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Towards fast background simulation with the CLIC framework

Muon Collider meeting

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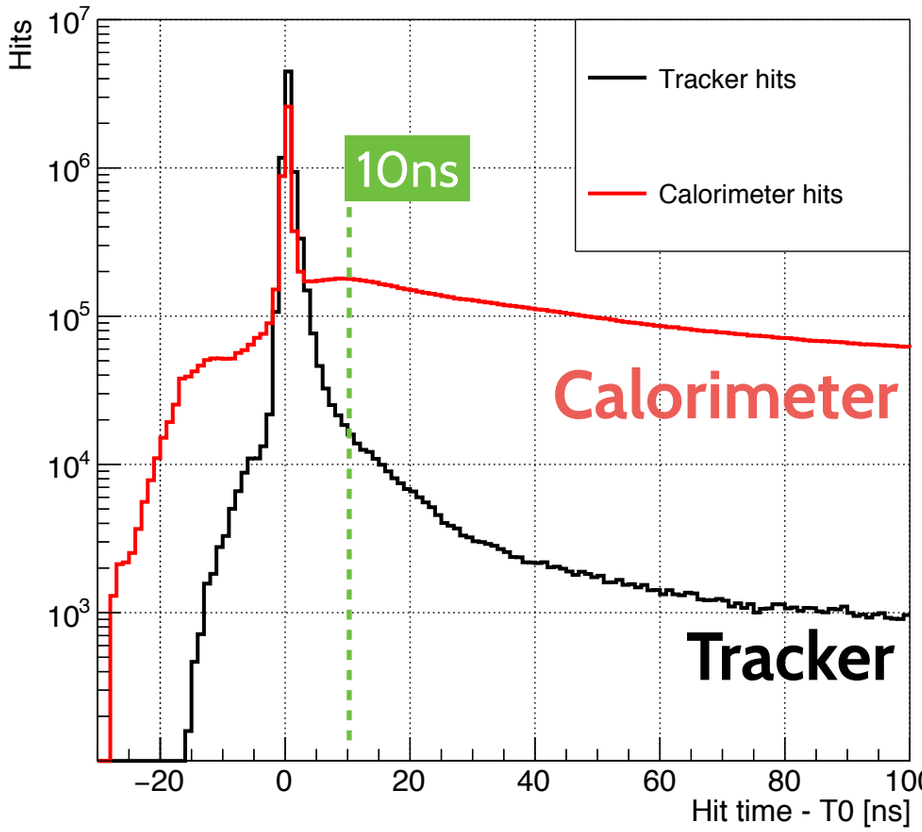
Optimising the background simulation

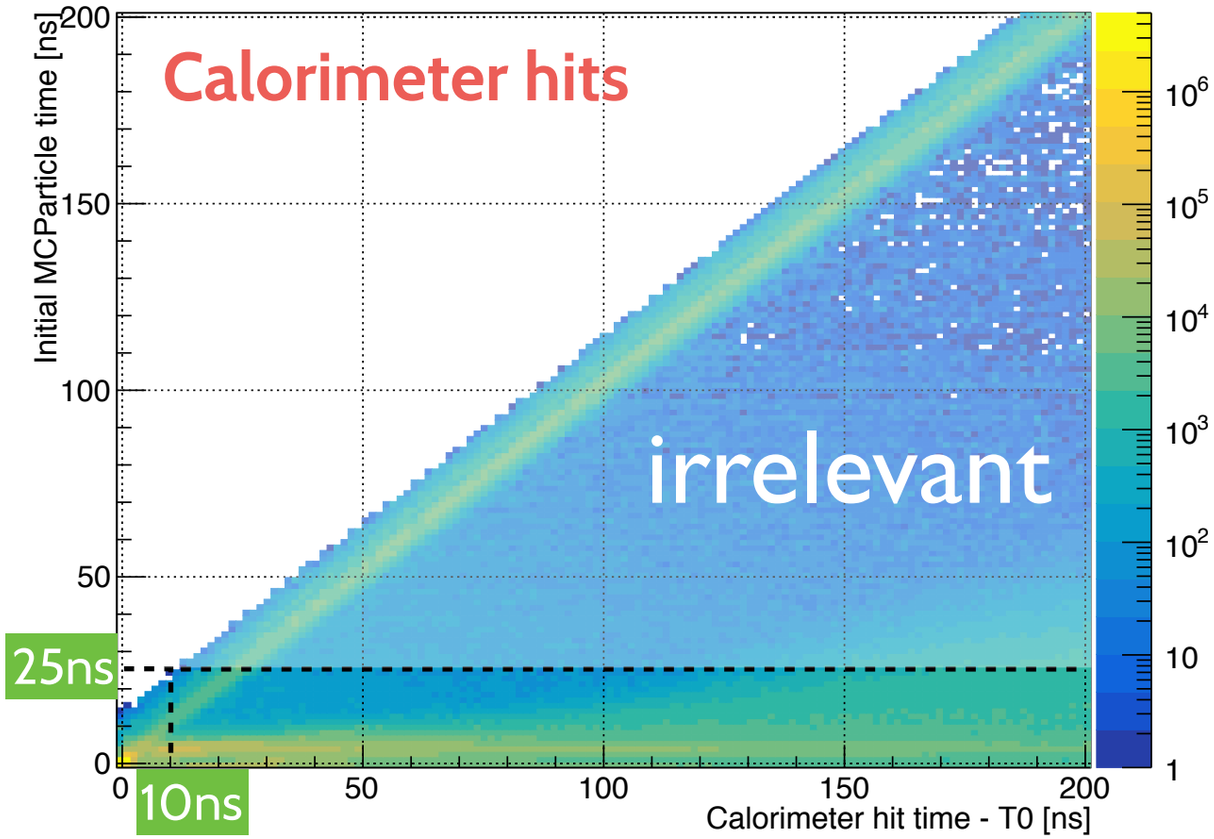
We start with 190M particles from each beam [$\mu^- + \mu^+$]

