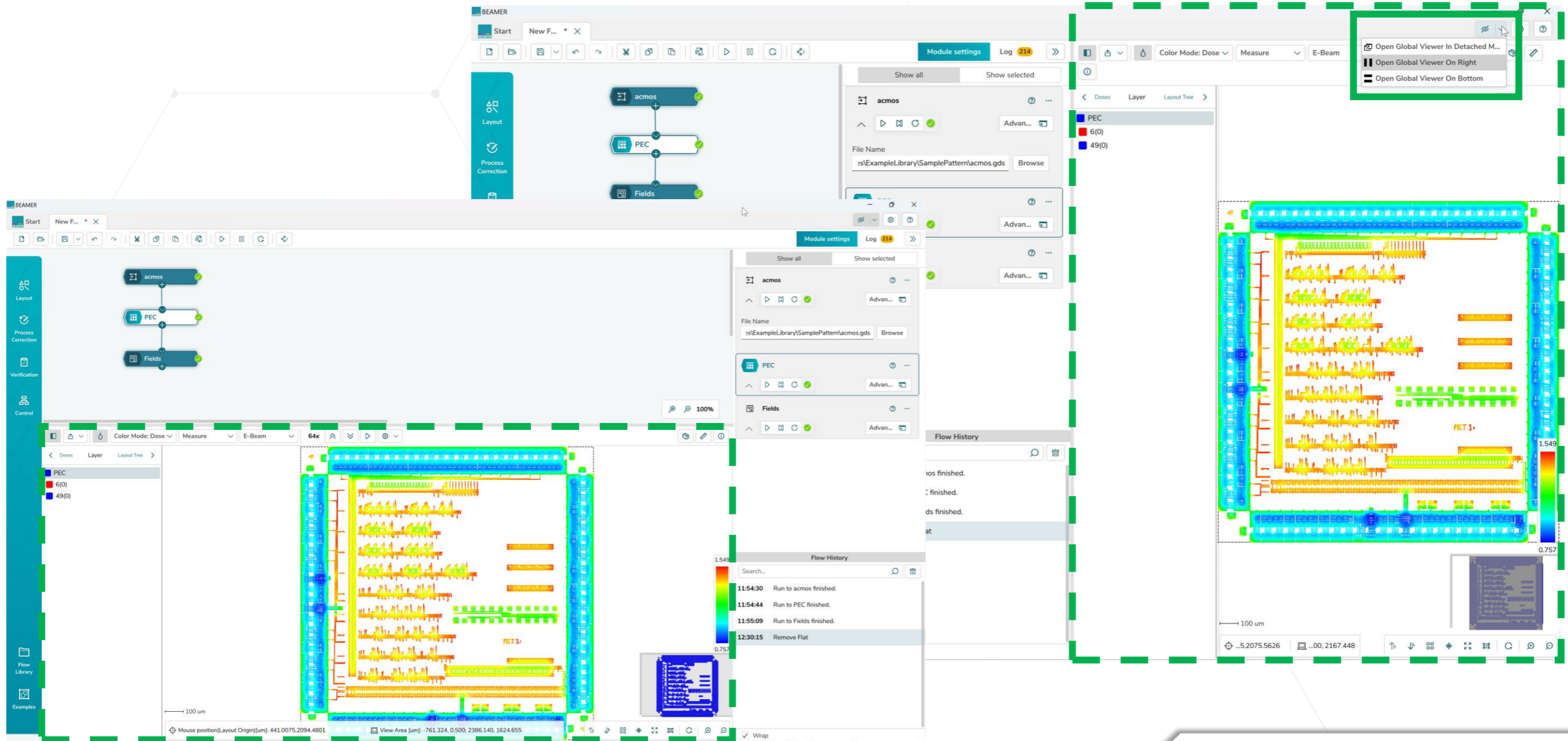


BEAMER

Update – What's new / What's coming up

Graphical user interface

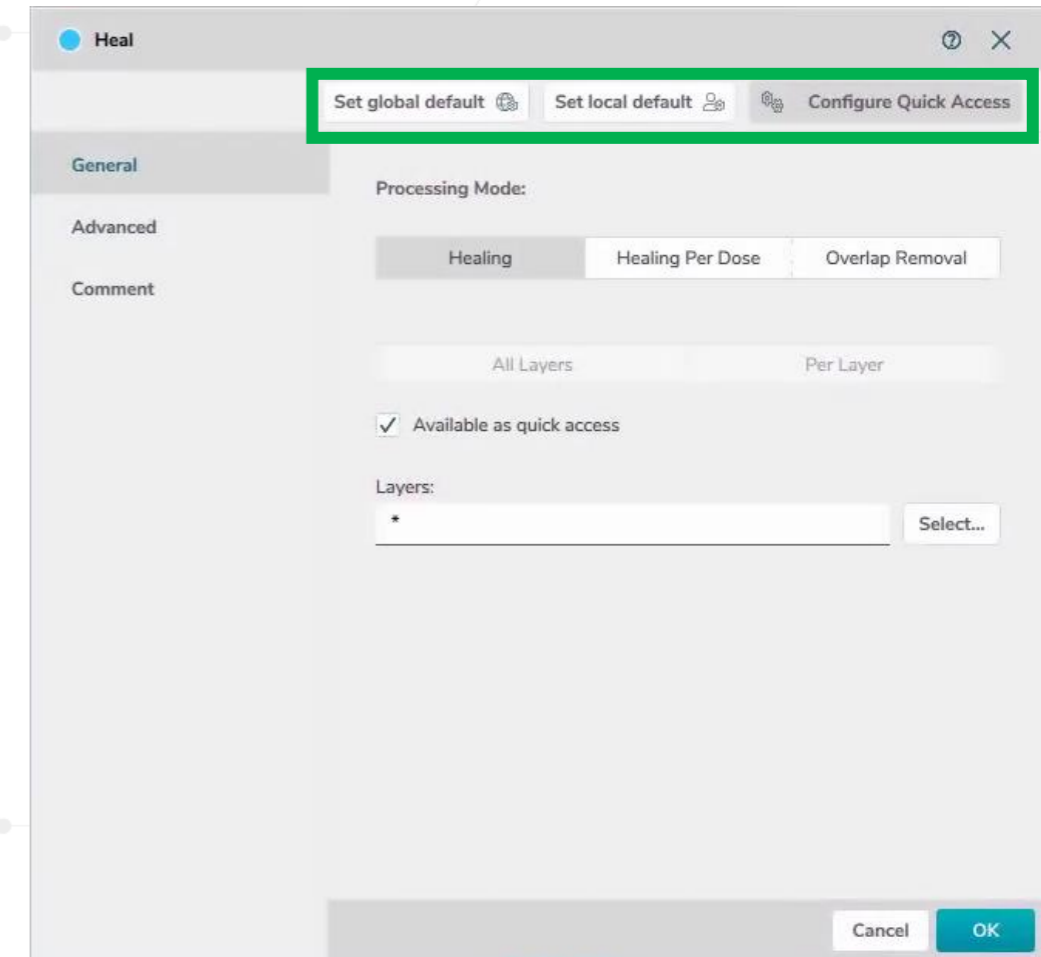


The screenshot displays the BEAMER software interface, which is divided into several functional areas:

