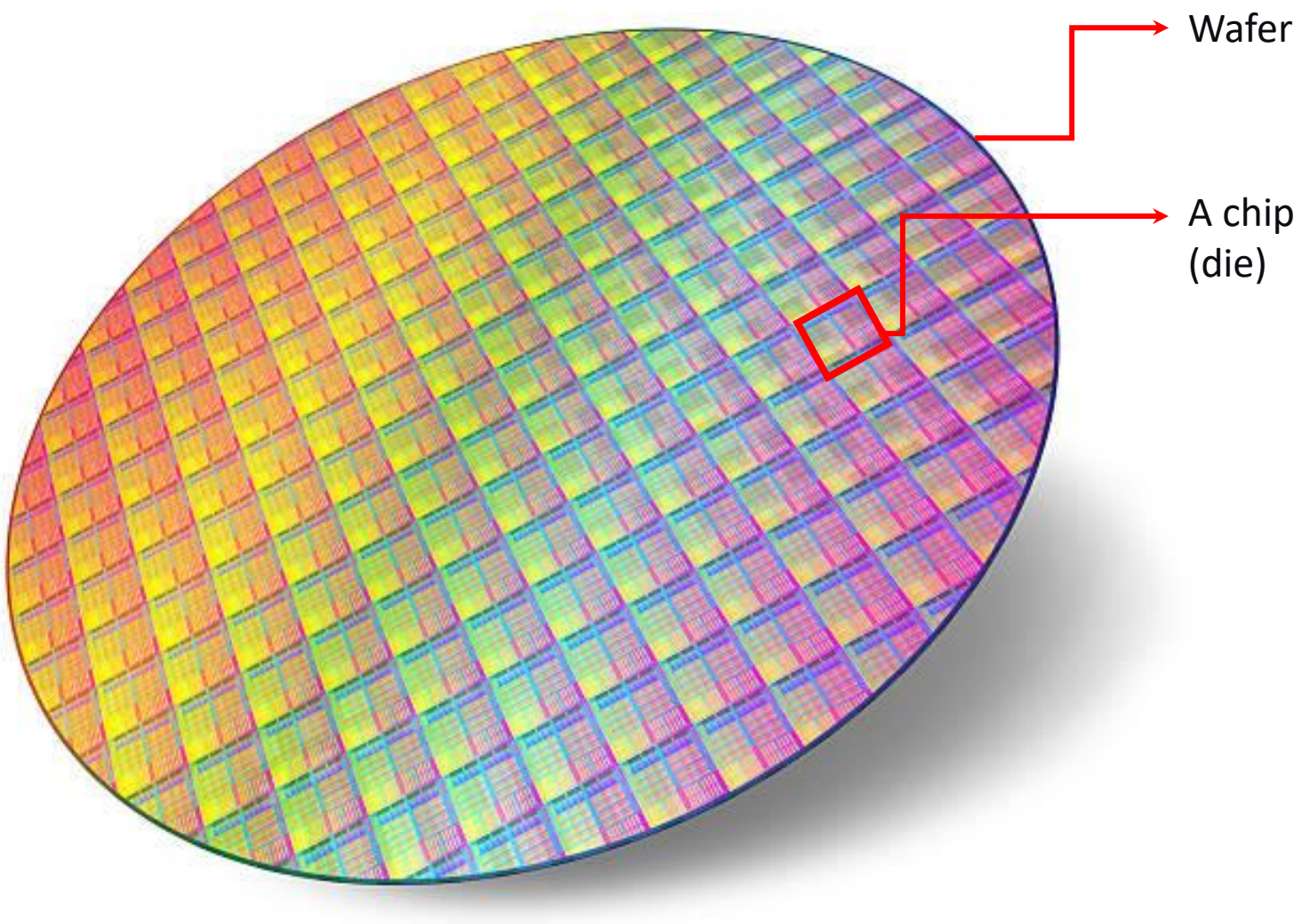
KLA India Software Workshop 2023

Jun 23, 2023

