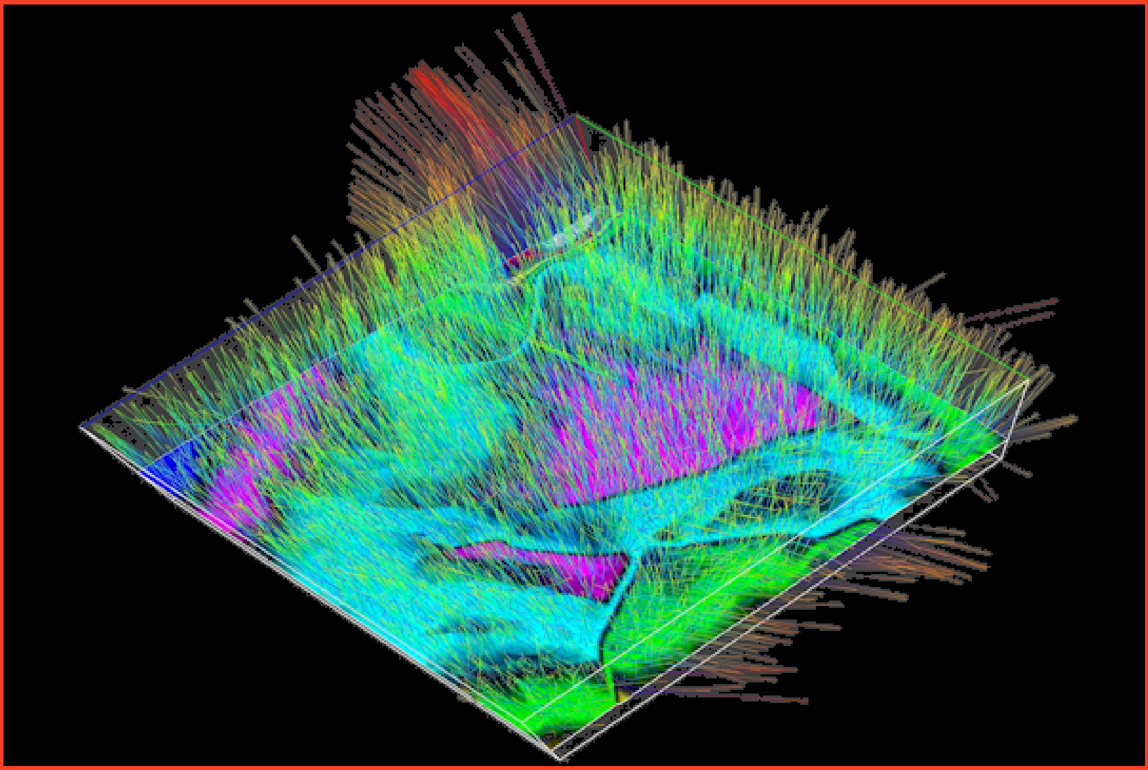
MARVEL® eyeBeam™ Module



Panorama Technologies

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MARVEL eyeBeam Module

Appendix D

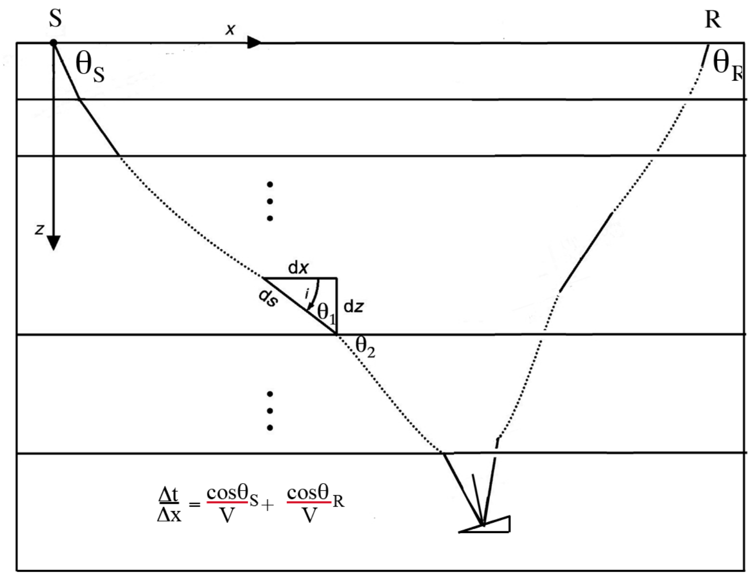
eyeBeam Module

This appendix discusses the optimum utilization of Panorama Technologies eyeBeam module and provides a brief explanation of the assumptions underlying the process. The article is divided into three parts: First, a brief overview summarizes the fundamental principles on which the module is based; second, the focus is directed toward data preparation for optimum results; and, third, the module's parameters are explained in detail.

Overview

In contrast to the Kirchhoff smear stack approach, eyeBeam estimates local dip elements, or beamlets, from the input data and then applies classical imaging principles to produce a properly migrated image. To a large extent, the process is based on Figure 207. Together with the near surface velocity, V, Equation 20 provides the precise relationship between the apparent dip, $\frac{\Delta t}{\Delta x}$, and the source and receiver take-off angles, θ_S and θ_R, respectively. As indicated in the figure, raytracing is used to locate the reflector that gave rise to the apparent dip. The opening angle, or either incidence angle at the intersection of the two rays, determines reflector dip. The sum of the source and receiver take-off angles are directly related to the apparent dip of a subsurface reflector. The opening angle (sum of the incidence angles) define the local reflector dip.

Figure 207. Fundamental components of Panorama Technologies eyeBeam module.



