



Continuous Readout Simulation with FairRoot for the PANDA Experiment

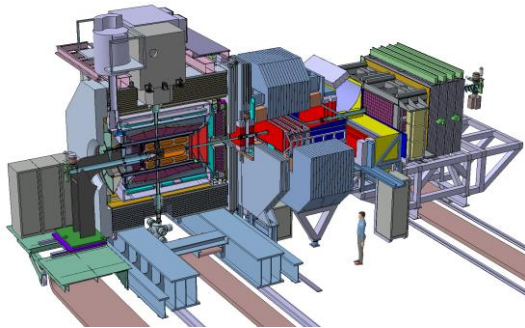
14. April 2015

Tobias Stockmanns

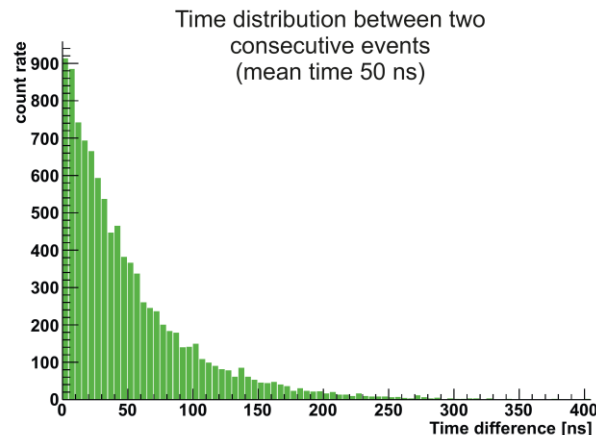
on behalf of the PANDA Collaboration and the FairRoot Team



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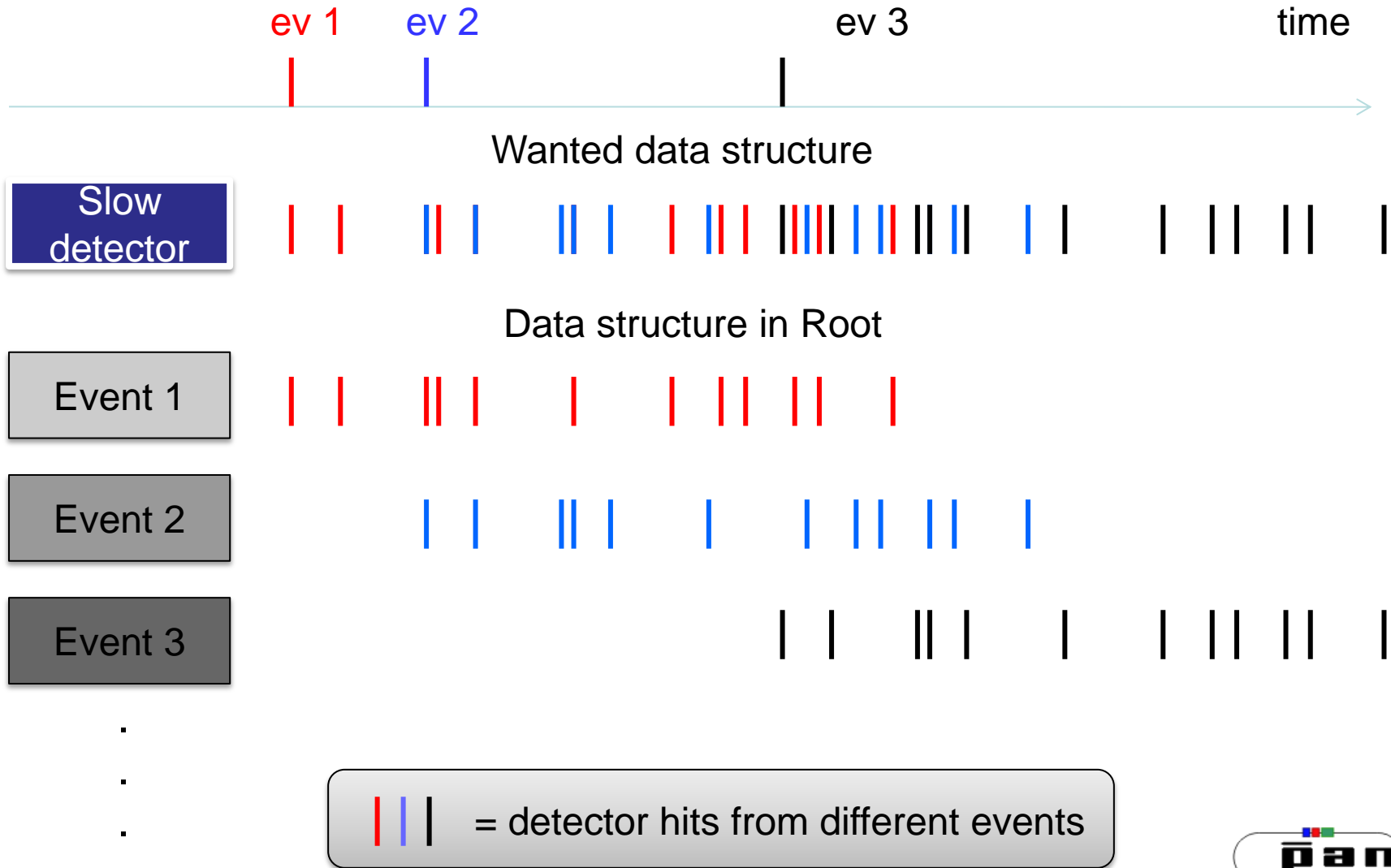


- Antiproton beam at proton target <math>< 15 \text{ GeV}/c</math>
- Signal and background-events very similar → no hardware trigger possible
- Quasi continuous beam with maximum interaction rate of 20 MHz → Poisson distribution
- Raw data rate of 200 GByte/s
- Reduction of 1000 needed for permanent storage $O(\text{PByte}/\text{year})$ → Online Event Filter
- Simulation of event overlap needed in FairRoot-Framework (ALFA)



