

Residual charges on HawkCam  
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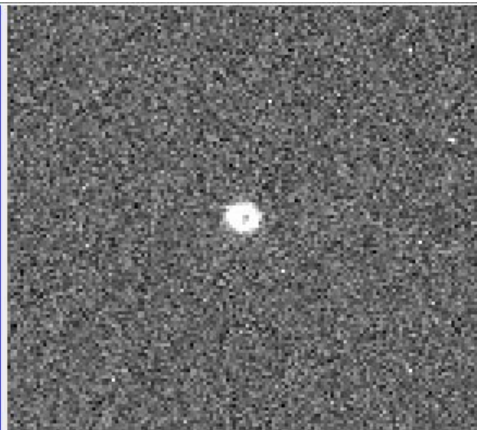
Marion Hidas



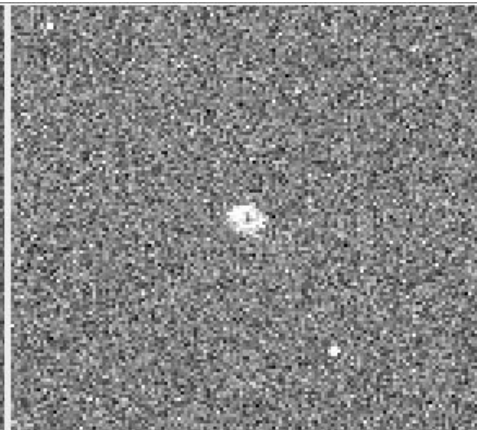
# the symptoms



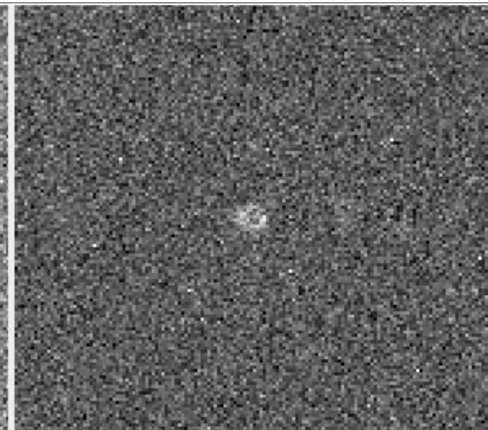
t=0  
star image



t=2.5min  
residual image  
in 60sec dark

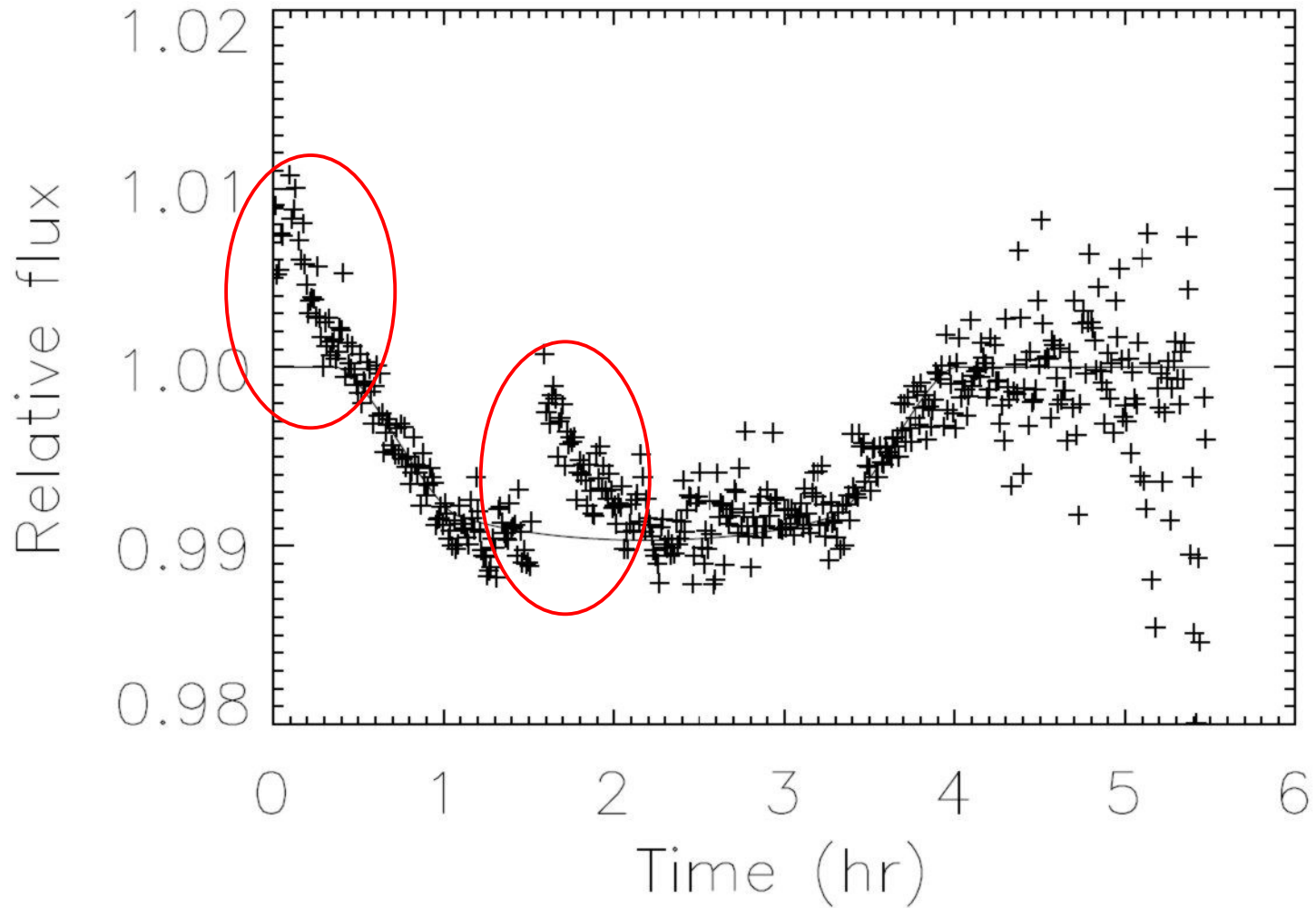


