

Status of 3D Sensors

FP420 Meeting

CERN

August 29, 2005

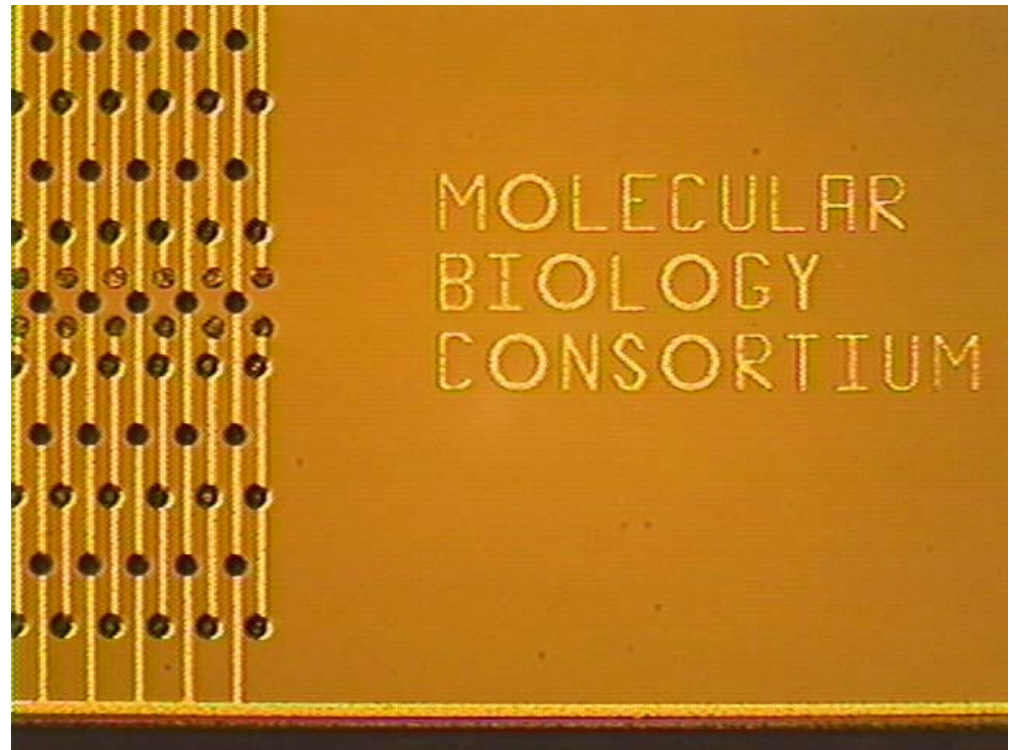
J. Hasi, A. Kok, C. Da Via, S. Watts (Brunel), S. Parker (Hawaii),
M. Garcia-Sciveres, K. Einsweiler (LBL), M. Freytis (Cambridge),
C. Kenney, E. Westbrook (MBC)

Outline

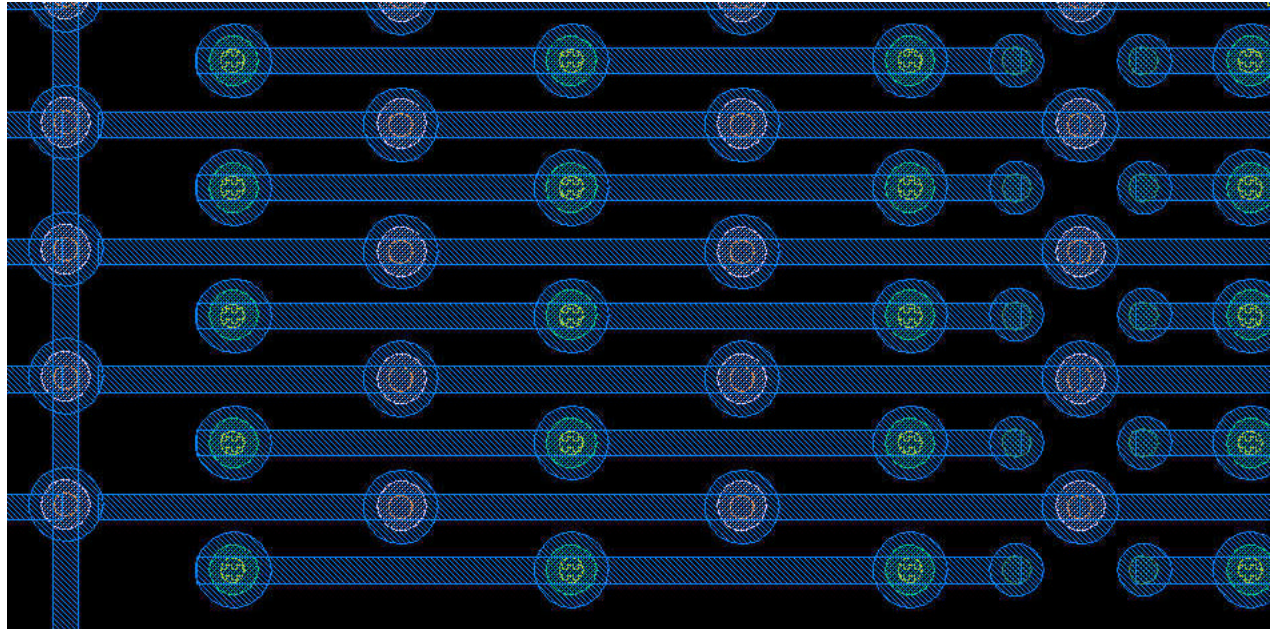
- 1) ATLAS Geometry: 2E, 3E, 4E
- 2) Bias Contact
- 3) Extended Edges
- 4) Tiling
- 5) Shingling
- 6) MCM
- 7) Overlapping
- 8) Vertical versus Horizontal
- 9) Mask
- 10) Process Status

