

# Design aspects of the planar CMS submission

A. Dierlamm, A. Junkes, C. Scharf, D. Schell

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# CMS planar submission

Aim: Test design options and production technologies for  $25 \times 100 \mu\text{m}^2$  &  $50 \times 50 \mu\text{m}^2$

- Focus is set on  $25 \times 100 \mu\text{m}^2$
- Feasibility of small pitches
- Resolution (in test-beam)
- Radiation tolerance up to which layer?
- Test of design parameters

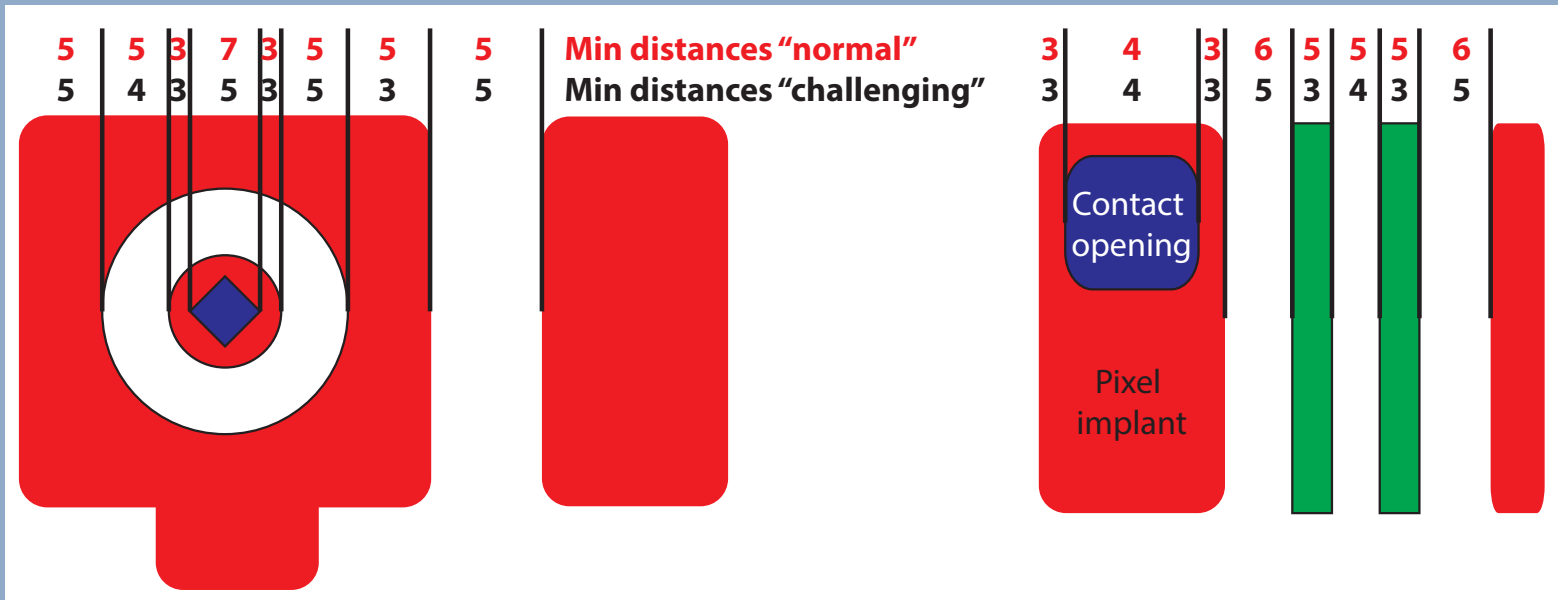
CMS problem: No rad hard read out chip for small pitch sensors

- Configurations for PSIROC4Sens, FCP130, PSI46dig,

Details on the submission:

- N-in-p on 6" wafer
- $150 \mu\text{m}$  active thickness (hopefully FZ on handle wafer)
- Physical thickness of wafer likely  $200 \mu\text{m}$
- Test of P-spray and P-stop with similar devices

