

Environmental Condition data collection in UTC Laboratories

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In this talk

- Introduction
- Measurement
- Data collection and management
- What CENAMEP is doing
- Conclusions

Introduction

- Environmental conditions: Mainly physical factors that can affect our timekeeping processes and other services:
 - These factors can originate from outside the laboratory, from nearby laboratories, or even from our own equipment.
 - Depending on the level of measurement involved, we must prepare ourselves to carry out environmental condition measurements.
 - Some of the environmental variables that are recorded can include:
 - Air temperature
 - Air humidity
 - Barometric pressure
 - Vibrations
 - And electromagnetic emissions, among others

Introduction

- Why should we measure and record these variables?
 - In terms of Services and Quality Systems (and legal requirements), we must have verifiable and traceable records to comply (for example, ISO/IEC 17025:2017 **6.3 Facilities and environmental conditions**)
 - In terms of unit references and timekeeping, we must understand which variables affect them and how
 - We can mitigate them to reduce uncertainty, improve stability, and increase precision
 - They can also affect the useful life of laboratory equipment

Introduction

- What sets the environmental conditions and their limits?
 - The use and storage specifications of standards
 - The use and storage specifications of auxiliary equipment
 - Occupational safety specifications (comfort and safety for personnel)
 - Characterization of the entire measurement process (method validation)

Specifications¹

Accuracy and stability

Conditions—any combination of:

Temperature	0 to 50 °C
Humidity	0 to 80% (40 °C maximum)
Magnetic Field	dc, 55, 60 Hz; 0 to 0.2 millitesla (2 Gauss) peak—any orientation
Pressure	47 kPa (equivalent to an altitude of 6 km)
Shock and Vibration	100-mm drop

Parameter	Standard cesium beam tube. Values are within:	High-performance cesium beam tube (Option 001)
Accuracy ²	$\pm 1 \times 10^{-12}$	$\pm 5 \times 10^{-13}$
Frequency Change vs. Environment	$\pm 1 \times 10^{-13}$	$\pm 8 \times 10^{-14}$
Warm-up Time:		
To normal operational status (typical)	15 minutes	15 minutes
To full specifications (typical)	30 minutes	30 minutes

5071A specifications of use

Measurements

- To bring services, meet Quality System requirements, or conduct scientific analysis, measurements must:
 - Have the required precision and uncertainty
 - Be performed continuously and periodically
 - Be time-stamped
 - Be properly formatted and stored
- This allows us to meet Quality System requirements and conduct deep and rigorous analyses.

Measurements

- Most frequently recorded environmental conditions in time and frequency metrology:
 - Air temperature
 - Air relative humidity
- Other measurements depending on the area include:
 - Barometric pressure
 - Vibrations
- Eventually necessary measurements:
 - Electric and magnetic fields

Measurements

- Measurements can be obtained:
 - Directly as generated by the device
 - From the device if it stores them
 - Through a direct communication interface (RS232 serial port, Ethernet, USB, etc.)
 - Through wireless communication interfaces (WiFi, Zigbee, Bluetooth, etc.)



Built in home Thermo-higro-barometer



With IoT devices you can make your own sensor mesh to monitoring anything that you want to know

Measurements

Measurements must meet basic requirements (e.g., ISO/IEC 17025:2017, accreditation, etc.):

- Required **precision**
- Required **uncertainty**
- **Traceability** to laboratories with CMC or accredited laboratories
- A laboratory that disseminate or calibrate may tolerate more environmental variations than one that maintains standards
- If both are in the same area, it's important to find the best balance between timekeeping and services (and costs)

