

# Weekly Smartpix Update

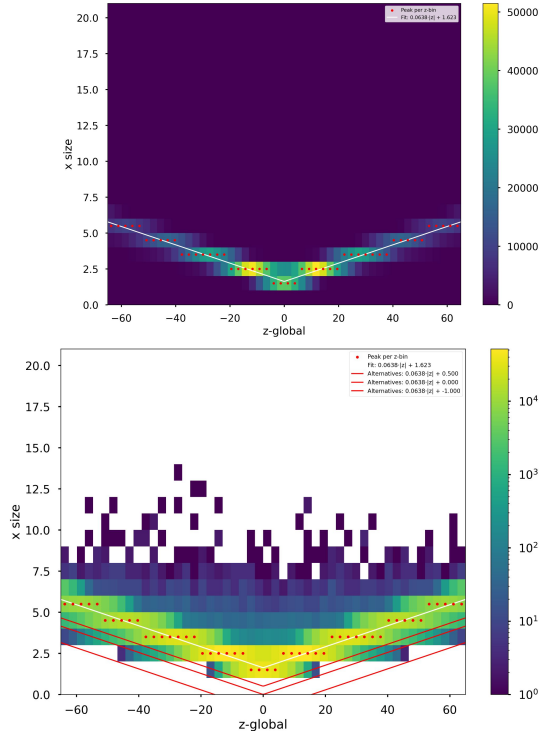
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October 21, 2026

# Paper Comments Responses

- Worked on comments from MLST, responded and resubmitted paper
- Major comment/responses to comments
  - Added a cut based study
  - Trained a network on zglobal, xsize only
  - Added a new timing smearing study with different timing resolutions
- Summarize these 3 studies here
  - See also [2026/10/15 I need to dump some plots somewhere](#) [2026/10/05 Cluster Cutting Study](#)

