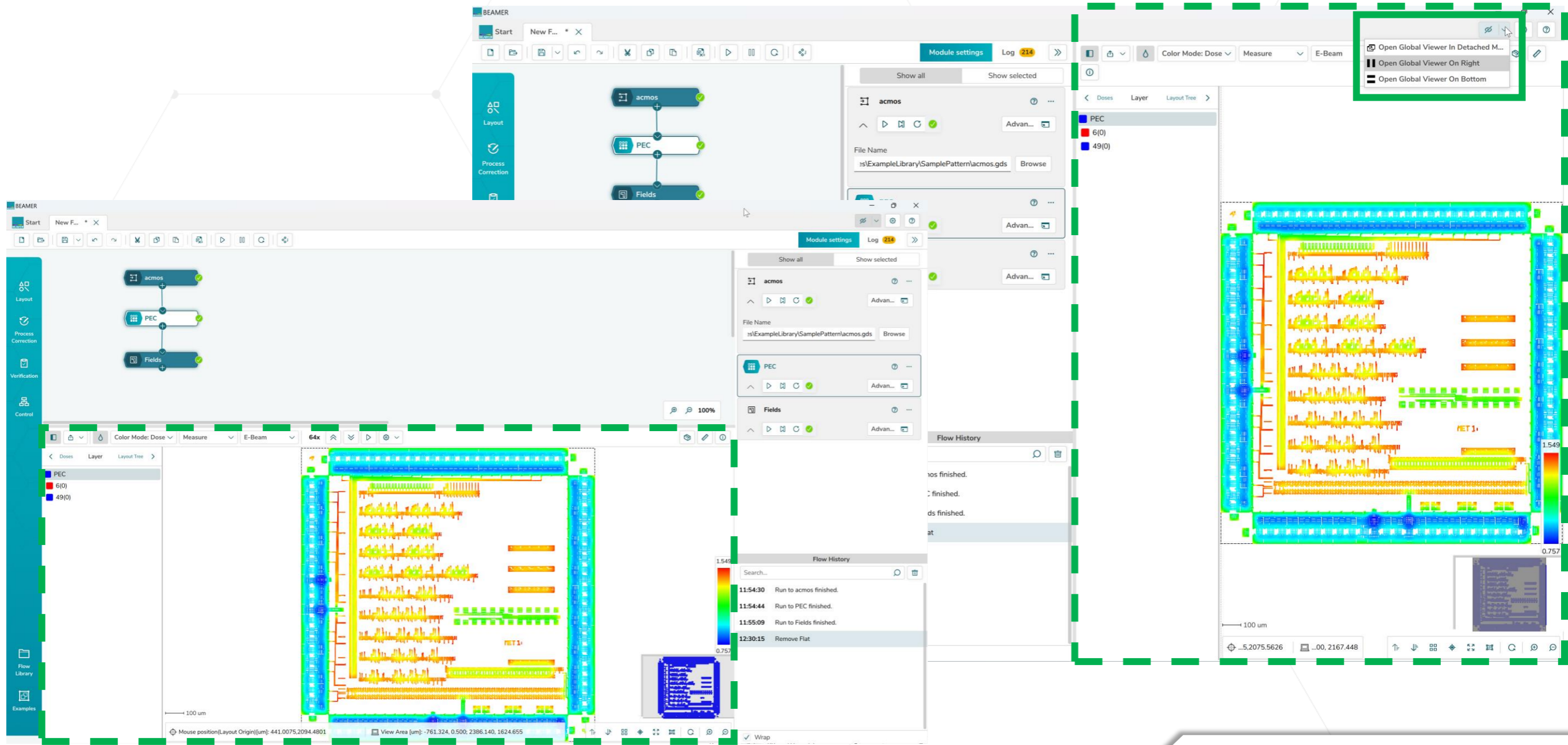


BEAMER

What's new 7.1

Graphical user interface

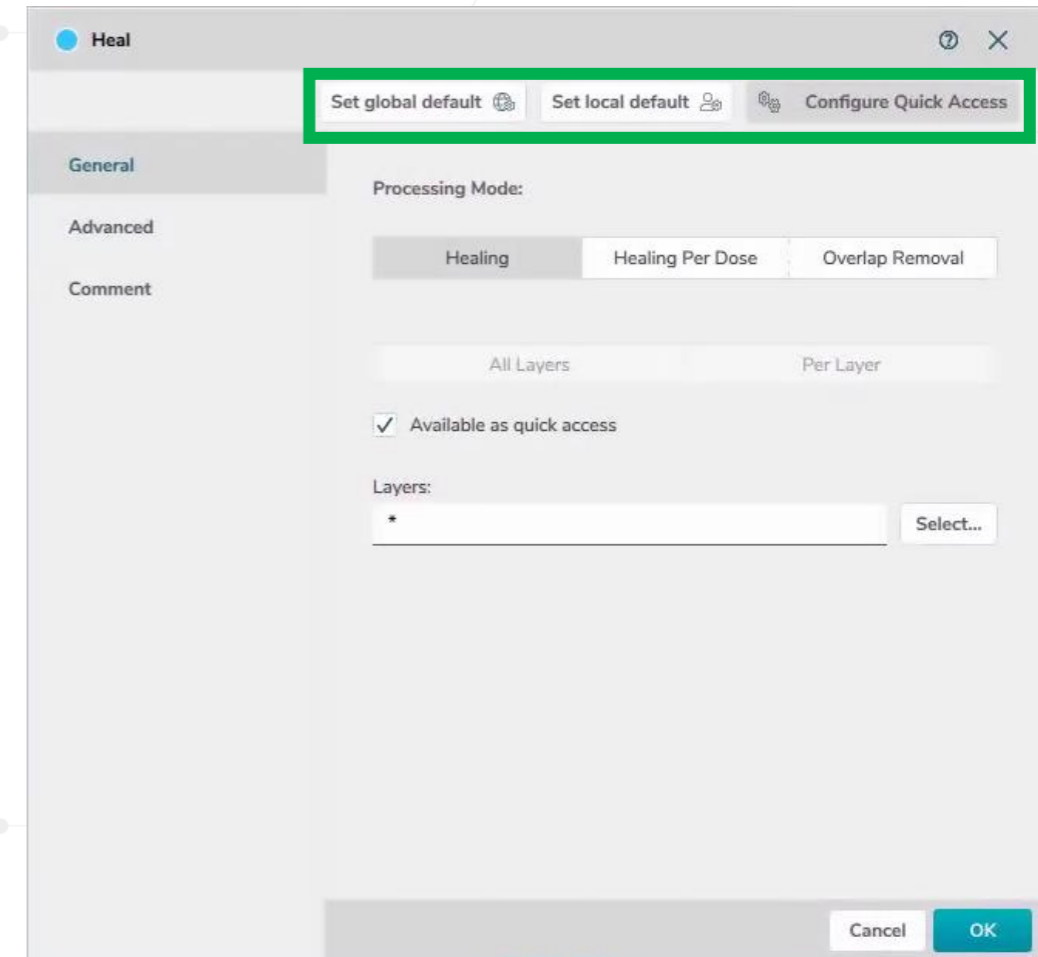


The screenshot displays the BEAMER 7.1 software interface, which is divided into several functional areas:

- Workflow Diagram (Top Center):** A vertical flowchart showing the process steps: 'acmos' (with a checkmark), 'PEC' (with a checkmark), and 'Fields' (with a checkmark).
- Module Settings (Right Side):** A panel for configuring the 'acmos' module, including a 'File Name' field set to 'ExampleLibrary\SamplePattern\acmos.gds' and an 'Adv...' button.
- Layout View (Bottom Center):** A 2D visualization of a device layout with a color-coded dose distribution. A scale bar indicates 100 μm. The status bar shows 'View Area [μm]: -761.324, 0.500; 2386.140, 1624.655'.
- 3D View (Right Side):** A 3D perspective view of the device structure, also showing dose distribution. A scale bar indicates 100 μm. The status bar shows coordinates: 'x: -5.2075.5626, y: ...00, 2167.448'.
- Flow History (Bottom Right):** A log of system events:
 - 11:54:30 Run to acmos finished.
 - 11:54:44 Run to PEC finished.
 - 11:55:09 Run to Fields finished.
 - 12:30:15 Remove Flat.
- Global Viewer Controls (Top Right):** A green dashed box highlights a menu with the following options:
 - Open Global Viewer In Detached M...
 - Open Global Viewer On Right
 - Open Global Viewer On Bottom
- Left Panel:** Contains navigation icons for 'Layout', 'Process Correction', 'Verification', 'Control', 'Flow Library', and 'Examples'.
- Top Bar:** Includes 'Module settings', 'Log 214', and 'Color Mode: Dose'.
- Bottom Bar:** Shows 'Mouse position(Layout Origin)[μm]: 441.0075,2094.4801' and a 'Wrap' checkbox.

