ERS 1

18 MONTHS IN ORBIT

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The Netherlands

INITIAL OBJECTIVES OF THE ERS-1 MISSION (1)

- TO SERVE BOTH THE SCIENTIFIC RESEARCH COMMUNITY AND THE APPLICATION RESEARCH COMMUNITY
- TO PROVIDE THESE USERS WITH A VARIETY OF SERVICES:

  REGIONAL SERVICE WITH SAR

  GLOBAL SERVICE WITH LBR

  FD SERVICE FOR NEAR REAL TIME USERS

  OFF-LINE SERVICE TO OTHER USERS

INITIAL OBJECTIVES OF THE ERS-1 MISSION (2)

- TO DEVELOP ADVANCED INSTRUMENTS FOR EARTH OBSERVATION (IN PARTICULAR IN THE MICROWAVE DOMAIN)
- TO DEVELOP AND PROMOTE EUROPEAN INDUSTRIAL CAPABILITIES FOR ADVANCED MICROWAVE TECHNOLOGIES
- TO ENSURE AN ACCURATE CALIBRATION OF THE INSTRUMENTS IN ORDER TO ALLOW A QUANTITATIVE USE OF THE DERIVED DATA PRODUCTS

INITIAL OBJECTIVES OF THE ERS-1 MISSION (3)

- TO DEVELOP EUROPEAN EXPERTISE AT SEVERAL LEVELS, IN PARTICULAR BY ENSURING INVOLVEMENT OF NATIONAL CENTRES AND FACILITIES IN THE DEVELOPMENT AND EXPLOITATION PHASE

- TO PREPARE THE USER COMMUNITY TO ANALYZE, ASSIMILATE AND, WHEN APPLICABLE, MAKE OPERATIONAL USE OF ERS-1 DATA

- TO PROMOTE THE INTERNATIONAL COOPERATION IN THE USE OF REMOTE SENSING DATA FOR PEACEFUL PURPOSES AND CONTRIBUTE TO LARGE INTERNATIONAL RESEARCH PROGRAMMES (WCRP, IGBP, TREES..)

ORBIT CONFIGURATION

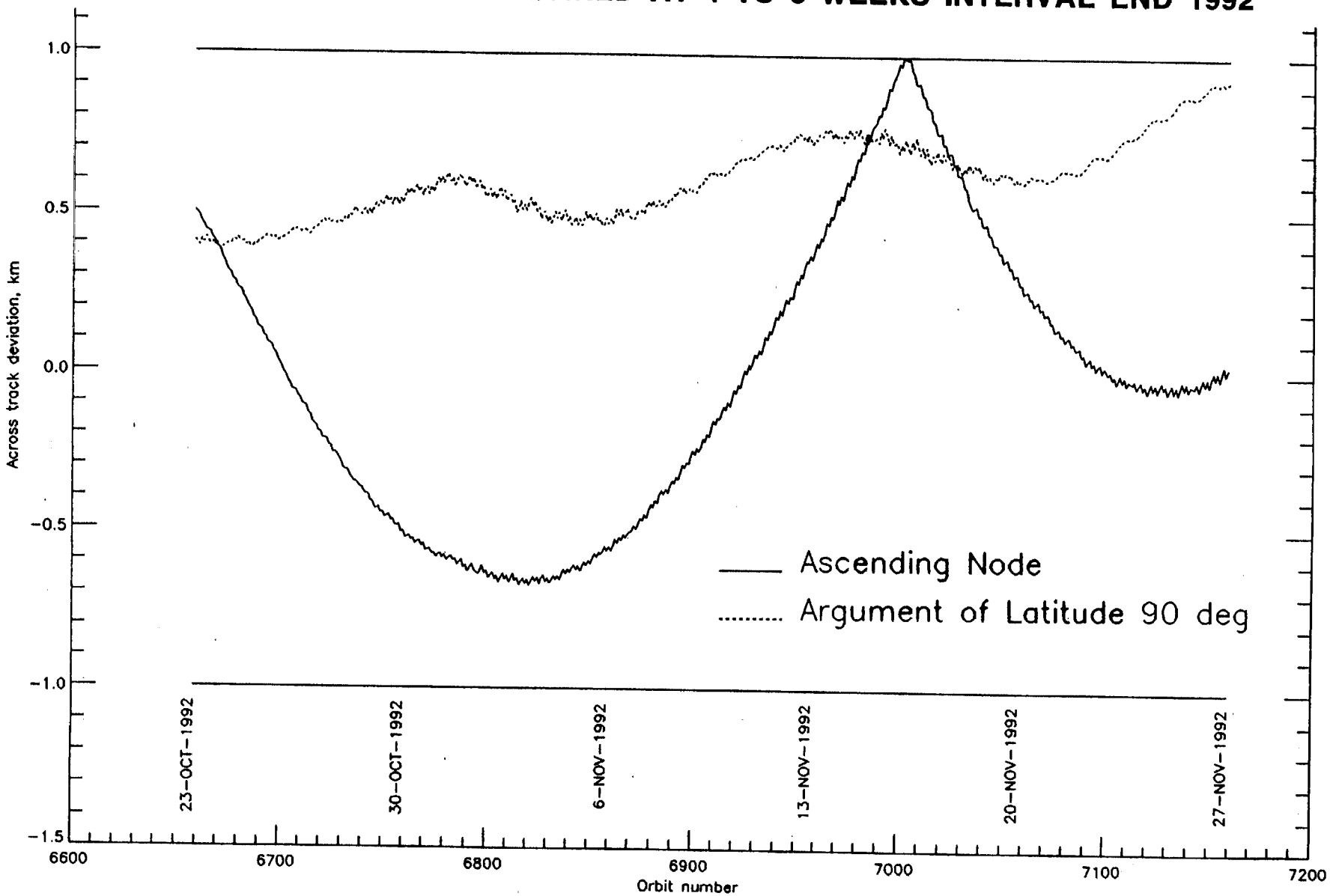
ORBIT SCENARIO IMPLEMENTED AS PLANNED FAST TRANSITION FROM 3 TO 35 DAY CYCLE)

VERY STABLE ORBIT CONFIGURATION :

- GROUND TRACK STABILITY MAINTAINED WITHIN ± 1 KM THROUGH ORBIT CORRECTION PERFORMED 1/WEEK AT THE BEGINNING OF THE MISSION AND 1/MONTH SINCE APRIL 1992 (REDUCED SOLAR ACTIVITY)

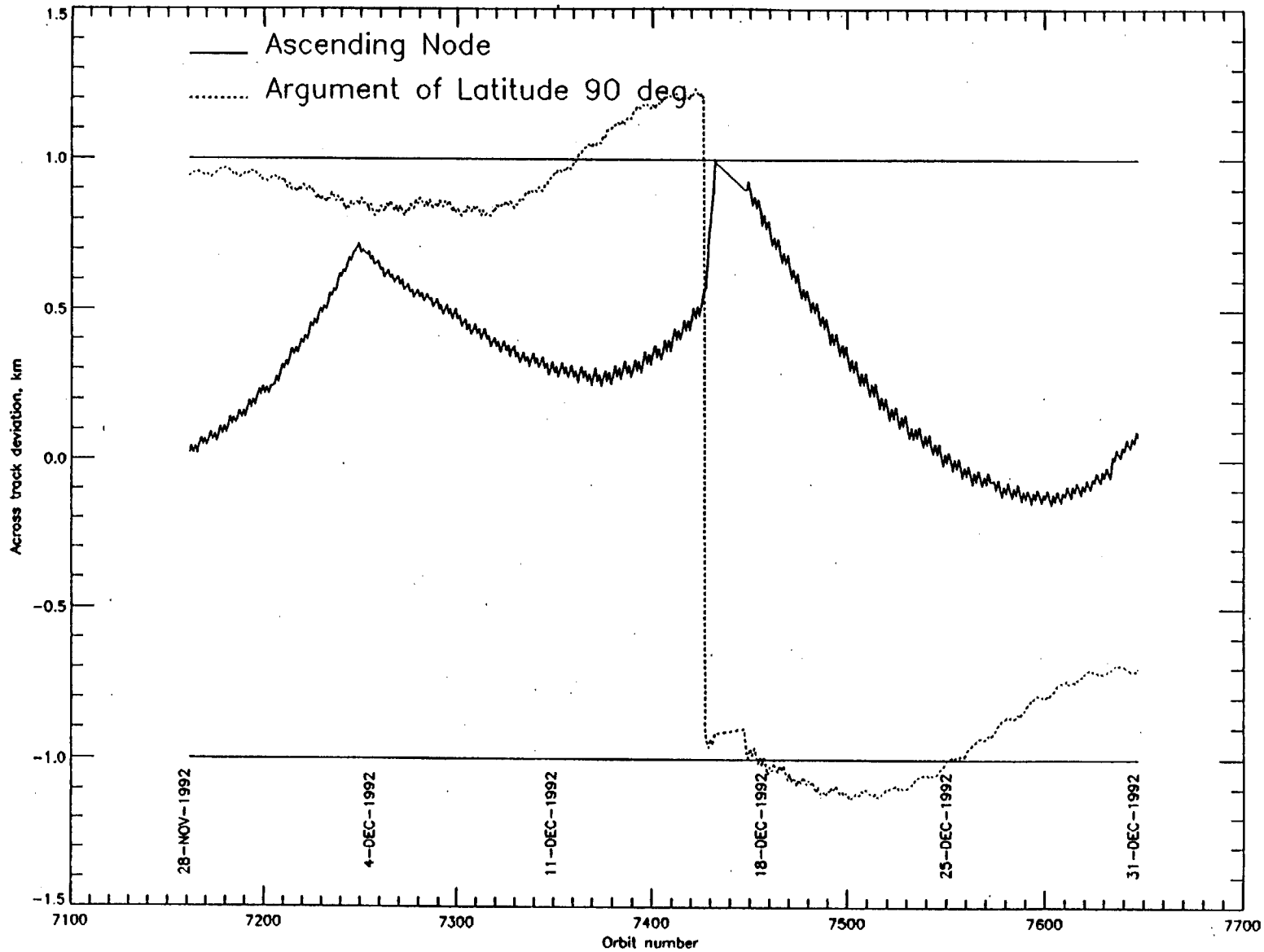
ORBIT CONTROL

ORBIT MAINTAINED WITHIN ±1 Km DEADBAND AT ALL LATITUDES, ALONG TRACK MANŒUVERS REQUIRED AT 4 TO 5 WEEKS INTERVAL END 1992



INCLINATION CORRECTION

INCLINATION CORRECTION PERFORMED 16 DECEMBER 1992,
satellite brought back from +1 Km to -1 Km boarder at argument of latitude 90º