- Workflow Diagram (Top Center):** A vertical sequence of three modules: 'acmos', 'PEC', and 'Fields', each with a green checkmark indicating successful completion.
- Module Settings (Right Side):** A panel for configuring the selected module. It shows 'acmos' with a file path: 'ExampleLibrary\SamplePattern\acmos.gds'. Below it, 'PEC' and 'Fields' settings are also visible.
- 2D Layout View (Bottom Left):** A top-down view of the device layout. It features a color-coded layer stack: PEC (blue), 6(O) (red), and 49(O) (dark blue). A scale bar indicates 100 μm.
- 3D Visualization (Bottom Right):** A perspective view of the device structure, showing the layout on a substrate. A color scale on the right indicates height or material properties, ranging from 0.757 to 1.549 μm.
- Flow History (Bottom Center):** 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 three options:
 - Open Global Viewer In Detached M...
 - Open Global Viewer On Right
 - Open Global Viewer On Bottom

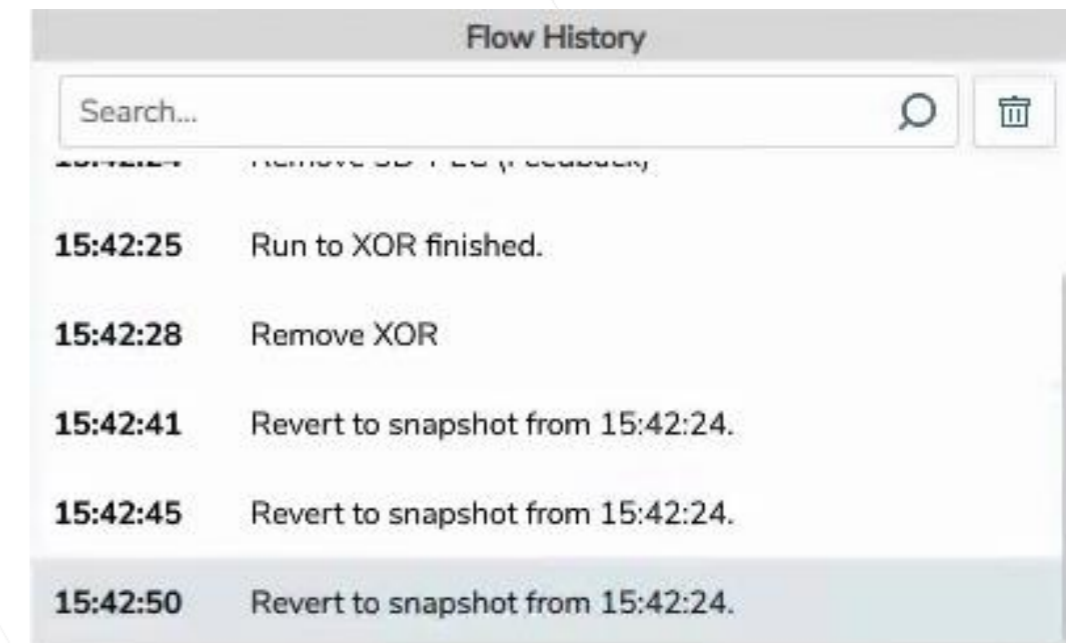
Quick Access Configuration

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.



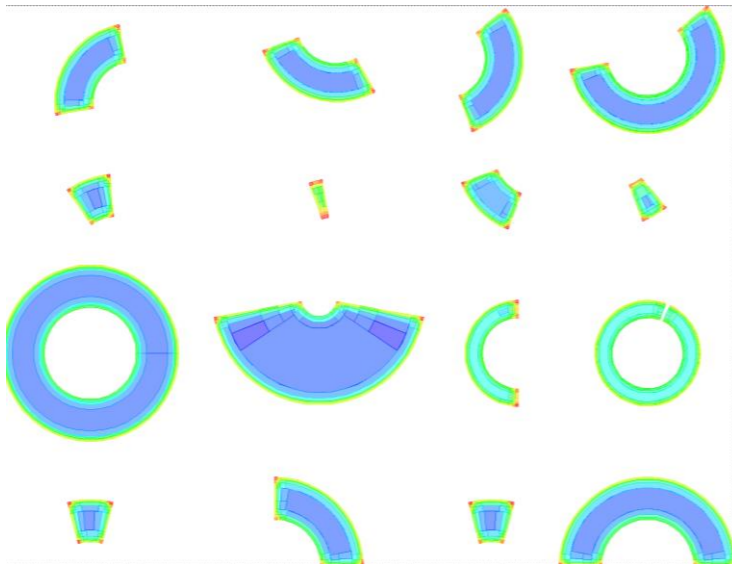
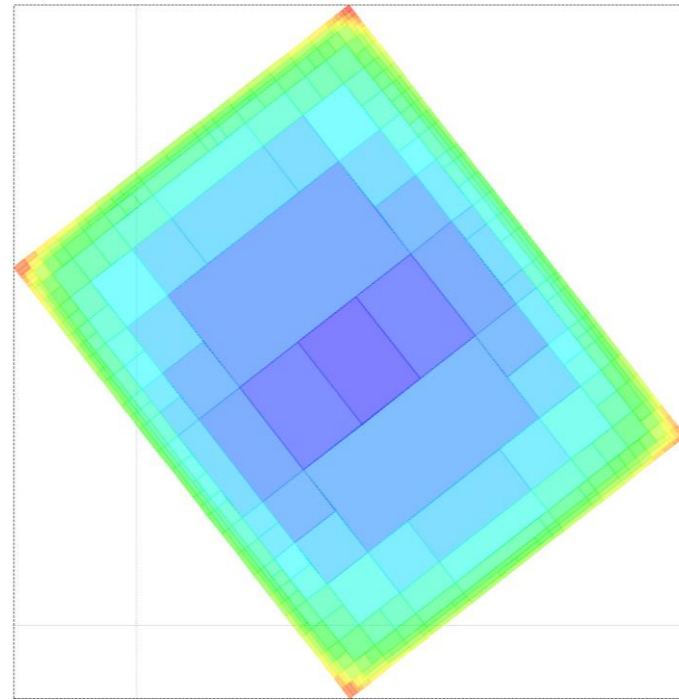
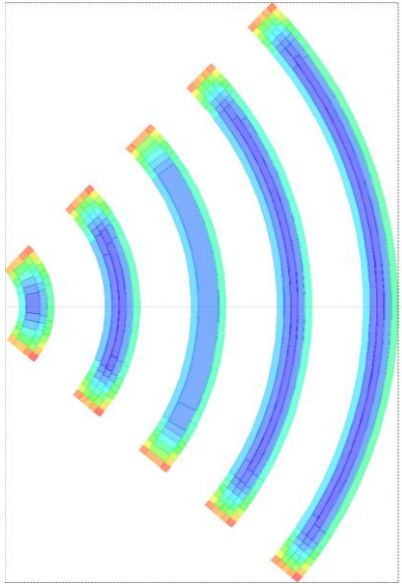
The Flow history feature allows to revert to a previous status of a module whose parameters have been since updated.

Also accidental deletes can be restored including results.