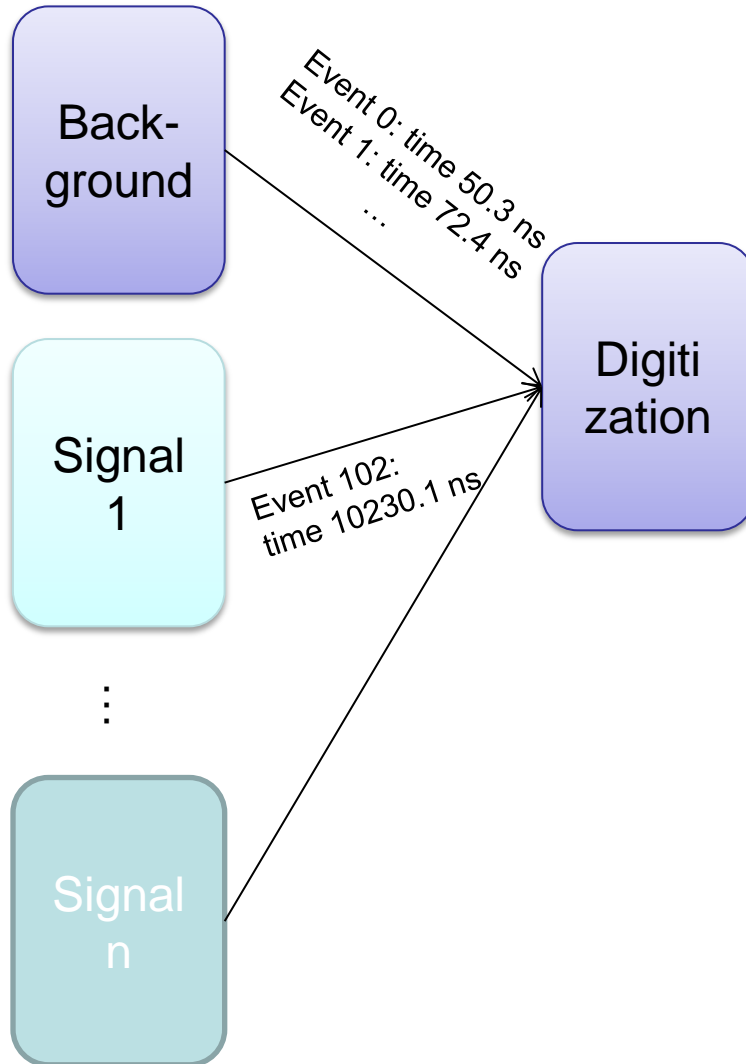
F. Uhlig 14/4/15 15:15
M. Al-Turany 14/4/15 15:30

Event Structure and Detector Response



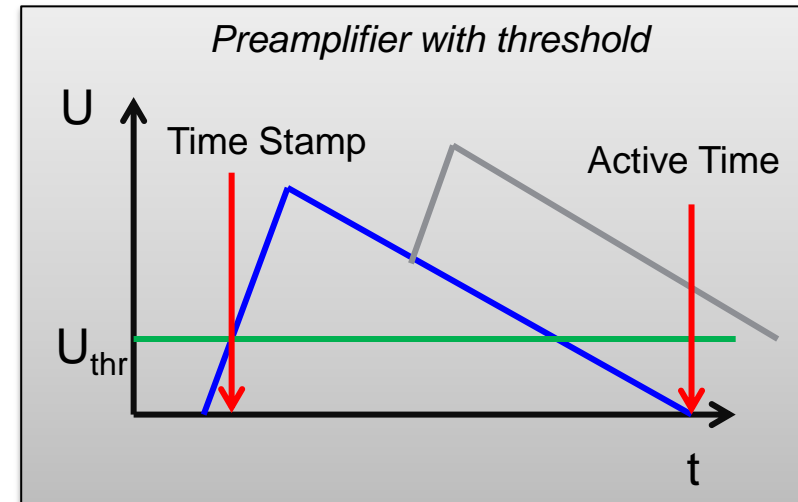
- 3 Stage approach:
 - Each event gets an event time generated after the simulation stage
 - In the digitization stage a buffer is introduced which keeps the data beyond an event boundary
 - In the reconstruction stage data is not retrieved event-by-event but based on time information

MC Files:



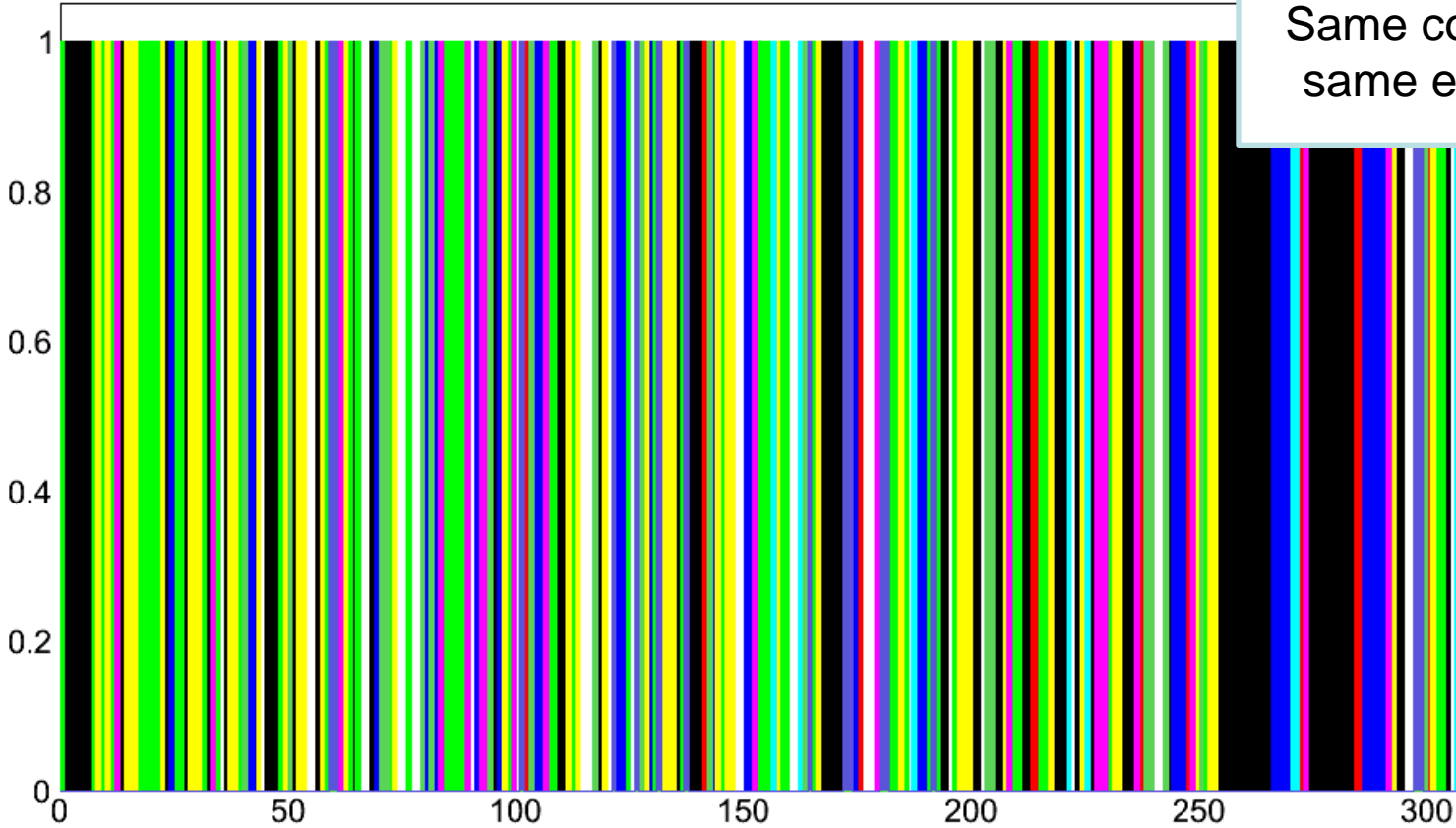
- MC file does not know anything about time structure
- Time structure is calculated at the beginning of digitization
- Many different signal files can be added to one background file

