

# RD50-Project Proposal: Small-Pitch 3D Detectors (Preview)



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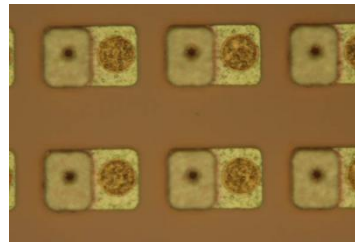
**I. Vila**

- **HL-LHC: Smaller pixel size** (25x100  $\mu\text{m}^2$  discussed)
- **Planar pixels:** already produced first 25  $\mu\text{m}$  pitch pixels
- **3D detectors are (also RD50) success story**  
-> want to keep as promising candidate for HL-LHC
- **But need to improve the aspect ratio (length/diameter of 3D columns) to avoid increase of dead area**
- **This proposal: Develop smaller-area 3D pixel sensors for the HL-LHC by increasing the DRIE aspect ratio (to ~40)**
- **Different configurations for various read out chips (CMS, Atlas and LHCb)**
- **Synergy between Spanish groups for the HL-LHC**
- **Work done in the framework of RD50 collaboration**
- **This is an open project and we are welcoming new interested groups**

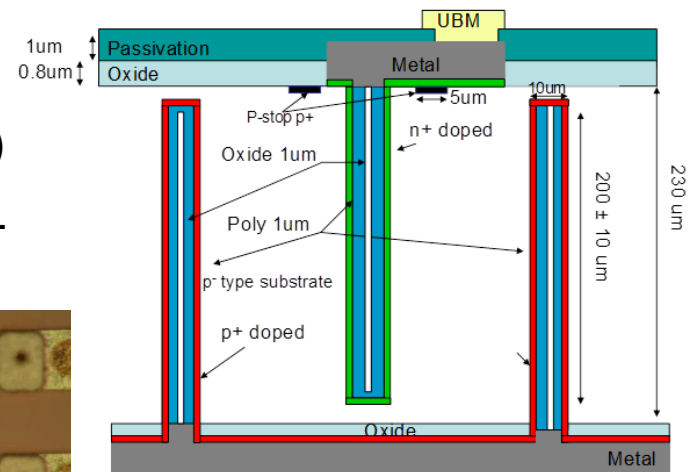
# Objectives

Adapting the technology (double sided process) proposed in 2006 and used for the Atlas IBL production done at CNM:

- Pixels (FE-I4, VeloPix, PSI46)
- Strips (baby)
- Pads (5x5 mm<sup>2</sup>)
- Test structures
- Slim edges 100um and 200um.