ATLAS Compatible

- 50 microns by 400 microns pixels
- Active Edges
- Radiation Hard Cell
- 200 microns thick



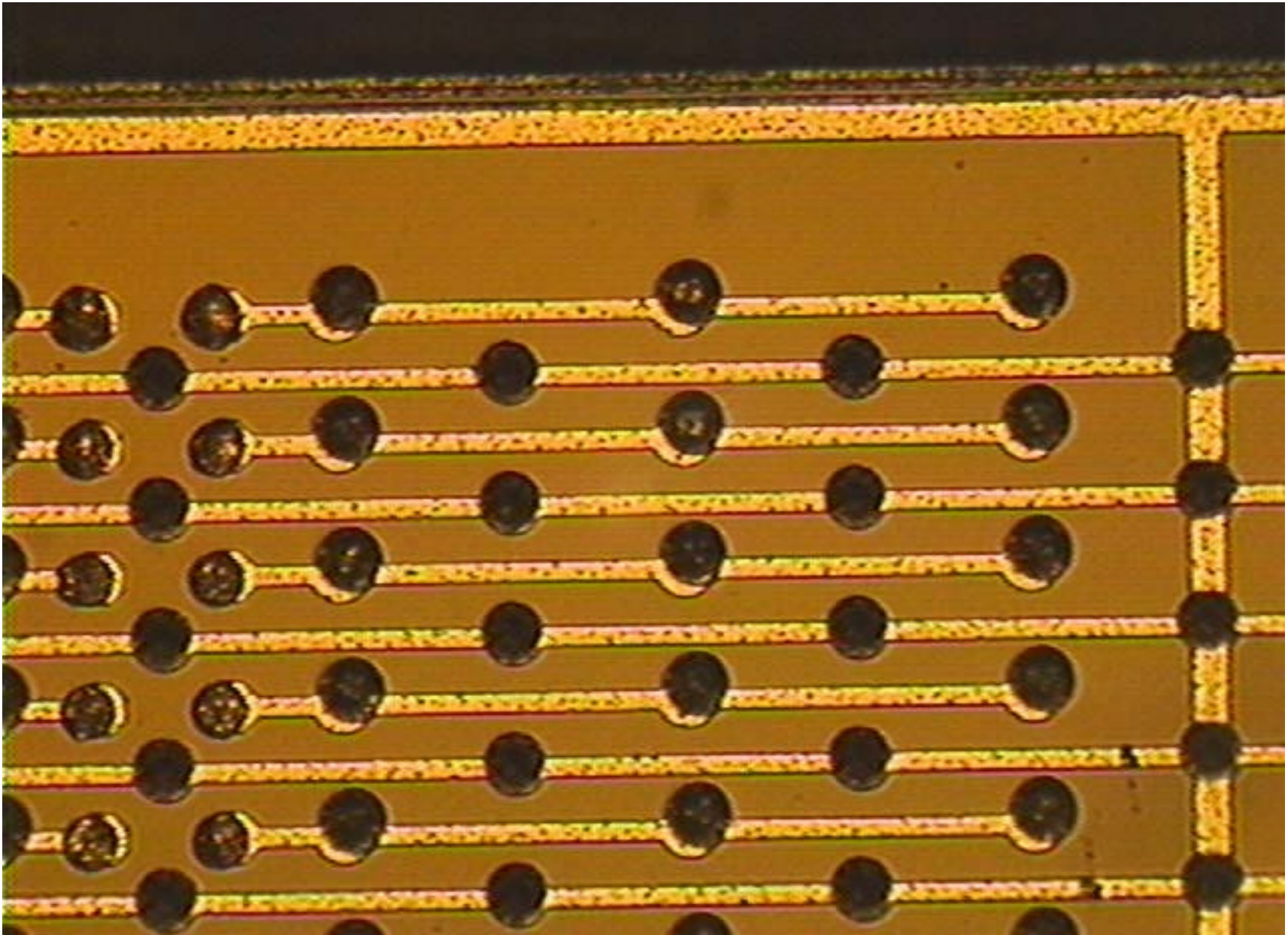
Cell Design



- Standard is 3E Cell
- 3 Collection and 3 Field Electrodes per Cell
- Electrodes partially sensitive

	2E	3E	4E
Electrode Area (%)	4	6	8
Depletion Distance (microns)	100	70	50

3E Sensor Cell



How to Bias Field Electrodes?

