Argon Emulation in The Simulation of the ATLAS Transition Radiation Tracker

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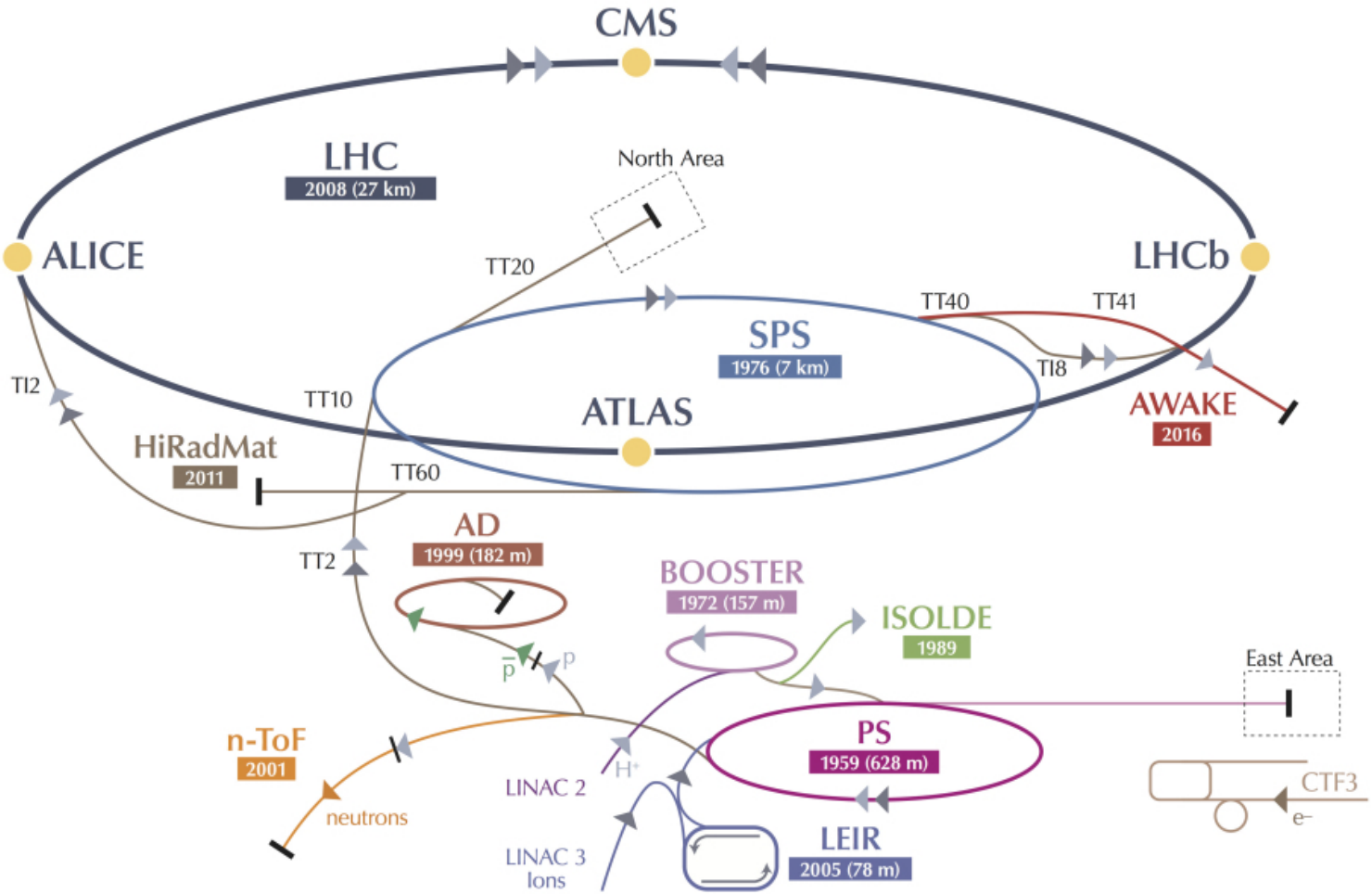

Overview of the CERN accelerator complex

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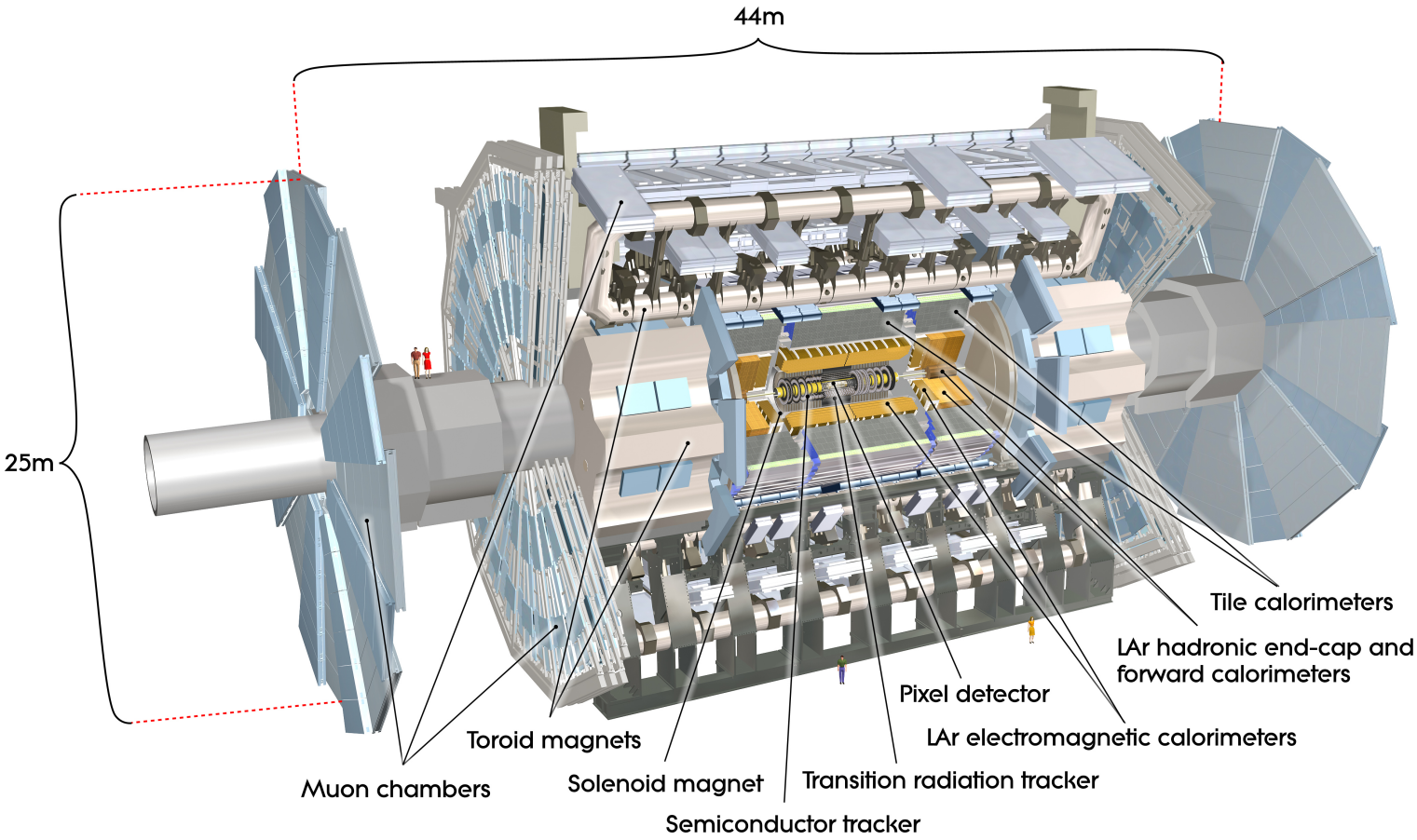