t=16min



t=23min

# the symptoms



# the model

Model of Rest et al. 2002:

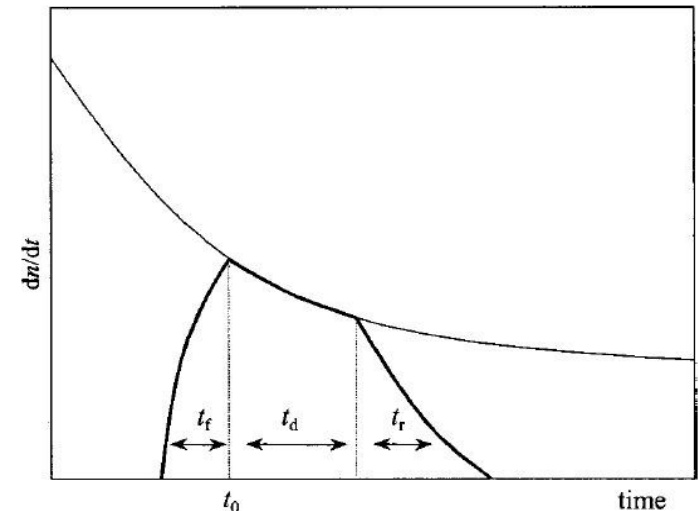
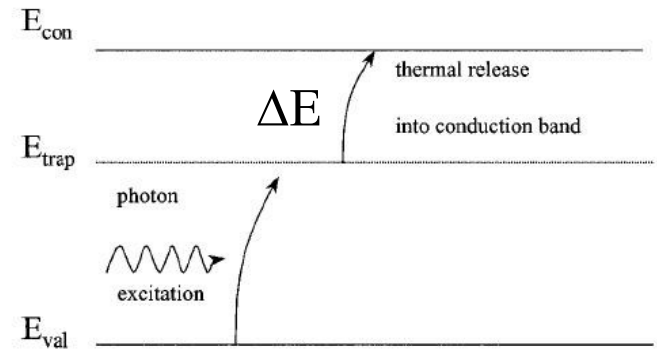
- Photoelectrons captured in trapping sites during exposure
- Thermally excited into conduction band
- Detected in subsequent exposures
- Number of filled sites,  $n$ , determined by:

# filled sites

$$\frac{dn}{dt} = r_{\text{ph}}(n_{\text{max}} - n)\sigma_0 - \frac{n}{\tau}$$

## Residual images in charged-coupled device detectors

Armin Rest,<sup>a)</sup> Lars Mürdermann,<sup>b)</sup> Ralf Widenhorn, Erik Bodegom,<sup>c)</sup> and T. C. McGlinn<sup>d)</sup>  
 Department of Physics, Portland State University, Portland, Oregon 97207-0751



# the model

Model of Rest et al. 2002:

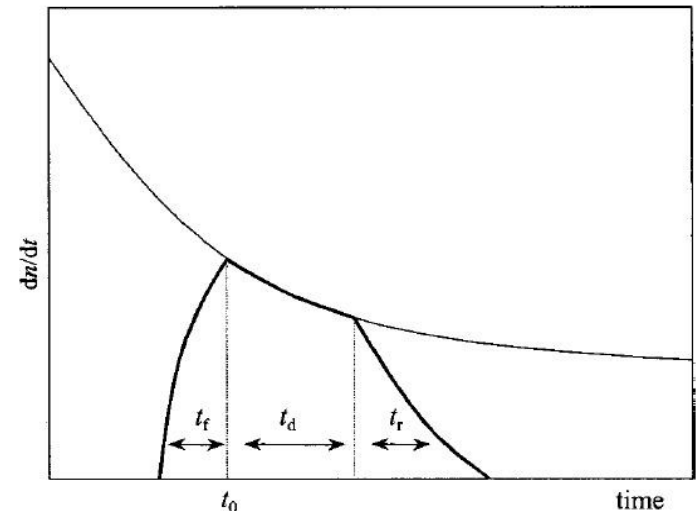
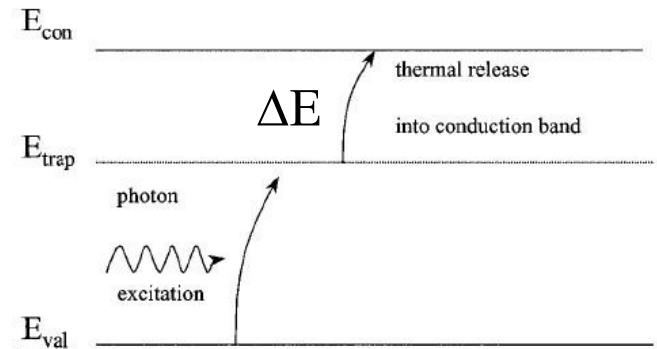
- Photoelectrons captured in trapping sites during exposure
- Thermally excited into conduction band
- Detected in subsequent exposures
- Number of filled sites,  $n$ , determined by:

$$\frac{dn}{dt} = \underbrace{r_{\text{ph}}(n_{\text{max}} - n)\sigma_0}_{\text{capture rate}} - \frac{n}{\tau}$$

# filled sites  $\downarrow$   $n$   
 photoelectron rate  $\downarrow$   $r_{\text{ph}}$   
 total # sites  $\downarrow$   $n_{\text{max}}$   
 capture cross-section  $\downarrow$   $\sigma_0$

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# the model

Model of Rest et al. 2002:

- Photoelectrons captured in trapping sites during exposure
- Thermally excited into conduction band
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- Number of filled sites,  $n$ , determined by:

