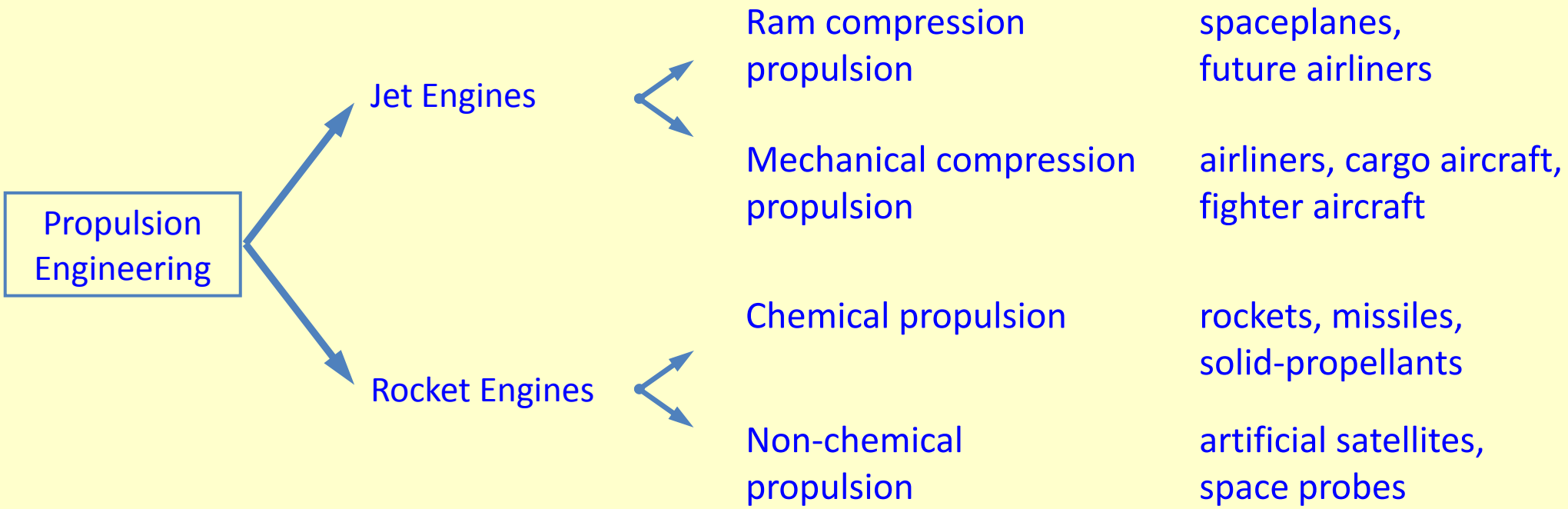
Introduction of Propulsion Engineering

Aerospace Engineering
Aerospace Vehicle System

Propulsion engineering / education are focused on the propulsion system of the aircraft and spacecraft. Propulsion engineering is mainly classified into jet engines with the air breathing and rocket engines without it.



We have a professor, 2 associate professors and a research associate working for their own researches as below.

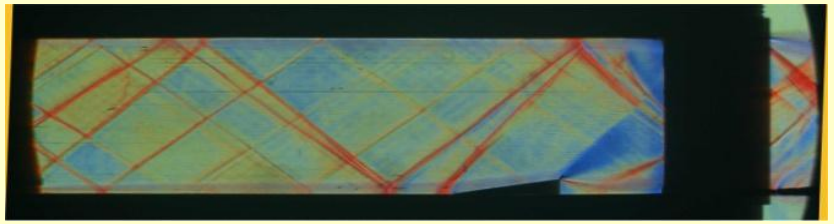
- Super sonic combustion in ram jet engine
- Combustion of Solid-propellant
- Jet engine components
- Non-chemical space engine