- simulating 1 bunch crossing takes 8 days [*at 8 parallel threads*]

Only hits in the short readout time window [~1 ns] are relevant

- assuming very conservative window: **10ns**
- finding time of the initial MARS15 particle responsible for each hit

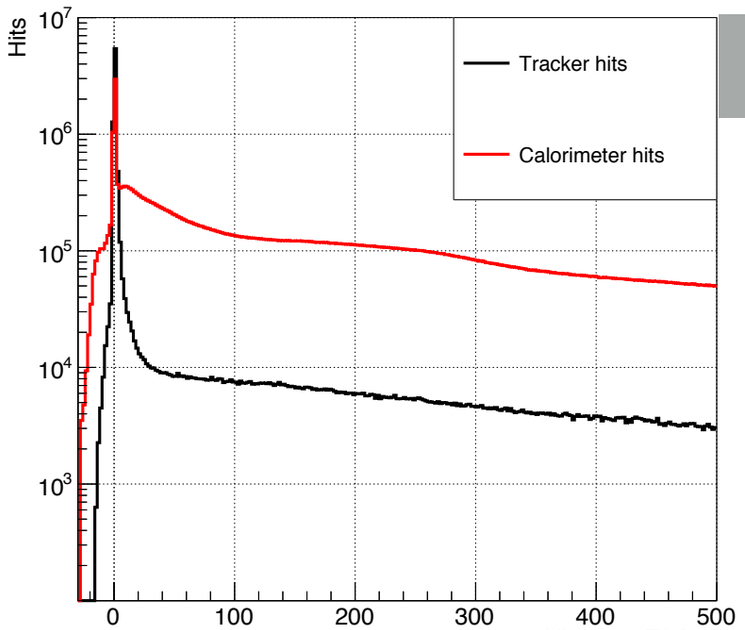




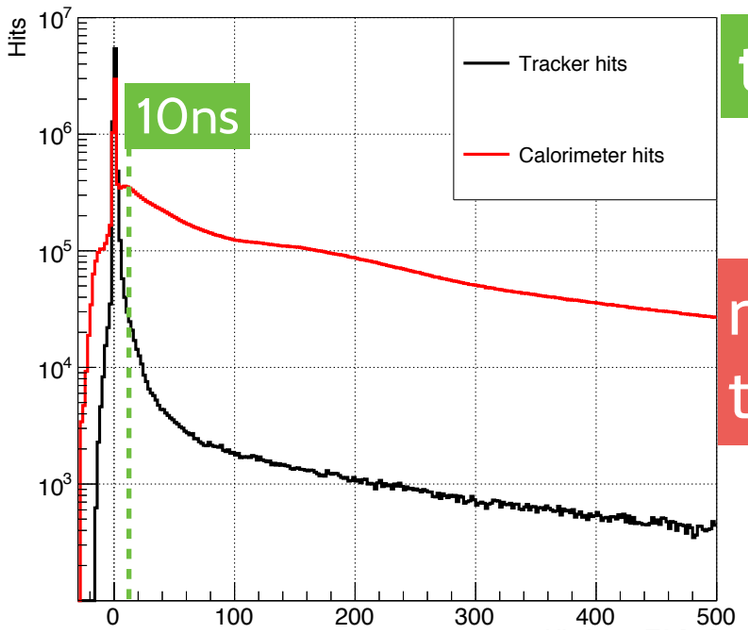
selection	*# of particles*	*CPU time*
all	380M	380 h
t < 25ns	98M (26%)	60 h (18%)

