Performance Evaluation of Stiched Passive CMOS Strip Sensors

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DESY.

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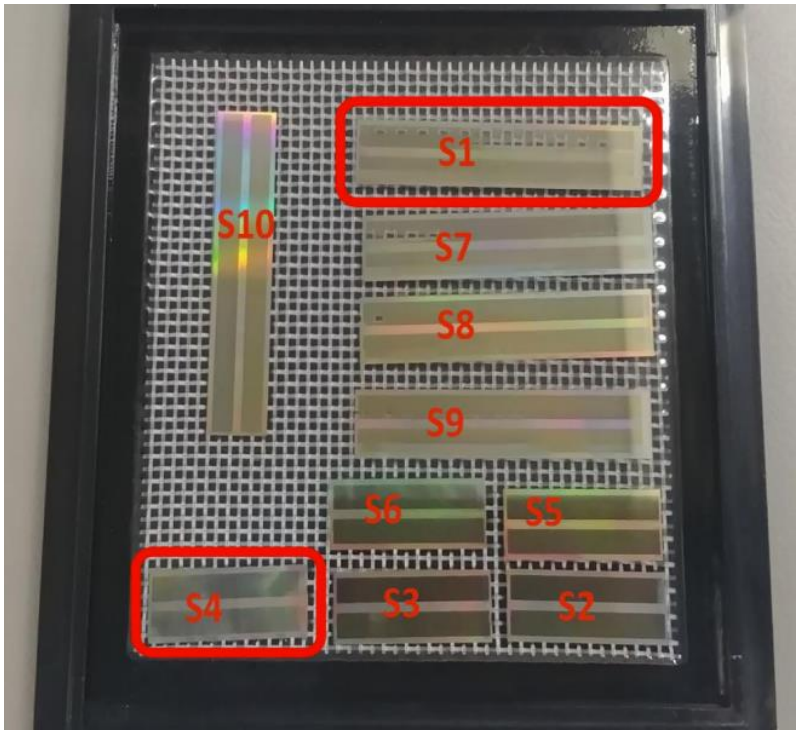
Passive CMOS strip detectors

First stitched strip sensors produced on 8" wafer by a commercial foundry

- L-Foundry 150 nm process (deep N-well/P-well)
- Up to 7 metal layers
- Wafer Resistivity: > 2 kΩ·cm
- Float-Zone silicon



Frontside process: **Reticle stitching**

$\Longrightarrow$ larger sensors

Two sensor lengths:

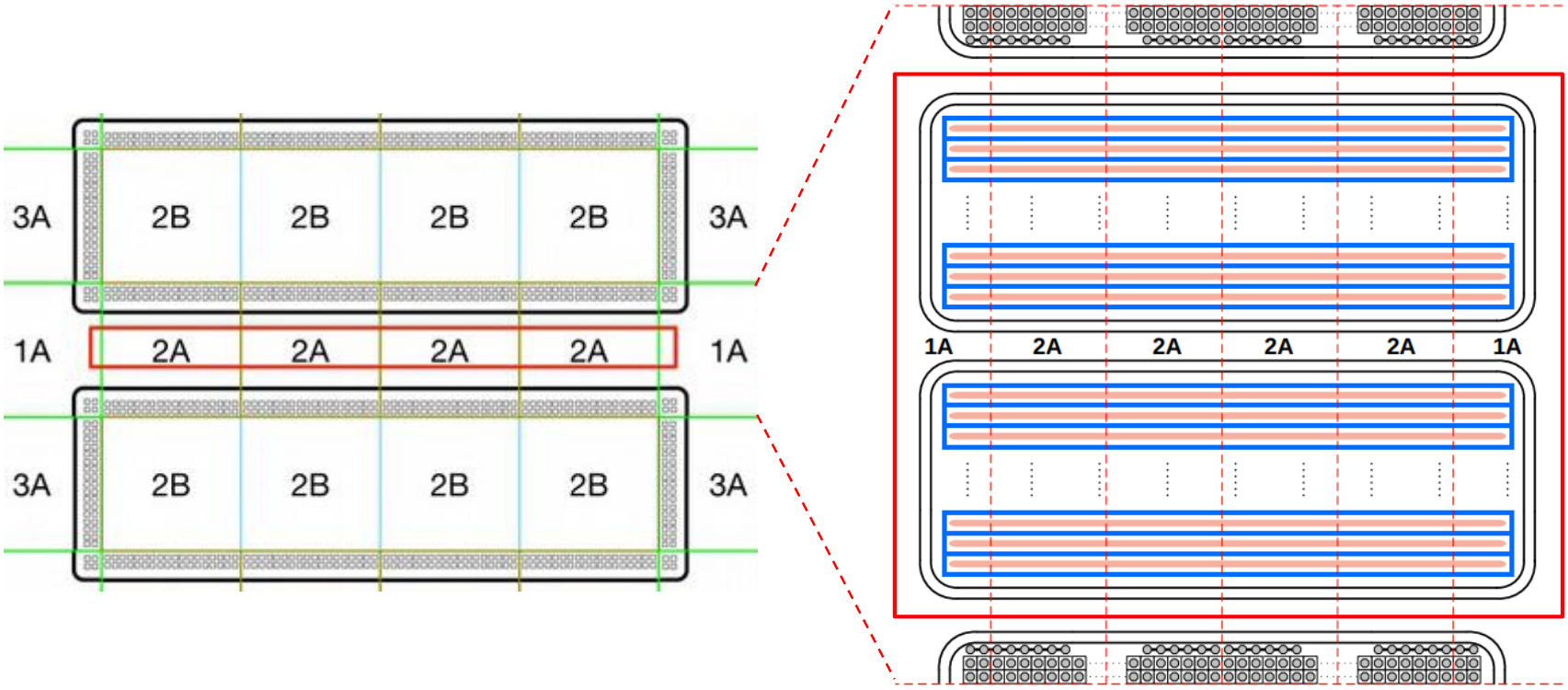
- 2 cm (short sensor)
- 4 cm (long sensor)

