

Learn tsmap

The whole course

Learn tsmap · wafertools.github.io/tsmap/learn

The latest version is always online at the address above.

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The glossary follows the last lesson. The latest version of this course is always at wafertools.github.io/tsmap/learn.



Welcome to tsmap

Lesson 00

Learn tsmap

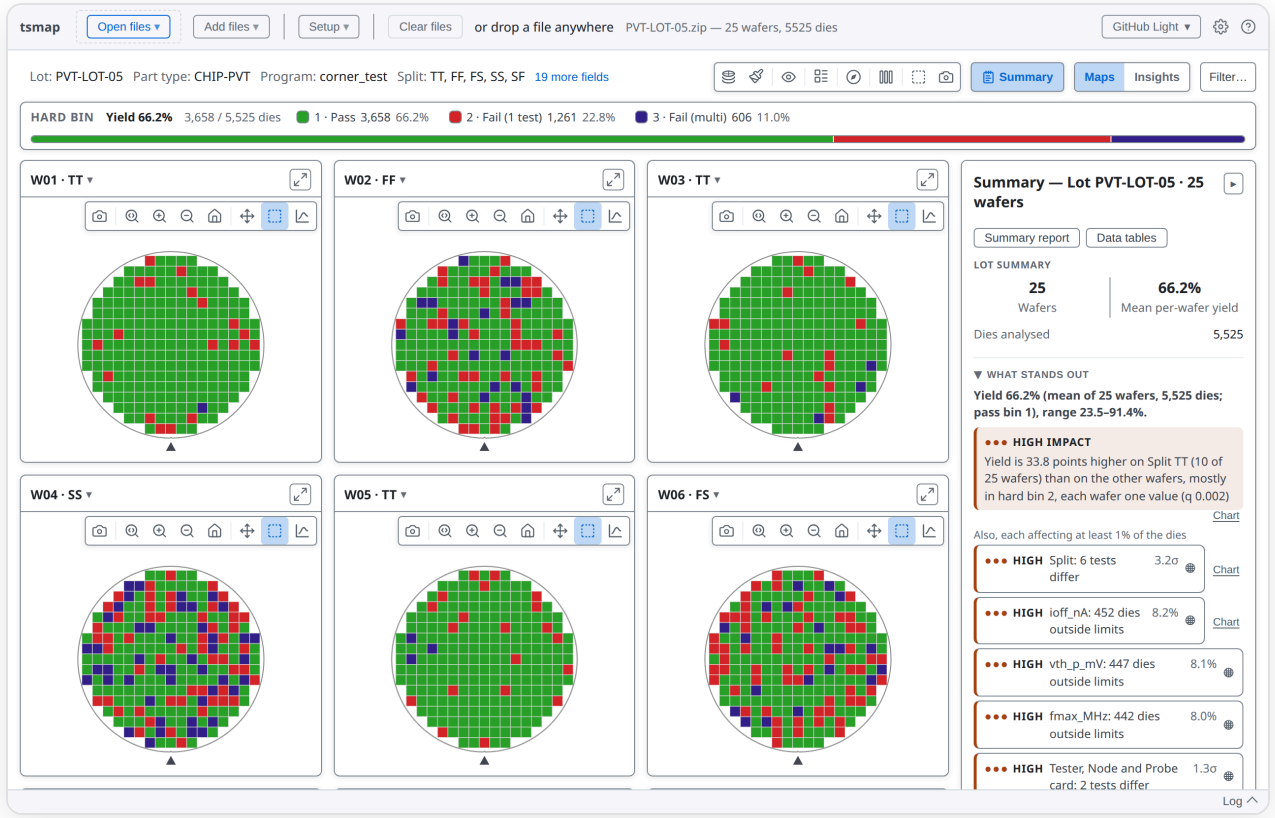
In this lesson

A wafer map is a picture of how a semiconductor wafer tested. This lesson gives you the few words you need to read one, then shows you where everything is on the screen.

- The words used in wafer testing: die, lot, test, bin, yield (the glossary lists them all)
- What tsmap is, the two ways to run it, and the library it is built on
- A tour of the screen, one area at a time

What you will be using

This is where you will end up: a lot of 25 wafers open in tsmap, with the bin legend, one map per wafer and a summary of what stands out. The rest of the lesson explains each part.



Wafers, dies and lots

Four words come up on every screen.

- A **wafer** carries tens, hundreds or thousands of usually identical chips, called **dies**
- Wafers are made and tested in batches called **lots**, often of 25
- A **tester** measures each die while a **prober** steps from die to die

A simple wafer map draws one rectangle for each die, so you can see where on the wafer the results are good or bad.

What a test records

The tester records two kinds of test result for every die.

- A **test value**: a measurement, such as a threshold voltage or a leakage current
- A **functional test**: only a pass or a fail, such as a scan chain

Testers usually write **STDF** (binary) or **ATDF** (text) files. Data can also arrive as CSV, JSON or Parquet files. tsmap reads all of these file formats, compressed or not.

Bins and yield

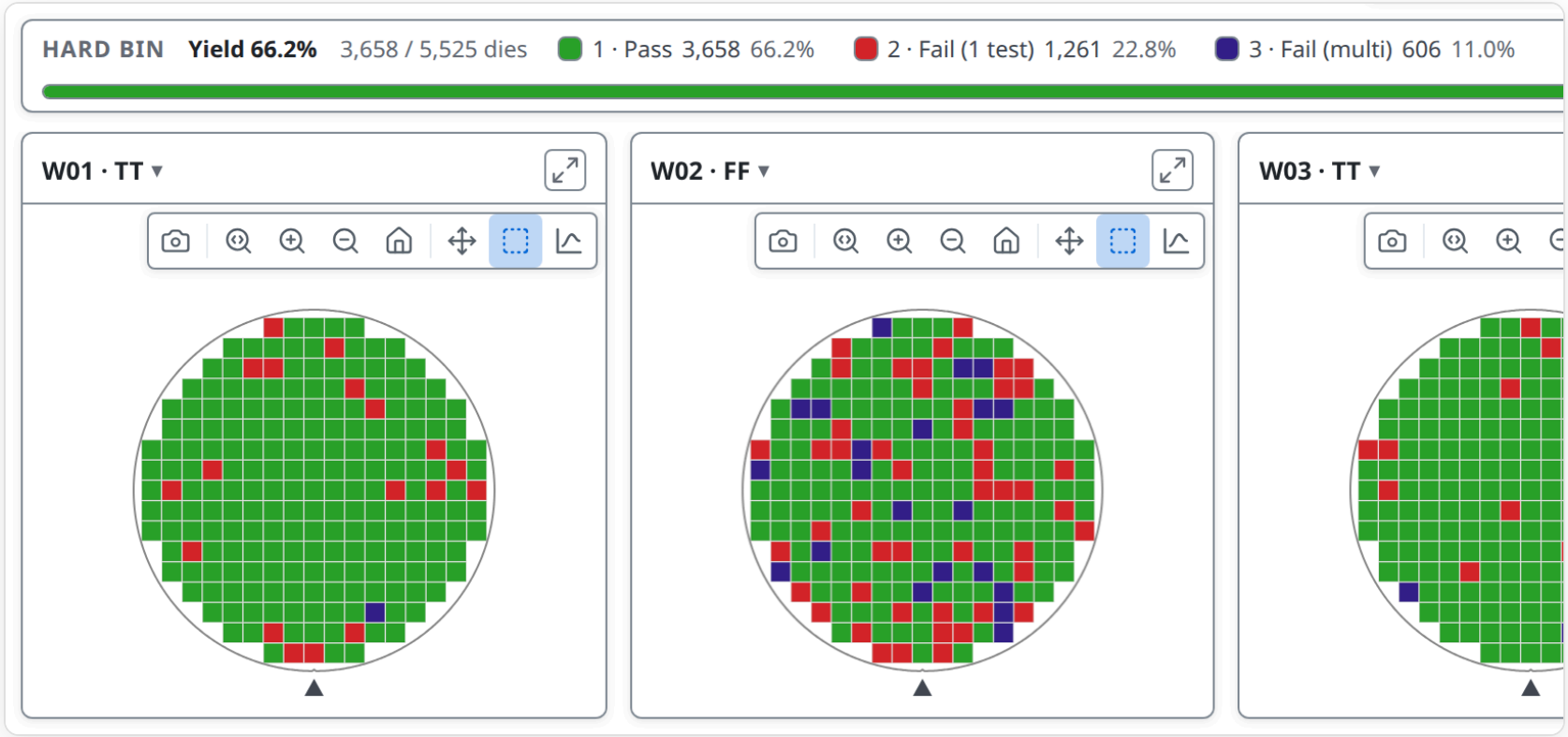
After testing, every die is classed into a **bin** (a category), and the bins are what colour the map. There are two kinds of bin:

- **Hard bin**: the sort result. Bin 1 is a pass bin in this example, in green, often known as the *production bin*.
- **Soft bin**: the test program's reason, usually finer than the hard bin, often known as the *engineering bin*.

Yield and reading the colours

Yield is the share of dies in a pass bin: 66.2% for this lot, shown in the legend.

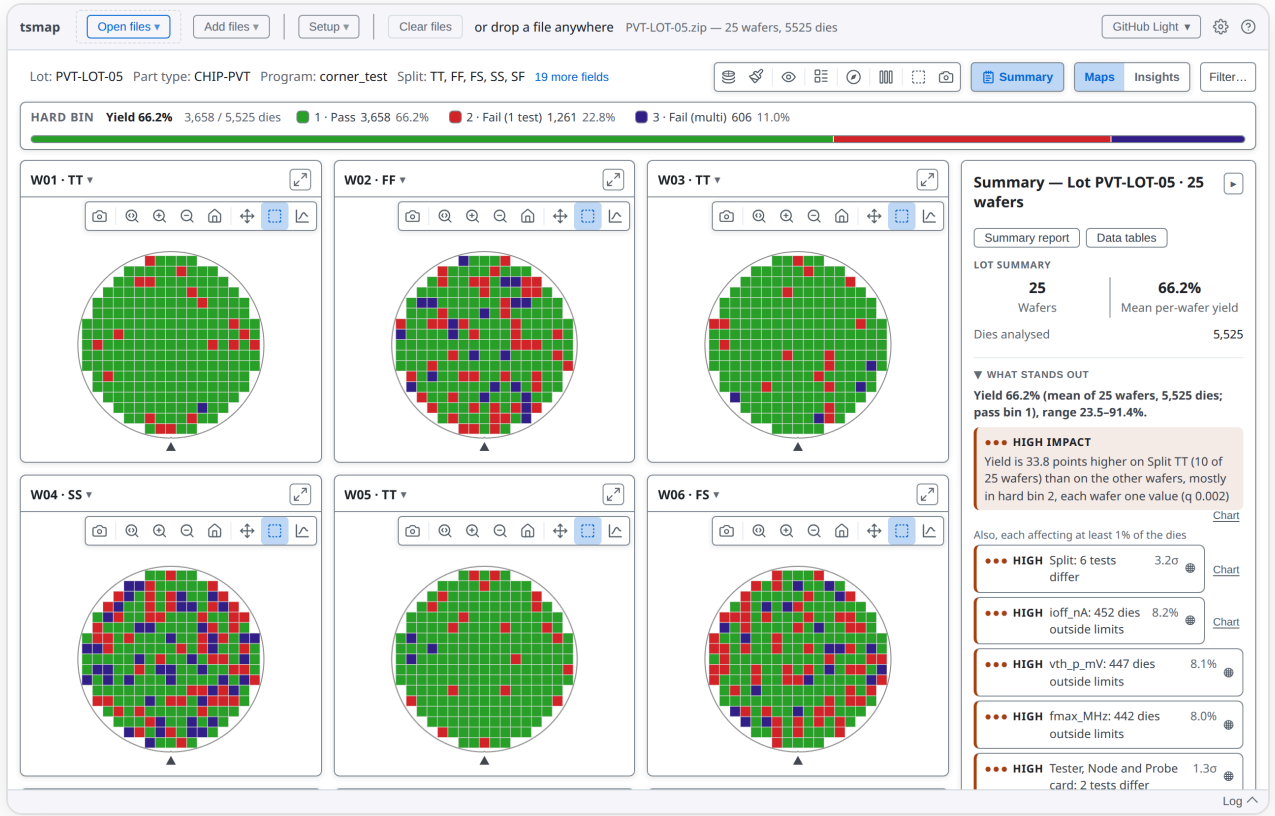
A map that is mostly green is a healthy wafer. The other colours show where the rest of the dies failed, and how.



What tsmap is

A viewer for wafer test data

Open STDF, ATDF, CSV, JSON or Parquet files and get interactive wafer maps, findings, charts and tables. You can start looking at your data straight away, with nothing to program.



Two ways to run tsmap

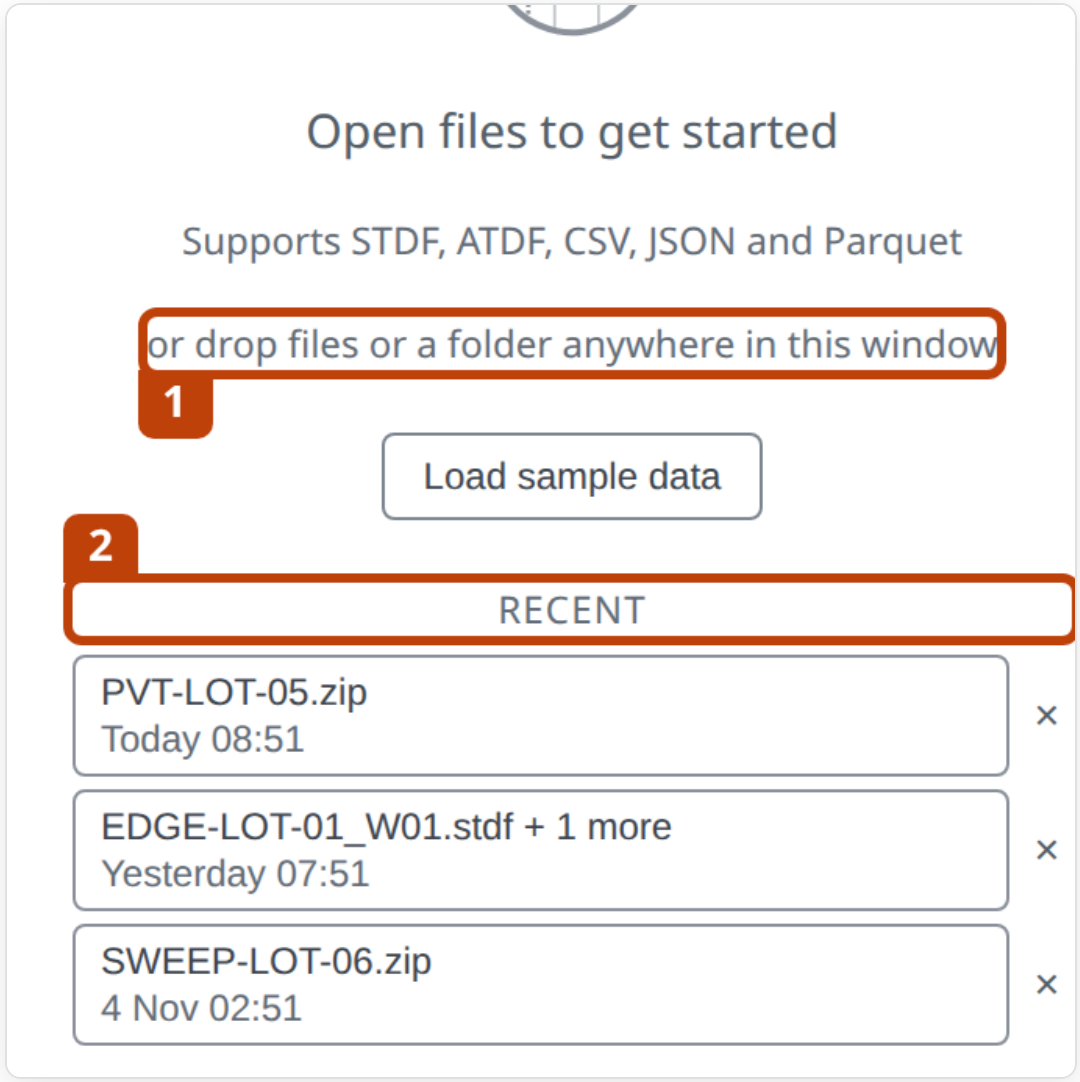
- **In the browser** at wafertools.github.io/tsmap/app: nothing to install, and it works offline after the first visit
- **As a desktop app** for Linux, macOS and Windows, from the releases page.
  The installers are not code-signed, so the first run may show a warning: what to click

Desktop only

The same test data parser, maps and charts run in both. Only the desktop app has:

1. dropping a whole folder
2. recent files
   - the command line, `tsmap://` links and file associations (lesson 12)

More about this in the user guide



Built on wafermap

tsmap is built on **wafermap**, our own fast open-source library that draws the maps and charts and finds the patterns.

You do not need to know anything about **wafermap** to use tsmap.

These lessons link to two guides:

- tsmap's user guide, which mostly covers loading data and configuration files
- The wafer map guide, which covers the maps and charts.

Your files and data stay with you

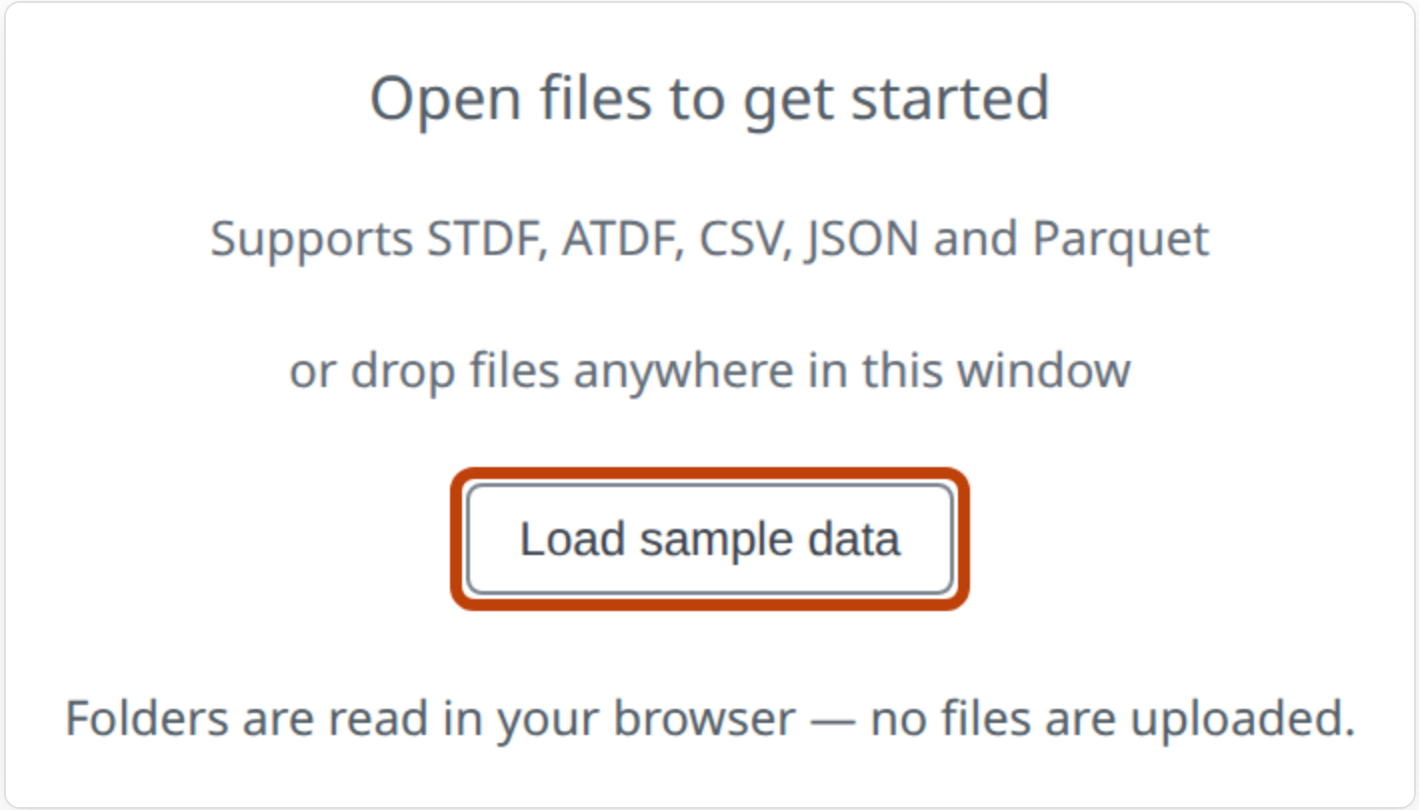
- Files are read on your own computer, in the browser or in the app
- Nothing is uploaded to a server, so your data stays with you

Finding your way round tsmap

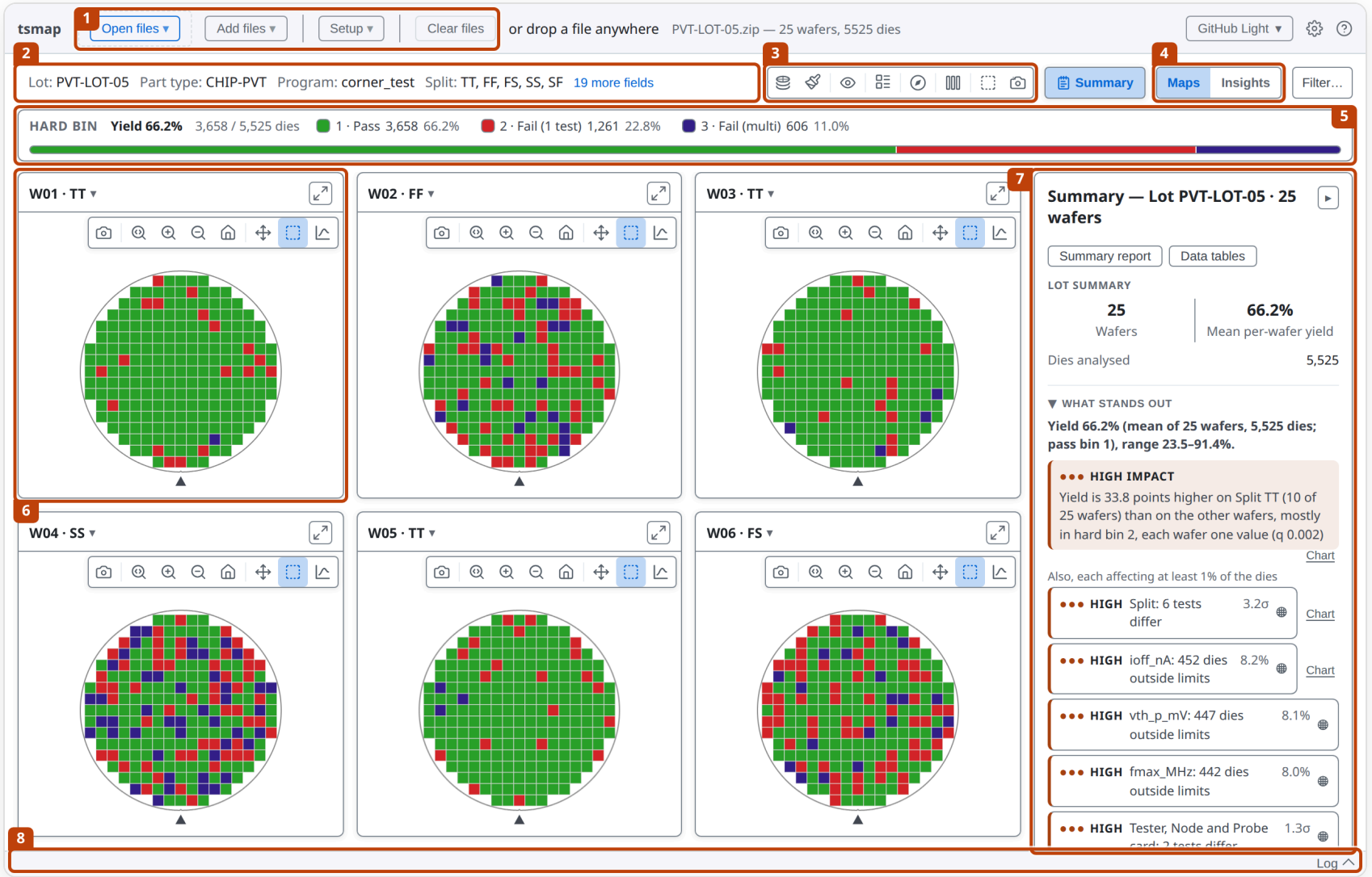
The main screen has eight areas. You will see them all numbered once, then described one at a time.

Everything starts here

Load sample data opens a synthetic lot of 25 wafers, so you can follow along without any files of your own. Most labs in these lessons use it.

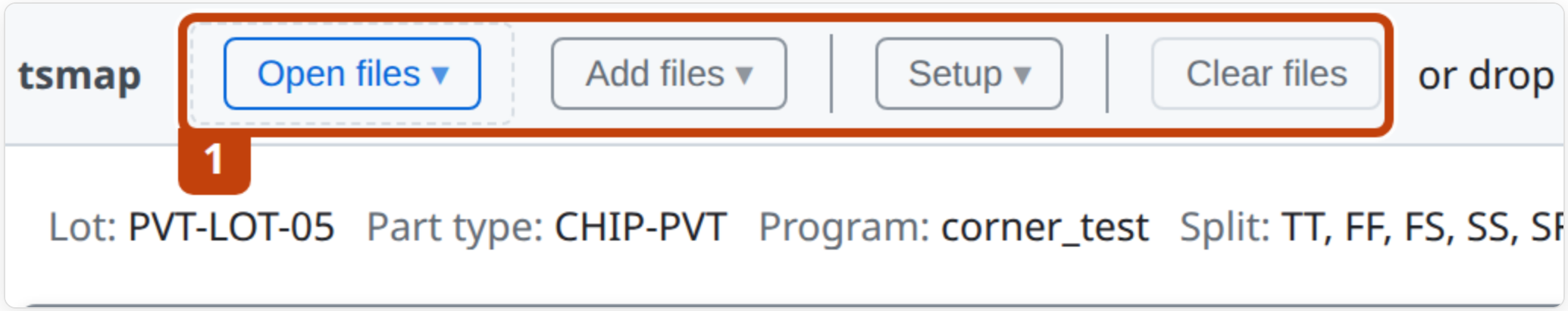


The screen at a glance



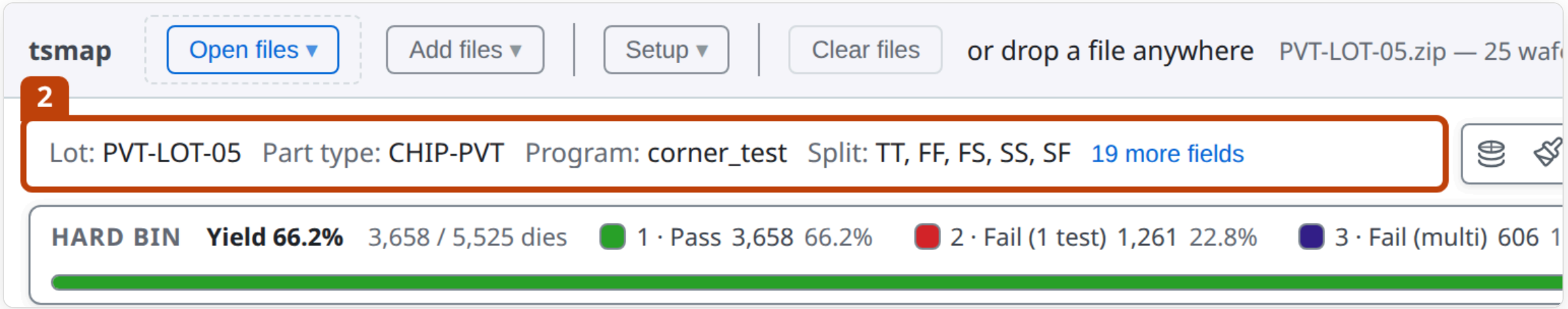
1 The app toolbar

The app toolbar opens and adds files, sets up the lot and clears it. Lesson 01 covers loading.



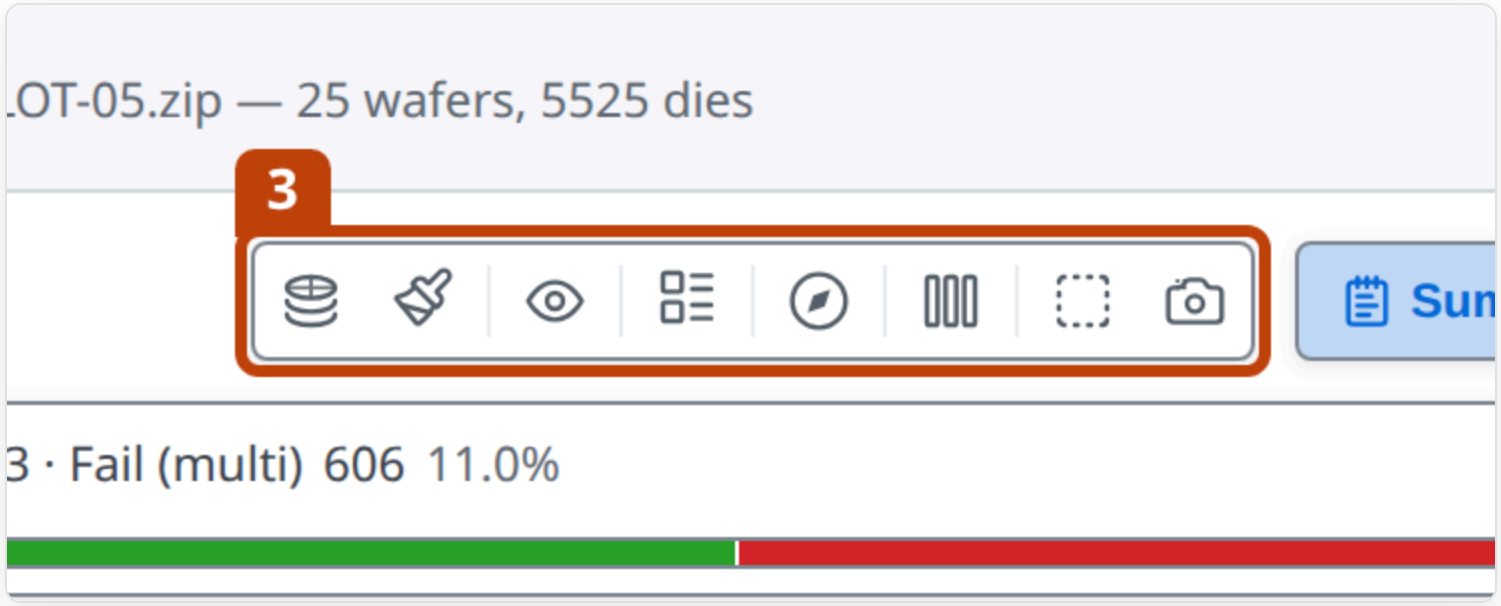
2 The lot header

The lot header shows the lot, part type, program and other fields read from the file.



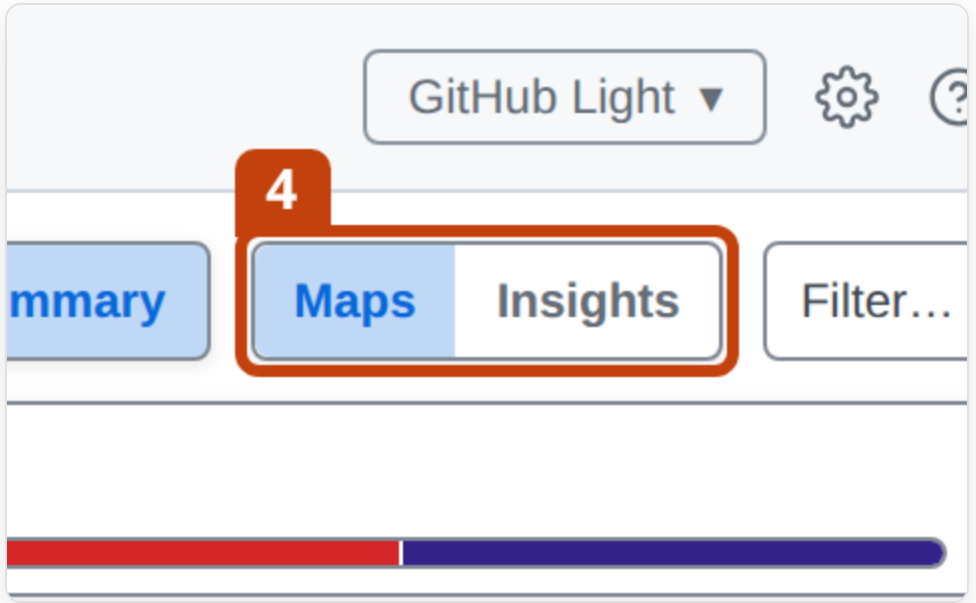
3 The map toolbar

The map toolbar controls what the maps show and how they look. Lesson 02 takes it button by button.



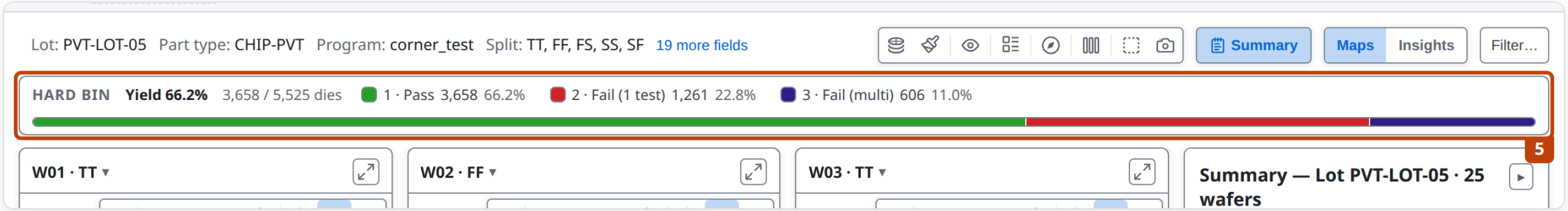
4 Maps and Insights

Maps and **Insights** switch between the wafer maps and the charts and statistics for the lot.



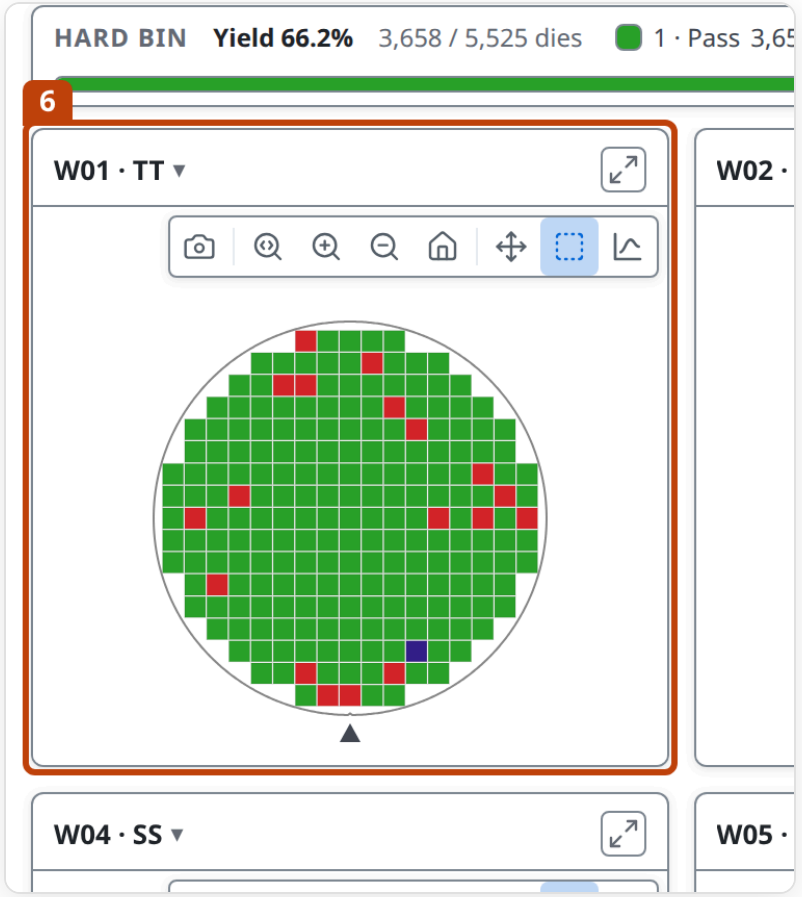
5 The bin legend

The bin legend shows how many dies fell into each bin, with the lot's yield first. Click any bin to display just that bin on the maps.



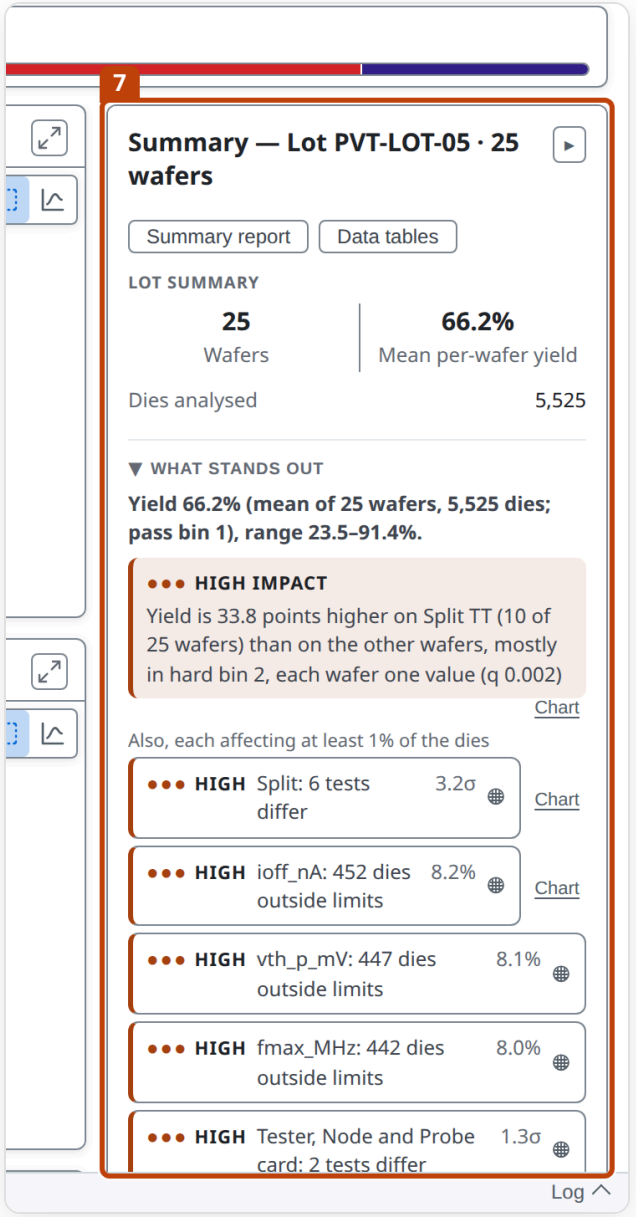
6 One card per wafer

Each wafer gets its own wafer map. Click the ▾ beside its name to show the wafer's details.



7 The Summary panel

The Summary panel shows what stands out in the lot, the findings, and the yield of every wafer.



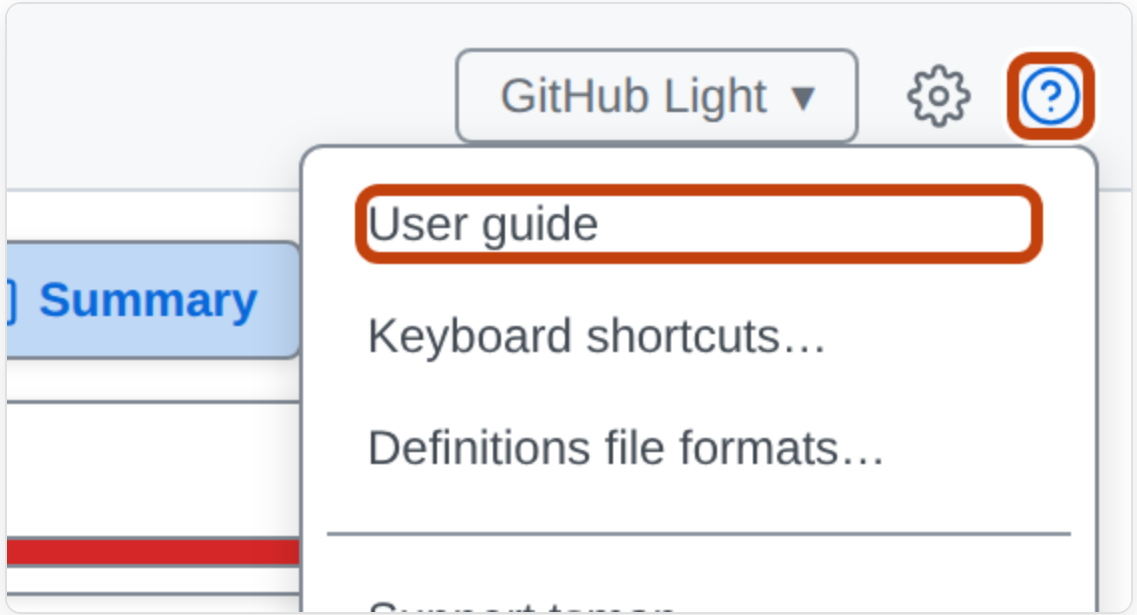
8 The log

The log records each data load, with any warnings. Click **Log** to open it.



Help is one click away

The **?** button opens the Help menu. **User guide** opens the full guide.



Every dialog

Maximize (F) and **Close (Esc)**, top right, are on every dialog.

Press **F** to fill the window, and **Esc** to close it.

How the lessons work

Thirteen short lessons

tsmap is quick to pick up. Load a file and you can start looking at it straight away, so you do not have to finish the lessons before using the app. They are there for when you want to go further.

- Each lesson is a few slides, then a short lab in the web app
- Use the arrow keys to move through the slides, and press **F** for full screen.
- New to tsmap? Go in order: lessons 00 to 06 are the core path. Otherwise pick the lesson you need
- For the detail behind a slide, follow the link to the user guide

LAB Try it yourself

1. Open the web app: wafertools.github.io/tsmap/app, or install the desktop app from the releases page
2. Click **Load sample data**
3. Find all eight areas from the tour
4. Click **Insights**, then **Maps** to come back

Recap

- A wafer map shows every die of a wafer, coloured by its bin or a test value; yield is the share that pass
- tsmap runs in the browser or as a desktop app, and keeps your files local
- The screen has eight areas: toolbar, lot header, map toolbar, views, legend, wafers, Summary and log

You now know the words and where things are. The next lesson is about getting your own data in.



Next lesson

01 · Getting data in →

Opening your own files, choosing tests and mapping columns.



Getting data in

Lesson 01

Learn tsmap

In this lesson

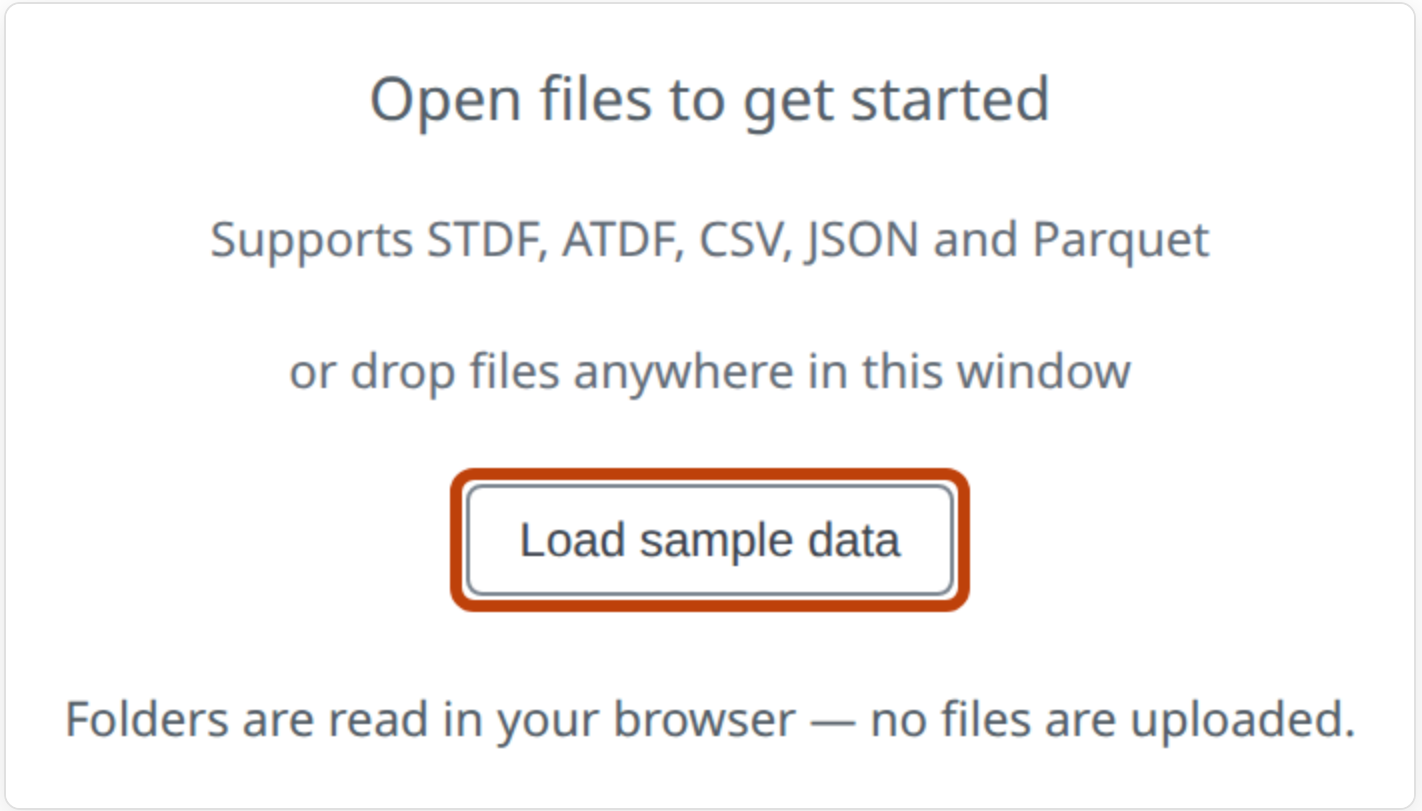
Most of the time, opening a file is a simple drag and drop. This lesson also covers the cases where you need more: many files, or a table whose columns tsmap has to be told about.

- Open files from inside the app, and build one lot from several files
- Choose and rename tests in the test selector
- Map the columns of a CSV, JSON or Parquet file

Opening test data files

The quickest start

Load sample data opens an example lot: 25 wafers from five process corners. More sample lots, one per feature, are listed in the user guide.



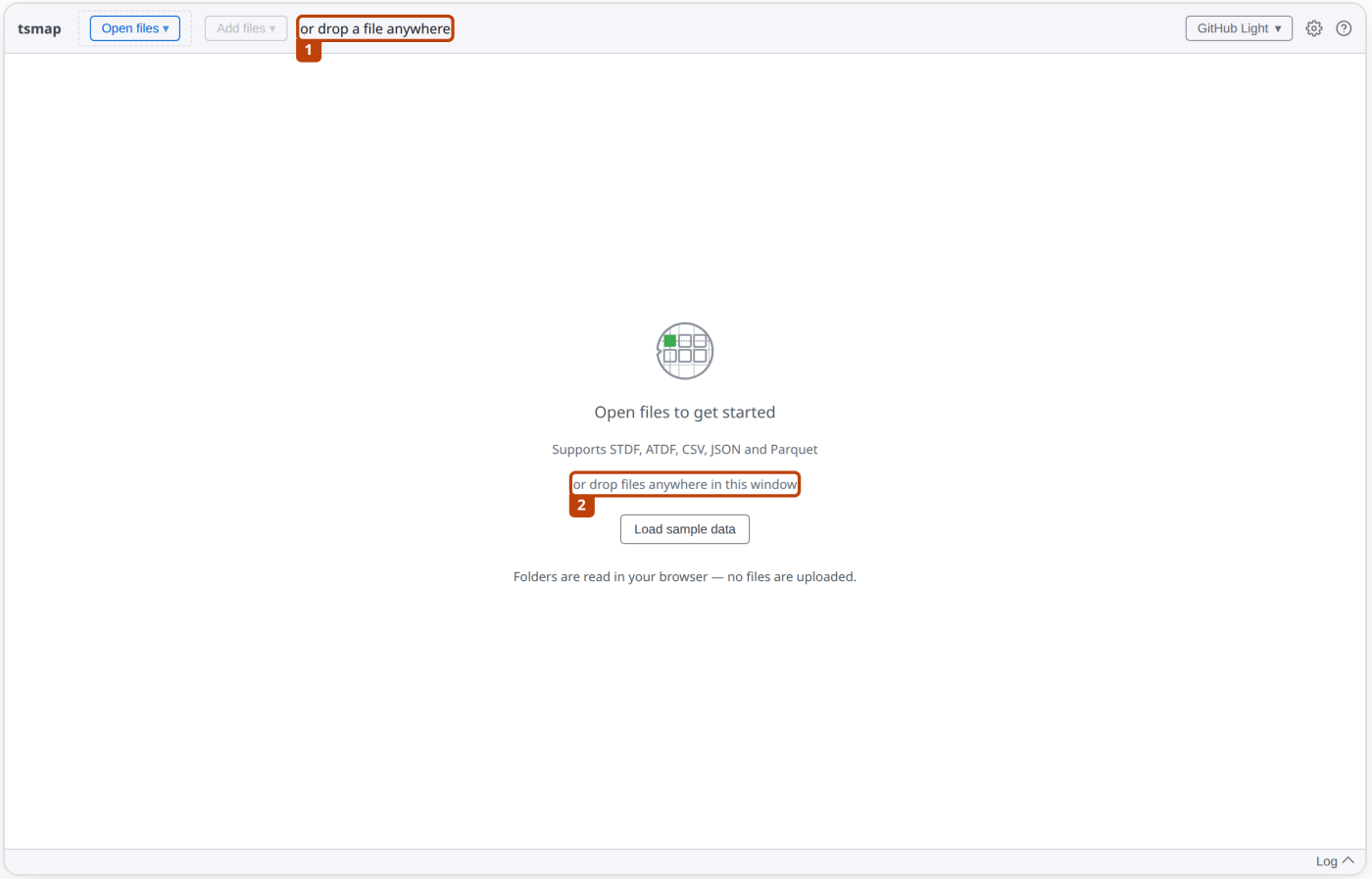
What tsmap reads

Whatever test data you have, you can probably open it in tsmap.

- **STDF** and **ATDF**: tester files, read directly
- **CSV**, **JSON** and **Parquet**: tables, after a simple column mapping step
- **.gz**, **.bz2** and **.zip**: compressed files are read without unpacking first

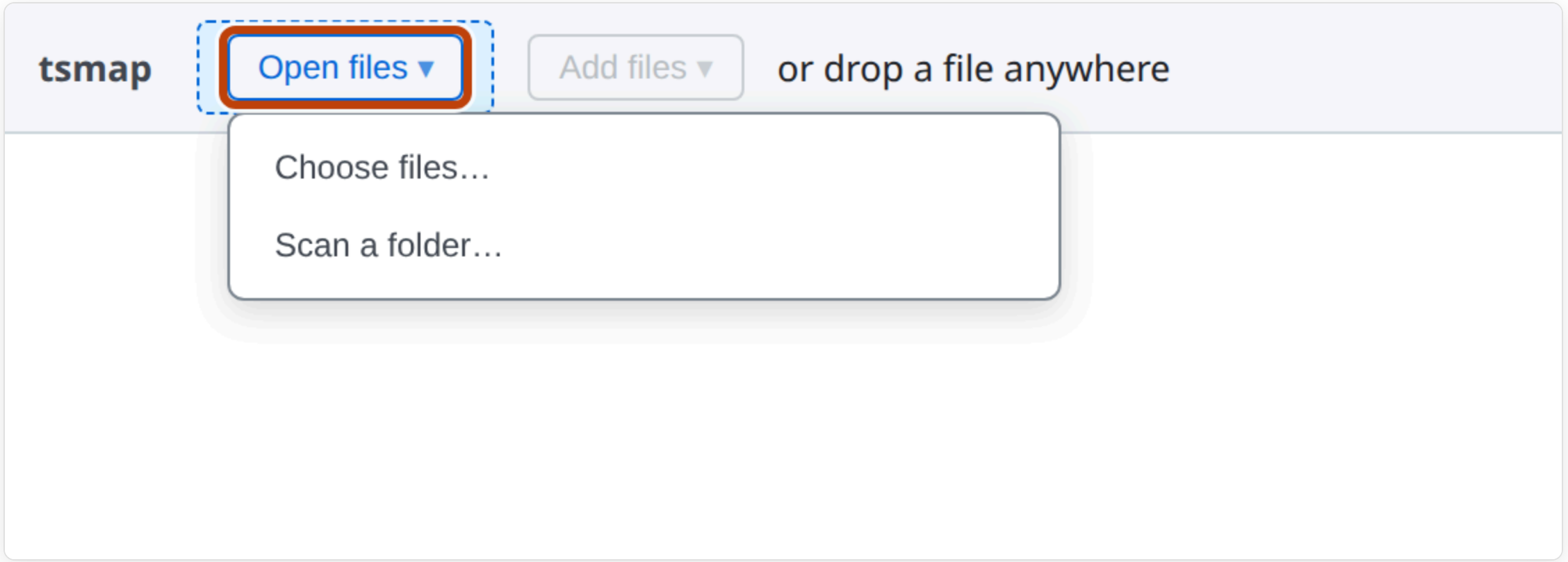
Drag and drop

Drop one or more files anywhere in the window. It is the same as picking them. In the desktop app, dropping a folder scans it.



Open files ▾

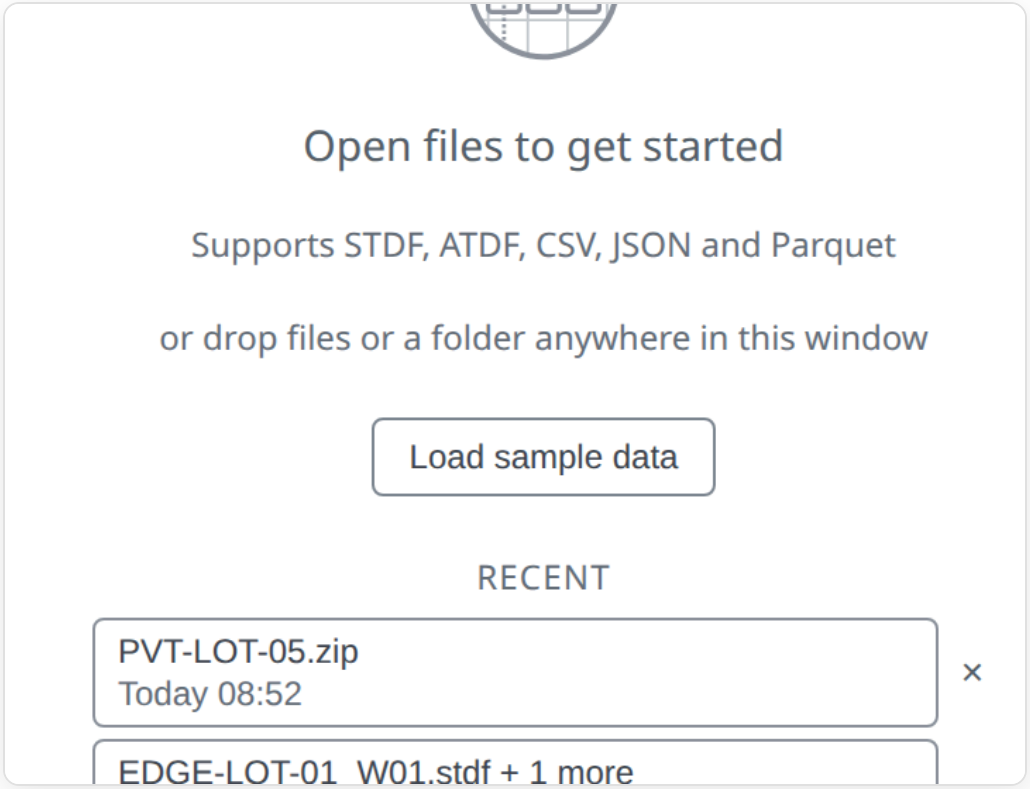
Open files ▾ opens a menu that offers **Choose files…** or **Scan a folder…**



Recent files

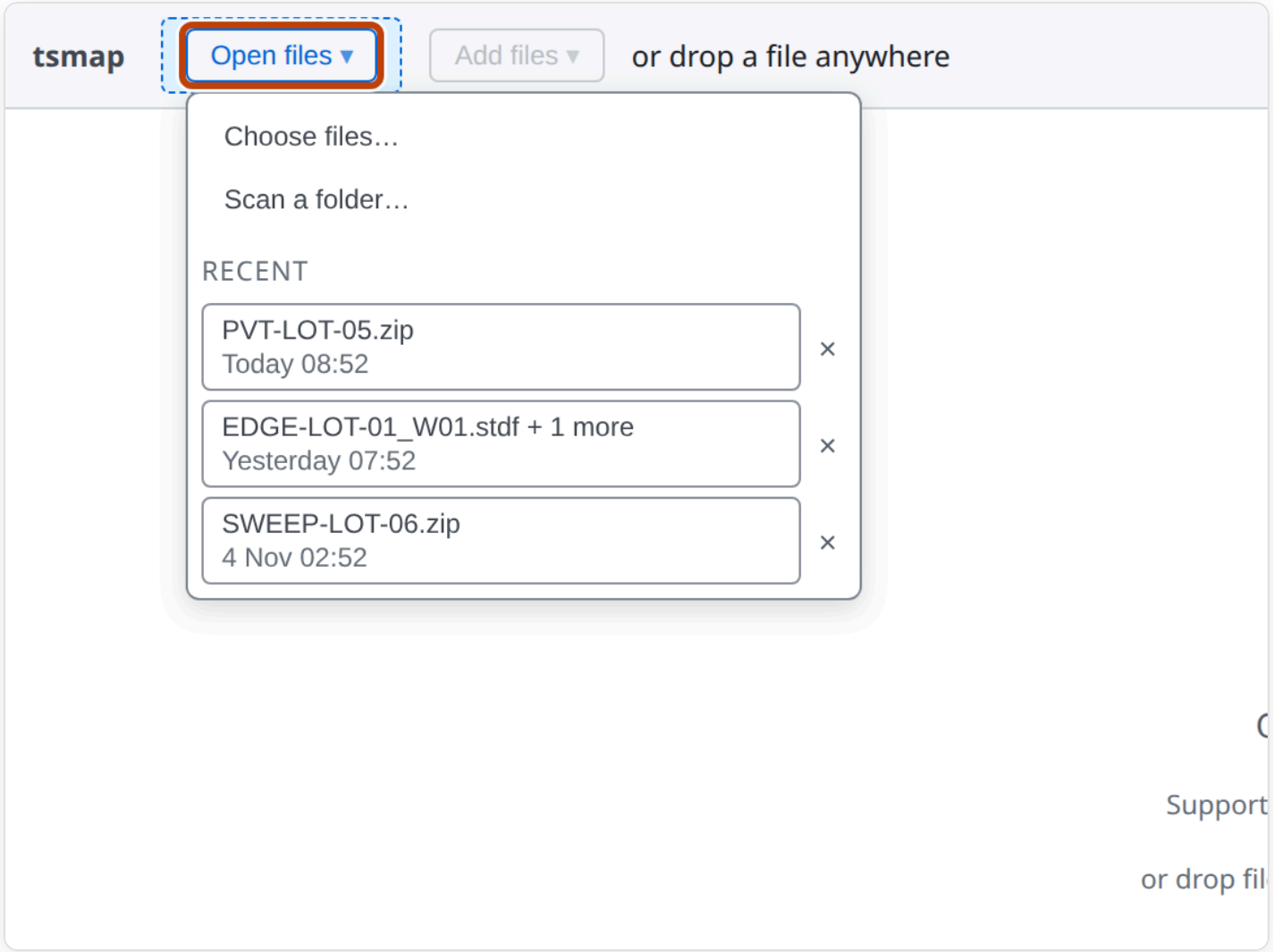
Desktop app only.

The last 8 file sets you opened are listed on the start screen, with when you opened each. Click one to open it again, or × to forget it.



Recent files in the menu

Once data is loaded the start screen is gone, so the same list sits under **Open files ▾**, below **Choose files…** and **Scan a folder…**. Opening a recent set replaces what is loaded. **Add files ▾** has no list, because adding from a recent set is not offered.



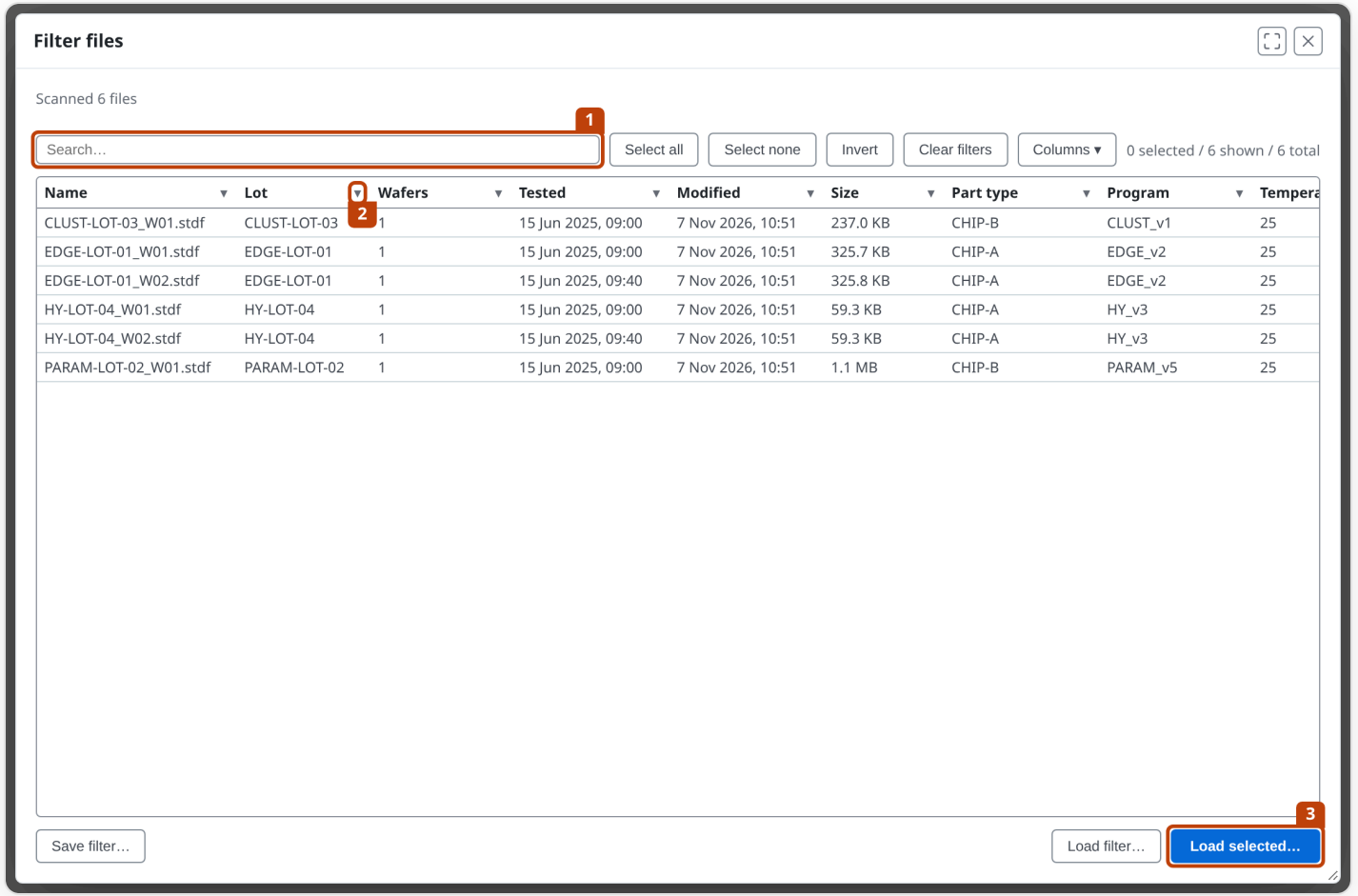
Scanning a folder

Hundreds of files? Let tsmap tell you what is in them before you load any.

The file filter

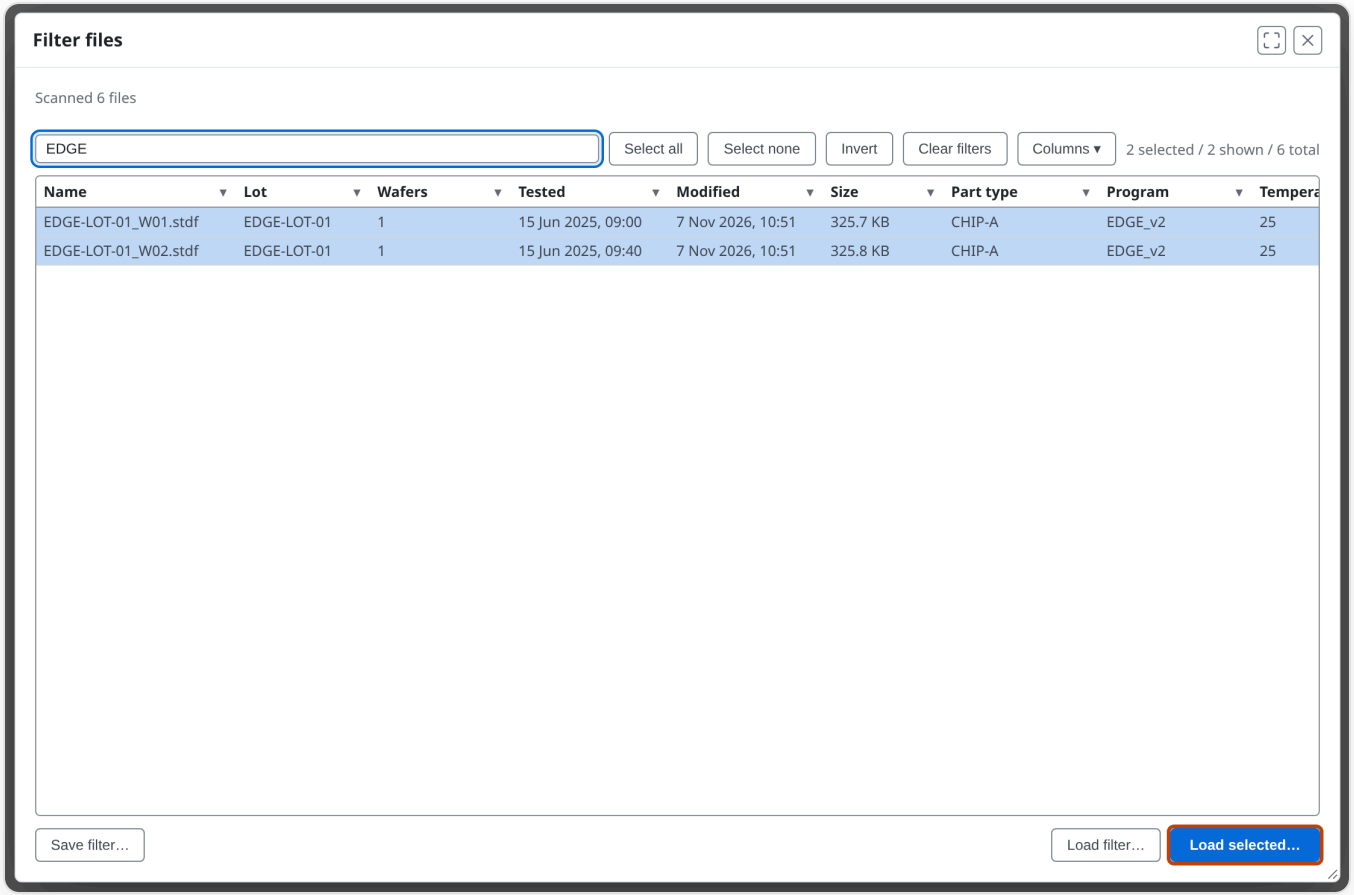
Scanning a folder reads only each file's header data, so it is quick even for a big batch. You then choose what to load.

- Click a column heading to sort; click ▾ to filter that column
- Search across every column



Select, then load

The usual routine: search for a string like **EDGE**, **Select all** of what is shown, then **Load selected…**. You load only the files you want.

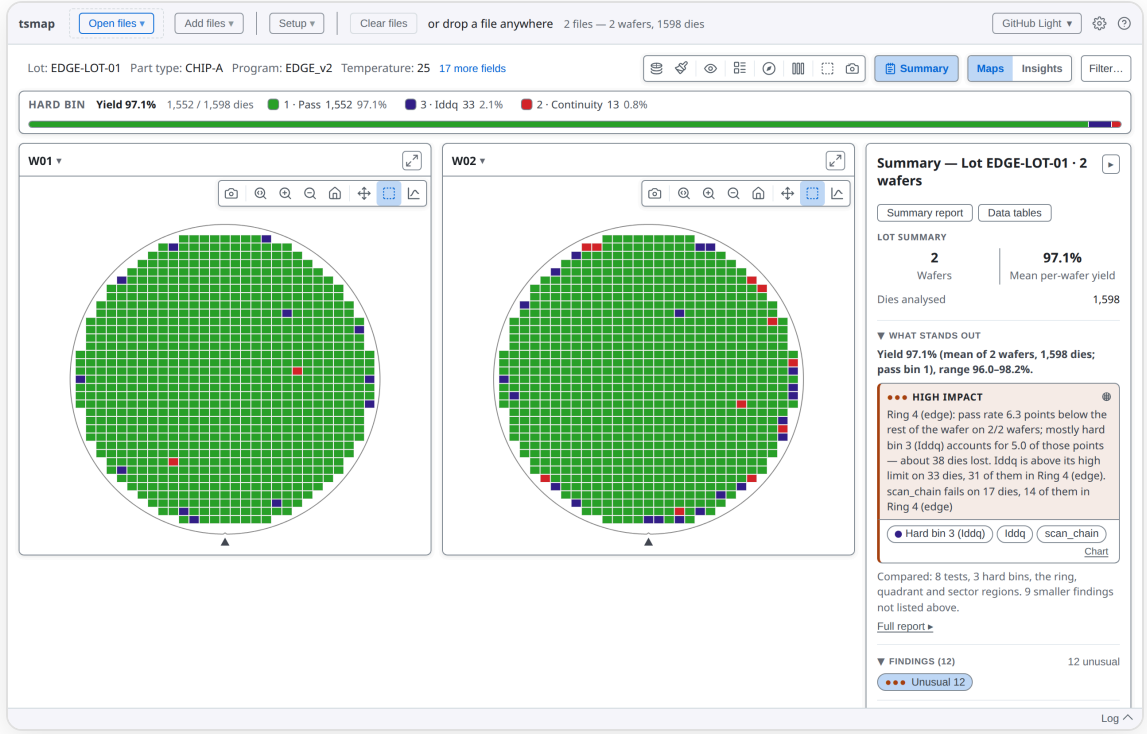


Filters you use again

- **Save filter…** keeps the filters in a file; **Load filter…** reselects matching rows
- A mixed folder: buttons above the table pick which kind of file to load
- Pick more than five files with **Open files** and tsmap offers this filter table

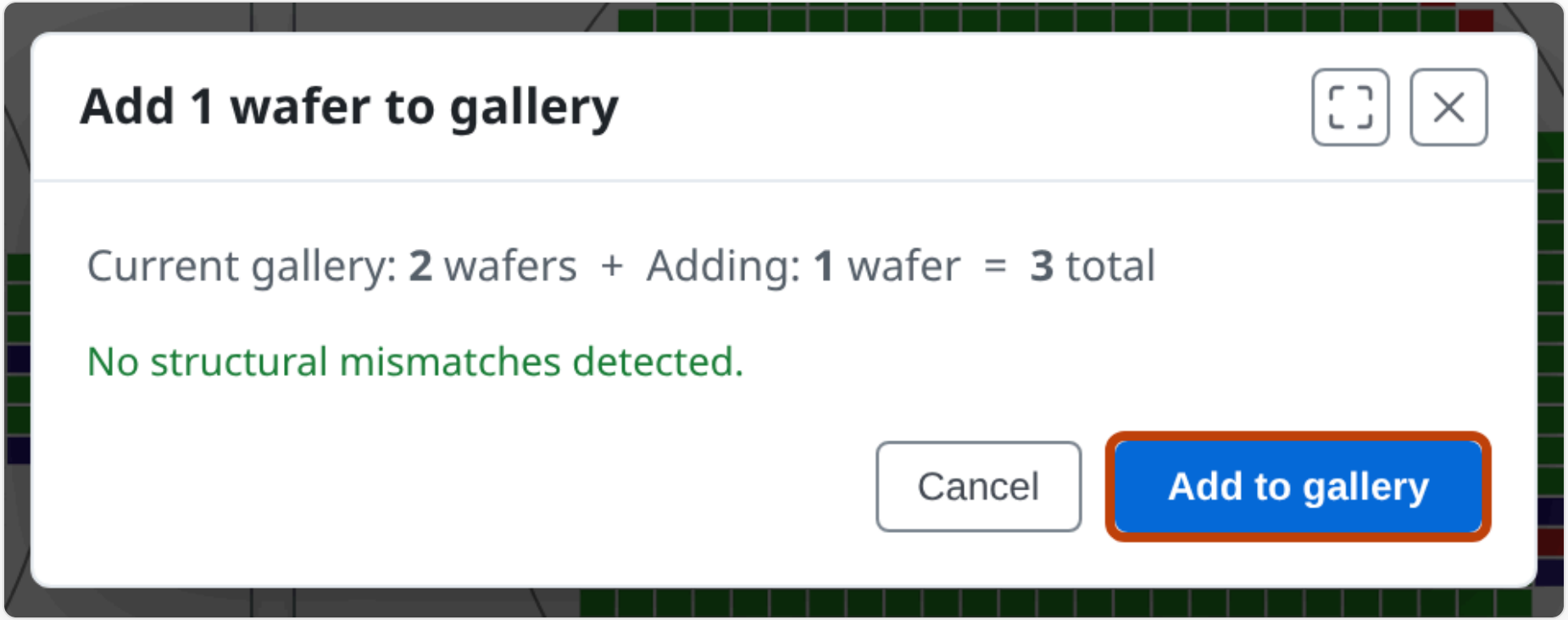
One lot from separate files

The two files of EDGE-LOT-01 hold one wafer each, and they load as one lot, `EDGE-LOT-01`. Files that name the same lot open straight away, as long as no wafer appears in more than one of them. A lot tested in several sessions arrives like this, one file per session. The six files used here are in the scan-folder zip on the sample files page.



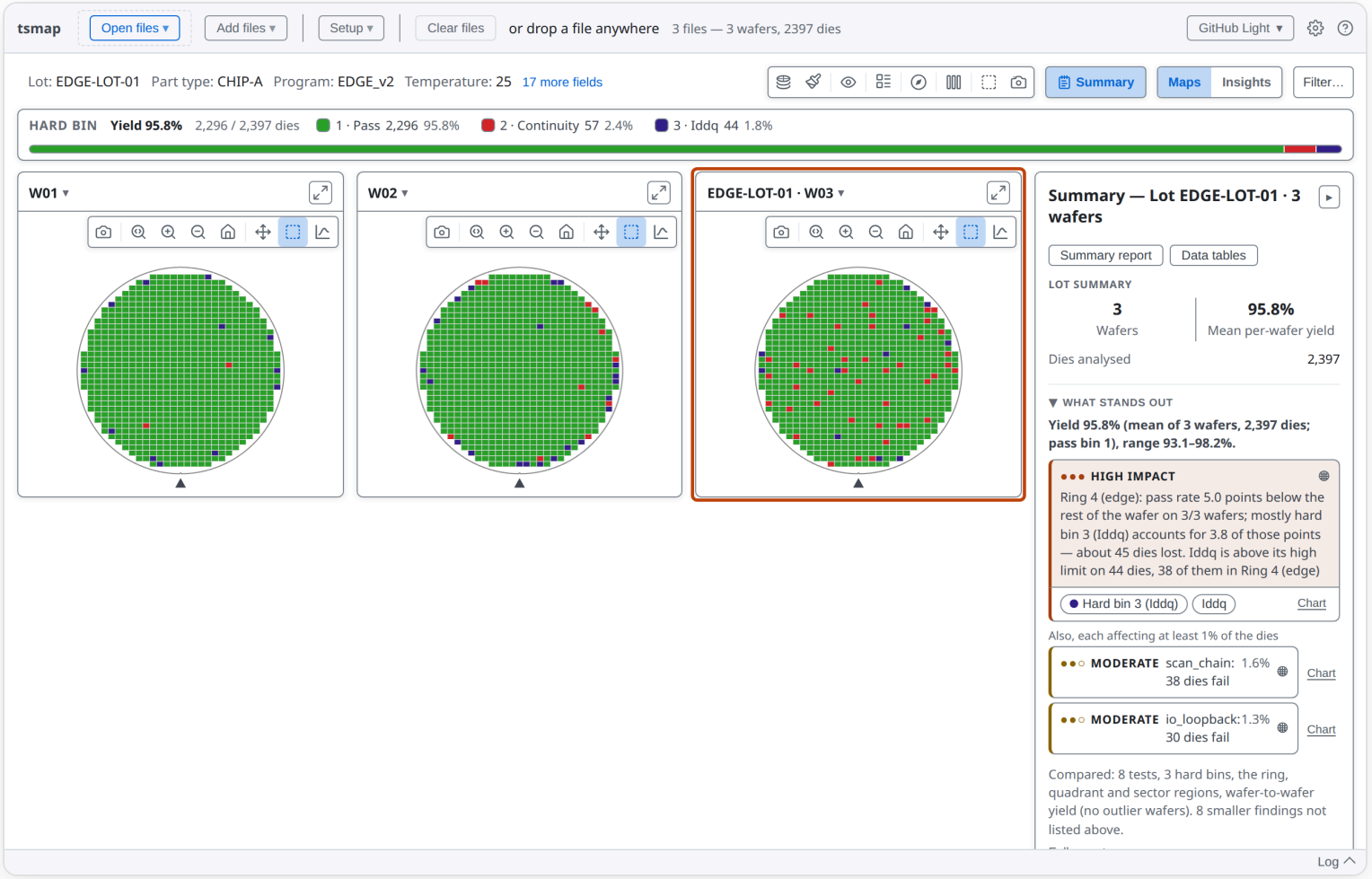
Add files

Add files appends wafers to what is already loaded. The confirmation warns when the new wafers differ from the ones you have: another die count, other bins, or a wafer ID that's already loaded. Read it and confirm before you continue, because mixing unlike wafers can mislead.



The lot grows

Once the third file is added, its wafer joins the same gallery, Summary and yield.



Naming the wafers

When the files come from different lots, tsmap suggests a label per wafer. A plain ID such as W01 gets its lot in front, so the W01 of EDGE-LOT-01 and the W01 of HY-LOT-04 stay separate, instead of being mistaken for one wafer. Edit any label, then **Continue →**



Test units across files

When files are combined, a test can arrive in different units.

- One file in mV and another in V? tsmap converts the later file to the first file's unit, and the log says so
- Any other difference, `mV` against `MV` included, may be another measurement. That test is left out of the views that compare wafers, so unlike numbers are never compared.

Two more ways to open test data

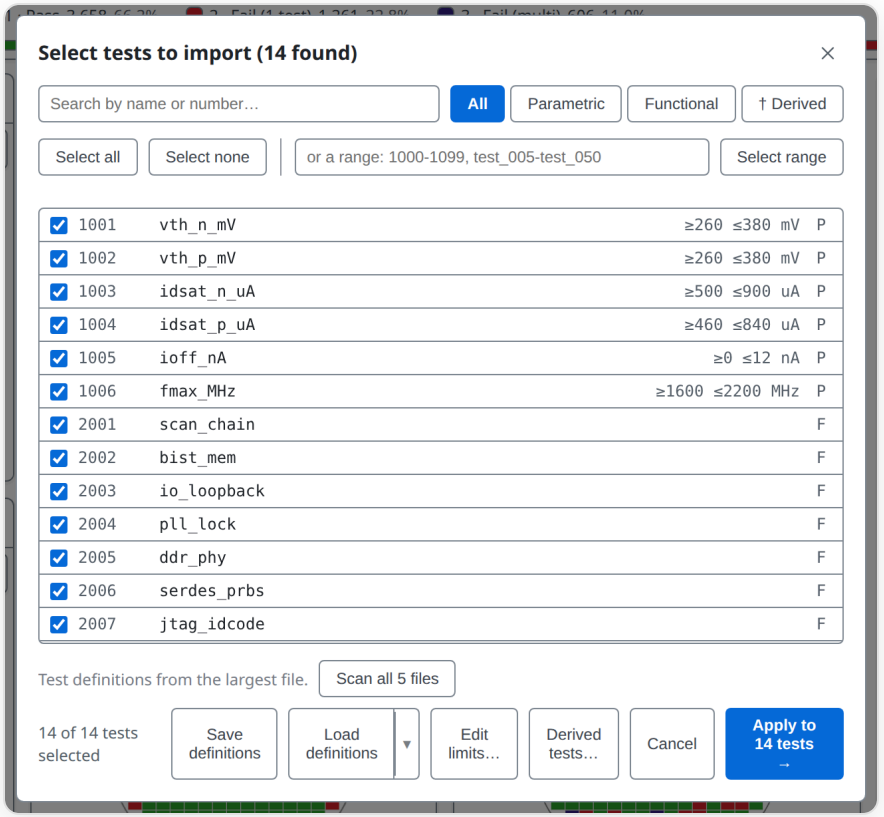
- **A link** that tells the web app which files to load
- **The command line**, which opens the files you name in the desktop app

Both are in lesson 12.

Choosing tests

The test selector

A test program can have hundreds or thousands of tests, and you rarely need them all at once. The test selector is where you choose what you need to analyse. A small lot imports every test by default, and **Setup ▾ → Tests…** opens the selector at any time.

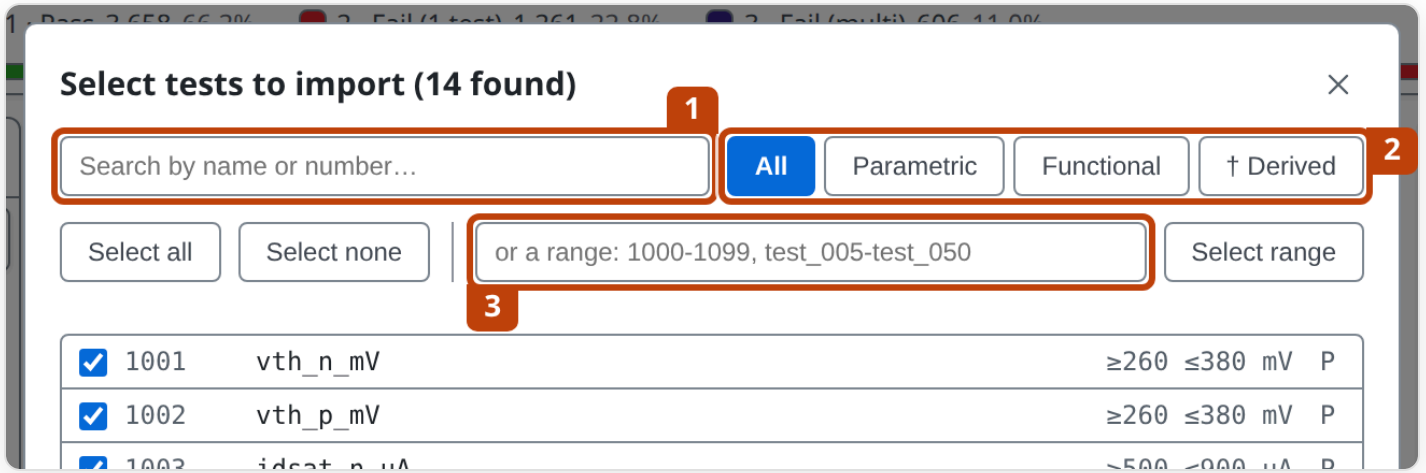


Edit limits…

Edit limits… in the selector opens a table of every test, where you can change its name, limits, units and type before the tests are imported. Lesson 02 explains test and spec limits, then walks through the table.

Narrow, then select

1. Search by name or number
2. Show one type of test
3. Select a range, such as `1001-1004`



Big lots start with no tests selected

Every test you import costs memory, so a large lot asks you to choose before it loads.

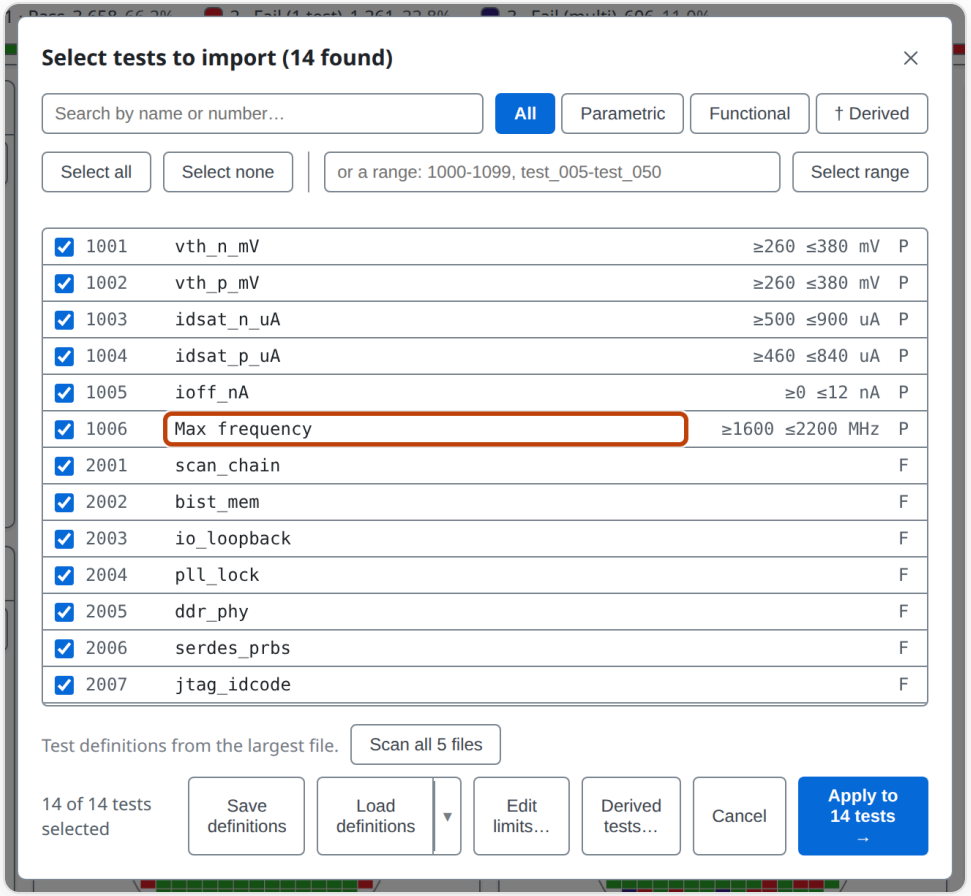
- A lot with many tests opens the selector first, nothing ticked
- The footer estimates memory: amber is slow, red asks first

Many files, many tests

- Several files: **Scan all N files** lists tests from every file
- Later, removing a test applies at once; adding one rereads the files

Rename a test

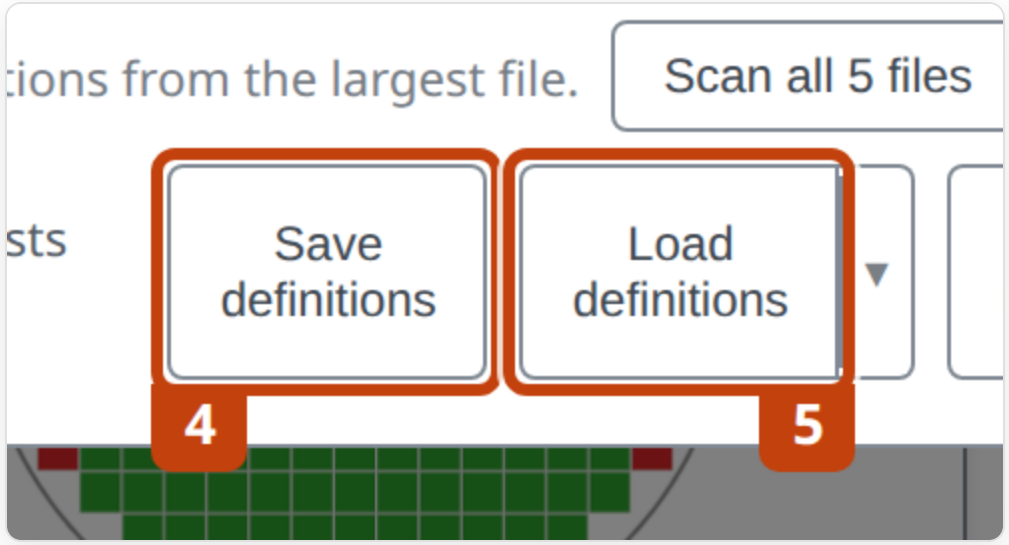
Test names from a tester can be cryptic. Click into a name and type a clearer one. **Enter** keeps it; only the displayed name changes, not the data.



Save and load definitions

4 **Save definitions** writes the selection, names, limits, units and test type to a CSV.

5 **Load definitions** reapplies it, which also gives limits to a program that shipped without them.



Mapping columns

CSV, JSON and Parquet only

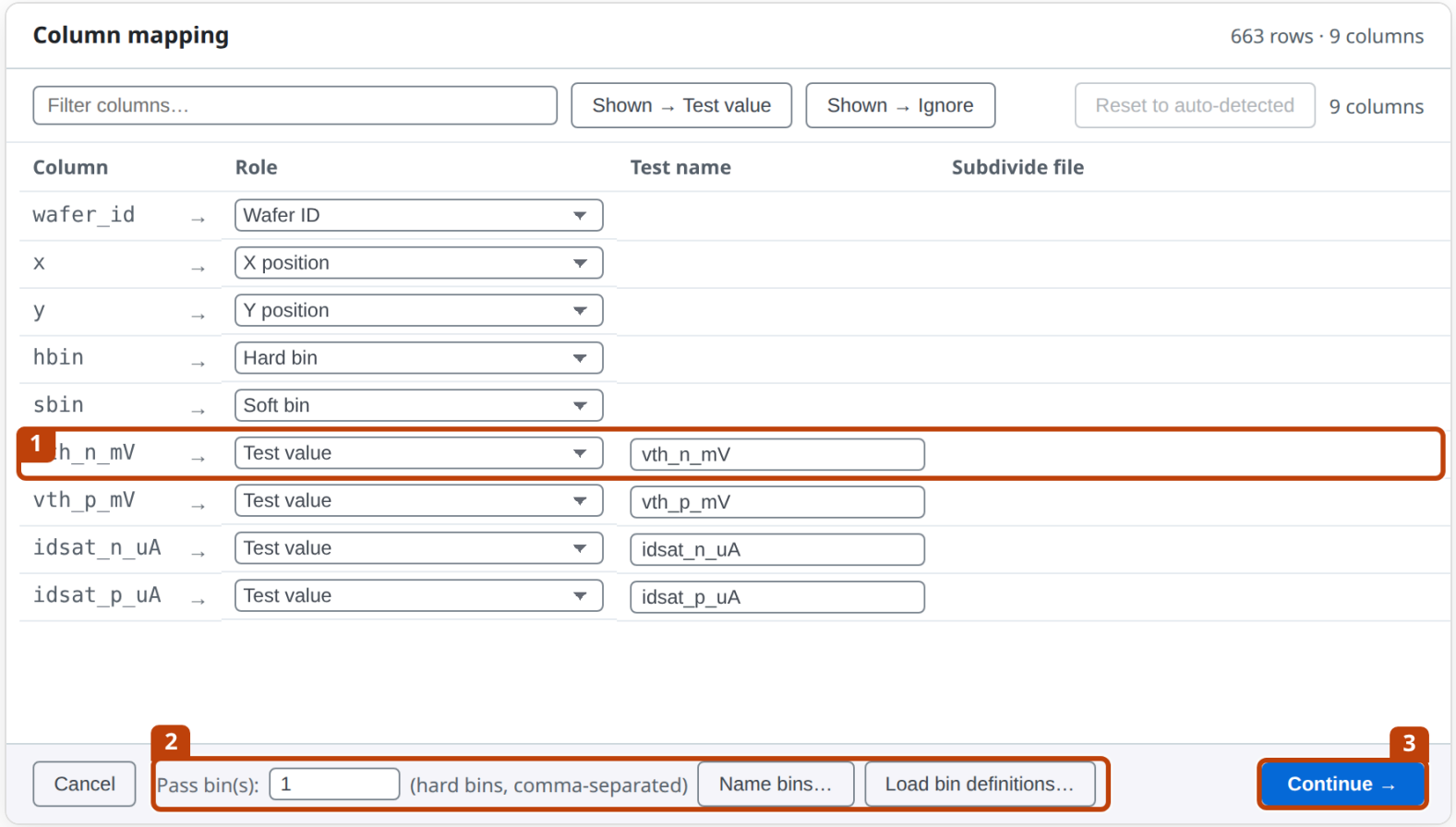
Not for STDF or ATDF

STDF and ATDF name every field in their records, so they go straight to the test selector without any need for column mapping.

A CSV, JSON or Parquet table can lay its columns out any way, so tsmap has to ask which column is the X position, which is the bin, and so on.

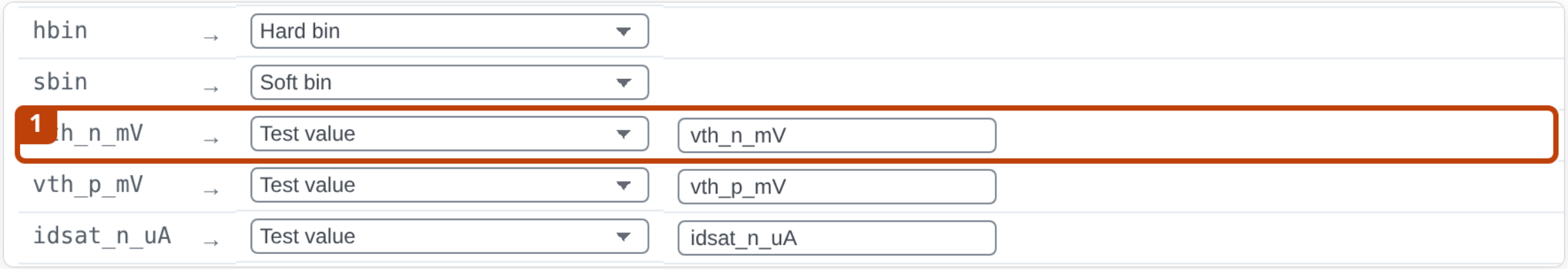
Column mapping

Every column gets a role. Common names are detected for you, so most of the time you only need to check that they are right, then **Continue →**



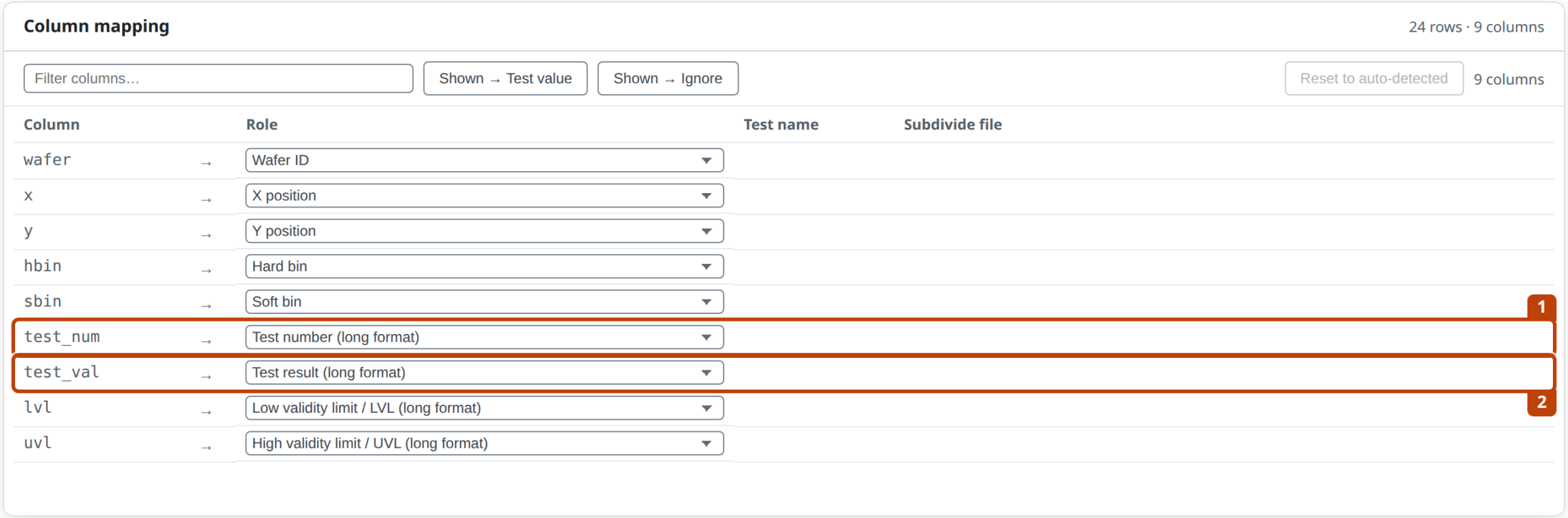
Wide format

In wide format there is one column per test. Each test column takes the **Test value** role 1.



Long format

In long format there is one row per die per test: a test number or name column, and a result column.



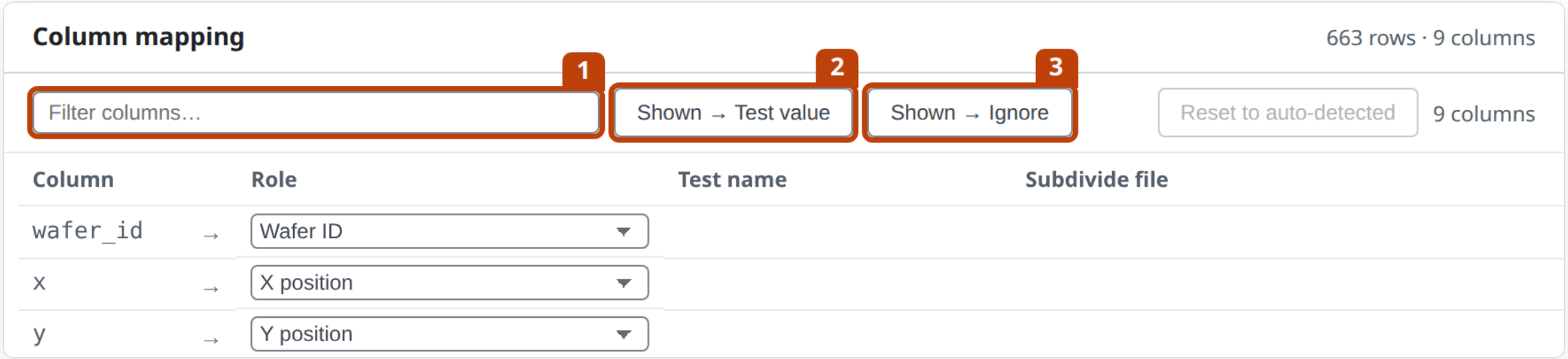
Roles worth knowing

Most columns are a test value or something to ignore. A few roles do more.

- **Lot ID**: map it so two lots' W01 stay two separate wafers
- **Pass/fail test**: a PASS/FAIL column, chosen for you
- **Display info**: a wafer fact, such as temperature, to group by
- **X** and **Y** are optional: without them, dies have no position

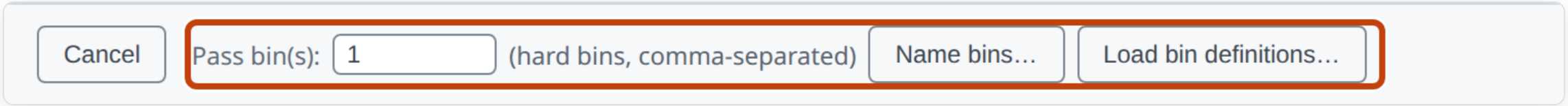
Many columns at once

1 Filter the columns by name, then give every shown column one role: 2 **Test value** or 3 **Ignore**.



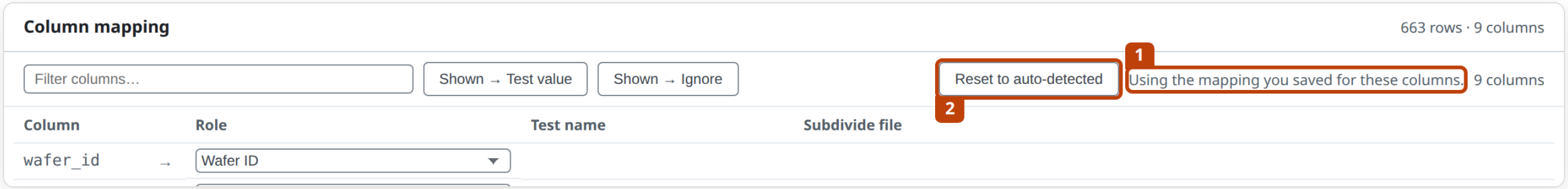
Pass bins

Pass bin(s) says which hard bins count as a pass, and the yield figure follows it. The default is 1. If your program passes in another bin, or several, list them with commas, such as `1,7`.



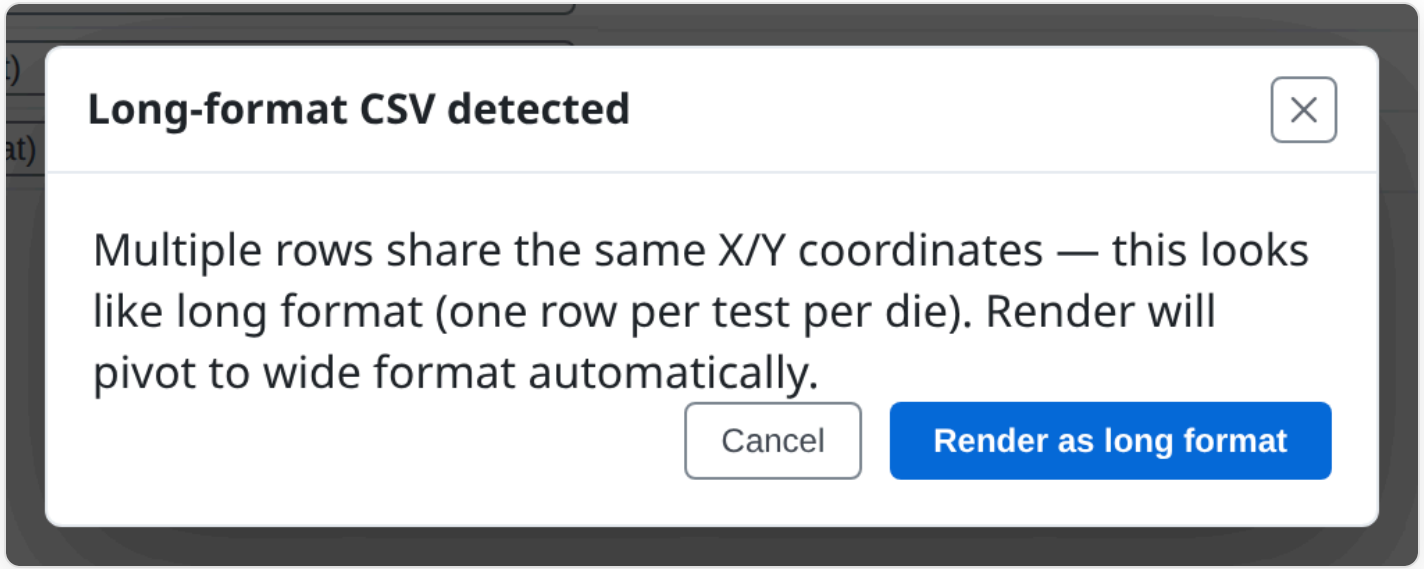
Saved mappings

The roles you confirm are remembered for that set of columns, so the next file with the same columns needs no checking. **Reset to auto-detected** forgets them.