Context, terminologies

Wafer, Chip



Die Layout

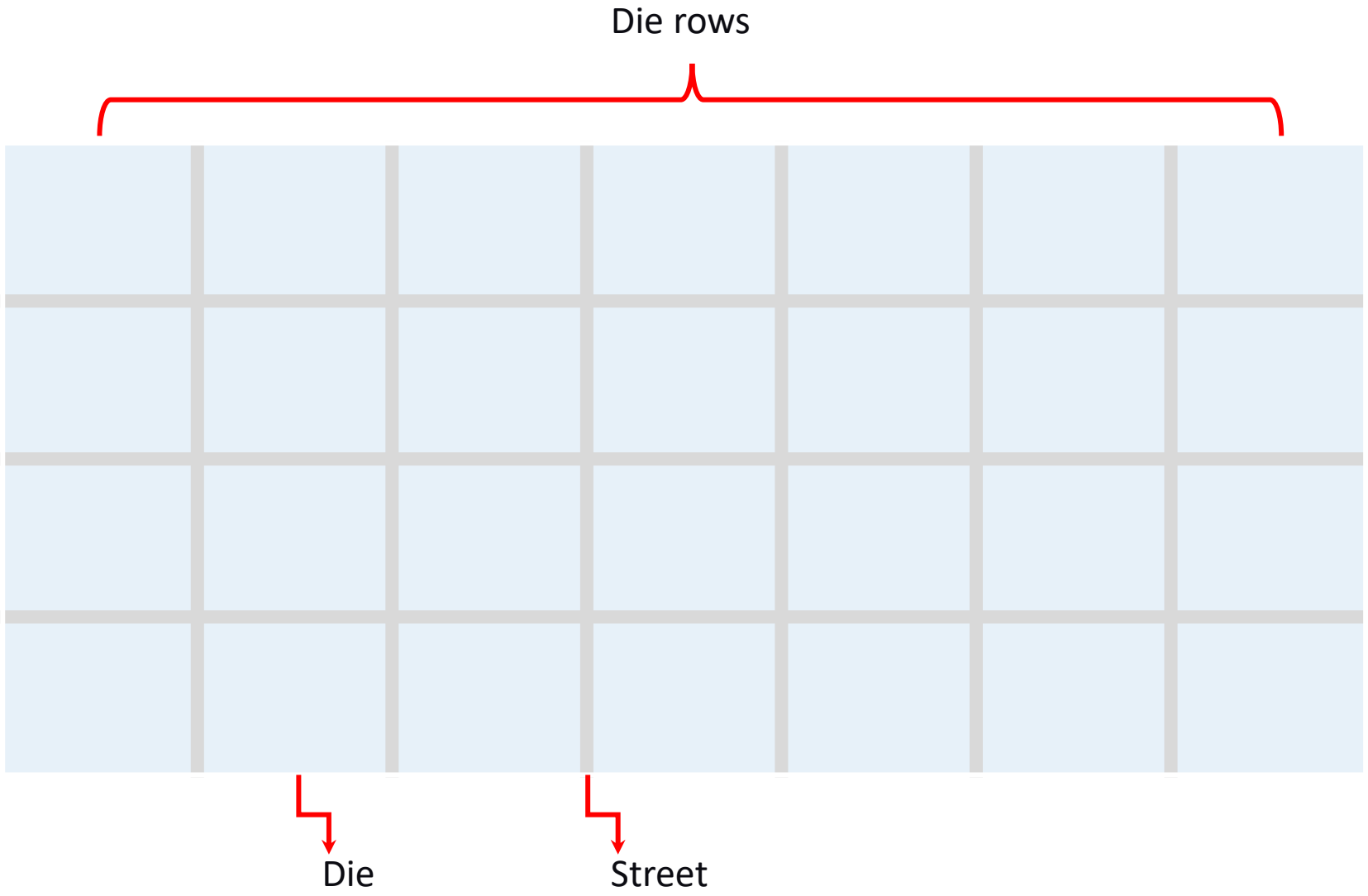
