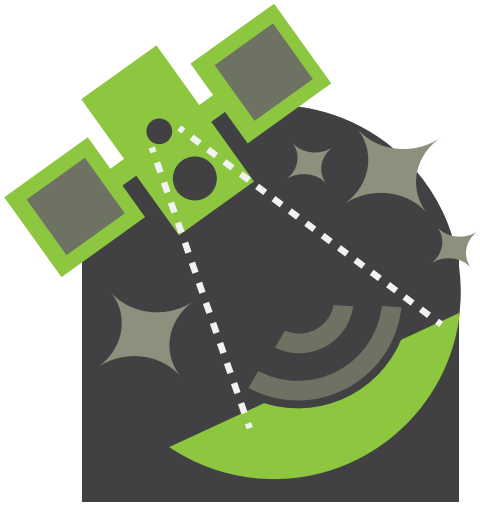


farearth
FOR SMALLSATS

Project guide

space ● earth ● intelligence pinkmatter

CONTENTS - Project guide

Learn more:
Supporting documents for further reading

Complete questionnaire
Action is required

Overview

Learn more:
1. Brochure
2. Technical overview

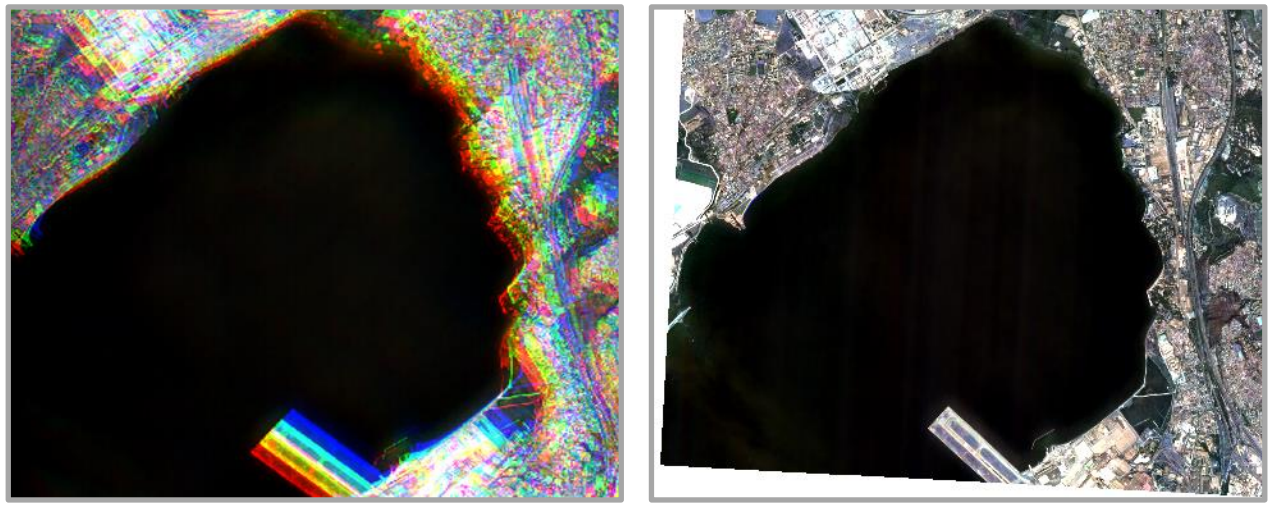
FarEarth for SmallSats **is a cloud-based image processing solution for small satellite Earth observation missions.** ***FarEarth*** **offers raw data input, repeated calibrations, continuous automated bulk processing, and delivery of analysis-ready data to the** ***Archive*****.**

We offer sensor modelling services by considering your specific sensor characteristics to give you the best possible product. ***Pinkmatter*** **works with you from pre-launch until your satellites' lifetime ends.**

With our flexible solution, you can integrate multiple ground stations and satellites. Offered as a fully managed cloud-based Software-as-a-Service (SaaS), this model allows you to reduce the costs associated with processing satellite imagery by scaling to meet your specific needs.

farearth FOR SMALLSATS

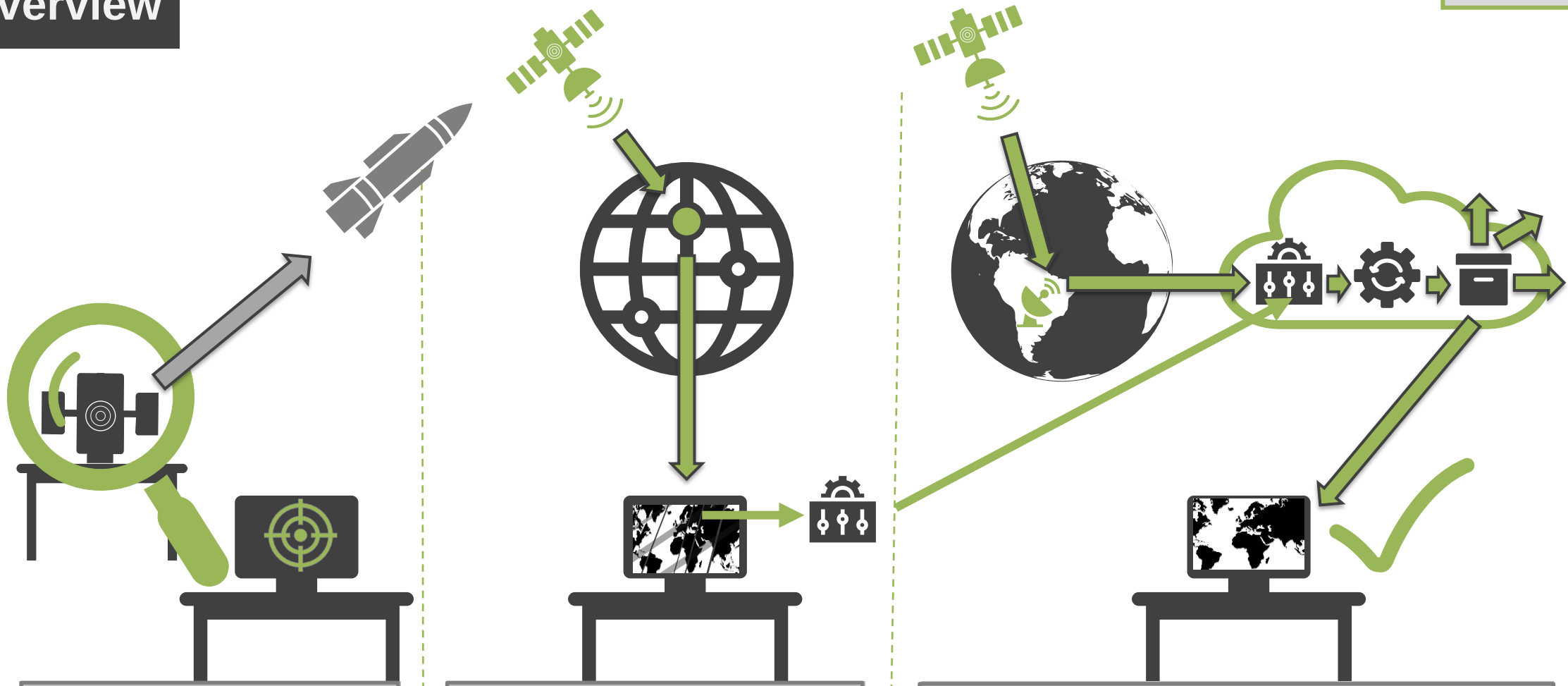
calibration & validation ● automated bulk processing ● SaaS ● affordable ● flexible ● scalable



