Study of Electron Identification performance with combined Xe/Ar

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Motivation

- Xenon gas leaks in TRT
- Some sections filled with argon
- No High Threshold hits (almost) in those sections
- This affects electron identification

Task description:

- *Study of Electron Identification performance with combined Xe/Ar TRT operation compared to electron identification performance for operation using Xe gas mixture.*

Overall plans

(Suspended till Ar geometry setting up is implemented for simulation)

- Simulate and digitize MC events (without pileup) $J/\psi \to ee$ (p>10 GeV) and $J/\psi \to \mu\mu$ (2<p<20 GeV) with various Argon geometries.
- Produce TRT D3PDs for each geometry.
- Study how Argon geometry affects HTfraction.
- Develop optimal PID approaches for various Argon geometries.

Separate study:

- Study dependance of HT fraction of layer 0 (Argon) part of the tracks from high threshold value set up for Argon.
  - high threshold values: 1, 1.5, 2, 2.5, 3 keV
  - muon energy 3 GeV, 6 GeV, 10, 15, 20 GeV
  - election energy 20 GeV

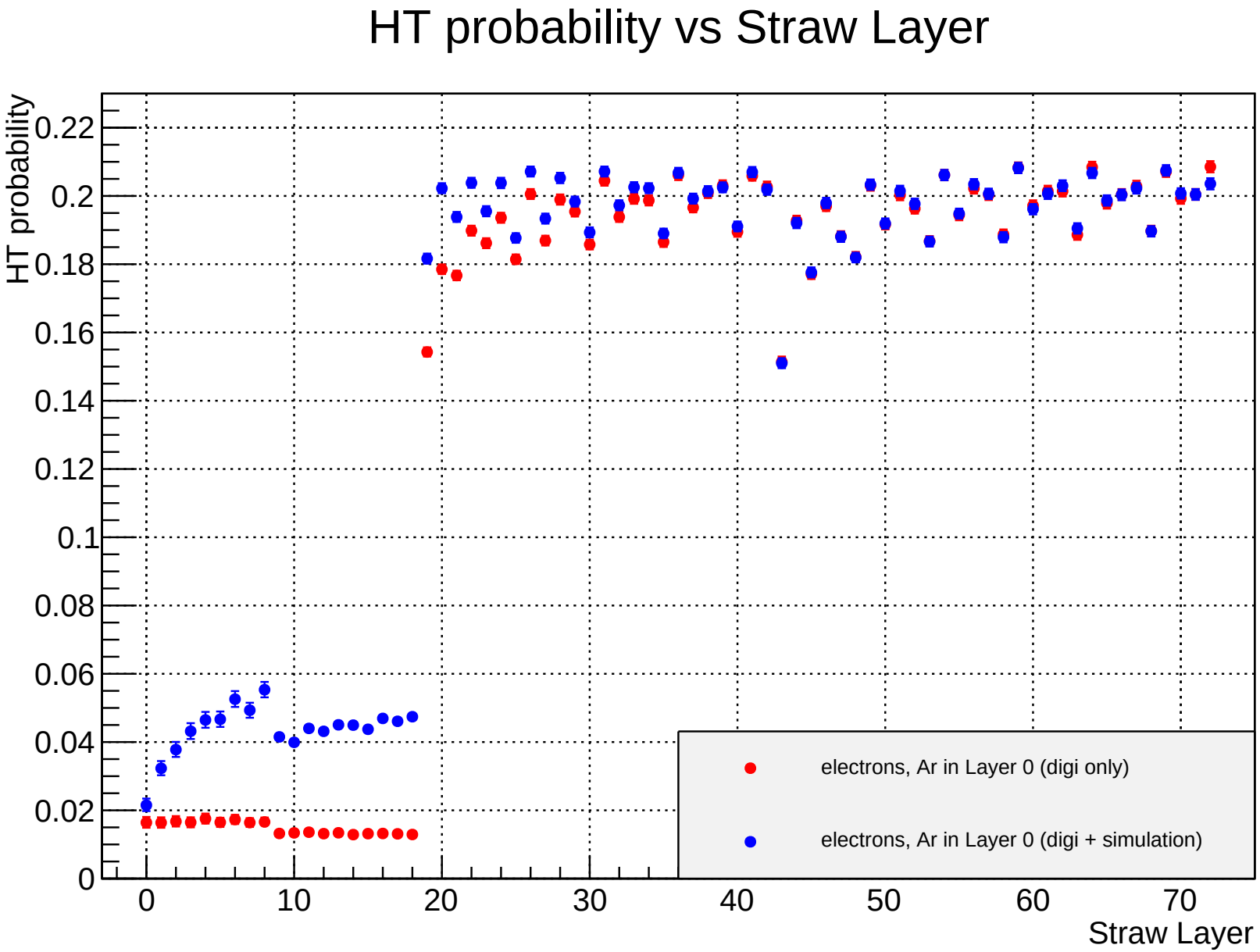
Current plans

- Generate monochromatic single electrons & muons flat in eta (|eta|<0.7), p=20GeV
- Run Simulation & Digitization with various configurations:
  - TRT with all Xenon (both simulation and digitization)
  - TRT with Argon in layer 0 (both simulation and digitization, do not ignore photon hits on digitization step)
  - TRT with Argon in layer 0 (digitization only, ignore photon hits on digitization step)
- Produce TRT D3PDs for each case.
- For each case plot and compare:
  - HTprobability versus barrel straw layer
  - HT fraction for entire track, for its layer 1 and layer 2 parts, for its layer1+2 part
  - muon efficiency VS electron efficiency