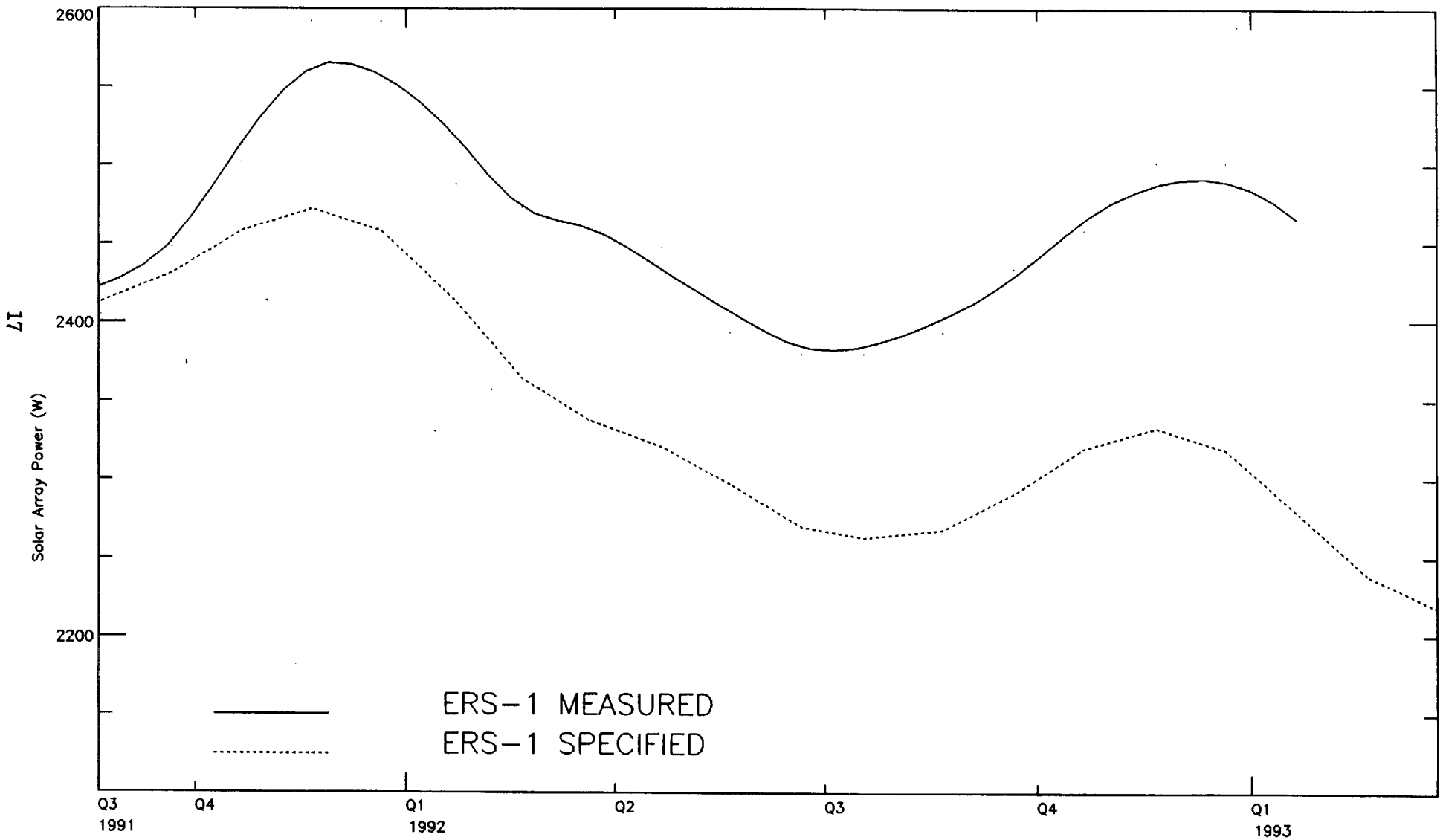


PLATFORM

ENERGY :	**VERY GOOD MARGIN**
THERMAL :	**GOOD STABILITY**
OPERABILITY :	**EXCELLENT**
AOCS :	**NUMEROUS SMALL PROBLEMS AT SENSOR LEVEL : ALL CIRCUMVENTED**

ERS-1 SOLAR ARRAY

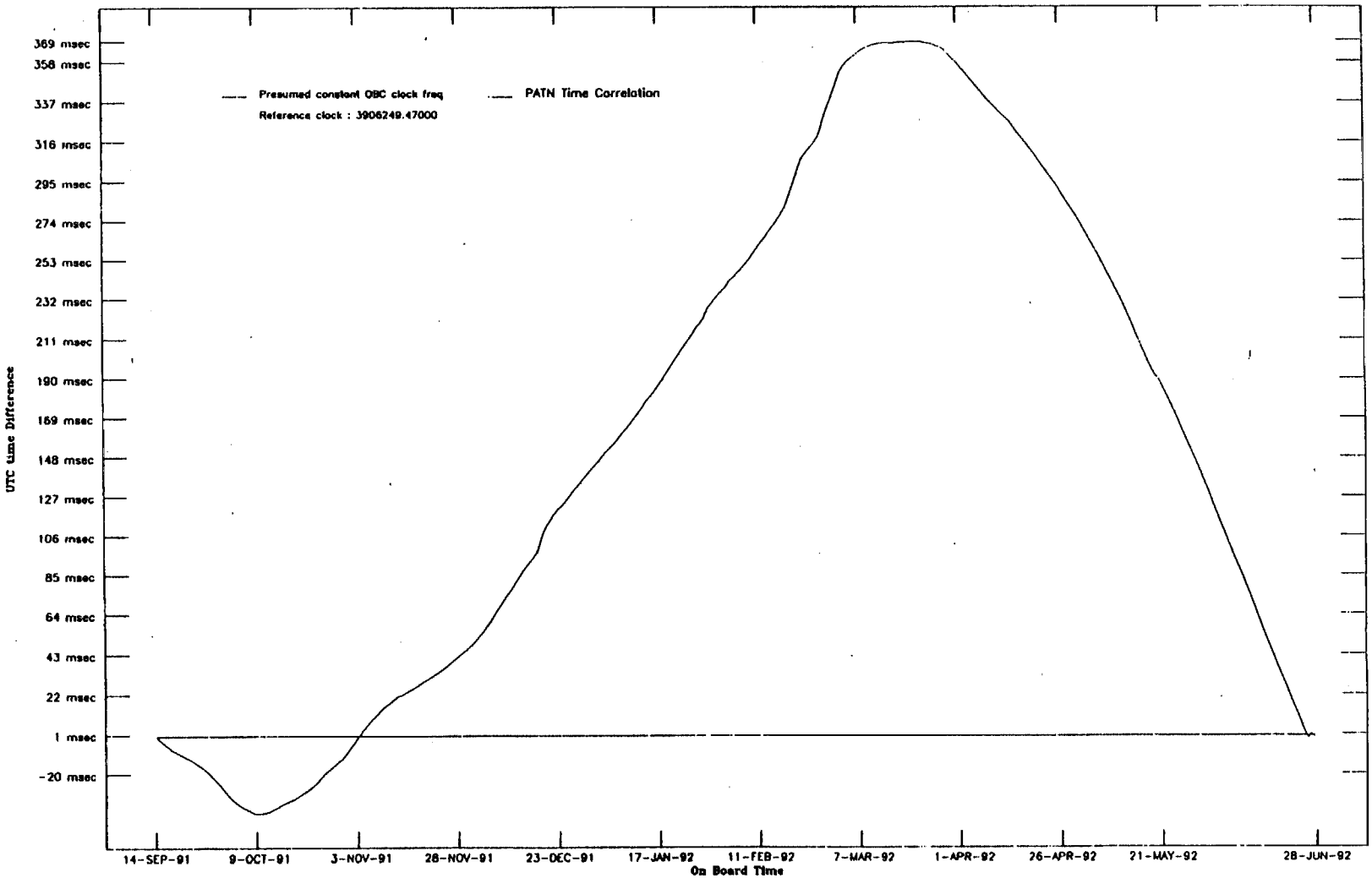
MEASURED POWER VERSUS SPECIFIED PERFORMANCES



SATELLITE TIME STABILITY

PERIOD 14 SEPT 91 TO 28 JUNE 92

MEAN CLOCK PERIOD: 3906249.470 ns **STABILITY OVER THE PERIOD± 9. 10-8**



ATTITUDE CONTROL CHARACTERISATION AND STABILITY

* ACCURATE CHARACTERISATION PERFORMED VIA SAR & WAVE MODE DOPPLER CENTROID ESTIMATES

*COMBINED PITCH/YAW HAS SEEN IN SAR ANTENNA PLANE:

- STATIC BIAS: 20 millidegrees
- HARMONIC ERROR: ± 30 millidegrees

ABOVE PARAMETERS HAVE PROVED TO BE STABLE SINCE LAUNCH AND CAN THEREFORE BE REMOVED

- RESIDUAL NOISE ERROR: 20 millidegrees

ERS-1 FUEL CONSUMPTION
&
CENTRE OF MASS EVOLUTION SINCE LAUNCH

FUEL CONSUMED: **33.7 Kg**
(317.6 Kg AVAILABLE AT LAUNCH)

CENTRE OF MASS CHANGE: 5mm ALONG THE Xs AXIS

INSTRUMENTATION (1)

GENERAL :

- **EXCELLENT STABILITY OF BOTH AMI AND RA**
- **MOST AMI AND RA PERFORMANCES ARE BETTER THAN SPECIFIED**
- **ATSR HAD VERY SMOOTH OPERATIONS TILL 27 MAY 1992, WHEN THE 3.7 MICRON CHANNEL FAILED. NO RECOVERY WAS POSSIBLE BUT THE IMPACT ON THE MISSION IS LIMITED**

INSTRUMENTATION (2)

- PRARE HAD A FATAL FAILURE AT THE END OF JULY 1991, AFTER A FEW DAYS OF SUCCESSFUL OPERATIONS. NO RECOVERY WAS POSSIBLE.
  THE LOSS IS PARTIALLY COMPENSATED THROUGH INTENSIVE LASER TRACKING ACTIVITIES

INSTRUMENTATION (3)

AMI :

- VERY GOOD OPERABILITY AND STABILITY
- ARCING : AUTOMATIC RESTART ACTIVATED WITHIN 15 SEC. EXCEPT MANUAL RESTART ONCE PER MONTH
- NO OBSERVABLE CHANGES SINCE LAUNCH IN INSTRUMENT CHARACTERISTICS
- ALL ENGINEERING CALIBRATION OBJECTIVES MET BEFORE THE END OF COMMISSIONING

