

Ways to collect $\sqrt{\text{almost(?)}}$ twice the $\sqrt{S494}$ statistics

... or reduce beamtime by half ...

R³B 2021 deadtime

	Electronics	ME	Deadtime (μs)	Limit (main)	S455	S515	S494
S2	VFTX	N	15		X X	X ?	
S8	VFTX	N	31	Readout (RIO3?)		X ?	
Sofia START	VFTX, (MADC32)	N,Y	9		X X		
Sofia Triple MUSIC	MDPP16	Y	25		X X		
Sofia Twin MUSIC	MDPP16	Y	40		X X		
Sofia TOF wall	VFTX	N	31 (est. 20-25)		X X		
CALIFA	FEBEX3	Y	free-running	35 μ dead/pile-up per ch. ?	X	X	
AMS	SIDEREM+SAM	N	100 ; 300	Readout	X	X	
-	INFN AMS DAQ					X	
Sofia MWPC	VMMR8	Y	27		X X	X	
NeuLAND (12 DP)	FQT+TAMEX3		50	CPU ↔ PEXOR	X (X)	X	
LOS	VFTX		9			X	
LOS	TAMEX		3 ; 15			X	
X5 PSP	FEBEX3		3 ; 43 ?	CPU ↔ PEXOR		X	
R3B MUSIC	MDPP16	Y	20			X	
SiPM fiber vacuum	PaDi+Clock-TDC					X	
Fiber vacuum	PaDi+KILOM/cTDC		3 ; 21	CPU ↔ PEXOR		X	
Fiber end	PaDi+KILOM/cTDC		3 ; 21	CPU ↔ PEXOR		X	
ROLU / SEETRAM / ionis.	Scalers					X	X
R3B TOF wall	FQT+TAMEX3		3 ; 21	CPU ↔ PEXOR		X	X
XY Fiber	PaDi+KILOM/cTDC		3 ; 21	CPU ↔ PEXOR			X
Fibers	PaDi+KILOM/cTDC		3 ; 21	CPU ↔ PEXOR			X
MASTER (trig)	VULOM	Y	13	Readout	X	X	X

Multi-event capable?

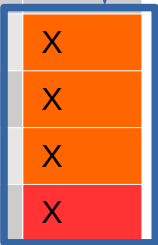
Values are for full create readout.

Values from previous year(s)
(need update)
Estimates
Values needed

VME

Second value is until
f_user return
(early DT release)

Limiting
Limiting next readout
(early DT release)
Excluding AMS



R³B 2021 deadtime

Multi-event capable?

Values are for full create readout.

	Electronics	ME	Deadtime (μs)	Limit (main)	S455	S515	S494
S2	VFTX	N	15		X X	X ?	
S				Readout (RIO3?)		X ?	
S					X X		
S					X X		
S					X X		
S					X X		
S					X X		
S					X X		
C				35 μ dead/pile-up per ch. ?	X	X	
A				Readout	X	X	
-						X	
S					X X	X	
N				CPU ↔ PEXOR	X (X)	X	
L						X	
L						X	
X				CPU ↔ PEXOR		X	
R						X	
	SiPM fiber vacuum	PaDi+Clock-TDC				X	
	Fiber vacuum	PaDi+KILOM/cTDC	3 ; 21	CPU ↔ PEXOR		X	
	Fiber end	PaDi+KILOM/cTDC	3 ; 21	CPU ↔ PEXOR		X	
	ROLU / SEETRAM / ionis.	Scalers				X	X
	R3B TOF wall	FQT+TAMEX3	3 ; 21	CPU ↔ PEXOR		X	X
	XY Fiber	PaDi+KILOM/cTDC	3 ; 21	CPU ↔ PEXOR			X
	Fibers	PaDi+KILOM/cTDC	3 ; 21	CPU ↔ PEXOR			X
	MASTER (trig)	VULOM	Y 13	Readout	X	X	X

Live dead-time measurements (S454)

```

1G+TAI 48:3
42.8k r - 41-49#MASTER 2, 1, 13; 13 3599.0k 0 3933.7k 5.8%
x861-41.#F101 2, 2, 4; 21 6859.5k 1 8189.9k 5.6%
x861-29.#F130 2, 2, 3; 5; 5 1199.8k 0 1216.8k 1.3%
x861-99.#F1100 2, 2, 3; 21 8625.0k 2 10636.4k 0.6%
x861-10.#F111E 2, 2, 3; 21 8625.0k 2 9665.4k 0.7%
x861-77.#F1120 2, 2, 4; 23 8628.3k 1 9990.3k 0.6%
x861-91.#F1130 2, 2, 3; 20 8626.8k 2 8221.8k 0.0%
x861-10.#TOF01 2, 2, 3; 21 8554.6k 2 10091.6k 7.6%
x861-10.#TOF02 2, 2, 3; 21 8546.1k 2 8558.7k 7.6%
x861-10.#TOF03 2, 2, 3; 21 8537.4k 2 9613.8k 8.1%
x861-10.#TOF04 2, 2, 3; 21 8546.1k 2 5200.4k 8.1%
x861-40.#gsi.de EB 71.5H 22.7% --- -T -
---S -
---X--- 76.9H 0.0%
0400 ±5σ ±20σ miss -1.225s
38.4k x861-3.#gsi.de TO 66.0H 6.3% --- -T -
02:00 991.4M /lustre/hebe/r3b/201904_s454/main0257_0001.lmd
  
```

Values from previous year(s) (need update)
 Estimates
 Values needed

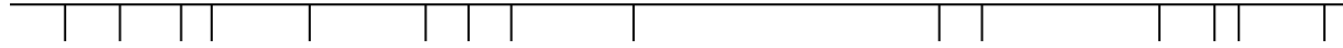
Second value is until f_user return (early DT release)

Limiting Excluding AMS
 Limiting next readout (early DT release)

