EM / Photon Prong CVN
Single Particle Training for Prod5.1

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Proposed training for $\bar{\nu}_\mu \mathrm{CC}\pi_0$ analysis:

- **EM ID & Photon ID**
  EM/Bkg — (Photon + Electron) vs. (Proton + Pion)
  Photon/Bkg — Photon vs. (Proton + Pion)

Done:

- **6 different binary networks training**
  - (EM / Photon) × (No nhit cut / nhit>=4 cut / nhit>=6 cut)
- **Evaluating networks on training sample**
  - Confusion matrices
  - Prong identification efficiency/purity vs nhit plots

In progress:

- Implementing EM/Photon Prong CVN scores on ND nominal MC sample and selecting $\bar{\nu}_\mu \mathrm{CC}\pi_0$ events with the new CVN scores

Will do:

- Make producer for new products ready, add hooks to StandardRecord and CAFMaker, add new network to UPS …

Dataset:

- /lfstev/nnet/R19-11-18-Prod5/Vertex-Update-ND-Single-Electron/Photon/Proton/PiPlus/PiMinus

Training parameters:

(Hyperparameters optimized by Derek)

- Test size = 0.1
- Iterations: train = 1000 / eval = 100
- Epochs = 100
- Batch size = 64
- Learning rate = 0.05
- SGD momentum = 0.68
- Learning rate factor = 0.75
- Learning rate patience = 10
- Early stopping patience = 20

Cuts applied on Prongs:

Trained on:

- Prong length <= 500cm
- Prongs are produced by generated particles:
  GEANT TrackID == 0
- Primary prongs (most energetic):
  png_idx = 0
- Prongs are contained:
  -180 < start x/y < 180,
  25 < start z < 1250
- 3 versions of nhit cuts:
  No nhit cut / nhit >= 4 / nhit >=6

Evaluated on:

- Prong length <= 500cm
- GEANT TrackID == 0
- Primary prongs / All prongs
- Prongs are contained

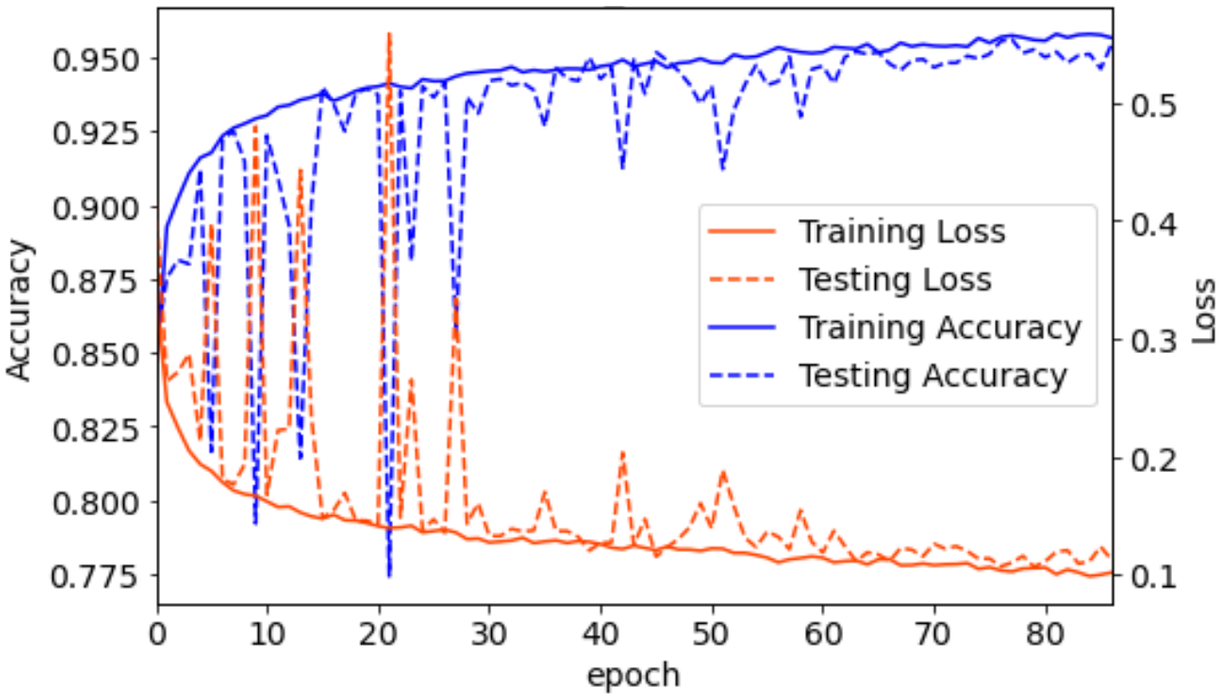
Prong types are labeled by 3D truth label

Training prong compositions

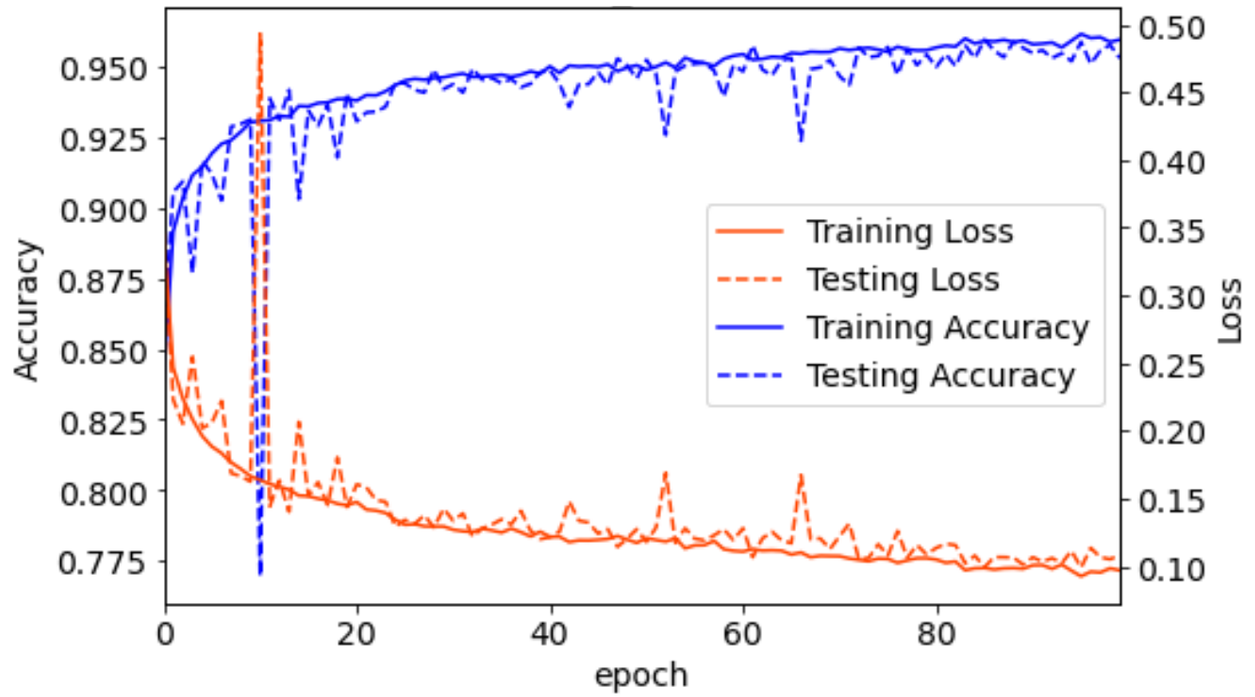
Generated Sample	Photon	Electron	Proton	PiPlus	PiMinus
EM ID	25%	25%	25%	12.5%	12.5%
Photon ID	50%	0	25%	12.5%	12.5%

