Next Steps for Sensor Procurement

1. Specifications and “optimized” design - open issues
2. Test-structures
3. Next steps
4. Conclusions

Specifications of "optimized" design

Parameter	Value	Comments
mechanical		
dimensions	107,600±50 µm x 28,000±50 µm	mounting tolerances
mechanical thickness	500±20 µm	mounting tolerances, X-ray conversion efficiency
flatness	< 20 µm	bump bonding, *value to be discussed*
dead region at edges	1200±25 µm	dead space for science
electrical@20°C [vacuum and air(<25% humidity); 0 to 1 GGy X-ray dose]		
n doping	3-8 kΩ·cm	depletion voltage, sideway depletion at edges
dead layer n^+-side	< 0.5 µm Al < 1 µm Si	minimize, but no compromise on breakdown; *values to be discussed*
doping non-uniformity	< 10%	distortions in charge collection
pixel dimensions	200x200 µm	see sensor design
maximum depletion voltage	350 V	expansion charge cloud for high photon densities
nominal operating voltage	500 V	
breakdown voltage	> 1000 V	Sensor should operate stably at 1000 V high voltage option for high photon densities; mounting, pulse shape, dead space at edges; *details of guard-ring design to be discussed*
pad layout		bump bonding, capacitance; see sensor design
coupling type	DC	
inter-pixel capacitance	500 fF	noise, cross-talk
total dark current sensor	50 µA	power
max. dark current/pixel	50 nA	noise, operation of read-out ASIC
max. dark current CCR	2 µA	power
passivation		irradiation, environmental effects *to be discussed*
electrical@20°C [vacuum and air(<25% humidity); unirradiated]		
dark current sensor@500V	200 nA	quality Si-bulk and technology
max. dark curr./pixel@500V	20 nA	quality Si-bulk and technology
max. dark curr. CCR@500V	200 nA	quality Si-bulk and technology

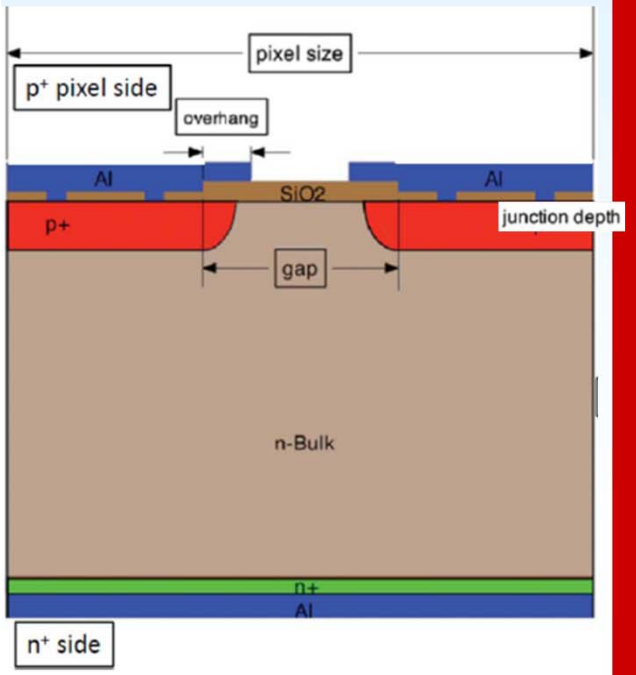
Issues:

- **mech. tolerances**
- **electr. properties**
- **specs w.o. dose ?**
- **max. dose**
- **environ. conditions**

