Subaru Hyper Suprime Cam survey optimized for optical transients (SHOOT)

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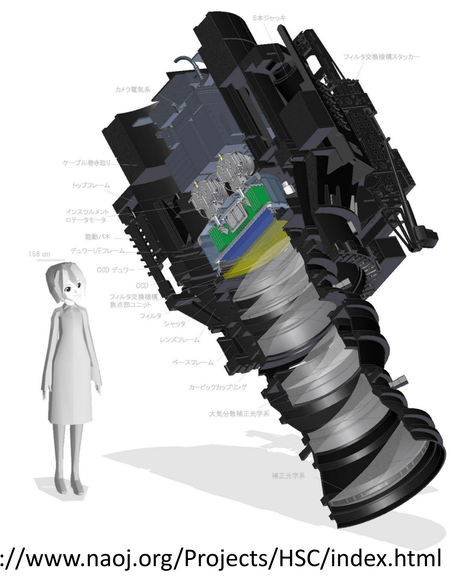
References
Tominaga et al. ApJ submitted
Morokuma et al. PASJ submitted (poster #5)
Tanaka et al. in prep.

Abstract

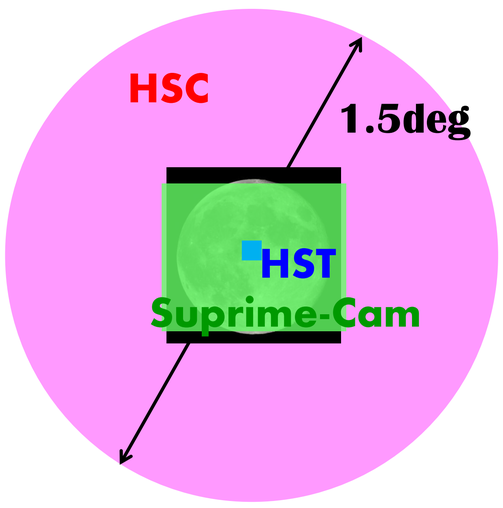
We have started Subaru Hyper Suprime Cam (HSC) survey optimized for optical transients (SHOOT). HSC with wide field-of-view (1.77deg^2) is a new instrument on the Subaru telescope, which has been open to the general use from Mar 2014, and has the most efficient wide-field deep imaging capability per unit time. For the SHOOT, we developed a quick image subtraction system with the HSC pipeline in order to realize prompt detection of transients. The system had been applied for openuse high-cadence surveys. This provided a list of transients about 30 minutes after each exposure and enabled us to make public some of supernova candidates immediately after the observing runs. The system realizes realtime optical transient finding not only in transient surveys with HSC itself but also in follow-up observations of any transients found by other facilities. The immediate detection and localization are essential to trigger further follow-up observations. HSC and the system can make a significant contribution, especially, to identification of the optical counterpart of the gravitational wave, which is predicted to be faint in optical and has a large error region.

Subaru Hyper Suprime-Cam

Miyazaki + 06, 12



http://www.naoj.org/Projects/HSC/index.html



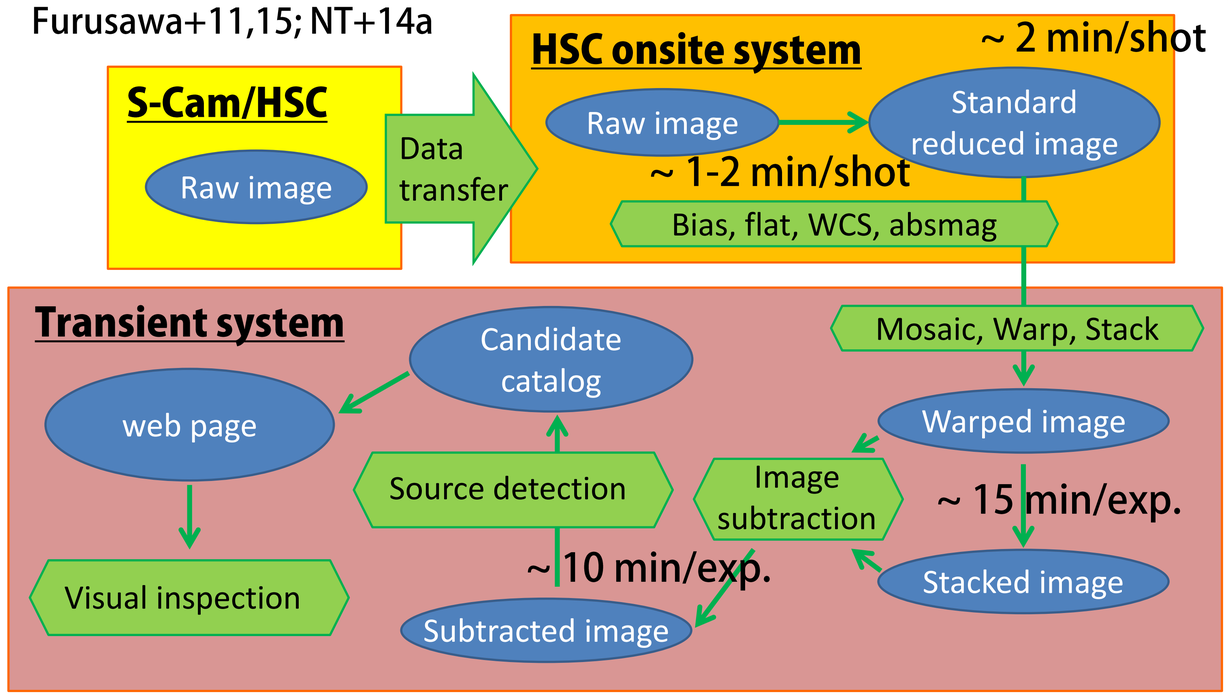
Field of view: 1.77deg^2
Depth: ~27.5mag (g, 1hr)