AMI PERFORMANCE VERIFICATION

* SAR CHIRP STABILITY: NO VISIBLE VARIATION SINCE LAUNCH

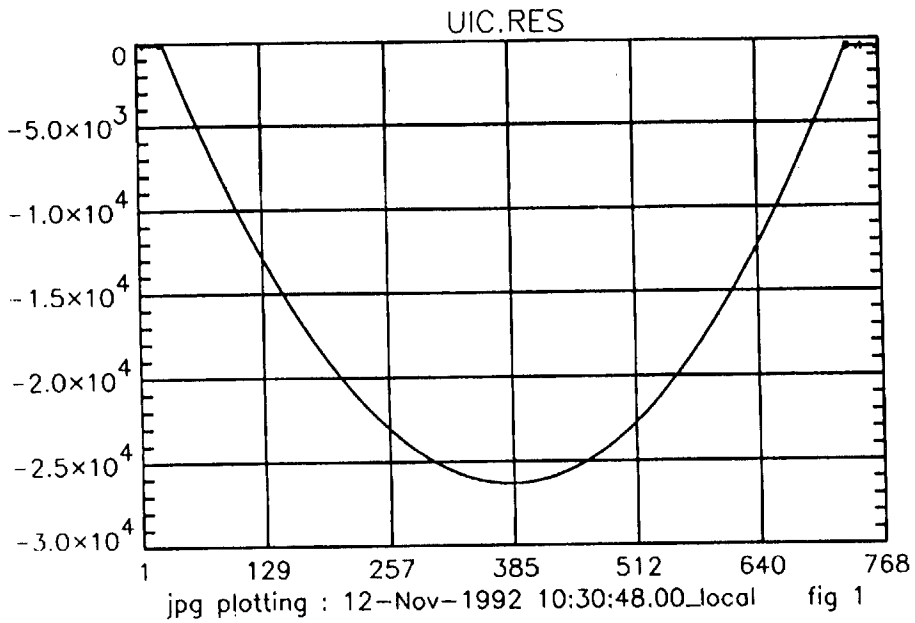
* OVERALL SAR SYSTEM STABILITY AS VERIFIED BY FLEVOLAND ESA TRANSPONDERS :*No variation of mean gain, standard deviation of 0.41dB*

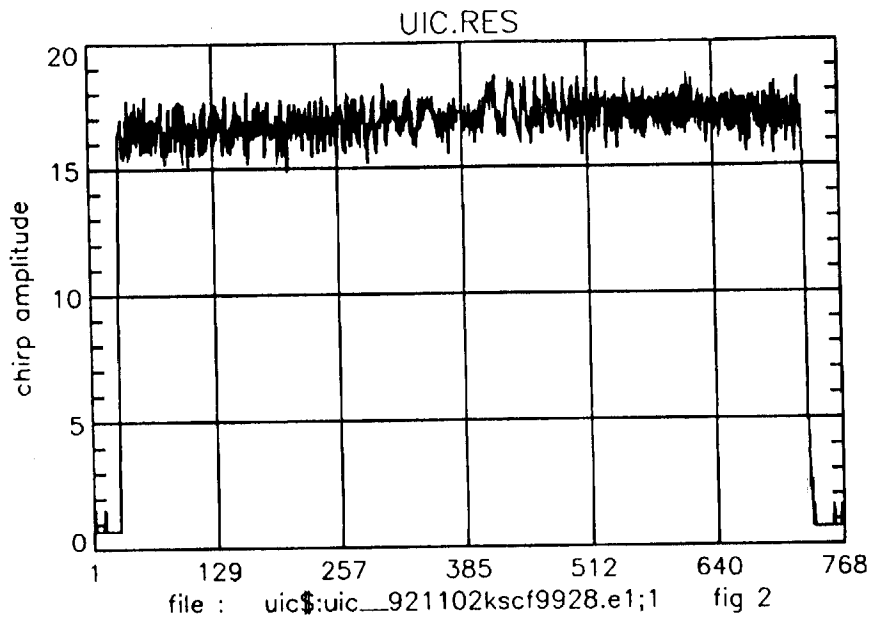
* WIND SCATTEROMETER STABILITY

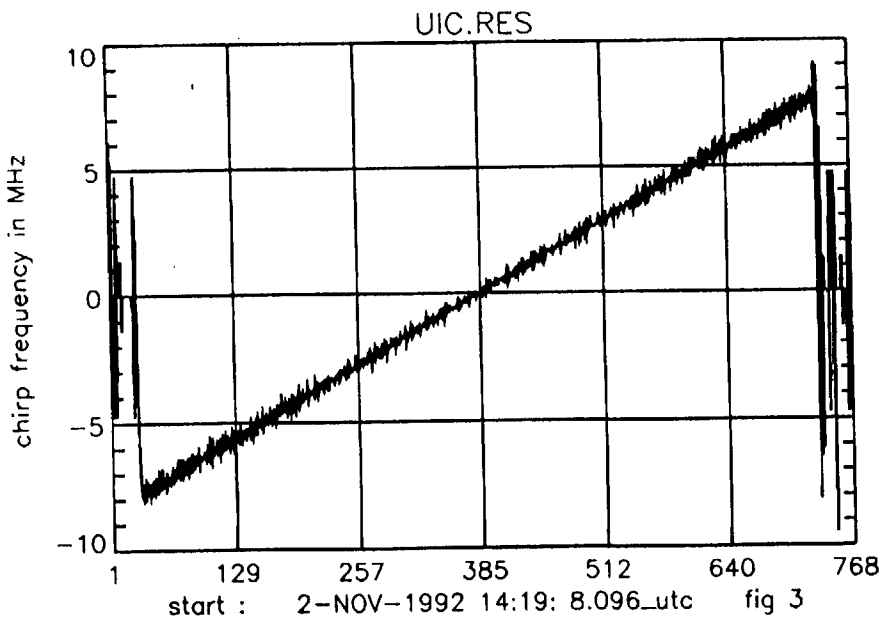
Brazilian rain forest test area confirms constant corregistration of the three beams within .3dB and no drift since the last calibration correction early March 92

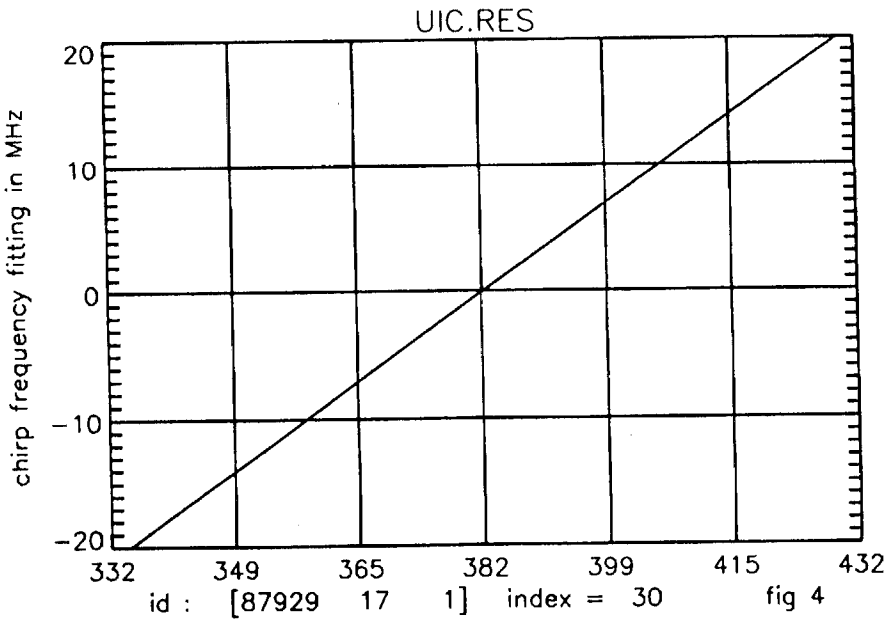
* SAR ANTENNA PATTERN VERIFICATION

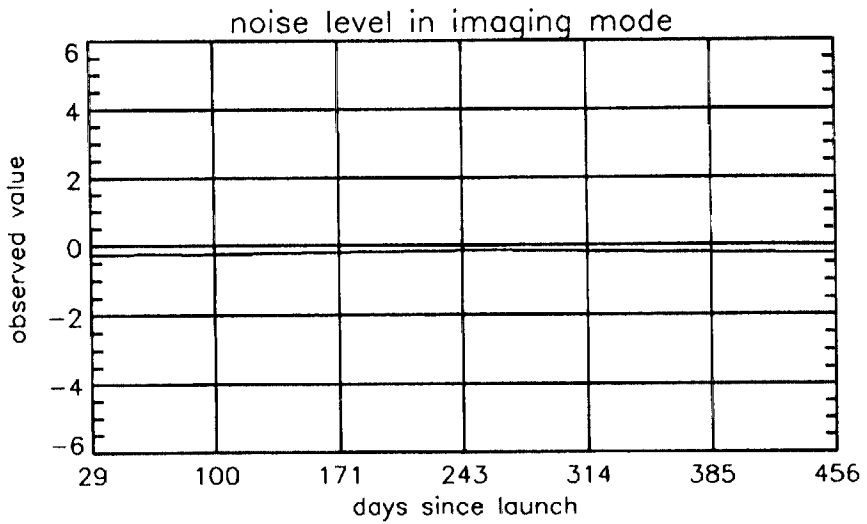
The sar antenna pattern can be verified on any single SAR image over selected zones of the Brazilian rain forest known to exhibit constant gamma properties

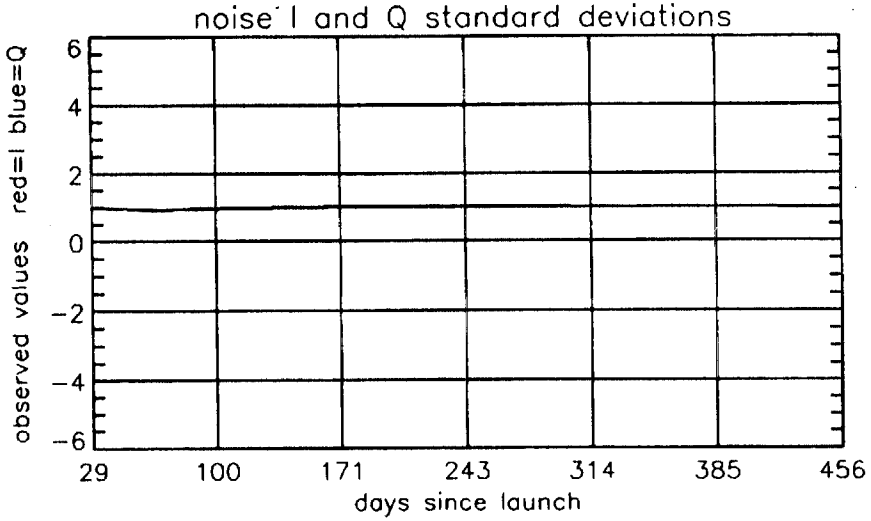

UIC.RES
0
-5.0×10^3
-1.0×10^4
-1.5×10^4
-2.0×10^4
-2.5×10^4
-3.0×10^4
1
129
257
385
512
640
768
jpg plotting : 12-Nov-1992 10:30:48.00_local fig 1

