

Search for nuclear γ -ray line emission from astrophysical sources in the GBM continuous spectral data

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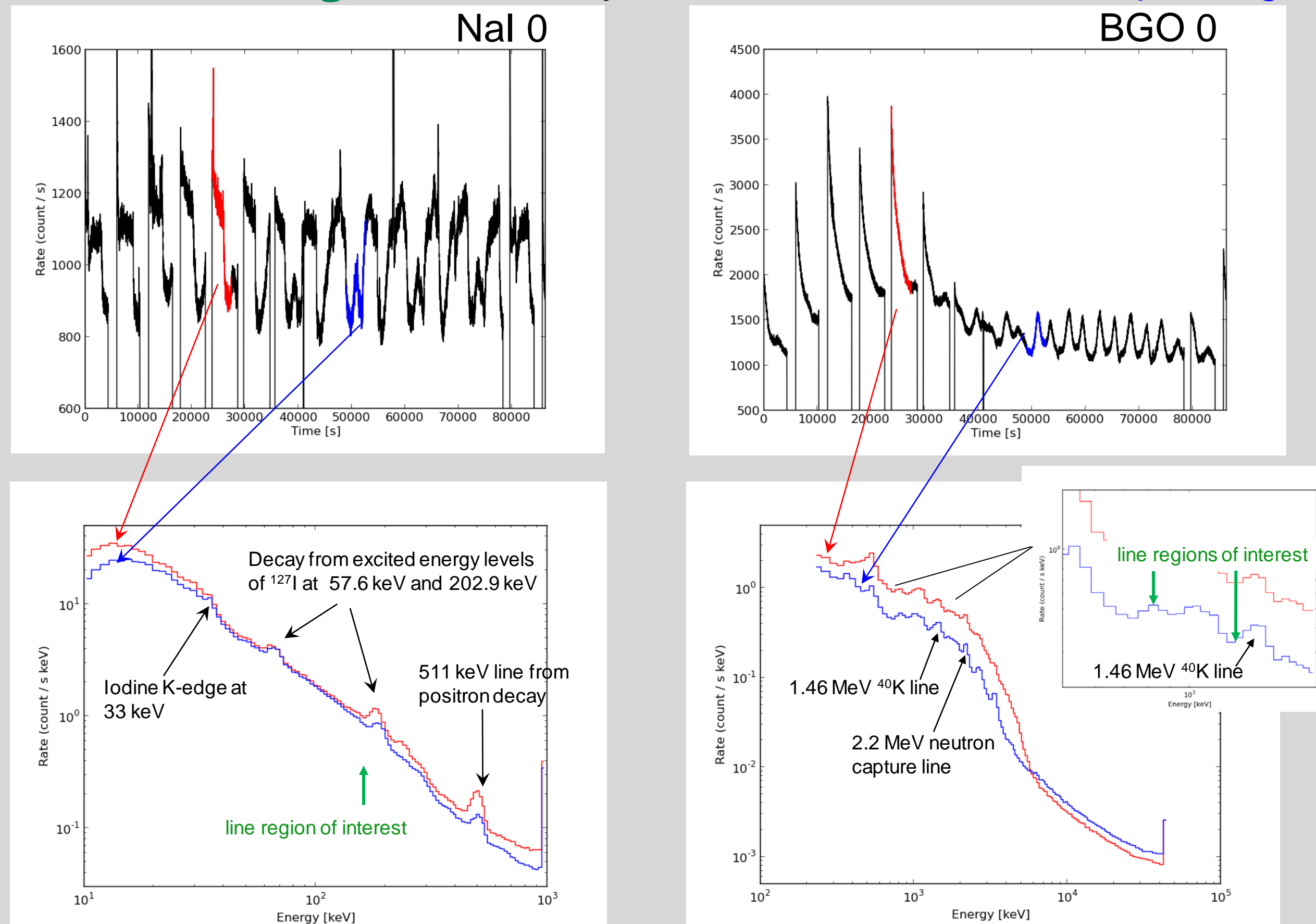
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Abstract: An evaluation of feasibility for using the GBM continuous CSPEC data for the detection of nuclear γ -ray line emission from astrophysical sources is presented. The GBM instrument provides continuous spectral data from all 14 detectors with a temporal binning of 4.096 s and 128 logarithmically spaced energy bands in the energy range from 8 keV to 1 MeV (NaI detectors) and from 200 keV to 40 MeV (BGO detectors), thus covering the energy range of interest for astrophysical nuclear lines. Since any point in the sky is always viewed by some of the GBM detectors at regular intervals the GBM CSPEC data can serve for such explorations. The main problem which strongly deteriorates the capabilities of GBM for this search is the highly varying background. In order to accomplish the aimed goal and to handle the background problem a dedicated analysis method is currently under development. The different steps of the procedure are presented together with first results of an investigation of the background behavior. In addition a rough estimate for the sensitivity of line detection from nearby SN events is given.