# Cut Based Study

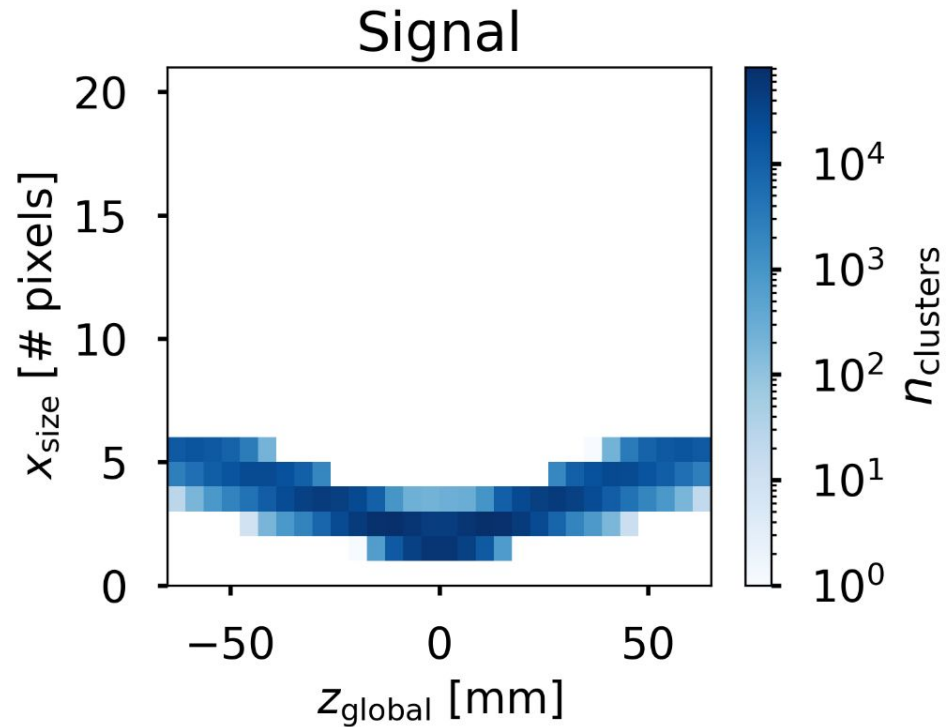
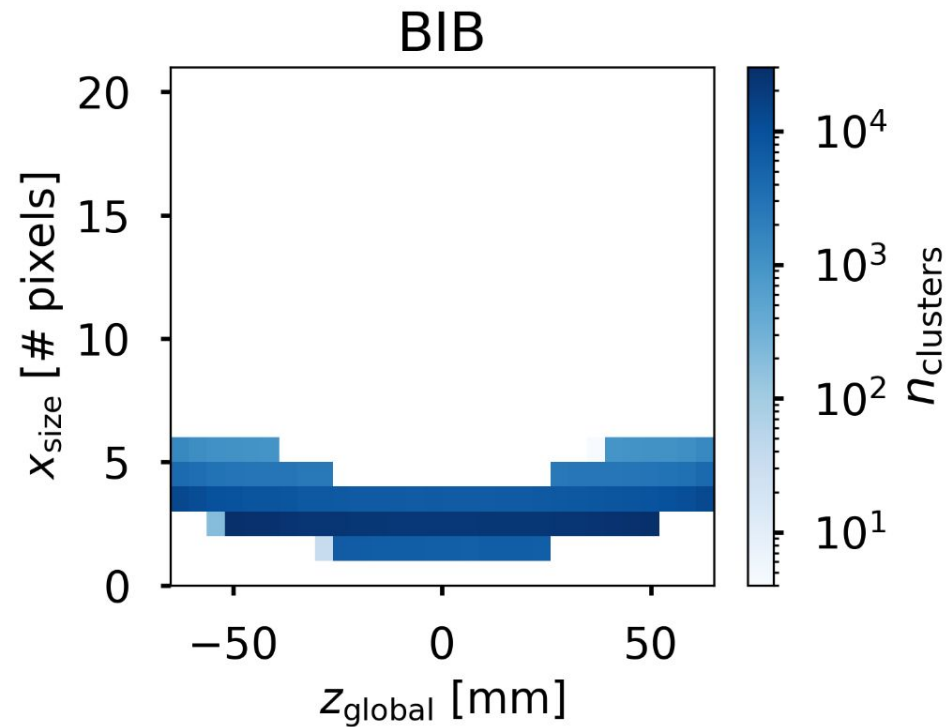
- Had linear cut with slope determined by fit to correlation between xsize and zglobal, parameterized by intercept.
- Can cut below the line, or can cut above and below 2 lines with intercepts mirrored around the fit intercept
- Can split into zbins and do a maximum and/or minimum xsize (integer) cut in each zbin
- The 4 types of cuts have similar ish performance/roc curves
- To present something simple, settled on a zbinned cut with maximum and minimum xsize in each bin, that I finagled boundaries until got 99.04%~99% Signal Efficiency, 40.8% background rejection, 53.4% data reduction



# Z binned cut, binning per module

fraction of total bib 0.5920269506765435 fraction of total signal 0.9904087562249321

```
cut: (('z-global'<=-52.0624973 and 'z-global'>=-65.074997 and xSize>=3.0 and xSize<=5.5) or ('z-global'<=-39.0499976 and 'z-global'>=-52.0624973 and xSize>=2.0 and xSize<=5.5) or ('z-global'<=-26.037497899999999 and 'z-global'>=-39.0499976 and xSize>=2.0 and xSize<=4.5) or ('z-global'<=-13.0249981999999992 and 'z-global'>=-26.037497899999999 and xSize>=1.0 and xSize<=3.5) or ('z-global'<=-0.0124984999999992418 and 'z-global'>=-13.0249981999999992 and xSize>=1.0 and xSize<=3.5) or ('z-global'<=13.000001200000014 and 'z-global'>=-0.0124984999999992418 and xSize>=1.0 and xSize<=3.5) or ('z-global'<=26.012500900000006 and 'z-global'>=13.000001200000014 and xSize>=1.0 and xSize<=3.5) or ('z-global'<=39.025000600000001 and 'z-global'>=26.012500900000006 and xSize>=2.0 and xSize<=4.5) or ('z-global'<=52.037500300000002 and 'z-global'>=39.025000600000001 and xSize>=2.0 and xSize<=5.5) or ('z-global'<=65.05 and 'z-global'>=52.037500300000002 and xSize>=3.0 and xSize<=5.5)) and (nPix < 10)
```