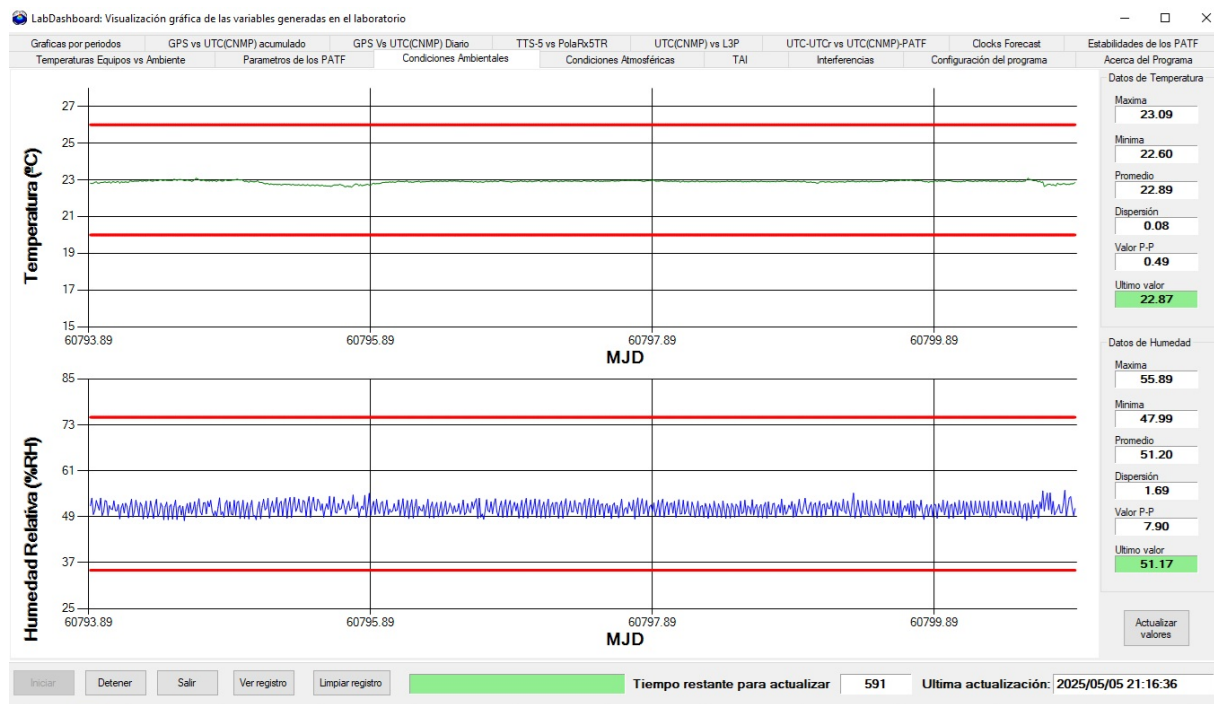
Data collection and management

- Variables must **not only** be recorded correctly, but they must have a purpose and be coherent:
 - Equipment protection and preservation
 - Regulatory compliance
 - Continuous analysis and improvement
- **Automation** of data collection, processing, analysis, response, and storage is essential
- A data acquisition plan must be established

What is doing CENAMEP

- CENAMEP records environmental variables such as:
 - Temperature and relative humidity inside laboratory areas
 - Air temperature and humidity outside the laboratory
 - Barometric pressure outside the laboratory
 - GPS interference levels (new)
- Data collection is **automated**:
 - Recorded at intervals equal or less than 15 minutes, and processed as needed
 - Stored with **second-level timestamps** (in Gregorian and MJD dates)
 - Stored in **CSV format** to enable analysis in any software (from Excel to R, depending on file size)
- All programs that acquires, formats and stores environmental data are developed in **C and C#** by lab personnel (integration with Word and Excel)

