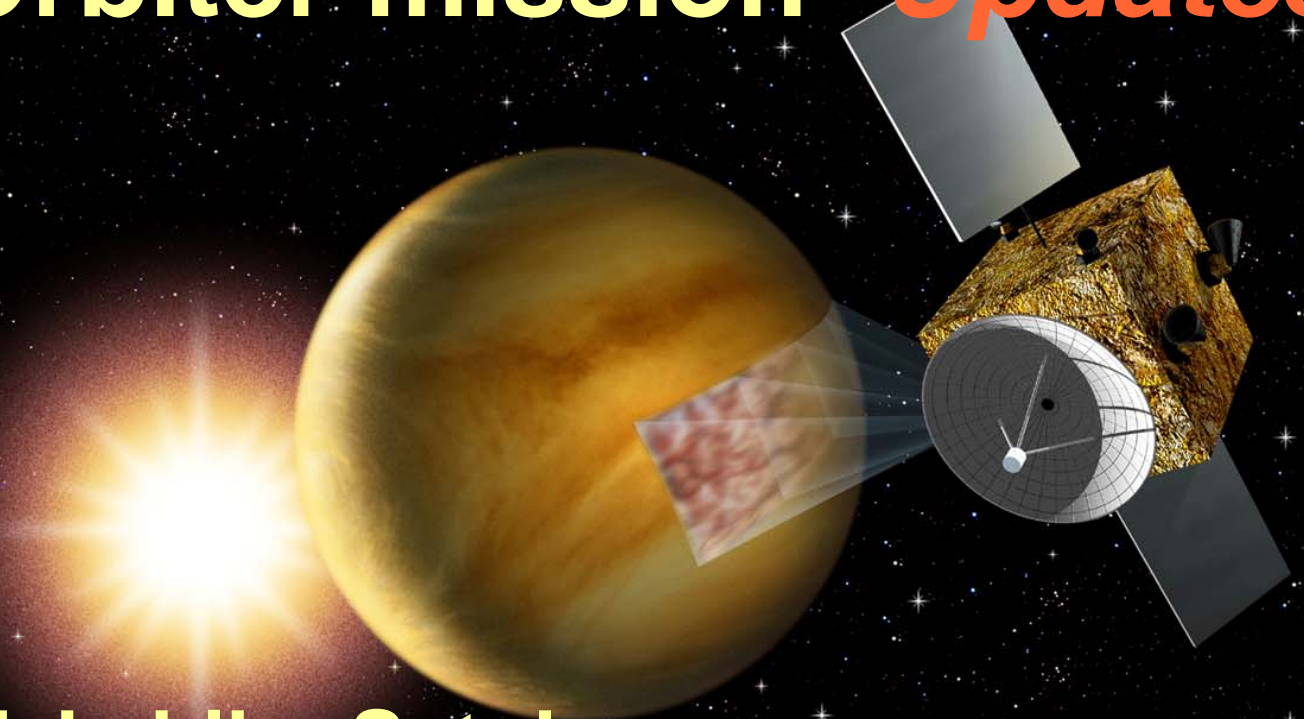




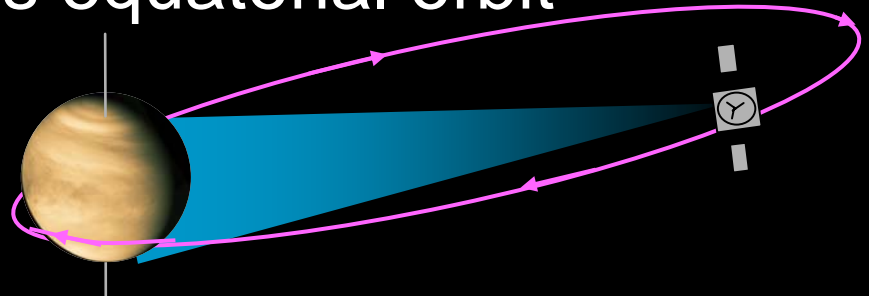
# PLANET-C: Venus Climate Orbiter mission *-Updates-*



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**George Hashimoto (Kobe Univ)**  
**PLANET-C team**

# Venus Climate Orbiter

- JAXA's 24th science spacecraft dedicated to the exploration of Venus meteorology (code name: *PLANET-C*)
- Atmospheric Dynamics
  - Imaging observations with 4 cameras (from UV to long-IR) + Lightning/Airglow Imager + radio science
  - Quasi-synchronous equatorial orbit



# Complementary missions



	<b>VCO</b>	<b>Venus Express</b>
Instruments	4 cameras Lightning/Airglow Imager Radio science	3 spectrometers 1 camera Plasma analyzer Magnetometer Radio science
Main target	Atmospheric dynamics	Atmospheric chemistry and dynamics, Surface processes, Plasma environment
Orbit	Equatorial	Polar

# Launch schedule

- Launch: June 2010  
Arrival: December 2010  
Mission life: > 2 years
- Mass: 480 kg (including fuel)
- Launch Vehicle:
  - **M-V** or **H-IIA** (still TBD)
  - *No payload increase even with **H-IIA** (deccelaration needs)*

Launch of PLANET-B Mars orbiter by M-V (1998)



