Controlling Write Order in BEAMER

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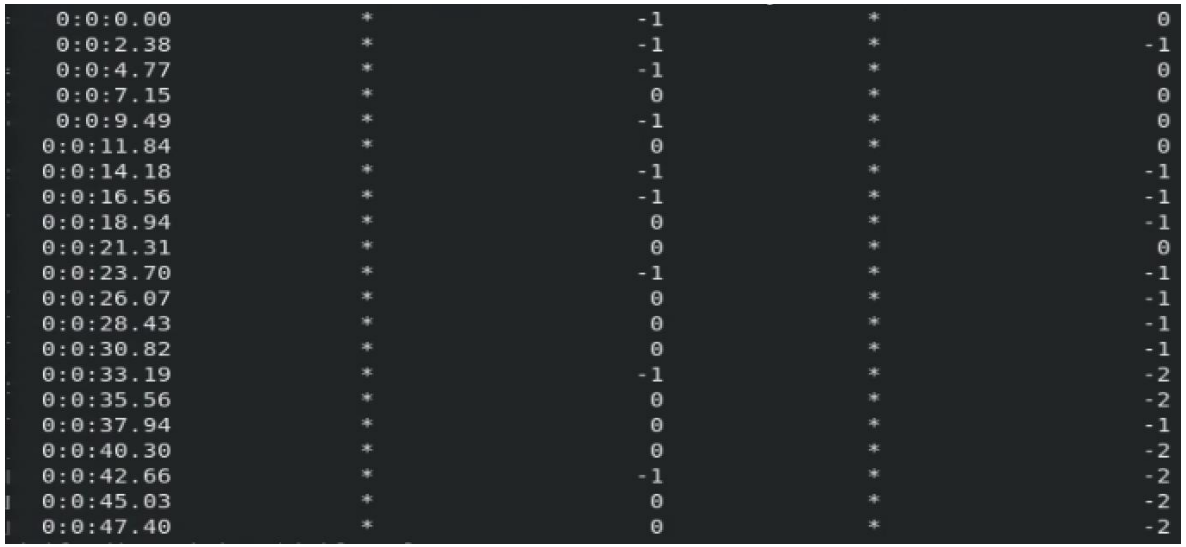
GenISys BEAMeeting - EIPBN

Why Do We Need to Control Write Order?

- **Ebeam's biggest Achilles heal….it's SLOW**
  - **The total exposure time can lead to DRIFT**



0:0:0.00	*	-1	*	0
0:0:2.38	*	-1	*	-1
0:0:4.77	*	-1	*	0
0:0:7.15	*	0	*	0
0:0:9.49	*	-1	*	0
0:0:11.84	*	0	*	0
0:0:14.18	*	-1	*	-1
0:0:16.56	*	-1	*	-1
0:0:18.94	*	0	*	-1
0:0:21.31	*	0	*	0
0:0:23.70	*	-1	*	-1
0:0:26.07	*	0	*	-1
0:0:28.43	*	0	*	-1
0:0:30.82	*	0	*	-1
0:0:33.19	*	-1	*	-2
0:0:35.56	*	0	*	-2
0:0:37.94	*	0	*	-1
0:0:40.30	*	0	*	-2
0:0:42.66	*	-1	*	-2
0:0:45.03	*	0	*	-2
0:0:47.40	*	0	*	-2

We minimize this effect with drift recalibrations throughout the cell exposure
But…. Maybe we can take this one step further by optimizing the write order

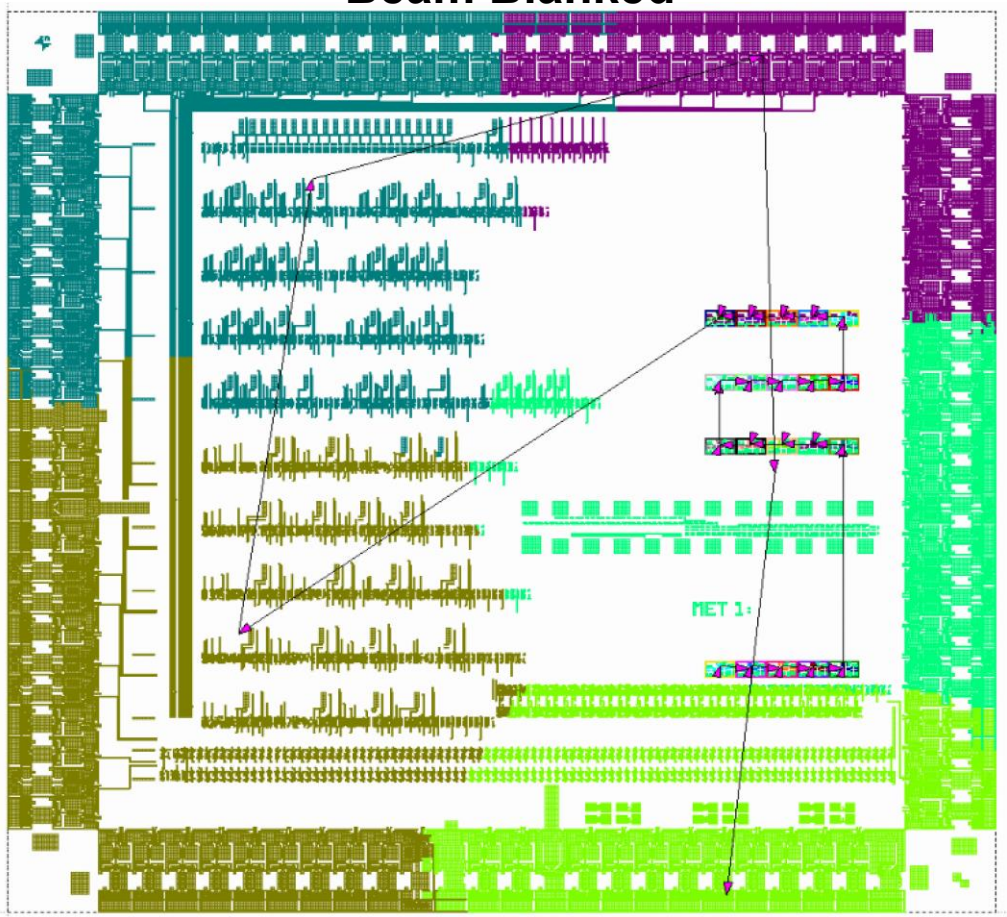
Levels of Write Order Control

- Field-to-field – Optimize mechanical stage movement between scanfields
  - Export module contains straightforward options, but also contains a very powerful option called “cell-to-field”
  - Cell-to-field is used in conjunction with the “fields” module (fracture module in Beamer 6)
- Subfield-to-subfield – Optimize mainfield deflection
  - Fields and export modules contain options for subfield sorting
- Trapezium-to-trapezium – Optimize the subfield deflection system
  - BEAMER 7 introduced a requested feature to allow write order control of trapezia within a subfield
- Within subfield – Optimize exel placement
  - The export module contains shot placement options, since these are pattern generator specific

