Albinoni (NICMOS) Analysis

SCP Collaboration Meeting
June 17 2003

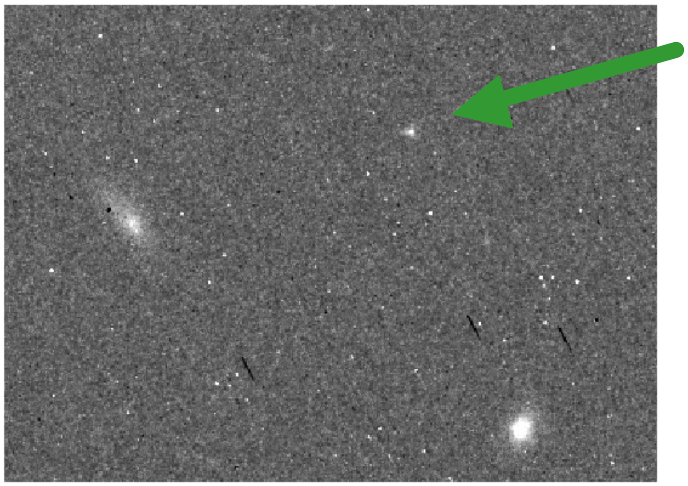
Greg Aldering
Vitaliy Fadeyev
with help from Shane Burns

Albinoni (1998eq) a SNIa at z=1.2 .

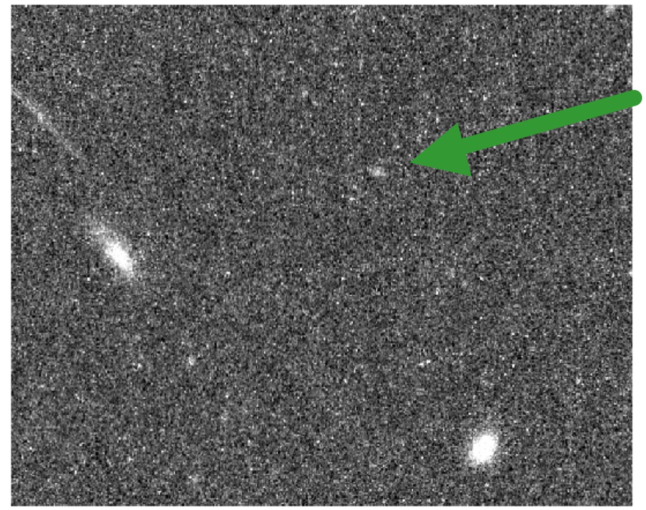
Datasets (1)

Albinoni is in close proximity to the host galaxy!

WFPC2 (PC) signal data

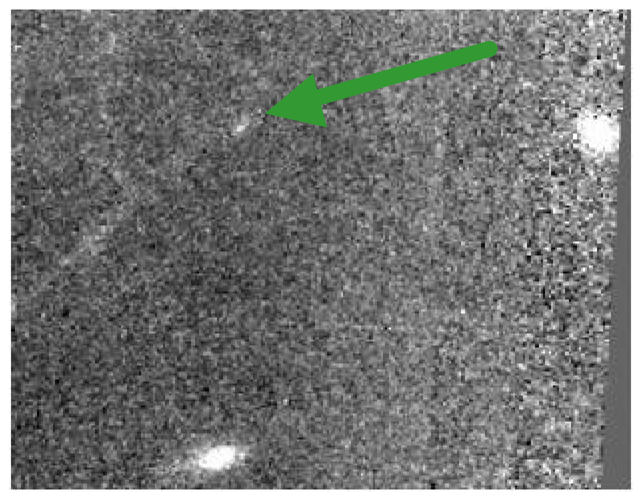


WFPC2 (PC) final ref



NICMOS signal data

NICMOS final ref



Datasets (2)

Dataset	N(exposures) x Time	Obs. Dates	Comments
WFPC2 signal data	4 epochs	10/26[1], 11/09[1], 11/19[3], 11/30[3] 1998	
WFPC2 final ref	5x 2700s + 1x 2600s	07/20-21/2001	
NICMOS signal data	8x 1026s + 4x 514s	11/18/1998	T = 62.5 K, MIF
NICMOS final ref	6x 1344s	12/09/2002	T = 77.2 K, SPARS, SAA persistence

F110W

Compared to the signal data, NICMOS final ref has
-- 50% higher QE due to the higher operating temperature,
-- different (better) readout sequence,
-- SAA persistence effect.