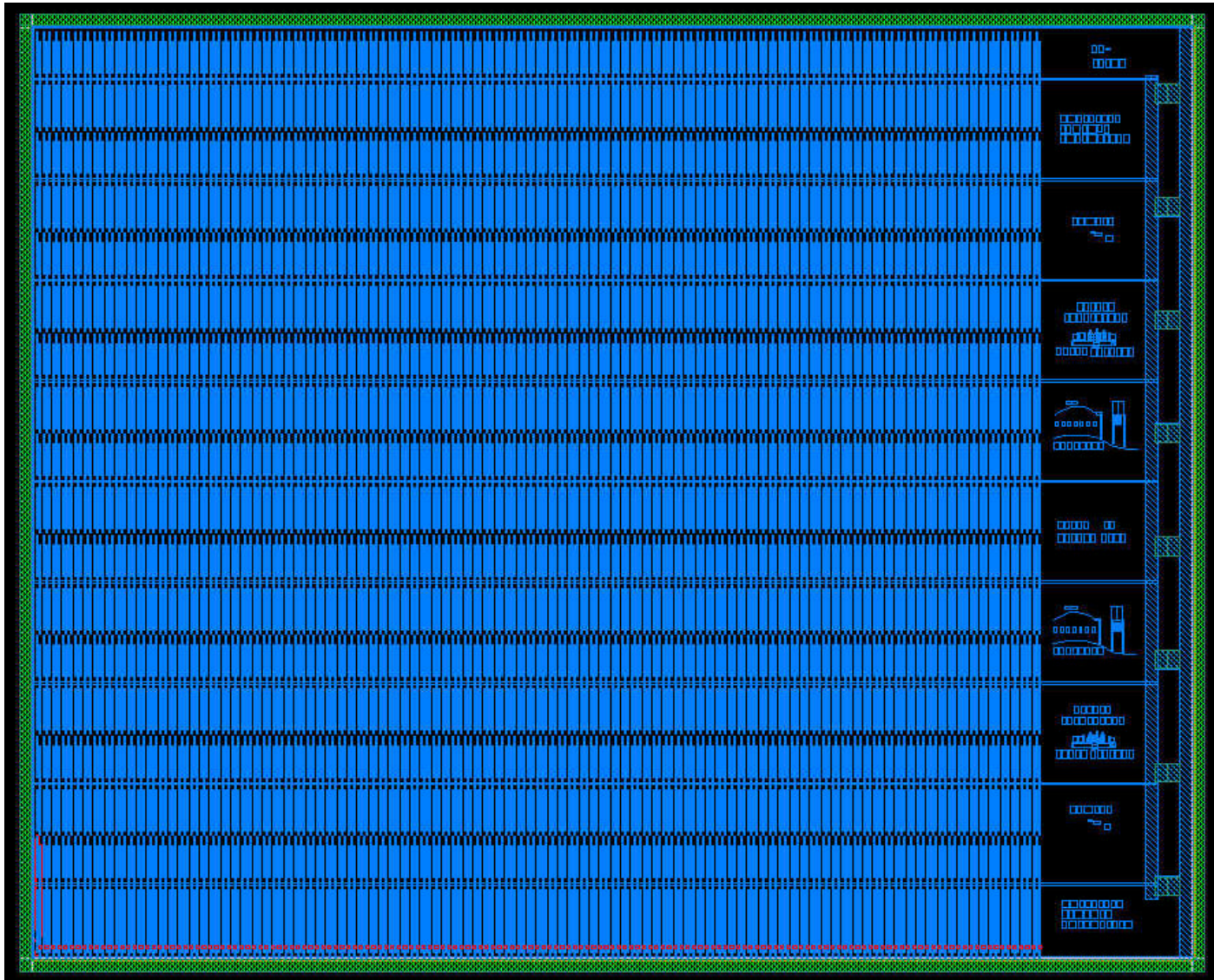
1) Extra Bump Pad – Too Late for ATLAS, HV?,
Try on FPIX2

