SUMAMPS–based Gain Maps and RMF for the HRC–I
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I. Scaled SUMAMPS
- SUMAMPS: sum of signals from 3 amplifiers nearest event signal on each side
- SAMP: scaled SUMAMPS = \frac{SUMAMPS}{C=148}, chosen to match PHA values (see Figures 1 and 2)
- SPI: pulse invariant (gain-corrected) SAMP
- SPI will replace PI in HRC event lists

II. Gain Maps
- Like PHA, scaled SUMAMPS reflect the gain decline over time (Figure 3)
- Observations of AR Lac at 21 locations on detector and HZ 43 and G21.5-0.9 at aiming used to make set of time-dependent gain correction maps
- Gain correction maps defined as \( g(z|t) = g_{\text{preflight}} + \gamma \times z + \alpha \times TC(t) \) where:
  - \( g(z|t) \) = preflight gain correction map, based on lab flat field maps
  - \( g_{\text{preflight}} \) = preflight gain correction map, based on lab flat field maps
  - \( \gamma \) = spatial correction surface, extrapolated for each epoch from set of 20 spatial correction factors. These correction factors are determined by matching profiles of 20 offset AR Lac observations per epoch to aimpoint profile (e.g. Figure 4).
  - \( TC(t) \) = this time-dependent correction function is fit to temporal correction factors (Figure 3). The correction factors are determined by matching profile of aimpoint observation at given time to profile at initial time for AR Lac, G21.5-0.9 and HZ 43.
- Final gain correction maps shown in Figure 5. They correct for the temporal and spatial variation in scaled SUMAMPS (Figures 7 and 8).

III. RMF
- We apply gain maps to HRC-I/LETG observations of Cygnus X-2, PKS 2155-304 and HR 1099
- Spectra are combined and background subtracted, using the continuum regions for each source (Table 1). We group the data into wavelength slices with at least 4000 counts per slice.
- We fit the SPI profile for each wavelength slice with two Gaussians (Figure 9).
- Example of profile matching to determine spatial correction factor. The red histogram shows the off-axis profile at a given time, and the blue histogram shows the aimpoint profile at the same time. The dotted black lines show the difference between the two profiles.
- Gain correction maps have removed the downward trend with time seen in Figure 3.

Table 1: HRC-I/LETG observations used to create RMF.

<table>
<thead>
<tr>
<th>Source</th>
<th>Date</th>
<th>Exposure Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cygnus X-2</td>
<td>1999-10-27</td>
<td>2259.02</td>
</tr>
<tr>
<td>PKS 2155-304</td>
<td>1999-10-27</td>
<td>13726.06</td>
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<tr>
<td>HR 1099</td>
<td>2002-11-30</td>
<td>29653.09</td>
</tr>
</tbody>
</table>

Figure 5: Mean SPI versus observation date for HRC-I observations of AR Lac, G21.5-0.9 and HZ 43. The blue line shows the mean SPI profile, and the cyan points show the mean SPI profiles for each source. The black bar in the lower right corner shows the typical 2-sigma error.

Figure 6: The final gain correction maps, shown on a log scale from 0.9 to 4.0. They proceed in chronological order from top to bottom, left to right.

Figure 7: SPI versus observation date for HRC-I/LETG observations of AR Lac (top), G21.5-0.9 (middle) and HZ 43 (bottom). The green points show the fit parameters for the primary (central) Gaussian and the cyan points show the fit parameters for the secondary (high-energy shoulder) Gaussian. The black and blue lines show the Loess smoothing of the data.