Sensor Specifications and Layout

Design Review - NA62 GTK ASIC Demonstrator Circuits

Oct. 7-8, 2008

General Parameters

Wafer specifications:

- 4” high resistivity FZ wafers
- <100> or <111>
- 4-8 kOhmcm starting material
- n-type, phosphorous doped
- thickness: 200 µm (±10 µm)
- bow: <30µm

Operation Parameters

- Depletion voltage: <30V
- Operation voltage: >300V
- Breakdown voltage:>500V
- Temperature: 5°C or less
- Radiation levels: up to 2E14 n_{eq} cm^{-2} per year
- Operation close to drift velocity saturation

Drift velocity

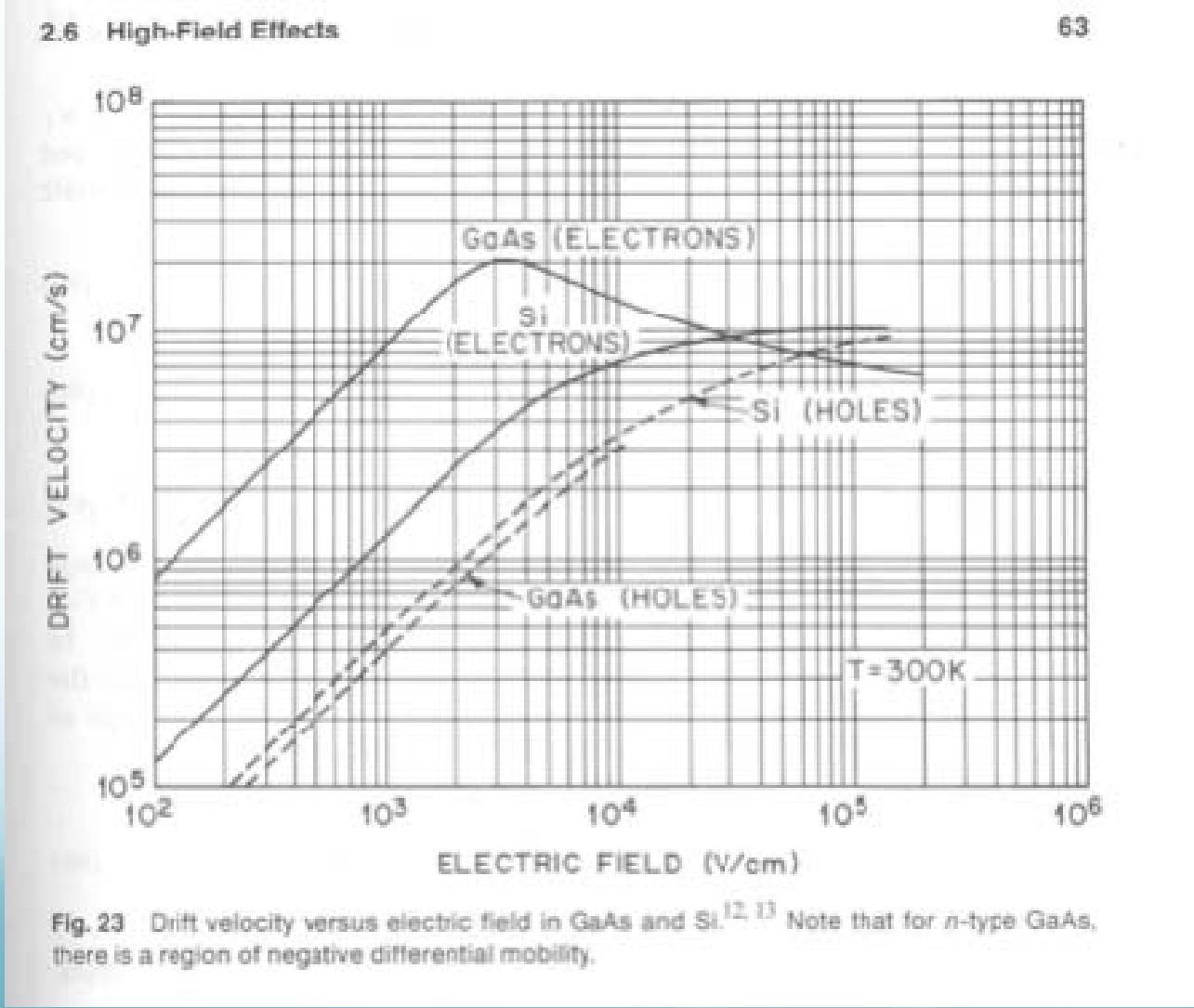


Fig. 23 Drift velocity versus electric field in GaAs and Si.[12, 13] Note that for *n*-type GaAs, there is a region of negative differential mobility.

