Andrea's comments to v4
Most of the comments are about style or to improve a bit further clarity. Only a few comments are substantial (indicated in bold) even if they can be fixed trivially.

Line 46: using "detectorS", plural, implies that we should cite other pixel detectors used in other experiments than CMS. I have no strong opinion: we can turn it into singular if you like. → changed to singular

The paragraph in rows 59-63 and the sentences in rows 55-58 could be merged or better coordinated to avoid a bit of duplication. All the concepts expressed there are interesting: nothing should be removed
Ok, changed to:

In order to maintain efficient and robust tracking at CMS under these conditions, the original pixel detector has been replaced by a new system, referred to as the \cmsph~\cite{Dominguez:1481838}. The installation of the \cmsph took place during the LHC winter shutdown 2016/2017.}

The \cmsph constitutes an evolutionary upgrade, keeping the well-tested key features of the original detector and improving the performance toward higher rate capability, improved radiation tolerance, and more robust tracking. It is expected to deliver high quality data until the end of LHC Run 3 (expected for 2024), after which the whole CMS tracker detector will be replaced in view of the High-Luminosity LHC~\cite{Collaboration:2272264}.

Line 82: "but" should be replaced with "and" → ok

Table 1: there is a comma which should be replaced in L2 row → fixed

Caption figure 3: remove "upgrade" → ok

Line 126: write something like "higher pseudorapidity REGIONS" →ok

Table 2: I suggest to use "ringS", plural. → ok

Line 155: add that the pixels are oriented with the long side parallel to the beam line → ok The pixels are oriented with the long side parallel to the beam line.

Line 170: can you check if "micro system and sensors" requires capital letters? → fixed following comment by Ulrich

Line 192: add an hyphen between "electro-collecting"→ ok

Line 231 and 232: please check 37 degrees and 215 um. In the section about the LA measurements the resulting LA is 27 degrees. Is there a typo which got propagated in the estimate of the charge width?

Yes, it is a mistake, it should be 27. The resulting width should be 145um.
We corrected it. Thanks.

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We corrected it. Thanks.

Lines 278 and 281: check if "double column" should be, actually, "double-column periphery" → The buffers are in the periphery but it is the whole double column which is set to readout-mode and therefore cannot make hit requests any more.

Around line 302: We should add one sentence that confirms that PSI46dig performance were well within expectations during pp collisions. This is in parallel to the sentence in row 320 → The sentence starting in line 303 "Based on ... " states already that p-p is OK. Anyway we have added a sentence.

Lines 322 and 323: Isn't "high hit rates" better than "high data rates" in this case? → yes, changed

Lines 324 and 325: concerning the statement in parenthesis: the procedures are described also in this section. I would remove the parenthesis and write something like "described late in this section and in sections 10 and 11" → ok, instead, removed the parenthesis all together.

Line 331: is it "high trigger rates" or "high hit rates" which matter in this case? You are right. Fixed.

Line 351: add "to synchronize the MODULE data transmission" → ok

Figure 7: I think we should remove the lines "with resets" because it is a different reset from the one described in row 341 and we give the false impression that with the 70 Hz reset also the old PROC600 behaved nicely at high hit rate. The cons is that we do not explain why we have not caught this problem during the module testing (we explicitly describe the X ray test among those done to grade the modules). Alternative solutions are:
1) Explain that in figure 7 the resets are issued after every trigger
2) Repeat the measurement of figure 7 with a 70 Hz reset (it can delay further the paper…) → Repeating the measurement at 70Hz is impossible within any practical time window.
Removing the line could be done but it then misses an important message,
We have added a comment in the caption.
I think it is justified that the test and the data taking were done under somewhat different conditions.

Line 361: add commas before and after "with one path inverted" → ok

Line 372: I do not understand why digital zeros are not needed also for the TBM08:

does it merge two different readout paths, too? I think I have asked this question already and maybe you answered (and I have not checked).

→ yes, here are comment and answer to v1. This is a feature that has been added to the newer version of the TBM and has not been there for TBM08.

