

# Pico-Balloons & Amateur Radio



# Brian Basura

## N6CVO

Technician - 2000

General - 2009

Extra Class - 2014

Pico-Balloonist - 2019

Hydroelectric Power Plant  
Technician (Retired)

# What's a Pico-Balloon



# Pico-Balloon Attributes

- Free Floating (not tethered)
  - Super-pressure Configuration
  - Neutral Buoyant at Altitude
  - Payload weighs 5 to 17 grams
- 
- Flight Duration in Days or Weeks
  - Can circumnavigate the Earth
  - Float at 30,000 to 50,000 feet

# Number One Question

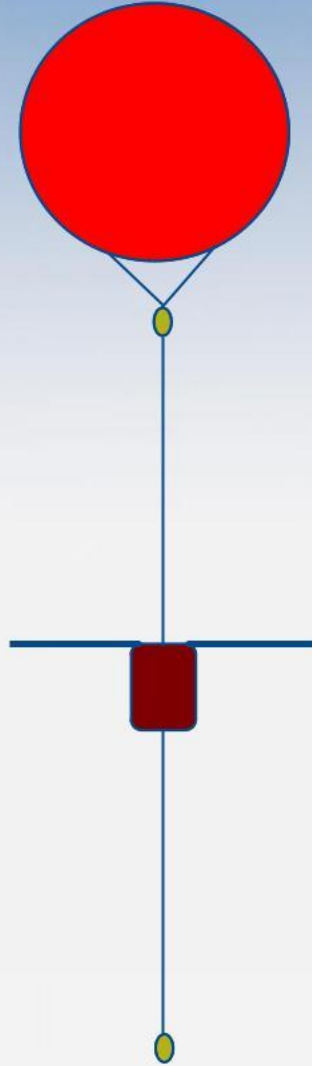


# Title 14 CFR Part 101

- **FAA Policies on Unmanned Free Balloons 14 CFR Part 101**
  - Subpart A (101.1) details payload criteria which must be used to determine whether unmanned free balloons must meet the provisions of Subpart D (101.31 through 101.39). **Balloons with the following payload weights and dimensions are not subject to the provisions of Subpart D:**
  - Balloon payloads that weigh less than **four pounds** and have a weight/size ratio of more than three ounces per square inch on any surface of the package, determined by dividing the total weight in ounces of the payload package by the area in square inches of its smallest surface.
  - Balloon payloads packages that weigh **less than six pounds**.
  - Balloons with payloads of two or more packages that weigh less than **twelve pounds**.
  - Balloons that use a rope or other device for suspension of the payload that requires an **impact force of fifty pounds or less** to separate the suspended payload from the balloon.



# Flight Package





# Balloon Envelope

- Types we have flown
  - Chinese 36” Party Balloon
  - Scientific Balloon Solutions SBS-13
  - Yokohama 32” Party Balloons
- Lifting Gas is H<sub>2</sub> (hydrogen)
  - More lift than He (helium)
  - Less leakage (molecule is diatomic)
- Free Lift of 6-8 grams

# Measuring Lifting Gas



# How Much Lifting Gas ?

## Calculation

14 gr Payload  
+ 6 gr Free Lift  
-----  
20 gr Total Lift

## Measurement

50 gr Weight  
-20 gr Total Lift  
-----  
30 gr Scale Reading

# Sealing the Fill Port

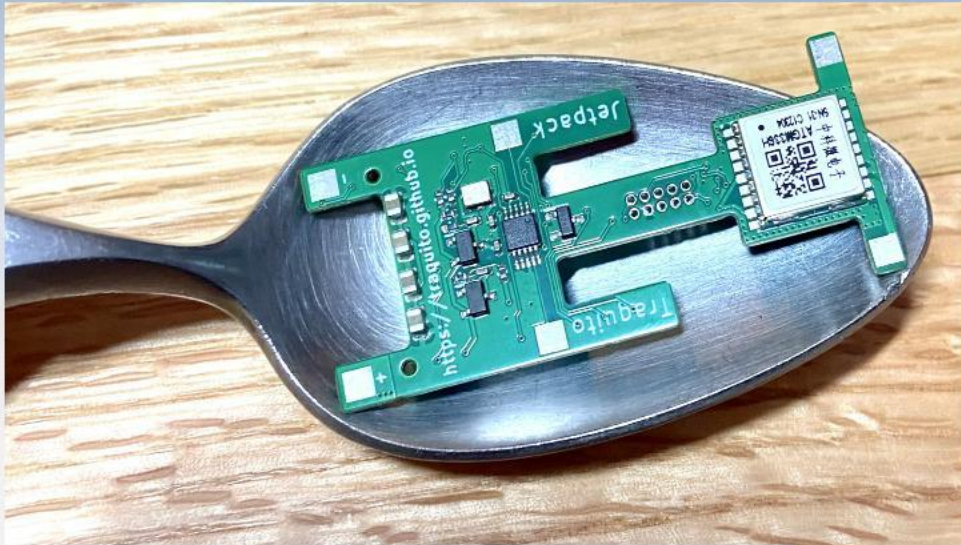


# Tracker Details

- Ham Radio transmitters
  - WSPR (HF 10m, 20m @ 10-17mW)
  - APRS (VHF 2-meters, 500mW)
  - other (QRSS, LoRa, RBN, etc.)
- Solar Powered (No Batteries)
  - Only transmit when in sunlight
- GPS receiver, computer, power management, startup circuitry, etc.



