Proposing to Observe an On-axis Point Source with ACIS

Proposal Threads for Cycle 12
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Proposing to Observe an On-axis Point Source with ACIS

Proposal Threads for Cycle 12

1. Thread Overview

Please note that this thread uses calculated values based on Cycle 10 effective area curves. If you have any questions about the results you get by following this thread, please contact the HelpDesk.

For this thread, we will calculate the exposure time required to detect the point source 1RXS J152417.7-200856 using ACIS. The source was previously observed with the ROSAT/PSPC. In addition to a source detection, we also want to:

- Obtain a source count rate.
- Obtain a rough spectral slope.
- Consider galactic NH and pileup.
- Select the operating mode and telemetry format.

We also need to prepare and submit a properly completed proposal to observe this object. See the Proposer Pages for more information about Chandra Proposals.

2. Preliminary Considerations

Check for Previous or Planned Observations by Chandra

If the target has already been observed, additional observations must be justified (variability, longer exposure, etc.). To determine if any previous observations exist, you can use Web ChaSeR, available at http://cda.harvard.edu/chaser.

Enter the RA and Dec of the object. The source 1RXS J152417.7-200856 is at RA: 15 24 17.70 and Dec: -20 08 56.5. Verify that these boxes are checked: Archived, Observed, Scheduled, and Unobserved.

The screen will look like this.

Click the Search button. There are no observations returned, so there are no other Chandra observations to consider in this proposal.

Target Visibility and Bright Sources

ObsVis is designed to view sky images with overlaid instrument fields-of-view (FOV's). It is available as part of CIAO4. To view sky in the region of 1RXS J152417.7-200856:
On-axis Point Source - ACIS - POG Cycle 12

- source ciao4
- run obsvis on the command line
- enter the coordinates into the "Target Coordinate Box"
- turn on desired chips using the toggle buttons on the right hand side of the screen.
- click the "New FOV" button

The Digital Sky Survey image for the region around 1RXS J152417.7-200856 will appear in a DS9 window. The resulting sky image with chips I0-I3 plus S2 and S3 is here. The instrument FOVs can be adjusted from the obsvis window or by directly manipulating DS9.

To check for X-ray sources, navigate "Analysis --> Catalogs --> ROSAT ALL Sky Survey Faint Source Catalog" within DS9. Several sources are found and displayed in DS9, but none are within the ACIS FOV. There are no other strong sources in the field of view, so a roll constraint is not required.

Planning an observation with Chandra is complicated by the fact that the maximum exposure time for a given target depends on the solar pitch angle (i.e. the angle between the viewing direction and the direction to the sun). The exposure time for this target is very short and the observation is not time constrained. Therefore pitch angle restrictions are not important for this proposal. They are described briefly here for completeness.

Pitch angle restrictions are described in detail in the POG. The pitch angle of a celestial source changes throughout the year. Therefore, the maximum exposure time might also change throughout the Cycle (see the maxexpo page for current restrictions.) There may be times when it is impossible to schedule a particular target. Proposers who require time constraints should use the PRoVis to check that the constraints are feasible. Please see threads on time constrained observations and how to classify constrained observations.

3. Calculate galactic Nh

One factor that will effect the exposure time needed to detect this point source is the amount of galactic Nh in the direction of 1RXS J152417.7-200856. You can use COLDEN to determine this amount. More information about this proposal tool can be found from the CXC Proposer page and the colden ahelp. For the case of 1RXS J152417.7-200856, we will use the web version of COLDEN at http://cxc.harvard.edu/toolkit/colden.jsp.

Use the pull-down menu to select the J2000 coordinate system, and enter the source coordinates in the RA and Dec fields. Click CALCULATE. The result is a galactic Nh of $8.8e20$ cm$^{-2}$ in the direction of the source, as shown here.

4. Calculate the Predicted Chandra Count Rate

Use PIMMS to determine the predicted Chandra count rate from the ROSAT/PSPC count rate. PIMMS will also calculate the ACIS pileup.

