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nSpec Version 0.21.1.0

> **Release Date:** 10 Mar 2022
>
> **Documentation Updated:** 09 Sep 2022
>
> **Major Features:** GDS Masking, Configurable Light Tower, Bare Wafer Alignment for Device Inspection

Overview

This version includes many features that didn't quite make it into v21.0.0 after many months of release candidate cycle testing held up that build. As a result, there are a large spread of features and functionality in this build that while they weren't necessarily tied to urgent deliverables, were deemed to be valuable for customer release by the product team.

Upgrading to v0.21.1.0

⚠ Required Library Update
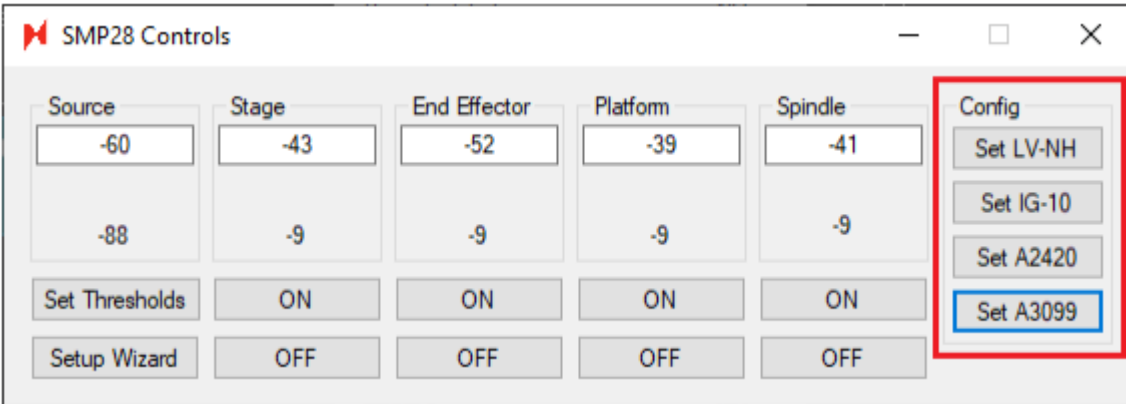
Autoloader 2s with a Generation 3 prealigner assembly (P/N: 3099) will need to have their Arduinos flashed by the latest TSToolKit software. This is in addition to the flash required for generation 3 aligner lasers. The exlog will show these values during initialization. The program option as of v0.21.1.0:

- For aligner lasers:
  - Gen2 do not need to be flashed (nSpec already assumes LV-NH)
  - Gen3 need to be flashed with IG-10
- For prealigners:
  - Gen2 do not need to be flashed (nSpec already assumes A2420)
  - Gen3 need to be flashed with A3099

Autoloader 2s with a Generation 3 prealigner will perform an automatic search for its starting position, which will now be written to the exlog.

The default Device Inspection parameter - *Golden Template Processing Batch Size* - has been updated to -1. The process value of this parameter is not affected when upgrading. -1 is now recommended.

For tools with a bonito camera, the recommended value for *Frame Refresh Limit (FPS)* is -1 (free run mode) and the recommended value for *Camera Acquisition Frame Rate Limit (Frames Per Second)* is -1 (free run mode). If you experience performance issues with nSpec when using these values, you may set hard limits to these options.

Major Enhancements

GDS Masking
- Overview
- Interface
- Workflows
  - Classic Device Masks Workflow (Export Mode = Horizontal/Vertical Tiles)
  - Custom Device Masks Workflow (Export Mode = Single Image (no Tiling))

Overview

nSpec now has a built-in utility for creating device inspection masks for *Calma GDSII* files - the *GDS Mask Creator*. This utility is accessible from *Main View / Stage View Utility GDS Mask Creator….*