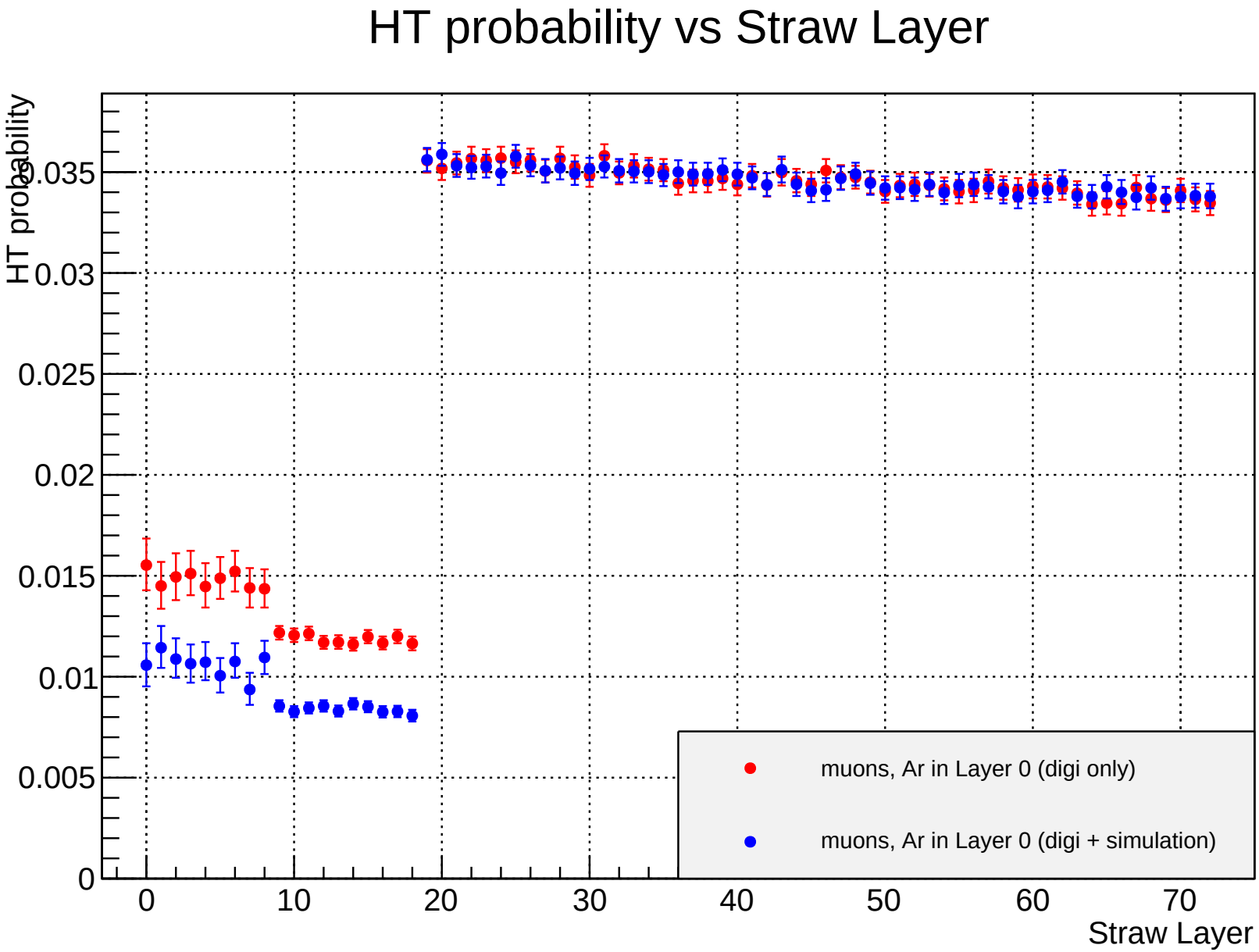
Progress

- Generated single particle samples (el, mu, |eta|<0.7, p=20GeV)
  - electrons, muons: 50000 evts * 20 trk/evt = 1000000 trks
- Simulated and digitized those samples according to 3 configurations.
- Plotted some results, see further slides.
- Track selection:
  - at least 15 hits;
  - pt >= 10GeV.
- However:
  - Constants RT and T0 for argon were not taken into account (yet).
  - Results for Argon in Layer0 (both in simulation and digitization) for muons are obtained for wrong Ar material properties (see backup). Good results are on their way.

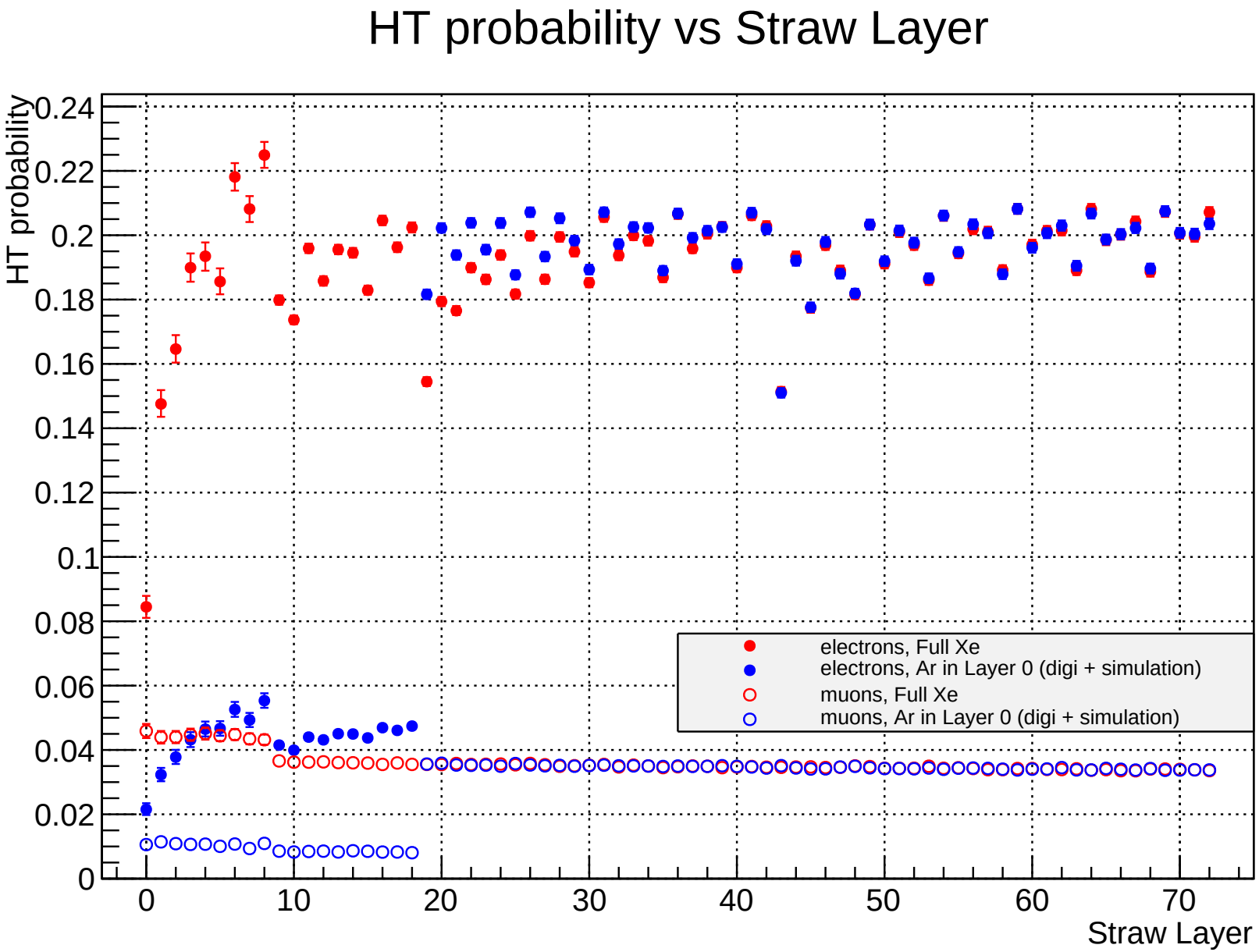
HT prob for electrons (digi+sim VS digi)



HT prob for muons (digi+sim VS digi)

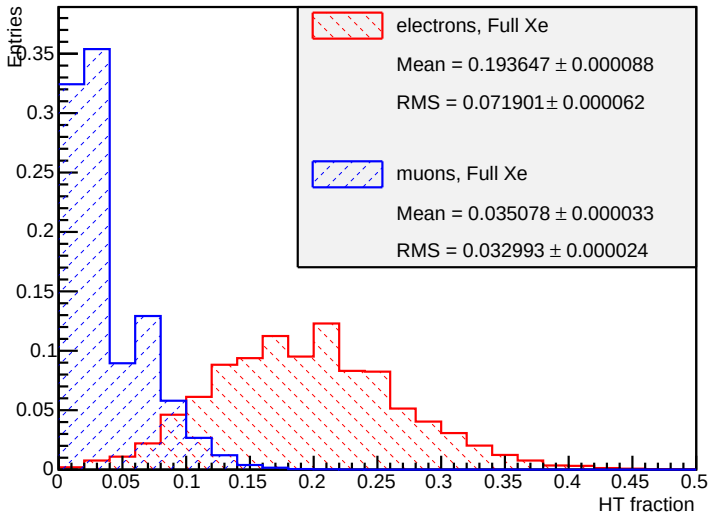


HT prob for el VS mu (Full Xe VS Ar layer0)

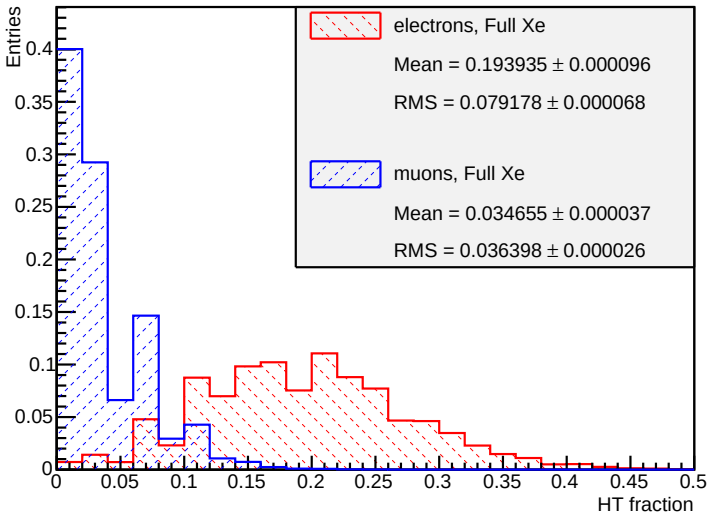


HT fractions (Full Xe)

