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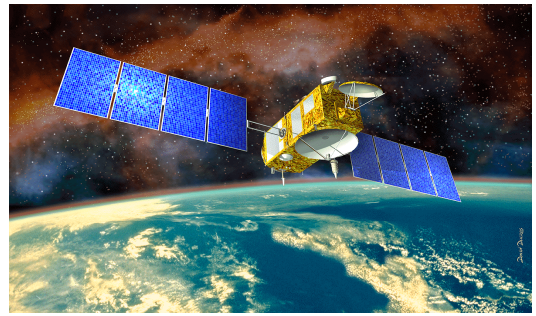
CENTRE NATIONAL D'ÉTUDES SPATIALES



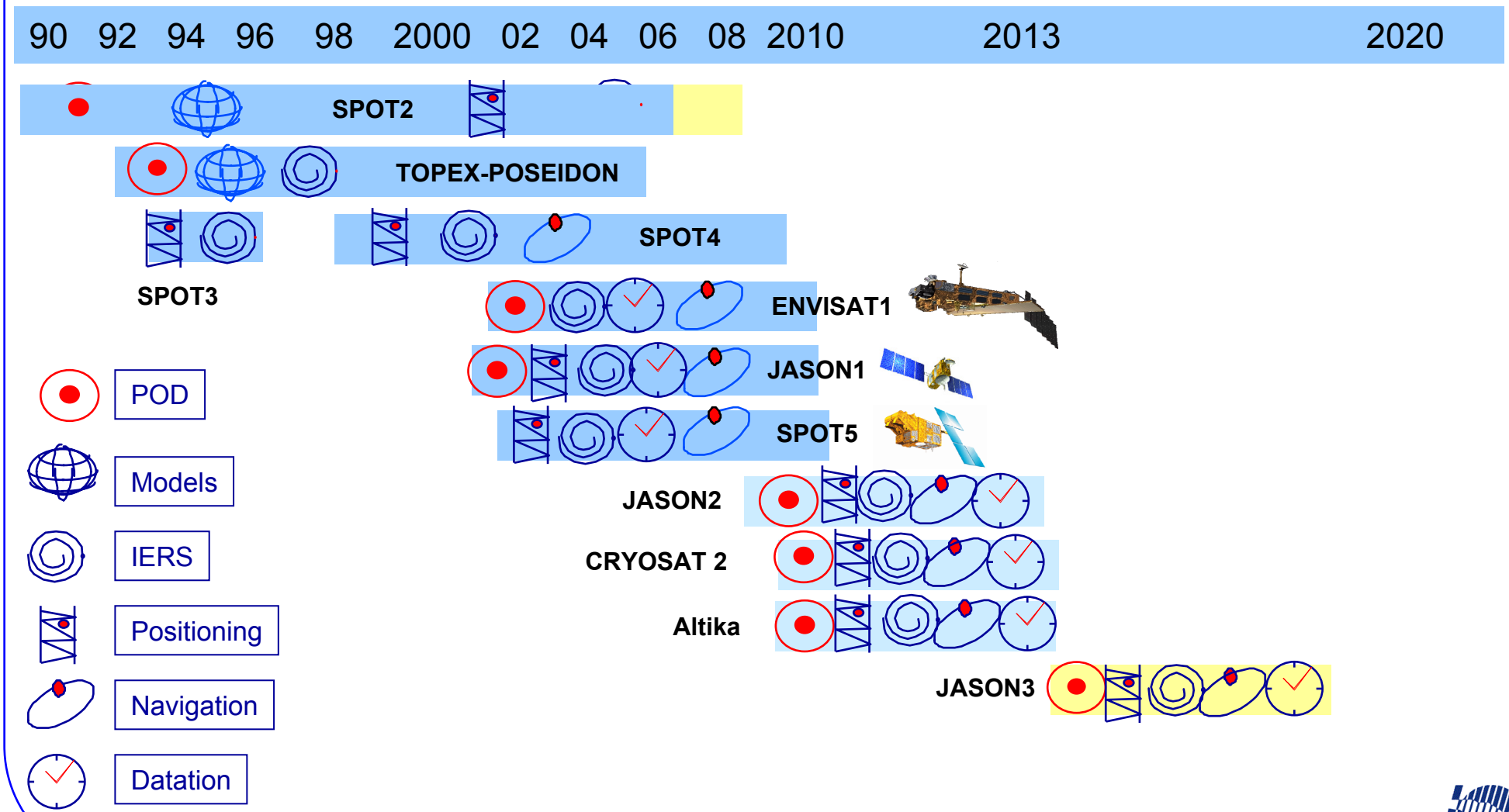
Doppler
Orbitography
and **R**adio positioning
Integrated by
Satellite

doris

DORIS SYSTEM EVOLUTIONS

- What's up in the "DORIS constellation" ?
- DORIS Instrument evolutions
- Network evolutions

What's up in the "DORIS constellation" ?