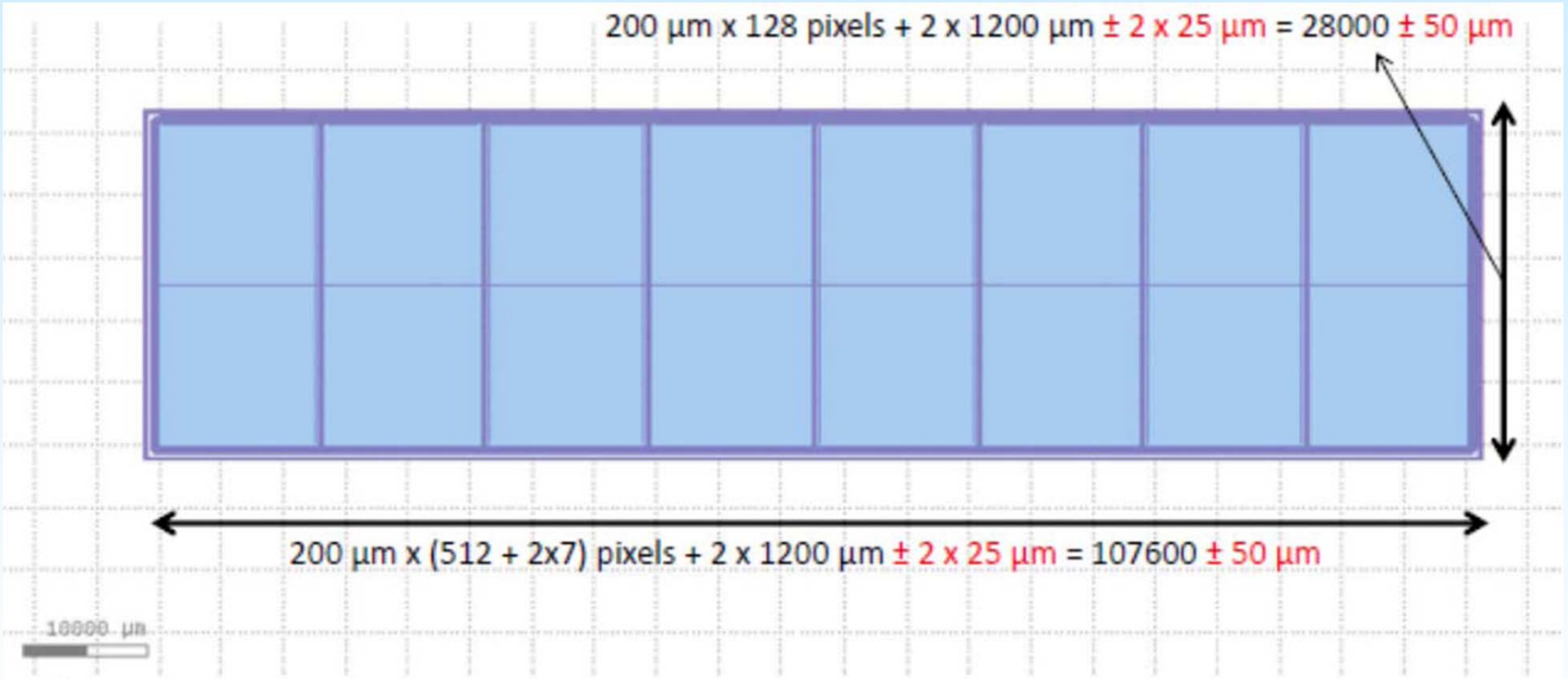
Parameters of "optimized" design

Geometry:	Gap between pixels: 20 µm Al overhang pixels: 5 µm Width implantation window pixel: 180 µm Gap pixel to CCR: 20 µm Width implantation window CCR: 90 µm Al overhang CCR: 5 µm Gap CCR to 1st guard ring (GR): 12 µm Width of implantation window GR 25 µm Al overhang left (towards pixel) GR 1, 2, … 15: 2, 3, … 16 µm Al overhang right (away from pixel) GR 1 – 15: 5 µm Gap between GR 1-2, 2-3, … 14-15: 12, 13.5, … 33 µm
Bulk resistivity:	5.1 kΩ·cm (and 3, 8 kΩ·cm to check effects of possible range)
p^+ implantation	$5x10^{15}cm^{-2}$ B, junction depth: 2.4 µm, lateral extension: 2 µm ($5x10^{15}cm^{-2}$ B@70 keV through 200 nm SiO_2; 4h @ 1025°C)
Oxide and passivation	SiO_2 field thickness: 250 nm Oxide charge before irradiation: $5x10^{10}$ cm^{-2} Oxide charge after irradiation: $3.0x10^{12}$ cm^{-2} Surface current density before irradiation: 10nA/cm^2 Surface current density after irradiation: 9 µA/cm^2 Si_3N_4: not simulated Passivation: not simulated Neumann boundary conditions on top of oxid

