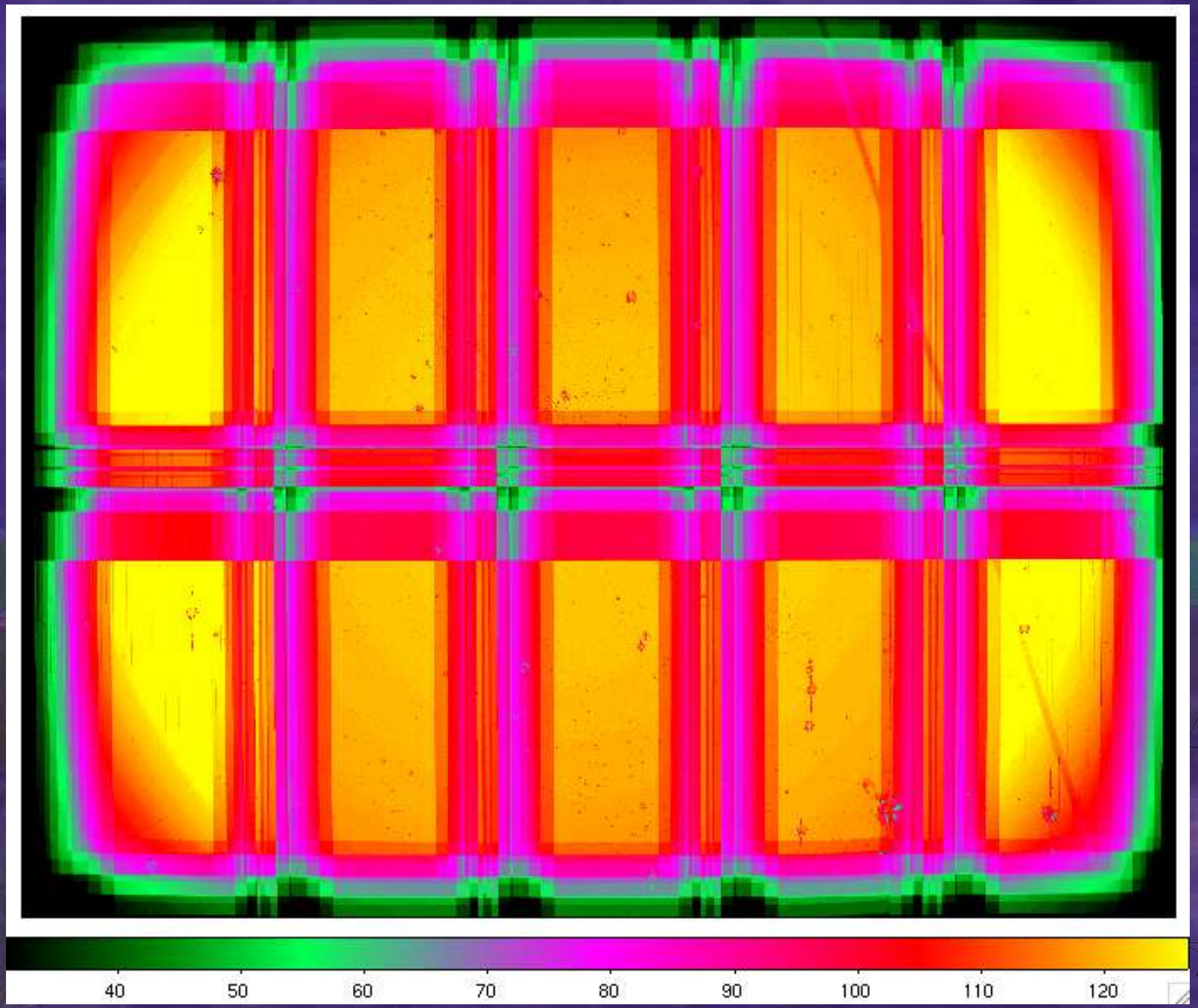
N4244 confidence map stack 20 dithered i-band frames

