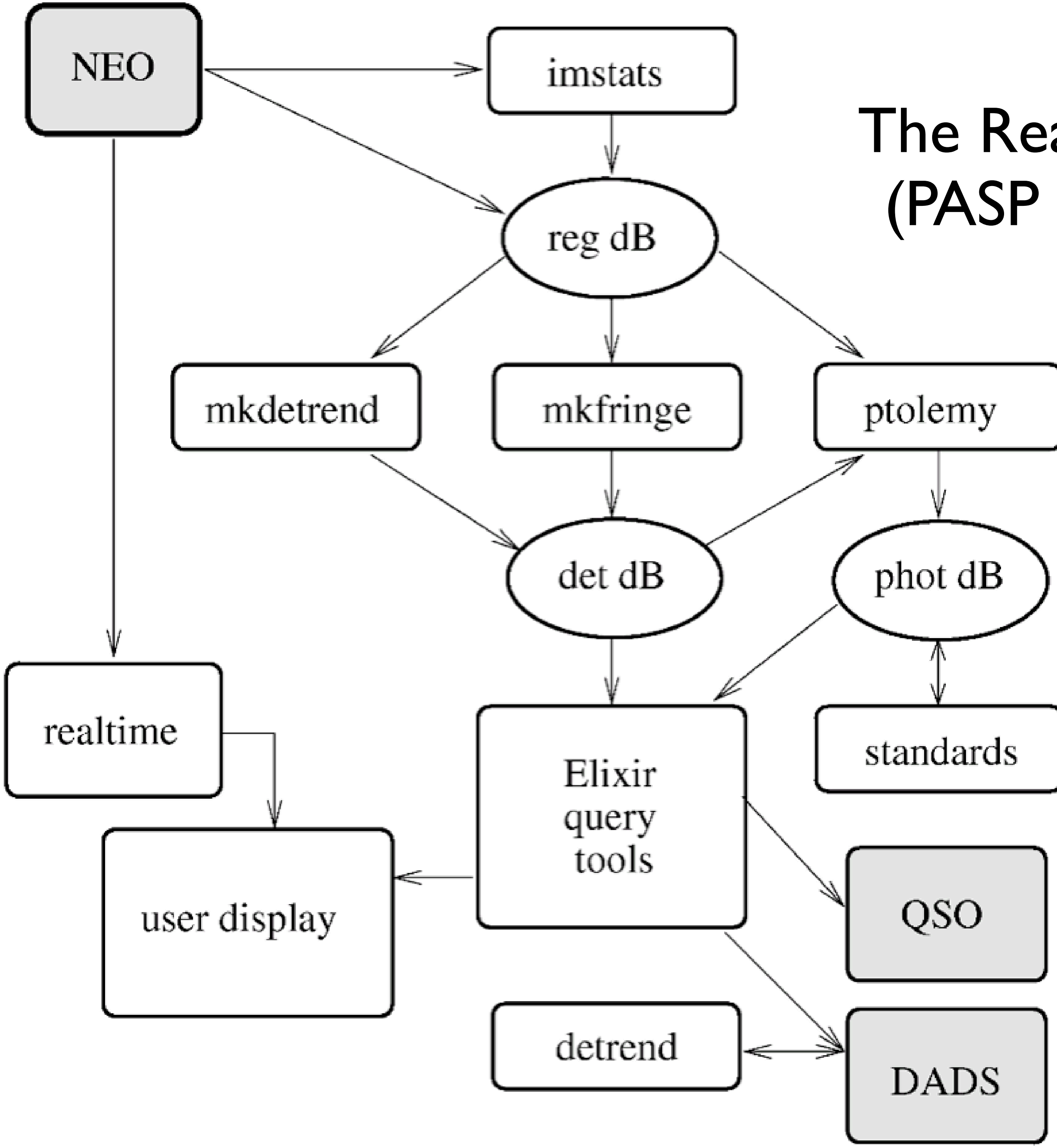
Elixir

Cause and Cure

The Real Fig 1?
(PASP paper)



Elixir Overview

- Databases: Image, Detections, Photometry
- Software: Image ops, DB interfaces
- Hardware:
  - Parallel CPUs, quick response
  - Data Storage