Two different batches:

- low concentration backside implant without metallization
- higher concentration backside implant with metallization

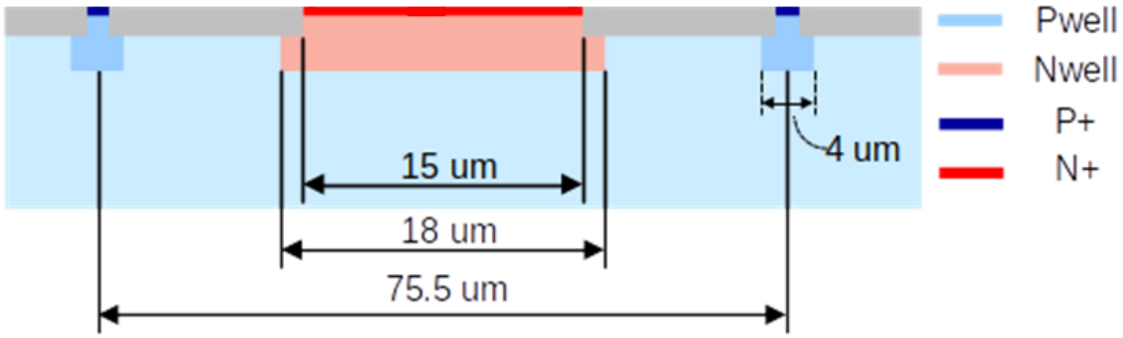
Stitching process

- Strip sensor produced with 1A and 2A reticles
- Stitched every 10mm along strip length
- Strip pitch of 75.5µm