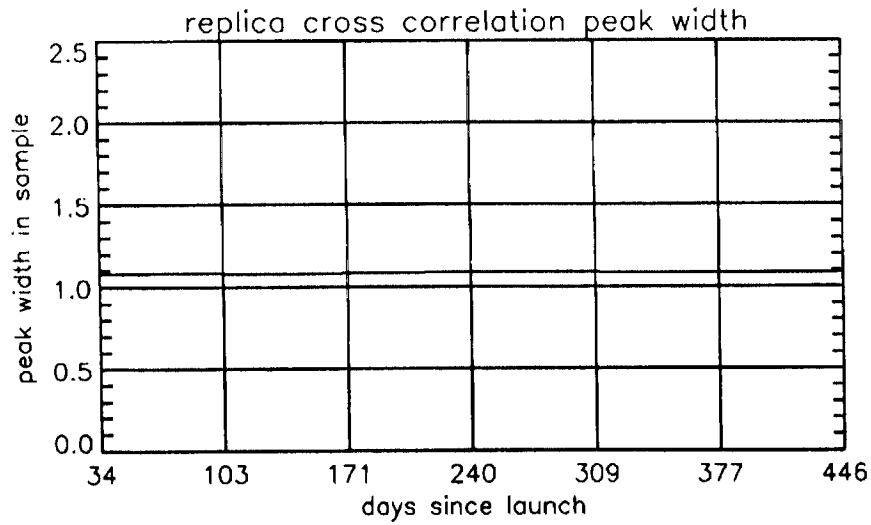

UIC.RES
chirp amplitude
20
15
10
5
0
1
129
257
385
512
640
768
file : uic$:uic__921102kscf9928.e1;1 fig 2

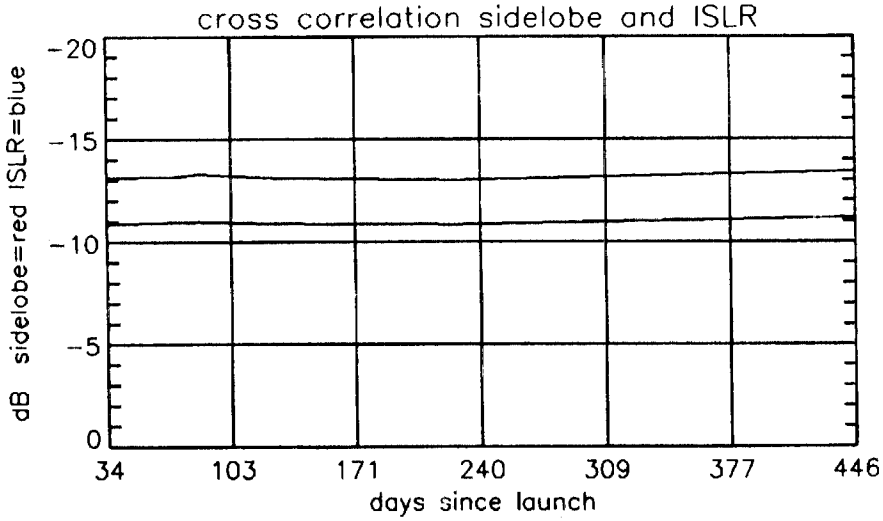

UIC.RES
chirp frequency in MHz
10
5
0
-5
-10
1
129
257
385
512
640
768
start : 2-NOV-1992 14:19: 8.096_utc fig 3


UIC.RES
chirp frequency fitting in MHz
20
10
0
-10
-20
332
349
365
382
399
415
432
id : [87929 17 1] index = 30 fig 4


noise level in imaging mode
observed value
6
4
2
0
−2
−4
−6
29
100
171
243
314
385
456
days since launch

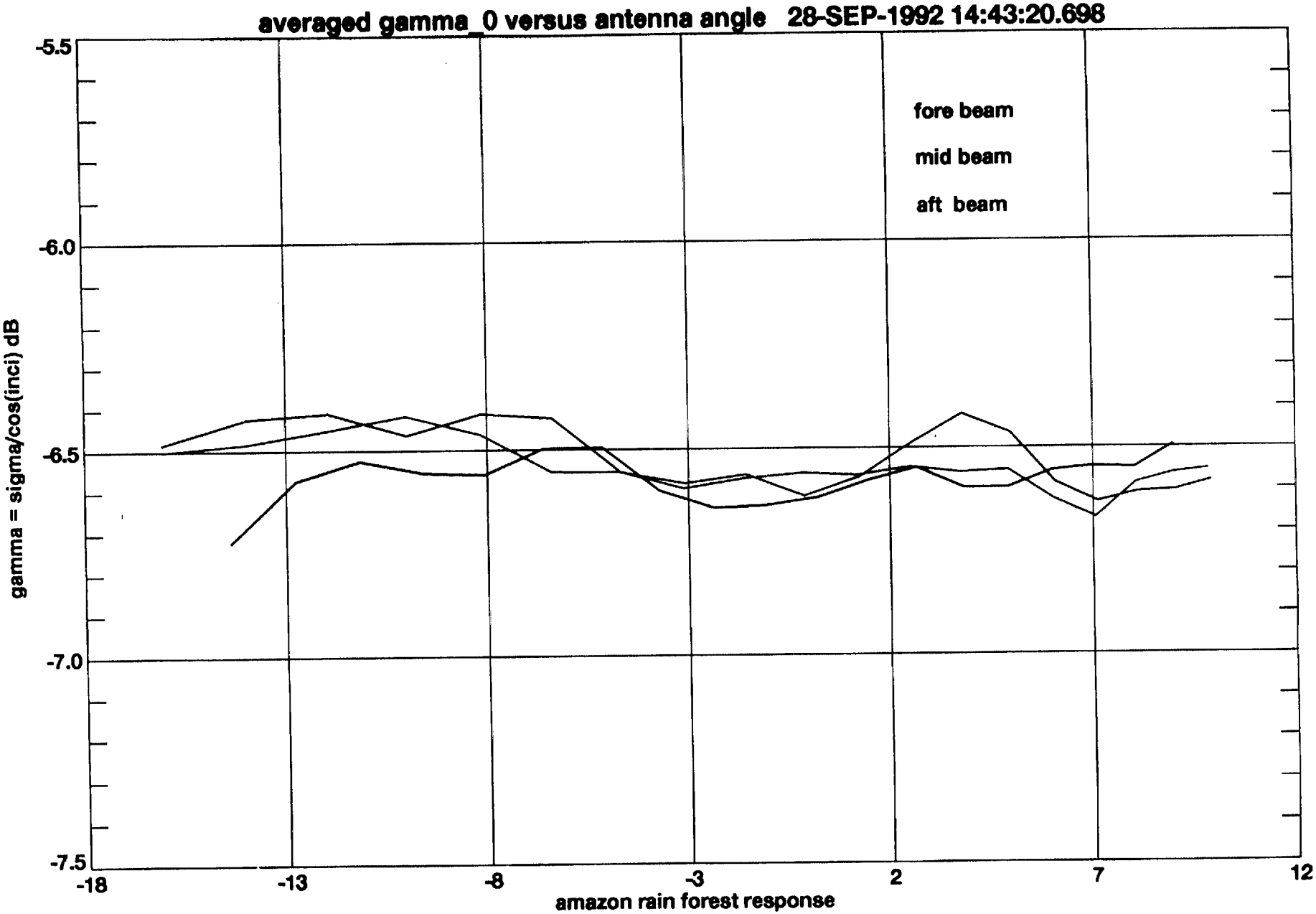

noise I and Q standard deviations
observed values red=I blue=Q
6
4
2
0
−2
−4
−6
29
100
171
243
314
385
456
days since launch

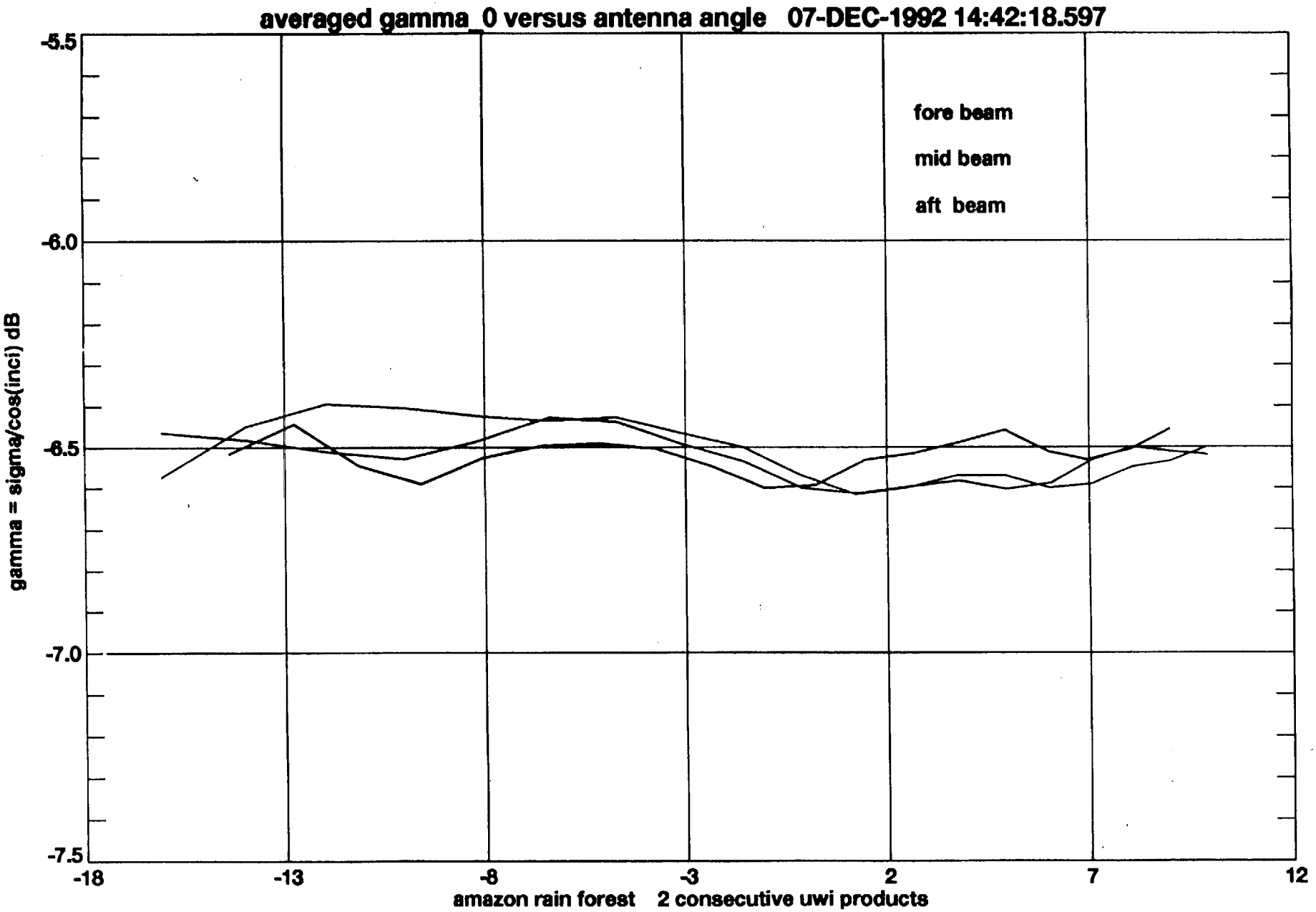

replica cross correlation peak width
peak width in sample
2.5
2.0
1.5
1.0
0.5
0.0
34
103
171
240
309
377
446
days since launch


cross correlation sidelobe and ISLR
dB sidelobe=red ISLR=blue
−20
−15
−10
−5
0
34
103
171
240
309
377
446
days since launch