2) Backside – Too Difficult

3) Frontside Tab – Default Plan

Collection Electrodes are Biased by Bump
Connections to ASIC

Field Electrode Bias Tab



Wire Bond
or
Conductive
Adhesive

1 mm Wide

Extended Edge Cells

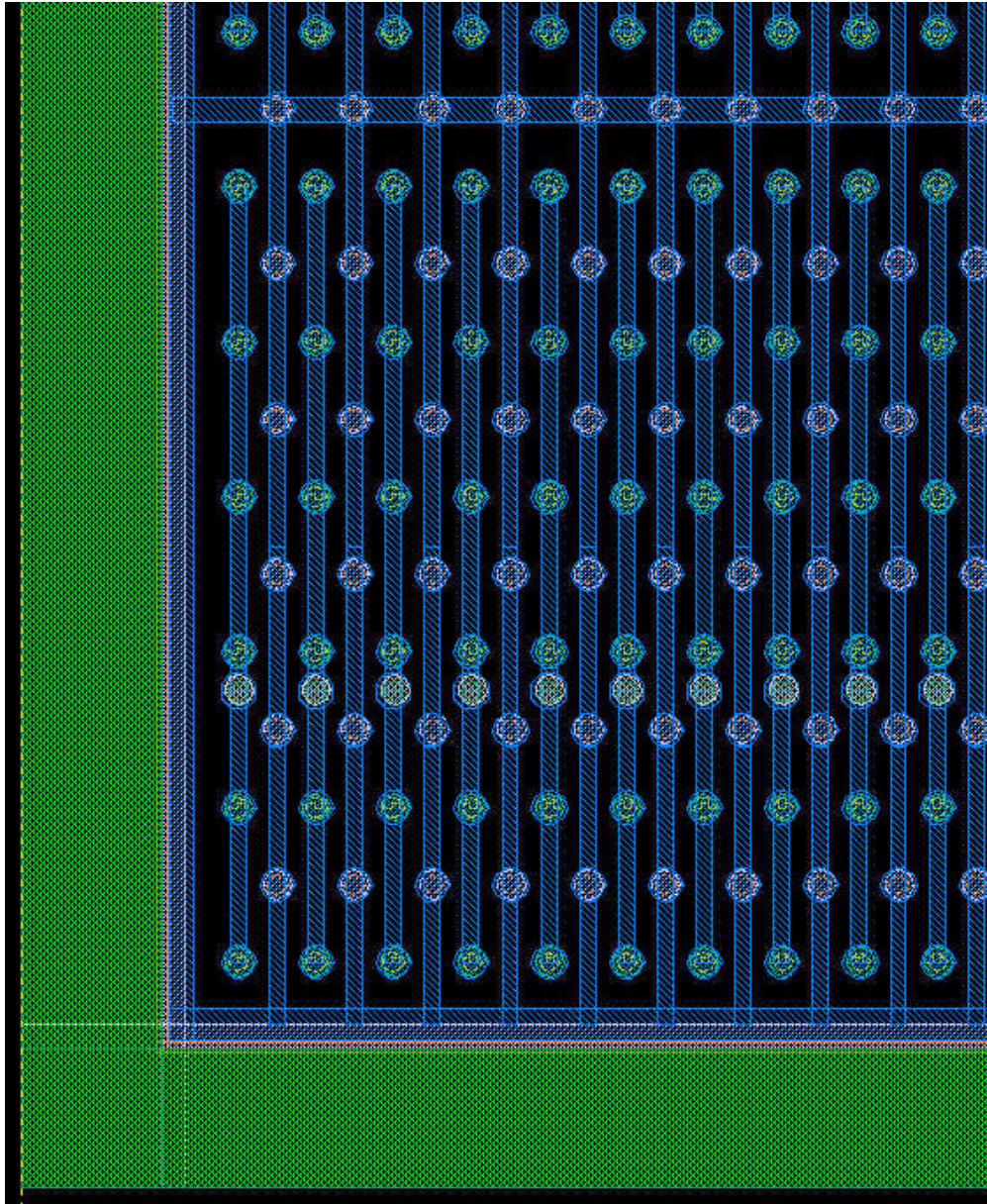
Sensor Edges Must Extend Beyond ASIC

ATLAS ASIC Border Extends Between 89 and 111 microns

Must Extend Pixels on Sensor Edges by at Least 111 microns as ATLAS Does

Increased Capacitance and Degraded Spatial Resolution

Side Cells



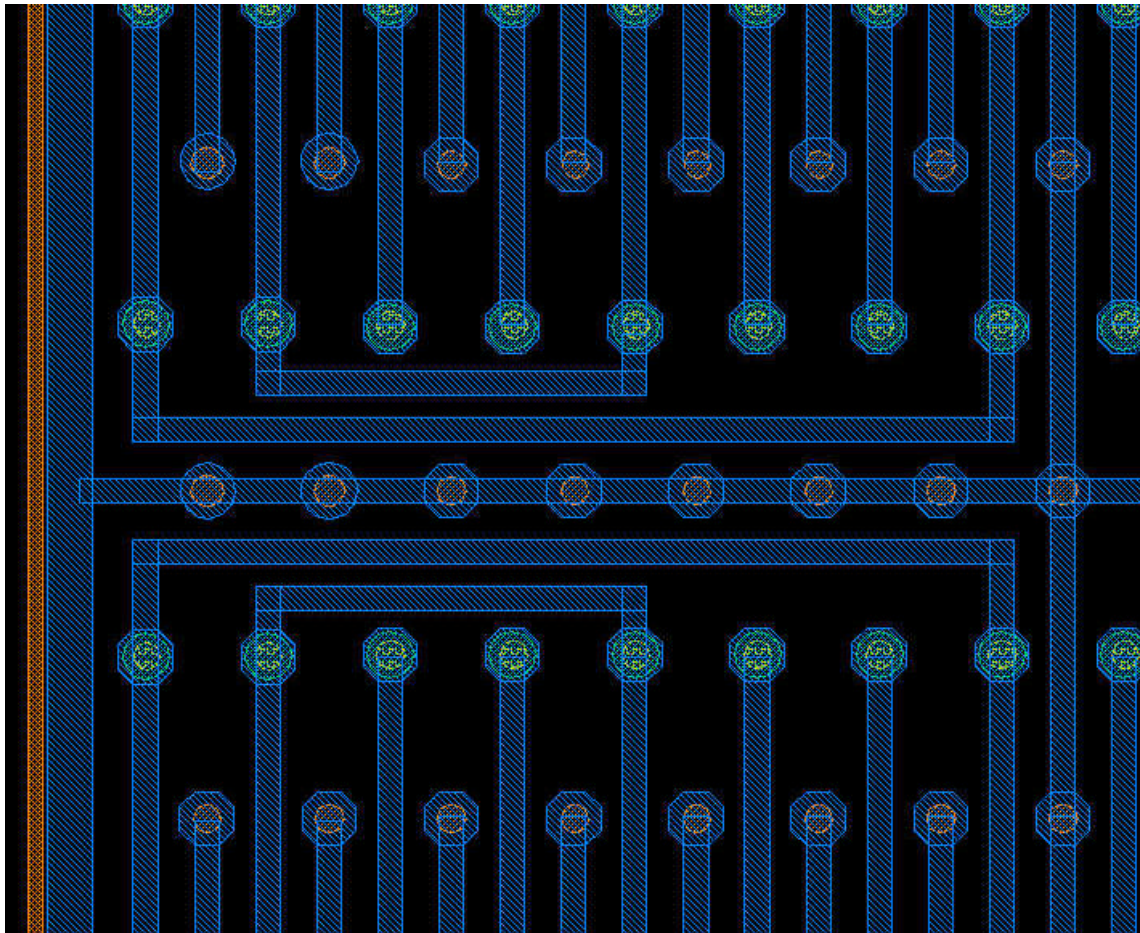
Add More Electrodes
to Side Cells

2E – 600 microns

3E – 134 microns

4E – 115 microns

Bottom Cells



