The Specification

3.65 Cosmetic defects

T-30 Cosmetic defects should account for no more than 5% loss in CCD area from non-usable pixels.

The requirement on bad columns derives from requiring no more than a 5% loss in CCD area from non-usable pixels. This allows us to operate the survey with 1 non-functional CCD in the focal plane. The budget is

- 1 non-operational focal plane CCD = 1.6%
- 10 cols ×2 lost due to glowing edge = 1%
- 10 rows ×2 lost due to glowing edge = 0.5%
- each bad column affects entire 4096 column, and 5 columns centered on the bad one (PSF size is 2 pixels), so each bad column is a loss of 0.25%
- 1.9% allocated to bad columns translates to 8 bad columns, in the mean over the focal plane.

Adjacent bad columns count as 2 columns bad plus 4 more affected, 0.3%, 3 adjacent bad columns as 0.35% and so on. Hot pixels and traps are less of a problem, if they don't affect many pixels.

This is actually a bad area specification.

But what does "bad column" mean?

SDSS

- There are many different kinds of "bad columns"
  - SDSS kept track of 6 different kinds:
    - Noisy
    - Low charge transfer efficiency
    - Hot spot:
      - single or cluster of hot pixels
    - Hot column
      - dark current past a threshold
    - Depressed column:
      - qe below a threshold, fixable with a flat field
    - Badly blocked column:
      - dead
    - http://www.sdss.org/dr3/dm/flatFiles/opBC.html

Megacam and e2v go with 3 kinds

Megacam

- Blocked column: strong trap.
  - Few dozens across mosaic
- Hot columns: hot pixel injecting charge.
  - dark current > 100 e-/pixel/hr at 173K
  - A couple across mosaic
- Depressed columns:
  - qe decrement
  - low sensitivity <80% of the mean
- bad column is one w/ >= 100 pixels of any type
- total: 0.2% of pixels are masked
- This translates into ~4 columns/CCD across focal plane

e2v

BLEMISH SPECIFICATION

Maximum allowed defect levels are indicated below.

Grade	0	1	2	5
Column defects - black or white	6	12	20	NS
White spots	450	800	1500	NS
Traps > 200e^-	30	50	80	NS
Total spots (black & white)	1350	2000	3500	NS

NS: Not specified.

Black spots are counted if the response is less than 50% of the local mean.

White spots are counted if they have a generation rate equivalent to 300 e^-/pixel/min at –100 °C.
(This is equivalent to a previously used definition of 100 e^- /pixel/hr at –120 °C).

Note: This deep-depletion variant has a different cosmetic specification to the standard silicon device.

Bad Columns in the DES

- How are we to approach a finer definition?
  - Adopt a S/N approach (we'll explain later)
    - Survey modeled as area, SN
  - Or the conventional approach, individual specs
    - Noisy
      - accept if noise <= sky noise < g?
    - Low charge transfer efficiency
      - accept if greater than 2x normal spec ?
    - Hot spots or clusters
      - count as fractional bad columns
    - Hot column (dark current past a threshold)
      - accept if dark subtracts out w/n sky-noise in g ?
    - Depressed column
      - qe below a threshold, fixable with a flat field
      - if so, and "fixable" means still have dynamic range to measure sky level in z, accept
    - Badly blocked column:
      - count as fractional bad column

e2v/Megacam ignores these two

G.B. notes that these are effectively cosmic rays and can be ignored if they are less common the CRs

This is the one that our spec addressed

- Essentially, if one can make any useful measurement of light with the pixel, it isn't "bad"
  - just misunderstood
- The current test is conservative
  - Current test:
    - |(column mean)-(neighbor col mean)| > 5σ
    - 10,000 e-, so 5σ is ~ 5%
    - any column that fails this is called labeled a "bad column"
  - If CCDs pass it, they -will- pass more detailed tests
- Since this is a yield limiting step,
  - more detailed tests
  - which will have the effect of being less conservative

The S/N Approach

Survey Signal-to-Noise Metric

- Define a generic signal-to-noise metric which accounts for the effects of survey area and depth on the S/N for an object
- It's basically given by S/N ∝ sqrt (area * exposure time), i.e., ∝ sqrt (number of photons)
- But you also account for the effect of lost area and depth, e.g., due to CCD bad columns, tiling strategy, etc.

S/N Example Calculation

- Galaxy in the r band
- N = 4 tilings
- f = 0.1 = area lost due to gaps between CCDs
- Define full DES area = 1
- Define full 4-tiling exposure time = 1

- Signal from area with full exposure time: (1-Nf) * (1)
- Signal from area with partial exposure time: (Nf) * [(N-1)/N]
- Total signal = (1-Nf) + f(N-1) = 1-f (makes intuitive sense)
- Total S/N = sqrt (1-f) (relative to full area and full exposure time)

- In detail we would use the actual DES tiling coverage distribution

- Will make S/N table for objects at different magnitudes, starting with galaxy at i=24 survey limit, and different lost area (f = 0.05, 0.1, etc.)

Connecting to Key Projects

- S/N metric should be reasonable for clusters and BAO, which rely on coadded imaging data (i.e., 1 bad column counts as 1 bad column)
- Supernovae and weak lensing rely more on individual exposures
- For example, for WL 1 bad column counts as multiple bad columns to account for impact on PSF measurements: a bad column w/i ~ a FWHM of a star makes it unusable for PSF determination
- Current bad column multiplier is 5
- Have started discussions with SN and WL working groups to firm up the usable area requirements
- Need to also consider lost area impact from glowing edges, as well as additional unavoidable losses due to cosmic rays and saturated stars