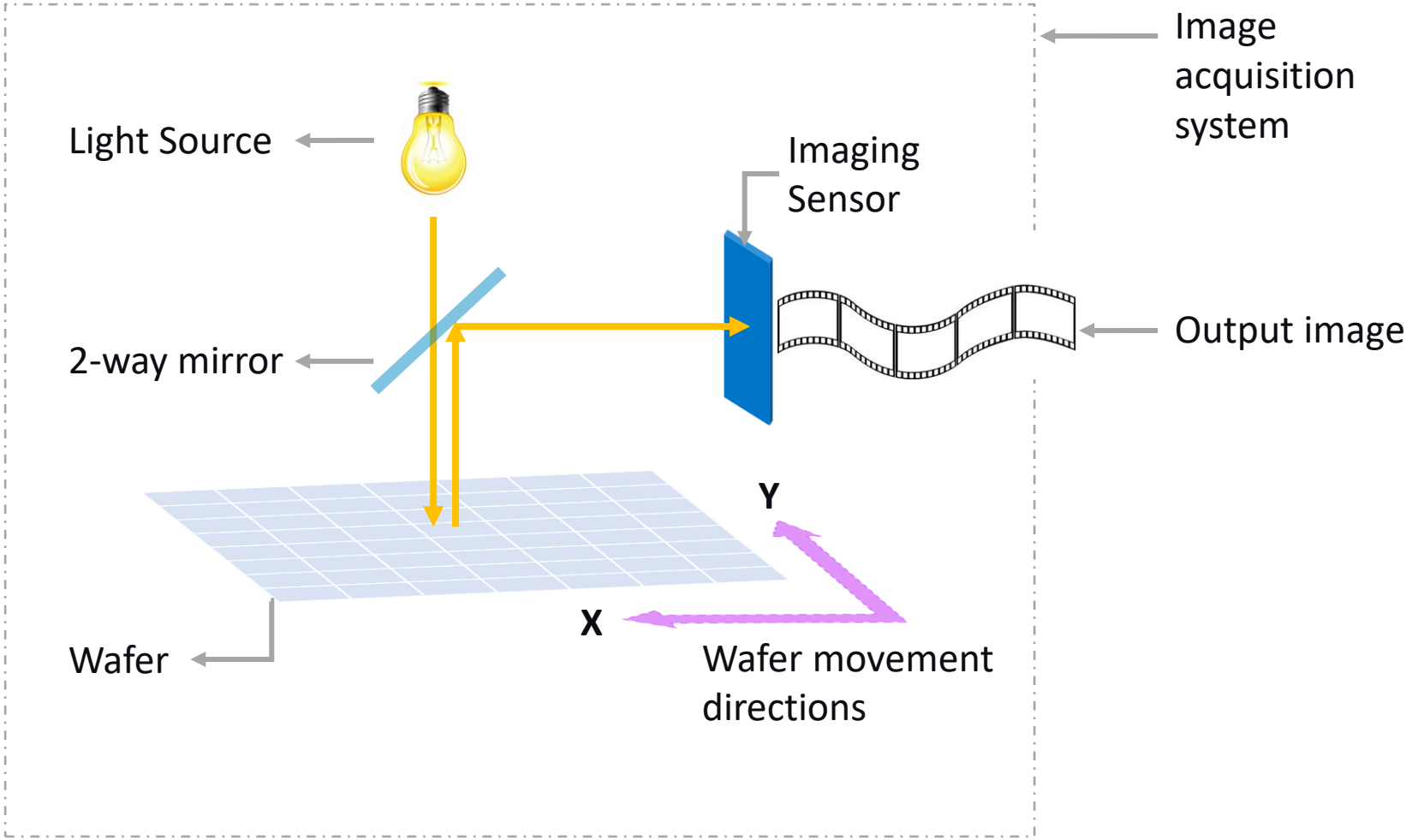
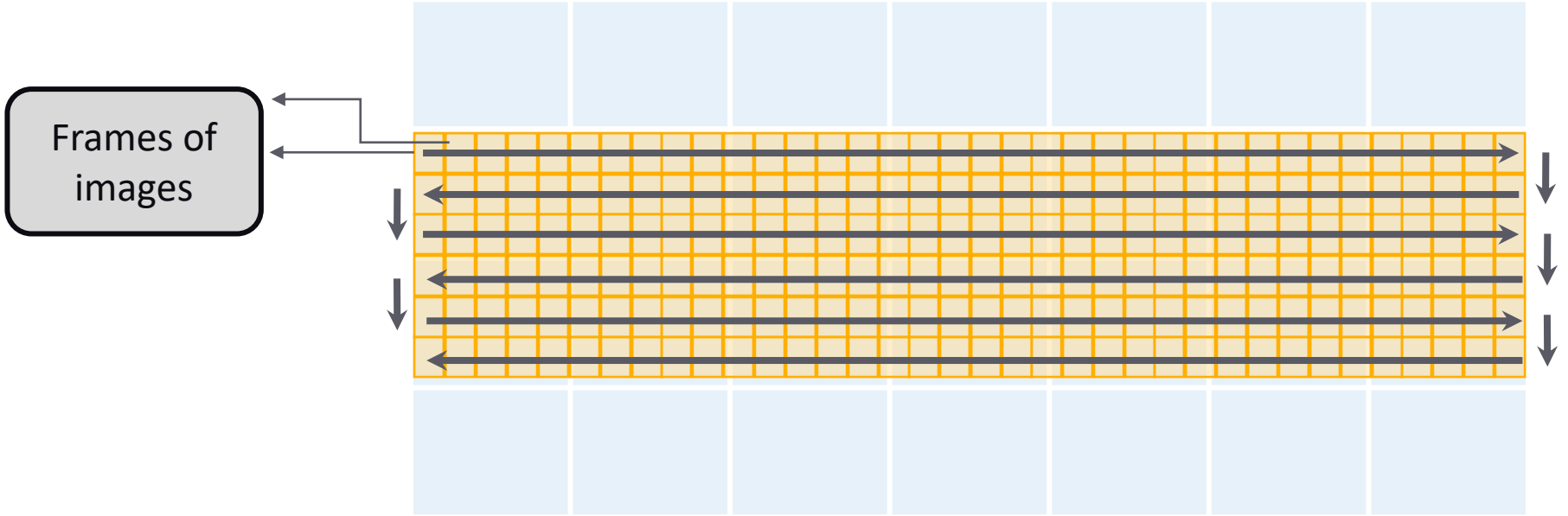