Analysis Improvements

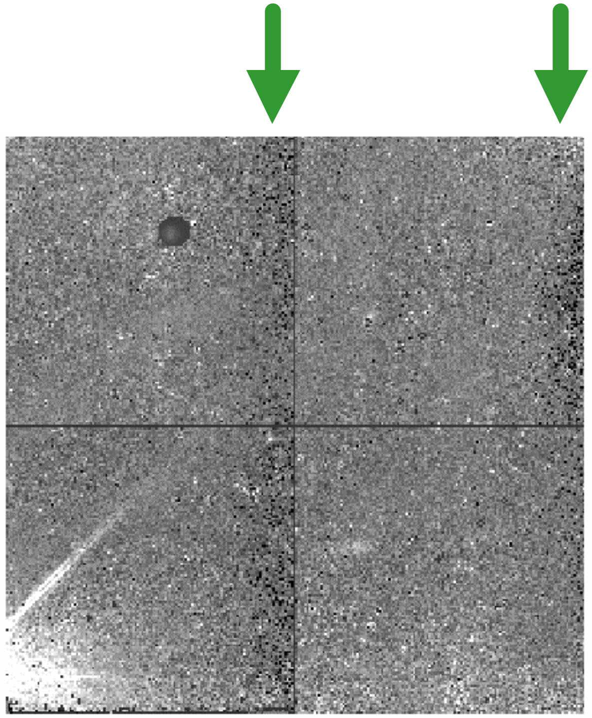
The important analysis topics are:

-- removal of excessive shading (relevant to the older data taken in MIF readout sequences),
-- spurious positive and negative spikes,
-- SAA persistence effect (only final ref. is affected).

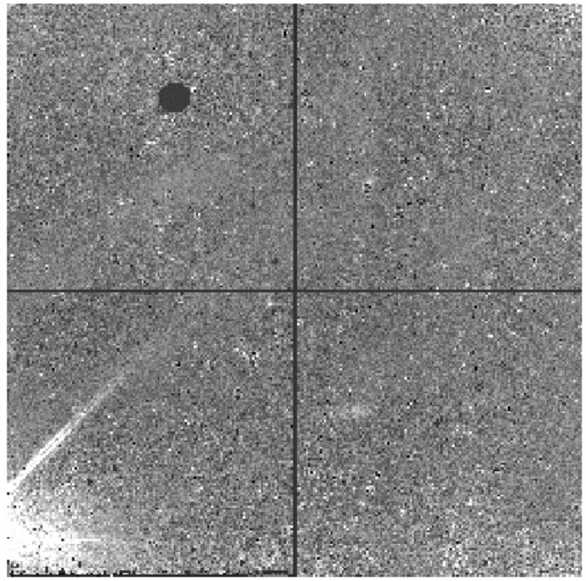
Our goal is precision photometry of deep exposures of faint signals. This is different than the vast majority of NICMOS programs.

Excessive Shading

The shading in the old data with MIF readout sequence was all due to a single readout.
The fix is to remove the bad readout from processing.