- Special buffer to store detector digis between events
- Stores data as long as it can influence later events (*Active Time*)
- Modifies the data if a detector element is hit a second time (*pile-up*)
- If time of new event is after *Active Time* the data is written to file
- Result is a randomized data stream for further processing
- Mimics realistic detector response



Digi Data Randomized

Digi Data Stream

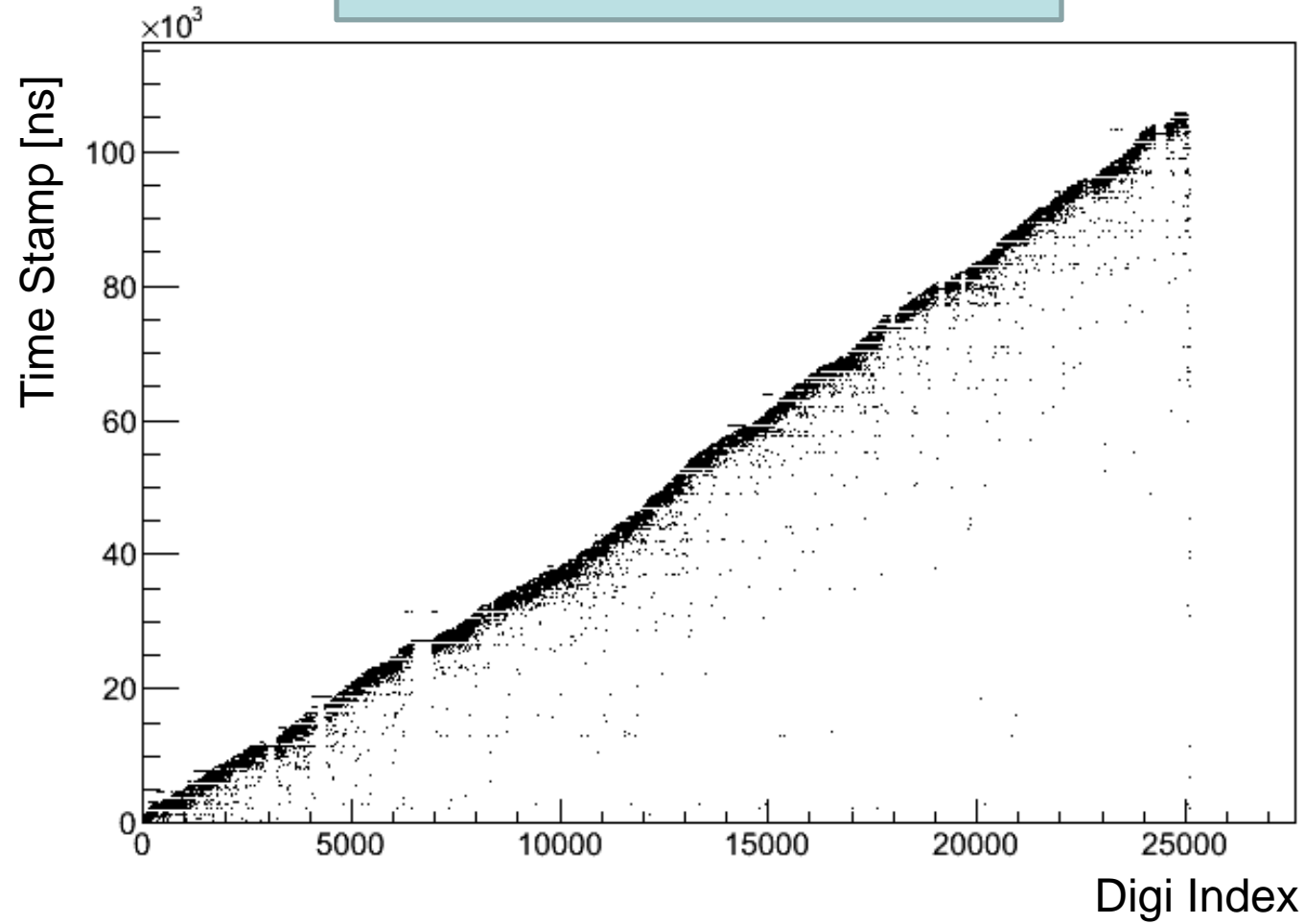


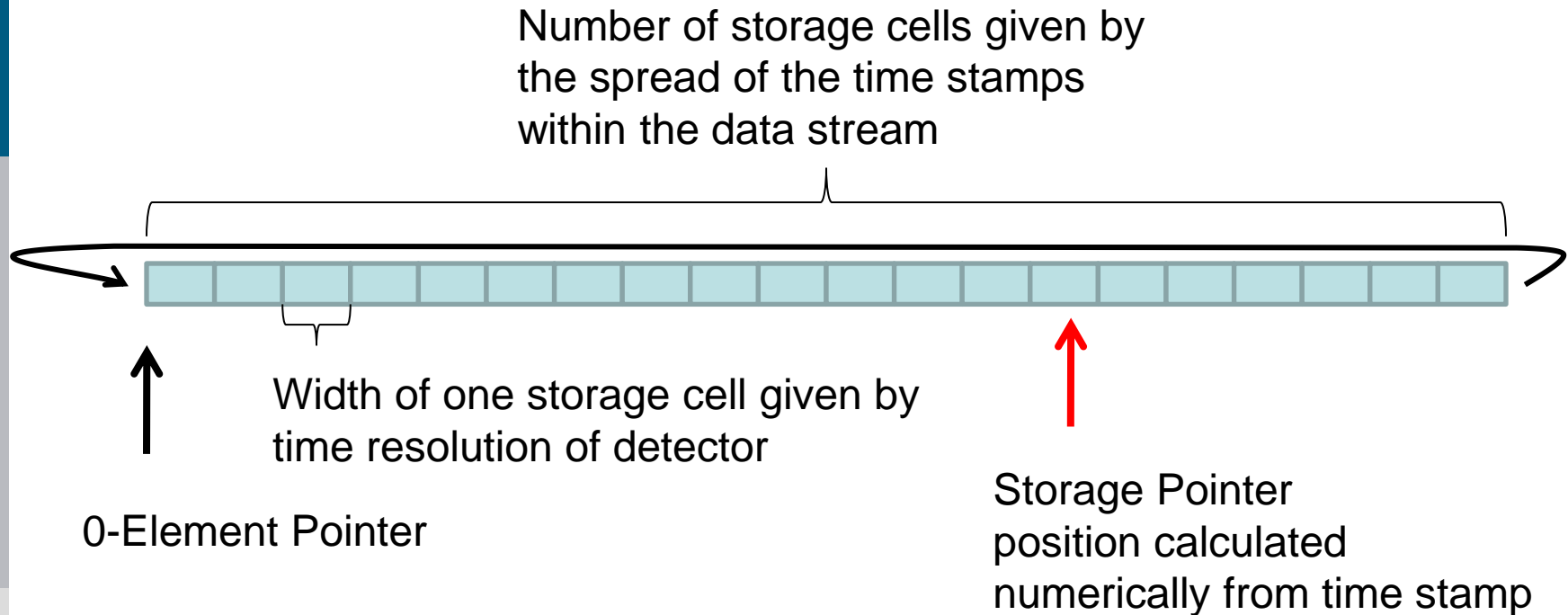
Same color =
same event

Digi Index



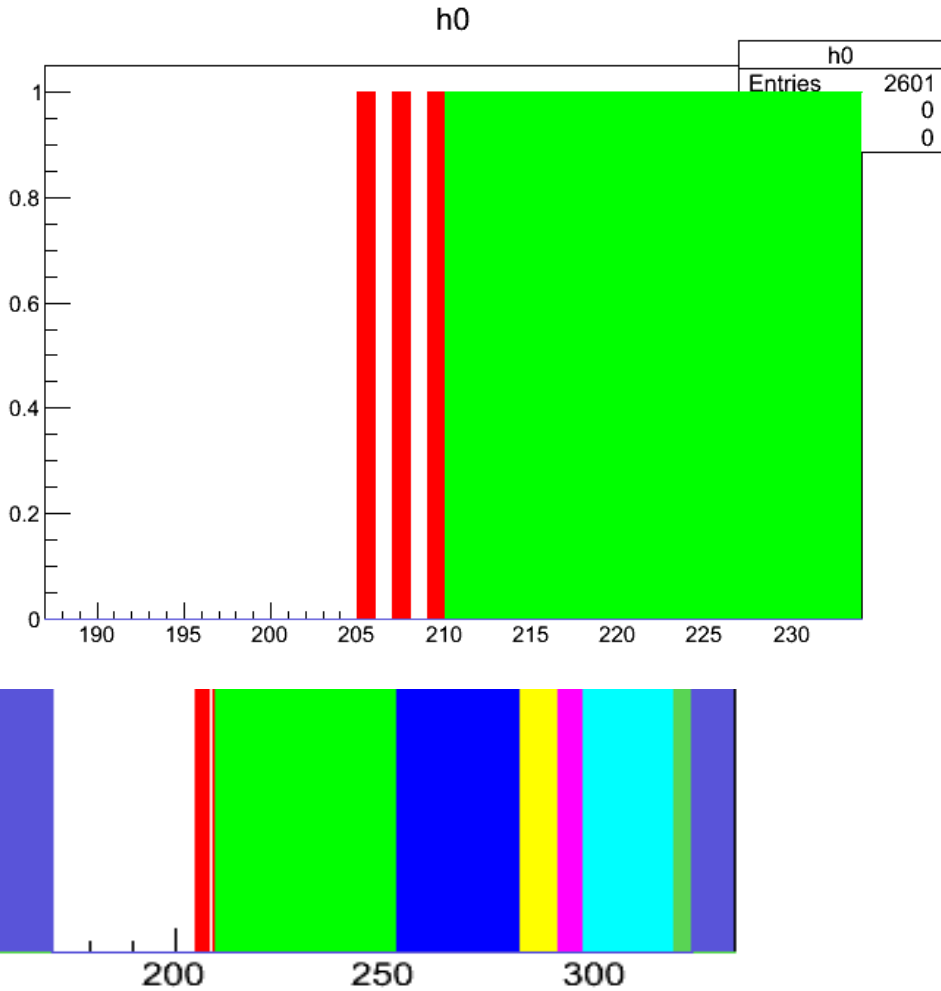
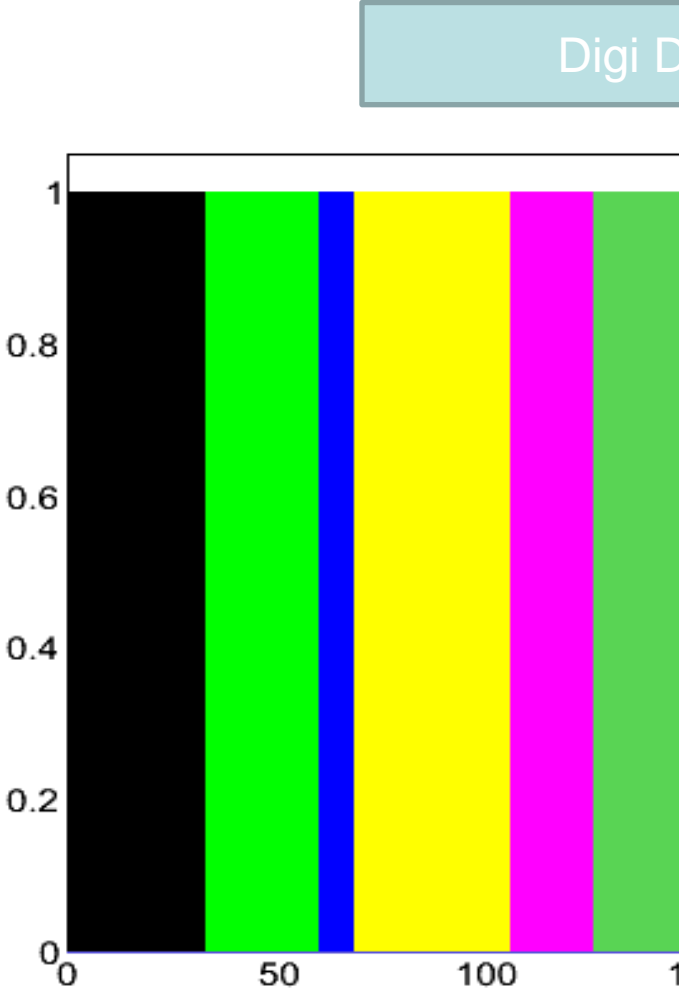
TimeStamp of Digi vs Index