# filled sites

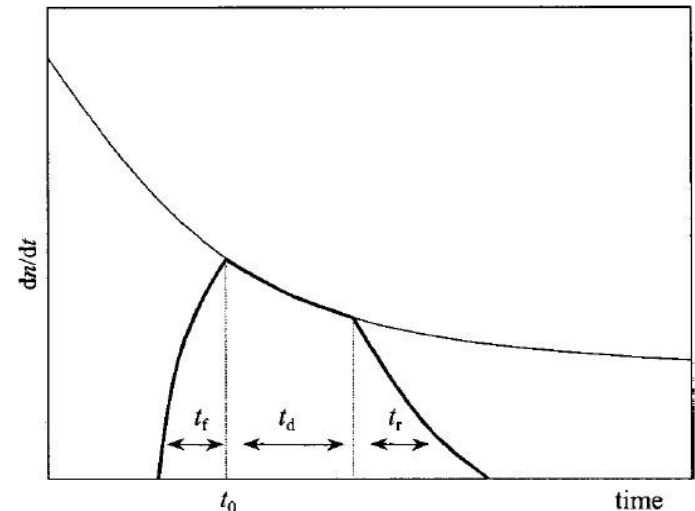
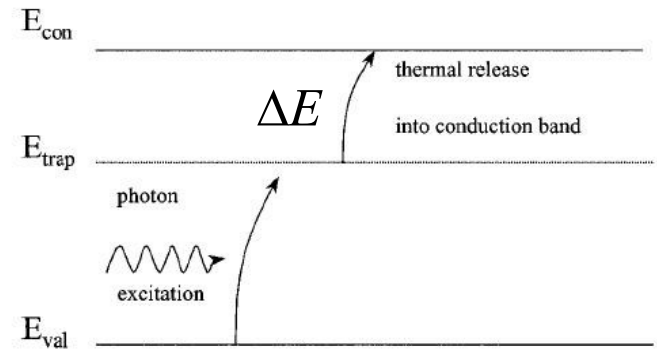
$$\frac{dn}{dt} = r_{\text{ph}}(n_{\text{max}} - n)\sigma_0 - \underbrace{\frac{n}{\tau}}_{\text{release rate}}$$

trapped e<sup>-</sup> lifetime

$$\tau = \tau_0 e^{\Delta E/kT}$$

## Residual images in charged-coupled device detectors

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# the model

Model of Rest et al. 2002:

- Photoelectrons captured in trapping sites during exposure
- Thermally excited into conduction band
- Detected in subsequent exposures
- Number of filled sites,  $n$ , determined by:

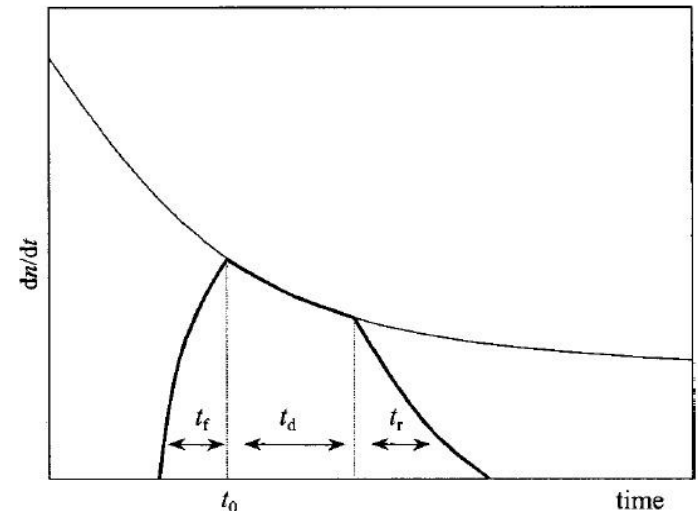
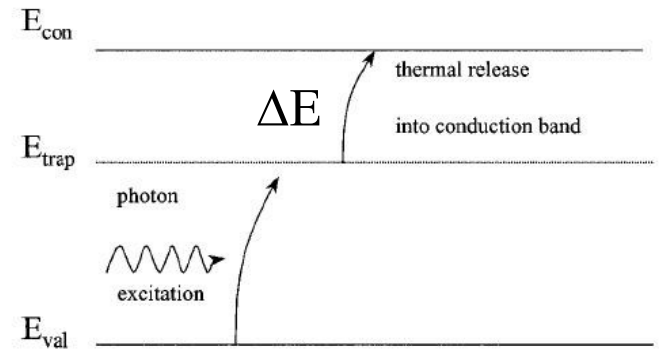
$$\frac{dn}{dt} = \underbrace{r_{\text{ph}}(n_{\text{max}} - n)\sigma_0}_{\text{capture rate}} - \underbrace{\frac{n}{\tau}}_{\text{release rate}}$$