Before fix

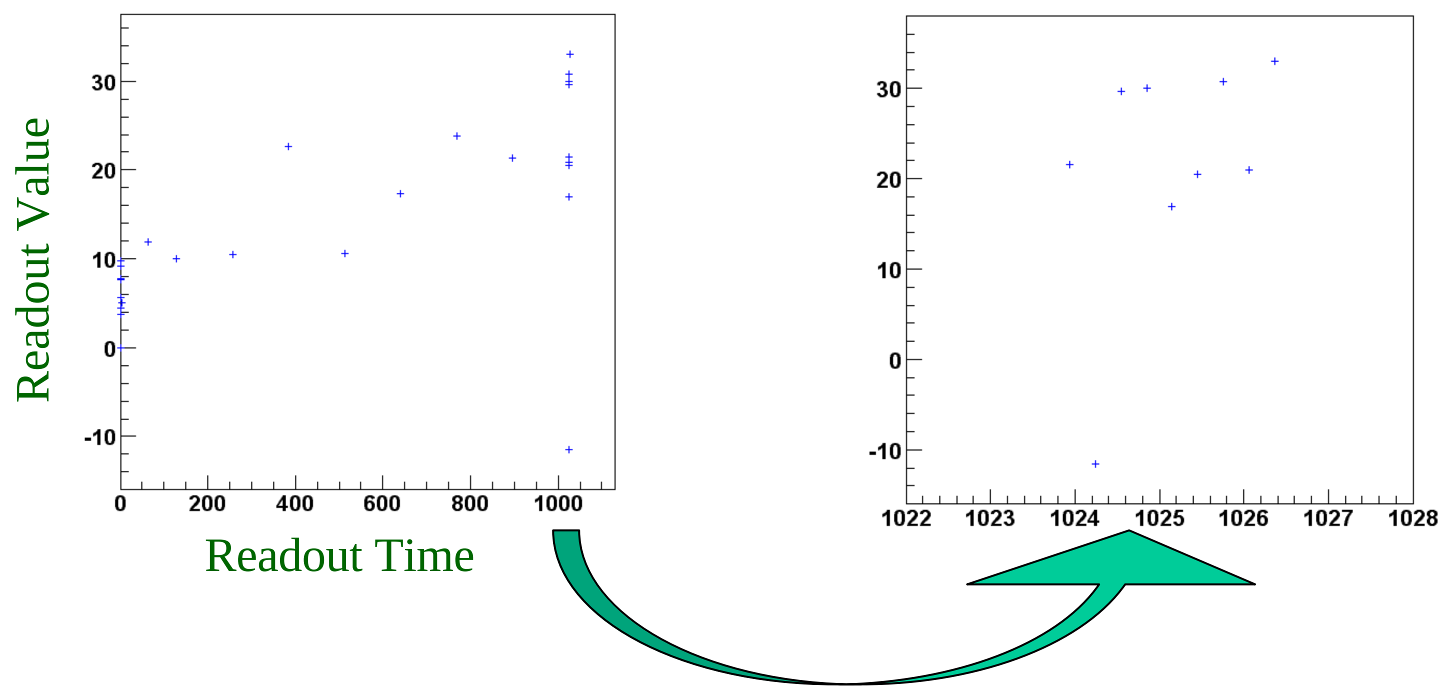


After fix

Spurious Negative Spikes

The effect is caused by deficiency of the CR rejection algorithm, which
-- looks for single 4 sigma jump,
-- brings down (shifts) the data points after the jump.
There are 65537 pixels and 26 readouts => 1.6 million samples per exposure.
4-sigma outliers do happen. In such a case the data values after the jump are downsized and the linear fit to extract the signal in the pixel results in an artificially low value. This is substantial for our faint signals.

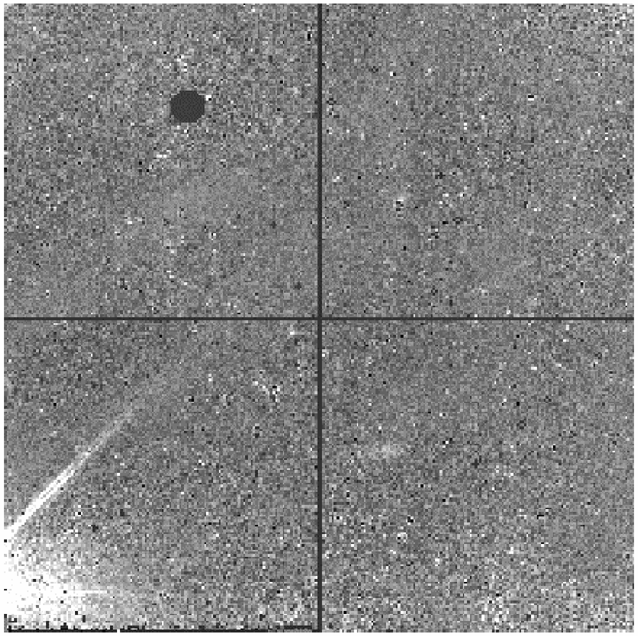
The cause is identified, but not yet fixed. STSCI is contacted.