If a storage position is calculated which would override old data, the old data is saved to disk and the storage cell is freed

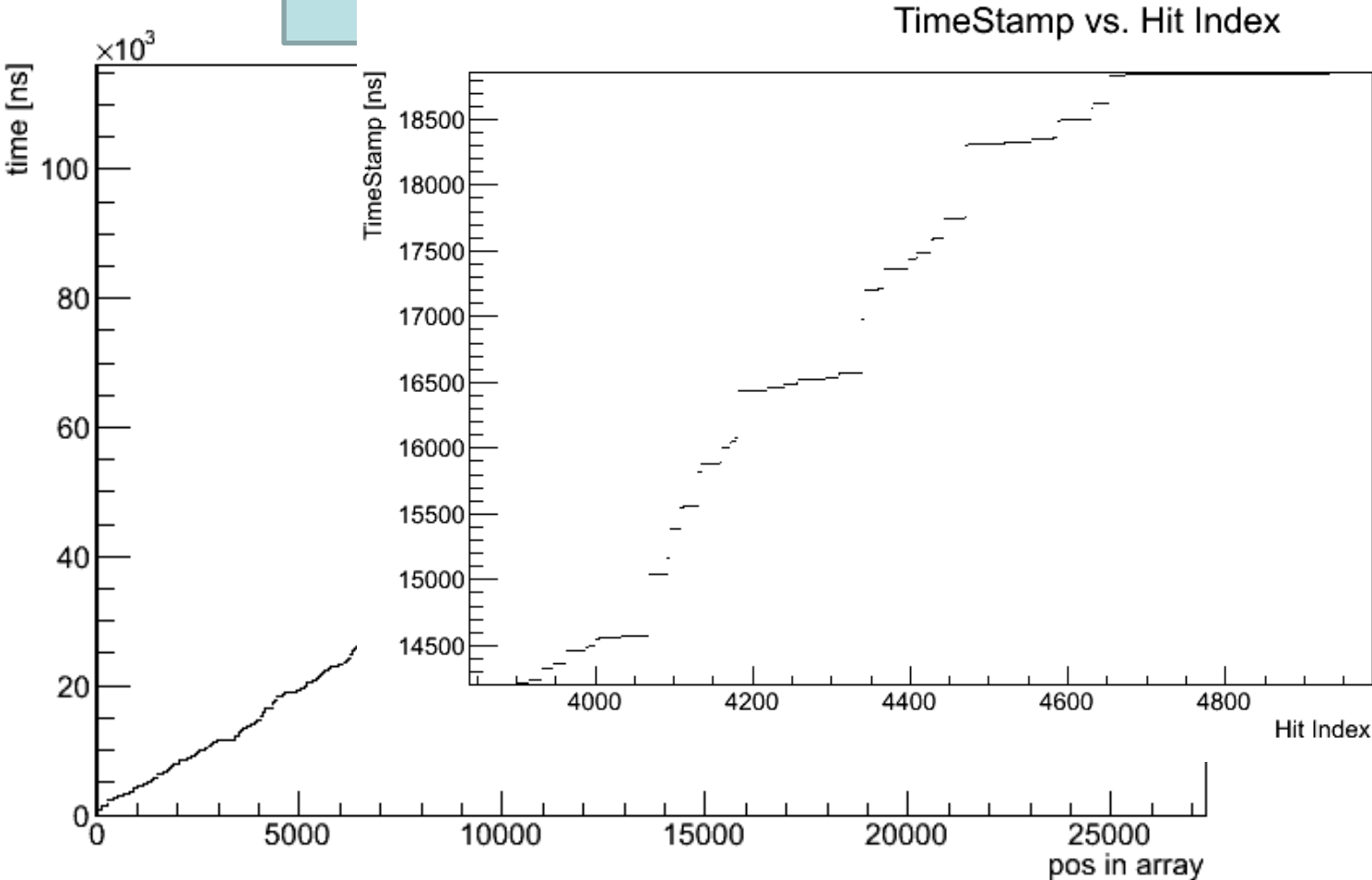
Digi Data Sorted



Digi Index



TimeStamp of Digi vs Index after



- Two different methods exists

```
FairRootManager::GetData (BranchName, Functor, Parameter);
```