Equation 20:

$$\frac{\Delta t}{\Delta x} = \frac{cos\theta_S}{V} + \frac{cos\theta_R}{V}$$

The ratios $\frac{cos\theta_S}{V}$ and $\frac{cos\theta_R}{V}$ are the derivatives, $\frac{\mathrm{d}\tau_S}{\mathrm{d}x}$ and $\frac{\mathrm{d}\tau_R}{\mathrm{d}x}$, of the source and receiver traveltimes, that is, the gradients in 3D. This fact allows you to compute dynamic traveltimes and provide proper amplitude correction to preserve AVO response and approximate true amplitude imaging. Figure 207 shows the schema for two-dimensions, but the general concept remains valid in three dimensions. In 3D, the source and receiver take-offs are specified by an azimuth and dip.

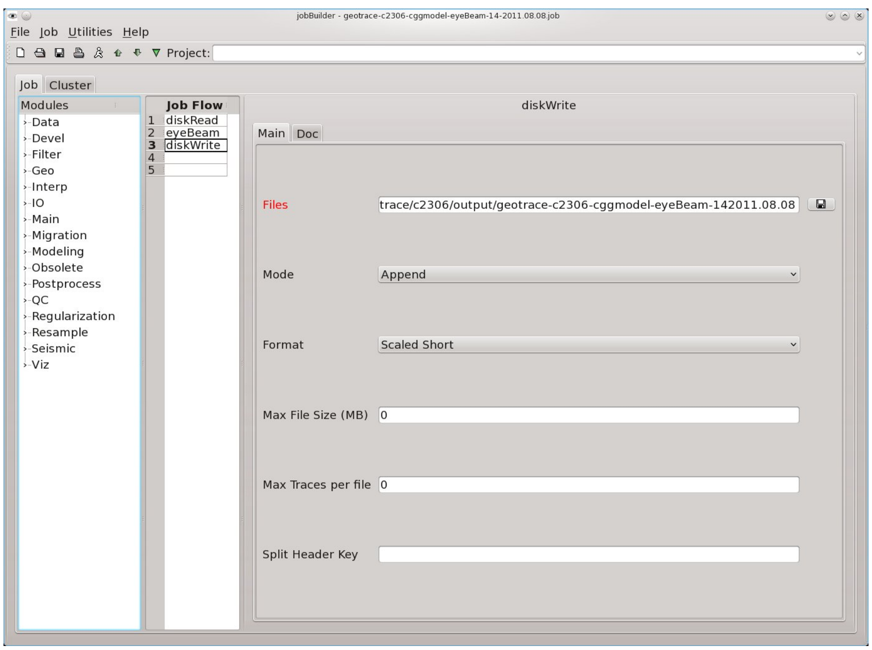
Key features of eyeBeam and its dynamic raytracer include

- Migration From Topography
- Full TTI imaging based on the dynamic raytracer
- Raytrace arrivals include
  - maximum energy
  - minimum velocity
  - minimum distance

Data Preparation

The quality of the final image produced by eyeBeam is controlled by the quality of the input data. In many cases, the quality of the final image can be controlled by proper preprocessing of the input data volume. Because estimates of local apparent dip are paramount, data preparation can and should focus on input data coherency and frequency content. In many cases, coherency be increased through signal enhancement applications and also careful choice of the frequency bandwidth. Spectral analysis should reveal the extent to which the data can be resampled to a larger sampling increment. Efficiency is highest when the maximum frequency can be limited to 31.5 Hz. To maximize throughput, data preparation should also include storing the properly processed data in a scaled 16-bit format. This reduces the input data size and results in faster data reads and writes. As shown in Figure 208, you do this by setting the output data format to Scaled Short. This setting effectively halves the output file size, thereby improving overall performance and efficiency of eyeBeam migrations.

Figure 208. Setting the output file format to scaled-short in diskWrite



Parameterization

Parameterization of an eyeBeam project uses both the diskRead module and the eyeBeam module.

diskRead

Parameterization of an eyeBeam project begins with the diskRead module. Figure 209 shows the Main panel of diskRead along with the parameters required to ensure that diskRead will construct appropriately-sized super-gathers (patches) to feed to the eyeBeam module. At your discretion, the parameters below diskRead's Mode field can also be set in the eyeBeam module. While several of these fields have reasonable defaults, they should always be reviewed before job submission. The fields are defined in Table 152.

The Files field in Figure 209 points to either a .segy file with properly filed headers or to a .dataset file containing the appropriate coordinate information to enable proper sorting of the input data into offset binned super gathers. Depending on the computer system being used, the sort may take awhile.

Table 152. diskRead Main Panel Fields

Field	Description
Migrate all Offsets at Once	If set to YES, traces are read in exactly the order they are stored. If set to NO, traces are read in common offset order. This should be set to NO for Beam Migrations.
Report (secs)	This is the report time for diskRead. For example, a value of 60 causes diskRead to report every minute.
Calculate Bins	If the input data has only CDPs and lines in the headers, this will calculate the real world coordinates for selecting super-gathers.
Calculate xy	If the input data does not have CDPs and lines set in the header, set this parameter to YES to have diskRead calculate CDP and line information from the world coordinates in the trace headers.
backupName	The name and location of the backup file used in restarts and recovery operations.
Offset Bins	These three fields are the minimum, maximum, and increment defining the leading edges of the offset bins. For example, if these values are set to 0, 20000, 100, then 199 offset bins beginning at 50 will be output.
Offset Bin Key	The header key for storing the Offset Bin value.