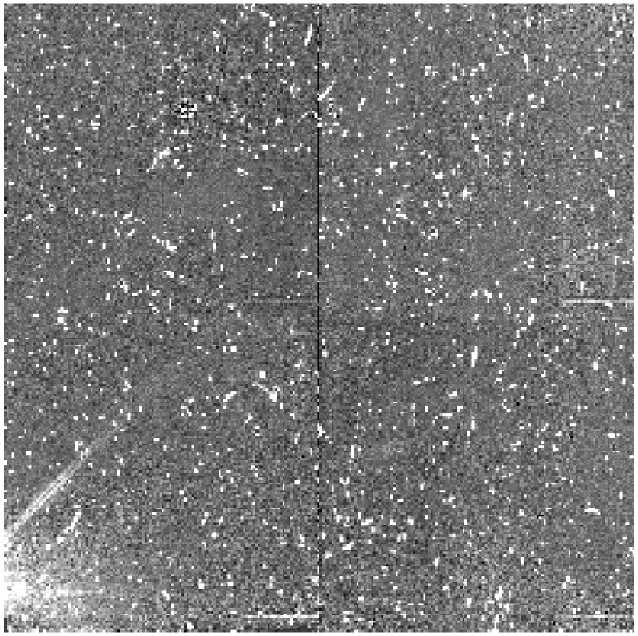
Spurious Positive Spikes

Some pixels have relatively large positive values, comparable to our signal. They are typically adjacent to pixels affected by a CR. Their readouts have a (less than 4 sigma) jump at the time of the CR, resulting in a positive value of the linear fit slope.
Conclude that this is a CR "spillover" to the neighboring pixels. Relevant for deep exposures, which may have 10-20% of the pixels affected by CR.

The cause is identified, but not yet fixed.



