HinOTORI: Hiroshima 50cm telescope project in Tibet area

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HinOTORI (火の鳥 phoenix)

(Hiroshima University Operating Tibet Optical Robotic Imager)

- A new robotic telescope with a 3-color camera in Tibet.
- A part of the coordinated project: "New development in astrophysics through multi-messenger observations of gravitational wave sources"
- The main purpose
  - Reveal activities of transient objects including super novae, GRBs, GW counterpart, etc. as a part of a world wide continuous observation network.
  - A path finder for future large astronomical facilities in Tibet area

http://home.hiroshima-u.ac.jp/~youtsumi/Tibet/

The Ministry of Education, Culture, Sports, Science and Technology(MEXT)
Grant-in-Aid for Scientific Research on Innovative Areas

[Japanese] [English]
科研費 KAKENHI

重力波天体の多様な観測による宇宙物理学の新展開

New development in astrophysics through multimessenger observations of gravitational wave sources

2012 - 2016

PI : Takashi Nakamura (Kyoto Univ.)
CoPI: Nobuyuki Kanda (Osaka City Univ.)

Notice

Annual Symposium 2012 Fiscal Year
date : March 1st-2nd, 2013
site : Osaka City University
Symposium wiki (circular, program, registration)

About the Project

- Overview of the Project
- Organization (Figure of the Idea)

Sub-Projects
Research Projects

- A01「重力波天体からのX線・γ線放射の探索」
- A02「天体重力波の光学赤外線対応現象の探索」
- A03 "New Developments in Astrophysics Through Multi-Messenger Observations of Gravitational Wave Sources: Neutrinos"
- A04 "Research on Data Analysis of Gravitational Wave Searches Link up with Various Observations"
- A05「重力波天体の多様な観測に向けた理論的研究」

総括班

- X00「重力波天体の多様な観測による宇宙物理学の新展開の総括的研究」

Next generation, advanced gravitational wave detectors will come soon !

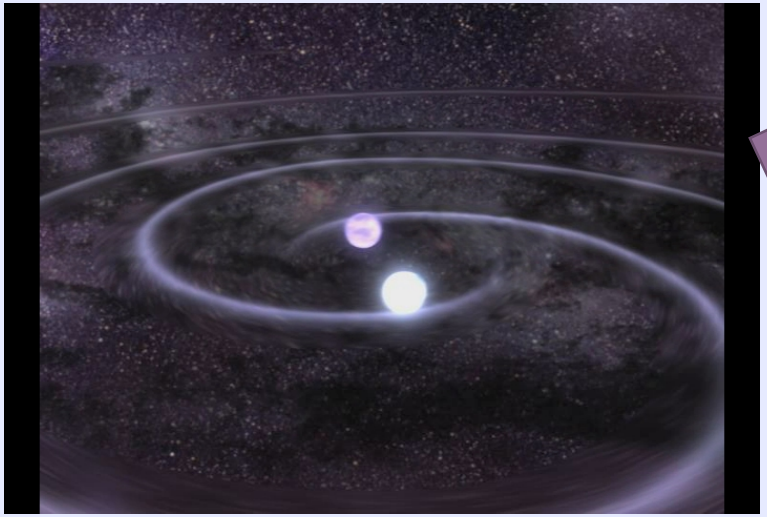
LIGO: Hanford, WA (米国)

LIGO: Livingston, LA (米国)

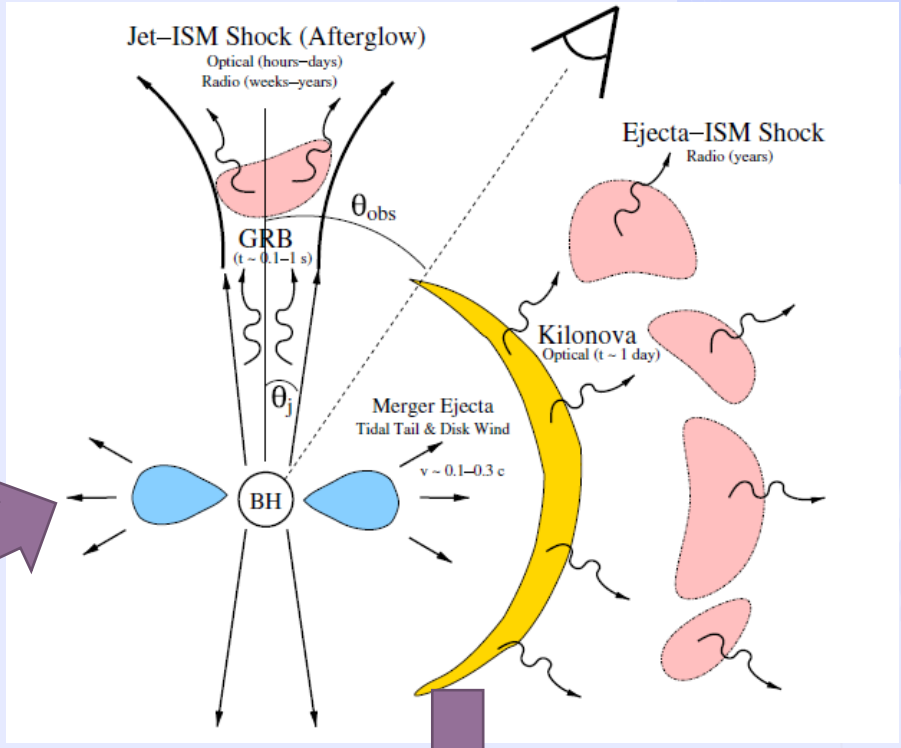
レーザー干渉計

GW sources by the distance of 200 Mpc are expected to be detected!

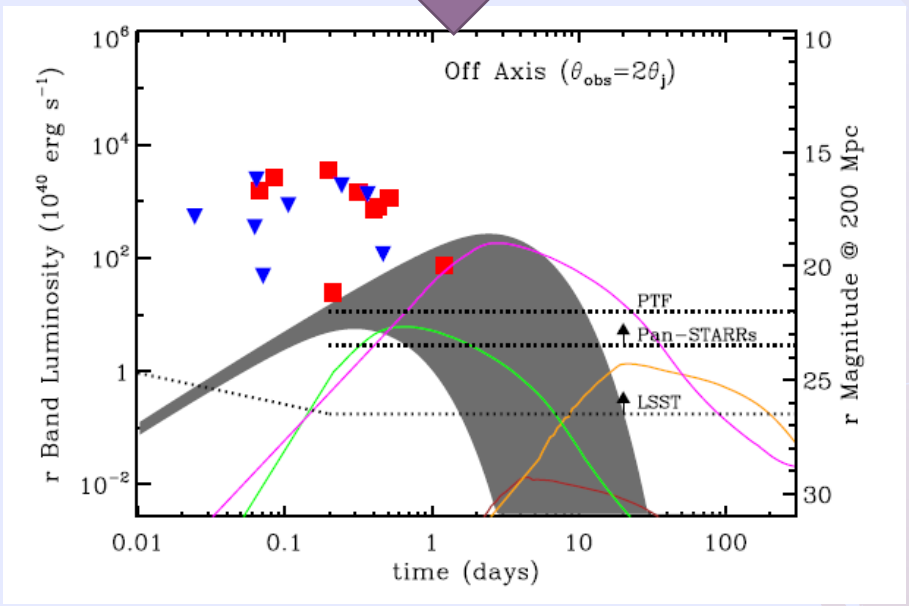
Searching for EM counter part is crucial for understanding the nature of GW sources



