Status report on
DNNROI sigproc

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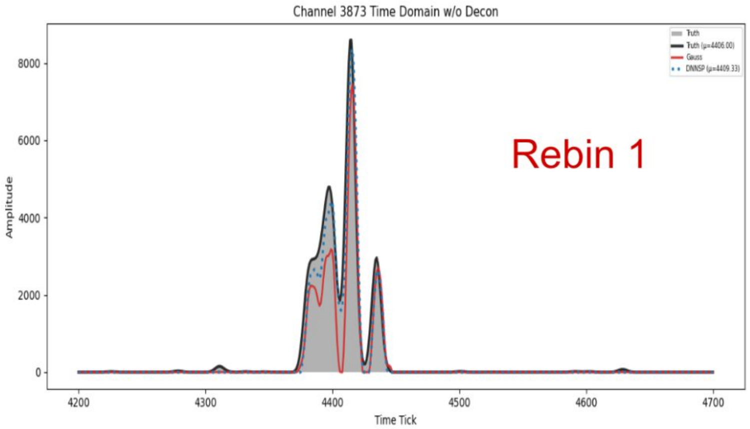
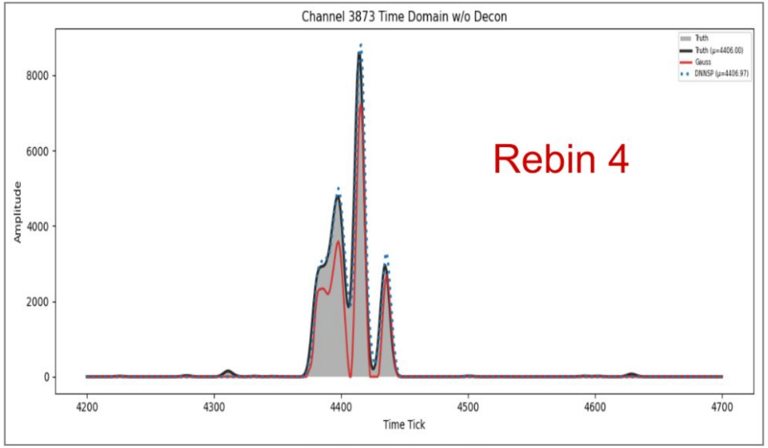
Outline

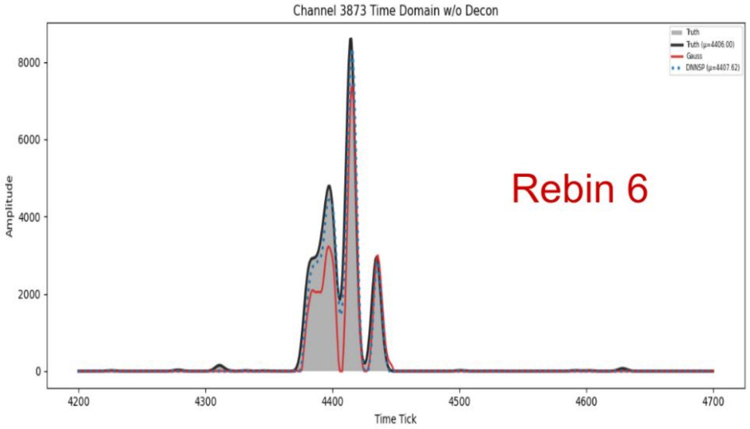
- Rebin effect on ROI window
- Imaging Threshold
- Padding
- Memory Profiling
- DNN-ROI for PD-VD

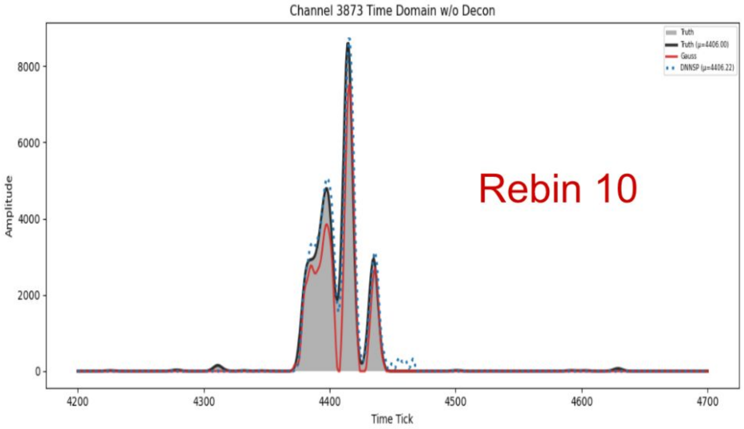
Baseline for Performance Evaluation				
Model	Rebin	Truth_thr	Padding	Chunking
MobileUNetV3	10	100	None	1