# filled sites  $\downarrow$   $n$   
 total # sites  $\downarrow$   $n_{\text{max}}$   
 photoelectron rate  $\downarrow$   $r_{\text{ph}}$   
 capture cross-section  $\downarrow$   $\sigma_0$   
 trapped  $e^-$  lifetime  $\downarrow$   $\tau$

- Integrate to get number of electrons added to or removed from image

## Residual images in charged-coupled device detectors

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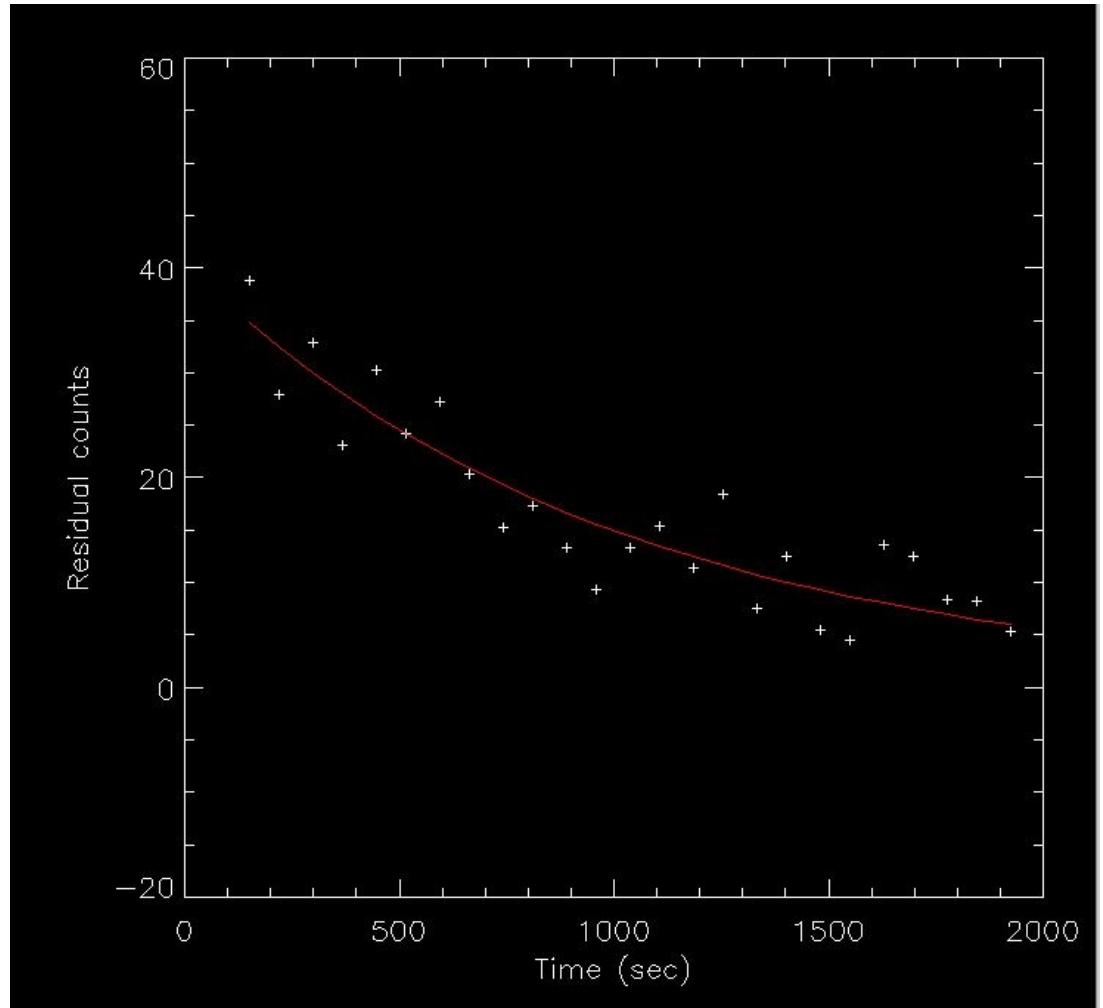


