Introduction of Hiroshima Astrophysical Science Center (HASC) and Possible Early Science in Ali

Michitoshi Yoshida

Director, HASC, Hiroshima University

Hiroshima Astrophysical Science Center

- Founded in 2004 April
- Higashi-Hiroshima Observatory and the 1.5m optical – infrared telescope (Kanata)
- Mission:
  - Observation of Targets of Opportunity (ToO) in collaboration with high-energy astronomical satellites (Fermi gamma-ray satellite, Suzaku X-ray satellite)
  - Reveal high-energy, dynamic activity in the universe
- Main targets:
  - Gamma-ray bursts, Supernovae, Novae, Cataclysmic variables, X-ray binaries, blazars, etc.

Staff Members of HASC

- Michitoshi YOSHIDA Director, Professor
- Koji KAWABATA Associate Professor
- Makoto UEMURA Associate Professor
- Hiroshi Akitaya Assistant Professor
- Tsunefumi Mizuno Associate Professor
- Hiromitsu TAKAHASHI Assistant Professor
- Takashi OHSUGI Professor (the former director)

Blue: optical – infrared (Kanata)

Orange: high energy (Fermi)

Green: high energy – optical –infrared (Kanata and Fermi)

Post-Docs and Graduate Students

• Masayuki YAMANAKA (PD)	Supernovae
• Mahito SASADA (PD)	Blazars
• Takeshi UEHARA (D3)	GRBs
• Kiyoshi SAKIMOTO (D2)	Instrumentation
• Ryosuke ITOH (D1)	Blazars
• Tetsuya HARAO (M2)	Instrumentation
• Takako OKUSHIMA (M2)	Suparnovae
• Hisayuki Sato (M1)	Nova
• Takahiro Ui (M1)	YSO

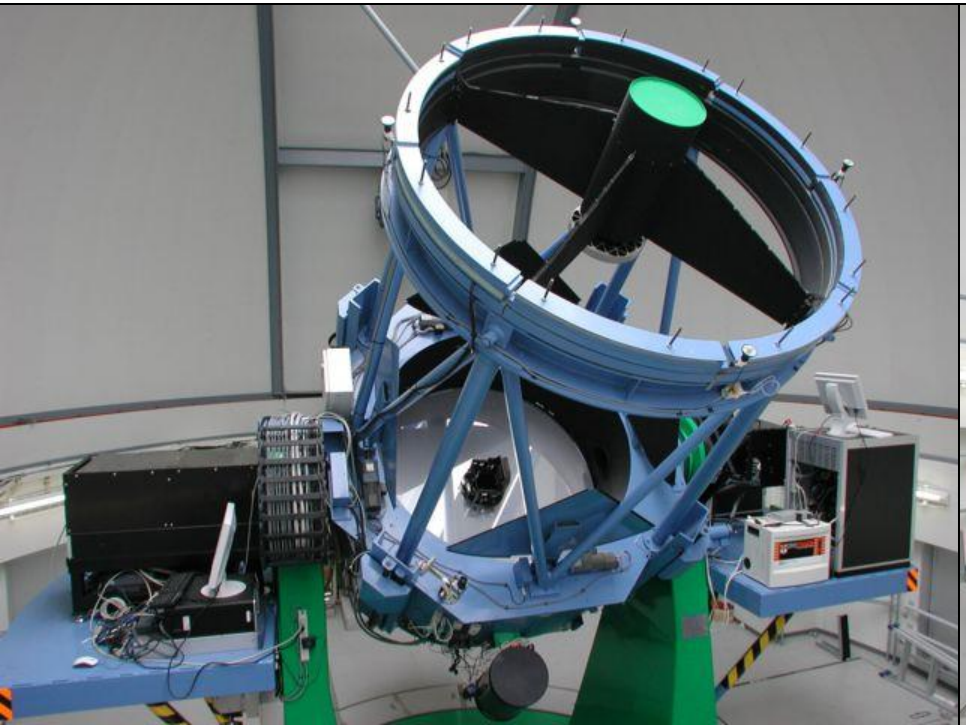
Kanata Telescope

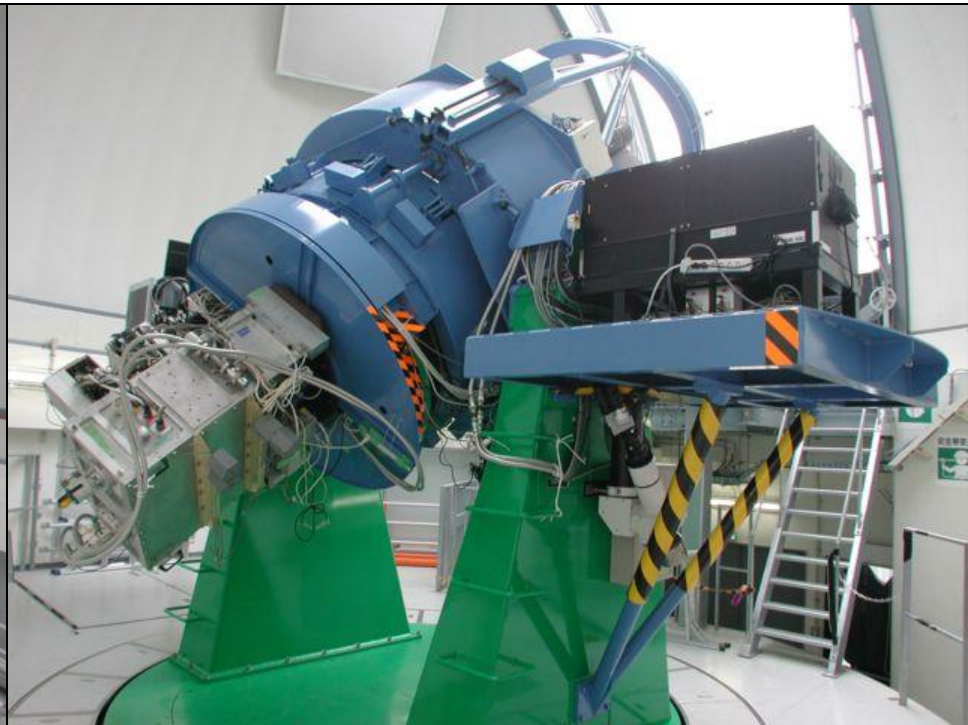
Diameter: 1.5m

Ritchy – Cretien F/12

Foci: Cassegrain, 2 Nasmyths

Originally constructed by Mitsubishi Electric Co. in 1996 for an instrumentation test bench of Subaru Telescope