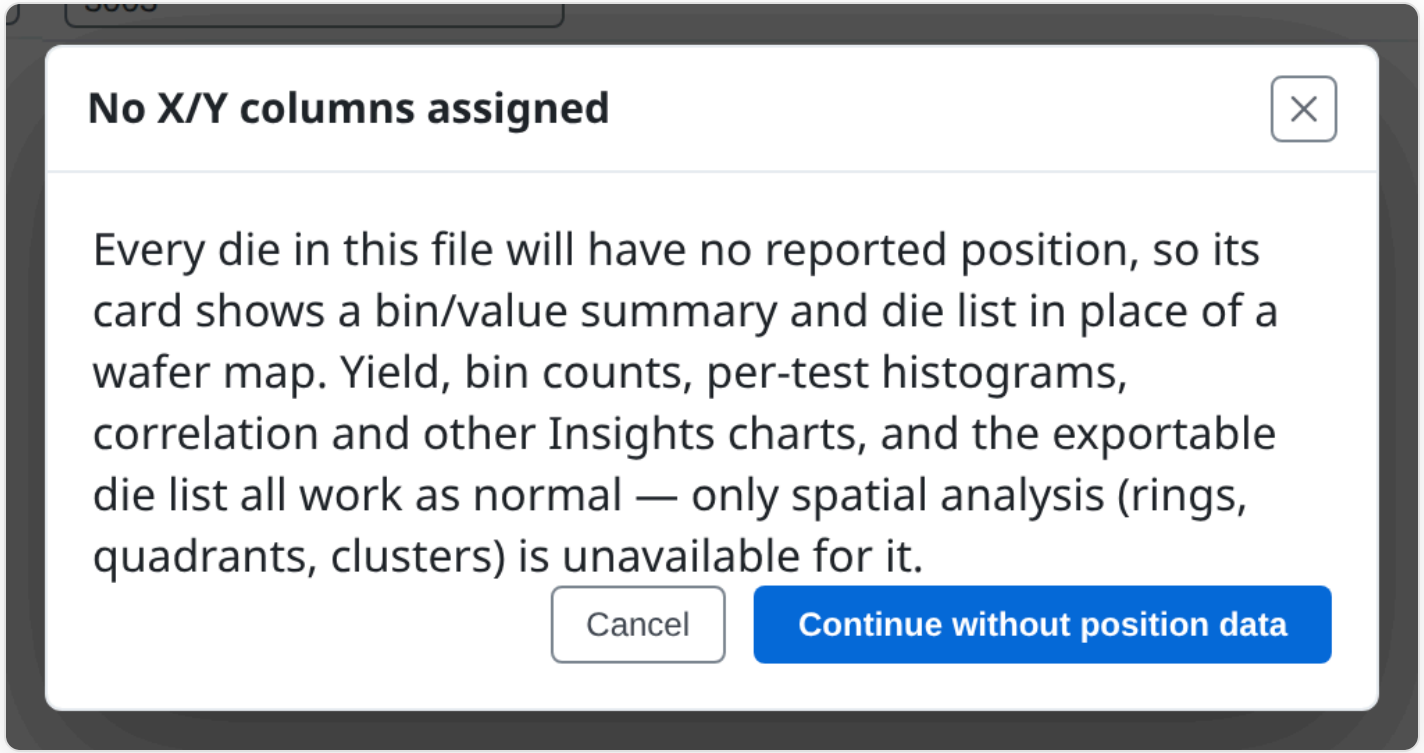
Long format asks first

When you press **Continue** → on a table in which several rows share the same X and Y, tsmap says it looks like long format and offers to **Render as long format**, pivoting it to one column per test. **Cancel** returns you to the mapping.



No position columns

With no X or Y column, tsmap asks before it carries on. **Continue without position data** shows each wafer as a bin and value summary and a die list, not a map. Yield, histograms and correlation work as normal; only spatial analysis, such as rings and clusters, is unavailable.



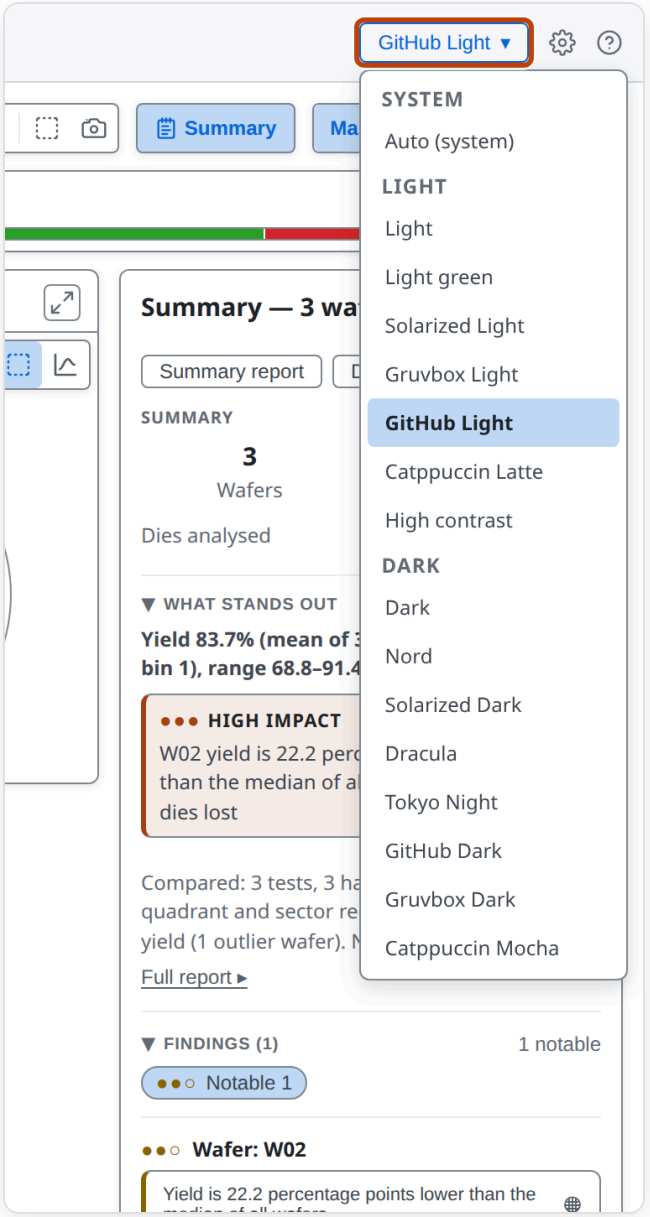
Bin names

A file may carry only bin numbers. Tables show them as bare numbers until you name them in **Bin definitions…** or load a bin definitions file, which also names the bins in the legend. Lesson 04 covers the window and lesson 12 the files.

Making it yours

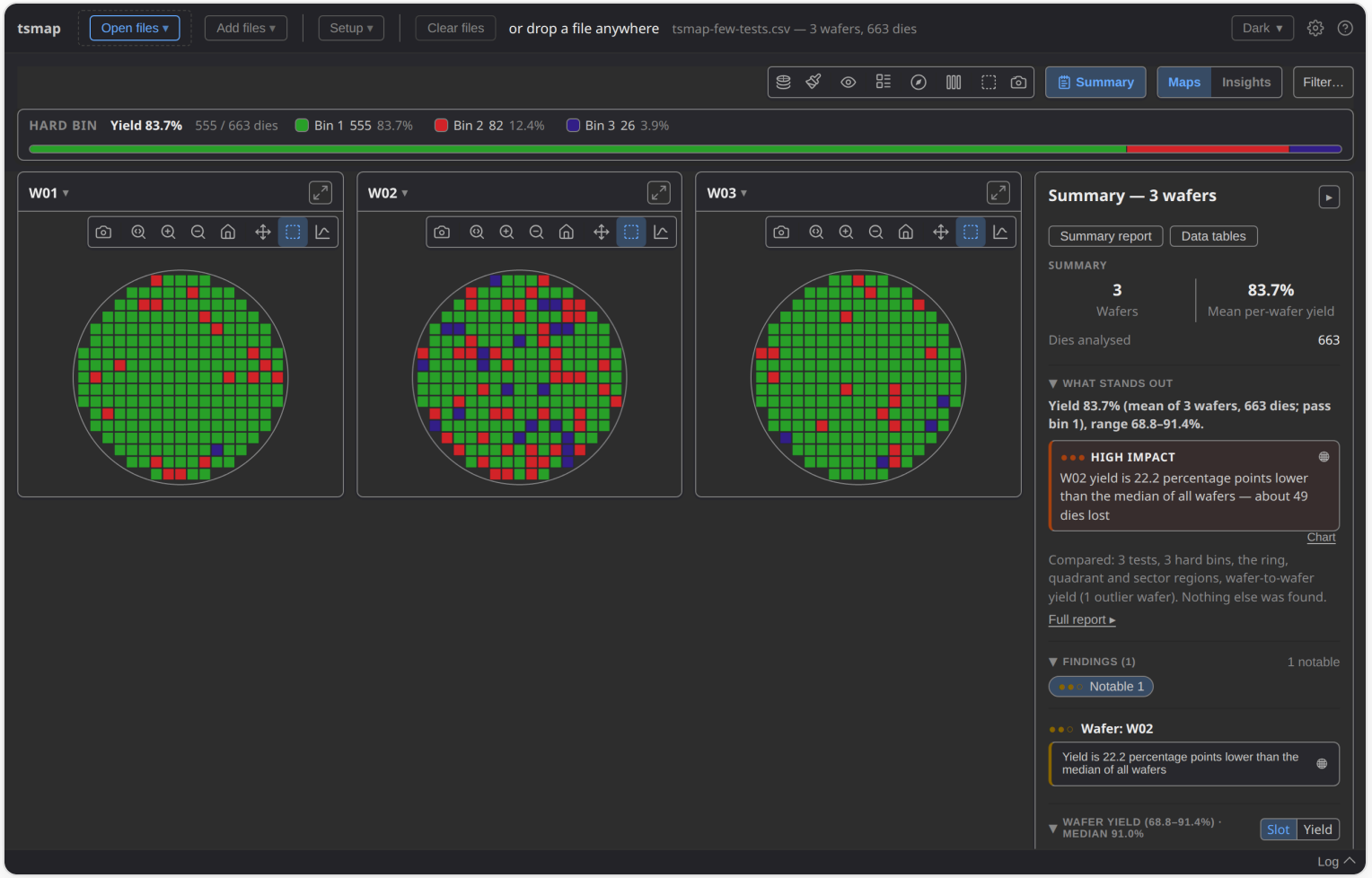
Colour theme

Choose a colour theme. Auto follows your system, or pick a light or dark theme. Your choice is remembered.



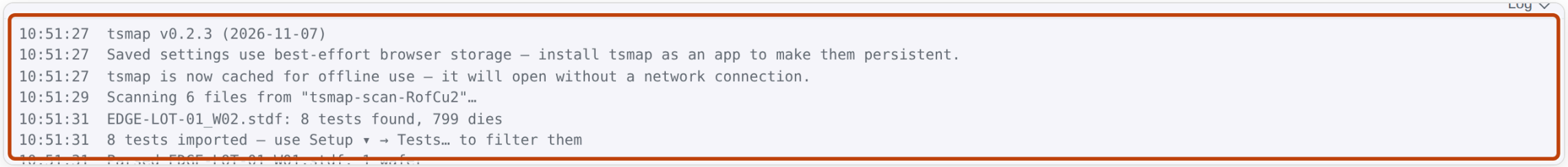
The whole app follows

Maps, charts and panels all take the theme's colours.



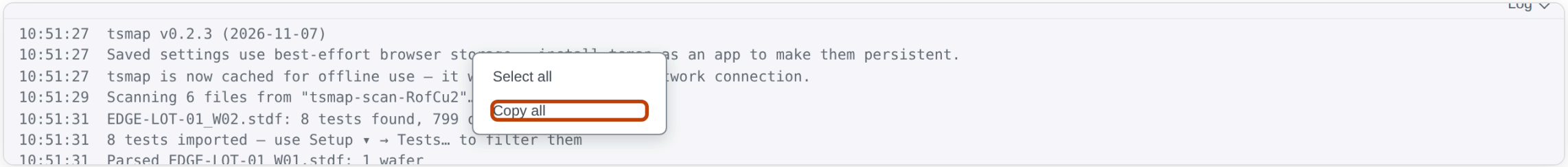
The log panel

The log panel shows what each load did. Warnings are counted on the **Log** button until you open it.



Copy the log

Right-click in the log for **Select all** and **Copy all**, which puts every entry on the clipboard: the thing to paste into a bug report.



LAB Try it yourself

1. Open the small sample CSV in the web app: check the roles, then **Continue →**
2. **Clear files**, then **Load sample data**
3. **Setup ▾ → Tests…**: rename a test, then apply
4. Download and unzip the scan-folder zip, then **Open files ▾ → Scan a folder…**: how many files does it list?
5. Switch to a dark theme, then open the log

ANSWERS Check your results

4. **Six** files, from four lots. Set the filter to one lot to list only its files.

Recap

- Drop files, **Open files**, or scan a folder and filter by lot
- **Add files** grows the lot; **Setup ▾** → **Tests…** chooses and renames tests
- Tables need a column mapping, and tsmap remembers it

With your data loaded and your tests chosen, you are ready to read the maps.

More in the user guide: Loading your data



Next lesson

02 · Reading a map and the toolbar →

Plot modes, colours, overlays, orientation and the gallery layout.



Reading a map and the toolbar

Lesson 02

Learn tsmap

In this lesson

A map only helps if you know what its colours mean and can change them to answer your question. This lesson covers what the toolbar changes and how to look closely at a single wafer.

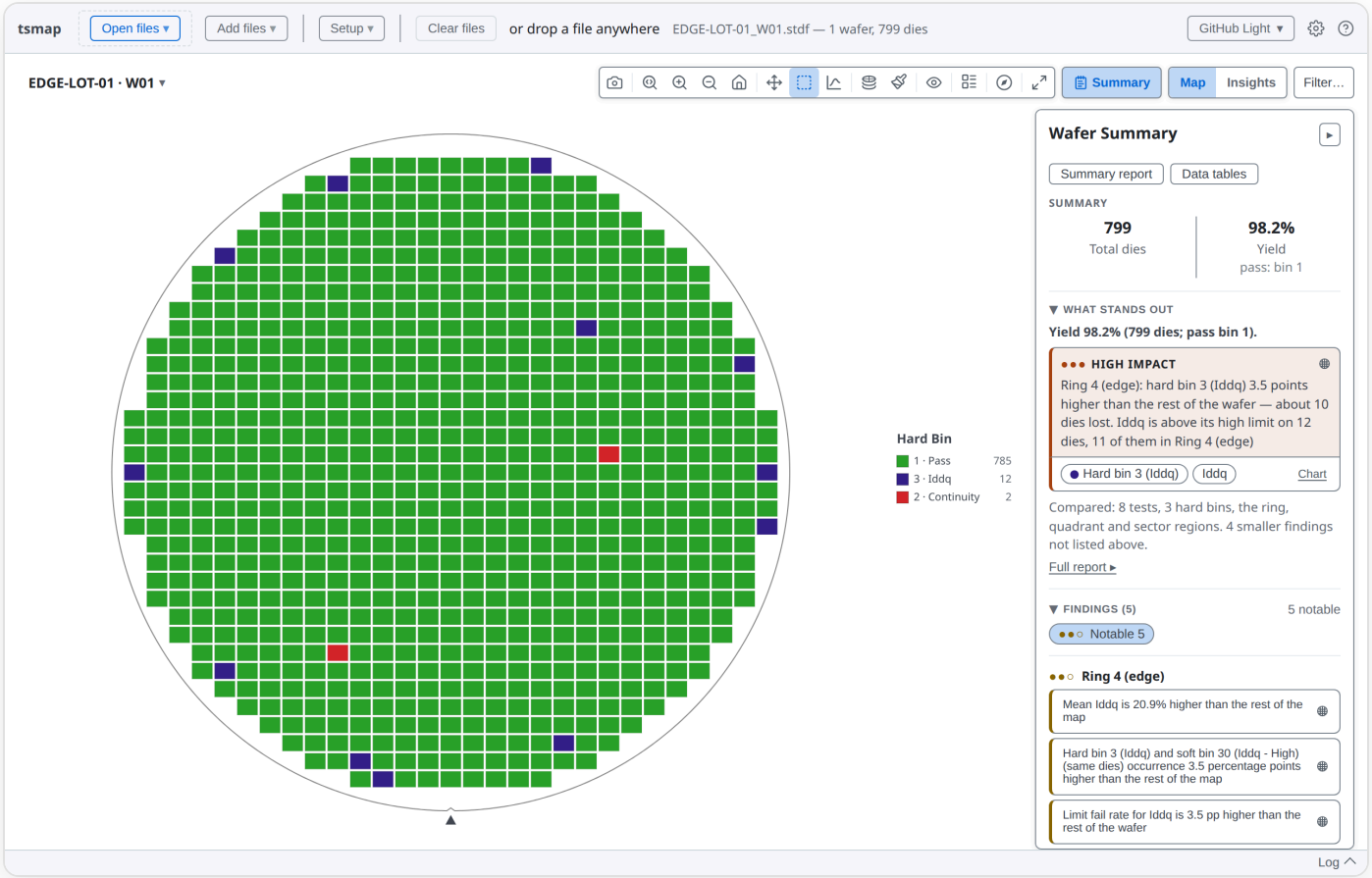
- Open one wafer, then a whole lot
- Change what the maps show: bins or a test's values
- Add overlays, turn the wafer, zoom in and read a single die

One wafer on its own

A file that holds a single wafer

One map

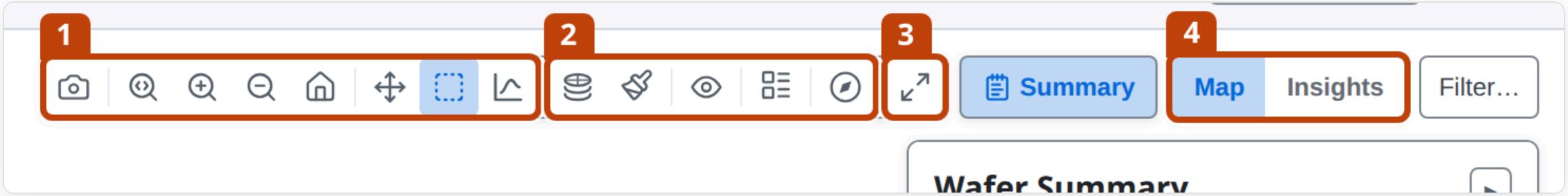
A file with one wafer opens as one full-size map, with the Summary panel open beside it. This is `EDGE-LOT-01`'s first wafer.



One toolbar

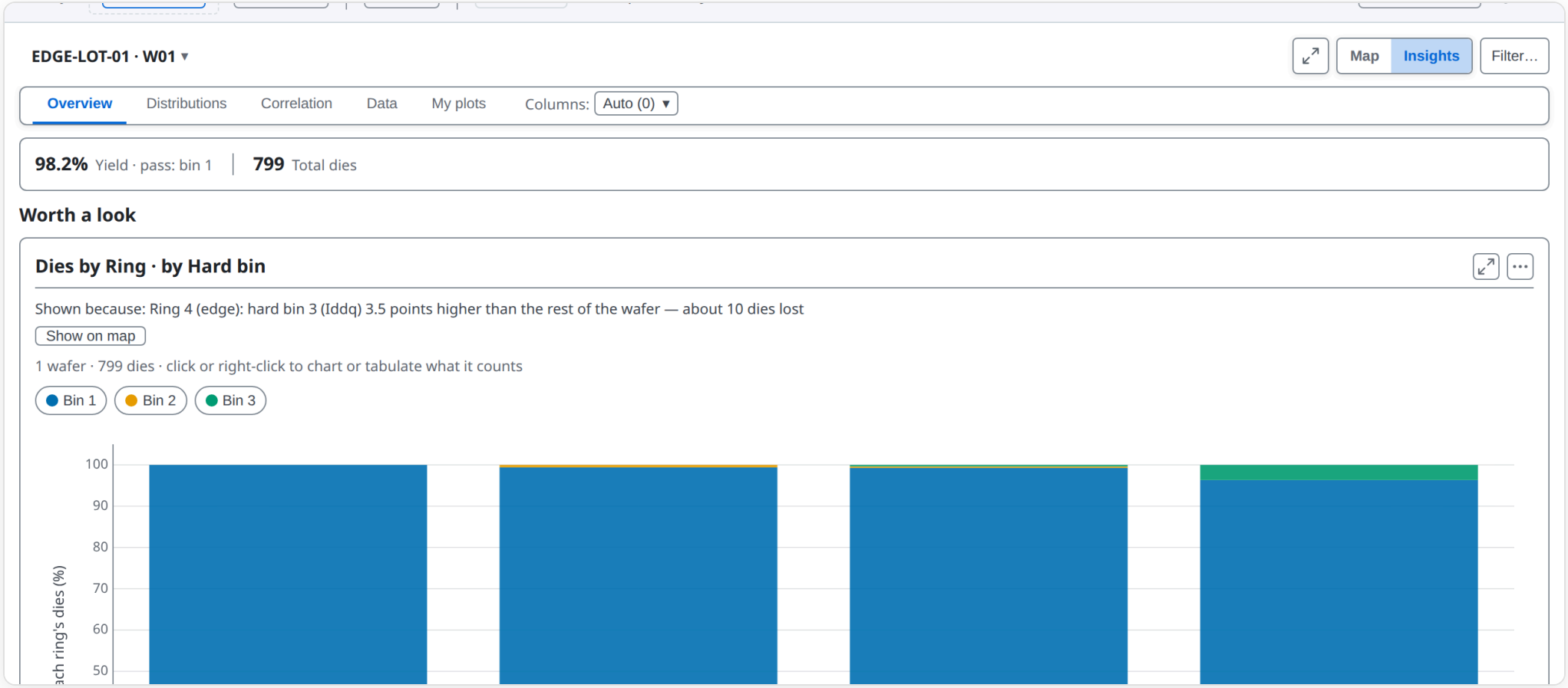
The toolbar has four groups, and each does one job.

1. Save, zoom, pan, select and chart this map
2. What it shows and how it looks
3. **Expand (E)**: **F** maximises, **Esc** closes
4. **Map | Insights**



Insights for one wafer

Insights on a single wafer has the same tabs, over this wafer's dies. There is no **Group by**: one wafer has nothing to group.



What needs several wafers

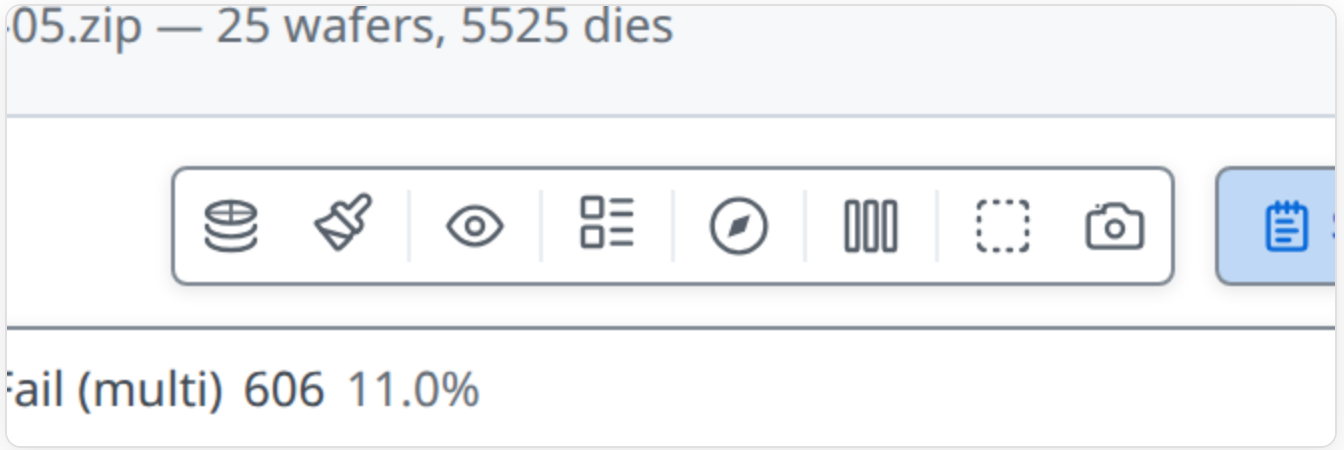
One wafer has nothing to stack, group or compare, so these appear only for a lot:

- the stacked plot modes, **Columns** and **Select the same dies** (lesson 04)
- the Summary panel's **Wafer Yield** list (lesson 03)
- in Insights, **Group by**, What divides yield and the comparisons (lessons 05 and 06)

What the map shows

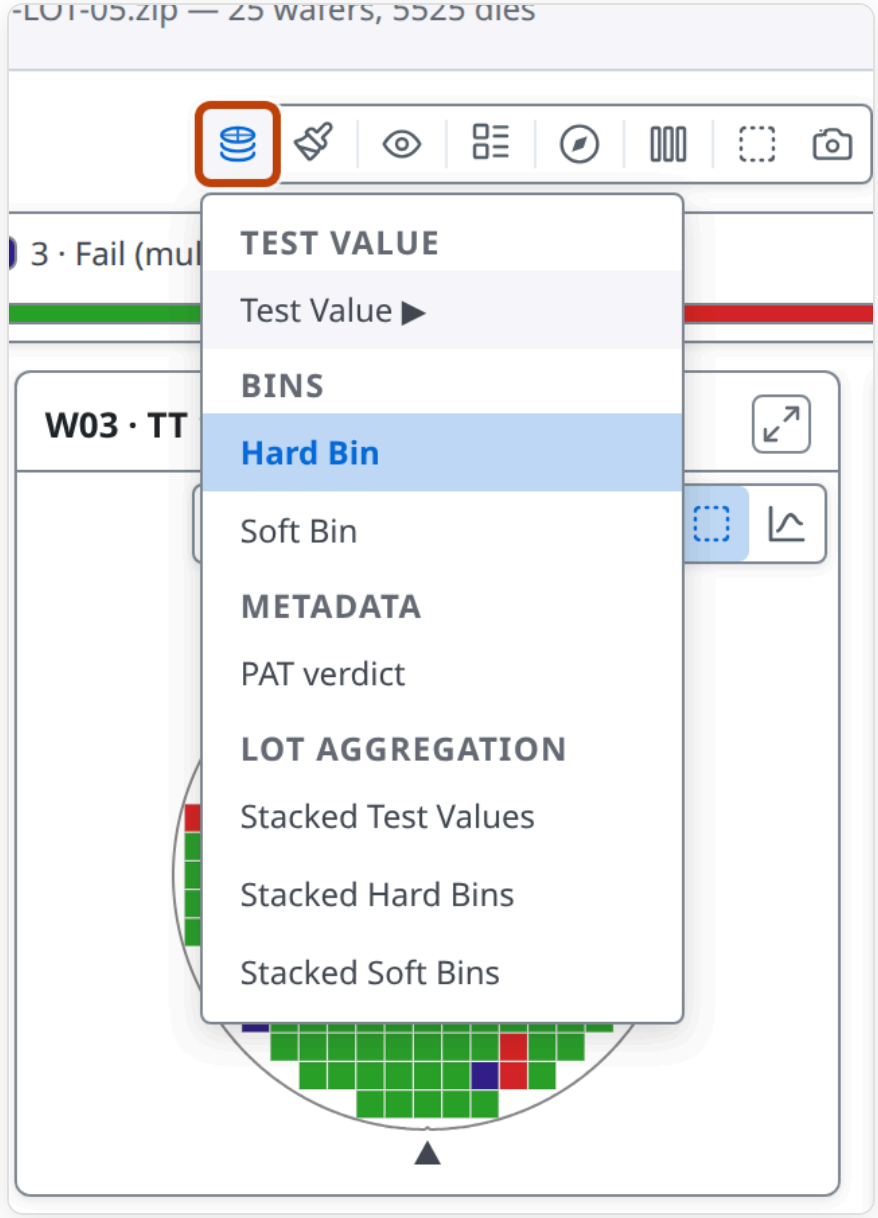
The gallery toolbar

Several wafers open as a gallery, one card per wafer. Every button here acts on all of them at once, so the wafers stay comparable. The camera saves the whole gallery as one PNG.



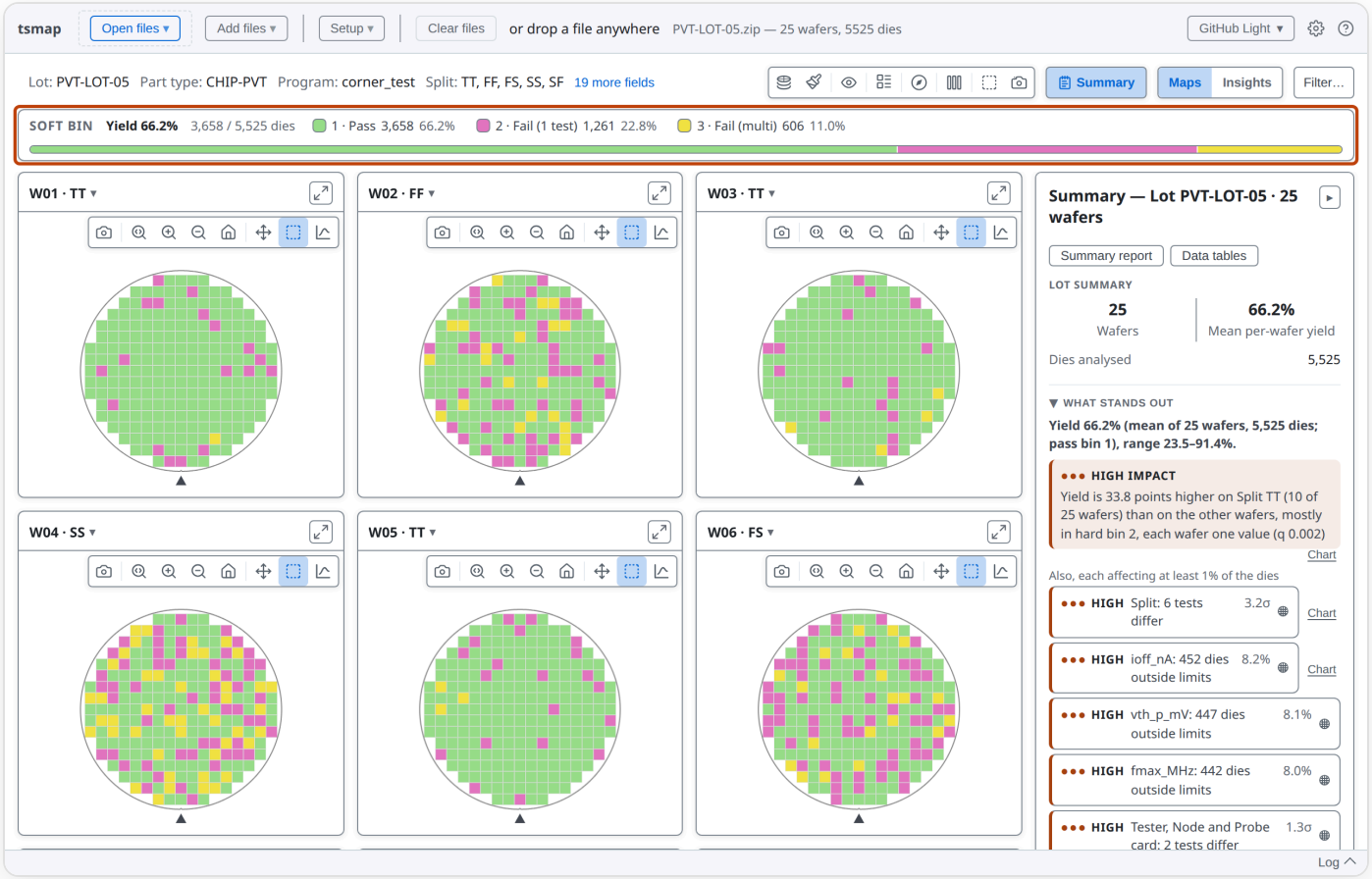
Plot mode

This is the button you will use most. It decides what the colours mean: each die's hard bin, its soft bin, or one test's value. The stacked modes come in lesson 04, PAT verdict in lesson 05.



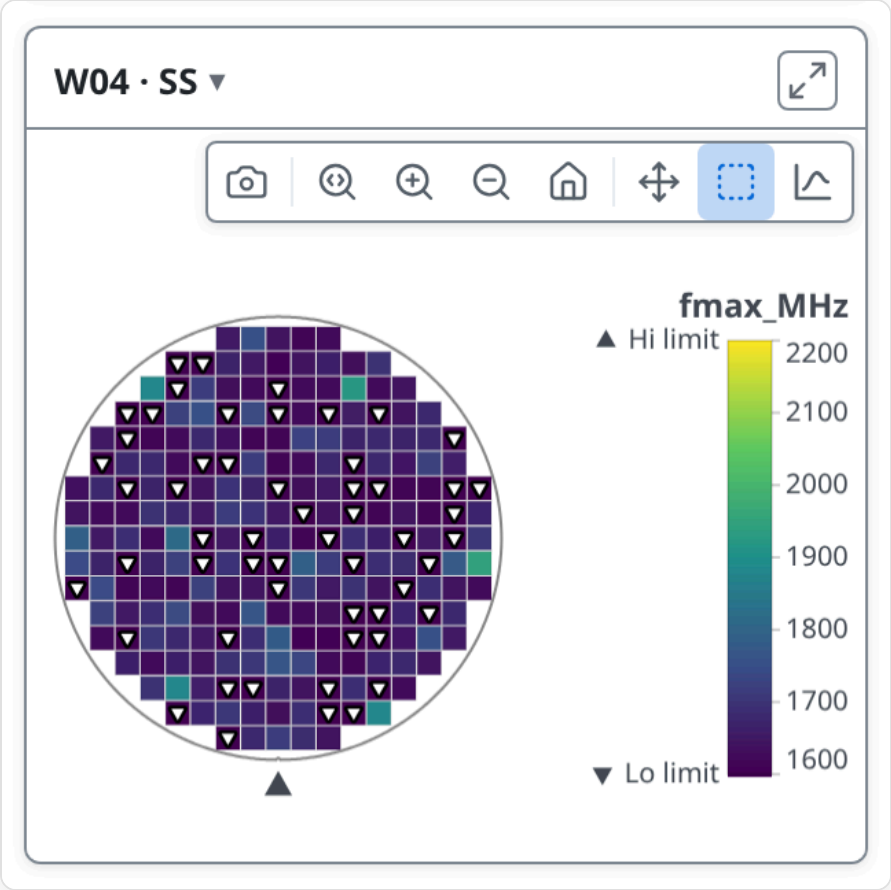
Soft Bin

Soft Bin colours each die by the test program's failure category, with its own legend. Use it when a hard bin is too coarse to tell you why dies failed.



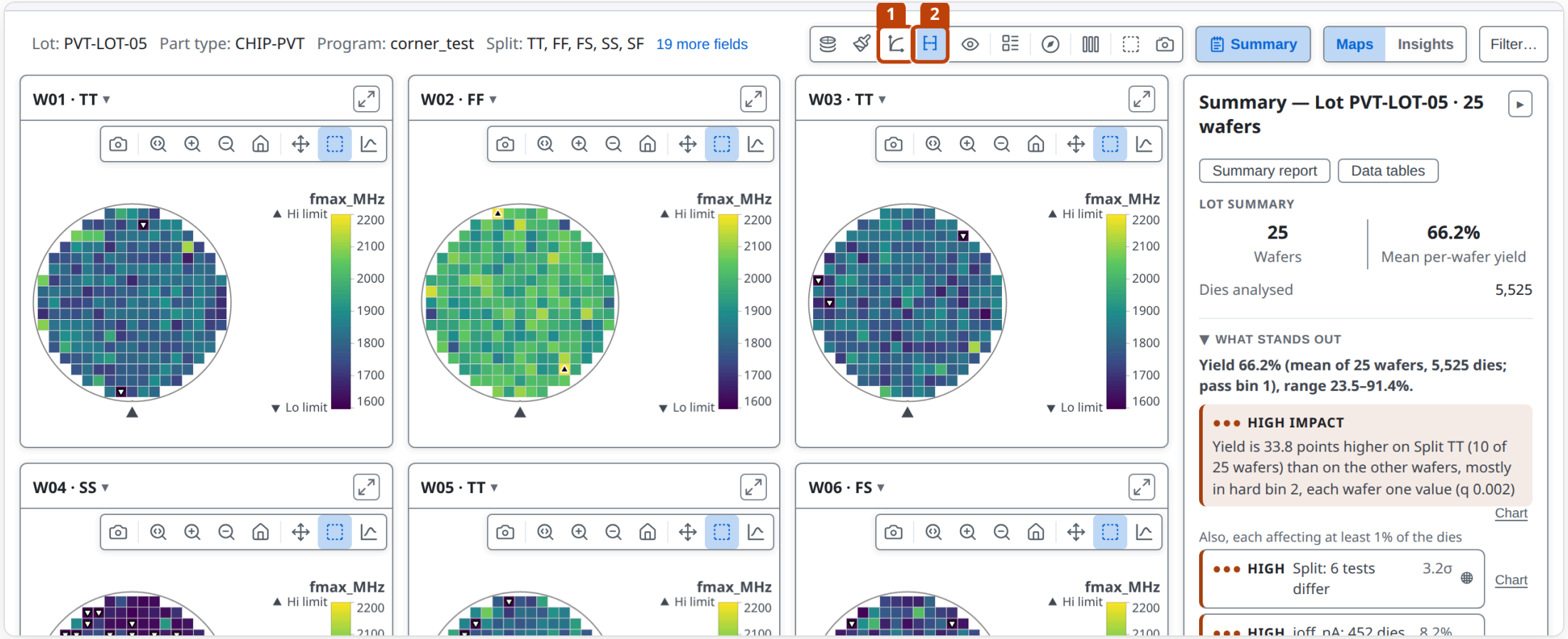
Test Value

Test Value colours each die by its reading, so you see how a measurement varies across the wafer. ▽ and △ mark dies below and above the test limits.



Two more buttons for values

In Test Value mode two more buttons appear: **1** Log scale. **2** Colour bar range: the test limits, the same on every wafer, or the data's own range.



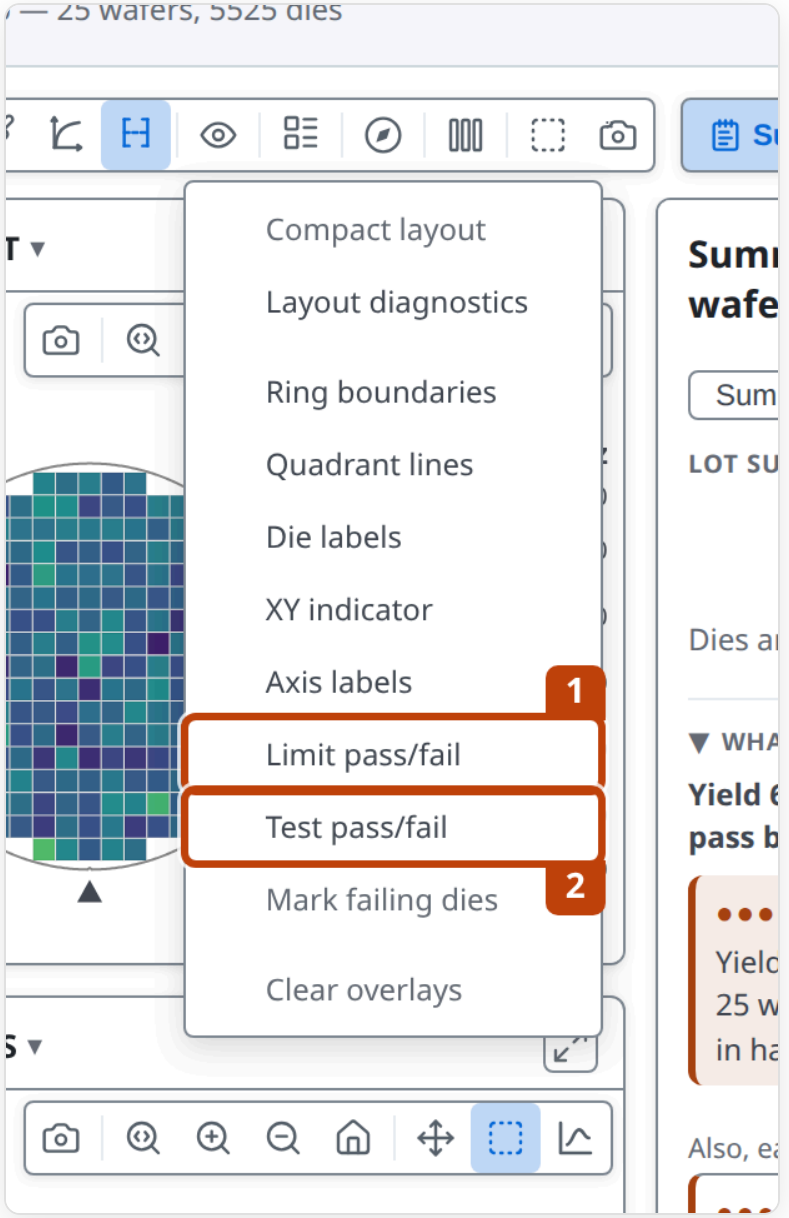
Two kinds of limit

A test can have two sets of limits, and they answer different questions.

- **Test limits** are what the tester judged each die by: they decide pass or fail
- **Spec limits** are the process specification: capability is measured against them when a test has both
- Charts draw test limits with short dashes and spec limits with long ones

Pass or fail, two ways

Sometimes you want to see which dies passed a test rather than its raw reading. In Test Value mode **Overlays** adds 1 **Limit pass/fail**, judged by the test limits, and 2 **Test pass/fail**, the verdict the tester recorded.



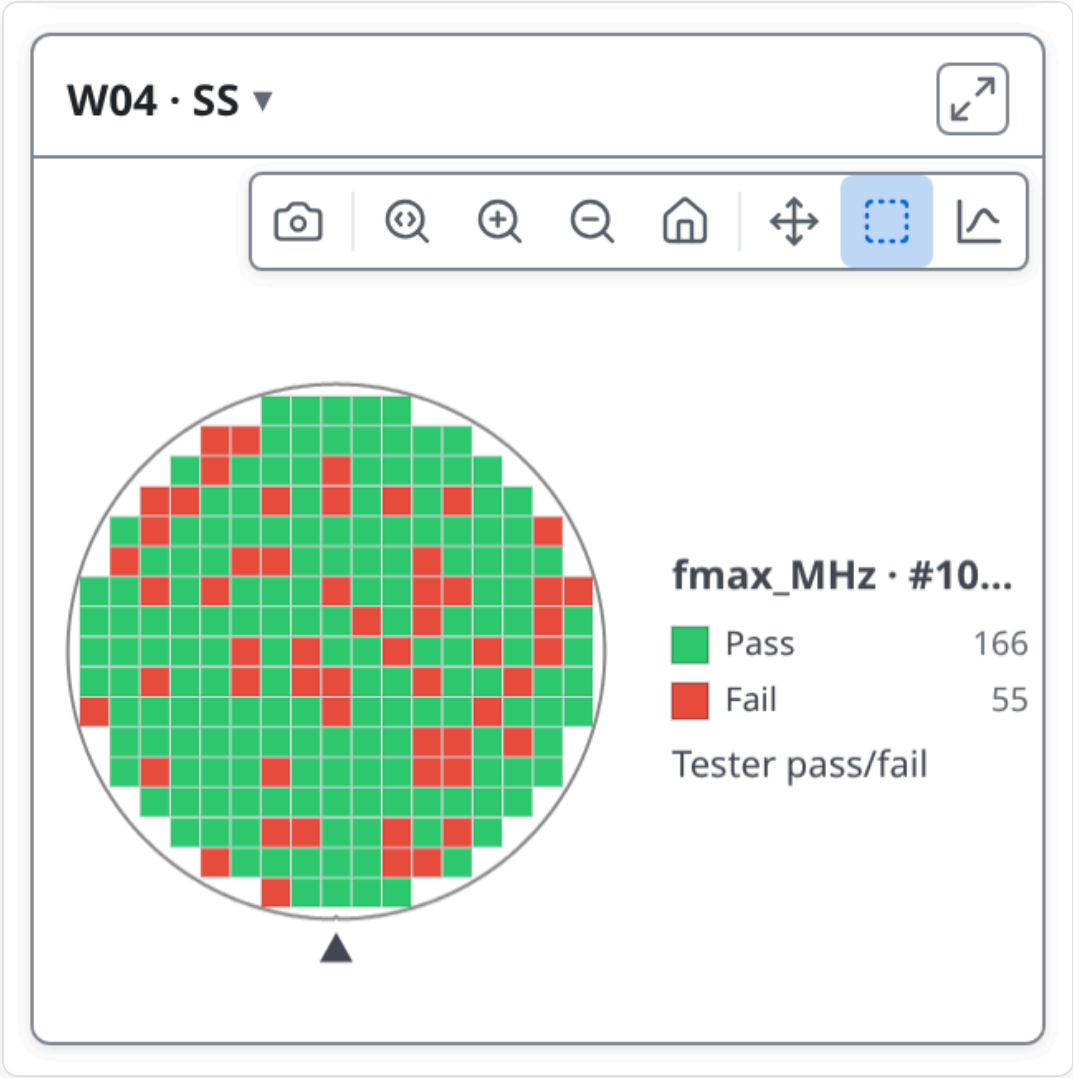
Limit pass/fail

Limit pass/fail shows dies inside the limits in green, below the low limit in blue and above the high limit in red, each with its count.



Test pass/fail

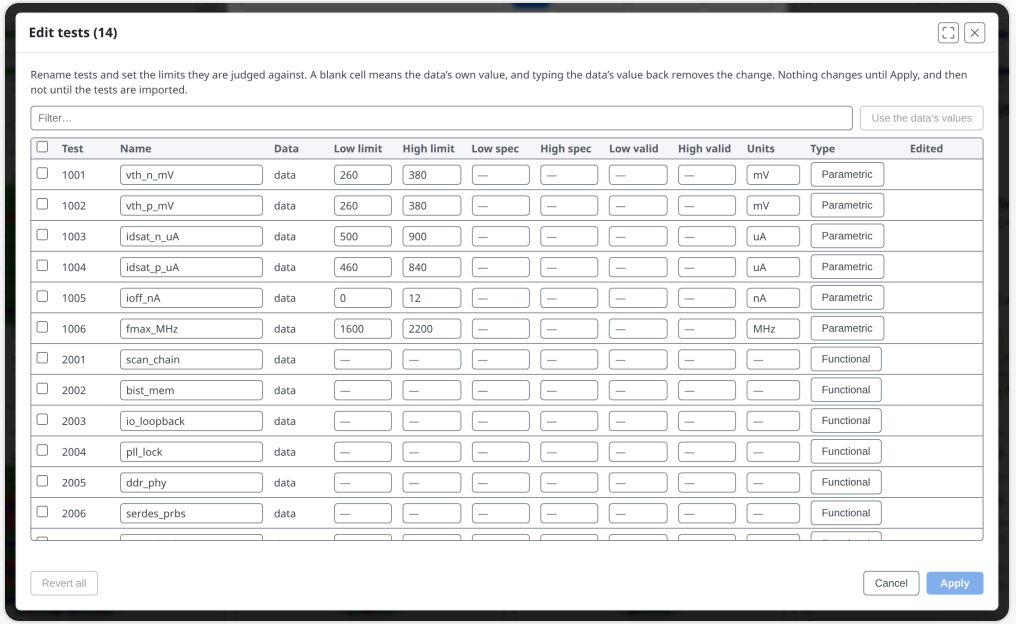
Test pass/fail shows the tester's own verdict. It can differ from the limits, and guard bands are one reason, so it is worth a look when the two maps disagree. A functional test always shows this way.



Setting limits yourself

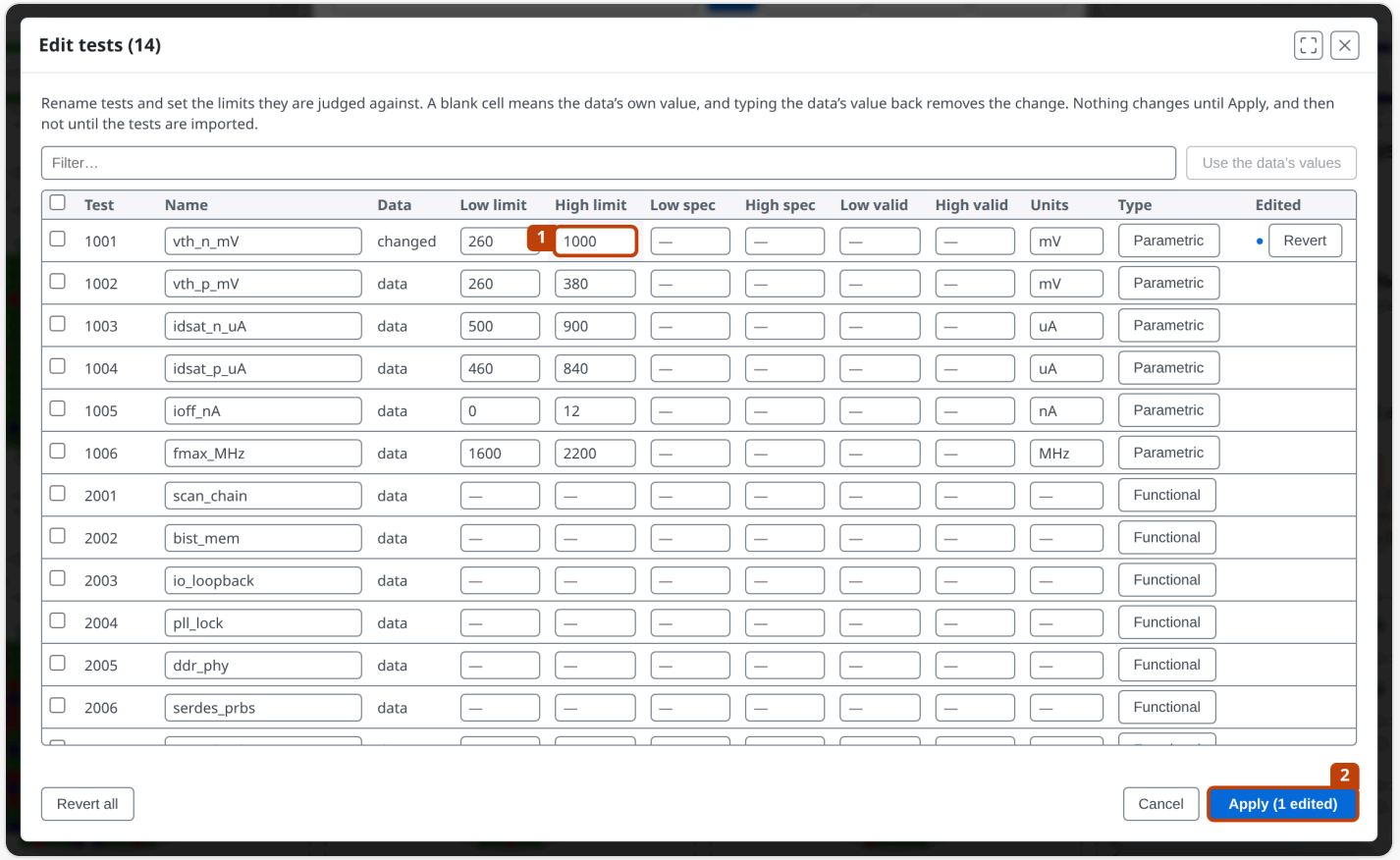
Some test programs ship without limits, or with limits that are not the ones you want to judge by. In the test selector (**Setup ▾ → Tests…**), **Edit limits…** opens a table of every test: its name, test limits, spec limits, validity limits, units and type.

Validity limits mark a reading as a tester clamp rather than a measurement. Lesson 11 uses them.



Change a limit

Type into a cell to change it. 1 The **Data** column then reads *changed* and the row gets a **Revert** button. 2 **Apply** counts the edited rows.



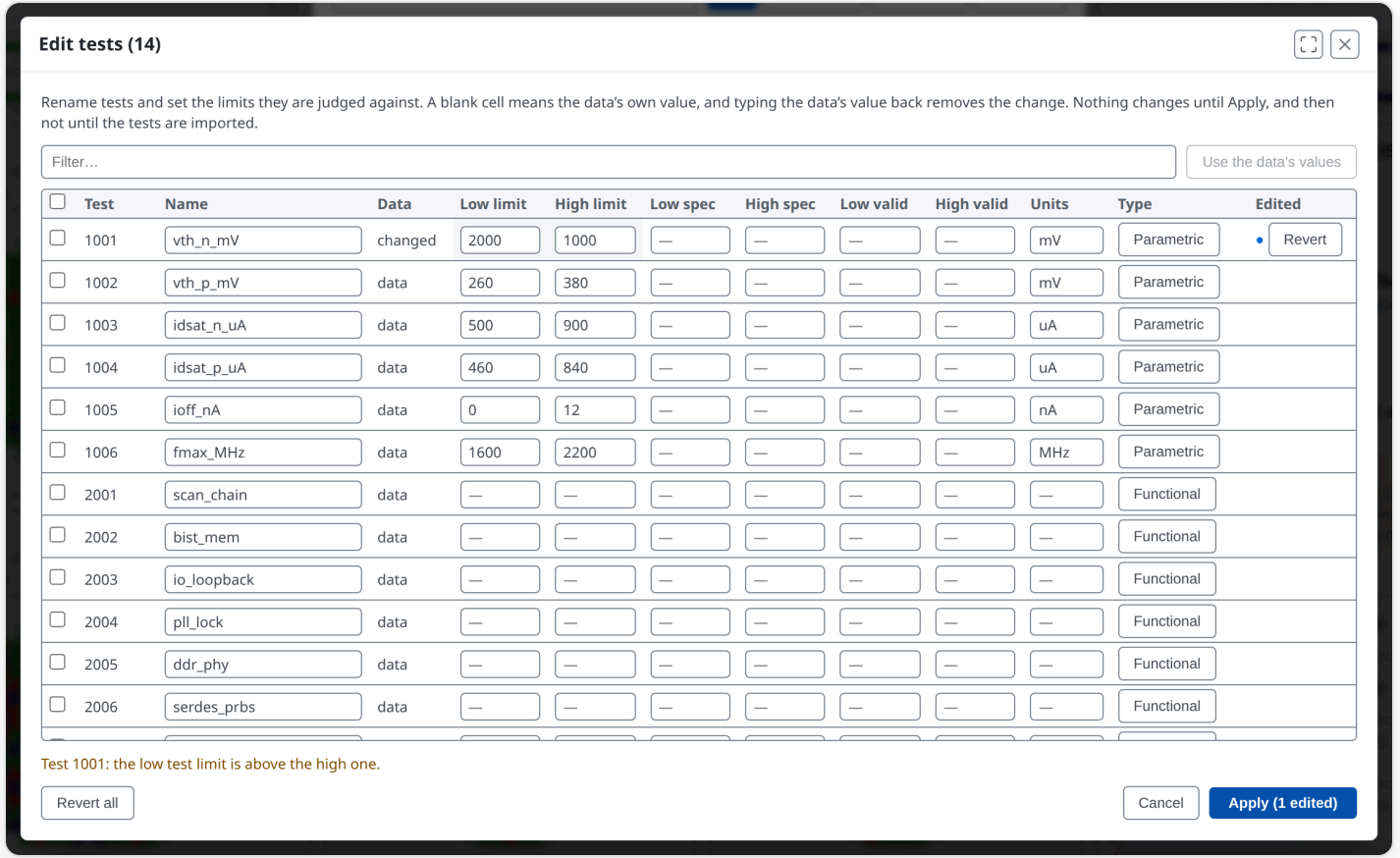
The rules of the table

- A **blank cell** means the data's own value: an edit can change a limit but cannot remove one the data states
- **Use the data's values** discards the changes on the rows you have ticked, and **Revert all** discards every change
- Units that differ only by an SI prefix, such as mV for V, convert the limits you give to the data's unit
- Functional tests are pass/fail only, so their limits are ignored

A limit that cannot be right

A low limit above its high limit is refused when you press **Apply**, with the test named.

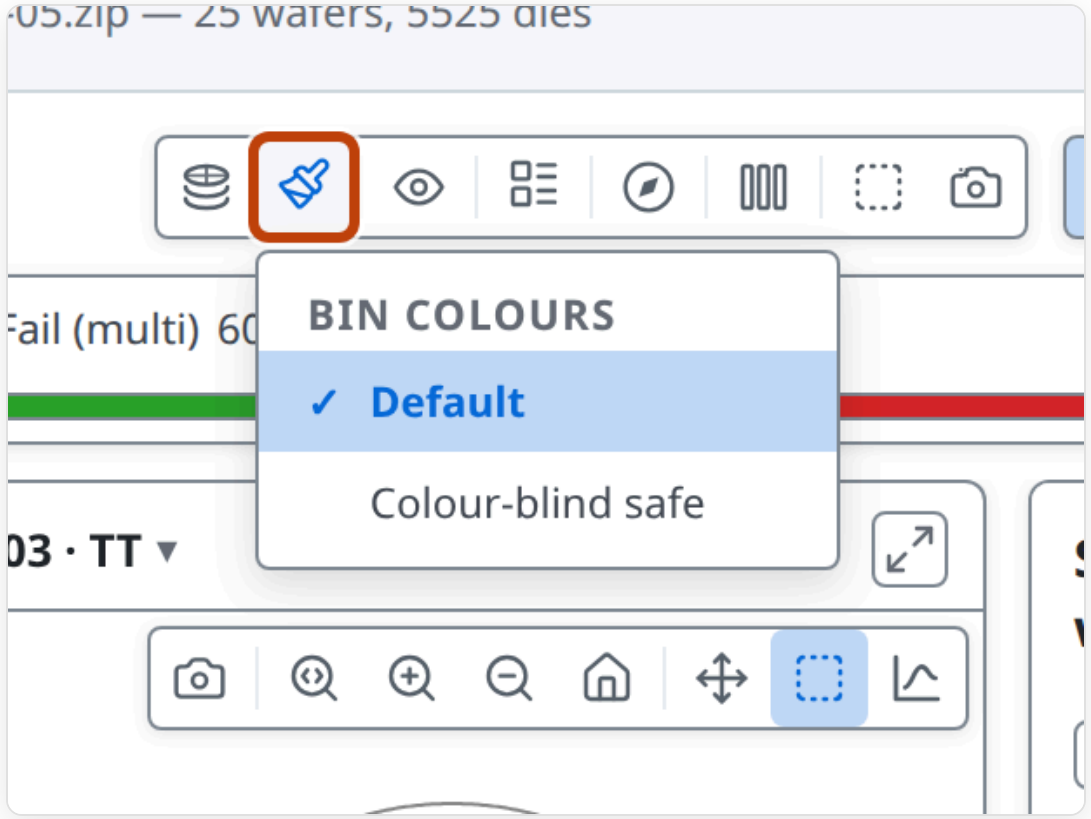
Nothing changes in the lot until you press **Apply to N tests** → in the selector and the tests are imported. **Save definitions** then keeps your limits in a file for the next lot of the same program.



Test	Name	Data	Low limit	High limit	Low spec	High spec	Low valid	High valid	Units	Type	Edited
1001	vth_n_mV	changed	2000	1000	—	—	—	—	mV	Parametric	Revert
1002	vth_p_mV	data	260	380	—	—	—	—	mV	Parametric	
1003	idsat_n_uA	data	500	900	—	—	—	—	uA	Parametric	
1004	idsat_p_uA	data	460	840	—	—	—	—	uA	Parametric	
1005	ioff_nA	data	0	12	—	—	—	—	nA	Parametric	
1006	fmax_MHz	data	1600	2200	—	—	—	—	MHz	Parametric	
2001	scan_chain	data	—	—	—	—	—	—	—	Functional	
2002	bist_mem	data	—	—	—	—	—	—	—	Functional	
2003	io_loopback	data	—	—	—	—	—	—	—	Functional	
2004	pll_lock	data	—	—	—	—	—	—	—	Functional	
2005	ddr_phy	data	—	—	—	—	—	—	—	Functional	
2006	serdes_prbs	data	—	—	—	—	—	—	—	Functional	

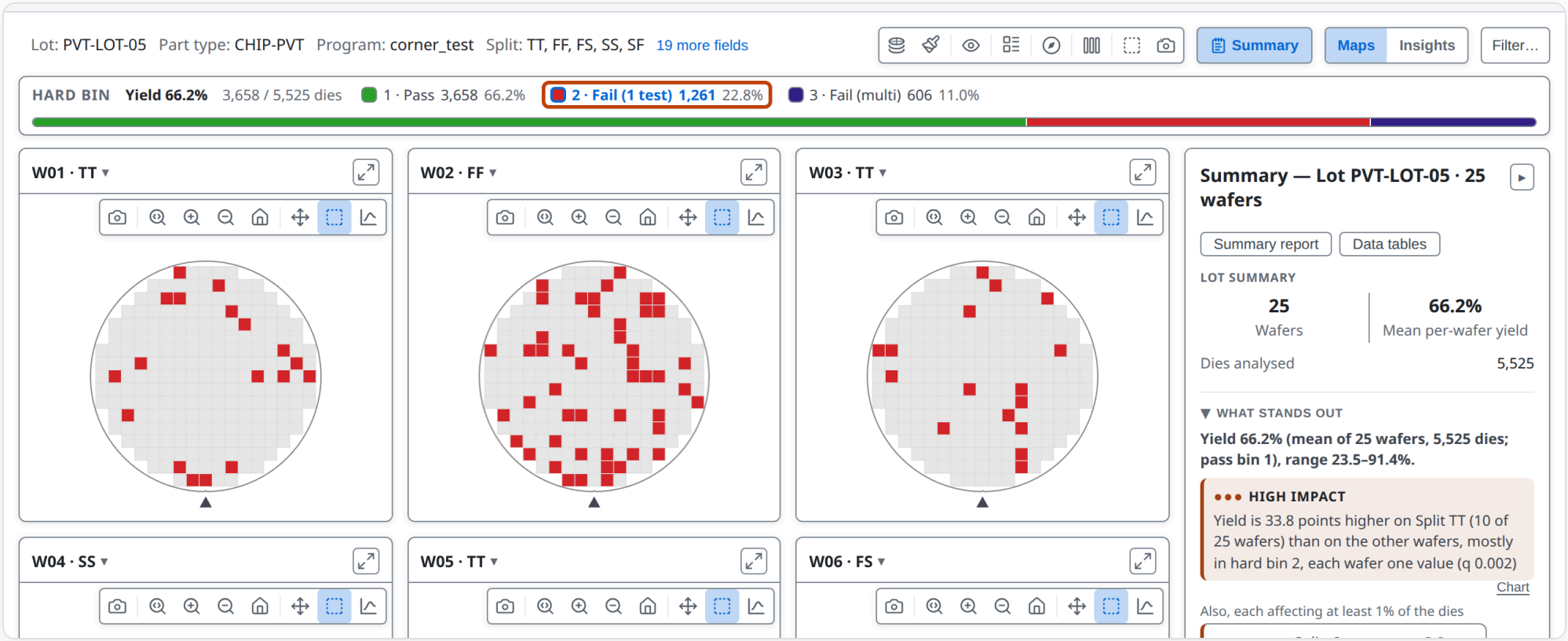
Colour scheme

Choose default or colour-blind safe bin colours. Passing bins are always shades of green, so a pass looks like a pass whichever you pick. In Test Value mode the same menu picks the value colours, and **Reverse gradient** flips them.



Highlight a bin

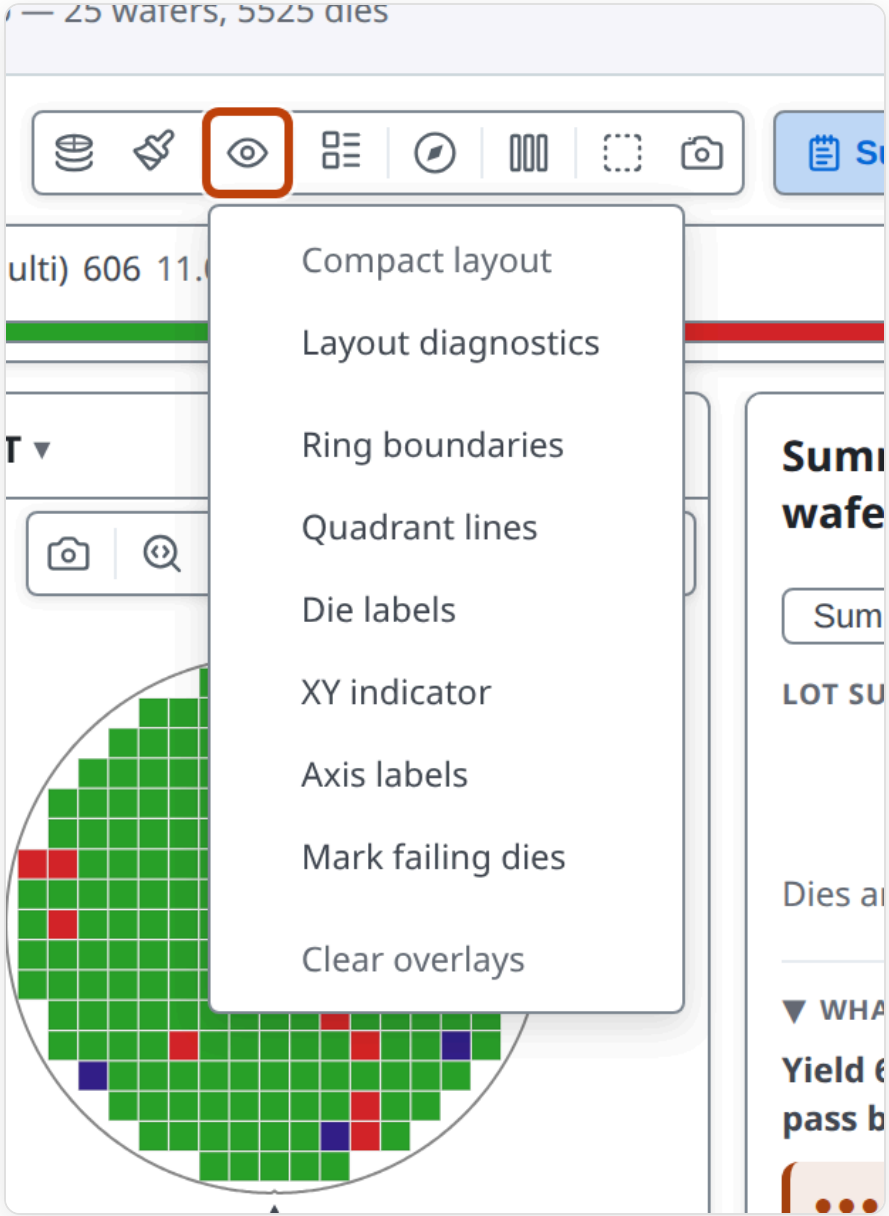
To follow one bin across the whole lot, click it in the legend. The others grey out, so you see at once whether it sits at the edge, in a corner or everywhere. **Ctrl** or **Cmd** + click adds more bins. Click the bin again to clear it.



Overlays and orientation

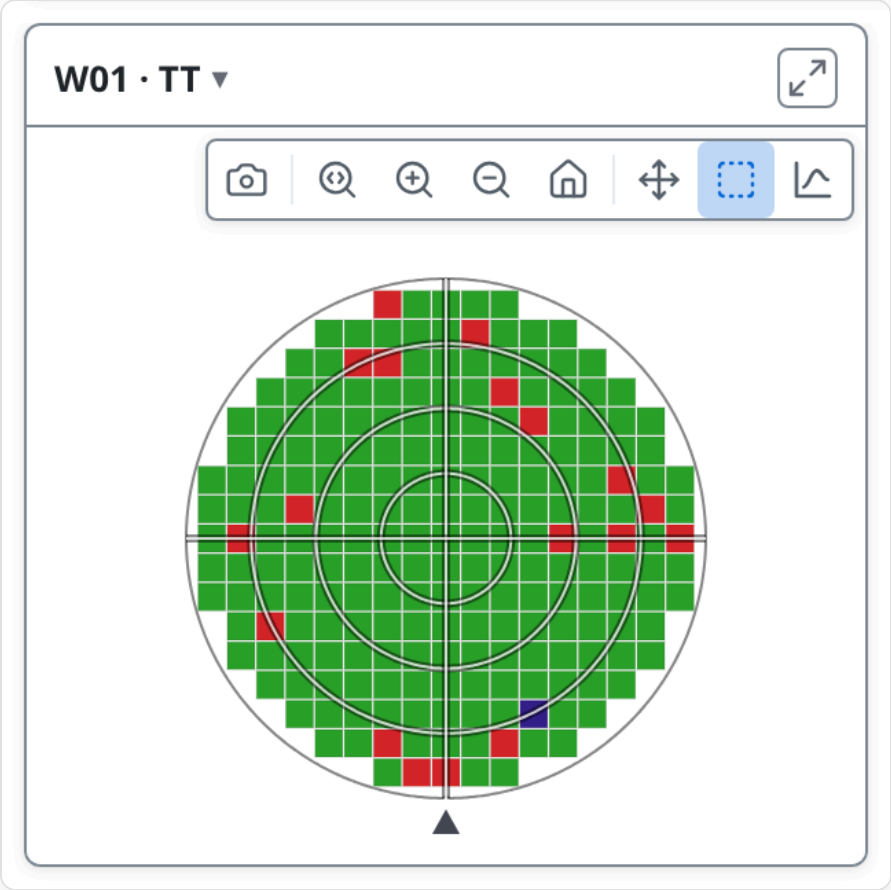
Overlays

Overlays are layers drawn over every map, to help you read position. **Clear overlays** turns them all off, and is greyed when none are on.



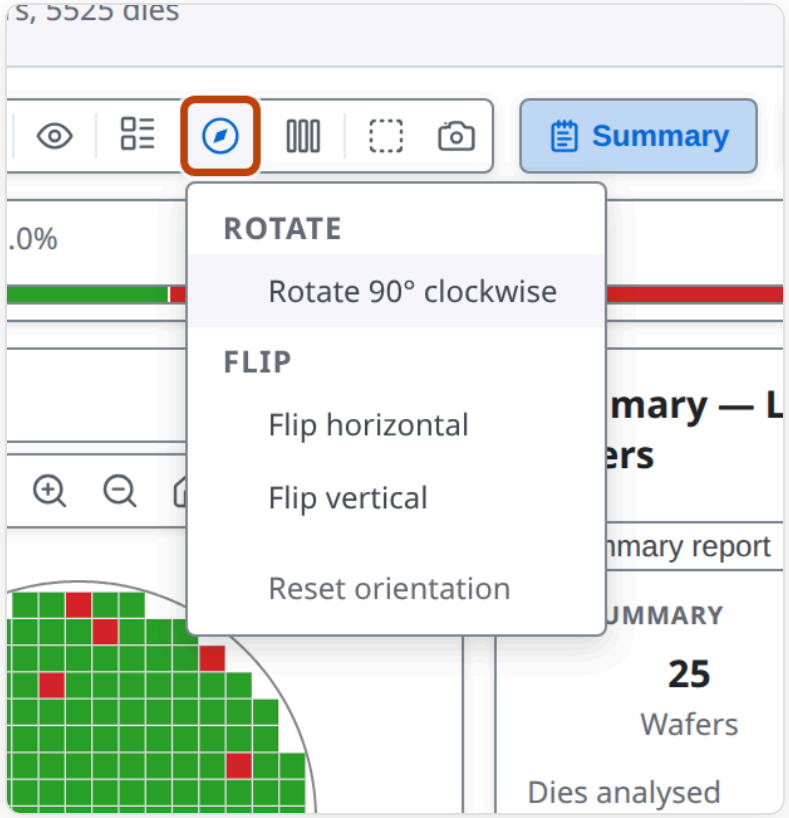
Rings and quadrants

Ring boundaries match the zones the findings use, so you can see what a finding such as "outer ring" refers to. Quadrant lines split the wafer into NE, NW, SE and SW.



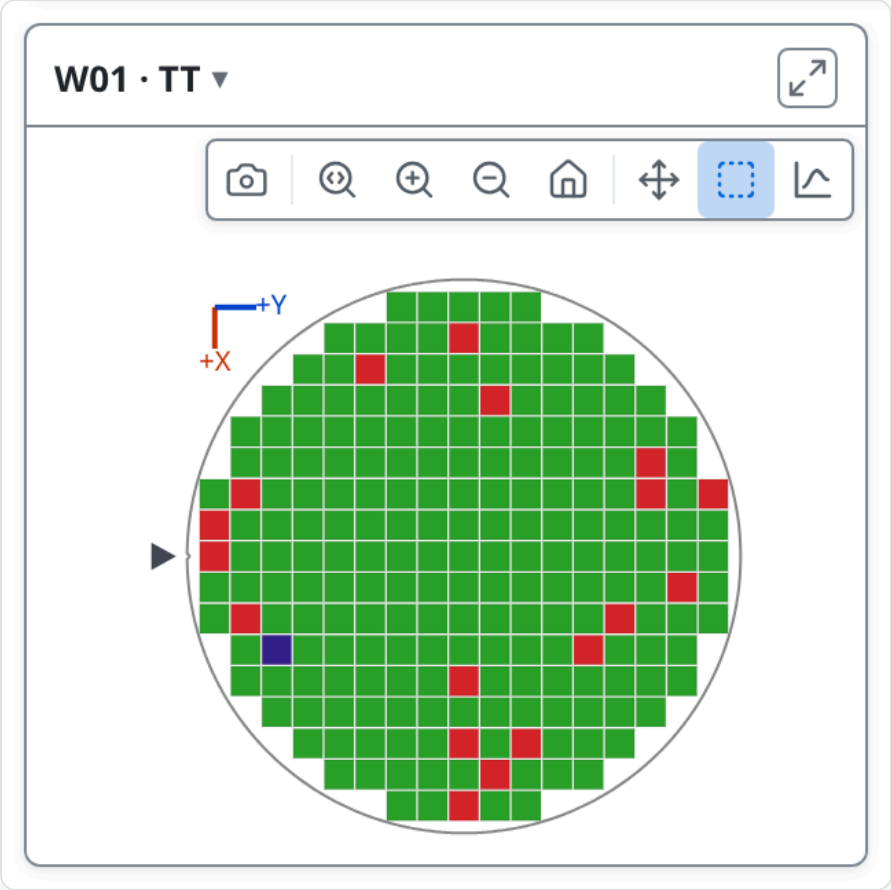
Orientation

Rotate or flip how the wafer is drawn, to match the way you are used to seeing it, such as with the notch at the bottom. Die coordinates never change, so a die keeps its address however the wafer is turned.



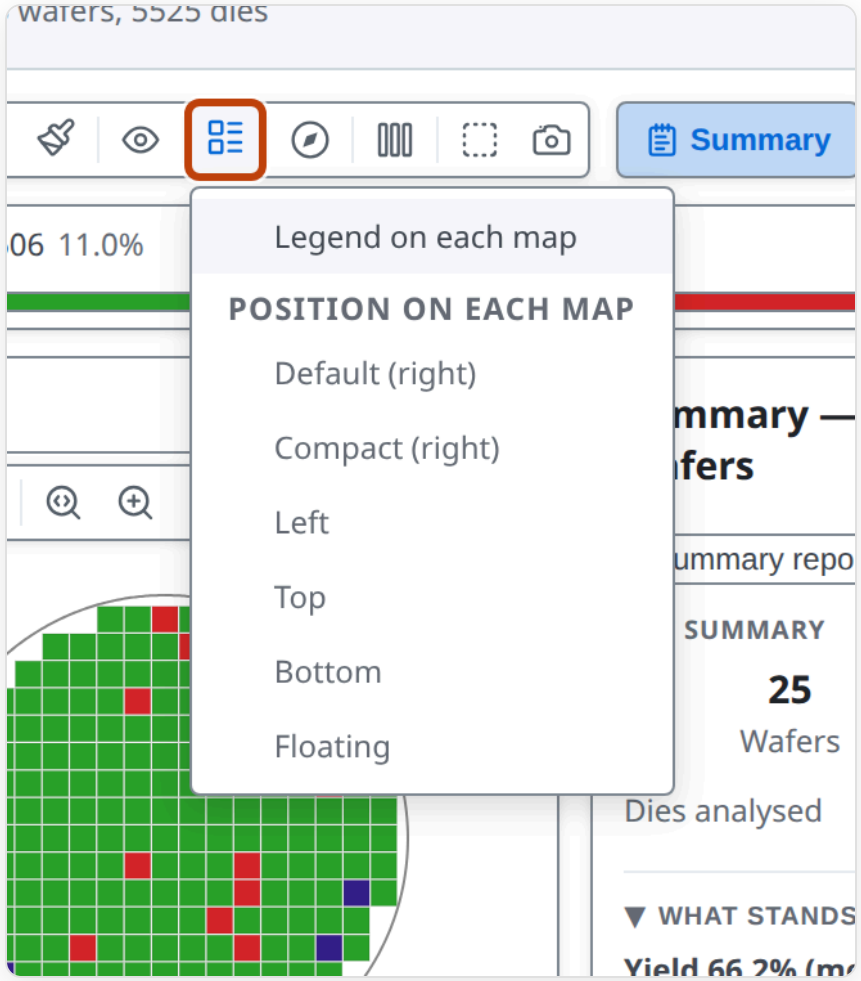
Turned to your convention

Once the wafer is turned, the XY indicator is shown too. **Reset orientation** goes back to the start.



Legend style

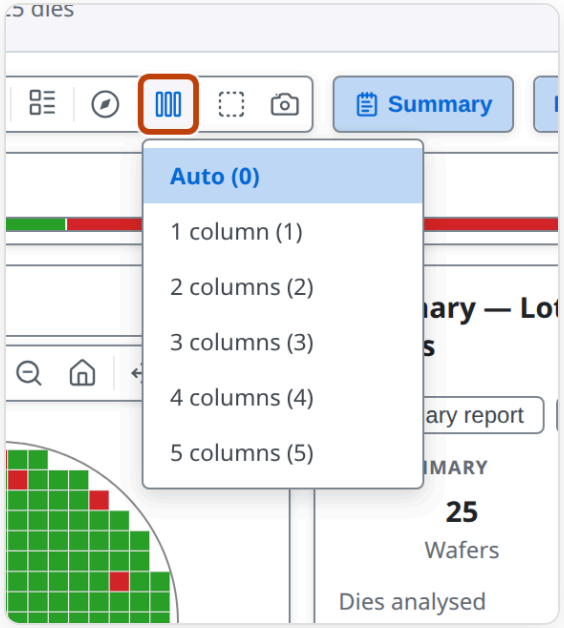
Legend on each map adds a legend to every card, then lets you choose where it sits.



Columns

Auto fits as many cards as keep each die at least 6 pixels across, so a dense wafer gets a wider card. A number divides the width between that many cards. With the pointer over the gallery, the keys **1** to **5** set the columns and **0** returns to Auto.

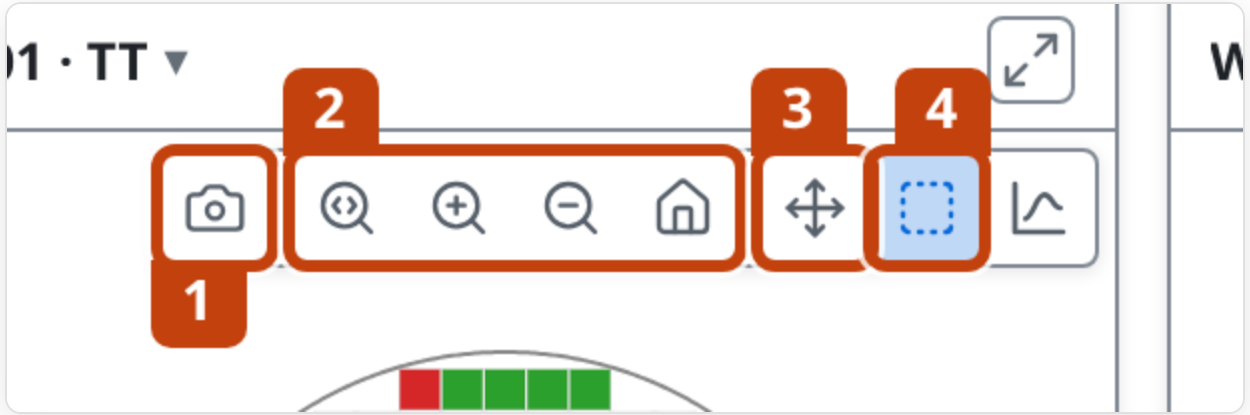
Try it on `PARAM-LOT-02`, twelve wafers of 2,709 dies each: with few columns the dies are big enough to aim at; with five they are not.



One wafer close up

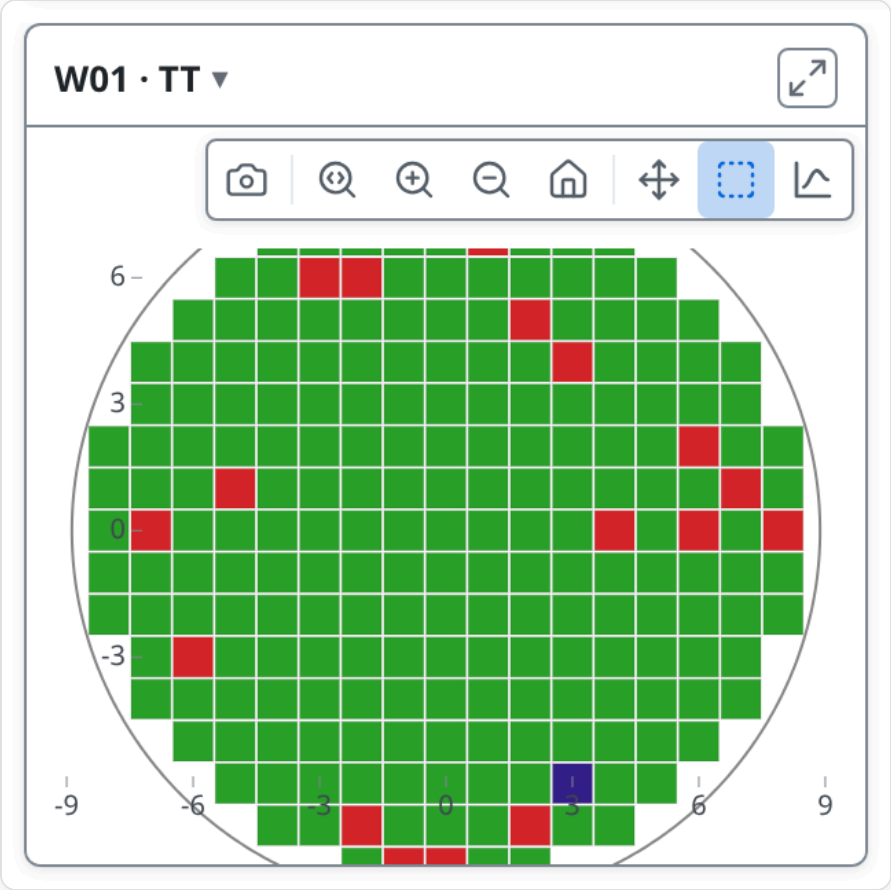
Each wafer's toolbar

1. Save this map as a PNG
2. Zoom to a region, in, out, reset
3. Pan
4. Select dies (lesson 08)



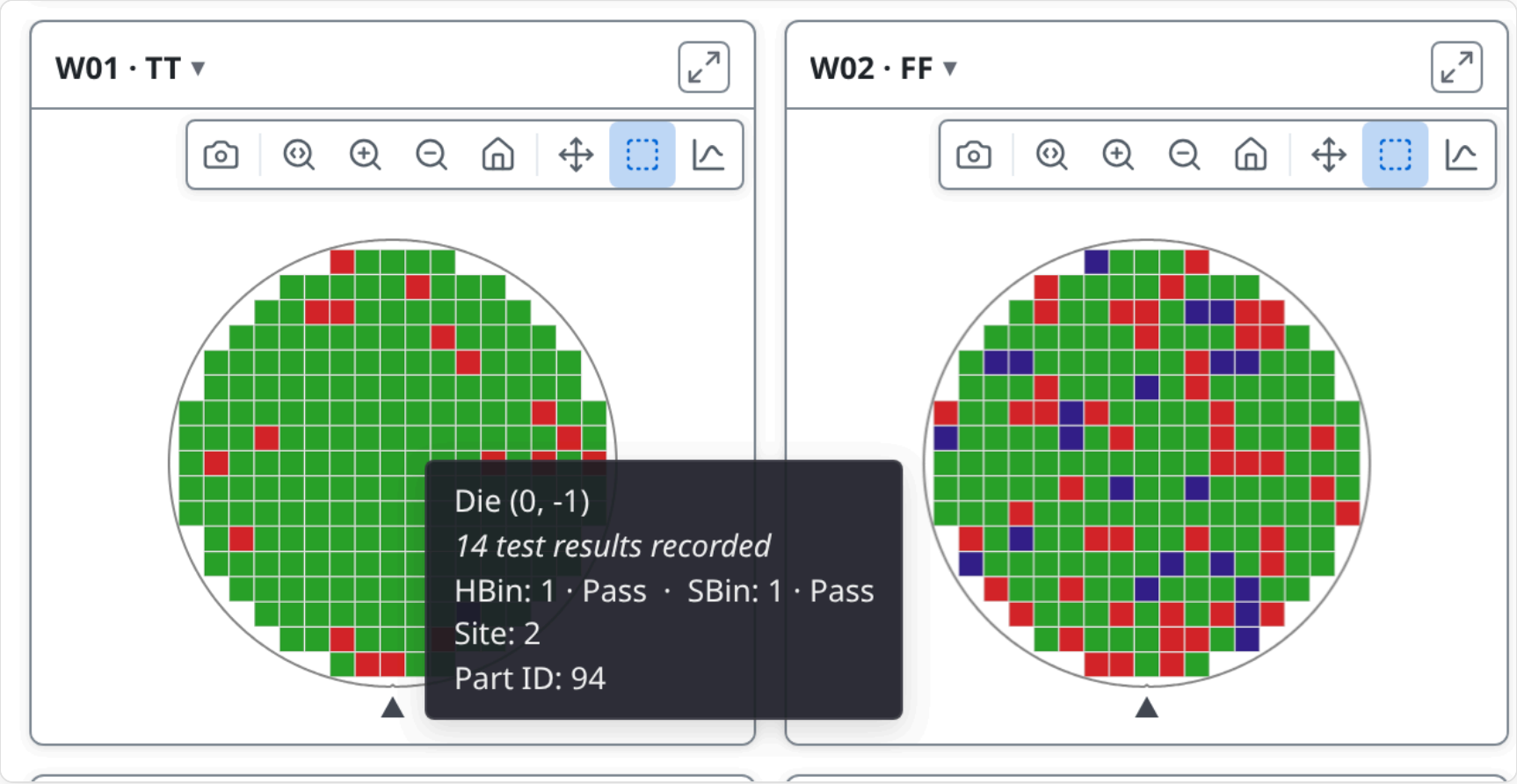
Zoom in

The wheel zooms at the cursor; hold **Space** and drag to pan. Click a map first and **Ctrl + / – / 0** zoom it; anywhere else they scale the whole window.



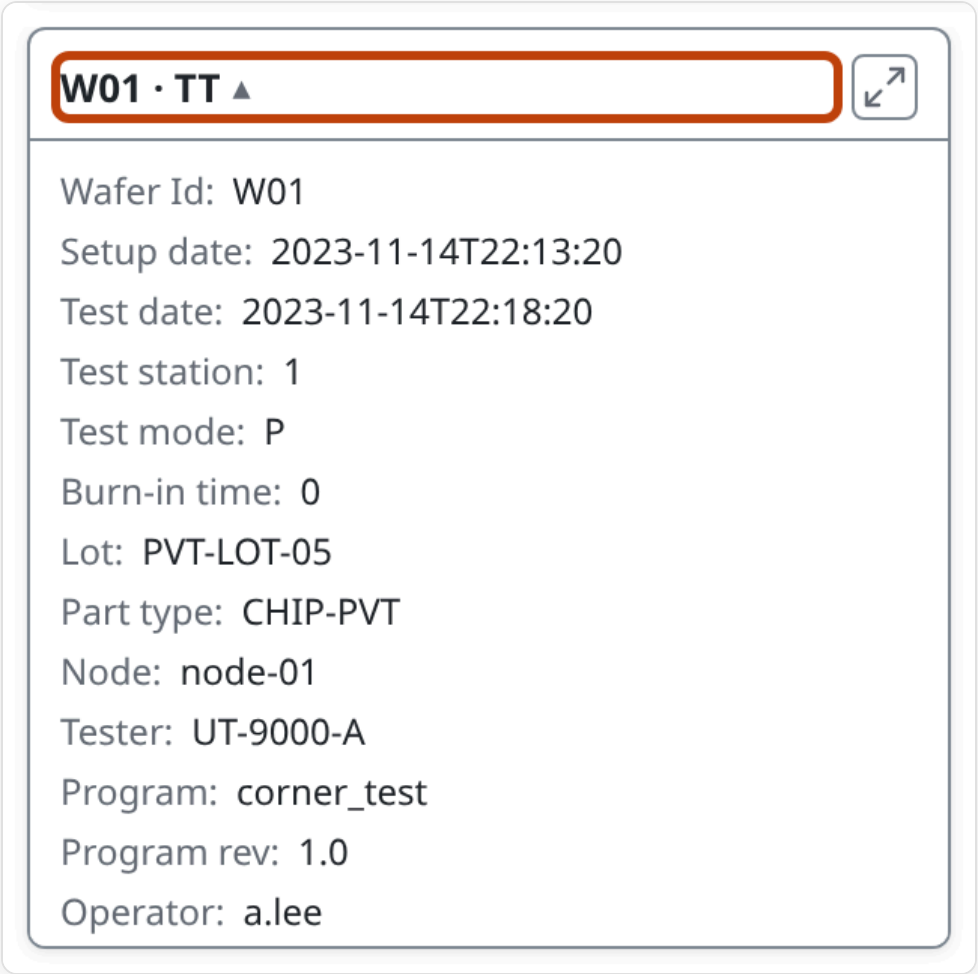
Read one die

Hover a die for its coordinates, bins, site and part ID. Coordinates are the prober's grid steps, the same however the wafer is turned.



The wafer's details

The ▼ beside a wafer's name lists everything the file says about that wafer.



Reading the colours

Not every unusual colour means a failure.

- **Grey** is no result for that die: not a fail
- **Dimmed** at the rim is the edge exclusion; **faded** is a die a filter drops (lessons 08 and 11)
- The legend lists pass bins first, then failing bins from the most dies down

When the map warns you

tsmap tells you when something about a map needs care. A ⚠ or ⛔ button appears in the toolbar only when there is something to report. ⛔ means dies may not sit where they appear, usually because the wafer size was guessed. ⚠ means something was skipped, but what is drawn is right. Click it to read why.

LAB Try it yourself

1. Open the single wafer and find the toolbar's four groups
2. **Clear files**, then **Load sample data**
3. **Plot mode** → **Test Value** → **fmax_MHz**: which split reads lowest?
4. **Overlays** → **Ring boundaries**, then back to **Hard Bin**
5. Zoom into W04 · SS and hover a failing die

ANSWERS Check your results

3. **SS** reads lowest: its mean `fmax_MHz` is about 1630 MHz, against about 1800 for TT and 1970 for FF. SS is the slow corner.

Recap

- **Plot mode** picks bins or a test; the legend highlights one bin
- **Overlays** and **Orientation** change how every map is drawn
- Each card zooms, pans and saves on its own

You can now ask the map a question by choosing what it colours, and read the answer die by die. Next, see what tsmap finds without being asked.

More in the wafer map guide



Next lesson

03 · Findings →

What tsmap noticed in the lot, and how to read it.



Findings

Lesson 03

Learn tsmap

In this lesson

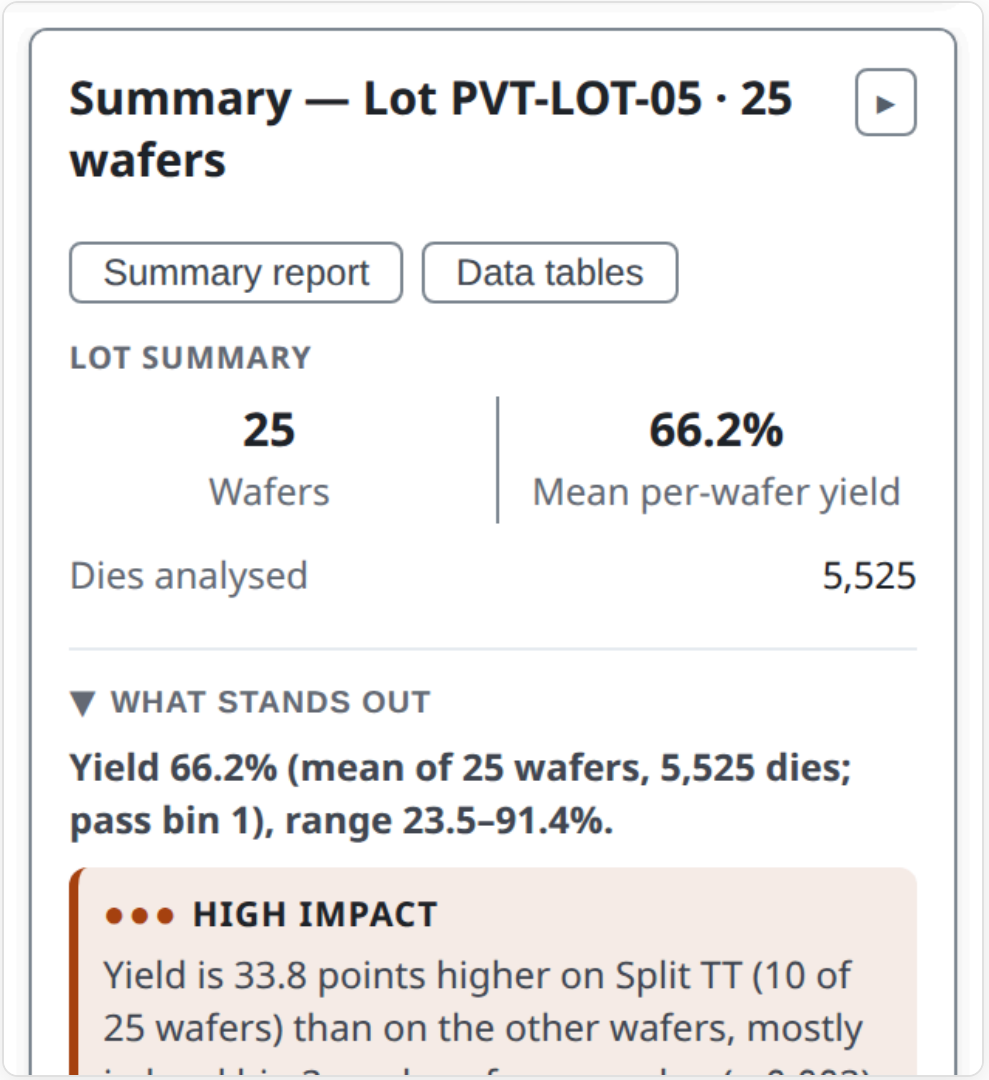
You have loaded a lot and want to know what is wrong with it. tsmap has already looked, and this lesson shows you how to read what it found.

- Read **What stands out**, and show any row on the map
- Read the **Findings** list and the patterns behind it
- Use the Summary panel's tables and reports

The headline items

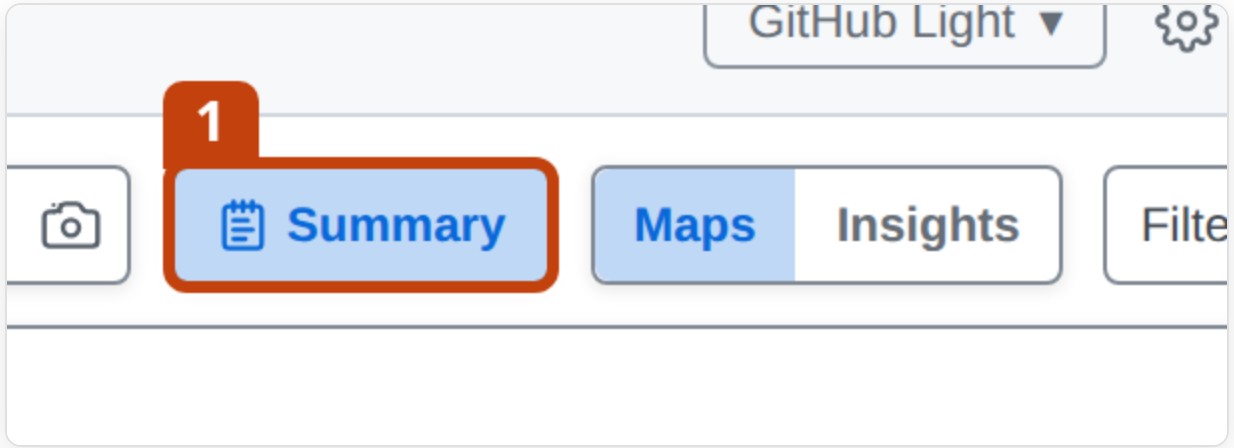
The Summary panel

This is the best place to start. The panel docks beside the maps and describes the whole lot you are looking at, so you can see what stands out before you open a single wafer. Applying a **Filter...** narrows it to the dies that are kept.



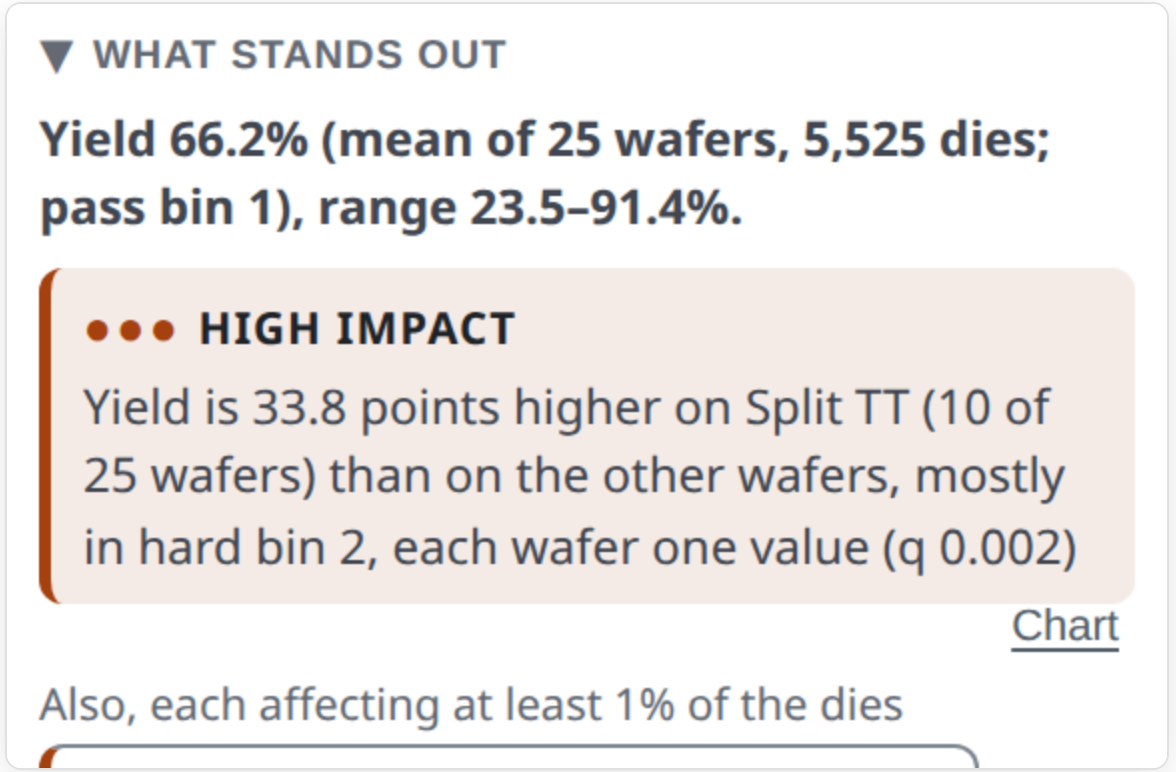
Open and close it

1 **Summary** opens and closes the panel. The ▶ at the end of the panel's title closes it too.



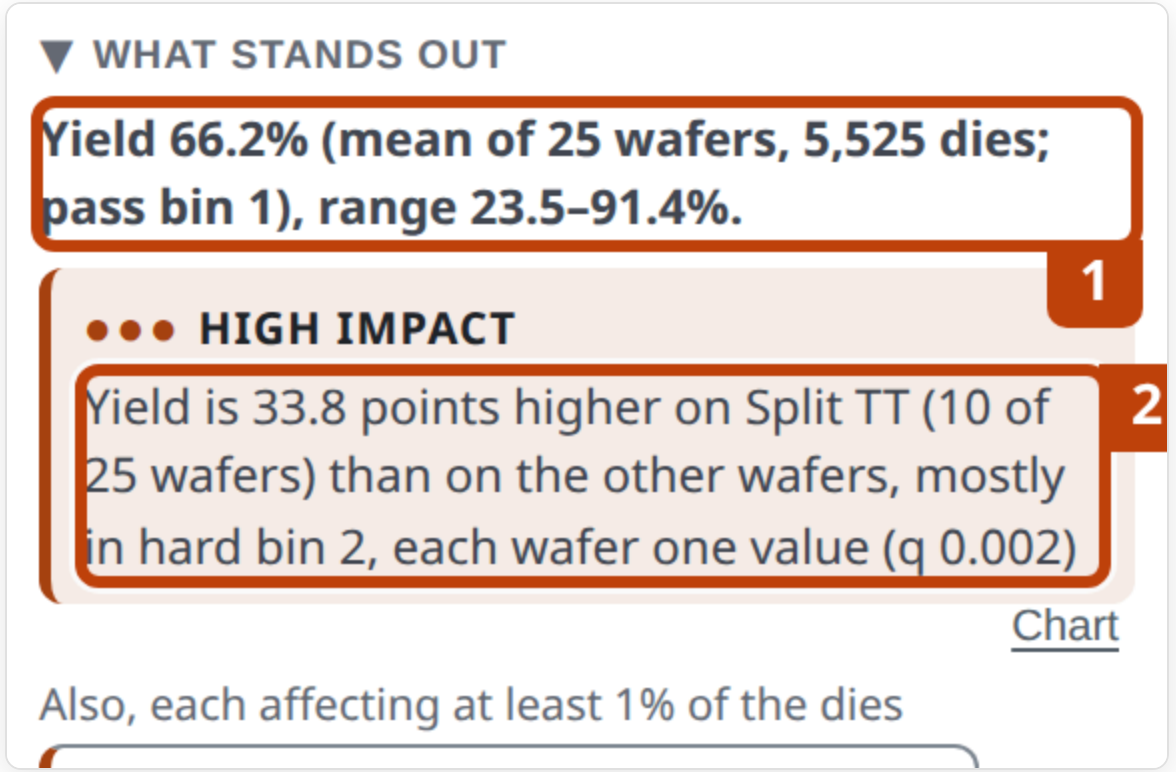
What stands out

The section opens with the yield as its headline. Below it are the items that cost the lot the most dies, largest first, so the top item is the first one worth looking into.



An item about groups of wafers

An item can compare groups of wafers, not just look at dies. 1 is the lot's yield. 2 says that wafers with split TT yield 33.8 points more than the other wafers, and that the loss is mostly in hard bin 2. Each wafer counts as one value, so the figure is about wafers, not dies.



