NASA SPACE APPS CHALLENGE 2026

MITOCHONDRIA

Astronaut Health Intelligence Platform

An open-source research prototype that keeps the crew health loop working when Earth is far away — offline-first, explainable and human-supervised.

OPEN SOURCE | OFFLINE FIRST | HUMAN OVERSIGHT

https://mitochondria.edocinfo.com

Research prototype · synthetic data · not NASA-endorsed · not clinically validated

Final Competition Edition · 14 November 2026 · Background: illustrative artwork from the project site



THE ASTRONAUT HEALTH MONITORING CHALLENGE

Spaceflight stresses the body on five interacting fronts

Space radiation

Dose and dose rate kept as separate quantities

Isolation & confinement

Fatigue, sleepiness, stress and workload as private context

Distance from Earth

Delayed or absent ground support

Altered gravity

Bone, muscle and cardiovascular adaptation

Closed environment

CO_2, O_2, pressure, temperature, noise, light

The challenge: gather health indicators so crews can evaluate and act — far from Earth.

Source: NASA Human Research Program — hazards of human spaceflight; NASA Space Apps Challenge 2026

WHY THE PROBLEM MATTERS

Distance turns health monitoring into an autonomy problem

Mission constraints → design

- Distance → local monitoring and protocol access
- Intermittent links → store-and-forward with idempotency
- Many devices → adapter contract + canonical model
- Artifacts → quality states, no silent imputation
- Adaptation → personal, phase-aware baselines
- High stakes → explainability, audit, human authority

Delayed / absent ground link

Real-time ground medicine cannot be assumed

≈ 98 ms median, 0 backend calls

Local action → visible update (validation ledger, self-check path)

Encrypt first, sync later

AES-GCM local store; authorised synchronisation

Source: Product thesis; data/validation (latency criterion)

Today’s health evidence is fragmented — and easy to over-interpret

Source	Typical problem	MITOCHONDRIA response
Wearables / phone sensors	Vendor algorithms, artifacts, missing samples	Quality levels; freshness; transport ≠ sample ≠ stored
Laboratory reports	Unstructured PDFs; units; reference ranges	Exact name + unit matching; ranges never imported
Questionnaires	Treated as diagnoses	Labelled self-report; not clinical instruments
Habitat telemetry	Implied causality	Shared timeline, explicitly non-causal
Research datasets	Mistaken for crew data	Research-only labels; no crew binding

Source: docs/CANONICAL_HEALTH_DATA.md; src/domain/biomarkers

THE MITOCHONDRIA SOLUTION

One loop: Monitor → Personalize → Correlate → Detect → Explain → Act → Learn

01
Monitor
Governed adapters

02
Personalize
Phase-aware baselines

03
Correlate
One timeline, non-causal

04
Detect
Reviewed patterns only

05
Explain
Evidence, gaps, uncertainty

06
Act
Protocol categories

07
Learn
Provenance + audit

OFFLINE-FIRST OPERATION

MISSION-SCOPED GOVERNANCE

EXPLAINABLE, RESEARCH-ONLY SCIENCE

Source: src/components/app-shell.tsx (health loop); docs/HEALTH_INTELLIGENCE_V1.md

PLATFORM VALUE PROPOSITION

What the platform gives each stakeholder

Crew Self

- Local, encrypted, offline capture
- Own evidence; self-assessment
- Synthetic lab-report review

Mission Operator

- Missions, crew, invites
- Settings + redacted audit log
- Synthetic demo launchpad

Ground Medical

- Mission snapshot
- Independent synthetic review queue
- Research-only decisions

Researcher

- Aggregate-only export
- 54-proposal Research Explorer

Integrators

- Adapter SDK, canonical model
- Apache-2.0, self-host, CI

Source: Master Manual §09.5 (role-based access); research privacy workspace

SCIENTIFIC FOUNDATION

Science leads — and every scientific claim carries its review state

Source	Size	Platform use
Biomarker Matrix v1.1	70 metrics	Canonical catalogue
Bone Health Handbook v7 (GR → EN)	63 variables	Reference + bone entry
Cardiovascular Handbook (GR → EN)	96 + 8 examples	Reference + exact matching
Nikolas immune + behavioural	117 + 99 records	Research-only intake
Provisional semantic proposals	54	Research Explorer

Boundaries

- No diagnosis or risk score
- No causation from association
- No clinical thresholds
- Baseline deviation ≠ diagnosis
- Questionnaires ≠ clinical instruments
- Synthetic ≠ astronaut evidence

*Source: src/domain/catalog/reviewed-mvp-v1.1.ts; data/scientific/**

IMMUNE · BONE · CARDIOVASCULAR · BEHAVIOURAL

Four integrated health domains

Bone

- Entry, CSV, document extraction
- Local evidence summary
- Handbook v7: 63 variables (EN/GR)

Cardiovascular

- Mission-scoped HR/HRV/BP context
- Handbook: 96 measurements + 8 examples
- No arrhythmia inference from PPG

Immune & microbiome

- Evidence summary + missing signals
- 117 handbook records (research)
- Microbiome–immune: research only

Behavioral, sleep & cognitive

- Readiness check-in context
- 99 handbook records (research)
- No mental-health diagnosis

Source: src/components/health-domain-workspace.tsx, bone-health-entry.tsx; data/scientific/nikolas--intake.v1.json*

SCIENTIFIC EXPLAINABILITY

Explainability and personal baselines: compare each astronaut with themselves

Preflight | Launch transition | Early adaptation | Stable mission | Return / recovery

Layer	Object	Rule
Personal baseline	PersonalBaselineComparison	Deviation + uncertainty, never “abnormal”
Clinical reference	ClinicalReferenceInterval	Assay interval; context only
Mission limit	MissionOperationalLimit	Programme rule with authority

Every finding explains

- What changed and why
- Missing evidence, confounders
- Confidence breakdown
- Uncertainty + source IDs