Method / Analysis Procedure:

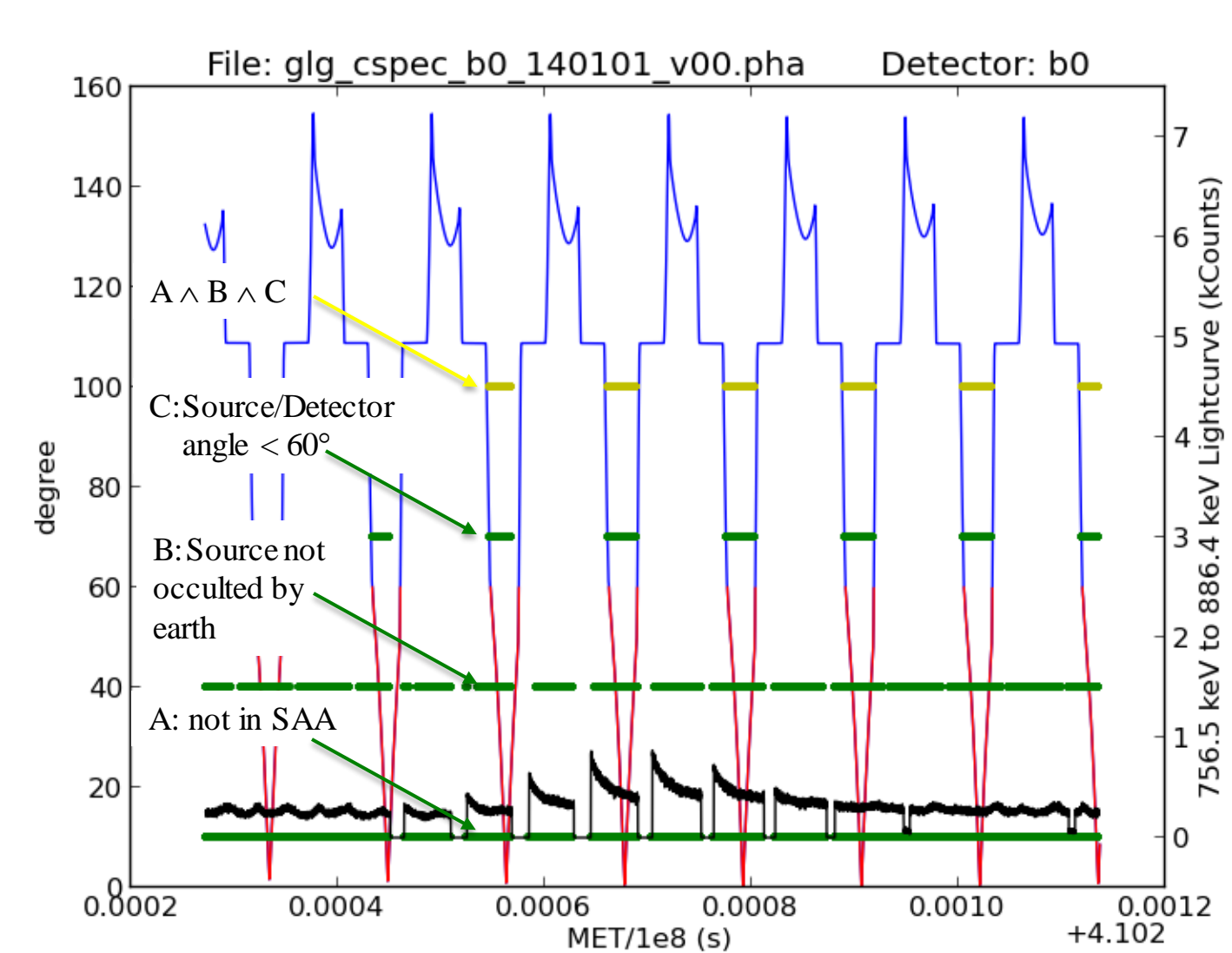
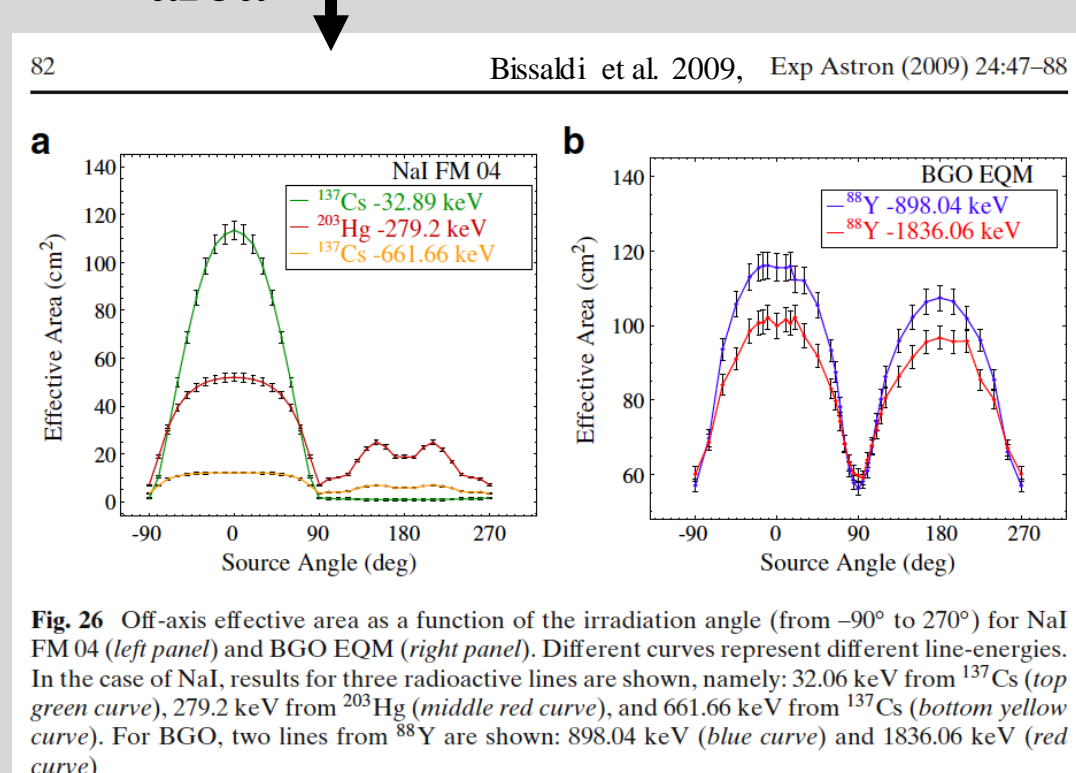
- ❑ Using daily CSPEC data with 4.096s bins / 128 logarithmically spaced energy bins
- ❑ Selecting data when a NaI/BGO detector is viewing the source of possible γ -ray line emission
 - from daily poshist file \Rightarrow angle of detector with respect to source (< 60 deg / < 40 deg / $< \dots$)
 - in addition accounting for earth occultation & good times
- ❑ Background method I: Adjacent Energy Bands
 - Determine line region excess counts (line region counts – counts, determined by background method)
 - Light curve of excess counts, first version with 1 day bins \Rightarrow monitor long-term behavior of excess counts
- ❑ Background method II: On - Off source observations
 - Subtract the excess count light curves derived from off-source directions (detector / source angles > 60 deg) from on-source observations (detector / source angles < 60)

