TABLE OF CONTENTS

1- DESCRIPTION

The DWEPIQ tool is used to quantitatively measure geometric distortions in Diffusion Weighted Echo Planar Imaging (DWEPI). This tool will allow systems with the DWEPI Option to quantitatively measure the effects of residual eddy currents induced by the diffusion gradients (B_0, on-axis, and cross terms) and the corresponding geometric distortions and magnitude reductions.

Note

For the ***TwinSpeed***, both gradient coils can be checked. Each GradMode is tested separately.

2- SITE PREREQUISITES

The site must be a Lightning system with 8.5 or later software configuration and the DWEPI purchasable option enabled. The site can be a 1.5T EchoSpeed or HighSpeed, a 1.0T HighSpeed, 1.5T SR150 CVi/NVi or 1.5T *TwinSpeed*. **All system calibrations must have been performed and all system parameters must meet or exceed current specifications.**

3- REQUIRED TOOLS

Item	Description	Part Number	Qty.
1.	100-mm SF9650 Liquid Silicon Sphere Phantom	2258366	1
	or		
	170-mm SF9650 Liquid Silicon Sphere Phantom	2258364	1
2.	TLT Head Loader	46-287899G1	1
3.	"Cut-down"* Foam Positioner for the 100mm Sphere	none	1

* Can be made from an EPI Foam Positioner (2170481) cut down to fit inside the TLT Head Loader.

4- SETUP

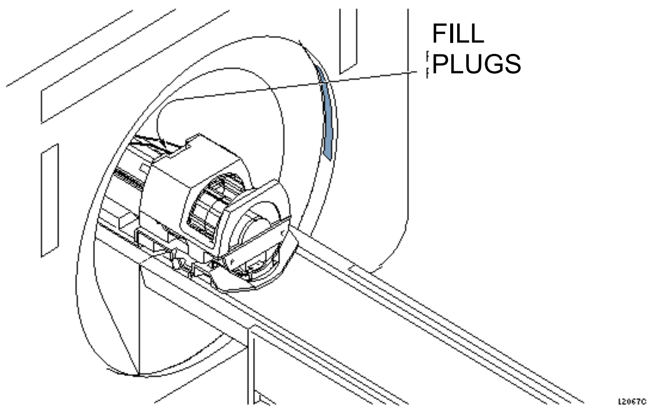
Important

All system calibrations must have been performed and all system parameters must meet or exceed current specifications.

1. Click on **[New Pt]**, and enter the following:

   Id: **geservice**
   Patient Name: **dwepiq**
   Patient Weight: **111 lbs**

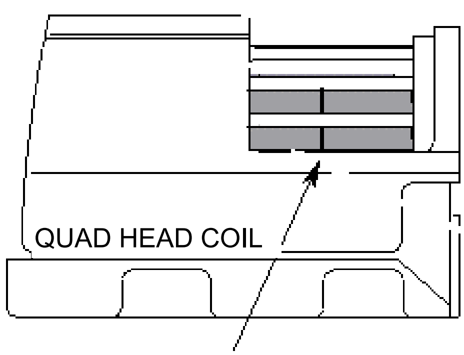
2. Place the DQA-III phantom in the head coil. Position it with the fill plugs up, and toward rear of magnet (see Illustration 4-1).



DQA-III PHANTOM POSITIONING
ILLUSTRATION 4-1

3. Landmark in the sagittal and axial planes (DQA-III coronal plane is not at isocenter). See Illustration 4-2 for positioning the phantom in the quad head coil.

Position DQA-III Phantom in the Head Coil.

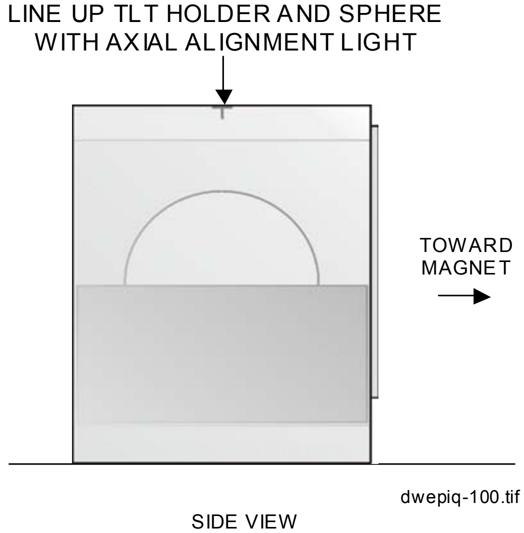


Landmark the DQA-III Phantom on the Landmark Line.

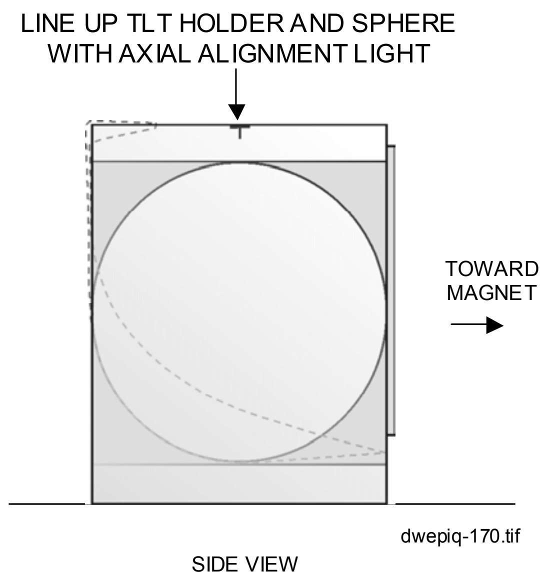
LANDMARKING DQA-III PHANTOM
ILLUSTRATION 4-2

4. At front enclosure on scanner, press LANDMARK. Do <u>NOT</u> press MOVE TO SCAN.

5. Replace the DQA-III phantom with either the "cut-down" EPI foam positioner and 100-mm SF9650 Liquid Silicon sphere phantom in the TLT Head Loader or the 170 mm SF9650 Liquid Silicon sphere in the TLT Head Loader. Move the TLT head loader to align the center of the sphere to match the original landmark set with the DQA-III phantom. Refer to Illustration 4-3 or 4-4.



