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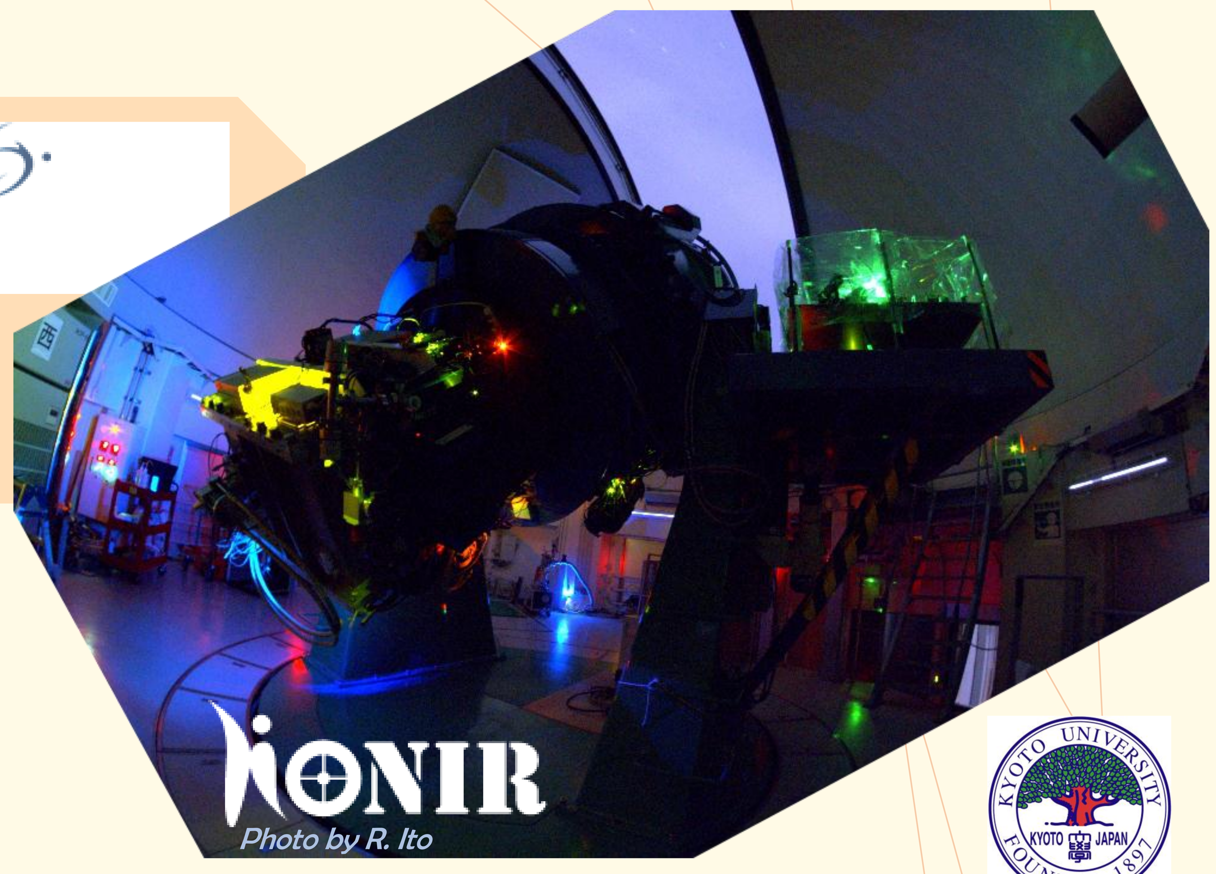
An Optical and Near-infrared Multipurpose Instrument HONIR



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[1] Kanata Telescope and HONIR

Kanata Telescope

- 1.5-m Ritchy-Cretien telescope at Higashi-Hiroshima Observatory (Hiroshima Astrophysical Science Center, Hiroshima University) (Fig. 1)
- Noteworthy observational results especially on variable objects such as blazers, super novae, and gamma-ray bursts.

