Euler Deconvolution (T44)

In this chapter:

Introduction to the extended Euler process

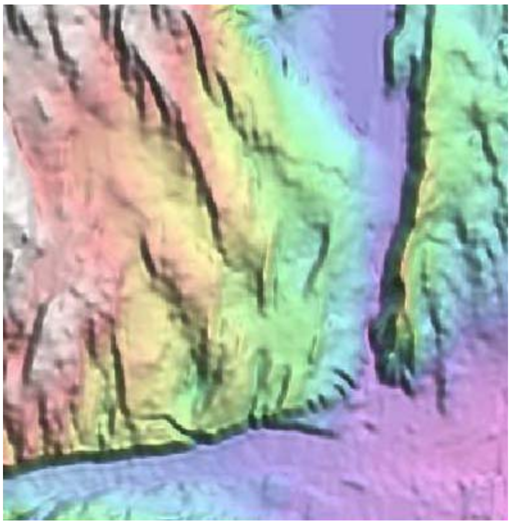
Parent topic: **Euler Deconvolution (T44)**

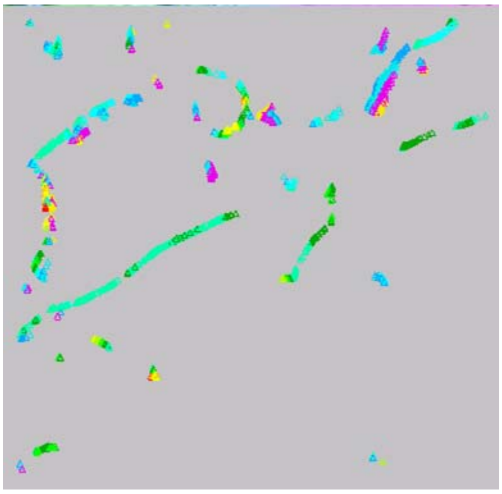
This tool enables you to conveniently obtain Euler depth estimates using best practice. This implementation of Euler deconvolution first appeared in 1993. It is based on earlier implementations by De Beers and Stockdale.

Since then after work by Nabighian and Hansen (2001), we have extended the Euler method to include equations from Hilbert transformations. Using this you can obtain superior depth solutions and data about geological structure (that is, you can use the process to calculate structural index). See Fitzgerald et al (2004) for details of this method.

Also, full tensor gravity and magnetic gradient grids, derived directly from observed survay data, are also supported in this tool. FTG data as it is known, gives a better performance at estimating depths to structures and also in more sharply defining boundaries, as there is more constraints in the signal and also more information about the causitive bodies, comarped to the integrated response of a vertical gravity or TMI survey. Often it is quite hard to get a good Euler solution from ground gravity data, whilst gravity tensor data behaves much better.

The following illustrations show a basement depth model and a corresponding population of calculated structural index of the Bishop dataset (Fitzgerald et al, 2006). We used this test data to validate the 'hybrid' Euler solver for basin studies.





The Euler Deconvolution tool creates a solution set from your grid dataset containing proposed sources which 'explain' the grid's anomalies. We refer to these sources as **Euler solutions**.

Euler Deconvolution calculates location, depth below sensor and reliability for each solution as well as error estimates in the form of standard deviations. The primary signal that is measured in potential field data derives from the edges or contacts of geological units. So this fact should reflect in what the solver is reporting.

In the standard Euler deconvolution process, each model contains solutions of a particular structural type, defined by the **structural index** parameter.

In the extended Euler process, the solution calculates structural type as the structural index output field.

The extended Euler method assumes that within a window, all gradients are caused by just one causative body. This body has simple shape with an integer-power dropoff for structural index. These assumptions may not hold true in many real geological situations.

After INTREPID calculates the full set of solutions, you can output a dataset containing classified and selected solutions:

- Selected according to reliability (goodness), depth and depth error, structural index, location and other calculated values.
- Classified according to depth, geographic location or cluster.

There is also the batch option for restricting the Euler Deconvolution process to a select set of XY pairs. We use this to continuously validate that for known models, this technique is functioning as well as we can manage, and that the answers are correct to within less than 1% error for the perfect cases, with no noise. Of course, this scenario then also opens up the perfect opportunity to devise ways to find the outlier solutions and why they occur in the first place. See the task specification section for more details.

INTREPID has a range of available formats for the output dataset.

The Euler Decomposition tool uses components of the analytic signal of the data to calculate the model. See "Analytic signal filter (reference)" in INTREPID spectral domain operations reference (R14).

Stages in the extended Euler deconvolution process

;*Parent topic:* **Euler Deconvolution (T44)**;

The extended Euler deconvolution process has two stages:

1. Generating extended Euler solutions for the grid.

   The left side of the **Euler Deconvolution** window has controls for the input of your grid. It enables you to:

   - Select the Euler, Werner or Hilbert variation that you require
   - Immediately reject solutions with unrealistic depth
   - Perform reduction to pole for magnetic data
   - Save intermediate derivative and analytic signal grids for inspection.

   At the end of this stage, you create an intermediate solutions file, a large ASCII text file.

2. Selecting the solutions for output.

   Using the selecting and sorting features, you can generate many different views of the solutions.

   You can also create 3D views in a two supported formats.

Continental Studies

In response to the availability of large scale contiental datasets (Australia, Namibia etc) that have a high fideleity, high frequency content, a new workflow is also being released at V5.0, designed to make it practical to handle very large observational geophysical grid datasets, in a repetative and sensible manner. Typically, the base grid can be as large as 5 to 10 Gigabytes, and so beyond the capacity of most desktop computers. The remaining optimization needed for a practical workflow here, is to allow users to divided a continent or province into a series of “sheets”, and then progressively work through each sheet. A new section is added to this manual to explain all the thinking and the details.

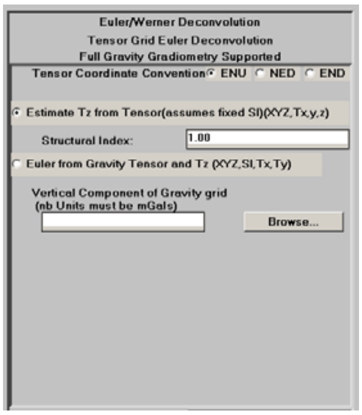
Using the Euler Deconvolution tool—Steps

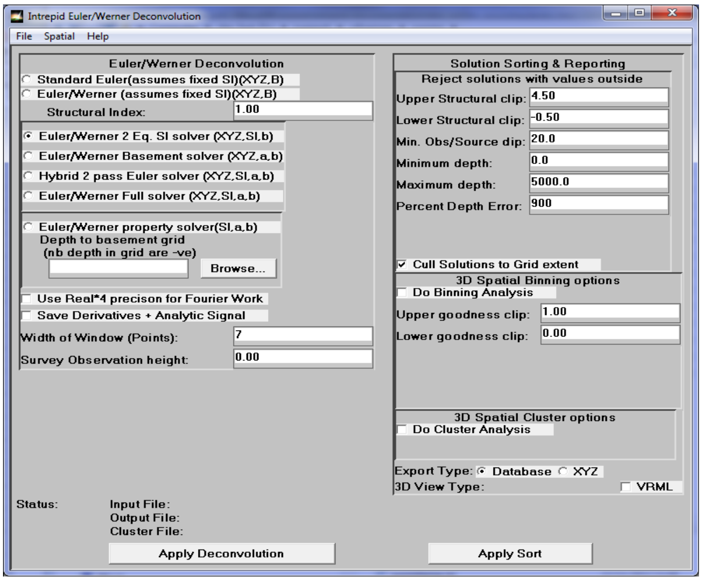
***Parent topic:* Euler Deconvolution (T44)**

>> To use Euler Deconvolution with the INTREPID graphic user interface

Euler Deconvolution is memory and computer intensive. If you are using this tool you require a relatively large amount of RAM and virtual memory.

1. Before using Euler Deconvolution, you could use Subsection (See Subsections of datasets (T21) to limit your grid to a manageable size if required. Alternatively, the tool itself allows you to create a simple rectangular subset.
2. Choose **Euler Deconvolution** from the **Interpretation** menu in the Project Manager, or use the command **euler.exe**. INTREPID displays the **Euler Deconvolution** window. The left part of the window is different depending on whether you are processing a scalar grid or a tensor grid.





3. If you have previously prepared file specifications and parameter settings for Euler Deconvolution, load the corresponding task specification file using **Load Options** from the **File** menu. (See Specifying input and output files for detailed instructions.) If all of the specifications are correct in this file, go to step 5 (calculating complete set of Euler solutions) or step 8 (refining the Euler solutions and creating an output dataset). If you wish to modify any settings, carry out the following steps as required.
4. Specify the grid dataset to be processed. Use **Open Input Grid** from the **File** menu. (See Specifying input and output files for detailed instructions.) INTREPID displays the dataset in the **Euler Deconvolution** window.
5. If required, specify a rectangular subset of the grid for processing. See Specifying the region for calculating solutions for detailed instructions.

6 Specify the output point dataset to be created with the results of the process. Use **Specify Output Point Dataset** from the **File** menu. (See Specifying input and output files for detailed instructions.)

7 If the complete set of Euler solutions does not already exist for the current grid, specify the Euler Deconvolution parameters and choose **Apply Deconvolution**. See Creating the complete set of Euler solutions—Steps for details.

8 If you only wish to produce the complete set of Euler solutions without rejecting any, go to step 11. In this case INTREPID produces only the complete set of solutions (see Output—the complete set of Euler solutions). It does not produce the output point dataset that you specified (see Output—Euler solutions point dataset).

9 Specify the criteria for selecting classifying Euler solutions for output. See Selecting and classifying Euler solutions—Steps for details.

10 When you have made specifications and settings according to your requirements, choose **Apply Sort**. INTREPID selects the solutions and save the output data as specified.

11 If you wish to record the specifications for this process in a `.job` file in order to repeat a similar task later or for some other reason, use **Save Options** from the **File** menu. (See Specifying input and output files for detailed instructions.)

12 If you wish to repeat the process, repeat steps 3–11, varying the parameters and data files as required.

13 To exit from Euler Deconvolution, choose **Quit** from the **File** menu.

You can execute Euler Deconvolution as a batch task using a task specification (`.job`) file that you have previously prepared. See Displaying options and using task specification files for details.

Specifying input and output files

Parent topic: **Euler Deconvolution (T44)**

To use Euler Deconvolution, you will need to specify at least the grid dataset to be examined and the point dataset for saving the results of the process. Choose the options as required from the **File** menu or from the main **Euler Deconvolution** window. You can preload the grid via the command line arguments, or via the Intrepid Project manager.

If you are browsing for a file. in each case INTREPID displays an Open or Save As dialog box. Use the directory and file selector to locate the file you require. (See "Specifying input and output files" in Introduction to INTREPID (R02) for information about specifying files).

In this section:

- Input
  - Input—input grid, band
  - Input—depth to basement grid
  - Input—vertical component
  - Input—solutions for re-sorting
  - Input—options
- Output
  - Output—FFT and derivative products
  - Output—the complete set of Euler solutions
  - Output—Euler solutions point dataset
  - Output—cluster dataset
  - Output—vector dataset formats
  - Output visualisation formats
  - Output—report
  - Output—options
  - Output—Convention for displaying Euler solutions

Task files

Example of input and output file specifications in a task specification (**.job**) file:

```
Input = C:/Intrepid/cookbook/eulerplay/tmi_ns.ers
Depth = C:/Intrepid/cookbook/eulerplay/dtm_ns.ers
Output = C:/Intrepid/cookbook/eulerplay/eulersols..DIR
ReportFile = euler.rpt
Cluster = C:/Intrepid/cookbook/eulerplay/eulercluster..DIR
```

At V5.0, the GOOGLE protobuf syntax is also supported. The above translates easily, by quoting the strings, and changing the equals to a colon.