E~1.5-2.5E6 V/cm

For V~300-500V

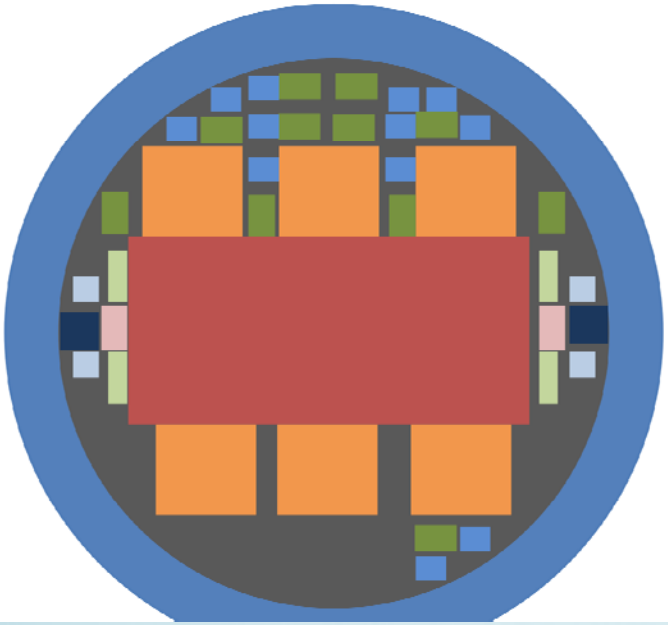
From Sze, Semiconductor Devices, 1985

High Voltage Operation

- Current breakdown has to occur far from the operating region (300-500V)
- Multi-guard structure
  - Test diodes from FBK irradiated to 2E14 n_{eq} cm^{-2}
  - Testdiodes with 4 and 12 guard rings evaluated after irradiation up to 1000 V
- Sufficient distance between last active pixel edge and scribe line
  - Suggested distanze by FBK: 1 mm

Sensor Wafer Layout

- In progress, first proposal available



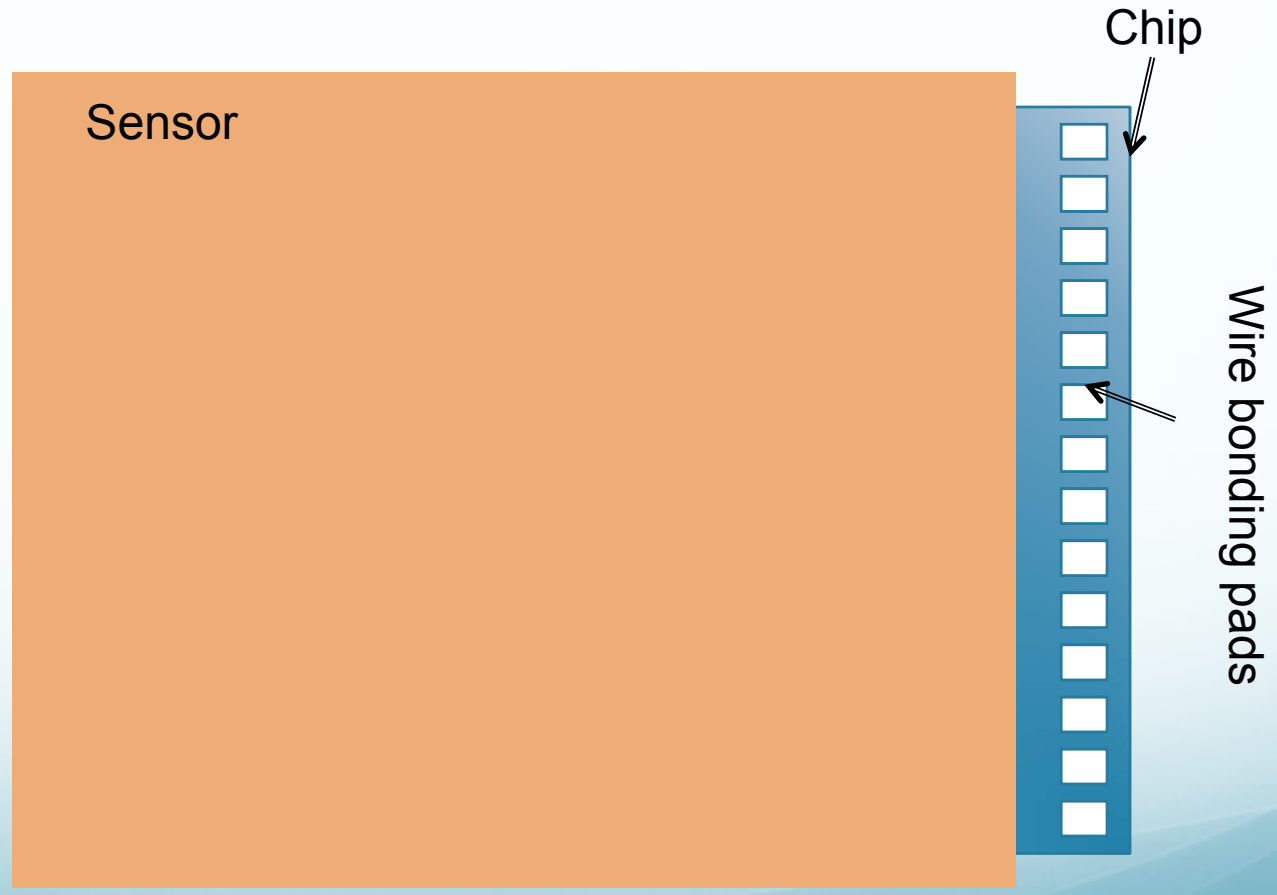
Legend for sensors:

