Tracking Simulation Update

Jinlong Zhang (SBU)

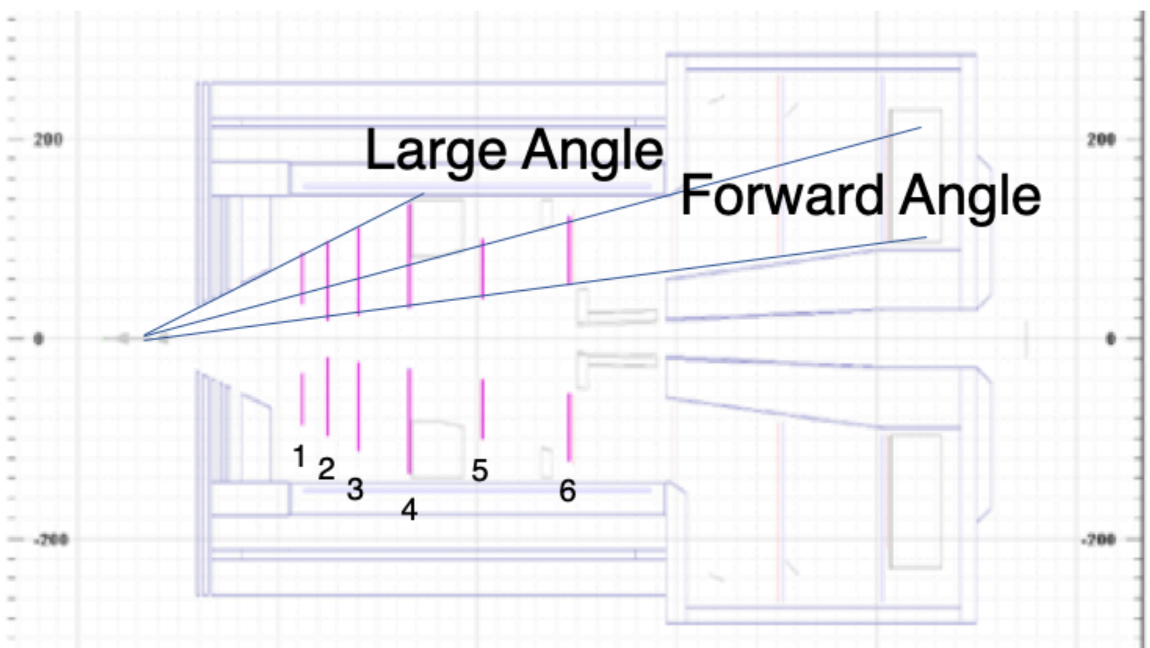
August 9, 2019

SoLID Collaboration Meeting

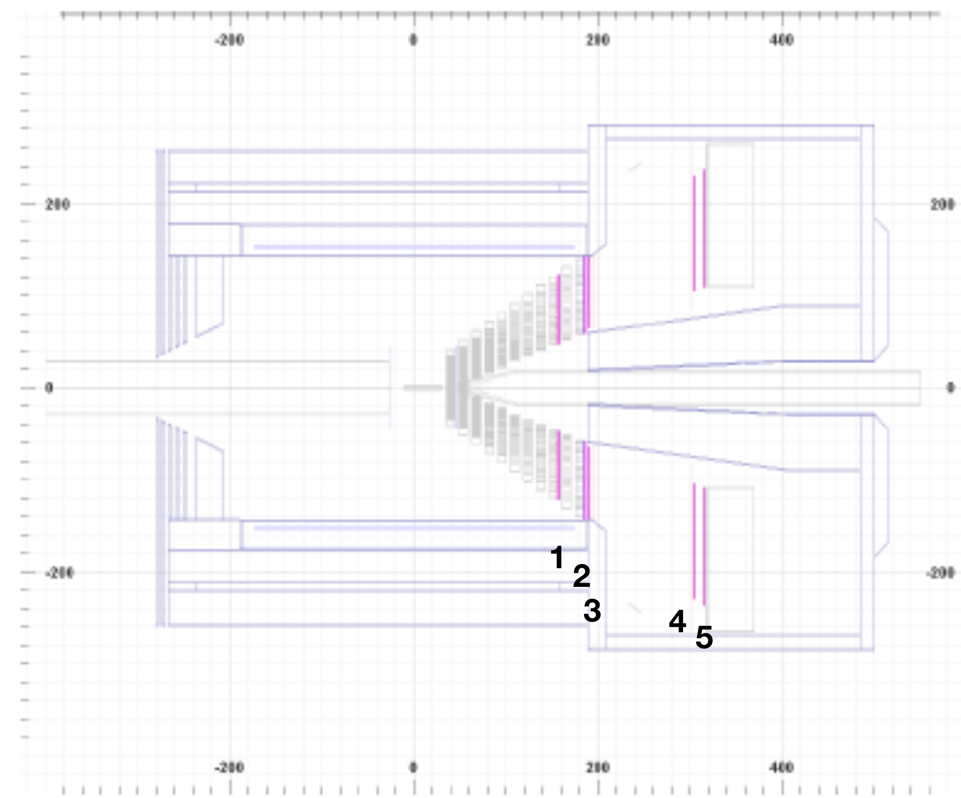
Outline

- Tracking framework: digitization and tracking (Rich, Ole, Weizhi, …)
- Alternative to APV
  - Readout with SAMPA (SIDIS)
  - Readout with VMM (PVDIS)
- Summary

GEM position

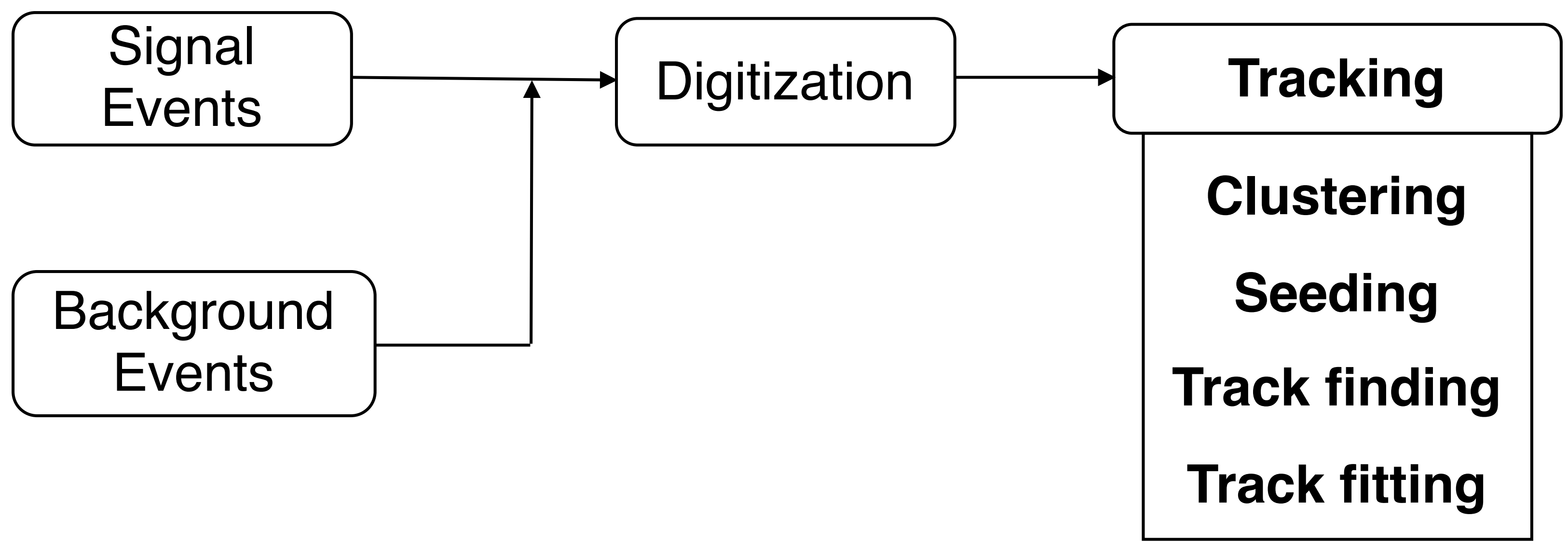


SIDIS / J/psi



PVDIS

Tracking framework



1. From MC events, simulate energy to charge using Cauchy-Lorentz mode
2. At strip level, simulate charge to ADC based on shaping functions (pulse shape)
3. Accumulate ADC contributed by signal hit and background hits in a given time window (determined by the pulse length)
4. From accumulated ADC for each strip:
   - APV and SAMPA: one sample (at peak position) or multi-sample (leading edge) for shape analysis
   - VMM: peak seeking -> one sample
5. Smear ADC with pedestal noise (Gaussian)
6. Clustering and tracking

