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Study of track separation capability for a MPGD-based TPC

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on behalf of the LCTPC–Asia group

2-hit resolution（2-track separation）

- A MPGD-based TPC can provide clearly track separation thanks to its small ExB effect compared with MWPC.
- We’re trying to investigate 2-track separation for a GEM-based TPC using electron beam.

Table III-2.4
Performance and design parameters for the TPC with standard electronics and pad readout.

Parameter	
Geometrical parameters	r_{in} = 329 mm, r_{out} = 1808 mm, z = $\pm$ 2350 mm
Solid angle coverage	up to $\cos\theta \simeq 0.98$ (10 pad rows)
TPC material budget	$\simeq 0.05\ X_0$ including outer fieldcage in r
	$< 0.25\ X_0$ for readout endcaps in z
Number of pads/timebuckets	$\simeq$ 1-2 $\times 10^6$/1000 per endcap
Pad pitch/ no.padrows	$\simeq 1\times 6$ mm^2 for 220 padrows
σ_{point} in $r\phi$	$\simeq$ 60 μm for zero drift, $<$ 100 μm overall
σ_{point} in rz	$\simeq 0.4 - 1.4$ mm (for zero – full drift)
2-hit resolution in $r\phi$	$\simeq$ 2 mm
2-hit resolution in rz	$\simeq$ 6 mm
dE/dx resolution	$\simeq$ 5 %
Momentum resolution at B=3.5 T	$\delta(1/p_t) \simeq 10^{-4}$/GeV/c (TPC only)

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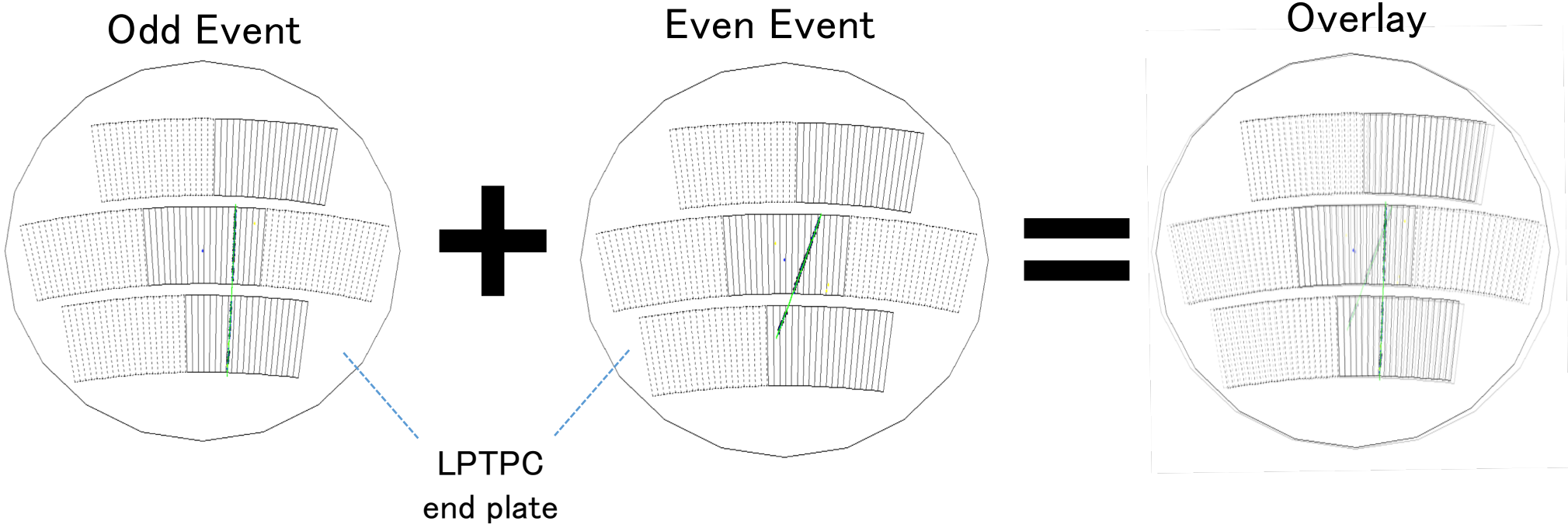
Idea for increasing multi track events

But, there is not much multi-track for each event …

Idea

Produce a pseudo multi-track event
merging two events (overlay)

(Example)



Merge method

1. Using SelectNthEventProcessor (MarlinTPC),

⋮

Select a number n to use only every nth event. So all further processors will not process the skipped events.