Table 2 Details of the optimized sensor design

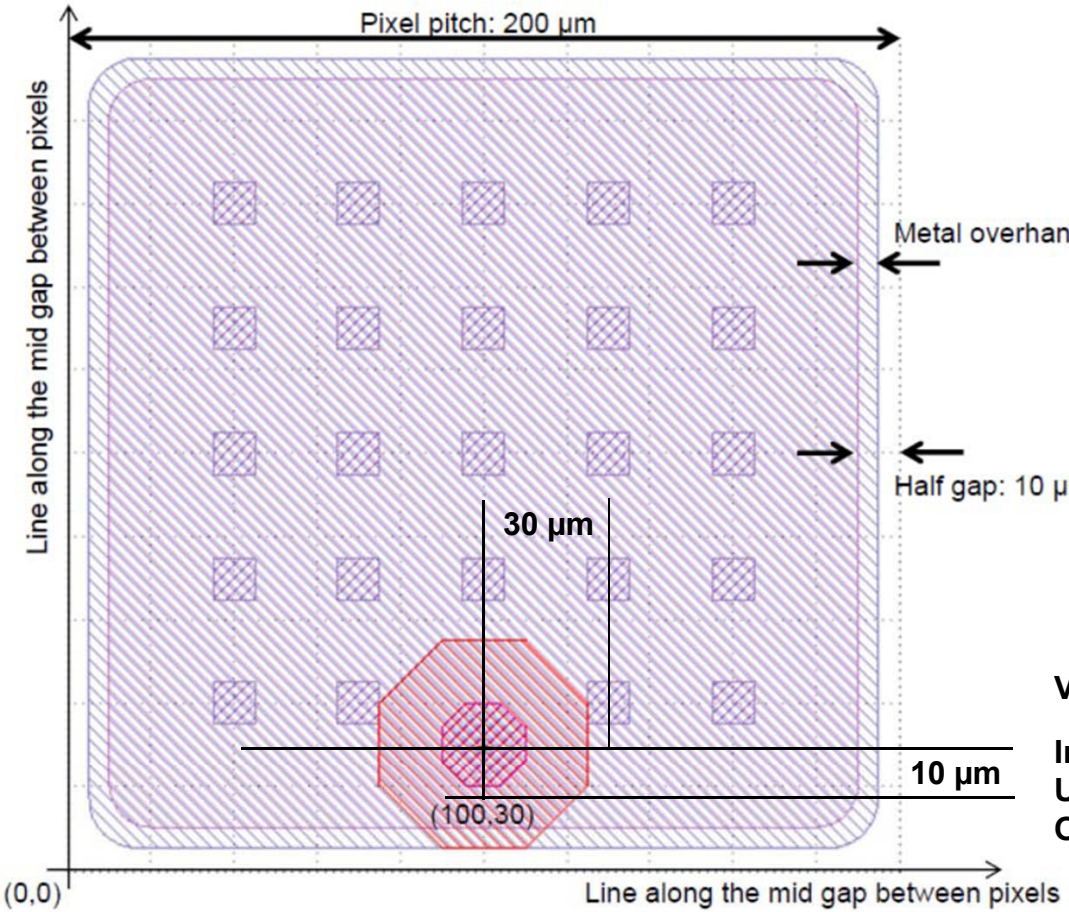


Overall + Layout



Comments:
- Number of pixels: (2 rows x 8 columns of ASICs) x (64 x 64 pixels/ASIC) = 128 x 512 = 65 536
- Dimensions of standard pixels: 200 µm x 200 µm
- Dimensions of pixels in between ASICs: 400 µm x 200 µm
- Distance pixel edge to cut: 1200 µm
  [Cutting tolerance: 25 µm (equal to width of the dicing track; 50 µm width of blade is assumed)]

