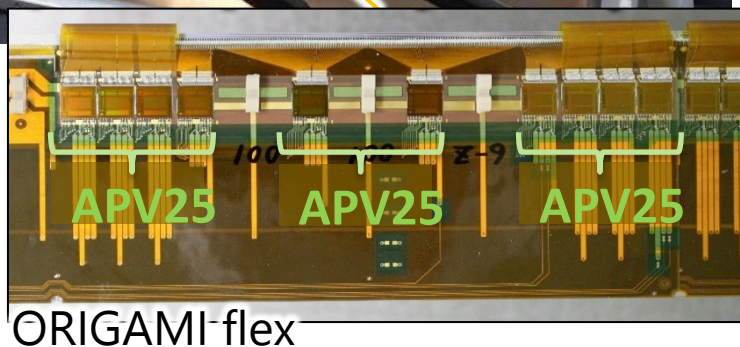
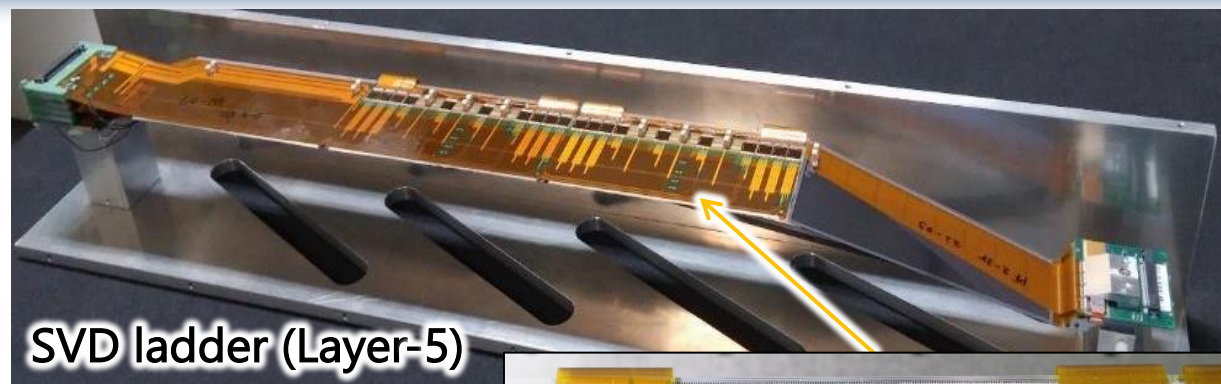


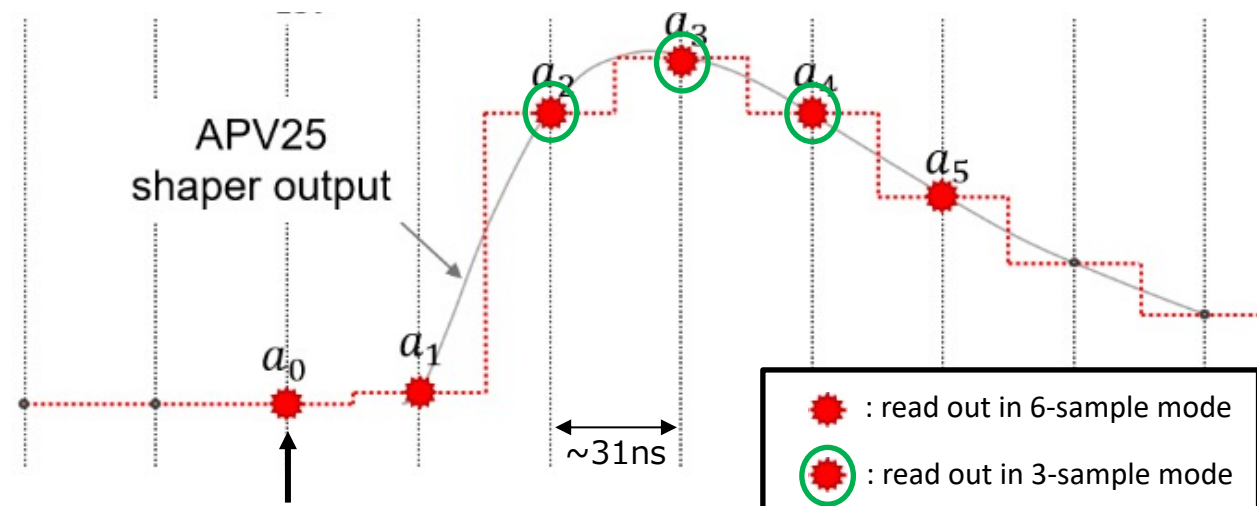
# Possibility of Higher trigger rate / Triggerless DAQ for SVD