Hyper Suprime-Cam (HSC) is the new instrument of Subaru telescope with the most efficient wide-field deep imaging capability per unit time, and thus the most efficient transient finder, especially for short transients.

The scientific operation was started from Feb 2014.

Quick analysis pipeline

Furusawa+11,15; NT+14a



1. The HSC onsite system obtains raw images from S-Cam/HSC.
2. The images after the standard reduction in the process of the quality analysis are passed to the transient system.
3. The transient system produces warped and/or stacked.
4. The produced images are processed with image subtraction and source detection.
5. The catalog of candidates are registered to MySQL database and listed in the web page.

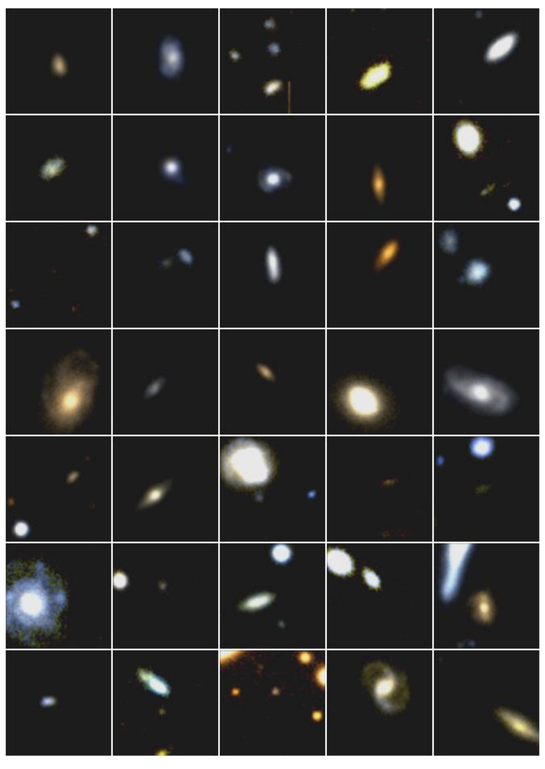
The whole process will finish within ~30min after the exposure.

Immediate detection and quick alerts

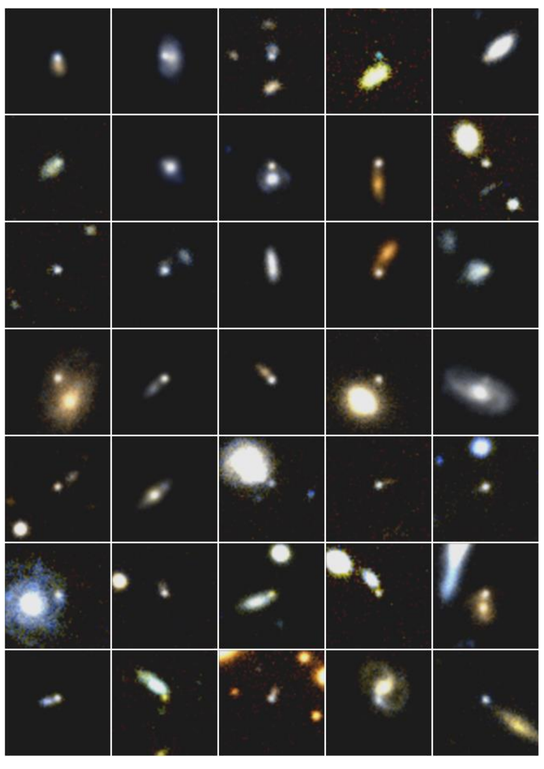
The supernova candidates were announced immediately after the observation runs.