Detector Background: 1 day, after SAA / outside SAA passages



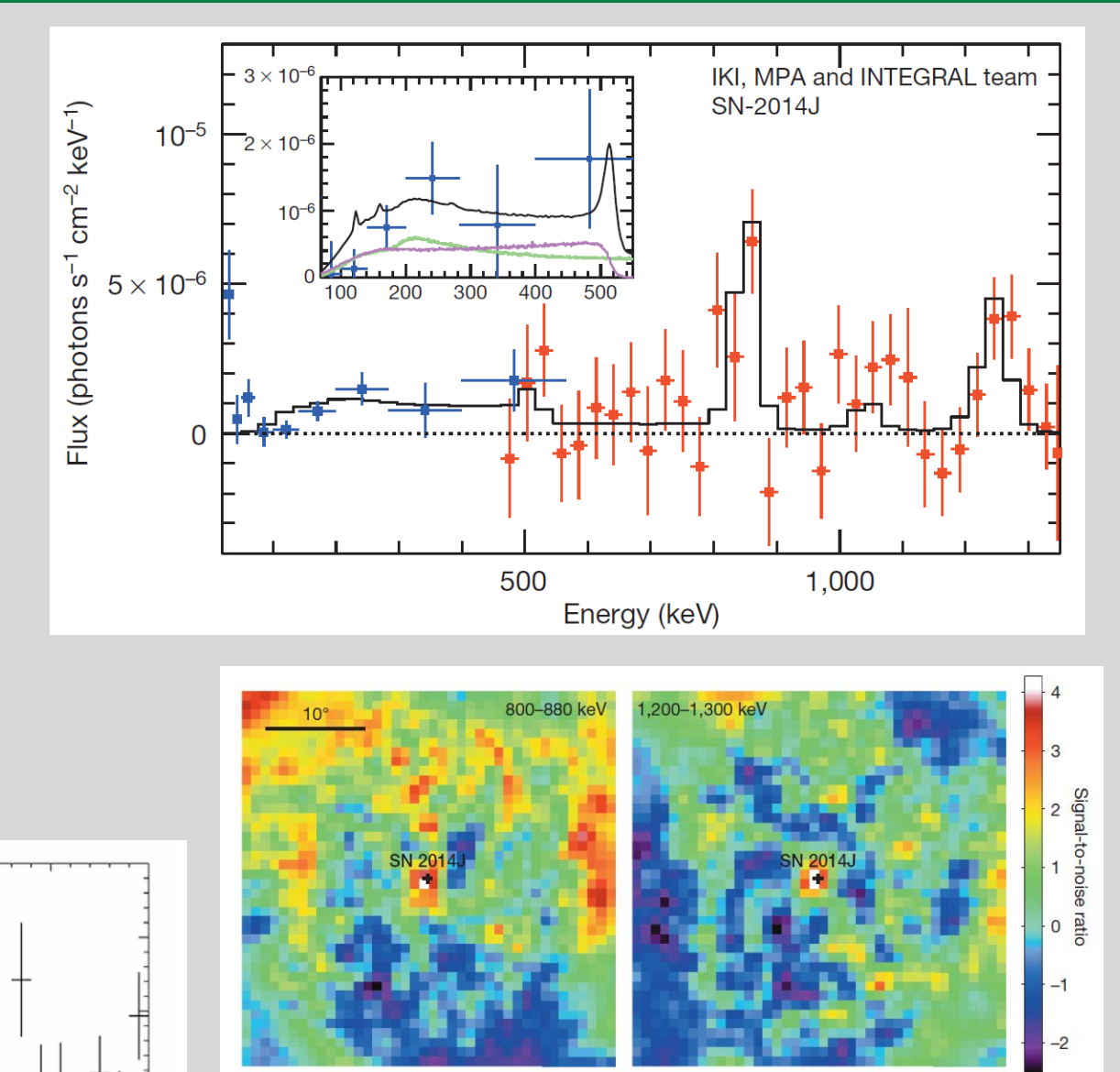
Data selection:

- ❑ Detector/Source angle < 60 deg
- ❑ Source not occulted
- ❑ Not in SAA
- ❑ Reminder: Off-axis effective area

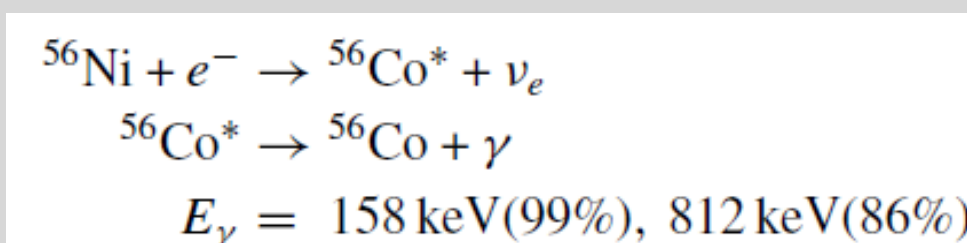


Motivation:

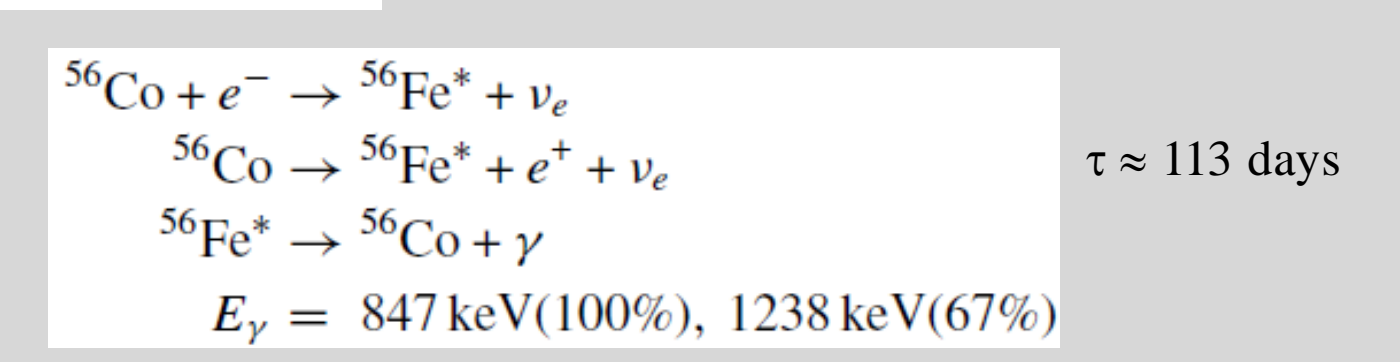
- ❑ Success of INTEGRAL for SN2014J
 - Churazov, E., et al., Nature, 512, 406 (2014): ^{56}Co lines at 847 and 1,238 keV and a γ -ray continuum in the 200–400 keV band from the type Ia SN2014J in the nearby galaxy M82.
 - Flux: $2 - 3 \times 10^{-4}$ photons $\text{s}^{-1} \text{cm}^{-2}$
 - Diehl, R., et al., Science Express, July 2014: SPI detection of lines at 158 and 812 keV from ^{56}Ni only ~20 days after the explosion
- ❑ Could GBM in principle also detect these lines?



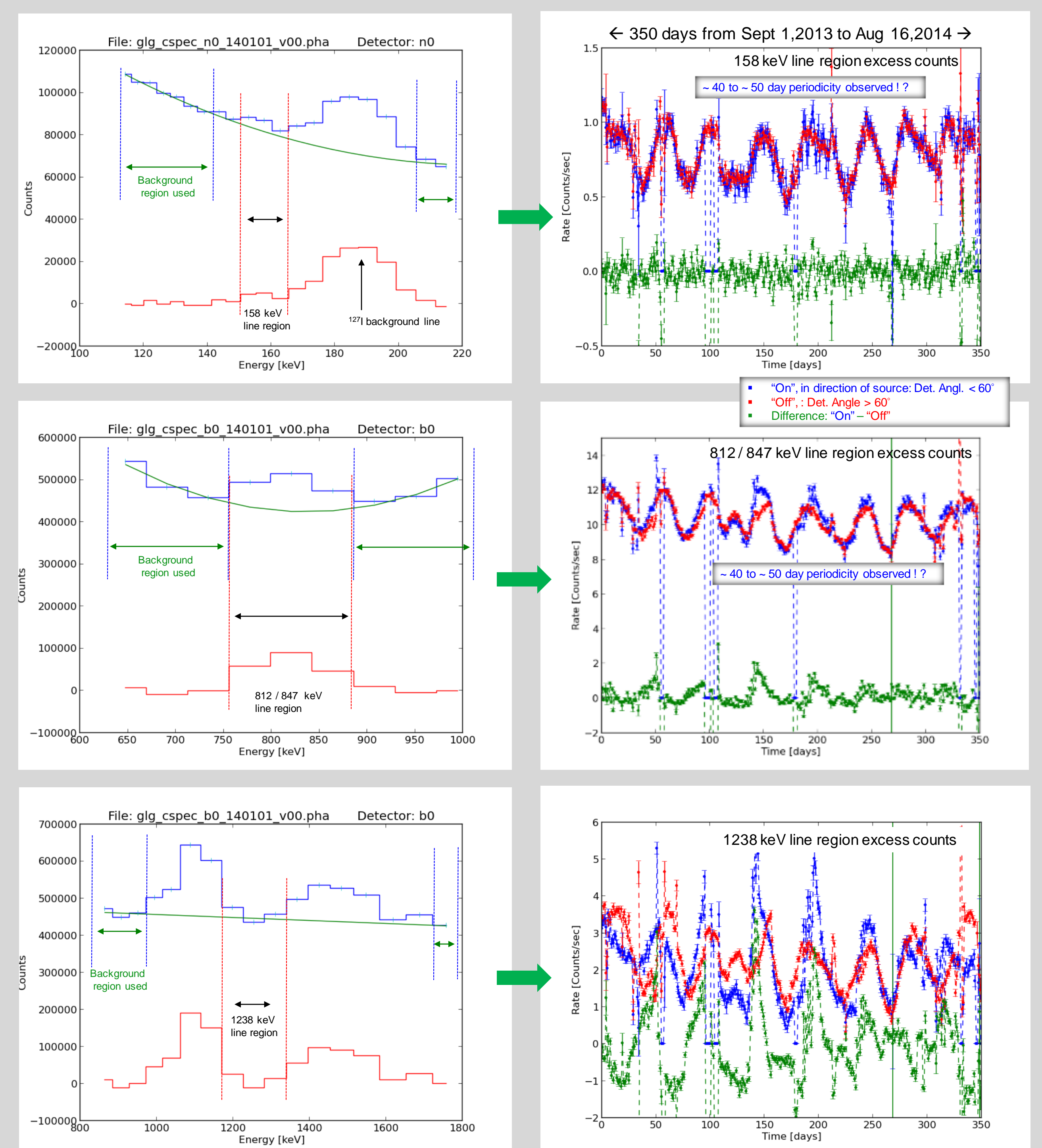
Decay chain: $^{56}\text{Ni} \rightarrow ^{56}\text{Co} \rightarrow ^{56}\text{Fe}$