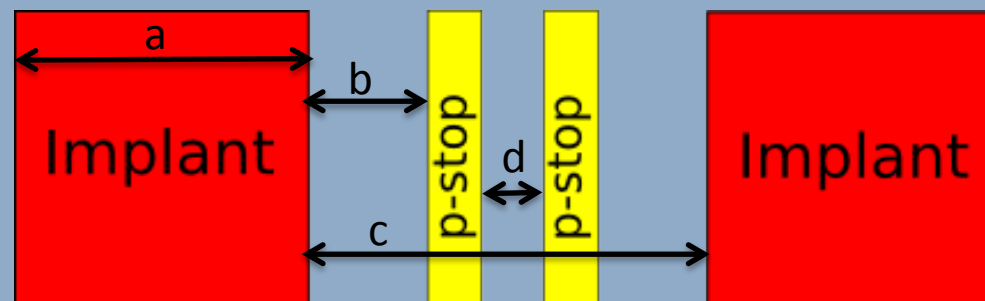
# Underlying design rules



# Overview of implant width

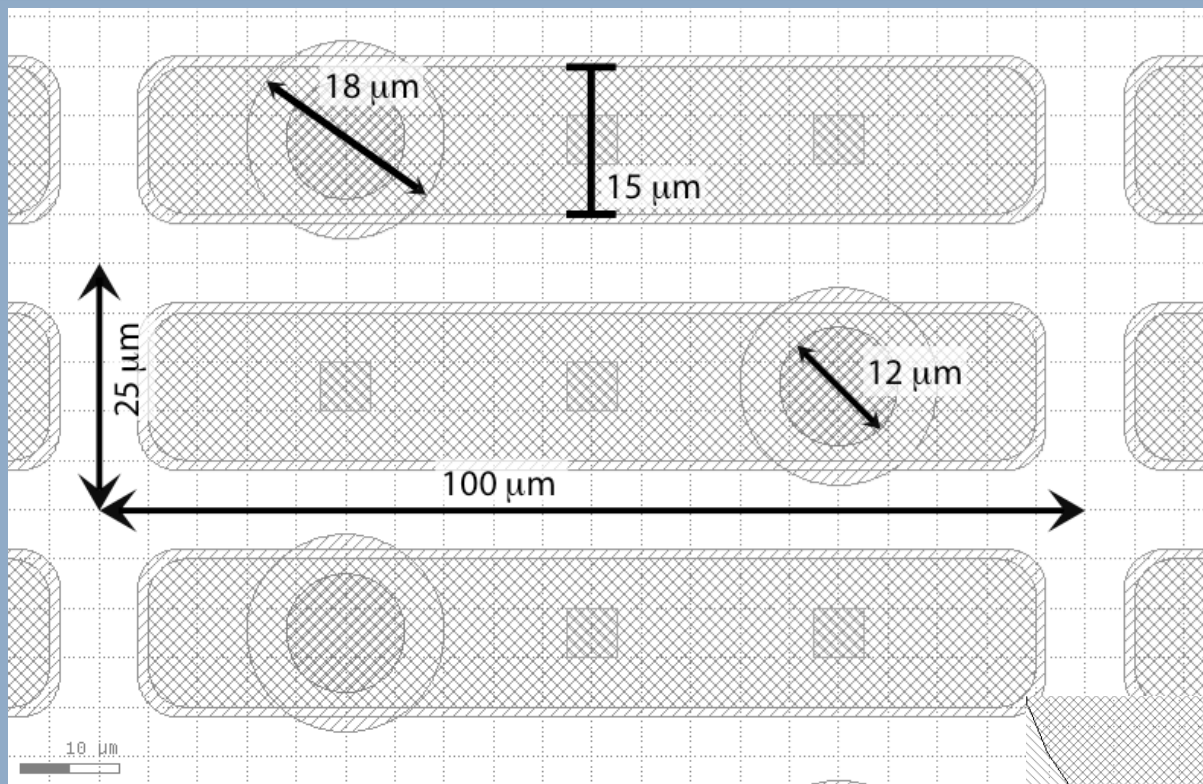
P-spray			
Implant	Small / $\mu\text{m}$	Normal / $\mu\text{m}$	Wide / $\mu\text{m}$
(a) Pixel 50x50	20	30	40
(c) Pixel to pixel	30	20	10
(a) Pixel 100x25	5	10	15
Pixel to pixel (c)	20	15	10

P-stop			
Implant	Small / $\mu\text{m}$	Normal / $\mu\text{m}$	Wide / $\mu\text{m}$
(a) Pixel 50x50 (100x25)	15	23 (10)	30 (5)
(b) Implant – P-stop	10	6 (5)	5
P-stop	5	5 (5)	3
P-stop to p-stop(d)	5	5 (0)*	4



\* p-common

# 25x 100 $\mu\text{m}^2$ p-spray “wide”



Three versions with implant width:

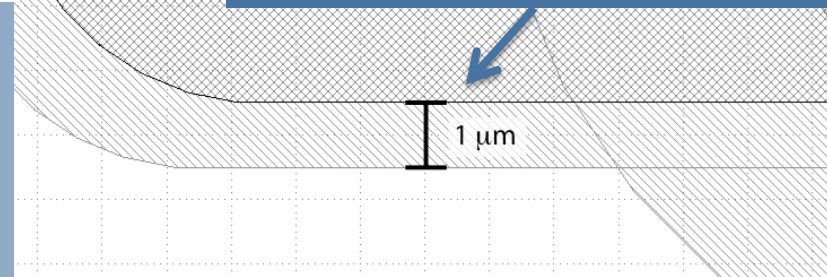
Small: 5  $\mu\text{m}$

Normal: 10  $\mu\text{m}$

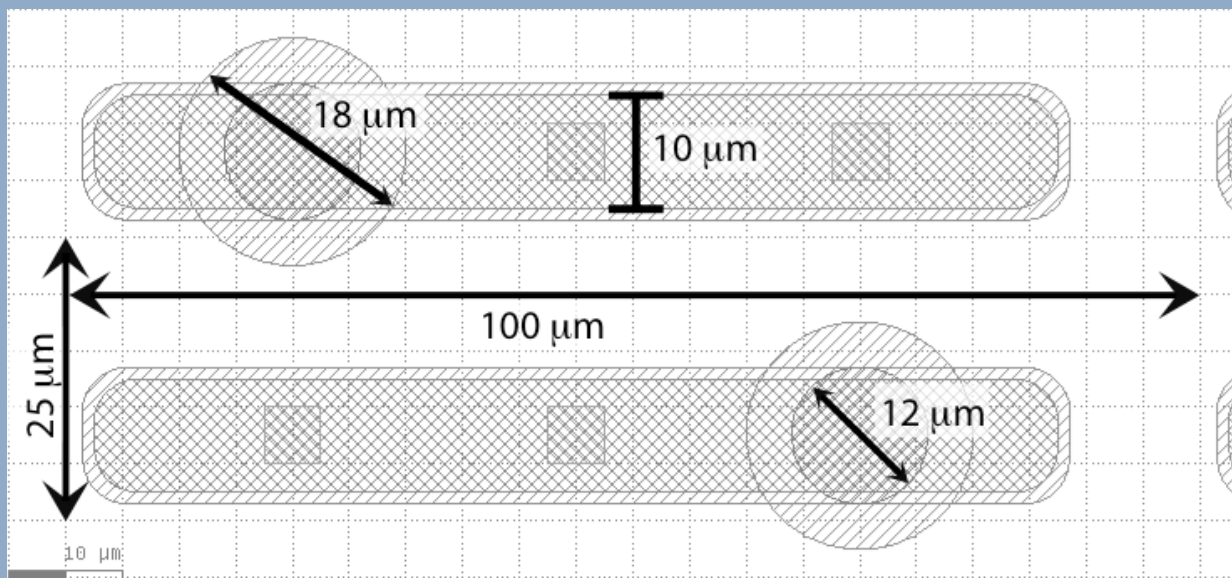
Large: 15  $\mu\text{m}$

Depends on lateral diffusion during processing – has to be discussed with vendor

- Metal overhang:
- -1.5  $\mu\text{m}$ , 0., +1.5  $\mu\text{m}$  or more?