POSITIONING TLT HEAD LOADER WITH 100 MM PHANTOM
ILLUSTRATION 4-3



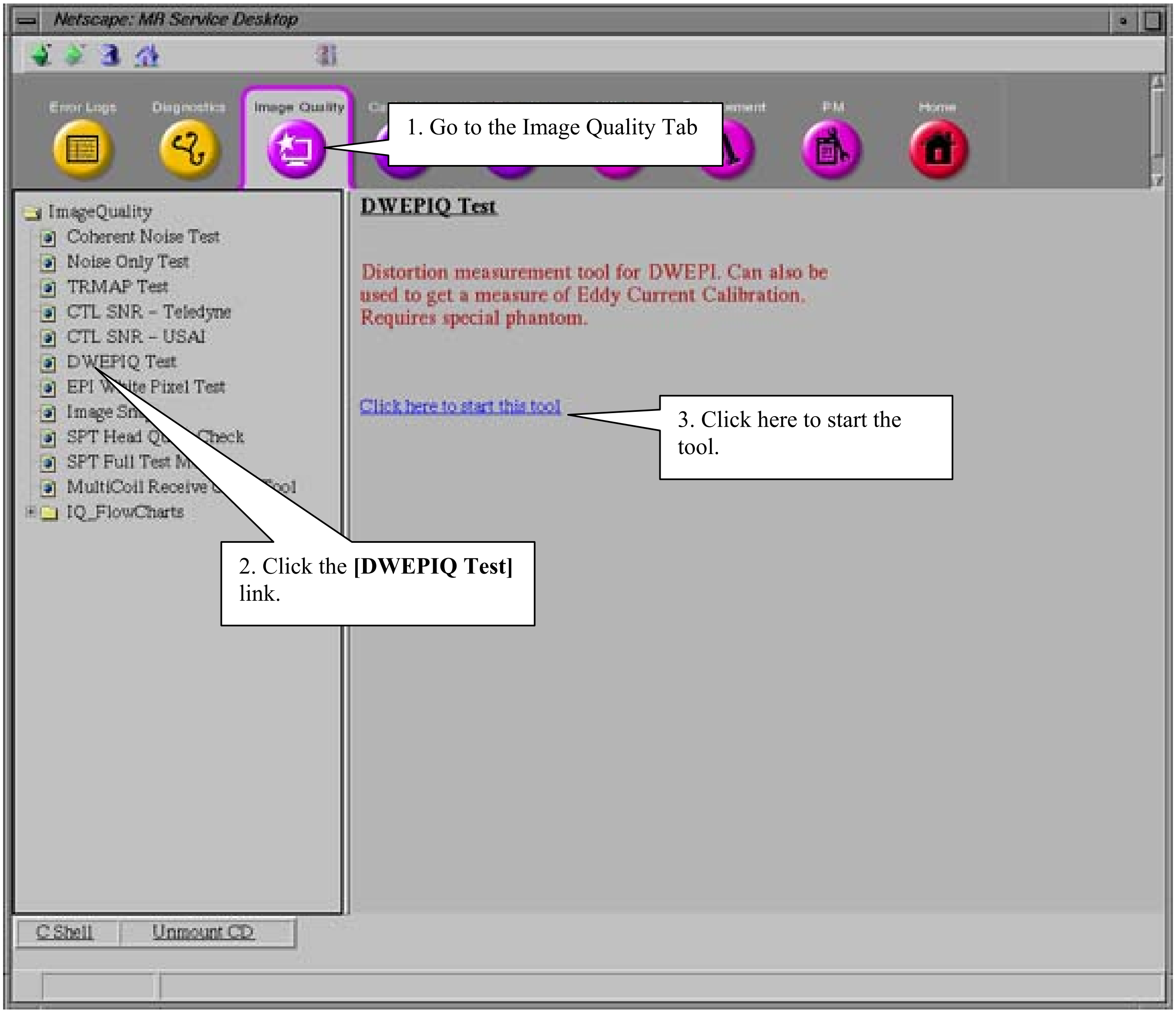
POSITIONING TLT HEAD LOADER WITH 170MM SILICON PHANTOM
ILLUSTRATION 4-4

6. Press ADVANCE TO SCAN on the magnet front enclosure.

7. Click on **[End Exam]** on the scan desktop, then [Confirm].

5- PROCEDURE

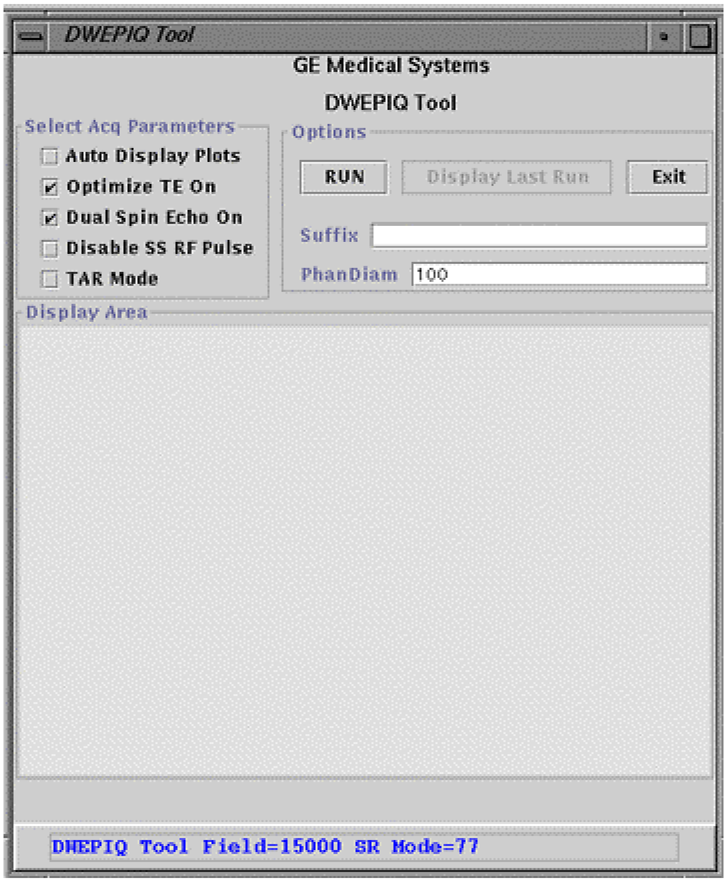
1. Go to the Service Desktop open the Service Browser if not already running by pushing the **[Service Desktop]** button on the left side of the screen. To start DWEPIQ, refer to Illustration 5-1.



STARTING THE DWEPIQ TOOL
ILLUSTRATION 5-1

For ***TwinSpeed***, highlight the **GradMode** to be used, then click on **OK**.

The DWEPIQ Tool window will appear as shown in Illustration 5-2.



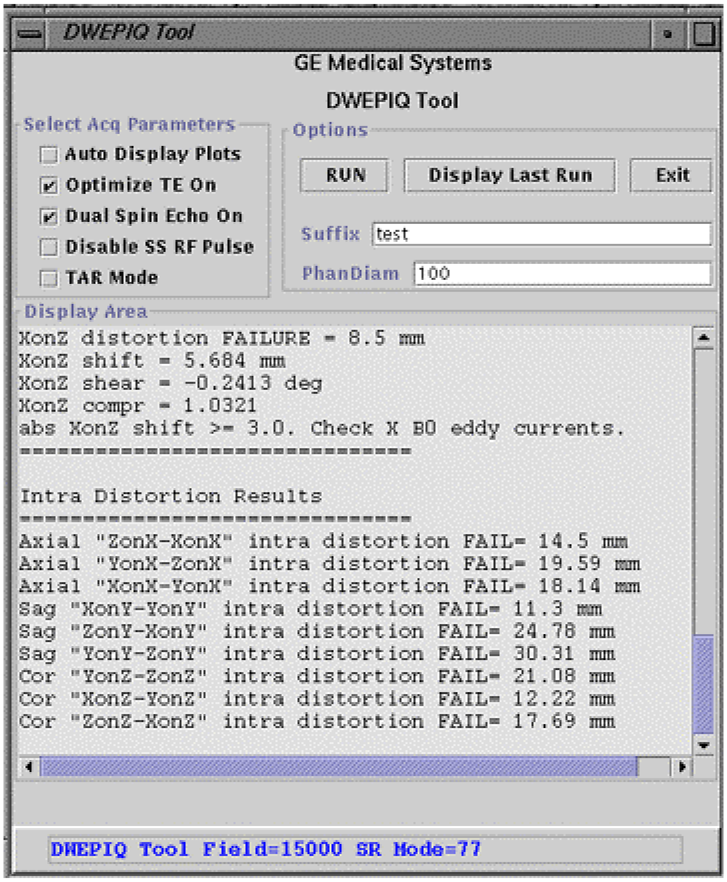
DWEPIQ TOOL WINDOW
ILLUSTRATION 5-2

The DWEPIQ Tool window opens with the “Select Acq Parameters” defaulted to “Optimized TE On” selected and “Dual Spin Echo On” selected. This is the mode that should normally be run. Optimized TE can be turned of as a troubleshooting step. Turning off Dual Spin Echo and leaving Optimized TE On, will almost always result in failures. Context sensitive help describing these functions is available while the cursor hovers over the text.