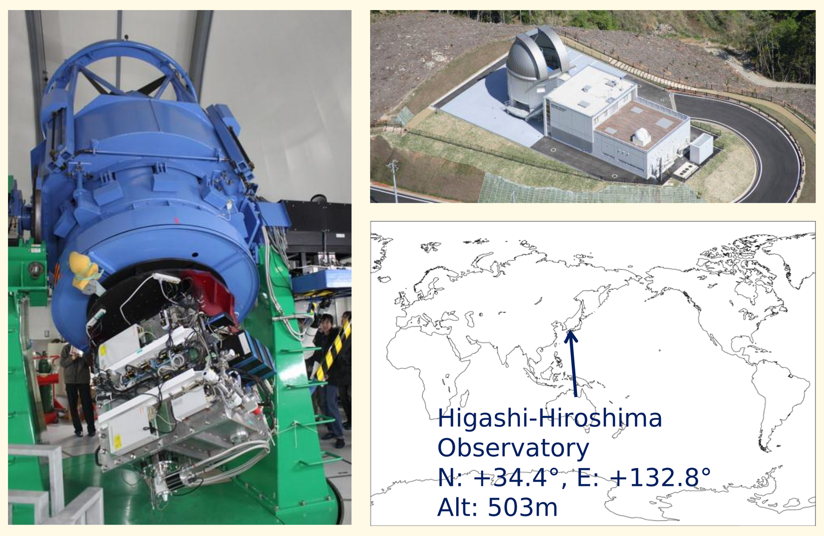

Fig. 1: Kanata telescope and Higashi-Hiroshima observatory

HONIR (Hiroshima Optical and Near-Infrared camera) (Fig. 2; Table 1)

- A brand-new instrument for the Kanata telescope (Cassegrain focus; F/12.3).
- Obtaining three band information among 0.5–2.4 μm simultaneously with a 10 arcmin sq. FOV.
- Spectroscopy and polarimetry (imaging- and spectro-polarimetry) are also available.
- Development History
  - 2007: development start.
  - 2009: NIR 1ch imaging mode installation
  - 2011: 2ch (optical × 1, NIR × 1) simultaneous imaging mode installation. (current)
  - future: spectroscopy and polarimetry mode, the second NIR arm installation.

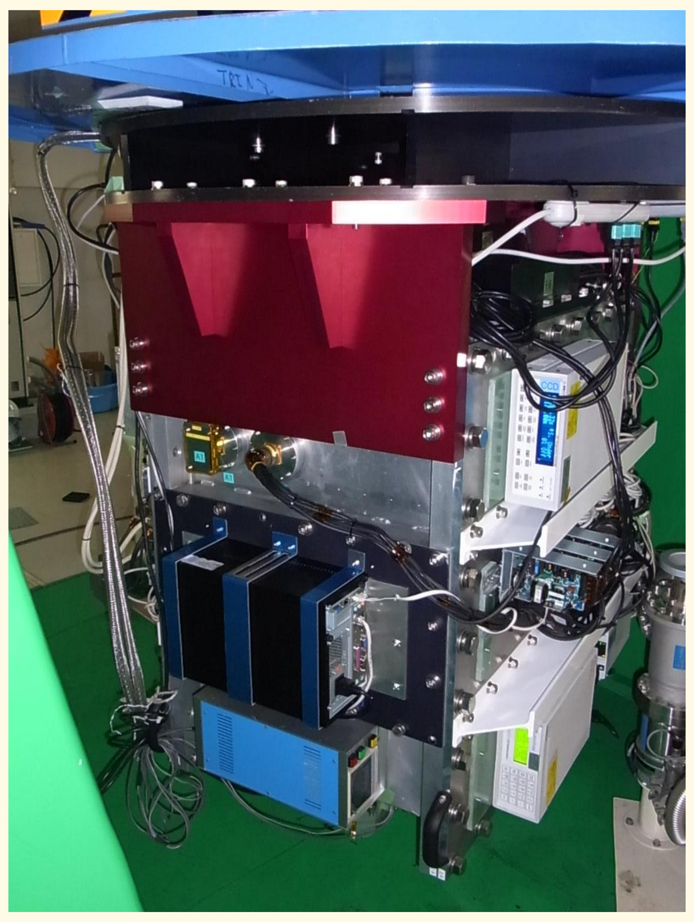

Fig. 2: HONIR on the telescope

Table 1: Basic parameters of HONIR

	Optical Arm	IR Arm #1	IR Arm #2 (in future)
Wavelength(μm)	0.5-1.0	1.45(1.15[1])-2.40	1.15-1.35
FOV & sampling	10′ x 10′ ; 0.29″/pixel		TBD
FOV size at the telescope focus	53.8 mm sq.		TBD
FOV size on the detector	30.7 mm sq.	40.9 mm sq.	TBD
Filters	B[2], V, R_C, I_C, z′, Y	Y, J, H[3], Ks[3]	H, Ks
Detector	CCD (Hamamatsu Photonics)	HgCdTe VIRGO (Raytheon)	TBD
Detector format	2048 × 4096 pix; 15μm /pix	2048 × 2048 pix; 20μm/pix	TBD

[1] Until the installation of IR Arm #2 (current); [2] partially transparent at 0.4-0.5μm; [3] to be moved to the IR Arm #2 after its installation.