Interface
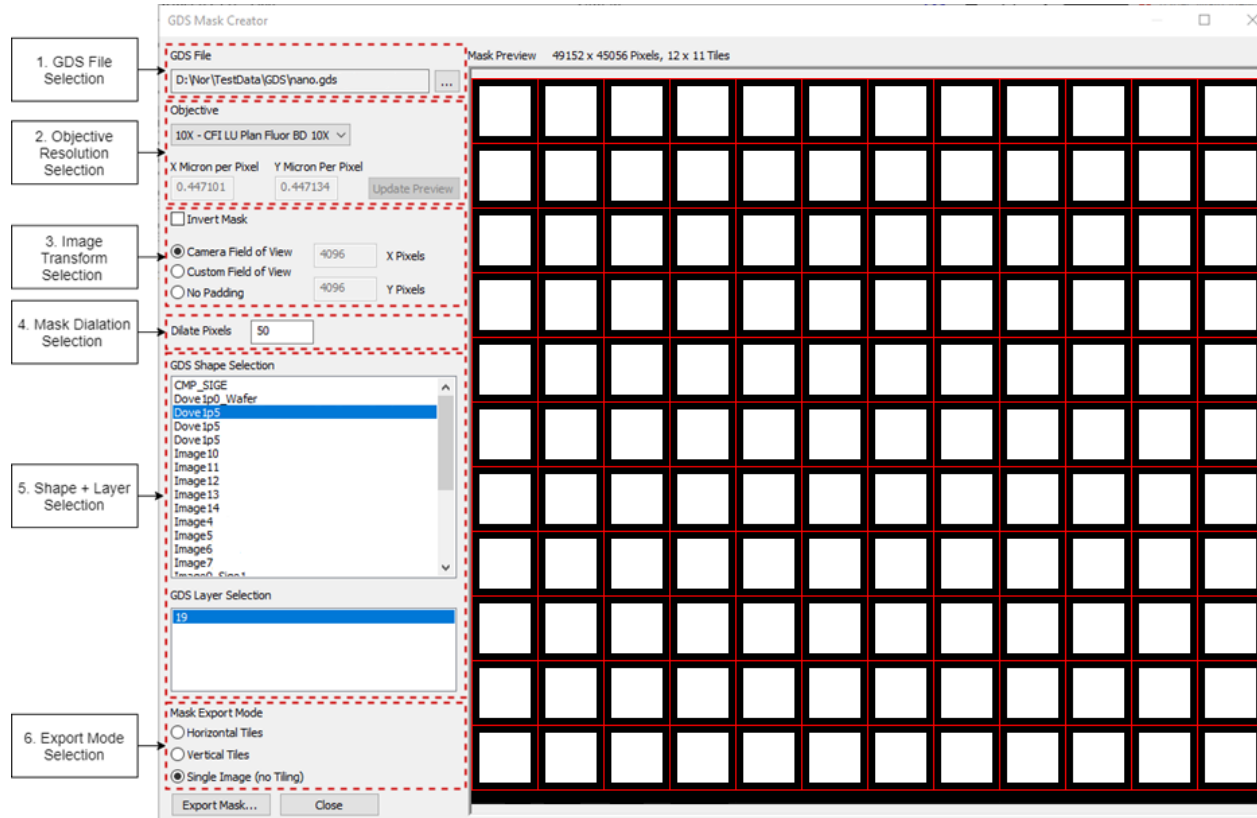
Control	Description	Usage
GDS File Selection	Sets a compatible Calma GDSII file	Select file used to create device layout
Objective Resolution Selection	Sets X/Y Micron per Pixel	Select objective used when creating device scan
Image Transform Selection	Color inverts and pads the entire image.	Select Camera Field of View
Mask Dilation Selection	Increases the number of pixels surrounding a shape's layer	0 is fine, but can be increased for more coverage
Shape + Layer Selection	Sets shape and layer to mask	Select shape (and appropriate layer(s)) used to create device layout
Export Mode Selection	Sets the mask export mode	See Workflow below
Mask Preview	Shows what the exported mask will look like when exported	

