DORIS DGXX

and

RINEX Products
IDS WORKSHOP, 13–14 March 2008

New DORIS DGXX and associated Products

*Recall from last presentation by JP-Granier at previous IDS Workshop:*

The DORIS DGXX equipment will be used on: Jason-2; SARAL; Cryosat-2; Sentinel-3; HY2; Jason-3

This equipment includes:
- Full internal cold redundancy of USO, MVR, and with Antenna automatic switch
- Each MVR allows 7 (UT) measurement channels in parallel

The 2GXX receiver performs more accurate and more complete phase, delta-phase and pseudo-range measurements
DORIS DGxx dual frequency Instrument
401.25MHz / 2036.25MHz

DORIS antenna

2 kg
h 420 x φ160 (mm)

DORIS DGxx
BDR *

18 kg
390 x 370 x 165 (mm)

* Boîtier DORIS Redondé
The DORIS Data measurements

**PARAMETER_NAME in TM DGXX**

**TDI Time tagging path, on 2 GHz channel**

**UC Time scale**

Delta_TDI_2GHz (0.1 µs) (>0)

**TDI Time tagging path, on 2 GHz channel**

**TDI_2GHz**

**4 µs transfer time for 40 bits phase measurement (Acos, Asin)**

Delta_F = (F_0 + 10^10) (10^14)

**Delta Phase 2GHz**

= \psi \text{ à } (T_2 \text{ 2GHz}) + \psi \text{ à } (T_2 \text{ 2GHz}) (2x2^{10}) chained mode

**Delta Phase 2GHz**

= \psi \text{ à } (T_3 \text{ 2GHz}) + \psi \text{ à } (T_3 \text{ 2GHz}) + 3.10^7/FOUSS (2x2^{10}) not chained mode

**Delta Phase 400MHz**

= \psi \text{ à } (T_0 \text{ 400MHz}) + \psi \text{ à } (T_0 \text{ 400MHz}) (2x2^{10}) chained mode

**Delta Phase 400MHz**

= \psi \text{ à } (T_3 \text{ 400MHz}) + \psi \text{ à } (T_3 \text{ 400MHz}) + 3.10^7/FOUSS (2x2^{10}) not chained mode

**ΔTAI** : time bias provided by CNES laboratoire Temps/Fréquence

D = Distance (Sat(T_SI+T3+Tp3+ΔTAI), Sta(TSI+T3+ΔSI))

T_3 = (D + Δtropo)/c ; after ionospheric correction

**ΔT** :

transit time Doppler measurement (2GHz phase center, detection UAM_2GHz) = 46 µs

Master Beacon

T_3 = T_SI = 2.1 s + 120 bits / 200 bits/s

**Δt** :

transit time Doppler measurement (400MHz phase center, detection UAM_400MHz) = 57 µs

Beacon 3rd generation

T_3 = T_SI = 4.7 s + 120 bits / 200 bits/s

**Δt** :

transit time T_3 (2GHz phase center, detection UAM_2GHz) = 864 µs

Beacon 1st, 2nd generation

T_3 = T_SI = 4.9 s + 80 bits / 200 bits/s

**Δt** :

transit time T_3 (400MHz phase center, detection UAM_400MHz) = 324 µs

**BP** :

Master Beacon

ΔT = (T_3 + ΔTAI - ΔSI) - T_SI

**BP** :

Beacon 3rd generation

ΔT = (T_3 + ΔTAI - ΔSI) - T_SI

**BP** :

Beacon 1st, 2nd generation

ΔT = (T_3 + ΔTAI - ΔSI) - T_SI

**BP** :

Distance (Sat(T_3 + ΔTAI) - Sta(T_3 + ΔSI))

**BP** :

Distance (Sat(T_3 + ΔTAI) - Sta(T_3 + ΔSI))
The DORIS Data exchange

- DORIS DGXX telemetry
- Satellite CC
- Precise Time Tagging
- ICC Pre-processing
- Rinex 3.0
- Data canceling
- Format adaptation to GINS
- PANDOR
- CNES POD ZOOM
- 1B Product
- Rinex redated accuracy µs
- IERS Combination Pilot Project
- Combination Research Center
- GRGS
- IDS Analysis Centers
- CLS/LEGOS
- IGN/IPGP
- INASAN
- GSFC
- GOP
- ESOC
- GA
- CDDIS
- IGN
- IDS Combination
- IERS ITRF
- SSALTO
- accuracy few µs
The DORIS 1.0 RINEX product Data format

The Doris 1.0 RINEX format is an application of the standard Receiver Independent Exchange Format Version 3.0 issued by the Astronomical Institute University of Bern.

The RINEX format can be used for DORIS as it makes little assumption about the actual content of the data file, but only constrains the formatting of the data.

Reference documents:
- Rinex Version 3.0 (Astronomical Institute University of Bern) dated 1st February 06
  @ www.aiub-download.unibe.ch/rinex
- Rinex Doris 3.0 SALP-SP-M-EA-15578-CN Issue 1.1 dated 12th February 08

Document providing details of algorithm for the Rinex computation:
- Specification technique du traitement Doris/DGXX de niveau 1.0 (in French)
The DORIS 1.0 RINEX product Data format

As for GNSS Rinex, the file consists of a header section and a data section.