Photometry Impactors

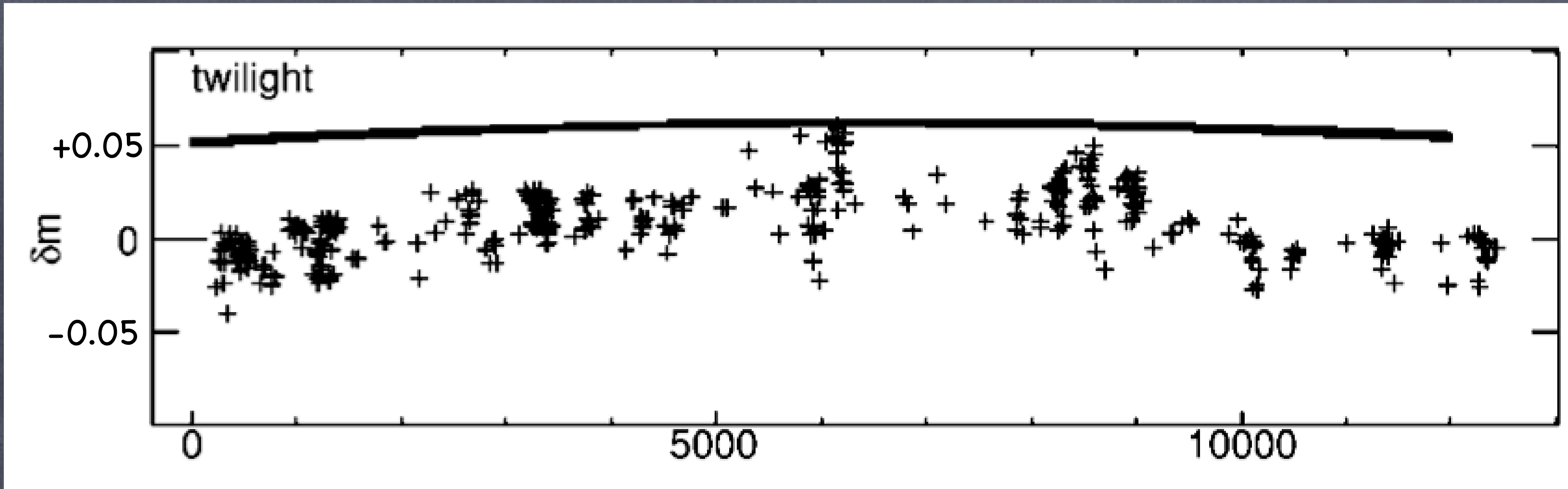
1. Flat-fielding
   a. Twilight Flats
   b. Photometric Superflats
2. Fringe correction for i′ and z′
3. Zeropoint (thanks, we′ll do our own)
4. Color term (maybe this too)

Systematics

* Random errors will average out
  - Spatial variations (no problem)
  - Color variations (problem for SNe)
* Must quantify and minimize systematics
  - Requires minimizing random errors
  - Must average to correct mean
* Consider SEDs of calibrators and SNe

Twilight Flats

1. Dark sky has fringes (O, H, OH line emission)
2. Dome flats suffer from uneven illumination
3. Twilight is continuum emission, even illum.
4. Good for high spatial frequency variations
5. But...



X (pix)

Flats -> flat sky, this is photometrically incorrect:
1. Varying pixel scale (2% for MegaCam)
2. Scattered light? Vignetting?

Sky concentration variations, not resp. variations

Use dithered photometry to correct flats

Stellar Flat Field Calibration Procedure

- Procedure outlined by Manfroid (1995,1996)
- Acquire 9-16 frames of a standard star cluster (Stetson 2000), each frame with non-parallel offsets
- Apply the standard image reductions including a high S/N flat field
- Apply the following minimization to the observations:

$$\chi^2 = \sum_{f,s} \frac{\left| m_0(f,s,\mathbf{x}) - m(s) - a(f) - \sum_i b_i \varphi_i(\mathbf{x}) \right|^2}{\sigma(f,s)^2}$$

where f=frame, s=star, **x**=position, and b_i are the coefficients to a polynomial $\varphi_i(\mathbf{x})$. The frame zeropoint can be described as