Image Acquisition



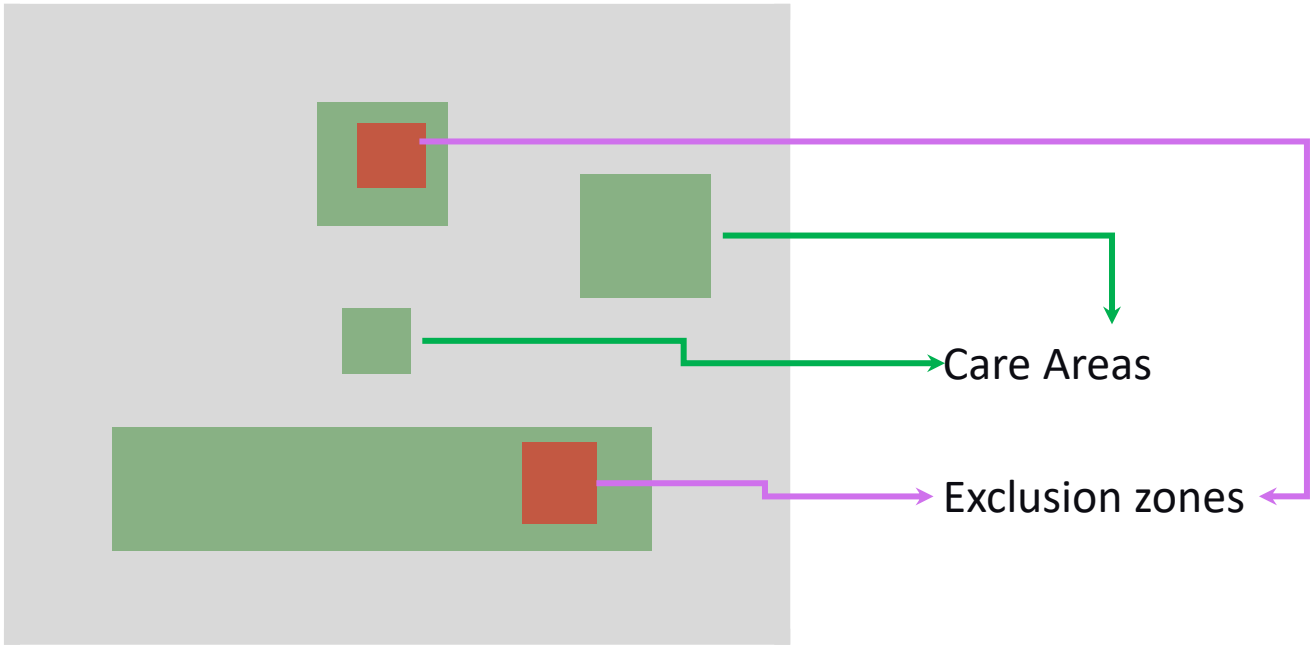
Swathing

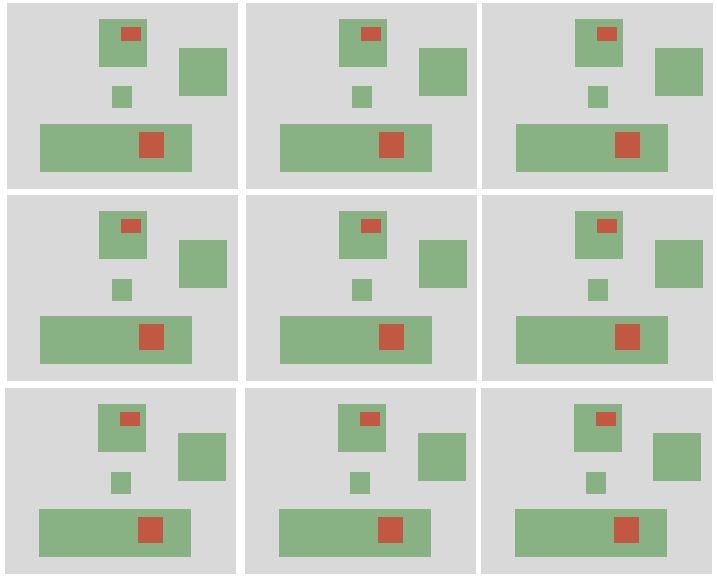
- Light source and sensor are fixed while the wafer moves in x and y direction to collect Wafer images
- A single sweep of wafer motion in ‘x’ as the image data is being collected is called a **Swath**