Tracking Evaluation

- **Efficiency**:
  - event level, fraction of events with good track(s) reconstructed
  - Single track signal event
- **Accuracy**:
  - track level, fraction of reconstructed tracks matching to MC tracks
  - Distance between hit on track and MC hit within 3 pitches
- **Resolution**:
  - how well kinematic variables reconstructed: momentum, theta, phi, vertex Z

APV, SAMPA, and VMM

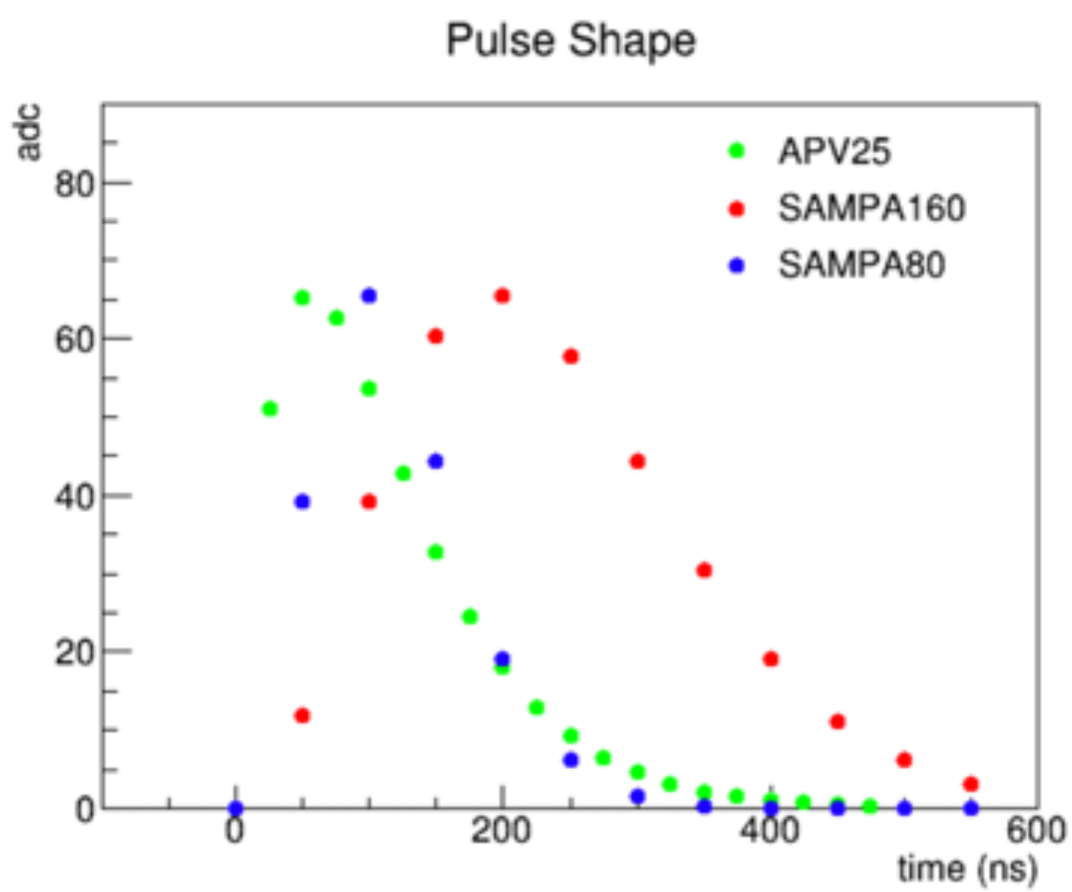
	Shaping time (ns)	Sampling period (ns)	ADC bits
APV25	50	25	10
SAMPA160	160	50	10
SAMPA80	80	50	10
VMM3	25, **50**, 100, 200	peak seeking	6

Slower shaping -> Larger time window -> more background hits
-> lower tracking efficiency/accuracy

