

# ACEP



## Mission and Spacecraft

Alpha Centauri Exploratory Probe



Spacecraft visualisation above Earth

## Exploring the Proxima system

ACEP is an uncrewed science spacecraft for exploring Proxima Centauri and its planet Proxima b. It connects interstellar transfer, orbital observation and conditional atmospheric investigation in one autonomous mission.

### INTERSTELLAR ENVIRONMENT

Measure dust, particles and radiation between stars.

### PLANETARY OBSERVATION

Map the planet and investigate its surface and atmosphere.

### LOCAL INVESTIGATION

Sample conditions along an atmospheric descent with Atmos.

# Why Proxima b matters

Close-range measurements can reveal how a nearby planet responds to its star and whether it retains an atmosphere.

## Proxima Centauri

An active red dwarf



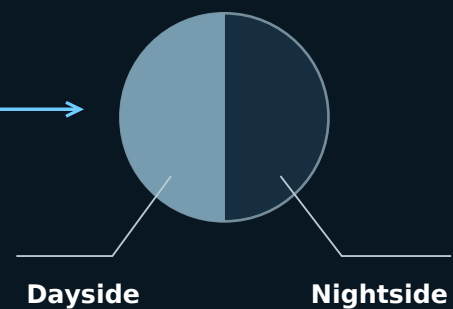
### Nearly circular orbit

Eccentricity 0.02 · orbital speed  $\approx 47$  km/s

Schematic; not to scale.

## Proxima b

ACEP target reference



0.0485 au

mean orbital distance

4.25

light-years from the Sun

11.18

Earth days per orbit

7.25

million km from its star

## An eleven-day year

Proxima Centauri is the nearest star to the Sun. Proxima b follows a nearly circular orbit at about one-twentieth of the Earth-Sun distance. Despite this close orbit, the faint red dwarf supplies only about 64% of the stellar energy per unit area that Earth receives. Its flares make atmospheric survival a central scientific question.

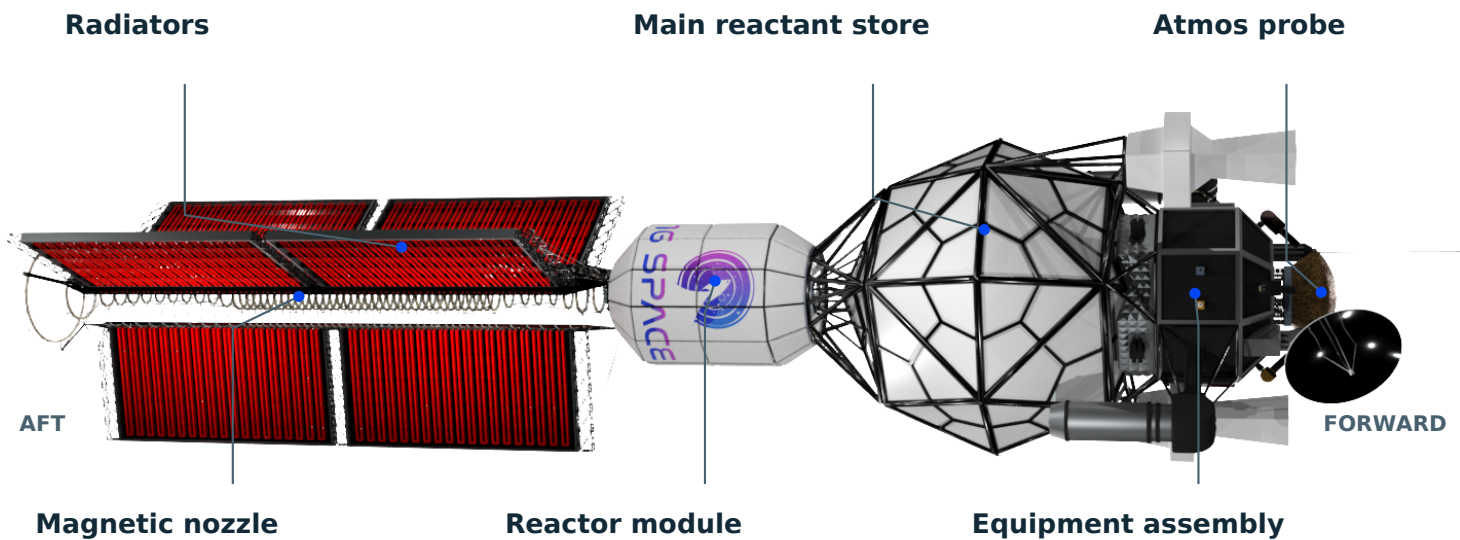
## A tidally locked world

In ACEP's target reference, Proxima b is tidally locked: it rotates once per orbit, keeping the same hemisphere facing its star. The boundary between the persistent dayside and nightside is the terminator. ACEP investigates the temperature contrast and how an atmosphere, if present, redistributes heat.

