

Comments and questions to content:

- In Section 3 you discuss a fiducial area cut for the larger (100x150) pixels, and you say that no such cut is used for the smaller pixels. I found this not very clear. Can you motivate this? Does this introduce a bias/penalty for the larger pixels? Can you comment on its relevance/quantify this? I think 1-2 additional sentences would help.
- In Section 3 the concept of „threshold“ is mentioned for the first time (top of right text column). This should be introduced much earlier, and explicitly. In Section 2, when you explain that the PSI46dig was used, you should introduce its readout scheme, and say that it digitizes the charge for hits that exceed a settable threshold.
- In the last paragraph of Section 3 you explain that you were limited in fluence by the radiation hardness of the ROC. This could/should come much earlier, maybe in the last paragraph of Section 1, because the reader wonders why you did not go higher in fluence.
- The concept of annealing is never mentioned. In particular, how were the sensors stored after irradiation? Did they receive a controlled annealing? Or is it irrelevant for some reason? Isn't annealing the reason why the ROC must be bump-bonded to the sensor before irradiation, which is at the source of your troubles? This should also be explained early.
- The loss of detection efficiency after irradiation seems to be a combined effect of 1) less charge collection in the sensor and 2) higher threshold needed in the ROC used for testing. I think this should be spelled out explicitly and be explained and, if possible, quantified. It also means that your efficiencies are conservative, which could also be brought out more prominently.
- You should say at the beginning what bias voltage will be used in ATLAS and CMS, so that people can have a feeling for how this compares with your measurement range and by how much it can be turned up later.
- For Fig. 6, why did you stop at different bias voltages for different sensors, or what did determine your bias voltage range in the first place? Why did you not go up further to see where you end with the MPV and efficiency? Add 1-2 sentences.
- For the discussion of Fig. 6 it is not optimal that you show sensors that differ not only in received fluence, but also in thickness and presence of bias punch-through structures. It would be much better to compare the same type of sensor. I suppose the reason is that you do not have more data?

Comments to phrasing, style, etc.:

- I think „radiation-tolerant“ should come with a hyphen (e.g. title)
- No need to capitalize „silicon“, e.g. in the title; in English this is not done (check e.g. the Wikipedia article)
- n, p, n-in-p are now mostly in italic, but not always. Be consistent. I think it could well be in standard font, as these are not variables. This would make your title and abstract look nicer.
- Author list: move „now with ...“ bracket to affiliation footnotes
- „high-radiation tolerant“ does read strange to me. „highly radiation-tolerant“? Appears in the abstract and again later.

Section 1:

- „of the signal–to–noise ratio and it can“ : split in two sentence; “The current design can...”
- remove the comma in “these sensors, is the distance”
- “It is well known, in fact, that in order”: get at least rid of the “in fact”, or even of all this phrase, starting the sentence then with “In order to...”
- “a single–sided process ¹.” There should not be a spacing before the super-script number of the footnote.
- when you use an ~ sign you sometimes have a space after it, sometimes not. Be consistent (no space looks better to me).
- Your footnote 2 looks ugly, because it comes right after the 2 of μm^2 . Either move the footnote or put this sentence simply in the main text.
- When you introduce direct wafer bonding, you should repeat the “Si-Si” that you use in the abstract (or get rid of it in the abstract).

Section 2:

- The references should come in the text in numerical order. I.e. [9] should actually be [4], and so on.
- Consider to force Fig. 1 to the top of the column, so that you do not have two lonely lines on top.
- Try to get rid of all „see“ phrases. Do not instruct the reader. In most cases you can just remove the word.
- „On some particular sensors, the pixels can also be equipped with bias punch–through structures“: this sounds as if you can take a produced sensor and put some punch-through structure onto it. Rephrase e.g. as „Some sensors have been fabricated with bias punch–through structures“
- “p–spray implants can be Low, Medium and High”: Explain what low, medium, high refers to: density of p-doping in the spray implant (I guess)

- The whole sentence that starts with “In fact, we can anticipate that in our tests of irradiated sensors” is somewhat strange and could be rephrased/simplified. In particular the remark “even in the case of p-spray” cannot be appreciated at this point.
- “terminate into the underlying layer”: it should be either “terminate **in** the underlying layer” or “reach into the underlying layer”
- What does the E in 3E etc. actually stand for? Can you please introduce it?
- Fig. 3:
 - I would find it very helpful if the words „Ohmic“ and „junction“ would appear in the sketch. You could just write „p+ Ohmic column“ instead of „p+ column“ and similar for n+.
 - In the caption: Replace „At the bottom it is reported the layout of the ... columns respectively.“ with something like “The layouts of the 100 x 150 μm^2 pixel cells with two (2E, left) and three (3E, right) junction columns are shown at the bottom.”

