41st Argos Operations Committee Meeting

Saint-Jean-de-Luz, FRANCE

June 5th to 7th, 2007

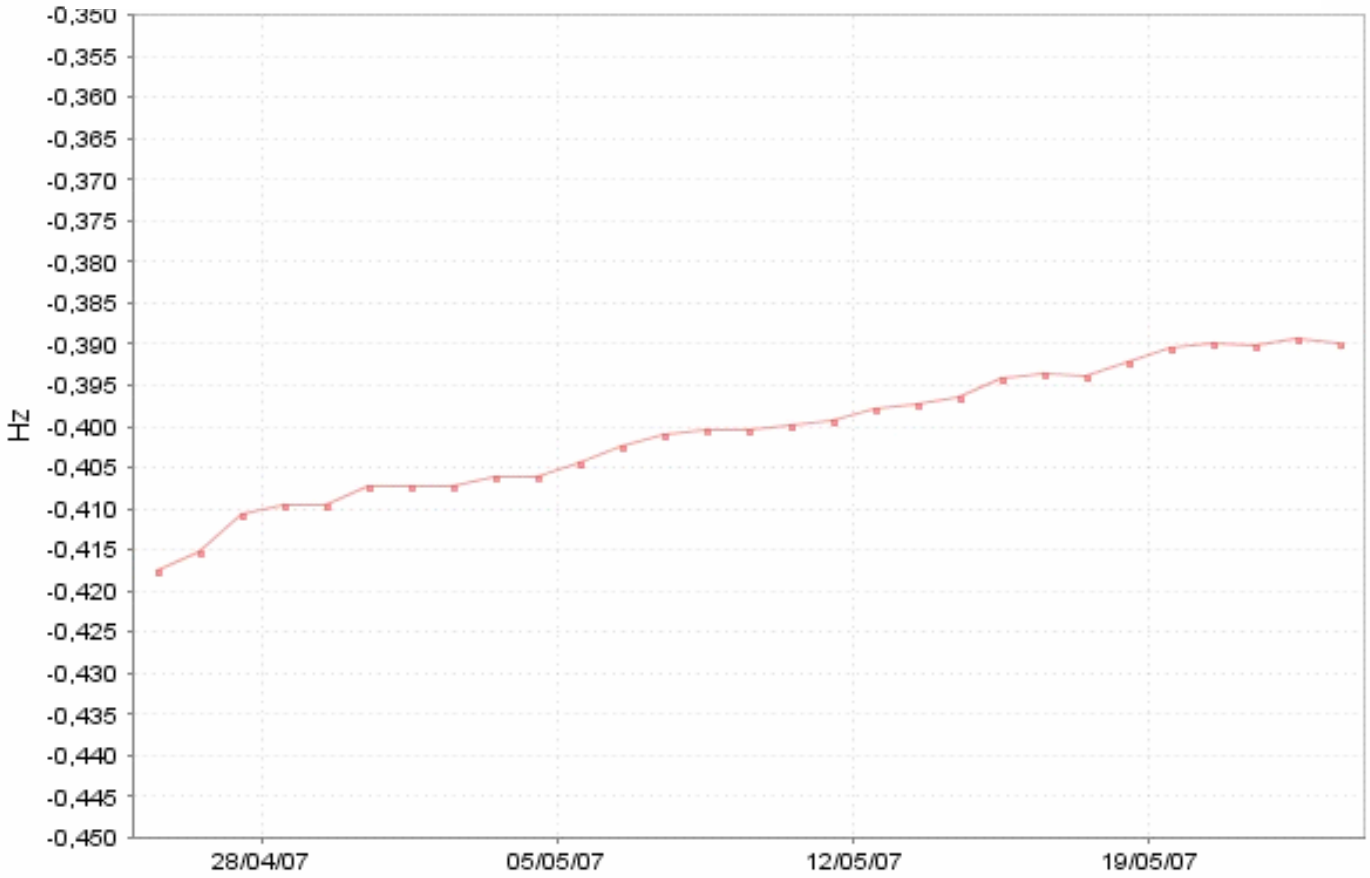
E-2-2 / ARGOS-3 COMMISSIONING on METOP-A - CNES

Plan of the presentation:

- ✓ USO and Datation Calibrations,
- ✓ Noise contribution over Europe and North Africa,
- ✓ Test Results from Platform emissions in Nominal Conditions,
- ✓ Test Results from Platform emissions with different EIRPs,
- ✓ Downlink Performance Testing,
- ✓ Measurements from Master Beacon: Global Ack Rate study,
- ✓ IDC Service for A3 & HD Platforms
- ✓ Allcast Service
- ✓ Demonstrators

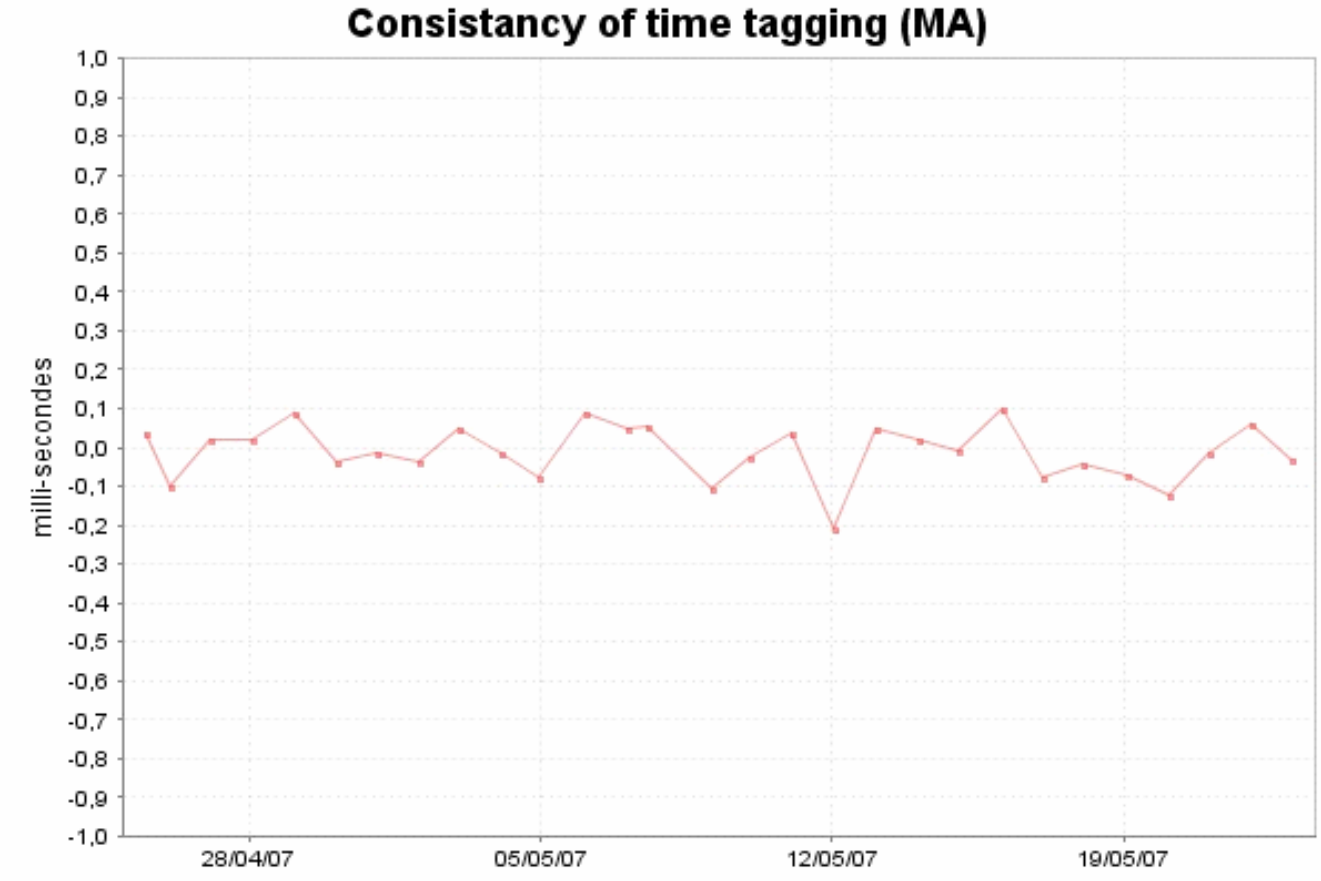
USO Frequency Calibration

- ✓ The USO is close to 10 MHz (this value corresponds to 0 Hz on the curve below)
- ✓ The frequency drift is lower than 1 mHz per day when the USO is stabilised.