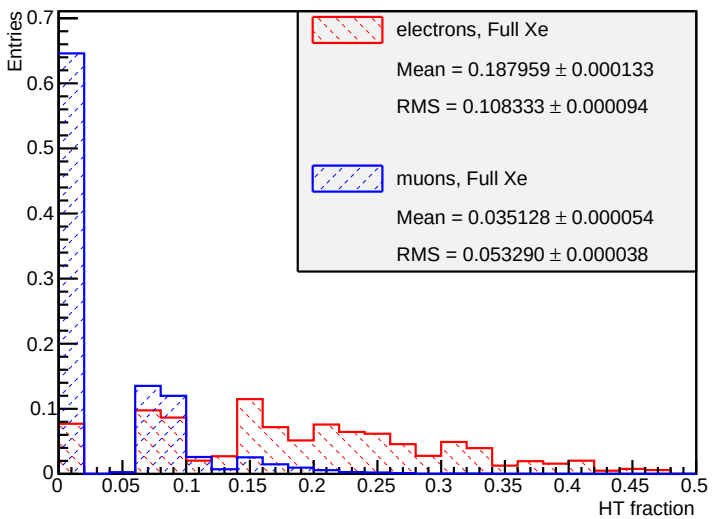
HT fraction for entire track



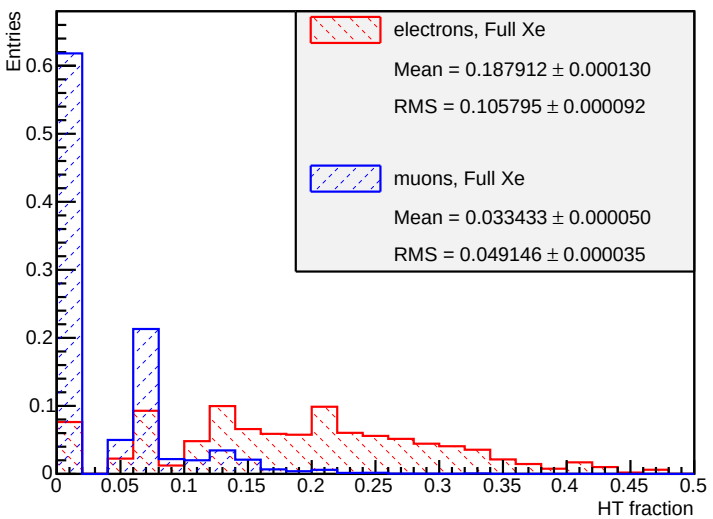
HT fraction for layer1+layer2 track part



HT fraction for layer1 track part

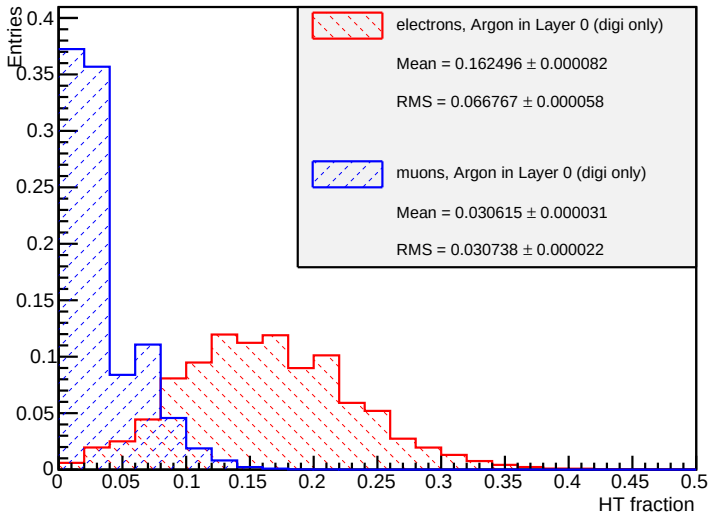


HT fraction for layer2 track part

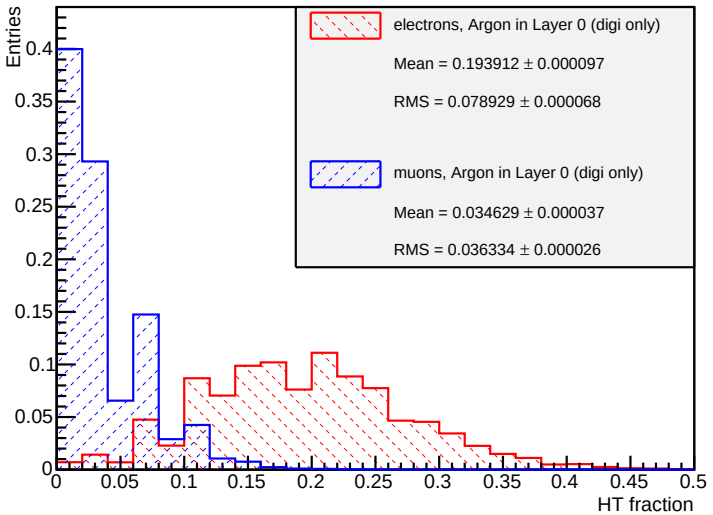


HT fractions (Ar layer0, digi only)

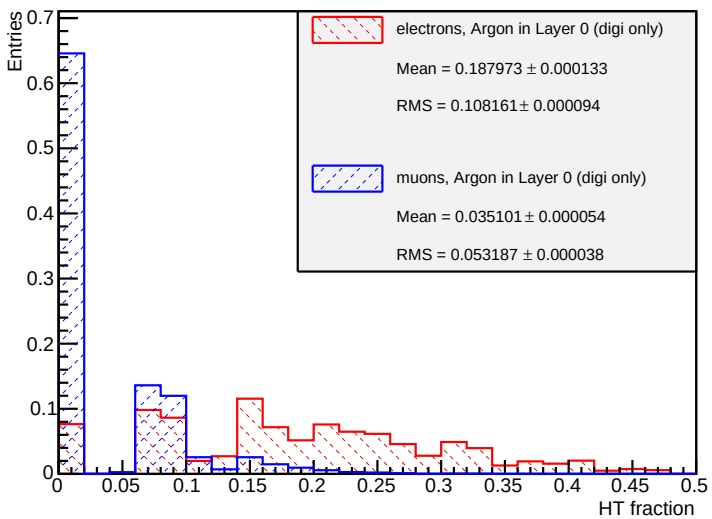
HT fraction for entire track



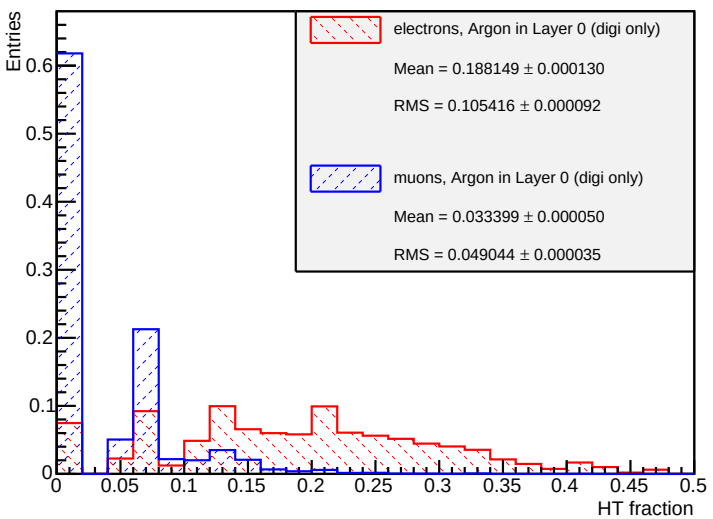
HT fraction for layer1+layer2 track part



