

## 8 Target of Opportunity (ToO) Observations

### 8.1 Overview of the Observations

- **Completing the AOT—IRAC, one epoch:** We plan the simplest kind of ToO, a single epoch with IRAC.
- **Completing the AOT—IRAC, multiple epoch:** We plan an even more sophisticated ToO, using IRAC, but observing the same object multiple times.

### 8.2 Target Selection and Suitability

ToOs, by their very nature, are transient events. Thus, the duplication rule “escape clause” applies, and re-observation of an object already in the ROC is likely to be approved because it is intrinsically changing.

### 8.3 Impact Definitions

Targets of Opportunity are categorized by the extent to which the execution of such an observation affects normal Spitzer scheduling and observing procedures. Therefore, as part of the proposal submission, *we must identify in our proposal* each ToO request, based upon the maximum delay—in our judgment—that is scientifically acceptable between the activation of an approved AOR and the execution of the observation.

The normal Spitzer scheduling process begins 5 weeks prior to when a sequence begins execution on the observatory (since the sequences run from Wednesday to Wednesday, this process usually begins on the Monday of the sixth week in advance). We do not expect any changes in this process for the Warm Mission.

Therefore, if we choose to activate an approved ToO with comfortably more than 8 weeks' notice, then this is *a low-impact ToO*. In order to truly have no impact on scheduling, the ToO must be activated more than 8 weeks before *the scheduling process for that week begins*, not just 8 weeks before *the desired observation date*.

Spitzer is designed to operate autonomously for periods of about a week, so the schedule is developed in units of weeks. A ToO that is activated less than 8 weeks in advance therefore affects scheduling for not just the *entire week*, but perhaps *the weeks before and after as well*. Because the SSC only communicates with the spacecraft once or twice a day, the fastest possible response for a ToO activation is 48 hours. **A ToO that is activated with less than a week's notice requires considerable effort to implement.**

Therefore, to summarize,

- High-Impact is < 1 week (normally a minimum 48-hour turnaround)
- Medium-Impact is 1–8 weeks
- Low-Impact is > 8 weeks.

Apart from the overhead burdens applied to all Spitzer observations, the SSC imposes no additional overheads on low-impact ToO observations.

Because of the heavy impact that high-impact ToO observations have on the short- and medium-term Spitzer schedule, **there is a maximum number of medium- and high-impact ToOs permitted per cycle.** We currently anticipating supporting only 1 to 2 per year.