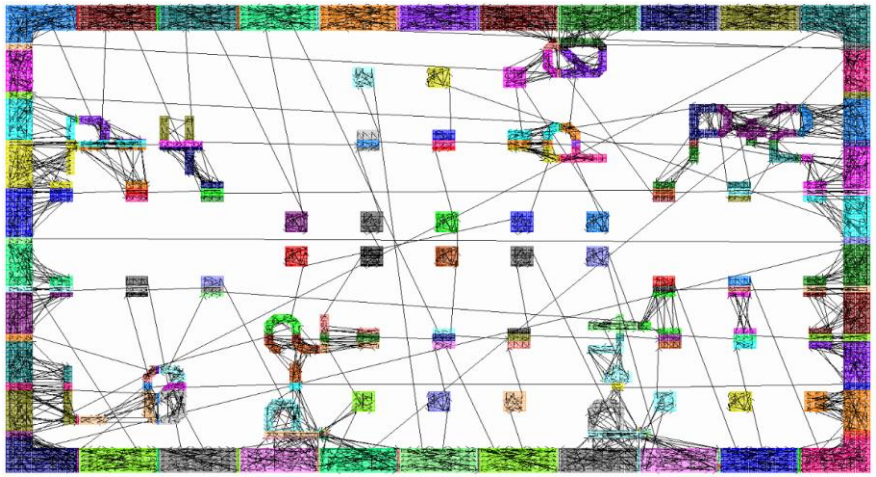
You can combine all of these to create a very powerful flow

Write Ordering Control Visualization

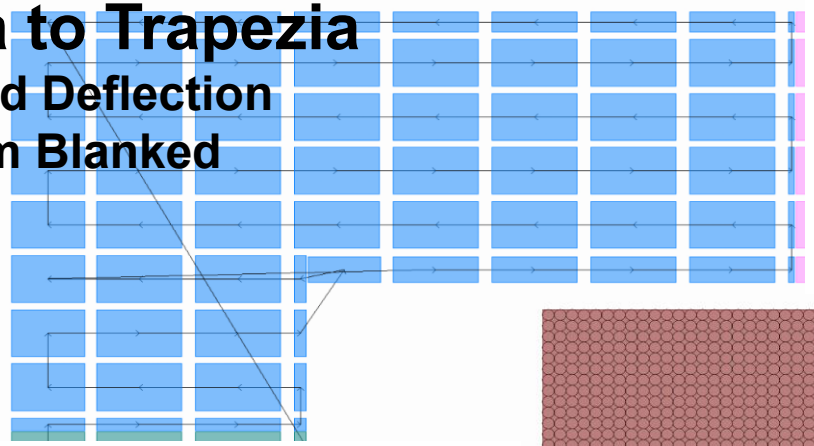
Field to Field
Stage Move
Beam Blanked



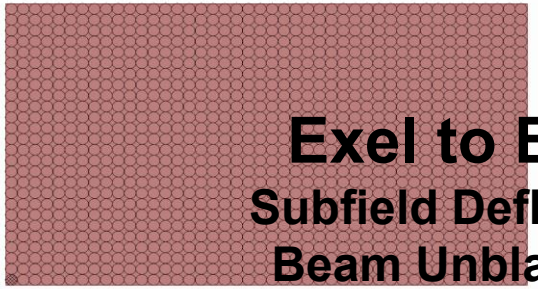
Subfield to Subfield
Main Deflection
Beam Blanked