# Current Trackers



Traquito  
Jetpack

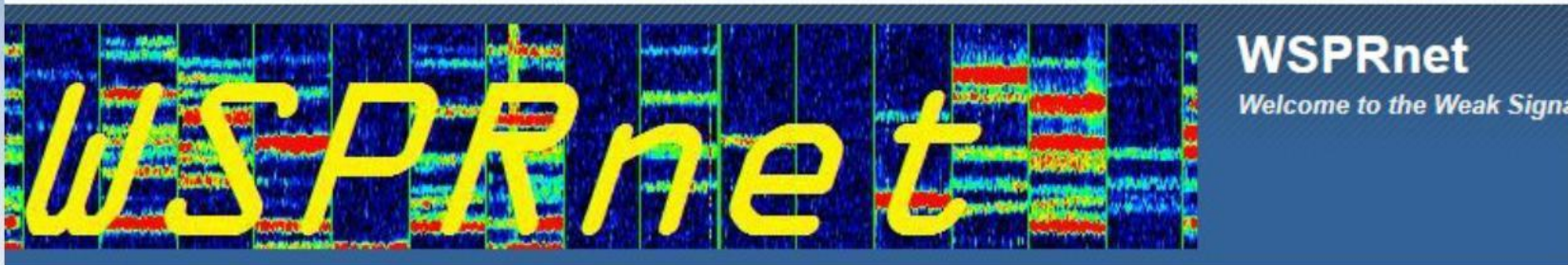
QRP Labs  
U4B



# Telemetry Data (WSPR)

- WSPR (Call Sign, 4-char Grid Square, Transmit Power, FEC all in 50-bits, 2-min transmission)
- Second WSPR transmission for altitude, precision location, voltage, temperature
- Receivers post to [WSPRNET.org](https://www.wsprnet.org)

# WSPRnet.org



## Spot Database

Specify query parameters

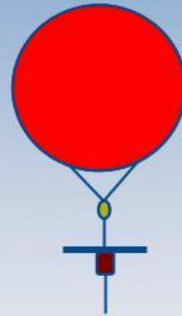
34 spots:

Timestamp	Call	MHz	SNR	Drift	Grid	Pwr	Reporter	RGrid	km	az	Mode
2023-08-04 21:00	KJ6CPU	28.126077	-24	0	BP41	0.01	K0ESQ	BP51io	94	81	W-2
2023-08-04 19:40	KJ6CPU	28.126077	-14	0	BP41	0.01	K0ESQ	BP51io	94	81	W-2
2023-07-30 05:20	KJ6CPU	28.126115	-18	0	PO93	0.01	BX6ABC	PL03	3662	211	W-2
2023-07-23 13:50	KJ6CPU	28.126126	-22	0	LO50	0.01	SDRPT	IM59ph	4725	279	W-2
2023-07-23 13:40	KJ6CPU	28.126125	-20	0	LO50	0.01	SDRPT	IM59ph	4725	279	W-2
2023-07-23 13:30	KJ6CPU	28.126126	-25	0	JN84	0.01	SDRPT	IM59ph	2191	264	W-2
2023-07-22 16:40	KJ6CPU	28.126052	-26	0	JN74	0.01	IW3HBX	JN65an	259	299	W-2
2023-07-22 16:30	KJ6CPU	28.126053	-23	-2	JN74	0.01	IW3HBX	JN65an	259	299	W-2
2023-07-22 16:20	KJ6CPU	28.126052	-21	0	JN74	0.01	IW3HBX	JN65an	259	299	W-2
2023-07-22 16:10	KJ6CPU	28.126054	-18	1	JN74	0.01	IW3HBX	JN65an	259	299	W-2
2023-07-22 16:00	KJ6CPU	28.126056	-17	-1	JN73	0.01	IW3HBX	JN65an	327	316	W-2
2023-07-22 16:00	KJ6CPU	28.126113	-21	-2	JN73	0.01	IZ6QQT	JN63hr	190	279	W-2
2023-07-22 15:50	KJ6CPU	28.126114	-19	0	JN73	0.01	IZ6QQT	JN63hr	190	279	W-2

unt  
word

0.4742,  
5.3647,  
39,  
346,  
33,  
10,

# WSPR Data Flow



**HF Radio**

**Sound  
Card**

**Computer**

**WSPRnet**

**USER**

**WSPR.  
rocks**

**Traquito**

**LU7AA**

# Flight Milestones

1. Receive Airborne Transmissions
2. Make it to a stable Float Altitude
3. Live through the first night
4. Cross the Atlantic or Pacific
5. Circumnavigate the Earth

# Long Flights are Hard

- Ten flights never made it out of the USA or have lasted less than a week
- Four flights made it out of the USA but vanished before circumnavigating
- That's  $2/3^{\text{rds}}$  or 67% of our flights!

# Circumnavigations

Eight of our balloons have flown for months making multiple laps around the world!

14 days 1.5 laps

31 days 1.8 laps

110 days 5.5 laps

125 days 5.5 laps

75 days 7.0 laps

114 days 9.8 laps

134 days 10.0 laps

**142 days 10.8 laps**

# Circumnavigations

Eight of our balloons have flown for months making multiple laps around the world!

14 days 1.5 laps	75 days 7.0 laps
31 days 1.8 laps	114 days 9.8 laps
110 days 5.5 laps	134 days 10.0 laps
125 days 5.5 laps	<b>142 days 10.8 laps</b>

