An Instrumental concept to monitor the sky at very low radio frequency

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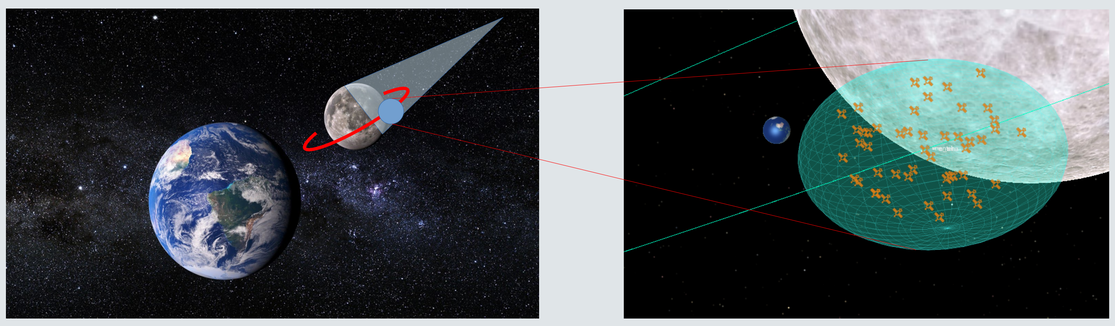
NOIRE project

(Nanosatellite pour un Observatoire Interférométrique Radio dans l'Espace)

NOIRE is an instrumental concept study that consists in an interferometer in space at observing at very low frequency (30kHz – 100MHz) [1]

Autonomous Scientific Observatory

~ 50 nanosat in lunar orbit in a formation of 100 km

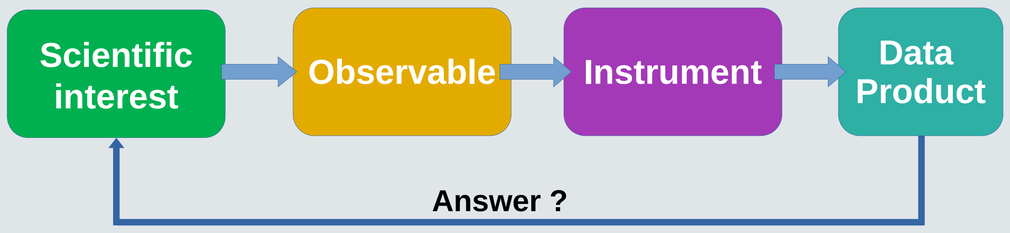


Simulation purpose

Various specification requirements are yet to be defined.

The scientific objectives are driving their definition.

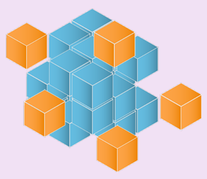
The instrumental simulation is implemented to test a given set of specification in regards to a science case.

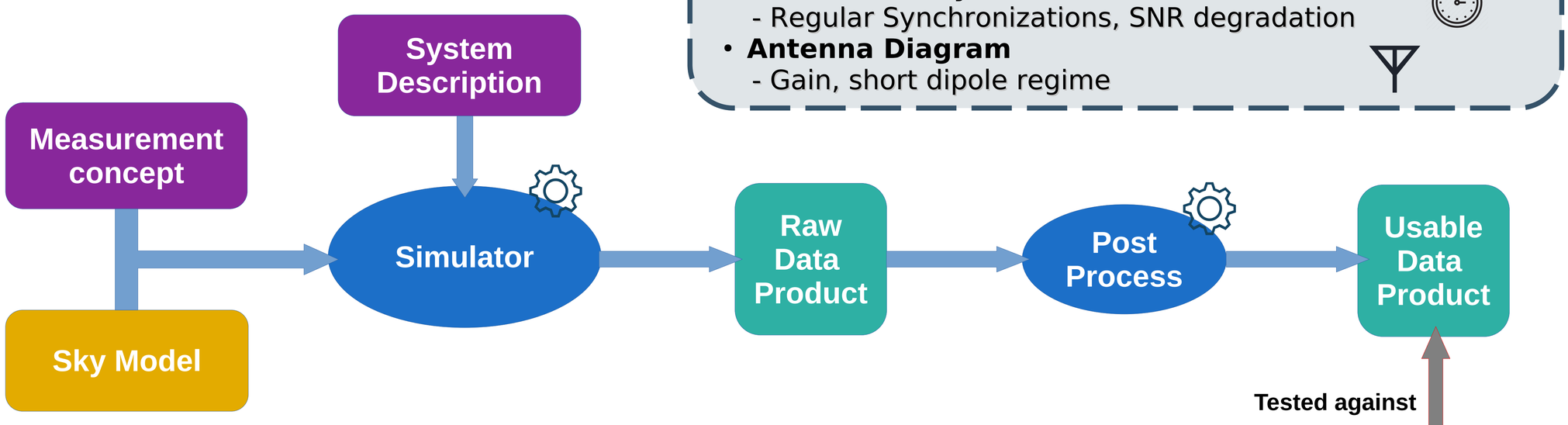


The Simulation Pipeline

- Hardware specifications
  - Clock accuracy
  - Antenna Gain
- Software specifications
  - Position accuracy
- Data Volume
- Relays
- more

