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ONERA

THE FRENCH AEROSPACE LAB

www.onera.fr

ONERA's airborne bi-static systems, experiments, calibration hardware, and synchronization

Hugo Keryhuel
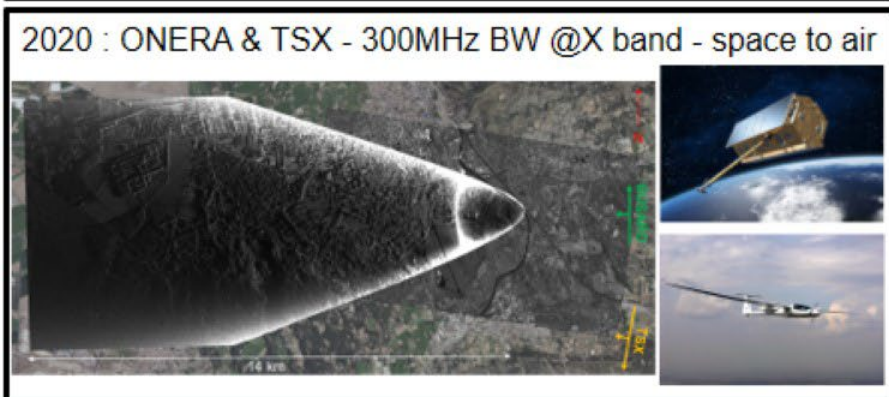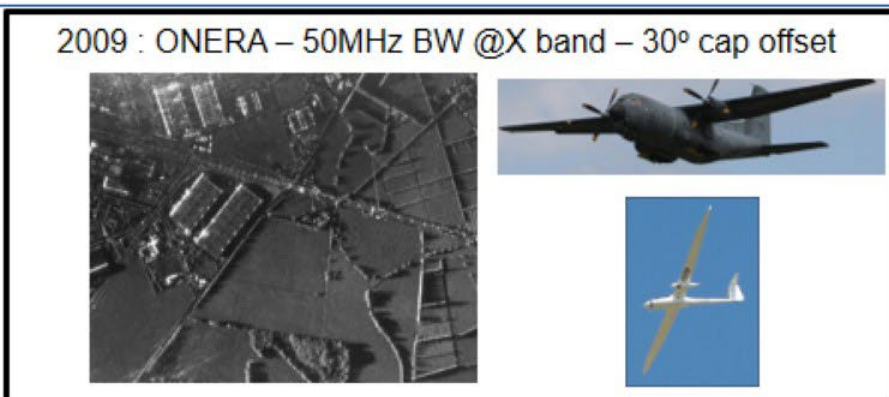
Dept. Of Electromagnetism & radar, ONERA

Summary

- Context

- Latest campaign overview

- Synchronization principle used

- Active transponder

Context – campaigns hindsight since 2003

2003 : ONERA & DLR 100MHz BW @X band ATI/XTI

2009 : ONERA – 50MHz BW @X band – 30° cap offset

2010 : ONERA & FOI - 70MHz BW @U/VHF band – mixed

2020 : ONERA & TSX - 300MHz BW @X band - space to air

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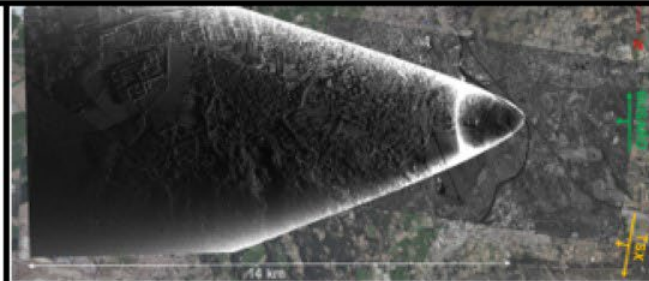
Context – campaigns hindsight since 2003

