**National Radio Astronomy Observatory**
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MEMORANDUM

To: 12 Meter Computing Report Series, No. _____

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Subject: New Beam Throw and Pointing Commands in FORTH


During the 1988 Summer Shutdown, we altered the way pointing corrections and reference beam offsets are entered in FORTH and displayed on the status monitor. For years we have mixed these two types of telescope offsets together. This was a bad practice that led to confusion, errors, and numerous hand calculations that should have been done automatically by the computer. The new scheme eliminates these problems and offers the following advantages:

1.  *Less typing.* After you set up an observing mode initially, you can enter further pointing updates by typing only two numbers (MAZO and MELO) instead of four.

2.  *Fewer mental calculations.* For continuum SEQUENCEs and FIVEs and spectral line BSPs, the position of the reference beam will be calculated automatically. There will be no more need to subtract the beam throw from the main beam pointing to get the reference beam.

3.  *A simpler way to change beam throw.* If an observer wants to change the beam throw from the default value (4' at 3 mm and 2' at 1 mm), you will dial in the new values on the subreflector control chassis, enter the new throw positions into FORTH, and the computer will take care of the rest. The azimuth pointing will not change as it did in the past and the existing pointing curves will still be valid. In the old system, the change to the azimuth pointing was so complicated that many observers shied away from changing the beam throw even when the astronomy required it. *Beam throw positions always must to default when loading SPECTRA or DBE or LRCVR*

4.  *Automatic centering of dual-beam maps.* For continuum dual beam maps, the computer will automatically center the map by subtracting off one-half the beam throw. Many a map has been ruined by the failure to do this.

5.  *Better documentation displays on the status monitor.* In both continuum and spectral line, the pointing offsets are always displayed explicitly. When in the beam switching observing mode, the +BEAM and -BEAM positions are displayed, and when in the position switching mode, the +BEAM and PSREF (position-switched reference) positions are displayed.


Here is how the new system works in detail:

a)  You will always need to enter pointing corrections for the azimuth and elevation at which you are observing. As before, you will take these from the pointing charts and enter them in MAZO and MELO. *Do not enter the*

*pointing corrections elsewhere, i.e., do not include them in the beam throw or the position-switched reference positions.* The pointing will be added to these latter positions automatically.

b) New command words have been installed to set the subreflector throw. These are

+AZ    (sets the +BEAM azimuth position)
-AZ    (sets the -BEAM azimuth position)
+EL    (sets the +BEAM elevation position)
-EL    (sets the -BEAM elevation position)

These values are entered in the usual format, for example

mm:ss +AZ

You can query what is set in for these values by typing

BEAMS

This will type out on the terminal screen numbers in the order

+AZ        +EL
-AZ        -EL

Note that these new beam throw parameters are the physical beam throw of the subreflector only. For example, for a 4 minute beam throw, we usually set the subreflector up to switch symmetrically, i.e., ±2 arc minutes. In this example, you would enter

2:00       +AZ
-2:00      -AZ
0          +EL
0          -EL

c) For almost all types of observing (position switching, beam switching, frequency switching, etc.), the main beam position will be that of the +BEAM. This quantity will always be displayed on the status screen. The main pointing equations in the computer will be set up for a +BEAM position of zero, i.e., the primary electrical axis of the telescope. In practice, the +BEAM will always be set to some nonzero value such as 2:00 or 1:00. The computer will adjust the pointing automatically, so long as what is typed into the +AZ (=> +BEAM azimuth) position agrees with what is dialed into the subreflector chassis. As always, you will have to use the subreflector calibration curve to go between real angular throw on the sky and the indicated readout of the subreflector.

d) Default values for the beam throws have been put in the FORTH receiver blocks so that when the computer is booted you will always get the standard value loaded in. The new beam throw and pointing offsets are defined in TRACK, so they will not change when you switch from SPECTRA to DBE.

*Not true*

*12M*

e) For position-switched observing, you will enter the reference offset positions with the usual RAZO and RELO commands. RAZO and RELO should be interpreted as the azimuth and elevation offsets from the main positions, given

by MAZO and MELO. *Do not add pointing corrections to RAZO and RELO; that will be done automatically.* For example, if the observer says he wants a 30' offset in azimuth for a PS scan, enter

$$
\begin{array}{ll}
30\text{:}00 & \text{RAZO} \\
0 & \text{RELO}
\end{array}
$$

Do not add the elevation pointing correction into RELO since the computer will do this for you. In almost all cases, RELO will be left at 0, so you will usually only have to change RAZO. Again, less typing.

f)    When you are doing a BSP scan in spectral line or a SEQUENCE or FIVE in continuum, the status monitor will display three new fields

| POINT. | x:xx | x:xx | (the az and el pointing corrections) |
|---|---|---|---|
| +BEAM | x:xx | x:xx | (the subreflector +BEAM position) |
| -BEAM | x:xx | x:xx | (the subreflector -BEAM position) |

The values displayed beside the label OFFSETS will be the sum of the POINT and the BEAM values and will change when the telescope moves from one beam position to the other.