SelectNthEventProcessor.cc Code URL:
https://ilcsoft.desy.de/MarlinTPC/current/doc/html/SelectNthEventsProcessor_8cc_source.html

2. Using OverlayProcessor (ilcsoft),

⋮

OverlayProcessor is used to overlay the pure simulation event data with the beam background noise data for the ILD simulation.

Overlay.cc Code URL:
https://github.com/iLCSoft/Overlay/blob/master/src/Overlay.cc

Merge method

1. Using SelectNthEventProcessor (MarlinTPC),
   produce Odd event slcio file and Even event slcio file

1 3 5 7 ⋯ 2 4 6 8 ⋯

SelectNthEventProcessor.cc Code URL:
https://ilcsoft.desy.de/MarlinTPC/current/doc/html/SelectNthEventsProcessor_8cc_source.html

2. Using OverlayProcessor (ilcsoft), merge two slcio files

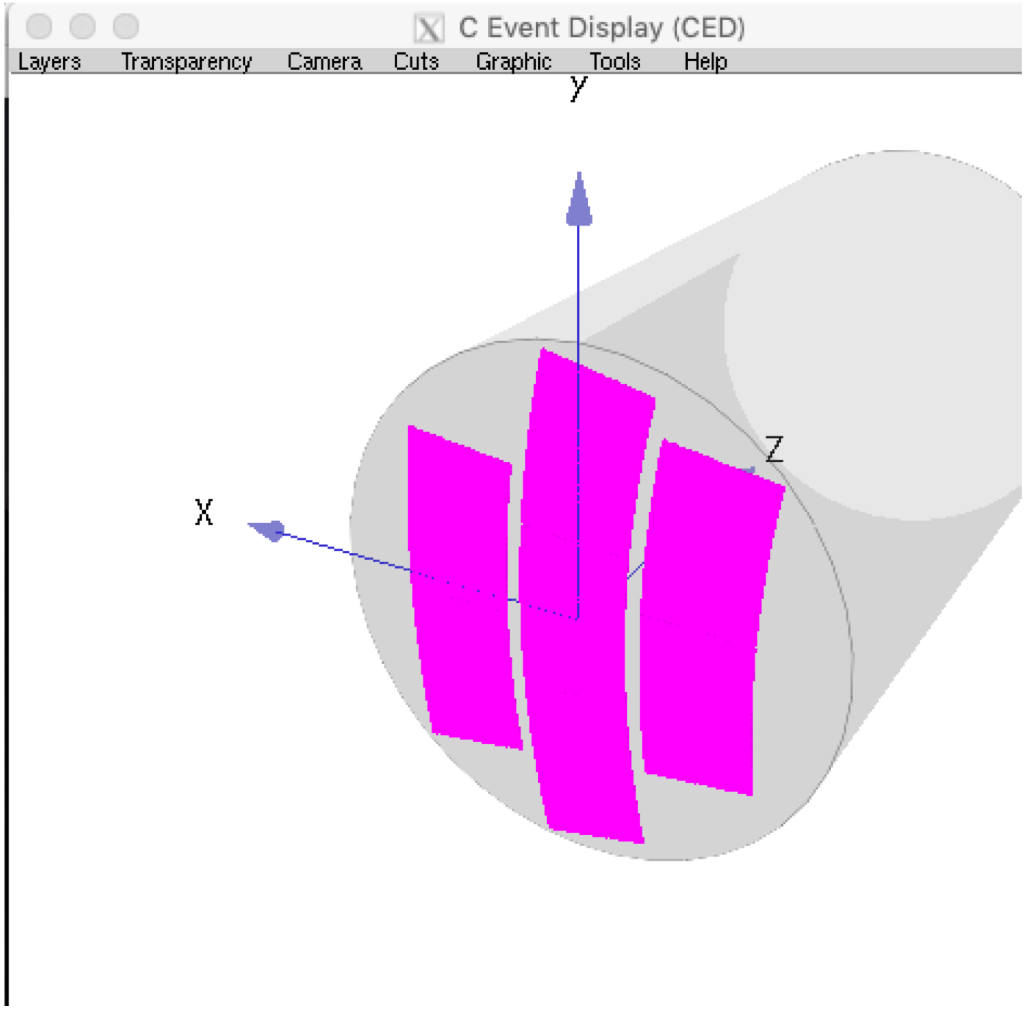
OverlayProcessor can only overlay data at hit level object.