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TRG/DAQ Workshop 2022

# SVD 6-sample mode and 3-sample mode



32 MHz clock sampling of APV25 shaper output waveform



Timing of the first sample is determined by the trigger timing.

→ Trigger timing resolution becomes important for 3-sample.

## ■ Two SVD readout mode

- 6-sample mode: reading out 6 samples per trigger (current SVD readout mode)
- 3-sample mode: reading out 3 samples per trigger
  - no intermediate sampling number because of APV25 specification

## ■ 3-sample mode requires good trigger timing, otherwise we may lost the signal peak.

- Some of the triggers doesn't satisfy the requirement.

## ■ 6/3-mixed sample mode: A new SVD readout mode that dynamically switches 3-sample mode and 6-sample mode event-basis depending on the quality of trigger timing.

- Fine timing trigger (e.g. large-E ECLTRG, TOP T0 TRG) → select 3-sample mode
- Course timing trigger (other than above) → select 6-sample mode

# Data rate

## ■ Data rate per b2link PCIe40 channel

- Expected max. data size per FTB (6-sample): 2.5 kB
  - MC under design machine parameters and scaling factors measured in data (see backup)

Trigger rate	30 kHz	40 kHz	50 kHz	100 kHz
Data rate in b2link	75 MB/s	100 MB/s	125 MB/s	250 MB/s

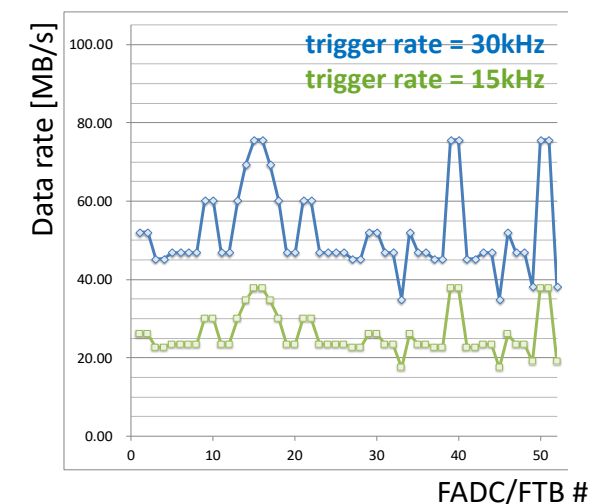
## ■ Data rate per ROPC

- Expected total data size (6-sample): 90 kB

Trigger rate	30 kHz	40 kHz	50 kHz	100 kHz
total rate (5 ROPC)	2.7 GB/s	3.6 GB/s	4.5 GB/s	9.0 GB/s
rate per ROPC	0.54 GB/s	0.72 GB/s	0.9 GB/s	1.8 GB/s