Computer generated image of the ATLAS detector

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✓ The Transition Radiation Tracker is one of the three sub-detectors of the ATLAS inner detector situated in the 2T magnetic field of the central solenoid.
✓ TRT is the outermost layer of the inner detector .
✓ TRT: 6.8 m in length and 2.2 m in diameter and weighs about 1500 kg .
✓ Provides tracking information for charged particles with:
$*|\eta| < 2$
$*pT > 0.5GeV$
✓ The TRT has two different geometrical arrangements of straws

- Barrel : Straws parallel to the beam axis
- End Cap : Straws perpendicular to the beam axis

TRT
General Concept

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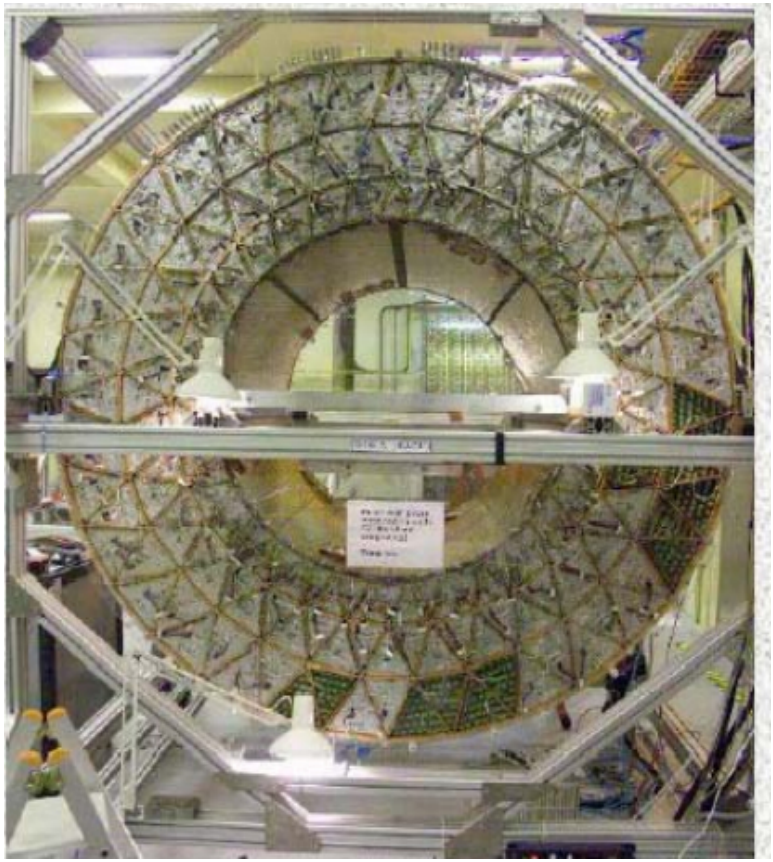

Barrel

End Cap

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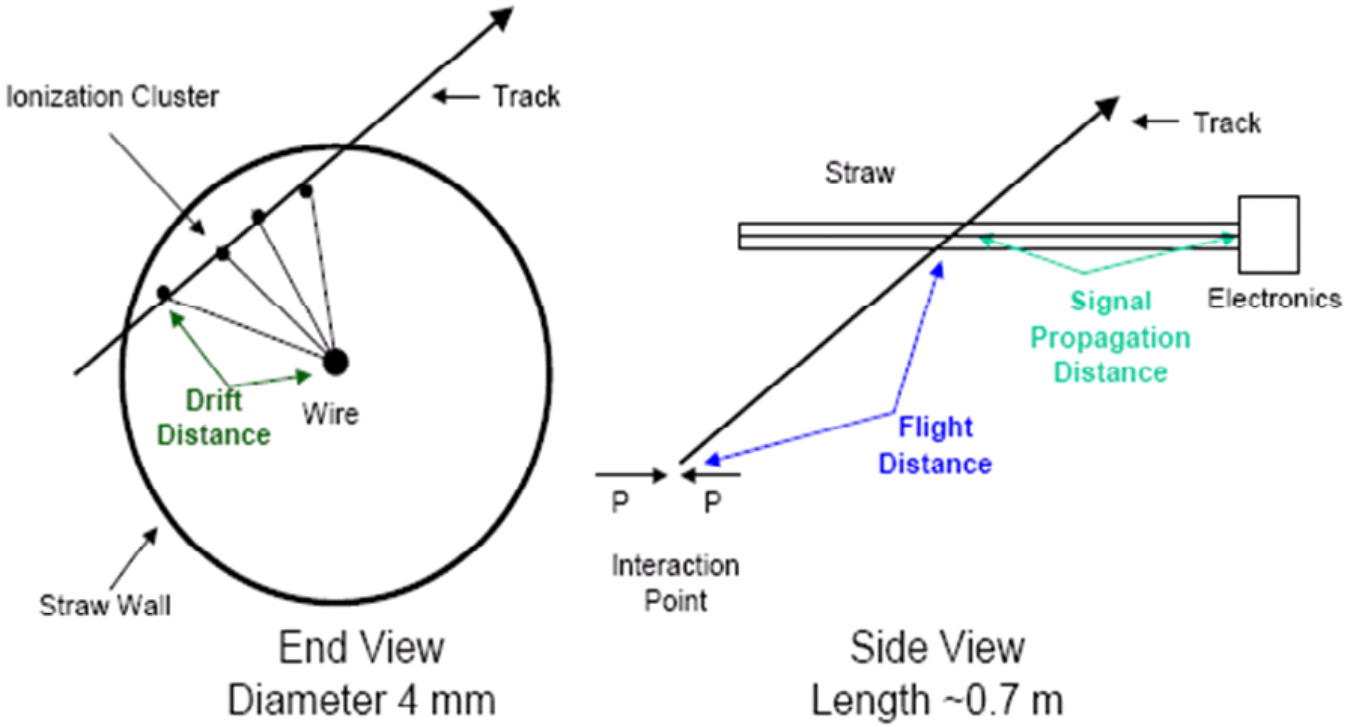

