Photon ENGINEERING
Illuminating Ideas

FRED™ New Features Version 16.42.1

Introduction

This document contains new features that have been added to the last release (v16.42.1) of FRED.

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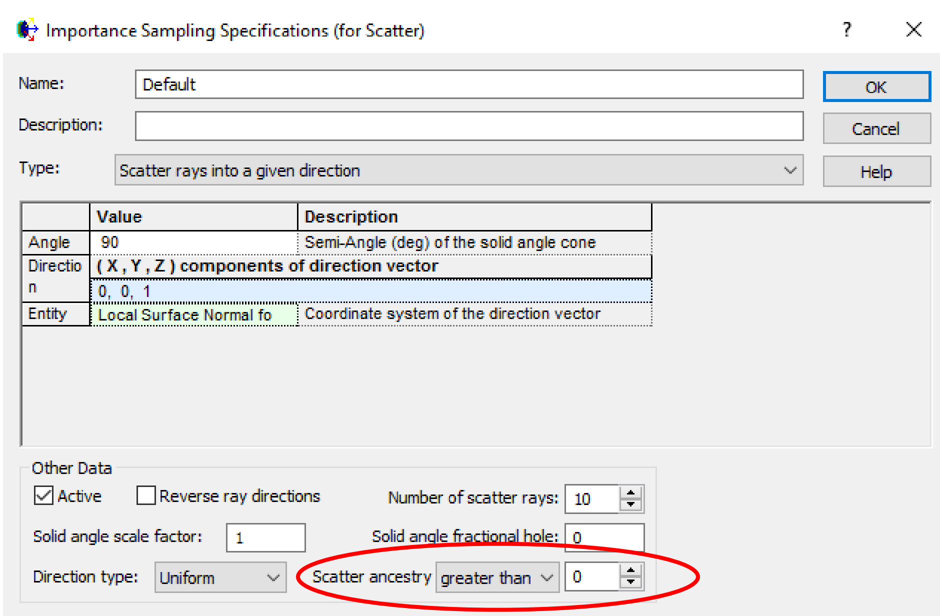
Rays and Raytracing

FRED Optimum can now use up to a maximum of 63 threads for multi-threaded raytracing and analysis. Previous versions could use up to 33 threads. The standard FRED version is unchanged and can use up to a maximum of 4 threads.

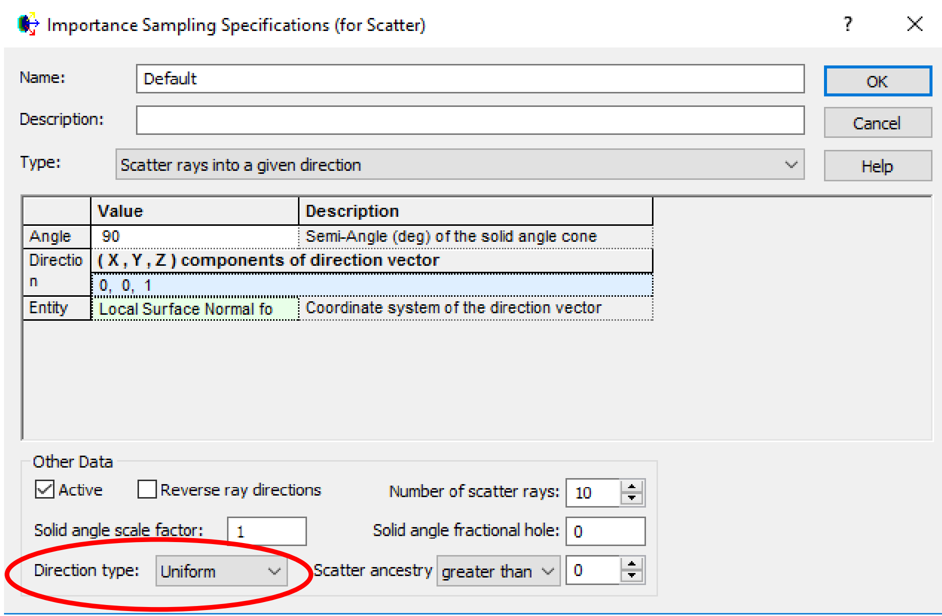
The 2^{31} ray limit has been removed. FRED will now trace up to 2^{63} rays.