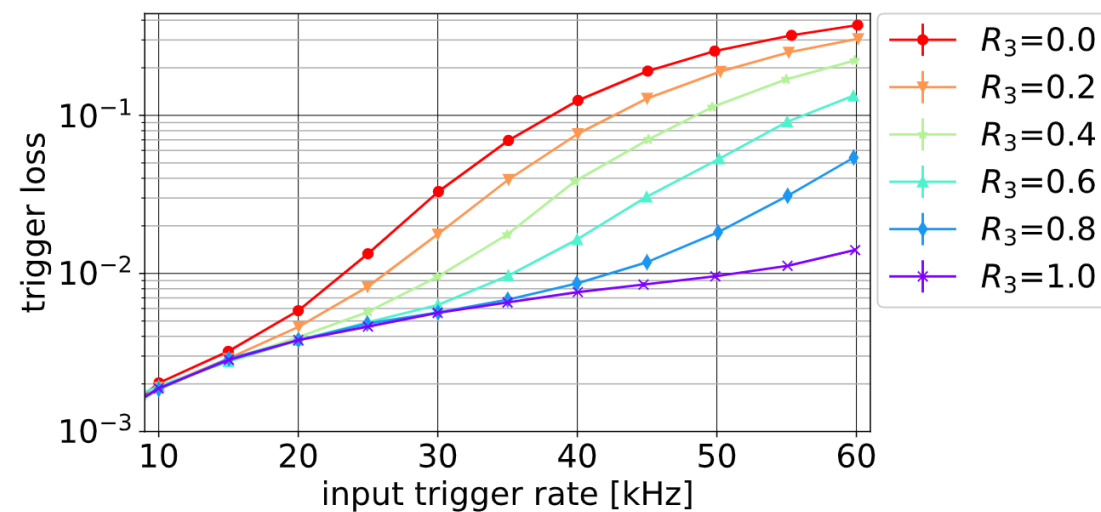
- **6/3-mixed sample mode reduces the data size.**
- **An increase in the zero-suppression threshold could also reduce the data size, but requires careful study of possible effects on the SVD performance.**

Expected data rate from FTB



# Trigger deadtime from APV-veto in FTSW

- **Trigger deadtime from APV-veto module in the FTSW master**
  - to avoid APV25 FIFO full
- **6/3-mixed sample mode is required to reduce the deadtime.**
- **Larger fraction of fine triggers (= 3-sample data) reduces the deadtime**
  - fine triggers: trigger jitter less than about 15ns (TBC)



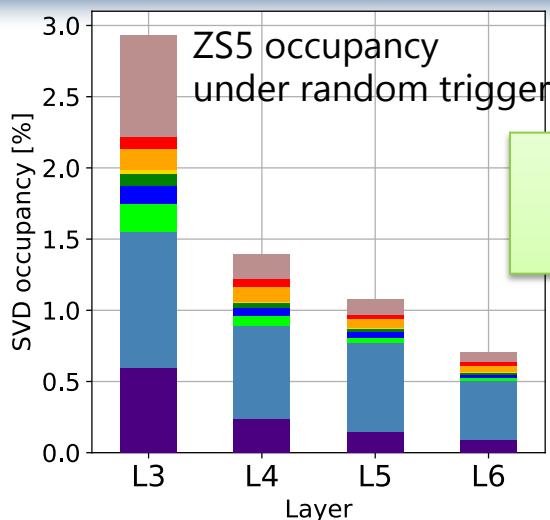
Trigger rate	30 kHz	40 kHz	50 kHz	100 kHz
fine trigger fraction for 3% deadtime	~ 0%	~ 50%	~ 70%	no hope...
fine trigger fraction for 2% deadtime	~ 20%	~ 60%	~ 80%	no hope...
fine trigger fraction for 1% deadtime	~ 40%	~ 80%	100%	no hope...

# Other limitations

- **Another limitation is acceptable trigger latency due to APV25**
  - 5.0 us (from beam collision to L1 arrival on APV25)
    - shortest among all subsystems
- **Triggerless DAQ is not possible for the SVD.**
- **The deadtime and trigger latency requirements are hard limits due to APV25 (FE ASIC). Relaxation of the limits requires the VXD upgrade.**

backup

# Expected data rate



Translation to ZS3 occupancy under physics trigger

**Physics/Random scaling**

× 2.00

(for all layers)

In previous, it was overlooked.

