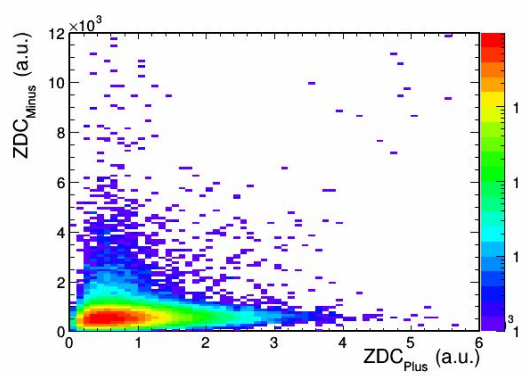
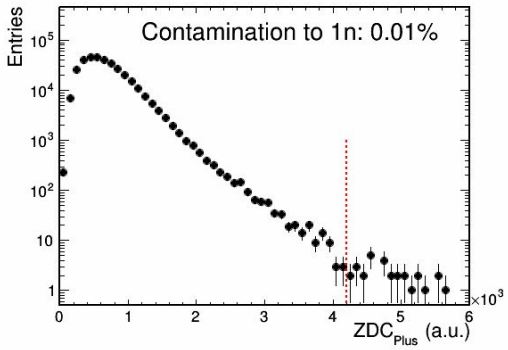
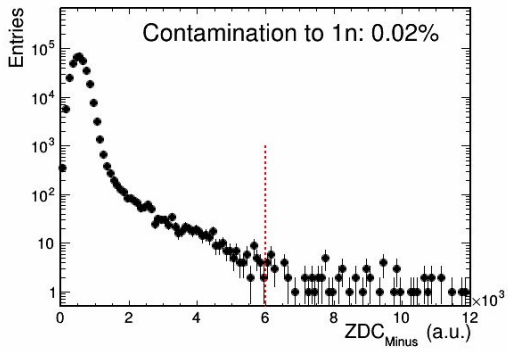
- Noise in ZDC: Can you check if there is an "isolated bunch" trigger? Without it, how do you know if the peak in your plan is really 1n, and not some mode of noise? What does the pulse shape look like in ZDC? How long is the tail?
    - We used the empty BX-s between bunch trains for this study, specifically with BXIDs 18-58, 204-228, 393-416, 581-604, 769-792, 904-931, 1095-1119, 1284-1307, 1471-1495, 1660-1683, 1796-1822, 1987-2010, 2175-2198, 2363-2386, 2550-2577, 2688-2709, 2877-2901, 3066-3089, 3254-3277, and 3442-3563 of fills 7450, 7454, and 7457. For instance, the bunch information of fill 7457 can be found in https://cmsoms.cern.ch/cms/fills/bunch_info?cms_fill=7457. The ZDC noise distributions can be found below and the noise tail contribution to neutron peaks is found to be negligible. Meanwhile, we added this plot in AN v7.



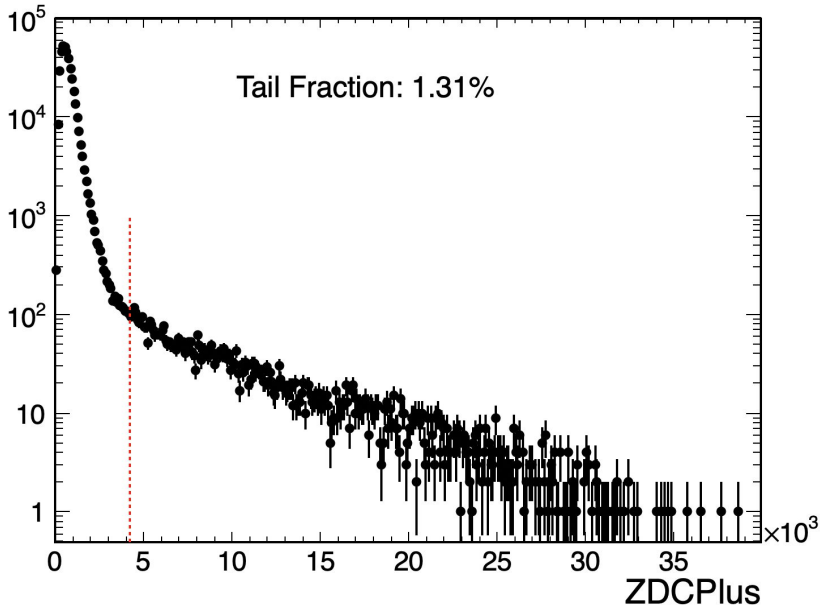




- Combinatorial: the problem is the wording "combinatorial", there is nothing else in the event to combine
    - Remove "combinatorial"
- Beam-intensity check: not much detail is in the approval backup, can you point me to the relevant location in the AN?
    - Added this part in the updated AN v7 section 5.7
- \upgamma for Lorentz boost is a good idea. Have you tried \usepackage{upgreek} to see if that enables the command?