2. If desired, type in a suffix in the box titled "Suffix" and press the "Enter" key to confirm. This will add the <suffix> as an extension on all output files to make data results collection easier. Refer to Illustration 5-3.

Note

Make sure to hit the "Enter" key after typing the suffix or the suffix will not be retained.



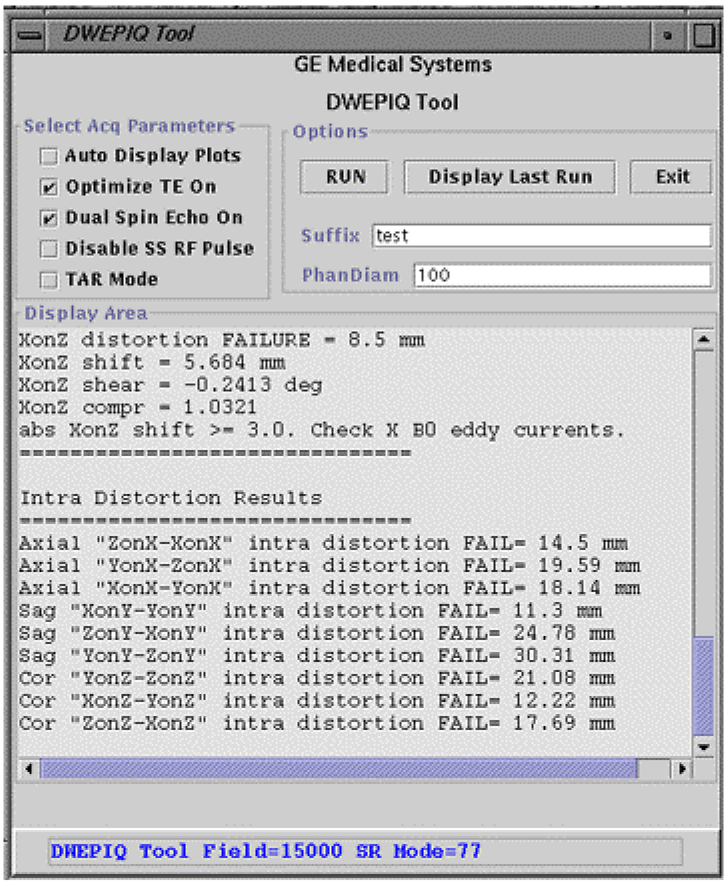
DWEPIQ TOOL WINDOW SHOWING SUFFIX “1stPass” AND DEFAULT PHANDIAM “170”
ILLUSTRATION 5-3

2. Make sure the phantom diameter is of the correct size in the box titled "PhanDiam". If you change the value, hit the "Enter" key to confirm the change.

3. To cancel this test or to start over, click on **[Exit]**.

4. After making sure the desired “Select Acq Parameters” are checked and the "Suffix" and "PhanDiam" information is as desired, click on **[RUN]** to start the test.

5. The test takes approximately 6 minutes to run. After the test is complete, the results are displayed in the "Display Area" in the "DWEPIQ Tool" window (refer to Illustration 5-4). A Pass/Fail indication is displayed along with possible problem areas to troubleshoot. If the test fails, review the results and refer to Appendix A for analysis.



DWEPIQ TOOL TEST RESULTS IN DISPLAY AREA
ILLUSTRATION 5-4

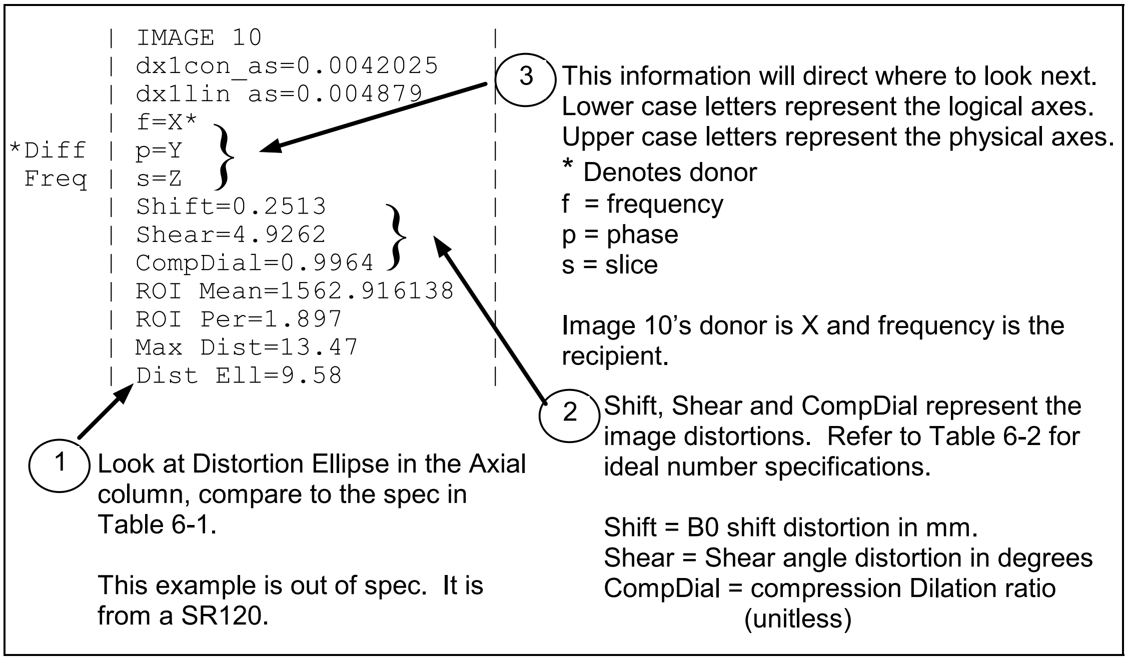
APPENDIX A - INTERPRETING DATA

```
              AXIAL-1                        SAGITTAL-2                         CORONAL-3
       ______________________________________________________________________________________________
       | IMAGE 4                     | IMAGE 5                     | IMAGE 6                     |
 No    | dn1con_as=-0.0094075        | dn2con_as=-0.003634         | dn3con_as=-0.020105         |
 Diff  | dn1lin_as=-0.002793         | dn2lin_as=-0.001604         | dn3lin_as=-0.0016595        |
       | f=X                         | f=Y                         | f=Z                         |
       | p=Y                         | p=Z                         | p=X                         |
       | s=Z                         | s=X                         | s=Y                         |
       | ROI Mean=1593.133423        | ROI Mean=1600.808350        | ROI Mean=1625.022095        |
       ______________________________________________________________________________________________
       | IMAGE 7                     | IMAGE 8                     | IMAGE 9                     |
       | dz1con_as=0.005664          | dz2con_as=0.0117925         | dz3con_as=-0.0622575        |
       | dz1lin_as=-0.0029875        | dz2lin_as=-0.00137          | dz3lin_as=-0.0020395        |
       | f=X                         | f=Y                         | f=Z                         |
*Diff  | p=Y                         | p=Z                         | p=X                         |
 Slice | s=Z*                        | s=X*                        | s=Y*                        |
       | Shift=0.5217                | Shift=0.2513                | Shift=-0.6537               |
       | Shear=-0.1252               | Shear=0.1506                | Shear=-0.2446               |
       | CompDial=0.9962             | CompDial=1.0002             | CompDial=1.0271             |
       | ROI Mean=1549.721680        | ROI Mean=1406.128662        | ROI Mean=1663.753052        |
       | ROI Per=2.725               | ROI Per=12.161              | ROI Per=2.383               |
       | Max Dist=1.16               | Max Dist=0.65               | Max Dist=-3.51              |
       | Dist Ell=0.94               | Dist Ell=0.53               | Dist Ell=-3.09              |
       ______________________________________________________________________________________________
       | IMAGE 10                    | IMAGE 11                    | IMAGE 12                    |
       | dx1con_as=0.0042025         | dx2con_as=-0.0116105        | dx3con_as=-0.0065555        |
       | dx1lin_as=0.004879          | dx2lin_as=-0.0015395        | dx3lin_as=0.0001445         |
       | f=X*                        | f=Y*                        | f=Z*                        |
*Diff  | p=Y                         | p=Z                         | p=X                         |
 Freq  | s=Z                         | s=X                         | s=Y                         |
       | Shift=0.2513                | Shift=-0.6537               | Shift=0.5217                |
       | Shear=4.9262                | Shear=0.0415                | Shear=1.1610                |
       | CompDial=0.9964             | CompDial=1.0058             | CompDial=1.0030             |
       | ROI Mean=1562.916138        | ROI Mean=1589.667358        | ROI Mean=1600.492920        |
       | ROI Per=1.897               | ROI Per=0.696               | ROI Per=1.509               |
       | Max Dist=13.47              | Max Dist=-1.23              | Max Dist=3.81               |
       | Dist Ell=9.58               | Dist Ell=-1.16              | Dist Ell=2.73               |
       ______________________________________________________________________________________________
       | IMAGE 13                    | IMAGE 14                    | IMAGE 15                    |
       | dy1con_as=-0.0140425        | dy2con_as=0.011447          | dy3con_as=-0.028087         |
       | dy1lin_as=-0.004568         | dy2lin_as=-0.0013565        | dy3lin_as=-0.0016745        |
       | f=X                         | f=Y                         | f=Z                         |
*Diff  | p=Y*                        | p=Z*                        | p=X*                        |
 Phase | s=Z                         | s=X                         | s=Y                         |
       | Shift=-0.6537               | Shift=0.5217                | Shift=0.2513                |
       | Shear=-1.1424               | Shear=0.1593                | Shear=-0.0097               |
       | CompDial=0.9990             | CompDial=0.9724             | CompDial=0.8828             |
       | ROI Mean=1566.928467        | ROI Mean=1556.270752        | ROI Mean=1372.652222        |
       | ROI Per=1.645               | ROI Per=2.782               | ROI Per=15.530              |
       | Max Dist=-3.72              | Max Dist=3.32               | Max Dist=11.47              |
       | Dist Ell=-2.90              | Dist Ell=3.04               | Dist Ell=11.45              |
       ______________________________________________________________________________________________
       | |Img7-Img10|=9.73           | |Img8-Img11|=1.46           | |Img9-Img12|=3.98           |
       | |Img13-Img7|=3.20           | |Img14-Img8|=2.68           | |Img15-Img9|=14.54          |
       | |Img10-Img13|=8.08          | |Img11-Img14|=4.14          | |Img12-Img15|=12.67         |
       ______________________________________________________________________________________________
agxw = 2.028416 G/cm
agdlval = 2.143 G/cm
esp = 672 uS
tsp = 3.86027 uS
pe_pixel size = 1.7578125 mm/pixel
ro_pixel size = 2.34375 mm/pixel
```