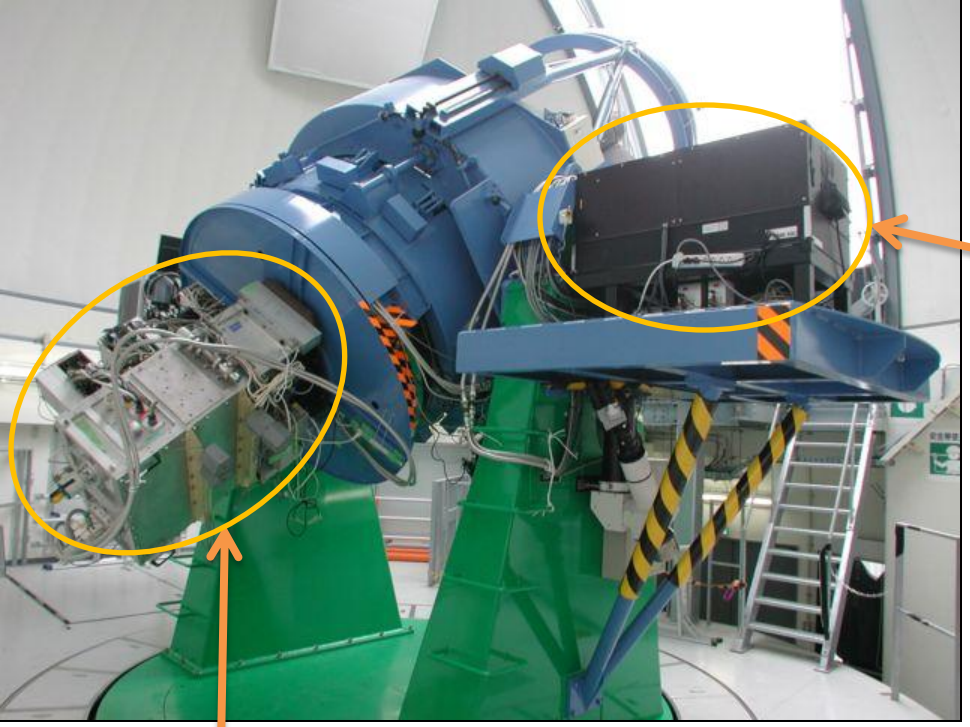


Katana Dome

Enclosure diameter: 9m
Height: 12m
Location: Fukujyo-ji, Higashi-hiroshima

Kanata Instruments

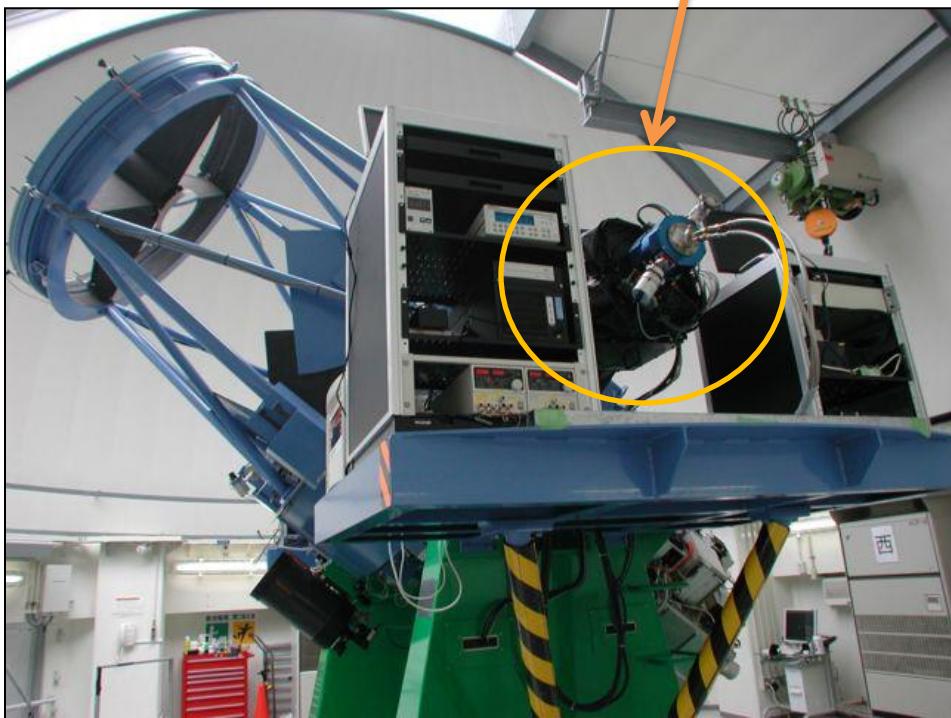
- **TRISPEC**
  - Simultaneous Optical and NIR Imager, Spectrograph, and Polarimeter
  - Imaging and spectroscopy in optical 1 band + NIR 2 bands simultaneously
  - FOV : 7’ x 7’; R = 140 - 360
  - developed by Nagoya University
  - photometry and polarimetry of blazars, cataclysmic variables
- **HOWPol**
  - Optical wide-field polarimeter/imager/spectrograph
  - One-shot polarimetry capability, low-resolution spectroscopy
  - FOV: 15’ x 15’; R = 610, 2300
  - photometry and spectroscopy of supernovae, novae
  - polarimetry of GRBs
- **High-Speed Camera and Spectrograph**
  - Optical imager/spectrograph with high-speed readout CCD
  - High speed imaging (min. exp. time = 30 msec) capability
  - FOV: 4’ x 4’; R = 20, 150
  - developed by Kyoto University
  - high-speed photometry of cataclysmic variables, novae