What is doing CENAMEP



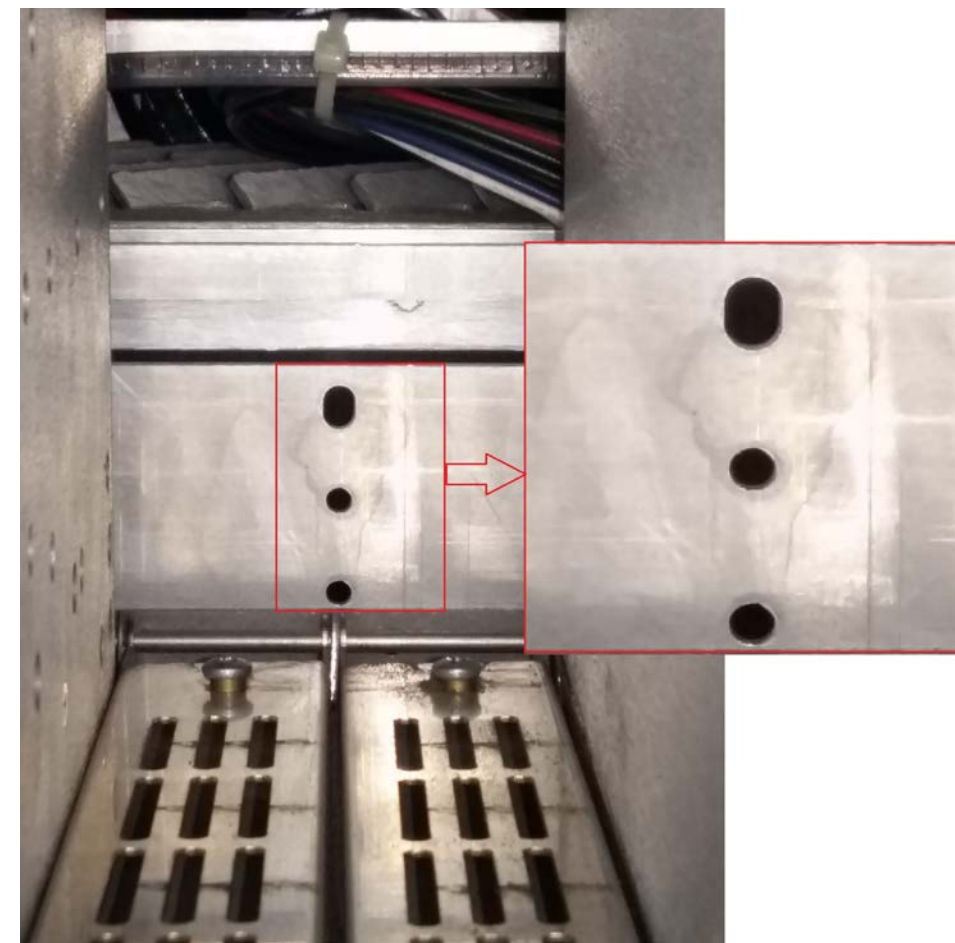
T&H Laboratory measurements



T-H-P External measurements

What CENAMEP is doing

- CENAMEP currently has two physical areas for time and frequency:
 - Standards area
 - Calibration and dissemination area
- Each area has its own regimen and environmental control objectives
- The standards area also has backup air conditioning to avoid large fluctuations during maintenance or if the main unit fail



What CENAMEP is doing

- **Measurements by area:**
 - **Standards area:** greater control of variations
 - **Calibration and dissemination area:** less control of variations