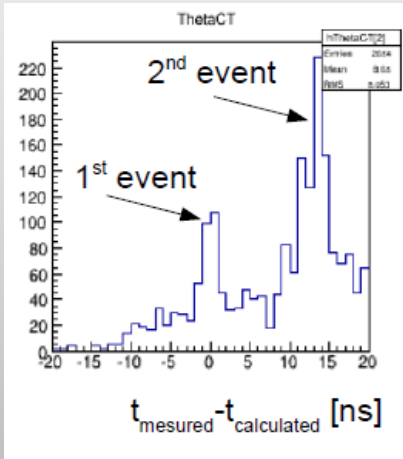
```
FairRootManager::GetData (BranchName, StartFunctor, StartParam,  
                             StopFunctor, StopParam);
```

- GetData with one functor/parameter runs always forward in time
 - Data is only read once
- GetData with two sets of functor/parameter is able to get data within a time window
 - Data can be extracted many times

- Different algorithms available to extract data:
 - All data up to a given time
 - All data in a time window
 - All data between timegaps of a certain size
- Other algorithms can be (easily) implemented

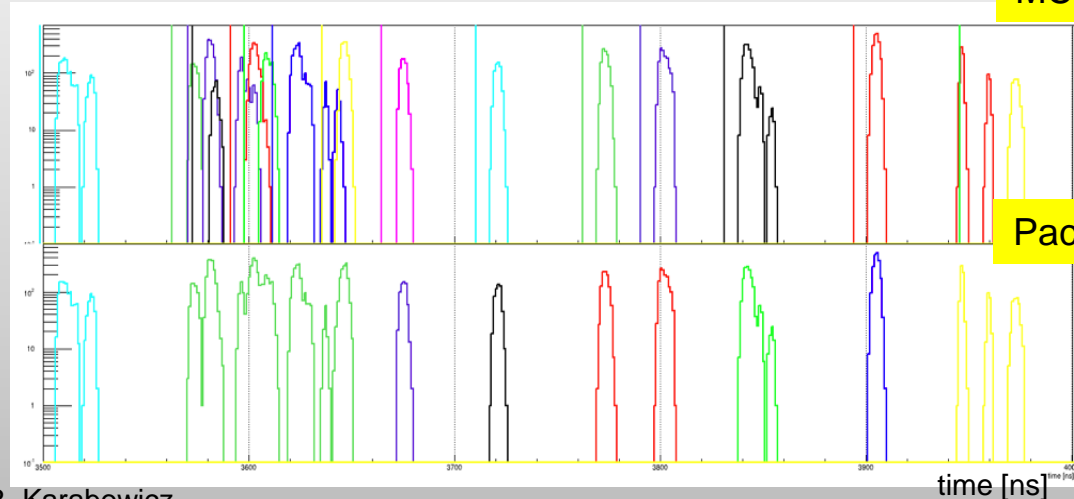
EXAMPLES

DIRC Pile-Up



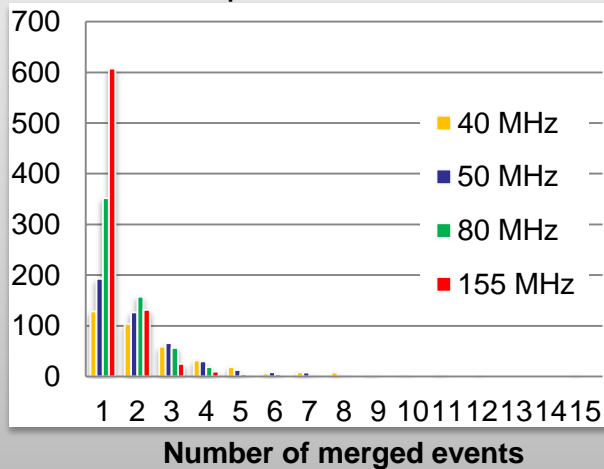
R. Dzygadło

GEM Digis – Event separation by time gap

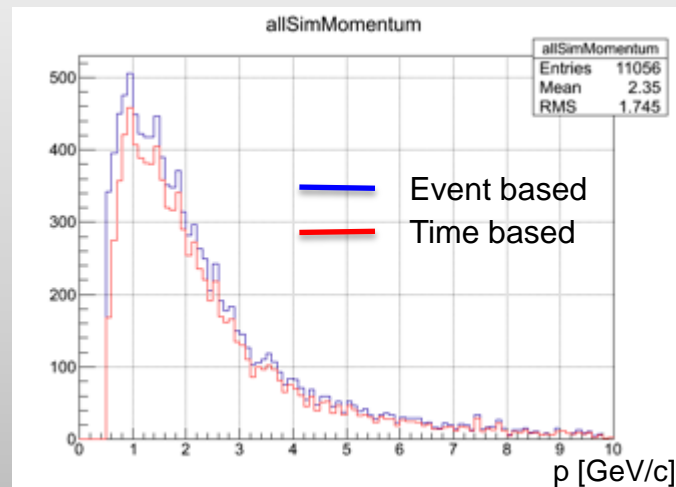


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Merged events for different clock frequencies of MVD



GEM track reconstruction



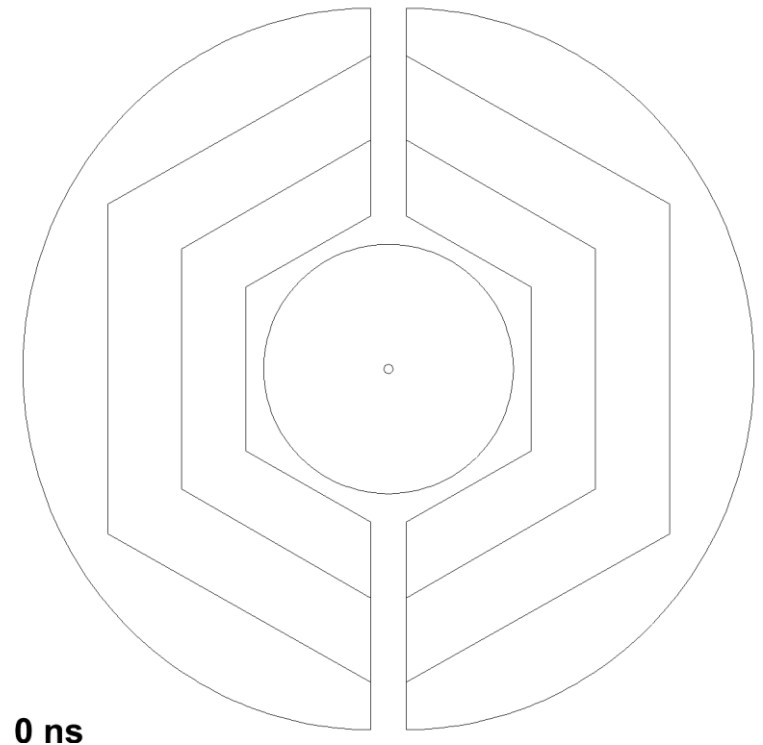
GEM tracking eff. for $p > 1 \text{ GeV/c}$:

- Event based: ~ 95%
- Time based: ~ 87%

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- Time-based simulation part of FairRoot-Framework
- Possible to simulate:
 - Event mixing depending on sub-detector features
 - Pile-up
- Data sorting by time stamps
- Reconstruction based on:
 - Time slices
 - Overlapping time intervals
 - Gaps in the data stream
 - ...