**ZS3/ZS5 scaling**

× 1.5 (Layer-3)

× 1.5 (Layer-4)

× 1.6 (Layer-5)

× 1.7 (Layer-6)

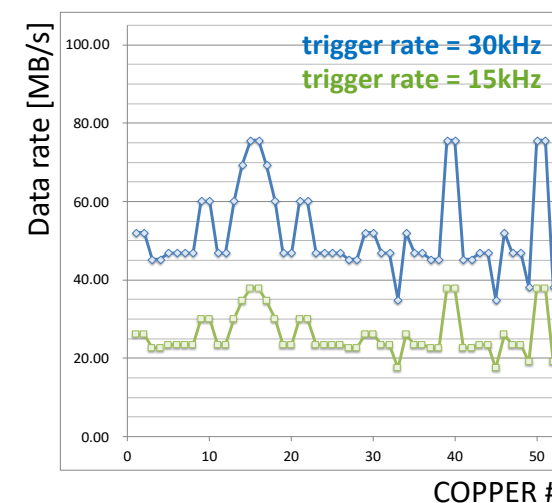
**Noise**

+ 1.0%

(for all layers)

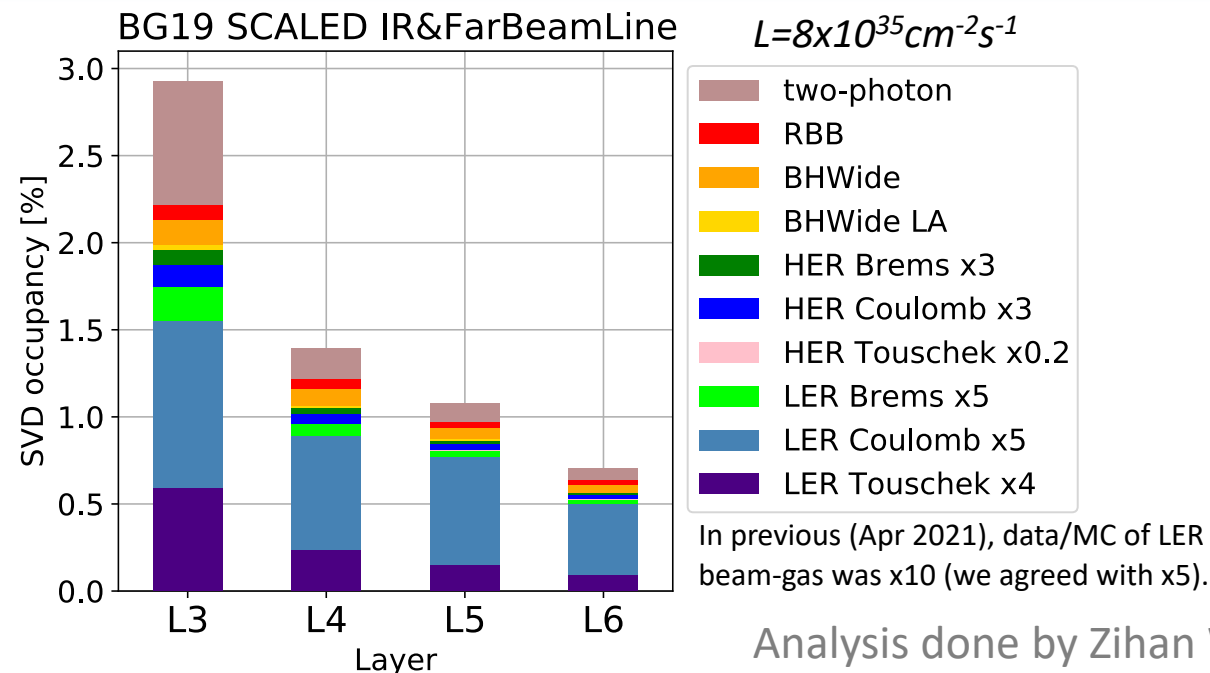
Layer	Occupancy (random) [%] beam BG(19ac) (ZS5)	physics/ random	Occupancy (physics) [%] (ZS5)	ZS3/ZS5	Occupancy (physics) [%] w/o noise (ZS3)	Noise occupancy [%] (ZS3)	Translated occ. [%] (ZS3)
3	2.93	2.00	5.86	1.5	8.79	1.0	9.79
4	1.40	× 2.00 =	2.80	× 1.5 =	4.20	+ 1.0 =	5.20
5	1.08	× 2.00 =	2.16	× 1.6 =	3.46	+ 1.0 =	4.46
6	0.70	× 2.00 =	1.40	× 1.7 =	2.38	+ 1.0 =	3.38

Expected data rate in COPPER



- Expectation of total SVD event size: **90 kB**
- Expectation of total SVD data rate @ 30kHz: **2.7 GB/s**
- **5 PCIe40/ROPC sets** for SVD
  - Expected SVD data rate per ROPC @ 30kHz: about 540 MB/s (= 2.7 GB/s / 5 ROPC)
  - Max. bandwidth of PCIe40/ROPC: about 870 MB/s (w/o software CRC calculation)
    - may be improved in the future by changing the network configuration from 10Gbps to 25Gbps.