Longer sampling period -> lower pulse shape resolution

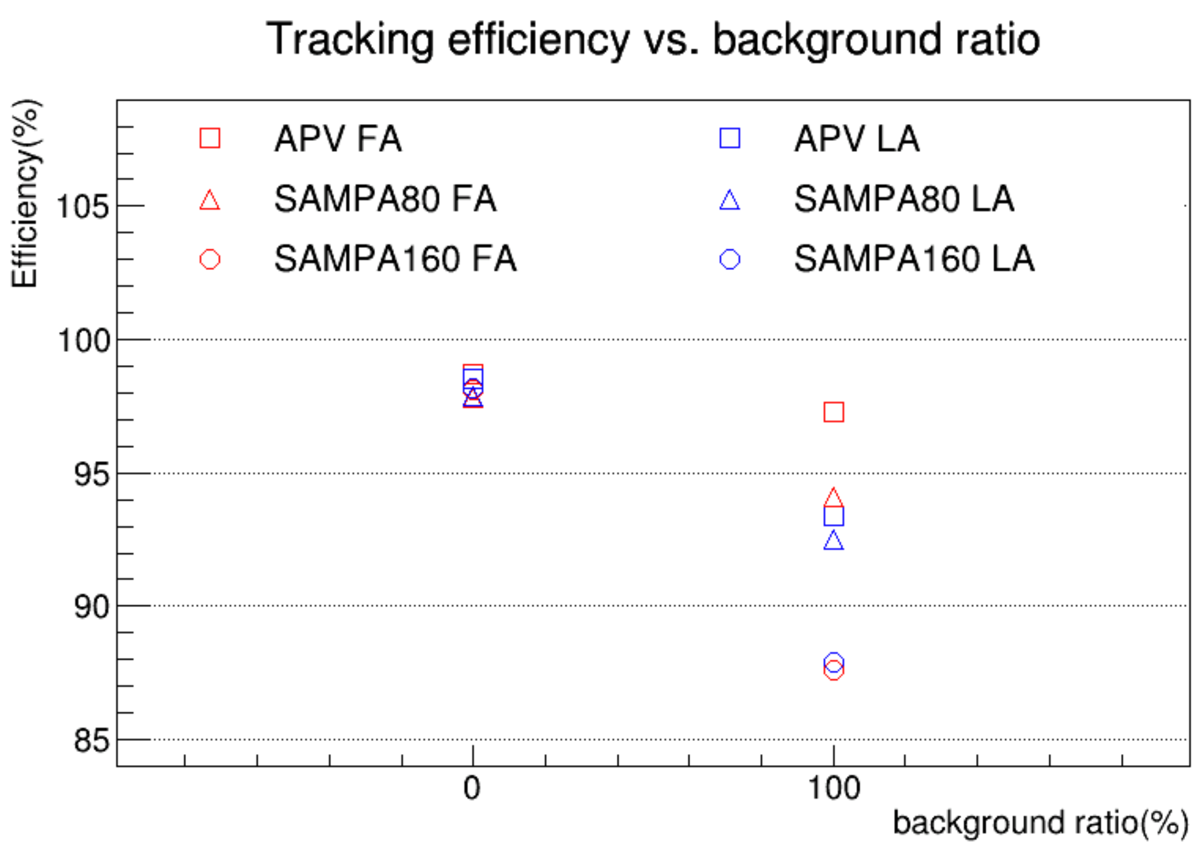
Lower ADC bits -> lower ADC resolution

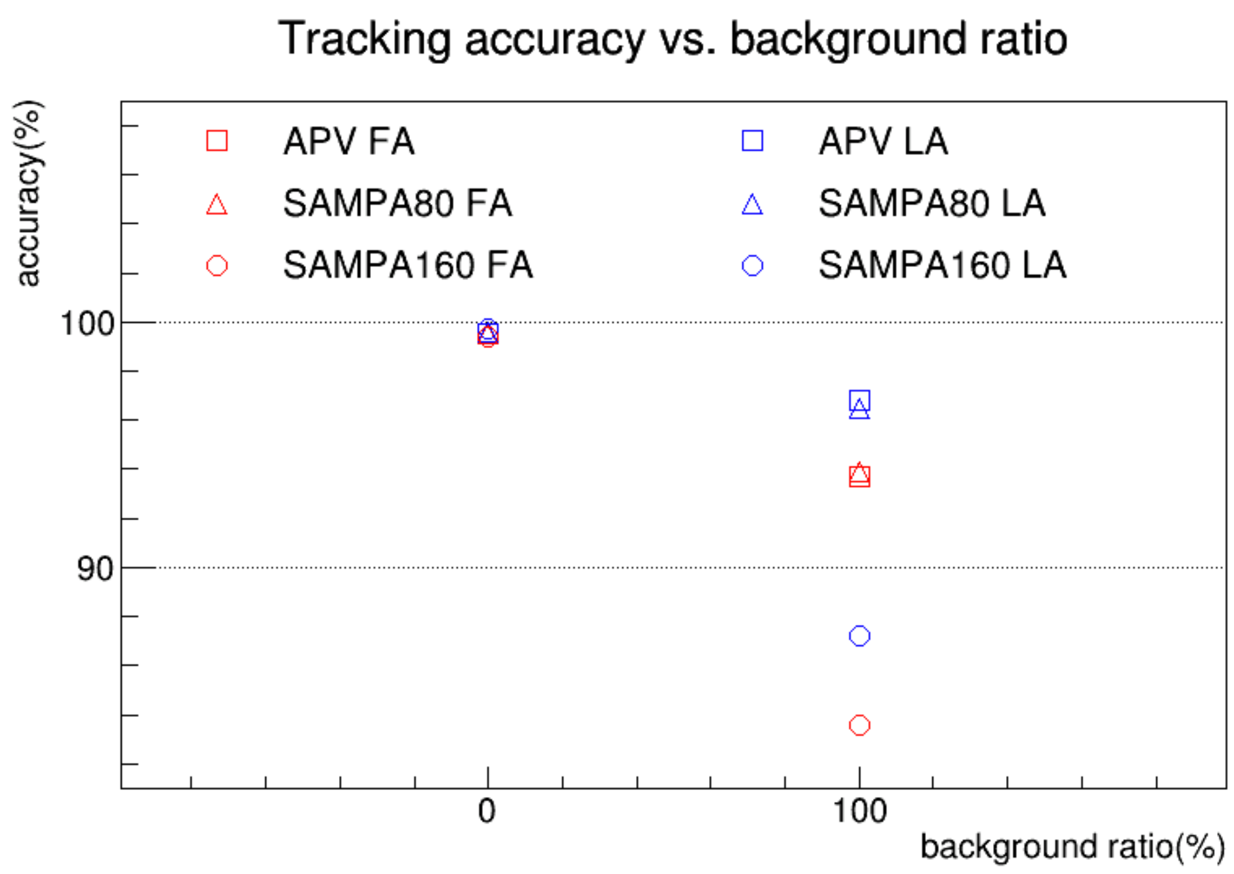
SAMPA



- Two versions: 160 ns (used by ALICE TPC) and 80 ns shaping time
- 50 ns sampling step (25 for APV)
- One sample: 5th for 160; 3rd for 80