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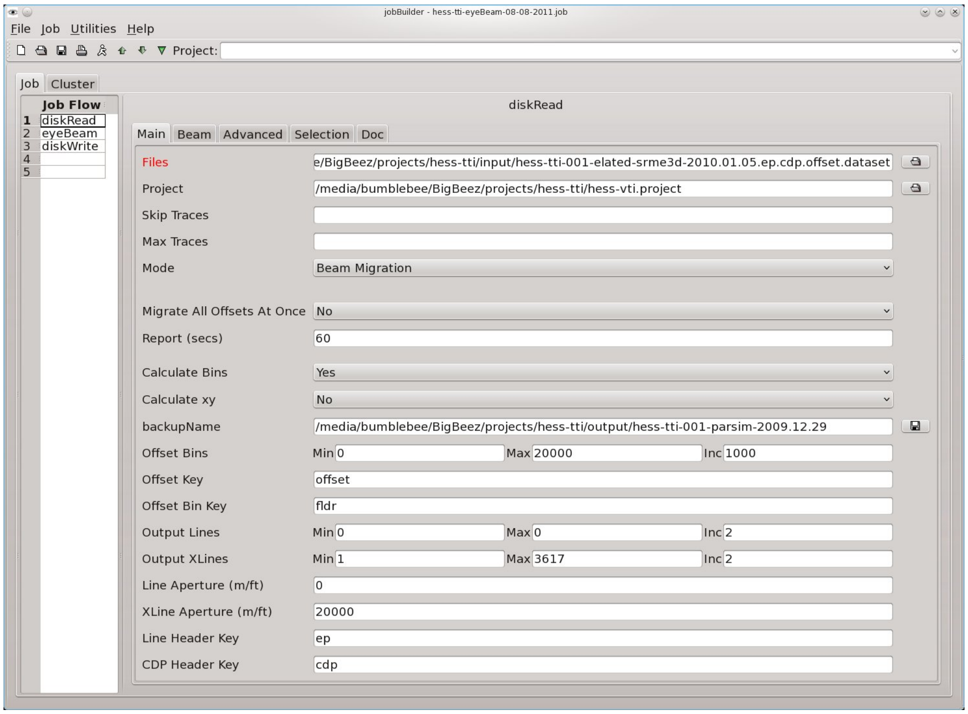
Table 152. diskRead Main Panel Fields–continued

Field	Description
Output Lines	These three fields are the minimum, maximum, and increment for the desired output line range. Figure 209 is a 2D setup so the values are set to output a single 2D line.
Output XLines	The minimum, maximum and increment for the desired output line range.
Line and Xline Aperture	The desired line and crossline half-apertures.
Line and CDP Header Keys	The header locations where this information is stored.

The diskRead Main panel is shown in Figure 209. The panel shows selection of Beam Migration in the Mode field. This ensures that diskRead constructs appropriate patches to feed to the eyeBeam module after the sort has been performed.

Figure 209. diskRead Main Panel



The diskRead Beam panel is shown in Figure 210. The most important field in diskRead's Beam panel is the Patch Size field. This field defines the size of the patch in both line and crossline directions. Reasonable values are project dependent, but are typically in the neighborhood of 200 meters. The diskRead Beam fields are defined in Table 153.

Figure 210. diskRead Beam Panel

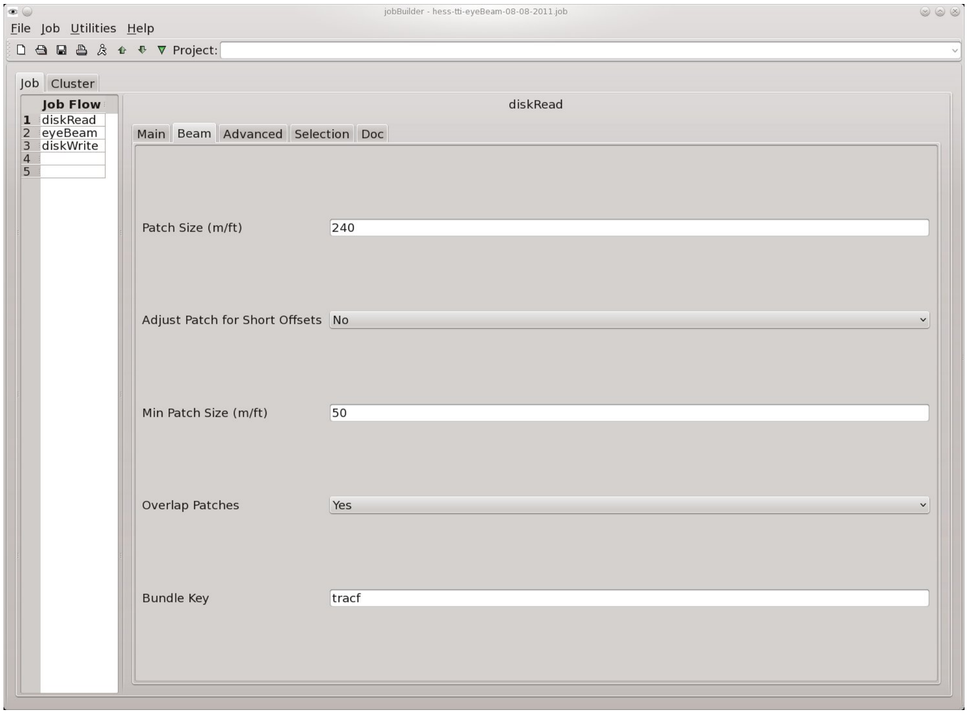
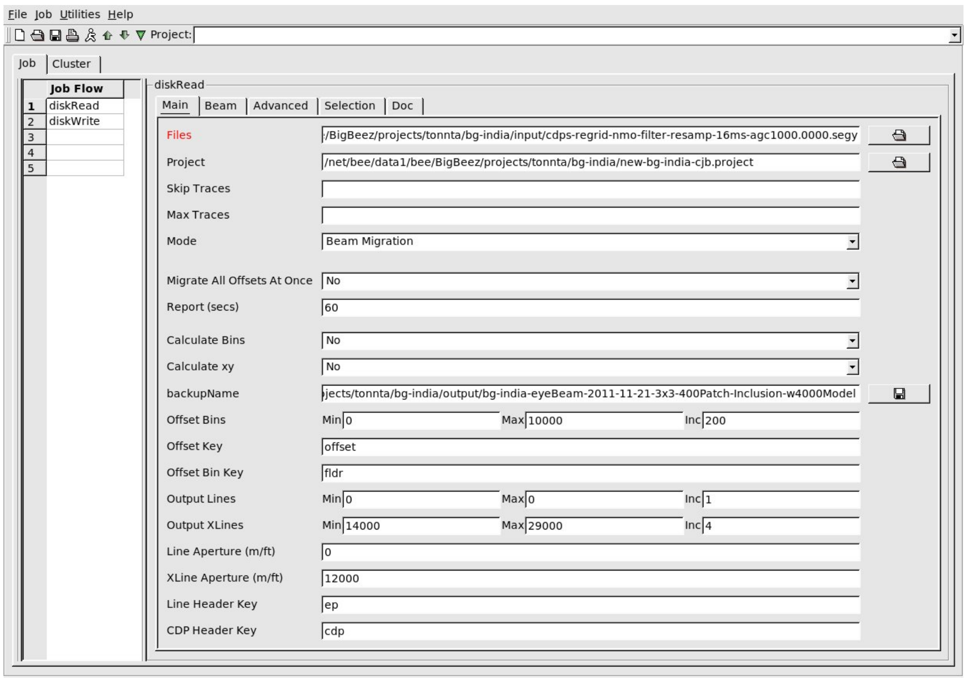


