Event determination (t_0) and sorting based on TOF counters

Dominik Steinschaden
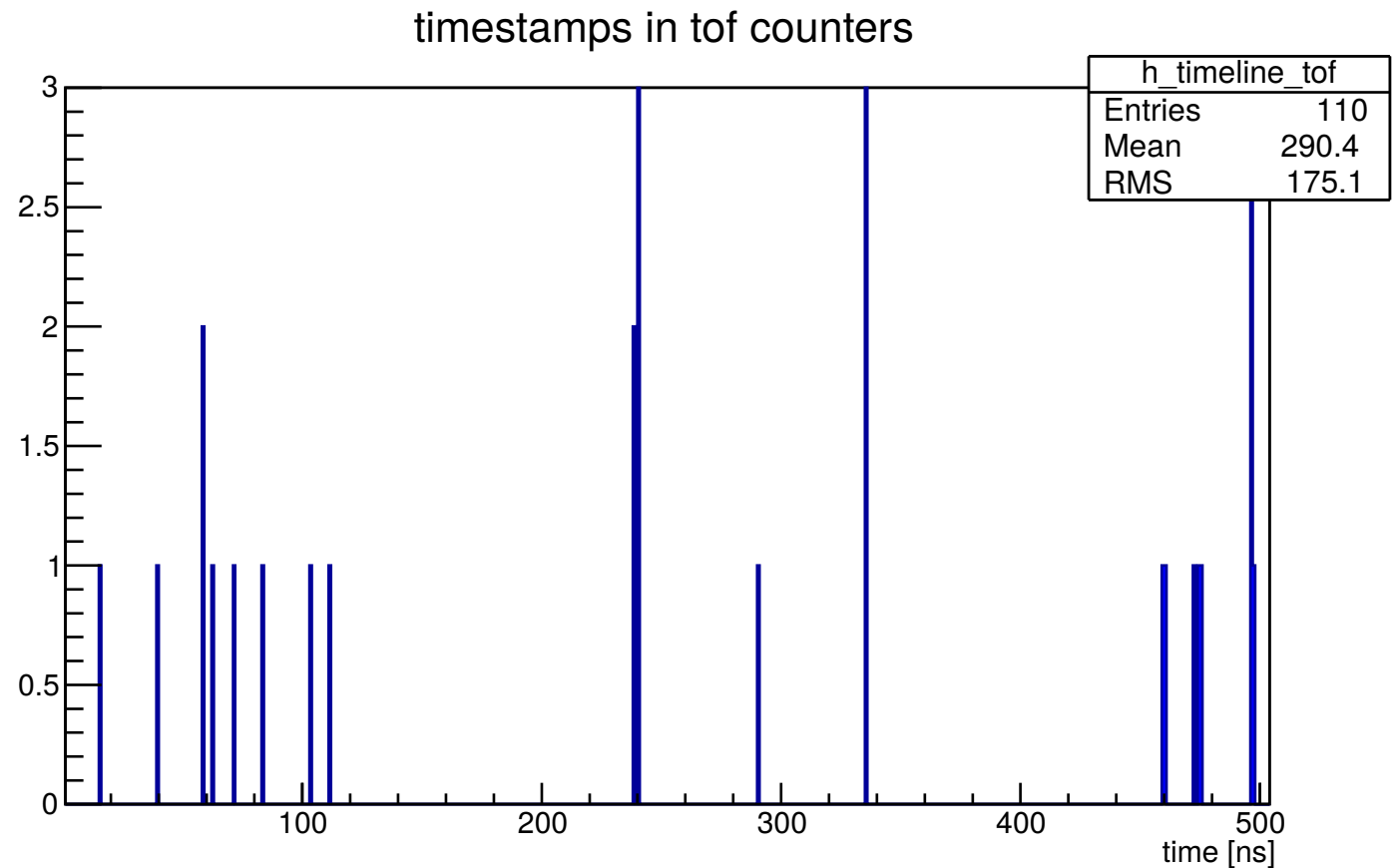On behalf of the Panda SciTil group

GSI, 6.12.2016

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- Event structure in TOF counters

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- Time based simulation
  - DPM generator
  - 20 MHz average event rate

- ~ 10 events
  - Events not clearly separated
  - Events may mixed

timestamps in tof counters

h_timeline_tof	
Entries	110
Mean	290.4
RMS	175.1

time [ns]