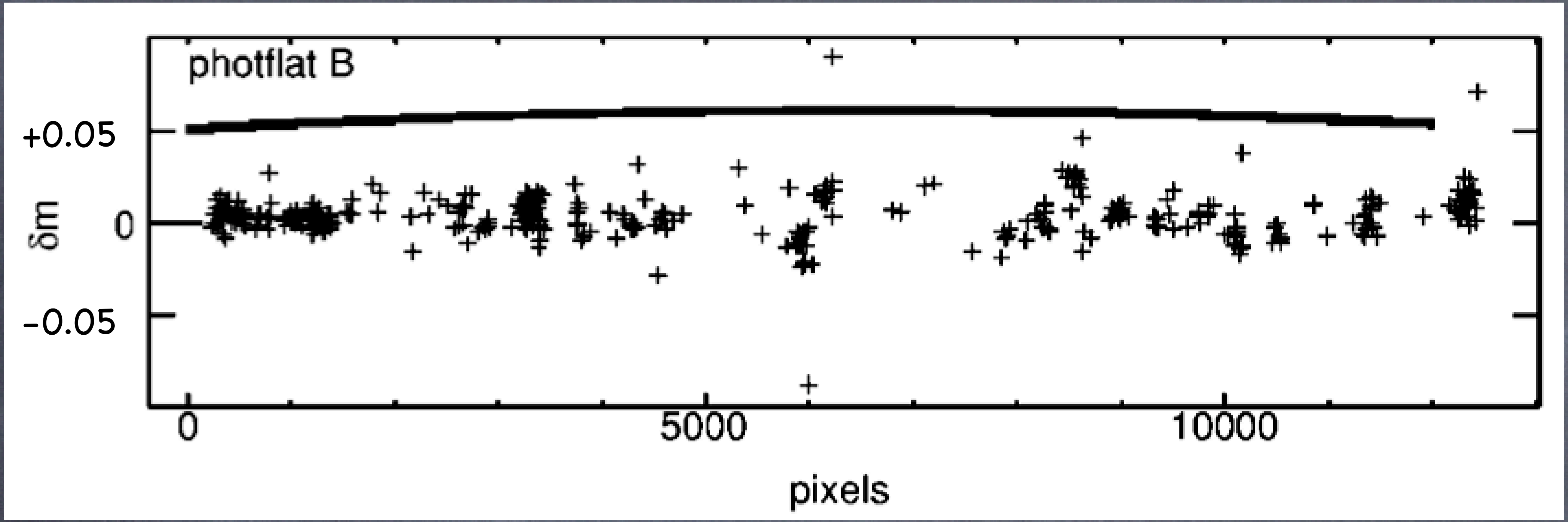
$$a(f) = a_0 + kX(f)$$

where X is the airmass of the frame.

- Result: A 2-D polynomial correction to the flat field in that band

(Nick Mostek, Indiana University)