# 25x 100 $\mu\text{m}^2$ p-spray “normal”



Three versions with implant width:

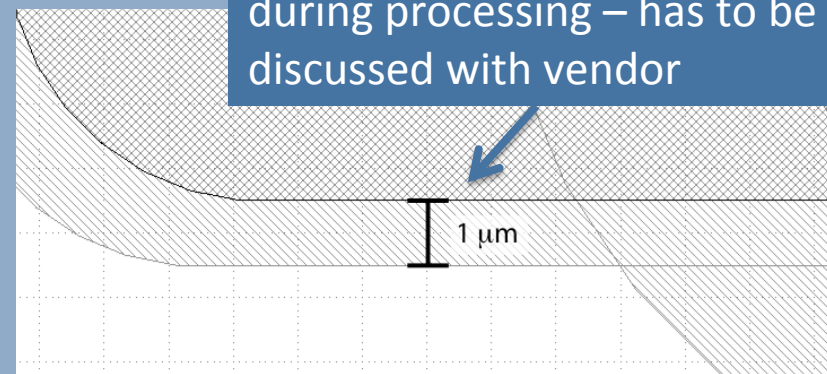
Small: 5  $\mu\text{m}$

Normal: 10  $\mu\text{m}$

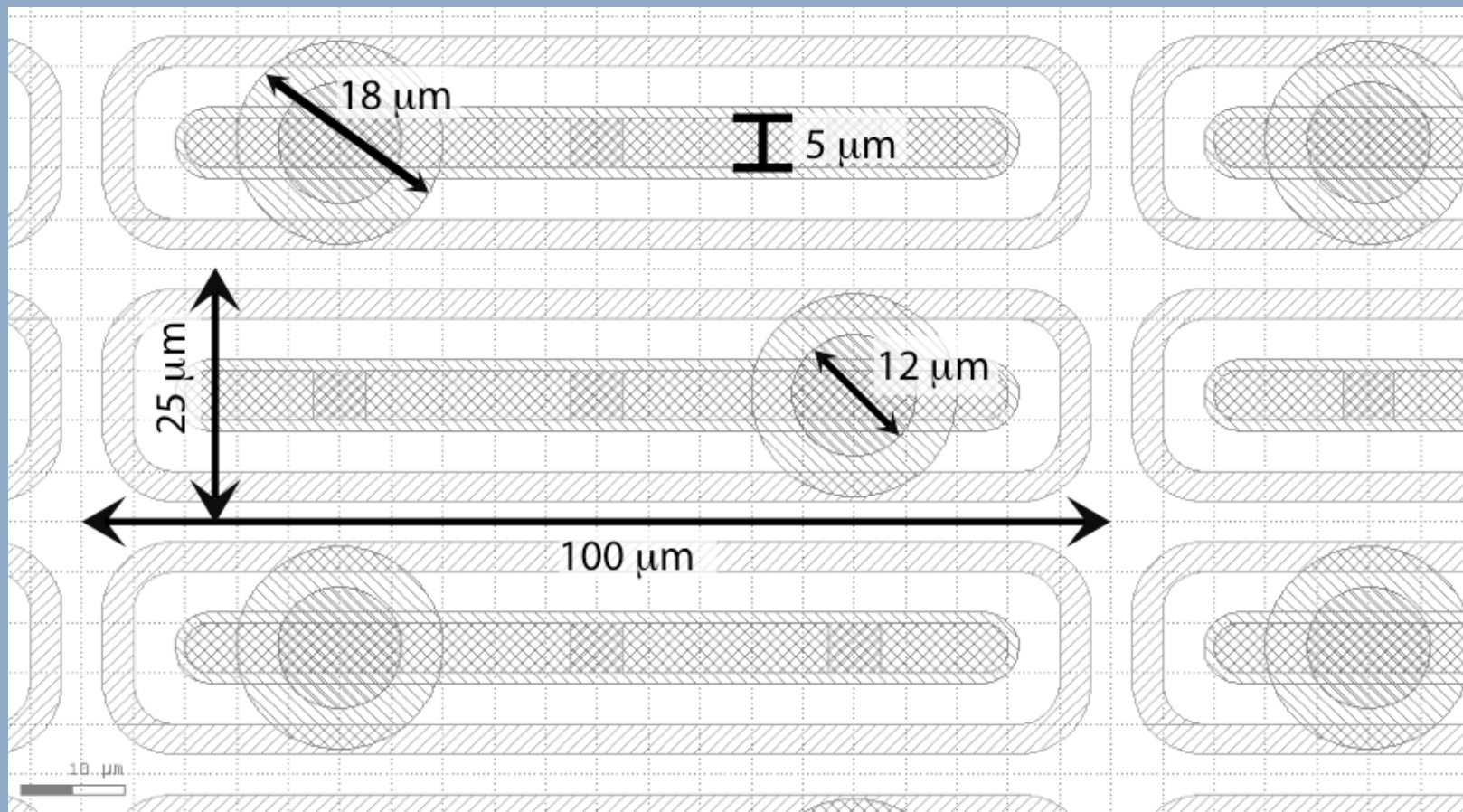
Large: 15  $\mu\text{m}$

Depends on lateral diffusion during processing – has to be discussed with vendor

- Metal overhang:
- -1.5  $\mu\text{m}$ , 0., +1.5  $\mu\text{m}$  or more?