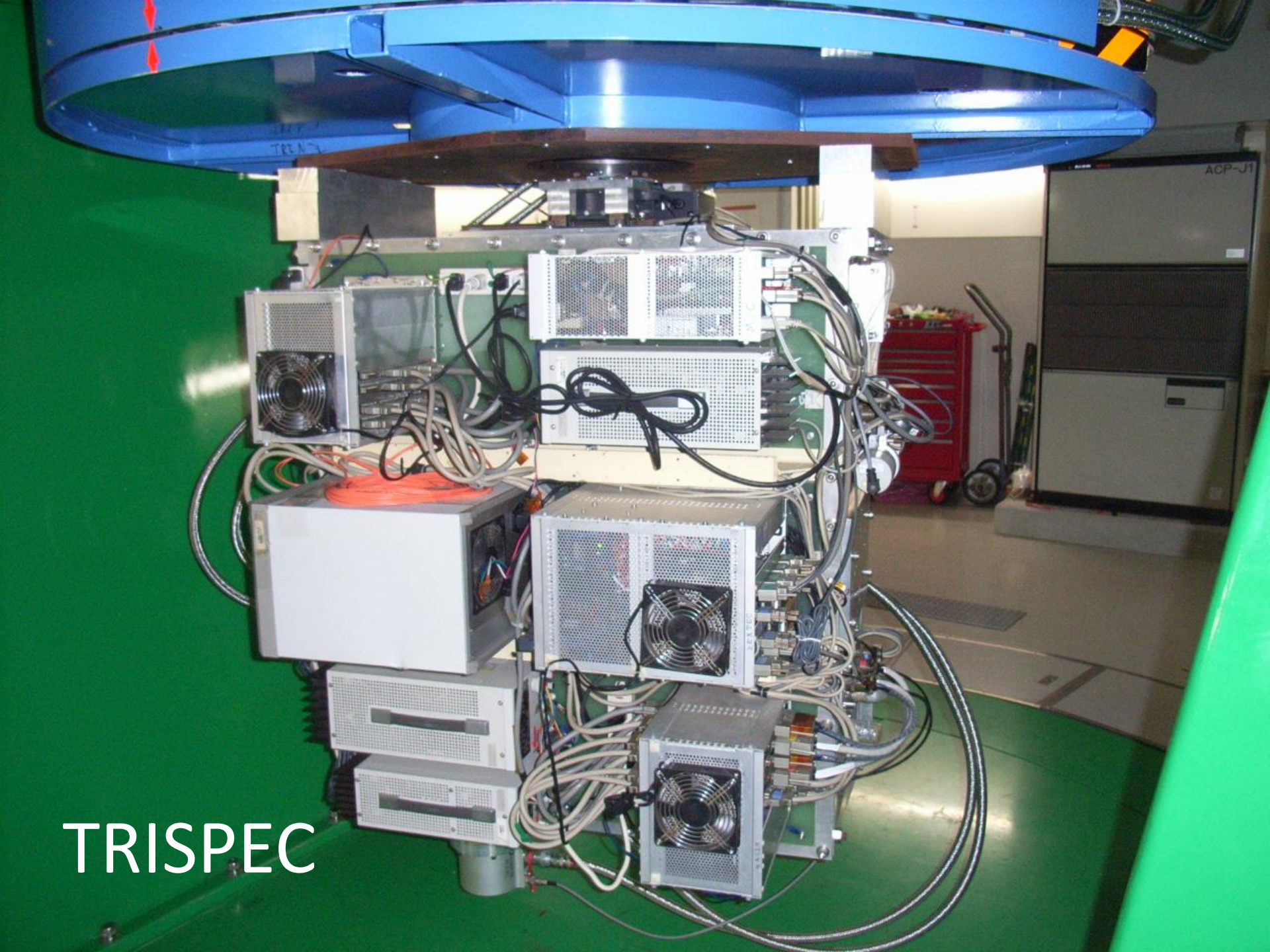
High-Speed Camera
and Spectrograph

HOWPol

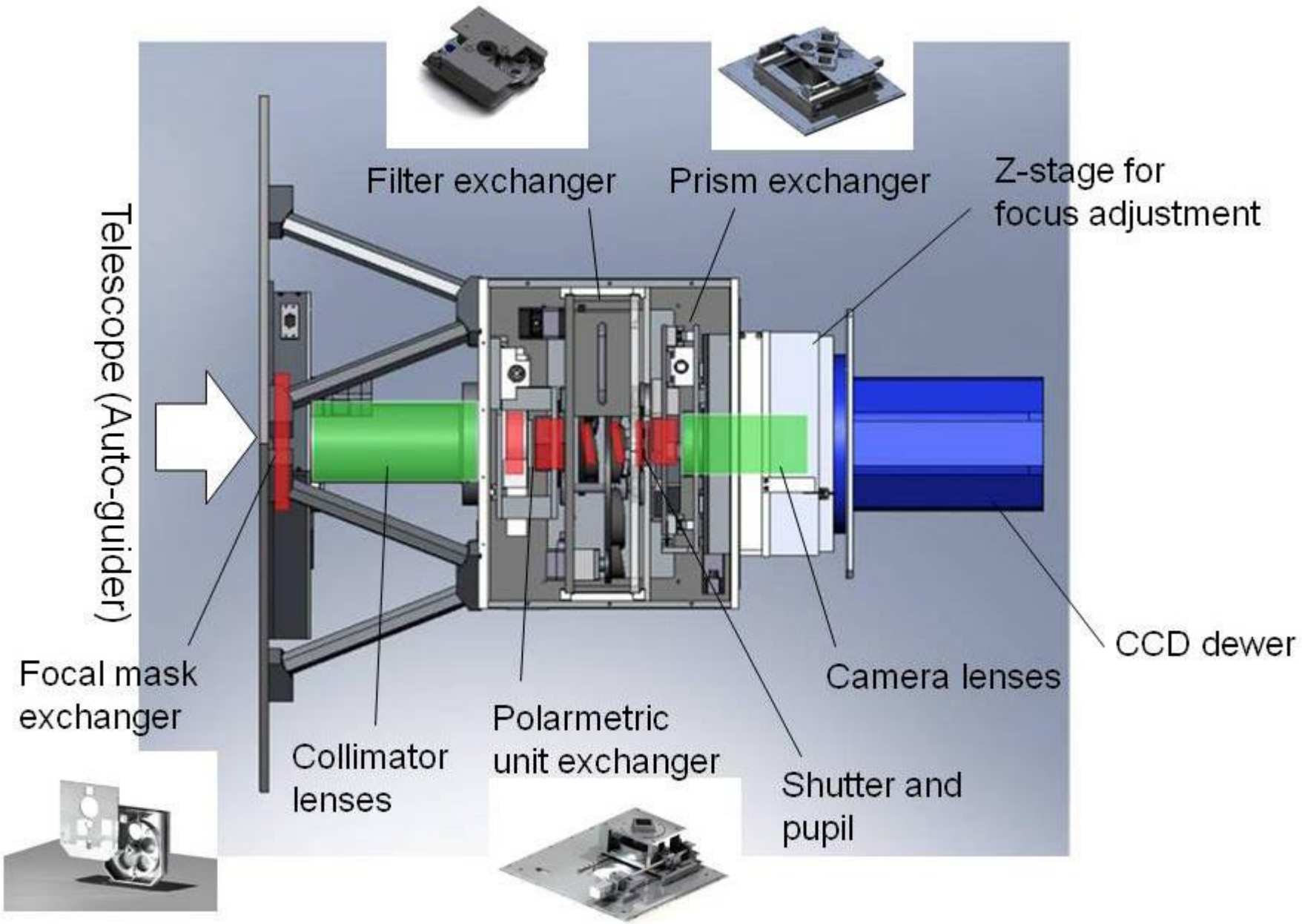
TRISPEC



All the instruments are attached to the telescope permamently

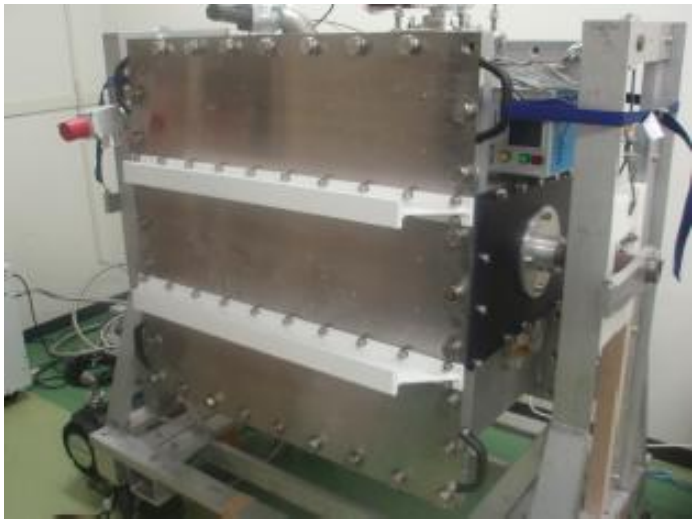

TRISPEC

HOWPol


Filter exchanger
Prism exchanger
Z-stage for
focus adjustment
Telescope (Auto-guider)
Focal mask
exchanger
Collimator
lenses
Polarmetric
unit exchanger
Shutter and
pupil
Camera lenses
CCD dewer

New Development

- HONIR (Hiroshima Optical Near-InfraRed camera)
  - Simultaneous Optical and NIR Imager, Spectrograph, and Polarimeter
  - Successor of TRISPEC
  - Wide FoV: 10’ x 10’ (TRISPEC: 7’x7’)
  - Good spatial sampling: 0.29”/pix
    (TRISPEC: 1.65”/pix)
  - High efficiency: limiting mag.(*) > 18.0@J-band
    (TRISPEC: 16.8@J-band)



*(S/N=10 for 10 min exposure)

HONIR is now being tested

GRBs, SNe, Novae, BH binary etc.

Fermi satellite

Suzaku satellite

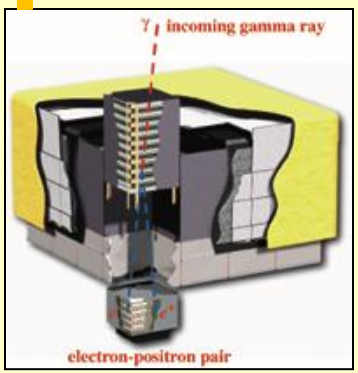
development

prompt observation

regular monitoring

optical & near-IR imaging/sp./polarimetry

operation collaboration development



gamma-ray detector: LAT

operation collaboration

Kanata telescope

High energy astrophysics group

Hiroshima Astrophysical Science Center (HASC)

Hiroshima University

Recent Science Results

- Early spectroscopy of a newly found gamma-ray Nova
- Statistical study of blazar optical polarization (the largest sample of blazar polarization in the world)
- Multi-wavelength study of blazar flares
- Multi-wavelength study of gamma-ray bursts afterglows

Targets of Opportunity Observation in Ali Site

What we can do

- Deep imaging
  - no hope without very wide (> 1degree) FOV and a large telescope
- High transparency for U, B, and NIR bands, low background for I and z bands are expected.
  - blue color imaging or infrared imaging may be productive.
- **One of the most productive projects is the time-domain astronomy**
  - ToO observations of GRB, supernovae, novae, or cataclysmic variables.

But

- ToO is a **trivial** observation project nowadays.
- Many ToO groups in the world.
- The most important thing is:
  - **<u>What the advantage the Ali site is.</u>**

➔good transparency in optical band

➔low background in optical and NIR bands.

