Hyper Suprime-Cam (HSC) Camera Design

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HSC Mechanics Overview

- Cable Wrapper
- Hexapod
- Frame (Jack Top Frame)
- HSC I/F Base (Main Frame)
- Telescope I/F (Inner Ring, Inner Hub)
- CCD Dewar
- Instrument Rotator
- Role-type Shutter
- Filter Exchanger
- Optics (Lens Barrel)
CCD Dewar

- **Requirement**
  - Fill $\phi 1.5\text{deg}$ focal plane ($\phi 500\text{mm}$ in diameter) with many CCDs
    - 4 side buttable CCD package is adopted to minimize the gap
  - CCDs must be installed on the focal plane accurately
    - CCD surfaces must be flat within the focal depth ($\pm 15\text{um}$)
    - The flatness of CCD surfaces must be kept at any direction of gravity
  - CCDs must be cooled down to $-100\text{C}$ uniformly over the focal plane to reduce thermal noise (dark current)
    - CCD dewar must be a vacuum chamber and evacuated
    - CCDs are cooled with mechanical cooler
    - CCDs (cold plate) must be thermally isolated (although the main heat inflow is the thermal radiation from the entrance window)
  - CCD readout electronics must be installed as close as possible to CCDs for secure operation
    - Electronics must be installed inside the CCD dewar
CCD Dewar: Overview

- Dimension: $\phi 700 \times 500$
  (c.f. Suprime-Cam $\phi 300 \times 250$)
- Weight: $\sim 160$kg

- 116 FDCCDs are installed on the $\phi 500 \text{mm focal plane}$
**CCD Dewar: Detail**

**Window**
Silica window (D=576, t=30) supported by aluminum and stainless parts is placed in front of CCDs

**Wall**
While supporting the window, feed-through holes and connectors to CCDs are attached

**Electronics**
CCD readout electronics are attached behind the CCDs (focal plane)

**Back Frame**
Pulse tube coolers, ion pump, etc will be attached from back of the dewar

**Focal Plane Assy**
CCD Dewar: Focal Plane Assembly

**Cold Plate**
Silicon-Carbide plate with ~10um flatness. CCDs are screwed to this plate and cooled.

**CCD Package**
CCD wafer is glued to AlN base plate. The vendor delivers homogeneous package with the height variation (between CCD surface to AlN plate) of P-V 20um.

**Base Flange**
The back side is the I/F to the instrument rotator. Support posts are attached to the front side of the base flange.

**Support Post**
The parts which support the cold plate. The material for support posts must be stiff and low thermal conductive. We plan to employ Zirconia for the material.
Focal Plane

1.5 deg FoV

Observable Area (1.59 deg FoV)

116 CCD
1 pix = 0''.166

Vignetting Plot

- 100
- 75
- 50
- 25
- 0

% 0 0.75 0.8

r (deg)
Focal Plane

1.5 deg FoV

4 CCDs for Auto-Guiding

8 CCDs for Auto-Focusing

Pre-Focus CCD (thicker AlN plate)

Post-Focus CCD (thinner AlN plate)

Science CCD
1.5 deg ~ 1 km, 1 pix = 3 cm
Shutter

• Specification
  – Shortest exposure time: 1 sec (target)
  – Movement uniformity: 1 %
  – Accuracy of exposure: 0.01 sec

• Space Constraint
  – Limited space for the shutter
  – Shutter should be as thin as possible

→ Role-type shutter looks most promising
Shutter

• Proto-typing in process in Taiwan
  – Completed by July. 2008
Filter Exchanger

• Specification
  – Number of filters: >2 filters, goal 6 filters
  – Max time between two visits in different filters 10 min (goal 5 min)

• Space Constraint
  – Limited space for the filter exchanger
    • Filter Stacker must be attached outside the HSC unit
Filter Exchanger

Focal Box
The box where the filter is set at the observation. The box co-rotate with the CCD dewar

Filter Stacker
Each stacker stores 3 filters and 3 filters are selectable

Main Frame
Base frame of HSC, where stackers are attached

Base design in progress by Uraguchi-san at Subaru
Filter

• Specification
  – Size: \( \phi 600 \text{mm}, <30 \text{mm thick (goal 10mm)} \)

• Proto-typing completed
  – Promising transmission can be realized by evaporation
  – However, the evaporation method is not enough to realize thin (~10mm) filter.
  We are investigating the sputter method
Summary

• CCD Dewar
  – Base design in progress
• Shutter
  – Proto-typing in process
• Filter Exchanger
  – Base design in progress
• Filter
  – Proto-typing completed

All components will be ready by 2010 summer