What's up in the "DORIS constellation"?

1.1 – instruments currently in operations

- ENVISAT1
  - Currently estimated satellite end of life : 2010
  - DORIS chain#1 lost in June 2004 ; chain#2 nominally operated since
    - accidental failure of an electronic part of USO#1
    - same failure should not affect chain#2
  - DORIS OBSW in version 6.0 since October 2004
    - More measurements of better short term quality thanks to routine measurement mode now available (chained measurements ; autonomous selection of beacons to be tracked)

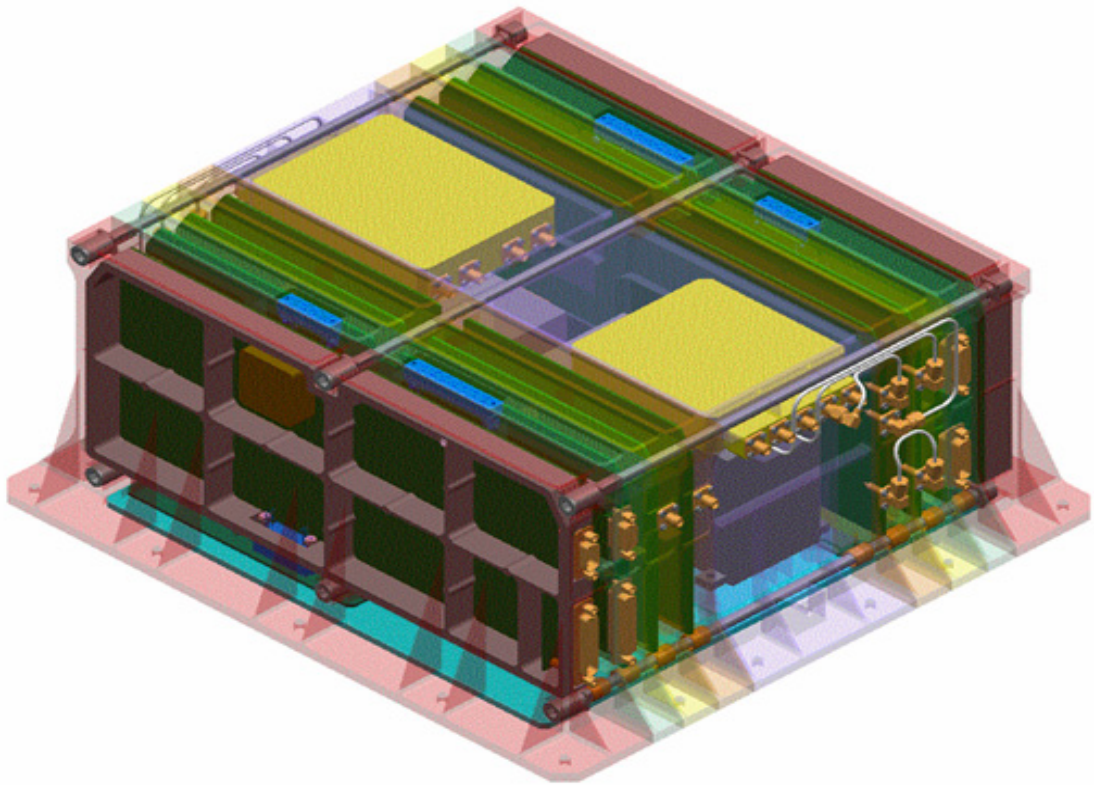
What's up in the "DORIS constellation"?

1.2 – instruments currently in operations

- Jason1
  - Satellite operating on redundant side since September 2005 (TM transmitter failure)
  - DORIS still unavailable for positioning mission although it was switched on redundant chain (end of June 2004) due to sensitivity of both USOs to radiations
- SPOT5
  - DORIS OBSW in version 2.08 since September 2005
    - allows shifted frequency beacons reception

DORIS Instrument evolutions
1 - “All in one box” concept

- Cold redundancy of Receivers and USOs
- 10 MHz distribution for other users with X-isolation
- Automatic RF antenna switching on active receiver
- 18 kg
- 390 x 370 x 165 (mm)