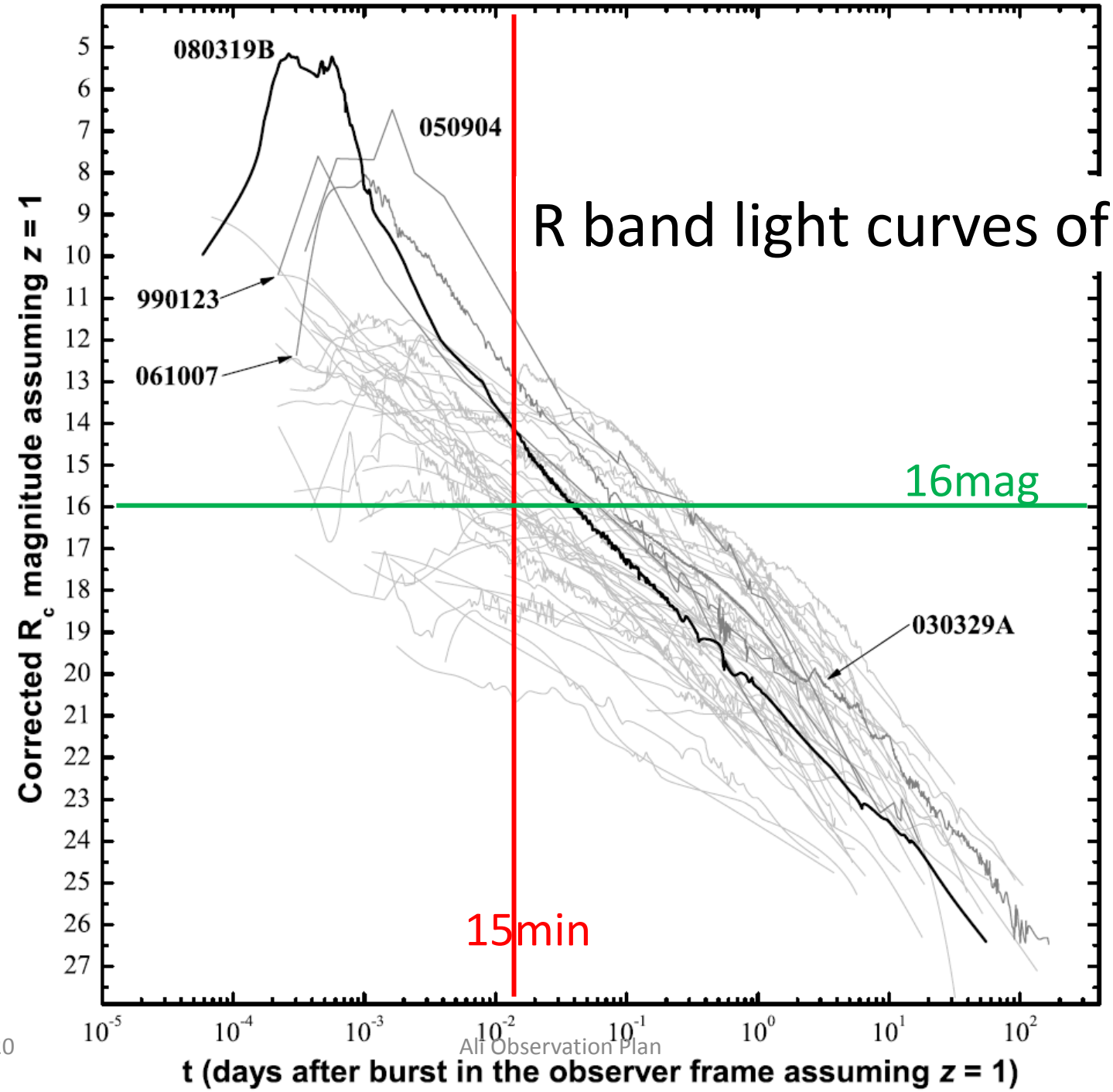
➔good weather condition (<= should be confirmed)

➔maybe good seeing (<= should be confirmed!!)

➔location in the world

What we can do

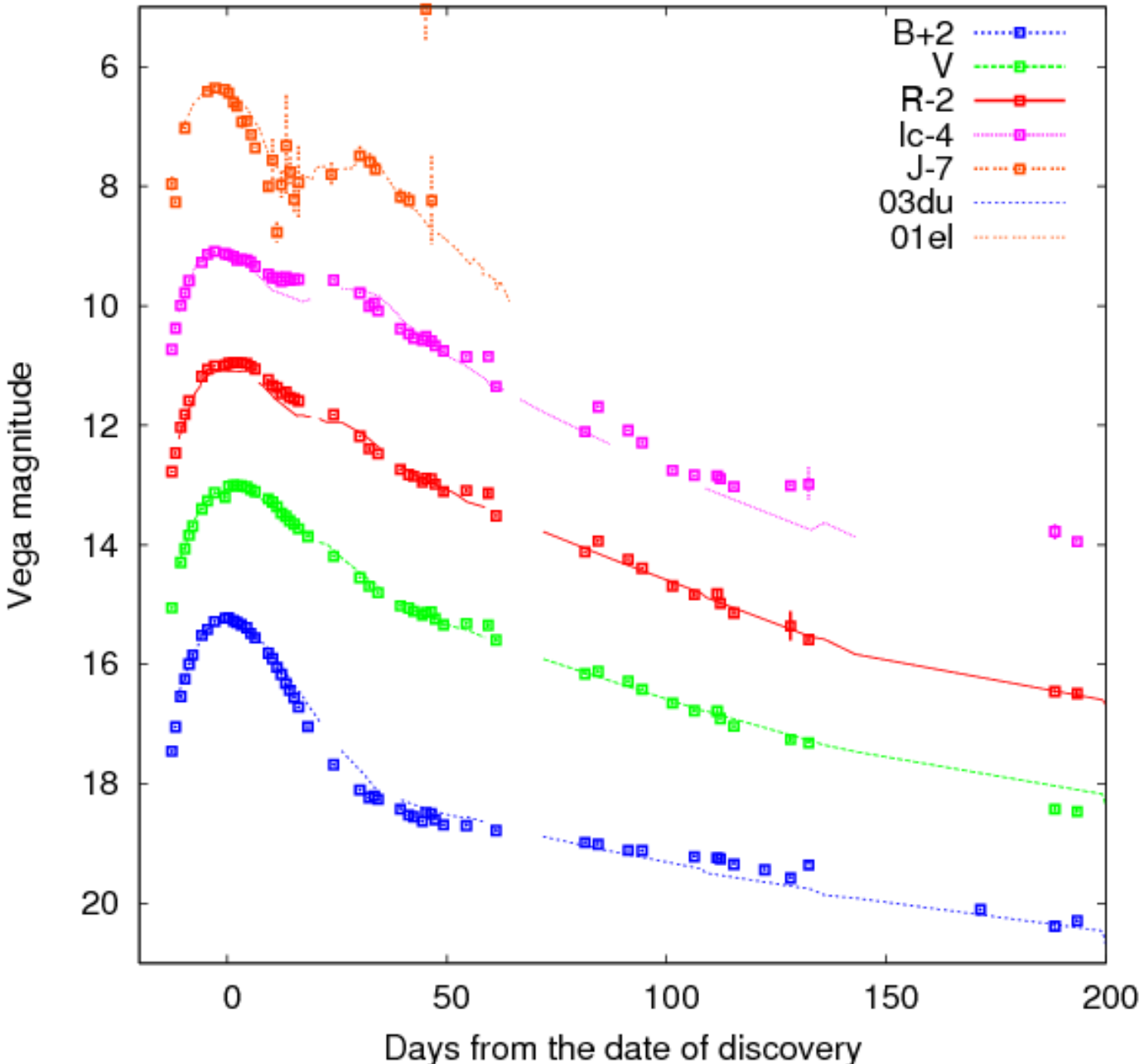
- Gamma-Ray Burst (GRB)
  - If you catch a very bright and important source in very early phase of the afterglow, it is a BIG HIT (maybe HOMERUN) !
  - but, **it is a gamble**.
  - **Automatic, robotic observation system** coordinated with GCN (GRB Coordinated Network) is needed.