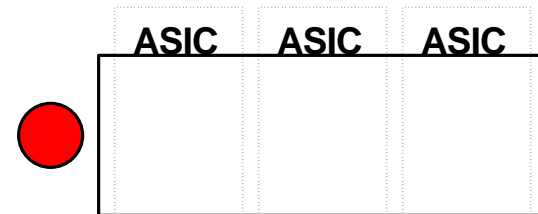
Gang Together Two Pairs of Pixels

Separated by At Least 3 Intervening Pixels – Eliminate Ambiguity

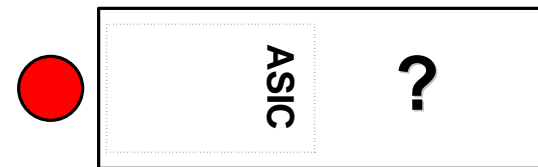
Adds 115 microns to Sensor Bottom Edge

Multi-ASIC Sensor Modules?

- Pro - Mechanical Issues
- Pro – Easier Alignment
- Con – Fabrication Yield
- Con – Bump Bond Yield
- Con – Not Possible for Horizontal Columns Without Big Dead Region!



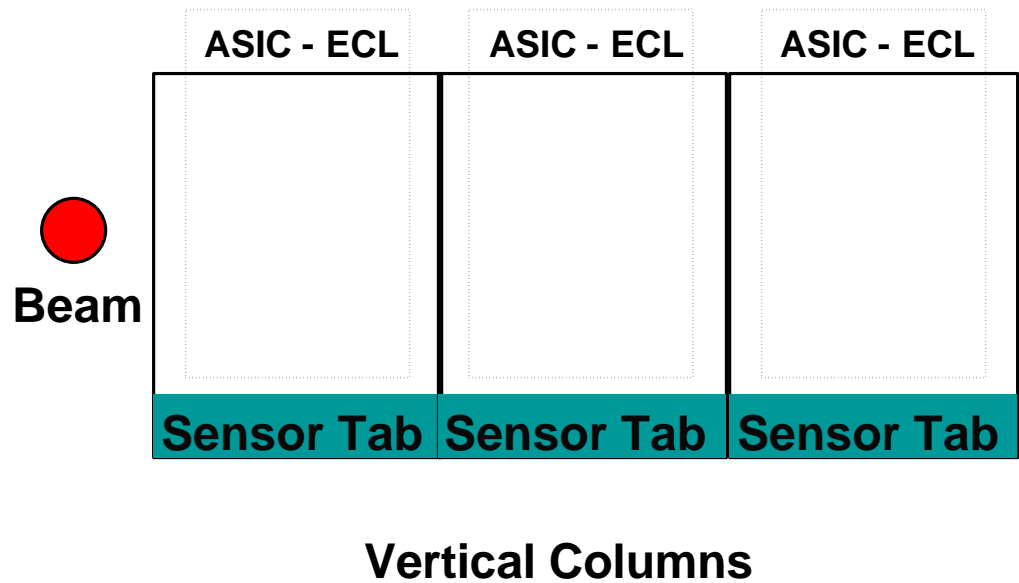
Vertical Columns



Horizontal Columns

Tile

- o Edge Butt Sensor
- o Theoretically 1 micron Wide Dead Gap Between Sensors
- o In Practice Probably 10-30 micron Dead Gap