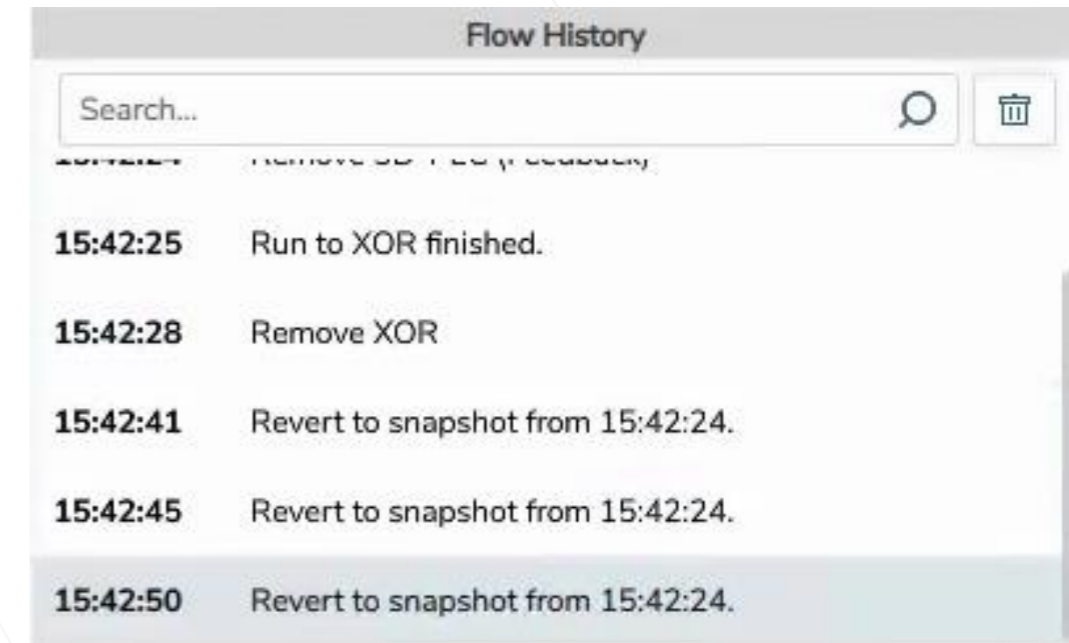
Quick Access Configuration

Quick Access can now be configured for the current user either as a *local default*, or as a *global default* in which case for all **BEAMER** users Quick Access applies for the selected values. The local default overrides the global setting.



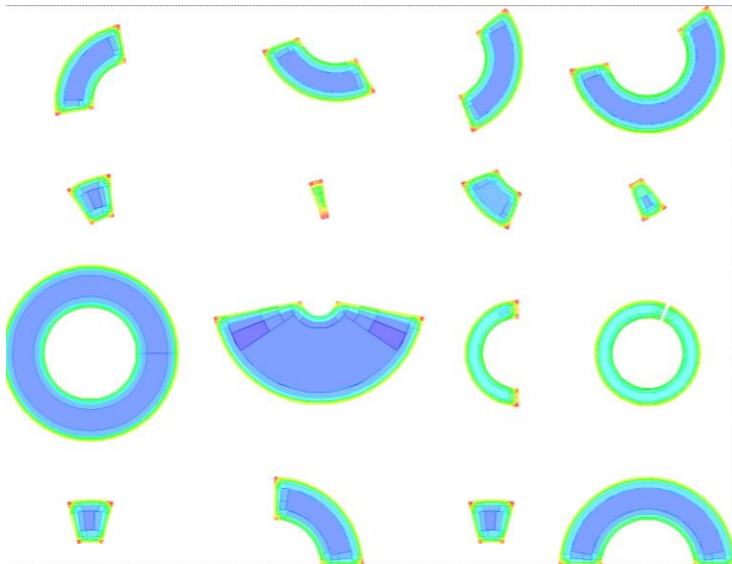
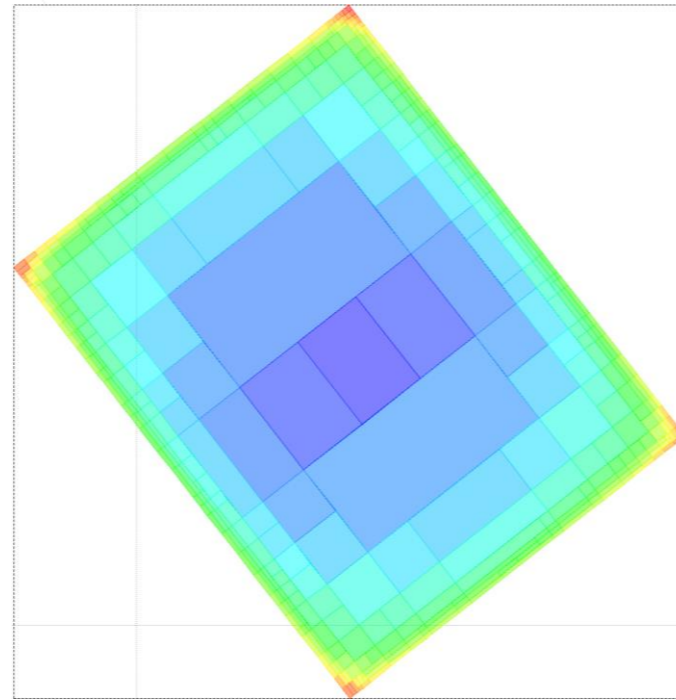
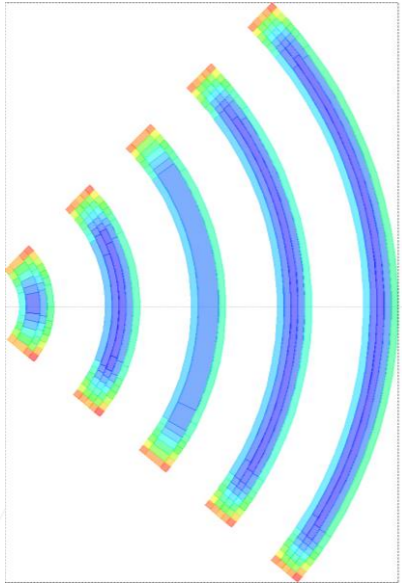
The Flow history feature allows to revert to a previous status of a module whose parameters have been since updated.

Also accidental deletes can be restored including results.



PEC

Improved PEC fracturing



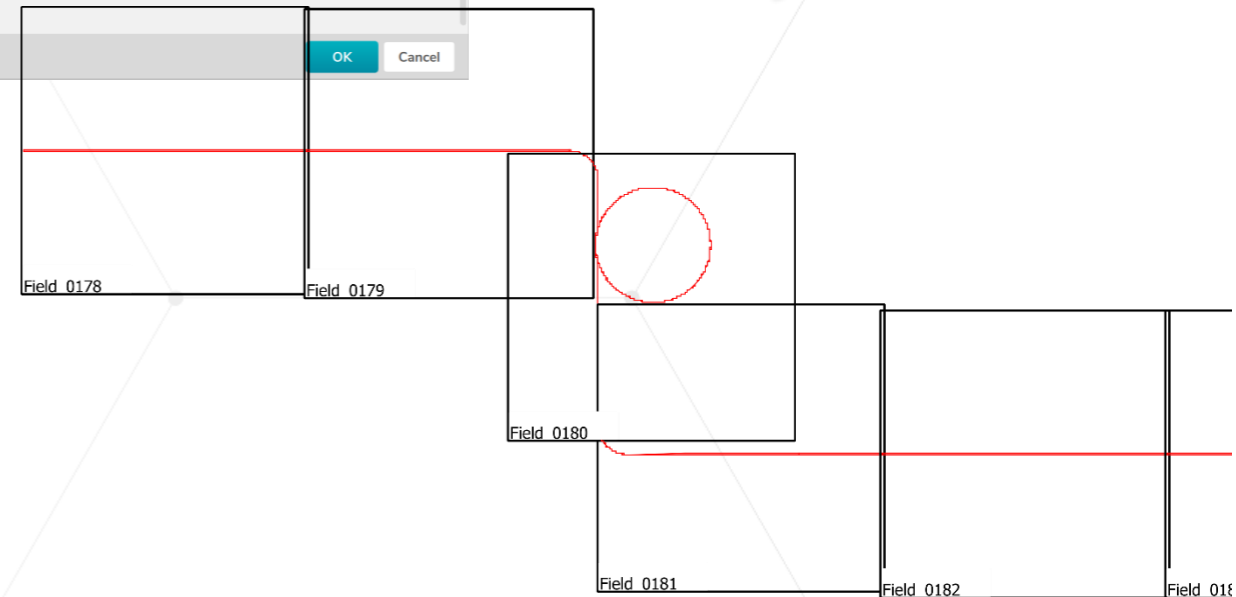
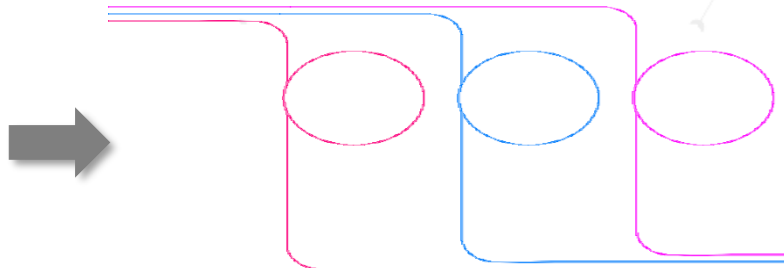
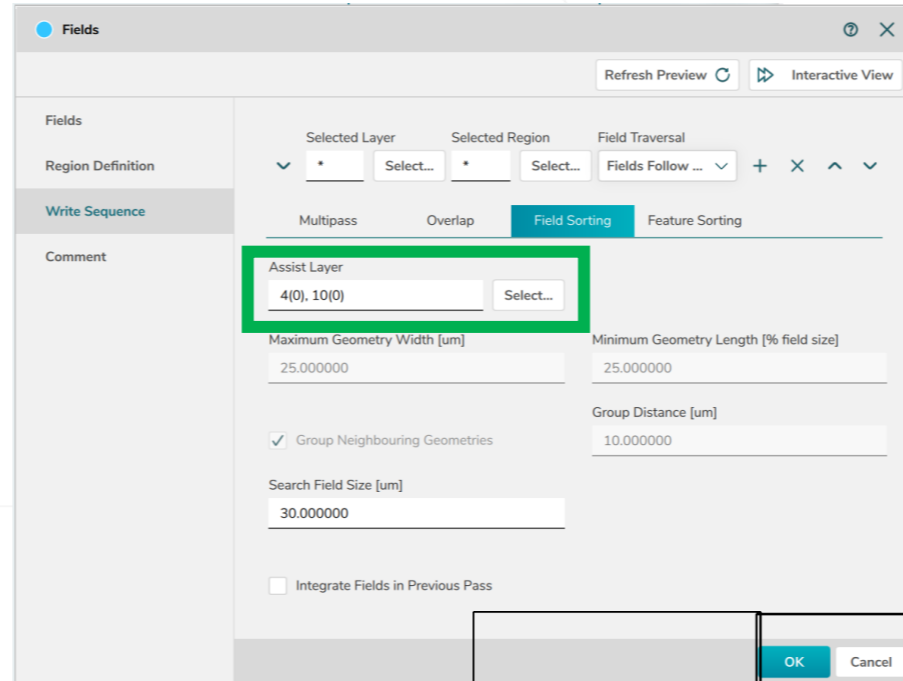
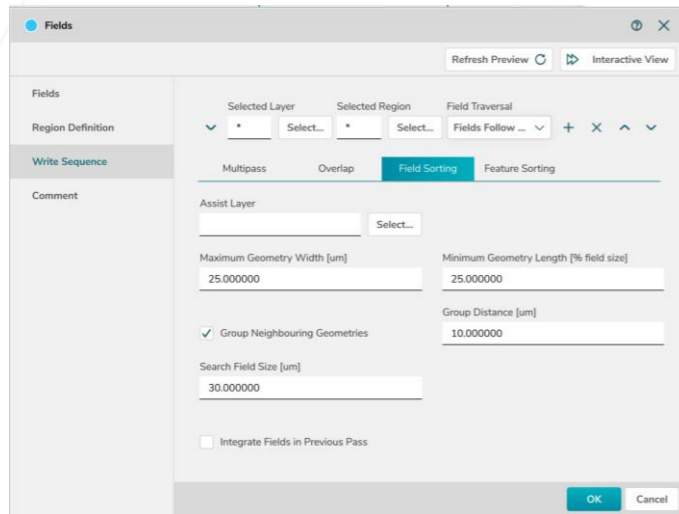
Generic element types like Circles / Arcs / Rotated Rectangles are maintained during fracturing. Dose fracturing of PEC will fracture e.g. ARC elements only into smaller ARC elements to improve the fracture quality.