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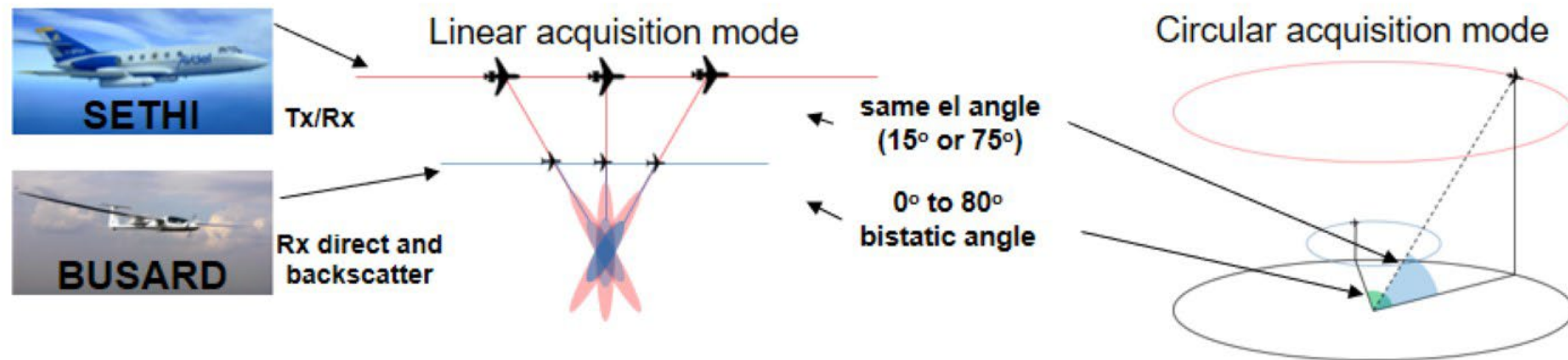First operational bi static campaign
2023 : ONERA – 700MHz @X band

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Latest campaign overview

SETHI Tx/Rx

BUSARD Rx direct and backscatter

Latest campaign overview

SETHI — Tx/Rx

BUSARD — Rx direct and backscatter

Linear acquisition mode

same el angle (15° or 75°)

0° to 80° bistatic angle

Circular acquisition mode

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Latest campaign overview

SETHI — Tx/Rx

BUSARD — Rx direct and backscatter
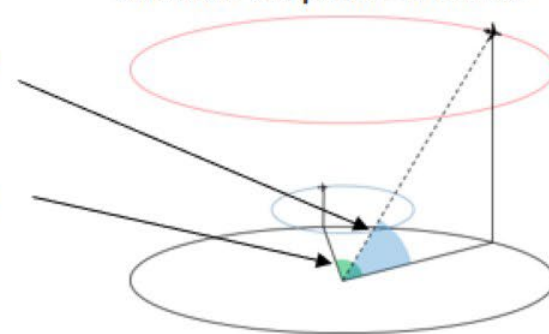
Linear acquisition mode

same el angle (15° or 45°)
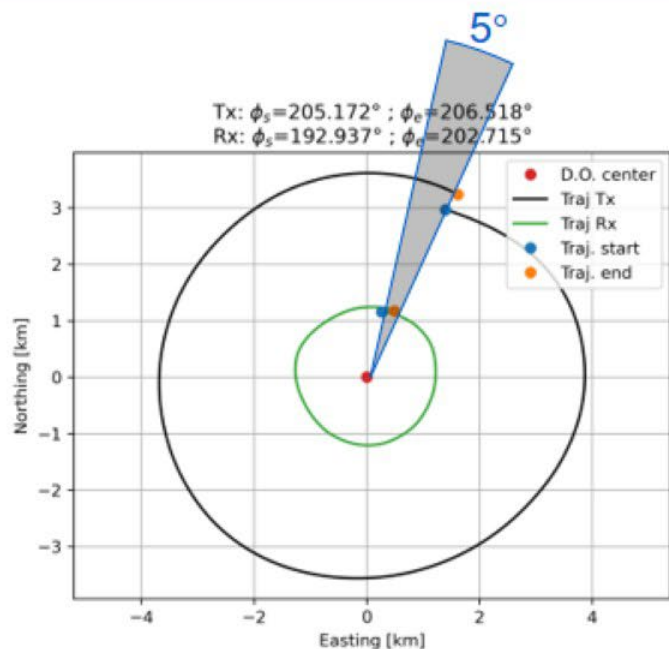
0° to 80° bistatic angle