Workflows

The *GDS Mask Creator* can be used to create classic device masks (mask linked to device templates) and custom masks. **Scans that include >100 template files must use the Classic Device Masks Workflow.**

Classic Device Masks Workflow (*Export Mode = Horizontal/Vertical Tiles*)

A large mask can be sliced into individual masks during export by selecting the *Horizontal Tiles* or *Vertical Tiles* export modes before exporting. When set to *Horizontal Tiles*, the mask is sliced based off the horizontal movement of the stage during a device scan. When set to *Vertical Tiles*, the mask is sliced based off the vertical movement of the stage during a device scan. The export mode should be chosen based on the type of scan being run:

Scan Type	Export Mode
Continuous Scan	*Horizontal Tiles*
Stop & Go scan with the program option Path Optimization = 0	*Horizontal Tiles*
Stop & Go scan with the program option Path Optimization = 1	*Vertical Tiles*

After clicking *Export Mask…* in the *GDS Mask Creator*, you must set the mask's filename as your target template's filename. For example, if your target template is *nano_demo_0001_template.png,* then your mask's filename should be *nano_demo.png*. After exporting, you may overwrite your template's mask(s). **Warning: If you export into the directory containing your target template, there will be no prompt to confirm overwrite of existing masks.**

Custom Device Masks Workflow (Export Mode = Single Image (no Tiling))

A new parameter has been added to the *Device Inspection* analyzer - *Custom Device Mask*; masks exported with the *Single Image (no Tiling)* export mode (using this workflow) will be specified using this parameter. Custom masks are used in addition to template masks. Specifically, custom masks are template masks are combined, before image analysis, to create an output mask. An output mask is created with the following method:

1. The custom mask is sliced depending on the number of template masks
   a. If a template is only one image, then the custom mask is not sliced
   b. If a template has *n* images, the custom mask will be sliced into *n* individual custom masks, where each individual custom mask lines up with its corresponding template mask
2. Each custom mask and template mask are lined up top-left corner to top-left corner
3. Each output pixel is the result of a logical AND operation between the template and custom masks' pixels
   a. Output pixels can only be white if both the pixel from the custom mask and the template mask are white. If either pixel is black (or both are black), the output pixel is black
4. Each output mask is cropped to the dimensions of the template mask
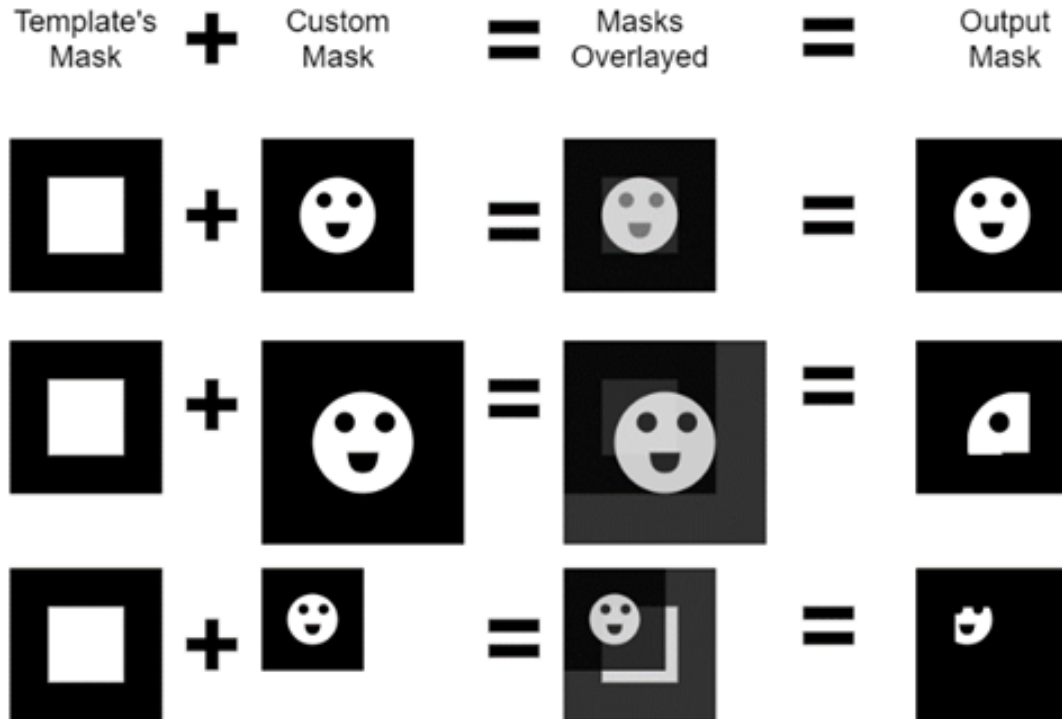
Bare Wafer Alignment - Dual Flat Support

