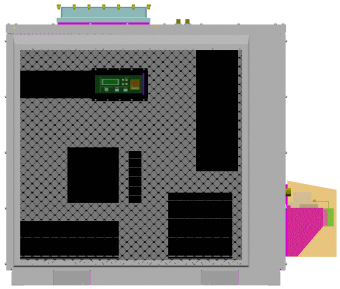
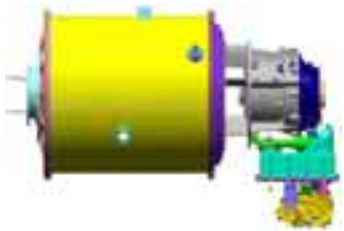
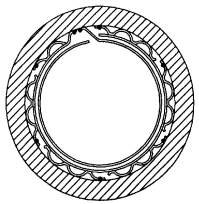
HONDA

Microturbine Research at Honda







Koichi Shinmura
Honda R&D Co., Ltd.
Wako Research Center
Saitama, Japan

1. Introduction:Corporate Profile

HONDA

Honda Motor Co., Ltd.

Competitive Product Designs

Honda R&D Co., Ltd.

- Wako R&D Center
  Tochigi R&D Center -Automobiles

- Asaka R&D Center
  - Motorcycles

- Asaka Higashi R&D Center
  - Power Products

- Wako Research Center

1. Introduction:Wako Research Center

HONDA

Humanoid Robotics
Capable of Walking and Decision-Making

Jet plane research

Jet engines research

NEW TECHNOLOGY

Contributing To Society:
Creativity and Innovation For a Brighter Future

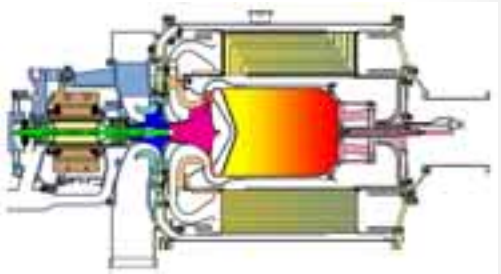
More Efficient , More Intelligent , More Environmentally Friendly Technologies

2. Research Activities on Micro Gas Turbine

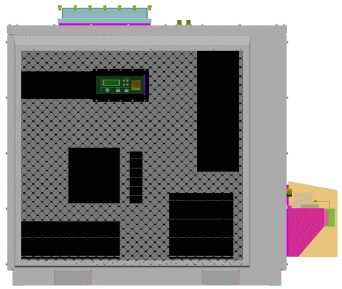
HONDA

Consisting of our own components technologies

Efficient, Compact, Clean



Gas Turbine Research



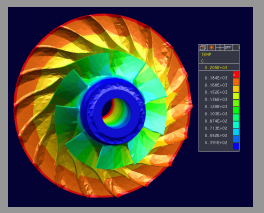
Generation System

Aerodynamics

3-D CFD Code

Design & Test

Reliability & Material

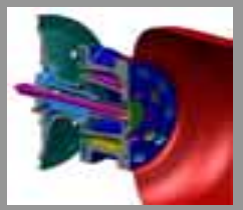


FEM

Burst Test

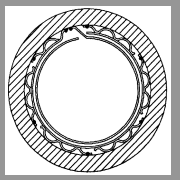
Heat
& Combustion

Recuperator



Lean Premix Combustion

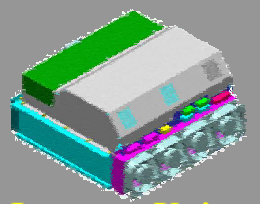
Rotor Dynamics
&Bearings



Air Foil Bearing

Power Electronics
&Generator

High Speed Generator



Inverter Unit

3. Microturbine Generation System

HONDA

System Specification

Performance @ISO Conditions (15°C , Sea Level)

System Power Output 42.4kW

System Efficiency 26.7% LHV

Including all auxiliary equipment and gas booster

Emission @15%O_2 NO_x, CO, HC < 2.5ppm

Engine Life 60,000 hours

Fuel City Gas 13A（200mmAq)

