SSC18-XII-03

Utilizing Commercial DSLR for High Resolution Earth Observation Satellite

9th August 2018

Canon Electronics Inc.

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New Entry into Satellite Business

- In 2012, CE decided to start business in space.
  - Established CE Space Technology Lab. calling small satellite specialists from outside of the company.
    (Now it is Satellite Systems Lab.)
- Objectives
  - Cultivation of new business.
  - Development of human resources.
  - Foster motivation.
- 50kg satellite was chosen for the first challenge.
  - Hand held size device is our specialty.

Lase Beam Printer

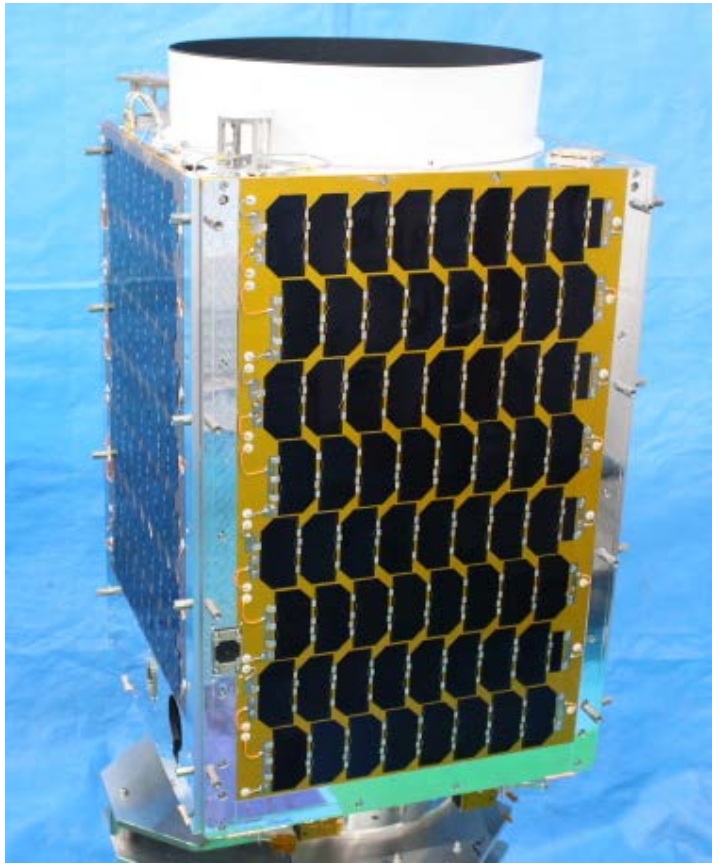
Scanner

Camera Units

CE-SAT-I Missions

- Educational and technical demonstration.
  - Experience a whole satellite project from design, development, test, launch, operation and verification.
- Make effective use of Canon group technology such as image processing, fine machining.
- Sub-meter GSD resolution remote sensing using 50kg class small satellite.

