SAMPEX pointing modes and history

The SAMPEX spacecraft Attitude Control System (ACS) operated in 3 modes over the course of the mission:

- Orbit Rate Rotation (ORR)
- Modified Orbit Rate Rotation (MORR)
- SPIN

These are described below. The times during which these modes were in place are summarized in Table 1 at the end, along with references for further details concerning the attitude control.

1) ORBIT RATE ROTATION (ORR) MODE

Original pointing mode of the mission; was in use during roughly the first 2 years of the mission. The ORR mode algorithm was designed to optimize the following requirements:

- spacecraft solar panels always facing the sun
- avoidance of pointing instruments into the RAM direction
- pointing as close to the local zenith as possible.

These requirements arose from (1) spacecraft power requirements, (2) the concern that looking into the RAM direction would greatly raise the likelihood of damage to the HILT proportional counter window, and (3) the desire to face upwards over the polar regions to study solar, anomalous, and magnetospheric particles. RAM avoidance was dropped after the HILT gas was exhausted in 1996.

2) MODIFIED ORBIT RATE ROTATION (MORR) MODE

Used after the first 2 years, interspersed with periods with SPIN mode. Requirements were the same as for the ORR mode with the additional requirement:

- instruments will point perpendicular to the local magnetic field when its strength is <0.3 Gauss, and will point along the local magnetic field in the direction nearest the zenith elsewhere

This additional science requirement was implemented after the discovery of trapped Anomalous Cosmic Ray Oxygen, especially in the region of the South Atlantic Anomaly (SAA). The pointing requirement has the result of looking at the trapped population when the spacecraft was in the SAA.

3) SPIN MODE

In spin mode the spacecraft rotates about the y (sun pointing) axis once per minute. This mode was introduced in 1996, and was in place through mid 1998, and occasionally afterwards. The science requirement was to give broad pitch angle coverage, especially for magnetospheric particles. RAM avoidance was not a requirement in this mode since by the time it was introduced the HILT proportional counter gas was exhausted.
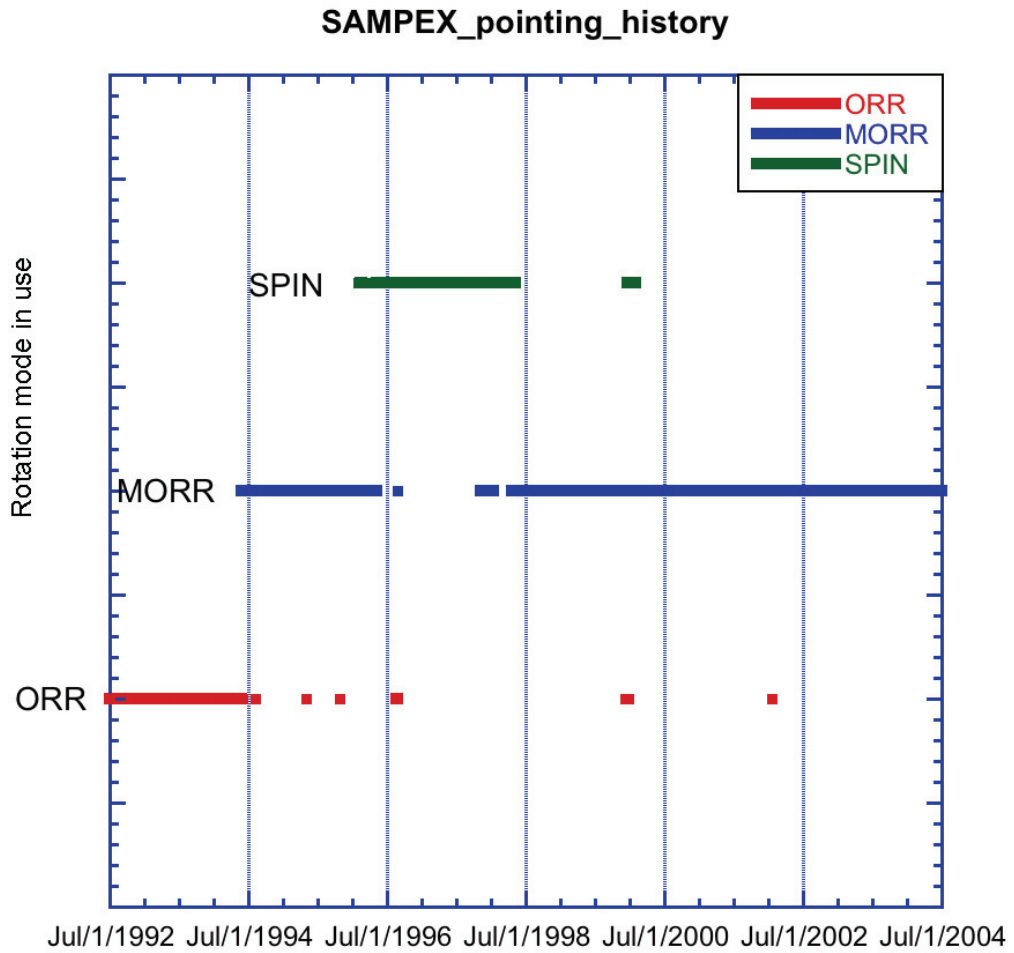
Figure 1 Overview of times when the different SAMPEX pointing modes were in use (see Table 1 for details).

