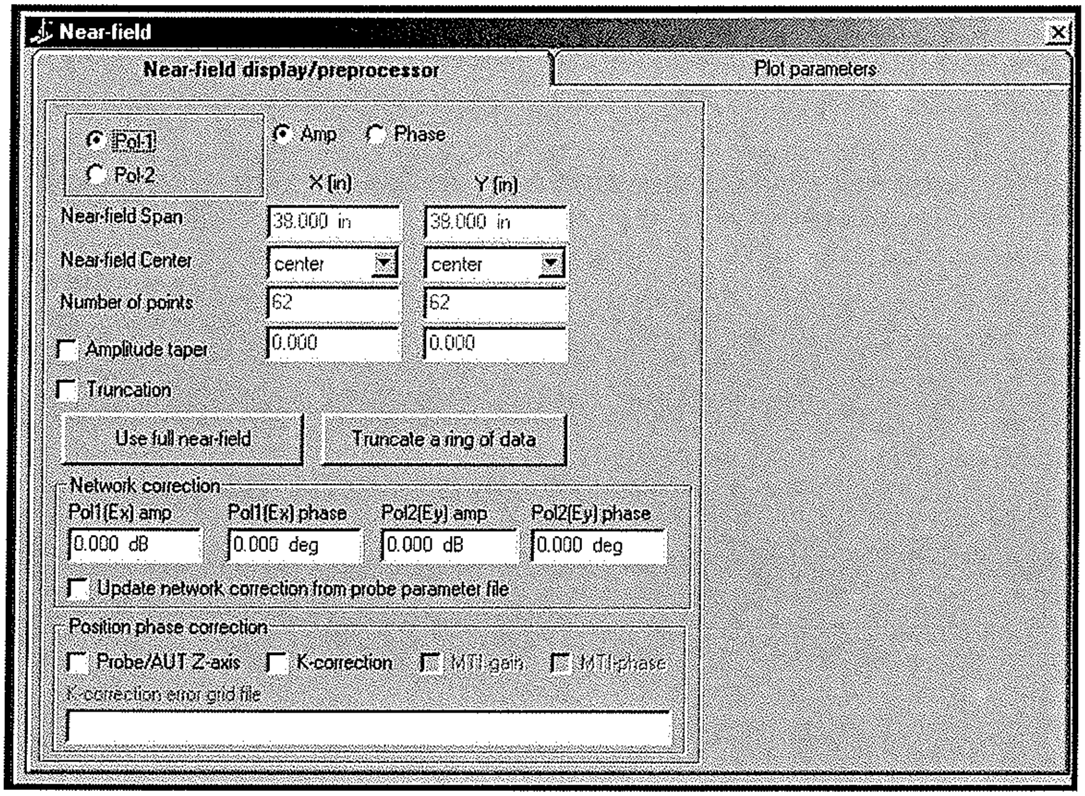


● Pol-1
○ Pol-2

● Amp ○ Phase

	X (in)	Y (in)
Near-field Span	38.000 in	38.000 in
Near-field Center	center	center
Number of points	62	62
☐ Amplitude taper	0.000	0.000

☐ Truncation

Network correction

Pol1(Ex) amp	Pol1(Ex) phase	Pol2(Ey) amp	Pol2(Ey) phase
0.000 dB	0.000 deg	0.000 dB	0.000 deg

☐ Update network correction from probe parameter file

Position phase correction

☐ Probe/AUT Z-axis ☐ K-correction ☐ MTI-gain ☐ MTI-phase

K-correction error grid file

Figure 4-8 Near-field Display Dialog

4.3.1 Near-field Pol-1, Pol-2

The near-field Pol-1 or Pol-2 option allows the operator to choose which near-field polarization to display. Pol-1 polarization is specified in the Probe setup dialog by Probe-1 sense and Pol-2 is specified by Probe-2 sense. If Probe-2 sense is set to "None", selecting near-field Pol-2 will result in a blank plot.

4.3.2 Amplitude and Phase

The amplitude or phase option allows the operator to choose whether to display a near-field amplitude plot or near-field phase plot.

4.3.3 Span, Center, Number of Points

Near-field plots are extracted from the near-field data directly with no interpolation. They will change each time you bring in a new file if the Set-Full-Nearfield-On-File-Read option is selected. Span represents the length of each axis (H or V), center is the placement of the span relative to H = 0, V= 0. The Number of points sets the density of the data. These values are not editable unless the amplitude taper or truncation boxes are selected.

All other options listed on this dialog are described in Section 5.2.