R band light curves of GRBs
080319B
050904
990123
061007
030329A
16mag
15min
Corrected R_c magnitude assuming $z = 1$
t (days after burst in the observer frame assuming $z = 1$)

What we can do (continued)

- Supernovae
  - More than 100 SNs in a year.
  - Most of which are faint, but some ones occur in the nearby and bright (ex. SN2011bh, SN2011fe).
  - KANATA continues to observe nearby SNs.
  - Close collaboration between KANATA, Japanese university telescopes and the Ali telescope

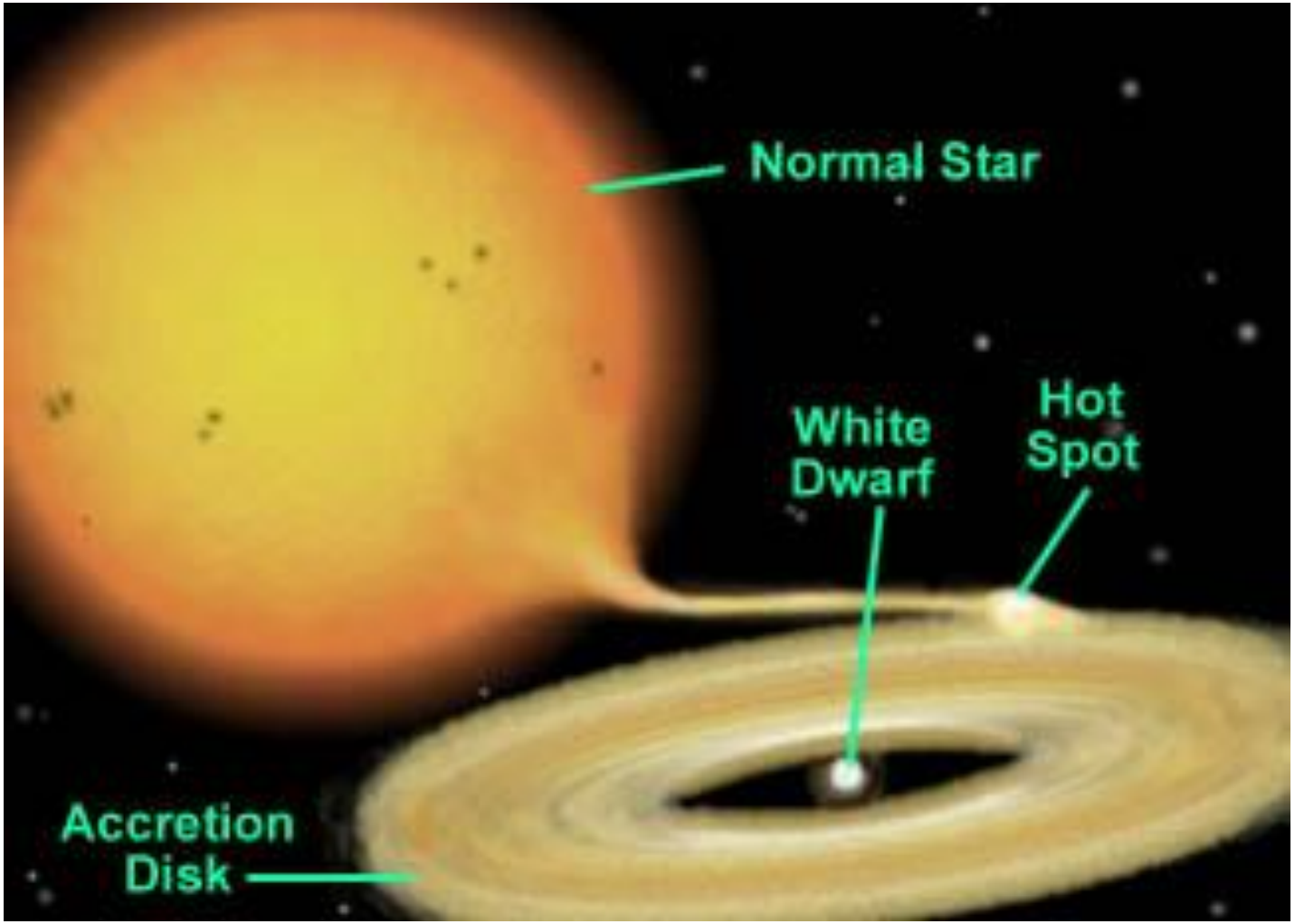
Light curves of SN2011B (Type Ia SN)



What we can do (continued)

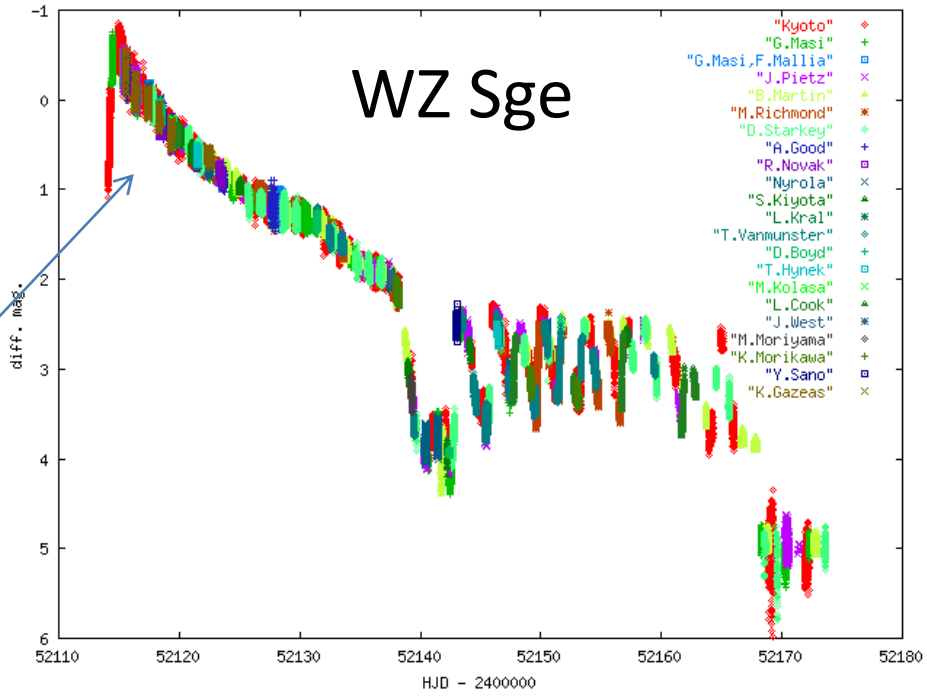
- Cataclysmic Variables and Novae
  - Many observation opportunities
  - Many targets
  - But, quite interesting phenomena do not occur so frequently.
  - Also, it is not easy to produce significant science results only by a single band photometry.
  - Multi-band, continuous monitoring may be a key observation.

