Vertex Detector material budget in the MuSIC geometry

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Current layout

Current Vertex Detector geometry uses the old material budget definition:

- **material in a single layer:**

active sensor	passive material
50 µm of Si	**140 µm of Si**
~0.05% X_0	**~0.14% X_0**

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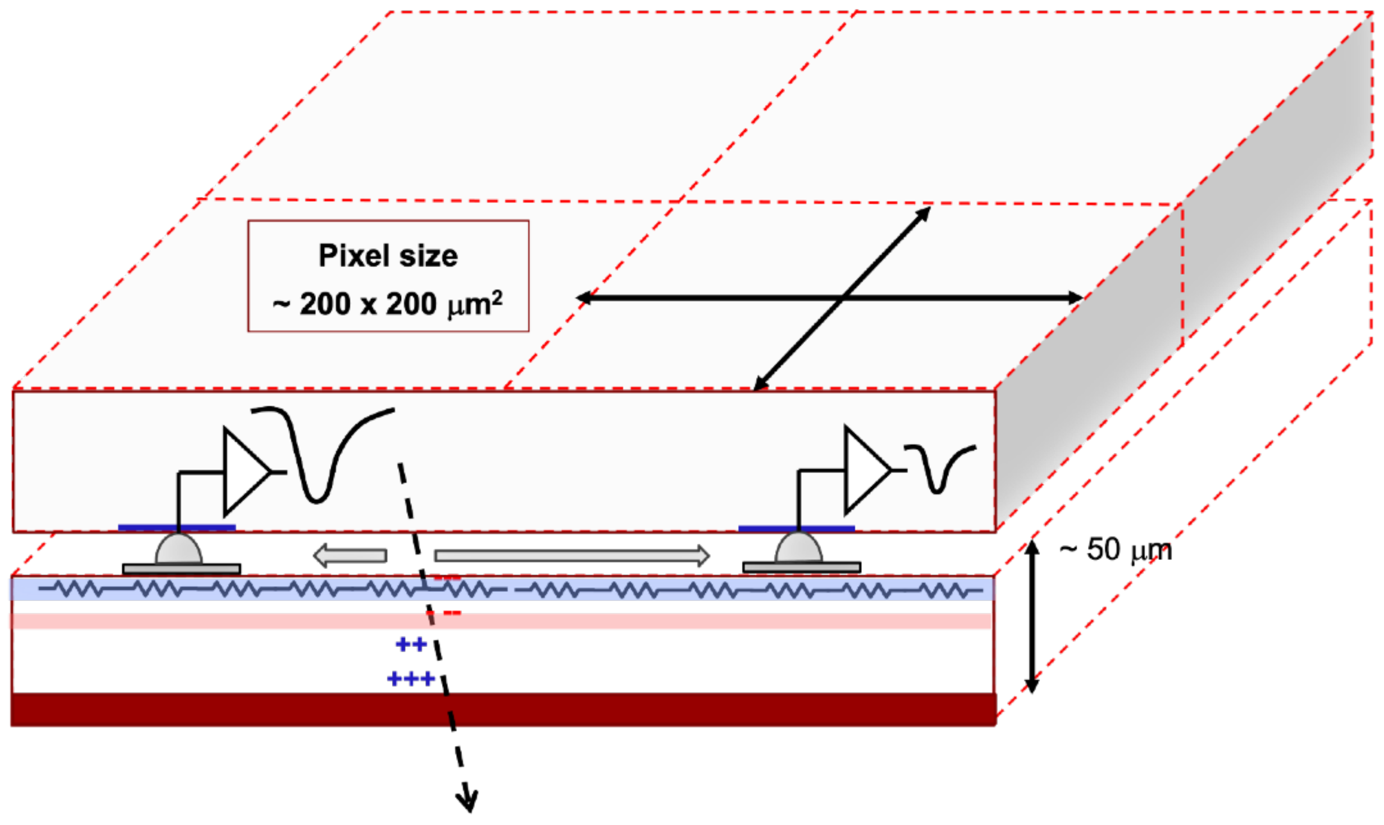
consistent with the sensor technologies we are considering: LGAD, RSD, MAPS