# Training a model on just xsize and zglobal

- Reviewer requested this, so I trained a big model to do it
  - No hyperparameter search, 1,121 parameters
- It performs somewhere between model 1 and the cut, as expected
- At 99% SE, has 68.5% BIB cluster rejection, 72.0% BIB data reduction

| Layer (type)                        | Output Shape | Param # | Connected to                           |
|-------------------------------------|--------------|---------|----------------------------------------|
| x_size (InputLayer)                 | [(None, 1)]  | 0       | []                                     |
| z_global (InputLayer)               | [(None, 1)]  | 0       | []                                     |
| q_input_2 (QActivation)             | (None, 1)    | 0       | ['x_size[0][0]']                       |
| q_input_1 (QActivation)             | (None, 1)    | 0       | ['z_global[0][0]']                     |
| concatenate_6 (Concatenate)         | (None, 2)    | 0       | ['q_input_2[0][0]', 'q_input_1[0][0]'] |
| q_dense_25 (QDense)                 | (None, 20)   | 60      | ['concatenate_6[0][0]']                |
| q_relu1 (QActivation)               | (None, 20)   | 0       | ['q_dense_25[0][0]']                   |
| q_dense_26 (QDense)                 | (None, 20)   | 420     | ['q_relu1[0][0]']                      |
| q_relu1_2 (QActivation)             | (None, 20)   | 0       | ['q_dense_26[0][0]']                   |
| q_dense_27 (QDense)                 | (None, 20)   | 420     | ['q_relu1_2[0][0]']                    |
| q_relu1_3 (QActivation)             | (None, 20)   | 0       | ['q_dense_27[0][0]']                   |
| q_dense_28 (QDense)                 | (None, 10)   | 210     | ['q_relu1_3[0][0]']                    |
| q_relu2 (QActivation)               | (None, 10)   | 0       | ['q_dense_28[0][0]']                   |
| q_dense_29 (QDense)                 | (None, 1)    | 11      | ['q_relu2[0][0]']                      |
| output_activation (QActivation)     | (None, 1)    | 0       | ['q_dense_29[0][0]']                   |
| =====                               |              |         |                                        |
| Total params: 1121 (4.38 KB)        |              |         |                                        |
| Trainable params: 1121 (4.38 KB)    |              |         |                                        |
| Non-trainable params: 0 (0.00 Byte) |              |         |                                        |