CV is the last stage of low mass binary evolution
➔ candidates of progenitor of Type Ia supernovae

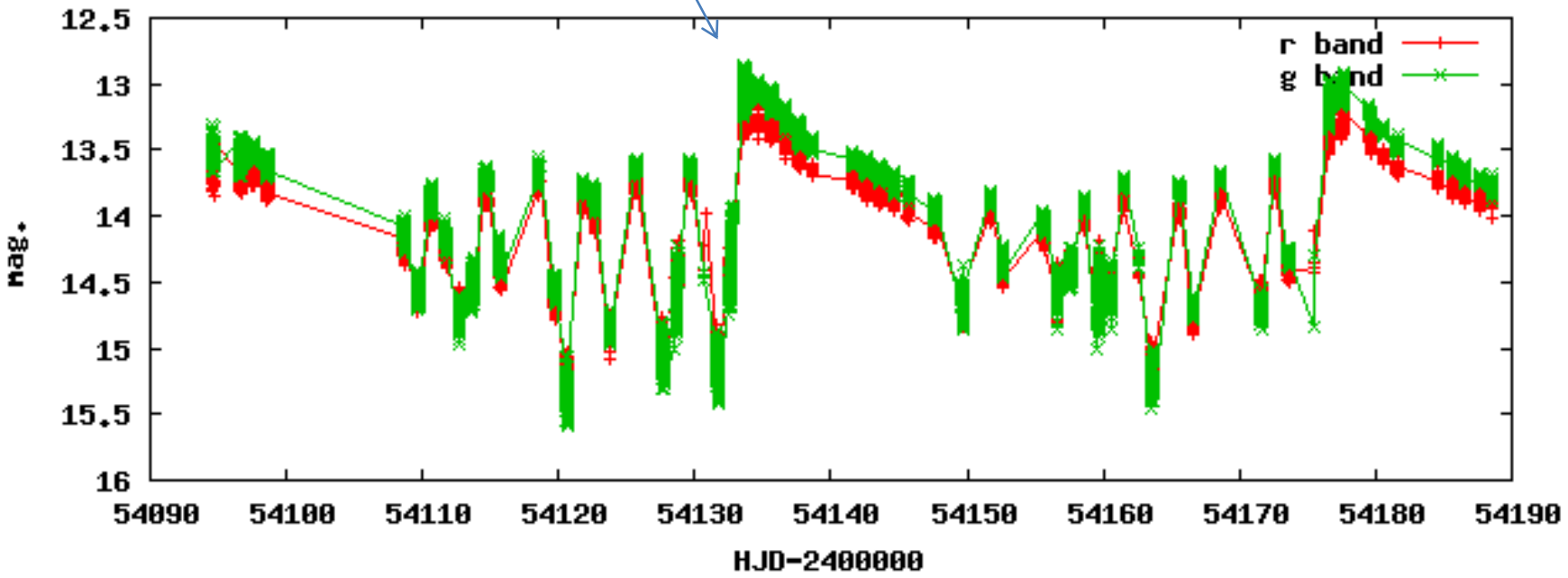


(Credit: K. Smale)