97

ERS-1 SAR RADIOMETRIC STABILITY
VARIATION AROUND THE REF. VALUE FOR
TRANSPONDER 2 (dB)
0.80
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
7-Sep-91
19-Sep-91
25-Sep-91
1-Oct-91
7-Oct-91
13-Oct-91
19-Oct-91
25-Oct-91
31-Oct-91
6-Nov-91
12-Nov-91
18-Nov-91
24-Nov-91
30-Nov-91
6-Dec-91
11-Jan-92
17-Jan-92
23-Jan-92
29-Jan-92
1-Feb-92
10-Feb-92
16-Feb-92
22-Feb-92
28-Feb-92
5-Mar-92
8-Mar-92
11-Mar-92
3-May-92
7-Jun-92
16-Jun-92
12-Jul-92
16-Aug-92
25-Aug-92
20-Sep-92
29-Sep-92


averaged gamma_0 versus antenna angle 28-SEP-1992 14:43:20.698
fore beam
mid beam
aft beam
gamma = sigma/cos(incl) dB
-5.5
-6.0
-6.5
-7.0
-7.5
-18
-13
-8
-3
2
7
12
amazon rain forest response


averaged gamma_0 versus antenna angle 07-DEC-1992 14:42:18.597
fore beam
mid beam
aft beam
-5.5
-6.0
-6.5
-7.0
-7.5
-18
-13
-8
-3
2
7
12
gamma = sigma/cos(inci) dB
amazon rain forest 2 consecutive uwi products

INSTRUMENTATION (4)

RA :

- VERY GOOD AND STABLE PERFORMANCES
- NO OBSERVABLE CHANGES SINCE LAUNCH
- CALIBRATION OBJECTIVES MET (VENEZIA CAMPAIGN)
- VERY GOOD ACQUISITION AND TRACKING OVER OCEAN AND ICE
- SEA ICE TRACKING ROBUSTNESS BEING IMPROVED
- THE SW TRACKER INTERRUPTS ABOUT ONCE EVERY 6 WEEKS AND REQUIRES MANUAL RESTART

RA PERFORMANCE STABILITY MONITORING

* ULTRA STABLE OSCILLATOR STABILITY MONITORING

From august 91 until december 92, total peak to peak variation equivalent to 1 cm.

* INTERNAL DELAY MEASUREMENT

Nominal value around 31μs, variation of 1ns in first months (15cm), permanently monitored and used in FD & offline processing

* INTERNAL GAIN LOOP MEASUREMENT

Increase of 0.3 dB in first months, since then stable within 0.15 dB round orbit variation, permanently monitored and used in FD & offline processing