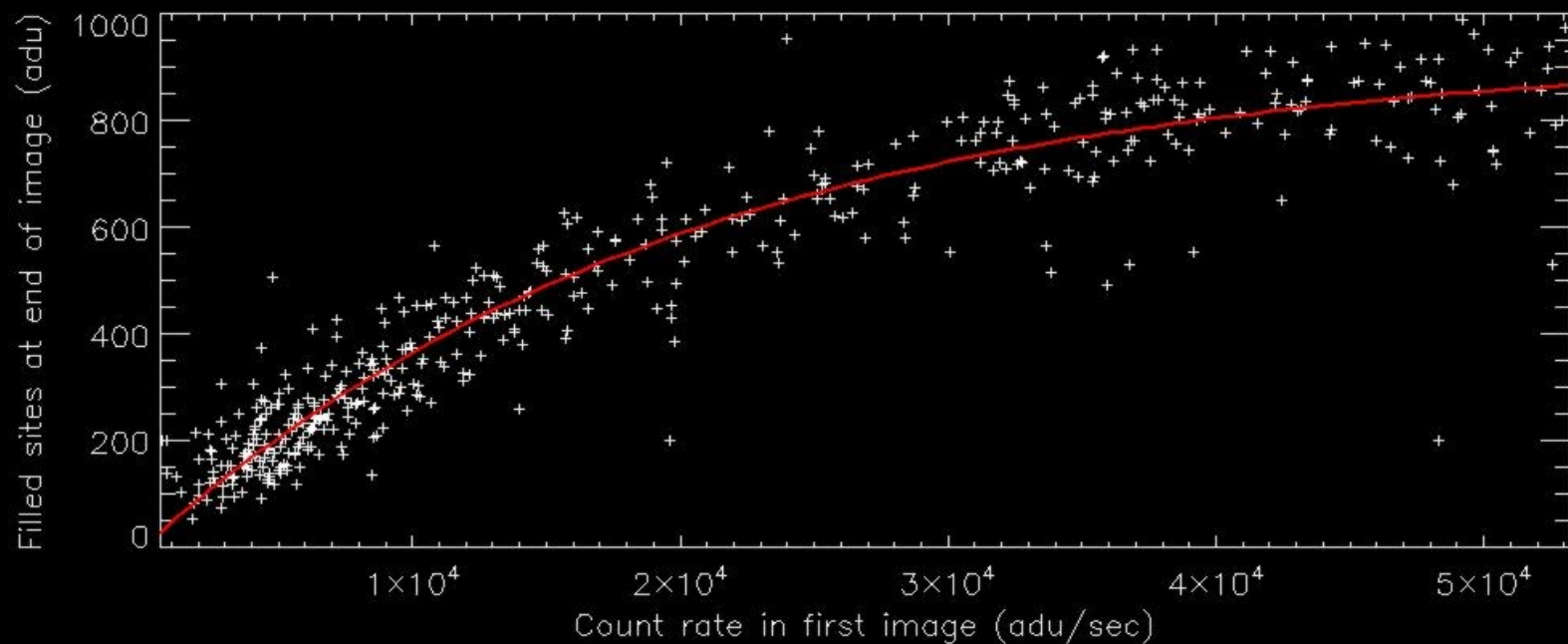
