Report on the current state of “Japanese University Rocket Projects”

Second Edition

October 2012

UNISEC
University Space Engineering Consortium

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“Japanese University Rocket Projects”

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Introduction

University Space Engineering Consortium (UNISEC) has compiled a report on the current state of " Report on Japanese University Rocket Projects" in October 2012. The latest version of report will be also been made available on the Internet at the UNISEC web site.
http://www.unisec.jp/member/jusat-e.html

In response to requests, the UNISEC continues this activity and will publish a revised and updated edition of the above directory in the future.

We hope this report can support professionals and students who are interested in Space Engineering Education in Japanese Universities.

Comments, queries and information with respect to this report are most welcome.

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Report on Japanese University
Japanese University Rocket Projects

University/ Organizer	**Akita University**	
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Keywords

Hybrid Rocket, Launch, Combustion, Space Education

【1】Overview and Science Highlights of the project

1. Application of low melting point thermoplastics to hybrid rocket fuel
2. Development of a small sounding hybrid rocket
3. Application of small hybrid rocket to science and engineering education with experience of project execution for university student

Launch site information

1. Noshiro space park (Asanai 3rd Kousai Taiseki-jyo in Akita prefecture)
   Rockets launch and recover from ground and maximum altitude is 500m.

2. Used place of swimming area in Ochiai, Noshiro city, Akita prefecture
   Rockets launch from the beach and recover from sea and maximum altitude is a several ten km high.

Fig.1 Noshiro space park

Fig.2 Sea launch place

Launch history

Date	Name	Altitude	Note
22, Mar. 2010	ASSP-HTJ-12	150m	Failure to parachute recovery
22, Aug. 2010	ASSP-HTJ-13	176m	Success to recovery
24, Aug. 2011	ASSP-HTJ-14	288m	Success to CANSAT carrying
25, Sep. 2011	ASSP-HTJ-15	232m	Success to recovery using new separation system
10, Oct. 2011	ASSP-HTJ-16	531m	Success to recovery from sea
30, May. 2012	ASSP-HTJ-17	250m	Failure to parachute recovery

Fig.3 HTJ-15

Fig.4 HTJ-16

Fig.5 HTJ-17

Launch plane

Date	Name	Altitude	Note
23, Aug. 2012	ASSP11-HTJ-18	1.3km	Challenge to Sea launch

【2】Achievements in Space Engineering Education through Rocket Activities (or Plan)

Past Rocket Activities

Data	Name	Target
Aug. 2009	5th Noshiro Space Event	Univ. student in Japan
Aug. 2010	6th Noshiro Space Event	Univ. student in Japan
Aug. 2011	7th Noshiro Space Event	Univ. student in Japan
Aug. 2012	8th Noshiro Space Event	Univ. student in Japan
Mar. 2010	Rocket Girl Training Course	High school student in Akita

Akita university curriculum

Name: Student independent Project

Target: All Akita univ. student (1 year)

Content: Development of small hybrid rocket and launch in Noshiro Space Event

Plan Rocket Activities

Data	Name	Target
Aug. 2012	8th Noshiro Space Event	Univ. student in Japan

【3】Papers

✧ Journal Publications

1.” Application to Hybrid Rocket Fuel of Low Melting Point Thermoplastics”, Yutaka Wada,_Mistutoshi Jikei, Ryuichi Kato, Nobuji Kato, Keiichi Hori, TRANSACTIONS OF THE JAPAN SOCIETY FOR AERONAUTICAL AND SPACE SCIENCES, AEROSPACE TECHNOLOGY JAPAN, Vol. 10 (2012)

2.“Combustion model of tetra-ol glycidyl azide polymer”, Yutaka Wada, et al., Proceedings of the Combustion Institute, Vol.32, pp.2005-2012 (2009)

3.“COMBUSTION MECHANISM OF TETRA-OL GLYCIDYL AZIDE POLYMER AND ITS APPLICATION TO HYBRID ROCKET”, Yutaka Wada, et al., Advancements in Energetic Materials and Chemical Propulsion by Begell House, Inc. pp.1099-1114, (2009)

✧ Contributions (in Japanese)

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✧ Books

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✧ Dissertations

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✧ Master's thesis

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▪

✧ Doctor’s thesis

▪

【4】Recent overseas researchers who collaborated with us (for a short period)