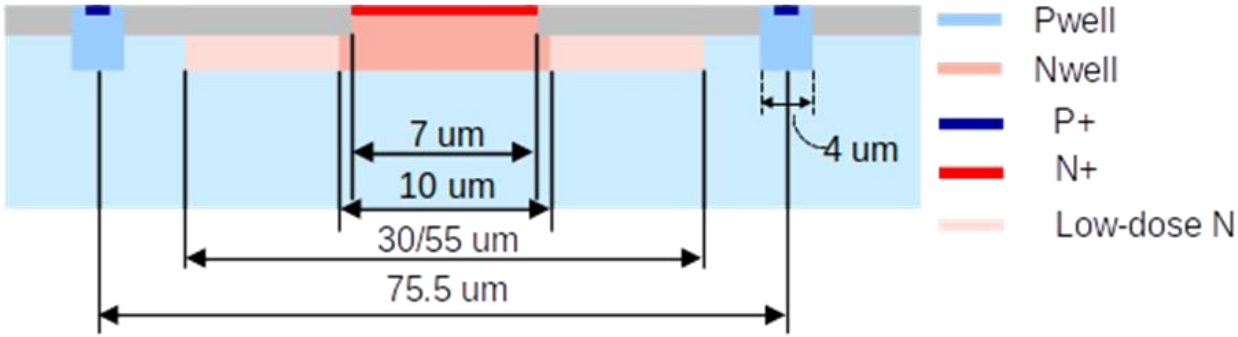


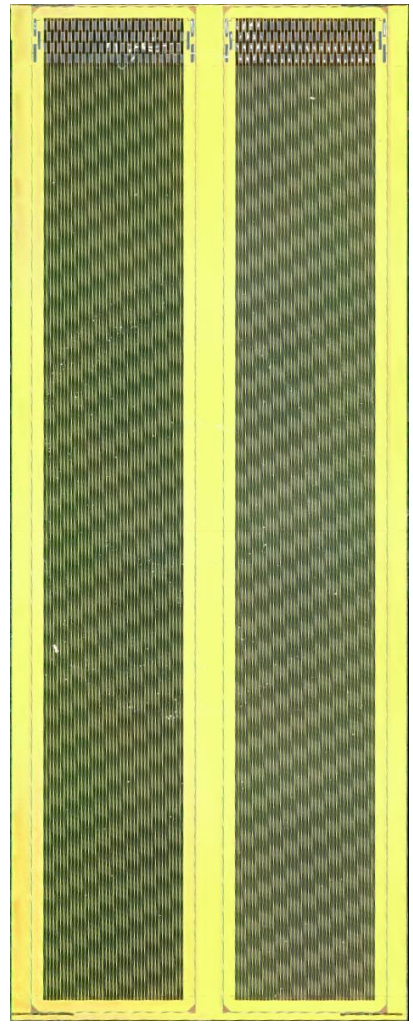
Passive CMOS strip detectors

Regular design



Low dose design





Low dose Regular

IV Results

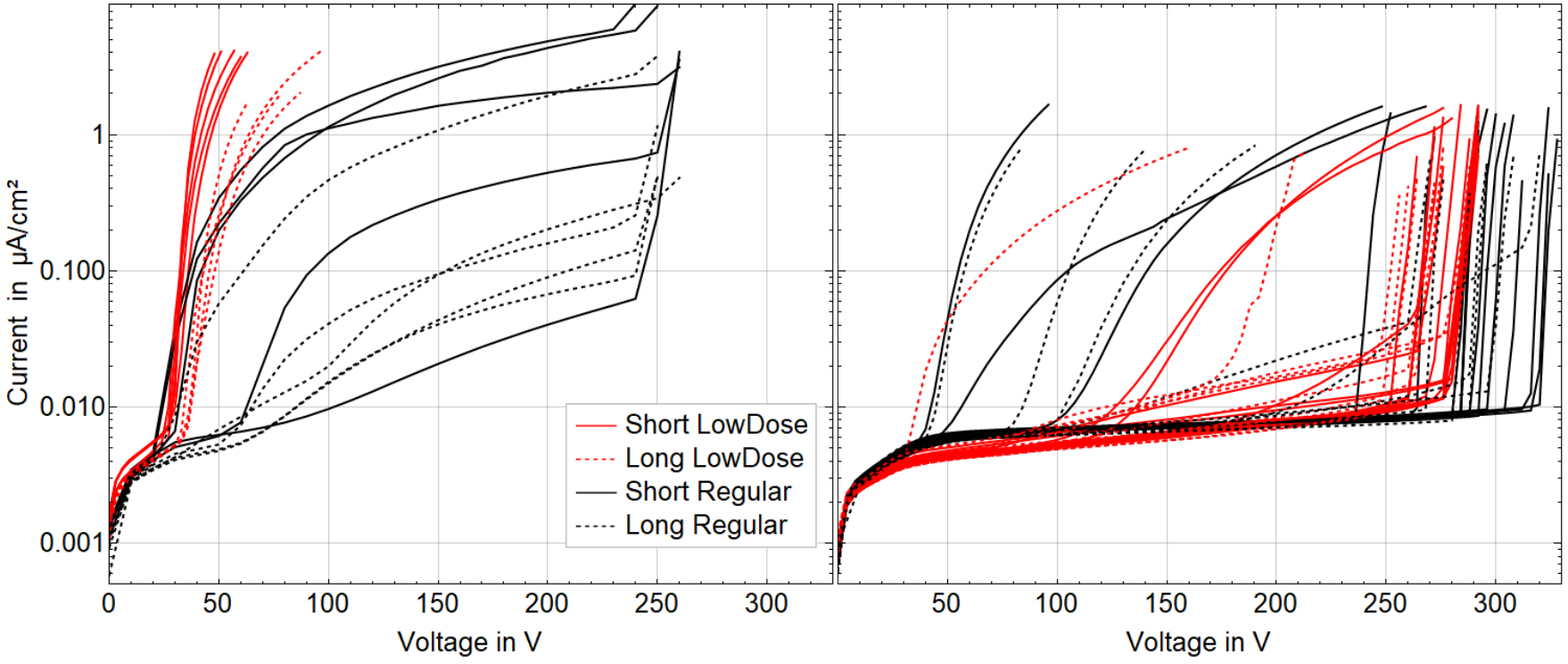
First Batch:

- Early breakdown for both designs
- Steeper current increase for regular design than for low dose

Second Batch:

- Breackdown voltage improved to >220V
- Only few bad sensors for both designs

⟹ Clear improvement



CV Results

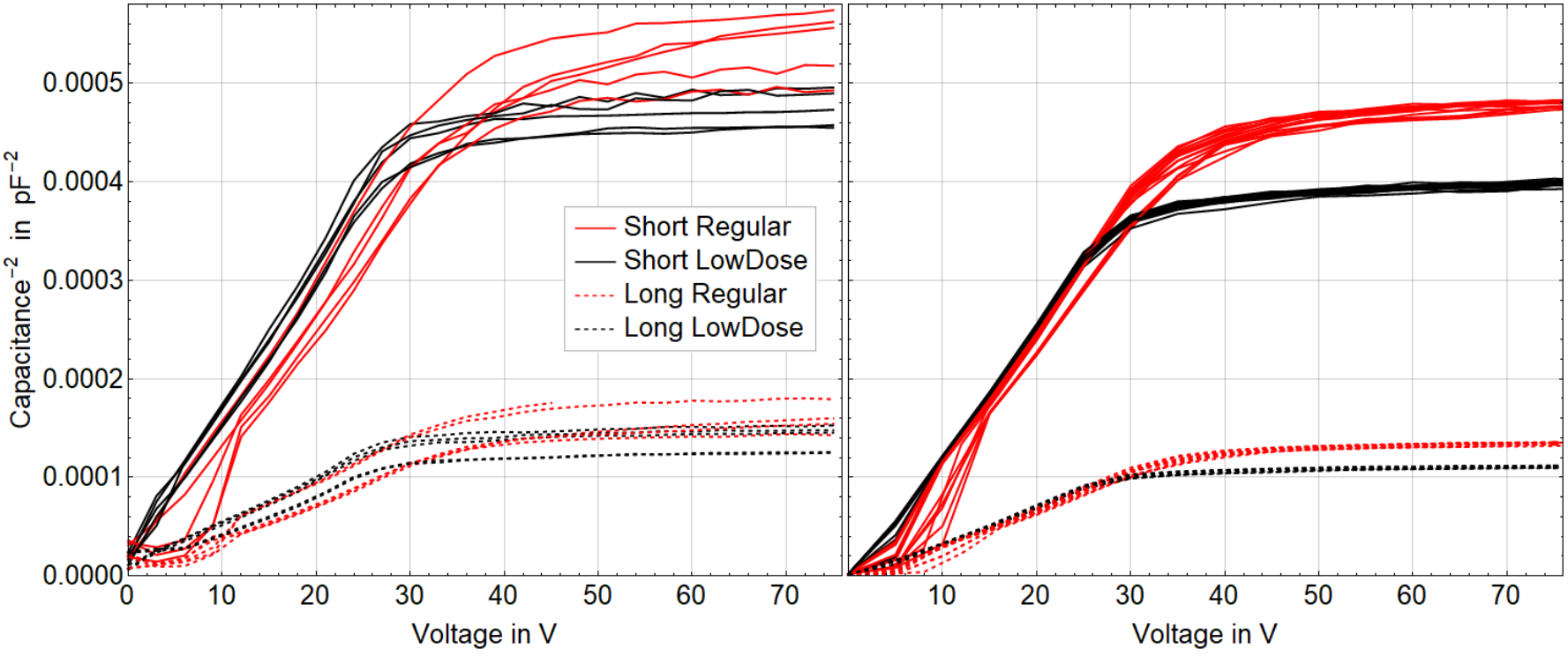
First Batch:

- Full depletion around 30-40V
- Stronger pronounced interstrip depletion for regular design

Second Batch:

- Improved homogeneity
- Lower capacitance for Low Dose design

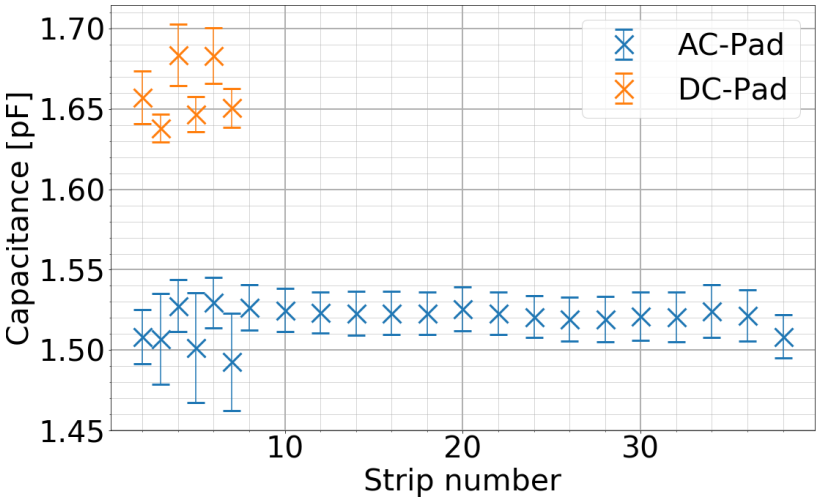
⟹ Less noise

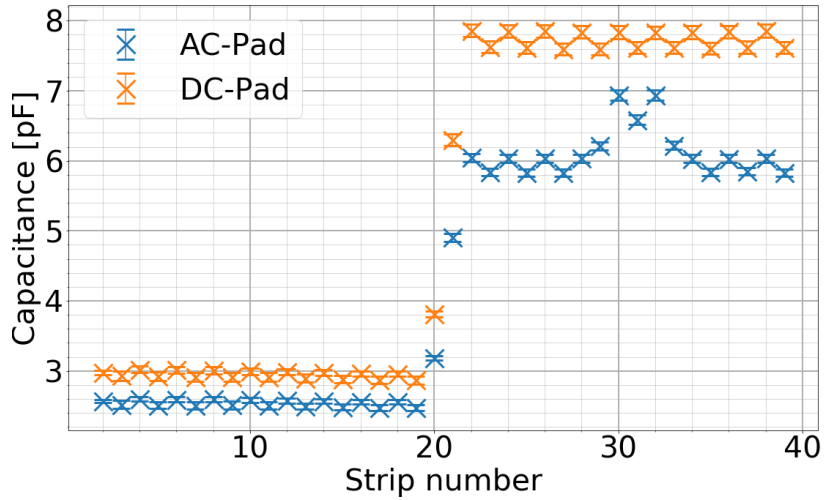


Interstrip capacitance results

Only first batch available

- Regular
  - Constant along strips
- Low Dose
  - Two different capacitances according to low dose implant widths

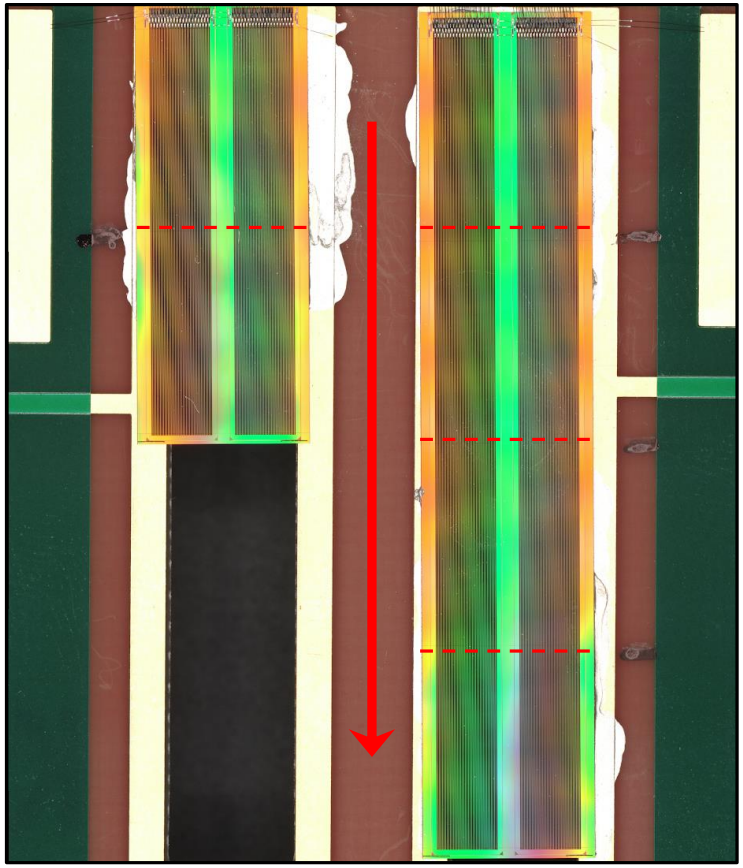


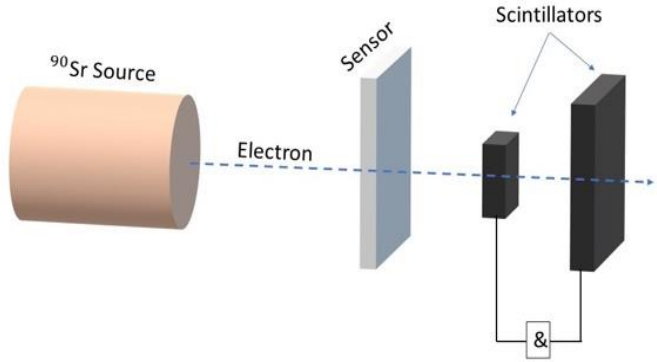


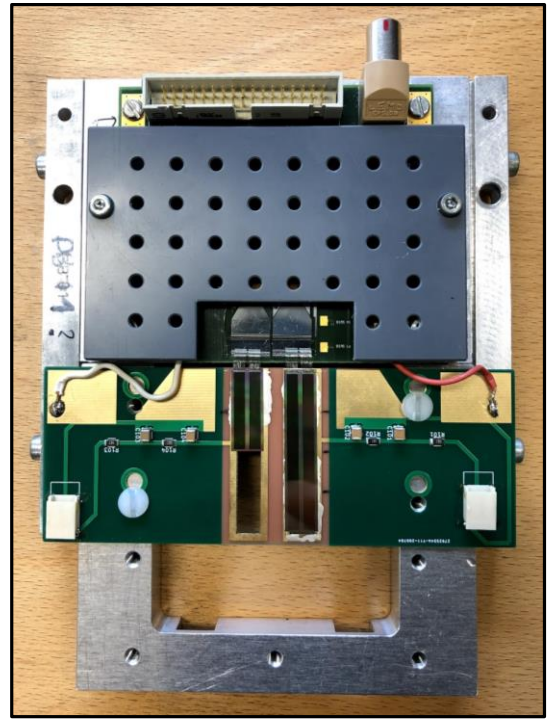
All electrical tests didn‘t show any issues with stitching