EM CVN training history

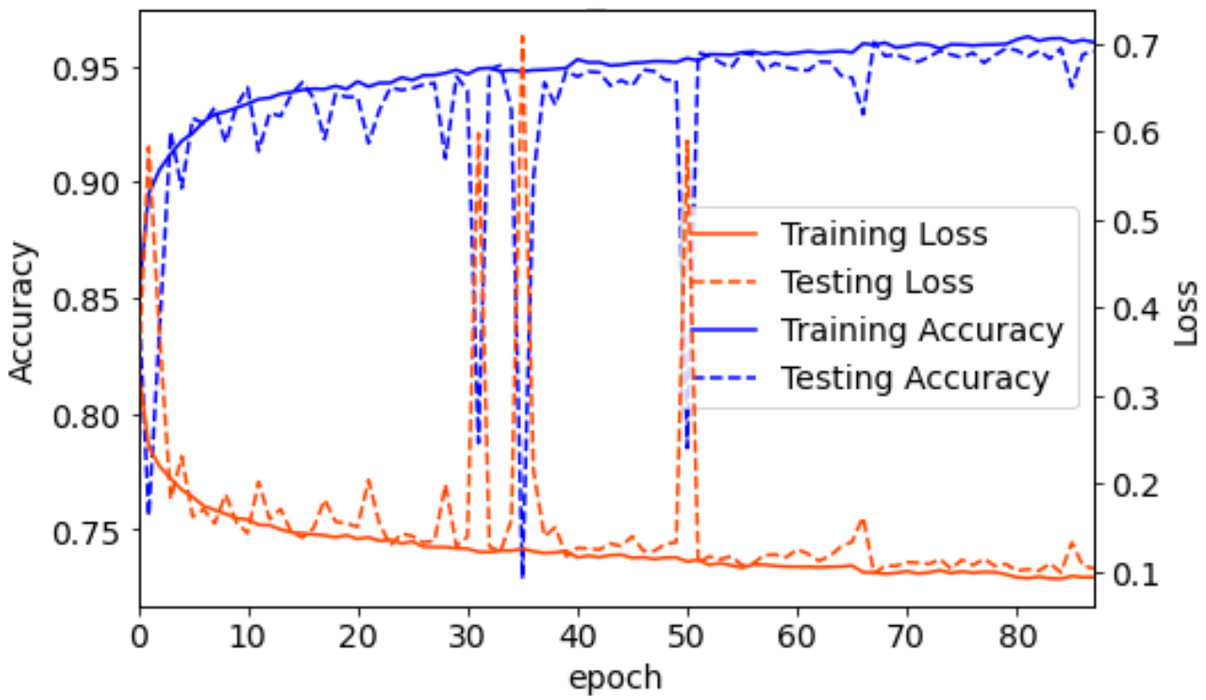
No nhit cut



nhit >= 4

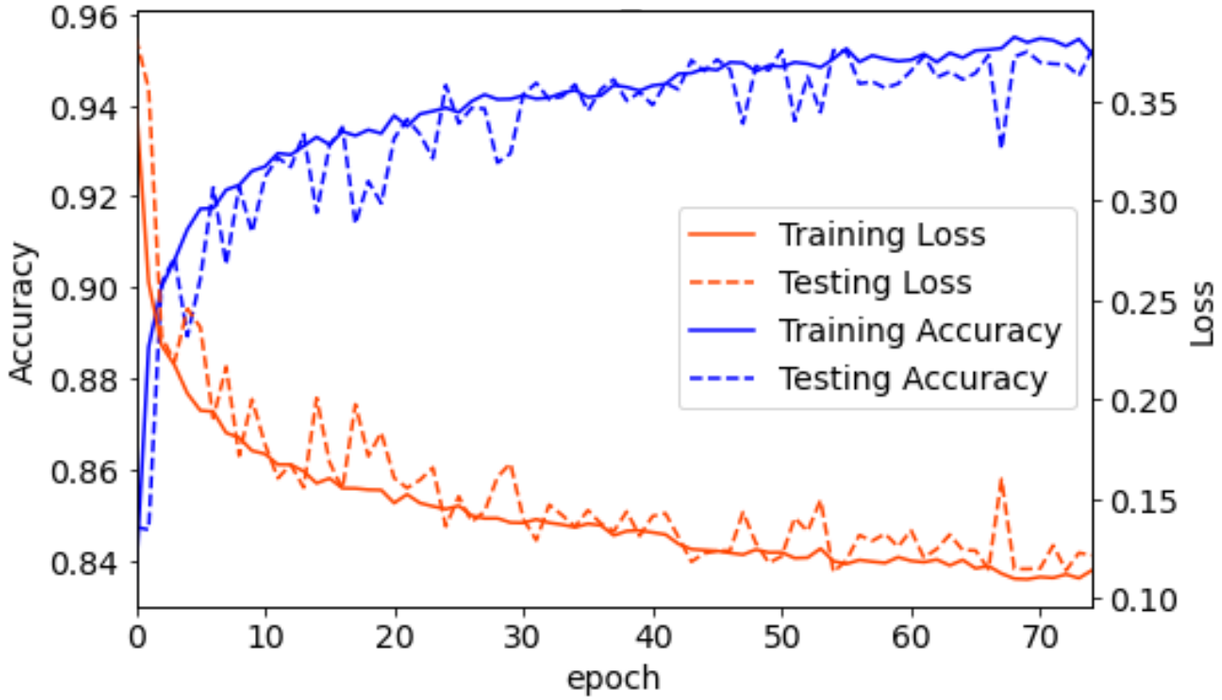


nhit >= 6

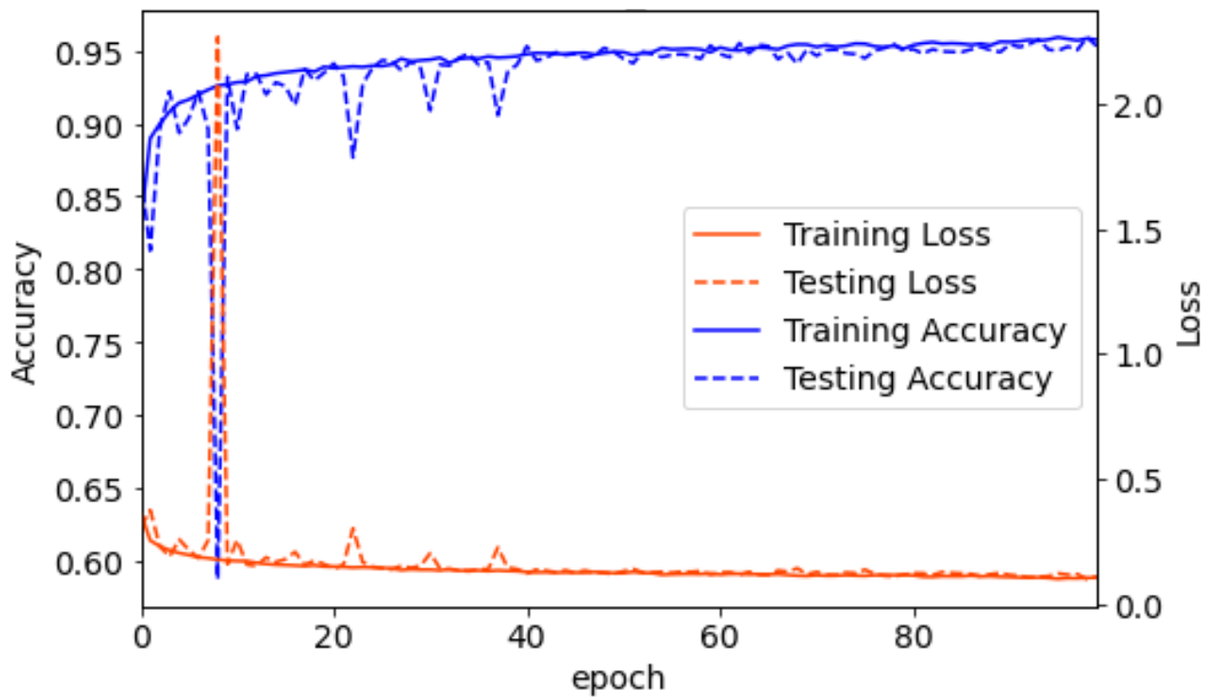


Photon CVN training history

No nhit cut



nhit >= 4



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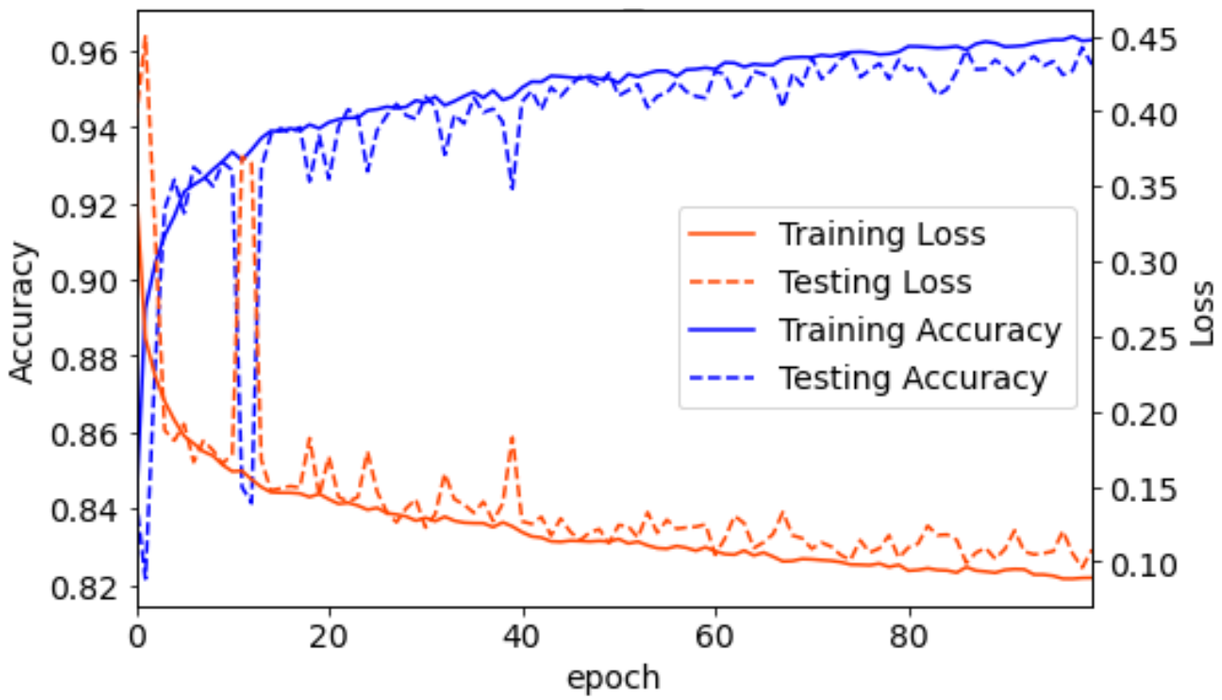
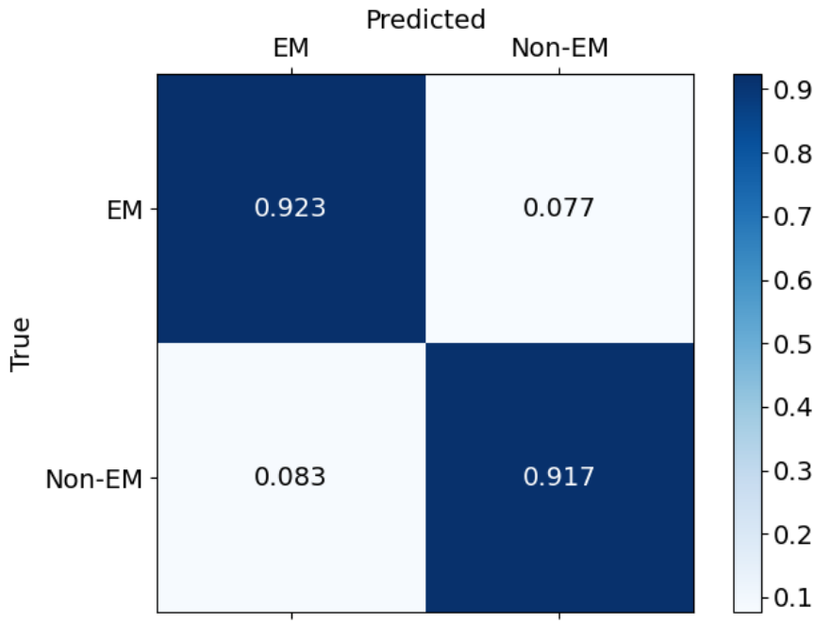


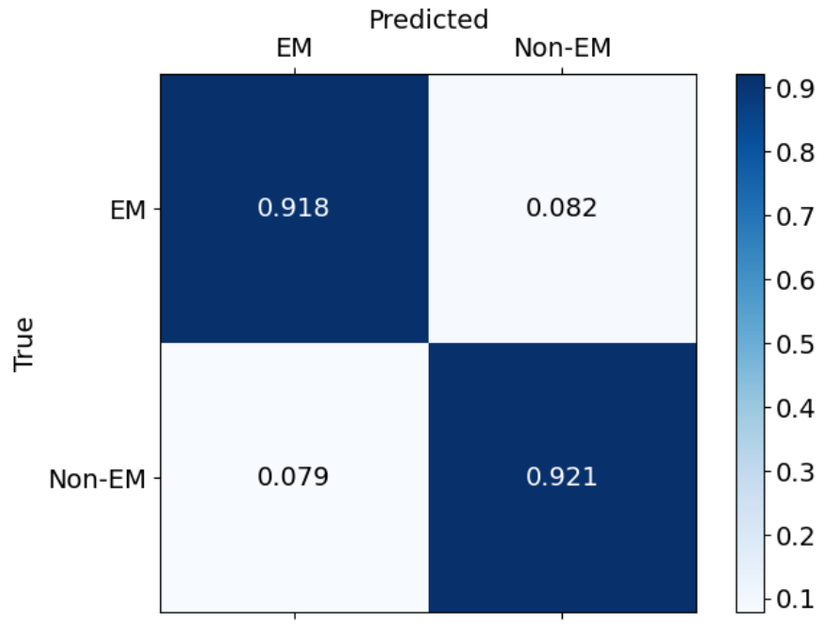
EM Prong CVN Identification Efficiency

(Evaluated on single particle electron / photon / proton / pion samples)