# Science objectives

- Meteorology
  - Mechanism of super-rotation
  - Meridional circulation
  - Meso-scale processes
  - Cloud physics
  - Lightning
- Solid planet
  - Detection of active volcanism
  - Inhomogeneity of surface material
- Zodiacal light (during cruise)



# Concept of meteorological 'survey' satellite

- Monitoring global structures  
→ Wide field of view
- Covering time scales from hours to months  
→ Continuous, systematic sampling  
Minimum interruption during the mission
- Local time coverage  
→ Equatorial orbit
- Meso-scales / Wind vectors  
→ High spatial resolution (~ 10 km)

# Spacecraft configuration

Mass 480 kg  
(including fuel)

Science payload 34 kg

Attitude control

Pointing accuracy  $0.1^\circ$

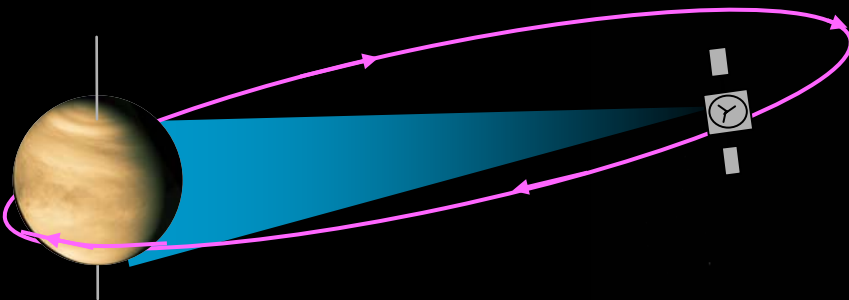
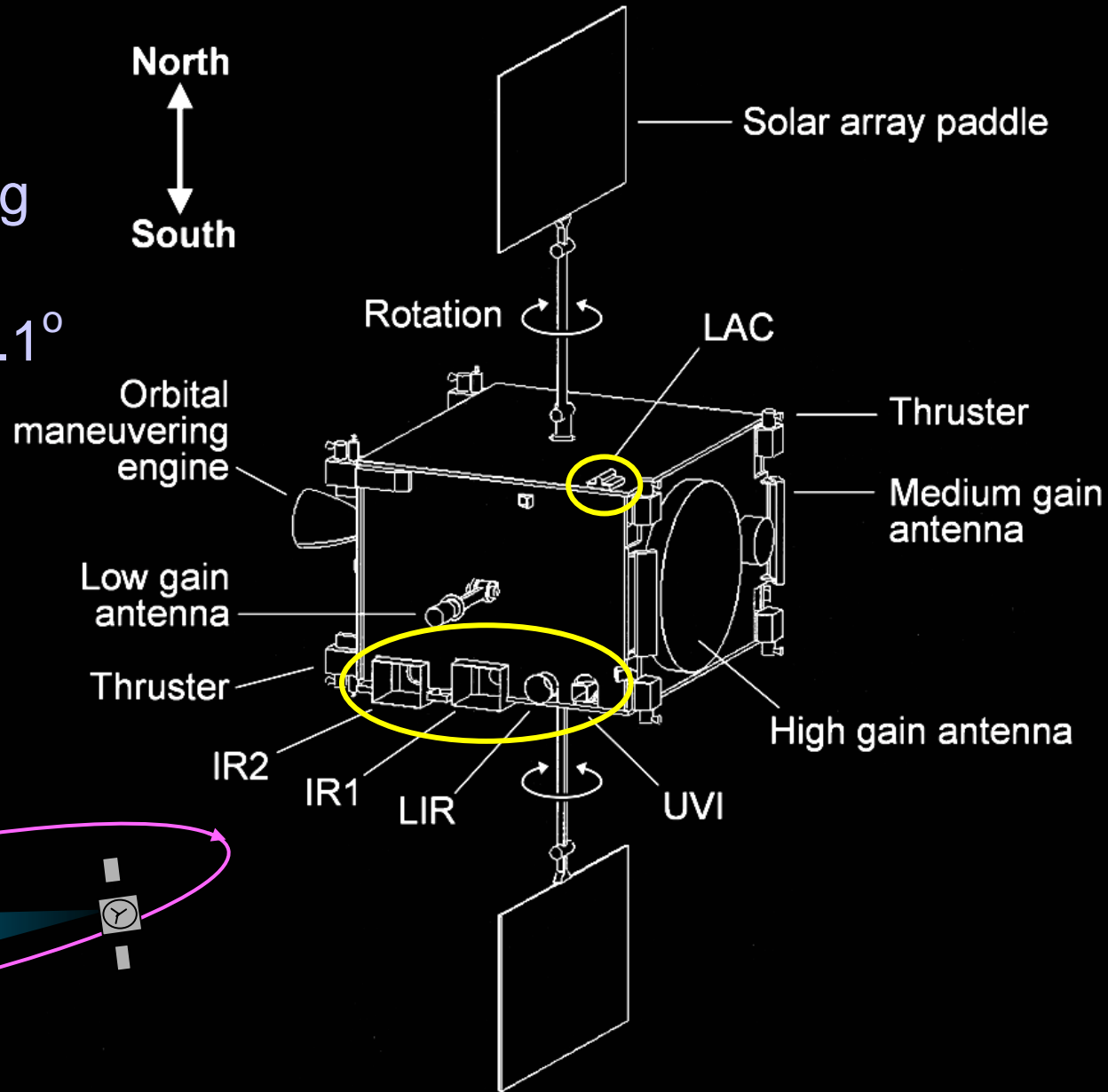
Stability  $0.01^\circ$