[2] Design and Specifications of HONIR

(1) Optics

- A reimaging optical system with three branched arms (0.5-1.0, 1.15-1.35, and 1.45-2.40 μm) split by two dichroic mirrors (Fig. 3, 4).
  (*) Only two arms (0.5-1.0 and 1.15-2.40 μm) with one DM are available at present.
- 10 arcmin sq.FOV; 0.29"/pix sampling.
- Designed for operation at 85 K.
- Spectroscopy (future extension) :
  Grisms (BK7 or S-FTM16) will be installed in each of the arms for low dispersion (R~350) spectroscopy. Installation of additional grisms for higher dispersion (R~700) and lower dispersion (R~30) are also planned.
- Polarimetry (future extension) :
  A rotatable super-achromatic half-wave plate, a barred lattice shape focal mask or slit, and an $LiYF_4$ (YLF; Perrin+08) Wollaston prism (Fig. 5) will be installed.

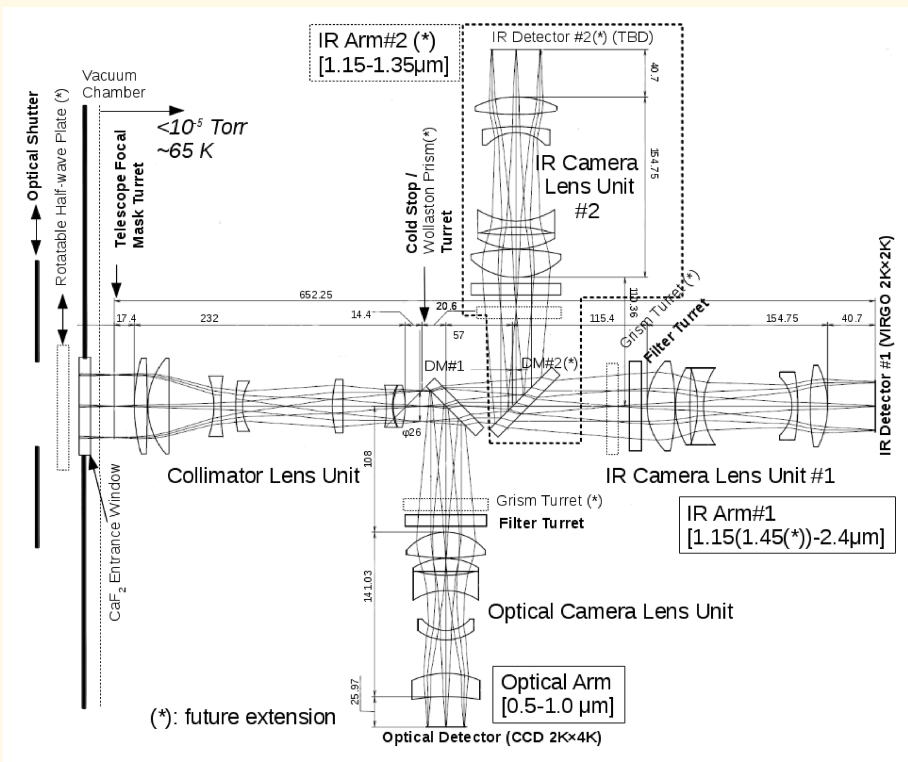

Fig. 3: Optical design.

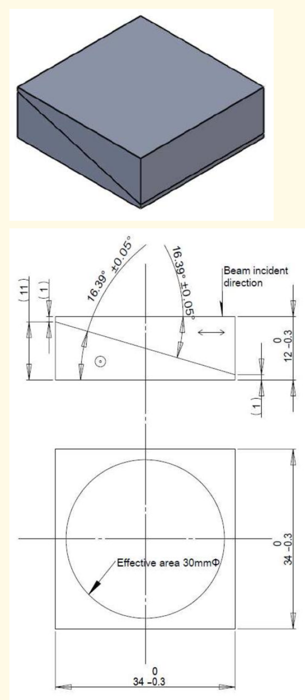

Fig. 5: Design of the YLF Wollaston prism.

(2) Detectors

- Optical arm : Fully-depleted back-illuminated CCD (Hamamatsu Photonics K. .K.; Kamata+06)
- IR arm #1: HgCdTe VIRGO array (Raytheon)
- The integrated control system *Messia 5* (Nakaya+06a) operates a front-end electronics *MFront2* (Nakaya+06b,12) for the CCD and *MACS2* (Nakaya+98) for the HgCdTe VIRGO array (Fig. 6).
- Current performance is summarized in Table 2. Readout noise of the HgCdTe array is too large at present and to be reduced.
- A new control system for the HgCdTe VIRGO array is under development (16 ports parallel readout, low readout noise, etc.) based on the readout electronics for the *Kiso Wide Field Camera (KWFC)* (Sako+12; paper 8446-251 in this conference.)