Evaluated on all prongs



No nhit cut



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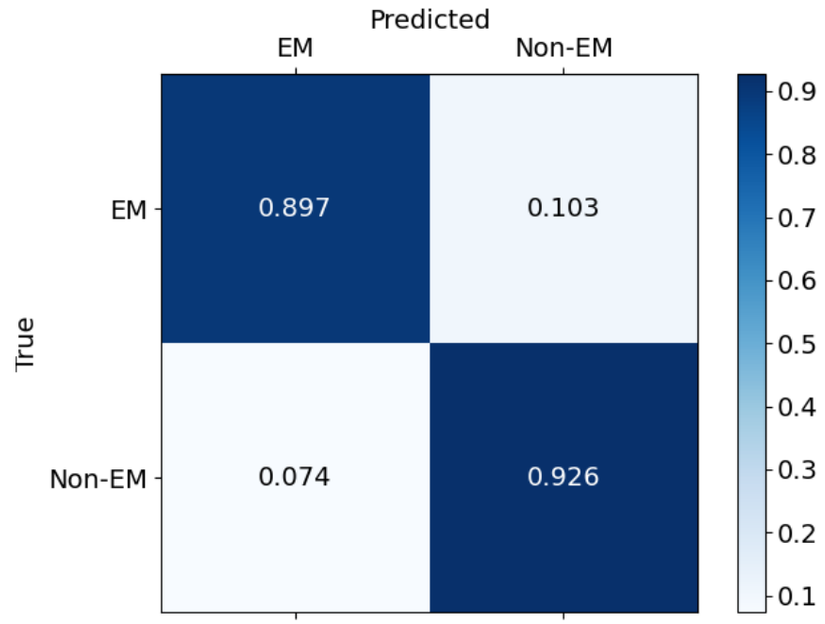
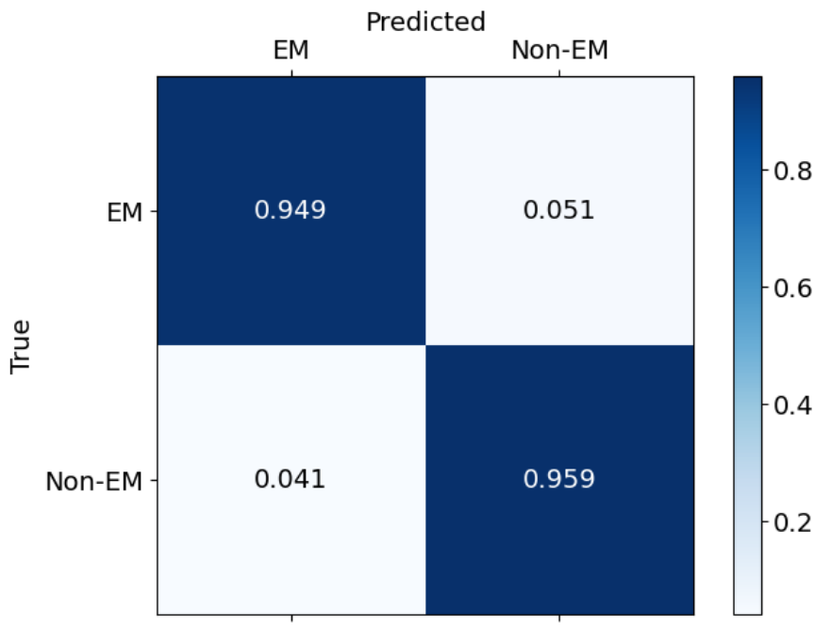


nhit >= 6

Evaluated on primary prongs



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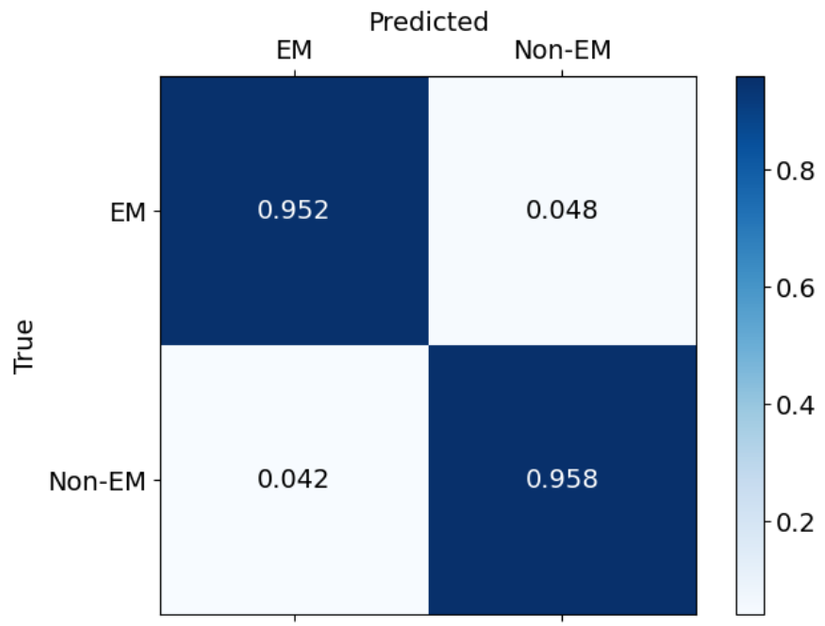

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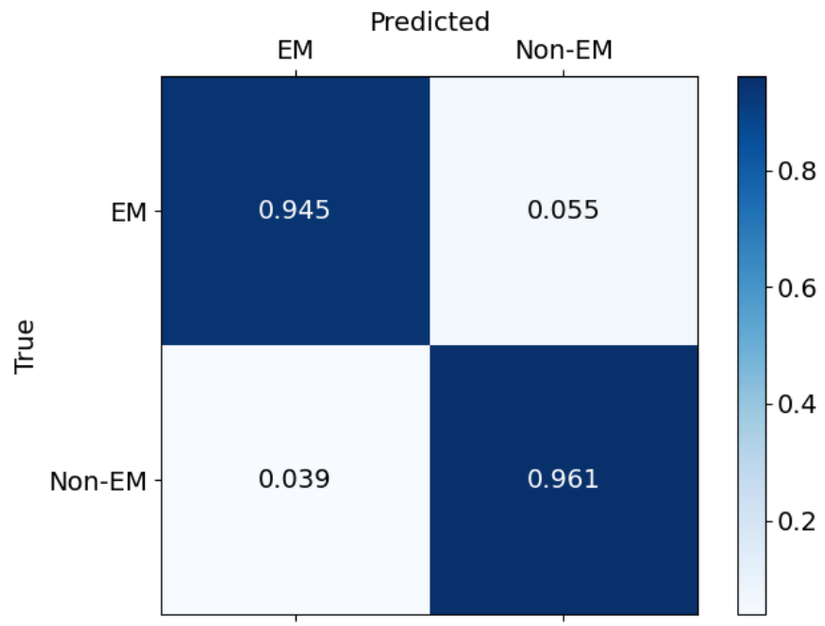
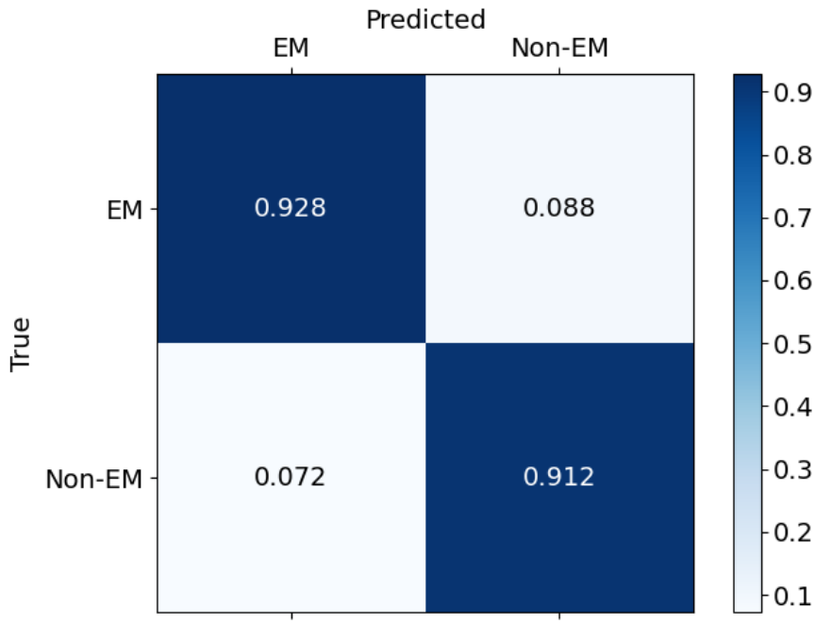


nhit >= 6

EM Prong CVN Identification Purity

(Evaluated on single particle electron / photon / proton / pion samples)

Evaluated on all prongs



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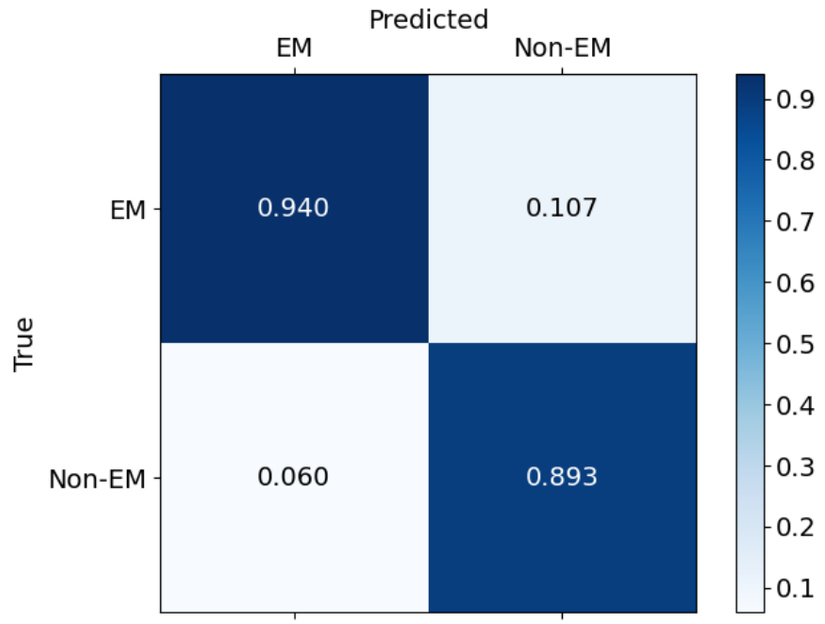