DORIS Instrument evolutions
2 - Processing Unit upgrade

- Obsolescent 31750 CPU has been replaced by an ERC32 CPU
  - ⇒ Increase of processing capacity
  - ⇒ Avoid “numerical error” identified on 31750 limiting the DIODE/2GM performance

DORIS Instrument evolutions

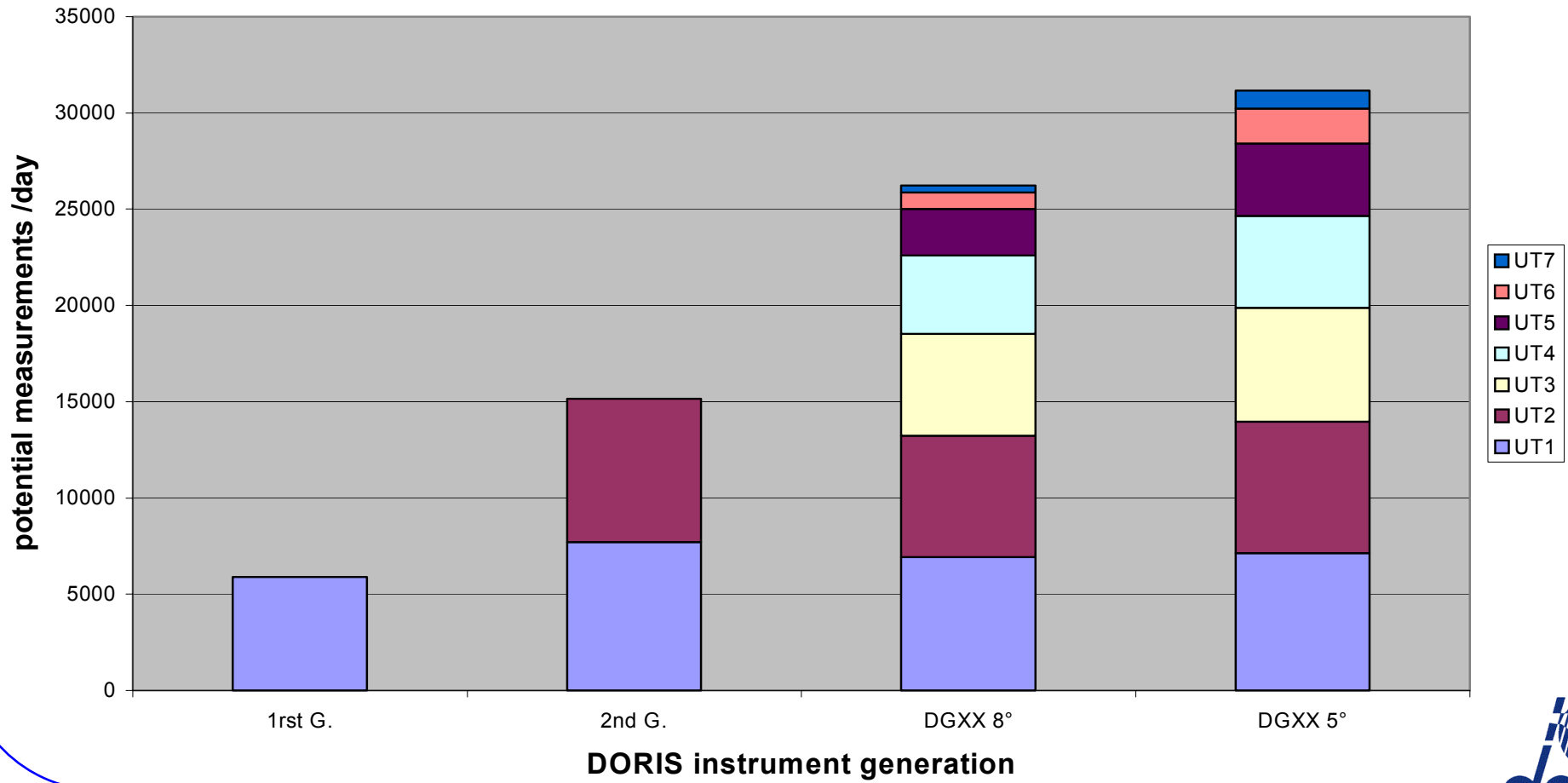
3.1 - Beacons Processing capacity upgrade

- Capacity to track beacons simultaneously has been increased :
  - 1 for the first generation instruments (SPOT2, Topex, SPOT3, SPOT4)
  - 2 for second generation instrument (ENVISAT, SPOT5, Jason1)
  - 7 for current DGXX receivers (Jason2, Altika, …)
    - ⇒ increases the number of measurements passes and geometrical diversity
    - ⇒ decreases/avoid the tracking conflicts (beacons in co-visibility > nber Proc.units)
      - ⇒Allows lower elevation measurements