Source: src/domain/baseline; docs/HEALTH_INTELLIGENCE_V1.md

Biomarkers are matched exactly — relationships are shown, never inferred

Relationship	Evidence	Platform behaviour
Sleep ↔ sleepiness ↔ vigilance	supported	Research display; DATA QUALITY prompts
Workload ↔ sleep ↔ HR/HRV	supported / limited	No stress label
Bone unloading ↔ urine calcium	supported	No renal-stone score
Bone ↔ vascular (CTX, PWV…)	exploratory	Display only
Microbiome ↔ immune	research only	Never operational
CO_2 ↔ cognition	conflicting	No causal rule

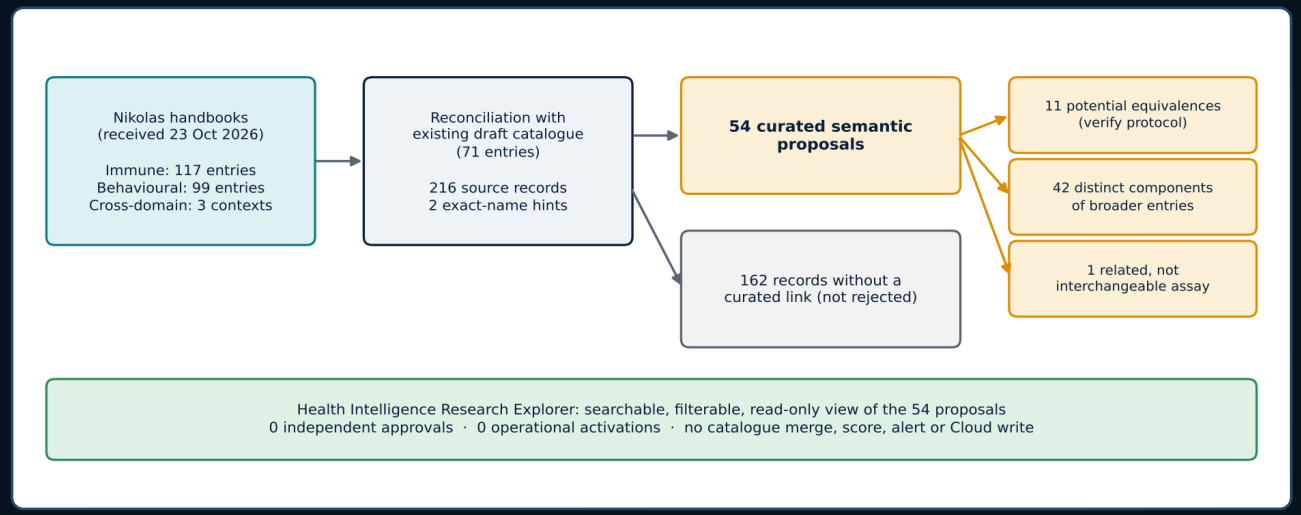
Exact matching

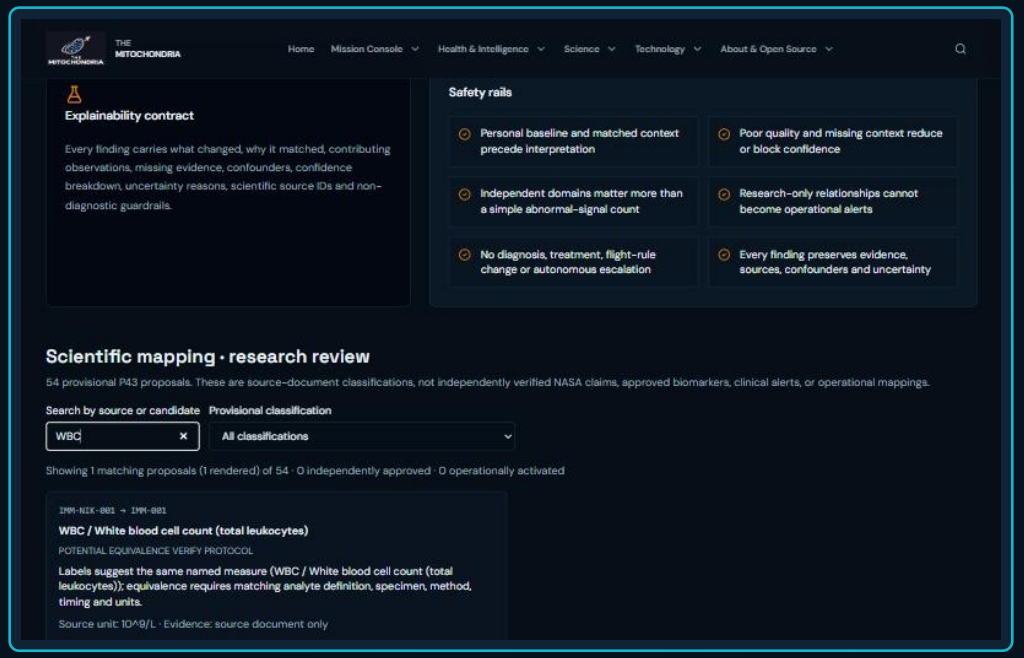
- 159 registry entries
- 96 metric/unit pairs accepted
- 63 bone: advisory hints
- Ranges never imported
- No fuzzy or filename routing

Source: data/scientific (biomarker source registry); src/domain/health-intelligence/patterns.ts

RESEARCH-ONLY SCIENTIFIC INTELLIGENCE

Nikolas' biological research, integrated as a searchable Research Explorer





Research Explorer — search "WBC" (live site)

216
source records

54
provisional proposals

11 · 42 · 1
equivalence · component · related

0 · 0
approvals · activations

Source: data/scientific/nikolas--intake.v1.json, p43-semantic-decision-proposals.v1.json; src/components/scientific-research-candidates.tsx*

SCIENTIFIC PROVENANCE

Every claim traces back to a file, a hash or a ledger

Scientific sources

- Greek handbooks byte-identical (SHA-256 tests)
- English layers joined by ID
- Source evidence labels attributed, not endorsed