TYPICAL ASCII OUTPUT
ILLUSTRATION A-1

The ASCII output file (*dwepi_check_results*, located in /usr/g/service/cclass) is being used as an example for interpreting the results of the DWEPIQ tool scans. The data represents an X on X eddy current problem in a SR120 Gradient Driver System. (Refer to Illustration A-1.)

For ***TwinSpeed***, check the correct file by its GradMode extension, e.g. *dwepi_check_results.ZOOM*



INTERPRETING THE ASCII DATA
ILLUSTRATION A-2

Table A-1
DISTORTION ELLIPSE (DIST ELL) SPECIFICATIONS

Gradient Driver System Type	Typical Ranges (Preliminary spec 4.5 mm)
SR150	1 - 3 mm
SR120	1 - 3 mm
SR77	5 - 7 mm
*SR20	1 - 3 mm

* SR20 uses ezdwi with ramp samplings.

Table A-2
DISTORTION SPECIFICATIONS

DISTORTION	IDEAL NUMBER
Shift (mm)	0.0
Shear (deg. °)	0.0
CompDial (unitless)	1.0

The ASCII (Illustration A-1) can be used to help decode the numerical output from the test.

1. Look at the distortion in the ellipse (Dist Ell) values for the Diffusion scans in the Axial column. See Illustration A-2.

2. After locating the image (or images) with the highest value, look at which distortion component (Shift, Shear or Compression/Dilation) is contributing the most to the overall distortion (refer to Table A-2).

In Illustration A-1, note that Images 10 & 15 have the largest Distortion in the Ellipse (**Dist Ell=9.58, Dist Ell=11.45**) and the largest components are the Shear angle & the Compression/Dilation (**Shear=4.9262, CompDial=0.8828)**.

The shift error measured in mm is the donor axes dependent only, since B0 currents, which are spatially independent, cause shift. Entire Grafidy procedure would need to be run to correct error.

Note

In the output file all 3 cells with the same donor axis will exhibit the same amount of shift. (The tool actually averages the shift error from the 3 cells, that's why the shift number is exactly the same in each of the 3 donor cells.)

CompDial (Compression Dilation) can be thought of as a ratio of pixel misregistration at the outer edge of the phase FOV.

$$\frac{\text{pixels in T2 edge phase FOV}}{\text{pixels in Diff edge phase FOV}} = \text{CompDial}$$

CompDial > 1.0 (Phase FOV dilated, image compressed)

CompDial < 1.0 (Phase FOV compressed, image dilated)

CompDial = 1.0 (Perfect, no phase FOV error)

3. Look for the donor/recipient relationship and how the distortion is manifested in the recipient. See Illustration A-2.

The donor is the physical gradient axis on which the diffusion lobes are applied. The recipient is the physical gradient axis which experiences the residual eddy current as a result of the diffusion lobe applied on the donor axis.

If the recipient is:

- frequency, the distortion will be evident in the Shear distortion
- phase, the distortion will be evident in the CompDial distortion ratio
- slice, the distortion will be evident in the ROI Per. Note: Typically this will only be evident if the error is very large.

For image 10 (see Illustration A-2), physical X was the gradient with the diffusion lobe applied (the donor) and the problem occurred as a shear distortion which meant the recipient of the eddy current problem was on the gradient that acted as the Frequency Encoding gradient (indicated as lower case f) which in this case was also X.

Since the donor and the recipient were upon the same gradient axis (X in this case) this represents a X on X linear eddy current problem.

This evidence is confirmed in the results in image 15 (see ASCII output file at the beginning of this Appendix). Once again X is the donor axis, and here the problem was seen as a compression/dilation problem that indicates the recipient was the phase encoding gradient (indicated as the lower case p). Again the donor and recipient were the same axis indicating a linear X on X eddy current problem.

Note

> Since there appears to be a significant problem with X on X (Linear eddy current), it would be expected to impact (de-phase) the signal when X is used as the Slice Select gradient. However, because of the high signal yield of the Dimethyl silicon phantom this usually isn't detectable.