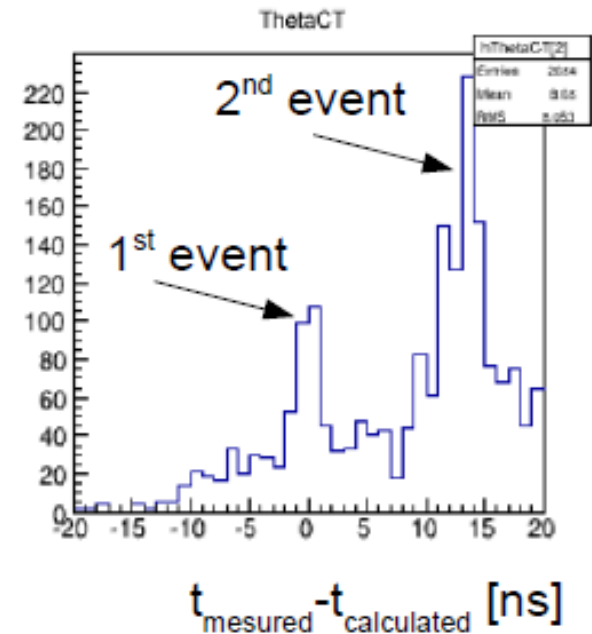
Various examples shown



BACKUP

Probability of hitting the same detector element within 50 ns (time spread of photons from the event):

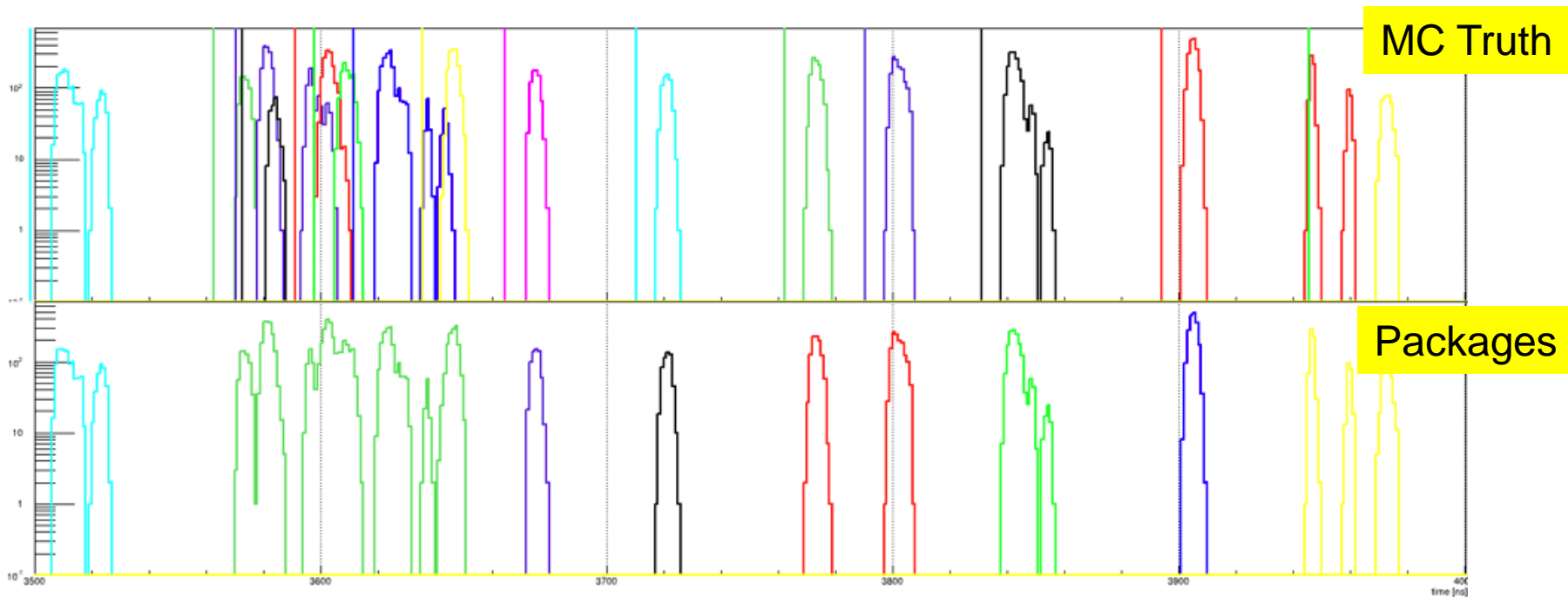
- ~4 % for background
- ~1.5% for uniform distribution
- 90 % of these events still could be separated using delta timing



R. Dzygadlo

- Select data packages according to time gaps between digi clusters
- Works very well for detectors with precise time measurement