4.4 Far-Field Processing

The far-field transform is used to convert acquired near-field data to the far field. On a far-field range, the far field is defined to be at a distance where the phase curvature of the field is less than some value. This value is often chosen as 22.5° and this corresponds to a far-field distance of

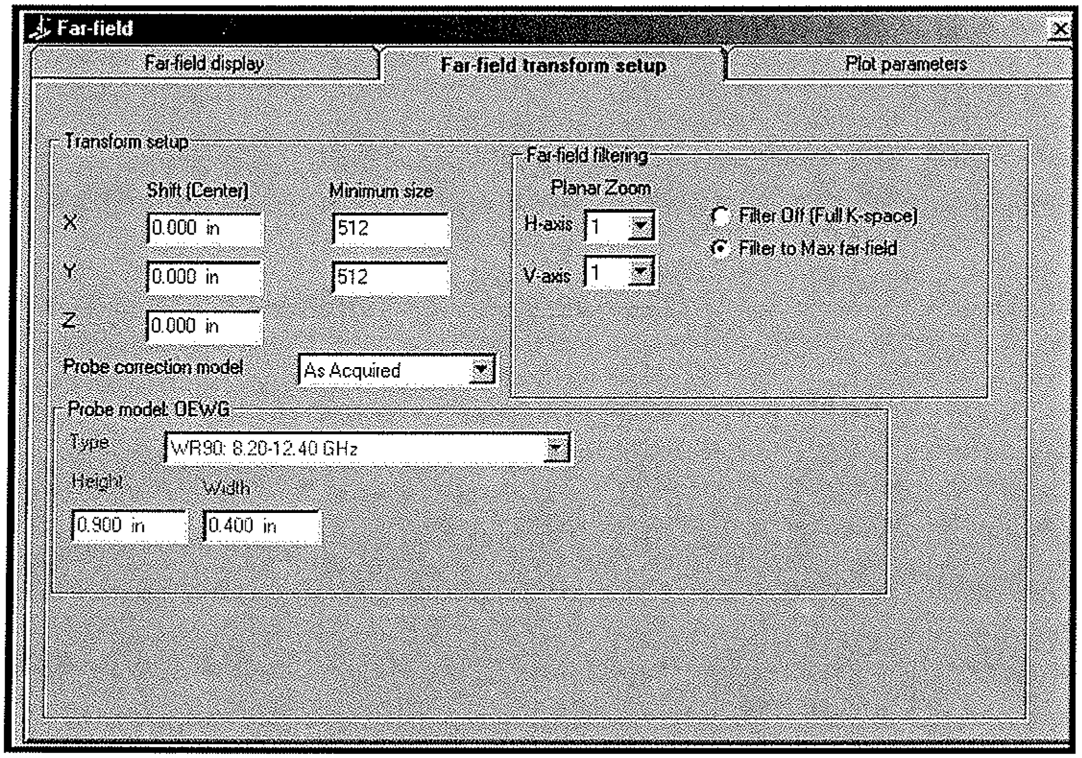
$2D^2$/Lambda. Often highly shaped antenna beams and antennas with deep nulls require far-field distances much greater than this. The far-field distance of the far-field transform is by definition infinite. In reality, the pattern is not moved relative to the AUT, it is simply changed from a spatial (X,Y) domain to an angular domain.

In the paragraphs that follow, certain terms such as H and V are used (i.e. H-span, V-span, H-center, V-center etc.). The H and V represent the horizontal and vertical dimensions of a two-dimensional plot. Depending on the coordinate system H and V take on different values such as Azimuth and Elevation, Kx and Ky etc

Certain sections are labeled "change forces re-transform". This means that changing these options invalidates the current transform and will cause a re-transform when a plot button is pressed.

4.4.1 FFT Setup

The far-field transform uses a Fast-Fourier Transform (FFT) to convert the near field (spatial X-Y) data to the far field (angular). NSI's far-field transform algorithm is written so that once the transform is completed, any pattern cut or orientation can be extracted by interpolating from the FFT transform space. Several parameters control the aspects of the transform and they are X,Y,Z shift, Minimum FFT size, Probe compensation, Far-field reference polarization and interpolation (see Figure 4-9).



	Shift (Center)	Minimum size
X	0.000 in	512
Y	0.000 in	512
Z	0.000 in	

Probe correction model: As Acquired

Planar Zoom
H-axis: 1
V-axis: 1

○ Filter Off (Full K-space)
● Filter to Max far-field

Type: WR90: 8.20-12.40 GHz
Height: 0.900 in
Width: 0.400 in

Figure 4-9 Far-field Transform Setup

4.4.1.1 *X/Y/Z Shift (Change Forces Re-Transform)*

The far-field transform rotational center is the point around which the output data are rotated. This is similar to the center of rotation of a far-field positioner except that in NSI's far-field transform the center of rotation can be adjusted without retaking data. This is particularly useful when trying to determine the phase center location of the antenna.

With X, Y and Z shifts equal to zero, the far-field transform center-of-rotation is at the phase center of the probe at the scan center. For an open-ended waveguide (OEWG) probe the phase center is usually at the center of the probe (in X and Y) and less than one quarter wavelength inside the aperture (in Z). By setting the Z shift equal to the negative of the probe-AUT separation distance, the transforms rotational center will be near the AUT aperture. When using the X, Y, Z shift to determine the antenna phase center these values should be iterated to make the particular phase pattern cut maximally flat and level over the desired beamwidth.