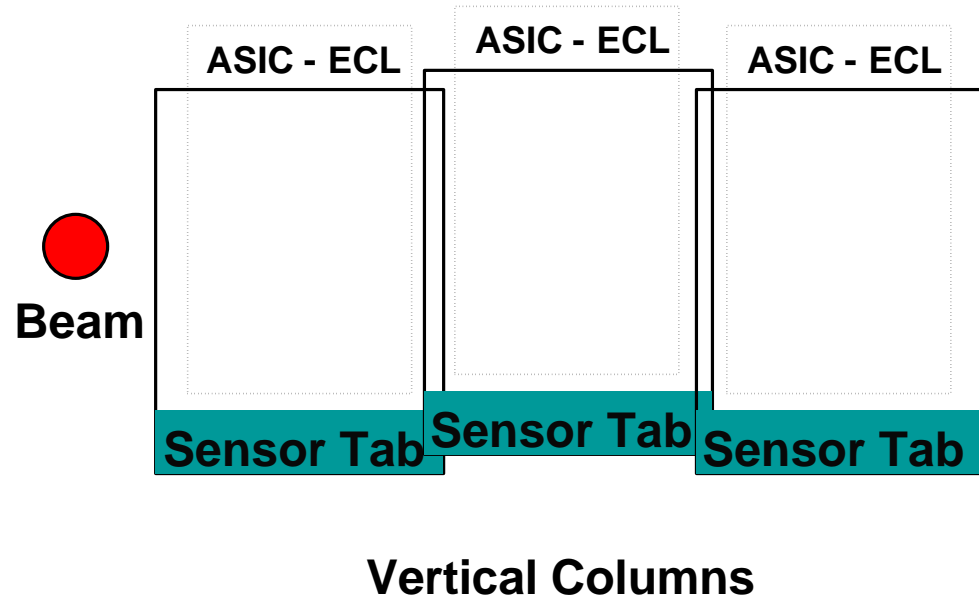


Shingle

- o Overlap Sensors

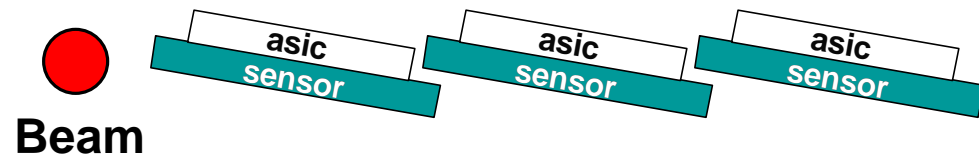
- o Perhaps Tilted

+ No Dead Gap



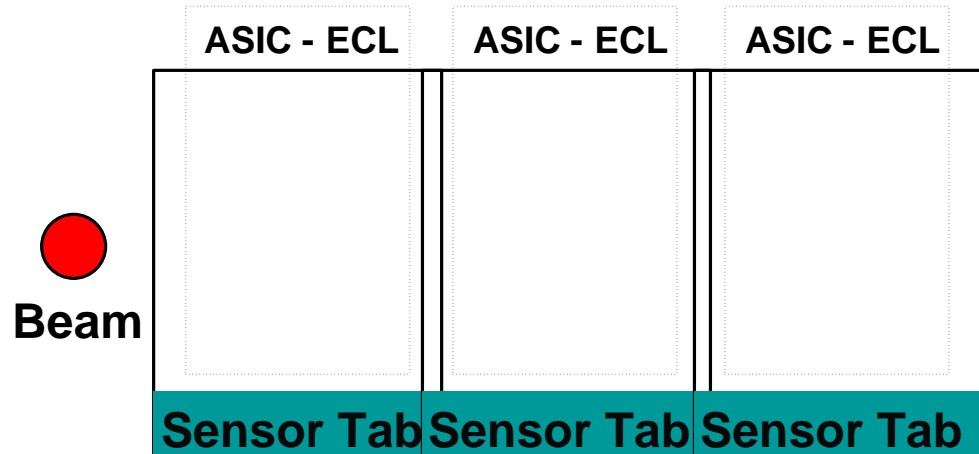
- Mechanical Complexity

- Reduced Sensitive Area



Offset

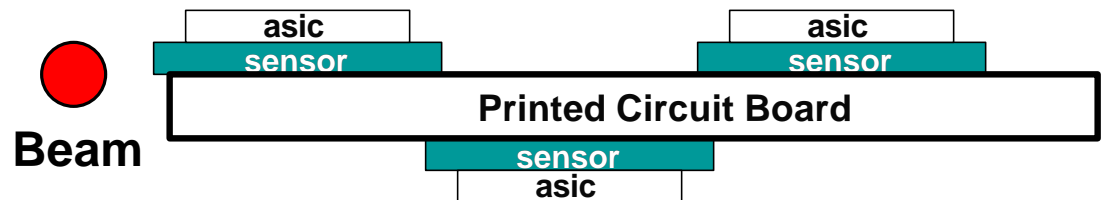
- Overlap Sensors
- Perpendicular to Beam