Using PIMMS

PIMMS is appropriate for sources with simple spectra. If the source has complex spectral or spatial structure, please refer to the other proposal threads.
The web version of PIMMS is at:  [http://cxc.harvard.edu/toolkit/pimms.jsp](http://cxc.harvard.edu/toolkit/pimms.jsp). Select the following values for the PIMMS Input fields.

- Count Rate
- Mission = ROSAT
- Detector/Grating/Filter = PSPC/None/OPEN
- Default Input Energy range (0.12 to 2.48 keV)

Select the following values for the PIMMS Output fields.

- Count Rate
- Mission = CHANDRA-Cycle 10
- Detector/Grating/Filter = ACIS-S/None/None
- Default Output Energy range (0.2 to 10.0 keV)

We have chosen to use ACIS-S. This is because we are working with a ROSAT source, and ROSAT has a lower energy bandpass than Chandra. ACIS-S includes two Backside-Illuminated (BI) chips, which provide better low-energy response compared to the Frontside-Illuminated (FI) chips. This is illustrated in chapter 6 of the POG.

To estimate a Chandra count rate from a ROSAT count rate, it is necessary to assume a model for the source's spectral energy distribution. Since this is unknown in the Chandra bandpass, we will calculate the count rate for two common models, a Power Law model with slope photon index = 1.0, and a 5 keV Bremsstrahlung model.

For the Power Law model, select the following fields.

- Model = Power Law
- NH = 8.8e20 cm\(^{-2}\)
- Photon Index = 1.0 (a), where N = AE\(^{-a}\)
- Count Rate = 0.07 cts/s

Select these fields at the bottom of the screen.

- Source = point source
- Frame time = 3.2 sec

Click CALCULATE. Shown here are the PIMMS results for the Power Law model. PIMMS predicts an ACIS-S count rate of 0.433 cts/sec with 44% pileup. PIMMS also calculates a background count rate of 2.4e-5 cts/sec.

For the Bremsstrahlung model, use the same values for the Input/Output fields and adjust the model parameters.

Using PIMMS
Model = Therm. Brems.
- NH = 8.8e20 cm\(^{-2}\)
- kT = 5.0 keV
- Count Rate = 0.07 cts/s

For this model, PIMMS predicts an ACIS-S count rate of **0.322 cts/sec** with 34% pileup, and a background count rate of **2.4e-5 cts/sec**.

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### ACIS Pileup

The PIMMS results show that 1RXS J152417.7-200856 is likely to be affected by ACIS pileup. Pileup results when the count rate is so high that two or more photons are detected as a single event. Pileup and pileup mitigation are discussed in the ACIS chapter of the POG. Since 1RXS J152417.7-200856 is expected to be a point source, selecting a subarray is a good approach for reducing pileup. When a subarray is selected only part of the chip is read out, allowing for a shorter integration time.

The frame time for standard subarrays is also provided in chapter 6 of the POG. For example, for the default 1/8 subarray on ACIS-S with one chip turned on, the CCD is exposed for **0.4 sec per frame** instead of 3.2 sec per frame. The shorter frame time reduces the probability that two or more photons will hit the same detect region in a given frame interval.

What is the pileup fraction for a **1/8 subarray** using a single chip? Using the Bremsstrahlung model, enter **0.4** in the PIMMS Frame Time field and click CALCULATE. The new PIMMS results shows that the pileup fraction is now reduced to 5%.

A pileup value of 5% is acceptable for many science purposes. If one of the science objectives is to carry out a detailed spectral fit, you might need to reduce pileup still further, for example, by using Continuous Clocking mode. It is desirable for spectral analysis to minimize pileup because some low-energy piled photons can be erroneously cast to higher energies, which distorts the spectrum. For the science goals of our observation, 5% pileup is acceptable.

### 5. Calculate the Required Exposure Time

To calculate the exposure time required to detect the source, we will use the values determined in the previous section for the 5 keV Bremsstrahlung model.

