

*New Single-sided 2d and (2+3)d
Stripixel Detectors: Concept, Simulation,
and Design**

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Outline

■ *Introduction*

- *Standard 2d stripixel detectors*
 - *Alternating stripixel detectors (ASD)*
 - *Interleaved stripixel detectors (ISD)*
 - *Standard 3d detectors*
 - *Single-Type-Column 3d detectors (3DSTC)*

■ *Novel 1-sided 2d and (2+3)d Stripixel Detector Concept*

- *Planar single-sided 2d stripixel detectors*
- *Planar+3d single-sided 2d stripixel detectors with single column*
- *Planar+3d single-sided 2d stripixel detectors with dual columns*

■ *Simulation and Design of 1st Prototype detectors*

■ *Summary*

Standard 2d stripixel detectors

Z. Li; Nucl. Instrum. & Meth. Vol. 518, No. 3, Feb. (2004) 738-753.

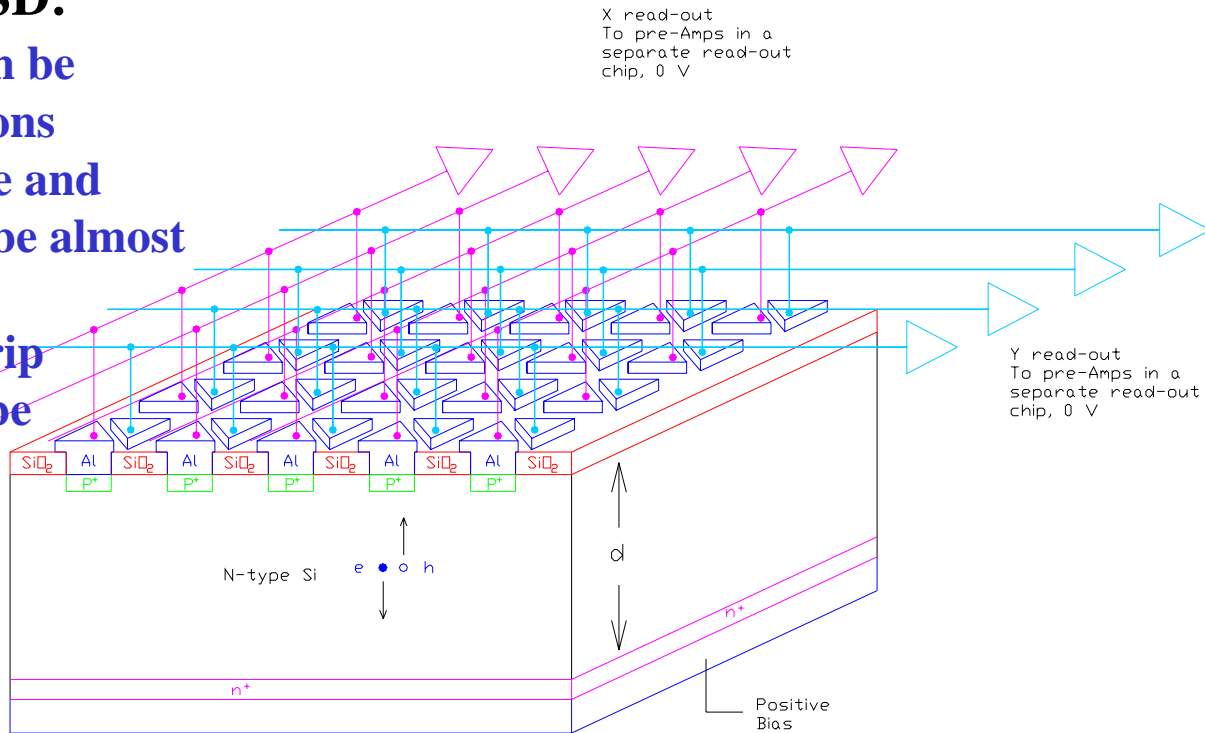
Interleaved stripixel detectors (ISD)

Each **pixel** is divided into two halves: **X-cell** and **Y-cell**, and connected by **X** and **Y** readout lines (**strips**) respectively

X-cell and **Y-cell** are interleaved (coupled)

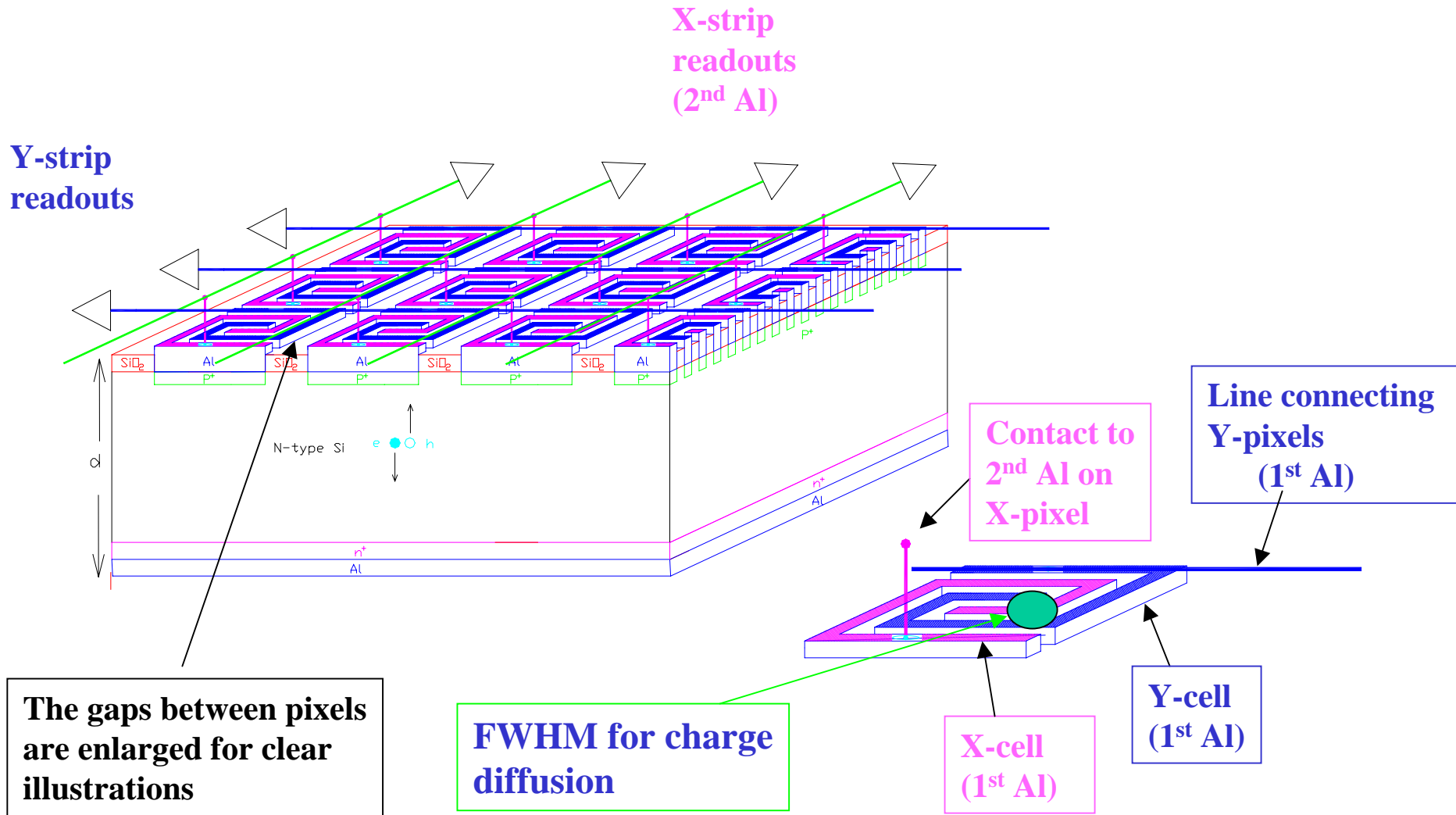
Unique advantages of ISD:

- **pixels and strip pitches can be made large in both directions**
- **The choices for pixel shape and interleaving schemes can be almost infinity**
- **The choice for X and Y strip readout schemes can also be almost infinity**



- **large capacitance/strip due to interleaving scheme**
- **Charge sharing**

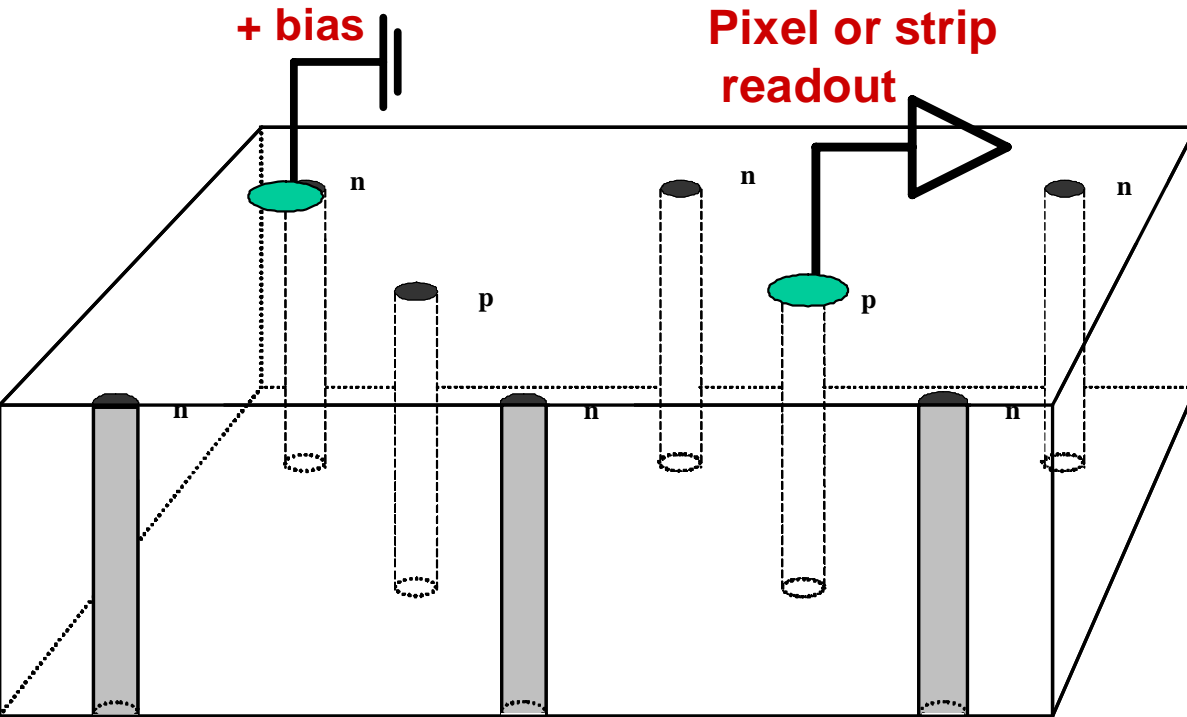
Schematic of a spiral interleaving scheme for ISD (PHENIX Upgrade at RHIC)