- Also measured temperature, humidity, and barometric pressure:
 - Primarily for the project “metrology for meteorology”
 - Secondarily, as part of external environmental control
- This opportunity was used to **normalize data** from the standards area and the external measurements area to report it under **METEO format**

What CENAMEP is doing

METEOROLOGICAL DATA CCTF V1.0
MeteoMon CENAMEP
REVISION DATE 2021-10-01

20250419 00:05 UTC

DATA TYPE
PGM / RUN BY / DATE
COMMENT
COMMENT
COMMENT
LAB NAME
/ TYPES OF OBSERV
SENSOR MOD/TYPER/ACC
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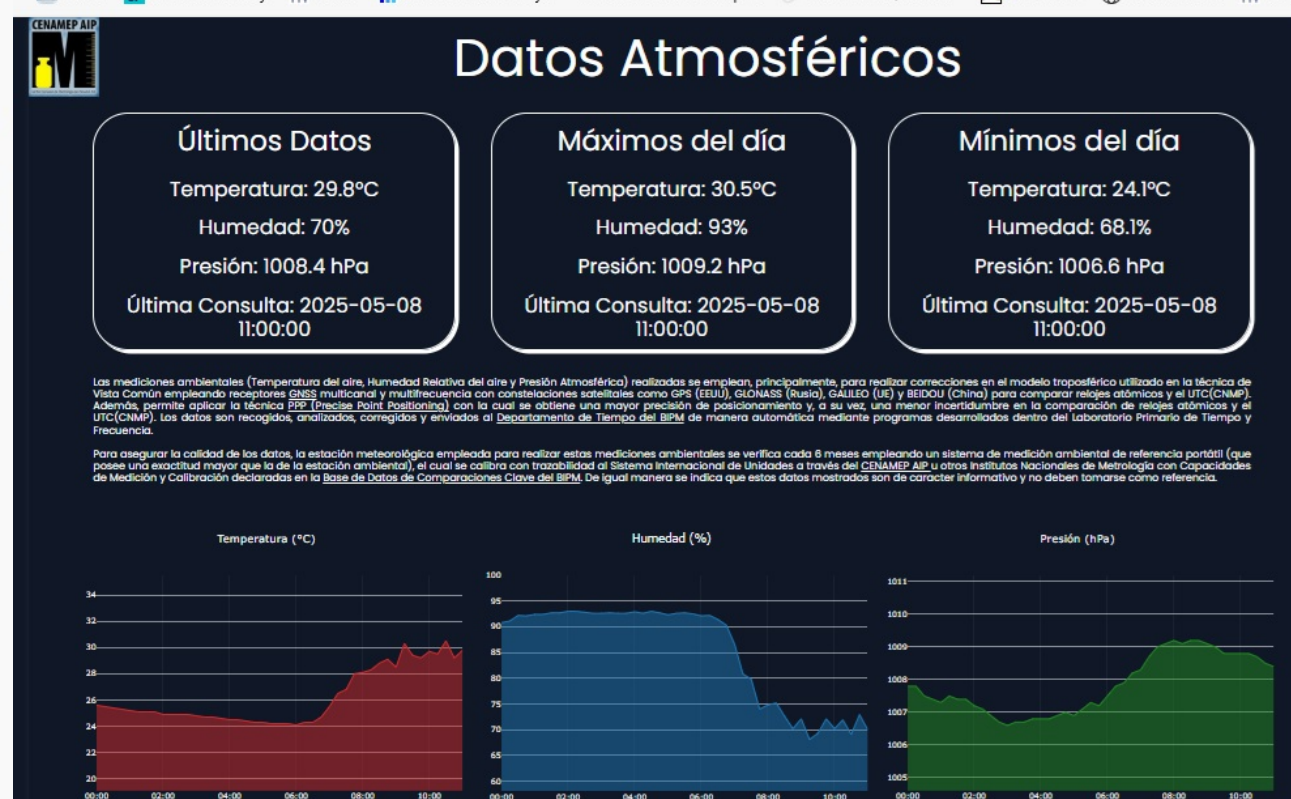
CNMP