- After the X direction swath (left -> right) is completed, the wafer is moved in Y direction for next swath
- The wafer then moves and swaths in the opposite direction to the prior swath (right -> left)
- The result is a serpentine pattern of movement and this whole series of image data grab is ‘Swathing’

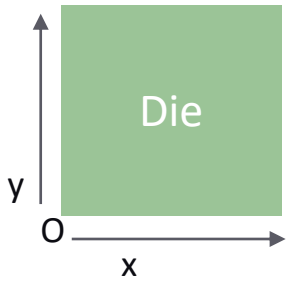
Care Areas in Die





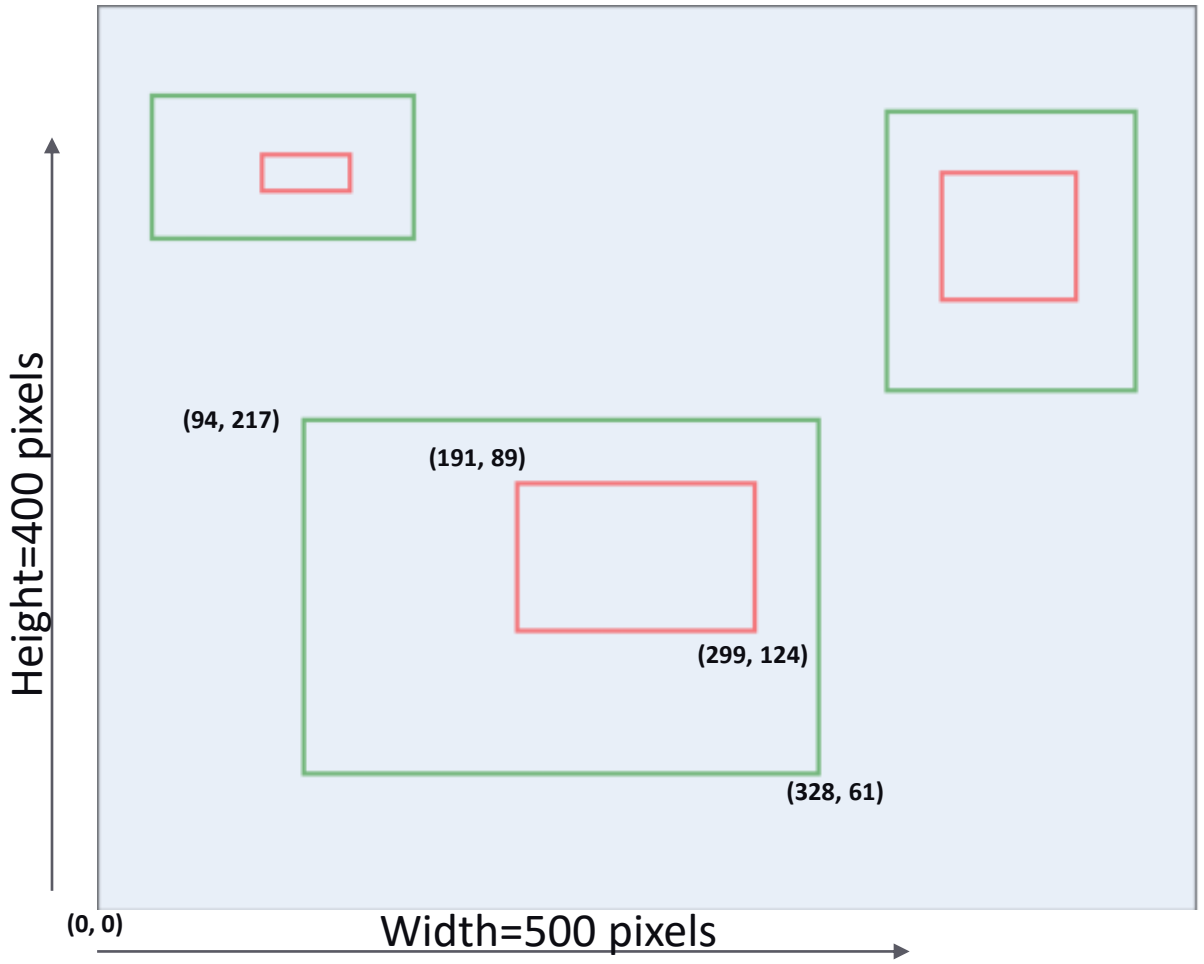
- **Care Area**: One or more rectangular ‘areas of interest’ marked within a die
- **Exclusion zones** are areas within care areas which are **not** ‘areas of interest’