Orbit

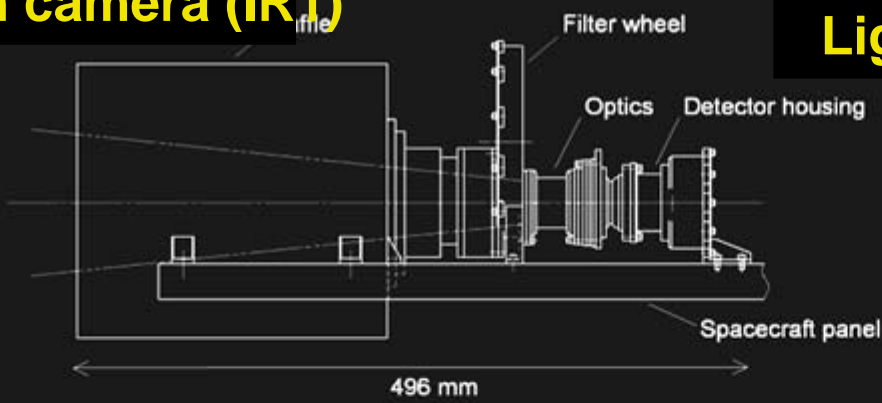
Periapsis 300km

Apoapsis 13 Rv

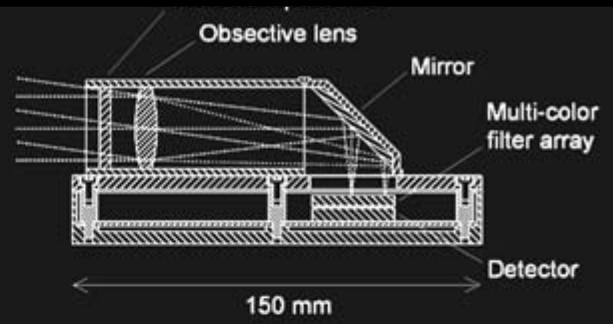
Period 30 hours



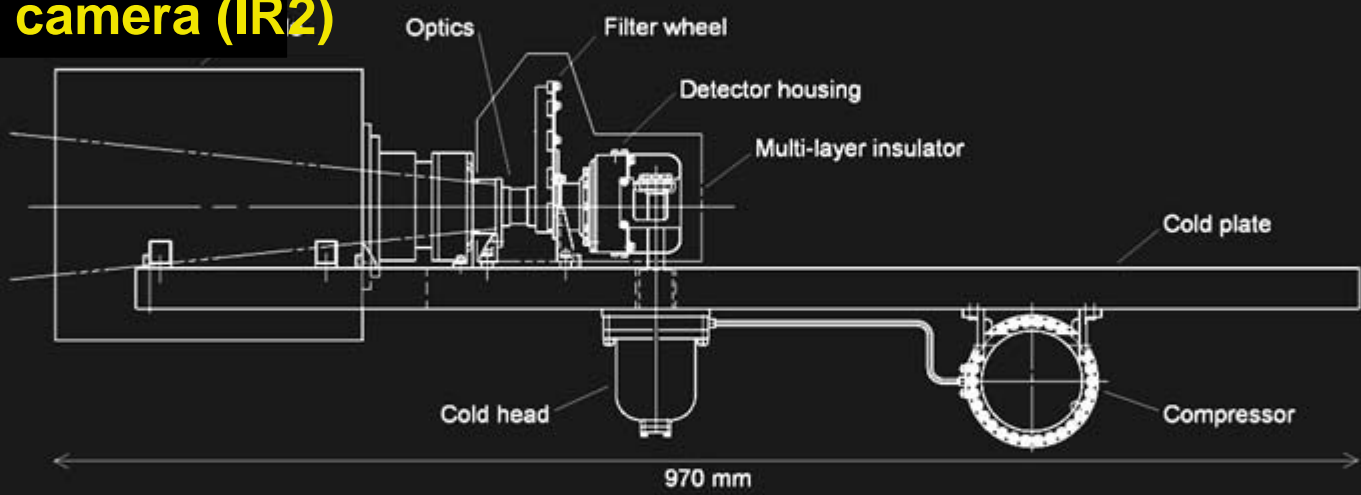
# 1- $\mu$ m camera (IR1)



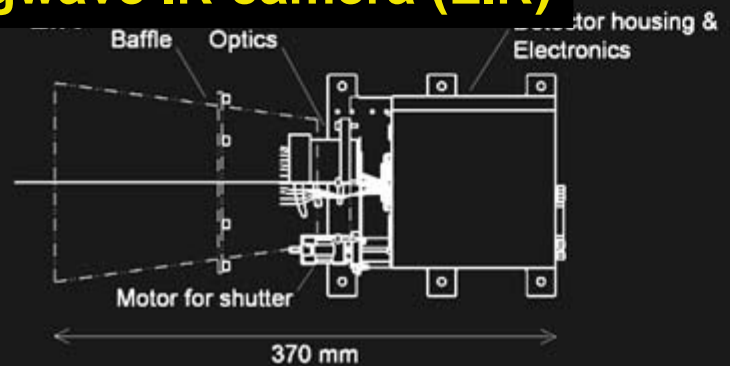
# Lightning and airglow camera (LAC)



