



Study of Muon Decays in KM3NeT/ORCA6

Gogita Papalashvili

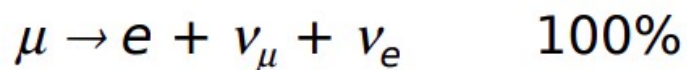
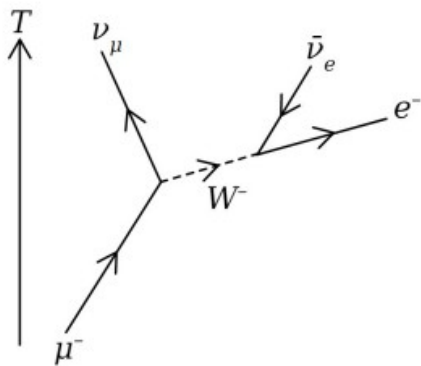


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 muon decays parameters
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- ◆ Decay simulations in ORCA6 detector and MC signals
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Muon decay parameters

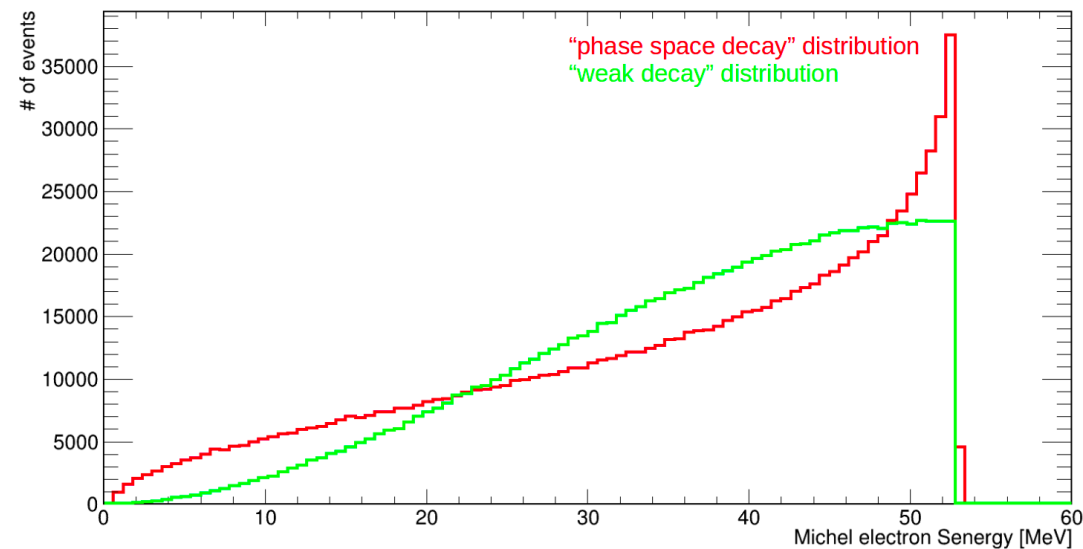


$$m_{\mu} = 105.6583745 \pm 0.000002$$

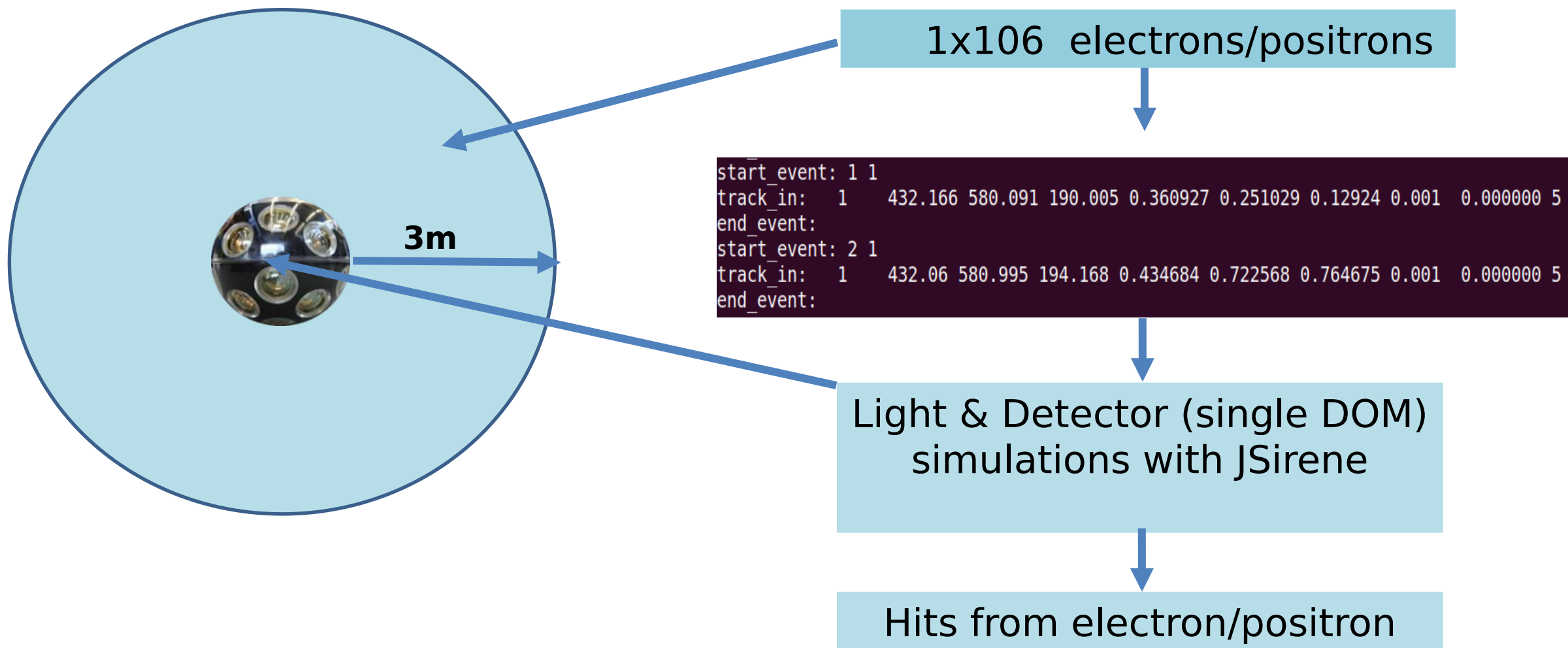
$$\tau_{\mu} = (2.1969811 \pm 0.0000022)$$

$$\tau_{\mu^{+}}/\tau_{\mu^{-}} = 1.00002 \pm 0.00008$$

Michel electron energy distribution

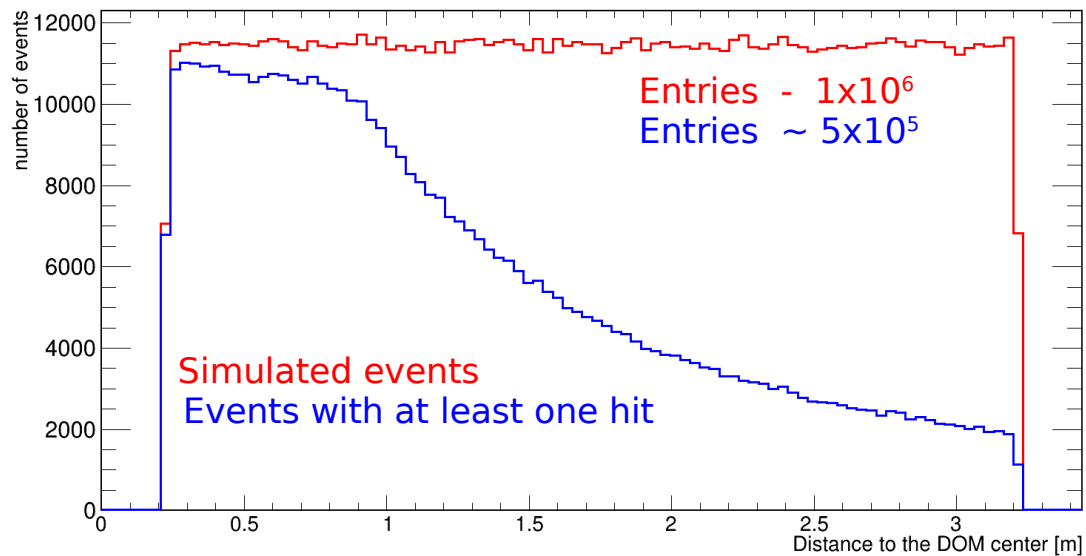


μ Decay signals with JSirene for a single DOM

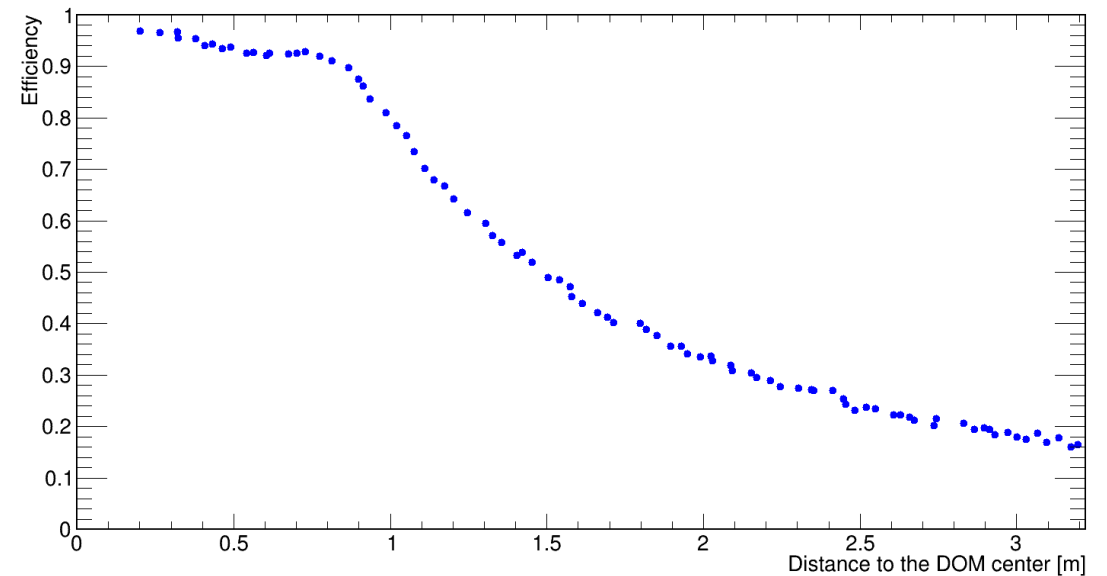


μ Decay simulations with JSirene for a single DOM

Electrons were evenly distributed around a DOM with max distance of 3.22m from the center of the DOM (3m from the edge)