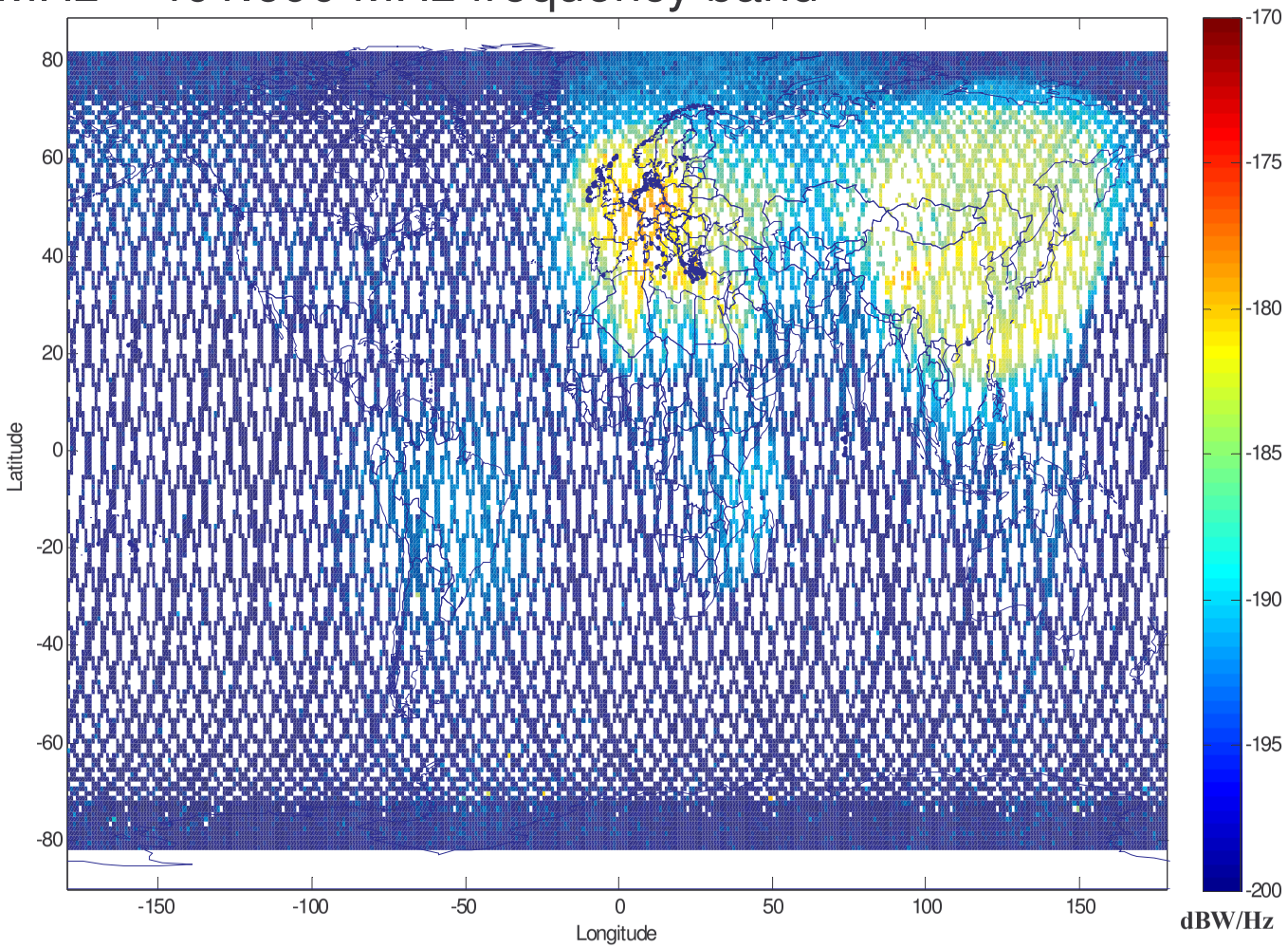
Datation Calibration:

- ✓ The DA0 is calculated every day over the last 72 hours with messages from the time reference beacon.
- ✓ The consistency of the time tagging reaches 100 µ-seconds few days after the instrument switching-on.



Noise measured by Argos-3:

- ✓ Measurements performed between the 22 February to 28 February in the 401.610 MHz – 401.690 MHz frequency band