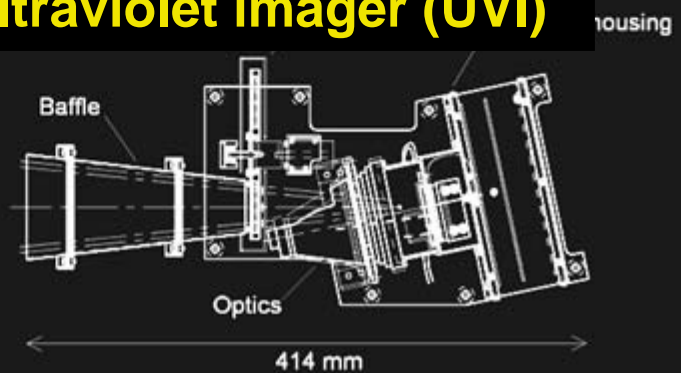
# 2- $\mu$ m camera (IR2)



# Longwave IR camera (LIR)



# Ultraviolet imager (UVI)

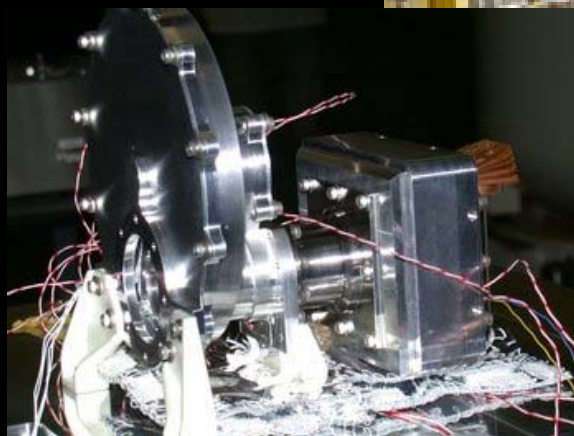




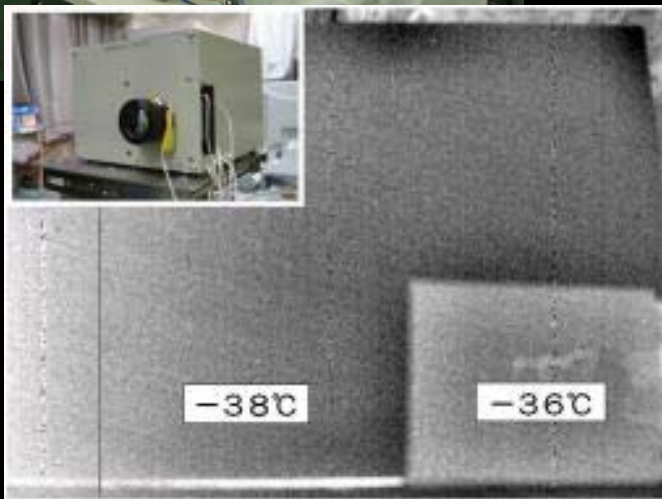
Test model of IR1 baffle



Radiation test



IR2 test model



LIR test image ( $10\mu\text{m}$ )



Thermal vacuum test

# Science instruments (1)

## 1- $\mu\text{m}$ camera (IR1) by Tokyo Univ.

$\lambda = 1.01 \mu\text{m}$  (near-IR window)

Pixels: 1024x1024, Detector: Si-CSD/CCD

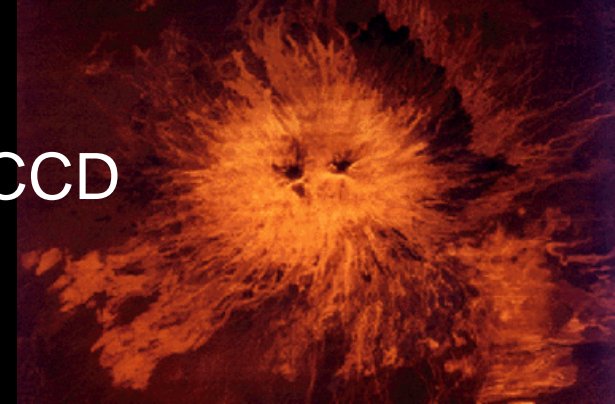
→ Cloud (day/night)

→ Surface (night)

Status: Developing PM

→ F/8 Optics (Lighter weight)

→ Aluminum Housing



IR-AE (PM)  
shared with IR2



Test model of IR1 baffle

# Science instruments (2)

## 2- $\mu\text{m}$ camera (IR2) by Kumamoto Univ.

$\lambda = 1.73, 2.26, 2.32 \mu\text{m}$  (near-IR window)