PEC

Improved PEC fracturing

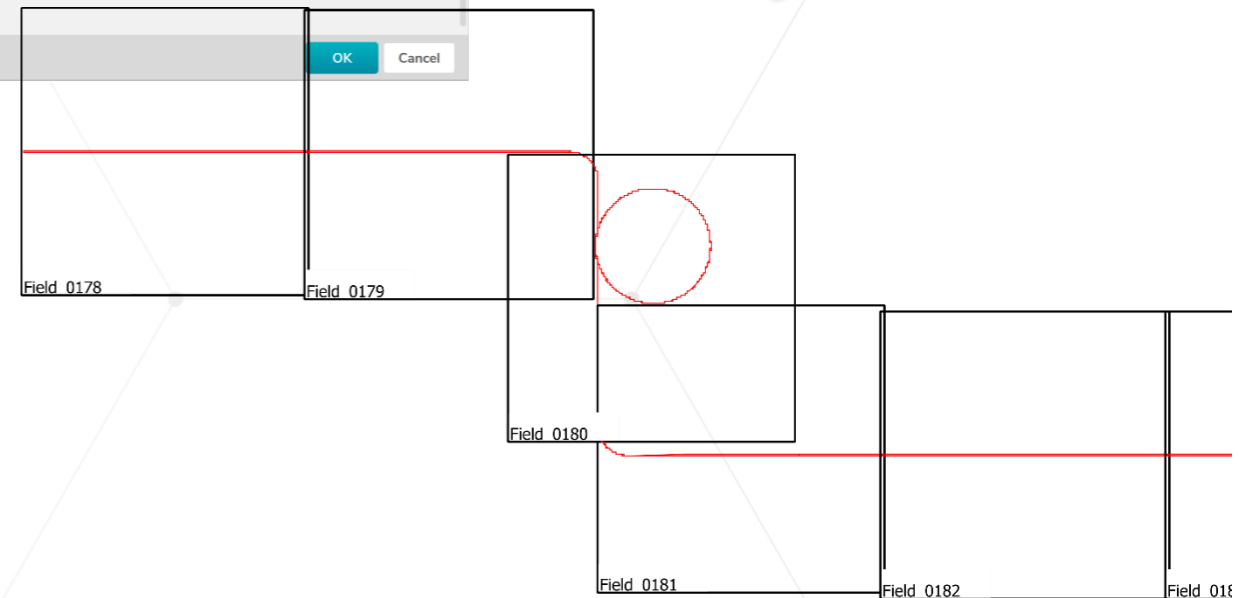
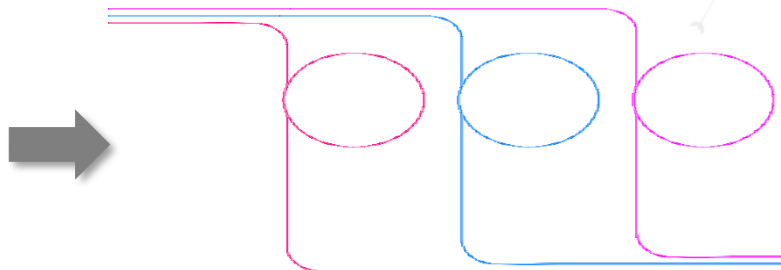
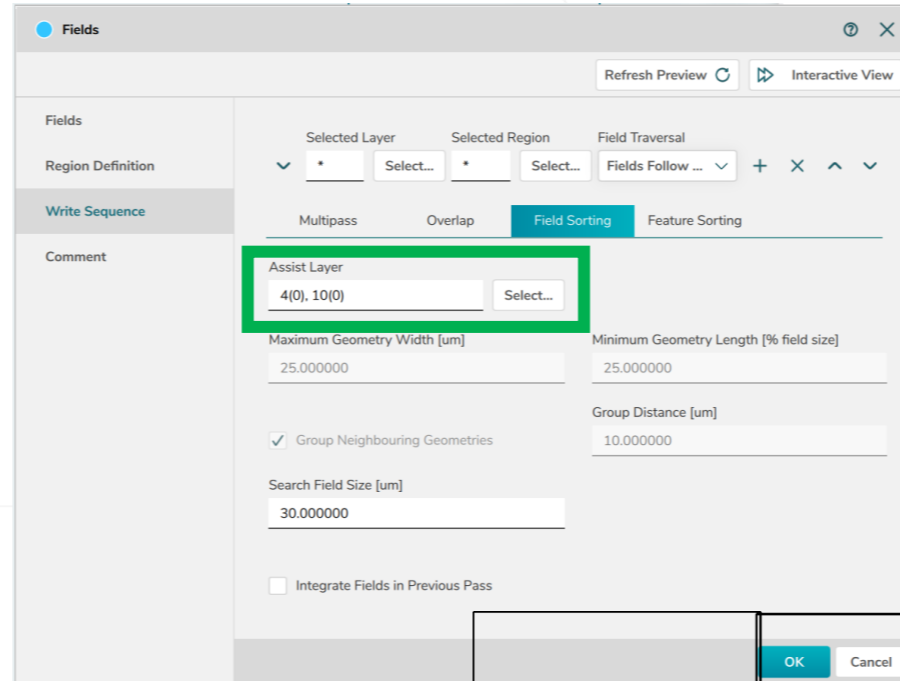
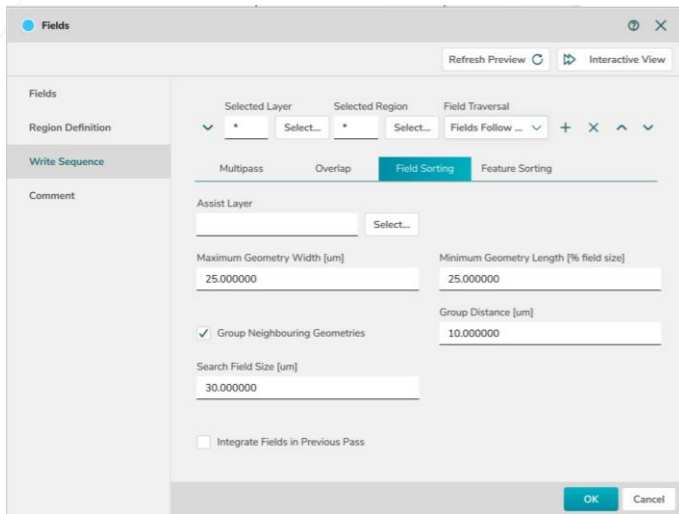


Generic element types like Circles / Arcs / Rotated Rectangles are maintained during fracturing. Dose fracturing of PEC will fracture e.g. ARC elements only into smaller ARC elements to improve the fracture quality.

Field control

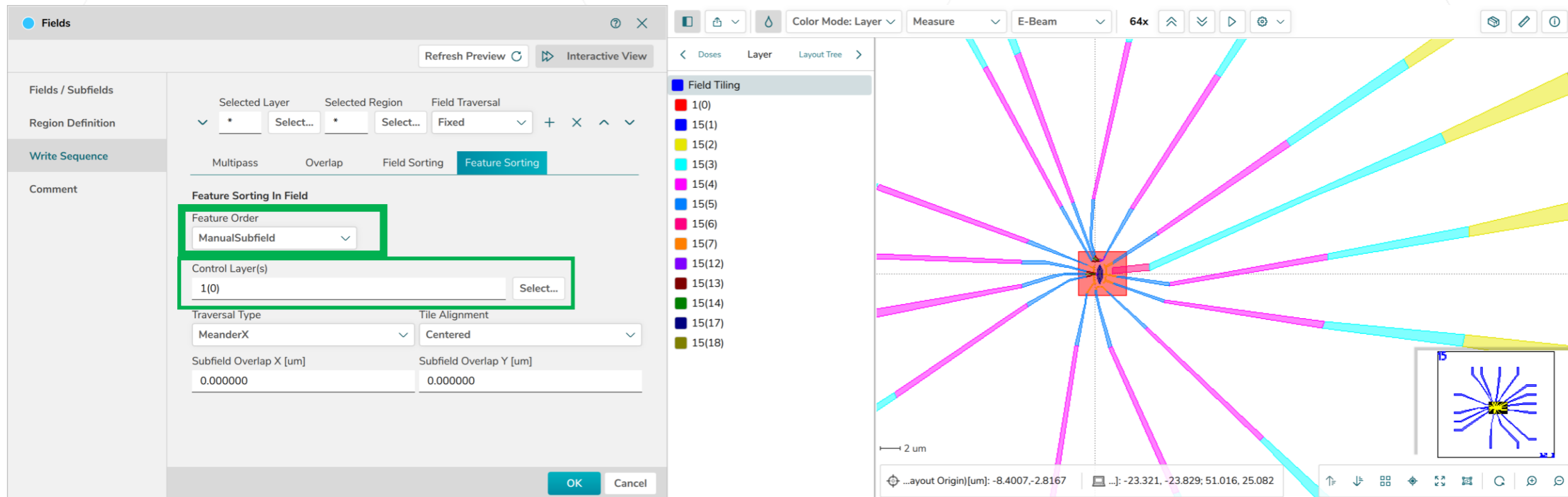
Fields Follow Geometry includes a new feature that helps to improve the quality of the results.