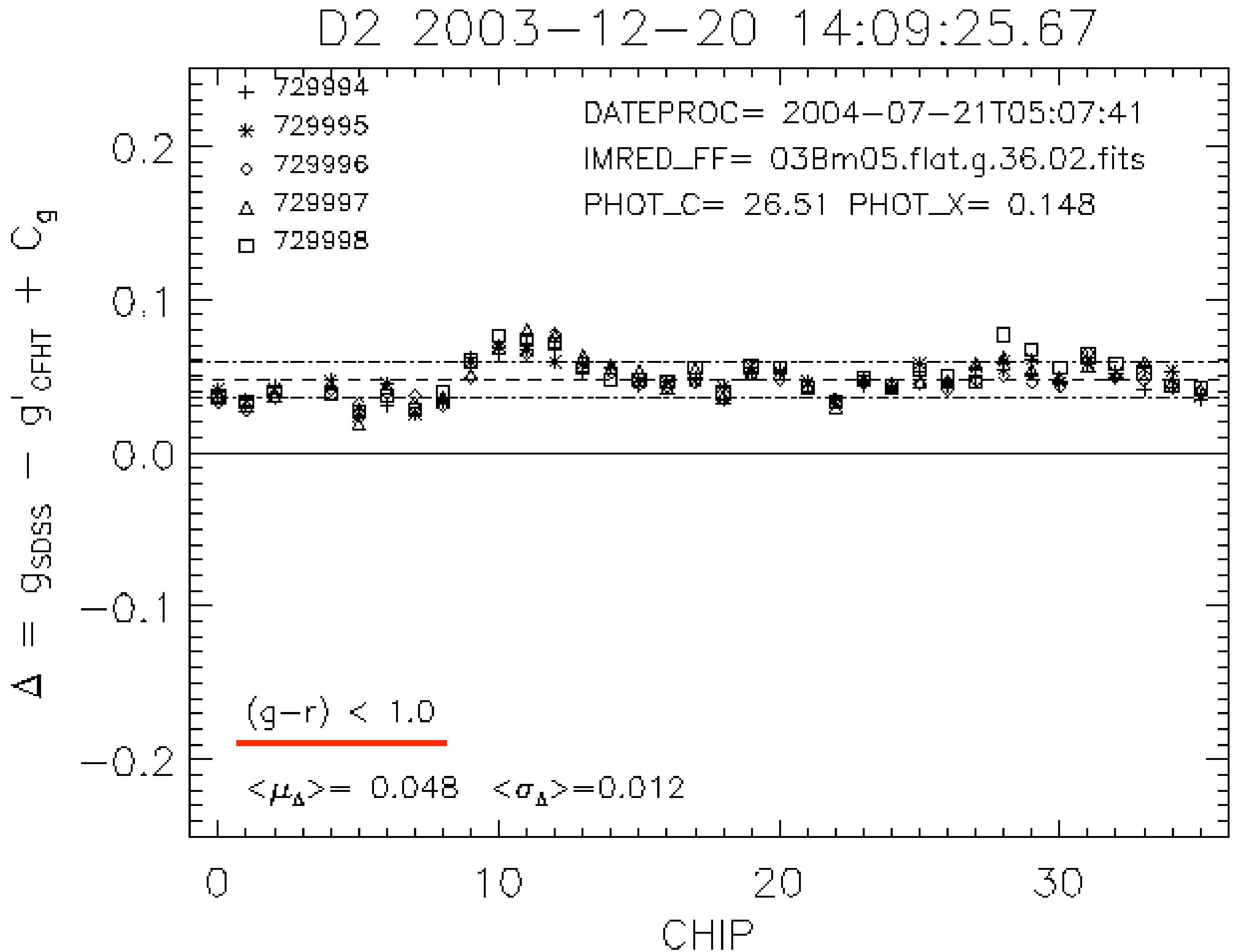
http://mimosa.astro.indiana.edu/snap/docs/WIYN_Status_Calib04.ppt