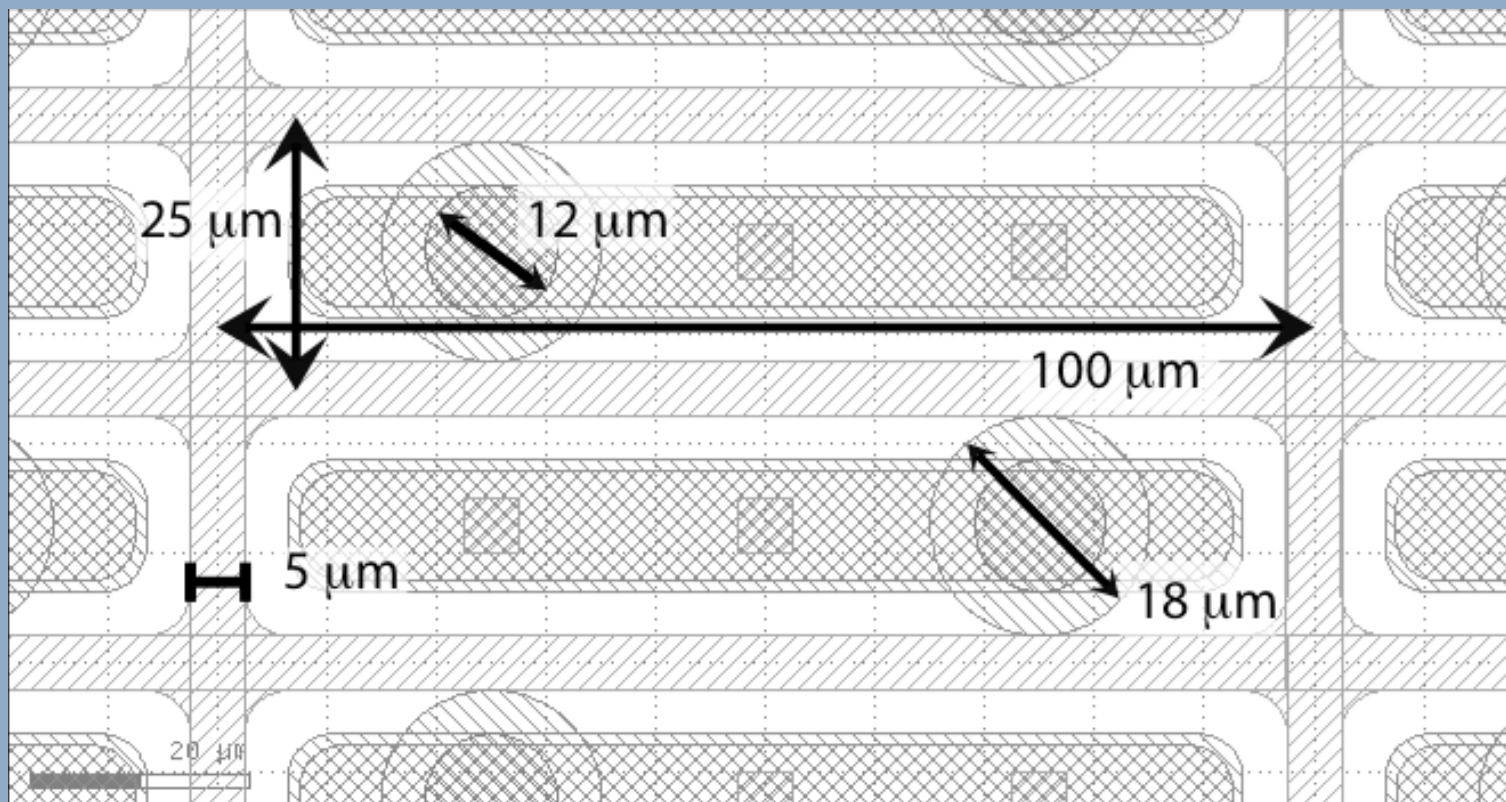


# 25x 100 $\mu\text{m}^2$ individual p-stop



Likely not the best layout

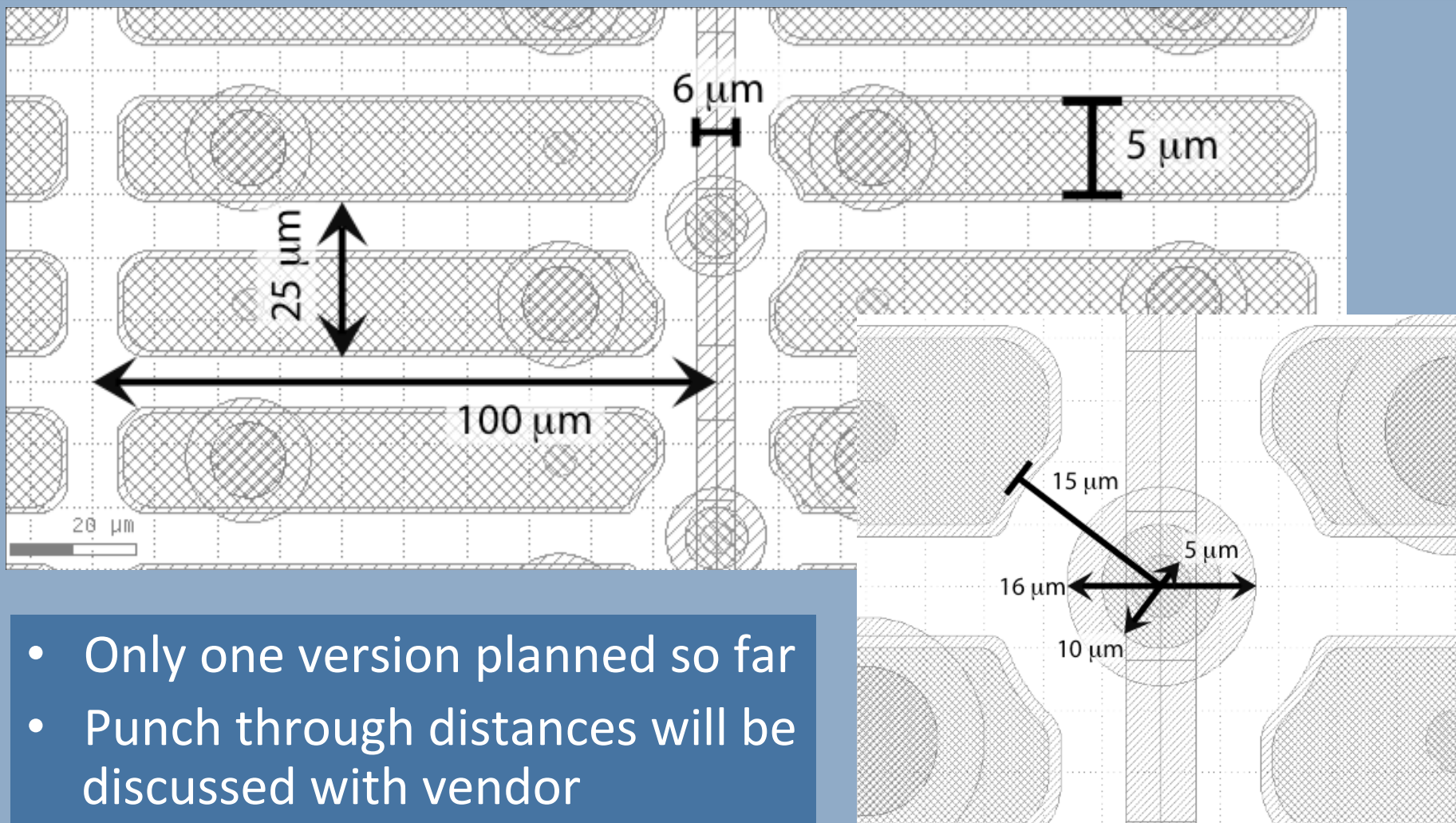
# 25x 100 $\mu\text{m}^2$ p-stop common



- 10  $\mu\text{m}$  implant width
- Exact value has to be identified with vendor



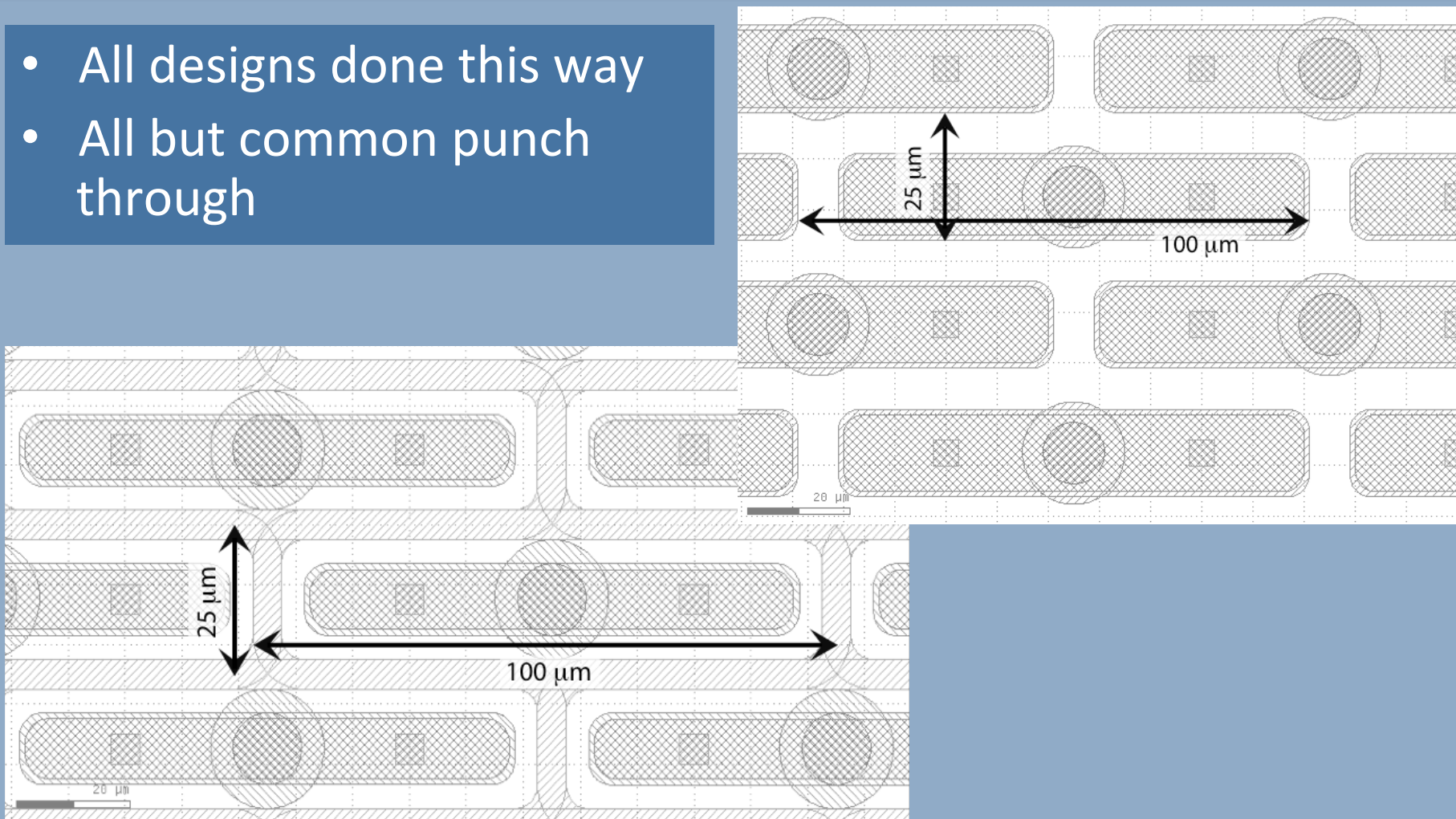
# 25 x 100 $\mu\text{m}^2$ p-spray common PT