Pixel Layout + Vias



Vias: **(10 µm)²**

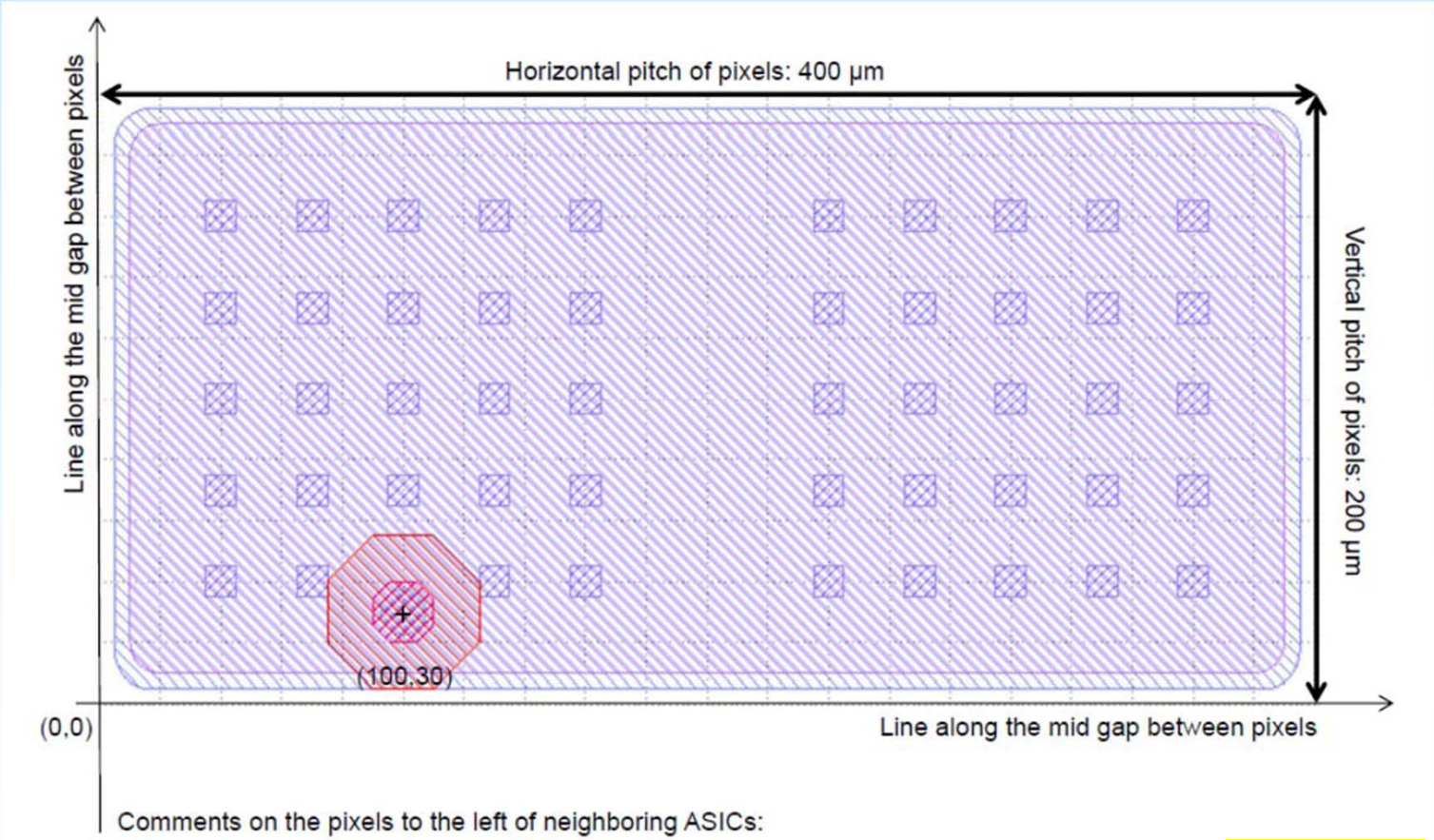
Indium: **50 µm**
UBM: **20 µm**
Opening: **14 µm**

