Systematic error corrections for UCAC2 positions

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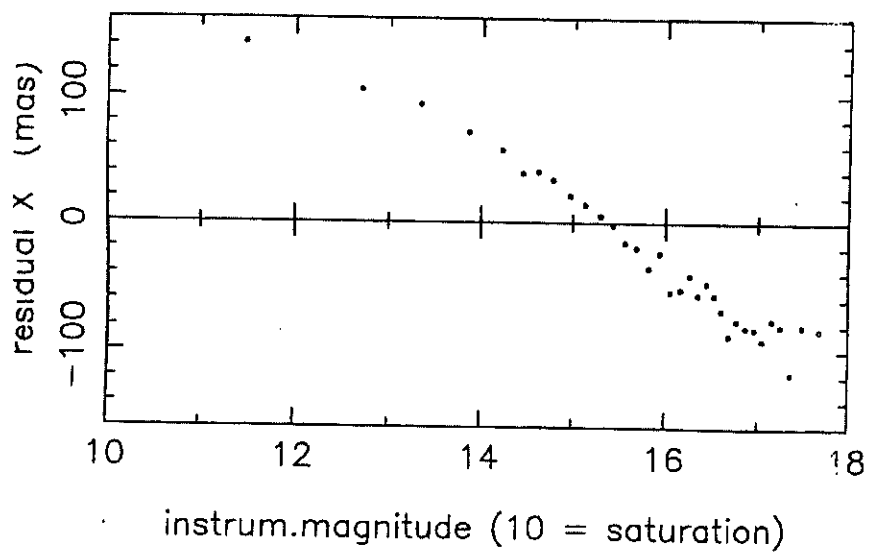
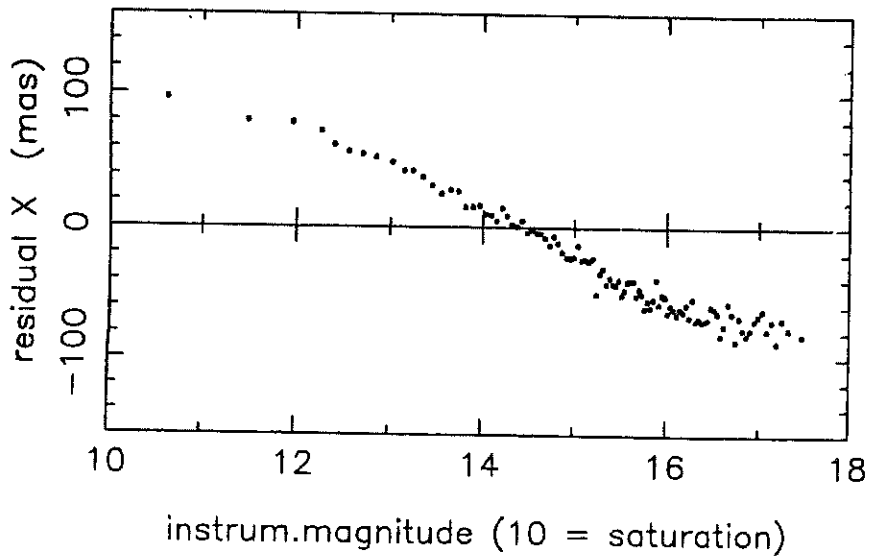
1 UCAC project overview

- USNO CCD Astrograph Catalog
- all sky astrometric survey
- 20 cm aperture 5-lens astrograph + 4k CCD camera
- 20 mas for 10 to 14 mag, 70 mas at 16th
- started in 1998 at CTIO
- March 2000: 1st data release
- Sept/Oct 2001: relocate astrograph to Flagstaff, AZ
- 80% of sky complete now
- soon: 2nd data release ($-90°$ to $\approx +35°$ declination)

2 Raw data processing: from pixels to x,y data

- dark correction (operating "warm" at -18 C)
- NO flats applied
- NO other corrections on a pixel-by-pixel basis ("reverse" CTE ...)
- 2D circular symmetric Gauss profile fits
- drop all problem cases (double stars ...)



