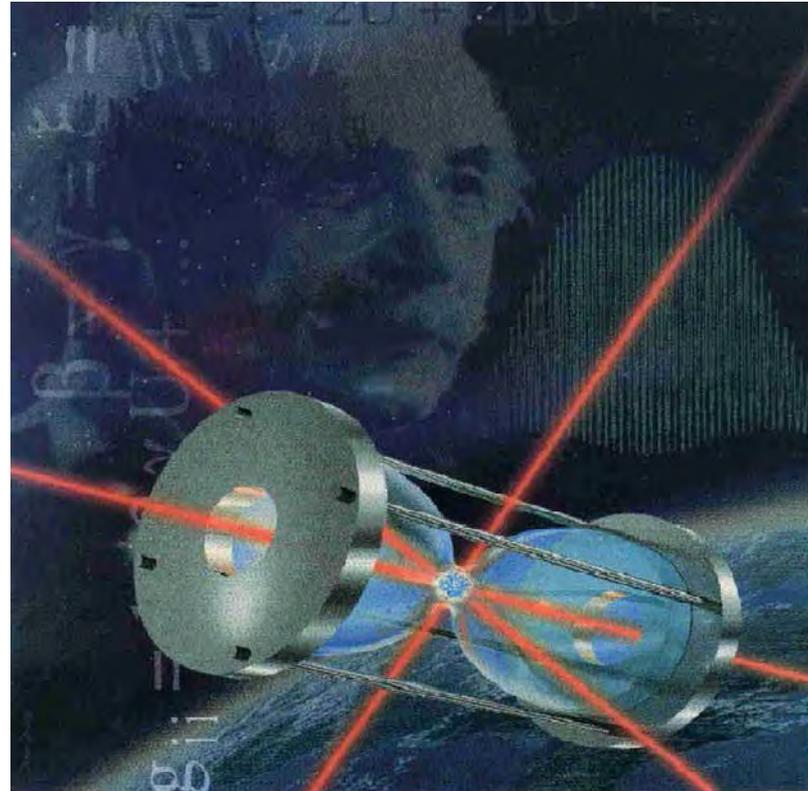


Quelques perspectives

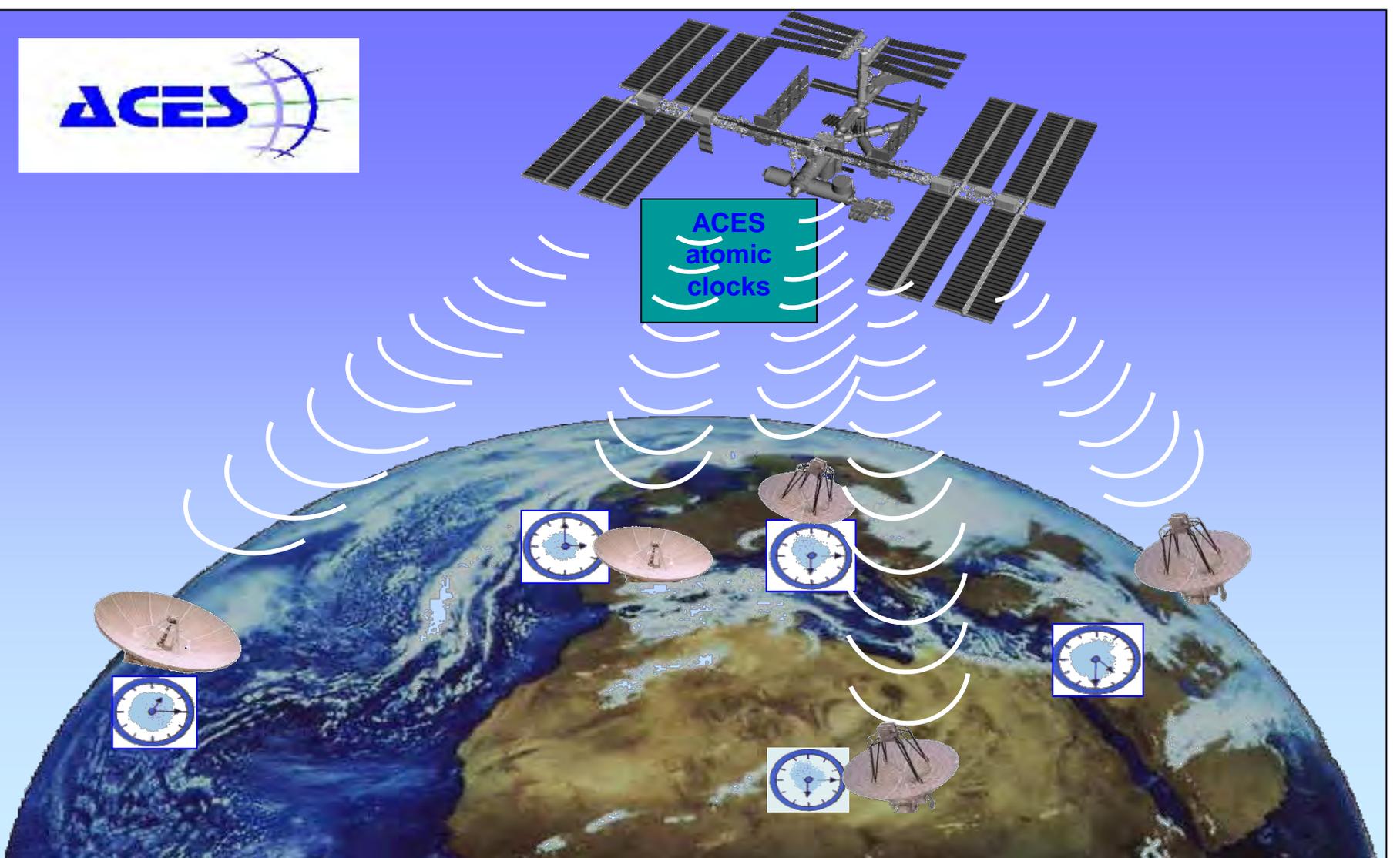
La mission spatiale PHARAO/ACES

1997



The logo for ACES (Atomic Clock Ensemble in Space) features the acronym "ACES" in a bold, blue, sans-serif font. To the right of the text is a stylized graphic of a satellite's solar panel array, consisting of several rectangular panels connected by a central structure, all in shades of blue and white.