Trapezia to Trapezia
Subfield Deflection
Beam Blanked

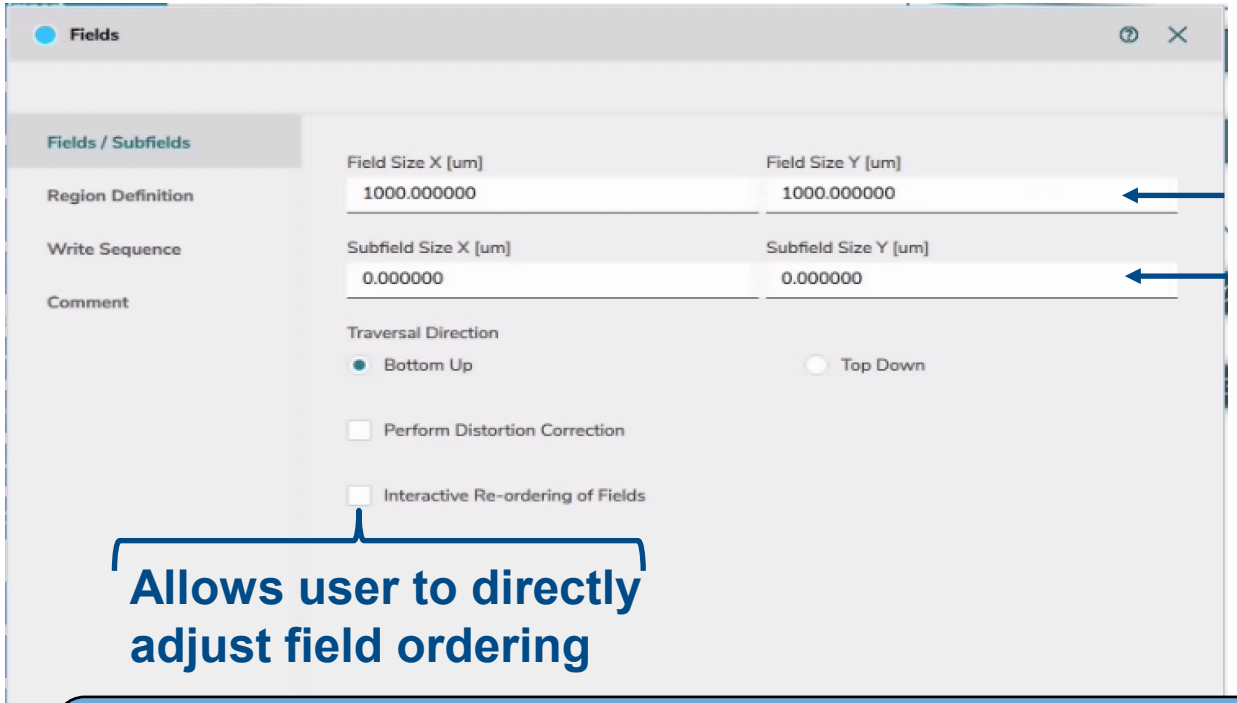


Exel to Exel
Subfield Deflection
Beam Unblanked



Beamer 7 Fields Module

- **The Beamer 7 Fields module (formerly part of Beamer 6 Fracture module) allows the user to generate fields of any allowed size, as well as control field ordering**



Allows user to directly adjust field ordering

Set Field Size

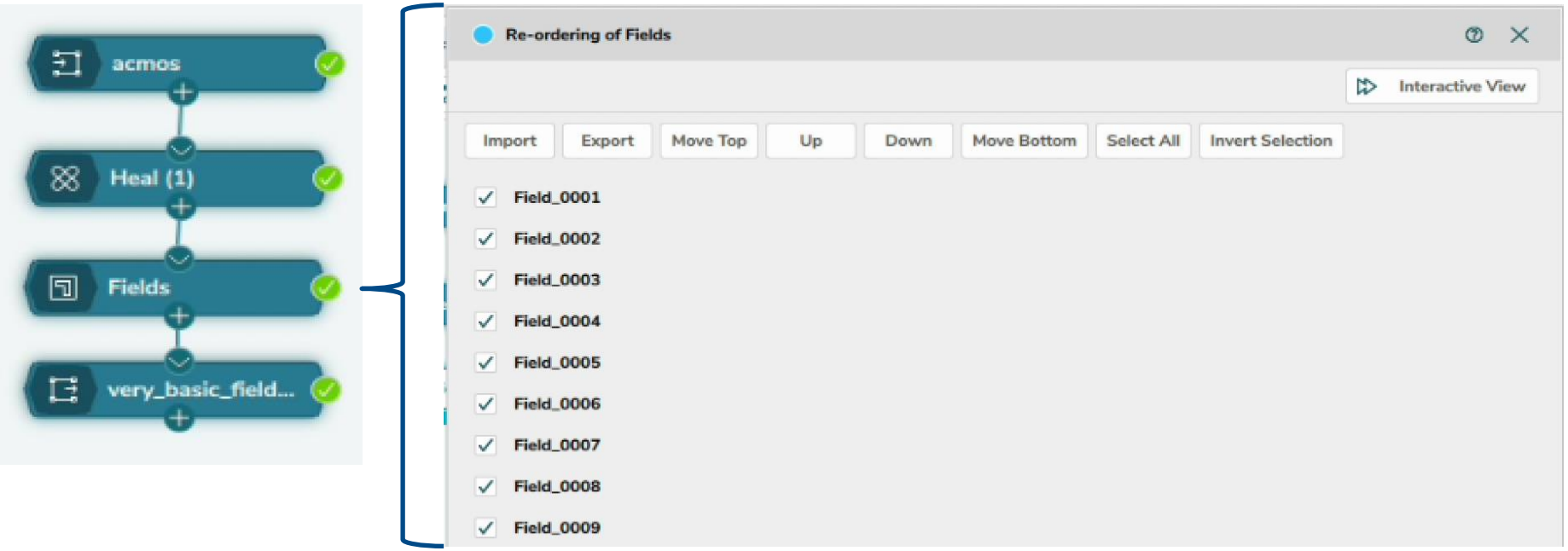
Set SubField Size

- **If set to 0, Export module ignores this**
- **If set to a non-zero value, export module uses this as its subfield size**
  - **Need to select "Cell To Field" and CellToSubfield options in Export module**

The Fields module generates hierarchical cells which the export module can use when creating fracture fields (cell-to-field)

Very Basic Manual Write Ordering

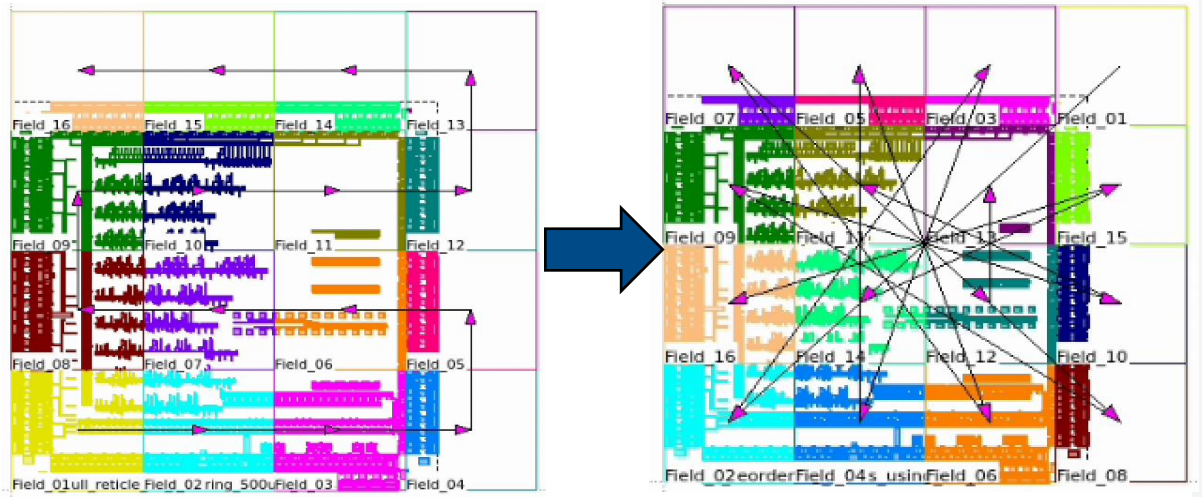
- The fields module allows the user to manually adjust the field write order and select which fields to write
- After setting a field order, the user can save this and recall it in the future