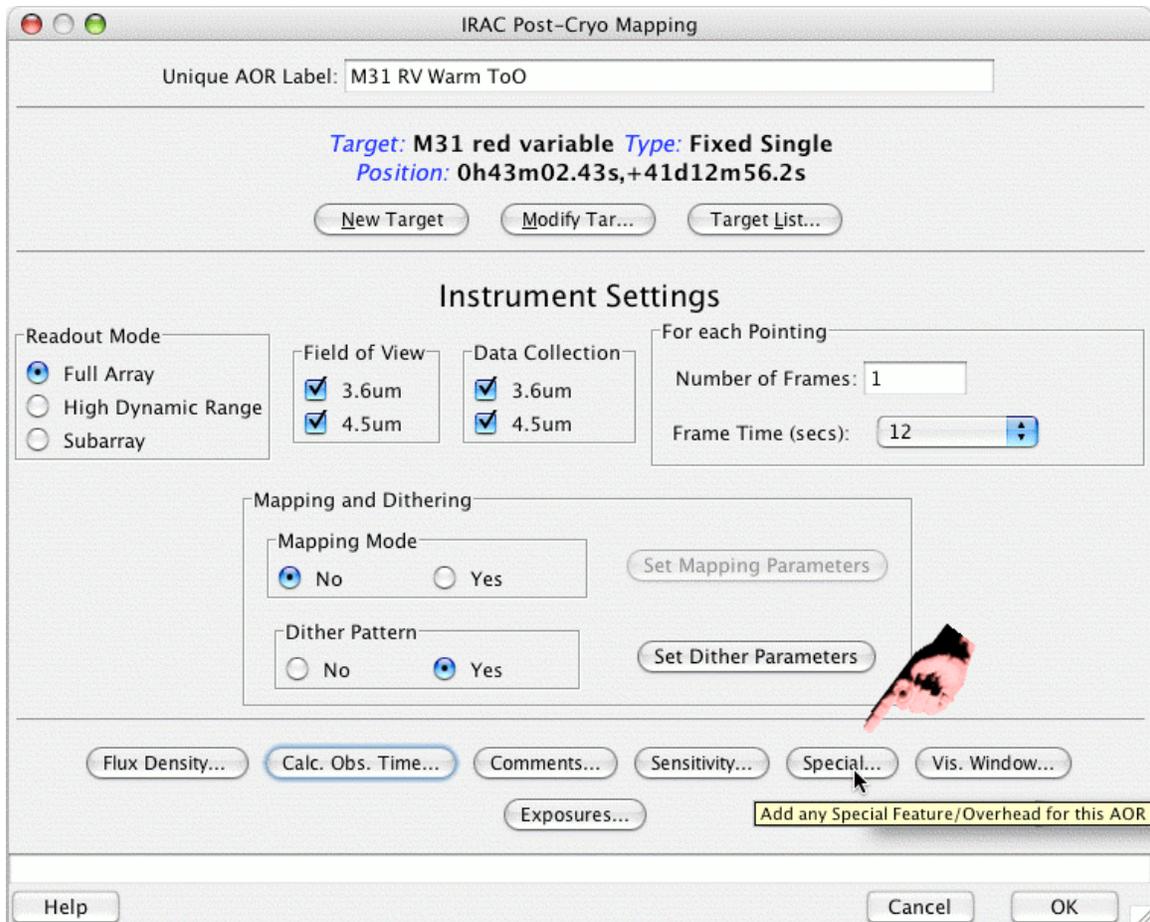
**NOTE: In the warm mission and up high- and medium-impact ToO observations cannot be included in GO proposals. They must be requested via Director's Discretionary Time.** See the current Call for Proposals. Low-impact ToO observations can be requested through the GO proposal process. There is no limit on the number of these low-impact ToO observations that can be approved for the Cycle.

In general, the more disruptive the ToO observation is to normal Spitzer scheduling and operations, the stronger the scientific justification must be to approve the proposed observation.