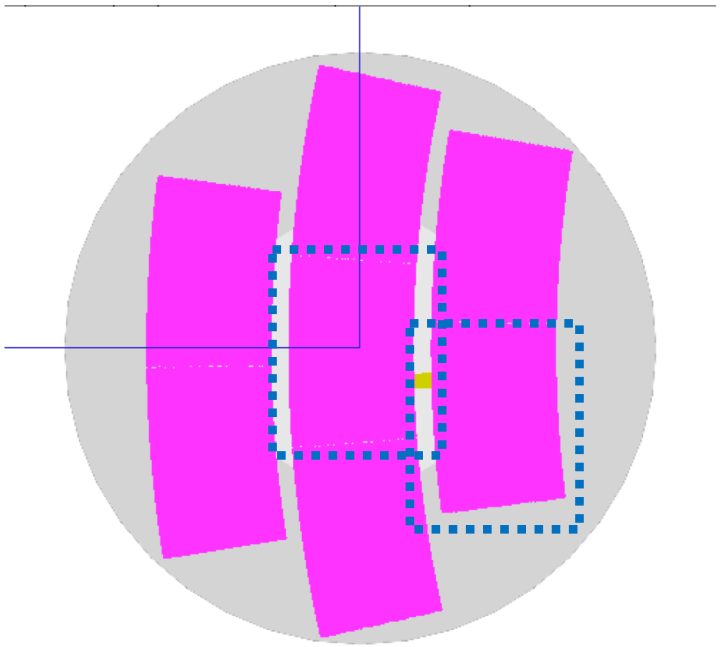
⇒ Firstly, as the test, merge at hit level

Overlay.cc Code URL:
https://github.com/iLCSoft/Overlay/blob/master/src/Overlay.cc

Event display check

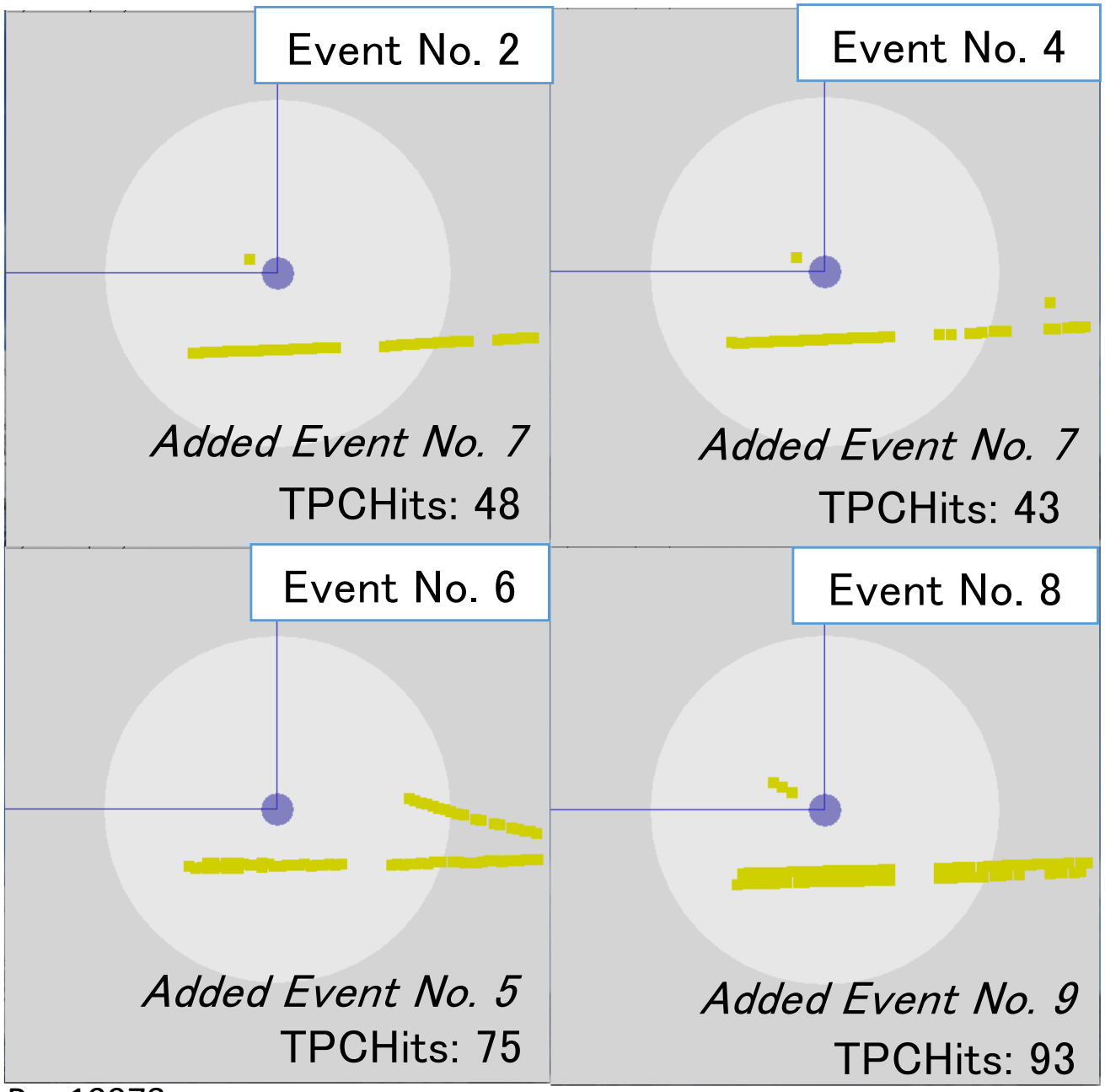
- Simple check of overlaid track using LCTPCViewer in MarlinTPC and the number of hits
- Use the odd event number file (evt No. 1, 3, 5, 7, 9) and the even event number file (evt No. 2, 4, 6, 8)