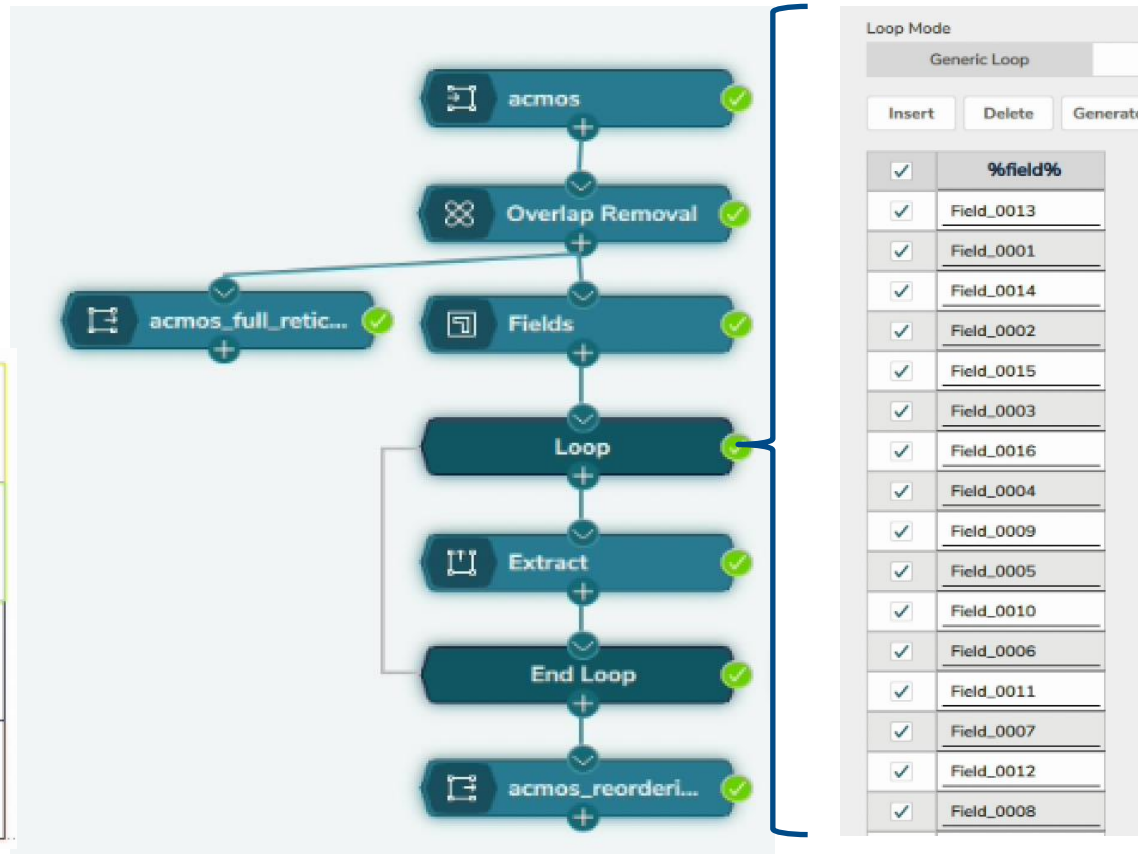


We have requested a feature to allow the user to automatically recall a field file list instead of requiring manual intervention each time

Saving Manual Write Ordering Workaround

- You can generate cells using the fields module, and then loop over the cells to control their write ordering
- This allows the user to save the loop order and automatically recall it during subsequent flow executions, avoiding the manual field reordering interruption in the Fields module





This is still somewhat cumbersome because the user will need to generate the loop list from scratch or modify the Fields generated loop list

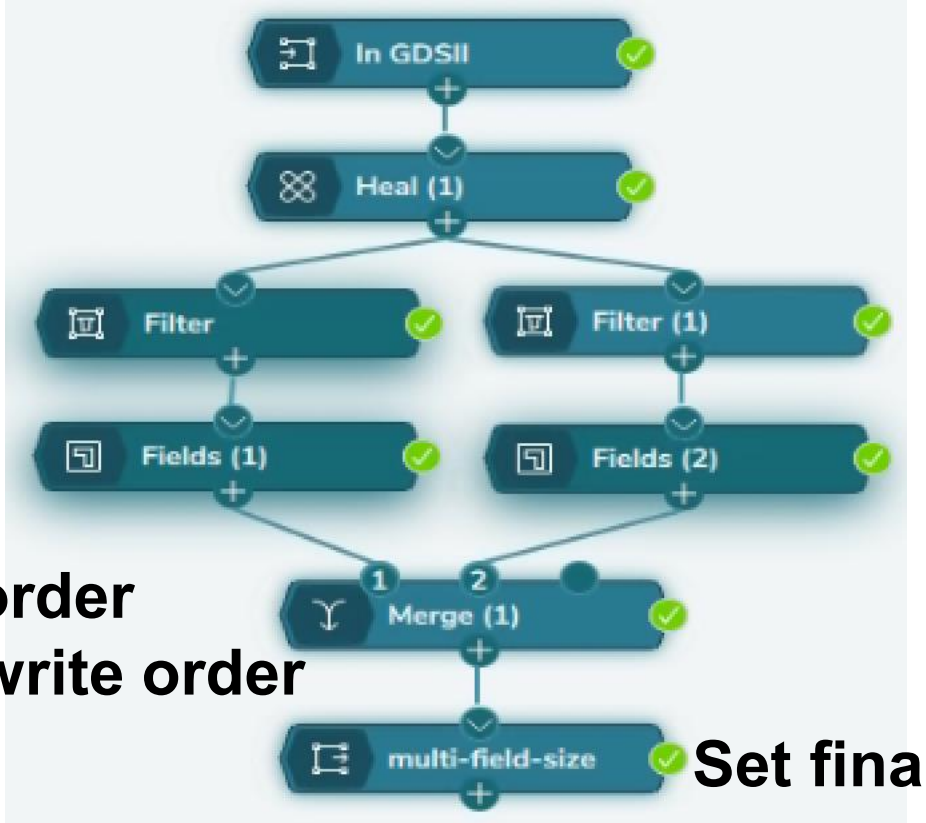
Generating Multiple Field Sizes Within A GPF And Adding Write Order Control