Doris data in Rinex files are stored in chronological order.

*Doris Rinex observables include three fundamental quantities:*

- Time
- Phase
- Pseudo-Range

*It include also other information concerning the measurement:*

- Received power level
- Oscillator relative frequency offset and meteorological data (pressure, temperature, humidity)

Flags are added at each data type.
The DORIS 1.0 RINEX product Data format

Pseudo Range:

The pseudo-range is the distance from the station antenna to the satellite antenna including transmitter and receiver clock offsets and other biases, such as tropospheric and ionospheric delays.

In the DORIS system stations are not synchronized, so the pseudo-range reflects the behavior of the free running station clock.

However, the DORIS system contains a few time reference stations; These stations contain frequency standards that ensure a low short-term noise and long term variations in the time of these stations are permanently monitored with respect to TAI.

Pseudo-ranges for these stations are corrected for long term drifts with respect to TAI. Pseudo-ranges from these stations reflect the small short-term fluctuations of the station clocks, and they reference TAI on average.

The pseudo-range is stored in units of 0.01 kilometers.

Observables are not corrected for external effects like atmospheric refraction, etc.
The DORIS 1.0 RINEX product Data format

**PHASE:**

DORIS DGXX receivers measure the unambiguous received phase over a pass at two frequencies.

The phase measurement does not contain any systematic contribution from intentional offsets of the transmitter or receiver oscillators leading to non-zero beat frequencies.

*Introduction of the 2 Doris frequencies in the RINEX version 3.0 observation code:*

<table>
<thead>
<tr>
<th>System</th>
<th>Freq. Band</th>
<th>Frequency</th>
<th>Channel or Code</th>
<th>Observation Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pseudo Range</td>
</tr>
<tr>
<td>DORIS</td>
<td>S1</td>
<td>2036.25</td>
<td>C1</td>
<td>L1</td>
</tr>
<tr>
<td></td>
<td>U2</td>
<td>401.25</td>
<td>C2</td>
<td>L2</td>
</tr>
</tbody>
</table>
Example of a DORIS RINEX FILE

VERS 3.00                  COMMENT
The file contains Doris measurements performed by JASON2
Satellite on the nominal chain of a DGXX instrument
JASON-2
SATELLITE NAME
9205201                    COMMENT
STILO                  CNES                  OBSERVER / AGENCY
CHAIN1              DGXX                1.00                REC # / TYPE / VERS
DORIS               STAREC                  ANT # / TYPE
0.0921        1.0921        0.8647                  APPROX POSITION XYZ
0.1230        0.4560        0.7890                  CENTER OF MASS: XYZ
D  10  L1  L2  C1  C2  W1  W2   F   P   T   H             SYS / # / OBS TYPES
2001     8    21     0     0    0.0000000                 TIME OF FIRST OBS
D  100   2 C1  C2                                          SYS / SCALE FACTOR
D          -2.000                                           L2 / L1 DATE OFFSET
48                                                      # OF STATIONS
D01  STJB ST JOHN S                             10 3   0    STATION REFERENCE
D02  TLHA TOULOUSE                              10 3   0    STATION REFERENCE
...  
D47  EASB EASTER ISLAND                         10 3   0    STATION REFERENCE
D48  KRAB KRASNOYARSK                           10 3   0    STATION REFERENCE
1                                                      # TIME REF STATIONS
D02    -0.000 1        -0.000 1  32884249.705 2  32884916.645 2      -139.000 7
-126.400 7    2361.256        1000.773 1        16.628 1       72.738 1
> 2001 08 21 00 00 42.939956370  0  2       -1.084696938 0
D01  -1805705.773 1   -355899.685 1  32744988.881 1  32744801.882 1      -130.250 7
-116.250 7    2361.256        1000.820 1         0.000 1       72.732 1
D02  -53937.326 1    -10628.958 1  32883455.396 2  32883416.388 2      -139.000 7
-126.400 7    2361.256        1000.773 1        16.628 1       72.738 1
END OF HEADER
TEST and VALIDATION

- Internal validation and comparison of the Rinex format with the previous Doris 1.0 level product using simulated data have shown coherent results.

- Simulated Doris measurements have been used to produce over three days of RINEX products files based on a prototype software.

- By mid April, equivalent RINEX products files will be available based on the application software that will be used in routine.

⇒ Point of contact for the validation:

Format:  emmanuel.lourme@cnes.fr
Orbit:   flavien.mercier@cnes.fr
CONCLUSION

This file will be produced once a day.

All the data provided in this file will have a time tagging accuracy of few µs and 1µs for the files redated after Pandor processing.

This file contains all the data needed to compute your own time tagging.

All the data of this file are as close as possible of the Raw Data.

All instrumental's corrections are applied to the Raw Data, and described at the beginning of the file.