4. Look to see if there are other lower level indicators.

(Images 9, 12, 13 and 14, of the ASCII output file, show some slight distortion within the ellipse [2.73 to 3.09])

In image 9, Y is the donor and there is some Compression/Dilation which indicates phase encoding gradient was the recipient, in this case demonstrating a Y on X crossterm eddy current.. This hypothesis is confirmed by looking at image 13 where Y is again the donor and there is some Shear distortion indicating the recipient was the Frequency Encoding gradient, in this case X again.

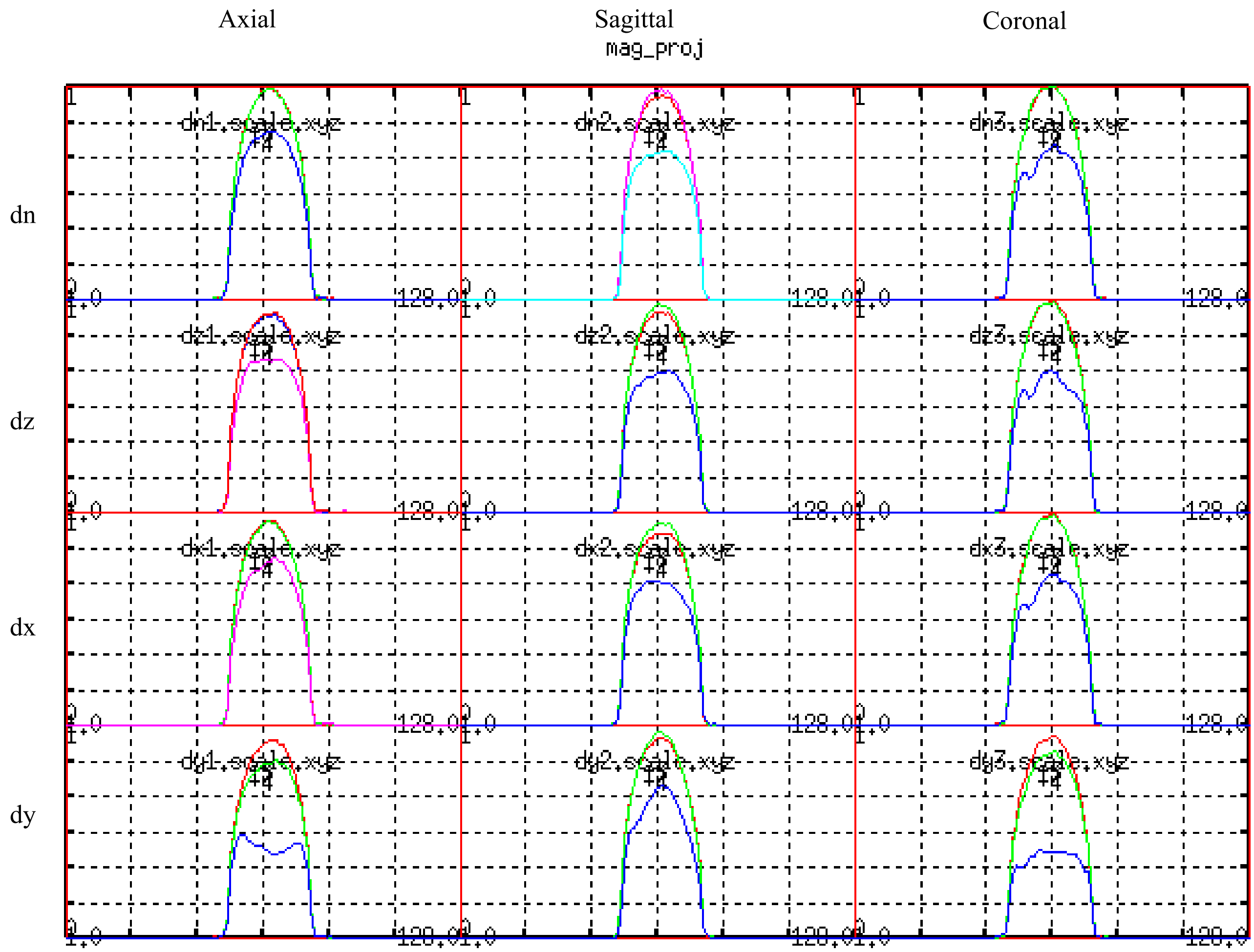
Image 12 indicates the presence of Shear. Z is the donor and recipient in this case, indicating some Z on Z eddy current effect. This is confirmed in image 14 where Z, now acting as the Phase Encoding donor - recipient causes some Compression/Dilation.)

In this example, the biggest problem is the linear X on X eddy current compensation.

Eddy currents in the 100 ms range effect distortions measured with this tool.

These eddy currents are the Long time constants; therefore, any adjustments should be made to the long time constants.

APPENDIX B - PLOT AND OUTPUT FILE DESCRIPTIONS

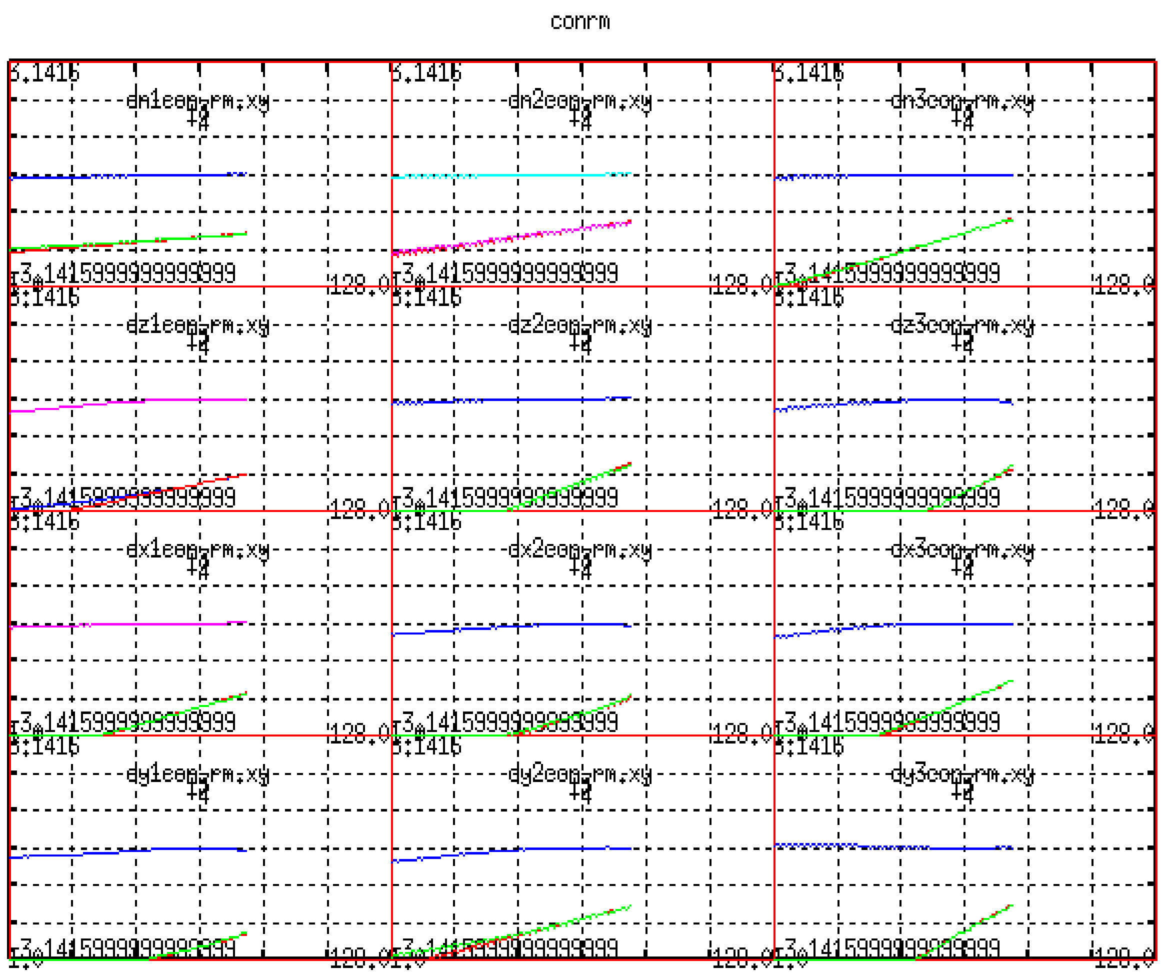


The magnitude projection plots displays the magnitude profiles of post row FT data. The 1st row is for the T2 (non-diffusion) scan. The 2nd row is for diffusion on logical Z(slice). The 3rd row is for diffusion on logical X (read). The 4th row is for diffusion on logical Y (phase). The 1st column is for Axial acquisition, the 2nd column for Sagittal acquisition, and the 3rd column for coronal acquisition.