The ray buffer preference settings have been modified so that the 64-bit version of FRED can store up to 1 billion rays in RAM at a single time (additional rays beyond this limit are stored in pagefiles on disk). The previous limit was 250 million rays stored in RAM at a single time. Additionally, the ray buffer preferences dialog now reports additional information about the total ray counts allocated by the current settings and the total amount of RAM available on the computer. This additional information makes specifying the ray buffer RAM allocation settings more convenient.

A new option has been added to scatter importance samples that allows them to be applied only when the scatter rays being generated meet a scatter ancestry level requirement. This option is useful when a scattering surface supports multiple scattering paths that are differentiated by their scatter ancestry. For example, suppose that an analysis is being performed on a telescope baffle and scatter ancestry up to level 2 is of interest. Two importance sample specifications can be assigned to the surfaces of the telescope baffle. The first importance sample would apply to scatter ancestry level 1 and generate rays into the hemisphere (i.e. the baffle scatters back into the baffle assembly). The second importance sample would apply to scatter ancestry level 2 and direct scattered rays into the aperture of the telescope.

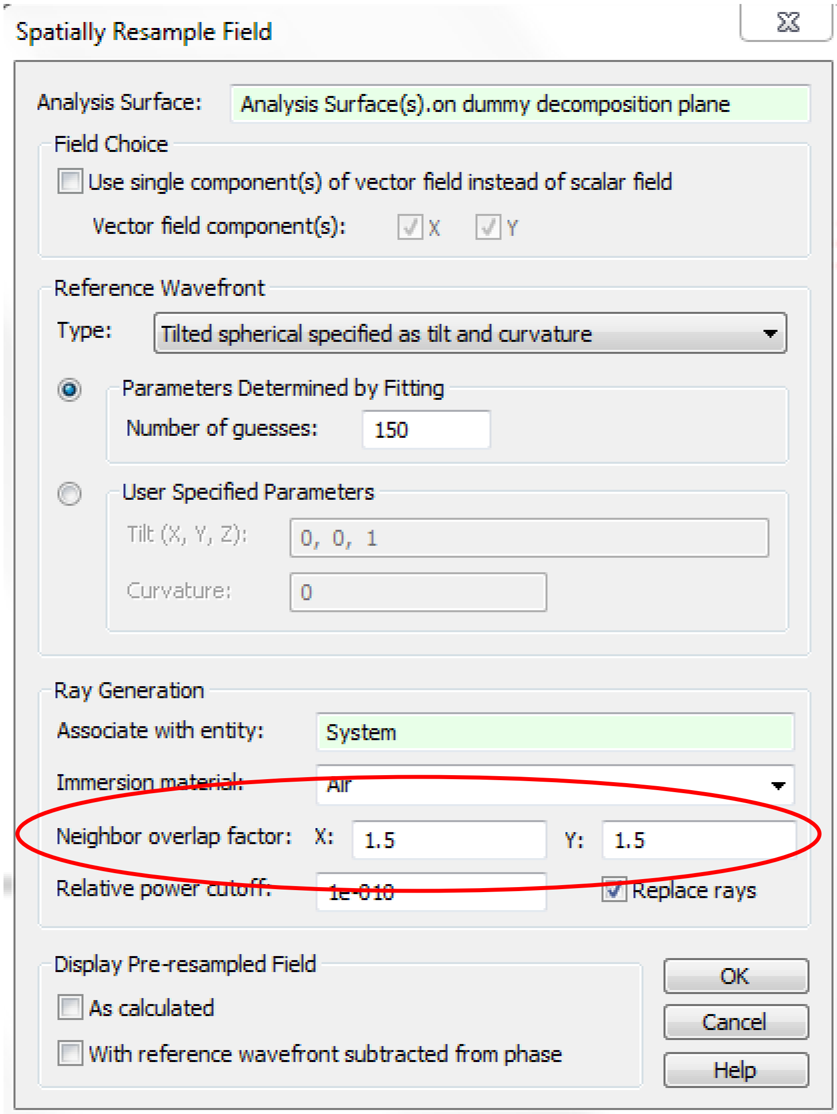


Added an option on the importance sample dialog that allows the user to choose how scatter ray directions are statistically distributed within an importance sample region. Two sampling options are available; Uniform and Monte-Carlo. The Uniform distribution option uniformly samples the angular region subtended by the importance sample and the individual scattered ray fluxes are scaled proportionally to the BSDF scatter function for a given ray direction. Previous versions of FRED used the Uniform option internally as the default behavior. The Monte-Carlo option statistically biases the individual scattered ray directions according to the BSDF scatter function and each of the scatter rays is assigned the same flux value (i.e. ray density is highest in the direction of peak BSDF). The new Monte-Carlo option is most useful when combined with BSDF functions that have narrow peaks in some preferential direction(s). For BSDF functions that have this preferential direction characteristic (ex. Harvey-Shack), the Monte-Carlo option can significantly improve the ray sampling statistics of the scatter distribution functions in their peak directions.



The 'Read rays from a file and generate dynamically' detailed source specification now accepts a CSV text file format with nine columns. The columns correspond to a ray's (x,y,z) position, (a,b,c) direction, flux, wavelength, and optical path length.

The Spatial Field Resynthesis function has been updated to include an explicit overlap factor for adjacent beamlets, equivalent to the setting in the Coherence tab of a detailed source model. Previous versions of FRED used an overlap factor of 1.5 and the user had no ability to modify this parameter. Adjusting the overlap factor allows the user to control the small amplitude modulation that results from the localization of gaussian beamlets representing the resynthesized field.