Subaru 8m

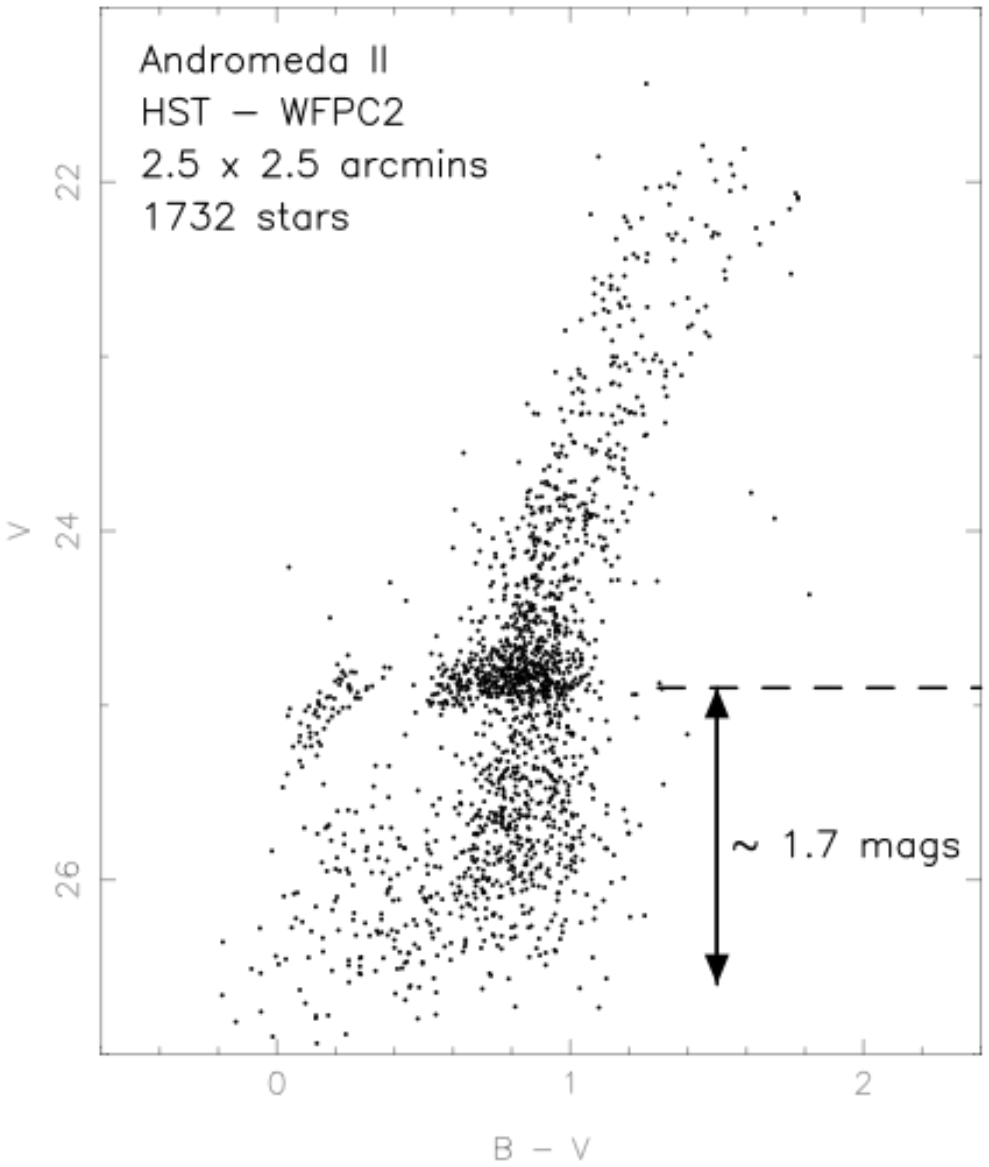
CTIO 4m
KPNO 4m

CFH 3.6m

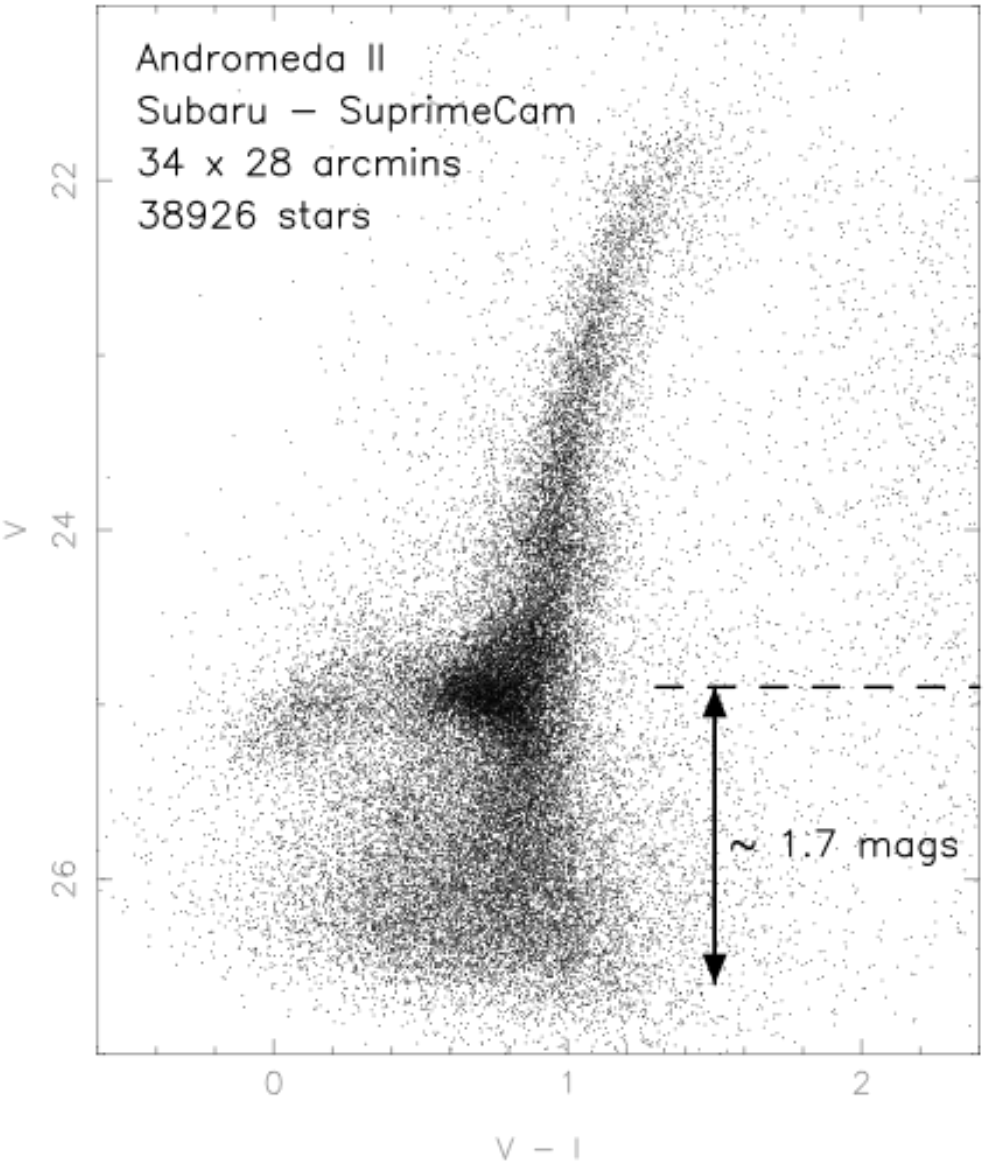
INT 2.5m
ESO 2.2m



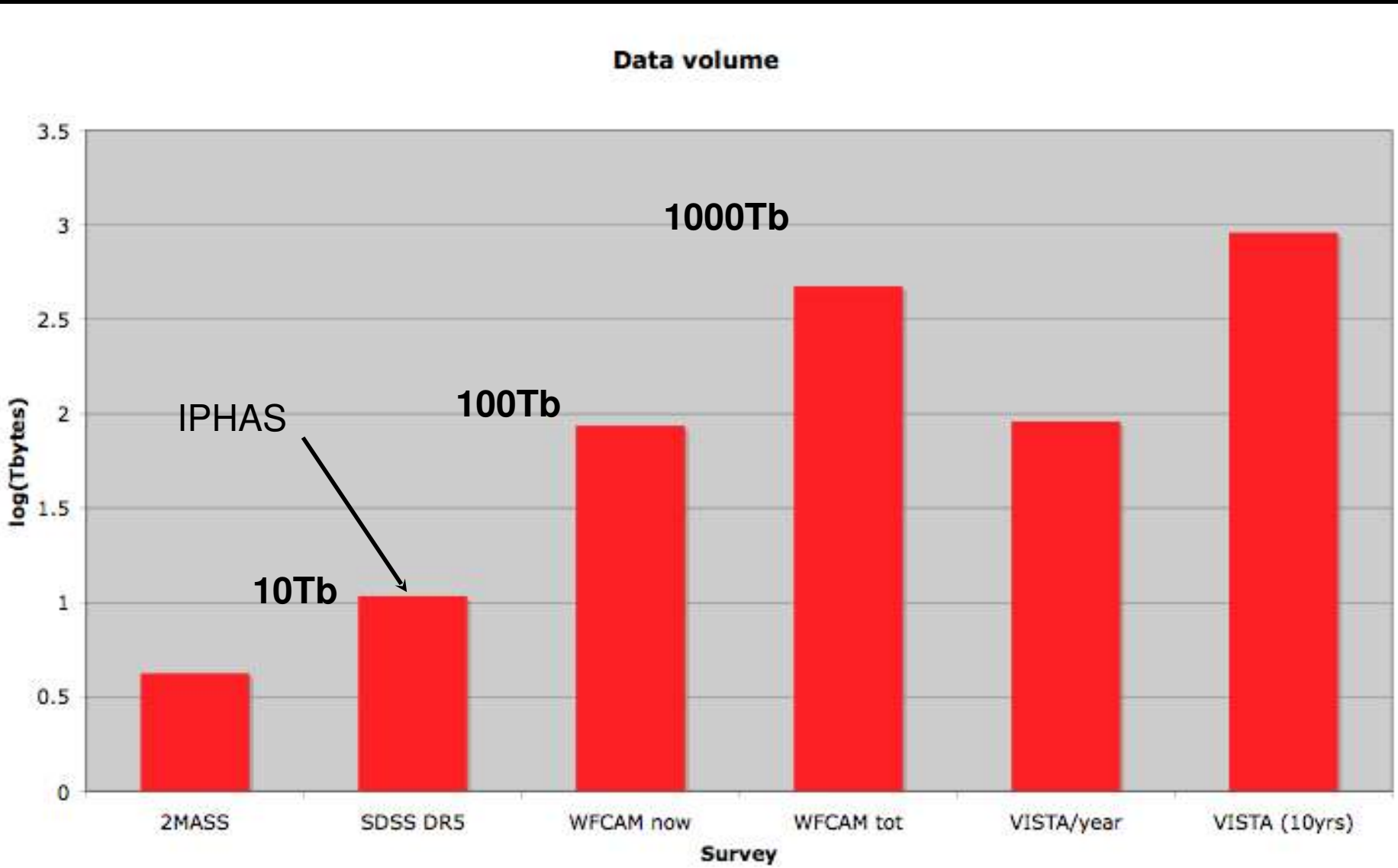
DART



WFPC2



SuprimeCam


Data volume
3.5
3
2.5
2
1.5
1
0.5
0
log(Tbytes)
1000Tb
100Tb
IPHAS
10Tb
2MASS
SDSS DR5
WFCAM now
WFCAM tot
VISTA/year
VISTA (10yrs)
Survey

overall data structure

- all primary I/O multi-extension FITS files (MEFs)
- telescope info PHU, detector-specific info SHU