DORIS Instrument evolutions

3.2 - Beacons Processing capacity upgrade

example : 1330 km orbit (Topex, Jason)



DORIS Instrument evolutions

4 - Dual frequency phase measurements simultaneity

- 1st and 2nd generation instruments (Spot2, Topex, Spot3, Spot4, Envisat)
  - measurement method : entire cycles counting
    - ⇒ No chance to have simultaneous measurements on 400MHz and 2GHz channels
    - ⇒ quasi random delay

- Miniaturized 2nd generation instruments (Jason1, Spot5)
  - measurement method : direct phase measurement
    - ⇒ simultaneous measurements on 400MHz and 2GHz channels at receiver processing level
    - ⇒ systematic delay at the antenna incoming signals due to different time delay on the 2 channels

- DGXX current generation instruments (Jason2, Altika, …)
  - measurement method : direct phase measurement delayed on 400MHz Channel to compensate receiver internal delay
    - ⇒ Simultaneous measurements at antenna level

DORIS Instrument evolutions
5 - New phase measurements

- "Traditional" phase increment "DeltaPhase" is maintained
- Additional phase "PhaseT0"
  - "Non ambiguous" phase measured every beginning of sequence (TDi)
- Additional phase "PhaseT1"
  - "Non ambiguous" phase measured 3s$_{OBT}$ after PhaseT0
- Additional phase "PhaseT3"
  - Not precisely time tagged but synchronous with beacon synchro word "T3" reception

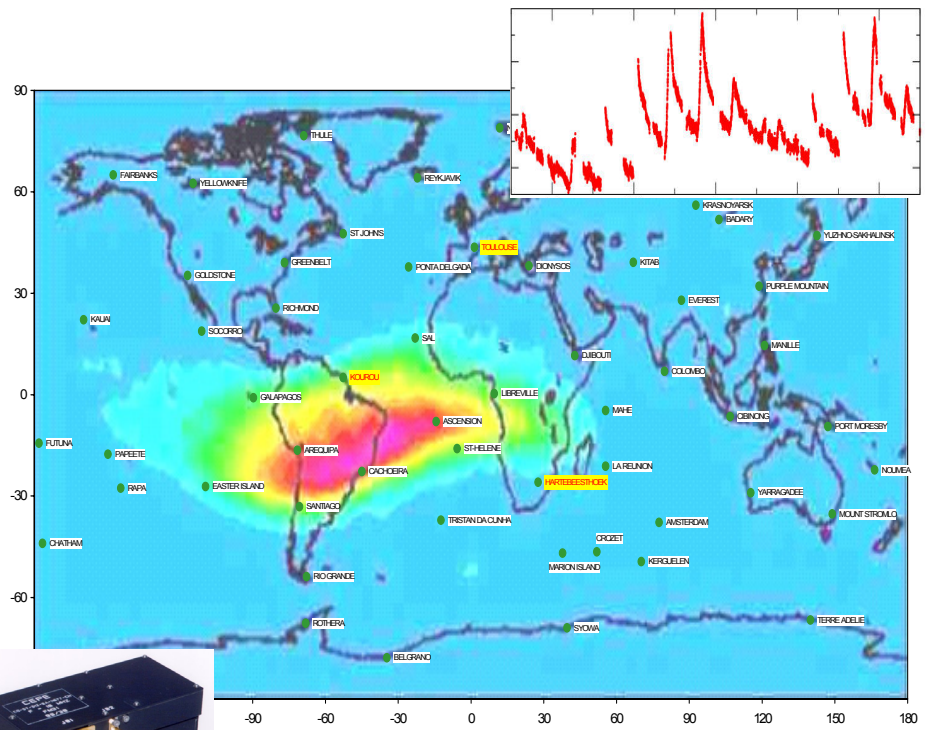
  ⇒ Shall not be considered as a phase measurement

  ⇒ In combination with T3_datation and PhaseT0 or PhaseT1, it may provide "pseudo range" measurements consistent with PhaseT0 or PhaseT1 measurements ; PhaseT3 – PhaseT0 (respectively T1) is exactly the pseudo range variation between instants T3 and T0 (respect. T1)