#### ***8.4 Single Instrument, Medium Impact***

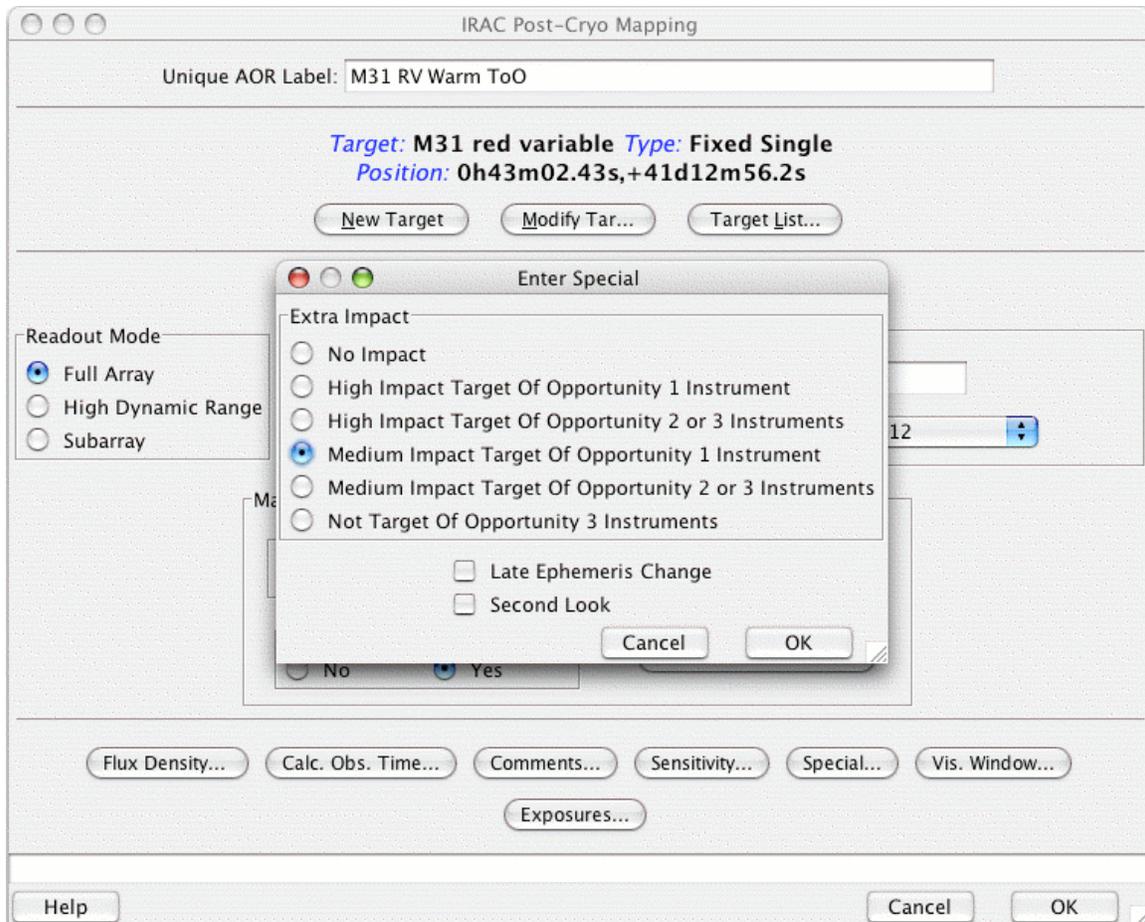
For our first example, we will design an IRAC observation. We decide, based on our science case, that we can live with a 1–8 week window for activation, so we settle on a medium impact ToO.

First, we design our IRAC observation. The IRAC observation in Figure 63 nominally takes 456 seconds.



**Figure 63: The IRAC Post-Cryo Mapping AOT window. Note the “special” button on the lower right!**

Figure 63 shows the IRAC AOR that we have designed. But before clicking “OK” (or at any time while editing the AOR), we need to click on the “Special” button in the lower right of the AOT window as indicated in Figure 63. Doing so results in a new dialog box. In Figure 64, we have selected “Medium Impact Target of Opportunity 1 Instrument. (There is no longer more than one instrument during the Warm Mission!)



**Figure 64:** The special overhead window which results from clicking on the “Special...” button shown in the previous figure.

Before selecting the impact option via the “Special” button, the AOR as designed took only 456 sec = 7.6 minutes. But now, having selected the overhead, the AOR takes 9816 sec = 163.6 min = 2.7 hrs. These 156 “extra” minutes are the special overhead charged to our observing program for having requested a medium impact ToO with one instrument. *The proposal we write using this AOR must ask for 2.7 hours, not 7.6 minutes.*

### 8.5 Single Instrument, Multiple Epoch

What if we want to plan an observation that follows the light curve of a transient event, such as a supernova? Maybe we need an observation soon after a SN, then we want another observation a week later, and then 3 weeks after that. In order to do this, **we need to apply the special overhead to each AOR in the sequence**, because each one of them, on their own, is a high- or medium-impact ToO.