time stamps in Tof counters

- Offset due to time-of-flight
  - ~2ns for SciTil
  - ~26 ns for FTOF
- Long event width
  - Late arriving particles
  - > 50 ns
- => Event Mixing
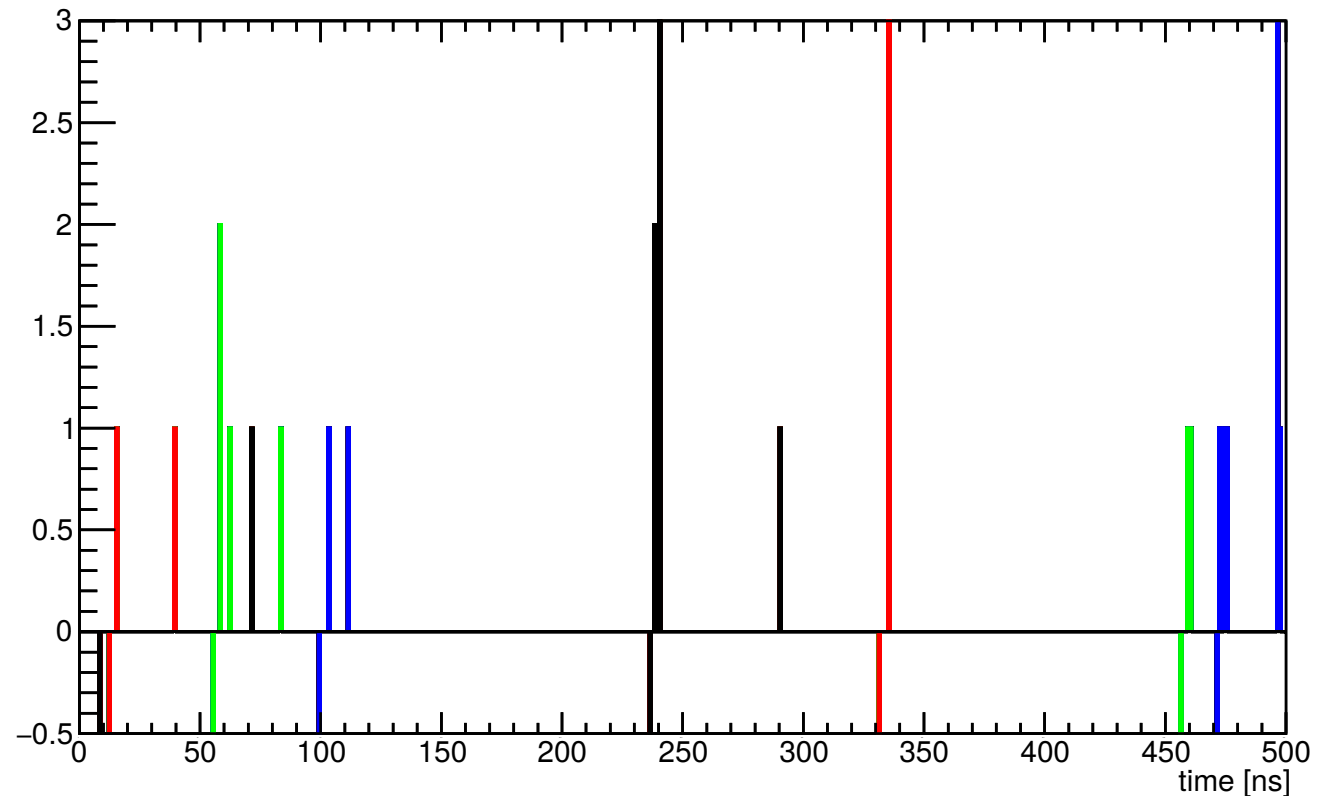
- Timestamps detected in TOF counters at an event rate of 20 MHz. On the negative y-axis the MC event time is indicated.

  All timestamps from a single event have the same colour. Consecutive events are iteratively coloured in black, red, green and blue.

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Event structure (event based)

Sources of late arriving /indirect

- Neutrons
  - Most prominent
- Backscattered Photons
- Backscattered Hadrons
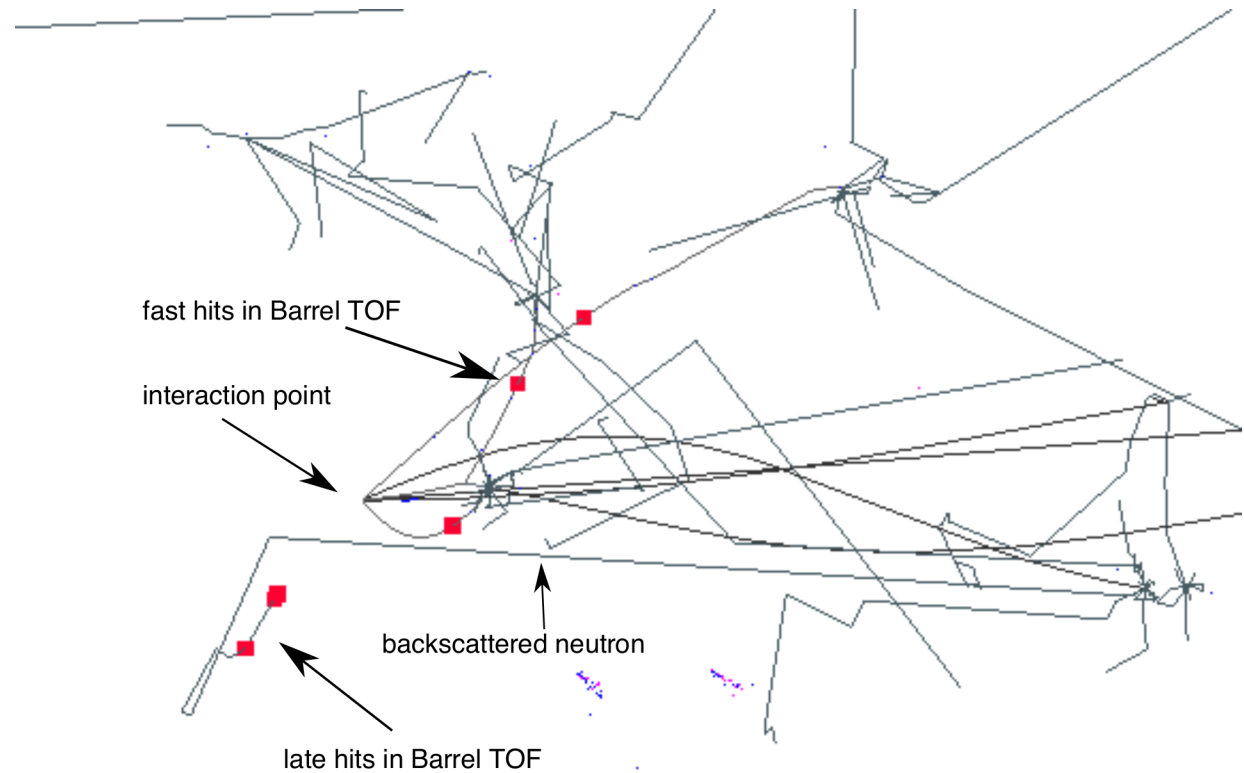- Slow/late/multiple decays