Input—input grid, band

Parent topic: **Specifying input and output files**

Specify the grid dataset for which you want to calculate solutions.

INTREPID automatically detects tensor grids and processes them accordingly.

Note: If you are processing tensor data, ensure that you know its coordinate system. See "Vector and tensor field data coordinate conventions" in INTREPID database, file and data structures (R05).

Interactive

To specify the input grid, choose main menu option **File > Open Input Image**.

Task files

(Task files only) You can also specify a list of individual data points in the grid. If you do this, INTREPID only calculates solutions for the points specified.

INTREPID requires (x, y, z) triplets, where z is the known depth.

If you select Method 7—Euler Werner property solver as your calculation method, use the third value of the triplet for the known depth.

If you select any other calculation method, put 0 as the value of the third number in every triplet.

Example:

```
Input = C:/Intrepid/cookbook/eulerplay/tmi_ns.ers
Band = 0
Required_Points = { X, Y, Depth, ... }
```

Input—depth to basement grid

Parent topic: **Specifying input and output files**

If you select Method 7—Euler Werner property solver as your calculation method, INTREPID requires a depth to basement grid.

Interactive

You can enter its path or browse for it.

Task files

Example:

```
Depth = C:/Intrepid/cookbook/depth_ns.ers
```

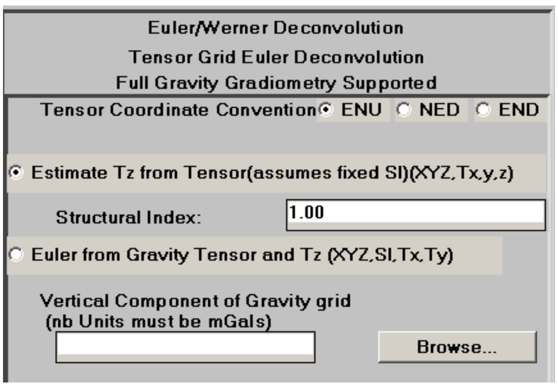
Input—vertical component

Parent topic: **Specifying input and output files**

If you use the Method 8—Tensor Bouguer solver method, INTREPID requires a vertical component grid.

This could typically be a ground gravity dataset that must share the same grid properties as the full tensor grid (the same number of rows and columns and the same origin and cell size).

Interactive



Task files

Example:

```
VerticalComponent = C:/Intrepid/cookbook/grav_z.ers
```

Input—solutions for re-sorting

***Parent topic:* Specifying input and output files**

(Interactive only) If you already have a set of solutions (**.rs** file—see Output—Euler solutions point dataset) and you want to classify and select from it to create an output points dataset, use this option to spoecify the solutions file.

Interactive

Choose main menu option **File > Open solutions for resorting**.

Task files

In batch mode you must calculate the solutions in the same task. You cannot load an existing set of solutions for sorting. There is no keyword in the task file language for this input file.

Input—options

***Parent topic:* Specifying input and output files**

If you wish to use an existing task specification file to specify the Euler Deconvolution process, choose **File > Load Options** to specify the task specification file required. INTREPID will load the file and use its contents to set all of the parameters for the Euler Deconvolution process. (See Displaying options and using task specification files for more information).

Output—FFT and derivative products

***Parent topic:* Specifying input and output files**

For extended Euler deconvolution we need to prepare up to 15 grid products for use in the process. INTREPID prepares and these automatically.

The products include:

- FFT grid of original signal (1)
- Original signal with Hilbert in X and Y (2)
- Analytic signal, analytic signal with Hilbert in X and Y (3)
- Derivatives of signal in X, Y and Z (3)
- Derivatives of signal with added Hilbert in X (3)
- Derivatives of signal with added Hilbert in Y (3)

Here is a complete list of intermediate grids. The filenames consist of:

- The input grid name (*inputgrid_*)
- A unique numeric code (*tempcode_*) to distinguish between different times that you run the task and
- The type of intermediate grid
- The text **_RESIZED** if INTREPID expanded the grid beyond its boundaries to prepare it for FFT. This does not normally happen if you use a subsection and specify the border within the grid (see Specifying the region for calculating solutions and Expanding the boundary of the input grid).

INTREPID saves these grids in the folder ***install_path*/temp**.

Since this is a routine process, INTREPID does not include options for you to manually prepare these grids yourself and submit them to the tool.

You can specify whether to retain these files after the Euler Deconvolution process. See Derivatives and analytic signal‘ for instructions.

You can examine any of the grids to make sure the FFT work does not contain ringing. If there is ringing, work on the input grid to reduce noise.

The 3-dimensional analytic signal computes the non-directional derivative as the square root of the square of the 2 horizontal and 1 vertical derivatives. The analytical signal is used as input to a Single Value decomposition.

INTREPID deletes these unless you want to save them (see Derivatives and analytic signal).

Transform products

***inputgrid_tempcode*_FFT**
***inputgrid_tempcode*_HILBERT_0_real**
***inputgrid_tempcode*_HILBERT_90_real**
***inputgrid_tempcode*_Analytic**
***inputgrid_tempcode*_Analytic_Hilbert_0**
***inputgrid_tempcode*_Analytic_Hilbert_90**

Derivatives

***inputgrid_tempcode*_XD_real**
***inputgrid_tempcode*_YD_real**
***inputgrid_tempcode*_ZD_real**
***inputgrid_tempcode*_XD_HILBERT_0_real**
***inputgrid_tempcode*_YD_HILBERT_0_real**
***inputgrid_tempcode*_ZD_HILBERT_0_real**
***inputgrid_tempcode*_XD_HILBERT_90_real**
***inputgrid_tempcode*_YD_HILBERT_90_real**
***inputgrid_tempcode*_ZD_HILBERT_90_real**

Output—the complete set of Euler solutions

***Parent topic:* Specifying input and output files**

INTREPID stores the complete set of extended Euler solutions in an ASCII text file. The name of this file is derived from the input grid's file name. The solutions file name consists of the input grid name with **_rs** appended. For example, the Euler solutions file for grid **mag_342** will be **mag_342_rs**. INTREPID also produces a history file with the **_rsh** appended.

The report file and this header file show what each column in the ASCII file represents.

INTREPID uses this file when you select and classify solutions for output. These are ASCII and contain all of the information necessary to preserve, sort, cull your solutions.

INTREPID does not overwrite any existing **_rs** file when you recalculate the extended Euler solutions using different parameters. It adds **1**, **2**, **3**, ... to the name of the input grid name as necessary. Thus, if you wish to resort to a previous output, you just need to choose the appropriate intermediate solutions file.

Output—Euler solutions point dataset

Parent topic: Specifying input and output files

When you select and classify the extended Euler solutions, INTREPID saves this data to a point dataset.

Task files

Example:

```
Output= C:/Intrepid/cookbook/eulerplay/eulersols..DIR
```

Dataset fields

The output point dataset for selected Euler solutions has the following fields:

Field	Description
`CellSize`	(Group by) Input grid cell size ('group by' field) previously **CELLSIZE**
`Window`	(Group by) Size of Euler window ('group by' field) previously **WINDOW**
`Structural_Indx`	Structural Index for solutions ('group by' field) previously **STRUCTURE**
`BIN`	Geographic bin number
`LAYERDEPTH`	Depth of mid point of layer (m). This acts as the layer number field.
`X`	East–West geographic location
`Y`	North–South geographic location
`Elevation`	Depth estimate for solution (m) previously **DEPTH**
`Reliability`	Reliability (0..1) of solution previously **RELIABILITY**
`Background`	Average field value in the region
`Goodness`	See Goodness for an explanation
`Strike`	The strike is the artan of the ratio of the two horizontal gradients, y/x
`Obs_Dip`	The vertical angle from observed grid point to the computed body location. If these are low we reject them. See Minimum observed dip.
`Grad_Amp`	Gradient amplitude of the analytic signal
`Trace`	Sum of leading diagonal terms in the matrix solver
`Grid_loc`	Ordinal position of the cell in the grid, numbered columnwise then rowwise.
`Alpha` `Beta`	See Maximum absolute alpha for information.
`Sratio`	See Maximum singularity ratio for explanation
`MaxDeterminant`	(Group by) A constant output value for the whole dataset. INTREPID looks through every solution, takes determinant of each solution matrix and then places the maximum value in this field.

Field	Description
X_Error Y_Error Elevation_Error Background_Error SI_Error XY_Error YZ_Error ZX_Error ZSI_Error	The quantities **XY_err**, **YZ_err**, **ZSI_err** represent the cross correlation of individual terms with each other. Surprisingly, the cross correlations are extremely small except for the case of a relatively small grid cell size and a large convolution kernel for a 2D body. This appears in the **XY_err** term. The weighted least squares single value solver directly determines these values

The log file reports a full account of all solutions attempted and their reject or accept status based on depth, XY, SI, or Numeric issues.

Also, the **Norm_CovarianceXY** field is a report of the estimated normalised covariance for each solution window for all the XY terms in the observations.

Typically, over 80% of observations have strong covariance.

Output—cluster dataset

Parent topic: Specifying input and output files

If you choose to classify your extended Euler solutions using clustering (see Cluster analysis), INTREPID saves the cluster data to a point dataset.

```
Cluster= C:/Intrepid/cookbook/eulerplay/eulercluster..DIR
```

Dataset fields

Kurt is Kurtosis, a population statistic

Skew is a measure of skew in the distribution of a cluster

Error is SD of the data in the cluster

The output cluster dataset has the following fields:

Field	Description
X, Y, X_Error, Y_Error	
Elevation, Elevation_Error, Elevation_Kurt	Depth estimates for solutions
Structural_Indx, SI_Error, SI_Skew, SI_Kurt	See Structural Index
Alpha, Alpha_Error, Alpha_Skew, Alpha_Kurt	See Maximum absolute alpha for information.
Beta, Beta_Error, Beta_Skew, Beta_Kurt	See Maximum absolute alpha for information.
Radius	Radius of cluster area
Number	Number of points in the cluster

Output—vector dataset formats

Parent topic: Specifying input and output files

INTREPID can output the selected and classified extended Euler solution data in the following formats. See INTREPID direct access, import and export formats (R11).

Option	Purpose
Database	Any supported binary database
XYZ	Geosoft XYZ format
GDB	Geosoft GDB format

Task files

Example:

```
ExportTypes= Database
```

Output visualisation formats

Parent topic: Specifying input and output files

Two formats for 3D representation of your Euler Solutions are available.

Option	Purpose
VRML	Virtual Reality Markup Language (VRML) is a common file format for internet browsers. The file produced here can be looked at in 3D using a plug-in such as Blaxlan.
BREP	OpenCascade 3D object representation viewer. A free viewer for BREP data is available from the OpenCascade WWW site.

Task files

Example:

```
Dump_VRML= No
Dump_BREP= No
```

Output—report

Parent topic: Specifying input and output files

Euler Deconvolution produces a report file describing its actions. The default file name of the report is **euler.rpt** in the current folder. In task files you can specify a different name and path.

Task files

Example:

```
ReportFile= euler.rpt
```

Output—options

Parent topic: Specifying input and output files

If you wish to save the current Euler Deconvolution file specifications and parameter settings as an task specification file, choose **File > Save Options** to specify the filename and save the file. (See Displaying options and using task specification files for more information).

