

Notes on Special Filters for Hyper Suprime-Cam (HSC)

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Hyper Suprime-Cam (HSC) has two Filter Exchange Units (FEU) to be attached to both sides of the Prime Focus Unit. Each FEU is equipped with three filters, and HSC can hold six filters in total at one time. These FEUs are installed apart from the installation/removal for Prime Focus Unit (POpt2), using a crane and the special tools. Each of installation and removal of FEUs requires another day-time work in addition to the POpt2 install/removal work. Because the operation of POpt2 and FEU requires more delicate work compared to the existing Top Units, we are limiting the HSC run once per month. Also, it is impossible to change filters during an observation run.

HSC Subaru Strategic Program (SSP) which is comprised of a number of Japanese and international researchers is on-going from the beginning of HSC science observations (in S14A) and will continue for over five years and 300 nights in total. In this SSP, five broad-band filters (g,r,i,z,y) and four narrow-band filters will be used. In order to accommodate the needs for researches of transient objects such as Supernovae, data acquisition should be made evenly over time, especially for broad-band filters.

Subaru Telescope established an HSC filter acceptance policy. According to this policy, a consortium was formed by researchers who plan to fabricate special filters to discuss the filter specification, information concerning production, production process, etc. So far, 15 narrow-band filters, including filters for the SSP, have been produced or secured their funds. Once a proposal for observations with these special filters are submitted to the open-use program and selected, they will be installed onto FEUs along with broadband filters.

The filter acceptance policy states that the director of Subaru Telescope will decide the start of filter production. According to the condition mentioned, when considering HSC filter production, please contact the Subaru Telescope (new development group: newdev@naoj.org) well before applying for funds.

Acceptance Policy for the Filters for Hyper Suprime-Cam (HSC)

October 16, 2016 Revised

July 29, 2015 Revised

July 16, 2013 Revised

February 20, 2013 Revised

June 18, 2009

Subaru Telescope, National Astronomical Observatory of Japan

1. Purpose

HSC filters are important components of HSC and they should be developed according to the specifications (such as wavelength, band width, and uniformity) designed for their scientific purposes. These filters are inserted into HSC and help yield advanced scientific achievements.

The filters:

- are large in size and the cost of production is very high
- require sufficient time for investigations (on fabrication and installation)
- affect the telescope operation significantly.

For these reasons, tight collaboration between filter developers and Subaru Telescope staff (including HSC team members) is essential. Hence a procedure for the fabrication of HSC filters was made.

2. Procedure for Filter Production

- 1) A team that wish to develop HSC filters should make preliminary discussions with Subaru Telescope and submit a proposal well before applying for funds.
- 2) Subaru Telescope will form a working-group which is comprised of selected members from Subaru Advisory Committee, Subaru Telescope, and a developing team and discuss from the standpoints of science and telescope operation about filter specifications and possibility of compromise on production, etc.
- 3) The director of Subaru Telescope will approve or deny a production of the filter based on the proposals from the review committee.

3. Rules for the filter production and acceptance

- 1) To secure funds to fabricate a special filter, the filter PI should contact one or more filter companies to get a quote for filter base material and cost for coating. In addition, cost to fabricate filter frame and for transportation from Japan to Hawaii (2 million JPY in total) should be included for a funding proposal.
- 2) For filter production, Subaru Telescope will provide the technical information about configuration/interface and technical support and advice as well.
- 2) Subaru Telescope will provide a transmittance measuring facility (in Mitaka, Tokyo) for the HSC filters and assist transmittance measurements.
- 3) After the delivery of a filter, Subaru Telescope will inspect the filter based on the mechanical specifications and optical characteristics at the National Astronomical Observatory of Japan in Mitaka. Passing the inspection is one of the conditions for the acceptance of the HSC filter.
- 4) Since Subaru Telescope will assume considerable responsibility for the operation of the filter, after the transportation to Hawaii, the right of the filter management will be transferred to Subaru Telescope.
- 5) HSC filters will be available for the open-use programs as a part of Subaru Telescope instruments. However, during the first three semesters (or 3 call for proposals) after it is open to the public, people who are interested in using the filters must obtain an approval in advance from the filter developing team.

Information required for the inspection of special filters for HSC

July 29, 2015. Subaru Telescope, NAOJ

1. Information to be submitted from the filter team to Subaru Telescope

- Name of the PI of the filter
- Contact e-mail address
- Name of the filter
- Manufacturer
- Specifications
 - Physical size
 - Material of substrate
 - Central wavelength (CW)
 - Uniformity of CW
 - Peak transmittance (TP)
 - Uniformity of TP
 - Full width at half maximum (FWHM)
 - Clear aperture (CA) size
 - Full width at 10% of TP within CA (FW10M)
 - Full width at 80% of TP within CA (FW80M)
 - Blocking (wavelength range and maximum transmittance)
- Transmittance measurement report from manufacturer
- Transmittance data both at the center and in area-weighted mean for publication in the HSC instrument web page

2. Transmittance measurement using a NAOJ facility

Subaru Telescope is responsible for the following measurement to check the achievement of specifications of the filter. Note that transmittance measurement report may be used for the judgment even if not all of the following settings are fulfilled.

2-1. Measurement points

It is desirable to measure transmittance of the filter at either of the following two sets of positions:

1. Edge-to-edge for two or more directions, with a separation 25mm or smaller, or
2. Thirty or more positions which are distributed approximately evenly over the entire filter aperture.

2-2. Wavelength resolution

It is desirable that the transmittance measurement is made with a wavelength resolution fine enough to determine the actual FWHM of the filter. For some wavelength range (e.g., near-infrared wavelengths) where the sensitivity of the instrument is low, using a realistic wavelength resolution (e.g., 5nm) by broadening the slit width will be acceptable.

2-3. Wavelength step

It is desirable to set wavelength measurement steps smaller than the half of the wavelength resolution. It is recommended to set wavelength steps fine enough for the case with broader slit width.

2-4. Signal-to-noise ratio

It is desirable to achieve S/N ratio of 20 or larger at the peak transmittance.