

Préparation de la mission ACES-PHARAO au SYRTE

Journée $G_{\phi\Sigma}$

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Expected performances

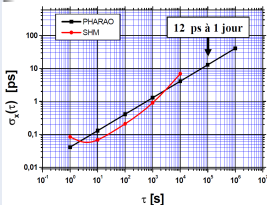
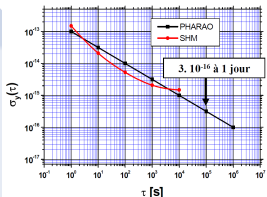
A realization of the second in space (PHARAO) :

- Accuracy better than $3 \cdot 10^{-16}$
- Frequency stability better than $10^{-13} t^{-1/2}$ for $t < 20$ days

A time scale of high stability (PHARAO/HMASER composite clock)

- better than 400 fs @ 300s
- better than 40ps @ 20 days

+ a microwave link (MWL) and a laser link (ELT)



- Atomic clock and microwave link performances in space environment
- Distant clock comparisons

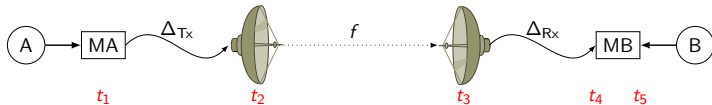


Common view :
 stability $\simeq 0.3$ ps @
 300s



Non common view :
 stability $\simeq 7$ ps @ 1
 day

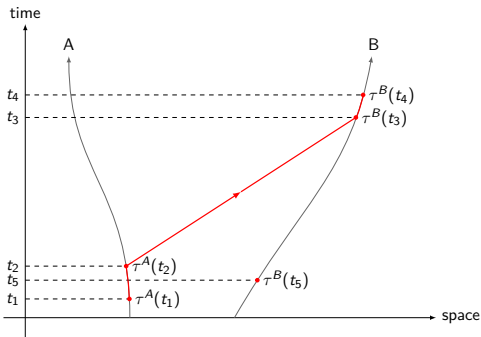
- Equivalence principle tests
- Relativistic geodesy



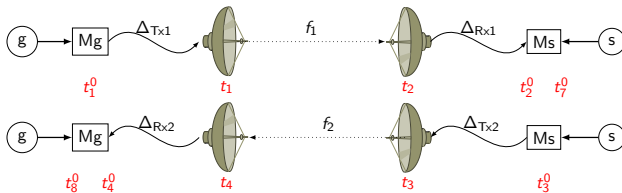
One-way measurement setup

If $\tau^A(t_1) = \tau^B(t_5)$, we define

$$\begin{aligned} \Delta\tau^B(\tau^B(t_4)) &= \tau_{\text{prod}}^B - \tau_{\text{rec}}^B \\ &= \tau^B(t_5) - \tau^B(t_4) \\ &= \tau^A(t_1) - \tau^B(t_4) \end{aligned}$$



$$\text{Desynchro : } \tau^B(t_4) - \tau^A(t_4) = -\Delta\tau^B(\tau^B(t_4)) - \left[T_{23} + [\Delta_{Tx} + \Delta_{Rx}]t \right]^A$$



Two-way measurement setup (= 2 × one-way)

2 observables :

$$\Delta\tau^s(\tau^s(t_2^0)) = \tau^s(t_7^0) - \tau^s(t_2^0)$$

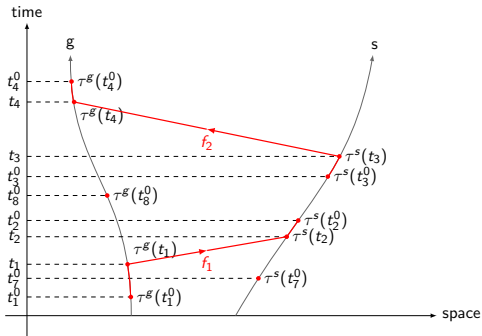
$$\Delta\tau^g(\tau^g(t_4^0)) = \tau^g(t_8^0) - \tau^g(t_4^0)$$