Field control

Fields Module - Fields Follow Geometry - Assist Layer

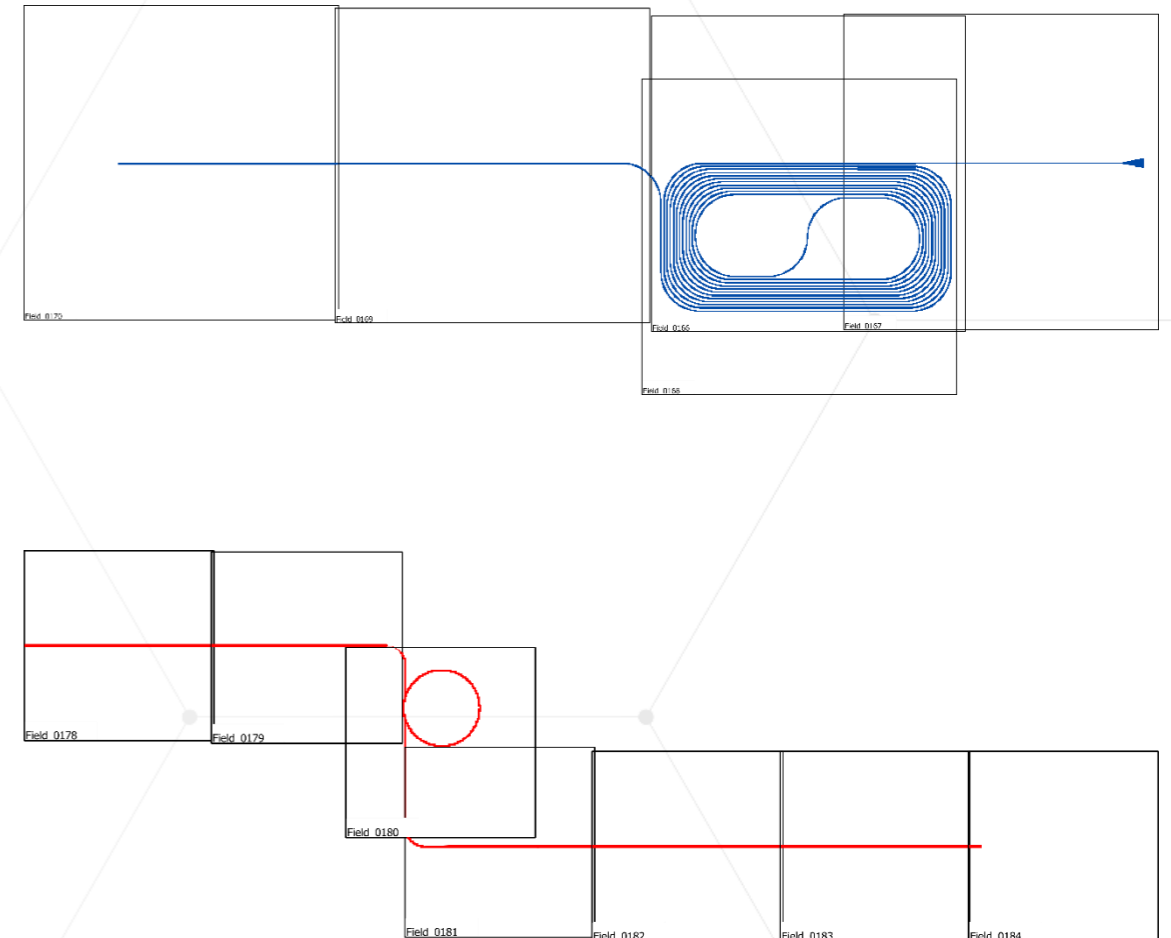
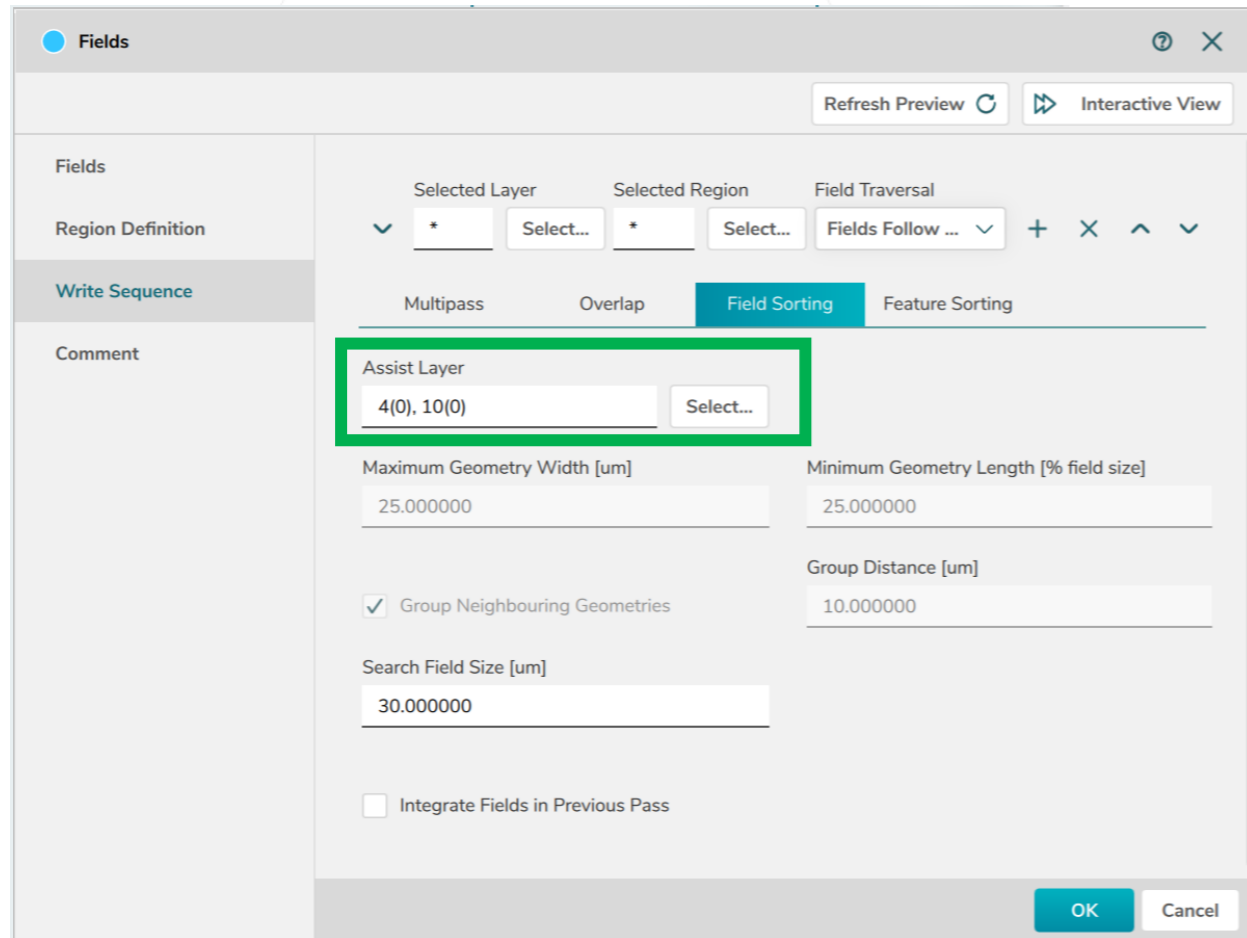
Fields Follow Geometry includes a new feature that helps to improve the quality of the results.

An *Assist Layer* can be included in the design narrowing down the geometry data that will be processed by the writing algorithm.