**That's a total of 52 times around the world!**

**And over 764 flight days!**

# QuartzFest 2024

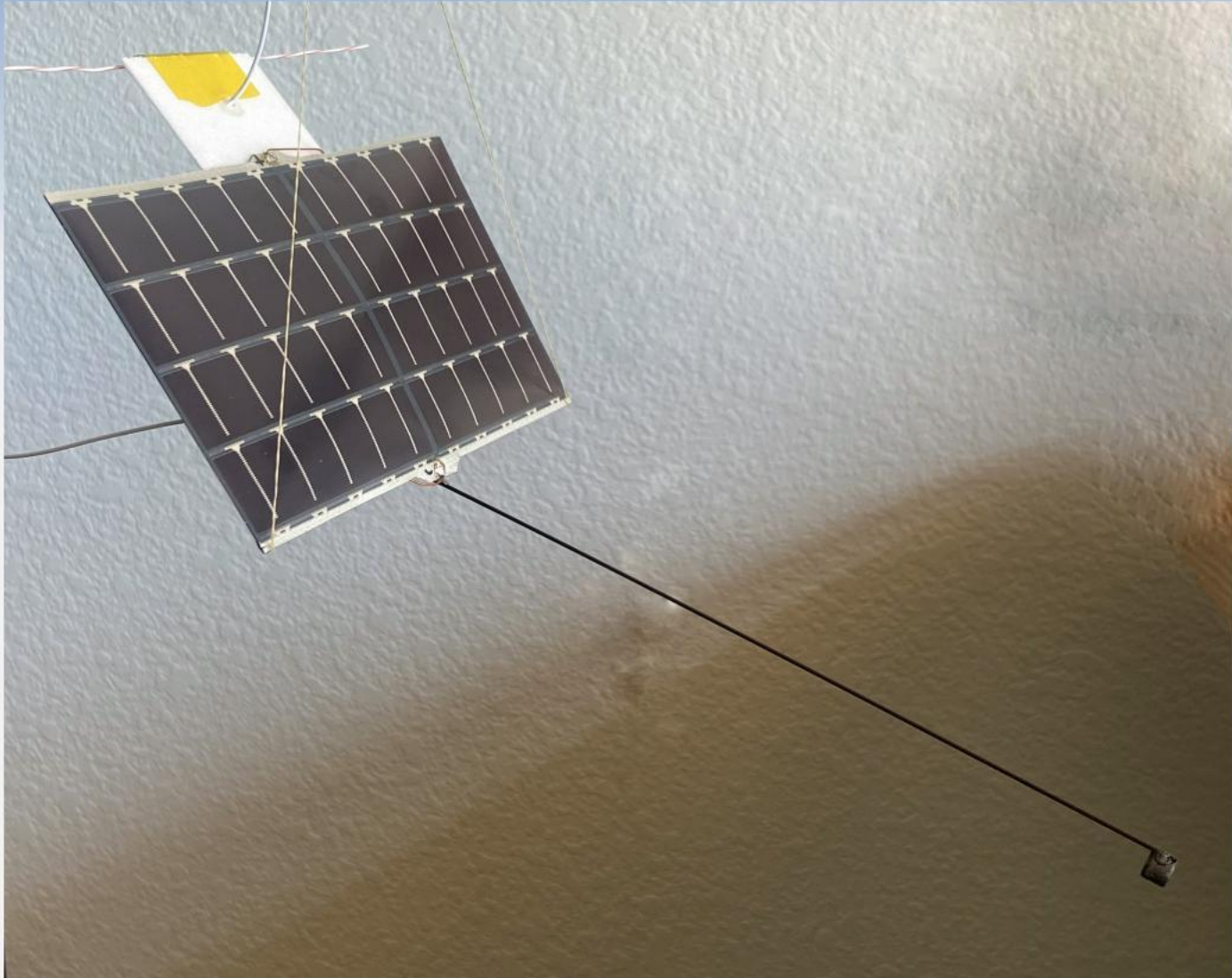
We launched three Pico-Balloons during the week long event.



Lets watch one of those launches



# KJ6CPU Flight

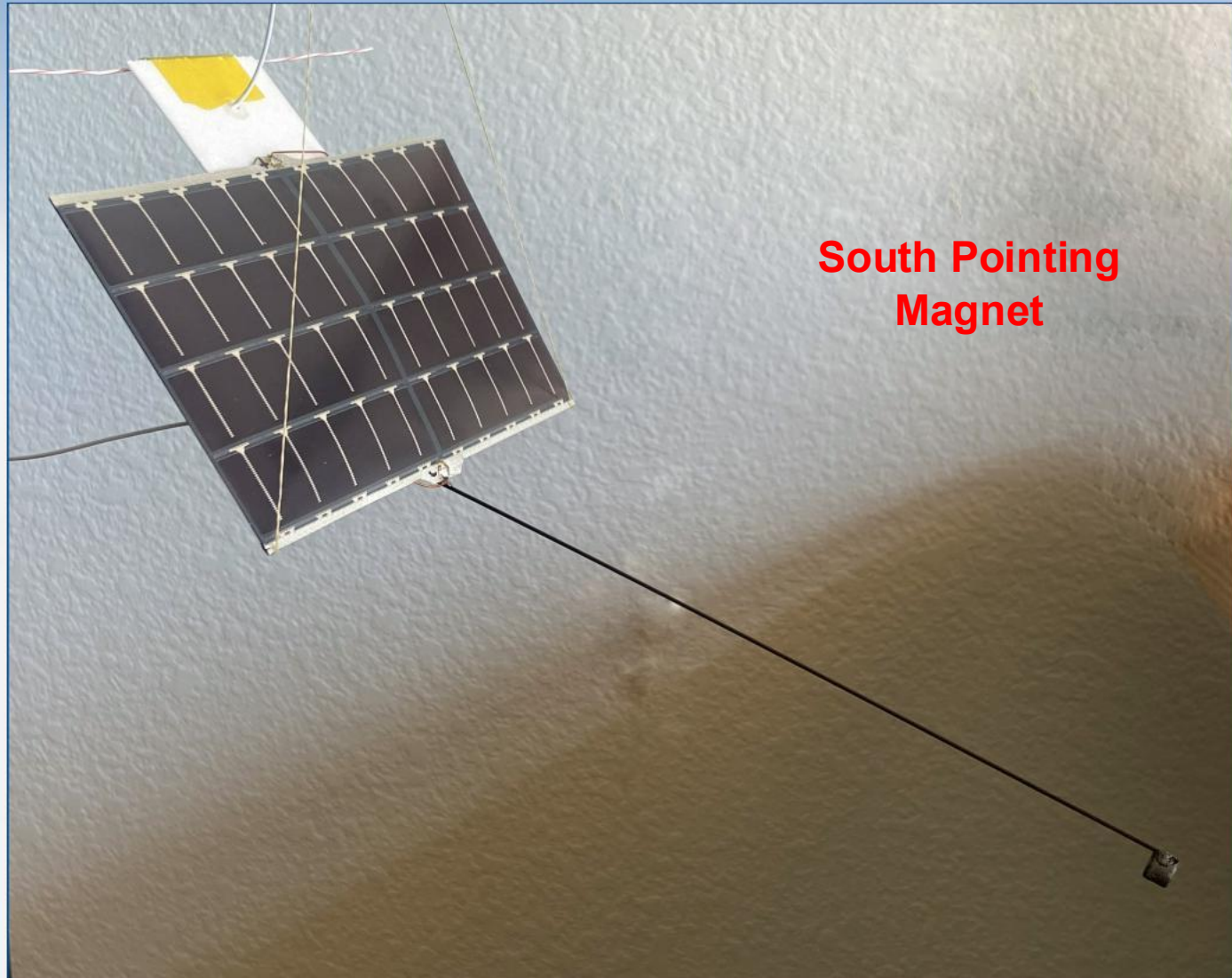


# KJ6CPU Payload

Total Weight 16.5 grams (0.6 ounces)