Electric Output

200VAC 3-Phase, 50/60Hz

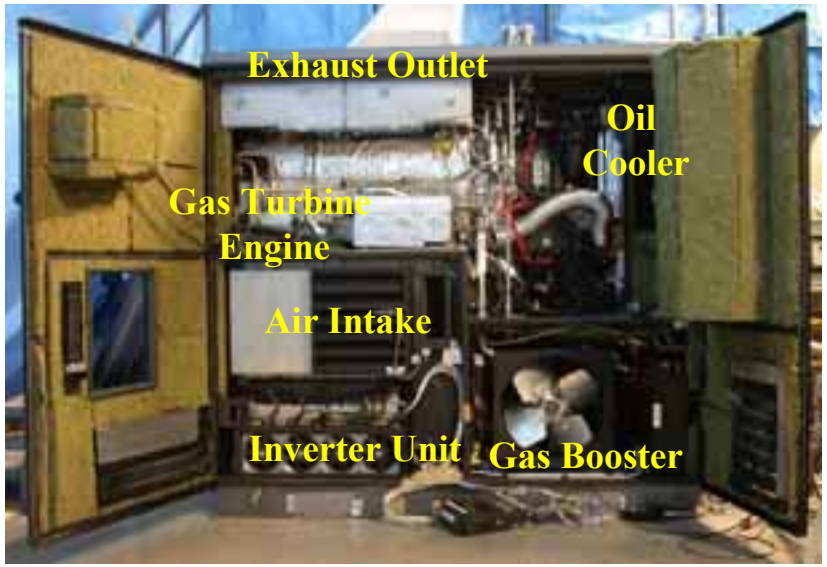
Grid-connect

Complying with Japanese electric standards

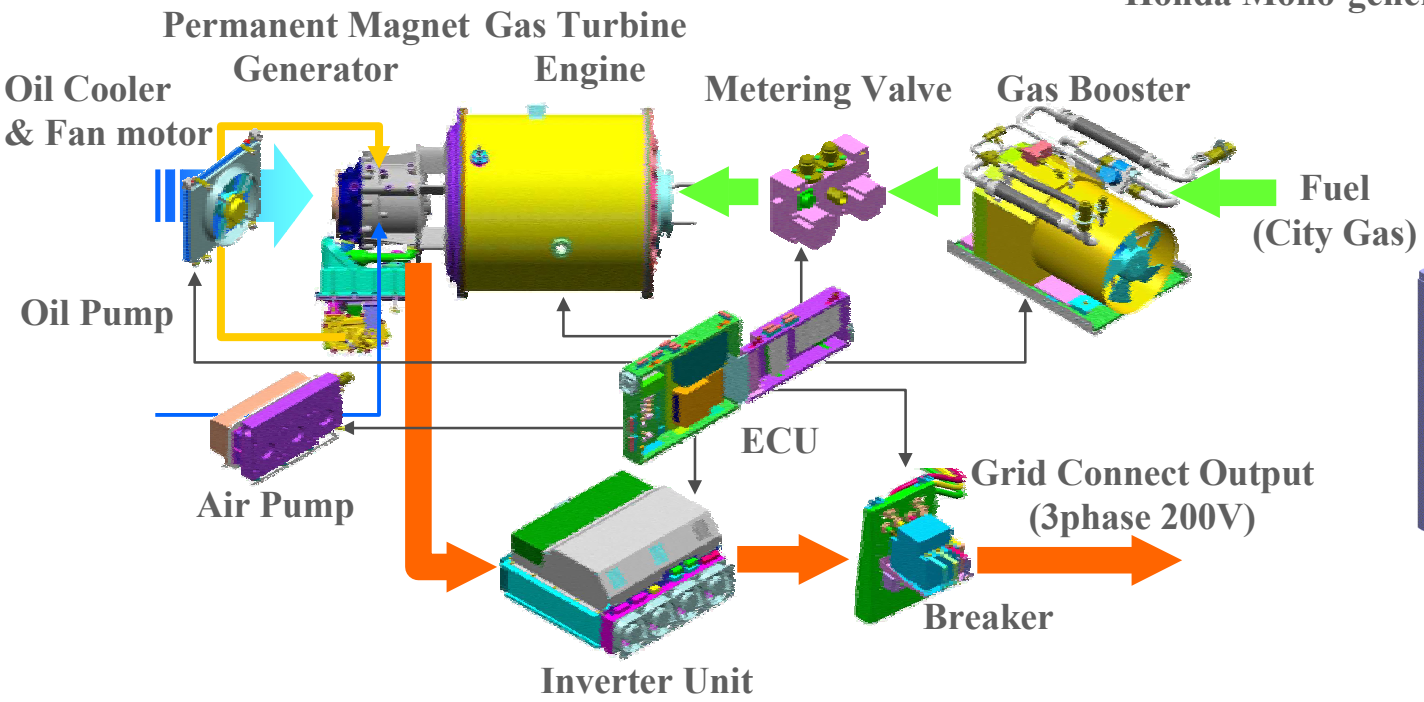
3. Microturbine Generation System

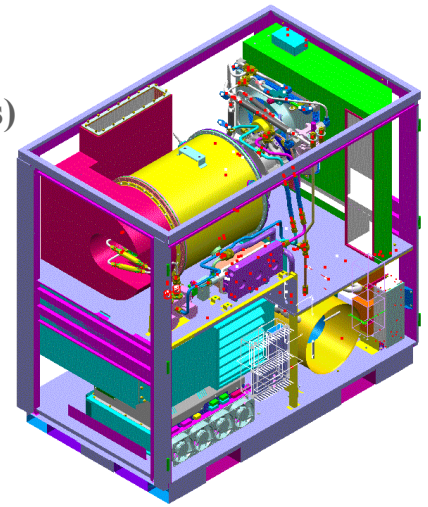
HONDA

Dimensions	
W	1506mm
D	942mm
H	1501mm
Weight	950kg
Sound	65.1dB@1m



Honda Mono-generation System Package

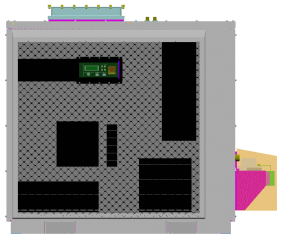


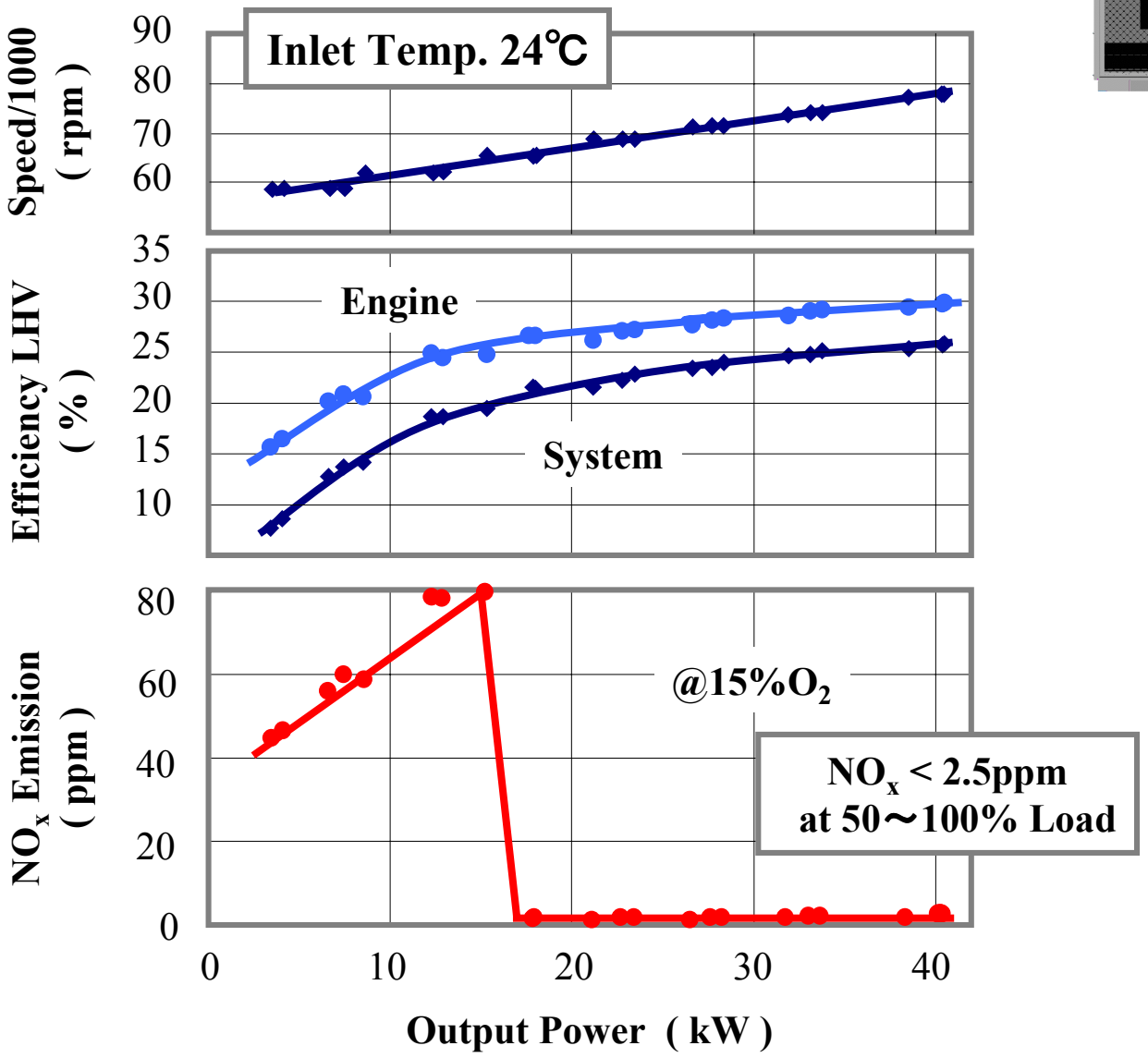


3. Microturbine Generation System

HONDA

System Performance Data

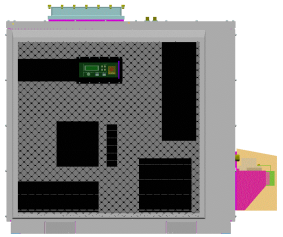


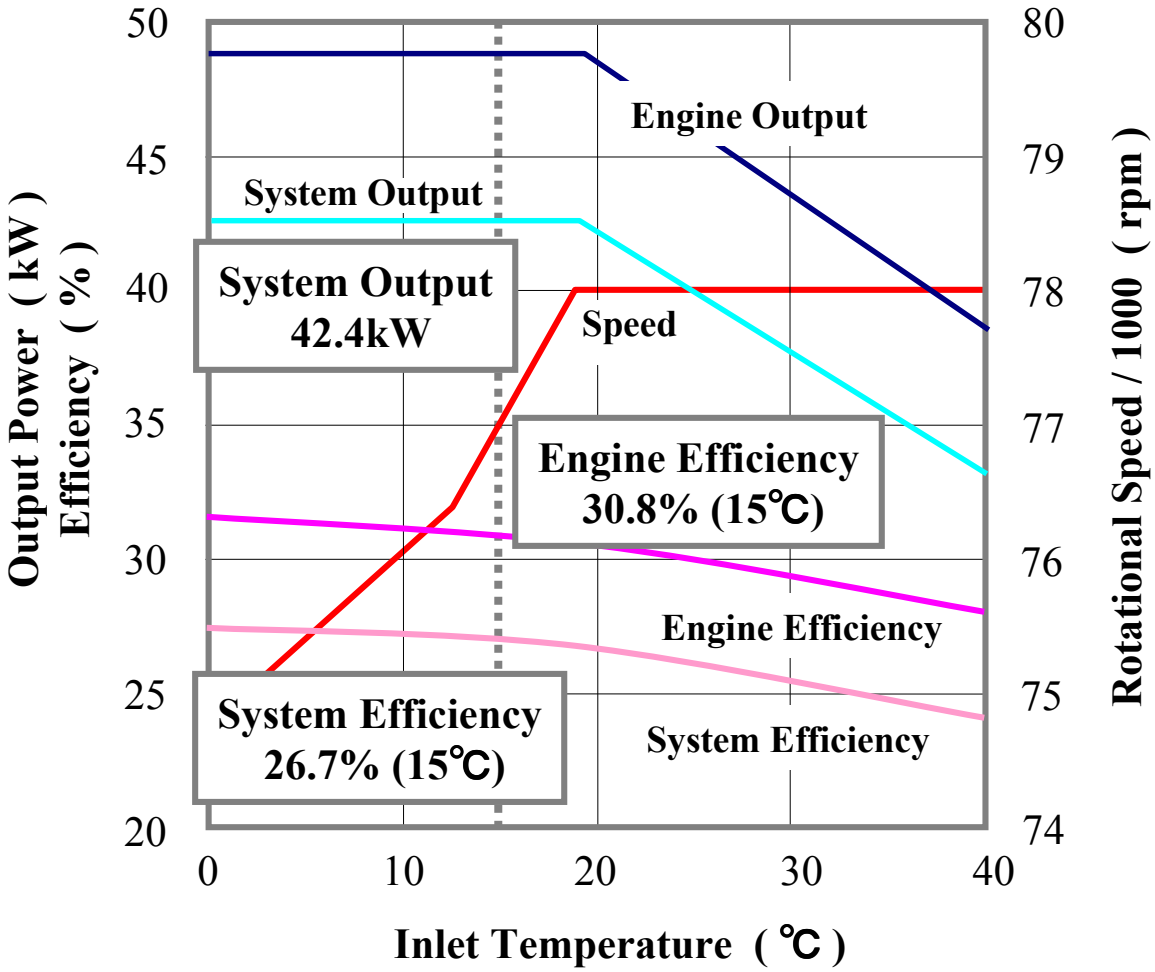


3. Microturbine Generation System

HONDA

System Performance Data





4. Microturbine Engine

HONDA

Engine and its components were all designed originally at Honda R&D

Axis-Symmetrical Compact Engine Design
ϕ 460 × L840 mm

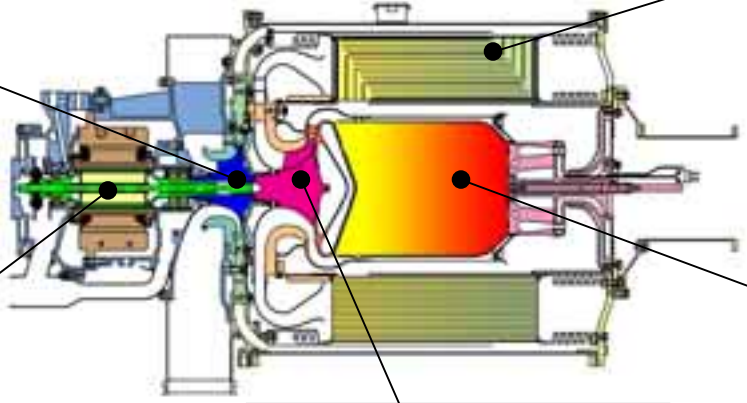
① Large combustion volume
