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Observation Interval Determination for the Chandra X-ray Observatory

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Abstract. Connecting the planned observations and the actual status of the Chandra X-ray Observatory is the observation interval determination pipeline (OBIDET). This collection of tools allows the Chandra X-Ray Center Data System automated processing to process the data through the necessary pipelines based on what was actually observed. The information created by OBIDET is utilized in the creation of the mission time line, and the good time intervals. OBIDET products are also contributors to the verification and validation of the automated processing.

We discuss here the data and methods used in the determination of the obi element intervals. The calculation of the overall time of the observation is described. We then go into detail on how the actual configuration is compared with the planned observation and how the tools determine which obi element should guide the data processing.

1. Introduction

Part of any astronomical observation is planning. However, even database driven plans can deviate due to any number of factors. After the observation has taken place, the plan and the actuality must be reconciled. In the case of the Chandra X-ray Observatory, the observation interval determination pipeline (OBIDET) is used for this task. The collection of tools that makes up OBIDET allows the automated processing system to determine the actual status and configuration of the observatory during the observation, and to send the data through the proper data processing thread. If the results of OBIDET are remarkably divergent from the planned observation, then automatic processing will halt and manual examination of the data will commence.

The goal of the obidet pipeline is three-fold. The first goal is to determine the times and telescope configurations. The actual start and stop of the observation that will be sent to the principal investigator is determined based on telescope slew times. The pipeline returns the detector in the focal plane, the status of the gratings, and the actual instrument parameters at the time of the observation. Secondly, these tools identify observation interval (obi) elements. These are time intervals with constant telescope configurations that contribute to mission time line calculations in later processing. Finally, obi elements are compared against the planned observation to determine which obi element should be processed through the automated system. All remaining elements are assigned a bad time status.

2. The OBIDET Pipeline

The Chandra X-ray Center Data System (CXCDS) pipelines are not identical to the familiar Unix pipelines. In the latter, the output of one tool is used as the input to the next. This can be true in the CXCDS pipelines, but is not always the case. Almost all of the tools within a CXCDS pipeline (henceforth pipeline) write output files that may be archived for later use or for distribution to the user. The pipeline controller is a C++ program that manages the processes for each tool in the pipeline. The advantage of the pipelines is to be able to run several tools in succession, with process management, and to have conditional control.

OBIDET consists of nine tools. A typical processing run will only execute eight of these tools. There are two instrument specific tools that will only execute if that instrument was planned to be used. Figure 1 contains the flow of the tools. This pipeline utilizes the conditional control of the pipeline controller when it reaches the instrument specific stage of processing. Each tool is briefly described in Figure 1.

2.1. Pipeline Overview

To determine the telescope configuration, OBIDET examines data from the individual instruments, the gratings assembly, the spacecraft engineering, and the science instrument module (SIM). In addition to finding the actual configuration, obidet determines the overall time range for the observation. The times calculated here as the start and stop of the interval are propagated throughout the processing. Once Chandra's configuration is determined, the pipeline intersects the stable intervals and determines the configuration that best matches the planned observation. An actual observational parameter file is populated and archived for later use.

The spacecraft configuration files created by the first series of tools in the pipeline are stored for use in later processing threads.The status of a subsystem or detector may contribute to the mission time line and good time intervals. These intervals report when the data are considered to be scientifically valid.

2.2. Key Processing Steps

Although all of the individual tools in the pipeline are necessary, there are 4 key steps:

1. Collecting subsystem information,
2. Observation interval time determination,
3. Merging the configuration information into Obi elements,
4. Checking the Obi elements against the predicted.

Observation Interval Time Range For proprietary reasons, CXCDS has chosen to process observation data from the midpoint of the slew to the target to the middle of the slew to the next target. Obi_asp_look examines the aspect camera information and reports the mid-slew times. In most cases, this is the time