BEFORE → AFTER

Overview

Learn more:
Technical overview



Pre-launch

Sensor modelling

In-orbit commissioning

First calibration campaign

Operational

- Acquisition
- Raw data input
- Systematic bulk processing
- Continuous calibration
- Delivery

Overview

Learn more:
Technical overview

ADVANTAGES OF FAREARTH

Quality products

- ☑ Decode satellite streaming data
- ☑ Radiometric calibration
- ☑ Geometric modelling
- ☑ Terrain corrected (orthorectification)
- ☑ Standard geo-referenced product formats
- ☑ Generated product metadata
- ☑ Product quality metrics
- ☑ Comparable across time and satellites

Flexible

- ☑ Ingestion options and APIs
- ☑ Prioritise pickup points
- ☑ Various processing workflows
- ☑ Deliver to your chosen destination
- ☑ Configurable rolling *Archive*
- ☑ One system for multiple missions and constellations
- ☑ Integrate multiple ground stations
- ☑ Flexible deployment options
- ☑ Optional custom reference data

Cloud-based Software as a Service

- ☑ Fully managed solution
- ☑ Monitors system health
- ☑ No in-house infrastructure to maintain
- ☑ Always up to date
- ☑ Scale when you need it
- ☑ Reliable and secure
- ☑ Access controlled
- ☑ Monitoring dashboards

Automated processing

- ☑ Custom-configured processing workflows
- ☑ Automated bulk processing
- ☑ Automated archiving and delivery
- ☑ Fast and reliable

Sensor modelling and calibration

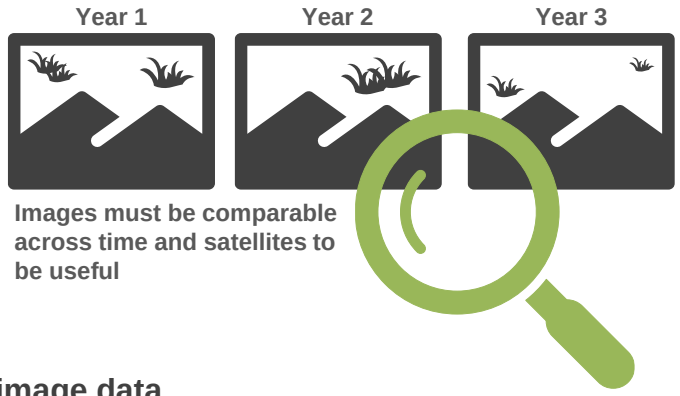
- ☑ Pre-launch support
- ☑ Continuous calibration
- ☑ Sensor-specific modelling, calibration & validation

Low risk

- ☑ Annual subscription
- ☑ Grow with your constellation
- ☑ Pre-launch sensor performance validation
- ☑ Secure cloud infrastructure

Image correction

Learn more:
Technical overview



Images must be comparable across time and satellites to be useful

Each smallsat presents unique challenges. Raw satellite image data contains anomalies introduced by external geometric and radiometric factors. Therefore, image correction is vital to achieving quality image products to make your images comparable across time and satellites.

Factors influencing smallsat image data

Distortions and noise are amplified with smallsats, requiring expert knowledge and new image processing approaches.

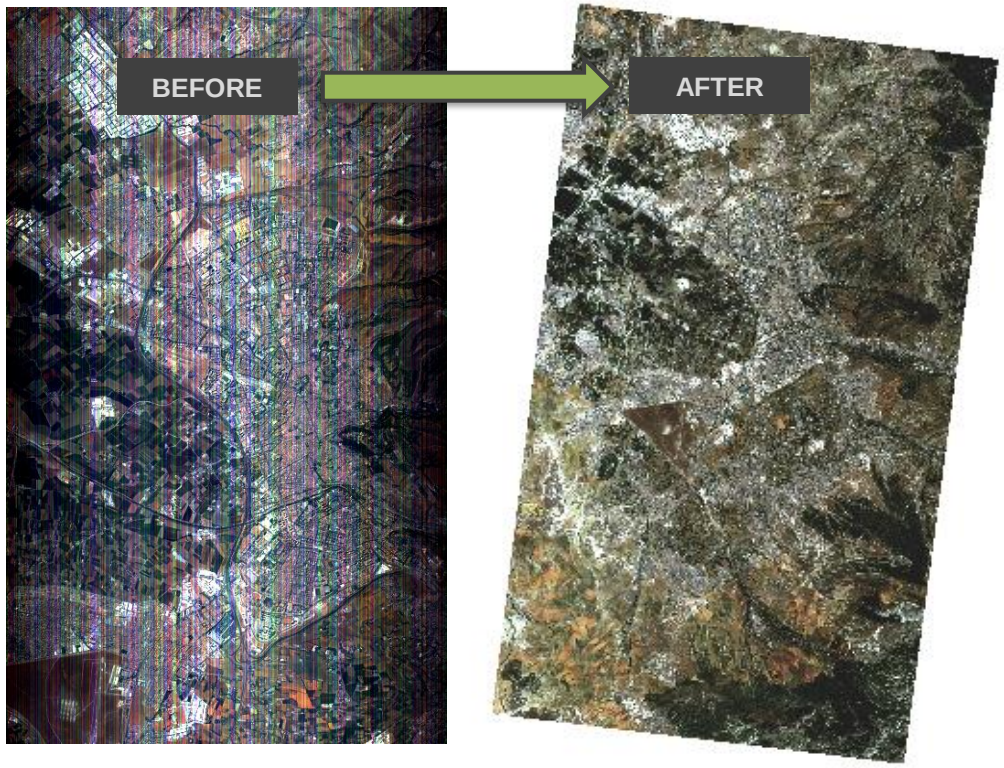
- ❑ Each camera is unique
- ❑ Satellite motion and vibration
- ❑ Orbital deviations
- ❑ Limitations for attitude determination
- ❑ Earth is semi-circular, perspective
- ❑ Compensation for incidence angle, terrain distortions

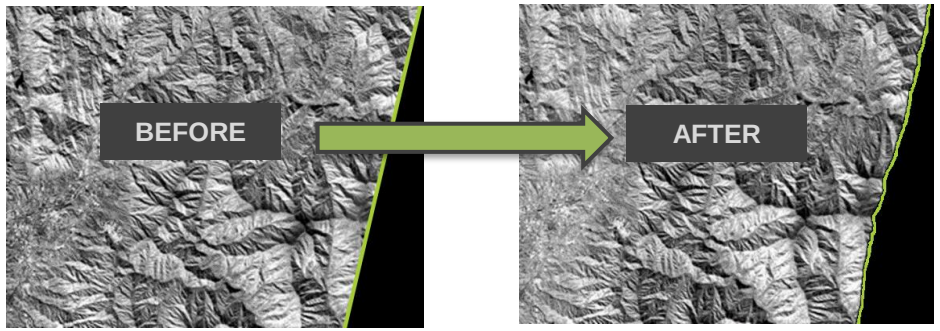
Image correction considerations

Geometric modelling	Radiometric calibration	Terrain correction
• Bad detectors	• Lens distortions	• Elevation model
• Striping	• Vignetting	• Look angle
• Band alignment	• Detector spectral response	• Projection
• Satellite pointing		