    . Currently under analysis

DORIS Instrument evolutions
6 - Hardened USOs

- On Topex, no problem detected coming from the sensitivity of the quartz oscillators to radiations
- On Jason1 the both USOs are sensitive to radiations (high energy protons trapped in SAA)
  - ⇒ frequency variations (~ 10^{-11}) when crossing SAA
- A specific process is applied to the current quartz resonators to decrease their sensitivity to radiation by a factor of ~10
  - See detailed presentation by P.Sengenes



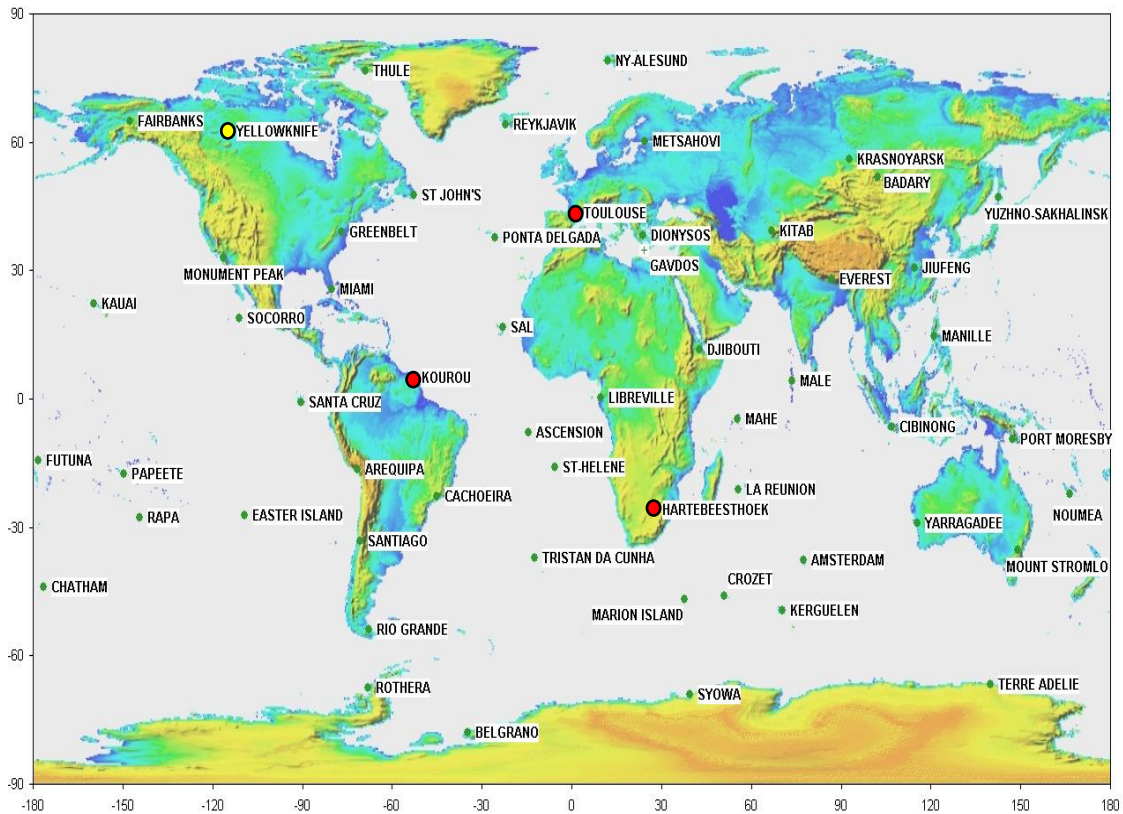
Network evolution
1 - 3rd génération beacons deployment

DORIS Network (March 2006)

- 70% of the DORIS stations already equipped with 3rd Generation beacons

Network evolution
2 - Additional Time and Master beacons

- 3 Master Beacons currently operating :
  - Toulouse
  - Kourou
  - Hartebeestoek
- 1 more MB planed to be installed in 2006
- 1 Time Beacon (driven by a HMaser) to be installed in Yellowknife



Network evolution
3 - Antennas consolidations

- DORIS stations are currently revisited to improve the antenna stability
  - See detailed presentation by H. Fagard

Network evolution
4 - Signal Integrity monitoring

- DORIS Integrity Team set up end 2004-beginning 2005
  - to
    - monitor permanently the DORIS signal transmitted in space,
    - control its characteristics,
    - investigate non nominal situations
    - take corrective actions if needed
  - By systematic analysis of
    - RF levels received by all the instruments in operations and comparison with theoretical waited levels
    - Orbit or positioning processing residuals
    - On board and beacons USOs frequencies
    - Datation performance on board Jason1
    - Navigation quality index on board Jason1

Monitoring of beacons USOs