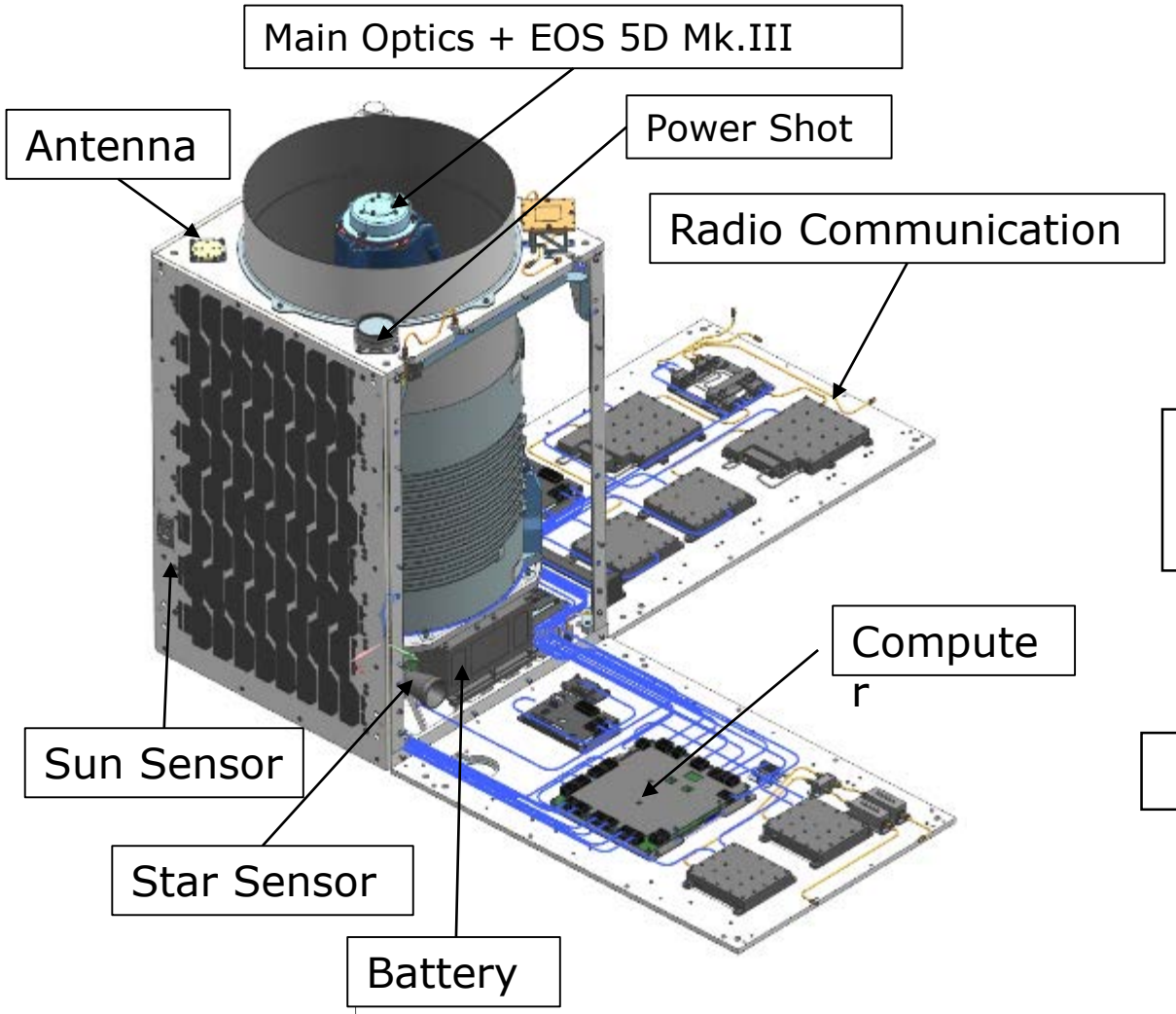
General Specifications



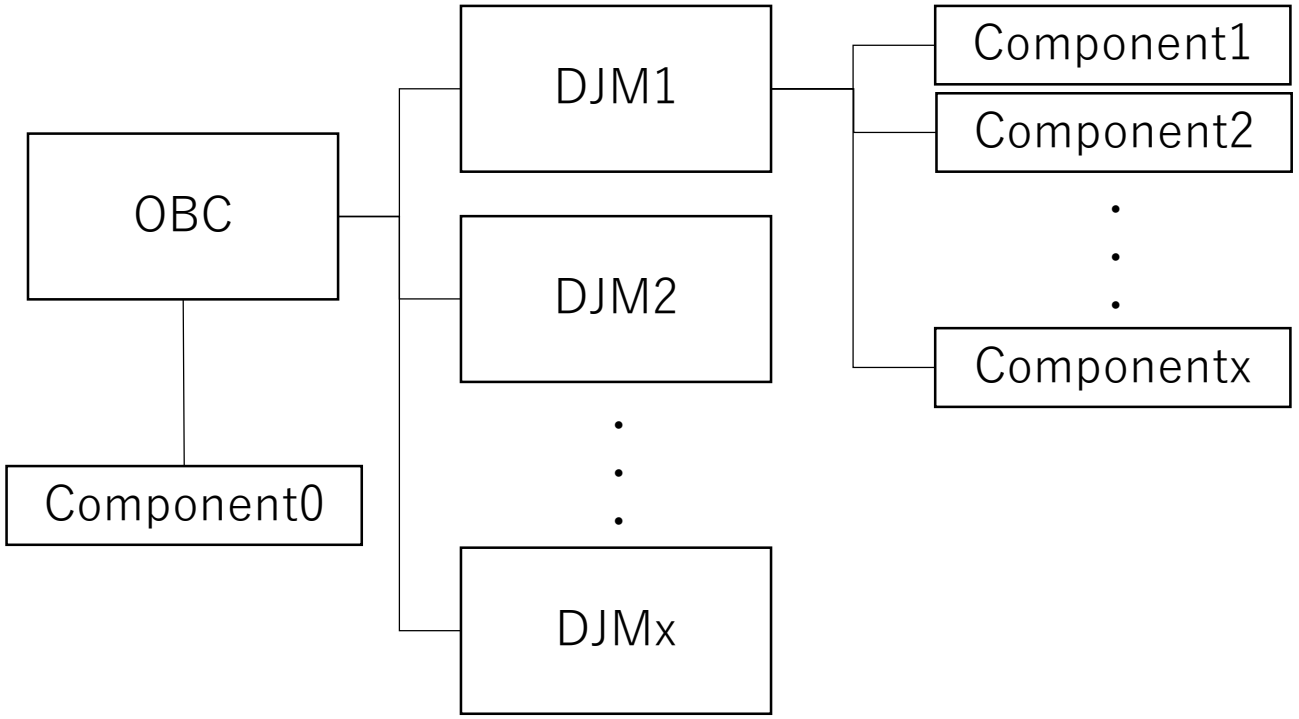
CE-SAT-I Flight Model

Mass	50kg class
Size	500×500×900 mm
Orbit	Sun synchronous orbit Height: 500km LTDN 9:30
Attitude control	Three axis zero momentum stabilization
Bus voltage	+15 V
Communication	Uplink: S-band 64kbps Downlink: X-band 2Mbps/250kbps

CE-SAT-I Configuration



Functional Block Diagram



Main Telescope + Camera

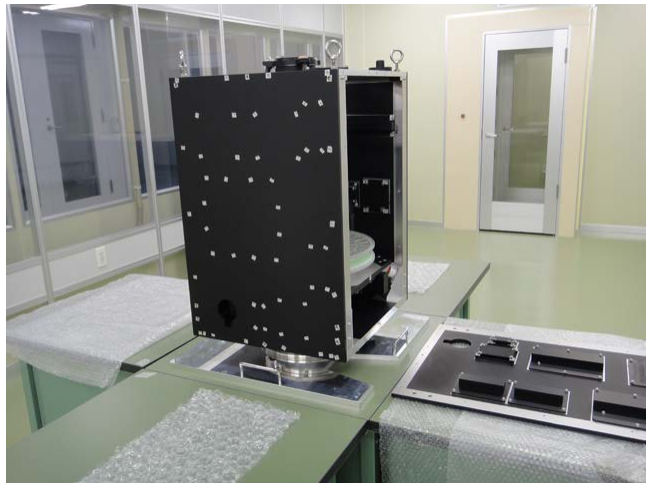
Main mirror diameter	400mm
Focal length	3,720mm
Telescope type	catadioptric: cassegrain + correction lens
Detector + Image processor	EOS 5D mk.III base
Resolution	0.9m GSD (at 500km height)
Foot print	6km × 4km

Sub Camera

Main lens diameter	16mm
Focal length	26.0(T) - 5.2(W)mm
Telescope type	Refracting telescope
Detector + Image processor	Power Shot S110 base
Resolution	100(T) – 500(W)m GSD (at 600km height)
Foot print	400×200(T)km – 2,000×1,000(W)km

Development and Test Facilities

- Design office and development environment is at Hakata. (until 2015)
- Headquarter is at Shibako-en, near the Tokyo tower.
- Factories are at Gunma (north Tokyo).