Prototype for PHENIX Upgrade at RHIC produced, 2d resolution of 25 μm obtained (80 μm pitches)

(Tojo et al., IEEE TNS Vol.51, No.5, pp 2337-2340)

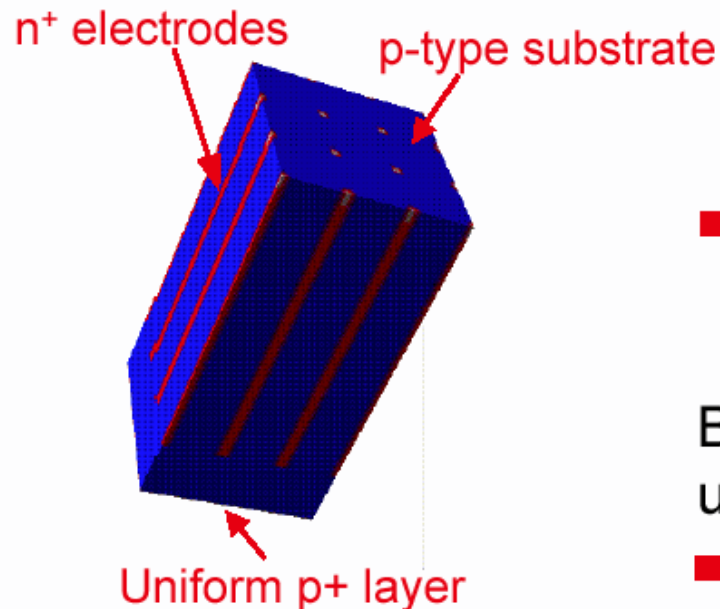
Schematics of a 3d detector (3d in terms of processing)



- 3d processing
- 2-column etched
- Read out only p or n electrodes

3DSTC detectors - concept (2)

Further simplification: holes not etched all through the wafer



- *Planar and 3d processing*
- *1-sided process*
- *Read out only*
n (or p) electrodes

➔ No need of support wafer.

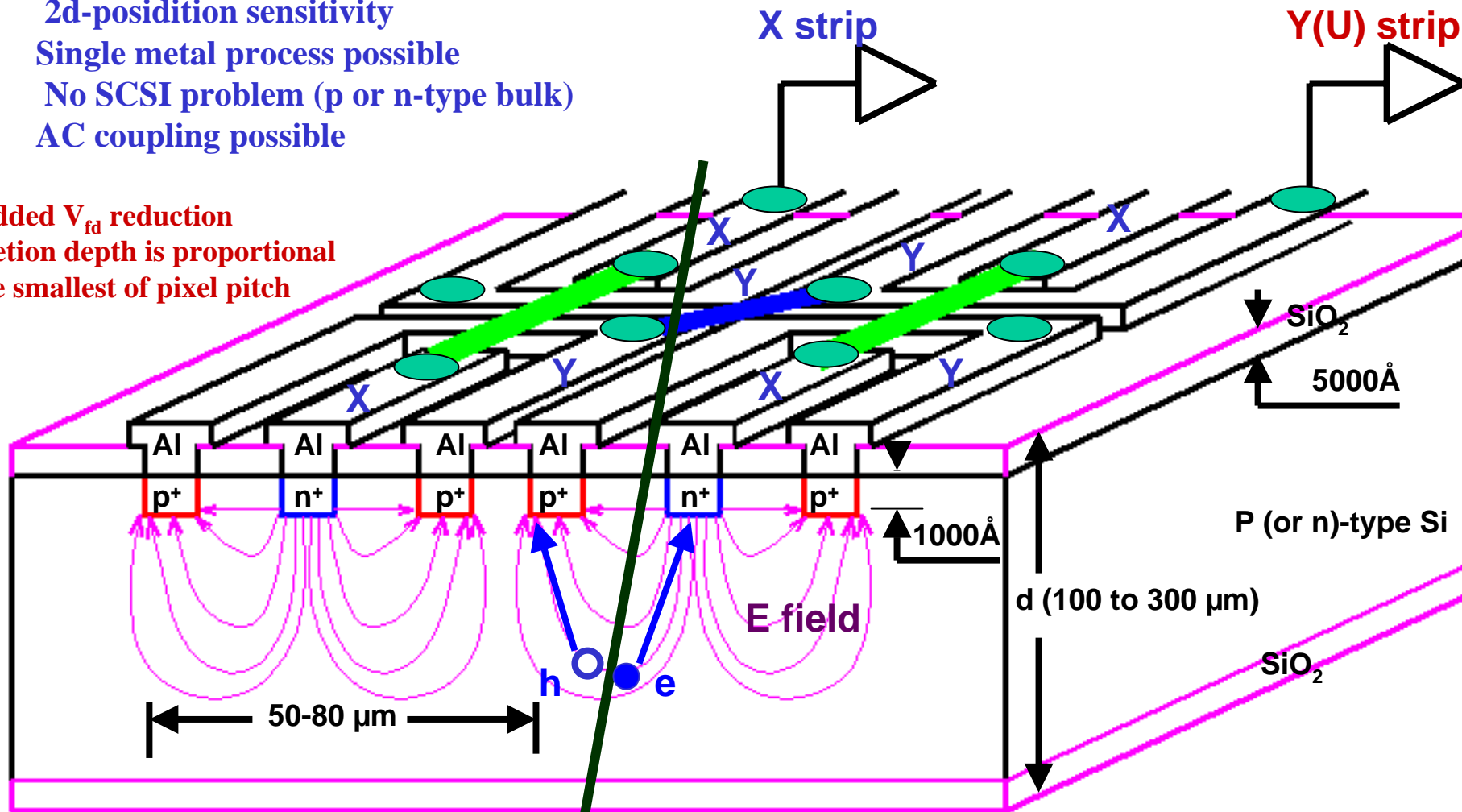
Bulk contact is provided by a backside uniform p+ implant

➔ single side process.

New planar single-sided 2d stripixel detectors

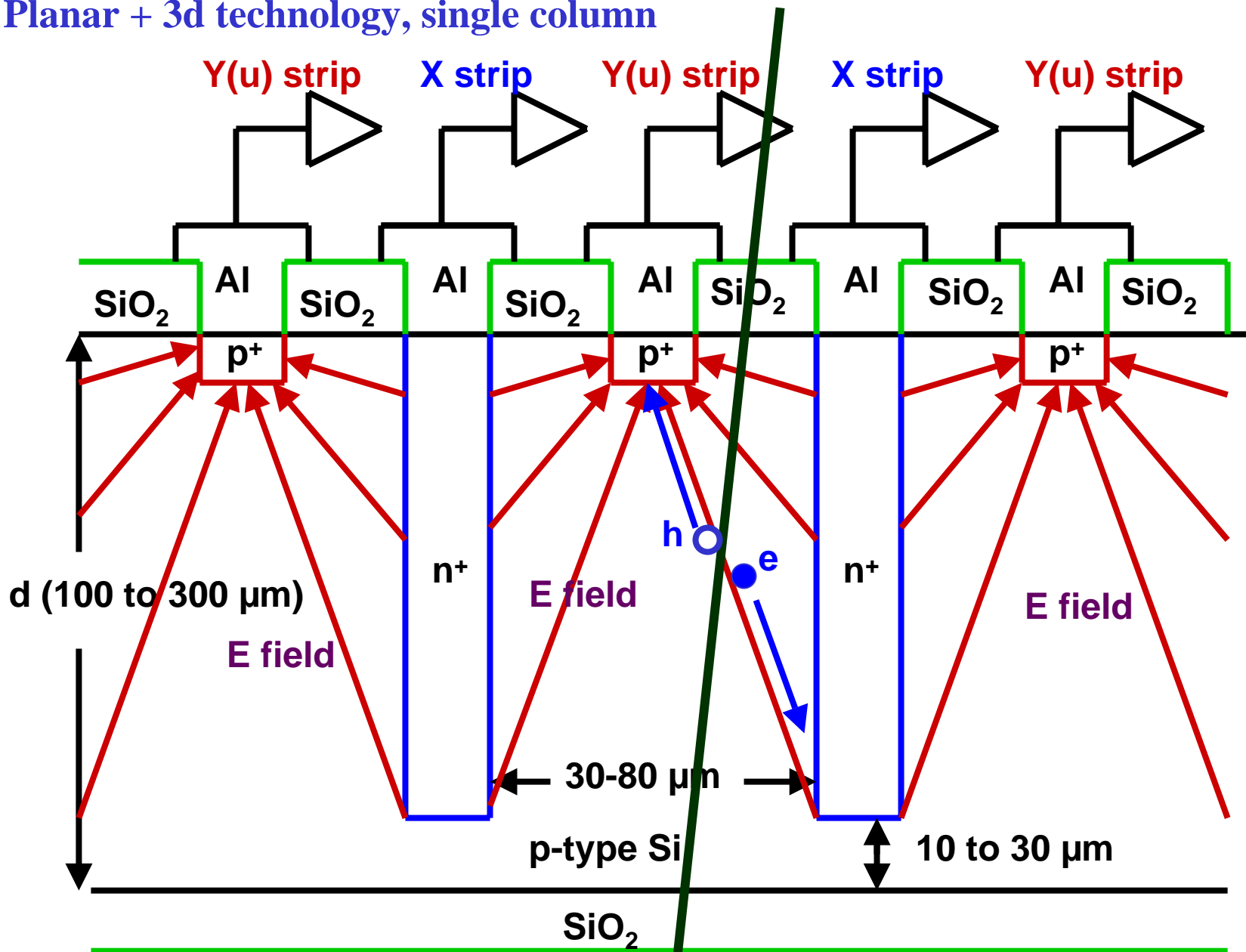
1. All planar technology
2. No charge sharing problem
3. No added capacitance
4. True one-sided process (no process on the back side at all)
5. 2d-position sensitivity
6. Single metal process possible
7. No SCSI problem (p or n-type bulk)
8. AC coupling possible