- **Problem: Fields module only allows user to set a single field size**
- **Solution: Split pattern according to selection rules (area, layer, filter, etc…) and assign different field sizes to each branch.**

Shape area < 2μm²

Field size = 250μm

Merging order controls write order

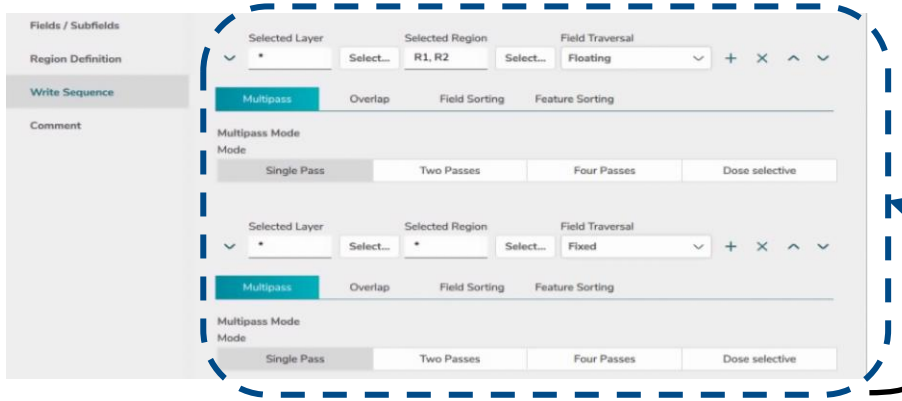


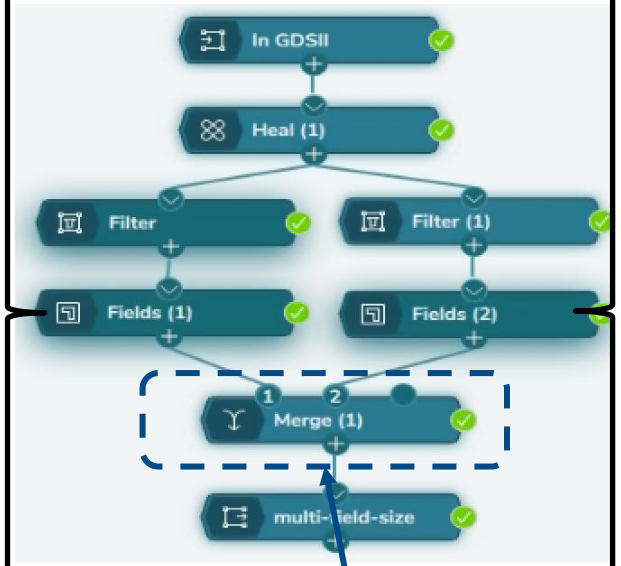
Shape area > 2um²

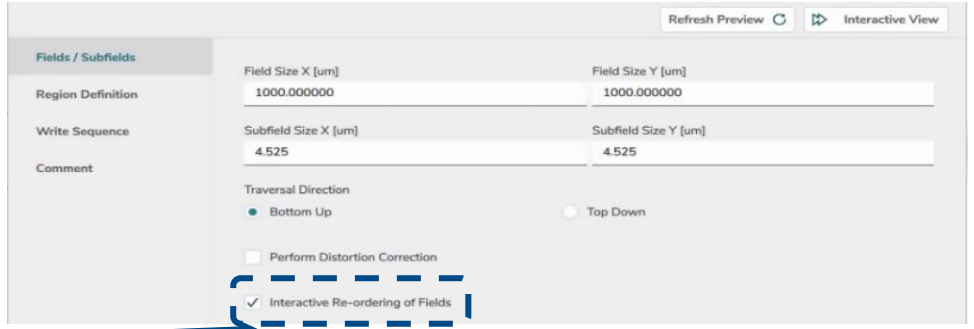
Field size = 1000μm

Set final field size = 1000μm

Multiple Scanfield Size
Fields Module Settings



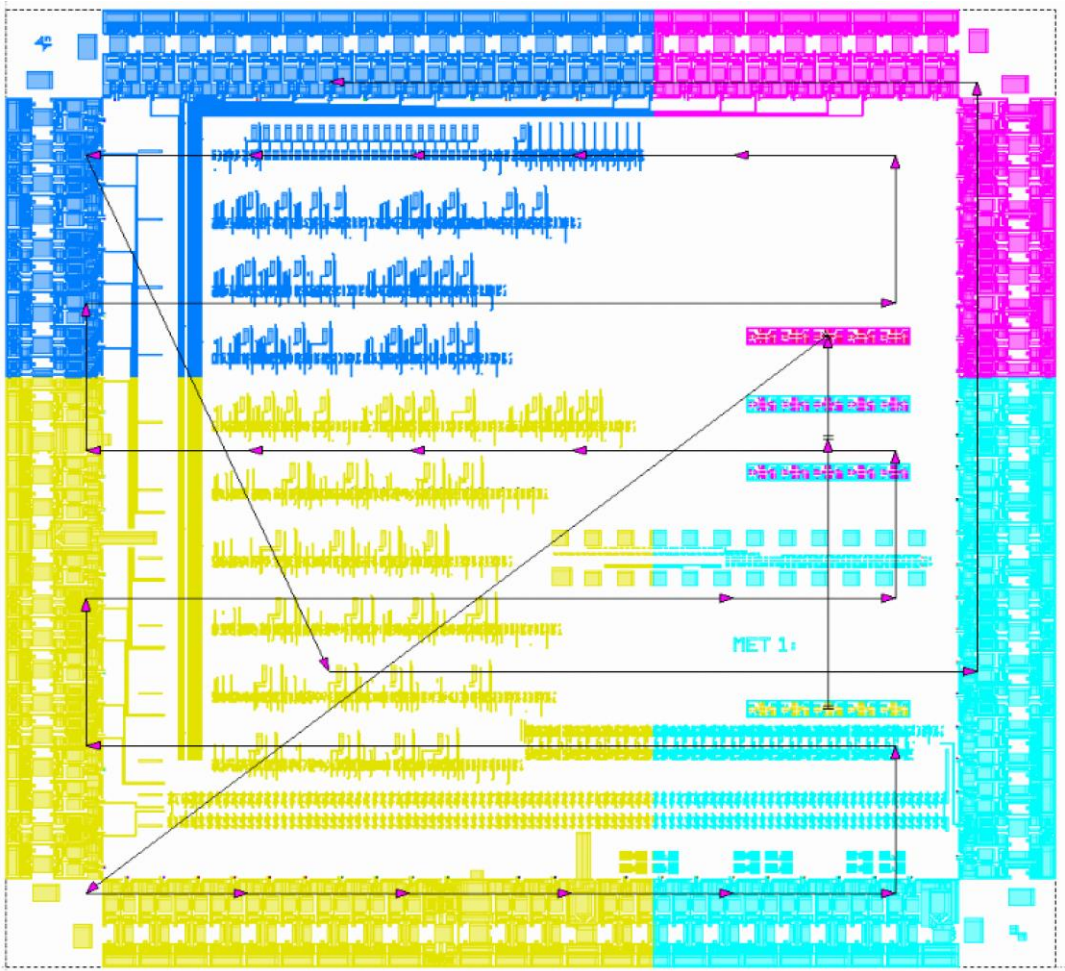




Allows write order control

