

Dear Lea,

Thank you very much for the new draft. I find the paper improved significantly with respect to the first version. You have already received a large number of comments so I removed overlaps as much as I can below (but a few of the comments may be the same as other reviewers).

Thank you and cheers,  
Anadi

### General comments

- Check the consistency in using Fig. (in the sentence) and Figure (at the beginning) - same goes for tables, sections, ...
- You still have several updates to make highlighted in red
- There is some inconsistency in the way you quote numbers smaller than 10 in the text (2 vs two)
- make sure you use Phase 1 pixel detector (and not pixel Phase 1 ...) everywhere in the paper
- make sure you use a consistent tense (present, past, ...)
- please double check that you quote the same operating temperature everywhere in the paper
- after having read the paper for 2nd time I am wondering whether it would be useful to add a dictionary? You have a lot of acronyms that are (correctly) defined only once. Considering the length of the paper finding the definition is not always simple
- Please check the bib: some references are missing a space between the initial and the last name, spurious symbols like "-", ....
- In general I am not sure writing the name of the functions is appropriate for a paper. It is good for an internal note

targeting CMS collaborators who have access to the code. I would remove all instances.

### Line by Line

- Abstract: move "as its innermost sub-detector" at the end of the sentence; I would replace forward/background with end-cap
- L50 up to a MAX instant. lumi ...
- L53 have been exceeded --> would have been exceeded
- Section 2: I would change the logical order of sentences by starting from "The detector layout is optimized ..." Then "During L1 a new beam pipe" and closing with "as a result the CMS phase 1 pixel detector consists of ..."
- Fig 1 I would add the radius values of the original detector and the Z for both, or remove all numbers (given that you have the table below). The right diagram is redundant?
- What is a shell? Please review all definitions (shell, half cylinder, quadrant,...)
- Tab 1: you don't show the number of ladders/rings?
- Fig 3 It would be great to use the same template if at all possible. What is the "sensitive" material? Also I don't think you have contributions from "other"? As Katja wrote there is a typo in the title bottom right. Please increase fonts.
- Section 3: I would cite the size of the pixel here since you nicely describe that some of them are x2 as large etc
- Tab 2 invert dose and fluence in caption; also fix finv
- L147 I would state that it is parallel to the beam line or z axis (the B lines are not necessarily parallel everywhere)
- Section 3.1.: I find the description of the sensor type to appear too late. It is more interesting to know that we have n-in-n than how many vendors were used.

- I would move the operational details :159-166 to the end
  - L167-172 to after L195
- L158 I would not write "have been continued" since studies should be completed by the time a detector is installed
- L172 I would not write "both suitable for operation". They must be!
- L176-177 These sentences may be merged.
- L178 "Another advantage of ...." --> "This effect is less prominent in..."
- L179 higher than? not clear what you refer to
- L189 remove "are"
- L218/226 start the sentence with "Three/Eight sensors ..."
- L299/300 do we have results to show?
- L302 what was the expected and observed value?
- L307 conceived --> developed
- Fig 7 I would leave the results up to 650-700 MHz/cm<sup>2</sup> to show the margin
- L375 "some probability" - can you quantify?
- L385 do you have any updated results to include?
- L389 I would write "three module designs"
- L408/409 same sentence?
- L439 more automated with respect to?
- L446 I would drop "finally" it has a negative connotation
- L449 This sentence does not flow well. Can you reword it? I assume you want to say that "After failing modules have been reworked, the yield rose to 90%"?
- L556 do we have uncertainties on these 2 values?
- Fig 11 I assume you'll produce these 2 plots with the same format?
- Fig 12 caption: calibrate --> calibration

- Fig 13 caption: the statement "is determined for the module qualification" is not clear. Please clarify
- L569 please rearrange the numbers in brackets (there is no correspondence)
- L571 "a bit lower" is too vague, can you please quantify?
- Also I would try to provide % wherever possible for both BPIX and FPIX
- Fig 15 I think you want to rework this Fig as well (legend is really small)
- L592 'detector mechanics are attached' is jargon please reword
- L647, 648 an example where exact definition of quadrant, shell is needed
- Fig 19 top: it is hard to really understand the Fig. DO we have a better one? also the bottom one may not need the insert
- L670 what values of pressure?
- L824 It would be good to slightly expand on this: what modules, how many, ...
- L911 Why wasn't FPIX tested in the same way?
- Section 6.3 (and later on when you describe the installation): it would be very helpful if you had a schematics of the connections of the pixels to the cavern services
- L957 We cannot use the word "believe". We could use "it was determined that ..."
- L965 can you reference a paper?
- L1001 is this at the end of life?
- Fig 32 I admit that the difference between the 2 plot except for the assumed load is not clear. Shouldn't we show only one with the correct expected load?
- L1092 how was it improved?

- L1124 This sentence is not completely clear. What "the hub address is set before mounting ..." how is it set?
- L1135 how many modules in a group?
- L1140 foru --> four
- L1153 what does a slice contain?
- At the end of the BPIX and FPIX integration section I would specify the final number of non functional modules and % of channels
- The BPIX is much more detailed than the FPIX section. Can this be consolidated?
- L1319 Fig --> Figure
- Fig 42 Can you clarify the trend exhibited by the uncertainties? why is the uncertainty increasing with DAC given that it is the spread among channels?
- L1408 The in time threshold is different from what reported in Tab 3
- Fig 44 adjust the position of the sub figures
- L1417 were --> where
- L1496 what do you exactly mean with SEU cross sections?
- L1499 and 1514 there seems to be a tension between "very minor" and "10%"?
- L1533-44 It is not always clear what Fig you are referring you, I suggest you have a look
- Fig 47 caption: what is the definition of "broken cluster"?
- L1552 please spell out LA as Lorentz Angle here
- L1555-1572 I find this part a bit hard to follow.
  - It would be better if you started by showing the evolution of Vdep versus luminosity (as determined from a proper fit) and then relate that to the Vbias applied to the sensor.
  - I assume you don't have the values for different modules (old and new) for the same lumi? The

significance of the comparison as it is now is slightly diminished because of the different lumi.

- It would also be preferable if you explained each plot separately and in detail.
  - please use fb-1 everywhere (replace pb-1)
  - Top right: is the difference observed scaling according to the dose as expected?
  - Bottom left: why is the cluster size of old module 52/fb) smaller than that of old modules (32/fb)?
  - Similar questions for Bottom Right
- Tab 5 I would use Vbias instead of HV
- Fig 51 this figure is very hard to read even on the laptop. Please reformat it. You could have 2 plots instead of 1 reducing the number of points, increasing legend size etc
- 1596 suppose --> supposed
- going to max voltage is jargon, applying max V is better
- L1594 and needs --> which needs (the power needs to be removed, not the leakage current)
- The leakage current can be --> The increase of leakage current can be ...
- 1603 please specify the value of the scale factor and why they differ layer to layer
  - Explain why the ratio data/sim is different from 1 for each layer at the start