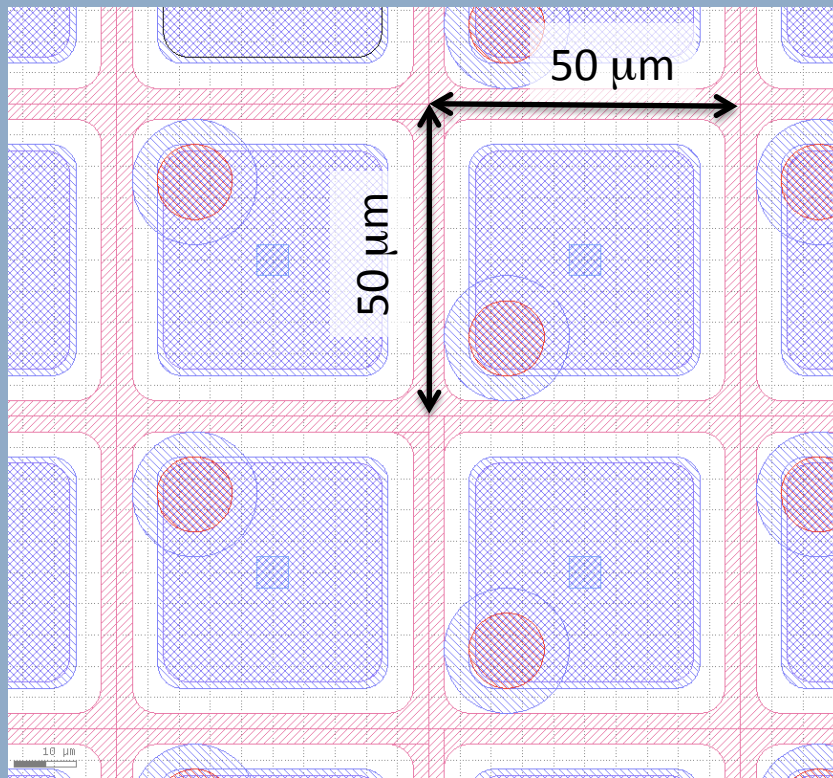
- Only one version planned so far
- Punch through distances will be discussed with vendor

# 25 x 100 $\mu\text{m}^2$ “bricked”

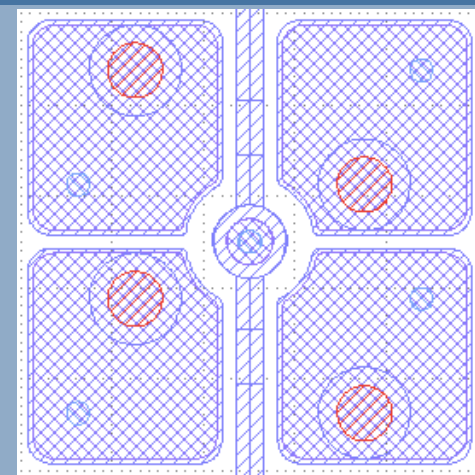
- All designs done this way
- All but common punch through



# 50 x 50 $\mu\text{m}^2$ p-stop



- Size for p-stop, common p-stop, metal overhang as for 25 x 100  $\mu\text{m}^2$
- Common punch through implemented (exact layout has to be discussed with vendors)



- P-spray, p-stop, common p-stop
- Implant width in normal and wide if possible
- “Bricked” and “non-bricked”

# Overview of sensors for ROC4Sens

ROC4Sens	p-spray			individual PT			common PT		
Geometry	No bias			individual PT			common PT		
Non-Bricked	small	normal	wide	small	normal	wide	small	normal	wide
50x50	r4s50x50_pspray_s	r4s50x50_pspray_r	r4s50x50_pspray_wide			r4s50x50PT	*not possible	r4s50x50cPT	r4s50x50cPT_wide
100x25	r4s100x25_pspray_s	r4s100x25_pspray_r	r4s100x25_pspray_wide					r4s100x25cPT	r4s100x25cPT_wide
100x100									
200x50									

ROC4Sens	p-spray			individual PT			common PT		
Geometry	No bias			individual PT			common PT		
Bricked	small	normal	wide	small	normal	wide	small	normal	wide
50x50		r4s50x50b_pspray_s	r4s50x50b_pspray_wide			r4s100x25PT_wide			
100x25	r4s100x25b_pspray_s	r4s100x25b_pspray_r	r4s100x25b_pspray_wide						
100x100									
200x50									