We can control field-to-field write order at various positions within the fracture flow

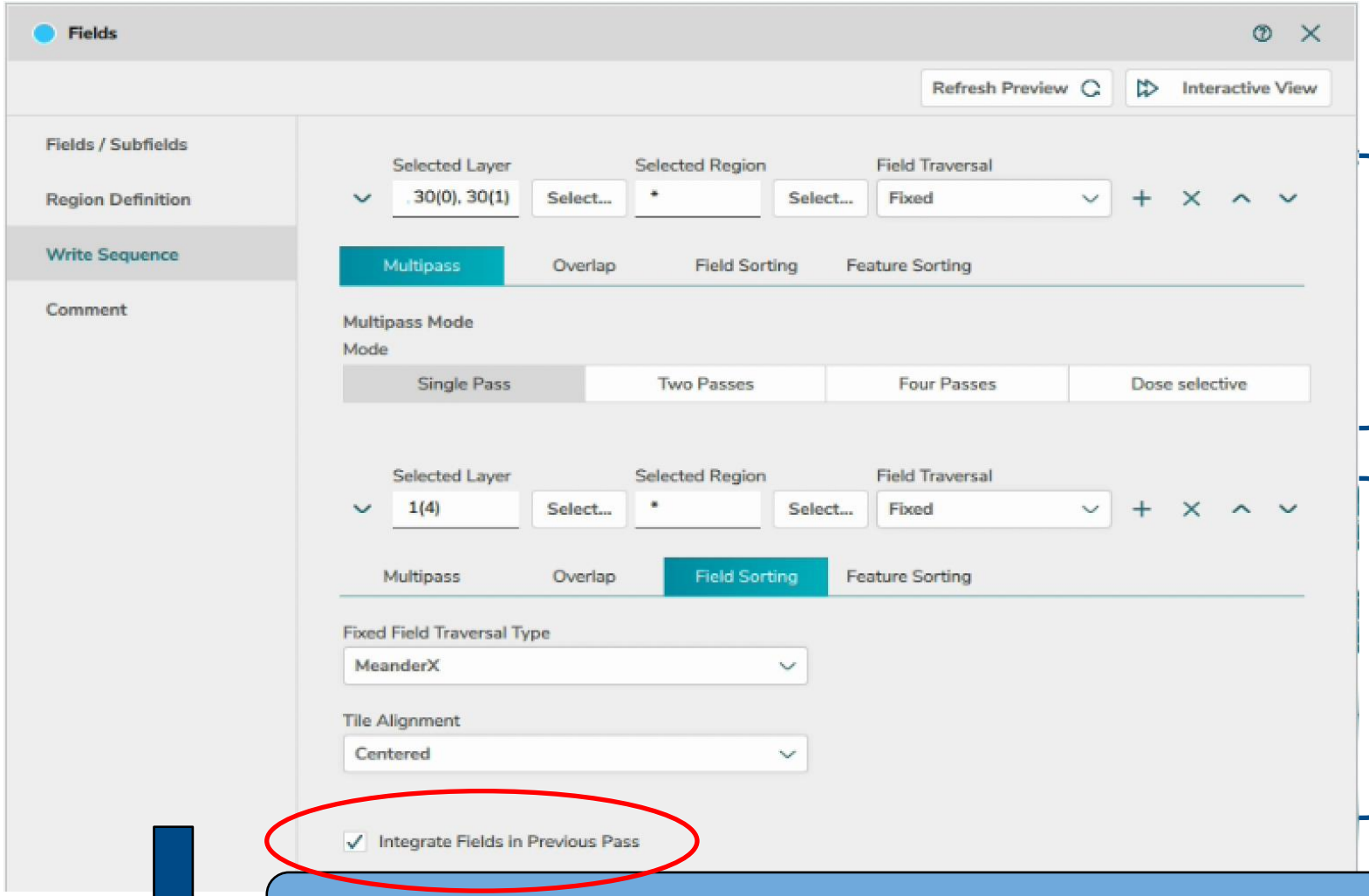
Multiple Scanfield Sizes and Ordering GPF Results



1.) Write critical features using field centering and a small field size=250μm
2.) Write additional small features using fixed fields and a 250μm field size
3.) Write large features using fixed fields and a 1000μm field size

Even though the Export module sets field size to 1000μm, the Fields module actually determines where the field boundaries are set, effectively allowing multiple field sizes