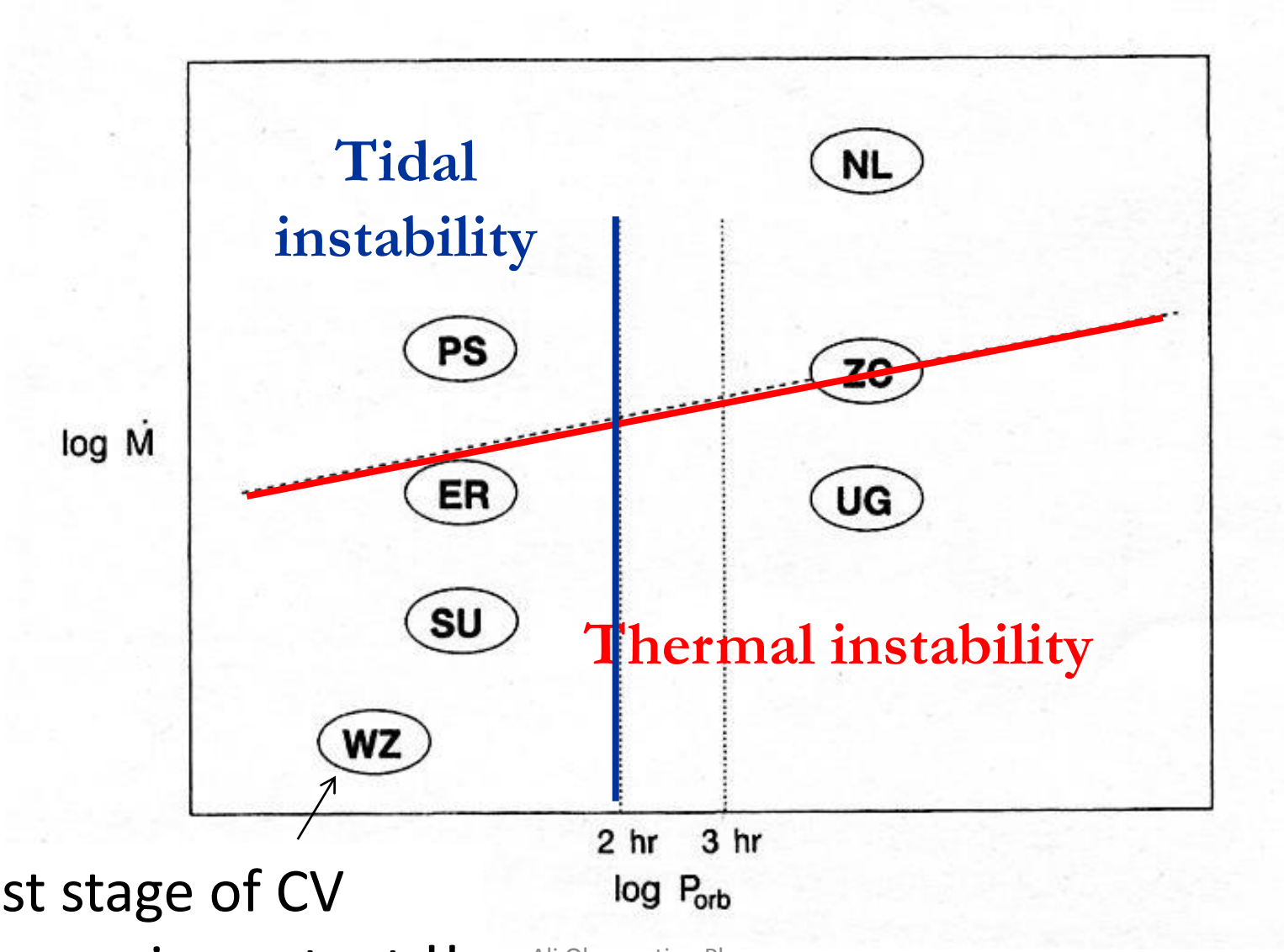
Light curves of CVs



super outburst



Unification model of CVs



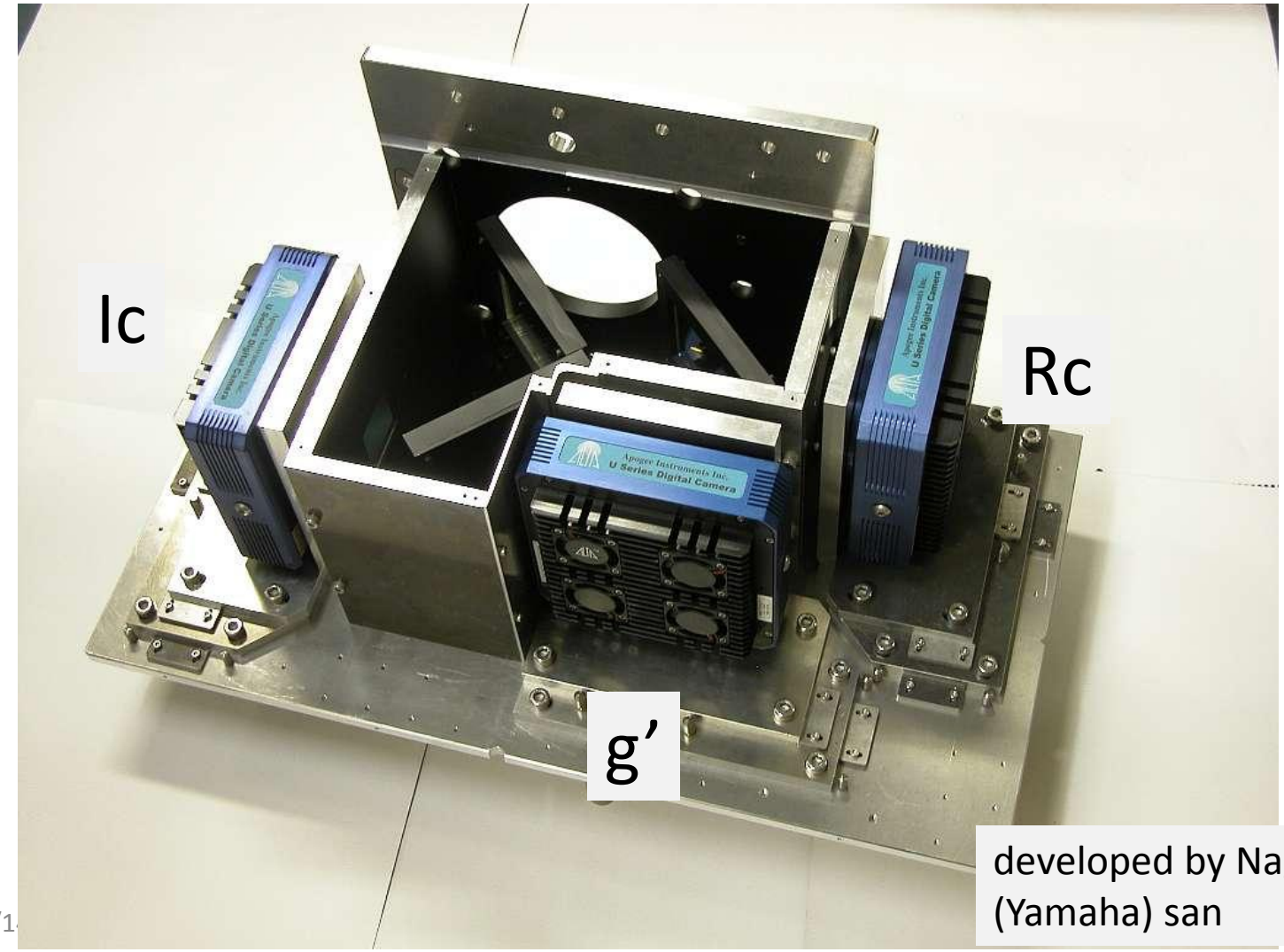
Last stage of CV

➔ very important !!

Dedicated instrument is needed

- Sato-san's optical three-band polarimeter
- Optical – infrared simultaneous imaging camera
- Optical – infrared two band polarimeter

The optical three-color camera for Okayama 50cm telescope



developed by Nagayama (Yamaha) san

The three color camera attached to the telescope

Summary

- SNs or CVs are suitable targets for early observations of the Ali telescope.
- Remote observation system ← long-term monitoring observations
- Automatic, robotic system is needed to do quick follow-up of GRBs
- Instruments which have unique capabilities
  - Infrared – optical simultaneous camera
  - multi-color polarimeter