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NOT what we plan to use

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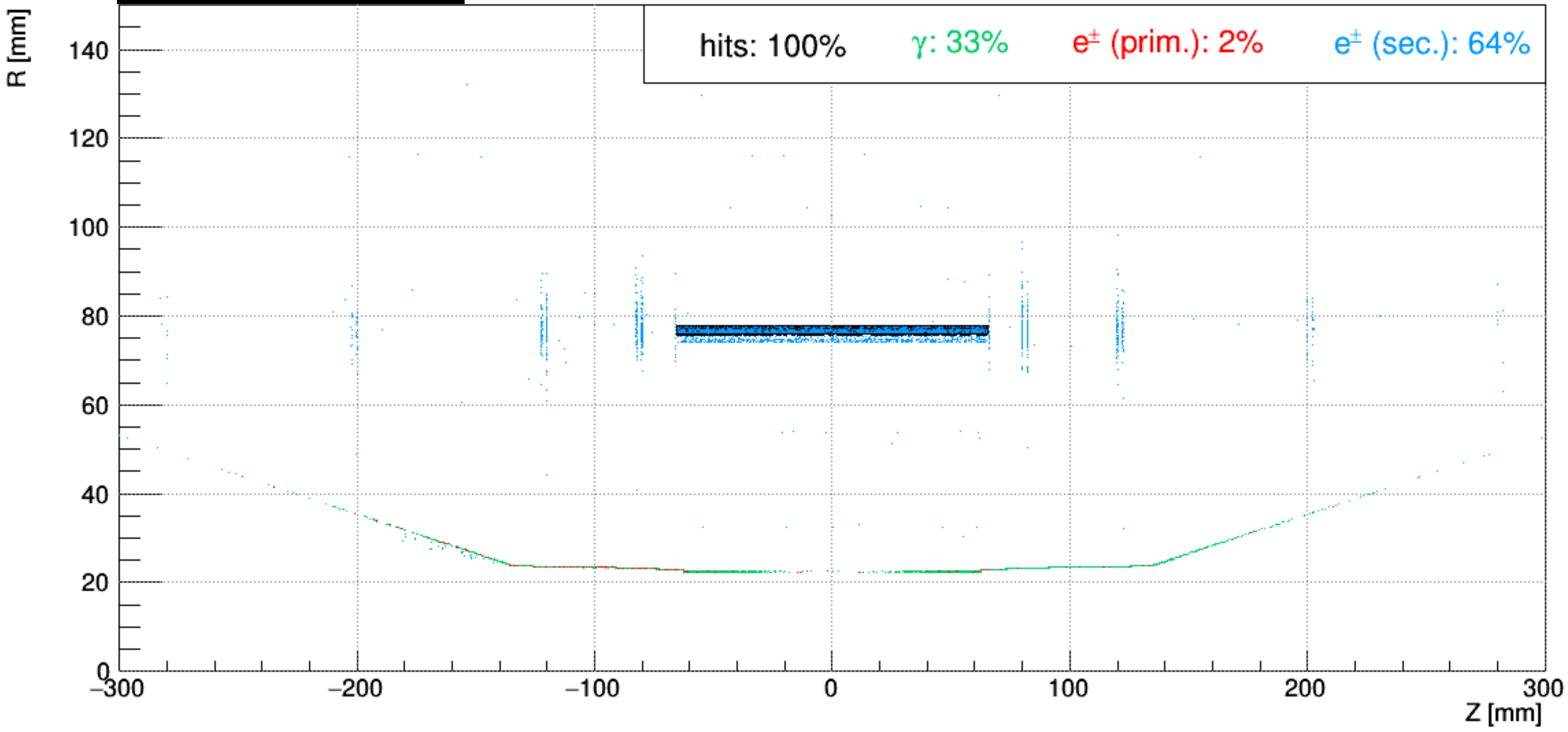
Actual amount of passive material defined by the technology

Considering two extremes: (no dedicated cooling)

- **classical scheme** (chip + HDI + support): **1% X_0** *taken from CMS HL-LHC pixel tracker*
- **monolithic scheme: 0.19% X_0** *taken from CEPC MIMOSA prototype*

BIB interacting with the tracker material contributes a lot to the occupancy
by producing secondary low-momentum e± particles