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



Fields module – ManualSubfield mode

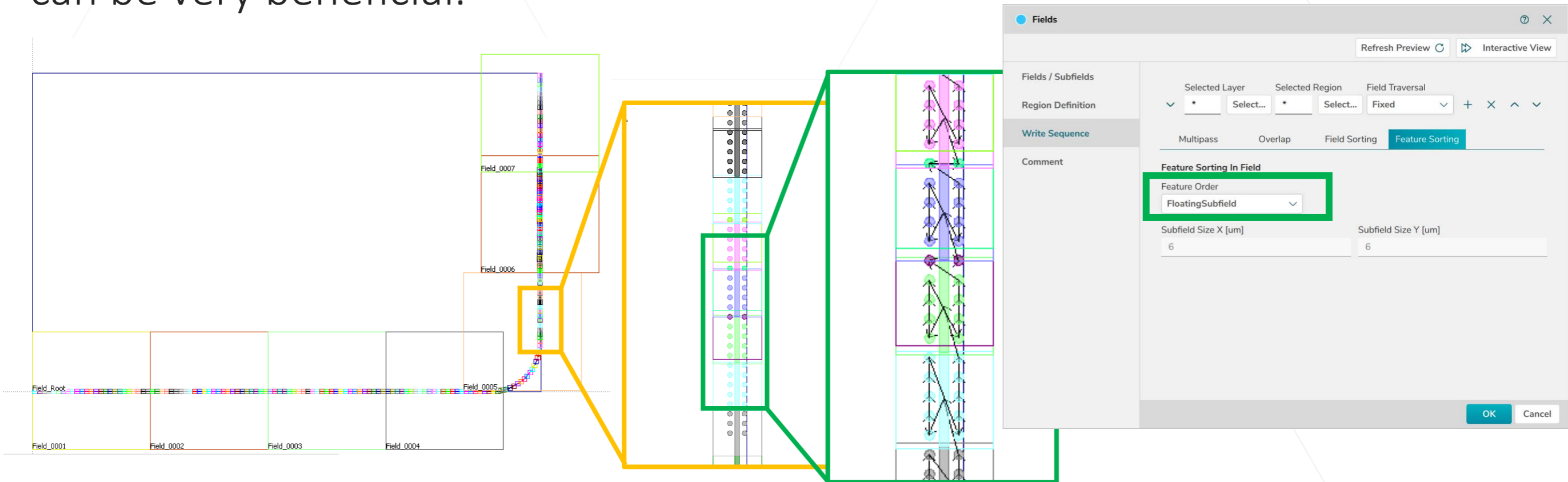
- The exposure order of critical regions within a Field are optimized using ManualSubfield
- The Control layer can be used to identify critical layout parts



The screenshot displays the GenISys Fields module interface. On the left, the 'Fields' panel is open, showing the 'Feature Sorting' tab. The 'Feature Order' dropdown is set to 'ManualSubfield', and the 'Control Layer(s)' field contains '1(0)'. The 'Traversal Type' is set to 'MeanderX' and 'Tile Alignment' is 'Centered'. The 'Subfield Overlap X [um]' and 'Subfield Overlap Y [um]' are both set to '0.000000'. The main window shows a visualization of a field layout with a central red square and multiple colored lines radiating outwards. A 'Field Tiling' legend on the left lists various subfields (1(0) to 15(18)) with corresponding colors. The interface includes a 'Refresh Preview' button, 'Interactive View' toggle, and various toolbars for navigation and measurement.

Fields module – FloatingSubfield mode

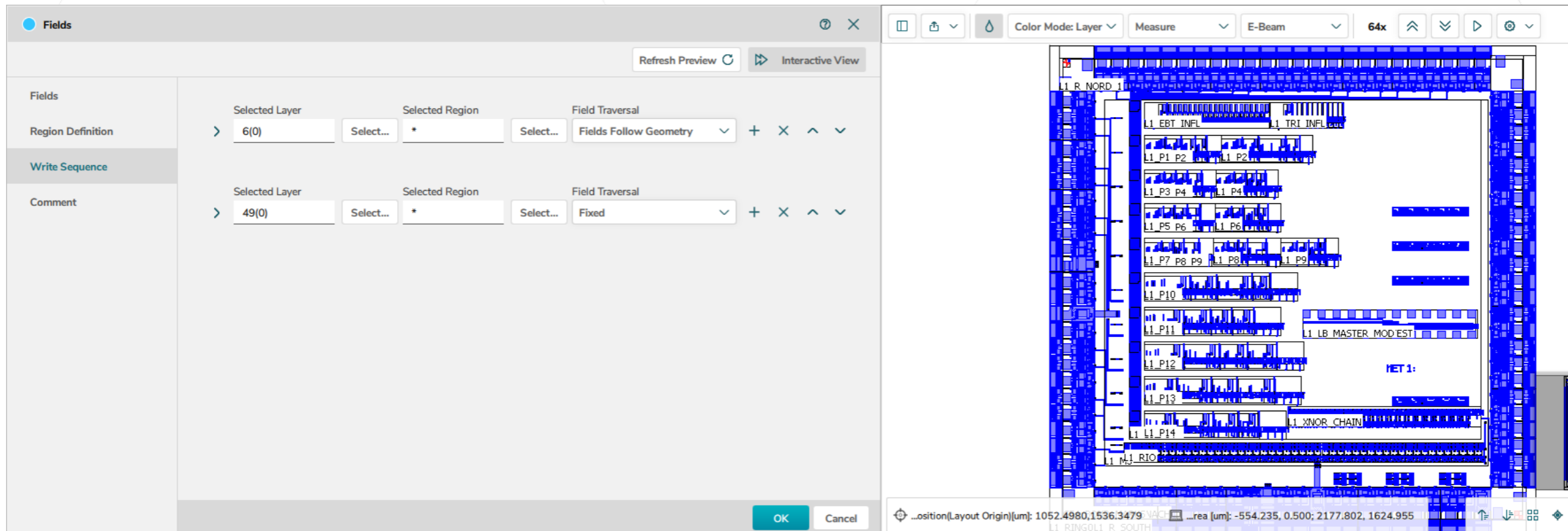
A floating subfield algorithm has been implemented that analyses the pattern and follows the path of the layout based on the feature distribution. This works very similar to the floating algorithm in the main field sorting. For sparse patterns, to follow a path, this method can be very beneficial.



The image displays a screenshot of the GenISys software interface, specifically the 'Fields' module. The main window shows a layout with several fields labeled 'Field_0001' through 'Field_0007'. A detailed view of a subfield path is shown, illustrating the 'FloatingSubfield' mode. The path is defined by a series of colored dots (blue, green, purple, pink) connected by lines, following the layout's features. The 'Fields' dialog box is open, showing the 'Feature Sorting In Field' section with 'FloatingSubfield' selected in the 'Feature Order' dropdown. Other settings include 'Subfield Size X [um]' and 'Subfield Size Y [um]' both set to 6. The 'Field Traversal' is set to 'Fixed', and the 'Feature Sorting' tab is active.