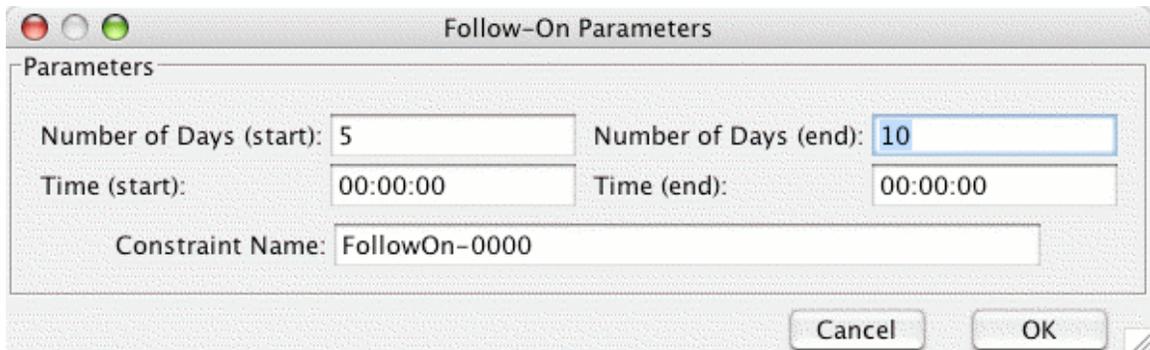
So, we create again (for purposes of this example) some very simple AORs for IRAC; we create three basically identical AORs. Again, they bear a striking resemblance to the ones designed above, e.g., each takes 2120 seconds before adding any additional ToO overhead.

In order to realize our vision of the first one going as soon as possible after we trigger it, the second going 1 week later, and the third going 3 weeks after that, we need to impose some constraints. More detail on constraints is included in other sections (e.g., section 7.5), but we summarize these steps here.