In version 0.21.0.0 we enabled Bare Wafer Alignment - a new type of scan alignment that intelligently detects where the wafer sits on the stage, identifies the wafer flat or notch, and then aligns the scan with the alignment feature positioned at one of the cardinal positions. This update adds support for dual flats.

Autoloader Alignment Improvements

A number of autoloader alignment improvements have gone into this build. In general, the autoloader should be more stable when wafer notches are placed onto the pre-aligner with slight offsets.

Camera Performance & Stability Improvements

This body of work sets the stage for higher throughput scanning.

New Features

- Highlights
  - Manual Defect Classification Correction Support
    - Running Single Classification Change (Single Tile view in nView):
    - Running Group Classification Change (Multi Tile view in nView):
  - Configurable Light Tower Support
  - Dual-Flat Bare Wafer Alignment Support
  - Device Inspection on Bare Wafer Support
  - SECS/GEM Upgrades:
  - General Improvements
  - Scanning Improvements
  - Analysis Improvements
  - Autoloader Improvements

- New Features Changelog

Highlights

Manual Defect Classification Correction Support

Users can now manually reclassify defects in nView.

> ⓘ Note, for *Group Classification Changes*, there is a known issue where attempting to open the dialog over a remote session (i.e. via TeamViewer) is difficult.

Running Single Classification Change (Single Tile view in nView):

Shift + M while moving mouse (to open dialog) to change a single defect classification name to any classification name in the drop down (Drop down is based off all defect classes that were present in the model at time of analysis).
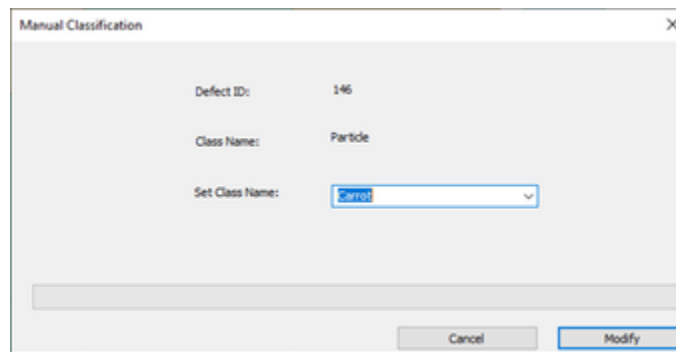
Running Group Classification Change (Multi Tile view in nView):

In nView's *Mosaic view*, before clicking and dragging across multiple tiles, hold down *M* button to open dialog.