COAST MODE
COAST MODE occurs when the spacecraft attitude determination algorithm is subject to large errors, which happens:

- if the satellite is in *sunlight,* and the y-axis direction is within 5 degrees of the local magnetic field direction (see Figure 2), or,
- if the satellite is in *eclipse,* and the y-axis direction is within 40 degrees of the local magnetic field direction.

These under these conditions the attitude control system stops sending down attitude data ("coasts") making the attitude determination subject to errors. Since the spacecraft can undergo rapid maneuvers during a coast mode period (e.g., RAM avoidance or pointing to the local zenith) a smooth interpolation over the coast period may be innappropriate. The Att_Flag in the on-line orbit data identifies periods when this is an issue.
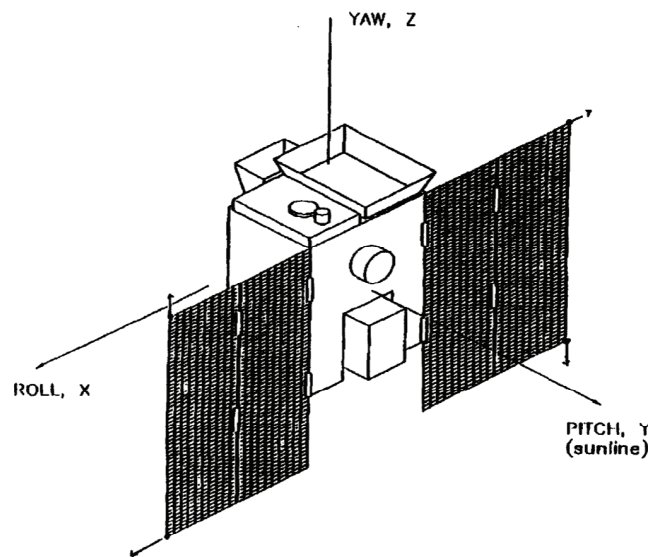
SATELLITE COORDINATES:

Figure 2: SAMPEX satellite coordinates: y-axis points to sun; z-axis is instrument boresight direction (from reference 2)

TRANSITION PERIODS
Although each of the pointing modes was meant to be used for extended periods of time, Table 1 has several entries when the modes were changed fairly frequently. These arose from several conditions:

- spacecraft safeholds or warm-restarts, when the pointing mode reverts to ORR
- test runs of the SPIN mode in early 1996
- changes from SPIN to MORR to enable measurement of solar particle ionization states during specific Solar Energetic Particle events (e.g., Nov 1997)
- support of a Long Duration Balloon flight in Dec-Feb 1999

It should be kept in mind in the spacecraft required 2 or more hours to complete the transition going into or out of SPIN mode.