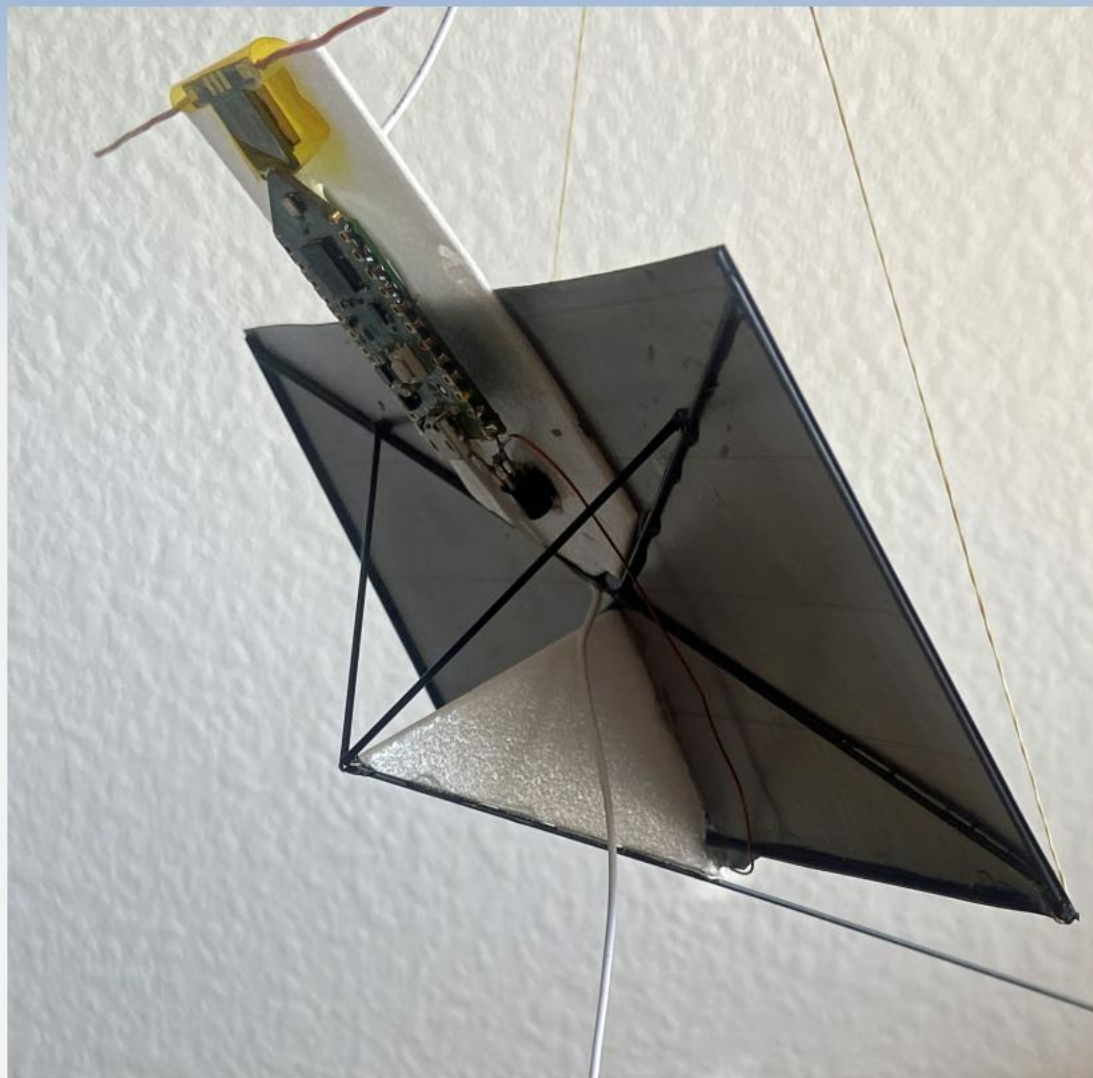
- WSPR on 10-meters
- Traquito tracker
- Solar Panel was double size and tilted at a 45° angle for a winter flight
- Neodymium magnet to keep the solar panel pointed South

# KJ6CPU Magnet



**South Pointing  
Magnet**

# KJ6CPU Underside



KJ6CPU at 41,000 feet



# KJ6CPU Demise

24-Jan-2024  
to  
08-Apr-2024

Lost on Day 76 at  
12:08 CDT, over  
Texas, after 76  
days and 7-laps  
around the world.