Why it has no buttons

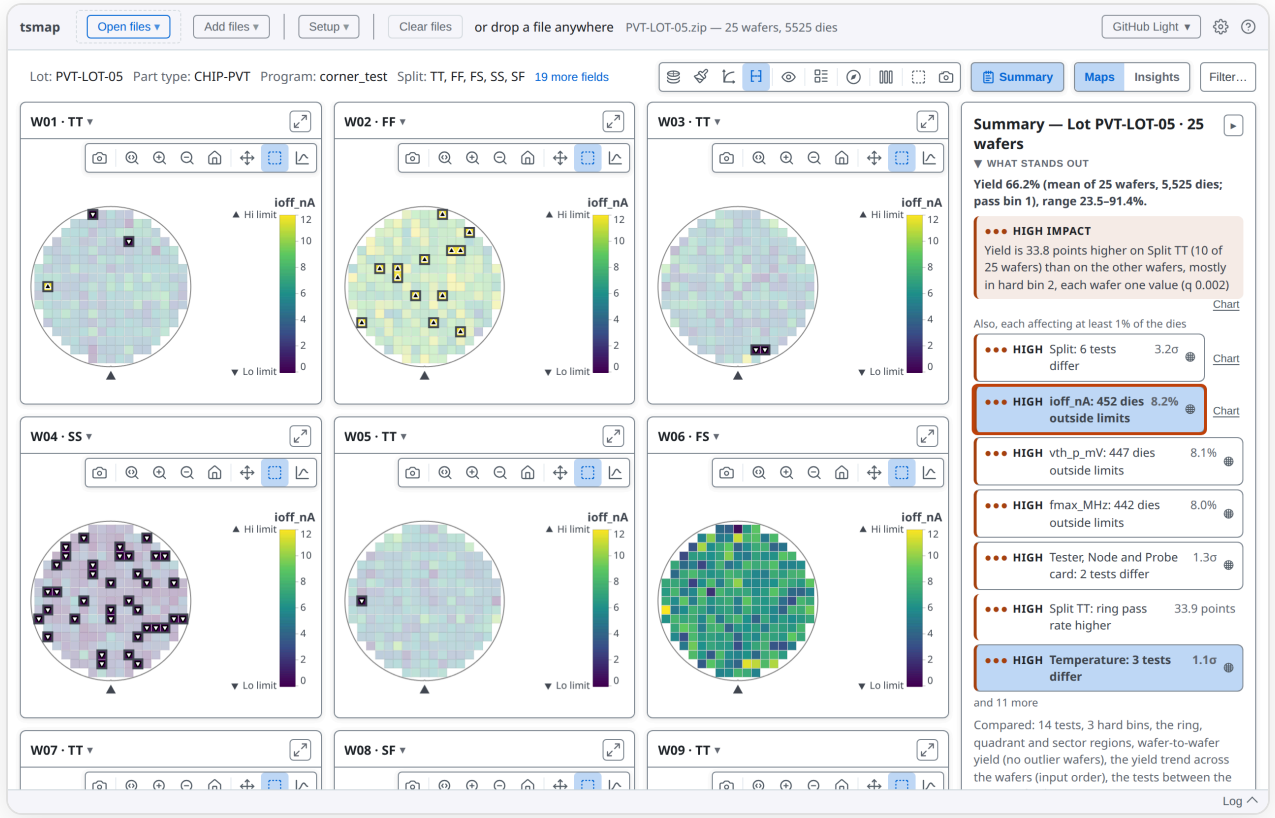
An item about groups of wafers has no single place on the map, so it has no buttons, and clicking it shows nothing. Its **Chart** link opens a bar of yield for each group.

Fields that move together

The lot's other fields are compared the same way. When two fields give the same groups, such as a tester and its probe card, tsmap names them together. It does not pick one for you; you choose which to follow.

Every row shows the affected dies

Click a row and the map shows which dies it is about. You can then see for yourself whether the problem sits at the edge, in one corner or all over the wafer. Click the row again to clear it.



Losses and signals

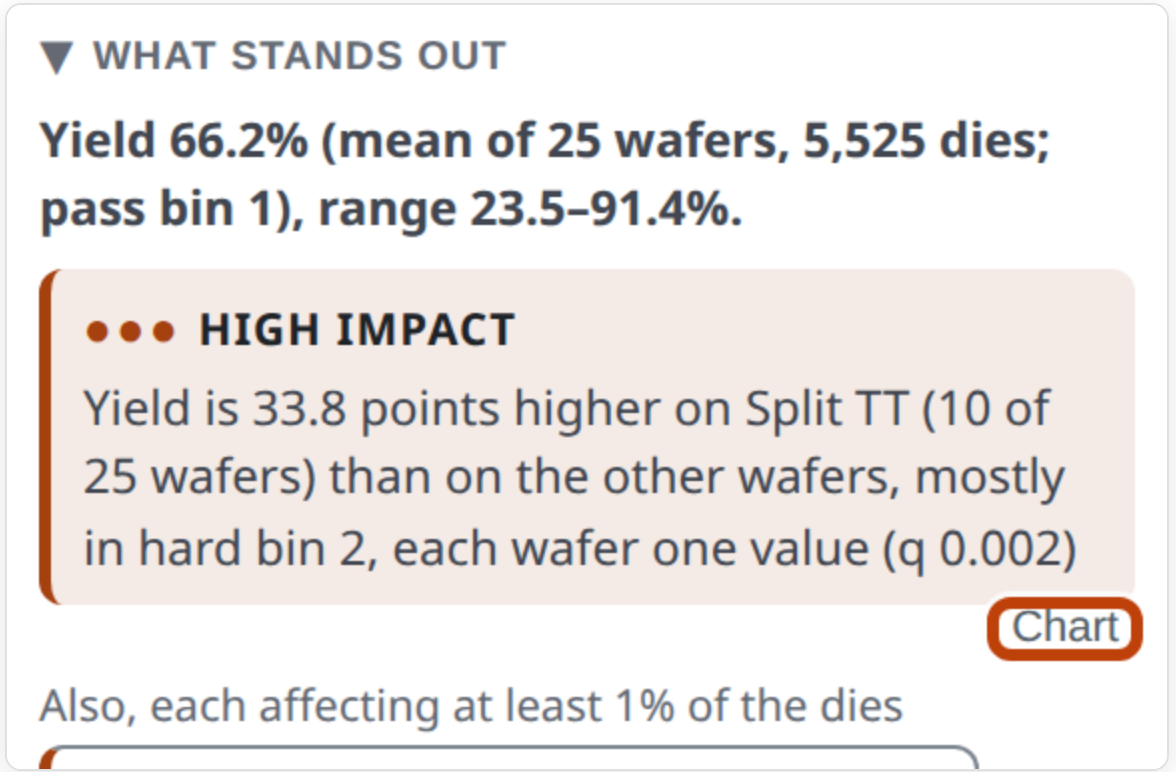
Each item is one of two kinds, and they call for different questions.

- A **loss** costs dies: a weak region, a low wafer, a failing test. Ask where the dies went.
- A **signal** moves values or compares groups, such as a split shift. A shift in a test will not show in yield, but it may still matter.

The dots and word beside an item are its **impact**: the share of the lot it affects. Read the impact first, to see how much an item matters.

Chart links

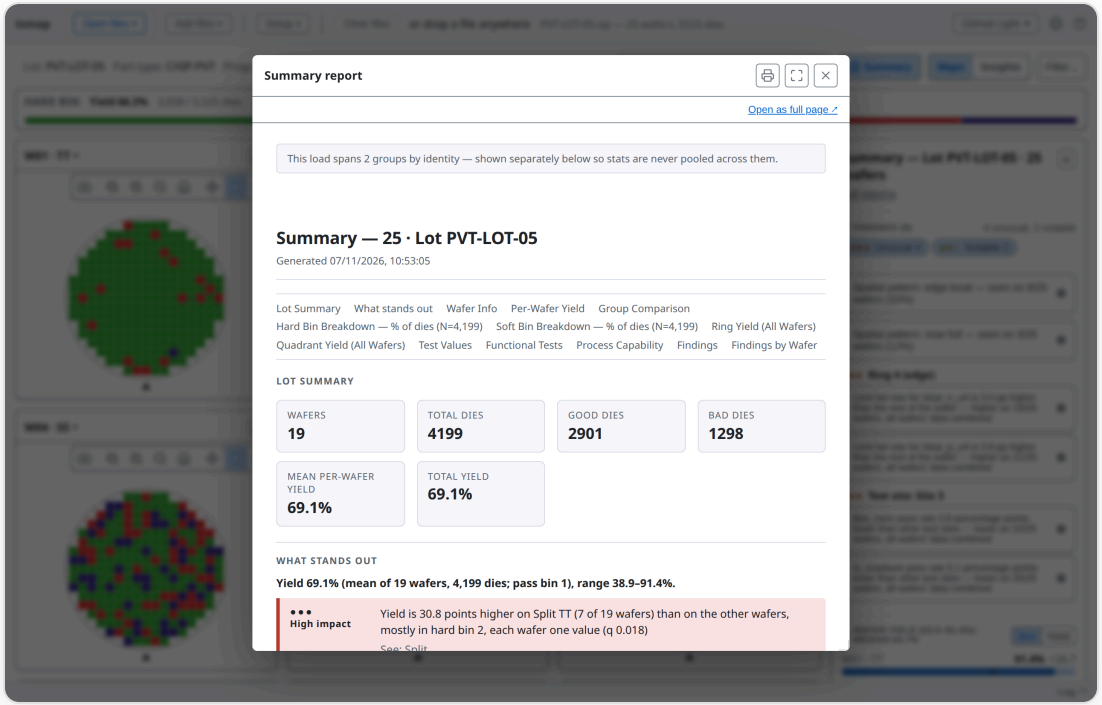
When you want the numbers behind an item, **Chart** opens Insights at this item's card, under **Worth a look**. The top item here is a difference in yield between splits, so its link opens **What divides yield**, the table that compares groups of wafers. *(Insights is covered in lessons 05 and 06.)*



Full report

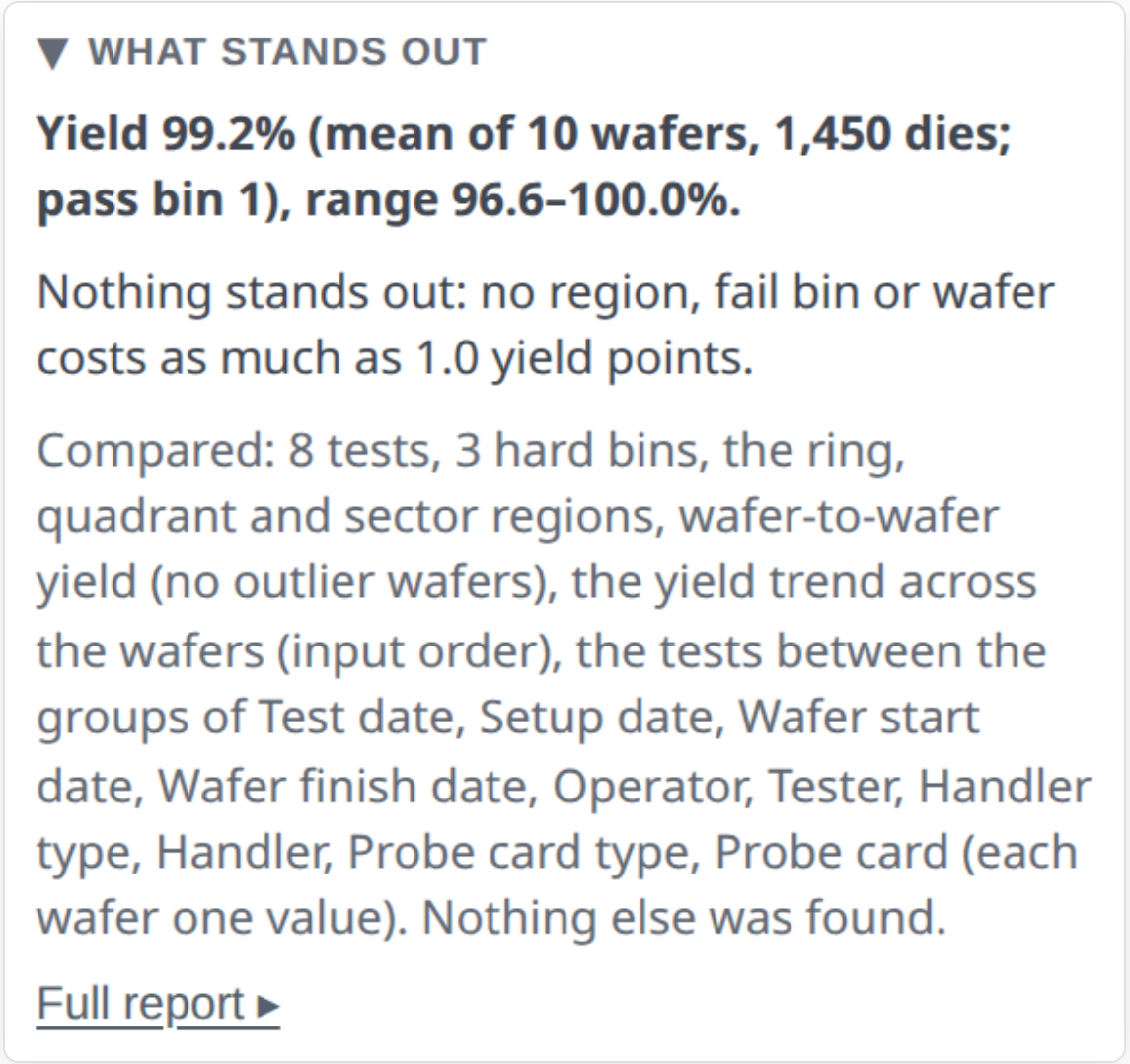
Full report ▸ at the foot of the section opens the report, which begins with the same items. The **Summary report** button at the top of the panel opens the same report.

The sample lot mixes test programs, so its report has one section for each group. The first section holds only that group's wafers.



A lot with nothing to report

A lot with nothing to report is a result too. When no region, bin or wafer costs about a yield point, the panel says so and lists what it compared, so you know it looked. This is `HY-LOT-04`.



Bigger lots

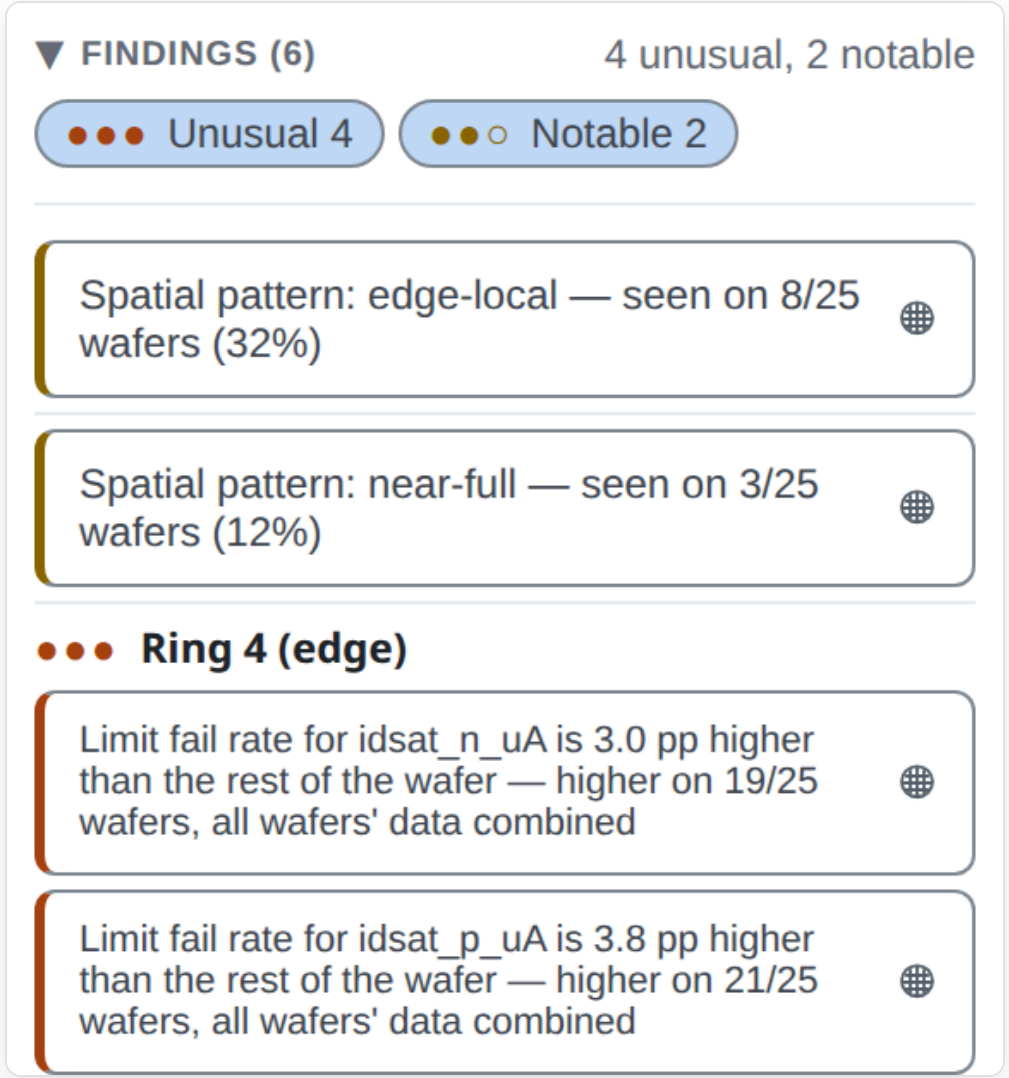
Checks on test values, such as a region reading high, take longer, so they run on their own only for small loads. On a larger one the Findings list says so, and **Analyse** adds them for every wafer.

More in the user guide

The Findings list

The Findings section

The list holds everything tsmap noticed, ranked by **severity**: Unusual, Notable or Minor. Severity is how strong the evidence is, not how many dies it costs. Use it to decide what to check first, and use impact to judge how much it matters.



Narrow the list

The **Unusual** and **Notable** buttons narrow the list. Click a finding to show it on the map.

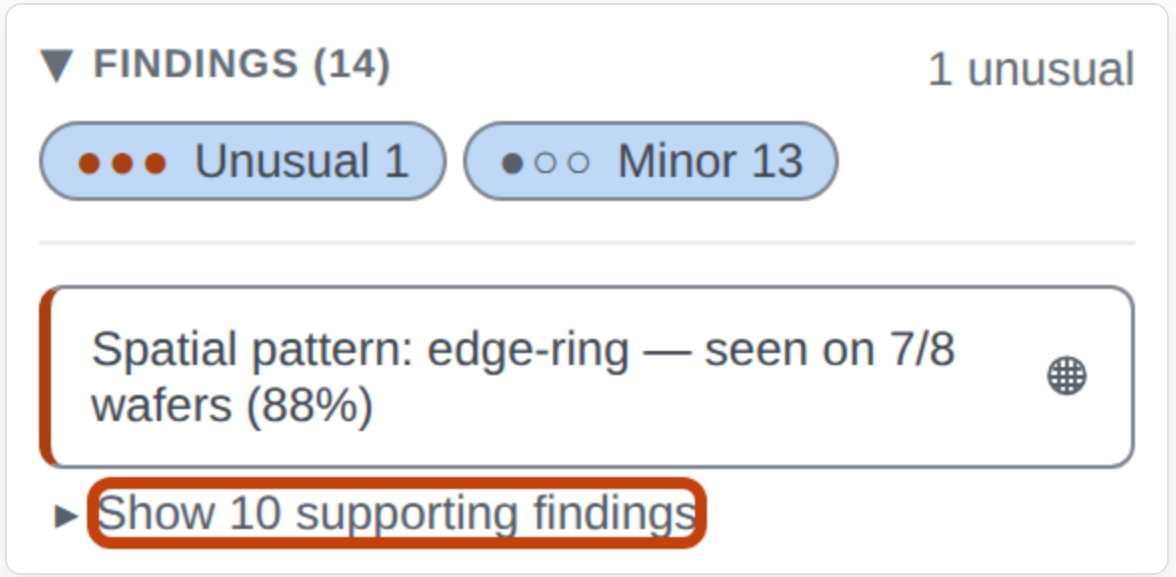
What tsmap looks for

tsmap compares each part of the lot with the rest, and checks the failing dies for shapes it recognises.

- **Regions**: rings, quadrants, finer sectors, and test sites that yield or read differently
- **Clusters** of failing dies, and **edge arcs** at the rim
- **Spatial patterns** such as a donut, scratch or centre spot
- **Reticle positions**, once a reticle is set (lesson 11)

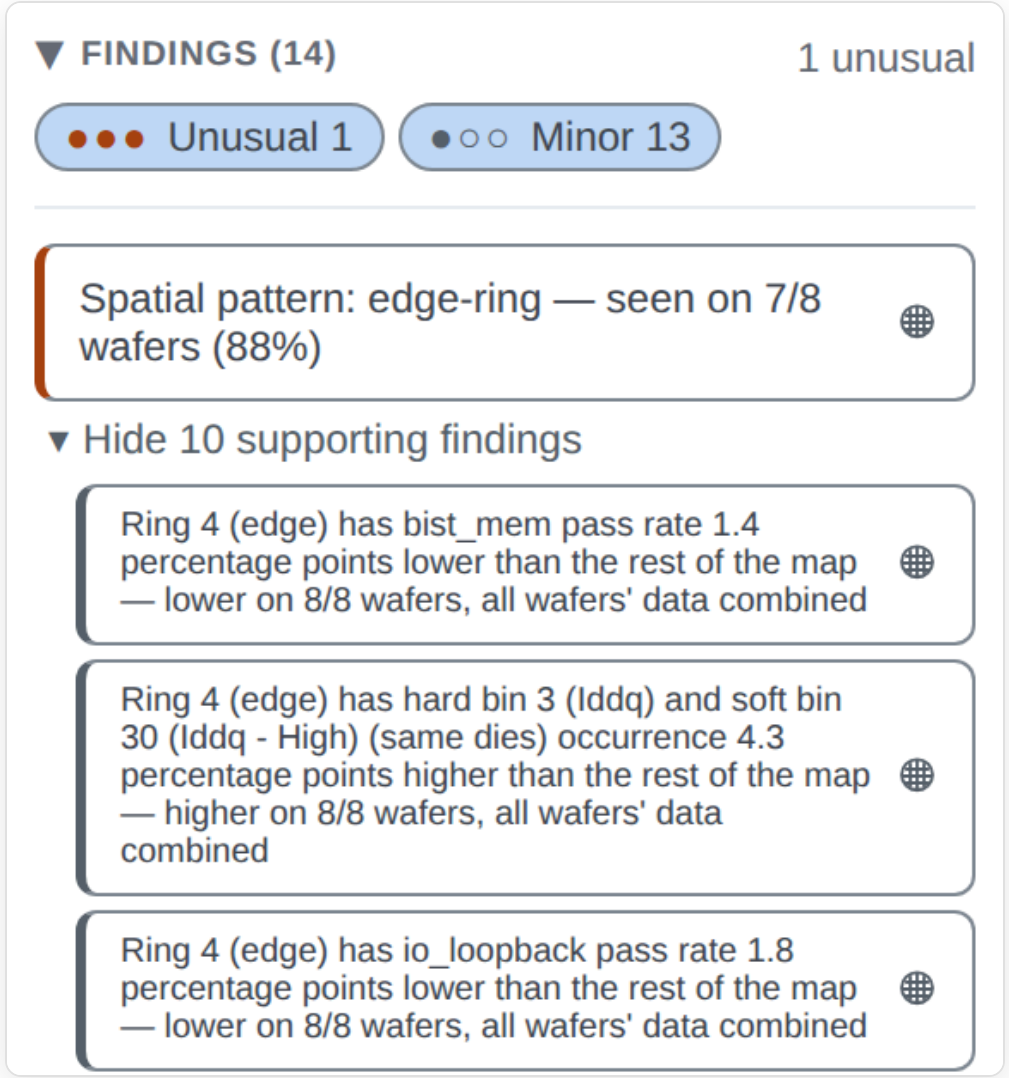
A pattern and what backs it

A spatial pattern is a shape tsmap recognises in the failing dies. It can have a **Show N supporting findings** line, which holds the smaller findings that add up to it. This is `EDGE-LOT-01`.



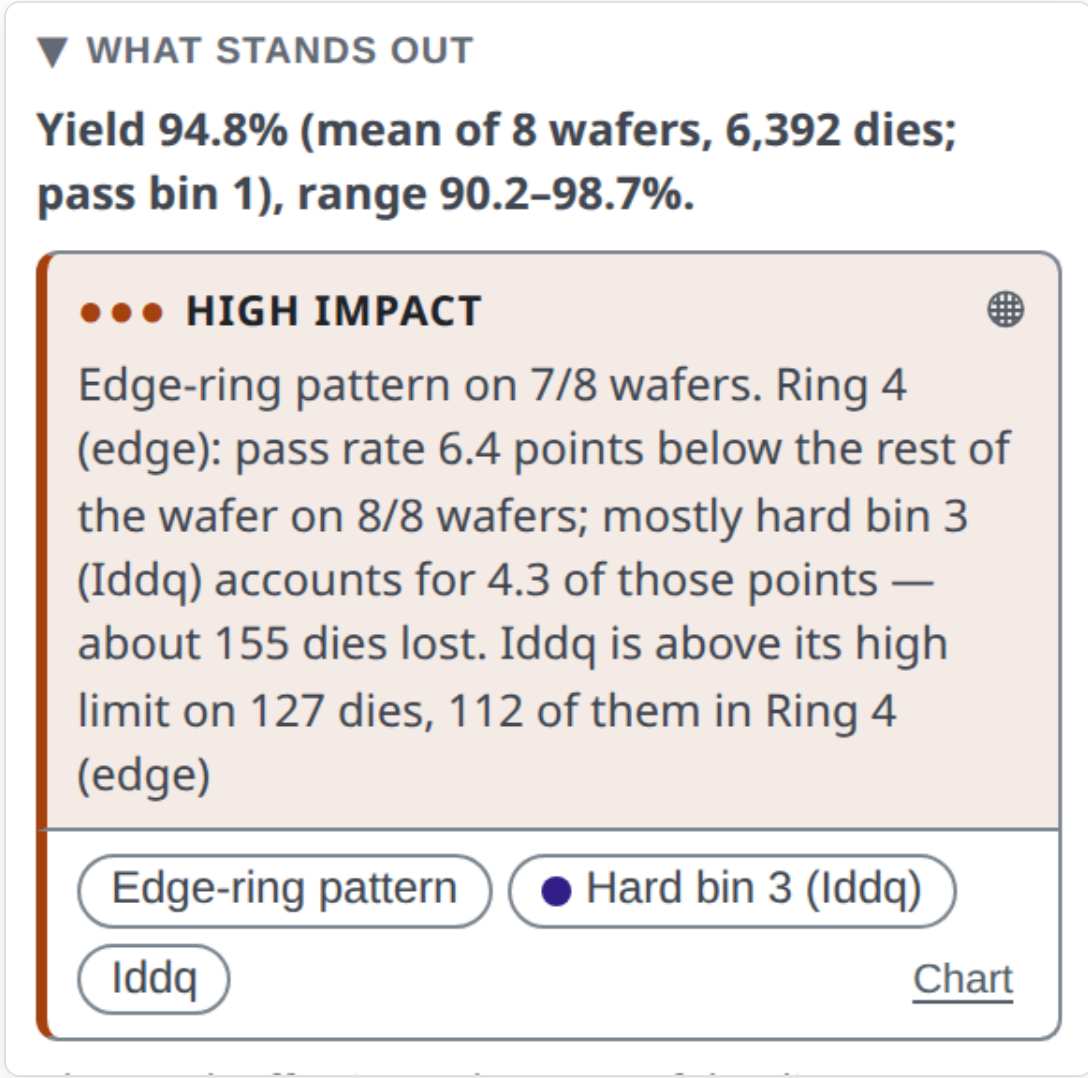
The supporting findings

When opened, the line lists the regional findings the pattern explains. You read one pattern instead of a dozen separate regions.



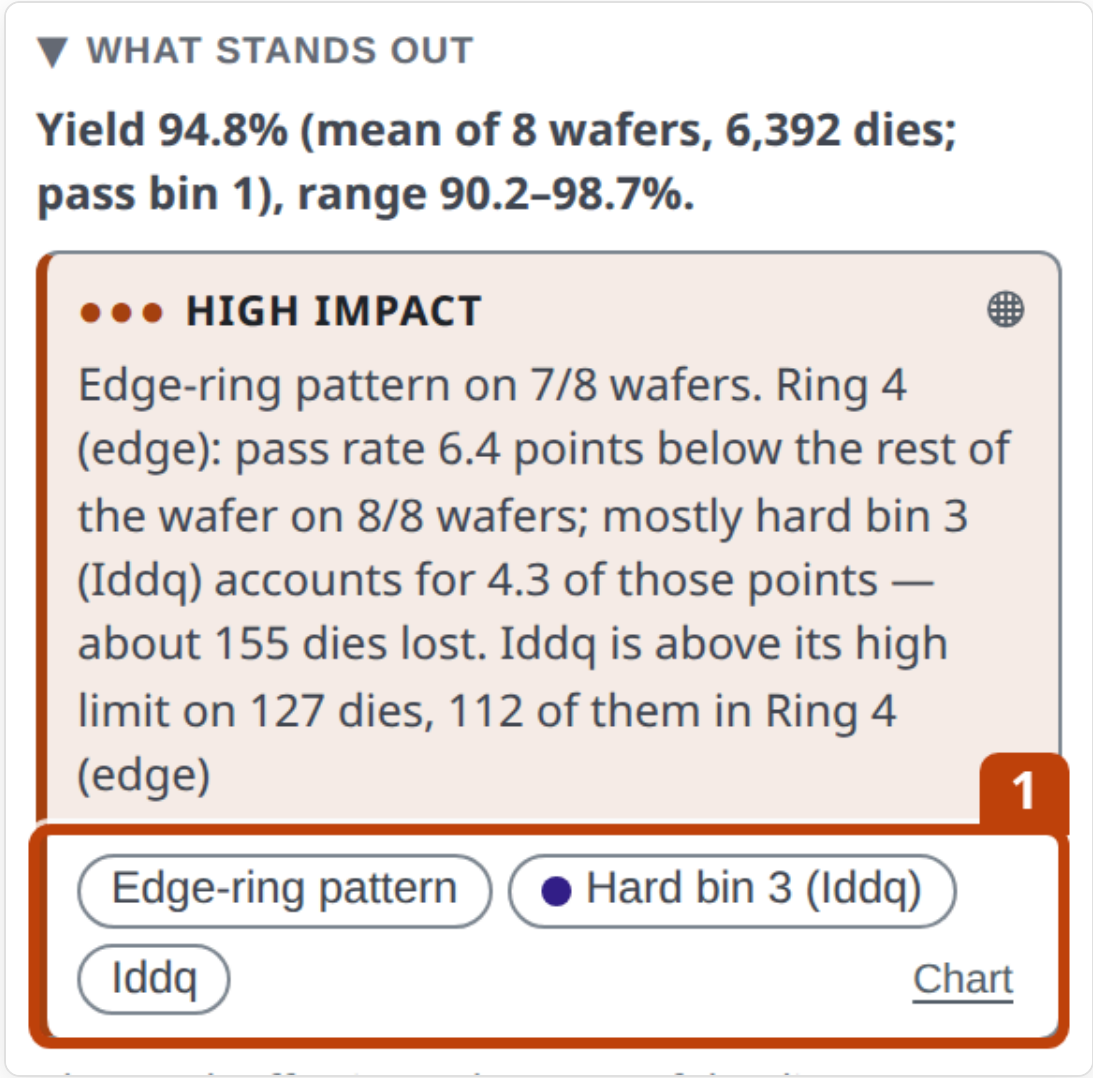
An edge ring

For an edge ring, the item names the pattern, the bins that make up the loss and the test behind it. Together they tell you what kind of problem to look for.



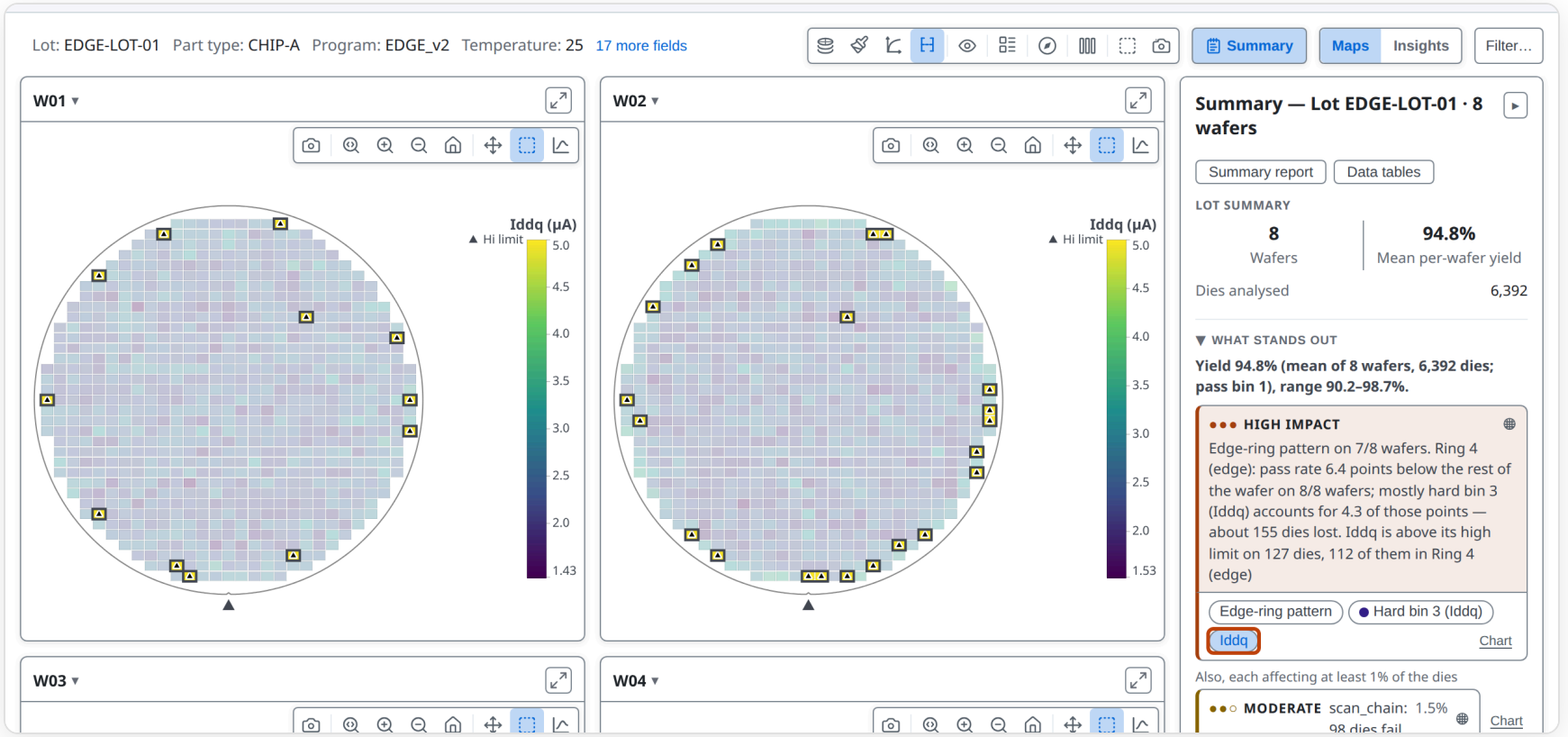
Buttons under an item

A pattern's item has small rounded buttons under it, and each names something behind it: the pattern, the bin and the test. 1 marks them. A bin's button carries its legend colour.



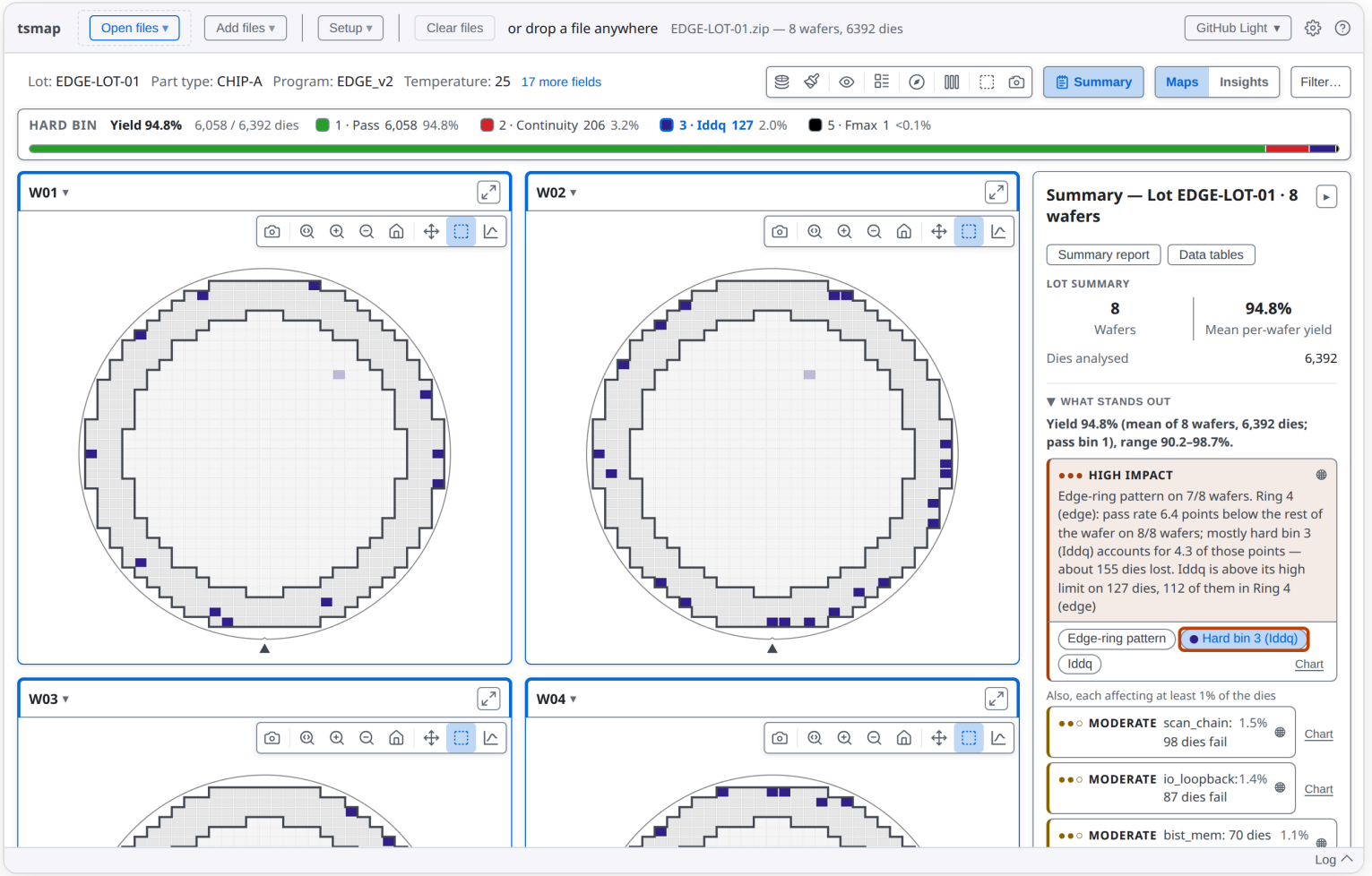
Show one at a time

Click a button to show only that test, bin or pattern on the map. It is the quickest way to see where one thing happens. This is `Iddq`, with the dies outside its limits marked ▽ and △.



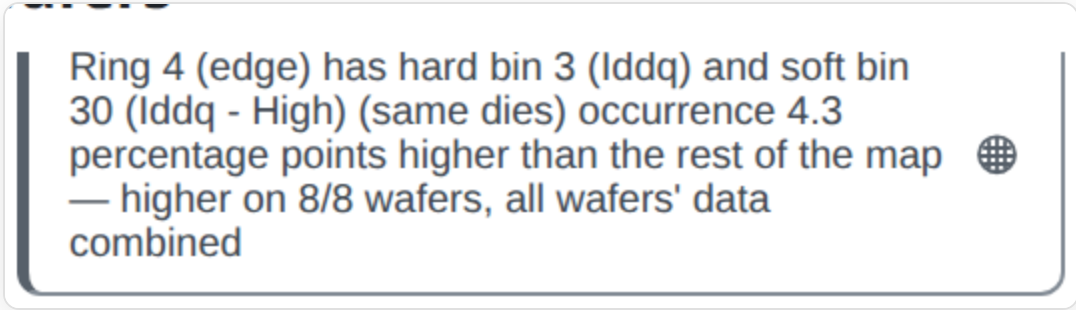
A bin button

A bin's button shows only the dies in that bin. This is hard bin 3.



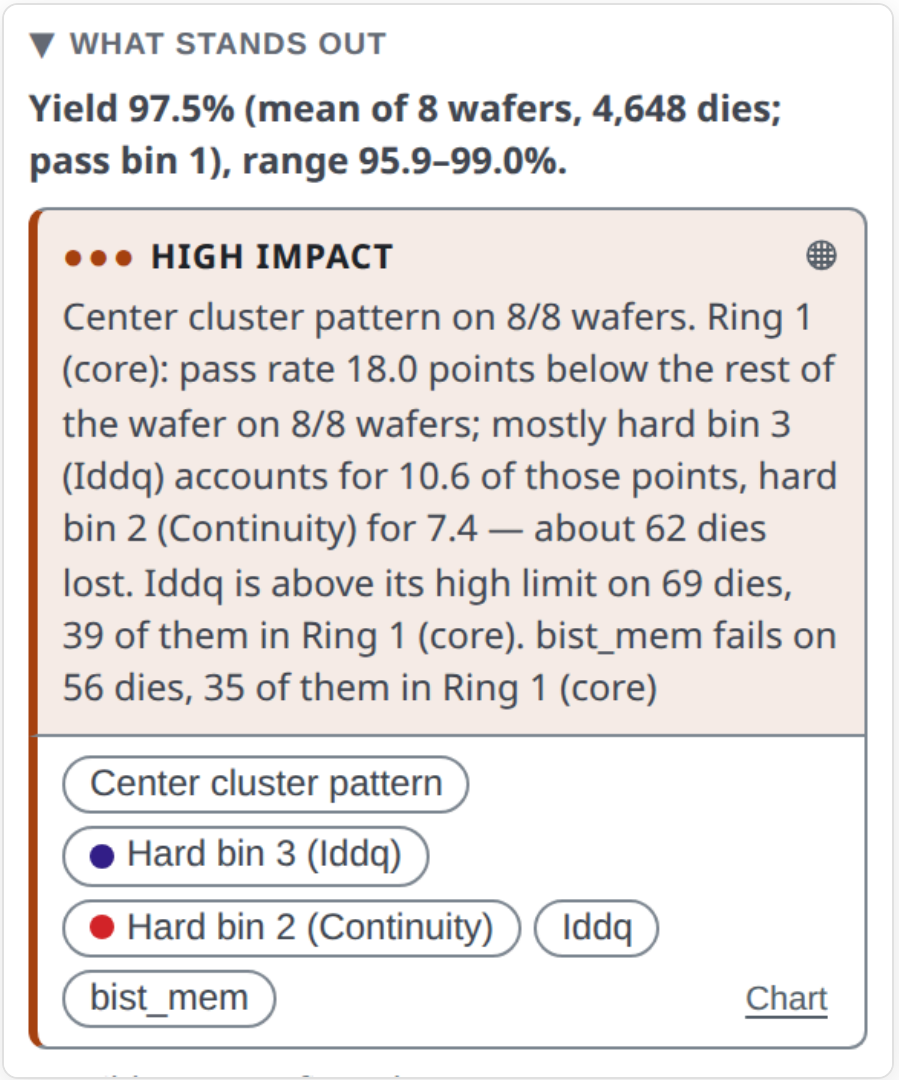
One group, two bins

"Hard bin and soft bin 3 (same dies)" is one group of dies counted in both bin types. It is one problem, not two. A finding about the pass bin is folded into the yield finding for the same reason.



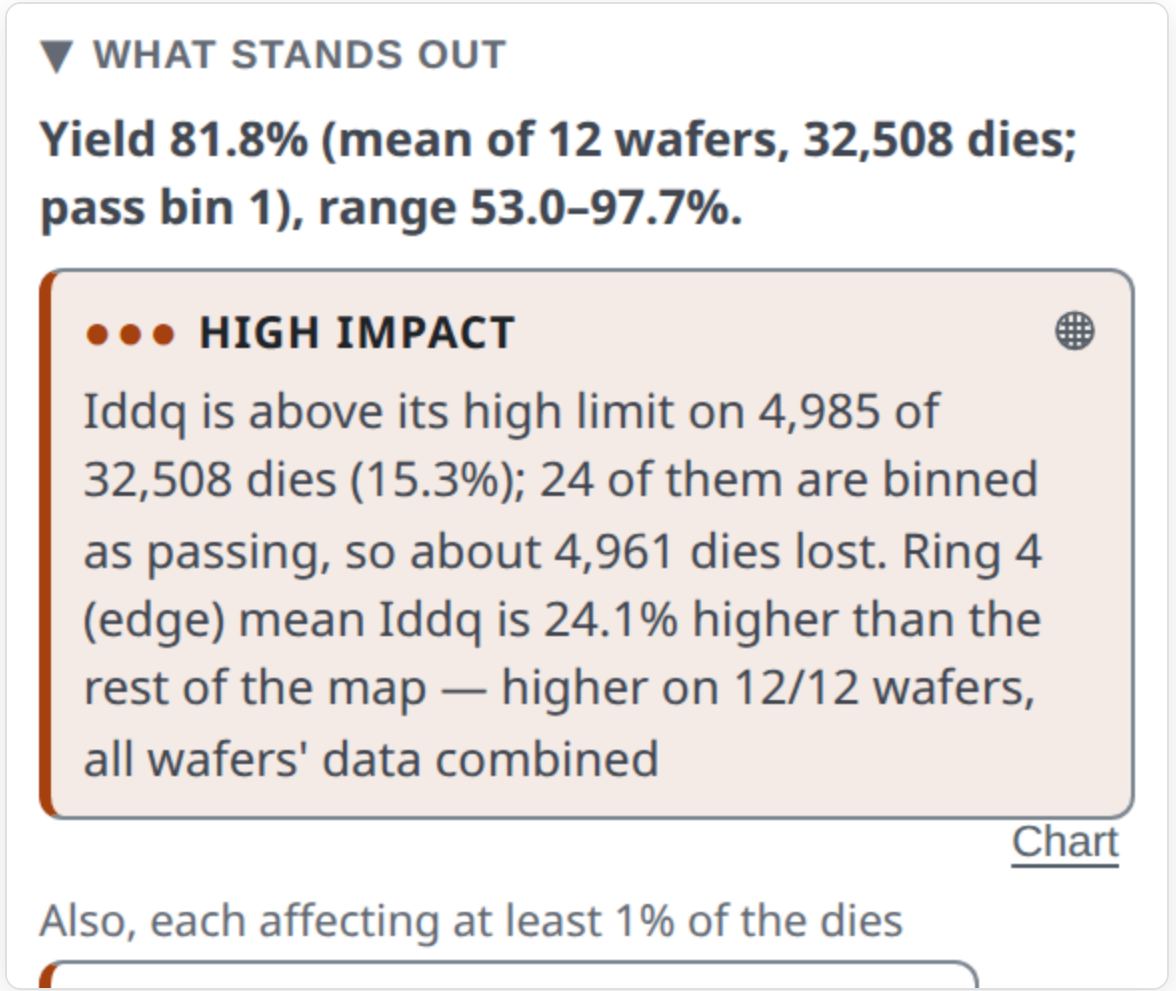
A cluster at the centre

Failing dies that sit together form a **cluster**. Here a small group fails near the centre of every wafer, in a different place on each. The item names the pattern and the bins behind it. This is `CLUST-LOT-03`, in the repository's `sample_data` folder.



A shift with no defect

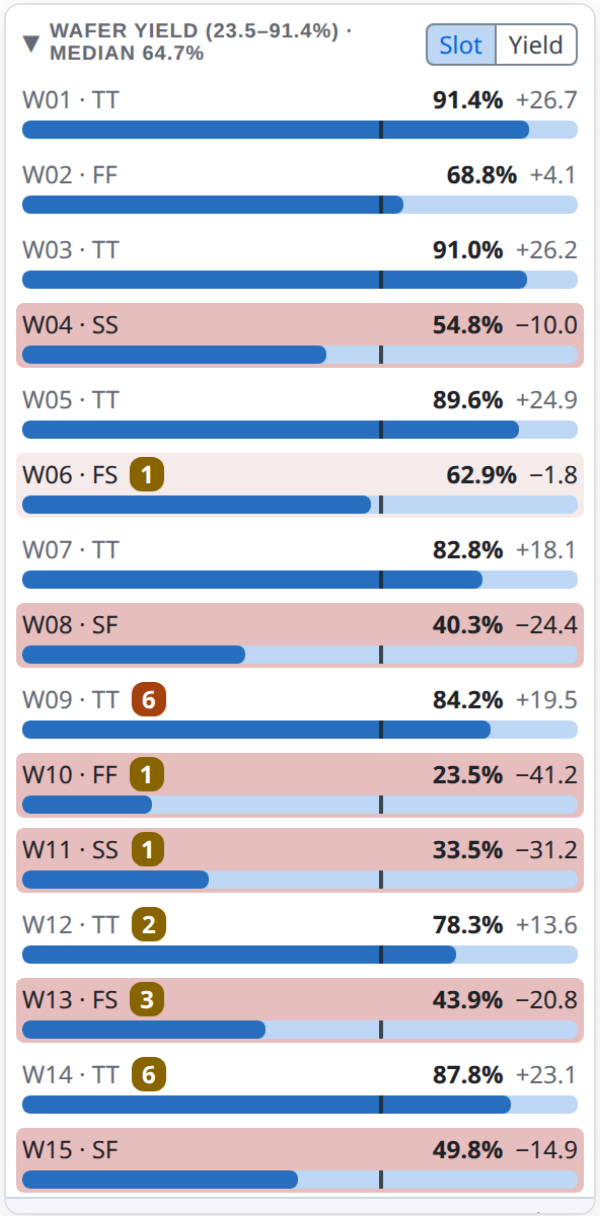
Not every item is a pattern of failing dies. In `PARAM-LOT-02` the top item is a test: `Iddq` is higher toward the edge on all twelve wafers, and many dies cross its high limit.



The tables

Wafer Yield

Wafer Yield draws one bar per wafer, in slot order, so a pattern that follows the slot order shows up. Use it to spot a wafer that sits apart from the rest: one far from the others is labelled a low or high outlier.

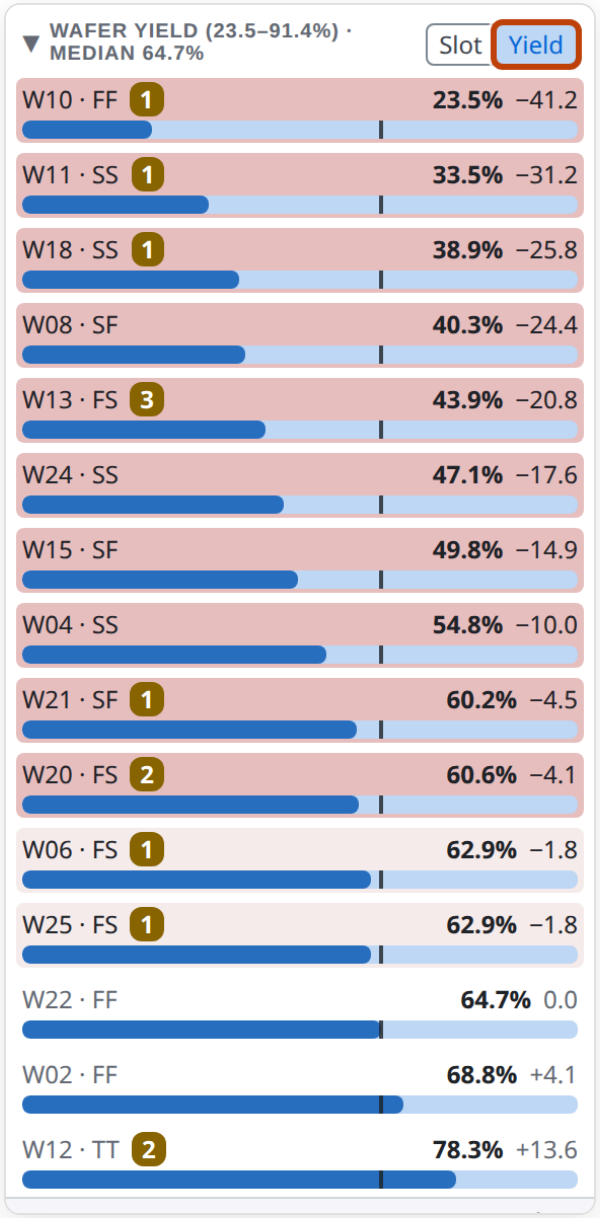


Wafer Yield rows

A badge on a row counts that wafer's findings. Click a row to open the wafer. A single wafer has no such list.

Sorted by yield

Yield re-sorts the wafers from lowest to highest, so the weakest come first. (The **Sort: yield** chart in lesson 05 goes the other way.) A row a point or more below the median is tinted, and darker as the gap grows.

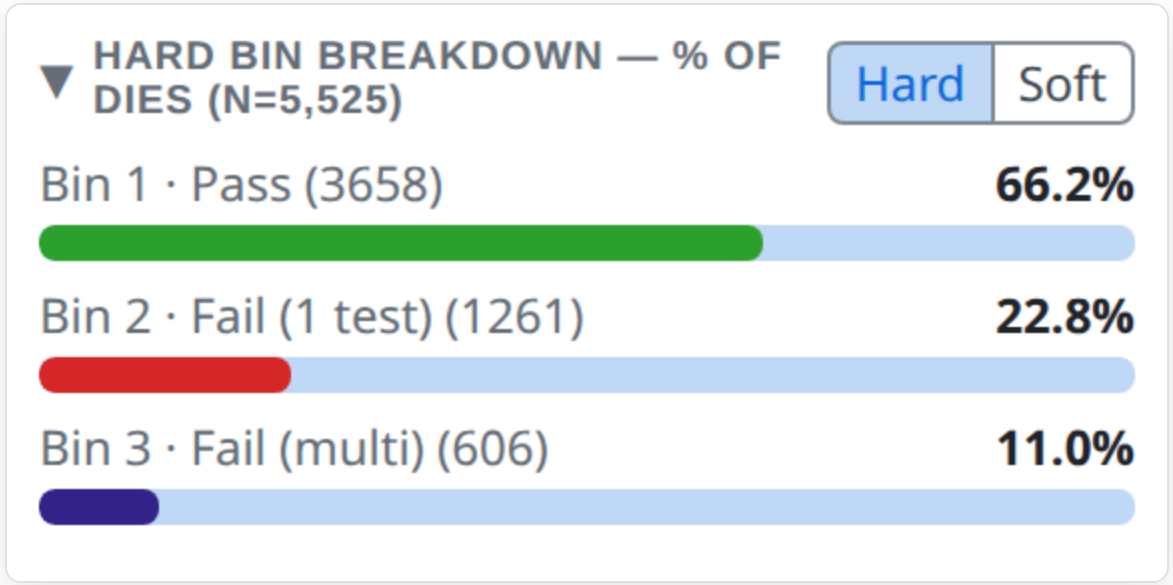


Which yield?

The panel's **66.2% mean per-wafer yield** averages the 25 wafers' own yields, each wafer counting once. A pooled yield counts every die once, so big wafers weigh more. The label always says which. Check it before you compare the figure with one from somewhere else.

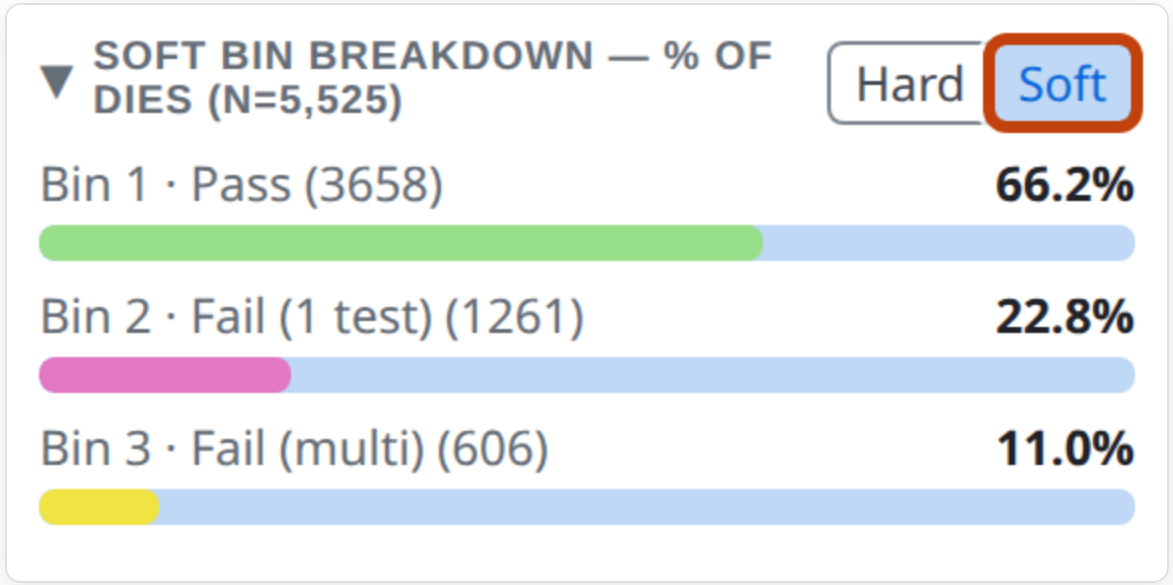
Hard Bin Breakdown

Hard Bin Breakdown shows where the lost dies went. Bars are a share of dies: pass bins first, then failing bins from the most dies to the fewest.



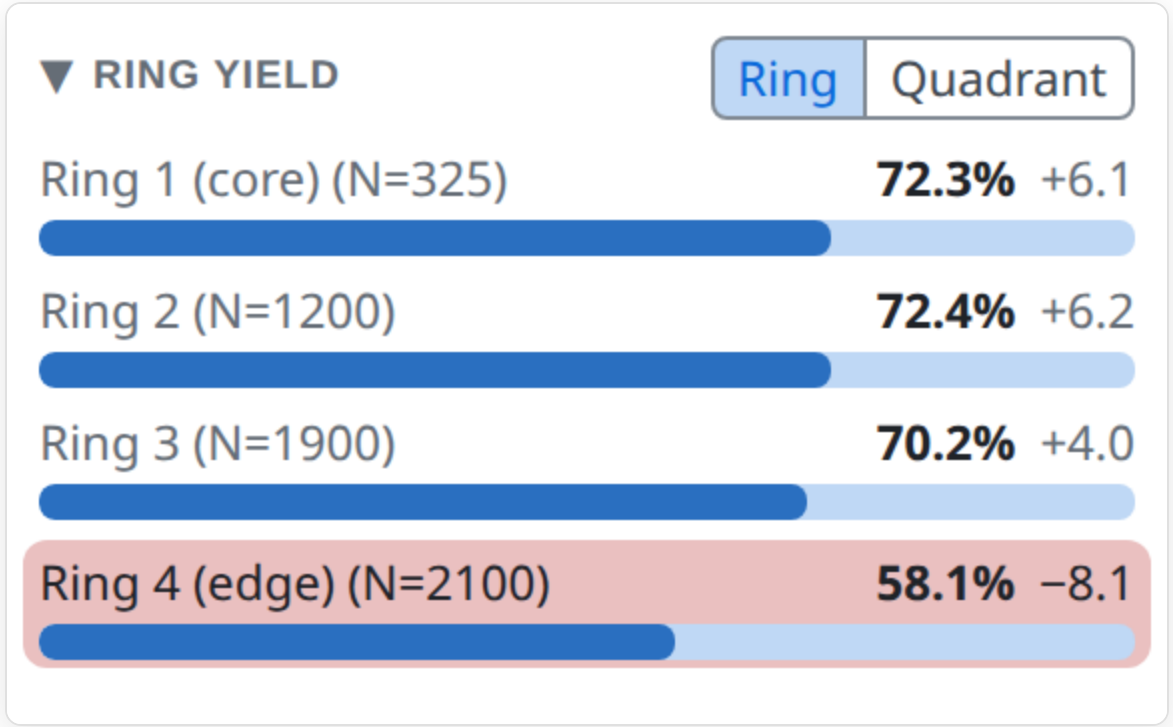
Soft bins

Soft switches the breakdown to soft bins, with their own colours. By default it follows the map's plot mode.



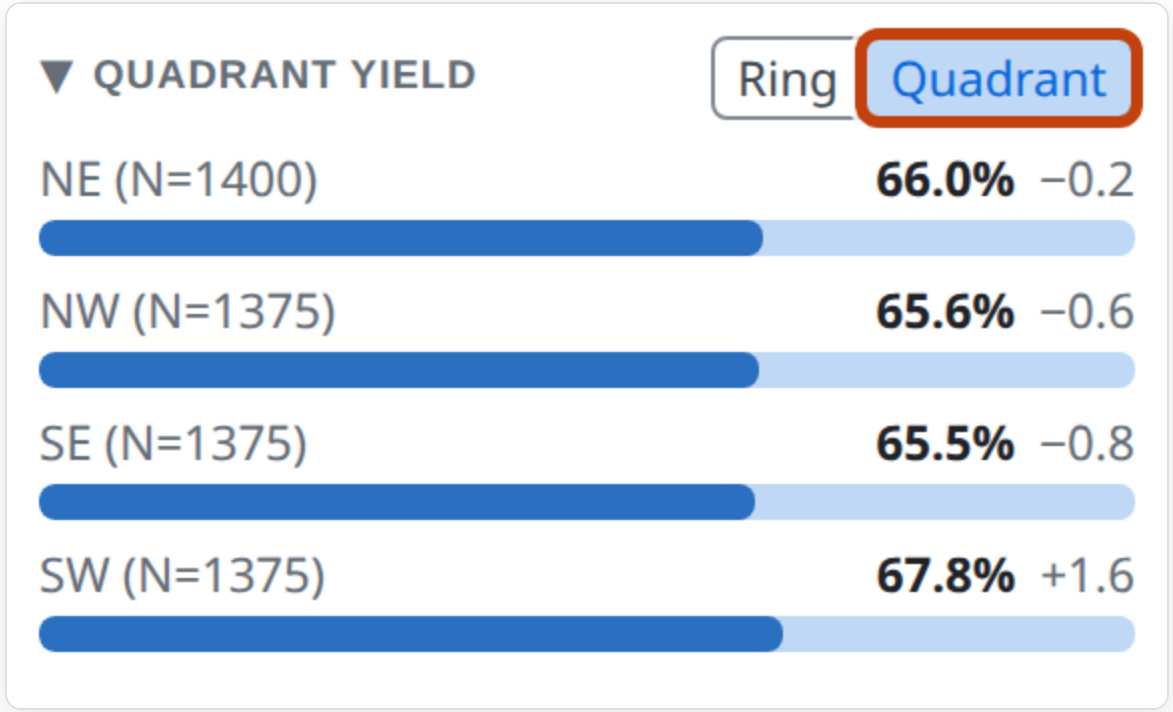
Ring Yield

Ring Yield shows yield by ring from the centre out, each row with its difference from the wafer's yield. Ring is the default because edge roll-off dominates real wafer maps.



Quadrant

Quadrant splits the wafer into NE, NW, SE and SW instead of rings.



Test Values

The Test Values table has one row per test: the mean, **Ppk** (lesson 06 explains it) and the share of dies within limits. Ppk uses the overall spread, wafer-to-wafer variation included.

TEST VALUES (6) — 25 WAFERS POOLED · N=5,525

TEST	MEAN	PPK	LIMIT YIELD
vth_n_mV	320 mV	0.58	92.9%
vth_p_mV	323 mV	0.54	91.9%
idsat_n_uA	692 µA	0.62	97.0%
idsat_p_uA	636 µA	0.63	97.2%
ioff_nA	6.21 nA	0.57	91.8%
fmax_MHz	1.77 GHz	0.44	92.0%

Functional Tests

The Functional Tests table gives pass and fail counts and the pass rate for each functional test.

▼ FUNCTIONAL TESTS (8) — 25 WAFERS POOLED · N=5,525

TEST	PASS	FAIL	PASS RATE
scan_chain	5374	151	97.3%
bist_mem	5381	144	97.4%
io_loopback	5412	113	98.0%
pll_lock	5460	65	98.8%
ddr_phy	5440	85	98.5%
serdes_prbs	5434	91	98.4%
jtag_idcode	5490	35	99.4%
power_seq	5480	45	99.2%

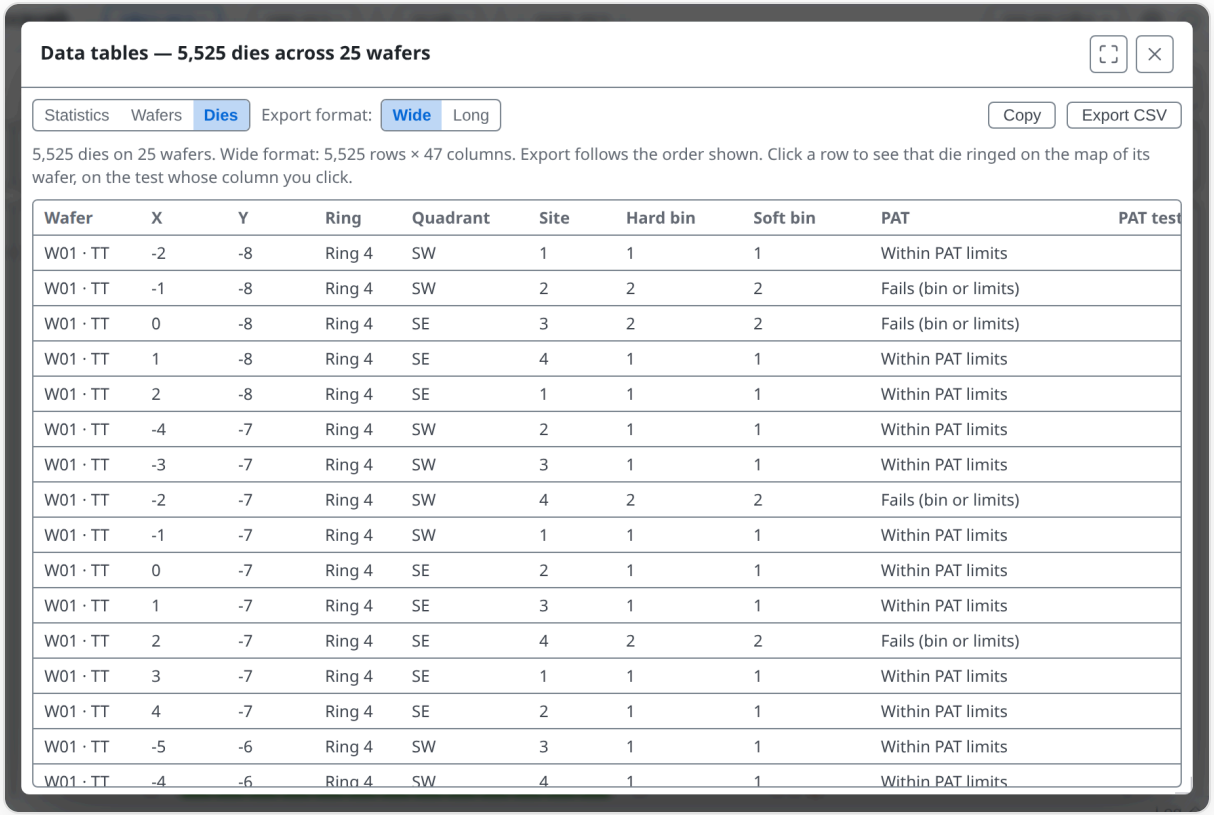
Summary report

Summary report 1 opens a printable report: the findings, bins, regions and the full per-test table. It is the report **Full report ▸** opens. Save it as a PDF from the print dialog.



Data tables

Data tables 2 opens the same tables as the **Data** tab in Insights (lesson 06): statistics, every die, and one row per wafer, each with **Copy** and **Export CSV**. Insights does not need to be on.



Wafer	X	Y	Ring	Quadrant	Site	Hard bin	Soft bin	PAT	PAT test
W01 · TT	-2	-8	Ring 4	SW	1	1	1	Within PAT limits	
W01 · TT	-1	-8	Ring 4	SW	2	2	2	Fails (bin or limits)	
W01 · TT	0	-8	Ring 4	SE	3	2	2	Fails (bin or limits)	
W01 · TT	1	-8	Ring 4	SE	4	1	1	Within PAT limits	
W01 · TT	2	-8	Ring 4	SE	1	1	1	Within PAT limits	
W01 · TT	-4	-7	Ring 4	SW	2	1	1	Within PAT limits	
W01 · TT	-3	-7	Ring 4	SW	3	1	1	Within PAT limits	
W01 · TT	-2	-7	Ring 4	SW	4	2	2	Fails (bin or limits)	
W01 · TT	-1	-7	Ring 4	SW	1	1	1	Within PAT limits	
W01 · TT	0	-7	Ring 4	SE	2	1	1	Within PAT limits	
W01 · TT	1	-7	Ring 4	SE	3	1	1	Within PAT limits	
W01 · TT	2	-7	Ring 4	SE	4	2	2	Fails (bin or limits)	
W01 · TT	3	-7	Ring 4	SE	1	1	1	Within PAT limits	
W01 · TT	4	-7	Ring 4	SE	2	1	1	Within PAT limits	
W01 · TT	-5	-6	Ring 4	SW	3	1	1	Within PAT limits	
W01 · TT	-4	-6	Ring 4	SW	4	1	1	Within PAT limits	

LAB Try it yourself

1. In the web app, **Load sample data**
2. Read the top item: which split yields most, and by how many points?
3. Click the **fmax_MHz** row under **Also**: which split's wafers carry the most marked dies?
4. Open **Findings** and click the **edge-local** spatial pattern: on how many wafers is it seen?
5. In **Wafer Yield**, choose **Yield**: which wafer is lowest?
6. Open **Data tables** and look at the **Wafers** table

ANSWERS Check your results

2. **TT**: its wafers yield 33.8 points more than the other wafers, mostly because fewer dies fail hard bin 2.
3. The **SS** wafers, such as W04: SS is the slow corner, so many of its dies fall below the `fmax_MHz` low limit (▽). The TT wafers have only a few marked dies.
4. **8 of 25** wafers: the finding says so, and the map marks its dies on each of them.
5. **W10 · FF** is lowest, at 23.5% yield. W11 · SS is next, at 33.5%.

Recap

- **What stands out** ranks losses and signals, largest first. Most rows show their affected dies on the map; an item about groups of wafers shows a chart instead.
- **Findings** lists what tsmap noticed by severity. Patterns carry the findings that support them.
- The tables, **Summary report** and **Data tables** carry the numbers behind all of it

When you open a new lot, read the headline and the top item first, click a row to see where it is, then use the Findings list for the rest.

More in the wafer map guide

Next lesson

04 · The lot view →

Stack a lot into one map, select the same dies on every wafer, name splits, and name and judge bins.



The lot view

Lesson 04

Learn tsmap

In this lesson

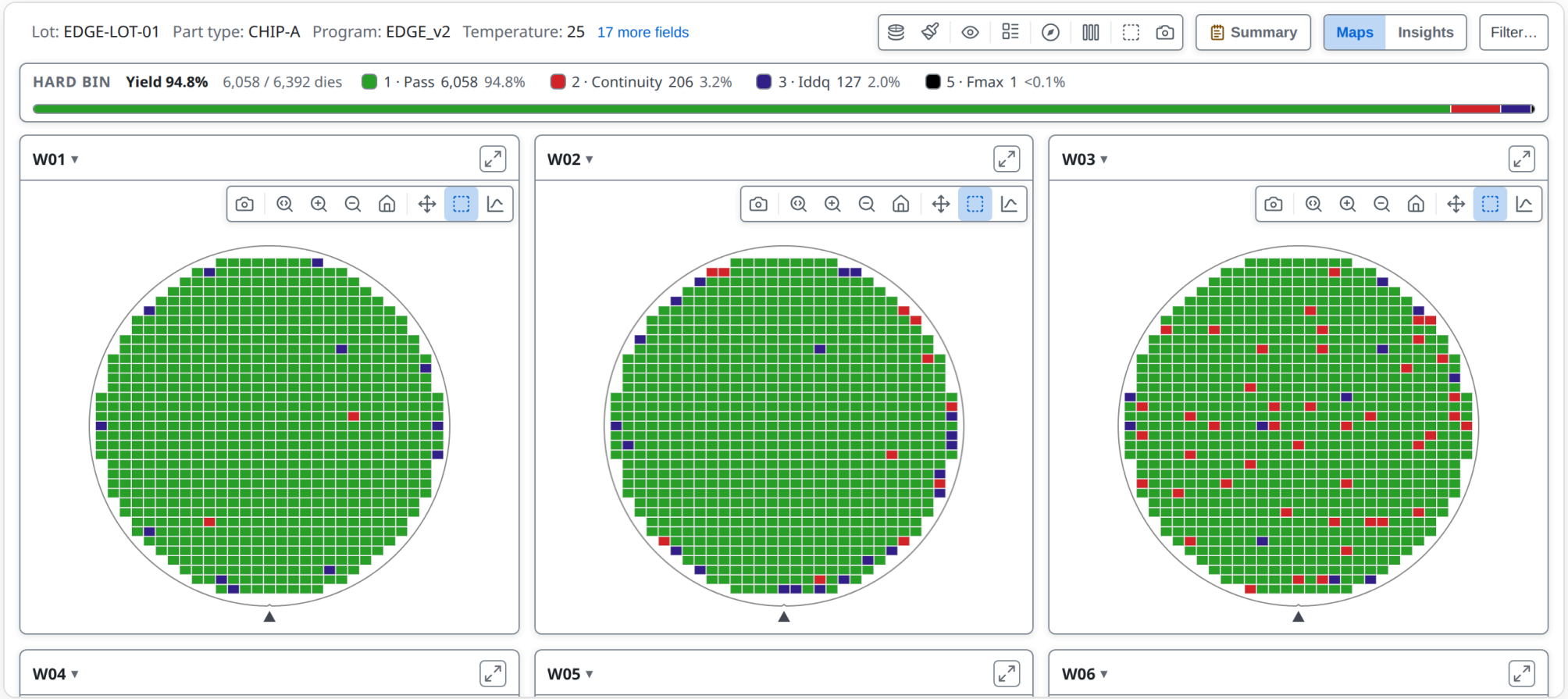
One wafer can mislead you: a pattern may be chance. A lot can show what repeats. This lesson shows how to look across all the wafers at once, and how to label wafers so you can compare them.

- Combine every wafer of a lot into one stacked map
- Select the same dies on every wafer
- Name wafer splits and show them on the maps
- Name bins and choose which ones count as a pass

Gallery and stack

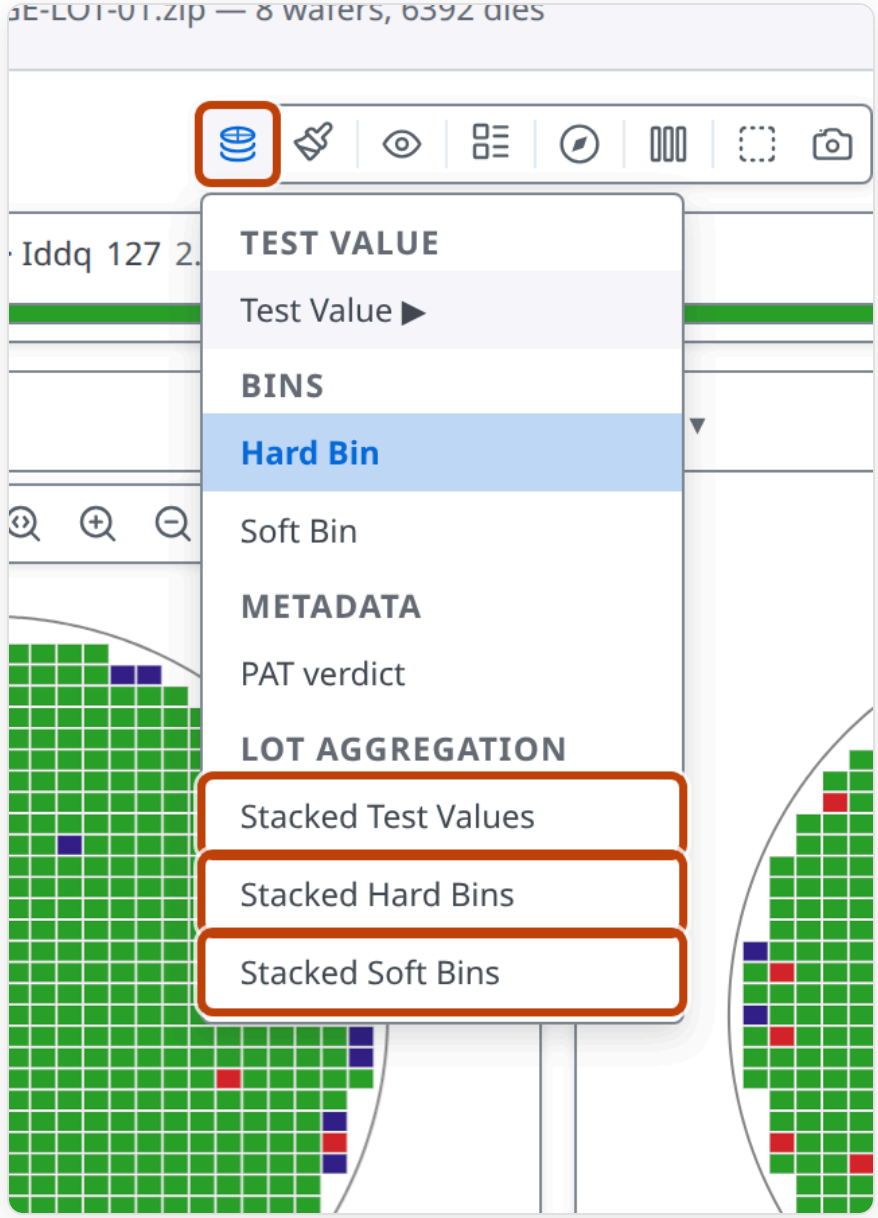
One card per wafer

A gallery shows each wafer on its own card. This is `EDGE-LOT-01`, eight wafers with an edge-ring defect. The buttons above act on all the cards at once (lesson 02).



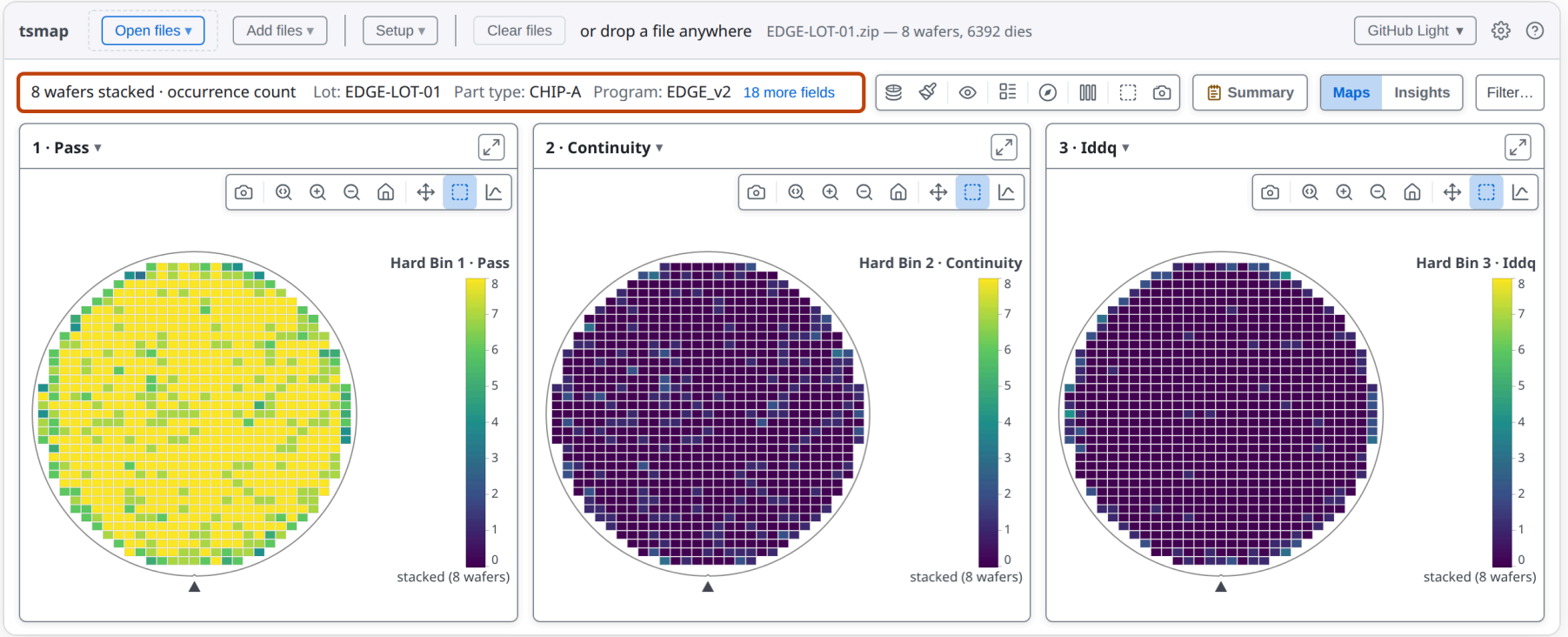
Stack the lot

One wafer's pattern can be chance. The same die positions failing on many wafers is not. Under **Lot aggregation**, three plot modes lay the wafers over one another, so what repeats stands out.



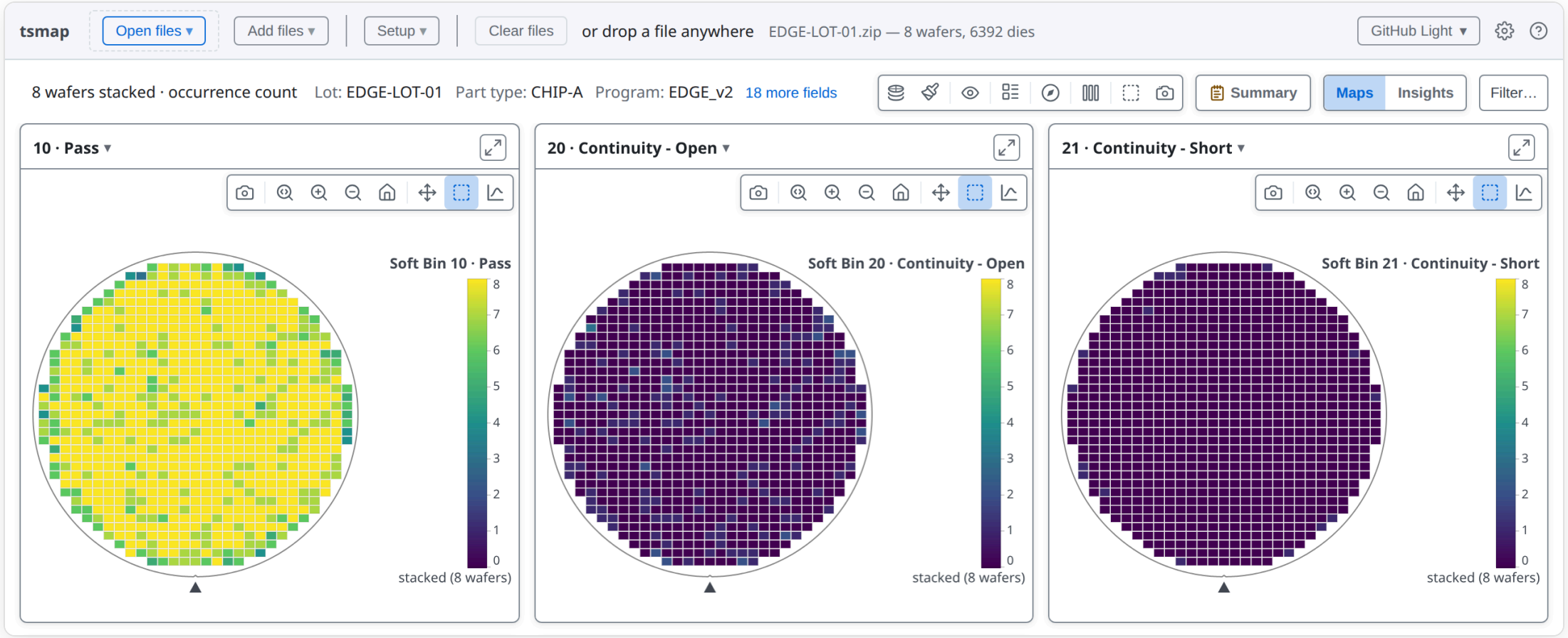
Stacked Hard Bins

Stacked Hard Bins draws one card per bin. Each die position is coloured by how many wafers had that bin there: 0 to 8 here. Pass is high everywhere except a ring at the edge, where the defect sits. A defect that repeats on every wafer is far easier to see here than on any single map.



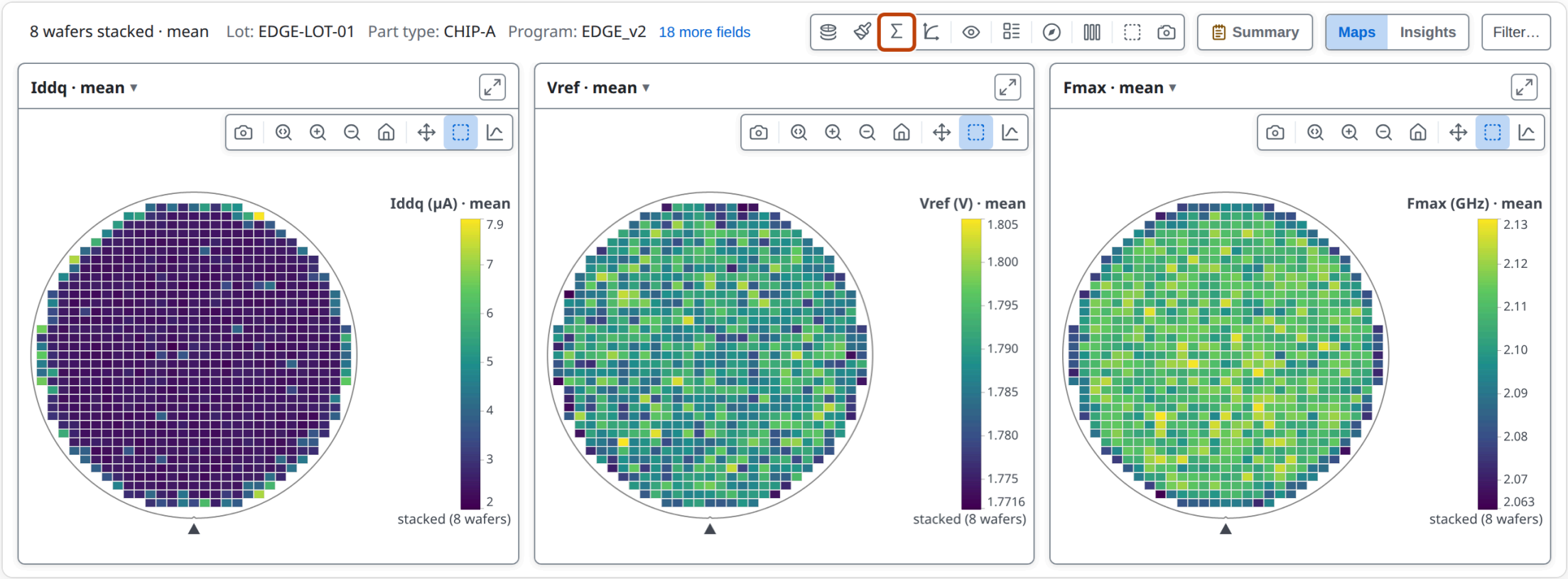
Stacked Soft Bins

Stacked Soft Bins does the same for soft bins, so each lot-level failure mode shows as its own map.



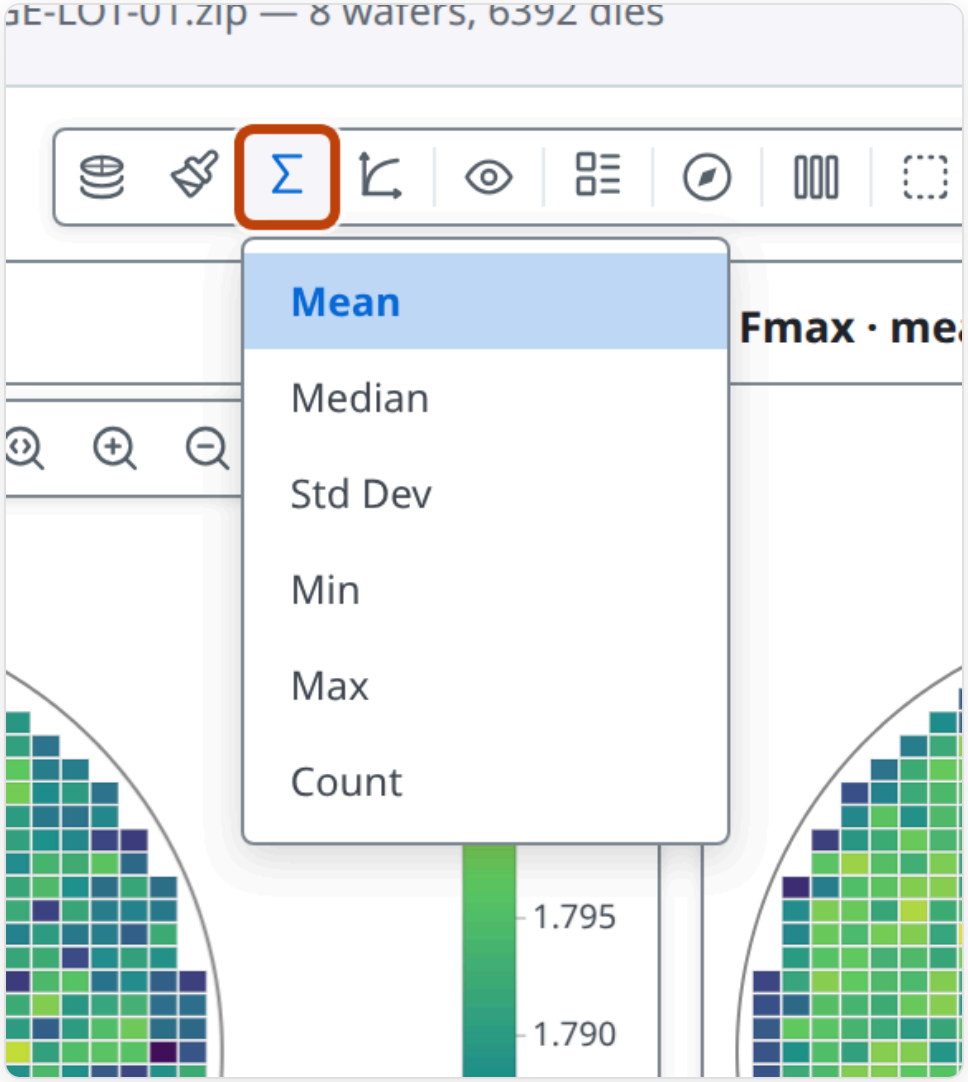
Stacked Test Values

Stacked Test Values draws one card per measured test (three here), with the values combined across the wafers. The header says how many wafers were stacked and how they were combined, so you always know what you are looking at.



Aggregation method

The **Σ** button picks how the wafers combine at each position. Choose the one that answers your question. With **Std Dev**, a bright position is where wafers disagree; with **Mean**, where they agree on a high value.



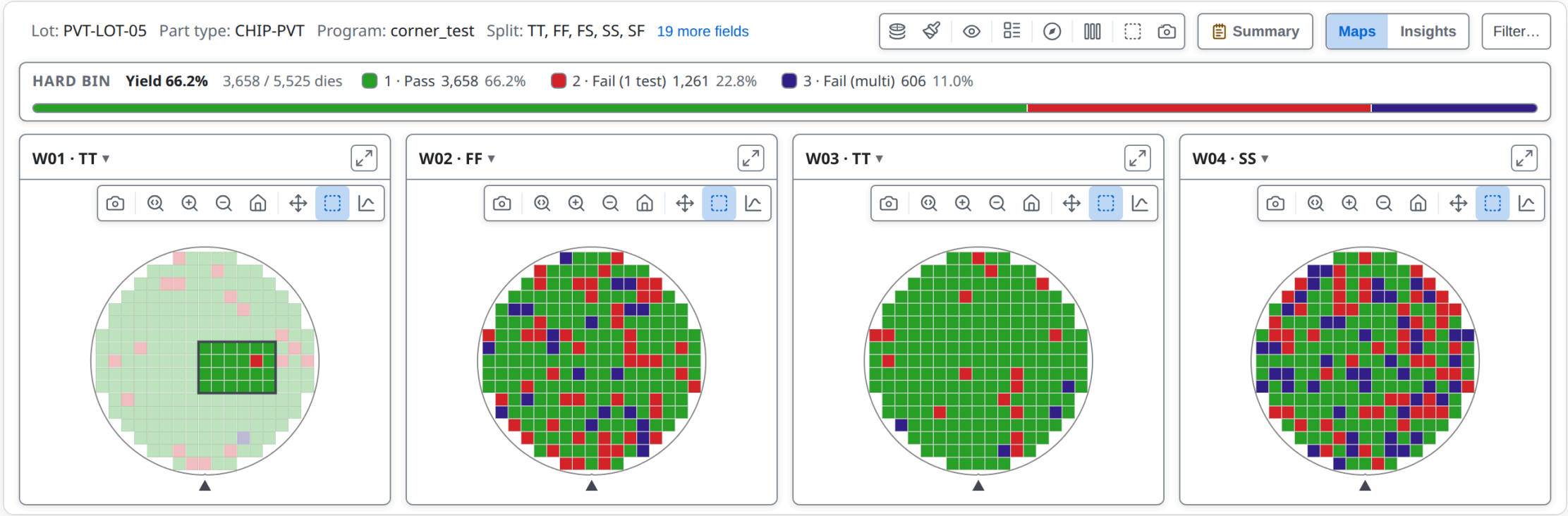
Wafers that are not stacked

Wafers with other pass bins or ring counts are not stacked, because their results would not be comparable.

Selecting across wafers

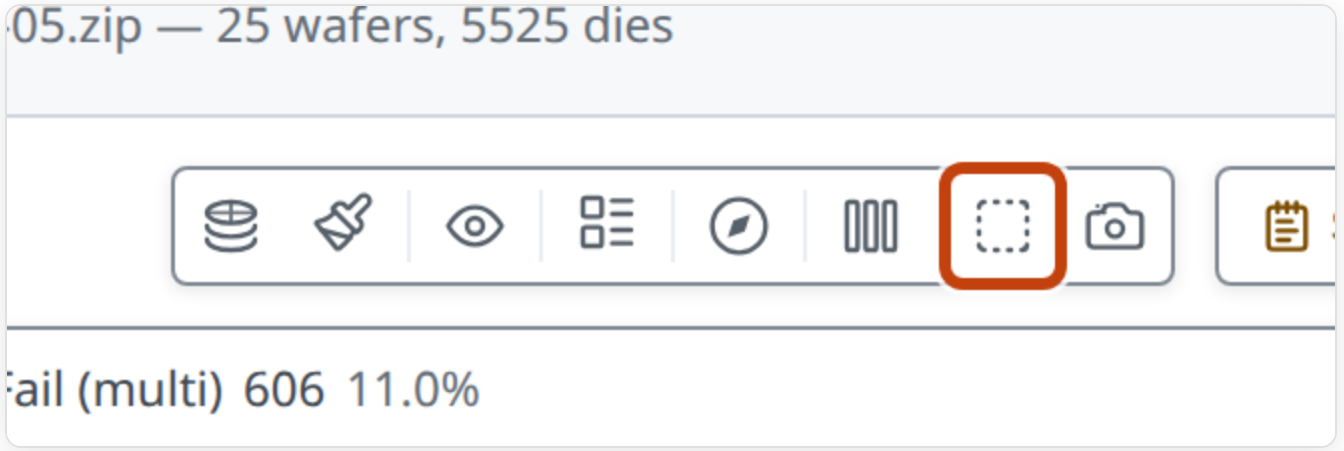
Select dies on one wafer

Selecting dies is how you ask "what is going on here?" about part of a wafer. Drag a box on a map: the dies inside it are selected and the rest fade. **Ctrl** or **Cmd** + click adds or removes a die; a click outside the wafer clears it. Lesson 08 charts a selection.



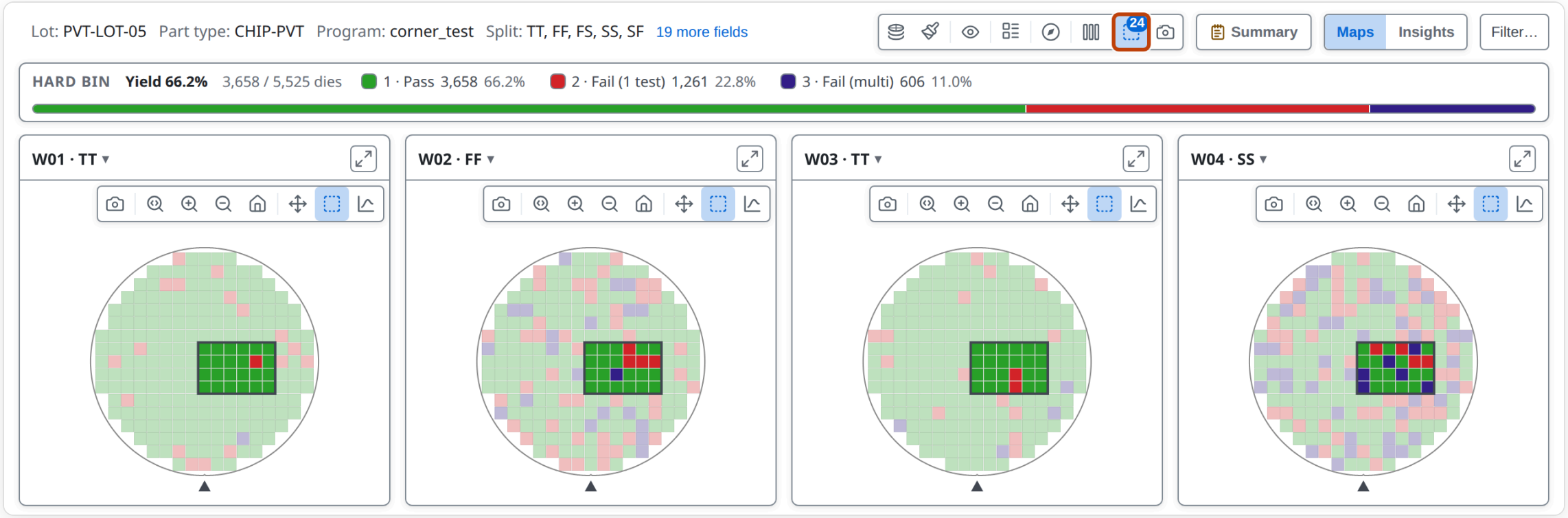
Select the same dies on every wafer

By default each card selects on its own. Turn this on when you want to check whether a region behaves the same way on every wafer.



One box, every wafer

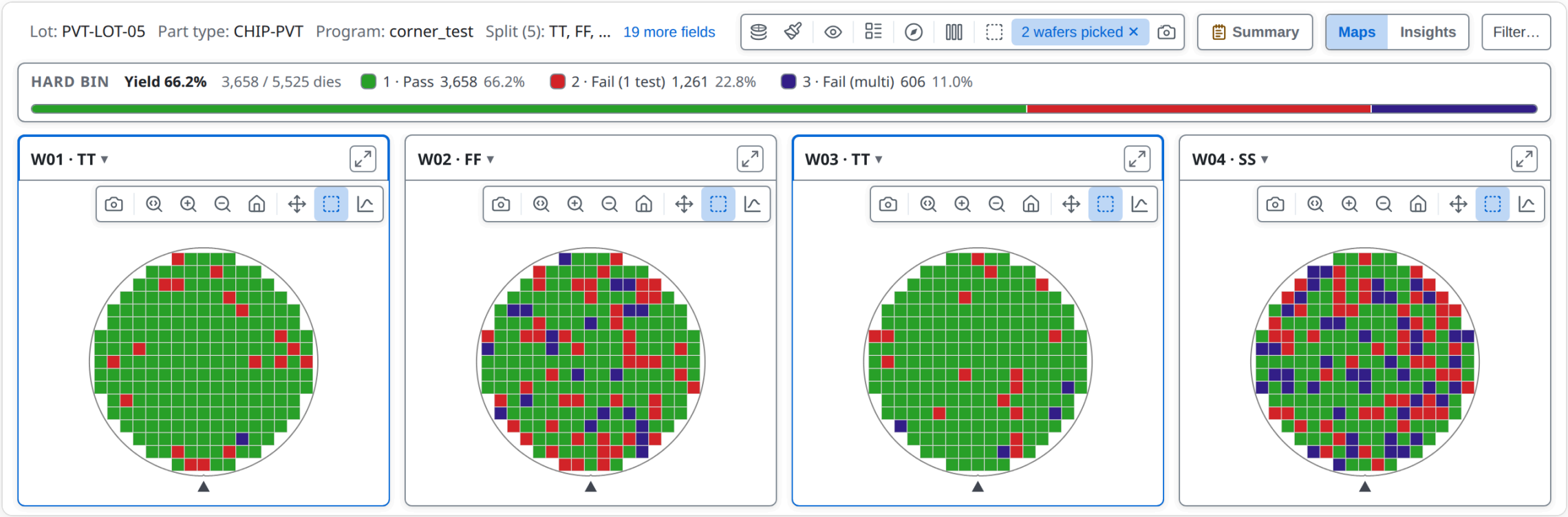
Drag a box on one wafer and the same positions are selected on every wafer. The badge counts them, and the button clears them.



(Charts of the selected dies are covered in lesson 08.)