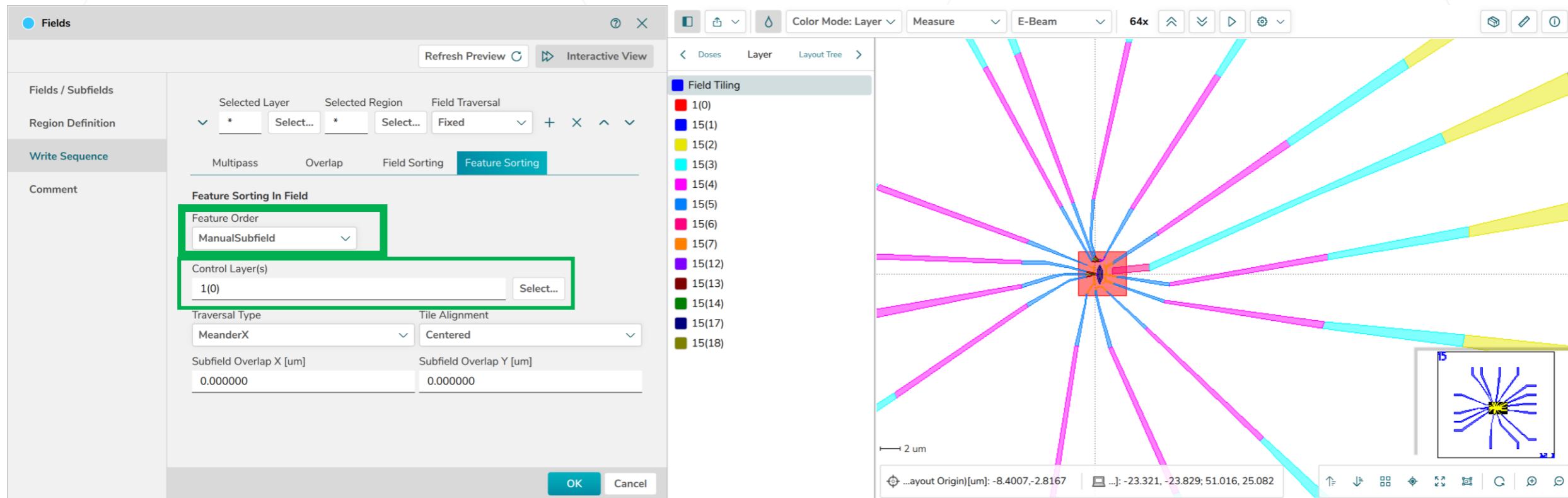


Fields Module - Fields Follow Geometry - Assist Layer

The *Assist Layer Selection* within the Fields module utilises user-predefined shapes as guides optimising different feature sorting and field sorting



The exposure order of critical regions within a Field are optimized using *ManualSubfield*
The *Control layer* can be used to identify critical layout parts



The screenshot displays the GenISys Fields module interface in ManualSubfield mode. The interface is divided into a control panel on the left and a main visualization area on the right.

Control Panel (Left):

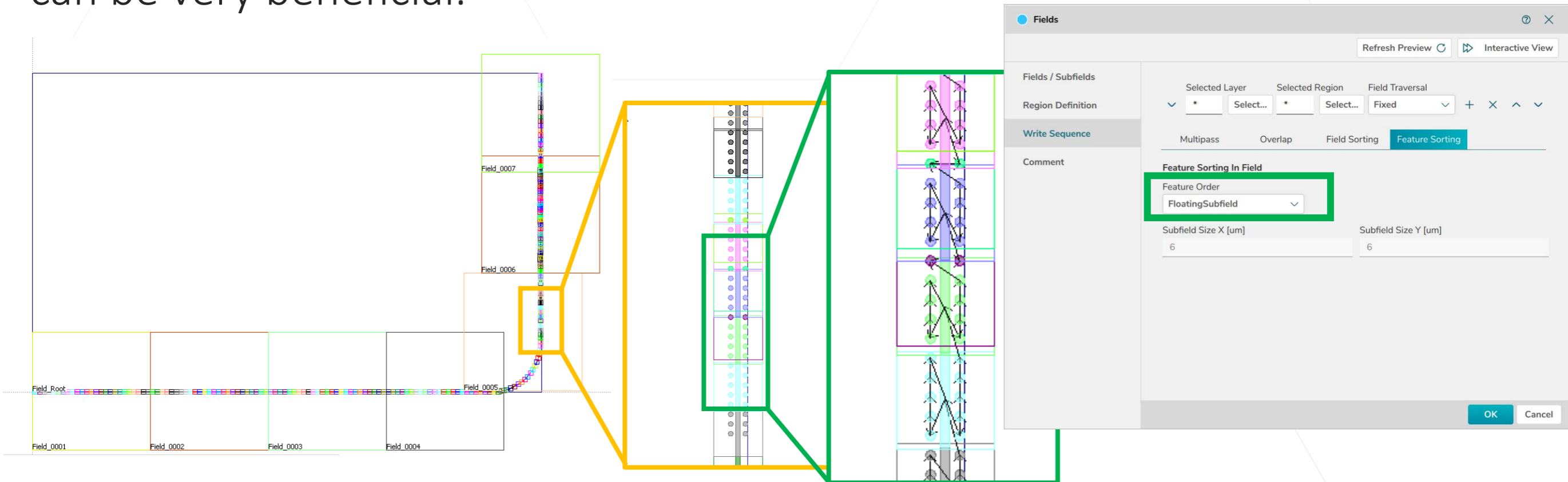
- Fields / Subfields:** Includes 'Refresh Preview' and 'Interactive View' buttons.
- Region Definition:** Shows 'Selected Layer' (*), 'Selected Region' (*), and 'Field Traversal' (Fixed).
- Write Sequence:** Includes 'Multipass', 'Overlap', 'Field Sorting', and 'Feature Sorting' (selected).
- Feature Sorting In Field:**
 - Feature Order:** Set to 'ManualSubfield'.
 - Control Layer(s):** Set to '1(0)'.
 - Traversal Type:** Set to 'MeanderX'.
 - Tile Alignment:** Set to 'Centered'.
 - Subfield Overlap X [um]:** 0.000000
 - Subfield Overlap Y [um]:** 0.000000

Main Visualization Area (Right):

- Field Tiling Legend:** Lists subfields 1(0) through 15(18) with corresponding colors.
- Field Layout:** A central red square is surrounded by numerous colored lines radiating outwards, representing the field layout.
- Toolbar:** Includes 'Color Mode: Layer', 'Measure', 'E-Beam', and a magnification of '64x'.
- Status Bar:** Shows coordinates: '...ayout Origin[um]: -8.4007,-2.8167' and '...]: -23.321,-23.829; 51.016, 25.082'.

Fields module – FloatingSubfield mode

A floating subfield algorithm has been implemented that analyses the pattern and follows the path of the layout based on the feature distribution. This works very similar to the floating algorithm in the main field sorting. For sparse patterns, to follow a path, this method can be very beneficial.



The image displays a software interface for the Fields module. On the left, a layout is shown with several fields labeled Field_0001 through Field_0007, and a Field_Root. A path is highlighted in yellow and green, showing the traversal of the layout. On the right, a 'Fields' dialog box is open, showing settings for 'Feature Sorting In Field'. The 'Feature Order' dropdown is set to 'FloatingSubfield'. Other settings include 'Subfield Size X [um]' and 'Subfield Size Y [um]', both set to 6. The dialog also has 'Refresh Preview' and 'Interactive View' buttons at the top, and 'OK' and 'Cancel' buttons at the bottom.

Path Sleeving

New Fracture Feature

The **Fracture** module includes a fast and easy way to *Generate Sleeves* on target layers using zero width path exposure characteristics increasing pattern quality without affecting throughput.

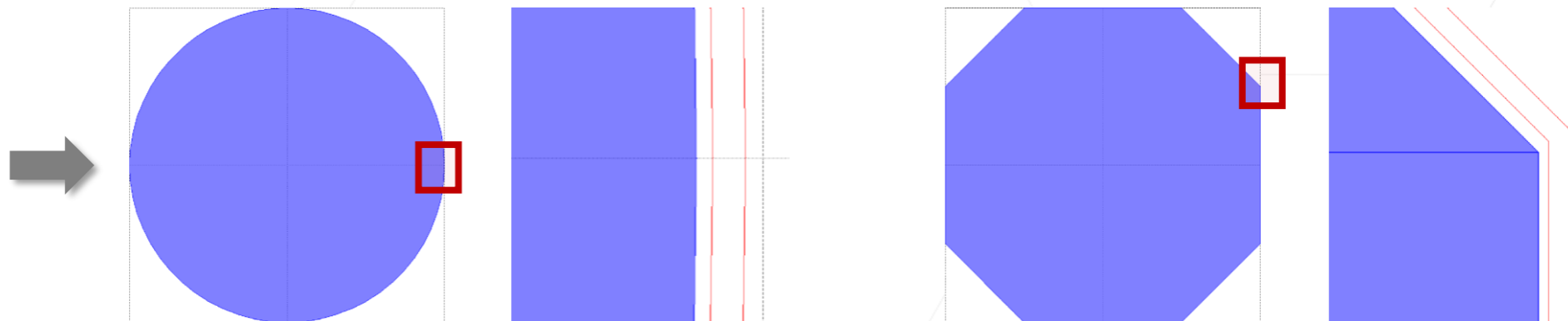
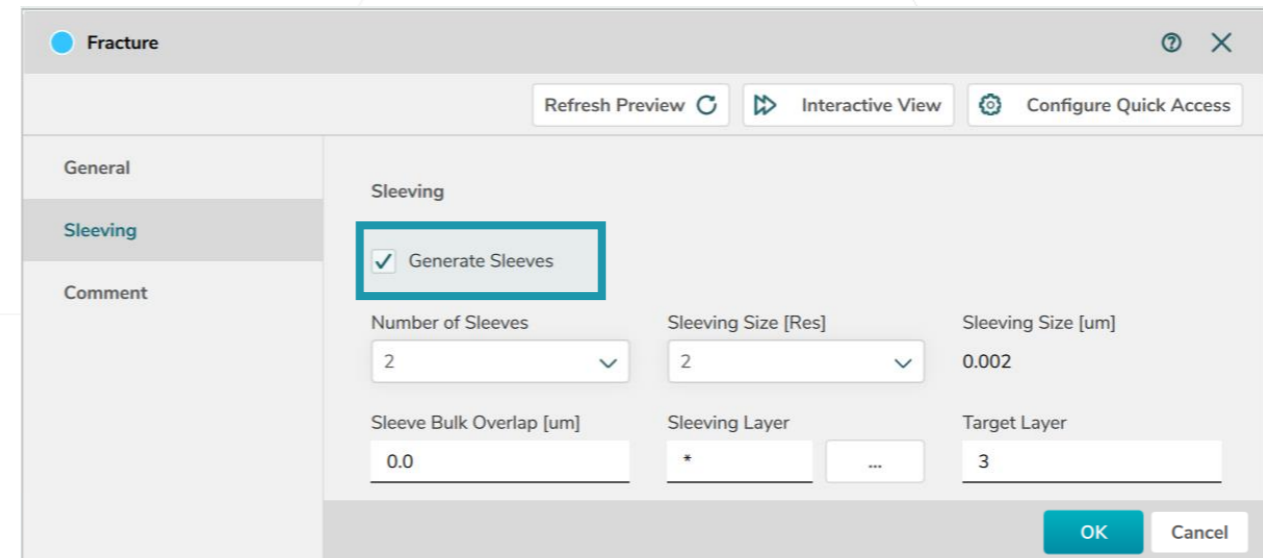
Parameters to control:

Number of Sleeves

Sleeving Size

Overlap between Sleeve and Bulk

Sleeving Layer



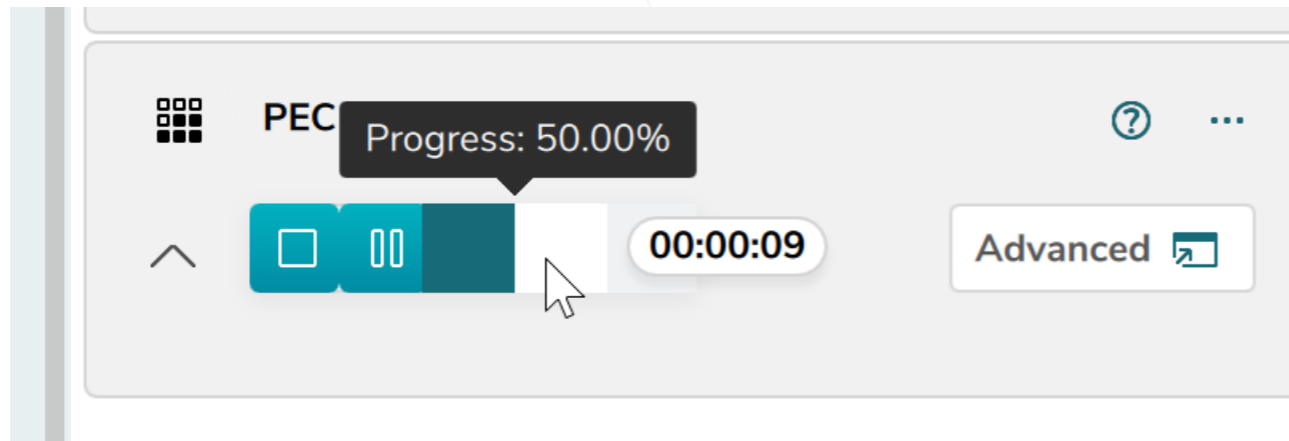
Sleeves generated by this method can find use in the capability of several tool exports:

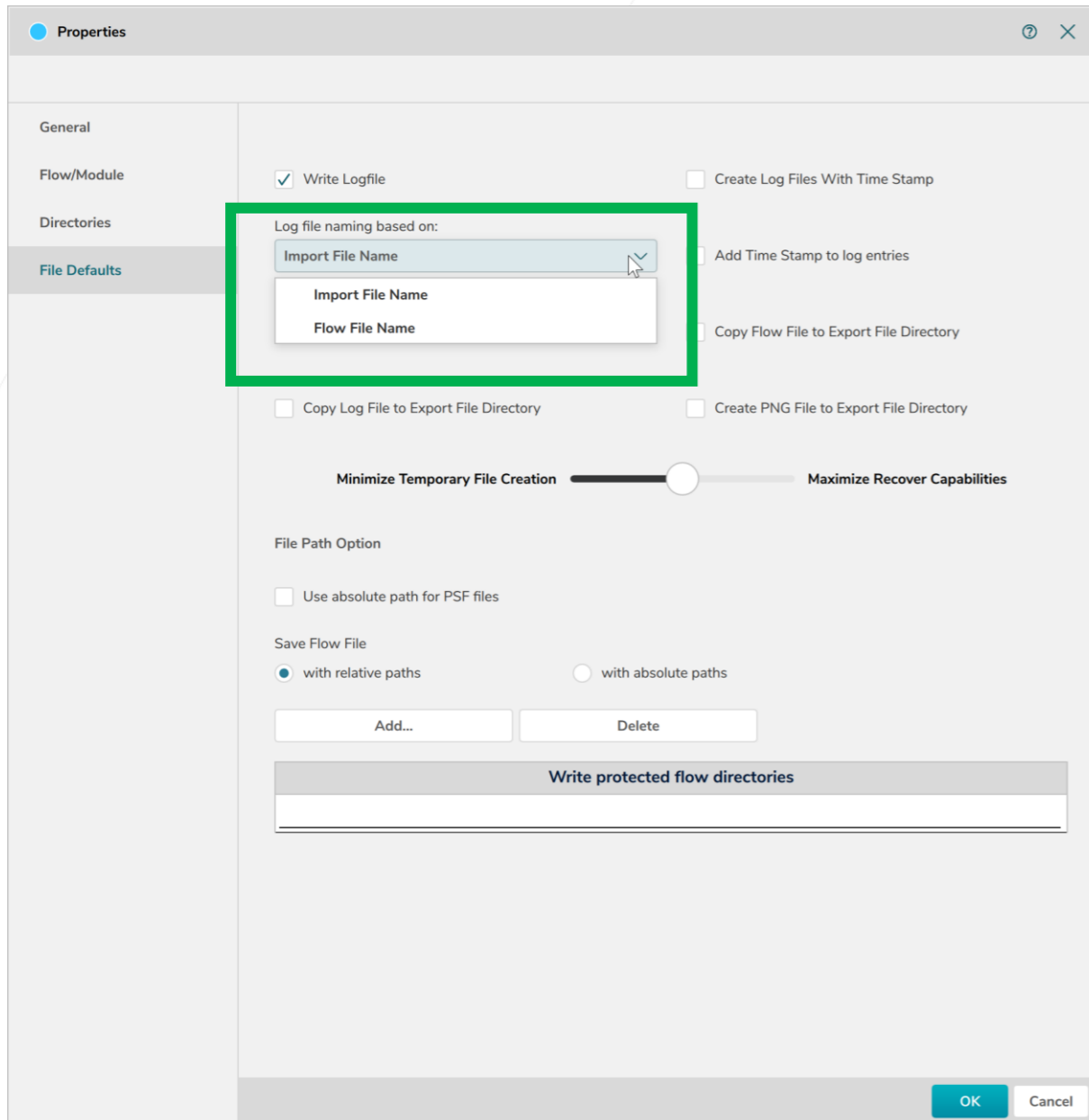
- taking benefit of the unique treatment during the exposure
- utilizing FDA to assign a compensational dose factor for example to benefit from a improved contrast at the edge of the shape
- utilizing Extract & Transform to duplicate the sleeves and create an intentional pattern smoothing (shift by half a beam step size and halving the dose)

Usability

Constant progress report

The tool tip provides more detailed information about the module status.



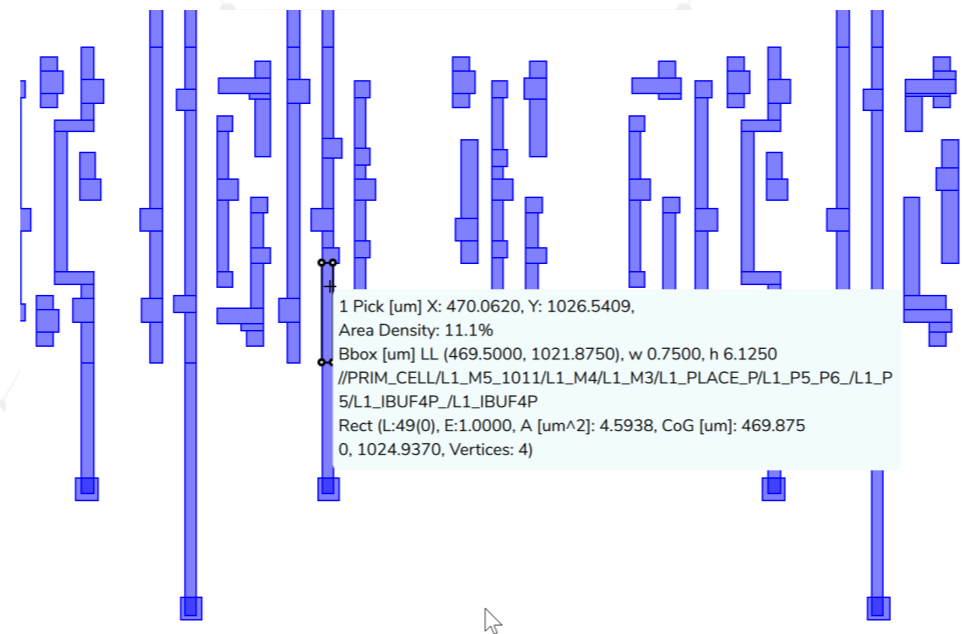
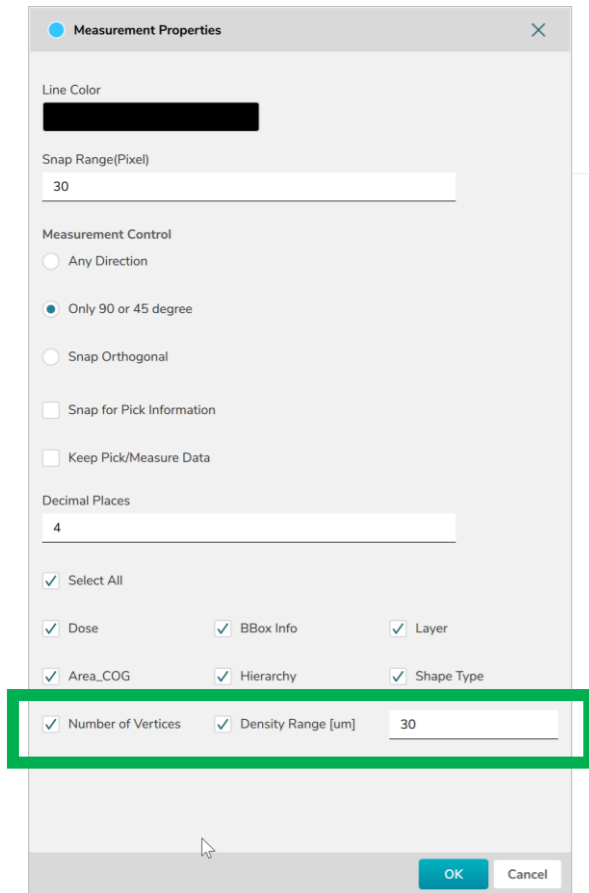


The User can choose either the Import File Name or Flow file Name as Log File Name (Properties, File Defaults).