A light-year measures distance; one astronomical unit (au) is approximately the Earth-Sun distance. Eccentricity measures orbital elongation; zero is circular. The minimum mass of 1.06 Earth masses comes from stellar motion; the true mass depends on orbital inclination.

# A tour of the spacecraft

A structural truss connects the propulsion plant, main reactant store and forward equipment assembly.



Side view; internal components are not shown.

**16.80 m**

overall length

**4.60 m**

maximum stowed diameter

**1,000 kg**

dry mass, including Atmos

## Electrical and thermal services

Three thermoelectric generators provide 100 kW combined rated output. Two 500 Wh packs provide 1 kWh nameplate storage. Radiators have 54 m<sup>2</sup> effective emitting area.

## Stored reactants

Fully loaded mass is 78,146 kg: 77,100 kg of main feedstock, 32.0 kg of antiprotons and 14.0 kg of metallic hydrogen, plus the dry vehicle.

MADS: Microwave Active Debris Shield. Metallic-hydrogen stabilisation is undisclosed. Forward and aft are fixed vehicle ends; their orientation to the trajectory changes at reorientation.

## Equipment and external systems

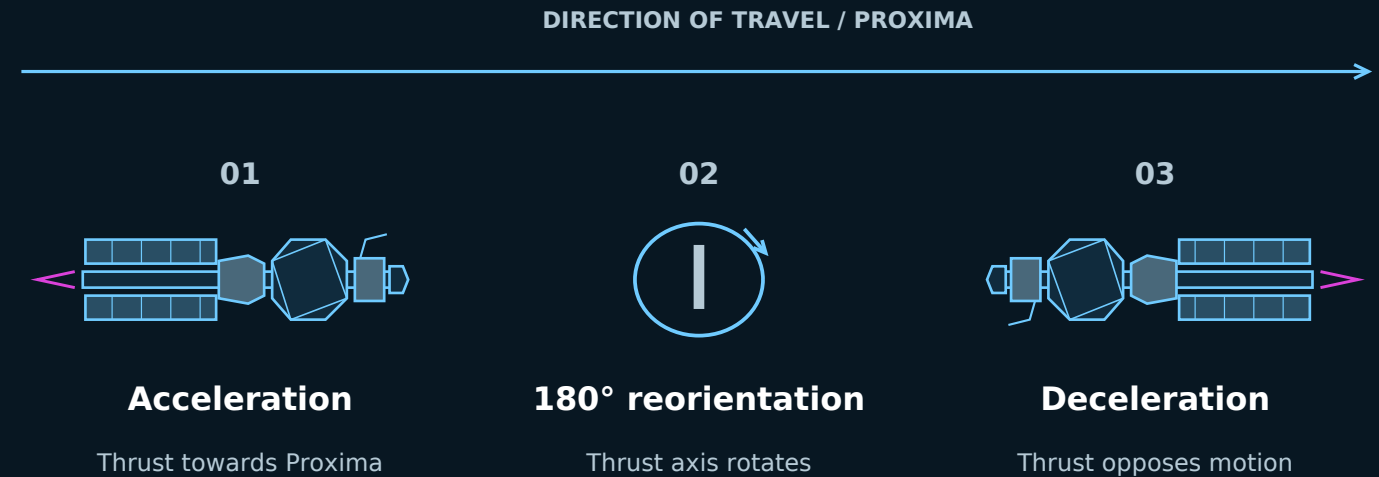
Forward systems house computing, navigation and science. Two MADS horns protect during acceleration. Optical transmitters serve Earth; radio receives Atmos data.

