

Summary of the Stray Light Study 2014

– measurements for correcting X-ray images –

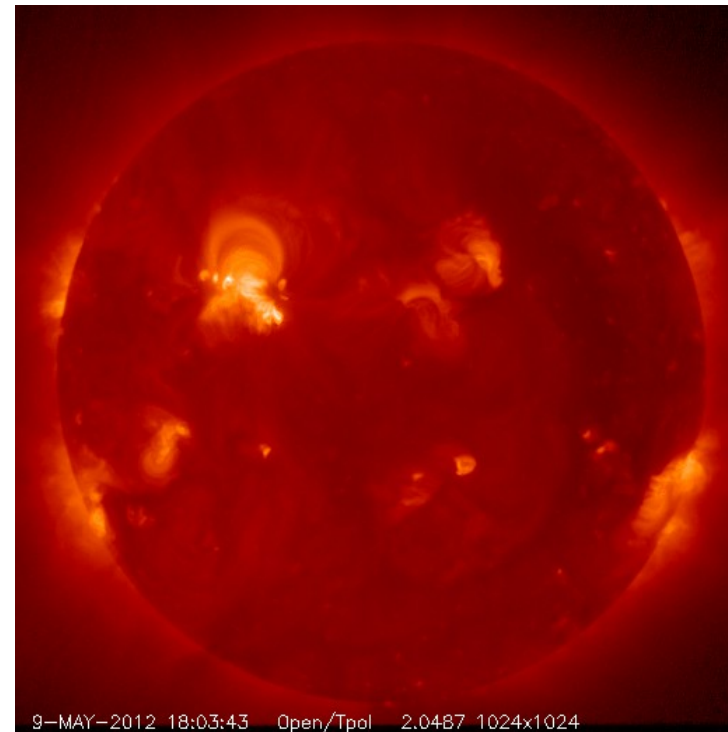
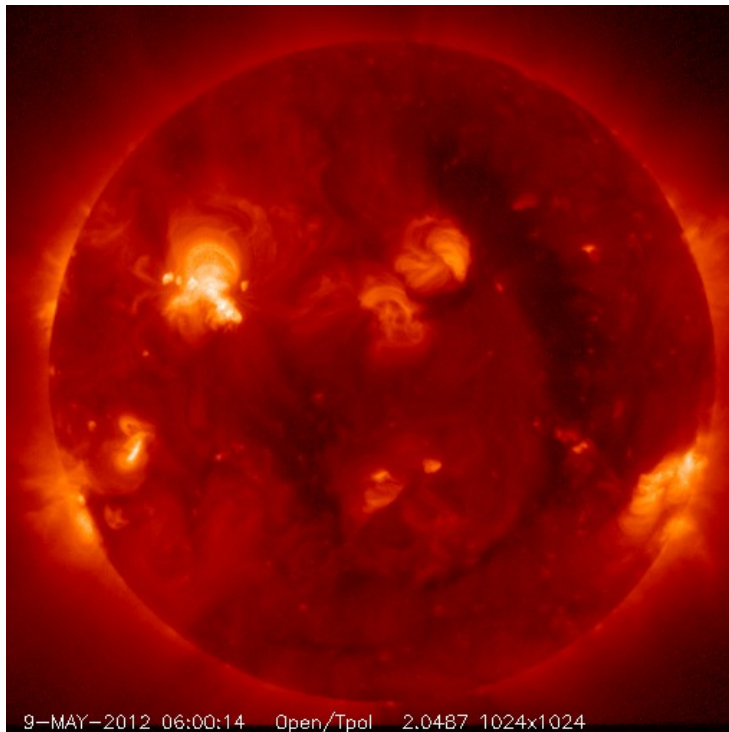
2-September, 2014 by Aki Takeda

1. Introduction

9-May-2012 : Ti-poly image blurring noticed.

First noticed in June as sudden rise of G-band intensity.

(cf : PPT file by DeLuca, McCauley, et al. 22-Jun-2012)



Our current understanding of the phenomena :

- caused by an XRT pre-filter failure (pinhole).
- visible stray light contaminating X-ray images.
- Yohkoh/SXT suffered the same failure in 1993, so presumably, corrected by **the same method as SXT**.



Use terminator images for correction.

- Take image with X-ray filter during Day to Night (or N to D) transition of the spacecraft.
- X-ray component is completely absorbed by the atmosphere while passing through the long optical path.
- Visible light component starts to decay some time after the extinction of the X-ray.
- There exists a short period of time (~30 sec for SXT) when the visible light component is purely detected through the X-ray filter (→ stray light image).