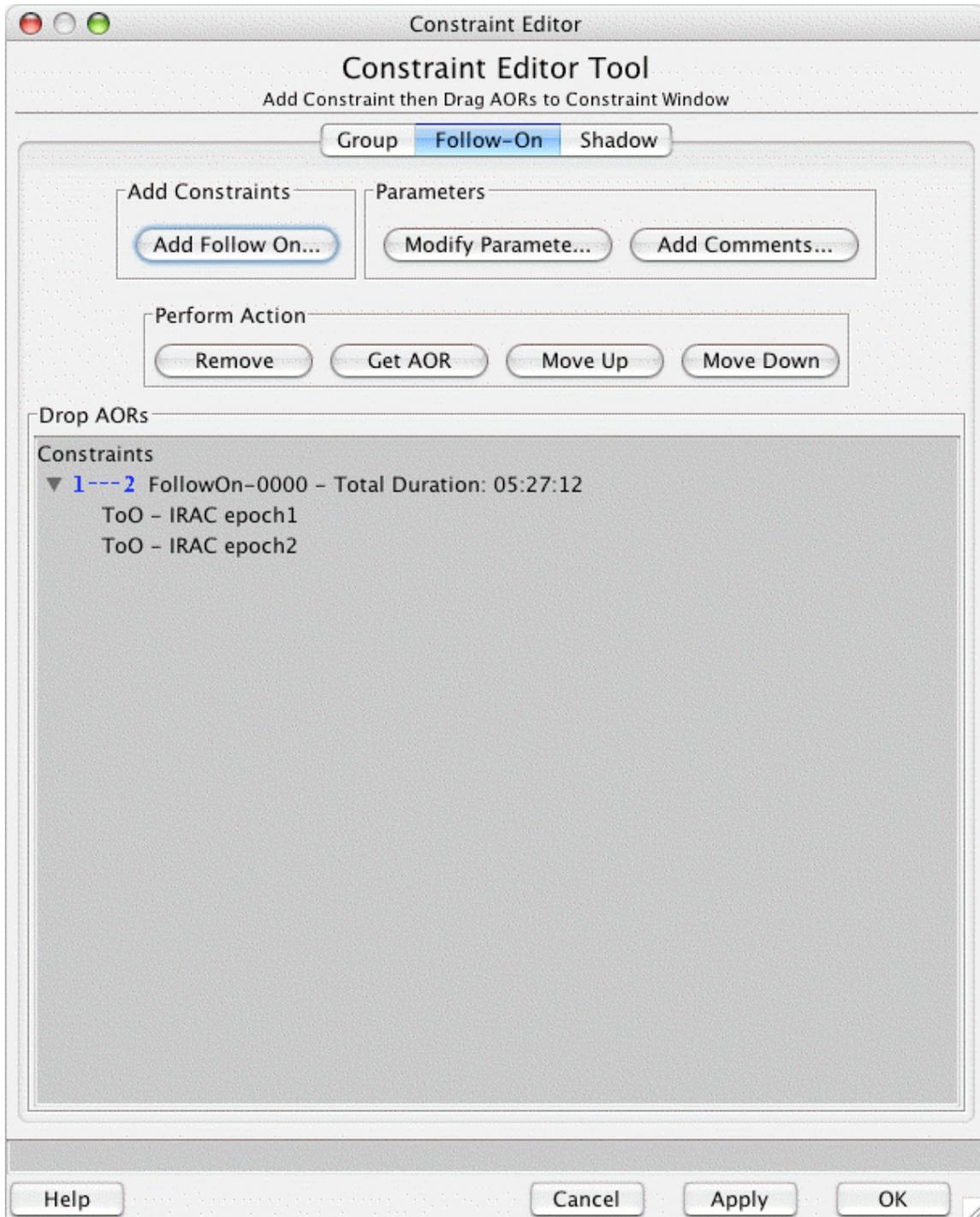
### 8.5.1 Setting Constraints

The loosest, best constraint to use to accomplish our goals here is the follow-on constraint, e.g., do this second AOR no sooner than time  $x$ , and no later than time  $y$  after the first AOR.

After creating all three of our IRAC AORs, we select the first one and choose "Group/Follow-on constraints" from the Tools menu. We then click on the "Follow-on" tab at the top of the window, then the "Add Follow On" button. For this first window, we want the second AOR to go no sooner than 5 days and no later than 10 days after the first, so we enter that information in the "Follow-On Parameters" pop-up window that appears (Figure 65). We then drag-and-drop the two relevant AORs into the constraint, resulting in Figure 66.



**Figure 65: Filling in the follow-on constraint dialog.**



**Figure 66: The first follow-on constraint.**

We repeat this process, but now we want to link the 2nd and 3rd AORs with a gap of no less than 18 days and no more than 25 days; see Figure 67.