- 1 full-size 60.0 × 27.0 mm² [62.0 × 29.0 mm²]
- 6 chip-size 13.5 × 12.0 mm² [15.5 × 14.0 mm²]
- 20 TO-demo 2.1 × 4.5 mm² [4.1 × 6.5 mm²]
- 20 CERN-demo 2.7 × 1.8 mm² [4.7 × 3.8 mm²]
- 4 CMS diodes 3.0 × 3.0 mm² [4.0 × 4.0 mm²]
- 2 CMS diodes 5.0 × 5.0 mm² [6.0 × 6.0 mm²]
- 4 no-bump-bonding test structures 6.0 × 0.9 mm² [8.0 × 2.9 mm²]
- 2 VTT alignment structures 4.0 × 7.0 mm²

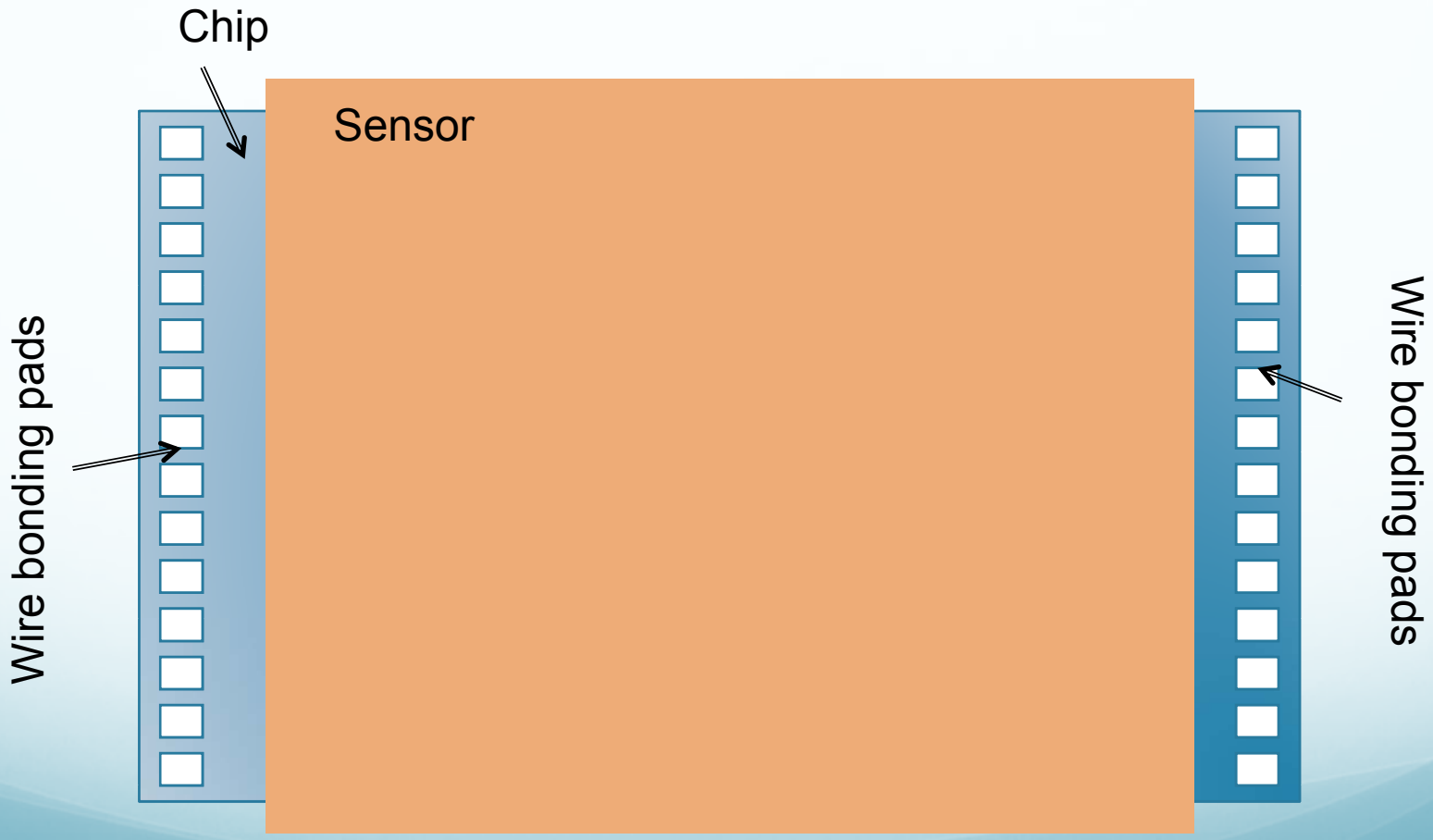
Structures per Wafer

	Name	Description	Active size
1	GTK sensor	2 x 5 pixel chip matrices (10 x 1800 pixels)	27 mm x 60 mm
2	Single chip sensor	1800 pixels	13.5 mm x 12 mm
3	TO demonstrator sensor		
4	CERN demonstrator sensor	45 pixel cells (9 x 5)	2.7 mm x 1.5 mm
5	Diode (CMS)	Test diode with multiguard structure and opening in the Al	
6	RD50 Radmon diode	Test diode with multiguard structure and opening in the Al	
7	20x3 matrix	Test structure with final size pixels, no bump bonding contacts, add opening in the central pads for laser measurements	6 mm x 0.9 mm
8	FBK test structures		
9	FC bonding test structures	Demonstrator size sensors for fc bonding tests	
10	…		

