Focal Plane Detectors and CCD Camera

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Overview

Comments:

1. There is every indication that the DECam CCDs will meet or exceed all specifications, and that the project has the competency and an appropriate plan to procure, test and integrate sufficient CCDs into the focal plane.

   …but some improvements will be suggested in final report.

2. Our single greatest concern is still the uncertainty in yield and its impact on budget and schedule.

3. Not withstanding the study undertaken since similar comments were made in an earlier review, we are not convinced that the expense and complexity of the proposed cooling system is required.

2) Yield

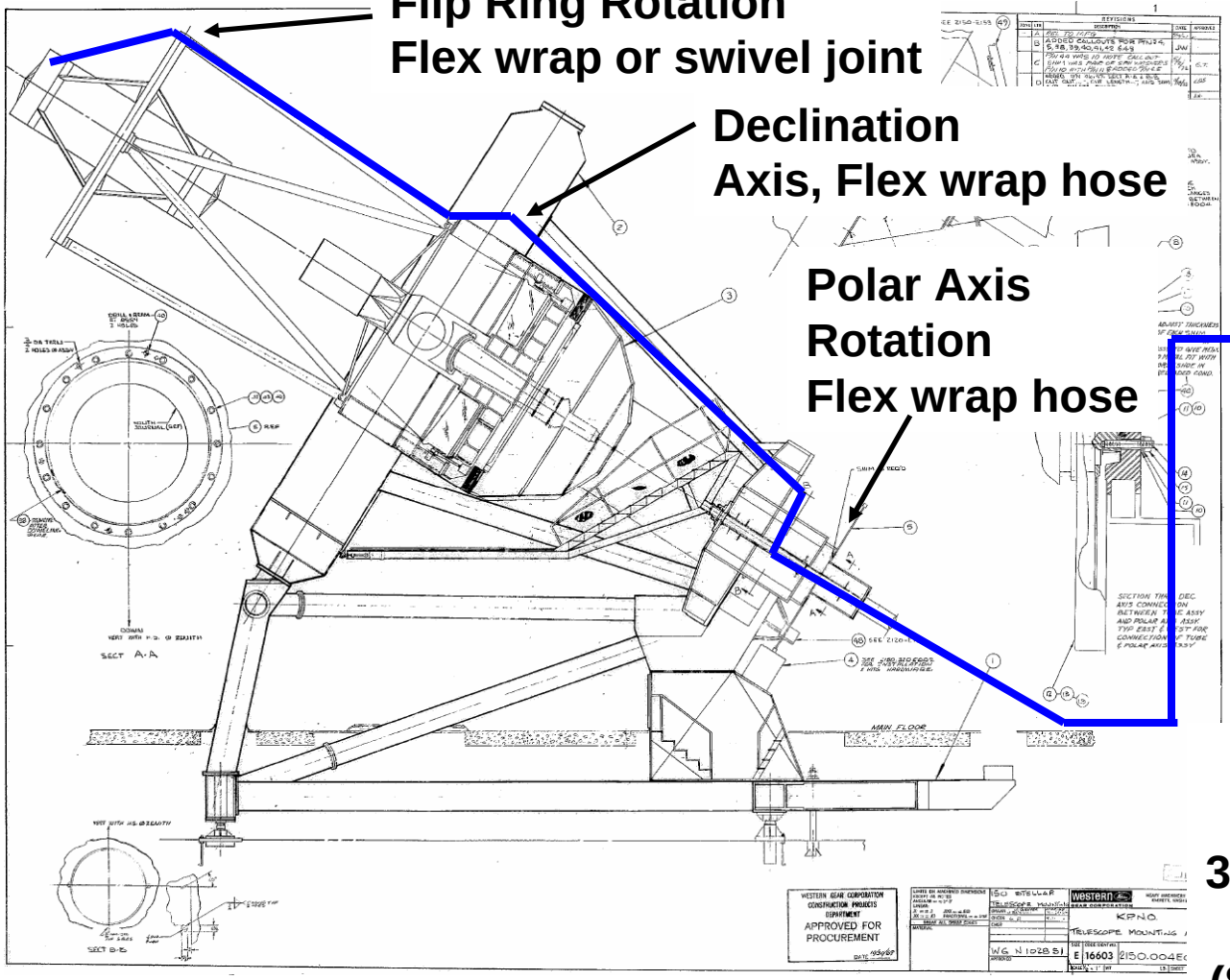
- 20% yield is required to deliver the a fully populated focal plane on time (~5% slack). Overall yield is estimated to be between 19% and 29%, based on recent devices produced after remedying the latest round of problems.
  - This finding is based on too few devices to be considered a reliable predictor of future yield.
- Overall yield is the product of the yields for each manufacturing step. Some defects originate at DALSA. Losses occur during backside processing and frontside metalization at LBL. Devices are selected for packaging based on wafer probing at -45C by LBL. A small number of devices can be damaged during packaging and some could fail flatness tests. A significant number of devices are rejected due to performance deficits, principally cosmetic defects which do not freeze out at operating temperature (-100C).
- We feel that this “cosmetic yield” may be artificially depressed by the simple way in which the flow down from scientific requirements has been performed.
- Ample noise margin is needed in the electronics to assure that the CCD noise yield is not degraded.