Rebin - 1D waveform

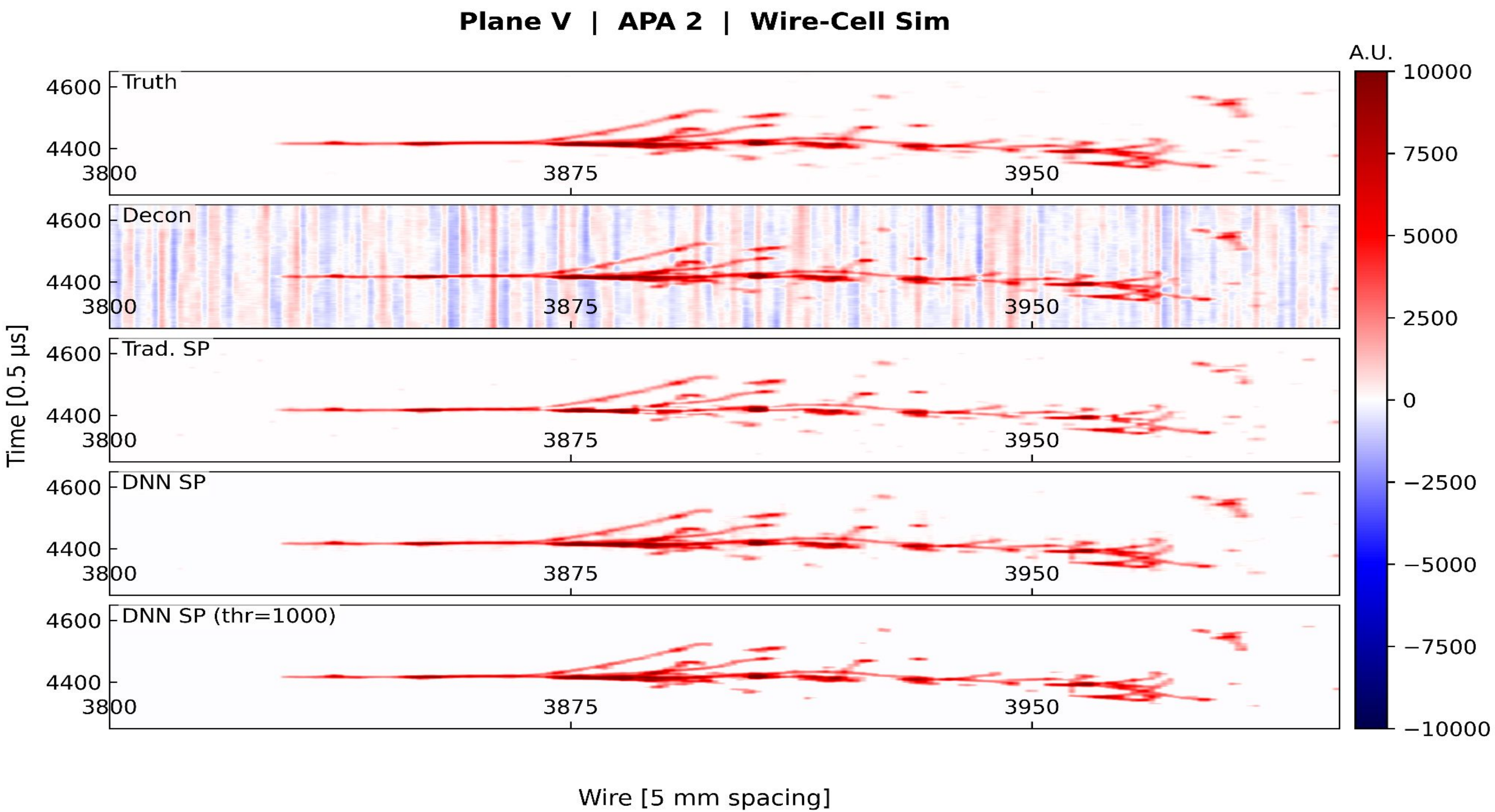




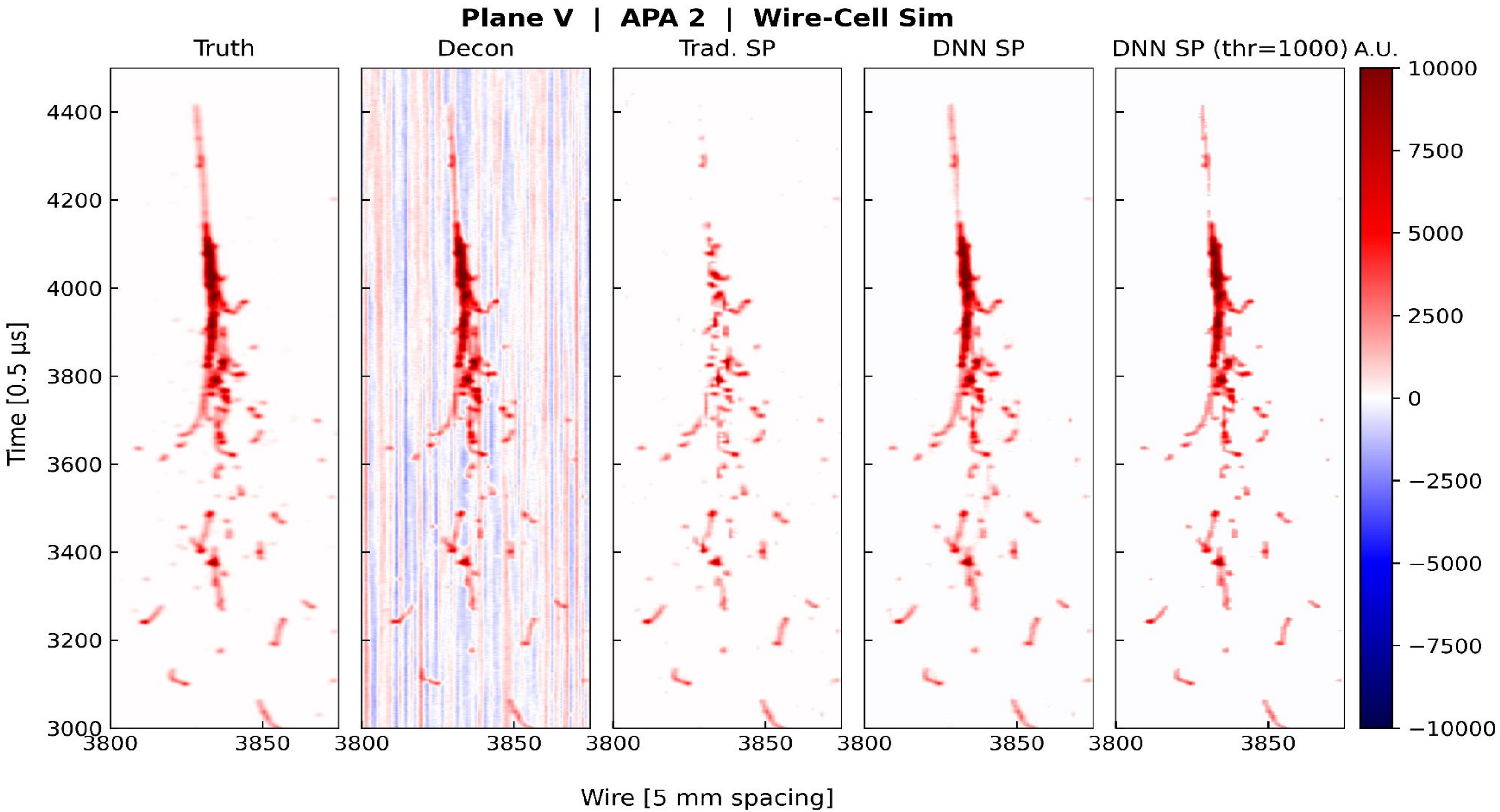




Imaging Threshold



Imaging Threshold



Padding - Strategy

After rebinning & masking (truth_thr) → start padding (e.g. padding = 1, min_length = 2)

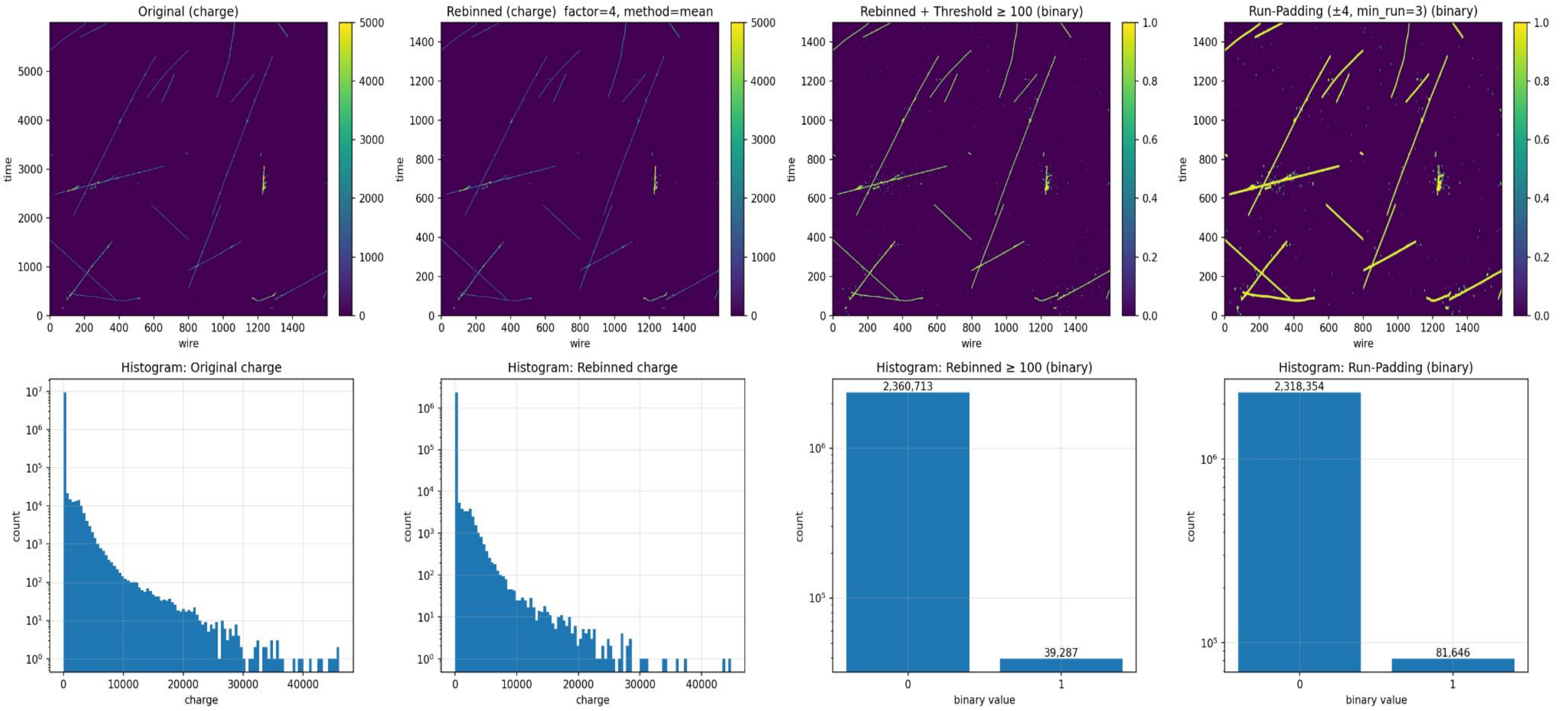
- Loop over the masked wire channel (truth ROI) and add 0 to the both ends
  - idx = [0, …, 19], row = [1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1]
  - idx = [0, …, 21], row = [0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1, 0]