ATel # 6291 on 4 Jul 2014 (NT+14a) Obs. run: 2 and 3 Jul 2014
First supernova candidates discovered with Subaru/Hyper Suprime-Cam
ATel # 6763 on 27 Nov 2014 (NT+14b) Obs. run: 25 and 26 Nov 2014
Supernova candidates discovered with Subaru/Hyper Suprime-Cam
ATel # 7565 on 26 May 2015 (NT+15a) Obs. run: 24 May 2015
Fifty supernova candidates discovered with Subaru/Hyper Suprime-Cam
ATel # 7927 on 19 Aug 2015 (NT+15b) Obs. run: 19 Aug 2015
Supernova candidates discovered with Subaru/Hyper Suprime-Cam

Jul 2014

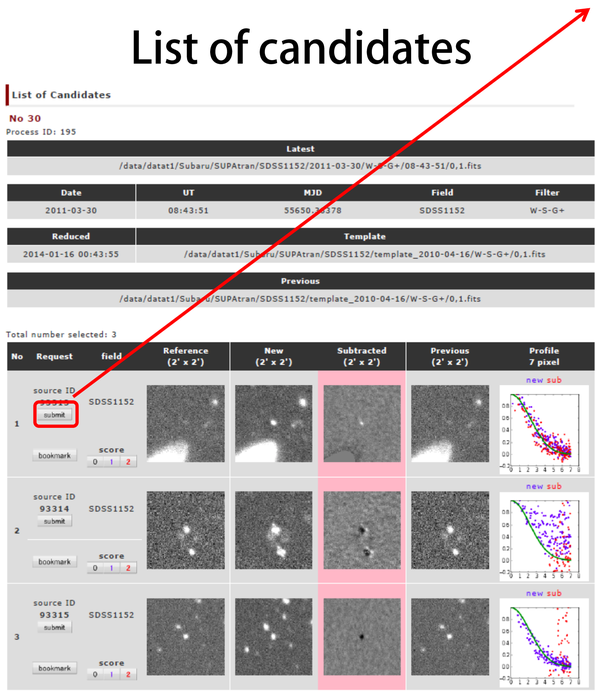


May 2015

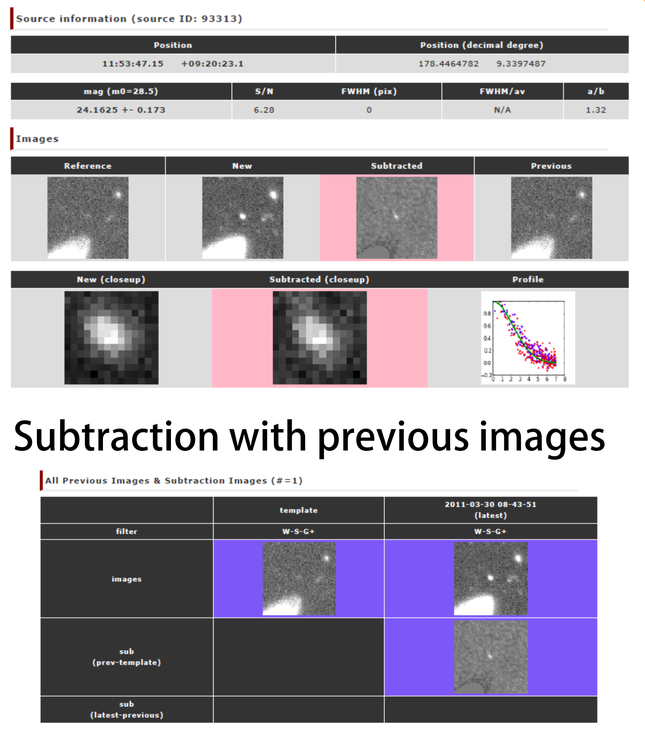


Web pages

List of candidates



Source information



Subtraction with previous images

A list of candidates is available with template, new, subtracted, previous images and radial prof. of objects for each exposure. A detailed information page is also available with a click. The page contains close-up images, subtracted image from previous images, light curves, images taken in other bands, and info. on other wavelength (X, radio, etc.), spectrum, and minor planets. The real object can be registered to databases with a click with a flag like SN, AGN, and variable stars, etc.

Conclusion

Since the optical counterpart is predicted to be faint and has a large error region, the sweeping with HSC is the most efficient to identify the optical counterpart of the gravitational wave. We have developed quick transient detection system for Subaru/Hyper Suprime-Cam. The system can immediately provide lists of transients and localize the optical counterpart after the detection of gravitational wave.
The system has been adopted also for a Target-of-Opportunity (ToO) observation of a fast radio burst (FRB). Since the procedure of the ToO observation is the same as in the case for the gravitational wave. We are ready for immediate follow-up observations of the optical counterparts of gravitational waves.