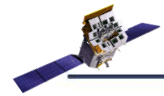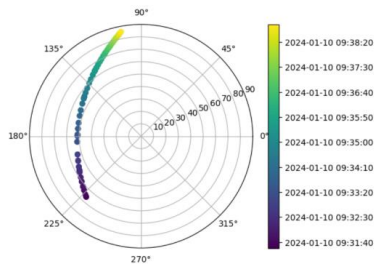# Ground Alert VHF Network
Einstein Probe : Early Performance Status

Einstein Probe : First VHF emitter activation

❖ **EP mission uses VHF network for alert distribution.**

  ❖ Launch on January 9th

❖ **First VHF switch ON January 10th from 9:30 to 10:00 UTC**

  ❖ VHF signal received and processed by 7 stations : Rikitea, Papeete, Marquises, Easter Island, Galapagos, Lamentin (Martinique) and Praia (Cap Verde)

  ❖ About 1.300 VHF packets received (including "idle" and "redundancy"), sent to and processed by FSC, and then sent to EP Science Center
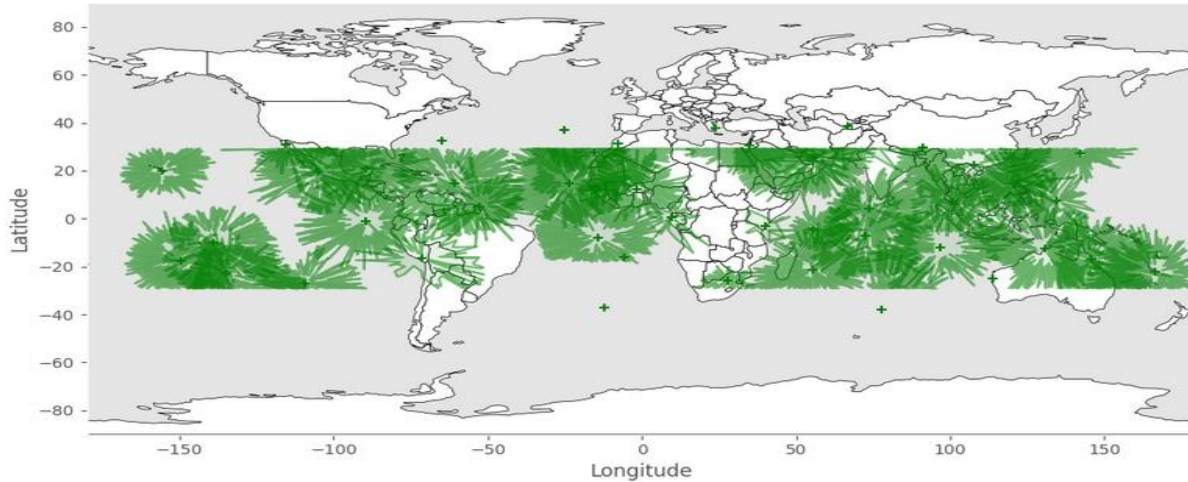

Rikitea : First signal
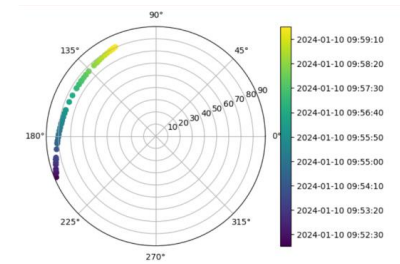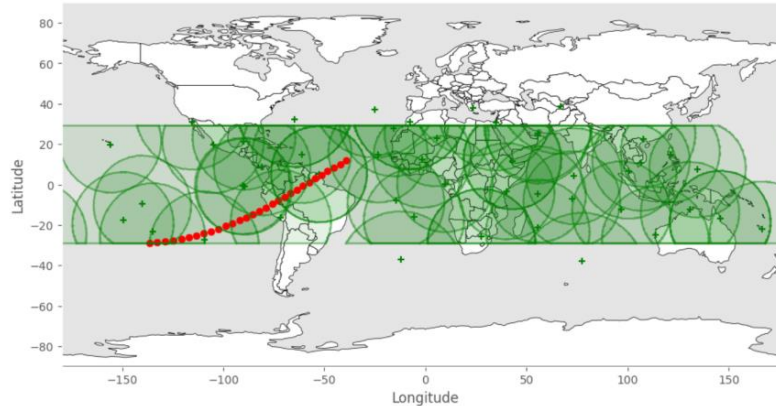
Le Lamentin : Last signal