- Detect the index where the value is different from the value in the next index
  - [0, 1 , 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1, 0]
  - starts = [0, 9, 20] & ends = [2, 15, 21] → check the length (ends - starts ≧ min_length)

- Determine the index window for padding
  - low = max(0, starts - padding) & high = min(W, ends + padding) → window = (low, high)

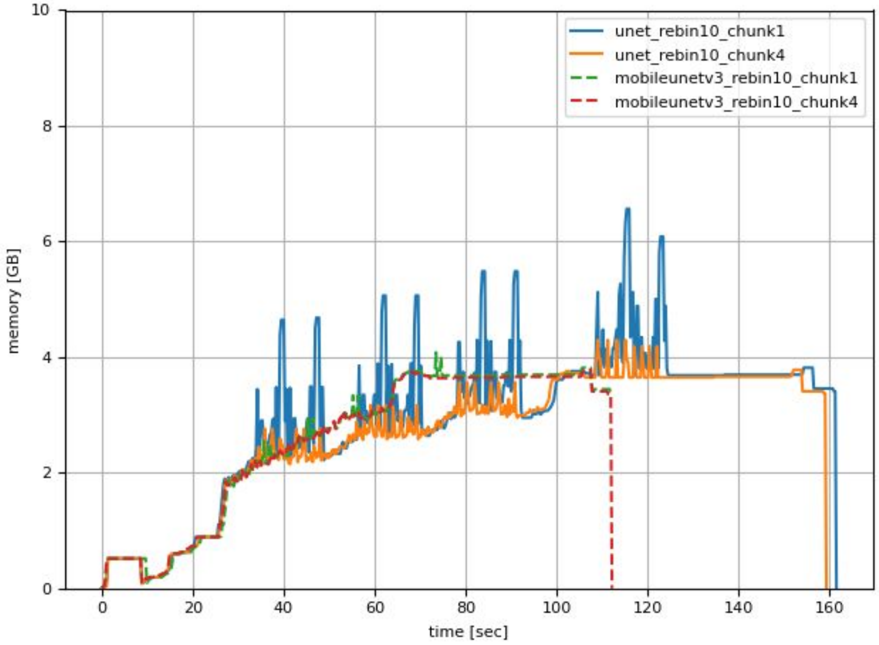
- Padding to the found window (0, 3), (8, 16)
  - (0, 3) - [1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 1]
  - (9, 16) - [1, 1, 1, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1]

Padding - Demonstration on 2D waveform



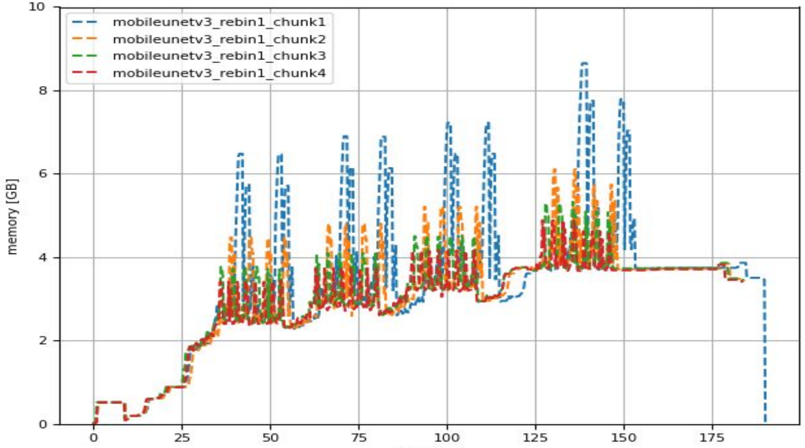
Memory Profiling - Memory Tracker & Activity Logger

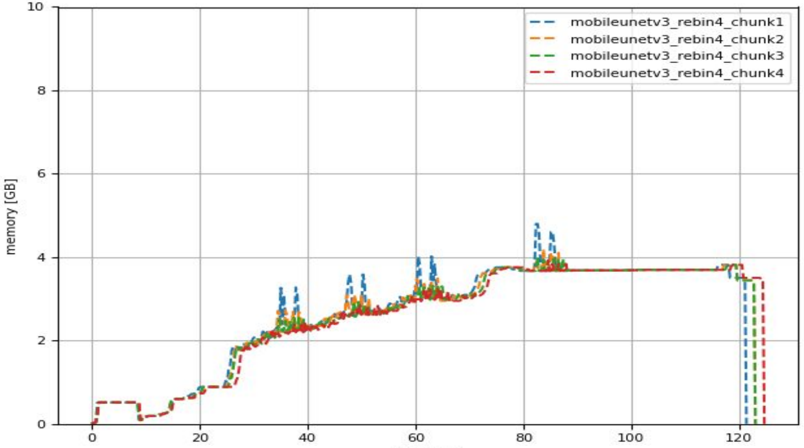
	MobileUNet V3 (MB)				UNet (MB)
chunk	Rebin 1	Rebin 4	Rebin 6	Rebin 10	
1	8848	4907	4448	4172	6710
2	6249	4278	4107	3966	5198
3	5447	4101	3990	3874	4646
4	4997	4015	3930	3860	4387

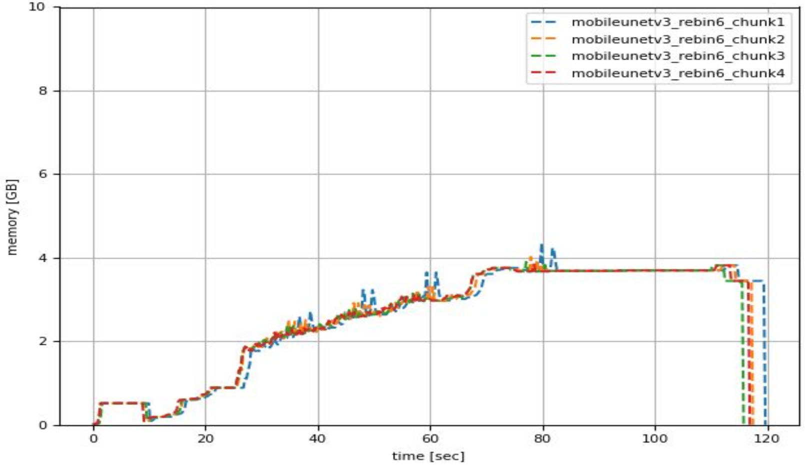


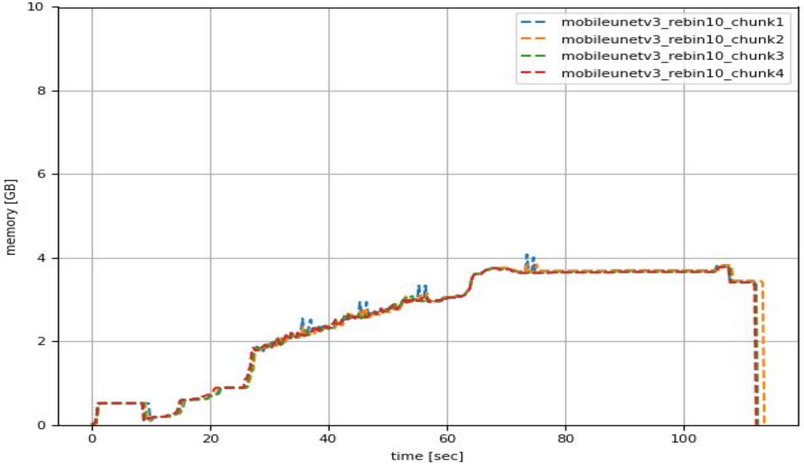
- Logged memory usage by top command (Haiwang's activity logger)
- Trad. SP reaches 2 GB → DNN SP starts with 2GB baseline
- Final accumulated memory is about ~3.9 GB, not depending on model architecture