The most promising GW sources ➔ NS-NS merger

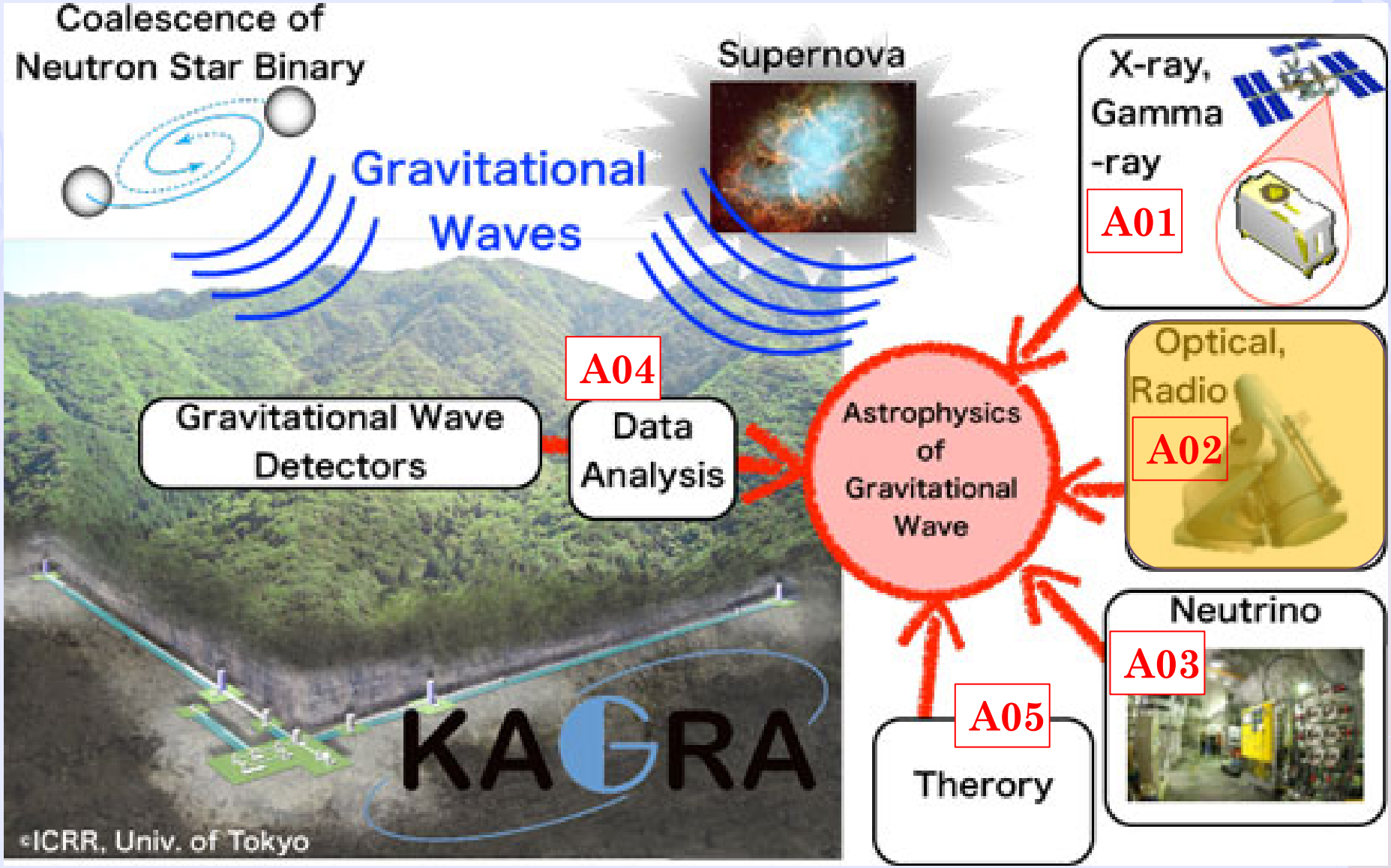


Metzger & Berger 2012



Remember the talk by Dr. Hyung Mok Lee yesterday

Overview of the project



Goals of the sub-project A02

PI: M.Yoshida

- Develop an optical-infrared-radio observation network for GW transient follow-up
  1. Kiso 6x6 deg^2 Camera (optical imager)
  2. OAO-WFC (wide-field infrared camera)
  3. IFU for the spectrograph of 3.8m telescope
  4. 50cm robotic telescope in Tibet (HinOTORI)
  5. Establish a transient observation network by utilizing existing facilities: Mini-TAO, IRSF, Kanata, Yamaguchi 32m radio tel., etc.

Japan Coordinated network for transients observation

A part of the project "Multi-messenger Observations of GW sources"
* collaborating with the KAGRA data analysis team
* science cases: GRBs, supernovae, blazars, etc.

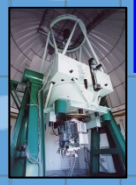
Main features:
5 deg^2 opt. imaging w/ 1m
1 deg^2 NIR imaging w/ 1m
opt-NIR spectroscopy w/ 1–8m
opt-NIR polarimetry

- 1m Kiso Schmidt telescope
  5 deg^2 camera ➔ 30 deg^2
- 1.5m Kanata telescope
- 50cm MITSuME
- 91cm W-F NIR camera of NAOJ
  1 deg^2 NIR camera
- Yamaguchi 32m radio telescope

50cm telescope
(Hiroshima Univ.
2014)

3.8m telescope
(Kyoto Univ.
2015)