Optimising even further

Many hits from particles at t ≤ 25ns still appear in the detector too late



all



t ≤ 25 ns

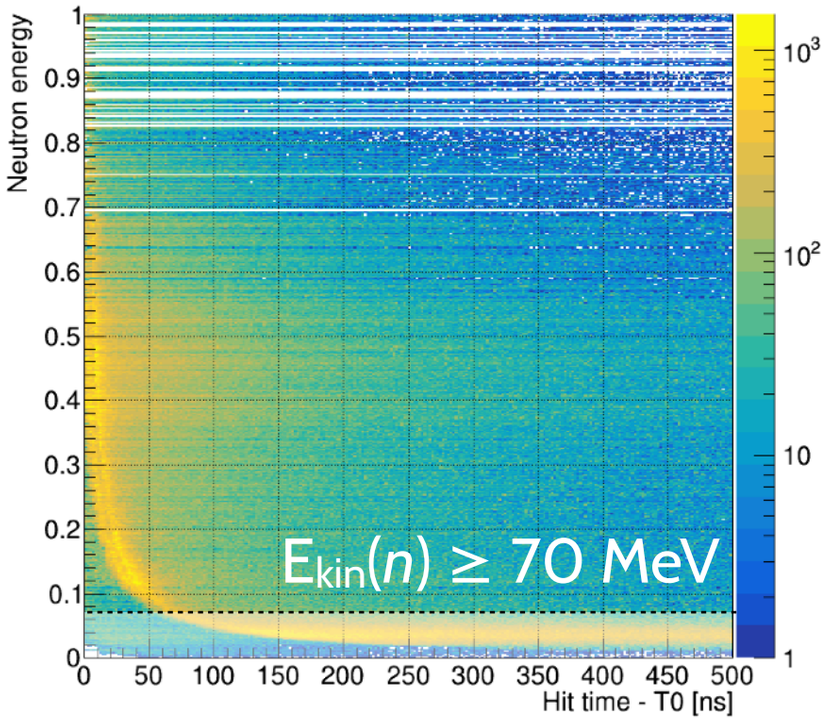
most crytical in the calorimeter

Most hits at large ***t*** offsets are from the **low-energy neutrons**

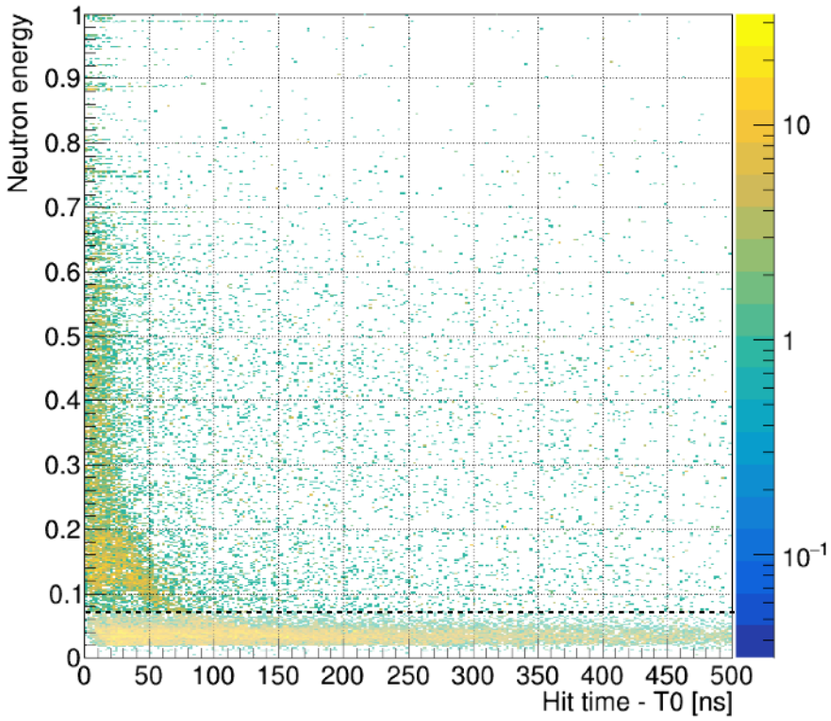
↳ slowest to simulate

Skip slow neutrons using a E_{kin} cut

Calorimeter hits



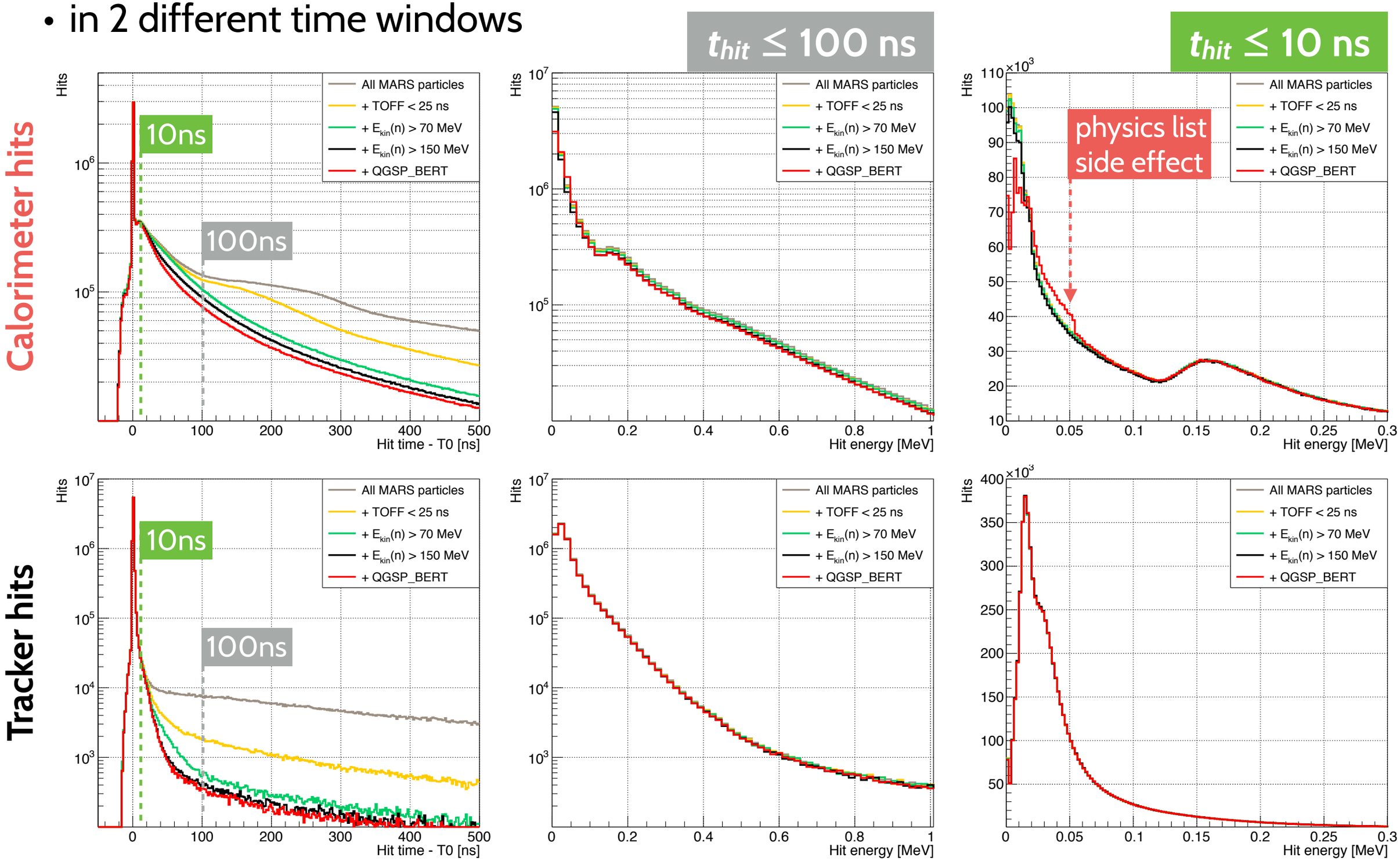
Tracker hits



Slow neutrons removed: hit energy