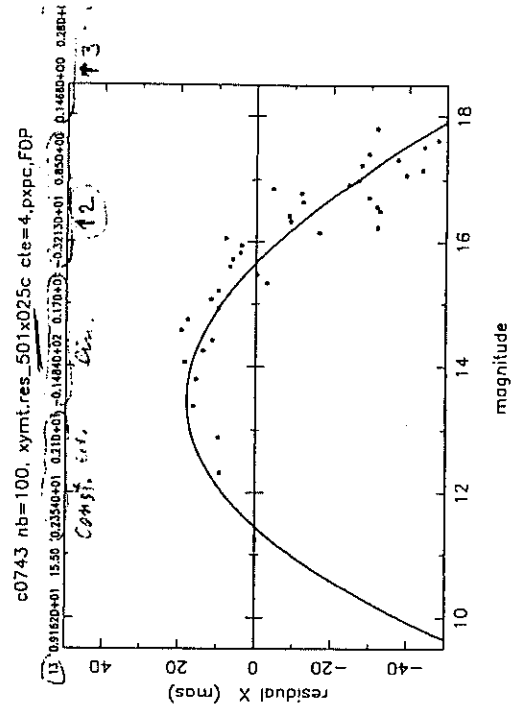


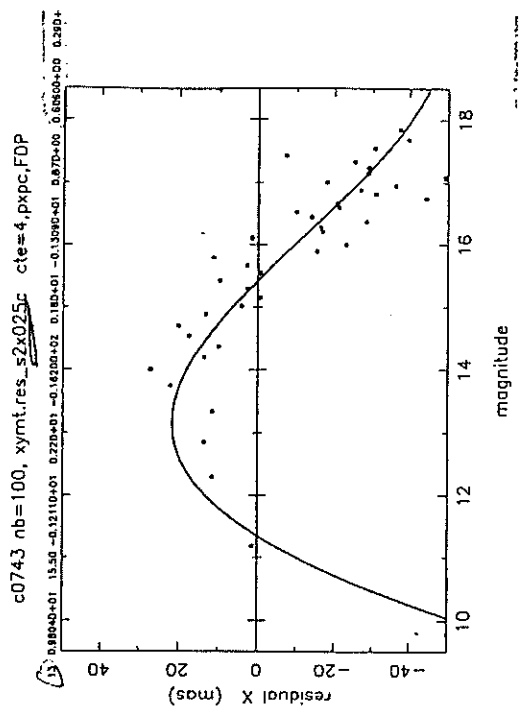
3 Types of systmatic errors in UCAC data

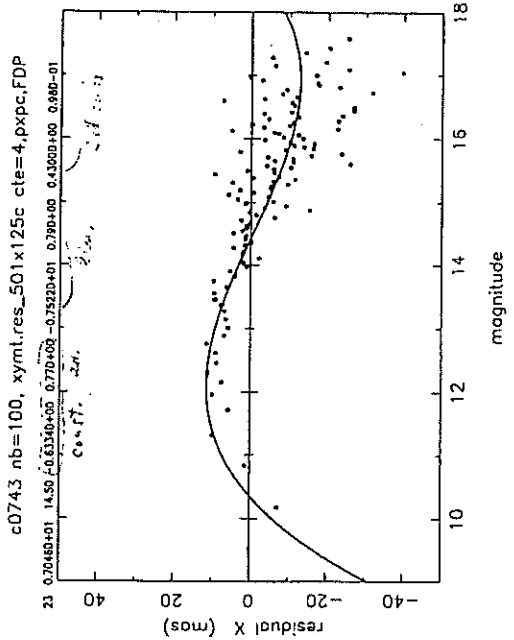
- low CTE (charge transfer efficiency) ⇒ biggest problem
  ⇒ coma–type errors, affecting "magnitude equation"
- FDP (field distortion pattern), includes
  - 3rd order optical distortion of lens
  - tilt of focal plane
  - distortions from filter
- empirical position correction for images near saturation
- pixel–phase error: function of FWHM of profiles (new in UCAC
- differential color refraction in atmosphere:
  ⇒ not an issue here
  handled by narrow bandpass (579–643 nm)