HT fraction for layer1 track part

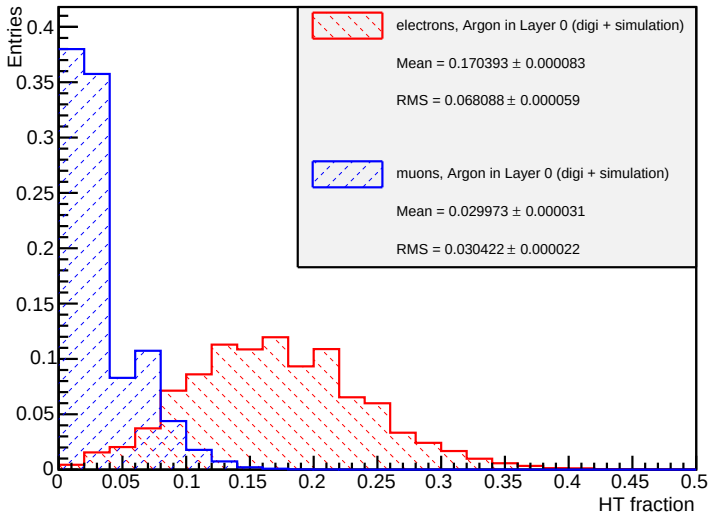


HT fraction for layer2 track part

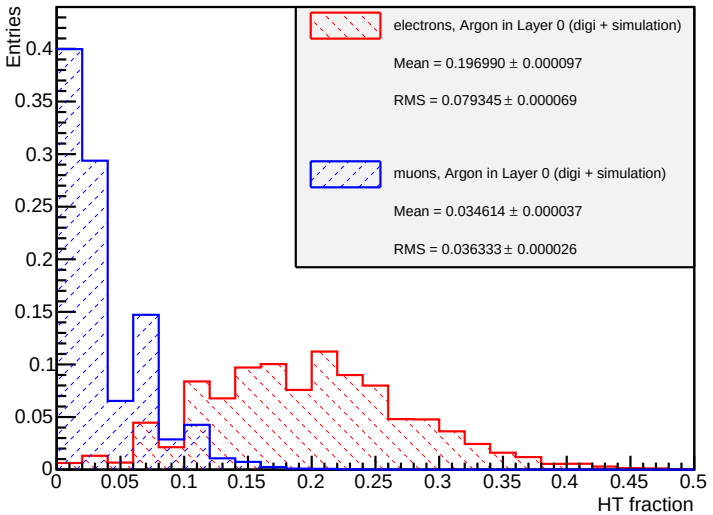


HT fractions (Ar layer0, digi+sim)

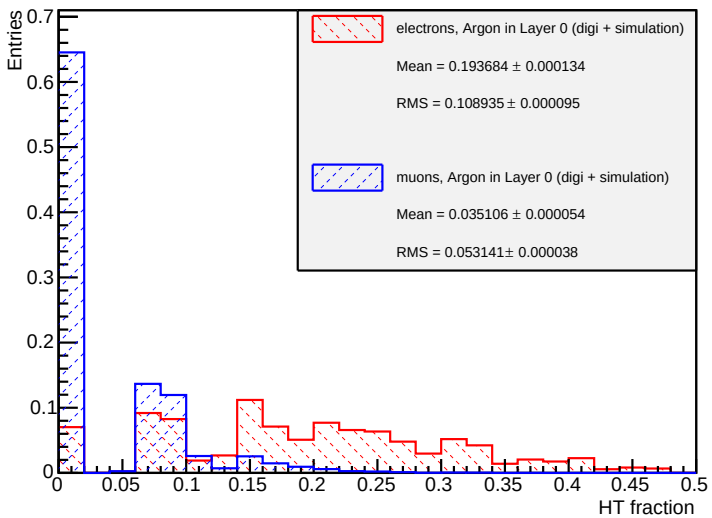
HT fraction for entire track



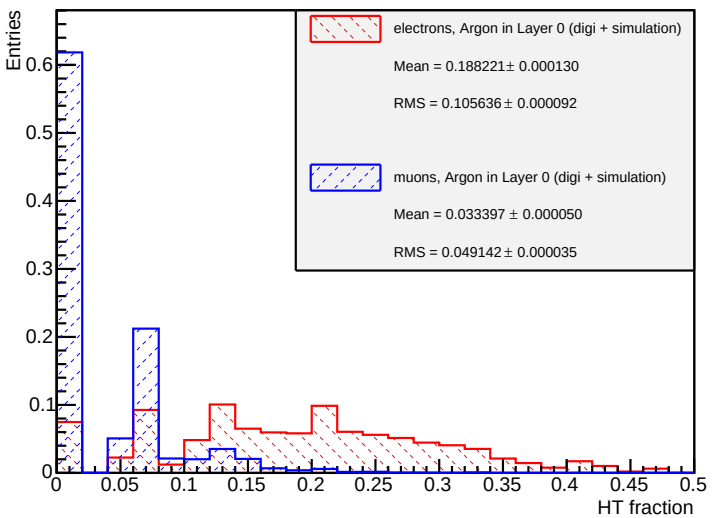
HT fraction for layer1+layer2 track part



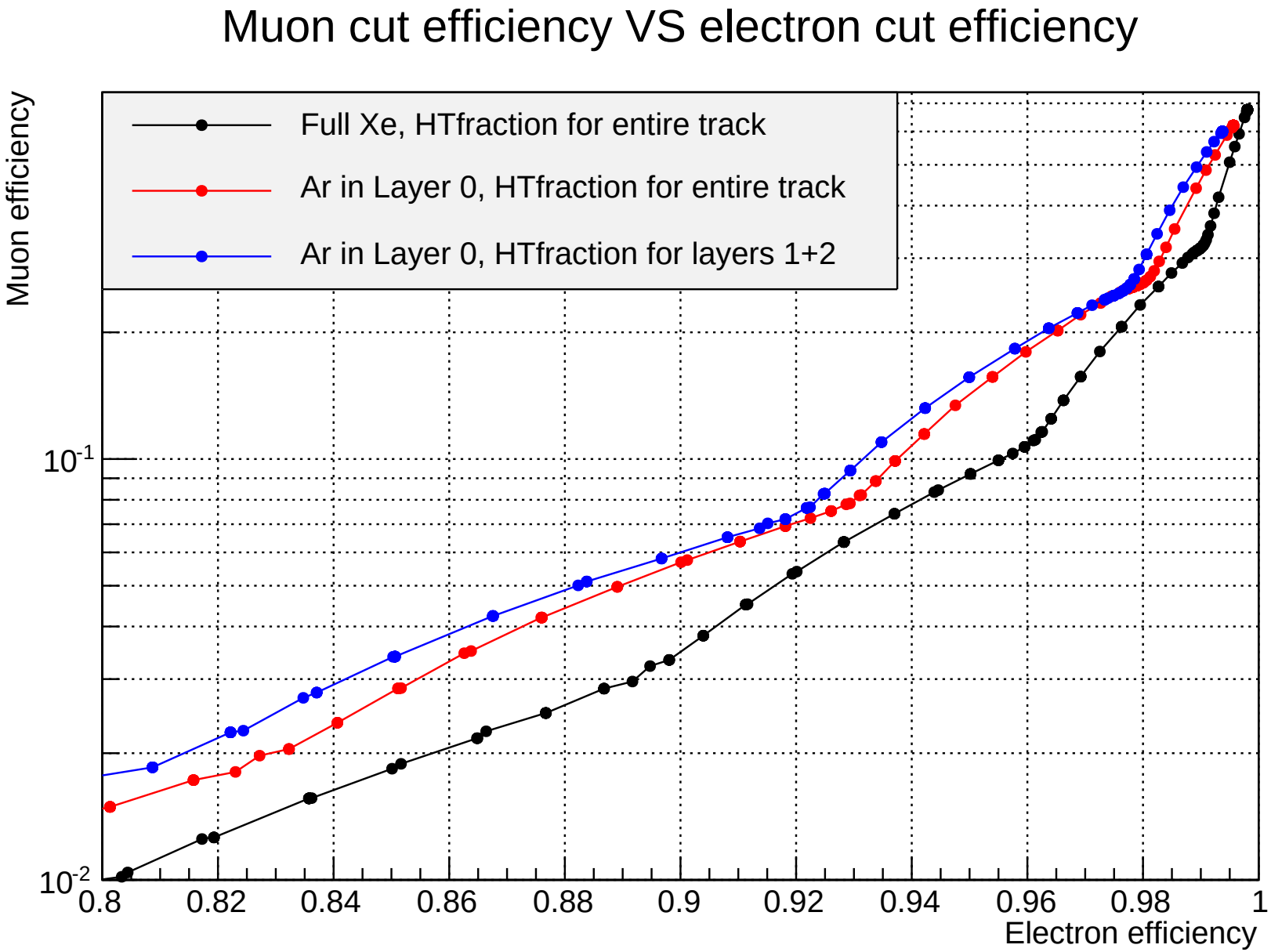
HT fraction for layer1 track part



HT fraction for layer2 track part



muon VS electron efficiencies



Further plans

- Discuss how we can check Argon mixture implementation
- Check Argon mixture implementation
- Obtain all results for correct argon implementation + take RT and T0 constants into account
- Similar study for endcaps
- Argon high threshold study