Cluster Arrival Time = Flight Time + Drift Time + Propagation Time

Descriptive schematic of time measurement by a straw tube from TRT

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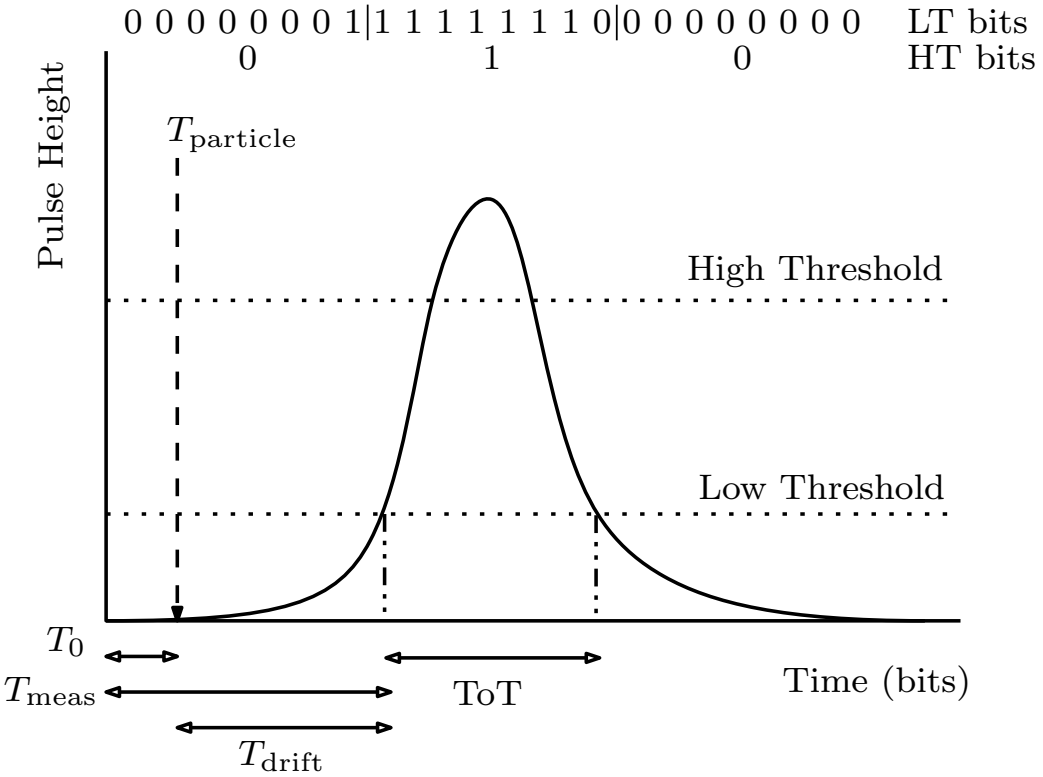

Schematic display of a signal pulse created by a particle when crossing the straw

- LT: for particle tracking
- HT & ToT : for PID

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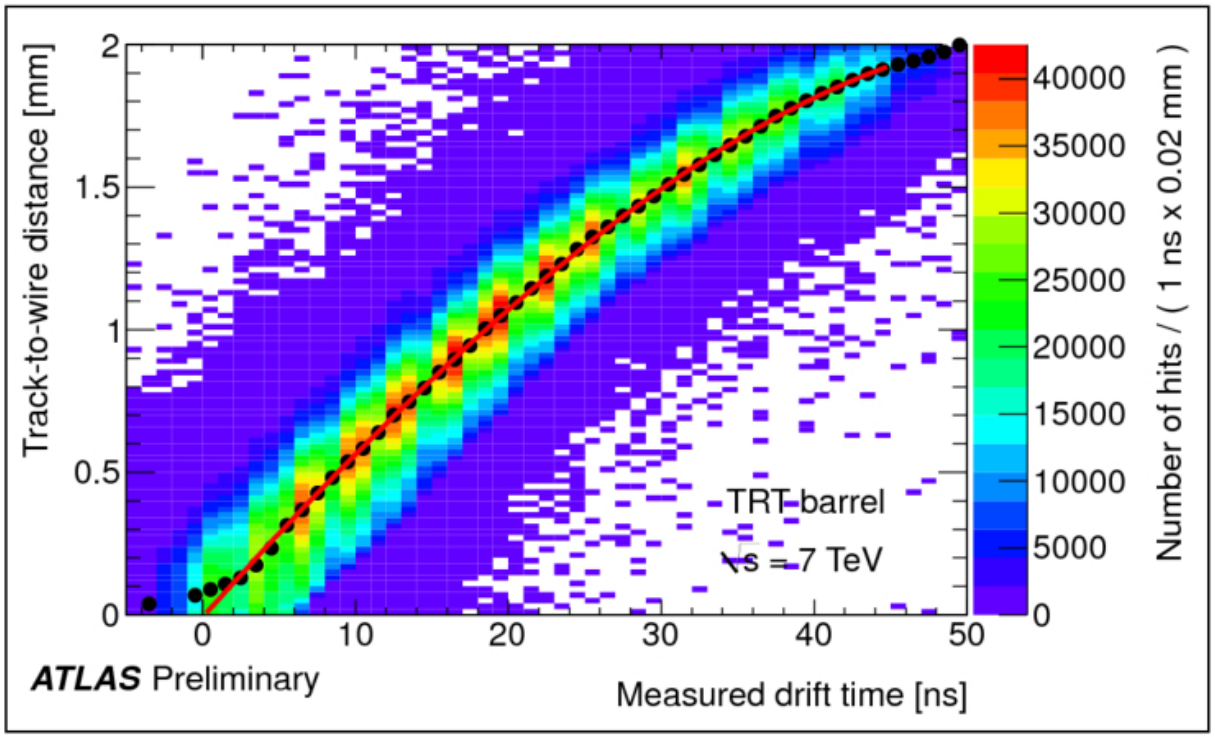
R-t relation curve



