Swift Hard X-ray Survey Where now?

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- **9 month survey paper is nearly ready for submission.**

- **22 month processing is nearly complete.**

- **exposure varies from 1.5X10^6 to 5.6X10^6 s**

- **the deficit is along the ecliptic plane including the GC**

- **noise continues to decline like roughly like t$^{1/2}$**

- **first very preliminary look at the data gives 157 new sources, mostly extragalactic! total >450**


noise

t$^{1/2}$

exposure
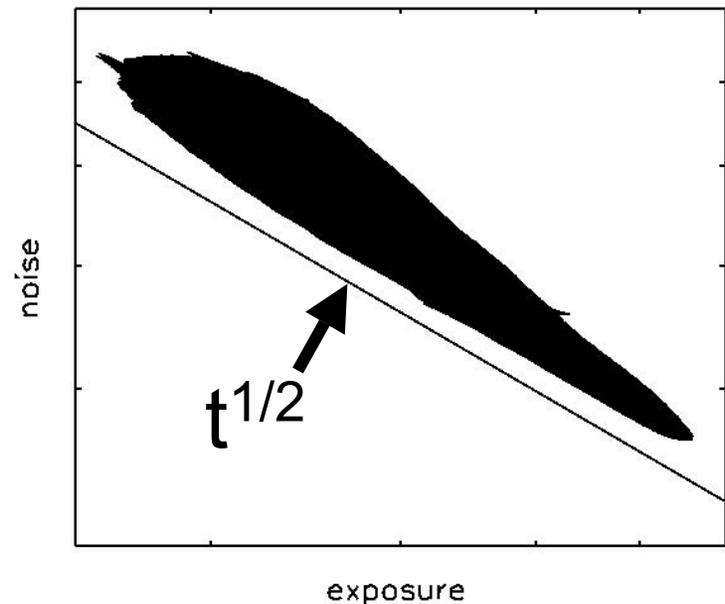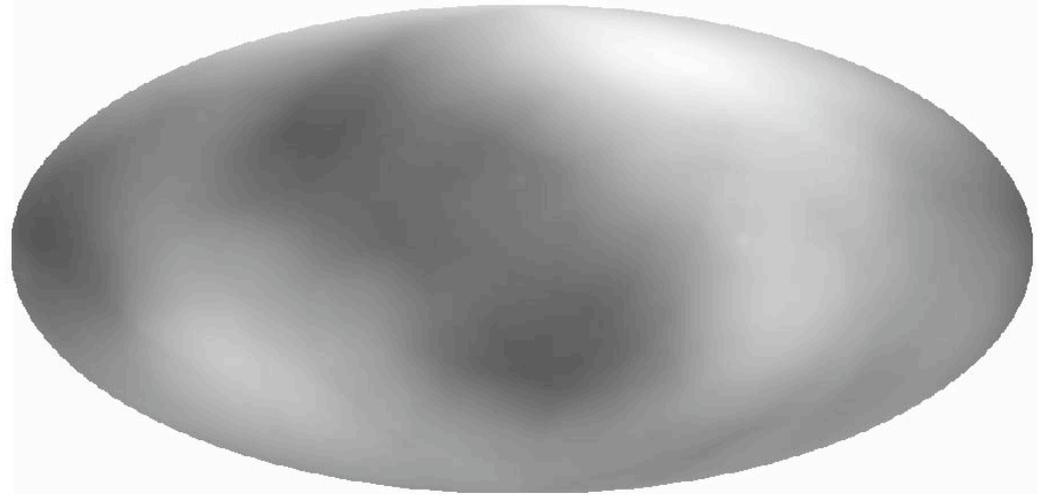
peak detection
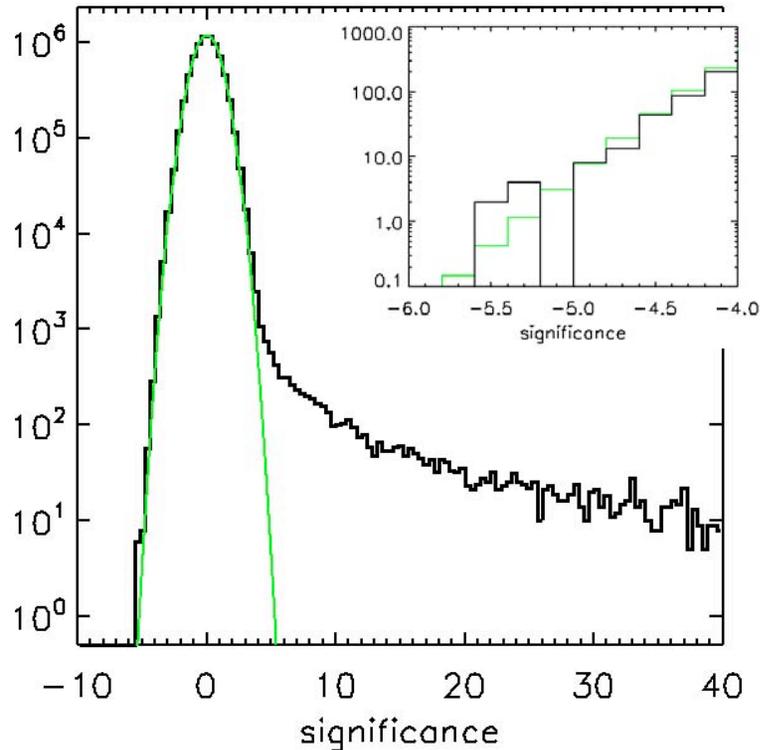
- **pixel SNR distribution (after renormalization) is very Gaussian**
- **Green curve is a best fit Gaussian to all the data <1σ significance and the σ of this distribution is 1.001**
- **the excess <5 sigma is small but this analysis does not take into account correlated groups of pixels**
- **negative peak search shows one peak at >5σ and 3 peaks >4.8σ**
- **improvements in peak detection can be made but are not expected to change senitivity**