VIEWER – pick information

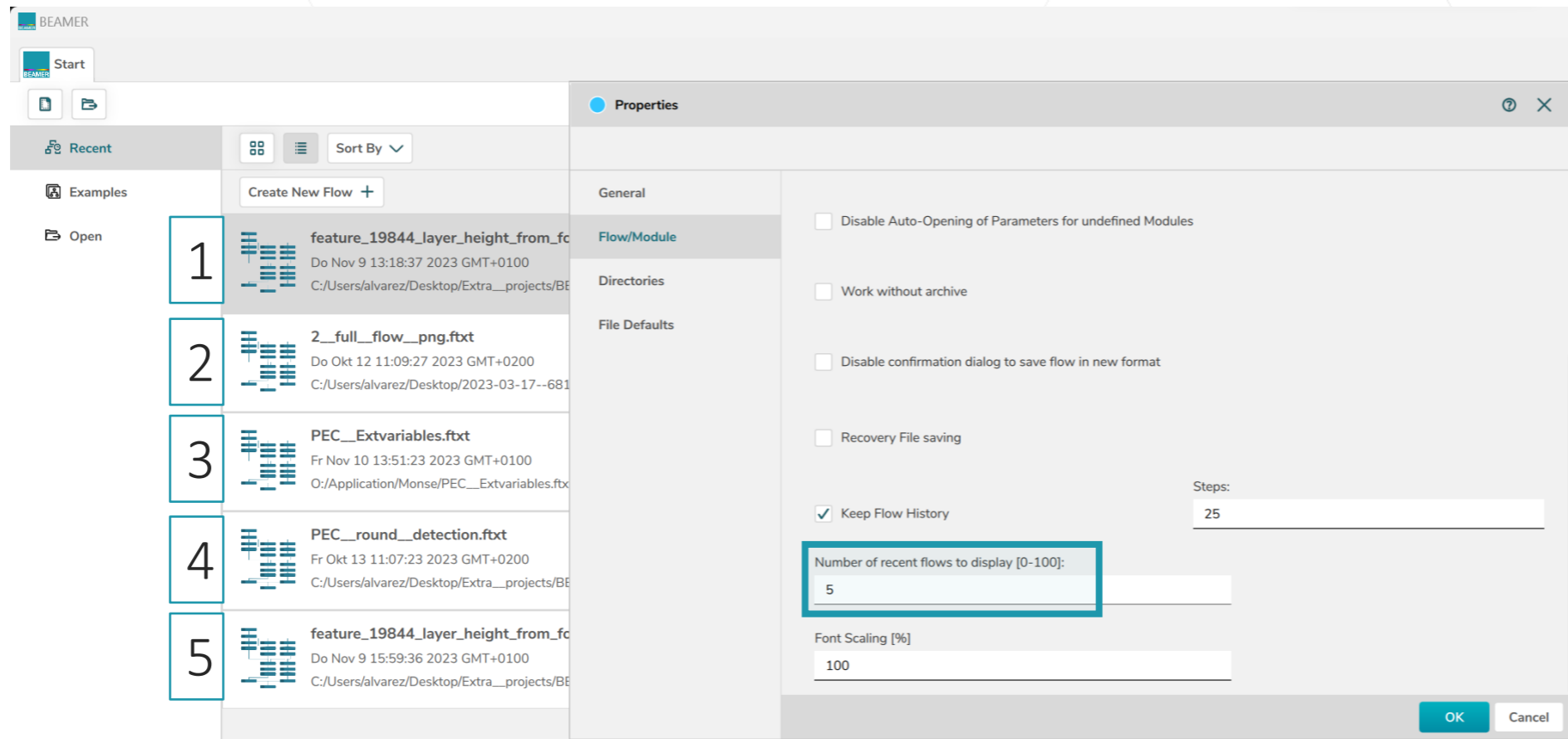
The VIEWER pick information has been extended to cover:

- Number of vertices
- Pattern density in a certain range



Controlling recent number of flows to display

Number of recent flows to display adds control in facilities with multiple BEAMER users



The screenshot shows the BEAMER software interface. On the left, a list of recent flows is displayed, with five items numbered 1 through 5. The first item is 'feature_19844_layer_height_from_fc', the second is '2__full__flow__png.ftxt', the third is 'PEC__Extvariables.ftxt', the fourth is 'PEC__round__detection.ftxt', and the fifth is 'feature_19844_layer_height_from_fc'. On the right, a 'Properties' dialog box is open, showing various settings. The 'Number of recent flows to display [0-100]:' field is highlighted with a red box and contains the value '5'. Other settings include 'Steps: 25' and 'Font Scaling [%]: 100'. The 'Keep Flow History' checkbox is checked.

Number	Flow Name	Date/Time	Path
1	feature_19844_layer_height_from_fc	Do Nov 9 13:18:37 2023 GMT+0100	C:/Users/alvarez/Desktop/Extra__projects/BE
2	2__full__flow__png.ftxt	Do Okt 12 11:09:27 2023 GMT+0200	C:/Users/alvarez/Desktop/2023-03-17--681
3	PEC__Extvariables.ftxt	Fr Nov 10 13:51:23 2023 GMT+0100	O:/Application/Monse/PEC__Extvariables.ftx
4	PEC__round__detection.ftxt	Fr Okt 13 11:07:23 2023 GMT+0200	C:/Users/alvarez/Desktop/Extra__projects/BE
5	feature_19844_layer_height_from_fc	Do Nov 9 15:59:36 2023 GMT+0100	C:/Users/alvarez/Desktop/Extra__projects/BE

BEAMER 7.0

```
BEAMER.bias(**gobject**, {'SoftFrame': 0.300000, 'Bias': 0.000000, 'CornerExtension': 1.000000, 'SuppressExtensionOfTinyCorners': False, 'Mode': 'X-Y', 'HierarchicalProcessing': True, 'LayerAssignment': 'AllLayer', 'TargetLayer': '0(0)', 'ExtentType': 'Automatic'})
```

```
BEAMER.fracture(**gobject**, {'FractureLayer': '*', 'KeepResolution': True, 'Resolution': 0.001000, 'BeamStepSize': 1, 'CurveApproxTolerance': 0.100000, 'CurveTolerance': 1.000000, 'FractureAxis': 'X_AND_Y', 'FractureMode': 'LRFT', 'BssFracturing': False, 'Symmetric Fracturing': False, 'FractureAngle': 'AnyAngle', 'FractureTolerance': 1.000000, 'FractureType': 'Flat'})
```

BEAMER 7.1

```
1 BEAMER.bias( **gobject**,
2     {'SoftFrame' : 0.300000,
3     'Bias' : 0.000000,
4     'CornerExtension' : 1.000000,
5     'SuppressExtensionOfTinyCorners' : False,
6     'Mode' : 'X-Y',
7     'HierarchicalProcessing' : True,
8     'LayerAssignment' : 'AllLayer',
9     'TargetLayer' : '0(0)',
10    'ExtentType' : 'Automatic'} )
11 |
```

The formatting of Python code has been improved for better readability.

```
1 BEAMER.fracture( **gobject**,
2     {'FractureLayer' : '*',
3     'KeepResolution' : True,
4     'Resolution' : 0.001000,
5     'BeamStepSize' : 1,
6     'NumberSleeves' : 1,
7     'SleevingSize' : 1,
8     'SleeveBulkOverlap' : 0.0,
9     'SleevingLayer' : '*',
10    'SleevingTargetLayer' : '',
11    'CurveApproxTolerance' : 0.100000,
12    'CurveTolerance' : 1.000000,
13    'FractureAxis' : 'X_AND_Y',
14    'FractureMode' : 'LRFT',
15    'BssFracturing' : False,
16    'SleeveGeneration' : False,
17    'Symmetric Fracturing' : False,
18    'FractureAngle' : 'AnyAngle',
19    'FractureTolerance' : 1.000000,
20    'FractureType' : 'Flat'} )
21
```

RuleOPC – Import/Export

Rule Based Process Correction

Configure Quick Access

General

Layer(s): *

Min Free Edge Size [um]: 0.050000

Min Segment Size [um]: 0.100000

Min Corner Size [um]: 0.150000

Max Segment Size [um]: 1000000.000000

Bias Limit [um]: 0.000000

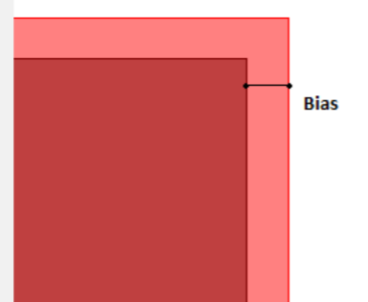
Insert Delete Up Down

<input checked="" type="checkbox"/>	Action	Dependence Param	Scenario	Condition
<input checked="" type="checkbox"/>	Bias	CD	AnySegment	true
<input checked="" type="checkbox"/>		-	-	