VME

Readout style Taxonomy

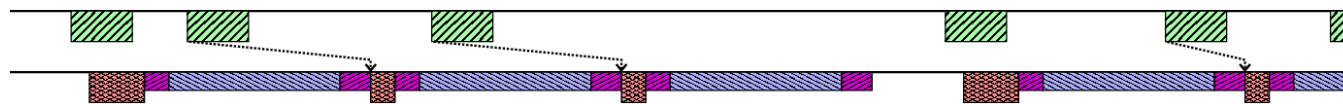
Trigger requests



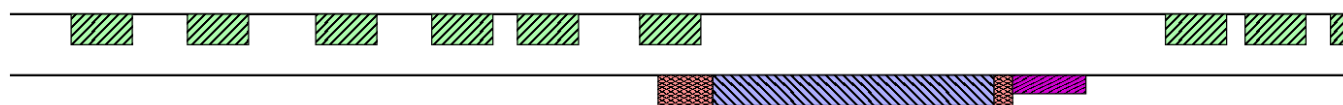
Single-event read-out



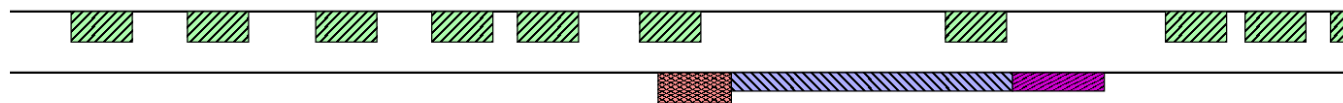
Single-event read-out, early DT-release



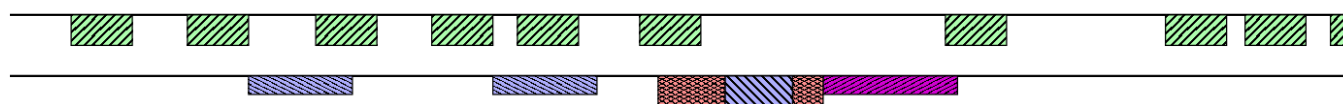
Multi-event read-out



Multi-event read-out, early DT-release



Shadowed multi-event read-out




 DAM conversion / busy

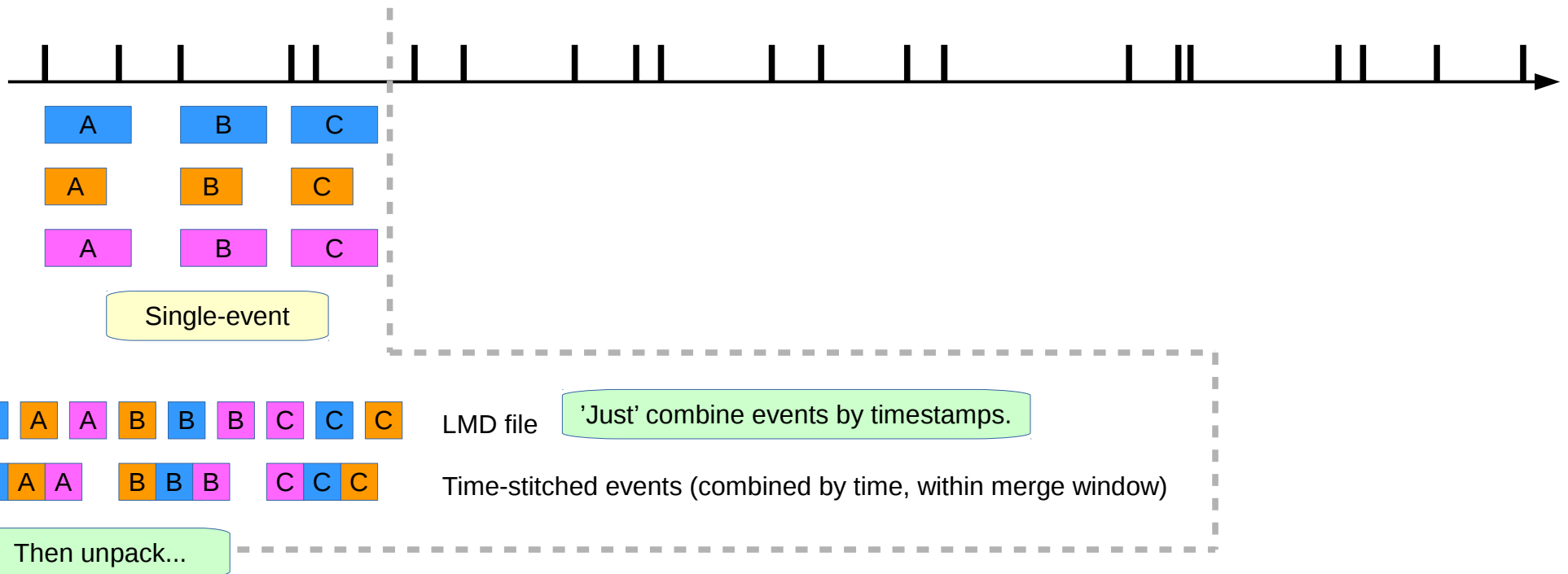
 DAQ overhead

 DAQ read-out

 (after dead-time release)

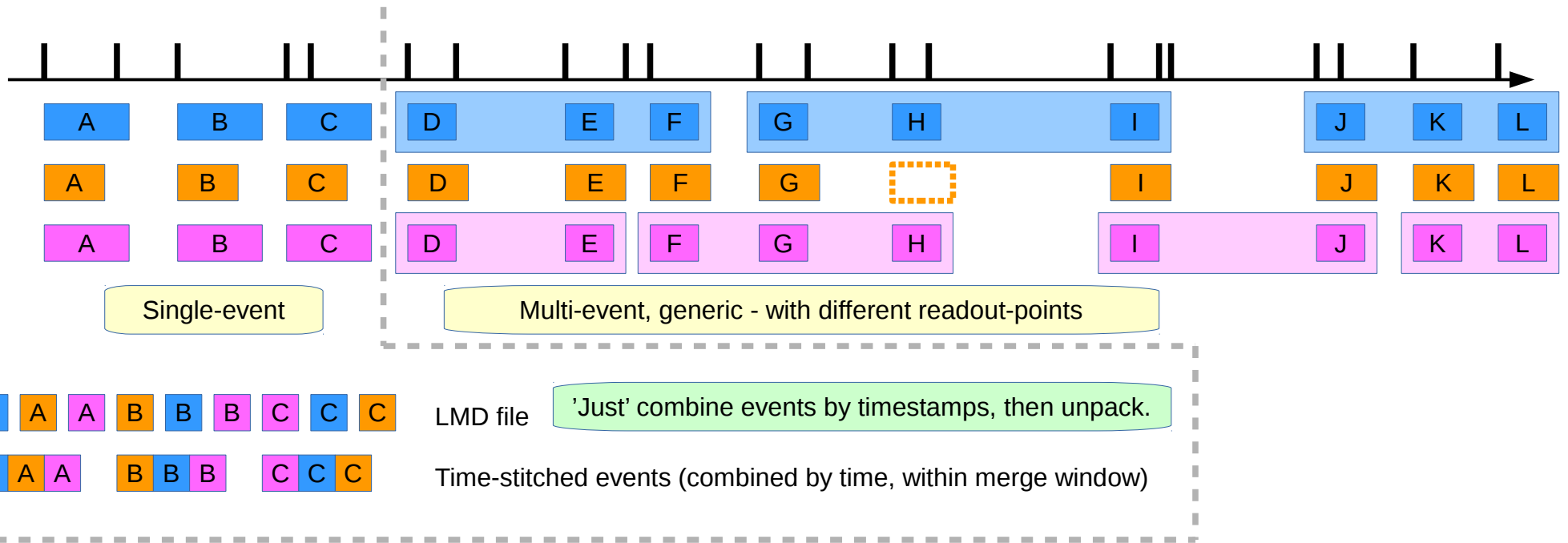
 (shadowed, background, non-DT)

Single-event, time-sorted



This is how we have made time-sorted data
look (to unpack & analysis) *like*
it comes from just one dead-time domain
—
one LMD event per physical event.