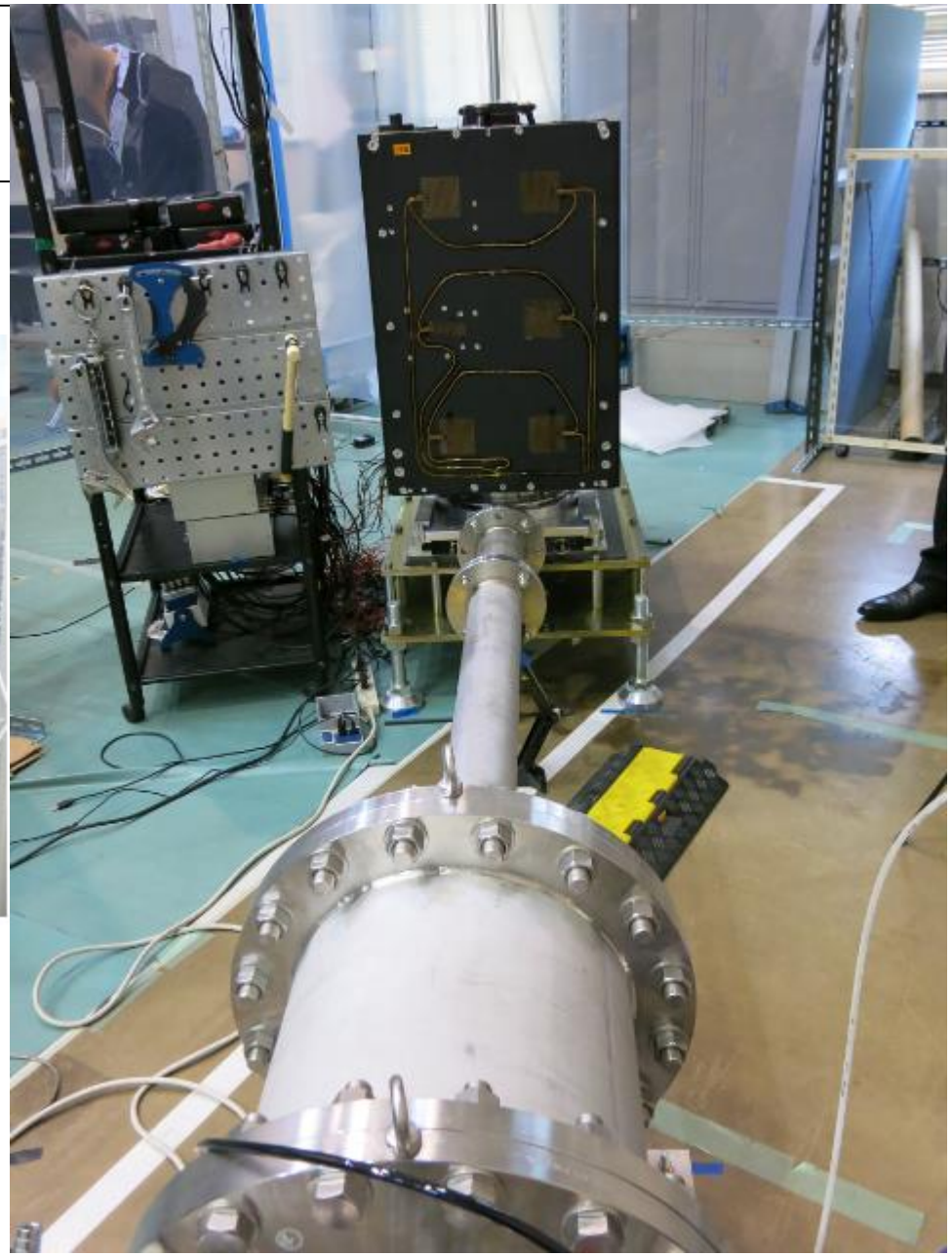
Clean room for assembly

Test equipment

System Environment Tests

Facilities at Kyushu Institute of Technology

Thermal vacuum test



Shock test

Ground Segment

- In-house made Stations at Akagi factory in North Tokyo.
- Stations are controlled from Tokyo HQ

	Spec
Mass	800kg
Dish Diameter	2.4m
XY range	2 - 178 deg

PSLV Launch

Indian CartoSat2E and 30 co-passengers' small satellites are launched by PSLV-C38 from Satish Dhawan Space Centre on 23rd June.

Launch campaign with Indian team

(C) ISRO

Operation Status: Initial Operation

- From the launch date to two months
  - Functions check of the satellite bus and the ground station.
  - Photography using the sub camera.
  - Sophistication of operation procedure and telemetry analysis.
- Basic functions are all normally verified.