+ No Dead Gap

Vertical Columns

- Reduced Sensitive Area



Mounting Options

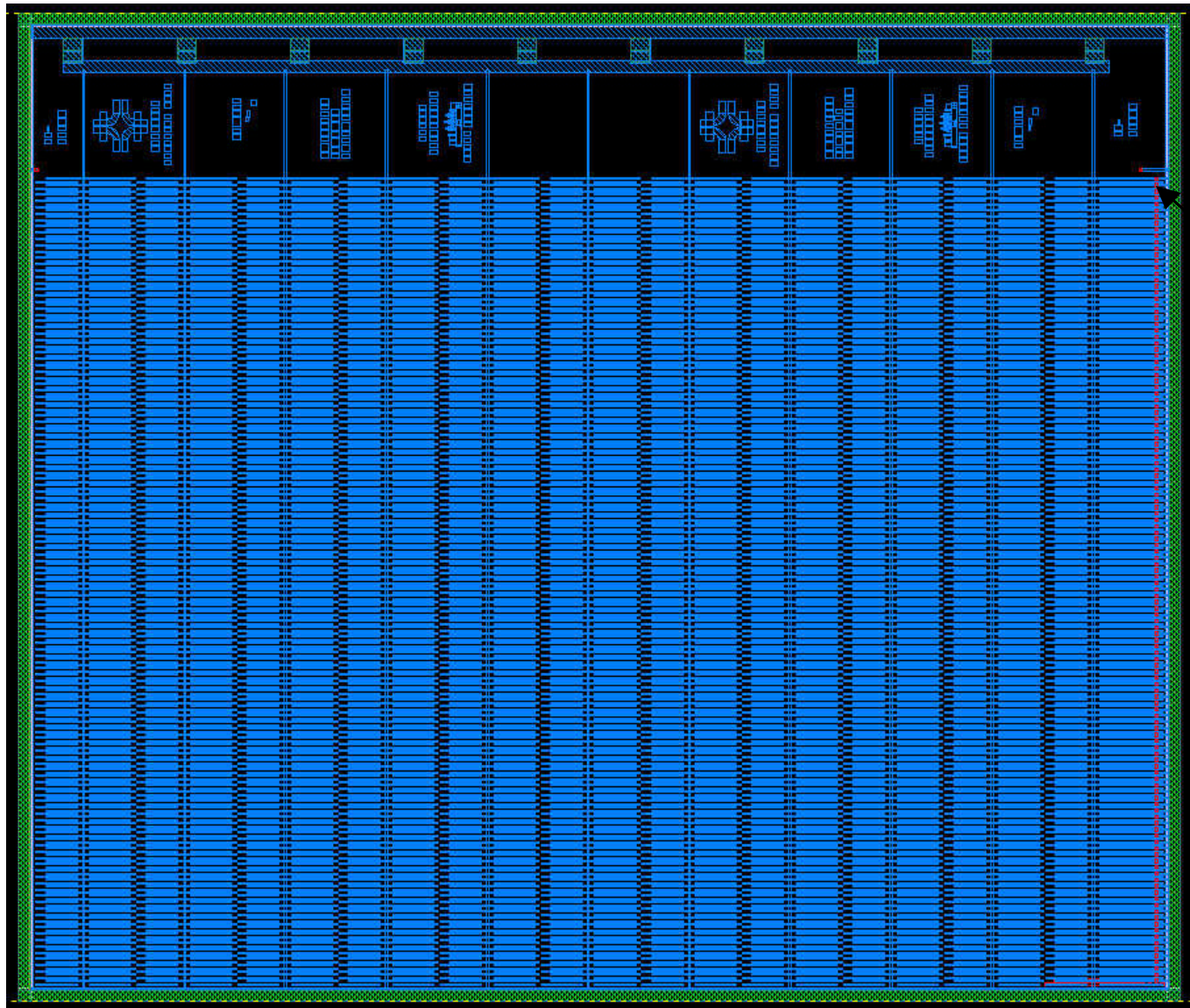
Horizontal Columns

- Can NOT be MCM or Tile
- Shingle - Complex
- Offset – Seems Best

Vertical Columns

- Tile, Offset, Shingle, or MCM
- Tile and Offset seem Best
- Could Reconsider MCM Later
depending on Yields

FPIX2 Sensor



Wire Bond
Pads to Bias
Field
Electrodes
and Edges

Sensor Bias
Via the ASIC
on a Special
Bump?