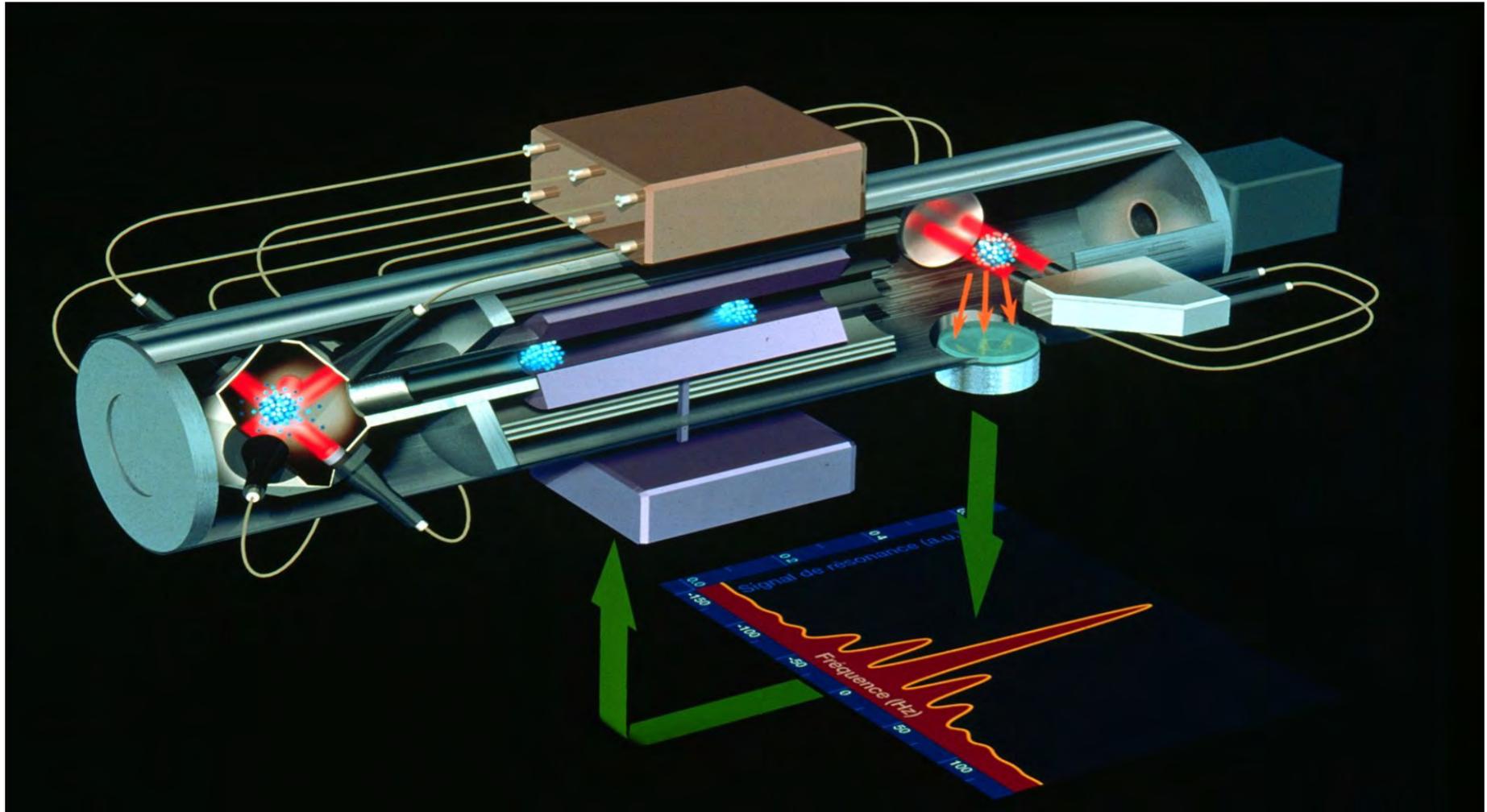
ACES

The diagram illustrates the ACES mission. At the top, a detailed 3D model of the International Space Station (ISS) is shown against a blue sky. A green rectangular box with the text "ACES atomic clocks" is positioned in front of the station. Below the station, a series of white, curved lines represent radio waves emanating from the station towards the Earth. On the Earth's surface, several ground stations are depicted, each consisting of a large, brown, parabolic satellite dish antenna. Next to each dish is a small, square icon of a clock face with a blue border and white hands, representing the atomic clocks used for synchronization and timing.

**ACES
atomic
clocks**

- **Horloge à atomes froids dans l'espace**
- **Tests de physique fondamentale**
- **Accès mondial**