Die coordinates convention - sample



Input Parameters in json format →

input.json



1. Die width, height
2. Street width
3. Care areas, Exclusion zones and their positions

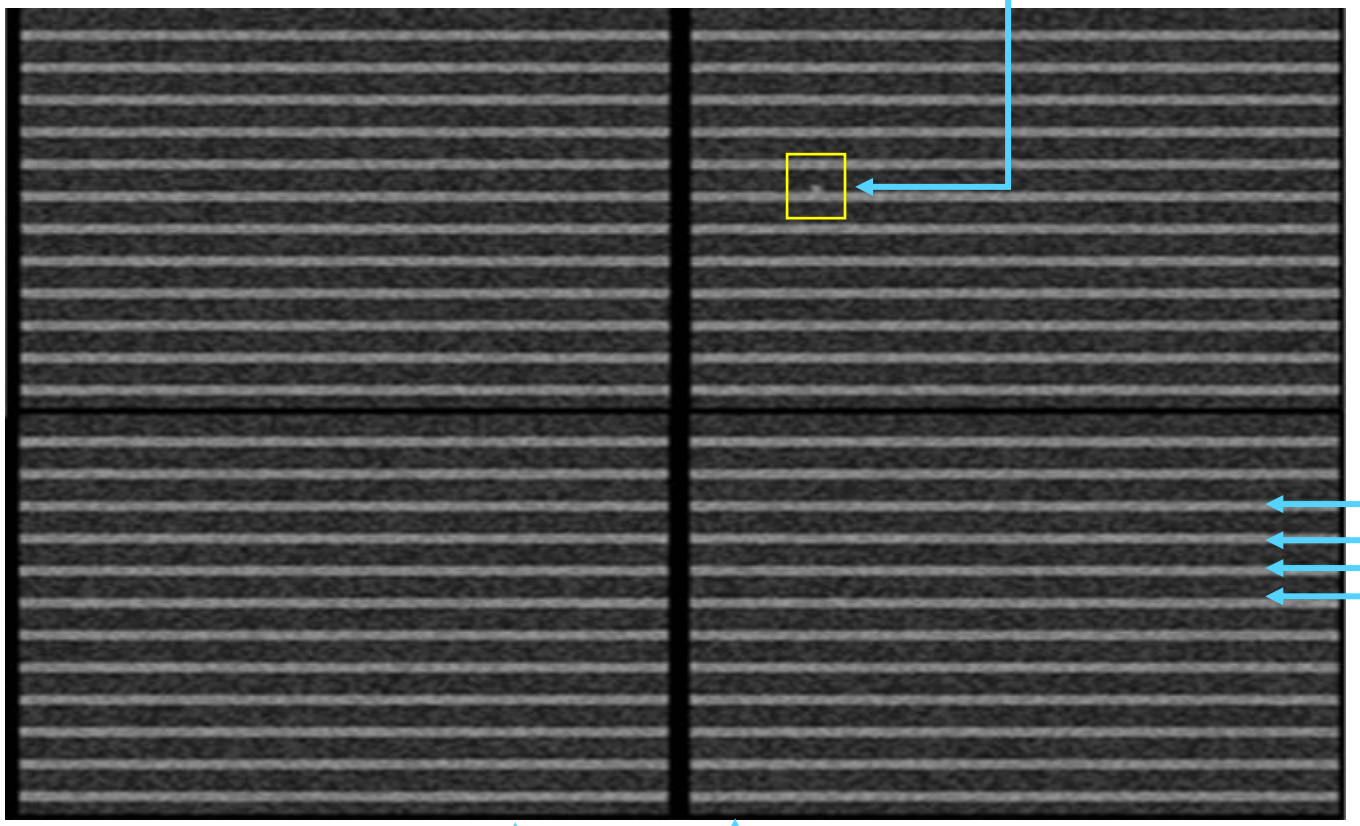
Die numbering schema

Die Numbering (Eg. 4 rows * 5 columns dies)