New field sorting module – for advanced Region and field sorting applications

- The fields module can create field and region/ sub fields within a layout
- During the system specific export, the user makes use of this structure via cell to field / cell to SF



The screenshot displays the 'Fields' module interface. On the left, there are two sections for configuration:

- Region Definition:** Selected Layer: 6(0), Selected Region: *, Field Traversal: Fields Follow Geometry.
- Write Sequence:** Selected Layer: 49(0), Selected Region: *, Field Traversal: Fixed.

The main view on the right shows a complex layout with various components labeled, including 'L1 R_NORD 1', 'L1 EB1 INFL', 'L1 TRI INFL', 'L1 P1 P2', 'L1 P3 P4', 'L1 P5 P6', 'L1 P7 P8 P9', 'L1 P10', 'L1 P11', 'L1 P12', 'L1 P13', 'L1 P14', 'L1 RIO', 'L1 LB MASTER MOD EST', and 'L1 XNOR_CHAIN'. The interface includes a toolbar with options like 'Color Mode: Layer', 'Measure', 'E-Beam', and a zoom level of '64x'.

Shape 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.

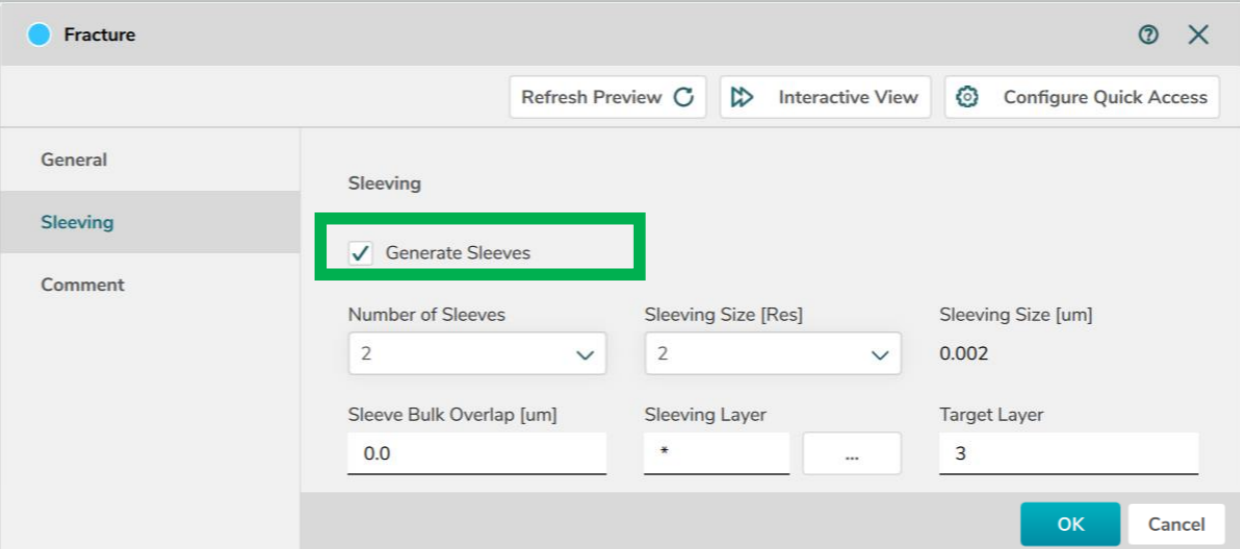
Parameters to control:

Number of Sleeves

Sleeving Size

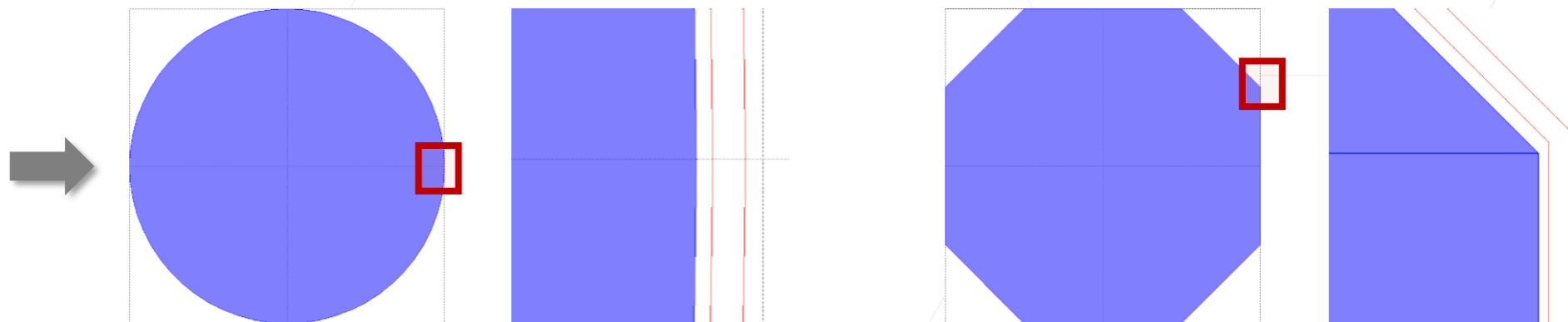
Overlap between Sleeve and Bulk

Sleeving Layer



The screenshot shows the 'Fracture' software interface with the 'Sleeving' configuration panel. The 'Generate Sleeves' checkbox is checked and highlighted with a green box. The configuration includes the following parameters:

| Parameter | Value |
|--------------------------|-------|
| Number of Sleeves | 2 |
| Sleeving Size [Res] | 2 |
| Sleeving Size [um] | 0.002 |
| Sleeve Bulk Overlap [um] | 0.0 |
| Sleeving Layer | * |
| Target Layer | 3 |

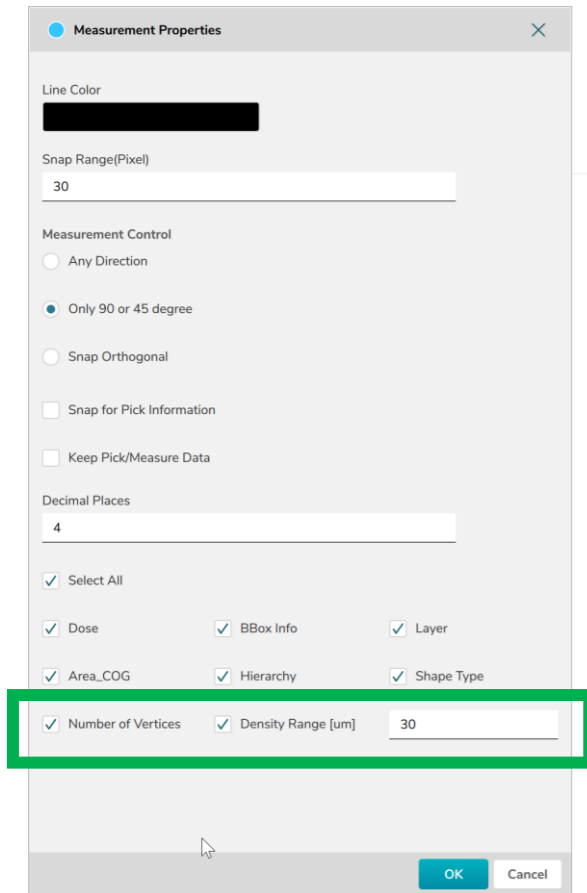


Sleeves generated by this method can find use in the capability of several tool exports:

- 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)