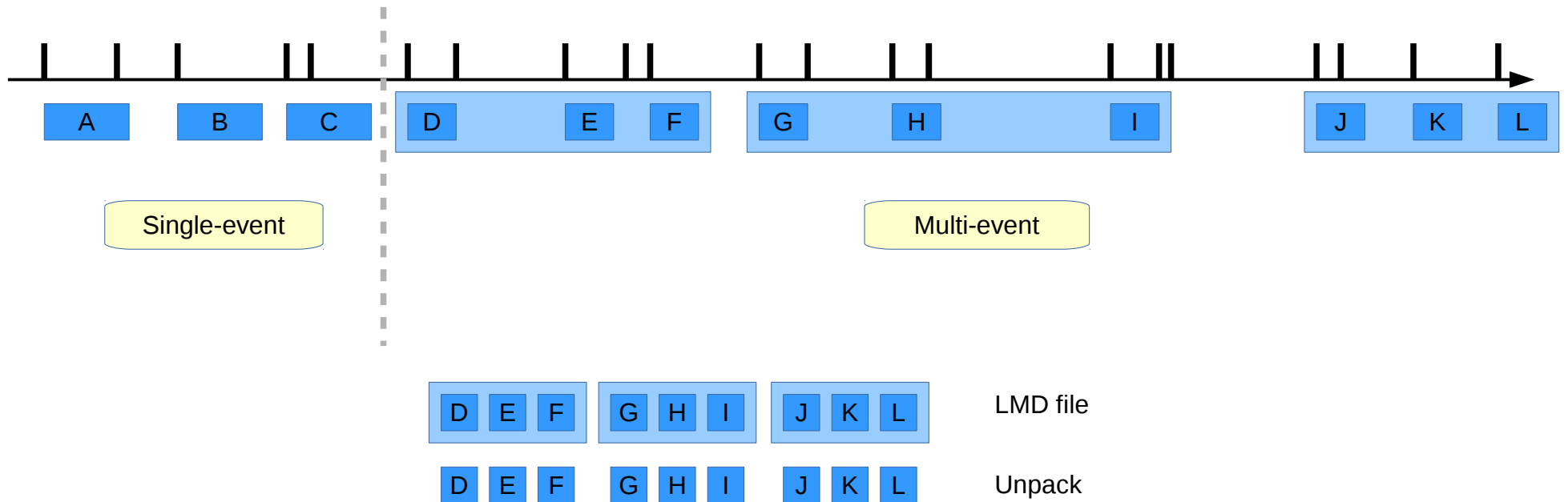
Multi-event, time-sorted



This is how we have made time-sorted data *look (to unpack & analysis) like* it comes from just one dead-time domain
 —
 one LMD event per physical event.

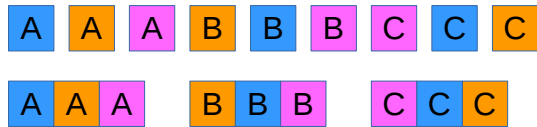
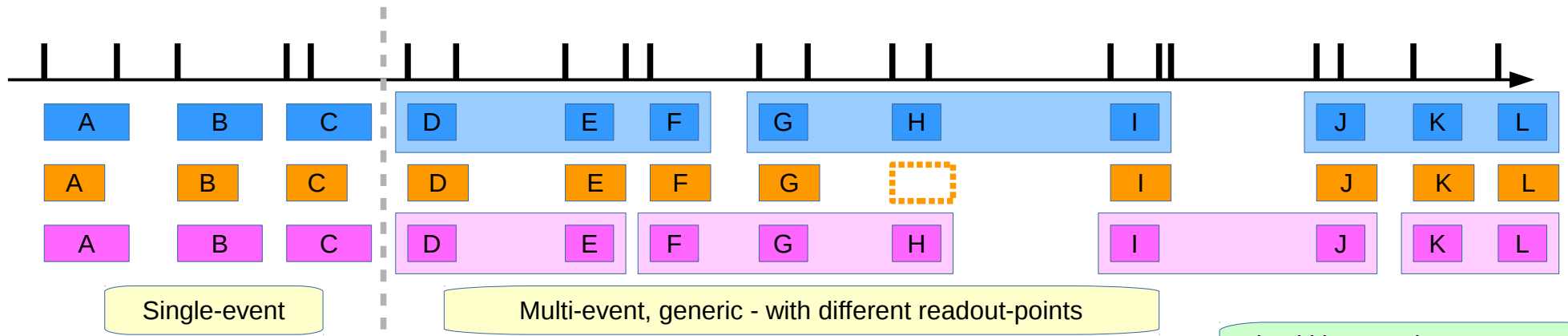
Now we want **multi-event time-sorted** data *look (to analysis) like* it comes from just one dead-time domain
 —
 one **event** per physical event.

Multi-event...



Multi-event from one dead-time domain
UCESB handles since ... 2006.

Multi-event, time-sorted

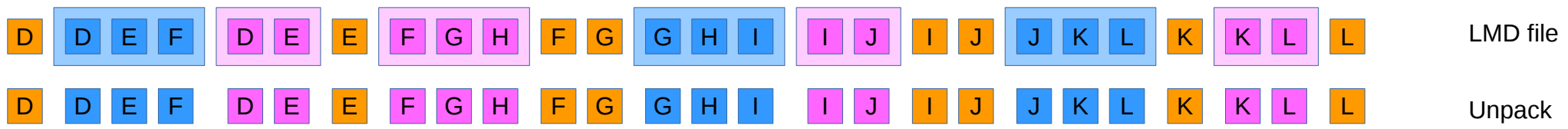


'Just' combine events by timestamps, then unpack.

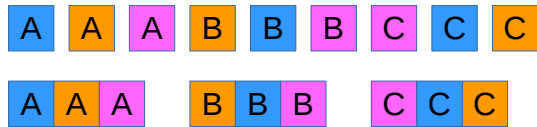
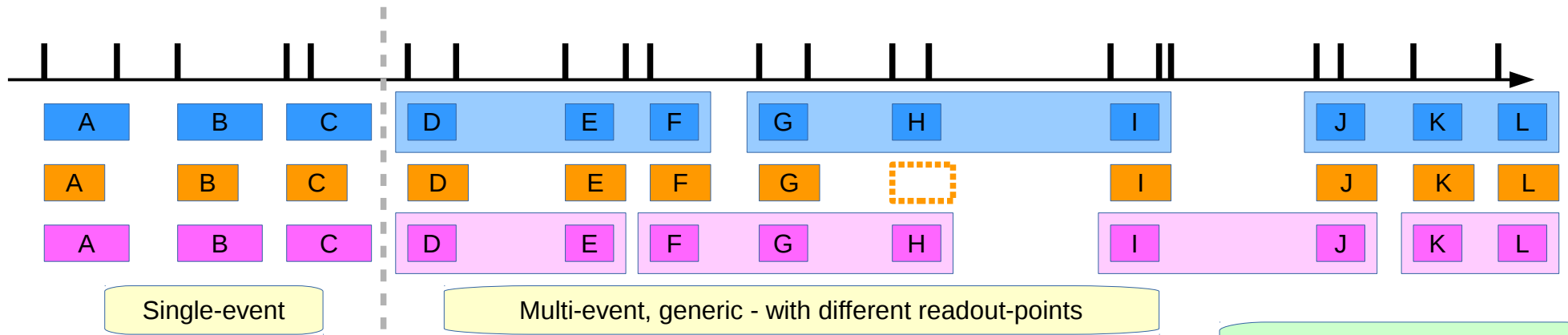
- (Multi-)events in LMD sorted by first time...
- 1) Unpack LMD events.
 - 2) ...
 - 3) ...
 - ...

This is how we have made time-sorted data *look* (to unpack & analysis) *like* it comes from just one dead-time domain — one LMD event per physical event.

Now we want **multi-event time-sorted** data *look* (to analysis) *like* it comes from just one dead-time domain — one **event** per physical event.