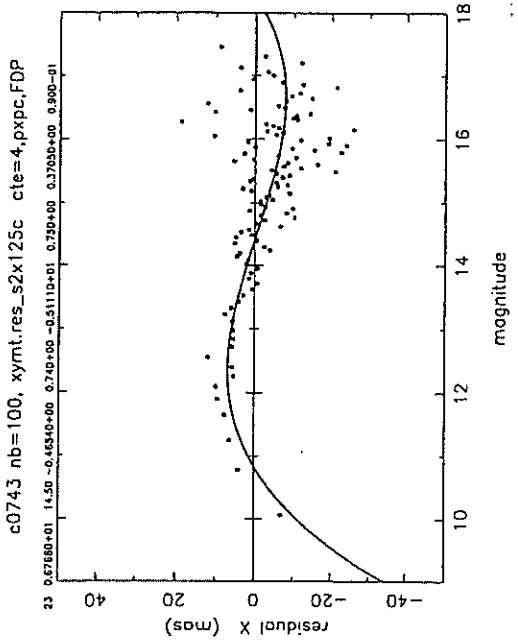
4 Astrometric calibrations

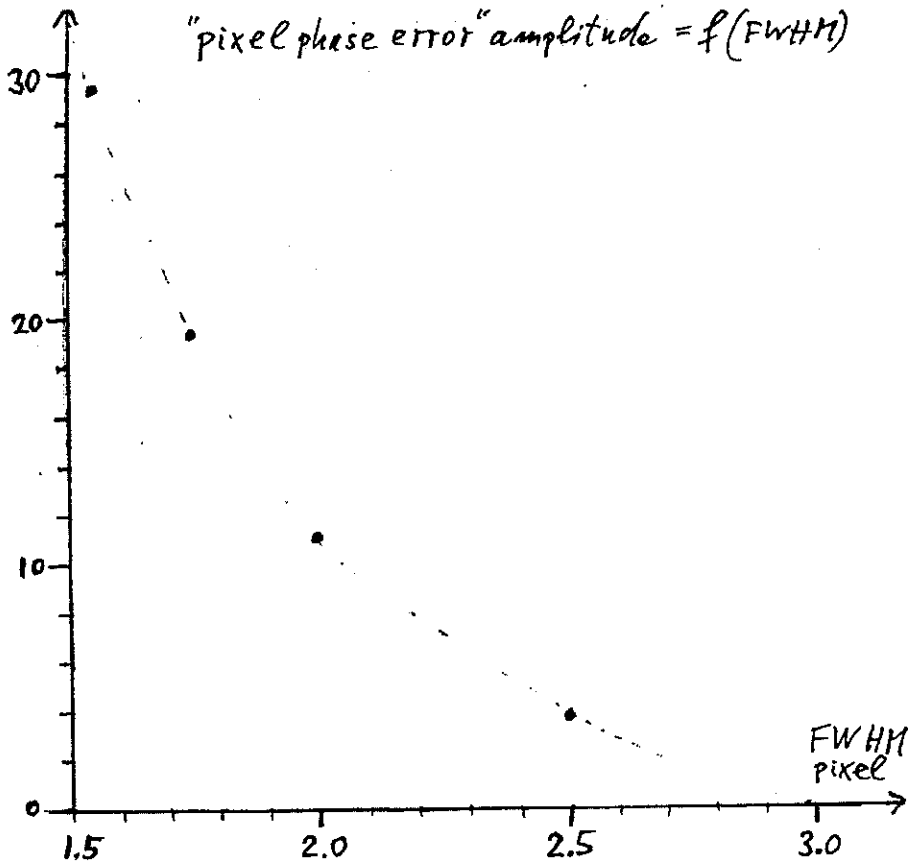
1. reference star residuals
   - separate for short / long exposures
   - separate for telescope on East / West pier
   - as a function of mag, color, x, y ...
   - 2–dim field distortion pattern
2. flip observations
   - 180° rotated w.r.t. sky
   - use many more stars than ref.star residuals typically 1000 versus 25
   - ability to determine certain systematic errors of the instrument independently of external references $\Rightarrow$ calibration
3. camera rotation by 90°
   - exchange x,y axes w.r.t. sky
   - not evaluated yet
4. overlapping frames with offsets
   - ... but same side of pier
   - successfully applied to 0.9–meter telescopes data
   - complementary to "flip" (resolve some degeneracy)
   - "food" for future block adjustment routines

