

Effects of the Dec. 13, 2006 Solar Storm on the IRS

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Summary

The $>100\text{MeV}$ proton flux from the Sun, as measured by the GOES 11 satellite, peaked at about 90 pfu on December 13, 2006 (day 347) at about 03:00 UT. This was the middle of the 5th day of IRS campaign 37, which ended on Dec. 14. The effects on the IRS arrays included: (1) a factor ~ 50 increase in the number of particle hits detected by IRS automatic pipeline data processing, (2) a factor $\sim 3\text{--}6$ increase in the read noise, and (3) a factor of 3 increase in the number of “rogue” pixels detected. All 3 increases were temporary and were confined to a period of about 12 hours around the peak proton flux. There is no evidence that IRS science has been seriously affected by the storm, but potentially affected observers will be alerted.

1. Particle Hits

The IRS data processing pipeline detects and removes the immediate effects of energetic particle hits on the detectors. Figure 1 shows the particle count per second as a function of time, derived from dark measurements taken at the beginning of each Period of Autonomous Operation (PAO), which occur approximately once per 24 hr. A peak of about 100 per second occurs at a SCLK time of about 850450000, or around December 13 at 03:24 UT, the date of the last dark measurement for that PAO. This is near the time of peak proton flux. The peak particle rate is a factor of about 50 above the average for earlier in the campaign, as well as the average for earlier campaigns, about 1.8 particles per second. The

next PAO showed slightly elevated numbers, but subsequent PAOs were similar to others in the campaign.

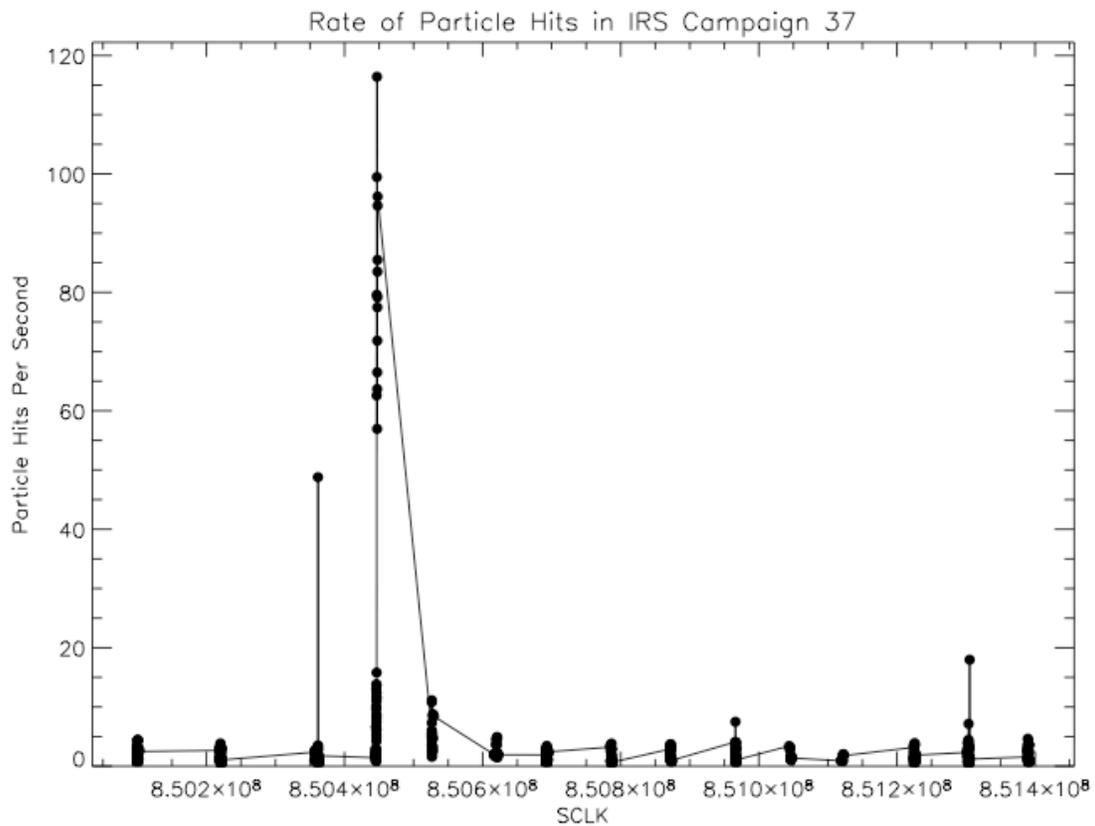


Fig 1. Rate of Particle hits in IRS-37, derived from dark measurements in all 4 arrays.