Condition

CD [um]	Bias [um]
0.000000	0.000000

Import Export Insert Delete



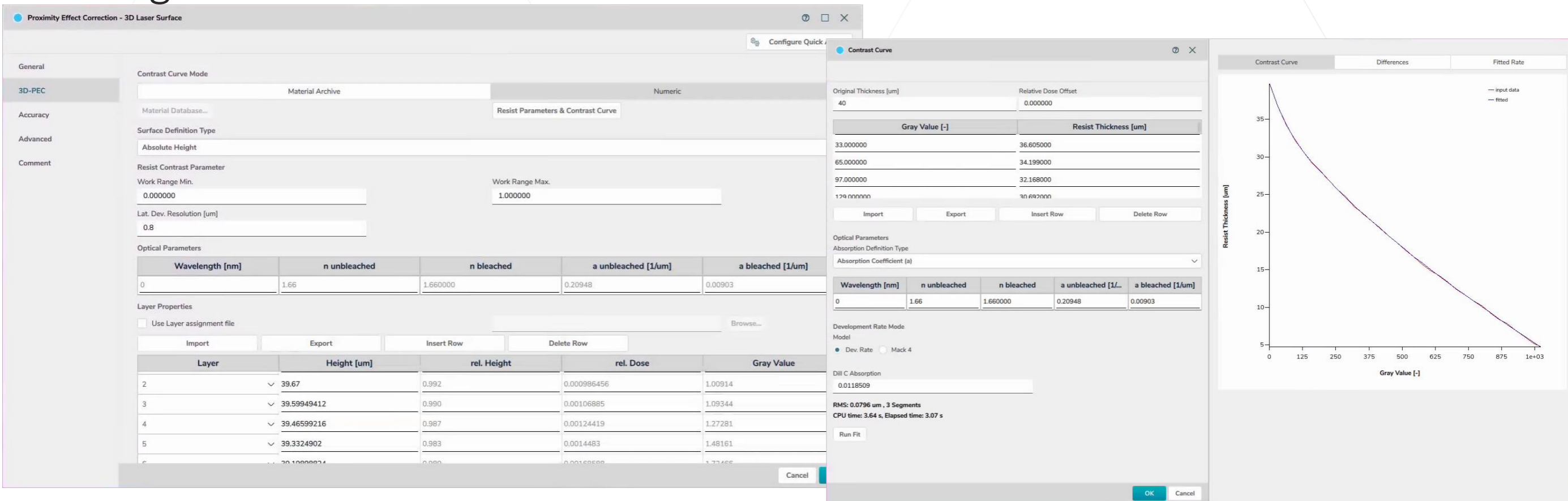
Segment Assignment Preview OK Cancel

For easier rule setup an import/export option has been added for the CD dependend bias correction

3D Laser Surface

Optimized user interface to follow a top-to-bottom approach setting up the correction.

Moved optical parameters to the *Resist Parameters & Contrast Curve* dialog.

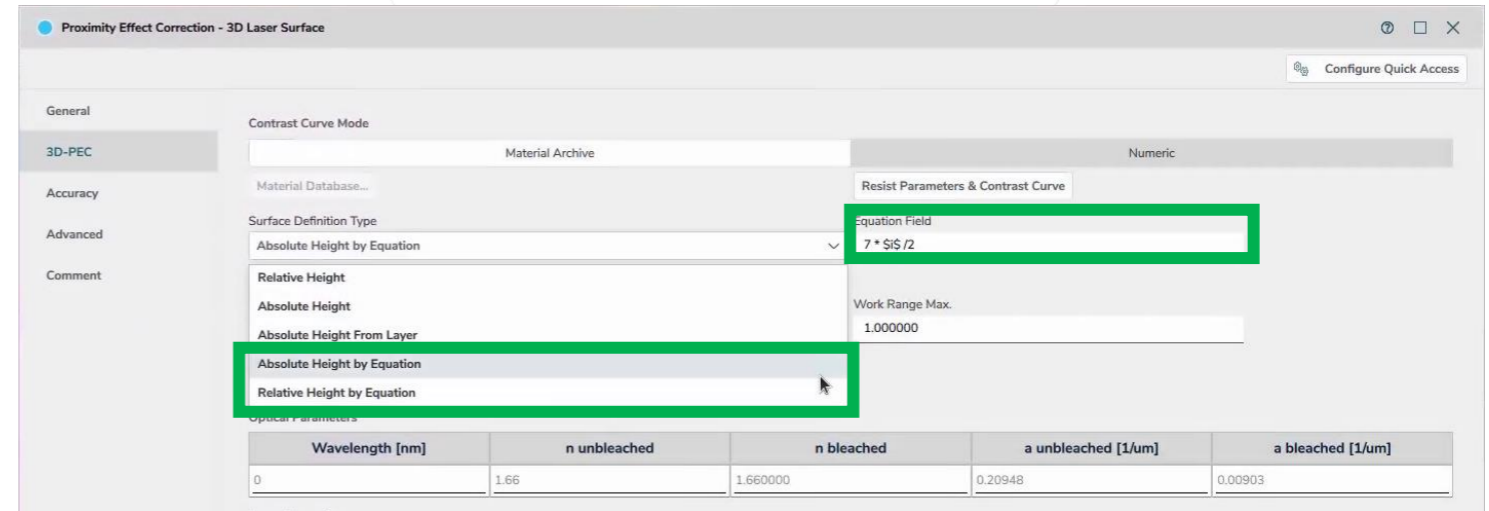


The screenshot displays the 'Proximity Effect Correction - 3D Laser Surface' software interface. The main window is titled 'Contrast Curve' and is divided into several sections:

- General:** Includes 'Contrast Curve Mode' (Material Archive, Numeric), 'Material Database...', and 'Resist Parameters & Contrast Curve'.
- Surface Definition Type:** Set to 'Absolute Height'.
- Resist Contrast Parameter:** Includes 'Work Range Min.' (0.000000) and 'Work Range Max.' (1.000000).
- Optical Parameters:** A table with columns for Wavelength [nm], n unbleached, n bleached, a unbleached [1/um], and a bleached [1/um].
- Layer Properties:** Includes a 'Use Layer assignment file' checkbox and a 'Browse...' button.
- Layer Table:** A table with columns for Layer, Height [um], rel. Height, rel. Dose, and Gray Value.
- Contrast Curve Dialog:** A separate window showing 'Original Thickness [um]' (40), 'Relative Dose Offset' (0.000000), and a table of Gray Value [-] vs Resist Thickness [um]. It also includes 'Optical Parameters' and 'Development Rate Mode'.
- Graph:** A plot of Resist Thickness [um] vs Gray Value [-]. The y-axis ranges from 5 to 35, and the x-axis ranges from 0 to 1e+03. The graph shows 'input data' (red dots) and a 'fitted' curve (blue line).

2 new *Surface Definition Types*:

- Absolute Height by Equation
- Relative Height by Equation



Layer properties table is filled using an equation defined by the user and the *Laser Contrast Curve*.

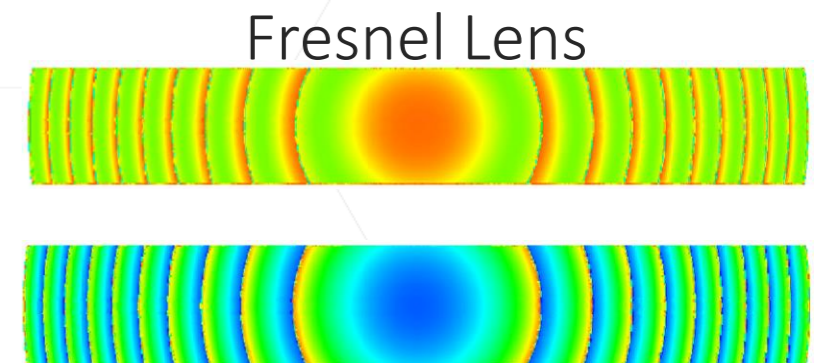
Layer	Height [um]	rel. Height	rel. Dose	Gray Value
30 (\$i\$: 1)	0.032110	0.003	0.983141	250.701
31 (\$i\$: 2)	0.064220	0.006	0.977	249.135
32 (\$i\$: 3)	0.096330	0.010	0.9709	247.58
33 (\$i\$: 4)	0.128440	0.013	0.964839	246.034
34 (\$i\$: 5)	0.160550	0.016	0.958815	244.498

Only **\$i\$** is predefined, but any type of equation can be used under the Contrast Curve limits.