Evidence records

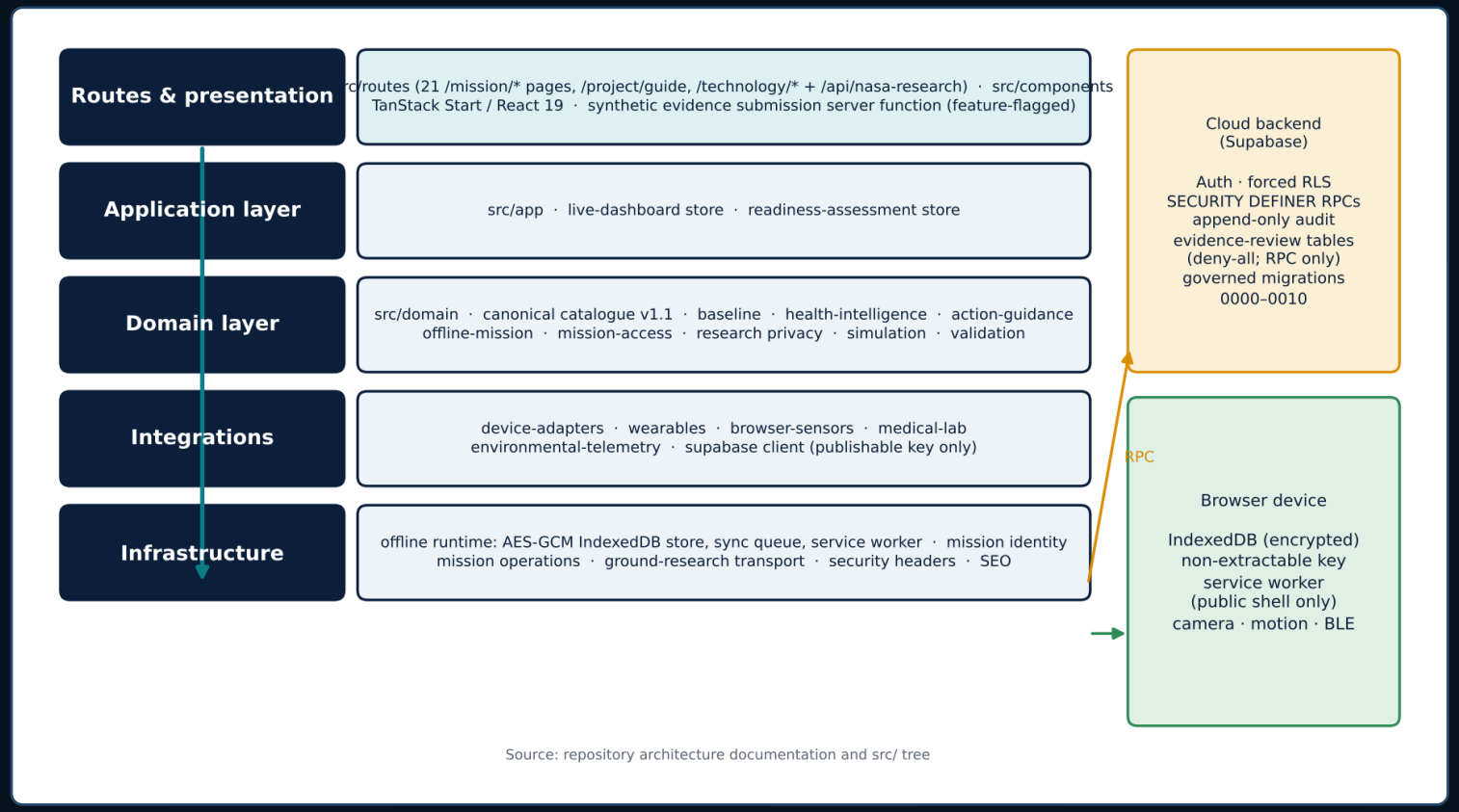
- Source SHA-256 + excerpt
- Submitter / reviewer snapshots
- Decision receipt + one event
- Audit rows without values

Governed ledgers

- Validation and usability criteria
- Scientific review workbook (216 rows)
- Evidence freeze + submission handoff
- 12 automated scientific verifiers

Source: src/domain/scientific-localization; data/scientific/; data/submission/*; scripts/verify-*.mjs*

Architecture: the cloud is not in the sensor-to-astronaut path



Source: repository architecture documentation and src/ tree

Open-source implementation

- Apache-2.0 on GitHub
- TanStack Start · React 19 · Supabase
- Forced RLS; RPC-only writes
- Governed migrations 0000–0010
- Self-hosting with Docker

Source: github.com/computech-gr/astro-vitality-core; docs/ARCHITECTURE.md; drizzle/migrations

Four mission-scoped roles, enforced in the database

	Crew Self	Mission Operator	Ground Medical	Researcher
Crew Self	one crew slot	allowed	forbidden	forbidden
Mission Operator	allowed	—	forbidden	allowed
Ground Medical	forbidden	forbidden	—	allowed
Researcher	forbidden	allowed	allowed	—