timestamp distribution in Barrel TOF

h_range_scit	
Entries	324153
Mean	4.66
RMS	3.512
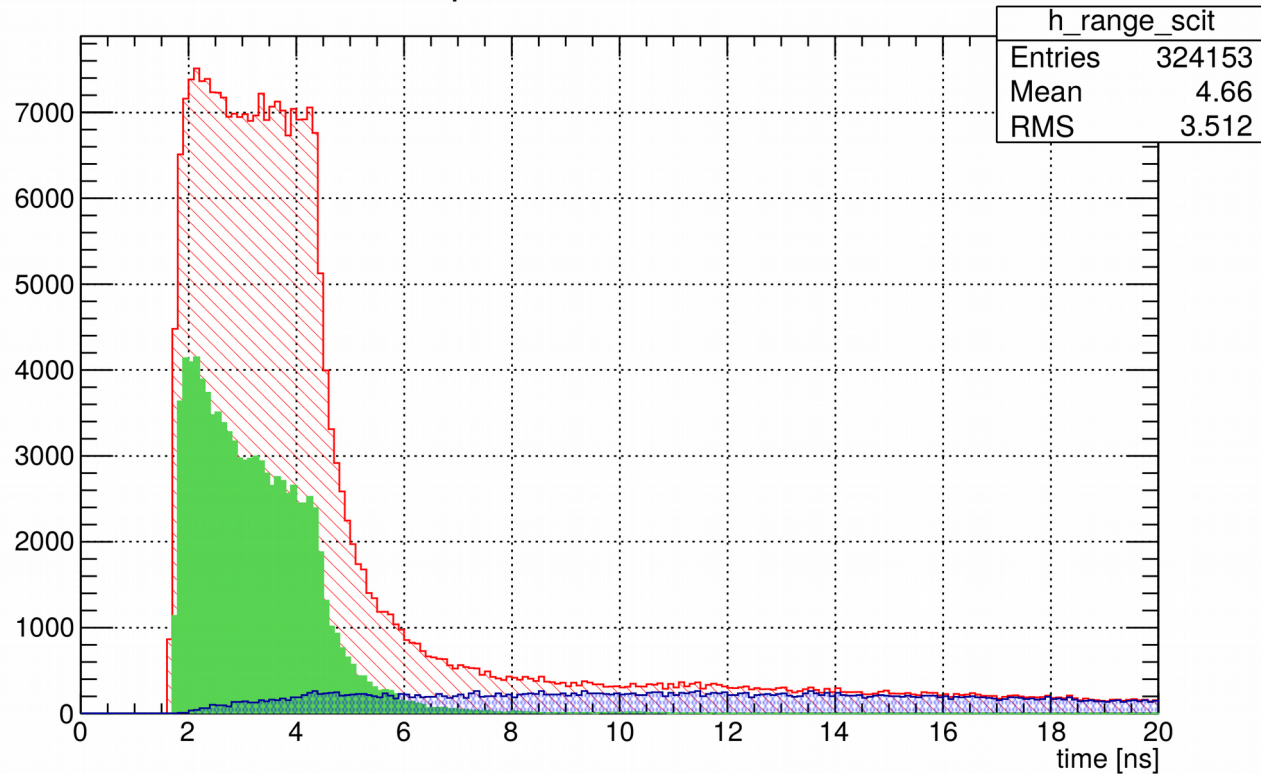
- Timestamp distribution in SciTil for all hits (red), primary particles (green) and hits initiated by neutrons (blue)

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Sources of late arriving /indirect