Comparing simulated hit energies at different levels of optimization

- in 2 different time windows



Slow neutrons removed: CAL hit positions

Comparing simulated hit positions at different levels of optimization

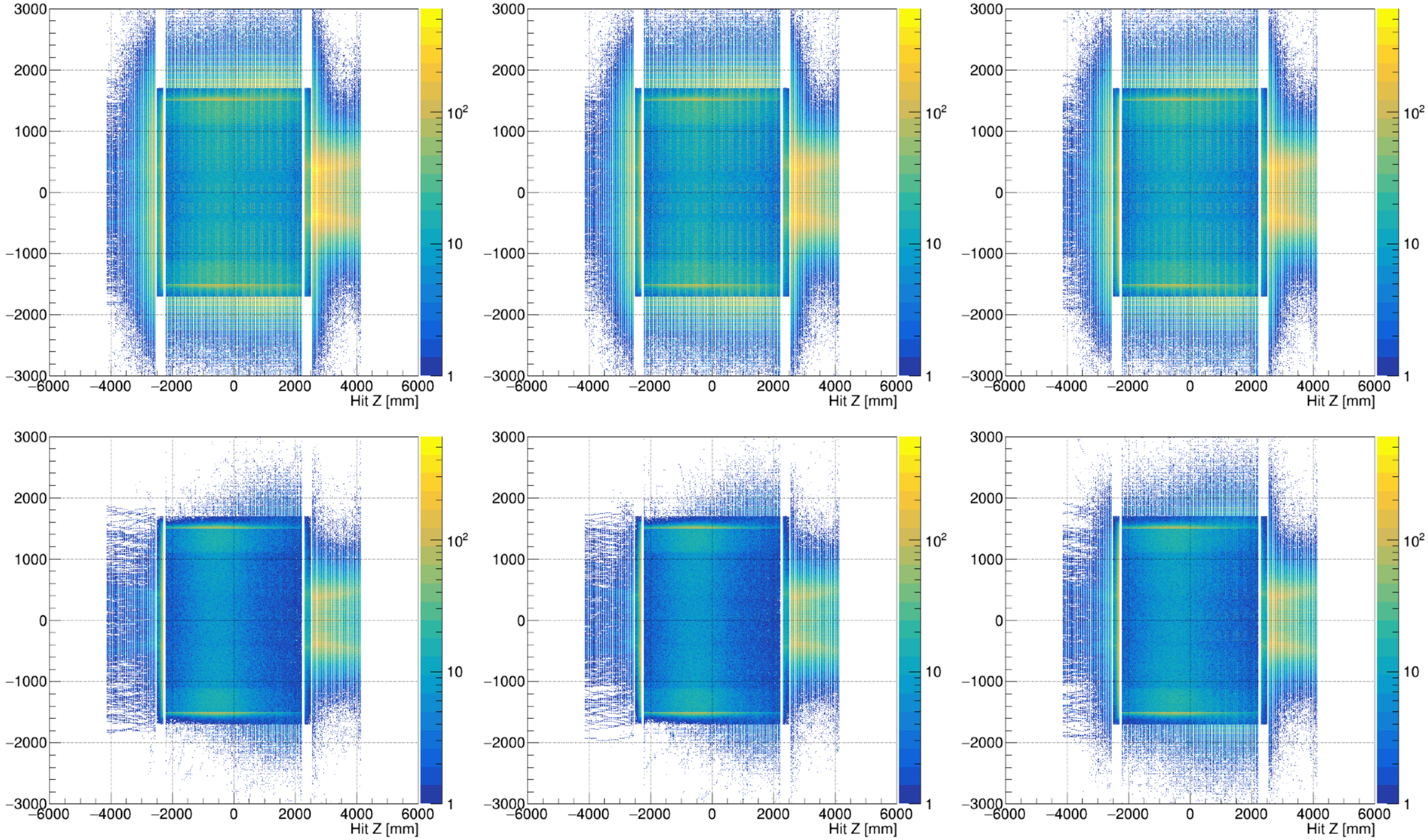
All MARS particles

$E_{kin}(n) \geq 150$ MeV

QGSP_BERT

$t_{hit} \leq 100$ ns

$t_{hit} \leq 10$ ns



Simulation performance

Comparing the time needed to simulate 1 bunch crossing [at *8 threads*]

selection	*# of particles*	*CPU time*
All MARS particles	380M	380 h
+ t < 25ns	98M (26%)	60 h (16%)
+ $E_{kin}(n)$ > 70 MeV	80M (21%)	31 h (8%)
+ $E_{kin}(n)$ > 150 MeV	78M (20%)	25 h (6.6%)
+ QGSP_BERT	78M (20%)	3 h (0.8%)

The safest optimization is: **t < 25ns + $E_{kin}(n)$ > 150 MeV** → **25h/bunch crossing**

After all the particle selection, effect of switching to the QGSP_BERT physics list can be neglected → we can simulate BIB at 3h/bunch crossing