Memory Profiling - Activity Logger

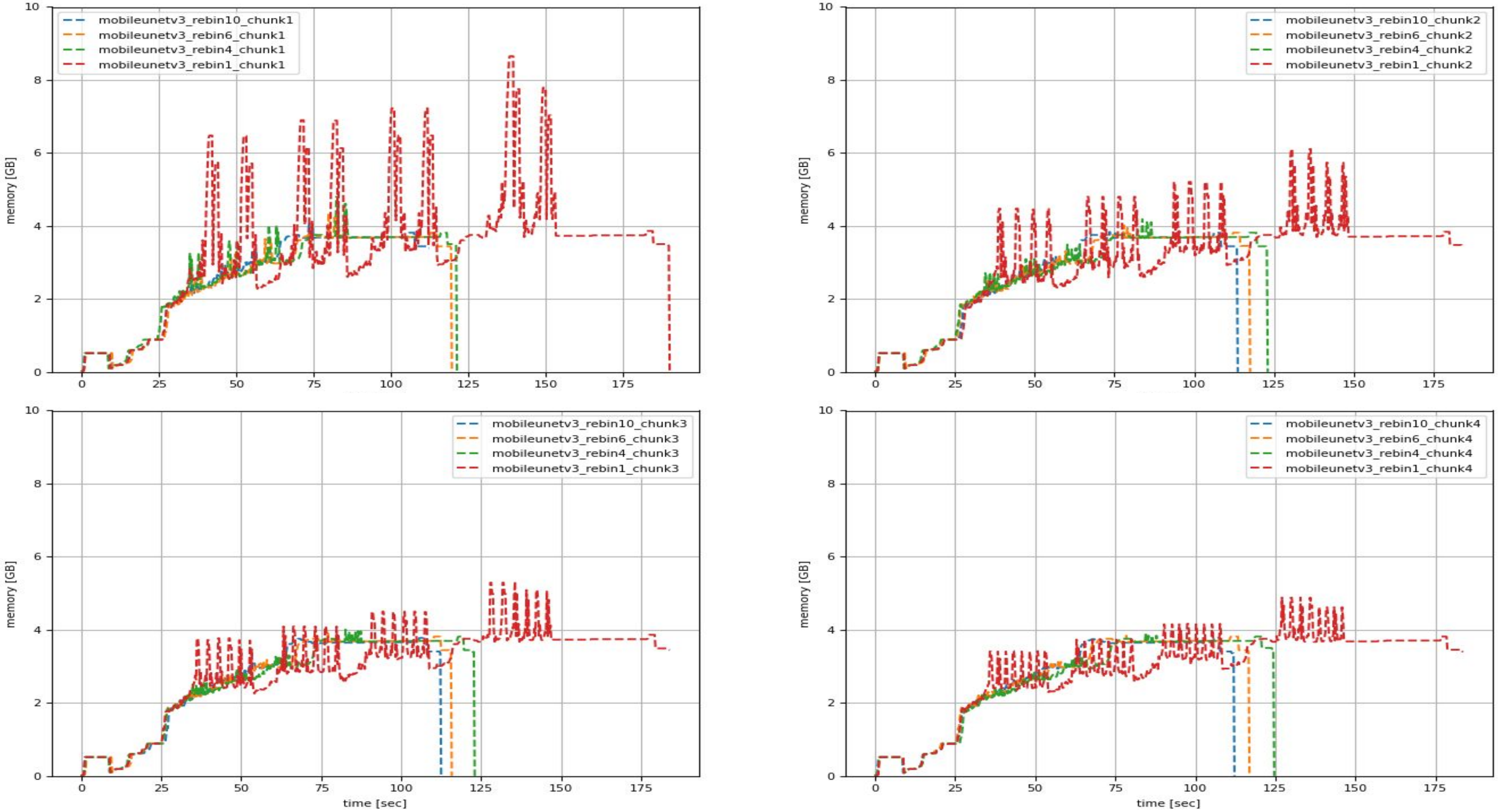




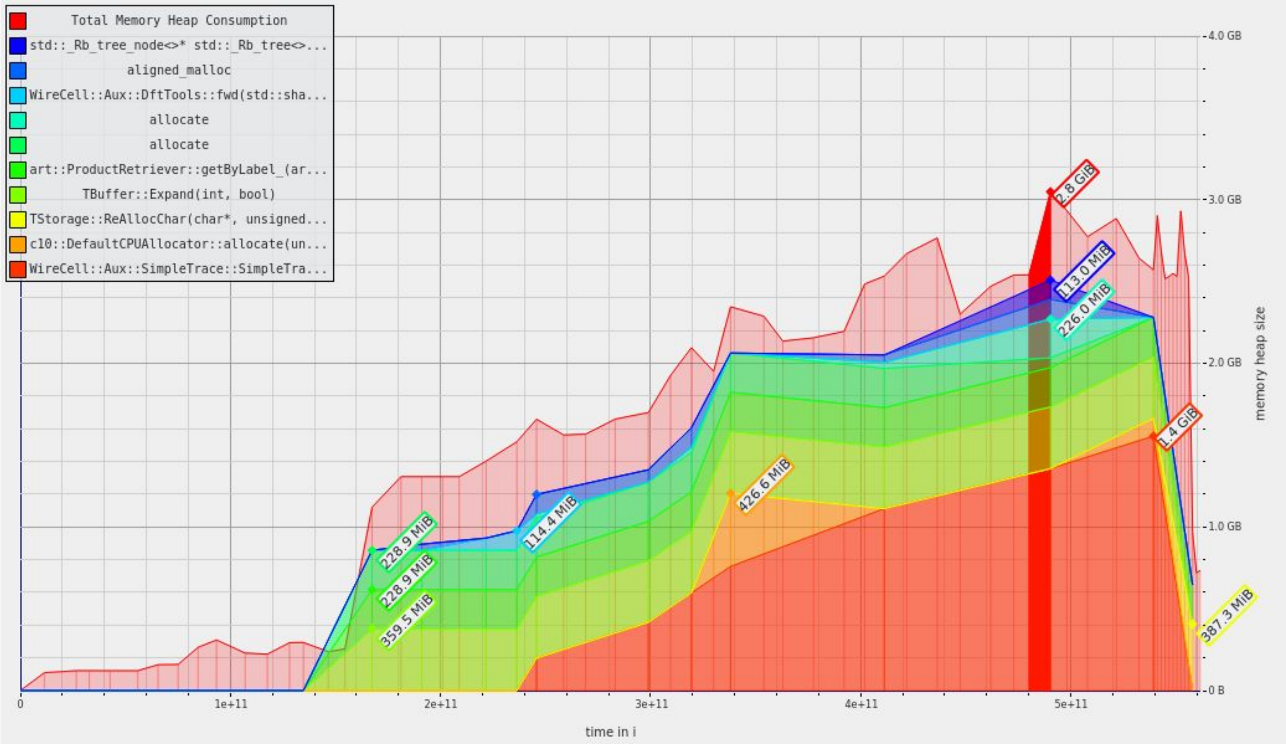




Memory Profiling - Activity Logger



Memory Profiling - Valgrind Massif



- MobileUNetV3 rebin 10, Threshold 100, valgrind massif

DNN-ROI for PD-VD - Configuration

Haiwang’s reco.fcl: https://github.com/HaiwangYu/wct-ci/blob/main/protodune-triton/reco.fcl

My fcl: /exp/dune/data/users/hnam/wire-cell-hnam/pdvd-data/test0924/pdvd_dnnroi/reco.fcl

Configuration file I used for this time:

/exp/dune/data/users/hnam/wire-cell-hnam/larwc/wire-cell-cfg/pgrapher/experiment/protodunevd

change made on:

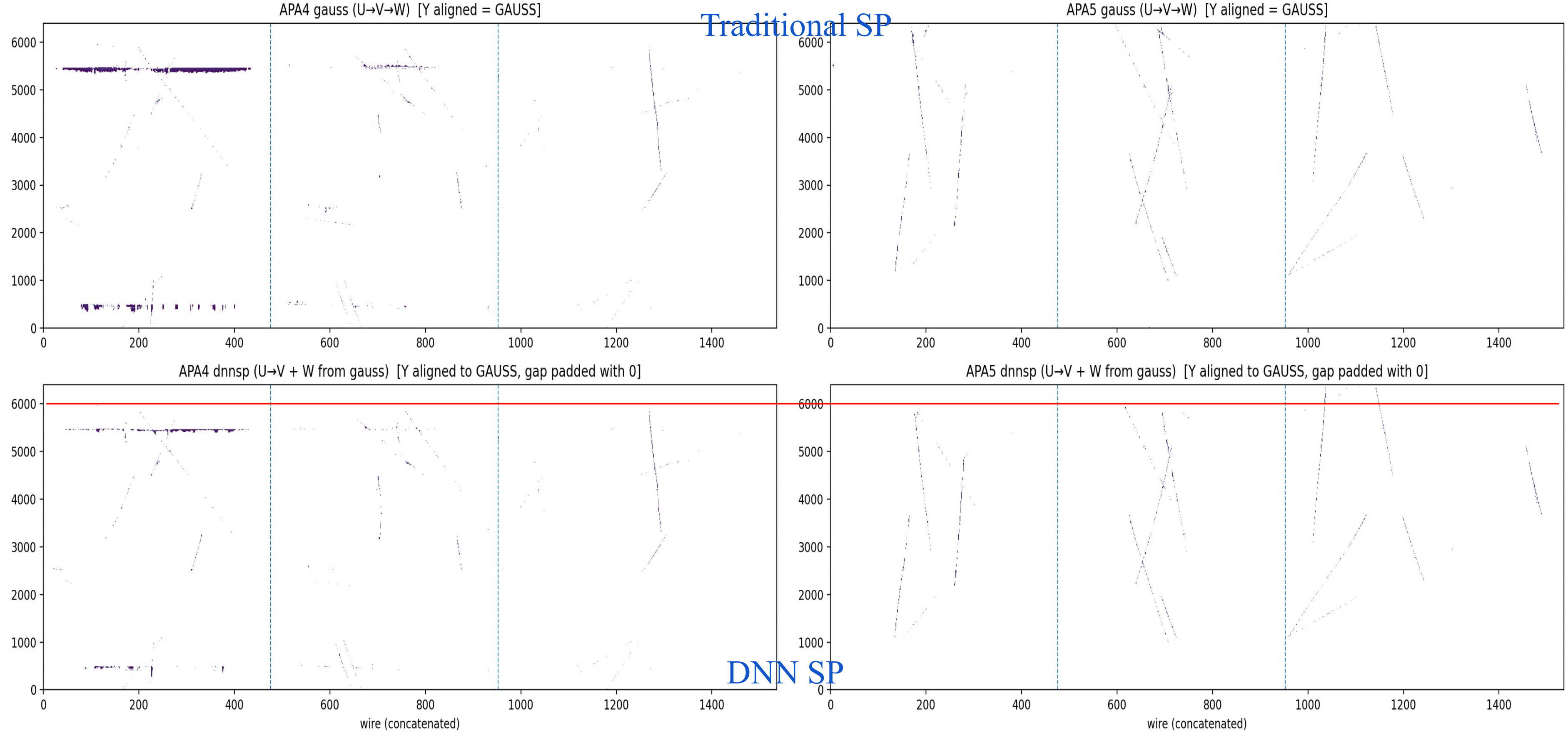
magnify-sinks.jsonnet

dnnroi.jsonnet

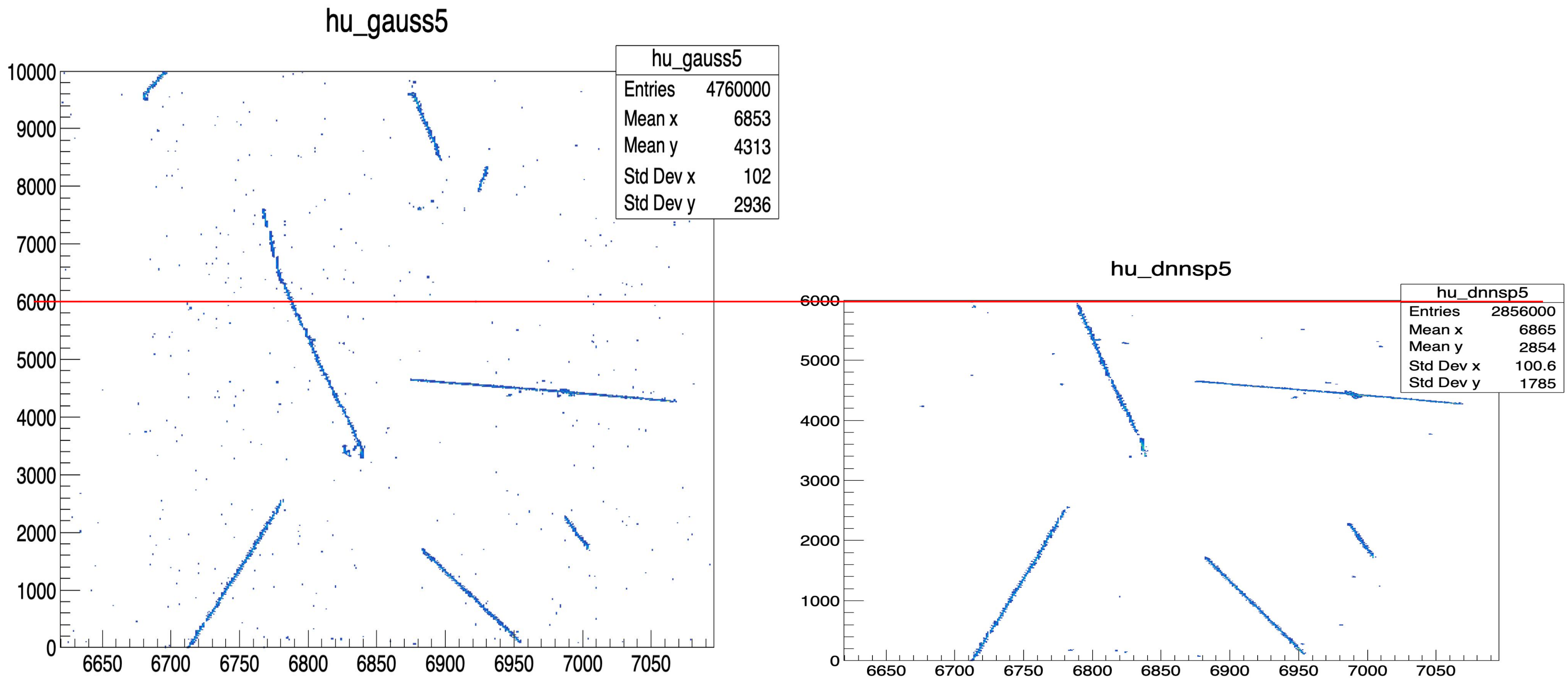
wcls-nf-sp.jsonnet

```
local epoch = std.extVar('epoch');  // eg "dynamic", "after", "before", "perfect"
local reality = std.extVar('reality');
local sigoutform = std.extVar('signal_output_form');  // eg "sparse" or "dense"


local use_dnnroi = true;
local inference_service = "TritonService"; // "TorchService" or "TritonService"
local nchunks = 1;
local model = "ts-model/mobileunet_largedataset_fullimage.ts"; // mobilenetv3-hokyeong.ts, unet-haiwang.ts



local wc = import 'wirecell.jsonnet';
local g = import 'pgraph.jsonnet';

local raw_input_label = std.extVar('raw_input_label');  // eg "daq"


local data_params = import 'params.jsonnet';
local simu_params = import 'simparams.jsonnet';
local params = if reality == 'data' then data_params else simu_params;


local tools_maker = import 'pgrapher/common/tools.jsonnet';
local tools = tools_maker(params);

local wcls_maker = import 'pgrapher/ui/wcls/nodes.jsonnet';
local wcls = wcls_maker(params, tools);
```