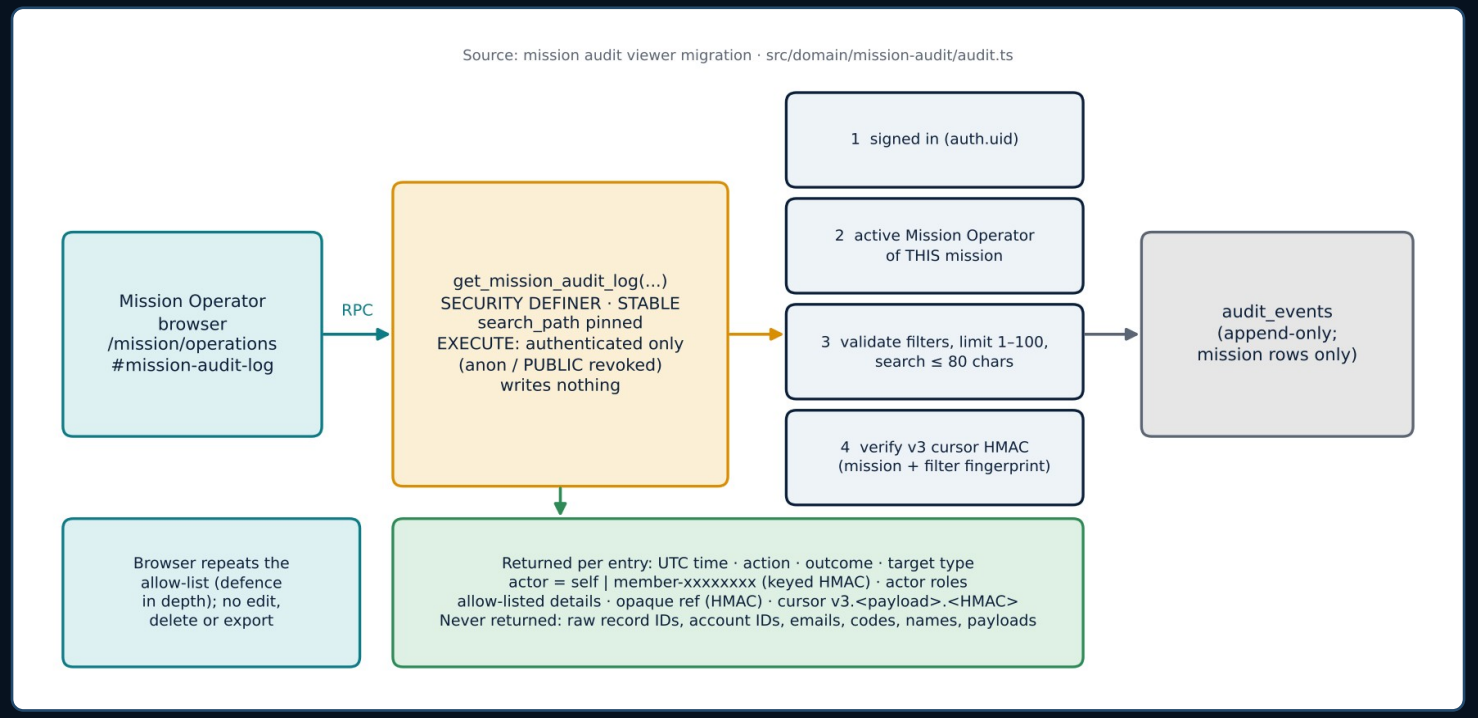
Same mission, both memberships active. Different missions: no restriction.
Enforced in PostgreSQL (mission_roles_compatible + trg_membership_role_compatibility).

Identity and rules

- Generic sign-in error (no enumeration)
- Self-service password change
- One-time, hashed, expiring invites
- GM invite: bind + independent approval
- Reviewer ≠ submitter; instant revocation

Source: src/infrastructure/mission-identity.ts; supabase/migrations (multi-role hardening)

Operators administer missions — and every action is audited



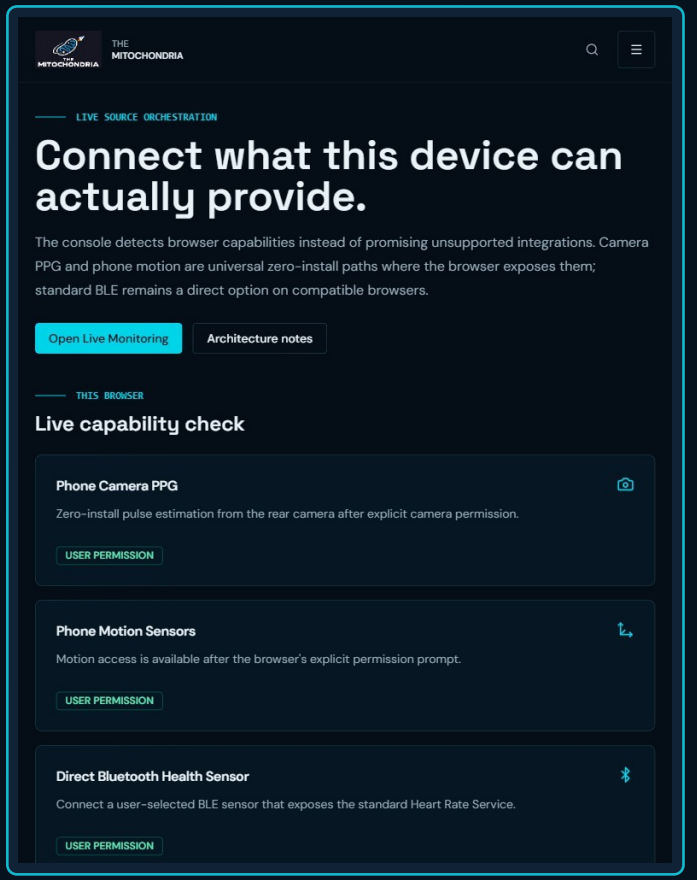
Recorded in production

- Mission Settings (view)
- Mission Audit Log
- Crew, invitations, memberships
- Every mutation audited

Source: src/components/mission-operations.tsx, mission-settings-panel.tsx, mission-audit-log.tsx

Wearables and phone sensors with honest states — nothing is fabricated

Source	Evidence	Notes
Camera PPG	Physical phone	Pulse estimate · not ECG
Phone motion	Physical phone	Clear error if no events
Web Bluetooth HR	Implemented	Standard Heart Rate Service
Health Connect / HealthKit	Adapter contract	Needs native host
Habitat & dosimetry	Adapter contract	Synthetic tests



Device Integration Center — live site

Source: src/integrations/browser-sensors; real-device evidence record (data/submission)