position accuracy
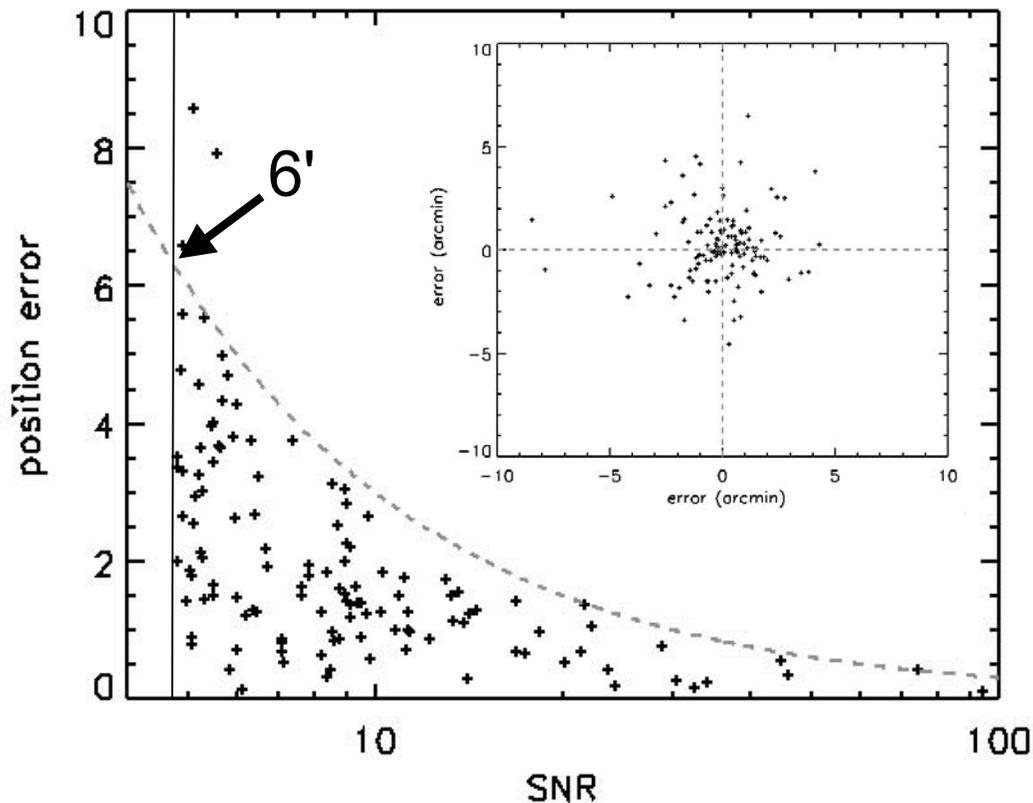
- **BAT position accuracy depends in significance as expected**
- **6 arcmin at the significance threshold 97% confidence**
- **XRT counterparts with matching spectra are unique**
- **for 9 months only 2 possible source confusion cases**

- There are many sources are just below the threshold so rooting around in the dirt can be very fruitful.