- Neutrons
  - Most prominent

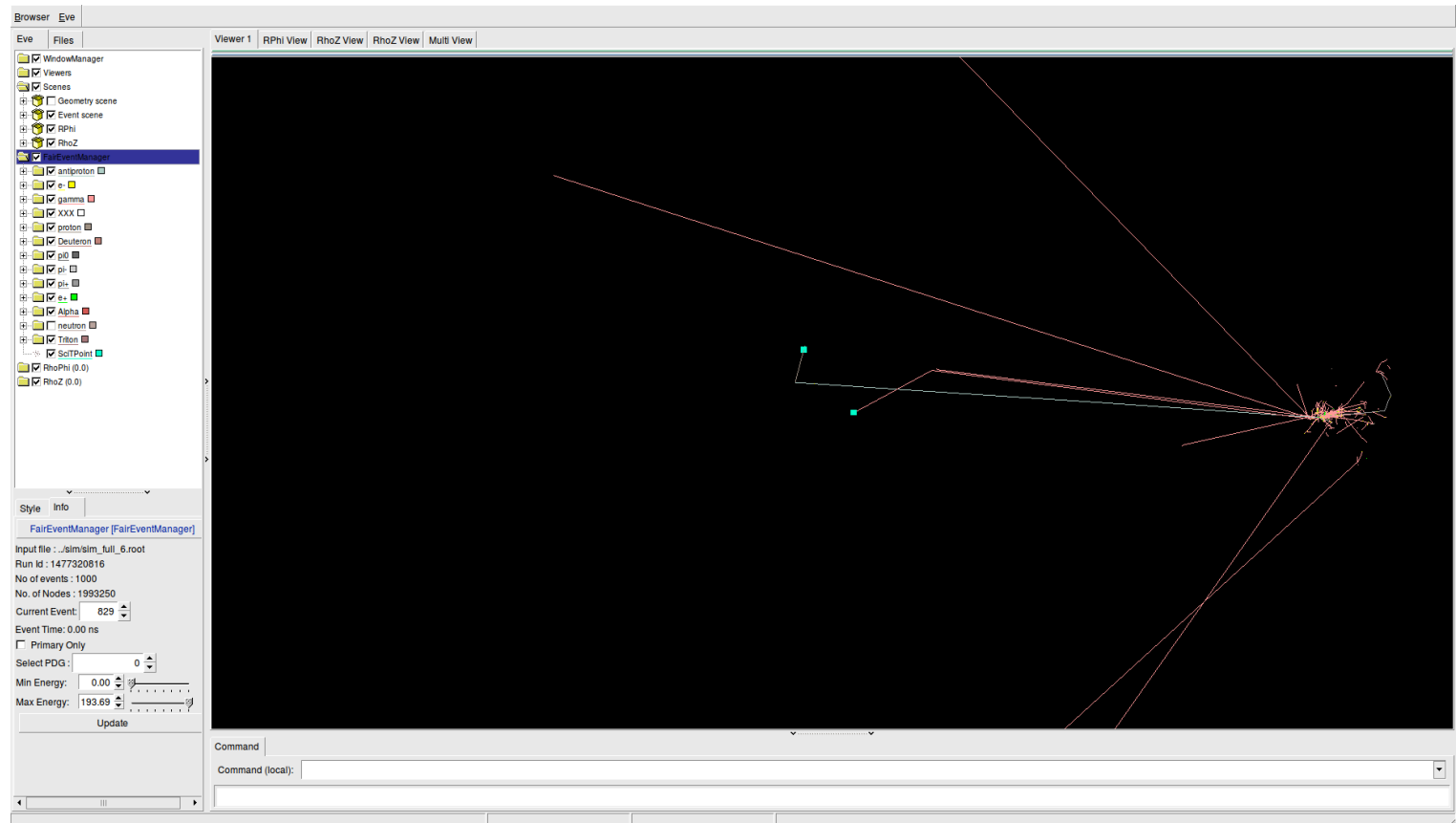fast hits in Barrel TOF

interaction point

backscattered neutron

late hits in Barrel TOF

Indirect/late Particles

Sources of late arriving particles/timestamps

- Neutrons
  - Most prominent
- Backscattered Photons

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Indirect/late Particles

Sources of late arriving particles/timestamps

- Neutrons
  - Most prominent
- Backscattered Photons
- Backscattered Hadrons
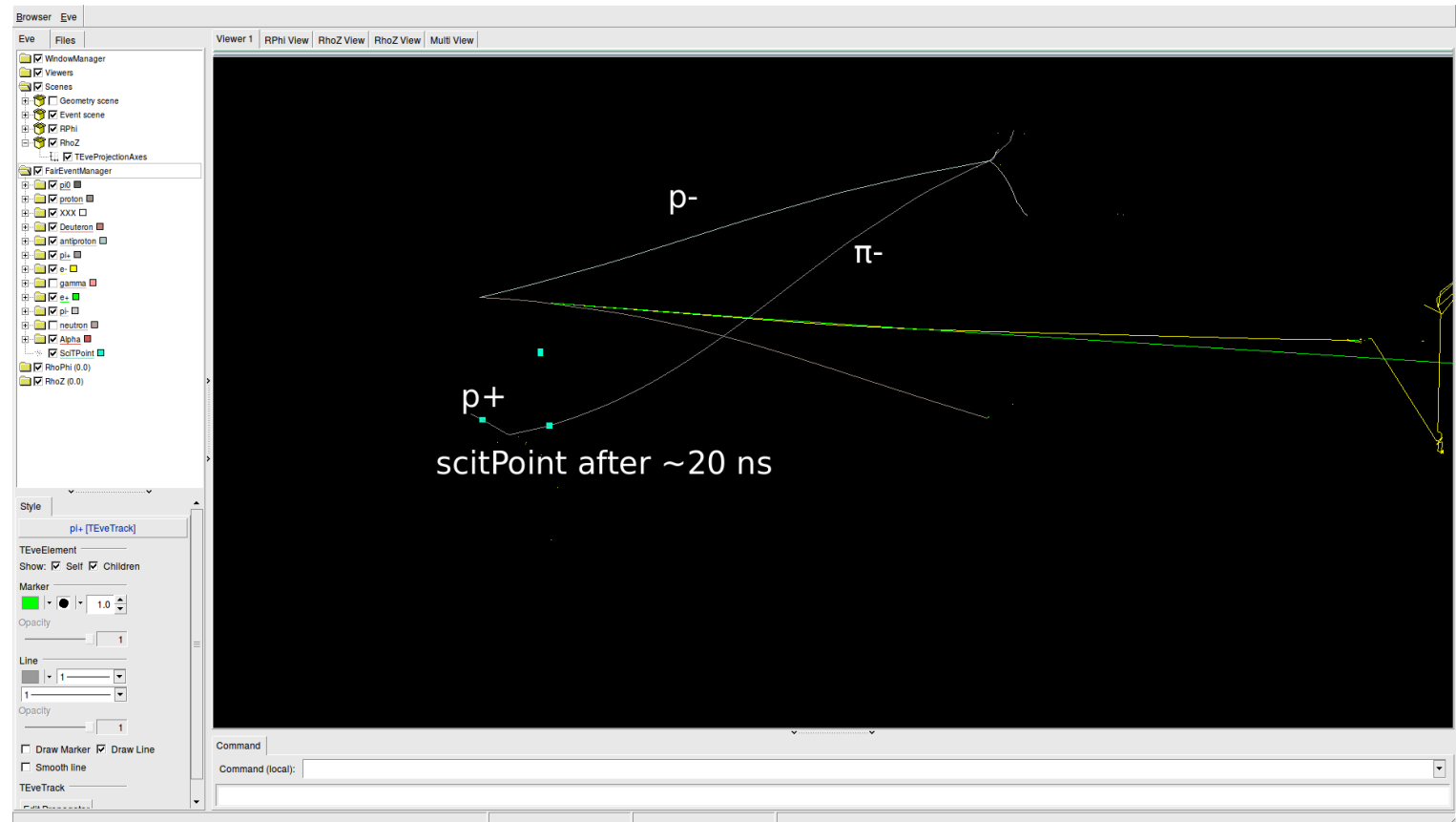