Source measurements

- Both strips designs bonded to one chip
- Voltage scan up to 100 V
- Scan through stitched areas





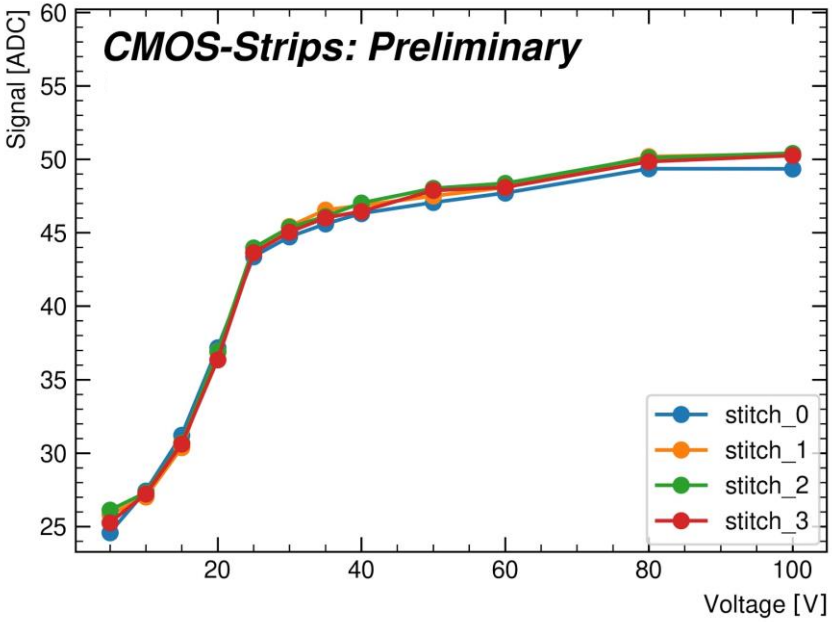


Regular design

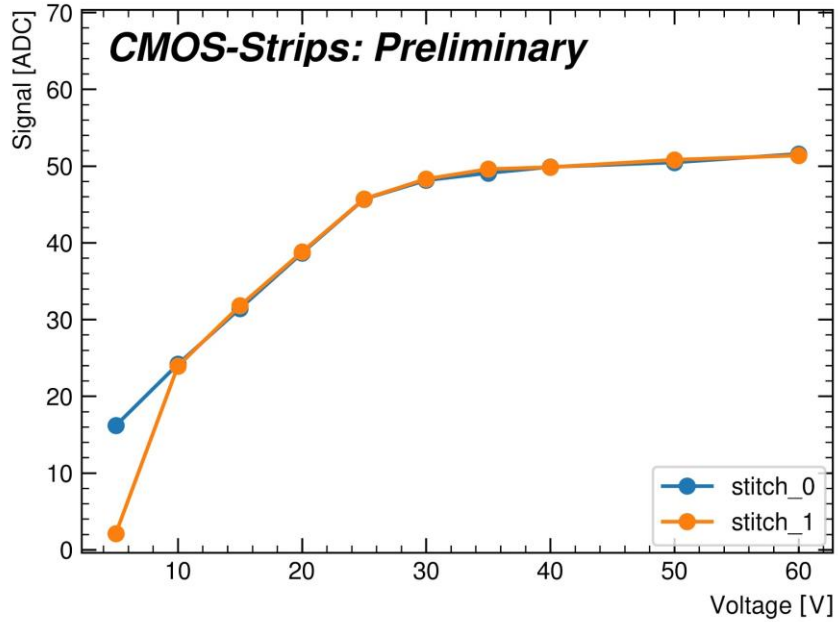
- Strong charge collection efficiency increase until full depletion
- Smaller increase for overdepletion