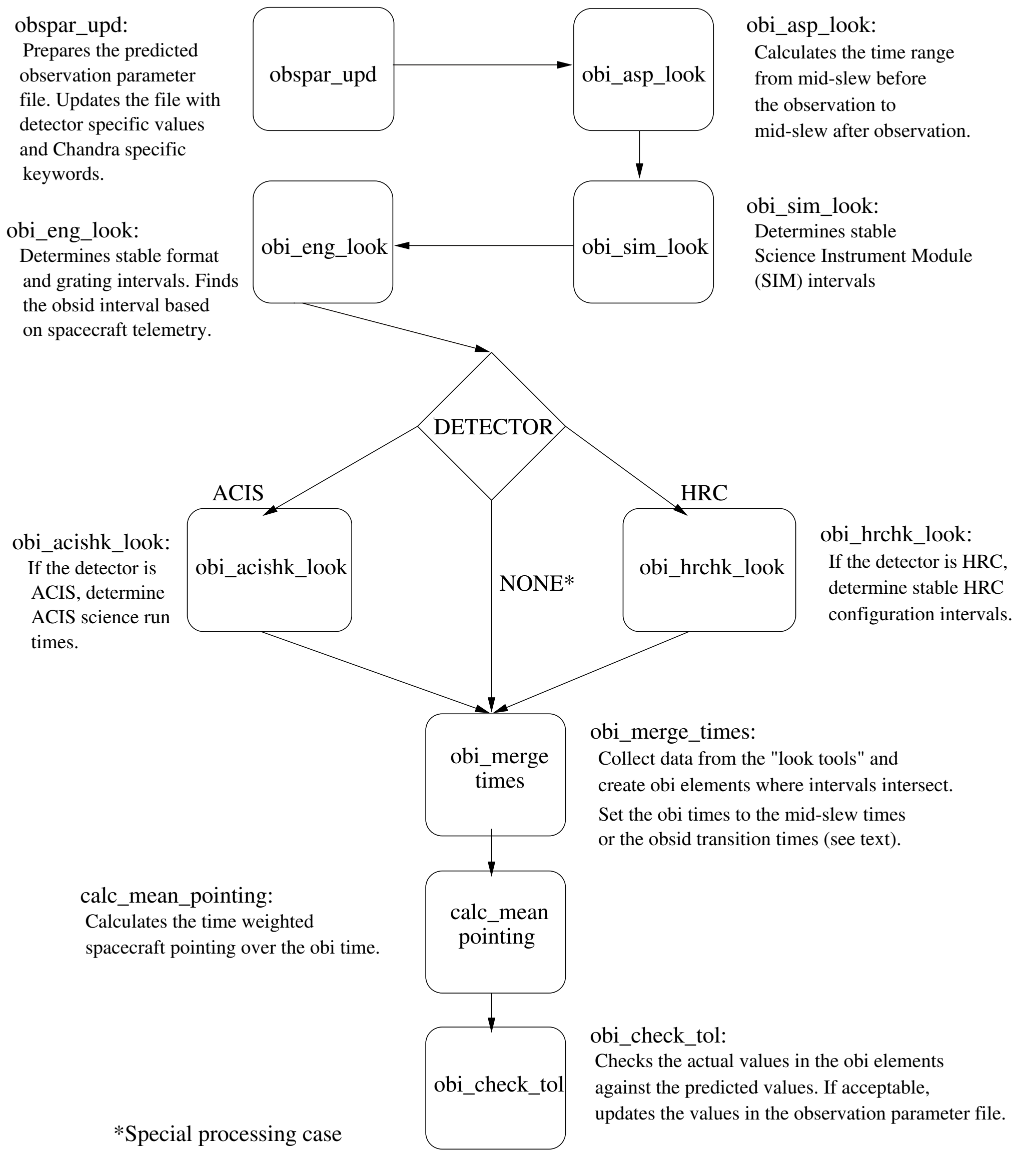

Figure 1. The flow of the observation interval determination pipeline.

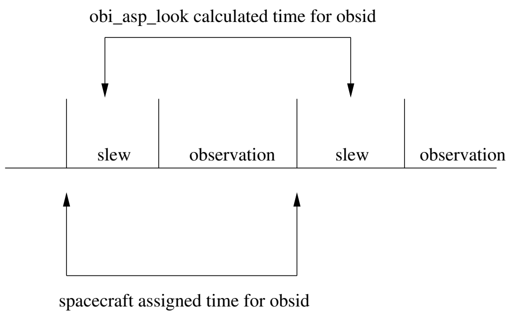

Figure 2. Spacecraft assigned time interval versus obi_asp_look assigned time interval for a given observation.

interval used for the rest of automated processing. Figure 2 describes how the time interval reported from obi_asp_look differs from the spacecraft assigned interval.

Merging The Configuration Information The configuration information collected at the beginning of OBIDET is merged in the tool obi_merge_times. Depending on the nature of the observation, the obi time is selected from the results of obi_asp_look or obi_eng_look. Obi elements are intervals where the spacecraft is in a stable configuration across all systems. Ideally, there should be only one obi element per observation. The tool will report an error if no obi elements can be created. The pipeline processing will stop here and a human must investigate.

Creating the Actual Observation Parameter File Even with a singular obi element, the information must be compared against the planned information in obi_check_tol. A veto is set if the detector or grating does not match the planned. Without any vetoes, the tool will create a new parameter file and populate it with the values in the obi element that best matches the planned observation. In the case where there are multiple matches, the element with the longest duration is selected.

3. Conclusion

OBIDET is vital for automated processing for the Chandra X-ray Observatory. This is the only place where the software can decide which pipelines to run and to set the actual parameters to continue processing. Without this step in the processing, manual intervention would have to occur, slowing down the time to report the results to the observer.

A secondary benefit of OBIDET is the preparation of data for use in later processing. Since the information collected is needed to establish intervals when the data are valid for the observation, the processing does not need to be repeated. This saves time in reduction of data and data distribution.

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