last pi+ hits at ~ 10 ns

Indirect/late Particles

Sources of late arriving particles/timestamps

- Neutrons
  - Most prominent
- Backscattered Photons
- Backscattered Hadrons
- Slow/late/multiple decays

- Direct particles:

  (also secondaries)

  - $TOF_{min} = 1.66$ ns
    - $v=c$, $\vartheta = 90°$
  - $TOF_{max} = 8.6$ ns (16.6 ns)
    - $P_t = 300$ MeV/c (150 MeV/c)
  - $\Delta t = 7$ ns (15 ns)

- Indirect particles/secondaries

  - Tof > 15 ns
  - Propably hard to reconstruct
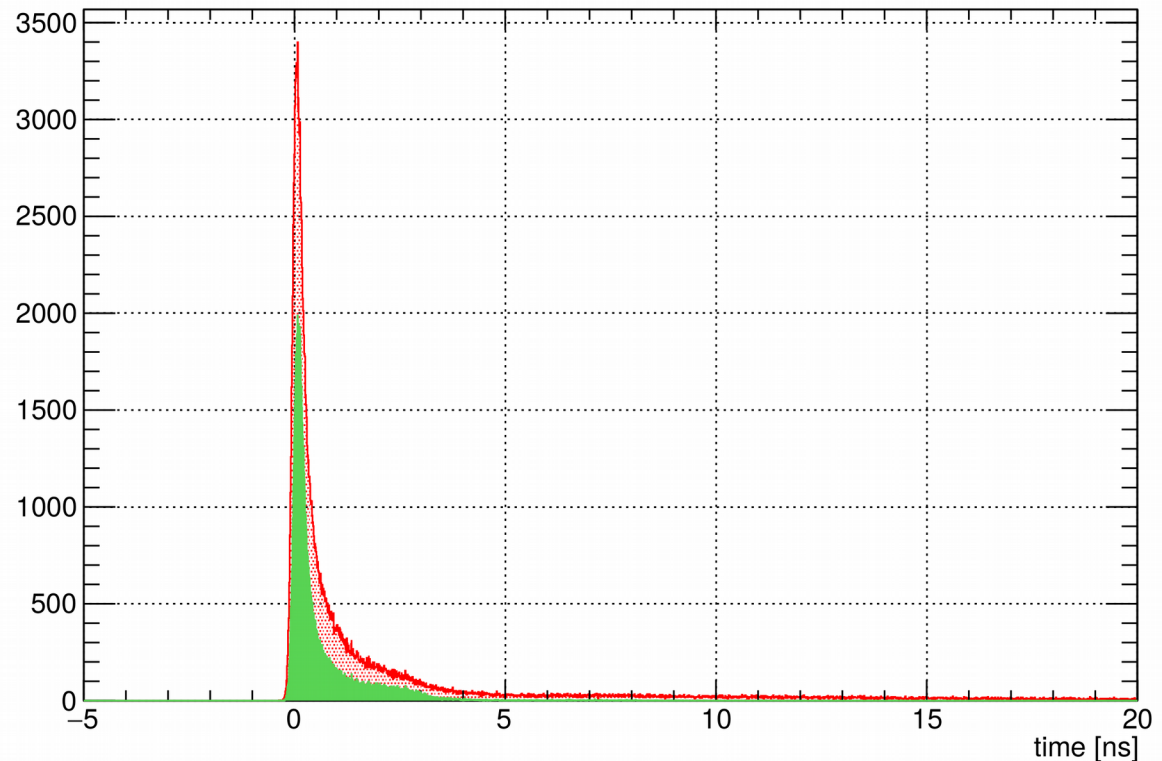 - Provide no additional
    information for analysis