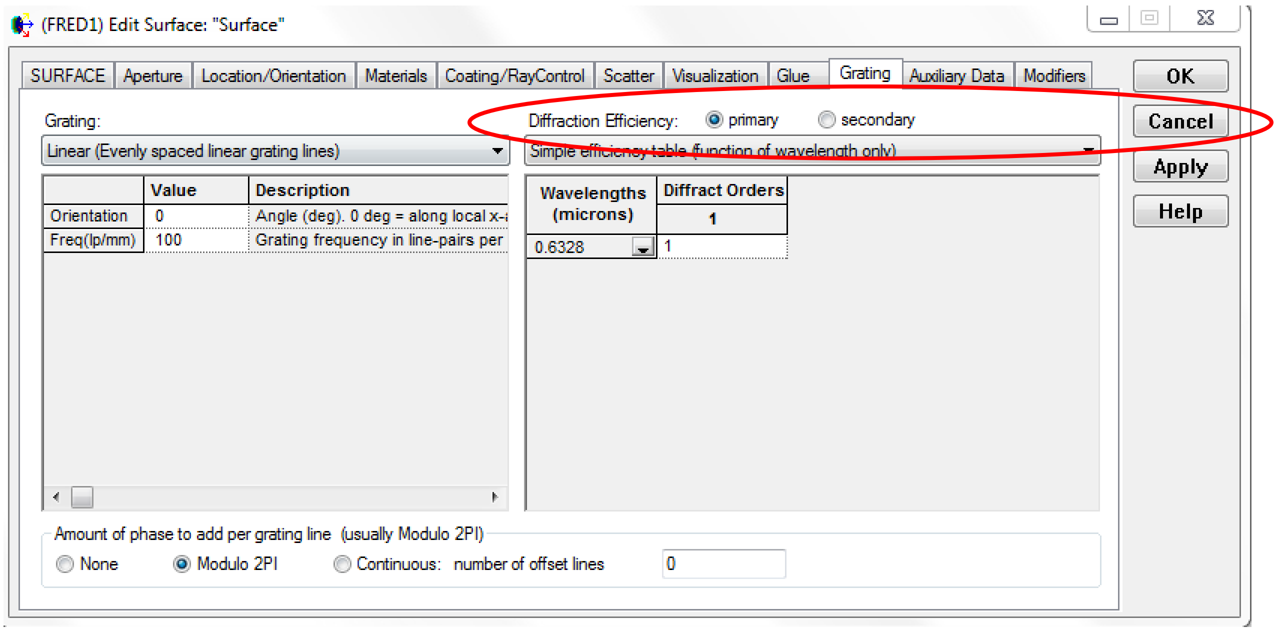


Model Loading and Update

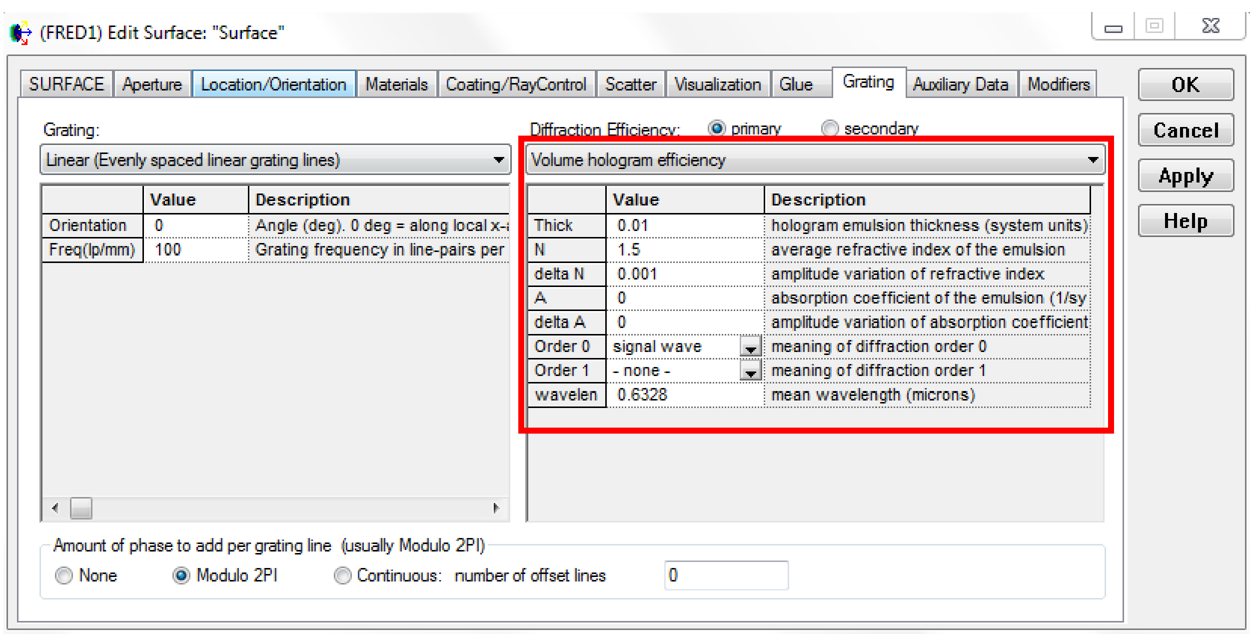
Large FRED files saved in this version will now load significantly faster than in previous versions. Additional information about the state of the document is now saved in the FRED file so that the need for a full document update cycle upon file load is not required. Note that your file will need to be saved in this version of FRED before you will see the performance increase. Tessellation of the model in the 3D view will still occur.
Sources have been modified so that the source ray powers do not need to be recalculated each time the source is created (i.e. when you ask FRED to perform a raytrace). In the new algorithm, power scaling of the source ray fluxes is calculated only once after the source is modified and is then stored within the document for reuse. Users should notice a reduced lag time between the raytrace request and the start of the actual raytrace computation for sources that create a large number of rays.

Diffraction Gratings

Previous versions of FRED only allowed a single diffraction efficiency specification to be applied to a grating that was independent of the direction of incidence of a ray on the grating surface. In this version of FRED, users can apply two diffraction efficiency tables (referred to as the "primary" and "secondary" efficiency tables) to account for the direction of an incident ray relative to the surface normal. When both efficiency tables are active, the primary efficiency table is used when the ray is propagating in the +Z direction relative to the grating surface and the secondary table is used when the ray is propagating in the -Z direction. When only one efficiency table is active, the behavior is unchanged from previous versions.