Circular acquisition mode

Up to 5000 SAR images produced :
- at least 1km² each with 20 cm resolution
- Geocoded
- Radiometry and geometric accuracy provided
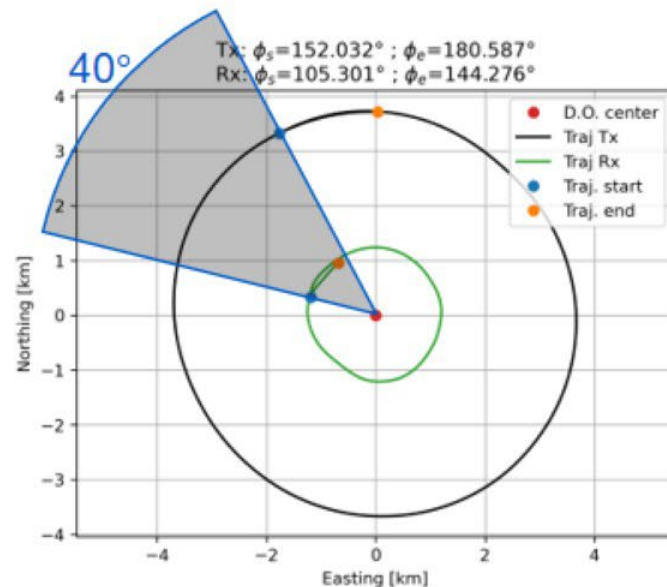- Resolution, PSLR, noise level within requirement

