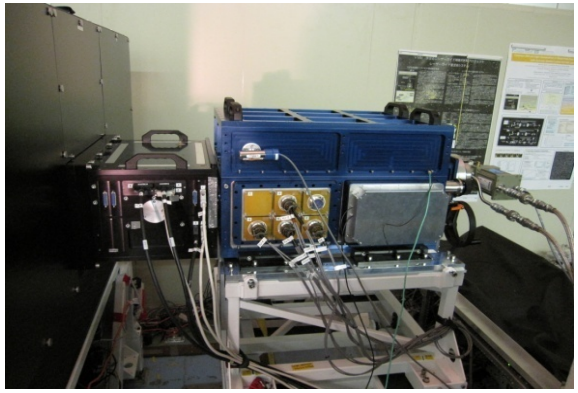
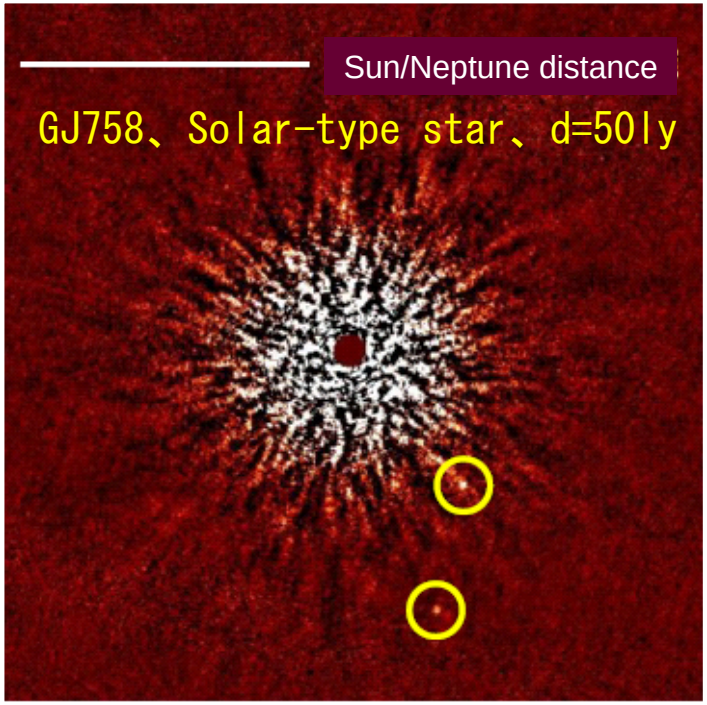
How to proceed "exoplanet" instrumentations for Subaru?

Introduction M. Tamura (Exoplanet Project Office)

- ★ CIAO+AO36
  - 2001-2007 (mostly open-use; S01A-)
  - The **first** dedicated "coronagraph" on the 8m class telescopes
  - ~35 refereed papers incl. nature/science
  - Many "discovery" papers incl. "SS" class
- ★ HiCIAO+AO188
  - 2009- (PI-type)
  - GJ758: First direct imaging of planets around a solar-type star (Thalmann+2009)
  - Circumstellar disk details: coming soon!
  - First Subaru Strategic Observations – **SEEDS** (Subaru Explorations of Exoplanets and Disks)
    - 2009-2014
    - 120 nights
    - First refereed paper already accepted



HiCIAO: Suzuki, Tamura, Hodapp et al.