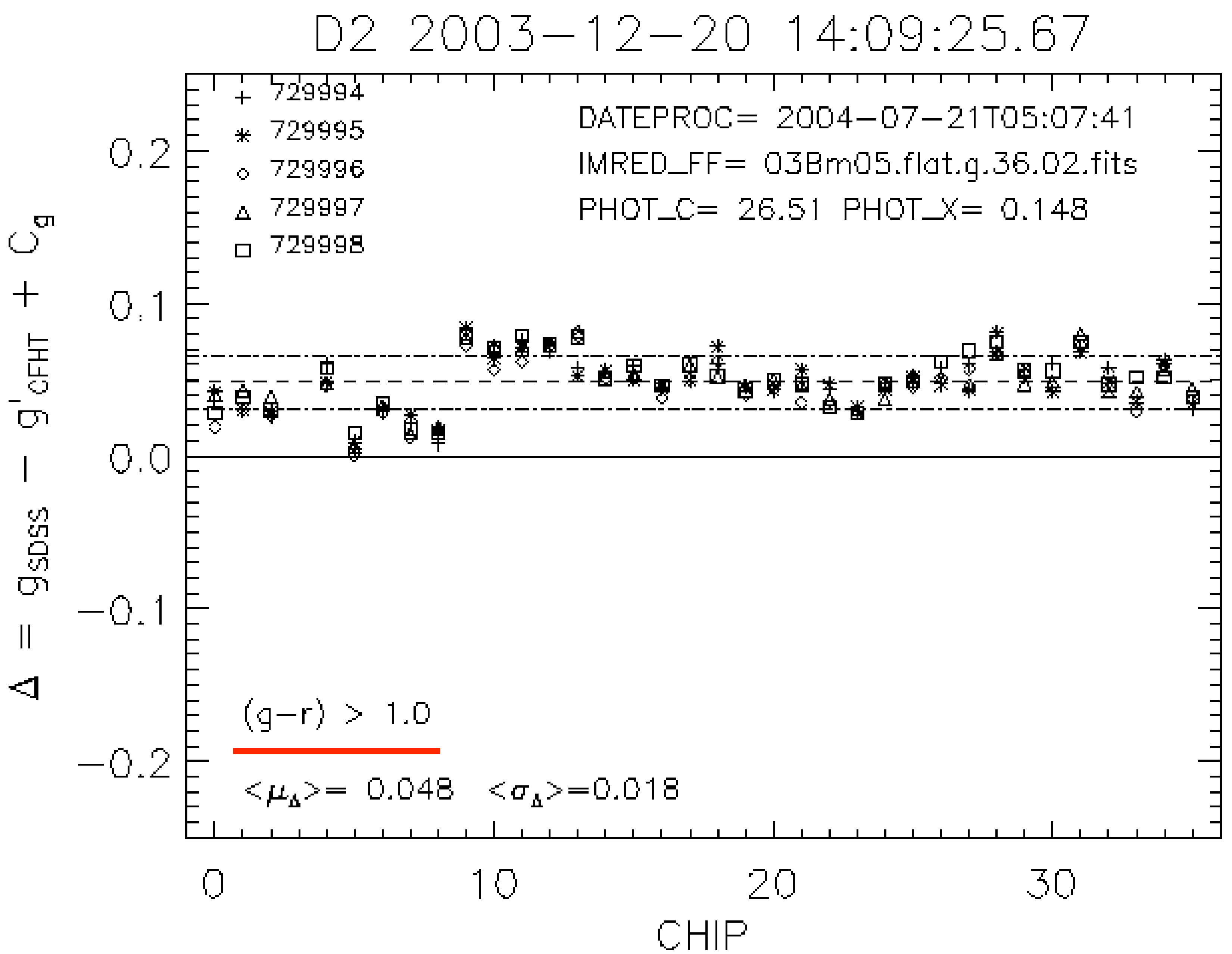
Corrects photometry to common zero point

Apparently reduces photometric error to ~1%,

For stars with color near that used for grid:



D2 2003-12-20 14:09:25.67
729994
729995
729996
729997
729998
DATEPROC= 2004-07-21T05:07:41
IMRED_FF= 03Bm05.flat.g.36.02.fits
PHOT_C= 26.51 PHOT_X= 0.148
(g-r) < 1.0
<μ_Δ>= 0.048 <σ_Δ>=0.012
Δ = g_SDSS - g'_CFHT + C_g
CHIP



D2 2003−12−20 14:09:25.67
729994
729995
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729997
729998
DATEPROC= 2004−07−21T05:07:41
IMRED_FF= 03Bm05.flat.g.36.02.fits
PHOT_C= 26.51 PHOT_X= 0.148
(g−r) > 1.0
$<\mu_\Delta>$= 0.048 $<\sigma_\Delta>$=0.018
$\Delta = g_{SDSS} - g'_{CFHT} + C_g$
CHIP
0.2
0.1
0.0
−0.1
−0.2
0
10
20
30

- Amount of random error is color dependent
- No global systematic offset with color
- If calibrators available on few chips could result in systematic error
- Test other filters

A Better Way?

- A region of photometrically calibrated objects (e.g. Stetson fields)
- Determine correction as a function of color: this is indicated by lack of structure in r′ SDSS comparison, which has no color term
- Skip photometric superflat and apply calibration surface with zeropoint, colorterms as function of (x,y, color)