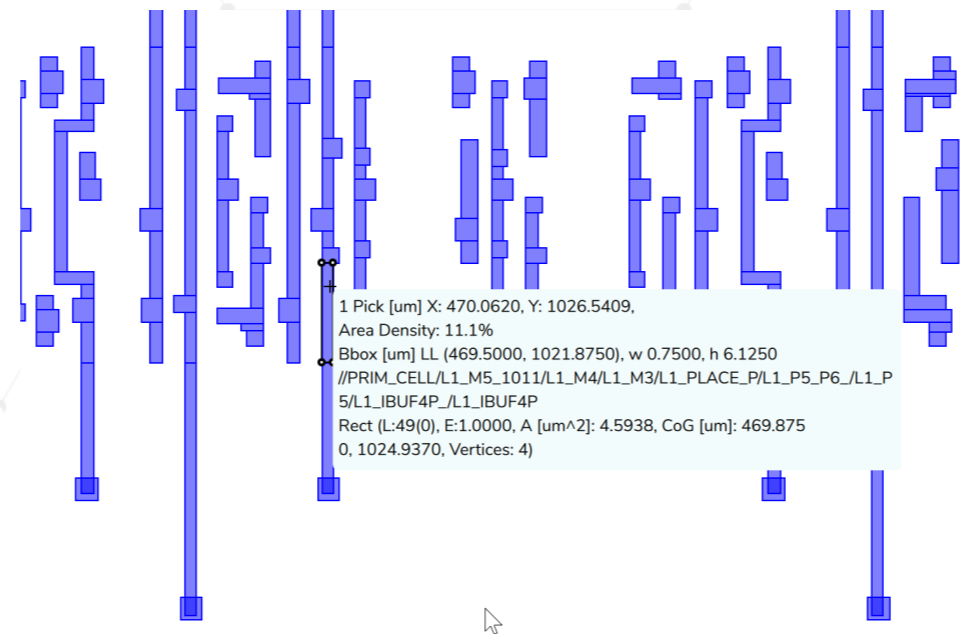
Usability

VIEWER – pick information



The VIEWER pick information has been extended to cover:

- Number of vertices
- Pattern density in a certain range



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

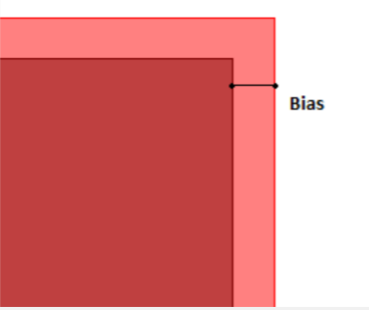
Insert Delete Up Down

| <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

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 |
```

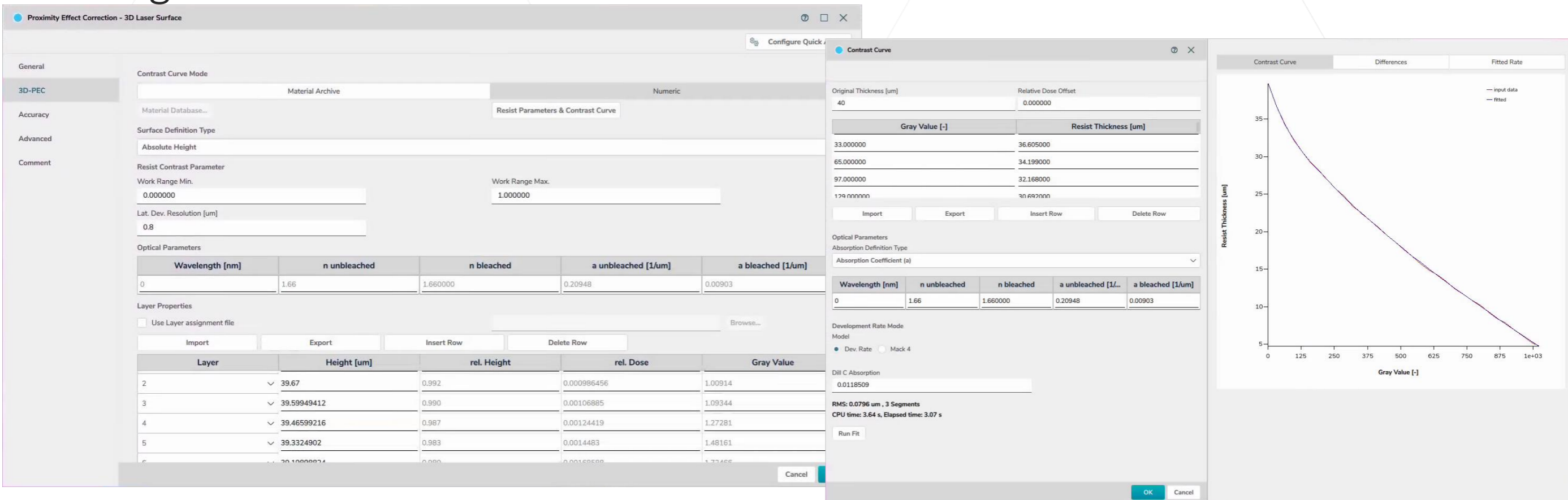
The formatting of Python code has been improved for better readability.