# Trained for 100 epochs

Test Loss: 0.3666

Test Accuracy: 0.8458

ROC AUC: 0.8895

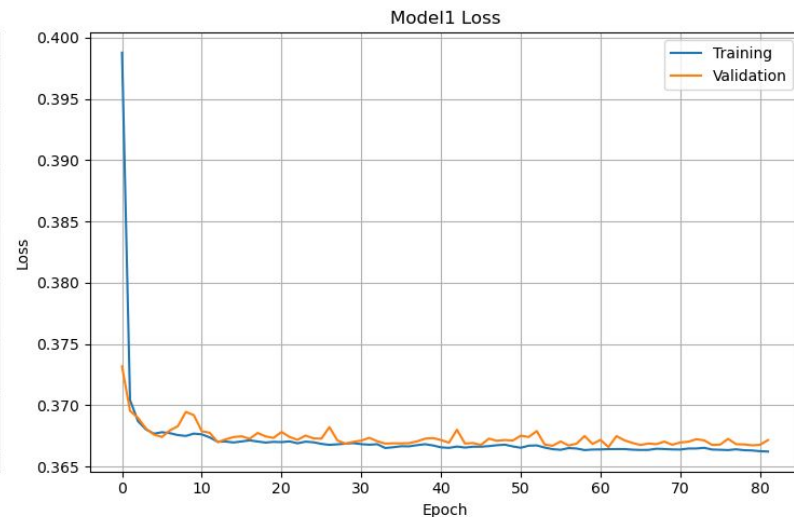
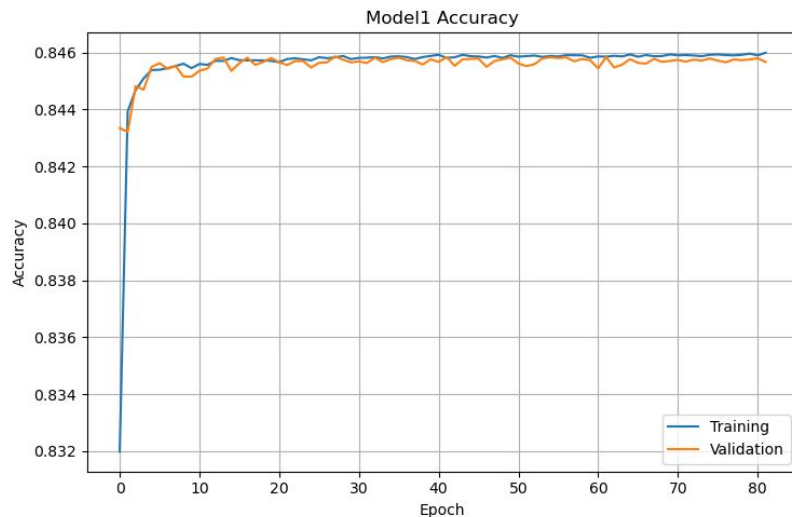
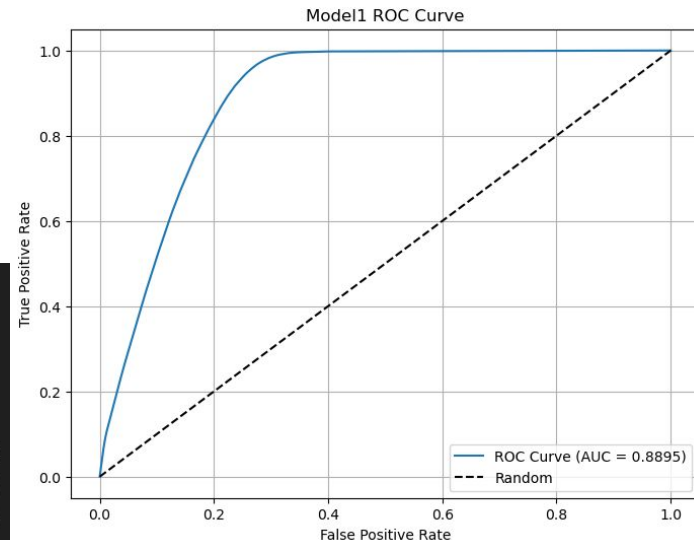
Background Rejection Metrics (Bkg Rej =  $1 - \text{FPR}$ ):

@ 95% signal efficiency: Bkg Rej = 0.7400 (FPR = 0.259971), Back Data Accep = 0.2282