Image correction

Learn more:
Technical overview





FarEarth compensates for various anomalies and does corrections and calibrations

- ❑ Sensor characterisation
- ❑ Sensor element positions
- ❑ Detector offsets
- ❑ Detector overlaps
- ❑ Lens characterisation
- ❑ Camera optics
- ❑ Cross-calibration
- ❑ Ground sampling distance (GSD) assessment
- ❑ Detector striping removal
- ❑ Modulation Transfer Function (MTF) characterisation
- ❑ Geolocation accuracy assessment and calibration
- ❑ Pointing accuracy assessment and calibration
- ❑ Swath width assessment
- ❑ Effective focal length (EFL) assessment

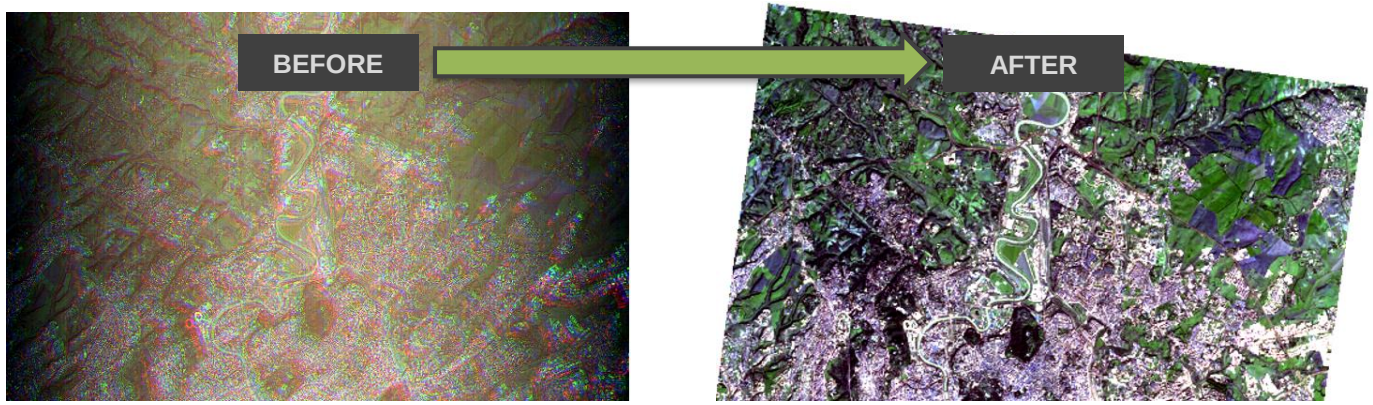


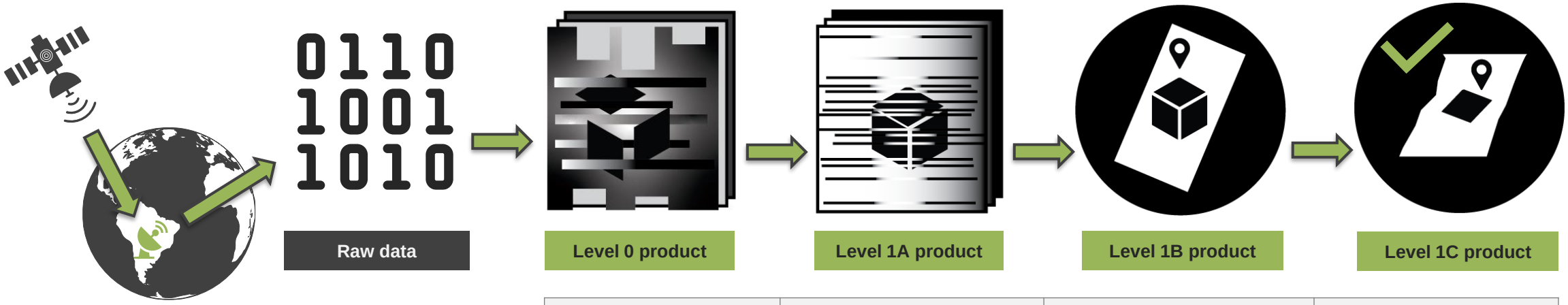
Image correction

Learn more:
1. Product level brochure
2. Raw data format document

Small satellite image data received from a ground segment undergoes multiple processing stages to produce usable image data products. Each stage provides products with varying amounts of data manipulation and advancement toward a usable image.

Note: The standard processing level definitions below are defined by Pinkmatter*. The processing level and output data formats can be tailored according to your operational requirements.*

***FarEarth* standard deliverable product**



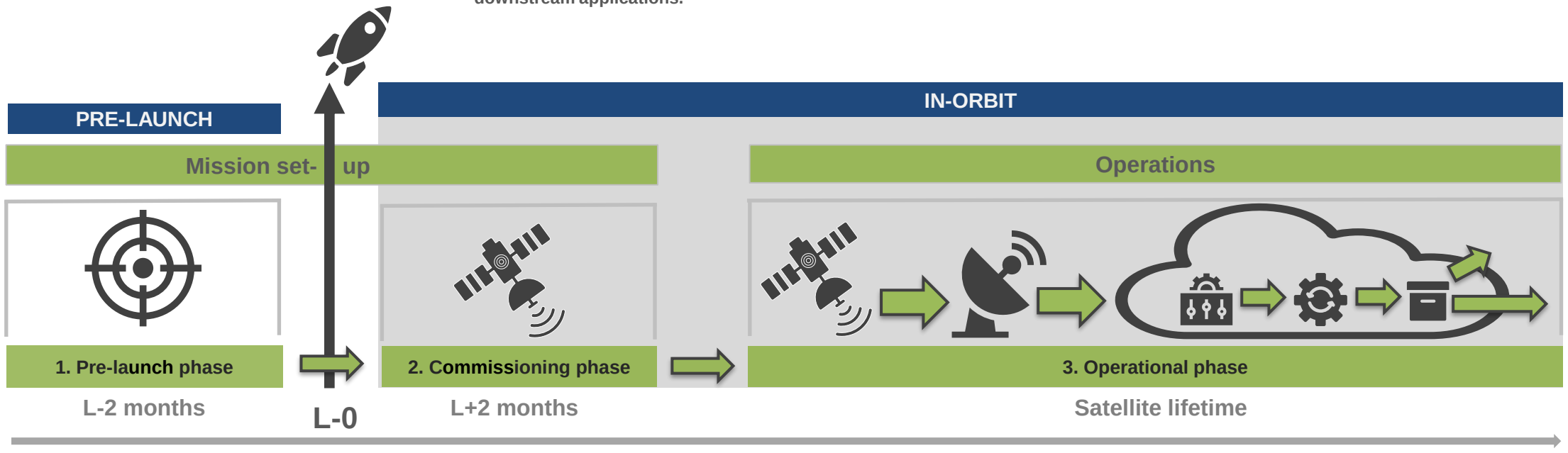
Raw data	Level 0 product	Level 1A product	Level 1B product	Level 1C product
	• Reformat raw telemetry data • Preserve data integrity	• Systematic corrections • Sensor geometry • Radiometric calibration • Georeferencing (RPC)	• Band alignment • RPC refinement • Terrain correction (Orthorectification) • Digital numbers to TOA radiance or reflectance	• Ortho product • Map projected

Project outline

Learn more:
Technical overview

Already in orbit?
Don't worry, you can still use *FarEarth*

Your FarEarth project is divided into mission set-up and operations. Mission set-up involves all steps before the satellite is fully operational. Downlinked data is systematically processed during operations into useable image products for downstream applications.