- raw + processed data stored Rice-compressed
  = lossless + FITS + efficient + 3-5 less storage
- LTO tape backups for offline store
- reliable transfer of data often a bottleneck
- object catalogues generated as MEF binary tables

overall processing philosophy

- pipelines driven by FITS keywords
  + overall observing structure
- pipeline processing controlled from scripts
  - use individual software modules for specific tasks
- use CFITSIO for I/O and access to headers
- derived QC parameters stored in FITS files
  - database for monitoring QC information
    + survey progress
- procedure driven by science requirements

image processing

$$D(x,y) = f(x,y)\ [S(x,y) + F(x,y) + O(x,y) + T(x,y)] + d(x,y)$$

flat sky fringe objects thermal dark/bias

Stack $\hat{I}(x,y) = f(x,y)\ [S(x,y) + F(x,y) + T(x,y)] + d(x,y)$

$$D(x,y) - \hat{I}(x,y) = f(x,y)\ O(x,y)$$

Master calibration frames

$$D'(x,y) = S(x,y) + F(x,y) + O(x,y) + T(x,y)$$

example - WFCAM processing steps

- prepare - ingest MEFs, check, index, select, preview, process
- instrumental signature removal - darks, flats, curtains, cross-talk
- sky artefact correction - group master skys by time/ OB
- combine - compute shifts, interleave, stack dithers
- catalog - detect and parameterise objects [aperture photometry]
- classify - morphological classification [curve-of-growth]
- astrometry - astrometric calibration per detector
- photometry - photometric calibration per pointing [detector gain]
- check - examine QC, reject bad products, visual inspection

INT WFC example IPHAS data processing

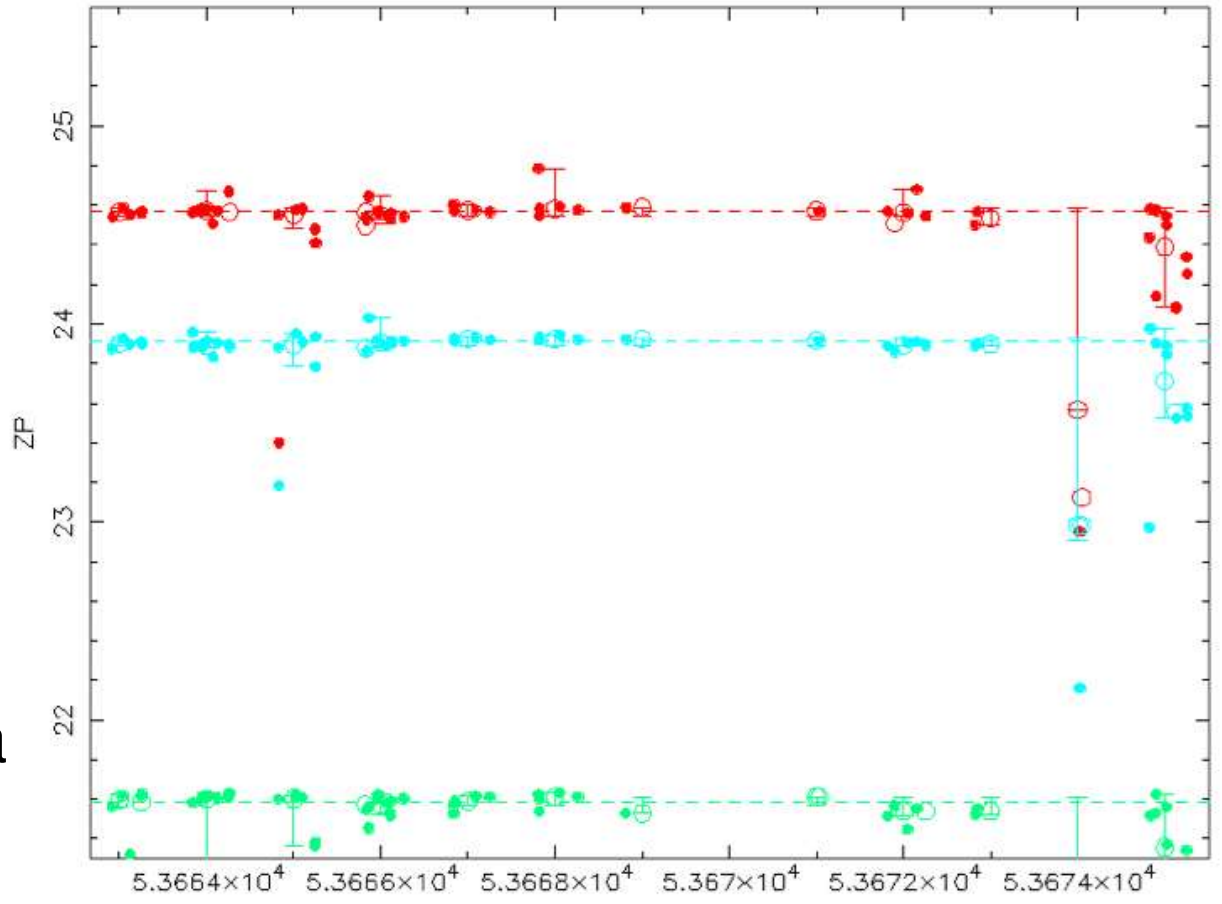
- automatic internet transfer of data from La Palma
- fix header problems insert approx. WCS, [linearize]
- create master bias, flats, [fringe frames]
- trim, bias-correct, flatfield (inc. gain corr), [defringe]
- confidence maps, generate catalogues
- astrometry based on 2MASS => ICRS *
- photometry based on nightly stds observations (5)
- Halpha tied to r' calibration *
- merge passbands generate CMDs, two-colour diagrams

IPHAS photometric calibration Oct2005b

r’

i’