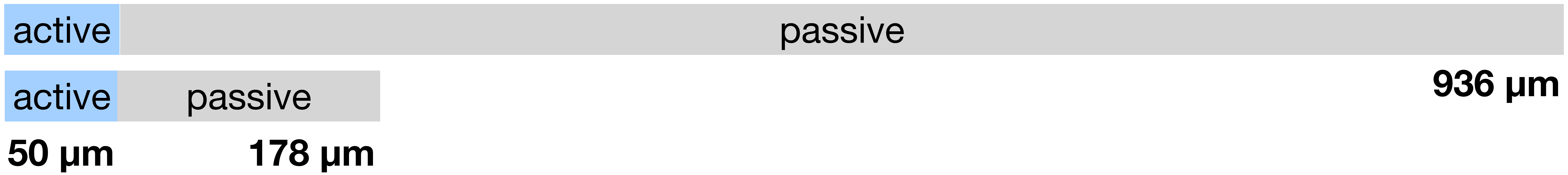
VTX Barrel: Layer 5 *- from an old 3TeV simulation*



Realistic layout

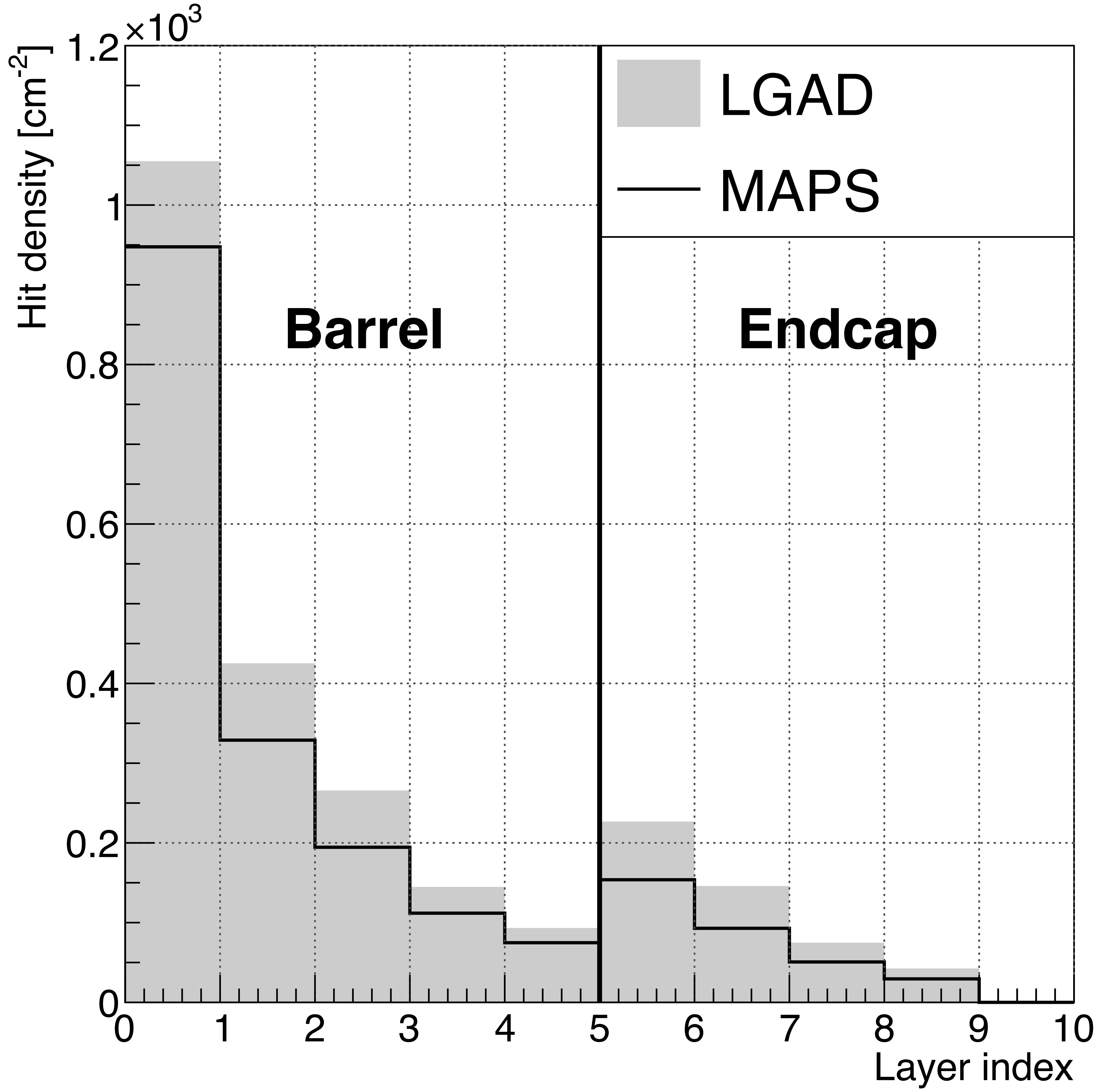
Simulated two variations of the MuSIC v2 geometry with BIB from a 10TeV μ^- beam