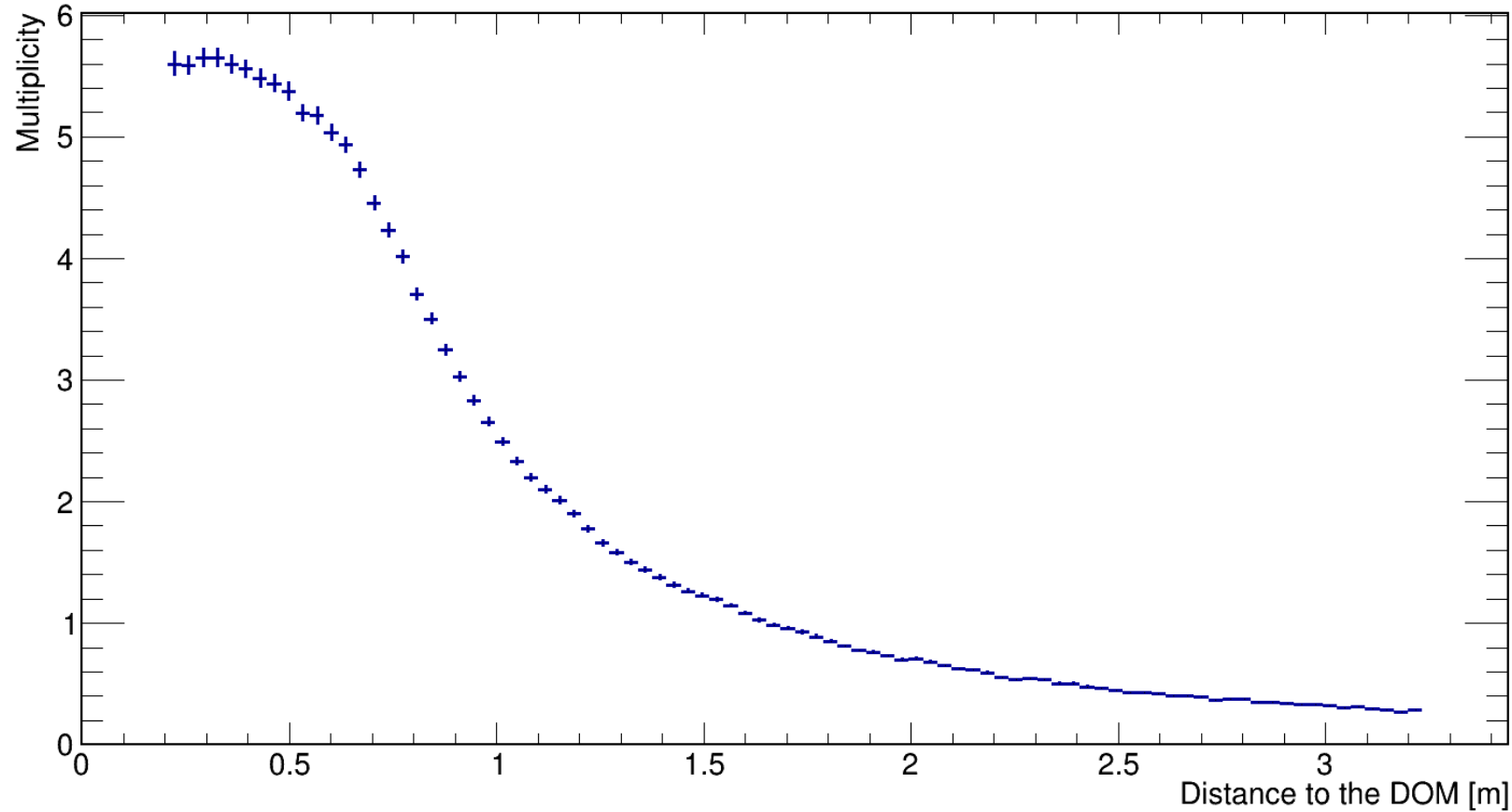
Efficiency of getting a hit with respect to the distance



$\sim 50\%$ of events have at least one hit

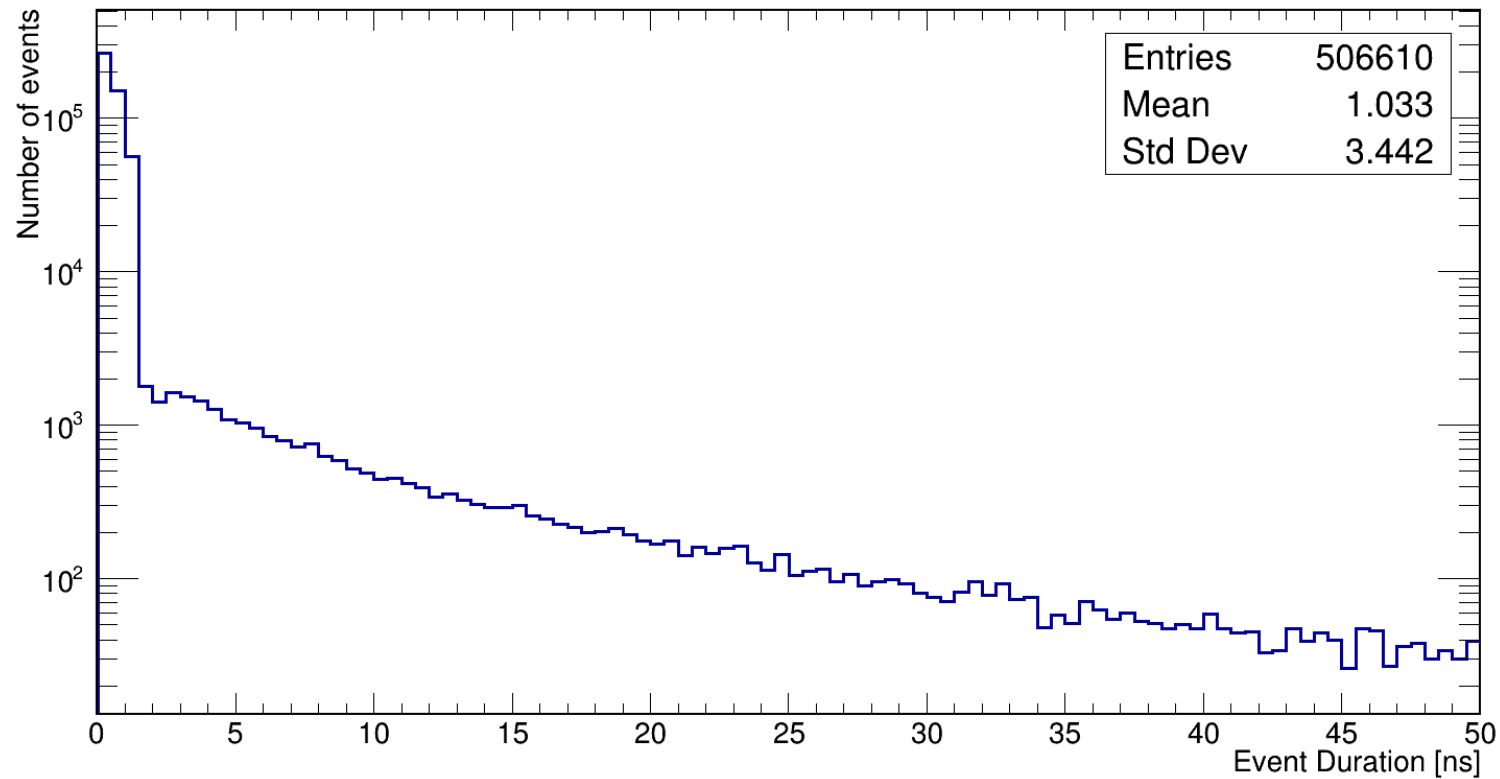
μ Decay simulations with JSirene for a single DOM