Halpha

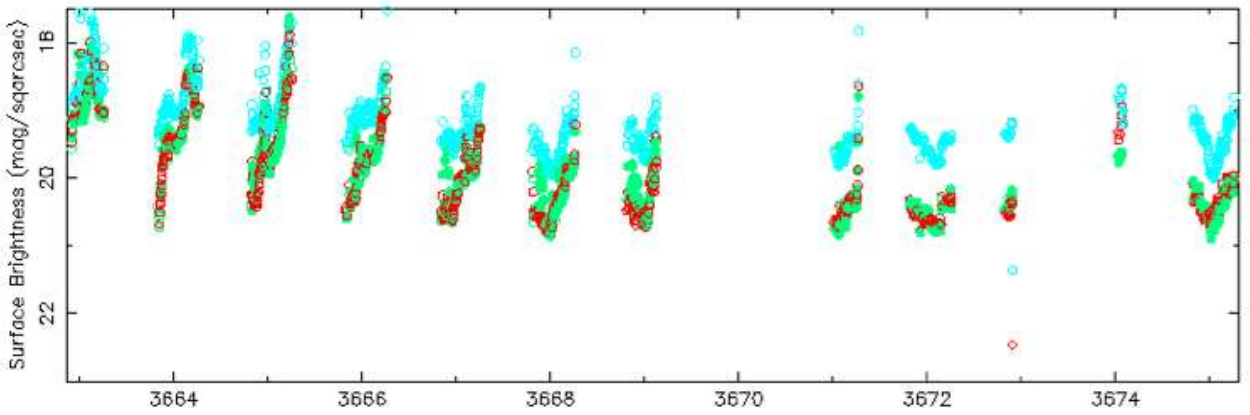


MJD

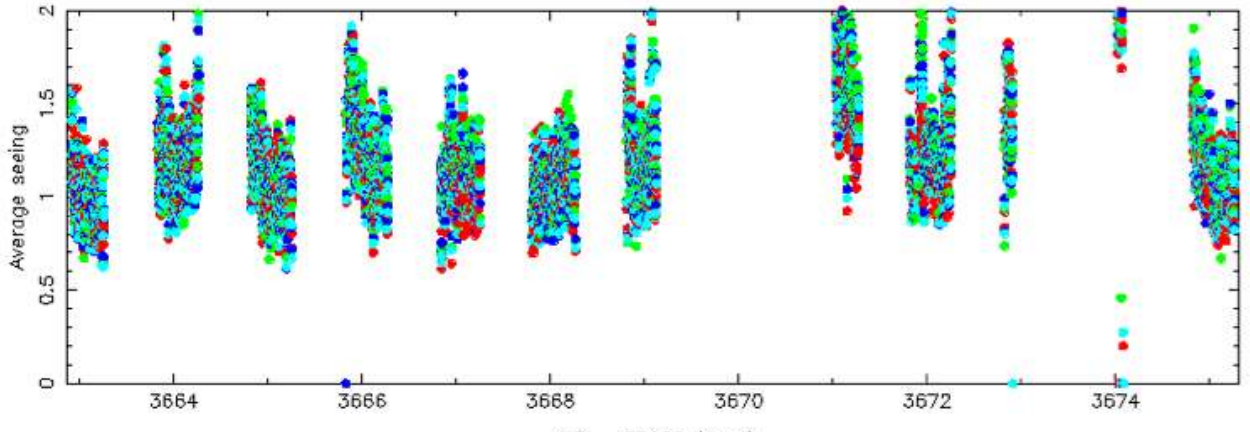
QC information from catalogues

- sky brightness + sky noise - estimate depth ?
- average FWHM of stellar images - seeing ?
- average ellipticity of stellar images - trailing ? focus ?
- aperture corrections - peculiar PSF ?
- astrometry - pointing ? residuals ?
- NIR = photometric calibration per pointing - extinction ? throughput ? problem images ?
- optical = photometric calibration per standard field per night -> week