L'horloge PHARAO

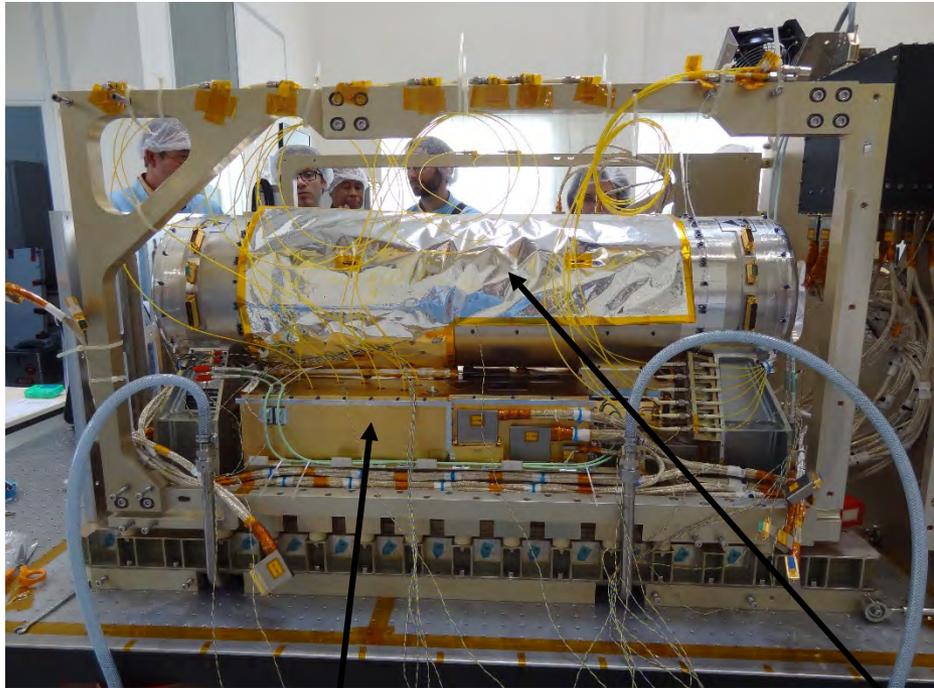


L'équipe PHARAO à Toulouse



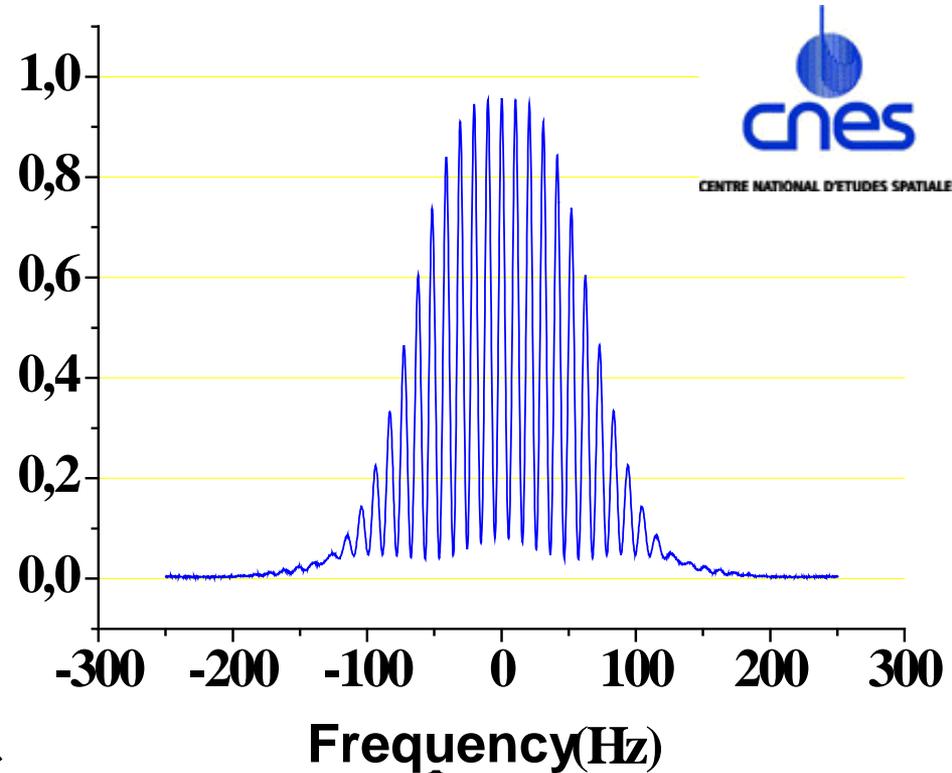


L'horloge spatiale à atomes froids PHARAO



source laser

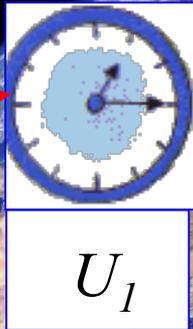
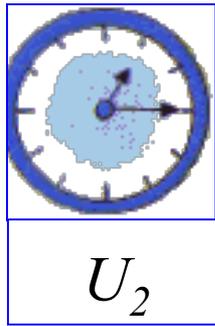
tube césium



Tests du modèle de vol terminés. Stabilité et exactitude attendues dans l'espace: 10^{-16}
Livré à l'ESA en Juillet 2014