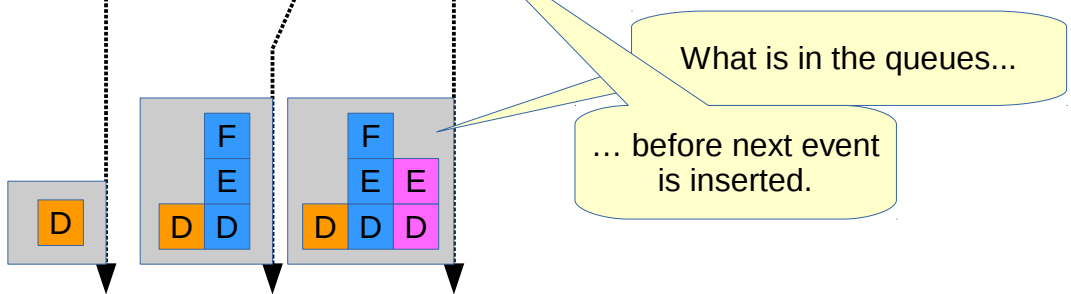
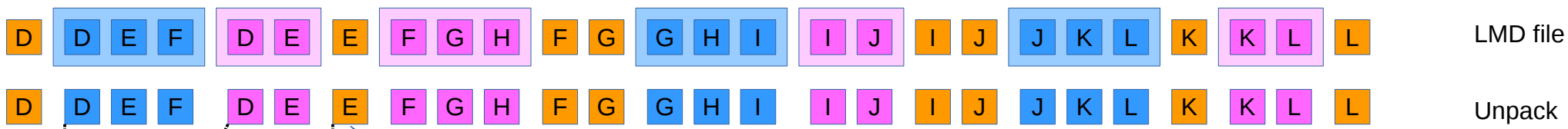
Multi-event unpack



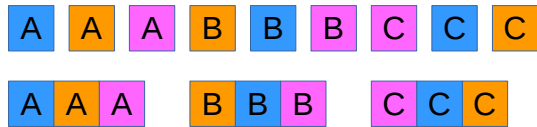
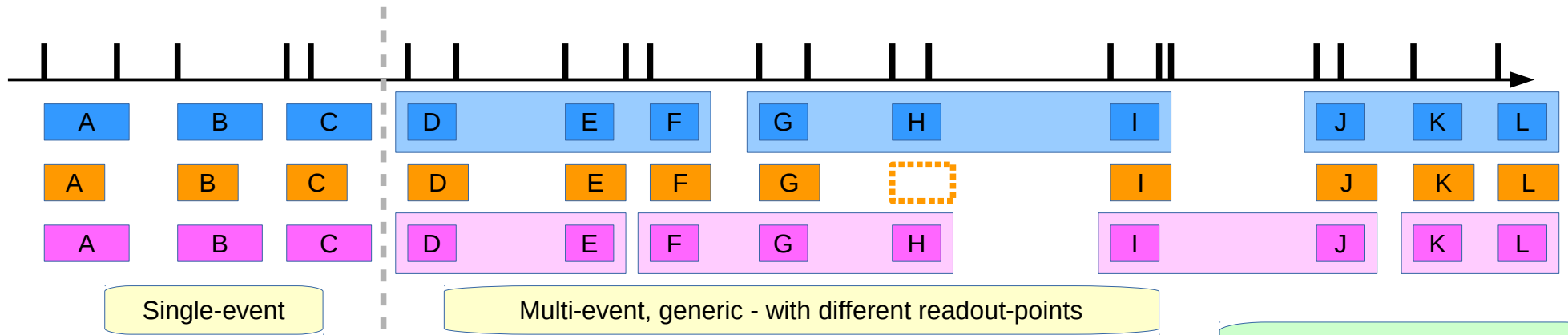
LMD file 'Just' combine events by timestamps, then unpack.

Time-stitched events (combined by time, within merge window)

- (Multi-)events in LMD sorted by first time...
- 1) Unpack LMD events.
 - 2) Put in queues (per source)
 - 3) ...
 - ...



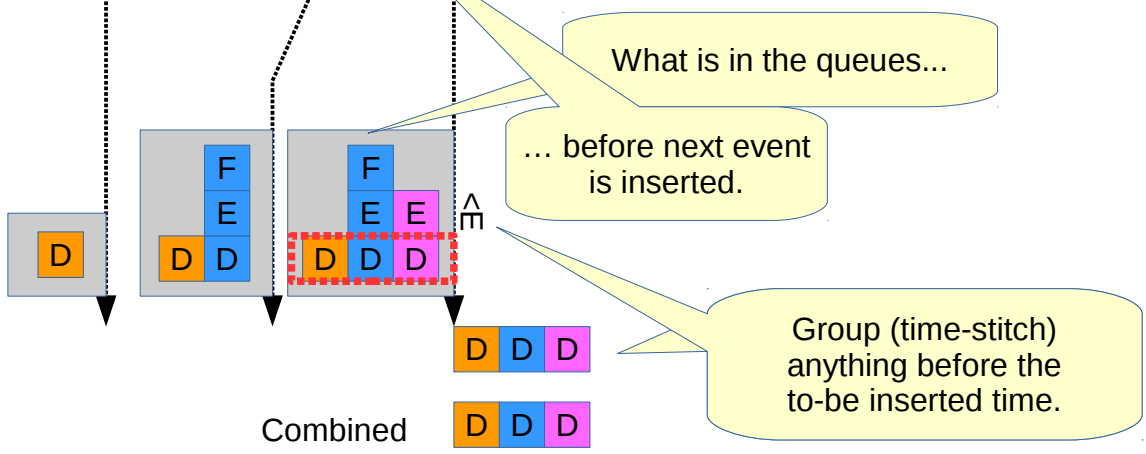
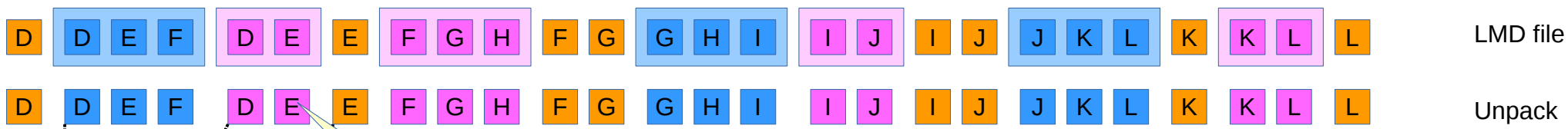
Multi-event unpack, into queues



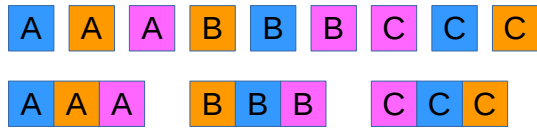
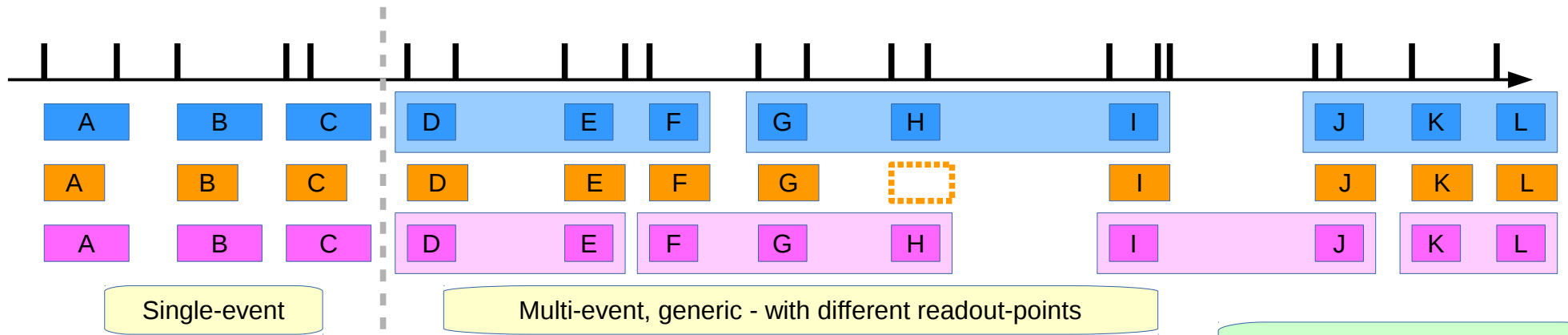
Just' combine events by timestamps, then unpack.