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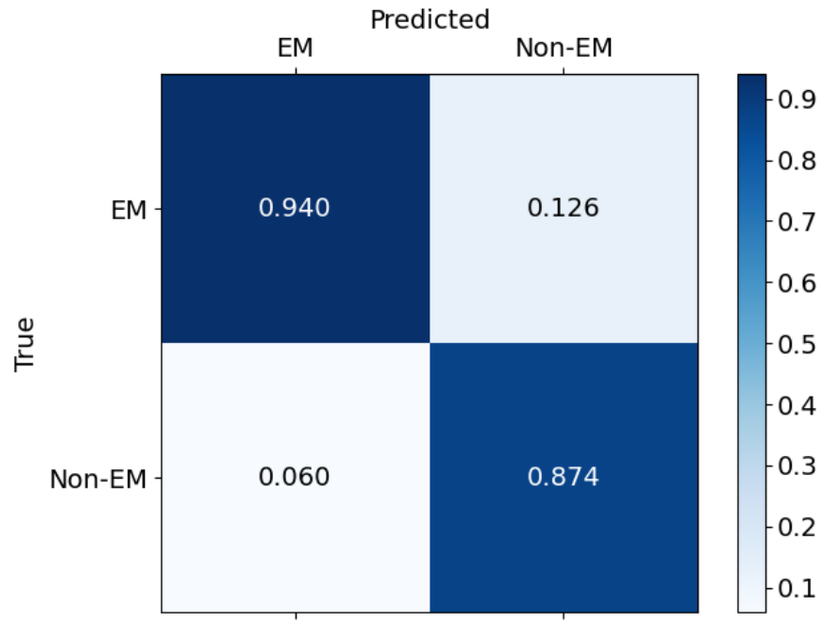
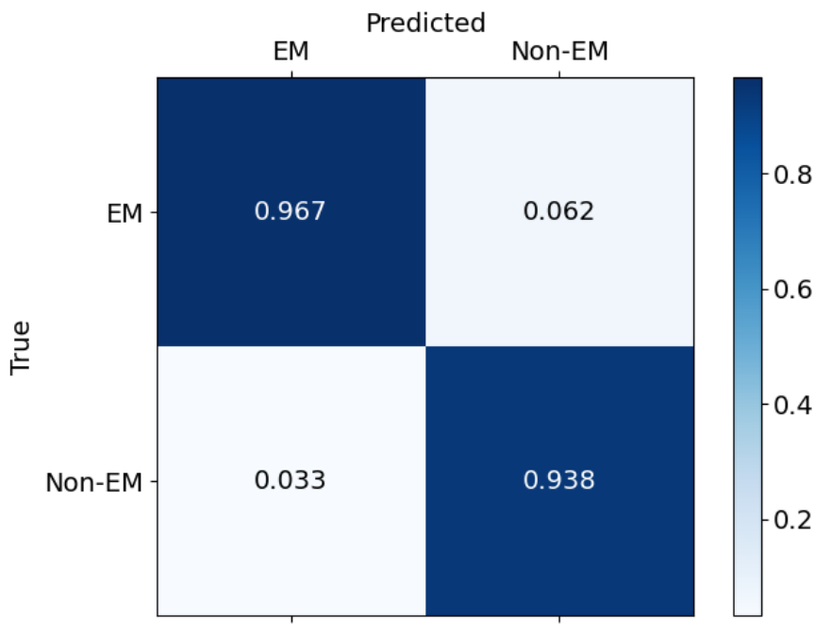


nhit >= 6

Evaluated on primary prongs



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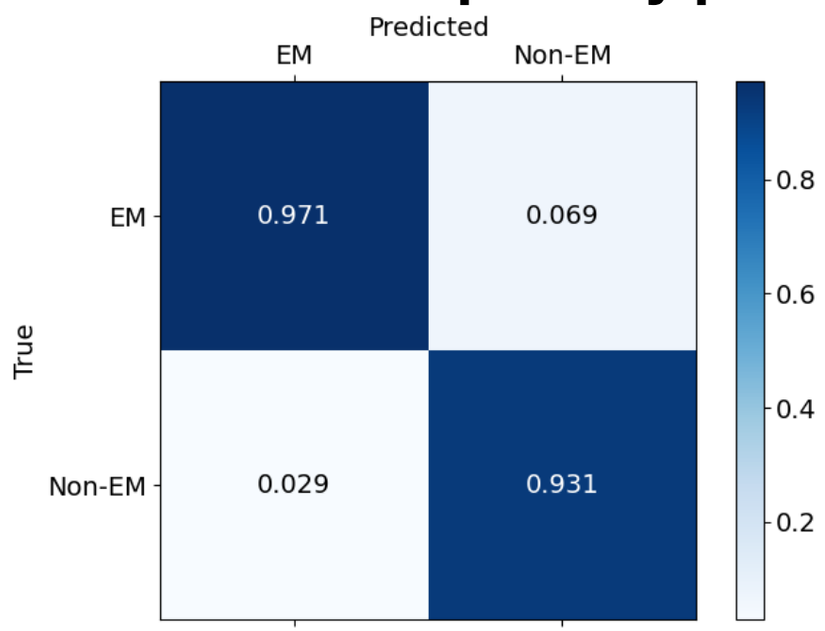

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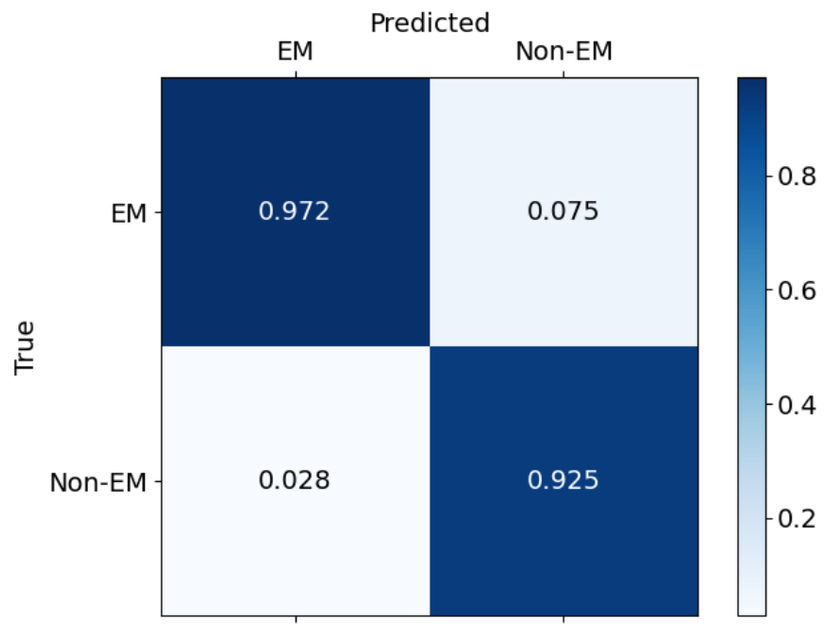
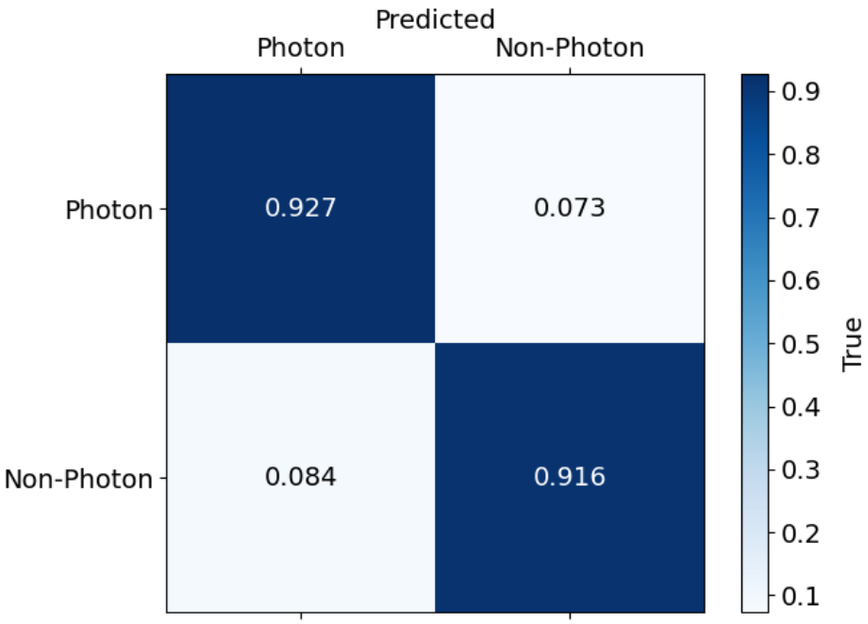


nhit >= 6

Photon Prong CVN Identification Efficiency

(Evaluated on single particle photon / proton / pion samples)

Evaluated on all prongs



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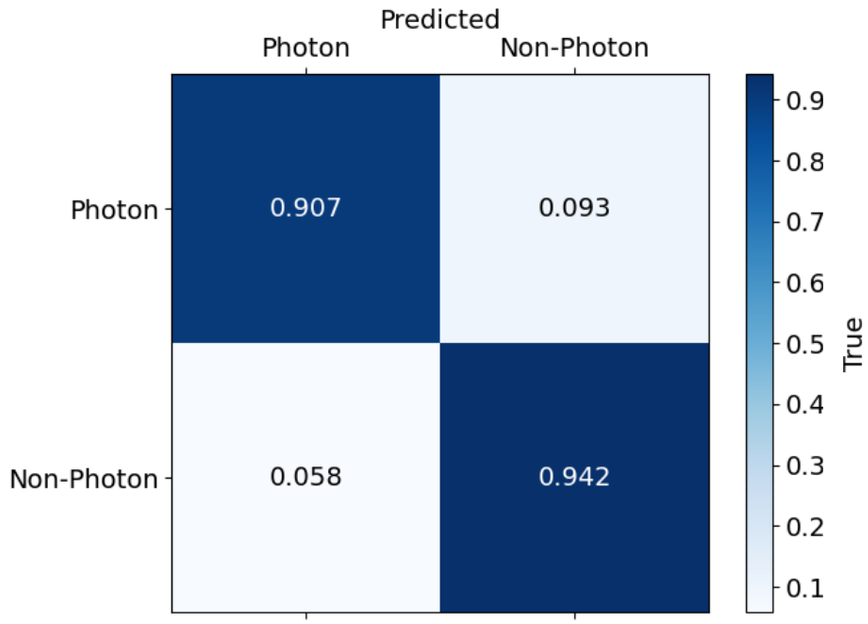