Pick whole wafers

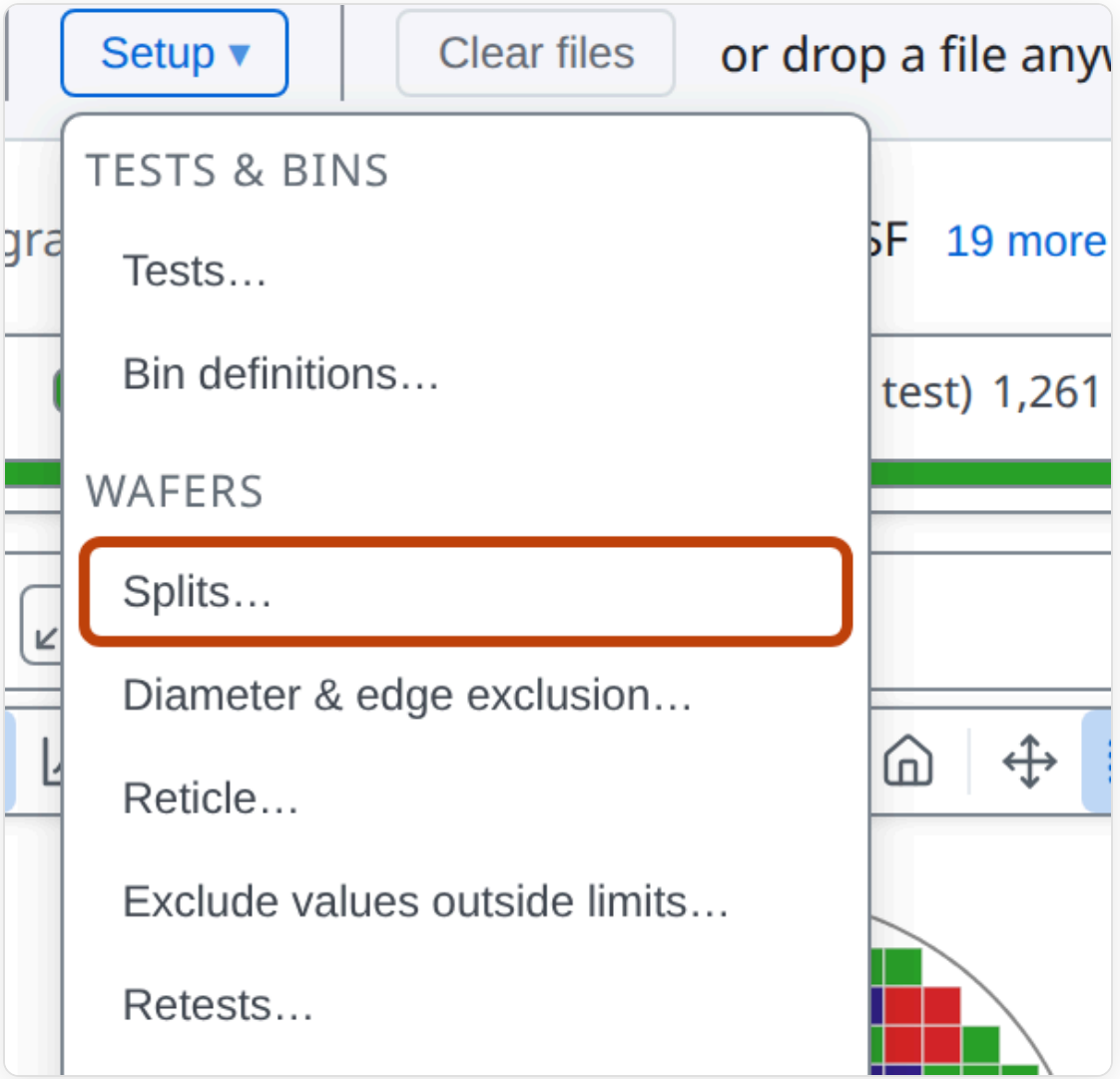
To look at some wafers rather than some dies, **Ctrl** or **Cmd** + click a card's header to pick that wafer. The toolbar counts the picked wafers. Right-click a picked card and the charts and tables cover every die of every picked wafer.



Wafer splits

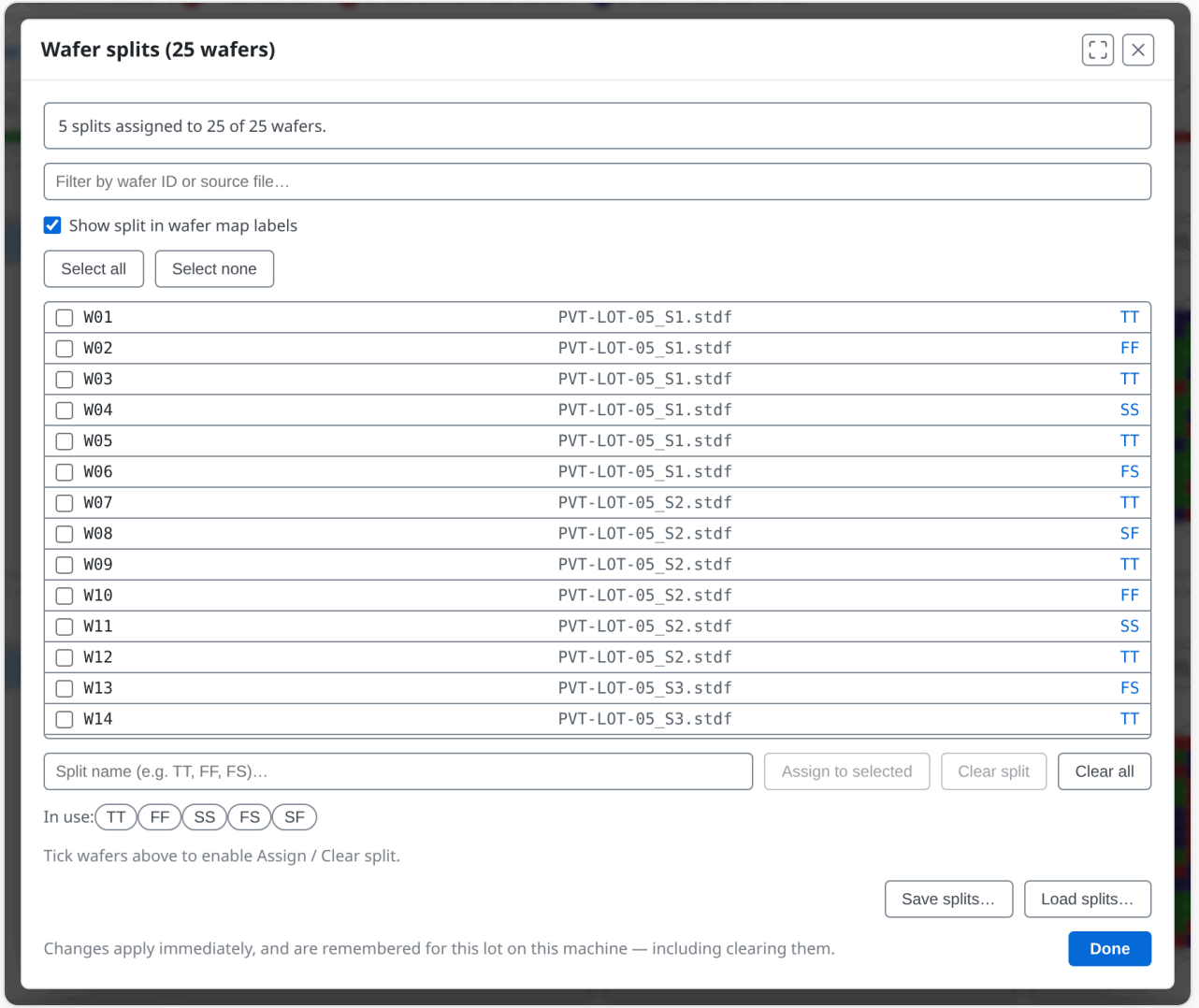
What a split is

A split is a name you give a wafer when the test data file doesn't include one, such as a process corner. It is how you tell tsmap which wafers belong together. Splits are what **Group by** compares in Insights (lesson 05). **Setup ▾ → Splits…** opens the dialog.



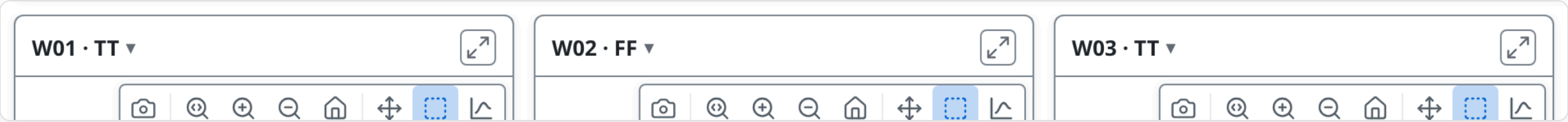
The Splits dialog

The banner at the top says where things stand. The sample lot's corners are already assigned, so you can see what a finished assignment looks like.



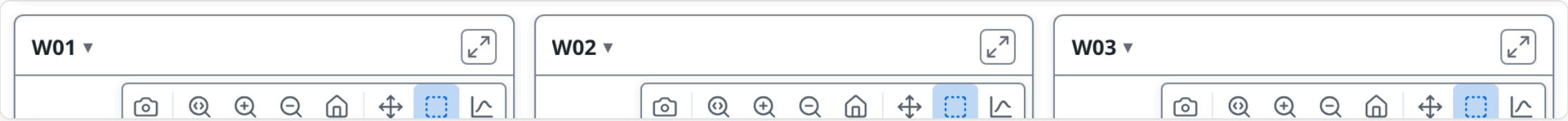
Splits in the labels

With **Show split in wafer map labels** ticked, the split follows the wafer ID on every card.



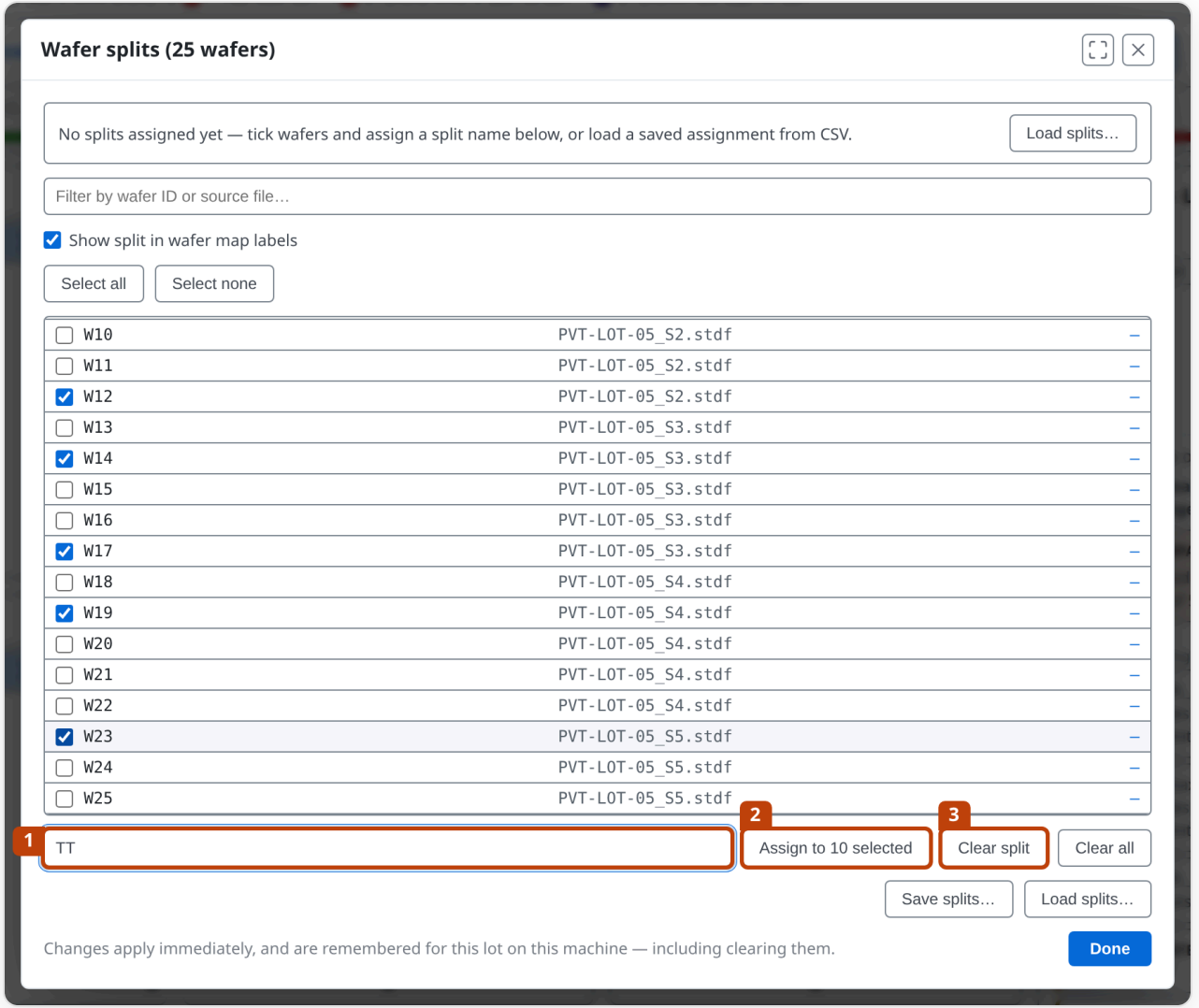
Plain wafer IDs

Untick **Show split in wafer map labels** and the cards show plain wafer IDs. The assignments are unchanged either way. The option only changes what the labels say.



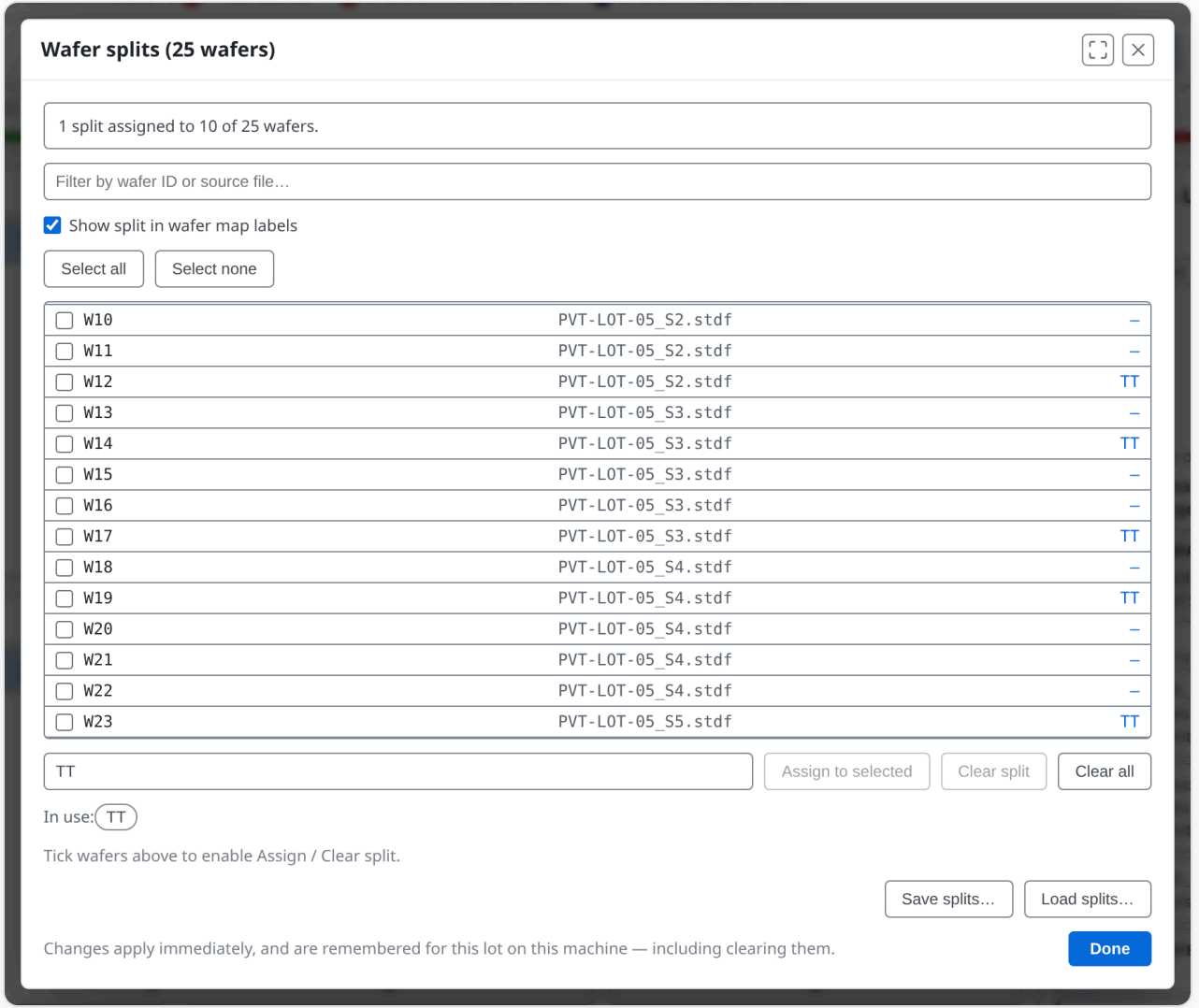
Assign a split

Tick wafers and type a name **1**, then **Assign to selected** **2**. **Clear split** **3** clears the ticked wafers; **Clear all** clears every wafer.



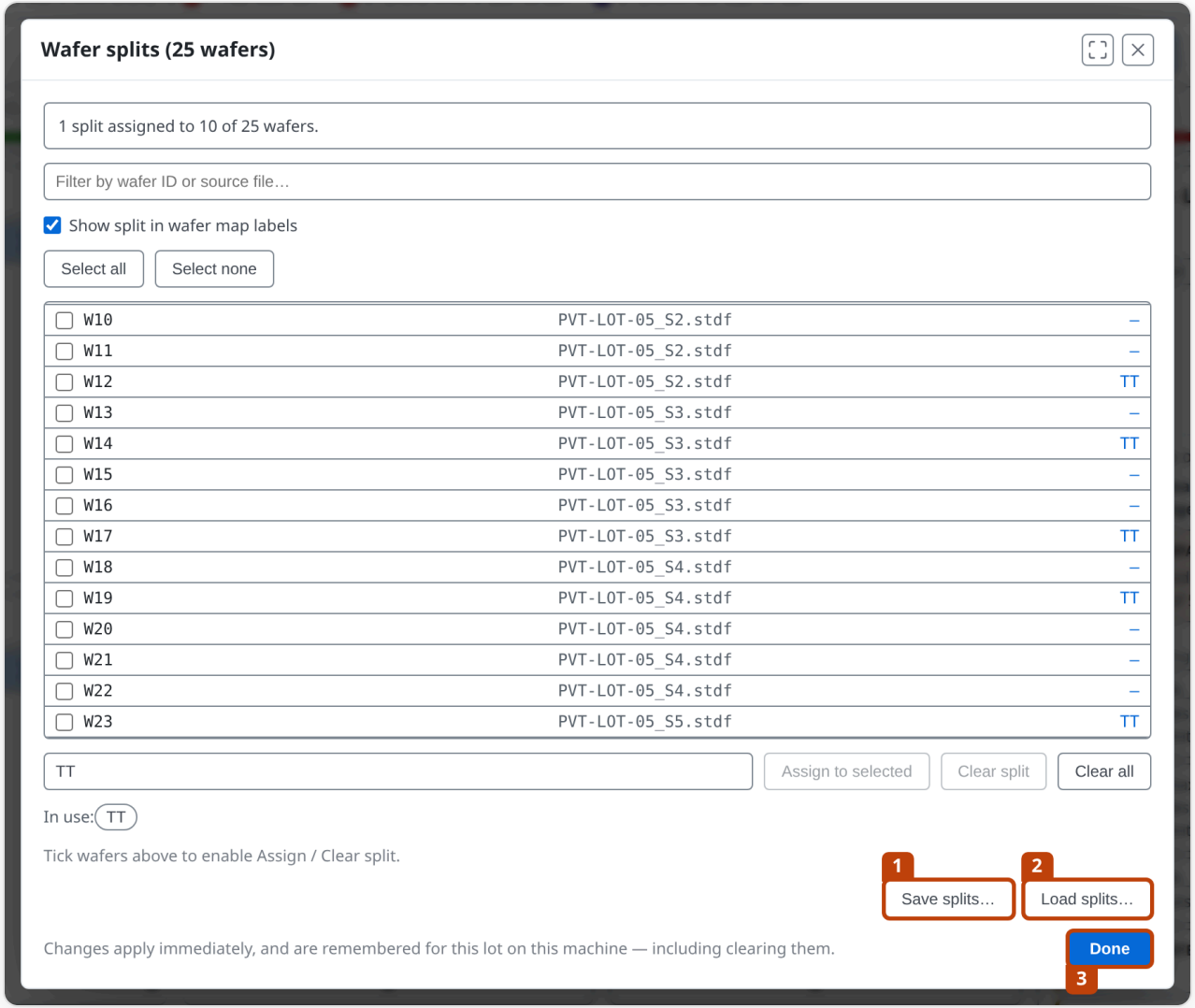
Reuse a name

Every action applies at once. Names in use appear beside **In use**: click one to reuse it, so TT and tt don't drift apart into two groups.



Save, load, finish

Save splits… 1 writes every wafer's split to a CSV. **Load splits…** 2 reads one back, matching by lot and wafer ID. **Done** 3 closes the dialog.



Remembered for the lot

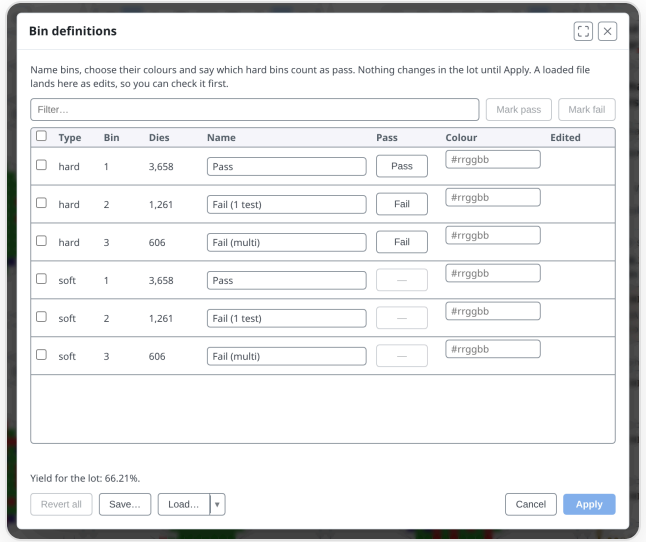
You do not have to assign splits again. Reopen the same lot and its splits come back, with the dialog open to show them. **Clear all** forgets them. A file with no lot ID cannot be matched, so save its splits to a CSV.

Naming and judging bins

Bin definitions…

Bin numbers mean little until they have names, and which bins count as a pass decides the yield of every wafer. **Setup ▾** → **Bin definitions…** opens a table of every hard and soft bin, with its die count, a name, whether a hard bin passes, and optionally the colour it is drawn in on the maps.

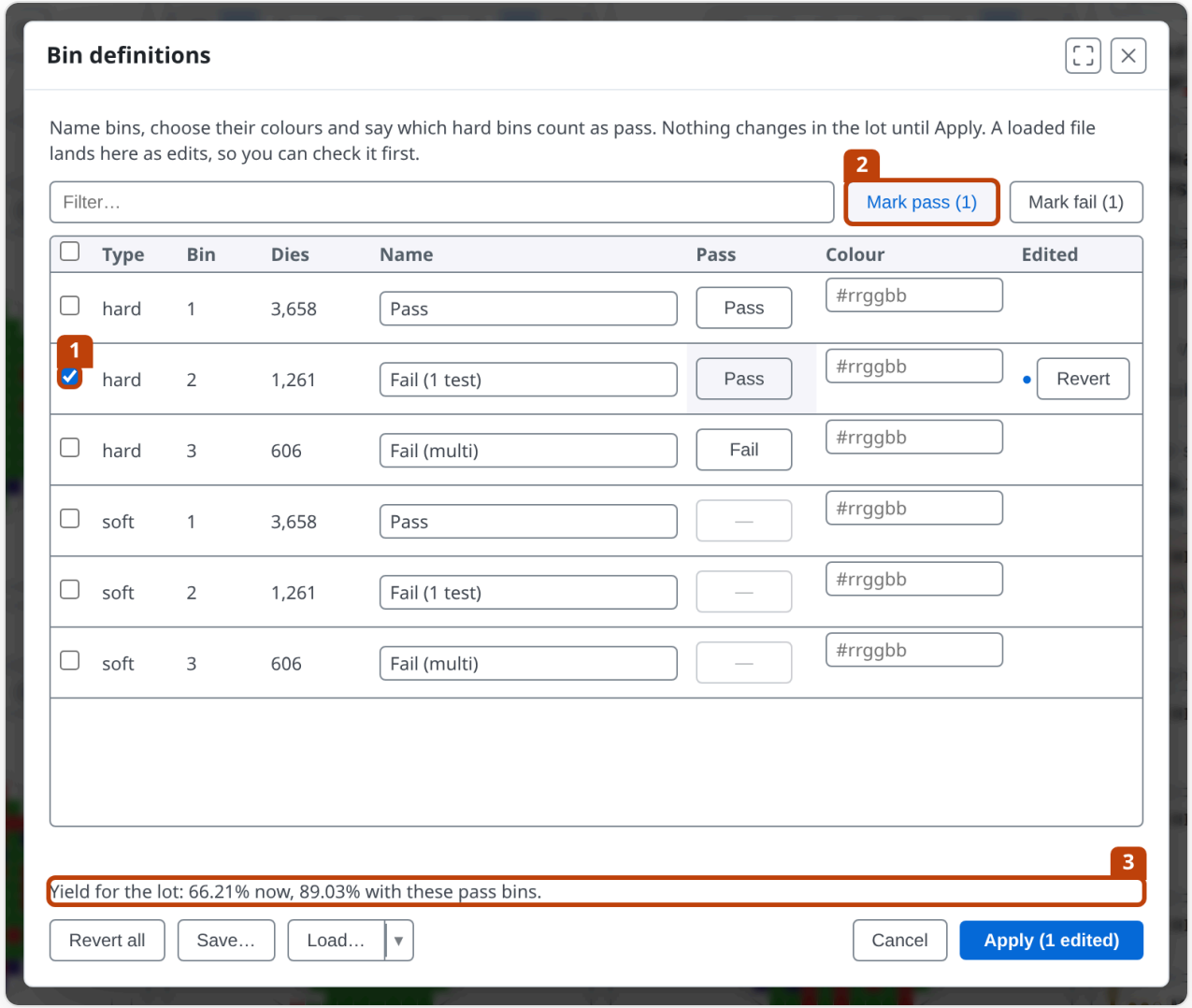
STDF and ATDF files carry names and pass flags of their own, so the table starts filled in. Edit a name or a colour in its cell. Nothing changes in the lot until you press **Apply**.



Change what passes

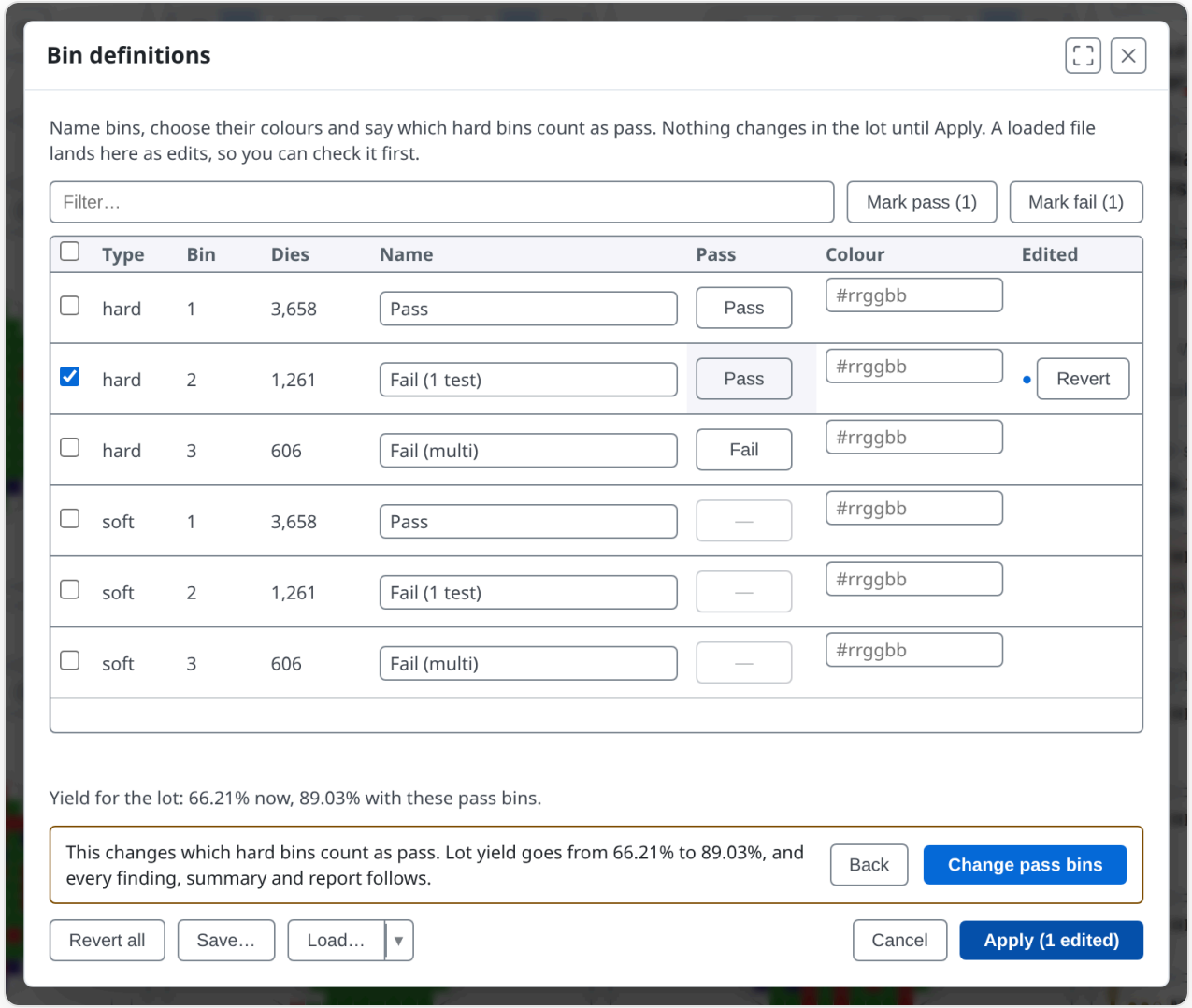
1 Tick hard bins, then **2** **Mark pass** or **Mark fail**. Soft bins have no pass flag.

3 The window shows the lot's yield now and with the new pass bins: here 66.21% becomes 89.03% if bin 2 counts as a pass.



Confirm a pass change

A changed pass flag changes the lot's yield and every finding, so **Apply** asks first, with both figures. **Change pass bins** goes ahead, **Back** returns to the table, and **Cancel** leaves the lot untouched. Files of bin definitions are in lesson 12.



One wafer in its own window

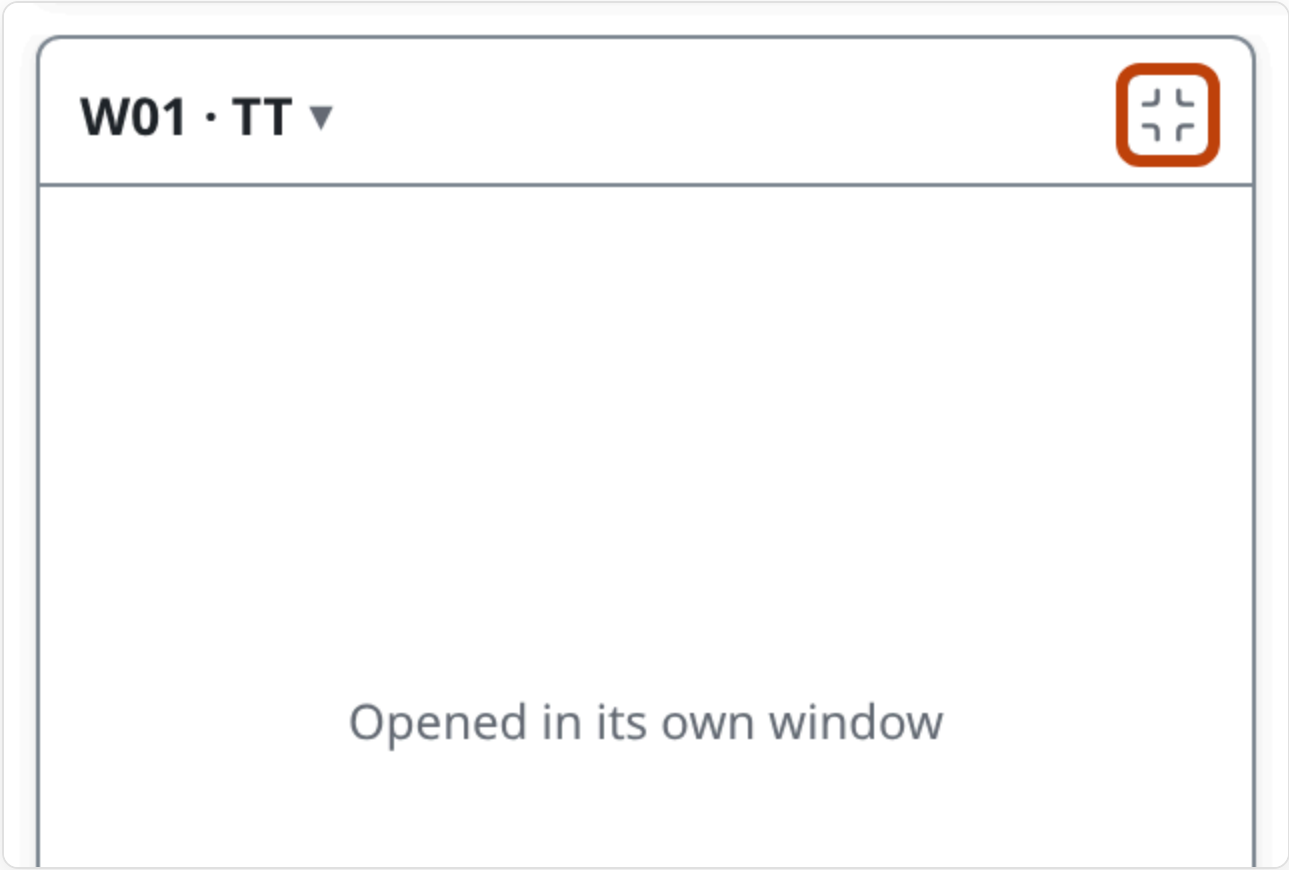
Detach a wafer

When one wafer needs a closer look, **Open full view**, the expand button in a card's header, detaches it into its own window with the full single-map toolbar.



Bring it back

When a wafer is detached, its card becomes a placeholder. Its **Reattach to gallery** button puts the wafer back; closing the window does the same.



LAB Try it yourself

1. Open `EDGE-LOT-01` in the web app
2. **Plot mode** → **Stacked Hard Bins**: on the **Pass** card, where is the count lower?
3. **Stacked Test Values**, then **Σ** → **Std Dev**
4. Back to **Hard Bin**: **Select the same dies on every wafer**, drag a box
5. **Setup ▾** → **Splits…**: tick W01 and W03, assign a name, then **Clear all**
6. **Setup ▾** → **Bin definitions…**: **Mark pass** on a bin, read the yield, **Cancel**

ANSWERS

Check your results

2. The Pass count drops in a **ring at the wafer's edge**, and the failing bins' cards show the same ring faintly. One wafer alone looks like scattered failures; stacked, the ring is plain.
3. The window shows the lot's yield now and with the new pass bins. **Cancel** leaves the lot as it was.

Recap

- **Stacked modes** turn a lot into one map per bin or test, so what repeats stands out
- **Select the same dies** reads one region across every wafer
- **Splits** name wafers the file doesn't, and show on every label
- **Bin definitions…** names bins, colours them and chooses which hard bins pass, with the yield shown before you confirm

The next lesson moves from maps to charts, and compares groups of wafers such as these splits.

More in the wafer map guide



Next lesson

05 · Insights: where yield is lost →

Which wafers, bins and tests lose yield, and what divides it.



Insights: where yield is lost

Lesson 05

Learn tsmap

In this lesson

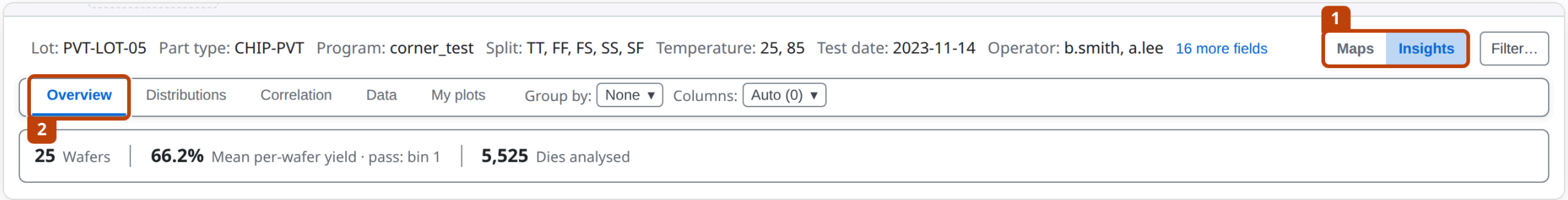
Maps show you where on a wafer dies fail. Charts show you which wafers, bins and tests are responsible. This lesson walks through the charts that answer "where is the yield going?"

- Find which wafers, bins and tests lose yield
- Use the buttons and menus every chart shares
- Compare groups of wafers, such as process splits

Where yield is lost

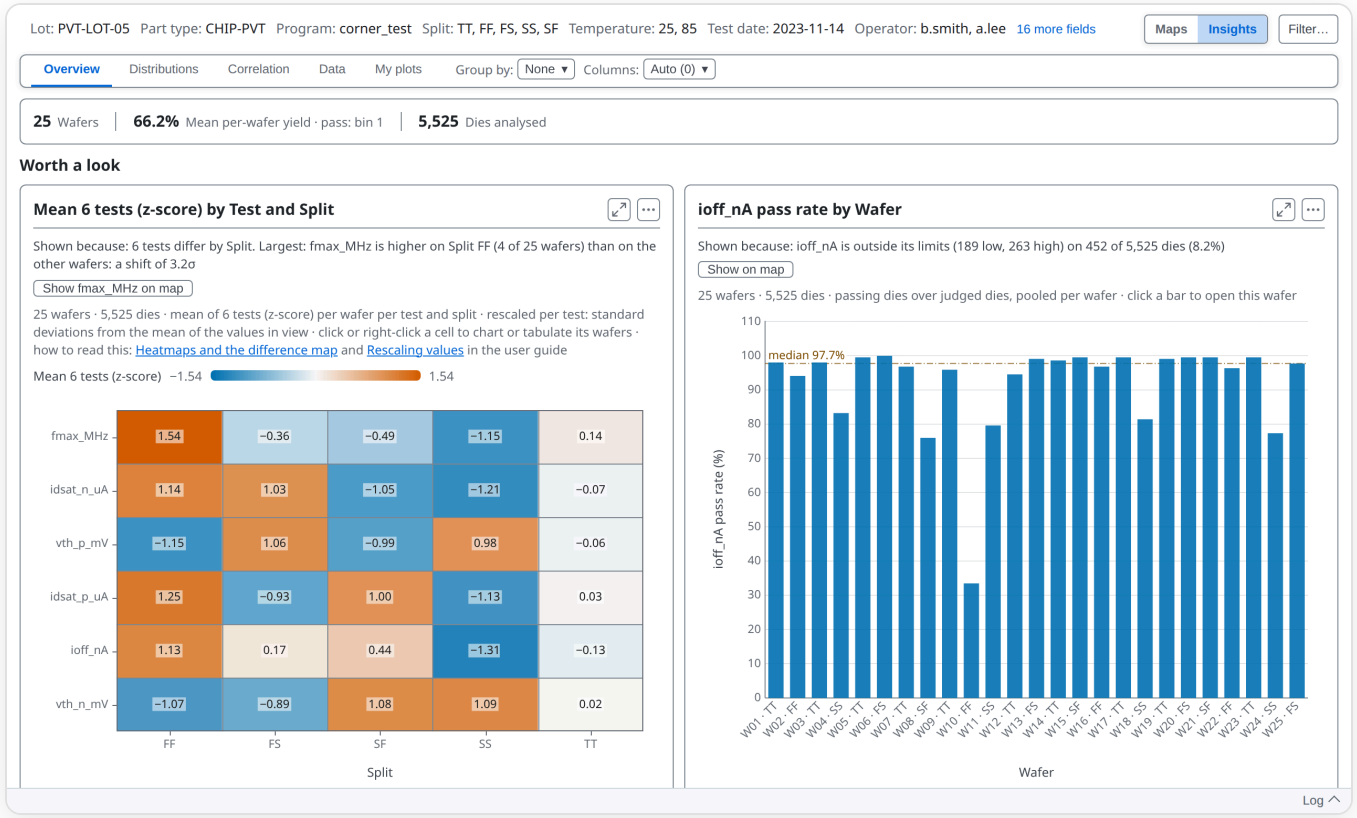
From maps to charts

The **Maps | Insights** switch 1 swaps the wafer view for charts of the same dies. **Overview** 2 is the first tab. Its tiles state the population, so you know which dies the charts describe.



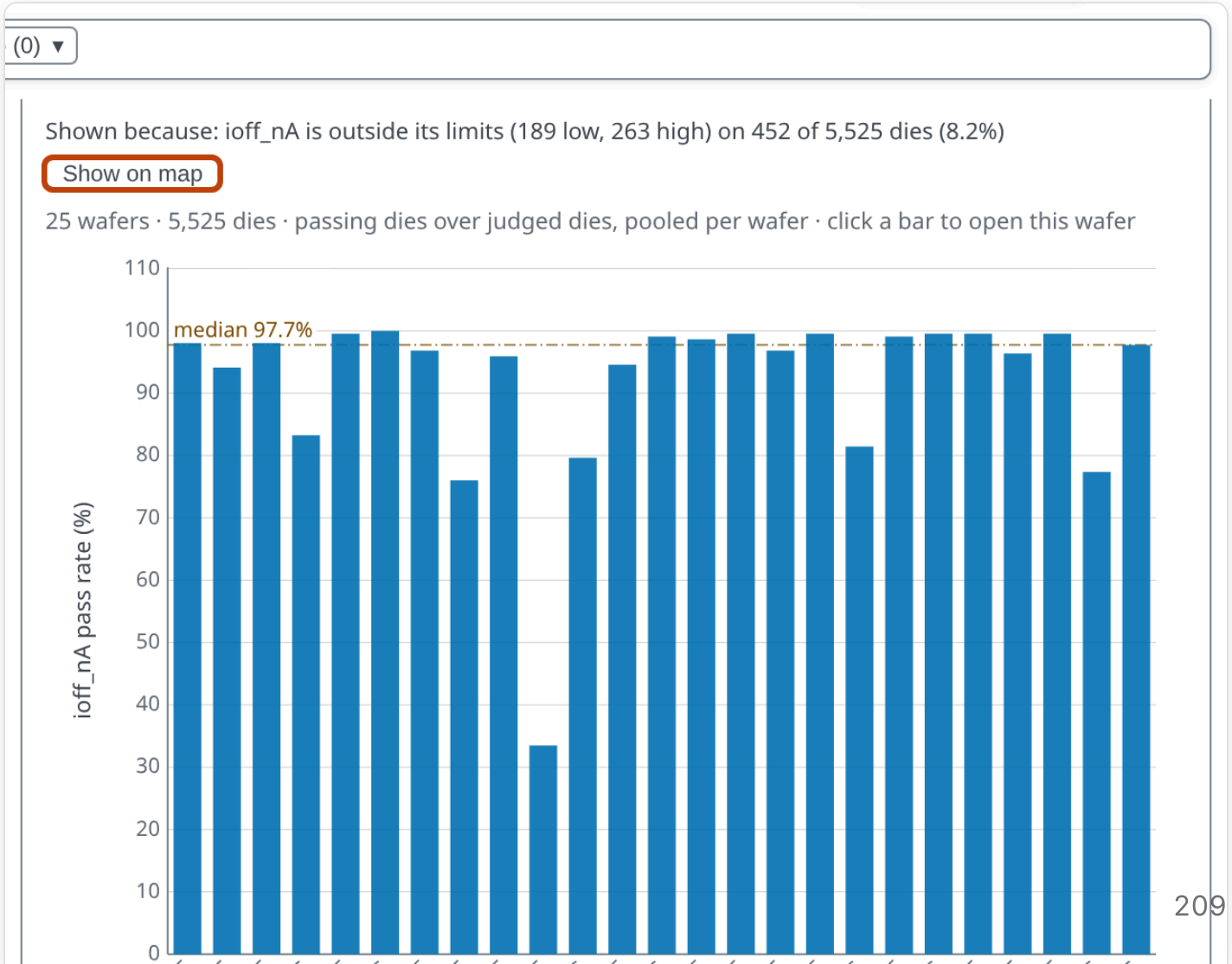
The Overview

Read it from the top. **Worth a look** comes first when something stands out, then **What divides yield**, then the standing cards: yield, bins, pass rates and regions. Scroll down: every card is a chart you can click.



Worth a look

The same items as **What stands out** (lesson 03), each drawn as the chart that shows it. Each card starts with a line saying why it is shown. **Show on map** opens the map that shows that item. On a card about groups of wafers that leads with a test, the button names that test, such as **Show fmax_MHz on map**. A lot with nothing to show has no Worth a look, and its Overview starts with the

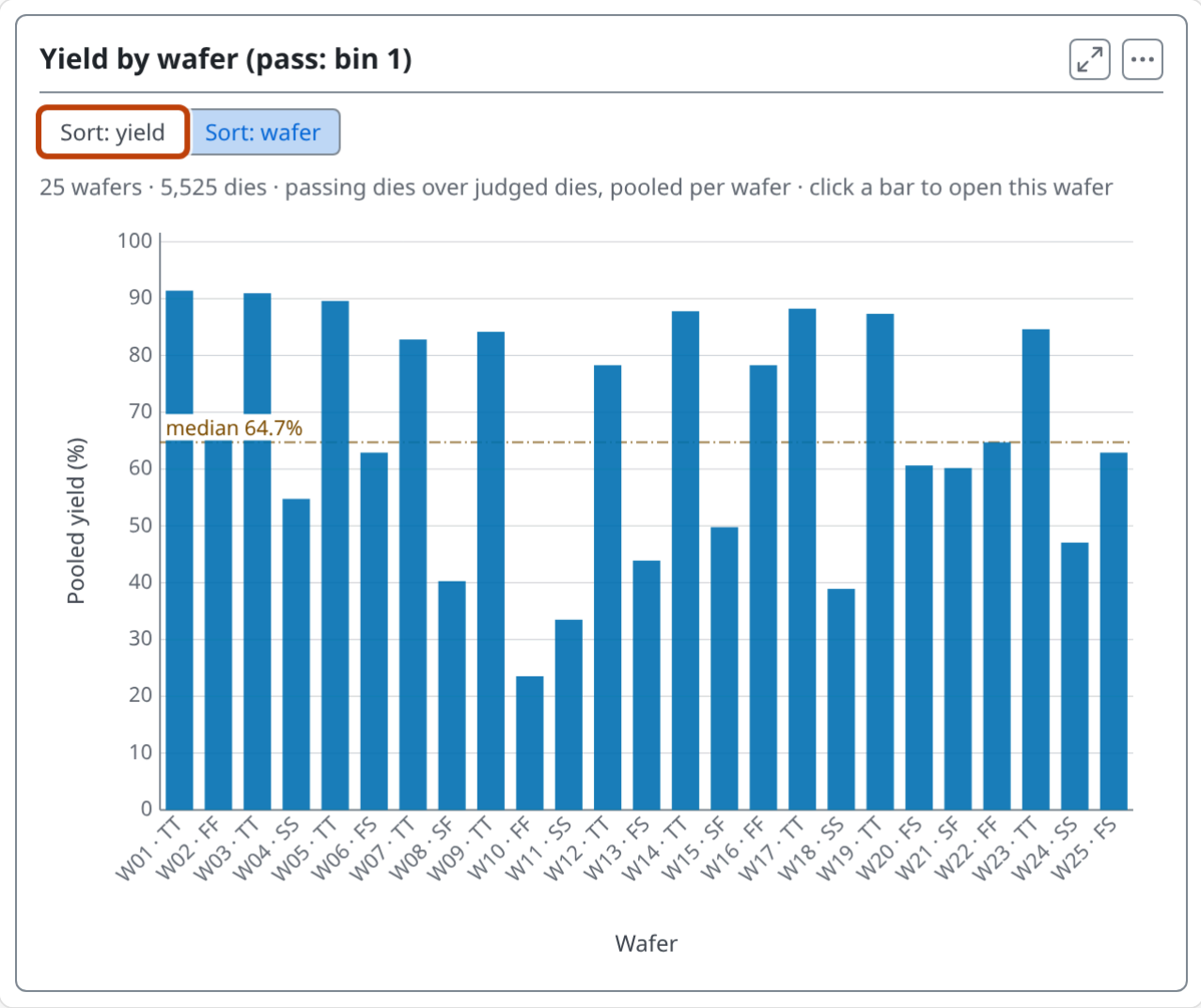


Cards about groups of wafers

A card about groups of wafers has no **Show on map**, because it has no place on the map. It is a bar of yield for each group, such as each split. When Insights is already grouped by that field, the card is left out, because the yield card shows the same bars.

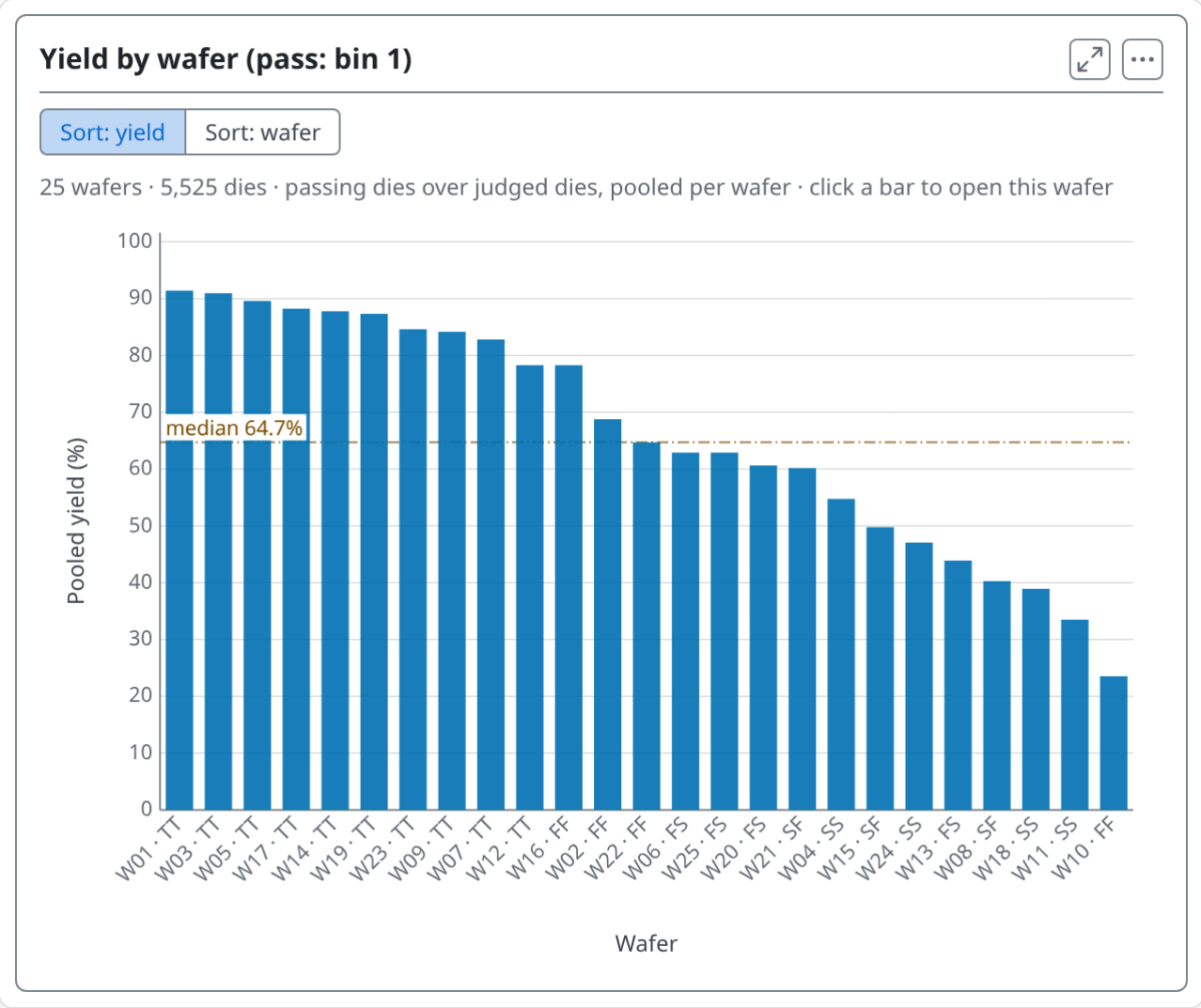
Yield by wafer

Start here to see which wafers are weak. Each wafer is one bar, with the median as a line. **Sort: yield** 1 orders the bars from highest to lowest yield. Click a bar to open that wafer.



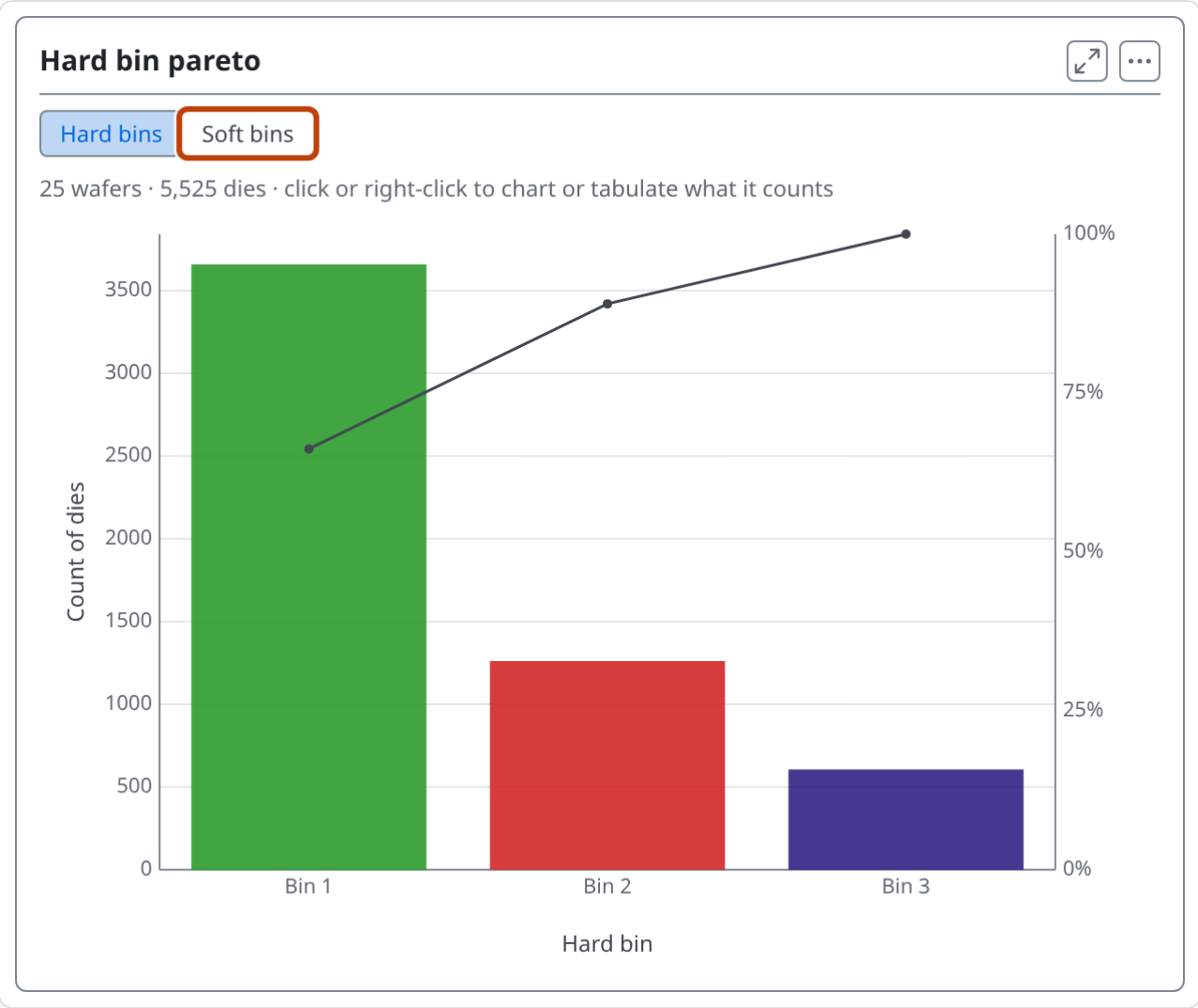
Sorted by yield

With **Sort: yield** on, the bars run from highest yield to lowest, so the weakest wafers are at the right: W10 (FF), then W11 and W18 (both SS). (The Wafer Yield list in lesson 03 sorts the other way, lowest first.)



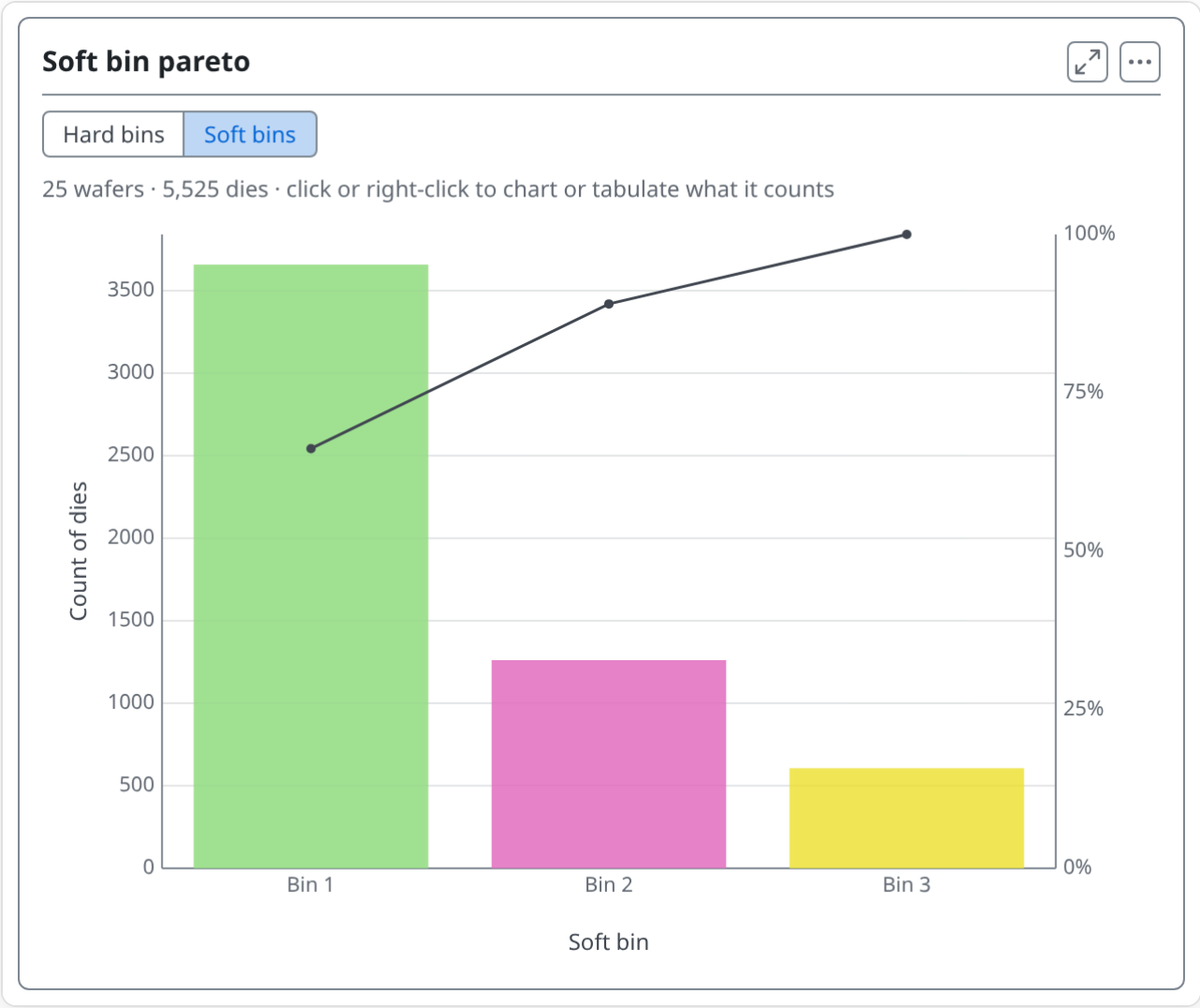
Bin pareto

The bin pareto shows where the lost dies went. A pareto chart is one bar per bin, largest first, with the running share of all dies as a line. The biggest bars are the ones to chase first. **Hard bins** or **Soft bins** switches the bin type. Click a bar to chart or tabulate its dies.



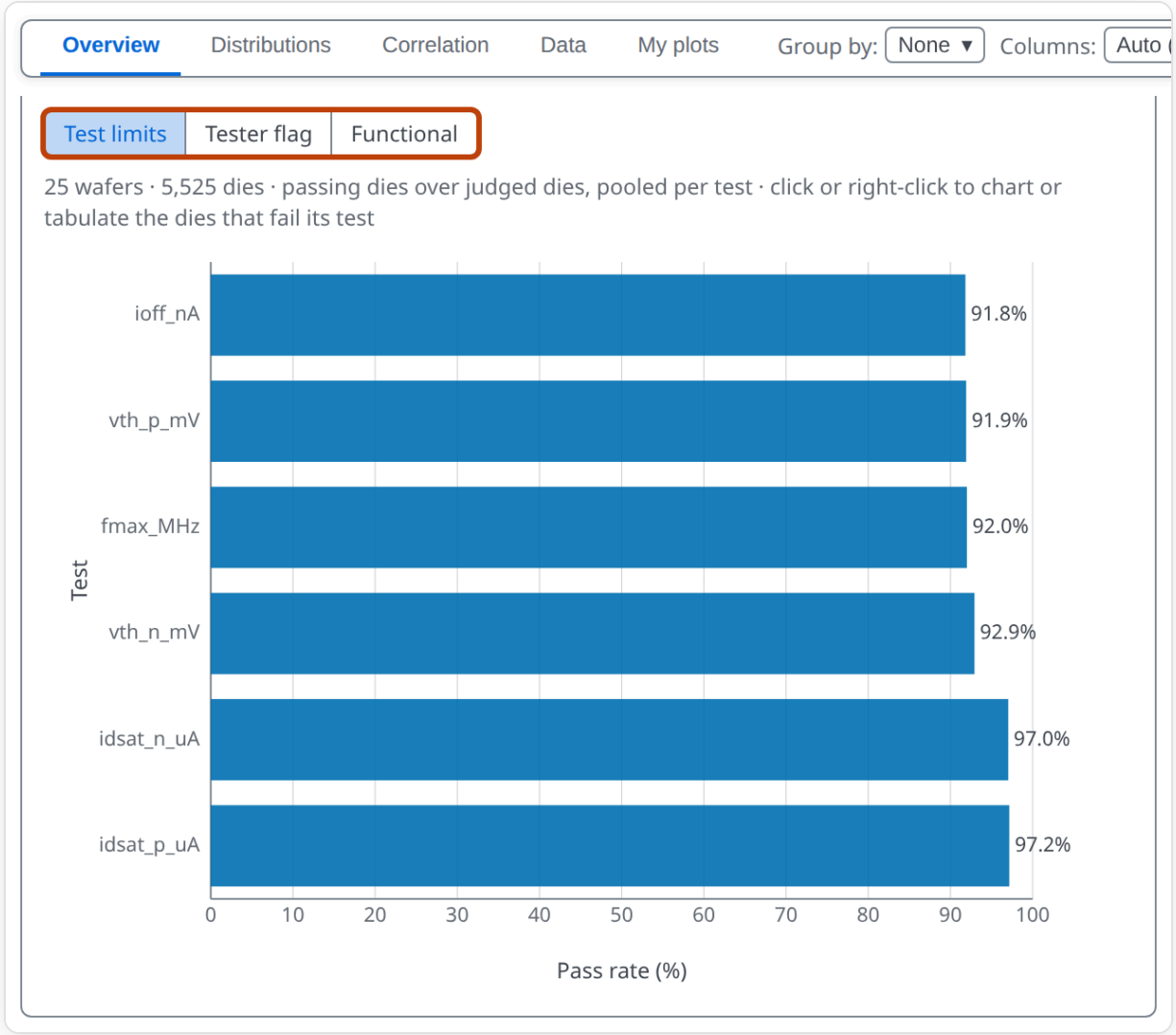
Soft bins

Soft bins (lesson 00) are numbered separately from hard bins, so the two charts can differ; in the sample lot they happen to match.



Pass rate by test

The share of judged dies that pass each test, lowest first, so the tests that cost you most are at the top. The three buttons choose how a die is judged.



Tester flag

Test limits judges the measured value against the limits. **Tester flag** uses the pass or fail the tester recorded. When the two disagree the card counts the dies judged differently: 215 in the sample lot. A large count is worth raising with whoever owns the test program.



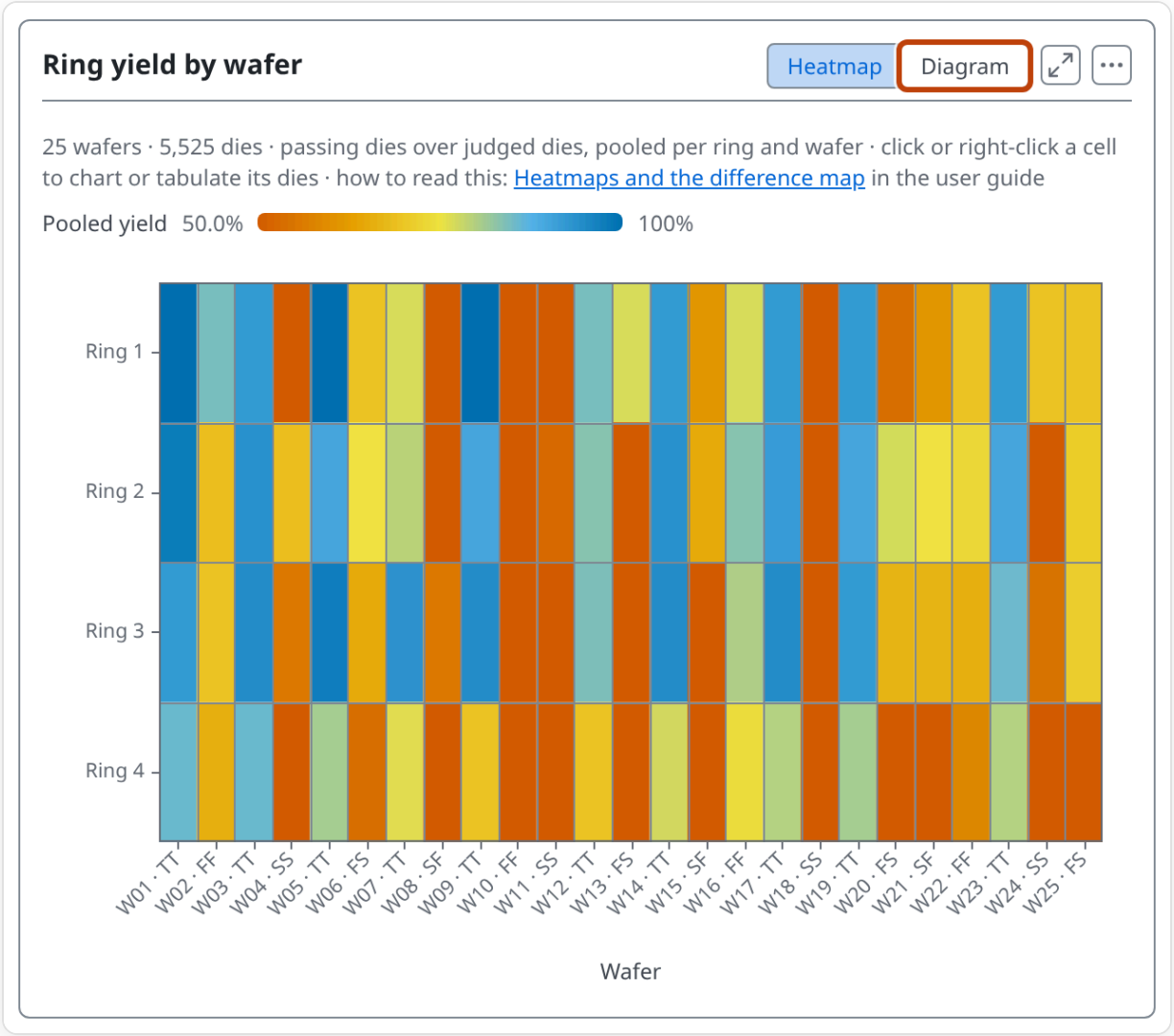
Functional tests

Functional covers tests that only pass or fail, such as a scan chain.



Ring yield by wafer

Is the loss at the edge on every wafer, or just on a few? This grid answers it: a row for each ring and a column for each wafer, each cell coloured by its yield. Ring 1 is the centre and the last ring the edge. **Heatmap | Diagram** 1 in the card's header chooses how the rings are drawn.



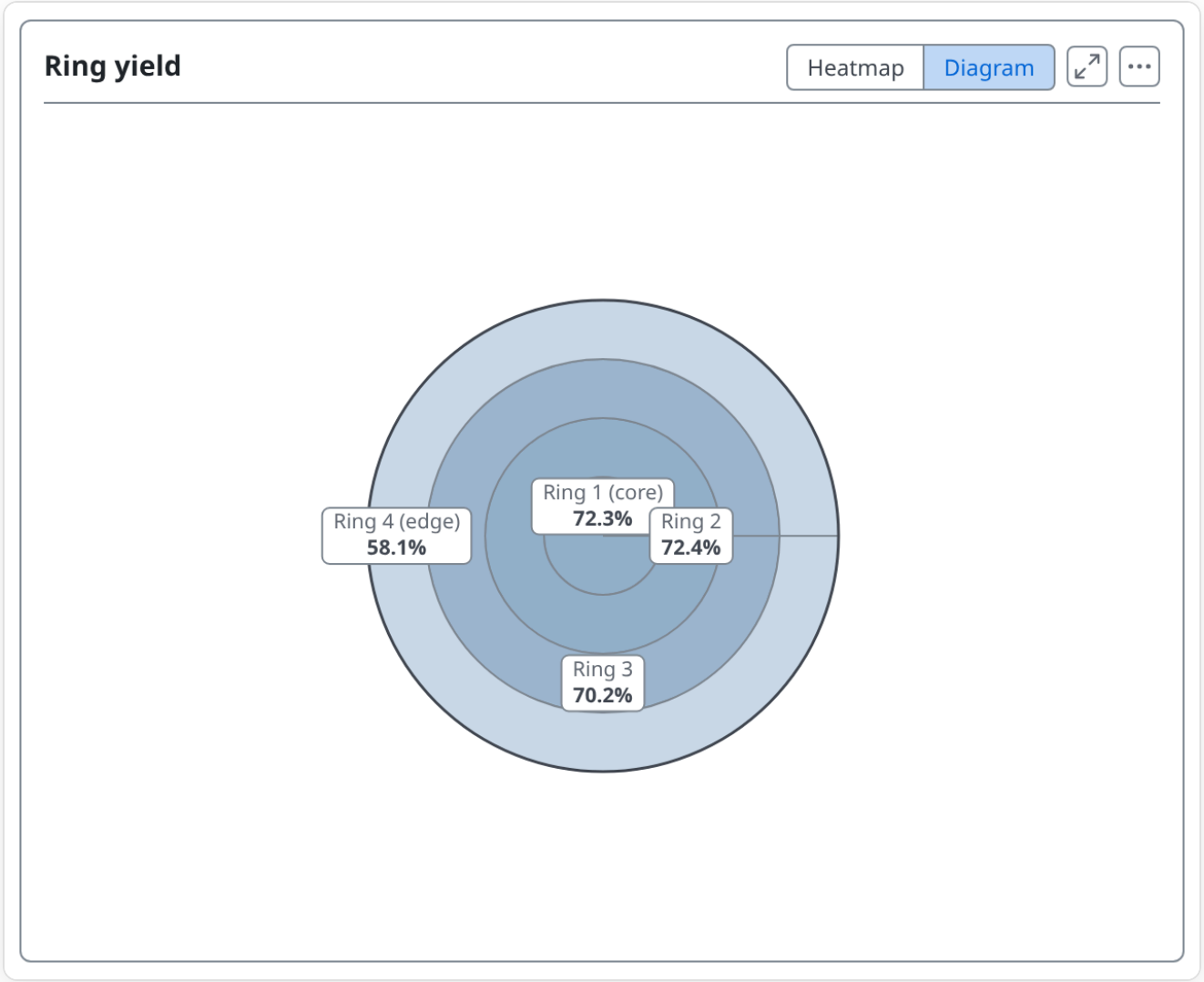
Reading the ring grid

Look for the shape of the dark cells.

- A dark row across every column is a process pattern: that ring loses yield on every wafer
- A dark cell in one column is one wafer
- Click a cell for the dies in that ring on that wafer

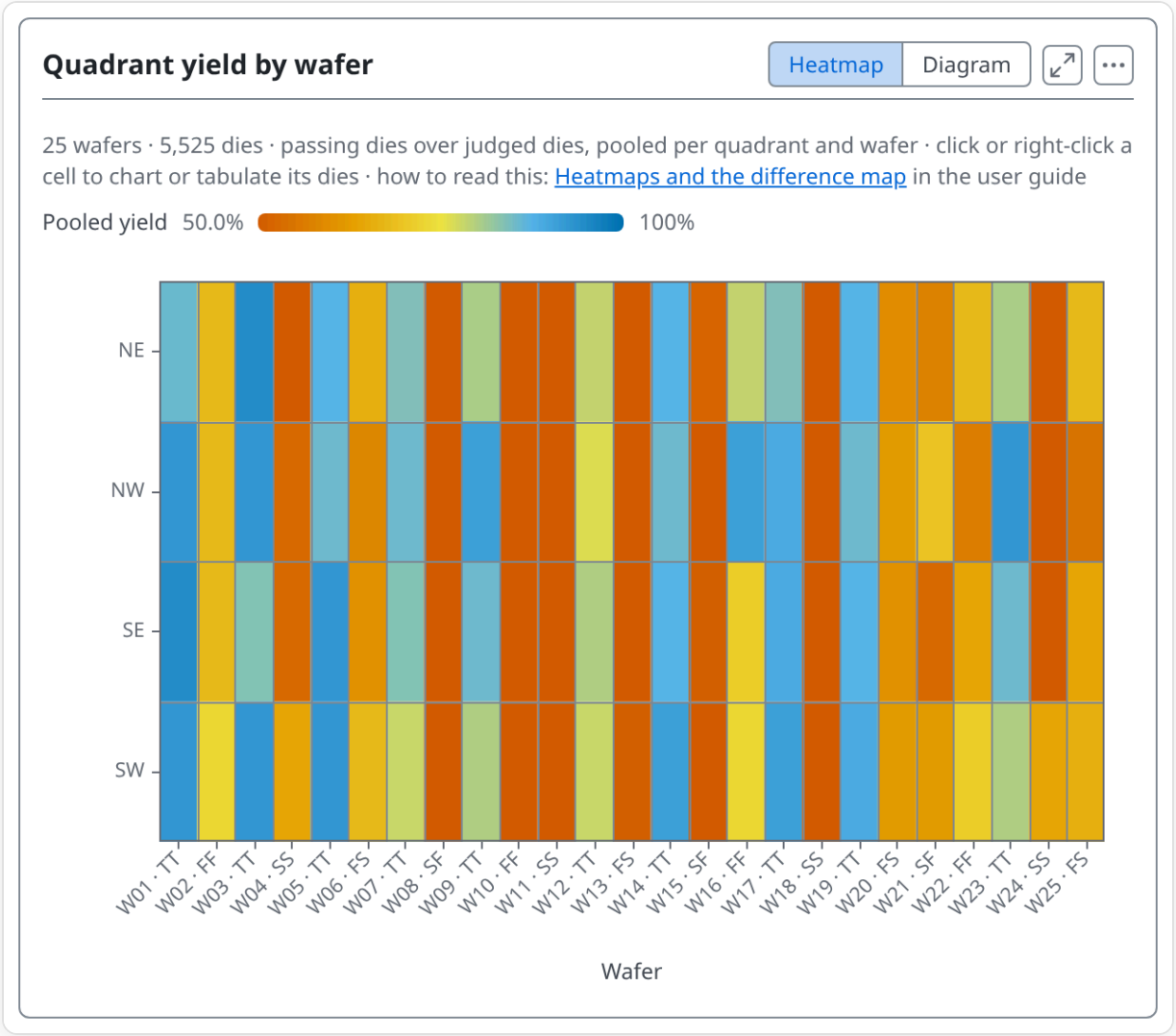
Ring yield as a diagram

Diagram draws the same rings as a wafer, pooled over every wafer, with each ring labelled with its yield. Use it to see the pattern across the wafer at a glance; use the heatmap to see which wafers it comes from. Click a region for its dies.



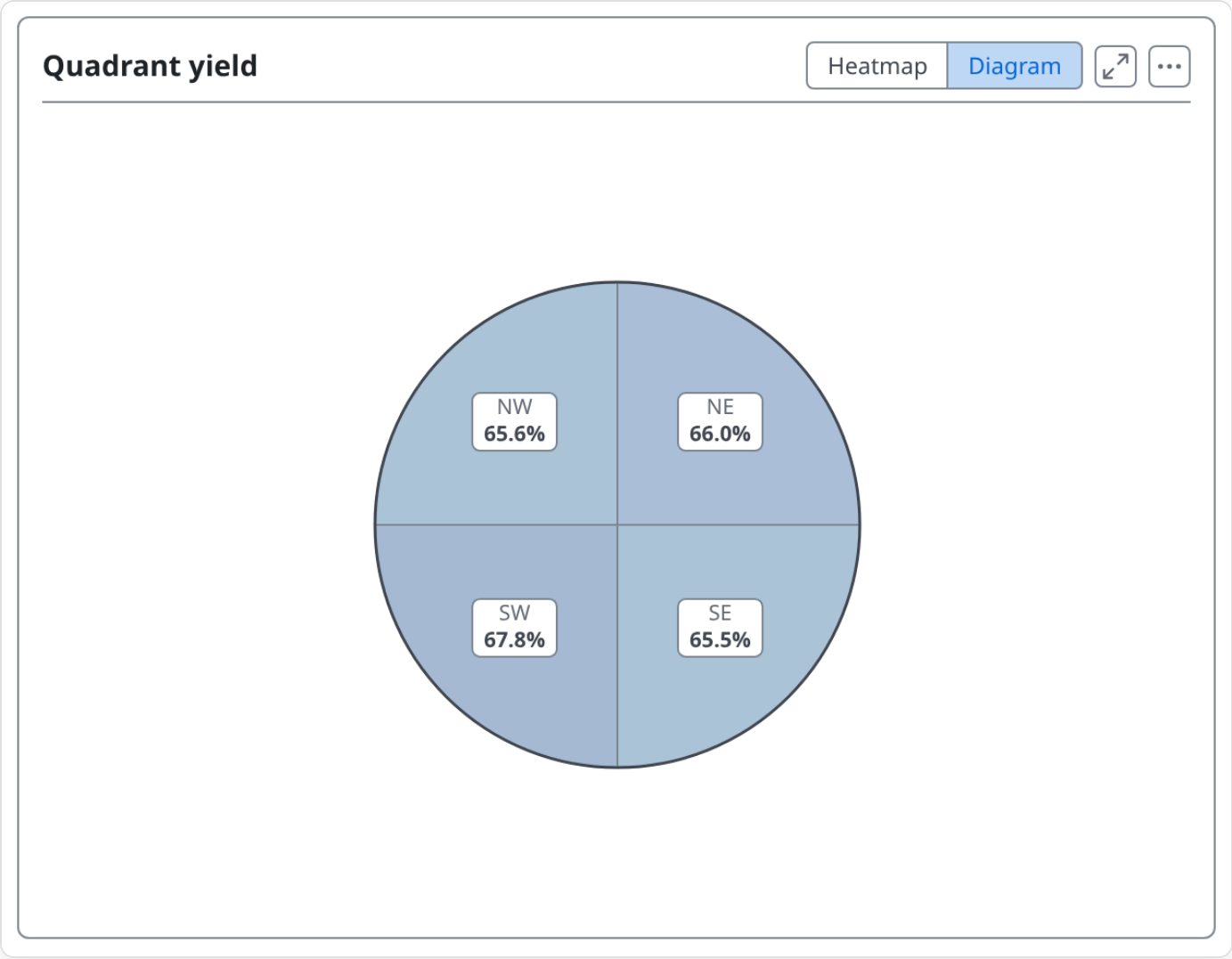
Quadrant yield by wafer

Quadrant yield by wafer is the same grid, for the four quadrants. A quadrant that is low on every wafer points at something one-sided in the process; one that is low on a single wafer points at that wafer.



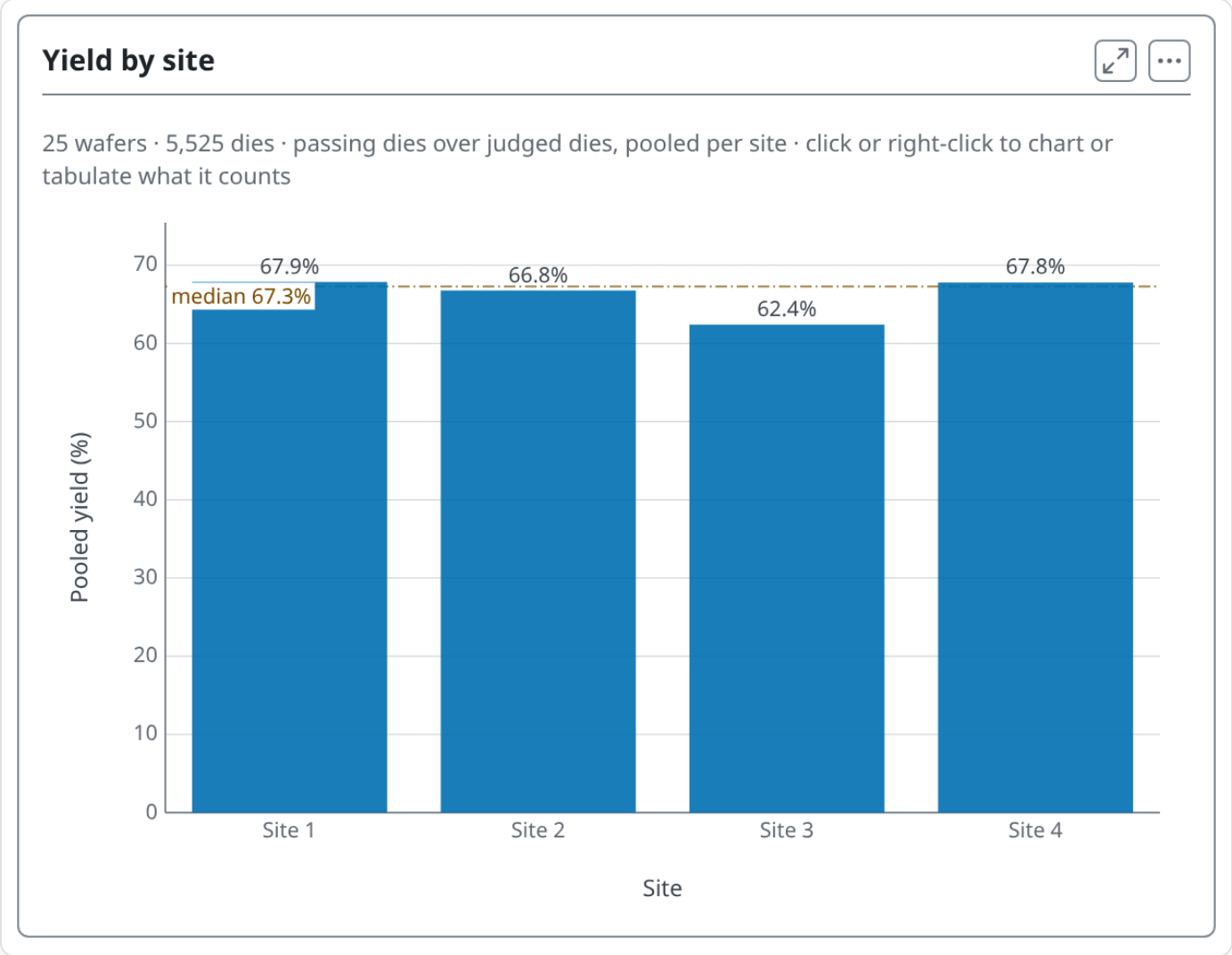
Quadrant yield as a diagram

With **Diagram** chosen, each quadrant is labelled with its yield, pooled over every wafer. A quadrant well below the rest shows a one-sided loss. Click a region for its dies.



Yield by site

Many testers probe several dies at once, each through its own numbered **site**. When a lot's dies come from two or more sites, this card shows the yield of each site over every wafer, so you can tell a weak probe site from a weak wafer.



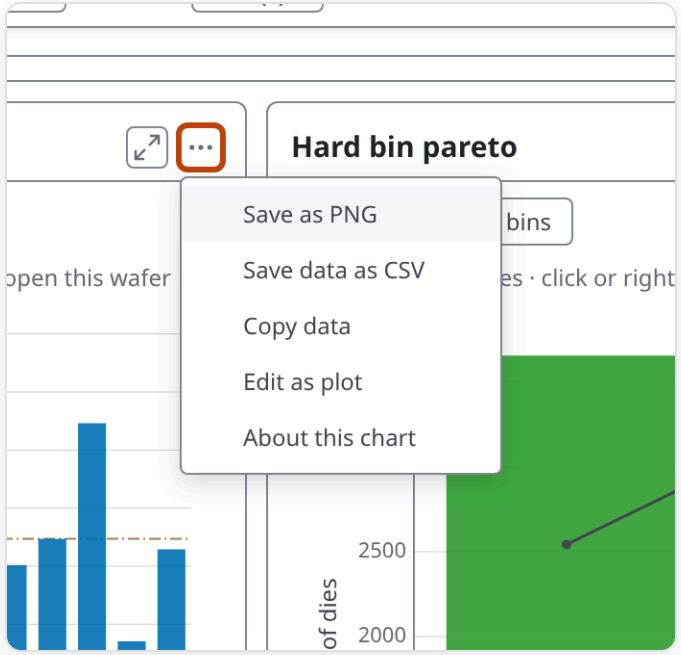
Reading yield by site

- With three or more sites, the median is drawn as a line to compare each site against
- A site that is low on every wafer points at that site's probe card, not at the wafers

Every chart's buttons

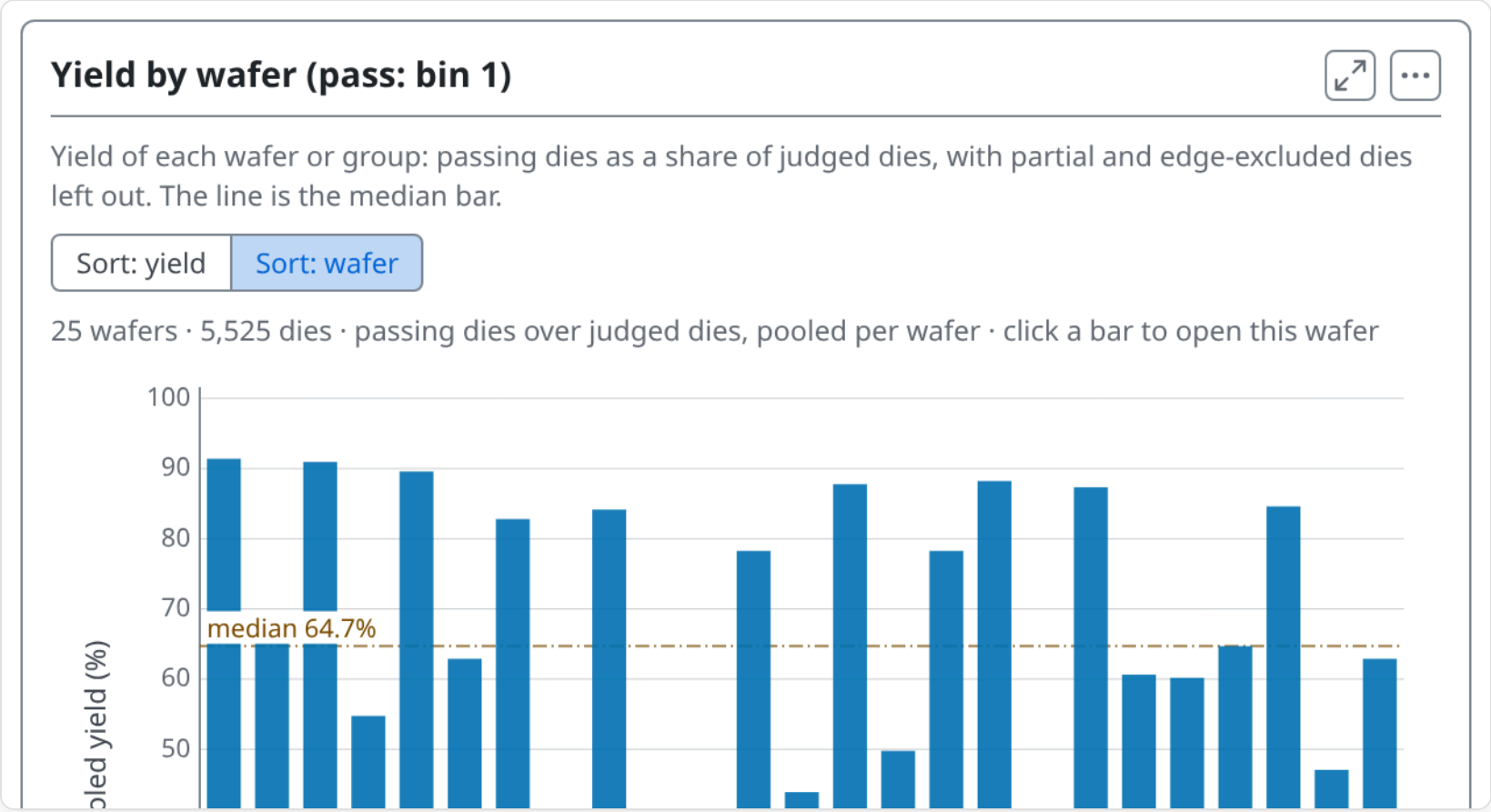
The ⋯ menu

Every chart has the same ⋯ menu, so once you know it you know them all. **Save as PNG** saves the picture. **Save data as CSV** saves the numbers behind it, and **Copy data** puts them on the clipboard as tab-separated text to paste into a spreadsheet. **Edit as plot** opens the chart as a plot of your own (lesson 10), and **About this chart** adds a line saying what it shows.



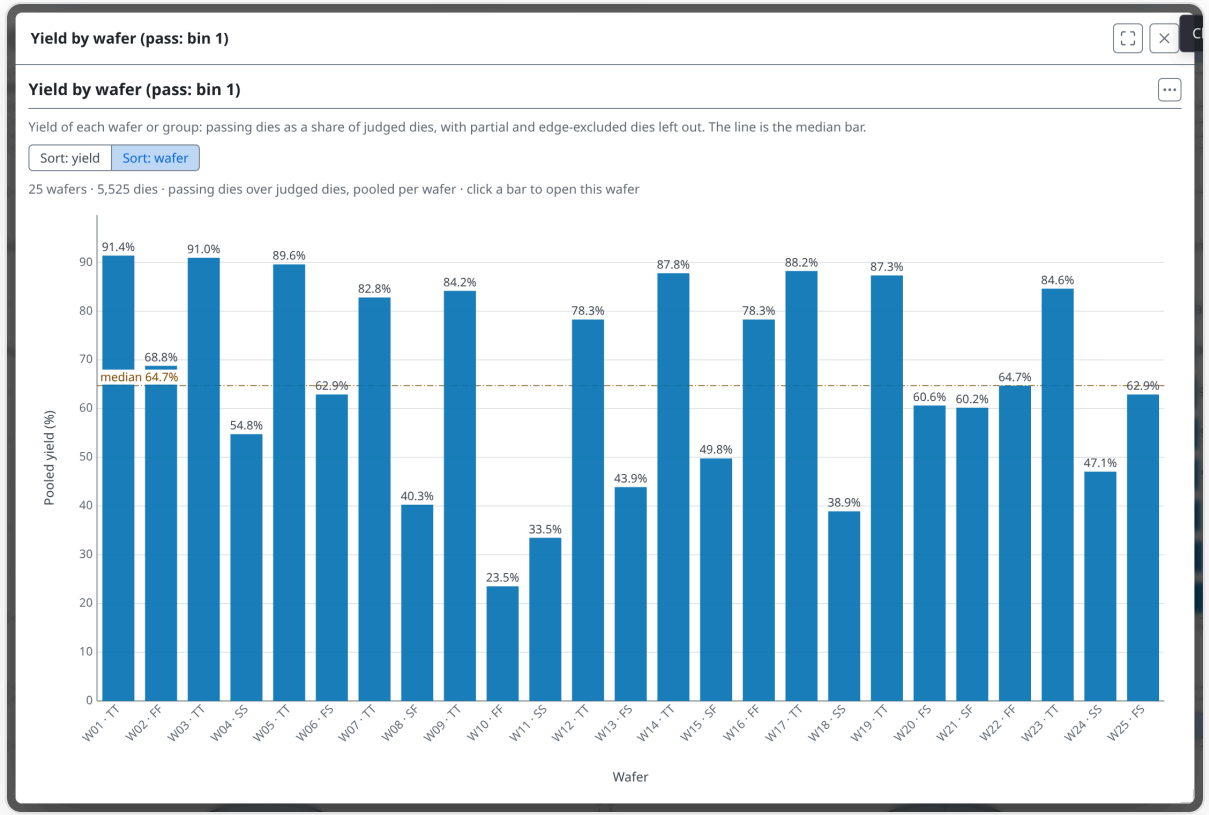
About this chart

When you meet a chart you do not know, turn on **About this chart** in its ⋯ menu. A line then explains what the chart shows and how to read it.



Expand

The **Expand** button, to the left of the ⋯ button, opens a chart in its own large window. **Save as PNG** there gives a full-size image, headed with its settings and named for the lot and chart.



Every mark opens something

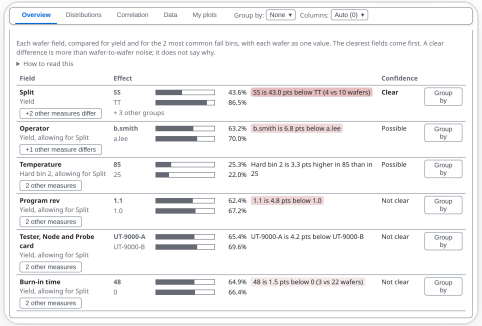
Charts are not dead ends. Click a mark to go deeper.

- A wafer's bar, box or point opens that wafer's map
- A bin, a histogram bar or a ring opens the menu of charts and tables for those dies (lesson 08)
- A capability box or a correlation cell moves the other charts to that test

Finding causes

What divides yield

Yield differs between wafers. This card checks whether it differs along a line you know about: each wafer field, such as the split or the tester, is compared for yield and the top fail bins (four or more wafers). Each field is one row: two bars, the worst and the best group's mean yield, a sentence giving the gap in points, and a **Confidence** of **Clear**, **Possible** or **Not clear**. Clear means a low q: the groups differ by more than noise, so it is where to look, not why. A button under a field opens its other measures. Fields that change together, such as the tester, node and probe card here, divide the wafers identically, so the card shows them as one row, since the wafers cannot tell them apart.



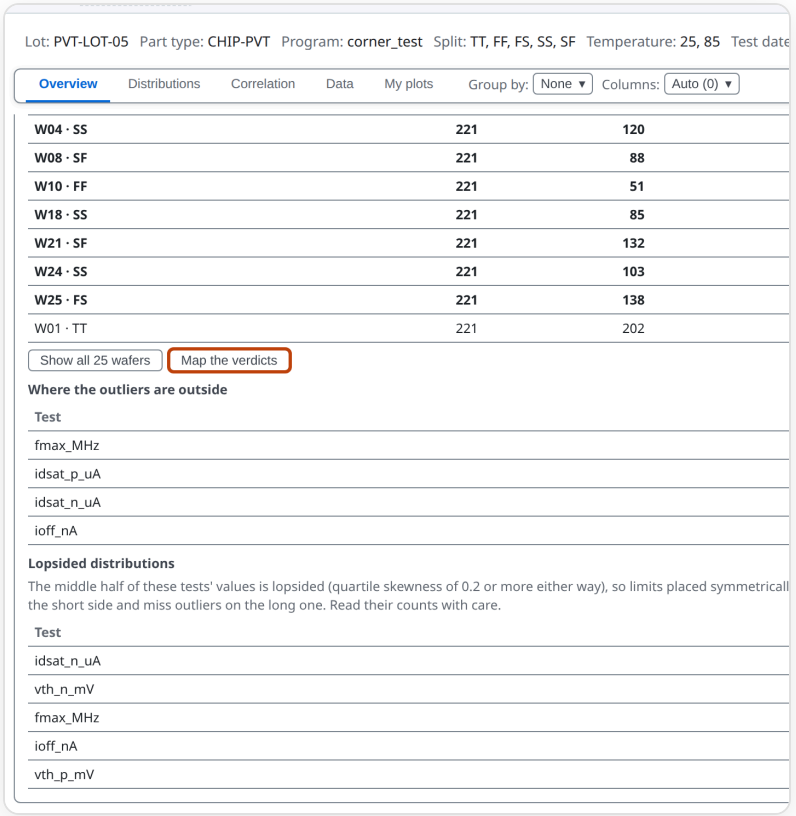
Allowing for another field

Wafers differ in several fields at once, and a strong one can hide another. So each field is read after taking out the strongest other field. A row that says **allowing for Split** shows what is left once the split's effect is removed. Its bars and the gap in points are still the plain difference between the groups.

A field can also rank because it goes with a group that has an effect of its own. In this lot the operator follows the sessions, so its row shows what the sessions did, not what the operator did. Read a row as where to look, not as a cause.

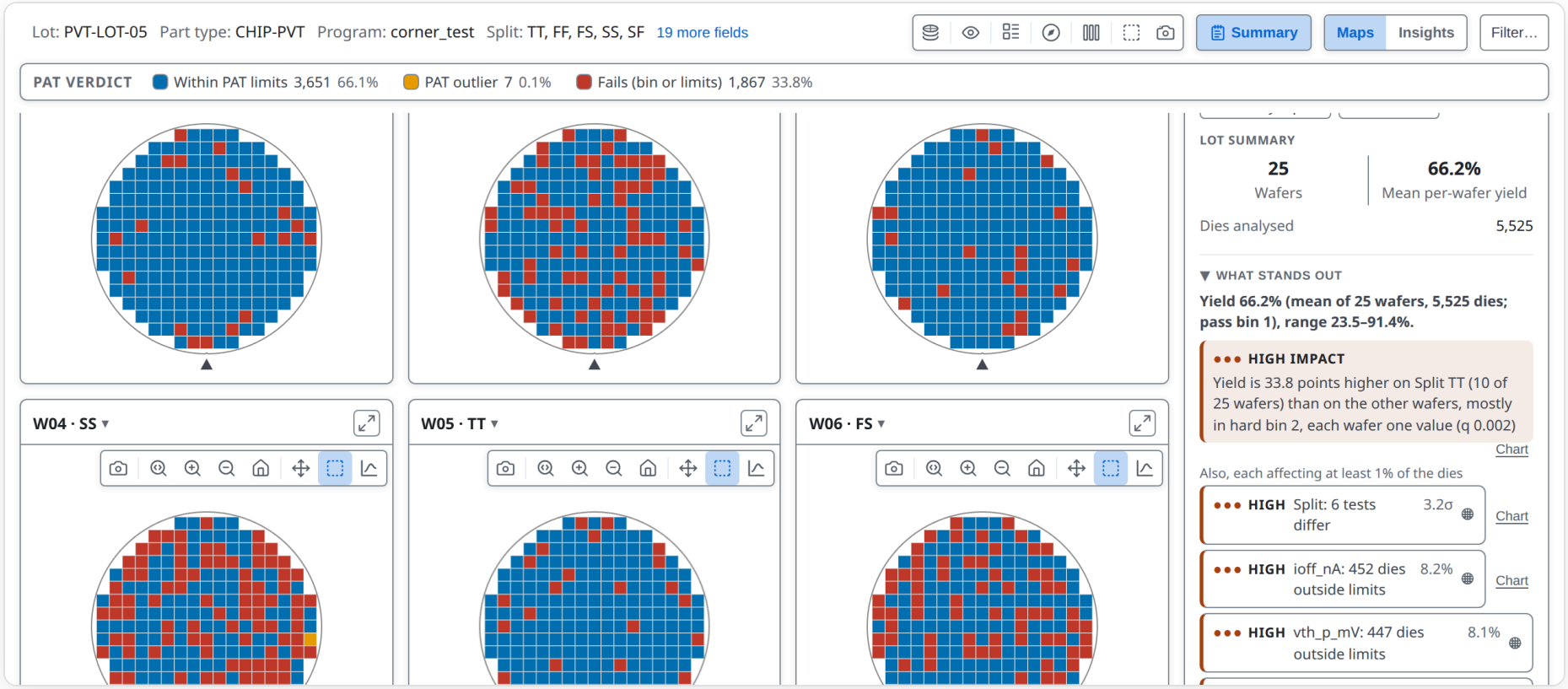
Part average testing

Some dies pass every limit and still look wrong, because they sit far from the rest of their wafer. Part average testing (PAT) finds them. The card counts them per wafer; **Show all 25 wafers** lists every wafer.



Map the verdicts

Map the verdicts returns to the maps coloured by PAT verdict: within the limits, outlier or fails its bin or limits. You can also choose **PAT verdict** in the **Plot mode** menu on the map toolbar.



How PAT limits are set

- Per wafer and test: the passing dies' median ± 6 robust sigma, never wider than the limits
- A wafer needs 30 passing values on a test
- It shows what PAT would flag; screening belongs in the test program

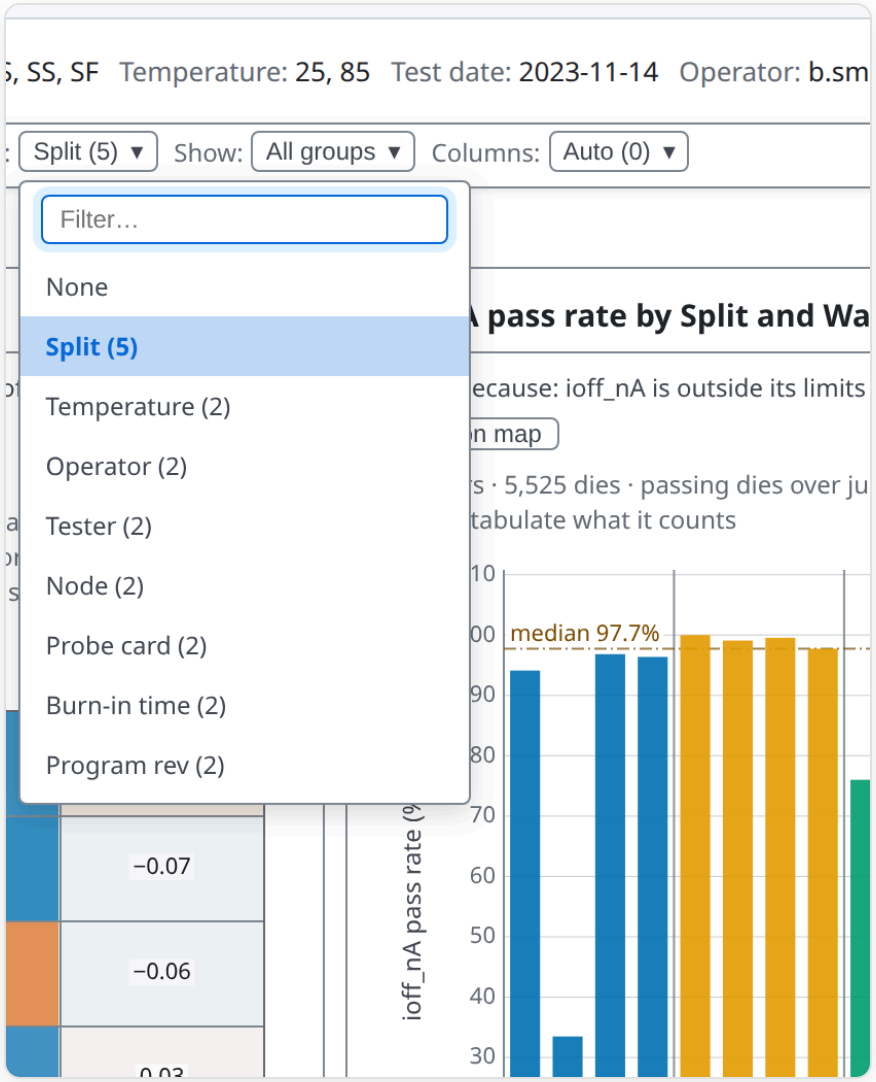
More in the wafer map guide

Group by

Group by lets you compare groups of wafers instead of single wafers. When a wafer field varies across the lot, **Group by** offers it. **None** shows each wafer; a field such as **Split (5)** pools wafers into groups. The number is how many groups the field makes. One wafer has nothing to group, so it has no Group by.