No added V_{fd} reduction
Depletion depth is proportional
to the smallest of pixel pitch

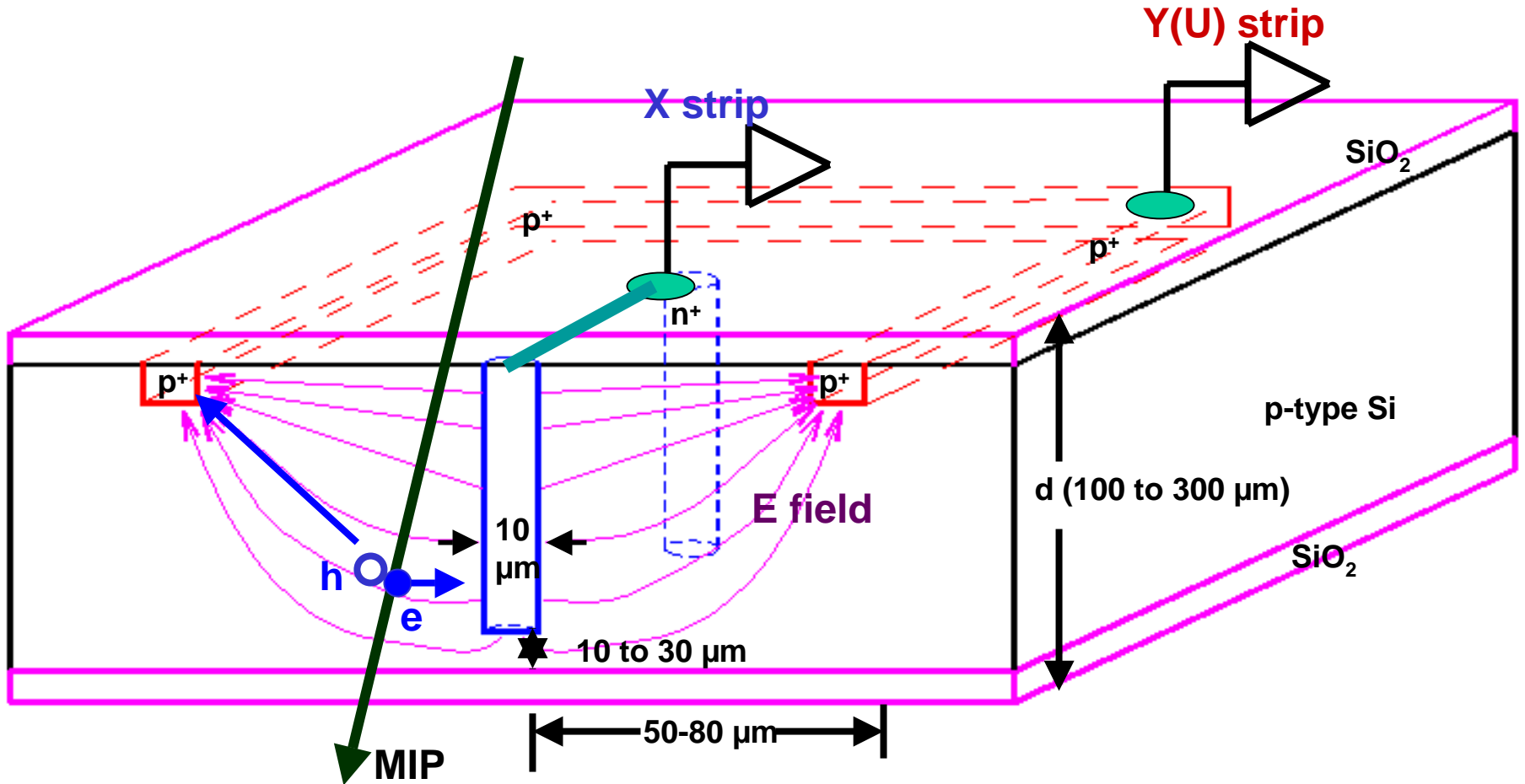


New (2+3)d Stripixel detectors

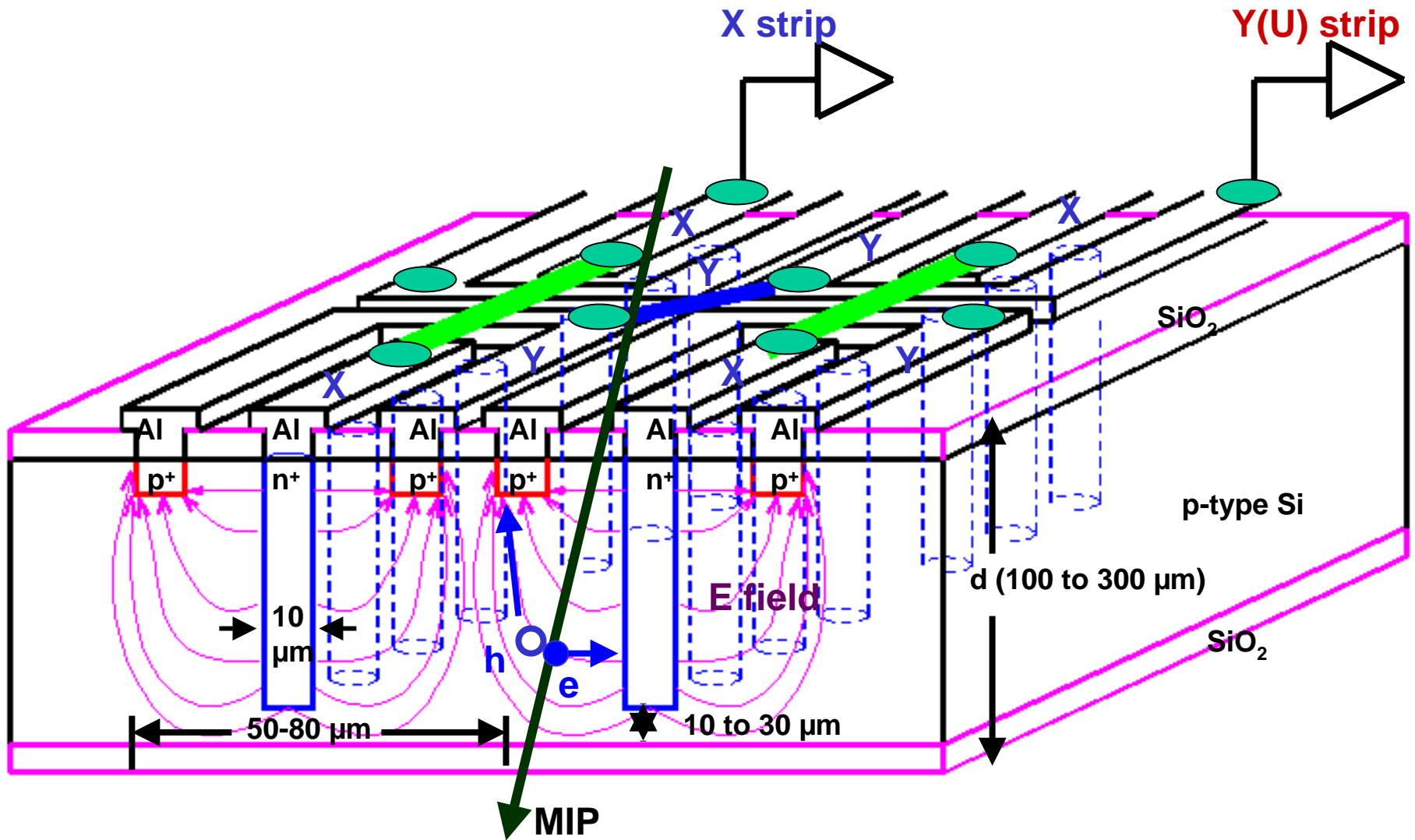
Type-I: Planar + 3d technology, single column



