



DORIS USO SENSITIVITY TO RADIATIONS

(Issue 1.1)

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1. PURPOSE

This document gathers informations about DORIS Ultra-Stable Oscillators (USO) and their sensitivity to radiations.

2. APPLICATION DOMAIN

This document applies to DORIS receivers in flight.

Future missions are mentioned for information, changes may still occur.

3. STATUS OF DORIS USOS SENSITIVITY TO RADIATIONS

Hereafter are gathered the available informations :

| Mission | Gen. | DORIS chain | USO S/N | USO type | Quartz S/N | Quartz origin | Quartz batch | Hardened Quartz | Sensitivity before irradiation Df/f per rad * | Sensitivity after irradiation Df/f per rad * |
|----------------|------|-------------|------------|----------|------------|-----------------|--------------|-----------------|--|---|
| SPOT2 | 1G | S | 474 | FEI | | US (SAWERS TBC) | | P (**) | U | |
| SPOT3 | " | S | MIQ5 | G | | | | N | U | |
| SPOT4 | " | S | MV3 | G | | | | N | U | |
| TOPEX-Poseidon | " | 1 | CEP E MV2 | G | 83 | SAWYERS | 8747 | N | U | |
| | | 2 | CEP E MV1 | G | 33 | SAWYERS | 8747 | N | U | |
| ENVISAT | 2G | 1 | CEP E FM23 | G | | | | N | U | |
| | | 2 | CEP E FM20 | G | | | | N | U | |

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|-----------|------|-------------|-----------------------------------|----------|----------------|-----------------------|----------------------|----------------------------------|--|---|
| Jason-1 | 2GM | 1 | CEP E FM19 | G | | SICN HQ swept (93) | | N | U | |
| | | 2 | CEP E FM28 | G | | SICN HQ swept (93) | | N | U | |
| SPOT5/H2 | 2GM | S | CEP E FM 30 FM31 FM32 | NG10 | 01 13 05 | SICN HQ swept (93) | 9906 9912 9912 | N | U | |
| Jason-2 | DGXX | 1 | FM48 | NG5 | 0054 | GEMMA THQ | 0444 | Y (30 kRad à 420 rad/h) | 6.4 ^E -12 | 2.17 ^E -12 |
| | | 2 | FM44 | NG5 | 0006 | GEMMA THQ | 0450 | Y (30 kRad à 420 rad/h) | 5.3 ^E -12 | 2.0 ^E -12 |
| Cryosat-2 | DGXX | 1 | FM 43 | NG5 | 0008 | GEMMA THQ | 0651 | Y (30 kRad à 420 | (***) | (***) |

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|------------------|-------|-------------|---------|----------|------------|---------------|--------------|-------------------------|--|---|
| | | | | | | | | rad/h) | | |
| | | 2 | FM 47 | NG5 | 0024 | GEMMA THQ | 0651 | Y (30 kRad à 420 rad/h) | (***) | (***) |
| HY2A | DGXX | 1 | FM 51 | NG5 | 0034 | GEMMA THQ | 0651 | Y (30 kRad à 420 rad/h) | (***) | (***) |
| | | 2 | FM 52 | NG5 | 0057 | GEMMA THQ | 0444 | Y (30 kRad à 420 rad/h) | 8.51 ^E -12 | 4.0 ^E -12 |
| SARAL- AltiKa | DGXX | 1 | FM 50 | NG5 | 0008 | GEMMA THQ | 0528 | Y (30 kRad à 420 rad/h) | 2.67 ^E -11 | 2.33 ^E -12 |
| | | 2 | FM 49 | NG5 | 0001 | GEMMA THQ | 0528 | Y (30 kRad à 420 rad/h) | 2.0 ^E -11 | 1.5 ^E -12 |
| Jason-3 | DGXX- | 1 | FM | NG10 | 0044 | GEMMA | 0846 | Y (***) | (***) | (***) |

| Mission | Gen. | DORIS chain | USO S/N | USO type | Quartz S/N | Quartz origin | Quartz batch | Hardened Quartz | Sensitivity before irradiation Df/f per rad * | Sensitivity after irradiation Df/f per rad * |
|--------------------|--------|-------------|---------|----------|------------|---------------|--------------|-----------------|--|---|
| | S | | 58 | | | THQ | | | | |
| | | 2 | FM 57 | NG10 | 0043 | GEMMA THQ | 0846 | Y (***) | (***) | (***) |
| Sentinel-3A | DGXX-S | 1 | FM 53 | NG10 | 0001 | GEMMA THQ | 0846 | Y (***) | (***) | (***) |
| | | 2 | FM 54 | NG10 | 0009 | GEMMA THQ | 0846 | Y (***) | (***) | (***) |
| Sentinel-3B | DGXX-S | 1 | FM 56 | NG10 | 0035 | GEMMA THQ | 0846 | Y (***) | (***) | (***) |
| | | 2 | FM 55 | NG10 | 0028 | GEMMA THQ | 0846 | Y (***) | (***) | (***) |
| SWOT | DGXX-S | 1 | FM 59 | NG10 | 0008 | GEMMA THQ | 0846 | Y (***) | (***) | (***) |
| | | 2 | FM 60 | NG10 | 0019 | GEMMA THQ | 0846 | Y (***) | (***) | (***) |
| HY2C/D | | 1 | | M | | | | Y | | |
| | | 2 | | M | | | | Y | | |
| Jason-CSA | DGXX- | 1 | | M | | GEMMA | | Y | | |

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|-------------|--------|-------------|---------|----------|------------|---------------|--------------|-----------------|--|---|
| | S | | | | | THQ | | | | |
| | | 2 | | M | | GEMMA THQ | | Y | | |
| Jason-CSB | DGXX-S | 1 | | M | | GEMMA THQ | | Y | | |
| | | 2 | | M | | GEMMA THQ | | Y | | |
| Sentinel-3C | DGXX-S | 1 | | M | | GEMMA THQ | | Y | | |
| | | 2 | | M | | GEMMA THQ | | Y | | |
| Sentinel-3D | DGXX-S | 1 | | M | | GEMMA THQ | | Y | | |
| | | 2 | | M | | GEMMA THQ | | Y | | |

Table legend :

FEI : USO manufactured by FEI US Company ; 5MHz doubled

G : USO manufactured by Rakon France Company (previously CEPE or CMAC) nested oven type ; direct 10MHz

NG : USO manufactured by Rakon France Company (previously CEPE or CMAC) Dewar type ; NG5/10 : 5MHz doubled / direct 10MHz

M : Mini- USO (RK410) manufactured by Rakon France Company nested oven type ; 5MHz doubled

U : Unknown

S : Single string

P : probably

Y : Yes

N : No

(*) : instantaneous value (function of dose rate) measured on ground at resonator level with low dose rate (~1rad/h)

(**) : quartz resonator pre-irradiated (cf DAxxx) : FEI process, around one several mégarad.

(***) Pre-irradiation of the component (resonator) : done (30kRad)

Characterisation of the sensitivity of the component wrt radiations after pre-irradiation : not done (an event occurred at the ONERA test laboratory, leading to closure of the only available laboratory at this time for this kind of low dose irradiation)

Note : The sensitivity to radiation of the DORIS instrument frequency observed in orbit is function of the quartz sensitivity itself but it is affected by the shielding effect of the USO body, the BDR body and the satellite body. This sensitivity is, of course, function of the external radiation level which is related to the altitude of the orbit and may vary with the cumulated dose received.

4. ADDITIONAL INFORMATION

A technical note by Gilles Cibiel details results about sensitivity of the DORIS USO wrt radiations .

(END OF FILE)