timestamp distribution in Barrel TOF

h_range_scit	
Entries	324153
Mean	4.66
RMS	3.512
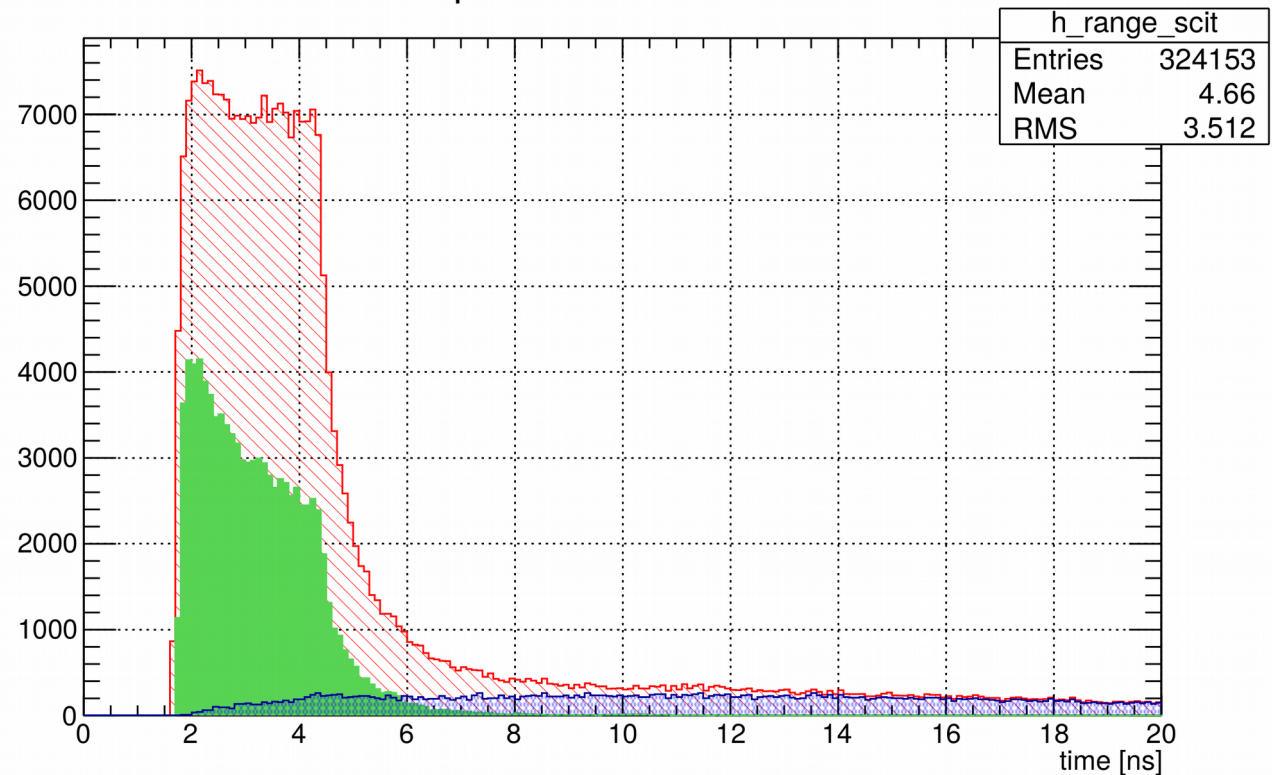
- Reduce the Offset and width

  - No tracking information!

  - Speed of light correction

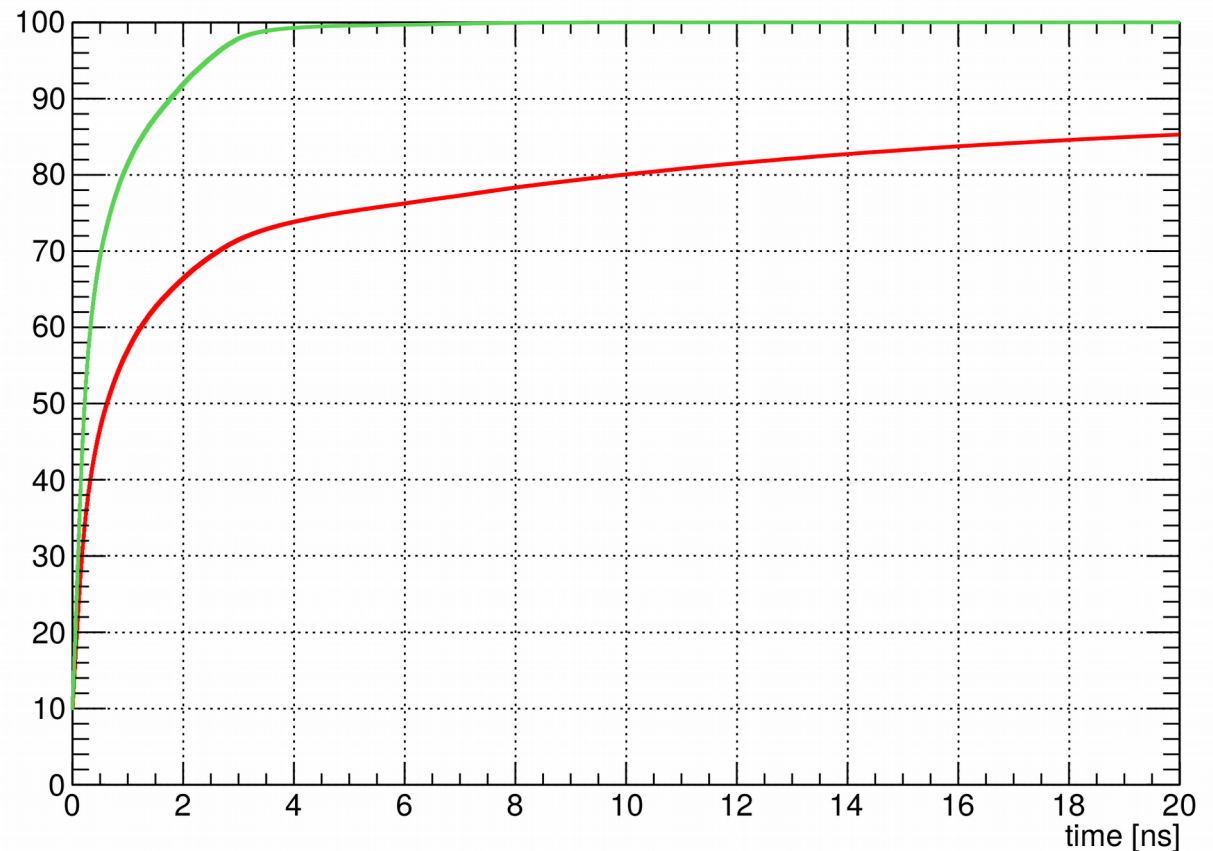   - Track length: straight line

    - v = c

corrected timestamps in Barrel TOF

- Timestamp distribution in SciTil after applying the speed-of-light correction for all hits (red) and primary particles (green)