② Minimize the heat radiation loss
③ Tough with the thermal deformation

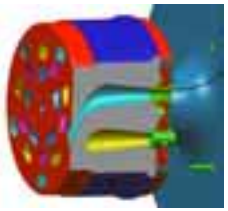
Compressor Rotor

Diffuser

Annular Recuperator

Centrifugal Compressor





Fuel-Air Mixer

High Speed Generator

Single Can Two-Stage Lean Premix Combustor

Coil

Stator Assembly

Radial Flow Turbine

Turbine Shroud

Turbine Rotor

Turbine Nozzle

Combustor Liner

4. Microturbine Engine

HONDA

Performance Data

		Version 1	Version 2
Rated Speed (rpm)		77,000	
Turbine Inlet Temperature (ºC)		900	
Compressor	Airflow (kg/s)	0.41	
	Pressure Ratio	3.8	
	Adiabatic Efficiency (%)	81.8	81.2
Turbine	Adiabatic Efficiency (%)	85.9	85.2
Recuperator	Temp. Efficiency (%)	87.6 →	90.6
	Air Leakage (%)	0.8	0.3
	Pressure Loss (%)	6.3	6.4
Combustor	Pressure Loss (%)	3.5	3.6
Generator	Efficiency (%)	94.7	95.2
Engine Power Output (kW)		47.8	51.7
Engine Efficiency (%)		30.8 →	32.9