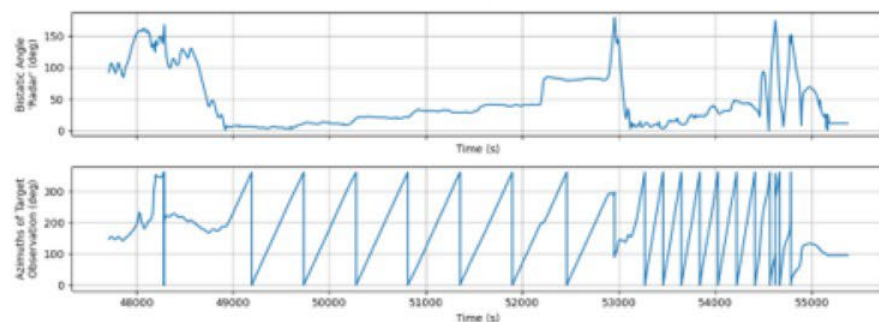Clock synchronization capabilities
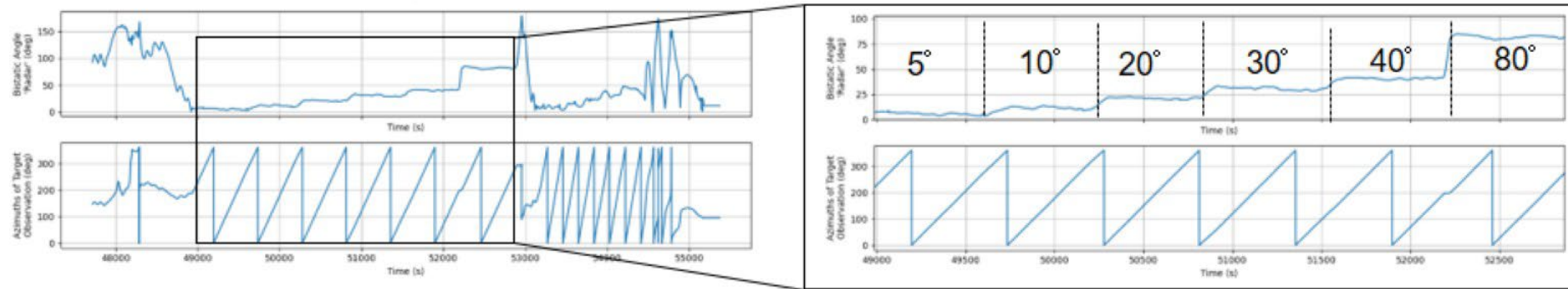
Latest campaign overview
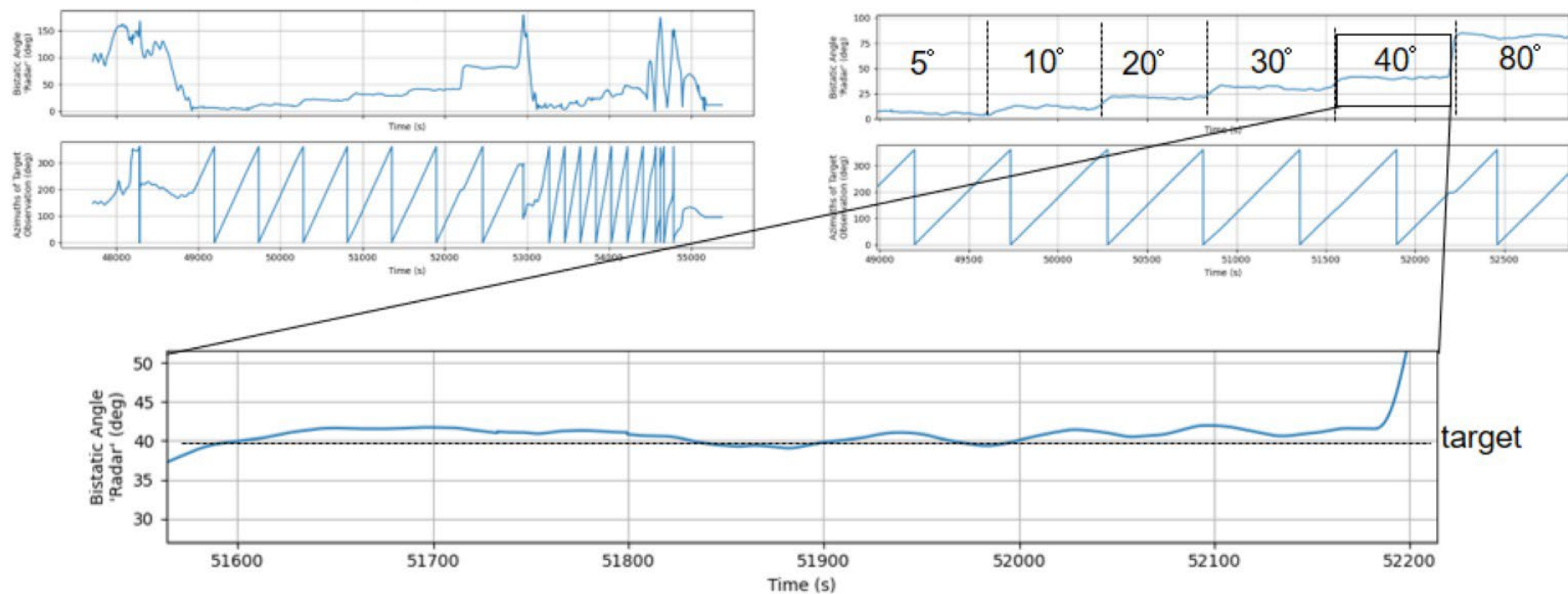