2.02  $\mu\text{m}$  ( $\text{CO}_2$  absorption),

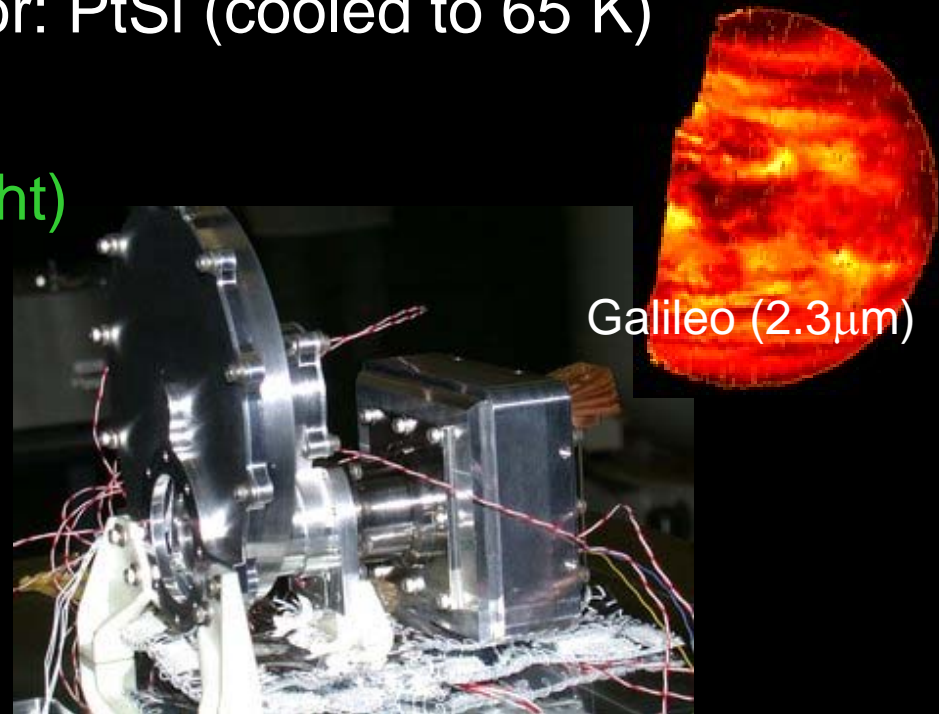
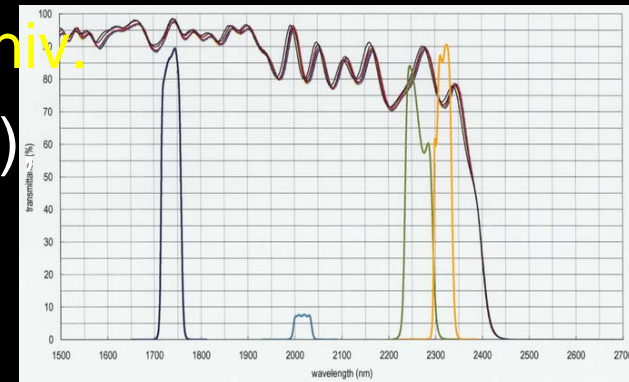
1.65  $\mu\text{m}$  (zodiacal light)

Pixels: 1024x1024, Detector: PtSi (cooled to 65 K)

- Cloud / Particle size
- Carbon monoxide (night)
- Cloud top height (day)
- Zodiacal light (cruising)

Status: Developing PM

- PtSi process (summer)
- Cold-plate material



IR2 test model

# Science instruments (3)

**Ultraviolet imager (UVI)** by Hokkaido Univ.

$\lambda = 283, 365 \text{ nm}$

Pixels: 1024x1024, Detector: Si-CCD

→  $\text{SO}_2$  / Unknown UV absorber (day)

**Longwave IR camera (LIR)** by Inst. of Polar Res.

$\lambda = 10 \mu\text{m}$

Pixels: 240x320, Detector: un-cooled bolometer array

→ Cloud top temperature (day/night)

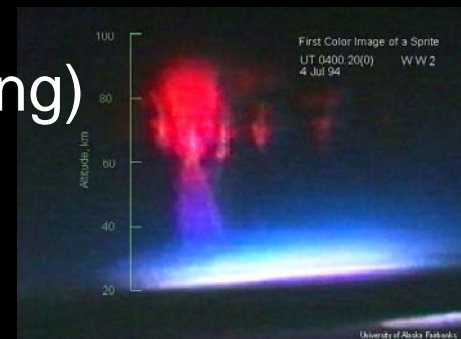
**Lightning & Airglow camera (LAC)** by Tohoku Univ.