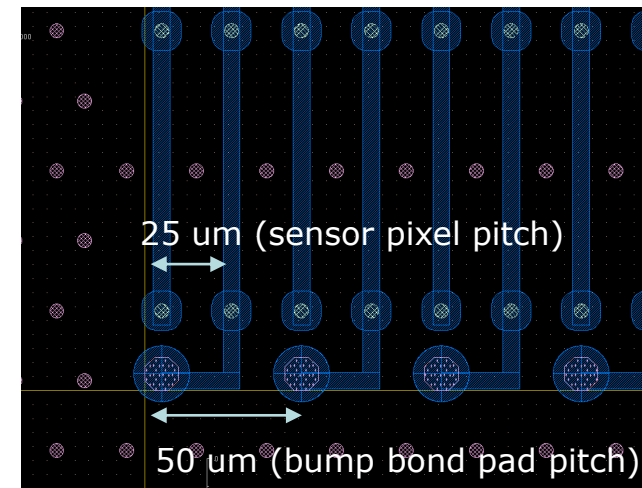
Medipix2 55x55 um<sup>2</sup>



FE-I4 chip: 50x250 um<sup>2</sup>

-> make 25x500 um<sup>2</sup> sensors

-> 2 sensor pixels match 2 chip pixels



*Working on a cryogenic process to increase aspect ratio*

*-> objective: 200um depth, 5um diameter (aspect ratio 40).*

***For thin substrates (<150um) the process is already available and reliable.***

# Increasing aspect ratio @ CNM: Cryogenic Silicon DRIE

*Pulsed process:*

*Etching gas:  $SF_6$*

*Sidewall passivation:  $C_4F_8$*

*Possibility to achieve **higher**  
aspect ratio (up to 40:1)*

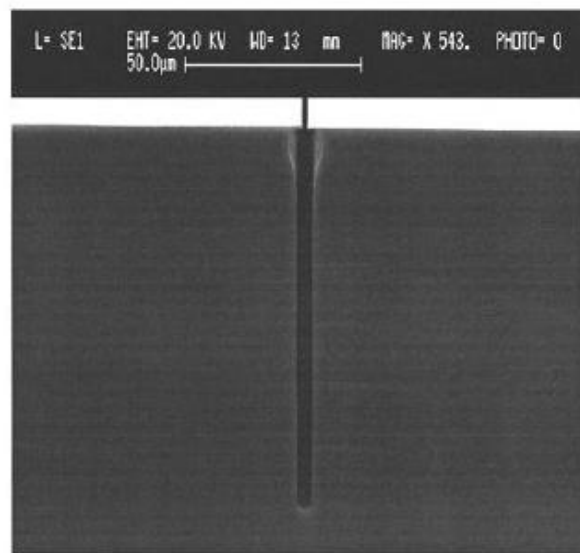


FIG. 11. Cross-sectional SEM image of silicon etch by using helicon reactor with cryogenic process (1999).