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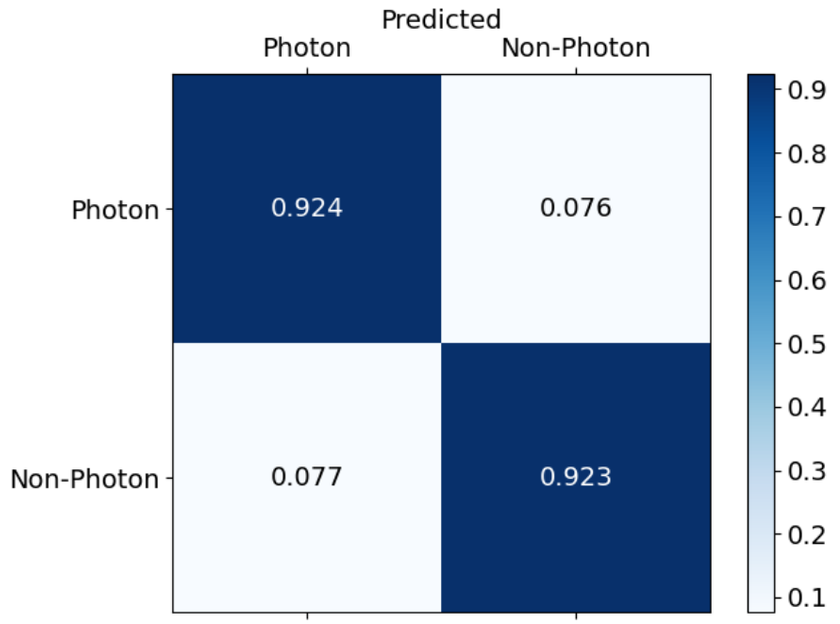
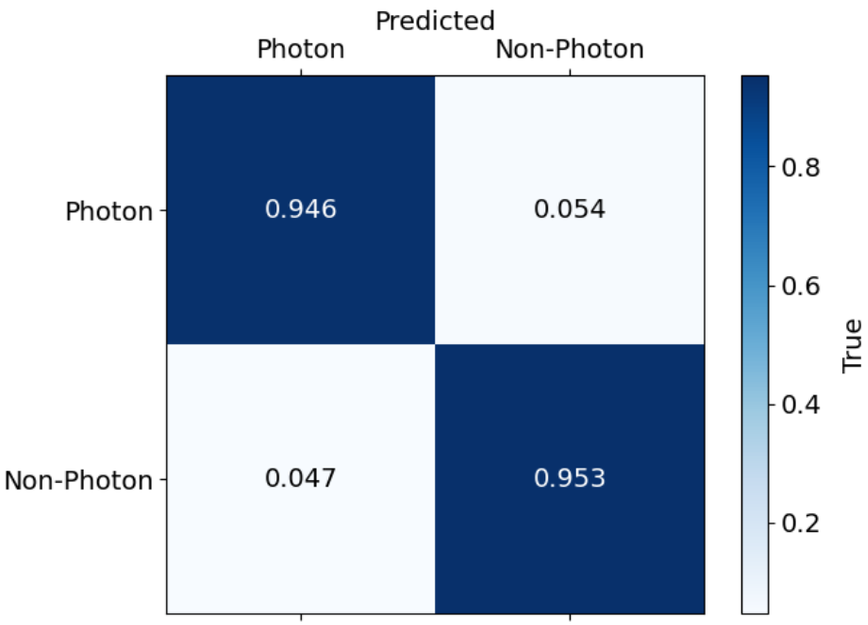


nhit >= 6

Evaluated on primary prongs



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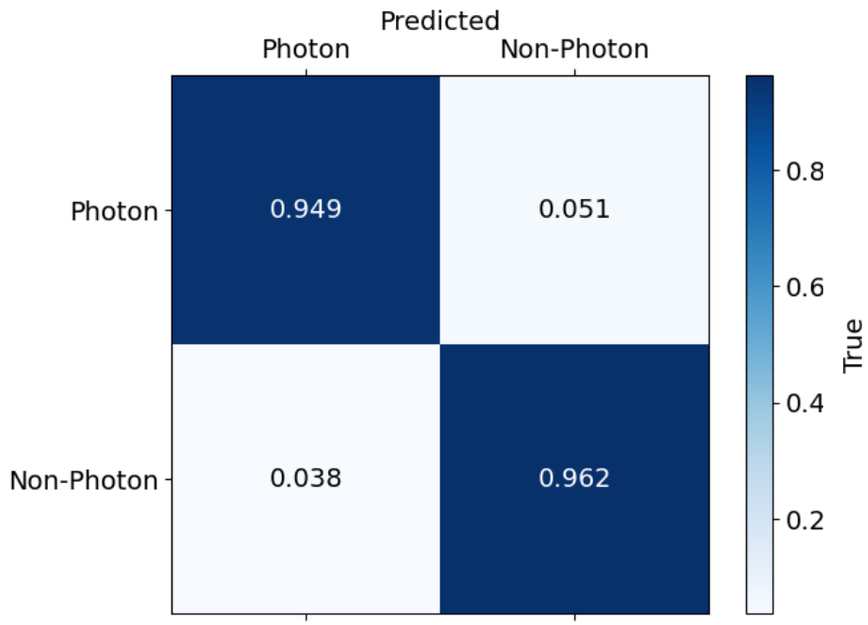
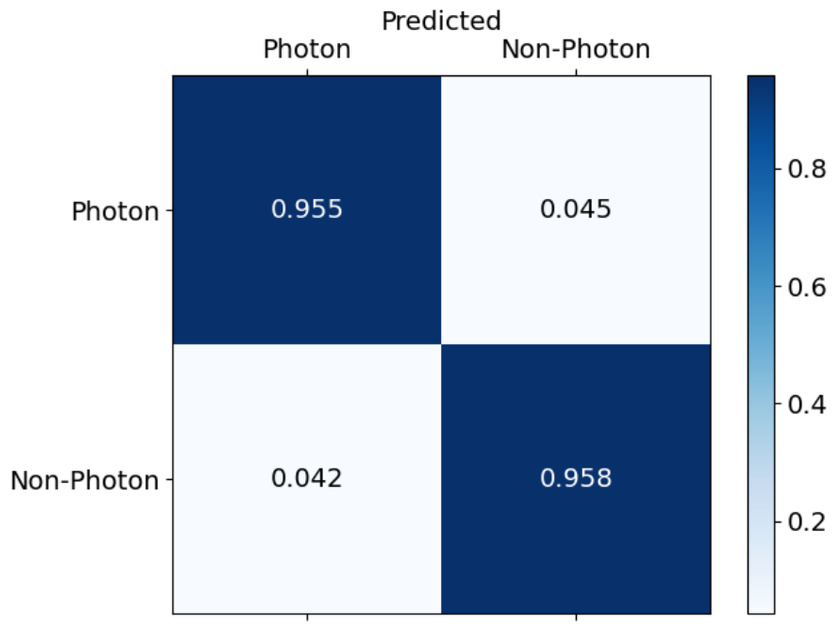


nhit >= 4



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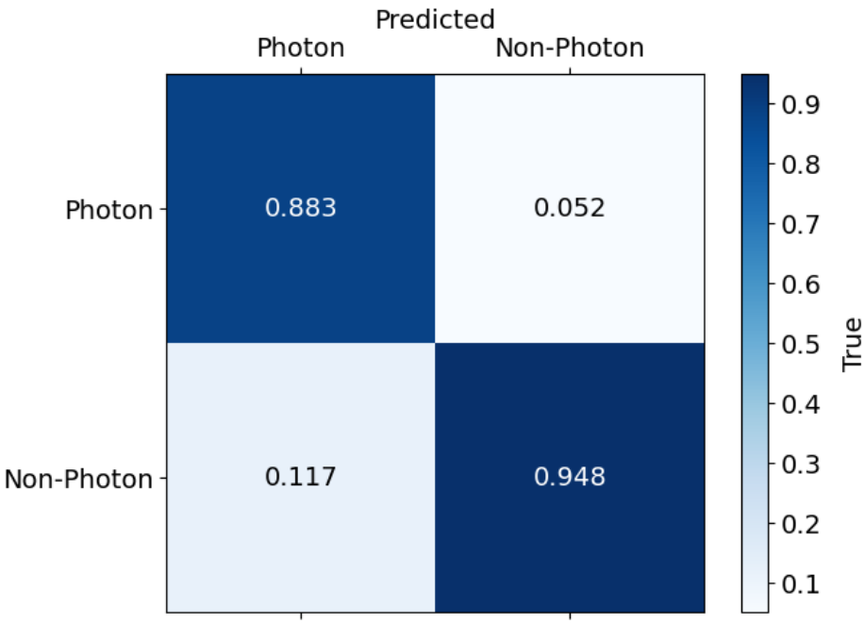
Evaluated on all prongs



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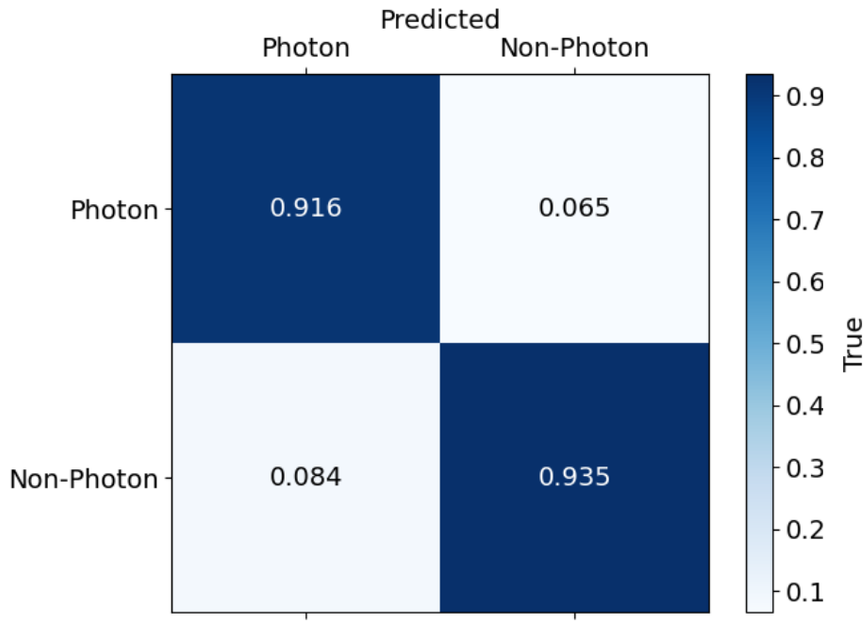

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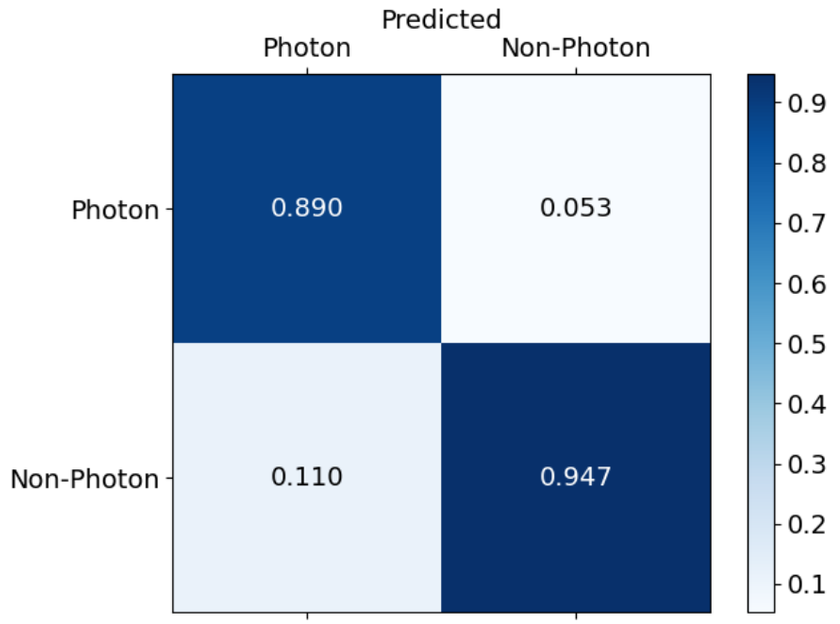
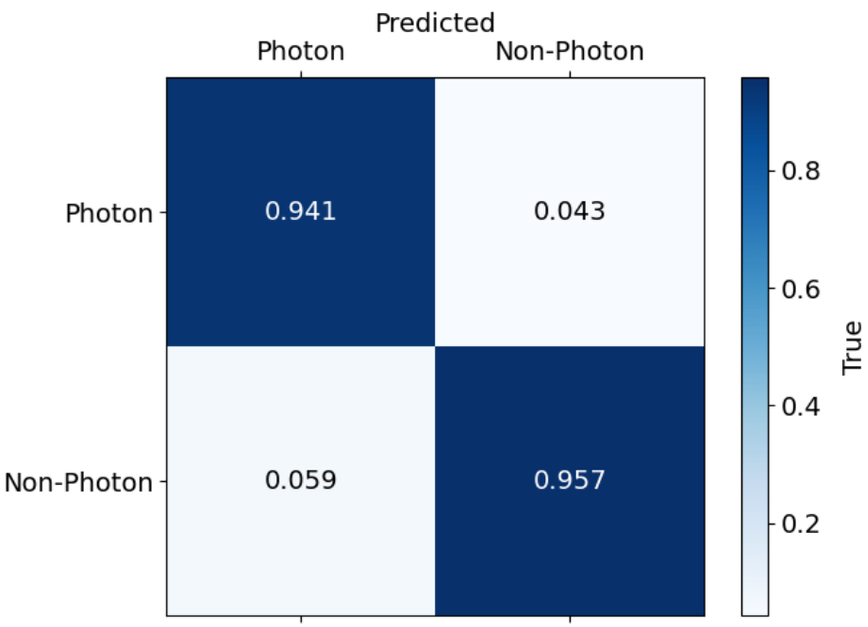