Each cell contains 3 plots. The highest amplitude plot is from the last Ky line in K space (1st Ky line in time for epi). The 2nd highest amplitude plot is from the center of K space and the lowest amplitude plot is from the 1st line in K space (last Ky line in time for epi).

The first row is normalized to the T2 acquisition plane that has the largest amplitude. Typically these amplitudes are very close to one another since no diffusion lobes (and hence no diffusion lobe residual eddy currents) are present.

Rows 2-4 are normalized to the cell with the largest amplitude out of these 9 cell values. Typically these amplitude plots will be close in value if there is no large residual cross term or on-axis eddy current that dephases the signal in the logical phase encode direction. If you see one of the plots in rows 2-4 that has a large difference (plot is very squashed and distorted) compared to the other 8 plots, then this usually indicates a large cross term or on axis eddy current that can corrupt the results of this test (as well as introduce very large DW EPI distortions).



The constant phase correction plots display the view specific constant phase error, the line fitted correction, and the delta error between the view specific data and the line fitted data. The vertical axis units for each cell are +/- pi radians. The 1st row is for the T2 (non-diffusion) scan. The 2nd row is for diffusion on logical Z(slice). The 3rd row is for diffusion on logical X (read). The 4th row is for diffusion on logical Y (phase). The 1st column is for Axial acquisition, the 2nd column for Sagittal acquisition, and the 3rd column for coronal acquisition.