Table 153. diskRead Beam Panel Fields

Module	Description
Patch Size (m/ft)	The actual patch or super gather size. The value defines a square around sources and receivers. Every trace with a source and a receiver in the corresponding square is included in the patch.
Adjust Patch for Short Offsets	This switch specifies whether or not eyeBeam reduces the patch size for small offsets. It enhances coherence to improve beamlet estimation.
Min Patch Size (m/ft)	The minimum patch size allowed for short offset reduction when the previous field is set to YES.
Overlap Patches	Set this to YES to increase the coherence at shallow depths.
Bundle Key	The header word location containing the unique value assigned to each patch.

If you plan to do multiple migrations using the same input, the diskRead data stream of super gathers can be output in presorted form by feeding the output from diskRead directly into diskWrite, as shown in Figure 211. The diskWrite module writes the data to the specified super-gather-sorted output file. In subsequent applications of eyeBeam, diskRead's input file field must contain the .segy super-gather-sorted output file and the Mode field must be set to General. Note that this approach can also be used effectively during the data preparation step.

Figure 211. diskRead General Panel



eyeBeam

Figure 212 shows the eyeBeam Main panel. The fields are explained in Table 154, and give the necessary information for a successful run of the module.

Figure 212. eyeBeam Main Panel

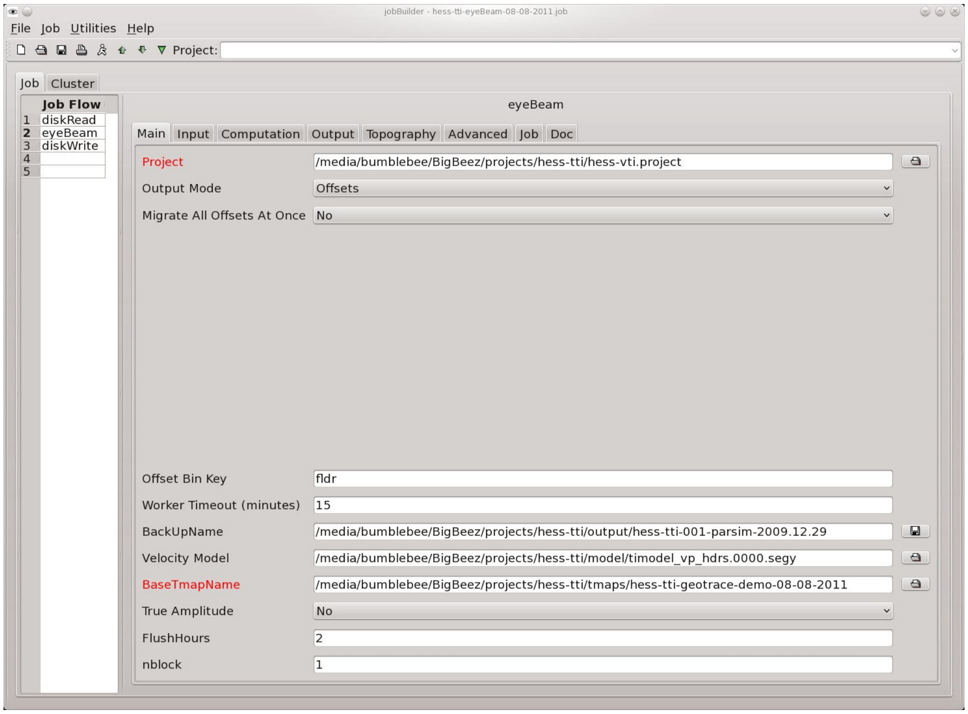


Table 154. eyeBeam Main Panel Fields

Module	Description
Project	This required field defines the input data geometric coordinates.
Output Mode	The output mode is normally Offsets or Stack. Use Offset mode to produce a range of offsets, and Stack to produce a stack of all offsets
Migrate All Offsets At Once	This should always be set to NO for eyeBeam migrations.
Offset Bin Key	It is recommended that this field be left at the default value, but any available header key can be used. **Note: Avoid using cdp, line, sx, sy, gx or gy used in other header related fields.**