- **LGAD:**
- **MAPS:**



Simulated two variations of the MuSIC v2 geometry with BIB from a 10TeV μ^- beam

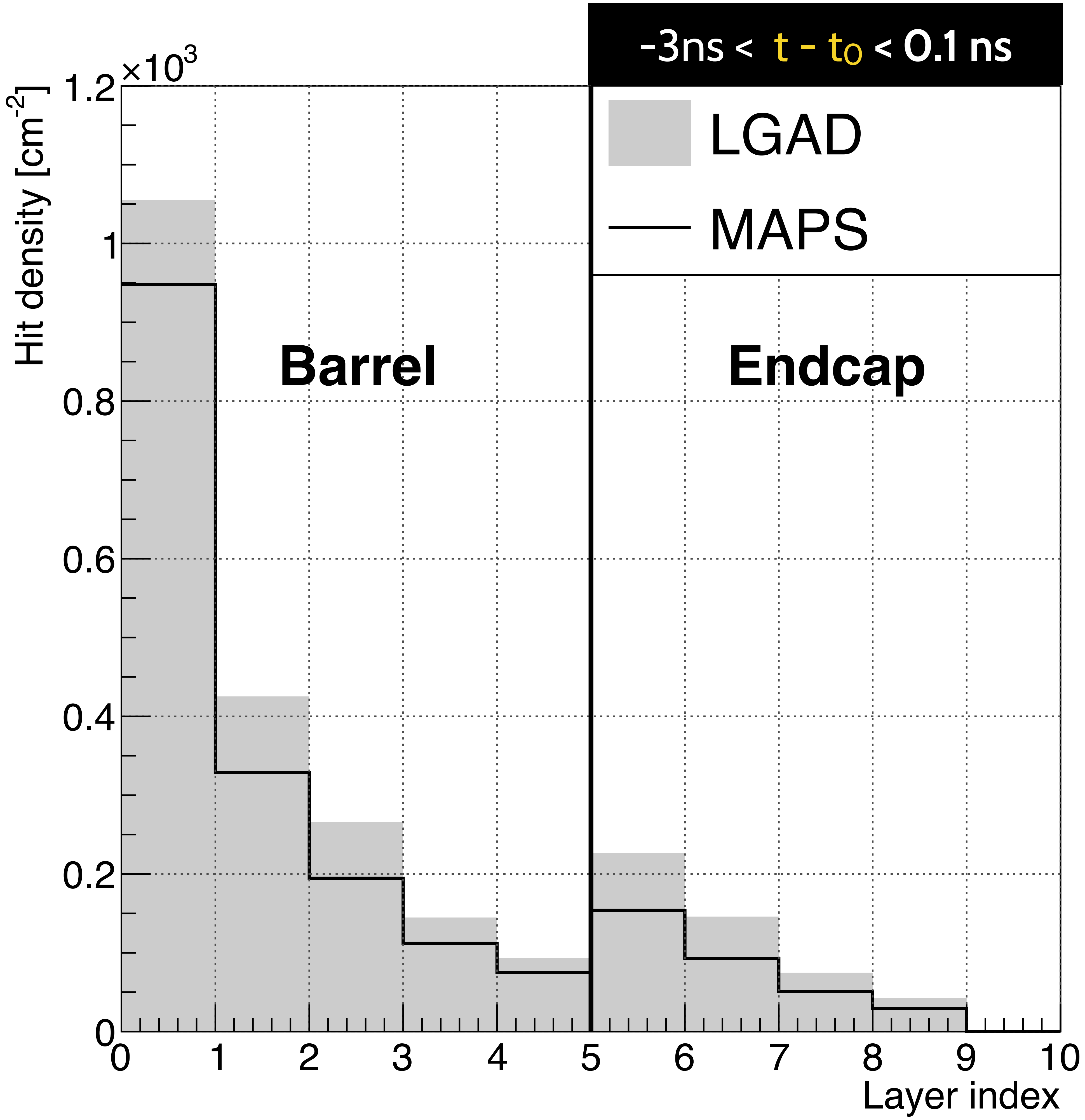
- **LGAD:** active | passive — 936 μm
- **MAPS:** active | passive — 50 μm, 178 μm

