

# Strips, FEI3, FEI4, CMS and pads detectors with LGAD in epitaxial and FZ wafers

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Run 6894 - **NO GAIN**

Run 6827 - **GAIN**

Glasgow - July 2014

## RD50 project. Institutes collaborating:

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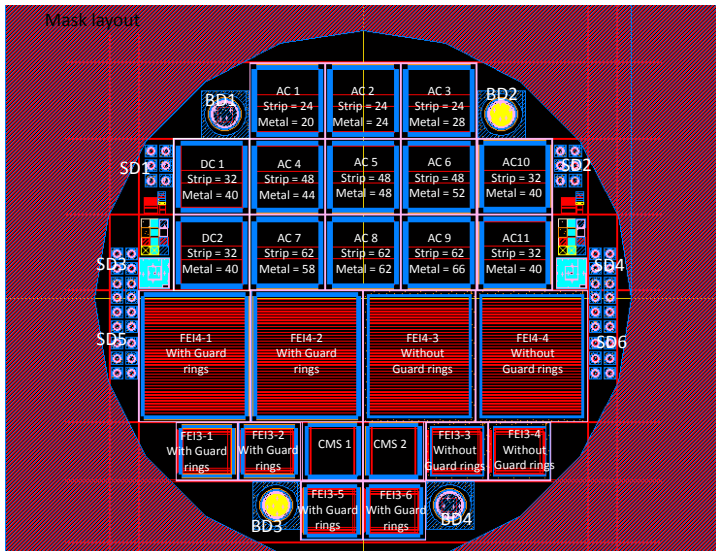
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# Mask layout



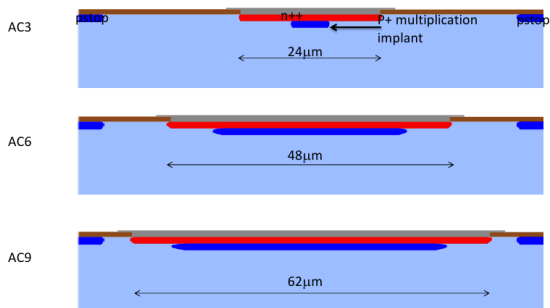
# Strip detectors

Pitch  $p = 80\mu\text{m}$

	Strip [ $\mu\text{m}$ ]	Metal [ $\mu\text{m}$ ]	P-implant [ $\mu\text{m}$ ]	$w/p$	P-implant / pitch
AC1	24	20	6	0.3	7.5%
AC2	24	24	6	0.3	7.5%
AC3	24	28	6	0.3	7.5%
AC4	48	44	30	0.6	37.5%
AC5	48	48	30	0.6	37.5%
AC6	48	52	30	0.6	37.5%
AC7	62	58	44	0.775	55%
AC8	62	62	44	0.775	55%
AC9	62	66	44	0.775	55%
AC10 and AC11 and DC	32	40	14	0.4	17.5%

# Strips cross section

## Strip outline



## Three different metal width:

- ▶ Field plate
- ▶ No field plate (metal as width as the strip)
- ▶ Metal smaller than the strip width

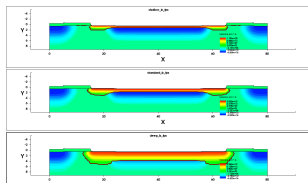
# Wafers

Thickness [ $\mu m$ ]	Resistivity [ $\Omega cm$ ]	Resistivity substrate [ $\Omega cm$ ]	Substrate thickness [ $\mu m$ ]	Nominal full depletion
9.8	110.5	0.006	525	9.3V
50.4	96.7	0.006	525	267V
75.2	104.6	0.006	525	550V
285 (FZ)	12000 $\pm$ 7000			70V

## Diffusion times of the dopant

- ▶ Shallow  $\longrightarrow$
- ▶ Standard  $\longrightarrow$
- ▶ Deep  $\longrightarrow$

## Strip cross section



# Fabrication finished in June 2013 in CNM Barcelona

## Two runs with and without gain (6827 and 6894)

### ▶ 4 Epitaxial $10\mu m$

1. Shallow
2. Shallow
3. Standard (with no p-stop)
4. Standard

### ▶ 4 Epitaxial $50\mu m$

5. Shallow
6. Standard
7. Standard (with no p-stop)
8. Deep

### ▶ 3 Epitaxial $75\mu m$

9. Shallow
10. Standard
11. Deep

### ▶ 3 Float Zone (FZ)

12. Shallow
13. Standard
14. Deep

# Wafers

## Institutes/Universities with sensors

- ▶ Santa Cruz
- ▶ CNM
- ▶ CERN/Santander
- ▶ Freiburg
- ▶ INFN
- ▶ Glasgow
- ▶ Ljubljana
- ▶ Liverpool
- ▶ IFAE