This will change all the defects in those tiles to the class name chosen in the drop down

Configurable Light Tower Support

nSpec systems with the light tower assembly can be configured by specifying a *LightTowerConfig.yml* file inside nSpec's *ProgramData/ConfigFiles* directory. Each individual light on the light tower can now blink, remain on, or remain off when a specific nSpec action is performed. Specifically, the following actions are available for configuration:

State	Trigger Action
ERROR_STATE	Job/scan fails
BUSY_STATE	Job/scan is running
FREE_STATE	The system is not in any other state
UNLOADING_STATE	Job/scan is finished
CALIBRATION_STATE	nScan is initializing

The following lights are available for configuration:

Light	Note
RED	
YELLOW	
GREEN	
BLUE	Only available on 4/5-color light towers
WHITE	Only available on 5-color light towers

ALARM	Not a light, but a sound

The following light states are available per light:

Enumeration	Descrirption
-1	State of the light will not change
0	Light will be off
1	Light will be solid on
2	Light will be blinking on and off

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Enumeration	Descrirption
-1	State of the light will not change
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2	Light will be blinking on and off

For example, an example action configuration can be the following:

```
ERROR_STATE:
    RED: 0
    YELLOW: 1
    GREEN: 0
    BLUE: 0
    WHITE: -1
    ALARM: -1
```

Sample configurations can be found in this Jira's attachments: NSPEC-4545

Dual-Flat Bare Wafer Alignment Support

The *Bare Wafer Alignment Wizard* now presents three new different types of fiducial arrangements:

- Dual Flat (180° offset)
- Dual Flat (90° offset)
- Dual Flat (45° or 135° offset)

When any of these options, nScan will use the longer of the two edges when determining the main edge (and consequently, the alignment angle).

Device Inspection on Bare Wafer Support

Device Inspection functionality has been upgraded to support device inspection analysis for bare wafers.

1. The

Bare Wafer Alignment Wizard now has a field for origin offset, which can be used to specify a wafer's origin with respect to the wafer's calculated center **in aligned coordinates** (NSPEC-5413).

1. Device Inspection scan's now accept

Bare Wafer Alignment (.json) files in addition to *Classic Device Inspection* Alignments (NSPEC-5329)

1. Basic Selection analyses will now automatically analyze defects within the device boundaries (

NSPEC-5361 adds device boundary detection functionality and NSPEC-5551 makes functionality automatic for device scans).

SECS/GEM Upgrades:

nSpec has introduced several upgrades to its SECS/GEM interface including the following:

JIRA ID	Description
NSPEC-4816	OCR ID is now always sent back to GEM host
NSPEC-4820	Events and variables added to indicate wafer positions as they navigate across the cassette, aligner, and stage
NSPEC-5420	Event added to indicate end of scanning; when nSpec is ready to accept more commands

General Improvements

JIRA ID	Description
NSPEC-4461	nSpec's with an interlock system now enforce that the enclosure is locked during nScan initialization
NSPEC-4862	Device IDs are now overlayed onto devices in the Device Layout dialog
NSPEC-5241	Hardware initialization updated to allow parallel loading of independent hardware items
NSPEC-5426	"Advanced" options are now hidden in Bare Wafer Alignment Wizard
NSPEC-5570	Fixed a bug where nSpec would crash when trying to view a deleted analysis group
NSPEC-5571	Fixed a bug where nInstall would leave a 'jobs.dbb' file in ProgramData

Scanning Improvements

JIRA ID	Description
NSPEC-5251	Updated image capture code to greatly improve overall scanning and live view performance

NSPEC-4550	*UseInitialZ* job property now properly prevents the overwrite of the autofocus group's specified offset
NSPEC-5194	Fixed a bug where video sweep would run on the RTX6000 and cause focus to fail
NSPEC-5274	*Camera Acquisition Frame Rate Limit (Frames Per Second)* program option can be set to free run mode (-1) **(SEE Upgrading SECTION)**

Analysis Improvements

JIRA ID	Description
NSPEC-5550	Device Inspection analysis performance for large datasets is greatly improved with update to Golden Template Batch Size functionality
NSPEC-4333	Destination folders for golden templates can now be created automatically
NSPEC-4406	Gen3 AI analysis performance for large datasets is greatly improved
NSPEC-4669	Database write times for defects is greatly improved
NSPEC-5058	Fixed a bug where Gen4 analysis would hang on the last image
NSPEC-5387	Fixed a bug where defects found with the Gen4 AI analysis would render at an incorrect orientation
NSPEC-5415	Default value for *Golden Template Processing Batch Size* has been updated to -1 (automatically determine batch size)