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25 04 18 00 15 00	27.9	69.2	1005.0	22.6	50.6
25 04 18 00 30 00	27.7	70.3	1005.4	22.6	51.9
25 04 18 00 45 00	27.6	71.2	1005.5	22.7	50.1
25 04 18 01 00 01	27.4	72.4	1005.8	22.7	51.3
25 04 18 01 15 00	27.1	73.9	1006.0	22.7	53.9
25 04 18 01 30 00	27.0	74.6	1006.0	22.7	51.0
25 04 18 01 45 00	27.0	75.2	1006.1	22.7	50.7
25 04 18 02 00 01	26.8	76.7	1006.2	22.7	53.9
25 04 18 02 15 00	26.9	76.8	1006.3	22.7	54.2
25 04 18 02 30 00	26.6	78.1	1006.5	22.7	49.3
25 04 18 02 45 00	26.5	78.6	1006.6	22.7	52.7
25 04 18 03 00 01	26.6	78.0	1006.7	22.7	54.3
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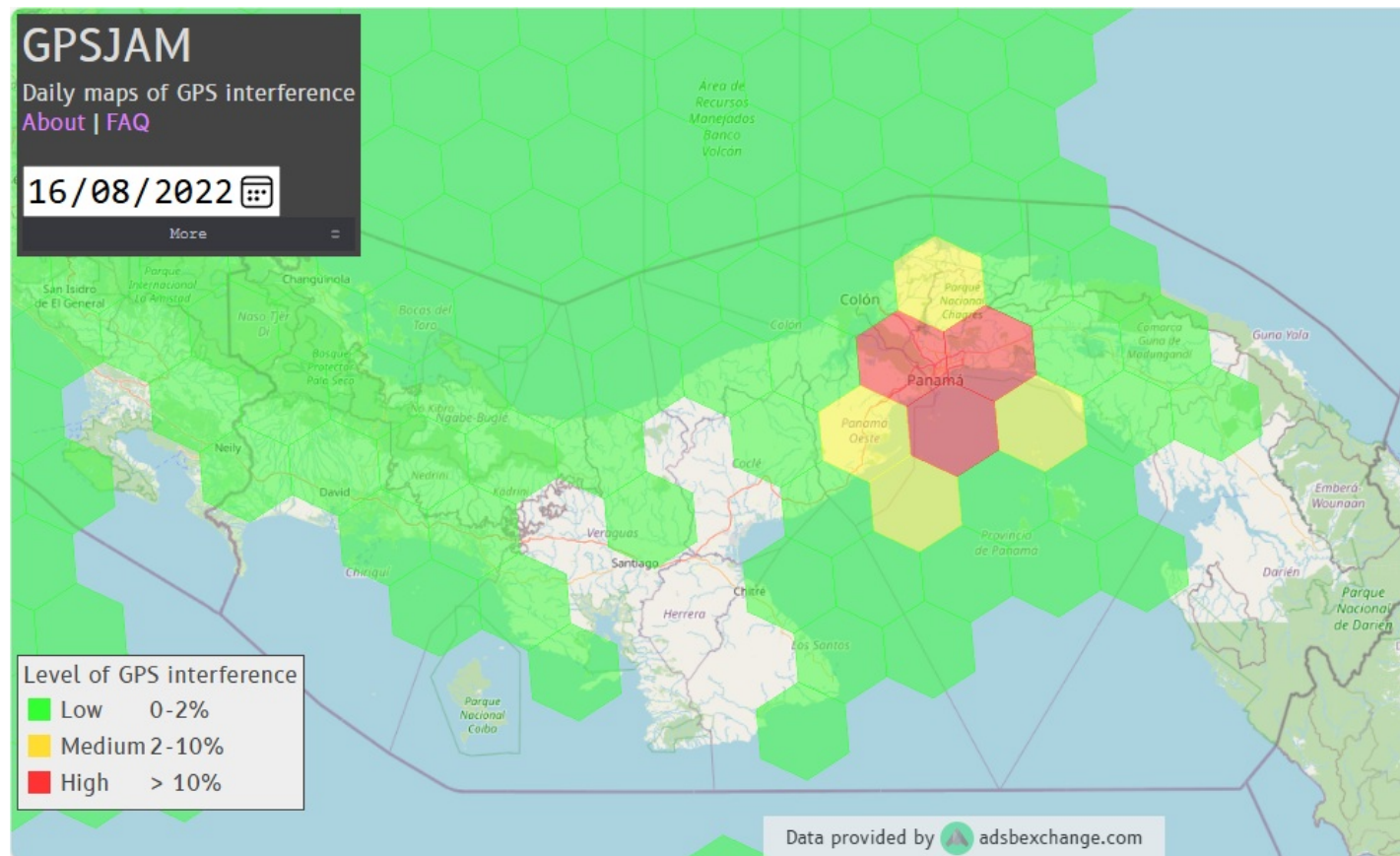
eguro | <https://horaexacta.cenamep.org.pa/temperatura.php>