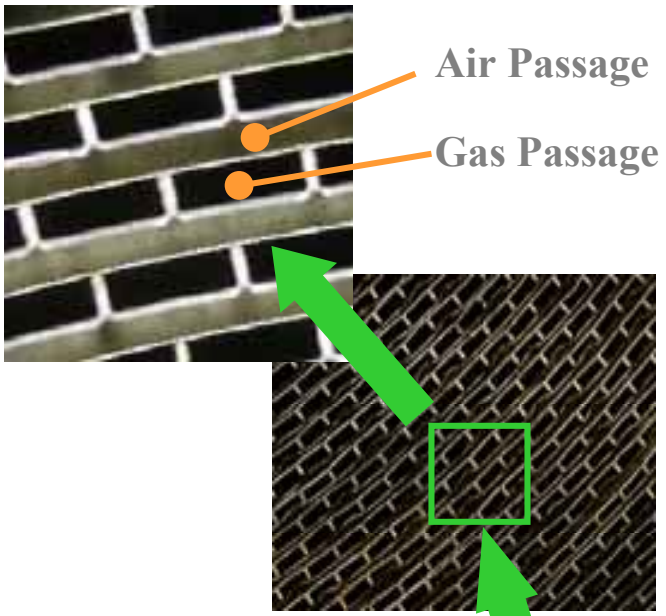
@ISO Condition

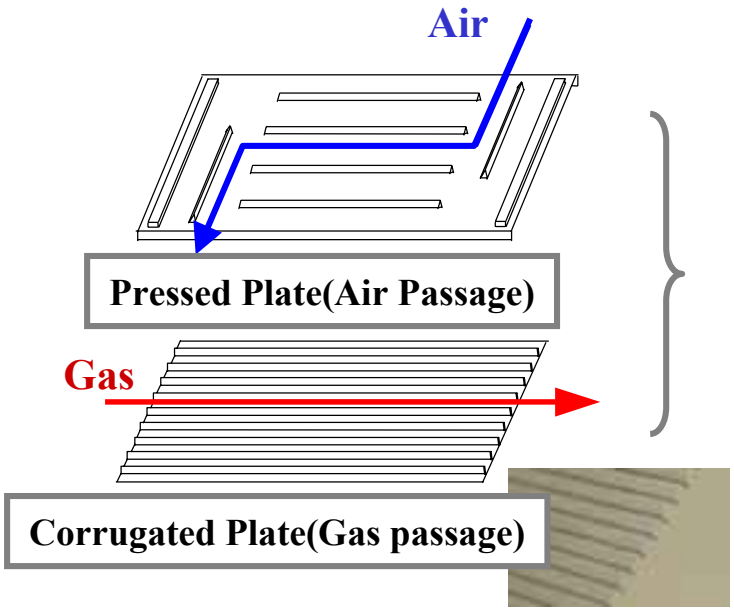
5. Engine Components : Recuperator

HONDA

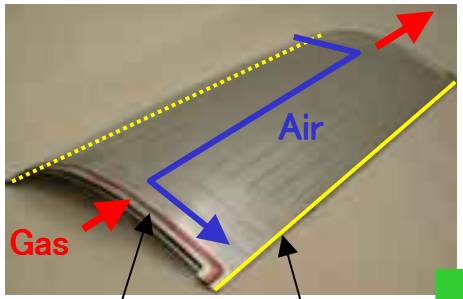
Recuperator Structure

Core Size	ϕ 430 × L289 mm
Core Weight	45 kg
Material	SUS304 (0.1mm thickness sheet)
Air condition	190°C , 0.34MPa
Gas condition	630°C , 0.11MPa

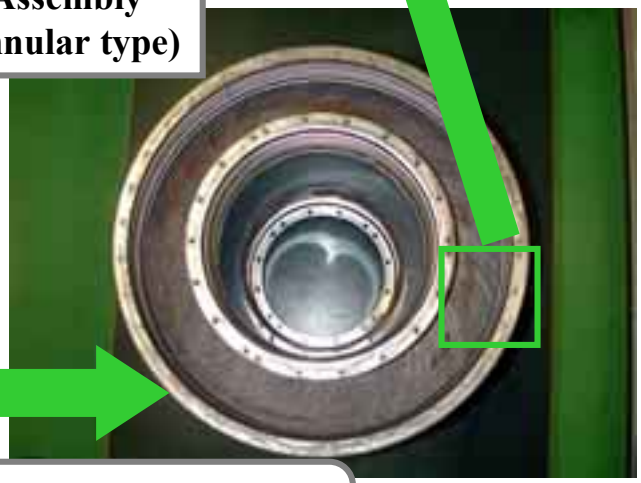




Laser Welded Cell
(Involute Shaped)



Assembly
(annular type)