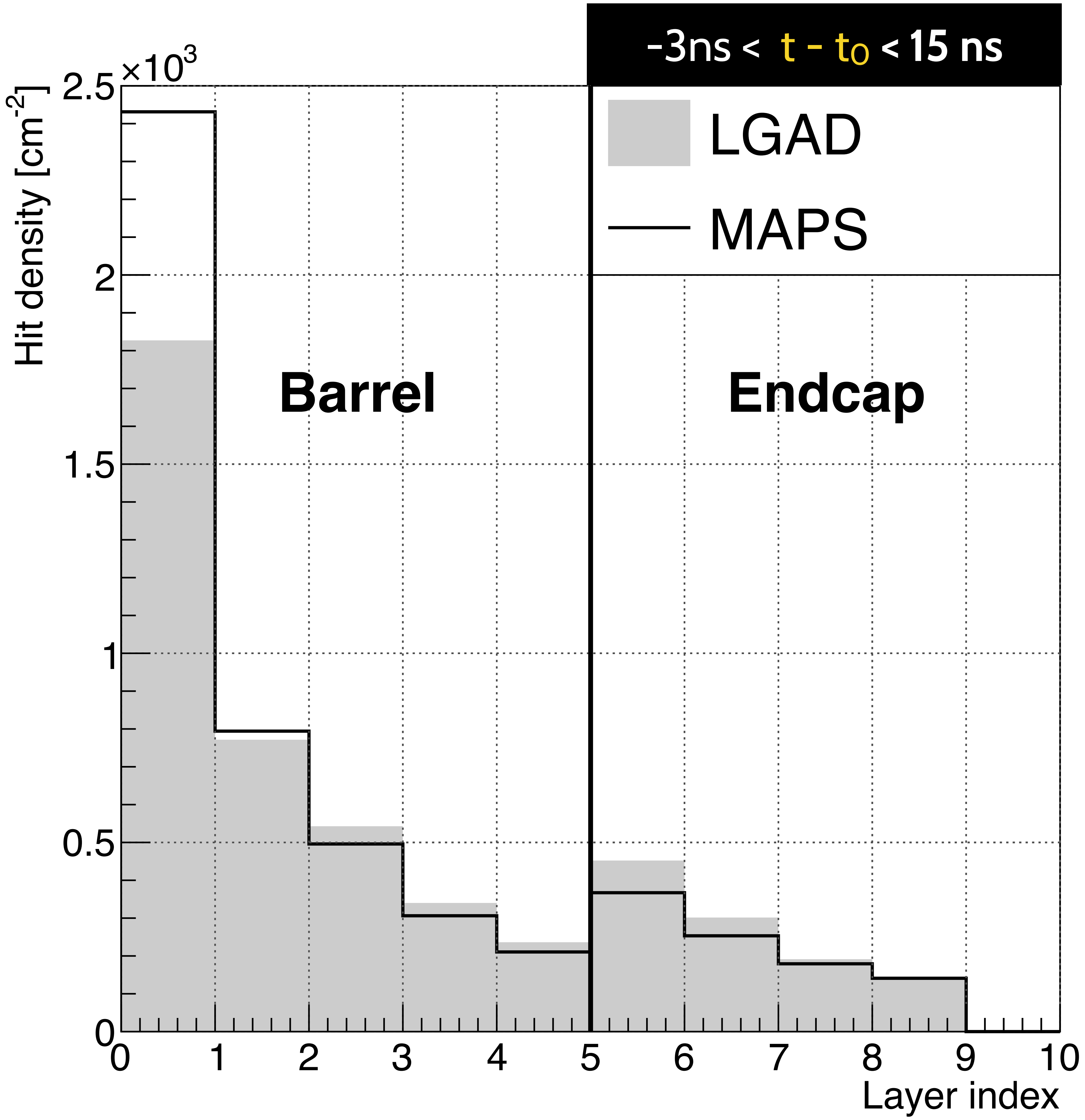


Extra material in the LGAD scheme increases hit density by 10-30%

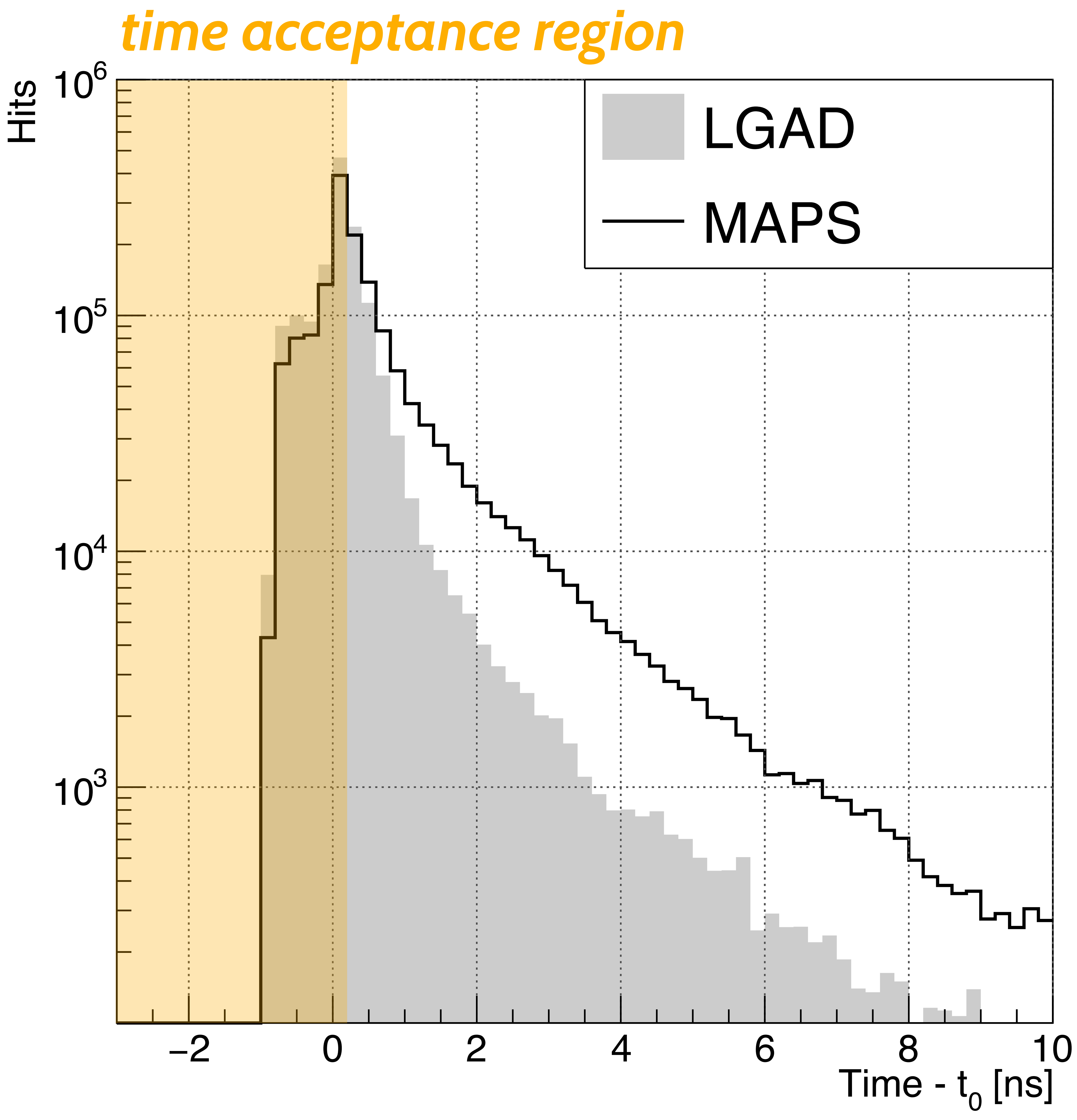
Effect on the timing

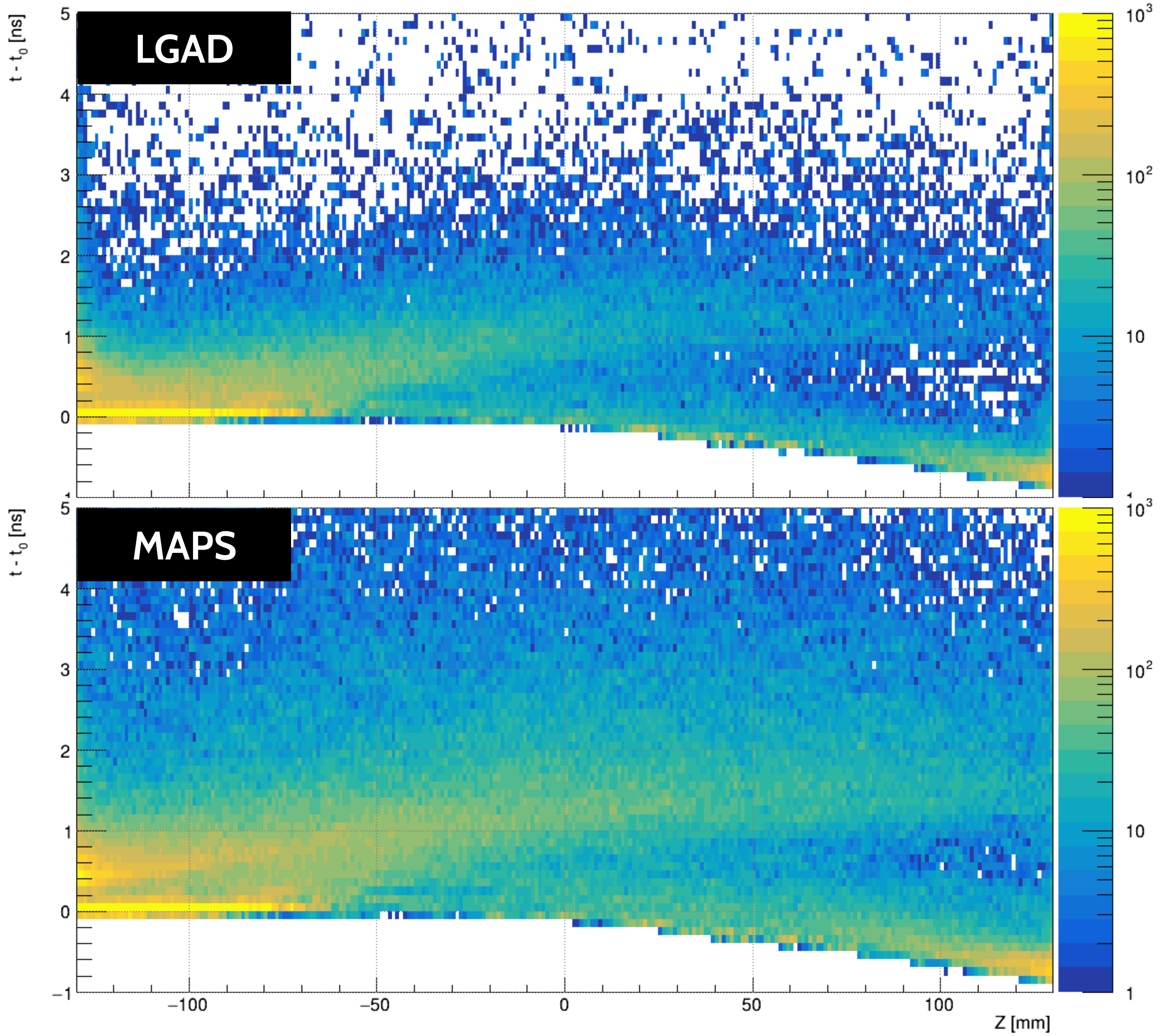
Total number of hits actually increases in the inner Barrel layers with lower material budget





There are extra hits created at larger delays: must be looping e± that were not stopped earlier





Conclusions

We need to include realistic amount of passive material in the Vertex Detector geometry

Going with an LGAD-like design could be a good choice if we want to be conservative