Integrating Fields Into the Previous Pass



Write a field of this first

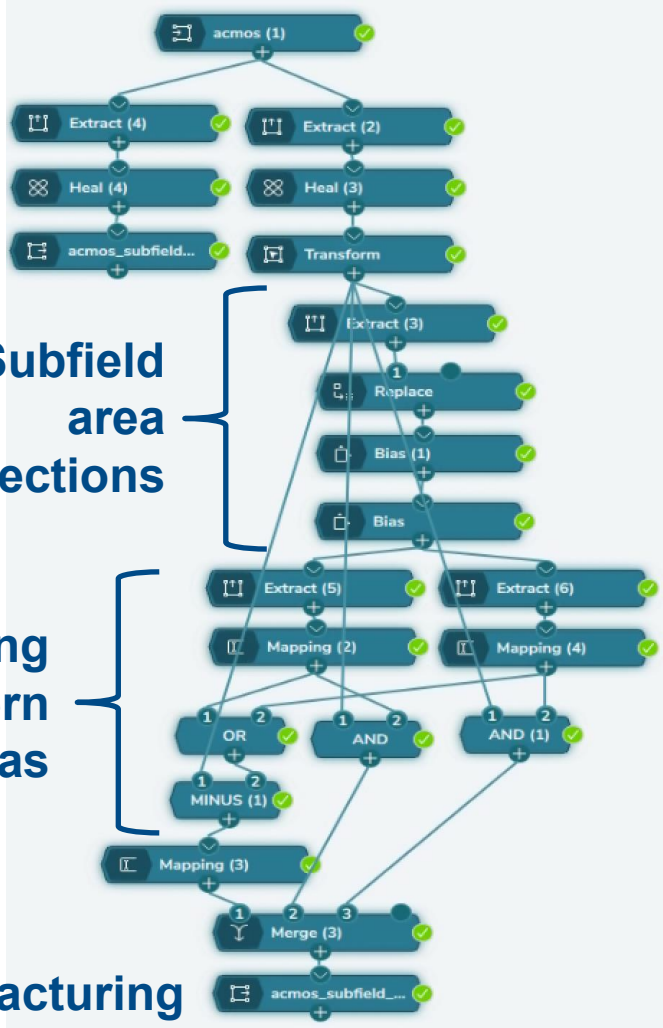
Then write a field of this

Loop back and repeat until finished

What is this useful for?
We are using it to test overlay with no stage moves

Write Ordering Within A Scan-field

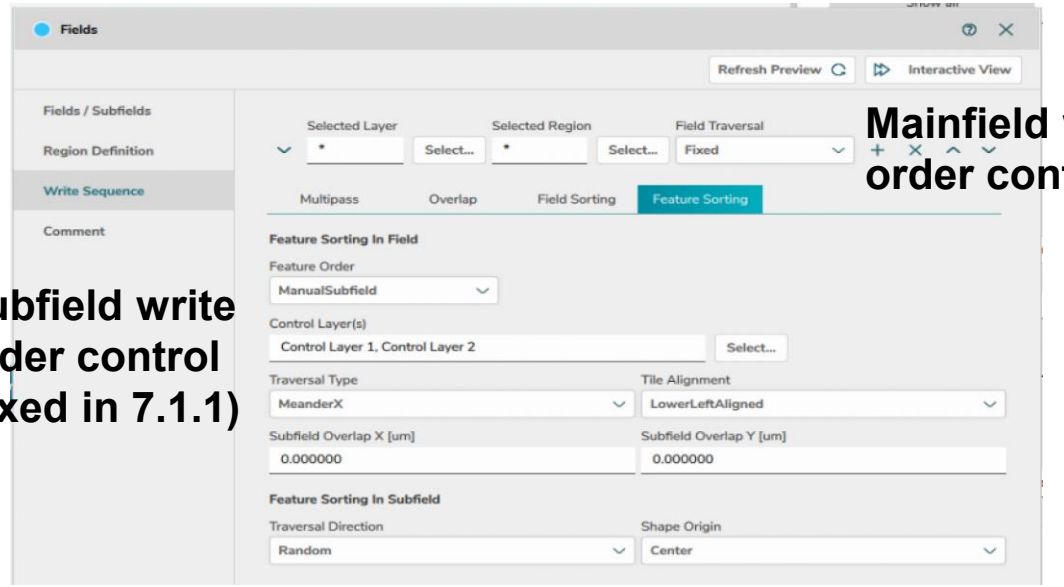
- What if you want to write-order sub-fields within a main-field?
- A useful method for defining areas within a main-field is to use Layer Order, which is then prioritizes the final fracture ordering
- The flow designates areas which are used to select out portions of the pattern
- These parts are then used in the final Export → Sub Field → Layer Order



The order these are entered determines their writing order, followed by everything else

Write Order Control - Mainfield and Subfield
Trapezia Write Order Control

- New feature in Beamer 7.2 allows the user to control trapezia write ordering within a subfield



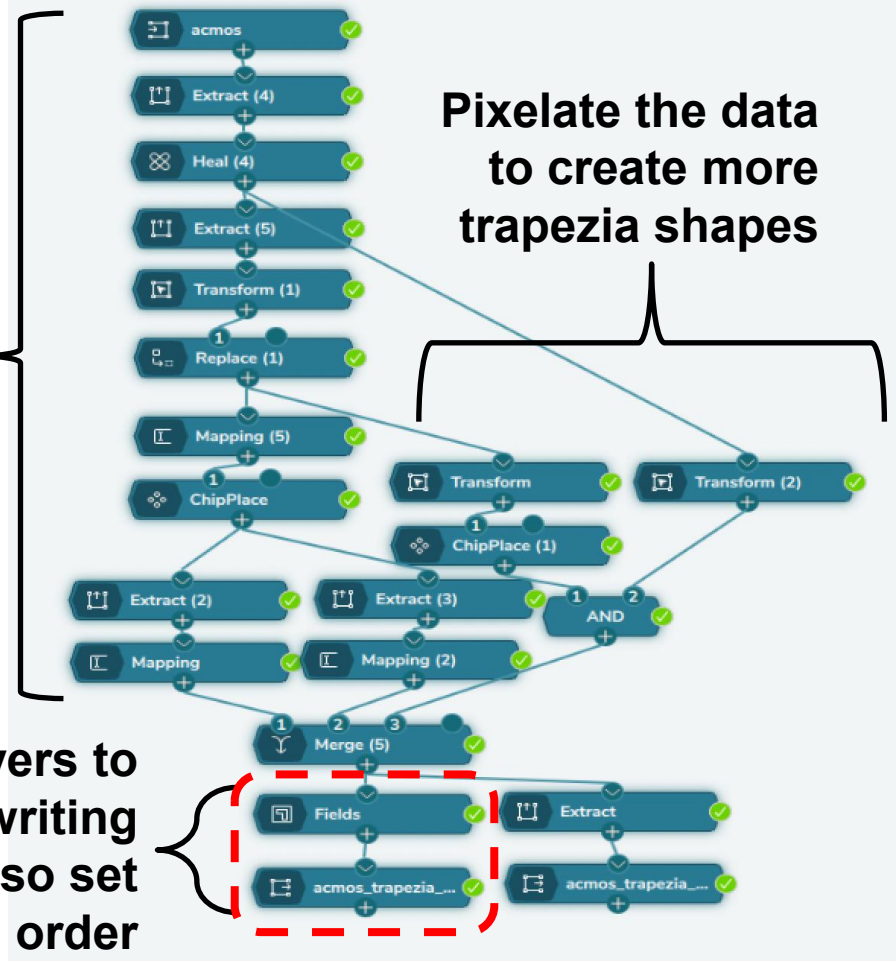
Subfield write order control (fixed in 7.1.1)