$\lambda = 777, 551, 553, 558, 630 \text{ nm}$

Pixels: 8x8, Detector: APD (50kHz sampling)

→ Lightning (night)

→  $\text{O}_2$  /  $\text{O}$  airglow (night)



# Science instruments (4)

## Sensor Digital Electronics unit (DE) by JAXA

Controlling cameras (IR1/2, UVI, LIR)

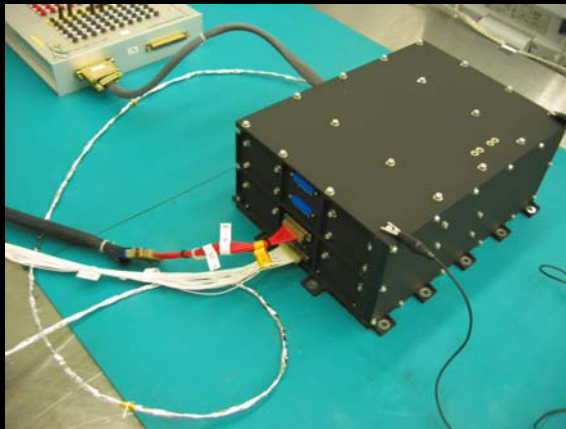
Dark subtraction / Flat calibration / Noise reduction