Schematics for the new (2+3)d detectors (Type-I) Single cell

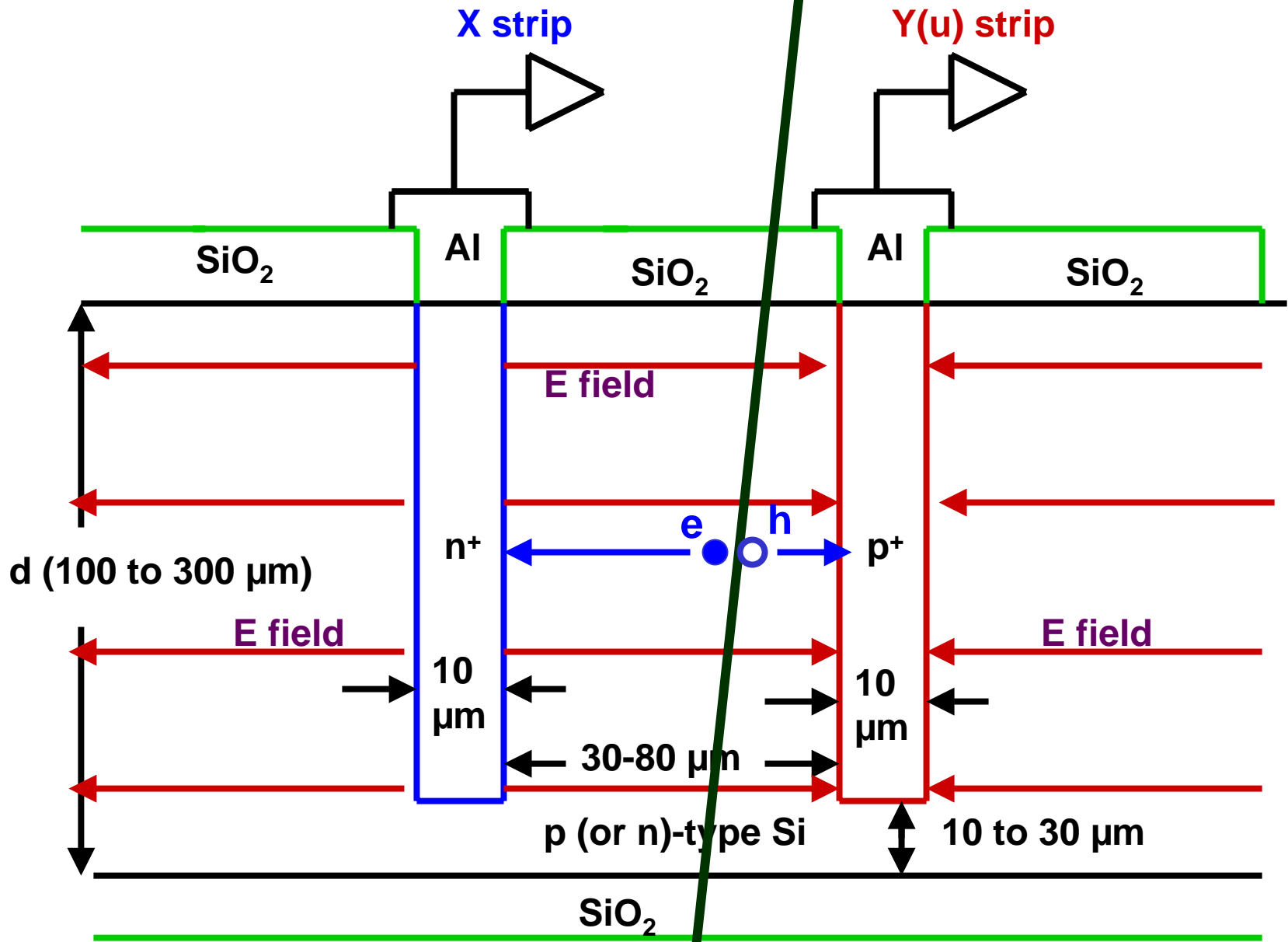


Schematics for the new (2+3)d detectors (Type-I)

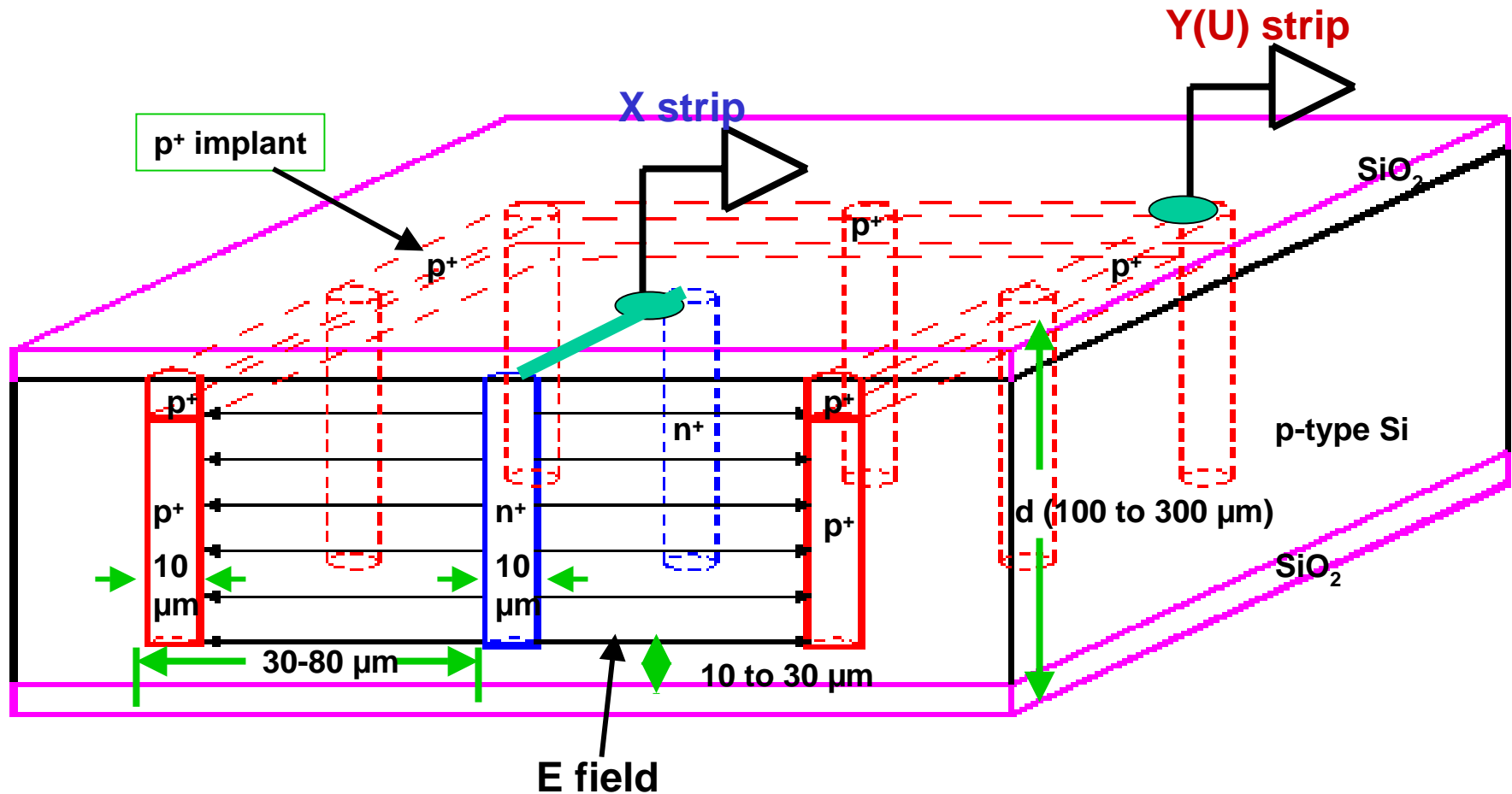


Schematics for the new (2+3)d detectors (Type-II)