Top 10 of Times' Year 2009 Scientific Discovery

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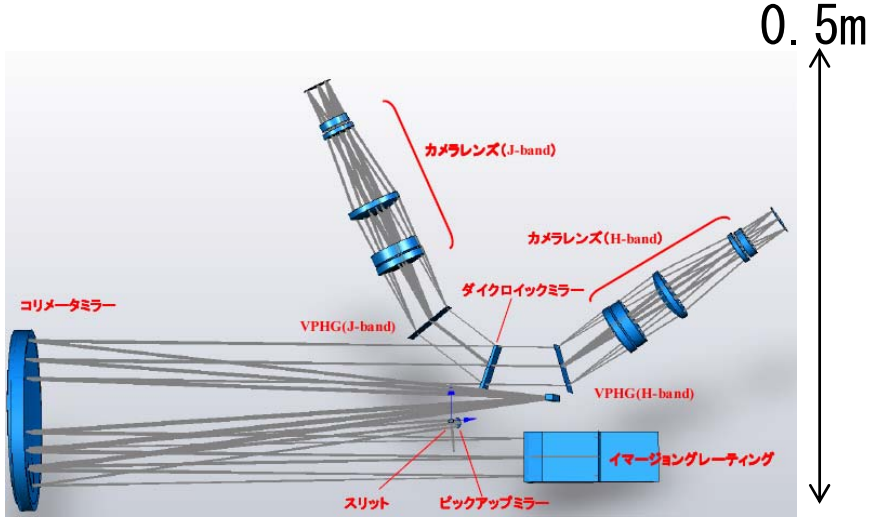
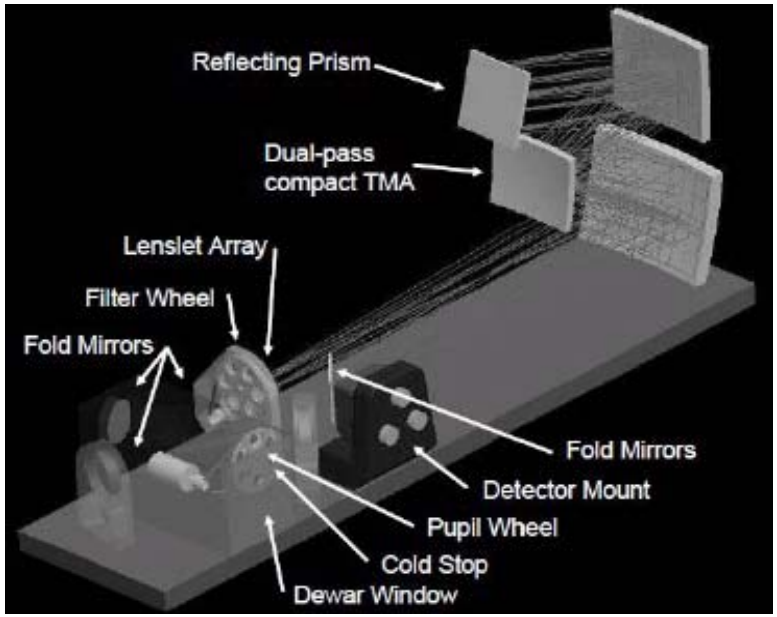
Exoplanet Instrument Future Lineups

★ IRDI (Infrared Doppler Instrument)
- 1m/s precision NIR spectrometer
- wavelength: 1.1-1.7 micron
- resolution： 70000（3pixel sampling）
- pixel sampling: 0.1"/pixel
- slit: 0.3" x 3" (w/wo AO188)
- immersion grating ZnSe & VPH-Gx2
- detector: HgCdTe2048x2048x2
- temperature: -50°



★ IIFS (Infrared Integral Field Spectrometer)
- wavelength: 0.8-2.4 micron
- spectral resolution：R=100
- pixel sampling: 15 mas
- detector: 2048x2048 HgCdTe
- lenslet array: 128x128, pitch 200 micron; fov1.8" x 1.8"
- total throughput: 34%（incl. detector）
- coupling with 32 x32 MEMS ExAO
- design lead by Princeton

Note: Both acronyms are tentative.