5° bistatisme

40° bistatisme

Latest campaign overview
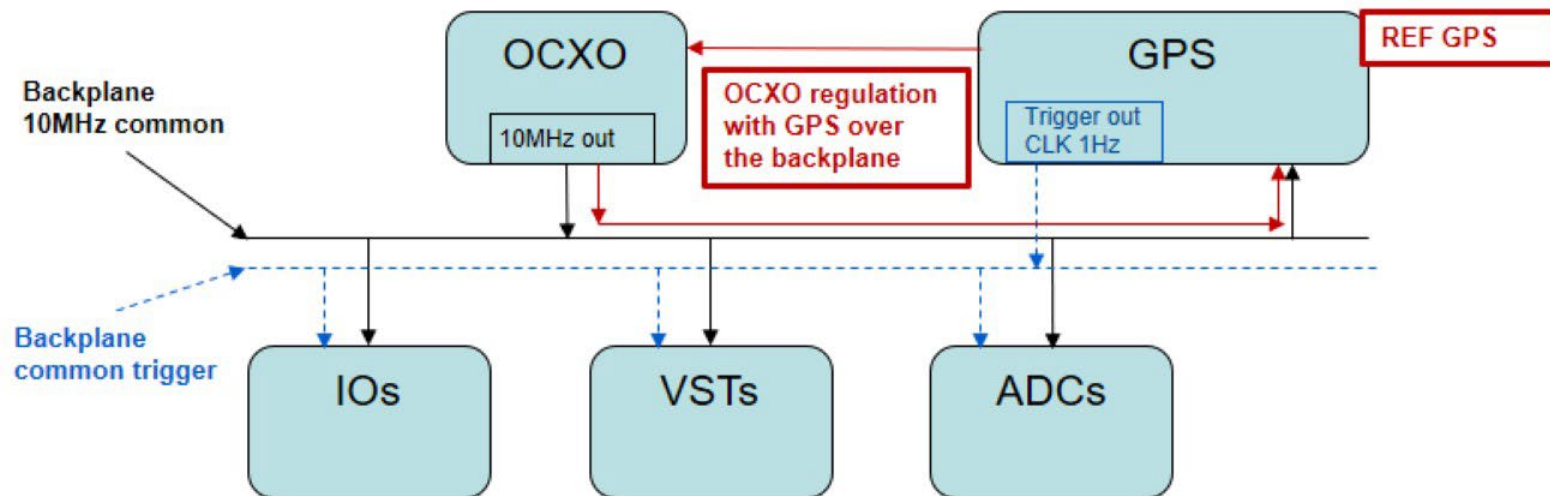
Latest campaign overview

Latest campaign overview

Synchronization principle

Phase 1 : Regulation OCXO over GPS (in between measurements)