DNN-ROI for PD-VD - Run 039300-0106

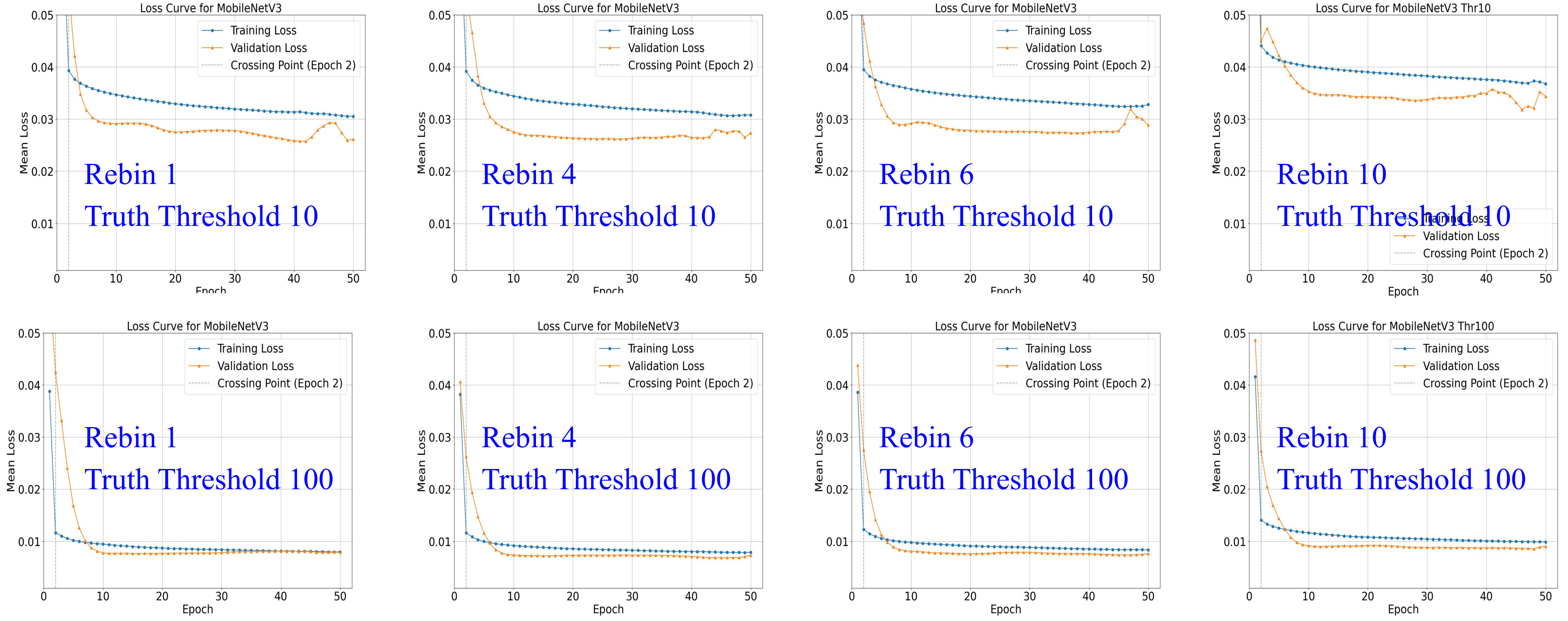


DNN-ROI for PD-VD - Run 039300-0115



Back Up

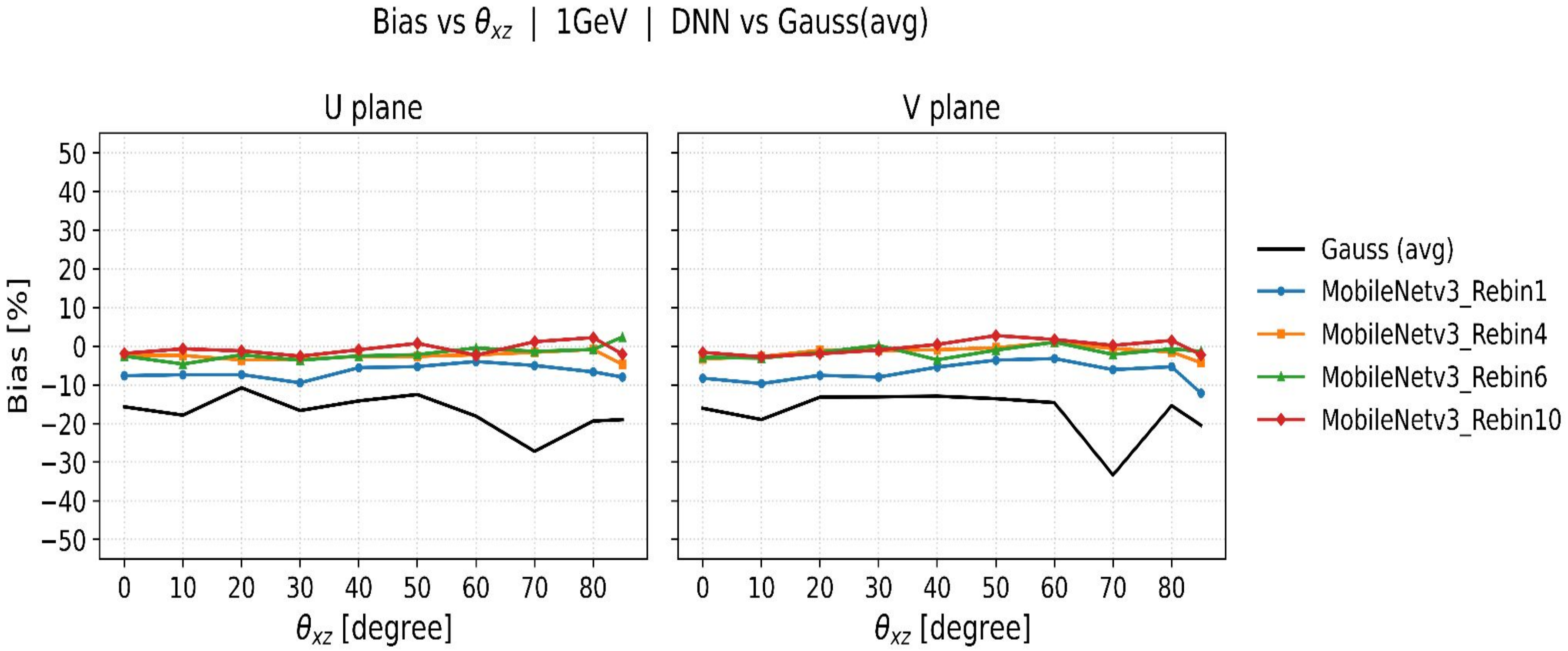
Train vs. Val. Loss Curve



- MobileUNet V3
- Dataset: cosmic-ray 590 events

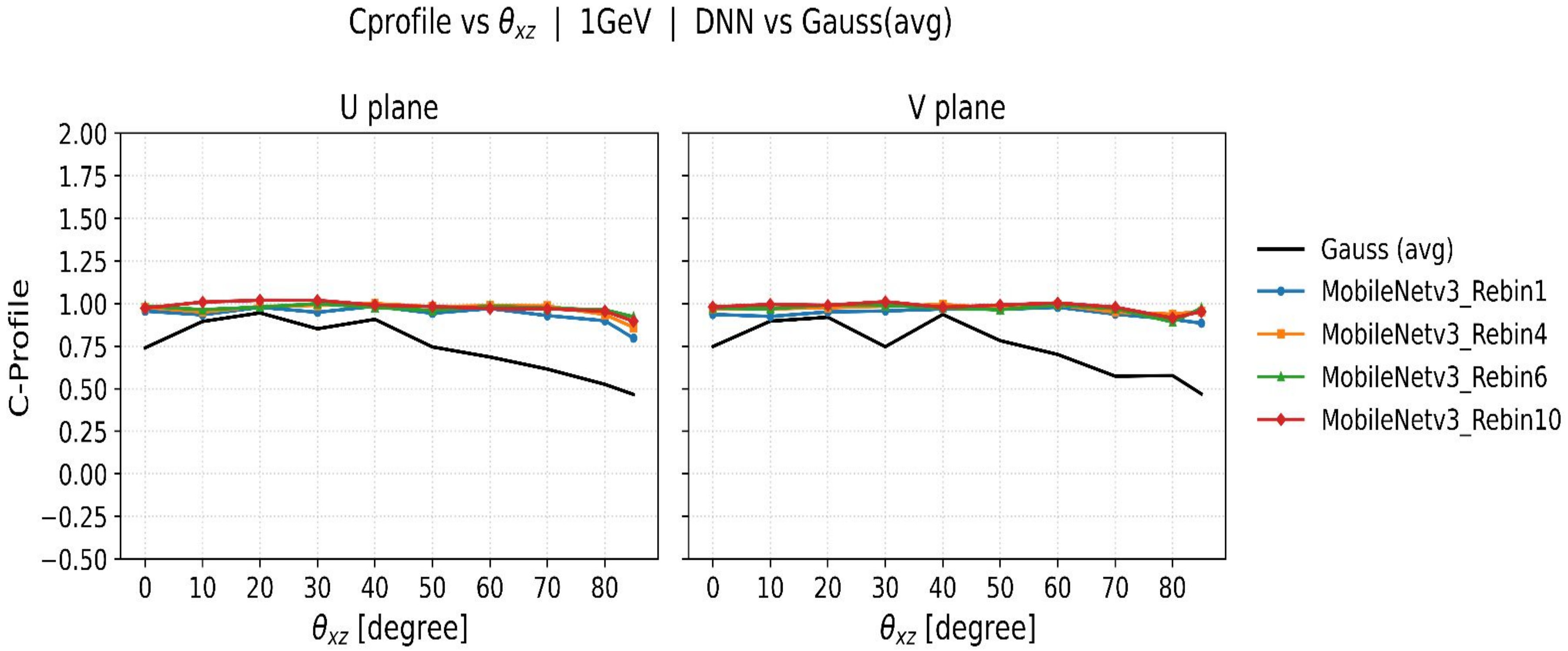
- High-resolution images leads lower final training loss
- The threshold 100 showed better performance across rebin factors