* SYSTEM NOISE MEASUREMENT

Confirms that receiver gain has increased by 0.3 dB in first months

* HEIGHT CALIBRATION CONSTANT

Confirmed to be 41.5 cm, following processing of Venice campaign data

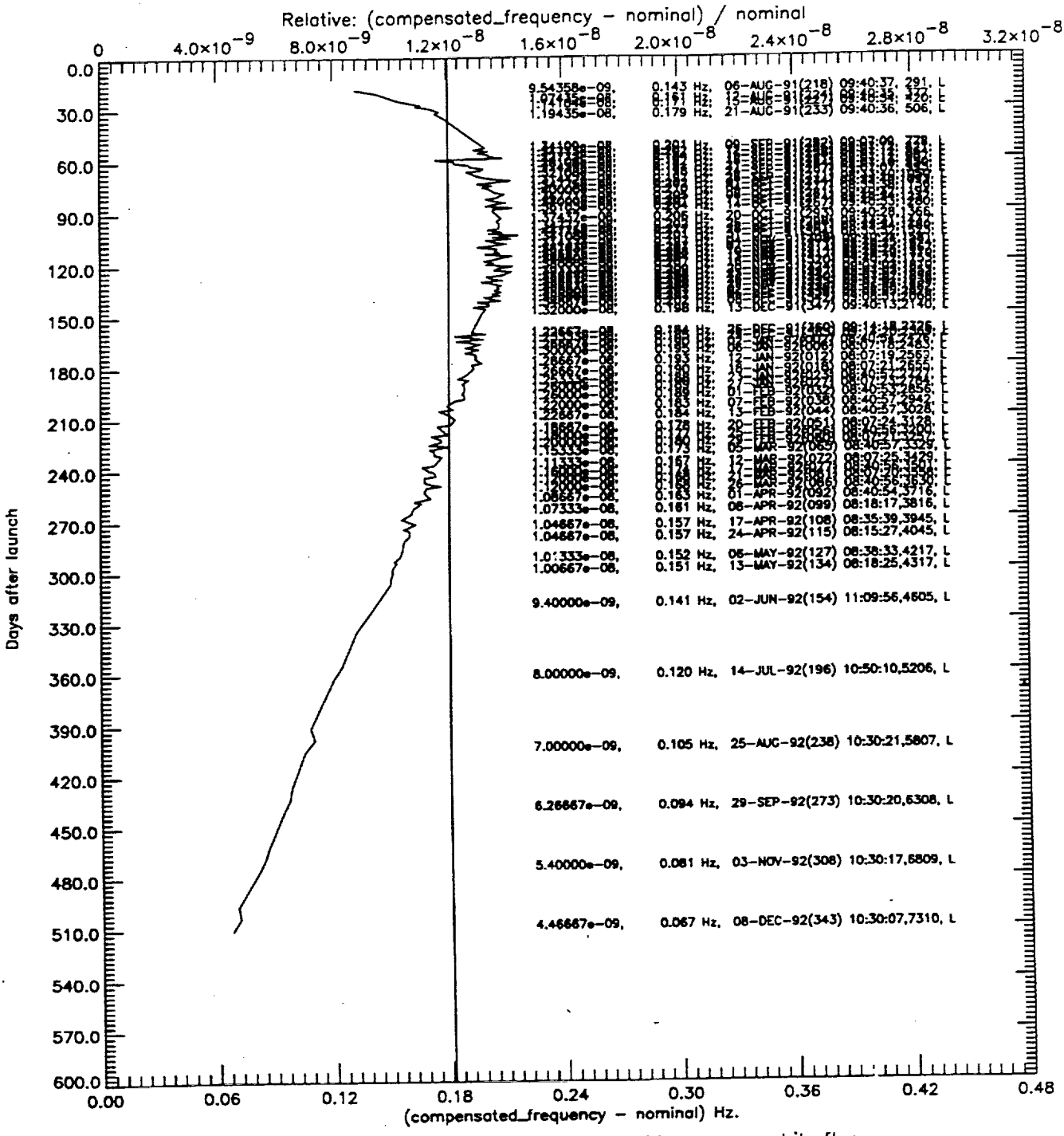
ERS−1

ESOC Mission Management and Planning Office − Pleval

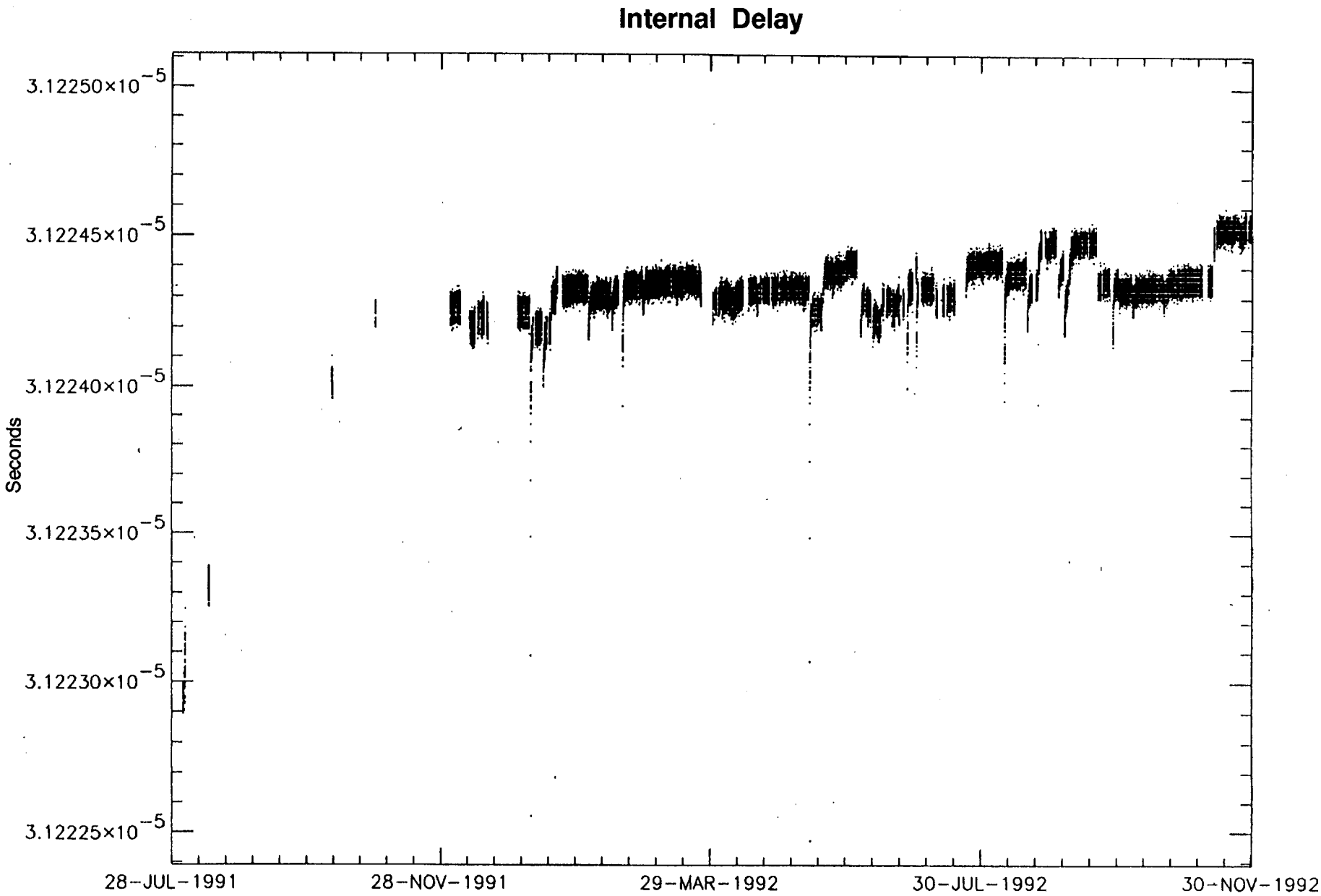
Reference Measurement System

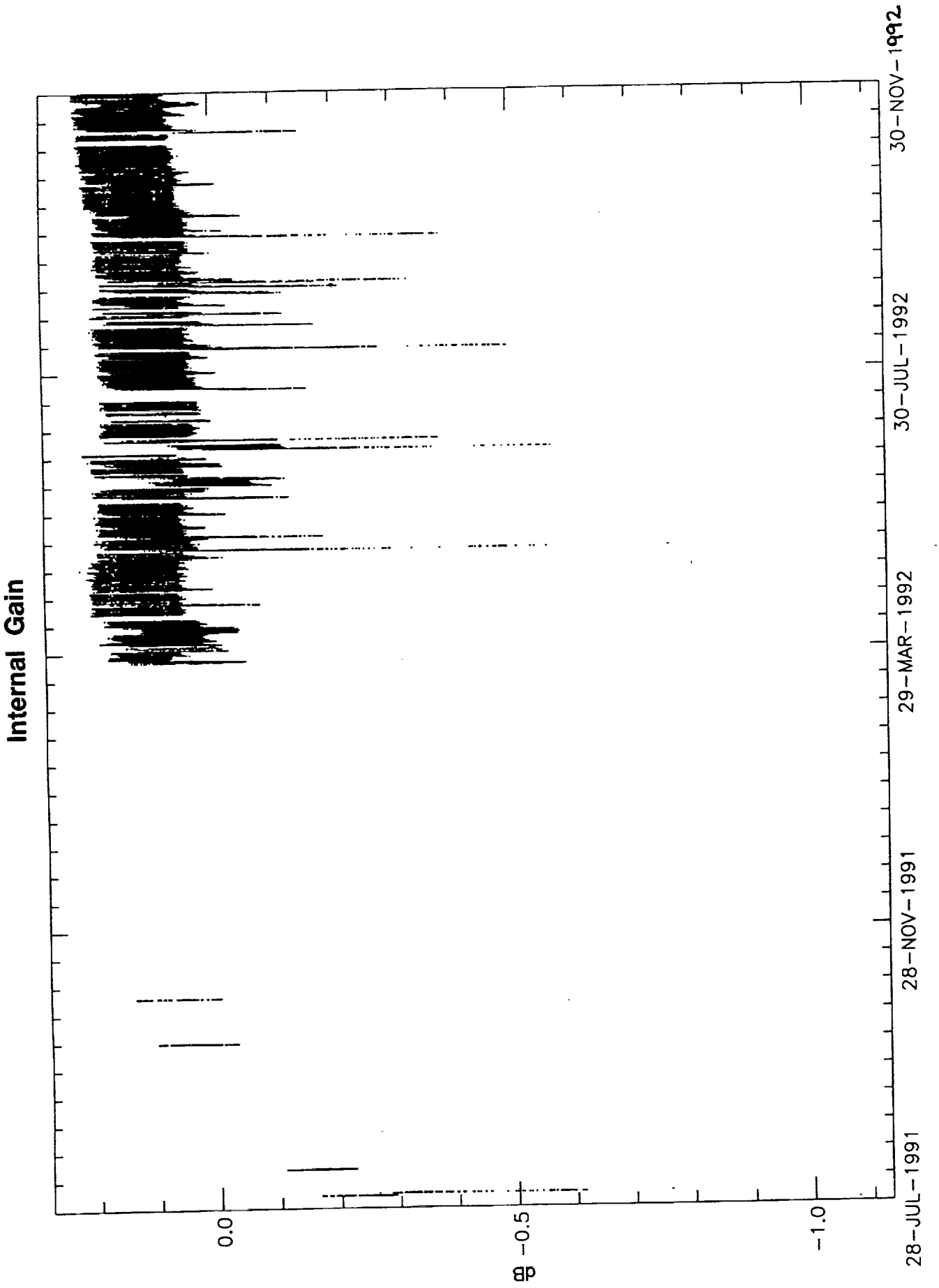
16: Long term stability rest. bit clock link 2 PB (USO)

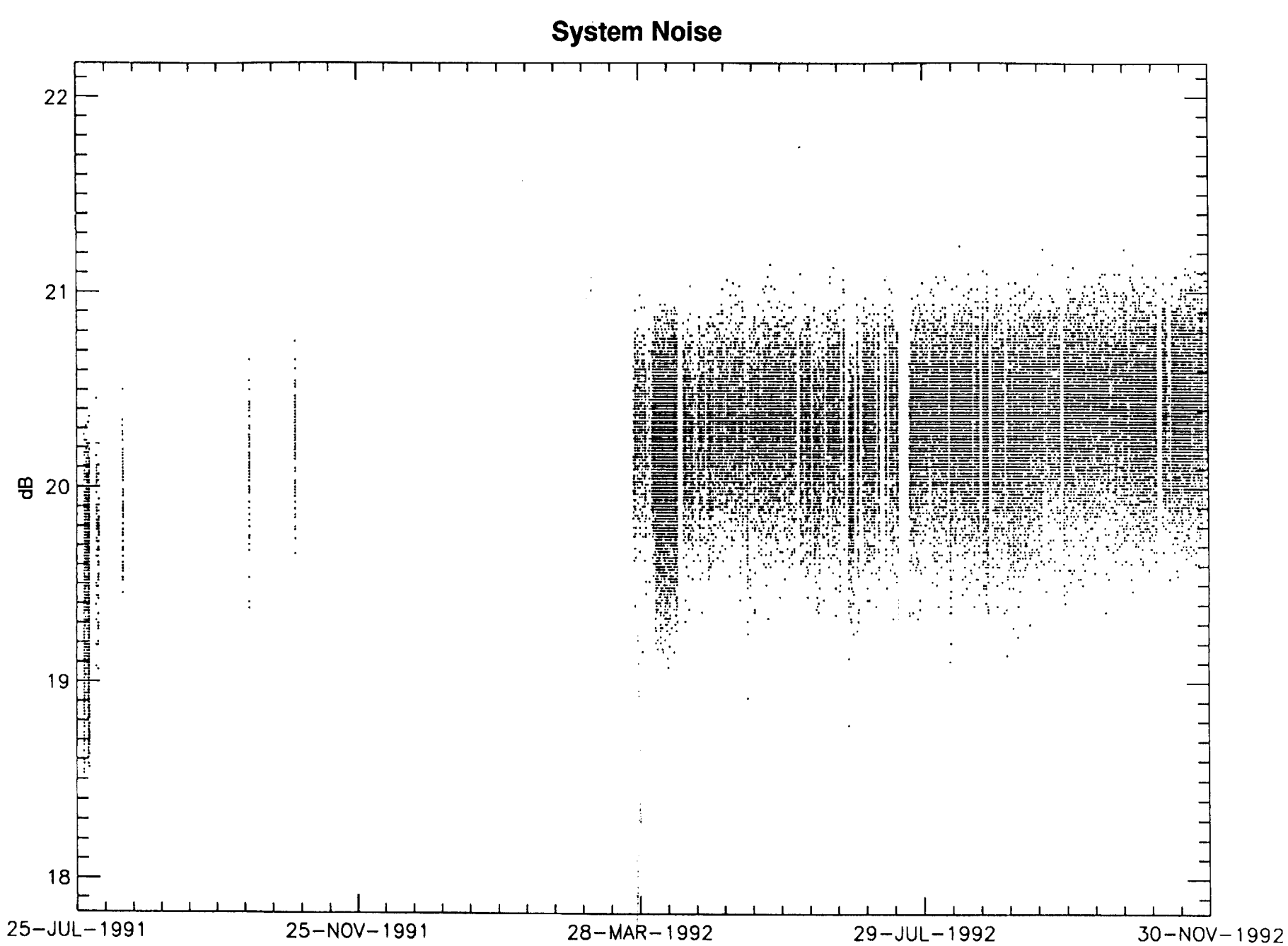
Nominal Frequency: 15000000.000
ln (freq−nom) : Mean = 0.181 Hz, Sigma = 0.031 Hz
ln (freq−nom)/nom: Mean = 1.206e−08, Sigma = 2.068e−09



Legenda: relative, freq−nom, date, year_day, hh:mm:ss, orbit, flag
Flag V: Valid measurement
Flag L: Valid measurement: Limits exceeded


Internal Delay
3.12250×10^-5
3.12245×10^-5
3.12240×10^-5
3.12235×10^-5
3.12230×10^-5
3.12225×10^-5
Seconds
28-JUL-1991
28-NOV-1991
29-MAR-1992
30-JUL-1992
30-NOV-1992


Internal Gain
0.0
-0.5
-1.0
dB
28-JUL-1991
28-NOV-1991
29-MAR-1992
30-JUL-1992
30-NOV-1992


System Noise
22
21
20
19
18
dB
25-JUL-1991
25-NOV-1991
28-MAR-1992
29-JUL-1992
30-NOV-1992

INSTRUMENTATION (5)

IDHT :

- **BOTH TAPE RECORDERS ARE NOMINAL AND ARE USED ALTERNATIVELY EVERY 3 MONTHS**
- **THE TWO X-BAND LINKS ARE NOMINAL AND STABLE**
- **THIRD TUBE NOT USED**