- 10MHz OCXO board <u>always master</u>
- Trigger generated by GPS board (common board clock 1Hz)
- 10 MHz OCXO frequency regulation over GPS
- ➔ servitude phase for the 10MHz OCXO over the 10MHz GPS (through PPS)
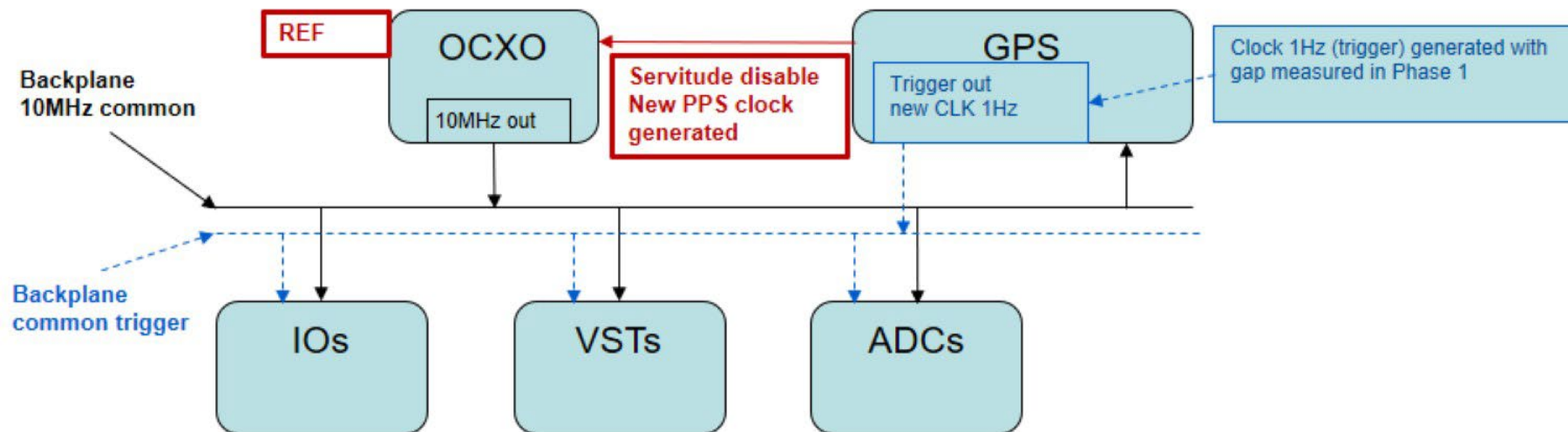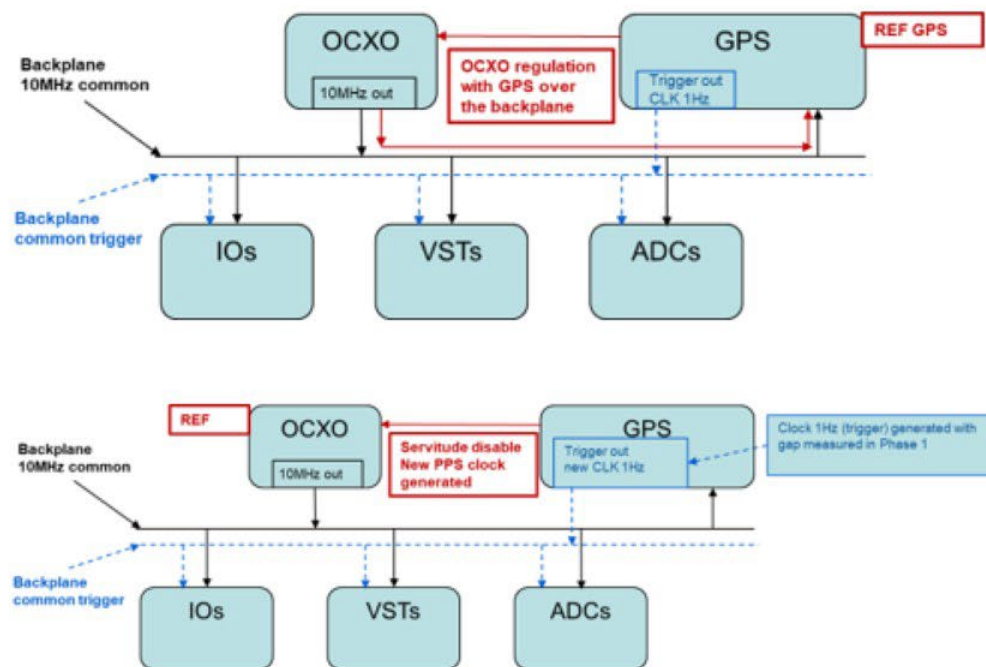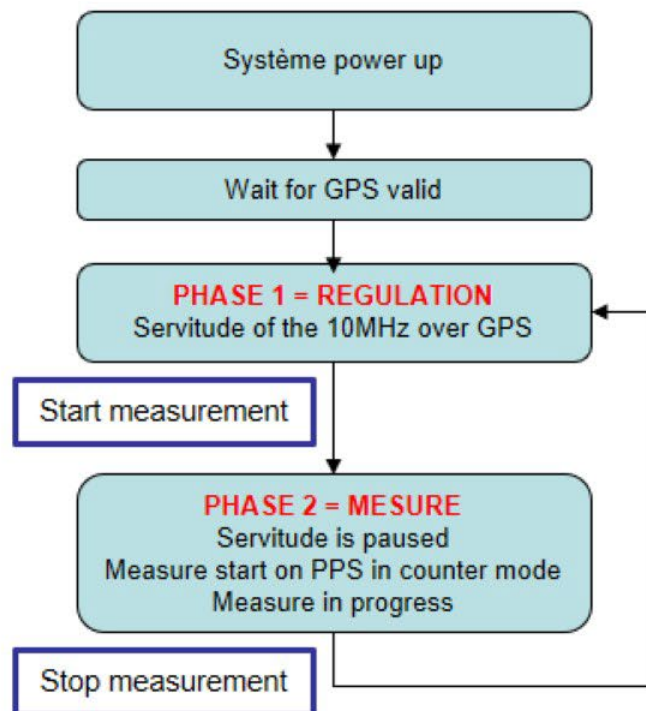- ➔ gap between system clock and GPS clock is measured