- Even using the same images, alternative processing of the same data has significantly different systematic noise.

- Therefore, a procedure must exist that extracts all the information and so has the potential to retrieve many additional sources.

- XRT counterparts are a powerful technique to confirm and ID marginal BAT sources

- Different systematic noise in various passes through the data have resulted in ~30 confirmed sources that are not abouve our courrent threshold vs ~6 sources that were not confirmed. These are still good detections
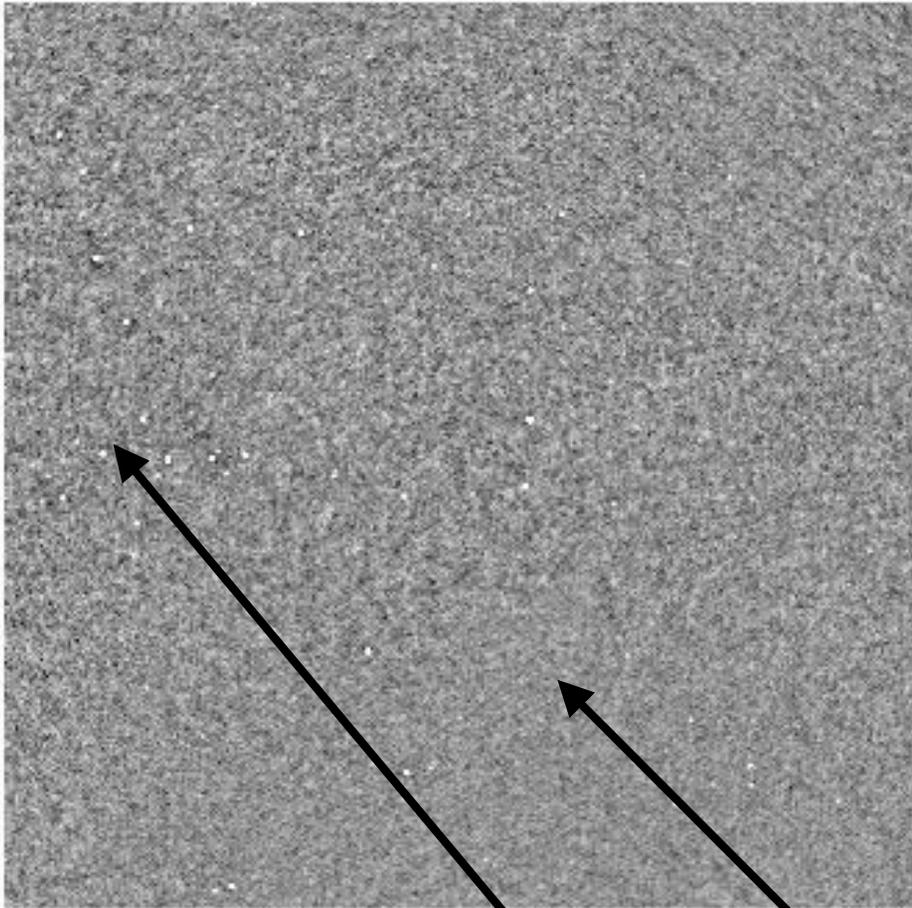
- **Noise is 1 to ~2 times statistical (median 1.27 implies systematic noise is 90% of statistical)**

- **If we could remove systematic noise, the number of AGN would increase by 40%**