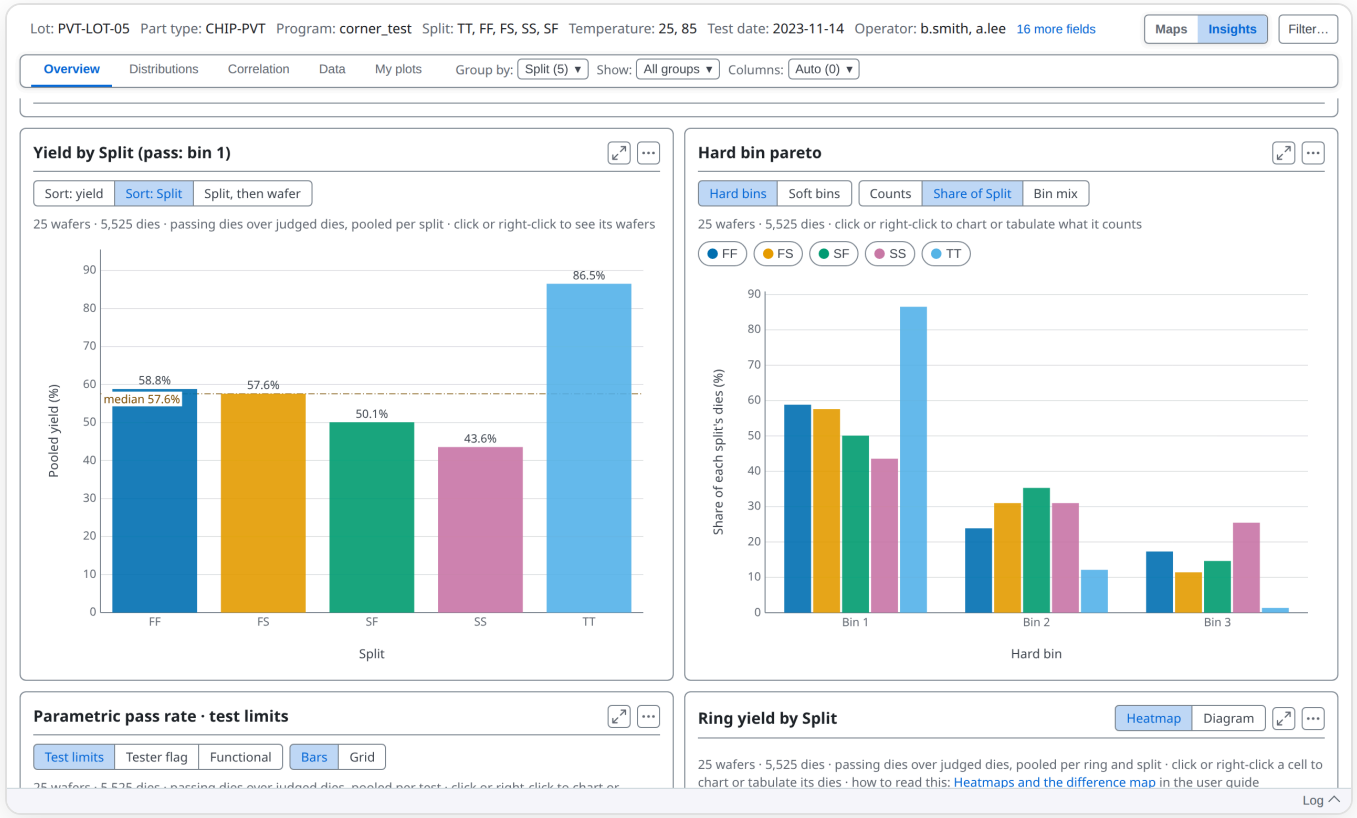
Fields to group by

The sample lot was tested in five sessions, so the menu also offers **Temperature**, **Tester**, **Node**, **Probe card**, **Burn-in time**, **Program rev** and **Operator**.



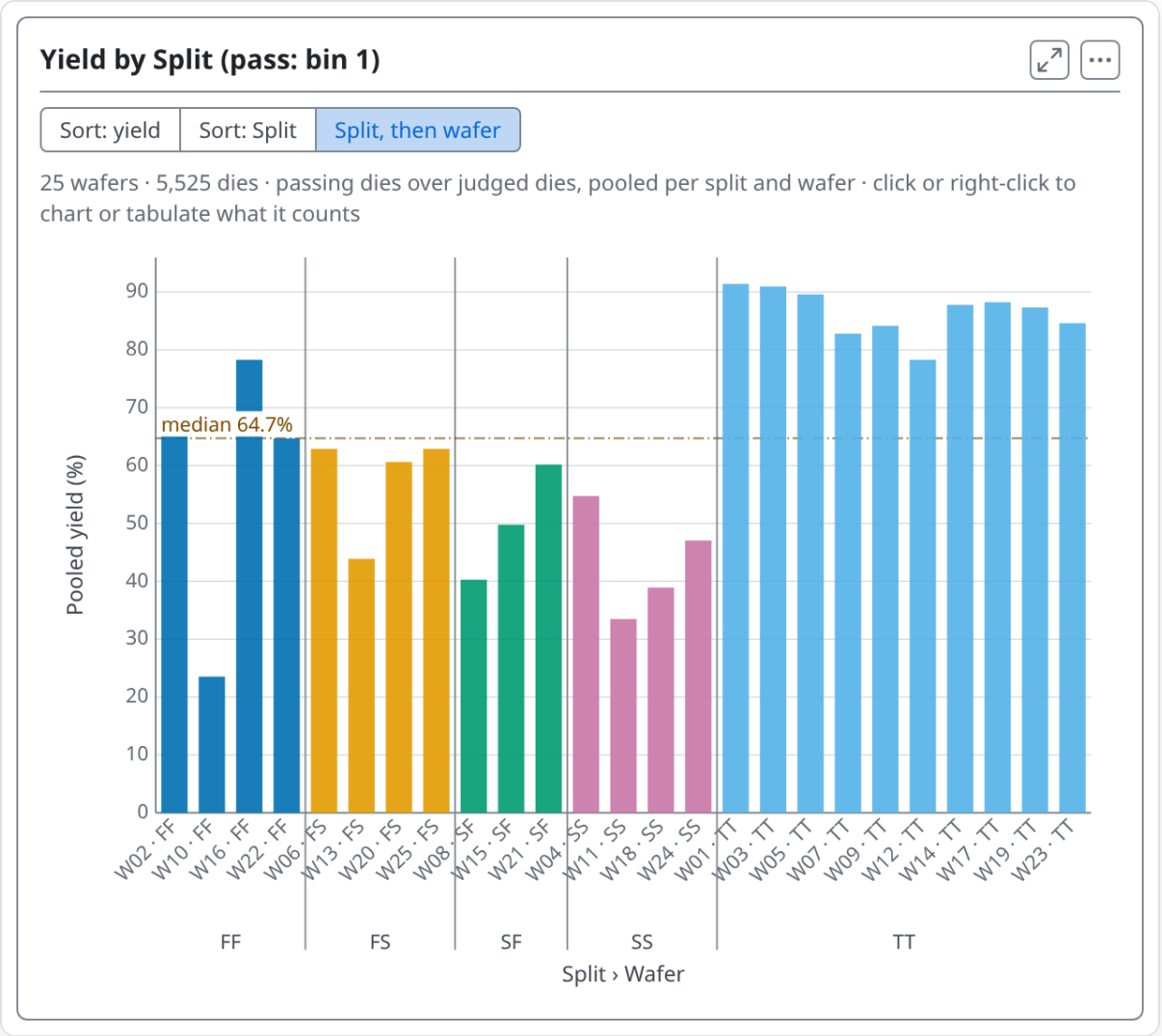
Grouped by Split

Every card now reports per split instead of per wafer. SS is lowest at 43.6%, TT highest at 86.5%, so the process corners account for the differences in yield. Click a split's bar to see its wafers; **Back** returns.



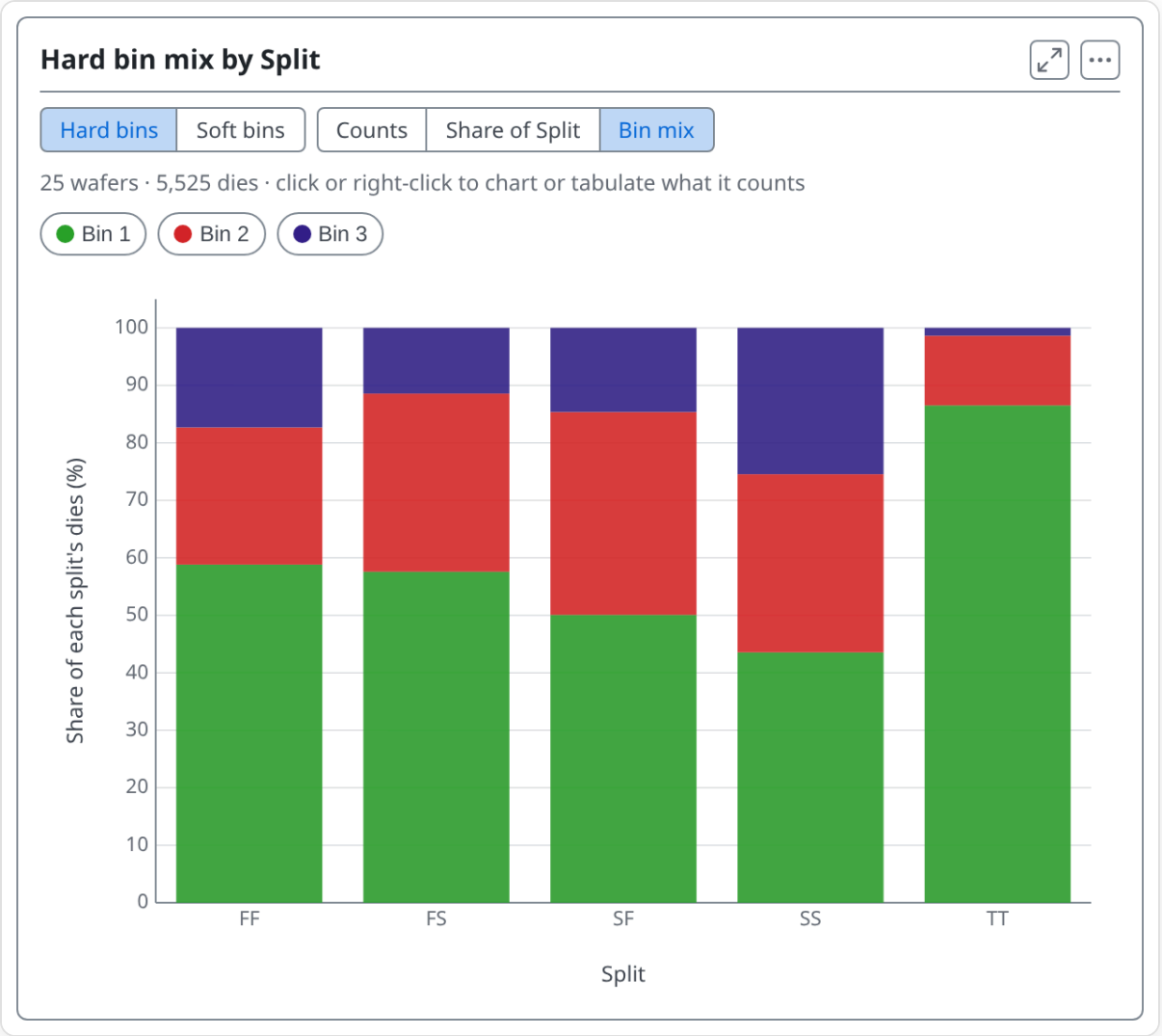
Wafers inside each split

With Group by on, **Yield by Split** also offers **Split, then wafer**. Every split's wafers sit inside it, so you see the spread between splits and the spread within each at once.



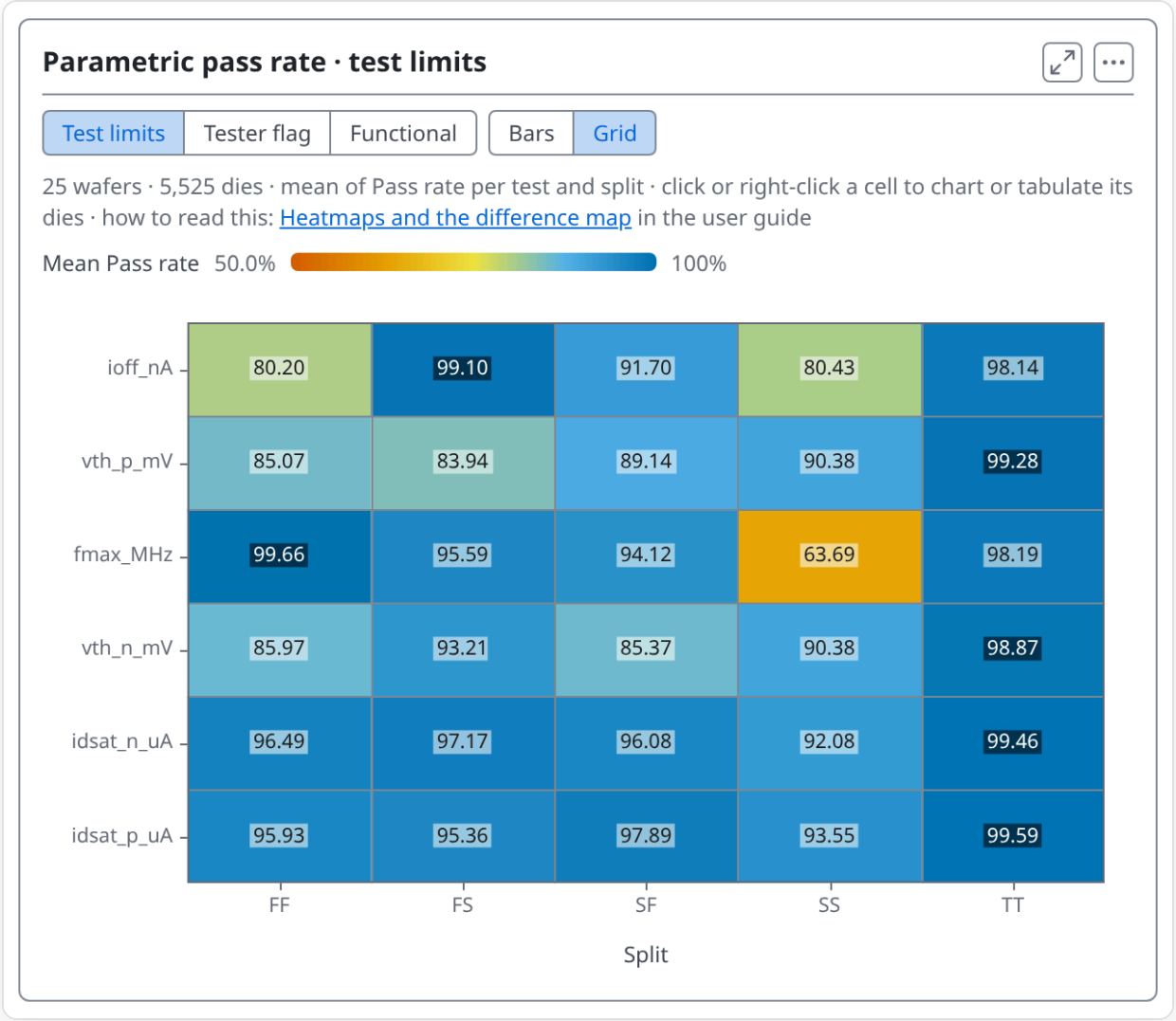
Bin mix

The bin pareto offers **Bin mix** when grouped: one bar per split, divided into its bins as a share of that split's dies. It shows what each split's loss is made of.



Pass rate as a grid

When grouped, **Pass rate by test** offers **Grid**: the worst 25 tests down the side and the splits across, each cell coloured by pass rate. A test that fails in one split stands out as one dark cell. With more than 25 tests the bar view also shows the worst 25; **All tests** shows the rest.



Columns of cards

Beside **Group by** and **Show**, **Columns** sets how many columns of cards every section of Insights uses. **Auto** fits as many as the width holds; a number divides the width that many ways. The keys **1** to **5** do the same, and **0** returns to Auto, as in the gallery (lesson 02). The choice stays while you move between the tabs.

LAB Try it yourself

1. In the web app, **Load sample data**, then switch to **Insights**
2. **Sort: yield**, then open **Pass rate by test**: which test passes least often?
3. **Group by** → **Split**: which split has the lowest yield?

ANSWERS Check your results

2. `ioff_nA` passes least often, at 91.8%. `vth_p_mV` is close behind at 91.9%.
3. **SS** has the lowest yield, at 43.6%. TT is highest, at 86.5%.

Recap

- **Overview** shows where yield is lost: by wafer, by bin and by test
- Every chart has a ⋯ menu, and every mark opens something
- **What divides yield** and **Part average testing** point at causes; **Group by** compares groups

You now know where the yield is going. The next lesson looks at how test values behave, and at the tables behind every chart.

More in the wafer map guide



Next lesson

06 · Insights: distributions and data →

How values spread, how groups compare, and the tables behind every chart.



Insights: distributions and data

Lesson 06

Learn tsmap

In this lesson

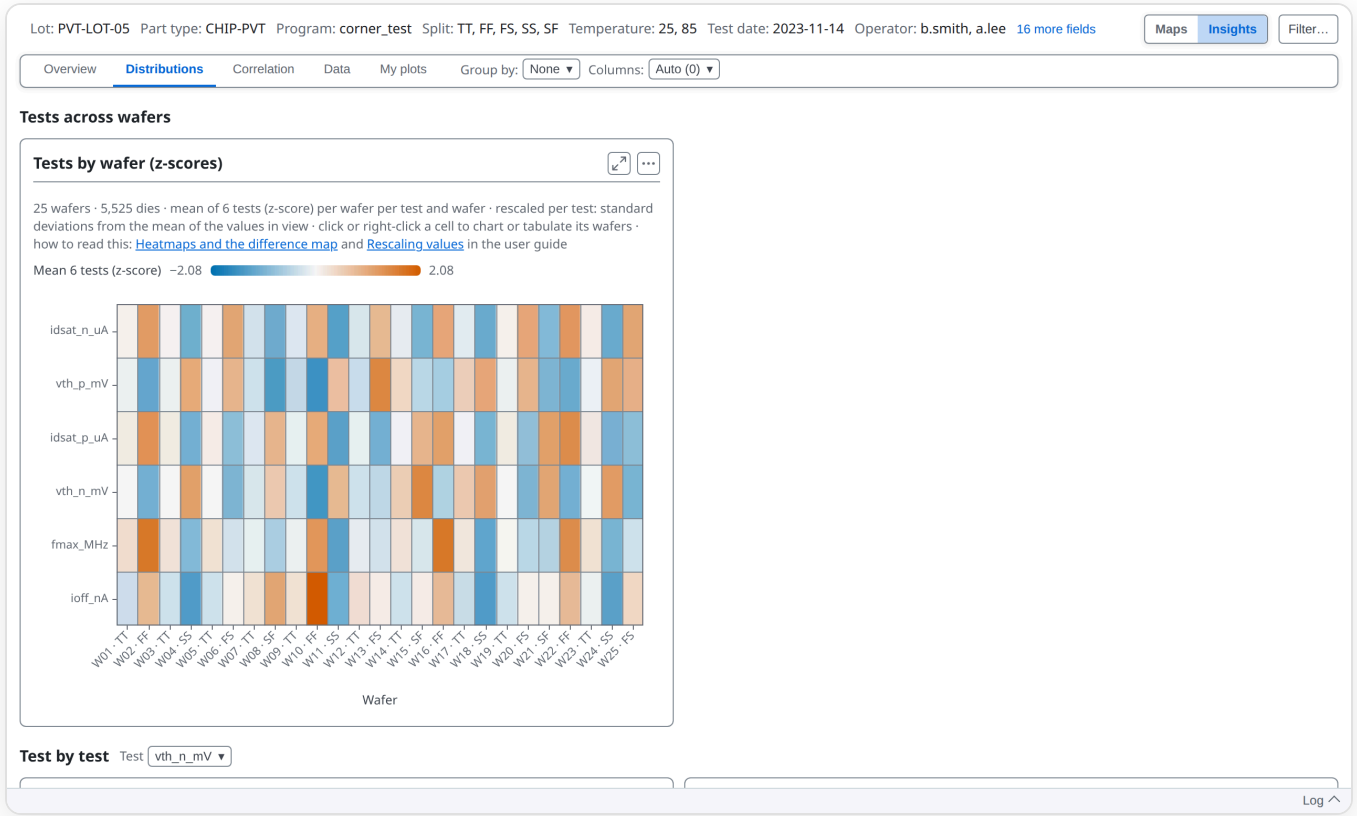
Yield tells you how many dies passed. The measurements behind it tell you how close to their limits the dies were. This lesson shows how test values spread, how groups of wafers compare, and where to find the numbers behind every chart.

- Read how values spread, and where tests sit against their limits
- Compare groups of wafers and see where on the wafer they differ
- Export the numbers behind every chart

Distributions

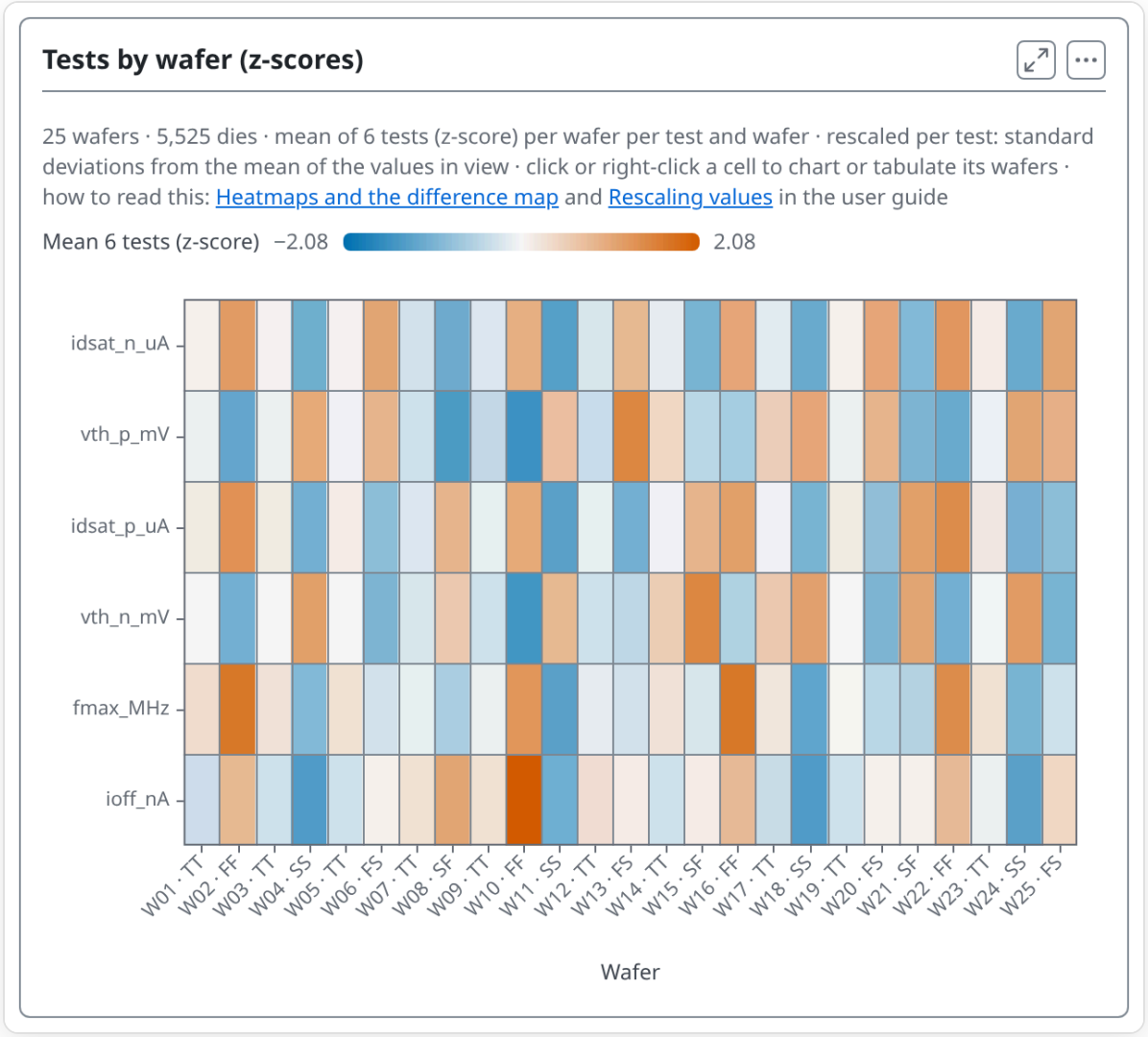
The Distributions tab

This tab is about how values spread: process capability, a box plot per wafer, a histogram and the trend across wafers. It answers "are my tests healthy, or close to failing?"



Tests by wafer

Which wafers behave differently from the rest? At the top of Distributions, **Tests by wafer** picks the tests whose wafers differ most and draws them as a grid. Each row is a test and each column is a wafer.



Reading the colours of the grid

The colour of a cell shows how far that wafer's mean is from the mean of all the wafers: blue is below, orange is above, and a pale cell is close to average.

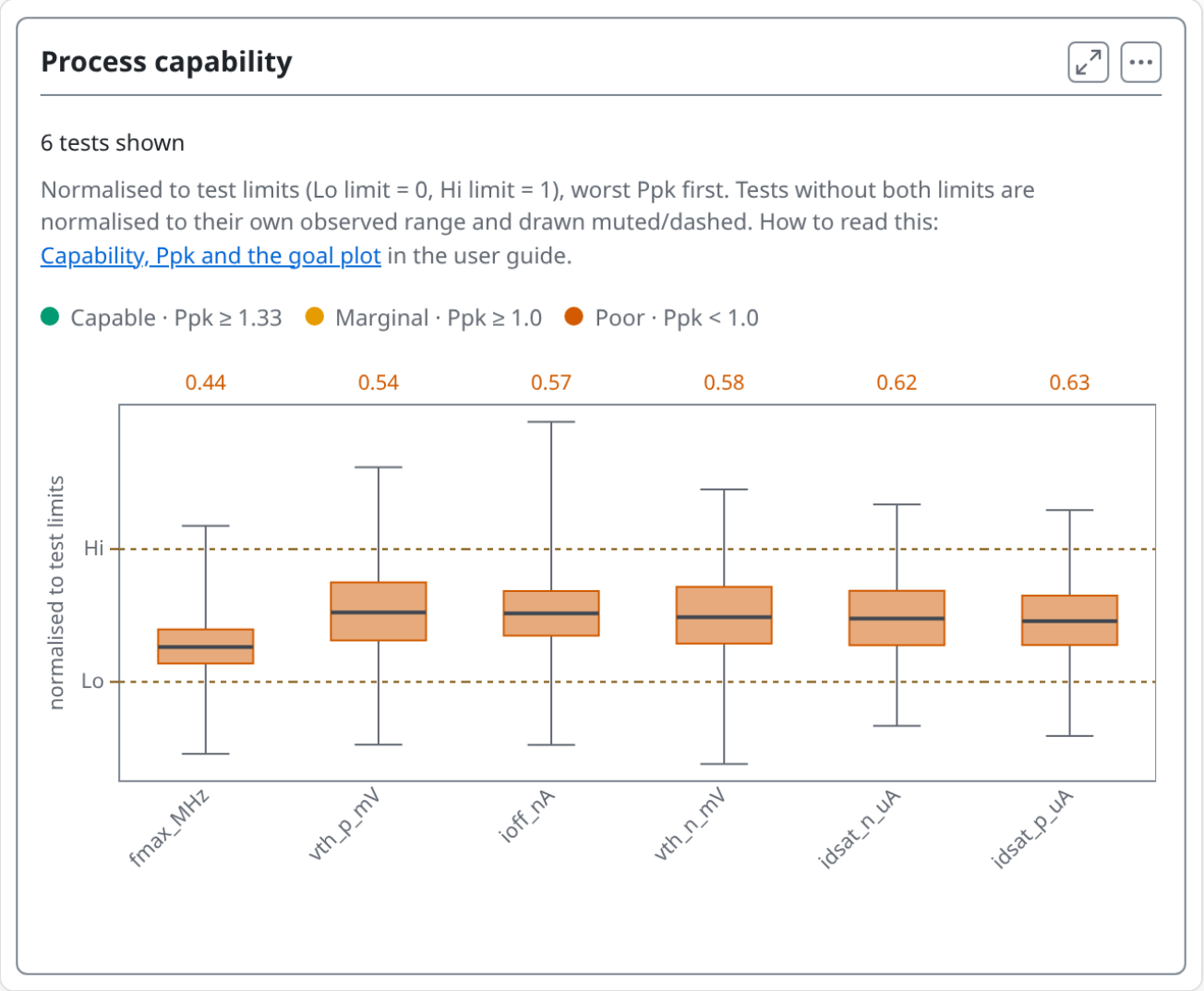
Reading the grid in z-scores

Each cell needs a common scale, so that millivolts and megahertz can sit side by side.

- Each test is rescaled on its own, so tests in different units share one colour scale
- The number in a cell is a **z-score**: how many standard deviations the wafer's mean is from the mean of all wafers
- A column that is dark in several rows is a wafer that moved several tests together

Process capability

How much room does each test have before it fails? Each test is rescaled against its own limits: the low limit becomes 0 and the high limit becomes 1. That puts tests in different units on one scale, so you can compare their margins directly.



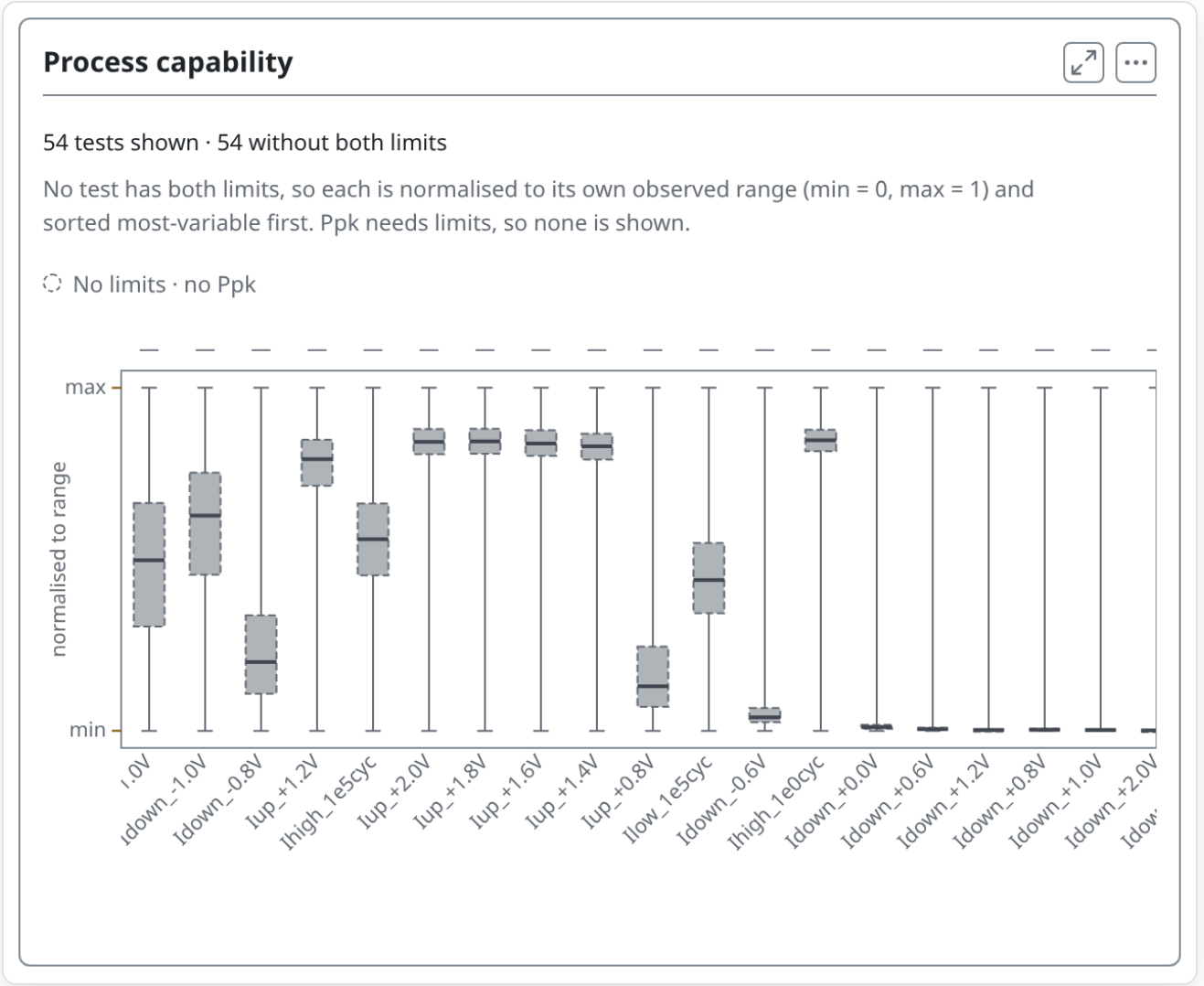
Reading the colours

Each test is a box showing where its values sit between the limits.

- A box centred between 0 and 1, whiskers inside, has room; one against 0 or 1 does not
- Lowest **Ppk** first: 1.33 or more is capable, under 1.0 poor
- Ppk is the gap from the mean to the nearest limit, in units of 3σ

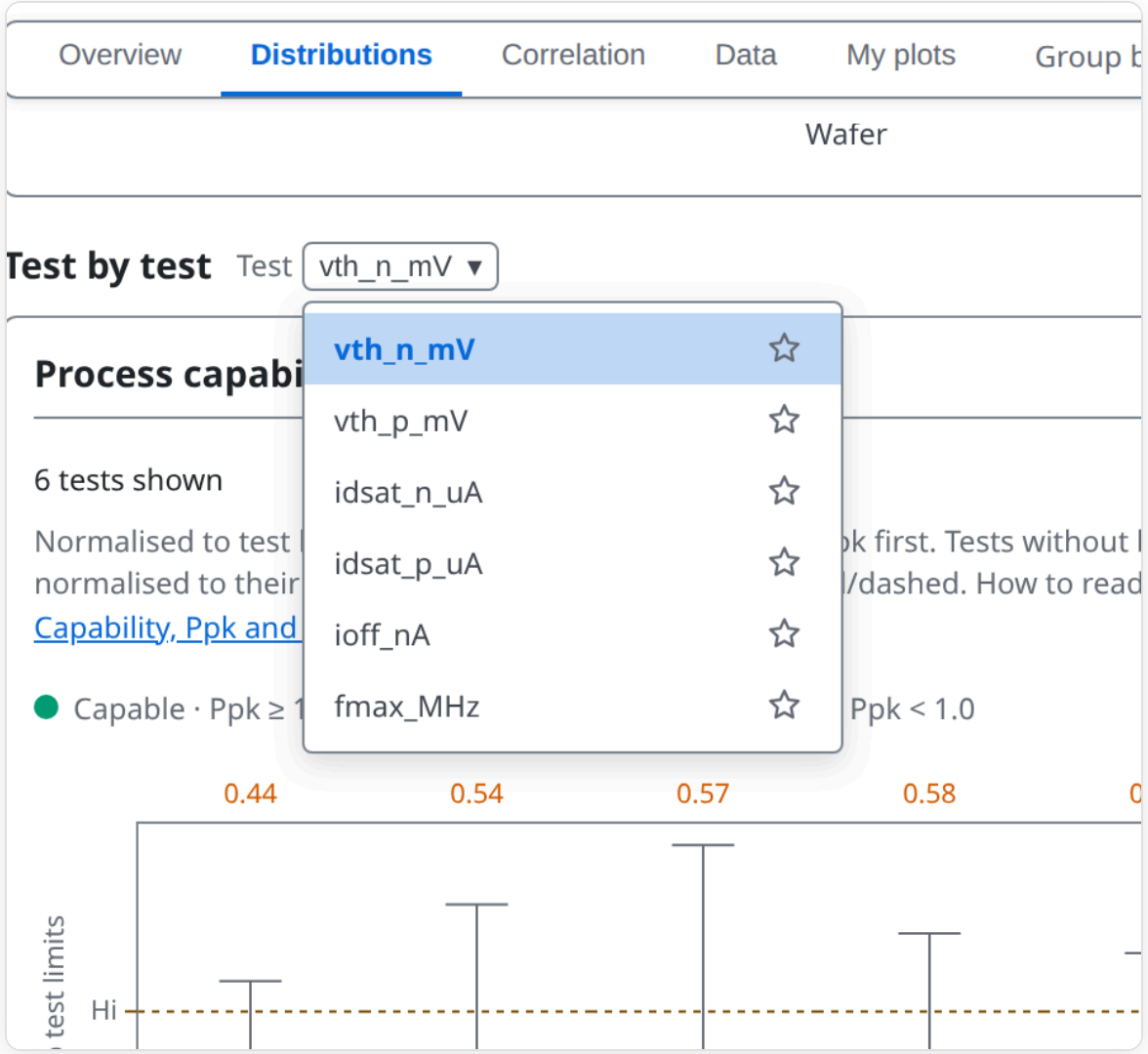
Tests with no limits

A test without both limits still appears, drawn muted and dashed on its own range, with no Ppk. Its place says how its values spread, not how near a limit they are, because there is no limit to be near.



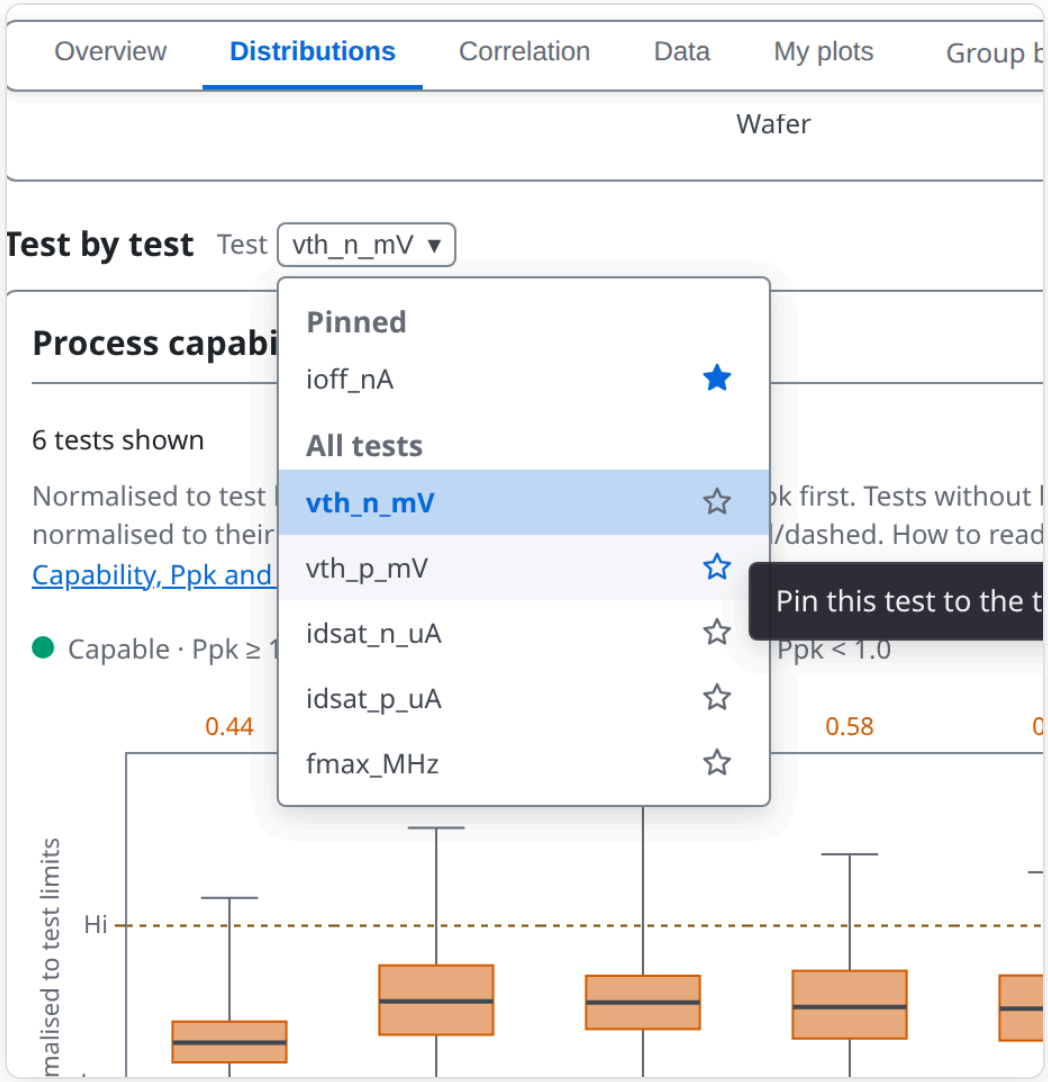
One test for every card

Under the heading **Test by test** there is one **Test** menu. Changing it changes the box plot, the histogram, the trend and the scatter together, so every card is about the same test and you can read them as one story.



Pin the tests you use

A lot can have hundreds of tests. Click the ☆ at the end of a row in any test menu, or press **P** on the focused row, to pin that test. Pinned tests are listed first, under **Pinned**, in every test menu in Insights, and tsmap remembers them for the next lot.

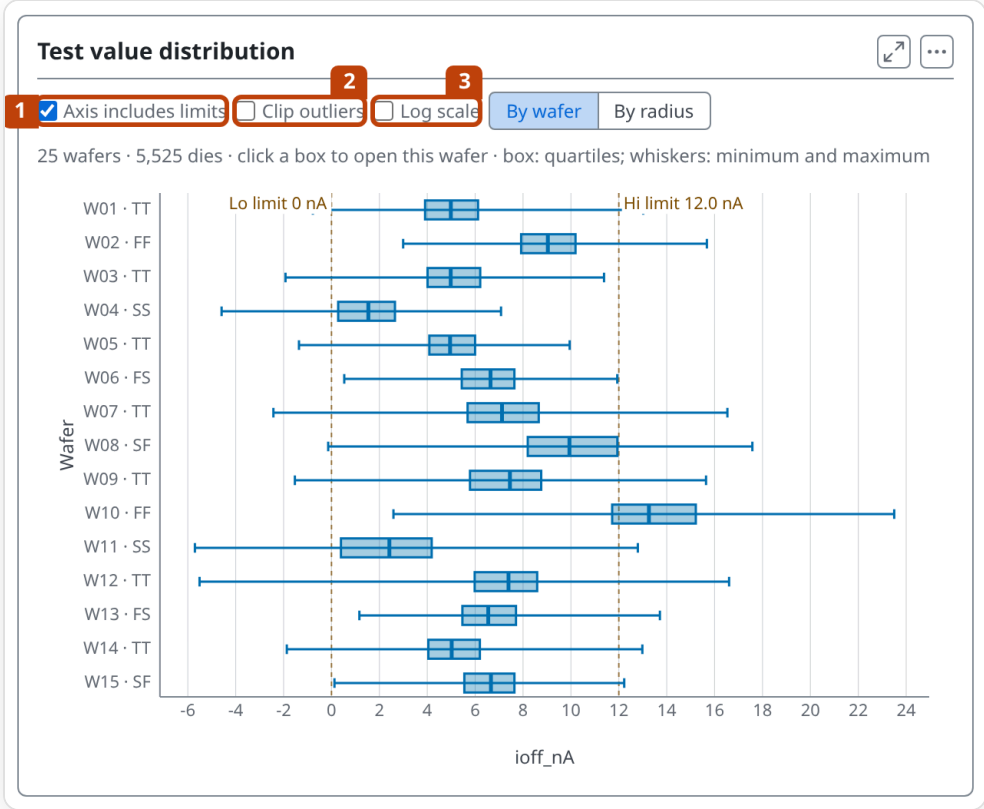


Other ways to change the test

Clicking a test in the capability chart does the same. A card shows a Test menu of its own only while you have expanded it.

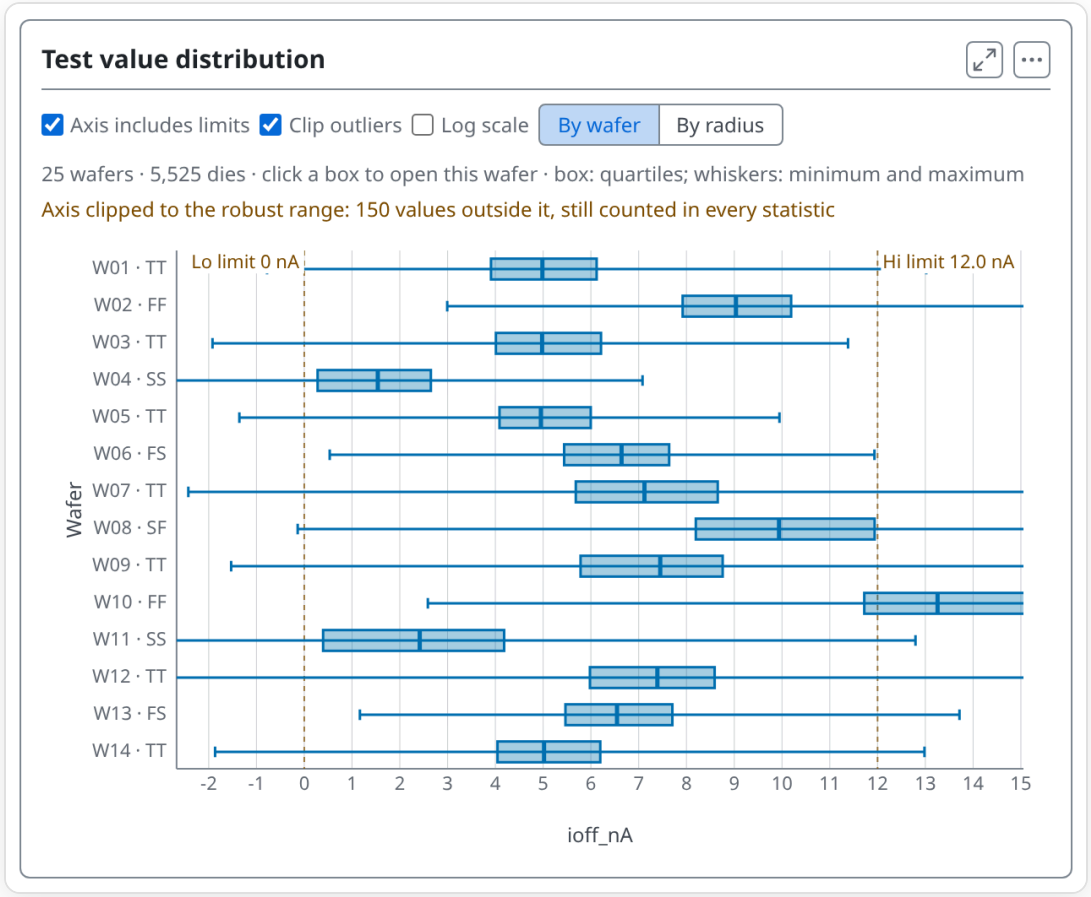
Axis controls

1 **Axis includes limits** widens the axis to the limits. **2** **Clip outliers** narrows it to the bulk of the data. **3** **Log scale**, on the box plot only, uses a log axis once every value is positive.



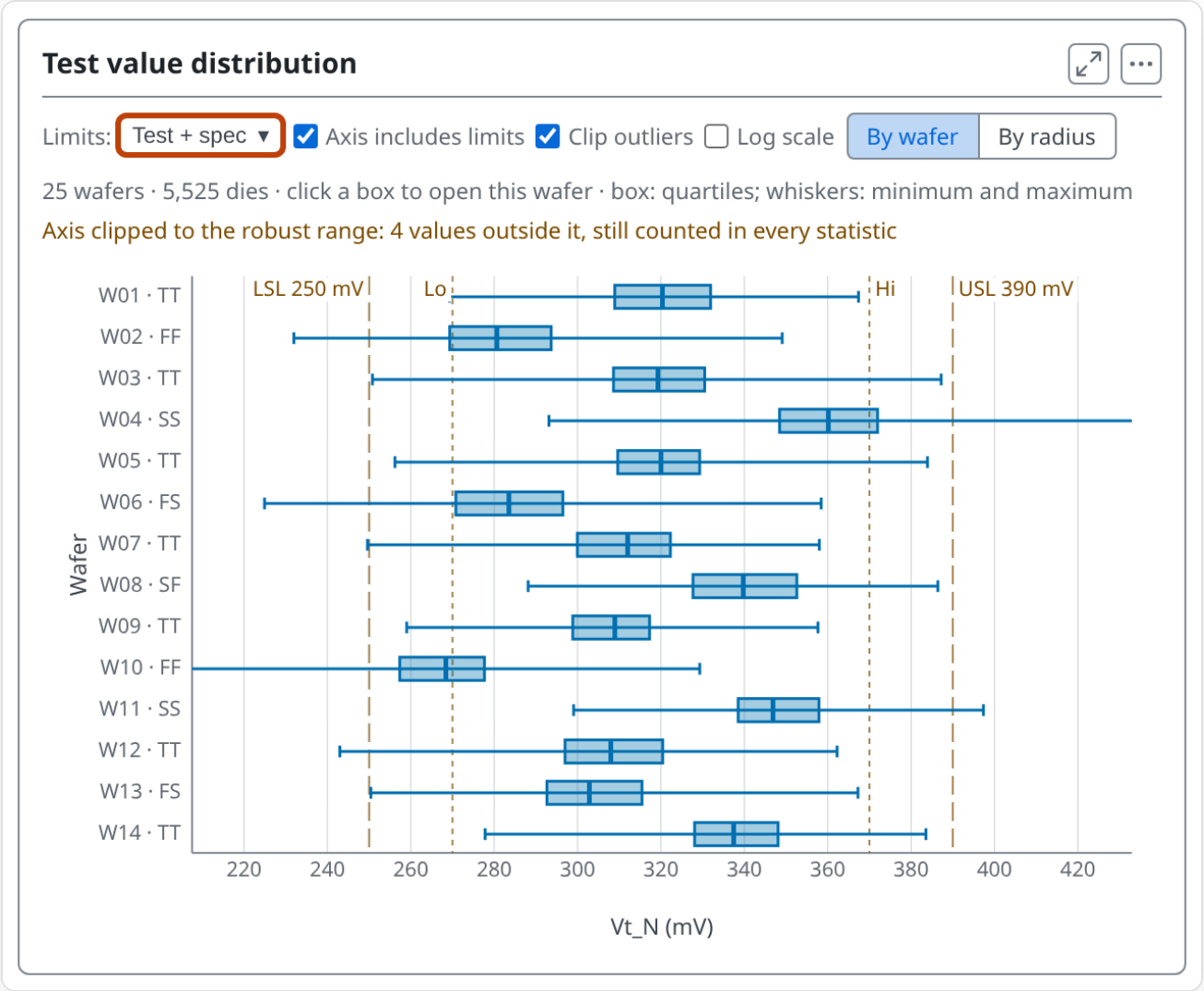
Clipping changes only the axis

Clipping does not remove data. The chart states how many values fall outside the axis, and every statistic still includes them.



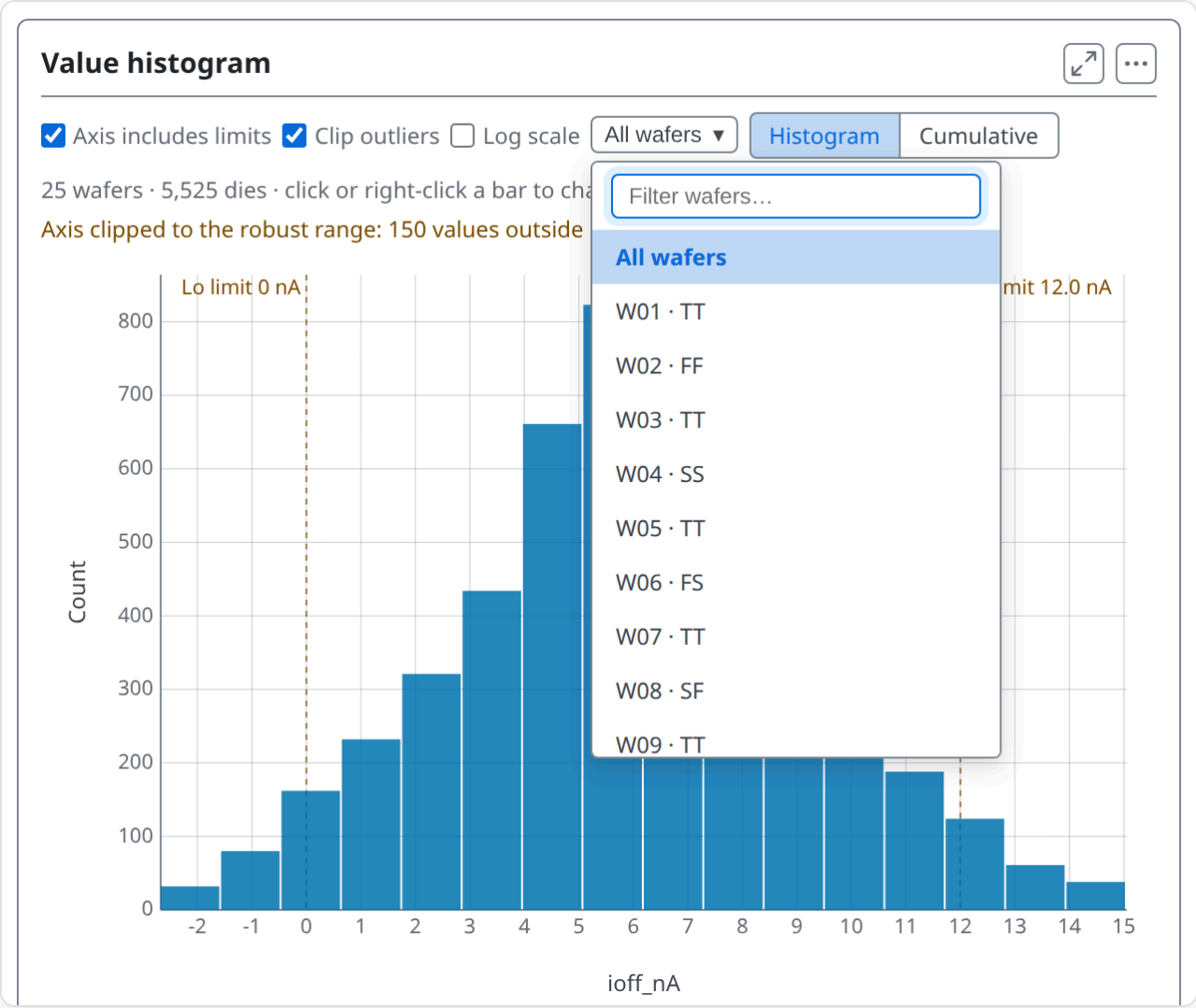
Which limits are drawn

When a test has both kinds, a **Limits** choice appears on the box plot, histogram, trend and scatter: **Test + spec** (the default), **Test limits**, **Spec limits** or **None**. A limit off the edge of the axis is marked with an arrow.



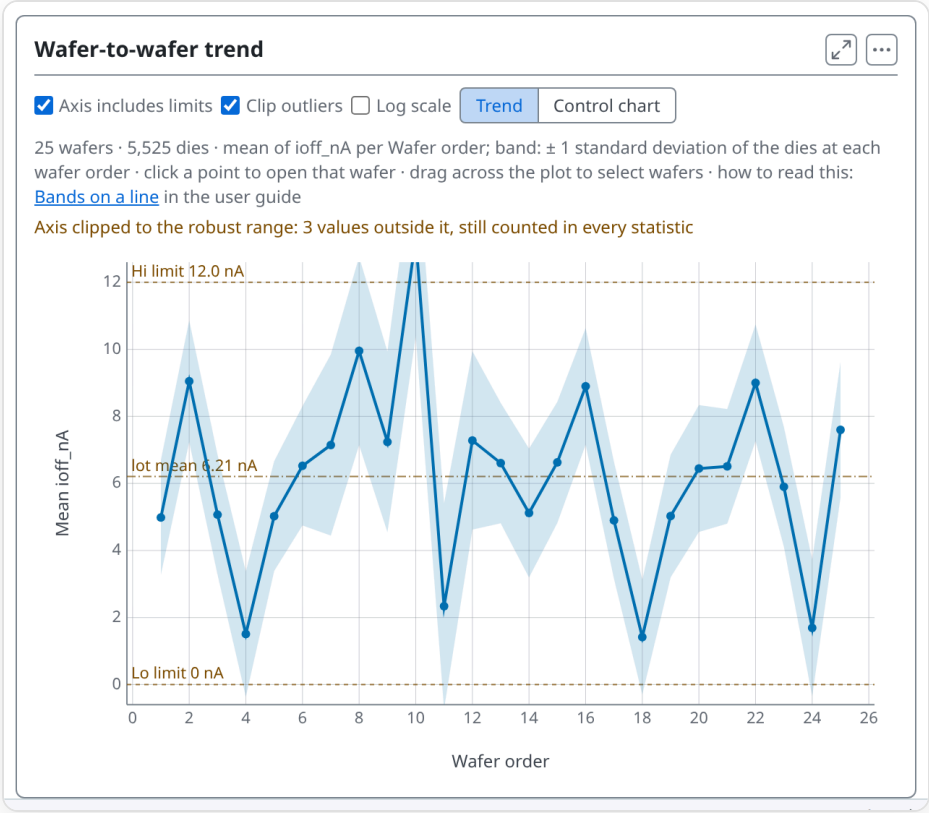
One wafer or all

The histogram has a **Wafer** menu: all wafers pooled, or one wafer. Type to filter the list.



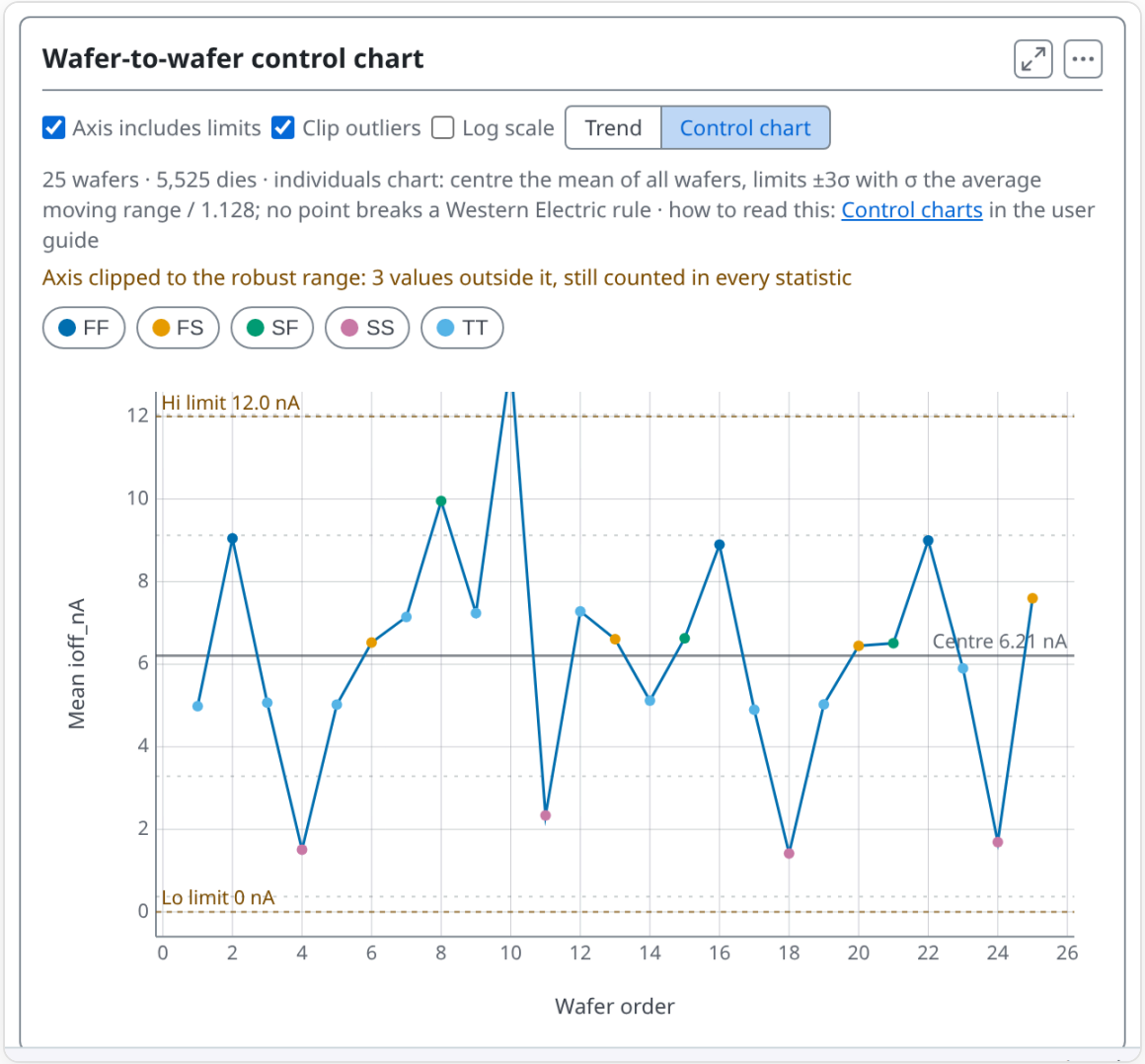
Wafer-to-wafer trend

Is the process drifting from wafer to wafer? This chart shows each wafer's mean in slot order, with a band of ±1 standard deviation. There is no sort, because a drift only shows in sequence.



Trend or control chart

Control chart shows the same wafers against control limits, with the points that break a rule marked.

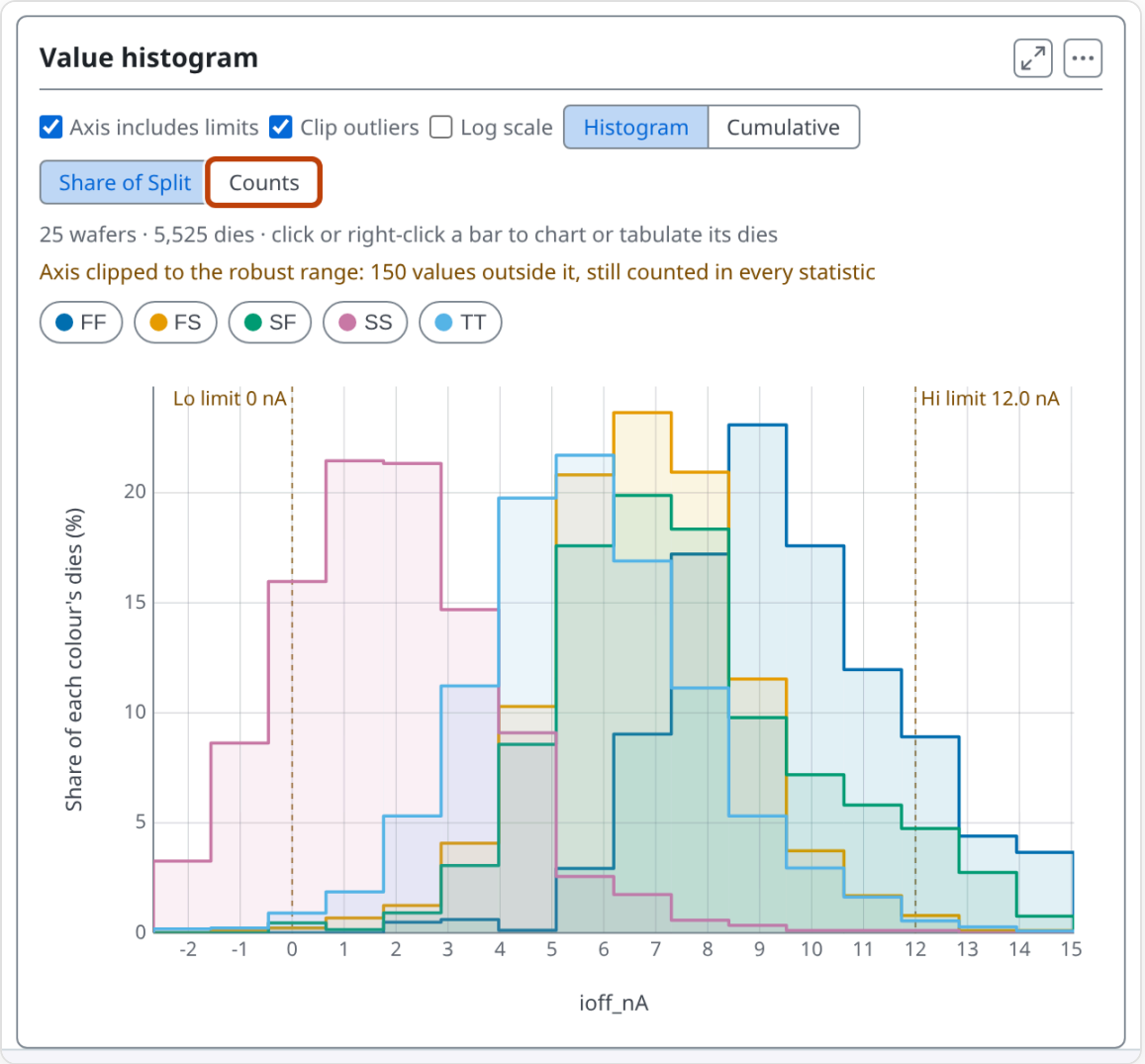


Which view to use

The two views answer different questions. The trend shows how the dies within each wafer spread. The control chart shows whether a wafer's mean stands out from the others, and it needs at least three wafers.

The histogram when grouped

With Group by on, each group's bars are a share of its own dies, so groups of different sizes compare by shape rather than by size. **Counts** shows the number of dies instead.



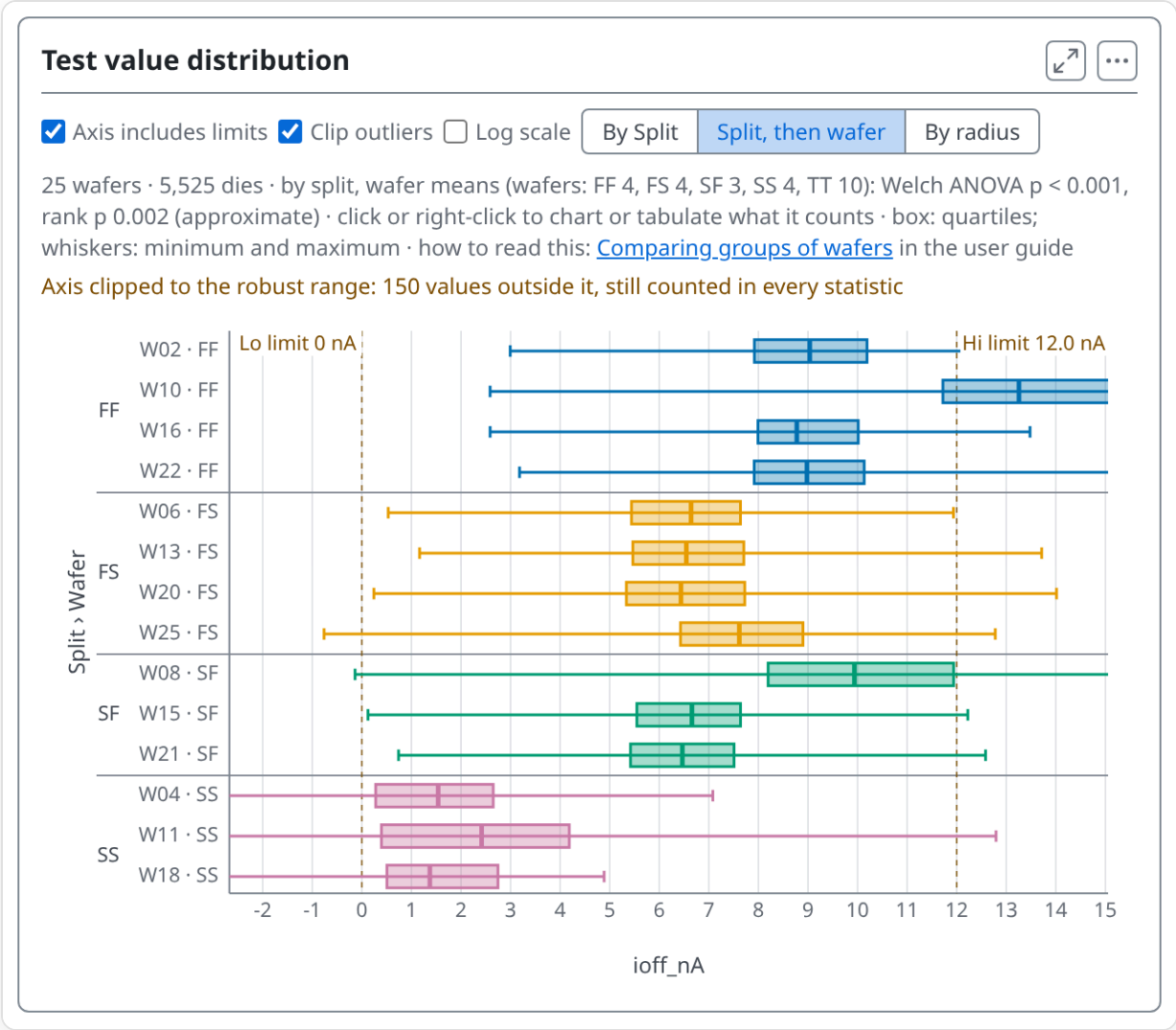
Histogram or cumulative

Cumulative draws the same values as a curve instead of bars. Each die sits at the share of dies at or below its value, on a scale where a normal distribution falls on a straight line. A group whose curve is further right has higher values, and a steeper curve is a tighter spread.



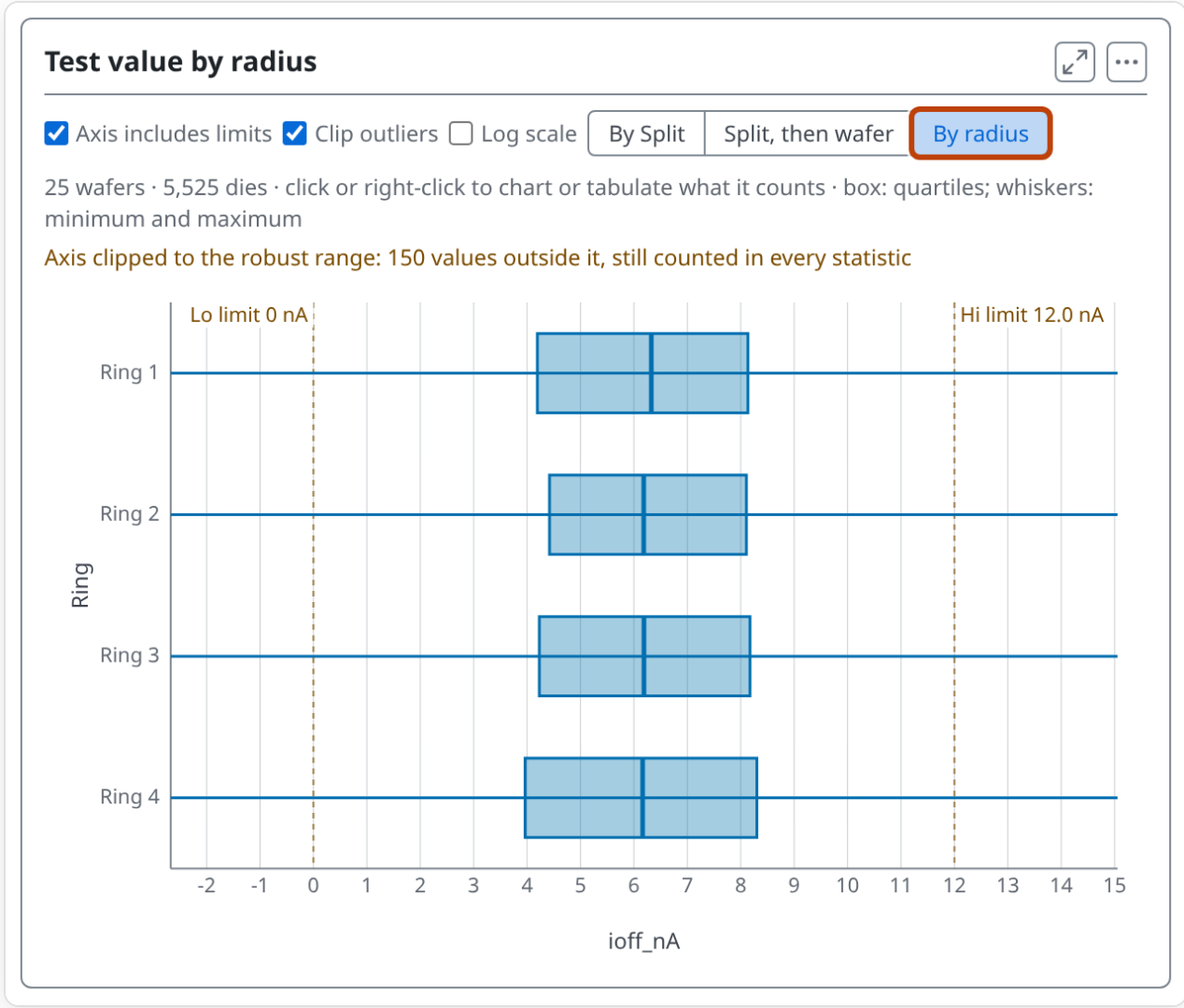
The box plot when grouped

With Group by on, the box plot also offers **Split, then wafer**: each split's wafers sit inside it, coloured by split, so you see the spread between splits and within each.



By wafer or by radius

The box plot can show one box for each wafer (**By wafer**) or one for each ring, from the centre of the wafer out to the edge (**By radius**). By radius is the one to use when you suspect a value changes with distance from the centre: the boxes then step up or down from Ring 1 to Ring 4.



Why each wafer counts once

Comparing groups raises a fair question: why not use every die? Because the dies are not independent.

- Dies on one wafer went through the same processing, so they are not independent
- Counted die by die, thousands of dies make a tiny difference between two wafers look certain
- So a comparison of groups takes each wafer's mean as one value: n is wafers

Comparing groups

When you compare groups, the table gives you three things to read.

- **Welch p**, **Rank p**: how likely a difference this large is by chance
- **q** corrects p for many tests: read q
- **Largest shift** is the size; **Control** compares each group with one

Comparison by split

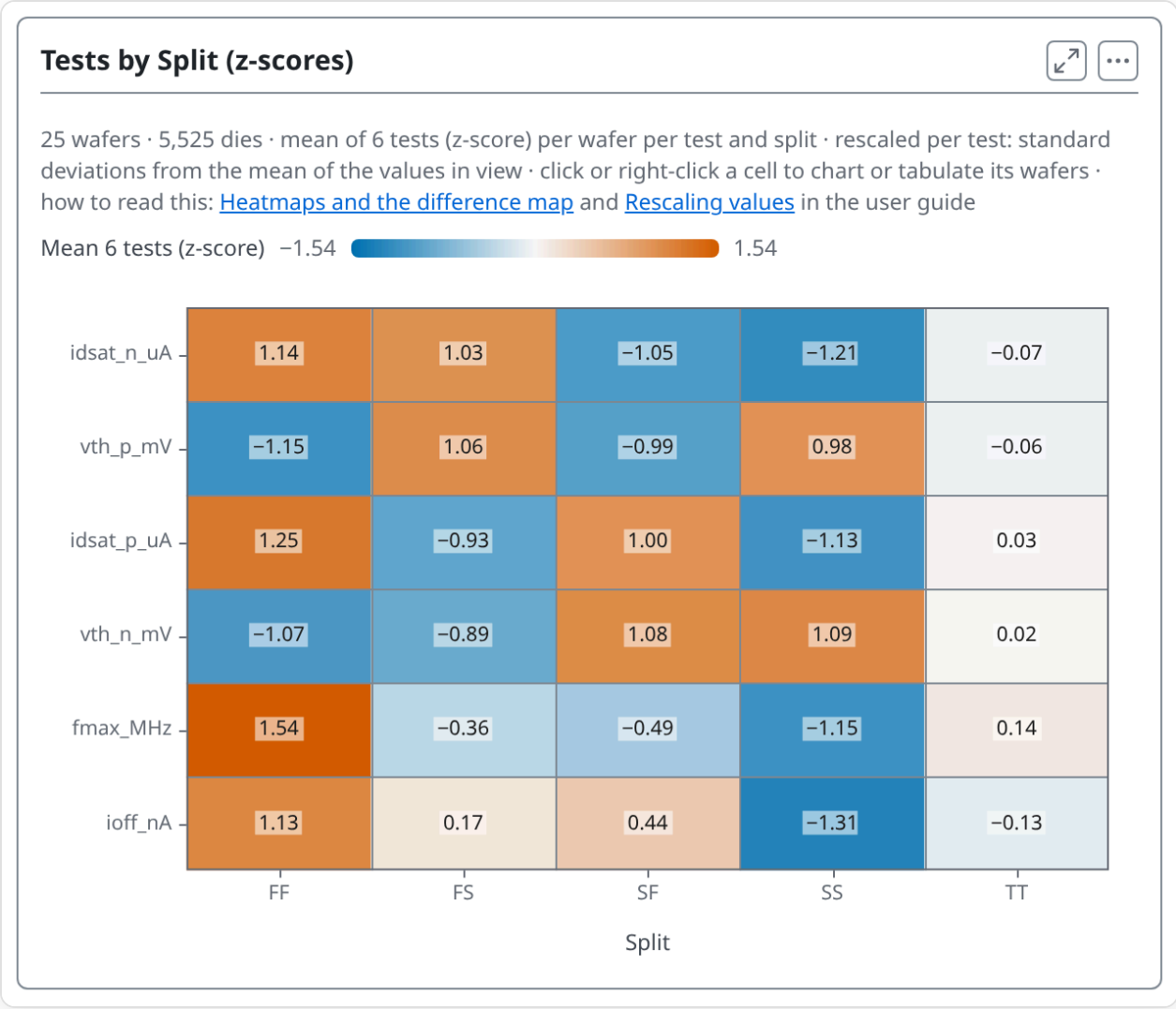
No control: compare all groups ▾ | Comparison CSV

Each wafer is one value, the mean of its dies, so n is wafers (FF 4, FS 4, SF 3, SS 4, TT 10). Welch: Welch's ANOVA (Welch's t for two groups). Rank: Kruskal–Wallis, approximate with fewer than five wafers in a group. q: Benjamini–Hochberg across the 6 tests, which the table is ranked by. How to read this: Comparing groups of wafers in the user guide.

Test	FF	FS	SF	SS	TT	Welch p	Rank p	q	Largest shift
idsat_n_uA	810 µA	798 µA	584 µA	567 µA	685 µA	< 0.001	< 0.001	**< 0.001**	17.2 SD · 61% of limits
idsat_p_uA	753 µA	549 µA	730 µA	530 µA	639 µA	< 0.001	< 0.001	**< 0.001**	16.7 SD · 59% of limits
fmax_MHz	1.96 GHz	1.72 GHz	1.70 GHz	1.62 GHz	1.78 GHz	< 0.001	< 0.001	**< 0.001**	15.1 SD · 57% of limits
ioff_nA	10.1 nA	6.79 nA	7.70 nA	1.74 nA	5.77 nA	< 0.001	0.002	**< 0.001**	6.5 SD · 69% of limits
vth_n_mV	283 mV	289 mV	357 mV	357 mV	320 mV	< 0.001	< 0.001	**< 0.001**	6.6 SD · 62% of limits
vth_p_mV	281 mV	360 mV	287 mV	358 mV	321 mV	< 0.001	< 0.001	**< 0.001**	6.8 SD · 66% of limits

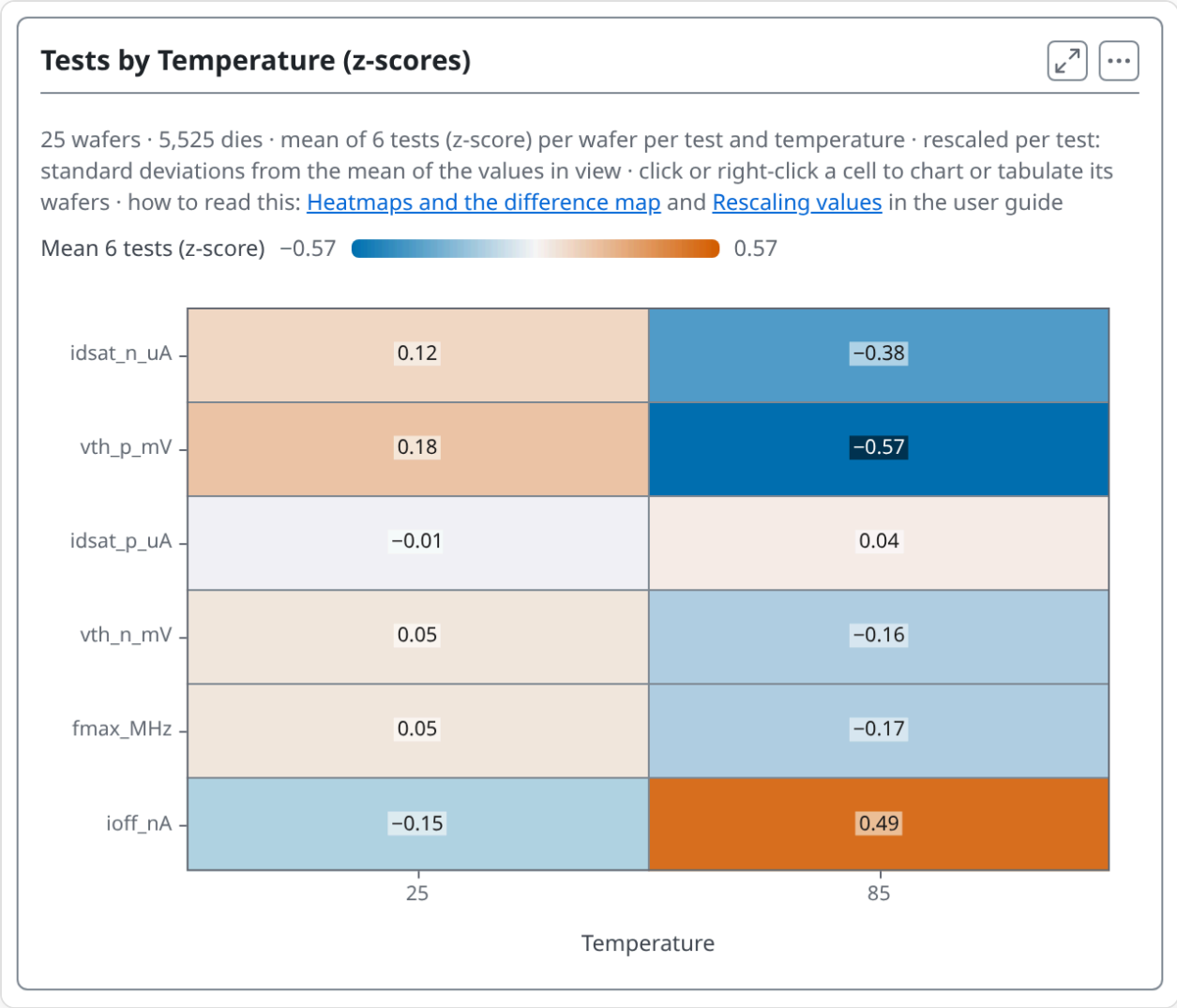
Tests by group

With Group by on, **Tests by wafer** becomes **Tests by split**: one column for each group instead of each wafer, in z-scores again. A group that is dark across several rows differs on several tests at once, which suggests one cause.



Group by temperature

Grouped by **Temperature**, the card compares the six wafers tested at 85 °C with the nineteen at 25 °C. At 85 °C leakage (`ioff_nA`) is high, while the thresholds and both `idsat_n_uA` and `fmax_MHz` are lower.

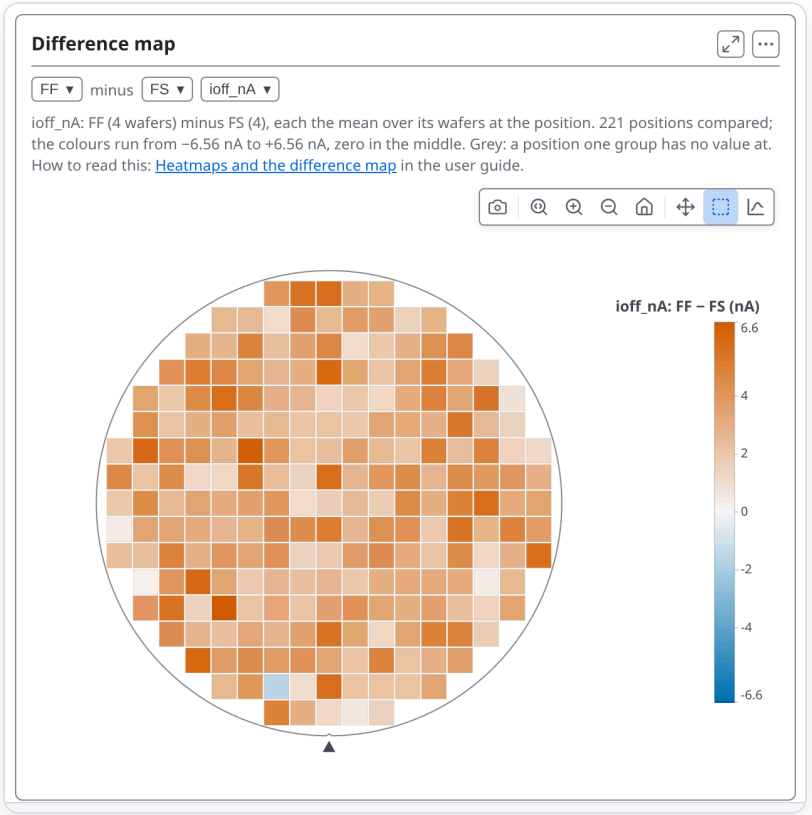


Other fields

Tester, program revision and burn-in time each pick out a different set of wafers. Group by each in turn to see which tests it moves.

Where on the wafer

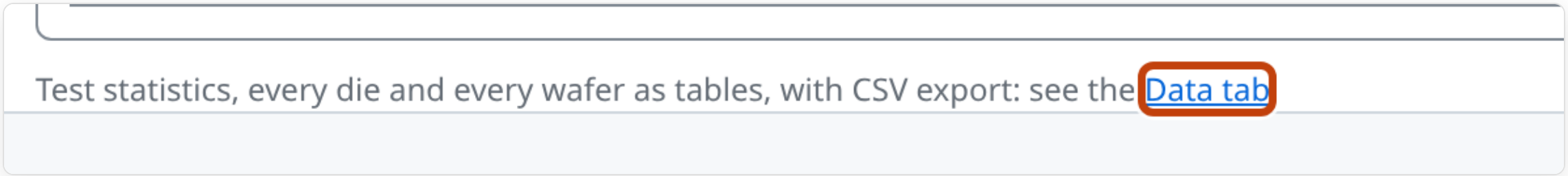
Once you know two groups differ, the next question is where. The difference map shows where on the wafer two groups differ, not whether the difference is significant. Use the comparison table for that.



The numbers behind it

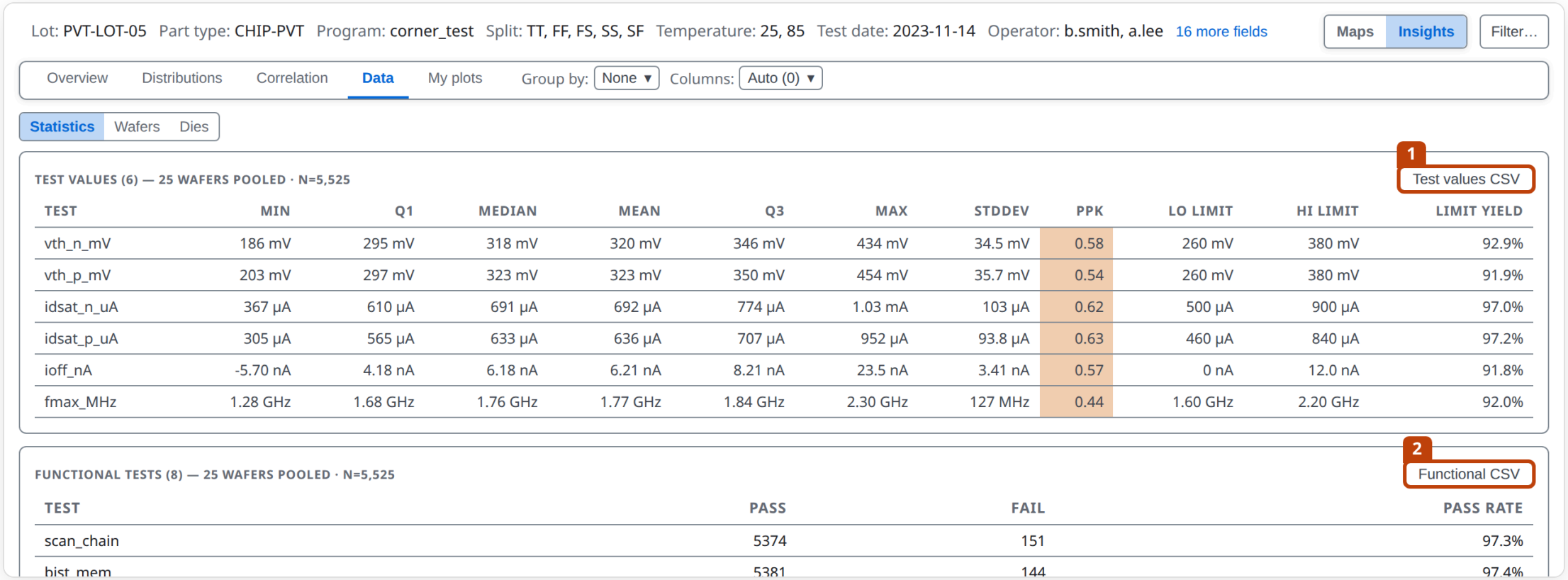
The Data tab

Every chart is drawn from numbers, and you can have them. **Data**, the tab after Correlation, holds every number behind the charts as tables. The foot of the Overview links to it too.



Statistics

The **Data** tab holds the same numbers as tables, in three sub-tabs: Statistics, Wafers and Dies. Statistics has two tables, each with its own CSV button: **1** **Test values CSV** and **2** **Functional CSV**.



Wafers

The Wafers table has one row per wafer: its lot fields, die counts, yield and the mean of each test.

Lot: PVT-LOT-05 Part type: CHIP-PVT Program: corner_test Split: TT, FF, FS, SS, SF Temperature: 25, 85 Test date: 2023-11-14 Operator: b.smith, a.lee 16 more fields

Maps Insights Filter…

Overview Distributions Correlation **Data** My plots Group by: None ▾ Columns: Auto (0) ▾

Statistics **Wafers** Dies

Copy Export CSV

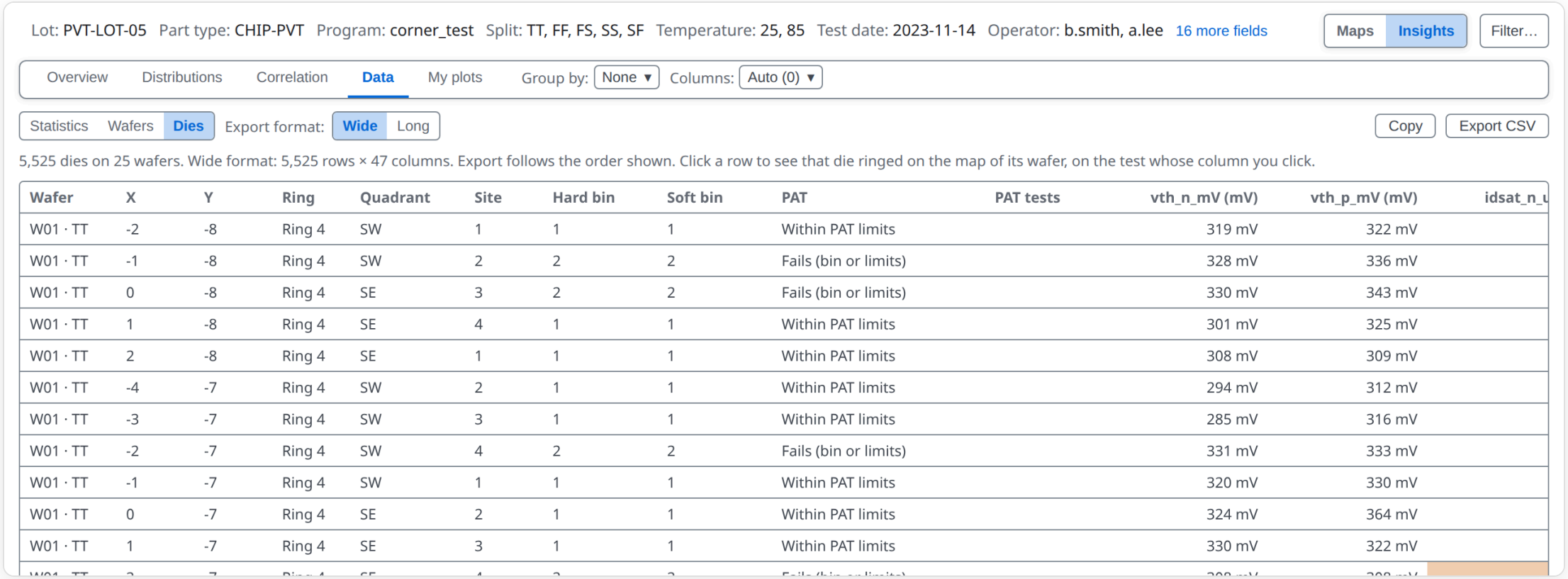
25 wafers. Click a row to open that wafer, on the test whose mean you click, or on its bins for its yield. Export follows the order shown.

Same on every wafer: Setup date 2023-11-14T22:13:20 · Test date 2023-11-14T22:18:20 · Test station 1 · Test mode P · Lot PVT-LOT-05 · Part type CHIP-PVT · Program corner_test · Test code WS · Wafer diameter 300 mm · Die height 16.9 mm · Die width 16.9 mm · Wafer flat Bottom · Centre die X 0 · Centre die Y 0 · X increases Right · Y increases Up · Probe head 1 · Site group 1 · Wafer start date 2023-11-14T22:18:20 · Handler type Prober · Handler PRB-11 · Probe card type Cantilever · Wafer finish date 2023-11-14T23:13:20

Wafer	Dies	Yield-eligible dies	Yield %	vth_n_mV (mV) mean	vth_p_mV (mV) mean	idsat_n_uA (uA) mean	idsat_p_uA (uA) mean	ioff_nA (nA) mea
W01 · TT	221	221	91.4	320 mV	319 mV	700 µA	651 µA	4.99 n
W02 · FF	221	221	68.8	282 mV	279 mV	820 µA	763 µA	9.05 n
W03 · TT	221	221	91.0	320 mV	319 mV	696 µA	652 µA	5.07 n
W04 · SS	221	221	54.8	360 mV	360 mV	575 µA	532 µA	1.51 n
W05 · TT	221	221	89.6	320 mV	321 mV	697 µA	647 µA	5.02 n
W06 · FS	221	221	62.9	284 mV	354 mV	805 µA	554 µA	6.52 n
W07 · TT	221	221	82.8	311 mV	311 mV	663 µA	618 µA	7.15 n
W08 · SF	221	221	40.3	340 mV	271 mV	575 µA	721 µA	9.95 n
W09 · TT	221	221	84.2	309 mV	307 mV	669 µA	626 µA	7.24 n

Dies

The Dies table has one row per die: position, ring, quadrant, site, bins, every test and the PAT verdict. **Copy** puts it on the clipboard and **Export CSV** saves a file; **Wide** has a column per test, **Long** a row per die and test.



Wafer	X	Y	Ring	Quadrant	Site	Hard bin	Soft bin	PAT	PAT tests	vth_n_mV (mV)	vth_p_mV (mV)	idsat_n_u
W01 · TT	-2	-8	Ring 4	SW	1	1	1	Within PAT limits		319 mV	322 mV	
W01 · TT	-1	-8	Ring 4	SW	2	2	2	Fails (bin or limits)		328 mV	336 mV	
W01 · TT	0	-8	Ring 4	SE	3	2	2	Fails (bin or limits)		330 mV	343 mV	
W01 · TT	1	-8	Ring 4	SE	4	1	1	Within PAT limits		301 mV	325 mV	
W01 · TT	2	-8	Ring 4	SE	1	1	1	Within PAT limits		308 mV	309 mV	
W01 · TT	-4	-7	Ring 4	SW	2	1	1	Within PAT limits		294 mV	312 mV	
W01 · TT	-3	-7	Ring 4	SW	3	1	1	Within PAT limits		285 mV	316 mV	
W01 · TT	-2	-7	Ring 4	SW	4	2	2	Fails (bin or limits)		331 mV	333 mV	
W01 · TT	-1	-7	Ring 4	SW	1	1	1	Within PAT limits		320 mV	330 mV	
W01 · TT	0	-7	Ring 4	SE	2	1	1	Within PAT limits		324 mV	364 mV	
W01 · TT	1	-7	Ring 4	SE	3	1	1	Within PAT limits		330 mV	322 mV	

LAB Try it yourself

1. In the web app, **Load sample data**, then switch to **Insights**
2. On **Distributions**, pick **ioff_nA** and turn on **Clip outliers**
3. On **Data → Dies**, export the table

Recap

- **Distributions** shows how values spread and where tests sit against their limits
- With **Group by** on, the same tab compares groups of wafers
- **Data** holds every number as a table you can export

You can now say how a test behaves and whether groups differ. Next: which tests move together.

More in the wafer map guide



Next lesson

07 · Correlation →

Which tests move together.



Correlation

Lesson 07

Learn tsmap

In this lesson

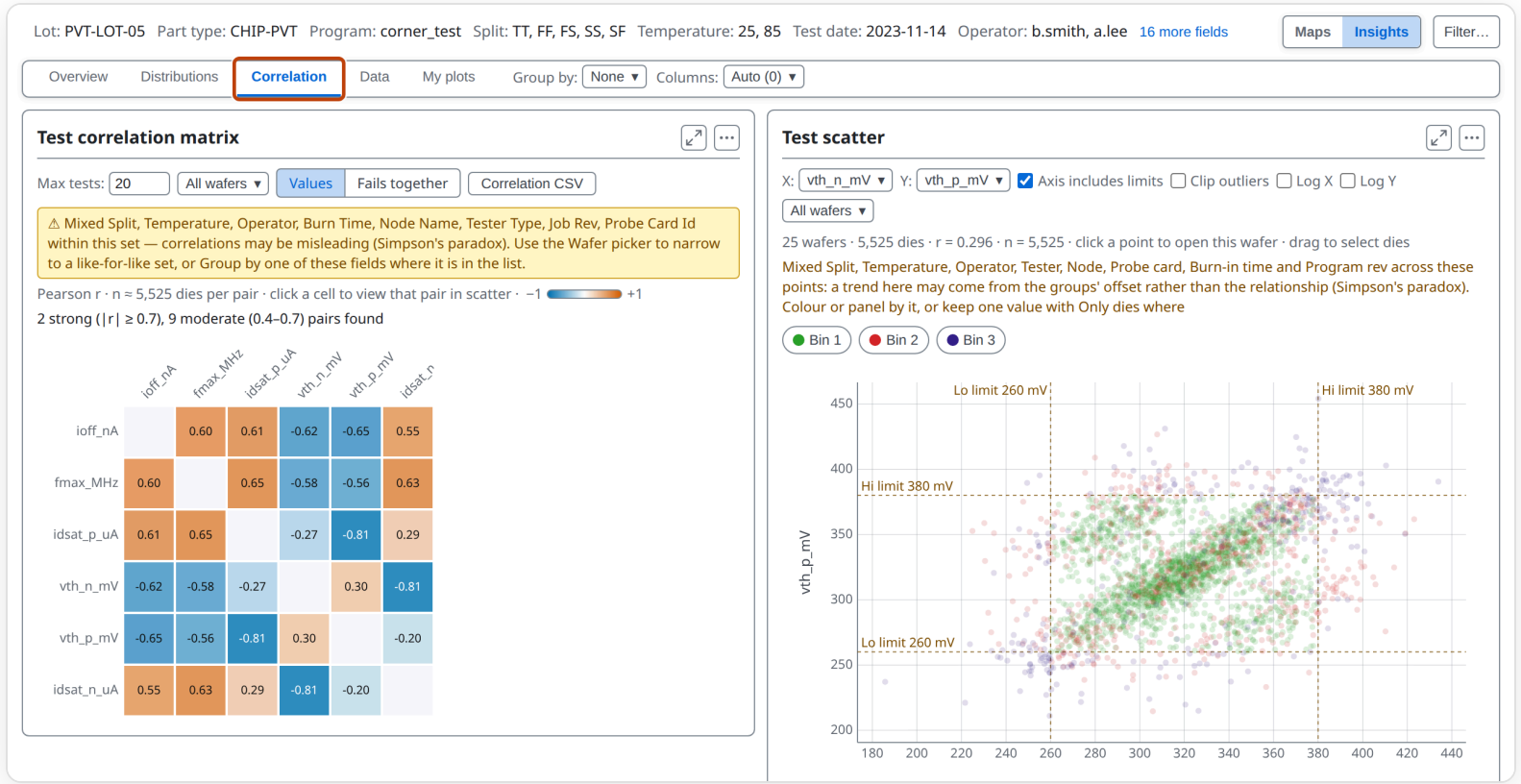
When one test moves, does another move with it? Knowing which tests travel together helps you find a shared cause, and spot a number that only looks like a link. This lesson shows how to read the matrix, and how to check a relationship before you trust it.

- Read the correlation matrix and open a pair as a scatter
- Check a relationship wafer by wafer and group by group
- Chart just the dies you drag a box around

The matrix and the scatter

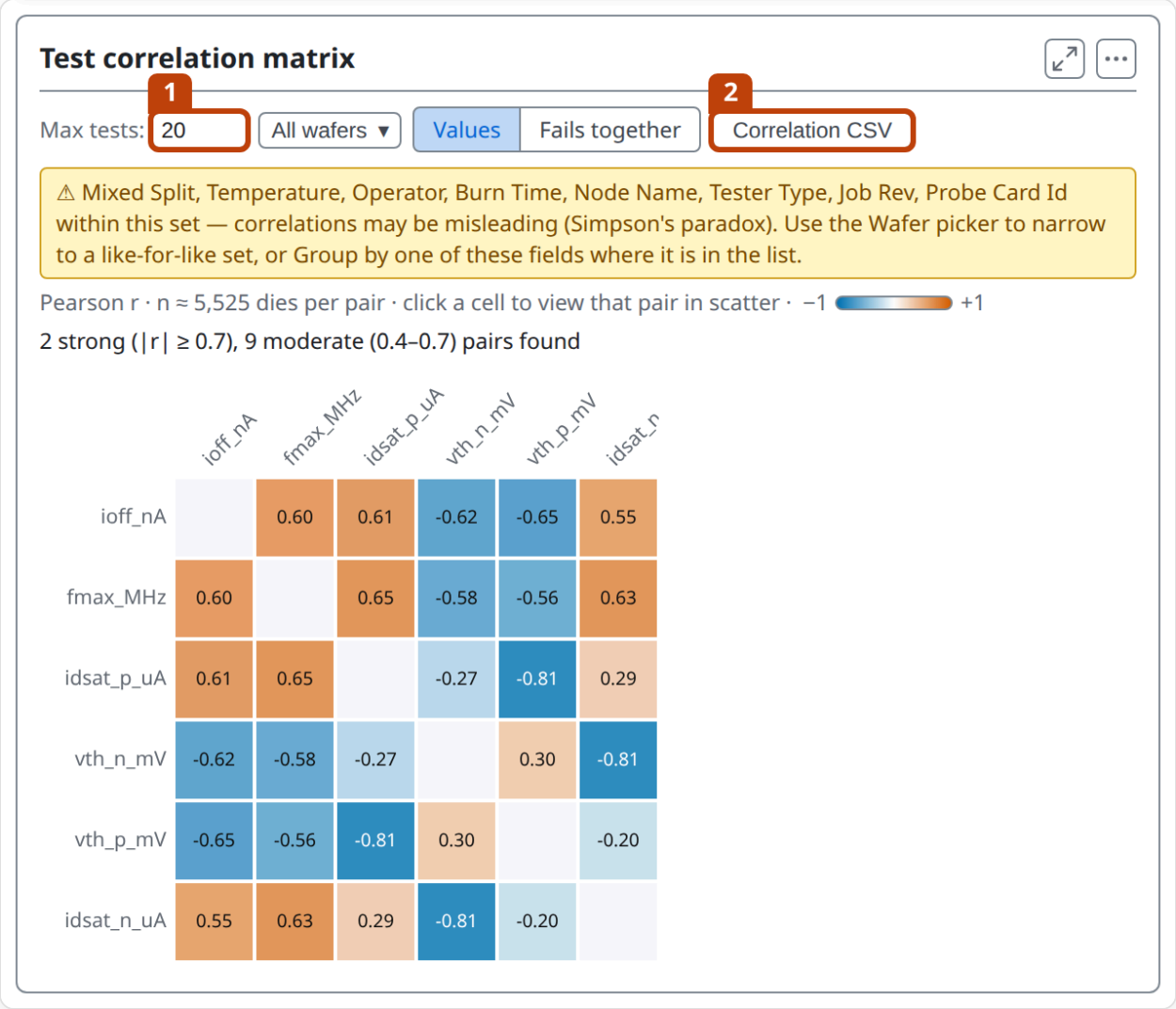
The Correlation tab

The matrix on the left shows the correlation between every pair of tests. The scatter on the right shows one pair, with a point for each die. Use the matrix to find a pair worth looking at, then the scatter to see it.



