International Participation for WFIRST: Japanese Perspective

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In 2015

- March: WFIRST SDT Final Report (NASA) Potential interest of Japanese contribution was presented.

- September: A Letter from Director Paul Hertz -- asking Japanese interests formally --

- December:
  WFIRST Working Group formed in Japan
  Science contact: T. Yamada(ISAS/JAXA), T. Sumi (Osaka U), M.Tamura (U Tokyo/NAOJ)
  Programmatic contact: Prof. M. Fujimoto (ISAS)
Potential Japanese Contribution Package

1. Subaru WFIRST Synergy Observations with HSC/PFS

2. Providing Polarimetry Unit for Coronagraph (Optional: Polarimetry Compensation Unit)

3. Ka-band Data Downlink Station in Japan

4. Coordinated Ground-based Activities
Subaru WFIRST Synergy Observations with Hyper Suprime-Cam (HSC) and Prime Focus Spectrograph (PFS)
Hyper Suprime-Cam (HSC)

- Nearly 1/3 Survey Speed of LSST
  - D = 8.2 m  FOV phi=1.5 deg
- Instrumental PSF 0''.3
  - Mostly seeing limited imaging at Mauna Kea
- High QE in Red (40 % @ 1 micron)
- Operational since 2014/03
Sample Image from HSC Survey Wide

3 hours to cover ~ 20 deg^2
## On-Going HSC Strategic Survey

<table>
<thead>
<tr>
<th>Layer</th>
<th>Depth</th>
<th>Total Area</th>
<th>Ttime total</th>
<th>fields</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEEP</strong></td>
<td>g &lt; 27.5, r &lt; 27.1, i &lt; 26.8, z &lt; 26.3, y &lt; 25.3</td>
<td>26.9deg$^2$</td>
<td>9.9h / 1.8deg$^2$ FoV</td>
<td>ELAIS N1 eCOSMOS, XMM-LSS, DEEP2-3</td>
</tr>
<tr>
<td><strong>WIDE</strong></td>
<td>g &lt; 26.5, r &lt; 26.1, i &lt; 25.9, z &lt; 25.1, y &lt; 24.9</td>
<td>~1400 deg$^2$</td>
<td>1h / 1.8deg$^2$ FoV</td>
<td>Equator</td>
</tr>
<tr>
<td>Ultra Deep</td>
<td>g &lt; 28.1, r &lt; 27.7, i &lt; 27.4, z &lt; 26.8, y &lt; 26.3</td>
<td>3.6deg$^2$</td>
<td>66h / 1.8deg$^2$ FoV</td>
<td>UDS COSMOS</td>
</tr>
</tbody>
</table>

- Well calibrated stable data by 2024
- Unique Narrow-Band filter observations
Subaru Prime Focus Spectrograph (PFS)

- Wide field: \( \sim 1.3 \, \text{deg} \) diameter
- Highly multiplexed: 2400 fibers
- Quick fiber reconfiguration: \( \sim 60-90 \, \text{sec} \) (TBC)
- Optical-NIR coverage: 380-1260nm simultaneously

- Developed by international collaboration, under the initiative of Kavli IPMU

Schedule

- Aiming to start science operation from 2019, as a facility instrument on Subaru.
Uniqueness of Subaru

- Earlier: HSC, before LSST is stably operated
- Deeper: HSC, before LSST sky is deepened by recurrent observations
- Wide-field Spectroscopy with PFS
- HSC Narrow Band Filters
- Northern Hemisphere
Subaru WFIRST Synergy Observations with HSC/PFS

- Subaru deep and wide optical photometry and spectroscopic data ready by the time of launch
  Useful for WFIRST early sciences

- Calibration of photo-z (PFS)

- Narrow-Band (HSC)
Japanese Subaru community is very positive and supportive

2015/12  Presentation at Subaru Advisory Committee
2016/01  Presentation and Discussions in Subaru Users’ Meeting (w/ J. Rhodes)
2016/04  focused workshop is planned (Tokyo)

Plans under discussion

WFIRST Synergy Survey in 2020’s
- HSC SSP Survey Data (public by middle 2020’s)
- PFS SSP Survey Data (partially public by 2024)
- New Survey coordinated with HLS/SNe Deep
  Part of WFIRST field is welcome to the North

WFIRST Specified Time Allocation
Notes: We need,

- Close discussions with Subaru community
  - SAC / UM
  - Initiative of Subaru Telescope
    It is not easy to secure a certain large number of nights in the middle of 2020’s NOW.

- Collaboration with HSC / PFS SSP
  (international) team already formed
2. Polarimetry Capability for WFIRST Coronagraph Instrument

Polarized Light from Planets and Disks
Development for Polarization Compensation System

Simulation based on the wave front error measured at JPL
→ Design / fabrication of BBM

(ISAS/JAXA WFIRST WG R&D)
Ka and S-band Ground station in Japan

WFIRST orbit
- Inclined geosynchronous: High Data rate to a dedicated ground station
- L2: Thermal stability. Lower radiation. Need multiple science downlinks per day

If L2 chosen, Japan can provide
- Ka-band (26GHz) Data downlink (need 270Mbps daily in 11.5hr) → New Usuda station 54m class (operational in 2019).
  (need to add 26GHz capability which is not in current plan)
- S-band uplink/downlink for navigation and emergency contact enhancements → Existing Uchinoura station 20m, 34m
Potential Japanese Contribution Package

3. Ka-band Data Downlink Station in Japan
Ka and S-band Ground station in Japan

Ground stations in Japan can compensate currently planned
- Existing Near Earth Network (NEN) S/Ka band 18 m
  antenna at White Sands
- New ~12 meter antennas at Punta Arenas

Especially important for microlensing exoplanet search
and any other high data rate GO program
4. Coordinated Ground-based Activities

- Microlensing Survey for Exoplanets
  - Development of WFIRST Data Reduction Pipeline
  - HSC/Subaru multicolor imaging of potential WFIRST target fields for Preselection of the Target Fields
  - Plan for 1.8m IR Telescope at SAAO for Precursor IR microlensing survey for better WFIRST field preselection and Concurrent observation for lens mass measurements via microlensing parallax.

- Ground-based High Contrast Observations
  - Observing WFIRST targets
  - Spectroscopy
  - Longer Wavelength
  - Monitoring
We are interested in WFIST project and would like to contribute by
- Subaru Wide Field Imager/Spectrograph
- Polarimeter Unit for Coronagraph
- Ka-band downlink Station
- Coordinated ground-based activities

Discussions underway by the leadership of ISAS/JAXA in collaboration with Japanese universities and institutes.