Output—Convention for displaying Euler solutions

Parent topic: Specifying input and output files

It is common practice to display Euler solutions point datasets using:

- Symbol colour to represent Depth,
- Symbol size to represent Reliability,
- Symbol strike to represent Angle.

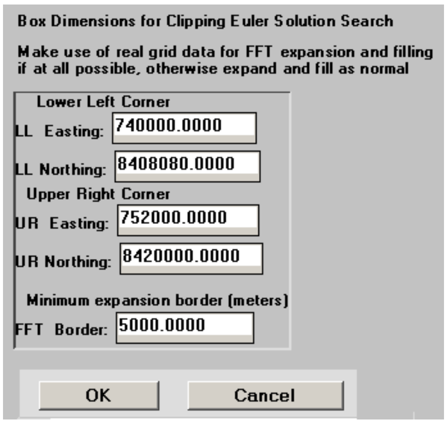
Specifying the region for calculating solutions

Parent topic: **Euler Deconvolution (T44)**

You can specify a rectangular subsection of the input grid. INTREPID only outputs solutions located within the subsection. Specify the subset in distance units of the grid dataset (usually metres).

If you specify extents of a region that completely contains the input grid, INTREPID does use the subset feature.

INTREPID uses any actual grid data that is available outside the subset for FFT filling and conditioning. You can specify the width of the grid expansion border for FFT in relation to this subset. See Expanding the boundary of the input grid for more details.



Option	Purpose
LL Easting	Minimum value for eastern direction. This value allows the interpreter to specify a minimum eastern value which forces statistical calculations to be performed only for data points whose eastern coordinate is greater than or equal to the eastern boundary value.
UR Easting	Maximum value for eastern direction. This value allows the interpreter to specify a maximum eastern value which forces statistical calculations to be performed only for data points whose eastern coordinate is less than or equal to the eastern boundary value.
LL Northing	Minimum value for northern direction. This value allows the interpreter to specify a minimum northern value which forces statistical calculations to be performed only for data points whose northern coordinate is greater than or equal to the northern boundary value.
UR Northing	Maximum value for northern direction. This value allows the interpreter to specify a maximum northern value which forces statistical calculations to be performed only for data points whose northern coordinate is less than or equal to the northern boundary value.

Task files

Example:

```
Subset Begin
      XLower= 520129.158
      XUpper= 595129.158
      YLower= 7236236.0
      YUpper= 7311236.0
      ...
Subset End
```

Creating the complete set of Euler solutions—Steps

Parent topic: **Euler Deconvolution (T44)**

In the first stage of the Euler Deconvolution process INTREPID generates a complete set of Euler solutions.

It saves these solutions to a file from which you can select solutions for the output dataset. See Output—the complete set of Euler solutions for details.

>> *To create the complete set of Euler solutions*

1. Ensure that you have specified the input grid dataset. See Specifying input and output files for instructions.
2. Specify
   - The extended Euler equation option (see The standard and extended Euler equation options).
   - (*Standard Euler and Euler Werner only*) The required structural index (see Method 1—Standard Euler, Method 2—Euler Werner and Structural Index).
   - (*Euler Werner property solver only*) The depth to basement grid (see Method 7—Euler Werner property solver and Input—depth to basement grid).
   - The FFT parameters (see Fast Fourier transform).
   - The survey height (see Survey observation height).
   - The size of the Euler window, determining the maximum depth of solutions (see Determining the maximum depth for solutions (window size)).
   - Whether to convolve the derivatives before use (see Derivatives and analytic signal).
   - Whether to save the derivatives and the analytic signal as grid datasets during the process (see Derivatives and analytic signal).
3. Choose Apply Euler. INTREPID will calculate and save the solutions and intermediate results datasets if specified.

See the following sections for details about this process.

The standard and extended Euler equation options

Parent topic: **Euler Deconvolution (T44)**

In this section:

The Euler equation is solved using a singular value decomposition to determine the unknowns of a system of linear equations.

The Traditional or Standard Euler technique uses the components of the analytic signal—three orthogonal derivatives all in the spatial domain, usually determined by Fourier methods.

Inputs are $\frac{\partial M}{\partial X}$, $\frac{\partial M}{\partial Y}$, $\frac{\partial M}{\partial Z}$ and the structural index.

The calculated output is a vector distance to the source with estimates of x,y,z and background and their errors.

For the extended Euler method, after Nabighian and Hansen (2001) and Fitzgerald and Reid (2000), we use the Hilbert transform to formulate 2 or 3 equations. By4 applying the Hilbert transform, we have achieved a circular rotation of the coordinate axes. This is an invariant for potential fields that allows us to create the new differential equations.

The extended Euler options are a unification of the Euler and Werner deconvolution in 3D using the generalized Hilbert transform.

The 2 Hilbert equations take the following parameters:

Equation 1 $H_x\left(\frac{\partial M}{\partial X}\right)$, $H_x\left(\frac{\partial M}{\partial Y}\right)$, $H_x\left(\frac{\partial M}{\partial Z}\right)$ and $H_x(M)$

Equation 2 $H_y\left(\frac{\partial M}{\partial X}\right)$, $H_y\left(\frac{\partial M}{\partial Y}\right)$, $H_y\left(\frac{\partial M}{\partial Z}\right)$ and $H_y(M)$

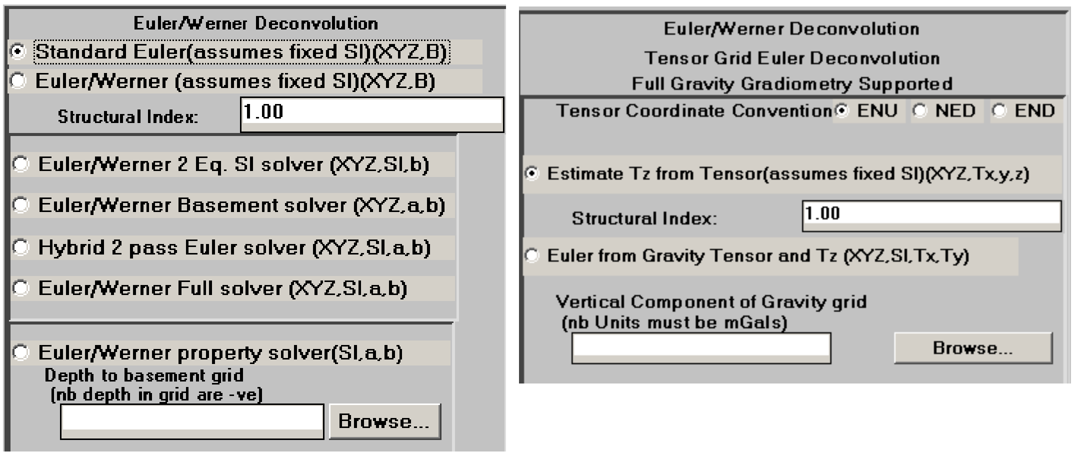
These extra equations use the Hilbert transform on standrad Euler equations. We have shown that if the field satisfies both Euler and LaPlace rce then the Hilbert transform of the fields also satisfies the Euler equation. Resulting independent equations can solve for more unknowns and therefore we could achieve an improved resulting set of estimates. You can test this by comparing the results of the Method 1—Standard Euler option with those of the Method 2—Euler Werner option.

The calculated output is a vector distance to the source with estimates of X, Y, Z, structural index and corresponding errors and covariance.

For a particular model, such as a dipping contact, you can calculate other properties including dip, strike and physical property contrast (density or susceptibility).

The Euler Deconvolution tool currently offers eight extended Euler equation options.

You can select the options in the user interface or using keywords in the task files.



The extended Euler calculations use combinations of three equations:

- Classic Euler equation (Classic)
- Hilbert transformation in North and East directions (Hilbert)

Depending on the options, you can solve for X, Y, Z, SI, B, α, β.

With some options you need to specify parameters or provide input data—SI, depth or vertical component (Z).

α and β are body property indicators calculated in some options.

Background represents background magnetic field or gravity without local anomalies.

Method 1—Standard Euler

***Parent topic:* The standard and extended Euler equation options**

This method uses only the Classic equation. This suffers from scatter and noise if the gradient grids are not very good.

It assumes fixed structural index (SI), which you specify as a parameter (see Structural Index).

It solves for X, Y, Z and B (Background).

Background represents background magnetic field or gravity without local anomalies.

Interactive

Standard Euler—*interactive*

In the **Euler Deconvolution** area:

1. Select **Standard Euler**.
2. Specify the **Structural Index** (see Structural Index).

Task files

Standard Euler—*task files*

Within the `Solve Begin - End` block:

- Set the `EquationCombo` keyword to `Classic`.
- Set the required value for the `StructuralIndex` keyword.

Example:

```
EquationCombo = Classic
```

```
StructuralIndex = 1
```

Method 2—Euler Werner

Parent topic: **The standard and extended Euler equation options**

This extended Euler method uses all three equations.

It assumes fixed structural index (SI), which you specify as a parameter (see Structural Index).

It solves for X, Y, Z and B (Background).

If you already know the SI (perhaps because you have sythetic data from models), you can compare the standard and extended Euler methods, and assess which one gives the more acceptable error distribution.

In all cases this method should yield the lowest error range, as we are solving for the least number of unknowns with the most equations.

Interactive

Euler Werner—*interactive*

In the **Euler Deconvolution** area:

1. Select **Euler Werner**.
2. Specify the **Structural Index**.

Task files

Euler Werner—*task files*

Within the **Solve Begin - End** block:

- Set the **EquationCombo** keyword to **All3_Fixed_SI**.
- Set the required value for the **StructuralIndex** keyword.

Example:

```
EquationCombo = All3_Fixed_SI
StructuralIndex = 1
```

Method 3—Euler Werner 2 Equation SI solver

Parent topic: **The standard and extended Euler equation options**

This extended Euler method uses only the two Hilbert equations. This is the default and our preference for the new user.

It assumes fixed background.

It solves for X, Y, Z, SI, β.

We have found that this has a good focusing ability, with a tight error envelope around discrete bodies. It is using phase inherent in the local stationary signal to best advantage. In practice it does the best on deep basement contacts.

We suggest that, in the selecting and sorting stage, you apply an upper and lower clip to calculated values of the SI. See Structural index clips.

Interactive

Euler Werner 2 Equation SI solver—*interactive*

In the **Euler Deconvolution** area:

1. Select **Euler Werner 2 Equation SI solver**.

Task files

Euler Werner 2 Equation SI solver—*task files*

Within the **Solve Begin - End** block:

- Set the **EquationCombo** keyword to **Hilbert_Only**

Example:

```
EquationCombo = Hilbert_Only
```

Method 4—Euler Werner basement solver

Parent topic: **The standard and extended Euler equation options**

This extended Euler method uses all three equations. Not recommenede for the novice user.

It solves for X, Y, Z, β.

We designed this option to solve for depth (Z), when you do not require the SI. It eliminates the SI, producing a superior result for X, Y, Z.

Interactive

Euler Werner basement solver—*interactive*

In the **Euler Deconvolution** area:

1 Select **Euler Werner basement solver**.

Task files

Example:

```
EquationCombo = No_SI
```

Method 5—Hybrid 2-pass Euler solver

Parent topic: **The standard and extended Euler equation options**

Not recommeneded for the novice user. This extended Euler method is a combination of:

- Method 3—Euler Werner 2 Equation SI solver and
- Method 4—Euler Werner basement solver

It solves for X, Y, Z, SI, α, β.