$\tau \approx 8.8$ days

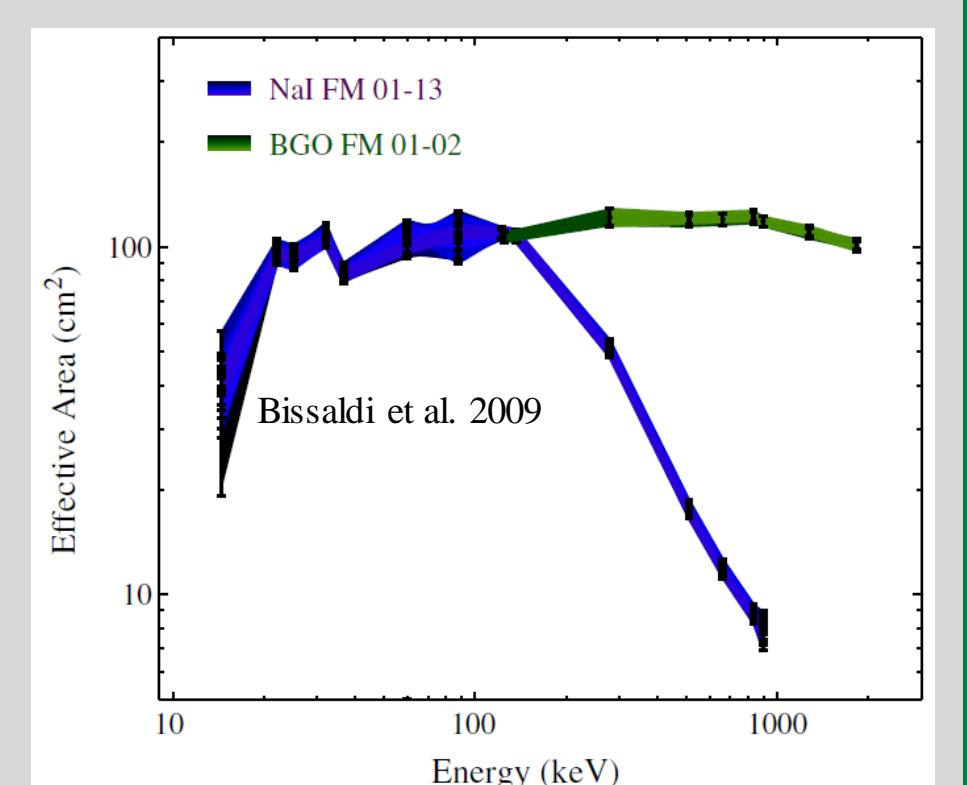


First Results: long-term dependence (~ 1 year)



- ❑ Current status / Open issues:
 - what causes the 40 – 50 day periodicity?
 - Background method II: difference in residuals observed for NaI- and BGO detectors?
- ❑ Next steps:
 - NaIs: add signals of all detectors
 - BGO background: exclude SSA passage region?
- ❑ First sensitivity estimate: for 158 / 810 / 847 / 1238 keV line detection from a SN event: $\sim 2 - 5 \times 10^{-3}$ photons $\text{s}^{-1} \text{cm}^{-2}$

- ❑ Reminder: Energy dep. of effective area



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