# BIB mitigation with AI

Simons progress report
24 April 2026

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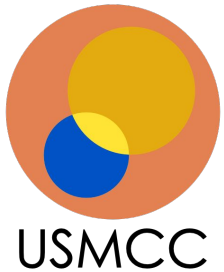
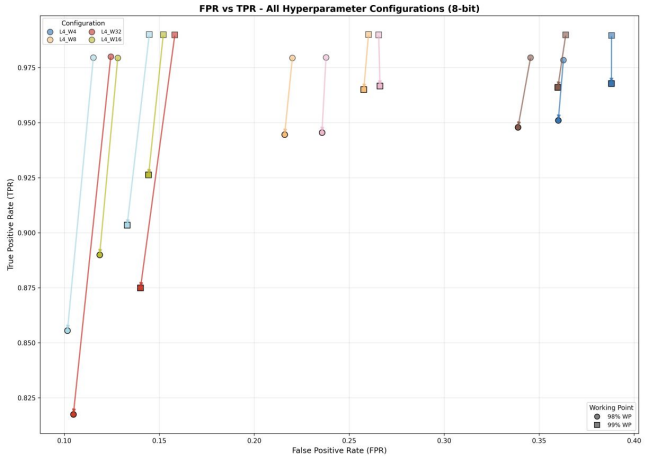


# Major updates since last time

***Meetings**:*
*Wednesdays at 11 am ET*
*[Indico] — all welcome!*

- **Report on SEE Impact Studies – Chicago**
  - General degradation of model performance
    - Models with high background rejection generally see significant degradation when subjected to radiation effects
    - Possible mitigations under study
  - Susceptibility of individual bits
    - Individual bits that are particularly important can cause temporary module failures
    - Should be able to identify and reset modules on time scales << interfill (Tova)

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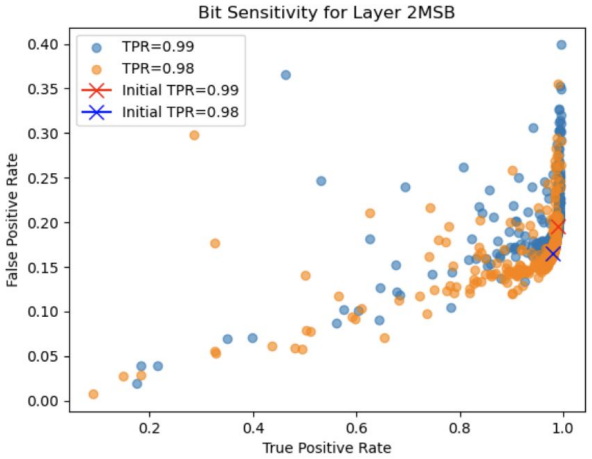

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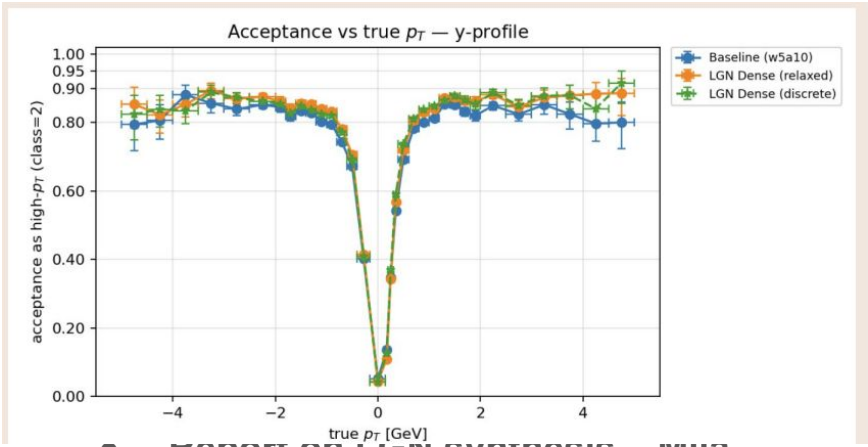