It produces all solutions using both of the methods. It then selects:

- X, Y and SI from Method 3—Euler Werner 2 Equation SI solver
- The best Z results from the two methods. This is the deepest of the two depths with a small scaling adjustment derived from the 'Bishop' study.

Interactive

Hybrid 2 pass Euler solver—*interactive*

In the **Euler Deconvolution** area:

1 Select **Hybrid 2 pass Euler solver**.

Task files

Hybrid 2 pass Euler solver—*task files*

Within the **Solve Begin - End** block:

- Set the **EquationCombo** keyword to **Hilbert_then_no_SI**

Example:

```
EquationCombo = Hilbert_then_no_SI
```

Method 6—Euler Werner Full Solver

Parent topic: **The standard and extended Euler equation options**

This extended Euler method uses all three equations.

It solves for X, Y, Z, SI, α, β.

This method solves for all unknowns.

Interactive

Euler Werner Full Solver—*interactive*

In the **Euler Deconvolution** area:

1 Select **Euler Werner** full solver.

Task files

Euler Werner Full Solver—*task files*

Within the **Solve Begin - End** block:

- Set the **EquationCombo** keyword to **All3_For_Contact_Case**

Example:

```
EquationCombo = All3_For_Contact_Case
```

Method 7—Euler Werner property solver

***Parent topic:* The standard and extended Euler equation options**

Not recommenede for the novice user. This extended Euler method uses all three equations.

It solves for SI, α, β.

It assumes known depth (Z), which you specify as a grid dataset (possibly sourced from other geophysical techniques such as seismic). Note that the values in the depth grid must be negative.

Use this option to produce property (SI) values, where you know the depth.

Interactive

Euler Werner property solver—*interactive*

In the **Euler Deconvolution** area:

1. Select **Euler Werner** property solver.
2. Specify the **Depth to basement grid** (see Input—depth to basement grid)

Task files

Euler Werner property solver—*task files*

Within the **Solve Begin - End** block:

- Set the **EquationCombo** keyword to **Known_Depth**

Within the **Process Begin - End** block:

- Set the **Depth** keyword to the path of the depth to basement grid dataset.

Example:

```
Depth = C:/Intrepid/cookbook/tmi_ns_depth.ers
...
        EquationCombo = Known_Depth
```

Notes about tensor deconvolution

***Parent topic:* The standard and extended Euler equation options**

Notes:

- If you are processing tensor data, ensure that you know its coordinate system. See "Vector and tensor field data coordinate conventions" in INTREPID database, file and data structures (R05).

  Before processing your data, select the correct coordinate convention (ENU, NED, END)

- For information about test work on perfect model data, contact our technical support service

Tensor methods:

- Method 8—Tensor Bouguer solver
- Method 9—Tensor gravity estimator with fixed SI

Method 8—Tensor Bouguer solver

***Parent topic:* The standard and extended Euler equation options**

This extended Euler method calculates the solutions from a tensor grid. It requires all three equations, and obtains the gradients from the tensor data in the input grid (see Input—vertical component).

It solves for X, Y, Z, SI, B, Tx and Ty, where Tx and Ty are horizontal gravity components

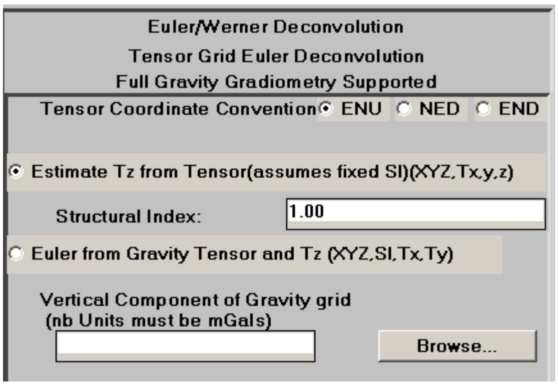
This method is similar to Method 6—Euler Werner Full Solver but uses the tensor data to obtain the gradients.

For important information see Notes about tensor deconvolution.

Interactive

Tensor Bouguer solver—*Interactive*

1 Specify a tensor grid for input. INTREPID recognises and validates the tensor grid automatically, displaying a different **Euler Deconvolution** panel in the application window.



2 In the **Euler Deconvolution** area, select:

- The **Tensor Coordinate Convention** of your dataset
- **Euler from Gravity Tensor and Tz**.

3 In the **Euler Deconvolution** area, specify the **Vertical component of gravity grid**.

Task files

Tensor Bouguer solver—*Task files*

Within the `Solve Begin – End` block:

- Set the `EquationCombo` keyword to `Tensor_Tz`

Within the `Process Begin – End` block:

- Set the `VerticalComponent` keyword to the path of the vertical component grid dataset.

Example:

```
      VerticalComponent = C:/Intrepid/cookbook/grav_ns_z.ers
...
            EquationCombo = Tensor_Tz
```


Method 9—Tensor gravity estimator with fixed SI

Parent topic: **The standard and extended Euler equation options**

This extended Euler method calculates the solutions from a tensor grid.

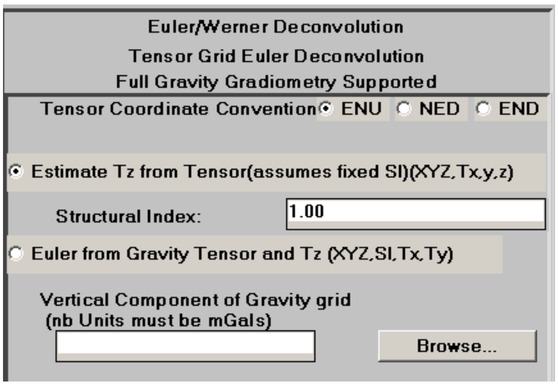
It assumes fixed structural index (SI), which you specify as a parameter (see Structural Index).

For important information see Notes about tensor deconvolution.

Interactive

Tensor gravity estimator with fixed SI—*Interactive*

1 Specify a tensor grid for input. INTREPID recognises and validates the tensor grid automatically, displaying a different **Euler Deconvolution** area.



2 In the **Euler Deconvolution** area, select:

- The **Tensor Coordinate Convention** of your dataset
- **Estimate Tz from Tensor**.

3 In the **Euler Deconvolution** area, specify:

- The **Structural Index** (See Structural Index)
- The **Vertical component of gravity grid**.

Task files

Tensor gravity estimator with fixed SI—*Task files*

Within the `Solve Begin – End` block:

- Set the `EquationCombo` keyword to `Tensor_Gravity_Estimator`
- Set the required value for the `StructuralIndex` keyword. See Structural Index.

Example:

```
EquationCombo = Tensor_Gravity_Estimator
StructuralIndex = 1
```

Euler Deconvolution parameters and execution

***Parent topic:* Euler Deconvolution (T44)**

In this section:

Fast Fourier transform

***Parent topic:* Euler Deconvolution parameters and execution**

The Euler Deconvolution process requires partial derivatives and analytic signal of the input grid. For a scalar input grid, INTREPID performs a Fast Fourier Transform (FFT) as the first step in obtaining the derivatives. For a tensor input grid, INTREPID obtains the derivatives directly from the tensor data and does not need to perform FFT.

INTREPID always saves and retains some products of this process in a temporary folder. You can specify that INTREPID retains all products for you to examine.

In this tool INTREPID always calculates the FFT (except for tensor input grid) and derivatives. Since this is a routine process, we do not currently provide an option for you to supply your own FFT or derivatives grids. See Output—FFT and derivative products.

Expanding the boundary of the input grid

To prepare for the FFT, INTREPID extends the boundary of the input grid, extrapolates values for this extended region and also interpolates any internal gaps in the grid.

If you defined a subsection of the input grid dataset, INTREPID may use a margin outside the subsection as the grid edge expansion (the **FFTBorder** text box or **`FFTBorder`** keyword). See Specifying the region for calculating solutions for details. If you did not define the subsection in this way, INTREPID expands the grid by +10%.

If INTREPID expands the grid, it appends a notation to the temporary grid dataset names that it produces from it. See Output—FFT and derivative products.

Detrending the grid

INTREPID always detrends the grid. See "Detrending data values" in INTREPID spectral domain operations reference (R14) for information. The value you assign to the keyword corresponds to the degrees in this reference topic.

Filling the gaps in the expanded grid

After expanding the grid, INTREPID assigns values to the new cells in the grid using an extrapolation process. You can choose one of two available methods—Arthur fill algorithm and maximum entropy. See "Estimating values for data gap cells" in INTREPID spectral domain operations reference (R14) for details.

INTREPID notes the extrapolated and interpolated regions of the grid and does not calculate solutions for them.

Grid edge rolloff

For best results from the FFT, the edges of the grid must be set to zero, but without sudden changes from the data within the grid. The grid data needs to 'roll off' to zero at the edge.

INTREPID has two sets of available edge roll off methods. See "Damping of dataset edges before spectral transform" in INTREPID spectral domain operations reference (R14) for details of this process.

Symmetry

With traditional FFT you can assume that the transformed dataset is symmetrical and therefore we only process one half.

When you include the Hilbert transfom, the FFT grid is no longer symmetrical and you need to process all of it. This parameter controls whether INTREPID processes all of the dataset or only half.

For the options that include Hilbert (all except Method 1—Standard Euler—see The standard and extended Euler equation options), the correct setting is No.

For Method 1—Standard Euler, the correct setting is Yes.

If you use interactive mode for the tool to run it or create a task file, INTREPID automatically selects the correct setting.

FFT grid precision

You can specify the precision of the spectral domain grid. See "Data Types in INTREPID datasets" in INTREPID database, file and data structures (R05) for the available numeric data types.

You can choose between 4 byte and 8 byte precision.

Saving the derivative and analytic signal grids

See Output—FFT and derivative products for information and instructions.

Interactive

Fast Fourier transform—*interactive*

1. Choose main menu option **Spatial > Rectangle**.
2. Ensure that you have specified any subset rectangle that you require (see Specifying the region for calculating solutions).
3. Enter the border width in metres in the **FFT Border** text box and then choose **OK**.
4. In the **Euler Deconvolution** area, check or clear the **Use real*4 precision for Fourier work** check box.

See also Output—FFT and derivative products.

Task files

Fast Fourier transform—*task files*

1. Within the **Subset Begin – End** block:
   - Set the **FFTborder** keyword to the width (in distance units) you require.
2. Within the **Solve Begin – End** block, set the following keywords (see the explanation of each parameter in this section and Syntax table for the available options):
   - **DetrendDegree**
   - **FillType**
   - **RolloffType**
   - **WindowType**
   - **UseSymmetry**
   - **ImproveEstimate**
   - **FFTPrecision**

Example:

```
Subset Begin
...
      FFTborder= 5000.0
Subset End
...
      DetrendDegree = 1
      FillType = ARTHUR
      RolloffType = COSINE
      WindowType = NONE
      UseSymmetry = Yes
      FFTPrecision = IEEE4ByteComplex
      ImproveEstimate = No
...
```

See also Output—FFT and derivative products.

Structural Index

Parent topic: **Euler Deconvolution parameters and execution**

The extended Euler deconvolution processes calculates the Structural Index (SI).

If you are using standard Euler or Euler Werner, you need to specify the SI. If you are using the other extended Euler options you no longer need to specify SI. See The standard and extended Euler equation options for details.

The following table contains a summary showing the relevance of the SI to each calculation option.