- **In the 22 month survey this would be an additional 80 AGN**
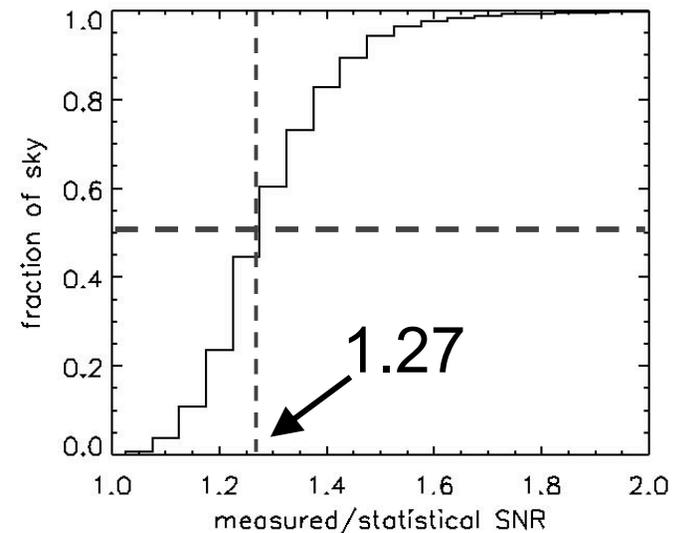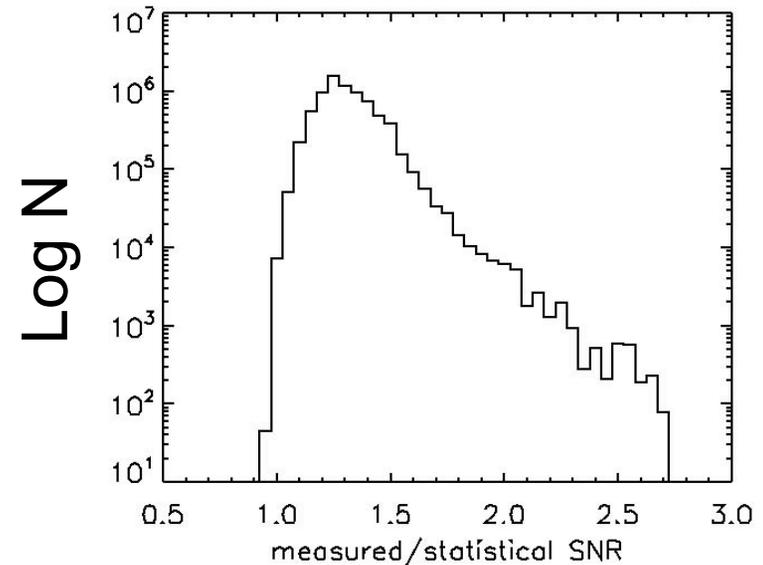
improved background subtraction