Synchronization principle

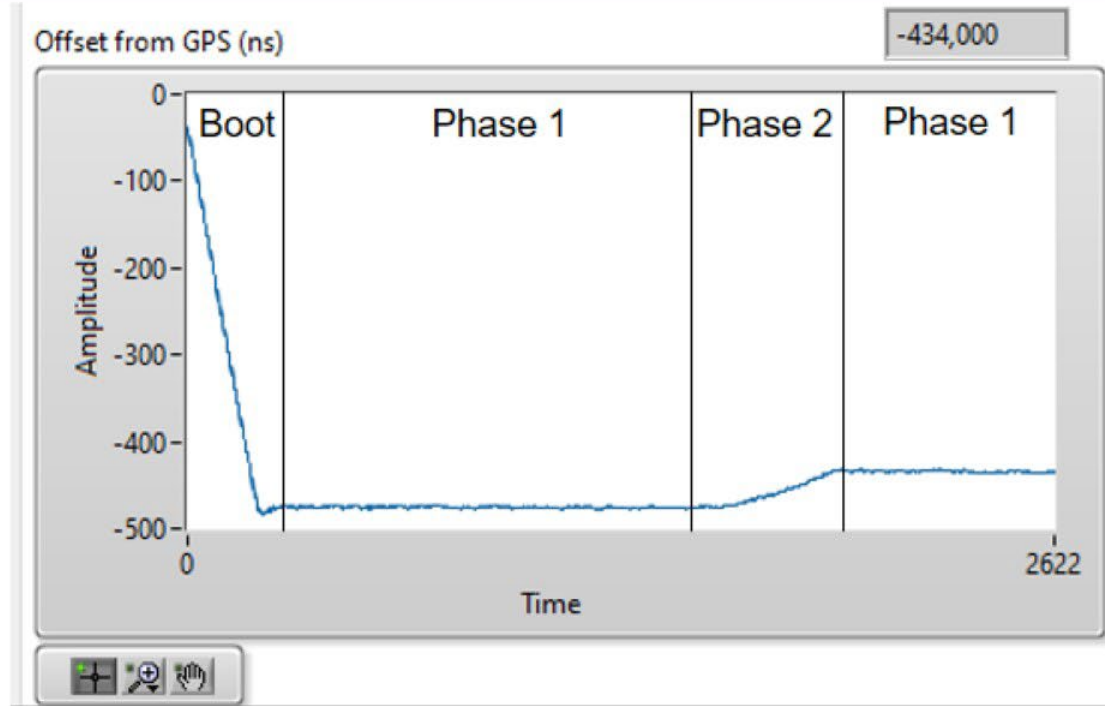## Phase 2 : Measure

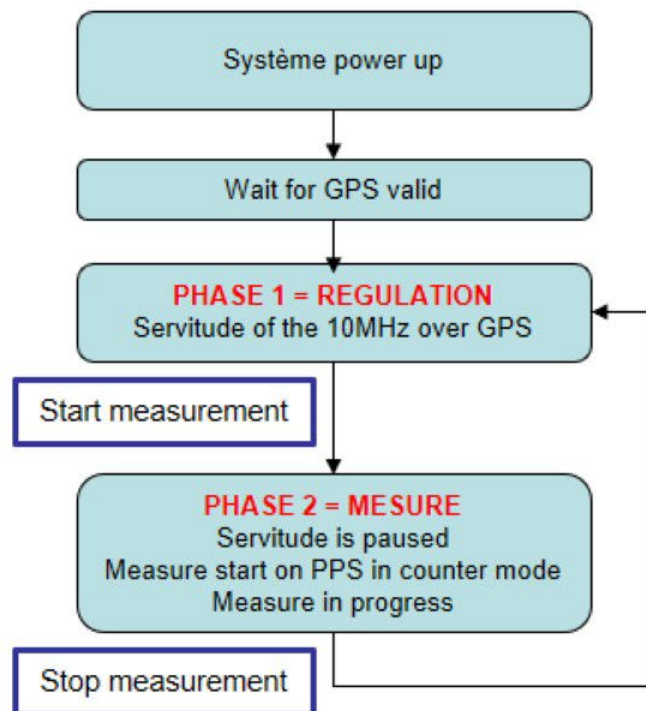- Starting acquisition
- 10MHz OCXO board <u>always master</u>
- Time offset between the system and the GPS is measured.
- Common clock PPS = 1Hz corrected at the start of the acquisition (take into account the offset between the system and the GPS)