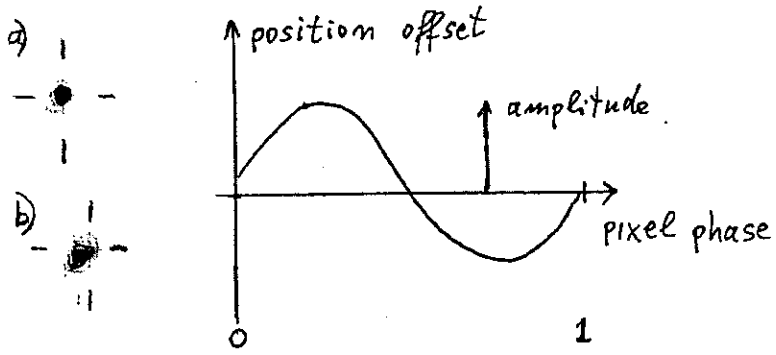




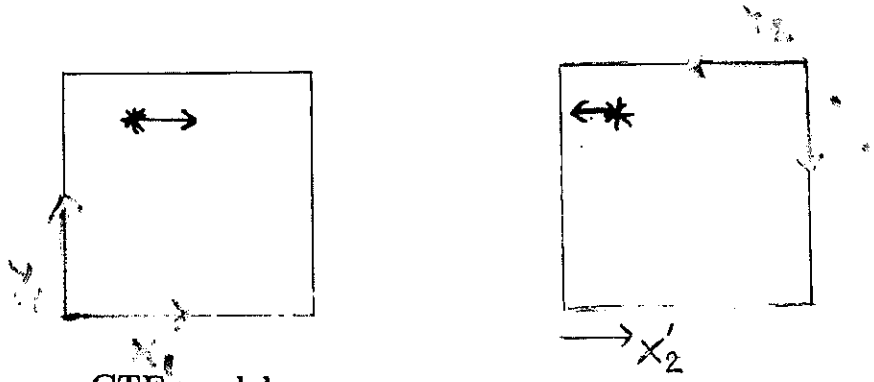








"normal" flip



CTE model

$$m = mag - mag_0$$

$$\delta x_1 = x_{observed} - x_{noCTE}$$

$$\delta x_1 = amx_1 + bm^2x_1 + cm^3x_1 + dmx_1^2$$

$$\delta x_2 = amx_2 + bm^2x_2 + cm^3x_2 + dmx_2^2$$

