5.2 KT homework 4

5.2.1 c)

After processing the data provided in the CSV files, we determined that the required cell size is approximately 11.7 cm for the pion π^0 originating from the B^+-decay, and 85.6 cm for the pion π^0 from the D^0-decay.

The LHCb experiment (Large Hadron Collider beauty experiment) employs calorimeter cells with sizes ranging from about 4×4 cm to 12×12 cm, depending on the detector region.[1]

Therefore, we can conclude that the cell size required for the B^+-decay lies within the existing range, whereas the maximum cell size estimated for the D^0-decay significantly exceeds the current design parameters.

In summary, a calorimeter capable of capturing photons from both the B^+- and D^0-decays is feasible within existing ranges, though additional considerations are necessary.

It is important to note that cell size is not the only factor in calorimeter design.

One critical constraint is the radiation resistance of the calorimeter, since it will be exposed not only to photons but also to other particles such as protons, neutrons, and pions.[2]

Another factor is ion production in scintillator crystals, which can disturb the electric field and lead to additional heating.[3]

Further challenges arise because calorimeter performance and charge collection degrade with increasing luminosity, which also shortens their operational lifespan.[4] [5]

Finally, operating temperature must be carefully controlled. Higher temperatures increase electronic noise, making efficient cooling systems essential for stable calorimeter performance.[6]

[1] See LHCb calorimeter design details: `https://cds.cern.ch/record/684651/files/ep-2003-032.pdf`

[2] Radiation resistance challenges discussed in: `https://arxiv.org/pdf/2503.03362`, Section 2

[3] Ion production effects: `https://inspirehep.net/files/6bebcec9e006b2c6feee2627349e9985,p.1`

[4] Luminosity effects on calorimeter lifespan: `https://cds.cern.ch/record/2293646/files/CMS-TDR-019.pdf`, p. 11,

[5] Secondary Source if the first doesn't work, `https://www.mdpi.com/2571-712X/8/1/4`

[6] Temperature and noise considerations: `https://indico.cern.ch/event/1508456/contributions/6649114/attachments/3132861/5558029/006_CMS_ECAL_HL.pdf`