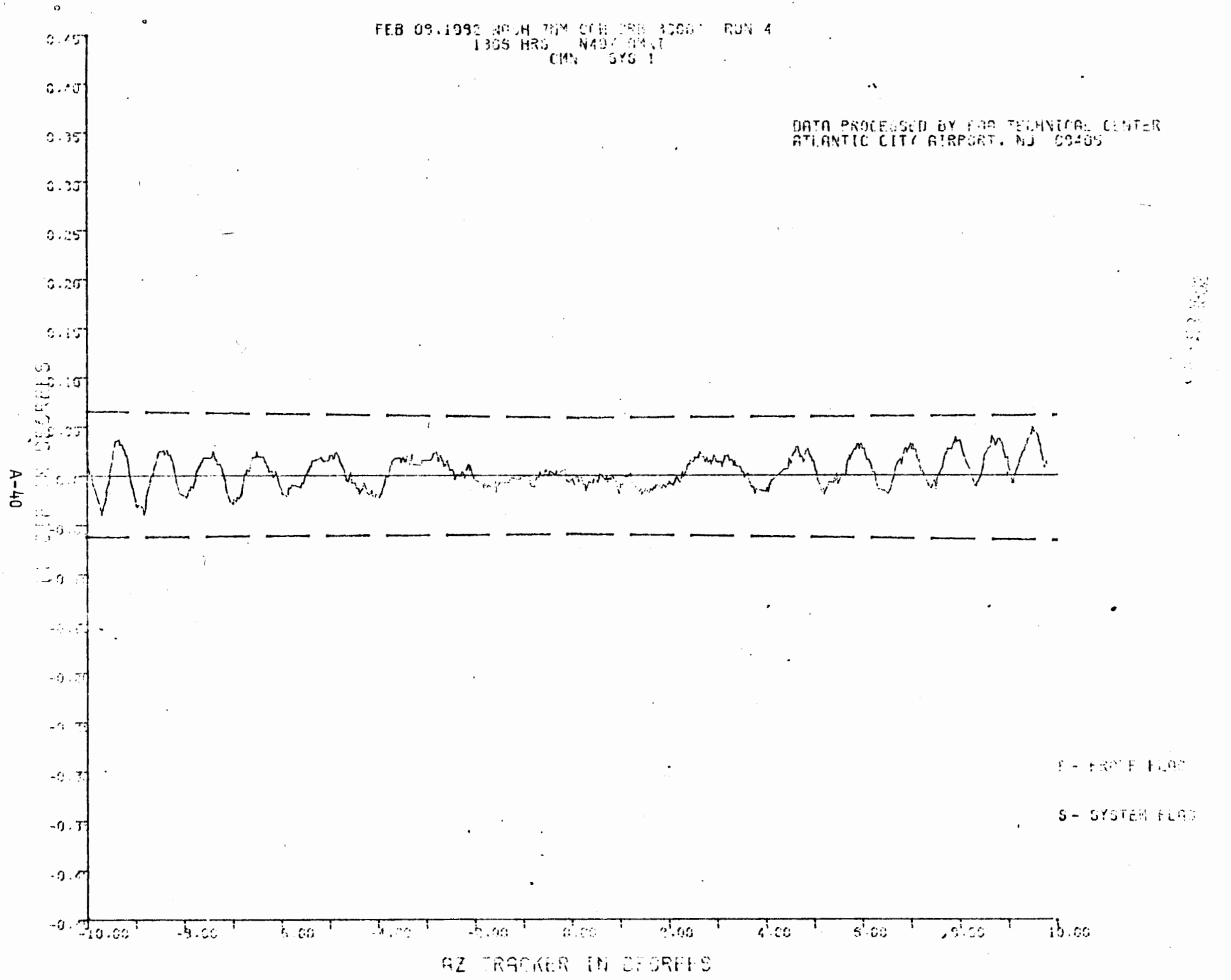

FEB 09.1982
1257 HRS
SYS 1
RUN 3
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ
S - SYSTEM FLAG
AZ TRACKER IN DEGREES
0.45
0.35
0.30
0.25
0.20
0.15
15.00

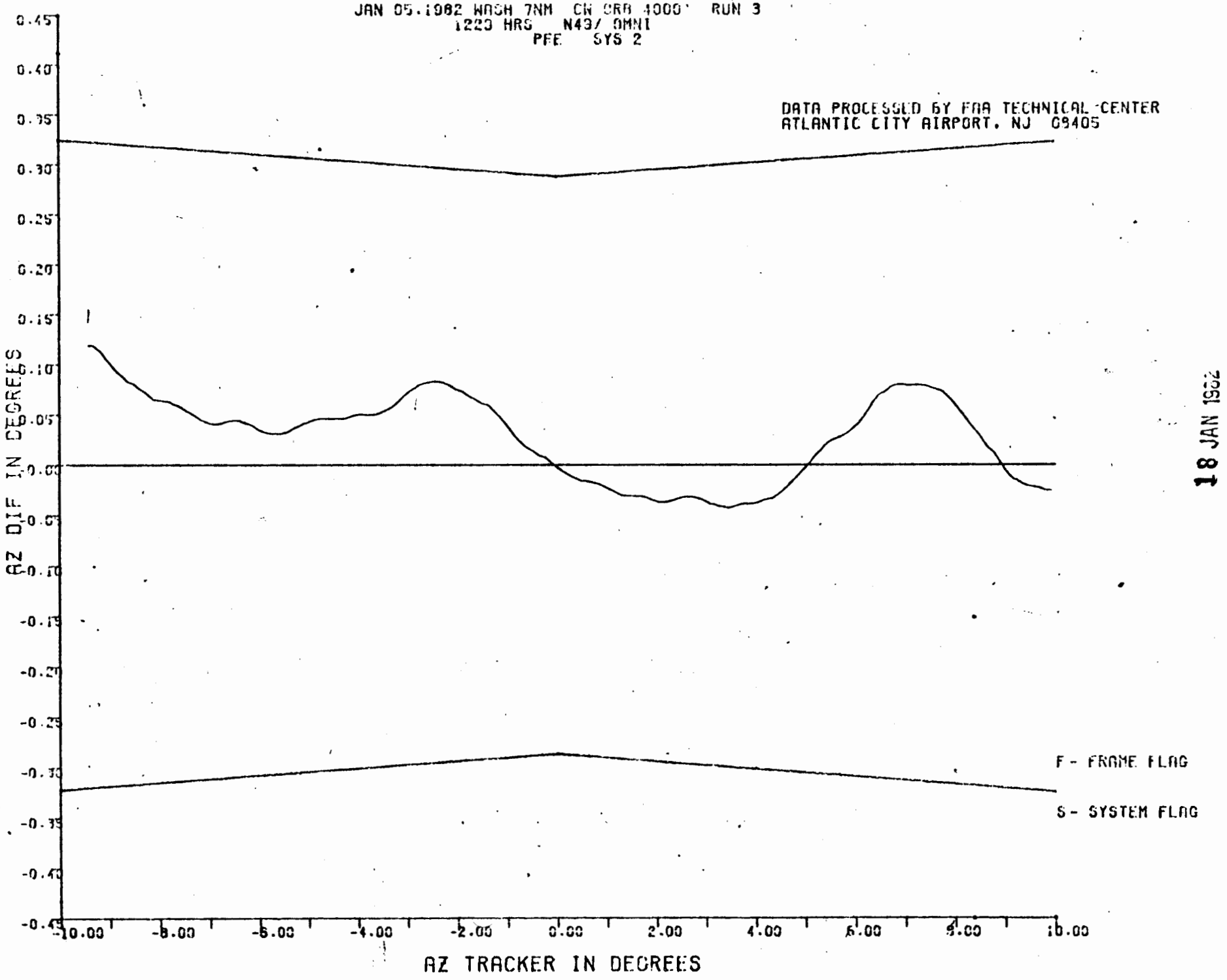

FEB 09.1992 RUN 4
1305 HRS
PFE
DATA PROCESSED BY TECHNICAL
ATLANTIC CITY AIRPORT, NJ 08405
AZ DIFF IN DEGREES
AZ TRACKER IN DEGREES
F - FRAME
S - SYSTEM
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05


FEB 09.1982 WASH 7NM CCW ORB 3000' RUN 4
1305 HRS N40/ OMNI
CFN SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
F - FRAME FLAG
S - SYSTEM FLAG
AZ TRACKER IN DEGREES
AZ DIFF IN DEGREES
18 FEB 1982


FEB 09.1982 WASH 7NM CCW ORB 3000' RUN 4
1303 HRS N40/OMNI
SYS I
DATA PROCESSED BY FAA TECHNICA CENTER
ATLANTIC CITY AIRPORT, NJ 08405
17 FEB 1982
EL MLS AND TRACKER
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG
_ - MLS
+ - TRACKER

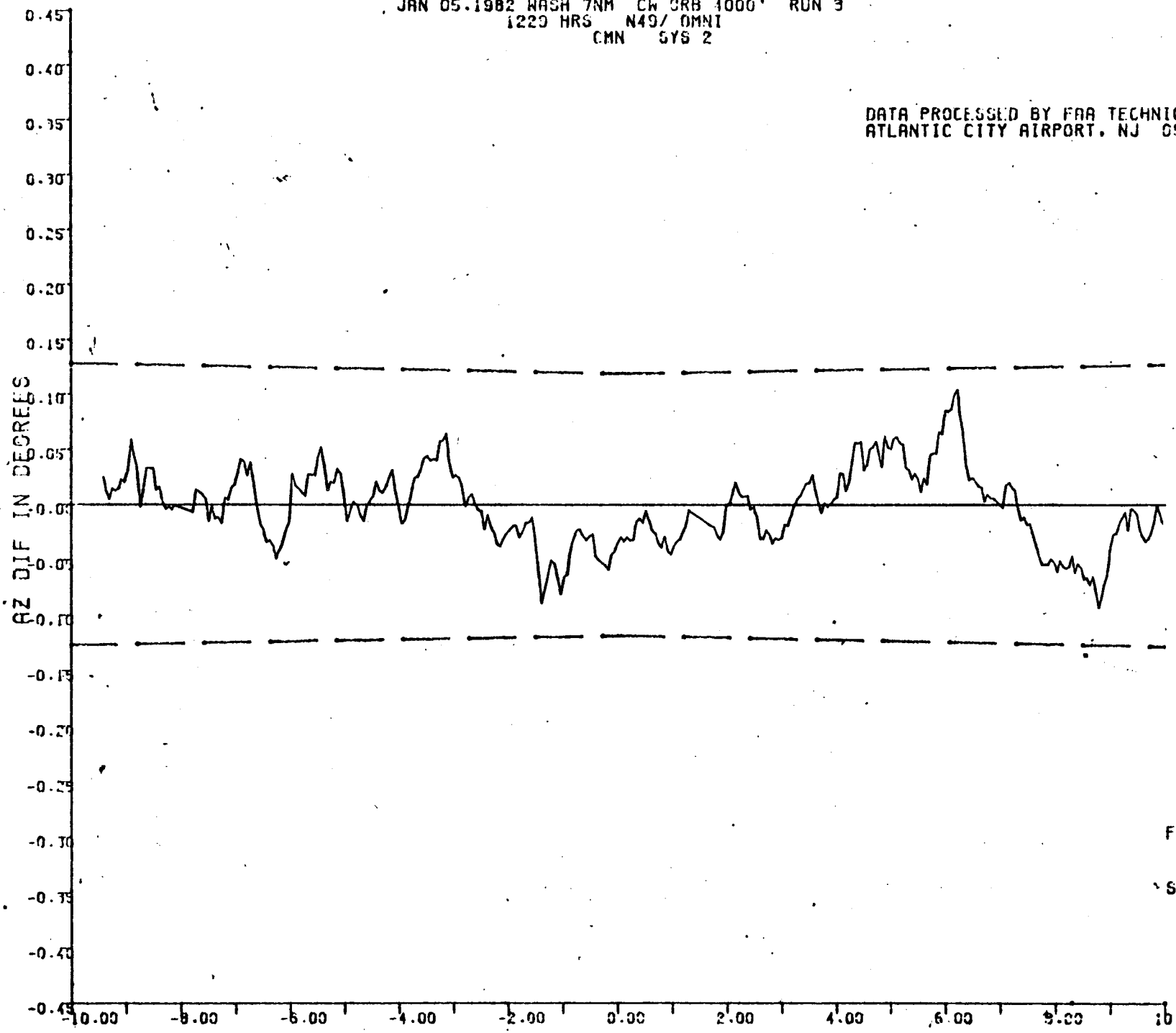

FEB 09,1982 WASH 7NM SCW ORB 3000' RUN 4
1305 HRS N43/ GMT
PFE SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
18 FEB 1982
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
P - PROFILE
S - SYSTEM FLAG


DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
AZ TRACKER IN DEGREES


JAN 05.1982 WASH 7NM CW ORB 4000' RUN 3
1223 HRS N43/ OMNI
PFE SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
AZ DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG
18 JAN 1982

JAN 05.1982 WASH 7NM CW ORB 1000' RUN 3
1220 HRS N49/ OMNI
CMN SYS 2

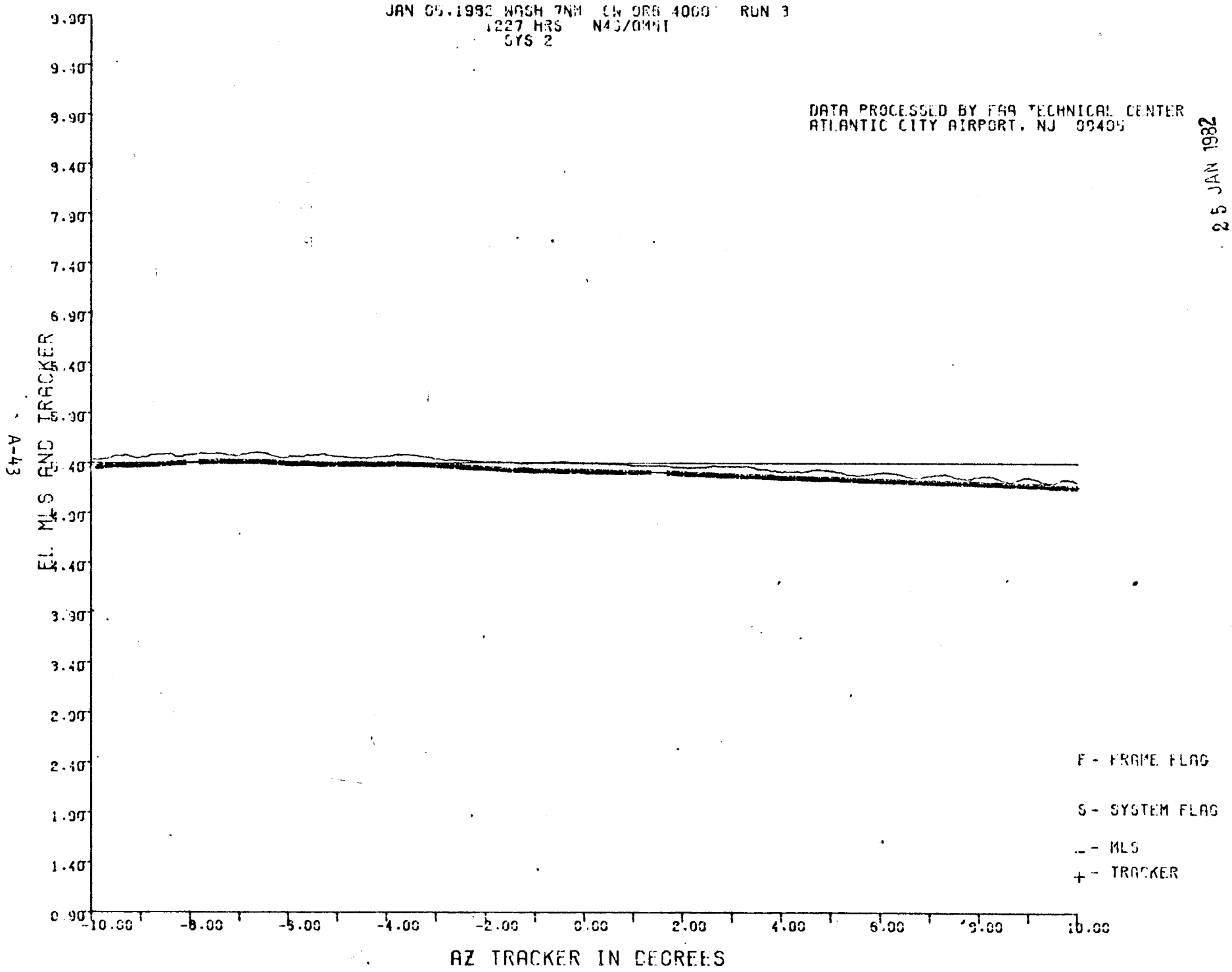
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405