Structural Index	Option
Parameter that you specify	Method 1—Standard Euler
	Method 2—Euler Werner
	Method 9—Tensor gravity estimator with fixed SI
Calculated output field	Method 3—Euler Werner 2 Equation SI solver
	Method 5—Hybrid 2-pass Euler solver
	Method 6—Euler Werner Full Solver
	Method 7—Euler Werner property solver
	Method 8—Tensor Bouguer solver
Eliminated in the calculation	Method 4—Euler Werner basement solver

About structural index

This parameter indicates the shape of the inferred geological bodies that make up the Euler solutions. Mathematically, the structural index is a power law operator that we use to define the decay response of the source. The Structural Index must be non-negative.

The following table shows some values of the Structural Index for four types of data (gravity, magnetic, full tensor gradient gravity and magnetic) and the corresponding shapes of inferred geological structures.

Structural Index			Structural Index Type	Inferred geological structure shape
Grav	Mag, FTG Grav	FTG Mag		
–0.5	.5	1.5	Step	Fault
0	1	2	Line of poles	Dyke
1	2	3	Point pole	Vertical pipe (e.g., Kimberlite)
2	3	4	Point dipole	Point source (nominally spherical)
Key: Grav = Gravity, Mag = Magnetic, FTG = Full Tensor Gradient				

Whilst this is correct for homogenous bodies, for a basement step over which you have a high quality gravity survey, the 2-equation Euler solver returns an SI > 0.0. This is comforting from a basic physics viewpoint, but it also indicates that the Euler theory has scope for further development.

The following table shows typical structural index values for different structures and potential fields. FTG = full tensor gradient data

Geological	Geophysical	Gravity	Magnetic, FTG Gravity	FTG Magnetic
basalt plug	point dipole	2	3	4
kimberlite	point pole	1	2	3
fault/dyke	line of dipoles	0	1	2
step		–0.5 (?)	0.5	1.5
contact/edge	dipping contact	–1.0 (?)	0	1

The negative values correspond generally to an inadmissable non-homogeneous situation. There is no Euler solution in these cases. Recent studies show that SI for gravity is, on average, not negative as shown above. The contact case appears to be non-homogeneous for gravity and therefore further moving away from the fundamental requirements of Euler's assumptions. Typical values of 0.2 for contact and 0.5 for a step are shown for model studies.

You can specify other non-integer values, such as 0.5, depending on the type of source.

Interactive

Structural index—*interactive*

(Standard Euler and Euler werner only) To set a fixed structural index value, in the **Euler Deconvolution** area:

1. Ensure that you have selected the **Standard Euler**, **Euler Werner** or **Tensor gravity estimator with fixed SI** equation option (see The standard and extended Euler equation options).
2. Enter the value required in the **Structural Index** text box.

Task files

Structural index—*task files*

(Standard Euler and Euler werner only) Within the `Solve Begin – End` block:

- Ensure that the value of `EquationCombo` is `Classic` or `All3_Fixed_SI` (see The standard and extended Euler equation options).
- Use the `StructuralIndex` keyword to specify the fixed structural index.

Example:

```
        StructuralIndex = 1.0
...
        EquationCombo = Classic
```

Determining the maximum depth for solutions (window size)

Parent topic: **Euler Deconvolution parameters and execution**

If you have come to this point in the manual, you maybe having problems. Do not worry, as a new user, there are a few things it takes time to grasp. Firstly, the grid extent dictates how deep you can see buried body edges. You cannot expect to see deeper than 1/5 the horizontal extent of your grid.

If your grid is 2km square, you will be lucky to get many solutions deeper than 200 m. Also, you can influence the maximum depth for Euler solutions found using the size of the Euler window. The Euler window size is the number of cells INTREPID uses for calculating derivatives and the analytic signal. The size of the Euler window is directly related to the maximum depth of solutions.

Where:
D = Maximum solution depth
W = Euler window size
C = Grid cell size
k = a constant

$$D = kWC$$

In the second stage of the Euler process INTREPID stores the Euler window size as the value of the 'group by' field **`Window`** in the output Euler solutions point dataset. See Output—Euler solutions point dataset for more details.

Deciding the Euler window size

Size of the window is used for determining the number of observations to pass to the solver (SVD) for the current point of interest in the grid. Choice of window size is mainly determined by the resolution of the data and the spatial extent of the anomalies. The larger the window size, the larger the matrices for the singular value decomposition and thus the more CPU consumption is required (n*n equations are formed for standard Euler).

While ensuring that you obtain solutions of sufficient depth, we recommend that you minimise the size of the Euler window. The size of the Euler window also greatly affects processing speed.

Time for Euler Deconvolution process increases as the cube of window size. The default window size is 7 x 7 grid cells. We recommend window sizes in the range 5 x 5 to 15 x 15.

We suggest that you match window size with the grid and the resolution of its features. ensure that it adequately spans the features being modelled.

With extended Euler, the number of equations passed to the solver is at least twice that for standard Euler and so the window size does not need to be as large. This is said from the perspective of an overdetermined set of input equations. The issue of independence of observations in a window is separate.

For example, if an observed dyke in a grid is 300 m wide and the grid cell size is 100 m square, a window size of 5 x 5 is adequate (25 Eigen vectors). INTREPID would process this 4 times faster than the default of 10 x 10 (100 Eigen vectors).

A simple rule of thumb

A rule of thumb for Euler Deconvolution is that maximum reliable depths are about twice the window size. For example:

Max reliable depth = 2 x Grid Cell Size x Window Size – Survey Height

This simple rule should help you tune the parameter settings for a predicted range of depth estimates.

Interactive **Width of window—*interactive***

In the **Euler Deconvolution** area, enter the number of data points in the **Width of window (points)** text box.

Task files **Width of window—*task files***

Within the `Solve Begin - End` block, use the `LateralSize` keyword to specify the number of data points in the window.

Example:

```
LateralSize = 7
```

Survey observation height

Parent topic: **Euler Deconvolution parameters and execution**

The height above the ground that the observations were taken, in the same units as the grid cell size. The Euler depths are offset by this amount to convert them to depths below the ground surface. This also significantly reduces the number of spurious near-surface solutions by accepting only admissible depth solutions.

Interactive **Survey observation height—*interactive***

In the **Euler Deconvolution** area, enter the required height in metres in the **Survey observation height** text box.

Task files **Survey observation height—*task files***

Within the `Parameters Begin - End` block, use the `SurveyHeight` keyword to specify the survey observation height in metres—assign a numeric value.

Example:

```
SurveyHeight = 100.0
```

Reduction to the pole

Parent topic: **Euler Deconvolution parameters and execution**

For magnetic grids, optionally reduce the dataset to the pole (RTP). Enter the survey date so that INTREPID can calculate the correct IGRF. As Euler is sensitive to the instantaneous phase of the field, the RTP dataset is 'new' and independent of the original TMI grid.

We have found that RTP is not necessary in Euler deconvolution and recommend that you do not use it. This withdrawn from the User interface at V4.5.

Interactive **Reduction to the pole—*interactive***

In the **Euler Deconvolution** area:

- Check or clear the **Compute a reduction to the pole** check box.
- Enter the date of the survey in the **Survey date** text box.

Task files **Reduction to the pole—*task files***

Within the `Solve Begin - End` block:

- Set the `DoReductionToPole` keyword to `Yes` or `No`.
- Set the `Date` keyword to the date of the survey, in the format *dd/mm/yyyy*.

Example:

```
DoReductionToPole = Yes
Date = 31/12/1999
```

Derivatives and analytic signal

***Parent topic:* Euler Deconvolution parameters and execution**

You can specify:

- Whether to convolve the derivatives
- Whether to save the derivatives

Convolve derivatives

The quality of Euler solutions critically depends on the coherence of your derivative grids. Derivatives amplify noise, so will naturally strengthen any incoherence in your data.

Of particular concern is aliasing, where there is more coherence in one direction than the other. By nature, aerial survey data is aliased, and poor gridding can fail to eliminate it.

The derivative covolution is a low pass filter, using local 3 x 3 Gaussian kernel.

Our ongoing testing shows that this filter distorts the perfect model tests and forces the depths to be worse estimates than when we don't apply this filter. This is withdrawn from the User interface at V4.5

Save derivatives

You can save the derivatives used in the Euler deconvolution process. It may be useful to display the Euler solutions point dataset with a derivatives grid as a backdrop.

See Output—FFT and derivative products for information about the output files.

Interactive

Derivatives and analytic signal—*interactive*

In the **Euler Deconvolution** area:

- Check or clear the **Convolve Derivatives (Anti-aliasing)** check box.
- Check or clear the **Save derivatives and analytic signal** check box.

Task files

Derivatives and analytic signal—*task files*

Within the **`Solve Begin - End`** block:

- Set the **`ConvolveDerivatives`** keyword to **`Yes`** or **`No`**.
- Set the **`SaveDerivatives`** keyword to **`Yes`** or **`No`**.

Example:

```
SaveDerivatives = Yes
ConvolveDerivatives = Yes
```

Apply Deconvolution

***Parent topic:* Euler Deconvolution parameters and execution**

After you have specified the input grid and parameters for calculating the complete set of Euler solutions, choose **Apply Deconvolution**. INTREPID calculates the solutions, saves them and also saves intermediate results datasets if you have specified this.

You can specify how you want INTREPID to use the INTREPID_MEMORY system parameter, RAM, virtual memory and temporary workfiles in the processing (*task files only*) (see INTREPID system parameters and `install.cfg` (R07)). The options are for INTREPID to:

- Use RAM according to the INTREPID_MEMORY system parameter value. If more memory is required, use temporary workfiles. (**`AUTO`**).
- Use temporary workfiles for all data (**`FORCE_DISK`**). All INTREPID data is written to temporary workfiles as it is processed.
- Use RAM and operating system virtual memory as required for data being processed (**`FORCE_MEMORY`**). If you select this setting, INTREPID ignores its INTREPID_MEMORY system parameter value.

Interactive

Apply deconvolution—*interactive*

To execute the extended deconvolution process and produce the full solution set, in the **Euler Deconvolution** area:

- Choose **Apply Deconvolution**.

Task files

Apply deconvolution—*task files*

Within the **`Solve Begin - End`** block:

- Set the **`DiskUsageRule`** keyword to **`AUTO`** or **`FORCE_MEMORY`** or **`FORCE_DISK`**.

Example:

```
DiskUsageRule = AUTO
```

Selecting and classifying Euler solutions—Steps

***Parent topic:* Euler Deconvolution (T44)**

After you have obtained the complete set of Euler solutions you can produce Euler solutions point datasets containing selected and classified solutions.

See Output—Euler solutions point dataset for details about the output dataset.

In the following sections:

- Selecting Euler solutions for output
  - Structural index clips
  - Minimum observed dip
  - Selecting solutions by depth
  - Maximum absolute alpha
  - Maximum singularity ratio
  - Restricting solutions to the grid boundary
  - Goodness
- Classifying Euler solutions
  - Binning analysis—classifying Euler solutions by depth
  - Binning analysis—specifying geographic bins
  - Cluster analysis

>> *To classify, select and output a collection of Euler solutions*

1 Ensure that the complete set of Euler solutions is available for you to process. You can do this:
   - Immediately before starting the selecting and classifying process, without exiting from Euler Deconvolution, so that INTREPID has just produced the complete set of Euler solutions. See Creating the complete set of Euler solutions—Steps for details.
   - By loading a previously created complete set of Euler solutions. From the main menu choose **File > Open solutions for resorting**. See Output—the complete set of Euler solutions.

2 Specify the criteria for selecting the solutions for output. See Selecting Euler solutions for output for details.

3 (*If required*) Specify the method of classifying the Euler solutions—binning or clustering. See Selecting and classifying Euler solutions—Steps for details.