From time to distance

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Leaking in the TRT straws

↓

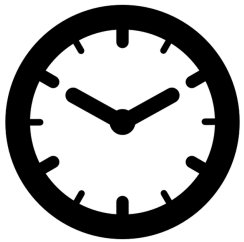
Losing Xenon Expensive ☹

↓

New Gas mixtures : Argon

↓

Simulated samples take time and disk space



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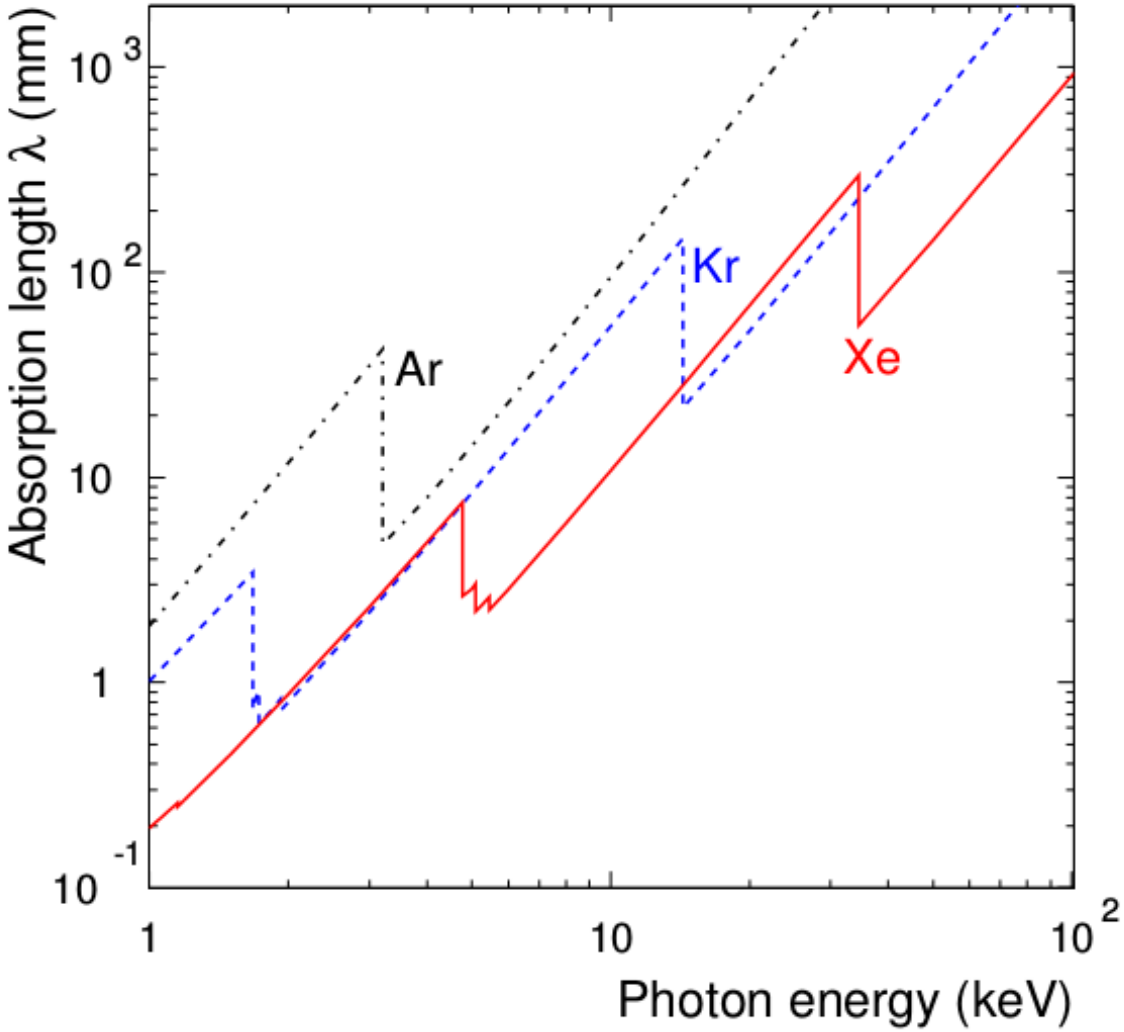

Difference Between Argon and Xenon

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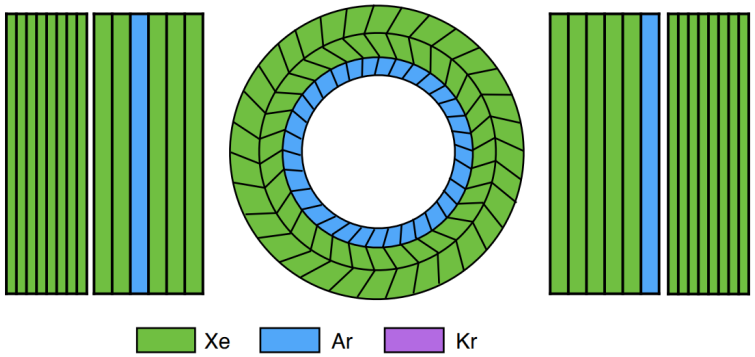
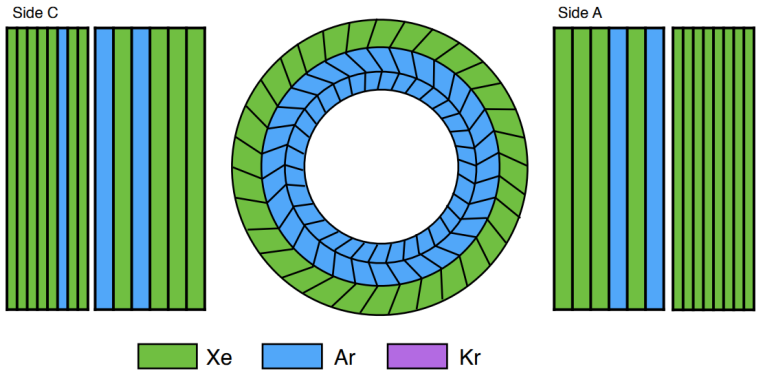