SB

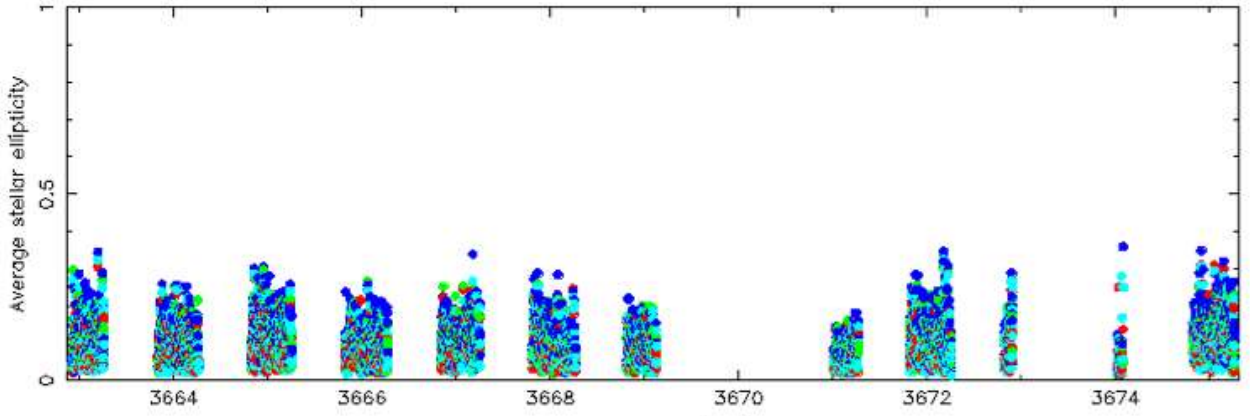


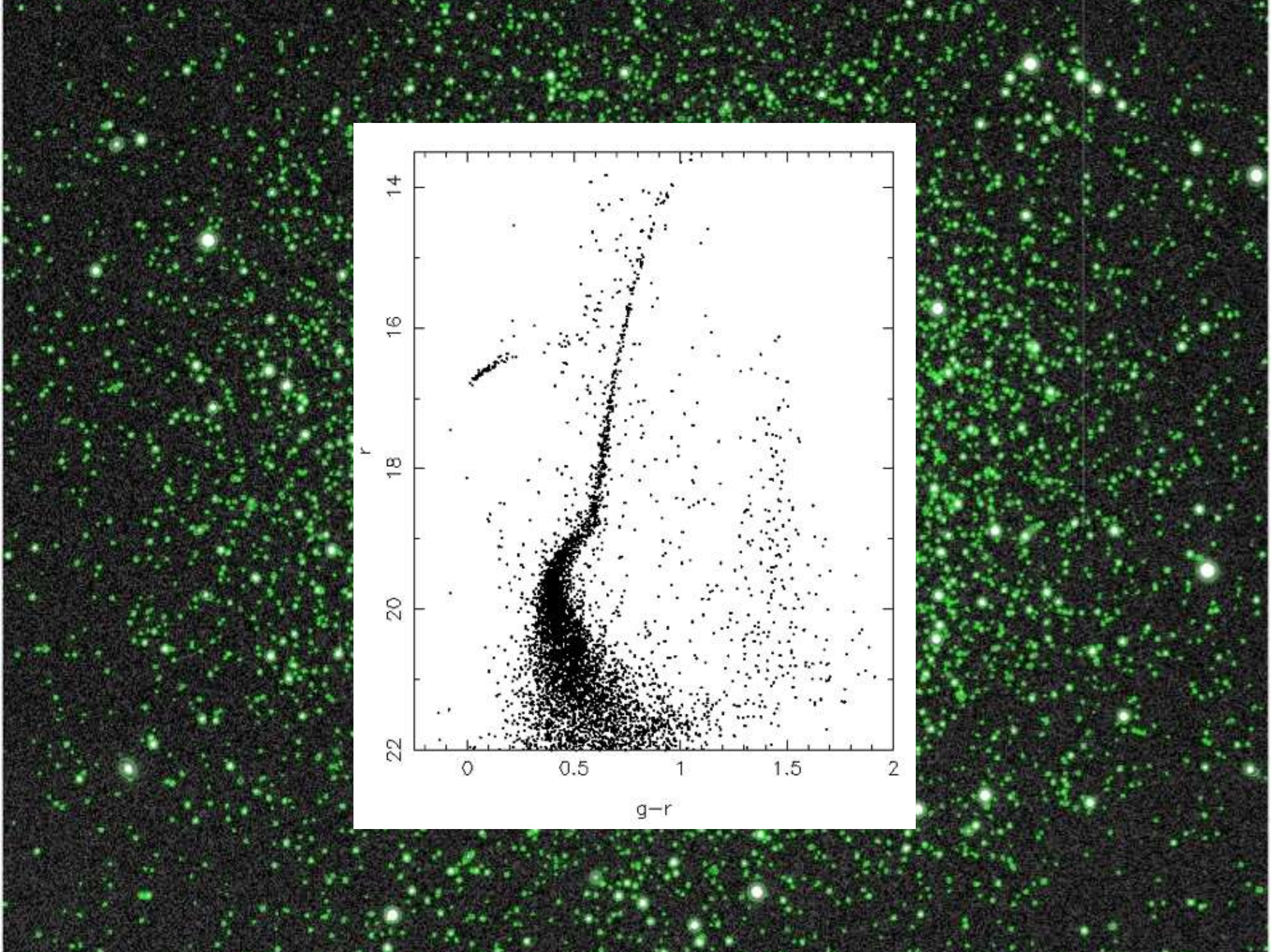
Seeing



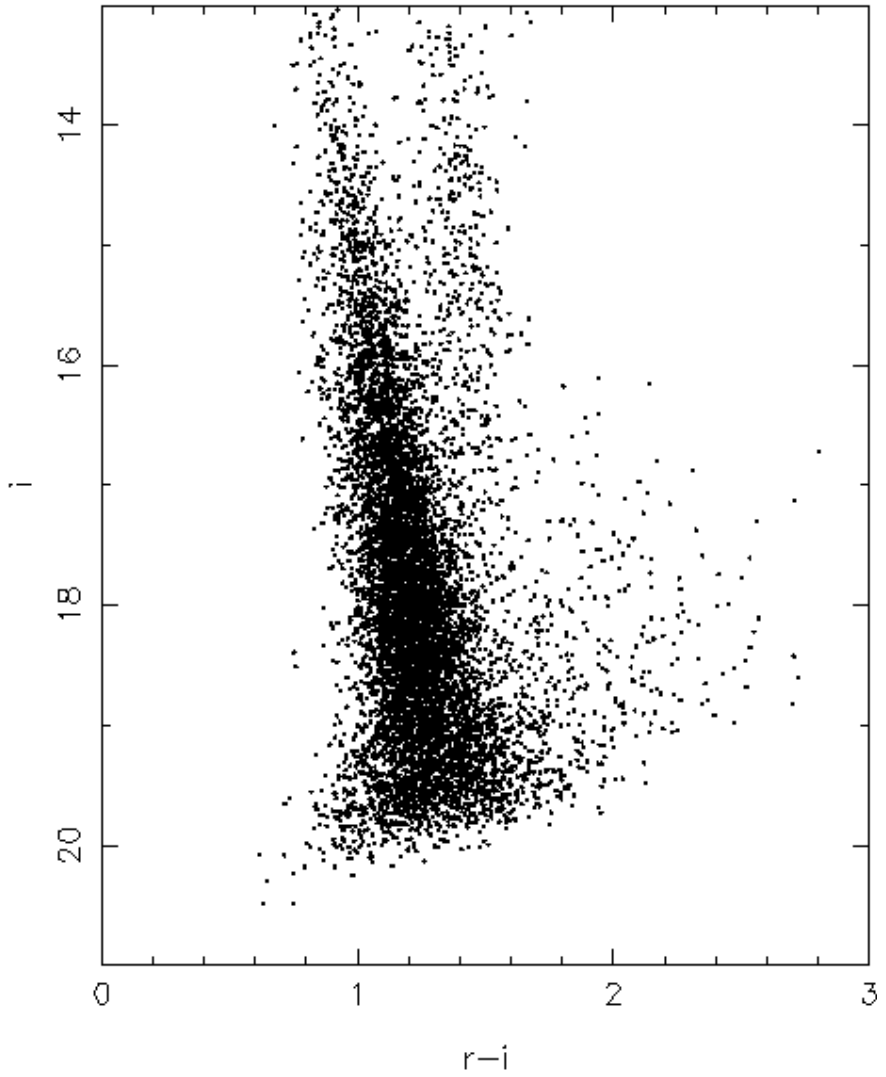
MJD - 50000

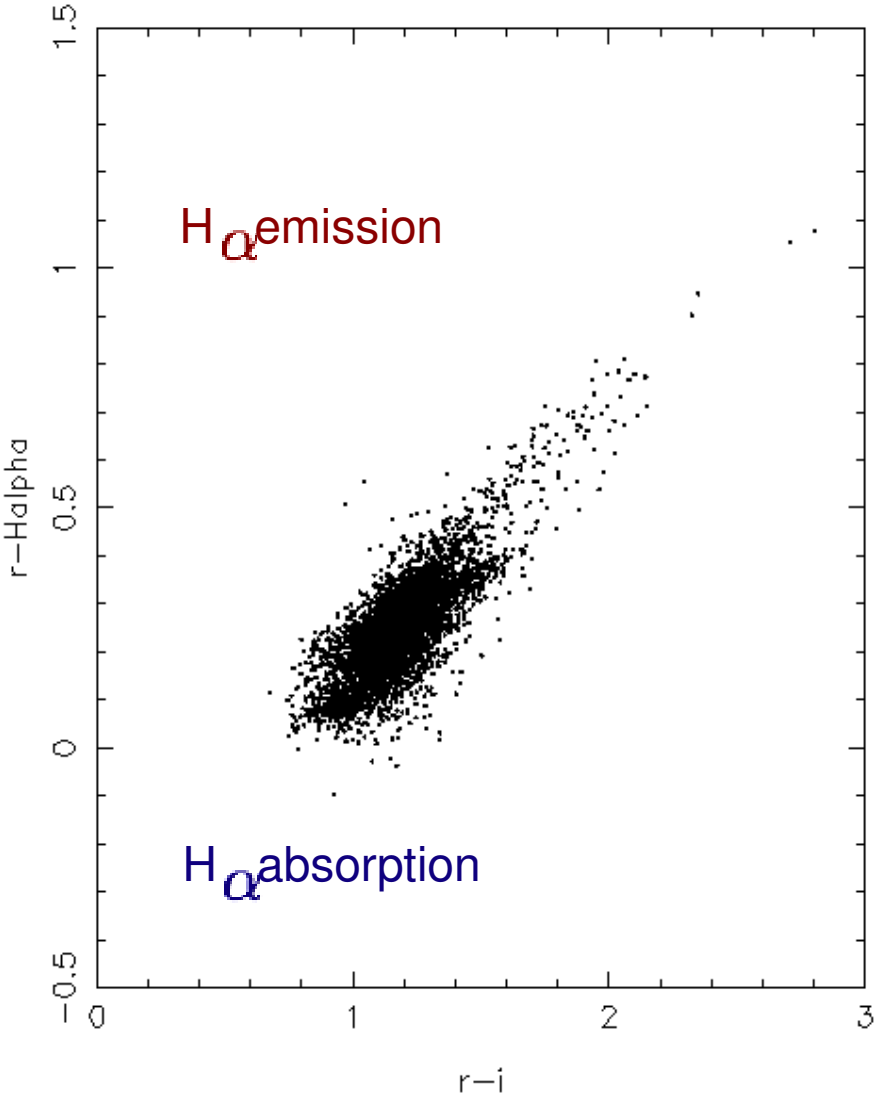
Ellipticity




14
16
18
20
22
r
0
0.5
1
1.5
2
g−r

IPHAS = 7500x2 GP fields 20 < l < 220 -5 < b < +5





Astrometric Calibration 2MASS [UCAC, SDSS]