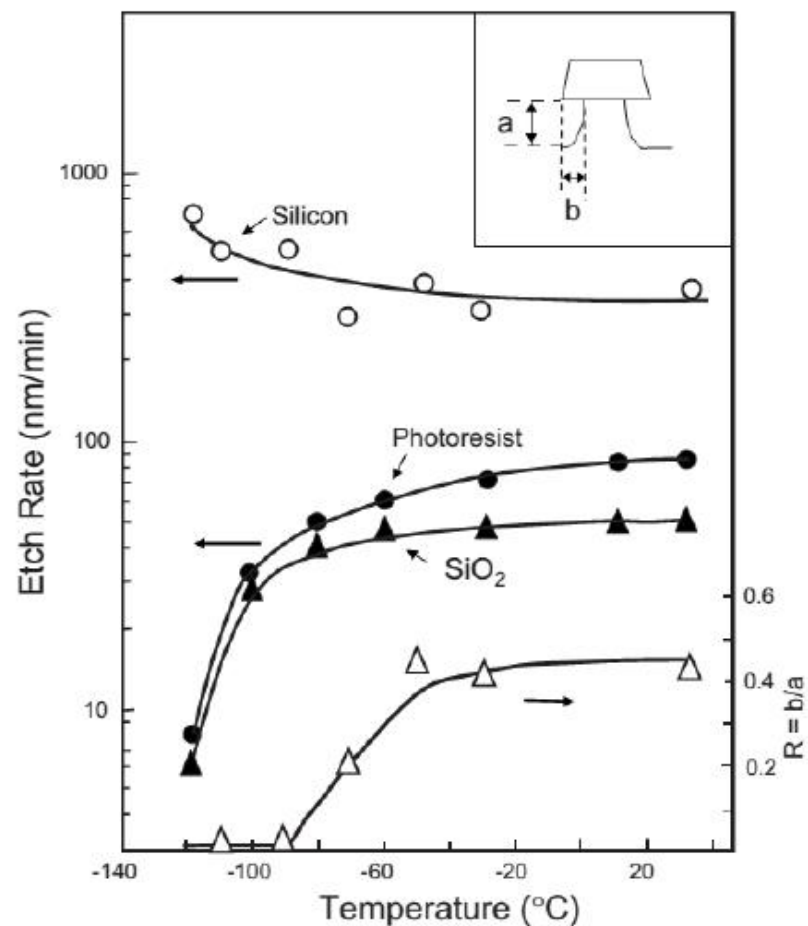
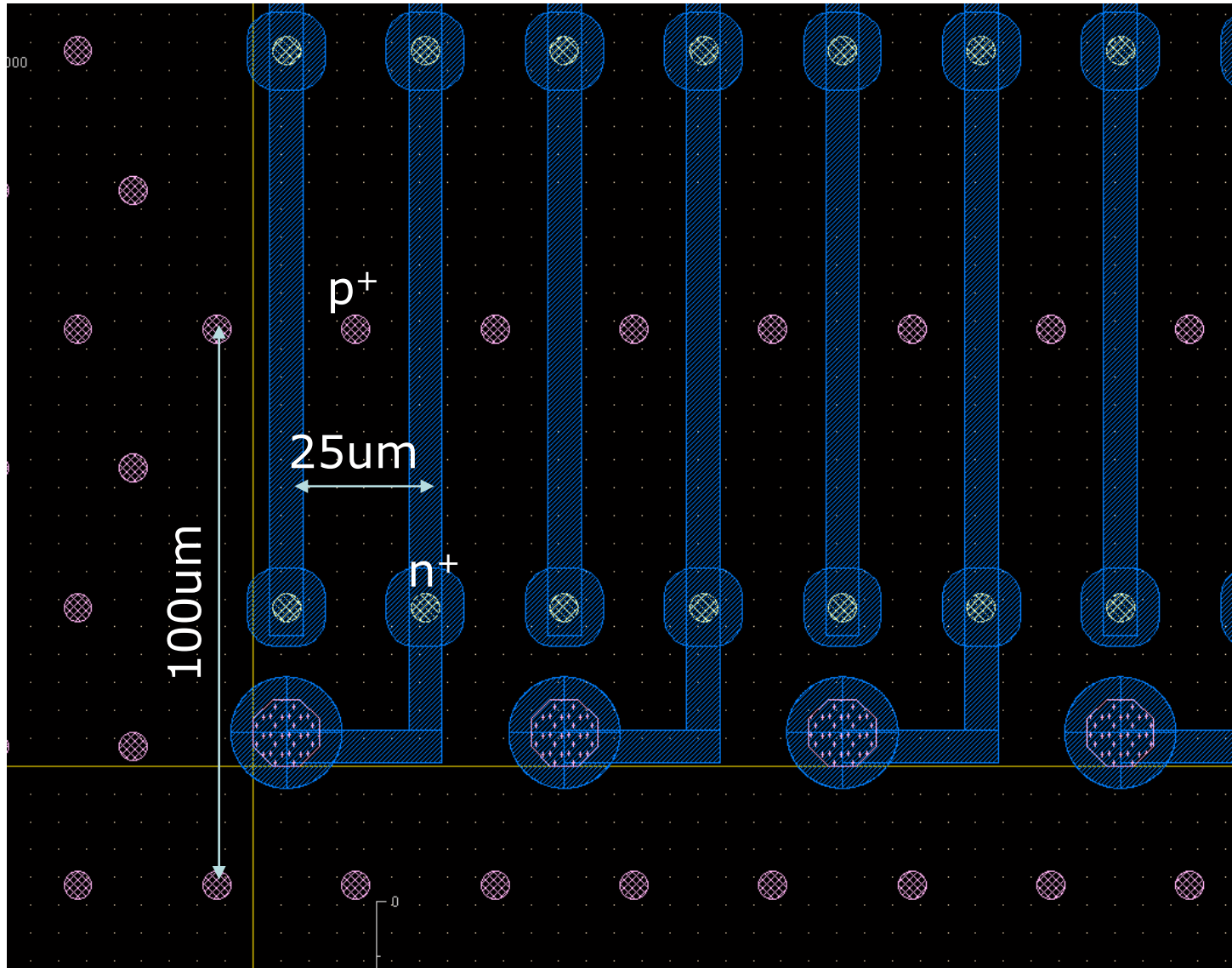