Synchronization principle

Synchronization principle

```
Système power up
        ↓
Wait for GPS valid
        ↓
PHASE 1 = REGULATION
Servitude of the 10MHz over GPS  ←┐
        ↓                         │
[Start measurement]               │
        ↓                         │
PHASE 2 = MESURE                  │
Servitude is paused               │
Measure start on PPS in counter mode
Measure in progress               │
        ↓                         │
[Stop measurement] ───────────────┘
```


Offset from GPS (ns)

-434,000

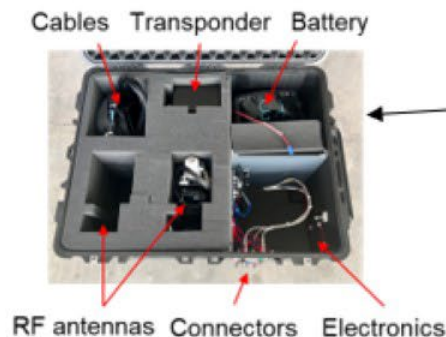Boot | Phase 1 | Phase 2 | Phase 1

≈ drift < 1µs for 600 sec

Active transponder

Requirements
- Easy to transport
- Easy to deploy
- Weather condition resilient
- Tracking capabilities
- Trajectory prediction algorithm
- Control software

Active transponder

Cables Transponder Battery

RF antennas Connectors Electronics

Requirements

- Easy to transport
- Easy to deploy
- Weather condition resilient
- Tracking capabilities
- Trajectory prediction algorithm
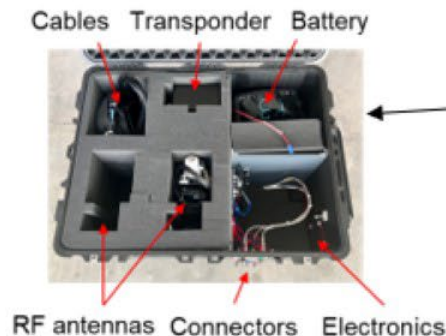- Control software

Active transponder

Cables   Transponder   Battery

RF antennas   Connectors   Electronics

Requirements
- Easy to transport
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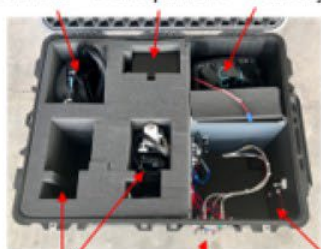- Trajectory prediction algorithm
- Control software

Dual axis motorized antenna
with tracking capabilities

Potential aircraft collision
detector

Active transponder

Cables   Transponder   Battery

RF antennas   Connectors   Electronics

Requirements
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Dual axis motorized antenna with tracking capabilities
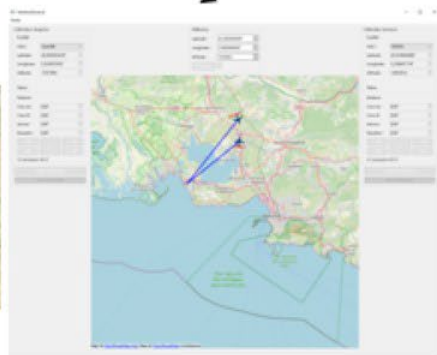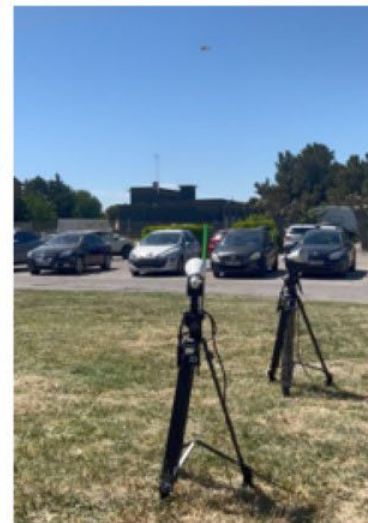

Potential aircraft collision detector

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