# Toward Venus orbit insertion of Akatsuki

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## **Development and launch**

- Objective: Understanding the atmospheric dynamics and cloud physics of Venus
- Spacecraft
  - Designed for remote sensing from an equatorial, elliptical orbit
  - Mass: 500 kg (incl. fuel) Payload: 35 kg
  - Three-axis attitude control
- Science instruments
  - 1μm Camera (IR1)
  - 2μm Camera (IR2)
  - Longwave IR Camera (LIR)
  - Ultraviolet Imager (UVI)
  - Lightning and Airglow Camera (LAC)
  - Ultra-stable oscillator (USO)
- Launched in May 2010



#### Failure of Venus orbit insertion

- The Venus orbit insertion (VOI) has failed on Dec 7, 2010 due to a malfunction of the propulsion system.
- The check valve between the helium tank and the fuel tank was blocked by an unexpected salt formation during the cruising from the Earth to Venus. As a result the orbital maneuvering engine (OME) became oxidizer-rich and fuelpoor condition, which led to an abnormal combustion in the engine with high temperature, and finally the engine was broken.





#### Toward the next VOI trial

- Since the main engine (OME) was destroyed, we decided to use the attitude control thrusters (or reaction control system, RCS) for further orbit maneuvers. RCS does not require oxidizer, and we disposed the oxidizer of 65 kg in Oct 2011 to reduce the weight.
- An orbit control maneuver was conducted using RCS in Nov 2011. This operation enabled a Venus encounter in 2015.



## **Thermal condition**

Akatsuki perihelion (0.6AU) 3655W/m<sup>2</sup>







The total power of 4 RCS thrusters is approximately 20% of the main thruster.



### Observation plan in the new orbit



#### Venus to be seen from Akatsuki's apoapsis (an equivalent 2x2 binned VMC image)



V0470\_0048



#### Latitudes to be observed (UDSC+IDSN32)





Trajectory of Akatsuki in a frame fixed to Venus and Sun (Center: Venus)

## Summary and additional information

- We have developed a detailed VOI plan, in which the attitude control thrusters are used instead of the main thruster. The date of VOI is December 7, 2015.
- The spacecraft has passed through the perihelion 8 times, and the final perihelion passage is scheduled for August 29. We are carefully monitoring the change of the temperature of the spacecraft.
- NASA DSN support for orbital determination ongoing
- The new orbit around Venus is a long elliptical one with the orbital period of 8-16 days. The spatial resolution to be achieved around the apoapsis becomes worth as compared to the original orbit whose period is 30 hours, although we can get high-resolution images in close proximity of Venus.
- We are going to install an onboard software which extracts a portion of the image area containing Venus for observations from far distances. This enables increase of the number of images to be obtained.
- All of the science instruments have been switched off for more than three years due to thermal constraints. Some of them will be turned on before VOI.