## Auxiliary manoeuvring

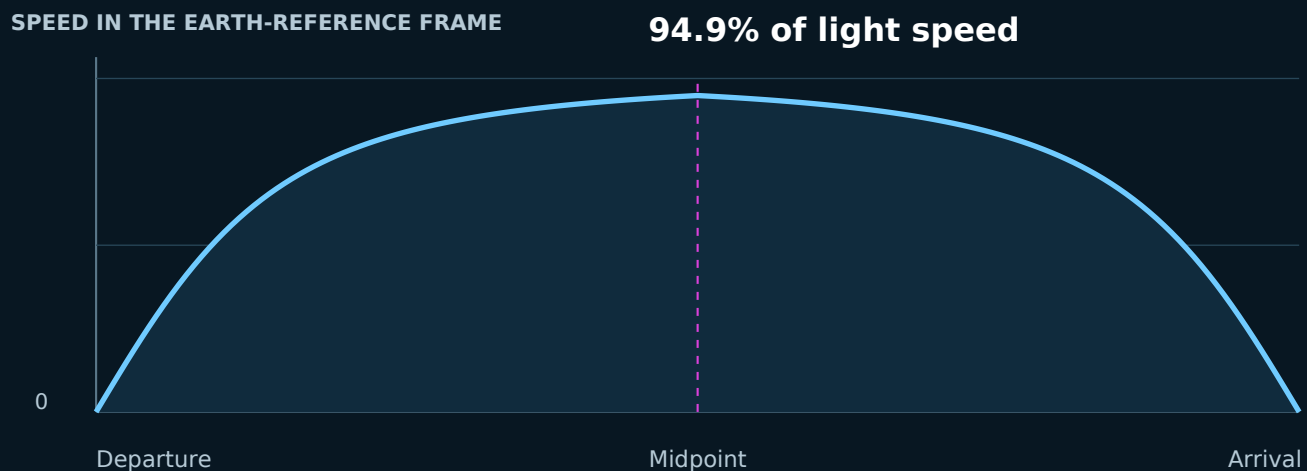
Three thruster units have four outlets each; any two support full operation with required shared services. Metallic hydrogen supplies thrust and heat without an oxidiser.

# Acceleration and deceleration

Sustained thrust accelerates ACEP during the first transfer leg and decelerates it after the midpoint reorientation.



The turn changes orientation, not the direction of travel.



## 1,288 days

elapsed aboard ACEP

## 5.8 years

elapsed in the Earth-reference frame

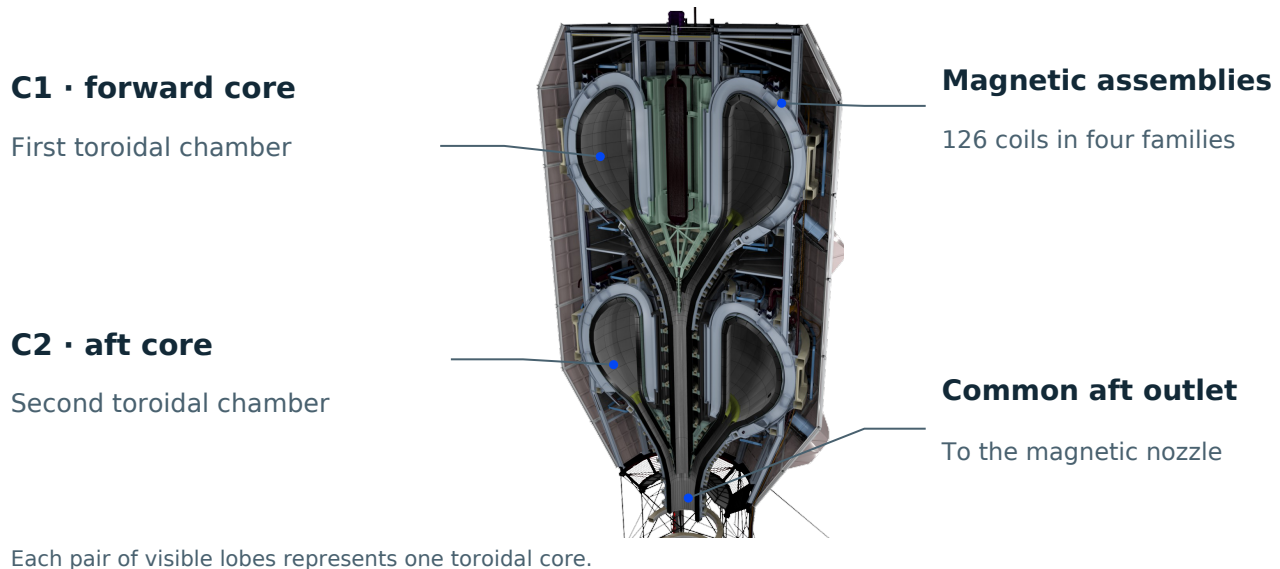
The profile uses 1 g of proper acceleration, measured aboard and equal in magnitude to standard Earth gravity. Reorientation occurs at day 644. Relativity gives different elapsed times aboard and in the Earth-reference frame; both clocks operate normally.

