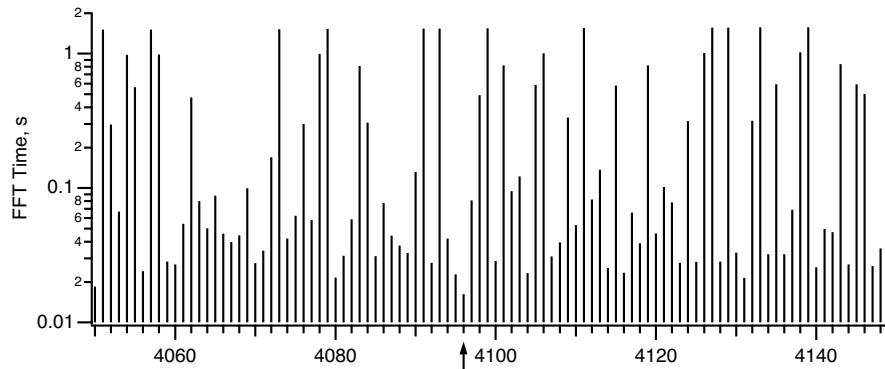


## Chapter III-9 — Signal Processing

points, then Igor changes its display mode to Sticks to zero. Also, if you perform an IFFT on a wave that is displayed in a graph and the display mode for that wave is Sticks to zero then Igor changes its display mode to Lines between points.

### Effect of the Number of Points on the Speed of the FFT

Although the prime factor FFT algorithm does not require that the number of points be a power of two, the speed of the FFT can degrade dramatically when the number of points can not be factored into small prime numbers. The following graph shows the speed of the FFT on a complex vector of varying number of points. Note that the time (speed) axis is log. The results are from a Power Mac 9500/120.



The arrow is at  $N=4096$ , a power of two. For that number of points, the FFT time was less than 0.02 seconds while other nearby values exceed one second. The moral of the story is that you should avoid numbers of points that have large prime factors (4078 takes a long time- it has prime factors 2039 and 2). You should endeavor to use a number with small prime factors (4080 is reasonably fast — it has prime factors  $2^2 \cdot 2^2 \cdot 2^2 \cdot 3 \cdot 5 \cdot 17$ ). For best performance, the number of points should be a power of 2, like 4096.

## Finding Magnitude and Phase

The FFT operation can create a complex, real, magnitude, magnitude squared, or phase result directly when you choose the desired output type in the Fourier Transforms dialog

If you choose to use the complex wave result of the FFT operation you can compute the magnitude and phase using the **WaveTransform** operation (see page V-1090) (with keywords magnitude, magsqr, and phase), or with various procedures from the WaveMetrics Procedures folder (described in the next section).

If you want to unwrap the phase wave (to eliminate the phase jumps that occur between  $\pm 180$  degrees), use the Unwrap operation or the Unwrap Waves dialog in the Data menu. See **Unwrap** on page V-1050. In two dimensions you can use **ImageUnwrapPhase** operation (see page V-433).

### Magnitude and Phase Using WaveMetrics Procedures

For backward compatibility you can compute FFT magnitude and phase using the WaveMetrics-provided procedures in the “WaveMetrics Procedures:Analysis:DSP (Fourier Etc)” folder.

You can access them using Igor’s “#include” mechanism. See **The Include Statement** on page IV-166 for instructions on including a procedure file.

The WM Procedures Index help file, which you can access from the Help→Help Windows menu, is a good way to find out what routines are available and how to access them.

### FTMagPhase Functions

The FTMagPhase functions provide an easy interface to the FFT operation. FTMagPhase has the following features:

- Automatic display of the results.