Live monitoring separates identity, transport, sample and storage

Mission identity

AUTHENTICATED MEMBERSHIP · LOCAL FALLBACK

Device transport

Connected ≠ sample received

Freshness

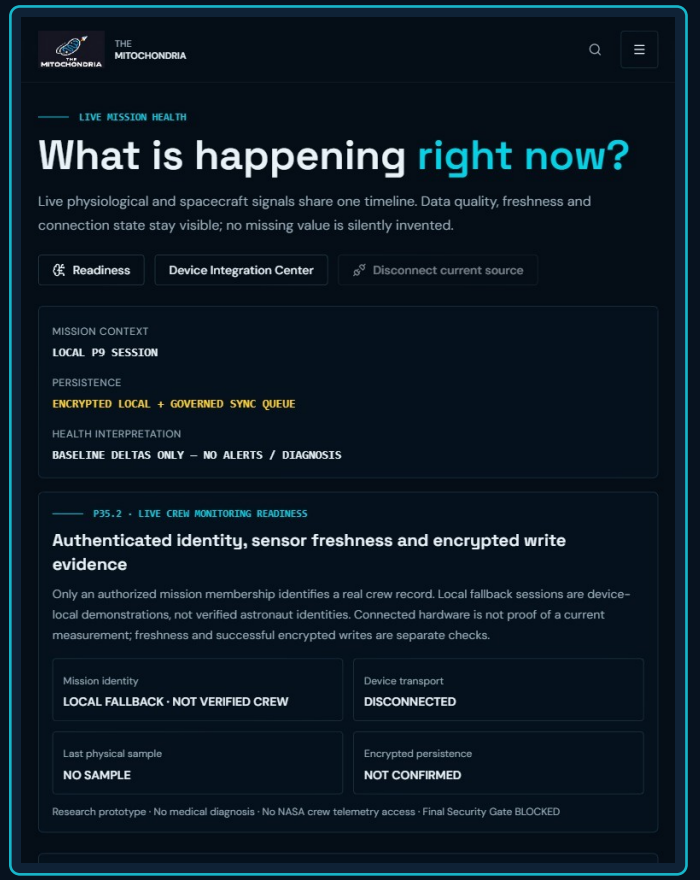
- LIVE · STALE · WAITING · DISCONNECTED
- 90 s physio / 180 s env
- Technical only

Last physical sample

Timestamp or NO SAMPLE

Encrypted persistence

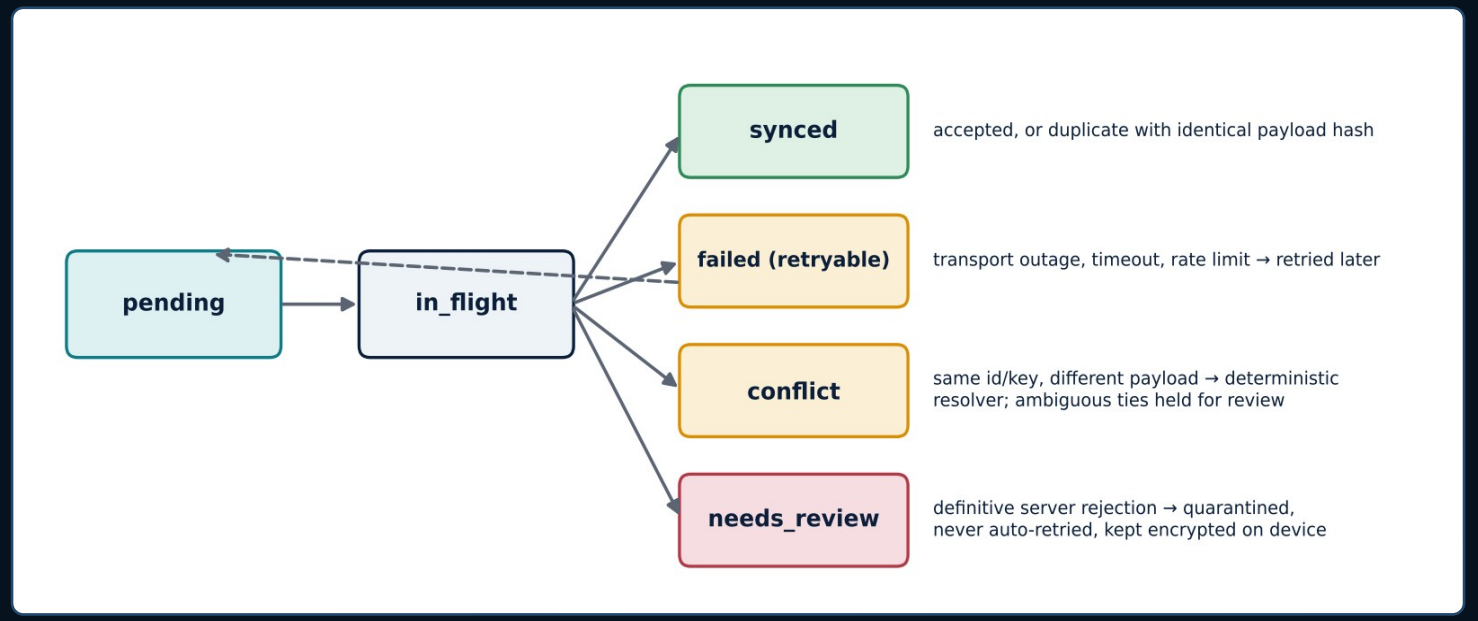
Confirmed count · WRITE FAILED



Live Monitoring — live site

Source: src/components/live-dashboard.tsx; src/app/live-dashboard/store.ts

Offline first: encrypt locally, synchronise with authority



No data loss: records stay encrypted on the device until an authorised sync succeeds

Guarantees

- AES-GCM, non-extractable key
- Idempotency + payload hash
- No anonymous cloud writes
- Service worker: public shell only