Time-stitched events (combined by time, within merge window)

- (Multi-)events in LMD sorted by first time...
- 1) Unpack LMD events.
 - 2) Put in queues (per source)
 - 3) Emit from queues (on new 'first' multi-event)

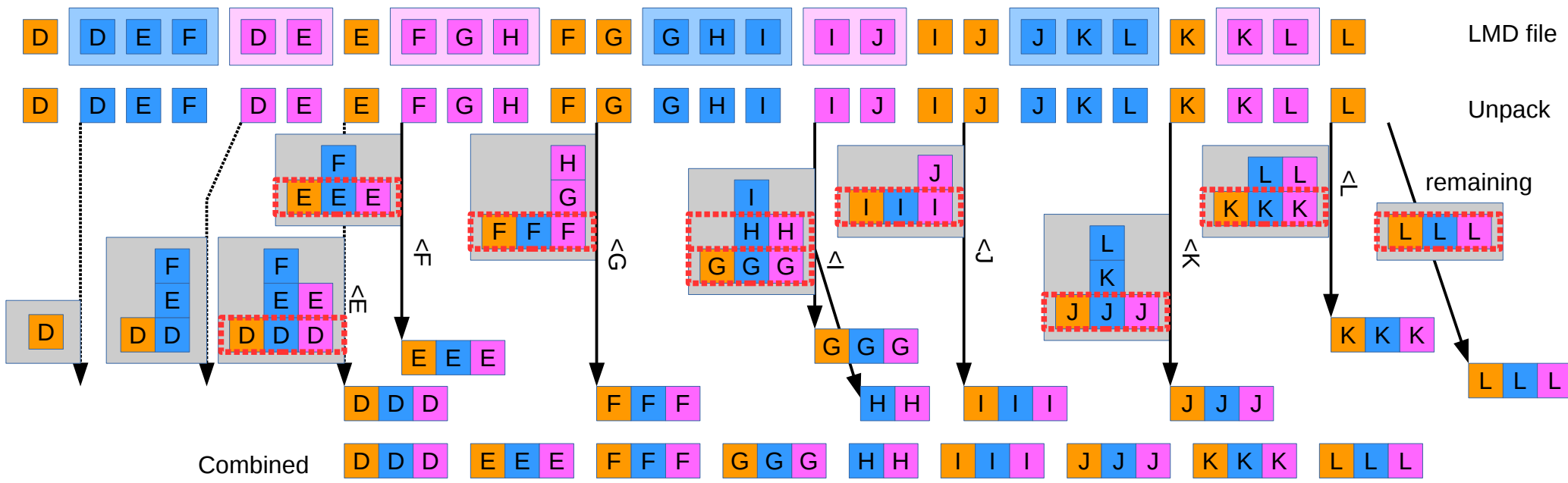


Multi-event time-stitch after unpack



'Just' combine events by timestamps, then unpack.

- (Multi-)events in LMD sorted by first time...
- 1) Unpack LMD events.
 - 2) Put in queues (per source)
 - 3) Emit from queues (on new 'first' multi-event)



R³B 2021 deadline

	Electronics	ME	Deadtime (μs)	Limit (main)	S455	S515	S494
S2	VFTX	N	15		X X	X ?	
S8	VFTX	N	31	Readout (RIO3?)		X ?	
Sofia START	VFTX, (MADC32)	N,Y	9		X X		
Sofia Triple MUSIC	MDPP16	Y	25		X X		
Sofia Twin MUSIC	MDPP16	Y	40		X X		
Sofia TOF wall	VFTX	N	31 (est. 20-25)		X X		
CALIFA	FEBEX3	Y	free-running	35 μ dead/pile-up per ch. ?	X	X	
AMS	SIDEREM+SAM	N	100 ; 300	Readout	X	X	
-	INFN AMS DAQ					X	
Sofia MWPC	VMMR8	Y	27		X X	X	
NeuLAND (12 DP)	FQT+TAMEX3		50	CPU ↔ PEXOR	X (X)	X	
LOS	VFTX		9			X	
LOS	TAMEX		3 ; 15			X	
X5 PSP	FEBEX3		3 ; 43 ?	CPU ↔ PEXOR		X	
R3B MUSIC	MDPP16	Y	20			X	
SiPM fiber vacuum	PaDi+Clock-TDC					X	
Fiber vacuum	PaDi+KILOM/cTDC		3 ; 21	CPU ↔ PEXOR		X	
Fiber end	PaDi+KILOM/cTDC		3 ; 21	CPU ↔ PEXOR		X	
ROLU / SEETRAM / ionis.	Scalers					X	X
R3B TOF wall	FQT+TAMEX3		3 ; 21	CPU ↔ PEXOR		X	X
XY Fiber	PaDi+KILOM/cTDC		3 ; 21	CPU ↔ PEXOR			X
Fibers	PaDi+KILOM/cTDC		3 ; 21	CPU ↔ PEXOR			X
MASTER (trig)	VULOM	Y	13	Readout	X	X	X

Multi-event capable?

Values are for full create readout.

Values from previous year(s)
(need update)
Estimates
Values needed

VME

Second value is until
f_user return
(early DT release)

Limiting
Limiting next readout
(early DT release)
Excluding AMS

R³B 2021 deadline

Deadtime is *not* like bad weather!
It can be addressed!

		ME	Deadtime (μs)	Limit (main)	S455	S515	S494
		N	15		X X	X ?	
S8	VFTX	N	31	Readout (RIO3?)		X ?	
Sofia START	VFTX, (MADC32)	N,Y	9		X X		
Sofia Triple MUSIC	MDPP16	Y	25		X X		
Sofia Twin MUSIC	MDPP16	Y	40		X X		
Sofia TOF wall	VFTX	N	31 (est. 20-25)		X X		
CALIFA	FEBEX3	Y	free-running	35 μd a. p. e-up per ch. ?	X	X	
AMS	SIDEREM+SAM	N	100 ; 300	Readout	X	X	
-	INFN AMS DAQ					X	
Sofia MWPC	VMMR8	Y	27		X X	X	
NeuLAND (12 DP)	FQT+TAMEX3		50	CPU ↔ PEXOR	X (X)	X	
LOS			9			X	
LOS			3 ; 15			X	
X5 PSP			3 ; 43 ?	CPU ↔ PEXOR		X	
R3B MUSIC		Y	20			X	
SiPM fiber vacuum	PaDi+KILOM/cTDC					X	
Fiber vacuum	PaDi+KILOM/cTDC		3 ; 21	CPU ↔ PEXOR		X	
Fiber end	PaDi+KILOM/cTDC		3 ; 21			X	
ROLU / SEETRAM / ionis.	Scale					X	X
R3B TOF wall	Fibers		3 ; 21			X	X
XY Fiber	Fibers		3 ; 21	CPU ↔ PEXOR			X
Fibers	Fibers		3 ; 21	CPU ↔ PEXOR			X
MASTER (trig)	VULOM	Y	13	Readout	X	X	X

Multi-event capable?

Values are for full create readout.

200?
DSP code?

3; 50
early DT
release

Needs
debug
(with beam??)

10?
VME CPU

Also affects
; ~ 15
PEXOR
firmware

EE dev.