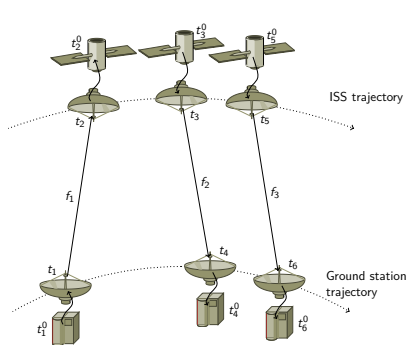
$$\tau^g(t_1^0) = \tau^s(t_7^0) \text{ and } \tau^s(t_3^0) = \tau^g(t_8^0)$$

Desynchro :

$$\tau^s(t_2) - \tau^g(t_2) =$$

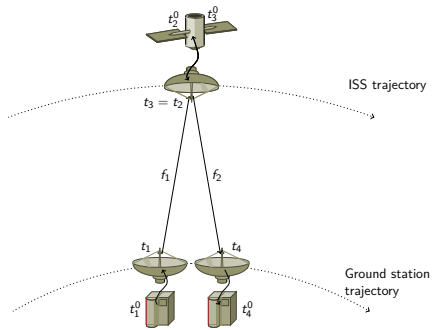
$$\frac{1}{2} ((\Delta\tau^g - \Delta\tau^s + [T_{34} - T_{12}]^g + \dots)$$





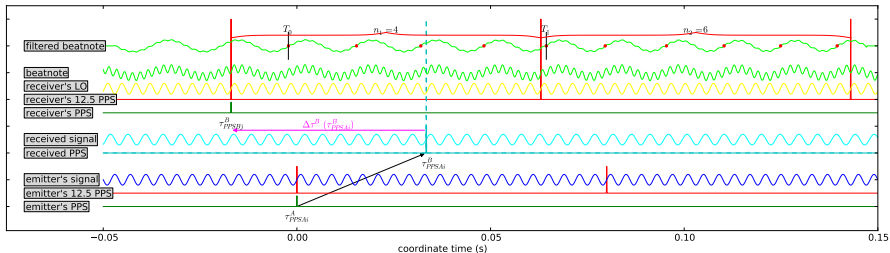
General case

one measurement each 80 ms on
ground and in space



Λ configuration (interpolated)

A third frequency (downlink) is used to determine the ionospheric delay.



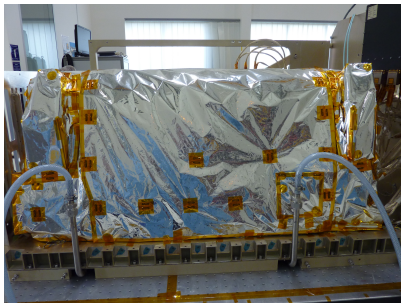
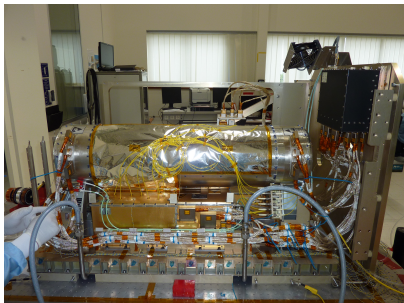
The system generates a beatnote between incoming signal and the local oscillator, then counts the number of zero-crossing for each sample.

Code = 100 MHz (beatnote : 195 kHz)

Carrier = 13.475 GHz / 14.703 GHz (beatnote : 729 kHz)



2 Ground terminals antennas already assembled, electronics under development (to be installed at SYRTE + PTB at autumn 2014).



PHARAO : FM integrated, working and is now under validation.