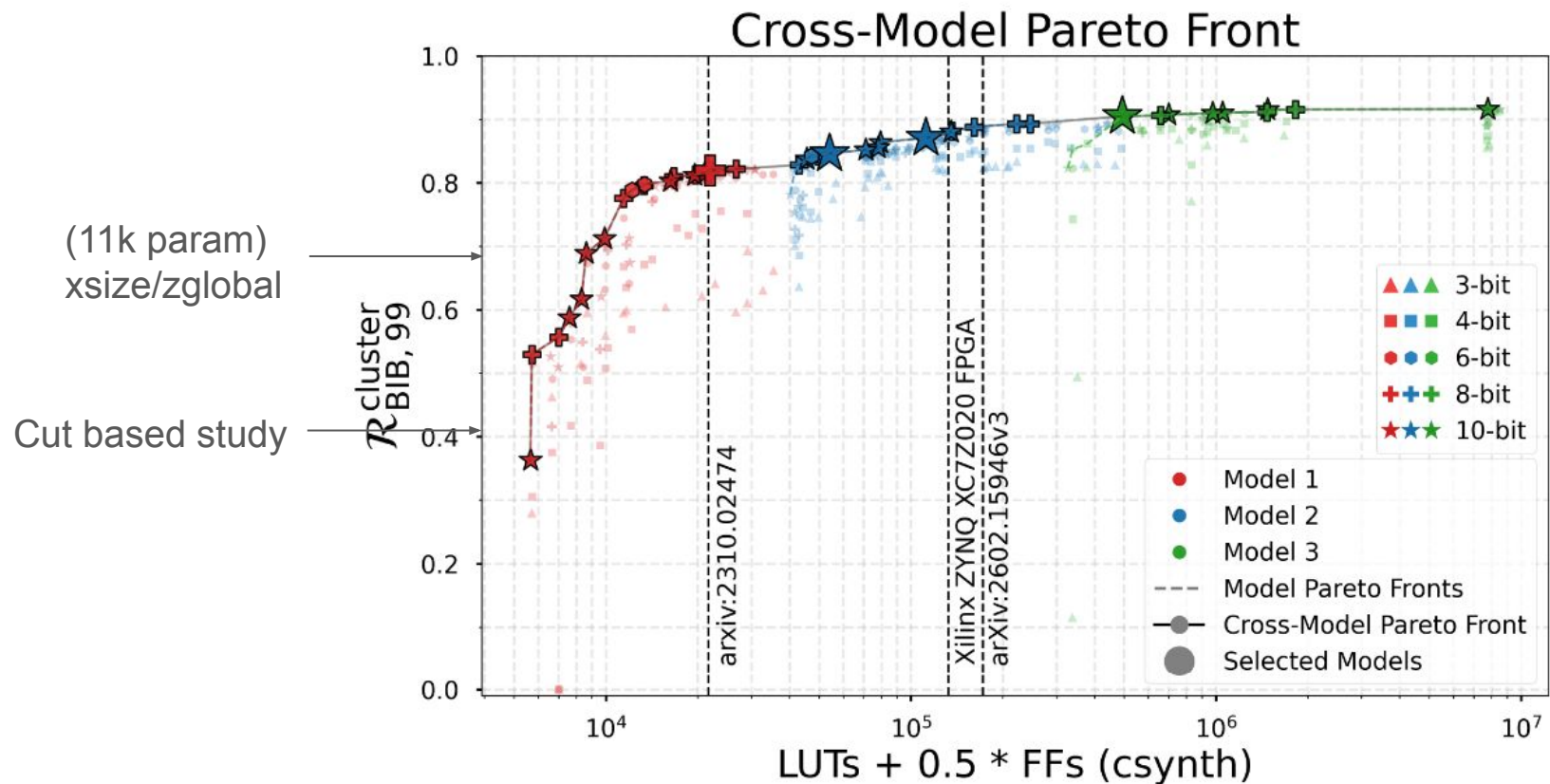
@ 98% signal efficiency: Bkg Rej = 0.7070 (FPR = 0.292997), Back Data Accep = 0.2592

@ 99% signal efficiency: Bkg Rej = 0.6853 (FPR = 0.314684), Back Data Accep = 0.2799