1. Name and Affiliation of Co-researcher
   Research Theme

2. Name and Affiliation of Co-researcher
   Research Theme

【5】Important mention, if any

n/a

University/ Organizer	**Hokkaido University / Laboratory of Space Systems**	
Supervisor	Harunori NAGATA, Professor	
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Keywords

CAMUI-type Hybrid rocket, Solar orbit transfer vehicle, Liquid droplet radiator, Pulse detonation engine

【1】Overview and Science Highlights of the project

A mission of a rocket is to accelerate payloads such as satellites. Recently, a demand of the launch of micro satellite is drastically increasing. However, there is no small launcher provided for the launch of micro satellites because miniaturizing liquid rocket is difficult and solid rockets using explosives result in high launch cost.
Using CAMUI type hybrid rocket, we develop a small launch system of safe and low cost for micro satellites, and develop a new market of small-scale space utilization.

Milestones to the space;

Launch into 60 km altitude to sample the stratospheric air.

Launch into 100 km altitude to provide micro gravity environments.

【2】Achievements in Space Engineering Education through Rocket Activities (or Plan)

We have been getting to original rocket project since 2008. The members of this project are first year master's degree student in our laboratory. The purpose of this project is to develop an automatic return rocket system with the CAMUI hybrid rocket motor. This system will enable students who develop the CanSat to provide a tool of convenient launch experiment. As the second year of this project, we developed the 1.3-m-long CAMUI hybrid rocket. The rocket have an avionics system which can do wireless communications with ground-based station using the bluetooth technology. And we launched the rocket twice. For a propulsion system, we designed and produced the CAMUI hybrid rocket motor whose thrust level is 310 N. The avionics system is composed of a microcomputer, angular velocity sensors. The data of the sensors are transmitted to a personal computer on the ground by the bluetooth.

【3】Papers

✧ Journal Publications

・Harunori Nagata, Shunsuke Hagiwara, Masahiro Nohara, Masashi Wakita, Tsuyoshi Totani, "Optimal Fuel Grain Design Method for CAMUI Type Hybrid Rocket," 47th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit, San Diego, CL, AIAA-2011-6105, July 31-Aug. 3, 2011.

・ 野原 正寛, 金子 雄大, 萩原 俊輔, 永田 晴紀, 「遺伝的アルゴリズムを用いた CAMUI 型燃料グレインの最適設計」, 日本機械学会論文集Ｂ編, Vol. 77, No. 777, pp.1249-1258, 2011.

・ Yudai Kaneko, Kouichi Kishida, Nobuyuki Oshima, Takuji Nakashima, Masashi Wakita, Tsuyoshi Totani, Harunori Nagata, "Effect of Temporal Variations of Internal Ballistics on Fuel Regression Rate in the CAMUI Hybrid Rocket," Journal of Space Engineering, Vol.3, No.1, pp.52-65, 2010.

・ Harunori Nagata, Shunsuke Hagiwara, Yudai Kaneko, Masashi Wakita, Tsuyoshi Totani, Tsutomu Uematsu, "Development of Regression Formulas for CAMUI Type Hybrid Rockets as Functions of Local O/F," 46th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit, Nashville, TN, AIAA 2010-7117, 25-28 July 2010.

✧ Dissertations

・ 岩城裕樹、水を推進剤とした太陽熱スラスタの熱設計手法の確立およびラバールノズル内超音速流れに伴う伝熱が推力および比推力に与える影響、2010.

・ 金子雄大、CAMUI 型ハイブリッドロケットの燃料後退特性におよぼす流れ場の影響、2010

・ 松岡常吉、対向流中における固体燃料管内燃え広がりの火炎特性、2010.

✧ Master's thesis

・ 亜酸化窒素の触媒分解反応を用いたハイブリッドロケット用点火器の開発

・ 液滴ラジエータにおける作動流体の自動循環制御手法

・ 拡大する環状流路でのデトネーション波の挙動

・ CAMUI 型固体燃料後退速度式の導出方法に関する検討

【4】Recent overseas researchers who collaborated with us (for a short period)

1. Name and Affiliation of Co-researcher
   Research Theme
2. Name and Affiliation of Co-researcher
   Research Theme

【5】Important mention, if any

n/a

University/ Organizer	**Tokai University**	
Supervisor	Ichiro Nakagawa, Professor	
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Keywords

Hybrid Rocket, Wax Fuel

【1】Overview and Science Highlights of the project

The number of hybrid rocket launches is 27.