Performance evaluation



- MobileUNet V3, Truth Threshold = 100
- Dataset: cosmic-ray 590 events

Performance evaluation



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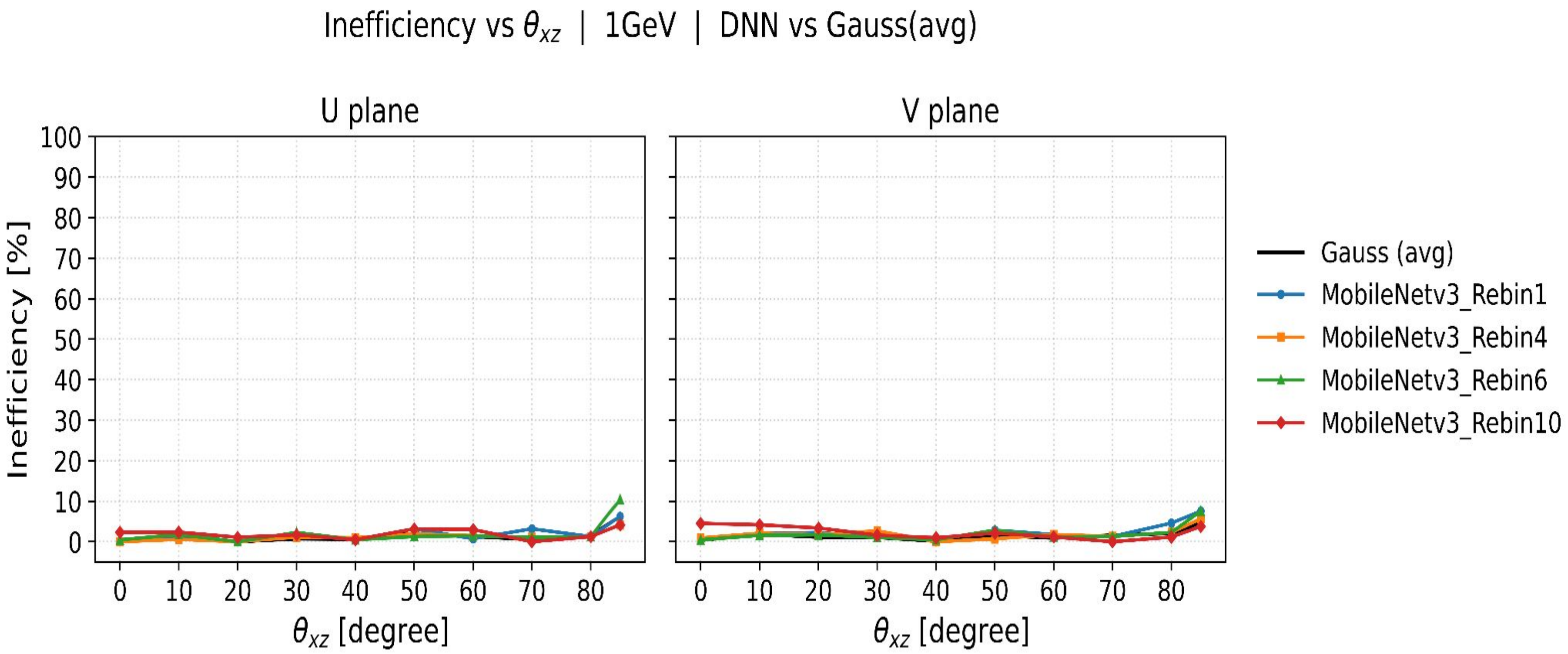
Performance evaluation



- MobileUNet V3, Truth Threshold = 100
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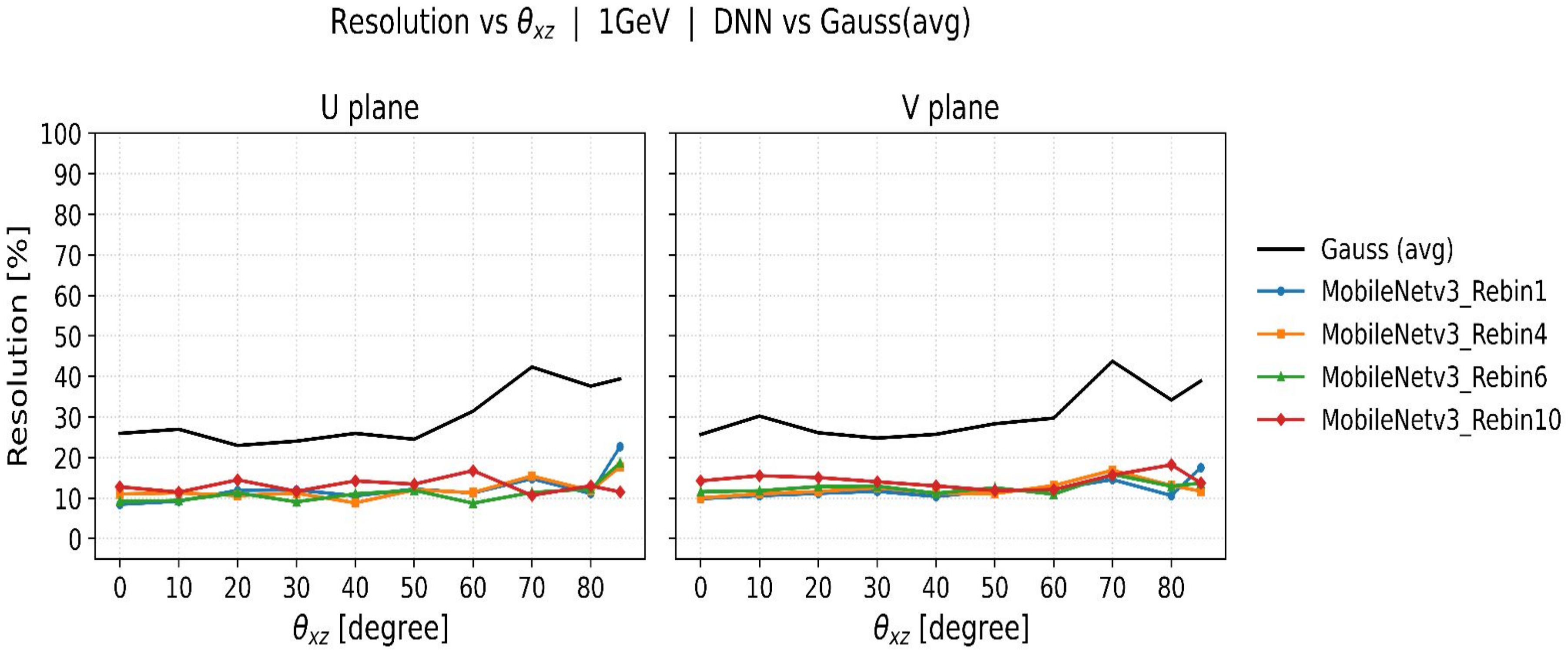
Performance evaluation