MADS provides outbound protection. The controlled handover requires adequate coverage through reorientation; MADS then remains off and the route-leading exhaust provides protection. Handover details and encounter limits are undisclosed.

Horizontal axis: Earth-reference elapsed time. Reorientation and local arrival manoeuvres are omitted.

# Inside the dual-core reactor

Dual-Core Magnetically Confined Antiproton-Augmented Fusion Reactor (DCMCAAFR)



## Confinement and controlled extraction

The two toroidal chambers are stacked along the spacecraft axis. Superconducting magnetic assemblies confine and shape the plasma, an ionised gas. Extraction fields guide both streams into a common aft transition and magnetic nozzle. Directed exhaust produces thrust in the opposite direction.

### Fusion and antiproton augmentation

The reactor admits proton-boron-11 feedstock and metered antiprotons. Its detailed reaction chain, energy yields and conversion processes are undisclosed. Mission performance follows the effective propulsion parameters and reactant inventories. Magnetic fields guide the charged plasma. Photons and secondary particles require shielding and thermal management.

### Control and fault isolation

Each core has its own confinement, injection, diagnostics and protection. AURAI selects plant mode; local controllers regulate fields, feed and plasma. Either core supports continuous operation up to 187.5 MW total plant demand while required services remain within limits. Secured equipment retains cooling and containment where required.