4 Select the format for the output points datasets. See Output—vector dataset formats.

5 (*If required*) Specify output to 3D visualisation formats. See Output visualisation formats.

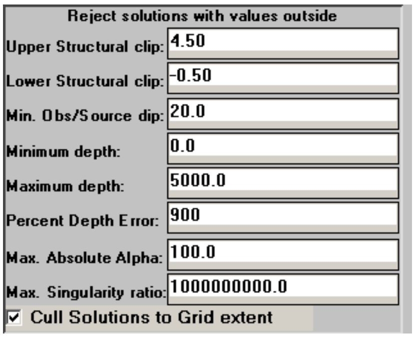
6 Choose **Apply Sort**. INTREPID selects, classifies and outputs the solutions according to your specifications.

Selecting Euler solutions for output

***Parent topic:* Euler Deconvolution (T44)**

In this section:

- Structural index clips
- Minimum observed dip
- Selecting solutions by depth
- Maximum absolute alpha
- Maximum singularity ratio
- Restricting solutions to the grid boundary
- Goodness



Structural index clips

***Parent topic:* Selecting Euler solutions for output**

The structural index clip determines which of the solutions are to be selected based on the characteristic power fall off of the signal. The structural index reflects the type of causative body for the anomaly (see Structural Index).

Option	Purpose
Lower Structural clip	Should range between –2 and say +2.
Upper Structural clip	Should range between 0 and say +4.

Task files

Example:

```
LowerStructuralIndexClip= -0.5
UpperStructuralIndexClip= 4.5
```

Minimum observed dip

***Parent topic:* Selecting Euler solutions for output**

The dip from the current point of observation of the field to the calculated source body is a good filter for rejecting poorly conditioned solutions. The deconvolution process ensures there are clusters of solutions around the causitive bodies and those solution estimates that derive from further away for shallow bodies are suspect.

Option	Purpose
Minimum observed or source dip	The default angle should be lower for gravity as the field is less varying and weaker - say 30, and higher for magnetics say 45.

Task files

Example:

```
MinimumObservationDip= 20.0
```

Selecting solutions by depth

Parent topic: Selecting Euler solutions for output

You can specify a range of depth values for selecting output solutions. If a solution has depth outside this range INTREPID will not select it for output.

Before final output depth is measured in metres below the survey sensor. If it selects a solution INTREPID will store its depth adjusted for Survey observation height in the **DEPTH** field of the output dataset.

You will already have limited the depth range when you calculated the complete set of Euler solutions, specifying the Size of the Euler Window parameter. Specifying the depth range while selecting for output is a further refinement of the set of solutions.

You can use this selection criterion to eliminate solutions above ground level. Set the Minimum Depth equal or greater than the nominal sensor clearance.

Option	Purpose
Minimum Depth	Minimum value for depth above which INTREPID omits solutions from statistical analysis. The default value is 0 units. INTREPID rejects solutions above the depth represented by this parameter.
Maximum Depth	Maximum value for depth below which INTREPID omits solutions from statistical analysis. The default value is 1000 units. INTREPID rejects solutions below the depth represented by this parameter.
Percent depth error	Percentage depth error is the estimated error normalised. INTREPID converts the estimated depth error divided by actual depth to a percentage. You can set a maximum percentage, and reject high-error data.

Task files

Example:

```
MinimumDepth= 0.0
MaximumDepth= 5000.0
Maximum_Percentage_Depth_Error= 900
```

Maximum absolute alpha

Parent topic: **Selecting Euler solutions for output**

The Extended Euler equations also solve for α & β.

α is associated with the Classic equation and is solved for instead of the BACKGROUND term. It is meant to reflect dip and material properties for the case of large scale geological structures such as a contact, where say, theoretically the SI is 0.0 for magnetics.

The generalized formulations in this tool allow for the calculation of α and β without going into what this might mean for specifically solved for bodies. A solution discrimination technique is based upon a requirment for this term to be zero or disappear for bodies with an SI > 0. As it can be a primary output from the solver, it is a better error indicator than values such as covariance and standard error estimates.

The population of α and β are well worth examining for patterns such as trends and bi-modal peaks.

Option	Purpose
Maximum absolute alpha	

Task files

Example:

```
MaximumAbsAlpha= 100.0
```

Maximum singularity ratio

Parent topic: **Selecting Euler solutions for output**

The solution for a least squares best fit involves a Singular Value Decomposition, where each term being solved for has a singular weight. The ratio of the maximum of these weights to the minimum is known as the singularity ratio and reflects partly the likelihood of the causitive body being 2-dimensional. It also has an element of ill-conditioning and signal strength. Tests indicate that solutions with high singularity ratio (greater than 2000) are likely to be less plausible solutions.

The behaviour of this factor varies markedly for gravity and magnetics, with much higher values reporting for gravity..

Option	Purpose
Max singularity ratio	

Task files

Example:

```
MaximumSRatio= 20000
```

Restricting solutions to the grid boundary

Parent topic: **Selecting Euler solutions for output**

See also Specifying the region for calculating solutions..

Option	Purpose
Cull solutions to Grid Extent	

Task files

Example:

```
Mask_Solutions= Yes
```

Goodness

***Parent topic:* Selecting Euler solutions for output**

The Euler method generates many solutions and estimates of the errors associated with each solution. There has been a lot of work reviewing and comparing the available error estimate techniques. The depth error and depth percentage method (see Selecting solutions by depth) has been popular, but our research indicates a belief that it is less trustworthy than the 'Reliability' method.

Reliability is really just a normalisation of the signal strength for each solution. It is a fractional number, ranging between 0 and 1. A value of 1 signifies perfect reliability.

This strength of signal, from our experience, is one of the better measures that indicate which Euler solutions to accept. The **`reliability`** field, output as part of a solution set, is a scaled value of the local solution condition over the maximum condition.

The maximum condition can be orders of magnitude bigger than those of perfectly good solutions, so reliability as a discriminator may not have as much spread as one would wish. Goodness is the reliability percentile of a solution. Since Goodness only veires between 0 and 1, it is easier to use for selecting solutions.

You can specify a reliability distribution percentile (Goodness) range for selecting output solutions. The Lower goodness clip and Upper goodness clip parameters specify the percentiles of high and low reliability solutions to reject.

If you classify the Euler solutions using binning (see Binning analysis—classifying Euler solutions by depth and Binning analysis—specifying geographic bins), INTREPID performs separate goodness clipping within each layer or geographical bin. If you do not use binning, INTREPID performs goodness clipping for the whole set of Euler solutions.

Option	Purpose
Lower goodness clip	Lower goodness clip value should be greater than or equal to zero. It determines the percentile at which you want INTREPID to start selecting the poorer solutions. Specify a value between 0 and 1, representing 0%–100%. For example, if you set a a value of 0.1, INTREPID omits the bottom 10% of results.
Upper goodness clip	Upper goodness clip value should be less than or equal to 1. It determines the percentile at which you want INTREPID to reject the higher reliability solutions. Specify a value between 0 and 1, representing 0%–100%. For example, if you set a value of 0.9, INTREPID omits the top 10% of results.

Task files

Example:

```
LowerGoodnessClip= 0.0
UpperGoodnessClip= 1.0
```

Classifying Euler solutions

***Parent topic:* Euler Deconvolution (T44)**

You can classify Euler solutions by binning analysis or cluster analysis. Binning analysis is the older of the two methods.

In this section:

- Binning analysis—classifying Euler solutions by depth
- Binning analysis—specifying geographic bins
- Cluster analysis

Binning analysis—classifying Euler solutions by depth

***Parent topic:* Classifying Euler solutions**

You can divide the range of solution depths into layers. The layers are numbered from 1 (the shallowest). INTREPID will classify each solution according to the depth layer to which it belongs. INTREPID computes statistics separately for the individual layers.

Layers have equal thickness, divided equally between minimum and maximum depths. If you have set minimum and maximum depths (see Selecting solutions by depth), INTREPID divides up the distance between them for the layers. If you have not specified depths, INTREPID uses the actual depth range of the full set of solutions.

The default number of layers is 1.

Option	Purpose
Do Binning Analysis	Check this box to perform vertical and horizontal binning classification. See also Binning analysis—specifying geographic bins. To disable vertical binning (layers), specify 1 vertical layer
Number of Vertical layers	Use this text box to specify the number of depth layers for the Euler solutions.

Task files

Example:

```
Binning_Analysis= Yes
NumberVerticalLayers= 1
```

Binning analysis—specifying geographic bins

Parent topic: Classifying Euler solutions

You may wish to obtain a collection of solutions which is well distributed geographically. In order to achieve this, Euler Deconvolution has a system of 'geographic bins'—subregions of the output dataset area.

You define the size of the bins and INTREPID applies the Goodness selection (see Goodness) to each bin separately. This means that, although solutions are selected from each region of the dataset, solutions from sparsely populated 'geographic bins' may have a lower average reliability than those from more densely populated bins.

Use **Bin Size East, Bin Size North** to specify the dimensions (in dataset distance units) of a 'geographic bin'.

If you have specified a geographic region for selecting output (See Restricting solutions to the grid boundary, a 'geographic bin' will be a subregion of this.

If you have not selected a geographic region, a 'geographic bin' will be a subregion of the whole input dataset.

If you specify a bin size larger than the whole output dataset, INTREPID will not use this selection method.

Option	Purpose
Do Binning Analysis	Check this box to perform vertical and horizontal binning classification. See also Binning analysis—classifying Euler solutions by depth. To disable horizontal binning, specify bin size larger than the dataset or subsection (see Specifying the region for calculating solutions) .
Bin size East	Use this parameter to specify the easting dimension (in dataset distance units) of a geographic bin. If you specify a bin size larger than the output dataset, INTREPID will not use this selection method.
Bin size North	Use this parameter to specify the northing dimension (in dataset distance units) of a geographic bin. If you specify a bin size larger than the output dataset, INTREPID will not use this selection method.

Task files

Example:

```
Binning_Analysis= Yes
XYBinEast= 10000000.0
XYBinNorth= 10000000.0
```

Cluster analysis

***Parent topic:* Classifying Euler solutions**

You can classify Euler solutions by grouping points that are close to each other into clusters. INTREPID creates a fusion of clusters based on the centers of gravity of each cluster. It stores the resulting data in a cluster dataset.

The algorithm puts in the same cluster all the clusters whose horizontal center of gravity distances are less than 2*max_horizontal_radius_confidence. You can perform iterations around the clusters is possible with a re-split and rejoin. INTREPID eliminates any cluster with less than 5 points to improve the significance of the statistical analysis of the clusters.

Since this process creates a good local populaion of similar solutions, INTREPID computes **skew** and **kurtosis** for further comparison work.

Option	Purpose
Maximum point separation	For INTREPID to group points they must be less than this distance from each other.

Task files

Example:

```
Cluster_Analysis= Yes
Maximum_Point_separation= 900.0
```

Continental Studies Workflows

At V5.0 a new wokflow is now available. Australia, Findland, Namibia etc. have high fideleity, high frequency content very large potential field observational geophysical grid datasets. The challenge is to be able to work in a repetative and sensible manner, while still using this data at its full resolution.

The typical simple constraint for lower cost and quicker exploitation mining, is that mineralised deposits should be no deeper than 500m, and perhaps more shallower than that. You cannot afford to compromise the geophysical data, if you wish to apply this constraint.