2015



2016

Change of gas geometry of the TRT between 2015 and 2016

Emulation
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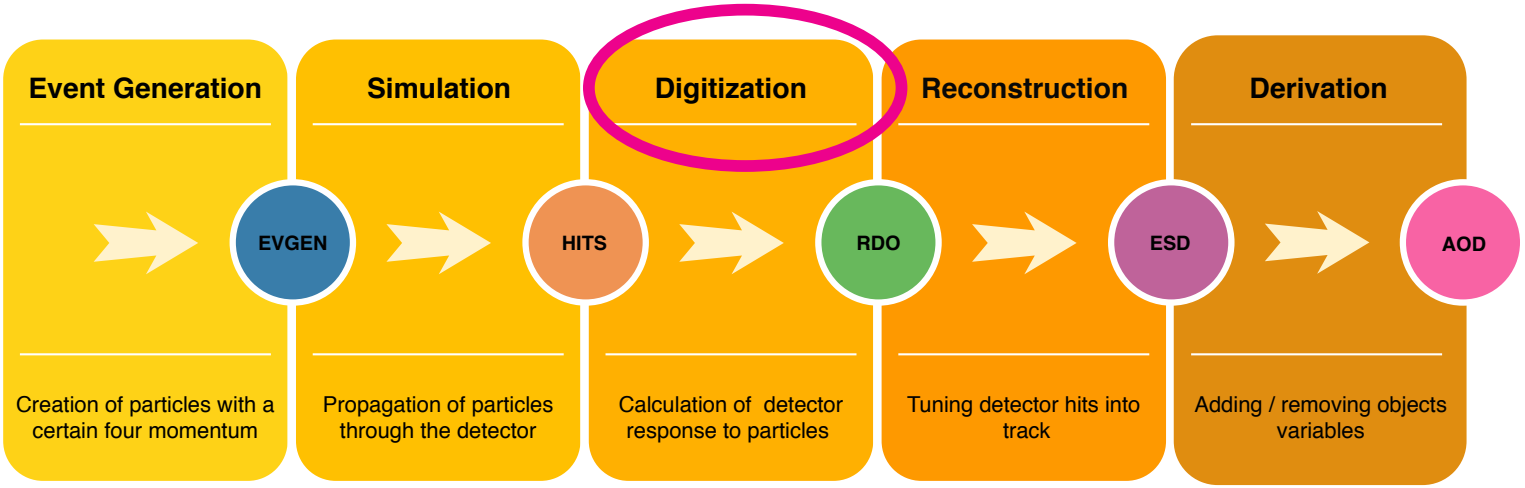

- **❶ Introduce new gas types in the ATLAS simulation framework : Emulated Argon**
- **❷ Mimic the HT response of the gas we wish to emulate : Argon**
- **❸ Scale the TR absorption efficiency during the digitization by a TR efficiency reduction factor (TRERF)**

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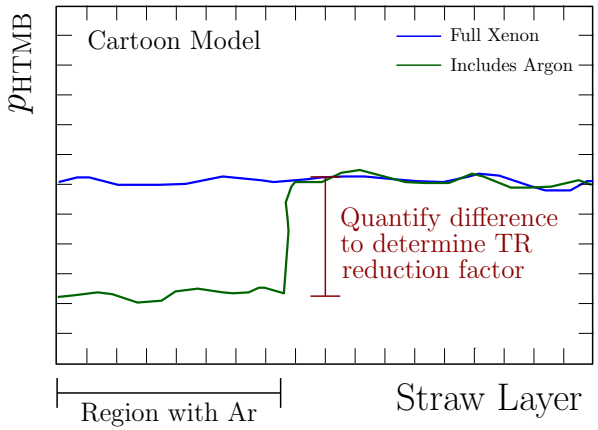

The TRERF is determined by comparing the HT probability versus straw layer (SL) for the gases

Region	Argon TRERF
Barrel	0.05
End Caps	0.2

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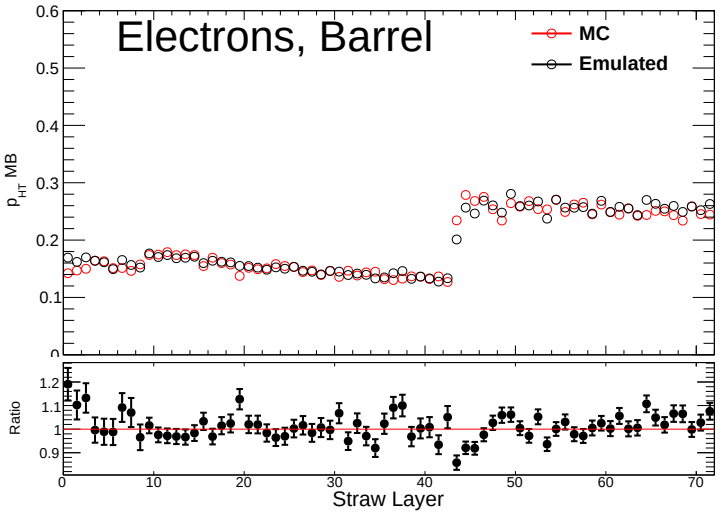