Reference documents available on SAMPEX Data Center web site describe additional details of the ORR mode (1) and MORR mode (2):

1) SAMPEX Science Pointing Modes with Velocity Avoidance, DRAFT, Jun 1991, J. R. Frakes, D. A. Henretty, T. W. Flatley, F. L. Markley, J. K. Forden, E. G. Lightsey, NASA GSFC

2) SAMPEX Special Pointing Mode, F. L. Markley, T. W. Flatley, and T. Leoutsakos, NASA CP-3299, pages 201-215, 1995

Pointing modes: ORR   original mode; 1 Rev per orb
                           MORR   modified 1 Rev per orbit mod
                           SPIN   1 Rev per minute mode

Note: times are times commands were sent or executed
                 transition between different pointing modes may
                 require ~2 or more hours to complete

start		stop		mode
7/3/92	0:00:00	5/26/94	13:46:28	ORR
5/26/94	13:46:28	6/1/94	18:41:01	MORR
6/1/94	18:41:01	6/2/94	14:52:07	ORR
6/2/94	14:52:07	8/10/94	15:40:17	MORR
8/10/94	15:40:17	8/10/94	22:40:00	ORR
8/10/94	22:40:00	4/30/95	12:22:51	MORR
4/30/95	12:22:51	5/1/95	13:07:01	ORR
5/1/95	13:07:01	10/24/95	13:41	MORR
10/24/95	13:41:00	10/27/95	18:26:00	ORR
10/27/95	18:26:00	2/1/96	15:07:12	MORR
2/1/96	15:07:12	2/1/96	19:15:00	SPIN*
2/1/96	19:15:00	2/13/96	13:34:32	MORR
2/13/96	13:34:32	2/14/96	19:30:00	SPIN*
2/14/96	19:30:00	2/14/96	20:30:50	MORR
2/14/96	20:30:50	2/16/96	18:00:00	SPIN*
2/16/96	18:00:00	3/5/96	15:25:08	MORR
3/5/96	15:25:08	3/8/96	17:45:00	SPIN*
3/8/96	17:45:00	5/8/96	13:33:00	MORR
5/8/96	13:33:00	8/19/96	0:00:00	SPIN*
8/19/96	0:00:00	8/24/96	8:53:00	ORR
8/24/96	8:53:00	8/26/96	8:53:00	MORR*
8/26/96	8:53:00	11/6/97	13:26:20	SPIN*
11/6/97	13:26:20	11/17/97	12:26:20	MORR*
11/17/97	12:26:20	12/18/97	13:08:01	SPIN*
12/18/97	13:08:01	1/14/98	12:45	MORR*
1/14/98	12:45:00	4/21/98	15:08:01	SPIN*
4/21/98	15:08:01	4/28/98	16:08:45	MORR*
4/28/98	16:08:45	5/7/98	15:05:09	SPIN*
5/7/98	15:05:09	12/5/99	14:40:00	MORR*
12/5/99	14:40:00	12/9/99	18:30	ORR*
12/9/99	18:30:00	12/17/99	20:10	MORR*
12/17/99	20:10:00	12/25/99	20:20:00	SPIN*
12/25/99	20:20:00	12/28/99	23:30	ORR*
12/28/99	23:30:00	2/2/00	20:05	SPIN*
2/2/00	20:05:00	1/16/02	14:29:31	MORR*
1/16/02	14:29:31	1/17/02	18:45	ORR*
1/17/02	18:45:00	7/1/04	0:00:00	MORR*

* = RAM avoidance requirement turned off
ref: SAMPEX MDF description Appendix I, SAMPEX "Event" table; table I

Table 1