Section 3:

- “test beam” is usually written without a hyphen (comes in the section title, for example)
- also I would not use a hyphen in “beam particle”
- Your hyphens seem to be sometimes single hyphens “-”, sometimes double hyphens “—”, called a dash. Hyphens between two words should be single hyphens.
- “Peltier cells”: not sure if cells is the right word. “Peltier modules” perhaps?
- Your degree symbol in “-20°C” looks strange (not round). Write as -20° (I did not try this out)
- “having the same granularity of the readout chip” → “having the same granularity as the readout chip”
- you need a comma in “HL–LHC), which will feature“

Section IV:

- “two pairs” is somewhat confusing, can this be simplified?
- “By contrast, the MIP-MPV trends”: why by contrast? Just say “The MIP-MPV trends”
- “reaches an higher“ → „reaches a higher“
- „a fluence more than twice as small“ → „less than half the fluence“
- „This well explains the advantage“ → „This illustrates the ...“
- „...doses, and, namely, the variation“ : it is either something in addition, then “and” is fine and “namely” must be removed, or it is a concretization of what was said before, then “namely” is fine but “and” must be removed.
- the comma before “doesn’t exceed ~90%“ must be removed
- „we obtain a detection efficiency of ~96.4%“: you should say at what voltage, so that one can compare. Also you can get rid of the „~“ here, since you quote a precise number.
- „the same sensor before the irradiation, at two bias voltages, 40 V (top plot) and 150 V (center plot)“ can be simplified to “the same sensor before irradiation at bias voltages of 40 V (top plot) and 150 V (center plot)”. Also in the caption of Fig. 8, where this is repeated.
- “independent from either the active layer thickness, or the“ should be „independent from both the active layer thickness and the“
- “or, at least, it would suggest” → “or it would at least suggest”

- Figs. 6, 9 13: if it's easy to do: „Bias Voltage“ → „Bias voltage“ in the x-axis label
- Fig. 7
 - the sentence starting with „top plot is for sensor“ does not read well. Consider something like: „sensor irradiated to ...(top), sensor irradiated to (center) ...“
 - In the caption: rms → RMS
- Fig. 8
 - Add a z axis label, i.e. a label for the color map, e.g. „Detection efficiency“
 - Axis labels: „short pitch“ → „Short pitch“, same for long pitch
 - In the caption, the last sentence is somehow messed up (“The efficiency clearly results affected...”)

Section V:

- the degree symbol in “5°” looks strange (see my earlier comment)
- In Table 1, add the unit “[%]” in the top row
- Full-stop missing after the very last sentence of the section.
- Fig. 9:
 - “sensor thickness is pixel 130 μm” → “sensor thickness is 130 μm”
- Fig. 10:
 - “and 25 x 100 μm² pixel size (2E).” → “and 25 x 100 μm² (2E) pixel size .” since “pixel size” refers to both sensors, while 2E does not.
 - “sensor’s ” → “ sensors’ ” (plural)
- Fig. 12: “before the irradiation” → „ before irradiation“
- Fig. 13: „ while the other is“ → „ while for the other sensor it is“ (or some other rephrasing)

Section VI:

- “capable to resist to the very high” : remove “to”
- “They are both thin planar and 3D sensors.” → „Both thin planar and 3D sensors have been produced.“
- „ A first round of tests on beam” → “First beam tests ... have been carried out...”
- The sentence starting with “Nevertheless, on the basis of” is very long and complicated. Simplify and / or split in two sentences.

References:

[9] Kastli → Kästli or at least Kaestli