Subaru @Hawaii



IRSF (Nagoya Univ.)
@ South Africa

miniTAO (Tokyo Univ.)
@ Chile

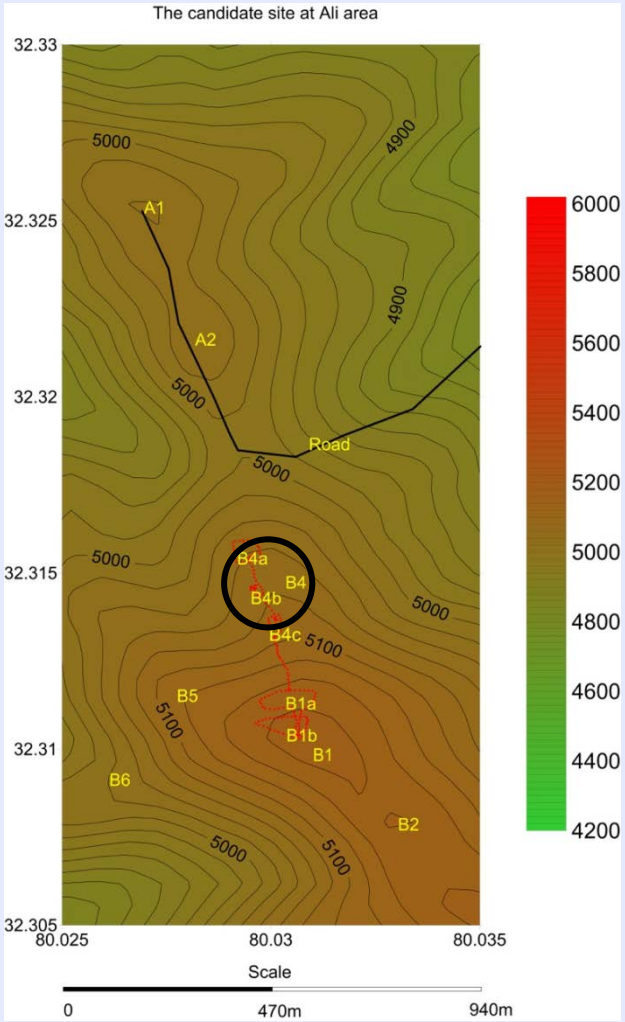
HinOTORI project

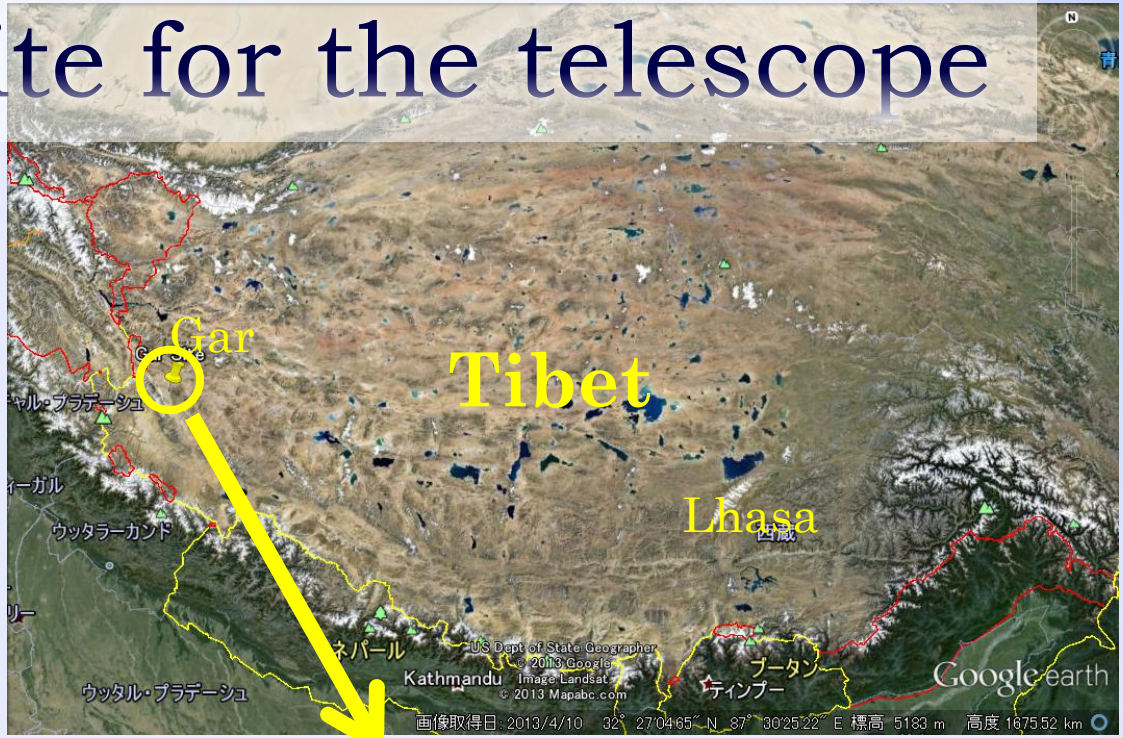
- Development of a 50cm robotic telescope + 3-color camera system
  - ➔ West China (Tibet area)

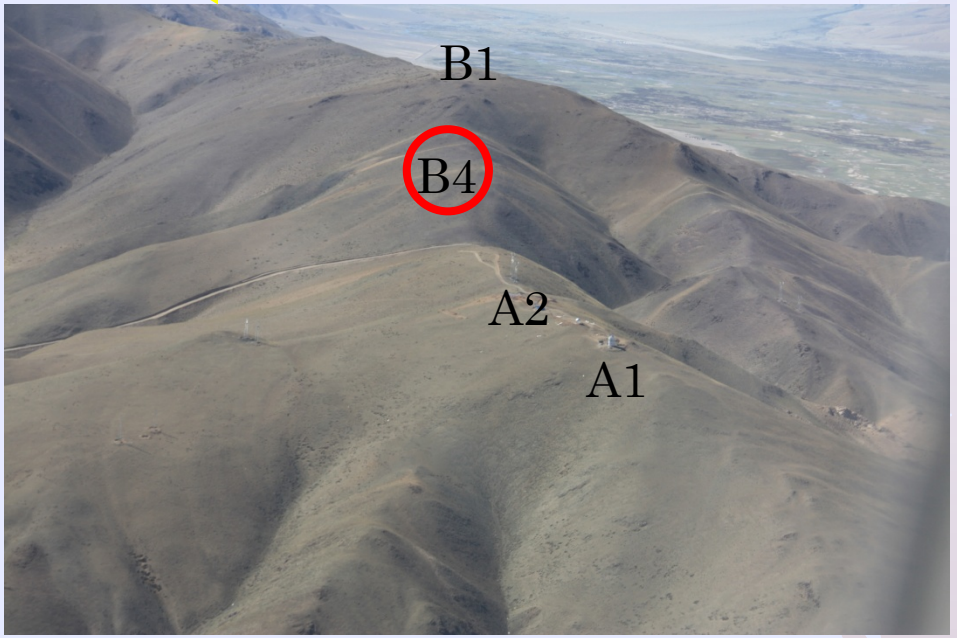
- Expected limiting mag. (S/N=5 for 10 min exp.)
  - 18.5 mag. u'-band
  - 21.1 mag. R_c-band
  - 20.8 mag. I_c-band

Candidate site for the telescope

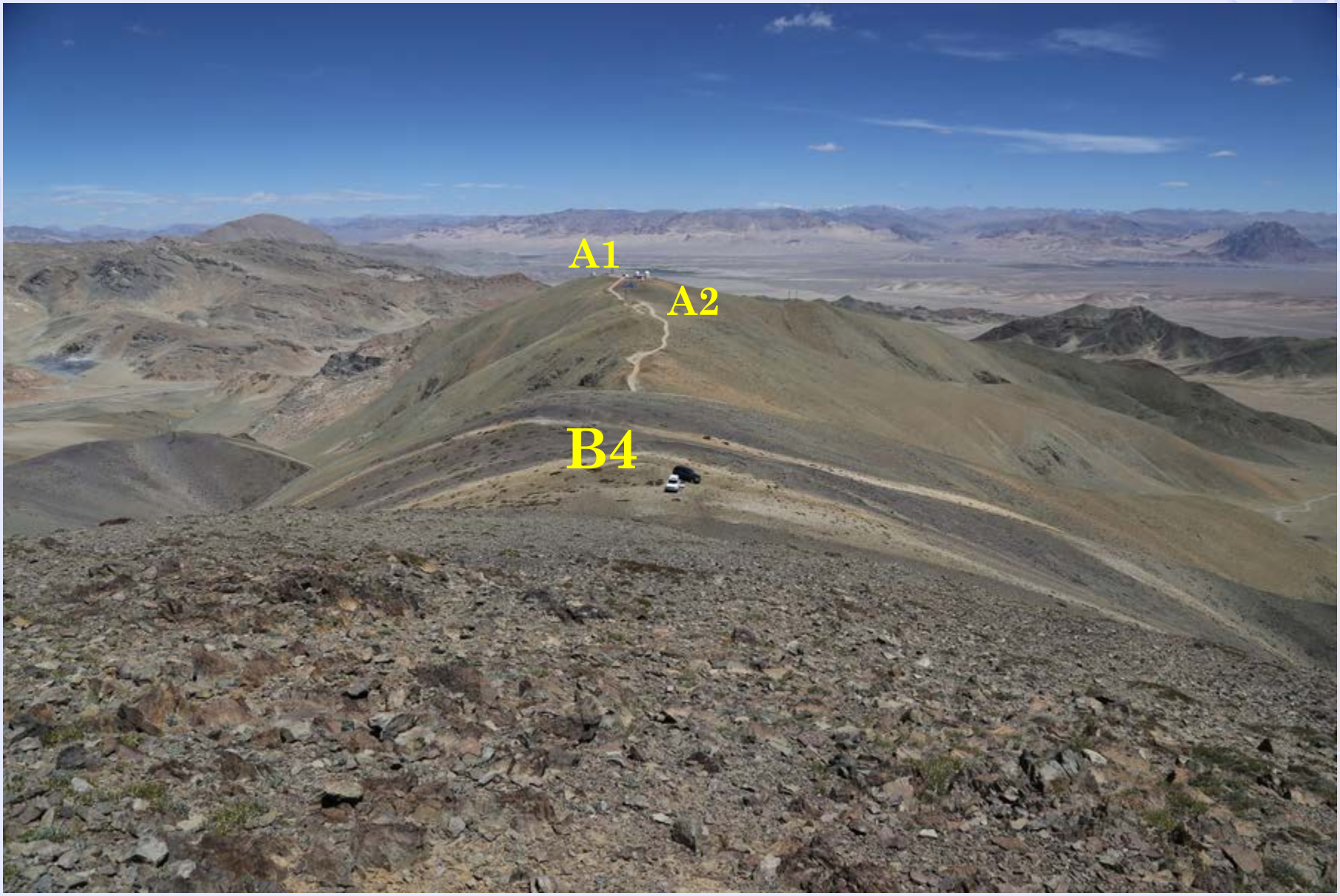
West end of Tibet:
～60 degree west from Japan
altitude: 5000m