Axial Sagittal Coronal

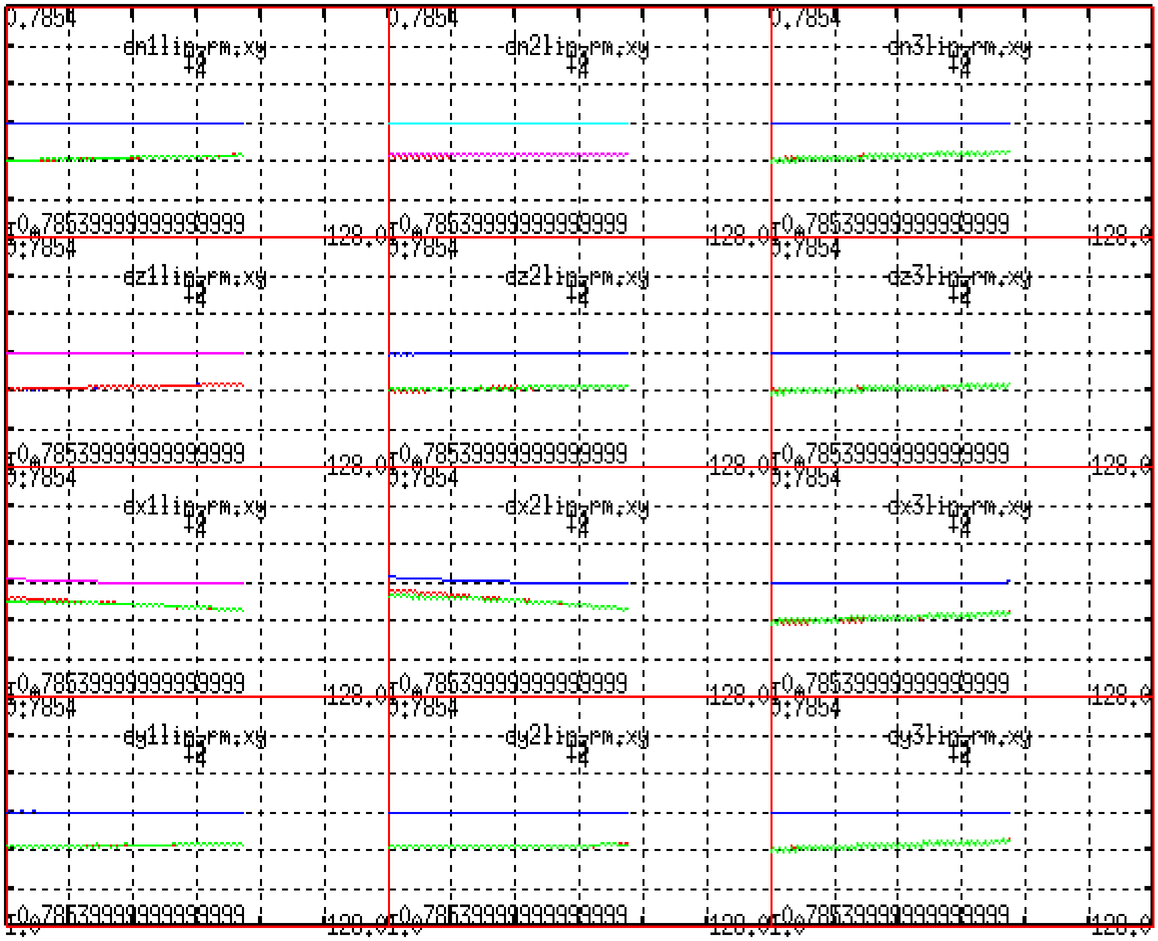
linrm

dn

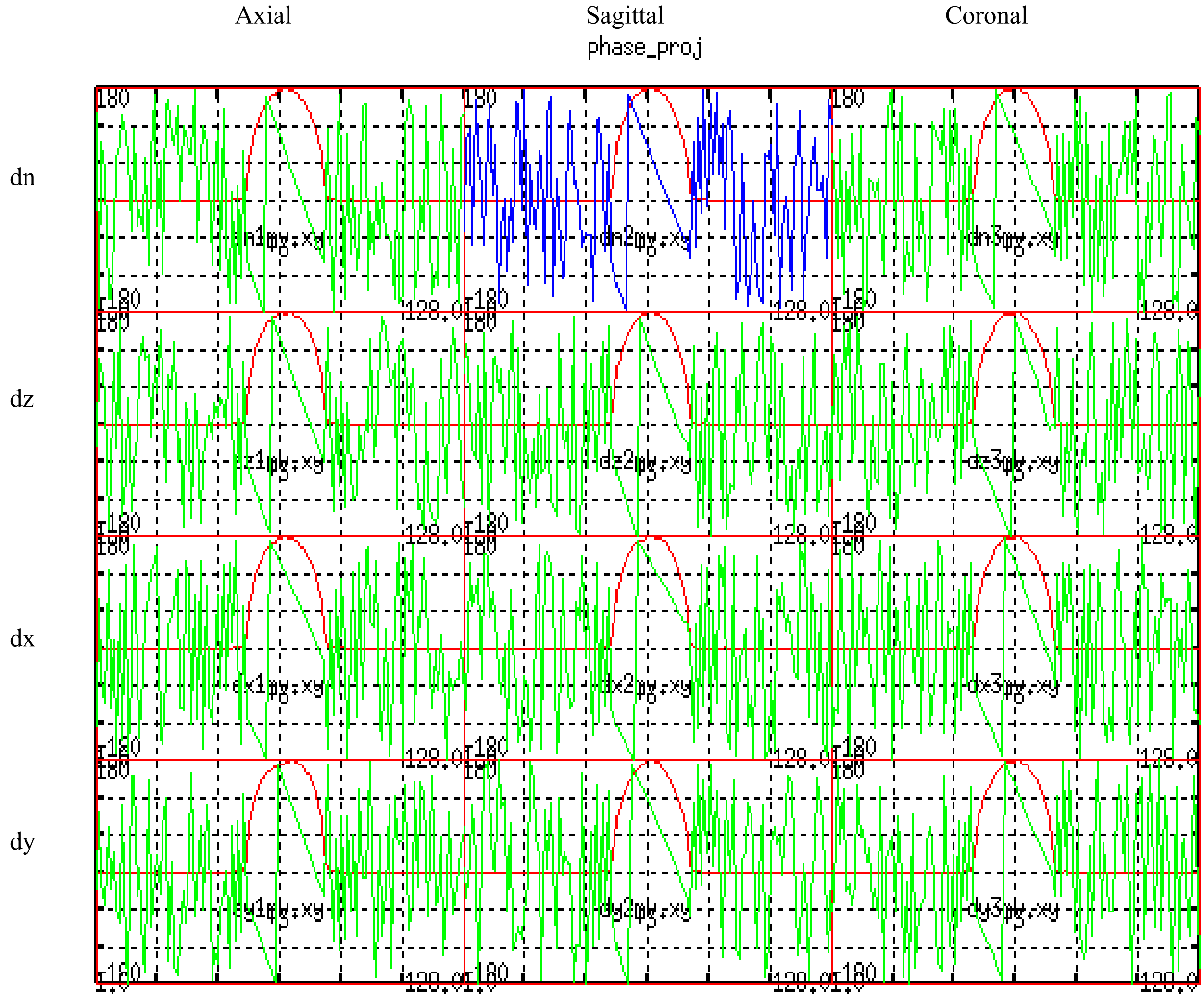
dz

dx

dy



The linear phase correction plots display the view specific linear phase error, the line fitted correction, and the delta error between the view specific data and the line fitted data. The vertical axis units for each cell is +/- pi/4 radians / freq point. The 1st row is for the T2 (non-diffusion) scan. The 2nd row is for diffusion on logical Z(slice). The 3rd row is for diffusion on logical X (read). The 4th row is for diffusion on logical Y (phase). The 1st column is for Axial acquisition, the 2nd column for Sagittal acquisition, and the 3rd column for coronal acquisition.



The phase projection plots displays the normalized magnitude from the center of K space and the corresponding phase data. The vertical axis units for each cell is +/- 180 degrees. The 1st row is for the T2 (non-diffusion) scan. The 2nd row is for diffusion on logical Z(slice). The 3rd row is for diffusion on logical X (read). The 4th row is for diffusion on logical Y (phase). The 1st column is for Axial acquisition, the 2nd column for sagital acquisition, and the 3rd column for coronal acquisition.

The phase plots should be relatively linear in regions of large magnitude (they can wrap around as seen in the above plots).

	AXIAL-1	SAGITTAL-2	CORONAL-3
	IMAGE 4	IMAGE 5	IMAGE 6
No Diff	dn1con_as=-0.0067465	dn2con_as=-0.0118395	dn3con_as=-0.0252275
	dn1lin_as=-0.000448	dn2lin_as=-8.3e-05	dn3lin_as=-0.000674
	f=X	f=Y	f=Z
	p=Y	p=Z	p=X
	s=Z	s=X	s=Y
	ROI Mean=1322.329102	ROI Mean=1323.683472	ROI Mean=1316.944702
	IMAGE 7	IMAGE 8	IMAGE 9
	dz1con_as=-0.017149	dz2con_as=-0.032231	dz3con_as=-0.041524
	dz1lin_as=-0.0003815	dz2lin_as=-0.000304	dz3lin_as=-0.0004895
	f=X	f=Y	f=Z
*Dif Slice	p=Y	p=Z	p=X
	s=Z*	s=X*	s=Y*
	Shift=-0.3726	Shift=-0.7367	Shift=-0.5560
	Shear=0.0084	Shear=-0.0280	Shear=0.0234
	CompDial=1.0007	CompDial=1.0002	CompDial=0.9984
	ROI Mean=1294.433960	ROI Mean=1311.909912	ROI Mean=1293.123901
	ROI Per=2.110	ROI Per=0.889	ROI Per=1.809
	Max Dist=-0.44	Max Dist=-0.81	Max Dist=-0.74
	Dist Ell=-0.43	Dist Ell=-0.78	Dist Ell=-0.70
	IMAGE 10	IMAGE 11	IMAGE 12
	dx1con_as=-0.0249695	dx2con_as=-0.027099	dx3con_as=-0.035931
	dx1lin_as=0.0010855	dx2lin_as=0.0016455	dx3lin_as=-0.0007895
	f=X*	f=Y*	f=Z*
*Diff Freq	p=Y	p=Z	p=X
	s=Z	s=X	s=Y
	Shift=-0.7367	Shift=-0.5560	Shift=-0.3726
	Shear=0.1943	Shear=0.2190	Shear=-0.0146
	CompDial=1.0015	CompDial=0.9988	CompDial=0.9996
	ROI Mean=1304.848999	ROI Mean=1309.444458	ROI Mean=1297.491211
	ROI Per=1.322	ROI Per=1.076	ROI Per=1.477
	Max Dist=-1.35	Max Dist=-1.22	Max Dist=-0.43
	Dist Ell=-1.13	Dist Ell=-0.99	Dist Ell=-0.42
	IMAGE 13	IMAGE 14	IMAGE 15
	dy1con_as=-0.021774	dy2con_as=-0.021946	dy3con_as=-0.0483305
	dy1lin_as=-0.0002165	dy2lin_as=-0.0001865	dy3lin_as=-0.0007005
	f=X	f=Y	f=Z
*Diff Phase	p=Y*	p=Z*	p=X*
	s=Z	s=X	s=Y
	Shift=-0.5560	Shift=-0.3726	Shift=-0.7367
	Shear=0.0293	Shear=-0.0131	Shear=-0.0034
	CompDial=0.9883	CompDial=1.0008	CompDial=0.9896
	ROI Mean=1259.532471	ROI Mean=1308.060791	ROI Mean=1257.663696
	ROI Per=4.749	ROI Per=1.180	ROI Per=4.501
	Max Dist=-1.61	Max Dist=-0.46	Max Dist=-1.61
	Dist Ell=-1.56	Dist Ell=-0.44	Dist Ell=-1.61
	|**Img7-Img10**|=0.74	|Img8-Img11|=0.56	|Img9-Img12|=0.29
	|**Img13-Img7**|=1.24	|Img14-Img8|=0.43	|Img15-Img9|=0.94
	|**Img10-Img13**|=1.44	|Img11-Img14|=0.63	|Img12-Img15|=1.22

agxw = 1.924194 G/cm
agdlval = 2.143 G/cm
esp = 704 uS
tsp = 1.799999 uS
pe_pixel size = 1.7578125 mm/pixel
ro_pixel size = 2.34375 mm/pixel

The ASCII output file containing the distortion results is in */usr/g/service/cclass/dwepi_check_results*. (Note that this file may have an extension on it if you specified one in the "suffix" box on the DWEPIQ Tool window). The data is arranged in the same 4x3 matrix format where the rows are logical diffusion axes and the columns are scan planes. Currently these are only preliminary guidelines for the Axial data column, since the current clinical usage of DW EPI is primarily for head axial scans. For ***TwinSpeed***, check the correct file by its GradMode extension, e.g. *dwepi_check_results.WHOLE*

Shift: This is a measure in units of mm of how each pixel in the image is shifted in the phase encode direction due to residual B0 eddy currents.