The minimum allowed requested exposure time for a Chandra observation is 1 ksec. This gives a total of 0.322 cts/sec \(\times\) 1000 sec = **322 counts**. The corresponding signal-to-noise ratio is \(\frac{322}{(322)^{1/2}} = 17.94\). Background is ignored here since there are only 2.4e-5 cts/sec \(\times\) 1000 sec = 0.024 background photons within the point source region. With a total of 322 counts, it will be possible to get a rough spectral slope. If a spectrum is required, the total number of detected counts should be at least 1000, which would increase the exposure time to 2-3 ksec.

For the purpose of filling in the RPS forms, we will assume that a **3 ksec** observation is sufficient to achieve our science goals.
6. Calculate the Total Field Count Rate

It is important to estimate the TOTAL count rate for an observation to check that telemetry limits are not exceeded. The total count rate is also important for selecting ACIS Exposure Mode and the Telemetry Format.

The total count rate includes the target source, any other sources in the field, and the background.

We have already confirmed using ObsVis that there are no other known sources in the field of view. It is unlikely there would be, since we have elected to use a single chip with a 1/8 subarray.

Therefore, the total count rate for our observation is the target source + the background.

To estimate the background, we need to know which ACIS-S chip is used. We have selected the BI chip **S3**.

In calculating the total field count rate, we need to consider all contributions to the background. Estimates of the background as a function of energy band are provided in the ACIS total background section of the POG. Table 6.11 gives the total background rate for the S3 BI chip to be 13.5 counts/sec/chip, for the energy band 0.3-15 keV. Since we are using a 1/8 subarray, our total background rate is 1.688 counts/sec.

Using the source count rate we calculated earlier, the total field count rate is 0.322 + 1.688 = **2.010 cts/sec**.

---

7. Select the Exposure Mode, Telemetry Format and Optional Chips

Available ACIS operating modes are Timed Exposure (TE) or Continuous Clocking (CC). These are described in the ACIS Operating Modes section of the POG. In CC mode, one spatial dimension is lost. Because one of our science goals is a source detection and location, **TE mode** is the most suitable.

ACIS Telemetry formats are described in the ACIS Telemetry Formats section of the POG. Choices for TE mode are Very Faint, Faint, and Graded. The telemetry formats differ in that they provide different amounts of information for each event. The Very Faint format provides the most information, followed by Faint, and then Graded. Each format has a different maximum count rate, or telemetry saturation limit, with Graded format having the highest. When selecting the telemetry format, you need to consider the tradeoff between the event information provided and the required maximum count rate for your field.

The total field count rate for our observation is 2.010 cts/sec. All of the ACIS telemetry formats would accommodate this count rate. Therefore, we select the **Very Faint format** for our observation, since this provides the most information about each event.

Since we have decided to turn on just one chip, we do not need to consider whether any chips should be optional. For more information on this issue, please refer to the ACIS chapter of the POG.

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8. Complete Target Form

For general instructions on how to submit a proposal, please see the "Using RPS to Prepare and Submit a Chandra Proposal" thread. The RPS target form should have the following parameter values for this observation. If a parameter isn't listed here, for example, Y Detector Offset, use the default RPS value or leave the field blank.
It should be noted that the target keywords were updated for Cycle 7. The list has been expanded from previous editions, and now has many keywords in common with the HST list. Choose as many target keywords as you feel are appropriate: this will aid in properly matching proposals to review panels during the Peer Review.

- Target Name -- 1RXS J152417.7-200856
- RA -- 15 24 17.70
- Dec. -20 08 56.5
- Total Observing Time (ksec) -- 3.0
- Count Rate -- 0.322
- Total Field Count rate -- 2.010
- Exposure Mode -- TE
- Event Telemetry Format -- Very Faint
- CCD’s On -- ONLY S3 should be checked Y
- Subarray Type -- Standard 1/8 subarray

Use this link to view the completed Target Form.