FP420 Mask

32 3E ATLAS Single Chips

6 4E ATLAS Single Chips

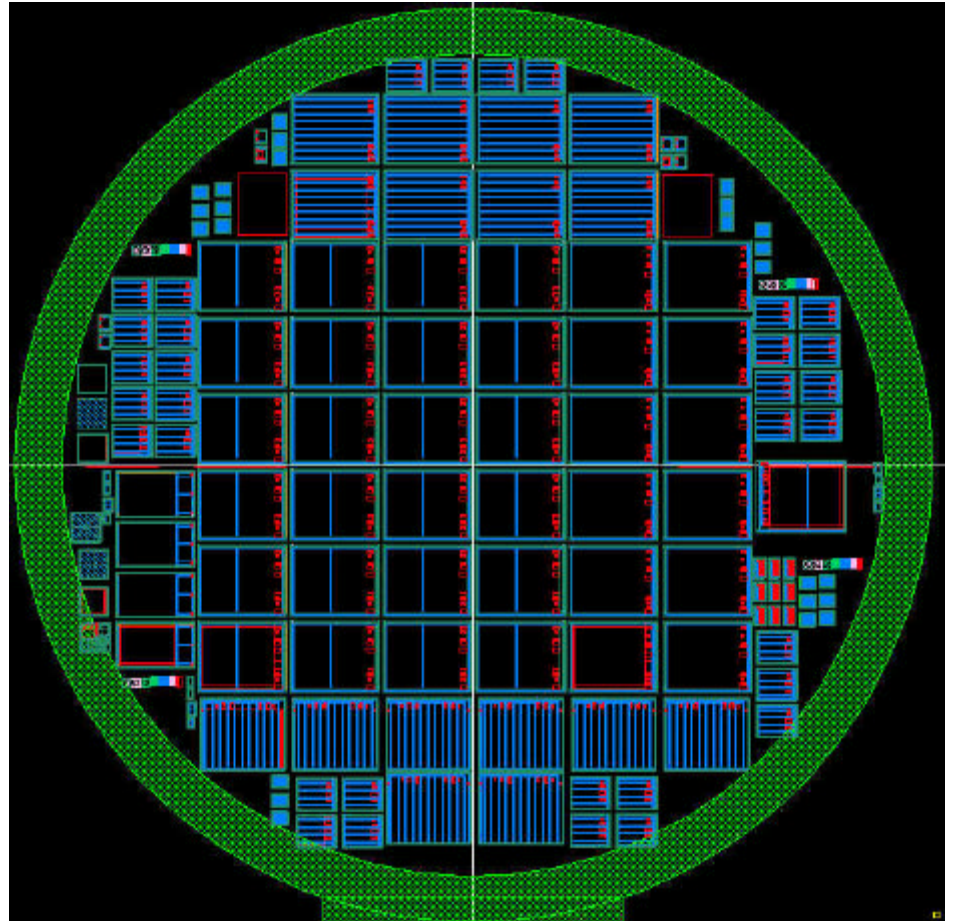
6 2E ATLAS Single Chips

Quarter Size ATLAS Chips

ATLAS Test Structures

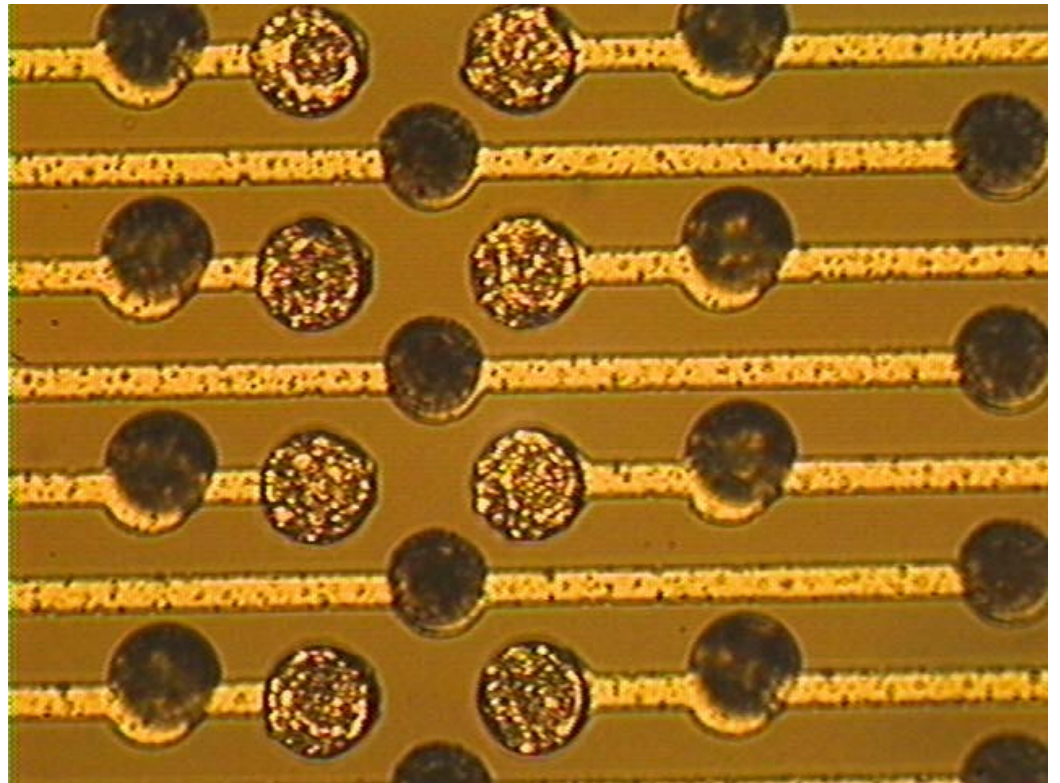
8 3E FPIX2 Single Chips

Modules Removed From Mask!



Bumps Bonding

- Use ATLAS Vendors:
IZM or Alenia
- Use Stanford Bonder
- Other Commercial Vendors
- MBC is Acquiring Bonder in 2006/2007



Preliminary Tests

- 2E Sensor with ATLAS FE-I3 ASIC
- Poor Yield this Batch!
- 250e- RMS Noise
- 7% Crosstalk
- Decent Am-241 Spectrum

Testing by M Garcis-Services, K. Einsweiler, and M. Freytis

Bonding by Alenia, IZM, and MBC

FP420 Run

- Start 6 Wafers
- 200 microns Thick
- N-type Material, 12.5 k Ω -cm
- P Sprays Implants are Done
- Fusion Bonding Done
- Field Oxide Grown
- Masks Finished
- **Estimated Finish Early November**