Readout area

Overlaid event display at hit level



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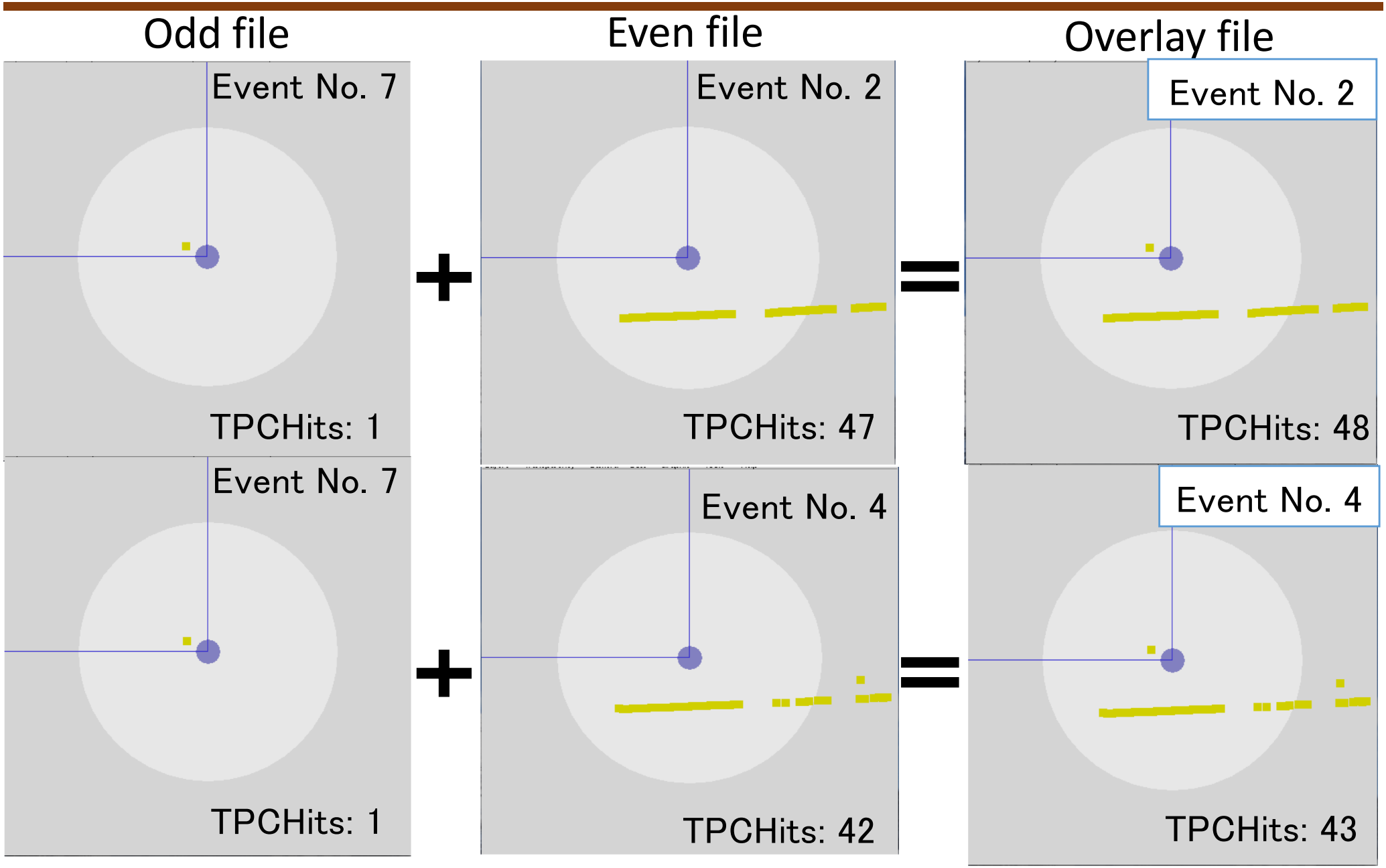
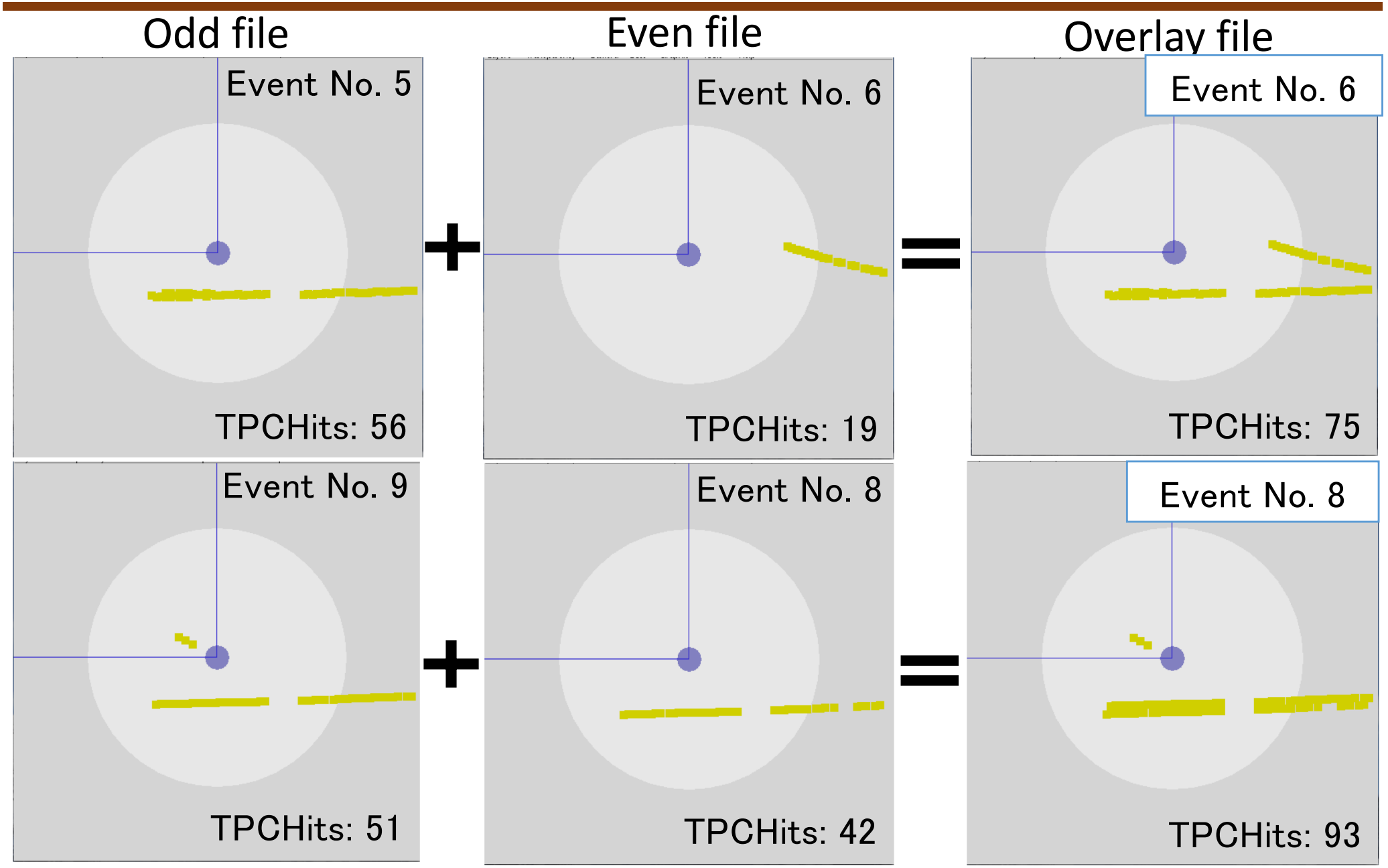
- The even event number was kept because the odd file was overlaid “on” the even file.
- The added event number seems to be determined by a random number.