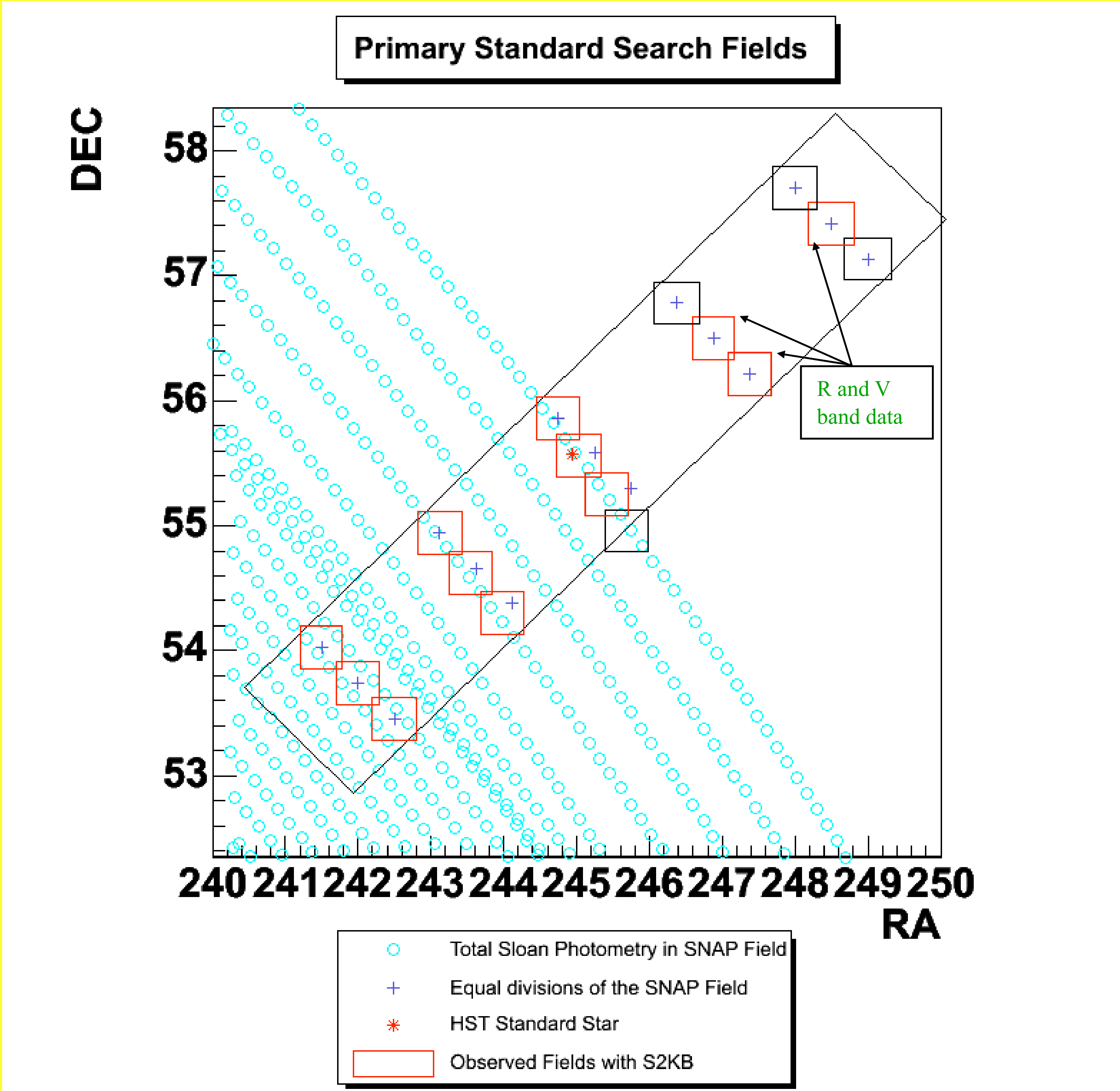
Fringe Correction

- Combined with other types of additive corrections that vary from image to image
- High and low spatial frequency decomposition
- Basis functions (what sounds like principle component analysis)
- Claim residuals of 5-10 counts peak-to-peak on 3000-5000 count background
- Details in a submitted paper (PASP)

Possible Improvements

- Photometry for grid analysis (not MAG_BEST)
- Verify that no systematic effects arise because of color differences in grid stars and objects of interest
- Test other methods for generating photometric flat
- Develop large field calibrated regions (being done for SNAP)

Nick
Mostek


Primary Standard Search Fields
DEC
58
57
56
55
54
53
240 241 242 243 244 245 246 247 248 249 250
RA
R and V
band data
Total Sloan Photometry in SNAP Field
Equal divisions of the SNAP Field
HST Standard Star
Observed Fields with S2KB