Cross section view

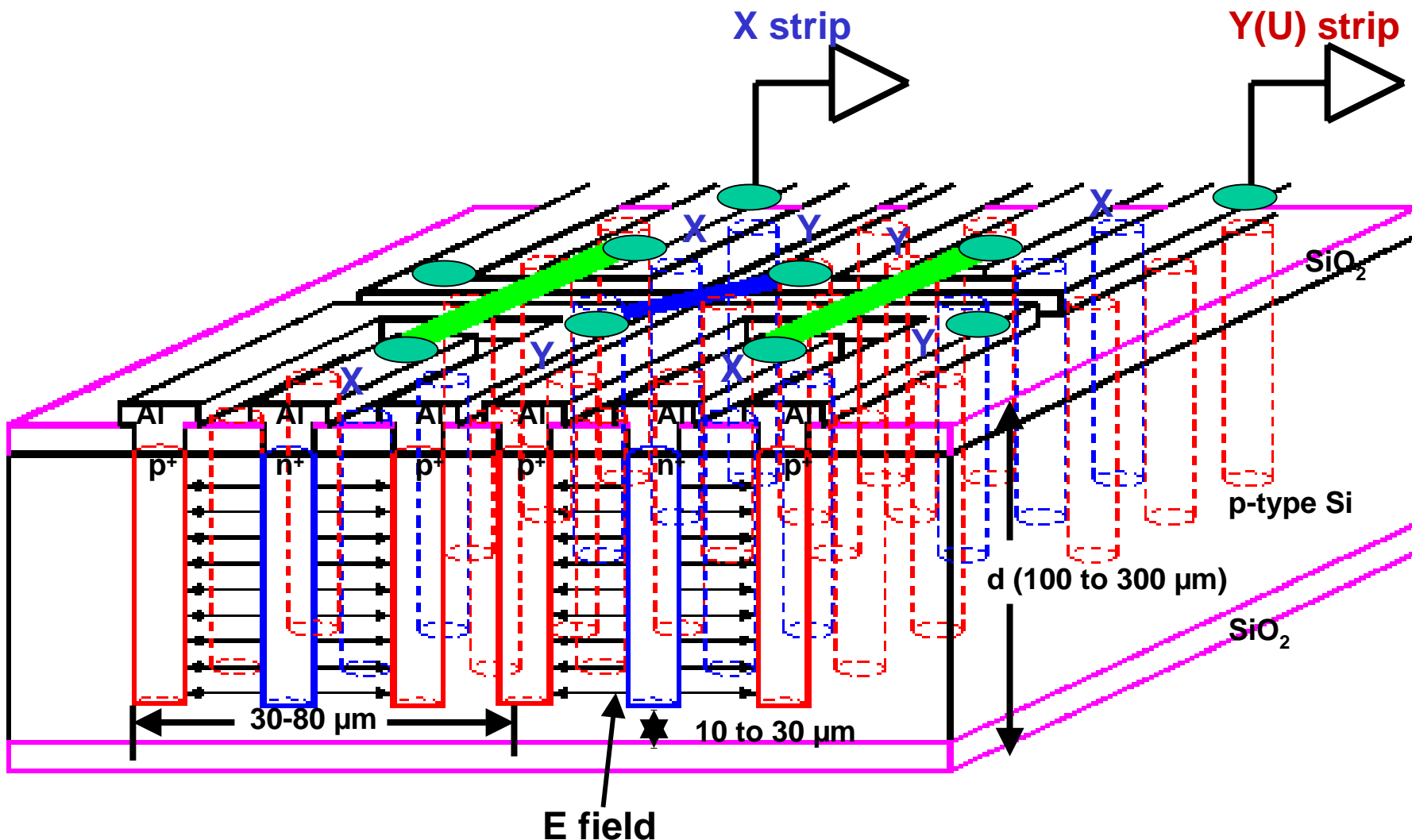


Schematics for the new (2+3)d detectors (Type-II) Single cell



New (2+3)d Stripixel detectors

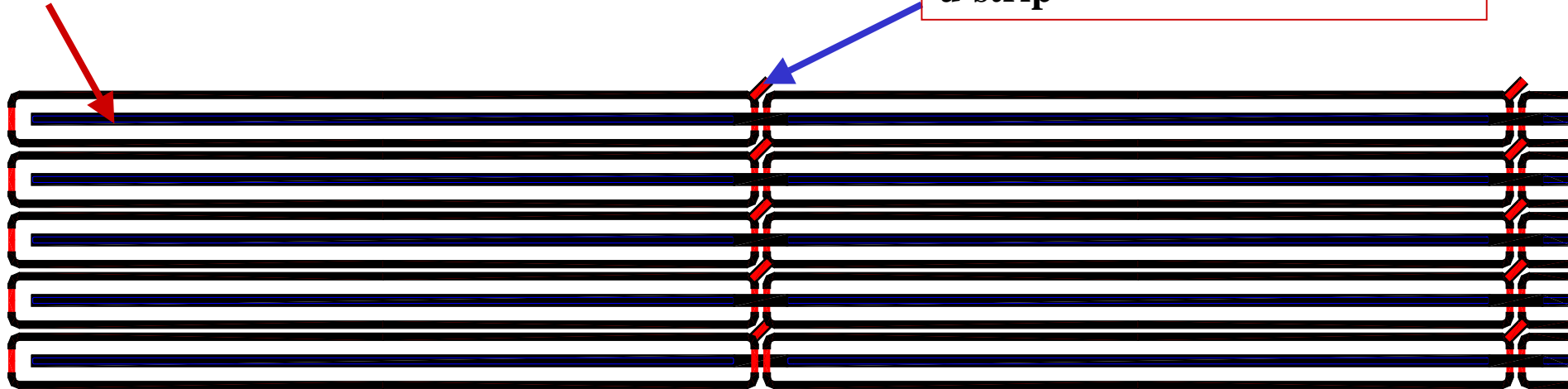
Type-II: Planar + 3d technology, dual columns



Schematics for the new (2+3)d detectors

X-pixel (n^+), etched holes, X-strip

Y-pixel (p^+), implanted ring (I)
etched holes (II)
u-strip



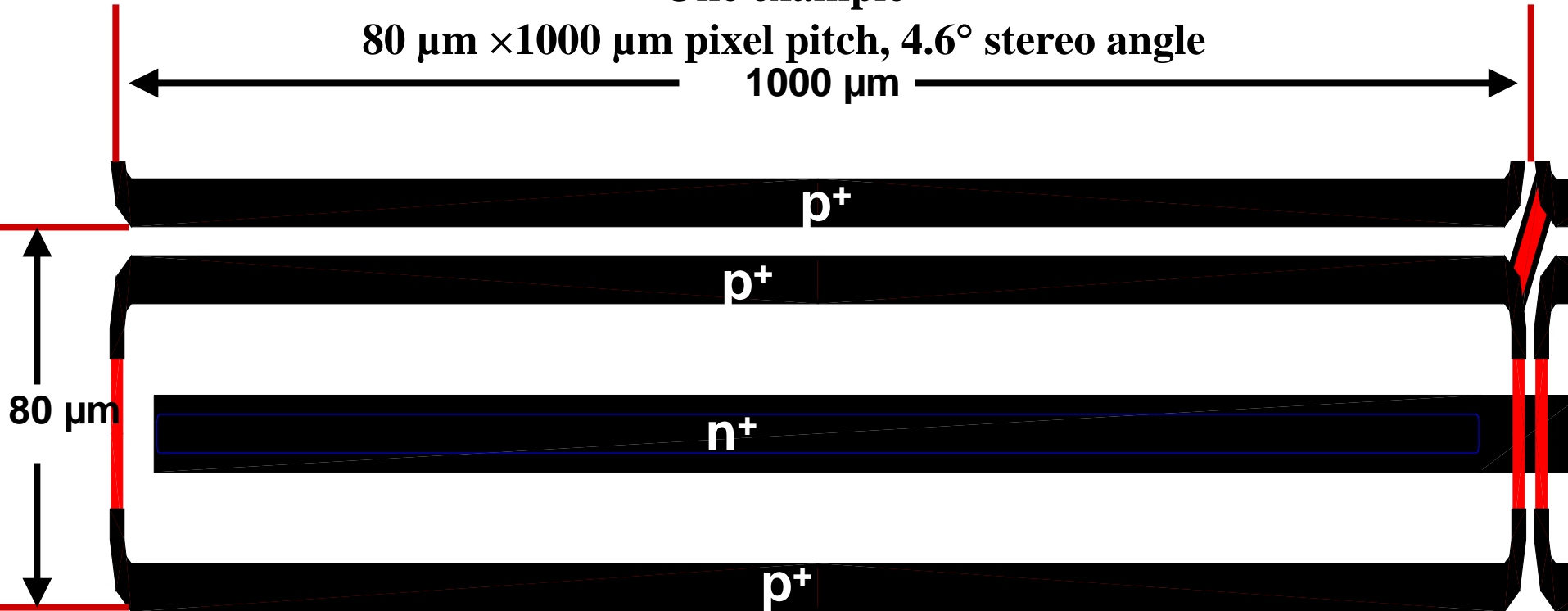
1. Partial planar technology ((2+3)d (I+II))
2. No charge sharing problem
3. No added capacitance
4. True one-sided process (no process on the back side at all)
5. 2d-position sensitivity
6. Single metal process possible
7. AC coupling possible
8. No SCSI problem (p or n-type bulk)
9. As radiation hard as 3d detector ((2+3)d (II))

Complicated 3d processing technology needed

Schematics for the new (2+3)d (I and II) detectors

One example

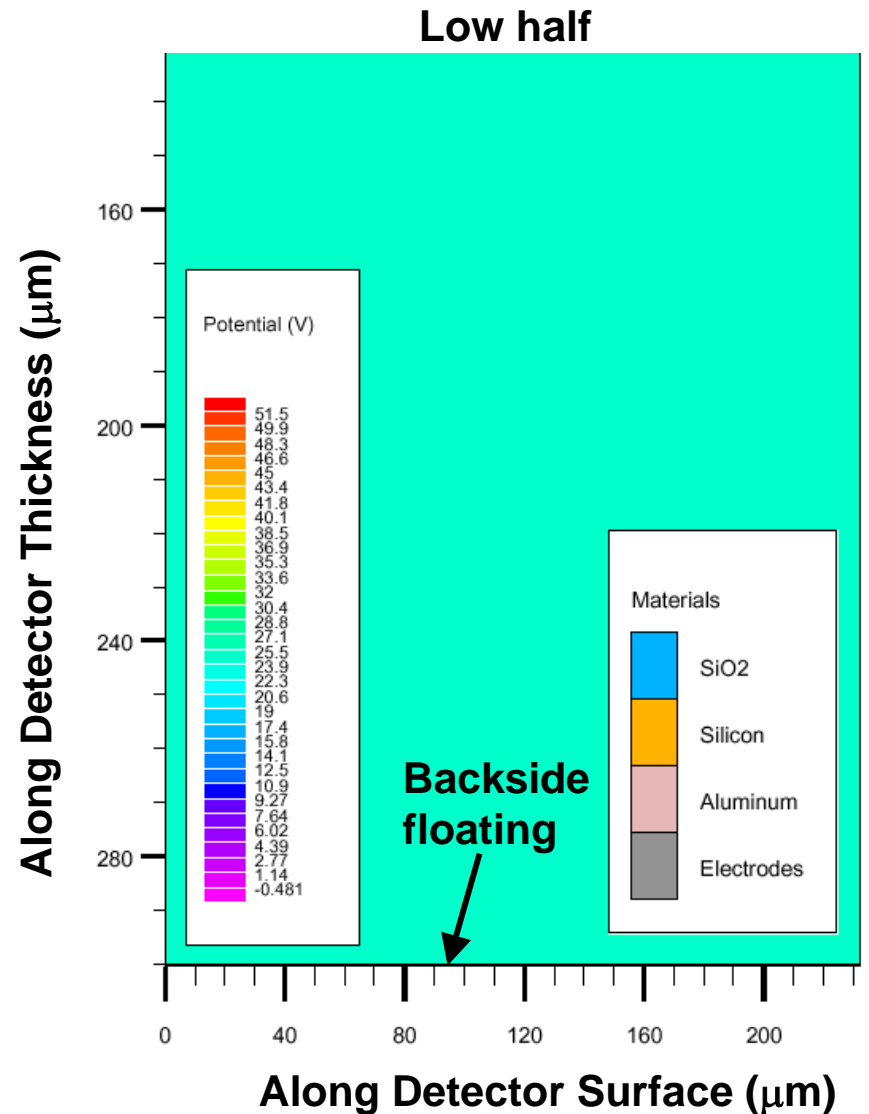
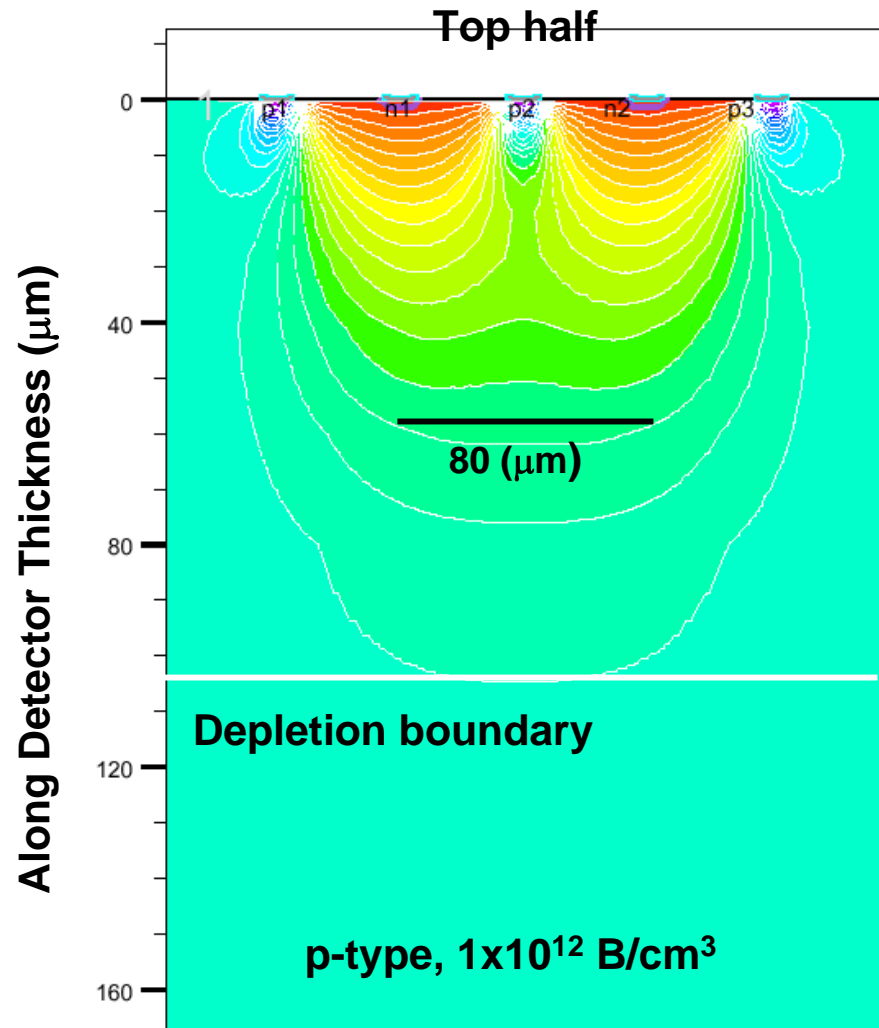
$80\ \mu\text{m} \times 1000\ \mu\text{m}$ pixel pitch, 4.6° stereo angle
 $1000\ \mu\text{m}$