Average multiplicity vs distance

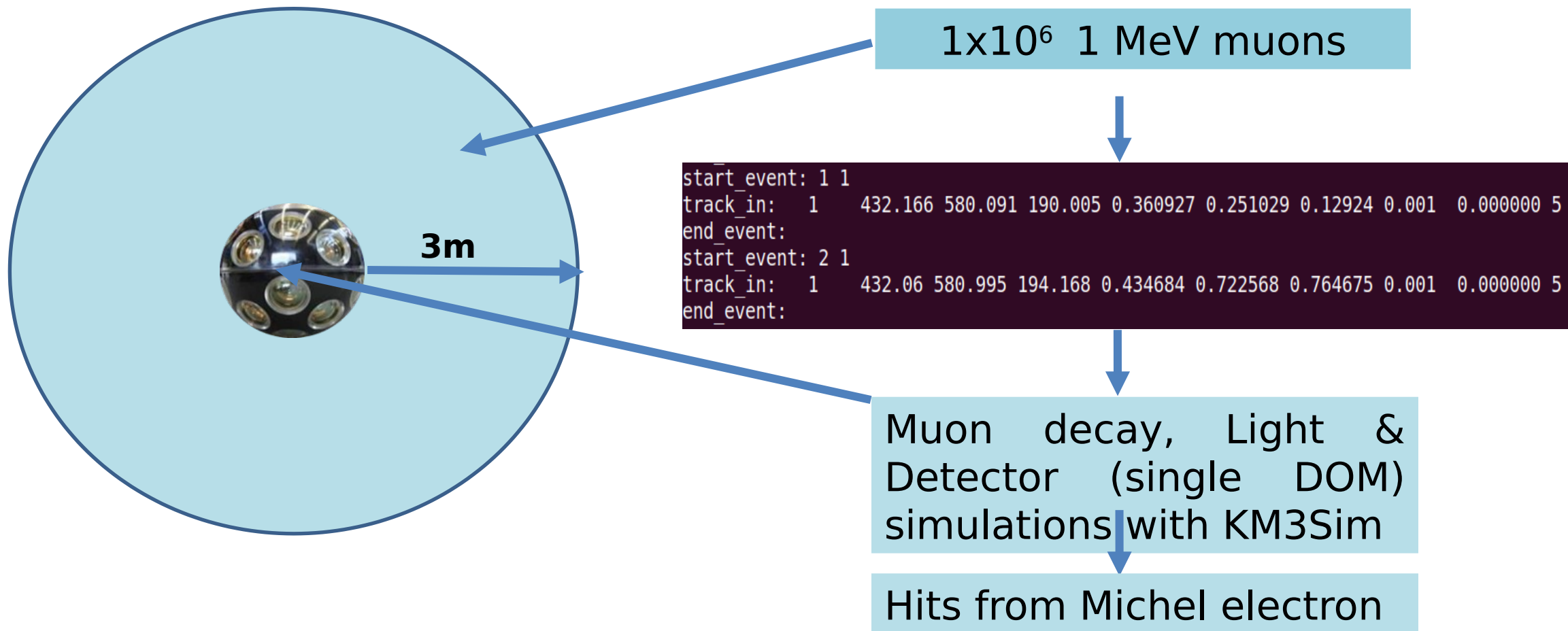


μ Decay simulations with JSirene for a single DOM

Event duration distribution, defined as $t_{\text{last hi}} - t_{\text{first hit}}$

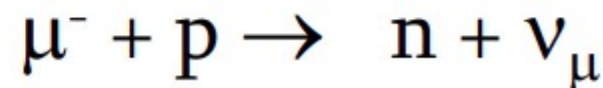
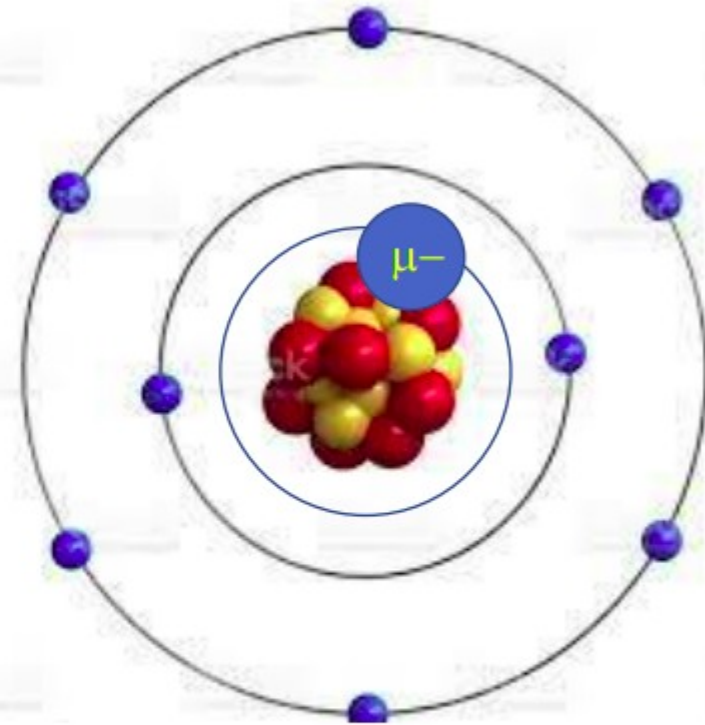
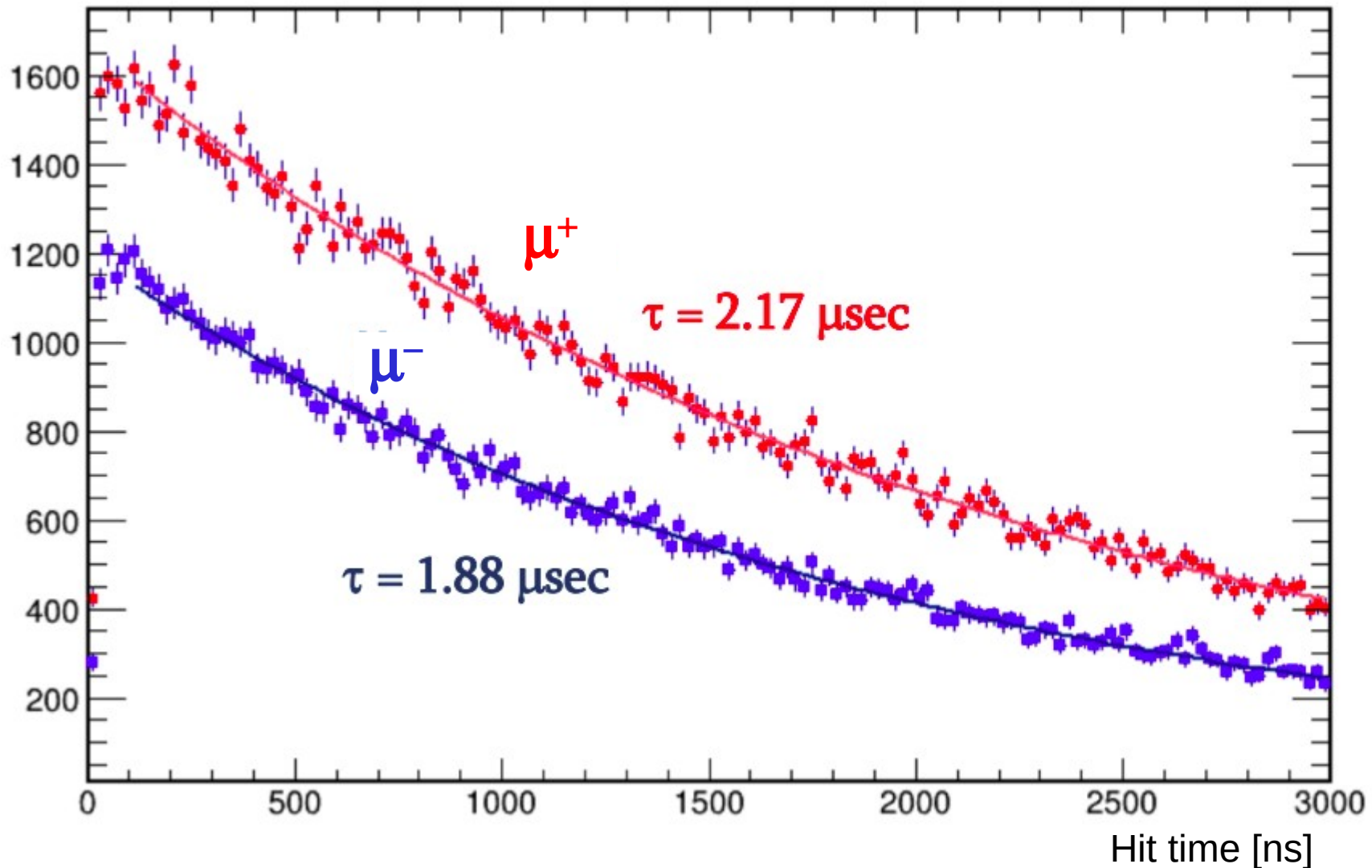


μ Decay simulations with KM3Sim for a single DOM



μ Decay simulations with KM3Sim

Hit time = First hit time of the event



D.F. Measday,
Physics Reports 354 (2001) 243
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Simulations with ROOT and JPP for ORCA6

Muons stopping in max 3 meter distance from a DOM taken from atm muon v7.1 production files