# Wafers from IZM with UBM with and without multiplication (6827, 6894)

▶ 4 Epitaxial  $10\mu m$

1. Shallow
2. Shallow
3. Standard (with no p-stop)
4. **Standard**

▶ 4 Epitaxial  $50\mu m$

5. Shallow
6. **Standard**
7. Standard (with no p-stop)
8. Deep

▶ 3 Epitaxial  $75\mu m$

9. Shallow
10. **Standard**
11. Deep

▶ 3 Float Zone (FZ)

12. Shallow
13. Standard
14. **Deep**

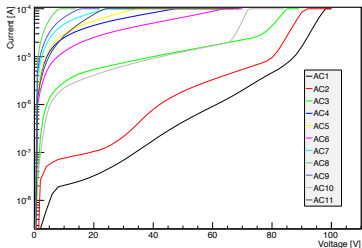
\* In red are the wafers with UBM back from IZM

\* NO diode came back from IZM

# W4 EPI 10 $\mu\text{m}$ Standard with and without gain: IV

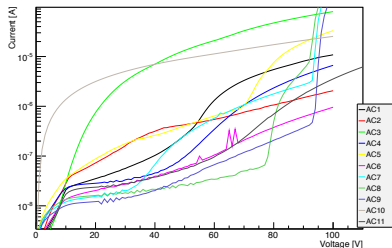
## 6827 GAIN

6827-4 Epi10 Standard



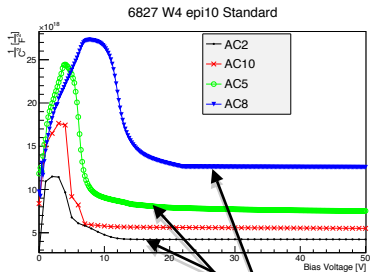
## 6894 NO GAIN

6894-4 Epi10 Standard

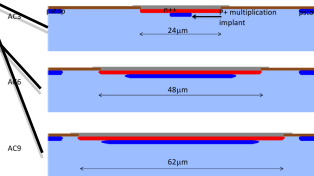
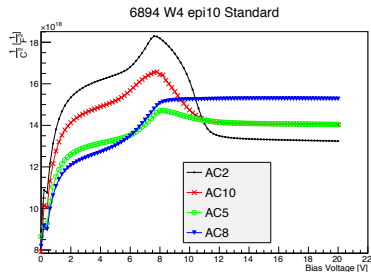


# W4 EPI 10 $\mu\text{m}$ Standard with and without gain: CV

## 6827 GAIN



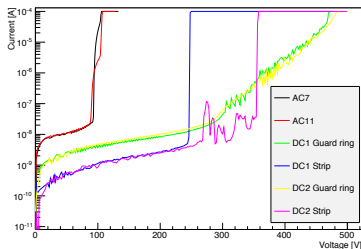
## 6894 NO GAIN



# W6 Epi $50\mu\text{m}$ standard with and without gain: IV

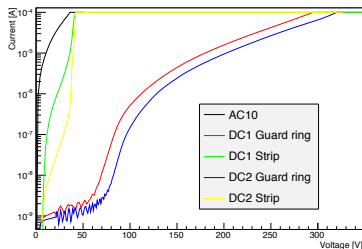
## 6827 GAIN

6827-6 Epi 50 Standard



## 6894 NO GAIN

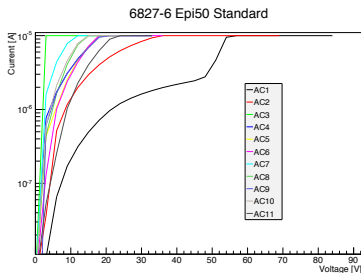
6894-6 Epi 50 Standard



- ▶ I did not have time to do all the IV's for W6 and W10. They are in CNM now.

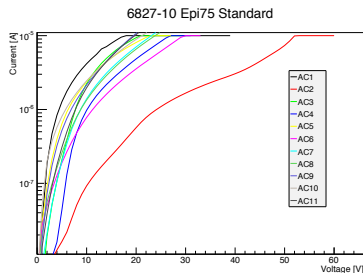
# W6 Epi $50\mu\text{m}$ standard with gain and W10 epi $75\mu\text{m}$ with gain: Measurements in wafer before UBM