X
X
X
X

Values from previous year(s)
(need update)
Estimates
Values needed

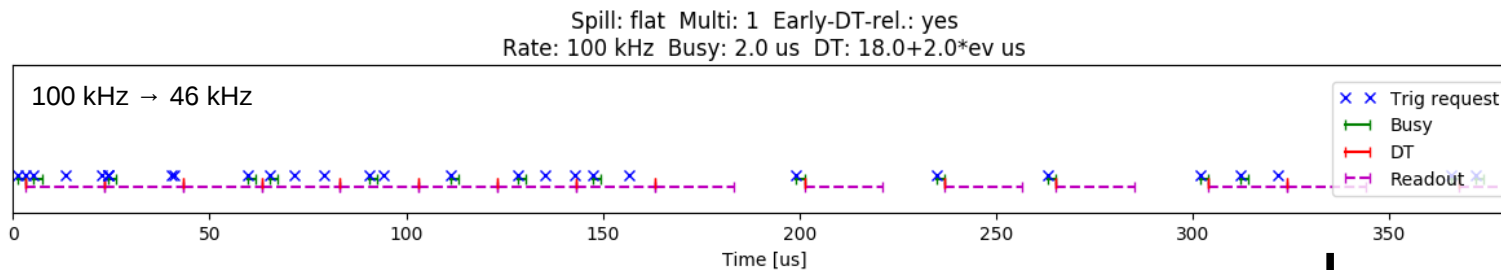
Second value is until
f_user return
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Limiting
Limiting next readout
(early DT release)

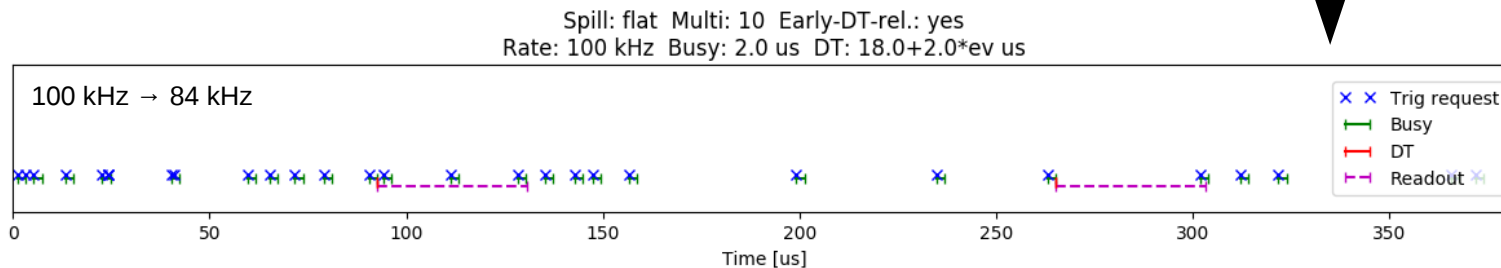
VME

S494 - ^{16}O breakup

- High-rate experiment: 100 kHz M. Heil; even a few 100 kHz...
- Only two kinds of systems: KILOM TAMEX = third event not before 20 μs
- Assume early DT-release after 2 μs , readout 20 μs .



- Multi-event (10 events):



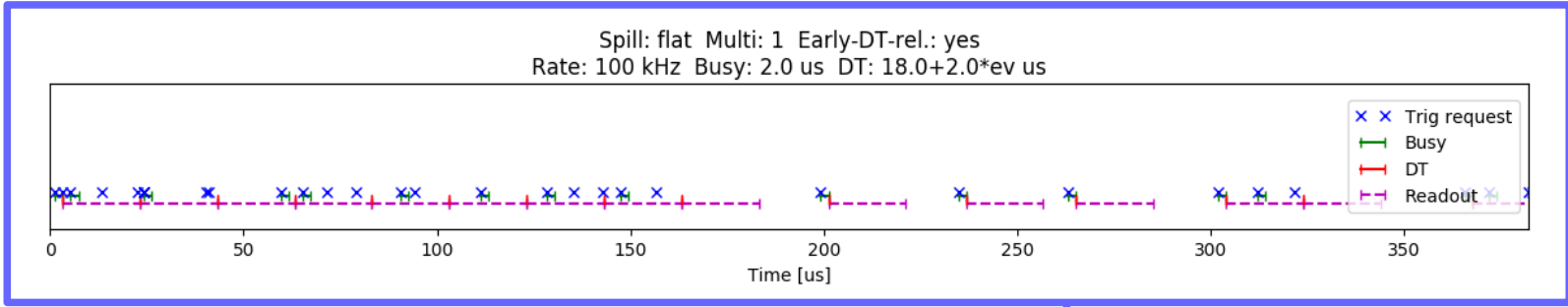
+ 80 %

Needed:

Readout
buffer

2
n

- Bonus: Good for evil spill structure.



Trigger request rate

Spill burst: flat Busy: 2.0 us

Multi: 1 ___no early DT-rel. ___

rate \ tDT (Hz) \ (us)	5.0	10.0	15.0	20.0
100k	58.8	45.4	37.0	31.2
200k	41.7	29.4	22.8	18.5
300k	32.2	21.7	16.4	13.2

___early DT-rel. ___

rate \ tDT (Hz) \ (us)	5.0	10.0	15.0	20.0
100k	80.4	68.8	56.4	46.2
200k	64.5	45.5	32.5	24.8
300k	52.5	32.4	22.1	16.7

Read-out time

Accepted trigger fraction (%)

Multi-ev. buffer size

Multi: 10 ___no early DT-rel. ___

rate \ tDT (Hz) \ (us)	5.0	10.0	15.0	20.0
100k	69.8	67.4	65.2	63.2
200k	53.6	51.0	48.6	46.2
300k	43.6	41.0	38.6	36.5

___early DT-rel. ___

rate \ tDT (Hz) \ (us)	5.0	10.0	15.0	20.0
100k	83.2	83.2	83.2	83.2
200k	71.4	71.4	71.4	71.4
300k	62.5	62.5	62.5	62.3

Multi: 100 ___no early DT-rel. ___

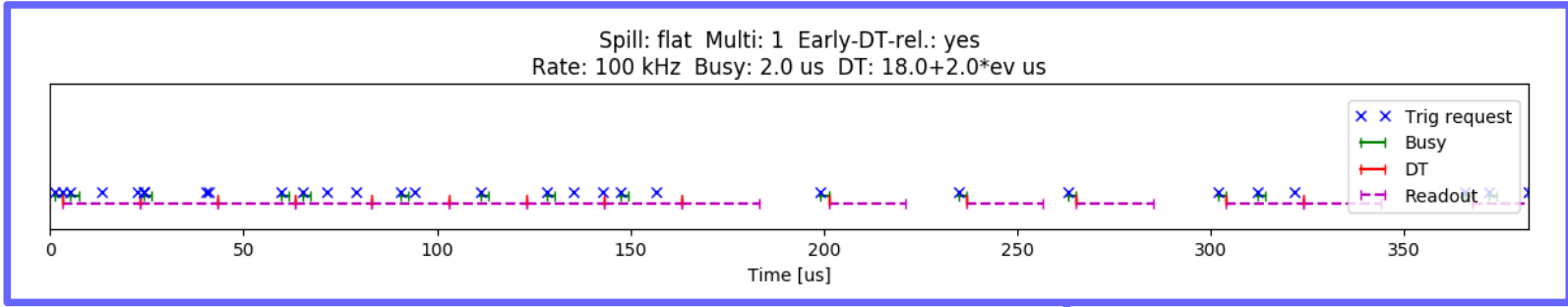
rate \ tDT (Hz) \ (us)	5.0	10.0	15.0	20.0
100k	71.2	70.9	70.6	70.4
200k	55.5	55.1	54.7	54.3
300k	45.3	45.0	44.7	44.2