Next steps

1. Simulate ~20 bunch crossings: each split in 3K virtual events

2. Prepare a background overlay processor that picks each virtual event from a randomly selected bunch crossing

BACKUP

Slow neutrons removed: hit energy

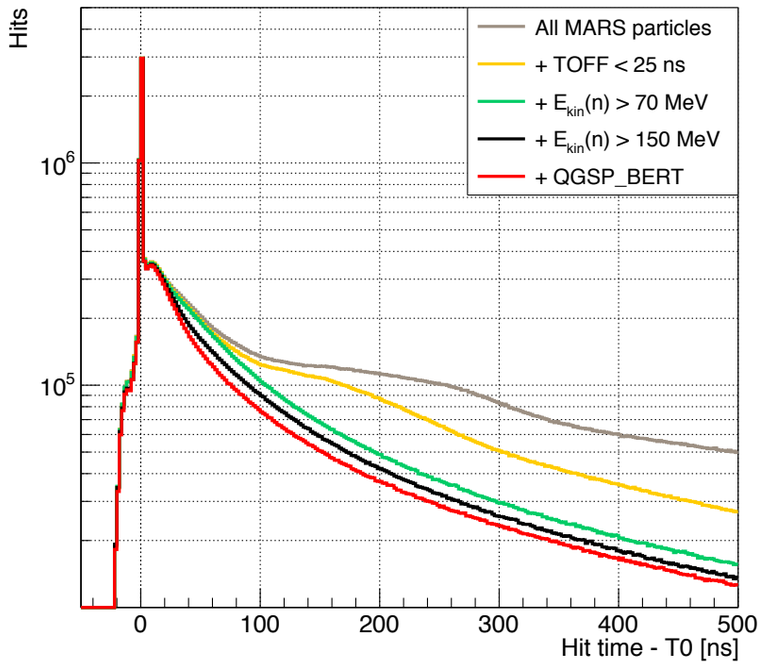
Comparing simulated hit energies at different levels of optimization