Backup slides

Ar mixture issues

Initial implementation:

```
GeoElement* argon = new GeoElement("Argon", "Ar", 18., 39.95);
m_materialArCO2 = new GeoMaterial("trt:ArCO2", 0.00174);
m_materialArCO2->add(argon, 0.8);
m_materialArCO2->add(const_cast<GeoMaterial*>
    (m_materialManager->getMaterial("trt::CO2")), 0.2);
m_materialArCO2->lock();
```

Constants:

```
Xe (for reference):
  getDeDxConstant(): 9.42642e-28
  getDeDxI0()      : 0.000367858
  getDeDxMin()     : 1.08668e-26
  getRadLength()   : 25144.7
  getIntLength()   : 307901
  getDensity()     : 2.73182e+16
Ar:
  getDeDxConstant(): 3.08492e-25
  getDeDxI0()      : 0.000155272
  getDeDxMin()     : 3.55629e-24
  getRadLength()   : 140.445
  getIntLength()   : 2.91381e+17
  getDensity()     : 0.00174
```

Ar mixture issues

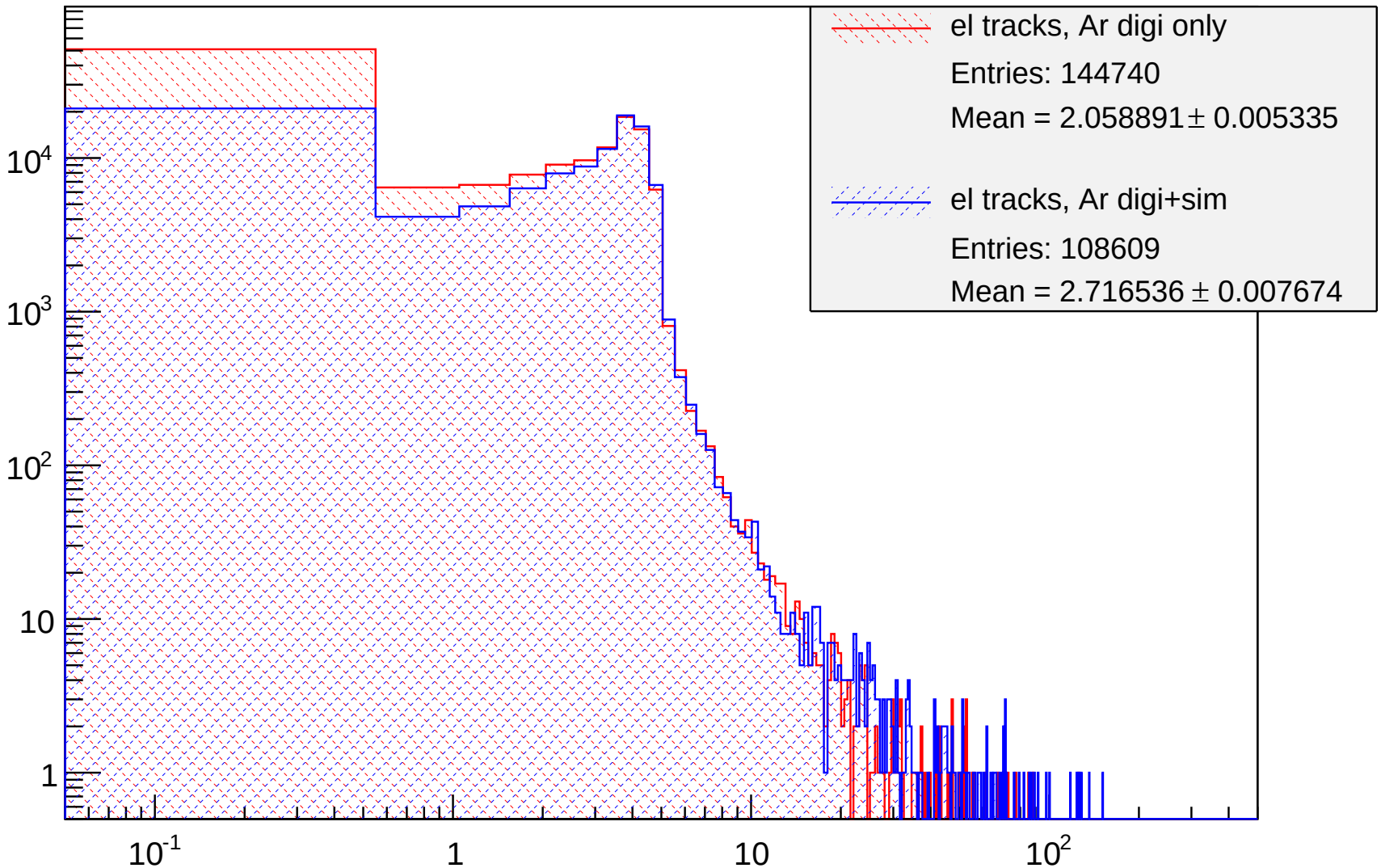
Corrected implementation:

```
GeoElement* argon = new GeoElement("Argon", "Ar", 18.,
    39.95*(gram / mole));
m_materialArCO2 = new GeoMaterial("trt:ArCO2",
    0.00178*CLHEP::g/CLHEP::cm3);
m_materialArCO2->add(argon, 0.7);
m_materialArCO2->add(const_cast<GeoMaterial*>
    (m_materialManager->getMaterial("trt::CO2")), 0.27);
m_materialArCO2->add(const_cast<GeoMaterial*>
    (m_materialManager->getMaterial("trt::O2")), 0.03);
m_materialArCO2->lock();
```