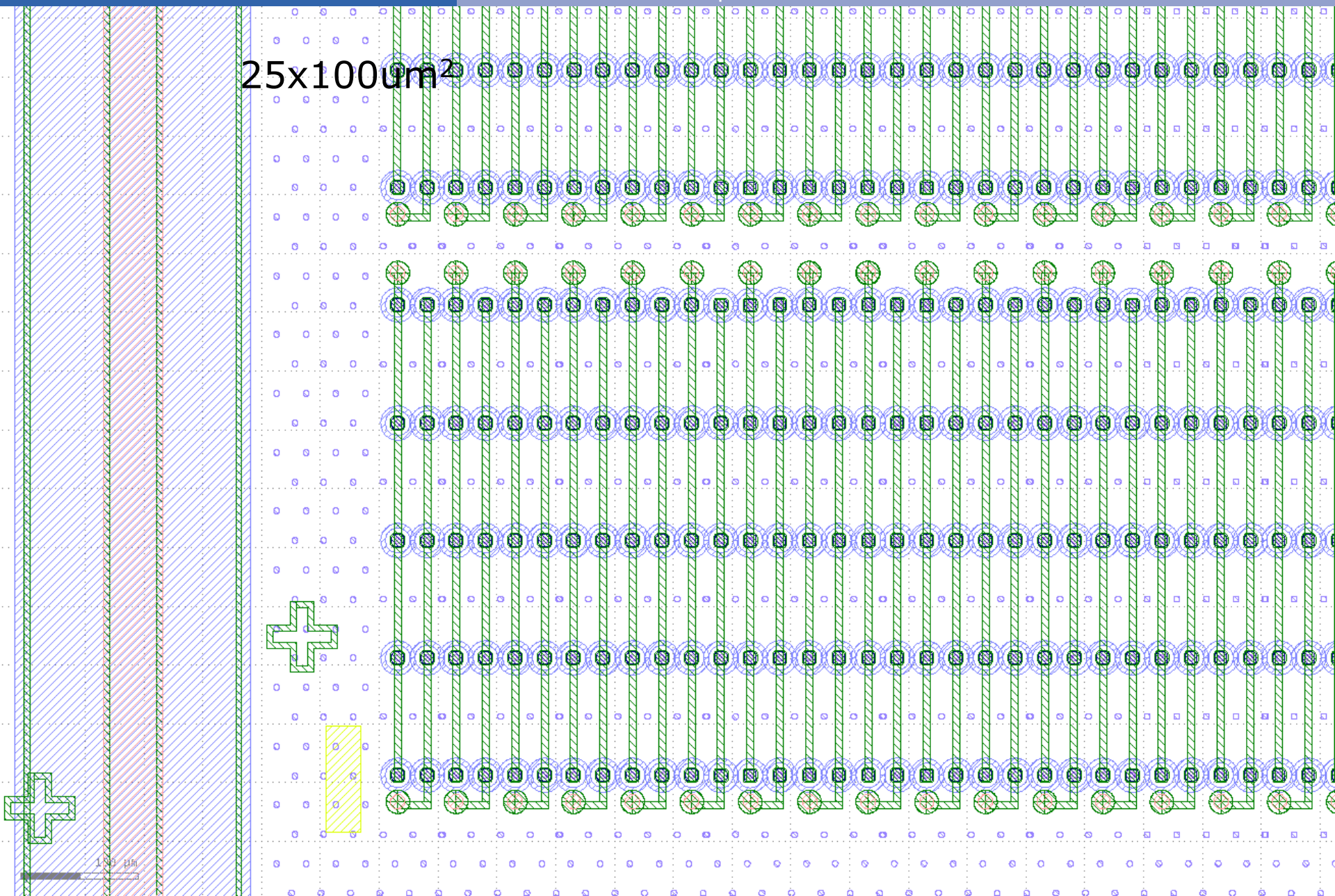
FIG. 10. Etch properties at cryogenic processes.