# KJ6CPU Last Contact

The balloon was flying over Texas in the Path of Totality. As the eclipse began, the signal was lost as



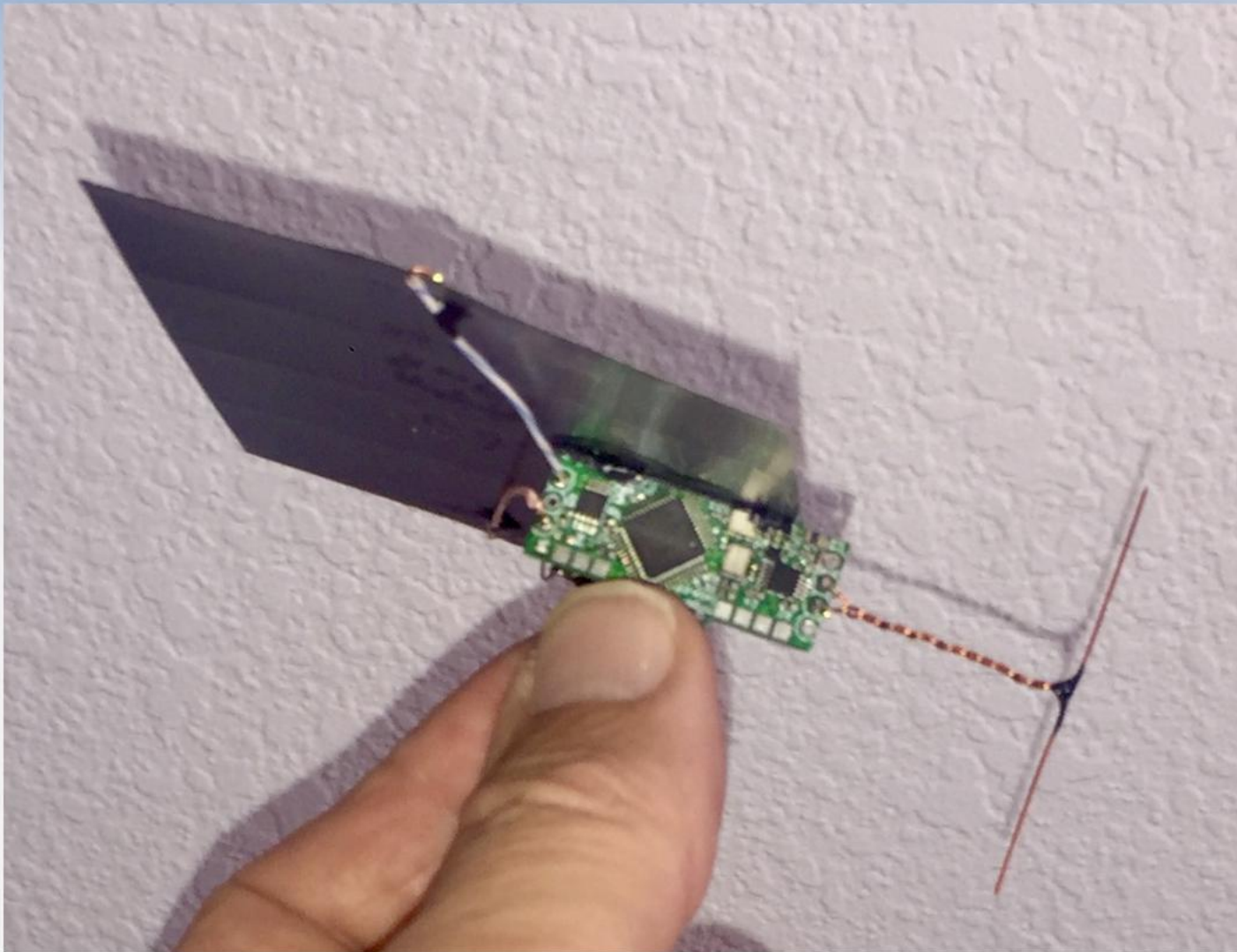
Predicted. When the sun came back from totality we expected to reacquire the signal but, the balloon was never heard from again.

# KJ6CPU Last Contact

There was no significant weather in the area but, there was a lot of air traffic viewing the eclipse. This air traffic was directly in the balloons flight path and their wake turbulence most likely took the balloon down.



# N6CVO Flight



# N6CVO Payload

Total Weight 9 grams (0.3 ounces)

- WSPR on 20-meters
- U4B tracker
- 20m Dipole Antenna (Full 33' Length)
- Configured for minimum weight

N6CVO at 49,000 feet

The image features a bright, overexposed sky with scattered white clouds. The text "N6CVO at 49,000 feet" is displayed in a dark blue, sans-serif font at the top center of the frame. The background is a gradient of light blue and white, with clouds visible in the upper corners and a very bright, almost white area in the lower half.

# N6CVO Stats

- Intermittent transmissions
- Very few spots were received
- Flew near 50,000 feet most of the flight
- First of our balloons to cross the equator
- Very few receiving stations in the southern hemisphere
- Most likely went down due to big storms in its flight path