Simulation and Design of 1st Prototype detectors

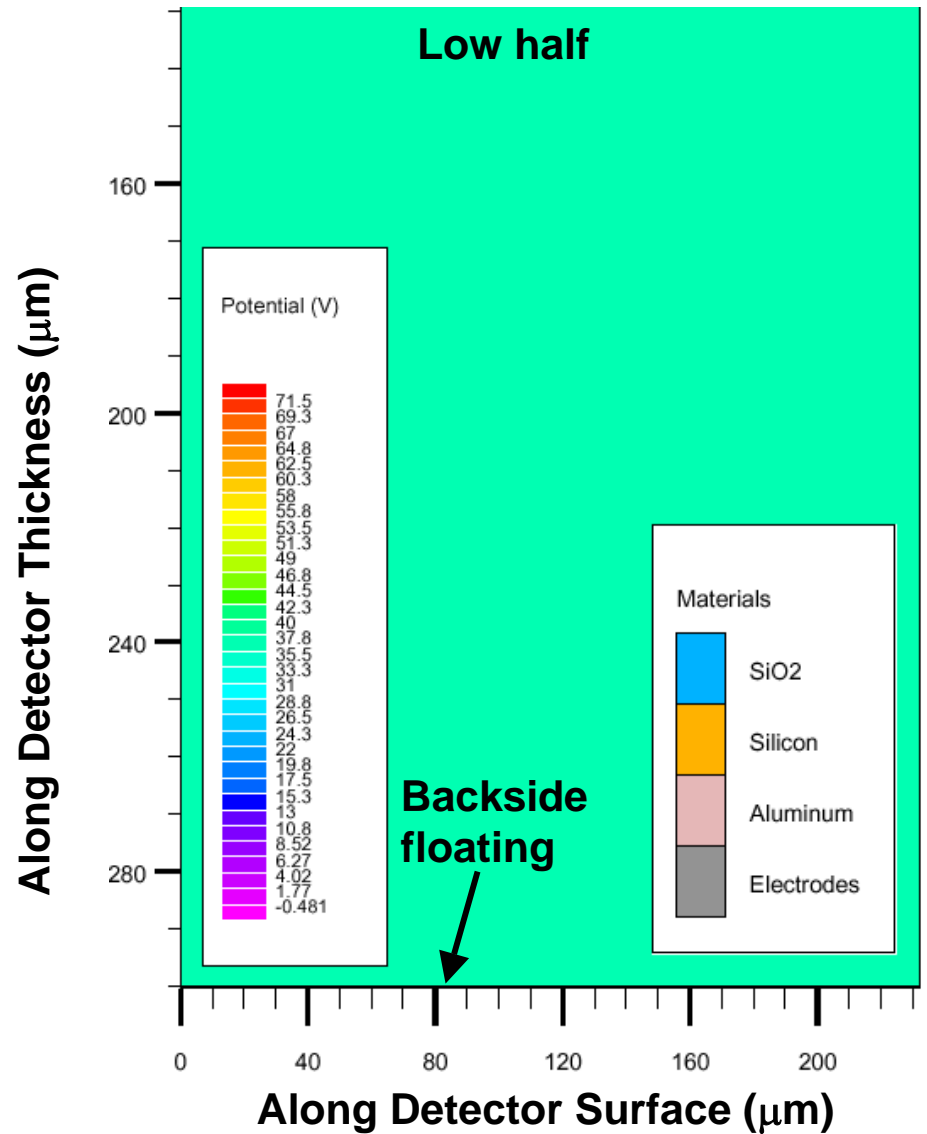
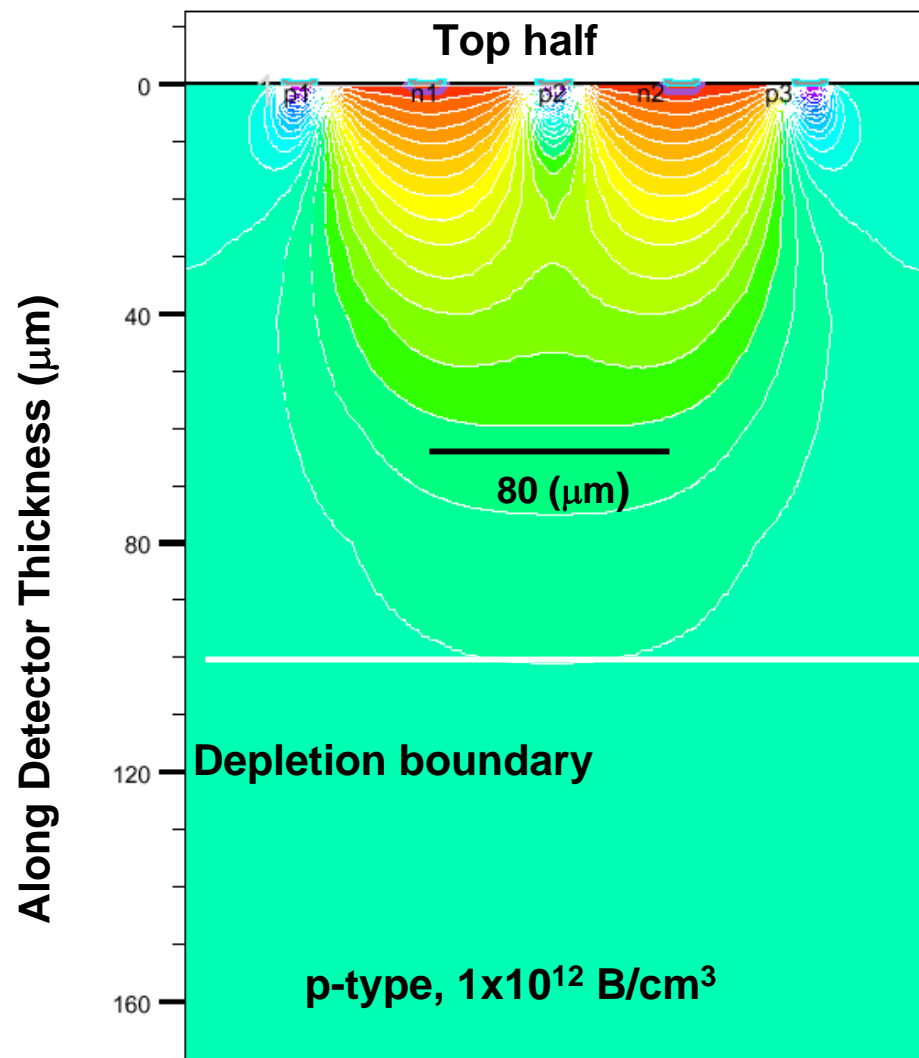
2d potential profiles