```
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
```

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.



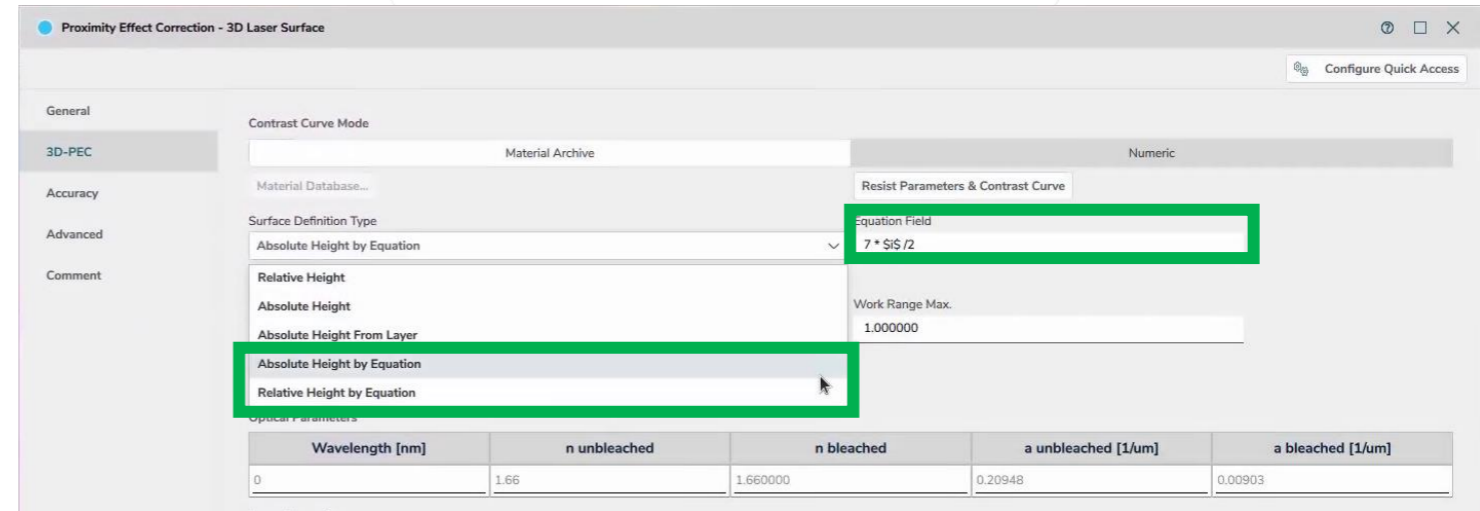
The screenshot displays the 'Proximity Effect Correction - 3D Laser Surface' software interface. The main window is titled 'Contrast Curve' and is divided into several sections:

- 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).
- Lat. Dev. Resolution [um]:** Set to 0.8.
- Optical Parameters:** A table with columns: 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: Layer, Height [um], rel. Height, rel. Dose, and Gray Value.
- Contrast Curve Dialog (Right Panel):**
 - Original Thickness [um]:** 40
 - Relative Dose Offset:** 0.000000
 - Table:**

| Gray Value [-] | Resist Thickness [um] |
|----------------|-----------------------|
| 33.000000 | 36.605000 |
| 65.000000 | 34.199000 |
| 97.000000 | 32.168000 |
| 174.000000 | 30.137000 |
 - Optical Parameters:** Includes 'Absorption Definition Type' and 'Absorption Coefficient (a)'.
 - Development Rate Mode:** Includes 'Model' (Dev. Rate, Mack 4) and 'Dill C Absorption' (0.0118509).
 - Performance:** RMS: 0.0796 um, 3 Segments; CPU time: 3.64 s, Elapsed time: 3.07 s.
 - Buttons:** Import, Export, Insert Row, Delete Row, Run Fit, OK, Cancel.
- Graph (Right Panel):** 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 plot 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*.

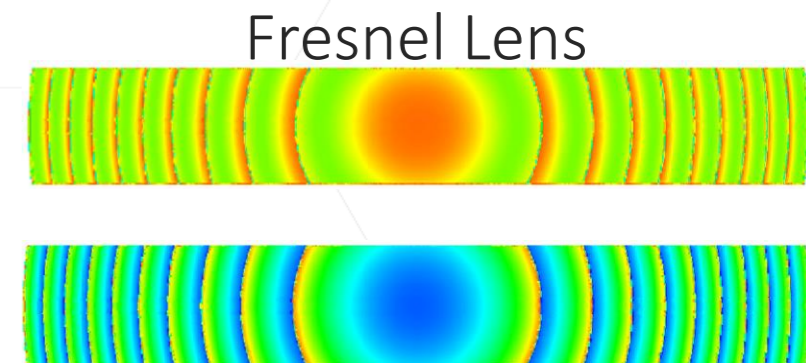
| Layer | Height [um] | rel. Height | rel. Dose | Gray Value |
|---------------|-------------|-------------|-----------|------------|
| 30 (\$i\$: 1) | 0.032110 | 0.003 | 0.983141 | 250.701 |
| 31 (\$i\$: 2) | 0.064220 | 0.006 | 0.977 | 249.135 |