JPEG2000 data compression

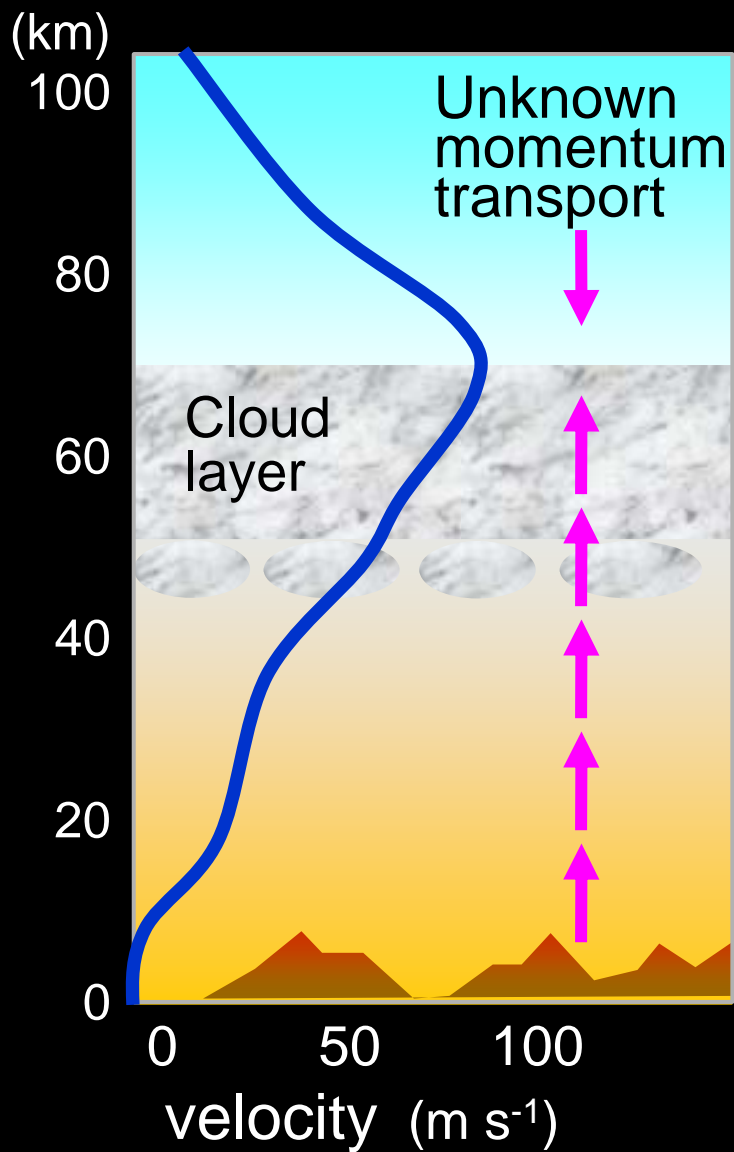
Status: Developing Simulator

→ Matching test with IR-AE

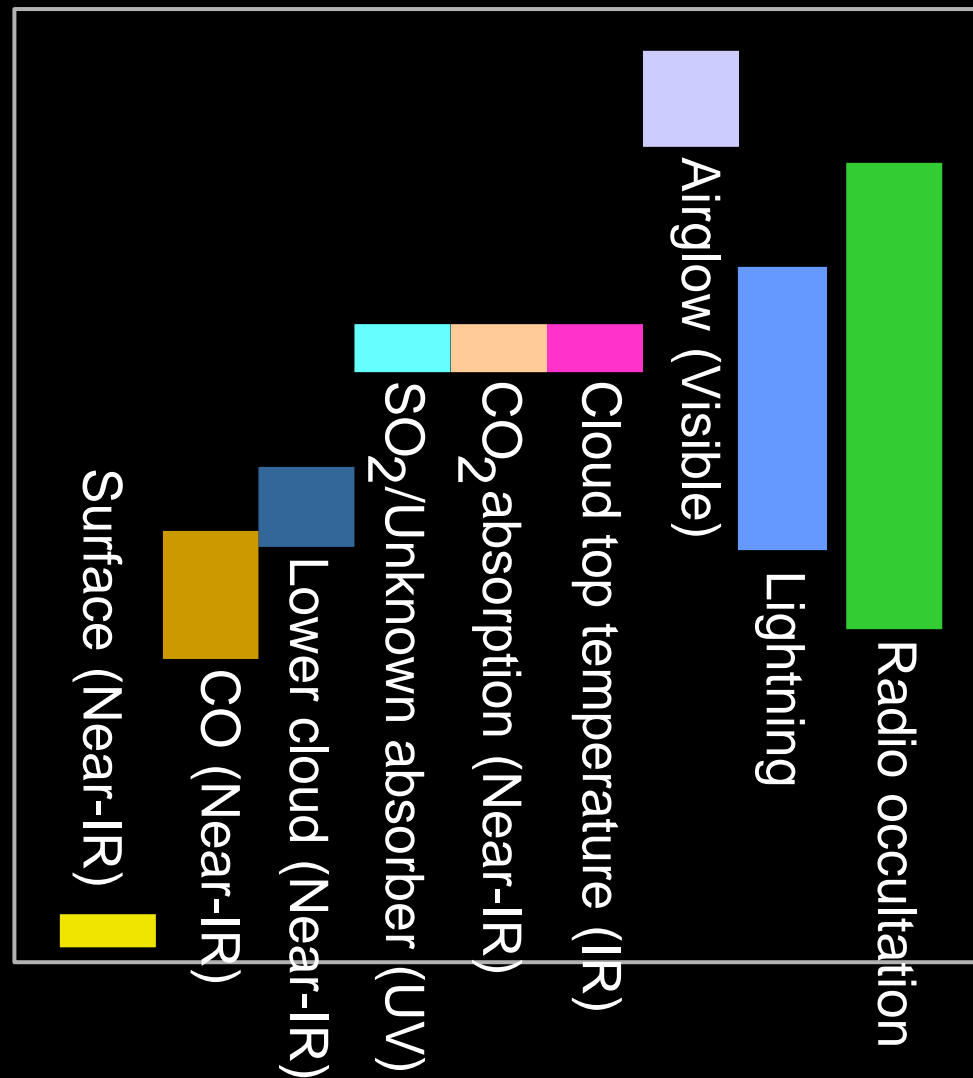
→ Tests with other cameras



# Altitude coverage

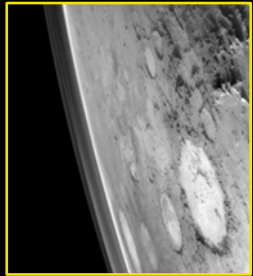


## Sounding region



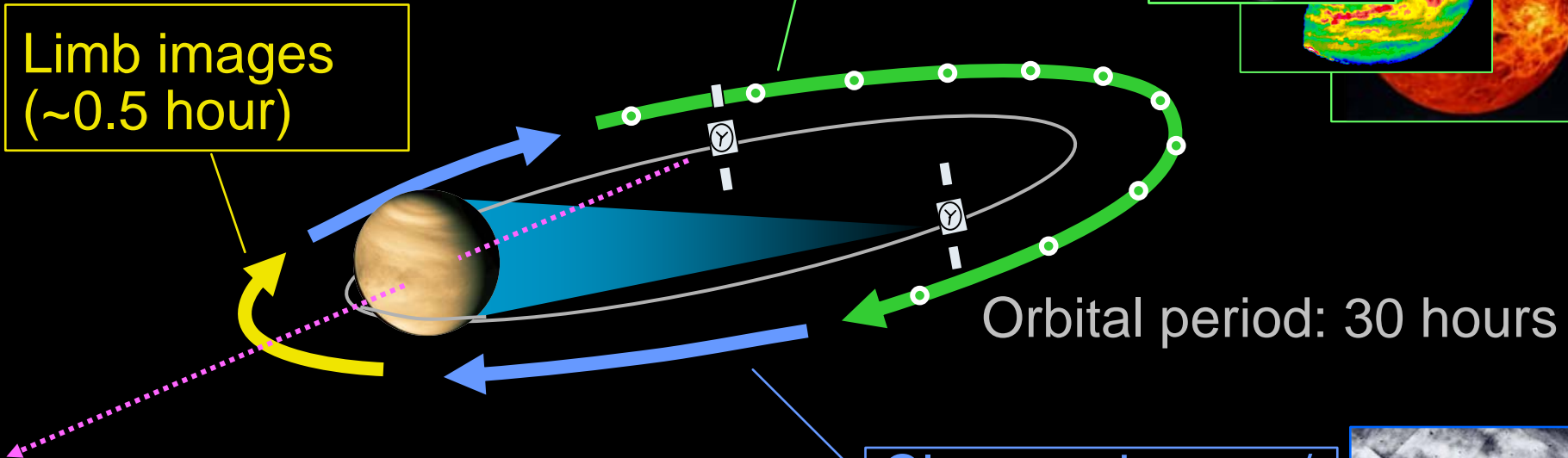
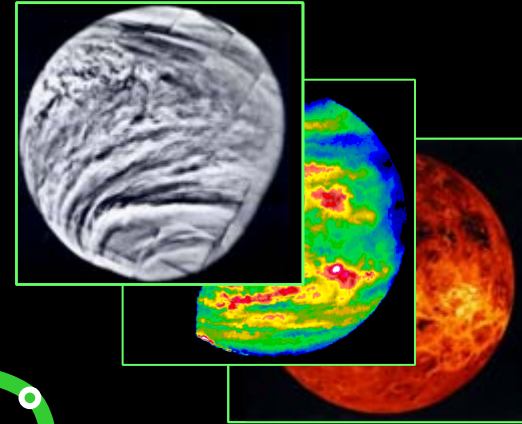
# Observation plan