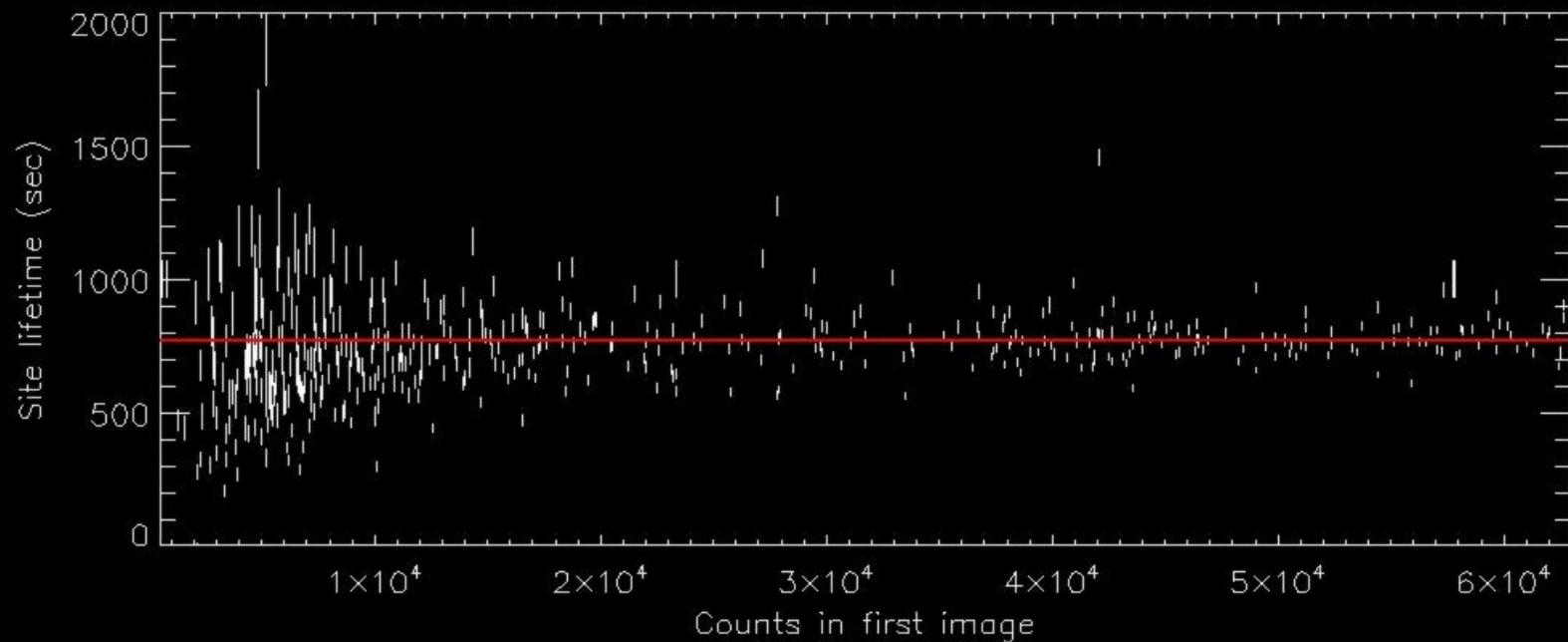
# measurements