Mainfield write order control

Trapezia write order control

Generate layers to select subfields

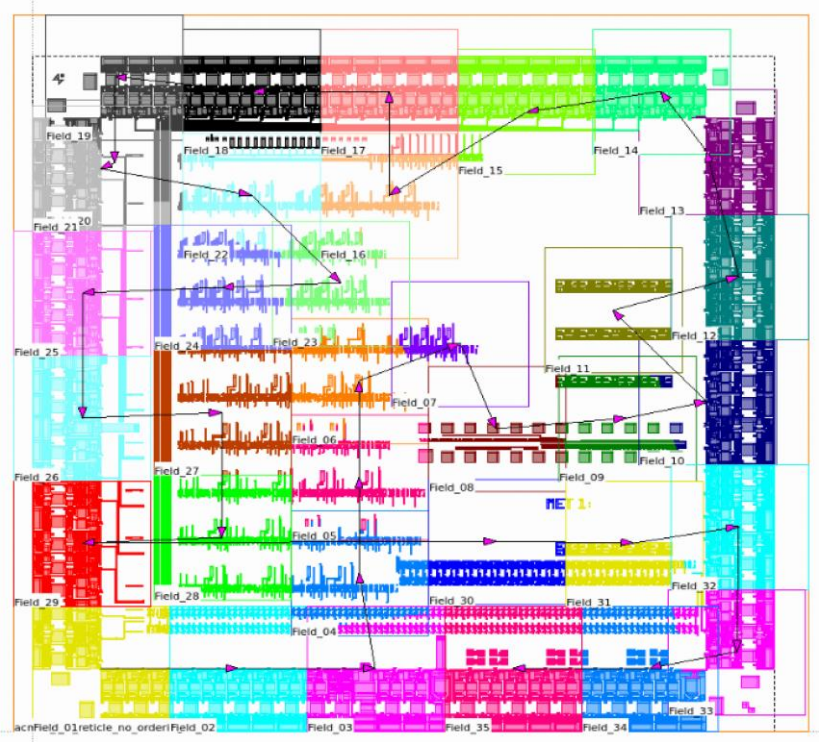
Pixelate the data to create more trapezia shapes



Use these layers to control subfield writing order and also set trapezia writing order

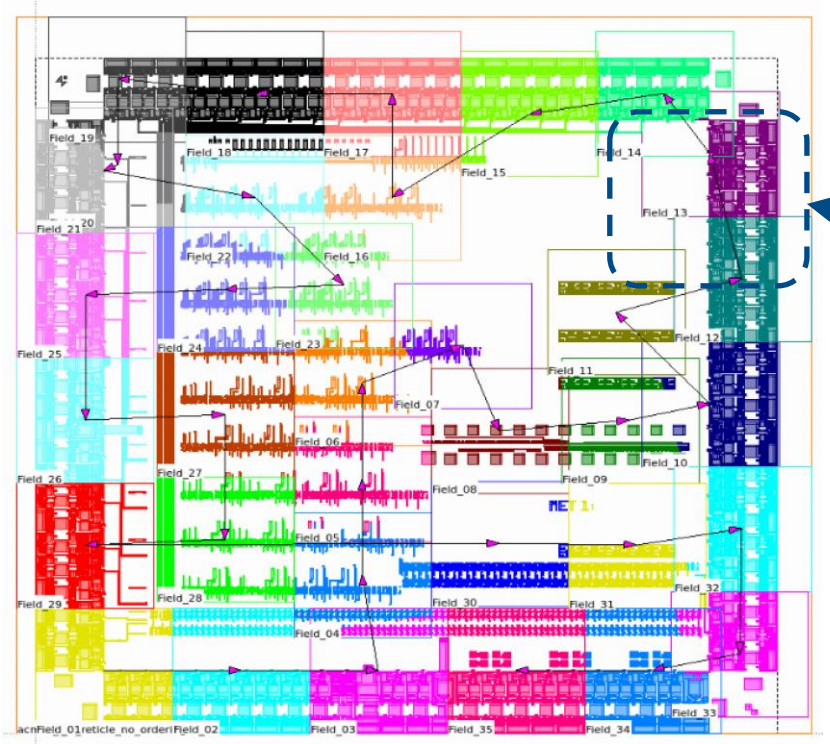
Export - Exel to Exel Write Control
A Mix of Exel Placement and Writing Order Control

- Beamer has options to allow the user to control exel placement and write order as part of the Export file format
- This can be useful to produce sharper edges on curved or slanted lines
- The user can also reduce write time to some degree through additional options



Improving Drift Calibration Control

- Drift recalibration/realignment is a routine that runs on a periodic schedule
- The problem is that the drift calibration doesn't always execute at the same position in the reticle during exposure if only using a simple timer
- An alternate method is to designate where, in the pattern, the system should execute a drift calibration. This can be done manually in the jobfile



Execute a drift calibration before exposing this block

Summary

- **Write ordering control is useful for writing critical features early in the cell exposure and for reducing the distance the mainfield/subfield deflection systems have to move the beam**
- **Beamer allows the user to control write ordering at the mainfield, subfield, and exel level**
- **Beamer allows the user to effectively use multiple scanfield sizes within a single pattern, allowing the user to reduce beam deflection for critical features**
- **The user can manually control where, in the pattern, a drift calibration occurs in the jobfile, or possibly in future in the fracturing**

Thank You!