Schematic Torino Demonstrator

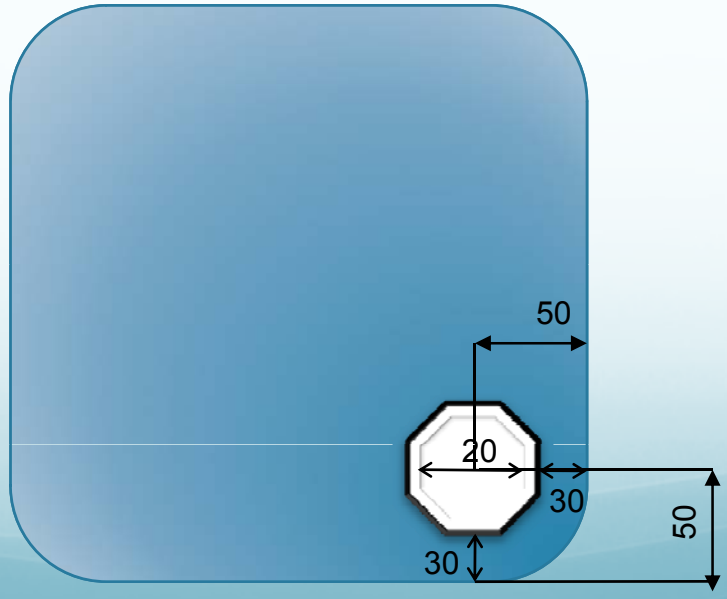


Schematic – CERN Demonstrator



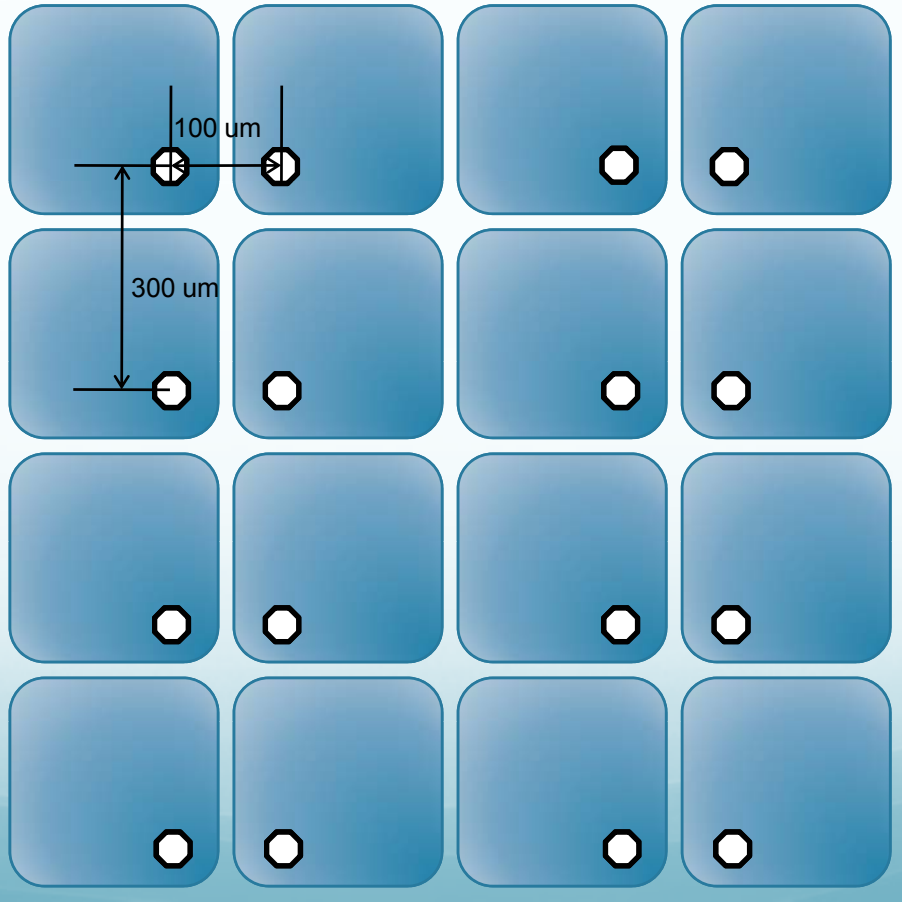
Bump Pad Layout

- Medipix/ALICE pad design
- Octagonal shape
- 26 µm diameter with 20 µm passivation opening
- Minimum distance required from pixel edge: 30µm->pixel center at 50 µm from the edge