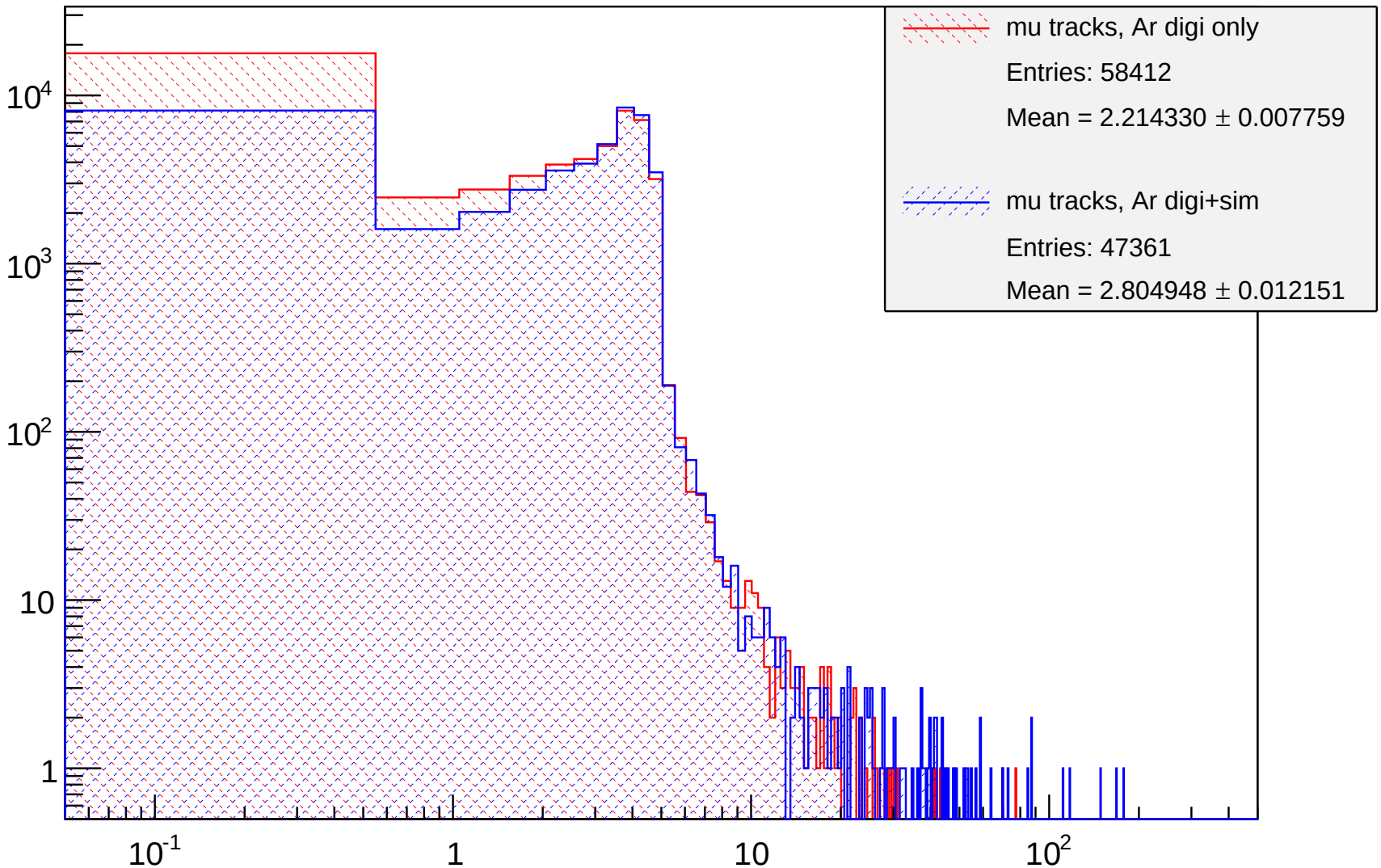
Constants:

```
Xe (for reference):
  getDeDxConstant():    9.42642e-28
  getDeDxI0()      :    0.000367858
  getDeDxMin()     :    1.08668e-26
  getRadLength()   :    25144.7
  getIntLength()   :    307901
  getDensity()     :    2.73182e+16
Ar:
  getDeDxConstant():    4.07438e-28
  getDeDxI0()      :    0.000145958
  getDeDxMin()     :    4.69695e-27
  getRadLength()   :    127272
  getIntLength()   :    601762
  getDensity()     :    1.11099e+16
```