- MobileUNet V3, Truth Threshold = 100
- Dataset: cosmic-ray 590 events

Time/Memory Measurement (Chunking + Rebining)

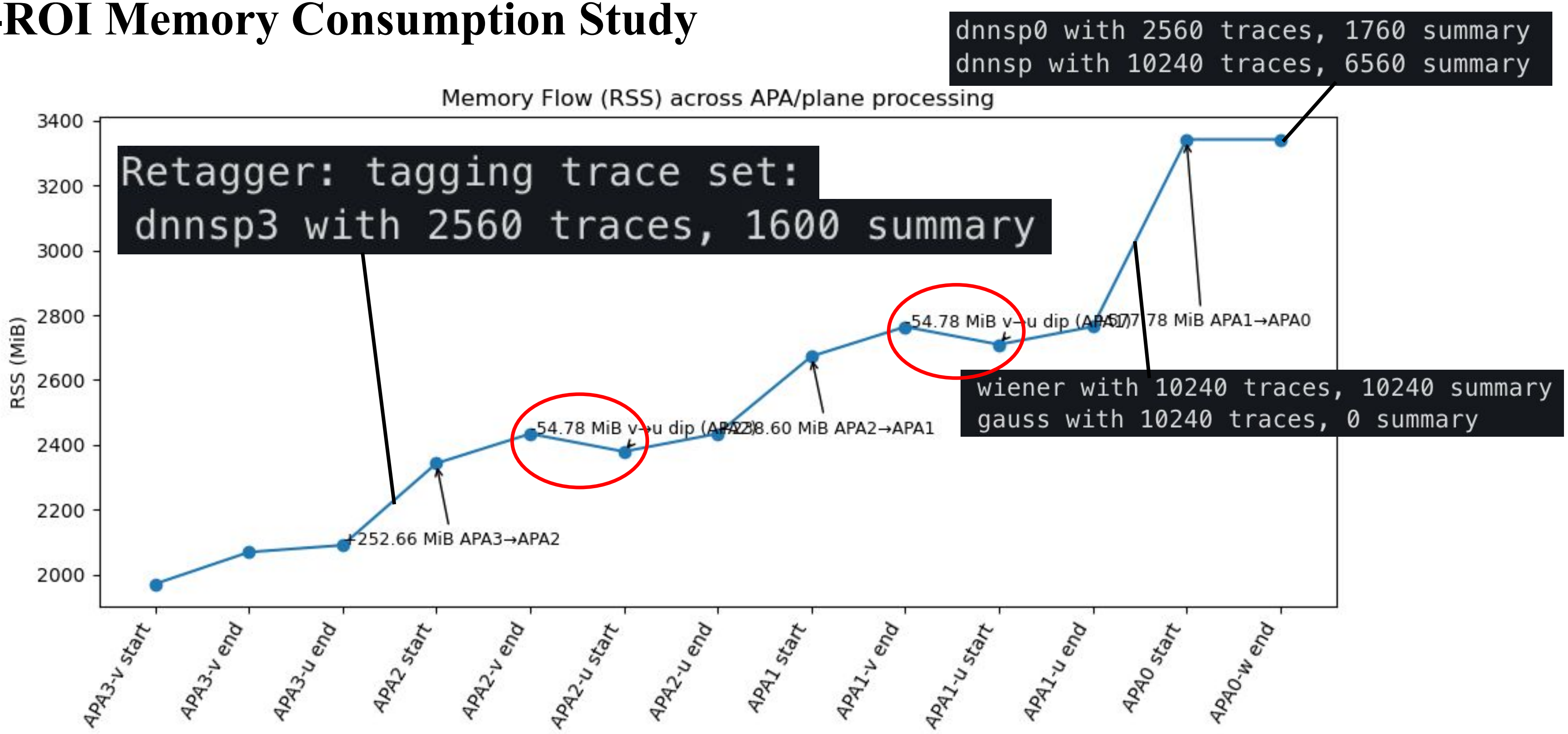
	MobileUNet V3 (MB)				UNet (MB)
nchunks	Rebin 1 (full)	Rebin 4	Rebin 6	Rebin 10	
1	**8608**	**4662**	**4210**	**3931**	**6468**
2	6000	4032	3861	3723	4962
3	5242	3860	3736	3616	4410
4	4760	3777	3687	3622	4151
5	**4539**	**3721**	**3641**	**3658**	**4021**
10	3977	3657	3648	3660	3792

- PD-HD cosmic-ray data: 27673-1

DNN-ROI Memory Consumption Study

Segment	Forward Start RSS (MiB)	End of Call RSS (MiB)	Change (same APA, MiB)	Change (previous plane, MiB)
APA4-V	1970.68	2068.87	+98.19	—
APA4-U	2068.87	2090.29	+21.42	—
APA4 → APA3	2342.95	—	—	+252.66
APA3-V	2342.95	2434.12	91.17	—
V → U transition	2379.34	—	—	–54.78
APA3-U	2379.34	2434.55	+55.21	—
APA3 → APA2	2673.15	—	—	+238.60
APA2-V	2673.15	2764.39	+91.24	—
V → U transition	2709.61	—	—	–54.78
APA2-U	2709.61	2764.82	+55.21	—
APA2 → APA1	3342.60	—	—	+577.78
APA1-W	3342.60	3342.60	—	—

DNN-ROI Memory Consumption Study



- MobileUNet V3, rebin = 10, nchunks = 5
- PD-HD cosmic-ray data: 27673-1
- ~ 1.2 GiB of memory comes from Retagger
- Study for different model & rebin & chunking?

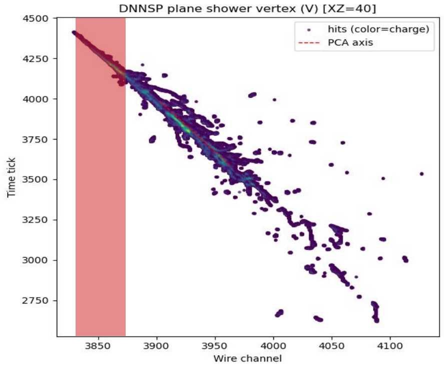
DNN-ROI Performance Evaluation

- For track events, three metrics are used: Bias, Resolution, and Inefficiency

$$Bias = 100 \times \left(\left\langle \frac{Q_{reco}}{Q_{truth}} \right\rangle - 1 \right) \quad Resolution = 100 \times \frac{RMS\left(\frac{Q_{reco}}{Q_{truth}}\right)}{\left\langle \frac{Q_{reco}}{Q_{truth}} \right\rangle} \quad Inefficiency = 100 \times \frac{Number\ of\ bad\ channels}{Number\ of\ valid\ truth\ channels}$$

- For shower events, a charge profile based on vertex information was added as the fourth metric:
  - Sum the charge along the shower direction up to 42 wire channels (≈ 1–2 radiation lengths)
  - Compare the reconstructed-to-truth ratio charge ratio

$$Q_{method} = \sum_{w \in W} Q_{method}(w) \qquad R_{cprofile} = \frac{Q_{reco}}{Q_{truth}}$$



- Samples were generated with
  - Detector configuration: ProtoDUNE - Horizontal Drift (PD-HD)
  - XZ angle: 0°, 10°, 20°, 30°, 40°, 50°, 60°, 70°, 80°, 85°
  - Shower energies: 100 MeV, 500 MeV, 1 GeV, 2 GeV, 3 GeV, 5 GeV
  - Software: WCT standalone (Tracks), LAr-WCT (Showers)