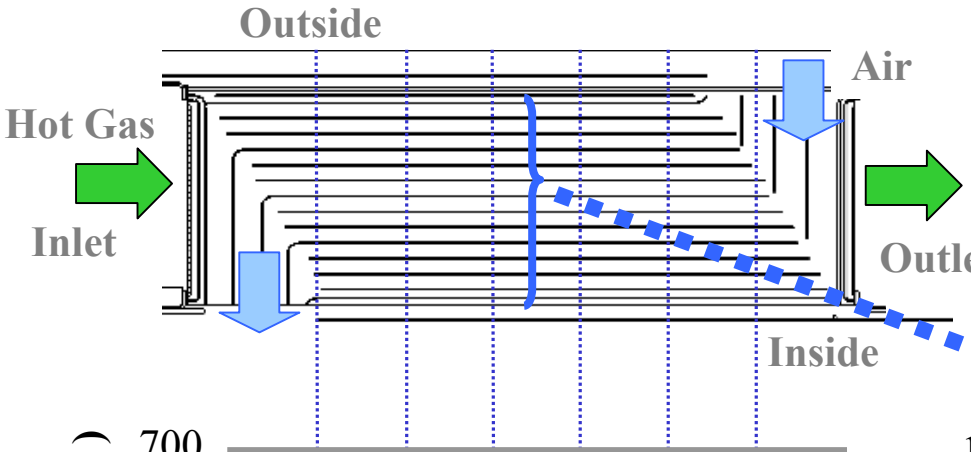


Brazing 510 Cells
all simultaneously

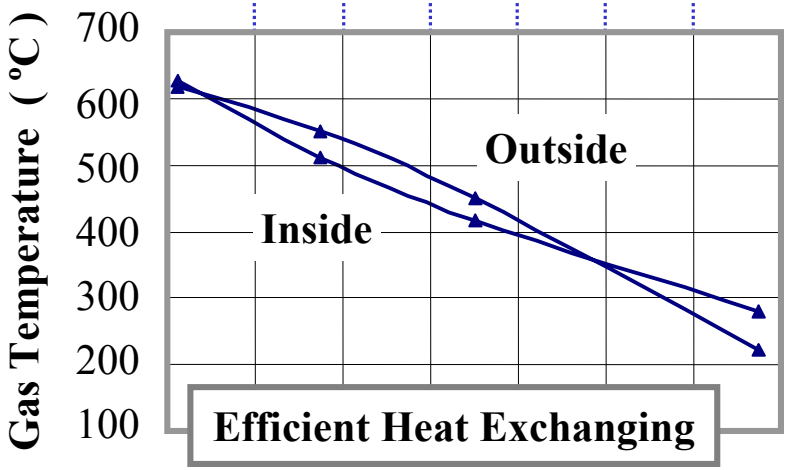
5. Engine Components : Recuperator

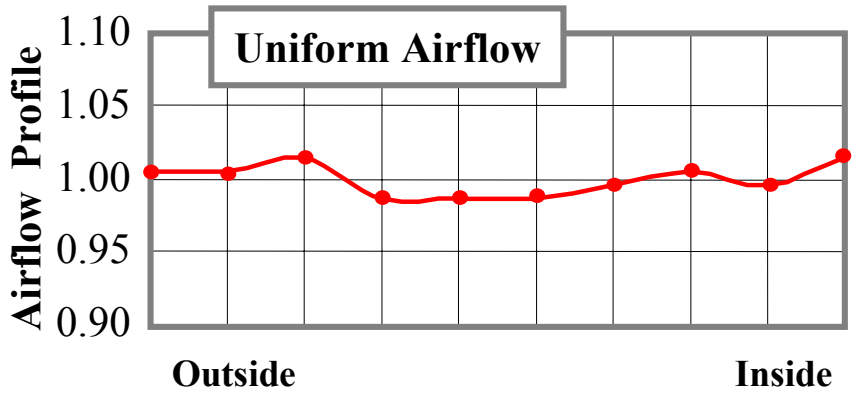
HONDA

Recuperator Performance Data



High Efficiency has been achieved mainly by a very uniform Airflow Profile

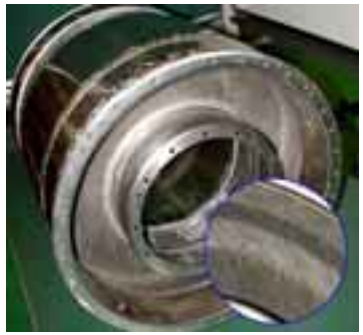


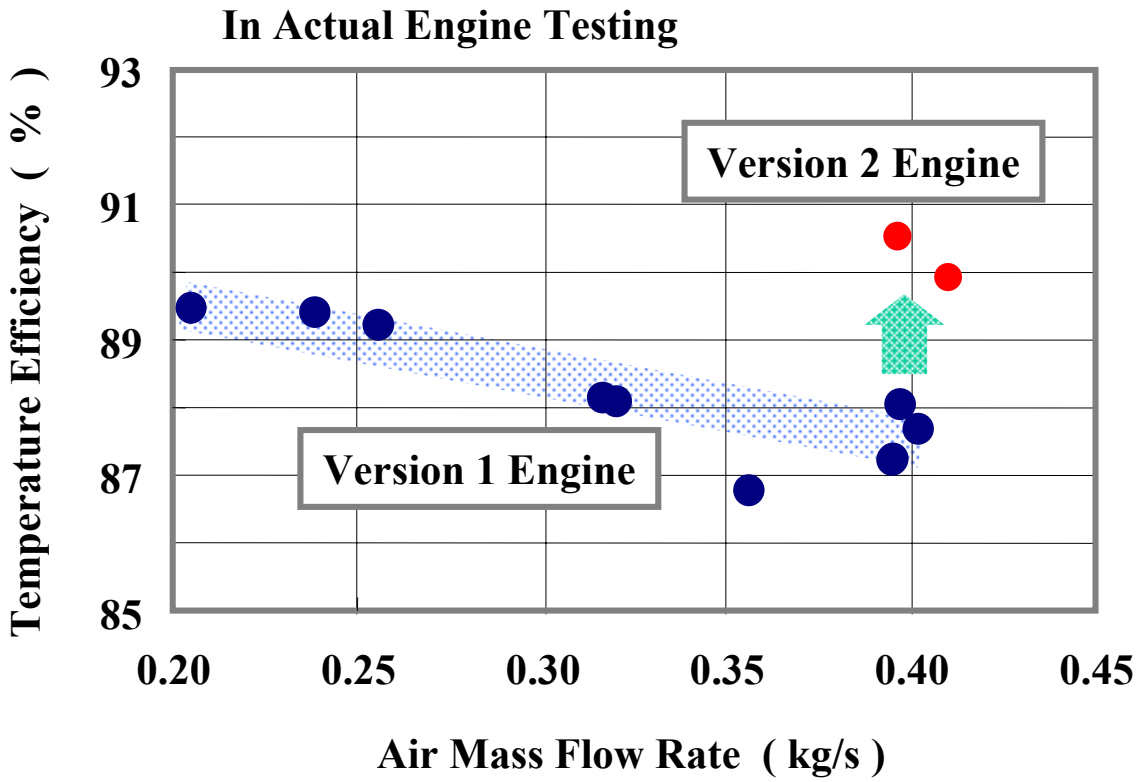


5. Engine Components : Recuperator

HONDA

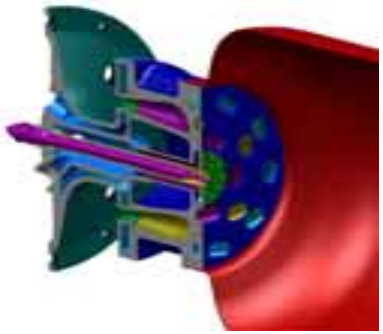
Recuperator Performance Data



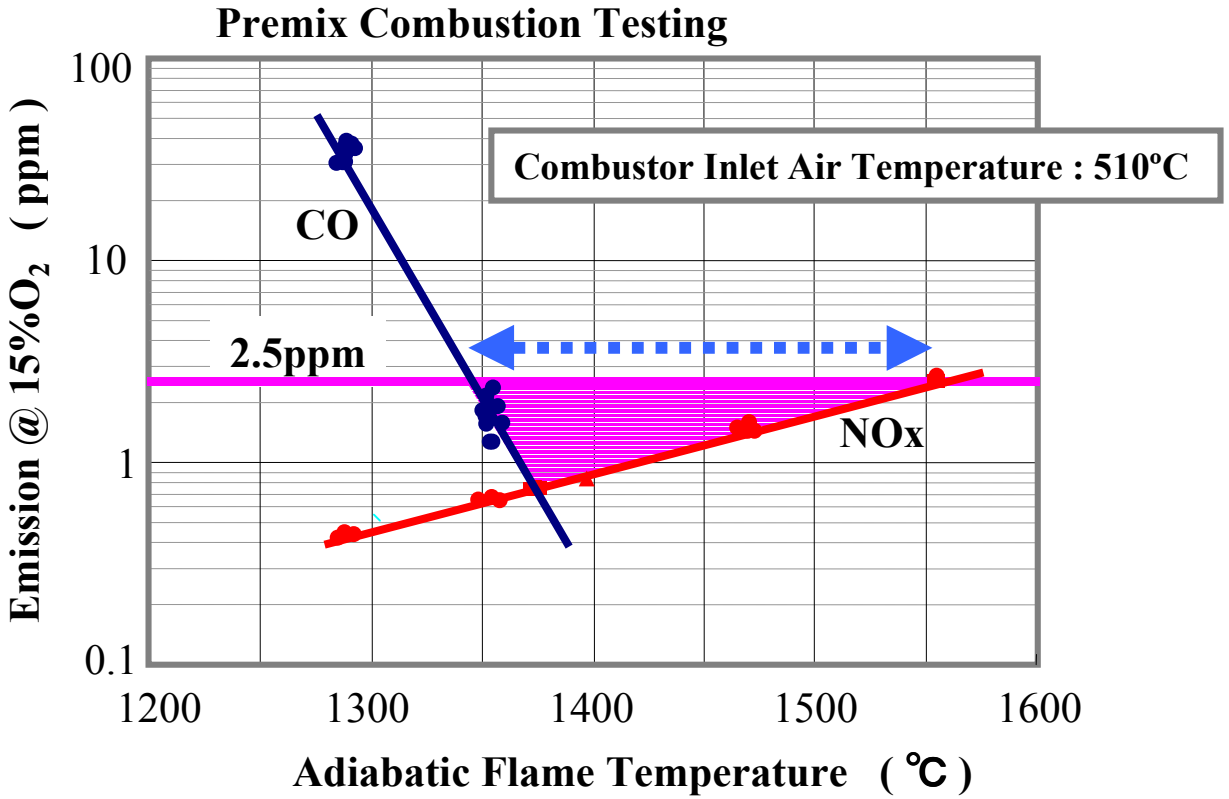


HONDA

Emission Performance of Premix Combustor



2 Stage Combustor