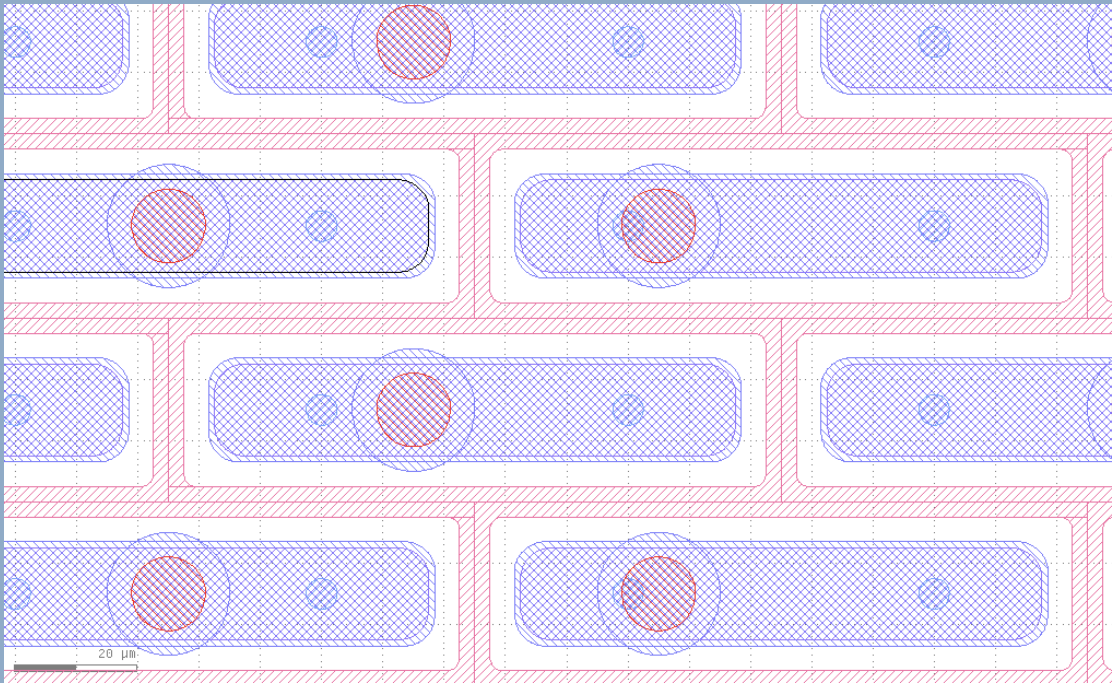
  

ROC4Sens	p-stop common			p-stop individual		
Geometry	No bias			No bias		
Non-Bricked	small	normal	wide	small	normal	wide
50x50		r4s50x50_cpstop_normal		r4s50x50_snr	r4s50x50_normal	r4s50x50_wide
100x25		*r4s100x25_cpstop_normal				r4s100x25_wide
100x100		*implant width to be optimized				
200x50						

ROC4Sens	p-stop common			p-stop individual		
Geometry	No bias			No bias		
Bricked	small	normal	wide	small	normal	wide
50x50		r4s50x50b_cpstop_normal			r4s50x50b_normal	r4s50x50b_wide
100x25		*r4s100x25b_cpstop_normal				r4s100x25b_wide
100x100		*implant width to be optimized				
200x50						

# 30 x 100 $\mu\text{m}^2$ common p-stop



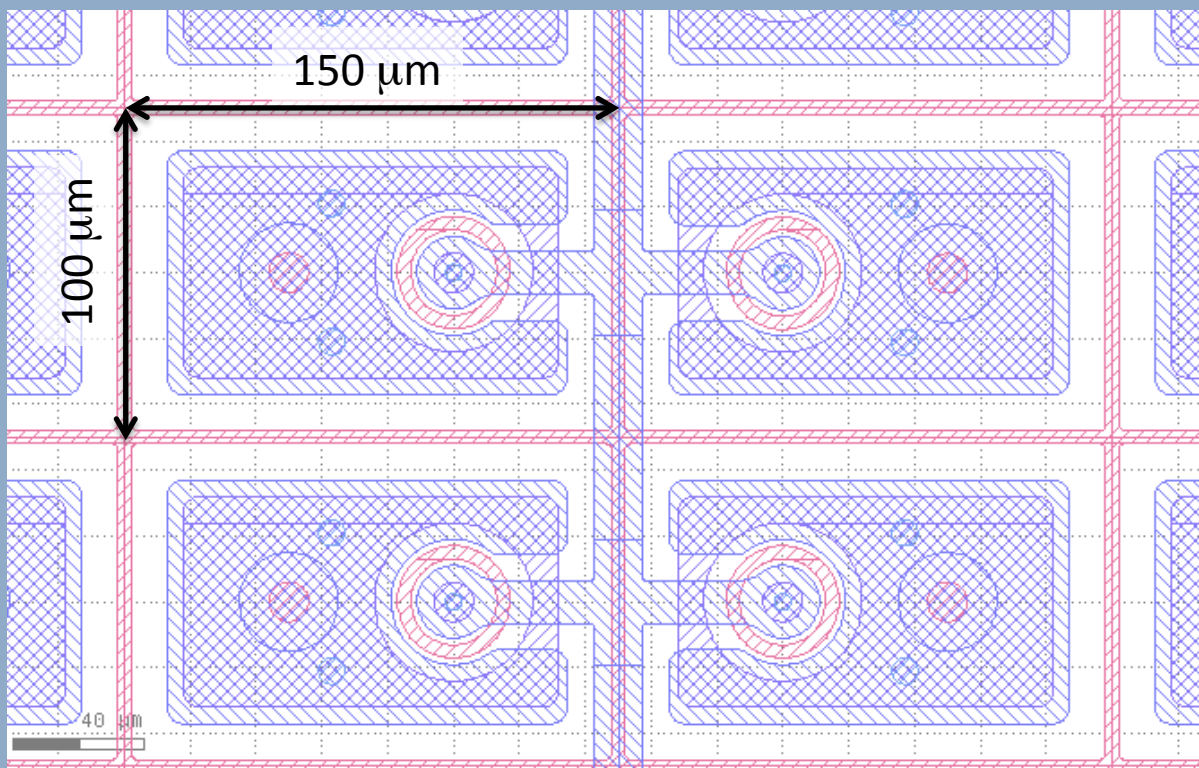
- Size for p-stop, common p-stop, metal overhang as for 25 x 100  $\mu\text{m}^2$
- Bump bond pads and contact opening also similar to 25 x 100  $\mu\text{m}^2$

