PETREL(Wide field UV Transient survey)

Yoichi YATSU@Tokyo Tech

Nobu KAWAI, Ryotaro NOTO, Asuka OHIRA, Hiroki HARA, Noriatsu NAKAMURA, Shun OGATA, Kaoru ASABA, (Tokyo Tech),
N. Tominaga(NAOJ), M. Tanaka(Tohoku Univ),
T. Morokuma(Univ Tokyo), N.Suzuki(IPMÚ), S.R.Kulkarni(Caltech)
on behalf of PETREL team.

4 years ago in Budapest...



We proposed a 6U cubesat for transient survery in UV sky. We had launched 2 satellites for technology demonstration.

Frontier: 0.1 day after explosion



Small telescopes still have advantages in flexible and quick observations

Target1: Shock breakout of Core Collapse SNe

- flash from shock heated photosphare
- $T \sim 10^5$ K => NUV ~ Soft-Xray





Time evolution of specturm

Tominaga+ (2009)

Goal: Investigation of the final 10 years of massive stars

Unraveling the mystery of mass loss activities just before supernova explosion.



We can investigate the mass loss activity of the last 10 years of massive stars from the lightcurves.

GW170817 was BLUE

The afterglow was BLUE in the very early phase!

GW170817

2017.08.18-19

2017.08.24-25



Utsumi+ 2017

We still do NOT know the mechanism/origin of this blue emission !!

Mission Requirements

Parameters	Value	Target	
Wave band	<mark>UV (< 300 nm)</mark>	SN/GW	
FoV	<mark>50 deg²</mark>	GW	
Survay Area	200 deg ²	SN	
Sensitivity(magAB)	19 magAB/orbit	SN(dim win)	
	20 magAB/day	SN(dens win)	
	<mark>20 magAB/hr</mark>	GW	Markey .
Cadence	<mark>1 hour</mark>	SN	High Hanging Fruit
Data Downlink	Alert: within 1 hour	SN/GW	- Martin Contra
	Image: within a day		Our target Low Hanging Fruit

Mission Concept: Wide and Shallow

Comparison of FoVs

UVT/PETREL can cover the FoV of ZTF



Sky coverage



Expected Event rates

Targets	Event rate			
Core Collapse Supernovae				
-Shock Breakout@Surface	1 evt/yr(0.1d exp×200deg² within 100 Mpc)			
-Shock Breakout@Wind	12 evt/yr(1d exp×200deg² within 200 Mpc)			
GW events (NS-NS)				
-Assuming GW170817	0.4-16 evt/yr (1mag dimmer than the model)			
-Without UV from Jet	0.1-4 evt/yr(2mag dimmer than the model)			

- Intensive surveys for the nearby galaxies of LMC/M31 will be conducted.
- In addition, type-Ia SNe, novae, stellar flares, tidal disruption events, etc will be detected.
- we will carry out coordinated observation with ZTF, GROWTH, Tomo-e Gozen, OISTER.

Detector

Current Design: COTS BI-CMOS

- \succ 11um pitch 2k x 2k
- Bit depth: 12 bit \geq
- Readout noise ~2e RMS \geq
- Low cost \$5,000/sensor!!! \geq







Optical Blined UV filter

- Asahi Spectrum corp. designed a 14 layers of HfO₂ filter for this mission.
- Can suppress redleak < 1/5000 \geq in 300-1000nm





67 76

PETEL UV band



Optical design



Mechanical/Thermal Design



UV Telescope Assy (Flight model)

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Radiator

Satellite System

UV MECH:UV-TELの展開カバー

Xsc

Specification of the satellite



Development

Environmental Tests are undergoing.



Fit check

Electrical integration test

Thermal Vacuum Test

Me

Prototype: HIBARI for technology demonstration

◆ Launched in Nov. 2021

◆ Key technologies have been demonstrated in orbit.



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Key1: Attitude Sensor(Star Tracker)

• We devloped a Star-tracker for this mission.

 \bullet ±5.7 arcs @ 3sigma (The Top-level accuracy in the world in this class.)



"Hibari"

Attitude stability of the satellite depneds on this device.

Key2: Transtmittor for Realtime communication

- Utilizing Globalstar network
- Almost anywhere/anytime



We can send detection alerts within a few min from trigger from anywhere.

Summary

- PETREL: a multi-purpose satellite developed by an academic-industrial alliance
 - Night-time mission: UV Astronomy
 - > Day-time mission: Spectral imaging of Earth
- ◆ 8cm refractor with BI-CMOS => 20 magAB@250~300nm for 1800 s exposure
- FoV=50deg², 100 deg²/orbit => 3500 deg² survey/year

Schedule

- > June-2021: Preliminary Design Review
- > Dec-2021: Critical Design Review
- > Oct-2022: delta-CDR
- > 4Q-2022: Final Integration/Environmental Tests
- ➢ 2Q-2023: Shipping
- > 3Q-2023: Launch

Petrel2 for Gamma and UV will be launched in 2026



Paper craft model MONITORING THE HIGH-ENERGY SKY WITH SMALL SATELLITES 2022

Coverage of PETREL a day



Configuration design

Component Layout (1/2)





BULK +X

Configuration design

Component Layout (2/2)

SIDE -X





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Project Members