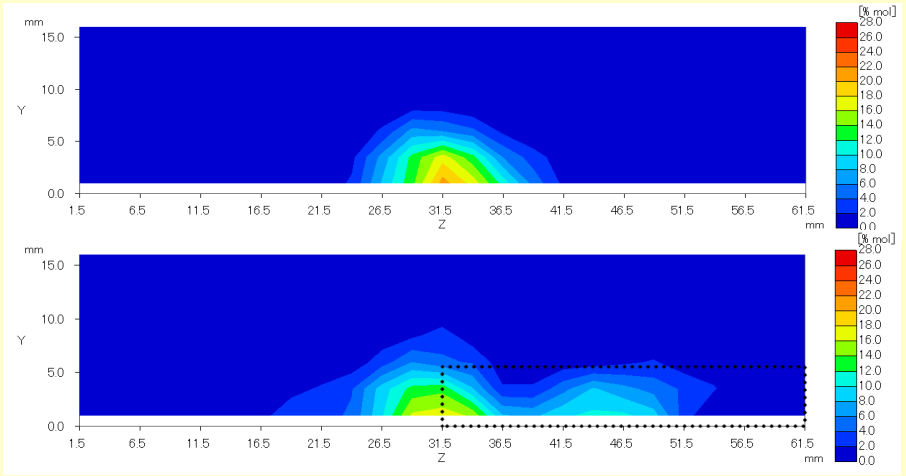
Propulsion Engineering

Research of Super Sonic Combustion in Ram Jet Engine

Associate Professor Obata

Super sonic vehicle will fly by the ram jet engine in the future. Super sonic combustion is required as a fundamental technology. 3D wedge is adopted for the stable combustion with the small total pressure loss in this study.



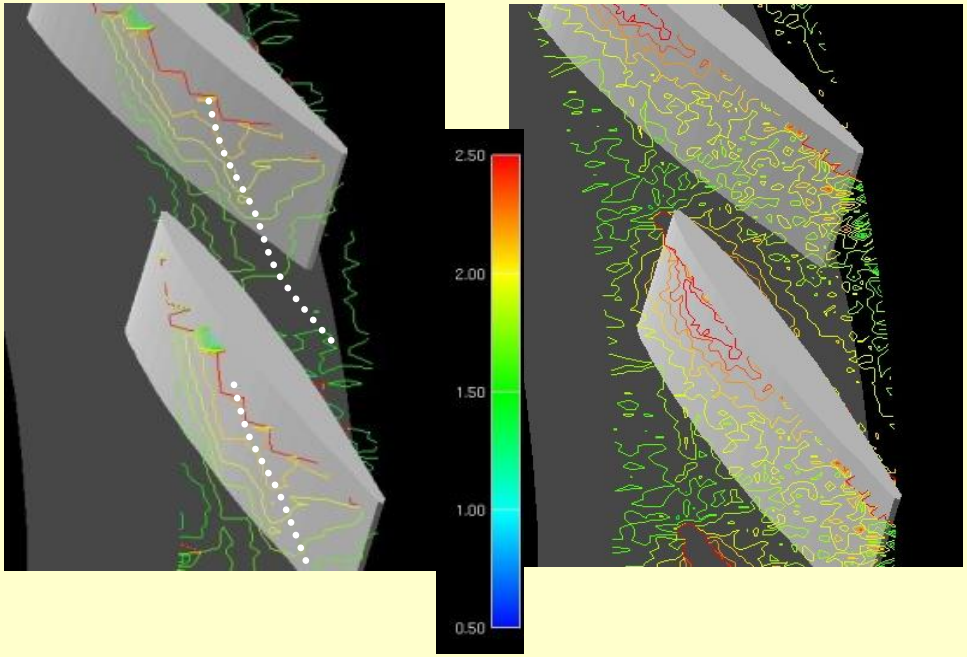


The left-side figure shows the experimental facility of ram jet engine. The right-upper-side figure shows Schlieren picture of the super sonic flow in the test section with the wedge. The other figures of fuel mol fraction indicate better mixing state with the wedge than the no-wedge.

Propulsion Engineering
Research of Jet Engine Components

Associate Professor Obata

Gas turbine engines are widely used for aircraft such as a fighter and an airliner. Every component in the engine is being developed for the increase of engine performance. We now study on the centrifugal compressor.



The left-side picture shows low pressure centrifugal compressor and Laser Doppler Velocimeter. The right-side 2 pictures show the contour lines of the fluid velocity, for the high flow rate the leakage vortex from the leading edge is released, whereas for the low flow rate near stall it would be broken. We try understanding and controlling these vortex behaviors.