## 375 MW

reactor plant rating

## 100 kW

combined TEG module rating

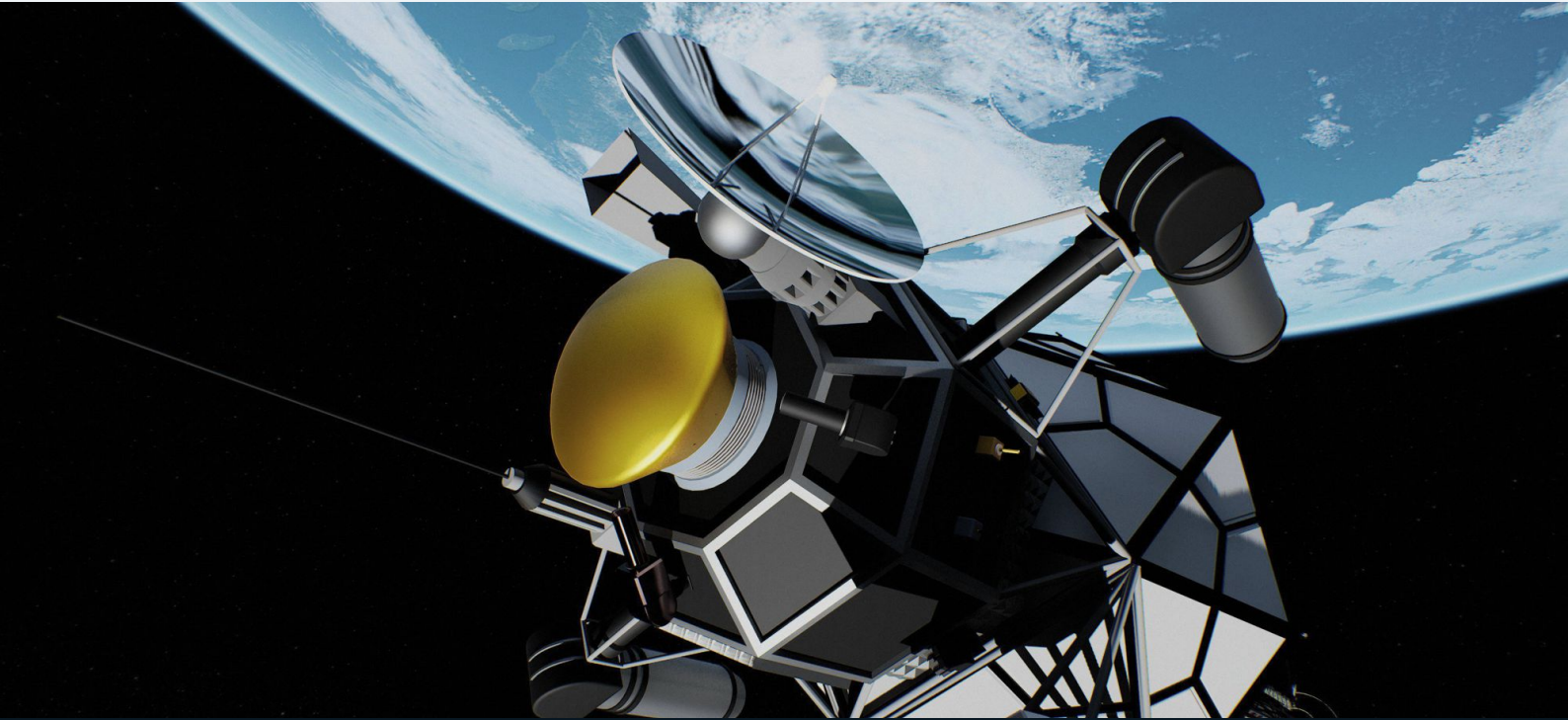
## 6 MW

rejection reference at 1,300 K

Thermoelectric generators convert recovered heat into electricity; radiators reject waste heat. Plant and exhaust power retain separate definitions. Detailed energy and thermal budgets, plasma coupling and antiproton containment are undisclosed.

# From orbit to atmosphere

The mothership supplies broad planetary coverage. Atmos adds direct measurements along one descent path.



## FORWARD ASSEMBLY

Atmos is the gold entry capsule at the front.

Spacecraft visualisation above Earth.

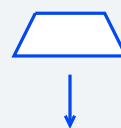


## Orbital observation

200 km nominal altitude

A near-circular polar orbit supports broad mapping. An orbit is continuous free fall around the planet. The achieved orbit follows local measurements of gravity and geometry.

Images and thermal maps reveal features and temperature patterns. Spectroscopy identifies chemical signatures in light; laser ranging measures distance.



## Atmos descent

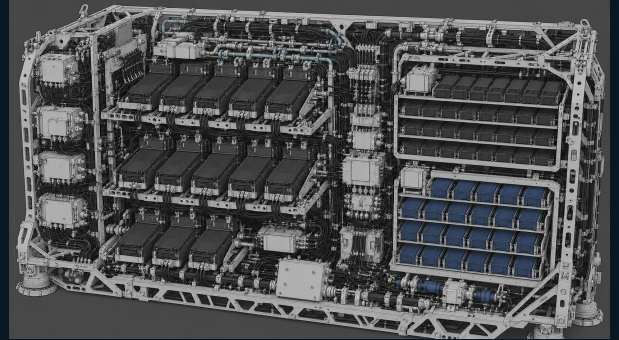
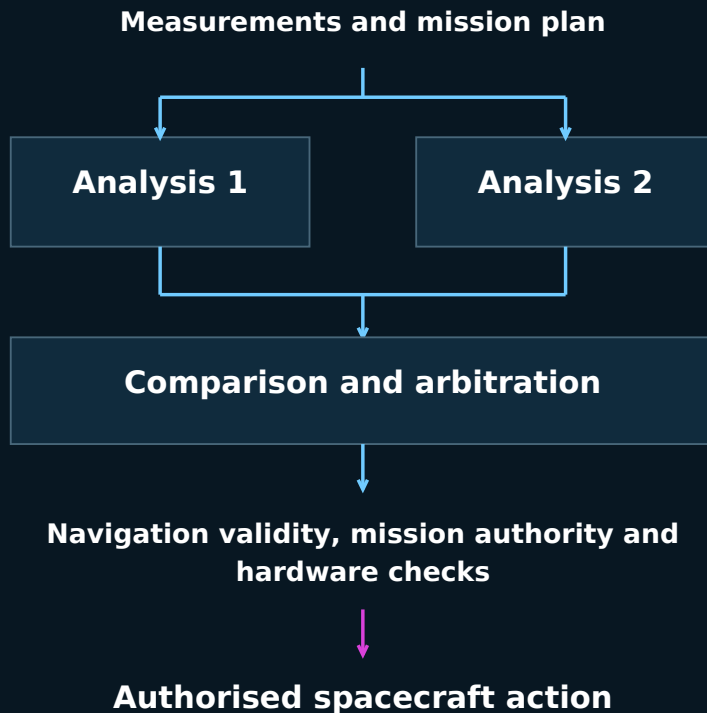
50 kg separable probe

Atmos measures pressure, temperature, gases and particles. Its ablative shield sheds material to carry away entry heat. Batteries power the instruments; a local radio link returns data to ACEP.