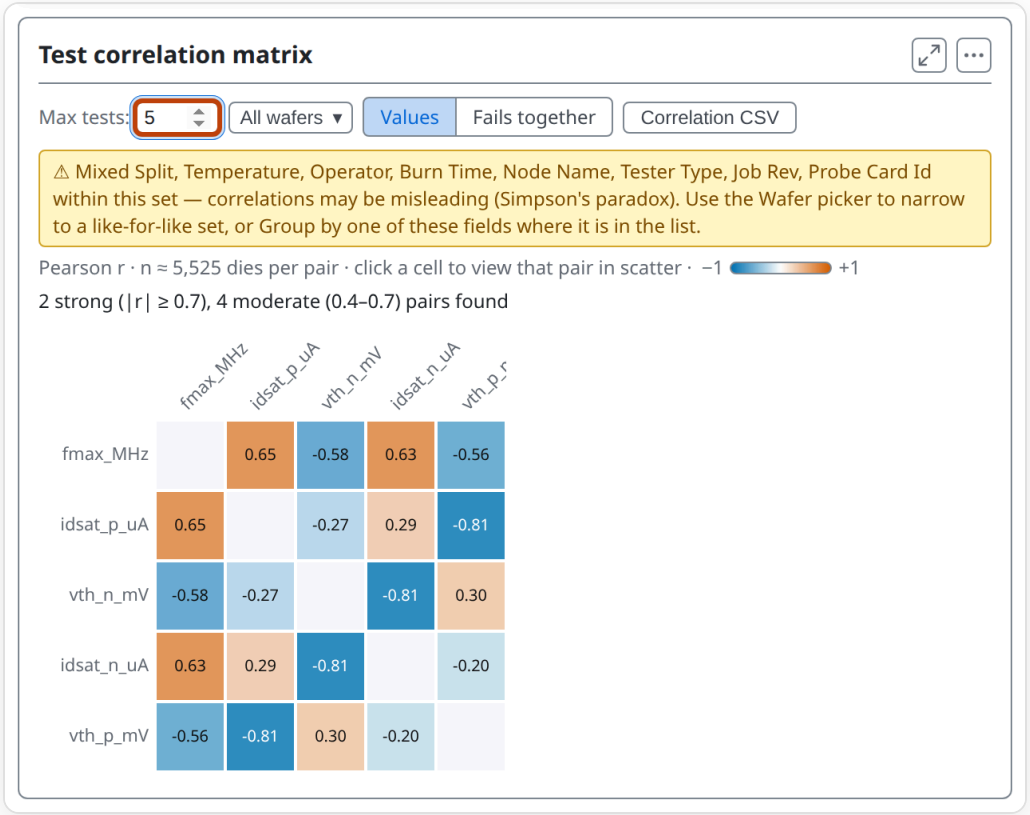
The matrix

Each cell is r for two tests. Blue: they rise together; orange: one falls as the other rises. Stronger colour, stronger link. A link is not a cause, but it tells you where to look. **1** sets how many tests; **2** saves a table.



Fewer tests

A matrix of many tests gets hard to read. You can set **Max tests** between 5 and 100 (default 20). The card counts pairs with |r| of 0.7 or more as strong and 0.4 to 0.7 as moderate. With five tests it finds 2 strong and 4 moderate.



Values or fails together

Values colours each cell by r, how two tests' values move together. **Fails together** asks a different question: of the dies that fail either of two tests, what share fail both?



Reading fails together

Read this view when you want to know which failures go together.

- A high cell means the two tests tend to fail on the same dies, which often means one cause
- A low cell means they fail on different dies
- The card names the pair that shares the most failures, and clicking a cell shows that pair in the scatter

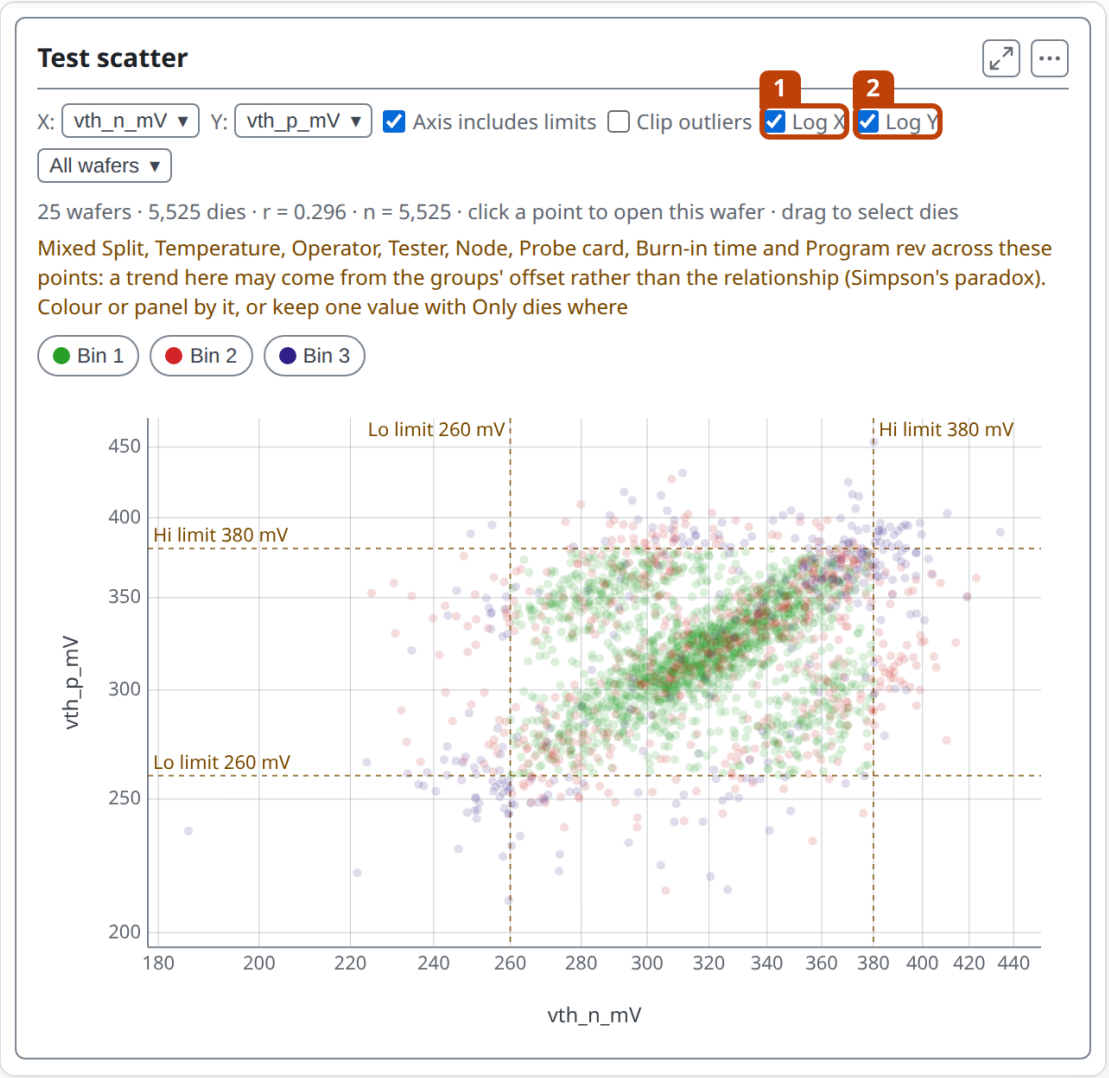
Open a pair

Click a cell and the scatter shows that pair, with **r** and **n**, the number of dies, above it. Here `idsat_p_uA` falls as `vth_p_mV` rises, r = −0.81, a strong link. Click a point to open its wafer's map.



Log axes

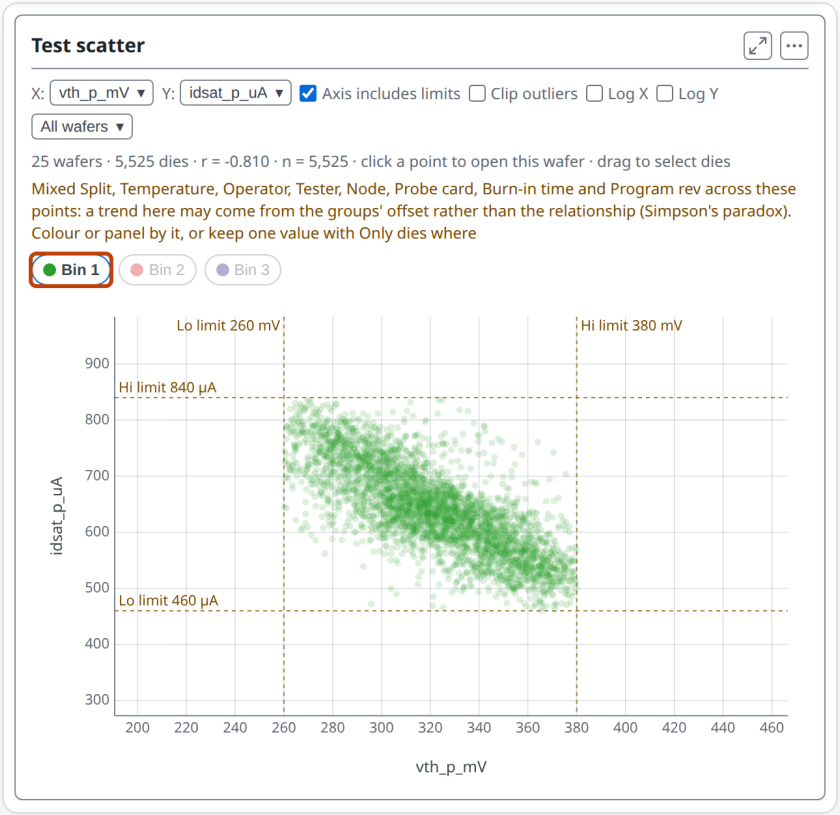
Log X and **Log Y** draw an axis on a log scale, which helps when values run over several orders of magnitude, such as leakage. Each is offered only while every value on that axis is above zero, because a log scale cannot show zero or a negative number.



Is it real?

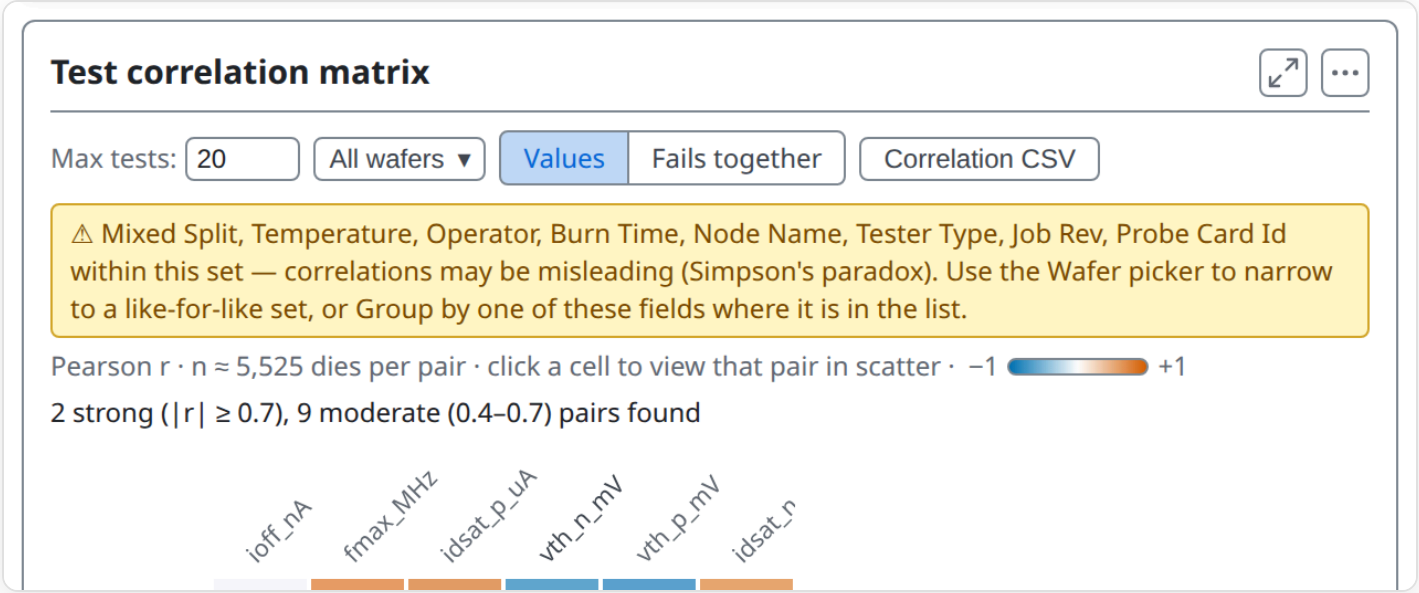
Bin buttons

The **Bin 1**, **Bin 2** and **Bin 3** buttons above the plot show or hide the dies of each bin. Click one to switch it off or on. This shows whether failing dies sit at one end of the relationship, which tells you whether the link has anything to do with yield.



The Mixed Split warning

A strong r is not always real. Pooling splits can make a trend that is only the groups sitting at different levels, not a link inside each group (Simpson's paradox). The card warns when the dies mix a field, so you know to check.



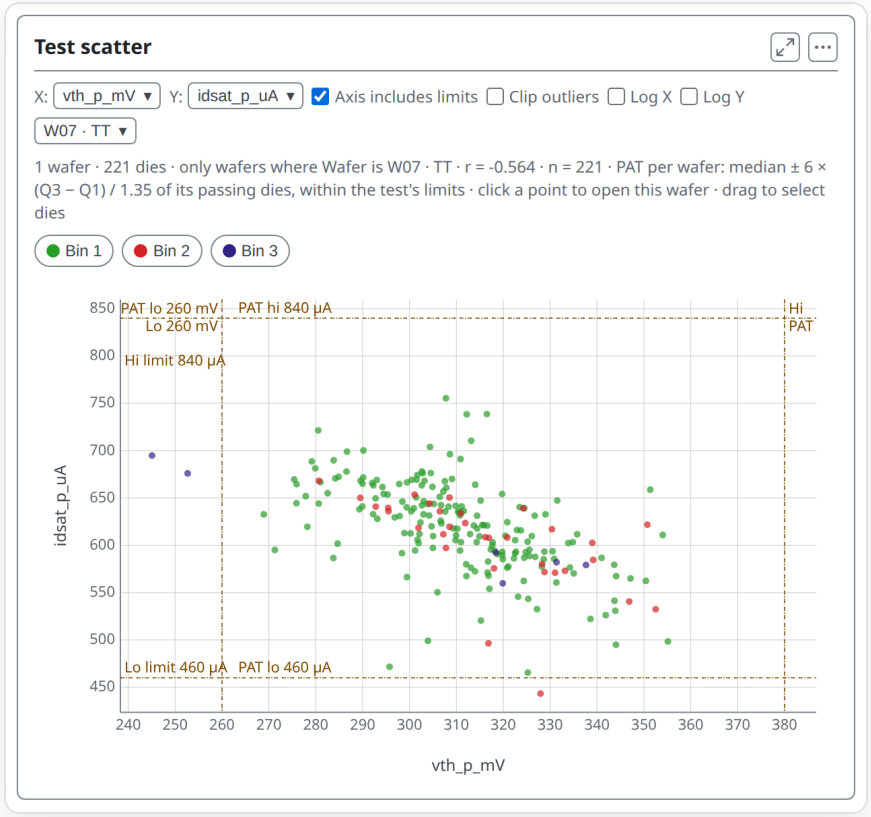
One wafer at a time

The first check is to look at one wafer. The **Wafer** menu narrows the scatter to one wafer. The **X** and **Y** menus pick the tests, as the matrix cells do.



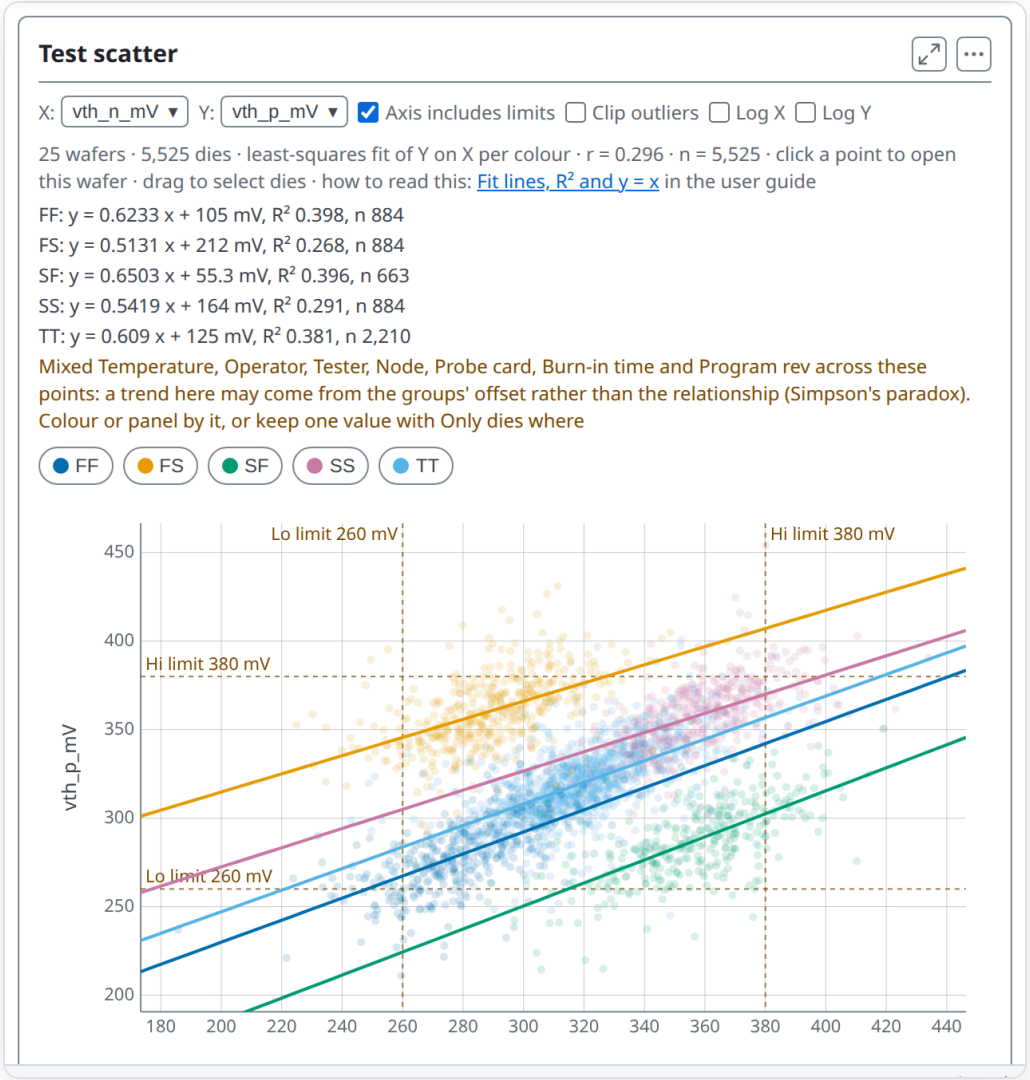
Inside one wafer

Looking at W07 alone, r is −0.564, not −0.81. Part of the pooled figure may come from the splits sitting at different levels. The warning is gone because only one wafer is left. The link is still there, but weaker than the pooled figure suggested.



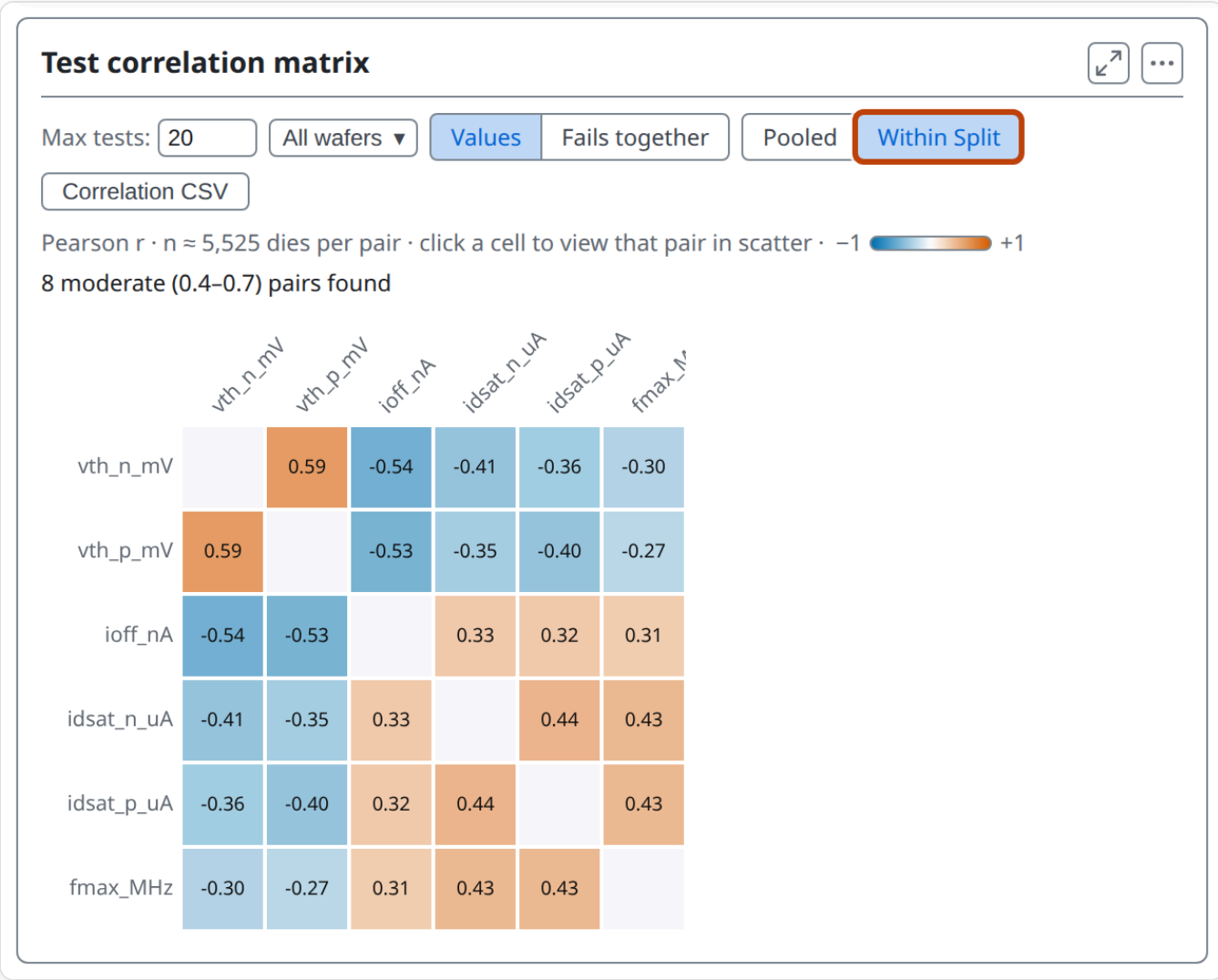
A line for each group

The second check is to look at each group. With Group by on, the scatter colours the dies by group and draws a fitted line through each. If the lines sit apart but run parallel, the groups differ in level; if they run in different directions, the pair does not move together in the same way in every group.



Within groups

You can run the same check on the whole matrix. With Group by on, it offers **Pooled | Within Split**. Pooled is the matrix you have seen. **Within** takes each group's own mean off every test first.



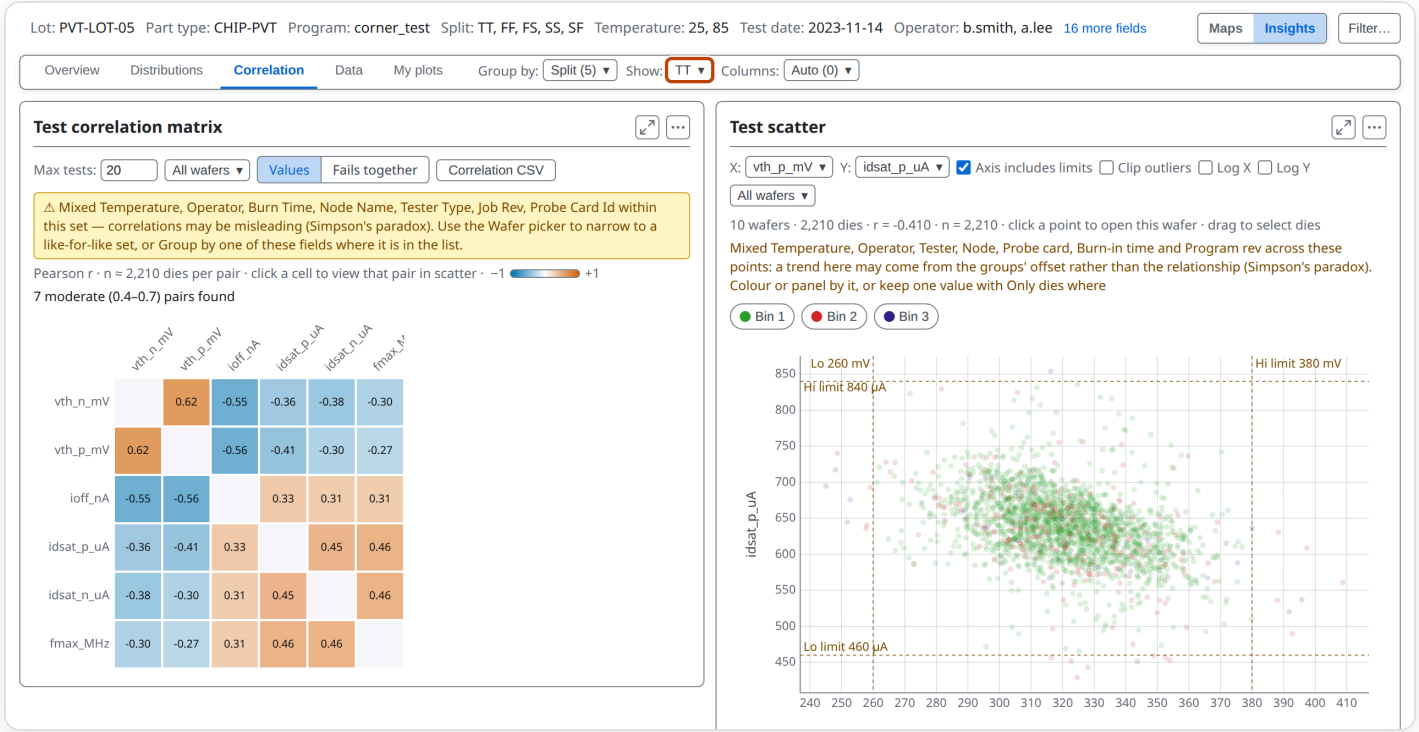
Pooled or within

Compare the two views pair by pair.

- Taking the group means off means a difference in level between groups is not read as a link between tests
- A pair that is strong pooled but weak within is the groups sitting at different levels, not the tests moving together
- A pair that stays strong within is a link inside every group

Group by

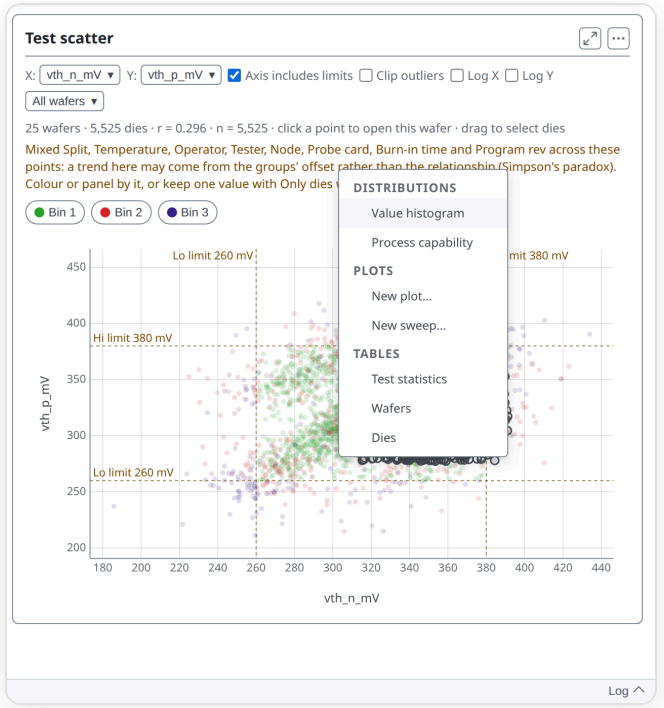
You can also look at one group on its own. **Group by** → **Split**, then **Show** → **TT**: the matrix and scatter use only TT's dies. `idsat_p_uA` against `vth_p_mV` reads r = −0.41 inside TT, not −0.81 pooled. The link holds, but part of the pooled figure was the splits sitting at different levels.



Dies from the scatter

Drag a box

To find out which dies sit at an extreme of the relationship, drag a rectangle over the scatter. The dies inside it, on any wafer, open the menu of charts and tables for just those dies.



(The same menu is the subject of lesson 08.)

LAB Try it yourself

1. In the web app, **Load sample data**, then **Insights** → **Correlation**
2. Click the cell for **idsat_p_uA** and **vth_p_mV**: what is r?
3. Pick **W07 · TT** in the **Wafer** menu: how does r change?
4. **Group by** → **Split**, then **Show** → **TT**, and pick the same two tests again in **X** and **Y**: does it still hold?
5. Drag a box over the scatter: how many dies does the menu say you have selected?

ANSWERS

Check your results

2. **`idsat_p_uA`** against **`vth_p_mV`** reads r = −0.81: when one rises the other falls. (`vth_n_mV` against `idsat_n_uA` reads −0.81 as well.)
3. On W07 · TT alone r is **−0.564**, weaker than the pooled −0.81. The warning has gone, because one wafer is not a mix of splits.

ANSWERS Check your results, continued

4. Inside TT, r is **−0.41**: still clearly negative, but weaker than pooled. Some of the pooled figure came from the splits sitting at different levels.
5. The menu names how many dies you selected; it depends on the box you drag.

Recap

- The matrix shows every pair; a cell opens that pair as a scatter
- r says two tests move together, not why
- Check it wafer by wafer and group by group before trusting a pooled figure

Next you will learn to filter and chart exactly the dies you care about.

More in the wafer map guide



Next lesson

08 · Drilling into any population →

Filter, select and chart just the dies you care about.



Drilling into any population

Lesson 08

Learn tsmap

In this lesson

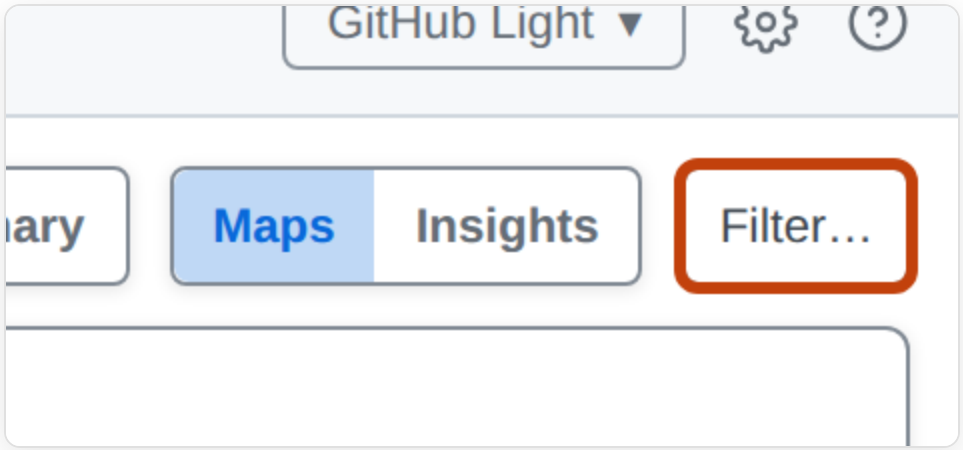
Sooner or later you want to ask about part of the data: one split, one bin, one region of a wafer. This lesson shows the two tools for that, filters and selections, and what the right-click menu does with them.

- Keep only the wafers and dies that meet your conditions
- Chart and tabulate any selection, bin or wafer
- Know what each entry of the right-click menu opens

Filtering

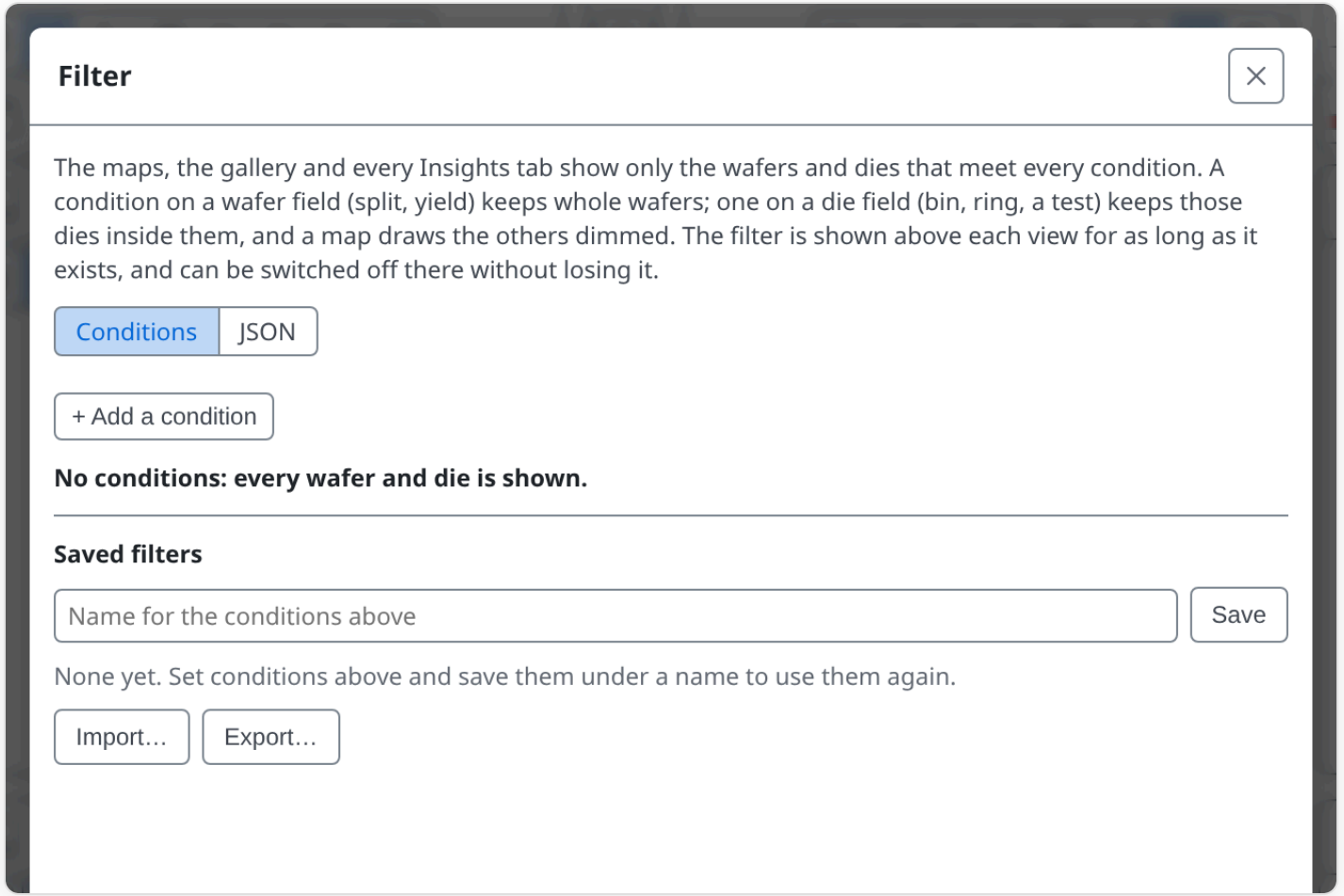
Filter…

Filter… lets you look at only the data you care about. The button is at the right of the toolbar, beside Maps and Insights. It keeps only the wafers and dies that meet conditions you set, in the gallery, on a single map and on every Insights tab.



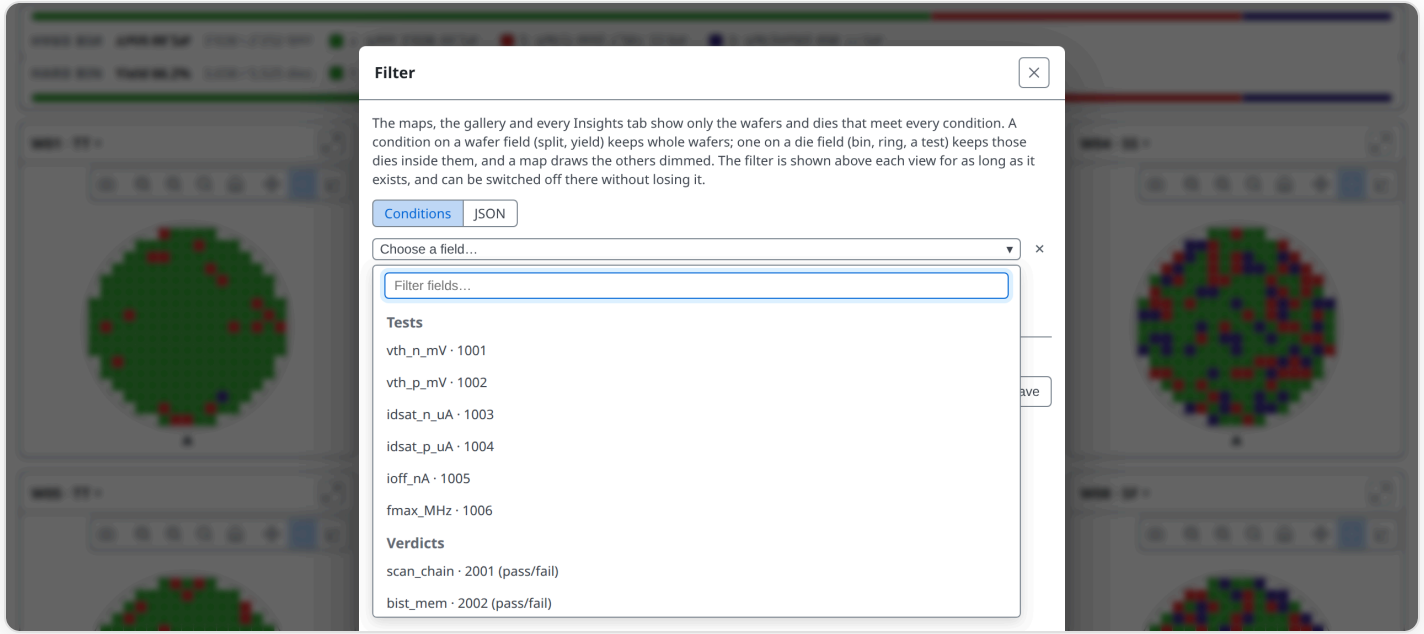
The Filter window

Add conditions; every one must hold. At the bottom of the window, **Apply** filters and **Cancel** leaves things as they were.



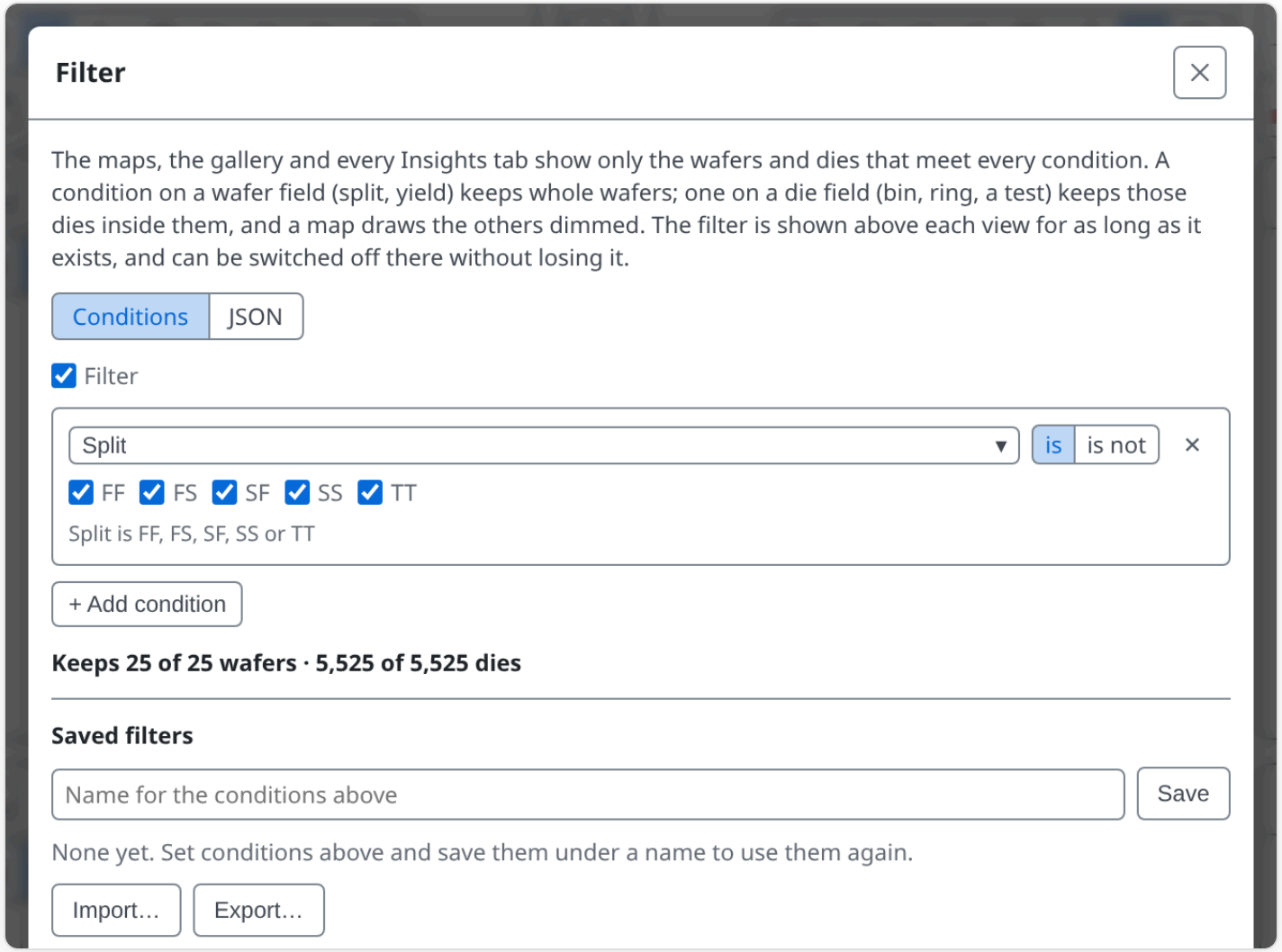
Choose a field

Each condition starts with a field: a test, a die field such as bin, ring or site, or a wafer field such as split, lot or yield. Type to search the list.



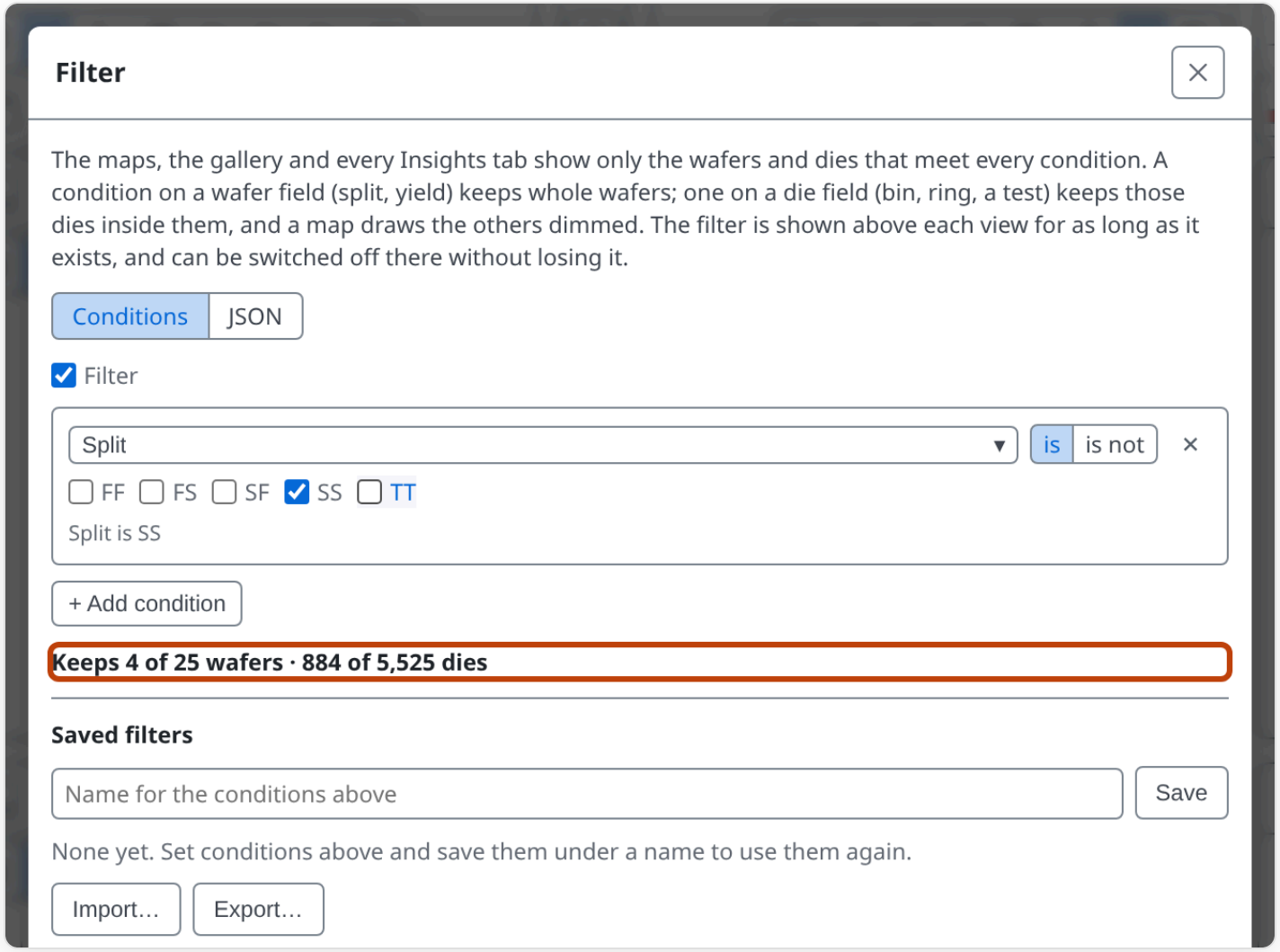
Category and number fields

A category field, such as the split, lists its values to tick; **is not** keeps everything except the ticked values. A number field, such as a test or a wafer's yield, keeps a range.



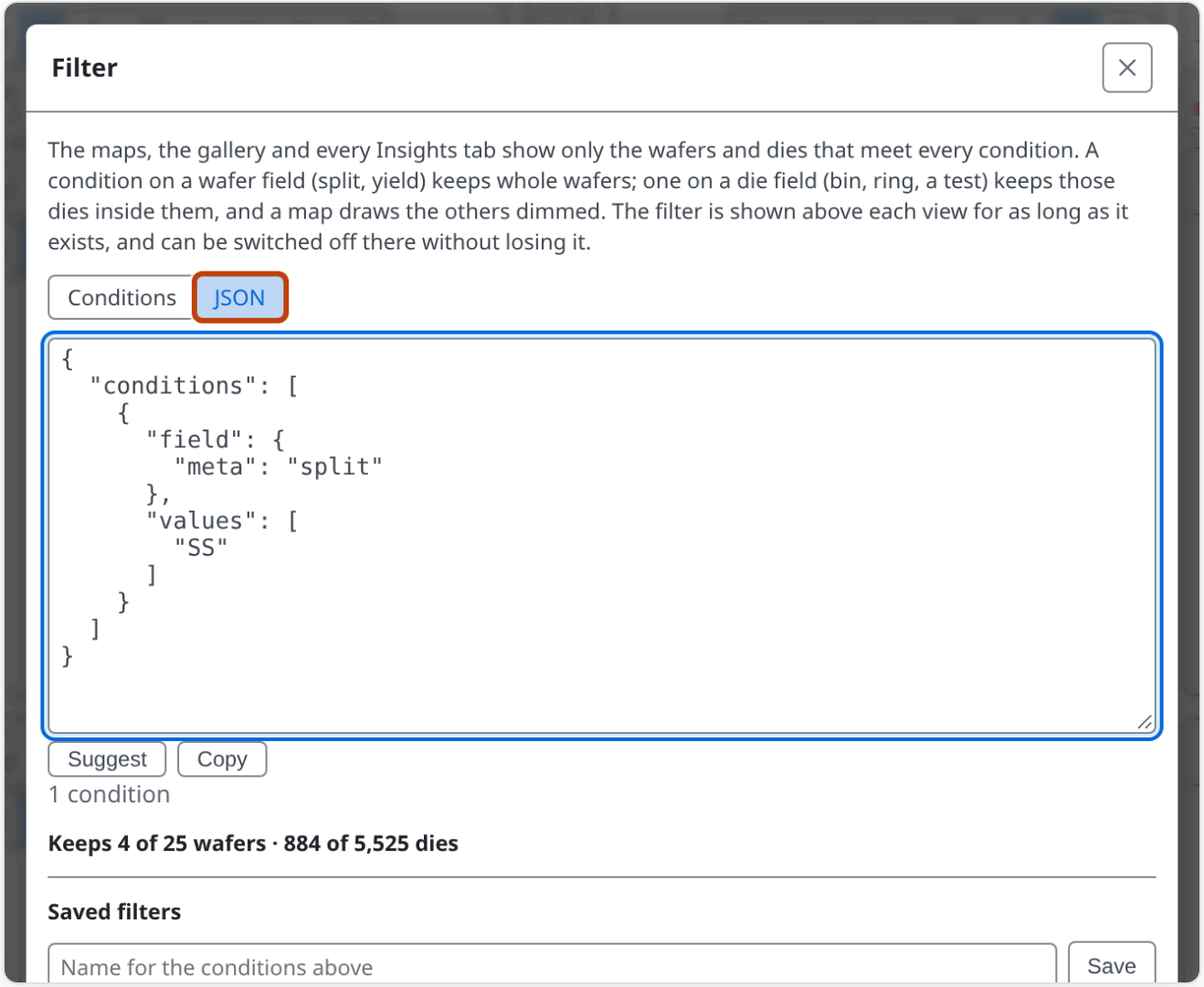
What it would keep

Untick every split except SS. As you edit, the window shows how many wafers and dies the conditions would keep, so you can check the filter before you apply it.



The filter as text

Conditions | JSON at the top of the window switches between the list of conditions and the same filter written as text. Edit it, paste one a colleague sent, or **Copy** it.



Suggestions in the JSON

- **Suggest**, or typing a comma or a brace, offers the keys, the lot's fields and tests, and the values a field takes
- The line under the text says how many wafers and dies the filter keeps, and follows what you type
- While the text cannot be read, **Apply** is held and the window says why

Wafer or die

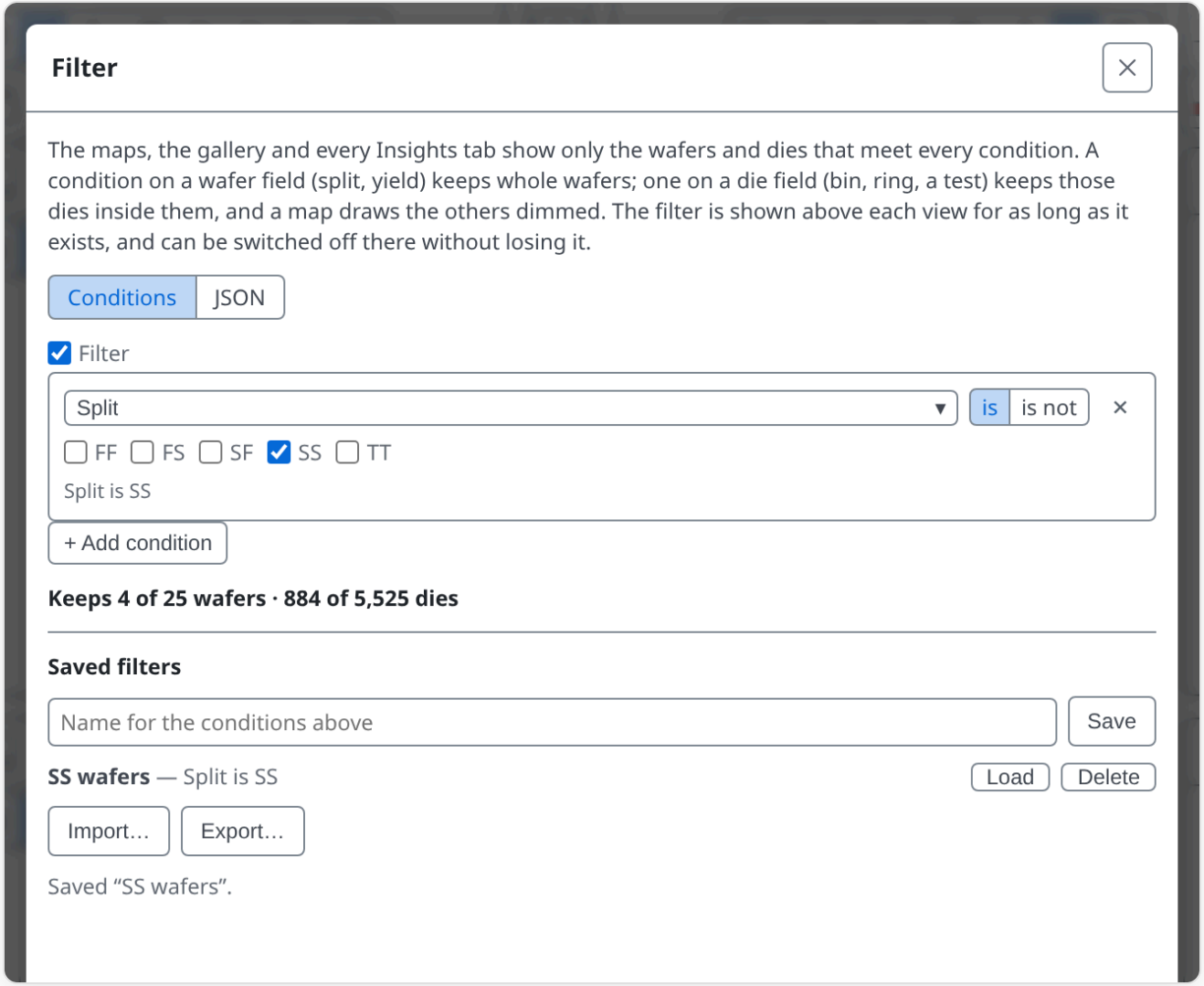
A condition works on one of two levels, and they behave differently.

- A **wafer** condition keeps whole wafers; the rest leave the gallery
- A **die** condition keeps matching dies; the rest are drawn faded
- The Summary panel and findings are worked out again over what is kept

Saved filters

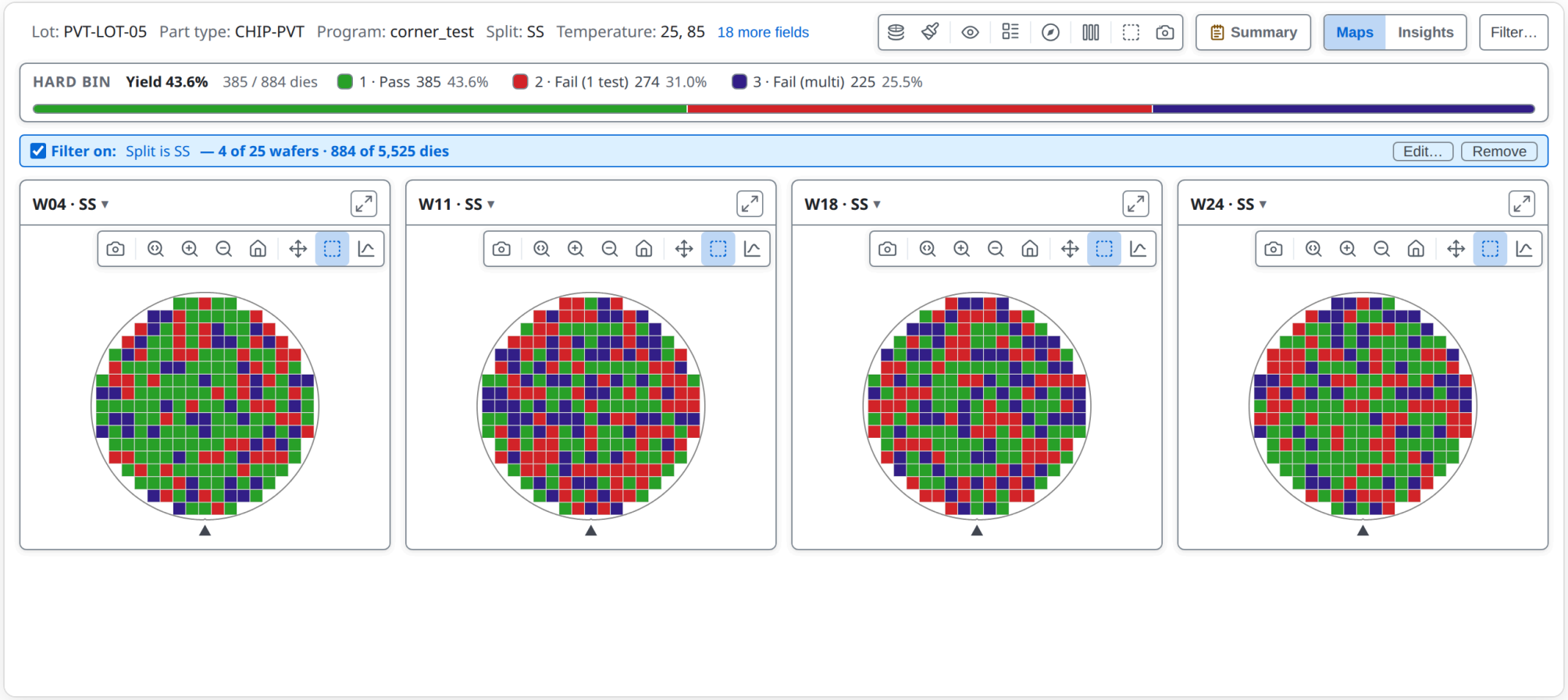
If you use a filter again and again, save it.

- **Save** keeps the conditions under a name
- **Load** puts them in the window to check; **Apply** uses them
- **Export…** writes the list to a file; **Import…** reads one back in



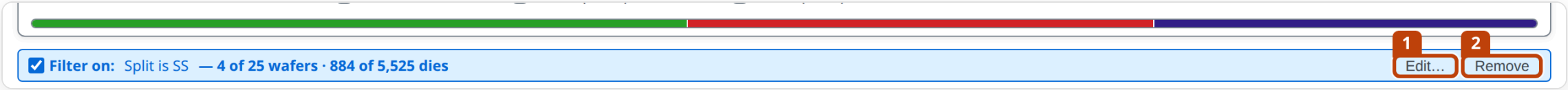
Applied

With the filter applied, four cards remain (W04, W11, W18 and W24), and the legend and yield describe only those wafers.



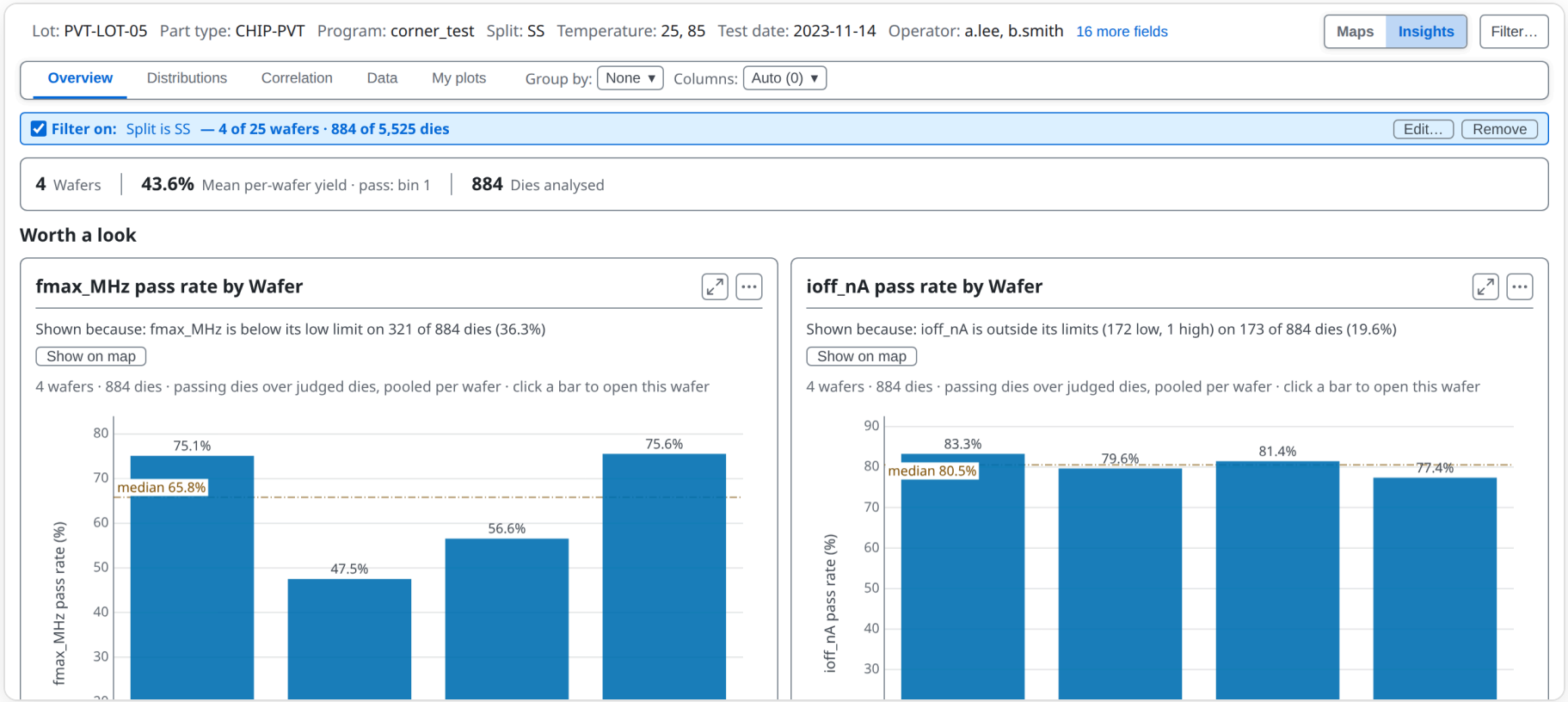
The filter line

A line above the view always states the filter and what it keeps. Its checkbox switches the filter off and on without losing it. **1** **Edit…** reopens the window; **2** **Remove** deletes the filter.



Insights follows

There is one filter for everything you are looking at, so Insights shows the same four wafers, and its charts and the **Group by** control work on what is kept. You never have to set the same filter twice.



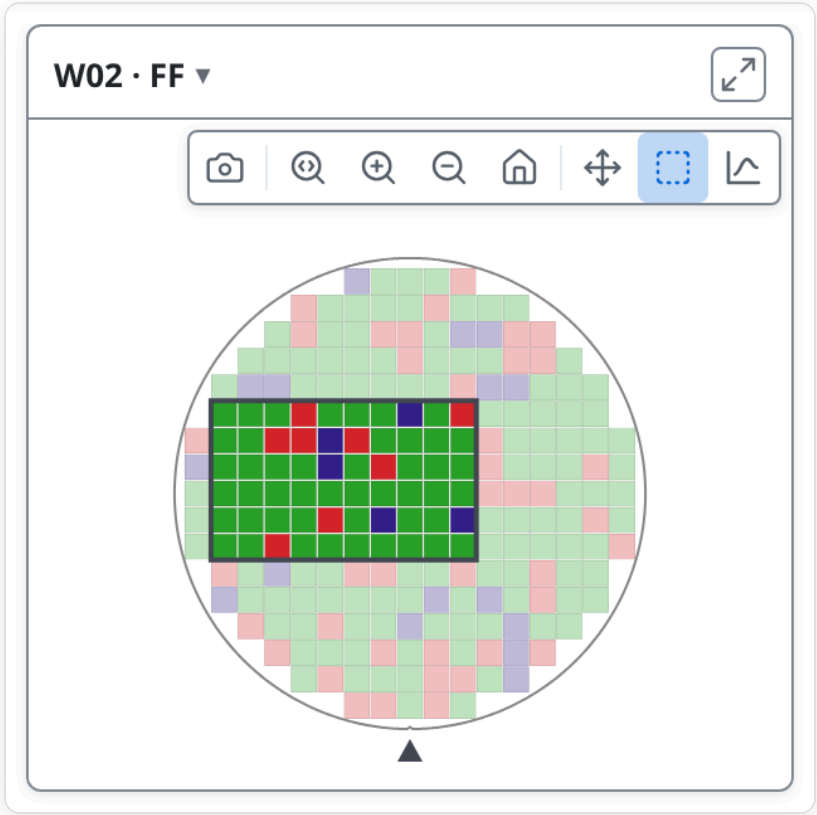
The filter stays

tsmap remembers the filter, and whether it is on, for the next lot and the next start. The line above the view always states it, so a carried-over filter is never applied unseen. **Remove** forgets it.

Charting a population

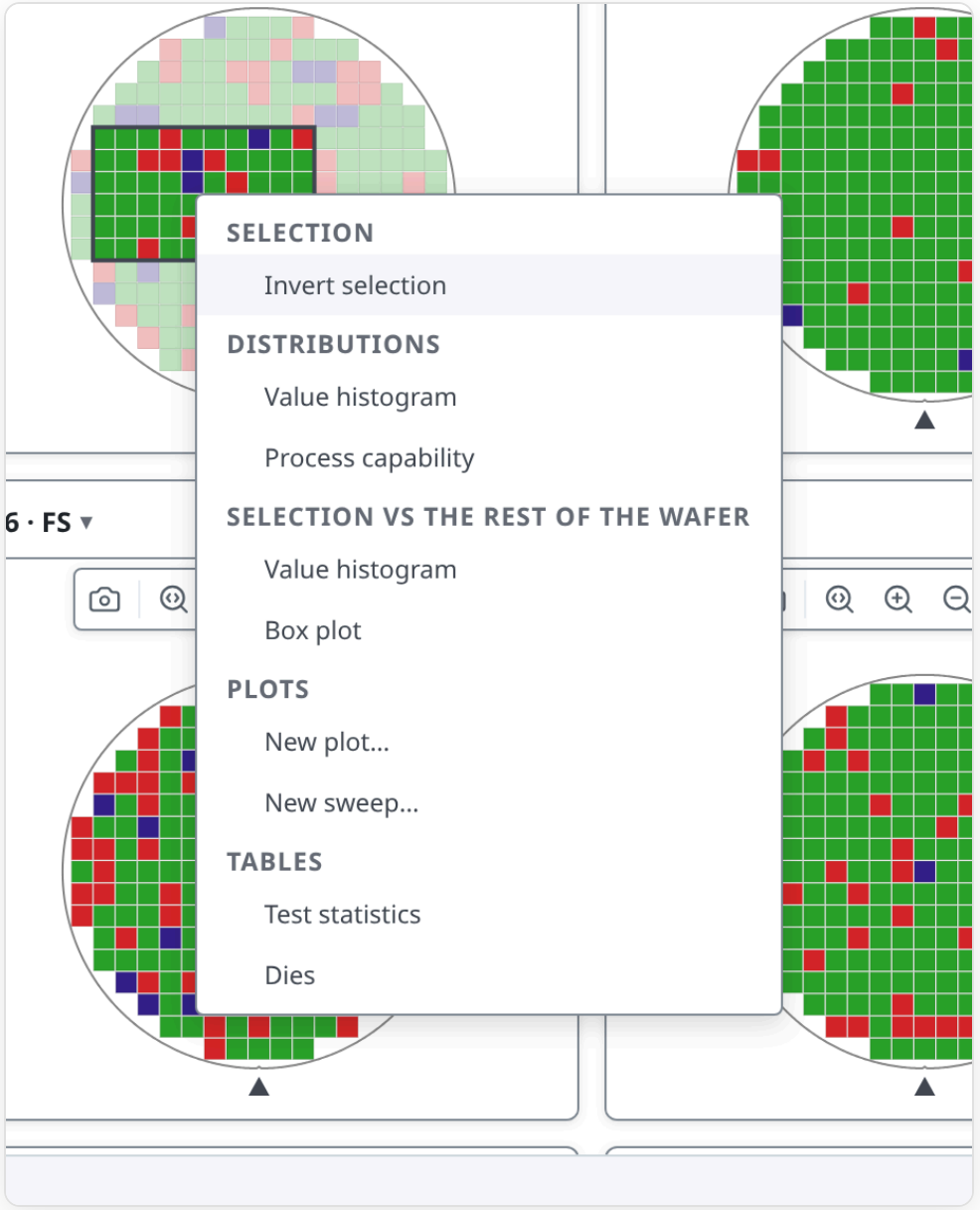
Select dies

A filter is for the whole session. A selection is for a quick question. Drag a box on a map: the selected dies keep their colour and the rest fade, with an outline round them. Ctrl or Cmd + click adds or removes a die; **Esc** clears.



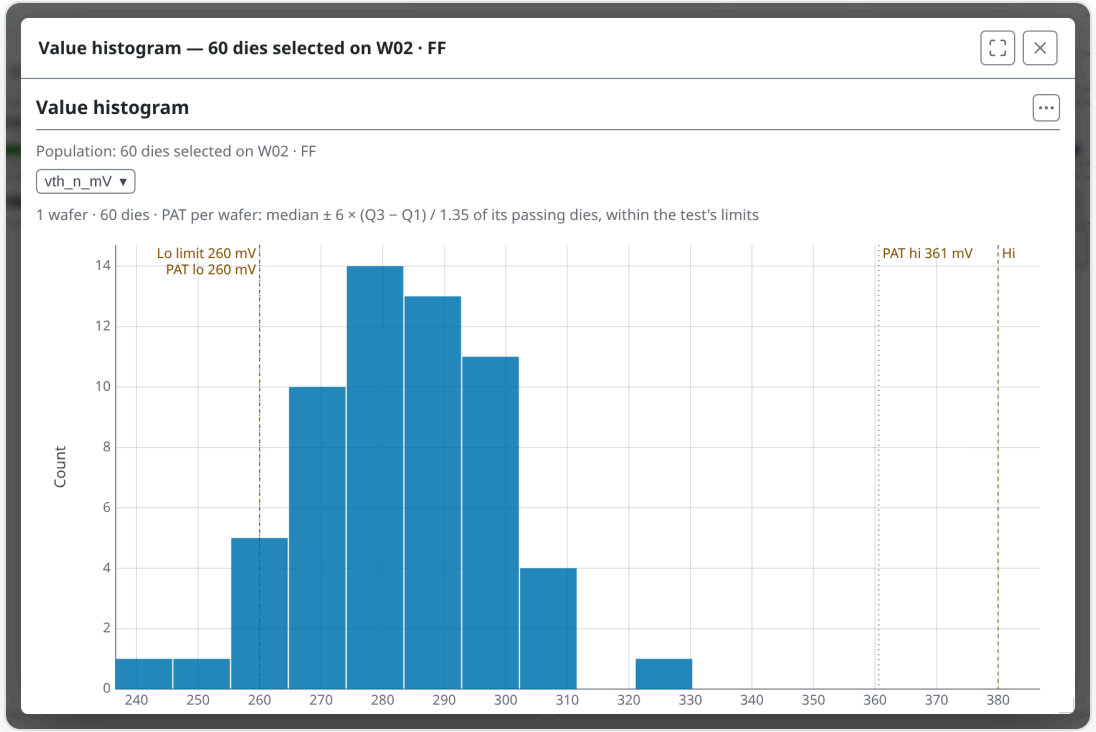
Right-click

Right-click the selection to ask about just those dies. The menu offers charts and tables: **Distributions**, your **Plots**, and **Tables**.



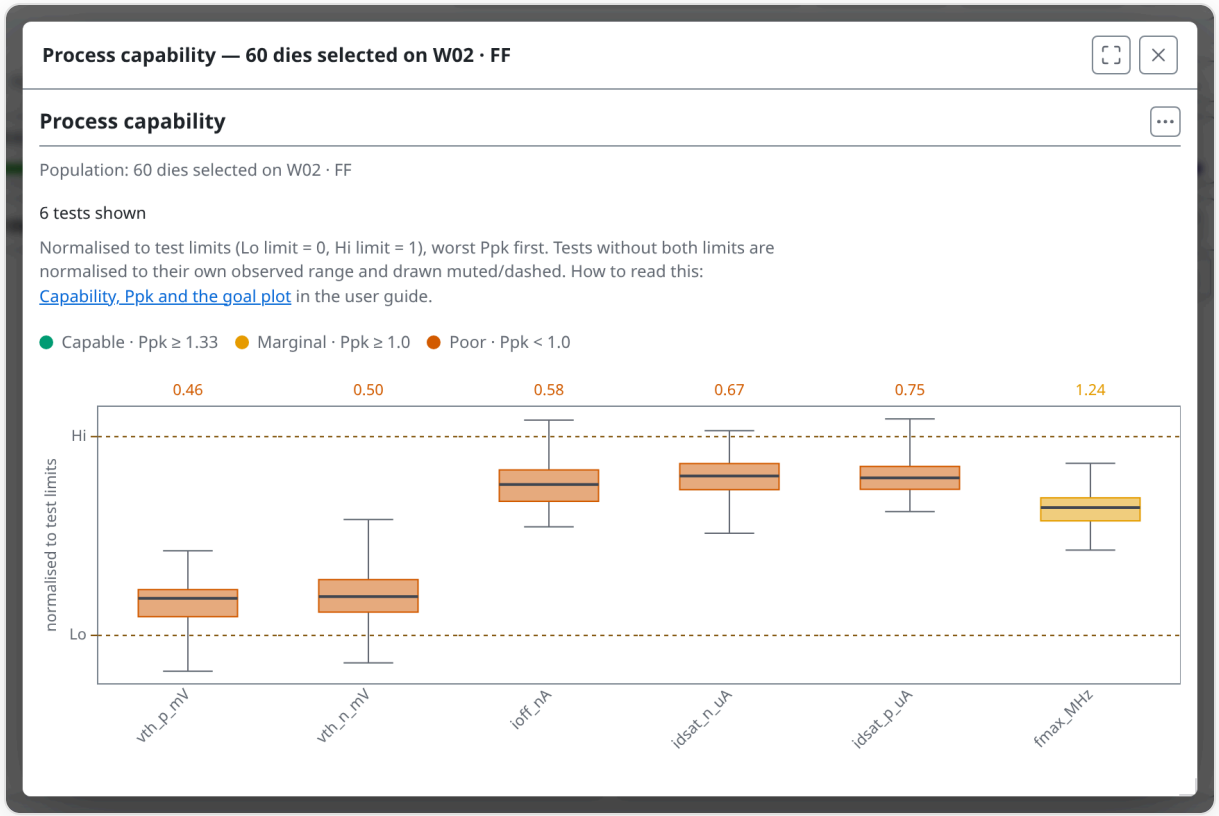
Value histogram

Value histogram shows how one test is distributed over just those dies, which tells you whether the selected region reads differently from the rest. The title and the line above state the population, so it cannot be mistaken for the whole wafer. The PAT lines are outlier limits worked out per wafer (lesson 05).



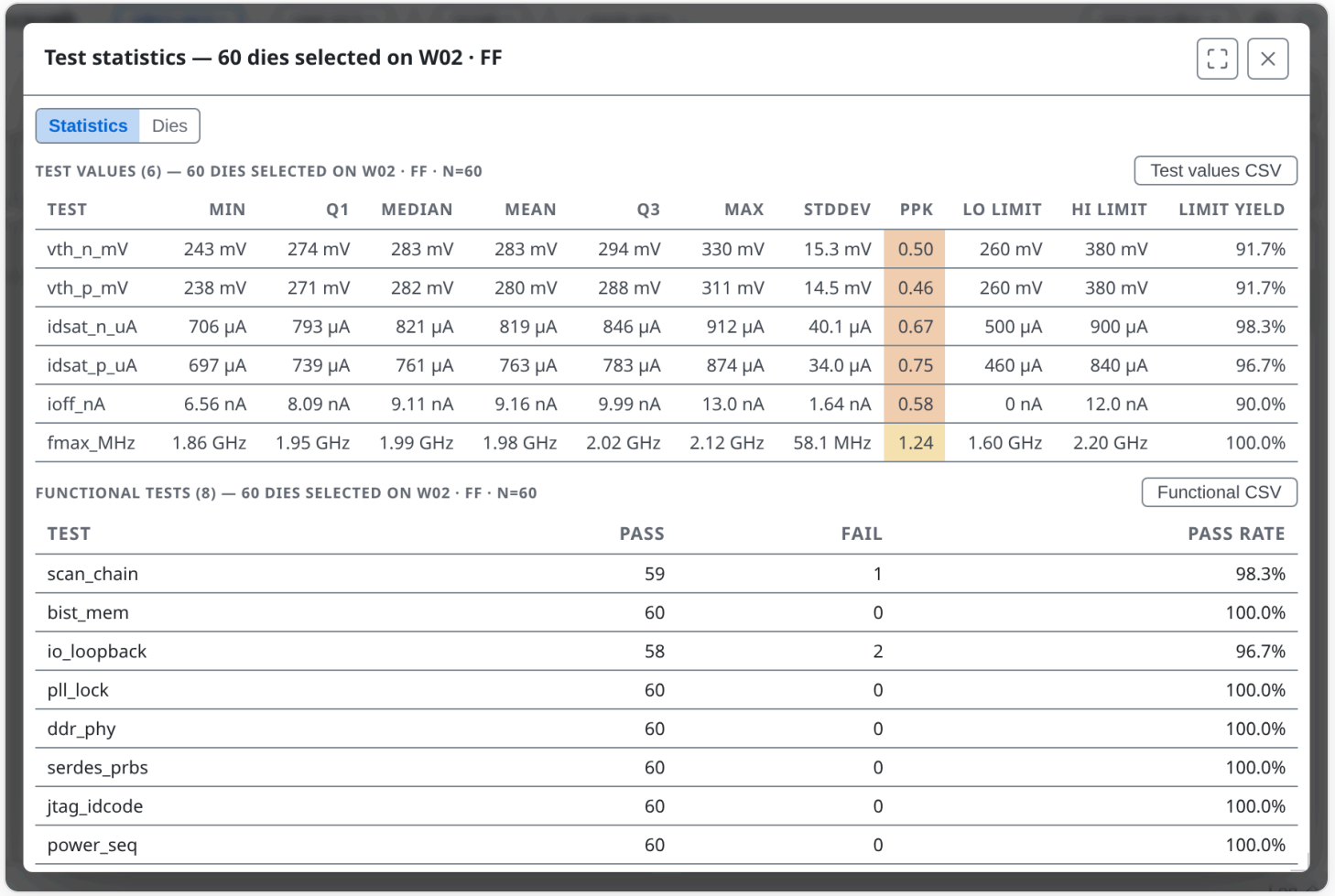
Process capability

Process capability shows each test's spread over the selected dies only, drawn against its limits and ordered worst Ppk first. Lesson 06 explains Ppk and charts the whole lot's capability, for comparison.



Test statistics

Test statistics shows the Test Values and Functional Tests tables, over the same dies.



Test statistics — 60 dies selected on W02 · FF

Statistics | Dies

TEST VALUES (6) — 60 DIES SELECTED ON W02 · FF · N=60 — Test values CSV

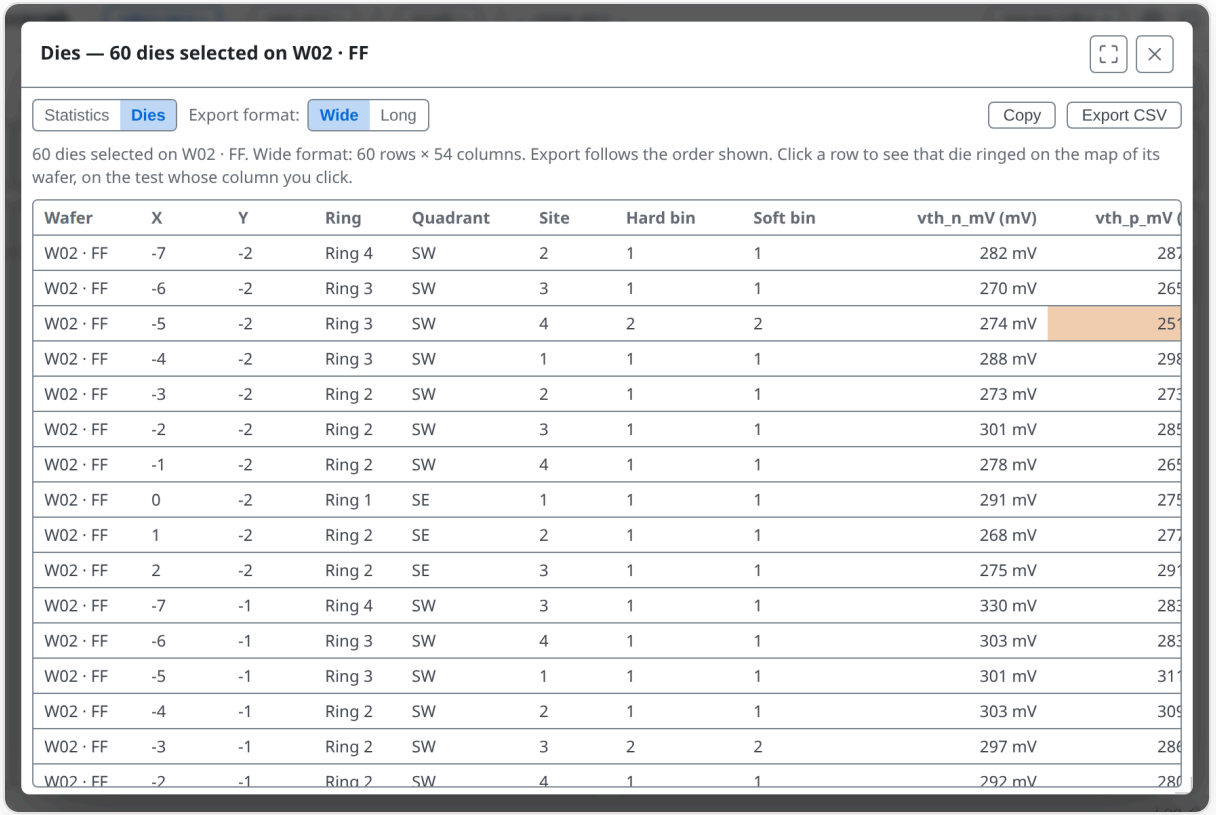
TEST	MIN	Q1	MEDIAN	MEAN	Q3	MAX	STDDEV	PPK	LO LIMIT	HI LIMIT	LIMIT YIELD
vth_n_mV	243 mV	274 mV	283 mV	283 mV	294 mV	330 mV	15.3 mV	0.50	260 mV	380 mV	91.7%
vth_p_mV	238 mV	271 mV	282 mV	280 mV	288 mV	311 mV	14.5 mV	0.46	260 mV	380 mV	91.7%
idsat_n_uA	706 µA	793 µA	821 µA	819 µA	846 µA	912 µA	40.1 µA	0.67	500 µA	900 µA	98.3%
idsat_p_uA	697 µA	739 µA	761 µA	763 µA	783 µA	874 µA	34.0 µA	0.75	460 µA	840 µA	96.7%
ioff_nA	6.56 nA	8.09 nA	9.11 nA	9.16 nA	9.99 nA	13.0 nA	1.64 nA	0.58	0 nA	12.0 nA	90.0%
fmax_MHz	1.86 GHz	1.95 GHz	1.99 GHz	1.98 GHz	2.02 GHz	2.12 GHz	58.1 MHz	1.24	1.60 GHz	2.20 GHz	100.0%

FUNCTIONAL TESTS (8) — 60 DIES SELECTED ON W02 · FF · N=60 — Functional CSV

TEST	PASS	FAIL	PASS RATE
scan_chain	59	1	98.3%
bist_mem	60	0	100.0%
io_loopback	58	2	96.7%
pll_lock	60	0	100.0%
ddr_phy	60	0	100.0%
serdes_prbs	60	0	100.0%
jtag_idcode	60	0	100.0%
power_seq	60	0	100.0%

Dies

The Dies table has one row per selected die, with its position, bins and every test value. **Export CSV** writes the table to a file and **Copy** puts it on the clipboard. Choose **Wide** (a column per test) or **Long** (a row per die and test) first.



Wafer	X	Y	Ring	Quadrant	Site	Hard bin	Soft bin	vth_n_mV (mV)	vth_p_mV (
W02 · FF	-7	-2	Ring 4	SW	2	1	1	282 mV	287
W02 · FF	-6	-2	Ring 3	SW	3	1	1	270 mV	265
W02 · FF	-5	-2	Ring 3	SW	4	2	2	274 mV	251
W02 · FF	-4	-2	Ring 3	SW	1	1	1	288 mV	298
W02 · FF	-3	-2	Ring 2	SW	2	1	1	273 mV	273
W02 · FF	-2	-2	Ring 2	SW	3	1	1	301 mV	285
W02 · FF	-1	-2	Ring 2	SW	4	1	1	278 mV	265
W02 · FF	0	-2	Ring 1	SE	1	1	1	291 mV	275
W02 · FF	1	-2	Ring 2	SE	2	1	1	268 mV	277
W02 · FF	2	-2	Ring 2	SE	3	1	1	275 mV	291
W02 · FF	-7	-1	Ring 4	SW	3	1	1	330 mV	283
W02 · FF	-6	-1	Ring 3	SW	4	1	1	303 mV	283
W02 · FF	-5	-1	Ring 3	SW	1	1	1	301 mV	311
W02 · FF	-4	-1	Ring 2	SW	2	1	1	303 mV	309
W02 · FF	-3	-1	Ring 2	SW	3	2	2	297 mV	286
W02 · FF	-2	-1	Ring 2	SW	4	1	1	292 mV	280

A snapshot of its dies

These charts are snapshots, so they do not change under you.

- Each chart states its population, so it is never taken for the whole lot
- A chart already open keeps its dies when the selection changes
- An entry that cannot be drawn stays, greyed, with the reason

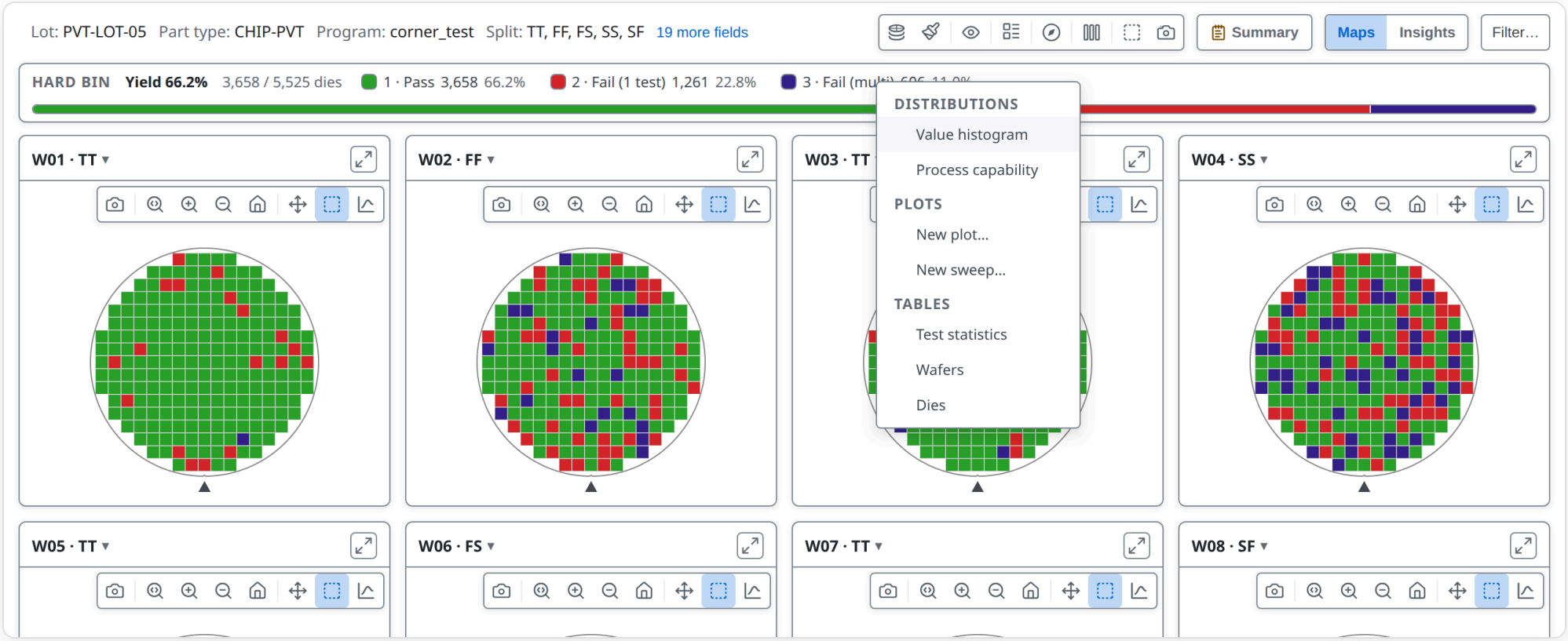
What you right-click decides the population

The menu is always the same. What changes is which dies it covers.

IF YOU RIGHT-CLICK…		THE CHARTS AND TABLES COVER…
dies you have selected	→	just those selected dies
empty map space, with nothing selected	→	every die on that wafer
a card's header	→	every die on that wafer
a bin in the legend	→	every die in that bin, on every wafer
a finding in the Summary panel	→	the dies the finding is about
a bar, box or point in an Insights chart	→	that wafer, or the dies the mark counts

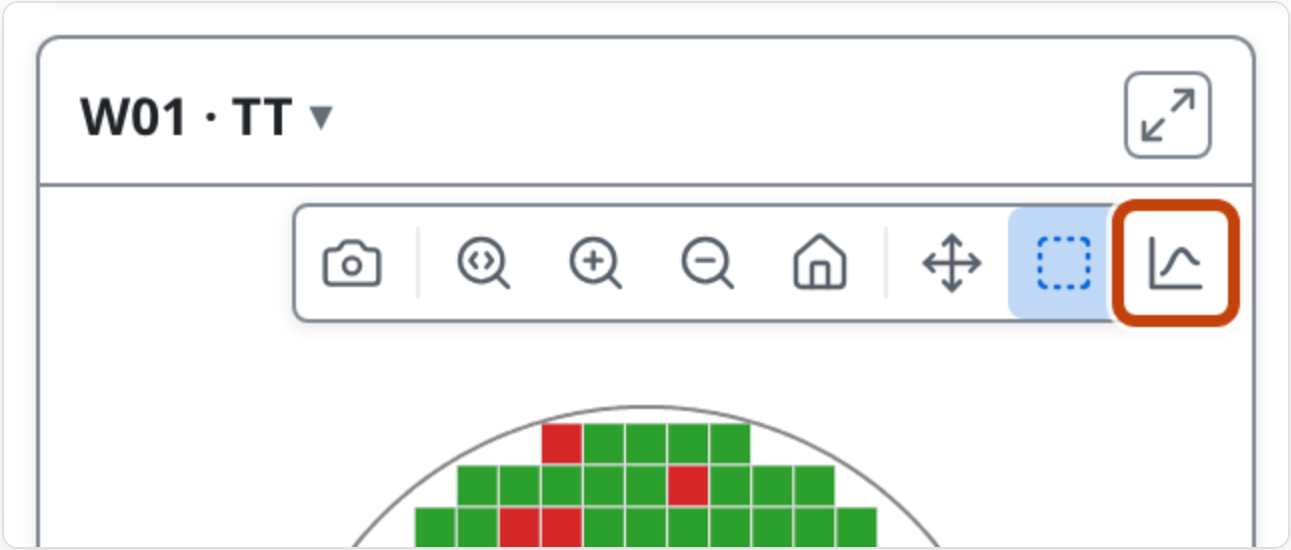
A bin

To study one failure mode across the whole lot, right-click a bin in the gallery's legend. The menu opens on that bin's dies on every wafer of the lot. It leaves your selection as it is; the legend only changes what is drawn.



A whole wafer

Each card's **Charts and tables** button, the small chart icon in its toolbar, opens the same menu for that wafer.



LAB Try it yourself

1. In the web app, **Load sample data**
2. **Filter...**, add **Split**, keep only **SS**, **Apply**
3. **Remove** the filter. Drag a box on W02 · FF and right-click it
4. Open **Value histogram**, then **Process capability**: which test has the lowest Ppk?
5. Right-click bin **3** in the legend and open **Dies**
6. Open **Filter...** and check no filter is left set, as filters are kept between lots

ANSWERS Check your results

4. It depends on the box you drag, because the card judges only those dies. For the 60 dies on the slide, `vth_p_mV` is lowest, at 0.46. Whatever the box, the worst Ppk comes first.

Recap

- **Filter…** keeps wafers and dies by condition, in every view
- Select dies, then right-click for charts and tables of just those dies
- A bin, a wafer or a finding each opens the same menu on its own dies

Next, make new tests of your own, and read a run of tests as a curve.

More in the wafer map guide



Next lesson

09 · Derived tests →

Compute new tests from measured ones.



Derived tests

Lesson 09

Learn tsmap

In this lesson

The tester measures what it was told to measure, but the question you have may be about a ratio, a margin, or the average of a run of tests. This lesson shows how to compute a new test from existing ones, and then use it like any other.

- Add a derived test in the **Derived tests…** editor
- Read the expression language and the live check
- Load derived tests from a definitions file
- Map and chart a derived test

What a derived test is

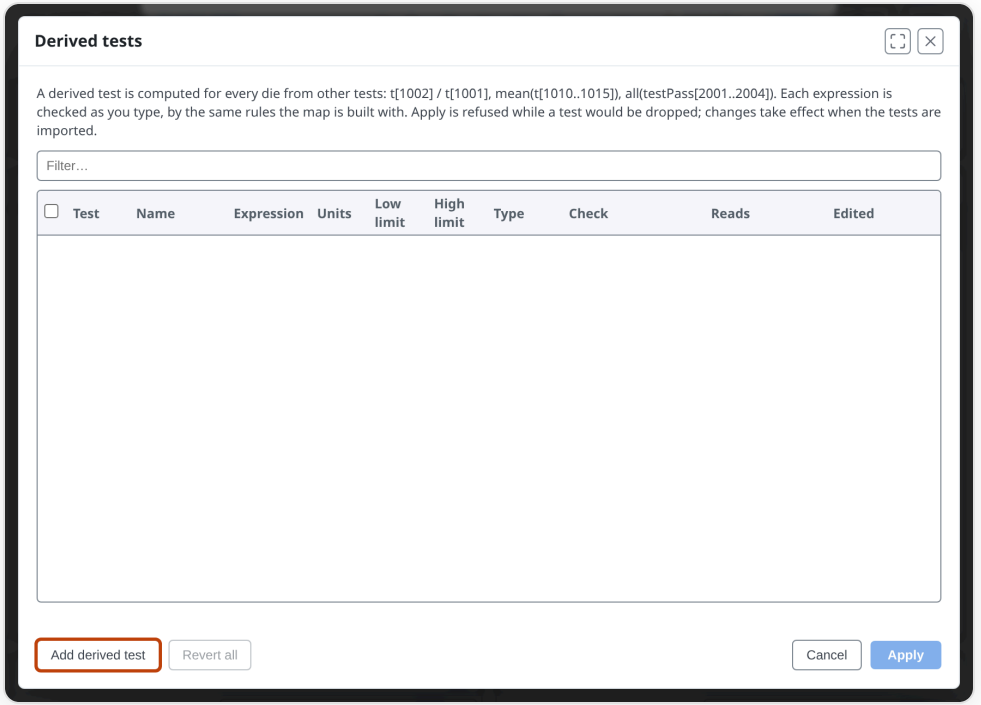
Sometimes the number you want was never measured. A derived test computes it.

- A test computed from others on the same die, such as a ratio or a margin
- Defined by an **expression**, which you type in the editor or write in a definitions file
- Then an ordinary test: map it, chart it, set limits

The Derived tests… editor

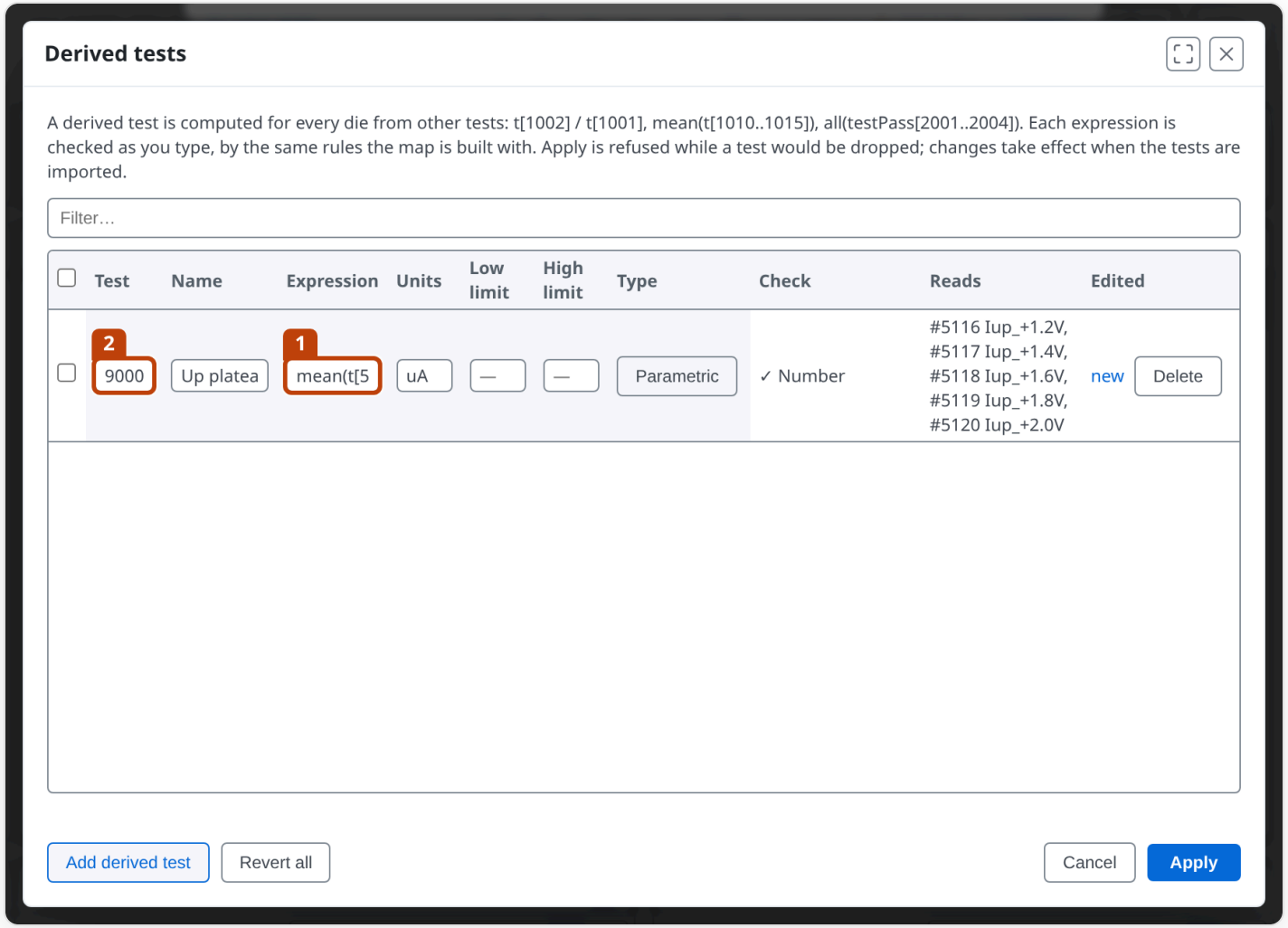
Open the test selector with **Setup ▾ → Tests…**, then press **Derived tests…** in its footer. The editor is a table with a row for each derived test: its number, name, expression, units, limits and type. It starts empty.

These slides use `SWEEP-LOT-06`, a two-state switching lot.



Add a derived test

Add derived test starts a row on the next free number 2, 900001 here, with the cursor in its expression 1., and here `mean(t[5116..5120])` averages five currents. The number cannot be a measured test's.