INSTRUMENT OPERATIONS

RA :	**SYSTEMATIC GLOBAL OPERATIONS**
ATSR :	**SYSTEMATIC GLOBAL OPERATIONS**
AMI WIND/WAVE :	**SYSTEMATIC GLOBAL OPERATIONS OVER OCEANS, EXCEPT WHEN SAR IS OPERATED. WAVE MODE IS OPERATED AT 200 KM INTERVALS**
AMI SAR :	**UP TO 12 MINUTES PER ORBIT, INCLUDING UP TO 4 MINUTES IN ECLIPSE**

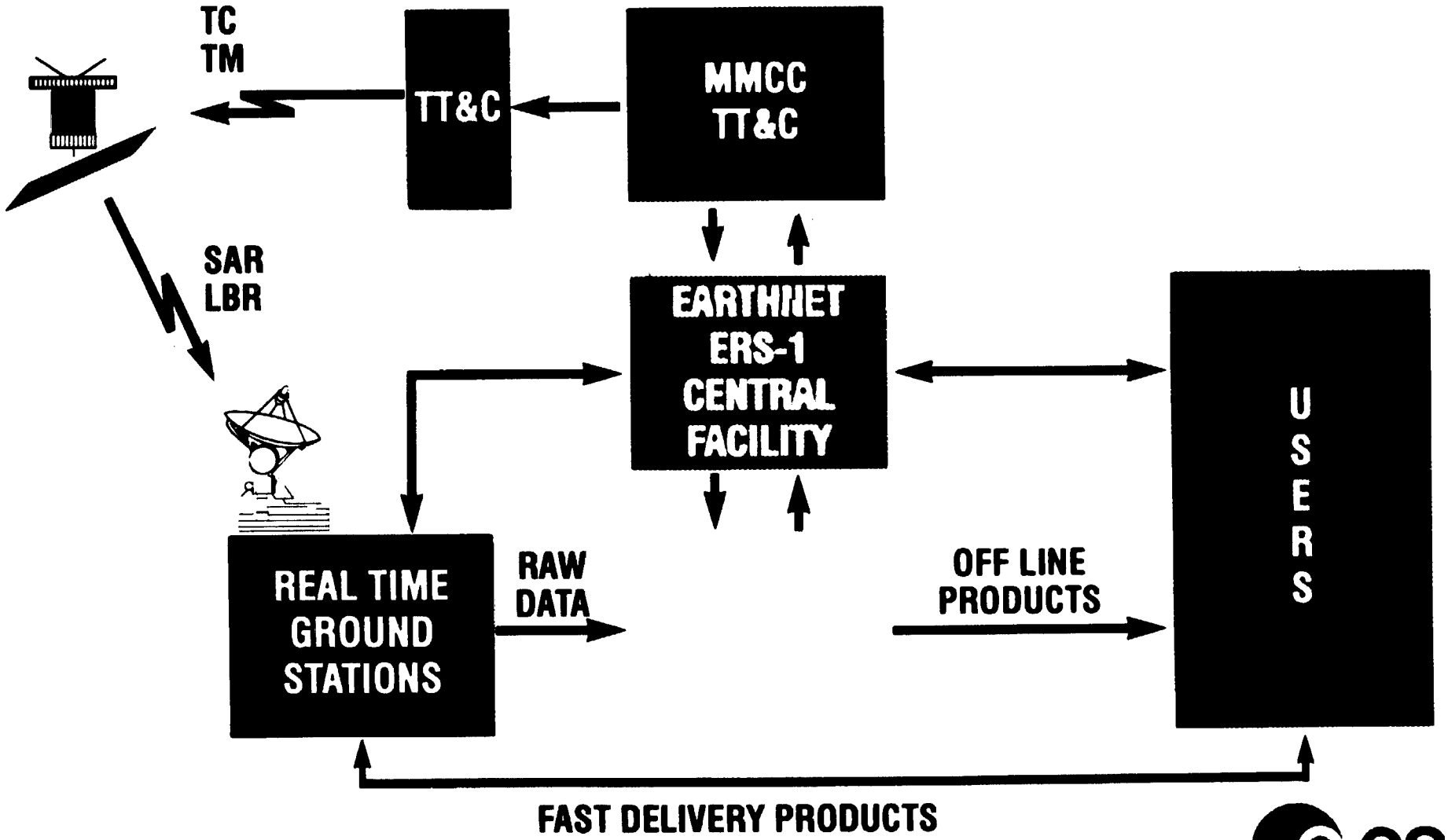
NOTE : ALL INSTRUMENTS ARE OPERATING ON THE "A" CHAINS SINCE LAUNCH.

PLATFORM AND INSTRUMENT AVAILABILITY

- SINCE LAUNCH : 99 % AVAILABILITY FOR THE PLATFORM. EXCEPT DURING THE PERIOD MID JULY- EARLY SEPTEMBER 1992, WHEN THE AVAILABILITY WAS REDUCED TO ABOUT 85%

- FOR THE INSTRUMENTATION : 97/98% AVAILABILITY. EXCEPT FOR THE PERIOD MID JULY- EARLY SEPTEMBER 1992 BECAUSE OF THE PLATFORM PROBLEMS

ERS-1 OVERALL GROUND SEGMENT



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LBR DATA ACQUISITION

- THE ACQUISITION OF LBR TAPE DUMPS IS PERFORMED AS FOLLOWS:

KIRUNA	10 ORBITS/DAY
MASPALOMAS	2 ORBITS/DAY
GATINEAU	1 ORBIT/DAY
PRINCE ALBERT (*)	1 ORBIT/DAY

(*) LBR DATA ACQUIRED AT PRINCE ALBERT ARE PROCESSED AT FD LEVEL AT GATINEAU TO COMPLETE THE GLOBAL LBR FD DATA SET, TO BE THEN ARCHIVED AT F-PAF.

LBR FD PRODUCTS

- WIND SCATTEROMETER : (UWI) — SIGMA NOUGHT TRIPLETS AND WIND FIELD (SPEED AND DIRECTION)
- RADAR ALTIMETER : (URA) — SIGNIFICANT WAVE HEIGHT WIND SPEED AT NADIR ALTITUDE
- SAR WAVE MODE : (UWA) — WAVE IMAGE SPECTRUM (WAVELENGTH AND DIRECTION)

GENERATED IN NEAR REAL-TIME ONLY AT THE FOLLOWING ESA STATIONS :

- KIRUNA
- MASPALOMAS
- GATINEAU

LBR FD DISSEMINATION

- LBR FD PRODUCTS ARE ROUTINELY DISTRIBUTED TO METEOROLOGICAL OFFICES OF PARTICIPATING STATES (AND NOAA) VIA THE GLOBAL TELECOMMUNICATION SYSTEM (GTS) IN WMO BUFR FORMAT

- AVERAGE DELAY FROM SENSING : 2 H 40 MINS.

SAR FAST DELIVERY PROCESSING AND DISSEMINATION

- SAR FD PRODUCT GENERATION SERVICE IS PROVIDED AT THE FOLLOWING ESA STATIONS :

  - KIRUNA
  - FUCINO
  - MASPALOMAS

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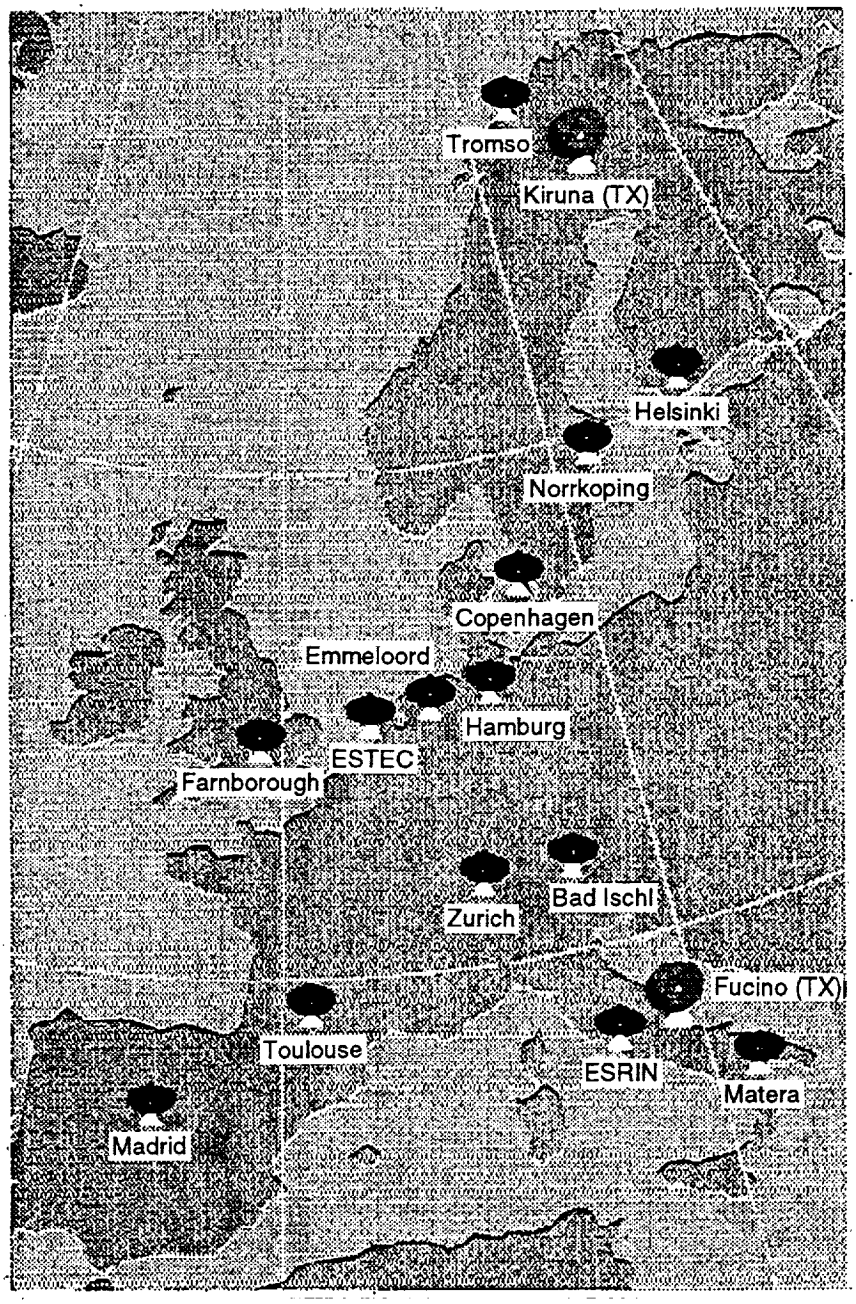
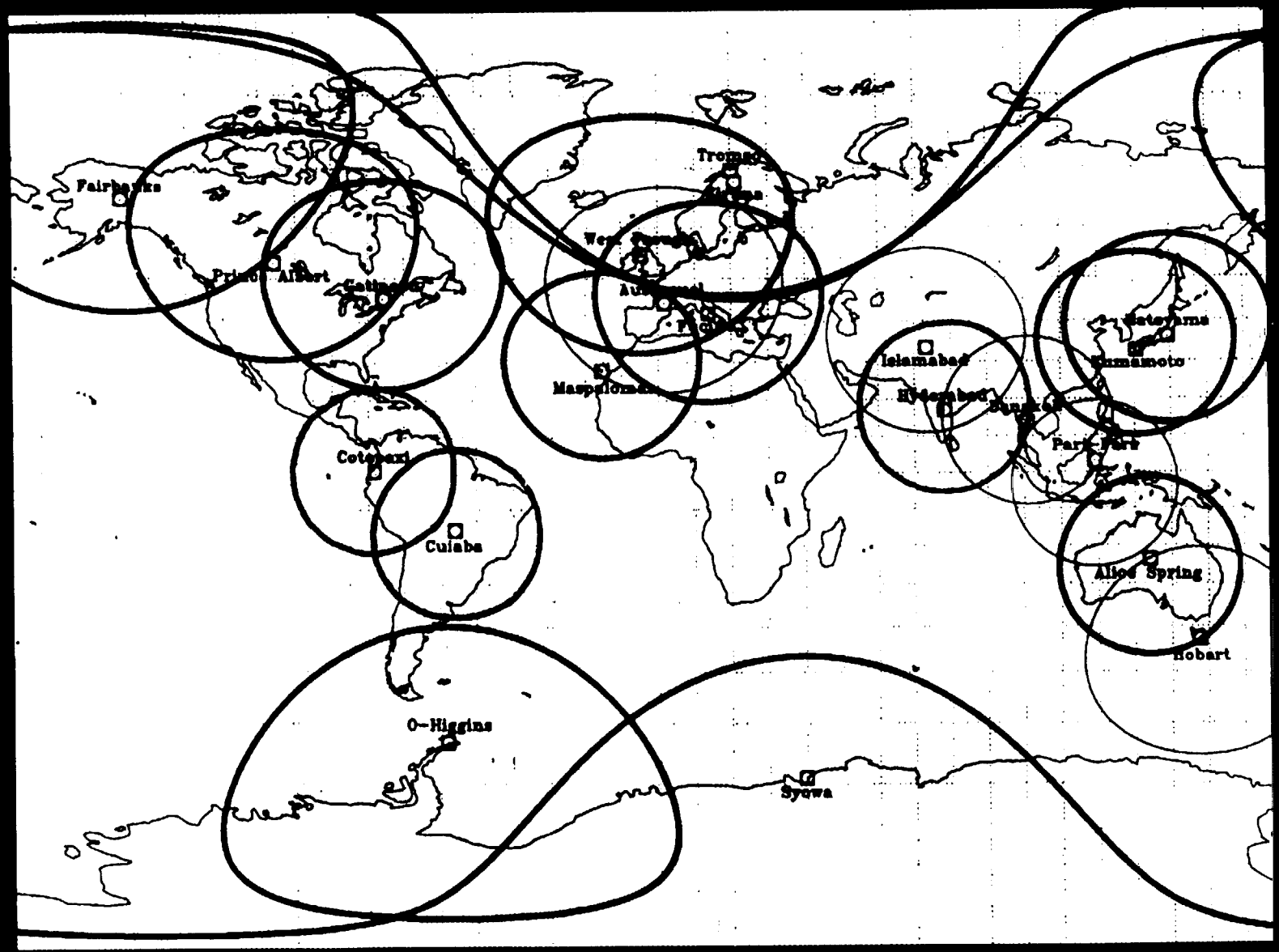
NEAR REAL-TIME DISSEMINATION OF ERS-1 SAR IMAGES OVER EUROPE