___early DT-rel. ___

rate \ tDT (Hz) \ (us)	5.0	10.0	15.0	20.0
100k	83.2	83.2	83.2	83.2
200k	71.4	71.4	71.4	71.4
300k	62.5	62.5	62.5	62.5

Trigger request rate

Multi-ev. buffer size



Spill burst: flat Busy: 2.0 us

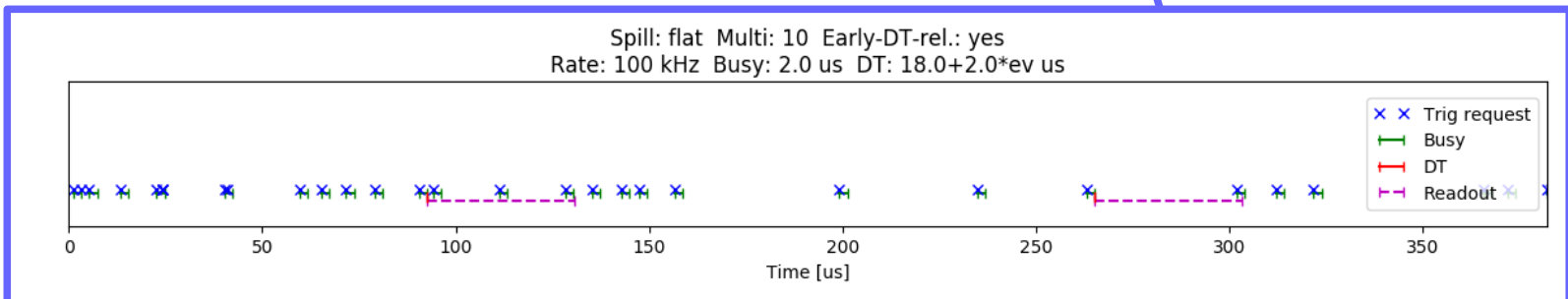
PEXOR improvement

Read-out time

Accepted trigger fraction (%)

Going multi-ev.

Multi:		no early DT-rel.				early DT-rel.			
rate \ tDT	(Hz) \ (us)	5.0	10.0	15.0	20.0	5.0	10.0	15.0	20.0
100k		58.8	45.4	37.0	31.2	80.4	68.8	56.4	46.2
200k		41.7	29.4	22.8	18.5	64.5	45.5	32.5	24.8
300k		32.2	21.7	16.4	13.2	52.5	32.4	22.1	16.7
10									
rate \ tDT	(Hz) \ (us)	5.0	10.0	15.0	20.0	5.0	10.0	15.0	20.0
100k		69.8	67.4	65.2	63.2	83.2	83.2	83.2	83.2
200k		53.6	51.0	48.6	46.2	71.4	71.4	71.4	71.4
300k		43.6	41.0	38.6	36.5	62.5	62.5	62.5	62.3
100									
rate \ tDT	(Hz) \ (us)	5.0	10.0	15.0	20.0	5.0	10.0	15.0	20.0
100k		71.2	70.9	70.6	70.4	83.2	83.2	83.2	83.2
200k		55.5	55.1	54.7	54.3	71.4	71.4	71.4	71.4
300k		45.3	45.0	44.7	44.2	62.5	62.5	62.5	62.5



S494 - ^{16}O breakup

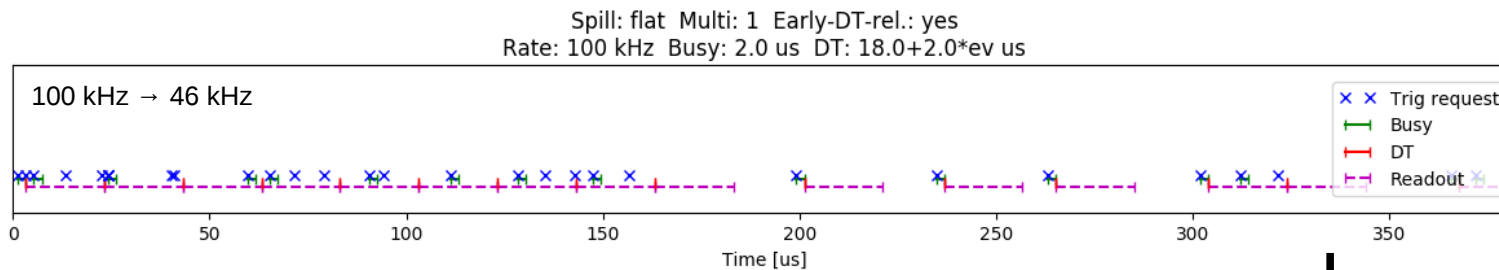
- High-rate experiment: 100 kHz

M. Heil; even a few 100 kHz...

- Only two kinds of systems: KILOM TAMEX

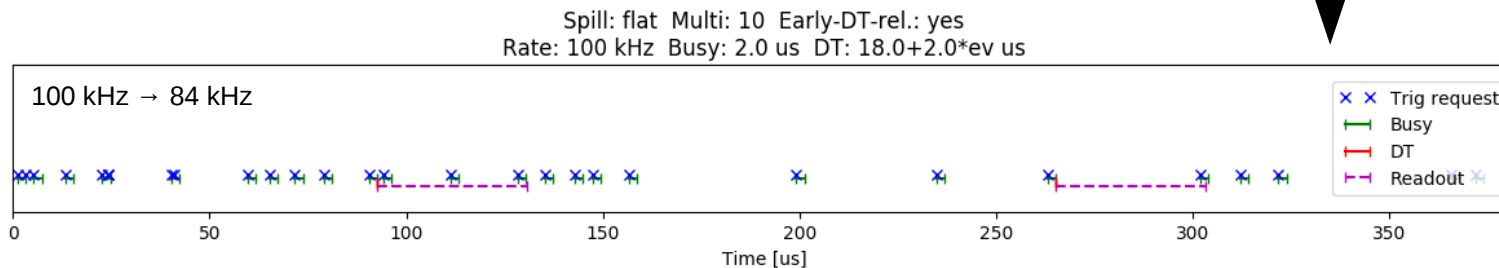
= third event not before 20 μs

- Assume early DT-release after 2 μs , readout 20 μs .



- Multi-event (10 events):

+ 80 %



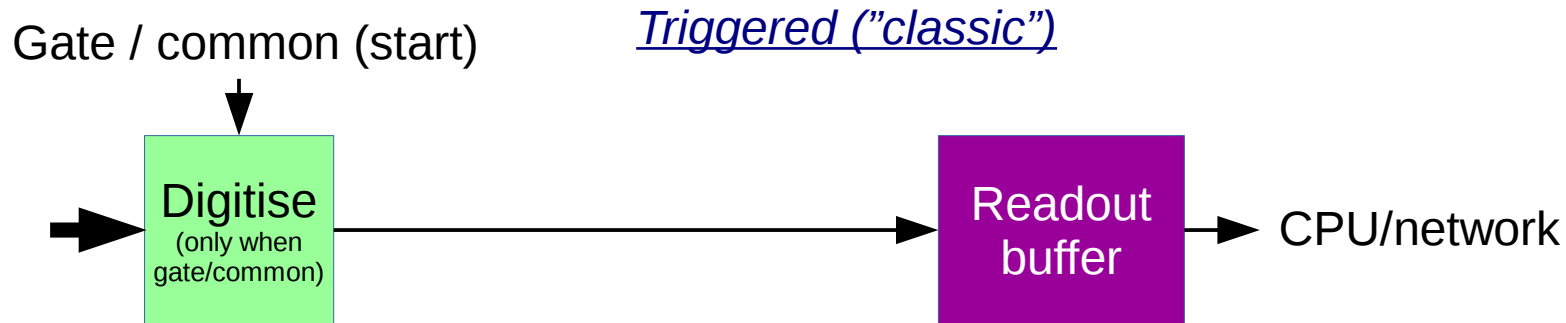
Needed:

Readout
buffer

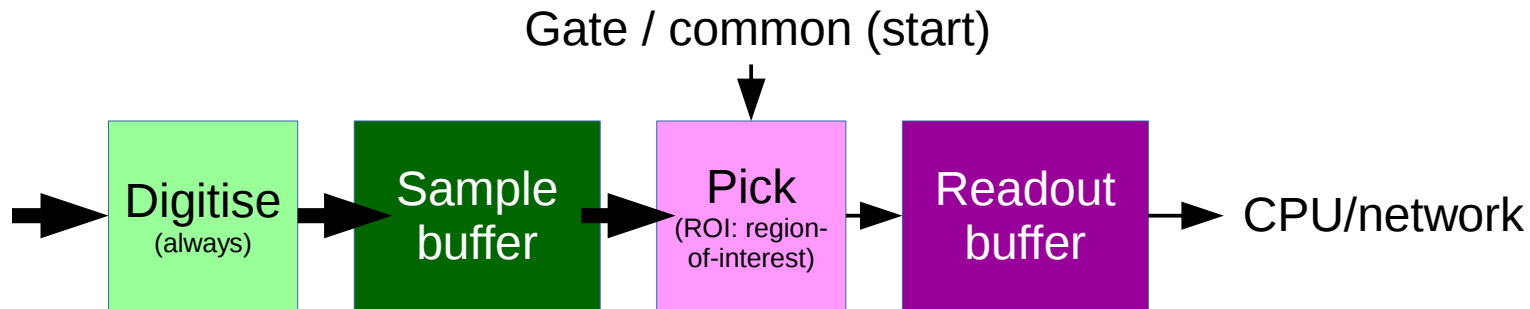
2
n

- Bonus: Good for evil spill structure.

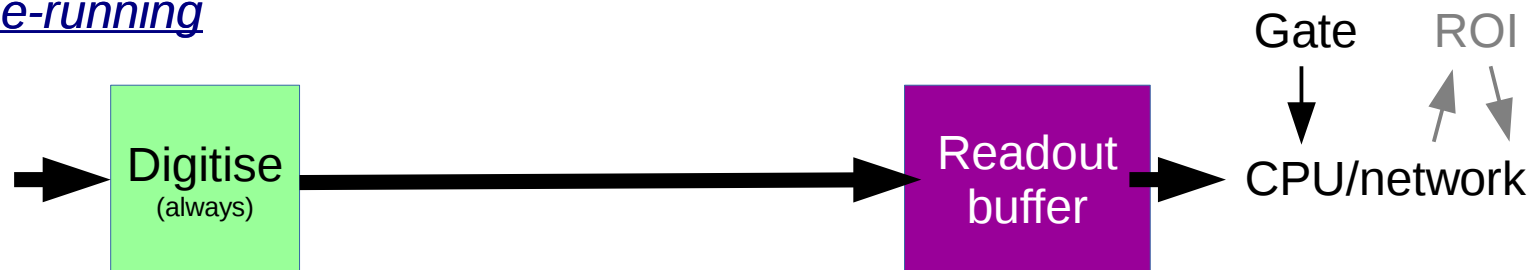
Data flow / Buffer topology



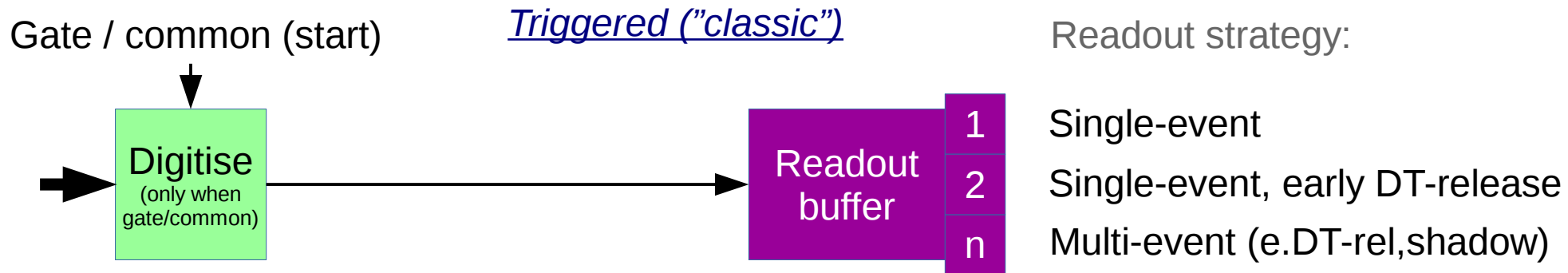
Triggered, free-running front-end



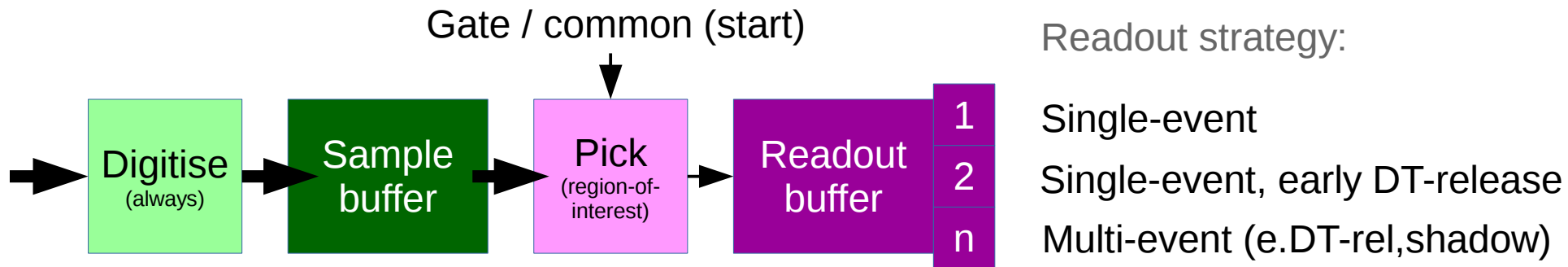
Free-running



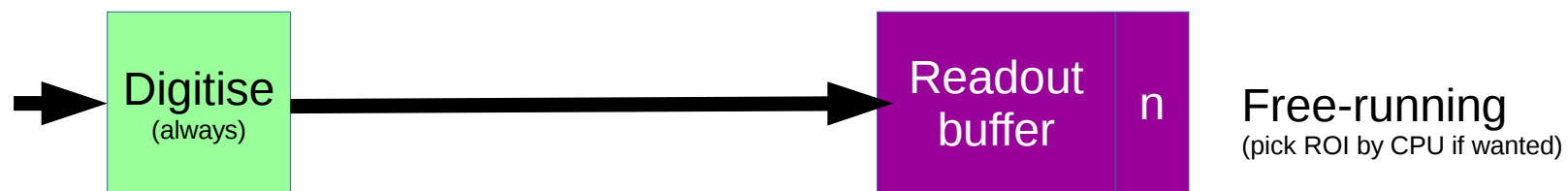
Data flow / Buffer topology



Triggered, free-running front-end



Free-running



Data flow / Buffer topology