Views of A1, A2 and B4 from B1

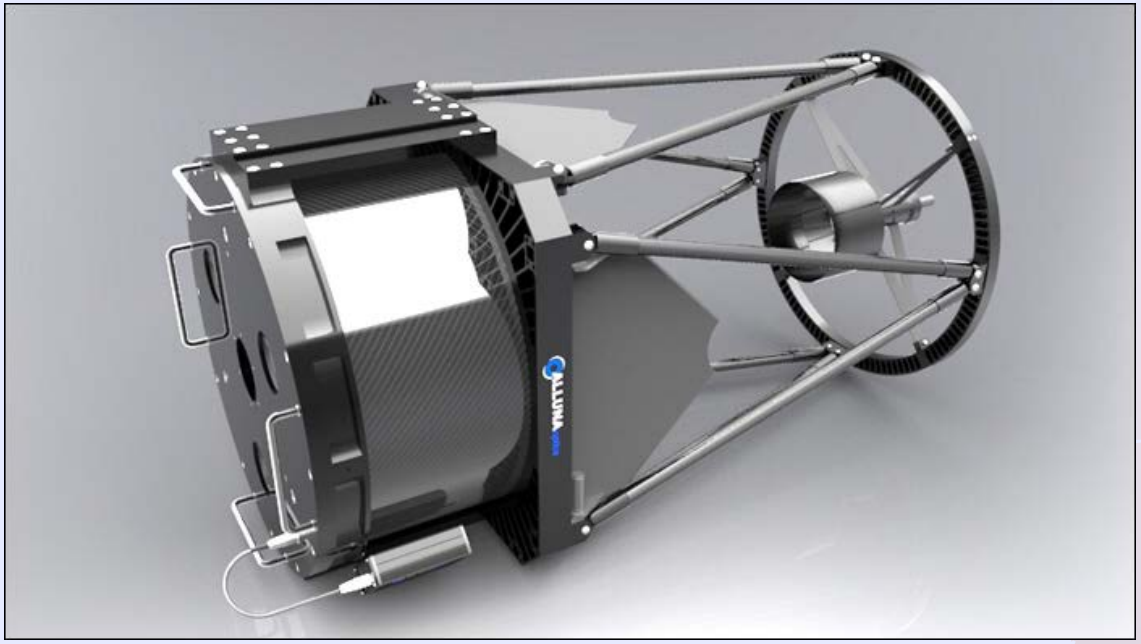


Environment	
Latitude	32.31373N
Longitude	80.030018E
Altitude	5130m
Telescope	
Type of telescope	Pure Ritchey-Chretien system
Diameter of the primary	510mm
F-ratio of the primary	3
Total focal length	4080mm (F/8)
Backfocus	460mm
Usable backfocus	360mm

Mount	
Tracking accuracy	0.3arcsec rms @ open loop for 10min.
Pointing accuracy	< 3arcmin
Maximum slewing speed	2 degrees/sec
Instrument	
Field of view	24 x 24 $arcmin^2$
Pixel size	13.5um
Pixel scale	0.7arcsec
Available bands	*u*', *R*c, *I*c
Optical elements	Fused silica

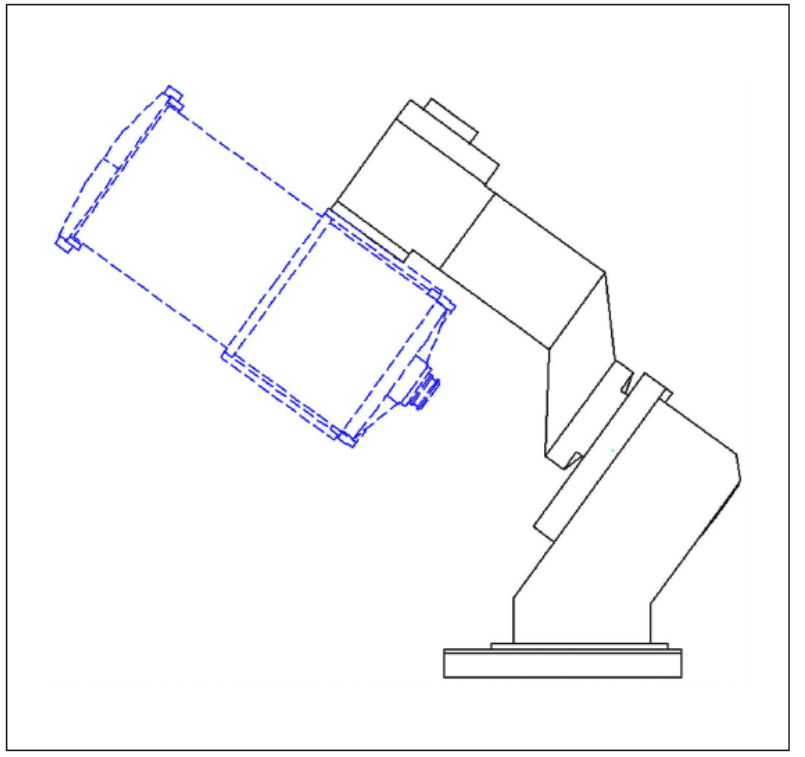
Telescope

Alluna 50cm telescope
(Germany: commercial product)