Muon decay simulations

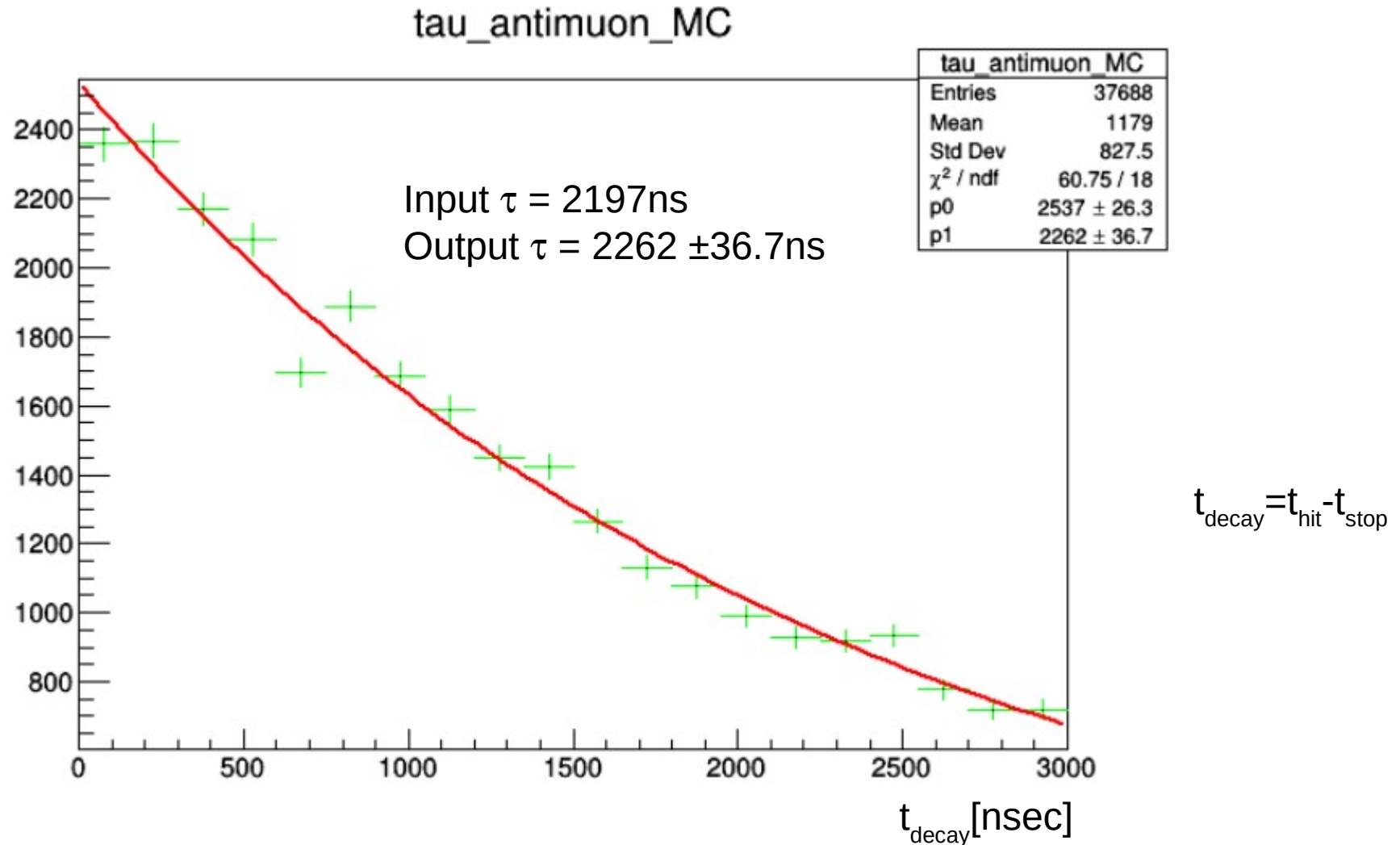
```
start_event: 170 1
track_in: 1 407.1350055811927 730.082423503678 470.7 0.11690043655418146 -0.36210766479199624 -0.9247769066279332 121.26509797460454 0.000 5
track_in: 2 456.50757201525073 577.1472825990655 80.12310734649577 0.8456182058434933 0.5822953211609274 0.7748345015570521 0.02323166110484152 3564.9489058938298 2
end_event:
```

Light & ORCA6 Detector simulations with JSirene
(including Michel electrons)

Background and event reconstruction with JPP

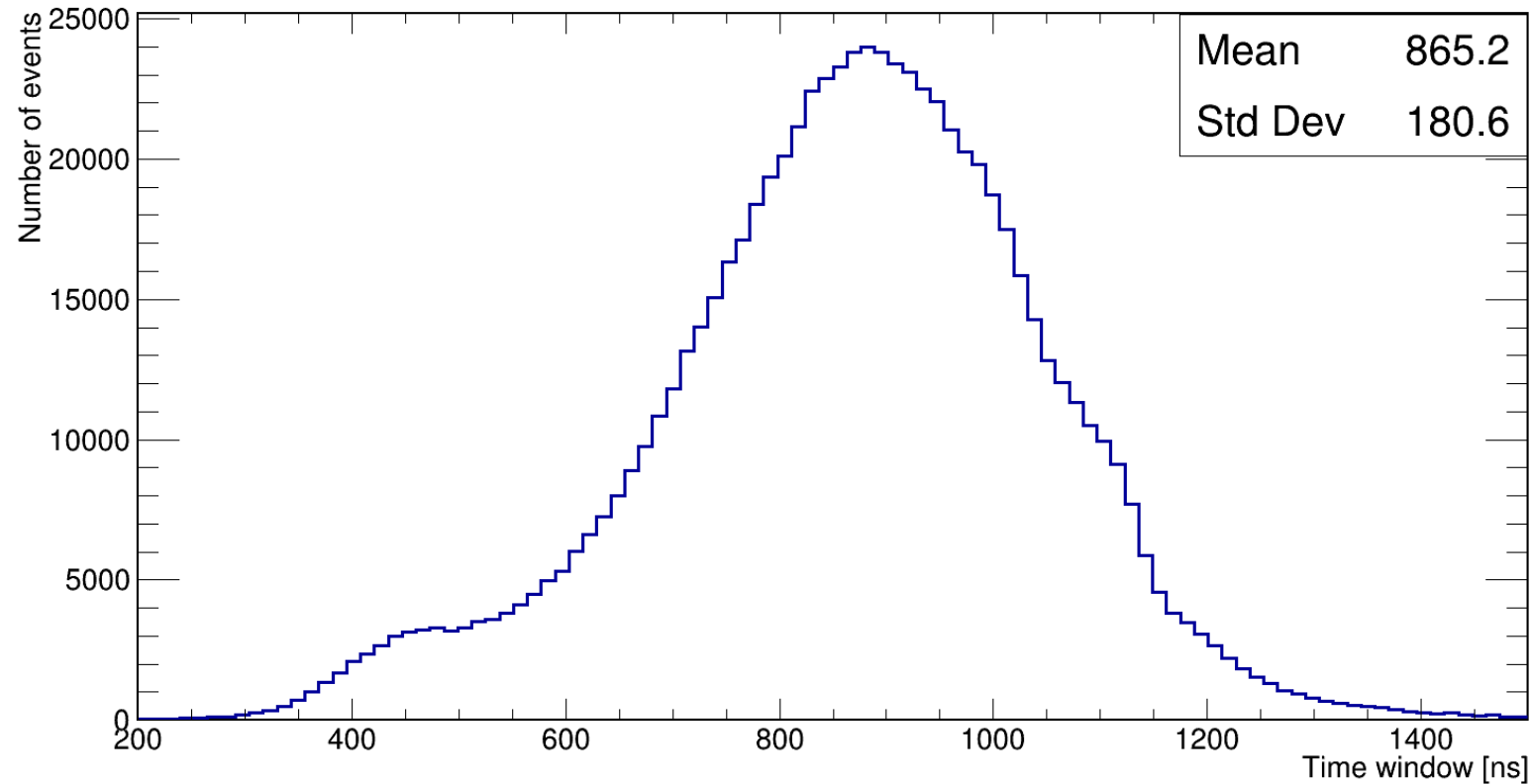
Muon decay MC signals

Decay signals in closest DOM ($r < 3.22$) for antimuons obtained from MC tracks and MC hits



