FINE POINTING CONTROL, OAO-3

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During periods of experimentation with the Princeton Experiment Package (PEP), the sensor used for spacecraft control was the fine error sensor located within the PEP. This fine error sensor, in conjunction with the balance of the control loop, was designed to acquire a star within the field of view of the fine error sensor; and hold the spacecraft within plus or minus one-tenth of an arc second in pitch, and plus or minus three-arc seconds about the yaw axis.

My first figure defines the result of a test that was conducted in orbit to measure the transfer function of the PEP.

This test consisted of driving the fine error sensor across the target star, about the pitch axis, at a stable rate of one-tenth of an arc second per second, and plotting the error signal as a function of the vehicle angle.

The resulting transfer function defines a maximum gain of about 36 volts per second of arc at null.

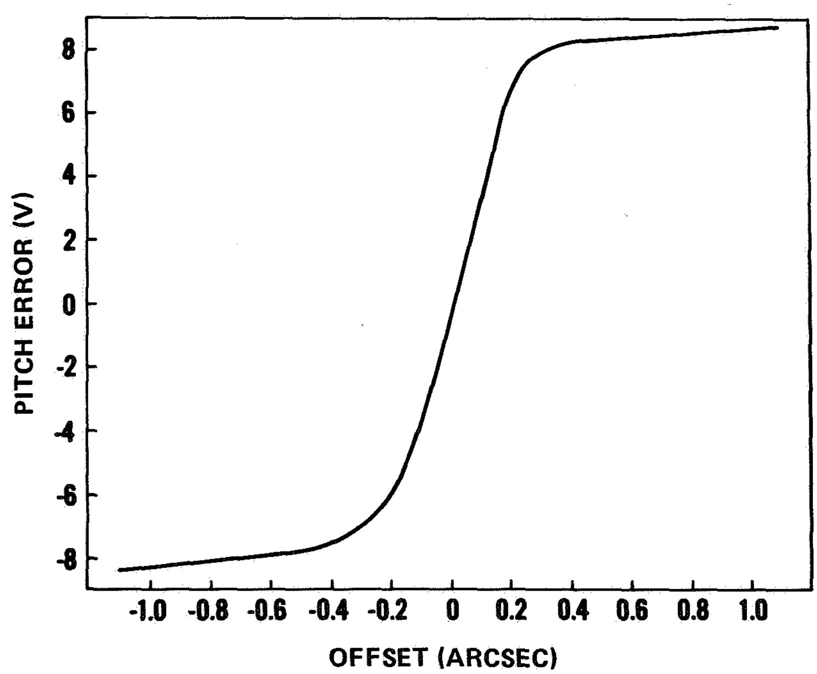

Figure 1. PEP fine error signal, pitch transfer function.

With regard to pointing accuracy and stability, the performance under control of the PEP fine error sensor has been exceptional, and far exceeds the plus or minus 0.1 arc second requirement.

This precise pointing has resulted in extremely high quality experiment data. It has been noted that the pointing stability varies as a function of the spacecraft attitude and orbital position. This phenomena is not completely understood at this time and is presently under study. The level of stability also varies as the spacecraft moves from "day" to "night." Additional variations have been tentatively attributed to noise sources. Figure 2 describes the settling and holding characteristics of the PEP control loop for a specific observation. During the initial period after settling, the spacecraft is in the light. During this period, the maximum of spacecraft jitter is encountered. This maximum jitter, however, is only plus or minus five-hundredths of an arc second.

During the dark portion of the orbit, the PEP stability is variable. For this particular observation, the maximum jitter is plus or minus three-hundredths of an arc second with relatively long periods of time when the jitter is less seven thousandths of an arc second.

To put this number in perspective, if the spacecraft were pointed at the earth, seven-thousandths of an arc second would be equivalent to one inch on the earth's surface. As stated previously, this defines a specific observation. There were observations when the jitter remained at relatively high levels of plus or minus three-arc seconds for the entire viewing time. There were also observations where the very quiet condition was maintained throughout the contact. The variation and jitter that were demonstrated in this figure approach the normal condition.

The performance goals for the OAO program have been more stringent with each launch.

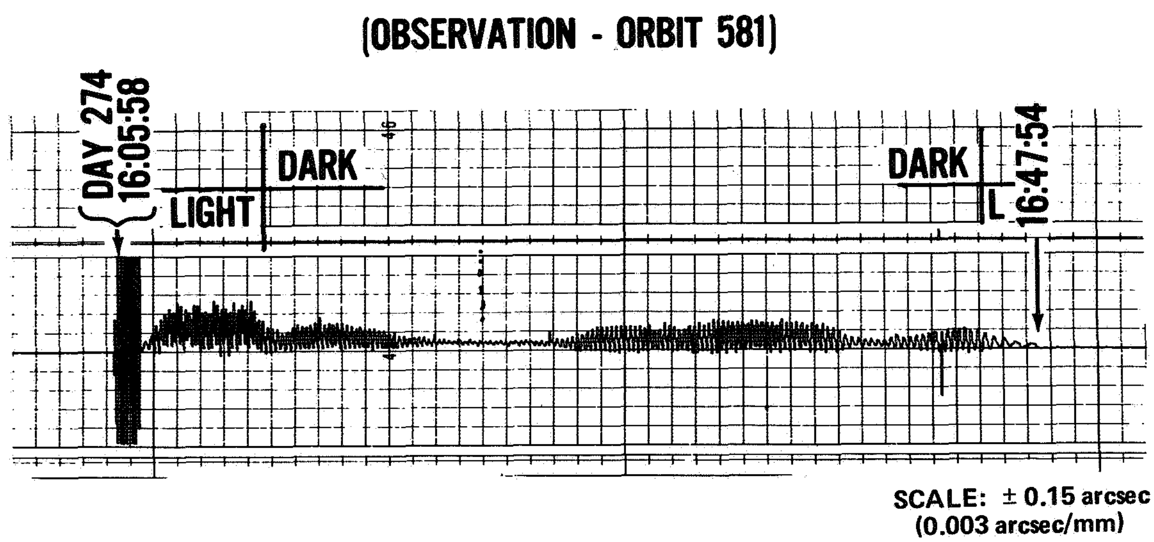

Figure 2. PEP fine error sensor signal.

My final figure summarizes the stability requirements for each spacecraft as dictated by the objectives of the on-board scientific instrument. This summary shows that the performance exceeds the original goals of the OAO program. In addition actual in-orbit data from OAO-C indicates an unprecedented pointing accuracy.

OAO SPACECRAFT	STABILITY GOAL (arcsec)	DEMONSTRATED PERFORMANCE (arcsec)
A2	±15.0	±3.0
B	±1.0	NO ORBIT
C	±0.1	±.007

Figure 3. Performance summary.