Difference between XRT and SXT cases:

	XRT	SXT
Orbit	Sun synchronous	Low inclined (31 deg.)
Eclipse season	May to mid-August	All year
Twilight frequency	Every ~98 min. (2014.8)	Every ~97 min. (1997.9)
Twilight (D to N) duration	5 to 10 min.	Typically 100 sec.
Data acquisition window	1 to 3 min.	Typically 20 sec.

- XRT stray light images can be taken only during limited months. However,
- the condition of data acquisition for each twilight event is better in XRT than SXT.

2. XRT Stray light measurement – 2014.

2.1. Basic structure of observing programs :

- (1) Full-Sun images before twilight (1024x1024, with the relevant filter, with multiple exposures, use synoptic obs., if available) . These are **Images to be corrected**.
- (2) **Monitor images for light curve** (256x256, in G-band and Ti-poly, centered on AR or bright structures, every 10 seconds, from 30 sec before the twilight to ~30 sec after entering the night). Important to be sure the stray light images were taken at the right timing.
- (3) **Stray light image** (1024x1024, with the relevant filter, DPCM, every ~60 sec, starting a few minutes after the twilight through the night entry).

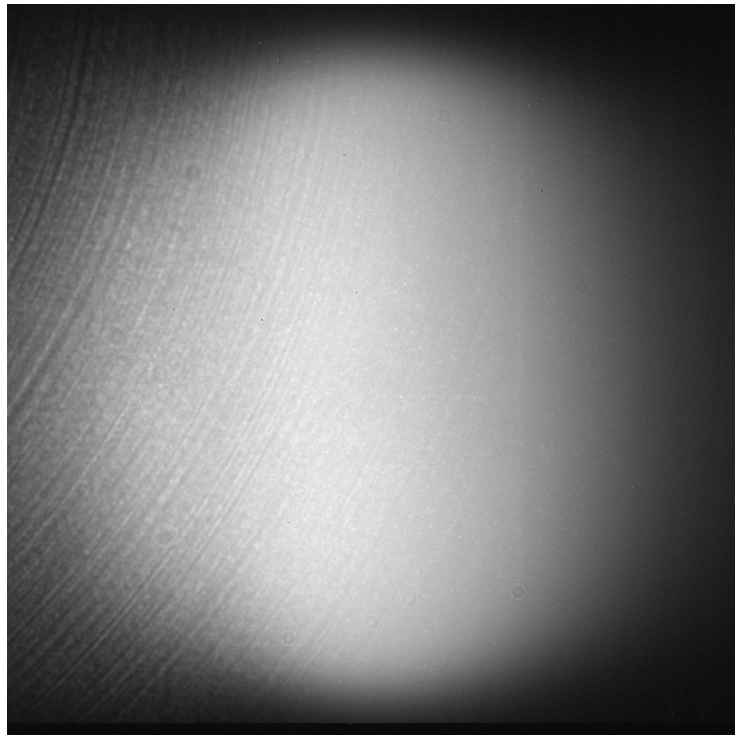
2.2 Dates of measurement and purposes

Timeline No.	Date & Time (UT)	Purposes
1	2014/05/06 17:40	Collect Light Curve, Ti-poly (250 msec) at Disk Center
2	2014/05/15 18:20	LC, Ti-poly (1.41 sec) & Al-mesh (707 msec) at DC
3	2014/05/27 20:30	LC, Al-poly (1.00 sec) & C-poly (1.41 sec) at DC
4	2014/07/03 18:30	LC, Ti-poly (1.41 sec) & Thin-Be (2.83 sec) at DC
5	2014/07/30 18:30	LC, Med-Al (32 sec) at DC
6	2014/07/31 15:49	LC, Med-Be (24 sec) at DC
	2014/07/31 17:27	LC, Thick-Al (64 sec) at DC
	2014/08/01 16:26	LC, Thick-Be (64 sec) at DC
7	2014/08/08 18:56	LC, Ti-poly (4.00 sec) & C-poly (4.00 sec) at N-pole
	2014/08/08 20:40	LC, Ti-poly (1.41 sec) & C-poly (1.41 sec) at E-limb
	2014/08/08 22:30	LC, Ti-poly (4.00 sec) & C-poly (4.00 sec) at S-pole

