

Overview of DORIS Frequency Permits, RFI Issues Worldwide

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● Overview of DORIS Frequency Permits :

- ◆ Difficulties,
- ◆ Example of Monument Peak,
- ◆ Conclusion

● Conventions

● RFI Issues Worldwide :

- ◆ Geodetic co-locations
 - GNSS,
 - SLR,
 - VLBI
- ◆ Occasional co-locations
 - ARGOS and SVOM,
 - radio-sounding systems

FREQUENCY PERMITS

● Space segment

- ◆ Delivery institution : ITU
 - Requested by projects of satellites hosting a DORIS receiver
 - ITU guarantees that no space system uses the same frequencies

DORIS frequencies:
 2036.25 MHz +/- 100 KHz
 401/25 MHz +/-20 kHz

● Ground segment

- ◆ Delivery institution : host country government
 - Requested by CNES/IGN or host agency
 - Guarantee : the country allows to install a transmitting antenna on its territory

☞ **Interactions with other ground systems are not examined by any international institution : only governments decide.**

Frequency permits / Difficulties

- **Difficulty due to the delivery institution for ground segment: host country government**
 - ◆ **Each country**
 - Specific request form, administrative loop, specific delay and duration
 - Specific work for each request, impossible to re use experience

Easier when managed by host agency

→ unavailability of several beacons in the world
is linked to these frequency permits issues

Beacon was turned OFF in Feb. 2010, following a NASA request.

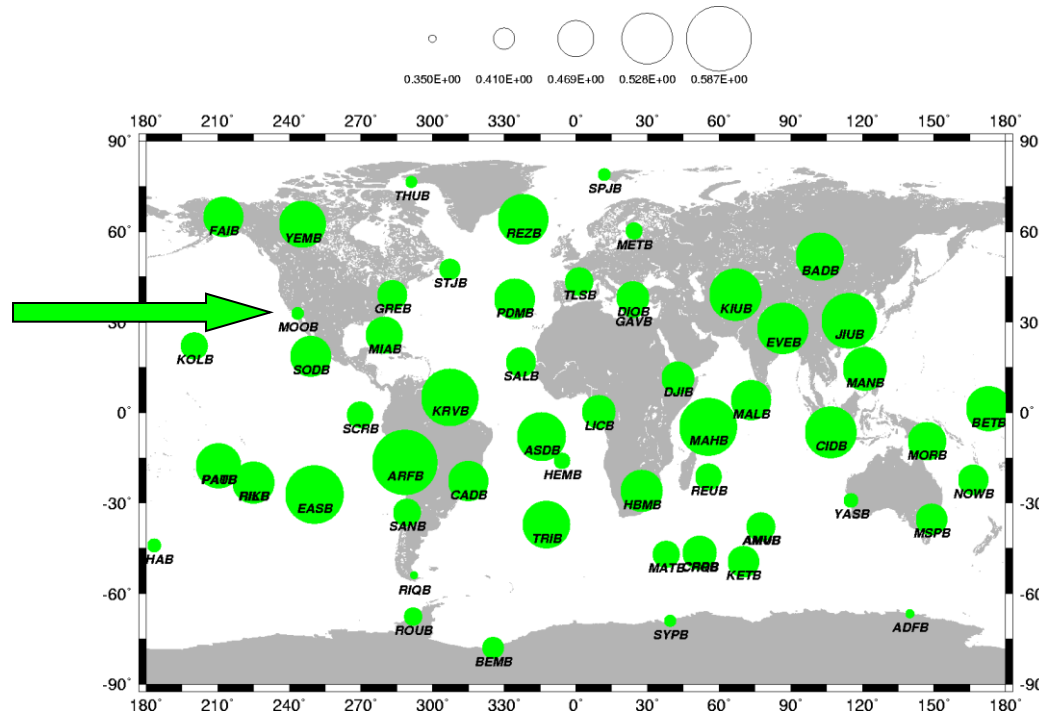
- **Cause** : Interference with new digital TV system using 2 GHz RF link
 - ◆ DORIS beacon was in the vicinity of a 2 GHz relay station
 - ◆ Reception antennas of the San Diego district pointing toward this relay station were perturbed by DORIS emission

No recourse was possible because emitting permit had expired



The case of Monument Peak

Unfortunate event : Monument Peak was an **excellent contribution** to the DORIS beacon network and a **very good station for colocation** (DORIS+GNSS+SLR)



Large spots = high residuals,
tiny spots = small residuals

➔ Only one solution after discussion with NASA: move DORIS beacon to another site:

- ◆ Goldstone has been proposed (no TV)
- ◆ But still not emitting in mid-2012.

Conclusion / frequency permits

→ SALP project decision :
frequency permit for a new
station is an **absolute necessity**
before installation

Conventions

● Convention:

- ◆ Between the three partners : CNES / IGN / Host Agency
 - ◆ Details each partner's responsibility and activity
 - ◆ Allows formalization of both sides commitments
- Standard conventions are proposed to Host Agencies : written with IGN and CNES legal officers,
→ **Since 2009 conventions are systematically established with new or renovated sites.**

As for the frequency permits, each country government has its specificities to establish conventions → administrative loop more or less rapid

RFI Issues Worldwide

Status of DORIS Radio Frequency Interference with other systems :

Many scientific interests in co-locations :

- ◆ Geodetic co-locations:
with GNSS, SLR, VLBI



- ◆ Occasional co-locations:
with ARGOS, SVOM, radio-sounding systems

➔ Radio-Frequency Interference risk, between DORIS and the other systems, have to be clearly examined.

➔ A complete compatibility dossier is being established for each system.