Release requires suitable atmospheric and entry conditions. Atmos has no parachute, landing or recovery system; its scientific return is the record received and retained aboard ACEP.

# AURAI and onboard decisions

Autonomous Unified Redundant Analytical Intelligence integrates mission evidence, projects outcomes and detects developing faults.



AURAI computing rig

## COMPUTING INFRASTRUCTURE

**3**

CPU's

**10**

GPU's

**32**

SSD drives

**20**

archive units

Two logical analytical instances compare assessments. They share some hardware and inputs; agreement does not exclude a shared error. Disagreement defers action or invokes a defined safe response. With one valid instance, stored mission sequences continue within pre-authorised guards; major decisions are not independently revised.

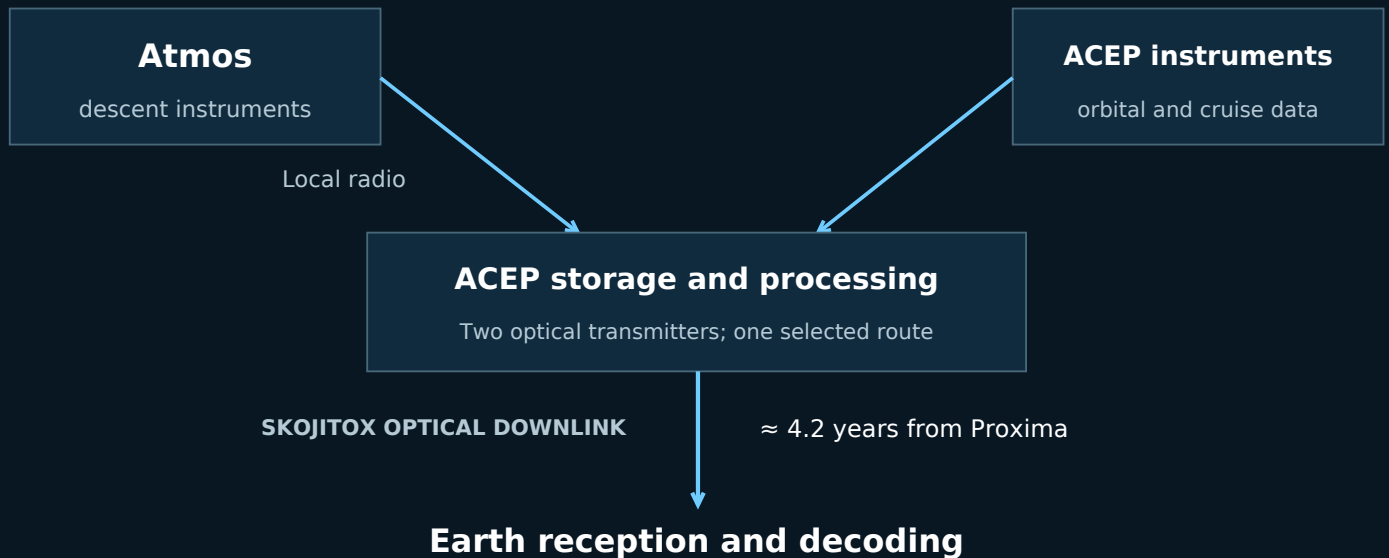
2 main + 1 auxiliary assemblies • 4 power supplies  
1 SSD controller • 1 holographic archive controller

CPU's handle general processing; GPU's perform parallel calculations. SSD's provide solid-state storage; holographic units provide long-term archiving.

AURAI's protected navigation fusion combines inertial, optical and validated X-ray pulsar measurements. Guidance, Navigation and Control uses the qualified state to direct the spacecraft. Pulsars are rotating neutron stars with regular observable pulses.

# From spacecraft to Earth

Local radio, onboard storage and an optical downlink preserve and transmit the mission's scientific record.



The interstellar link is transmit-only: there is no Earth-to-spacecraft command or acknowledgement path. Acquisition, transmission and reception carry different timestamps. Emission alone does not establish delivery.



Mission Control room

## ACEP Advanced Telemetry

ACEP is the spacecraft. ACEP Advanced Telemetry is its mission-monitoring interface, presenting ship-centred state across navigation, propulsion, power, communications and science.

**A live interface refresh does not remove the interstellar signal delay.**

### READ EACH VALUE WITH ITS CONTEXT

Source and status / Event time and reference frame / Units and uncertainty  
Distinguish measured, reconstructed, predicted and unavailable values.