- No difference between the stitches

Long



Short

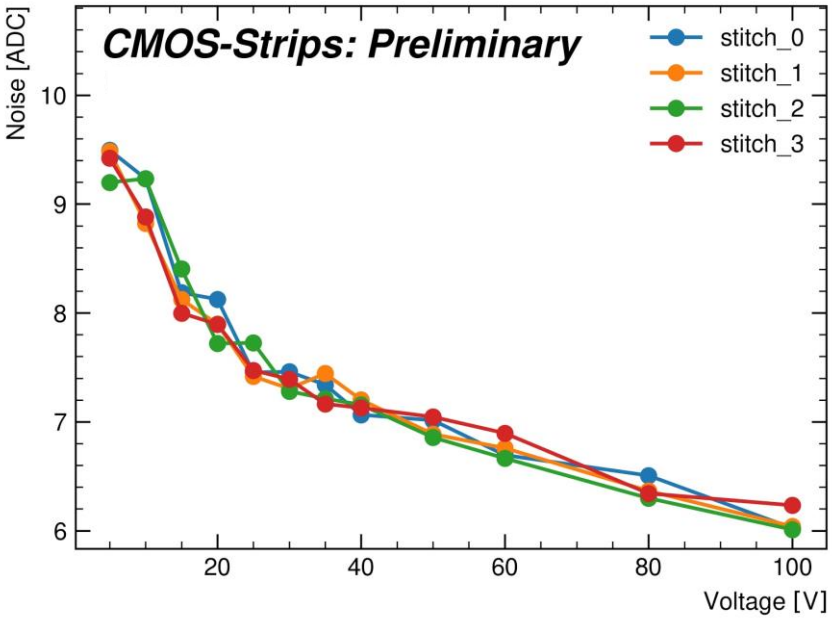


Regular design

- Decrease with higher voltage
- Low signal-to-noise ratio of 45 to 7/4

- No difference between the stitches

Long



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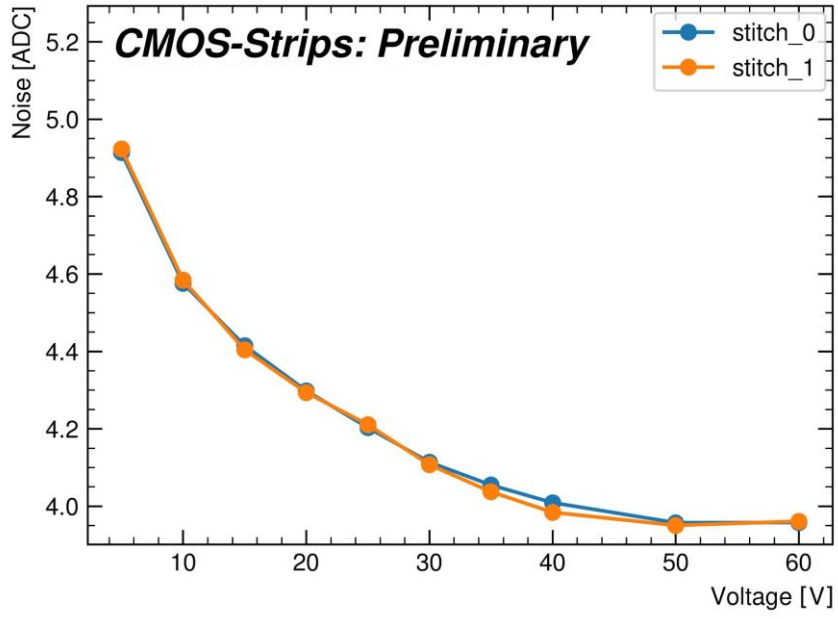
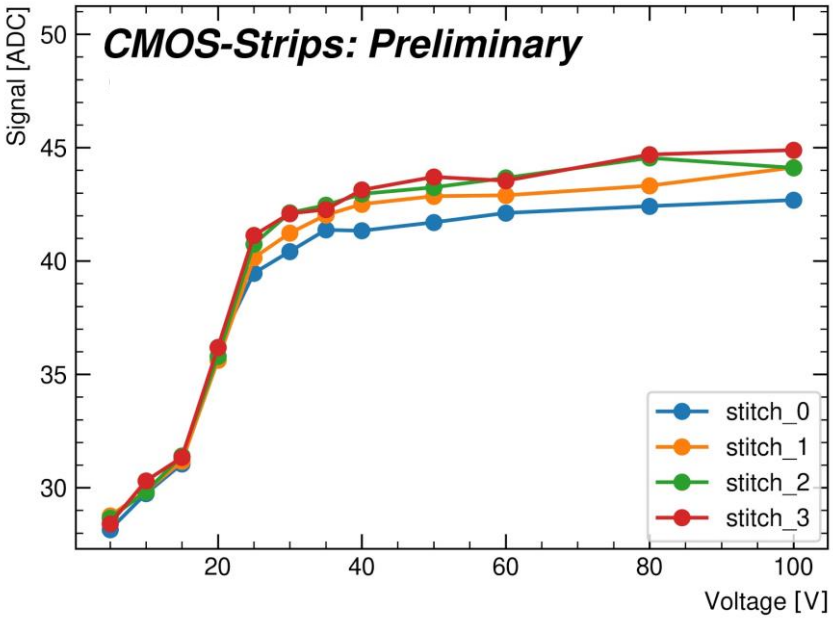


Low dose design

- More inhomogenious than regular design
  - Maybe due to different strip designs or different masking
- Less increase for overdepletion