e)    When you are doing a PS scan in spectral line or continuum, the status monitor will display the fields

| POINT. | x:xx | x:xx | (the az and el pointing corrections) |
|---|---|---|---|
| +BEAM | x:xx | x:xx | (the subreflector +BEAM position) |
| PSREF | x:xx | x:xx | (the position-switched offsets) |

The values displayed beside the label OFFSETS will be the sum the POINT values and the +BEAM values when the telescope is in the source position, and the POINT and PSREF values when the telescope is in the reference position.

f)    The system is set up to be as fool-proof as possible: When you are doing beam switching, the computer will use the +BEAM and -BEAM positions and ignore anything in PSREF. Conversely, when you are doing position switching, the computer will ignore anything in the -BEAM fields. Thus, if you are doing a mixture of beam switching and position switching observing, you don't have to zero out the unneeded fields. Again, less typing and fewer chances for error.

g)    If you are doing PS or TPM observing and are using Right Ascension and Declination offsets instead of AZ and EL offsets, you must remember to zero out RAZO and RELO (PSREF) since these values will be added on top of the RA and DEC offsets. The system has always worked like this, however; nothing new here.

h)    While installing the new beam throw parameters in the continuum task DBE, we took the opportunity to clean up the terminology used for continuum observing. Here are the changes:

    i)    We made a distinction between observing procedures and observing modes. *Observing procedures* refer to our main continuum observing algorithms such as FIVEs, SEQUENCEs, and FOCALIZEs. *Observing modes* refer to the two switching modes, beam switching (BS) or position switching (PS). In other words, BS means that the subreflector

is nutating, and PS means that the subreflector is locked down. Several of the observing procedures can be executed in either the BS or PS observing modes.

ii) We changed continuum Grid Mapping (also known as "Salter Mapping") to take advantage of the beam throw parameters discussed above. In the past, you started a grid map by typing the command "n AROW," where n was the number of rows to be mapped. Now, you type

GRID *variable*

DBMAP        for a dual beam map, or

SBMAP        for a single beam map.

Note that you do not type the "n" anymore for the number of rows; that is taken care of by the SROW parameter. The two procedures do the same thing except that DBMAP subtracts one-half the beam throw to center the mapping field at the midpoint of the two beams, whereas SBMAP centers the map on the main beam. In addition SBMAP can be run in PS mode (subreflector locked) as well as BS mode.

i) When applying RA/DEC offsets to a spectral line BSP observation, you now need only to enter the offsets into the main position using the MRAO and MDCO commands. These same offsets will be applied to the reference beam position, so there is no need to enter reference offsets using the RRAO and RDCO commands; these fields are now ignored.

j) The following two tables should help to make clear how the spectral line and continuum observing procedures make use of the new beam throw settings.

## Continuum Observing Options

| Observing Procedure | Observing Mode | Subreflector Motion | Main Beam Position | Reference Beam Position |
|---|---|---|---|---|
| SEQUENCE | BS | SWITCHING | +BEAM | -BEAM |
|  | PS | LOCKED | +BEAM | PSREF |
| FIVE | BS | SWITCHING | +BEAM | -BEAM |
|  | PS | LOCKED | +BEAM | PSREF |
| FOCALIZE | BS | SWITCHING | +BEAM | -BEAM |
|  | PS | LOCKED | +BEAM | PSREF |
| SPTIP | BS | SWITCHING | N/A | N/A |
| DON | BS | SWITCHING | +BEAM | N/A |
| DOFF | BS | SWITCHING | N/A | -BEAM |
| DON-OFF | BS | SWITCHING | +BEAM | -BEAM |
| DBMAP | BS | SWITCHING | Tracks midpoint of beams | |
| SBMAP | BS | SWITCHING | +BEAM | N/A |
|  | PS | LOCKED | +BEAM | N/A |
| DRIFT | BS | SWITCHING | +BEAM | N/A |
|  | PS | LOCKED | +BEAM | N/A |
| NSFOC | BS | SWITCHING | +BEAM | -BEAM |

Notes:

(1) Pointing Corrections are always added to both the source and reference beam positions.
(2) The commands DON, DOFF, and DON-OFF are the new names for the old commands SON, SOFF, and SON-OFF.

## Spectral Line Observing Options

| Observing Procedure | Subreflector Motion | Main Beam Position | Reference Beam Position |
|---|---|---|---|
| PS | LOCKED | +BEAM | PSREF (or RA-DEC off) |
| APS | LOCKED | +BEAM | Absolute Ref. Pos. |
| BSP | SWITCHING | +BEAM | -BEAM |
| FS | LOCKED | +BEAM | N/A |
| TPM | LOCKED | +BEAM | PSREF (or RA-DEC off) |
| PSM | LOCKED | +BEAM | PSREF (or RA-DEC off) |
| APM | LOCKED | +BEAM | Absolute Ref. Pos. |

Notes:

(1)    As in the continuum case, pointing corrections are added to both the source and reference positions.

(2)    The spectral line observing task does not include a "mode" setting as does continuum;  the observing mode (beam or position switching) is implicit in the observing procedure.