Checked as you type

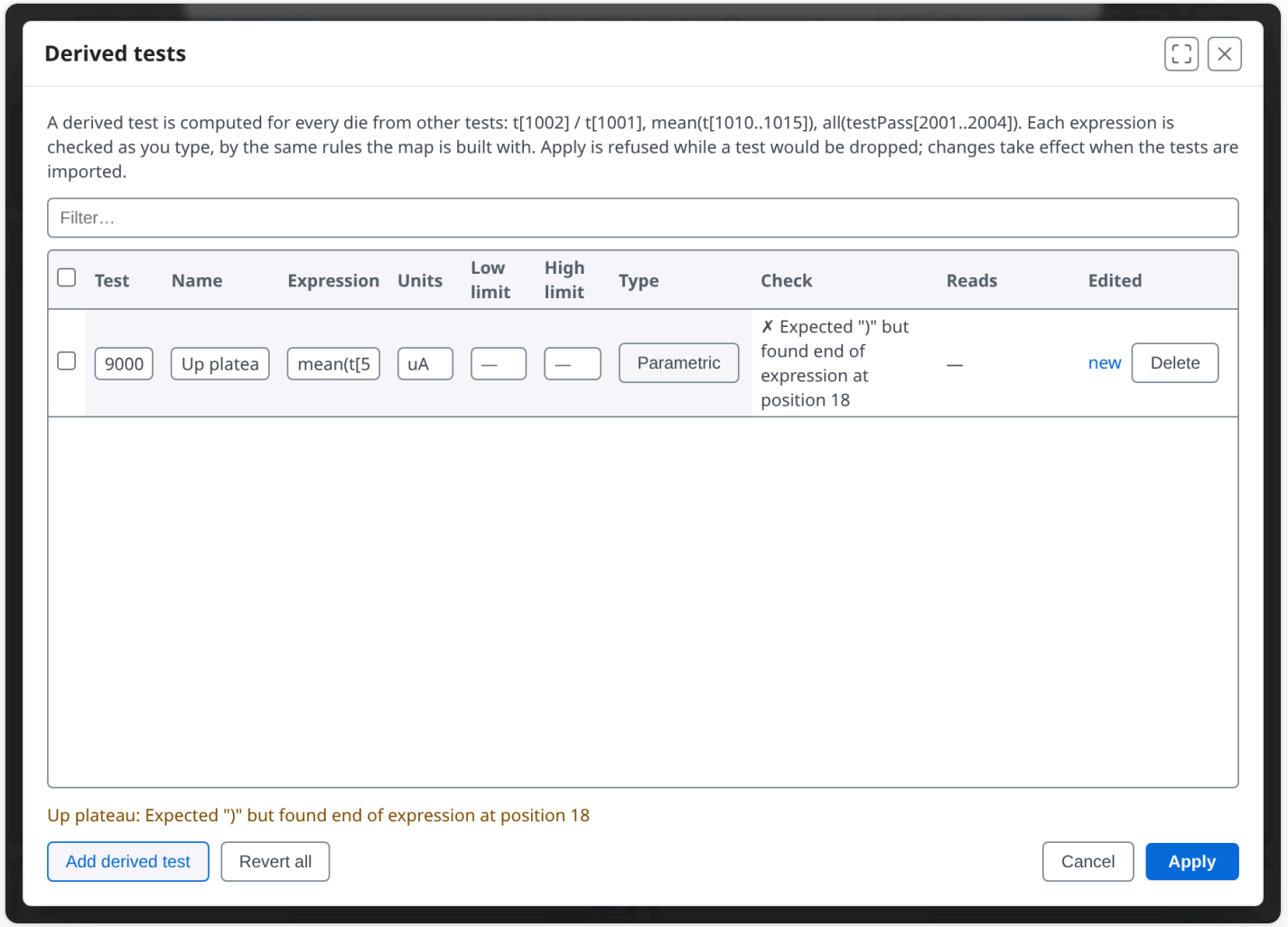
The **Check** column judges every expression as you type it, by the same rules the map is built with.

- ✓ **Number** means the test is parametric. ✓ **Verdict** means a true-or-false test, which needs the **Functional** type
- **Reads** lists the tests the expression depends on, by number and name
- Units that do not match across a `+` or `-` are flagged, not refused: give the derived test its own units

A mistake shows at once

A mistake gives ✗, the reason and the position. Here the closing bracket is missing, at position 18.

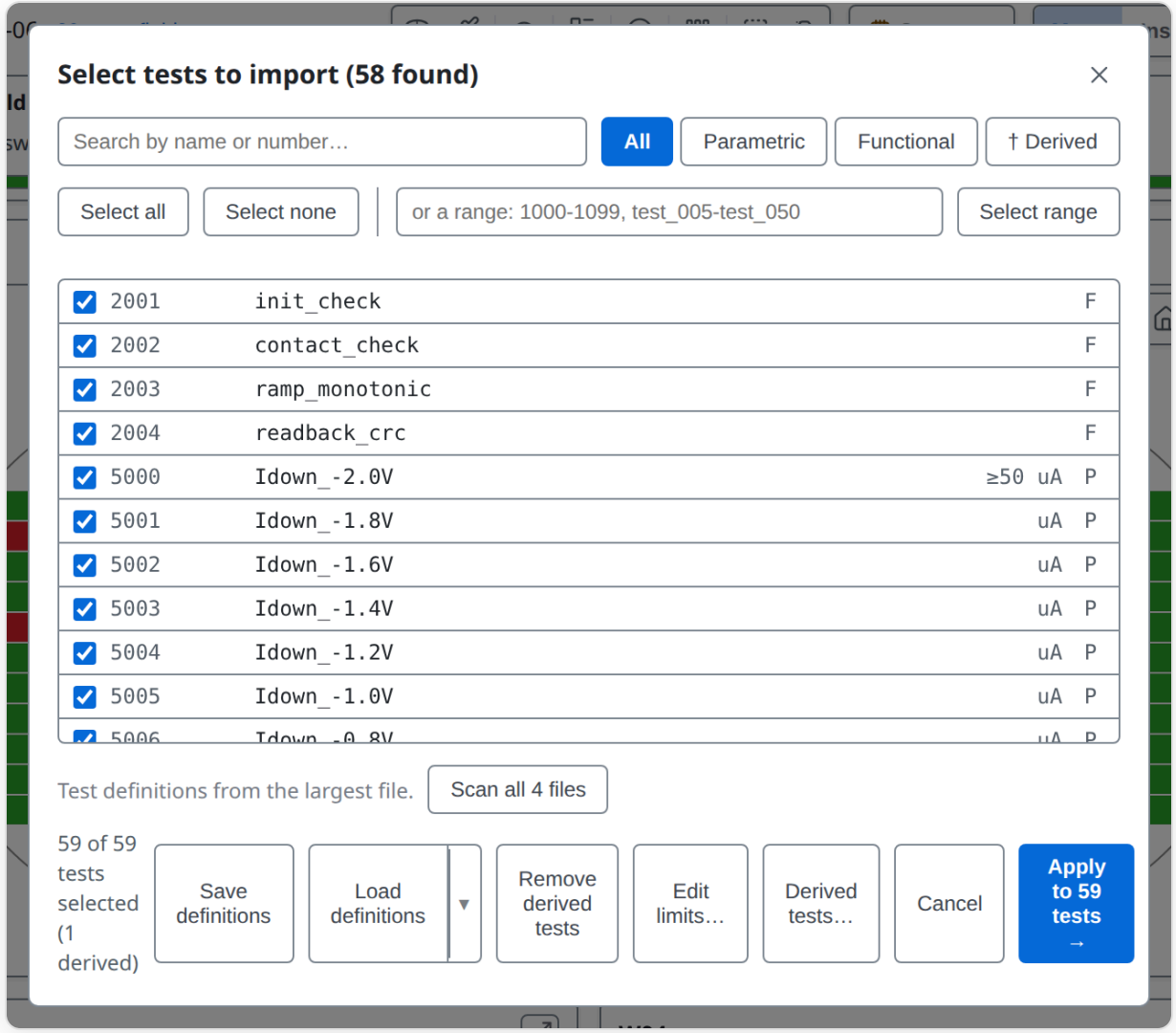
Apply is refused while any row has a ✗, so what you apply is what gets computed.



Apply

Apply puts the test in the selector, where the footer counts it, here "1 derived". Like every change in the selector, it takes effect when you press **Apply to N tests** → and the tests are imported.

Save definitions writes them to a definitions file.



What an expression can say

Expressions: what they read

WRITE	IT GIVES
`t[5116]`	the measured value of test 5116
`testPass[2001]`	the pass or fail result stored in the data file
`specPass[5116]`	whether the value is inside its limits
`diePass()`	whether the die's bin counts as a pass
`dieX()`, `dieY()`	the die's position
`hbin()`, `sbin()`, `site()`	the die's hard bin, soft bin and probe site

A derived test can use the value of another derived test, so you can build up a calculation in steps.

Expressions: what you can do with them

An expression can calculate and it can choose.

- **Arithmetic** `+ - * / % ^` and **comparisons** `< ⩽ > ⩾ = ≠`, with `and or not`
- **Choosing**: `if(condition, a, b)`, a when true, b when false
- **Functions**: `abs sqrt ln log10 exp floor ceil round sign pow min max`

For example `abs(t[1020] - t[1010])`, or `if(dieX() < 5, t[1010], -1)`. A true-or-false expression needs **F** as its test type.

Expressions: ranges and missing data

A run of tests can be combined into one value.

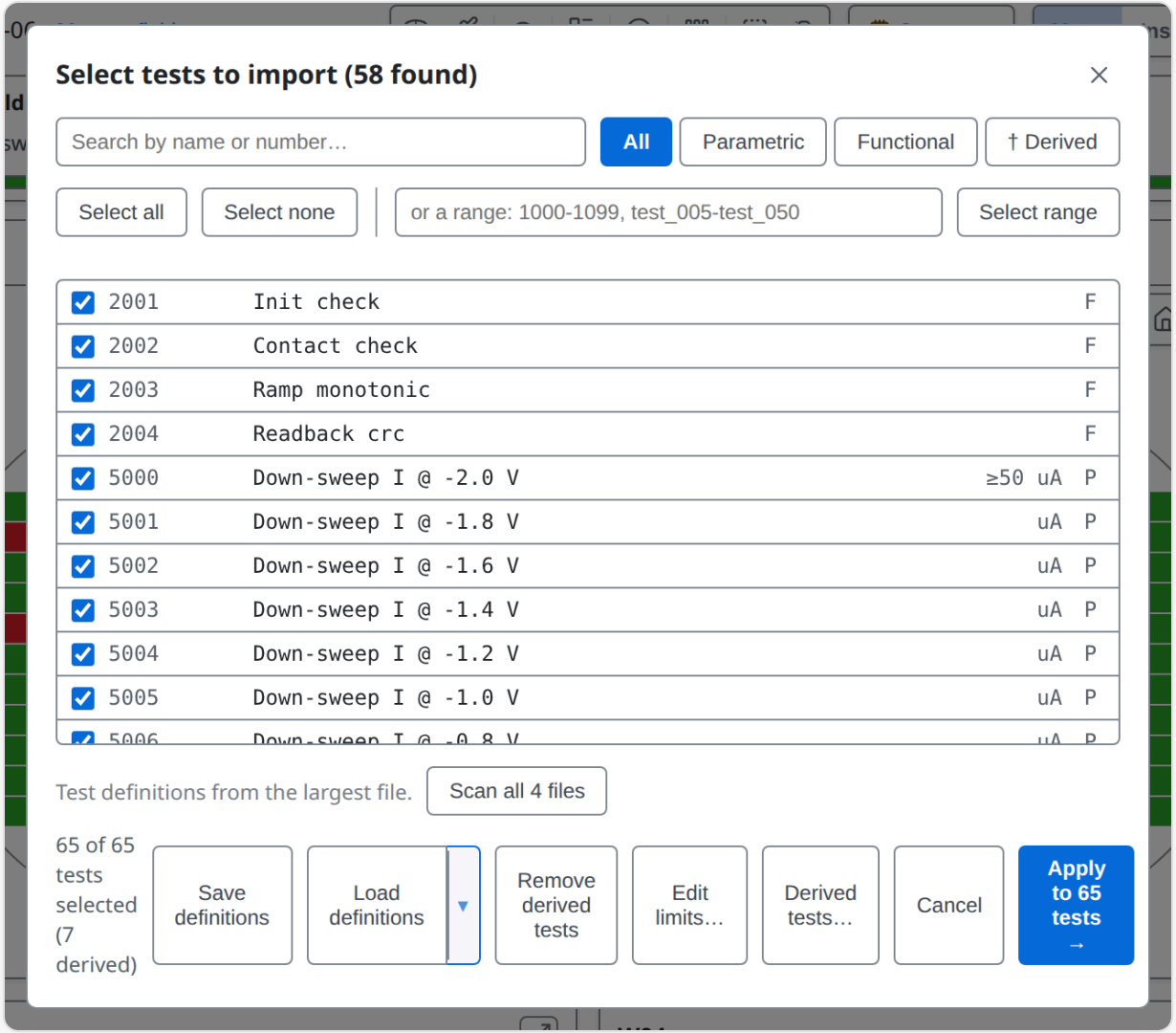
- `5116..5120` is every test in that range that exists, combined into one value:
  `mean sum min max` for numbers, `all any none countTrue countFalse` for verdicts, `countKnown` for either; blanks are skipped
- A missing input leaves the die blank, never zero
- A test that cannot be computed is left out, with the reason in the log

More in the user guide

From a definitions file

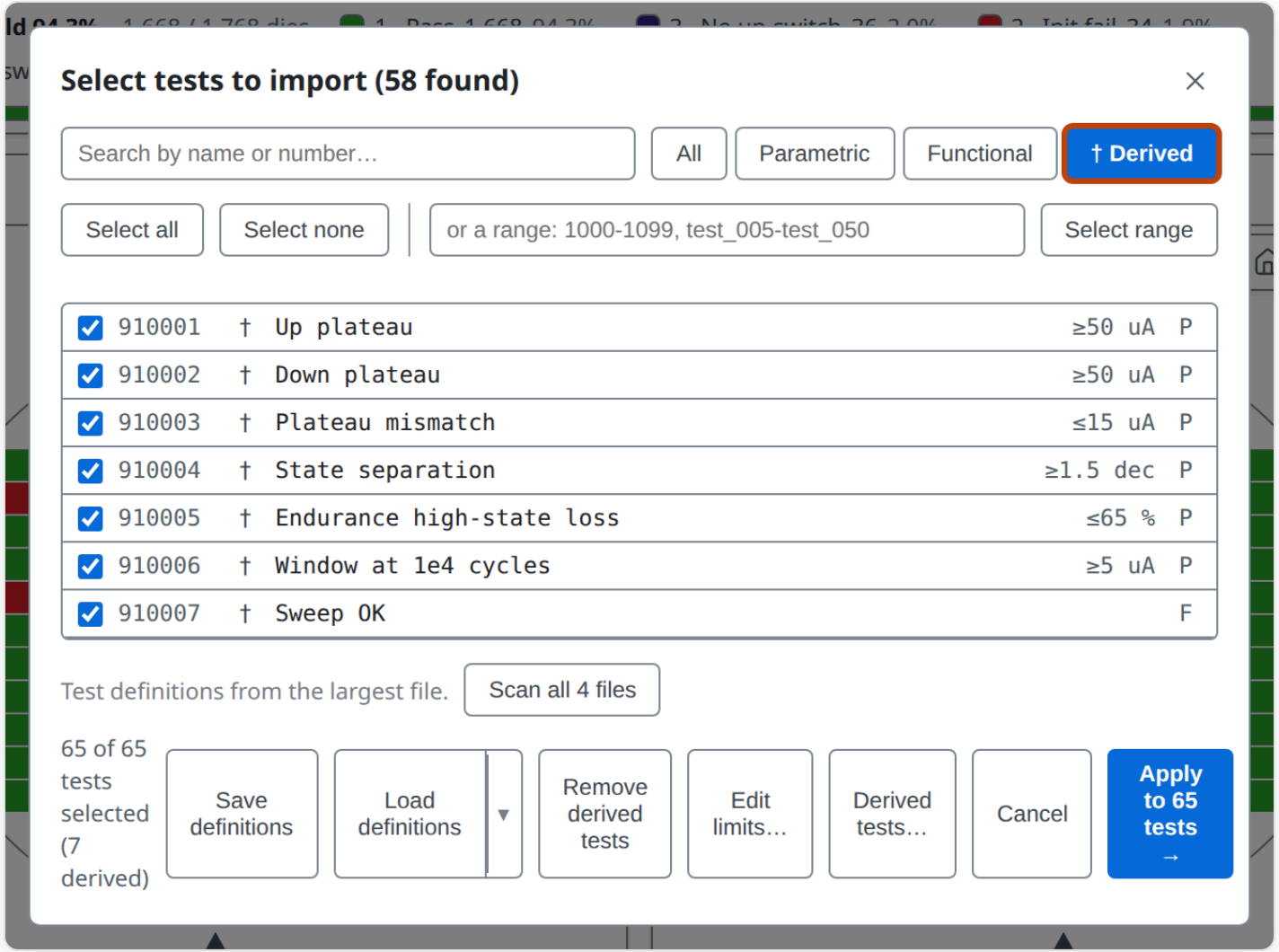
Load the definitions

A definitions file can carry derived tests in an **expression** column. Open **Setup ▾ → Tests…**, then **Load definitions** and choose `SWEEP-LOT-06`'s test definitions. It renames the tests and adds 7 derived ones, counted in the footer, and replaces any derived tests you had.



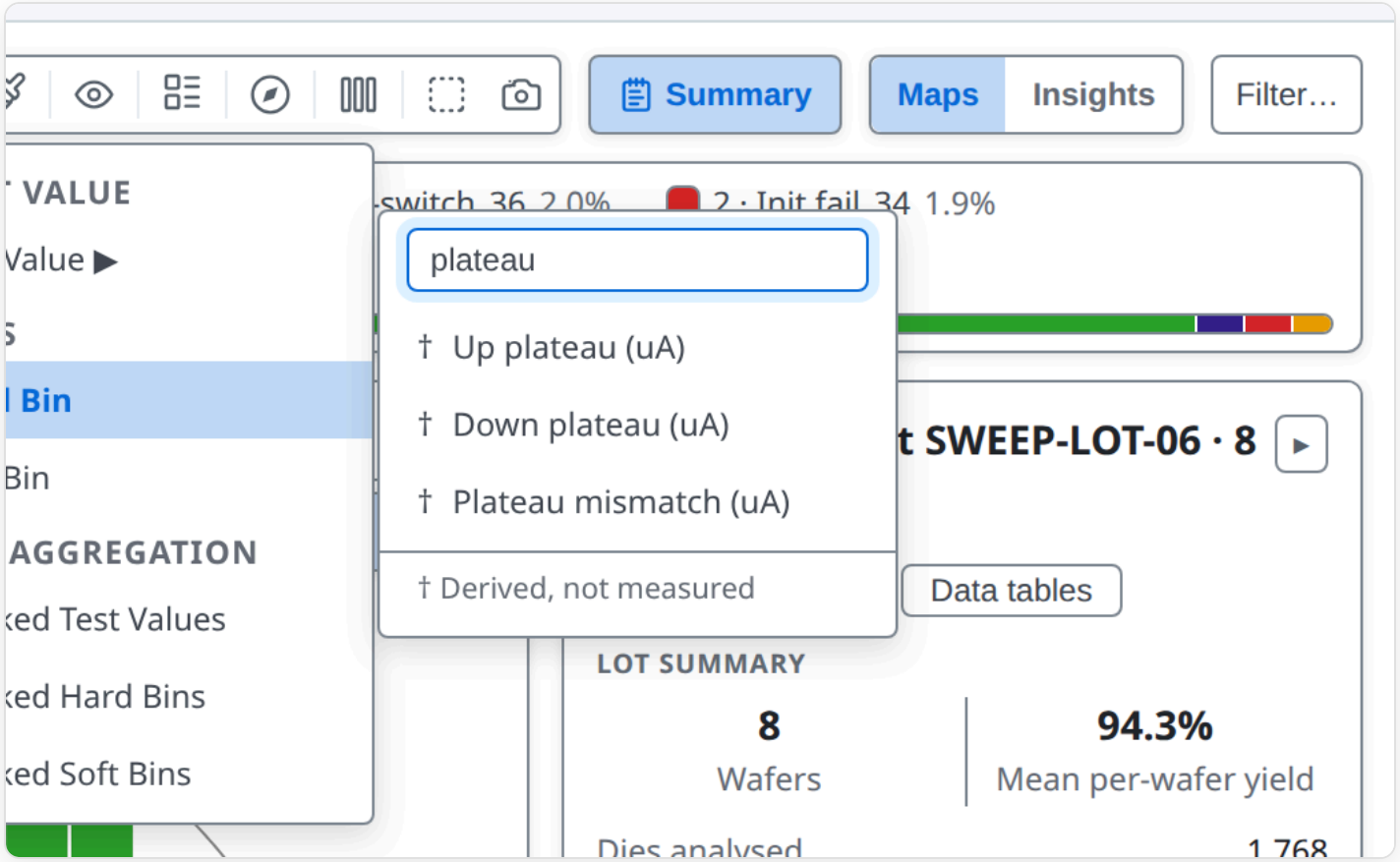
The † Derived filter

† Derived shows only the derived tests, each marked †. In a file, give each a number no measured test uses: a derived row with a measured test's number is ignored, and the log says so.



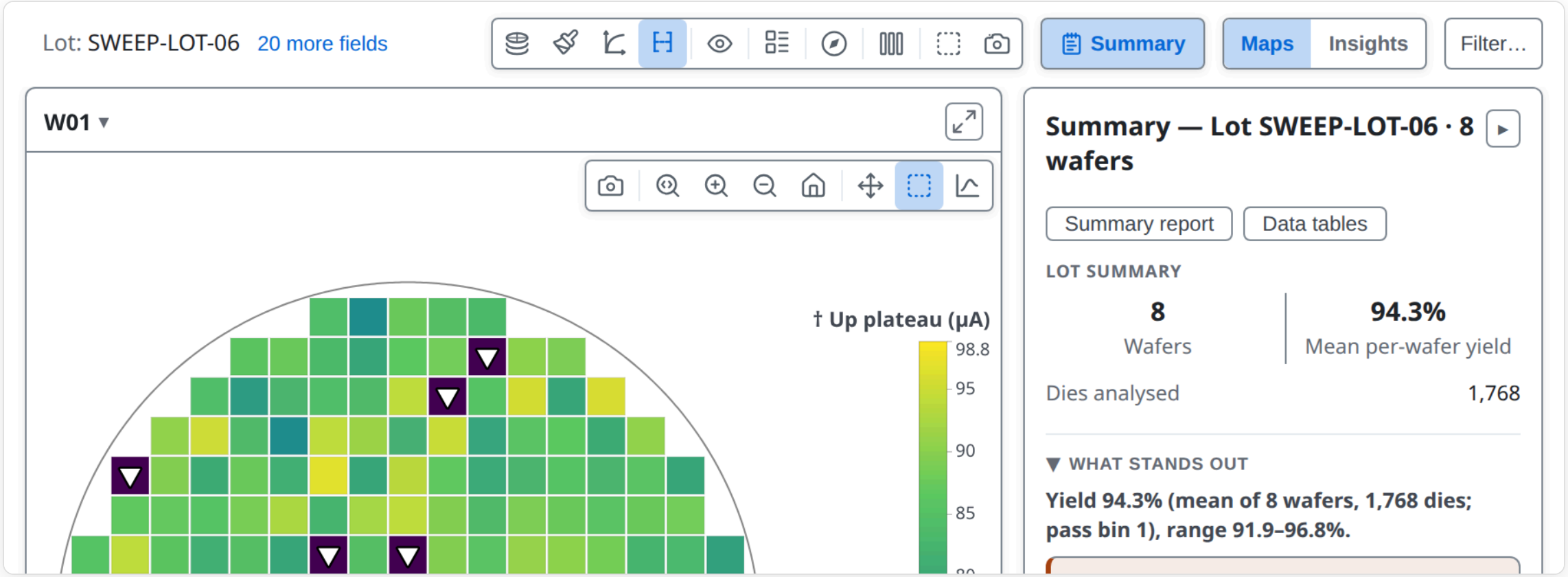
Derived tests in the map's test list

Once defined, a derived test appears in the map toolbar's test list. It is marked †, with the note Derived, not measured, so nobody mistakes it for a tester reading. Type in the box to search.



Mapped like any test

Choosing † **Up plateau** colours every die by its computed value, exactly as it would for a measured test.



Kept for the next lot

You do not have to redefine your derived tests each time.

- Derived tests stay defined from one load to the next, ready for the next lot of the same program
- A lot from another program can reuse the same test numbers: the log warns, with examples
- **Remove derived tests**, in the selector's footer, drops them all, for data they do not apply to

LAB Try it yourself

1. Open `SWEEP-LOT-06`, then **Setup ▾** → **Tests…** → **Derived tests…**
2. **Add derived test**, name it `Up plateau`, expression `mean(t[5116..5120])`: what do **Check** and **Reads** say?
3. Delete the closing bracket: what does the check say now? Put it back
4. **Apply**, **Apply to 59 tests** →, then **Plot mode** → **† Up plateau**
5. **Load definitions** with `tsmap-sweep-testdefs.csv` (sample files), then **† Derived**: how many derived tests?

ANSWERS Check your results

2. ✓ **Number**, and **Reads** lists the five tests 5116 to 5120 by number and name.
3. ✗, with the reason and the position: `Expected ")" but found end of expression at position 18`.
4. The map colours each die by its computed Up plateau current.
5. **7** derived tests, each marked †. The file's tests replace the one you wrote.

Recap

- A **derived test** is computed from others and marked †
- The **Derived tests…** editor checks each expression as you type, and **Apply** is refused while one has a ✗
- A definitions file can carry derived tests too, and they stay defined for the next lot

With derived tests you can ask questions the tester never recorded. The next lesson builds your own charts, including charts of a run of tests read as a curve.

More in the user guide



Next lesson

10 · Your own plots and sweeps →

Build, keep and reuse your own charts, and read a run of tests as a curve.



Your own plots and sweeps

Lesson 10

Learn tsmap

In this lesson

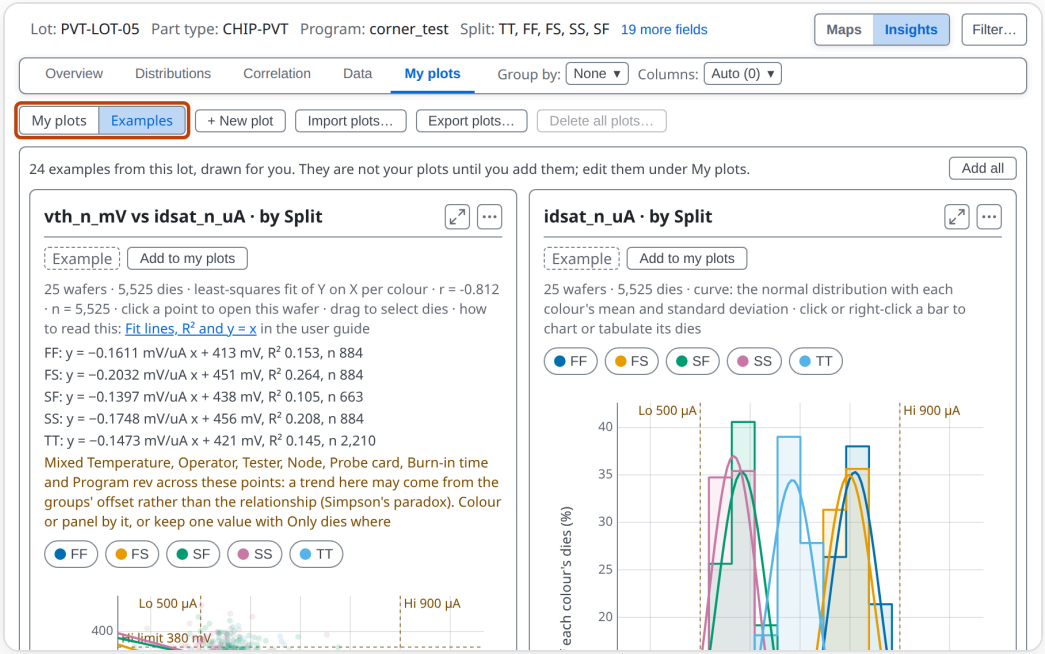
The charts in Insights answer the common questions. When yours is different, you can build the chart yourself. This lesson shows how to make a plot, keep it, and use it again on the next lot.

- Build your own charts in the plot editor
- Keep them, export them and reuse them on the next lot
- Read a run of tests as a sweep curve

Plots

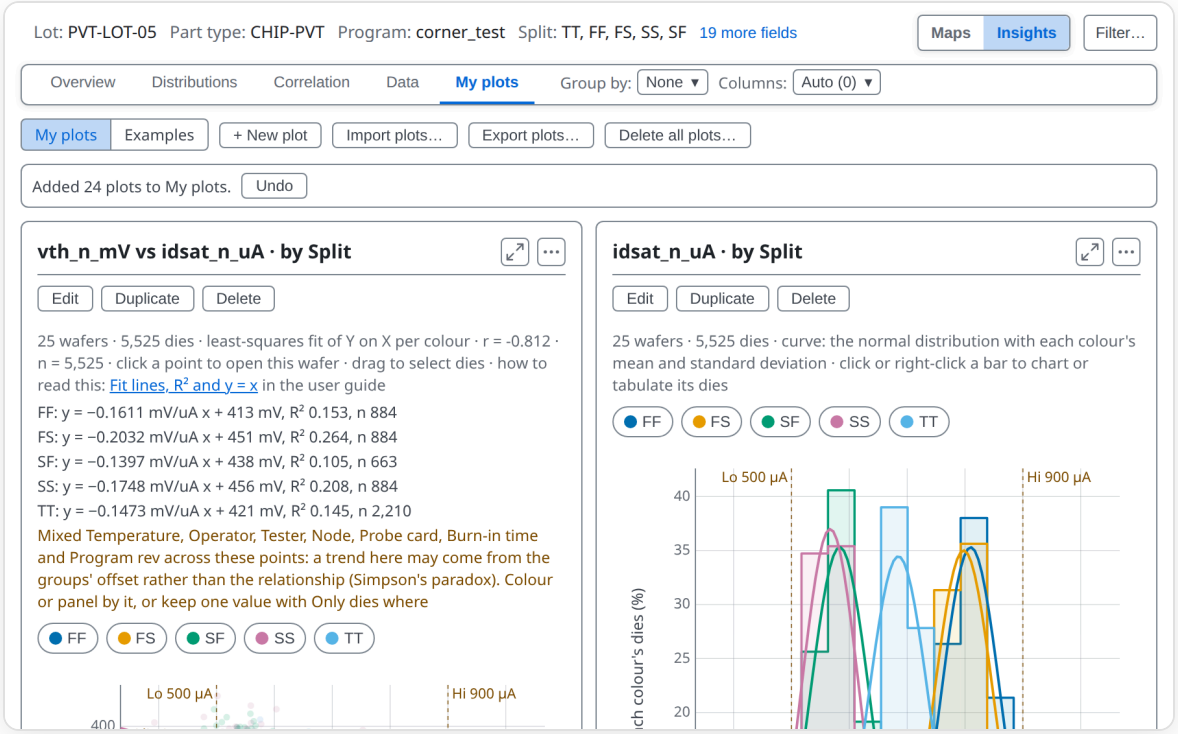
Examples

The quickest way to start is to look at examples. On the sample lot, the **My plots | Examples** switch shows one or the other, never both. **Examples** draws one plot of each chart type the lot can show, chosen from the lot's own data. Each is marked **Example**, because it is not yet yours. **+ New plot** opens a scatter already set to the lot's first two tests.



Keeping examples

Add to my plots on one example keeps just that one, and its button then says **In your plots**. **Add all** keeps every example you do not have yet and takes you to **My plots**, with an **Undo** that removes only what it added. Under each plot, the **how to read this** link opens the guide section for that kind of chart.



Edit, Duplicate, Delete

Each card has three buttons: **Edit** changes the plot, **Duplicate** copies it so you can try a variation, and **Delete** removes it. Delete can be undone straight afterwards. Changes in the editor are drawn at once and kept as you make them, so there is no save button to forget.

The plot editor

The editor has two pages. **Setup** chooses what the chart shows, and **Customise** how it looks. To go back, **Reset** undoes this visit's changes; **Cancel** undoes and closes; ✕ keeps them.

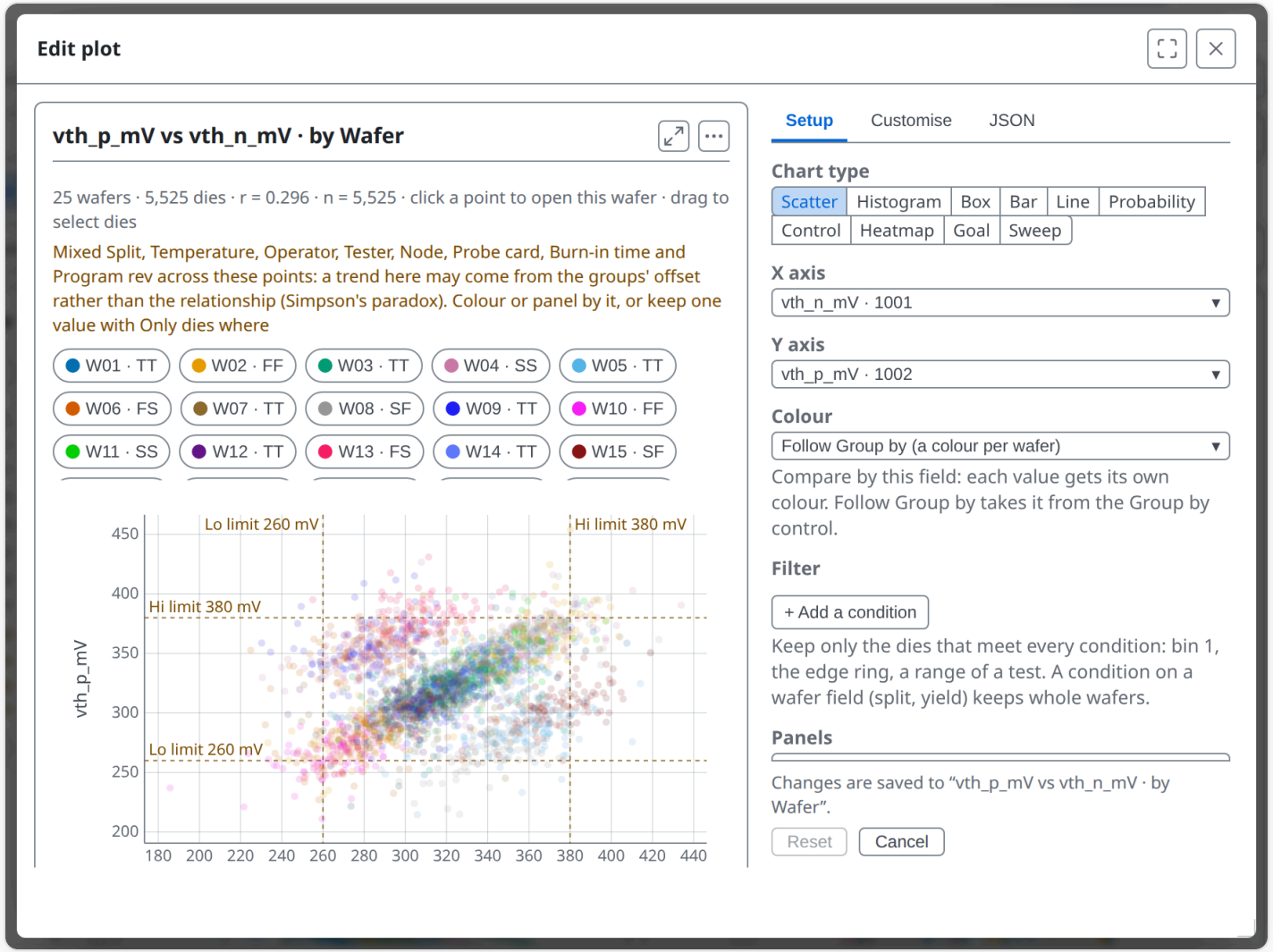
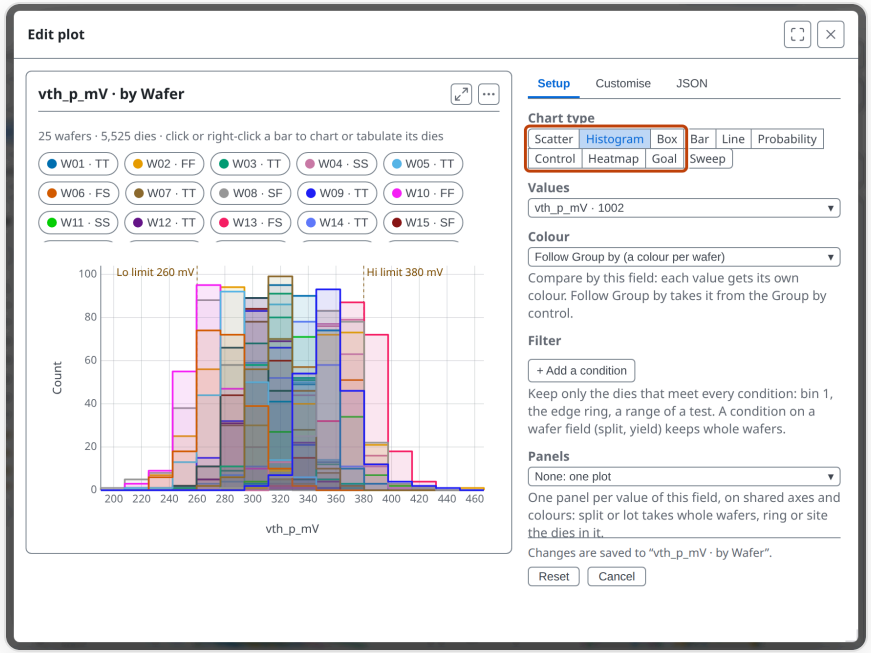


Chart types

Pick the type that matches your question. There are ten, and each takes different fields: a histogram takes one set of values, a box or bar takes categories. **Sweep** reads a run of tests as a response curve: choosing it swaps the fields for a series form (see Sweeps, at the end of this lesson), and choosing another type brings the plot's own fields back.



The everyday five

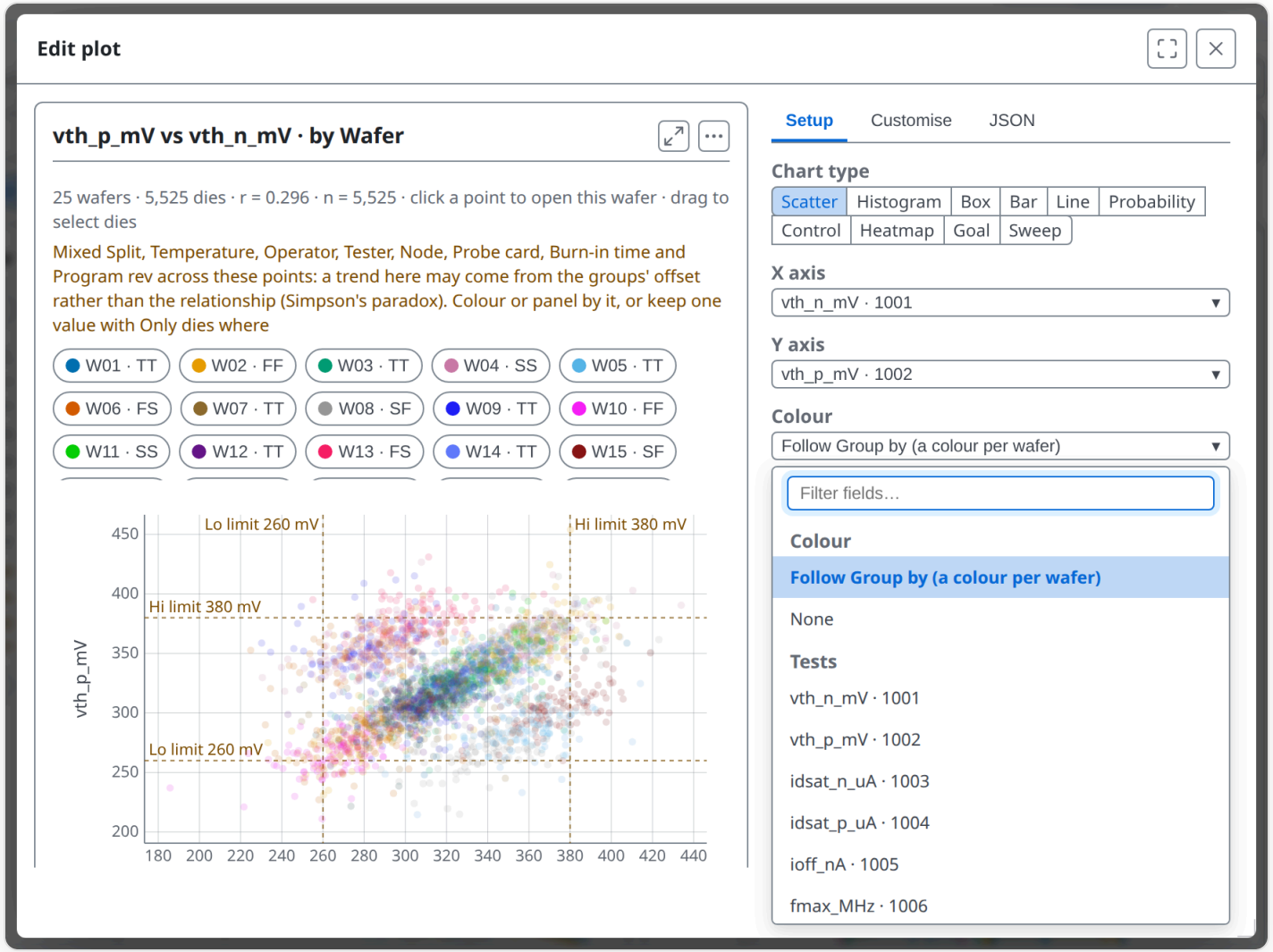
TYPE	SHOWS
Scatter	one field against another, a point per die or wafer
Histogram	how often each value occurs
Box	the spread in each category: middle half, median, extremes
Bar	one value or count per category
Line	a value in order, such as across wafers

Four for closer reading

TYPE	SHOWS
Probability	each group's values on a scale where a normal spread is a straight line
Control	one value per wafer in order, with rule breaks marked
Heatmap	a colour for every pair of two categories, such as tests by wafer
Goal	each test placed by how off-centre and how wide it sits in its limits

X, Y and Colour

These three choose the data. Each opens a list of fields: any test, a die's position, ring, bin or site, a wafer's yield, or a wafer field such as split. Colour separates the data into groups, each with its own button above the chart.



Colour by Split

Colouring by Split gives one colour per split. **Follow Group by** is the default: the colours follow the Group by control above the charts, so changing it once recolours every plot that is set to **Follow Group by**.



Group by or Compare by

There are two ways to split the data, and they work at different levels.

- **Group by** pools whole wafers by a wafer field, for every chart
- A plot's **Colour** and **Categories** can also split dies: by ring, bin, site or a pass/fail test
- A ring is never a Group by choice: every wafer has dies in every ring

More settings

The editor has more settings than you will need at first. These are the ones people reach for.

- **Filter**: keep only the dies that meet conditions
- **Panels**: one small plot per value of a field; a **Columns** control above them, or the keys **1** to **5** while the pointer is over the plot, sets how many sit side by side
- **Fit line**: least squares, or orthogonal for two measures of one thing
- **One mark per**: a point per die or per wafer

Many tests, many groups

For bigger questions, the editor can combine several tests or nest groups.

- **Several tests…** puts a list or range of tests in one plot; **Rescale values** puts them on one scale (to limits, or as z-scores)
- **In ranges** cuts a number into bands, such as Idsat deciles
- **+ Add a level** nests categories, such as wafers inside each split

Reading against limits and totals

A few settings help you judge data against a target.

- **What-if limits** draw proposed limits on a histogram and say how many dies would change
- **Colours**: stacked, 100%, or each colour's share, to compare groups of different sizes
- **Cumulative line** turns a bar sorted largest first into a pareto

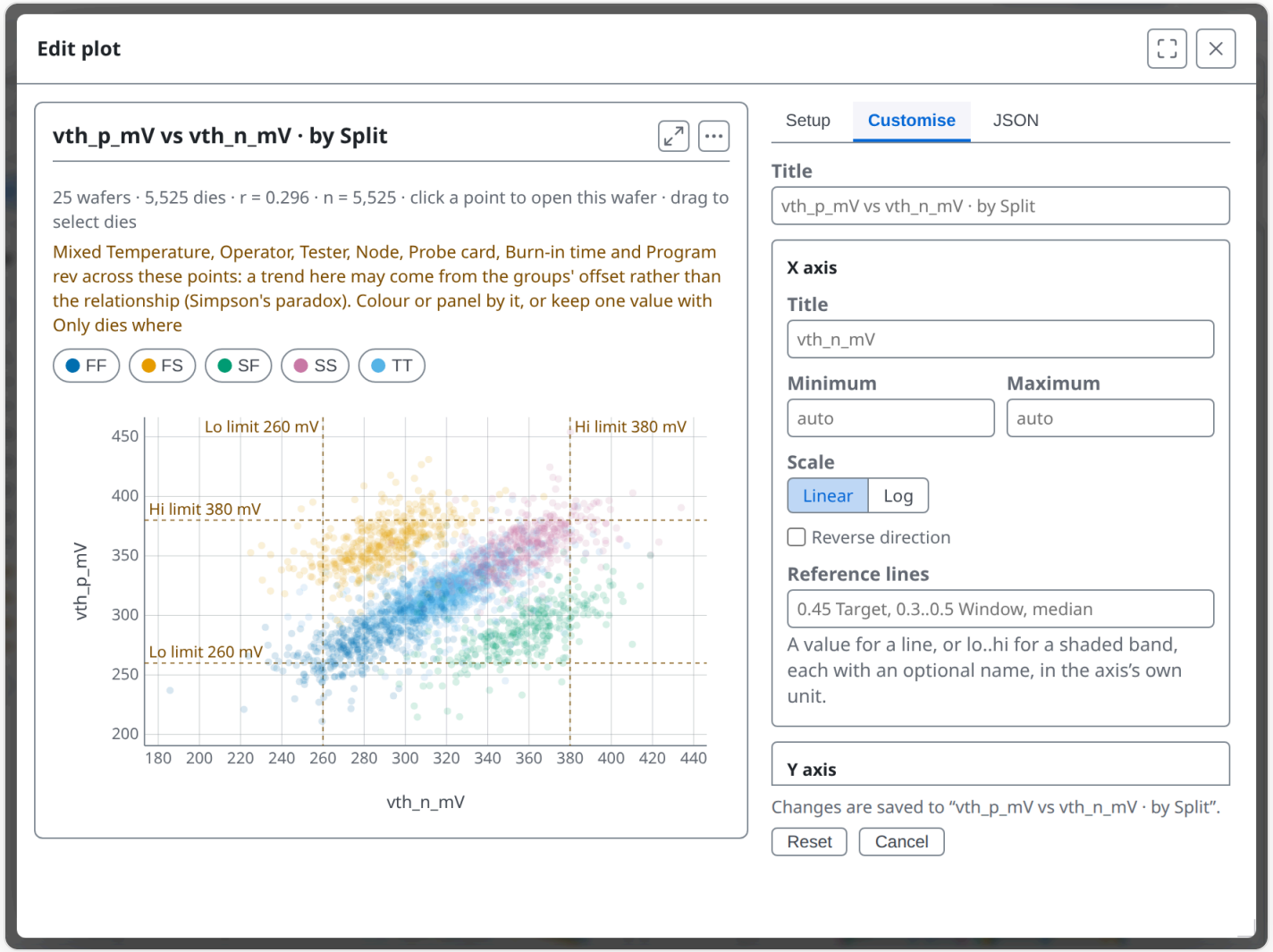
A plot's filter and the page filter

You can filter in two places, and they combine.

- **Filter…** in the toolbar narrows every view, and is not saved with a plot
- A plot's own **Filter** is saved with it and narrows that plot only
- A plot shows the dies that pass both; neither changes the other

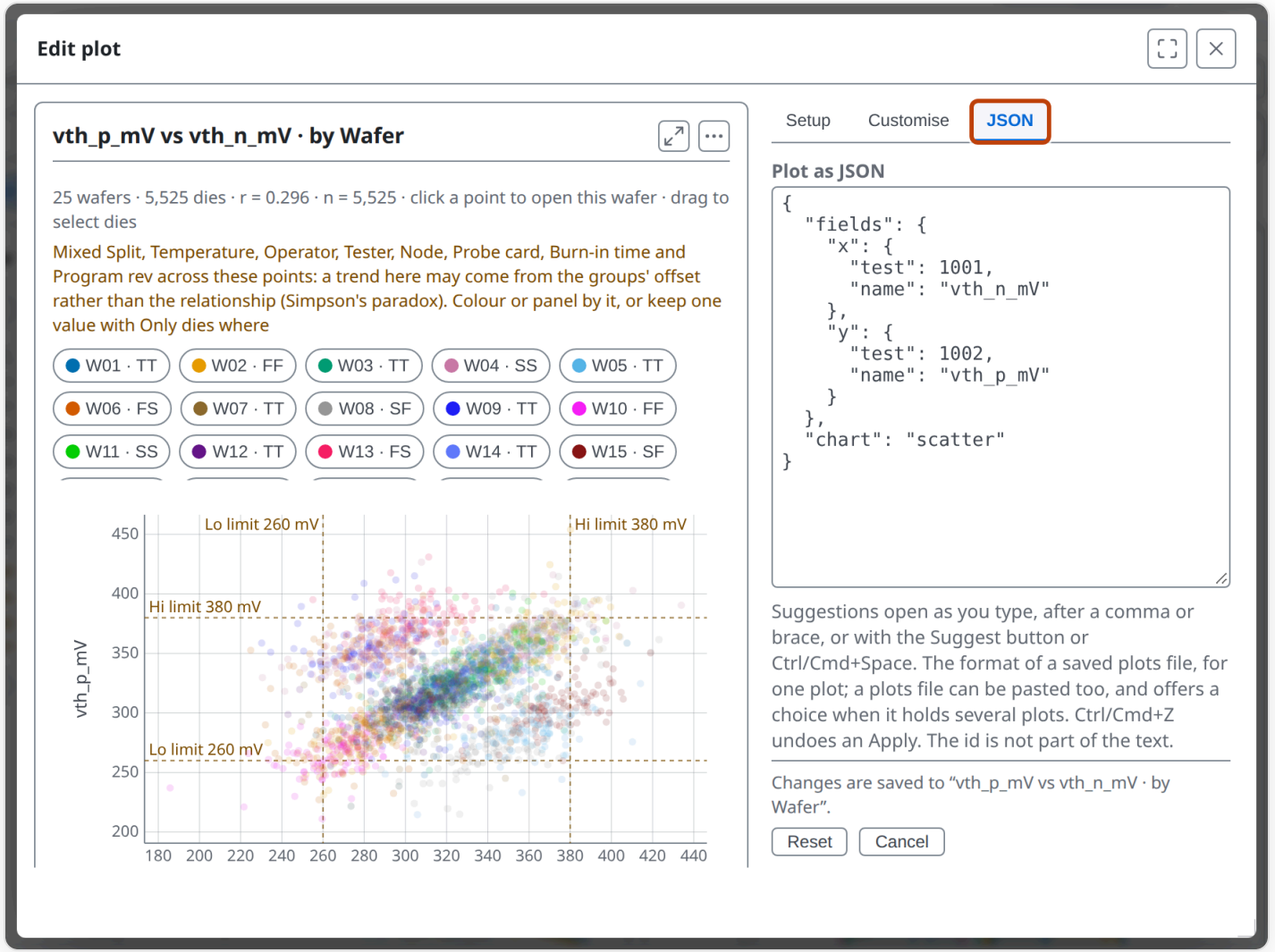
Customise

Customise changes how the chart looks without changing what it says. On the **Customise** page you can set titles, each axis's minimum and maximum, its **Linear** or **Log** scale, **Reverse direction**, reference lines, and which limits are drawn (**Test + spec**, **Test**, **Spec** or **None**).



The JSON tab

Beside Setup and Customise, **JSON** shows the same plot as text. This is how you share a plot: copy it, or paste one someone sent you. You can also edit it directly.



Suggestions in the JSON

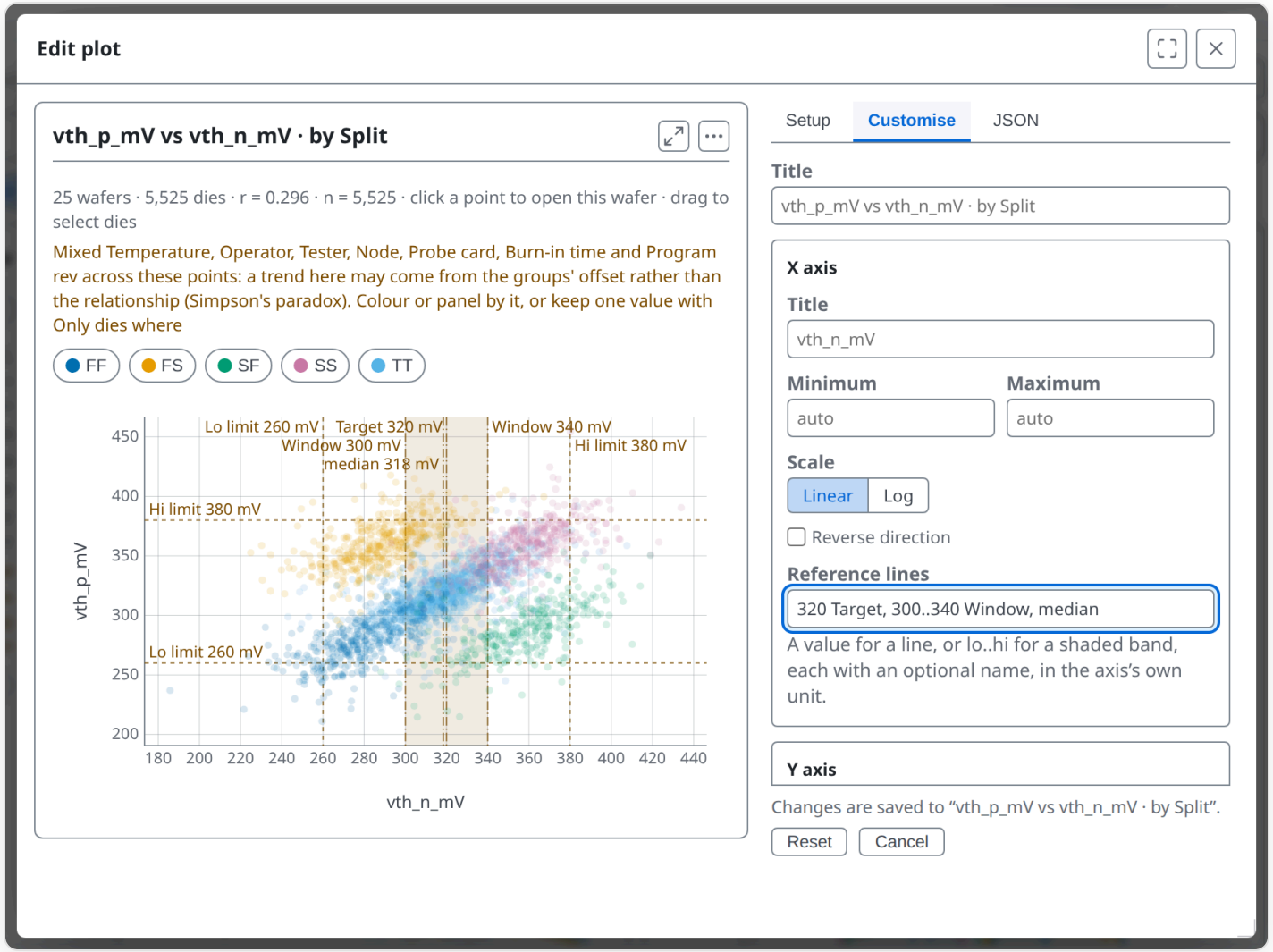
You do not have to remember the keys.

- Suggestions open as you type, after a comma or a brace, or with **Ctrl+Space**
- They offer the keys, the lot's tests and fields, and the values a field takes
- A change is drawn at once, and **Ctrl+Z** undoes the last one

Reference lines

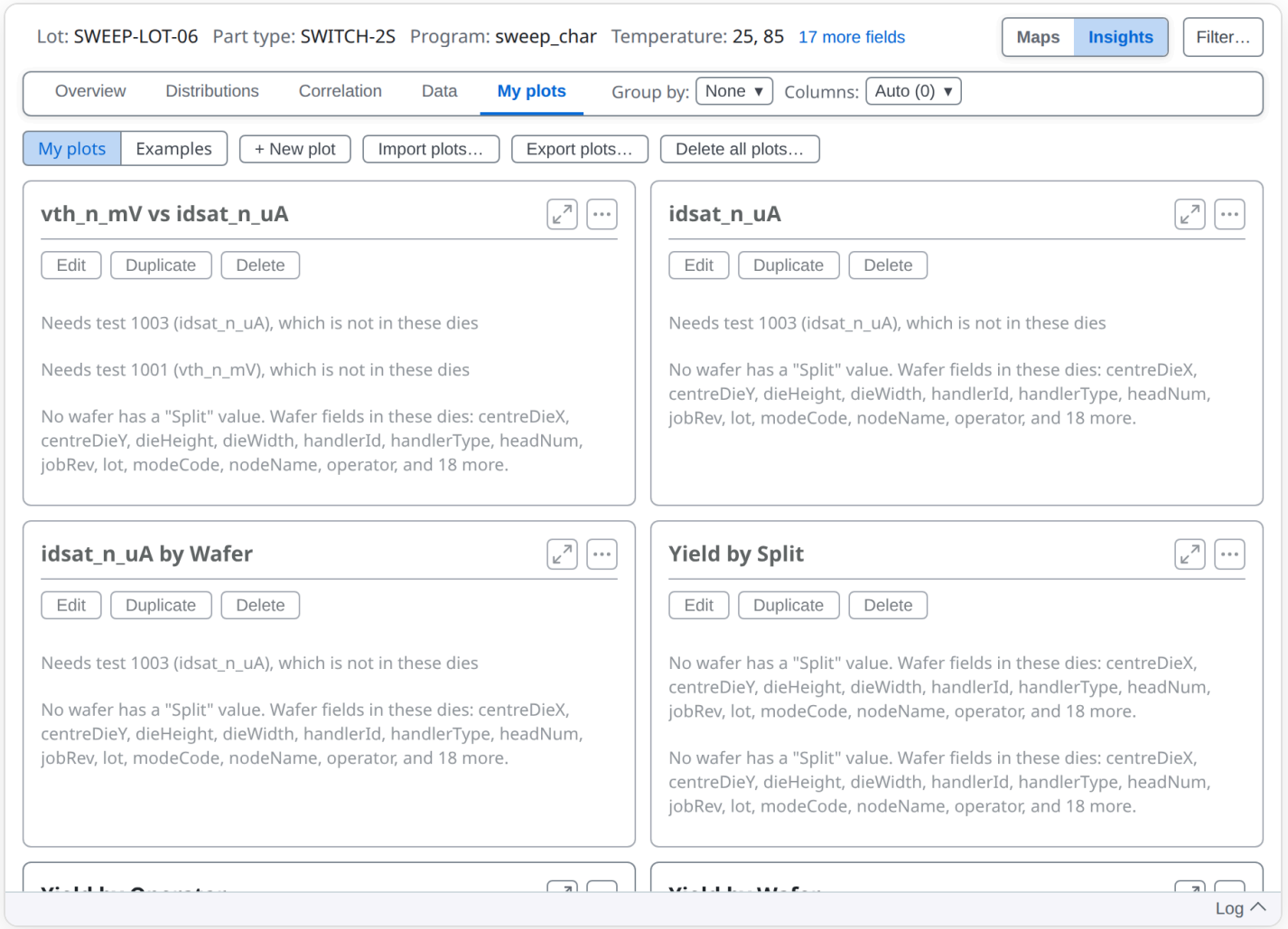
Reference lines mark your own target, guard band or customer limit on a value axis, to see how the data sits against a number that matters to you. In **Customise**, write a value or a `lo..hi` band, each with an optional name:

```
320 Target, 300..340 Window, median
```



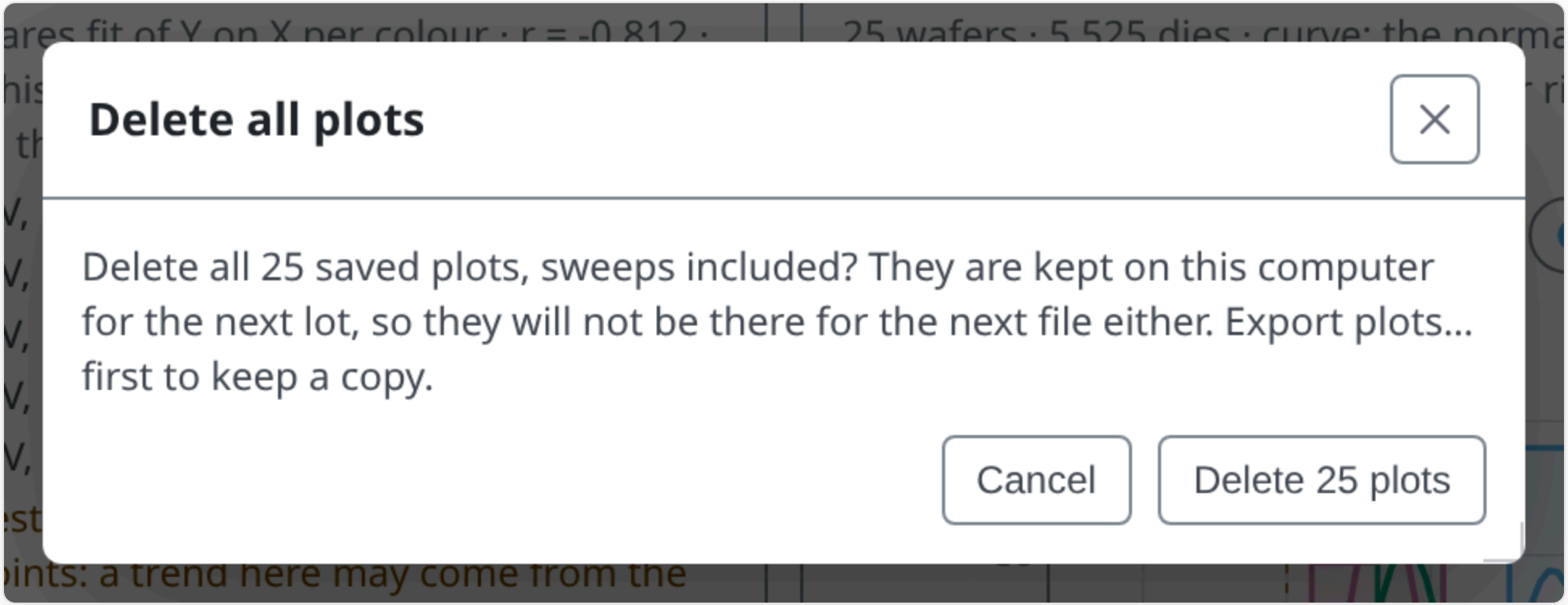
Your plots are kept

You build a plot once. A plot is a recipe, not a picture, so tsmap keeps your plots and draws them again on the next lot. One that needs a test the new lot lacks stays, dimmed, with the reason, instead of silently disappearing.



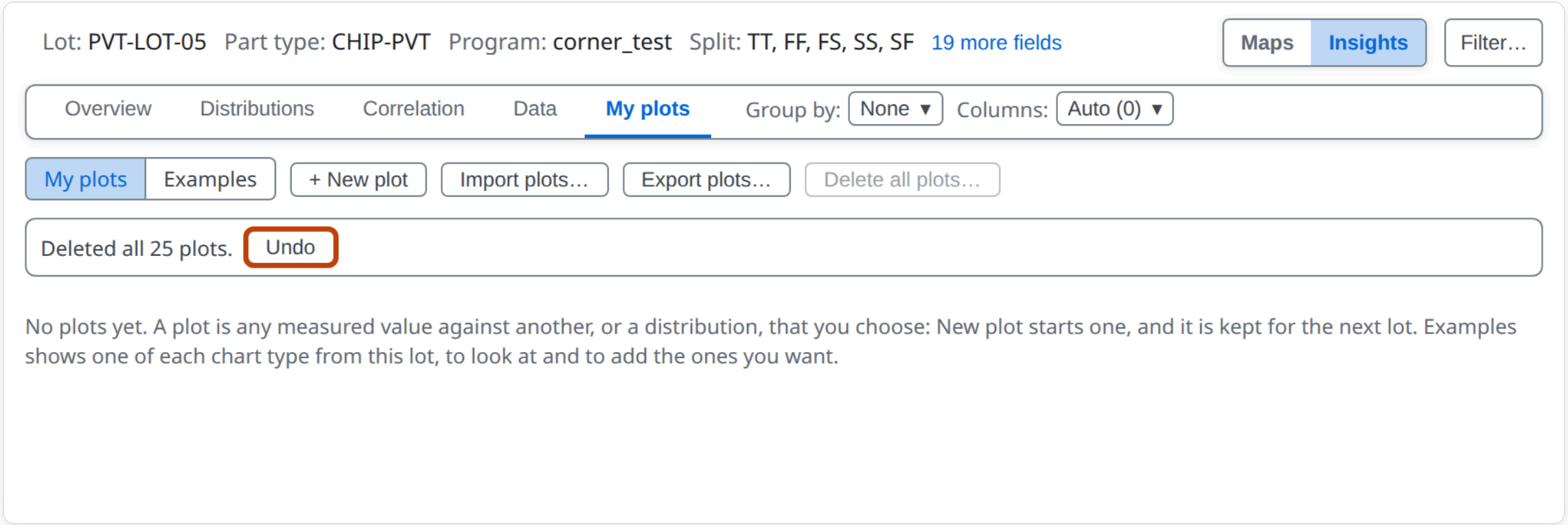
Export, import, delete all

Export plots… writes every plot to a file and **Import plots…** adds the plots of such a file, so a set can move to a colleague or another machine. **Delete all plots…** asks first.



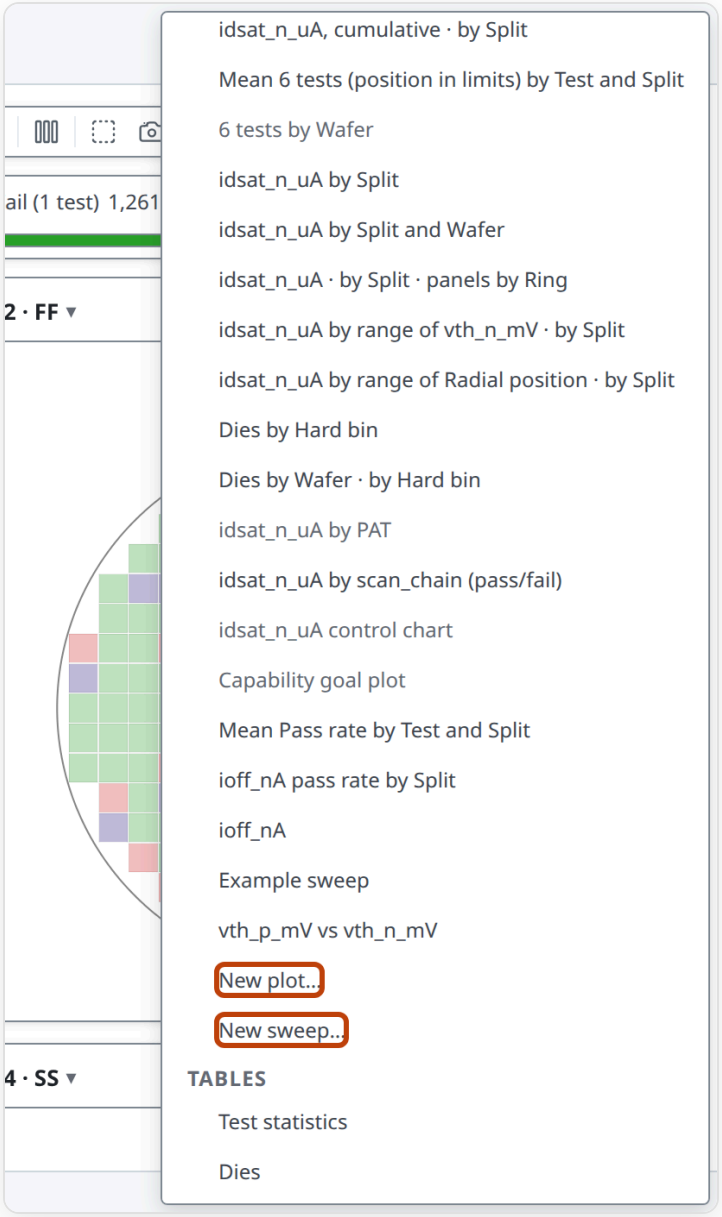
Undo

Right after deleting, **Undo** brings the whole list back.



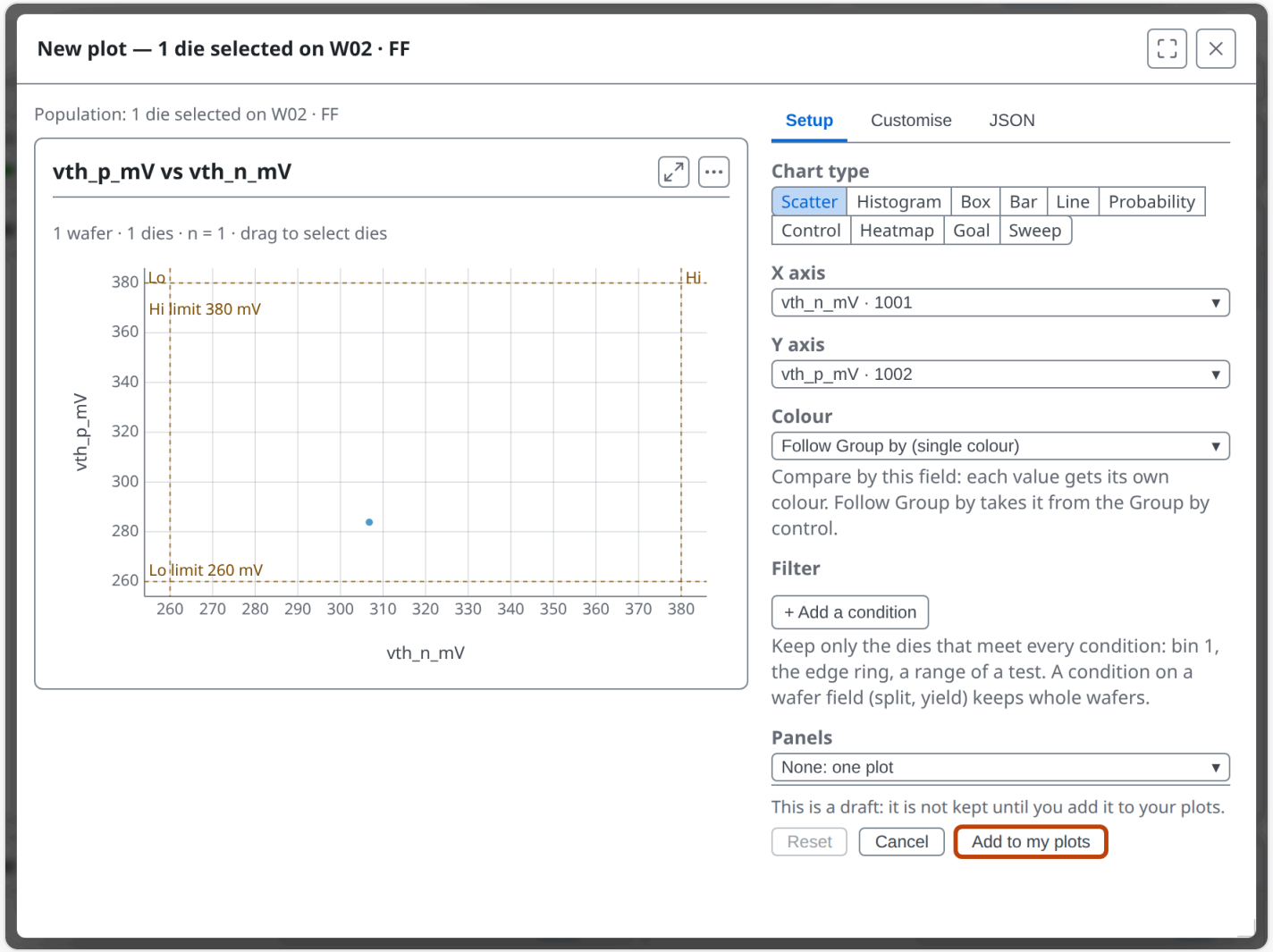
From the right-click menu

You can also chart a selection with your own plots. Every saved plot is a row in the menu on a selection, drawn over just those dies. **New plot…** and **New sweep…** at the end of its Plots section start a draft on them.



A draft

A draft is a trial. It is kept only if you press **Add to my plots**, and **Cancel** discards it.



Sweeps

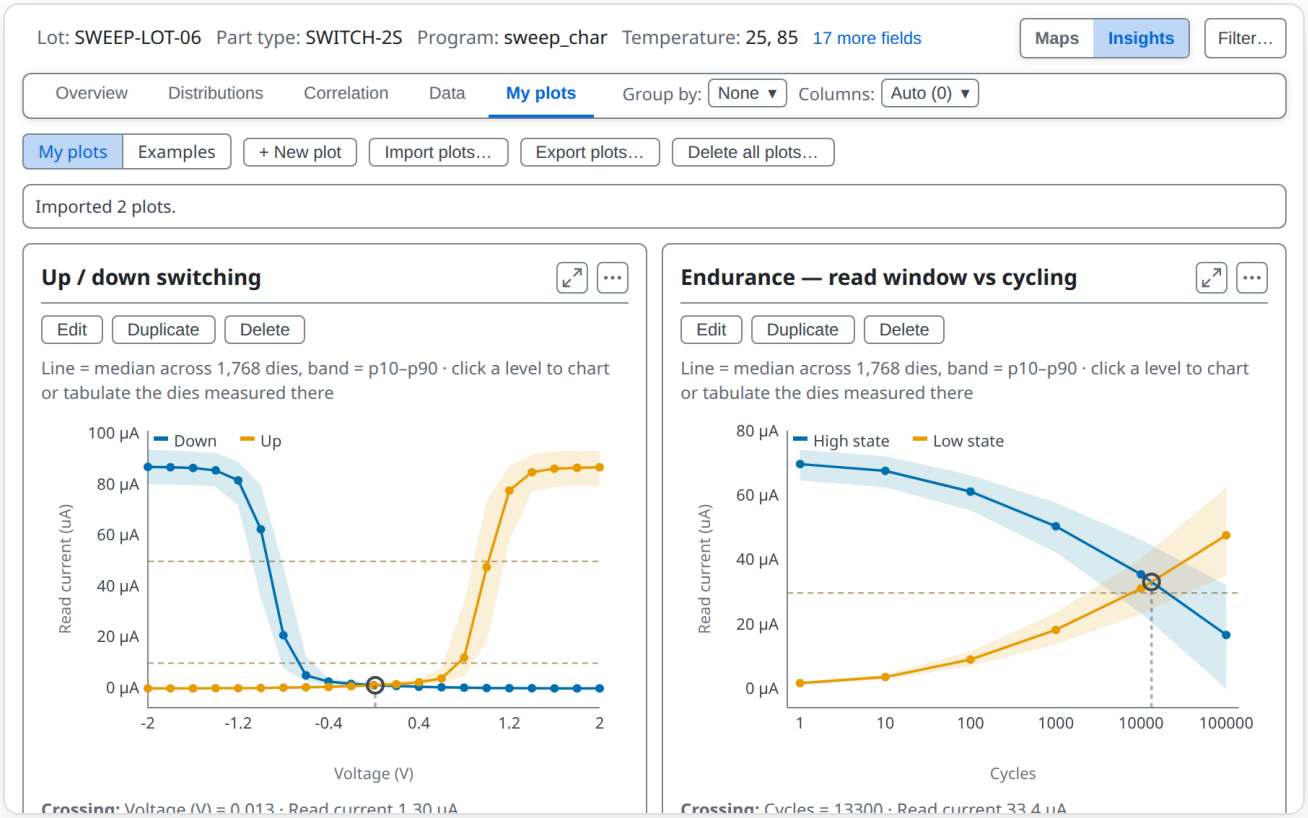
A run of tests as a curve

Some test programs measure the same thing at a series of levels, such as a current at a run of voltages, with one test for each level. Read one test at a time, and the run is dozens of numbers. Read as a curve, it is one shape. The **Sweep** chart type draws that run of tests as one curve.

These slides use `SWEEP-LOT-06` and its definitions file from lesson 09. Its plots file is on the sample files page.

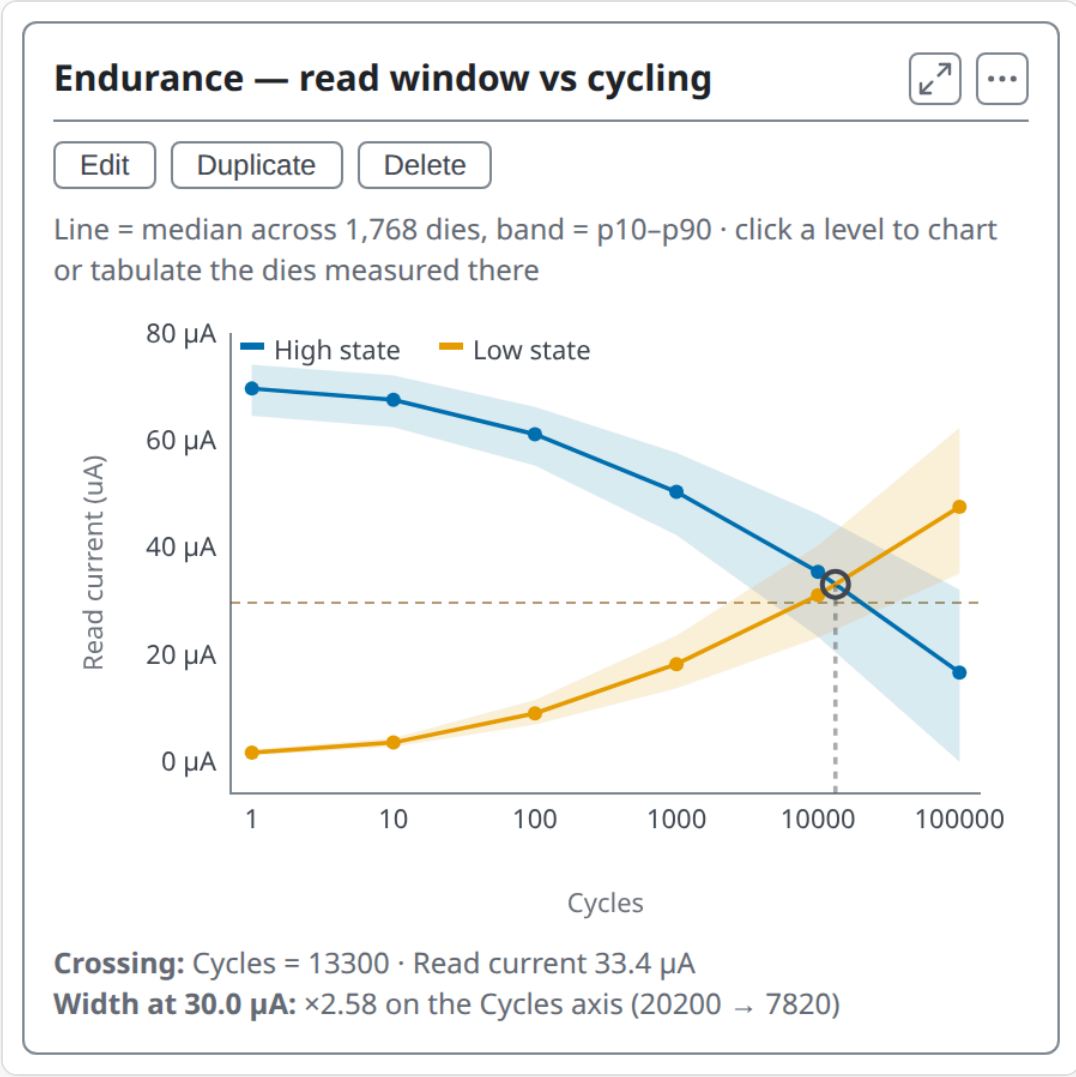
Import plots…

Import plots… reads a plots file and adds its plots, which is a quick way to start from someone else's setup. `SWEEP-LOT-06`'s plots file brings two sweeps. Each line is the median across the dies, with a shaded band from the 10th to the 90th percentile.



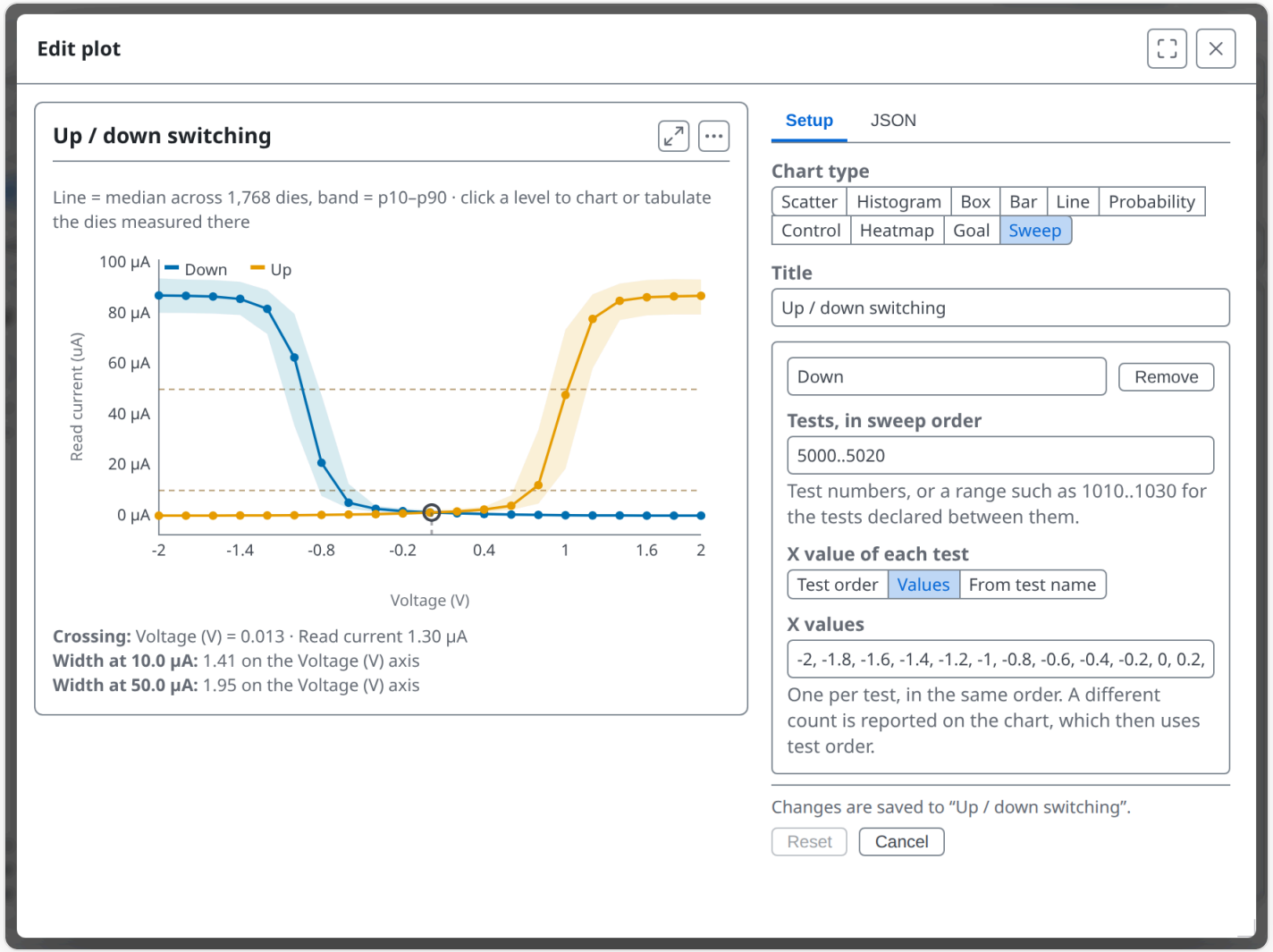
What the card measures

- A sweep card reports two results for its first two curves
- **Crossing** is where they meet
- **Width** is how far apart they are at the sweep's set levels (dashed lines)
- On a log axis the width is a ratio, such as ×2.93



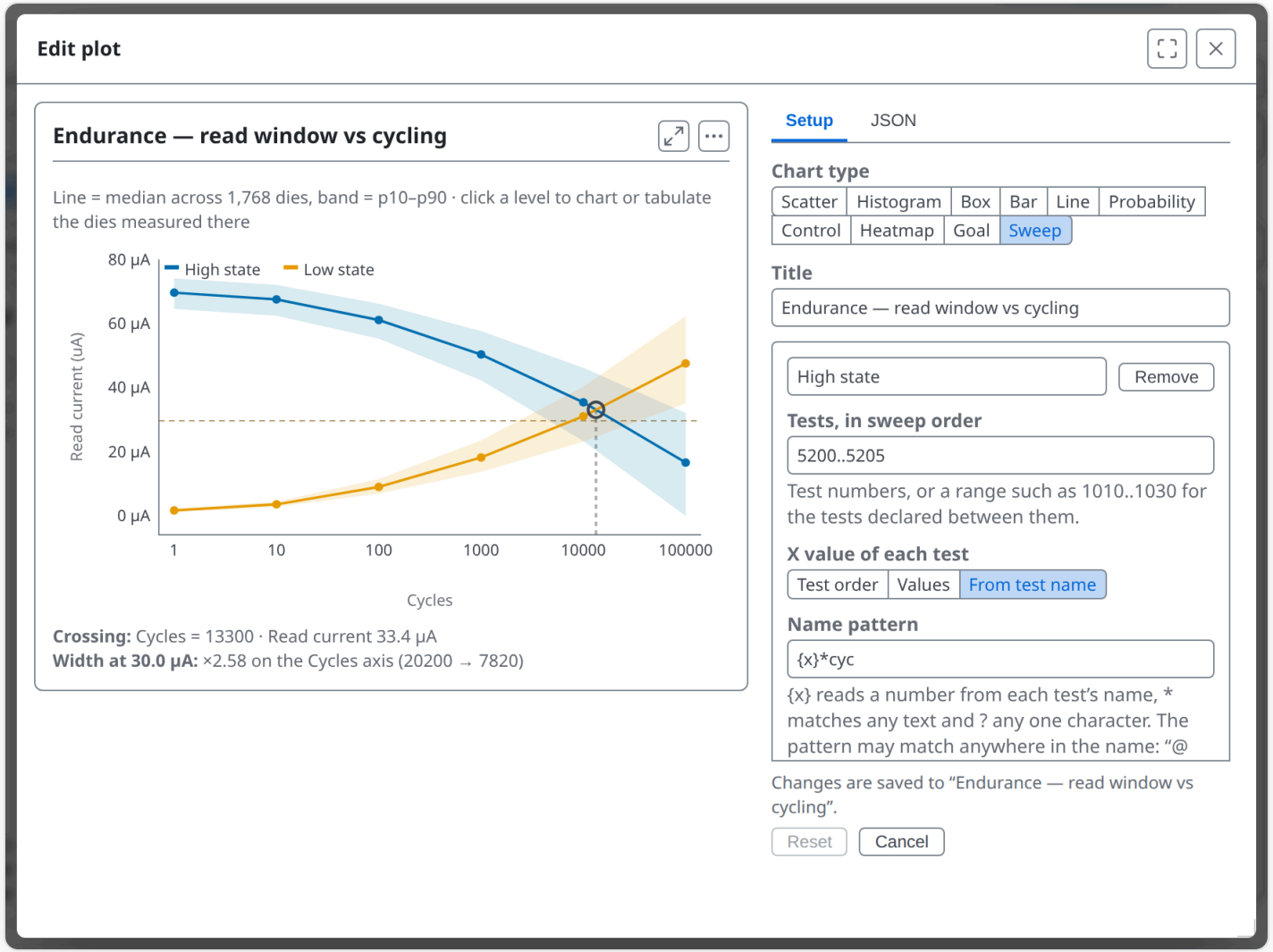
The sweep editor

To build or change a sweep, press **Edit**. It opens the sweep beside a live copy of its curve, so you see the effect of each change. For each series, type its tests in sweep order, then say where each test's X comes from.



From test name

Each test's X comes from its **Test order**, typed **Values**, or **From test name**: here the cycle count in "High-state I after 1e2 cycles". **+ Add series** adds a curve.



A sweep remembers its tests' names

A sweep is saved with the names of its tests. If a later lot uses the same test numbers for other measurements, the sweep does not draw them and says so on its card, instead of drawing another quantity as the same curve.

LAB Try it yourself

1. In the web app, **Load sample data**, then **Insights** → **My plots** → **Examples** → **Add all**
2. **Edit** the first plot and set **Chart type** to **Box**
3. Set **X axis** to **Split**: which split differs most?
4. Open **Customise** and put a reference line on the value axis
5. **Export plots…**, then **Delete all plots…** and **Undo**
6. Open `SWEEP-LOT-06`, load its definitions as in lesson 09, then **My plots** → **Import plots…** and choose `tsmap-sweep-plots.json`. **Edit** the **Endurance** plot and read where its X values come from

ANSWERS

Check your results

3. **FF** and **SS** sit furthest apart, at opposite ends, with TT between them. FS and SF fall between, depending on the test.
4. The X values come from **From test name**: each test's name carries its cycle count, as in "High-state I after 1e2 cycles".

Recap

- **My plots** are recipes, redrawn on the next lot
- The editor offers ten chart types, Sweep among them; X, Y and Colour take tests, die fields or wafer fields
- **Export plots…** keeps a copy; **Undo** brings back a delete for ten seconds
- A **sweep** reads a run of tests as a curve and measures where two curves cross

Next, the wafers that do not look like the usual ones.

More in the wafer map guide

Next lesson

11 · Unusual wafers →

Multi-project wafers, no positions, retests and multi-site testing.



Unusual wafers

Lesson 11

Learn tsmap

In this lesson

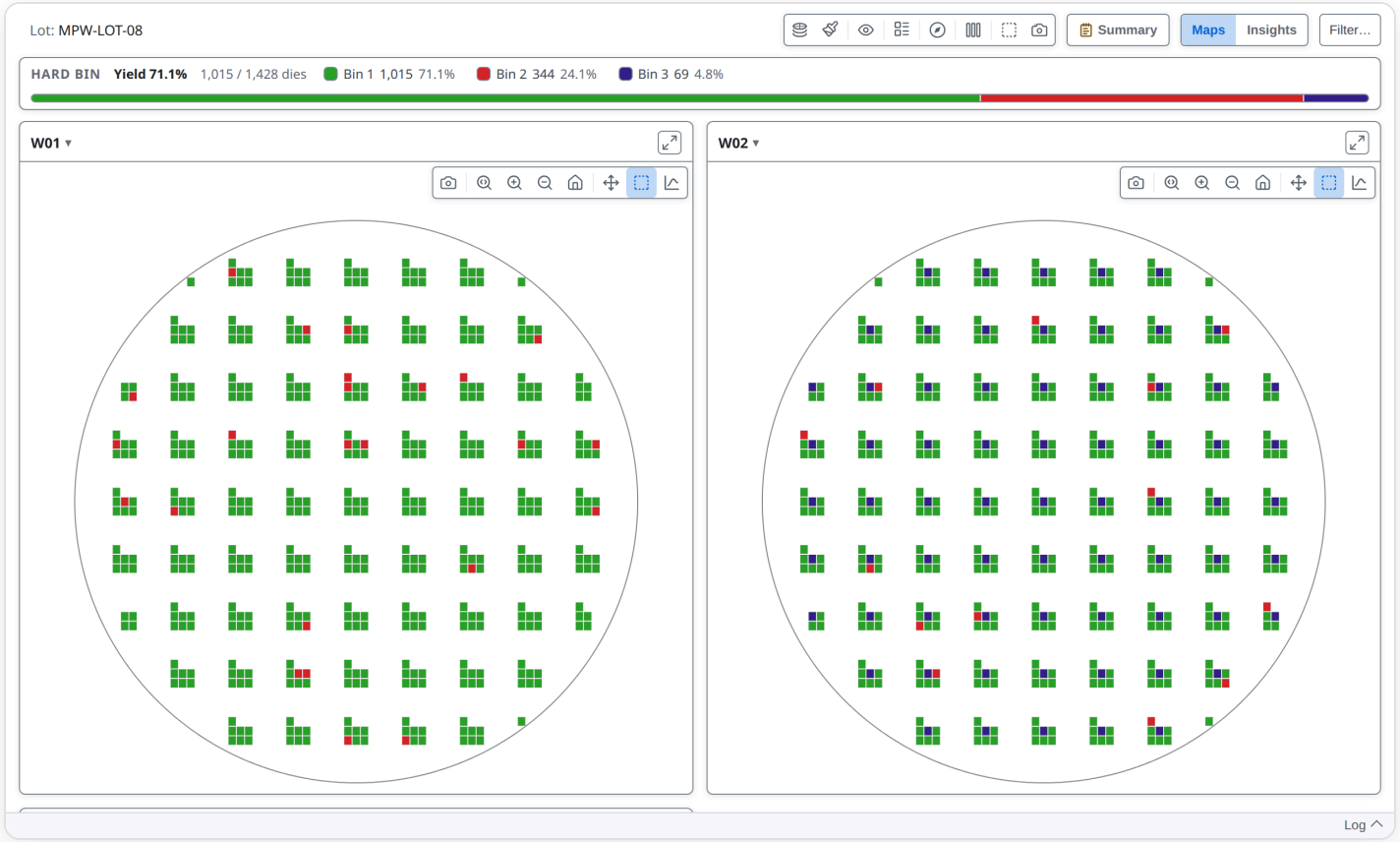
Not every wafer is a neat circle of positioned dies with one result each. This lesson covers the awkward cases: wafers that are mostly empty, wafers with no positions, dies probed more than once, and data the tester recorded wrongly.

- Read multi-project wafers and wafers with missing positions
- Set the reticle, diameter and edge exclusion
- Handle clamped values and repeated dies

Layouts

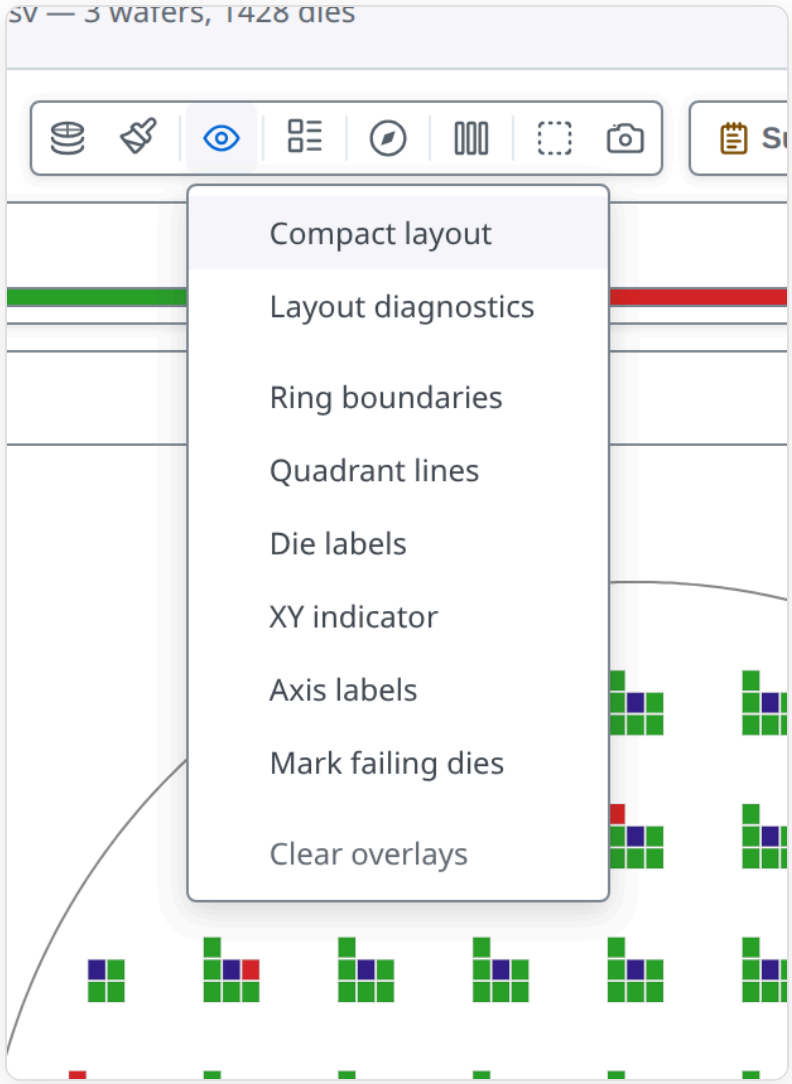
A multi-project wafer

A multi-project wafer shares one wafer between several products. Each reticle holds only a few of one product's dies, so the map is mostly empty and every die is tiny. This is `MPW-LOT-08`.



Compact layout

tsmap can tidy this up for you. When the occupied columns and rows repeat at a regular pitch, **Overlays** offers **Compact layout** and **Layout diagnostics** at the top.



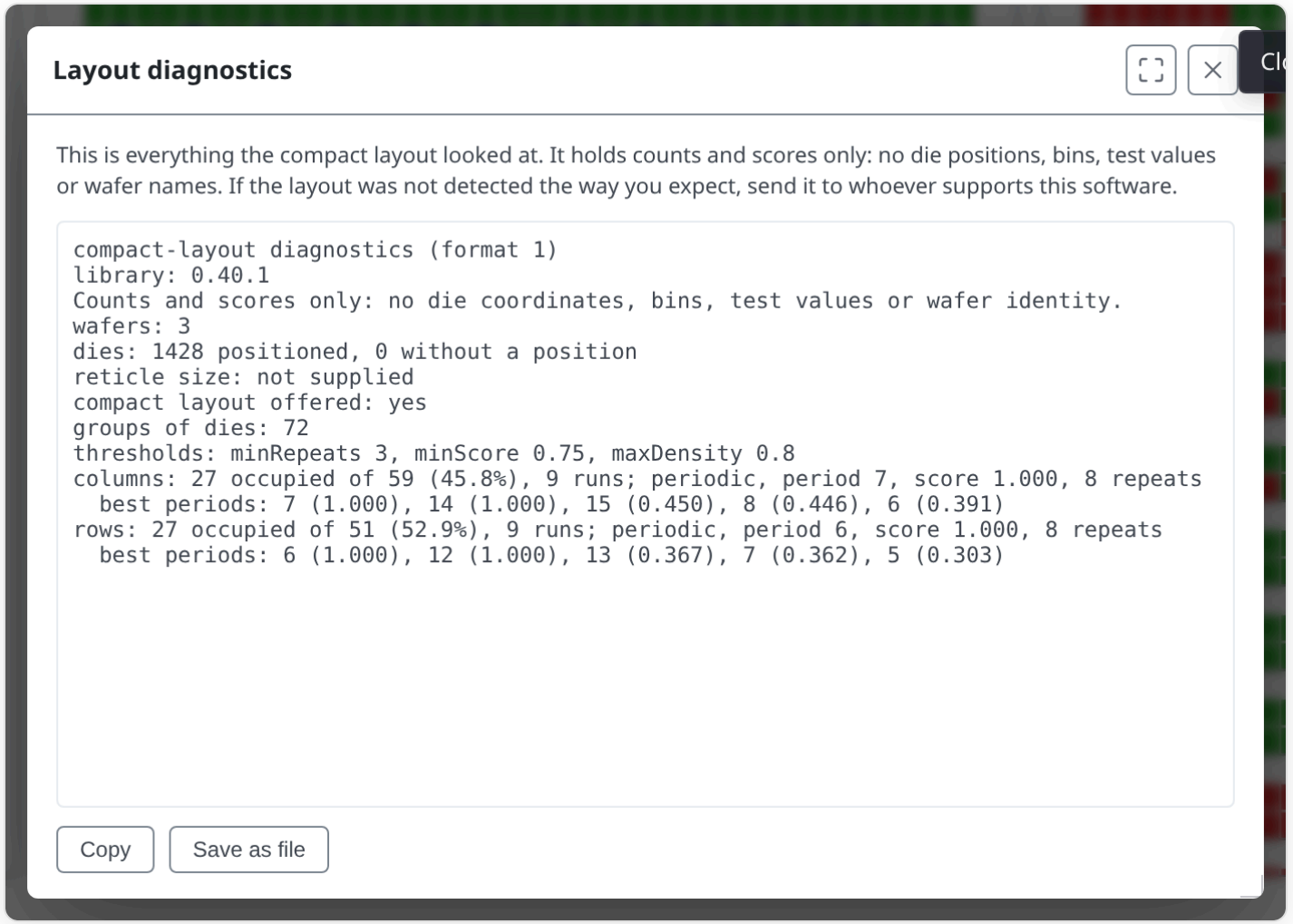
Compact

In the compact layout, empty rows and columns are removed and each group of dies is outlined. Every die is still counted, so yield and findings do not change, and a die's tooltip keeps its original coordinates.



Layout diagnostics

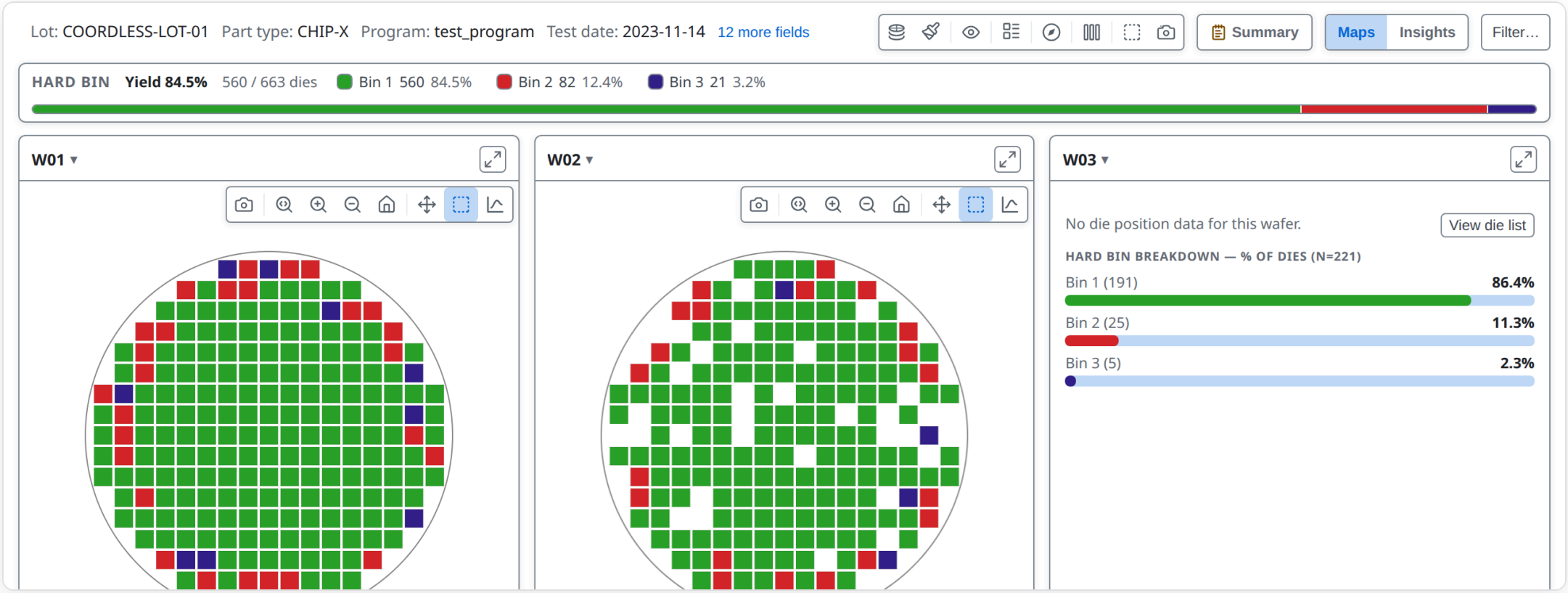
If a layout is not recognised as you expect, this window shows what the detector saw: counts and scores only, with no positions, bins or wafer names, so nothing about your data leaves with it. Use **Copy** or **Save as file**, then send the result to whoever supports tsmap.