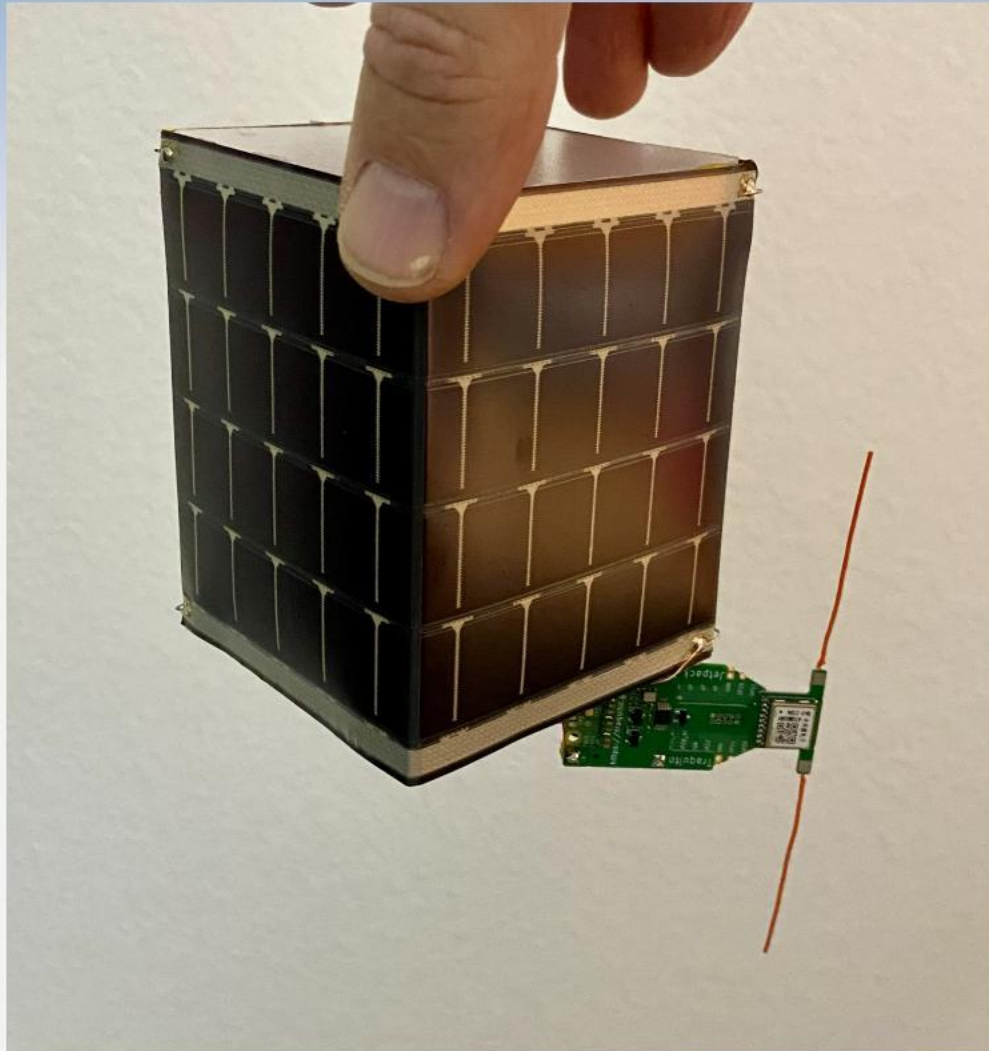
# N6CVO Demise

26-Jan-2024  
to  
09-Jun-2024

Lost somewhere  
east of Tonga after  
134-days aloft and  
10-times around  
the world.



# N6JED Flight

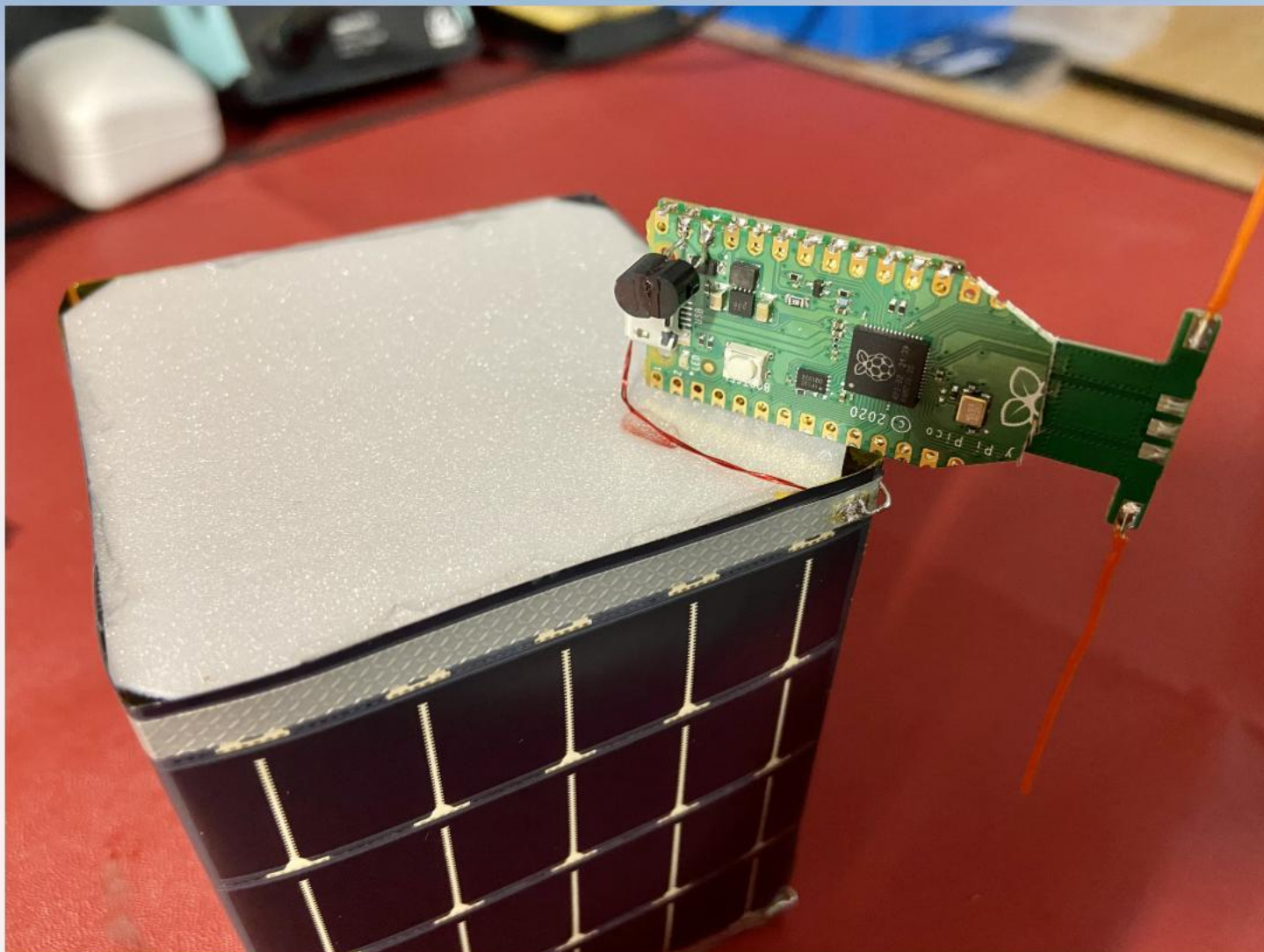


# N6JED Payload

Total Weight 18.3 grams (0.65 ounces)