Shear: This is a measure of the image shear angle in units of degrees which is due to cross or on axis residual linear eddy current effects on the logical readout gradient. The shear angle determines how each pixel in each Freq encoded bin will shift in the phase encode direction dependent upon its distance from the center of the image. The pixel misregistration in the phase encode direction will be worse at the edges of the FOV in the frequency encode direction and go to zero at the center of the image. Typically on very well tuned systems we see this number being less than 1 degree.

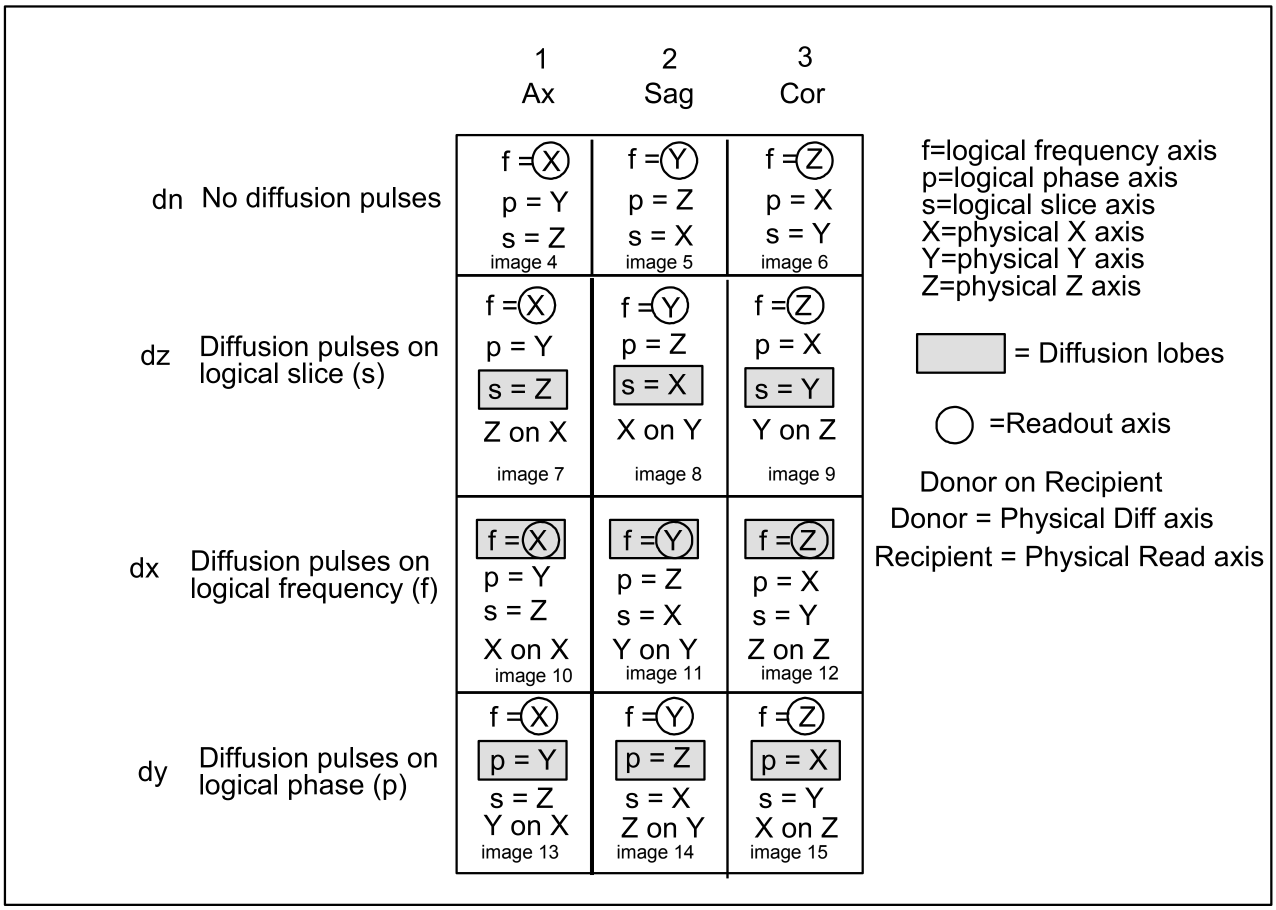
CompDial (Compression Dilation)**:** This number is unitless and represents the ratio of the FOV change due to residual cross or on axis residual linear eddy current effects on the logical phase encoding gradient. A number greater than 1 indicates a FOV dilation (phantom compression), a number less than 1 indicates a FOV compression (phantom dilation). The closer the number is to 1 the better. The misregistrations due to compression or dilation are worse at the edge of the phase encode FOV and go to zero at the center of the image.

Max Dist (Max Distortion)**:** This is a number in units of mm and represents the vector sum of shift, shear, and comp/dial distortions anywhere in the FOV. Due to the effects of shear and comp/dial the worse case pixel misregistration will ALWAYS occur in one corner of the FOV. There are no preliminary guidelines as to what this error can be but it is always >= the Dist Ell value.

Dist Ell (Distortion Ellipse)**:** This is a number in units of mm and represents the vector sum of shift, shear, and comp/dial distortions within a hard coded elliptical area that represents the 95th percentile area of a human head centered in the image. The preliminary guideline for this number is +/- 4.5 mm. Typically Echospeed systems that are properly calibrated and using the ramp sampled, 30cm FOV, 0.75 phase FOV protocol can easily meet these requirements. Dist Ell values for Echospeed are typically in the 1-3 mm range. Highspeed systems cannot do epi ramp sampling and do not have a fast receiver, therefore the echo spacings on Highspeed are much larger and distortion effects are much worse. Typical Dist Ell values that have been seen on Highspeed systems are in the range of 5-7 mm.

Inter Diffusion Distortions: The 3 numbers reported at the bottom of each column are the “intra-diffusion” distortion numbers. (Example for the axial data are |Img7-Img10|, |Img13-Img7|, and |Img10-Img13|). This number is in units of mm and represents the maximum misregistration between the same pixel location between two of the intermediate diffusion images before they are combined into the combined diffusion image. This is a representation of how well each of the 3 diffusion images “lay on top of each other”. The preliminary guidelines are again +/-4.5 mm. Again Echospeed system using the ramp sampled protocol should be able to easily meet this requirement while Highspeed systems will have more difficulty due to the longer echo spacings for epi.

The following illustrates the logical to physical gradient axis mapping as well as the diffusion lobe axes. Use this diagram to interpret the hardcopies of the graph mode and image plots.



REVISION HISTORY

REV	DATE	AUTHOR	PRIMARY REASONS FOR CHANGE
0	Oct 20, 2000	G. Boerner	Initial release.
1	Sep 3, 2001	J. Gerber	Updated for TwinSpeed scanner with Leo1 release.
2	Oct 3, 2001	K. Schraufnagel	Updated to reflect on-screen text.
3	Jun 14, 2002	Hawthorne	Updated images and descriptions in section 5 for Optimized TE.
4	Sept 6, 2002	Hawthorne	Added Service Browser interface instructions for starting tool.