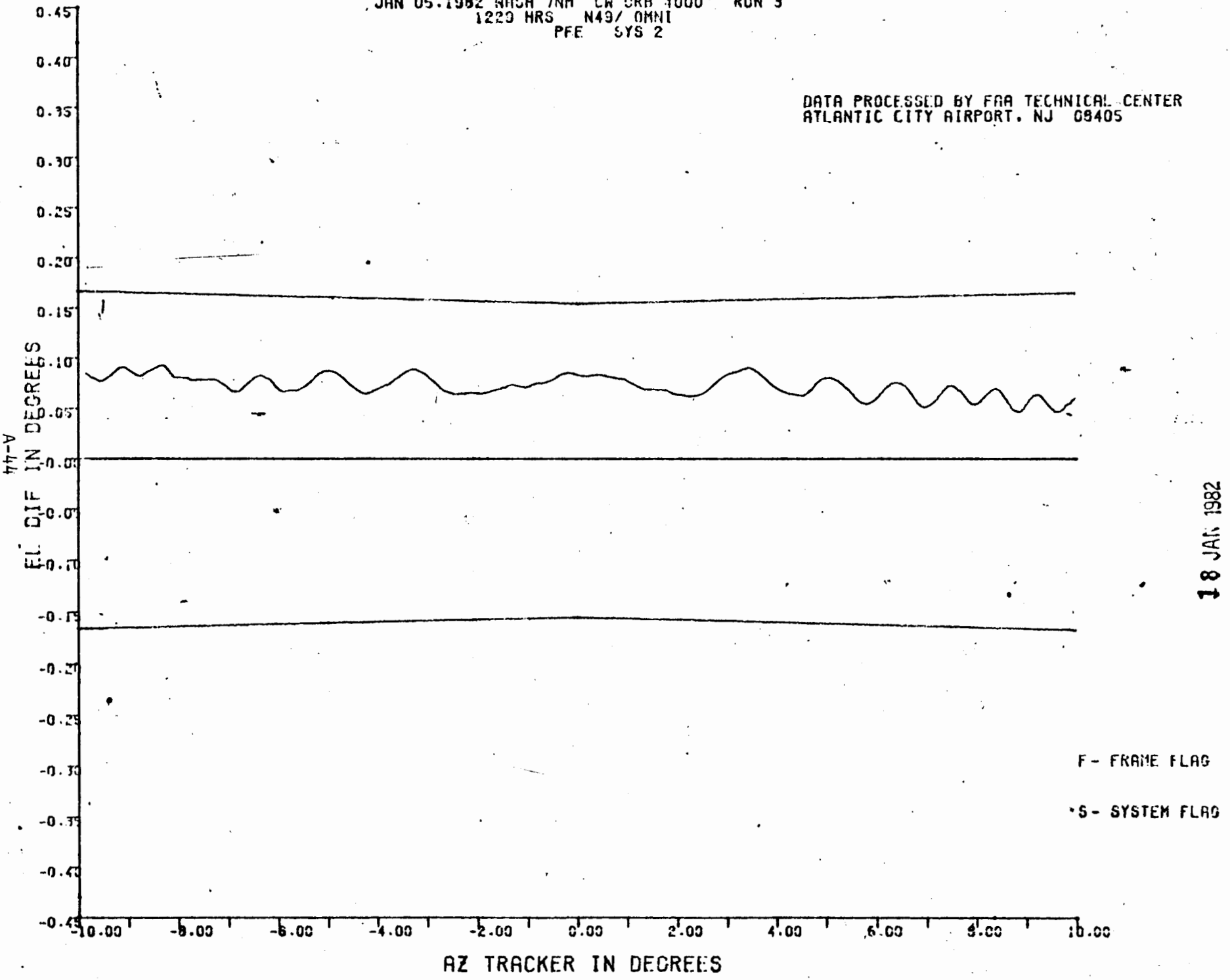


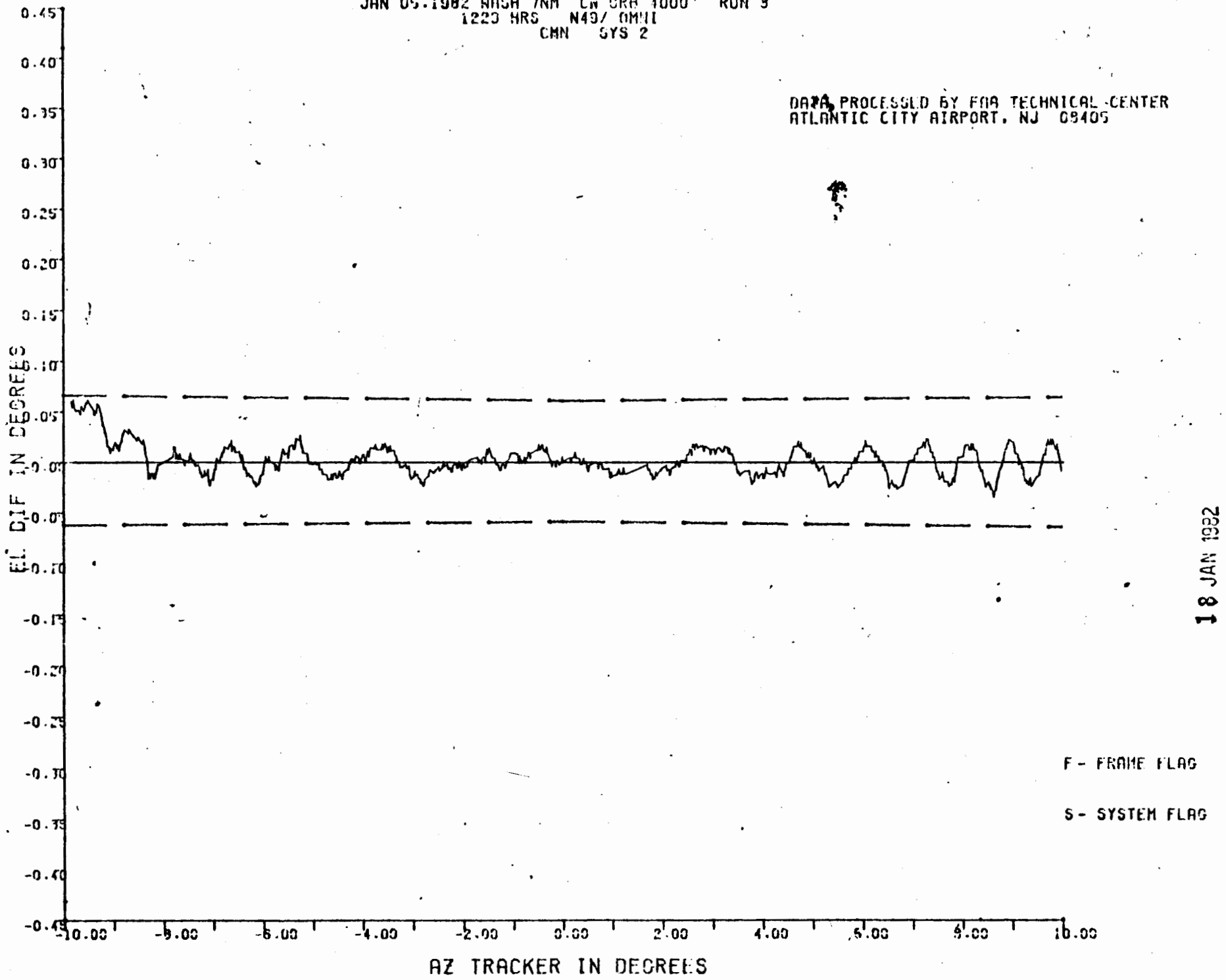
18 JAN 1982

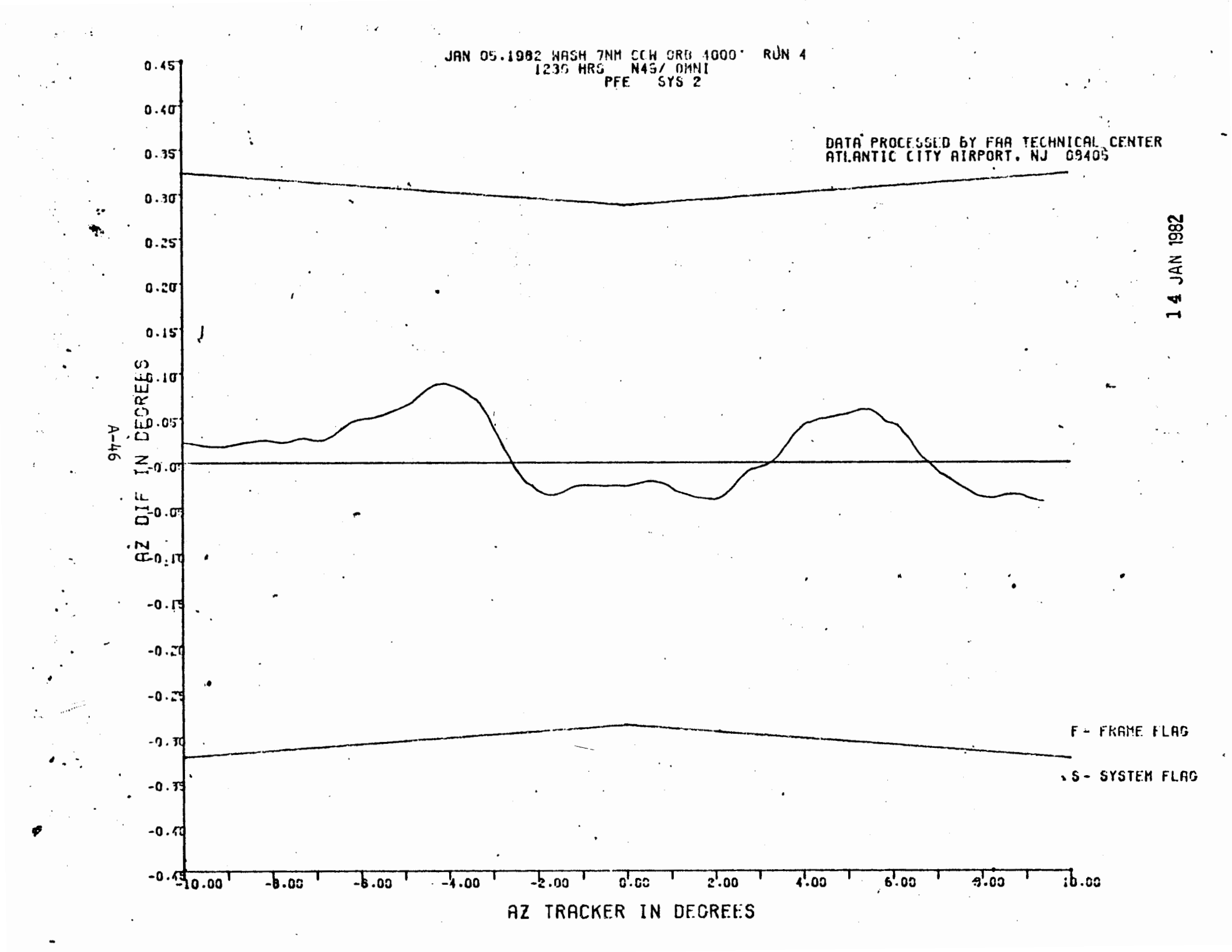
F - FRAME FLAG

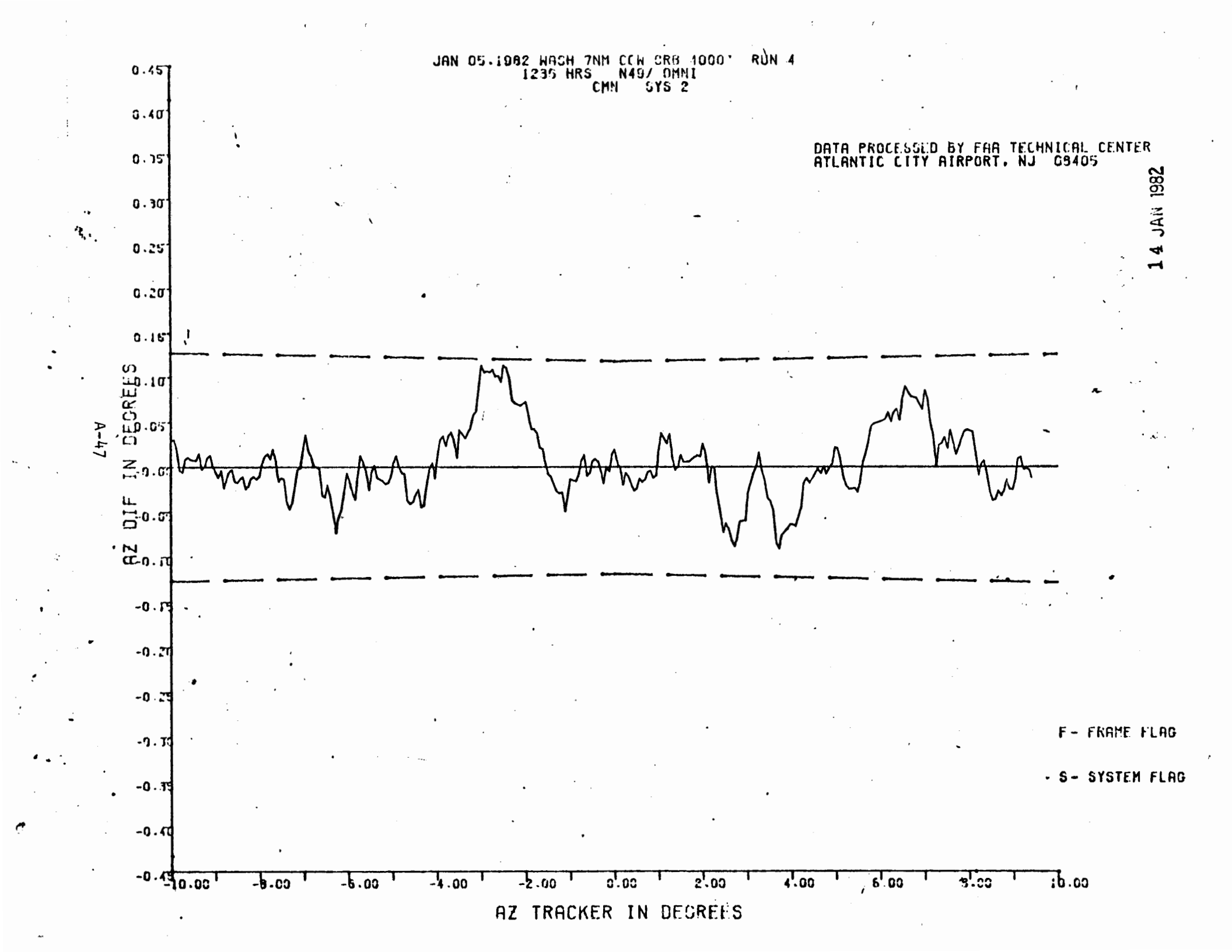
S - SYSTEM FLAG

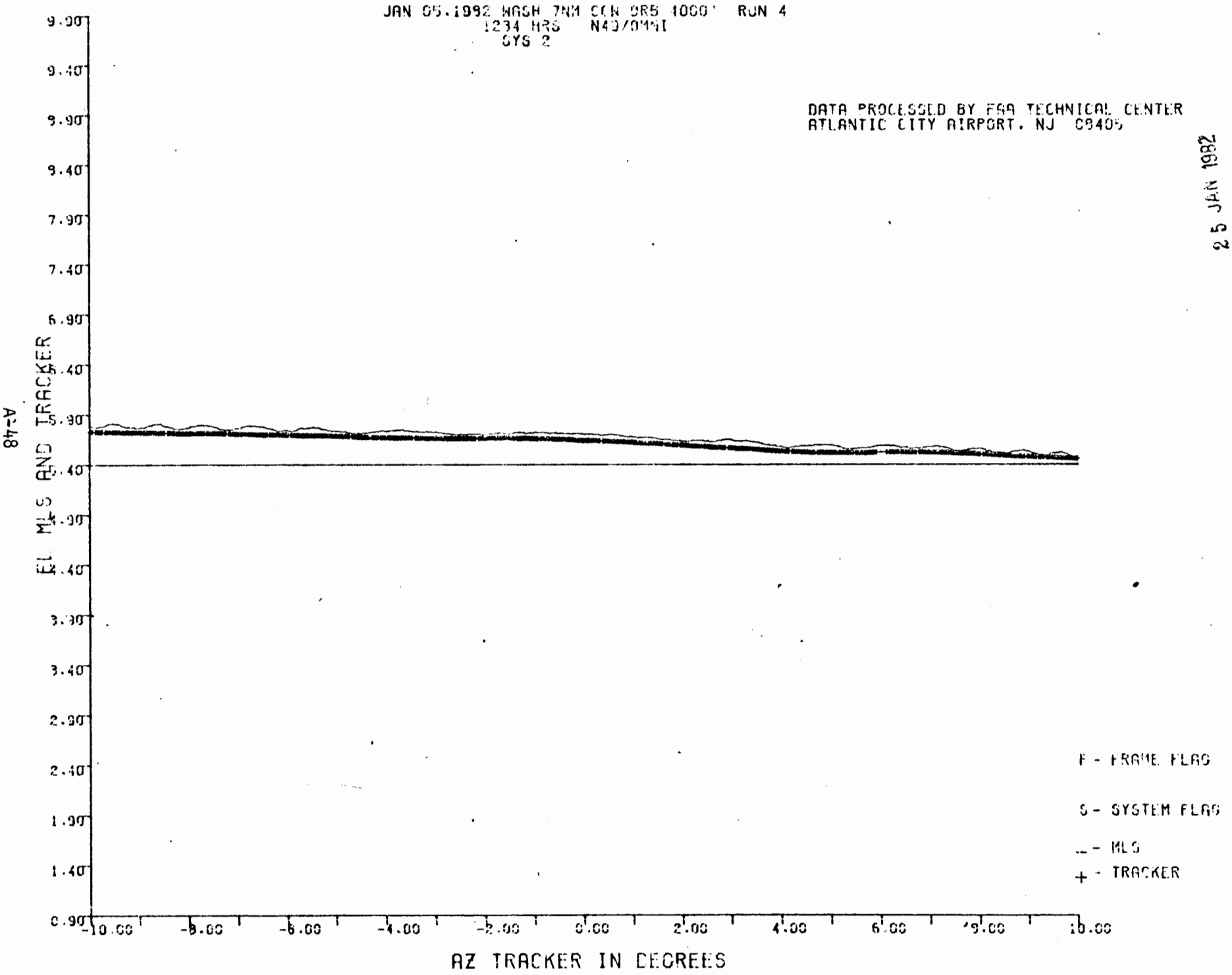

JAN 05.1982 WASH 7NM CW ORB 4000' RUN 3
1227 HRS N40/04W1
SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
25 JAN 1982
EL MLS AND TRACKER
A-43
9.90
9.40
8.90
8.40
7.90
7.40
6.90
6.40
5.90
5.40
4.90
4.40
3.90
3.40
2.90
2.40
1.90
1.40
0.90
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG
_ - MLS
+ - TRACKER

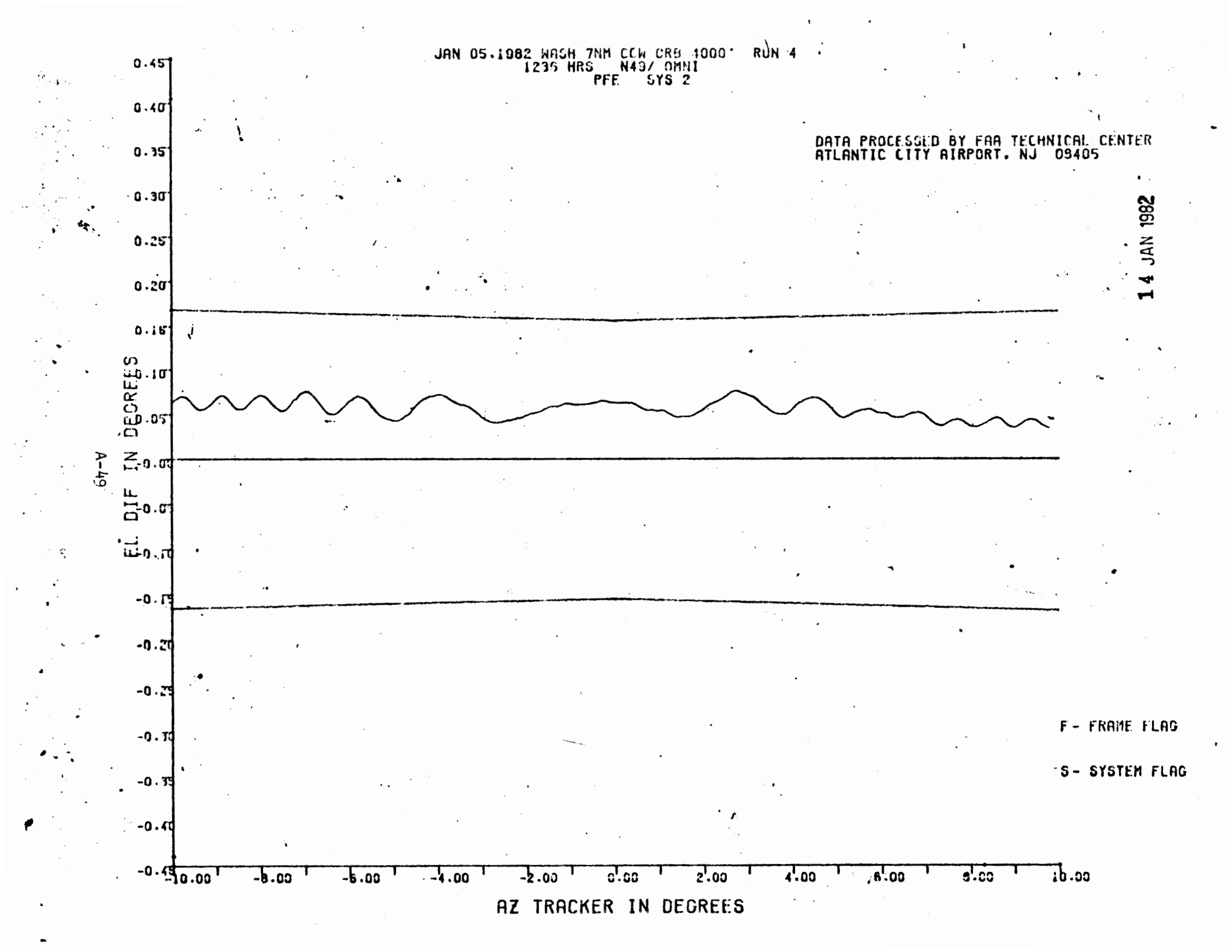