- Flight readiness report

- Access to your *FarEarth* portal
- Commissioning calibration report

- Level 1C product with quality metrics delivered to *Archive*

Project outline

Complete:
Project questionnaire

INFORMATION WE NEED FROM YOU

- ❑ Mission objectives & requirements
- ❑ Basic satellite specifications
- ❑ Basic sensor specifications

You can use our *FarEarth for SmallSats* solution at any phase of your small satellite mission.

We will work with your team to define the recommended configuration to match your requirements. Once you place your order, your *FarEarth for SmallSats* project starts.

1. Pre-launch phase

- ❑ Our project manager provides you with a project plan to guide you through the various project phases

- ❑ We coordinate with your engineers to develop a mission-specific sensor model and raw data decoder

- ❑ You receive regular progress reports

2. Commissioning phase

- ❑ You get access to your *FarEarth* portal

- ❑ After the satellite launch, we validate your first images and perform calibration

3. Operational phase

- ❑ Systematic bulk processing

- ❑ You get access to an online course and user guide. The *FarEarth* portal is easy-to-use

- ❑ You log support requests in our ticketing system

- ❑ Regular re-calibration ensures accurate and consistent image quality over the lifetime of your satellite

FarEarth for SmallSats

Pre-launch phase

Complete:
Pre-launch document

Already in orbit?
Don't worry, you can still use *FarEarth*

1. Pre-launch phase — L-2 months

L-0

2. Commissioning phase — L+2 months

3. Operational phase — Satellite lifetime

We coordinate with your engineers to develop a mission-specific sensor model and raw data decoder. We validate the performance of your sensor from the laboratory test data you provide.

TIMELINE

Steps	Duration estimate	Responsibility
Provide satellite, sensor, and raw data format specifications	2 weeks	Satellite operator / integrator
Provide lab test data	2 weeks	Satellite operator / integrator
Pre-flight calibration	4 weeks	*Pinkmatter*
Flight readiness review	1 week	Satellite operator / integrator and *Pinkmatter*

What we need from you

- ❑ Complete pre-launch document
- ❑ Provide lab test data

What we do

- ❑ Develop a mission-specific sensor model
- ❑ Develop a raw data decoder specific to your mission

Why?

- ❑ The commissioning phase will use preliminary calibration parameters
- ❑ Validate sensor performance for launch go-no-go decision

What you get

- ❑ Sensor validation report

Pre-launch phase

Complete:
Pre-launch document

Don't have lab test data? Don't worry, talk to us!

INFORMATION WE WILL NEED FROM YOU

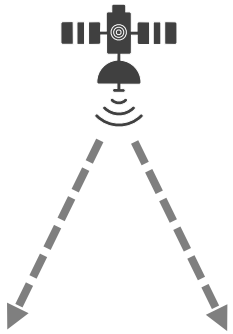
You receive a detailed list of information we need from you.

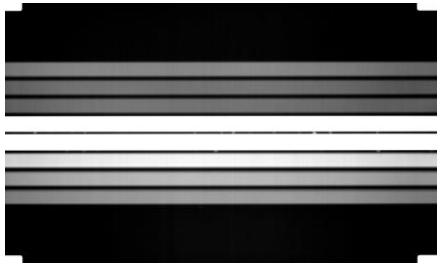
Pre-launch document

Some information required from you:

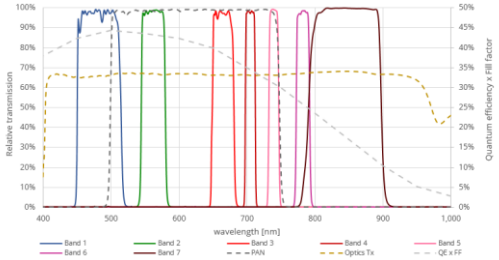
- ❑ Theoretical and laboratory datasets
- ❑ Sensor data integration control document (ICD)
- ❑ Sensor field of view (FOV)
- ❑ Lens effective focal length (EFL)
- ❑ Ground sampling distance (GSD)
- ❑ Bus specifications
- ❑ Payload data stream format
- ❑ Sensor lab test data

You need to complete this document

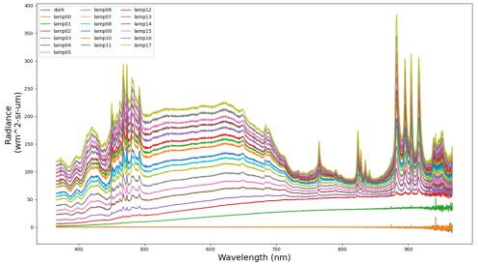




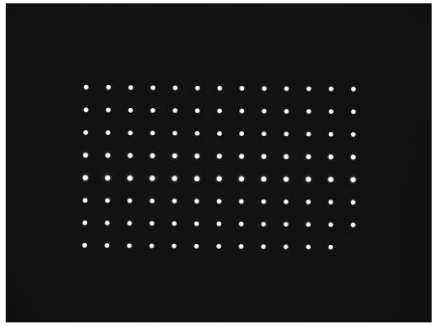
Flat field correction



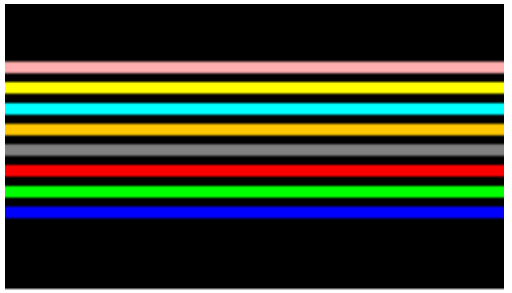
Spectral response functions



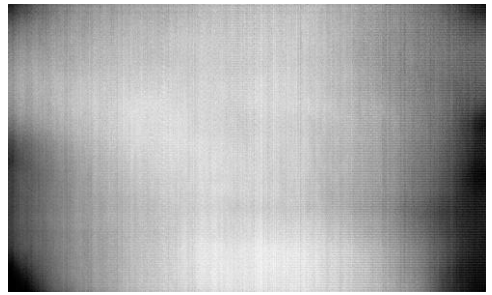
Integration sphere data



Lens distortion grids



Sensor layout



Dark view

Pre-launch phase

Learn more:
Technical overview

WHAT YOU WILL RECEIVE

After the sensor test information evaluation, you receive a pre-launch sensor validation report for your flight readiness review.