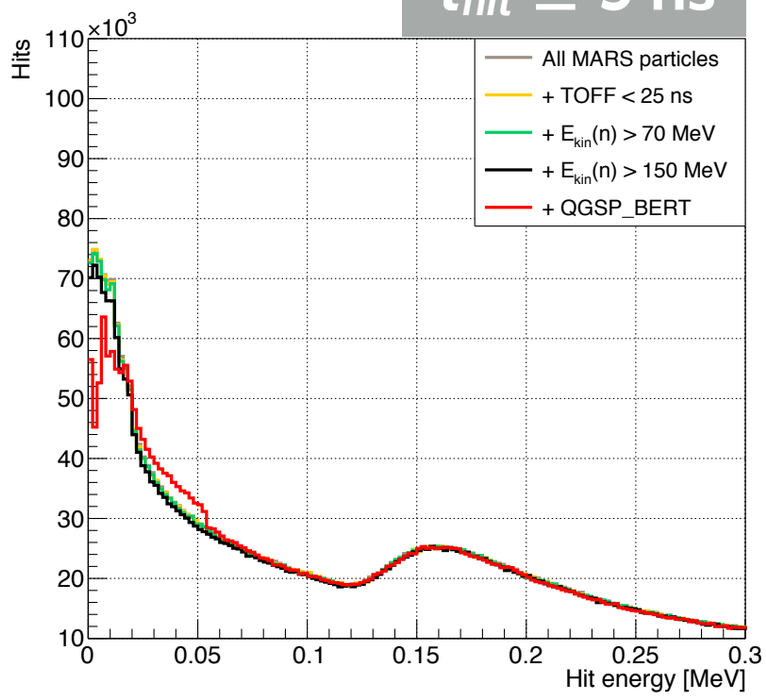
- in 2 different time windows

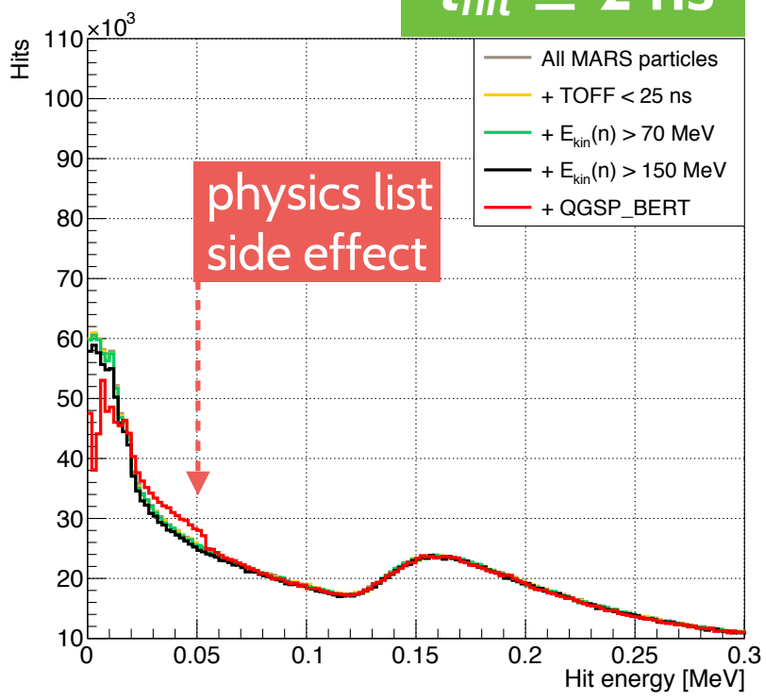
$t_{hit} \leq 5$ ns

$t_{hit} \leq 2$ ns

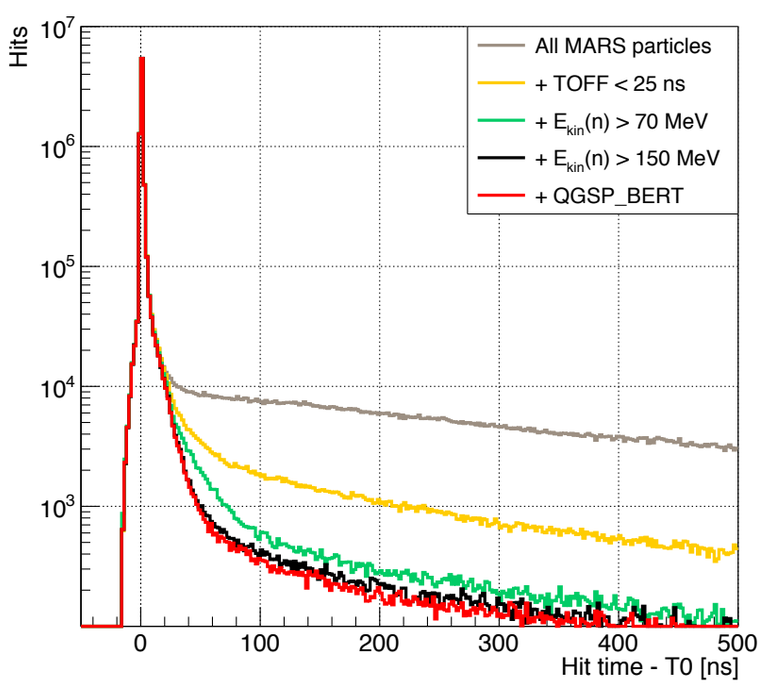
Calorimeter hits

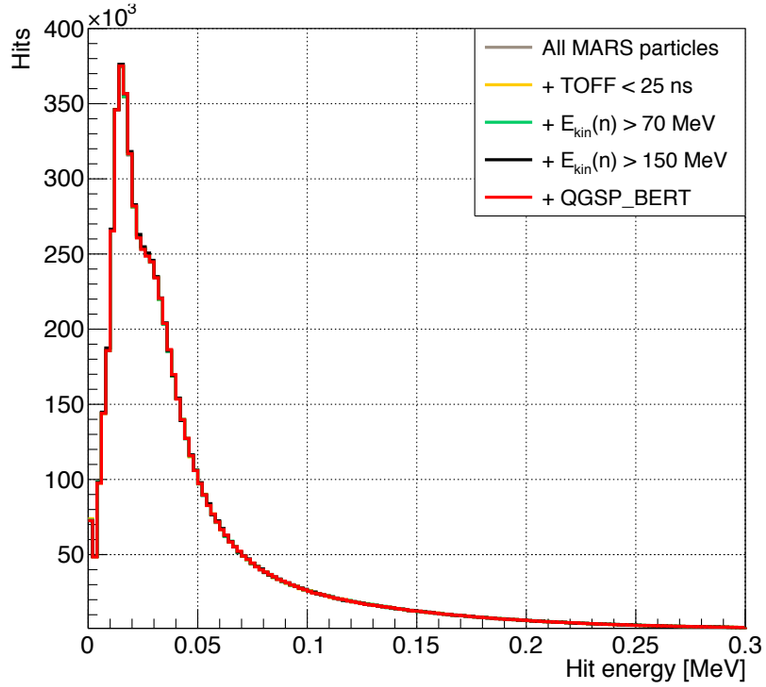


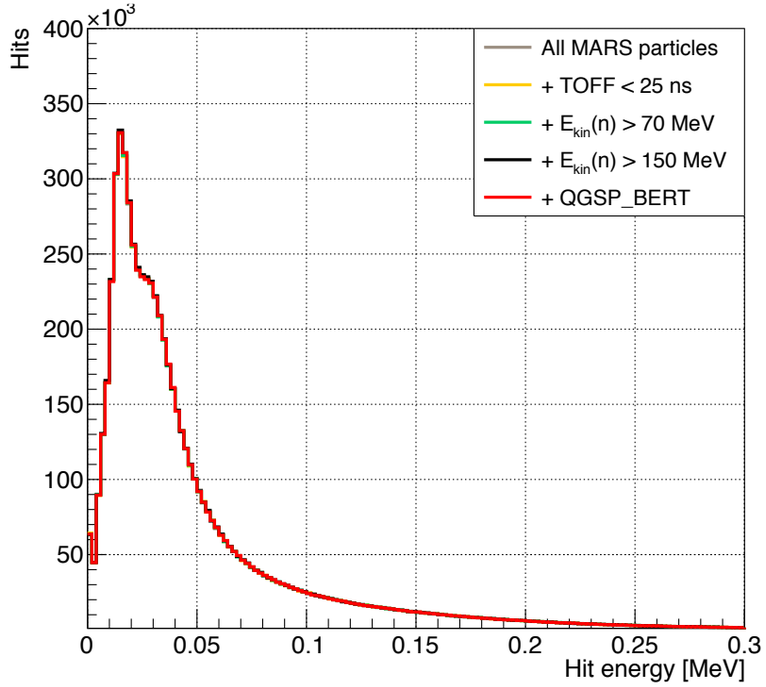