JAN 05.1982 WASH 7NM CW ORB 4000' RUN 3
1220 HRS N49/ OMNI
PFE SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG
18 JAN 1982

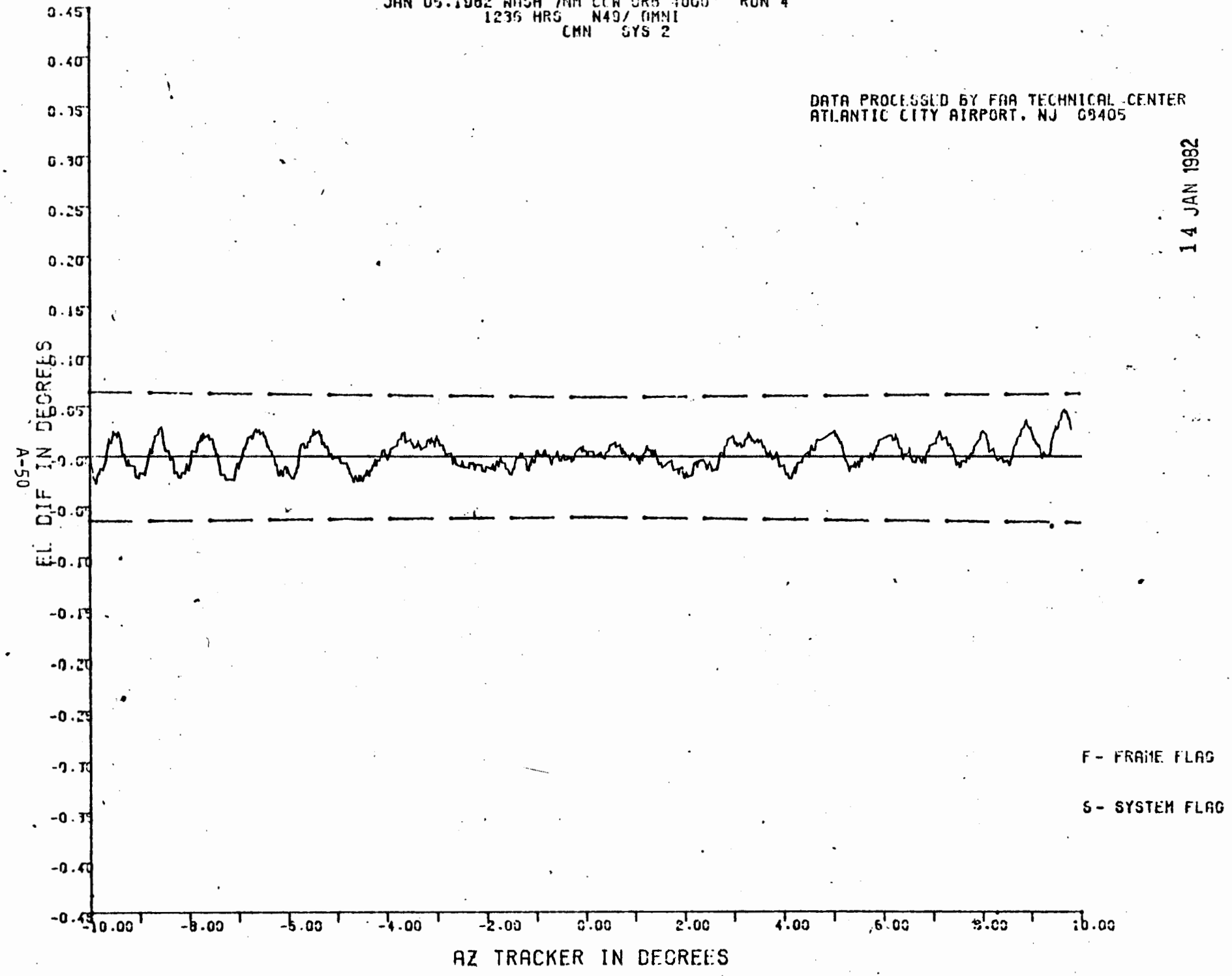

JAN 05.1982 WASH 7NM CW ORB 1000' RUN 3
1220 HRS N49/ OMNI
CMN SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.40
-0.45
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
18 JAN 1982
F - FRAME FLAG
S - SYSTEM FLAG

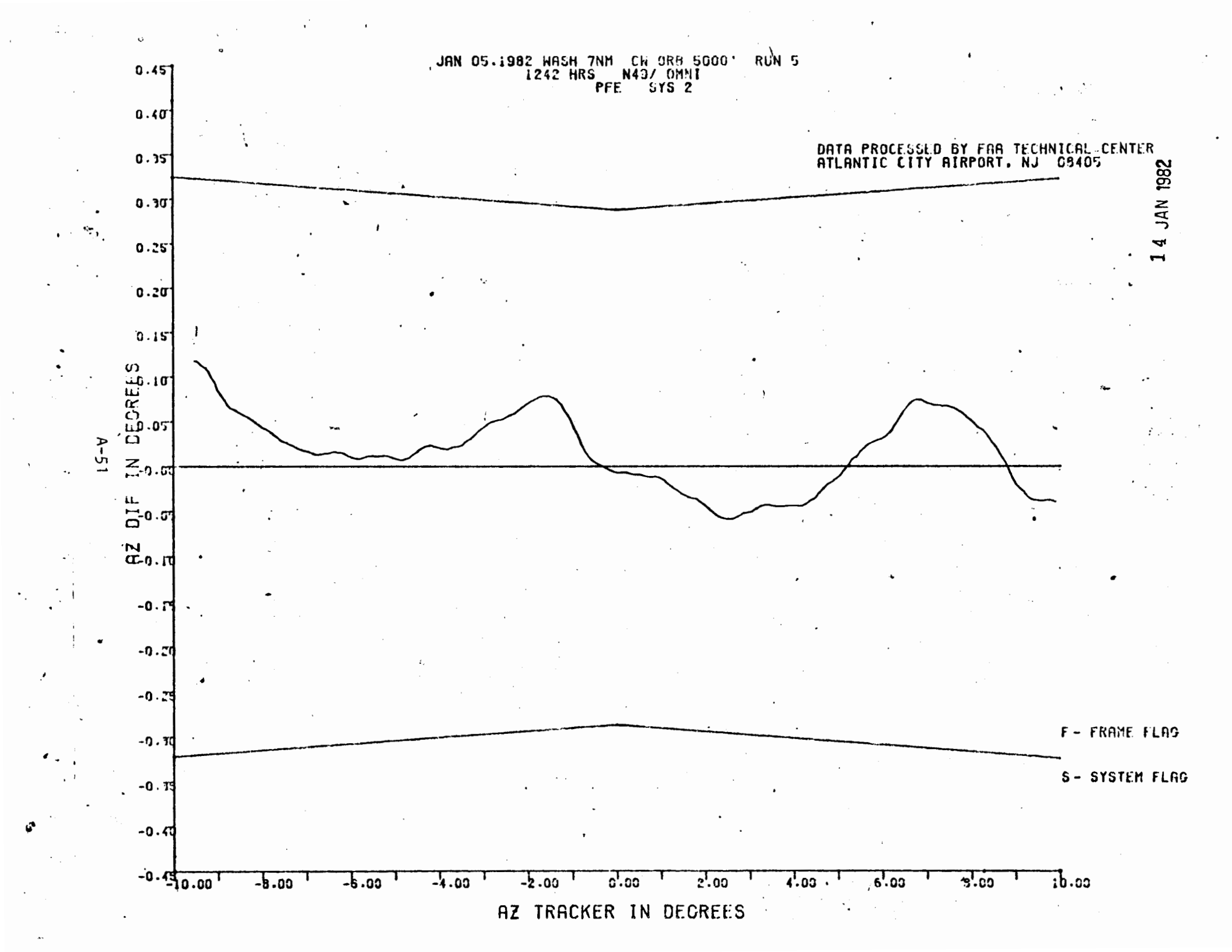

JAN 05.1982 WASH 7NM CCW ORB 4000' RUN 4
1230 HRS N45/ OMNI
PFE SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
A-46
AZ DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG

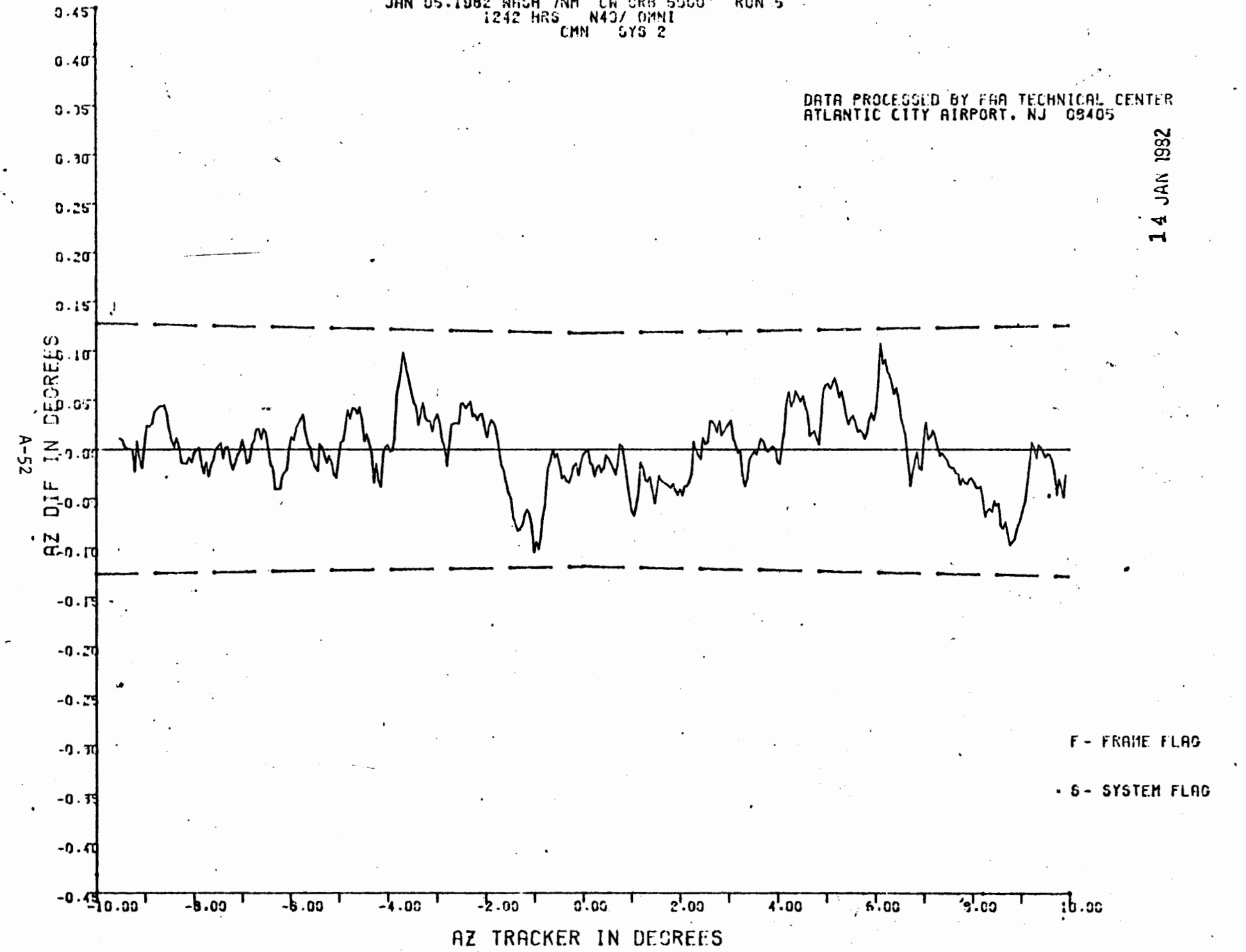

JAN 05.1982 WASH 7NM CCW CRB 1000' RUN 4
1235 HRS N49/ OMNI
CMN SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
AZ DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F- FRAME FLAG
S- SYSTEM FLAG

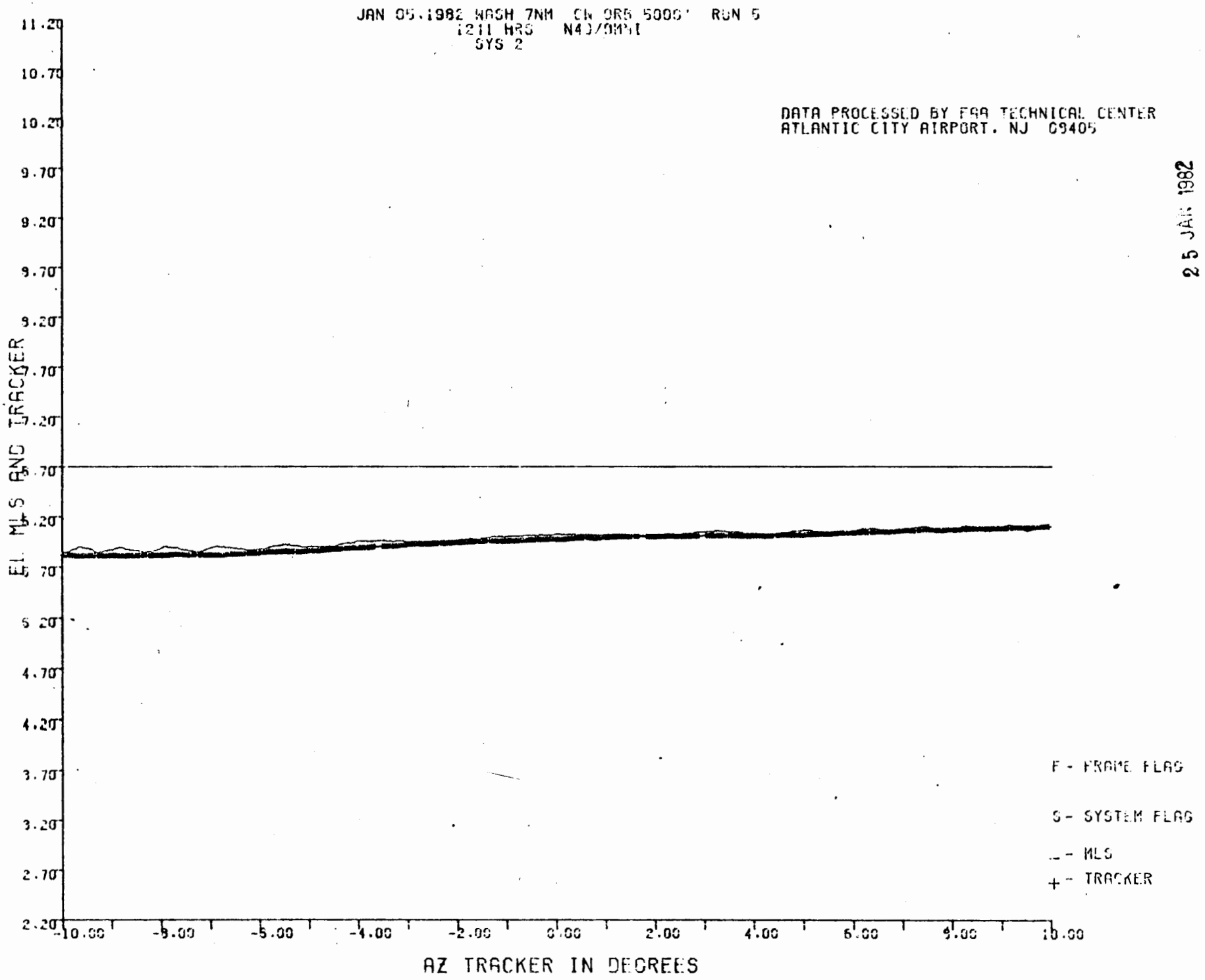

JAN 05,1992 WASH 7NM CCW ORS 1000' RUN 4
1234 HRS N40/0491
SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
25 JAN 1992
EL MLS AND TRACKER
9.90
9.40
8.90
7.90
7.40
6.90
6.40
5.90
5.40
4.90
4.40
3.90
3.40
2.90
2.40
1.90
1.40
0.90
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG
_ - MLS
+ - TRACKER

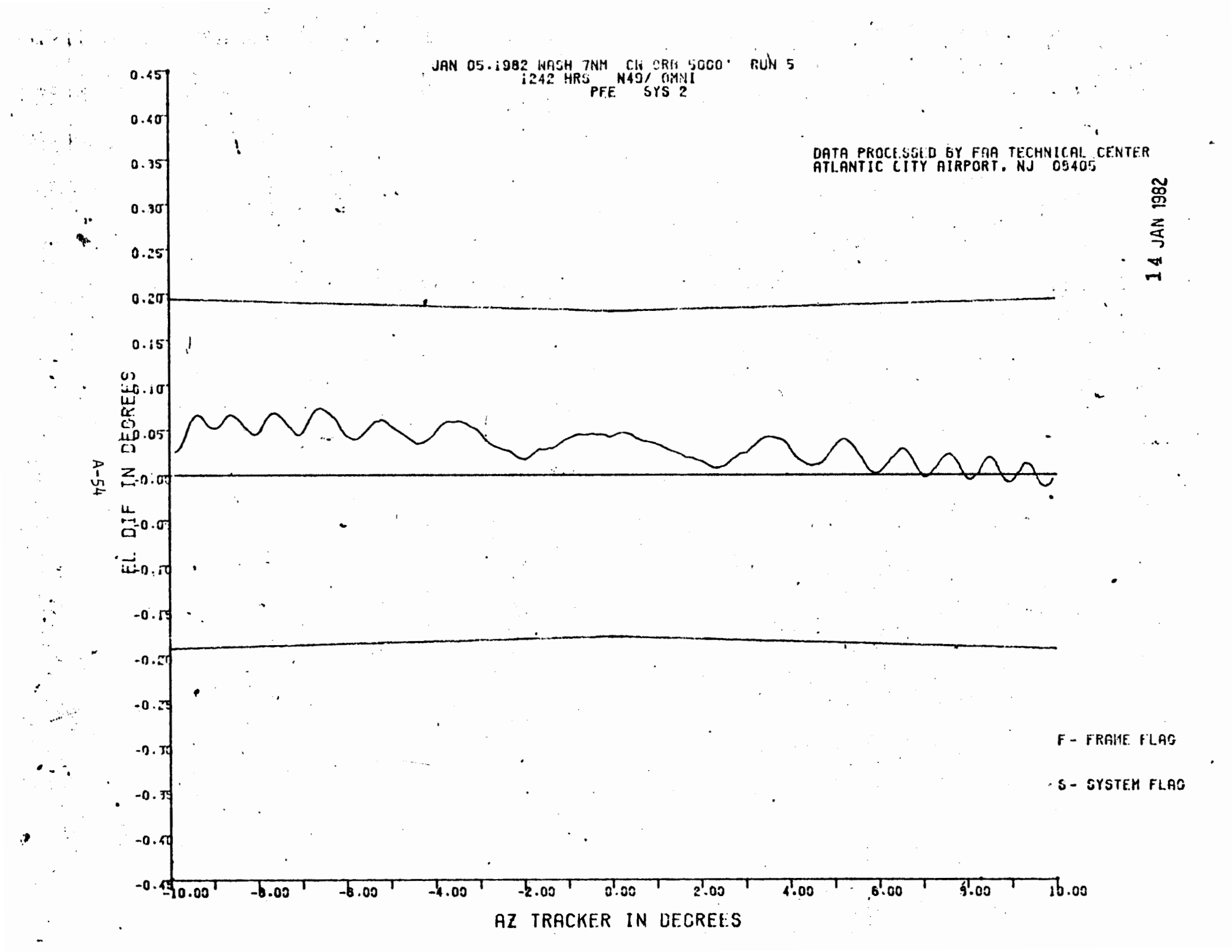

JAN 05.1982 WASH 7NM CCW CRS 1000' RUN 4
1235 HRS N49/ OMNI
PFE SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG

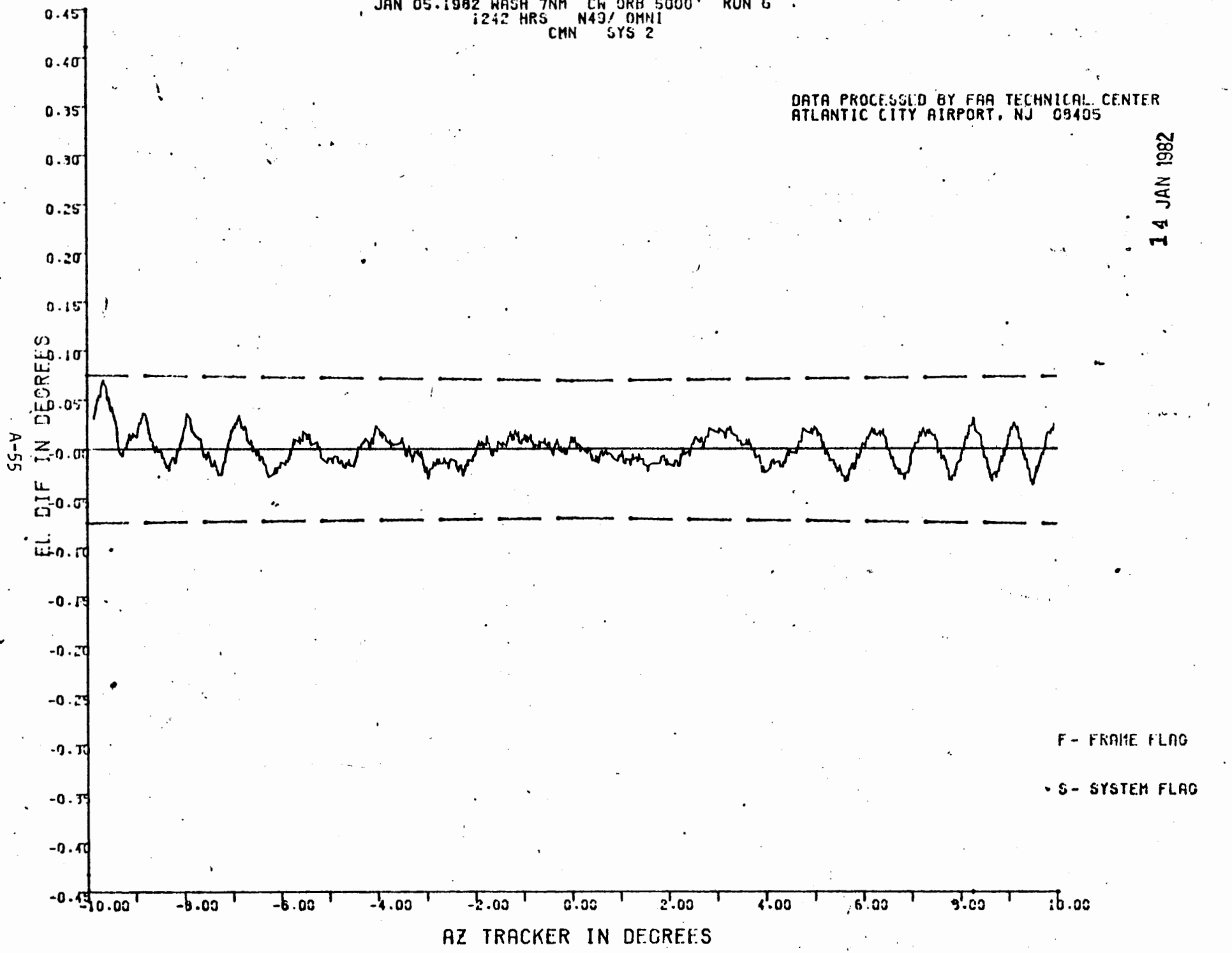

JAN 05.1982 WASH 7NM CCW ORB 4000' RUN 4
1236 HRS N49/ OMNI
CMN SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
EL DIF IN DEGREES
A-50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG

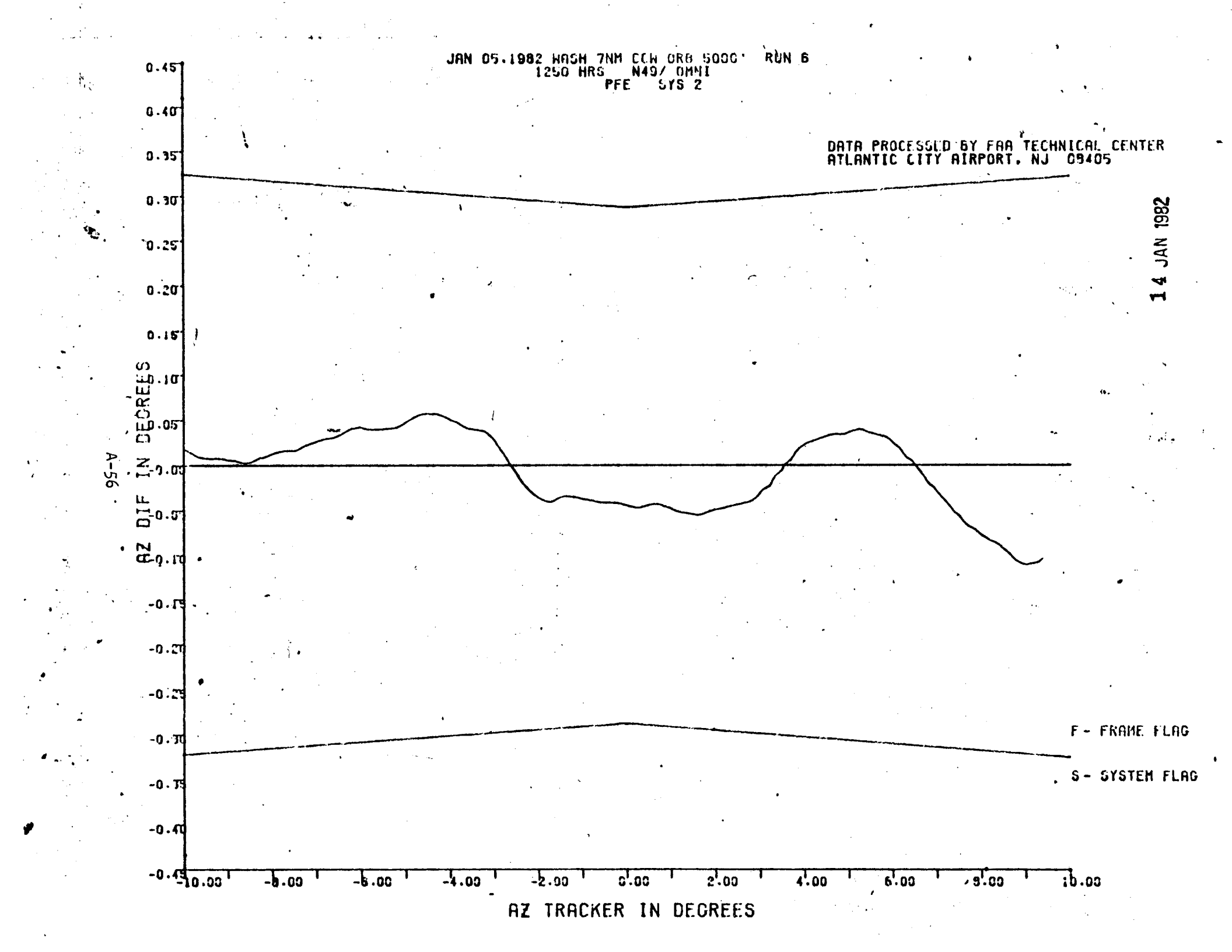

JAN 05.1982 WASH 7NM CW ORB 5000' RUN 5
1242 HRS N40/ OMNI
PFE SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
AZ DIF IN DEGREES
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG
A-51