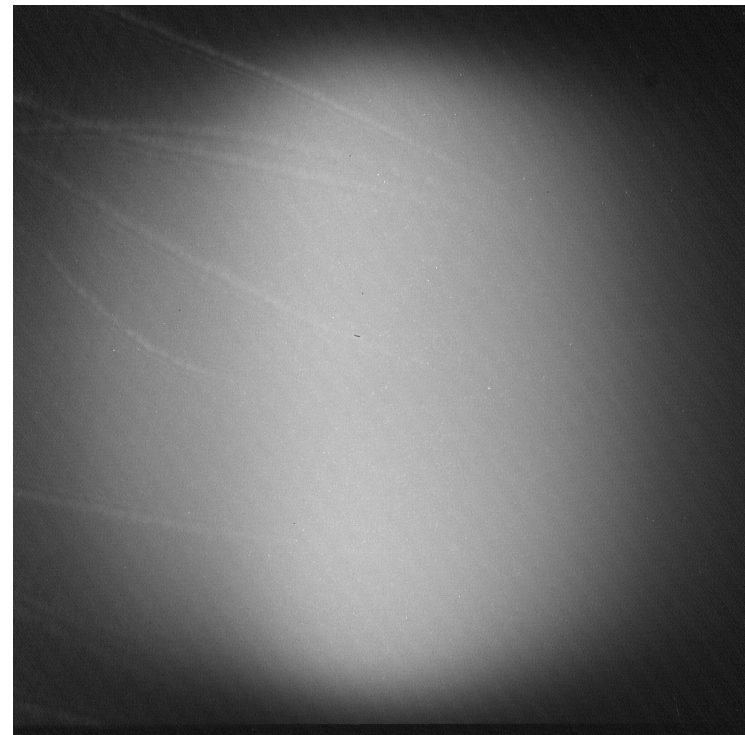
3. Results

(1) Out of 9 X-ray analysis filters, significant visible stray-light components were detected only with the Ti-poly and C-poly filters.

- Ti-poly (at DC pointing)
[XRT20140515_182503.4.fits]



- C-poly (at DC pointing)
[XRT20140527_204601.0.fits]



(2) Stray-light images consist of 3 components:

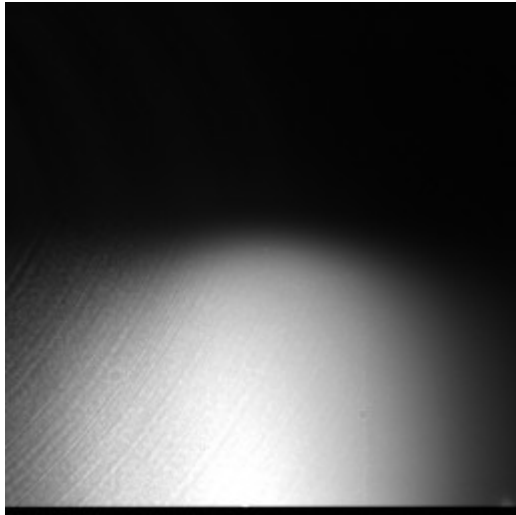
- Solar disk component (brightest).
Ti-poly disk is 2.5 times brighter than C-poly's.
- Structures particular to each filter.
Ti-poly: tree-ring-like shape (stable with time and pointing).
C-poly: wavy streak-like (pointing dependent).
- Dark component (weakest contribution).
Rapid changing periodic stripes similar to those found in dark frames.

(3) At the polar- and limb-pointings, stray-light images are different most significantly in the solar disk component.

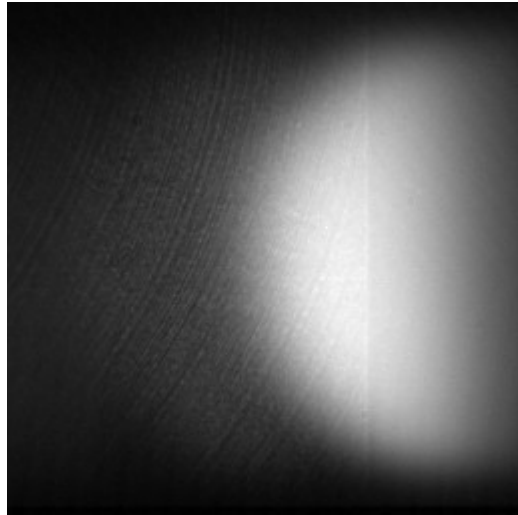
Stray-light images at N-pole, E-limb, and S-pole pointings.

