Doris ground antennas
Radio Frequency characterization

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Based on Daniel Belot’s Work and Report

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OUTLINE

- CONTEXT, MOTIVATION
- MEASUREMENT AND ANALYSIS REQUEST
- MEASUREMENT CAMPAIGN
- RESULTS
- UPCOMING ACTIVITIES
An issue was raised by several IDS users about a possible bias in the position of the phase center of the DORIS ground antennas.

Recommendation from IDS Governing Board (Lisbonne 2010)

- The vertical offsets between Starec and Alcatel antennas must be looked at. There could be a correlation between the scale errors and the numbers of Alcatel antennas.

- Action to provide calibration results of Alcatel and Starec antenna.
Analysis requested to CNES Antenna Department

1. Characterize STAREC antenna considering phase center defined by the manufacturer
   - Gain pattern
   - Phase law

2. Compare this characterization with manufacturer’s specifications

   => In case of inconsistency, determine the position of the phase center for which measured phase law corresponds to specifications

- Determine variability of the phase center position on a set of 7 STAREC antennas

  » Type 52291  serial number: 50, 56, 128, 01
  » Type 1828-25 serial number: 140, 143, 144
DORIS ground antenna : **STAREC**

- **Specification document**:
  - modeling of DORIS instrument (CO-SP-DO-OP-2460-CN)
- **Total size** : 974 mm
- **Reference plan H0**: antenna base
  - **H2G** : 2036.25 MHz Phase center : **877mm** / H0
  - **H400** : 401.25 MHz Phase center : **390mm** / H0
● dispersion authorized

- 400 MHz : $\epsilon = \pm 4^\circ$
- 2 GHz : $\epsilon = \pm 2^\circ$
MEASUREMENT CAMPAIGN
Measurements performed by the CNES Antenna Department

BASE COMPACTE DE MESURES D’ANTENNES
Objectifs : Connaître et maîtriser le rayonnement des antennes seules et sur structures

Chambre anéchoïque faradisée :
22 m x 12.5 m x 12 m

● for more details, cf. backup slides
MEASUREMENT CAMPAIGN
Measurement protocol

- Antenna placed on measurement device
- Antenna aligned with the Z axis of the measurement frame
- Antenna rotates to cover elevation angle ($\theta$) from $-180^\circ$ to $180^\circ$
- 4 measurement series (4 plans) $\phi = 0^\circ, 45^\circ, 90^\circ, 135^\circ$
Several configurations exist on the network
- In order to analyze the impact of the configuration, each one has to be measured
  - C1 : Doris antenna alone
  - C2 : Doris antenna on small triangular interface
  - C3 : Doris antenna on small triangular interface + IGN disc
  - C4 : Doris antenna on large triangular interface

⇒ Tests measurements have been performed on one antenna (n°56)
⇒ Measurements performed for the 4 configurations
Results:

C1: reference position of phase center (antenna alone)
C2: Phase center position shift -2mm
C3: Phase center position shift -2mm
C4: Phase center position shift -3mm

⇒ Impact of the interface under the accuracy specification for phase center position (± 5mm)

⇒ Impact of the interface in the measurement noise

Measurements performed in C1 configuration (antenna alone)
Significant for all configurations
RESULTS
(7 STAREC Antennas)

From 2 measurement reports:

- DORIS Antennes sol : DCT/RF/AN - 2011.0024572
- DORIS antennes 56, complément de mesure (on coming)
Gain pattern

- Black curve: specified gain law
- Blue curves: gain measured on right hand polarized signal (useful signal)
- Red curves: gain measured on left hand polarized signal

⇒ Good consistency between measurement and specification for both 400MHz and 2GHz
⇒ Results equivalent for the 7 antennas
Phase law, phase center position principle (1/2)

Considering the specified phase center position

- measurements are performed
- compared to specification

Discrepancies between spec and measurement

\[ \text{spec} \]
\[ \text{measurement} \]
Phase law, phase center position principle (2/2)

New position is taken into account

● Phase law is determined again
● Compared to specification

Discrepancies between spec and measurement

● After several iterations, a measured phase center position can be estimated
Phase center position:

- Specified phase center position: 390mm / H0

- Measured phase center position: 383mm / H0

=> 7mm of discrepancies (0.01 λ)

(Consistent results obtained on 7 antennas)
Results
400MHz Channel (2/2)

Phase law

- To stay in the ±4° dispersion, a new phase law is proposed:
  - Determined by adjustment on the 7 antennas measurements
Phase center position:

- Specified phase center position: 877mm / H0
- Measured phase center position: 860mm / H0

=> 17mm of discrepancies (0.12*λ)

(consistent results obtained on 7 antennas)
Results
2GHz channel (2/2)

Phase law

To approach the ±2° dispersion, a new phase law is proposed:
- Determined by adjustment on the 7 antennas measurements
Conclusion

Concerning DORIS STAREC ground antennas

Measurement campaign performed by antenna dep. shows:

- **No variability of phase center position** between antennas

- The specified phase center positions should be modified
  
  - 2GHz: 860 mm /H0
  - 400MHz: 383 mm /H0

- Measured phase law should be applied
Analysis of the impact of those new values in IDS solutions needed

Integration of those results in specifications and processing

- Information to users, analysis centers…
- How? To be defined with IDS.

Similar analysis on ALCATEL antennas if possible

- Need to have a significant set of antennas
- On going investigation to get functional antennas
THANK YOU
Backup slides
**BASE COMPACTE DE MESURES D’ANTENNES**

**Objectifs :** Connaitre et maîtriser le rayonnement des antennes seules et sur structures

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**Simuler la distance satellite sol**

- Réflecteur parabolique : 5,3 m x 5,6 m, 48 tonnes.
- Focale : 13 m.
- État de surface : 25 μm RMS.
- Zone tranquille maximale de 4 m x 4 m x 4 m.

15 sources primaires de 0,4 à 200 GHz.

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**Simuler la liaison bord sol**

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**Isoler l’antenne dans l’espace**

- Absorants : -70 dB de réflectivité typique à 8 GHz.


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**Positionner l’antenne dans l’espace**

- Diagramme de rayonnement, directivité, gain, localisation centre de phase, temps de propagation de groupe. Performances système, surface équivalente radar.

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**Réaliser les mesures avec précision**