- **Diffusion**
- **Premix**

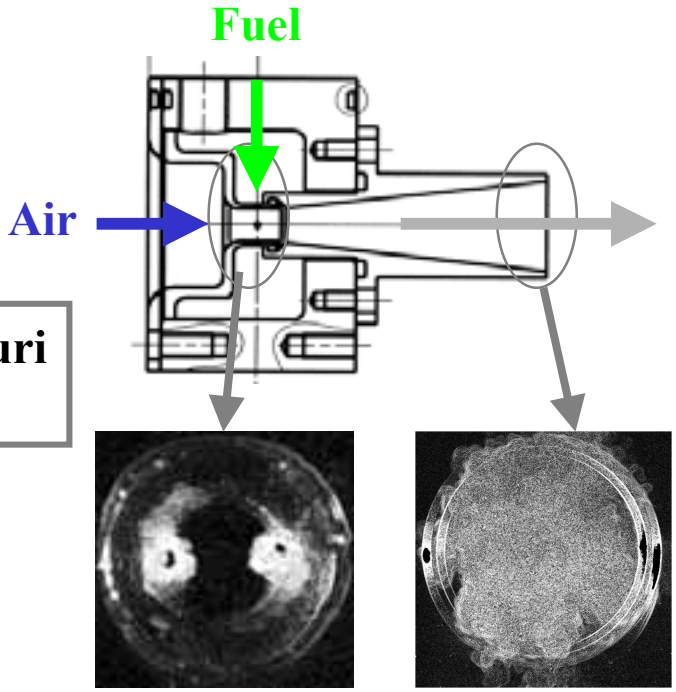


Sufficient wide range of low emission for actual generator use

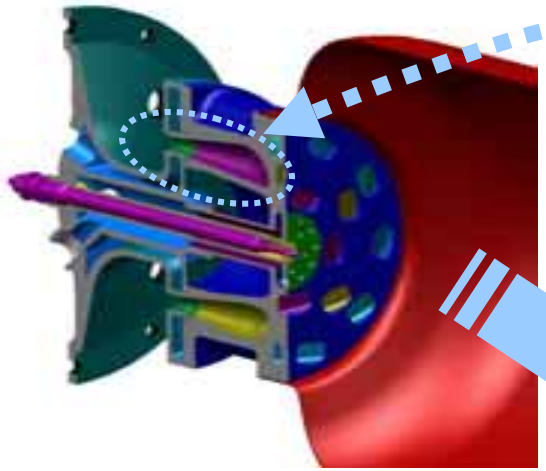
6. Engine Components : Combustor

HONDA

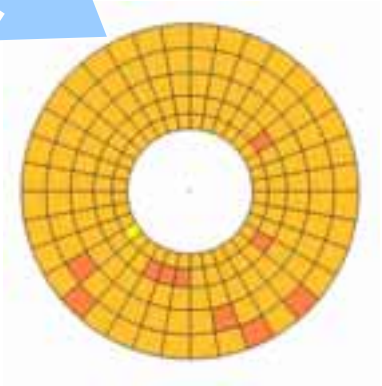
Premixer Performance Data



Single Venturi Mixer



Multi Venturi Mixer (20 Single Venturi Mixers)



Non-Uniformity

	+10%
	±5%
	-10%

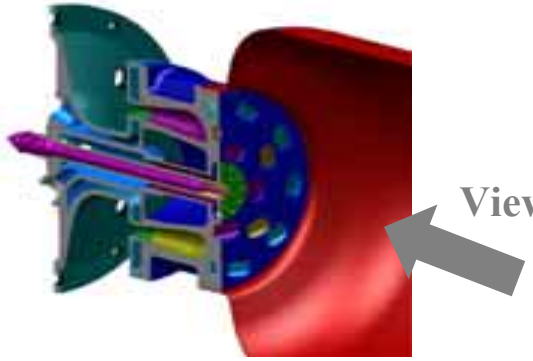
Condition

Air Flow Rate : 50g/s
Pressure : Ambient
Temperature : 28℃
Span Gas : C_3H_8 , 908ppm

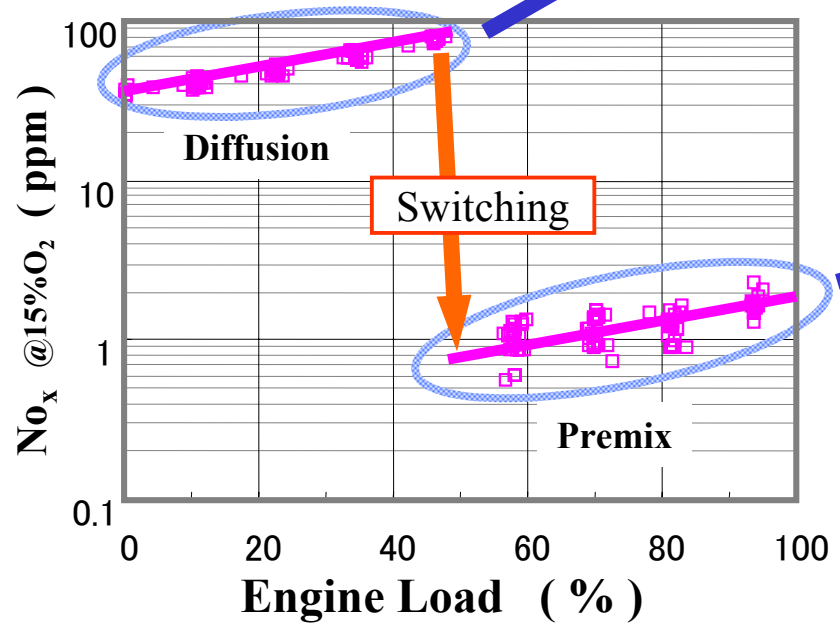
Non-Uniformity of Mixture is within ± 10% in Combustion Zone

