**Minutes of the initial meeting of a joint WG (IVS-IGS-ILRS)
for the study on the determination of the phase centers
of the GPS-transmitters employing VLBI**

held in Kötzting/Germany

February 23, 2000 / 19:30

Participants:

For IVS: Brian Corey (IVS-nominated Rep.)
Ed Himwich (IVS-nominated Rep.)
Nancy Vandenberg (IVS-CC)
Axel Nothnagel (IVS-Analysis coordinator)
Wolfgang Schlüter (IVS-chair)

For IGS: Tom Herring (IGS-nominated Rep.)
Tim Springer (IGS-nominated Rep.)
For ILRS: Graham Appelby (ILRS-nominated Rep.)
Richard Biancale (ILRS-nominated Rep.)

Objectives of the WG

At the IGS Analysis Center Workshop held at Scripps Institution of Oceanography in 1999 the stability of the GPS global reference frame was discussed. It became apparent that there is a large uncertainty about the location of the phase center of the GPS transmitter. The possibility of "mapping" the GPS-phase center using VLBI was discussed, and it was suggested that IVS could help to find a solution.

IVS considered this at its 2nd Directing Board Meeting in Birmingham, even though there was only an informal request. The Board proposed to establish a Working Group on this topic and to invite members of the other services.

The objectives of this WG were defined as follows:

"The WG could be set up to study the feasibility, equipment, time required, and if it could be done with accuracy sufficient to make it worthwhile."

It was clearly pointed out that VLBI plays the leading role, but as orbit determination and scaling problems are involved, the SLR technique will contribute too.

The nominations of the WG members have been made by the three services through their respective chairpersons.

Regulations of Working Groups

The WG operates under the leadership of the IVS. The IVS regulations for WG are similar to those for IGS and are in accordance with ILRS regulations, in particular: The WG will have

- a finite life span,
- a membership list (see participants, all nominated representatives).
- The IVS Directing Board has named Brian Corey as chair of the WG.
- The WG operate autonomously and will report to the boards of the three services as necessary.

Discussions

The present situation was reviewed with regard to apparent phase center offsets of the satellite transmitting antennas, and the relationships among the phase center offsets, receiving antenna phase patterns, and terrestrial scale errors were discussed. Scale changes of ~10**-8 and satellite antenna offsets of order 1 meter in the radial direction are observed when these quantities are estimated from GPS data. The GPS analyses assume the satellites are point sources, whereas the satellite antennas are phased arrays consisting of two concentric rings of helical antennas. There is also a 5 cm bias between the orbits determined by IGS and by laser ranging to the GPS satellites.

Useful information that VLBI observations of the GPS satellites could potentially provide includes estimates of the phase center location relative to the satellite center of mass. One possible observing scenario that was discussed was to use the VLBA, perhaps in conjunction with the EVN, to do differential observations between each GPS satellite and neighboring extragalactic sources. Mapping the individual elements of the satellite phased arrays is desirable; unlike the case with extragalactic sources, however, the satellite signal is spatially coherent at the source, so the standard radio astronomical methods for inverting interferometric visibilities to generate a map of the source do not apply.

The initial goal of the WG is to investigate the feasibility of mapping the transmission wave fronts and to determine the accuracy with which phase center offsets could be estimated from VLBI observations (in conjunction with information provided by the IGS or ILRS). If the expected accuracy is deemed worthy (e.g., error in phase center under 1 meter), then a proposal to conduct observations, correlate the VLBI data, and analyze the results would be submitted to a suitable funding agency (e.g., U.S. National Science Foundation) under the guidance of the WG.

Next steps

The next step is to gather detailed information on the satellite specifications (dimensions, power, etc.).

The WG will set up an e-mail list via the IVS-CC. Experts in radio imaging of coherent sources will be invited to participate in WG discussions.