2) Yield (continued)

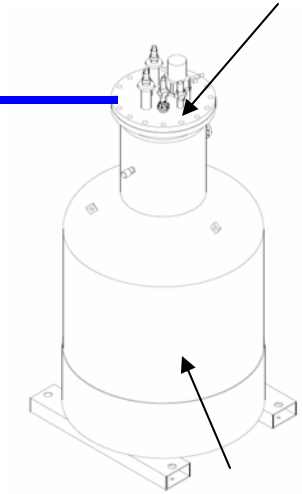
Examples of how cosmetic specs may be relaxed:

- “Carbon trading”: specify cosmetic defects as an average across the entire focal plane rather than across a single detector. Allow increase in bad pixels/columns on some CCDs if others are better than the requirement.
- Determine how much of the image area is deemed to be lost due to a single bad pixel or columns versus a contiguous cluster. Does a single bad column count as 4 columns lost due to the width of the PSF? (Do two contiguous bad columns count as 5 lost.)
- Alternatively does the requirements flow down take into account the recovery of bad pixels by dithering? I.e. are bad columns like gaps between CCDs?

3) Cooling system



LN2 Closed Loop Circulation System



1000L Reservoir,
LN2 pump,
300 W Gifford McMahon
GN2 condenser.
(8kW power dissipation)

Rich Schmitt

3) Cooling system

- A (mostly) closed cycle continuous flow cryostat is fed by long LN2 lines from a 1000L reservoir off-telescope where return gas is liquified by a 300W Gifford McMahon cooler dissipating 8kW.
- The DECam team estimates a thermal load of **40W** at the cryostat, 30W in the LN2 transfer system and 30W in the remote, then allows another 100W safety margin.
- WBS 1.5.2 Cooling & Purge Systems = $594,606 (FY8-10)
- Radiative transfer from window to CCDs, the dominant thermal load, was not discussed, nor was radiation shielding within the dewar shown. An independent estimate by Roger Smith indicates that the total load could vary between 25W and 65W depending on emissivity and shielding.
- A single Cryotiger can sink **35W** at -120C for a few tens of k$ (capital only) and 0.5kW dissipation at the compressor. While we do not wish to micromanage the design, this example suggests that more work on this problem could save considerable funds, simplify the cooling system, and leave room to purchase ample spares.

Recommendations

1. By CD-2 sufficient CCDs must have been fully tested to provide a more accurate yield projection, and enable the project to carry a smaller range of budget and schedule scenarios. Develop testing strategy for lot 2 2k x 2k and 2k x 4k devices in advance of CD-2, so as fully validate the assumed yield for *both* types of CCD.
2. By CD-2 develop more detailed plans for the fall back scenario in which some CCDs are replaced with better ones in Chile.
3. In both funding scenarios (1 & 2), maintain a *steady pace* in the manufacture, packaging and testing of CCDs. Ramp up to a pace which will fully engage the various participants ASAP and avoid interruptions to maximize yield.
4. Work with science team to develop a more sophisticated measure of performance yield. A formal process should be initiated to update the science requirements flow down, which should be under change control.
5. Continue to examine the options for a substantial simplification and cost saving in the cooling system. Obtain empirical data on radiative transfer from window to CCDs and the effectiveness of aggressive radiation shielding. Conduct an *external* review prior to CD2 to address this topic.