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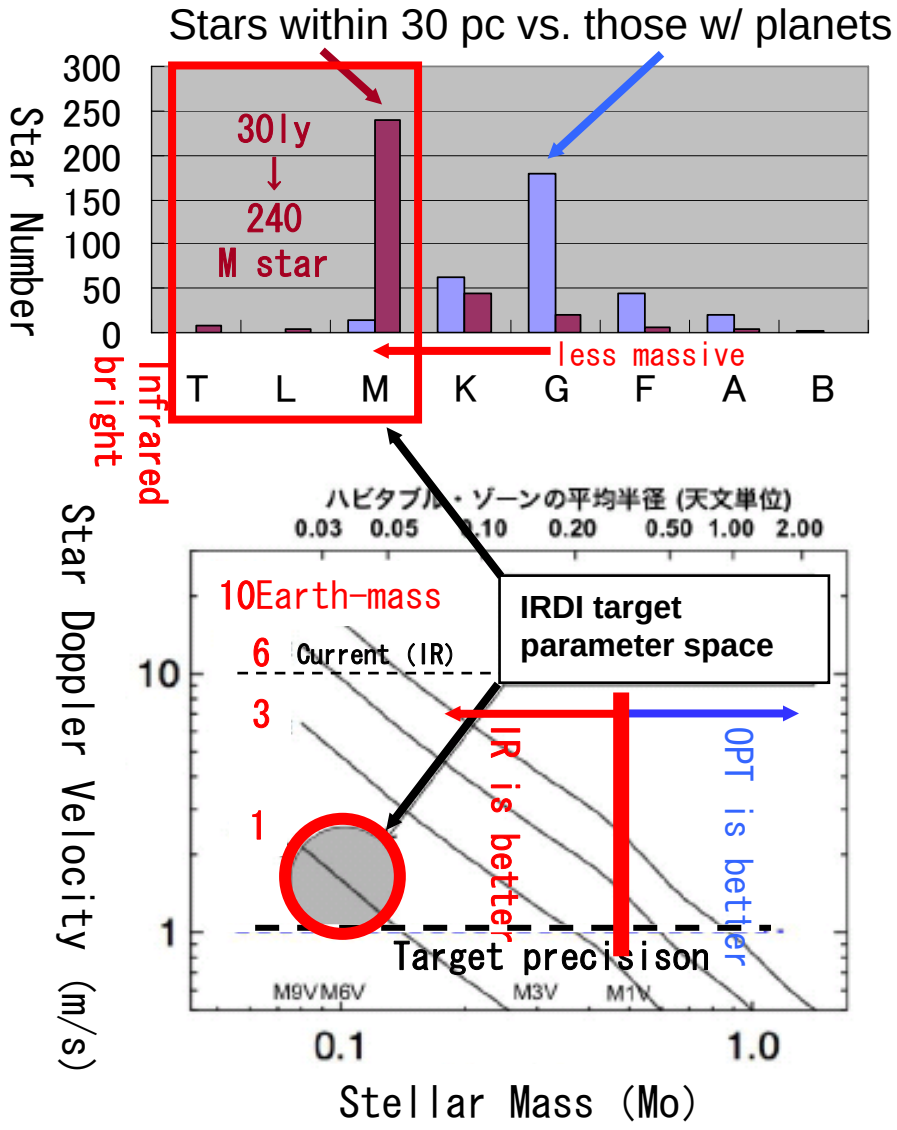
Why these? Why Subaru? – A Strategy for IRDI

- ★ The only approach for Japan to attack the Earth-like planets except for microlensing.
  - ➢ Note that microlensing planets are mostly cannot be followed-up.
  - ➢ Kepler/Corot will make the first report but their targets are not suitable for future works.
- ★ IRDI can be the first serious **Earths finder** on 8-m class telescopes.
- ★ Yearly time span not necessary for planets at habitable zone around M stars; only a **weekly** time span fien. So, time allocation on 8m class telescopes feasible; probably not for 30m class telescope for some time.
- ★ **~1000 targets** can be observed for nearby M stars, but only a few tens for nearby G stars.
- ★ Providing targets for direct imaging w/ TMT (**SEIT**).



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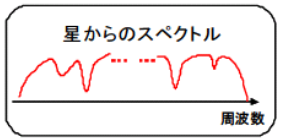
How to combine these ? (technical points)

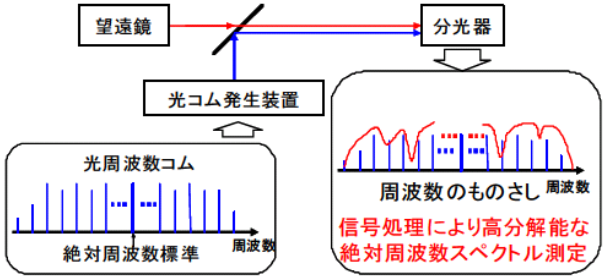


Wavelength calib.
astro-com (500nm w.)