Event display at hit level



Tracks(hit) are overlaid and the sum of hits is consistent.

Event display at hit level

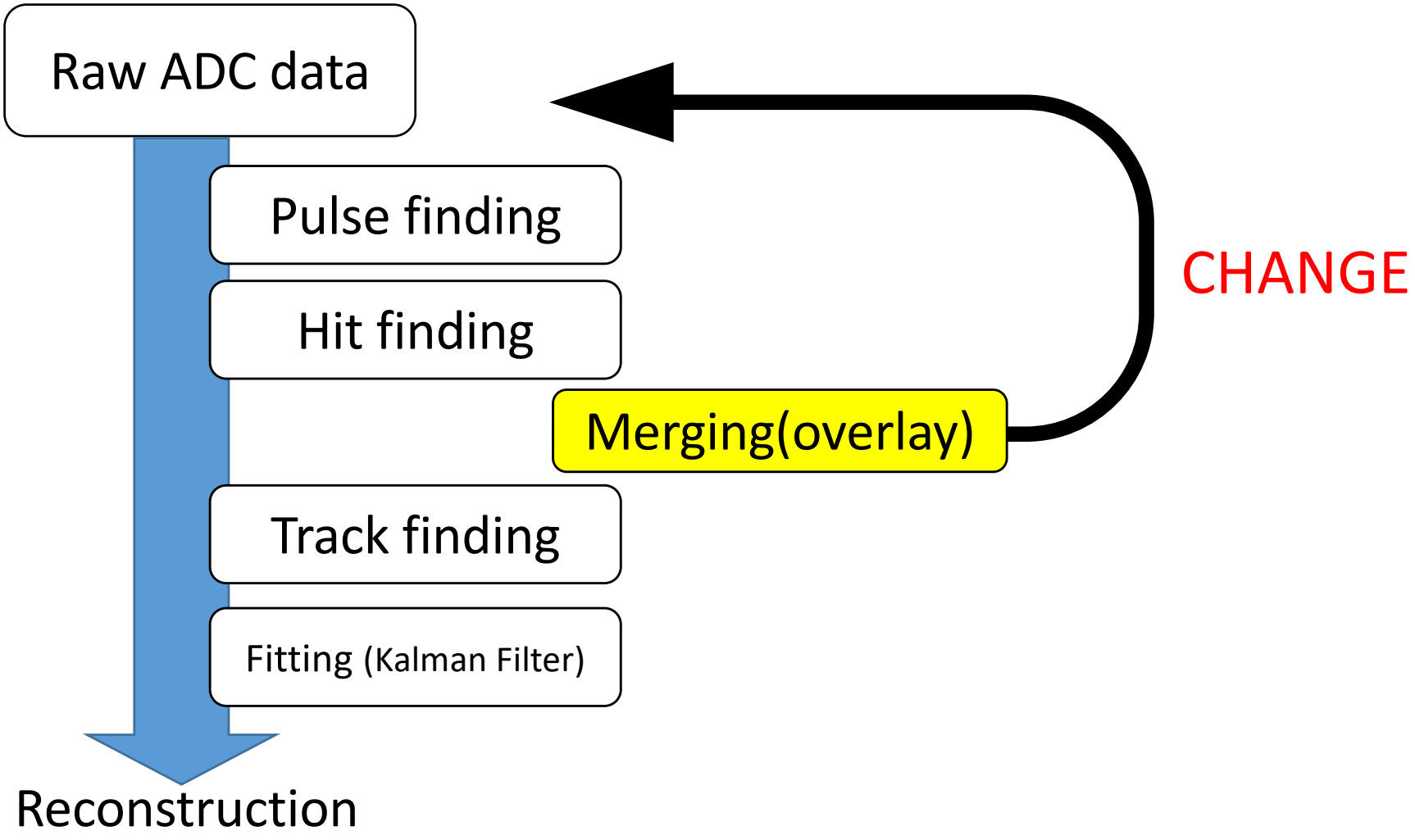


Tracks are overlaid and the sum of hits is consistent.

