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SCUBA-2 and JCMT Secondary Mirror

1. Summary

The behaviour of the JCMT Secondary Mirror Unit (SMU) has to be clarified as part of the feasibility study for using the DREAM technique. An attempt is made to describe DREAM-specific features required in the planned SMU upgrade.

2. References

"Application of DREAM Observing to SCUBA 2", B.D.Kelly, W.D.Duncan, 2001, SC2/ANA/S100/006

"DREAM, the Dutch REal-time Acquisition Mode for SCUBA", R.S. Le Poole and H.W. van Someren Greve, 1998, http://www.strw.leidenuniv.nl/~lepoole/

3. Introduction

This document summarises some of the issues relating SMU behaviour to the acquisition of data using the DREAM technique, and is intended to help in specifying features required of the combined SMU/SCUBA-2 system.

4. Control of SMU Offset

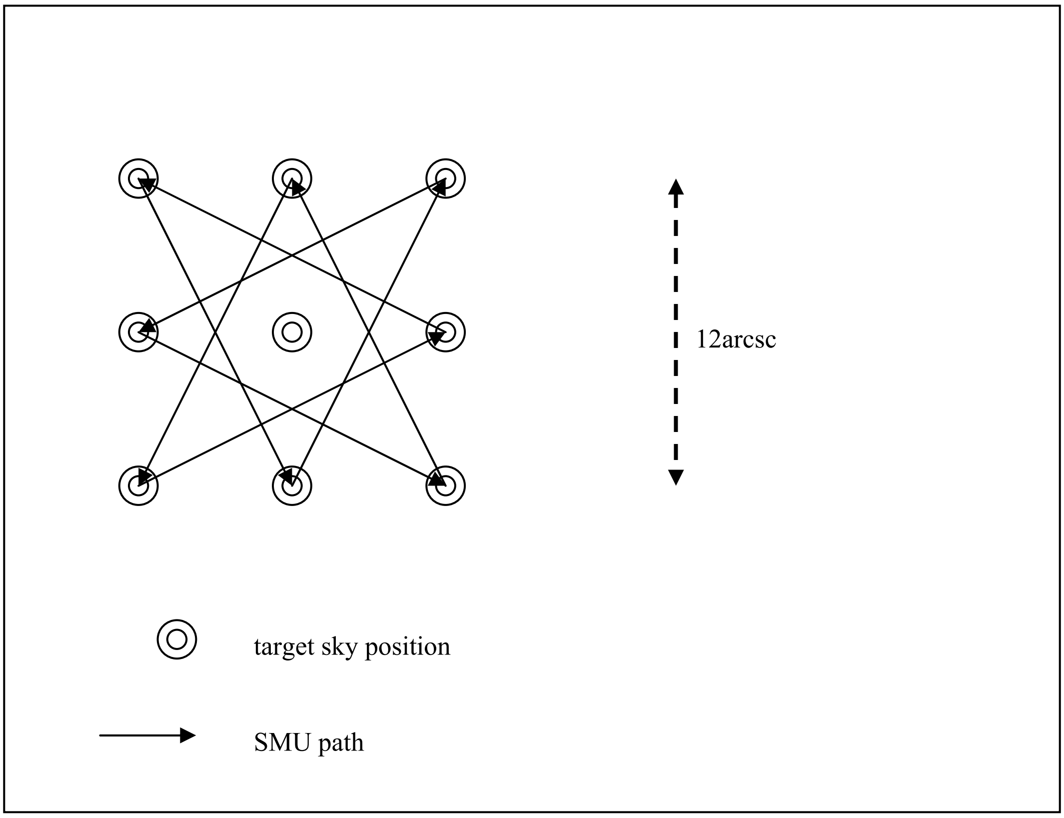
The current SMU offsets by stepping through a table of 1024 (X,Y) positions, each complete cycle through the table taking 1.024 seconds (ie 1millisec per position). This underlying implementation is hidden inside the computer running the OS/9 system. The command interface to the SMU runs on the supervising VMS machine and operates in terms of chop specifications, jiggle patterns and coordinate systems.

The revised SMU system is expected to interact with the Real-Time Sequencer, and is expected to behave as part of the Telescope Control System, which is driven by the standard set of JCMT commands (SETUP_SEQUENCE, etc.) plus information in XML files.

5. Example of a DREAM Jiggle Pattern

The initial design for the jiggle pattern is a star-shaped path with eight vertices. The diagram shows this as a pattern for a single bolometer on the 850 array. Data taking occurs throughout the pattern, and the measured values are used to calculate interpolated values for the target sky positions.

In this pattern each of the eight straight sections is 13.4 arcsec long. If the pattern is completed twice in



1.024 seconds, then 64msec is spent on each straight section. We can guess that the velocity profile along the straight section might approximate a sinusoid. The maximum velocity is then 0.32 arcsec/millisec. The real system might have a steeper velocity profile, leading to a larger maximum velocity, but this number gives us a working estimate.

6. Matching the Telescope Tracking Accuracy

Chris Mayer performed tests on the JCMT tracking performance in 1991. The tracking error was found to be about 0.3arcsec. This can be used to set a reasonable limit on other sources of "tracking" error, if the other sources are required to be less than the telescope error. The conclusion is that the DREAM synchronisation shouldn't be worse than 0.5 millisec. From analysis of SCUBA data, Rudolf LePoole estimates that 0.05 millisec is a better figure for the synchronisation required. Both these give a tighter specification than is provided by the Real-Time Sequencer.

7. Required SMU Support for DREAM Patterns

DREAM patterns have to be defined in a coordinate system fixed relative to the SCUBA-2 array of pixels, that is, in Nasmyth coordinates. The SMU intrinsically operates in differential Alt-Az coordinates, so there has to be a time-dependent rotational transformation between the two.

The rotation rate between SMU and Nasmyth coordinates is equal to the rate of change of telescope elevation, which when tracking at the sidereal rate has a maximum of about 0.5 arcsec/sec. This turns into a motion of about 0.01 of a bolometer separation at the corners of the array in 70 sec.

A possible scheme would be if a pattern in Nasmyth coordinates was given to the SMU high-level software. At intervals of one or two minutes a command could be sent to the high-level software instructing it to translate the pattern into SMU coordinates and load it into the SMU real-time system. The SMU could then execute the pattern repeatedly as necessary.

The final choice of DREAM patterns is not yet fixed. The eight-pointed pattern is just the first one investigated which gives satisfactory results in simulations. Circular patterns have been tried, but these are unsatisfactory as the data generated give ill-behaved least-squares analysis. Patterns suitable for sampling both 850 and 450 simultaneously have yet to be found. All this means that the DREAM patterns have to be downloadable into the SMU.

8. Conclusion

An initial guess at the requirements for a revised SMU to support the DREAM technique on SCUBA-2 indicates that we need

- synchronisation of SCUBA-2 data acquisition with SMU motion to 0.05 millisec
- ability to specify the DREAM pattern in Nasmyth coordinates
- ability to download the pattern into the SMU