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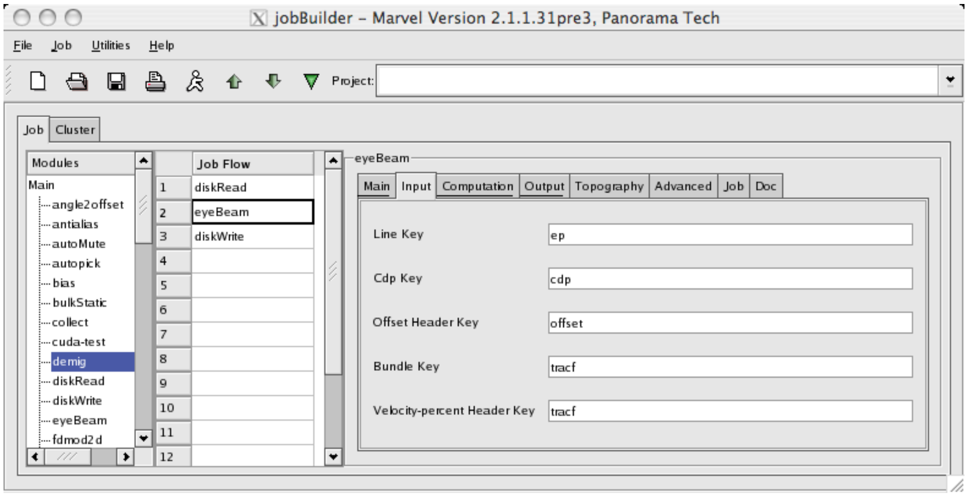
Table 154. eyeBeam Main Panel Fields–continued

Tab	Description
Worker Timeout (minutes)	This field defines the length of time eyeBeam will allow a worker to be inactive. If communication is not achieved after this time limit, the eyeBeam master assumes that the worker is dead.
BackUpName	This file is used to store backup information to enable a restart after any suspension of execution.
Velocity Model	When given, the velocity model serves two purposes. It provides the necessary velocity information for differential moveout of the traces in each super gather to the average offset of that ensemble. It also defines the near surface velocity for computation of take-off angles. This is a seismic file in any format MARVEL can read, typically, SEG-Y. The units are m/s, or ft/s, but can be anything else, depending on the choice of units in the seismic data.
BaseTmapName	The base name of the traveltime file(s). This name is the tmap file name without the .tmap extension. **Note: This is a REQUIRED entry.**
True Amplitude	When set to YES, eyeBeam will use the amplitudes computed during the generation of traveltimes by rayShooter.
Flush Hours	The length of time between each output of backup information to the BackUpFile.
nblock	**Note: This parameter should not be set when using eyeBeam.**

The eyeBeam Input Panel in Figure 213 defines the header storage locations for the various indicated parameters.

Figure 213. eyeBeam Input Panel



The eyeBeam Computation Panel is shown in three forms in Figure 214, Figure 215, and Figure 216. The fields on these panels are the most important eyeBeam parameters, and are defined in Table 155.

Figure 214. eyeBeam Computation Panel, Application Range Utilization field set to All

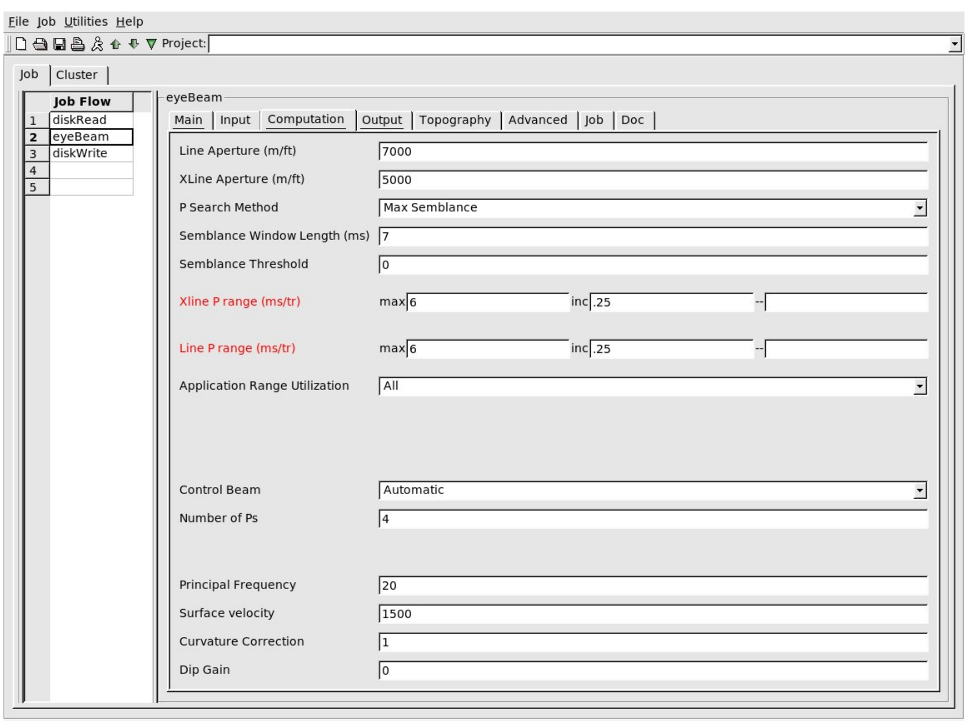


Figure 215. The eyeBeam Computation Panel, Application Range Utilization field set to Exclude