Fairbanks
Prince Albert
Cotopaxi
Cuiaba
O-Higgins
Syowa
Hobart
Alice Spring
Kumamoto

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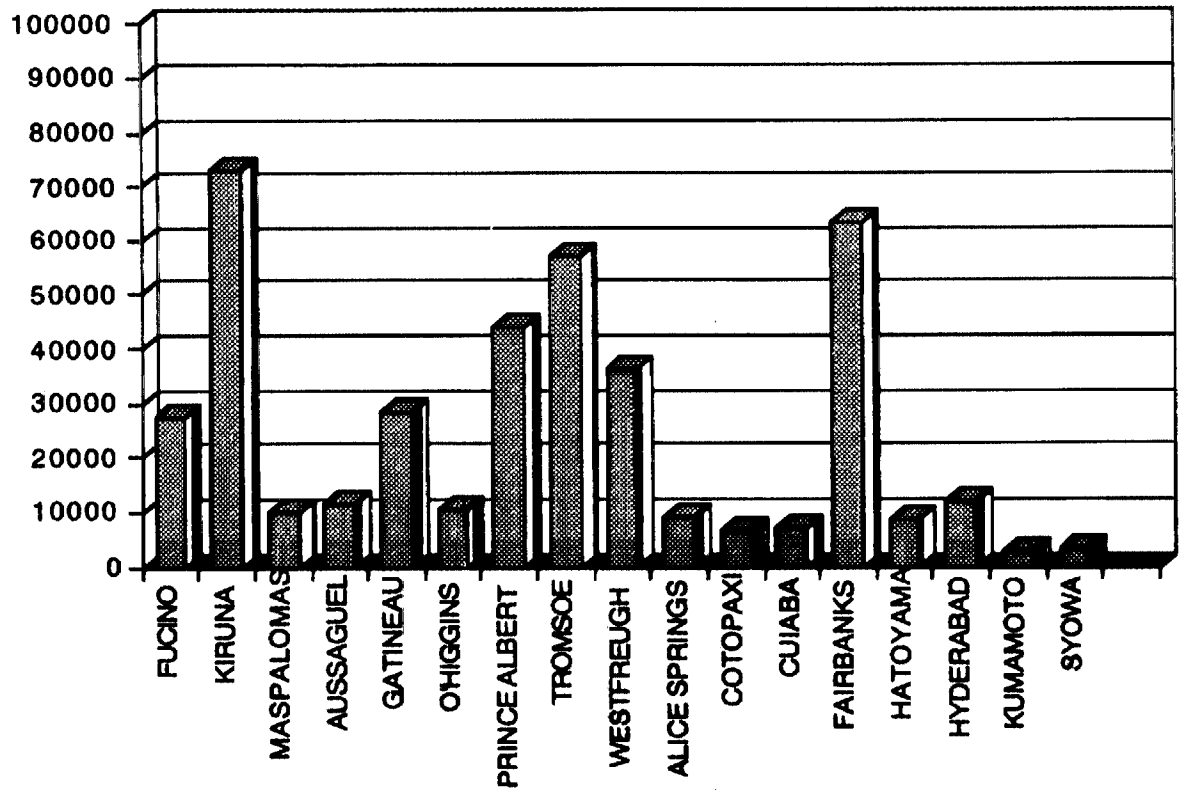
ACQUIRED SAR FRAMES FROM BEGINNING OF MISSION



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SAR FRAMES PLANNED FOR ACQUISITION

(STATUS AS OF 30 OCT. 92, PLANNING UP TO 28 FEB.93)

	PHASE A	PHASE B	RTM	PHASE C	TOTALS
FUCINO	8594	3545	669	14607	27415
KIRUNA	23876	19634	910	28358	72778
MASPALOMAS	3714	670	174	5562	10120
TOTAL ESA	36184	23849	1753	48527	110313
AUSSAGUEL	3912			7386	11298
GATINEAU	6668	6222	560	14704	28154
O'HIGGINS	514	4742		5309	10565
PRINCE ALBERT	11408	8290	357	23698	43753
TROMSOE	18558	16675		21871	57104
WEST FREUGH	10139	8567		17266	35972
TOTAL NATIONALS	51199	44496	917	90234	186846
ALICE SPRINGS	2027	607		6485	9119
COTOPAXI	108	290	68	6142	6608
CUIABA	311	269	153	6461	7194
FAIRBANKS	13947	16696	136	32714	63493
HATOYAMA	2181	489		5663	8333
HYDERABAD	2048	878		9009	11935
KUMAMOTO	2737	145			2882
SYOWA	1291	889		848	3028
TOTAL FOREIGN	24650	20263	357	67322	112592
WORLDWIDE TOTALS	112033	88608	3027	206083	409751

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AN EXPANDING USER COMMUNITY

- THE PARTICIPATION TO THE CALIBRATION AND VALIDATION PROCESS
- THE SCIENTIFIC COMMUNITY AND THE ANNOUNCEMENT OF OPPORTUNITY
- THE (PRE-) OPERATIONAL COMMUNITY AND THE PILOT PROJECTS
- THE COMMERCIAL DISTRIBUTOR AND THE FIRST APPLICATIONS
- LARGE INSTITUTIONAL USERS

INTERNATIONAL COOPERATION

- THE INTERNATIONAL PARTNERS: NOAA, NASA, NASDA, ISRO, INPE ETC.
- THE FOREIGN STATIONS AND THE AGREEMENTS
- THE PARTICIPATION TO THE ANNOUNCEMENT OF OPPORTUNITY AND TO THE PILOT PROJECTS
- THE CEE/JRC COOPERATION
- THE CONTRIBUTIONS OF PARTICIPATING COUNTRIES TO THE DATA ANALYSIS AND EXPLOITATION EFFORT

IMPROVEMENTS TO SYSTEM AND SERVICES

- IMPROVE THE TIME RESPONSE OF THE MISSION PLANNING SYSTEM
- INTRODUCE SAR QUICK-LOOK PRODUCTS
- FUNCTIONALITIES OF THE USER INTERFACE
- IN COOPERATION WITH ERS-C DISTRIBUTOR IDENTIFY NEW PRODUCTS AND SERVICES

OBJECTIVES STILL TO BE ACHIEVED

- WIDEN THE COMMUNITY EXPLOITING THE SAR FD PRODUCTS IN REAL TIME (VIA BBDN) OR OFF-LINE (AS COPY FROM FD)
- IMPROVE DRASTICALLY THE CAPABILITY TO RECOVER DATA FROM SOME NON-ESA STATIONS
- COMPLETE THE FULL VALIDATION OF SOME OFF-LINE PRODUCTS E.G. SAR PRODUCTS FROM SOME FOREIGN STATIONS AND RA PRODUCTS
- IMPROVE THROUGHPUT FOR GENERATION OF OFF-LINE RA PRODUCTS (LEV. 2 AND WAVEFORM). CORRECTIVE MEASURES ARE BEING IMPLEMENTED
- PROCESS LBR BACKLOG AND MORE GENERALLY DEFINE STRATEGY FOR RE-PROCESSING OF ERS-1 LBR DATA