Propulsion Engineering
Research of Solid Propellant Combustion

Professor Tanaka

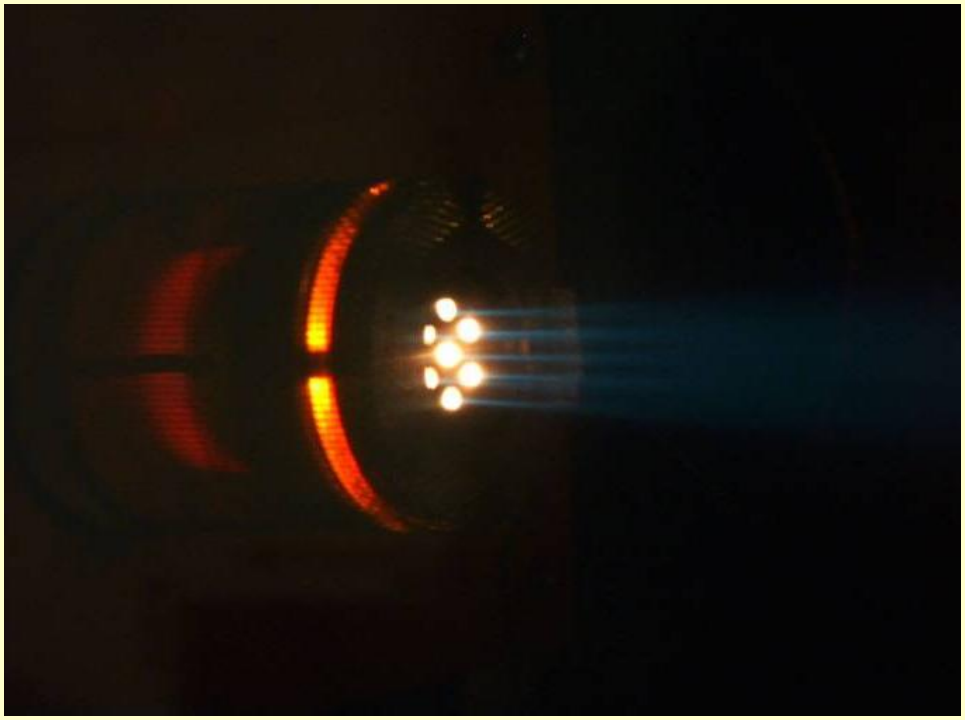
Solid propellants are widely used for space rockets and military missiles. Although the solid rocket motor has the longest history in jet propulsion engines, lack of information still remains in solid propellant combustion phenomena. More elaborate studies are needed to accomplish the more secure operation and attain the higher-performance.

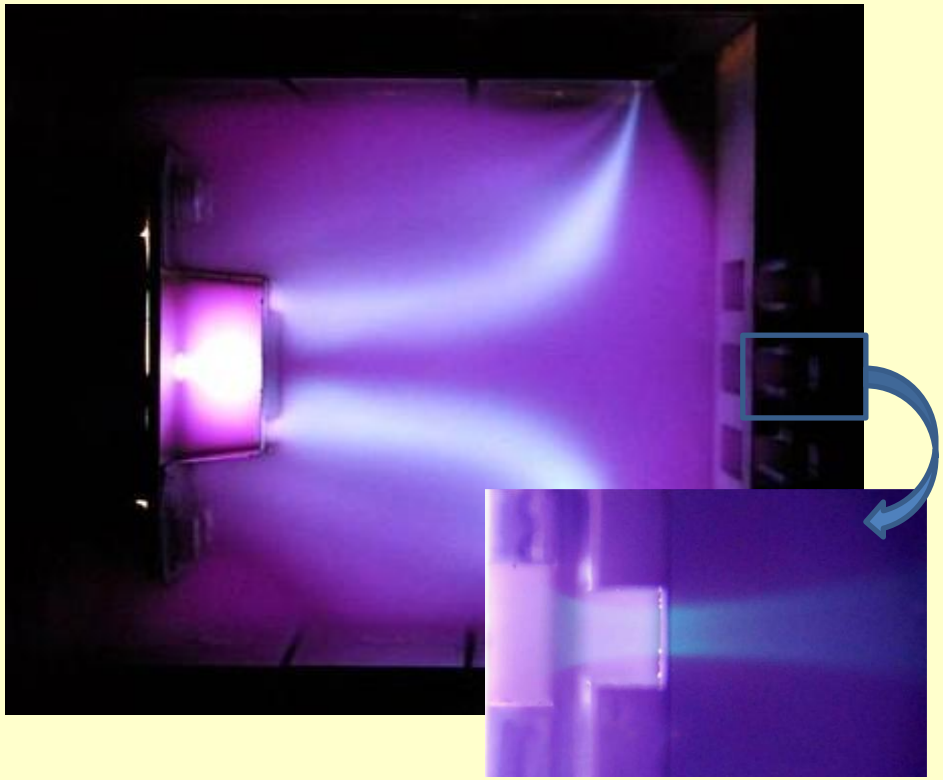
The left picture shows a device to investigate the effect of the initial temperature on the solid propellant combustion. The temperature distributions in propellants are measured by ultra-fine thermocouples. The building in the right picture is for solid rocket motor ground tests. This laboratory is a unique and only one facility conducting motor combustion ground tests in a university- or research institute- lab scale in Japan.