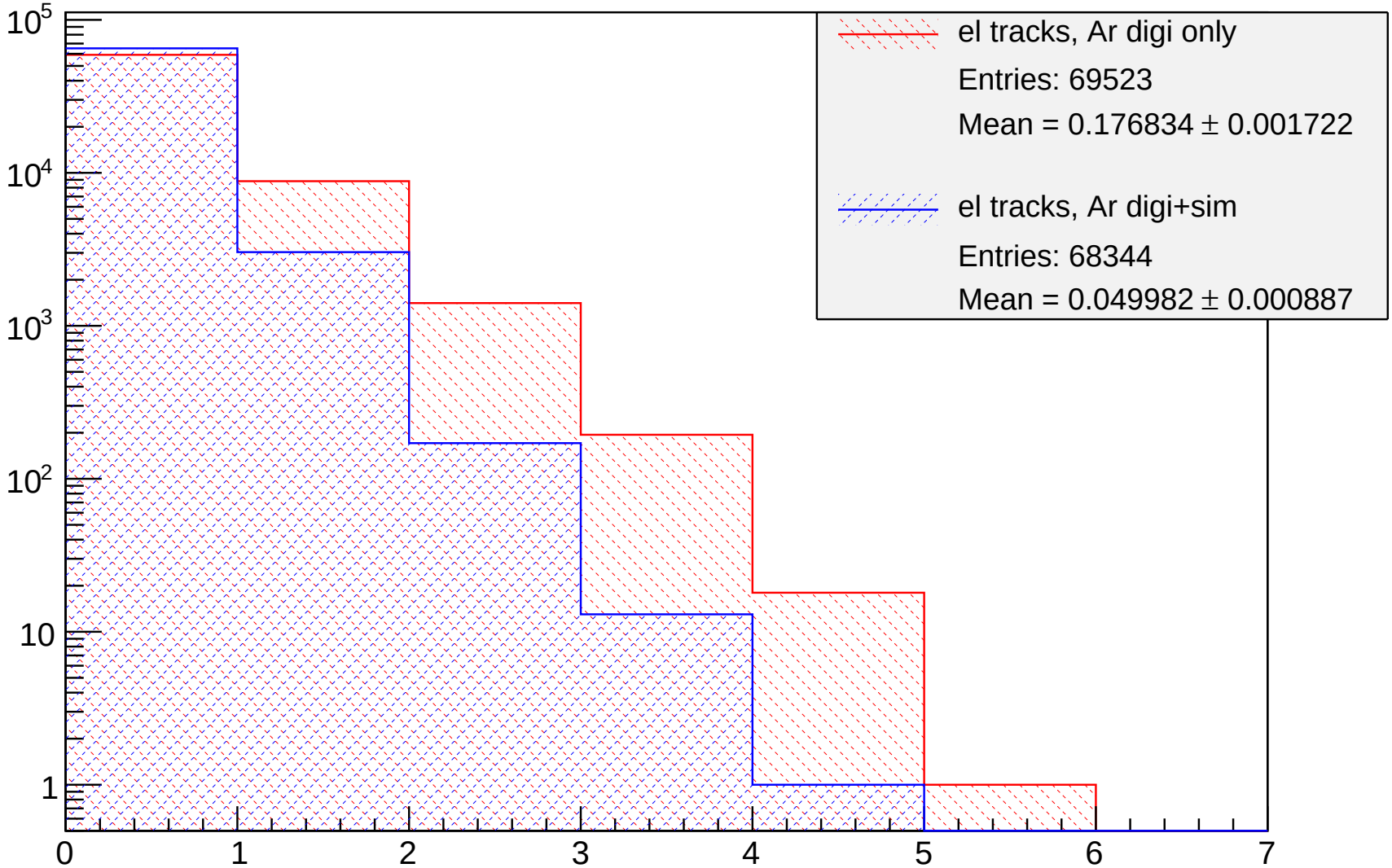
Hits lengths distribution



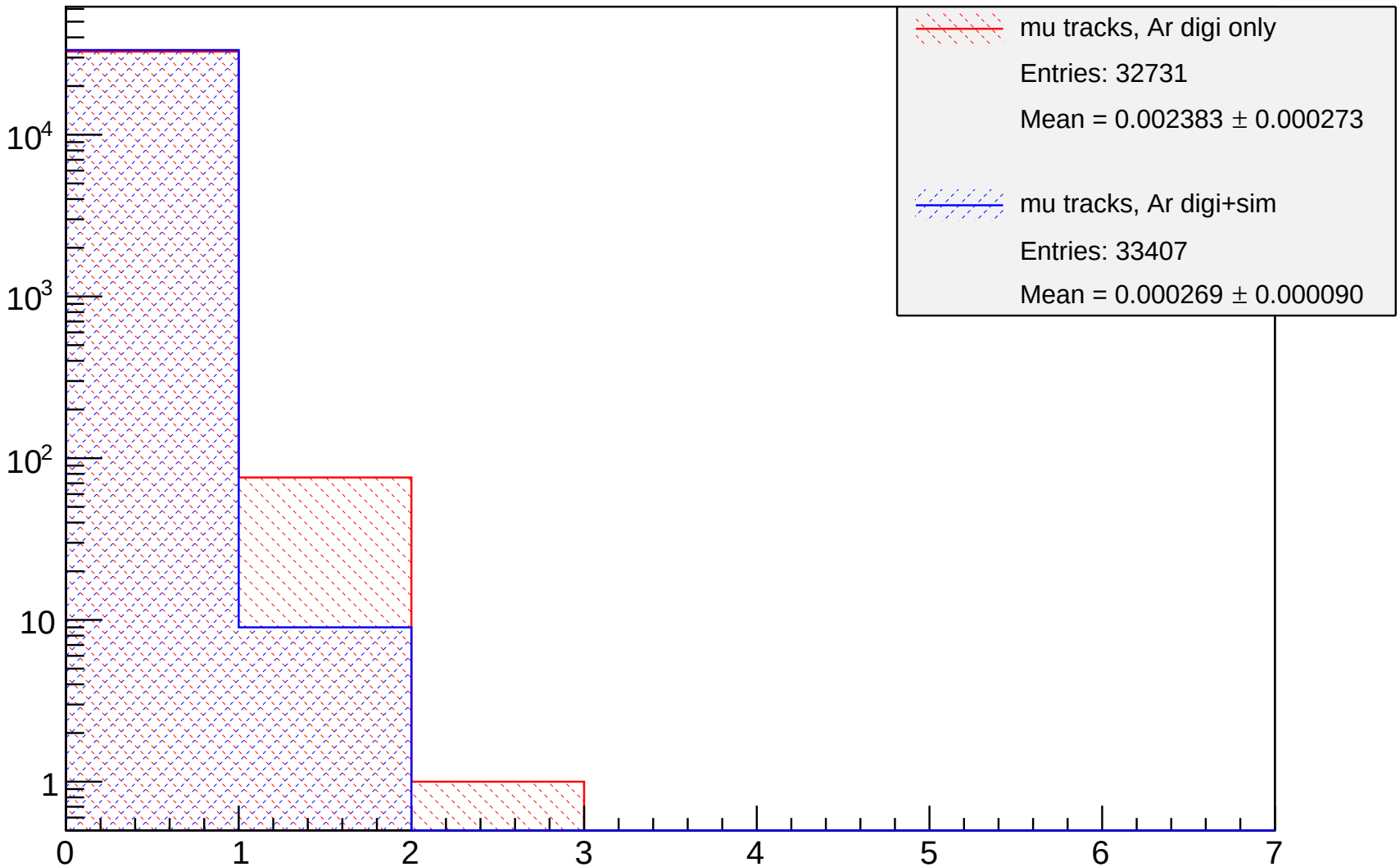
Hits lengths distribution



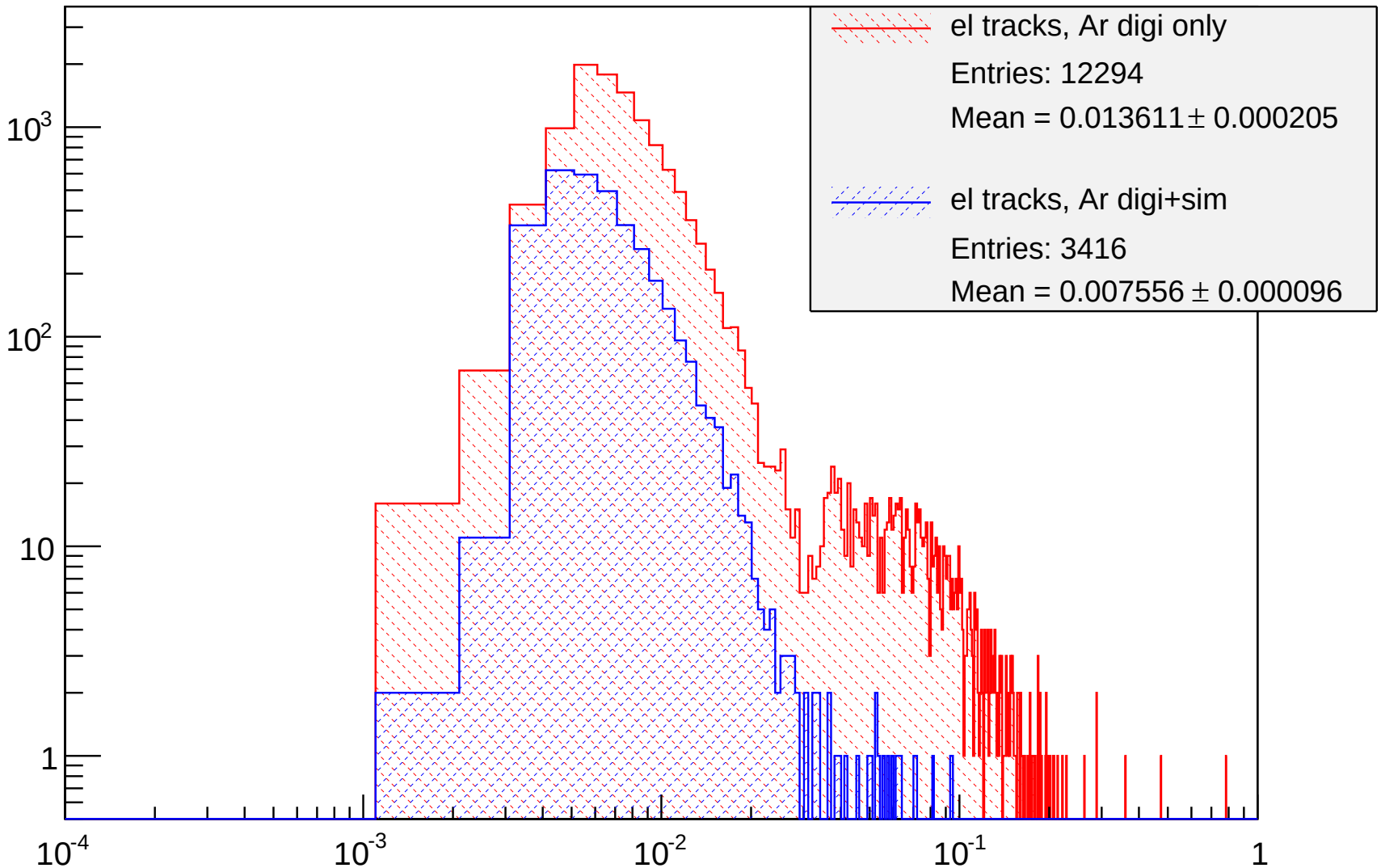
Photon hits number



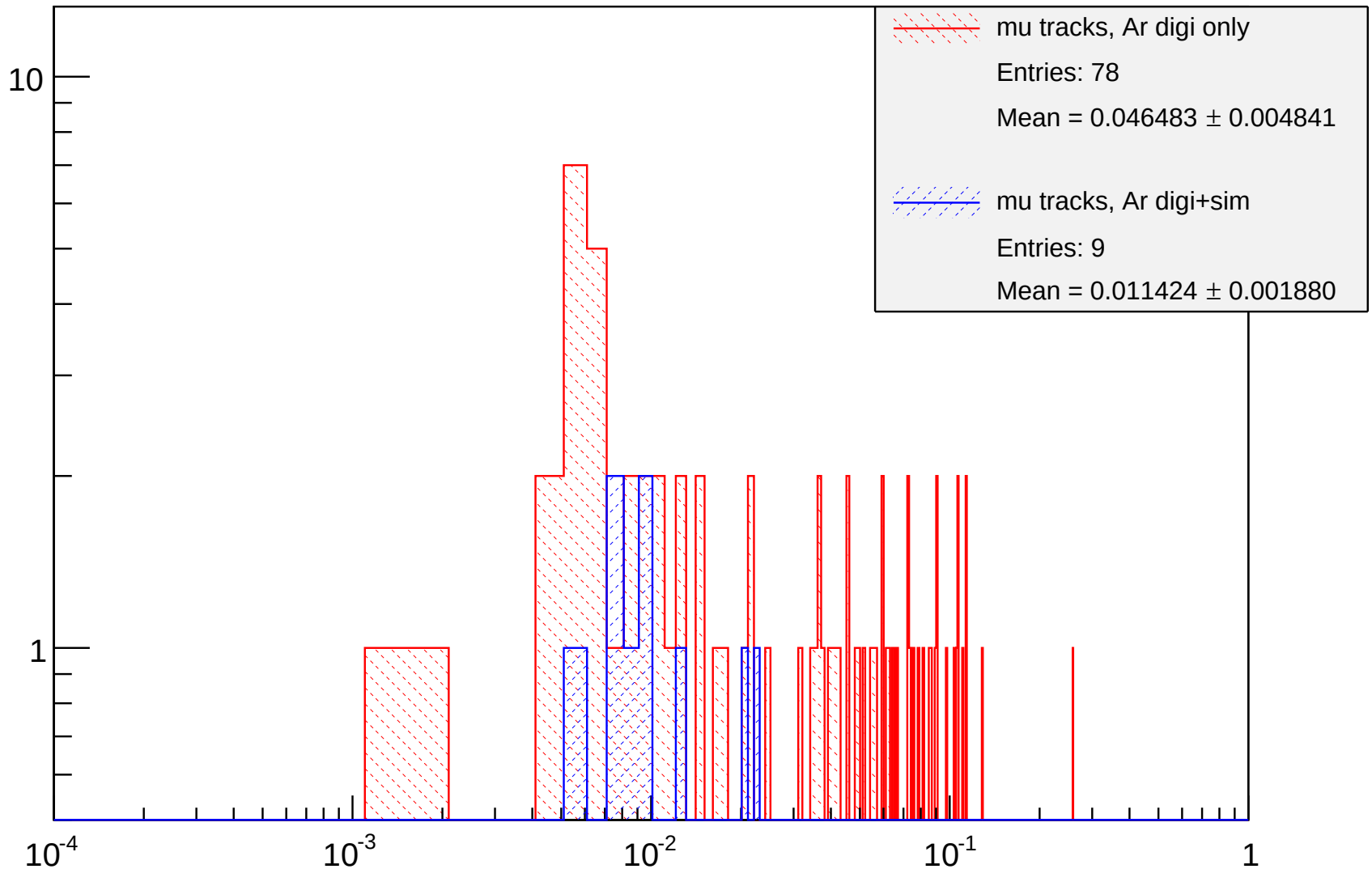
Photon hits number



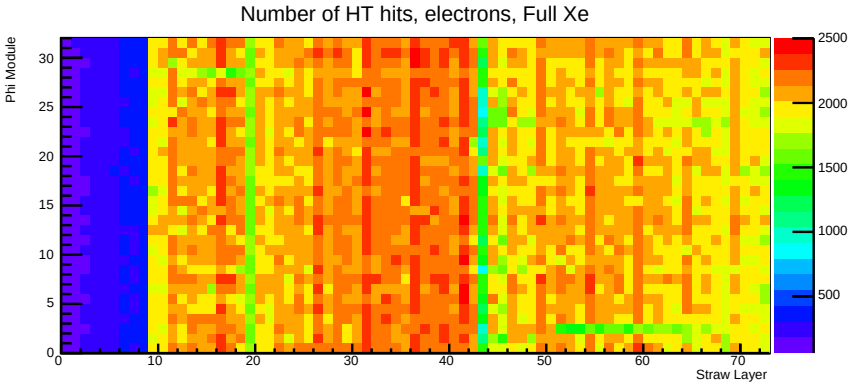
Photon hits energies

