

MDDW 20 directions	Direction vectors in the magnet coordinate system
16	(0.468173, -0.834308, -0.291108)
17	(0.550834, -0.425872, -0.717784)
18	(0.111012, -0.264029, -0.958105)
19	(0.111012, 0.264029, -0.958105)
20	(0.031984, 0.799591, -0.599693)



Direction vectors for additional sets of directions can be obtained through the Application Hotline.

5.3 Defining customized diffusion directions

For Diffusion Tensor Imaging (DTI), you can define customized diffusion directions (= diffusion vector sets, DVS). Multiple direction sets (each containing at least 6 linearly independent directions) can be provided in a text file that has to comply with a specific syntax.



Careful direction selection is required to ensure a reliable tensor estimation. In general, an isotropic distribution of the diffusion directions is recommended.

5.3.1 Creating the DVS

Required syntax

General:

- #: Lines starting with a hash symbol # are interpreted as comments and get ignored.
- Empty lines, tabulators and space characters get ignored (with one exception as explained below).
- There is no case sensitivity.

Number of diffusion directions:

- Each section containing a DVS is introduced with the instruction:

```
[directions = <number>]
```

where <number> indicates the actual number of diffusion vectors. A single file might contain multiple sections with different numbers of vectors. Please note that this instruction must not contain any spaces or tabulators.

Normalization:

- Each DVS might include a normalization directive:

```
normalization = <norm>
```

where <norm> is either `maximum`, `unity` or `none`. If this directive is missing, `unity` is used.

- `unity`: Each vector gets normalized to unity. This mode will ensure that every direction receives a weighting with the same b-value.
- `maximum`: First a unity normalization gets applied. Afterwards, the whole vector set is scaled such that the largest vector component of the whole set is 1.0. This mode ensures best use of the gradient performance, thus yielding the shortest echo times. However, it should only be used in the xyz coordinate system.
- `none`: No normalization is applied at all, the vectors are used as provided. For the internal diffusion gradient calculation, the vector with the largest magnitude is taken as the reference. Its amplitude will produce the b-value specified in the user interface (UI).

The actual b-value corresponding to a user defined diffusion vector can be calculated by the following equation:

$$b_{\text{actual}} = b_{\text{UI}} \times \text{Magnitude}_{\text{actual}}^2 / \text{Magnitude}_{\text{maximum}}^2$$

Coordinate system:

- Each DVS might include a coordinate system definition:

```
coordinatesystem = <system>
```

where <system> is either `prs` or `xyz`. If this definition is missing, `xyz` is used.

- `xyz`: The DVS is played out in the physical gradient coordinate system. Diffusion vector directions do not depend on the actual slice orientation.
- `prs`: The DVS is played out using the rotation matrix of the current slice, i.e. the phase-read-slice coordinate system is used. Therefore, diffusion vector directions are linked to the actual slice orientation.

Comment:

- Each DVS might contain a comment:

```
comment = <comment>
```

where <comment> is a user defined text that appears as a tooltip in the user interface.

Number of diffusion vectors:

- Each DVS must include the specified number of diffusion vectors:

```
vector[<index>] = ( <value1>, <value2>, <value3> )
```

where <index> specifies the vector index (counting starts at 0) and <value1> ... <value3> define the three spatial coordinates. In `xyz` coordinates, it is required that no vector component exceeds a value of 1.0. In `prs` coordinates, it is required that no vector length exceeds a value of 1.0.

Valid DVS, example

The following is an example for a valid DVS containing one direction set.

```
# -----
# Example
# -----
[directions=6]
```

```

Normalization = unity
CoordinateSystem = xyz
Comment = This is an example!
vector[0] = ( 1.0, 0.0, 1.0 )
vector[1] = ( -1.0, 0.0, 1.0 )
vector[2] = ( 0.0, 1.0, 1.0 )
vector[3] = ( 0.0, 1.0, -1.0 )
vector[4] = ( 1.0, 1.0, 0.0 )
vector[5] = ( -1.0, 1.0, 0.0 )

```

This file defines a single DVS consisting of six non-collinear vectors given in physical gradient coordinates. It includes a user comment and a unity normalization directive. The latter triggers internal vector re-scaling so their length equals 1.0:

```

Vector[0] = ( 0.707107, 0.000000, 0.707107 )
Vector[1] = ( -0.707107, 0.000000, 0.707107 )
Vector[2] = ( 0.000000, 0.707107, 0.707107 ) etc.

```



The definition of diffusion vectors can include one or multiple vectors of length zero. Such a vector corresponds to an image with b-value = 0. It is recommended not to include these vectors in the DVS file but to define the b-value = 0 scans as a separate diffusion weighting in the UI. Otherwise the UI option **ADC maps** might not be available.

5.3.2 Importing the DVS

- ✓ DTI license is available
 - ✓ DVS file (extension .dvs) is available on the file system of the host, directory: %CustomerSeq%/DiffusionVectorSets
 - ✓ EPI diffusion sequence has been selected
- 1 Open the **Diff Neuro** parameter card.
 - 2 Select the **Free** diffusion mode.