SAMPA for SIDIS



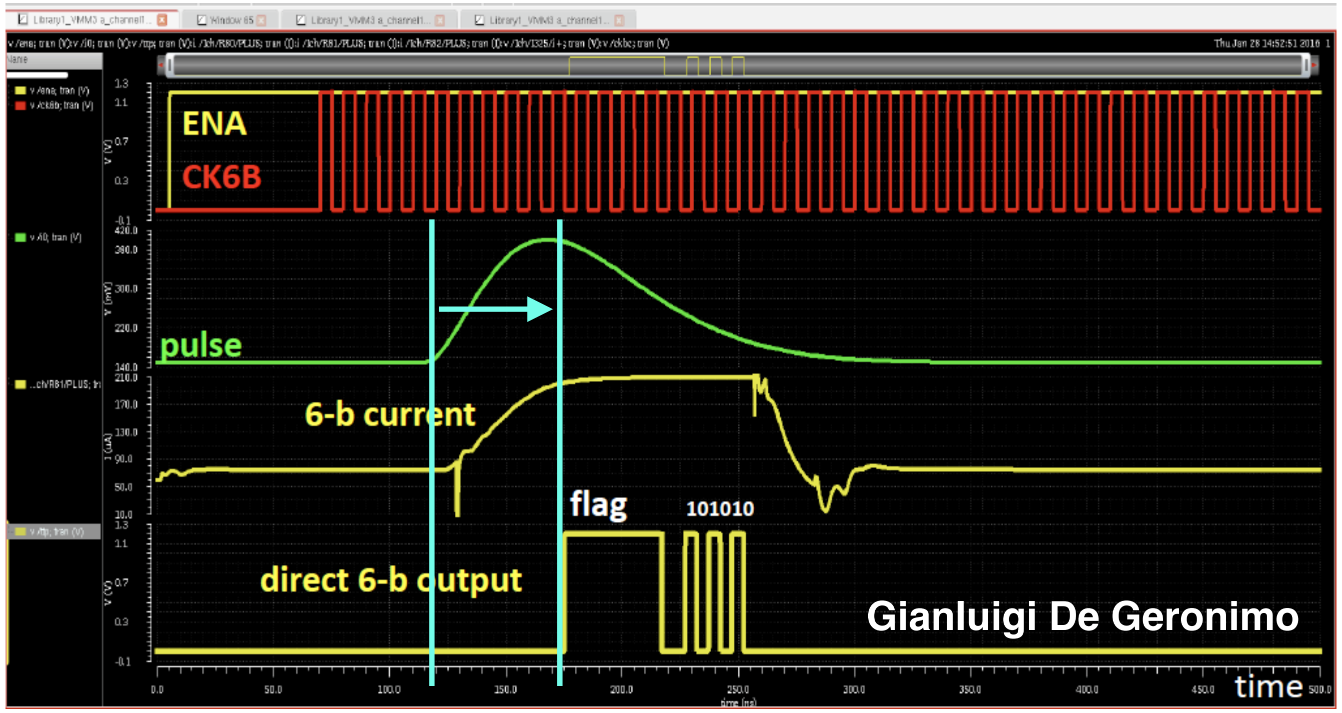


- SAMPA 160: ~10% worse for both efficiency and accuracy than APV
- SAMPA 80: better than SAMPA 160 as expected, ~3% worse than APV25 for FA tracking efficiency.