We have not compared the number of IRS particle hits directly with the solar proton flux, but it is likely that the two numbers are highly correlated.

2. Read Noise

Based on the a preliminary examination of dark measurements, the read noise in all four IRS arrays increased drastically at approximately 03:06 on Dec. 13, or SCLK 850446500. The first AOR affected was 0020922880 (caldrk for Short High and Long High), where the read noise increased by a factor of 5.5 in SH, and by a factor of 2.5 in LH, compared to the identical AOR in IRS-36.

3. Rogue Pixels

IRS arrays have “rogue pixels,” pixels with abnormally high dark current that vary with time. (The pixels are labeled “rogue” because the high dark currents can be temporary and unpredictable.) Figure 2 shows the Long High (LH) rogue pixel history for IRS-37. The solar flux peaked just before we took one set of 60s LH darks, from which these measurements were drawn. Right after the storm peaked, the count went up about a factor of 3 from the typical value for the rest of the campaign. The subsequent set of 60s LH dark measurements, taken two days later, showed that the rogue pixels were back to normal. Unfortunately, we don’t have better time resolution on the rogue pixel measurements, but visual inspection of science AORs taken right after the solar peak showed that the increased rogue count lasted only about 6hr.

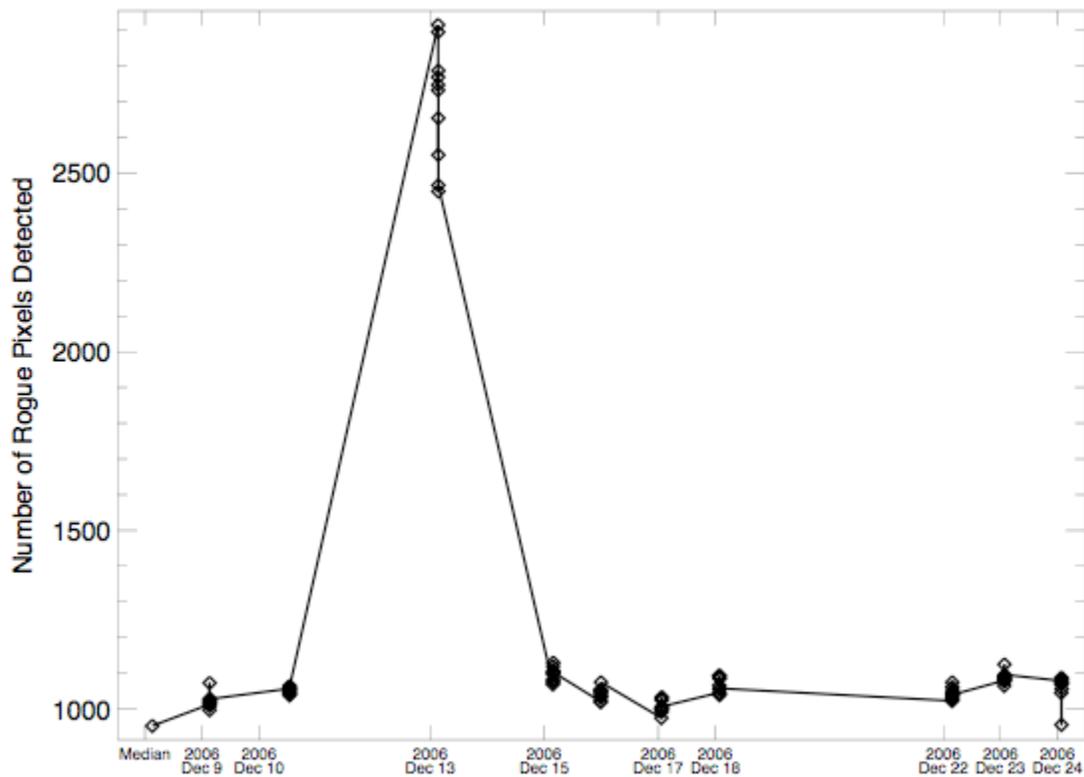


Fig 2. Per-DCE rogue pixel counts in IRS-37, derived from dark measurements in the Long High (LH) array. The number of rogue pixels in the median LH dark is shown at bottom left.

Except for the Dec 13 measurements, the rogue count per DCE is similar to values measured for IRS-36, a campaign with little solar activity.

4. Conclusions

Any effects of the Dec. 13 solar storm on the IRS arrays appear to have been temporary. Even during the period of high proton flux, about 12 hours surrounding 03:00 UT, there is no evidence that IRS science was seriously affected. Before final reprocessing and distribution of IRS-37 science data, the IRS IST will distribute a memo alerting all potentially affected observers to report any problems to SSC Science User's Support.