$V = -50$ V at p^+ electrodes, 0 V at n^+ electrodes



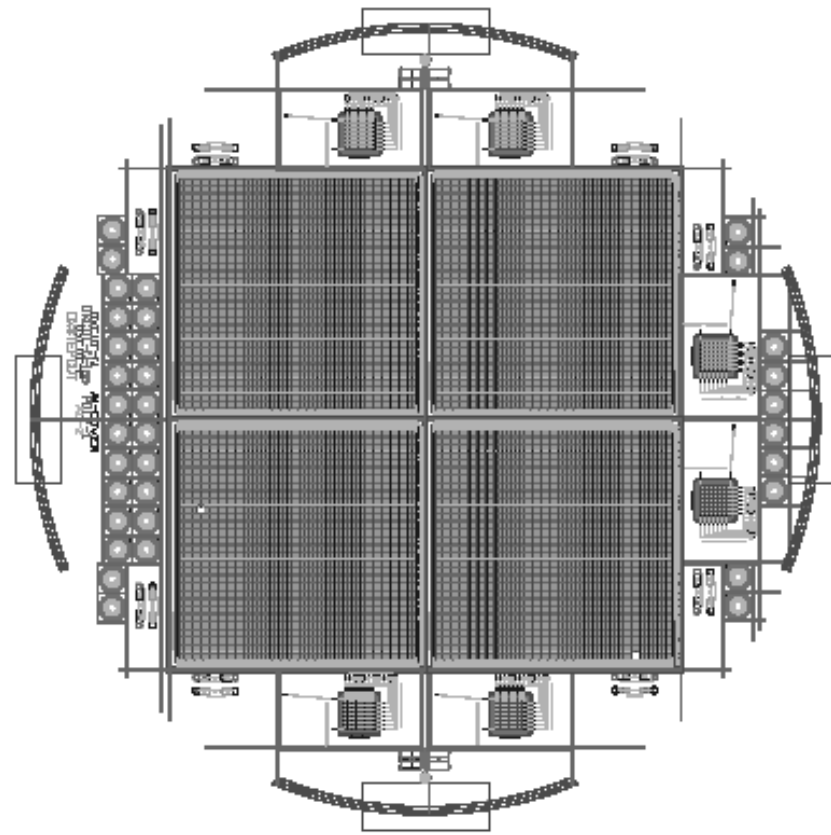
2d potential profiles

$V = -70$ V at p^+ electrodes, 0 V at n^+ electrodes



Design of 1st Prototype

1. Design is just finished
2. Two $3\text{ cm} \times 6\text{ cm}$ chip (4"-wafer)
3. 3 cm long strips
4. $80\ \mu\text{m} \times 1000\ \mu\text{m}$ pixel size
5. $10\ \mu\text{m}$ n^+ hole sizes
6. 384 x and 384 u strips
7. 4.6° stereo angle
8. If no n^+ holes etched –
just single-sided planar 2d detectors
9. If n^+ holes etched -- (2+3)d detectors



A collaboration program has been developed between BNL and CNM:

CNM will do the 3d processing (n^+ hole etching and doping)

Giulio Pellegrini and Manuel Lozano

BNL will do the remaining planar processing

Mask set will be ordered in a week

Prototype processing will start in one month

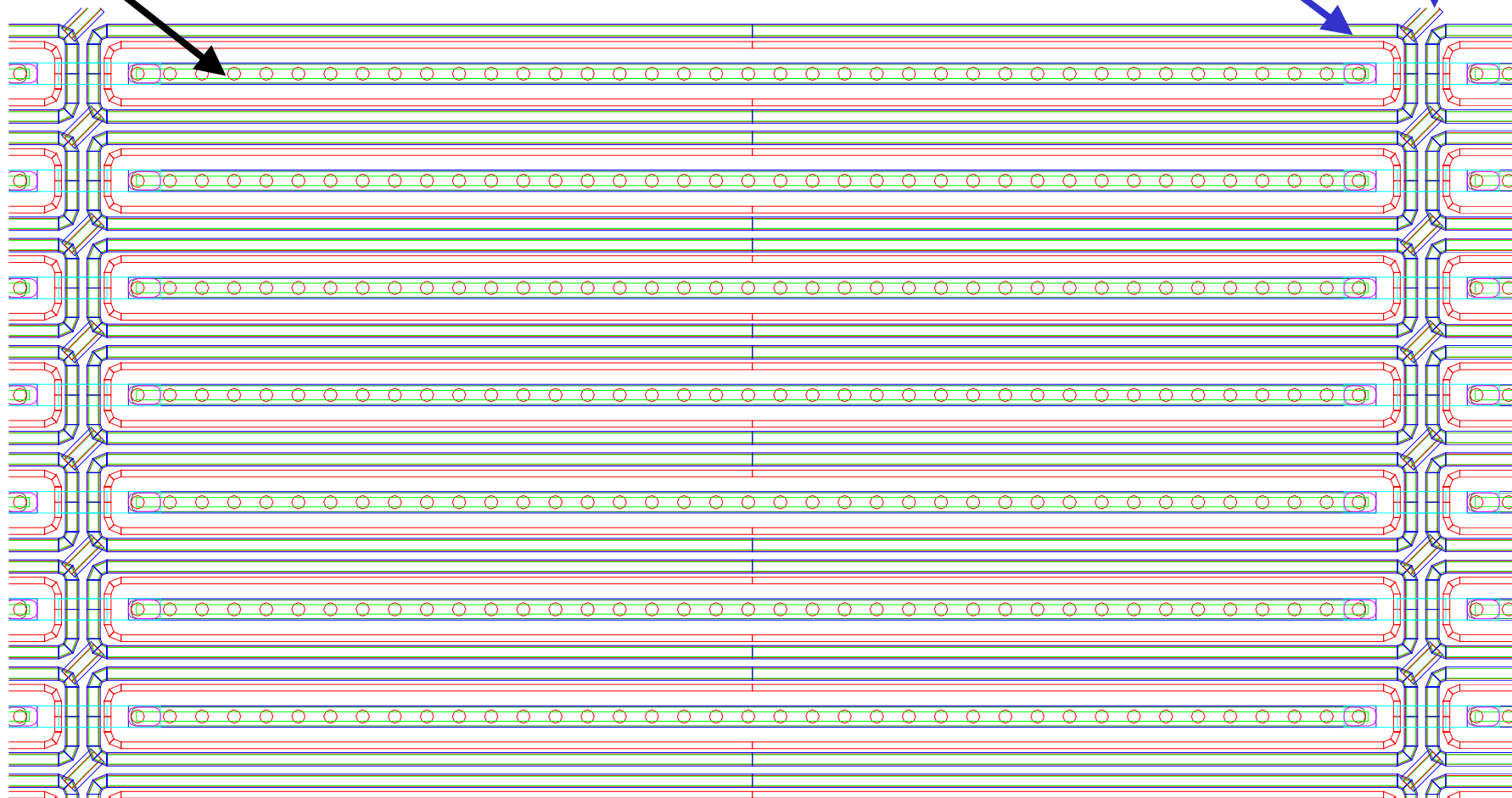
Processing completion date projected as Fall, 2005

Design of 1st Prototype detectors

X-pixel (n^+), etched holes, X-strip

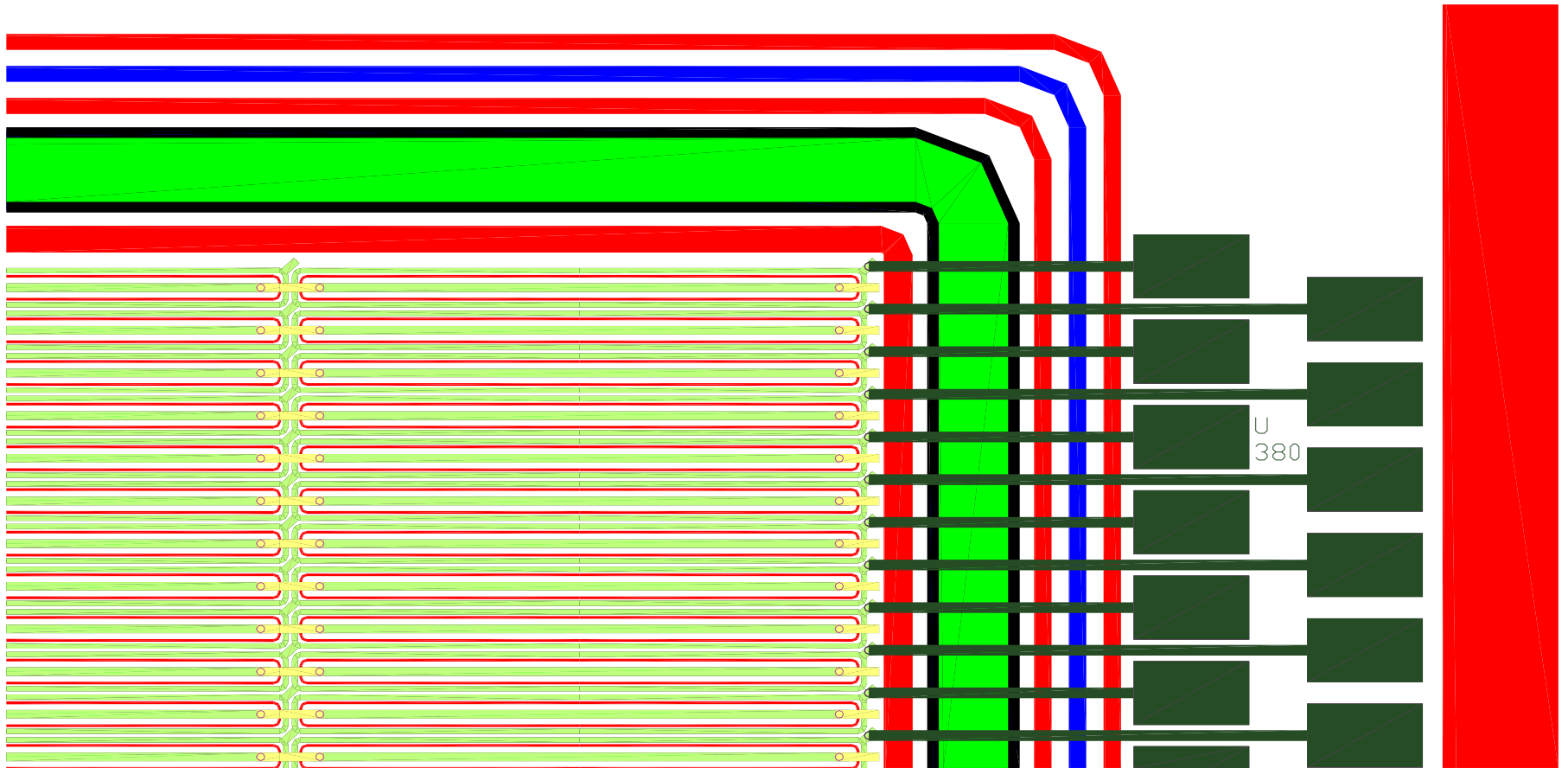
Y-pixel (p^+), implanted ring (I)
u-strip