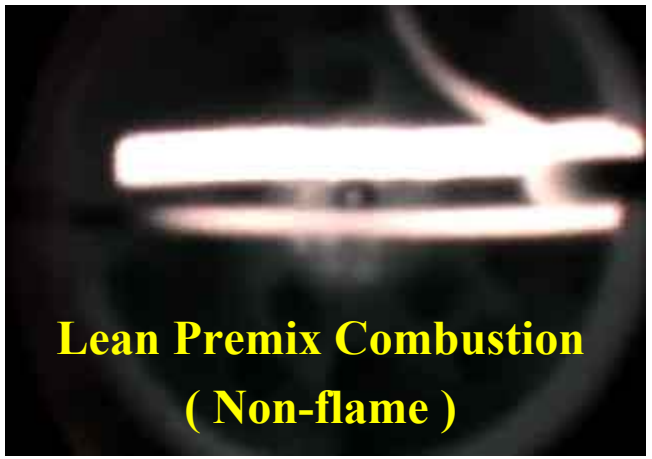
HONDA

Visualization of Combustion



2 Stage Combustion Testing





7. Air Foil Bearings

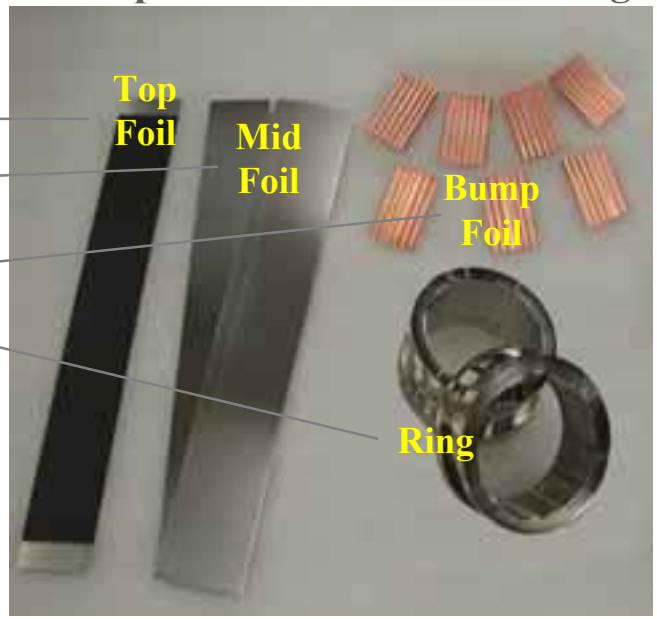
HONDA

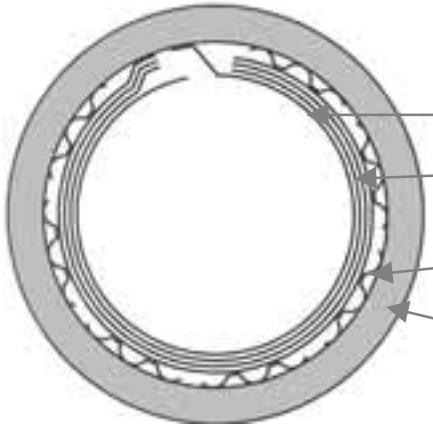
Completed the component research stage

Journal Bearing

Thrust Bearing

Components of Journal Bearing



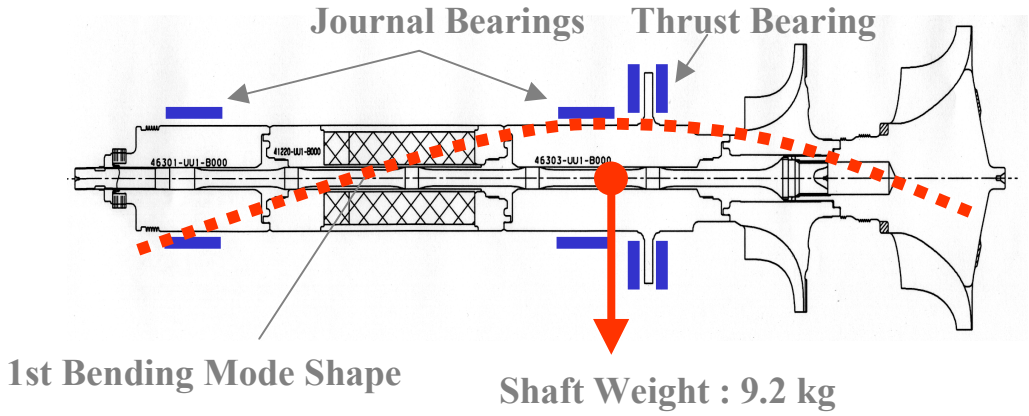


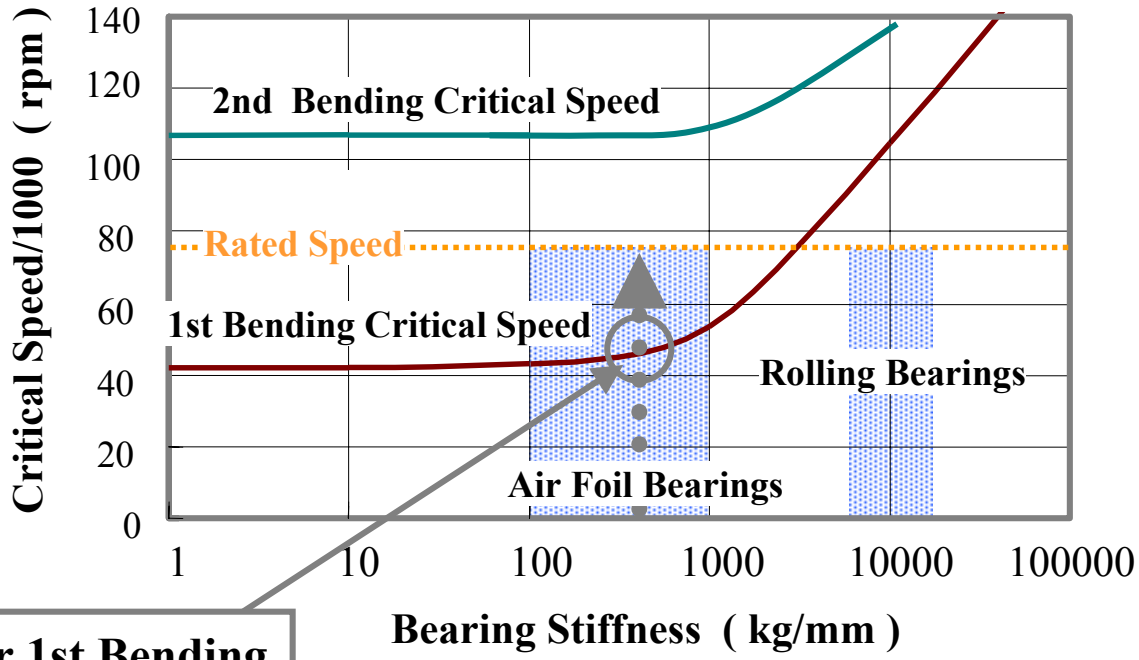
Structure of Journal Bearing

7. Air Foil Bearings

HONDA

Shaft & Bearings Design



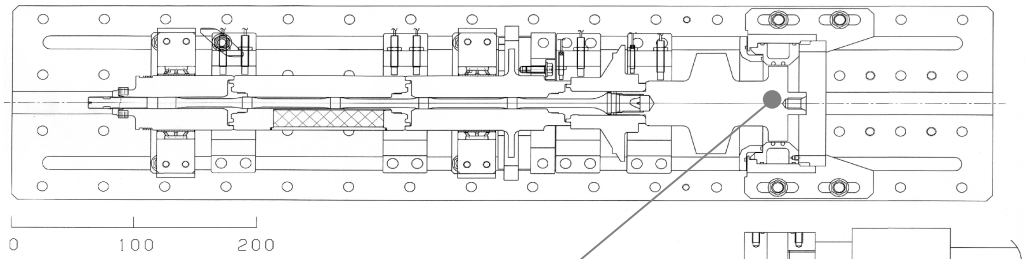


Getting over 1st Bending

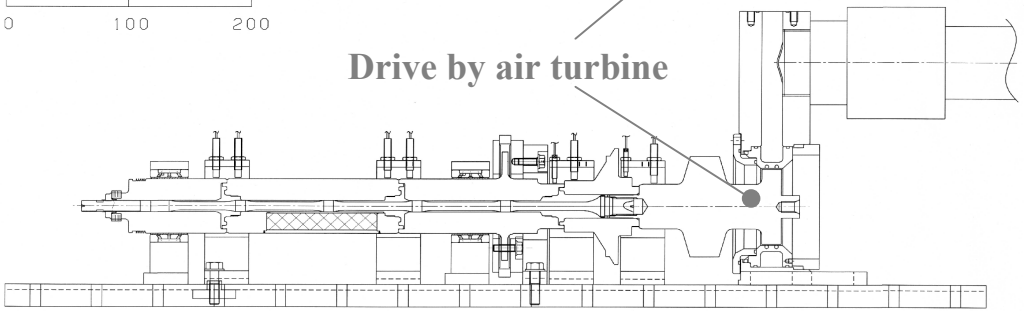