Un test de l'effet Einstein



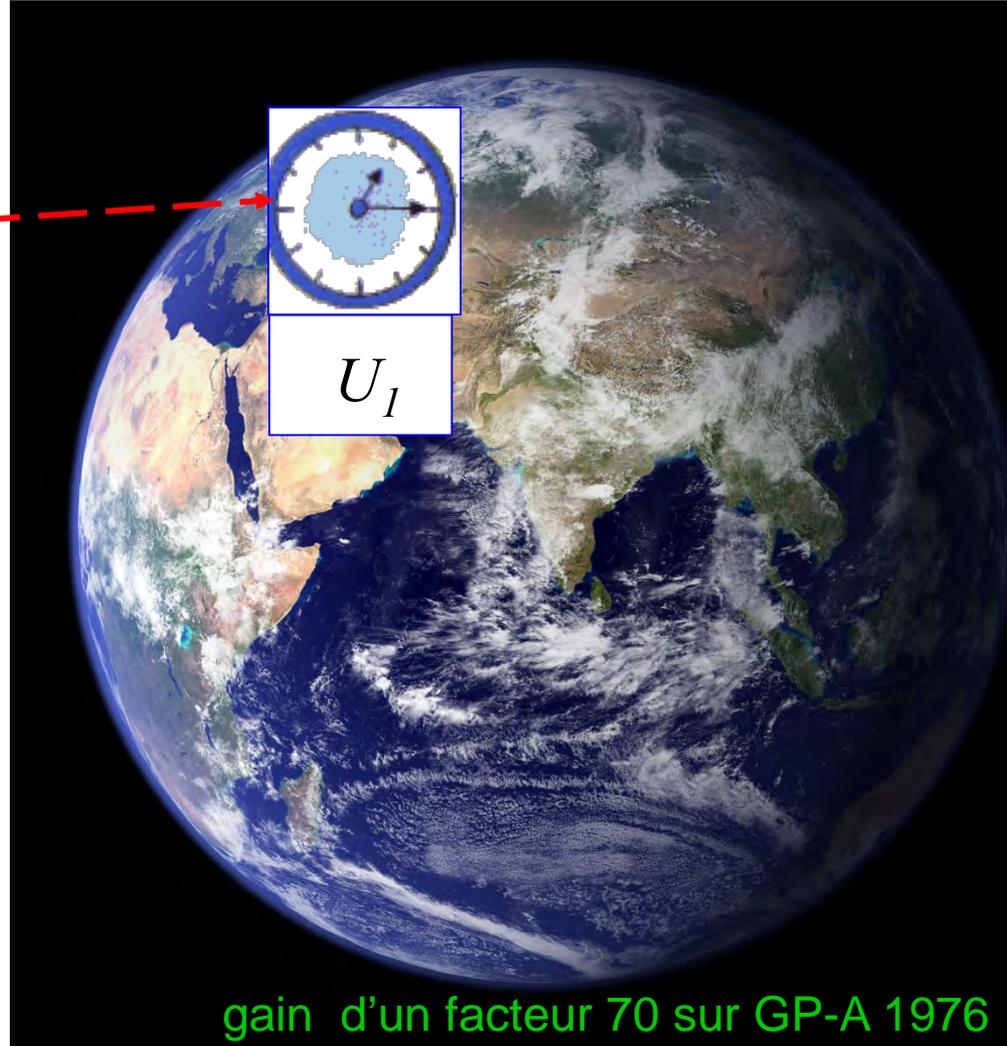
$$\frac{\nu_2}{\nu_1} = \left(1 + \frac{U_2 - U_1}{c^2} \right)$$

Décalage de fréquence

$4.59 \cdot 10^{-11}$

Horloges d'exactitude 10^{-16}

Test à $2 \cdot 10^{-6}$



gain d'un facteur 70 sur GP-A 1976

ACES Network of Ground Institutes



First MWL Ground terminal delivered to PTB in 2015

ACES sur la plateforme externe de Columbus

S122E09893

L'ISS



esa



ACES

date de lancement prévue: fin 2018
durée de la mission : 18 à 36 mois