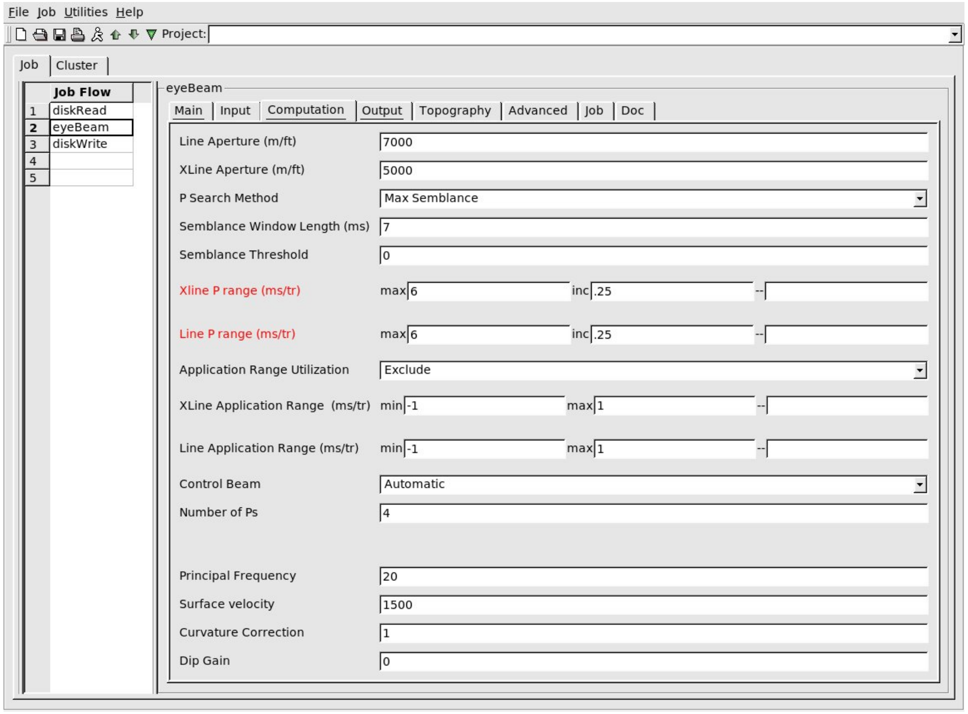


Figure 216. The eyeBeam Computation Panel, Application Range Utilization field set to Include

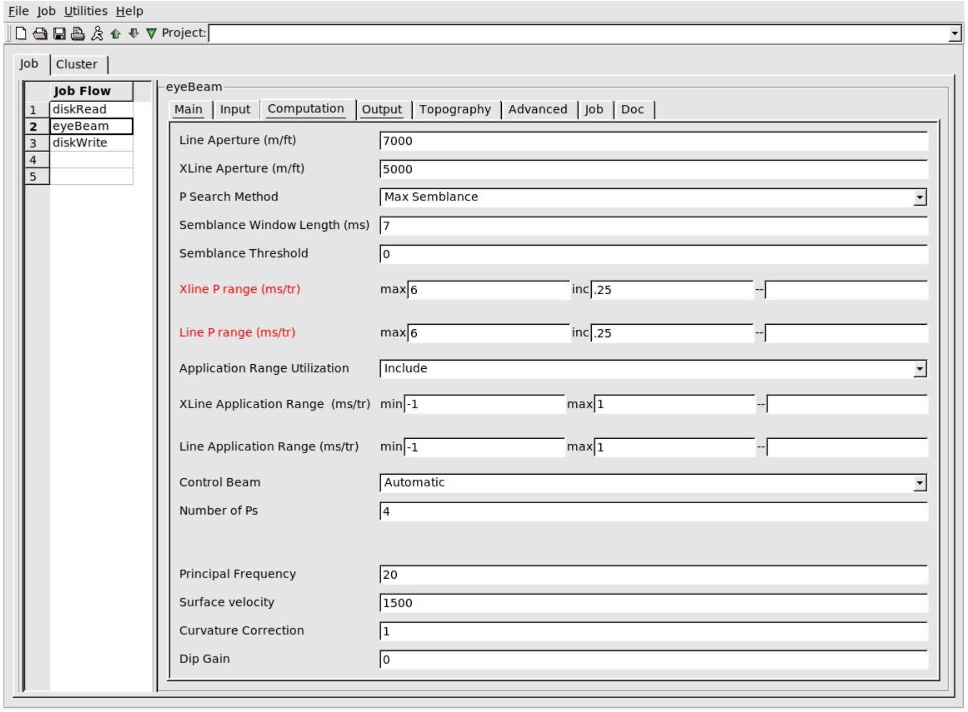


Table 155. eyeBeam Main Panel Fields

<table>
<tr><th>Module</th><th>Description</th></tr>
<tr><td>Line and Xline Aperture</td><td>These fields define the migration half-aperture for the migration</td></tr>
<tr><td>pSearch Method.</td><td>This field has two options. You can choose the p-values based on either the maximum semblance or maximum slant stack amplitudes. The recommendation is to set this field to Max Semblance.
When set to Max Semblance, the two parameters Semblance Window Length and Semblance Threshold appear. Semblance Window Length controls the length of the vertical window from which p-values are selected. Semblance Threshold provides a threshold for rejecting p-values whose semblance is below this value.
When set to Max Stack, p-values are determined from the slant stack volume or field. No other parameters need be set.</td></tr>
<tr><td>Xline P Range</td><td>The max value and increment. The range is the defined from negative max to max.
Note: This is a REQUIRED entry.</td></tr>
<tr><td>Line P Range</td><td>The max value and increment. The range is then defined from negative max to max.
Note: This is a REQUIRED entry.</td></tr>
<tr><td>Application Range Utilization</td><td>This field can be set to All, Exclude, or Include.
When set to All, the p-search is performed over the entire set of slant-stack p values.
When set to Exclude, the p-search is performed over those p-values outside the range defined by the Xline Application Range and Line Application Range fields.
When set to Include, the only allowable p-values are based on the range defined within the Xline and Line Application Ranges.</td></tr>
<tr><td>Control Beam</td><td>The three options are Fixed P Range, Automatic and No Control.</td></tr>
<tr><td>Number of Ps</td><td>The actual number of p-values to migrate when Control Beam is Automatic.</td></tr>
</table>

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Table 155. eyeBeam Main Panel Fields–continued

Tab	Description
Principal Frequency	Principal Frequency is used to define the Fresnel zone.
Surface velocity	If no initial velocity volume is provided, this value defines the near surface velocity.
Curvature Correction	When set to 1, this flag causes the eyeBeam algorithm to correct for local curvature.
Dip Gain	When set, a linearly increasing scale factor will be applied to higher dips.

Figure 217 shows the eyeBeam Output Panel, which defines the range and limits of the desired output data volume. The meaning of these parameters are defined in Table 156.