Sub Camera View 1

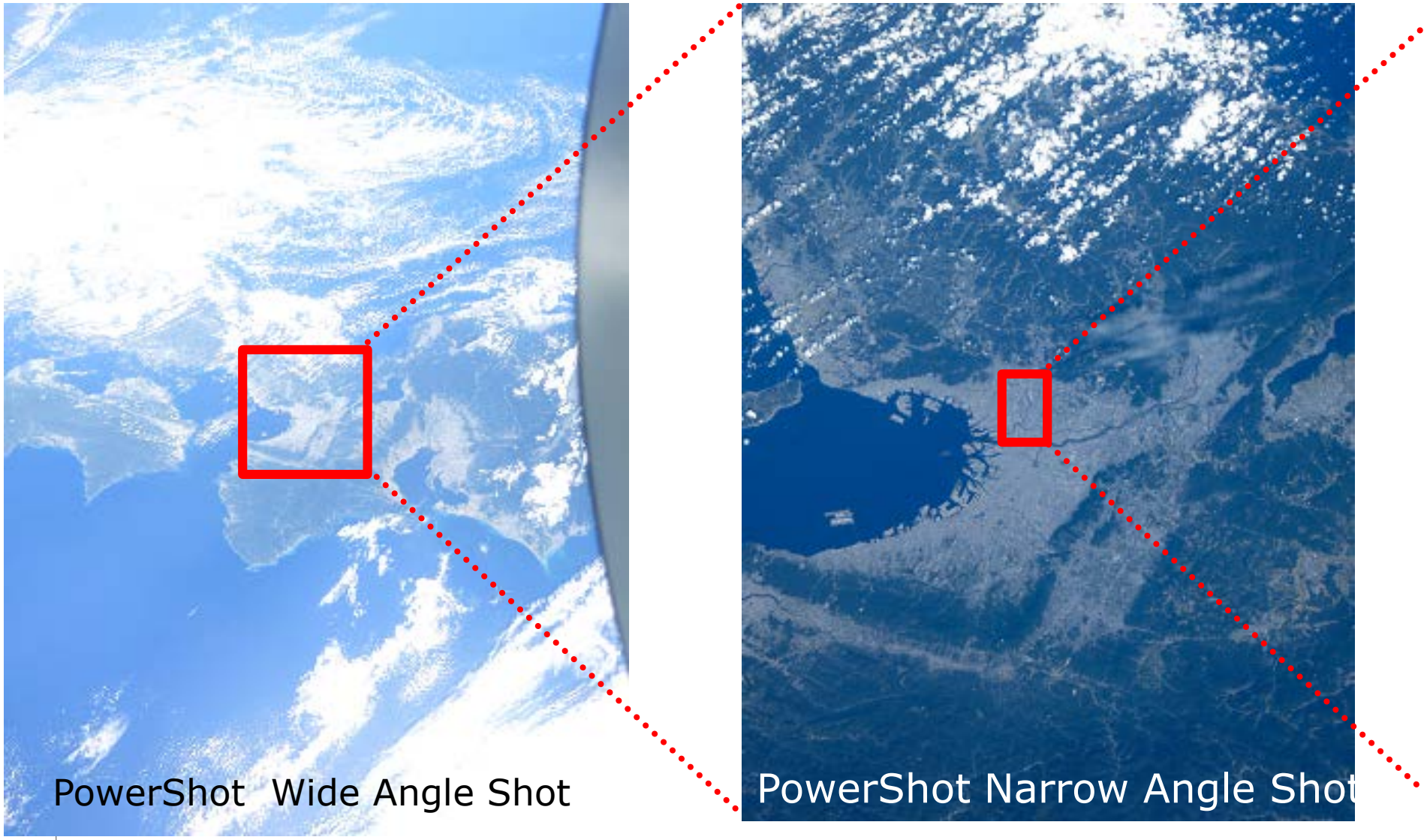
Sub Camera View 2

Sub Camera View 3

Operation Status: Nominal Operation

- On 1st September, 2017
  - First light of the main telescope.
  - Adjustment mechanism is set at default position.
  - Aim at Osaka from above Nagoya due to weather forecast.
  - Sub camera was also used to identify the footprint.
- Result
  - Sub meter GSD was achieved but there are some aberrations.
  - Cars are clearly identified.