Long



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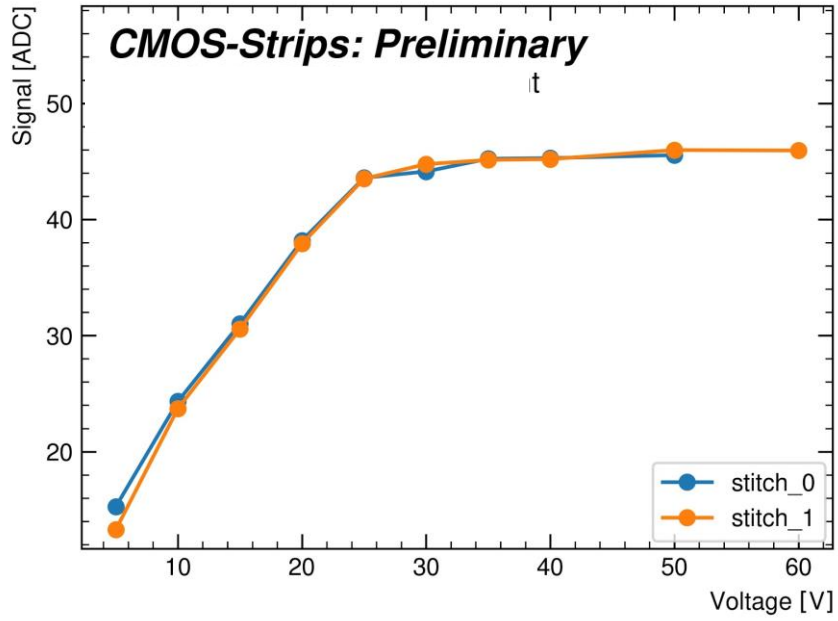
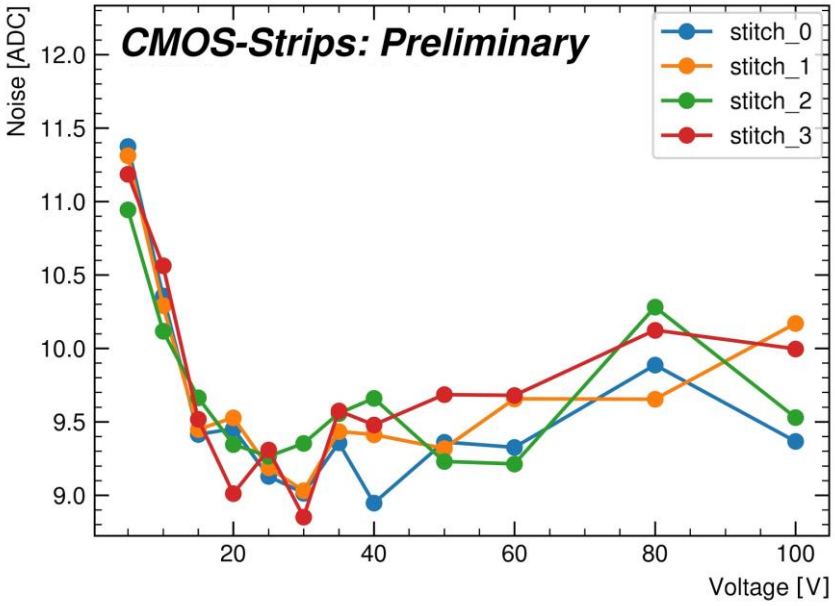


Low dose design

- Higher than for regular design
- Stronger fluctuations

- Maybe due to different implant width within the sensor

Long



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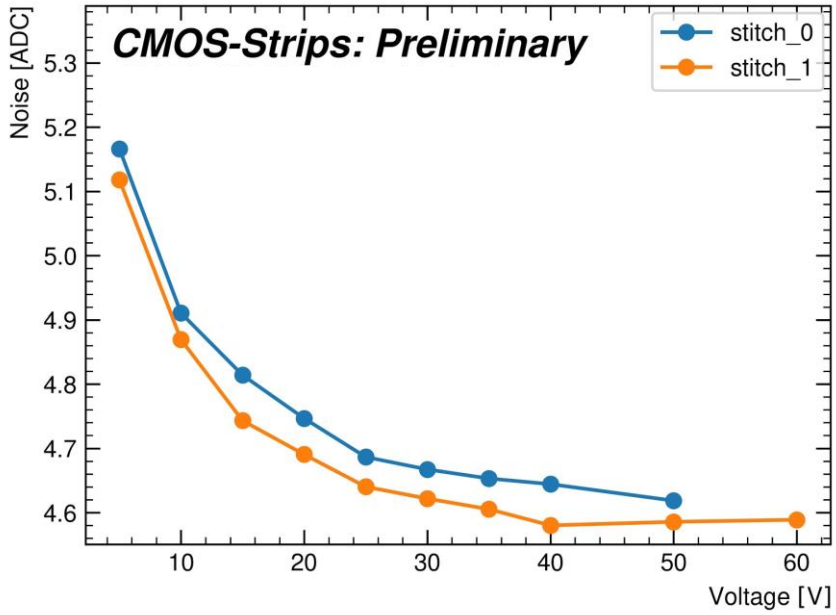

Summary & Outlook

Summary:

- Two batches of stitched passive CMOS sensors electrically tested
  - Large improvement for second batch
  - Breakdown way higher than depletion

- First batch source measured
  - Expected signal behaviour
  - Low signal-to-noise-ratio

Stitching works

Outlook:

- Complete measurements of second batch
- Irradiation studies