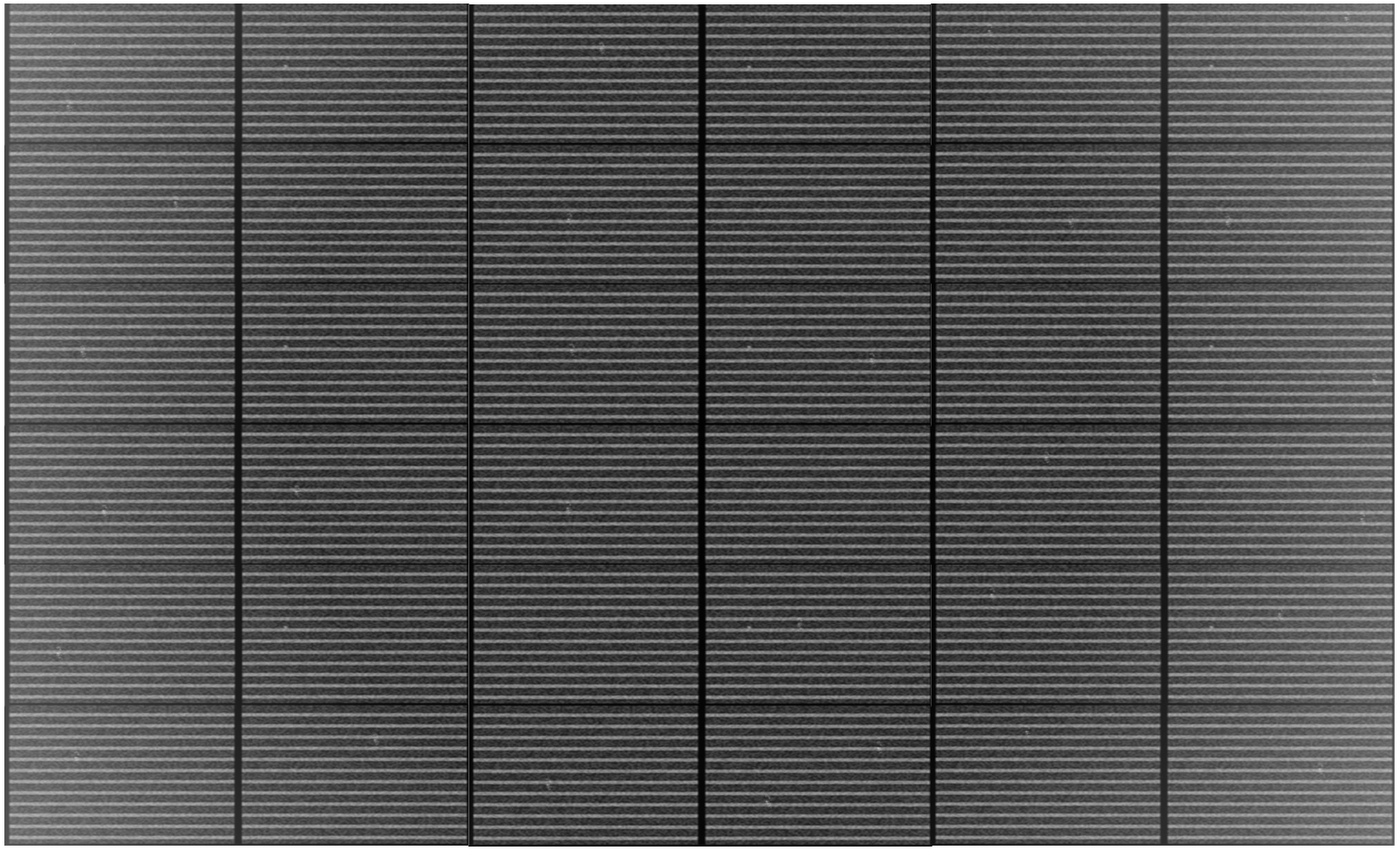
1	2	3	4	5
10	9	8	7	6
11	12	13	14	15
20	19	18	17	16

Problem

Problem: Detect & Report Anomalies in the Dies



Problem: Imaging Variation



Because of imaging variations during manufacturing process, dies which are farther off will have subtle background variations

Problem Statement

Circuit patterns in all dies are expected to be identical
Manufacturing defects will show up as anomalies in the images
All defects are **single pixel** defects

Input:

- Each Image grab (frame) from the 'acquisition system' is provided as one file on the disk/server
- For each wafer move, one frame of image - n * m pixels is generated (image size of each file is same)
- Many moves make up a single swath
- The name of the file includes the index of the frame (for 5th frame, the file name will be - wafer_image_**05**.png and so on)
- Multiple swaths may be required to image a die row
- The size of the die (width, height) and street (width) shall be provided in pixels
- Care areas within each die will also be given
- Exclusion zones within care areas in each die may also be given optionally
- Each data set contains: input json, multiple images representing a wafer

Problem Statement (contd.)