## Conclusions

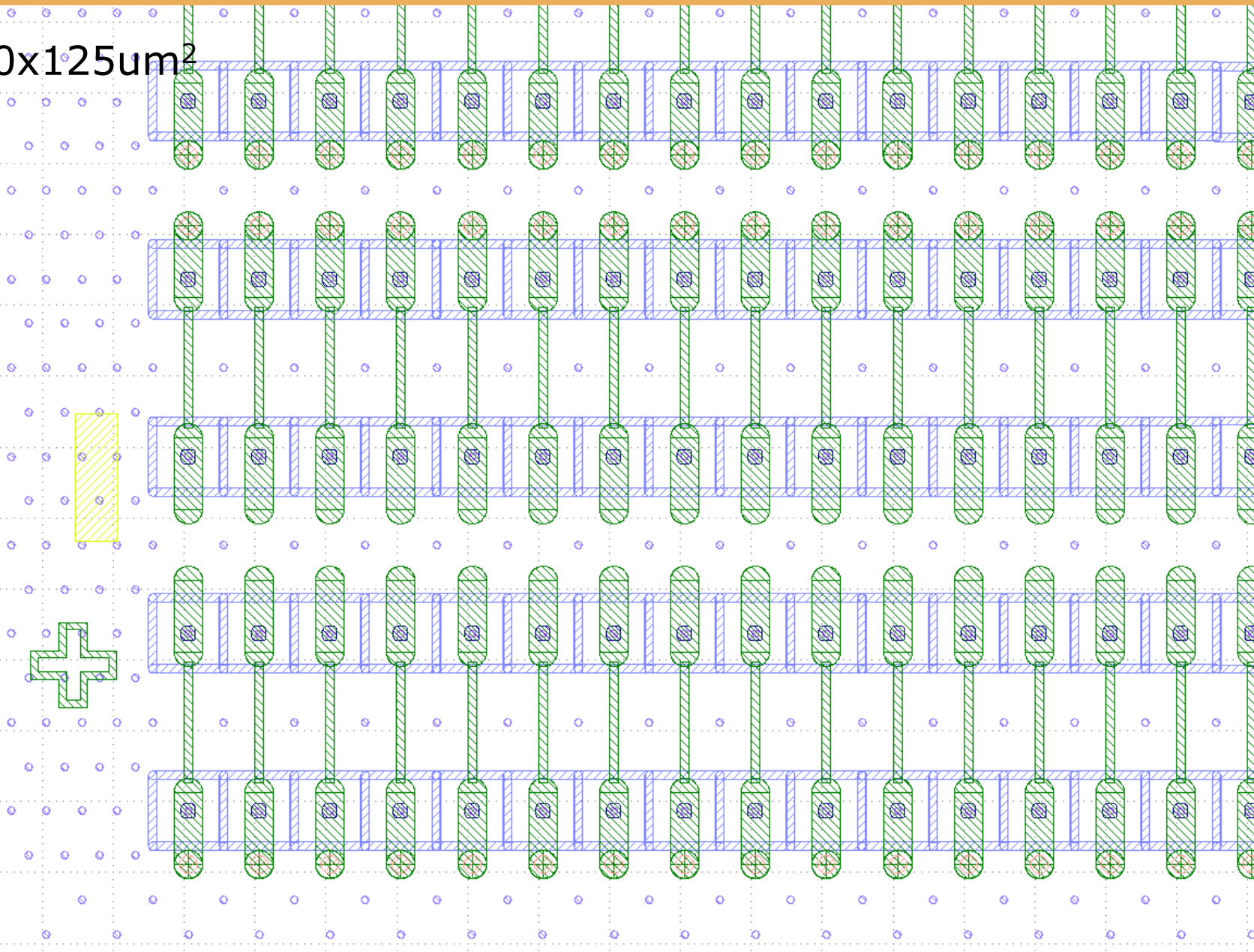
- We are working to adapt the double side 3D technology to the new pixel geometry foreseen for the upgrade of the LHC experiments.
- A common effort between (so far) Spanish institutes in the framework of RD50 collaboration
- Open for interested groups
- There is still place to push the limits of the 3D detector technology ( with preference to double sided)
- Elaborate RD50 project proposal in preparation