9 month image

rough

smooth

- **The background subtraction and particularly the subtraction of bright sources (cleaning) is not perfect**
- **incorporate Earth occultation in background model**
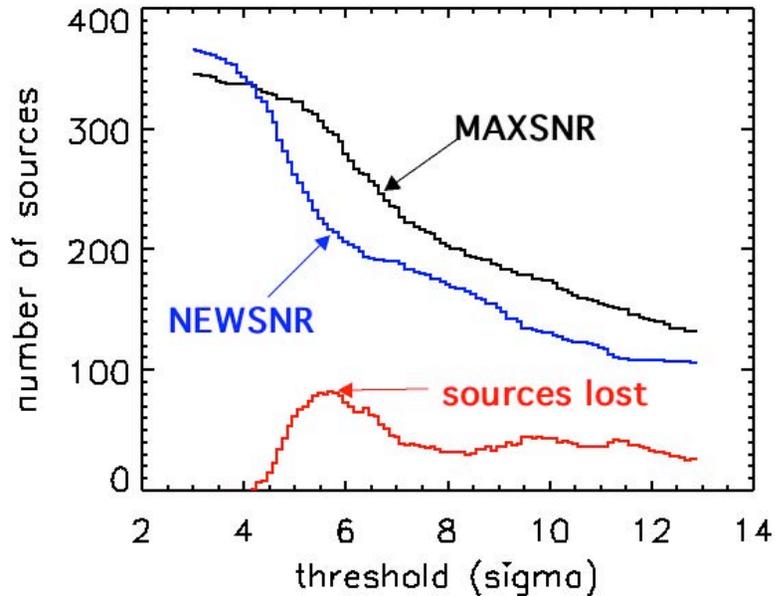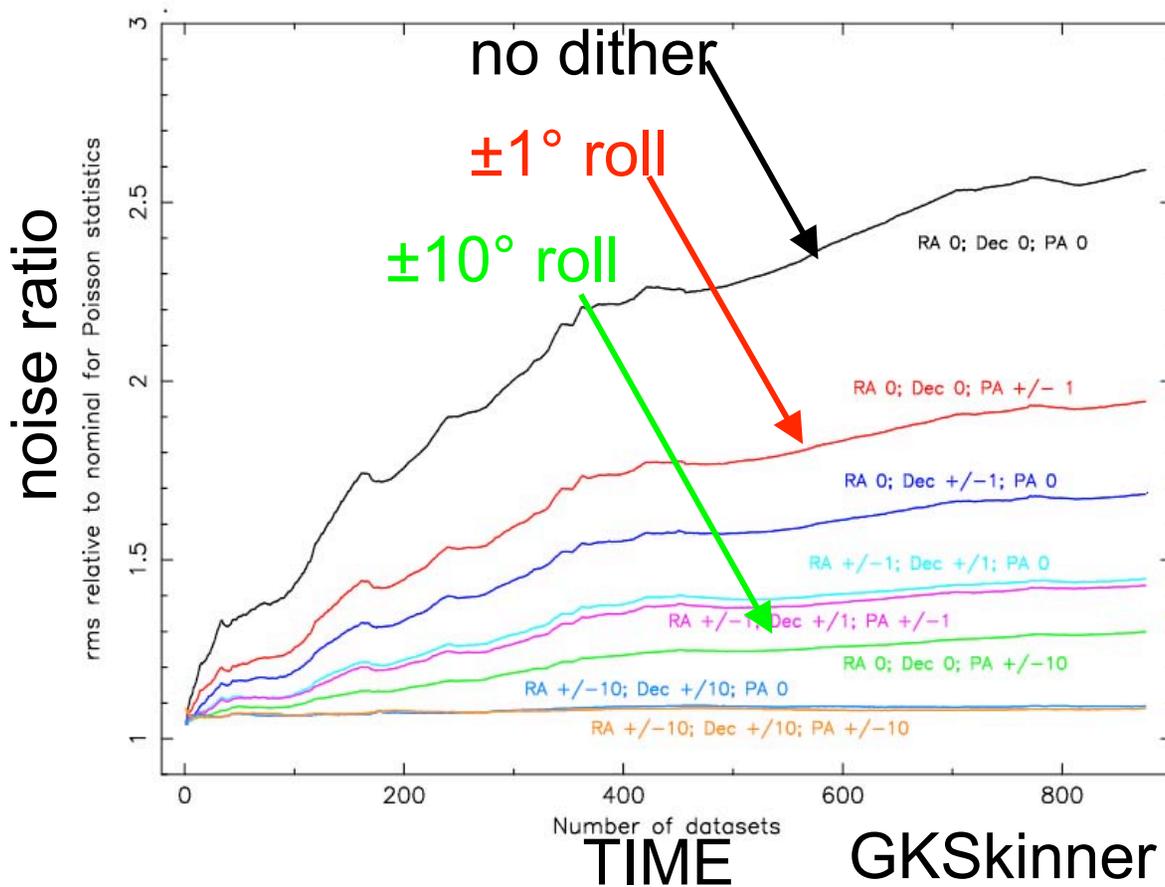- **improve bright source subtraction with edge response model**

energy and time optimization

- **all of our source detection has been performed using the full energy band**
- **there are significant variations in the spectrum**
- **there are significant variations in the noise characteristics with energy especially in the bottom band!**
- **optimizing the search in energy space could yield significant returns**
- **all hard x-ray sources are variable**
- **a similar optimization in the time domain could be equally rewarding**

improved operations

These curves show how the systematic noise grows during long integrations with the same orientation with and without dithering

- **Increase amplitude of roll angle dithering (reduced systematics)**
- **Smooth out exposure at high latitudes (find more bright sources)**
- **Avoid regions of sky with high systematics (Sco X-1)**

- **There is a lot that can be done to get more from the BAT data. There are many opportunities to help with the survey analysis.**

- **Some changes in our operations could improve the BAT survey efficiency significantly**

- **We expect BAT to continue working for a long time eventually detecting ~1000 sources, mostly AGN.**

- **Most will have X-ray and UV follow up from Swift.**

- **This unique data set can only be fully utilized by follow up observations with other instruments. How do we encourage these observations?**

- **Expect a lot more from the BAT hard x-ray survey.**