Cosmo**Meter**

REAL-TIME IONIZING RADIATION MONITOR FOR AVIATION

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*Development of a **portable cosmic radiation detector** capable of measuring ionizing radiation in real time — integrating GPS tracking and flight data logging into a **single lightweight airborne platform**.*

01 The Problem

Ionizing cosmic radiation is a persistent occupational hazard for aviation personnel. At cruising altitude, exposure rates are **50–100× higher** than at sea level — yet real-time personal dosimetry remains absent from commercial aviation.

Sanlorenzo et al., 2015 — Significantly elevated melanoma incidence in pilots and cabin crew vs. the general population.

02 Beneficiaries

PILOTS	CABIN CREW	AIR FORCE
Comm. & Military	Long-haul flights	High-altitude ops

03 Competitive Analysis

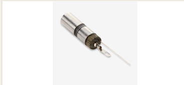
FEATURE	CARI-7A	LIULIN-3M	COSMOMETER
Direct Measurement	✗	✓	✓
GPS Tracking	✗	✗	✓
Flight Data Logging	✗	✓	✓
Weight	—	960 g	376 g
Unit Cost	—	—	€118

– Cost & Value

UNIT COST	WEIGHT
€118.24	376 g
VS. LIULIN-3M	**AUTONOMY**
2.5× lighter	>12 h

04 System Architecture

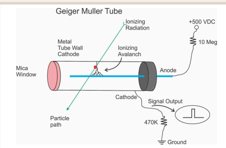
COSMOMETER — HARDWARE PIPELINE

SENSOR	PROCESSING	POSITION	IMU	STORAGE	INTERFACE
					
LND 71412	ESP32 MCU	GPS NEO-6M	MPU-9250	microSD	WiFi Dashboard
500 V · α β γ	3.3 V · WiFi	NMEA 0183	9-DOF	CSV / JSON	Real-time

05 Radiation Sensor — LND 71412

DETECTOR TYPE	Energy-Compensated GM Tube
GAS FILLING	Ne + Halogen
OPERATING VOLTAGE	500 V
OPERATING TEMP.	-10 °C to +75 °C
RADIATION TYPES	α, β, γ, X-ray

GM TUBE PRINCIPLE



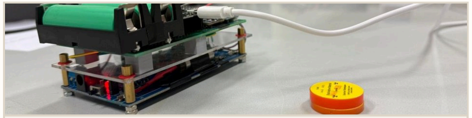
– Power System

→ Two rechargeable Li-ion cells (3.3 V) charged via dedicated charging module

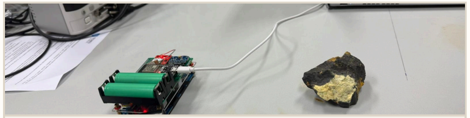
→ 5 V → 500 V boost converter for GM tube polarisation

→ Battery pack — autonomy >12 h continuous operation

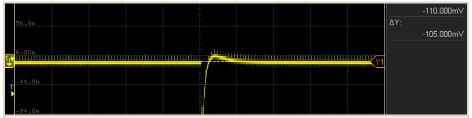
06 Experimental Validation



T.02
Cobalt-60
Gamma pulse detection at distances 3–24 cm. Count rate decreases with distance.



T.02
Uranium Ore
Radiation field from uranium sample detected. Count rate elevation above background confirmed.



T.03
Oscilloscope
Real GM pulse reading captured on oscilloscope. Waveform confirms detector response at 500 V operating voltage.

$\mu Sv/h \approx 0.111 \times CPM$ **Dose rate conversion for Cs-137** — estimates ionizing radiation exposure from raw pulse count. Experimental results follow **CPM ∝ 1/√d** — doubling distance reduces CPM by √2 ≈ 1.41.

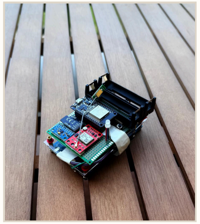
MEASURED COUNT RATES (CPM)

Law: CPM(2d) ≈ CPM(d) / √2 · Background ≈ 20–25 CPM

SOURCE	DISTANCE	CPM MEASURED	CPM EXPECTED (1/√D)
Cobalt-60	3 cm	185	185
Cobalt-60	6 cm	155	131
Cobalt-60	9 cm	159	107
Cobalt-60	12 cm	142	92
Cobalt-60	24 cm	137	65
Uranium	12 cm	454	454
Uranium	24 cm	284	321

Experimental uncertainty: Full isolation of samples was not possible. Background radiation and contributions from surrounding objects inflate measured CPM at larger distances, explaining the deviation from the 1/√d expected values, particularly for Cobalt.

07 Prototype



Electronics assembly

3D-printed enclosure

08 Real-Time Dashboard

WiFi dashboard — radiation visualisation and accumulated dose monitoring

09 Conclusions

01 CosmoMeter demonstrates feasibility of a **lightweight (376 g, €118) radiation monitoring platform** for aviation.

02 **Radiation, GPS, IMU and data logging** successfully integrated in a single embedded system, overcoming HV and EMI challenges.

03 Experimental results confirm detector sensitivity. Uranium results broadly consistent with **CPM ∝ 1/√d law**. Cobalt-60 deviations attributed to incomplete sample isolation.

Future work: Spectroscopic detection to identify radiation type (α, β, γ) and more detailed characterisation of the in-flight radiation environment.

– Acknowledgements

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