Pre-launch sensor validation report

Mission sensor

- Focal plane assembly & sensor layout
- Sensor layout & bands
- Spectral response functions

Pre-Launch calibration & datasets

ESUN coefficients

- Result

Flat-field correction

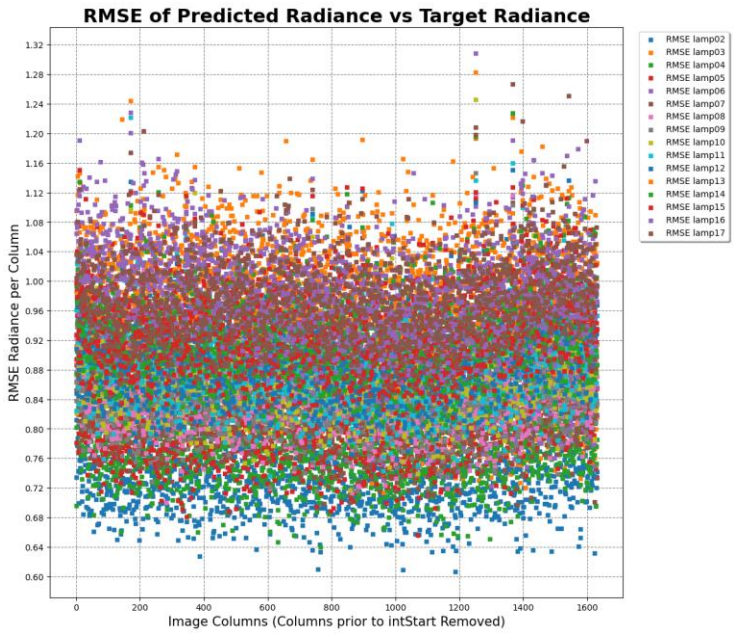
- Result – NUC modelling
- Result – calibration coefficients

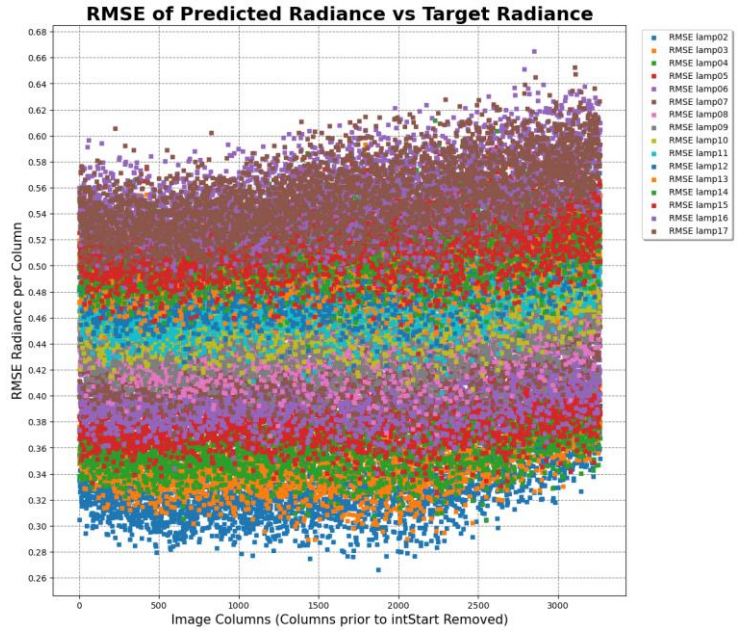
Bad pixel columns

- Result

Conclusions

You will get a validation report





Commissioning phase

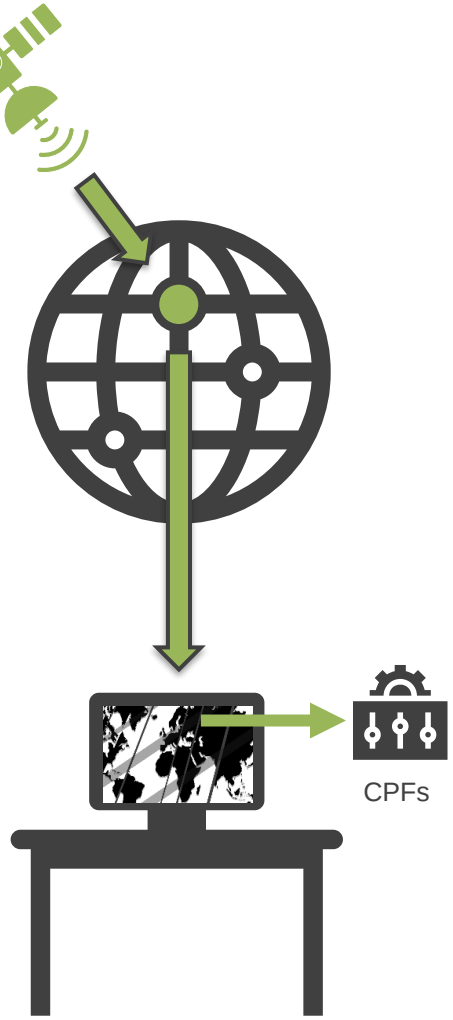
Learn more:
Technical overview

1. Pre-launch phase — L-2 months
L-0
2. Commissioning phase — L+2 months
3. Operational phase — Satellite lifetime

Congratulations, your satellite is in orbit! It is time for commissioning:

A. **You receive access to your *FarEarth* portal**
B. **Let's get started with your first calibration campaign**

A. Welcome to your portal



B. First calibration campaign

Welcome to the portal

Learn more:
Getting started video

1. Pre-launch phase — L-2 months
2. Commissioning phase — L-0 to L+2 months
3. Operational phase — Satellite lifetime

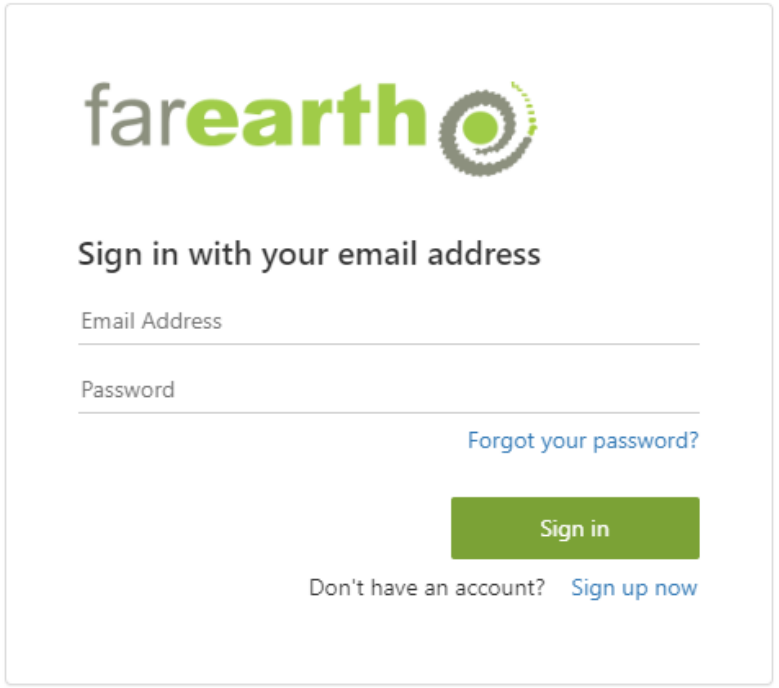
Once your satellite is in orbit, you can access the *FarEarth for SmallSats* portal. The *FarEarth* portal is easy-to-use. Watch the "getting started" video to familiarise yourself with some features.