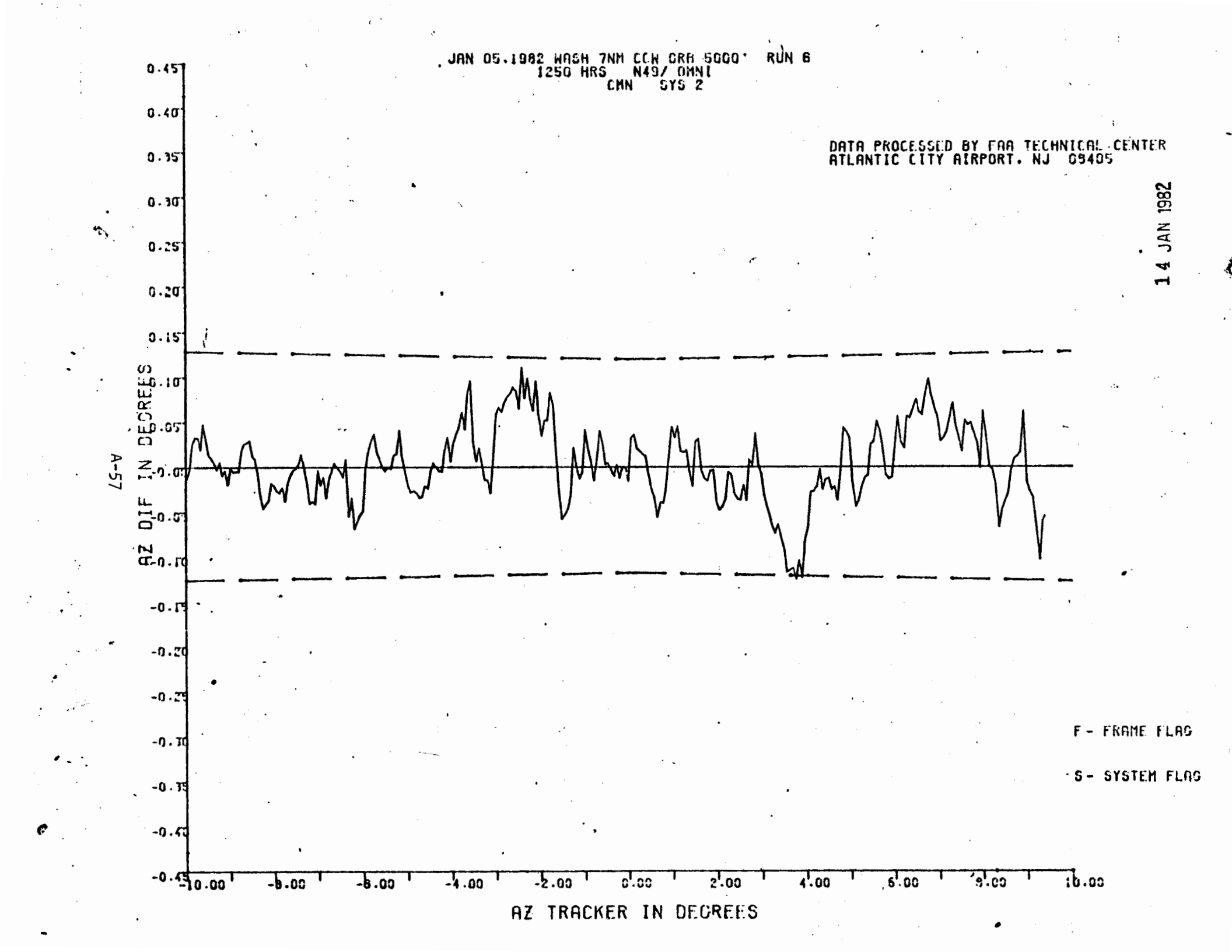

JAN 05.1982 WASH 7NM CW CRB 5000' RUN 5
1242 HRS N40/ OMNI
CMN SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
AZ DIF IN DEGREES
A-52
0.45
0.40
0.35
0.30
0.25
0.20
0.15
-0.40
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG

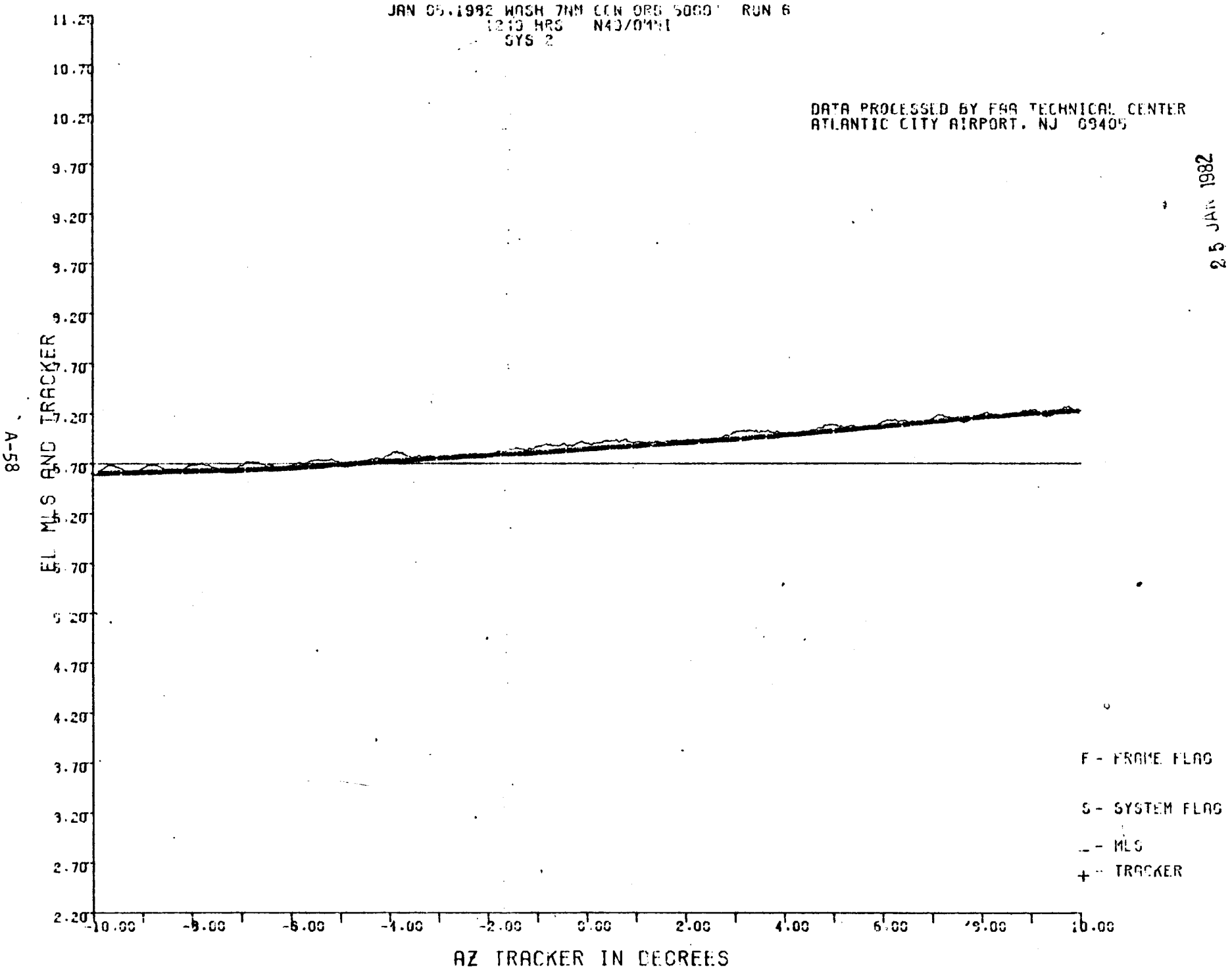

JAN 05,1982 WASH 7NM ON ORB 5000' RUN 5
1211 HRS N40/0MSL
SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
25 JAN 1982
EL MLS AND TRACKER
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG
_ - MLS
+ - TRACKER

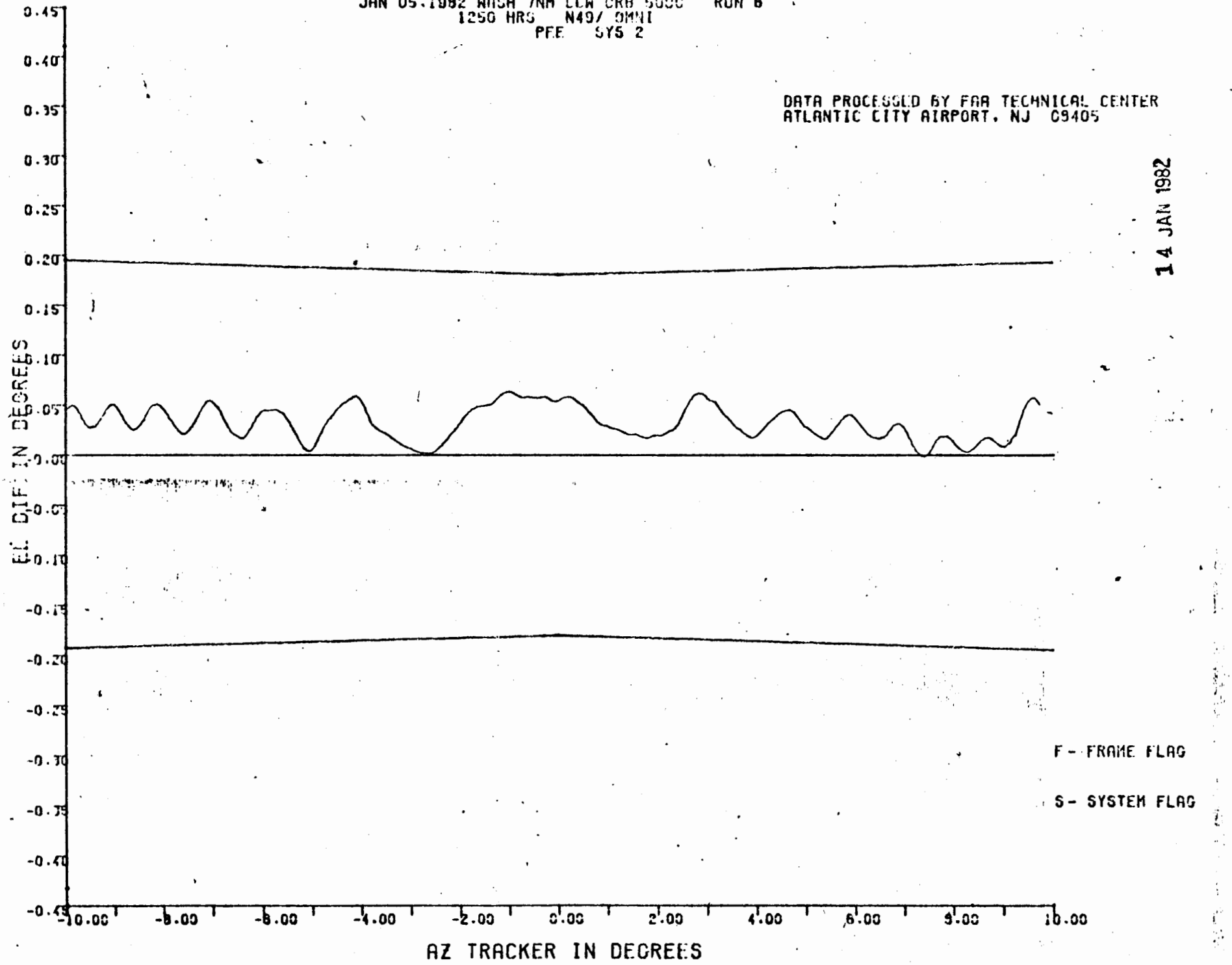

JAN 05.1982 WASH 7NM CW ORB 5000' RUN 5
1242 HRS N49/ OMNI
PFE SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.40
-0.45
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG

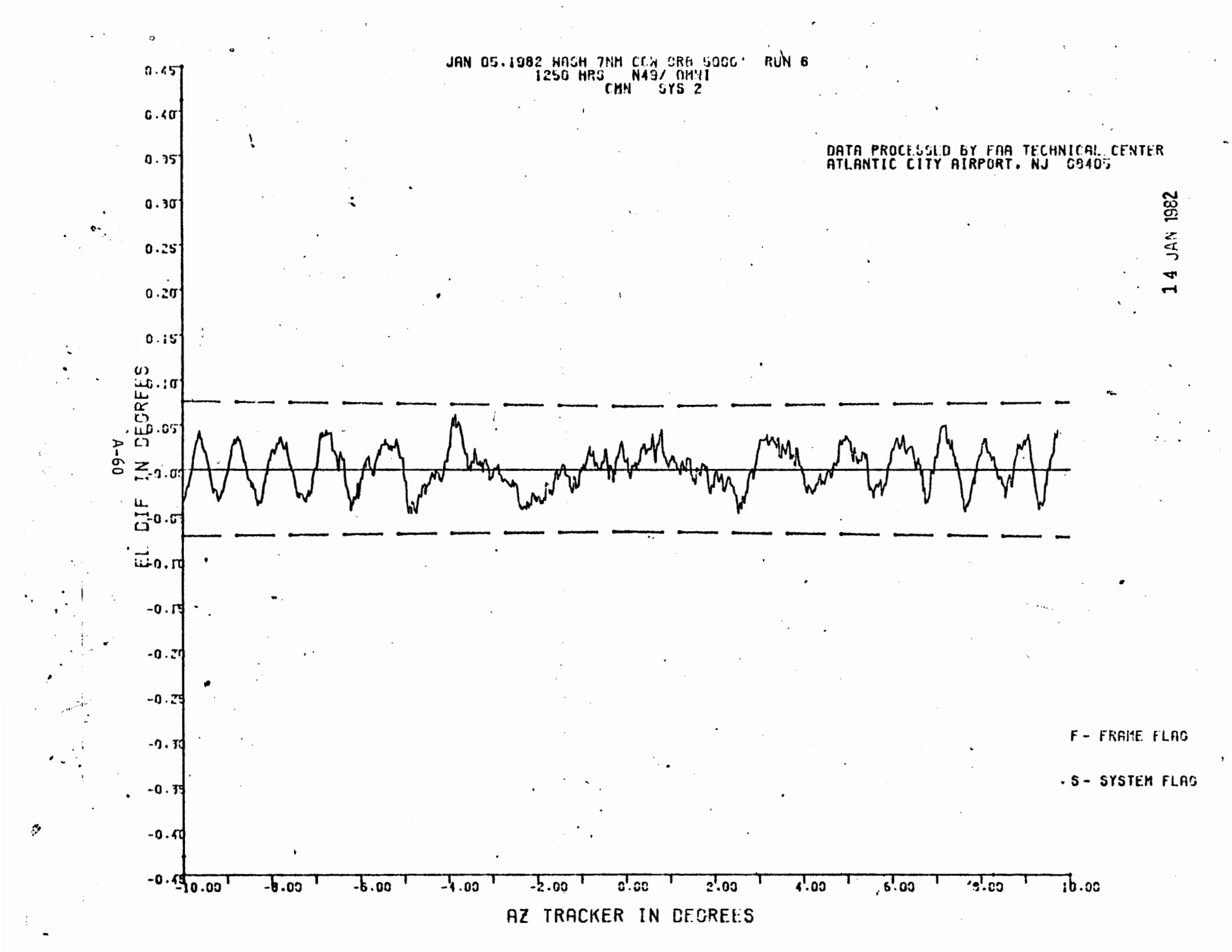

JAN 05.1982 WASH 7NM CW ORB 5000' RUN 6
1242 HRS N49/ OMNI
CMN SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.40
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG

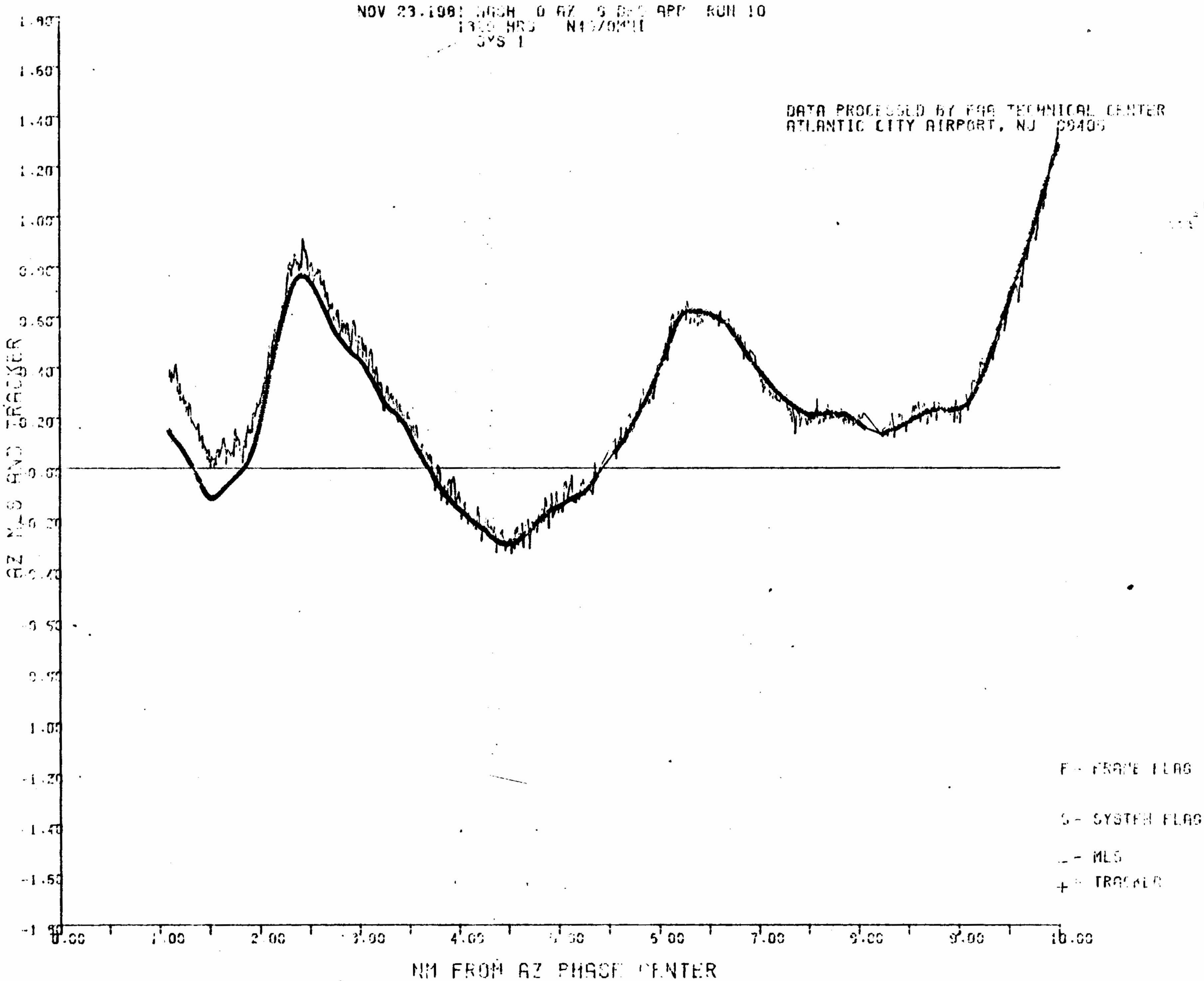

JAN 05.1982 WASH 7NM CCW ORB 5000' RUN 6
1250 HRS N49/ OMNI
PFE SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
AZ DIF IN DEGREES
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.10
-0.40
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00

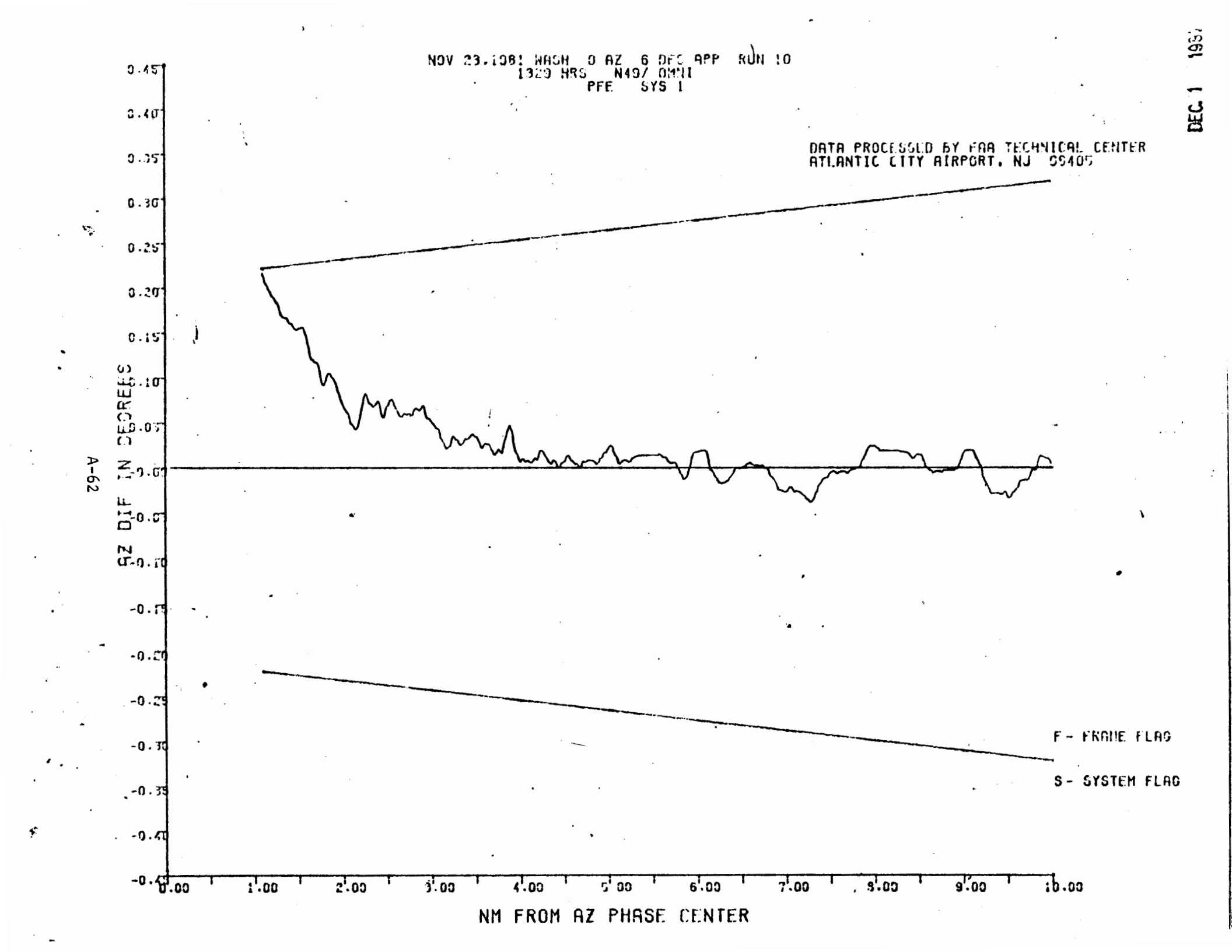

JAN 05.1982 WASH 7NM CCW ORB 5000' RUN 6
1250 HRS N49/ OMNI
CMN SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
AZ DIF IN DEGREES
AZ TRACKER IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.10
-0.20
-0.30
-0.40
-0.45
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
F - FRAME FLAG
S - SYSTEM FLAG

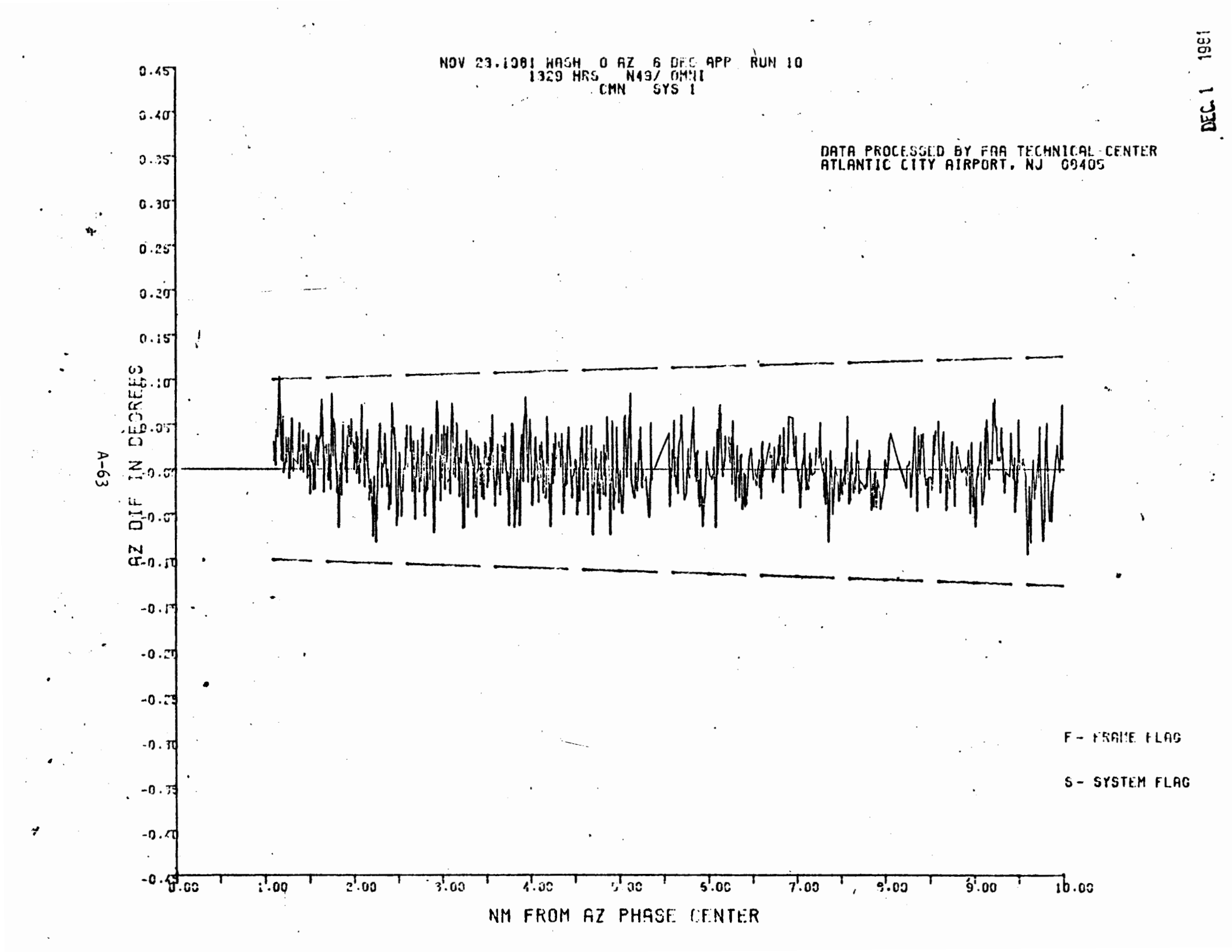

JAN 05,1982 WASH 7NM CEN ORB 5000' RUN 6
1210 HRS N40/OMNI
SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
25 JAN 1982
A-58
EL MLS AND TRACKER
11.20
10.70
10.20
9.70
9.20
8.70
8.20
7.70
7.20
6.70
6.20
5.70
5.20
4.70
4.20
3.70
3.20
2.70
2.20
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG
_ - MLS
+ - TRACKER

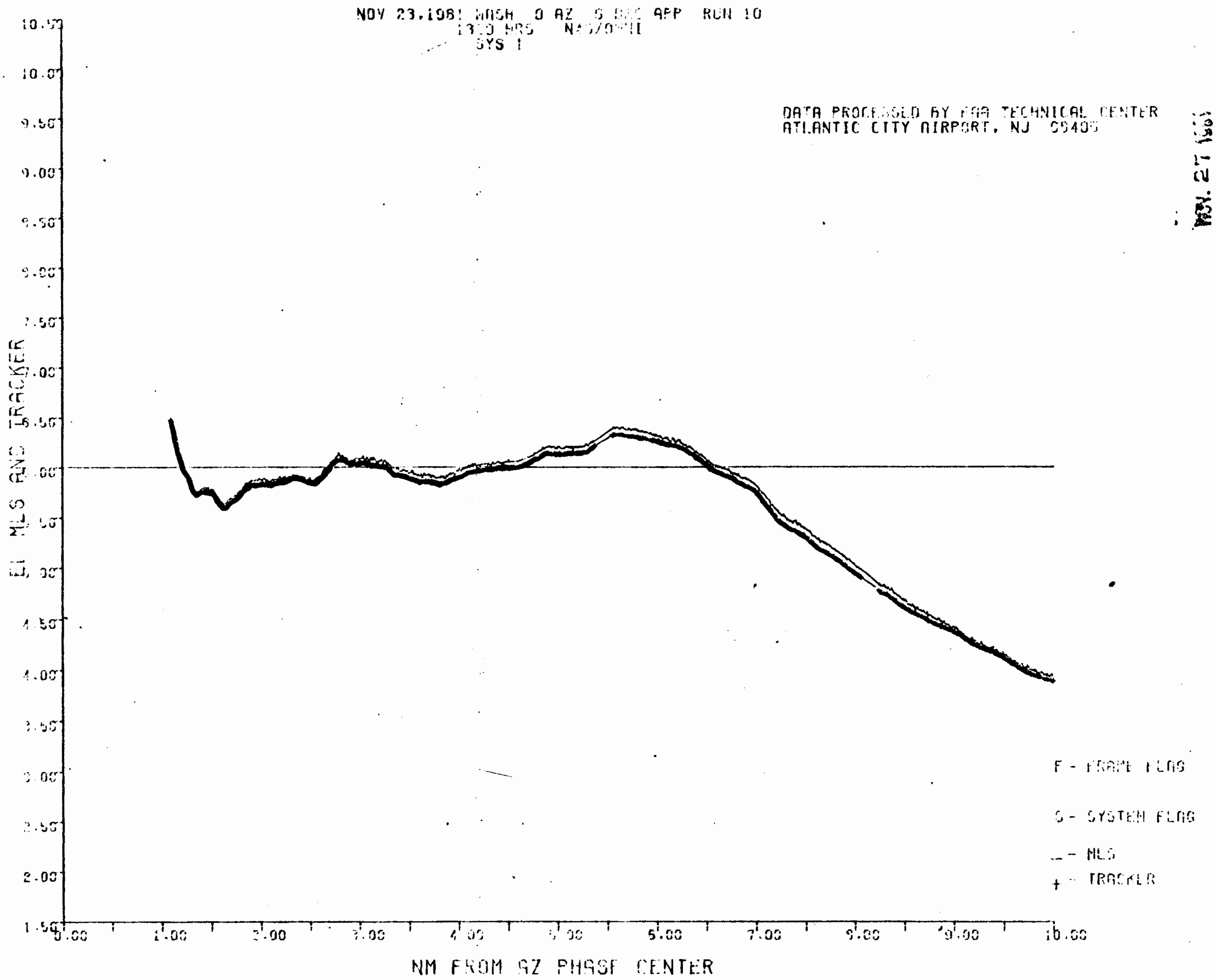

JAN 05.1982 WASH 7NM CCW CRB 5000' RUN 6
1250 HRS N49/ OMNI
PFE SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG

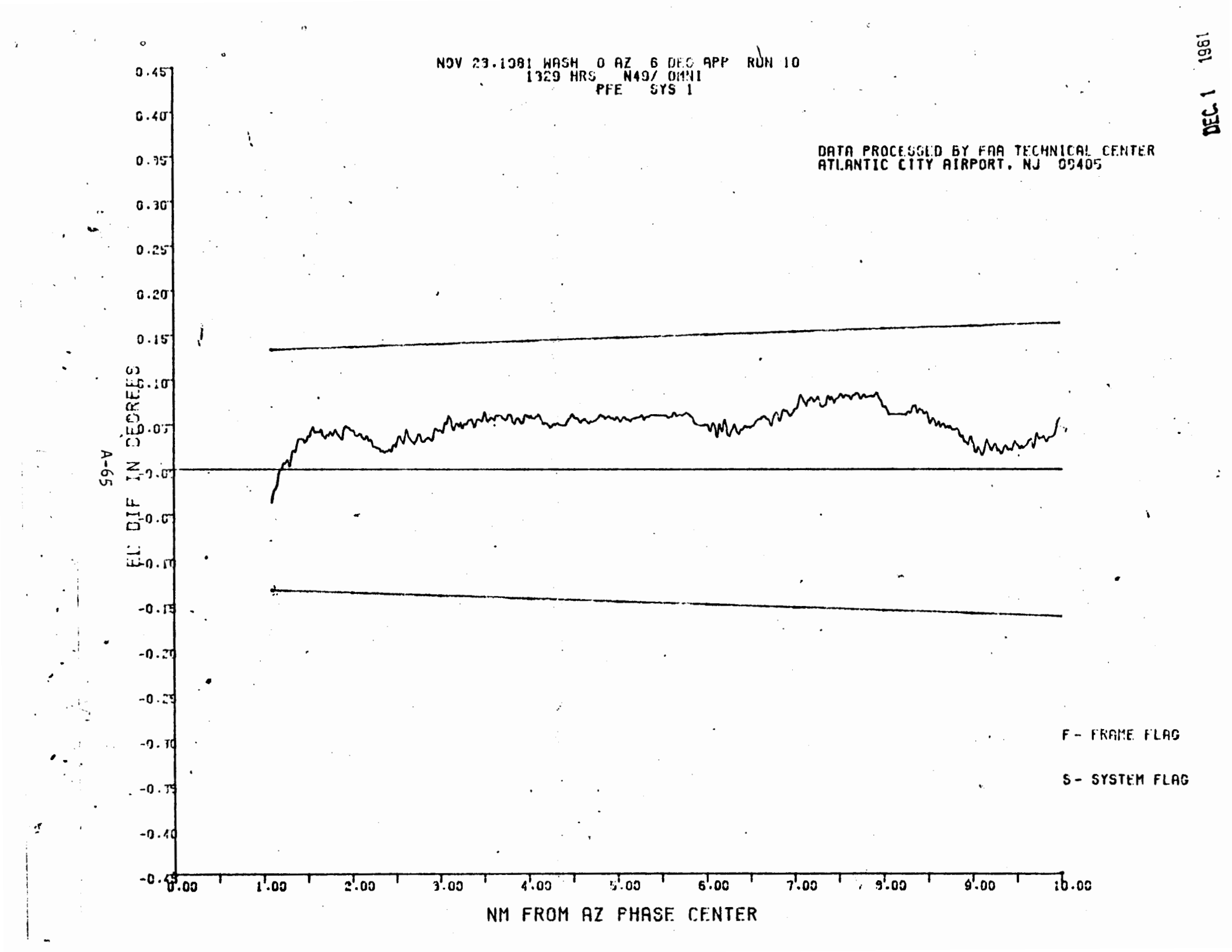

JAN 05.1982 WASH 7NM CCW ORB 5000' RUN 6
1250 HRS N49/ 0MYI
CMN SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
A-60
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-10.00
-8.00
-6.00
-4.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
AZ TRACKER IN DEGREES
F - FRAME FLAG
S - SYSTEM FLAG

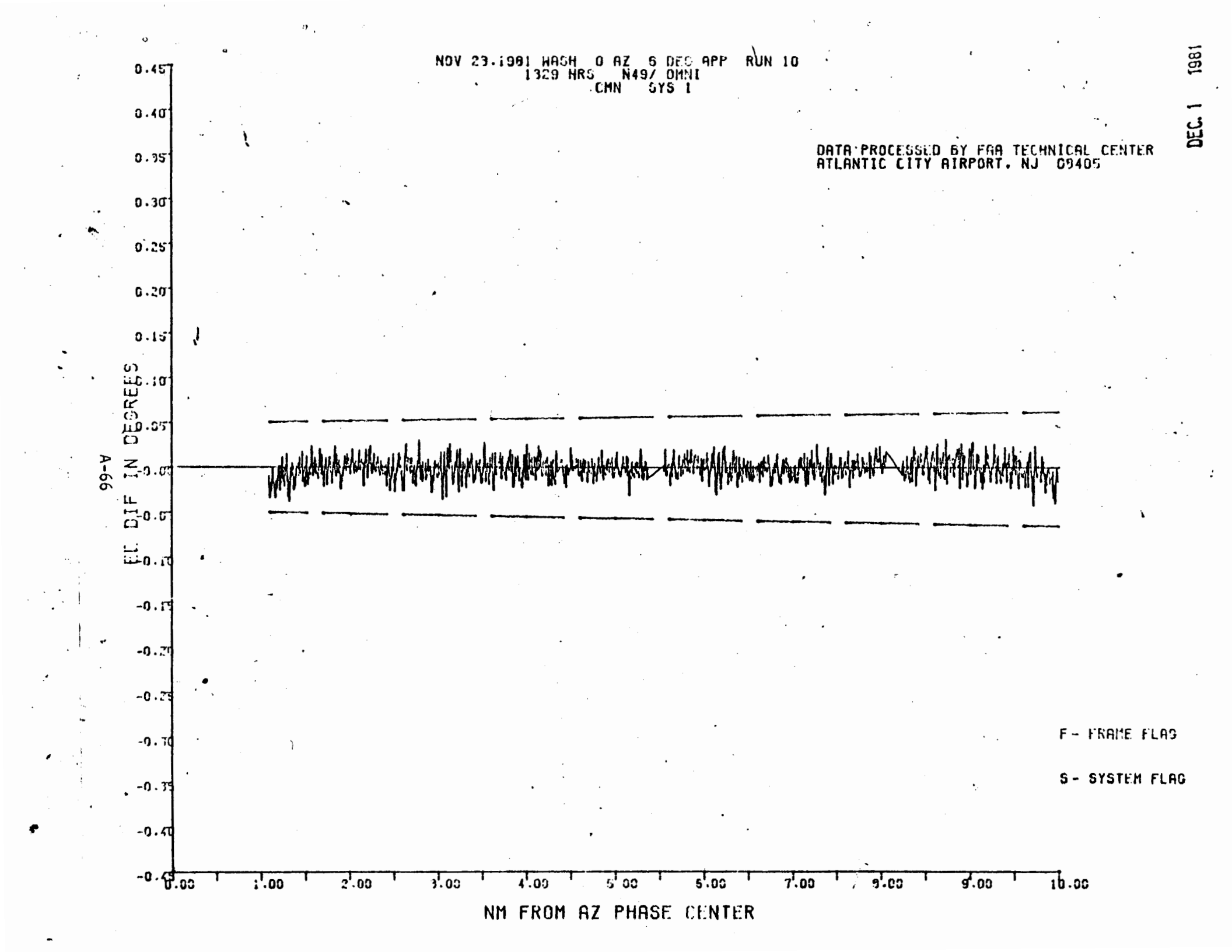

RUN 10
SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
AZ MLS AND TRACKER
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG
- MLS
+ TRACKER

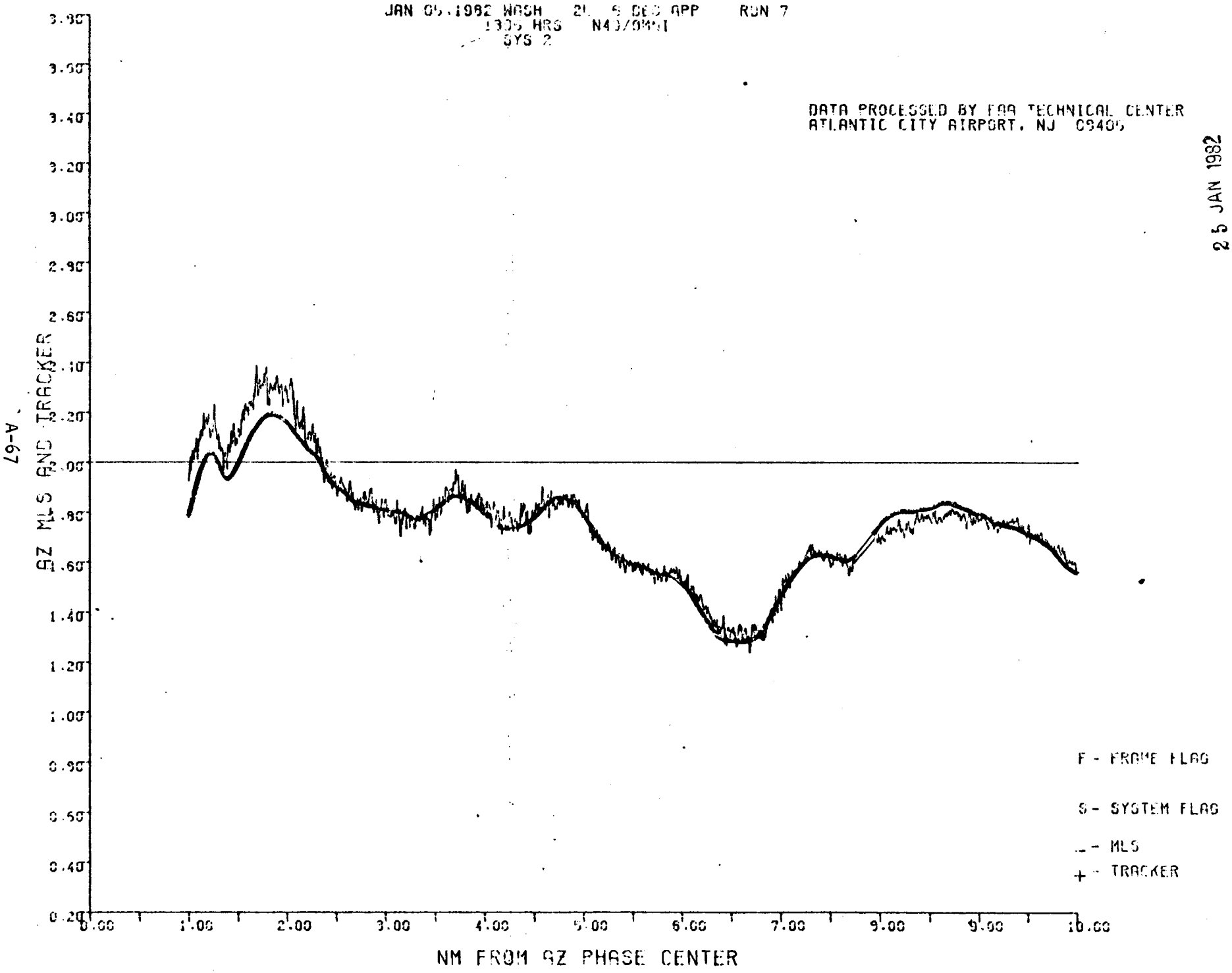

NOV 23,1981 WASH 0 AZ 6 DEG APP RUN 10
1329 HRS N49/ OMNI
PFE SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
DEC 1 19
AZ DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG
A-62

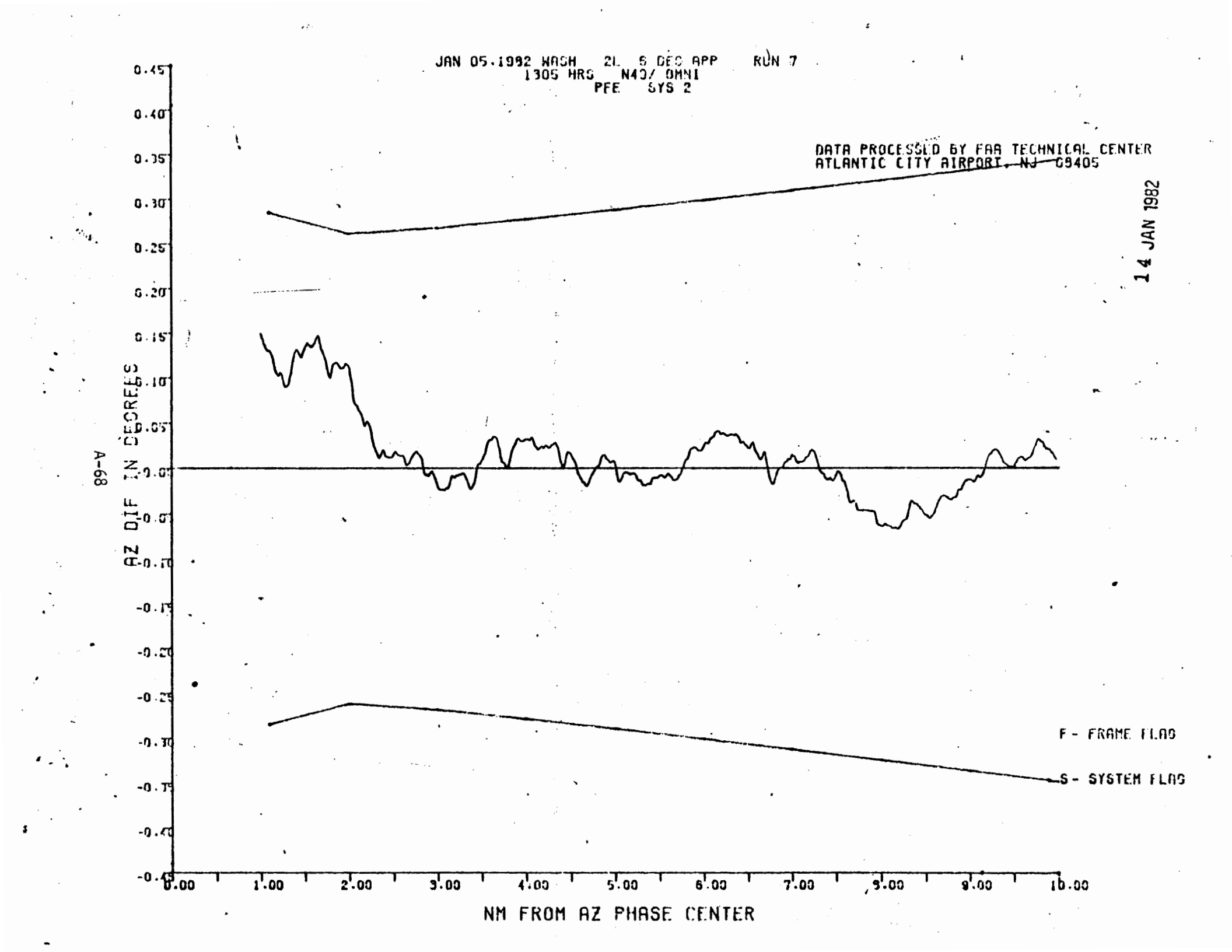

NOV 23.1981 WASH 0 AZ 6 DEG APP RUN 10
1329 HRS N49/ OMNI
CMN SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
DEC 1 1981
AZ DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG

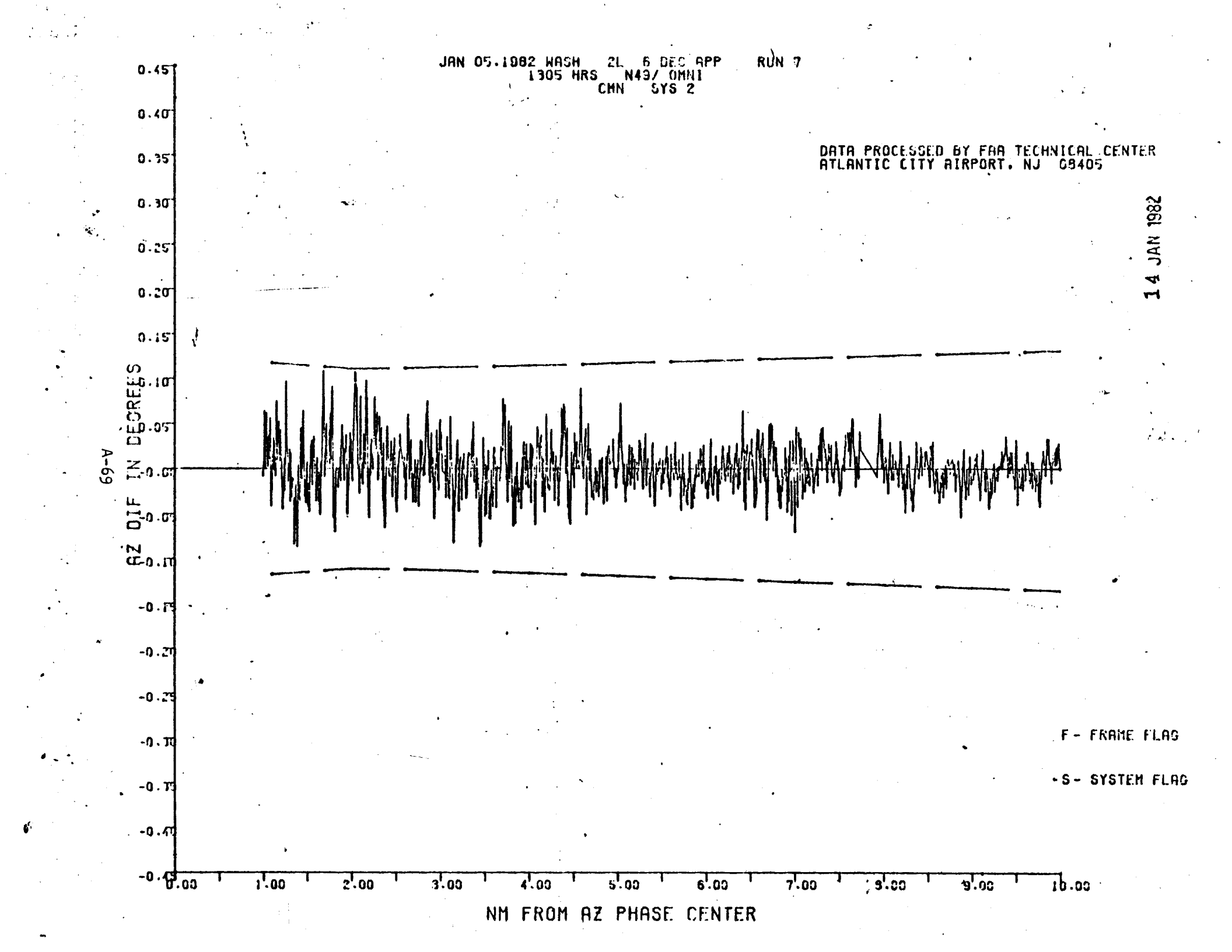

NOV 23,1981 WASH 0 AZ
APP RUN 10
SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ
EL MLS AND TRACKER
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG
- MLS
+ - TRACKER

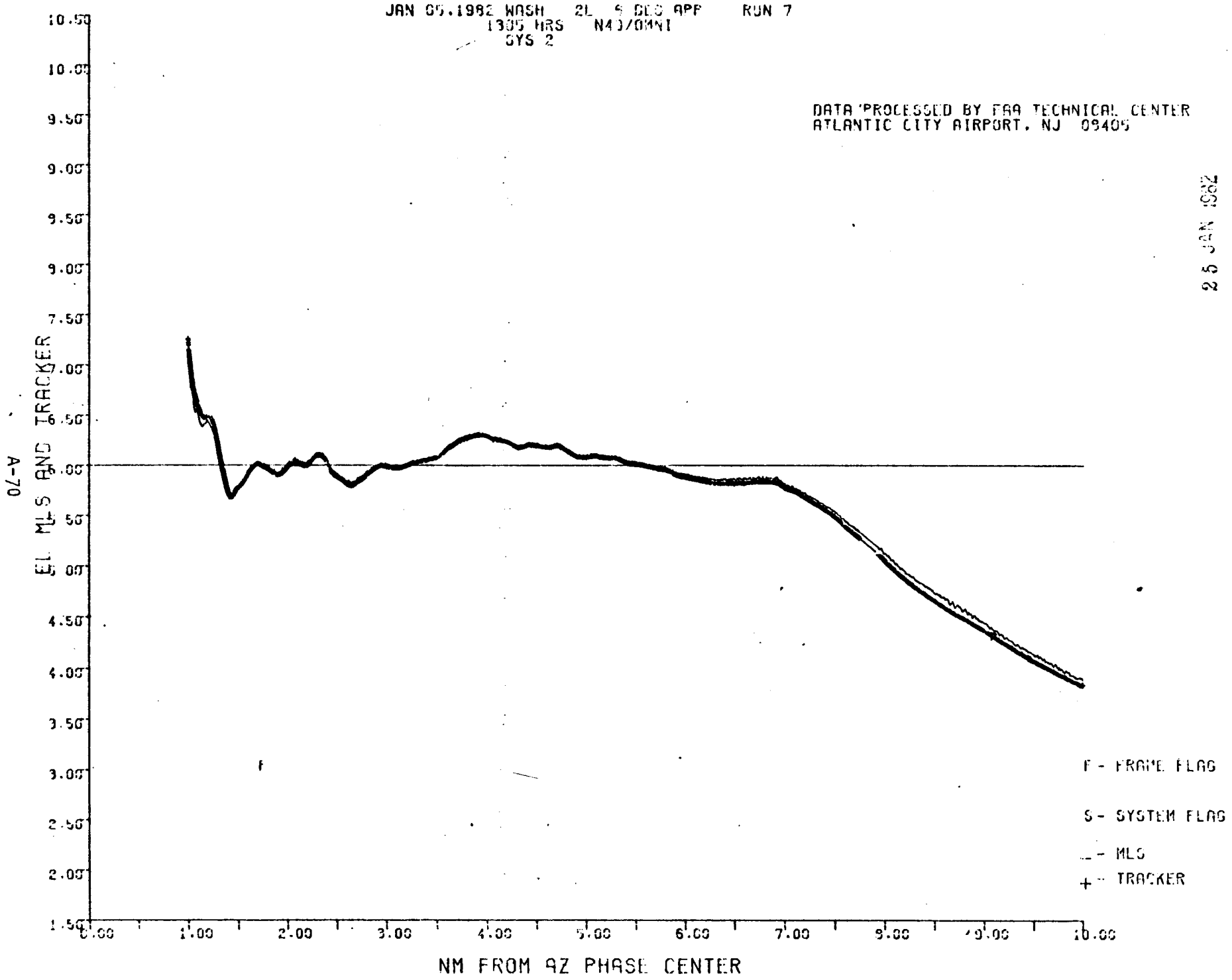

NOV 23.1981 WASH 0 AZ 6 DEG APP RUN 10
1329 HRS N49/ OMNI
PFE SYS 1
DEC 1 1981
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG
A-65

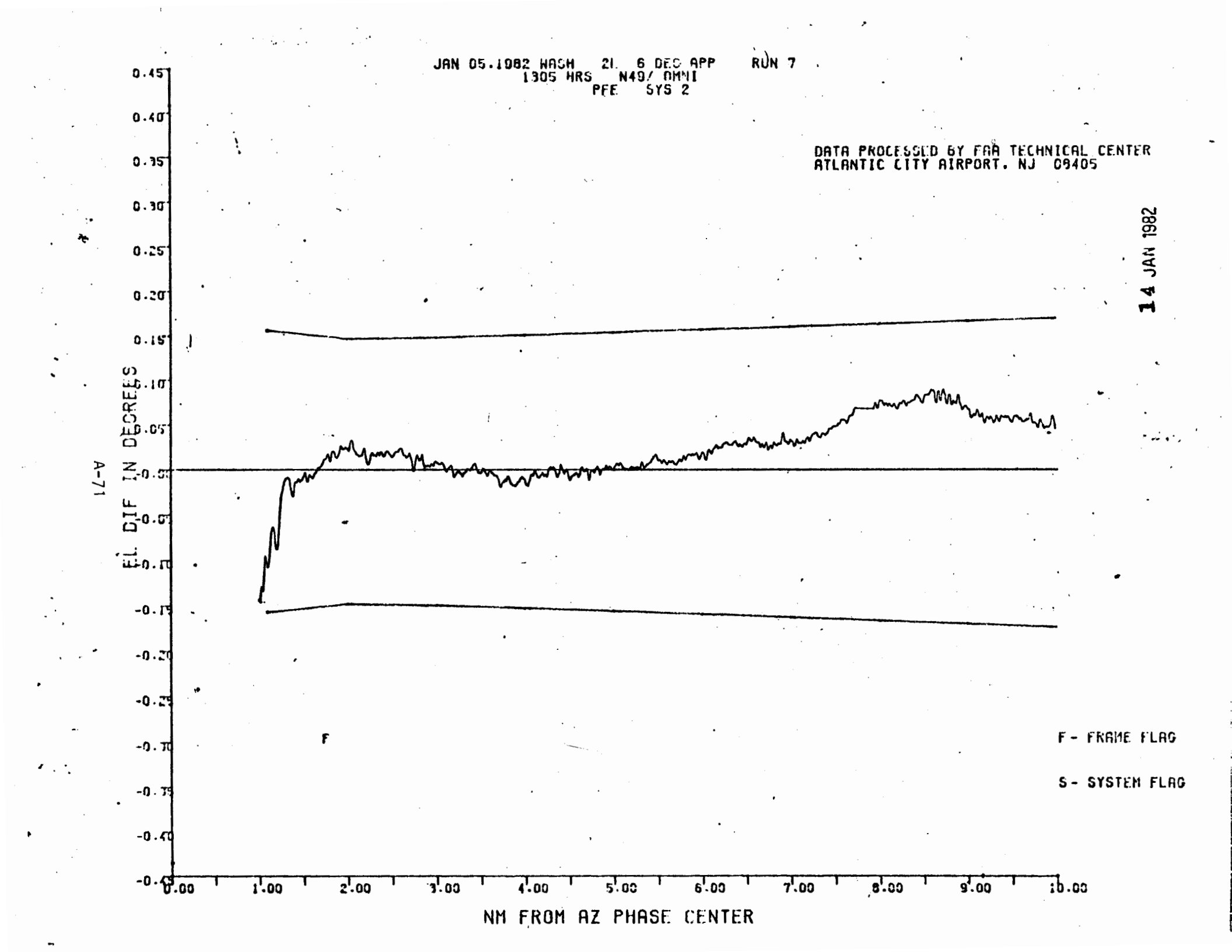

NOV 23.1981 WASH O AZ 6 DEG APP RUN 10
1329 HRS N49/ OMNI
CMN SYS 1
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
DEC 1 1981
A-66
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG

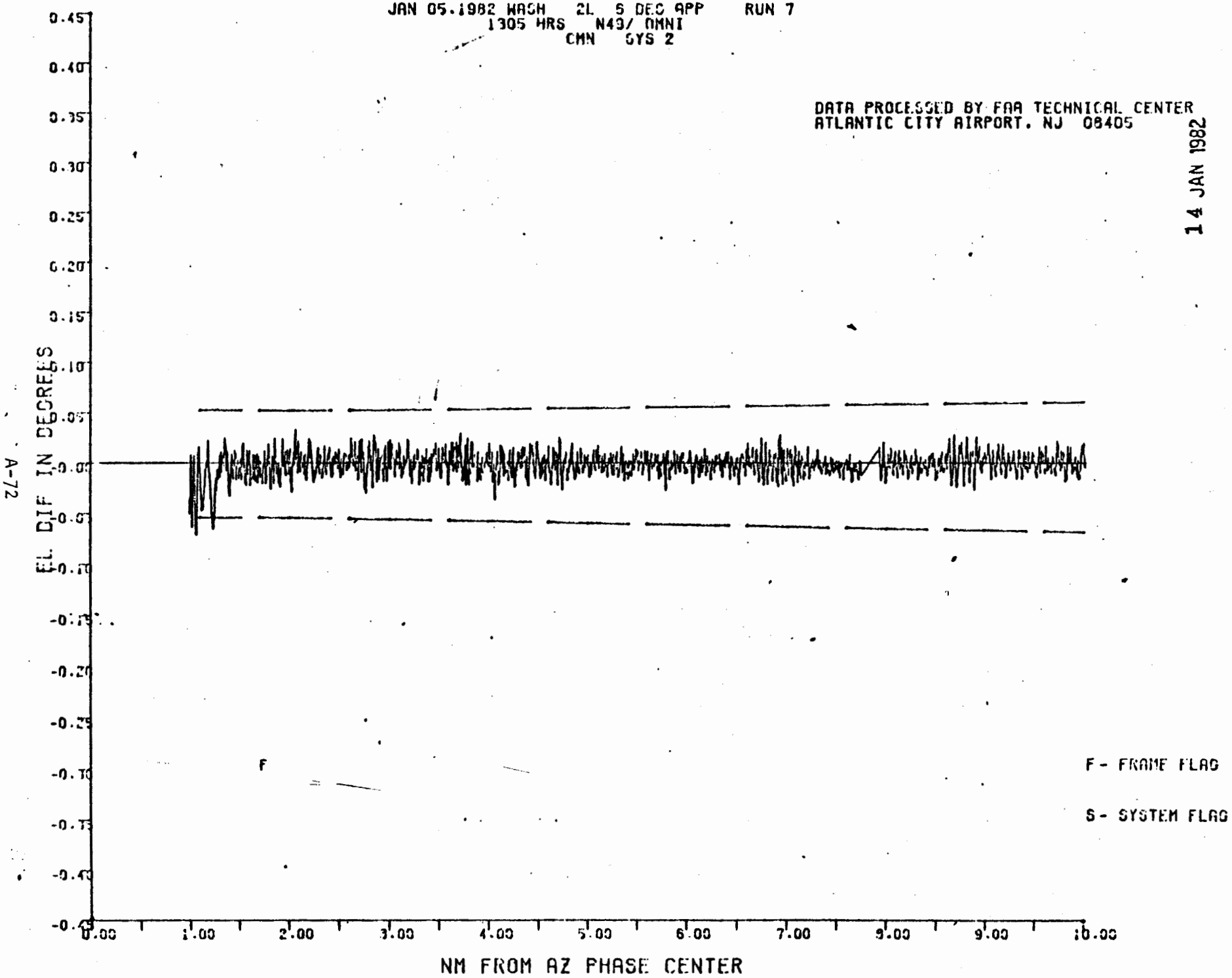

JAN 25,1982 WASH 21L 9 DEC APP RUN 7
1305 HRS N40/0MNI
SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
25 JAN 1982
GZ MLS AND TRACKER
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM GZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG
_ - MLS
+ - TRACKER


JAN 05.1982 WASH 2L 6 DEG APP RUN 7
1305 HRS N40/ OMNI
PFE SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
AZ DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.10
-0.20
-0.30
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG


JAN 05.1982 WASH 2L 6 DEC APP RUN 7
1305 HRS N49/ OMNI
CMN SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
69-A
AZ DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG


JAN 05,1982 WASH 2L 9 DEG APP RUN 7
1305 HRS N43/OMNI
SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
25 JAN 1982
EL MLS AND TRACKER
A-70
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG
_ - MLS
+ - TRACKER


JAN 05.1982 WASH 21. 6 DEG APP RUN 7
1305 HRS N49/ OMNI
PFE SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
F
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM AZ PHASE CENTER
F - FRAME FLAG
S - SYSTEM FLAG


JAN 05,1982 WASH 2L 6 DEC APP RUN 7
1305 HRS N49/ OMNI
CMN SYS 2
DATA PROCESSED BY FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, NJ 08405
14 JAN 1982
EL DIF IN DEGREES
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
F
F - FRAME FLAG
S - SYSTEM FLAG
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
NM FROM AZ PHASE CENTER
A-72