# Expected data rate of SVD

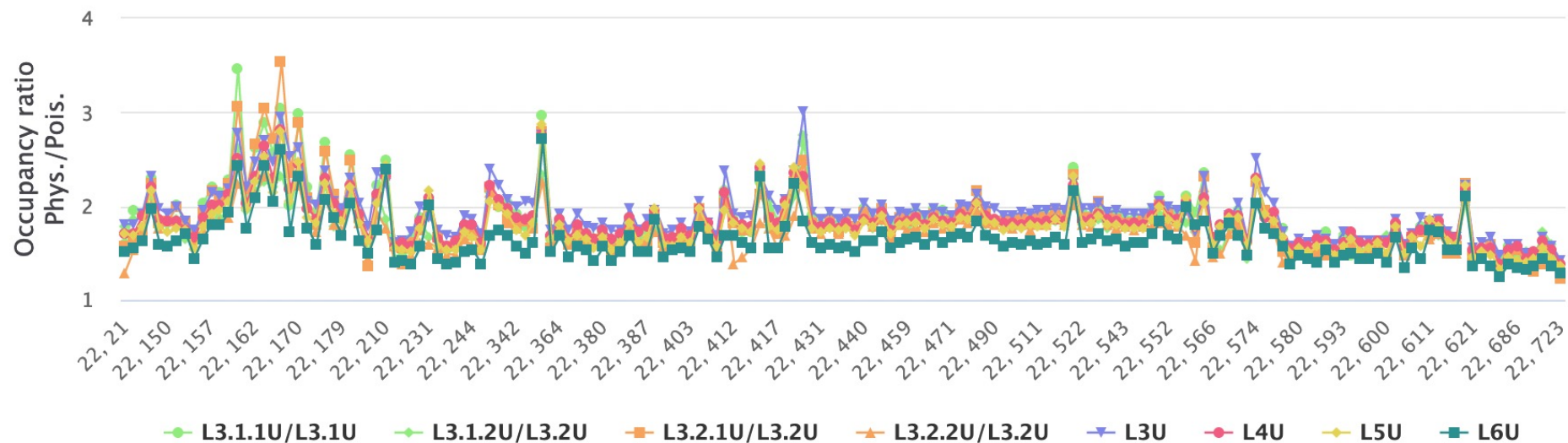


- **SVD online occupancy (= hit occupancy under physics trigger and ZS3) is required to calculate the data rate.**
- **While future SVD occupancy at the design machine parameter is estimated by the beam background MC scaling with measured data/MC factors, the estimation is under the random trigger and ZS5.**
  - Corrections for physics/random and ZS3/ZS5 (and electrical noise) are to be applied to estimate the occupancy under physics trigger and ZS3.



# Physics trigger occupancy vs. Random trigger occupancy (cont'd)

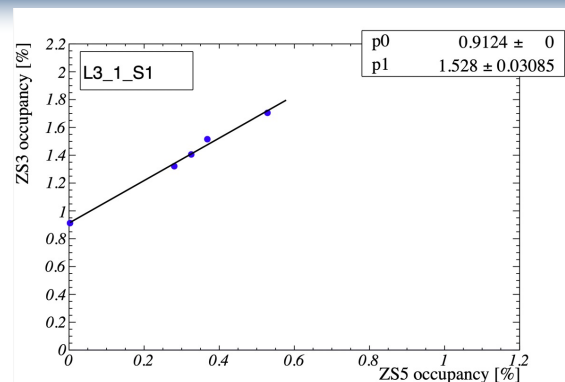
Occupancy Ratio: Physics trigger (w inj. veto) / Poisson trigger (w/o inj. veto)