transforamtion of flip x,y data

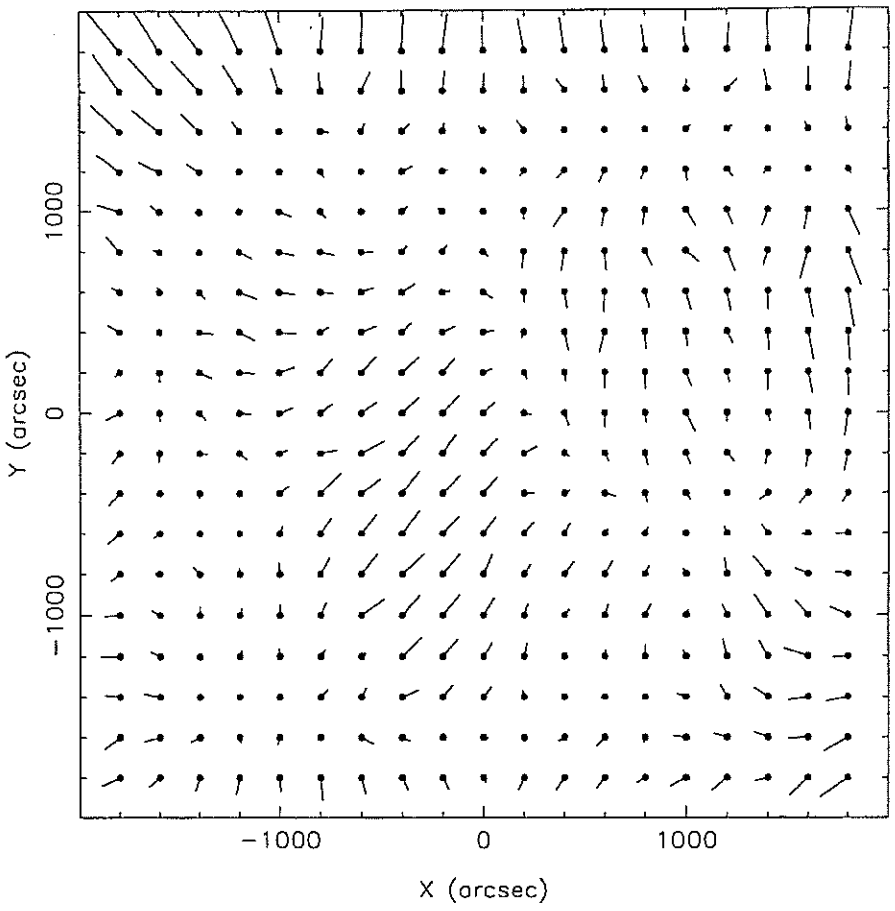
$x_2' = \hat{x} - x_2 \approx x_1$

$\hat{x}$ = maximal x = dimension of CCD

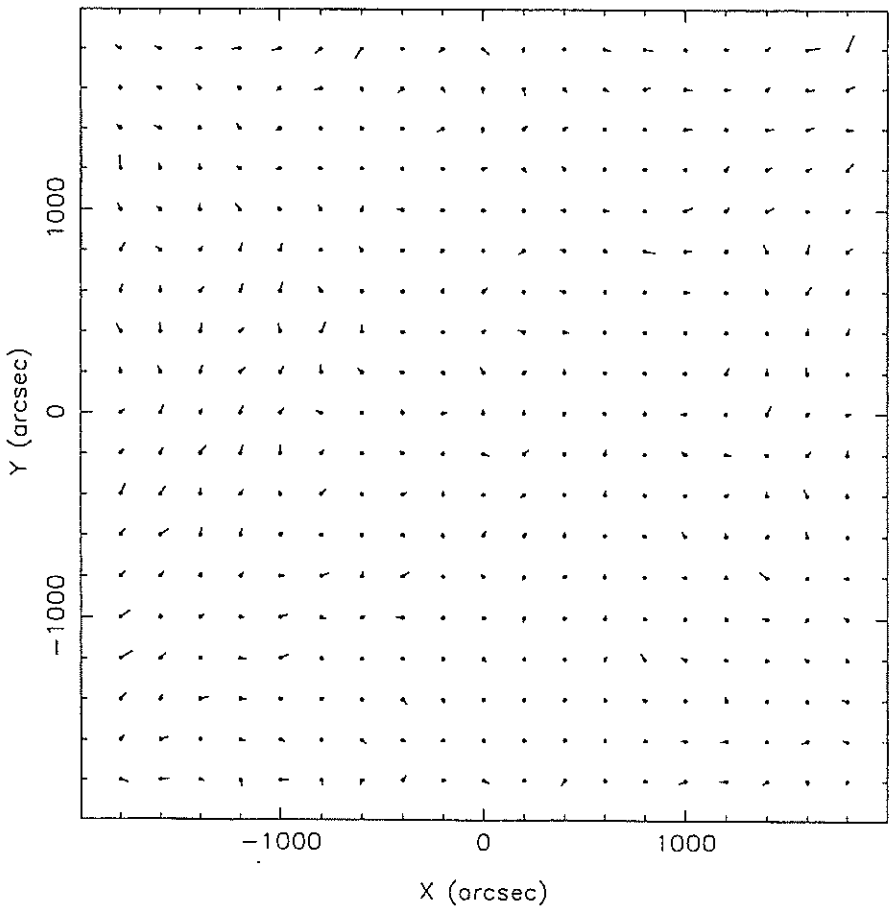
$\Delta x = x_1 - x_2' =$ linear model (x,y) + difference in CTE terms