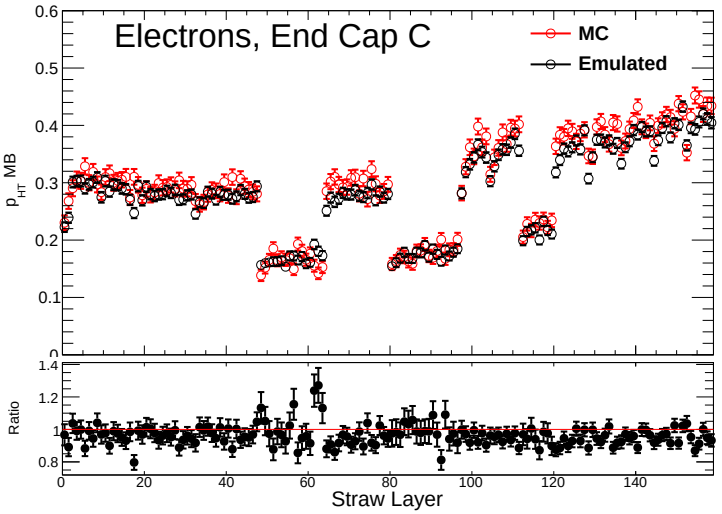

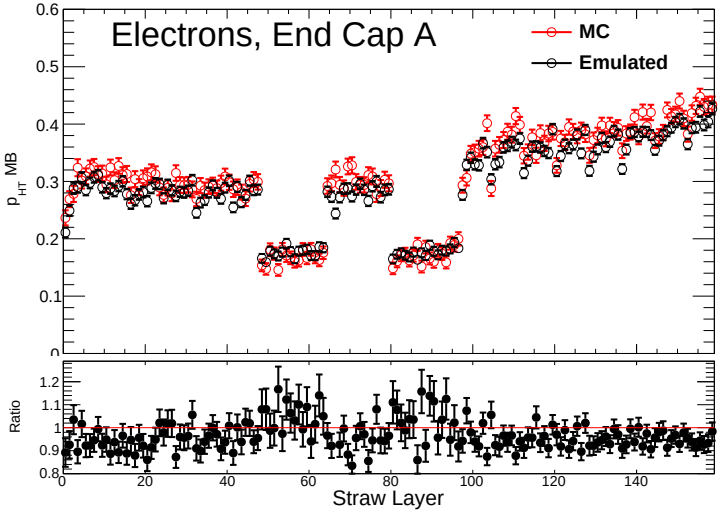

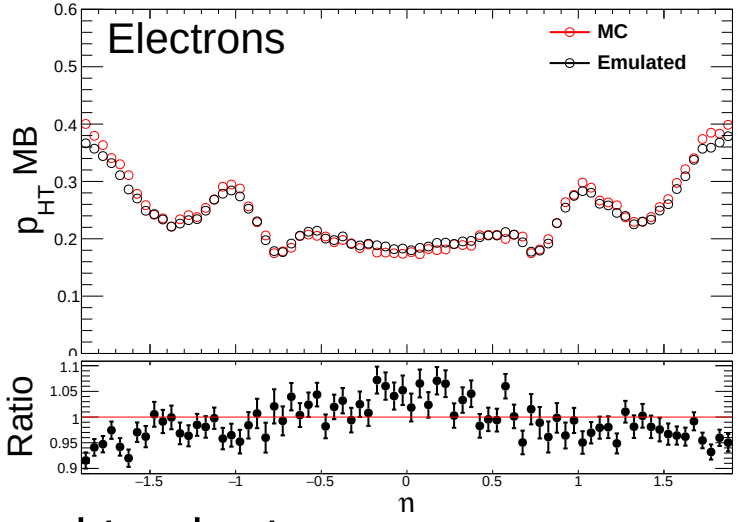

pHTmb vs SL and track eta

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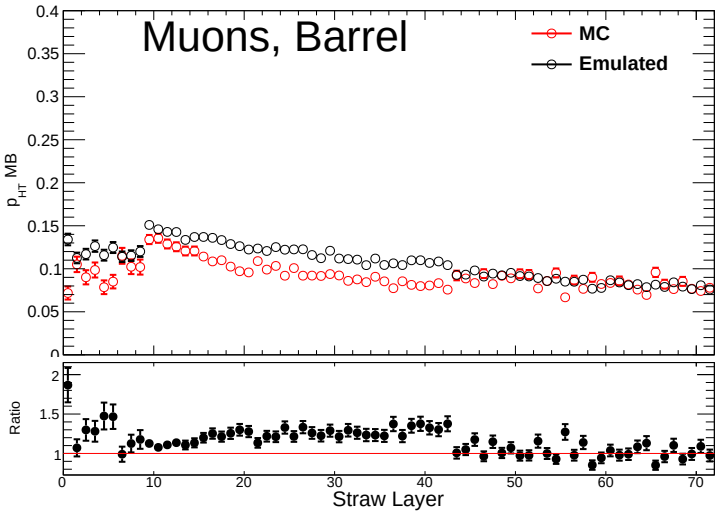