7. Air Foil Bearings

HONDA

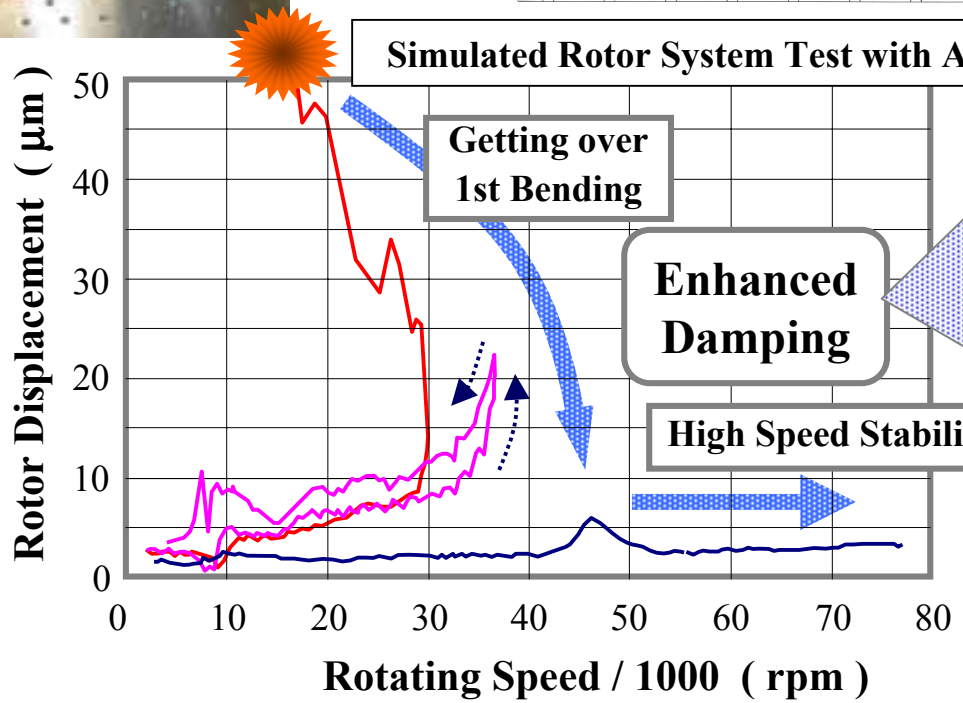
Shaft Component Testing



Drive by air turbine



Simulated Rotor System Test with Air Foil Bearings



Getting over 1st Bending

Enhanced Damping

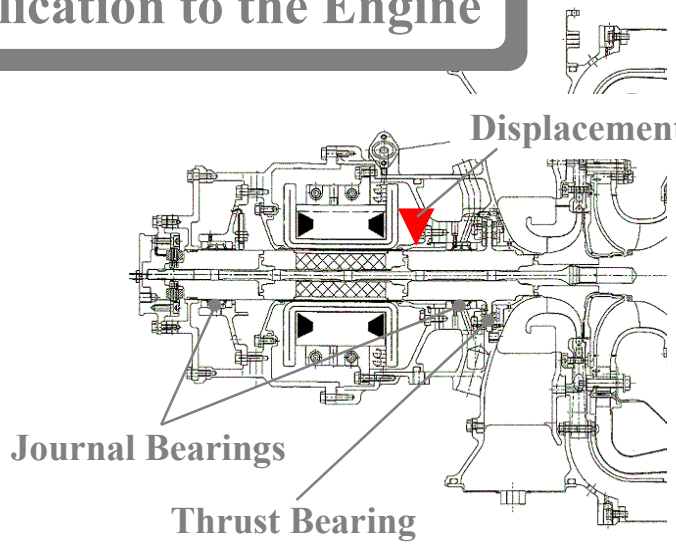
High Speed Stability

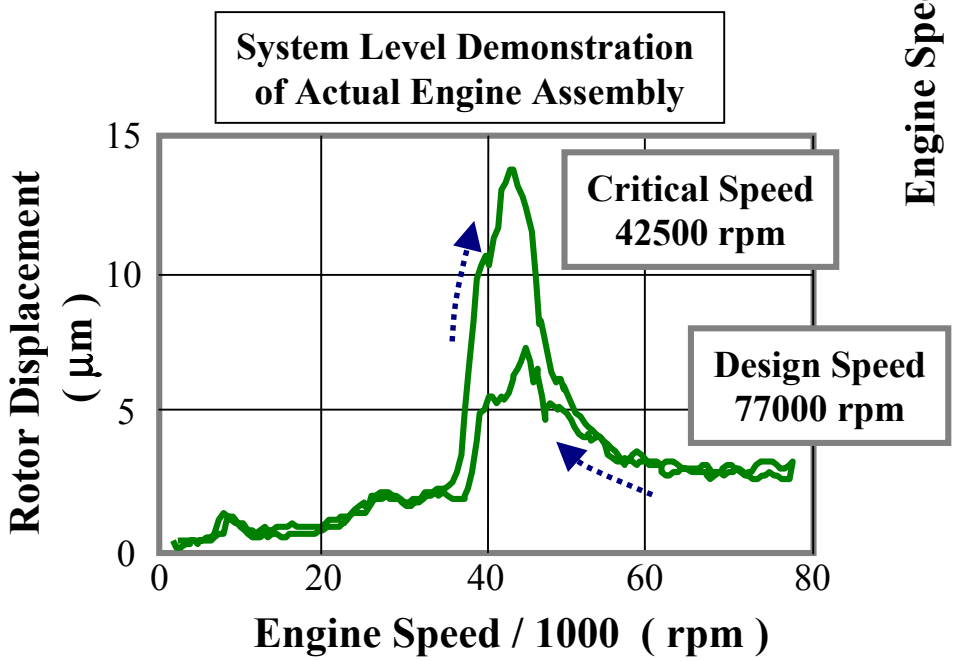
Modifications of Foils

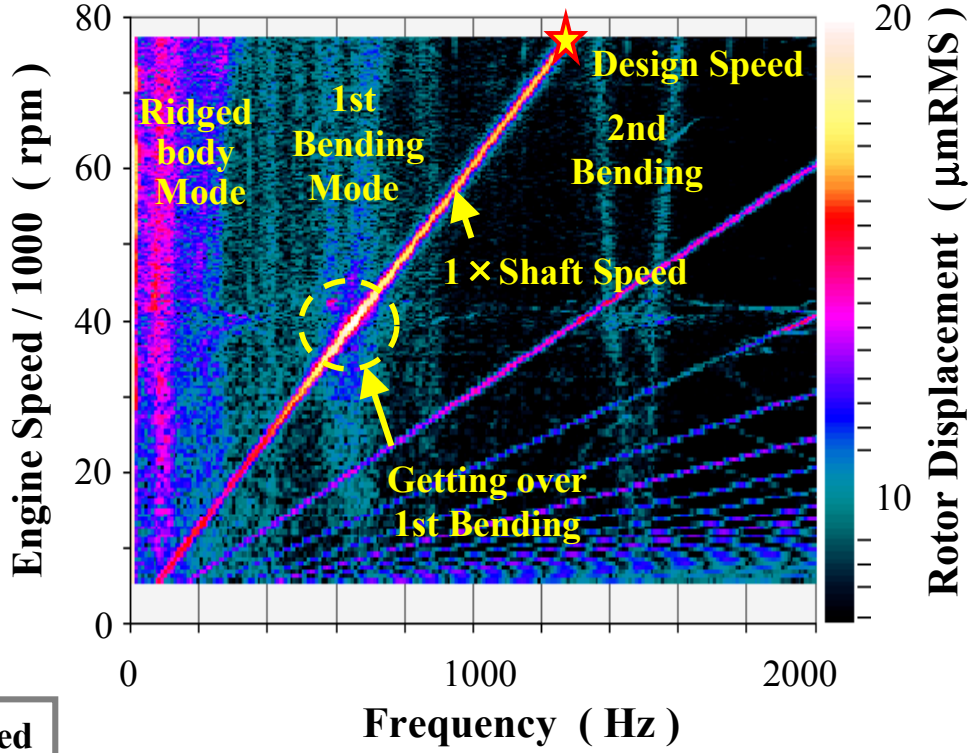
7. Air Foil Bearings

HONDA

Application to the Engine







Confirmed the sufficient capability for the engine application

Honda R&D Co., Ltd.
Wako Research Center

Lab. 12
Koichi Shinmura

koichi_shinmura@n.f.rd.honda.co.jp