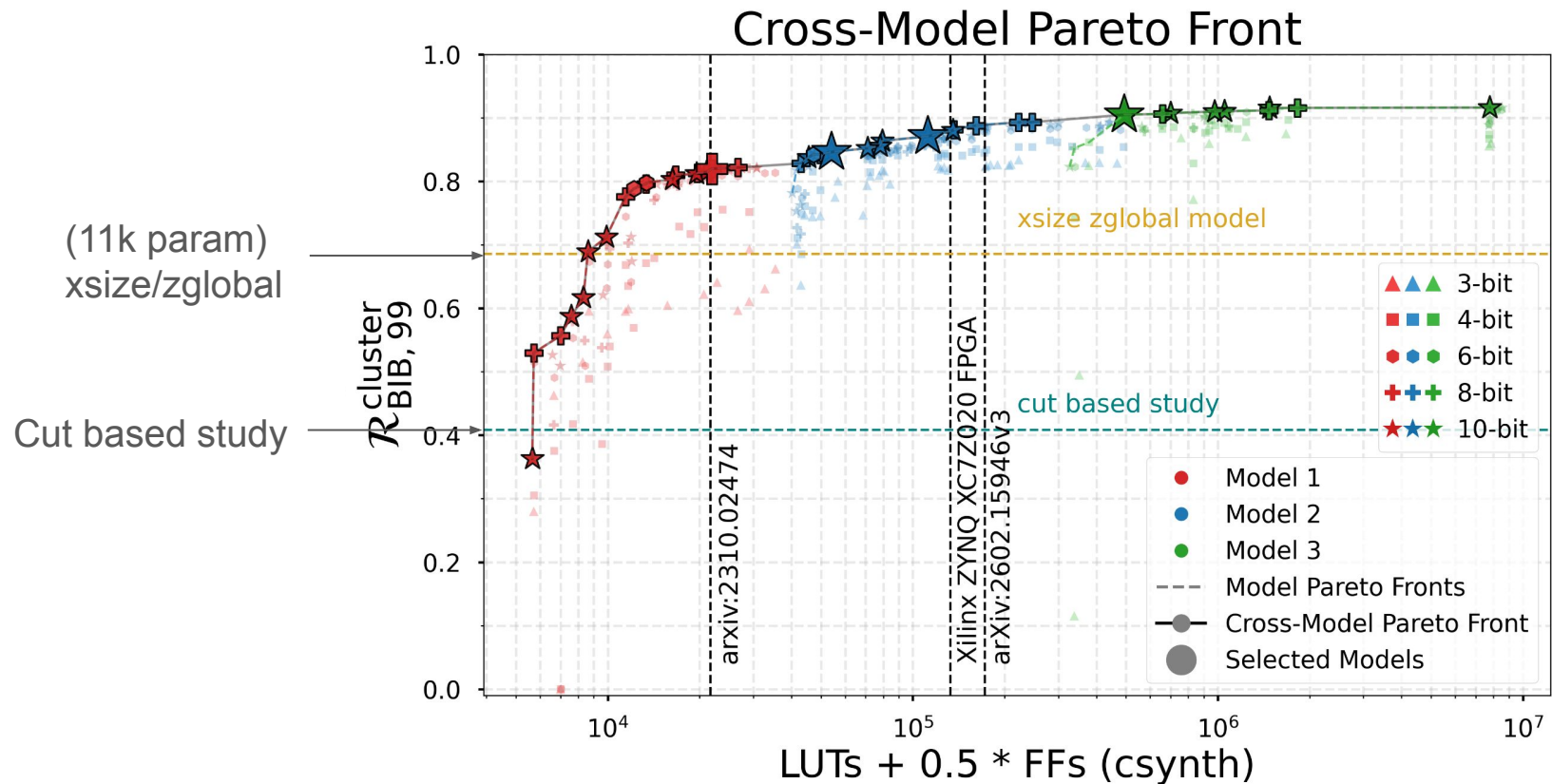
Accep = 0.2799



# Comparing xsize/zglobal cut and model to CrossPareto



# Comparing xsize/zglobal cut and model to CrossPareto



# Timing Smearing Study

- The  $[-3\sigma, 5\sigma]$  timing cut keeps 99.9% of signal and filters out a large amount of BIB
- Timing cut is orthogonal to model selection or geometric cut.
- No pixel sensors have the 30 ps timing and 25  $\mu\text{m}$  x 25  $\mu\text{m}$  spatial resolution specified in MAIA design
- Dataset assumes the spatial resolution for pixel simulation, timing resolution by smearing the truth hit\_time, which is **idealized** sensor timing response
- Since timing resolution is unknown, train on just geometric features.  
Separately apply the timing cut on the smeared hit times
- Applied timing smearings of 30, 60, 100, 200, 300, 400, 500, 1000 ps and examined performance of model at 99% SE, timing cut, timing cut + model