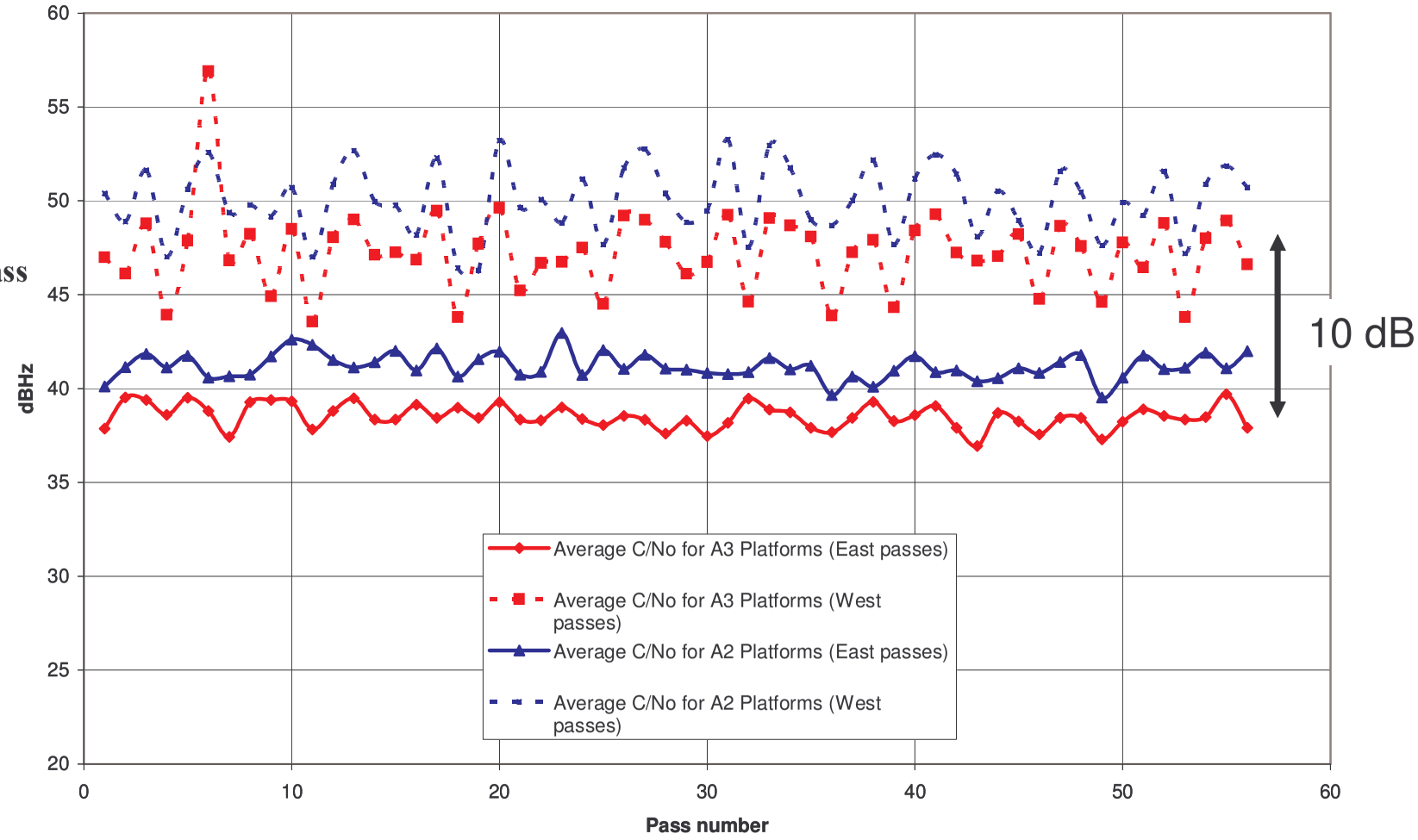


Up to 20 dB

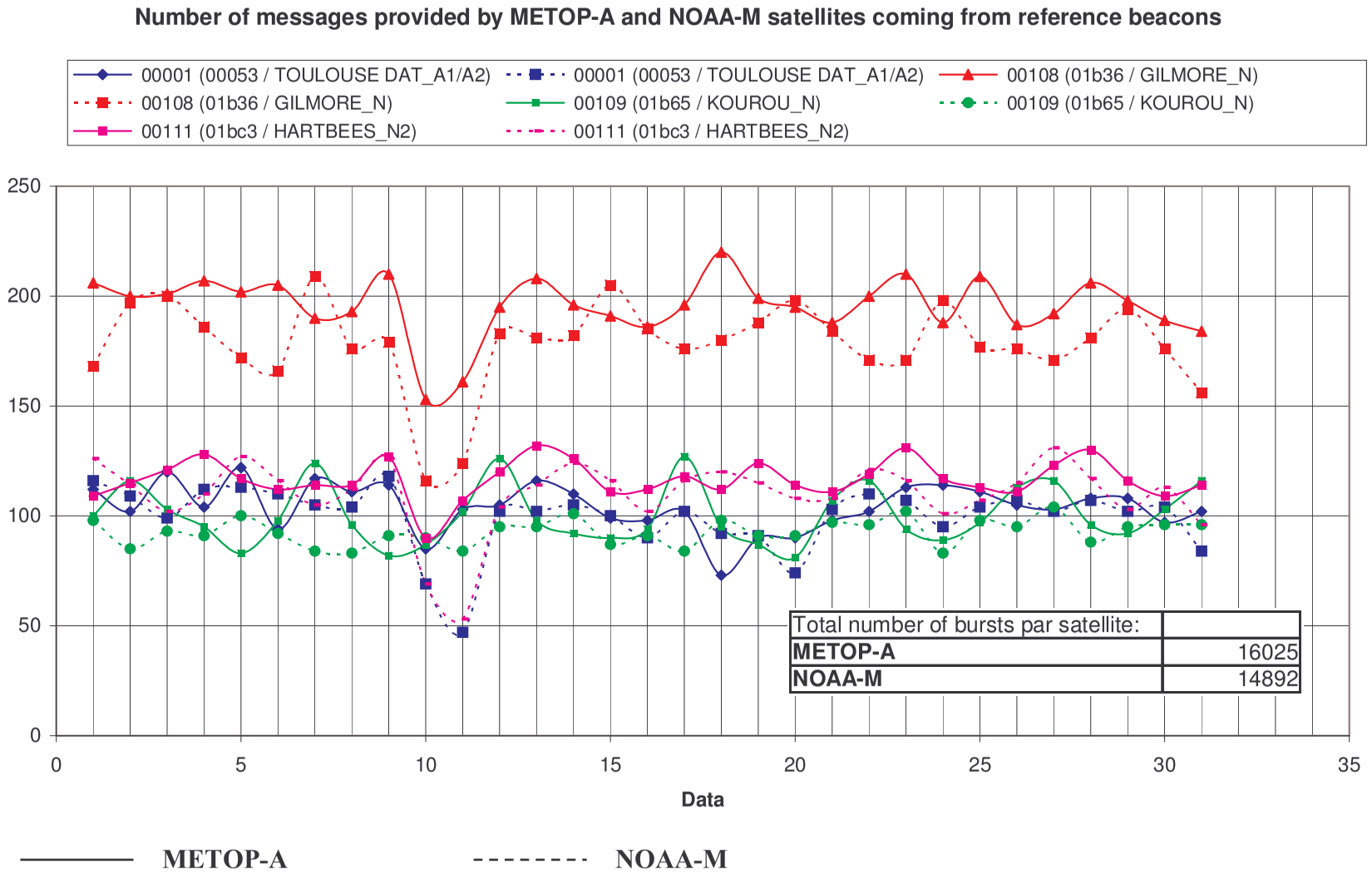
Noise measured by the instrument:

- ✓ Noise analysis from the tests in nominal conditions (platforms located at Toulouse)

Average C/No for A2 & A3 Platforms during a satellite pass



METOP-A and NOAA-M comparison:



Tests in nominal conditions:

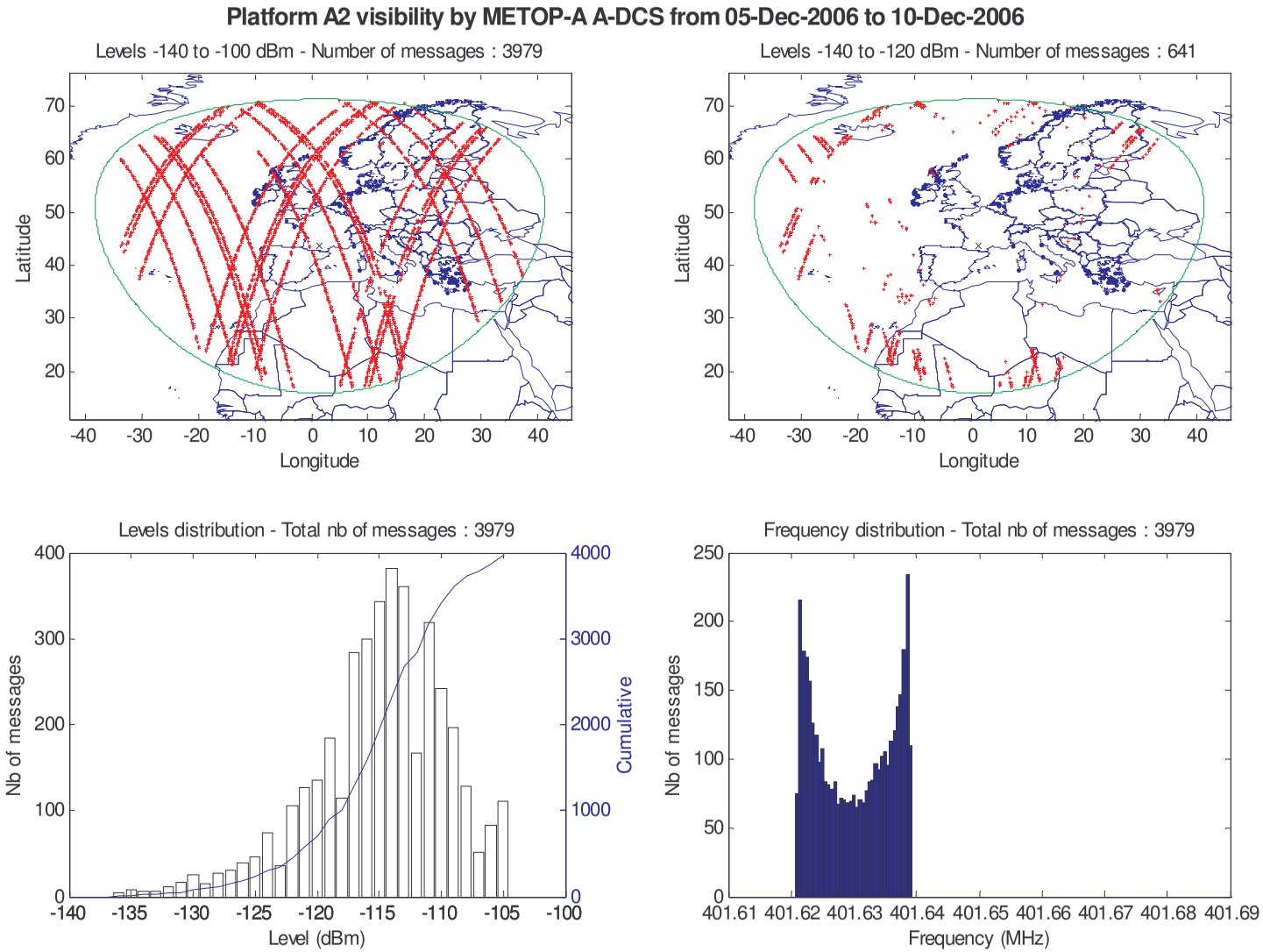
- ✓ Period of tests: from the 5/12/2006 to the 10/12/2006
- ✓ Platforms located at Toulouse
- ✓ Argos-3 instrument configuration: **SIDE 1**
- ✓ The Platforms have been transmitted messages (including all burst lengths) in nominal conditions:

  A2 Platforms (@400bps): EIRP = 33 dBm (whip antenna), from 32 bits to 256 bits per burst,

  A3 Platforms (@400 bps): EIRP = 30 dBm (whip antenna), from 32 bits to 256 bits per burst,

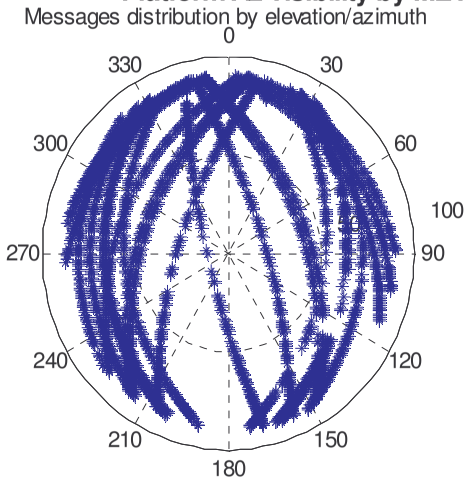
  HD Platforms (@4800 bps): EIRP = 37 dBm (whip antenna), from 544 bits to 4640 bits per burst.

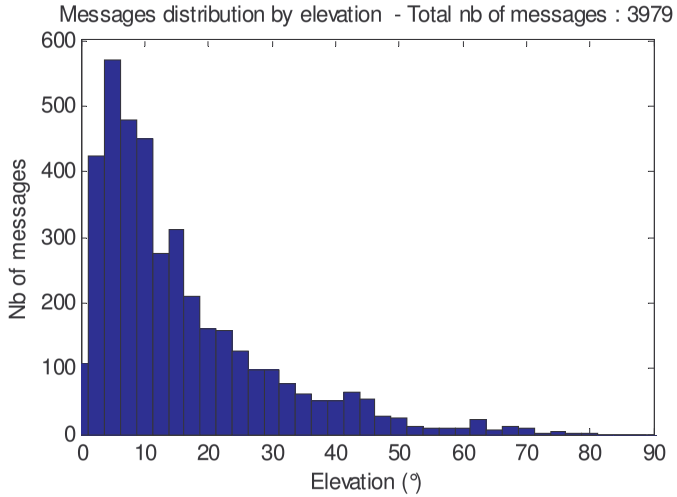
Tests in nominal conditions: A2 Platforms