nhit >= 6

Evaluated on primary prongs



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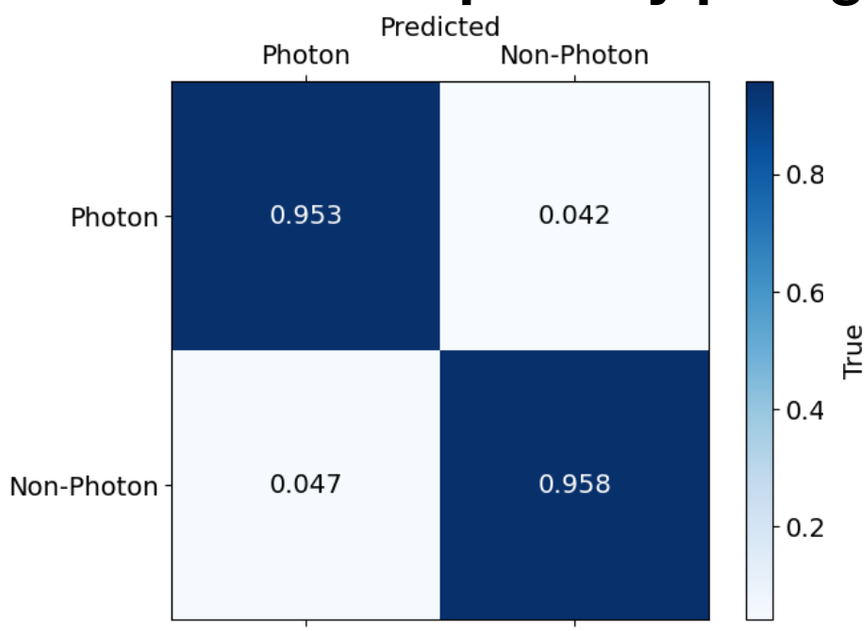

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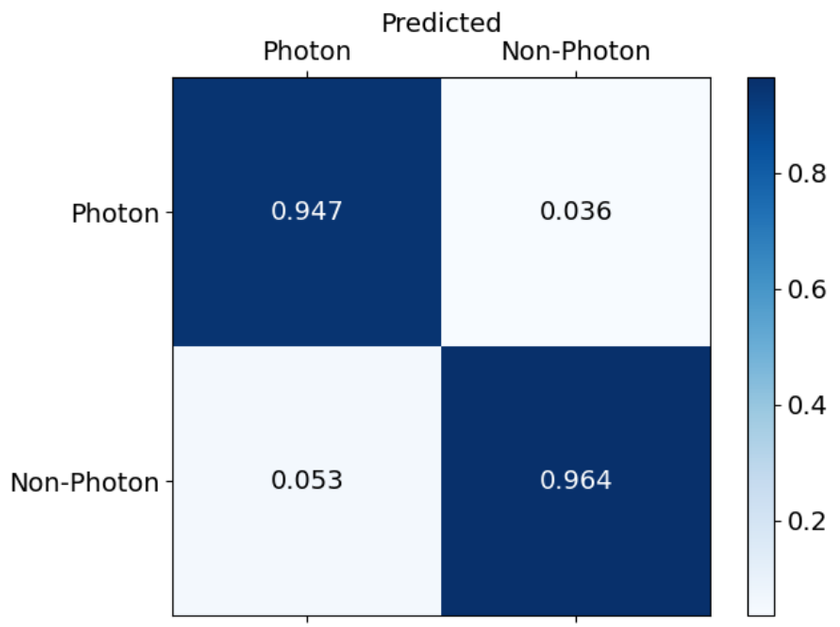
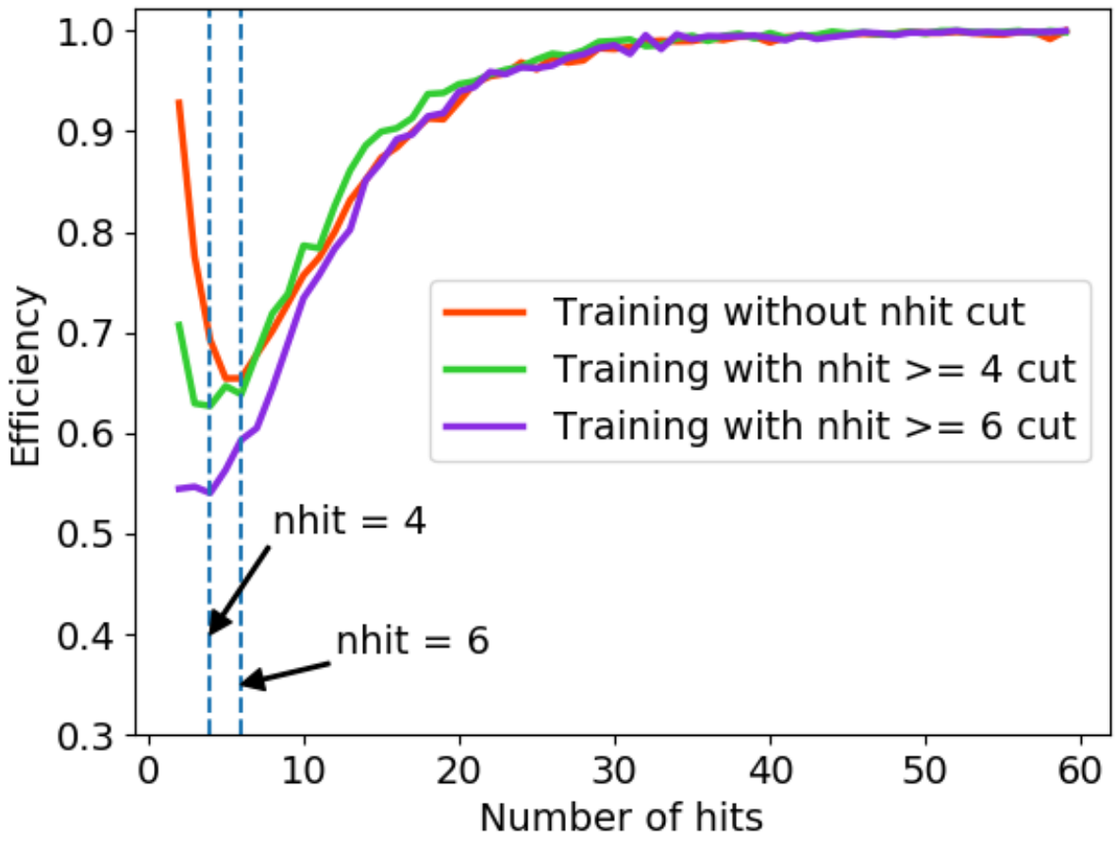


nhit >= 6

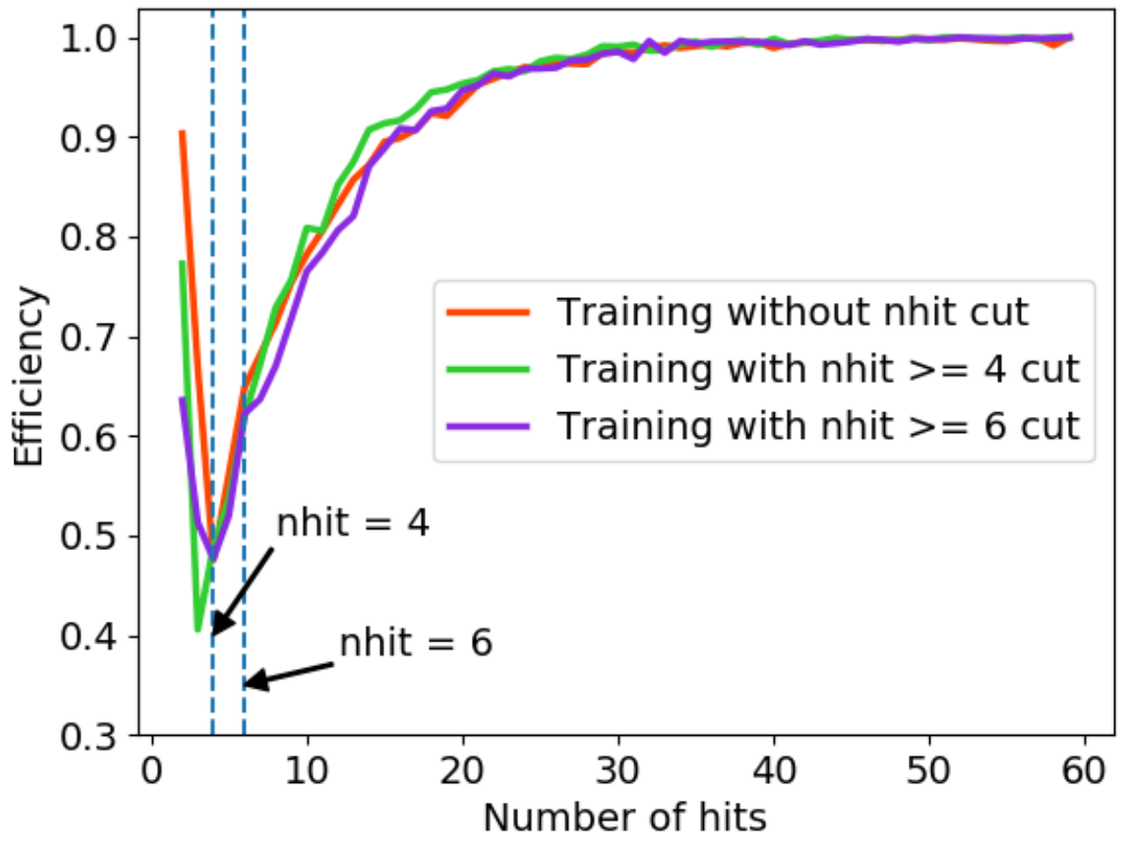
EM Prong CVN Identification Efficiency vs. nHit