What we do
- ❑ Configure the system according to your specific requirements

What you do
- ❑ Create your login
- ❑ Watch the "getting started" video

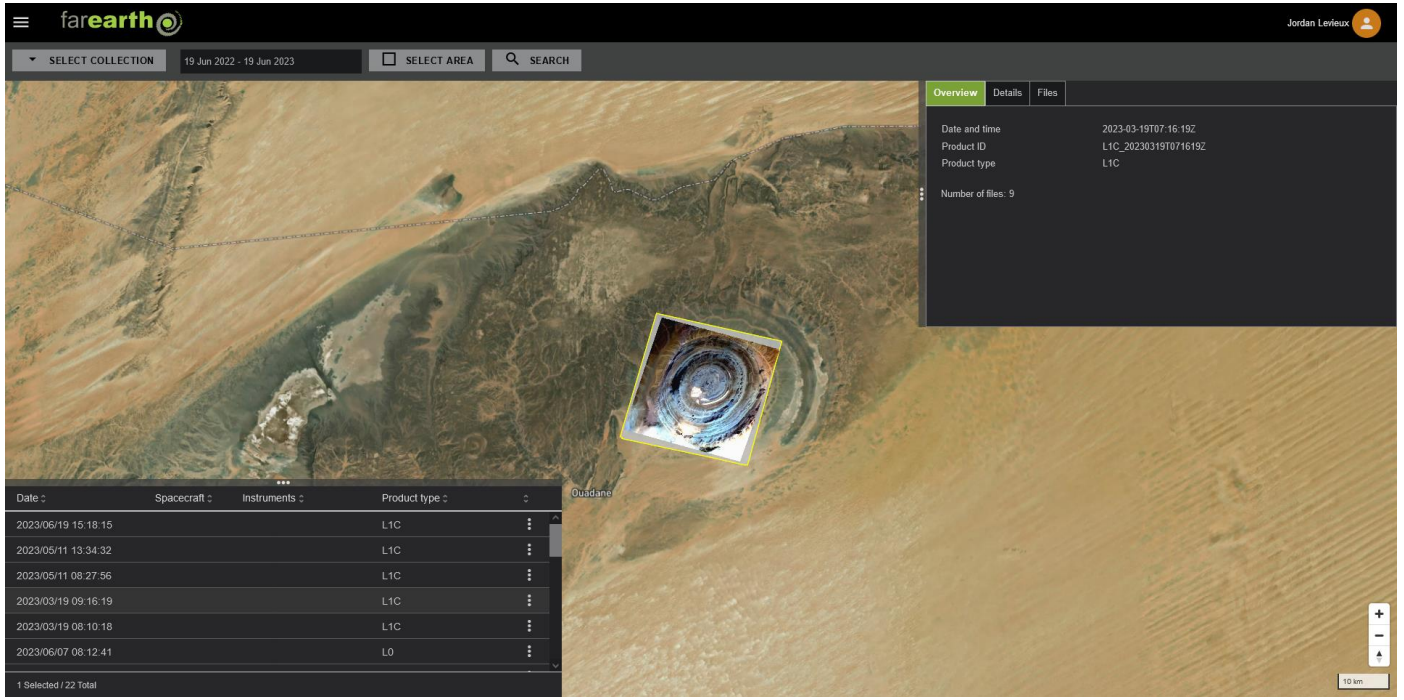
Why?
- ❑ Familiarise yourself with the portal

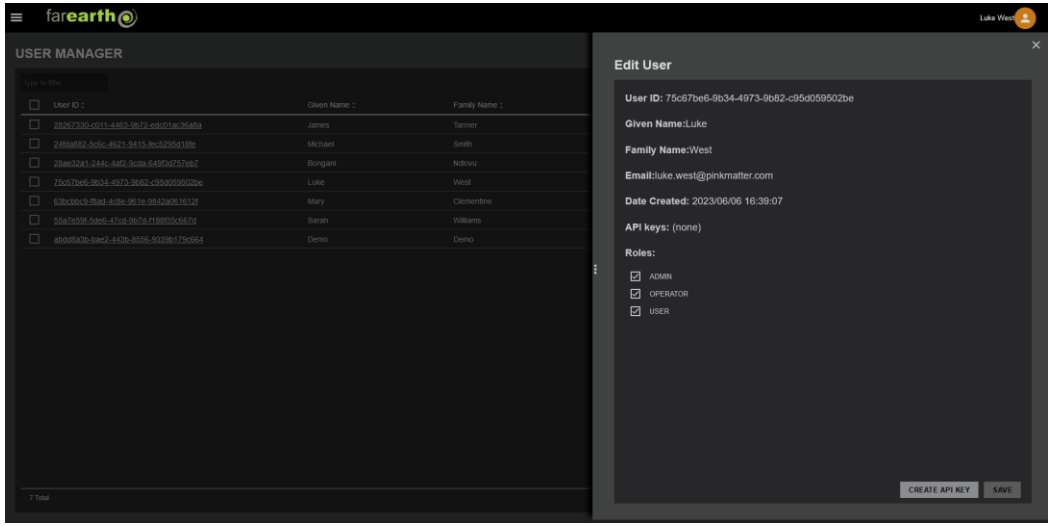
What you get
- ❑ Access to the *FarEarth* portal