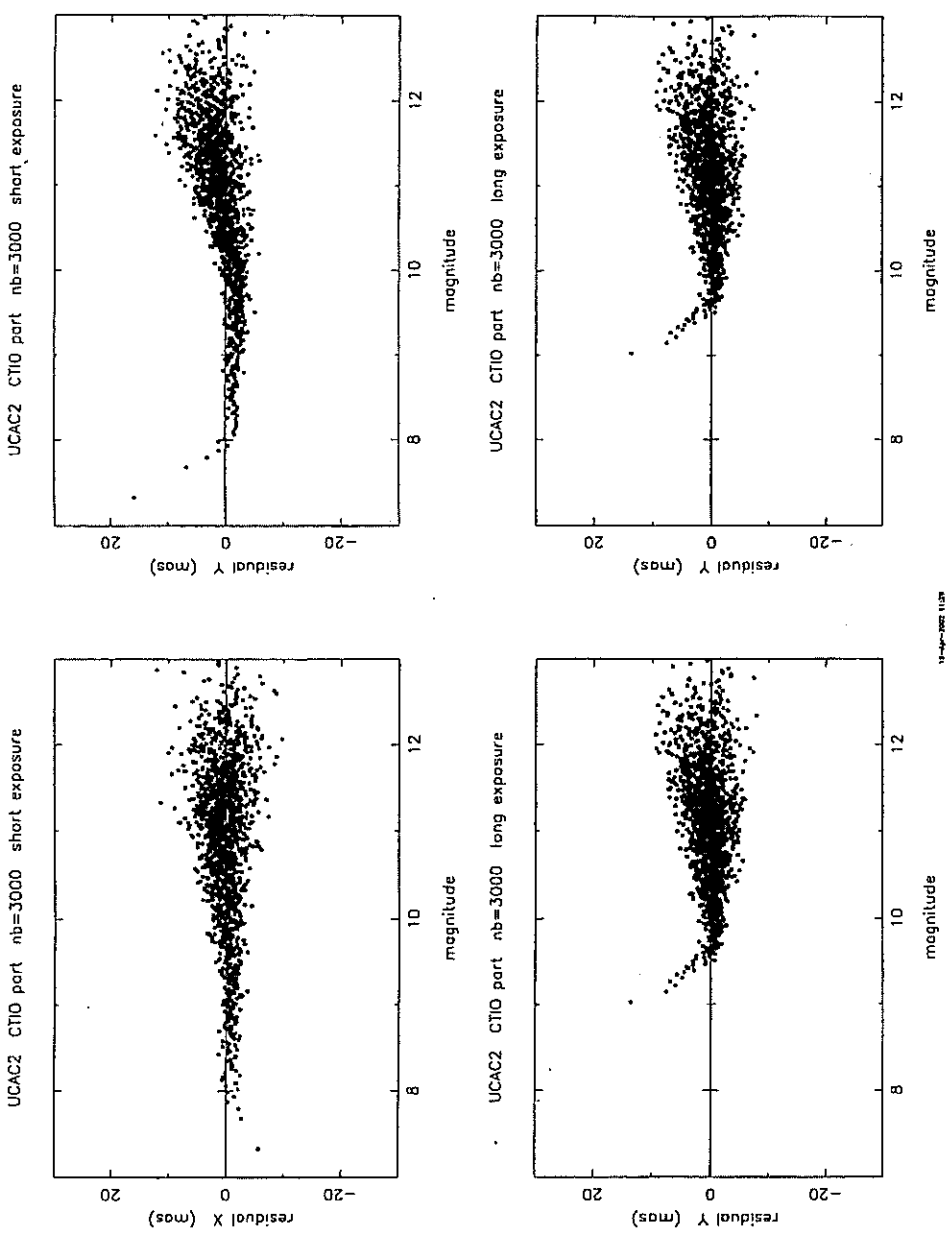
$\Delta x = \ldots + am\hat{x} + bm^2\hat{x} + cm^3\hat{x} + dm(\hat{x}^2 - 2\hat{x}x_2 + 2x_2^2)$