- P-spray, p-stop, common p-stop
- Implant width in normal and wide if possible
- “Bricked” and “non-bricked”

# Overview of sensors for FCP130

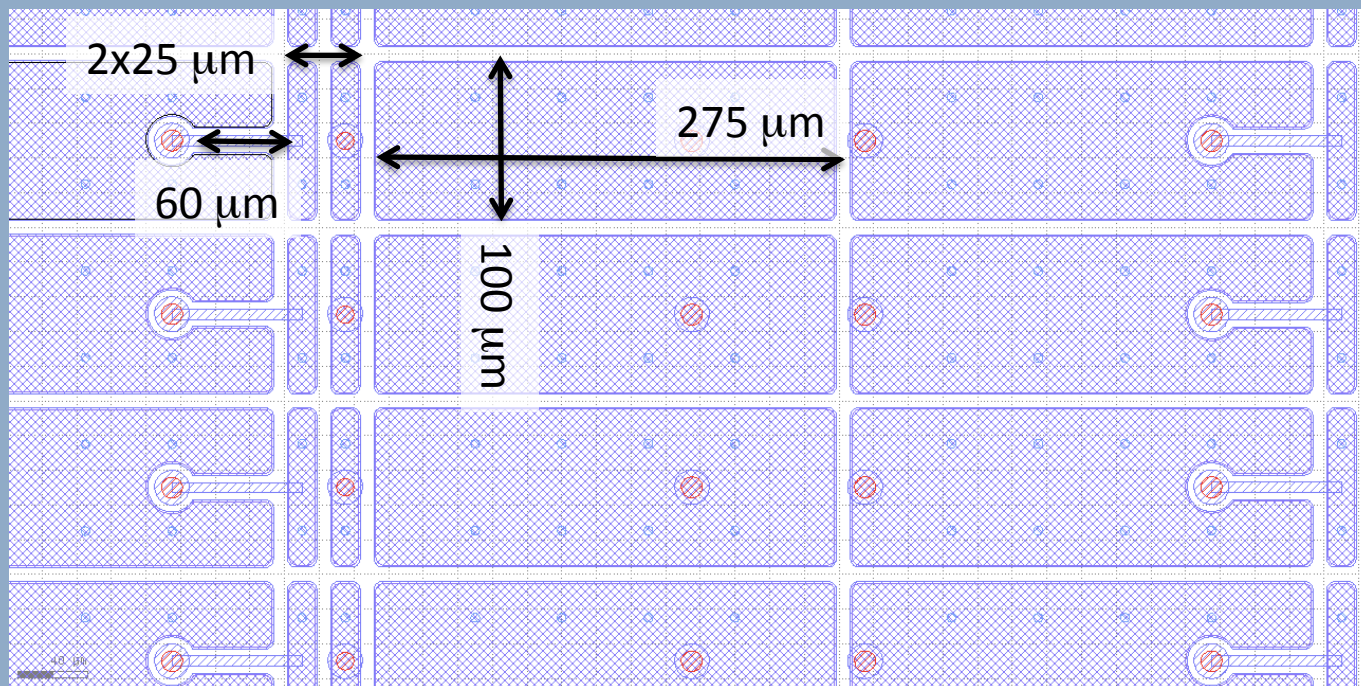
FCP130	Insulation: p-spray								
Geometry	No bias			Individual PT			common PT		
Non-Bricked	small	normal	wide	small	normal	wide	small	normal	wide
100x30	fcp130100x30_psp	fcp130100x30_psp	fcp130100x30_pspray_wide			*see r4s100x	*not possible	fcp130100x3	fcp130100x30cPT_wide
200x60									
100x90									
FCP130	Insulation: p-spray								
Geometry	No bias			Individual PT			common PT		
Bricked	small	normal	wide	small	normal	wide	small	normal	wide
100x30									
200x60									
100x90									
FCP130	p-stop common			p-stop ind.					
Geometry	No bias			No bias					
Non-Bricked	small	normal	wide	small	normal	wide			
100x30		fcp130100x30_cpstop_normal				fcp130100x30_ipstop_wide			
200x60									
100x90									
FCP130	p-stop common			p-stop ind.					
Geometry	No bias			No bias					
Bricked	small	normal	wide	small	normal	wide			
100x30		fcp130100x30b_cpstop_normal							
200x60									
100x90									

# BPix and FPix for comparison



- Similar design as in n-in-n submission for comparison
- Punch through in BPix design
- Open punch through as in FPix
- No biasing scheme (also FPix)

# Try with routing lines



- Use PSI46dig with  $25 \times 100 \mu\text{m}^2$
- Routing lines have to be used
- Available with three columns
- Available in  $50 \times 50 \mu\text{m}^2$



# Sensors for PSI46dig

PSI46dig???	p-stop individual	p-stop common	p-spray
Geometry	No bias	bias grid	bias grid
Non-Bricked	open p-stop	PT	PT
100x150	fpixf_pstop	bpixpt_cpstop	bpixpt_pspray
PSI46dig???	p-spray	p-spray	
Geometry	No bias	w/ fpix periphery	
Non-Bricked	wide	wide	
Hybrid 50x50 8x8	psi46dig50x50s_pspray_wide		
Hybrid 100x25 2	psi46dig100x25x2s_psi46dig100x25x2_pspray_wide		
Hybrid 100x25 3	psi46dig100x25x3s_pspray_wide		

# Summary

- All designs and the current wafer layout on the  
→ Document Sharepoint

[https://espace.cern.ch/Tracker-Upgrade/Pixel\\_sensors/SitePages/Home.aspx](https://espace.cern.ch/Tracker-Upgrade/Pixel_sensors/SitePages/Home.aspx)

# Back Up Slides