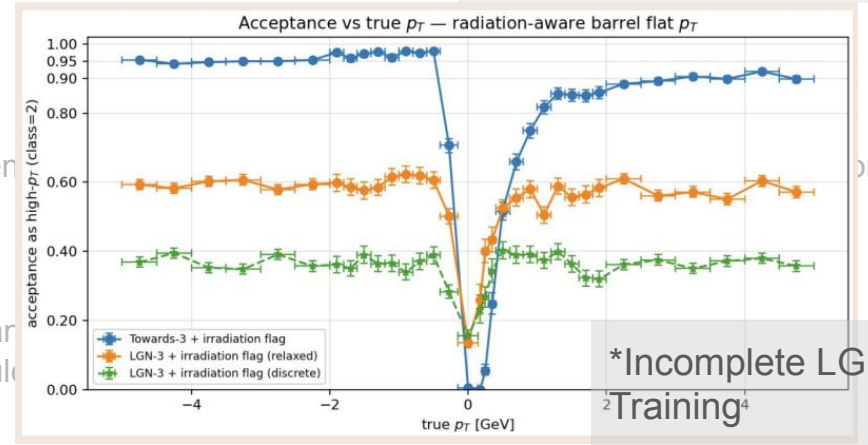


*Incomplete LGN Training

- **Report on LGN synthesis – Mila**
  - LGN synthesis now possible with both external library (da4ml) and in-house script
    - FPGA resource usage and timing information produced for Models 2 (cluster profiles) and 3 (convolutions)
  - Quantized torch training of neural networks on Smartpixels dataset to provide fair comparison for LGN
    - LGNs outperforming quantized NNs for Model 2
  - Initial studies using datasets with simulated sensor damage from radiation
    - Testing possibility of providing level of damage as model input

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# Current Roadblocks

- **LGN**: Availability of muon collider dataset

# Ongoing Work

- **LGNs**: Further investigation of radiation damage effects.
- **SNNs**: Evaluating personpower.
- **DNNs**: Understanding optimal choice for input quantization
- **Smartpix Lab Testing**: Calibrating cold box temperature measurement

# Open Tasks

- **SNN**: Iterate on dataset, want to first conclude ECAL study before moving to smartpixels
- **Tracking**: Muon collider dataset incorporating merged clusters with detailed digitization
  - Common harness
- **General**: Gain knowledge about ASIC synthesis

# Update: March 27, 2026

# Major updates since last time

- ***Meetings**: Wednesdays at 11 am ET [Indico] — all are welcome!*

- **BDTs for BIB rejection**
  - Heard update from Jordan + nice discussion

- **SNNs (UTK)**
  - Applications to ECAL
  - Previous work: developing a training dataset

- **Outlining our overarching goals/pillars—subject to shuffling + redefinition!**
  - Defining operation of ML-enabled FEs
  - Towards a public dataset for BIB rejection
  - More advanced synthesis of BIB rejection models
  - Benchmark models using current technologies under consideration (DNN, BDT, SNN, LGN)

# Current roadblocks

- **LGN** – unclear why we cannot exactly reproduce public results with SmartPixels dataset
- **Smartpix Training** – Messy environment for quantized training and synthesis – QKeras out of date, hls4ml differences for Vitis and Catapult
- **Smartpix Lab Testing** – Noisy filter outputs make validation harder

# Open tasks

- **LGNs**: proceed with synthesis
- **SNNs**: iterate on dataset, want to first conclude ECAL study before moving to smartpixels
- **DNNs**: Want to refine estimates of chip area, data rate. Eventually validate synthesis on FPGA.
    - Longer term: consider differential distributions, digitization implementation.

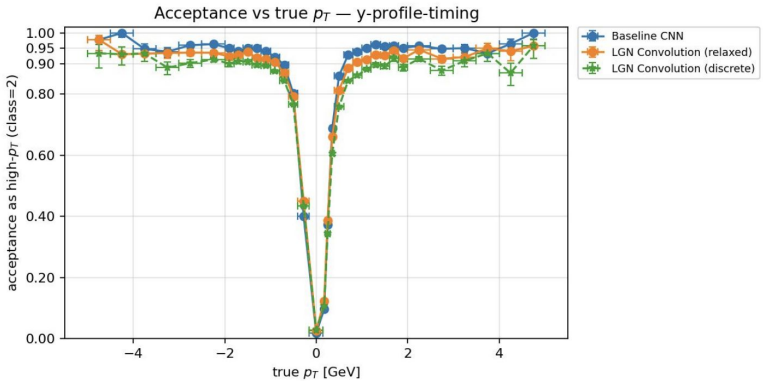
# Update: March 13, 2026

# Major updates since last time (3/13/2026)

- **Meetings**: Wednesdays at 11 am ET [Indico]
  - All are welcome to join!
  - First meeting on 3/11 [Indico] – several contributions (not enough time to cover all!)

- **LGN Updates**:
  - Very nice introduction to LGNs (Lino)
  - Partially reproduced SmartPixels public results w/ conventional NNs (Mila)
  - LGNs (relaxed and discretized) perform nearly as well as conventional NNs on SmartPixels dataset

- **UTK ML for clustering**
  - ML applications to cluster shape to be discussed at next meeting
  - SNN for smartpixels study in revival/literature phase; training to be described
- **Chicago Smartpix NNs for BIB**
  - Understanding details of hyperparameter tuning.
  - Lab testing of filtering ASIC. (lower priority recently
  - Rough investigation of SEE effects in weights.



# Current roadblocks (3/13/2026)

- No significant roadblocks

- **LGN** – unclear why we cannot exactly reproduce public results with SmartPixels dataset
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# Open tasks

- **LGNs**: proceed with synthesis
- **SNNs**: tasks TBD following literature conclusion
- **DNNs**: Want to refine estimates of chip area, data rate. Eventually validate synthesis on FPGA.
    - Longer term: consider differential distributions, digitization implementation.