(Evaluated on single particle electron / photon / proton / pion samples)

Evaluated on all prongs



Evaluated on primary prongs



EM Prong CVN Identification Purity vs. nHit

(Evaluated on single particle electron / photon / proton / pion samples)

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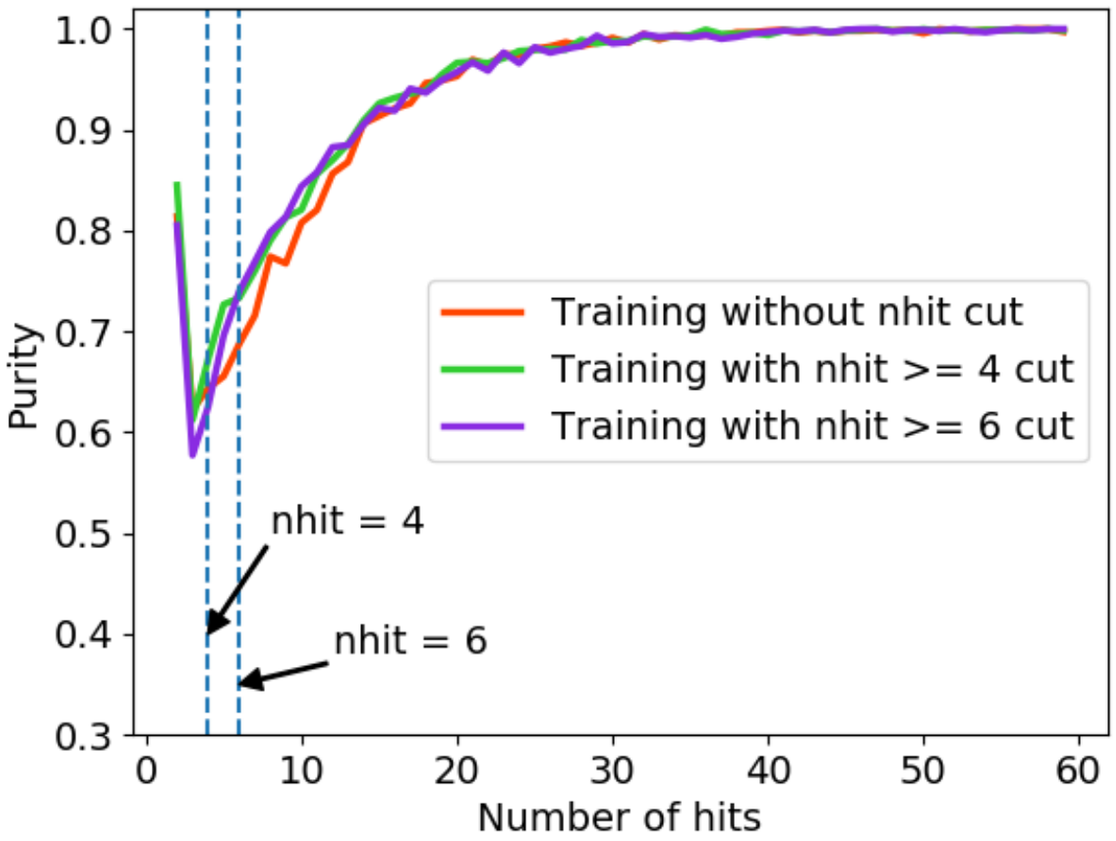
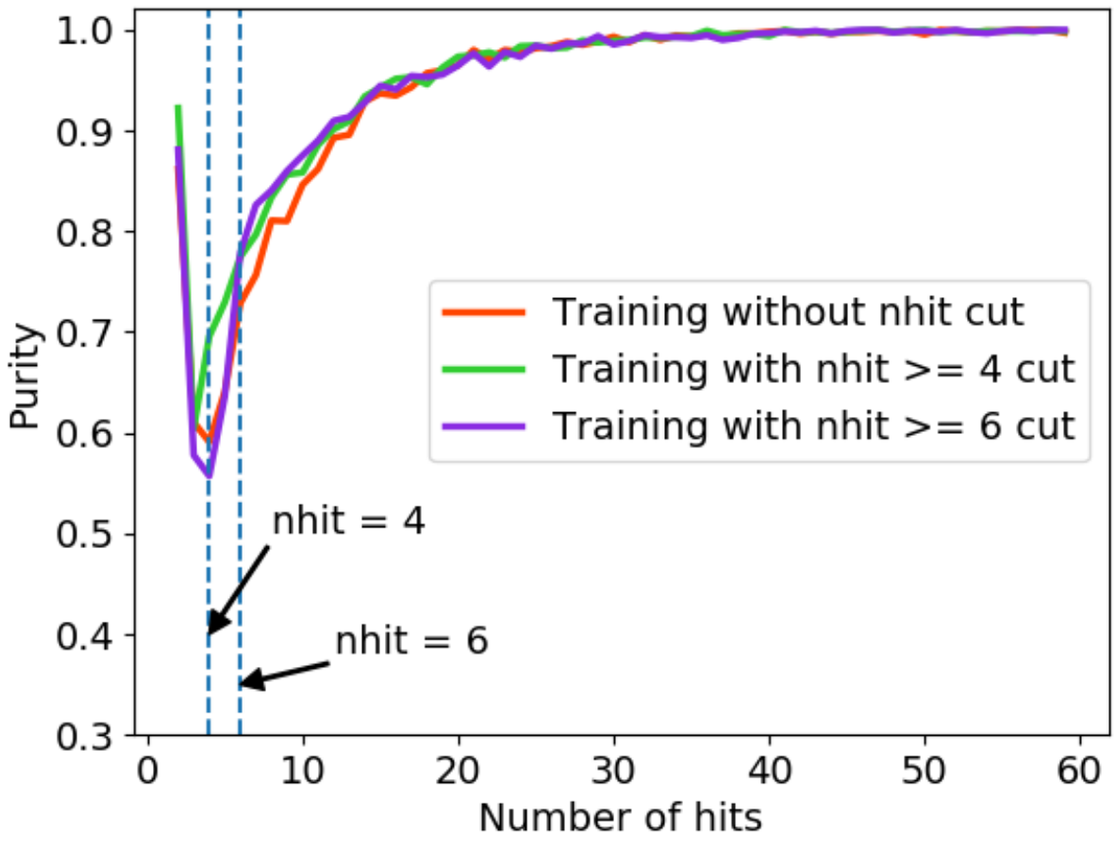


Evaluated on primary prongs



Photon Prong CVN Identification Efficiency vs. nHit

(Evaluated on single particle photon / proton / pion samples)

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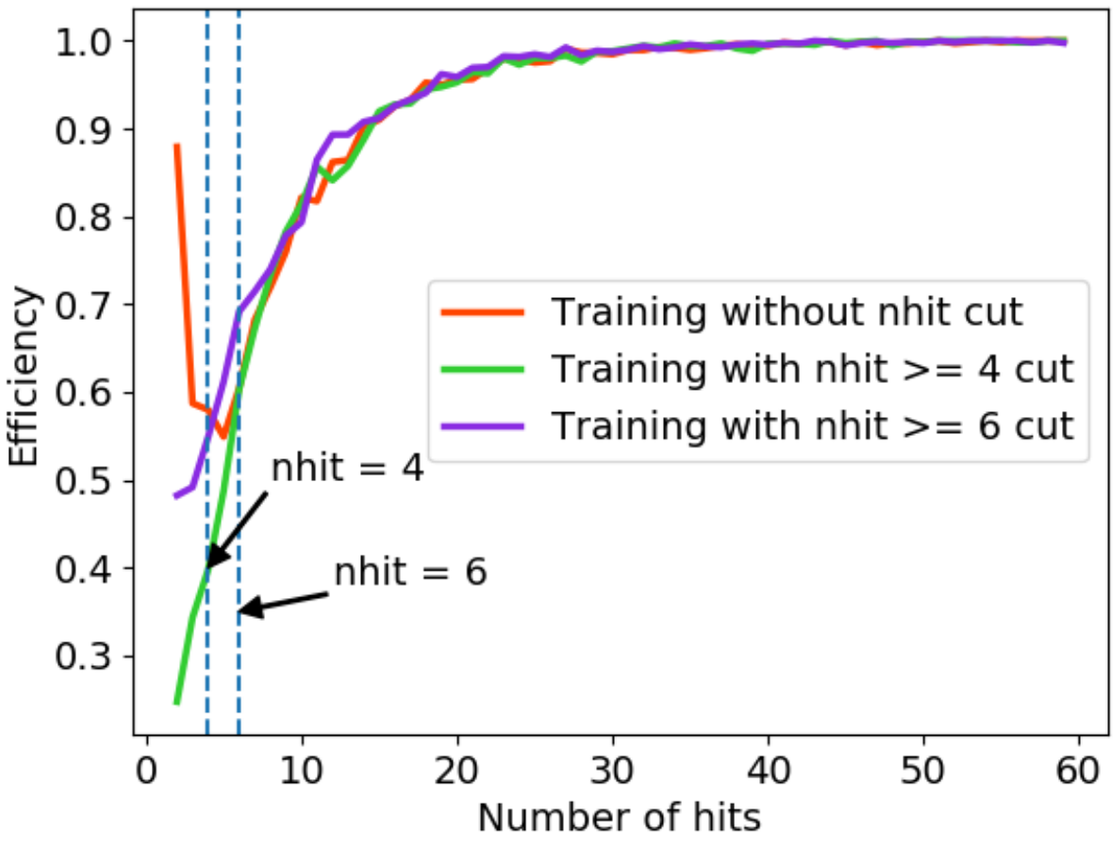
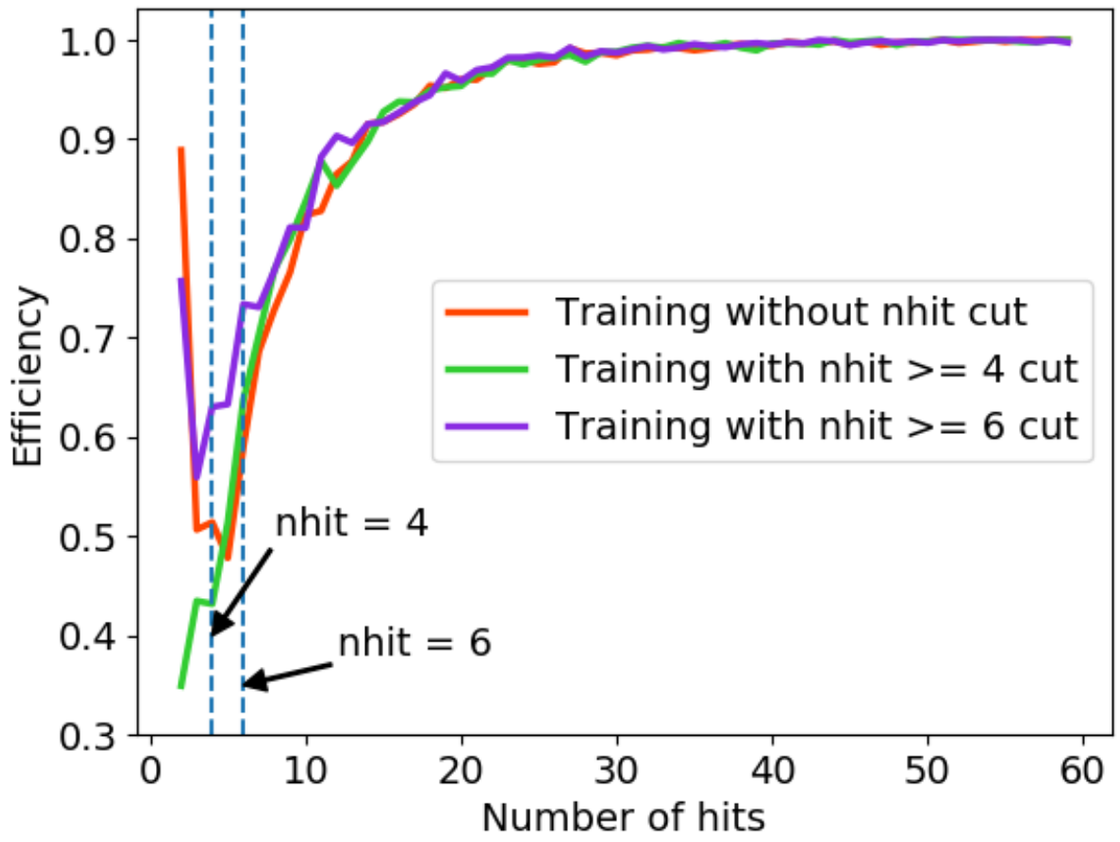