Missing positions

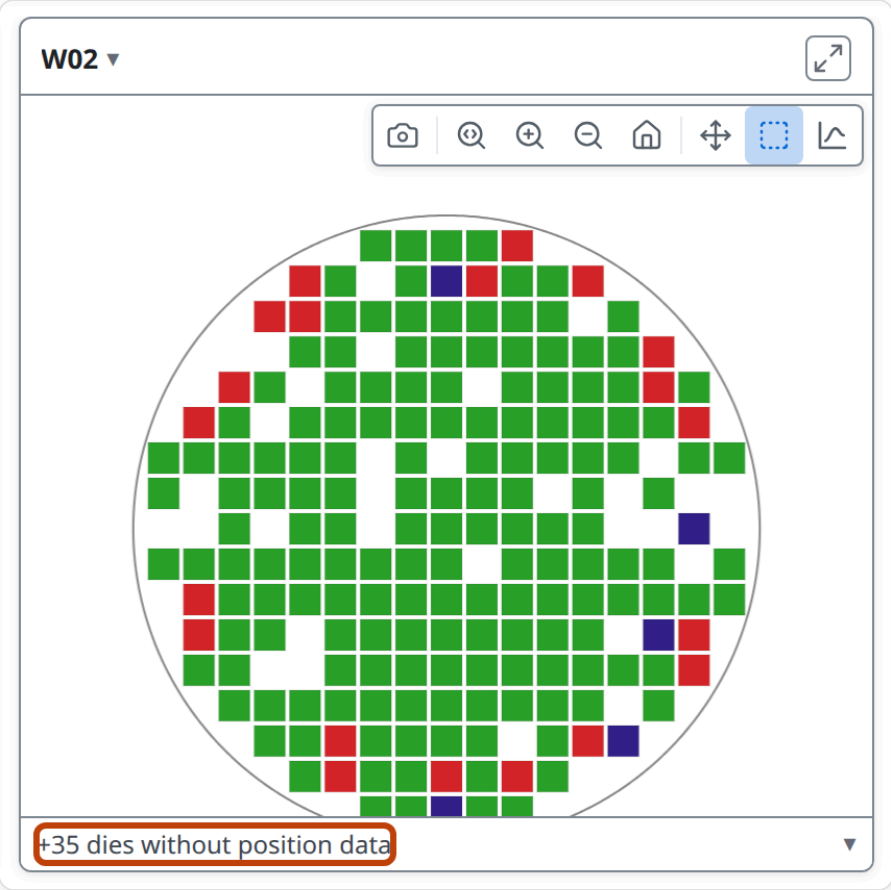
Three kinds of wafer

In the lot `COORDLESS-LOT-01`, **W01** has an X/Y position for every die. **W02** is mixed: some dies have results but no X/Y position. **W03** has results for its dies but no X/Y positions at all, so there is nowhere to draw them on a map.



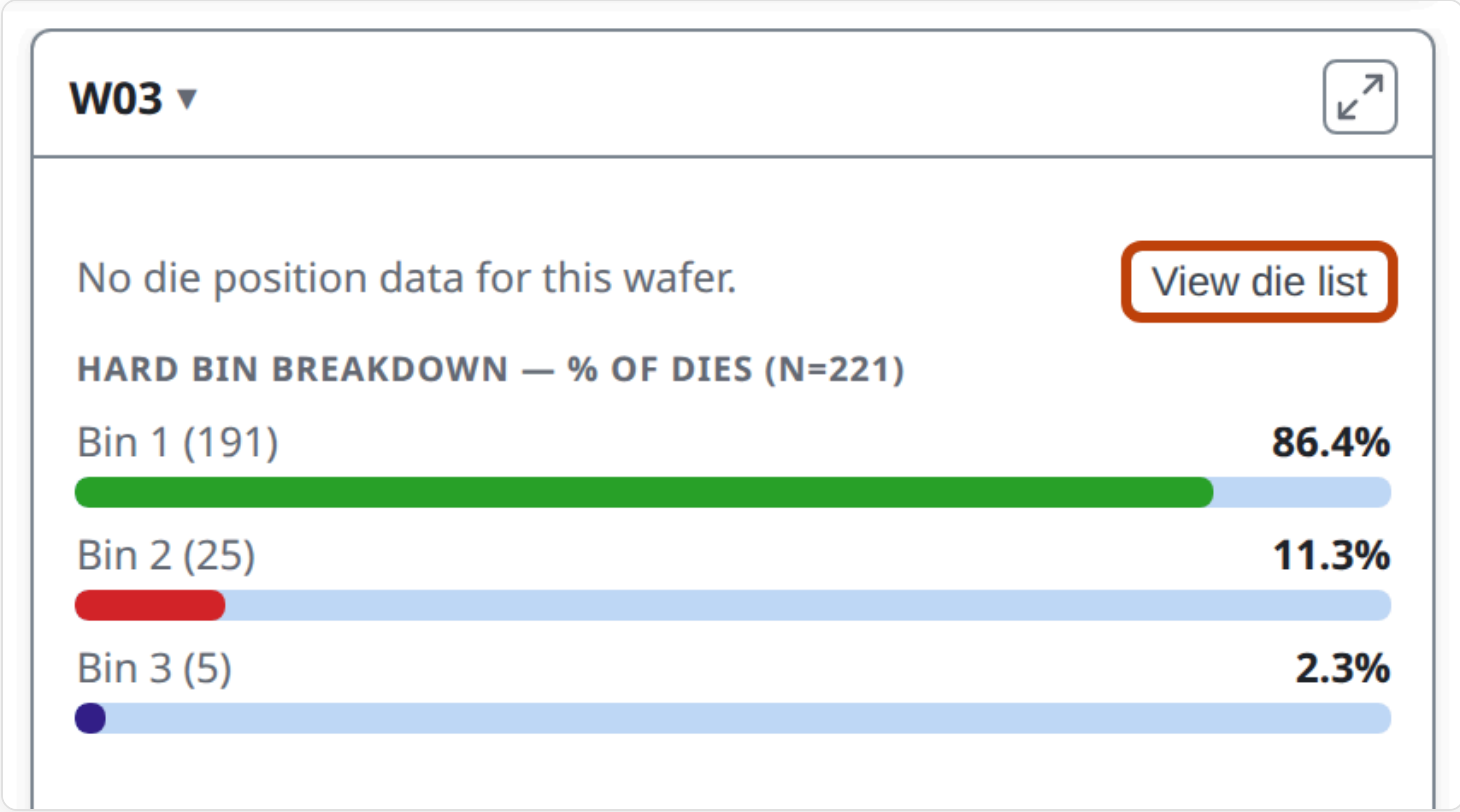
A mixed wafer

A mixed wafer draws the dies that have positions, so the map is true to what is known. A footer counts the rest; click it to see them.



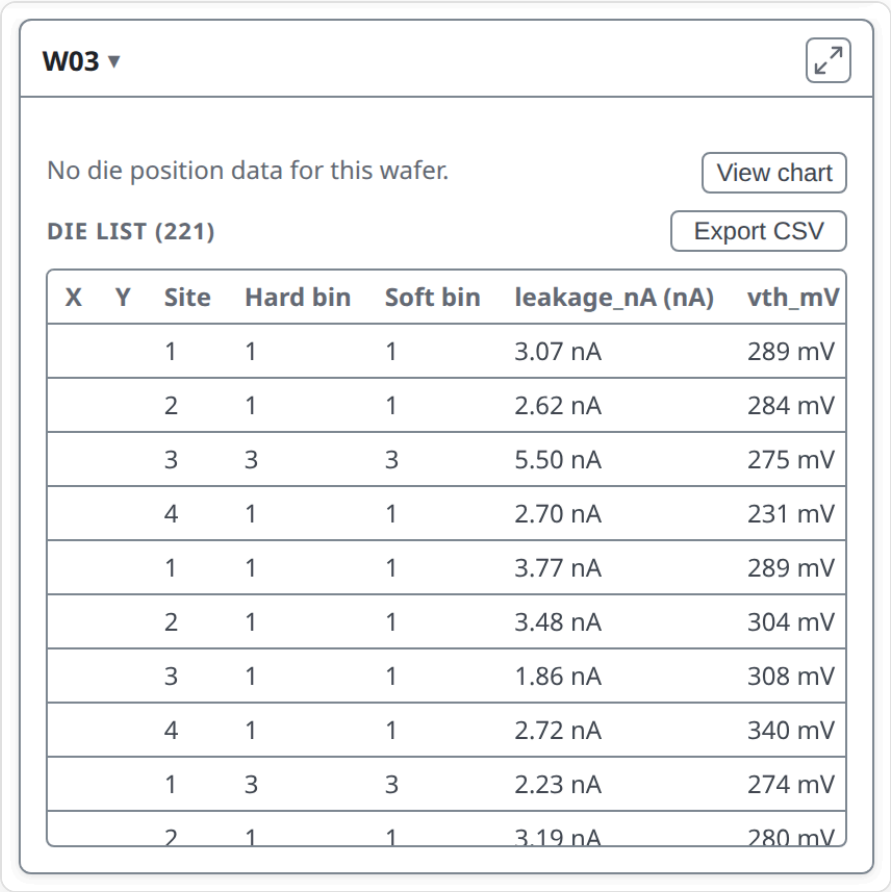
No positions at all

With no positions there is no map to draw, so the card shows a summary instead: a bin breakdown in the bin colour modes, or a histogram when colouring by a test value. **View die list** shows every die.



The die list

The die list has a row for every die, with its position (blank here), site, bins and every test value. **Export CSV** saves it, and **View chart** switches back.



X	Y	Site	Hard bin	Soft bin	leakage_nA (nA)	vth_mV
		1	1	1	3.07 nA	289 mV
		2	1	1	2.62 nA	284 mV
		3	3	3	5.50 nA	275 mV
		4	1	1	2.70 nA	231 mV
		1	1	1	3.77 nA	289 mV
		2	1	1	3.48 nA	304 mV
		3	1	1	1.86 nA	308 mV
		4	1	1	2.72 nA	340 mV
		1	3	3	2.23 nA	274 mV
		2	1	1	3.19 nA	280 mV

What it changes

Layout findings (edge ring, quadrants, clusters) use only positioned dies, because they need to know where a die is. Yield, bin counts and test statistics include every die, so no result is lost.

More in the user guide

Repeats and sites

Retests

A die is sometimes probed again after it fails, to see whether the failure was real. Every probe is a result, but the die needs only one.

- When the same die position appears more than once, one result has to stand for the die
- By default it is the last
- The die's tooltip says how often it was probed, and the log notes repeated dies

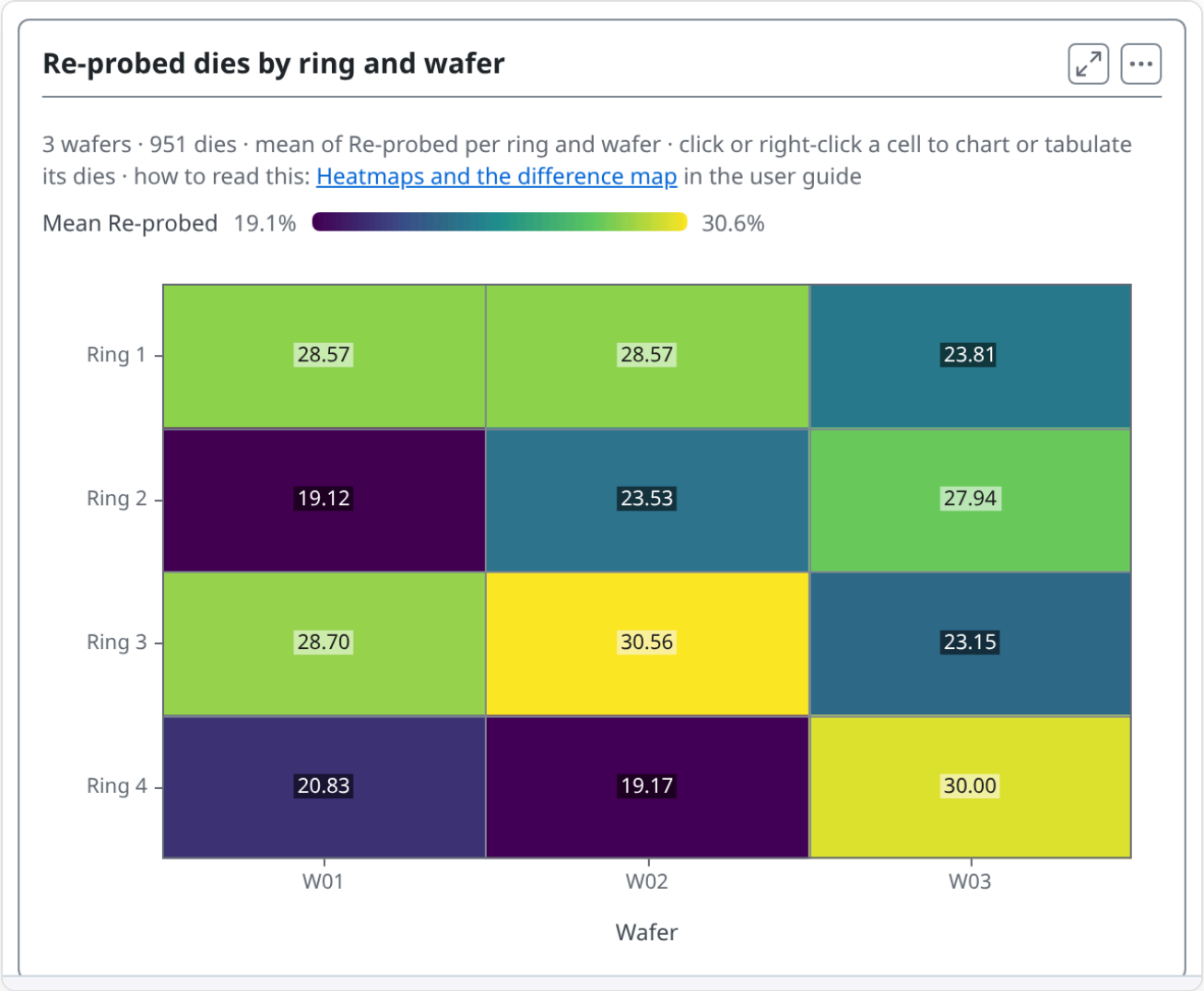
A lot with retests

`RETEST-LOT-07` has:

- a second pass over most failing dies
- a re-probe of a few passing ones
- a third probe of some

Where the retests are

When a lot has dies probed more than once, the Overview gains a **Re-probed dies** card: the share of dies re-probed in each ring of each wafer.



Reading the retests

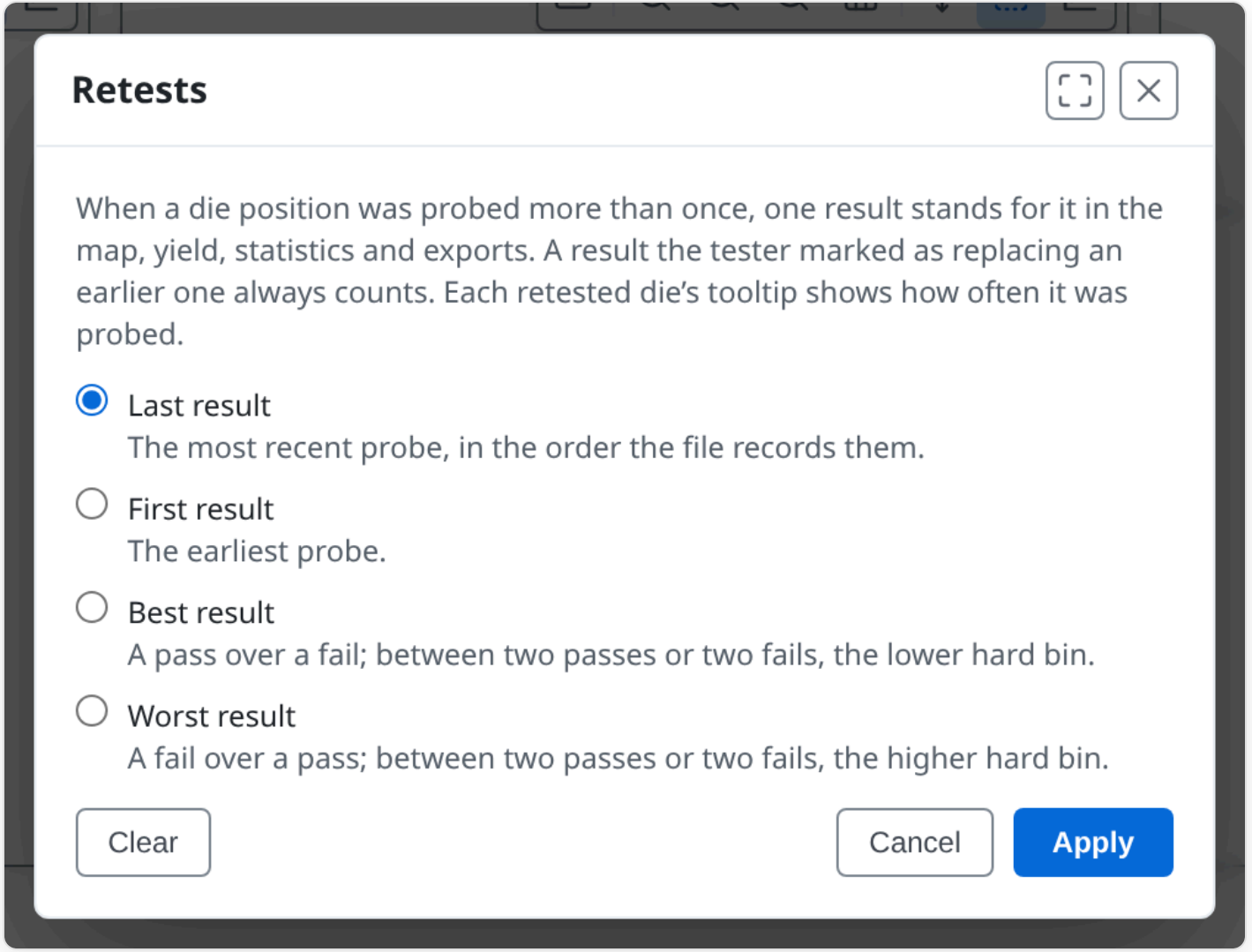
Look for where the retests concentrate.

- A bright cell is a ring where retests cluster
- That can mean a contact problem at that radius, rather than bad dies
- Re-probed is also a field you can plot (lesson 10)

Setup ▾ → Retests…

The probe you choose changes the yield.

- **Last** or **First**: the probe by its place in the file
- **Best**: a pass over a fail, then the lower hard bin
- **Worst**: a fail over a pass, then the higher hard bin

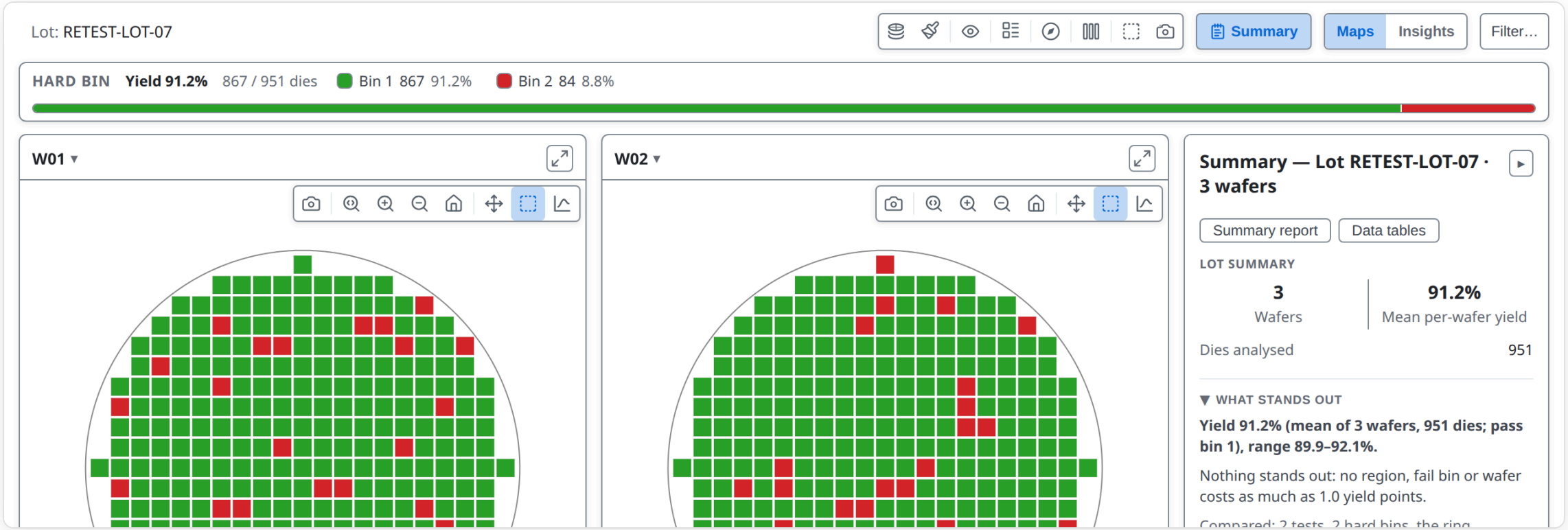


A result that replaces another

A result the tester marked as replacing an earlier one always counts, whichever choice you make.

One choice, every figure

The chosen result is the die on the map and in the yield, findings, Insights, tables and exports, so every figure agrees. `RETEST-LOT-07` yields 86.1% with the last result, 79.2% with the first, 91.2% with the best and 75.8% with the worst.



The same wafer twice

If one file holds the same wafer more than once, a column that tells the passes apart (a temperature, say) makes each pass its own map, and the log names the column. With nothing to tell them apart the repeats are treated as retests.

Test site

Sites are a different kind of repeat, and are not retests.

- Many testers probe several dies at the same time, each through its own numbered **site** (1, 2, 3…)
- STDF and ATDF record each die's site. In a CSV, JSON or Parquet file, map the site-number column to **Test site**
- All sites share one wafer map; the tooltip shows a die's site, the findings compare sites, and a plot can be split by site

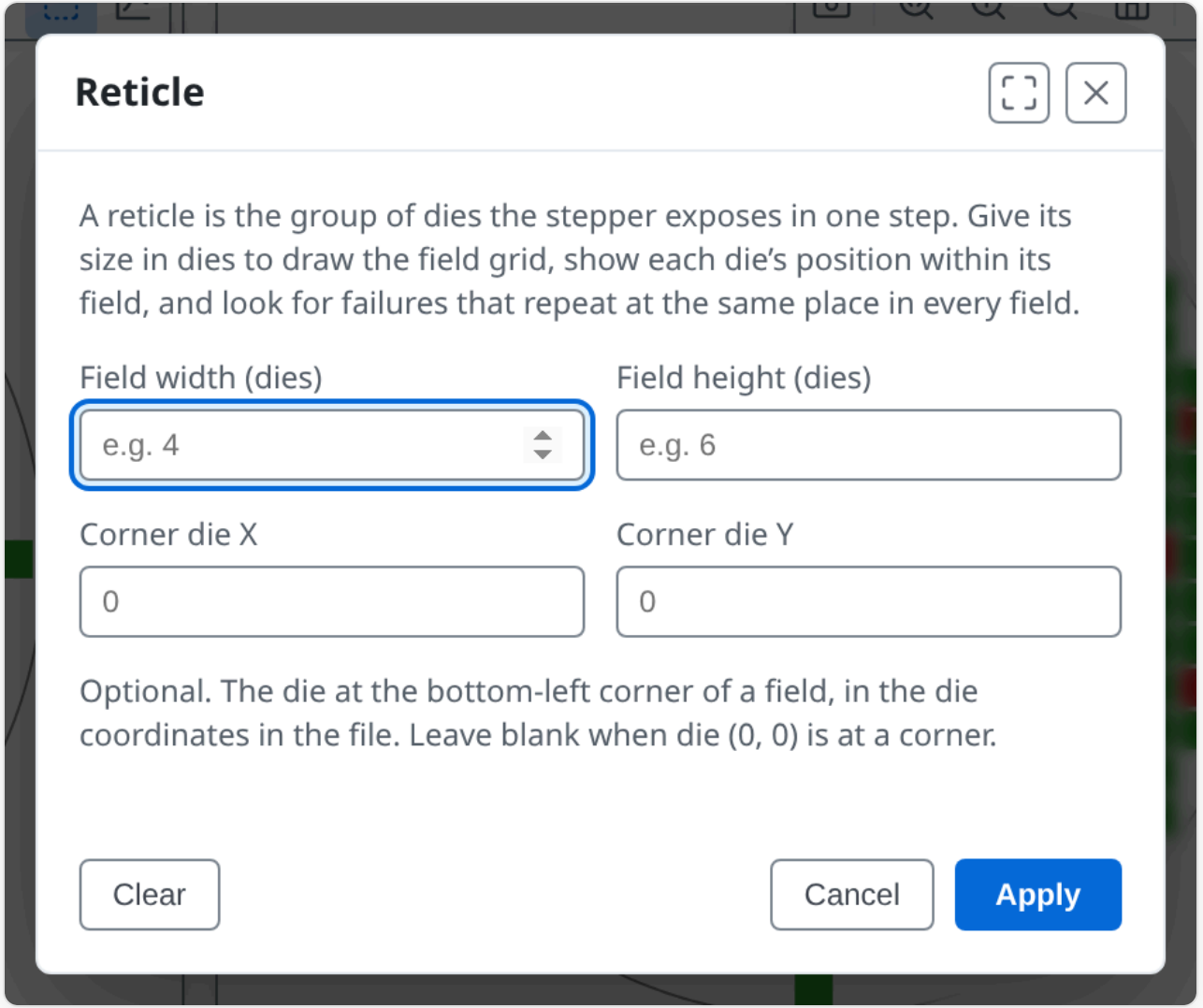
Sites are not separate wafers

Subdivide file by this column makes one wafer per value of a column, for files that pack several wafers with no wafer column. Never use it for sites: they share one wafer.

Geometry and limits

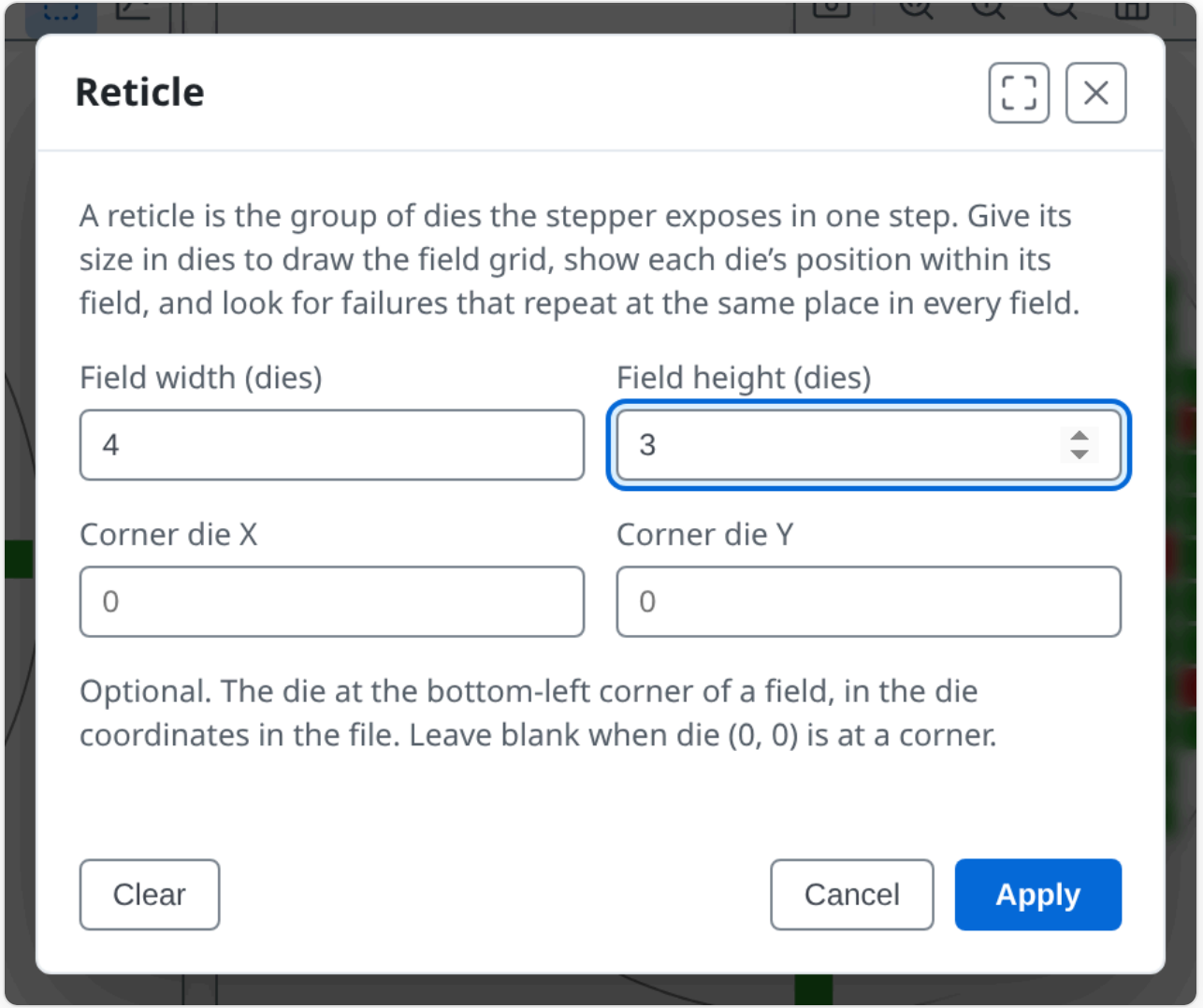
Reticle...

A reticle is the group of dies exposed in one stepper shot. Defects that repeat in every field point at the mask, so it is worth telling tsmap the reticle's size. Files don't record it, so enter its width and height in dies. Set the corner die only if a field doesn't start at (0, 0).



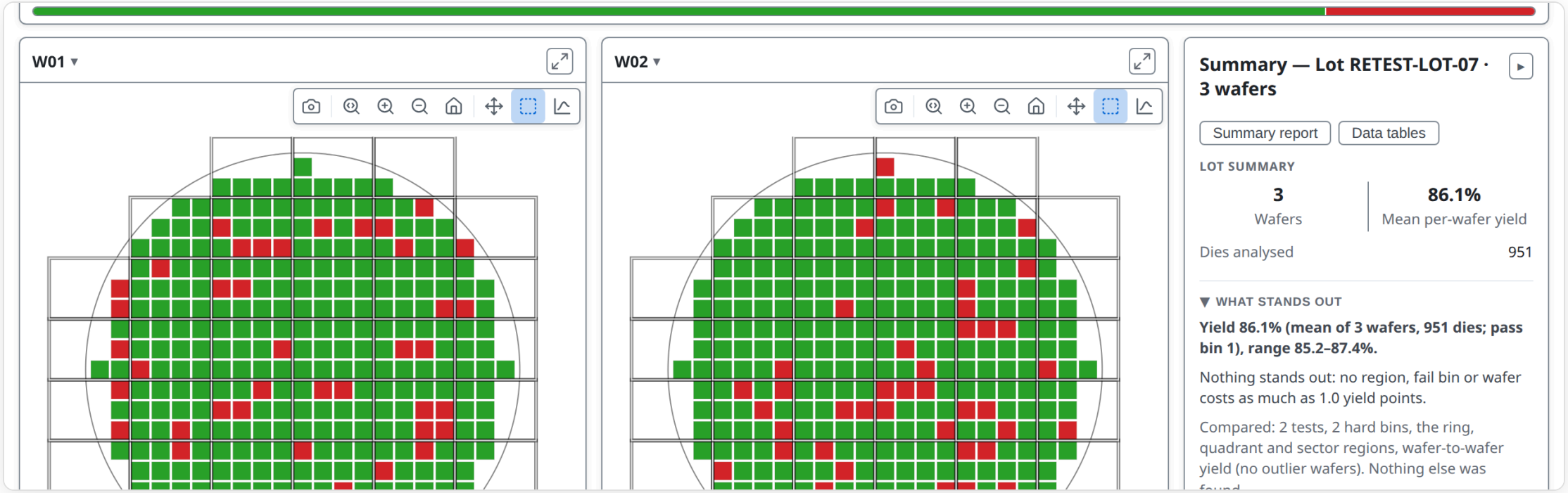
A field of 4 by 3

Here the field is 4 dies wide and 3 high. **Apply** takes effect at once. **Clear** removes the reticle. The reticle applies to every wafer and is remembered.



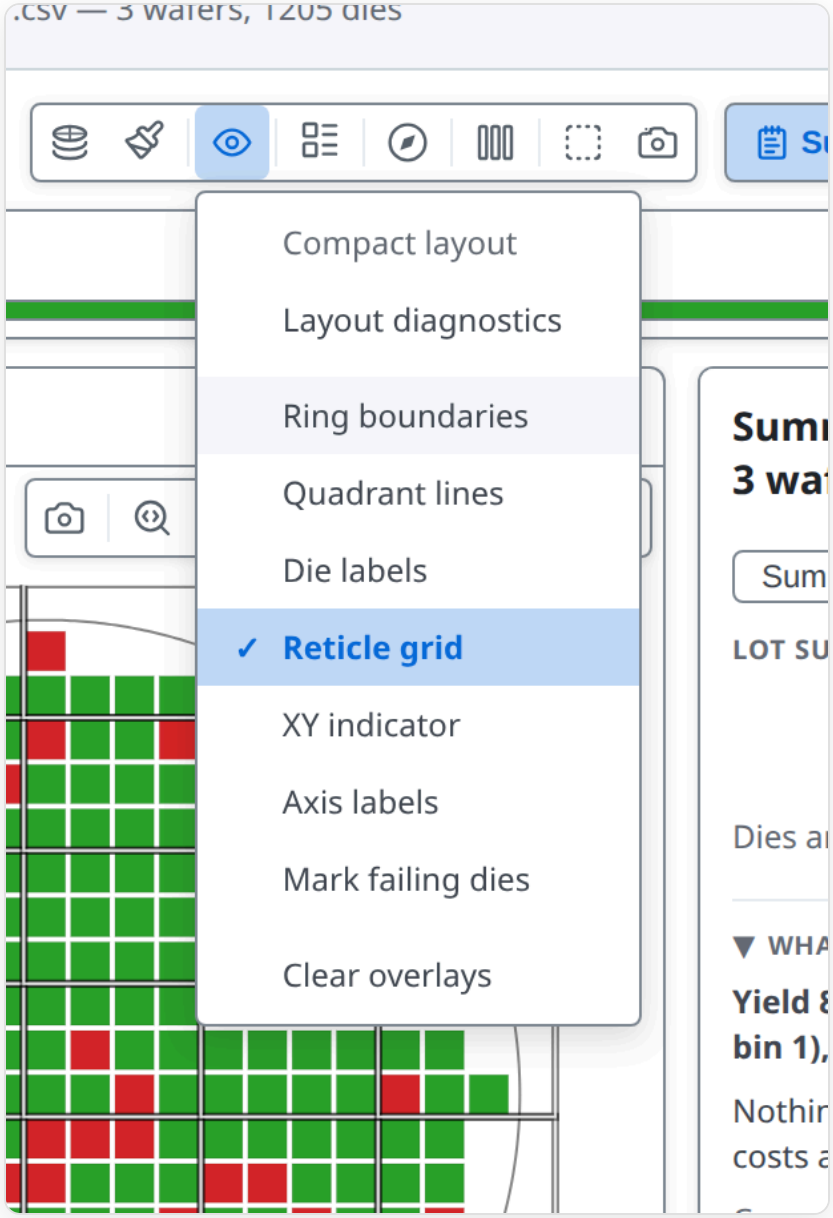
The field grid

- The grid is drawn and the tooltip gives each die's cell
- Findings look for a cell that fails in every field
- **Reticle cell** yield joins the Summary and the Overview: low everywhere points at the mask



Reticle grid

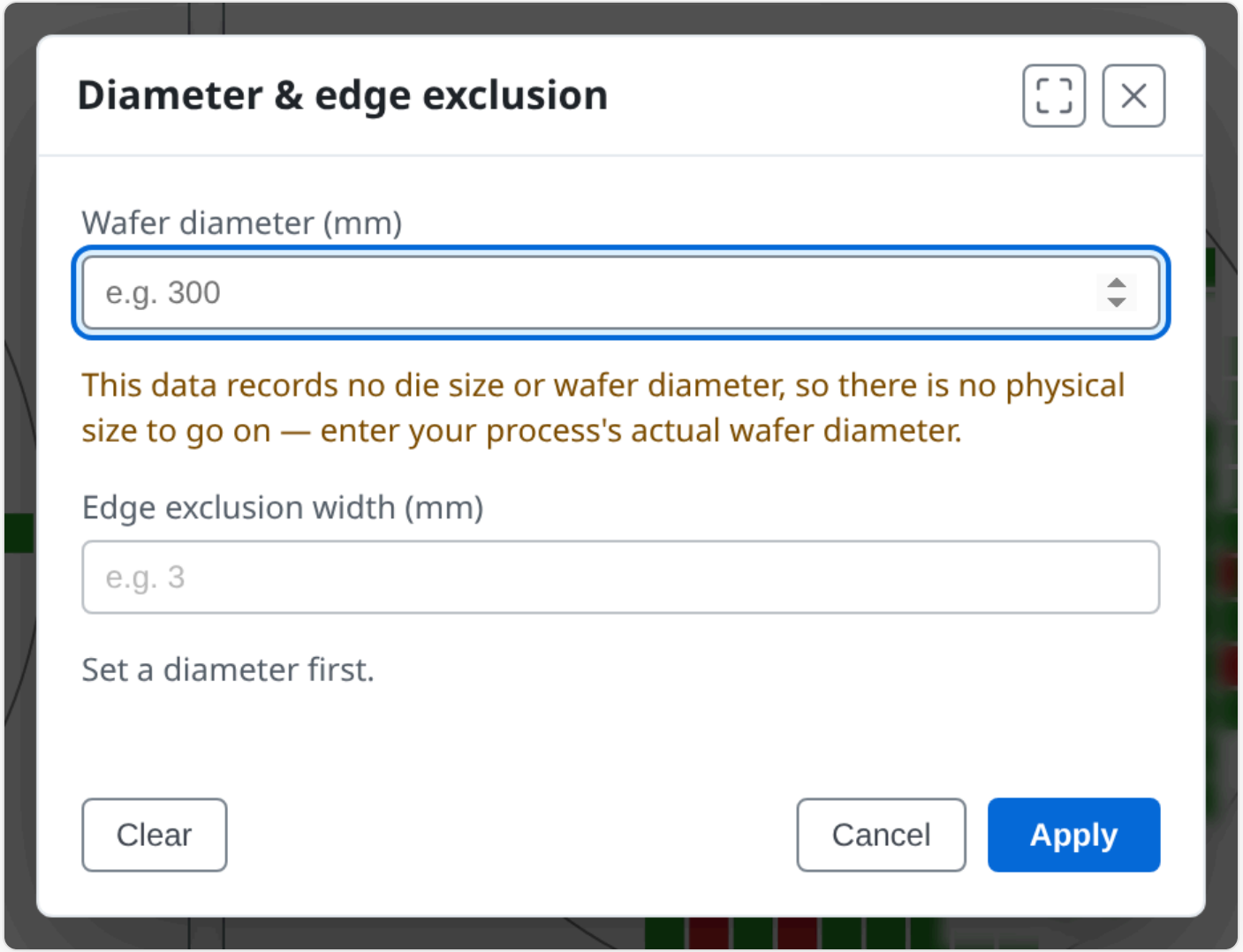
Overlays ▾ → **Reticle grid** hides or shows it. Plots gain two fields: **Reticle cell**, a die's place inside the field, and **Reticle shot**, which exposure it came from.



Diameter and edge exclusion

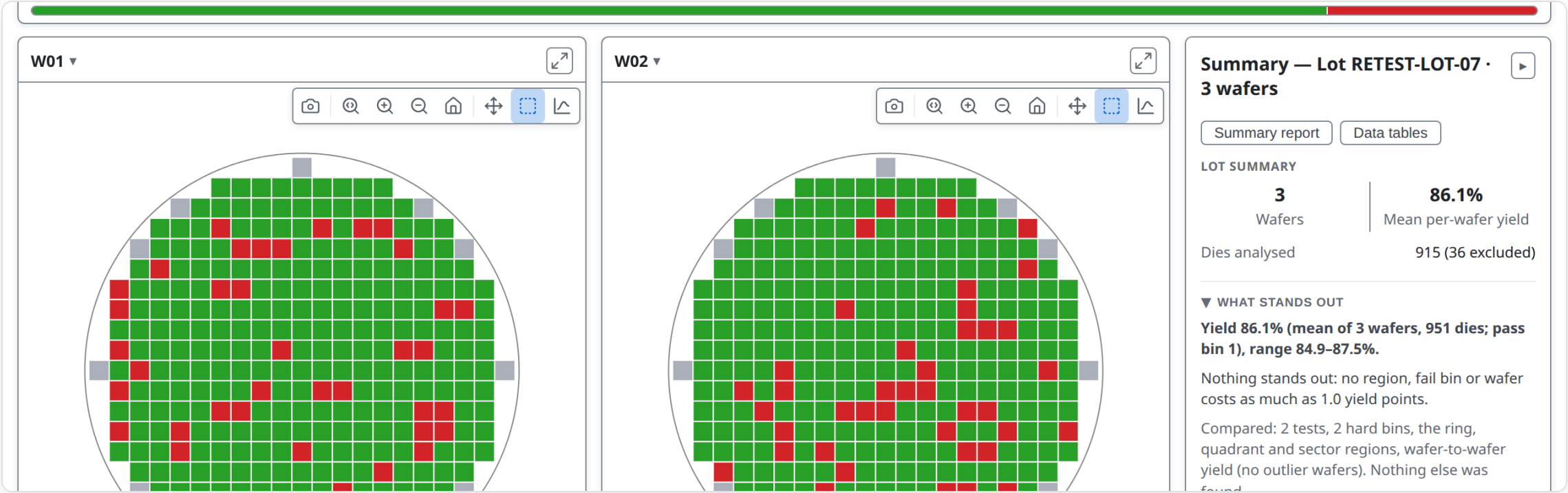
tsmap works out the wafer's size from its dies. When there are too few dies to do that, enter the diameter.

- **Edge exclusion**: a band at the rim, in mm, left out of yield and drawn dimmed
- The band needs a diameter first



A band at the edge

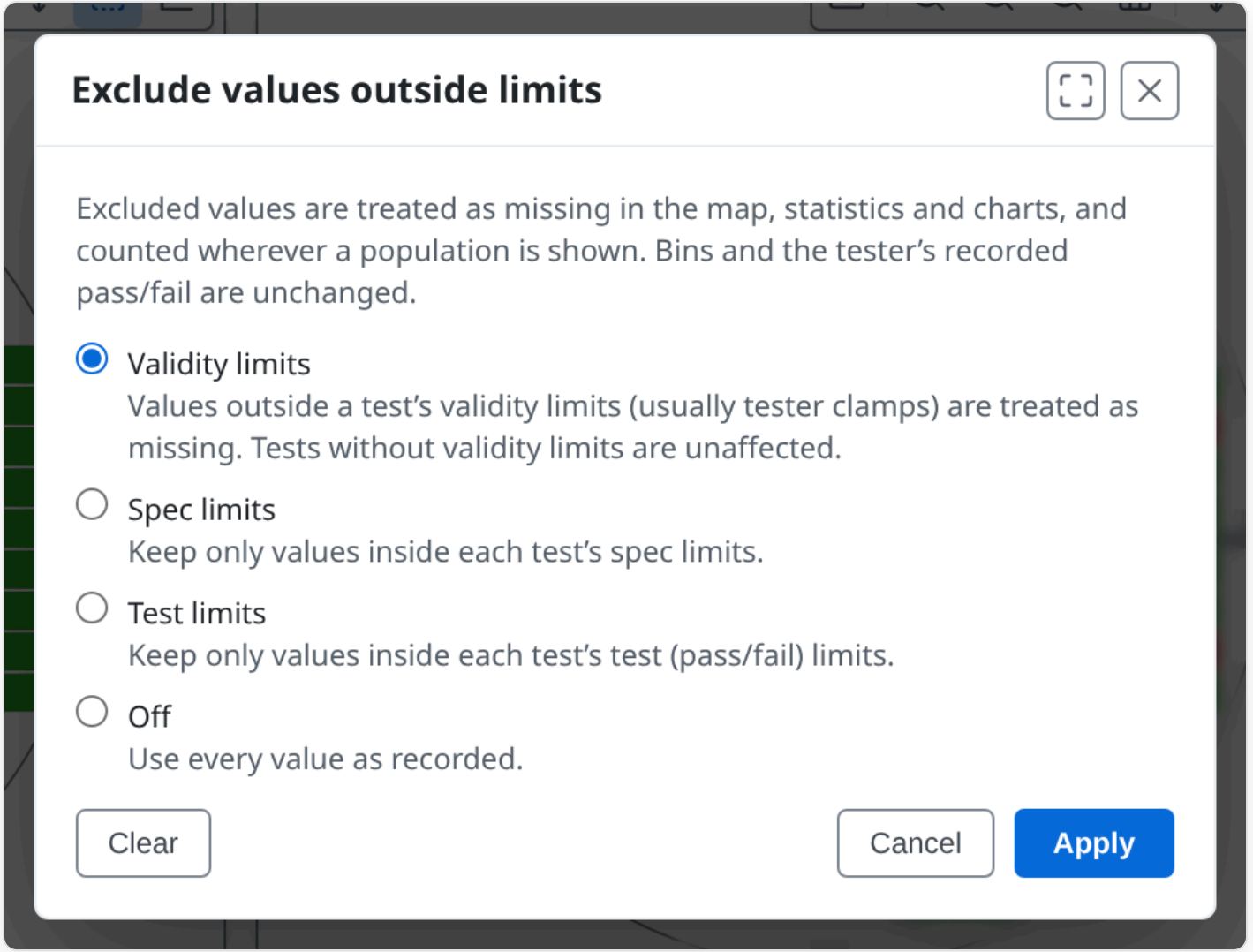
With 300 mm and 10 mm entered, dies within 10 mm of the edge are left out of yield and drawn dimmed. Both values are remembered.



Exclude values outside limits…

Sometimes a number in the data is not a measurement.

- A tester out of range records its rail, such as a compliance clamp, not a reading
- Values outside a test's **validity limits** count as missing: grey, and out of the statistics



Other limits to exclude by

Instead of validity limits, you can choose the spec limits or the test limits, or switch the exclusion Off.

Nothing is hidden

The tooltip on a grey die names the excluded value, and the Summary panel's Test Values table shows an **Excl.** column. Bins and the tester's pass or fail are unchanged, so yield is the same.

LAB Try it yourself

1. Open the multi-project wafer, **Continue →**, then **Overlays →** **Compact layout**
2. Open the wafers without positions: open W03's **View die list**
3. Open the clamped readings and switch **Exclude values outside limits…** between **Validity limits** and **Off**
4. Open the retested lot, **Continue →**, then try each choice in **Setup ▾ → Retests…** and watch the yield
5. On the sample lot, **Setup ▾ → Reticle…**, enter 4 by 3 and **Apply**

Recap

- **Compact layout** shows multi-project wafers at a readable size
- Wafers with missing positions keep every die in the numbers
- **Retests…** chooses which probe stands for a die tested more than once
- **Reticle…** and **Diameter & edge exclusion…** supply what the file does not say, and **Exclude values outside limits…** removes tester clamp values

The last lesson covers automation.

More in the user guide



Next lesson

12 · Automation and integration →

The command line, links, and definitions files.



Automation and integration

Lesson 12

Learn tsmap

In this lesson

If you open the same kind of data every day, or you want another tool to open it for you, clicking through the dialogs gets tiresome. This lesson shows how to open data from a link or the command line, and how to save your setup so you only have to make it once.

- Open data from a link or the command line
- Use the definitions files: tests, splits, bins and plots
- See and reset what tsmap remembers

Opening data automatically

From a link

Another application, or a colleague's message, can open the web app on a data file. The link holds the address of the file:

```
…/app/?dataUrl=<encoded URL>&dataFormat=csv
```

Name the format: `stdf`, `atdf`, `csv`, `json`, `parquet` or `zip`.

The lab link

The labs in these lessons use this kind of link. This one opens the sample CSV:

Open the sample CSV

The data server must allow pages from other websites to read the file (this is called CORS). If the fetch fails, the log says so.

More in the user guide

The command line

On the desktop app, name files when you launch it, and they open without a single click:

```
tsmap lot1.stdf lot2.stdf
tsmap lot1.stdf --splits my-splits.csv
tsmap lot1.stdf --plots my-plots.json
tsmap --url https://… --url-format stdf
```

`tsmap --help` lists everything. Launching again hands the files to the running window.

tsmap --help

The first lines of what it prints:

```
tsmap [OPTIONS] [FILE...]

Options:
  --list <FILE>          A text file of data-file paths, one per line
  --tests <FILE>         A test-selection list; pre-fills the selector
  --splits <FILE>        A wafer-splits CSV, applied once loaded
  --bins <FILE>          A bin-definitions CSV, applied over the data
  --setup <FILE>         A setup file: diameter, edge exclusion, reticle, ...
  --plots <FILE>         A plots file, added to your saved plots
```

More options

Options let a launch carry its own setup.

- `--wafer-diameter`, `--edge-exclusion`, `--reticle`: the dialogs' values, for that launch
- `--tests` fills in the test selector; `--list` reads a list of paths
- A `tsmap://open?url=…` link opens the desktop app from a web page

More in the user guide

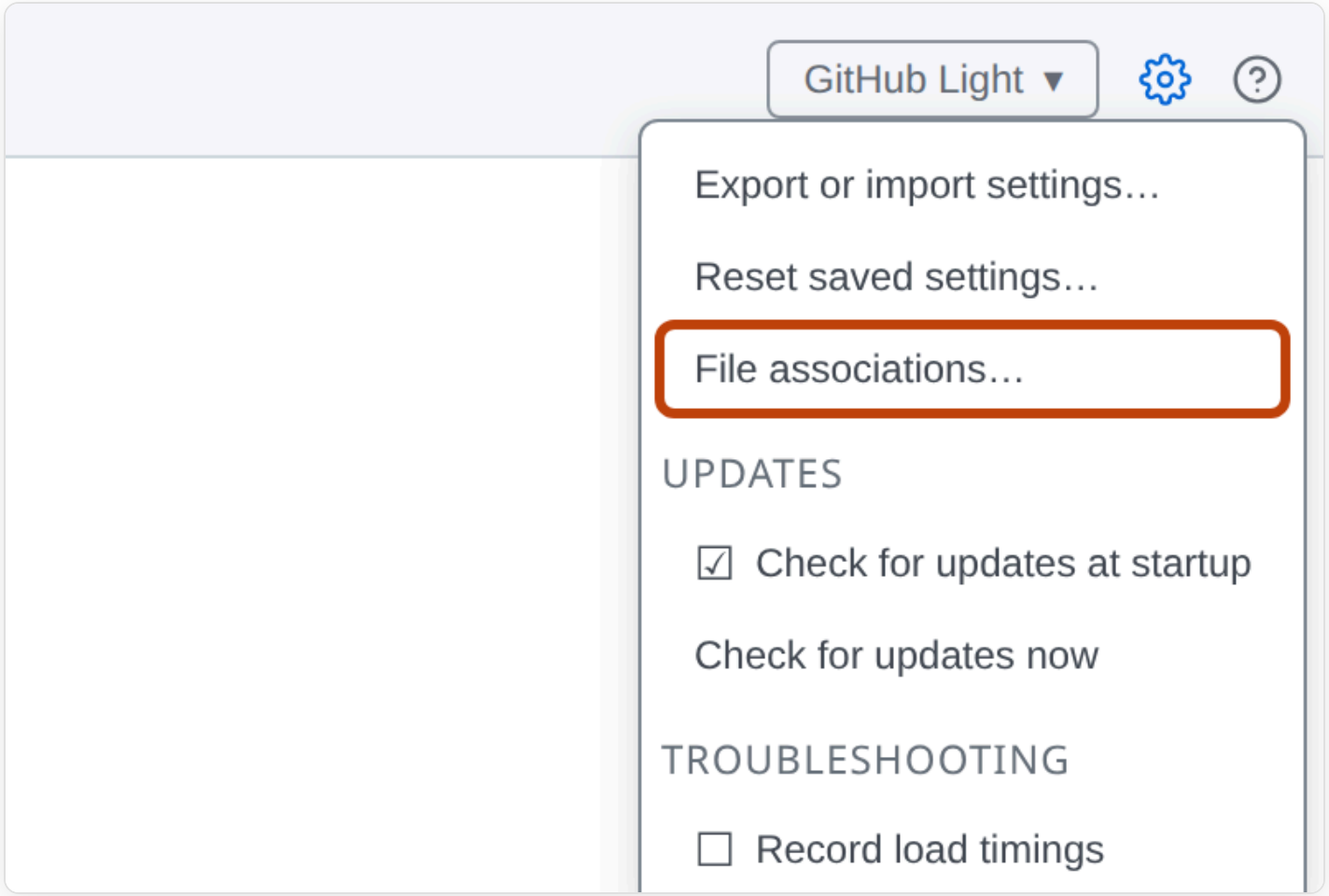
Data behind a login

Data often sits behind a login, and a link should not carry a password.

- Use a presigned URL, which builds the access into the address
- `--url-headers auth.txt` sends a token from a file (desktop)
- See the integration guide and a live demo

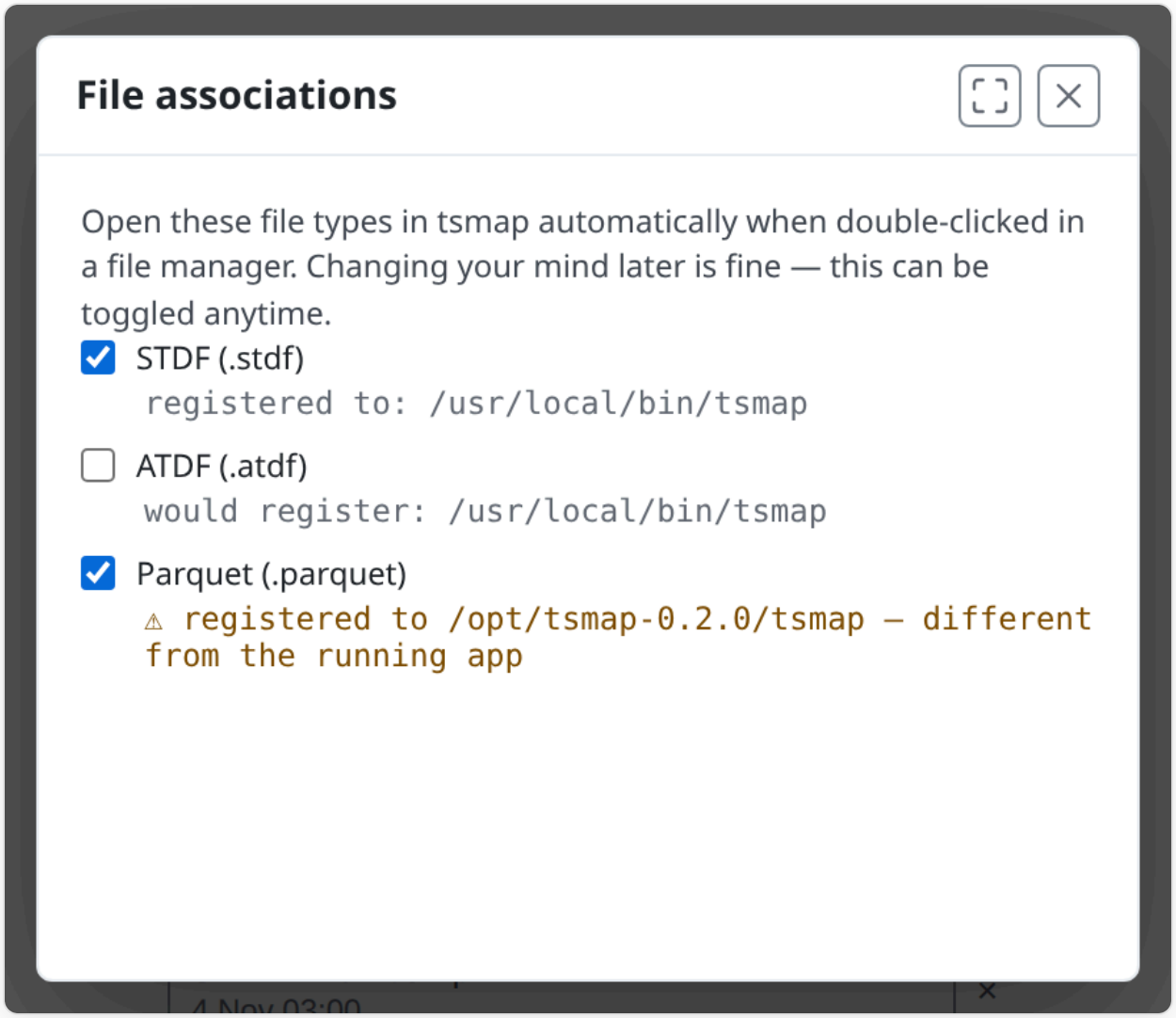
File associations

To open files by double-clicking them, use the desktop app. **Preferences → File associations…** opens `.stdf`, `.atdf` and `.parquet` files in tsmap. Nothing is associated until you tick it. It is not available in the browser.



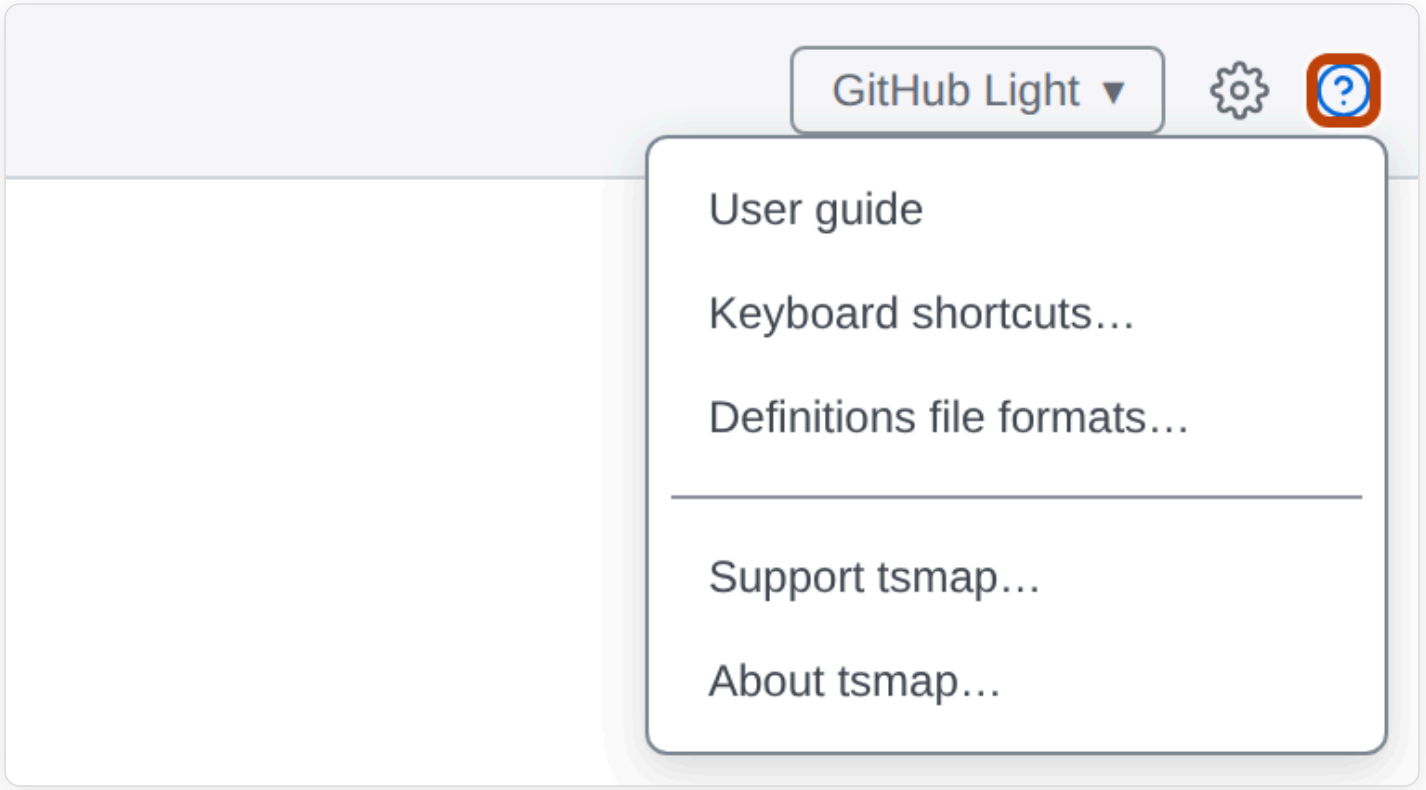
The File associations window

One row per file type. A tick means double-clicking that type opens it in tsmap, and the path under it is the copy of tsmap that is registered. A ⚠ warns when that is a different copy from the one running, as after an upgrade or a dev build.



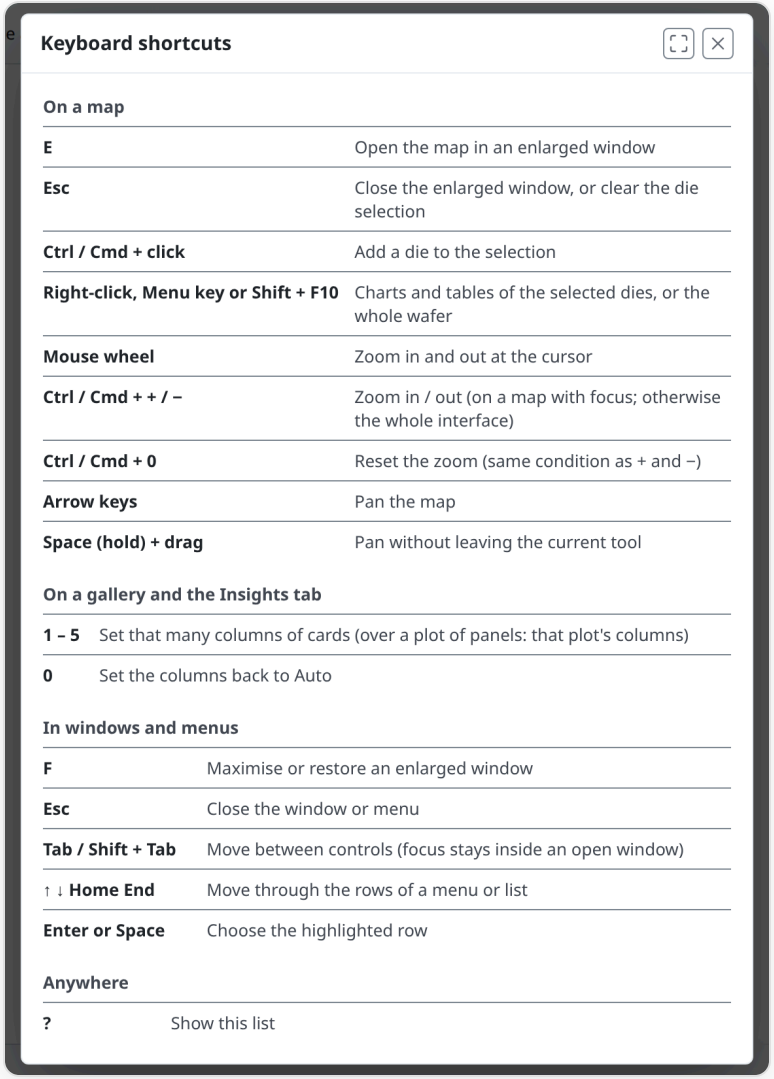
The Help menu

- **User guide** opens the full guide
- **Keyboard shortcuts…** lists the keys; **?** opens it from anywhere
- **Definitions file formats…** is covered in the next section



Keyboard shortcuts

Help → Keyboard shortcuts..., or **?** from anywhere, lists the keys for maps, galleries, windows and menus. Zooming, panning, **E** for an enlarged map and **1–5** for the columns of cards are all here.

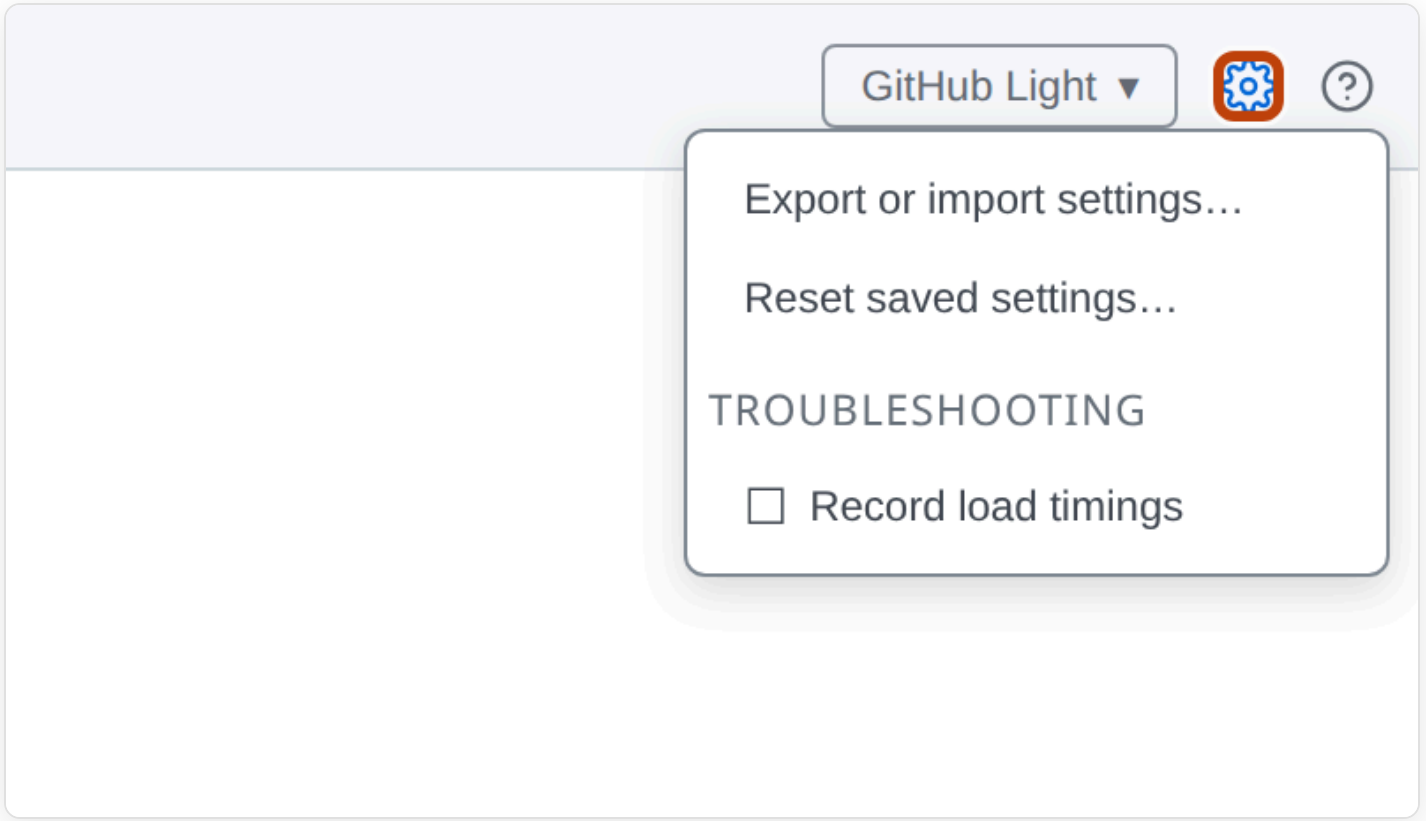


The rest of the Help menu

- **Support tsmap...** opens the page on how to support the project
- **About tsmap...** shows the version

The Preferences menu

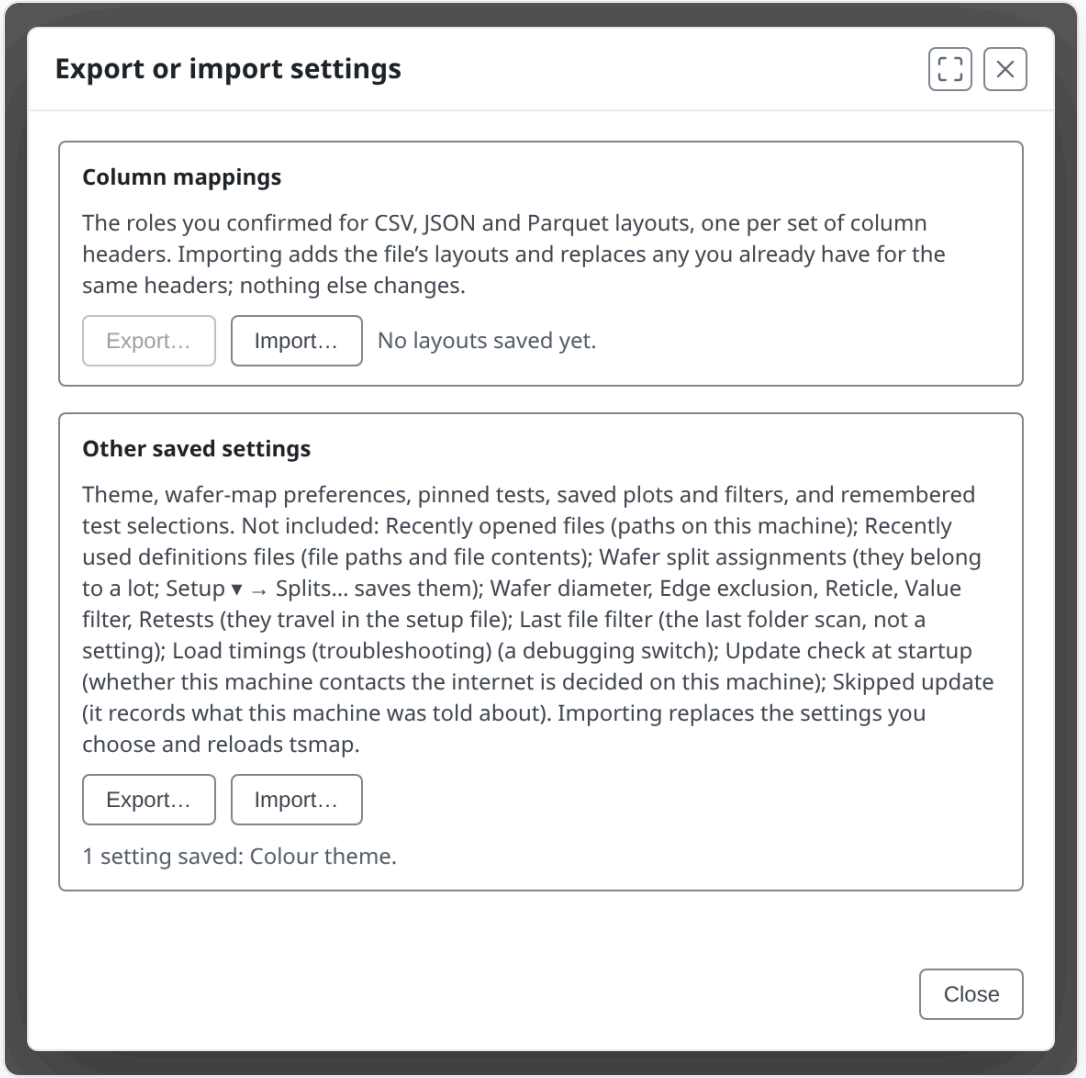
The gear works with nothing loaded, so you can set things up before you open any data.



- **Export or import settings…** carries your column mappings and preferences to another machine

Export or import settings

Use this to set up a second machine. **Export…** writes a file and **Import…** reads one. Column mappings merge at once; the other settings are chosen from a list, and tsmap then reloads. The window lists what is never included.



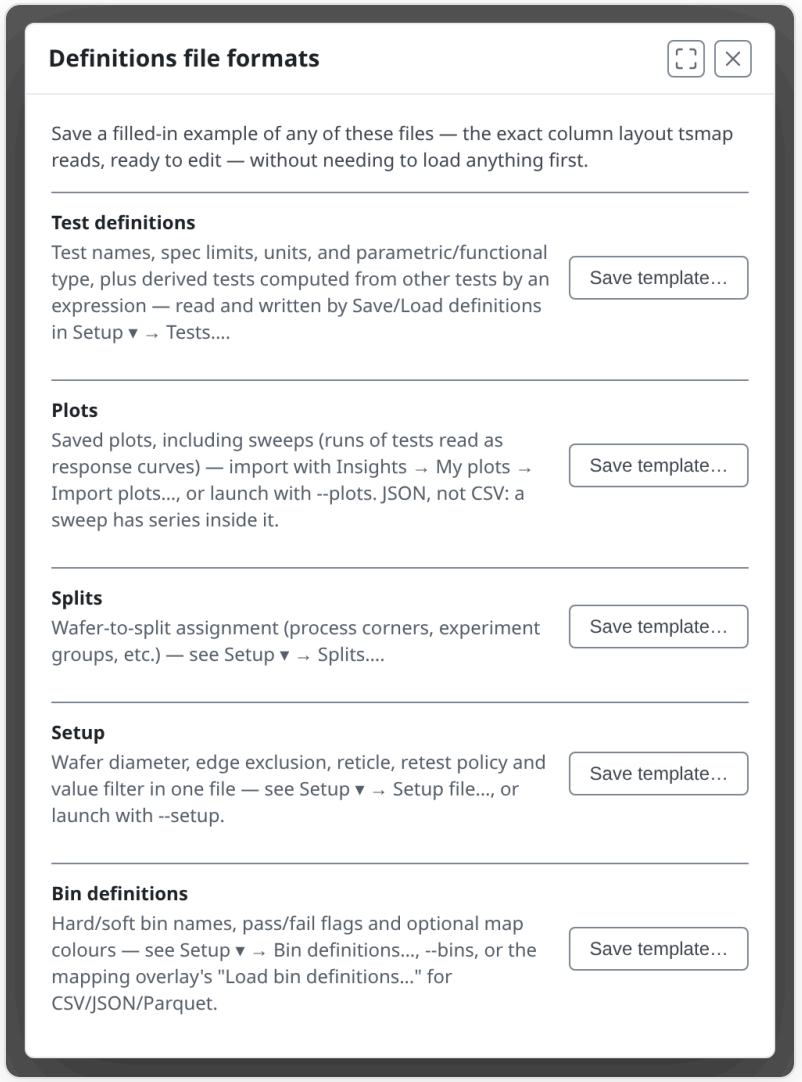
The rest of the Preferences menu

- **Reset saved settings…** is covered after the definitions files
- **Record load timings** is for bug reports only: it adds timing lines to the log. Leave it off otherwise

Definitions files

Definitions file formats...

Earlier lessons used files that tell tsmap about your data: test names and limits, splits, plots, bin names. This window lists all five kinds. Each has a **Save template...** button that writes a filled-in example in the exact layout tsmap reads.



Start from a template

You can save a template and edit it before you have any data. It is the easiest way to get a layout right.

Four CSV files and one JSON

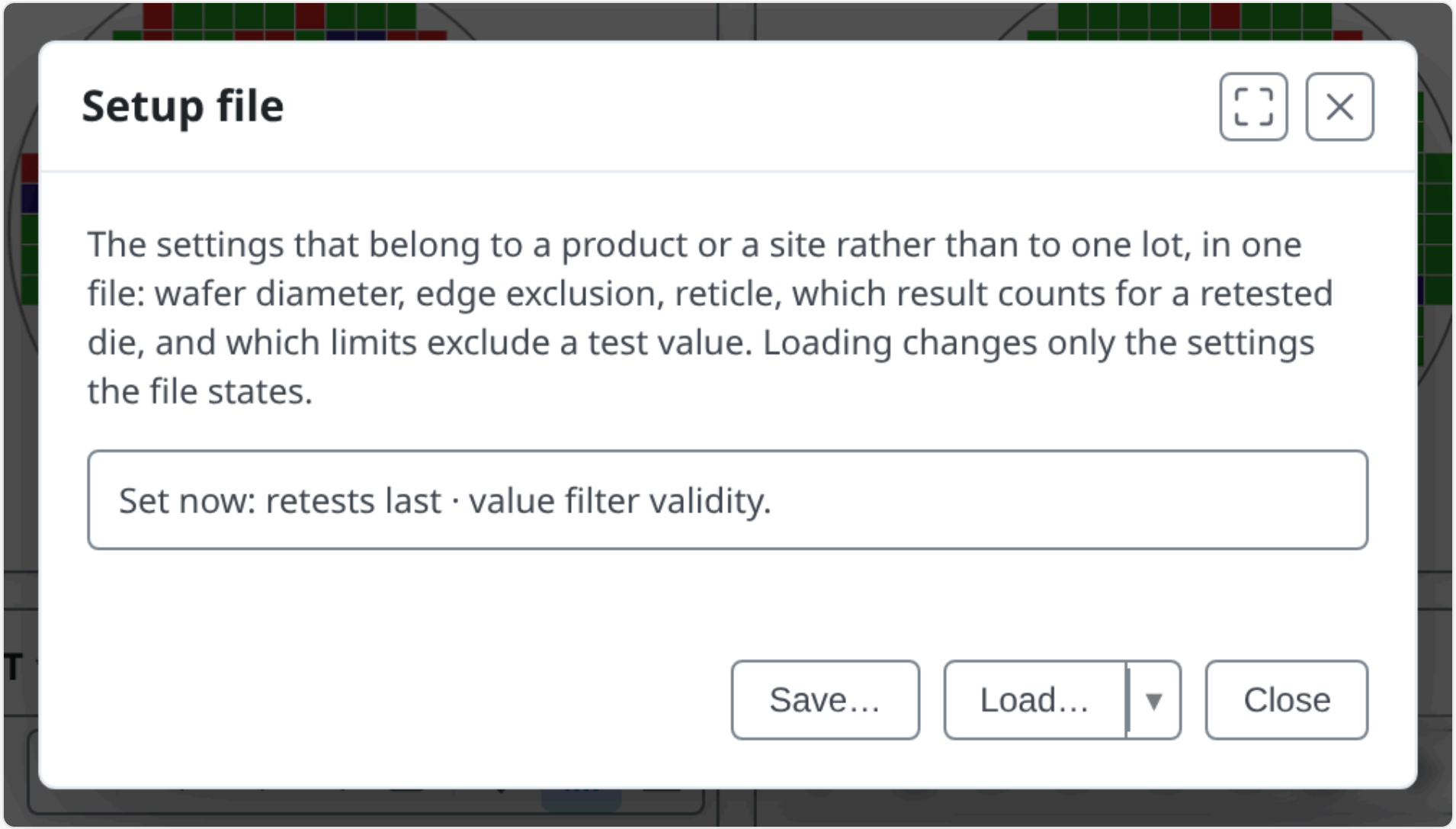
Where each is covered:

- CSV: test definitions (lesson 01), splits (04), bin definitions and the setup file (here)
- JSON: plots and sweeps (10)
- Every format is in the user guide

Setup file…

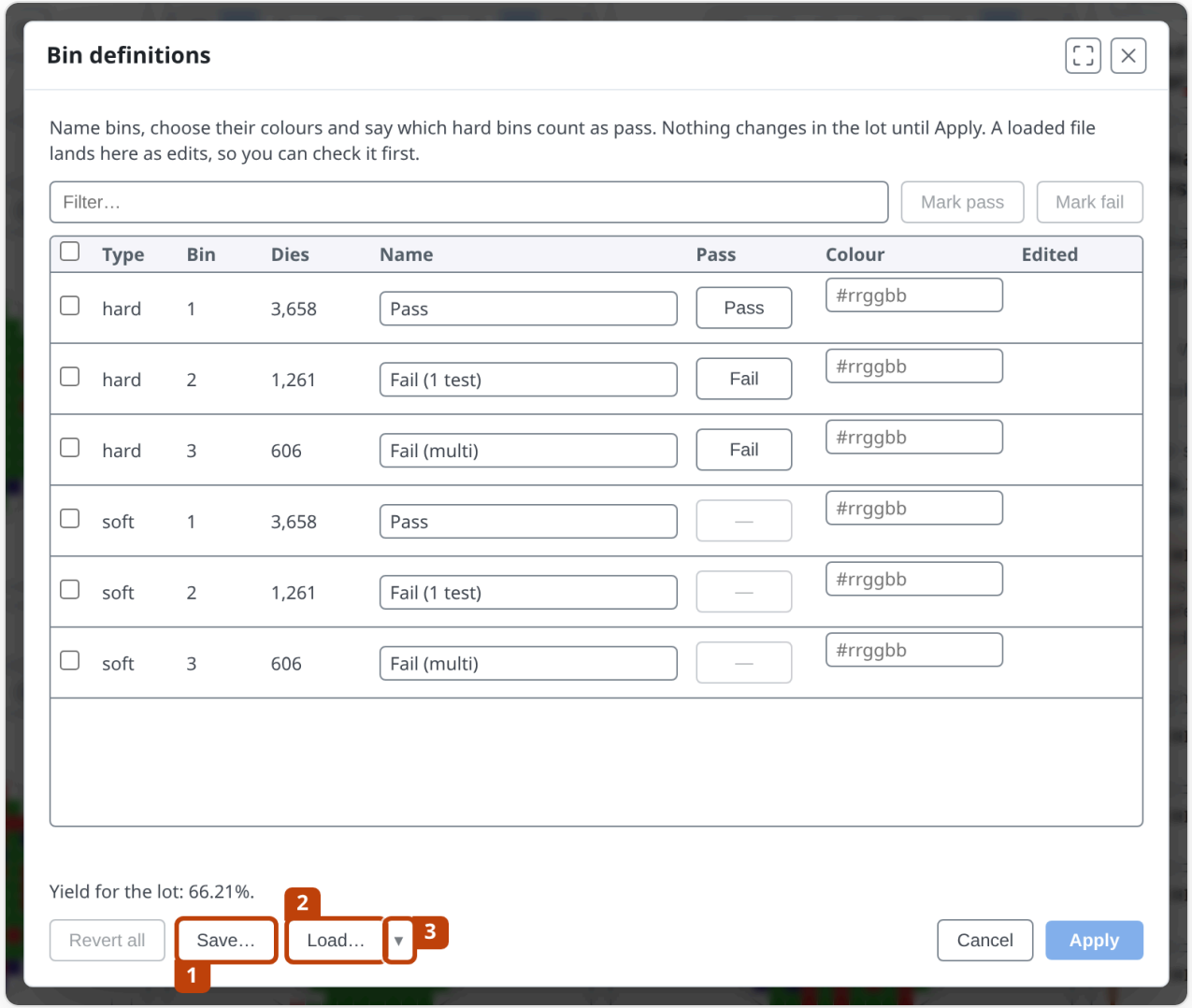
If you set the same geometry for every lot of a product, save it once. The last rows of **Setup ▾** (diameter, edge exclusion, reticle, retests, value filter) can be saved as one file for a product or a site, and loaded again from **Setup ▾ → Setup file…**: **Save…** writes it, **Load…** reads one, and the ▾ lists recent files. On the command line, `--setup` applies one for a single launch.

The Setup file window



Saving and loading bin definitions

The Bin definitions window (lesson 04) saves and loads files, and a loaded file lands as edits you can check before **Apply**. 1 **Save…** writes them to a CSV file. 2 **Load…** reads one. 3 The ▾ lists recently used files.

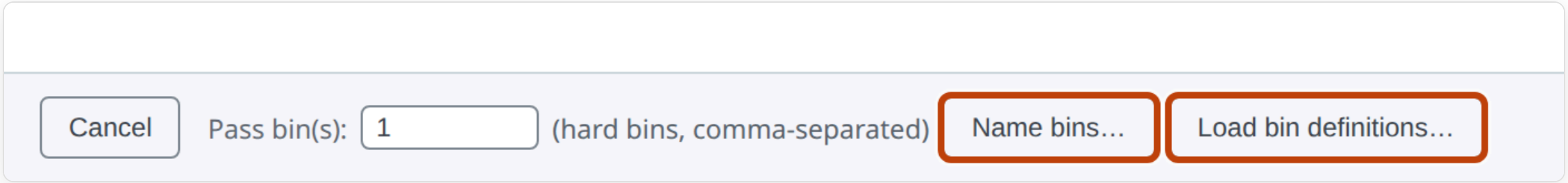


STDF, ATDF and the rest

A table has only bin numbers, so every bin is a bare number until you load definitions. STDF and ATDF files can carry bin names, but you can load definitions for them as well. Bin colours from a file can be switched off under **Colour scheme**.

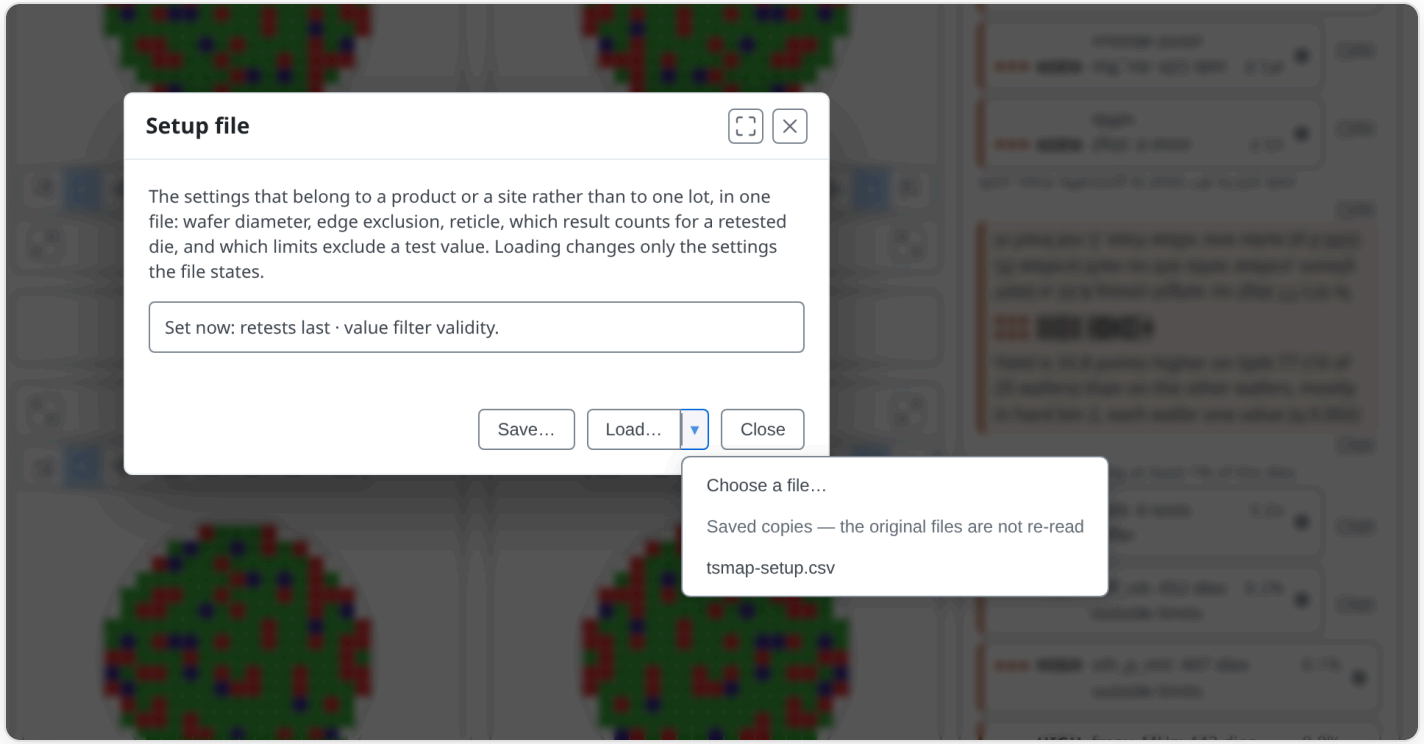
In the column mapping

For a table, you can name the bins in the column mapping before you continue: **Name bins…** opens the bin table over the bins in the sample of rows it holds (add a rare one by number), and **Load bin definitions…** reads a file. Both are next to **Pass bin(s)**.



Recent definitions files

- The ▾ beside **Load…** lists recent files of that kind
- In the browser an entry is a copy from when you last used it
- Changed since? Use **Choose a file…** to pick it again

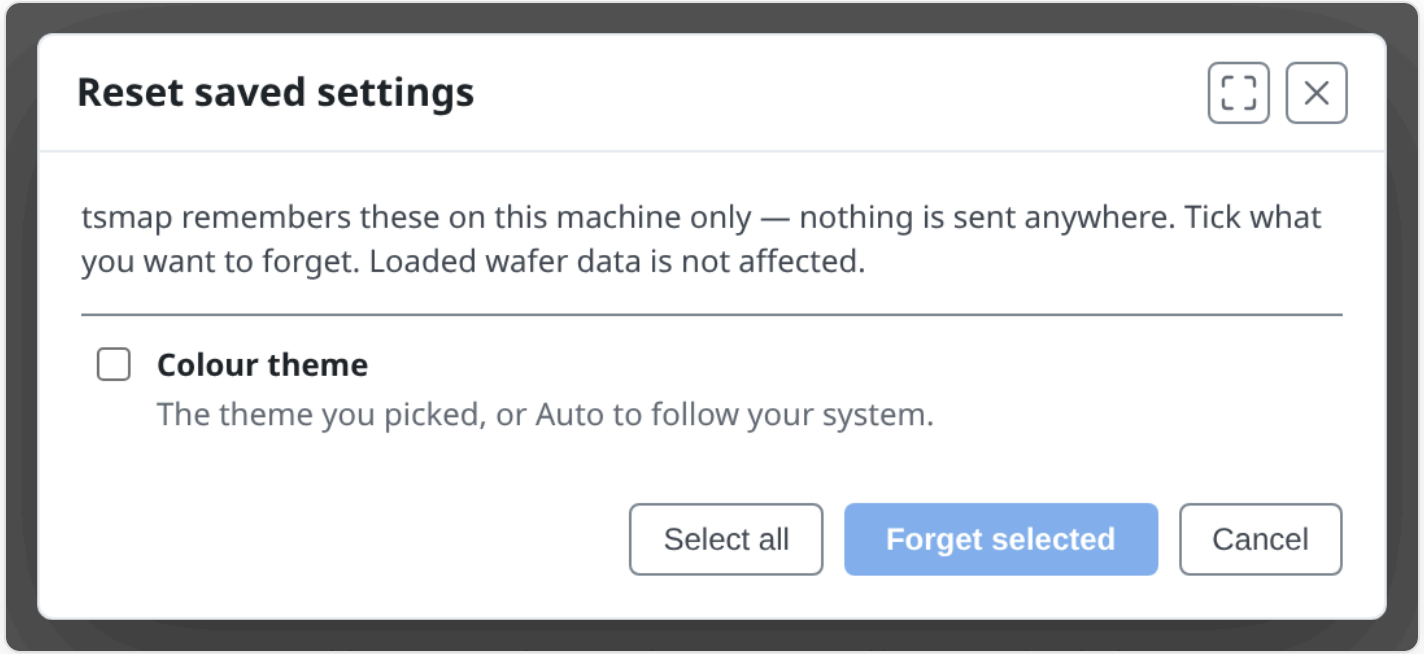


What tsmap remembers

Reset saved settings…

tsmap keeps a lot between sessions, which is convenient until you want a clean start.

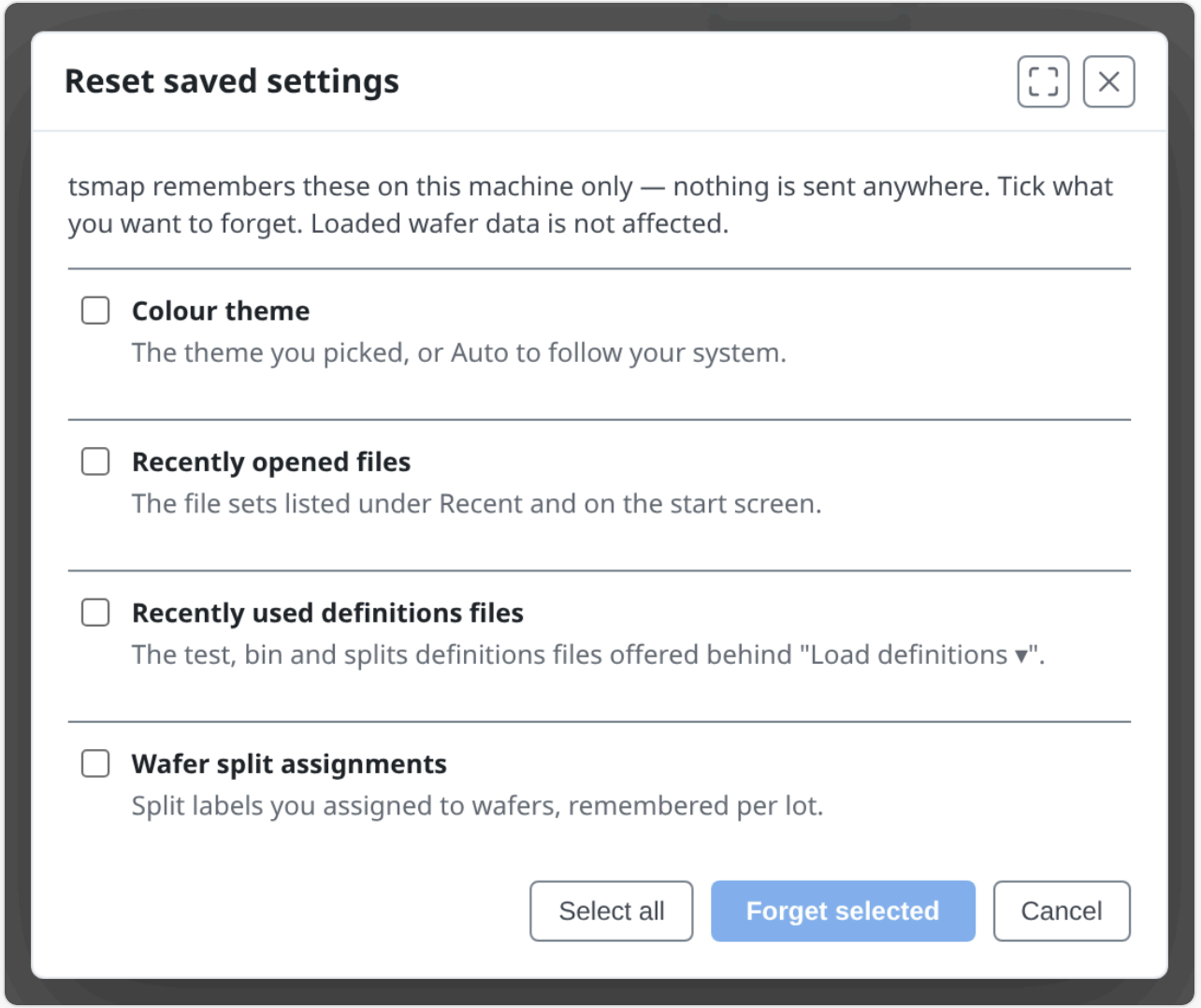
- Theme, splits, mappings, plots, filters, geometry: kept on this machine
- The window lists what is stored now



Forgetting settings

On the desktop app the list also holds **Recently opened files**.

Tick the items you want to forget, then choose **Forget selected**. **Reset saved settings…** is also the way to undo anything an earlier lab left behind.



Nothing is sent anywhere

Loaded wafer data is not affected by a reset. Saved settings stay on this machine, and tsmap does not upload your data.

LAB Try it yourself

1. Open **Help** → **Definitions file formats…** and save the splits template
2. On the sample lot, open **Setup ▾** → **Bin definitions…** and **Save…**
3. *Optional, desktop app only:* in a terminal run `tsmap --help`, then `tsmap sample.stdf` with any STDF file to open it from the command line
4. Open **Preferences** → **Reset saved settings…** and read the list of what is stored, then **Cancel**

Recap

- A link or the command line opens data with no clicking
- Templates show the exact layout of every definitions file
- **Reset saved settings…** shows and forgets what tsmap remembers

That is the whole app, from loading a file to automating it.

More in the user guide



That is every lesson

Back to the start, or open the app and try your own data.

wafermap is the library tsmap is built on. To use it in your own application, see the wafermap documentation, quickstart and developer guide.



Glossary

The words the lessons use

Learn tsmap

Glossary

Wafer. A thin disc of silicon, usually 200 or 300 mm across, that carries hundreds or thousands of identical chips. Lesson 00.

Die. One chip on a wafer. A wafer map draws one square for each die, coloured by its result. Lesson 00.

Glossary

Lot. A batch of wafers made and tested together, often 25. tsmap says "lot" only when every wafer carries the same lot ID. Lesson 00.

Tester. The equipment that runs the test program and records each die's results. Also called ATE, for automatic test equipment. It writes the STDF or ATDF file tsmap reads. Lesson 00.

Glossary

STDF and ATDF. The tester's own file formats. STDF is the binary standard test data format; ATDF is its text form. tsmap reads both directly, so there is nothing to convert. Lessons 00 and 01.

Prober. The machine that steps the wafer under the probe card, one die after another, so the tester can touch each die in turn. Lesson 00.

Glossary

Site. Many testers probe several dies at once, each through its own numbered site (1, 2, 3...). Sites are positions on the probe card, not separate wafers: all of them belong to the same wafer. Lesson 11.

Hard bin. The sort result for a die. A pass bin, usually bin 1, is a good die. The wafer map's legend lists the hard bins with their counts. Lesson 00.

Glossary

Soft bin. The test program's own reason for a result. It is finer than the hard bin: several soft bins usually roll up into one hard bin. Lesson 00.

Pass bin. The hard bin, or bins, that count as a pass. The default is 1, but some test programs pass in another bin or in several. The yield figure and its label follow the pass bins you set, so check them first when a yield looks wrong. Lesson 01.

Glossary

Test value. One number measured on one die by one test, such as a threshold voltage or a leakage current. A die carries a value for every test the program ran on it. Lesson 00.

Functional test. A test with no measured value, only a pass or a fail, such as a scan chain. It has no value to colour on a gradient, so the map shows the tester's verdict, and it gets a pass rate instead of statistics such as Ppk. Lessons 00, 03 and 05.

Glossary

Yield. The share of dies that land in a pass bin. A wafer's yield counts that wafer's dies. A lot's **mean per-wafer yield** averages its wafers' yields, so each wafer counts once. A **pooled yield** counts every die once, so a wafer with more dies weighs more. The label always says which. Lessons 00 and 03.

Edge exclusion. A band at the rim of the wafer, measured in millimetres, that is left out of yield and drawn dimmed. Edge dies are handled roughly and may fall partly outside the exposed area. It needs a wafer diameter first. Lessons 02 and 11.

Glossary

Notch and flat. The cut in the edge of a wafer that tells machines which way round it is: a small V-shaped notch, or on older wafers a straight flat. Orientation turns the drawn map to match your convention; the dies' coordinates never change. Lesson 02.

Test limits. The range a test's value must fall in for the die to pass: the low and high limits stored in the test program. In Test Value mode a die outside them is marked ▽ (below) or △ (above). Lesson 02.

Glossary

Verdict. A go or no-go result: the pass or fail the tester recorded for a die on a test, or a derived test that gives yes or no. It can differ from what the limits say; guard bands are one reason. A verdict has no value to plot, so charts treat it as a category. Lessons 02 and 10.

Spec limits. The product specification for a test. Test limits are often set inside the spec limits as a guard band. Process capability is measured against the spec limits when a test has both, and against the test limits otherwise. Lesson 06.

Glossary

Validity limits. The range a real measurement can lie in. A tester that runs out of range records its limit, such as a current held at its clamp, and that number is not a reading. A value outside the validity limits can be left out of the statistics. Lesson 11.

Excluded value. A test value outside the limits you chose for exclusion, the validity limits by default. It counts as missing for that test on that die, in the map, the statistics and every chart, and the die is drawn grey. Bins and the tester's own pass or fail are unchanged, so yield is the same. Lesson 11.

Glossary

Split. A name you give a wafer that the data file does not include, such as a process corner: TT, FF, SS. Splits are what **Group by** compares in Insights. Lesson 04.

Lot stack. Every wafer of a lot laid over the others, so each die position shows a count or a combined value across the wafers. One wafer's pattern can be chance; the same positions failing on many wafers is not. Lesson 04.

Glossary

Wafer attribute. A fact about a whole wafer rather than a die: its lot, product, test program, temperature, operator or test date, or a split you gave it. A wafer attribute tells wafers apart, and it is what **Group by** pools them on. Lessons 01 and 05.

Group by. Pools whole wafers by a wafer attribute for every chart on the Insights tab, so each chart draws one group for each value. It takes wafer attributes only; to separate the dies within each wafer use **Compare by**. One wafer has nothing to group, so it appears only for a lot. Lessons 05 and 10.

Glossary

Compare by. What one plot separates its marks by: its **Colour** and, on a bar or box, its **Categories**. It can use a wafer attribute, or a ring, bin, site or verdict. Where **Group by** pools wafers for the whole tab, Compare by acts on a single plot. Lesson 10.

Die region. A category a die falls into from where it sits, worked out rather than recorded: its ring, quadrant, reticle cell or reticle shot. A die belongs to all of them at once, which is why a region can separate the dies in a plot but is never a **Group by** choice. Lessons 10 and 11.

Glossary

Reticle. The rectangular area exposed in one step of the lithography machine. The same pattern is stepped across the wafer, so each reticle holds a fixed block of dies. tsmap can overlay the reticle grid. Lesson 11.

Reticle cell. A die's place inside the reticle: which of the field's dies it is, such as column 1, row 3 of a 4 × 3 field. The same cell recurs in every exposure across the wafer, so a cell that is poor everywhere points at the mask or the lens rather than at the wafer. Lesson 11.

Glossary

Reticle shot. Where on the wafer the reticle was placed for a die: one exposure of the mask. Each shot is a different place on the wafer, so a poor shot points at something that varies across the wafer, such as focus, tilt or the edge. This is not the reticle cell, which is inside the mask. Lesson 11.

Retest policy. When the same die position appears more than once, one result has to stand for the die. **Last** is the default; **First** keeps the earliest probe; **Best** prefers a pass over a fail, then the lower hard bin; **Worst** prefers a fail over a pass, then the higher hard bin. The choice feeds every figure. Lesson 11.

Glossary

Part average testing (PAT). A screen for dies that pass every limit but sit far from the rest of their wafer on a test. The PAT limits are worked out per wafer and test: the median plus or minus six robust sigma, never wider than the test's own limits. A die outside them is a **PAT outlier**. Lesson 05.

Robust sigma. A measure of spread that outliers cannot inflate: the interquartile range divided by 1.35, around the median. PAT sets its limits from it. Lesson 05.

Glossary

Ppk. A capability index: the gap from a test's mean to its nearest limit, in units of three standard deviations, using the overall spread, wafer-to-wafer variation included. 1.33 or more is usually called capable; under 1.0 is poor. Lesson 06.

r. The correlation between two tests, from −1 to 1. Near 1 means one rises as the other rises; near −1 means one falls as the other rises; near 0 means no straight-line link. **n** is the number of dies behind it. Lesson 07.

Glossary

Welch p. How likely a difference between groups of wafers is to be chance, comparing the groups' means without assuming equal spreads. Each wafer counts once, so n is the number of wafers. A small p says the difference is unlikely to be chance, not that it matters or why it is there. Lesson 06.

Rank p. The same question as Welch p, asked of ranks instead of values (the Kruskal–Wallis test), so one odd wafer cannot drive the answer. Lesson 06.

Glossary

q. Welch p adjusted for how many tests were compared at once (the Benjamini–Hochberg method). Compare many tests and some will look different by chance; q allows for that. Lesson 06.

z-score. How far a value is from the average, counted in standard deviations. A z-score of 0 is average, +1 is one standard deviation above and −1 one below. Rescaling every test to z-scores puts tests in different units on one colour scale. Lesson 06.

Glossary

Filter. Conditions that keep only some wafers and dies, such as one split, a bin, or a range on a test. One filter applies to the gallery, the map and every Insights tab, and each figure is worked out again over what is kept. A die the filter drops is drawn faded. Lesson 08.

Probability plot. Each group's sorted values against their cumulative share, on a scale stretched so that normally spread data falls on a straight line. A shift, a wider spread, a second population and outliers each bend the line differently. Lessons 06 and 10.

Glossary

Western Electric rules. Four tests for a control chart that say a run of points is unlikely to be chance: one point beyond 3σ; two of three beyond 2σ on one side; four of five beyond 1σ on one side; eight in a row on one side of the centre. Each is marked at the point that completes it. Lesson 10.