    - We changed γ to γ_L for Lorentz factor to avoid potential confusion
- l47: misplaced comma. Could change to: "The PbPb sample, when requiring functional zero degree calorimeters (ZDC), corresponds to..."
    - Done
- l50-51: need to be rephrased, since the core is not pure LO and the tail is not pure HO. You should write that you separate the core from the tail, where the former is dominated by LO while the latter is dominated by HO.
    - Rephrased to “The α spectrum of $\mu^{+}\mu^{-}$ pairs is decoupled into core and tail components, where the core is dominated by leading-order $\gamma\gamma$ scattering while the tail is dominated by high-order $\gamma\gamma$ interactions.”
- should we change the acoplanarity symbol from alpha to A_phi? This is what is used by FSQ-16-012 and HIN-19-003
    - If possible, we would like to keep α denotation to keep consistency with other experiments. Practically, α shows up everywhere (text and plots of paper and note) in this analysis, it is not super easy to change all of them.
- Line 89-90: use an asymmetric example - 1nXn instead of XnXn. This way readers will know one is from one side the other is from the other side
    - Done
- l94: remove "combinatorial". This background has nothing combinatorial. In the answers you write that this is inelastic collisions. It should be fine to simply call it "background", you can add "inelastic" or "non-UPC" or "non-electromagnetic" if you want to add something.
    - Removed “combinatorial”
- l111: in -> for
    - Done
- why not account for neutron peak resolution together with EMD pileup: not very satisfying answer in your document... Can you explain again why this can’t be done?
    - When we correct neutron contamination because of detector resolution, we need the alpha or mass distribution from **exactly 2n emitted** (e.g. 0n**2n** contamination to 0n1n) selected by tight ZDC cuts. In our current matrix, we do not have distributions from exact 2n but >=2n, and we cannot use >=2n distribution instead of exact 2n distribution to do the correction. Therefore, it is not trivial to combined these two kinds of correction into one matrix
- since you also see neutron peaks in emptyBX: doesn't your EMD PU correction account for both in-time and out-of-time pileup? If that is the case, a short note could be added somewhere to the paragraph about it (starting l114)
    - Yeah, the current procedure does take care of the out-of-time pileup if any. However, the ZDC distribution (from all triggered emptyBX) shown in our last responses to approval homework is not an apple-to-apple comparison to that in normal data taking. In emptyBX data, we could trigger any empty BX between the BXs with two beams, which means BX with two beams could happen right after

the triggered empty BX. In that case, the signals from the next BX with two beams will be treated as ZDC signals according to the ZDC signal definition developed by ZDC group. However, in normal data taking, two triggered events at least have 4-BXs interval (100 ns), the tail contribution of previous BX (out-of-time pileup) with two beams is on the order ~10^{-4}-10^{-3} according to the discussion with Quan Wang, a ZDC expert. Meanwhile, I did a quick cross check using the emptyBX data, as shown below. I only selected the triggered empty BX **RIGHT AFTER (25ns)** the BX with two beams, the tail contribution (out-of-time pileup) to neutron peaks is ~1.3%. Because of the exponentially decreasing feature as time, the contribution of out-of-time pileup in the UPC (collision) data with 4-BX interval (100ns) is negligible.



- Figure 1 caption: vertical bars => vertical lines
  - Done
- Figure 2: y-axis change to <alpha^core>, to be consistent with the symbol in the text
  - Done
- Figure 2 caption: vertical bars => vertical lines
  - Done
- l128: "Figure 1 shows the alpha distributions of mumu pairs in PbPb collisions, corrected for efficiency and dissociative pileup, for different neutron..."
  - Done
- l132: is nearly all from (x2) -> is dominated by, mostly originates from
  - Done
- Line 134: ...include for example soft photon…
  - Done
- l135: remove "etc."
  - Done

- l139: not sure you can refer to supplementary material in the main body (probably not)? But if you can, then the planned supplementary material (in the sense of material submitted to the journal, not simple public plot posted to the CMS public page) should be included in this paper draft.
    - We plan to submit this supplementary plot to the journal. If we cannot, we probably remove this rapidity dependence sentence in the future.
- Line 155, 158, 159, 161: it is clear everything here refers to <alpha^core>. No need to keep repeating
    - Removed duplicated <alpha^core>
- Line 169-172: this sentence doesn't really add anything to the paper
    - Removed this sentence
- Line 173: show => has
    - Done
- l175: (1.227 +- 7 (stat.) +- 8 (syst.)) \times 10^{-6}. Give numerical value for STARlight prediction.
    - Done
- l177: \sim -> about
    - Done
- l178: rephrase: "A constant fit... yields a chi2 with a p-value corresponding to 5.7 sigma"
    - Done
- l190: missing comma after "spectra" (also, spectra -> spectrum)
    - Done
- <M> results are given before the associated systematic uncertainties are discussed! not good. Suggest moving this discussion of systs. on <M> earlier, together with those on <alpha>.
    - Moved to the systematic paragraph
- Line 191: extrapolate => interpolate, or estimate
    - Done
- Line 191: underneath => in the
    - Done
- Line 192: extrapolation => this procedure
    - Done
- l198: clearly -> much
    - Done
- Line 199: it's not energy, it's virtuality. If PT is 0 you won't have any alpha
    - We think they do not conflict with each other, the tiny virtuality results in a back-to-back feature between muon pairs. Therefore, the pair mass is proportional to the sum of photon energies. If you are not satisfied with this term, we are happy to hear your suggestion of rephrasing.
- remove "Preliminary" from figures
    - Done