Source: src/infrastructure/offline/; docs/OFFLINE_MISSION_MODE.md*

Laboratory evidence: synthetic reports reviewed in the browser

1 Crew Self + consent

2 Local extraction

3 Exact name + unit

4 Human selection

5 Date + confirmation

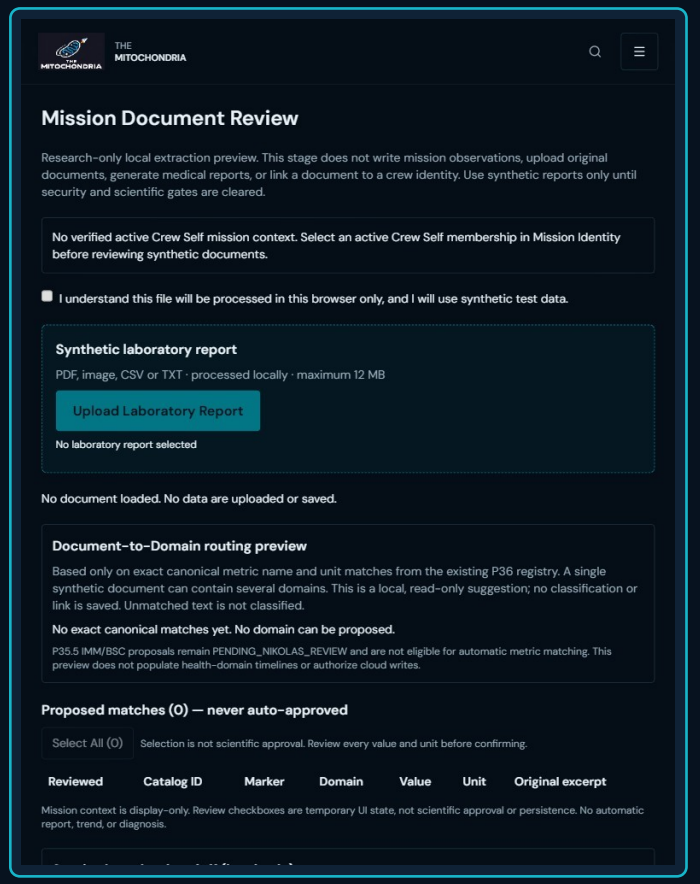
6 Preview or submit

Accepted input

PDF, image, CSV, TXT ≤ 12 MB · synthetic only

Never

Upload of the original · unit guessing



Mission Documents — live site

Source: src/components/mission-document-review-workbench.tsx; src/domain/biomarkers

GROUND MEDICAL WORKFLOW

Ground Medical review — eight synthetic values, read-only, session-safe

1

Ground Medical Workspace

2

Refresh → 8 values · pending

3

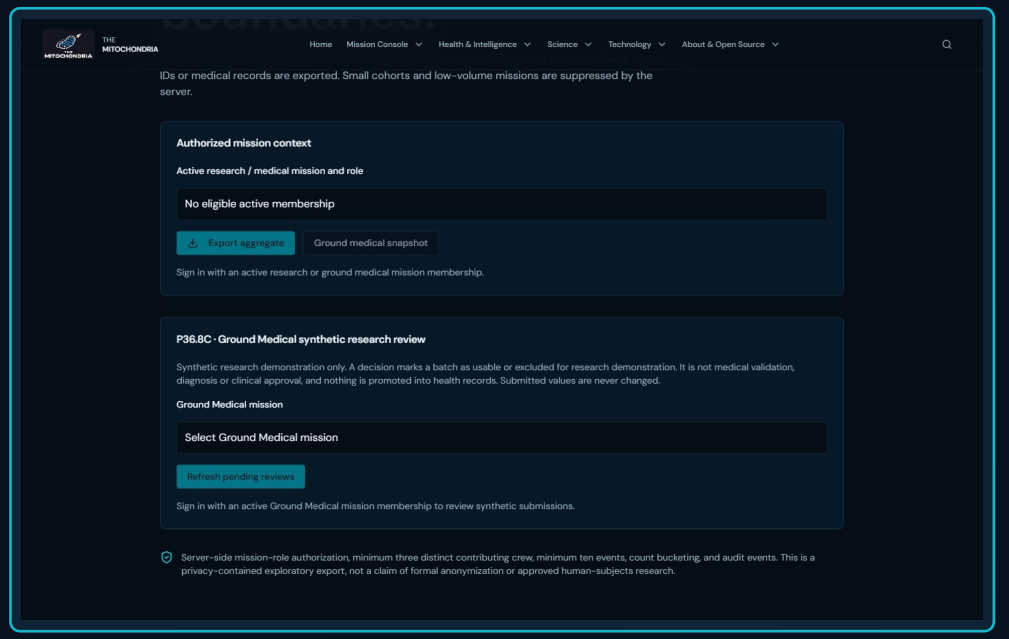
View values + excerpts

4

Decide only if authorized

Session safety

- Tab return: rows hidden, re-checked, same batch restored
- Sign-in change, revocation or mission switch: rows cleared
- Stale responses discarded; neutral status texts



Ground & Research Console before sign-in — live site

Research-only · no clinical meaning · never promoted to health records

Source: src/components/p368b-ground-medical-review.tsx; drizzle/migrations/0009–0010; tests/integration-pg

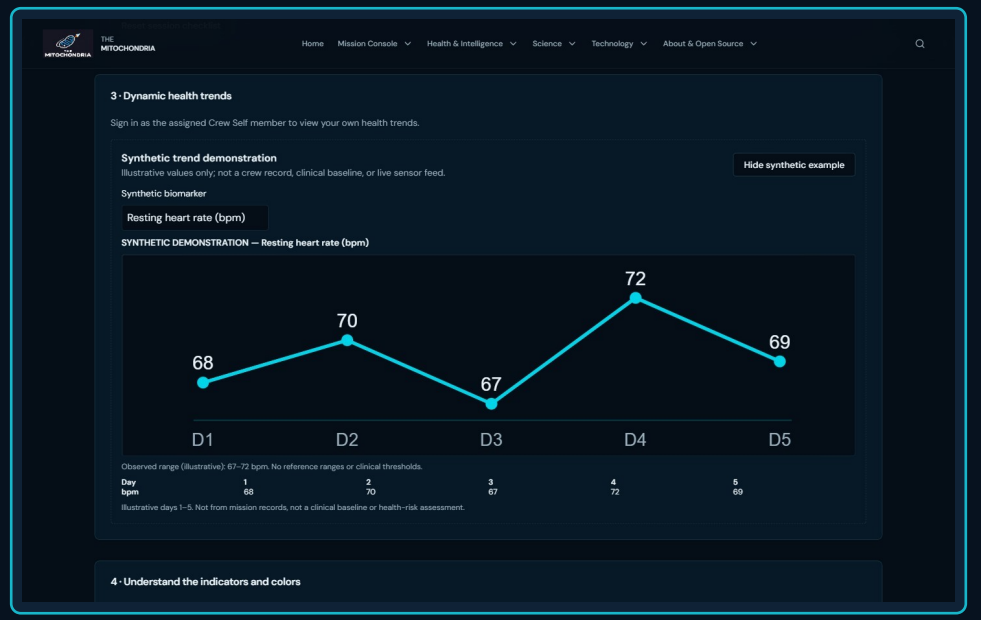
Daily Health Companion: the astronaut’s day, with honest data