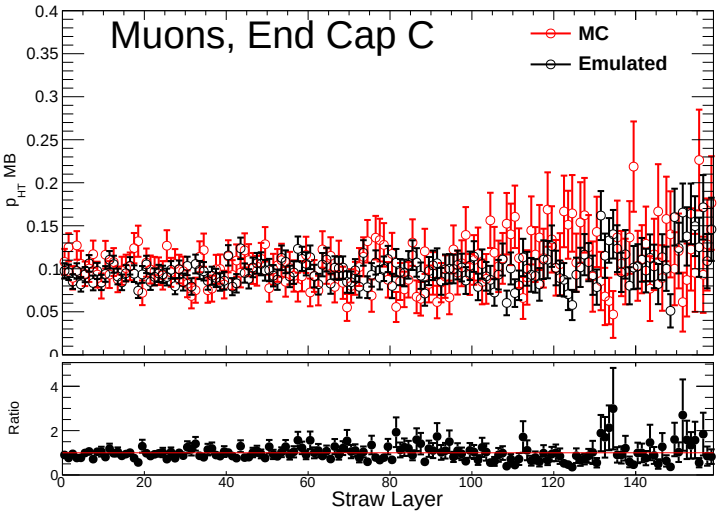

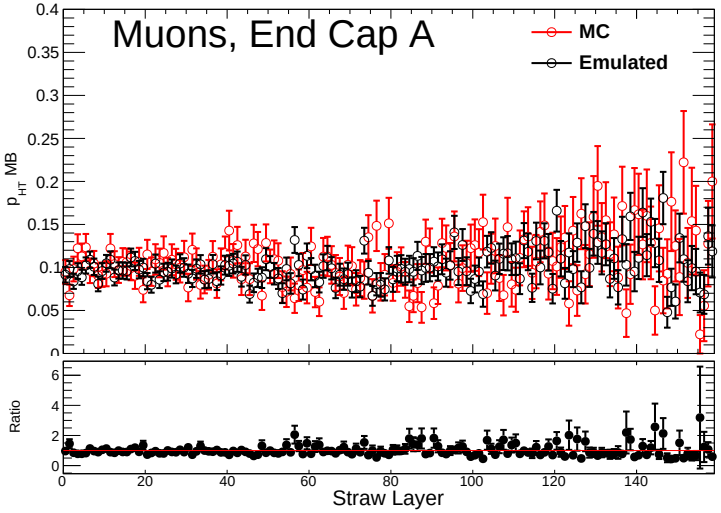

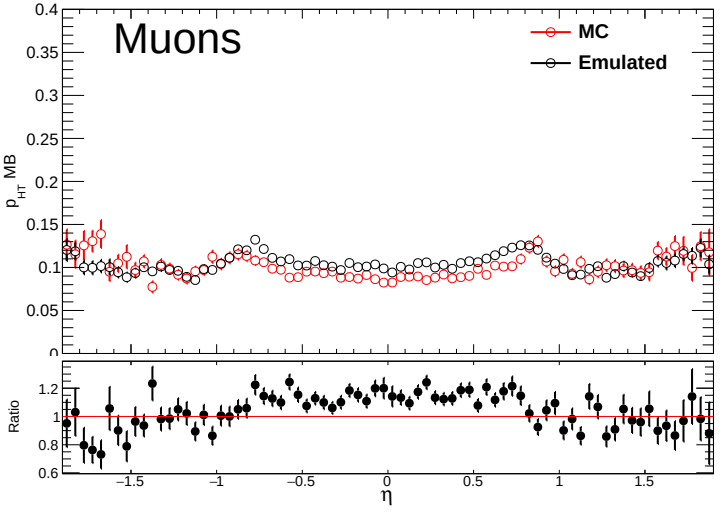

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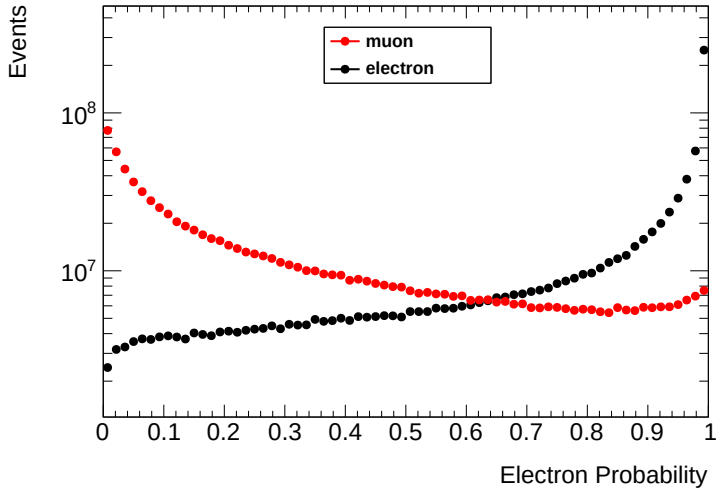

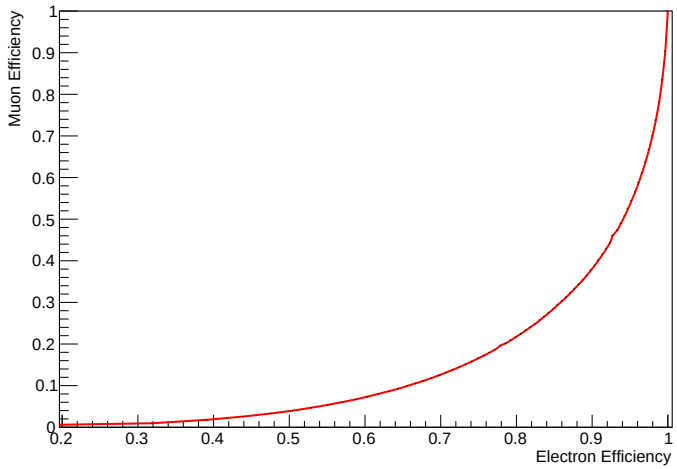

Electron probability and the corresponding performance curve calculated for muons and electrons from Z candidate decays. These distributions include tracks in all regions of the TRT and at all occupancies

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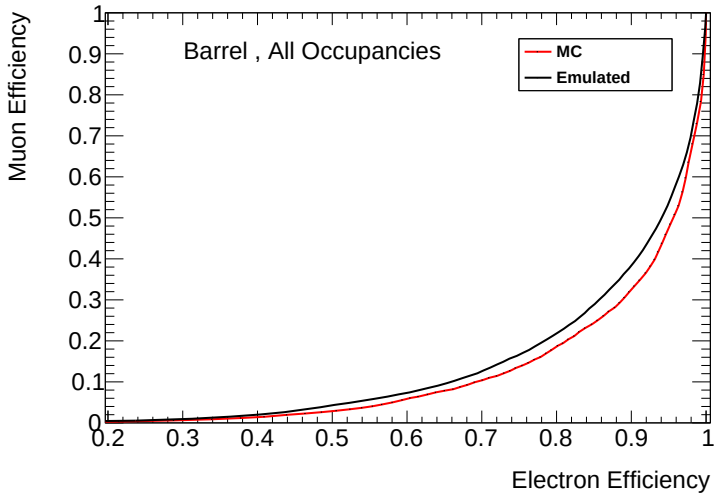