Figure 217. eyeBeam Output Panel

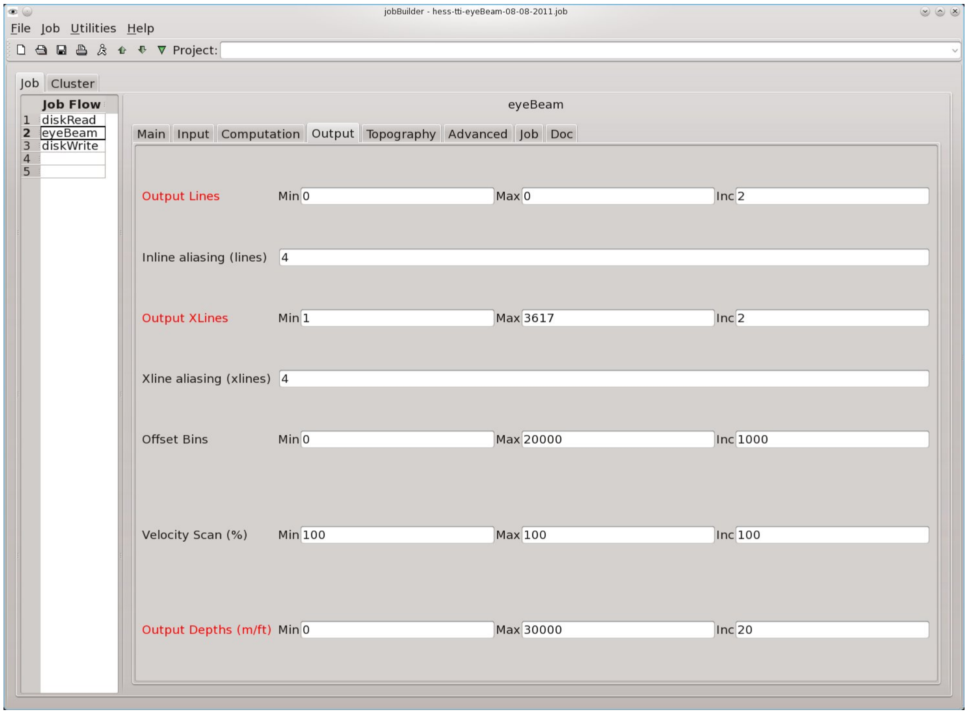

Table 156. eyeBeam Output Panel Fields

Module	Description
Output Lines	The output line range. **Note: This is a REQUIRED entry.**
Inline aliasing (lines)	Defines the desired spacing length for antialiasing. The larger this value is, the more anti-aliasing is applied.
Output XLines	The output xLine range. **Note: This is a REQUIRED entry.**
Crossline aliasing (xlines)	Defines the desired spacing length for antialiasing. The larger this value is, the more anti-aliasing is applied.
Offset Bins	Defines the endpoints of the desired output offset bins. For example, the values 0, 20,000, and 1000, define output offsets ranging from 500 to 19,500.

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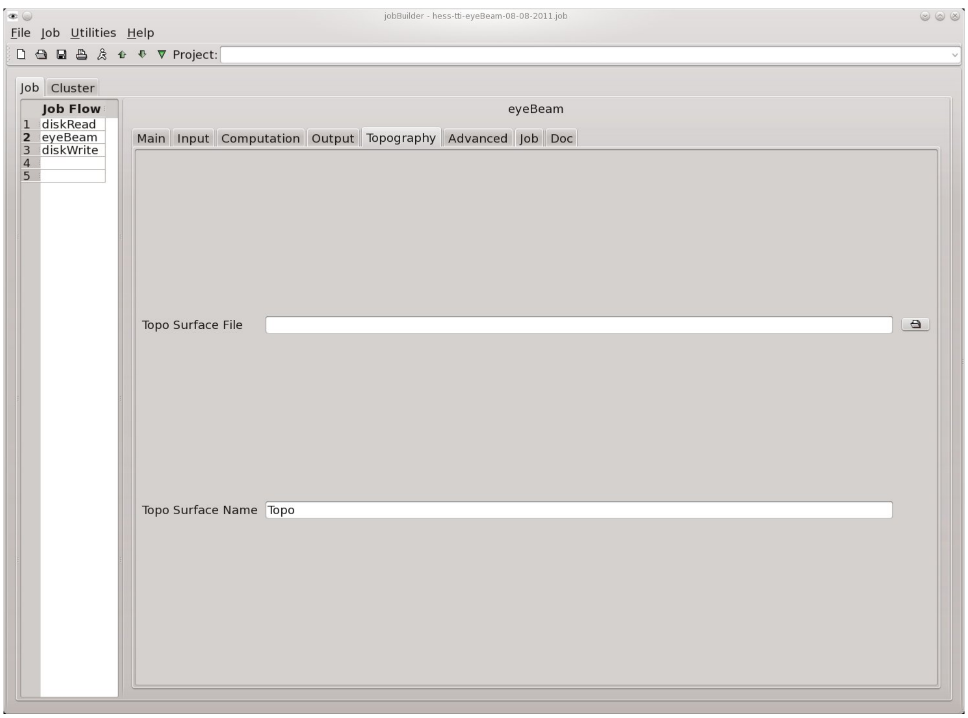
Table 156. eyeBeam Output Panel Fields–continued

Tab	Description
Velocity Scan (%)	Setting the minimum, maximum, and increment provide the percentage range over which migrations should be performed. For example, setting this range to 90, 110, 5 will produce output volumes using 90, 95, 100, 105, and 110 percent of the original velocity field.
Output Depths	Defines the minimum, maximum, and increment for the each output trace. **Note: This is a REQUIRED entry.**

The eyeBeam Topography Panel fields in Figure 218 define the topographic surface file and the surface name.

Figure 218. eyeBeam Topography Panel



The eyeBeam Advanced Panel in is shown in Figure 219. The fields are described in Table 157. It is best to simply use the default values for these fields.