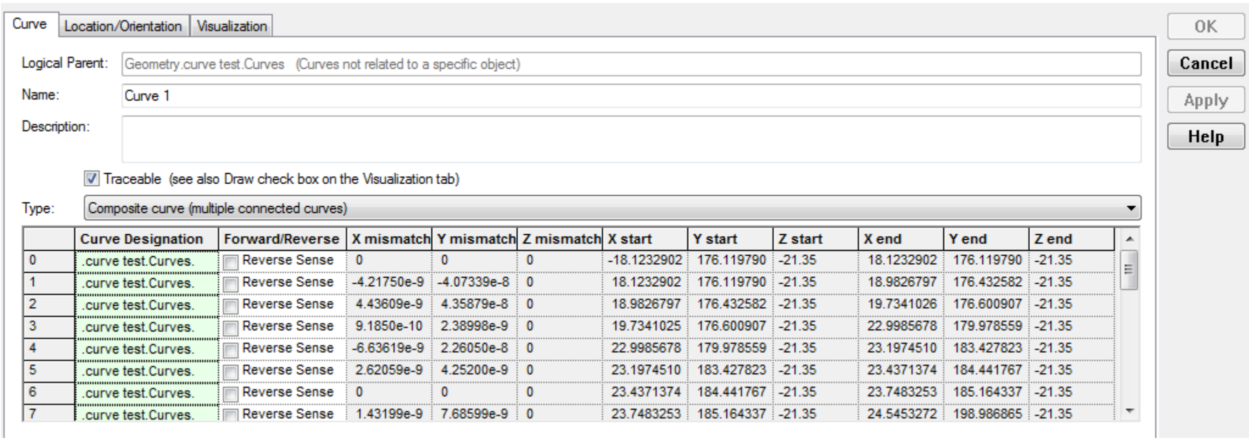
A new diffraction grating efficiency type has been added called, "Volume hologram efficiency", which is an implementation of Kogelnik's 1969 paper, "Coupled wave theory for thick holographic gratings". This efficiency calculation supports polarized rays in both reflection and transmission.



Geometry Editing

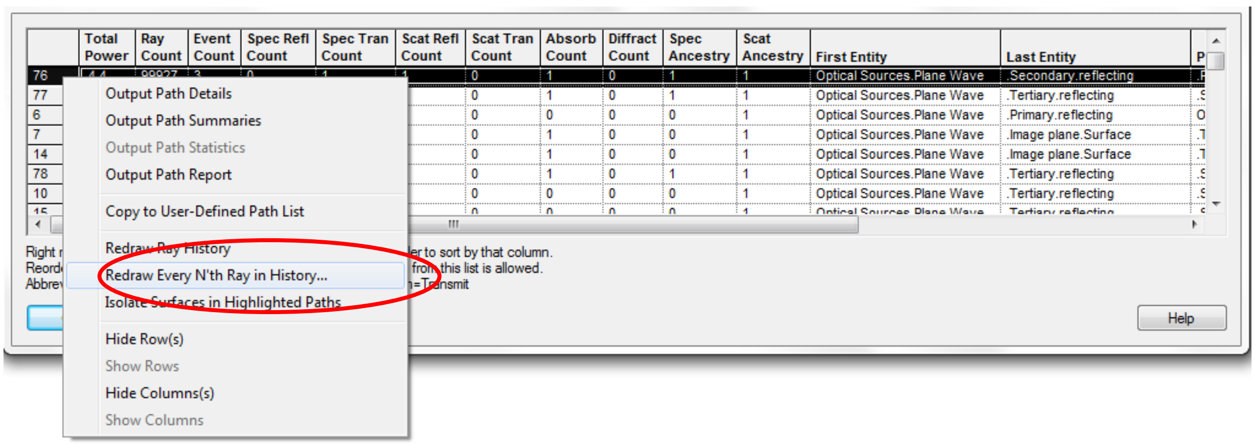
300 lenses have been added to the Edmund catalog and 27 lenses have been added to the Qioptiq/Linos catalog. The dialog for composite curves has been modified to include 9 additional columns of data that show the (x,y,z) starting point and ending point for each curve as well as the magnitude of the differences between the ending

point and starting point between adjacent curves. This allows the user to quickly assess where there is a misalignment between curves which are intended to be connected end to end in the composite curve.