u-strip



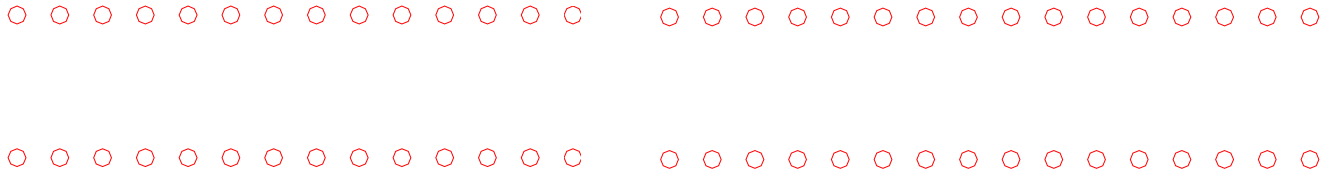
Design of 1st Prototype detectors

u- strips

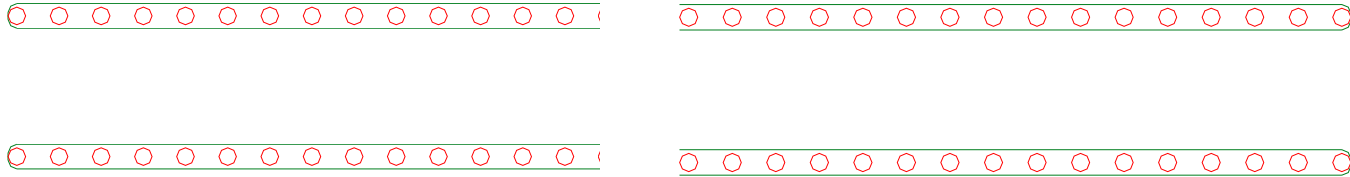


Processing steps

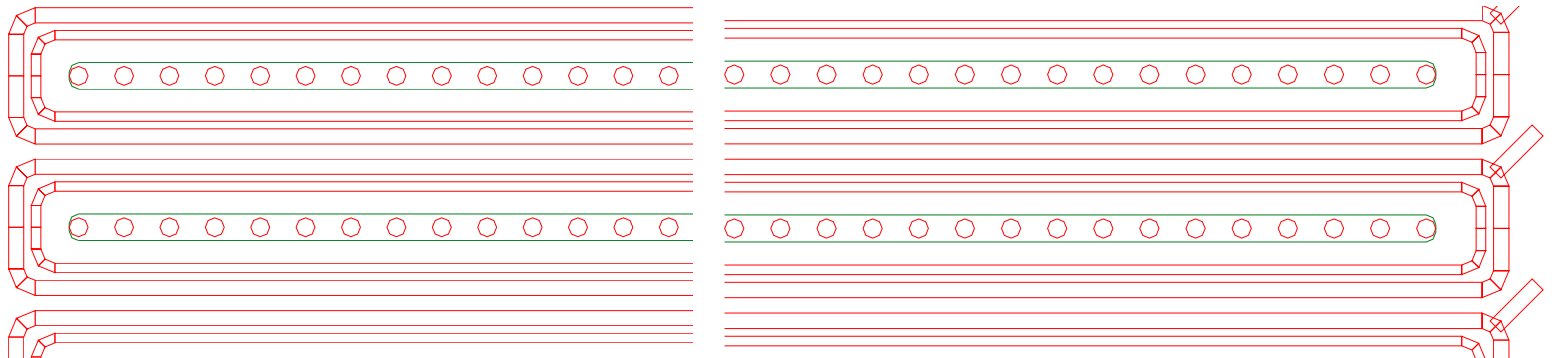
n⁺ hole etching



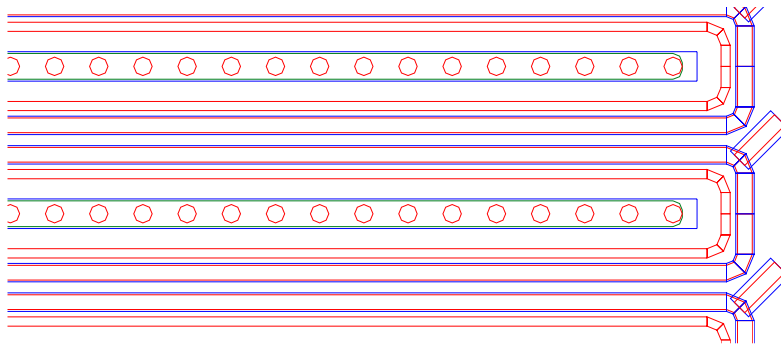
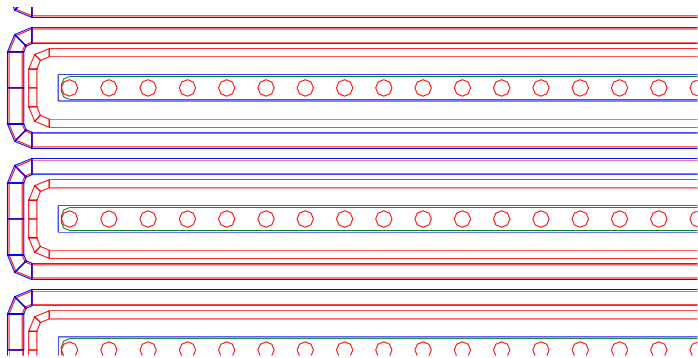
n⁺ implant



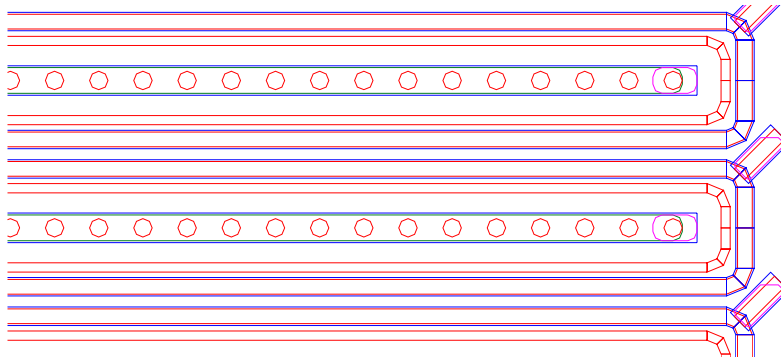
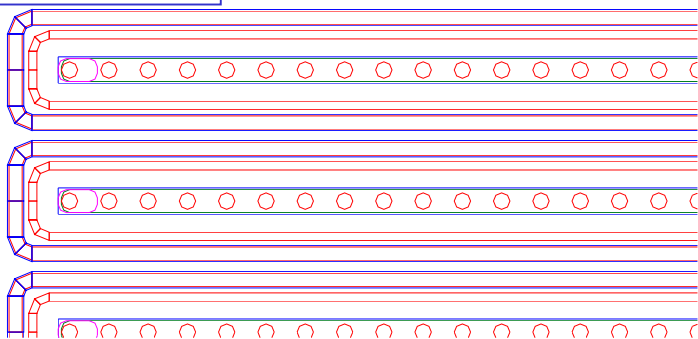
p⁺ implant



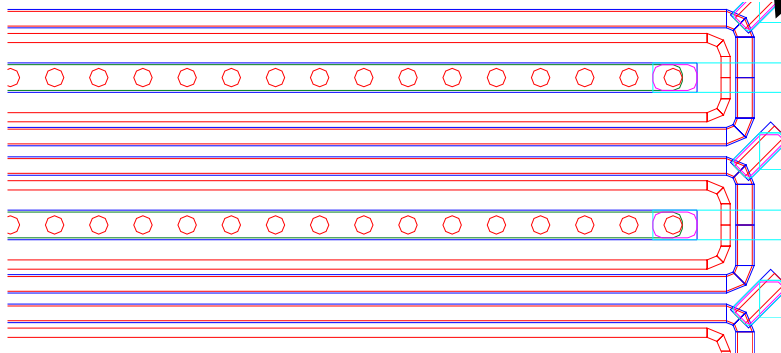
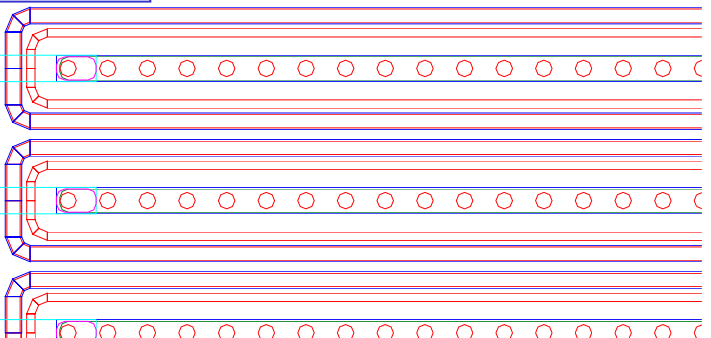
1st Al



polyimide



2nd Al



x-strip

u-strip

SUMMARY

- **New single-sided stripixel detector concept:**
 - True single-sided process
 - Two dimensional position sensitivity
 - No charge sharing problem
 - Minimum added capacitance
- **Types of New single-sided stripixel detectors:**
 - Planar 2d detectors --- simple processing
 - (2+3)d detectors with single columns --- relative simple processing, modest radiation hardness
 - (2+3)d detectors with dual columns --- full 3d processing, most radiation hard
- **First prototype of Planar 2d detectors and (2+3)d detectors with single columns has been designed, and processing will soon begin at CNM and BNL**