Comments:
- Dimensions of standard pixels: 200 µm x 200 µm
- Width of p^+ implantation: 180 µm
- Gap between neighboring p^+ implantation: 20 µm
- Metal overhang: 5 µm
- Position of the center of the opening in the passivation for bump bonding: (100, 30)

Issues:

- dimensions /no. of vias
- distance between vias
- distance vias to bondpads

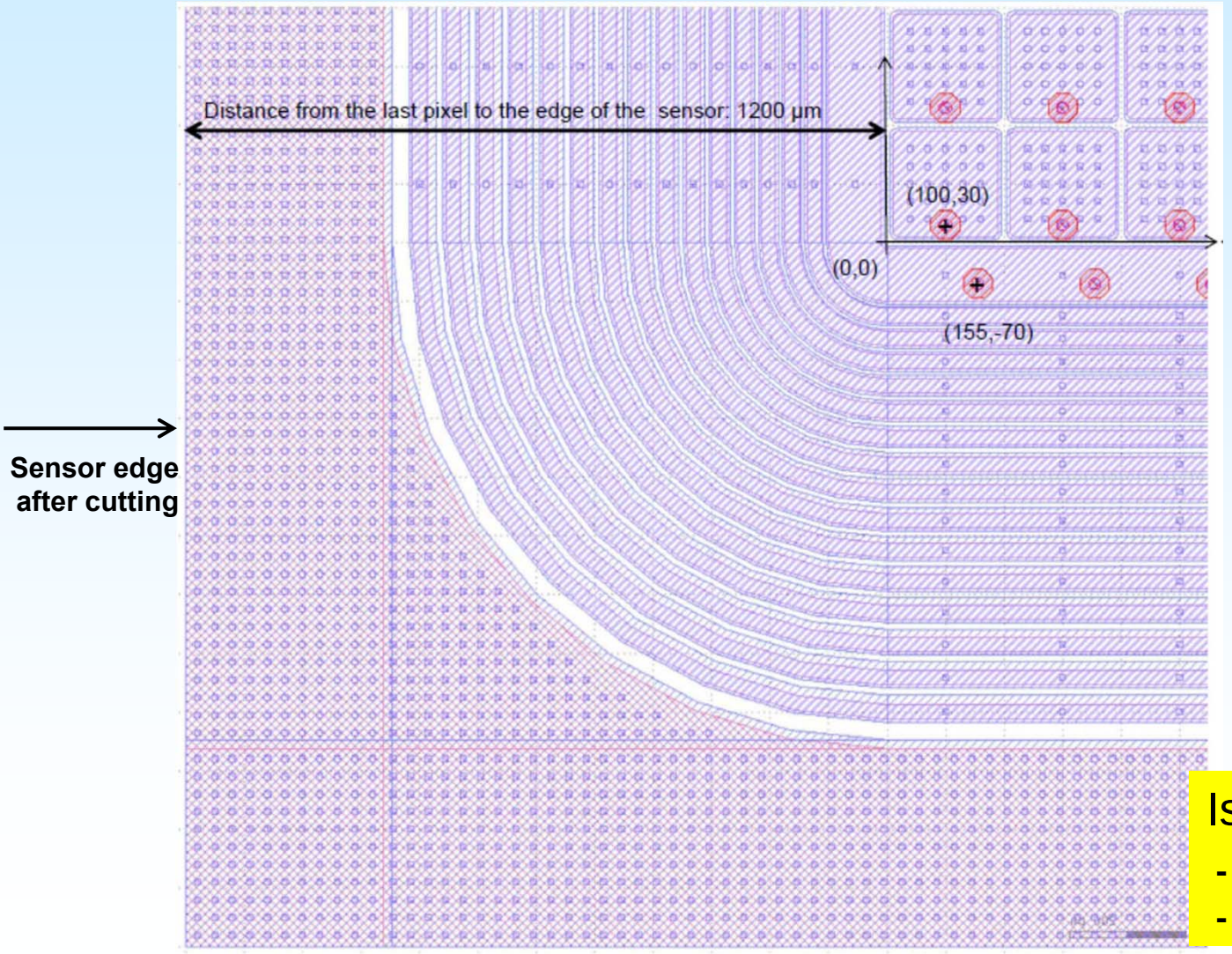
Special Pixel Layout