Lines 344-348. I am not a TBM experts but I am confused by the statement that one 160 Mb/s path is kept
in sync with the other one by adding zeros only in TBM09 and TBM10 and not in TBM08. I am also
confused by the TBM08 paths being INdependent while the ones of TBM09 TBM10 are more dependent. I
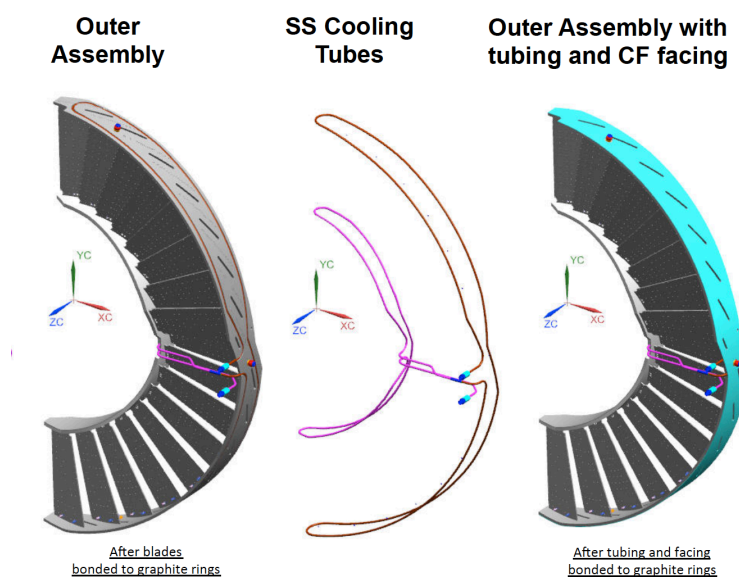would have guessed the opposite.
-The semi-independent nature of the TBM09 and TBM10 was a specific request from PSI. This is the real
situation. I think Roland was a bit paranoid about synchronization, but that is just a guess on my part.

Line 382: indicate what has been the actual setting during the physics run. → The setting used is 147usec. Add a sentence.

Line 556: I would replace "about THIS calibration" → ok

Line 565: adopted à adapted → changed

Lines 731 and 733: I realized that reading this sentence I don' get where the cooling loops are embedded: there are two rings (called assemblies in this section) in each disk and two cooling loops in each disk: one for each assembly. Each assembly has two graphite rings: an inner and an outer one. In which of the FOUR graphite rings are the TWO cooling loops? → One cooling loop goes through both, the outer and inner graphite ring of an assembly (see picture below). We are open to suggestions on how to make this more clear.

Outer Assembly	SS Cooling Tubes	Outer Assembly with tubing and CF facing
After blades bonded to graphite rings		After tubing and facing bonded to graphite rings

Line 778-779: quote also the inner diameters of those pipes → ok

Line 793: also for FPIX states that the end flange is used to connect the detector ground to the CMS ground → ok, added: The CMS central ground wire is connected at the end flange.

Line 816: clarify that 10 Gb/s is the data transfer speed of each FED → ok

Lines 818-820: make more clear that FEDs and FECs are FC7 boards with different f/w (and different FMCs) → ok, added a sentence.

Line 860: "DCU" is not defined in the paper → removed

Line 1026: "HEP" is not defined in this paper → changed to "particle physics"

Line 1121: add a comma between setup and measurements → ok

Line 1133: replace "for THE short commissioning" → ok

Figure 31: add the information about the direction of the CO_2 flow in the two graphs. I think it is opposite in the two cases. → ok

Lines 1423-1424: I am wondering if this reference to section 3.6 is needed:
- we have a more precise reference in row 1428 when we remind the S-curves method
- in rows 1416-1420 we explain briefly the strategy
- in row 1420 we refer to the paper [2] for more details.
I think that this reference to section 3.6 could be misleading here. → ok, removed.

Line 1474: I would replace "The calibration of the internally injected charge" with "In the offline reconstruction the conversion of the internally injected charge from Vcal DAC units to electrons is done using..." → ok

Line 1567: add "charge trapping" and an additional cause of signal loss → ok

Lines 1567-1570: First of all, it is not only recalibration but also adjustment of the HV bias set points. Secondly, we have to report in the paper the HV bias settingS we have used in 2017 and 2018. No need to go in details but we can say we started at xxx V and at the end of 2018 run (after zz fb-1) we operated L1 at ... L2 at ... L3 and L4 at ... FPIX at ...
Added a sentence added.

Line 1571: clarify that we use the cluster charge associated to reconstructed tracks ("on-track") → done

Line 1587: is there a sensible paper (CMS or PIXELAV) to be cited to support this statement? What about TRK-11-001? The original PIXELAV paper? → Added reference to the tracking paper.

Caption figure 47: replace with "CLUSTER hit efficiency" → ok