Autoloader Improvements

JIRA ID	Description
NSPEC-5139	Notch detection algorithm greatly improved to accommodate off-center aligner placement
NSPEC-5242	Aligner type is now autodetected **(SEE Upgrading SECTION)**

New Features Changelog

T	Key	Summary
	NSPEC-4317	Remove an exlog during video sweep
	NSPEC-4333	Allow destination folders to be created for a new template during analysis process
	NSPEC-4461	Ensure doors are locked on initialization if enclosure is being used
	NSPEC-4545	Implement Dynamic Light Tower for nSpec

NSPEC-4669   Improve DB write times for defect exports

NSPEC-4721   Return wafers to correct slots when using Find & Return All on Manual Control Dialog

NSPEC-4745   Add manual classification correction for AI analysis

NSPEC-4790   Cannot save light controller settings that are not shown in Image Settings Group Dialog

NSPEC-4816   Always Send OCR ID Back to GEM Host During a Scan

NSPEC-4820   Add SECS/GEM Event to Notify Host of Wafer Positions

NSPEC-4835   Scan for Autoloader2 Gen3 Start Position

NSPEC-4862   Add Device ID to LiveView Boundaries

NSPEC-4890   Add Ability to Create Masks from GDS Files

NSPEC-5126   nReg's failure messages should be visible in nLog

NSPEC-5129   Create User Interface for GDS-based Device Masking

NSPEC-5139   Notch detection shall be still able to work with small off-center placement

NSPEC-5145   Add Ability to size masks to multiples of the Camera dimensions

NSPEC-5154   Add slicing of mask into Device Inspection Analysis

NSPEC-5155   Add slicing of mask into Mask Creator Dialog

NSPEC-5241   Update Hardware Manager initialization to allow parallel loading of independent hardware items

NSPEC-5242   Auto-Detect Autoloader Aligner Type

NSPEC-5259   Convert Frame Buffer Code to a Concurrent Queue Rather than the Circular Buffer

NSPEC-5260   Pre-allocate cv::Mat that camera data will be copied to by the callback thread

NSPEC-5261   Use reference-based snapshot code for Live View

NSPEC-5274   Update GeniCam frame rate limit Program Option to allow Freerun mode

NSPEC-5296   Add dilation of mask into Mask Creator Dialog

NSPEC-5361   Allow Exclusion of non-Device Area for Basic Selection Analysis on Device Inspection Scans

NSPEC-5370   Extend MESIntegration for Loop Testing/Auto-responses

NSPEC-5400   Extend Bare Wafer Alignment to Work With Dual-Flat Wafers

NSPEC-5413   Add Origin Offsets to Bare Wafer Alignments

NSPEC-5415   Set the default value for Golden Template Processing Batch to -1

NSPEC-5420   Add SECS/GEM Event for End of Scanning

NSPEC-5422   Rename "Calibration" to "Objective" in GDS Mask Creator

NSPEC-5426   Update Bare Wafer Alignment GUI to hide "Advanced" options

NSPEC-5427   Add Origin Offset to Bare Wafer Alignment GUI

NSPEC-5472   Automate tile ordering in GDS Mask Creator (tooltip description of tile ordering)

NSPEC-5476   Update Wizard with Dual-Flat alignment options

NSPEC-5527   Dilate Pixels text box should not accept values higher than 100

NSPEC-5551   Remove Basic Selection Analysis Parameter Specific to Device Inspection Scans