Residual “light curve” for each pixel

→ fit for  $n_0$  &  $\tau$

→  $n_0(r_{\text{ph}})$





# measurements

$$\frac{dn}{dt} = r_{\text{ph}}(n_{\text{max}} - n)\sigma_0 - \frac{n}{\tau}$$

<b>ea01</b>	T = 258K	$\tau = 1000\text{s}$
	$n_{\text{max}}$ (ADU/pix)	$\sigma_0$ (pix/ADU)
Bessell B	980	5.9E-5
Bessell V	980	5.6E-5
Bessell R	790	5.0E-5
SDSS i	660	4.4E-5

<b>ea02</b>	T = 258K	$\tau = 800\text{s}$
	$n_{\text{max}}$ (ADU/pix)	$\sigma_0$ (pix/ADU)
Bessell B	880	4.6E-5
Bessell V	940	4.2E-5
Bessell R	1000	3.8E-5
SDSS i	1200	2.5E-5

# image correction

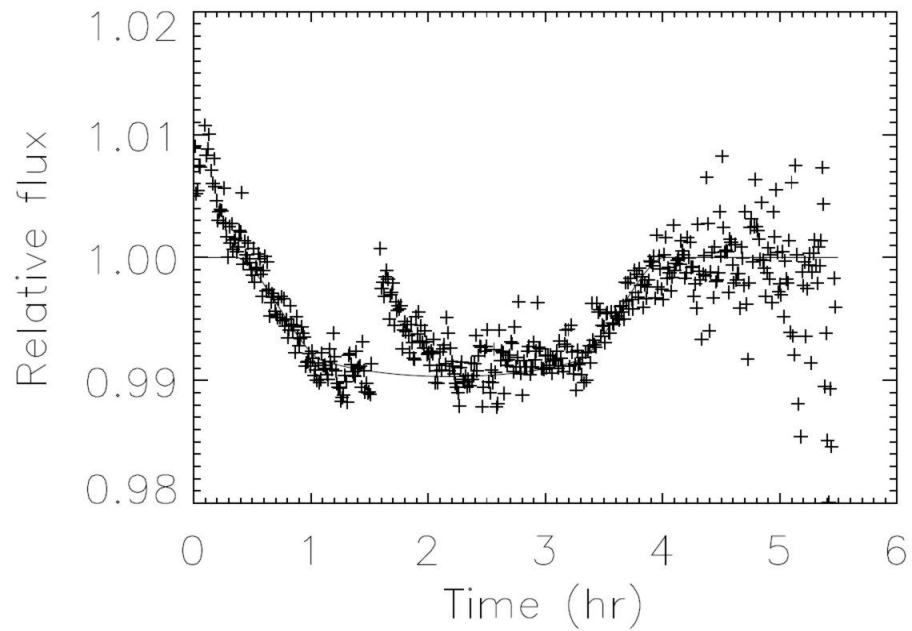
Before...



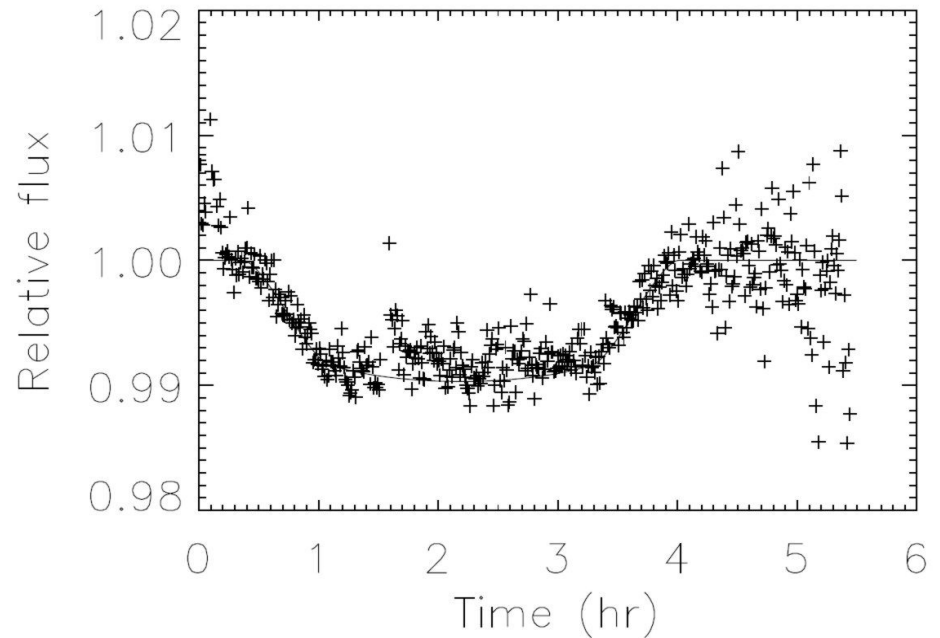
After

# image correction

Before...



After



# future work...

- Repeat analysis after applying linearity correction
- Confirm temperature dependence of  $\tau$
- Resolve degeneracies in model parameters and measure formal errors
- Understand the physics...
- Complete documentation and publish