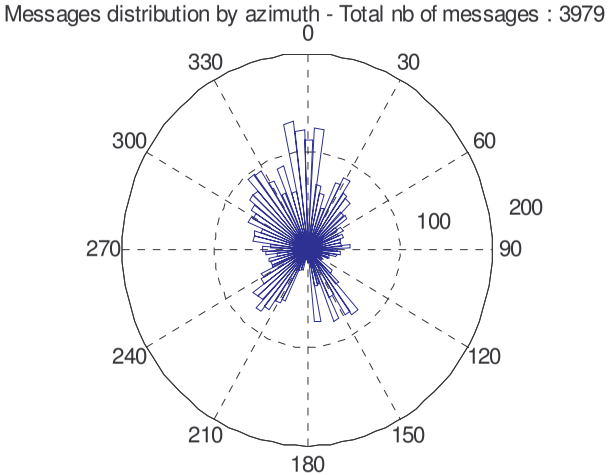


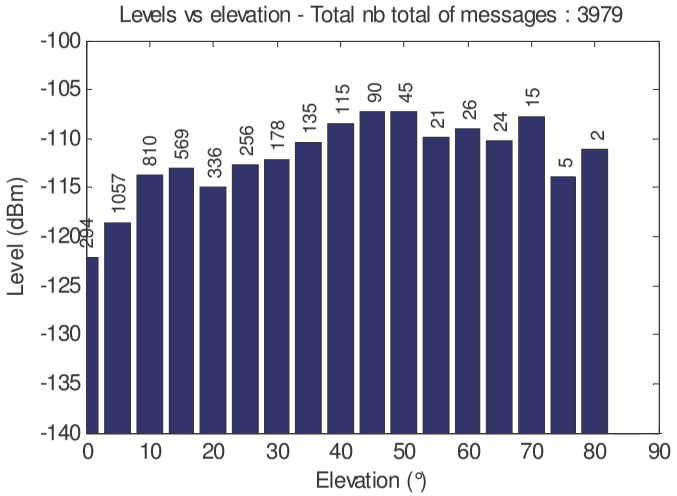
Tests in nominal conditions: A2 Platforms

Platform A2 visibility by METOP-A A-DCS from 05-Dec-2006 to 10-Dec-2006









Tests in nominal conditions: Conclusions

- ✓ The results depend on the geographical passes:
  Worst performances on East satellite passes
- ✓ ID recovery probability:
  A2: **82%** (East passes: 77,8% and West passes: 83%)
  A3: **75,7%** (East passes: 69,9% and West passes: 79%)
  HD: **17,2%** (East passes: 2,2% and West passes: 28,2%)
- ✓ Complete burst recovery probability **(including all burst lengths)**:
  A2 : **68,45%**
  A3 : **74,39%**
  HD : **16,9%**
  - **Conclusions:**
  - ➢ **6%** difference for the ID recovery probability between the A2 and A3 platforms (in favour of A2 but with a power of 3 dB higher)
  - ➢ Loss of **13,5%** between the ID recovery probability and the Complete burst recovery Probability for A2 platforms
  - ➢ The Data Collection Service is better for A3 platforms than the A2 platforms with an EIRP 3dB lower
  - ➢ **The ID recovery probability and the Complete burst recovery probability are very close for platforms using a channel coding (A3 and HD)**
  - ➢ Very low reception probability for HD platforms **over Toulouse due to high level of noise** ⇒ other tests have been performed in a better environment.

Tests with variable EIRP:

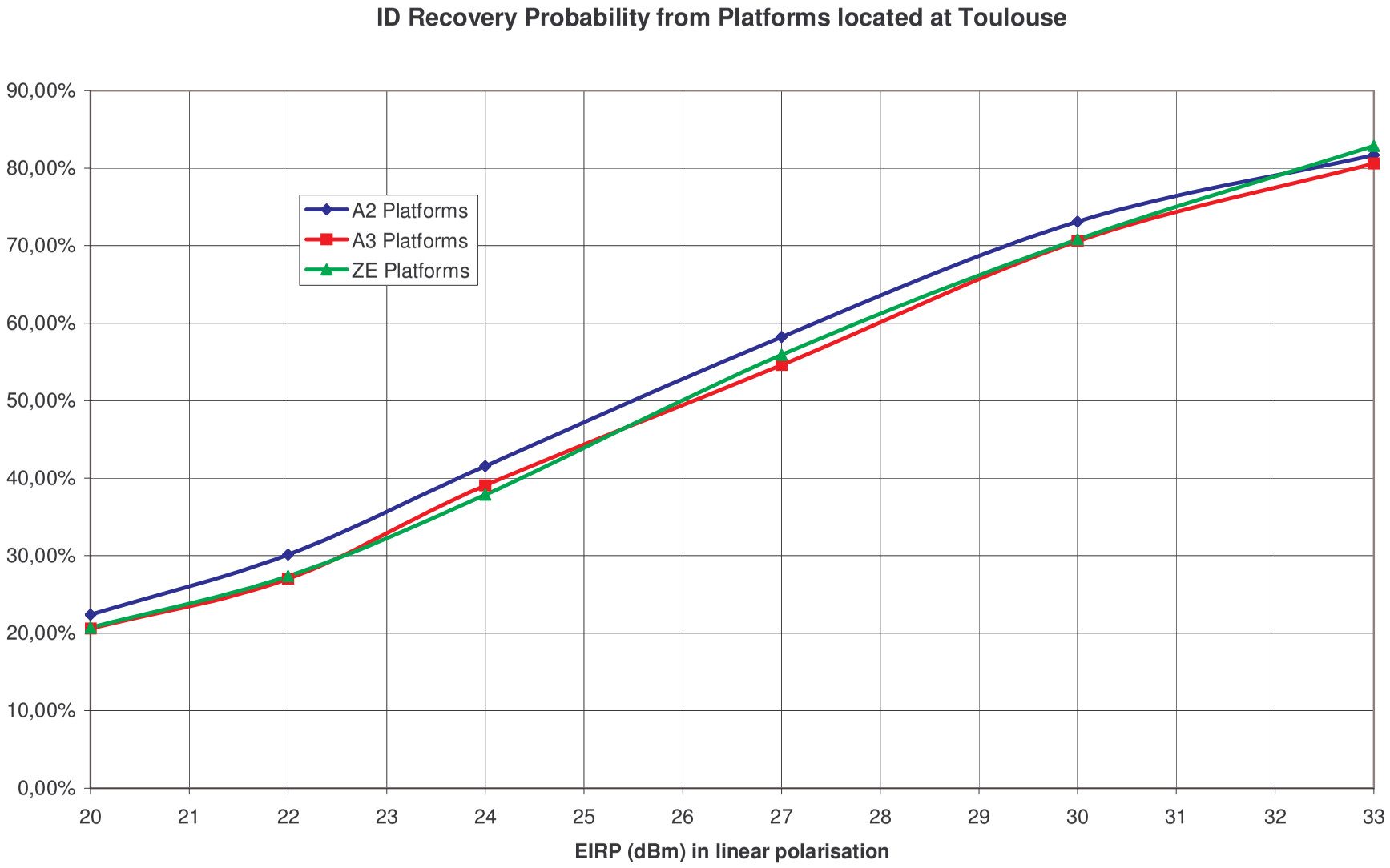
- ✓ Period of tests: from the 3/04/2007 to the 16/04/2007
- ✓ Platforms located at Toulouse
- ✓ Argos-3 instrument configuration: **SIDE 2** (switch-on the 22 March 2007)
- ✓ The Platforms have been transmitted messages as described hereunder (T_R = 30 sec):

  A2 Platforms (@400bps): EIRP = 20 dBm, 22 dBm, 24 dBm, 27 dBm, 30 dBm and 33 dBm (whip antenna), 128 bits per burst,