integral of corrected timestamps in Barrel TOF

- Direct particles (primaries)
  - 4 ns --> > 99%
- Total
  - 1ns --> 60%
  - 2 ns --> 70 %
  - 4 ns --> >75%
- "Core Event width"
  - t_{Core} = 4 ns

- Integrated timestamp distribution in SciTil after applying the speed-of-light correction for all hits (red) and primary particles (green)

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Make it short:

- One can show the same behavior for the FTOF
    - Speed-of-light correction
    - 4 ns => >99% of primaries
    - 4 ns => >75% of secondaries
- "Core Event time"
    - $t_{Core} = 4$ ns

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Basic algorithm

- Due to the low particle multiplicity per event every timestamp can potentially be the trigger for an event. After a trigger has been accepted, there is a dead-time of 4 ns (red) where no other trigger is accepted. All timestamps after a trigger and within a window of 15 ns are assumed to belong to a single event (green). These event time windows potentially overlap to ensure the completeness of the data.
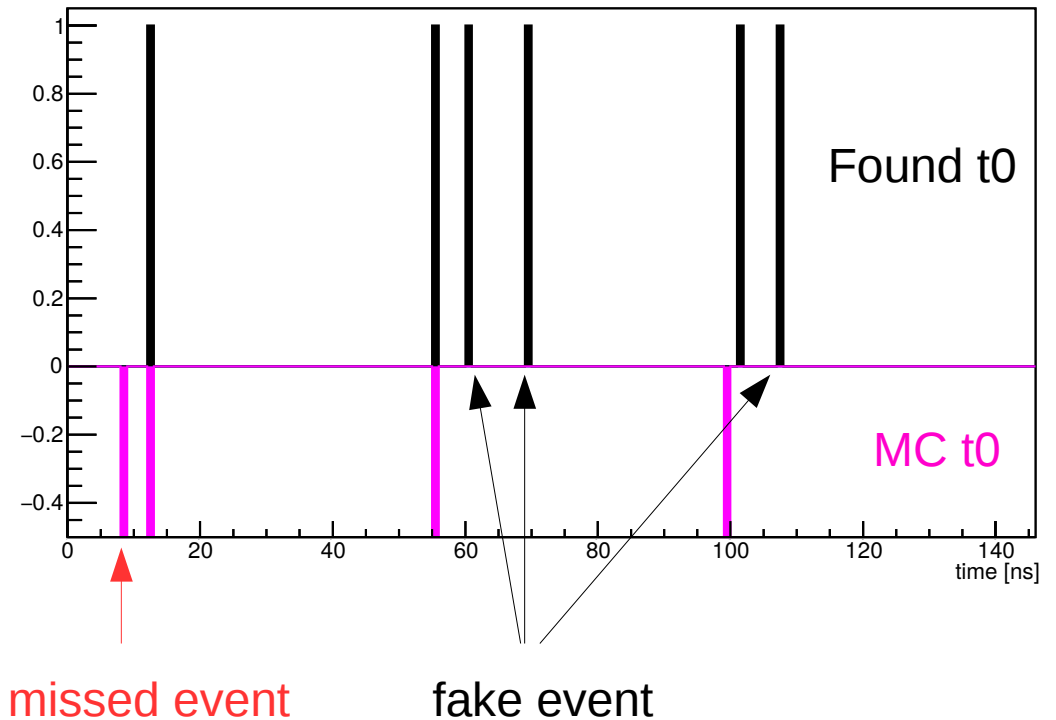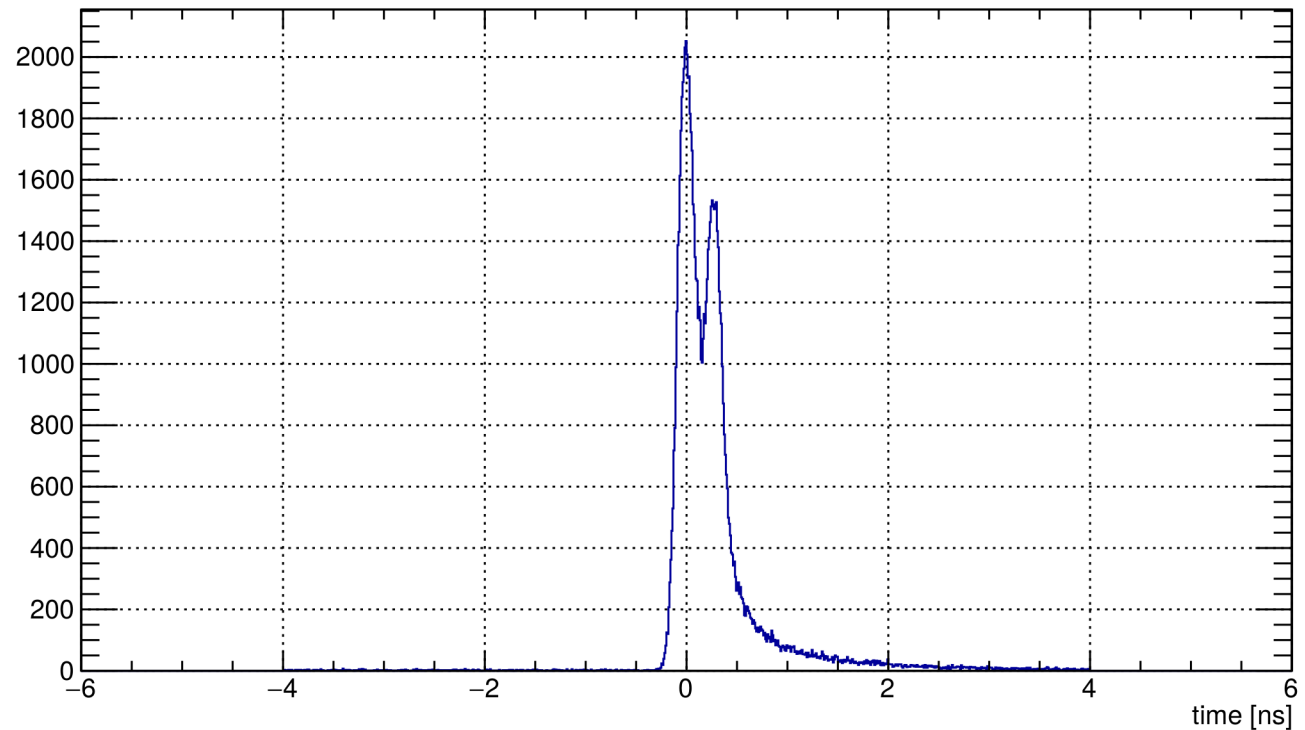