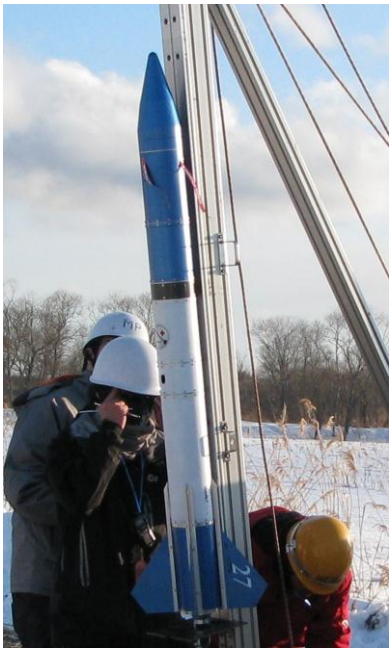
The hybrid rockets uses WAX fuel.

The parachute separation devise with no explosives is developed originally.

The maximum altitude is approximately 1km.

We launch hybrid rockets during spring and summer holidays.

Our launch sites are Noshiro in Akita or Taikicho in Hokkaido.



The 27th rocket was launched successfully in 19/2/2012.

【2】Achievements in Space Engineering Education through Rocket Activities (or Plan)

- We have student rocket project as an extracurricular class
- They conduct design, manufacture, experiments and launch of original hybrid rockets for themselves.
- Target is to learn expert knowledge, technical skill and teamwork.
- Members are about 50 students, from freshman to master's degree course students.

【3】Papers

✧ Journal Publications (since 2011)

・Nakagawa, I. and Hikone, S., "Study on Regression Rate of Paraffin-Based Hybrid Rocket Fuels", Journal of Propulsion and Power, Vol. 27, 2011, pp. 1276-1279

✧ Contributions (in Japanese, since 2011)

・Nakagawa, I., "A Study on Paraffin-based Fuel Hybrid Rockets," 28th International Symposium on Space Technology and Science, 2011-o-1-06v, Okinawa Convention Center, Gonowan, Japan, June 5-12, 2011.

・Maruyama, S., "Study on Mechanical Characteristic of Paraffin-based Fuel," 28th International Symposium on Space Technology and Science, 2011-a-31s, Okinawa Convention Center, Gonowan, Japan, June 5-12, 2011.

・Iijima, K., "Improve Combustion Efficiency of Wax Fuel Hybrid Rocket," 28th International Symposium on Space Technology and Science, 2011-a-32s, Okinawa Convention Center, Gonowan, Japan, June 5-12, 2011.

・Kawai, H, Nakagawa, I. and TSRP team, "Development of Hybrid Rockets in TSRP," Space Transportation Symposium in FY2011, ISAS/JAXA, Jan. 2012.

✧ Master's thesis(since FY2011)

・Iijima, K., "Experimental Study on the Effect of a Baffle Plate of Wax Fuel Hybrid Rockets "

・Ishiguro, T., "Study on Improvement of Combustion Efficiency of Wax Fuel Hybrid Rockets"

・Maruyama, S., "Study on Mechanical Characteristics Improvement of Wax Fuel for Hybrid Rockets"

【4】Recent overseas researchers who collaborated with us (for a short period)

3. Name and Affiliation of Co-researcher
   Research Theme
4. Name and Affiliation of Co-researcher
   Research Theme

【5】Important mention, if any

n/a

University/ Organizer	**Wakayama University** **Institute for Education on Space (IfES)**	
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Keywords

Hybrid Rocket, Launch Site, BalloonSat, Rocket Girls and Boys, CanSat

【1】Overview and Science Highlights of the project

Wakayama University has been working on setting up launch sites for student rocket projects in Japan. As a result, we have two "playgrouds" for rocket launches and balloon experiments: Kada (Wakayama pref.) and Izu-Oshima Island (Tokyo pref.). A launcher is also available at each site. Furthermore, rocket-engine tests (J-type) can be carried out in Wakayama univ. since 2012/04. So students can use well-equipped machine tools and measurement devices for their activities. These convenient sites and facilities are available for any student projects almost anytime. Please contact us, if you need them!

Three-teams are active in Wakayama univ., and collaborating each other.