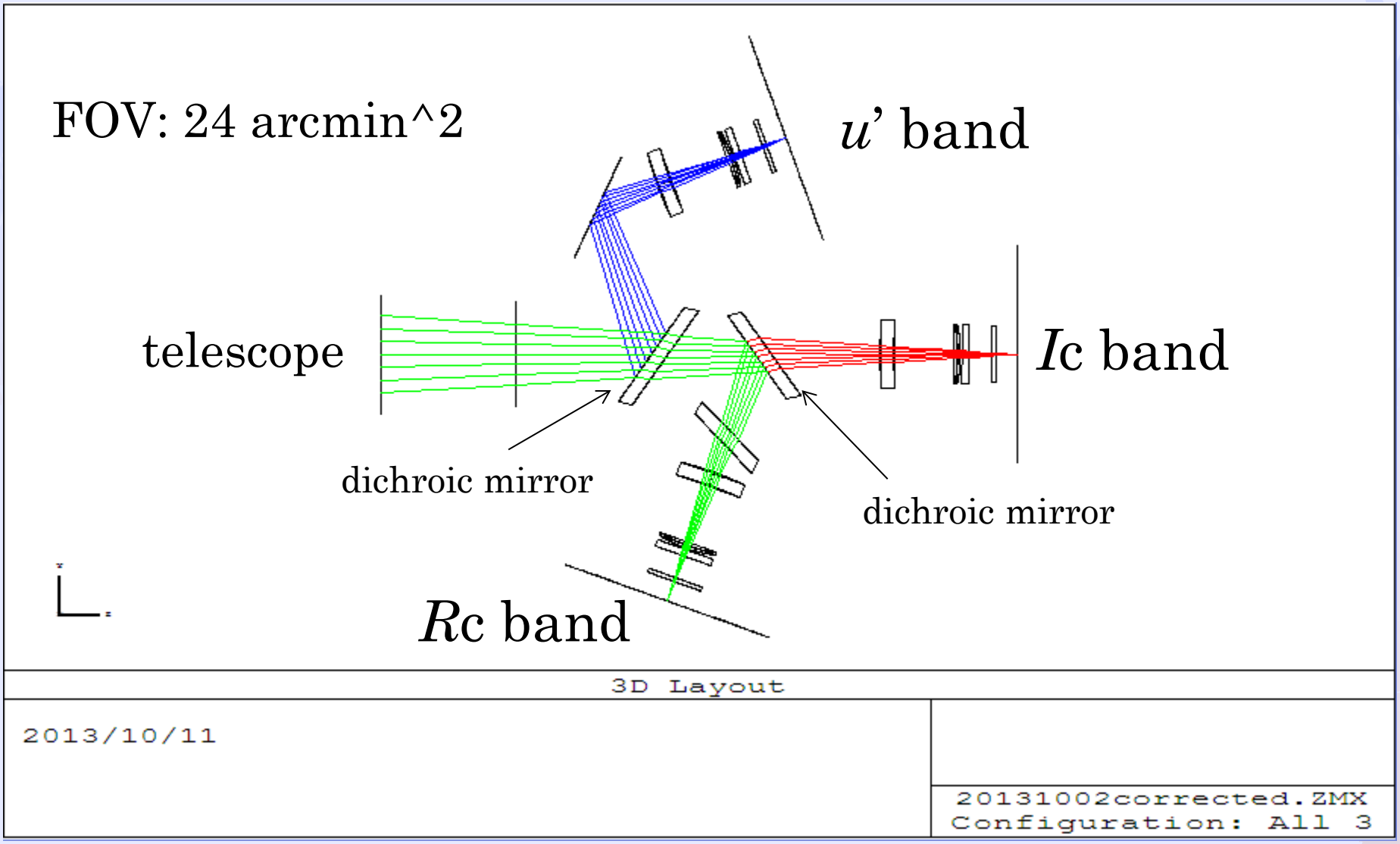


Telescope Mount

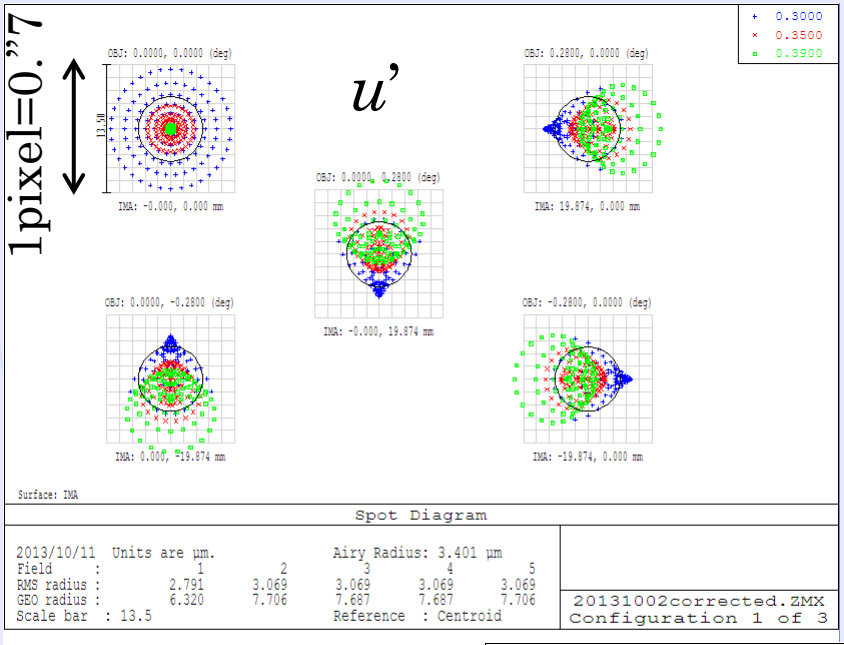
Showa Kikai Co.
SHOWA 60EL
pointing speed: 3deg/sec
pointing accuracy: 3 arcmin
resolution: 0.1 arcsec
weight: 1.2 tons