Main Camera Image –Osaka(First Light)-



Main Camera Image –Osaka(First Light)-

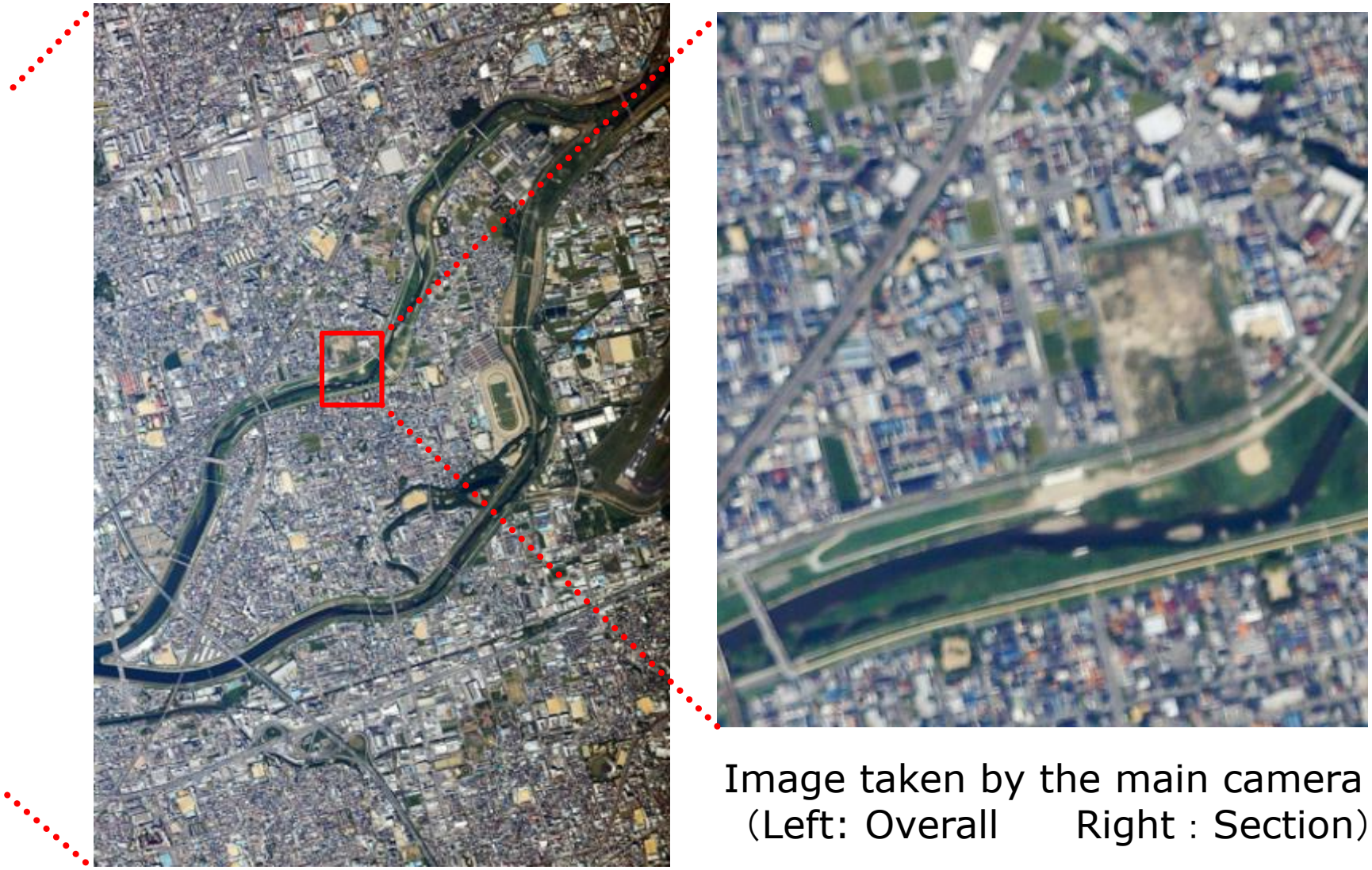


Image taken by the main camera
（Left: Overall　Right：Section）

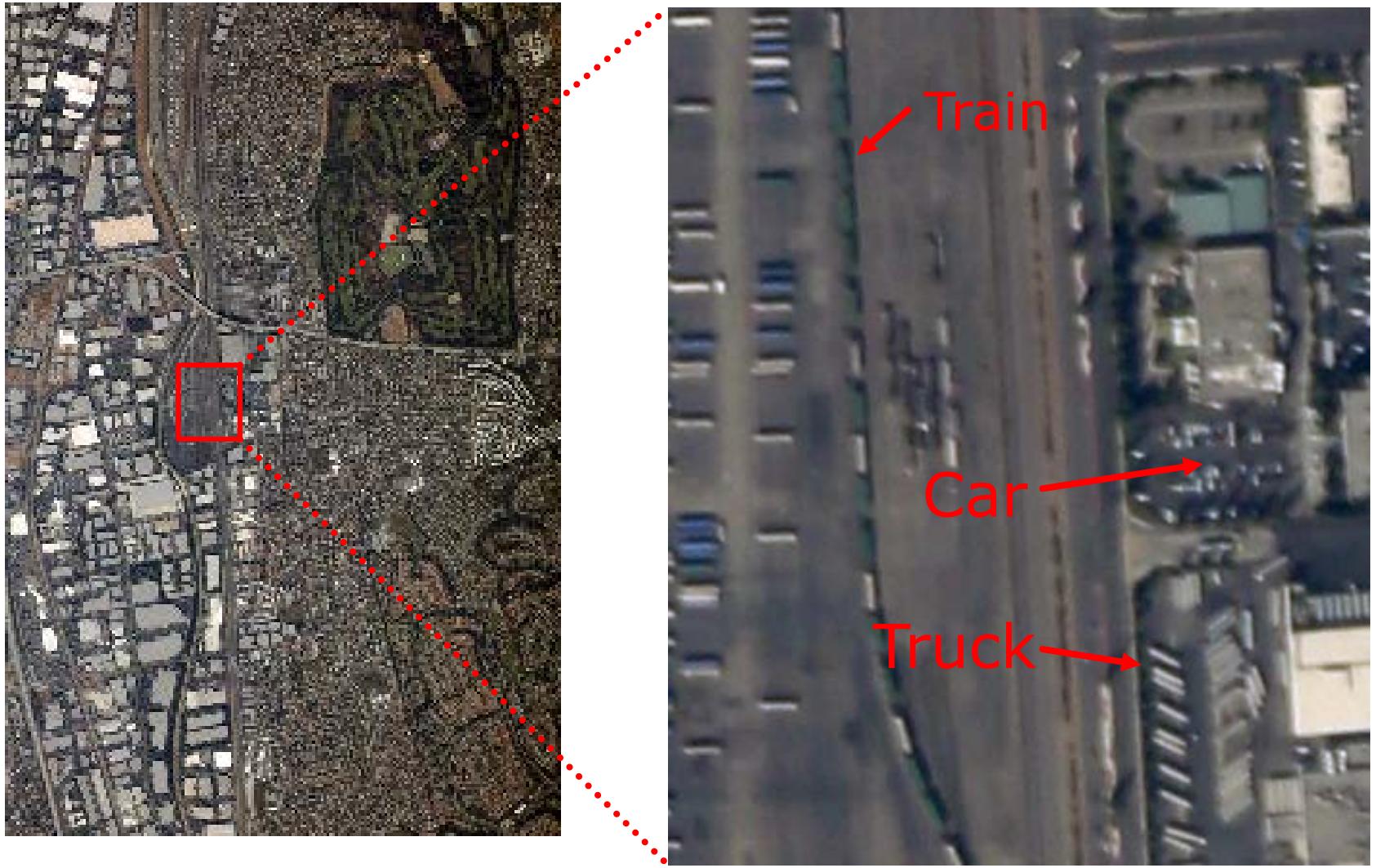
Current and Future Operation Tasks[1]

- Correlation of mathematical models of the satellite to reduce aberration of the main optics.
  - Images become far more sharp.
  - Large “camera chart” is preparing at Akagi ground segment.
- HDR imaging and night vision.
  - Using the merit of area sensor.
- Motion picture.
- Image process and data extraction.

Current and Future Operation Tasks[2]

- Identify secular change and deterioration of the spacecraft.
- Introducing automatic and autonomous operation.
- Advanced tests.
  - OBC program update to improve performance.
  - Fine attitude control using different combinations of sensors and actuators.

Main Camera Image –Los Angeles-



Future Plans: Research

- CE-SAT-I continuous operation for design verification.
- About next project
  - Verification of mass production model of CE-SAT-I using in-house components.
- Future project
  - More higher resolution with higher sensitivity.
  - More compact satellite.
  - Other spectrum observation.

Future Plans: Business Domain

- Whole satellite, satellite components, ground segment.
- Professional service from design to operation.
- Image and analysis data using own satellite constellation platform.

- Every options are examined now.
- Collaboration is welcome.


Thank you