Figure 219. eyeBeam Advanced Panel

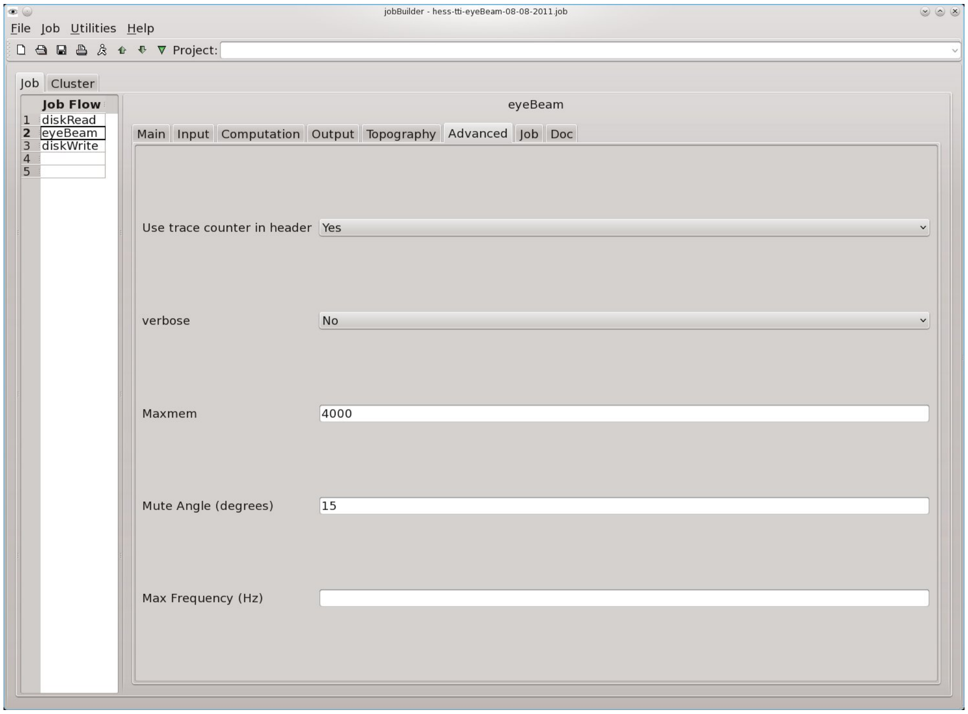


Table 157. eyeBeam Advanced Panel Fields

Module	Description
Use trace counter in header.	When set to YES, the trace counter is set.
Verbose	When set to YES, eyeBeam will print debug information to the log file.
Maxmem	The amount of memory, in megabytes, to allow for each process on each node.
Mute Angle (degrees)	The value applies an automatic mute at this angle on each output CDP and line gather.
Max Frequency (Hz)	This field applies a low-pass filter to the input with this value as the highest frequency. It is best to use the default value and avoid the extra calculations. If you want to filter the data, it is better to do so before migration.

The eyeBeam Job Panel shown in Figure 220 defines computer based parameters related to how the process generates output. The terms are defined in Table 158.

Figure 220. eyeBeam Job Panel

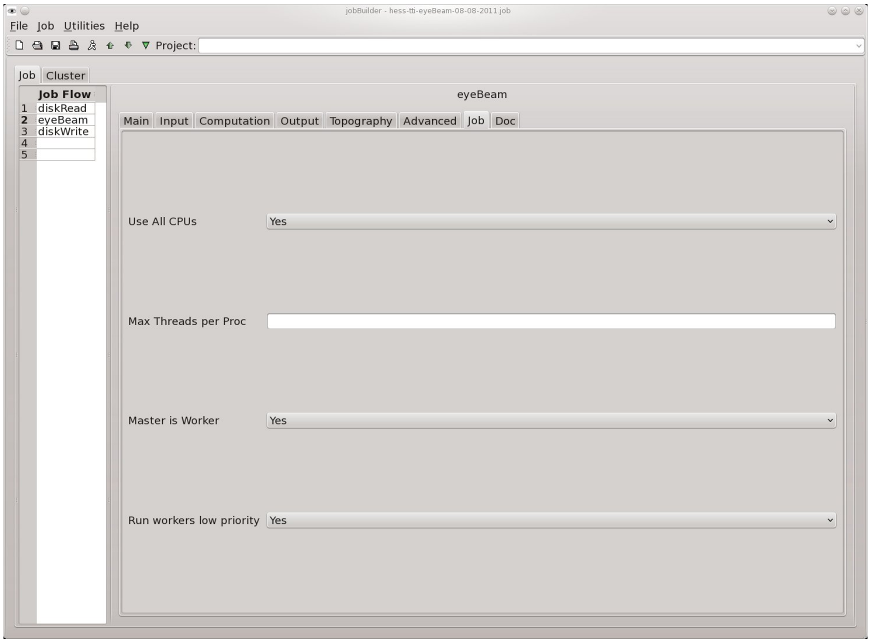


Table 158. eyeBeam Advanced Panel Fields

Module	Description
Use All CPUs	When this is set to YES, Marvel initializes eyeBeam as a single process utilizing all cores on the node. When set to NO, Marvel initializes eyeBeam as multiple processes, where each process uses a single core.
Max Threads per Proc	When Use All CPUs is set to NO, you can set this value to the number of cores per process. For example, when running on an 8 core node, setting Max Threads per Proc to 4 would cause two instances of eyeBeam slaves to each use exactly 4 cores during execution.
Master is Worker	When set to YES, the master node will also be used as a worker. In this case, the master node will have one master process and at least one slave process in execution. When set to NO, the master node does little or no actual computation. Its primary purpose is to send and receive parameters and monitor and handle input and output. The recommended setting is NO.
Run Workers Low Priority	When set to Yes, all processes, except the master, will be run in a reduced priority *nice* mode.

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January 14, 2013