A short Guide to Chandra Instruments

1 *Chandra* Instruments

The *Chandra* suite of science instruments comprises two imaging/readout devices (HRC and ACIS) and two gratings (LETG and HETG)

ACIS is an array of CCD detectors, often used for imaging spectroscopy. The layout is shown in Figure 1. Each chip is $8' \times 8'$ with a pixel size of $0.49''$. Chips S3 and S1 are back-illuminated and have slightly different characreristics than the front illuminated chips. Aimpoints are on S3 for ACIS-S and I3 for ACIS-I. Highest (sub-arcsecond) resolution is obtained within 1-2 arcmin from the aimpoints, depending on the energy of the source.

HRC comprises two microchannel plate detectors, one optimized for imaging (HRC-I) and one for spectroscopy when used with a grating (HRC-S). The FOV of HRC-I is $30' \times 30'$ and the pixel size is $0.13''$. The HRC also allows for fast timing observations (16 μs, for caveats see the Proposers Observers Guide and Timing Fact Sheet). The HRC has minimal intrinsic energy resolution.

High Resolution Spectroscopy is obtained by use of the High Energy Transmission Grating (HETG: range 0.4-10keV)) and Low Energy Transmission Grating (LETG: range 0.07-10keV). The LETG provides very high resolving power ($E/\Delta E > 1000$ between 0.08 and 0.2 keV). The HETG consists of two gratings, the Medium Energy Grating (HEG) optimised for the range 1.2-15Å and the High Energy Grating (HEG) covering the range 2.5-31Å. Gratings can be used to mitigate pile-up for bright sources. The zeroth grating order is an image.

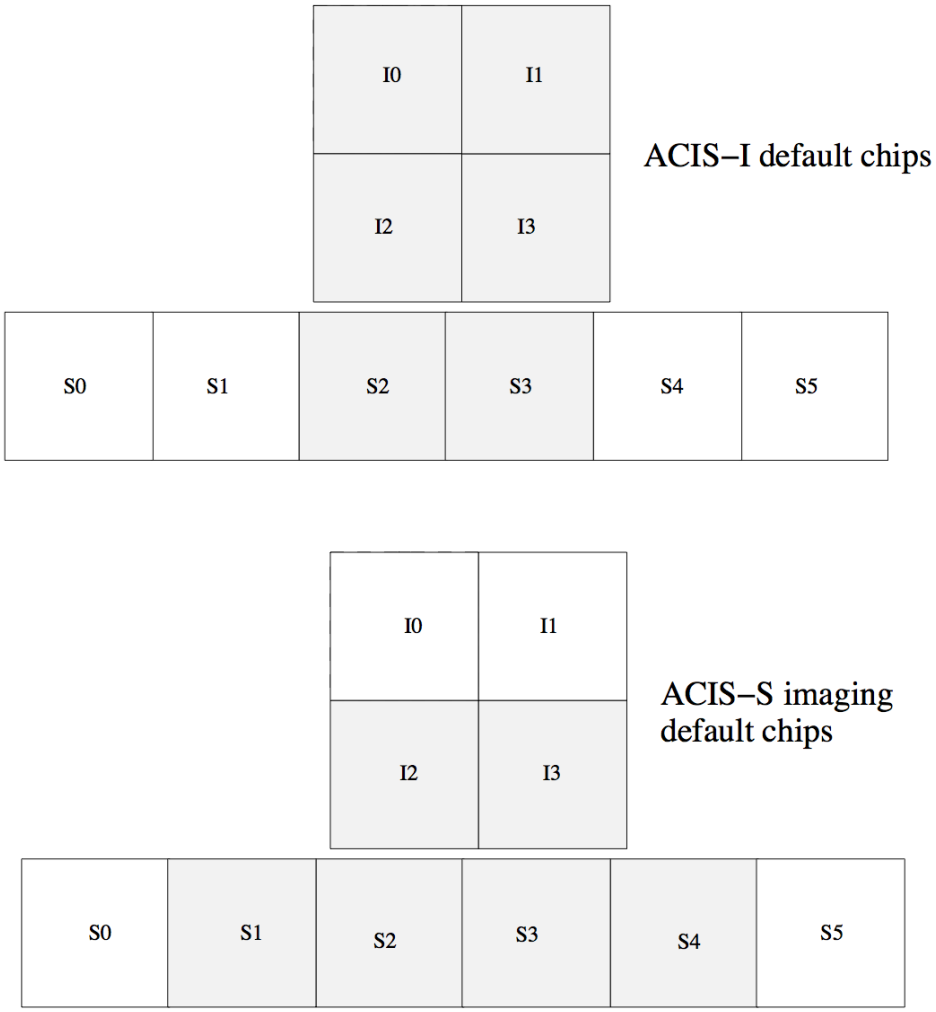

Figure 1: A schematic drawing of the ACIS focal plane, not to scale. The ACIS-I array consists of chips I0-I3. ACIS-S consists of chips S0-S5. Any combination of up to 6 chips can be turned on. In order to avoid over heating the ACIS Power Supply and Mechanism Controller, observers are asked to specify which chips can be turned off.

1.1 Comparision of *Chandra* Imaging Instruments

ACIS is most often used for imaging combined with low resolution spectroscopy. The pixel size is such that the core of the PSF of an on-axis falls mostly into one pixel. The HRC has smaller pixels that oversample the PSF of an on axis point source: it therefore has the highest spatial resolution. The HRC-I detector has the largest field of view. It is somewhat less sensitive than ACIS, and has very little sensitivity above 2keV.

Instrument	FOV arcmin	pixel size arcsec	energy resolution eV at 1keV	timing resolution s	effective area cm^2 at 1keV, on axis
ACIS-I	16.9×16.9	0.492	60[1]	3.2[2]	367 (FI)
ACIS-S	8.3×18.3	0.492	120(BI), 60(FI)	3.2[2]	367(FI) 555 (BI)
HRC-I	30×30	0.13	$\sim$ 1000	16×10^{-6}	227
HRC-S	6×99	0.13	$\sim$ 1000	16×10^{-6}	227

Notes
(1) Energy resolution of FI chips row dependant
(2) Number for full frame, < 3.2 for subarray

Table 1: *Chandra* Imaging Capabilities

1.2 Comparision of *Chandra* Spectrometers

The LETG is optimized for high resolution spectra in the 0.08-0.2 keV region. It is most often used with HRC-S as the readout instrument. It can be used with ACIS-S, but with decresed QE below 0.6keV and a smaller wavelength range. The HETG was designed primarily for use with ACIS-S, where the intrinsic energy resolution of the CCDs can be used for order sorting. It can also be used with the HRC-S as readout.

	HETG/ACIS-S	LETG/HRC-S
wavelength range (Å)	1.2-31	1.2-175
resolving power ($E/\Delta E$)		
@12.4Å(1keV)	1000	20
@100Å(0.12 keV)	-	1000
effective area (cm^2)		
@12.4Å(1keV)	42[1]	26[2]
@100Å(0.12 keV)	-	7[2]

(1) HEG plus MEG first orders summed
(2) First order, positive and negative orders summed

Table 2: *Chandra* Spectroscopy Capabilities