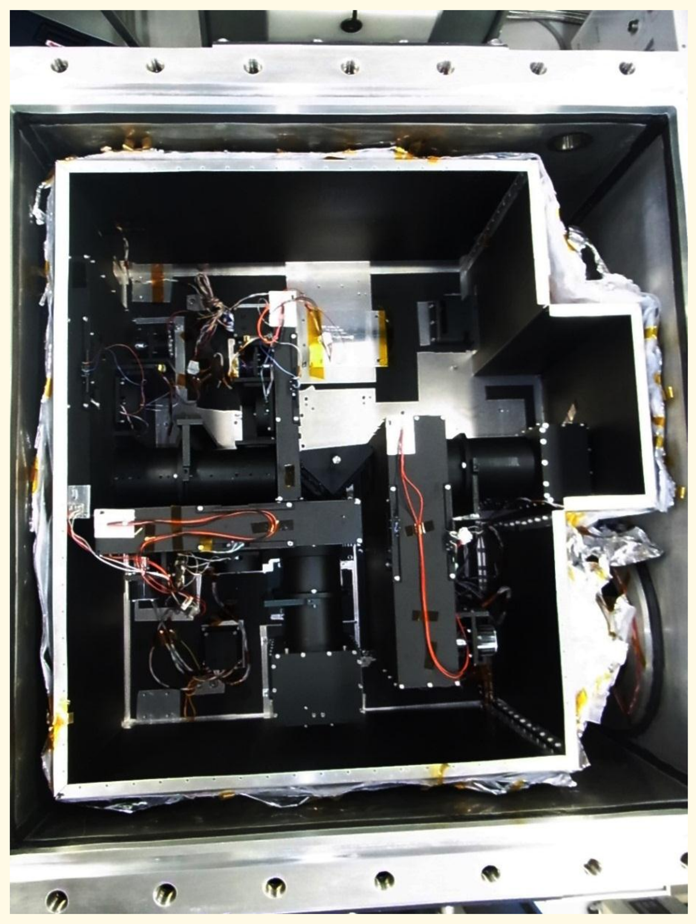

Fig. 4: Optical components on the optical bench.

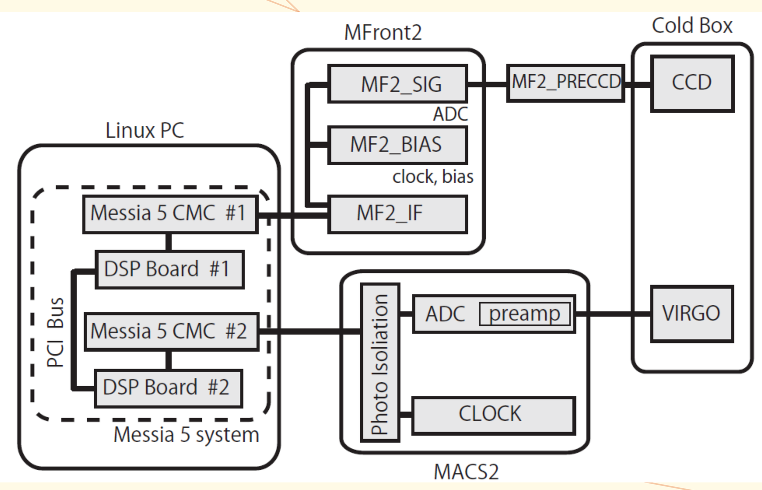

Fig. 6: Block diagram of the detector system.

Table 2: Detector performance.

	CCD (2k × 4k)	HgCdTe (2k × 2k)
Control system	Messia 5 +MFront2	Messia 5 +MACS2
Readout ports	4	4 (16 in future)
Readout rate	133 kHz	234 kHz
Frame rate (sec/frame)	17.4	4.5
Conv. factor (e-/ADU)	1.54-2.15	3.4
Readout noise (e- rms)	~8	~170-240

(3) Cryogenics

- The optical bench in a vacuum chamber (0.96 x 0.96 x 0.63 m; welded Al alloy) is cooled down to and kept at 60-70 K by a single stage Gifford-McMahon cycle refrigerator (140W@70K).
- After 6 days evacuation and cooling, the temperature and pressure are kept at suitable levels (60-70 K and < 10^{-5} Torr, respectively) for 36 days at least (at -5~+15 deg C environment).