RFI interference due to (too) close colocation

Close co-location is specially interesting in the framework of ITRF (International reference Frame realization) in order to reinforce the geodetic link between all techniques.

→ Recommendation: (COLOC1)

- ◆ - maintain DORIS-GNSS co-location,
- ◆ - in the future, increase the number of DORIS - SLR and DORIS – VLBI co-locations.

This recommendation has a strong support from the DORIS geodetic community

- **DORIS/GPS : No interference**

- **DORIS/Galileo:**

- ◆ With 400 MHz Chanel:

- No interference so far for 3rd and 4th overtones
- experience on many stations
- Report in progress on DORIS-REGINA Radio-Frequency Inter-compatibility :
 - * Theoretical study, then measurements close to the Toulouse DORIS beacon, and finally BCMA labo measurements.
 - * Expected conclusion : **minimum distance between both antennae, installations constraints or suggestions.**



- ◆ With 2 GHz channel: interference wrt Galileo TM/TC stations must be verified

- Kiruna no problem (no DORIS)
- Kourou: current distance between both antennae is 20 km
- Nouméa: distance is 60 km
- La Réunion: 30 km.
- Papeete : Galileo site is not definitely confirmed yet



- **No interference so far** : frequencies are very different

- Experience on different stations :
Grasse, Metsahovi, Greenbelt,
Jiufeng, Papeete, HBK, Yaragadee,
Mount Stromlo



- Hosting a DORIS beacon in a SLR station means almost no additional work
 - ➔ **This kind of colo-cation presents only advantages**
 - ➔ **Common Maser may be useful to both system**

DORIS-VLBI RFI

Current colocations DORIS/VLBI:



Greenbelt:	237m	VLBI 2010
Yarragadee*:	130m	VLBI 2010 planned
Badary*:	50m	VLBI 2010 planned in 2014
Kauai:	200m	VLBI 2010 planned
Ny Alesund:	> 1km	VLBI 2010 planned in 2017
Metsahovi:	> 1k m	VLBI 2010 planned in 2015
Syowa *	> 1km	

(* DORIS stations usually interrupted during VLBI campaigns)

- **No interference with current VLBI** (cf paper Gennady Il'in et al.: *About the Compatibility of DORIS and VLBI Observations, IVS*)

but DORIS was interrupted anyway during VLBI runs (Yarragadee, Syowa, Badary) to prevent possible interference.

→ coordination IVS/IDS reinforced: tests in Yarragadee: **no interference**

→ problem solved (no more interruption)

→ communication through IVS and IDS: *letter from IVS "Compatibility of DORIS and geodetic VLBI using the S/X System at Badary, Syowa, and Yarragadee"*:

- **Risk of interference with VLBI 2010 :**

◆ On going experiment in Greenbelt : cf next presentation IDS4_2 « Co-location considerations and RFI Mitigation Techniques. L. Hilliards et al. »

- Current study in collaboration with Goddard Space Flight Center
- Greenbelt DORIS beacon will be made available for in situ tests with local VLBI 2010 antenna.

◆ **GOAL :**

- allow DORIS/VLBI co-location **without interrupting DORIS emissions**,
- Harmonize the protocol for management of close coexistence of DORIS and VLBI (setting installation recommendations , e.g. distance + RF shield)

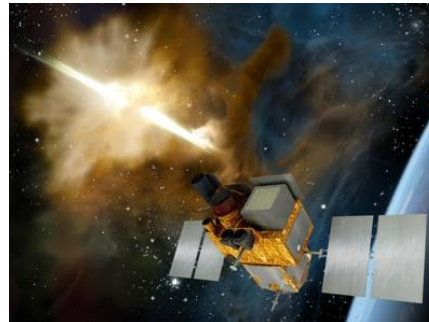
- **DORIS-ARGOS RFI : No interference so far**

- ◆ ARGOS are most of the time only receivers (60 receiver sites, 8 emitters),
- ◆ Experience on different stations : Papeete (distance = 3m), Krasnoyarsk, and Fairbanks.
- ◆ ARGOS and DORIS are close in frequency (H3/H4) and there is a possibility of Multiple interactions for GNSS antennas : (to be checked by CNES/IGN REGINA teams)



- **DORIS-SVOM RFI : No interference**

- ◆ **DORIS-SVOM compatibility has been demonstrated**
- ◆ Many stations, complete RFI file report available (SV-GS-RP-299-CNES , J.P. Granier).



- Radio-sounding system may be present on meteorological sites such as MAHE, CHATHAM, ...

- Principle: (experiment duration ~ 1h30)

Hydrogen Balloon (rapidly ascending)
+ sensors (temperature, pressure, moistures)
+ GPS (wind speed calculation)
+ battery, transmission system

measurements to
→ reception
antenna
(~403 MHz)

- Risk of interferences with DORIS :
sometimes occur when the antenna receiver gets locked on one
of DORIS's main frequencies → radio-sounding measurements may be lost

→ recommendation for a DORIS location close to a radio-sounding :

- ◆ system : antenna distance > 35m
- ◆ Do not place DORIS in the direction of frequent winds wrt reception antenna
- ◆ radio shield between both antennas



- **Frequency permit is an absolute necessity** before installing a new station, even though it does not prevent all interruptions.
- RFI dossier needs to be completed **especially for VLBI 2010**
- RFI/Preliminary conclusions :
 - with Geodetic techniques:
 - * GNSS: **no interference with GPS**, to be confirmed with Galileo
 - * SLR : **no interference**
 - * VLBI : **risk of interference only with VLBI2010**, can be managed, installation recommendations under consideration
 - With other systems :
 - ◆ **No interference** with ARGOS and SVOM
 - ◆ RFI with radio-sounding system (**but solutions exist**)

THANK YOU!