- Ti-poly

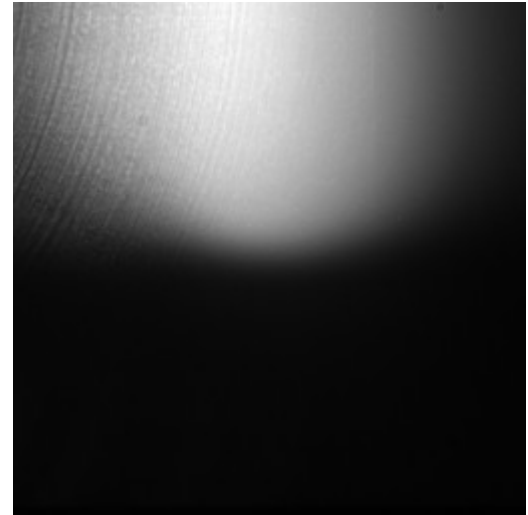
XRT20140808_191124.0.fits



XRT20140808_205020.5.fits

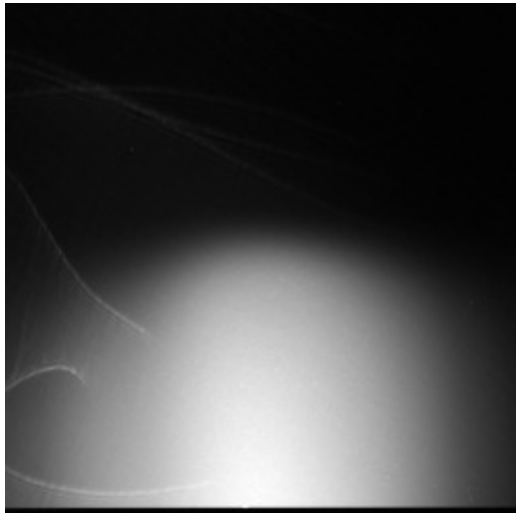


XRT20140808_222905.4.fits

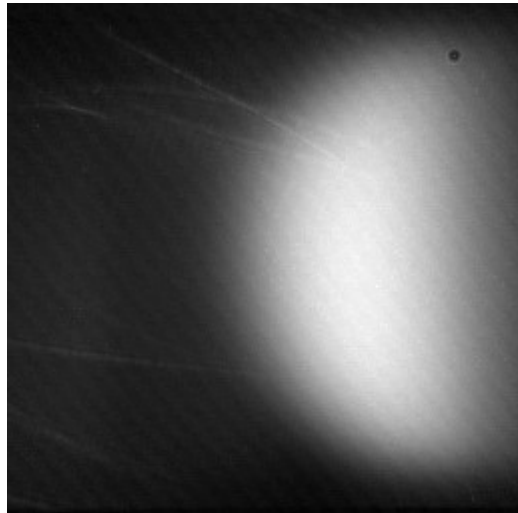


- C-poly

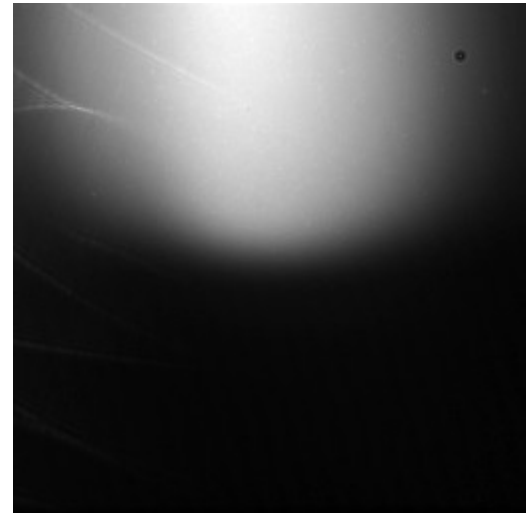
XRT20140808_191137.1.fits



XRT20140808_205031.0.fits



XRT20140808_222918.5.fits



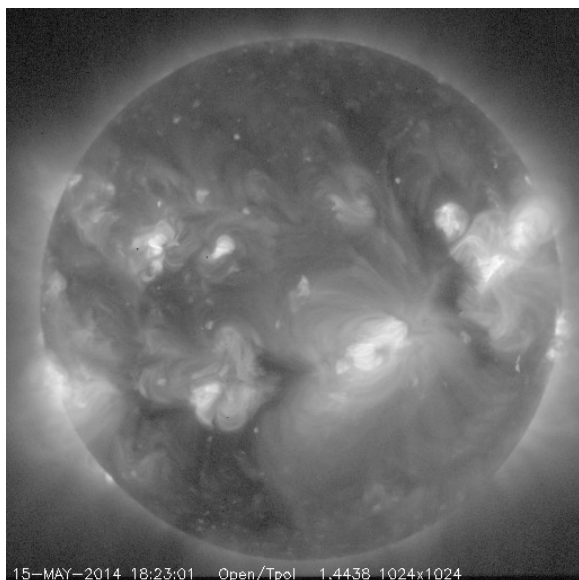
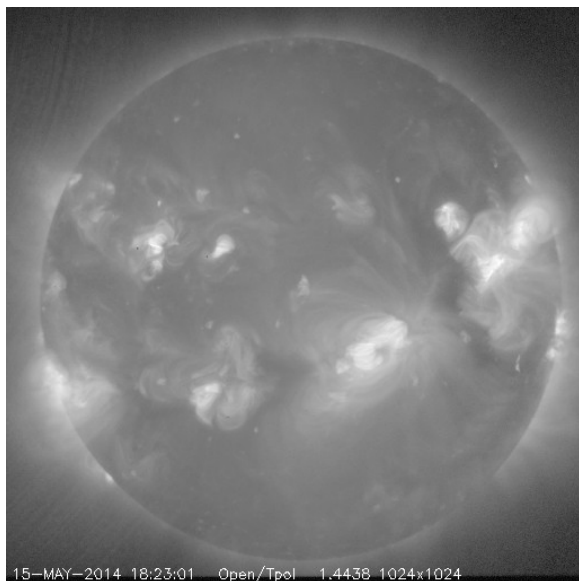
(4) Stray-light images are good for quantitative correction of X-ray coronal images taken closely in time with and at the same pointing as the stray-light image.