| 32 (\$i\$: 3) | 0.096330 | 0.010 | 0.9709 | 247.58 |
| 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:

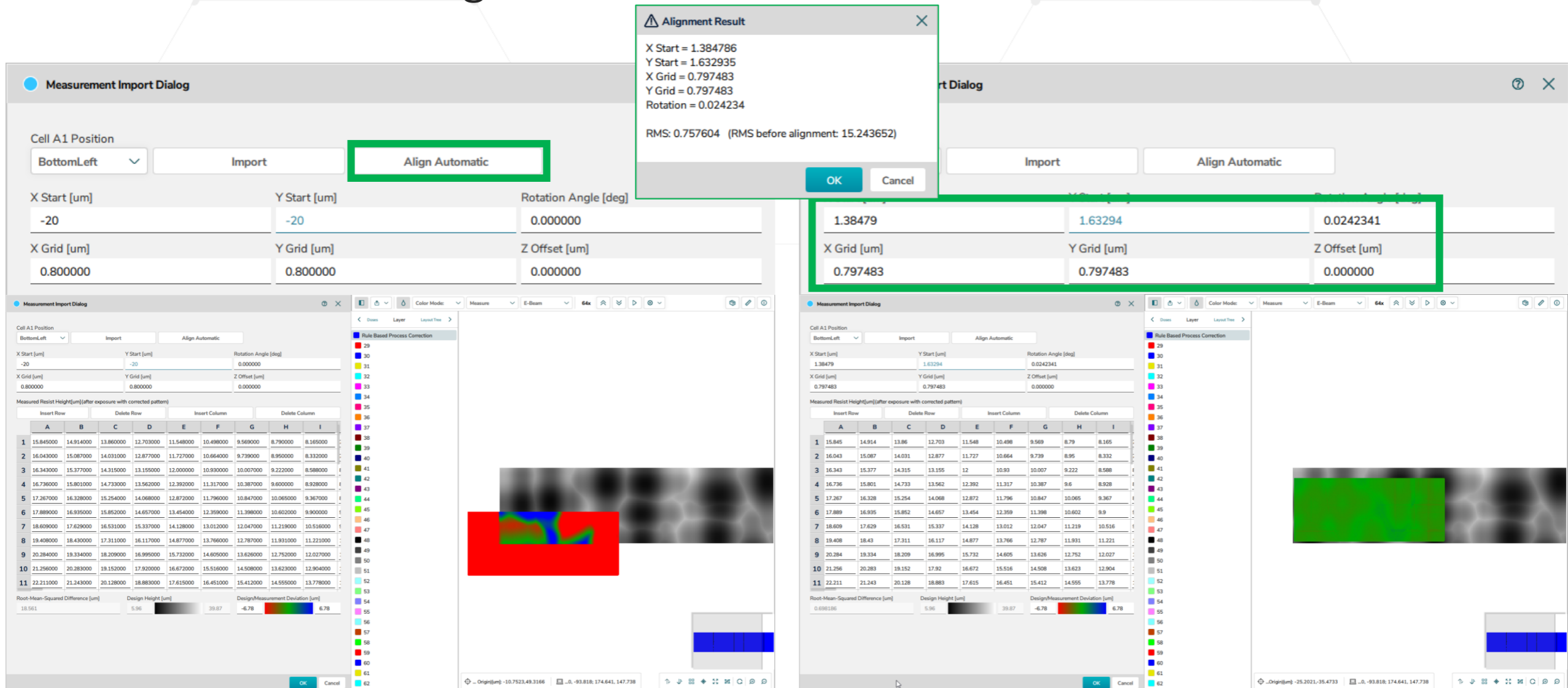
$$\sin \left(\$i\$ * \frac{3.1416}{180} \right)$$

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



Feedback Loop – automatic alignment

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



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

- 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 input fields:

- 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 shows the following output fields:

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

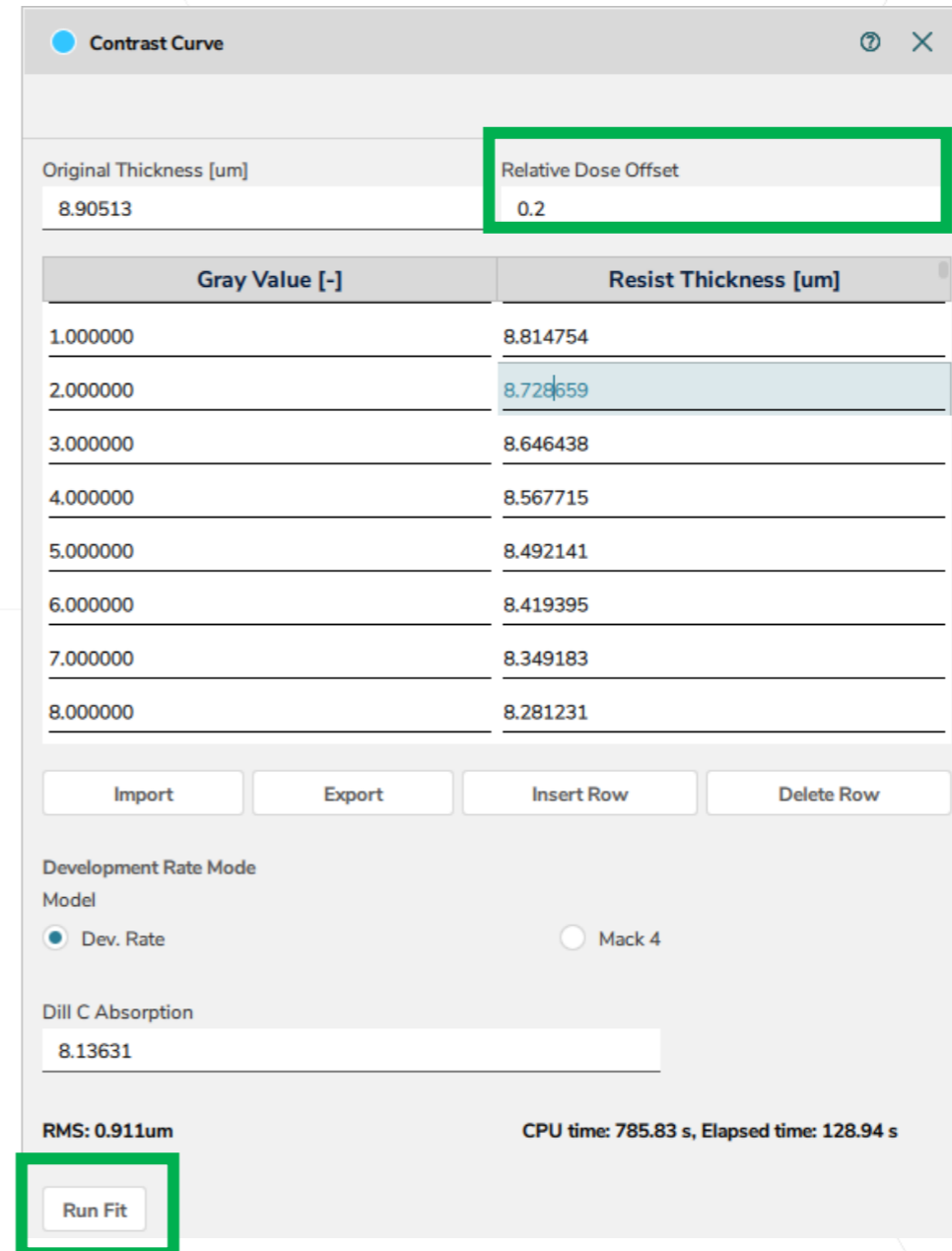
The Measurement Import Dialog also displays a table of Measured Resist Height [um] (after exposure with corrected pattern) and a color-coded image of the resist height.

| 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:

| Original Thickness [um] | Relative Dose Offset |
|-------------------------|----------------------|
| 8.90513 | 0.2 |

| 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 |

Buttons: Import, Export, Insert Row, Delete Row

Development Rate Mode
Model
 Dev. Rate Mack 4

Dill C Absorption
8.13631

RMS: 0.911um CPU time: 785.83 s, Elapsed time: 128.94 s

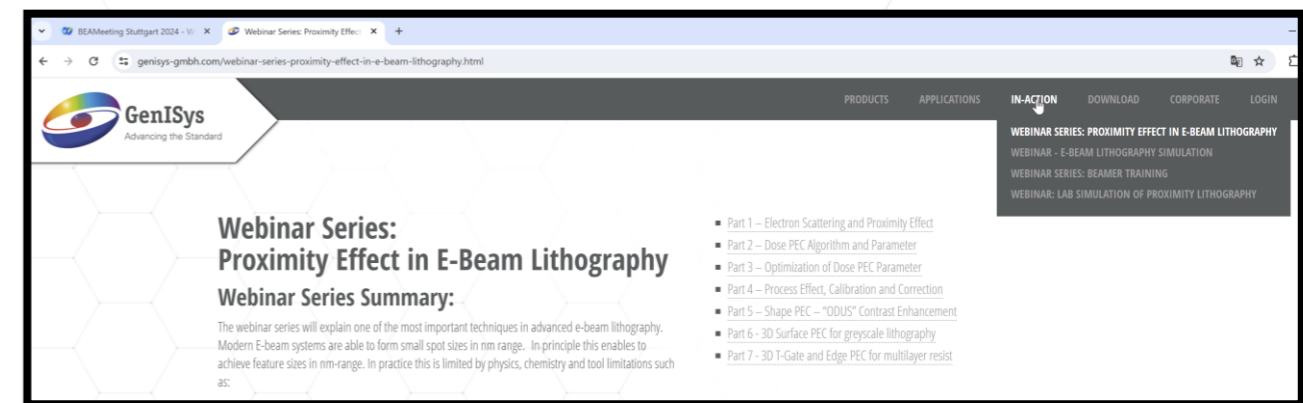
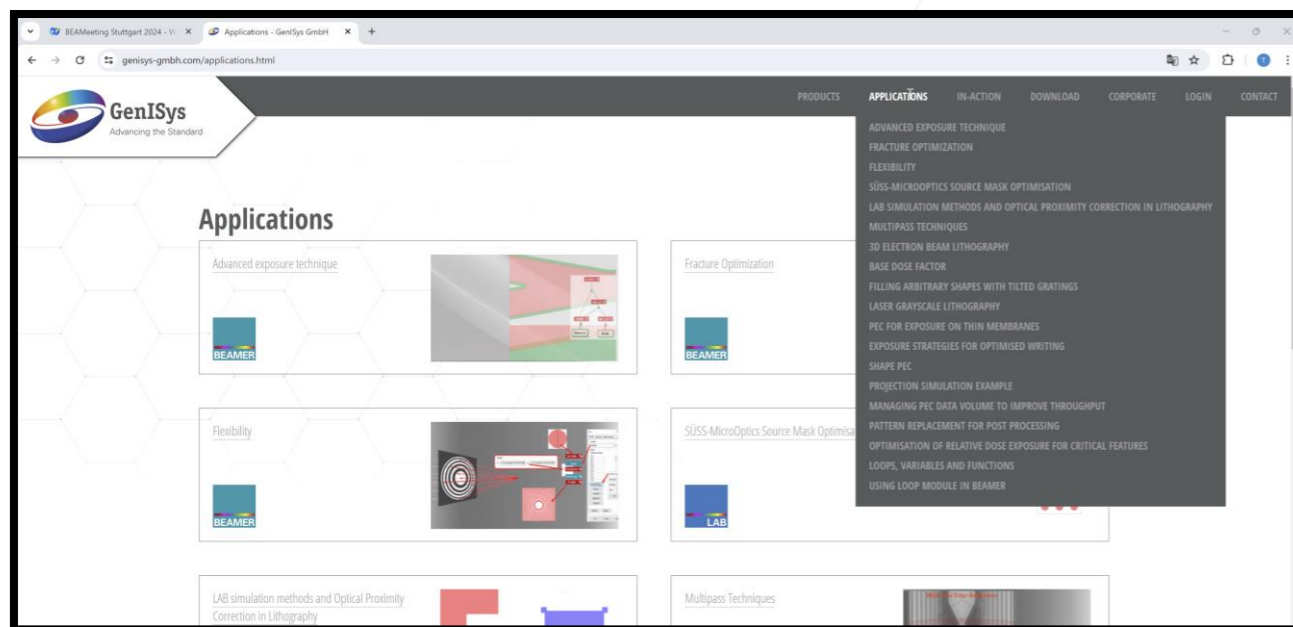
Run Fit

BEAMER 7.2

- Infrastructure – remove wx libraries completely
- Shape detection in DXF import
- Import: Layout check to identify small gaps / overlaps
- Fields module: Shape sorting within subfield
- Performance improvements: Floating fields / RuleOPC



BEAMER 7.2 release June 2024 (after EIPBN 2024)



Thank You!

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