Issue of merge level

Merging at the hit level, it is probably unable to evaluate 2 track separation properly.

Coding so that Overlay Processor can be merged at raw data level.



Event number and Number of elements

- The number of raw data was checked using anajob command.
- The sum of the number of raw data is consistent.

▼Event number & Number of elements in original data

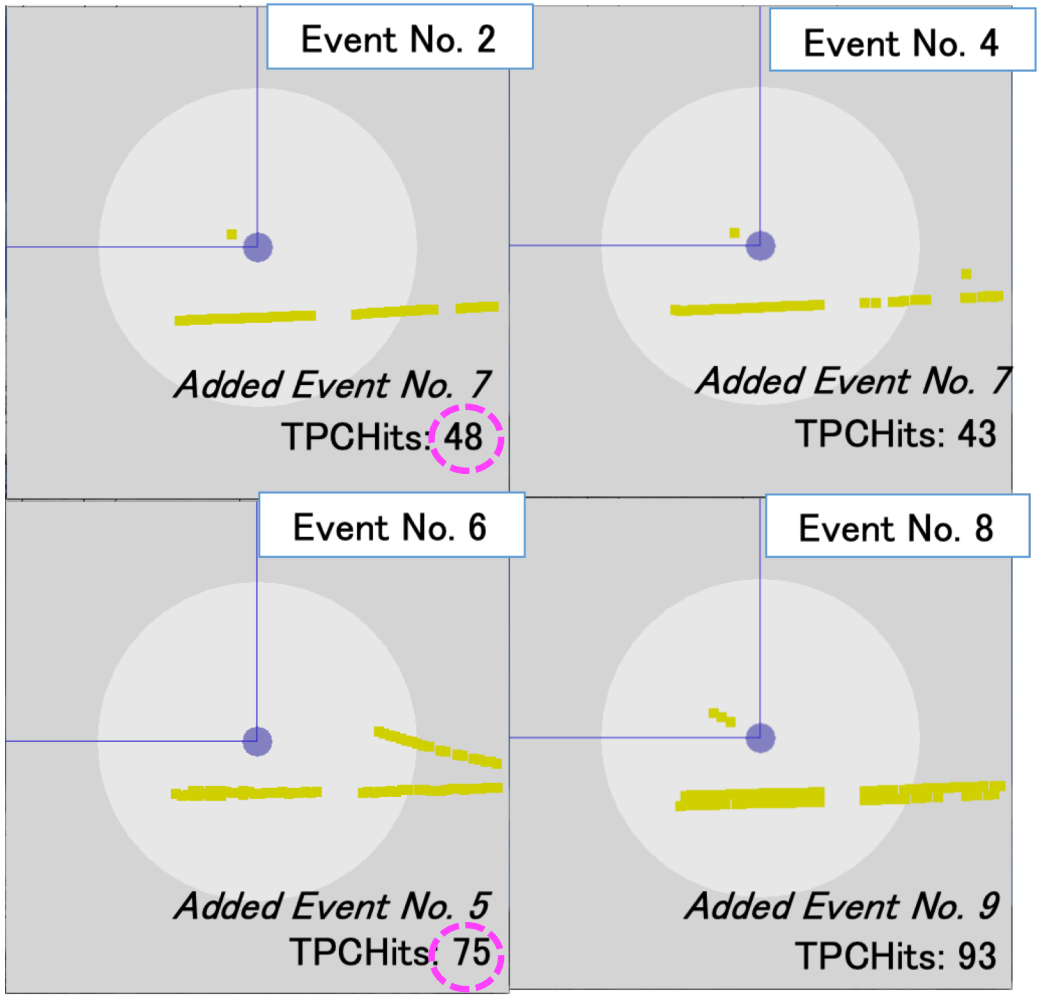
Event No.	1	2	3	4	5	6	7	8	9
RawData	704	731	764	661	861	684	523	766	684
Hit	50	57	53	42	56	19	1	42	51