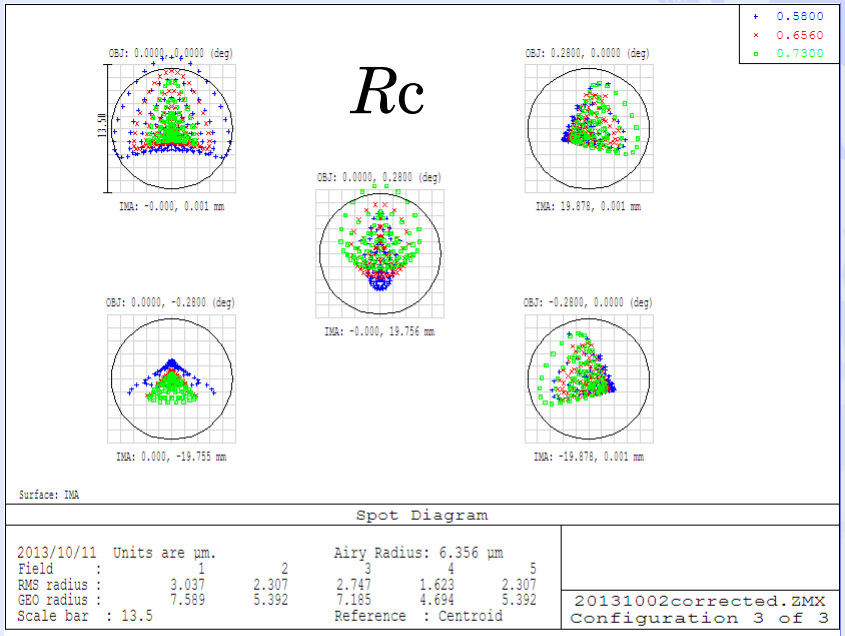


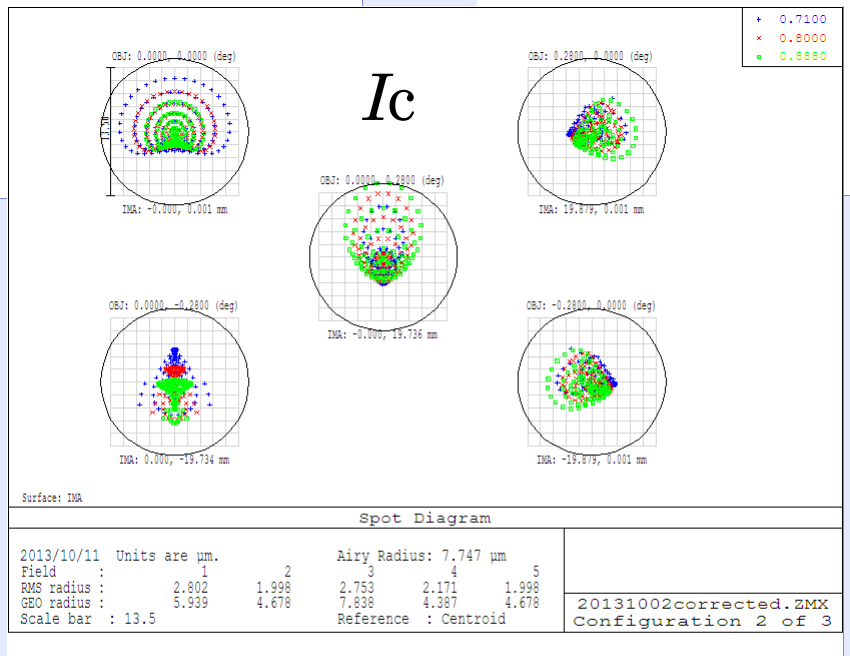
Optical Layout of the 3-color camera



Spot diagrams for *u'*, *R*c and *I*c bands



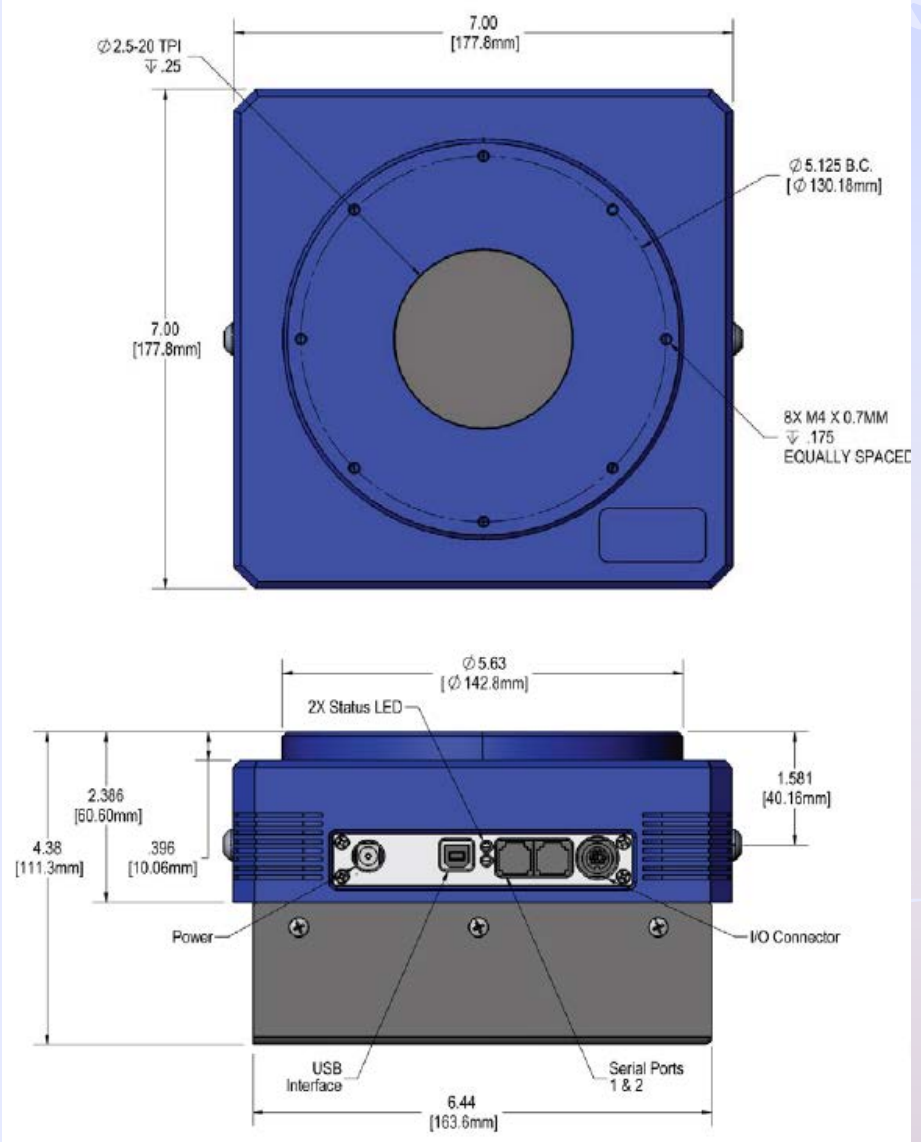




CCD camera

Apogee ALTA U42

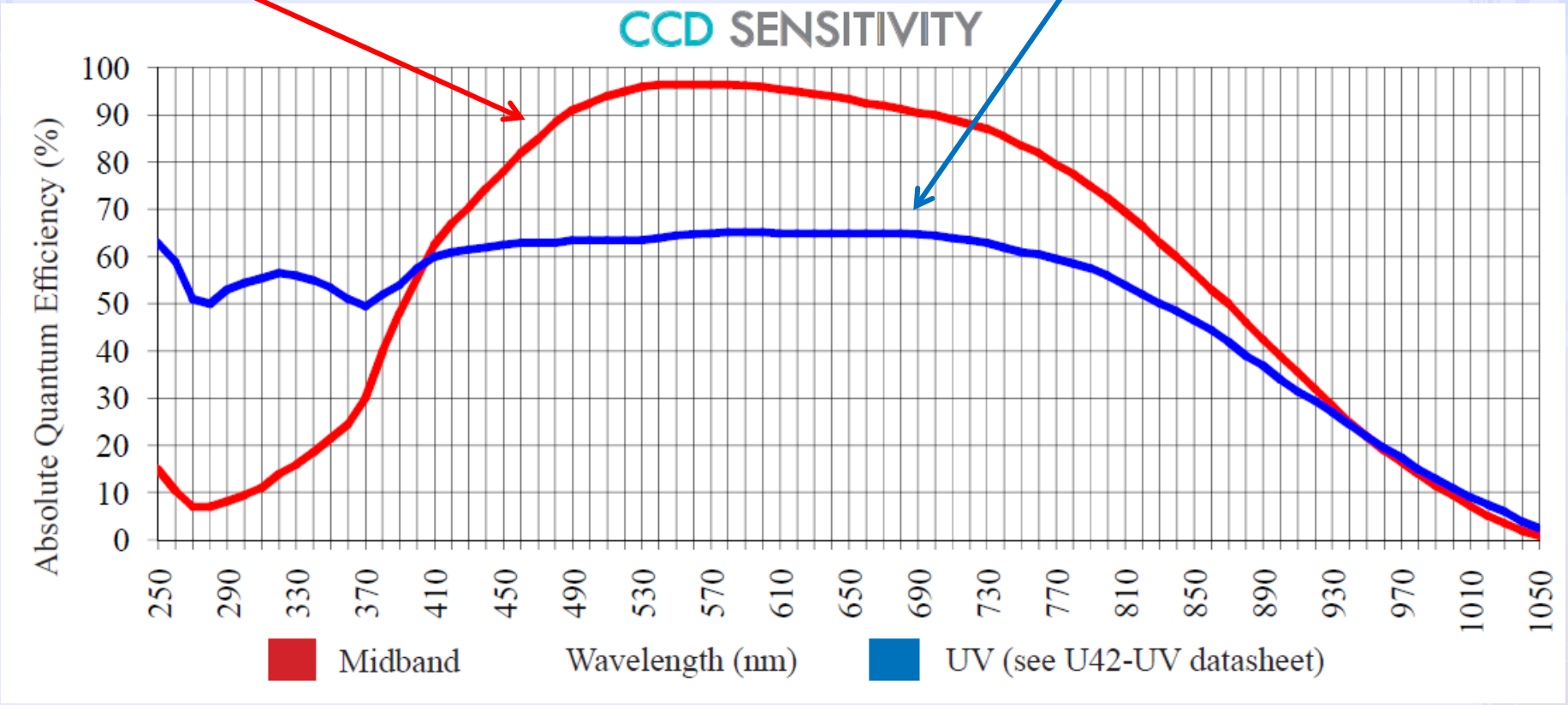
CCD chip	E2V CCD42-40
Array Size	2048 x 2048 pix
Pixel Size	13.5 microns
Imaging Area	27.6 x 27.6 mm
Full Well	100K electrons
QE at 400 nm	75%
Peak QE	>90%
Dark Current	<0.3 e/pix/s (-45℃)
Cooling	60 – 65℃ below ambient