WCS - ZPN projection $r' = r + k_3 r^3 + k_5 r^5 ...$

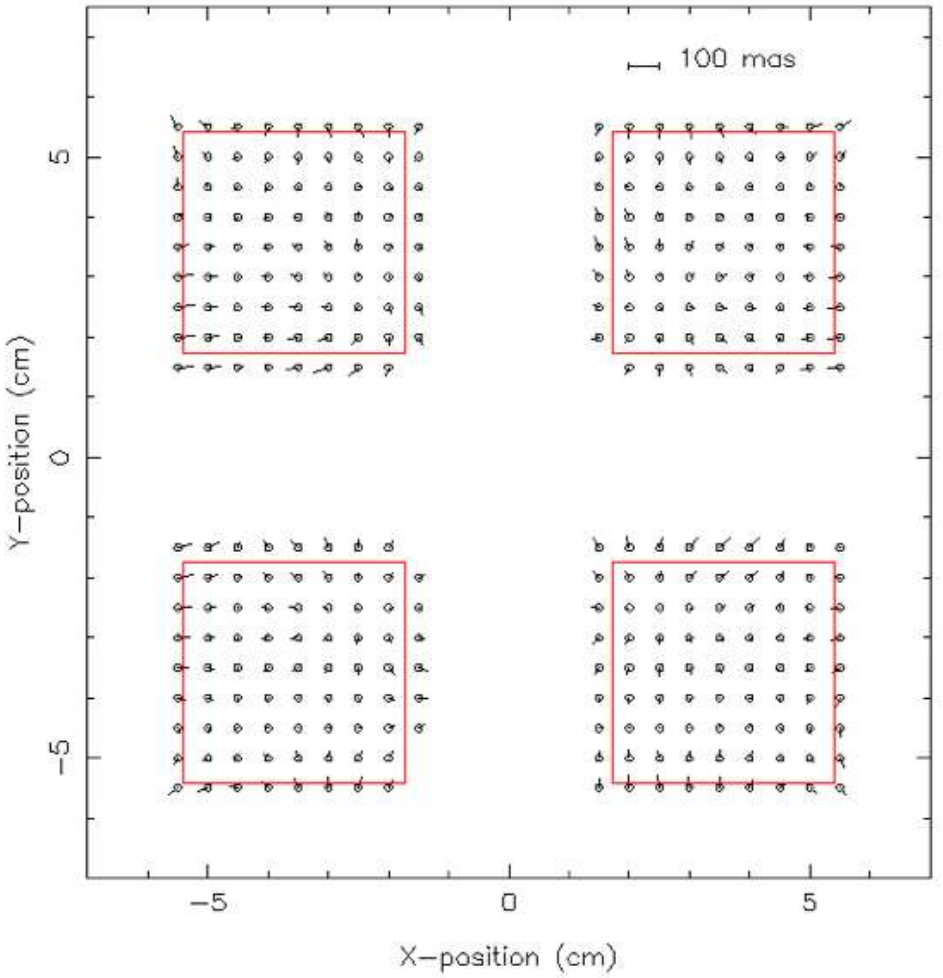
Linear solution per detector

$$\xi' = ax' + by' + c$$

$$\eta' = dx' + ey' + f$$

⟶ rms < 100 mas

Tabulated systematics from stacked residuals

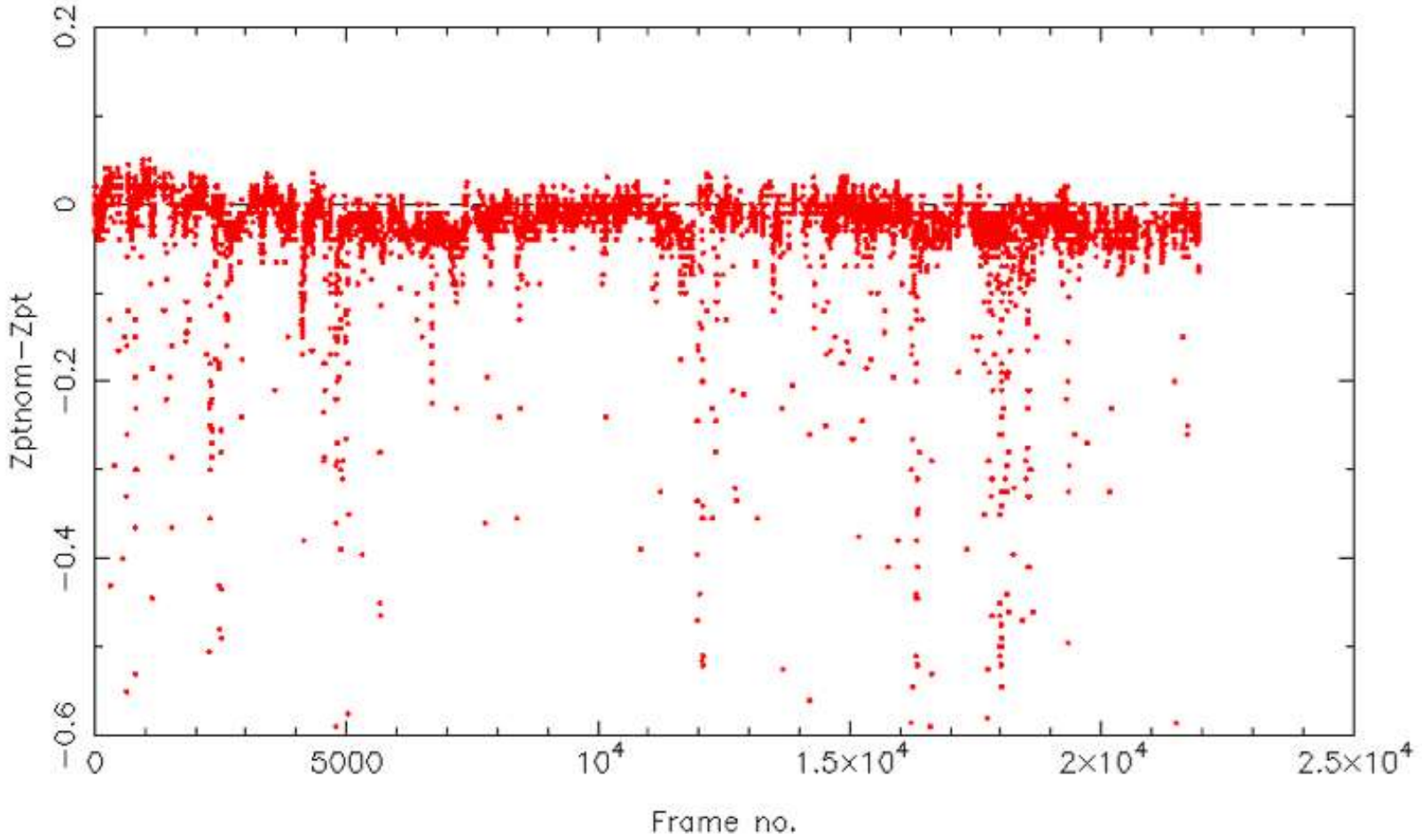


Photometric calibration

NIR - 2MASS + FS fields; optical - SAs + SDSS + (skymapper)