This requires a workflow that removes and/or minimizes the need to repeat computation of the required gradient grids, using FFT methods. Typically, the base grid can be as large as 5 to 10 Gigabytes, and so beyond the capacity of most desktop computers. The use of penta-scale, LINUX based super computers, or the CLOUD, allows one to do the gradient operations once, store them, then, with the new workflows, just create a refernec to the existing gradient grids.

The remaining optimizations needed for a practical workflow, are to allow users to divided a continent or province into a series of “sheets”, and then progressively work through each sheet, adjusting the sorting, binning, quality and fractions of the solutions as requried, depending upon the underlying geophysical responses to the geology of the area. For instance,

1 in areas of deep sand cover, magnetic response can be quite muted, compared to outcroping basement rocks.

2 your objective might be to find magnetic sources that are of a more 2D or 3D character, so you sort looking for higher Structural Index bodies.

By way of example, the Australian TMI high resolution grid is 8 Gigabytes, with a cell size of 80m. Euler requires typically 8 or 9 gradient grids, if the 2 Equation Euler/

Werner solver case is chosen, in order to not just get depths, but also estimates of the Structural Index. On a desk top computer, the elapsed time to do the preconditional work of gradient computation, can amout to more than a week of time. No-one wants to have to carry this overhead, nor to be restricted to a limited number of "runs".

The features of the new workflow are

- You must create all the necessary gradient grids, however you like, and have them sitting in a designated directory, that can then be referenced by each invocation of the Euler tool.
- This also applies to the primary spatial grid dataset. In this case, the prior work involves a simple conversion to the spectral form of the same dataset (Fourier transfornmed grid), and then making sure the correct back refernce to the original spatial form of the grid is carried in the metadata refeneced Intrepid "isi" file. This is a block structred ASCII file, so easily examined and edited. The gfilt tool will do this job for you.
- The existing subsectioning capability within the tool has a modified behaviour, when the above conditions are presented to the tool. Instead of cookie cutting a small part of the spatial grid into a new, smaller grid, as is normally done, it instead, just references back to the large scale gradient and original signal grids, picking out the required readings by row and column.
- As the solver section of the tool is likely to be exercised by geology sheet boundaries, provision for storing the intermediate "raw solutions" in seperate directories, is also made.
- This then just leaves the task of sorting, clustering, sifting the solutions to reject the many that fall outside your requirements. This aspect has not received any attention so far with the new workflow.
- This is only available through the batch interface at present, and not all the Euler/Werner equations are tested or available. Choose the 2 equation Hilbert for now.

An example of using the tool in this manner, via a batch task file follows. This task is distributed with V5.0, and forms part of the internal testing suite.

```
#  V5.0 Euler deconvolution Example job file -
# A workflow for
# a.very large scale,
# b. high resolution,
# c.  subsection tiling
#  involving precomputed grids that can be treated as READ_ONLY.
#
#  this example uses FFT grid as input, previously computed
#  this example also uses precomputed gradient grids for the
HILBERT 2 equation case
#  the precompputed grids are refeneced via a new keyword
#     SaveDerivativeDirectoryName: "reuse_derivative_grids";
#
# Euler consists of two stages:
# Stage 1: generates a solutions file from the grid (*.rs)
# Stage 2: accepts/rejects solutions according to user specified
criteria, and writes the
#          accepted solutions to an Intrepid point dataset.
#
```

```
# The example job file computes both stages and creates a report
file.
# Usage: fmanager -batch euler.task
#

IntrepidTask {
      Euler {
      #     InputGridName: "D:/test_data/FullTests/euler_test/
real_data/grids/mag_t.ers"
# start with an FFT grid as input
            InputGridName: "D:/test_data/FullTests/euler_test/
real_data/fftGridName.ers"
            Band: 0
            Output: "D:/test_data/FullTests/euler_test/real_data/
output/mag_t..DIR"
            ReportFile: "euler.rpt"
            SurveyHeight: 100.0;
            ExportTypes: Database;
            #  3D visual formats of solutions
            Dump_VRML: false
            Dump_BREP: false
            Sort {
                  # main rejection of false solutions criteria
                  LowerGoodnessClip: 0.0
                  UpperGoodnessClip: 1.0
                  LowerStructuralIndexClip: -0.5
                  UpperStructuralIndexClip:  4.5
                  NumberVerticalLayers: 1
                  MinimumDepth: 0.0
                  MaximumDepth: 5000.0
                  # if vector from observation point to solution
dips less than 20, discard
                  MinimumObservationDip: 20.0
                  # ratio of estimated Depth error to depth value
                  Maximum_Percentage_Depth_Error: 900
                  #  extended Euler can calculate a property of teh
source - alpha
                  Maximum_Absolute_Alpha: 100.0
                  MaximumSingularityRatio: 1000000000.0
                  Binning_Analysis: false
                  # actual bin size
                  XYBinEast: 10000000.0
                  XYBinNorth: 10000000.0
                  Mask_Solutions: true  # do not keep solutions
outside original spatial grid
                  Cluster_Analysis: false
                  # no cluster if values separated by more than this
distance
                  Maximum_Point_separation: 900.0;
            }
            Solver {
                  # method specifying which formulation you want
                  ####  Classic Hilbert_Only All3_Fixed_SI
All3_For_Contact_Case No_SI
```

```
                    EquationCombo: Hilbert_Only
               # default SI if one is needed, Most Solvers estimate
this quantity
                    StructuralIndex: 1.0
                    # window size for equations as you pass over the
grid
                    LateralSize: 7
                    # some conditioning for FFT work
                    RolloffType:     Cosine_RollOff;
                    WindowType:      NO_Window;
                    FillType: ARTHUR  # MEM or maxiumum Entropy
                    FillStopAtEdge: false;
                    DetrendDegree: 1
                    OutputPrecision: IEEE4ByteReal
                    FFTPrecision: IEEE4ByteComplex
                    # Can exploit FFT symmetry for most operations..
Hilbert not always
                    UseSymmetry: false
                    DiskUsageRule: AUTO
                    #  you can save computation time for repeated
runs, by saving the outputs
                    SaveDerivatives: true
                    SaveDerivativeDirectoryName:
"reuse_derivative_grids";
                    # do an RTP on mag data... not necessary
                    DoReductionToPole: false
                    IGRF {Date: "31/12/1999" }
               }
               # it is possible to specify a smaller internal area
#  in this special case, of starting from an FFT grid,
#  1. do not write out a subsection grid as the new source file
#  2. catch the subsection start row/col, end row/col
#   3.  get the euler SVD solver to just use these limits
               Subset {
                    XLower: 474550.0;
                    XUpper: 485250.0;
                    YLower: 5986850.0;
                    YUpper: 6000600.0;
                    # size of expanded grid as a percentage of
original grid size.
                    FFT_BorderPercentExpansion:  120.0;
               }
}}
```

Displaying options and using task specification files

Parent topic: **Euler Deconvolution (T44)**

In this section:

- Main block structure of a Euler Deconvolution task file
- Displaying options
- Syntax table
- Using task specification files

Main block structure of a Euler Deconvolution task file

Parent topic: **Displaying options and using task specification files**

The following table shows the main block structure of a Euler Deconvolution task file. See Syntax table for more details.

Block definition	Contents
`Process Begin`	Task file outer block
`...`	—Tool name and date stamp
`...`	—Input and output files specification
`Parameters Begin`	—Parameters block
`SurveyHeight =`	——Survey height for calculating solutions
`Sort Begin`	——Selecting and classifying solutions block
`...`	———
`Sort End`	
`Solve Begin`	——Calculating solutions block
`...`	———
`Solve End`	
`Subset Begin`	——Region for calculating solutions block
`...`	———
`Subset End`	
`Parameters End`	—End
`Process End`	End

Displaying options

Parent topic: **Displaying options and using task specification files**

You can view the parameters selected for the Euler Deconvolution process:

- In the controls of the **Euler Deconvolution** window OR
- By saving the task specification (**`.job`**) file and viewing its contents
- At V5.0, look at the protobuf language specification file “intrepid_tasks.proto” that is available under the API directory, identify the syntax section for Euler, and there it all is, with lots of comments. The beauty and power of this approach is, that this is exactly the same file that is being used by INTREPID to build the parsers that decode the *.task files.

Syntax table

Parent topic: Displaying options and using task specification files

This table has a complete task specification file outline with all possible statements and blocks.

<table>
<tr><th>Statement</th><th>Description</th><th>Unit</th><th>Default</th></tr>
<tr><td>Process Begin</td><td></td><td></td><td></td></tr>
<tr><td>Name = Euler</td><td>Specifies Euler Deconvolution as the application for this task.</td><td></td><td></td></tr>
<tr><td>Input = <path></td><td>See Input—input grid, band</td><td></td><td>oblig</td></tr>
<tr><td>Depth = <path></td><td>See Input—depth to basement grid</td><td></td><td>oblig</td></tr>
<tr><td>VerticalComponent = <path></td><td>See Input—vertical component</td><td></td><td>oblig</td></tr>
<tr><td>Output = <path></td><td>See Output—Euler solutions point dataset</td><td></td><td>oblig</td></tr>
<tr><td>ReportFile = <path></td><td>See Output—report</td><td></td><td>euler.rpt</td></tr>
<tr><td>Cluster = <path></td><td>See Output—cluster dataset</td><td></td><td>oblig</td></tr>
<tr><td>Parameters Begin</td><td>Parameters block</td><td></td><td></td></tr>
<tr><td>Subset Begin</td><td></td><td></td><td></td></tr>
<tr><td>XLower = <number></td><td rowspan="4">Extents of subsection.
See Specifying the region for calculating solutions</td><td>m or °</td><td rowspan="4">extent of dataset</td></tr>
<tr><td>XUpper = <number></td><td>m or °</td></tr>
<tr><td>YLower = <number></td><td>m or °</td></tr>
<tr><td>YUpper = <number></td><td>m or °</td></tr>
<tr><td>FFTborder = <number></td><td>Width of FFT border. See Fast Fourier transform</td><td>m or °</td><td>5000</td></tr>
<tr><td>Subset End</td><td></td><td></td><td></td></tr>
<tr><td>SurveyHeight = <number></td><td>See Survey observation height</td><td>m</td><td>0</td></tr>
<tr><td>Solve Begin</td><td>Solve block</td><td></td><td></td></tr>
<tr><td>Band = <ord></td><td>Band of input grid to process.
See Input—input grid, band</td><td></td><td>0</td></tr>
<tr><td>StructuralIndex = <number></td><td>Structural Index setting when required
See Structural Index</td><td></td><td>1 or calc</td></tr>
<tr><td>LateralSize = <ord></td><td>Euler window size. See Determining the maximum depth for solutions (window size)</td><td></td><td>7</td></tr>
<tr><td>DetrendDegree = <0|1|2></td><td rowspan="4">Pre-FFT and FFT settings.
See Fast Fourier transform</td><td></td><td>1</td></tr>
<tr><td>FillType = <ARTHUR|MEM></td><td></td><td>ARTHUR</td></tr>
<tr><td>RolloffType = <COSINE|LINEAR|NONE></td><td></td><td>NONE</td></tr>
<tr><td>WindowType = <COSINE_BELL|HANNING|HAMMING|BLACKMAN|TRIANGLE|NONE></td><td></td><td>COSINE</td></tr>
<tr><td>UseSymmetry = <Yes|No></td><td></td><td colspan="2">If Hilbert: No
If no Hilbert: Yes</td></tr>
<tr><td>FFTPrecision = <datatype></td><td></td><td colspan="2">IEEE8ByteComplex</td></tr>
<tr><td>EquationCombo = <Classic|Hilbert_Only|All3_Fixed_SI|All3_For_Contact_Case|No_SI|Known_Depth|TensorBouguer|TensorEstimateGravity</td><td>Processing option. See The standard and extended Euler equation options</td><td></td><td>Classic</td></tr>
<tr><td>DiskUsageRule = <AUTO|FORCE_MEMORY|FORCE_DISK></td><td>See Apply Deconvolution</td><td></td><td>AUTO</td></tr>
<tr><td>Required_Points = {x, y, depth, ...}</td><td>See Input—input grid, band.
The presence of this block changes the way the tool works. Just the required points are used, instead of the whole grid.</td><td></td><td>all points in dataset</td></tr>
<tr><td>ConvolveDerivatives = <Yes|No></td><td>See Derivatives and analytic signal</td><td></td><td>Yes</td></tr>
<tr><td>SaveDerivatives = <Yes|No></td><td></td><td></td><td>No</td></tr>
<tr><td>DoReductionToPole = <Yes|No></td><td>See Reduction to the pole</td><td></td><td>No</td></tr>
<tr><td>Date = <date></td><td>Survey date for calculated IGRF model</td><td></td><td>31/12/1999</td></tr>
<tr><td>Solve End</td><td></td><td></td><td></td></tr>
</table>