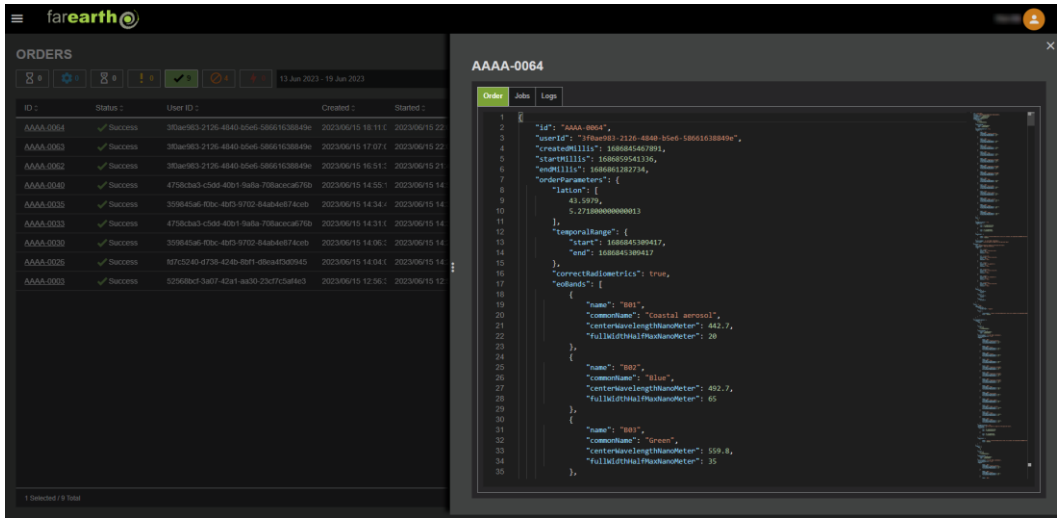


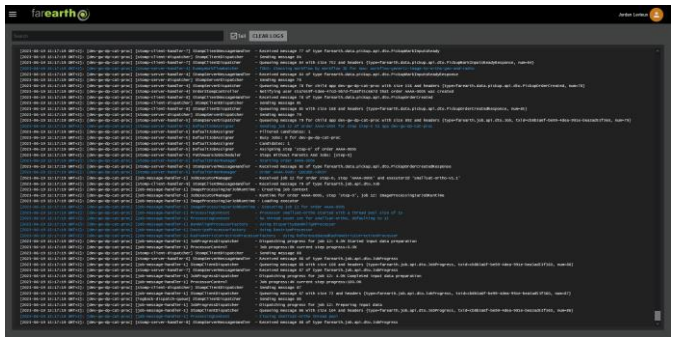
Welcome to your portal

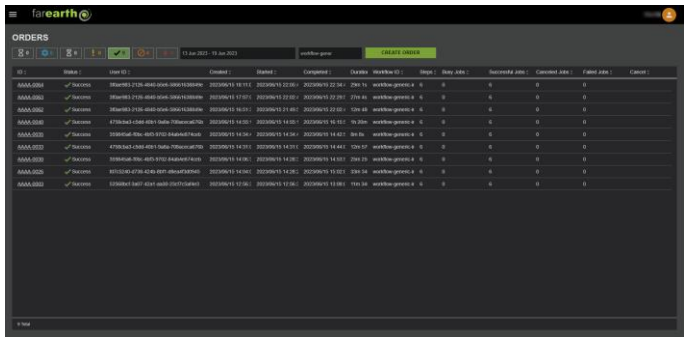
Learn more:
Getting started video





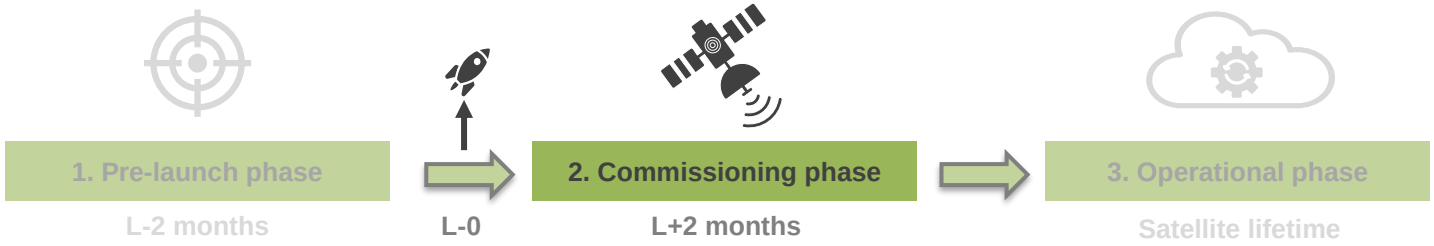






In-orbit calibration

Complete:
Calibration campaign document



TIMELINE

Once your satellite is launched, you complete the in-orbit satellite commissioning. This typically takes 4 to 6 weeks.

Once your satellite is commissioned, your first *FarEarth* calibration campaign starts.

Steps	Duration estimate	Responsibility
Provide raw data stream for validation	1 week	Satellite operator
Acquire images over calibration sites	± 4 weeks	Satellite operator
Consultation on required changes if required	Throughout calibration phase	Collaborative
First calibration with a report	4 weeks	*Pinkmatter*
Process first images for validation	Throughout calibration phase	*Pinkmatter*

What we need from you

- ❑ Acquisitions over all specified well-known calibration sites

What we do

- ❑ Radiometric calibration
- ❑ Geometric characterisation
- ❑ Process your first images for validation

Why?

- ❑ We create Calibration Parameter Files (CPF) specific to your sensor for image corrections during the operational phase

What you get

- ❑ Calibration report
- ❑ Sample of processed images

In-orbit calibration

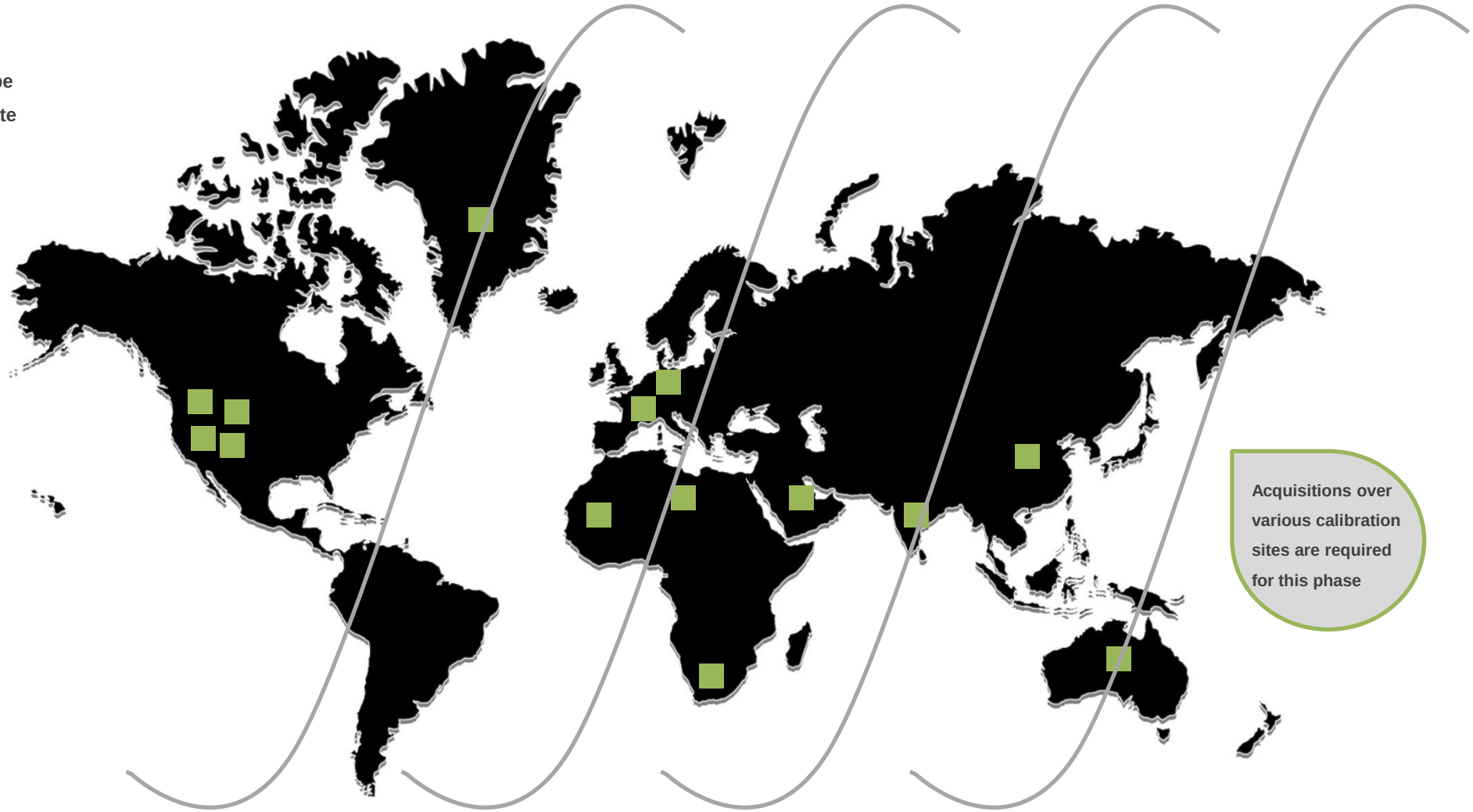
Complete:
Calibration campaign document

We supply you with a calibration campaign document that lists the calibration sites to be imaged. We will use these images to calibrate your sensor.