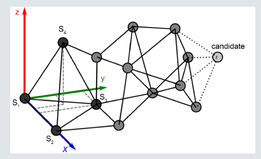
- Δυ, τ
- # Satellites
- Orbits
- Strategy



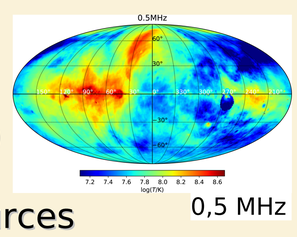


Unique Constraints

- **Topology**
  - Baselines have to be measured onboard
  - Low control → UVW coverage
  - Relative velocities → limit integration time
- **Data limitation**
  - Strong restriction on the volume produced → Telecom, Onboard computation, Power
- **Clock accuracy**
  - Regular Synchronizations, SNR degradation
- **Antenna Diagram**
  - Gain, short dipole regime

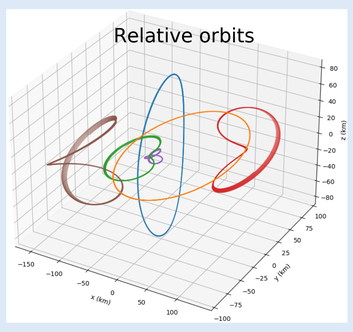


- Model of the source of interest
- Background :
  - GSM
  - USLA [2]
  (model with absorption)
- Model of foreground sources
- Perturbations (RFI)



0,5 MHz

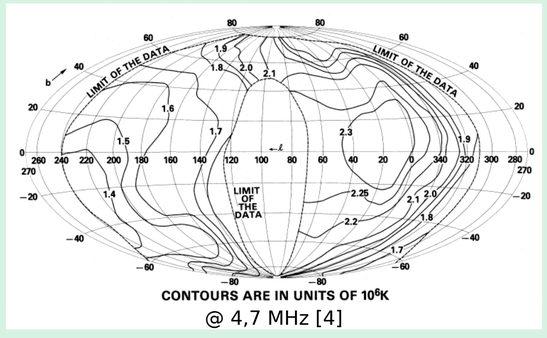
- 3D interferometer
- Significant relative velocities
- Full sky imaging
- SWHT [3] to simulate background visibilities
- Multiple aquisition modes



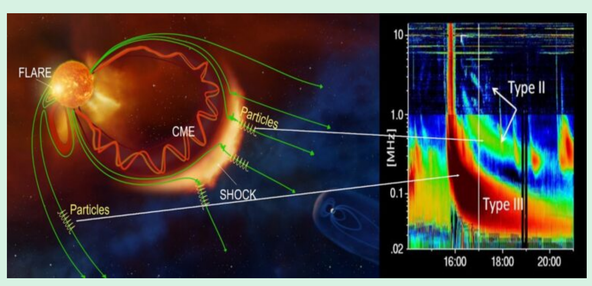
Scientific Objectives

Map the sky at extremely low frequency

The sky remains mostly unknown in this frequency range



@ 4,7 MHz [4]

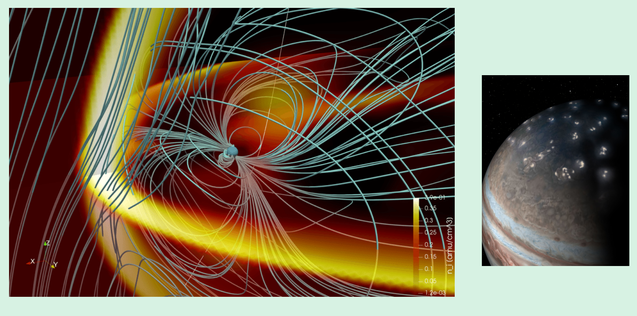


Track the propagation of Solar burst (type II and III)

As a tracer of the particle acceleration in the inner heliosphere and potential magnetic connections from the lower solar corona to the larger heliosphere.

Study planetary magnetospheres
- radiation belts
- atmospheric electricity

Opportunity to observe Uranus and Neptune (<10MHz) since Voyager



We need your inputs !

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Références :

[1] Cecconi *et al*. (2018), NOIRE Study : Towards a low frequency radio interferometer in space, IEEE Aerospace Conference
[2] Cong *et al.* (2021), An Ultra-long Wavelength Sky Model with Absorption Effect, *The astrophysical journal*
[3] Carozzi T. D. (2015), Imaging on a Sphere with Interferometers : the Spherical Wave Harmonic Transform, *Monthly Notices of the Royal Astronomical Society: Letters*
[4] Novaco & Brown (1978), Nonthermal galactic emission below 10MHz, *Astrophysical Journal*

Image Credit :

- Duisterwinkel et al (2018)
- dias.ie/cosmicphysics/astrophysics/astro-surround/
- Jarmak et al (2020)
- NASA/JPL-Caltech/SwRI/JunoCam