Propulsion Engineering
Research of Non-Chemical Propulsion

Associate Professor Nakayama

Non-Chemical propulsion systems, *e.g.* arcjets and ion thrusters, are installed in some meteorological, communication and observation satellites due to some attractive properties as space propulsion system: lower propellant consumption rate and longer durability.





The left figure shows ion beam flows from a laboratory-model ion thruster with exhaust-speed of over 100 km/s. The right figures show a directly-observed discharge plasma and an ion beam flow of a two-dimensional visualized ion thruster. This thruster is a technical unique thruster for some numerical model validations and fundamental understandings of ion thrusters.

Research Activity by Graduate Students (2006–2008)

•Nishio, Hara, Obata: Experimental Study for Mixing Enhancement of Helium Gas Injected into Supersonic Air Stream (First Report), National Symposium of Transportation System to Space, Sagamihara, Kanagawa, January 2006 (oral)

•Nishio, Hara, Obata: Experimental Study for Mixing Enhancement of Helium Gas Injected into Supersonic Air Stream (Second Report), 2006 JSASS North Branch Symposium and 7th Reusable Space Propulsion System Symposium, Sendai, Miyagi, March 2006 (oral, Best Presentation Award)

•Nishio, Shimomura, Obata: Development of Supersonic Mixing Layer behind a Wedge, 47th JSASS AeroEngine and SpacePropulsion Conference, Himeji, Hyogo, March 2007 (oral)

•Tanaka, Tanaka: Low Pressure Deflagration Limit of Solid Propellants, Annual conference of Japan Explosive Society, Edogawa ward, Tokyo, May 2006 (oral)

•Seki, Tanaka, Tanaka: An Effect of Negative Catalyst on Intermittent Burning at Intermediate Pressure of AP Composite Propellants, Autumnal conference of Japan Explosive Society, Kitakyushu, November 2006(oral)

•Tanaka, Seki, Tanaka: Low-Pressure Combustion Characteristics of Solid Propellants, 44th Symposium (Japanese) on Combustion, Hiroshima, December 2006(oral)

•Seki, Tanaka: Pressure Control Mechanism of a Motor with Solid Propellants of Intermittent Burning Characteristics at Intermediate Pressure, Annual conference of Japan Explosive Society, Edogawa ward, Tokyo, May 2007(oral)

•Urakawa, Seki, Tanaka: Effects of Ignition on Pulse Operation Characteristics of a Solid Propellant Rocket Motor, Autumnal conference of Japan Explosive Society, Kitakyushu, October 2007(oral)

•Seki, Urakawa, Tanaka: Unstable Combustion Induced by Fine AP Particles in Composite Propellants, 45th Symposium (Japanese) on Combustion, Sendai, December 2007(oral)

•Urakawa, Seki, Tanaka: A Thin Solid-Propellant Rocket Motor with Multi Nozzles, Annual conference of Japan Explosive Society, Edogawa ward, Tokyo, April 2008 (oral)

•Teraura, Nakayama: Experimental Evaluation of a Visualized Ion Thruster with Spectroscopic and Probe Scanning , The 51st Space Science and Technology Conference, Sapporo, Hokkaido, October 2007 (Oral)

Name in blue: graduate student