Tracker hits







Slow neutrons removed: TRK hit positions

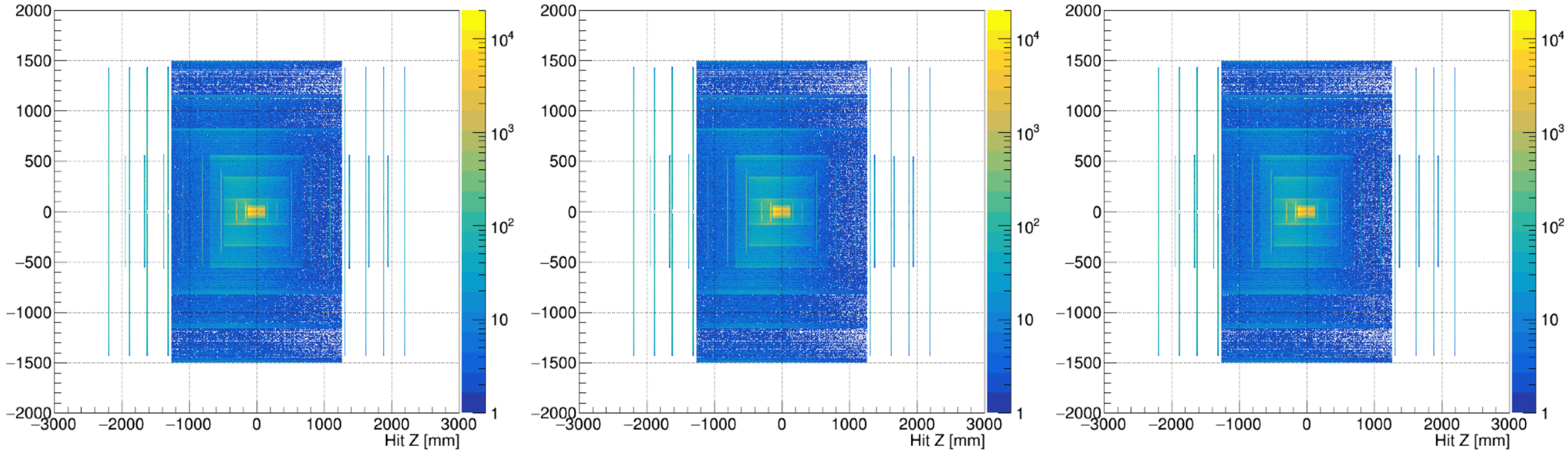
Comparing simulated hit positions at different levels of optimization

All MARS particles

$E_{kin}(n) \geq 150$ MeV

QGSP_BERT

$t_{hit} \leq 100$ ns



$t_{hit} \leq 10$ ns