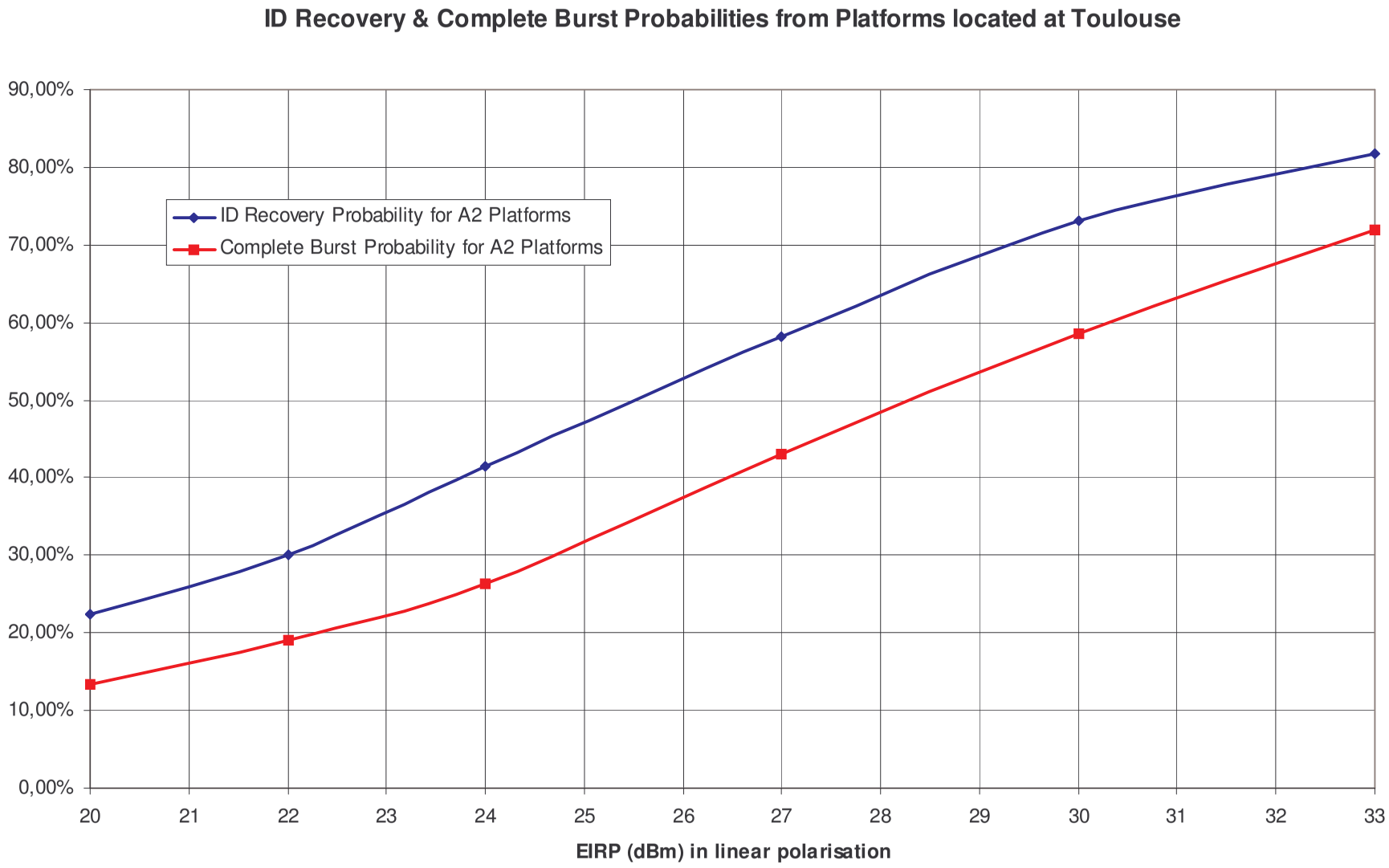
  A3 Platforms (@400 bps): EIRP = 20 dBm, 22 dBm, 24 dBm, 27 dBm, 30 dBm and 33 dBm (whip antenna), 128 bits per burst,

  HD Platforms (@4800 bps): EIRP = 30 dBm, 33 dBm, 35 dBm and 37 dBm (whip antenna), 2080 bits per burst.

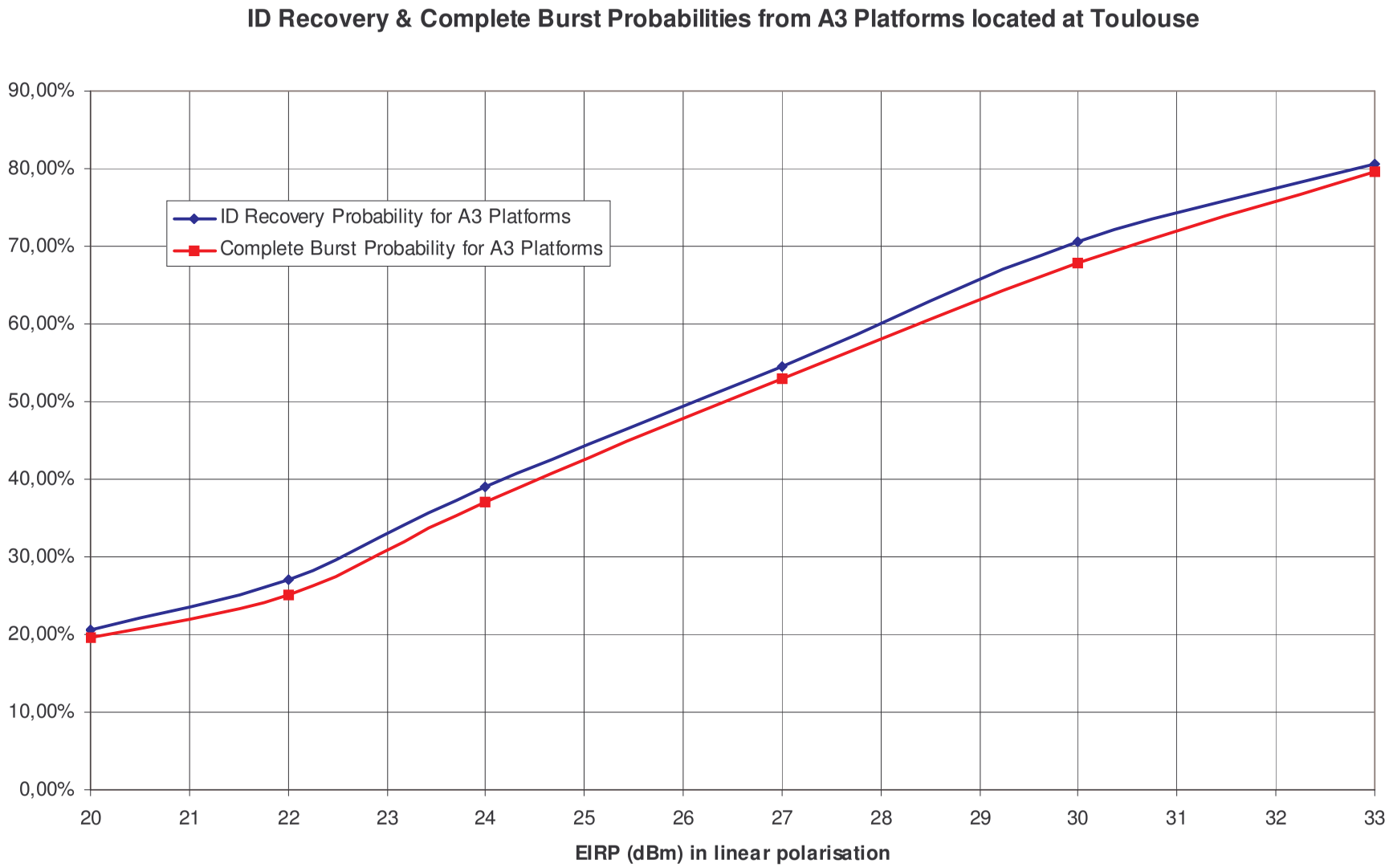
Tests with variable EIRP: A2, A3 and ZE platforms