VMM

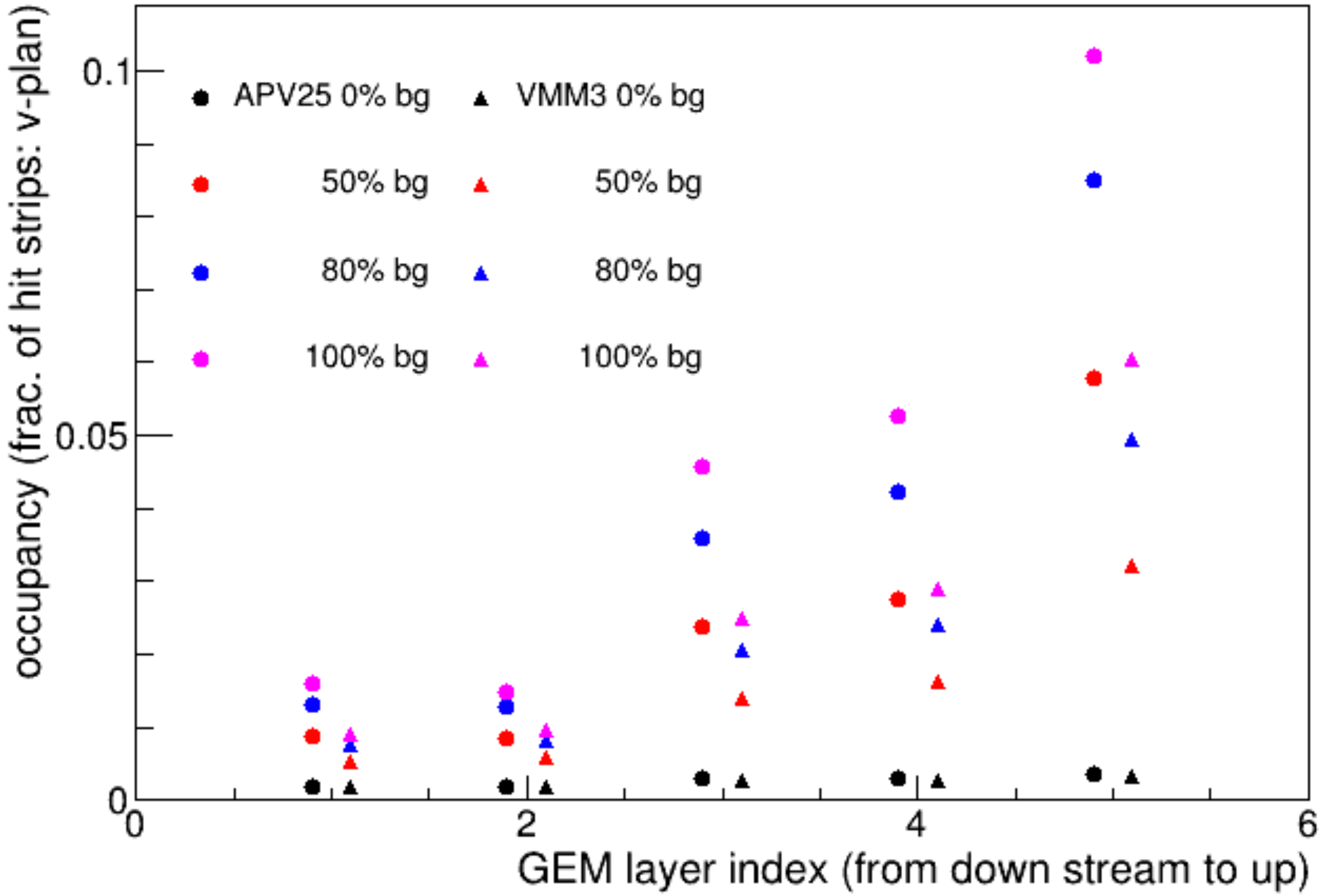
Preliminary

- "Digital" output: instead of sampling the pulse shape, VMM seeks for pulse peak on the fly; only one "sample" at peak
- Before trigger arrives, VMM keep self-resetting, non-triggered hits (bkgd) and pile-up pulse contribution suppressed significantly
- Low resolution ADC (6-bit)



- Assuming perfect trigger timing
- Background contribution only for those come in 0 - 50 ns (peaking time)