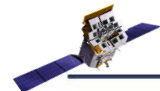❖ **It works !!! But…**

VHF Network : Deployment status (47 Ground Stations)
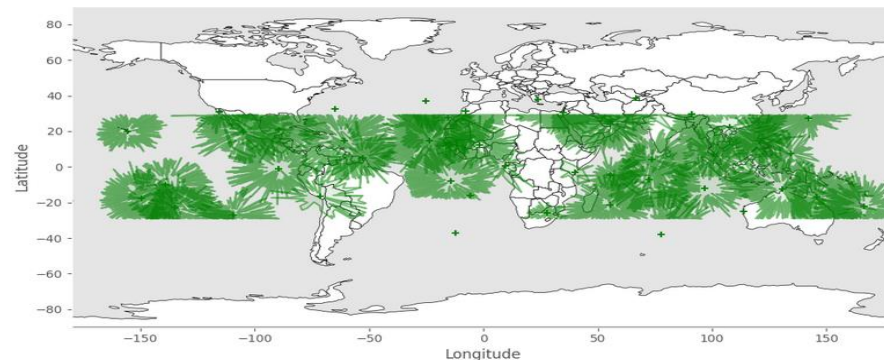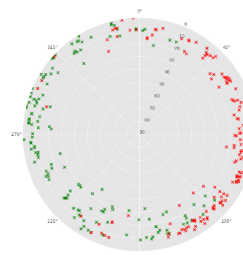

Theoretical coverage

Real coverage (from EP)

VHF Alert Network : Initial findings

❖ **Geographical coverage lower than expected (~50%)**

- ❖ Some stations are still not operational (known)
- ❖ Some stations work rather fine, some others are more erratic
- ❖ AOS / LOS average elevation is higher than expected (15° for "good" stations, more than 45° for "worst" ones)

❖ **Higher messages loss rate than expected (~75% for recurrent messages)**

- ❖ Some large gaps with no data
- ❖ Some loss of messages during passes (between AOS and LOS)

VHF Network coverage (2024/03/20)

Darwin : AOS/LOS   *Mahe : AOS/LOS*

Seq Count	8436	8437	8438	8439	8440	8441	8442	8443	8444	8445	8446	8447	8448	8449	8450	8451	8452	8453	8454	8455	8456	8457	8458	8459	8460	8461	8462	8463	8464	8465	8466	8467	8468	8469	8470	8471	8472	8473	8474	8475	8476	8477	8478	8479	8480	8481
Recieved	OK	KO	OK	OK	OK	KO	OK	OK	OK	OK	KO	KO	OK	KO	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	KO	KO	KO	OK	KO	OK	OK	OK	OK	OK	OK	KO	OK	OK	OK	OK	OK	OK	OK	OK	OK

Lamatin : APID 78, fisrt pass, 2024/01/10

© cnes
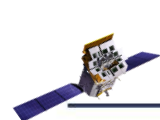
VHF Alert Network : Identified limitation origins

❖ **High industrial noise**
(10 times higher than link budget worst case, some times much more, with quick fluctuations)

  ❖ No sufficient margins in the link budget to absorb such a level of noise
    ⇨ Increase of AOS / LOS elevation
    ⇨ Small transmission gaps due to loss of signal during passes