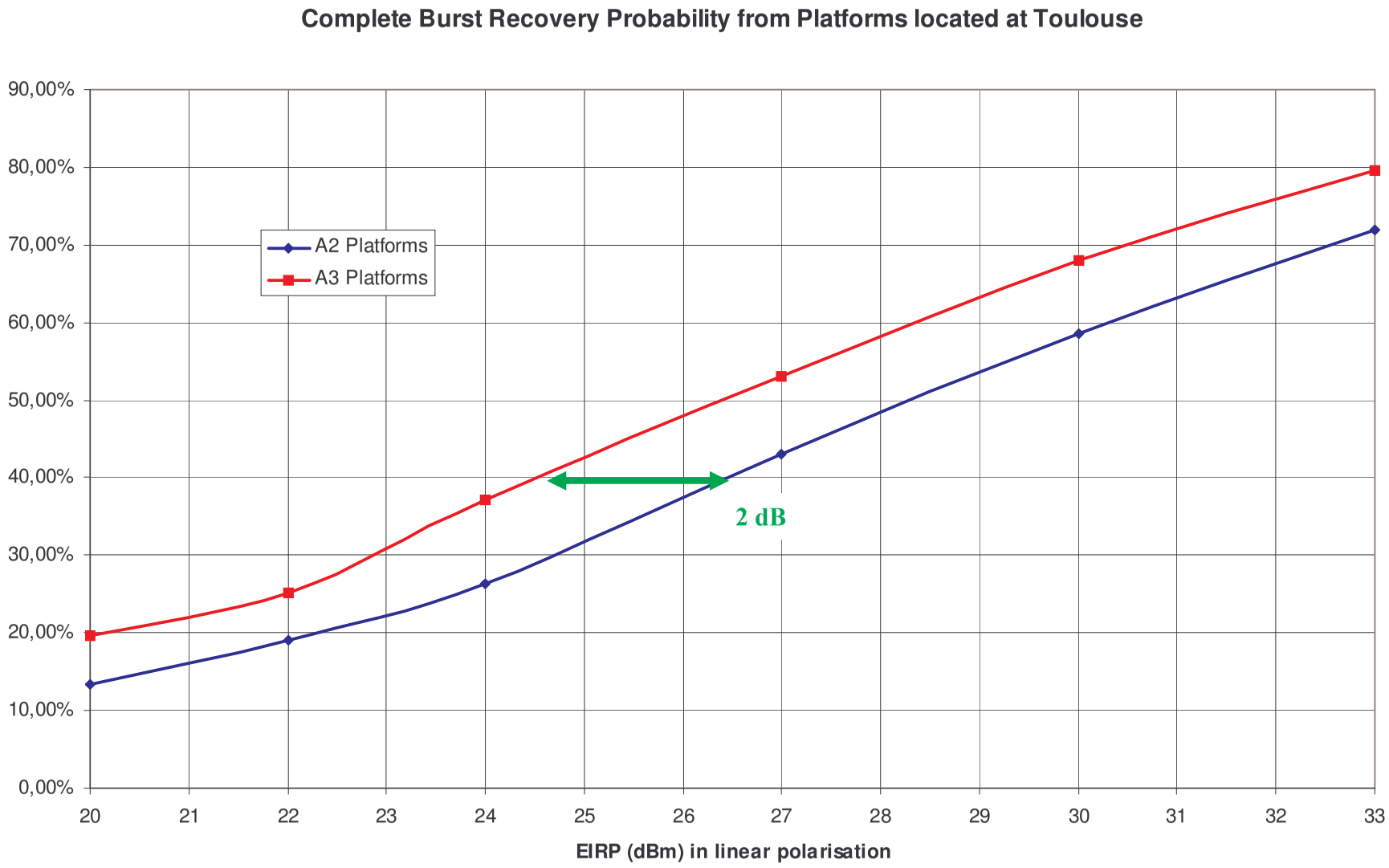
Tests with variable EIRP: A2 platforms



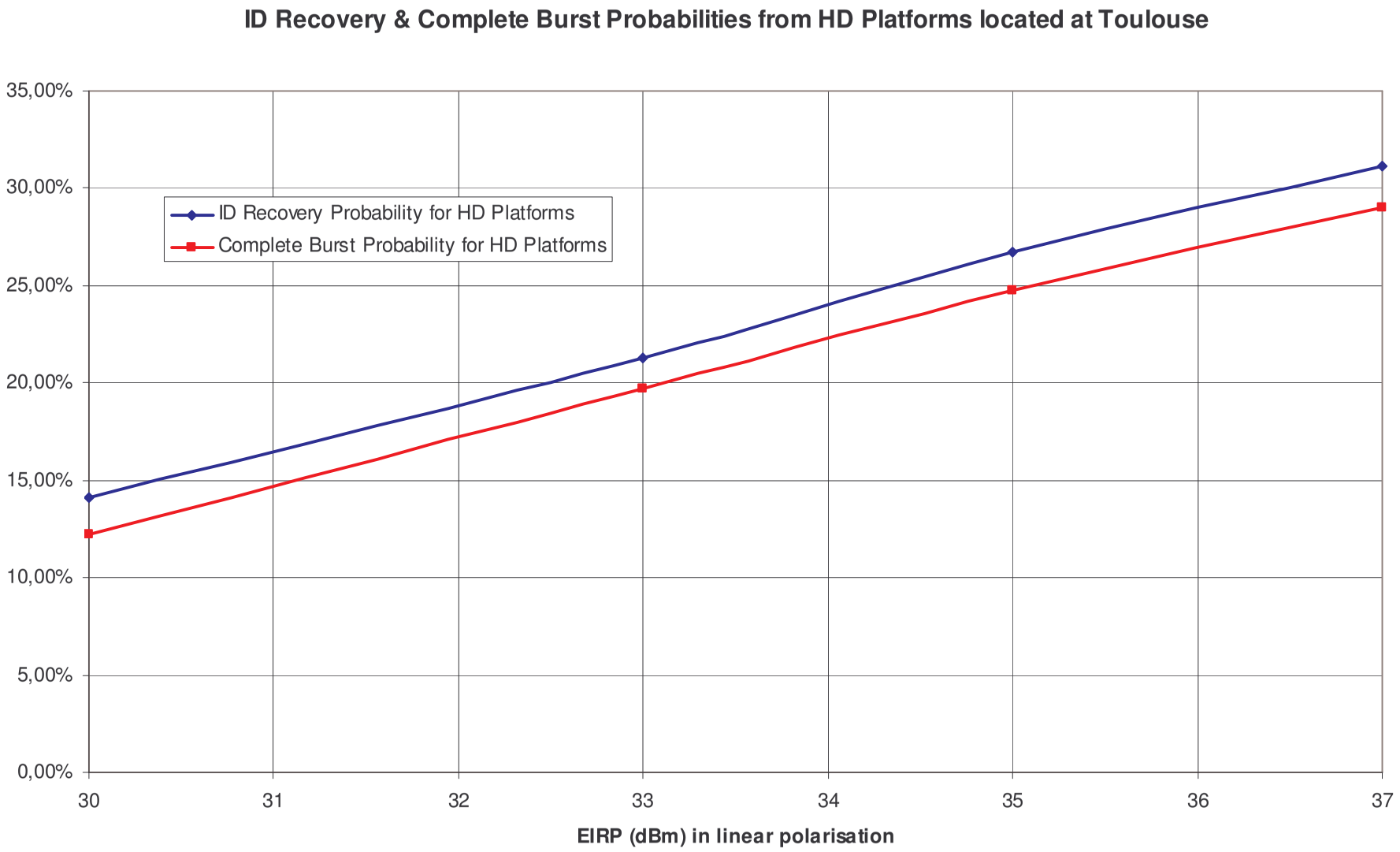
Tests with variable EIRP: A3 platforms



Tests with variable EIRP: A2 vs A3 platforms

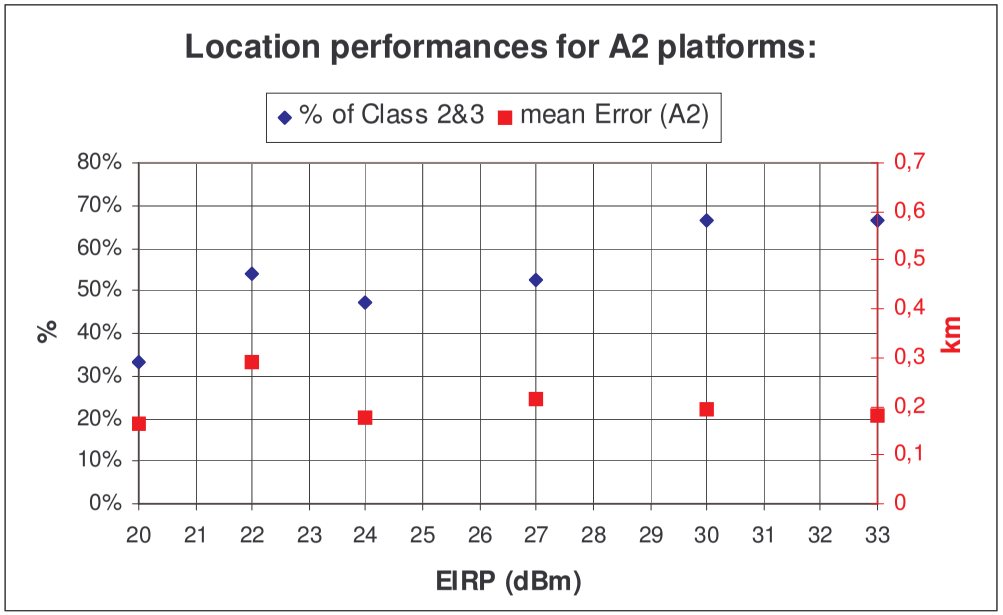


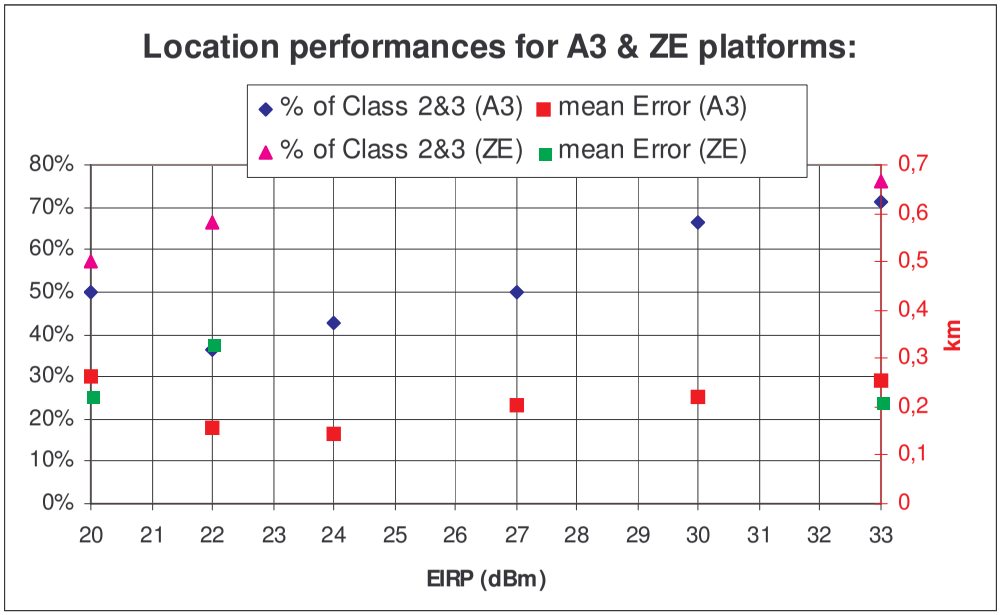
Tests with variable EIRP: HD platforms



Tests with variable EIRP: A2, A3 & ZE platform locations

- ✓ Location performances for A2, A3 & ZE platforms with measurements over 3 days
- ✓ Definition and Class of locations:
- Calculated from at least 4 messages received during a satellite pass,
- Class 2: 150 m ≤ estimated accuracy in latitude and in longitude < 350 m
- Class 3: estimated accuracy in latitude and in longitude < 150 m