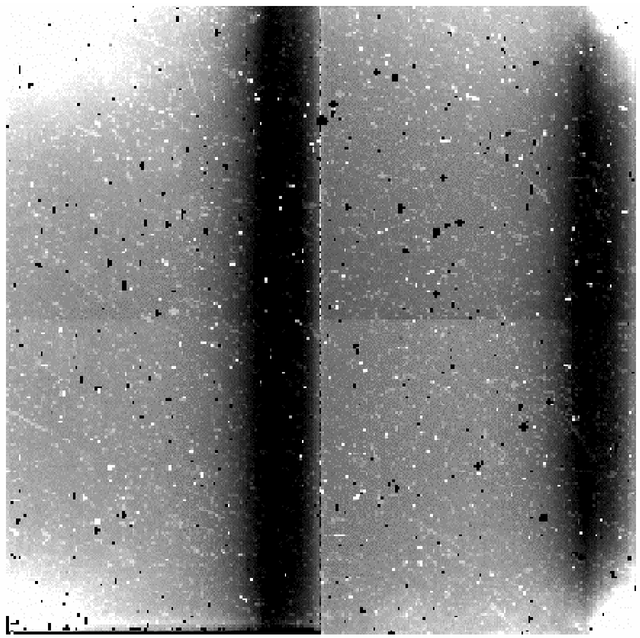
Processed exposure



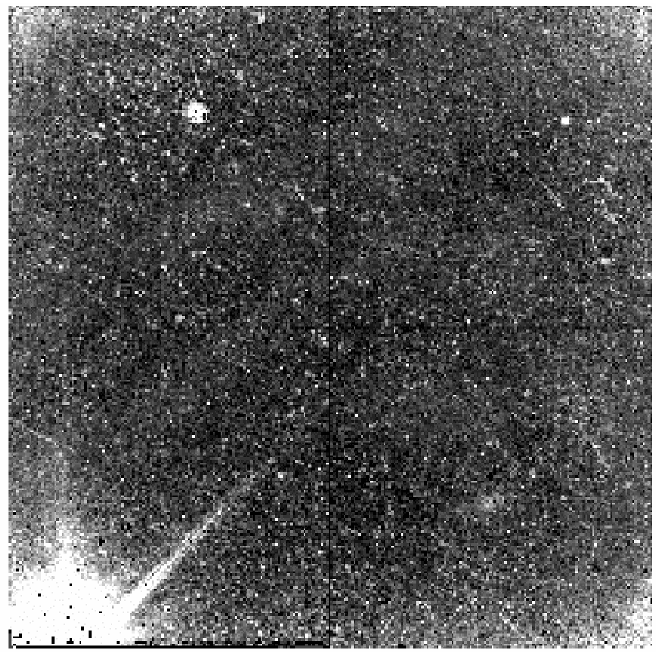
Last readout

Post-SAA Darks (1)

--> For the recent NICMOS data, a special pair of 600 sec exposures automatically provided immediately after HST passage thru SAA.
--> The CR afterglow is clearly visible, on the background of "shading" and amplifier afterglow. The affected pixels have time-accumulating signal with slowly decaying amplitude.
--> SAA-affected pixels show up in both Post-SAA dark and the subsequent scientific exposure.



Post-SAA dark



Subsequent Scientific Image

Post-SAA Darks (2)

There is a spread in the SAA-affected pixel decay constants. Therefore we did not subtract the Post-SAA dark. Decided to veto the affected pixels instead:

(1) correct the shading from "smart averaging" of the columns in the central horizontal 40-pixel wide band of the image.

(2) for each pixel find the nearest block of 11x11 pixels and fit it to a plane iteratively throwing out the outliers.

(3) create a mask by selecting on the distance to the plane in the 2 exposures:

$$((dev1/sigma1)^2 + (dev2/sigma2)^2)/2 > 1.5^2$$

$$dev1 > 0$$

$$dev2 > 0$$

The mask is applied to the image in the data processing.

The procedure removes 5 to 17% of the pixels in an exposure.

“Warm” and “Cool” pixels

From the visual examination of the images, it was found that some pixels are consistently bright/dark and not masked out. They might be “warm” or “cool” and therefore only relevant for deep not overly dithered exposures of faint sources.

Use the data to find such pixels (28 exposures of SuF02-060 and SuF02-065):

- remove the pixels “containing sources”
- apply the iterative 11x11 block-fitting technique to find the outliers
- select the pixels which are 5 sigma outliers in at least half of the exposures

Preliminary NICMOS Photometry

--> For the 1st iteration, we decided to do the photometry with drizzled images. The final ref. image is subtracted.

--> The signal shape is approximated using the TinyTIM simulator, subsampled by a factor of 10.

--> The direct fit results in a "doughnut" shape for the residuals.

--> Smear the signal shape by 2D gaussian -> OK. The fit prefers sigma of 0.65 drizzled pixels (= 0.33 original pixels). Attribute the result to positional errors (to be verified by fitting the individual exposures).

--> After corrections, $f_{\mathbf{lambda}}$ = (0.603 +/- 0.018) ergs/(cm^2 A sec) (about 45% less than Shane's estimate without final ref).

--> This corresponds to m(Vega) = 24.38 (no K-correction, about 10 days after max). Expect m = 23.79 at maximum in F110W at z=1.2 for s=1, or 0.2-0.5 fainter 10 days after.

Systematic Errors

Systematic Effect	Estimated Error[%]
Position (matching final ref to the signal data)	6.6
QE temp. scale from 62.5K to 77.2K	2.1
SAA rejection algorithm	1.5
Residual shading	0.8
Nearby star diffraction ray	0.4
Photometric scale accuracy	2.0
Total	7.4

The measurement errors are 3.0% (to be verified).

Work Plan

To complete the work, we plan to do the following:

- if not fixed by STSCI, fix the pos/neg. spikes problems
- verify that the measurement errors are correct
- fit the individual images (better answer; assess the signal stability and verify the positional errors)
- vary the TinyTIM simulation (position dependence, focus breathing, right lightcurve timing)
- K-corrections