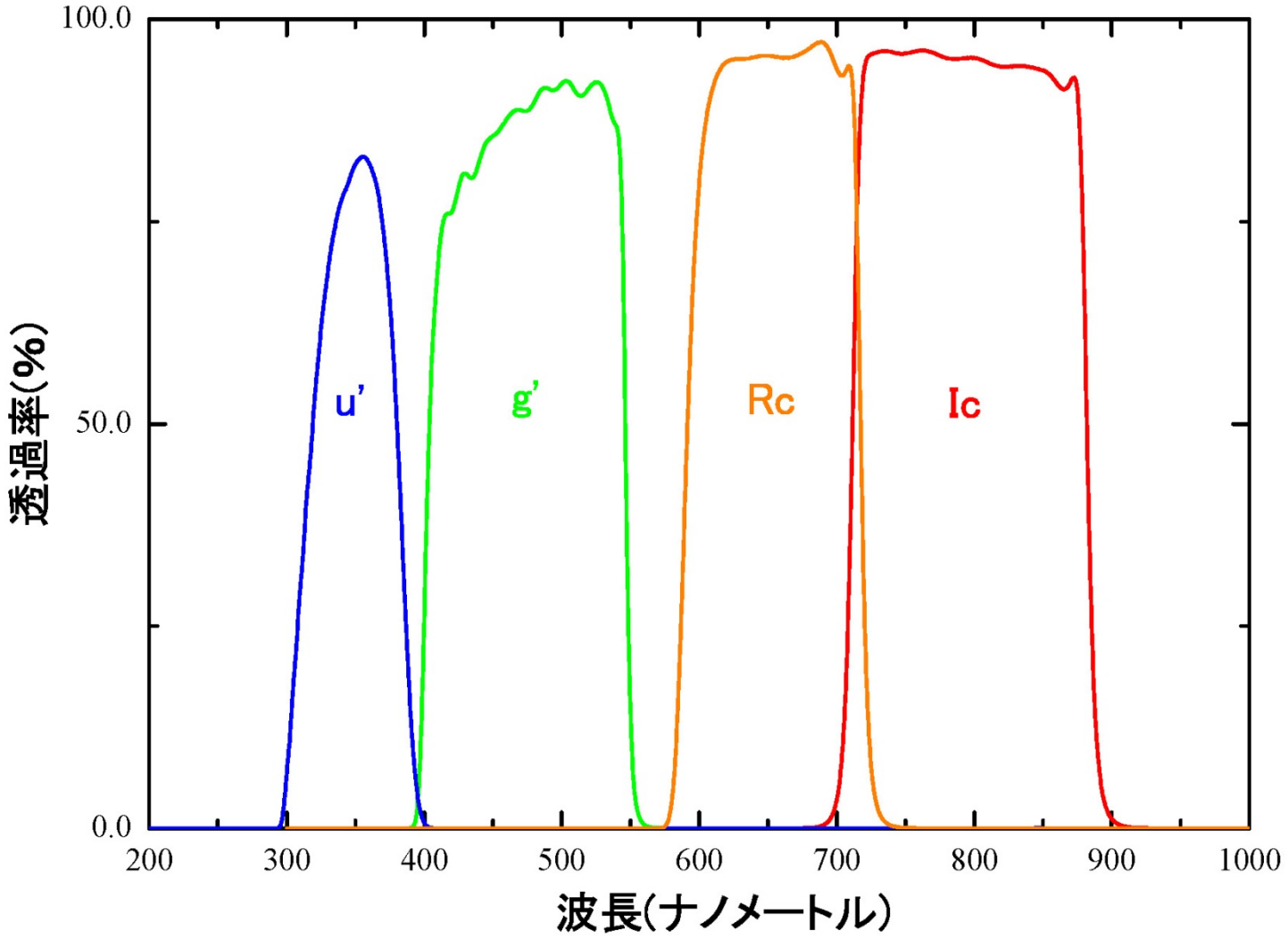
QE of the CCD

Red curve: for *R*c and *I*c bands

Blue curve: for *u*' band



Filters


100.0
50.0
0.0
透過率(%)
u'
g'
Rc
Ic
200
300
400
500
600
700
800
900
1000
波長(ナノメートル)

Operation

- Fully robotic operation
  - Heritage of MITSuME project will be used.