- WSPR on 10-meters
- Traquito tracker
- Four vertical solar panels to supply power from sunrise to sunset
- No blocking diodes for shaded panels
- Heavy for our standards

# N6JED Configuration



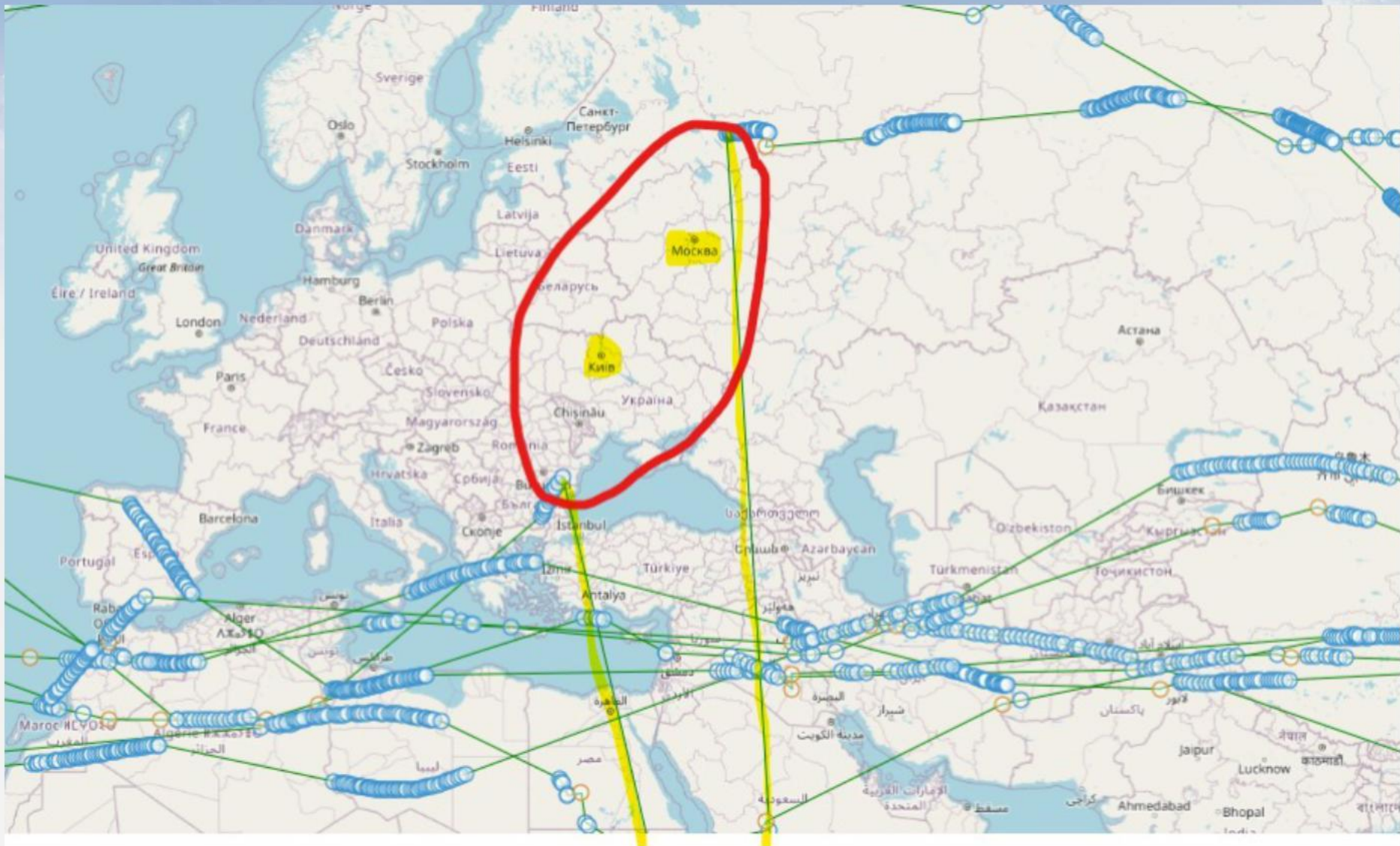
# N6JED at 40,000 feet



# N6JED Accomplishments

- Best performing transmitter we have flown
- Spotted 3,875 times
- 97,238 Reception Reports!
- GPS location was Spoofed over Ukraine and the actual location was reacquired north of Moscow