Event Determination Algorithm
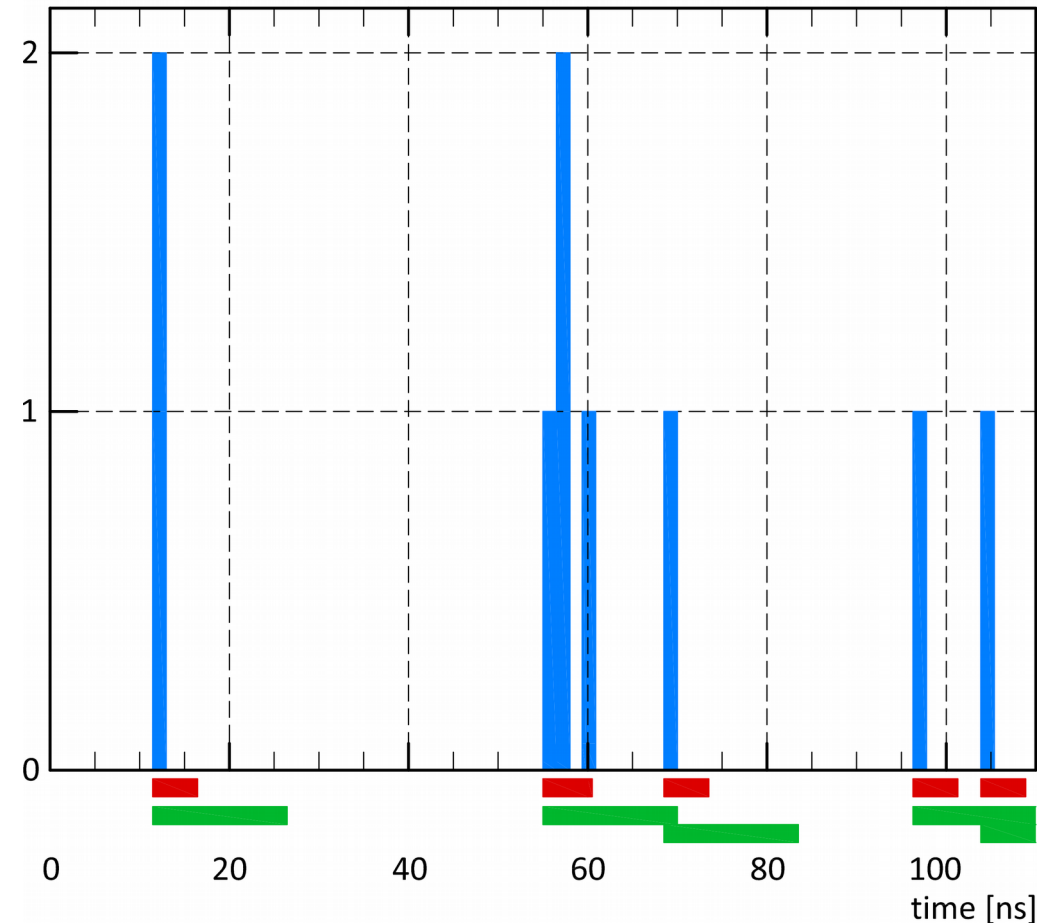
- "Timebased" timestamps in the TOF counters after applying the speed-of-light correction

Results

Event rate	2 MHz	20 MHz	20 MHz w. fake reduction
Correctly identified	93% (>99)	89 % (96)	83%
misidentified	80%	66%	29%
Event included in previous package	0.5%	4%	4%
Missed events	6.5%	7%	12%

Found t0

MC t0

missed event   fake event

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t0 distribution for correctly identified events

- 2 MHz

- T0 determination
    - σ < 1 ns

- Double peak structure
    - Slightly different timestamp distribution of Barrel TOF and FTOF

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Outlook

- Improve cut parameters
    - Core event width
    - Event package time window
- Include more sub detector information
    - Enhance determination rate ("neutral events")
    - enhance fake event reduction ?

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Thank you for your attention

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