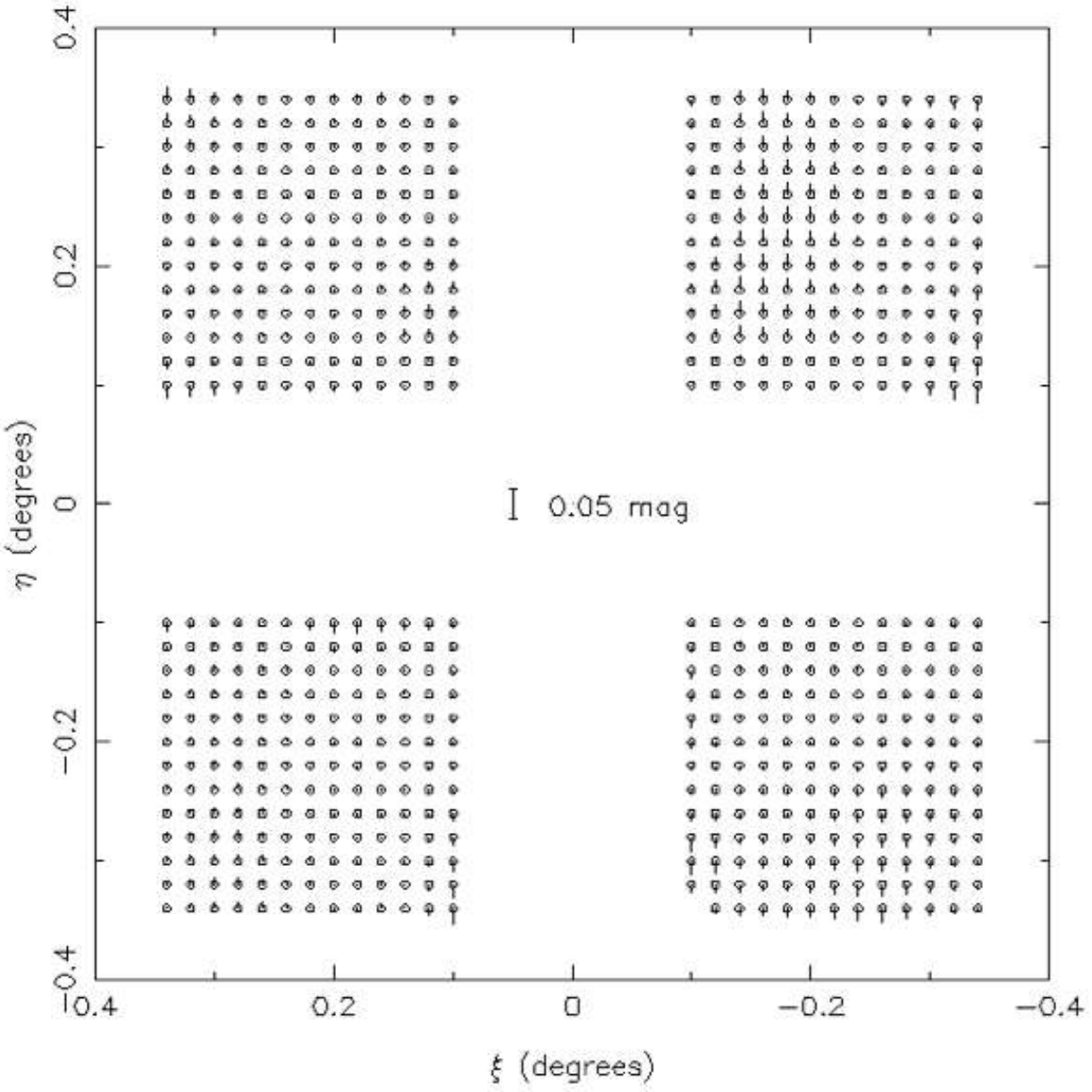
- colour equations to convert to instrumental system
- 2MASS s:n> 10 in J,H,Ks and 0 < J-Ks < 1 (GP extinction)
- NIR ~100-1000 “standards” per pointing; optical ~10-50
- required to be stellar and unsaturated (8m-class imagers)
- NIR -> Zpt + error per pointing; compare with FS fields
- optical -> Zpt + error per night/week