Output:

- Detect and report the anomalies found within the care areas in the output format (given below)
- Report defects only if they fall inside a care area but not within the exclusion zones
- Each reported defect should include the die index, location of the defect in die coordinates (x-pix, y-pix)
- Need to **Unit test** the code written and achieve maximum code coverage for the solution

Output format

Output file format (CSV) – (please note: no header)

(no header)
1,133,4
1,212,297
2,122,93
2,770,394
3,587,431
3,241,23

Die#, defect_pixel_x, defect_pixel_y

The output will be validated by a validator application

Milestones and Ground rules

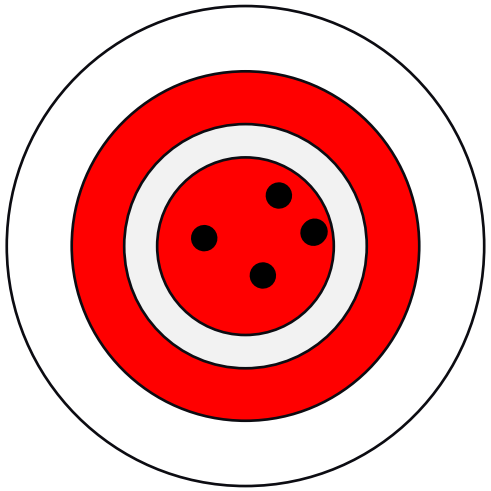
Milestones and ground rules

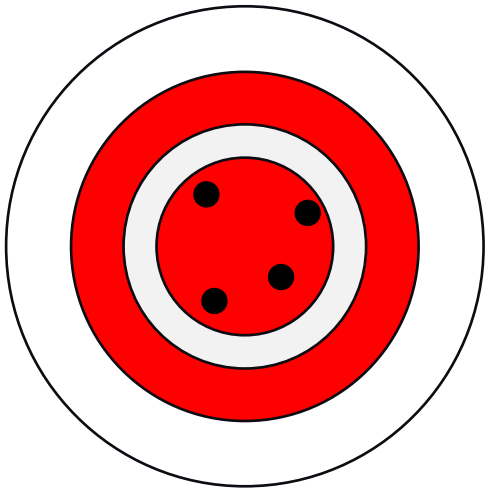
- Milestones
  - 5 different data sets to find out defects from the image and output to get generated and validated
  - All different data sets should be solved in sequence
    - These data sets are sequenced in the order of increasing complexity
  - Code should be unit testable (along with code coverage information if possible)
  - Code shall get updated to the github repository (created by students) on a per hour basis.
    - The code from github shall be the reference for validation

- Rules
  - Choose any programming language of your choice to solve the problem at hand
  - The solution (output.csv) shall get validated using validator program with the help of KLA (link will be given during the workshop)

Accuracy and Impurity

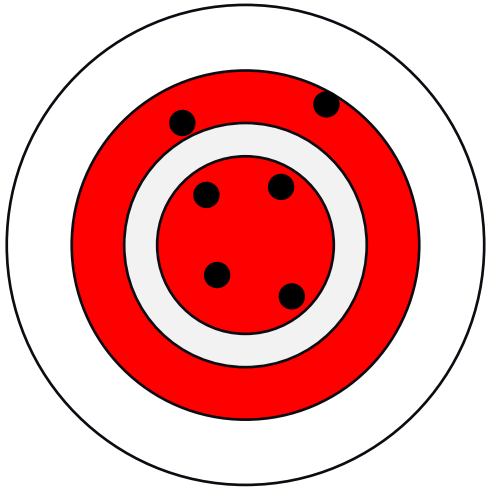
Accurate, Pure

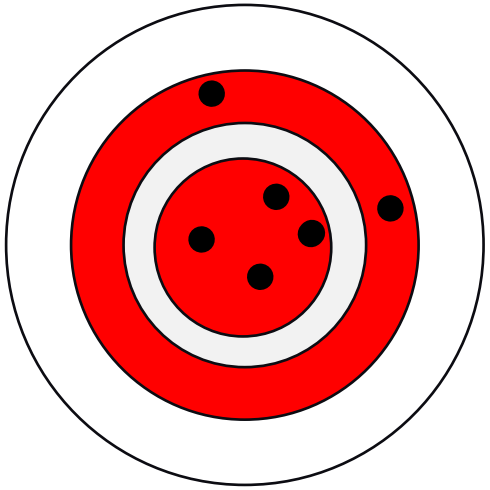




Inaccurate, Pure

Inaccurate, impure





Accurate, Impure

Milestones – More details…

- Level-1: (Link-1)
  - Defect Accuracy and Purity > 95%
- Level-2: (Link-2)
  - Defect Accuracy and Purity > 95%
- Level-3: (Link-3)
  - Defect Accuracy and Purity > 95%
  - Unit Test with maximum code coverage
- Level-4: (Link-4)
  - Defect Accuracy and Purity > 95%
  - Unit Test with maximum code coverage
- Level-5: (Link-5)
  - Defect Accuracy and Purity > 95%
  - Unit Test with maximum code coverage

Level-6 is optional

Q & A

All the best! Thank you!!