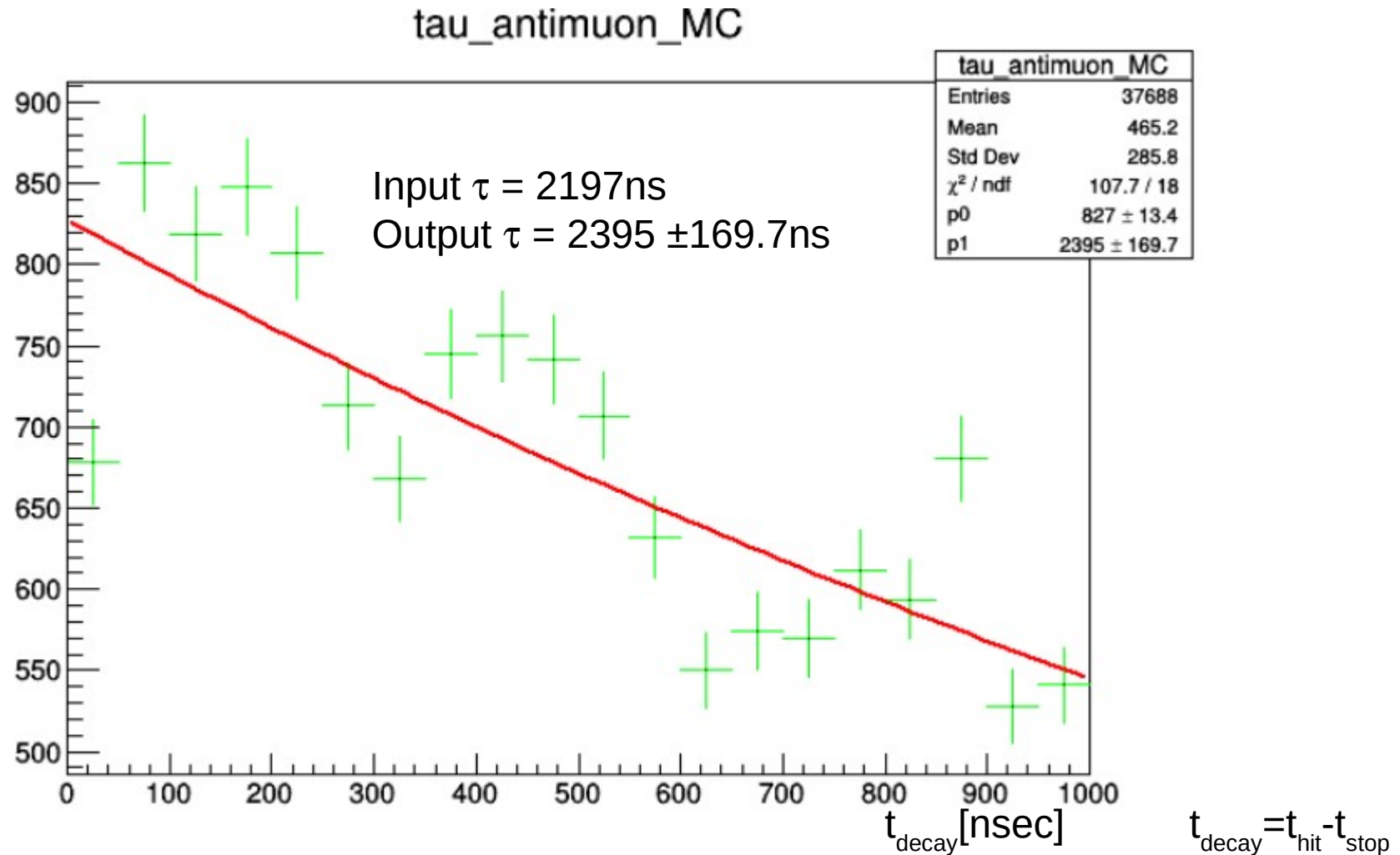
Muon decay signal time window

Time window obtained from mupage files, defined as $t_{\text{last hit}} - t_{\text{stop}}$



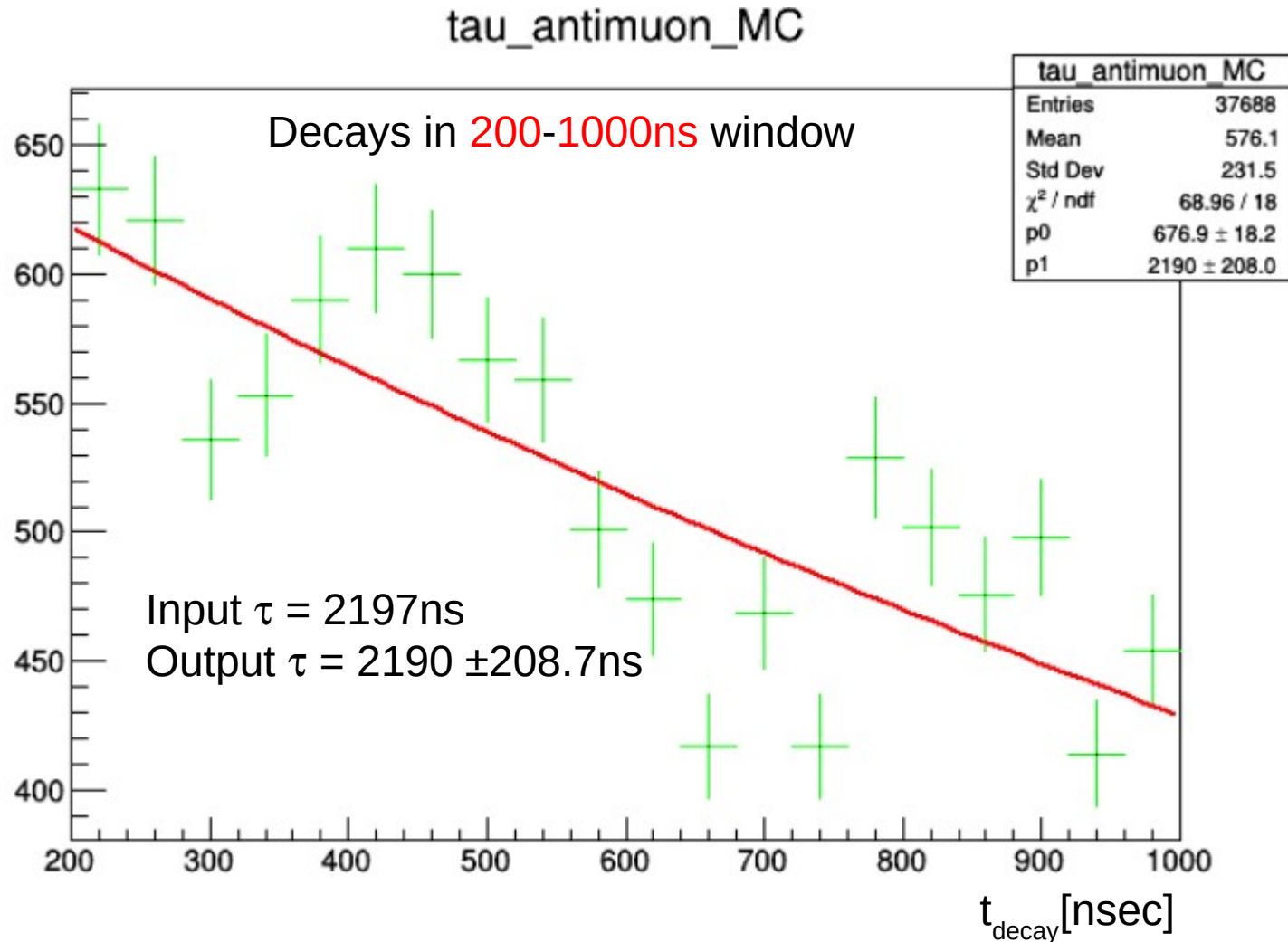
Muon decay MC signals

Antimuon decays with closest DOM for antimuons obtained from MC tracks and MC hits



Muon decay MC signals

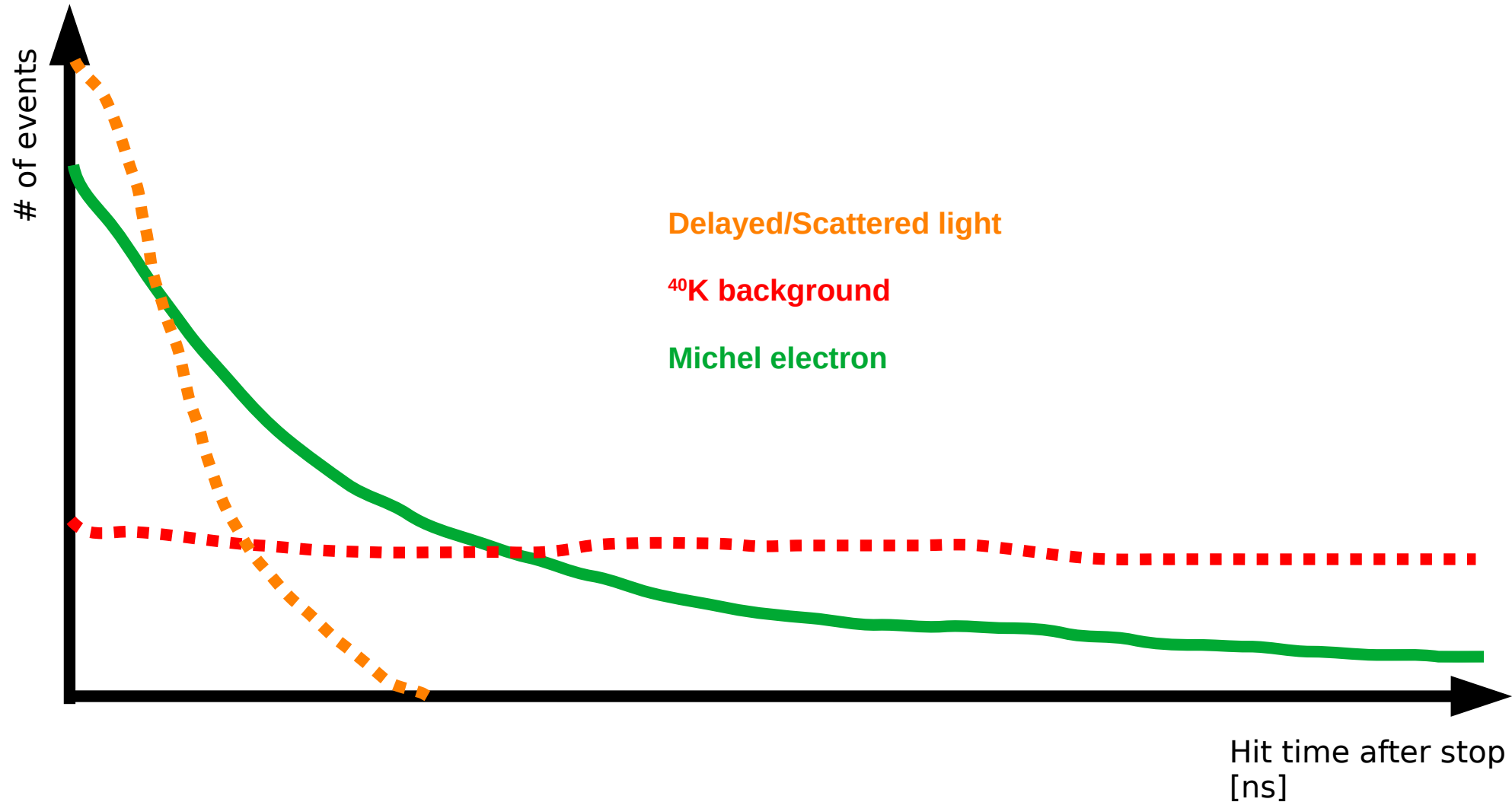
Reconstructed antimuon decay times from MC hits in **200-1000ns** time window