Example of Equations:

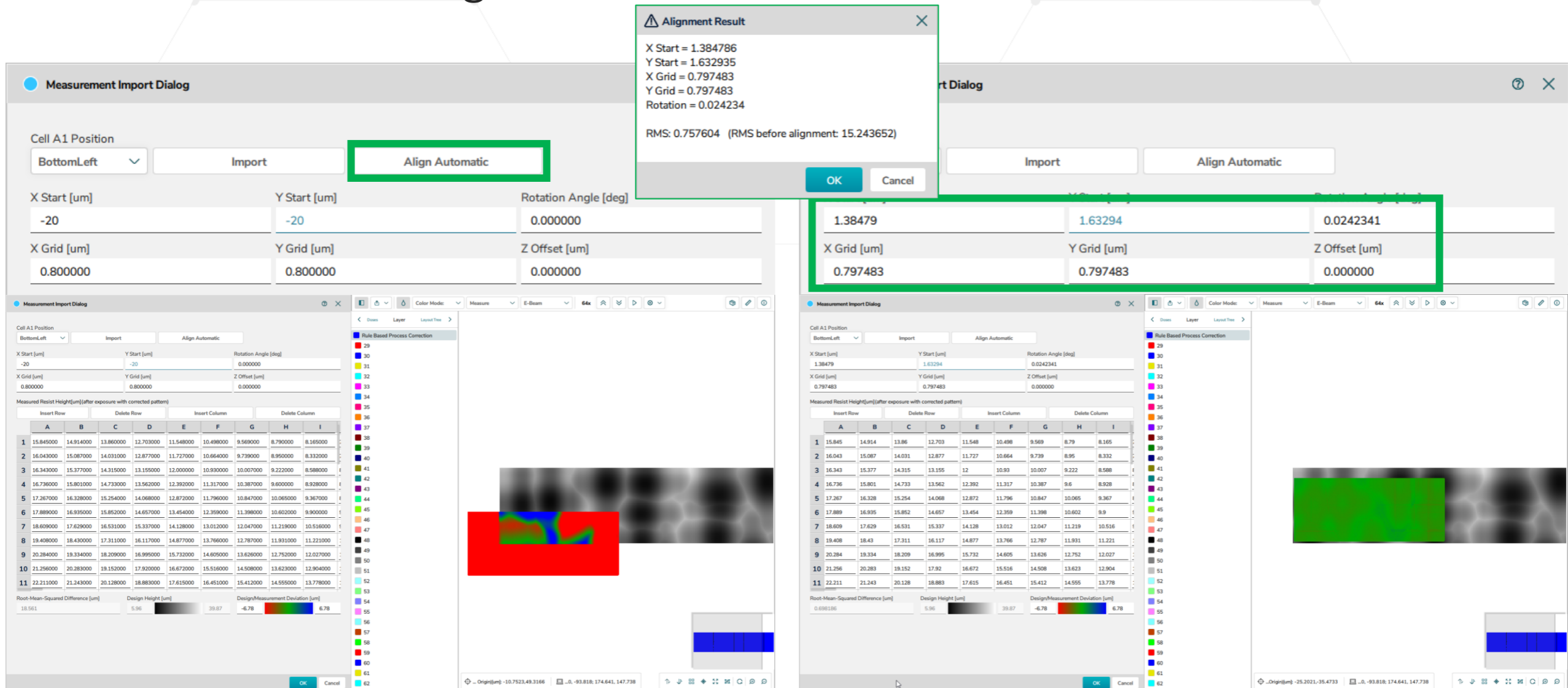
$$\sin \left(\$i\$ * \frac{3.1416}{180} \right)$$

$$7 * \frac{\$i\$}{218}$$



Feedback Loop – automatic alignment

- Imported measurement data can be automatically aligned now to the correction target.



The screenshot displays the BEAMER 7.1 software interface, specifically the Measurement Import Dialog and the Alignment Result dialog. The Measurement Import Dialog has the 'Align Automatic' button highlighted with a green box. The Alignment Result dialog shows the following values:

Alignment Result

- X Start = 1.384786
- Y Start = 1.632935
- X Grid = 0.797483
- Y Grid = 0.797483
- Rotation = 0.024234
- RMS: 0.757604 (RMS before alignment: 15.243652)

The Measurement Import Dialog also shows the following values:

- Cell A1 Position: BottomLeft
- X Start [um]: -20
- Y Start [um]: -20
- Rotation Angle [deg]: 0.000000
- X Grid [um]: 0.800000
- Y Grid [um]: 0.800000
- Z Offset [um]: 0.000000

The Alignment Result dialog also shows the following values:

- X Start [um]: 1.38479
- Y Start [um]: 1.63294
- Rotation Angle [deg]: 0.0242341
- X Grid [um]: 0.797483
- Y Grid [um]: 0.797483
- Z Offset [um]: 0.000000

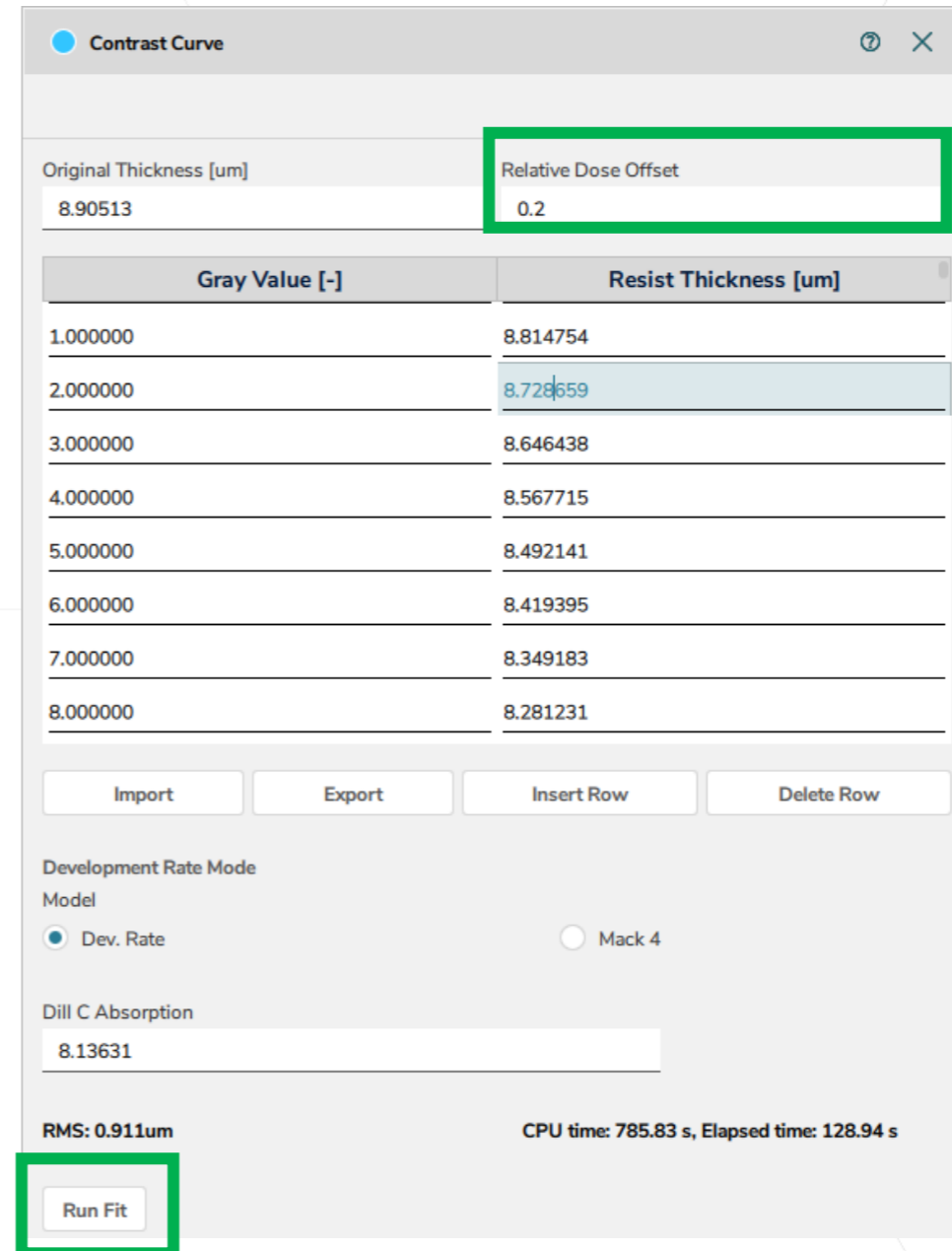
The Measurement Import Dialog also displays a table of Measured Resist Height [um] (after exposure with corrected pattern) and a color-coded image of the resist pattern.

Insert Row	Delete Row	Insert Column	Delete Column						
A	B	C	D	E	F	G	H	I	
1	15.845000	14.914000	13.860000	12.703000	11.548000	10.498000	9.569000	8.790000	8.165000
2	16.043000	15.087000	14.031000	12.877000	11.727000	10.664000	9.739000	8.950000	8.332000
3	16.343000	15.377000	14.315000	13.155000	12.000000	10.930000	10.007000	9.222000	8.588000
4	16.736000	15.801000	14.733000	13.562000	12.392000	11.317000	10.387000	9.600000	8.928000
5	17.267000	16.328000	15.254000	14.068000	12.872000	11.796000	10.847000	10.065000	9.367000
6	17.889000	16.935000	15.852000	14.657000	13.454000	12.359000	11.398000	10.602000	9.900000
7	18.609000	17.629000	16.531000	15.337000	14.128000	13.012000	12.047000	11.219000	10.516000
8	19.408000	18.430000	17.311000	16.117000	14.877000	13.766000	12.787000	11.931000	11.221000
9	20.284000	19.334000	18.209000	16.995000	15.732000	14.605000	13.626000	12.752000	12.027000
10	21.256000	20.283000	19.152000	17.920000	16.672000	15.516000	14.508000	13.623000	12.904000
11	22.211000	21.243000	20.128000	18.883000	17.615000	16.451000	15.412000	14.555000	13.778000

Dose Offset in Contrast Curve

The Relative Dose Offset is introduced to consider non-zero exposure dose for Gray value 0.

- The whole gray value range covers the relative exposure dose between relative dose offset and 1.
- The change of relative dose offset affects the contrast curve fitting result. User needs to rerun the fit.
- It offers the full number of gray values in a relevant dose range for finer granularity.



The screenshot shows the 'Contrast Curve' window with the following data and controls:

Gray Value [-]	Resist Thickness [um]
1.000000	8.814754
2.000000	8.728659
3.000000	8.646438
4.000000	8.567715
5.000000	8.492141
6.000000	8.419395
7.000000	8.349183
8.000000	8.281231

Other fields and controls:

- Original Thickness [um]: 8.90513
- Relative Dose Offset: 0.2
- Buttons: Import, Export, Insert Row, Delete Row
- Development Rate Mode: Model (radio buttons)
- Dev. Rate (selected) / Mack 4
- Dill C Absorption: 8.13631
- RMS: 0.911um
- CPU time: 785.83 s, Elapsed time: 128.94 s
- Run Fit button

Thank You!

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