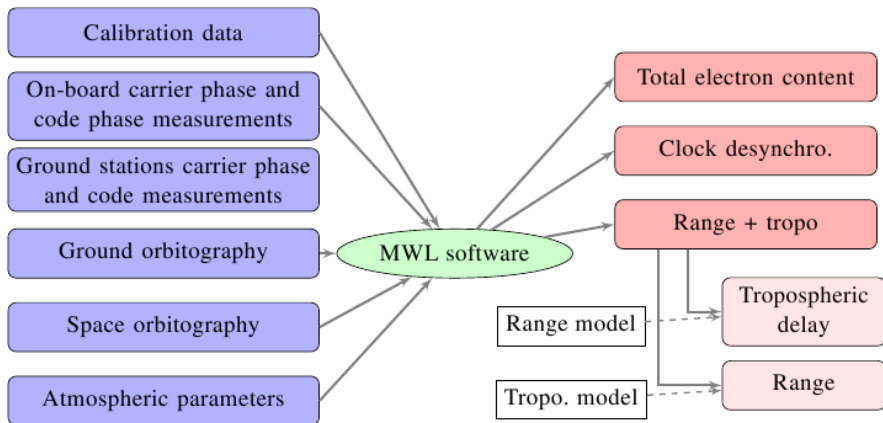


MWL Antenna :
FM delivered

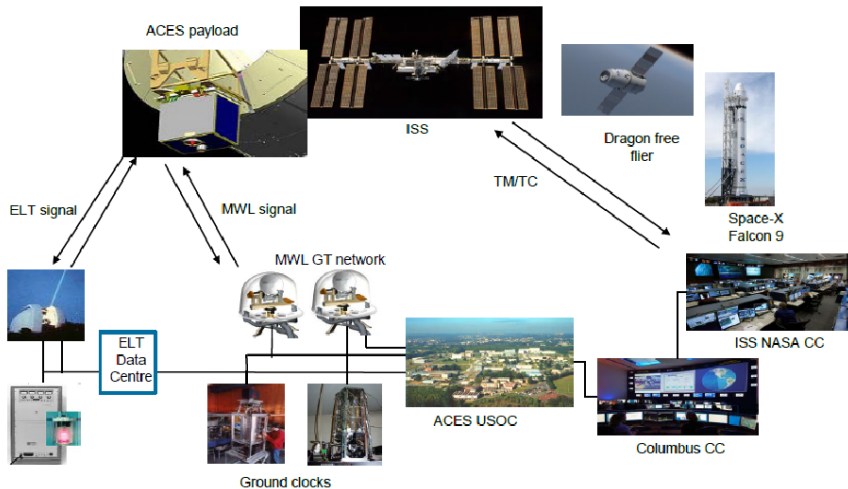


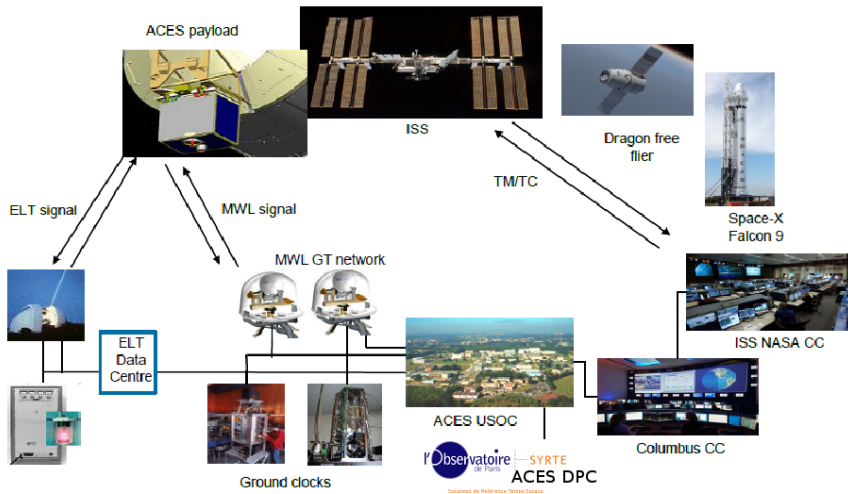
MWL Electronics :
FM in construction

SHM (H-Maser) : pending...



Status : low-level data processing under development at ASTRIUM, high level data processing and scientific analysis under development at SYRTE.





- ACES flight model integration and tests (SHM last blocking point)
- Ground stations installation (prototypes in SYRTE and PTB end of 2014)
- Data processing chain implementation
- **Launch in may 2016**