Trello GO UP Academy KCD B Modified Julian Day... NIST SIM Time and Frequ... GPSJam GPS/GNSS... kcdb-cbkt TAI database Time



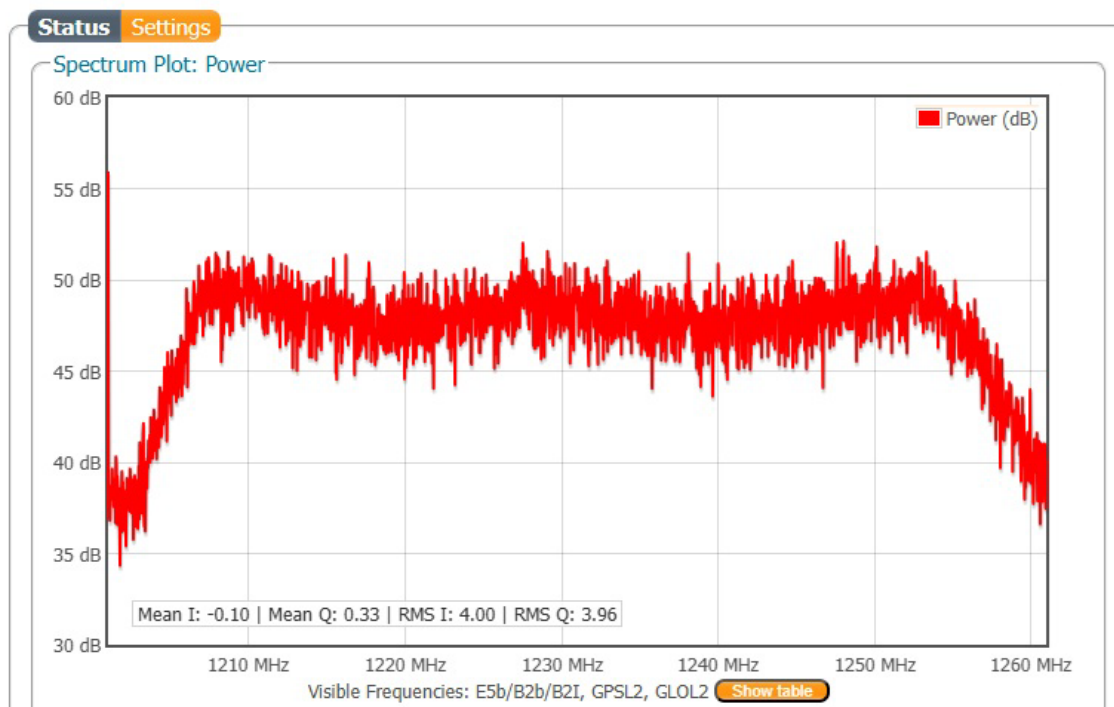
What CENAMEP is doing

- The concerns about interference started after an event in August 2022, and were discovered via a social media discussion by someone outside the SIM area
- Reference: <https://gpsjam.org>



What CENAMEP is doing

- Initially we thought it was a TTS-5 failure, but an anomaly was recorded by the PolaRx5TR



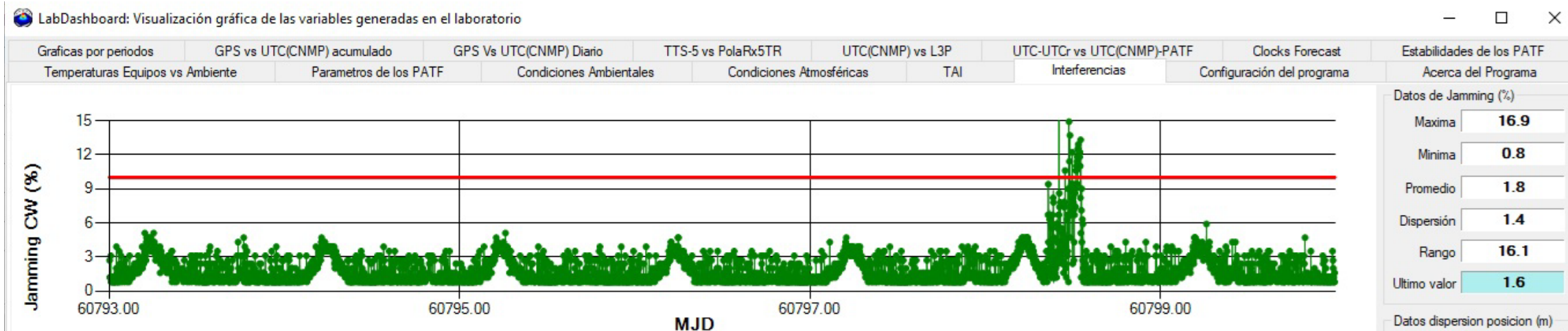
PolaRx5TR Spectrum power without anomalies



PolaRx5TR Spectrum power with anomalies

What CENAMEP is doing

- They were rapid events (sometimes lasting no more than 5 minutes) on GPS L1 or L2
- To catch more of them, we acquired a Microchip BlueSky license for a S650
- After establishing the normal background of the area, event recording began



What CENAMEP is doing

- Measurements started recently this year
- Several events have been recorded
- Likely due to being in a logistics convergence area (cargo trucks, ships, freight trains)
- With GPS, WiFi, and LTE blockers being cheap and easily available (e.g., USD 11 to USD 60 on AliExpress), they may be used to block cargo tracking

What CENAMEP is doing

bloqueador de frecuencias

Descarga la app de AliExpress

ES/PAB

¡Bienvenido
Identificate / Regístrate

PAB24.10

~~PAB45.47~~ -47% dto.

Precio mostrado antes de impuestos ; 5% de descuento extra

Compra 3 piezas y obtén -1% dto.

Generador de señal de ruido RF T88C, 0,2-2000MHZ, fuente de ruido, bloqueador de fuente de seguimiento de espectro Simple

1 vendido(s)

Vendido por T88 Electroni... (Vendedor)

Envío a Panamá

Compromiso de AliExpress

Envío: PAB3.45
Entrega: 20-40 días

Política de devoluciones y reembolso...

Seguridad & Privacidad
Pagos seguros: No compartiremos tus d...
Datos personales seguros: Protegemos ...

Comprar

Agregar al carrito

Conclusions

- Controlling environmental conditions is important for calibration labs and UTC timekeeping
- It is not just about measuring environmental variables — it is essential to organize them and integrate them into laboratory processes
- Good environmental records allow for the discovery of factors that affect lab performance
- As improvements are made, more variables should be analyzed appropriately

Thank you all!

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