▼ Event number & Number of elements (RawData) in overlay data at rawdata level

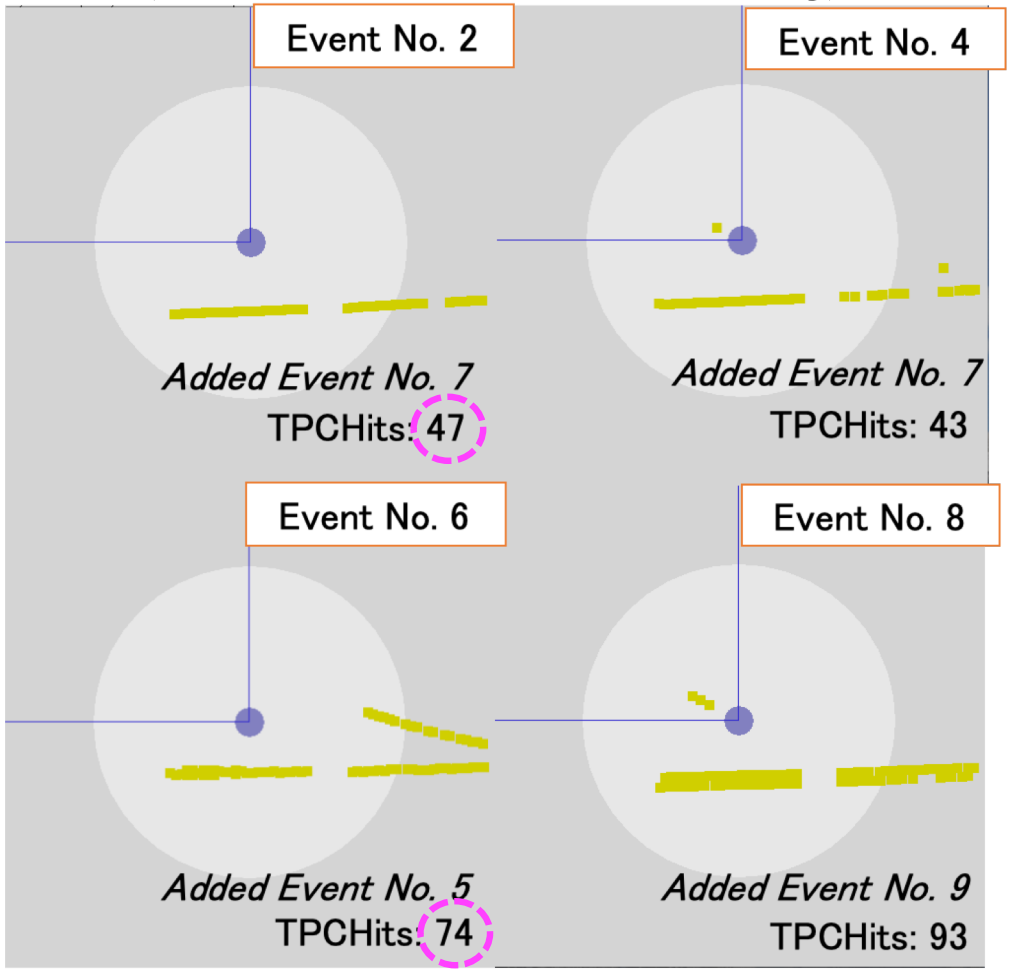
Event No.		2		4		6		8	
Added Event No.		7		7		5		9	
RawData		1254		1184		1545		1450	
Expectation		731+523 =1254		661+523 =1184		684+861 =1545		766+684 =1450	

Event display using hits

▼Merging at hit level



▼Merging at raw data level
(below means after hit finding)



Merging at hit level and raw data level has slightly different track shapes and the number of hits.

Summary and prospect

- We're trying to investigate 2-track separation for a GEM-based TPC using electron beam.
- Since there is not much multi-track for each event, we have produced a pseudo multi-track event merging two events.

- Merging at hit level was succeeded.
- Coding so that Overlay Processor can be merged at raw data level.
- It seems to be able to merge, but probably it is not merge ADC values.

  → merge the ADC value at same cellID

Thank you for your attention.

Back up

Processor on Marlin TPC

TrackerRawDataToDataConverterProcessor
PulseFinderProcessor
ChannelMappingProcessor
RowBasedHitFinderProcessor
TrackMakingKalmanFilterProcessor
SelectNthEventProcessor
OverlayProcessor

▼**Reconstruction Flow**