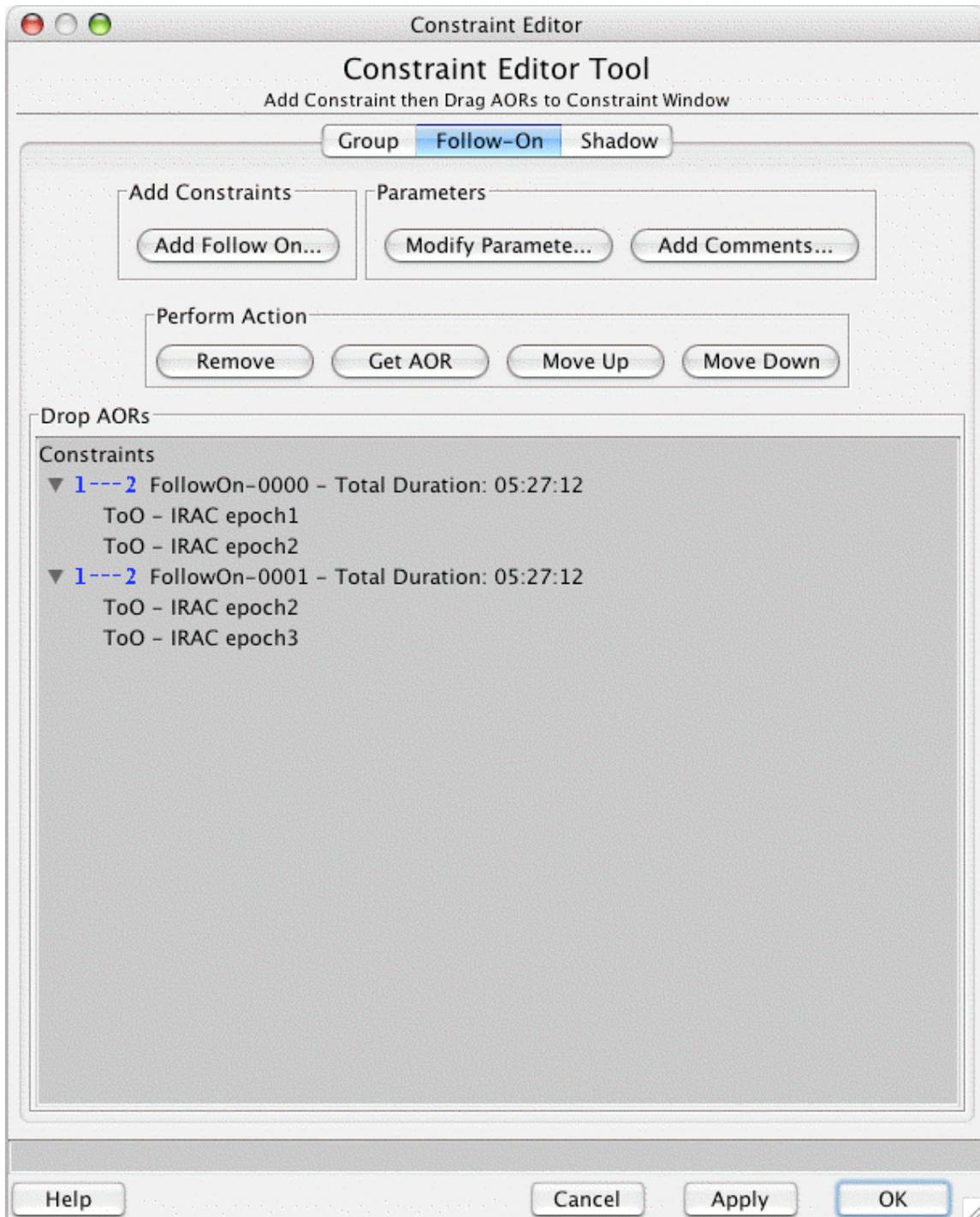


Figure 67: The second follow-on constraint.

We click “Apply” and then “OK.” Note that the boxes under “F” are checked in the main Spot window now.

### 8.5.2 Special Overhead

Now, note that when we initiate the first AOR in the sequence, we are impacting a schedule with <1 week's notice, a schedule with <2 weeks' notice, and a schedule with <8

weeks' notice. This means that *each* of these AORs qualifies as a ToO; the first is a high-impact, and the other two are medium impact. We edit the AORs, click the “special” button, and select the corresponding overhead. This program, with all the overheads (two high-impact and one medium-impact, single instrument) comes now to 12.1 hrs.

### **8.6 Hints and Tips**

While writing our ToO proposal, we don't know *when* the observations will be needed. Some programs will know *where* the object is (watching for flaring in a given source), and some will not (nova outburst follow-up). In our proposal, we must describe the trigger criteria clearly, e.g., this observation will be triggered if a comet of the right family and size is discovered during this Cycle and is within this distance of the Sun.

A description of the target provenance and schedulability for ToO targets is required for Exploration Science GO proposals.

Even if we don't know where we will need to point Spitzer, we still need to create representative IRAC AORs.

The total time we need to request in our proposal is the total time *including* the special overhead, not just the elapsed time of the solitary observations.

The “special overhead” for multiple AORs *occurring as close in time to each other as possible* need only be applied to one of the group of AORs, not to each one.

The “special overhead” for multiple AORs *occurring with a specified number of days between them* need to be applied *to each AOR in the set*.

Once our interesting object does whatever we're waiting for it to do, the very first thing we should do is pull up Spot, enter it as a target, and *check the visibility windows*. Calling in an activation request won't do much good if Spitzer can't view the object.

### **8.7 Obtaining the AOR File**

The AOR file, ready to be loaded into Spot, containing the raw AORs developed in this chapter can be downloaded from the SSC Cookbook webpage:

<http://ssc.spitzer.caltech.edu/warmmission/propkit/cookbook/>.