Calibration campaign document

Information required from you:

- ❑ Acquire images over the specified well-known calibration sites
- ❑ Acquire calibration data using all the sensor's different nominal operational modes
- ❑ Acquire calibration data across the sensor's thermal operating range



Acquisitions over various calibration sites are required for this phase

In-orbit calibration

Learn more:
Technical overview

You receive your first images!

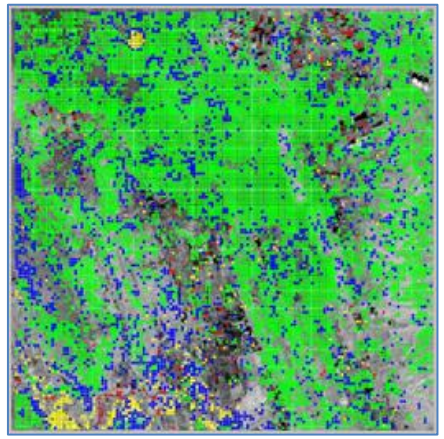
In-orbit calibration report

The outcome of the calibration

Assessment of:

- **Geolocation accuracy**
- **Effective ground sampling distance (GSD)**
- **Swath width**
- **Line rate**
- **Spectral response**

Observations and recommendations



FarEarth verifies the accuracy by measuring the radiometric value and geometric location of pixels. The image shows the geometric difference between the processed data and reference data.

Green < 0.5 pixels

Teal >=0.5 & <1 pixels

Blue >= 1 & < 2 pixels

Yellow >=2 & <5 pixels

Red >= 5 pixels

Operational phase

Learn more:
1. Getting started video
2. User manual

1. Pre-launch phase — L-2 months
2. Commissioning phase — L-0 to L+2 months
3. Operational phase — Satellite lifetime

You are good to go! Your satellite is ready to acquire operational images.
***FarEarth* automatically processes and archives these images.**

Because the sensor changes over time, regular in-orbit re-calibration is required. This process is similar to the initial in-orbit calibration and will not interfere with your operations.

PRODUCT

- Level 1C
- Industry standard file
- Radiometric calibration
- Geometric modelling
- Orthorectification
- Standardised metadata

What we need from you

- ❑ Continuously upload your images to the *FarEarth* pick-up point
- ❑ Manage and monitor orders in the portal
- ❑ View and download your products from the *Catalogue*

What we do

- ❑ Systematic automated image processing
- ❑ Regular in-orbit calibration
- ❑ Manage infrastructure and system performance
- ❑ Support via a ticketing system

Why?

- ❑ *Pinkmatter* will review sensors quarterly and adapt your CPF files to ensure the accuracy of your data

What you get

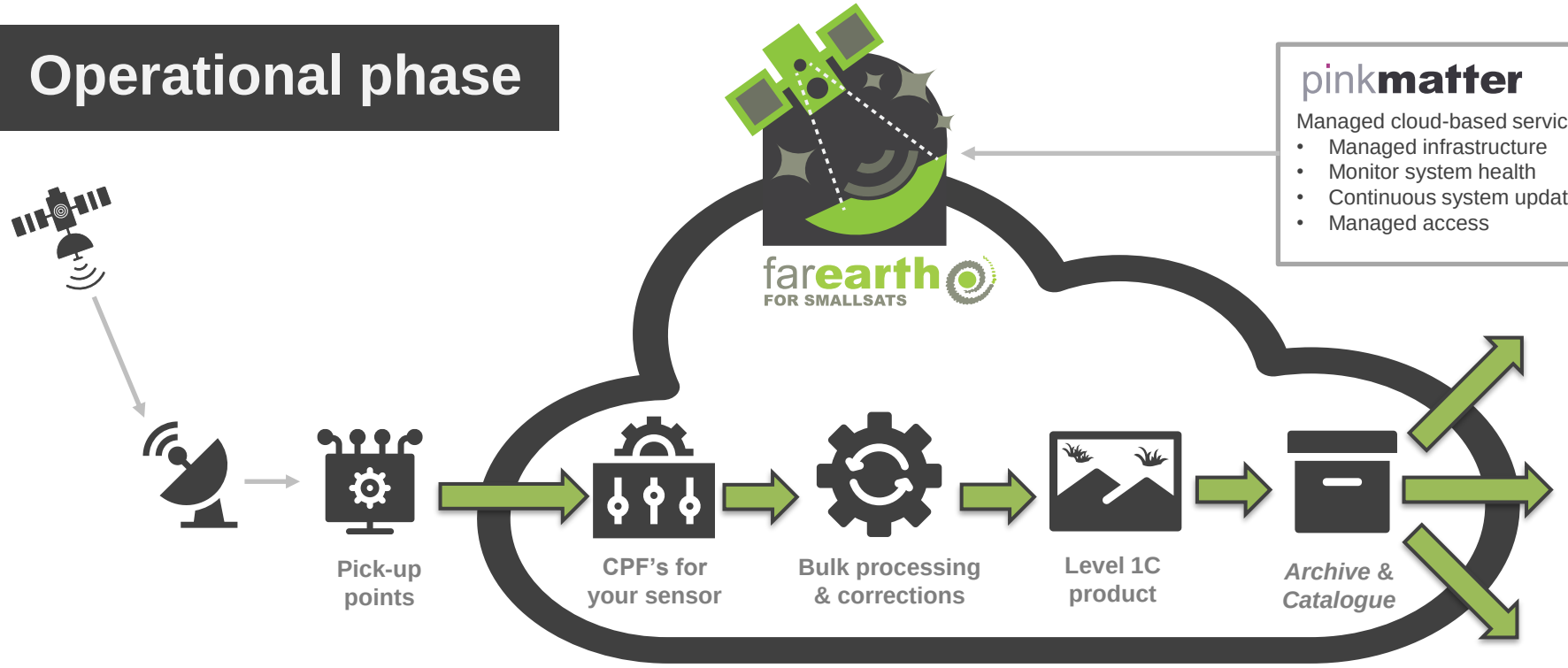
- ❑ Fully managed service
- ❑ Level 1C products with quality metrics
- ❑ Regular Calibration Reports

Operational phase

Learn more:
1. Getting started video
2. User manual

pinkmatter
Managed cloud-based service
- Managed infrastructure
- Monitor system health
- Continuous system updates
- Managed access

Support via a ticketing system



Regular in-orbit re-calibration

- Radiometric calibration
- Geometric modelling
- Orthorectification

- Standard geo-referenced product formats
- Product meta-data
- Product quality metrics

Search and download products

Customer operator **OR** API's

- Manage and monitor orders
- View and download products

FarEarth standard API's allow for integration and automation