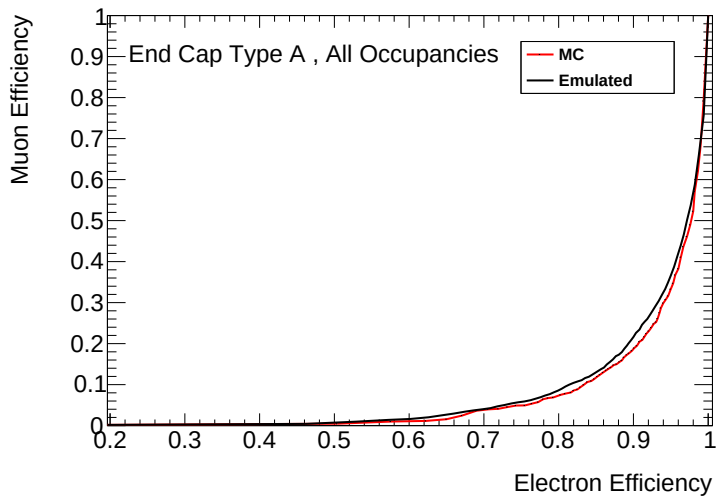

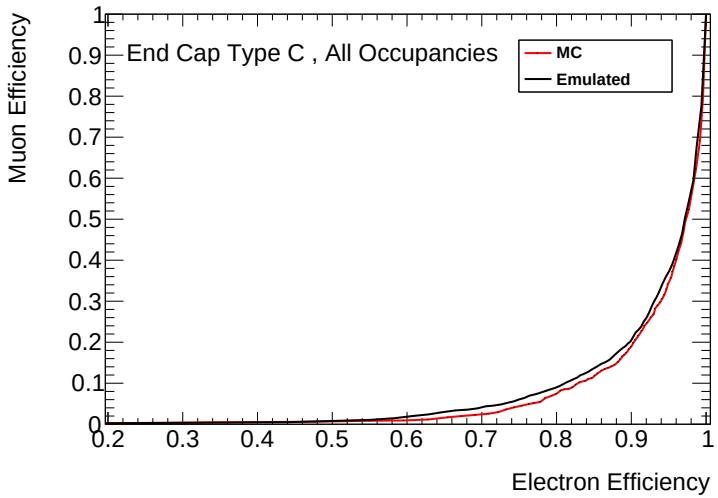

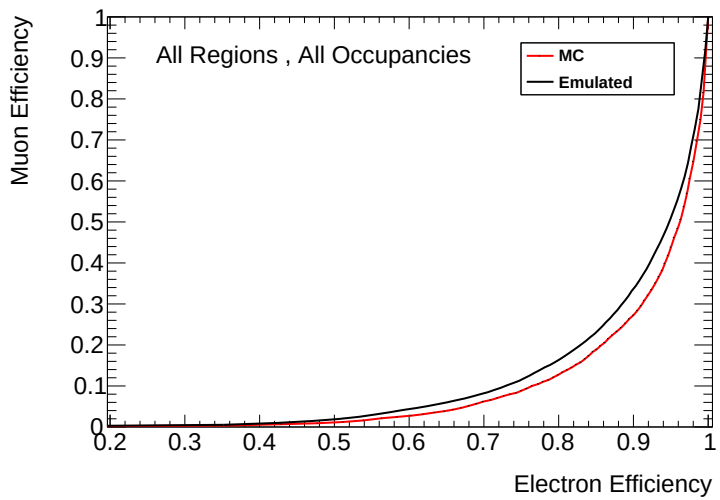

performance ROC curves

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✓ Production and test of emulated sample with different TRERF for Barrel and End Cap
✓ Electrons respond very well to emulation
✓ The best TRERF were chosen by relying only on electron plots
TRERF = 0.05 For Barrel & TRERF = 0.2 For End Caps
✓ Going to low TRERF lead to better agreement in electron and less for ROC curves
✓ Results consistent in high occupancy

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Different TRERF Tested

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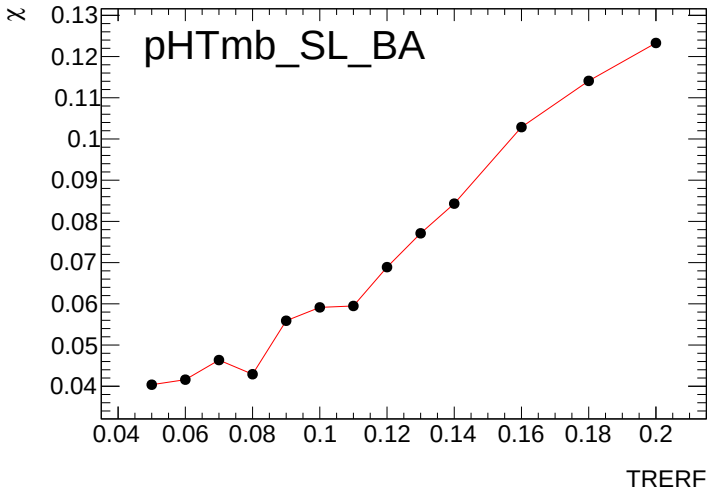

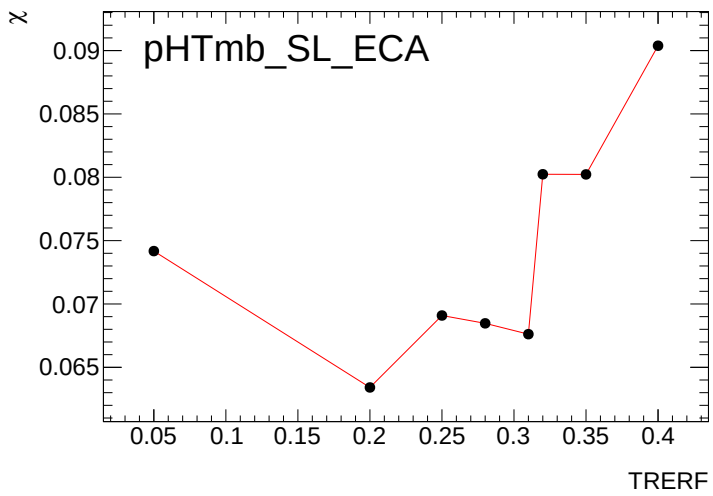

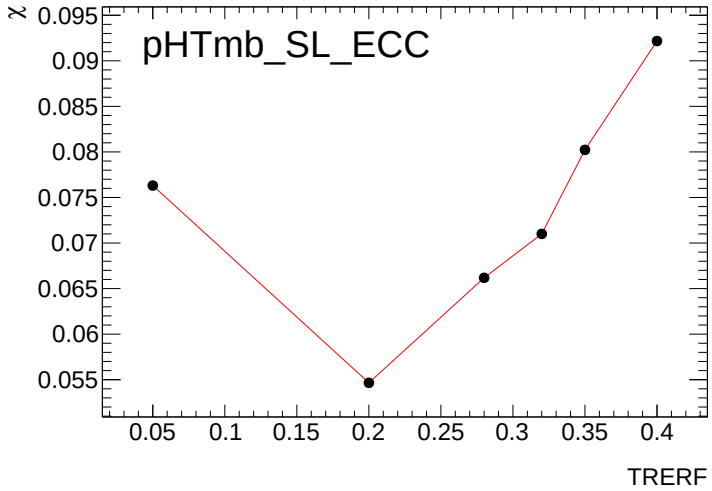

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From each HT probability versus SL we calculate :

$$\chi = \frac{1}{n} \sum_{i=1}^{i=n} \frac{|Pemul_i - Pmc_i|}{Pmc_i} \quad (1)$$

n : number of bins
Pemul : pHTmb from Emulated samples
Pmc : pHTmb from MC samples

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