$$1 - e^{(-1/2.2)} - (1 - e^{(-0.2/2.2)}) = 0.32$$

Only $\sim 27.8\%$ of muons decay in 100-1000ns time window

Muon decay reconstructions



Data in numbers

ORCA6 data:

of files 2 610 (2613)
of events 4.30×10^8
of days 551

ORCA6 MC:

of files 3014
of events 5×10^7
of days 77

DST are made for events with stopping point $< 3.22\text{m}$

ORCA6 data DST:

of files 2 610 (2613)
of events 9.57×10^6
of days 551

ORCA6 MC DST:

of files 3014
of events 7.6×10^5
of days 77

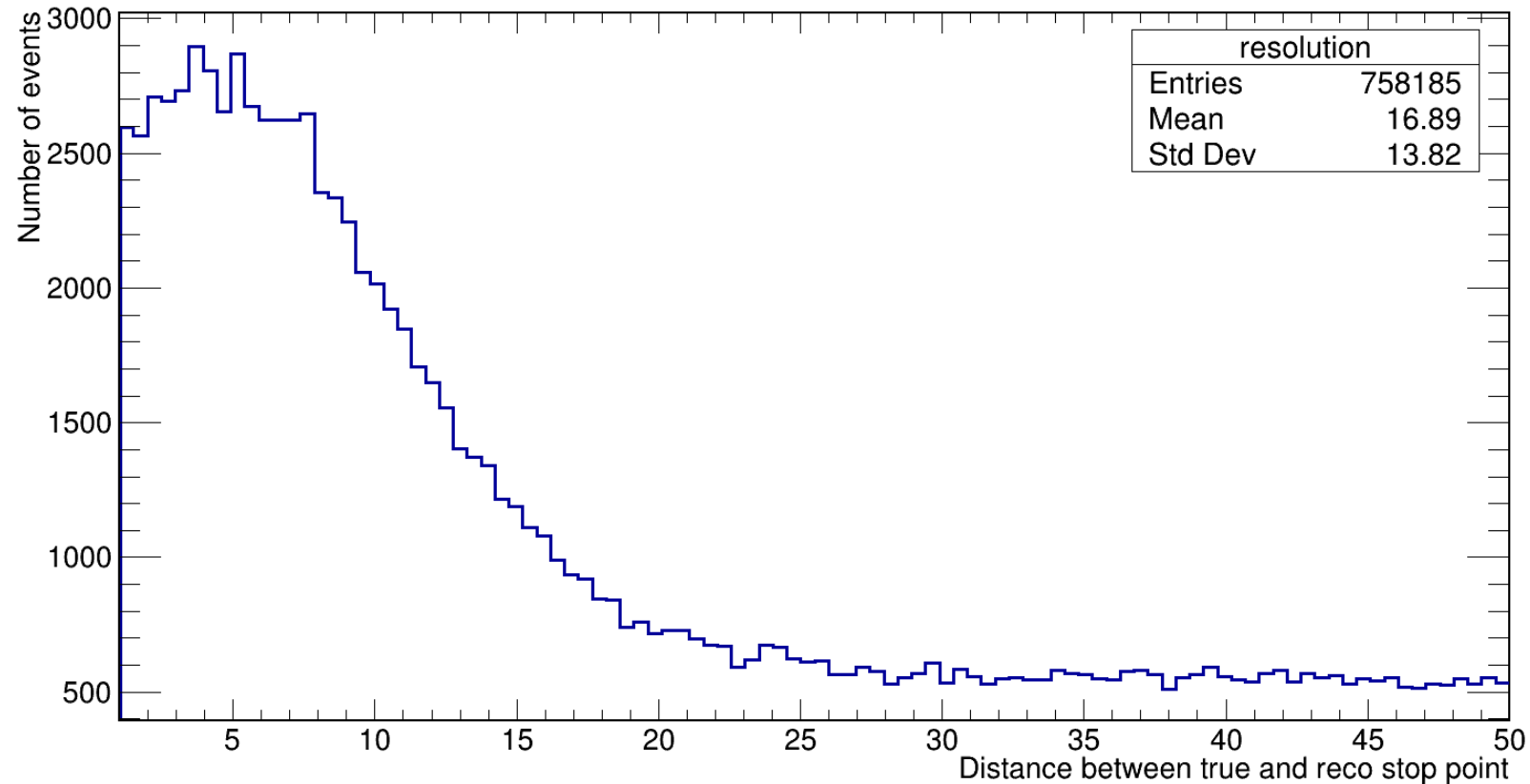
ORCA6 MC DST for true stops

of files 3007
of events 6.93×10^4
of days 77

Expected stop in 3m 477582
Decayed in region of 0.2 and $1\mu\text{sec}$ 132911
Expected michel events 66455

Stopping point resolution

Stopping point resolution for MC and reco tracks with cuts



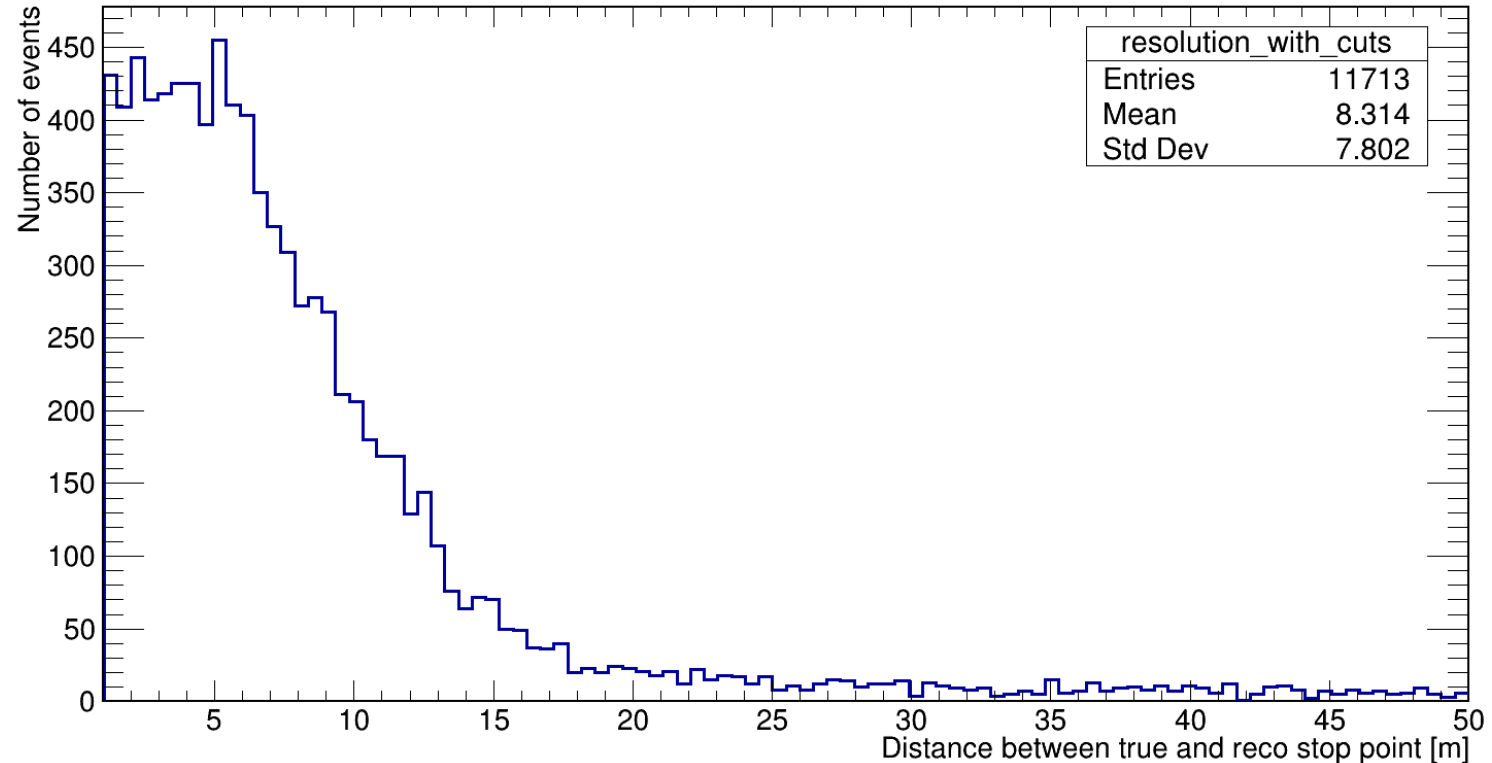
Closest DOM in 3 meteres guessing efficiency 9%

Stopping point resolution

Cuts applied:

Likelihood >150
likelihood over nhits>2
Floor!=1
Floor!=2
dir_z<-0.85
of hits of track>50