-- Every revolution, More than 2 years --



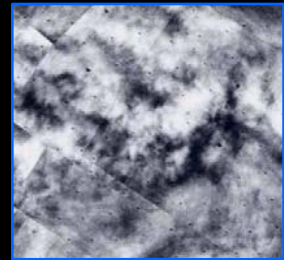
Limb images  
(~0.5 hour)

Successive Global images  
of atmosphere and ground  
surface (~24 hours)

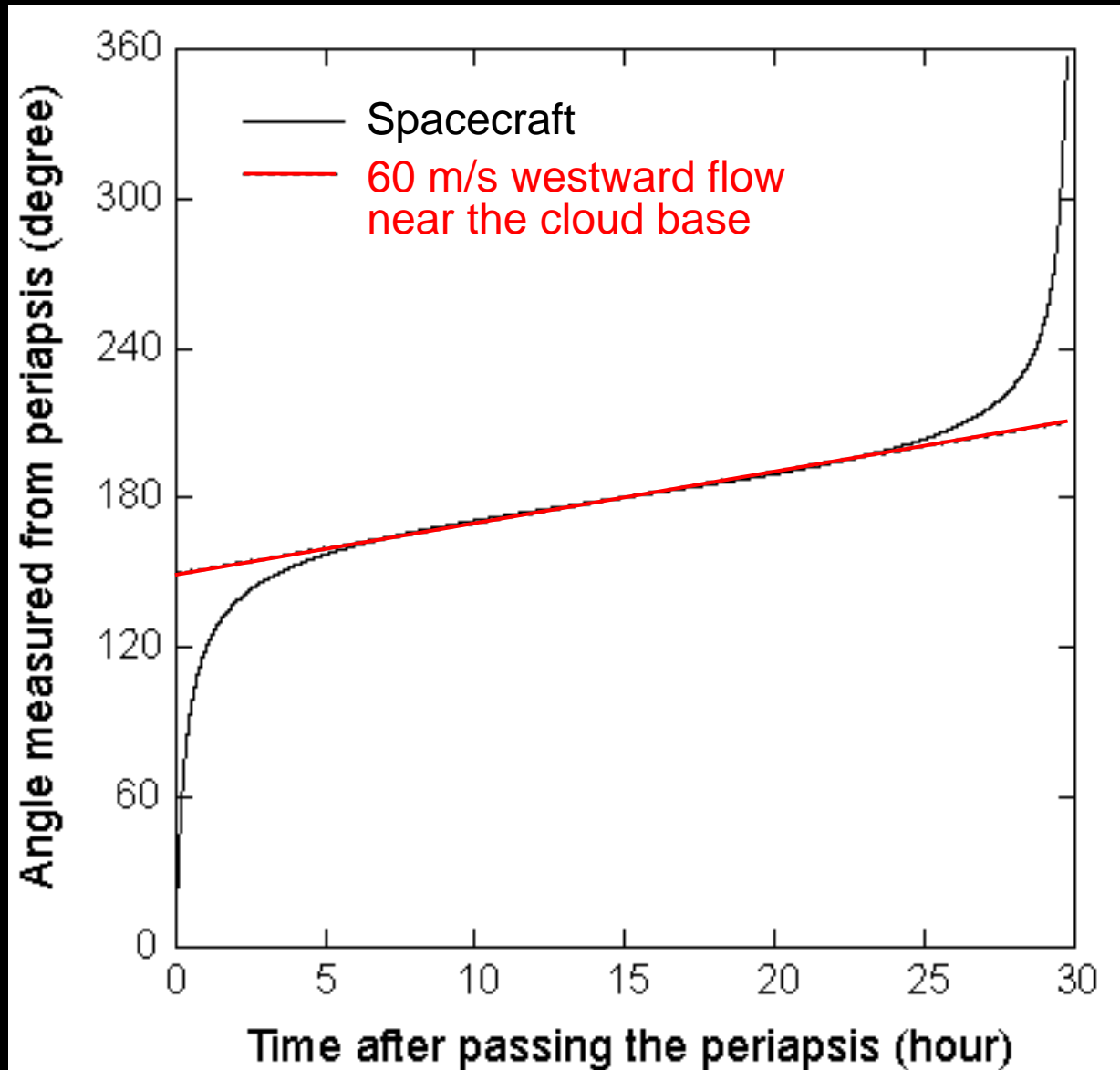


Temperature /  
 $H_2SO_4$   
vapor / Ionosphere  
by radio occultation

Close-up images/  
Lightning/Airglow  
(~3 hours x 2)



# Orbital motion roughly synchronized with the super-rotational flow near the cloud base



# Summary

- VCO is optimized for systematic, continuous sampling of meteorological data (essential to study atmospheric dynamics).
- Instruments (in PM-developing phase) are for global mapping of clouds and minor constituents, detection of lightning, and determining vertical structures of the atmosphere.
- VCO complements ESA's Venus Express which explores broad topics of Venusian environment with different approaches.
- VCO will be launched and arrive at Venus in 2010 (launch vehicle still TBD). The data will become open to the international science community after calibration.