Poseidon 2 altimeter design and operating

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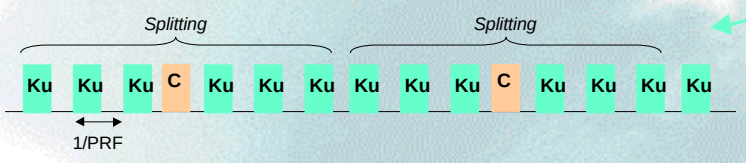
Summary
Poseidon 2 altimeter inherits radiofrequency characteristics and general design from the experimental altimeter Poseidon 1 flying on-board TOPEX/POSEIDON. Important evolutions have been made, such as the introduction of a second frequency in the C-band and intensive use of digital technics for the chirp generator and the base band demodulator.
The instrument is being developed by Alcatel Space Industry.
The main operating modes are described here.

Poseidon 2 main characteristics

Characteristics	Ku Band	C Band	Common
Mean altitude			1347 km
Weight			2×25 kg (full redundancy)
Frequency	13.575 GHz	5.3 GHz	
Bandwidth	320 MHz	320 or 100 MHz	
Pulse width	105.6 µs	105.6 µs	
PRF	1800 (or 1680) Hz	300 (or 420) Hz	
Antenna diameter			1.2 m
Gain	42 dB	33 dB	
Beamwidth	1.3°	3.4°	
Power supply			70 W
Peak output power	7 W	16 W	
Waveform samples number			128

Characteristics of the dual frequency operation

C- and Ku-band pulses are not transmitted simultaneously but interlaced. This simplifies the on-board hardware, some sub-assemblies thus being common to both bands.
Two different configurations may be used (modification is done by uploading).
➔ One C-band pulse transmitted every 6 Ku-band pulses Pattern : 3 Ku / 1 C / 3 Ku
➔ One C-band pulse transmitted every 4 Ku-band pulses Pattern : 2 Ku / 1 C / 2 Ku



Main operating modes

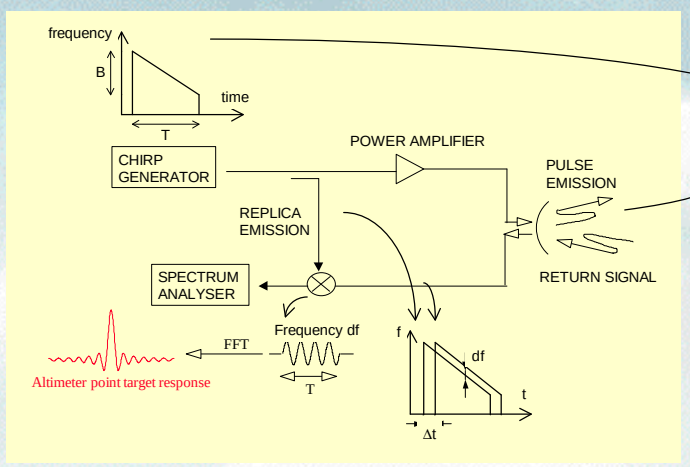
❑ Nominal mode : tracking
→ Tracker algorithm : gain and range tracker.
→ On-board estimation.

❑ Internal calibration
→ Cal-1 : Measurement of the instrument point target response.
→ Cal-2 : Measurement of the reception channel transfer function.

The processing algorithms (tracker and estimator) are applied on the mean of NIMP elementary pulses which constitutes a 50 ms cycle.

Nominal values for a 3Ku/1C/3Ku pattern are { NIMP = 90 in Ku-band ; NIMP = 15 in C-band }

Their operation is based on the **FULL DERAMP** technic

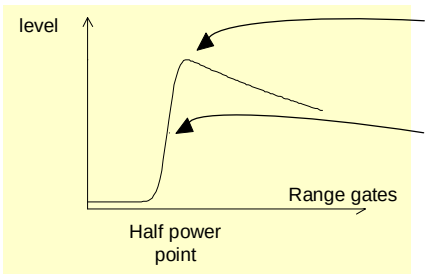


$$\left.\begin{aligned}\partial f &= \frac{B}{T}\partial t \\ \partial t &= \frac{2\partial d}{c}\end{aligned}\right\} \Rightarrow \partial f = k \times \partial d$$

⇨ ***A frequency variation is thus proportional to a distance variation .***

⇨ ***A frequential resolution of 9.47 kHz corresponds to a distance variation of 47 cm on the sea surface.***

The tracking algorithm

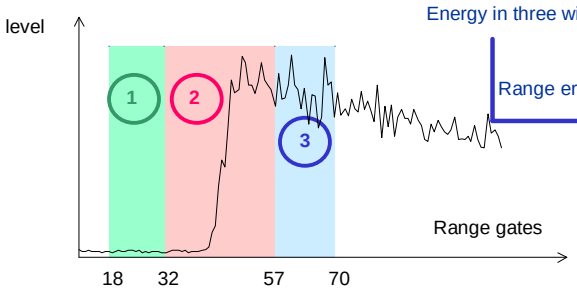


❑ **Automatic Gain control (AGC) first order loop**
⇒ To maintain the signal at a constant amplitude in the analysis window

❑ **Range second order loop**
⇒ To maintain the leading edge of the waveform at a determined range gate

PRINCIPLE

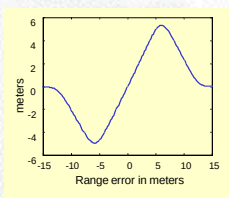
Energy in three windows : **E1**, **E2**, **E3**



Range error calculation for the N cycle

$$\varepsilon(N) = a\left[\frac{1}{2}k\left(\frac{E3}{N3} - \frac{E1}{N1}\right) - \left(\frac{E2}{N2} - \frac{E1}{N1}\right)\right]$$

Calculated error ε(N) as a function of the real range error (H1/3 = 4 m)



Independent calculation in Ku- and C-band → **AGC commanding a variable-gain amplifier**

Calculation only in the Ku-band, results are used in both frequencies → **- Tracker range rate HPR is applied on each elementary pulse.**
- Tracker range H0

Coarse altitude correction CGA is used to determine the replica emission instant - Accuracy : 4 range gates

Fine altitude correction CFA is applied in the spectrum analyser to recenter the echo - Accuracy : 1/64 range gate