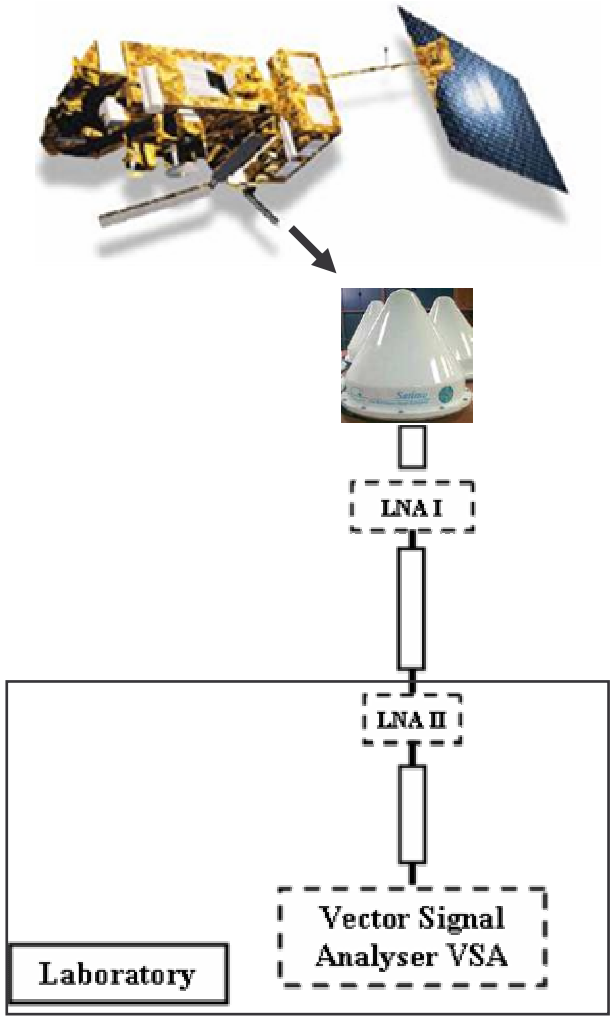
Uplink Random access conclusions:

- ✓ Difficult environment for the tests: Important level of noise: up to 20dB above the expected level,
- ✓ Important Traffic Density for Low Data Rate Platforms: close to 5,5 Erlangs,
- ✓ The dynamic range for A2, A3 & ZE platforms is close to 30 dB (-136,15 dBm to -105,35 dBm for A2 and -136,7 dBm to -105,35 dBm),
- ✓ The dynamic range for HD platforms is: 20 dB (-125 dBm to -105,35 dBm),
- ✓ In nominal conditions <u>when the satellite is over Toulouse</u>:

  - more than 68% of complete burst can be received correctly for A2 platforms with an EIRP = 33 dBm,
  - more than 74% of complete burst can be received correctly for A3 & ZE platforms with an EIRP = 30 dBm (power gain between 2 and 3 dB vs A2 platforms),
  - more than 17% of complete burst can be received correctly for HD platforms with an EIRP = 37 dBm (this probability can be increased in a better noise environment, see IDC session for HD platforms and Master Beacon session),

Downlink Performance Testing:

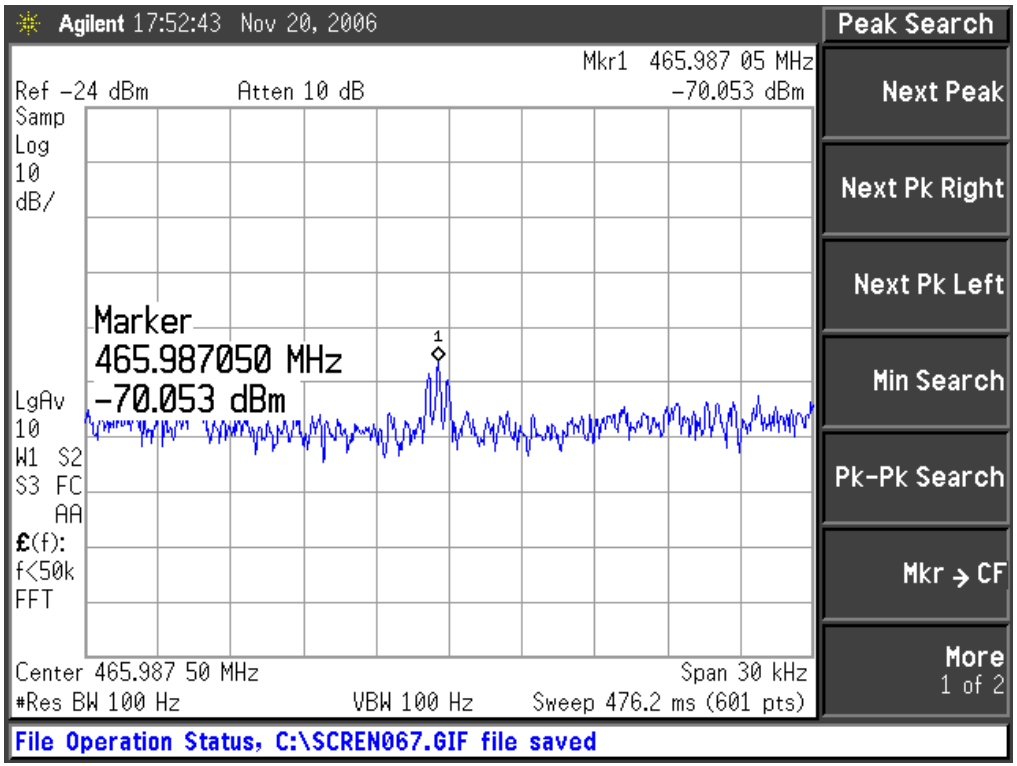
- ✓ Some spectrum have been measured manually



Link budget (estimation):

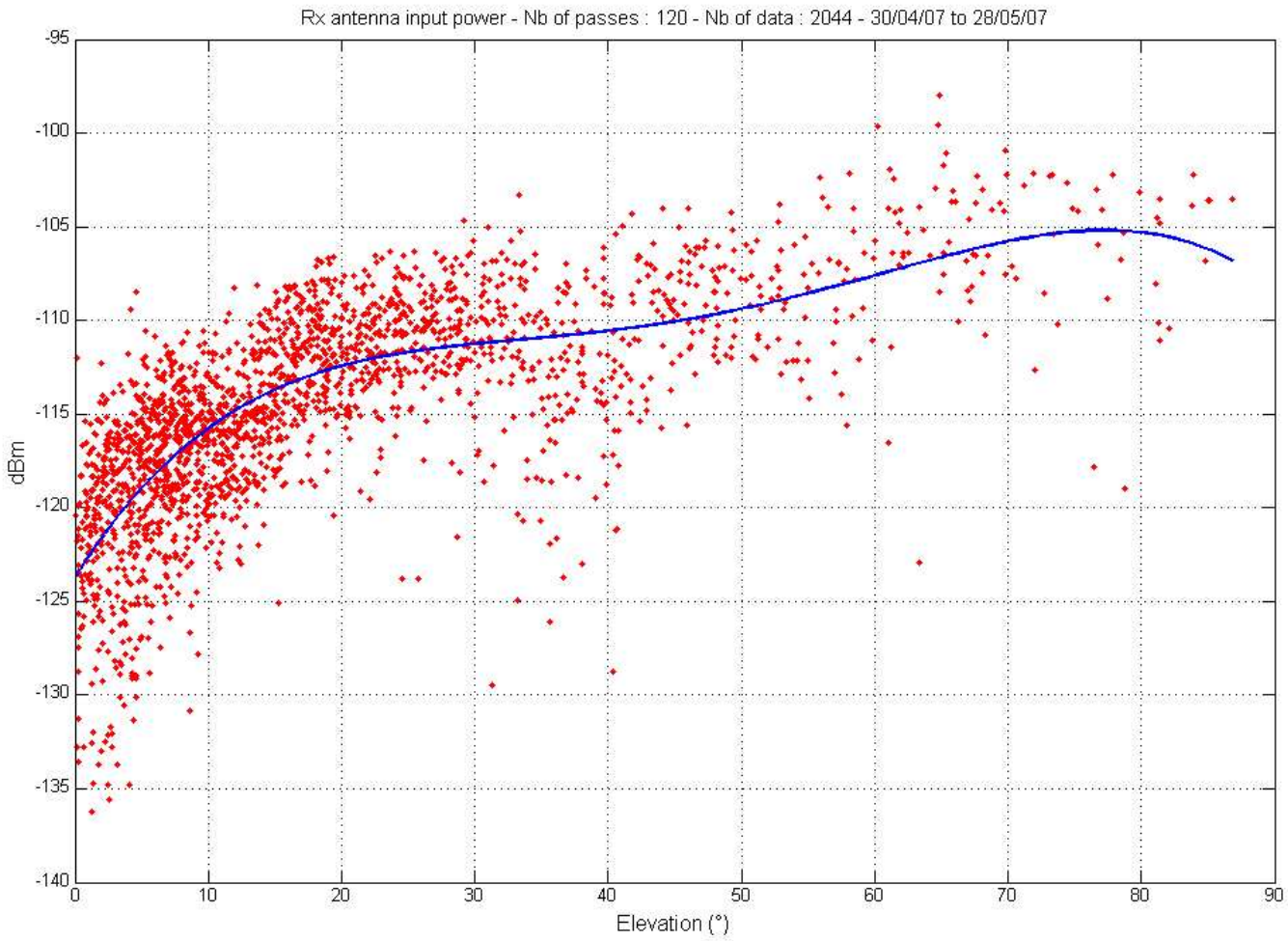
Elevation angle ≈ 9° (satellite-platform distance ≈ 2400 km)

Power received (at antenna port) ≈ -126,5 dBm



Downlink Performance Testing: automatic measurements

- ✓ Estimation of the received power (dBm) over the elevation angle range [0°; 90°]:



Performances of the Master Beacon located in Toulouse:

Estimation over 25 satellite passes

- ✓ Uplink Complete Burst Ratio:
  - East satellite passes: 4%
  - West satellite passes: 35%
- ✓ Downlink Message Ratio:
  - East satellite passes: 84% but not enough satellite passes which generated downlink messages
  - West satellite passes: 62%
- ✓ Global Acknowledgement Ratio:
  - Uplink Complete Burst Ratio close to the results obtained during the random access uplink tests = 24,6%
  - Global Acknowledgement Ratio = 15%

- ✓ Uplink Complete Burst Ratio affected by the high level of noise over Europe and North Africa.