NSPEC-5553   Remove GDS "Create Mask" Option from Device Layout Editor

40 issues

Bug Fixes

Changelog

T	Key	Summary
	NSPEC-4406	Gen3 AI analyzer running out of RAM
	NSPEC-4550	CorrectAfterFirstFocus job property does not work as expected
	NSPEC-4925	Autoloader3_Gen2 uses incorrect slot number when OCR read fails
	NSPEC-5058	gen4 analysis freezes on the last image sometimes
	NSPEC-5062	It takes over 4 minutes to write the db after 40k images DI scan
	NSPEC-5090	Running a Job From a Database Checks Job Too Late
	NSPEC-5091	Autoloader Settings From Job Are Not Used When Running Job From Database
	NSPEC-5097	Mosaic broken when 10x scan and gen4 and 7zip run concurrently
	NSPEC-5194	Video Sweep runs on RTX6000 and causes focus to fail
	NSPEC-5249	Alignment error in Create Device Layout dialog causes nScan to crash
	NSPEC-5278	BSpline and Triangular Mesh Focus Algorithm Undefined Behavior
	NSPEC-5298	Error message when selecting autofocus group with 'PreFoc' RT algorithm
	NSPEC-5306	Gen IV Analysis fails due to CUDA exception in Image pipeline
	NSPEC-5321	"Reporting Export > Output Folder" program option broken
	NSPEC-5329	Enable Wafer Alignment for DI Scans
	NSPEC-5335	Condition Variable can can produce sync issues with Thread Pool
	NSPEC-5336	ACS Motor Connection Triggers uncaught exception due to improper use of argument for %s string formatting
	NSPEC-5387	Gen 4 AI Defects Render at Incorrect Orientation

NSPEC-5409   nSpec does not schedule post scan analysis

NSPEC-5412   GDS mask size limit exceeded

NSPEC-5423   Entering big number into "Dilate Pixels" text box causes freezing

NSPEC-5424   Cannot export a mask in GDS Mask Creator

NSPEC-5428   User cannot select layers in GDS Mask Creator

NSPEC-5430   nScan crash when creating or loading a Device Layout/GDS

NSPEC-5431   GDS Mask Creator creates extra white space

NSPEC-5456   Cursor shifts and appends when inserting a value to the GDS edit box

NSPEC-5505   Basic Selection (Morphological range) analysis fails

NSPEC-5506   Basic Selection (Intensity Exclusive) analysis fails

NSPEC-5507   Basic Selection (Intensity Inclusive) analysis hangs

NSPEC-5510   Gen3 Writing to Database After Analysis Fails

NSPEC-5511   Gen3 Extra Defects Written to DB

NSPEC-5512   Precision autofocus fails because of image and template size mismatch

NSPEC-5517   When selecting many tiles for group reclassification no "Success" message appears

NSPEC-5520   DI analysis does not work

NSPEC-5529   gen4 AI analysis fails

NSPEC-5530   All PreFocus points have the same exact Z saved to db

NSPEC-5533   User can try to save empty mask in 'GDS Mask Creator'

NSPEC-5544   Device ID column in image database not populated after BS analysis on DI scan

NSPEC-5550   DI analysis fails on GPU with out of memory error for large devices

NSPEC-5554   DI scanning freezes with Prefoc 3CP

NSPEC-5570   nSpec crashes when viewing a deleted analysis group

NSPEC-5571   nInstall adds an extra 'jobs.dbb' to fresh program data

NSPEC-5579   Last tile missing from Wafer scan sometimes

NSPEC-5599   Memory Leak in Schedule Analysis Dialog

NSPEC-5601   No offset applied for Auto/ManualLargeDeviceMask during Precision scan

NSPEC-5627   Append "_mask" to Exports

NSPEC-5629   Camera and stage angles are not updated when loading a JSON alignment file

NSPEC-5641   Frame + Encode/Save thread backups cause missing scan database image rows

NSPEC-5647   Detection classes are not written to the scan database properly

NSPEC-5691   nScan crashes when attempting to close scan setting dialog

50 issues