Stopping point resolution for MC and reco tracks with cuts

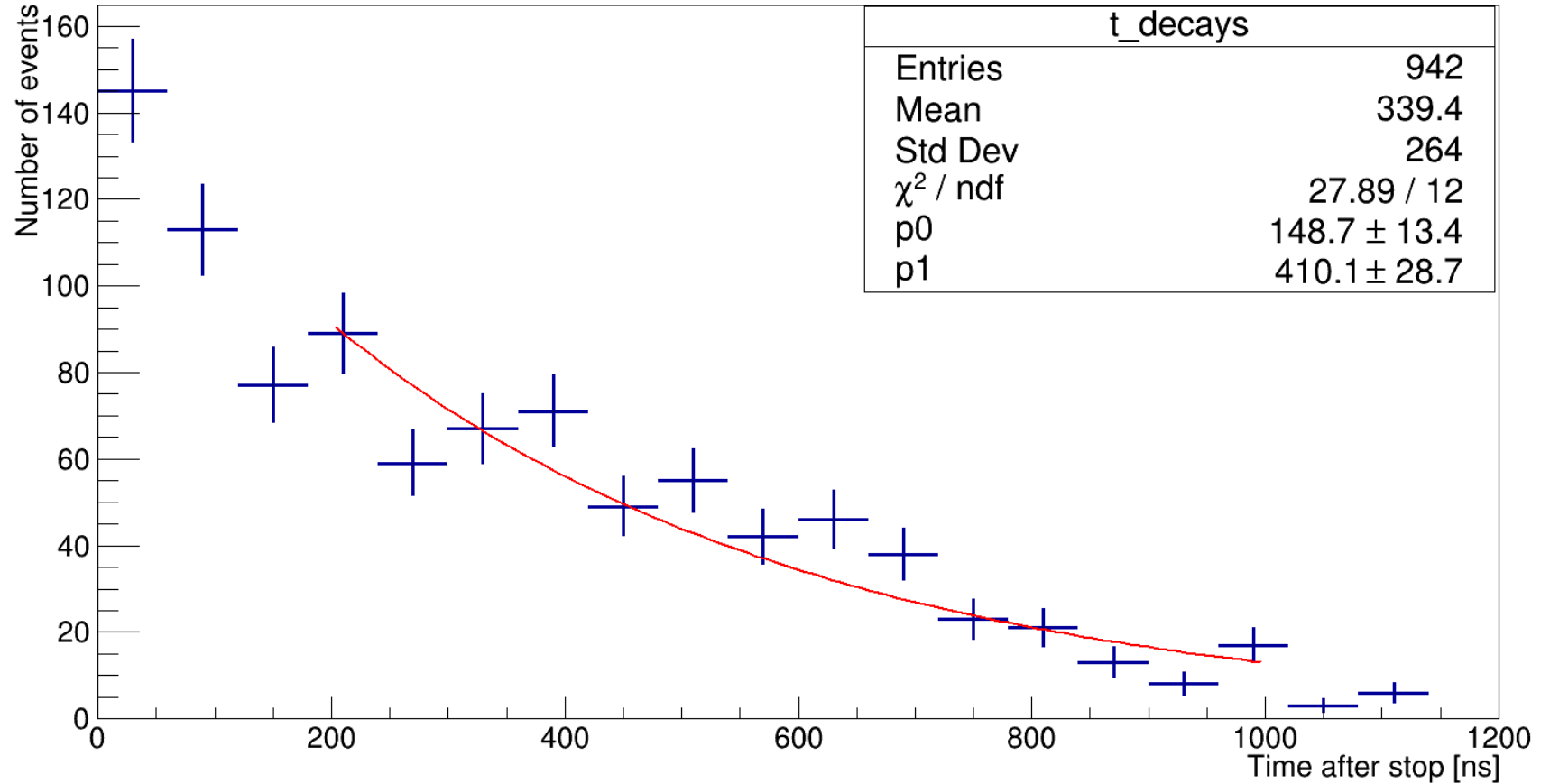


Closest DOM in 3 meters guessing efficiency 35%

Searching for decay signals in files with decays

Cuts applied:

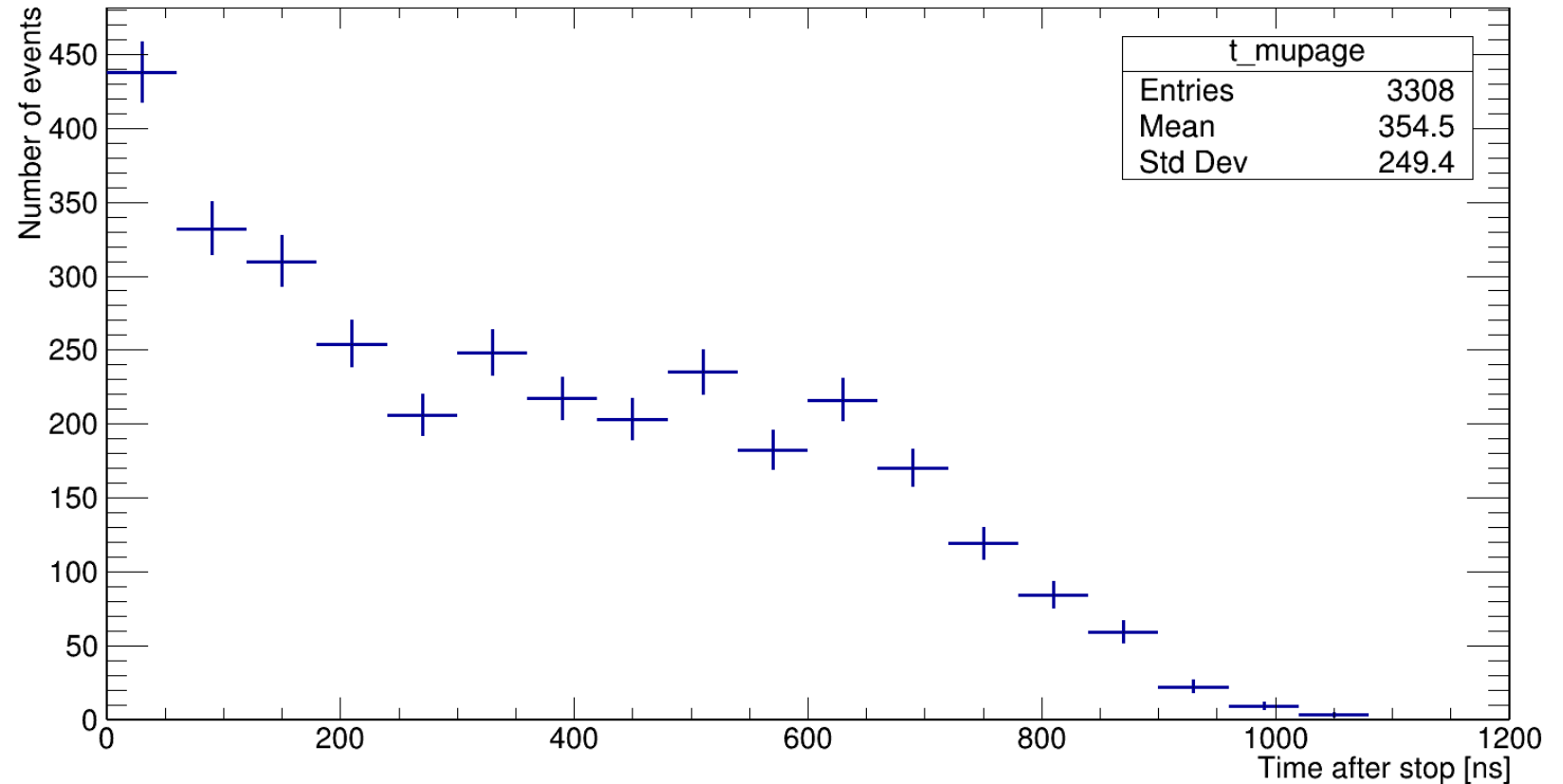
Likelihood >150
likelihood over nhits>2
Floor!=1
Floor!=2
dir_z<-0.85
of hits of track>50



Searching* for decay signals in files without decays

Cuts applied:

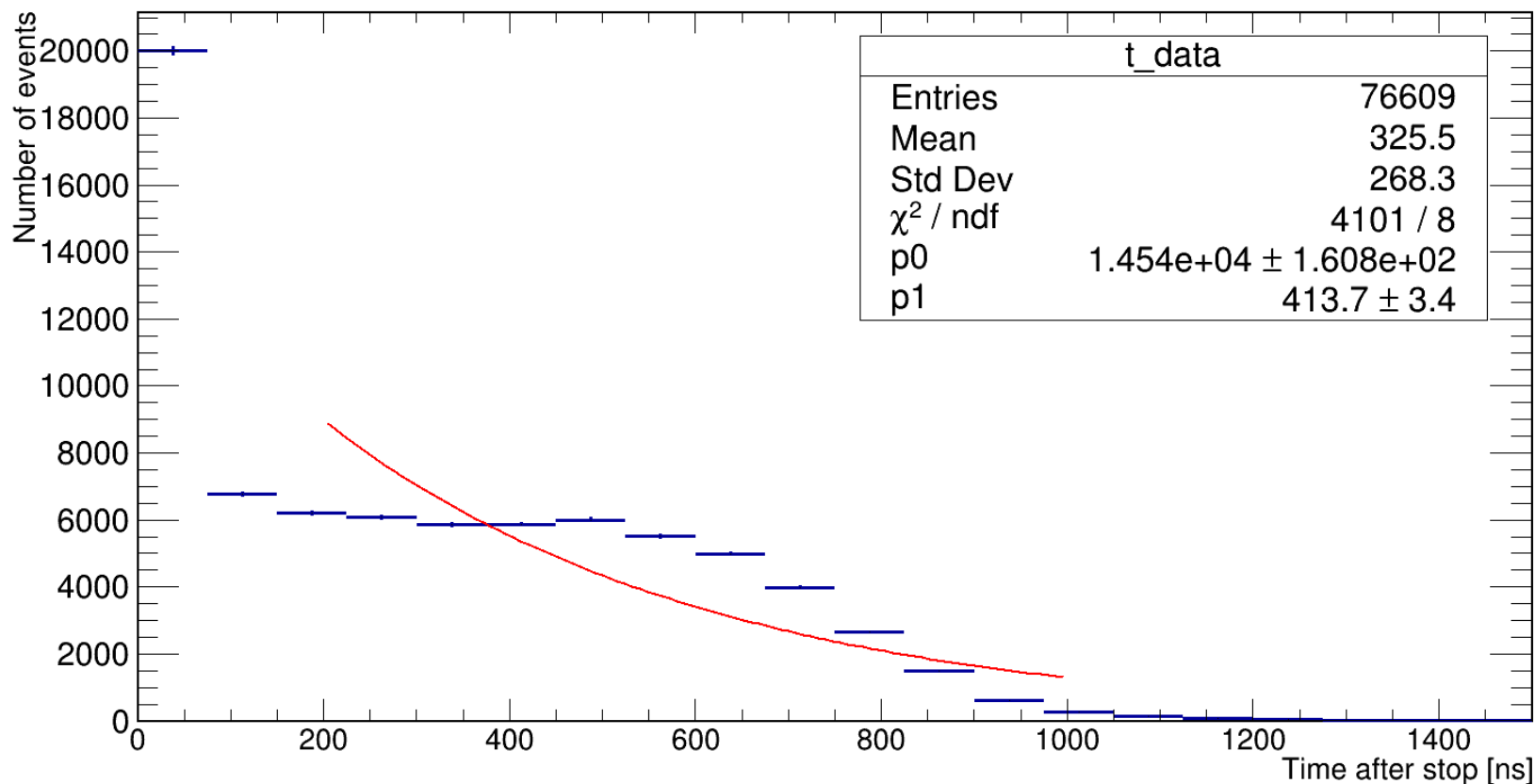
Likelihood >150
likelihood over nhits>2
Floor!=1
Floor!=2
dir_z<-0.85
of hits of track>50