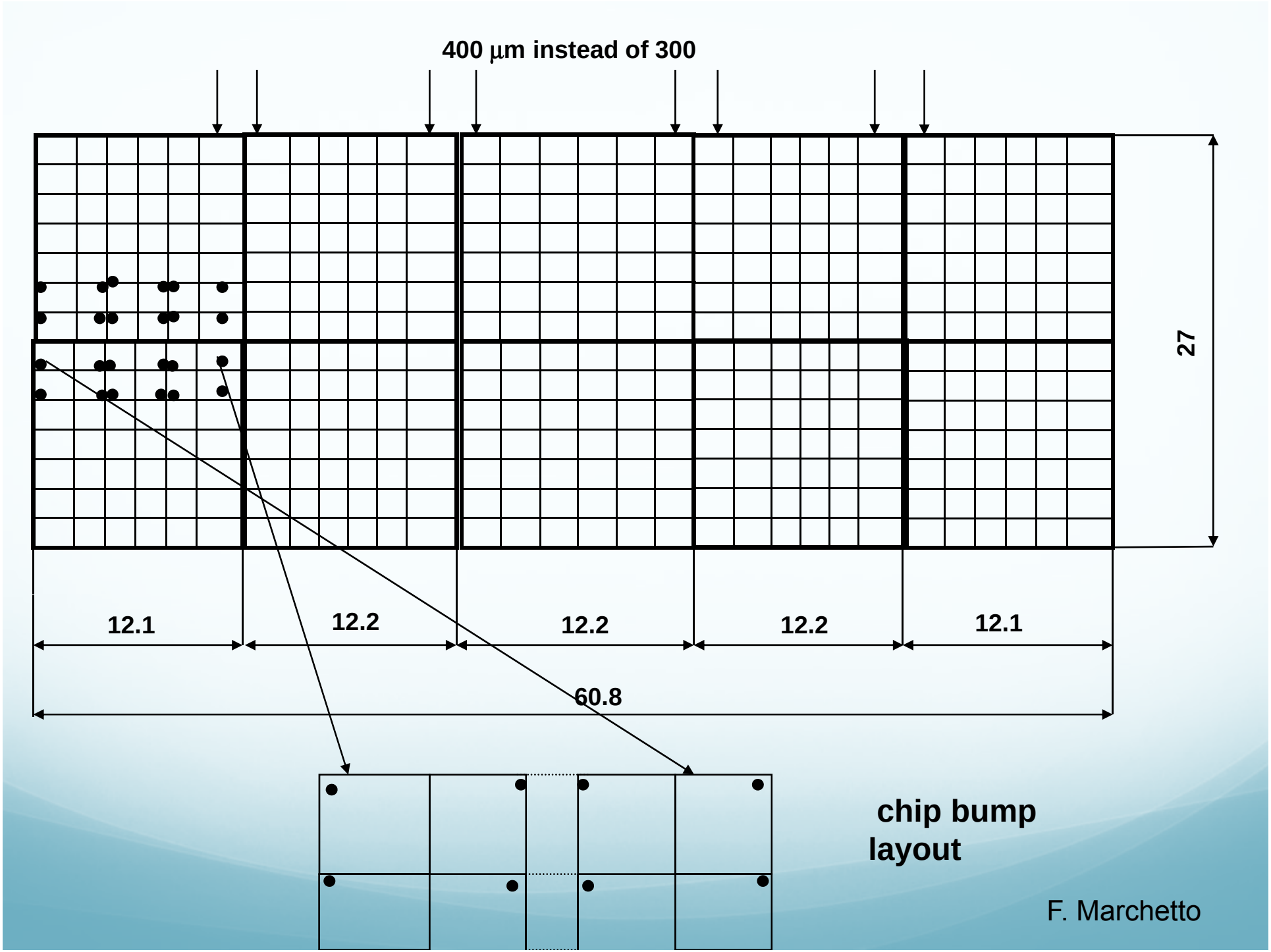


Bump Pad Arrangement

- Proposed scheme: mirrored bump pads on neighboring columns (chip layout)



F. Marchetto


400 μm instead of 300
27
12.1
12.2
12.2
12.2
12.1
60.8
chip bump layout
F. Marchetto

Bump Pad Center Coordinates

- Coordinate system origin at the lower-left side corner
- i -> column number from 1 to 200
- j -> row number from 1 to 90

X Coordinates in mm

- 1-40:
  - 0.05, 0.55, 0.65, 1.15, 1.25, 1.75, …,11.35, 11.45, 11.95
  - -> odd: (i-1)*0.3+0.05 even: i*0.3 - 0.05
- 41-80:
  - 12.25, 12.75, 12.85, 13.35, 13.45,…, 23.65 ,24.15
  - -> odd: (i-1)*0.3+0.25 even: i*0.3 + 0.15
- 81-120:
  - 24.45, 24.95, 25.05, 25.55, 25.65,…, 35.85 ,36.35
  - -> odd: (i-1)*0.3+0.45 even: i*0.3 + 0.35
- 121-160:
  - 36.65, 37.15, 37.25, 37.75, 37.85,…, 48.05 ,48.55
  - -> odd: (i-1)*0.3+0.65 even: i*0.3 + 0.55
- 161-200:
  - 48.85, 49.35, 49.45, 49.95, 50.05,…, 60.25 ,60.75
    - -> odd: (i-1)*0.3+0.85 even: i*0.3 + 0.75

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Coordinates

- X Coordinates in mm:
  - odd: (i-1)*0.3 + 0.05 + INT(i/40)*0.2
  - even: i*0.3 – 0.05 + INT(i/40)*0.2
  - INT means integer part of the ratio between i and 40
- Y Coordinates in mm:
  - 1-45:
    - 0.05, 0.35, 0.65, 0.95, …,12.95, 13.25
    - -> (j-1)*0.3 + 0.05 for j ≤45
  - 46-90:
    - 13.75, 14.05, 14.35, 14.65, …,26.35, 26.65, 26.95
    - -> (j-1)*0.3 + 0.25 for j > 45

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Outlook

- Finalize specification and wafer layout by beginning of October
- Submit information to FBK
- Meeting with FBK to discuss mask layout by beginning of November

Backup

Non-BB Teststructure