Statement	Description	Unit	Default
Sort Begin	**Sort block**		
LowerGoodnessClip = <number>	See Goodness		0
UpperGoodnessClip = <number>			1
LowerStructuralIndexClip = <number>	See Selecting Euler solutions for output		-0.5
UpperStructuralIndexClip = <number>			4.5
MinimumDepth = <number>	See Selecting solutions by depth	m	0
MaximumDepth = <number>			5000
MinimumObservationDip = <number>	See Minimum observed dip	°	20
Maximum_Percentage_Depth_Error = <number>		m	900
MaximumAbsAlpha = <number>	See Maximum absolute alpha		100
Mask_Solutions = <Yes|No>	See Restricting solutions to the grid boundary		Yes
Binning_Analysis = <Yes|No>	See Binning analysis—classifying Euler solutions by depth and Binning analysis—specifying geographic bins		No
NumberVerticalLayers = <ord>			1
XYBinEast = <number>		m or °	10 000 000
XYBinNorth = <number>		m or °	10 000 000
Cluster_Analysis = <Yes|No>	See Cluster analysis		No
Maximum_Point_separation = <number>	See Cluster analysis	m or °	900
ExportTypes = <Database|XYZ|GDB>	See Output—vector dataset formats		Database
Dump_VRML = <Yes|No>	See Output visualisation formats		No
Dump_BREP = <Yes|No>			No
Sort End			
Parameters End			
Process End			

Using task specification files

Parent topic: Displaying options and using task specification files

You can store sets of file specifications and parameter settings for Euler Deconvolution in task specification (**.job**) files.

>> To create or edit a task specification file with the Euler Deconvolution tool

1. Start Euler Deconvolution.
2. (*If editing*) Load the task specification (**.job**) file (File menu, Load Options).
3. Set parameters as required.
4. Save the task specification (**.job**) file (File menu, Save Options).

>> To use a task specification file in an interactive Euler Deconvolution session

Load the task specification (**.job**) file (File menu, Load Options), modify any settings as required, then choose Apply Deconvolution or Apply Sort or both as required.

>> To use a task specification file for a batch mode Euler Deconvolution task

Type the command **euler.exe** with the switch **-batch** followed by the name (and path if necessary) of the task specification file.

For example, if you had a task specification file called **surv329.job** in the current directory you would use the command **euler.exe -batch surv329.job**

Task specification file example

Here is an example of a Euler Deconvolution task specification file.

```
Process Begin
	Name  = Euler
	Comments= "Intrepid Audit Stamp v4.0 Build 69-22/ 4/2006"
	Input = C:/Intrepid/cookbook/eulerplay/tmi_ns.ers
	Output= C:/Intrepid/cookbook/eulerplay/eulersols..DIR
	ReportFile= euler.rpt
	Cluster= C:/Intrepid/cookbook/eulerplay/eulercluster..DIR
	Parameters Begin
		SurveyHeight= 0.0
		Sort Begin
			ExportTypes= Database
			LowerGoodnessClip= 0.0
			UpperGoodnessClip= 1.0
			LowerStructuralIndexClip= -0.5
			UpperStructuralIndexClip= 4.5
			NumberVerticalLayers= 1
			MinimumDepth= 0.0
			MaximumDepth= 5000.0
			MinimumObservationDip= 20.0
			Maximum_Percentage_Depth_Error= 900
			MaximumAbsAlpha= 100.0
			XYBinEast= 10000000.0
			XYBinNorth= 10000000.0
			Mask_Solutions= Yes
			Dump_VRML= No
			Dump_BREP= No
			Cluster_Analysis= Yes
```

```
                Binning_Analysis= No
                Maximum_Point_separation= 900.0
          Sort End
          Solve Begin
                StructuralIndex= 1.0
                LateralSize= 7
                RolloffType= COSINE
                WindowType= NONE
                FillType= ARTHUR
                Band  = 0
                DetrendDegree= 1
                FFTPrecision= IEEE4ByteComplex
                UseSymmetry= Yes
                EquationCombo= Classic
                DiskUsageRule= AUTO
                SaveDerivatives= Yes
                ConvolveDerivatives= Yes
                DoReductionToPole= Yes
                Date  = 31/12/1999
          Solve End
          Subset Begin
                XLower= 520129.158
                XUpper= 595129.158
                YLower= 7236236.0
                YUpper= 7311236.0
                FFTborder= 5000.0
          Subset End
     Parameters End
Process End
```

Now for a model study example, where we already know the correct answer, and we wish to verify that Euler can get the right answer. The job repeats for each Euler equation type, and then checks the answer at known HOT SPOT locations for each of the formulations. This model data and the results are available for anyone wishing to try this and devise something similar for themselves. This is taken from our internal test system.

```
type =  { Classic Hilbert_Only All3_Fixed_SI All3_For_Contact_Case
No_SI }
Repeat Begin

Process Begin
     Name  = Euler
     Input = models/ModelCombo/ModelCombo_MagAtPole_160mCell.ers
# if you just want to do the sort in batch
     #Input= ../models/ModelCombo/
ModelCombo_MagAtPole_160mCell.rs
     Output= combo_$type
     Parameters Begin
# will reject initial solutions if depth less than SurveyHeight
          SurveyHeight= 0.0
          Sort Begin
                ExportTypes= XYZ
```

```
                    LowerGoodnessClip= 0.0
                    UpperGoodnessClip= 1.0
                    #NumberVerticalLayers= 5
                    MinimumDepth= 0.0
                    MaximumDepth= 4000.0
                    MinimumEast= -10000000.0
                    MaximumEast= 10000000.0
                    MinimumNorth= -10000000.0
                    MaximumNorth= 10000000.0
                    #XYBinEast= 3000.0
                    #XYBinNorth= 3000.0
                    Dump_VRML= Yes
                    Maximum_Percentage_Depth_Error  = 10000
               Sort End
               Solve Begin
                    StructuralIndex= 2.0
                    LateralSize= 5
                    SaveDerivatives= No
                    RolloffType= COSINE
                    FillType= ARTHUR
                    #FftGridName     = models/ModelCombo/
ModelCombo_MagAtPole_160mCell_fft
                    Band  = 0
                    DetrendDegree= 1
                    OutputPrecision= IEEE4ByteReal
                    FFTPrecision= IEEE4ByteComplex
                    #UseSymmetry= Yes
                    #EquationCombo= All3_For_Contact_Case
                    #EquationCombo= All3_Fixed_SI
                    EquationCombo= $type
                    #EquationCombo= Hilbert_Only
                    #EquationCombo= No_SI
                    #EquationCombo= Classic
                    DiskUsageRule= AUTO
                    Date       = "25/8/2000"
                    #DoReductionToPole = Yes
                    DoReductionToPole = No
                    Required_Points = { 540200, 6466500, -500,
                              546500, 6458400, -400,
                              554000, 6452500, -250 }
               Solve End
          Parameters End
Process End
Repeat End
```

And now an example in the new V5.0 syntax. We distribute this file at V5.0 as part of the sample_data/examples/tasks area -#

```
# Example job file - Euler deconvolution
# Euler consists of two stages:
# Stage 1: generates a solutions file from the grid (*.rs)
# Stage 2: accepts/rejects solutions according to user specified
criteria, and writes the
#          accepted solutions to an Intrepid point dataset.
#
```

```
# The example job file computes both stages and creates a report
file.
#  the fault/contact importer for Geomodeller is available from
V2012 onwards
# Usage: fmanager -batch euler.task
#
# when done, combine all the by worm contact, orientation and
limited fault extents solutions into a coherent "fault network"
for import into Geomodeller

IntrepidTask {
      Euler {
            InputGridName: "../datasets/mlevel_grid.ers"
            Band: 0
            Output: "../datasets/euler..DIR"
            ReportFile: "../datasets/euler.rpt"
            SurveyHeight: 60.0;
            ExportTypes: Database;
            #  3D visual formats of solutions
            Dump_VRML: false
            Dump_BREP: false
            Sort {
                  # main rejection of false solutions criteria
                  LowerGoodnessClip: 0.0
                  UpperGoodnessClip: 1.0
                  LowerStructuralIndexClip: -0.5
                  UpperStructuralIndexClip:  4.5
                  NumberVerticalLayers: 1
                  MinimumDepth: 0.0
                  MaximumDepth: 5000.0
                  # if vector from observation point to solution
dips less than 20, discard
                  MinimumObservationDip: 20.0
                  # ratio of estimated Depth error to depth value
                  Maximum_Percentage_Depth_Error: 900
                  #  extended Euler can calculate a property of teh
source - alpha
                  Maximum_Absolute_Alpha: 100.0
                  MaximumSingularityRatio: 1000000000.0
                  Binning_Analysis: false
                  # actual bin size
                  XYBinEast: 10000000.0
                  XYBinNorth: 10000000.0
                  Mask_Solutions: true  # do not keep solutions
outside original spatial grid
                  Cluster_Analysis: false
                  # no cluster if values separated by more than this
distance
                  Maximum_Point_separation: 900.0;
            }
            Solver {
                  # method specifying which formulation you want
                  ####  Classic Hilbert_Only All3_Fixed_SI
All3_For_Contact_Case No_SI
```

```
                        EquationCombo: Hilbert_Only
                # default SI if one is needed, Most Solvers estimate
this quantity
                        StructuralIndex: 1.0
                        # window size for equations as you pass over the
grid
                        LateralSize: 7
                        # some conditioning for FFT work
                        RolloffType:     Cosine_RollOff;
                        WindowType:      NO_Window;
                        FillType: ARTHUR  # MEM or maxiumum Entropy
                        FillStopAtEdge: false;
                        DetrendDegree: 1
                        OutputPrecision: IEEE4ByteReal
                        FFTPrecision: IEEE8ByteComplex
                        # Can exploit FFT symmetry for most operations..
Hilbert not always
                        UseSymmetry: false
                        DiskUsageRule: AUTO
                        #  you can save computation time for repeated
runs, by saving the outputs
                        SaveDerivatives: false
                        # do an RTP on mag data... not necessary
                        DoReductionToPole: false
                        IGRF {Date: "31/12/1999" }
                }
                # it is possible to specify a smaller internal area
within a grid
                Subset {
                        # size of expanded grid as a percentage of
original grid size.
                        FFT_BorderPercentExpansion:  120.0
                }
}}
```

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Parent topic: **Euler Deconvolution (T44)**

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