1: Wakayama Space Project (WSP), Wakayama univ.

WSP is a student project which has two themes: hybrid-rocket and balloon-sat. This project isn't based on any laboratories and any departments, therefore any grade/department of students can join this project.

2: Institute for Education on Space (IfES), Wakayama univ.

The IfES staffs design and implement various educational programs though rocket and other space activities. They use three types of rockets: hybrid-rockets, model-rockets, and paper-rockets. The staffs started to make a hybrid-rocket in 2012/04. The main purpose is making curriculums that assist the students and stuffs to become dependable people. A model-rocket (type-H) is dedicated to "Can-sat koshien". This event gives an opportunity of space engineering to high school students. A paper-rocket, which is made by A4 papers and daily necessities, is easy to make even for elementary school student. So it is a good educational tool to learn a sense of safety and physics.

3: TOKAI - ROCKETEERS (TR)

The TR is a rocket team which consists of stuffs. The members have adequate experiences of rocket development. They can advise the WSP and the IfES members on technical matters.

These three-teams corporate each other on rocket-engine tests, rocket building, rocket launches, and any other experiments and measurements.

Rocket Activity in 2012 (History)

Date	Experiment	Team	Site
2012/04/05	Rocket-engine test	WSP	Wakayama univ.
2012/04/08	Paper-rocket launch	WSP,IfES	Kada
2012/04/15	Paper-rocket launch	WSP,IfES	Kada
2012/04/28	Rocket engine test	TR	Wakayama univ.
2012/05/01	Rocket engine test	WSP	Wakayama univ.
2012/05/19	Hybrid-rocket launch	IfES,WSP	Kada
2012/05/26	Paper-rocket launch	IfES	Kada
2012/05/27	Paper-rocket launch	IfES	Kada
2012/06/02	Rocket engine test	WSP	Wakayama univ.
2012/06/16	Model-rocket launch (H-type)	WSP,IfES	Kada
2012/06/17	Hybrid-rocket launch	WSP,IfES	Kada
	Hybrid-rocket launch	IfES,WSP	
	Model-rocket launch (H-type)	IfES,OEM	
	Octocopter flying test	IfES,OEM	

Rocket Activity in 2012 (Plan)

Note: We are planning to implement “Rocket engine test” and a “Hybrid-rocket launch” after 2012/08/06 but do not have a concrete plan yet.

Date	Experiment	Team	Site
2012/06/30	Rocket engine test	WSP	Wakayama univ.
2012/07/07	Hybrid-rocket launch	TR,WSP,IfES	Kada
2012/07/08	Hybrid-rocket launch	IfES,WSP	Kada
2012/07/15	Can-sat koshien	IfES	Kada
2012/08/03-05	Can-sat koshien	IfES	Kada
2012/08/06	Hybrid-rocket launch	IfES,WSP	Kada
2012/08/XX	Hybrid-rocket launch	WSP	Noshiro
2013/03/XX	Hybrid-rocket launch	WSP,IfES	Izu

【2】Achievements in Space Engineering Education through Rocket Activities (or Plan)

As official educational program in Wakayama University, there has been student rocket project for any grade of students for half a year. Also, in the second half term of this year, project management course by utilizing hybrid rocket will start, and this is also for any grade/department of students.

As unofficial ones, “rocket girls and boys” and “Can-sat koshien” for high school students, as mentioned above, has been organized by Wakayama University too. A paper-rocket seminars are held for elementary, junior high school students and their teachers.

【3】Papers

- ✧ Journal Publications
  - ▪
- ✧ Contributions (in Japanese)
  - ▪
- ✧ Books
  - ▪
- ✧ Dissertations
  - ▪
- ✧ Master's thesis
  - ▪
- ✧ Doctor’s thesis
  - ▪

【4】Recent overseas researchers who collaborated with us (for a short period)

n/a

【5】Important mention, if any

n/a

Other Important Universities

This is a list of Japanese universities that you may want to check their activities.

The information will be added into this report in the near future.

1	Kyushu Institute of Technology – Space Systems Laboratory
	http://www.mech.kyutech.ac.jp/yonemoto/index.html http://www.mech.kyutech.ac.jp/yonemoto-lab/
2	Tokyo Metropolitan University – Aerospace Engineering, Graduate School of System Design
	http://www.sd.tmu.ac.jp/en/graduate/aerospace.html

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