## ■ Physics occupancy/random occupancy in Mirabelle

- The random occupancy in the plot is **without** injection veto, but it should be well similar to the occupancy **with** injection veto.
  - the effect of the injection BG is diluted by a given injection rate and a short BG duration.
- **While the ratio is not very stable and sometimes fluctuates according to the bad background condition and the injection veto setting, we can reasonably say that it was about 2.0 or less during exp.22**

# ZS3 occupancy vs. ZS5 occupancy

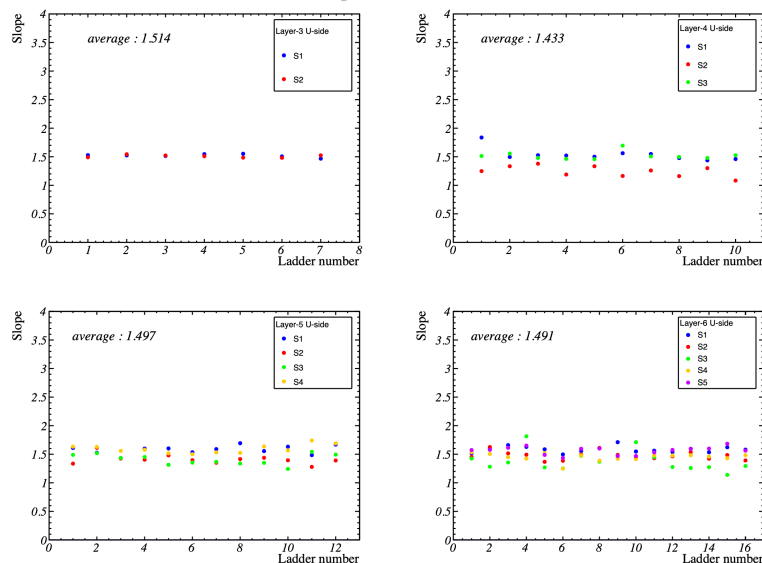


ZS5 and ZS3 occupancy in each sensor are calculated in several physics runs and plotted. The plot is fitted with a linear function.

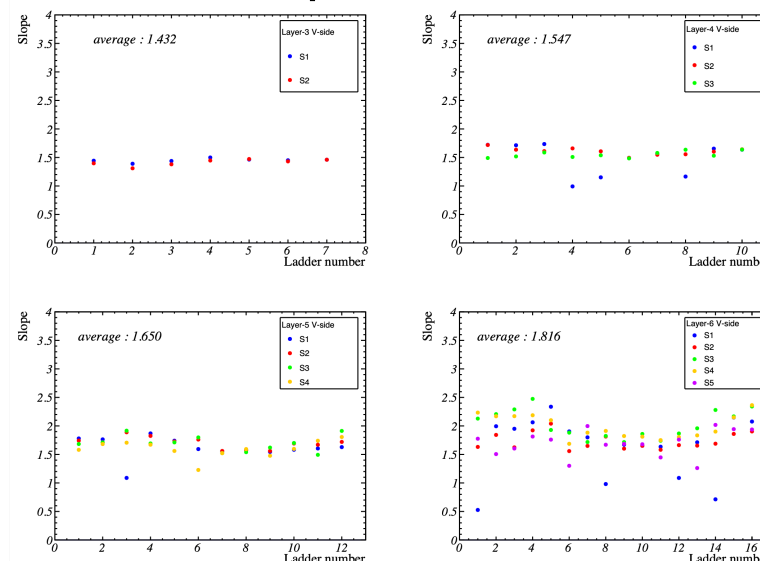
$$\text{Slope} = \text{ZS3}/\text{ZS5}$$

Dataset: Physics runs in Nov-Dec 2021 and no beam run in Dec 22, 2021

## Slopes in U-side



## Slopes in V-side



Resulting ZS3/ZS5: 1.5 (Layer-3), 1.5 (Layer-4), 1.6 (Layer-5), 1.7 (Layer-6)

See more details of the analysis in

<https://confluence.desy.de/pages/viewpage.action?pageId=238049220>

in previous, we used 2.0-3.0 determined by BG MC