❖ **Geographical coverage of about 50%**

  ❖ Large areas with no stations (sea, no hosting site, non operating stations)
  ❖ Higher AOS / LOS
    ⇨ Large gaps with no station visibility (up to 74 mn !)
    ⇨ Loss of about 50% of recurrent messages

❖ **On board alert message repetition strategy**

  ❖ Repetition duration too short with respect to network gaps
    ⇨ Loss of alert messages

VHF Network « blind orbit » (2024/03/20)

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VHF Alert Network : Ways of improvement

❖ **High industrial noise**

   ❖ Not possible to improve link budget
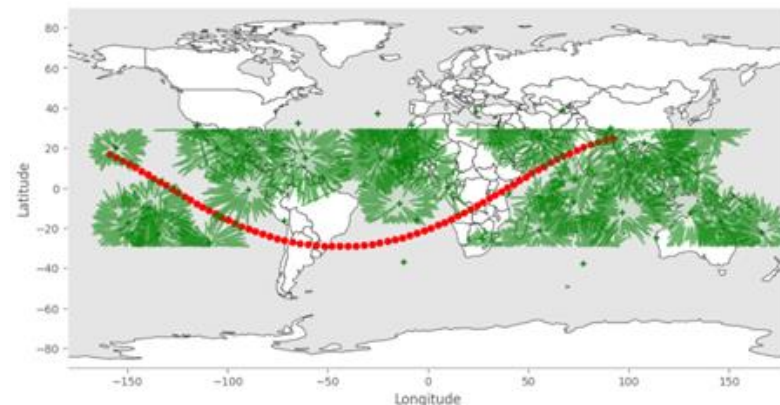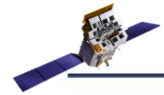   (increase onboard RF power, lower modulation data rate, antennas gain pattern, …)

   ❖ Take into account time and spatial fluctuation of the noise level
   (2 distant stations don't see the same noise level at the same time).

   ⇨ Network densification to increase multiple co-visibility

Seq Count	8304	8305	8306	8307	8308	8309	8310	8311	8312	8313	8314	8315	8316	8317	8318	8319	8320	8321	8322	8323	8324	8325	8326	8327	8328	8329	8330	8331	8332	8333	8334	8335	8336	8337	8338	8339	8340	8341	8342	8343	8344	8345	8346	8347	8348	8349	8350	8351	8352	8353	8354	8355	8356	8357	8358	8359
Papeete	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK																																					
Marquises					OK	KO	KO	OK	kO	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	KO	KO	KO	kO	OK	OK																											
Rikitea					OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	KO	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	KO	
Easter Island																																																			OK	KO	KO	KO	KO	KO	KO	OK

First EP activation, 2024/01/10

❖ **Geographical coverage**

   ❖ Increase network coverage (> 75%)

   ⇨ Recover non operating stations

   ⇨ Look for new hosting sites and try to fill large gap

❖ **On board alert message repetition strategy**

   ❖ Be robust to large coverage gaps

   ⇨ Increase / optimize repetition duration (up to 30 mn)

VHF Alert Network : Summary

❖ **Early VHF operations on Einstein Probe :**

  ❖ Functional operation of VHF system and network

  ❖ But some weaknesses of the link budget and of the network coverage

  ❖ With high consequences on VHF message recovery

❖ **Short term actions :**

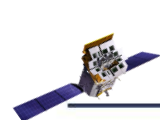 ❖ Increase network coverage : Goal, coverage > 75% by end 2024

  ⇨ Recover "out of service" stations : already started, few more stations in line now
     (Athens, Arequipa, Malindi, St Helens, Tristan Da Cunha)

  ⇨ Prospect for new hosting sites to fill-in holes : Brazil, Africa

  High Priority

  ⇨ Densify network to increase co-visibilities

  Later

  ❖ Improve alert message repetition strategy :

  ⇨ Analysis ongoing at SVOM System Level

  ⇨ Could be extended to EP Mission

Thank you !
谢　谢