What it offers

- 5 mission environments
- 4-item routine · participation only
- Reminders 1 min (demo) – 4 h
- Own trends: unit · time · source · quality
- 7 / 30 / 90-day and source filters

By design, never

- Health or readiness scores
- Prescribed schedules
- Push or background alerts
- Mixing synthetic and crew data



Synthetic trend example (labelled) — live site

Real-account check (development environment): Crew A 27 charted · B 23 · C 51 — no foreign identifiers

Source: src/components/astronaut-daily-health-companion.tsx; src/domain/companion; docs/P49_DEMO_READINESS_RESULTS.md

SESSION INTEGRITY · MISSION SWITCHING · STALE RESPONSES

A private view must never outlive its authorization

Event	What the user sees
Tab hidden → shown	Rows hidden · re-check · restored if still authorized
Sign-in / sign-out / user update	Fail closed at once, then re-read memberships
Revoked or different user	All private rows cleared · neutral status
Mission / scope switch	Queue, values, filters cleared
Late response	Dropped unless latest request + same scope

Enforcement point

Row-level security in PostgreSQL; the client rules only stop rendered data outliving authorization

Not claimed

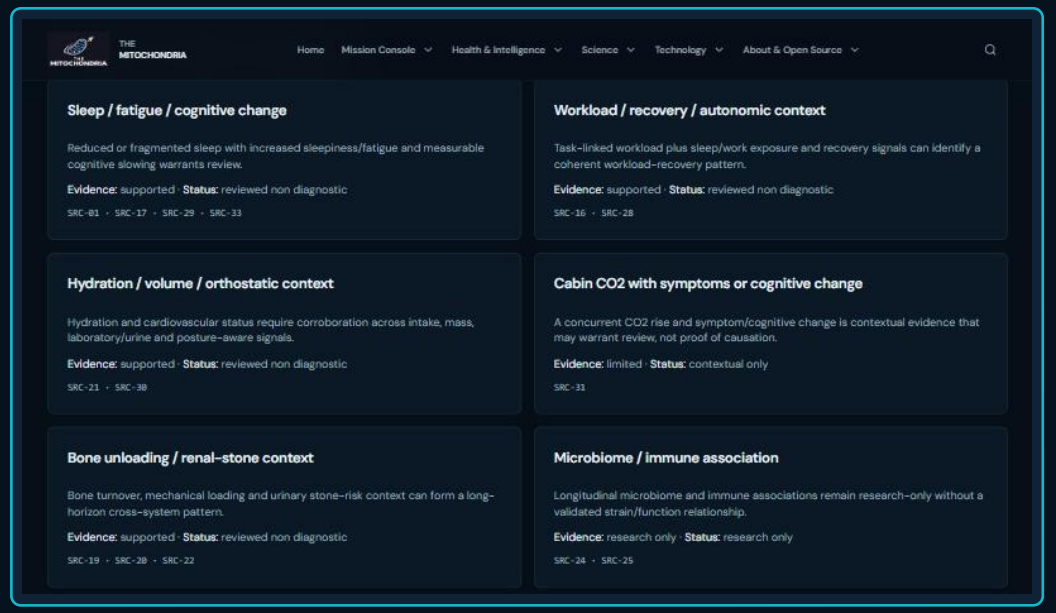
Real-time revocation of an idle visible page; signed-in revocation acceptance (pending)

Source: src/domain/companion/crew-revalidation.ts; src/components/p368b-ground-medical-review.tsx; Master Manual §31.4

EXPLAINABLE HEALTH INTELLIGENCE

Health intelligence explains — it never diagnoses

Pattern	Evidence	Status
Sleep / fatigue / cognition	supported	non-diagnostic
Workload / recovery / autonomic	supported	non-diagnostic
Hydration / orthostatic	supported	non-diagnostic
CO_2 with symptoms	limited	contextual only
Bone unloading / renal	supported	non-diagnostic
Microbiome / immune	research only	never operational



Reviewed pattern catalogue — live site

Source: src/domain/health-intelligence/patterns.ts; src/components/explainable-alerts.tsx

NASA OSDR: real research metadata, clearly not crew data

Bounded proxy

- GET /api/nasa-research
- Fixed origin; 12 s; 1 MiB
- Accession OSD-<n>; ≤ 500 rows
- No credentials; no-store

Labels on every package

- classification: research_only
- subjectBinding: none
- clinicalActivation: false
- Not astronaut telemetry



NASA Scientific Evidence — live site

Source: src/routes/api.nasa-research.ts; src/domain/nasa-research/import.ts

Mission-scoped privacy and governance, enforced where data lives

Controls

- Forced RLS; RPC-only writes
- Evidence tables deny-all
- Audit without values
- CSP, HSTS, Permissions-Policy

Privacy

- Documents stay in the browser
- Research Workspace: aggregate-only
- Suppressed below 3 crew / 10 events
- Counts rounded down to tens