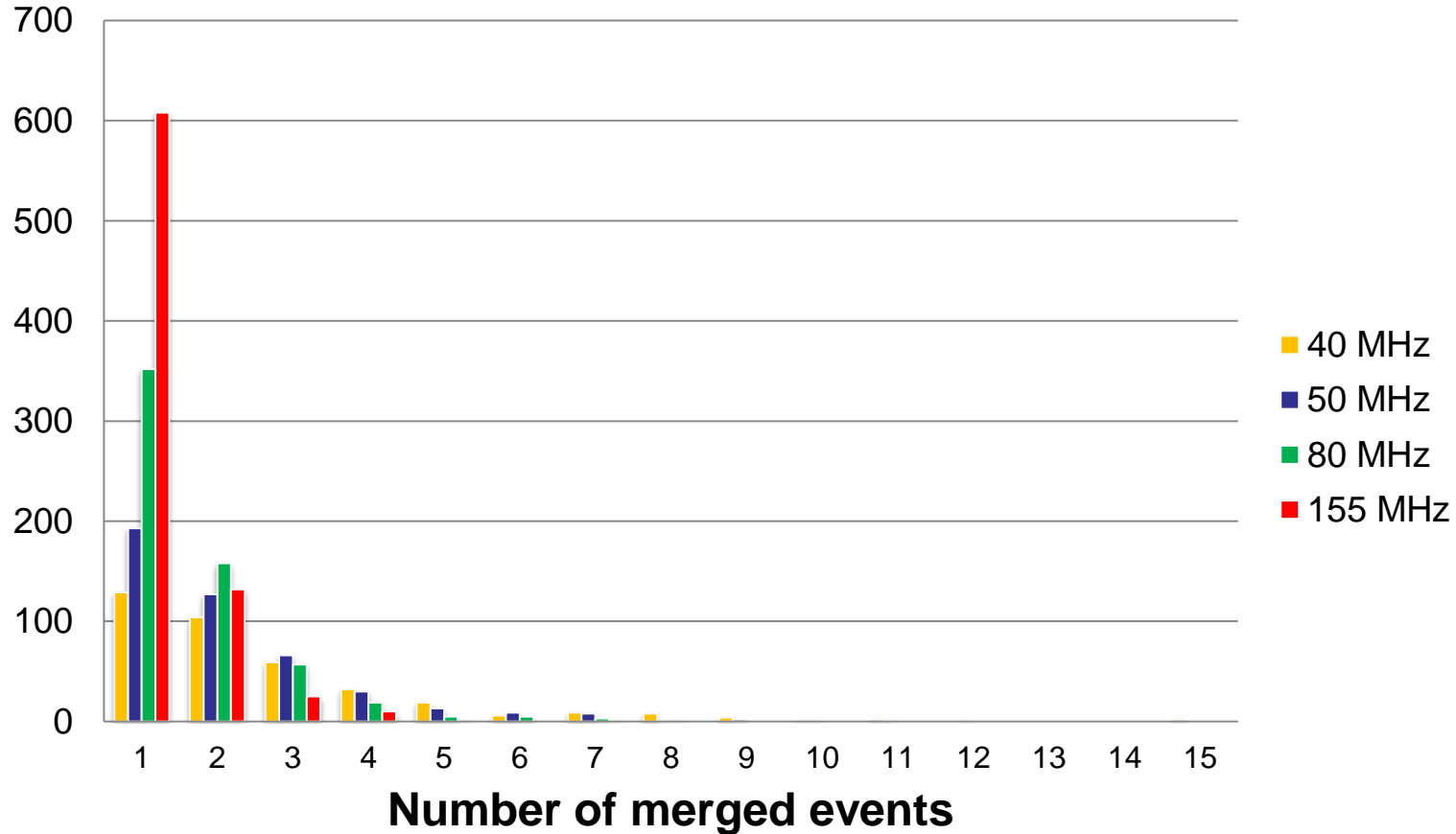
Example: GEM Digis



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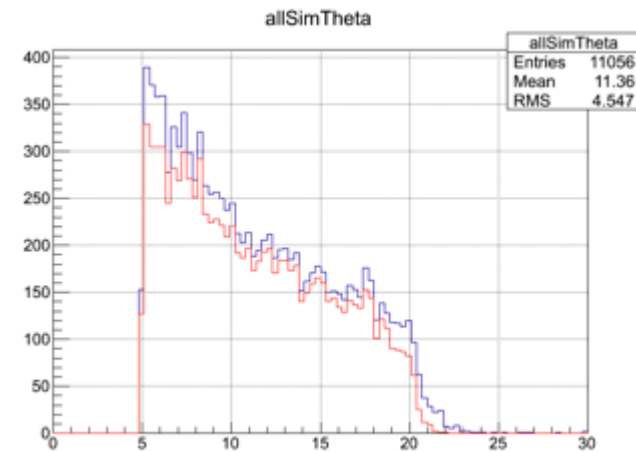
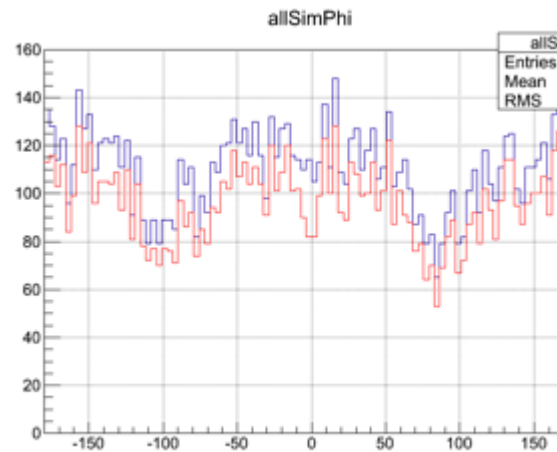
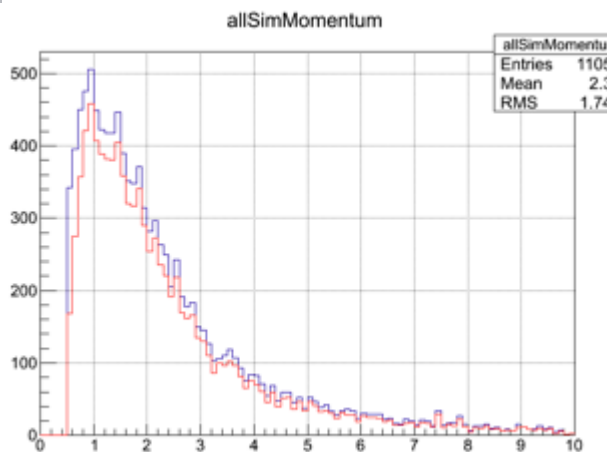


Merged events for different clock frequencies of MVD



GEM Tracking Efficiency

87% for primaries with $|p| > 1 \text{ GeV}/c$,
compared to $\sim 95\%$ in event-based reconstruction



R. Karabowicz



Simulation Flow