UCAC2 r10, CTIO, scale=10000, final smoothed 020329



UCAC2 r10, t07, scale=10000, CTIO 2000−2002, 020409



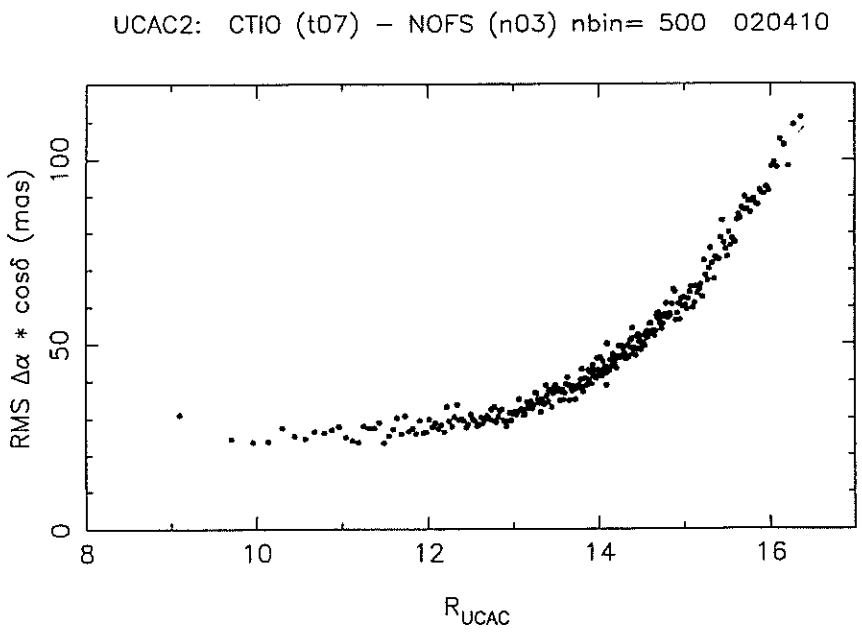


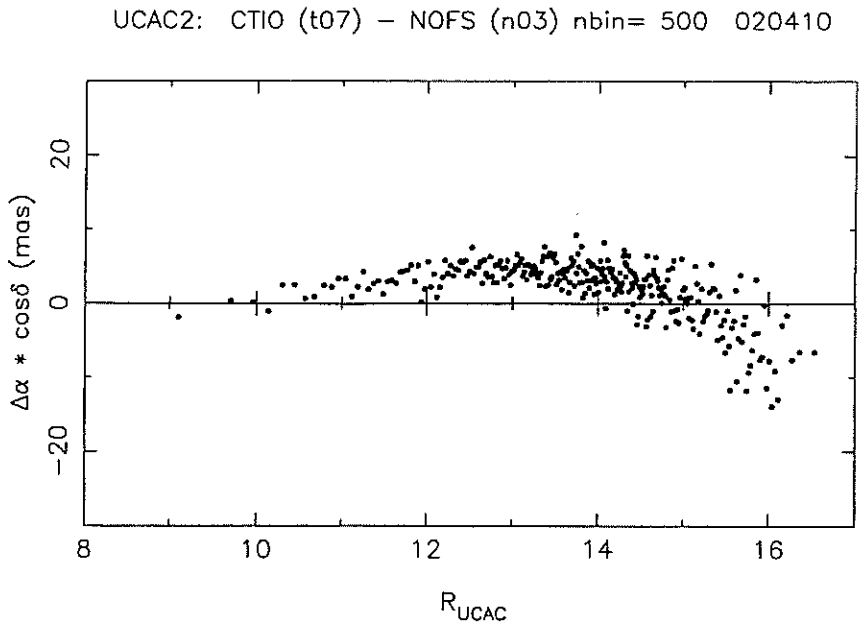
5 Some results

- small magnitude equations ≤ 5 mas
- no systematic errors f(color) (≤ 2 mas)
- nearly no remaining field distortions (≤ 3 mas)
- CTIO – NOFS data: sum of remaining effects ≤ 10 mas

6 UCAC2 status

- postion part done : 52.9 million stars (n ≥ 2 observations)
- sky coverage: $-90° \leq \delta \leq +25°(+45°)$
- proper motions bright: Tycho–2, AC2000
- special: AGK2 (1930 epoch) for $-5° \leq \delta \leq +15°$
  $\Rightarrow \sigma_\mu \approx 1\ mas/yr$ (10 to 13 mag)
- proper motions faint: SPM + NPM ("yellow sky")
  PMM measures
- plan: match with photometry data (2MASS, TASS)
- release likely on 3 CD's
- as soon as possible (this summer ?)