Comments on the pixels to the left of neighboring ASICs:
- Dimensions of pixels: 400 µm x 200 µm
- Width of p^+ implantation: 180 µm (vertically)/ 380 µm (horizontally)
- Gap between neighboring p^+ implantation: 20 µm
- Metal overhang: 5 µm
- Position of the center of the passivation-opening for bump bonding: (100, 30)

Issues:
- check !

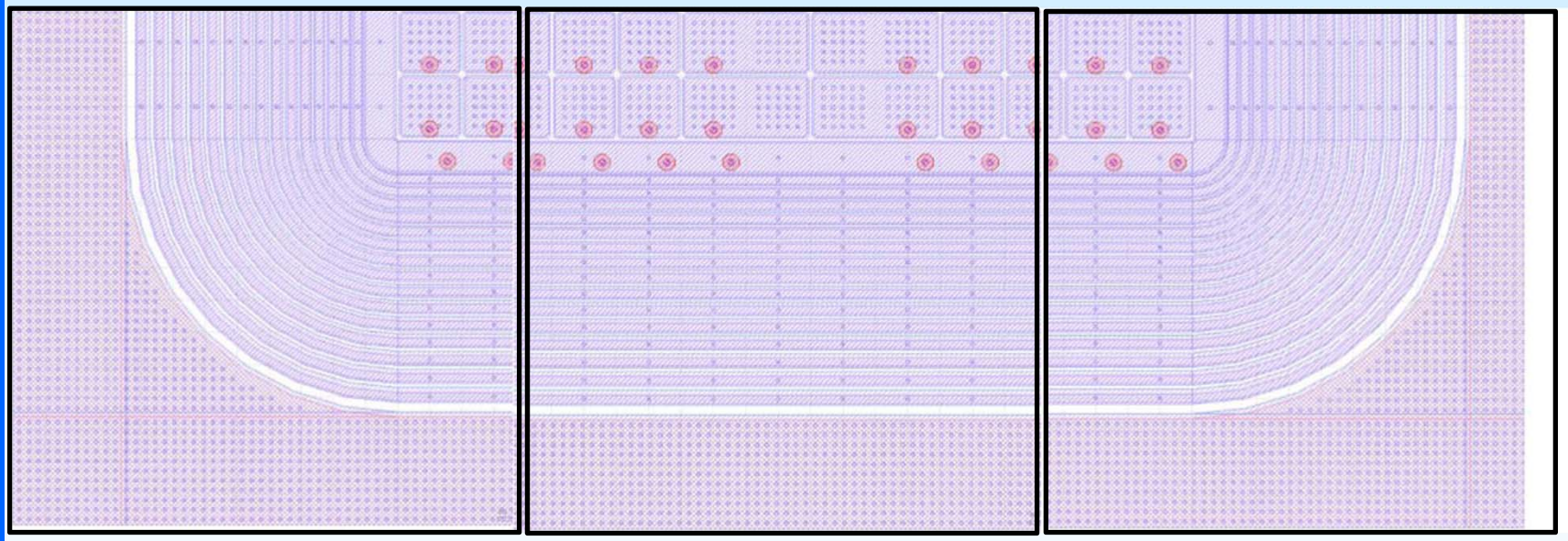
Alignment Marks + Scribe Lines



Issues:

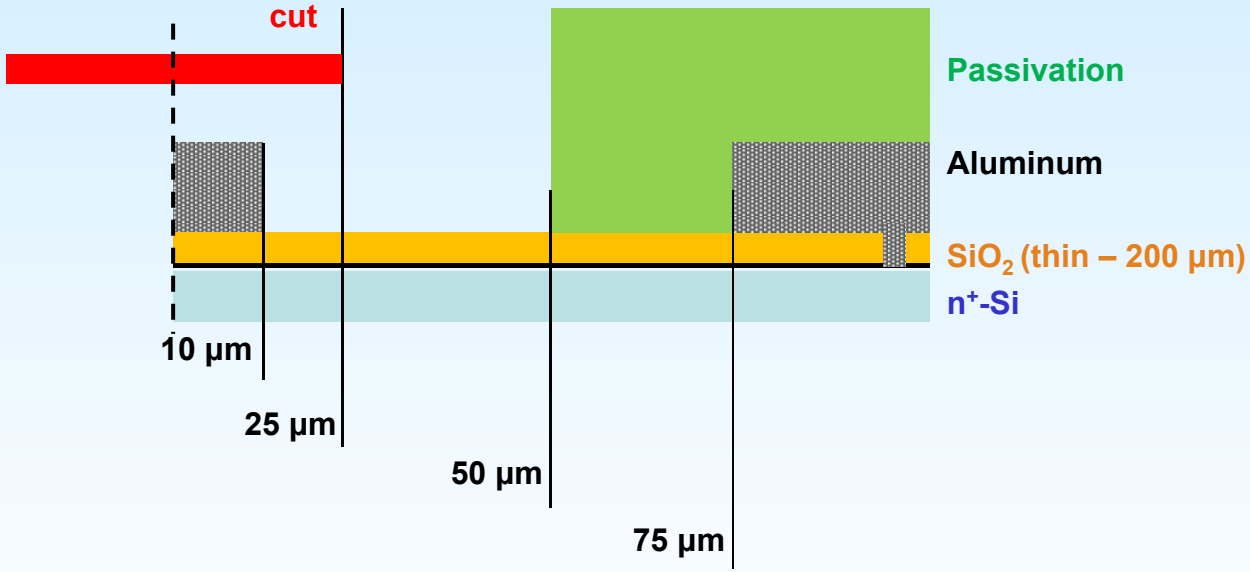
- **scribe lines**
- **alignment marks**

Pixels at sensor edges



Issues:

Scribe lines



Issues:

- layout of scribe lines
- length of scribe lines

Test structures:

A complete set of test structures is available:

- **16 x 16/ 64 x 64 pixel sensors (check radiation damage specifications)**
- **Various strip sensors (check optimization I-V, C-V, charge losses)**
- **Strips structures for resistance/capacitance measurements (implants, Al, d_{ox},…)**
- **MOS C with GR (incl. windows for TCT)**
- **Pad diodes circular and square (incl. windows for TCT)**
- **Gate controlled diodes with GR (circular/finger)**
- **PMOSFET (circular, elliptical)**
- **Guard ring structures**
- **Scribe lines**
- **and more**

Issues:

Next steps: Volume of order

	delivery date from signing of the order	number of working sensors + test structures per delivery
1.	24 weeks	24
2.	36 weeks	36
3.	options for add. sensors	128

Issues:

- **volume ,**
- **packages**
- **delivery dates**
- **quality control**
- **Who ???**

Next steps: Vendors

Incomplete list:

- **Canberra**
- **CiS**
- **Hamamatsu**
- **Micron**
- **SINTEF**
- **VTT**

Issues:

- **number of vendors to address**
- **information on technology**
- **demonstrated reliability**
- **on-site quality control**
- **available prototypes**
- **cost**
- **Who ???**

Summary:

- Based on extensive measurements + simulations → sensor design
- After agreeing on open issues → ready for ordering
- Moment that **???** should join UNI-HH effort to assure continuity