[Things to consider to correct other images]

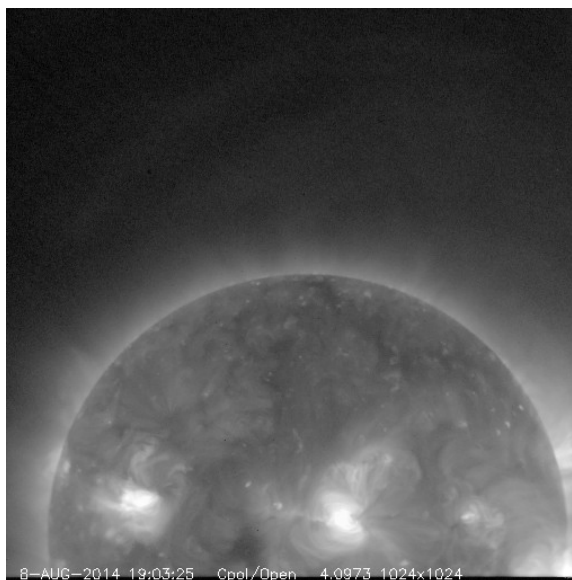
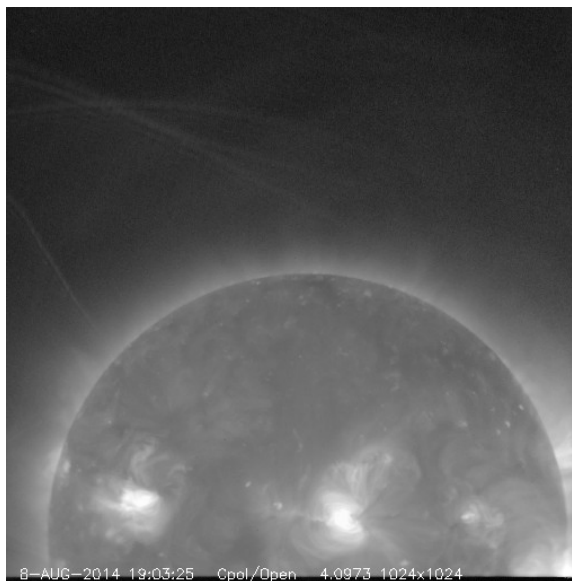
- Pointing of the stray-light image needs to be the same as the image to be corrected.
- Long term variation of the stray-light intensity. (Stray-light in May-2014 is approximately twice the level in May-2012.)
- Reproducibility of the pointing. (Seasonal change of the offset between Hinode and XRT, typically 10 to 30 arcsec.)
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Examples of image correction (top: before corr., bottom: after corr.)

Ti-poly at DC



C-poly at N-pole



Ti-poly at S-pole