(4) Other Features

- Four rotating turrets (filters, focal masks, etc.; Fig. 7): The stepping motors and bump sensors are controlled by the integrated control system *Motionnet* (Nippon Pulse Motor Co., Ltd.).
- Optical shutter (Fig. 8): A shutter plate with a rectangular aperture driven by a linear actuator travels on the entrance window on the chamber. Exposure time stability is better than 0.1 msec (at minimum 0.3 sec exposure).

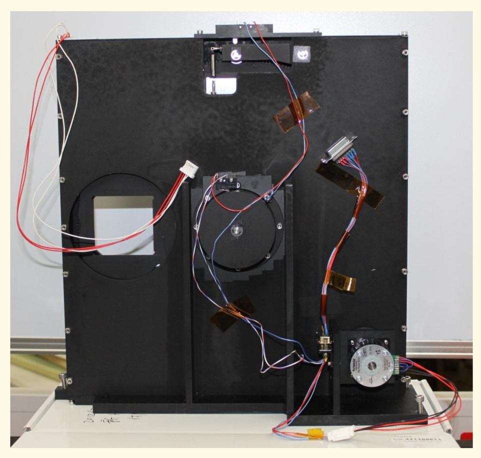

Fig. 7: Focal mask turret.

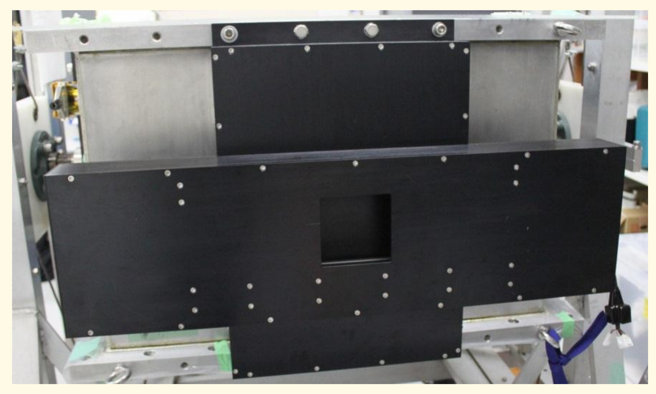

Fig. 8: Optical shutter unit.

[3] Observational Results

Imaging (Fig. 9)

- Image size : 0.9" fwhm (NIR) or 1.7" fwhm (optical) at the center of FOV (incl. seeing and telescope tracking error.)
- Blurring at the edges → to be solved by re-alignment of the lenses.

Photometry (Fig. 10)

- NIR light curve of the young stellar object (m_J~11.7 mag); photometric precision of 0.01-0.02 mag.

Fig. 9: Pseudo-color composite images. (a) M42 (V, J, K_s; 9′.2 × 9′.8), (b) NGC891 (V, R_C, I_C; 6′.2 × 9′.5) , (c) NGC891 (J, H, K_s).

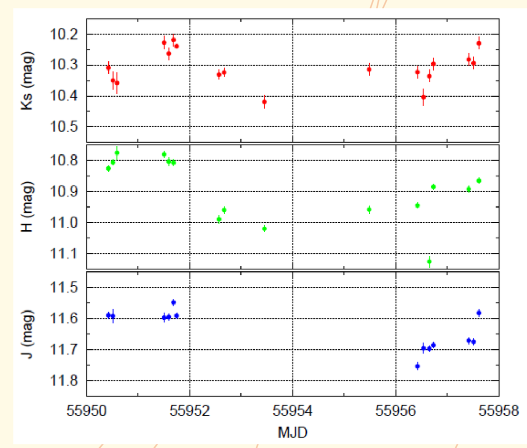

Fig. 10: NIR light curve of the young stellar object MM Mon. 60sec × 5 dithering for each data point.

[4] Future Prospects

- 2012-2013 autumn/winter : spectroscopy and polarimetry functions installation.
- 2014 or later ? : the second NIR arm (IR arm #2) installation.

References

- ✓ Oliva et al. (1997) A&AS, 123, 179.
- ✓ Kamata et al. (2006) Proc. SPIE, 6276, 62761U.
- ✓ Nakaya et al. (1998), Proc. SPIE, 3354, 368.
- ✓ Nakaya et al.(2006a), PASP, 118, 478.
- ✓ Nakaya et al.(2006b), Proc. SPIE, 6269, 62693G.
- ✓ Nakaya et al.(2012). PASP, 124, 485.
- ✓ Sako et al. (2012), Proc. SPIE, 8446 (in this conference).

Web page:
http://hasc.hiroshima-u.ac.jp/instruments/honir/