UCAC2: CTIO (t07) – NOFS (n03) nbin= 500 020410
RMS Δα * cosδ (mas)
0
50
100
8
10
12
14
16
R_UCAC


UCAC2: CTIO (t07) – NOFS (n03) nbin= 500 020410
Δα * cosδ (mas)
−20
0
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8
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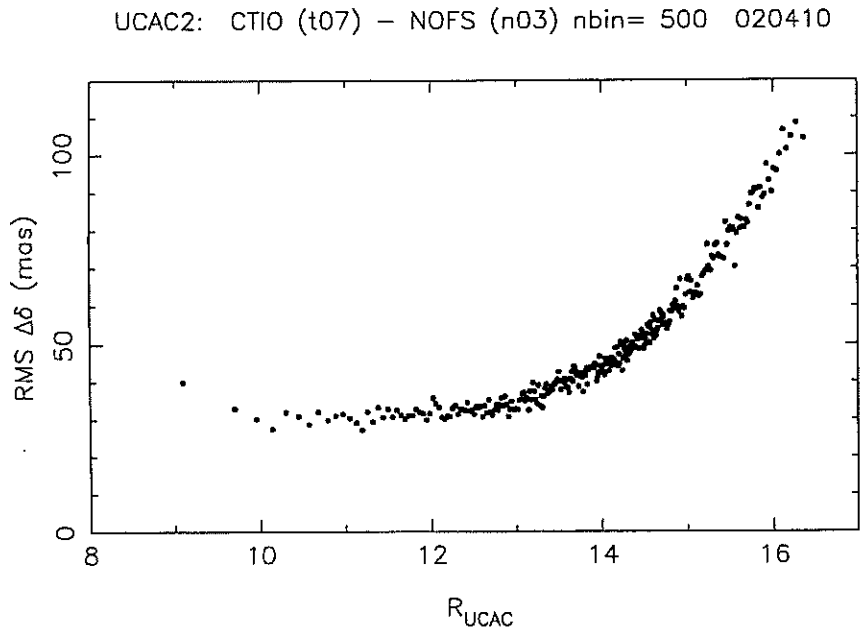
12
14
16
R_UCAC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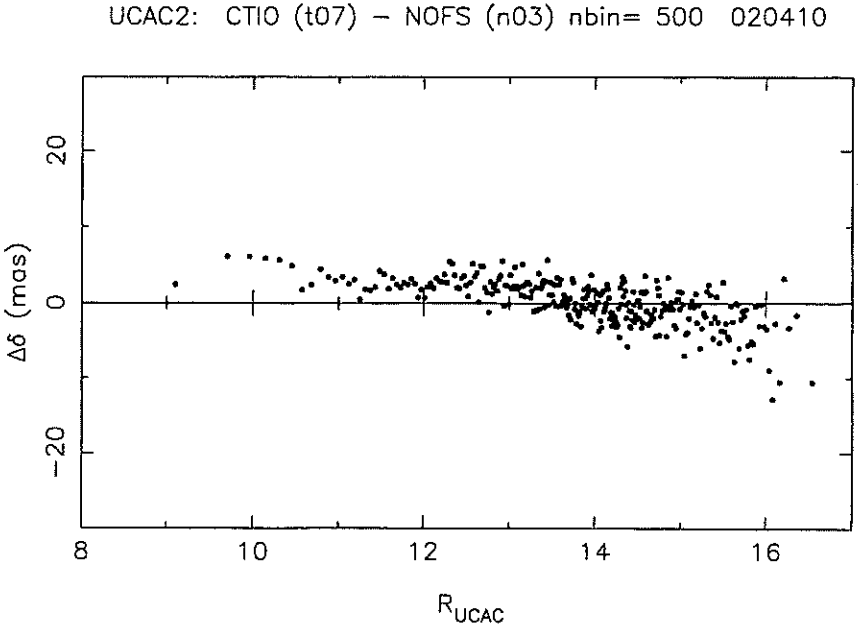
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Δδ (mas)
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8
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UCAC: 67682 survey fields completed as of April 11, 2002