# Atlas Fe-I4 geometry, 25x500um.



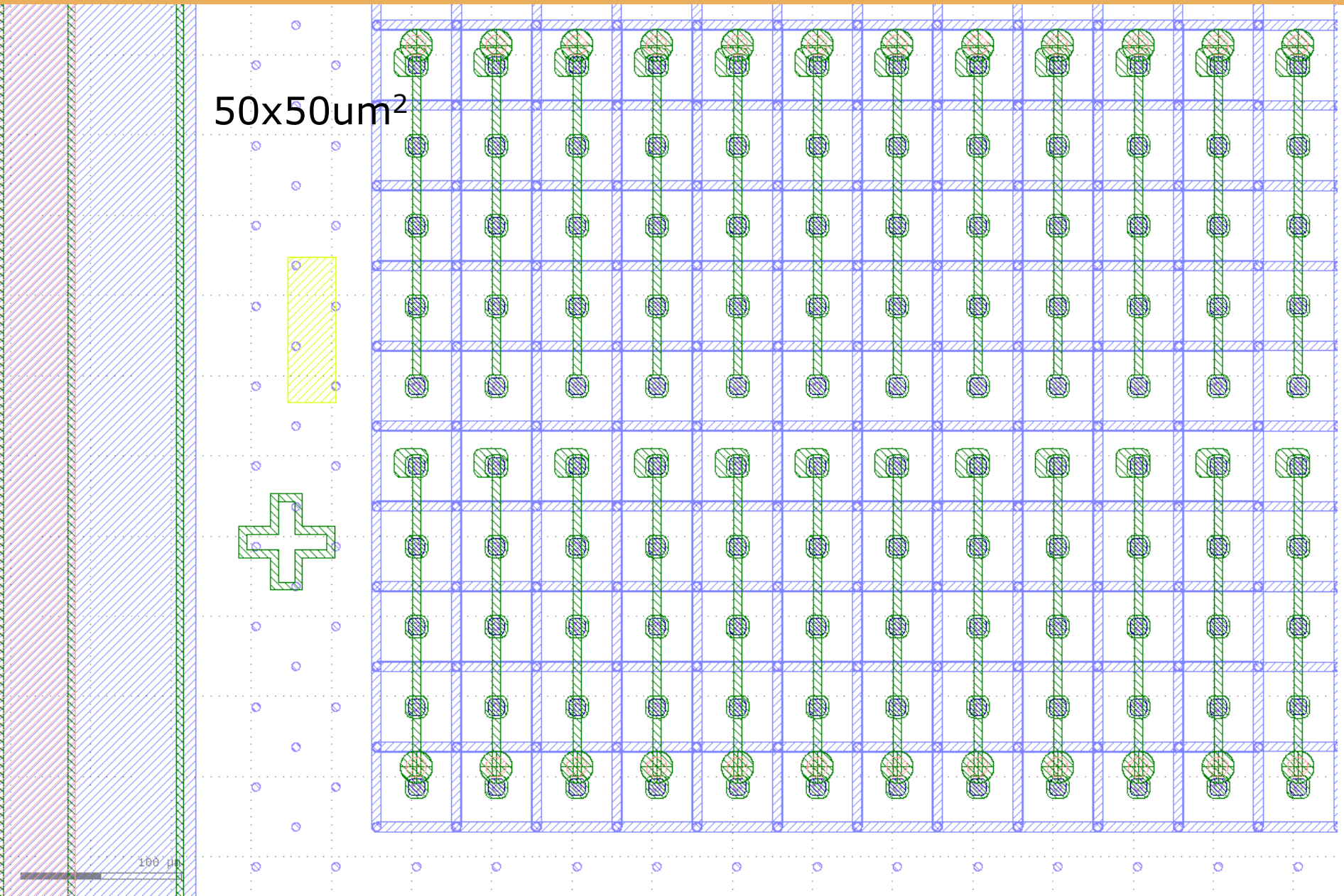


50x125 $\mu\text{m}^2$



100  $\mu\text{m}$





# Strip and pad detectors

- Strip pitches 25x100um
- Strip pitches 25x50um
- Strip pitches 30x100um
- Strip pitches 30x50um
- Strip Pitches 50x50um

No guard ring.

Holes 5um diameter

Electrodes 150 x 128

Useful to study radiation hardness

Metal routing to fit 80um pitch electronics (**Alibava Systems**).

May be connected through our AC fan ins.