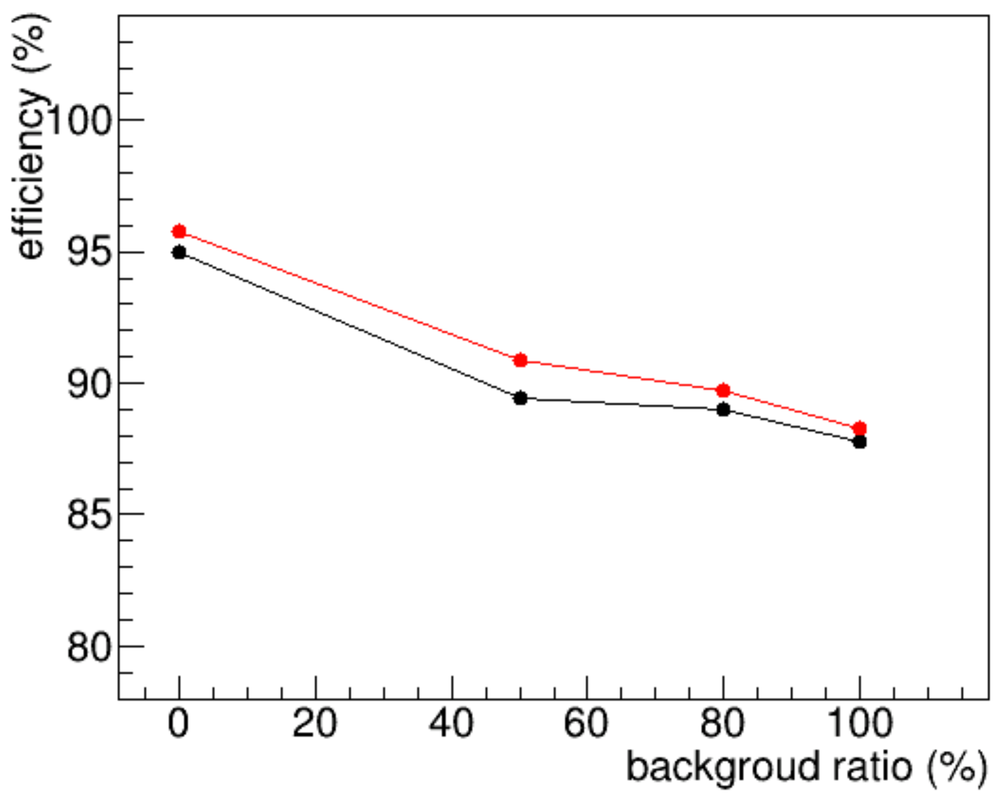
PVDIS Occupancy

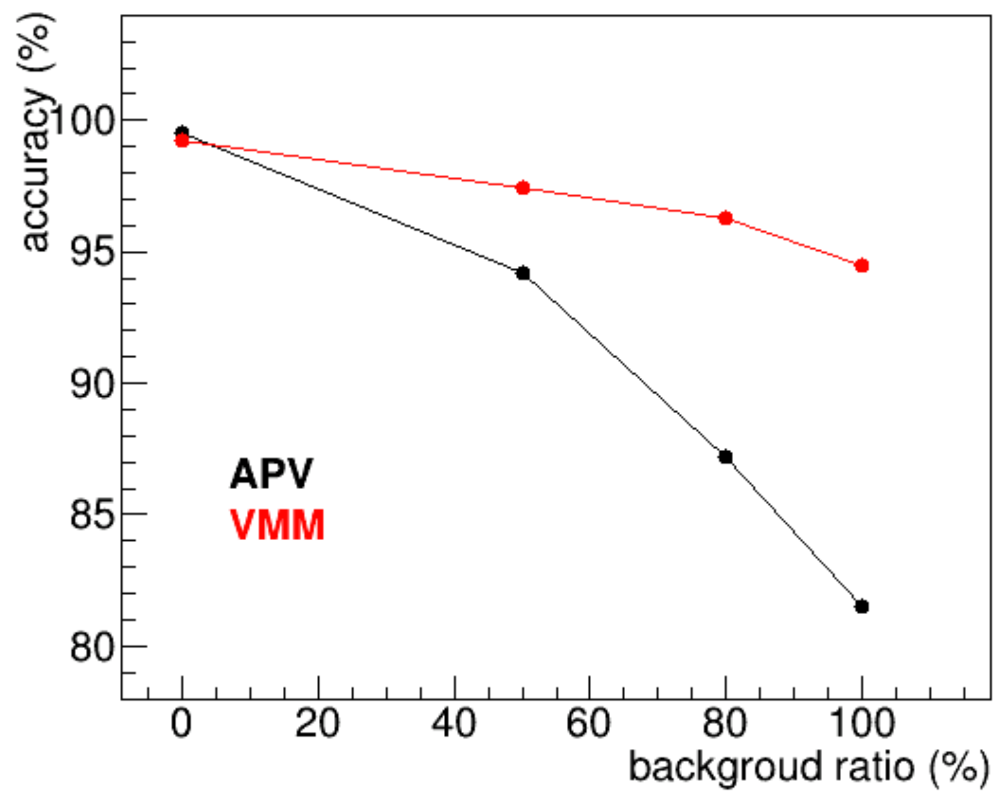


Noise rejected

- High occupancy is one of main issues impact the tracking efficiency and accuracy
- Without background, two readout modes have similar occupancy
- VMM3 have ~40% lower occupancy than APV25 (3 sample, check pulse shape) with 100% background

VMM





- APV: ADC ~ 200, ped noise sigma~15, ADC min cuts > 95 (didn’t tune from Weizhi’s setup).
- VMM: ADC ~40, ped noise sigma ~5, ADC min cuts > 16 (tuned to APV to have similar 0% background efficiency)
- Efficiency sensitivity to background ratio seminar for APV and VMM
- Accuracy decreases LESS for VMM (low occupancy) than APV

Summary

- SAMPA160 gives lower efficiency and lower accuracy, both at ~10% level than APV

- SAMPA 80 better than SAMPA160, but slightly worse than APV

- VMM, preliminary studies, using narrow time window for background hits, accuracy improved significantly.

Thanks to Nilanga, Weizhi, and Alex for their inputs.

SAMPA Resolution

	Forward angle			Large angle		
	APV	SAMPA80	SAMPA16	APV	SAMPA80	SAMPA16
Momentum	1.410	1.417	1.442	1.098	1.098	1.154
Theta	0.995	0.998	1.066	1.054	1.053	1.068
Phi (mrad)	4.147	4.166	4.229	2.142	2.104	2.219
Vertex Z	9.076	9.100	10.281	5.481	5.477	6.064

- Resolutions for SAMPA80 are comparable with APV25, and better than SAMPA160 with about 5%.