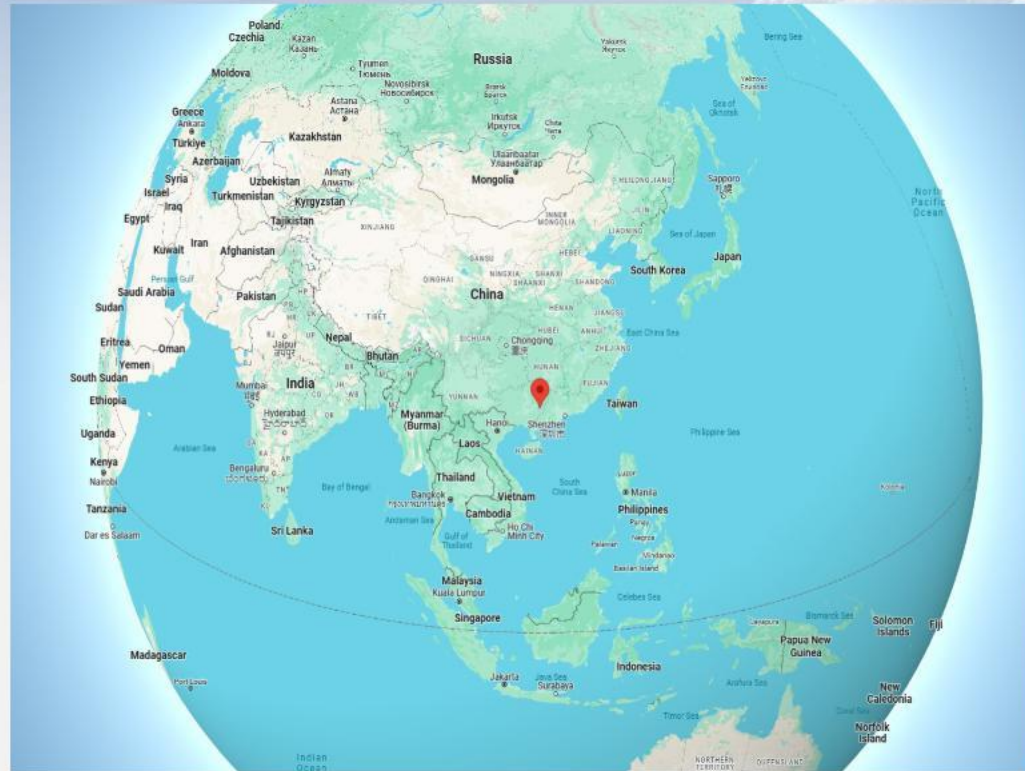
# N6JED GPS Spoofed



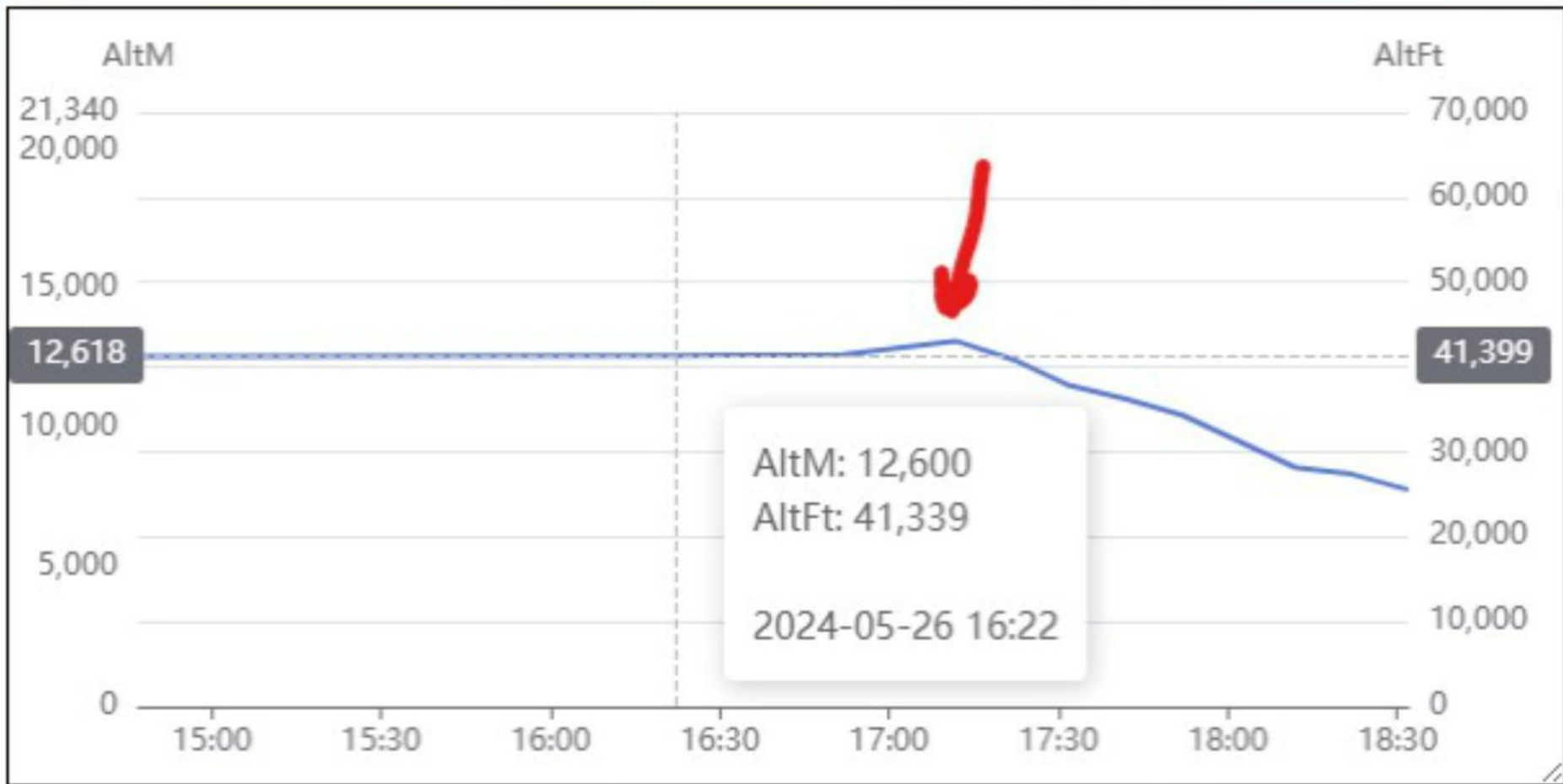
# N6JED Demise

24-Jan-2024  
to  
16-May-2024

After 114-days and  
9-times around the  
world it developed  
a leak over China  
and went down near  
Shenzhen.



# N6JED Leak



# Flight Path Prediction

- NOAA Air Resources Laboratory  
HYSPLIT Model
  - Supercomputer
  - Works well with good data input
  - Fills in gaps when no contact is received
- Windy.com
  - Enter proper Flight Level (ie. FL450)
  - User interprets speed and distance
  - Big picture and seeing storms

# Resources

## Experts

- picoballoon ([Groups.io](https://groups.io))

## Tracking

- Traquito
- WSPR.rocks
- LU7AA
- QRP-LABS
- SondeHub Amateur

# Resources

## Trackers

- Traquito (complete system)
- QRP-LABS.com
- ZachTek.com
- WB8ELK
- Others..

## Balloons

- yokohamaballoon.com
- aliexpress.com
- scientificballoonsolutions.com

# Thanks

I want to thank my good friend

**N6JED**

who has been instrumental in making these  
flights a success.

I also want thank all of you that are interested  
and send words of encouragement.



Keep looking up as there is more to come!