Evaluated on primary prongs



Photon Prong CVN Identification Purity vs. nHit

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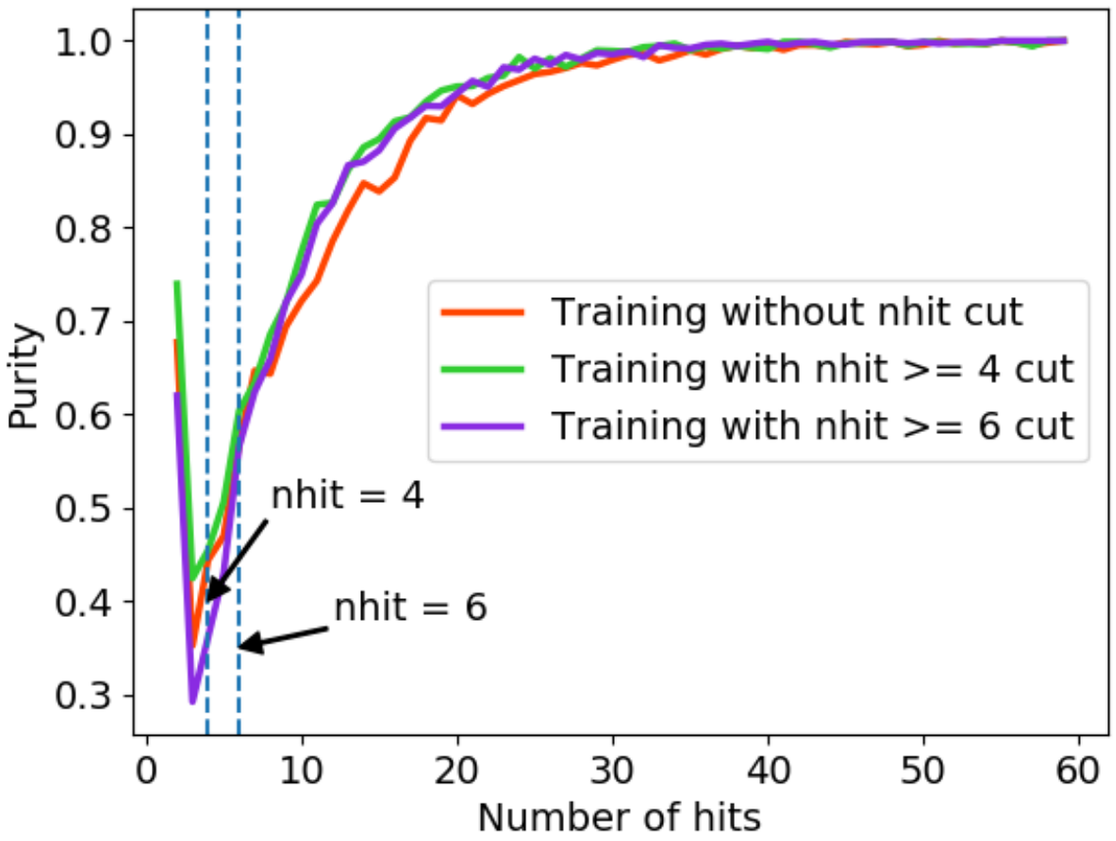
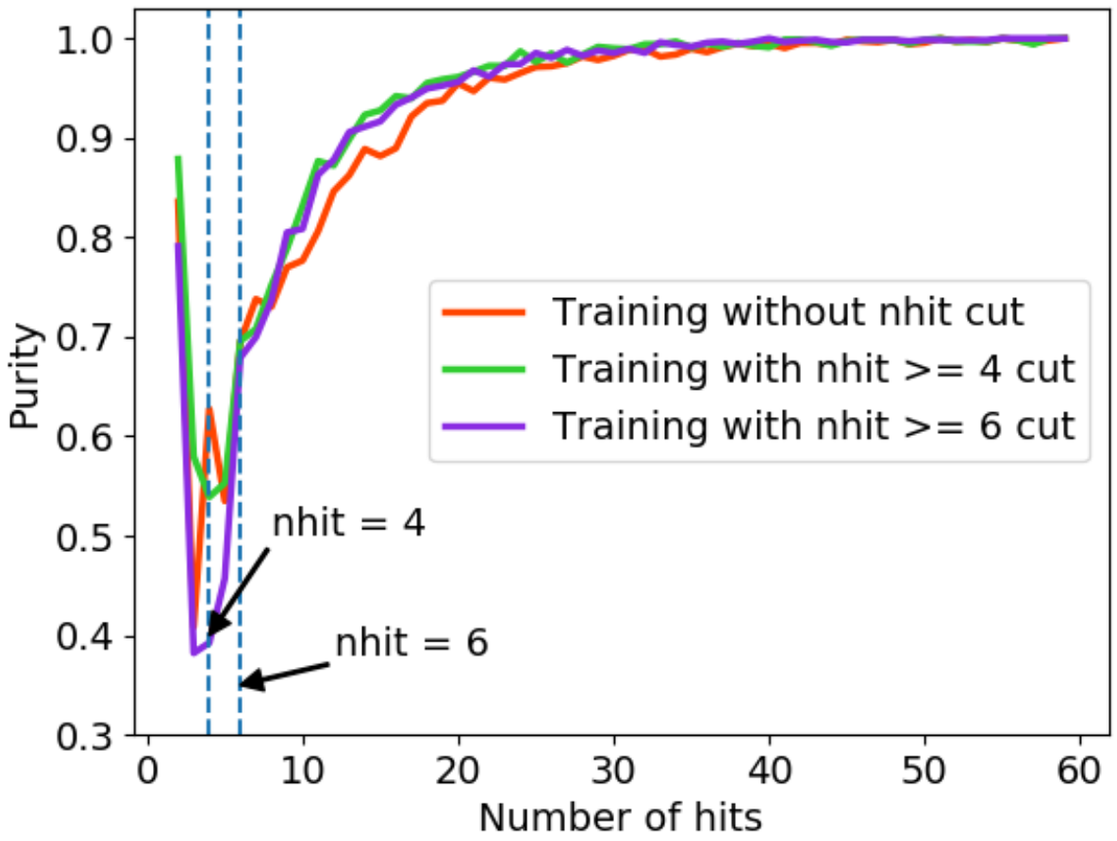


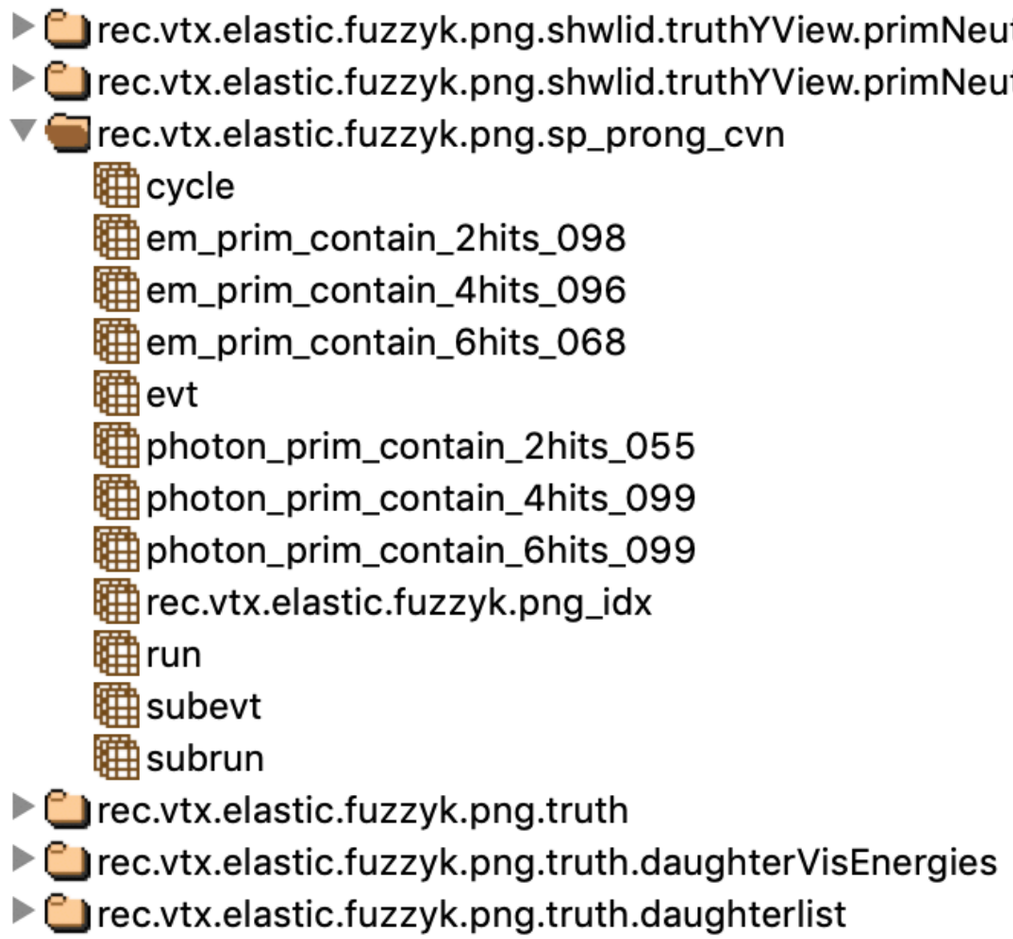
Evaluated on primary prongs



Work in progress:

Jobs are running to implement new CVN scores to Nominal ND MC sample. Will take a look after jobs are done.

Files are in /lfstev/nnet/fgao/ND-MC-Nominal-RHC/



For a prong:

If there is no pixel map, fill -5.0;

If length > 500cm, fill 0.

Backup