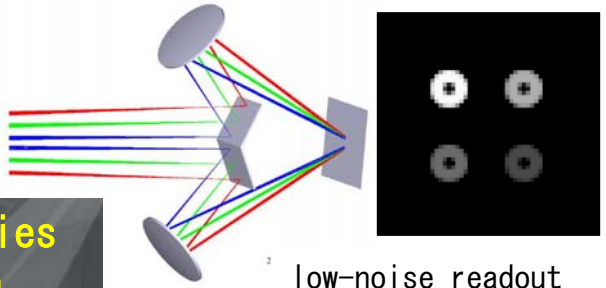
OPT
Doppler
experience

IR wavefront sensor
e.g., pyramid mirror

Kurokawa

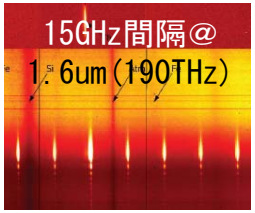


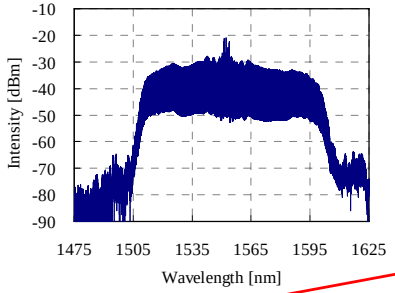
Sato



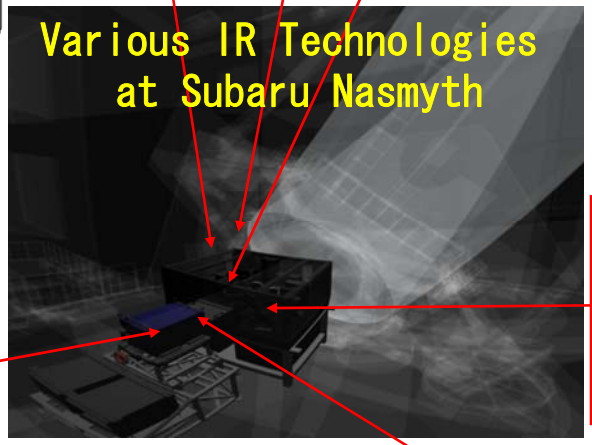
low-noise readout

Hayano+Guyon+Princeton

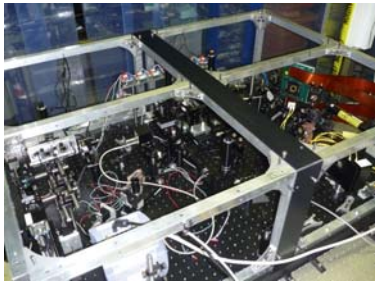




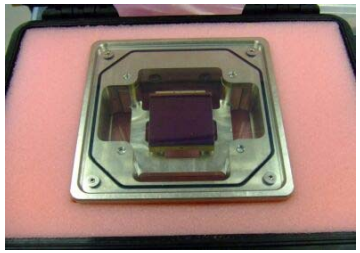
Tamura



1024
SCExAO
&
IIFS

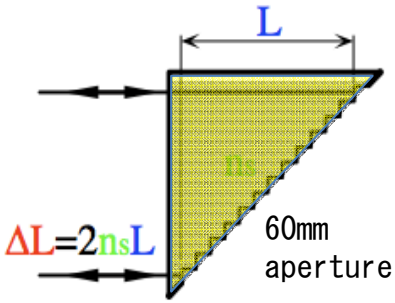


2048x2048 IR array
ASIC readout



Usuda

"Compacting" optics
Immersion grating
VPH grating
(ZnSe n=2.4)



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Short Summary

- ★ For exoplanet studies, three kinds of instruments / developments are necessary on Subaru after HiCIAO/AO188IRDI.
  - ➢ SCExAO for better contrast for giant planet direct imaging.
  - ➢ IIFS for characterization of giant planets
  - ➢ IRDI for many detections of Earth-like planets around M stars
- ★ Budgets for SCExAO and IRDI are becoming ready externally (at least partly from JSPS/MEXT).
- ★ International collaborations are sought.
  - ➢ IIFS probably lead by Princeton
  - ➢ Some IRDI components

Grants-in-Aid for
- Specially Promoted Research
- Scientific Research on Innovative Areas

- ★ Transporting technology (ExAO/IIFS) and providing targets (IRDI) for TMT (SEIT) should be in scope for future Subaru instruments.
- ★ These instruments can also be used for other applications.