MITSuME @ OAO

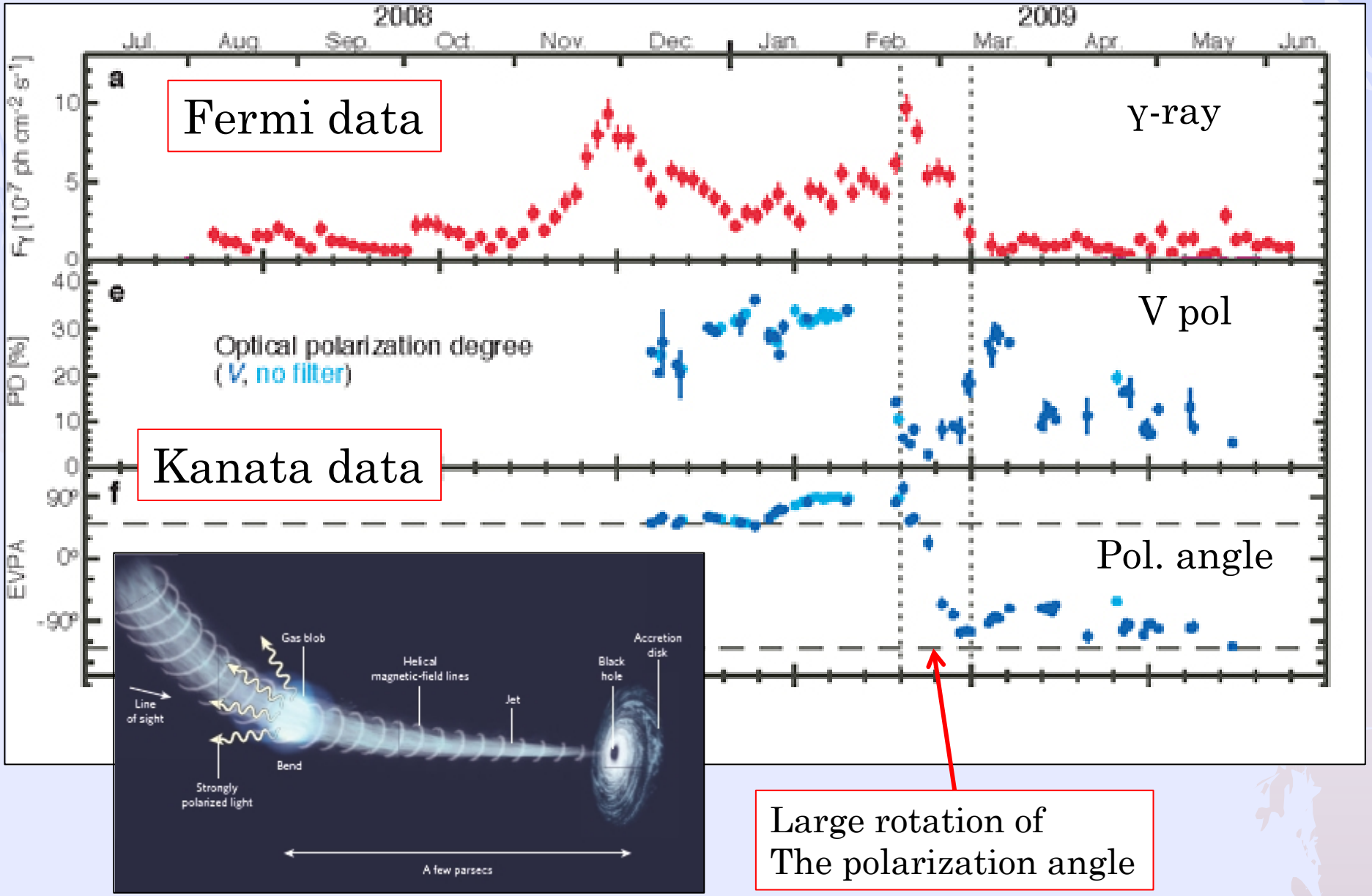
Science Cases

- Prompt follow-up of GRBs、GW transients
  - triggered by GCN, LIGO/Virgo collaboration
- Prompt follow-up of supernovae in
  - UV light curves of shock breakout of Type II SN
- Short- and long-term monitoring of AGNs
  - coordinated with Katana telescope and high-energy satellites (Fermi, Suzaku, and Astro-H)

u band capability is unique and important for transient observations

Multi-wavelength observations of the blazar 3C279

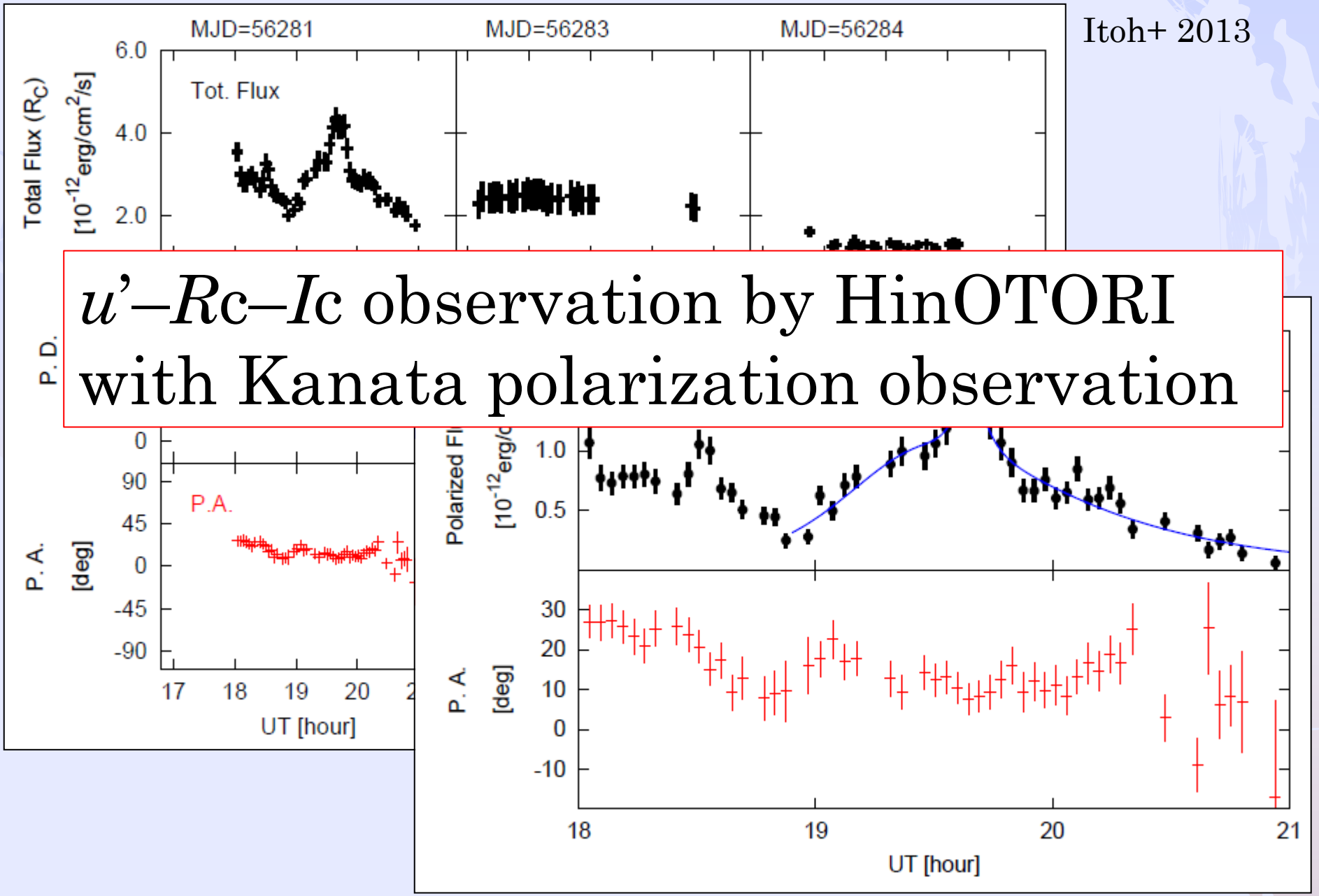
Abdo+ 2009



Large rotation of
The polarization angle

Short term variability of NL-Sy1 PMN J0948+0022

Itoh+ 2013



u'–*Rc*–*Ic* observation by HinOTORI with Kanata polarization observation

Summary

- HinOTORI project – A 50cm robotic telescope with 3-color (*u*'-*R*c-*I*c) camera
- Location: west end of Tibet alt: 5100m
- Transient objects observations:
  - GRBs, GW transients
  - Supernovae
  - AGNs (blazars)
- A path finder for future large telescopes in Tibet area
- Telescope will be installed in 2014. The regular operation will be started in 2015.