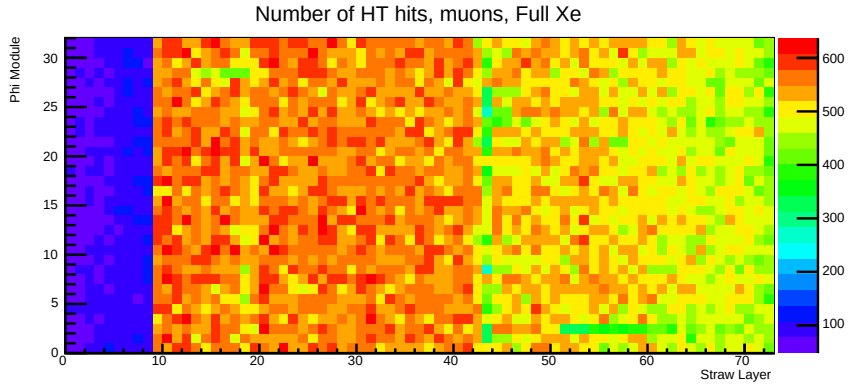


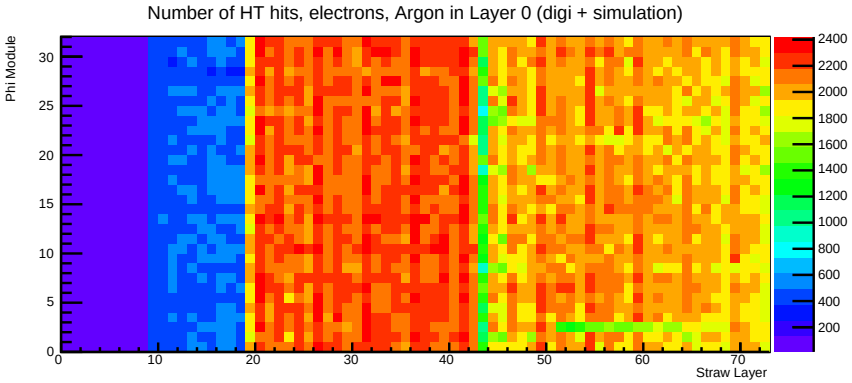
Photon hits energies

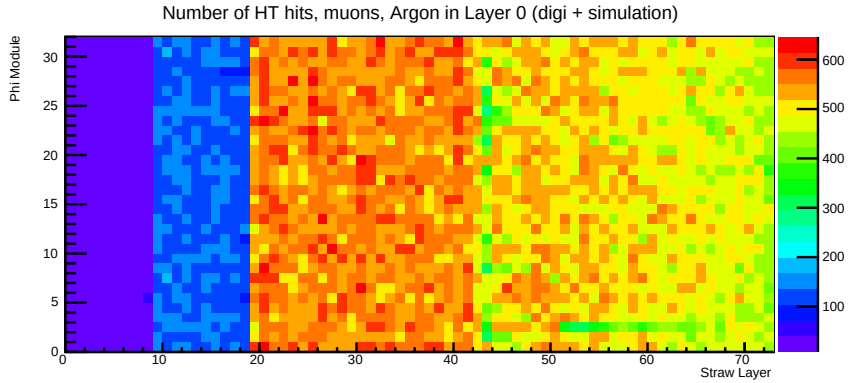


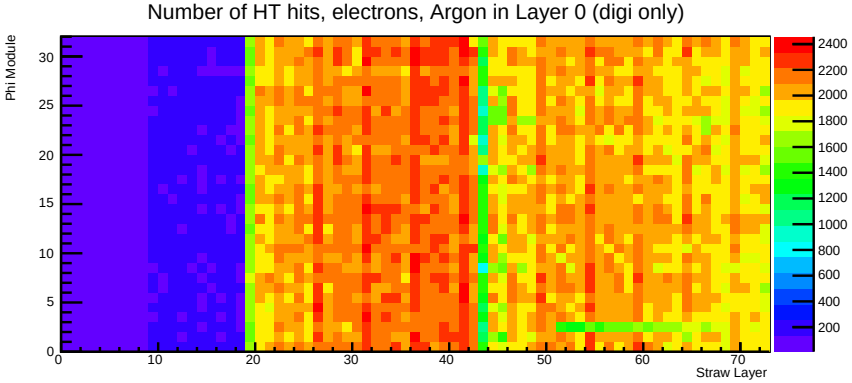
HT hits (Phi module VS straw layer)

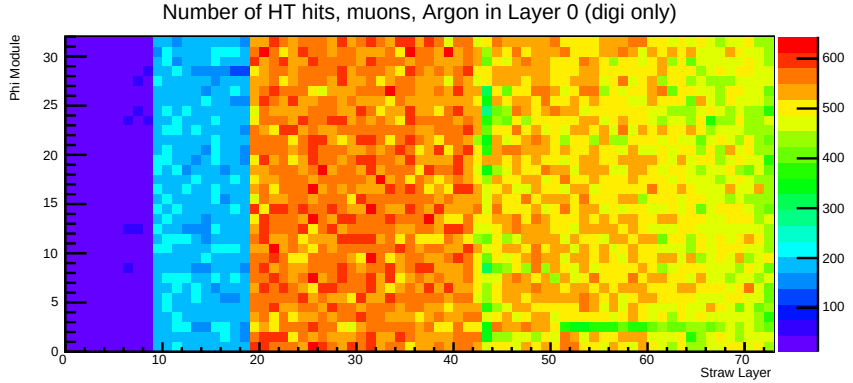












HT hits number VS straw layer