Raytrace Paths

A new option for redrawing raytrace paths has been added that allows the user to draw every N'th ray along the path. This option is useful when a raytrace path contains a large number of rays and drawing all rays would obscure the user's ability to visually assess the path in the 3D view.



Raytrace path scripting commands have been modified to allow negative indexing of the event ID numbers. For example, an event ID of -1 specifies the last event along the path, -2 the next to last, etc. There is no change to the behavior when supplying zero or a positive event ID number. For example, an event ID of 0 specifies the first event along the path, 1 is the second event, etc.

3D BSDF Plotting

The Plot Scatter 3D option, accessed by right mouse clicking on a scatter node and selecting "Plot Scatter 3D", has been updated with additional coordinate system conventions for designating specular directions at which the BSDF is evaluated. These additional coordinate system options are intended to support anisotropic scatter models by viewing the scatter functions in 3D for arbitrary specular directions relative to the scatter model coordinate system.

Script Commands

The following script commands have been added or modified for this release:

Script Command	**Description/Modification**
SpatiallyResampleScalarField2	Spatially resample a scalar field with control over the adjacent beamlet overlap factor.
SpatiallyResampleVectorField2	Spatially resample a vector field with control over the adjacent beamlet overlap factor.
GetNURBCurveControlPtCount	Retrieve the number of control points in a NURB curve.
GetNURBSurfControlPtCount	Retrieve the number of control points in a NURB surface.
GetNURBSurfControlPtCount2	Retrieve the number of control points in a NURB surface using (i,j) control point indexing.
GetNURBSurfControlPt	Retrieve the x,y,z position and weight of a specific control point from a NURB surface.
SetNURBSurfControlPt	Set the x,y,z position and weight of a specific control point for a NURB surface.
GetNURBSurfControlPt2	Retrieve the x,y,z position and weight of a specific control point from a NURB surface using (i,j) indexing.
SetNURBSurfControlPt2	Set the x,y,z position and weight of a specific control point for a NURB surface using (i,j) indexing.
GetGratingKVector	Retrieve the k-vector and local frequency from a grating surface at a specific x,y,z position.
SetDiffractEfficiencyVolHOE	Specify the parameters of a primary volume HOE efficiency specification.
GetDiffractEfficiencyVolHOE	Retrieve the parameters of a primary volume HOE efficiency specification.

Script Command	Description/Modification
SetDiffractEfficiencyVolHOESecondary	Specify the parameters of a secondary volume HOE efficiency specification.
GetDiffractEfficiencyVolHOESecondary	Retrieve the parameters of a secondary volume HOE efficiency specification.
SetDiffractEfficiencyTableSecondary	Specify the parameters of a secondary simple efficiency table.
GetDiffractEfficiencyTableSecondary	Retrieve the parameters of a secondary simple efficiency table.
SetDiffractEfficiencyFileSecondary	Specifies the parameters of a secondary full efficiency table.
GetDiffractEfficiencyFileSecondary	Retrieves the parameters of a secondary full efficiency table.
AddCatalogLensReversed	Adds a catalog lens with the ordering of the surfaces reversed from their definition in the catalog.
PathEvent2	Retrieves all parameters of an event from a raytrace path with additional information about diffracted orders (compared to PathEvent).
PathEventIsDiffract	Queries a path event to see if it is a diffraction event.
Path Script Commands	The path script commands have been modified to use negative indexing so that the last event is given by index -1, second to last event is -2, etc.
ImpSampGetScatterLevel	Retrieve the scatter ancestry level criteria from an importance sample specification
ImpSampSetScatterLevel	Set the scatter ancestry level criteria for an importance sample specification

Script Command	Description/Modification
DeleteSourceDirIthMultiAngle	Deletes an angle specification from a source with ray direction type, "Multiple source angles (plane waves)"
InsertSourceDirIthMultiAngle	Inserts an angle specification into a source with ray direction type, "Multiple source angles (plane waves)"
DeleteSourceDirIthMultiPos	Deletes a position specification from a source with ray direction type, "Multiple source positions"
InsertSourceDirIthMultiPos	Inserts a position specification into a source with ray direction type, "Multiple source positions"