Governance

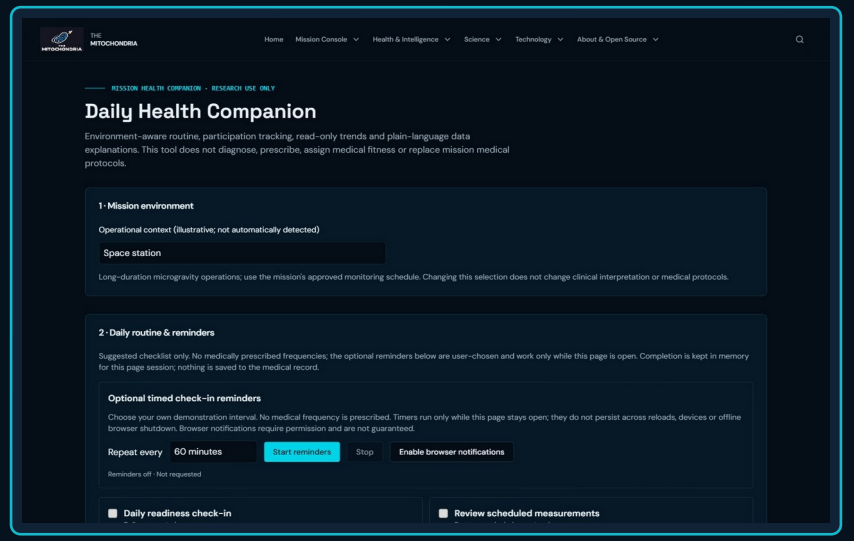
- Owner approval per migration
- Separation of duties
- Instant revocation
- Ethical use: synthetic only

Source: docs/SECURITY_MODEL.md; src/security/headers.ts; .github/workflows

Live demonstration: 15–20 minutes, no admin access, no real data

Path	Time	Route
A · Public	~8 min	Menu → Companion → Live → Research Explorer → Intake/Report → Ground console → Validation
B · Crew Self	~4 min	Sign-in → own trends + filters → tab switch → isolation check
B · Ground Medical	~3 min	Workspace → 8 values → tab switch → mission switch
B · Researcher	~1.5 min	Aggregate export or suppression
B · Operator (optional)	~1.5 min	Launchpad tracker and offline report

https://mitochondria.edocinfo.com · NASA Evaluator Quick Start Guide (FINAL)



Daily Health Companion — live site

Source: NASA Evaluator Quick Start Guide (FINAL), Section 5

FINAL COMPETITION EDITION · AUTOMATED VERIFICATION

Engineering evidence — reported as it is

✓

Quality #338 — release commit 4e448ea

✓

Security Scan #326 — Trivy

864

tests passing (162 files, dev env.)

305 / 305

database integration assertions

Evidence	Result
Crew Self intake — disposable PostgreSQL	PASS 14/14
Typecheck · lint · build (dev env.)	PASS
Medical v3 Release Gate #75	BLOCKED BY DESIGN
Owner gates P3663 · P3664 · P20	PENDING EVIDENCE
Clinical activation	DISABLED

Public evidence

github.com/computech-gr/astro-vitality-core/actions — runs for commit 4e448ea

Source: GitHub Actions runs #338, #326, #75; docs/P52_1_CI_REPAIR.md; docs/P53_MEDICAL_EVIDENCE_OWNER_READINESS.md

WHAT THIS RELEASE DOES NOT CLAIM

Scientific limitations and future validation

Owner-evidence gates

P3663 restore · P3664 risk · P20 official rules

Signed-in revocation test

Dedicated accounts; Crew Self and Ground Medical

Independent science review

54 proposals: 0 approved, 0 activated

Device and live acceptance

Offline OCR, two-account isolation, phone notifications, live review

Not claimed

- Clinical validation
- Regulatory clearance
- Flight qualification
- Astronaut deployment
- NASA endorsement

Source: data/submission/p46-acceptance-evidence.v1.json, p47-competition-handoff.v1.json; Master Manual §32 and §39

WHY IT MATTERS BEYOND THE COMPETITION

Mission impact and future potential

Crew autonomy

Health loop works without a ground link

Personal, not population

Phase-aware baselines per astronaut

Explainable by design

Evidence, gaps and uncertainty on every finding

Research-ready

Analog missions, research teams, education

Open and extensible

New sensors and catalogues via contracts

Trustworthy

Governance and provenance built in

Source: Master Manual §02 and §39.3

CLOSING

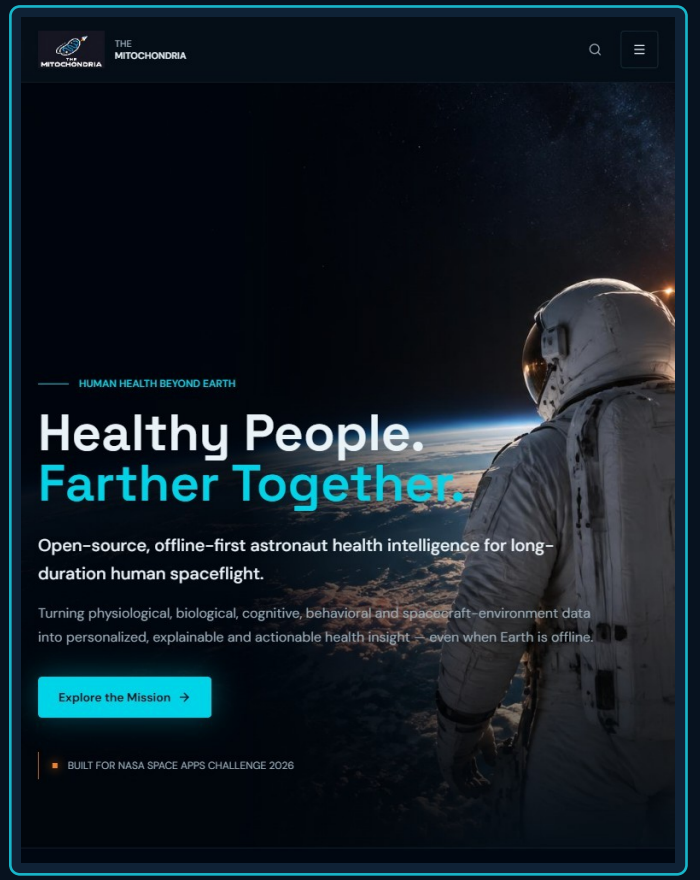
Healthy people. Farther together — with evidence you can check.

Try it

- mitochondria.edocinfo.com
- Public path: no account
- Evaluator guide: 15–20 min

Read and review

- Master Operations & Technical Manual
- github.com/computech-gr/astro-vitality-core
- Apache-2.0 · contributions welcome



Home — live site

Research prototype · synthetic data only · not NASA-endorsed · not clinically validated