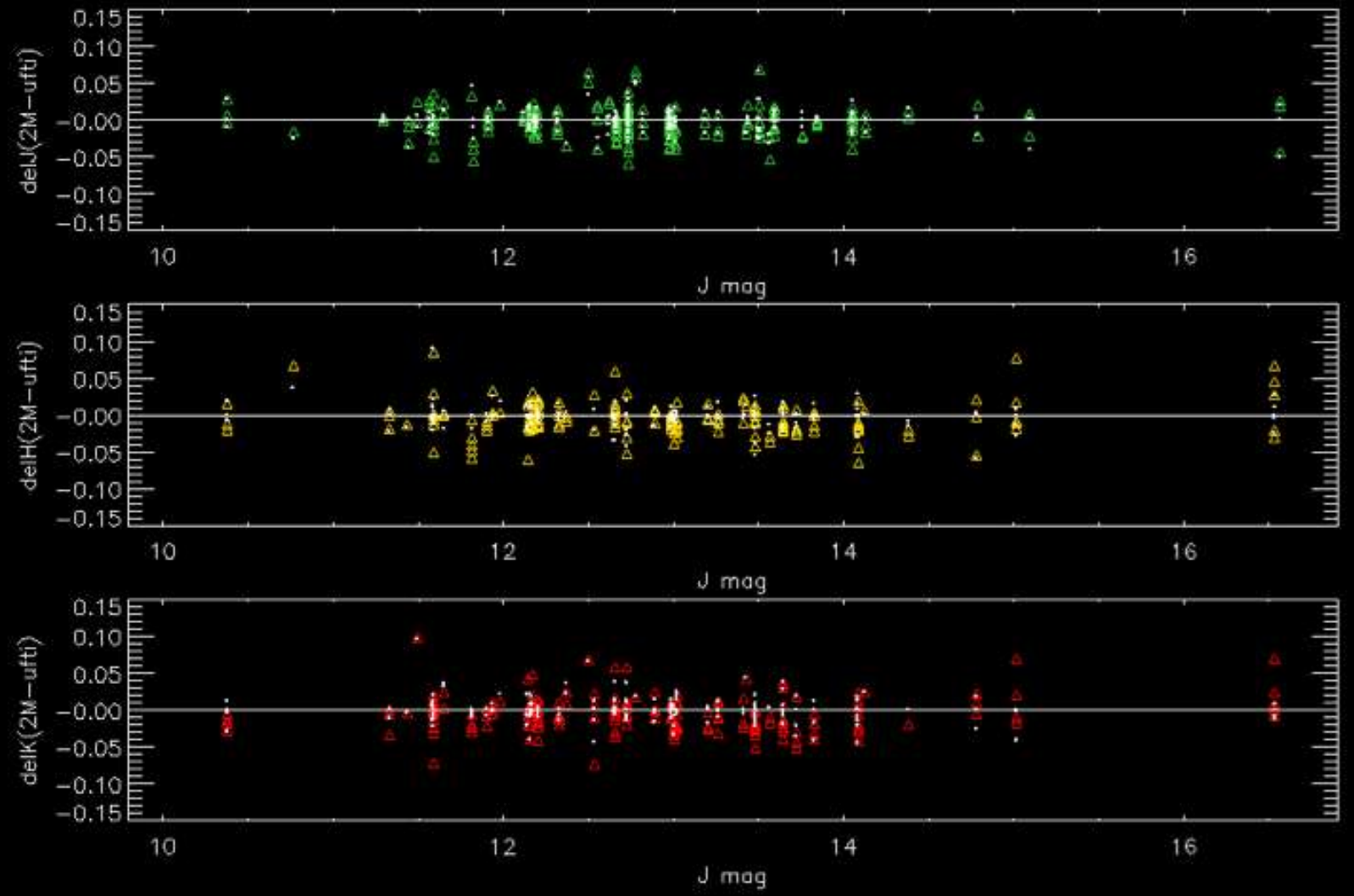
WFCAM K-band ΔZpt semester 05B

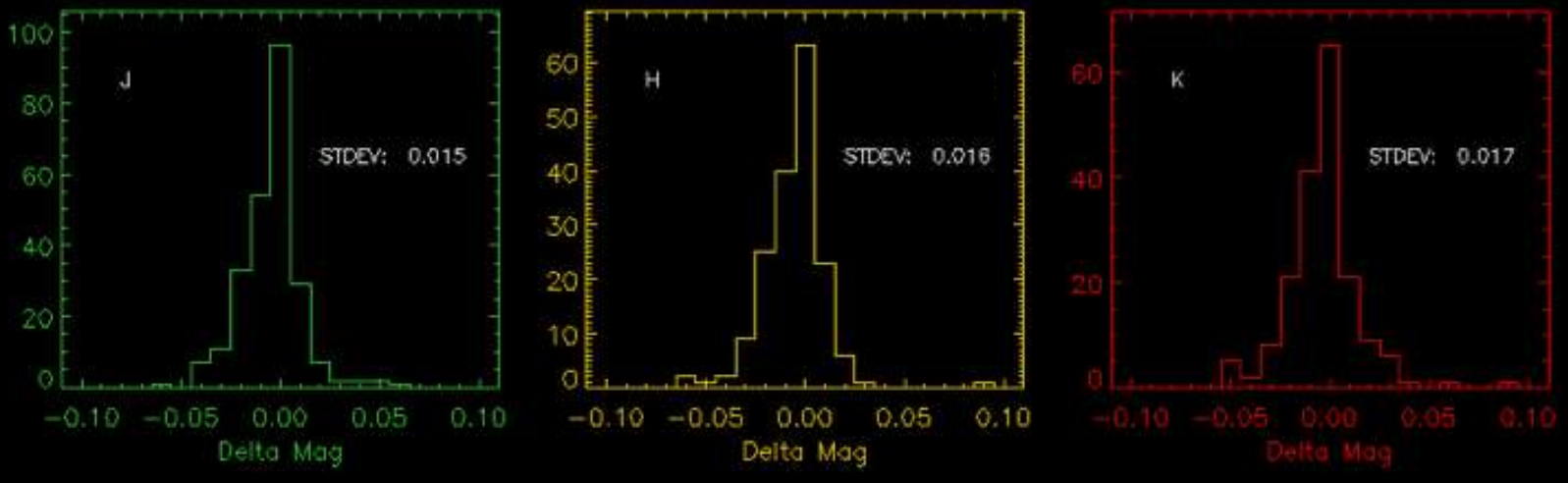


Example WFCAM illumination correction

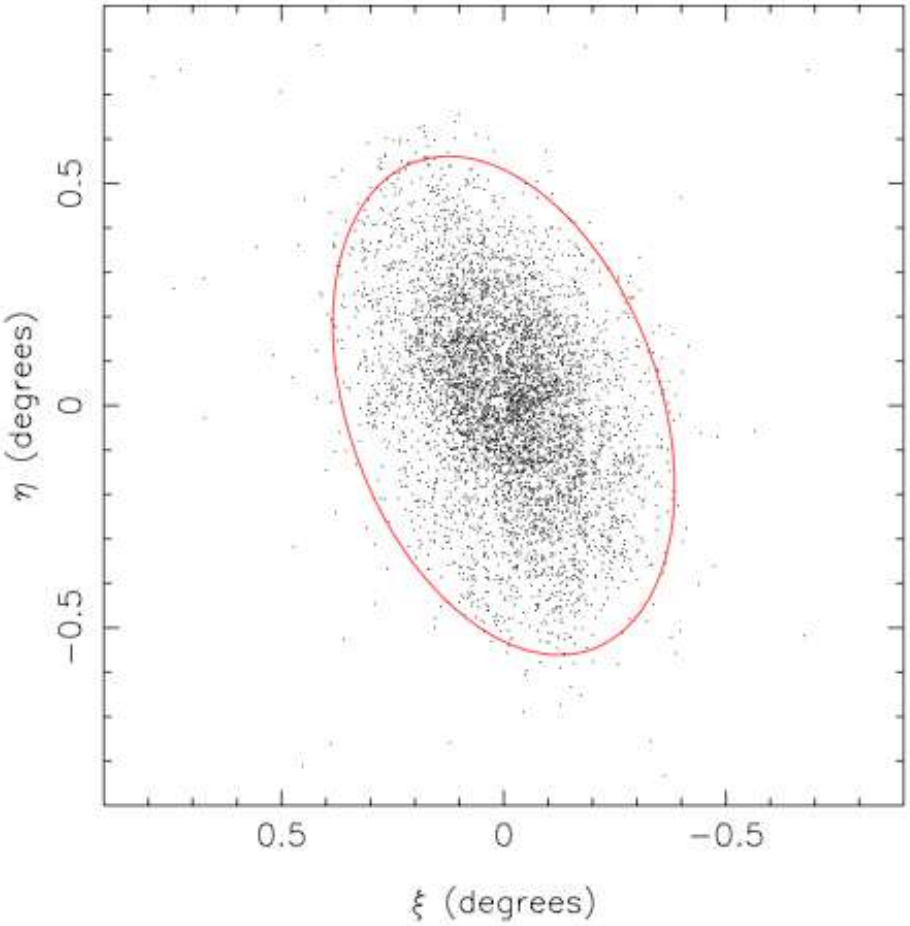
4” diam aperture

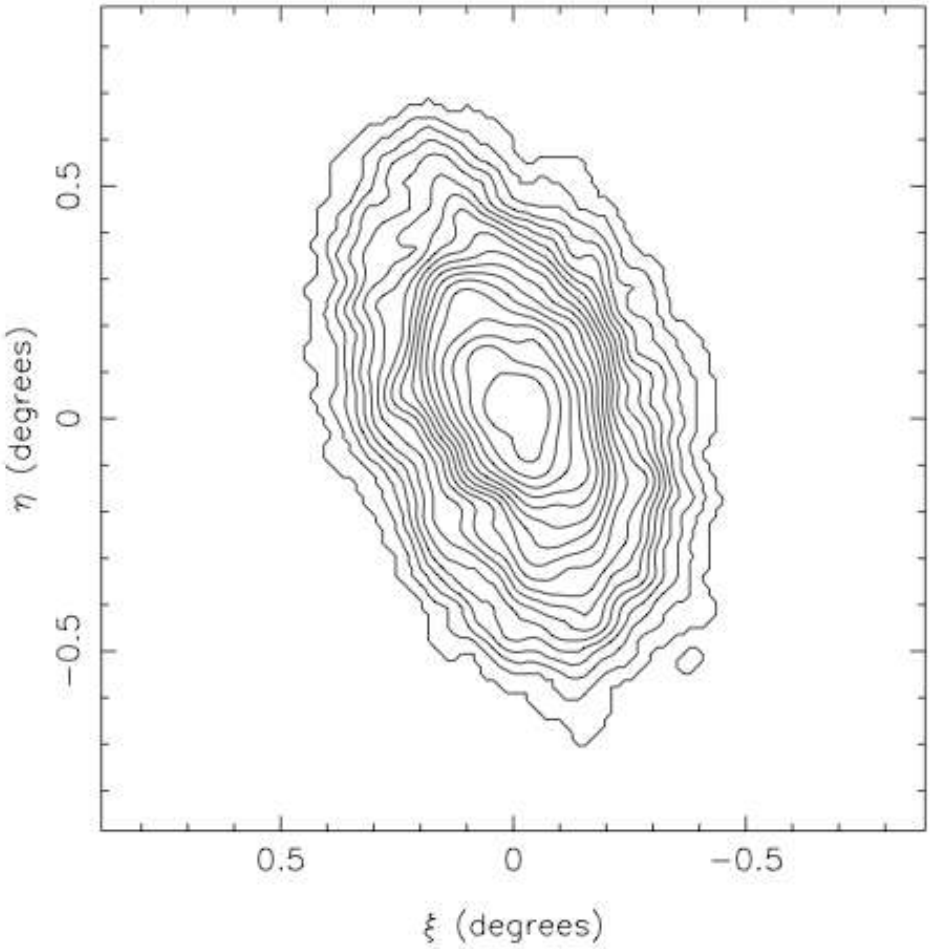



delJ(2M−ufti)
delH(2M−ufti)
delK(2M−ufti)
0.15
0.10
0.05
−0.00
−0.05
−0.10
−0.15
10
12
14
16
J mag


J
STDEV: 0.015
H
STDEV: 0.016
K
STDEV: 0.017
Delta Mag
−0.10
−0.05
0.00
0.05
0.10

Panoramic survey of M33






fin
DART