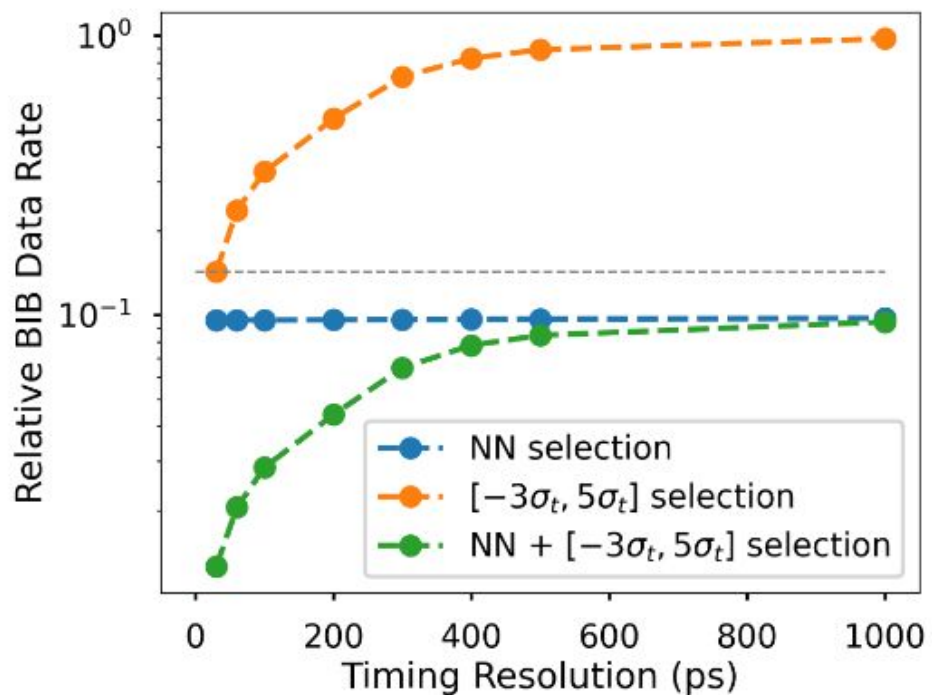
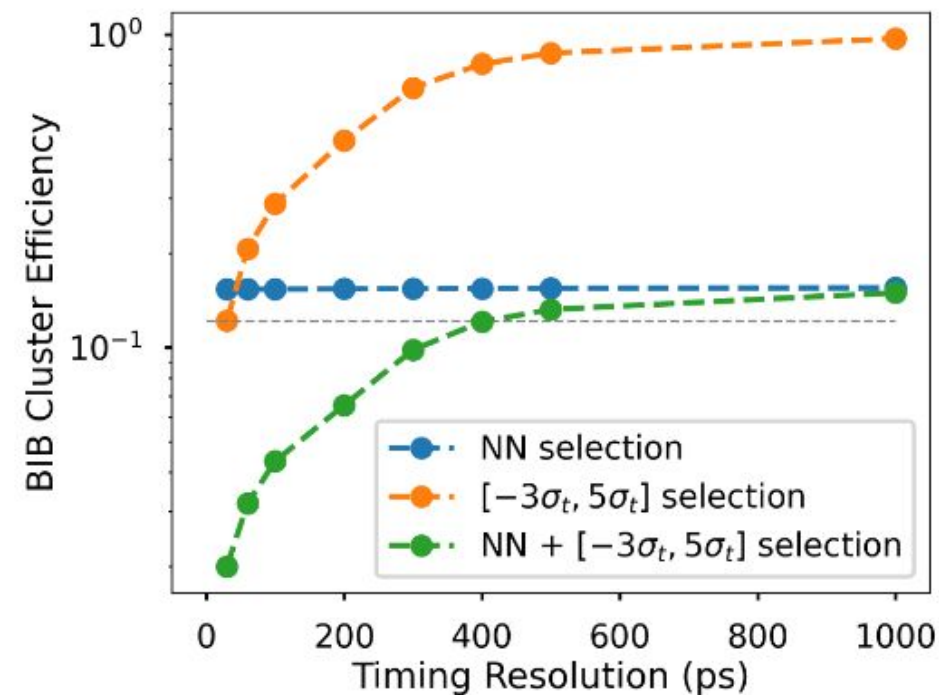


Figure 12: Performance of the selected model 2 architecture and a  $[-3\sigma_t, 5\sigma_t]$  timing selection with varying timing resolution  $\sigma_t$ , characterized by the BIB cluster efficiency,  $1 - \mathcal{R}_{\text{BIB},99}^{\text{cluster}}$  (left), and the BIB Data rate,  $1 - \mathcal{R}_{\text{BIB},99}^{\text{data}}$  (right). In this figure  $\sigma_t$  is varied from 30 ps to 1000 ps, while in other figures it is kept constant at 30 ps.