Conclusions from the Master Beacon measurements:

- ✓ The Global Acknowledgement Ratio is affected by the Uplink Complete Burst Ratio (HD platforms), in average :
  - Toulouse: 15%,
  - Svalbard: 70,3% (estimation over 100 satellite passes),
  - Fairbanks: 73,5% (estimation over 40 satellite passes).
- ✓ As can be seen, the Uplink Complete Burst Ratio is improved in a better noise environment, in average:
  - Toulouse: 24,6%
  - Svalbard: 68,6%
  - Fairbanks: 73,1%
- ✓ The Downlink Message Ratio is better than 62% in average for Toulouse, Svalbard and Fairbanks.

Interactive Data Collection (IDC): A3 Platform

- ✓ Some tests have been conducted with an A3 Platform in the IDC configuration in Toulouse
- ✓ Conditions of tests: Whip antenna, Fo = 401,670 MHz, T_R = 20 s (when the Ack is not received), 3 dB loss between antenna & platform receiver, West Pass

Date	EIRP (dBm)	Packet Type	Max. Elev. (°)	Pass duration:	AOS (UTC)	Total number of burst transmitted (after opening the session)	Total number of received burst	Total number of Ack received correctly (output of the RX)	Global Ack Rate (%)	Uplink Complete Burst Rate (%)	Downlink Message Rate (%)	Total number of bits transmitted in the IDC service
09/03/2007	27	from 32 to 256 bits	15,6	8 min 18 sec	11:32	67	58	52	77	86,6	89	6976
12/04/2007	30	256	59,8	15 min 19 sec	21:08	87	66	63	72	75,8	95	16128
16/04/2007	27	256	77,3	15 min 22 sec	10:02	80	60	56	70	75	93	14336

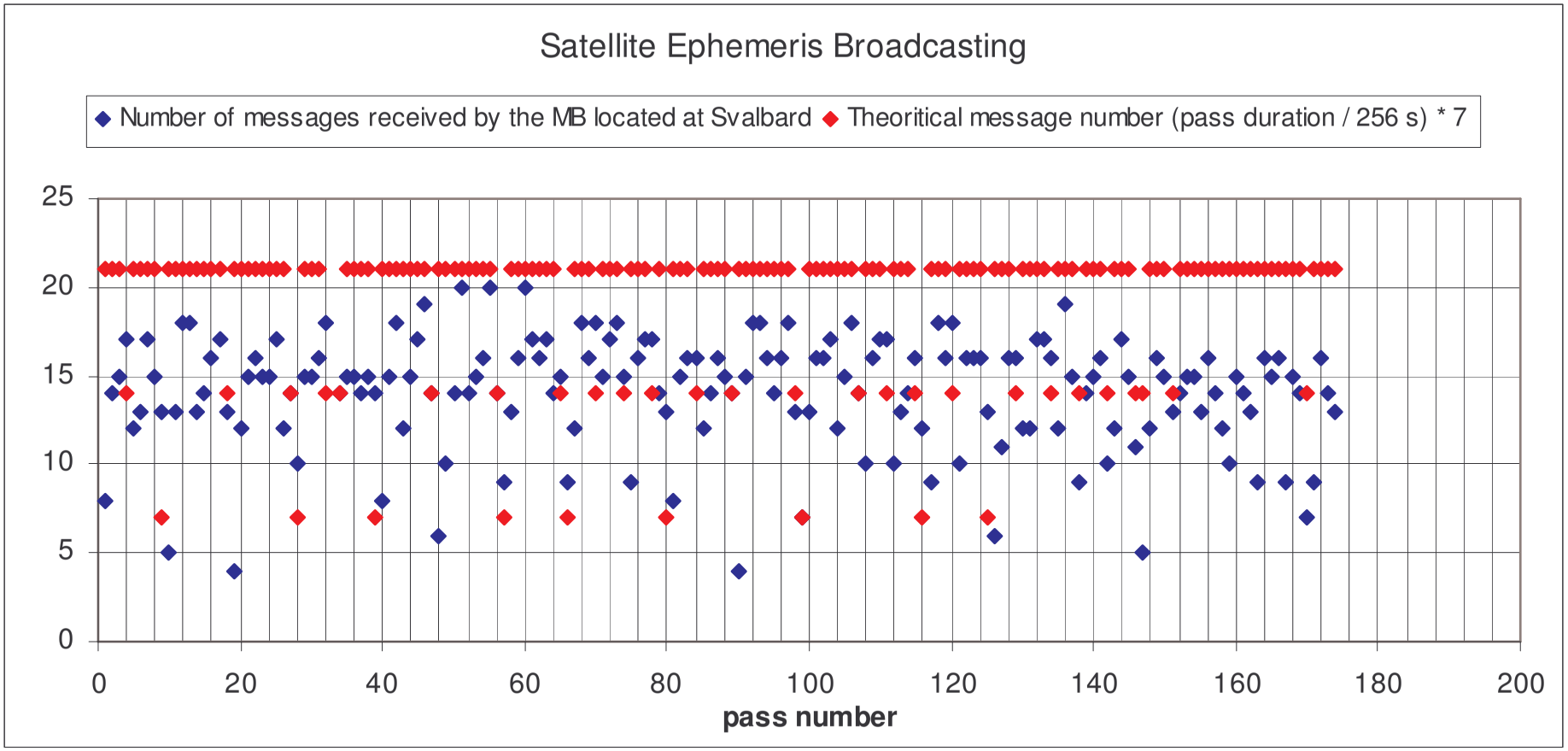
- ✓ These results are representative of tests with good performances, the objective was to transmit as much as possible the highest data volume during the satellite pass. Therefore 52, 63 and 56 bursts have been sent respectively in a secure way.
- ✓ The need today (for instance for ARGO applications) is to transmit 16 messages of 256 bits per pass (with Argos-2, 4 messages can be transmitted per pass).

Interactive Data Collection (IDC): HD Platform

- The Master Beacon located at Fairbanks have been configured in an IDC HD platform,
- All satellite passes have been considered (no criteria on the maximum elevation angle),
- These tests have been carried out between the 10 April and the 17 April 2007 (SIDE 2),
- EIRP = 37 dBm (circular polarisation, 0° ≤ Elev. Angle ≤ 60°, 9dB ≤ TE_{TX} ≤ 13dB, 20dB ≤ TE_{RX} ≤ 26dB, close to whip antenna conditions, fo = 401,595 MHz),
- Burst emissions: from 512 bit packet to 9 x 512 bit packet,
- Total number of bursts correctly transmitted per pass in average = 61
- Global acknowledgement Rate in average = 46%
- Total number of bits transmitted in the IDC Service per pass in average = 181,1 kbits.
- These encouraging performances have to be assessed again when the HD platform density will increase (up to 1 Erlang).

Allcast messages:

- The Downlink Message Management Centre (DMMC) through the MB has scheduled the Argos-3 instrument to broadcast allcast messages as the UTC message, the Constellation Status message and Satellite Orbit Parameter messages (7 satellites) every 256 seconds.



Demonstrators:

- ✓ Some demonstrators will be deployed in order to evaluate the Argos-3 system performances in the context of their applications
- ✓ Fishing application (in a high traffic density):
- Objective: pseudo-ack emissions to the NOAA satellites (bust repetition monitored by the downlink), system parameter modification as the frequency emission, the repetition period, the capability of stopping the platform emission, or the GPS acquisition period.
- ✓ Drifting buoy application:
- Objective: data emissions when the satellite is in view, use of the satellite ephemeris and the Argos-3 time broadcasting for better accurate sensor acquisition.
- ✓ Profiling float application (ARGO):
- Objective: profile transmission of 80 levels (PMT-A2) and 800 levels (PMT-HD) through the IDC Service, minimisation of the time spend on surface.

Demonstrators:

- ✓ DORIS application:
- Objective: remote control of Doris beacons through the Argos-3 downlink (ID, time modification, repetition period, satellite ephemeris, logbook collection).
- ✓ Lab application:
- Objective: test on PMT-A3 & PTT-A3 platforms and comparison with the PMT-A2 & PTT-A2 platforms, low power applications
- ✓ Seminar in November 2007 (TBC): Presentation of the Argos-3 demonstrator outcomes