## 6827 GAIN



Epi  $50\mu\text{m}$  depletes @ 150V

## 6827 GAIN



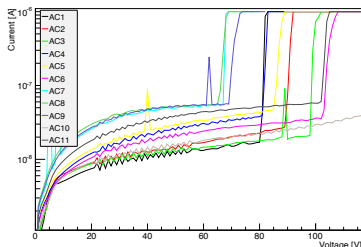
Epi  $75\mu\text{m}$  depletes @ 450V

- Measurements in wafer before UBM

# W6 Epi $50\mu\text{m}$ standard NO gain and W10 epi $75\mu\text{m}$ NO gain: Measurements in wafer before UBM

## 6894 NO GAIN

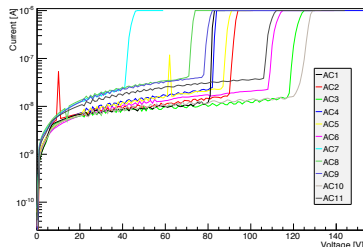
6894-6 Epi50 Standard



Epi  $50\mu\text{m}$  depletes @ 150V

## 6894 NO GAIN

6894-10 Epi75 Standard



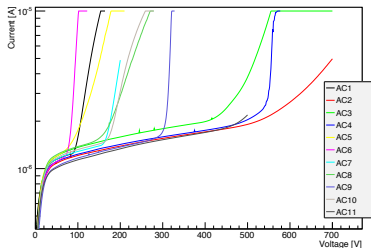
Epi  $75\mu\text{m}$  depletes @ 450V

- Measurements in wafer before UBM

# W14 FZ deep with and without gain: IV

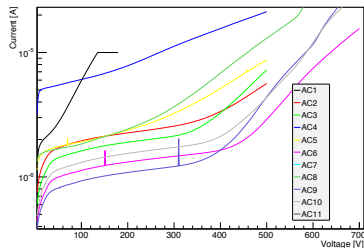
## 6827 GAIN

6827-14 FZ Deep



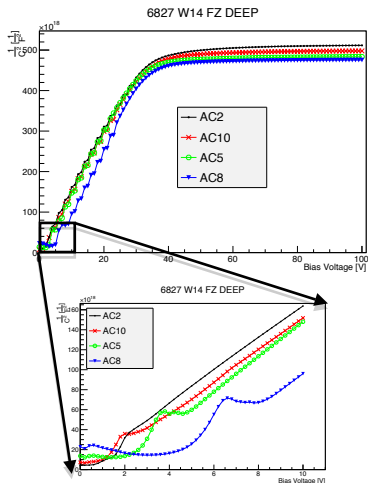
## 6894 NO GAIN

6894-14 FZ Deep

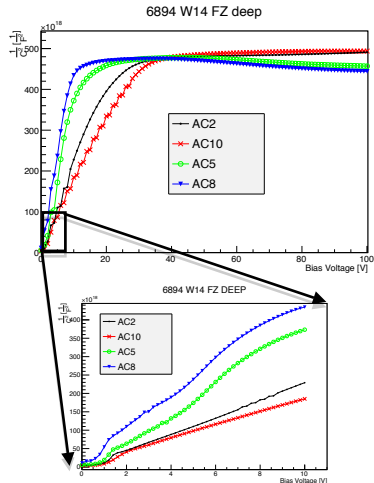


# W14 FZ deep with and without gain: CV

## 6827 GAIN



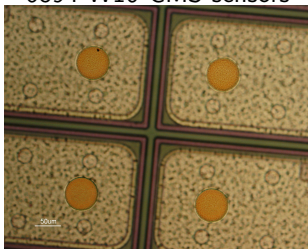
## 6894 NO GAIN



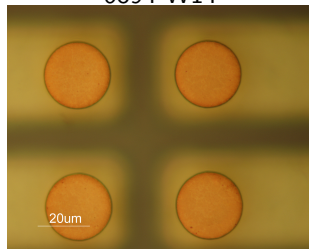


# Photos of UBM

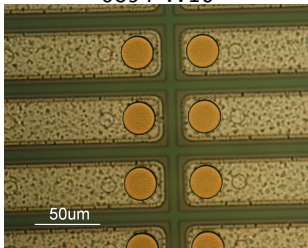
6894 W10 CMS sensors



6894 W14



6894 W10



No diodes came back!!!



# Wafers

## Future work

- ▶ We have to decide which ones we want to flip chip (4 FE-I4, 6 FE-I3, 2 CMS):
  1. Wafer 4: Epitaxial  $10\mu m$  Standard
  2. Wafer 6: Epitaxial  $50\mu m$  Standard
  3. Wafer 10: Epitaxial  $70\mu m$  Standard
  4. Wafer 14: FZ Deep
- ▶ AC10, AC11, DC1, DC2 from W4, W6 and W14 will be sent to irradiation with neutrons
  1.  $\phi_1 = 10^{15} n/cm^2$
  2.  $\phi_2 = 5 \cdot 10^{15} n/cm^2$
- ▶ We would like the diodes back from IZM, and irradiate the big ones
- ▶ If you want to measure with laser from the back do NOT forget to remove the back metal

Thanks for your attention