4.4.1.2 Minimum FFT Size and Span (Change Forces Re-Transform)

The minimum FFT size controls the number of points in the transform space. The transform always uses the nearest power of two larger than the near-field data and the minimum FFT size. If the minimum FFT size is set to zero and the near-field data had 21 points in X and 33 points in Y, then the transform space will have 32 points in H and 64 points in V. These extra points are filled with zeroes before transform so as not to affect the numerical result. This is called zero padding. The greater the padding the finer the far-field grid.

Data are interpolated from these points to produce cuts and sector patterns. If the transform space is too coarse, the interpolation will not produce smooth plots. If this occurs try increasing the FFT sizes and plot again. In general, you should use the smallest FFT size required that does not affect interpolation. This can be determined by comparing far-field plots of different FFT sizes. If increasing the FFT size does not affect the pattern, the increased size is not necessary. The limits on the FFT size are due to available memory and processing time. Note: if there is not enough physical RAM in the computer, Windows will try to swap memory to disk. This causes the hard disk to access continually and slows down the transform.

Another thing to try in order to produce smoother plots, with the same FFT dimensions, is to set the Z-shift to the aperture of the antenna before processing. This will reduce the phase variations in the far-field patterns and improve the interpolation.

The transform space span is not controlled directly by the user. It is automatically determined by the near-field data and is inversely proportional to the near-field spacing. The greater the near-field spacing the smaller the transform space. In general, a near-field spacing of 0.5 wavelength is the maximum spacing required. Often it is a good idea to use 0.48 wavelength spacing. This is because it corresponds to a transform space of ±90°. A smaller near-field spacing causes the transform space to include a portion of imaginary space. Data in imaginary space usually gives an indication of the multi-path in the measurement.

Near-field spacing greater than 0.5 wavelengths causes the transform space to be truncated. For example, a 1 wavelength near-field spacing causes the transform space to be truncated near 30°. Plotting far-field data beyond 30° would do no good because the transform algorithm clips it so that aliasing effects are not shown in the clipped region. If the AUT true far-field amplitude is wide and beyond the clipped region, the lost energy is aliased into the transform space and may cause errors. This can be determined by comparing two scans of differing densities and observing the pattern changes. If the changes are low enough over the region of interest with the larger sampling, then using it will reduce acquisition and processing times without degrading performance.

One consequence of transform space truncation is increased directivity. If the true AUT pattern levels outside the clipped space are high, the calculated directivity will be too high.

4.4.1.3 Probe Compensation (Change Forces Re-Transform)

Probe compensation is used to correct for directivity in the pattern of the probe. The greater the directivity the more compensation is required. On the far-field transform tab of the Far-field menu, the probe compensation is usually set to "As acquired". This causes the probe model to be set to that selected at the time of acquisition. Under certain conditions, you may want to override the acquired probe correction. This is done by selecting some other probe compensation model in this menu.

Several probe compensation models are available with the software: **OEWG**, **None**, **Cosine**, and **Pattern file** (Professional option only). The most commonly used is **OEWG** (open-ended waveguide). NSI's software uses a computer model developed by NIST to calculate the principal-Pol probe correction required for the OEWG probe. Selecting the proper waveguide band will create a probe pattern that is within ±0.2 dB of the true pattern. In NSI's implementation of the OEWG pattern model, the cross-Pol pattern is not modeled.

Other models can be used when different probes are used. **None** is used for low gain probes measuring high-gain antennas, or when trying to determine the effect of different probe models. **Cosine** is used if the cosine-power pattern factor is known for the antenna. NSI uses the NIST pattern file format. For further information on this format, please see Appendix B.

$$\mathbf{N = -0.5/\log\{Cos(angle_{-10})\}}\quad \textbf{Example: -10 dB point 30°, N= 8.0}$$

Pattern file is used when the probe far-field pattern has been previously measured or calculated. The pattern file format is discussed in Appendix B.

The probe model is specified at the time of acquisition but can be overridden during processing by changing the probe compensation option on the Far-field transform tab of the Processing/Far-field menu from "As acquired" to another probe type.

4.4.1.4 Far-field Reference Polarization (Change Forces Re-Transform)

The far-field reference polarization specifies in what polarization the AUT pattern will be displayed. The polarization vectors are usually set to their corresponding coordinate system (See Section 5.3.2) but others are available if desired. The sense and Tau angle should be set the same as the expected AUT principal polarization. For example, if the AUT is right-hand circular, then set the sense to RHCP. The Tau angle is always set to 0.00° when the sense is RHCP or LHCP.

4.4.1.5 Axial Ratio

Axial ratio can be derived from principal and cross-Pol CP plots by the following formula or table:

$\mathbf{AR(dB) = 20\log\{[1+10^{CP/20}]/[1-10^{CP/20}]\}}$ where: CP is the cross-Pol to principal-Pol level.

As a rule, a 6 dB change in cross-Pol affects the AR by a factor of 2. Thus -19 dB cross-Pol gives a 2 dB AR and -25 dB cross-Pol gives a 1.0 dB AR.