History

15 Jan 2003  Initial Version
15 Dec 2003  Updated for Cycle 6
01 Dec 2004  Updated for Cycle 7
15 Dec 2005  Updated for Cycle 8
15 Dec 2006  Updated for Cycle 9
15 Nov 2007  Updated for Cycle 10
10 Dec 2007  Updated for Cycle 10
15 Dec 2008  Updated for Cycle 11
15 Jan 2010  Updated for Cycle 12

URL: [http://cxc.harvard.edu/pog/threads/ptsrc/](http://cxc.harvard.edu/pog/threads/ptsrc/)  Last modified: 15 January 2010
Image 1: Web ChaSeR
### On-axis Point Source - ACIS - POG Cycle 12

**Chandra X-ray Center**

**Observation Search**

**Search**

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**Customize Output:**

- **Sort Order:** Status (ascending or descending)
- **Display:** Format (HTML), Row Limit (50)
- **Coordinate System:** Equatorial J2000, Equinox 2000

For online support, please contact the [CXC Helpdesk](http://cda.harvard.edu/chaser/).
On-axis Point Source - ACIS - POG Cycle 12

Image 2: Obsvis Roll and Visibility

Roll/Pitch/Visibility for 15 24.17 70 -20 08 5

Time Interval: 01 Jan 2009 – 31 Dec 2009

Date (days since JD 2451000)
Image 3: ObsVis Field of View
COLDEN: Galactic Neutral Hydrogen Density Calculator

**Proposal Planning Toolkit**

**Coordinate System:** RA: 15 24 17.0 20 08 56.5
  
  or

  **Target Name:**

  **Dataset:** NRAO
  
  **Velocity Range:** Low: 550.0 km/s High: 550.0 km/s

  **Galactic L2:** 345.023665
  
  **B2:** 29.960402
  
  **NH:** 8.80
  
  **Comments:** Interpolated

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Proposal Planning Toolkit

PIMMS v3.9d: with ACIS Pile up and Background Count Estimation

Input: Count Rate, Flux, Flux Density

Mission: ROSAT
Detector/Grating/Filter: PSPC/None/OPEN

Input Energy: 0.12 to 2.48 keV Default

Output: Count Rate, Flux, Flux Density

Mission: CHANDRA-Cycle 10
Detector/Grating/Filter: ACIS-S/North

Output Energy: 0.2 to 1.0 keV

Model: Power Law
Galactic NH: 8.8e20 cm^{-2}
Redshift(z): NH: cm^{-2} Photon Index: N=AE^{**}
Source: point source
Frame Time: Specify 3.2 sec

CALCULATE VIEW OUTPUT CLEAR HELP

PIMMS Prediction: 4.33E-01 cts/sec
Pileup: 44 % 0.5146 cts/frame
Background: 0.1608 cts/sec 2.4E-5

The CXC updates PIMMS and related calibration files annually in coordination with the release of the Call for Proposals (CFC). Results for other missions included in CXC PIMMS are therefore not guaranteed correct and up-to-date for other proposals.

For online support please contact the CXC Helpdesk

http://cxc.harvard.edu/toolkit/prop_help_pimms.html#Input Energy
Proposal Planning Toolkit

PIMMS v3.9d: with ACIS Pile up and Background Count Estimation

Input: Count Rate, Flux, Flux Density

Mission: ROSAT
Detector/Grating/Filter: PSPC/None/OPEN

Input Energy: 0.12 to 2.48 keV

Output: Count Rate, Flux

Mission: CHANDRA-Cycle 10
Detector: ACIS

Output Energy: 0.2

Redshifted

Galactic NH: 8.8e20 cm\(^{-2}\)
Redshift (z): NH:
kT:

Source: point source
Frame Time: 0.4 sec

PIMMS Prediction: 3.223E-01 cts/sec
Pileup: 5%

For online support please contact the CXC Helpdesk

http://cxc.harvard.edu/toolkit/prop_help_pimms.html#Input Energy