Searching for decay signals in ORCA6 data

Cuts applied:

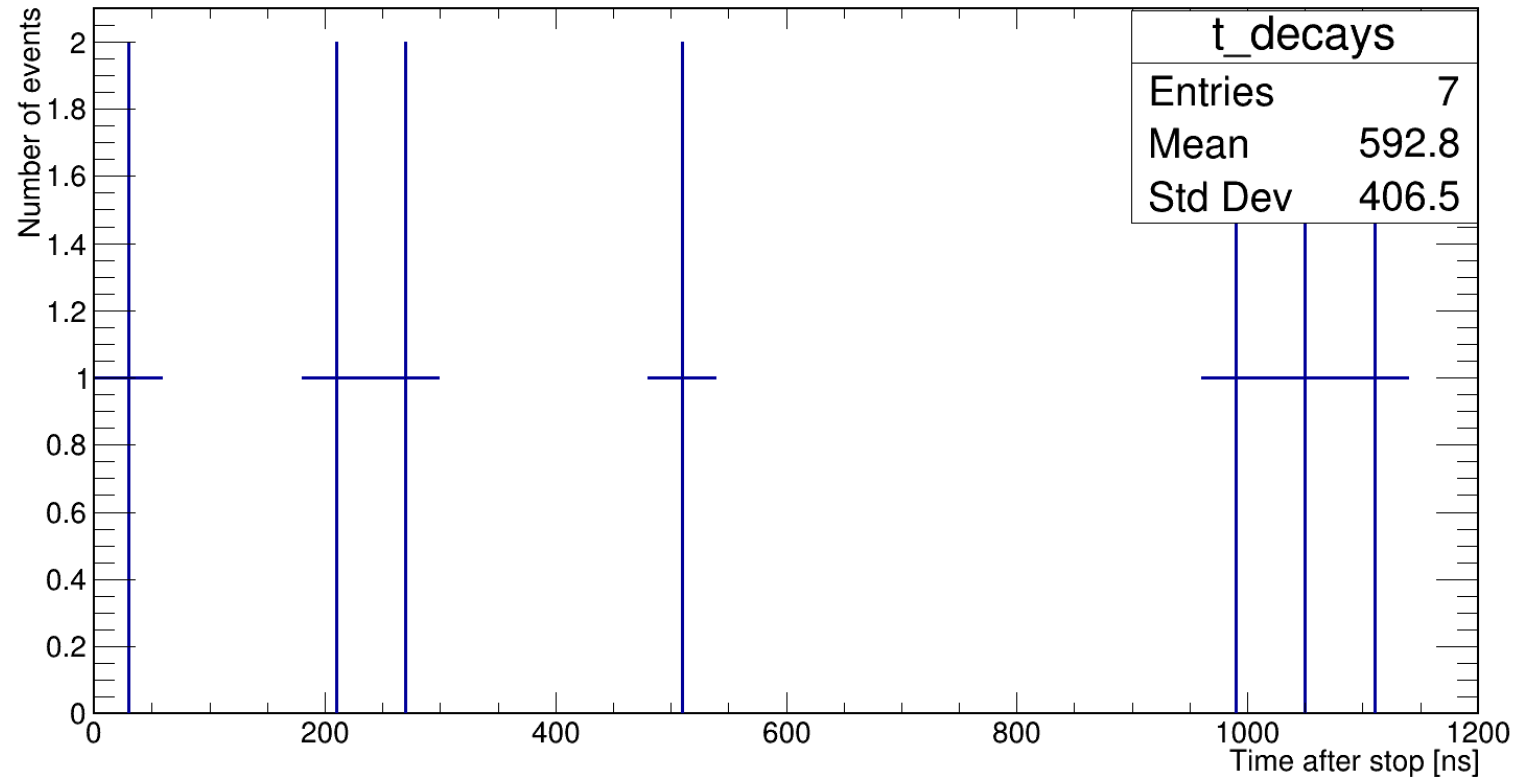
Likelihood >150
likelihood over nhits>2
Floor!=1
Floor!=2
dir_z<-0.85
of hits of track>50



Searching for decay signals in files with decays

Cuts applied:

Likelihood >150
likelihood over nhits>2
Floor!=1
Floor!=2
dir_z<-0.85
of hits of track>50
At least two hits 2ns window



Searching* for decay signals in files without decays

Cuts applied:

Likelihood >150

likelihood over nhits>2

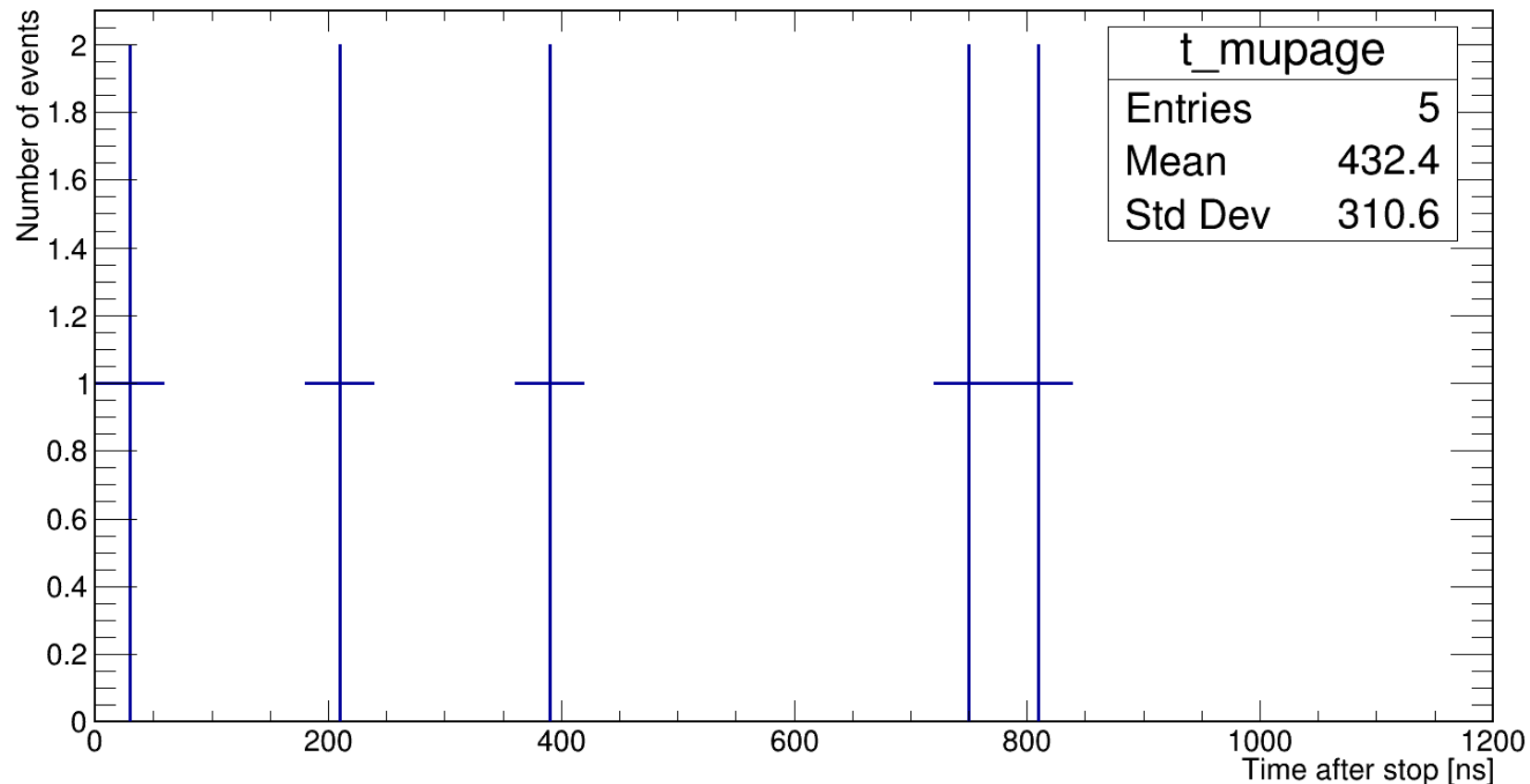
Floor!=1

Floor!=2

dir_z<-0.85

of hits of track>50

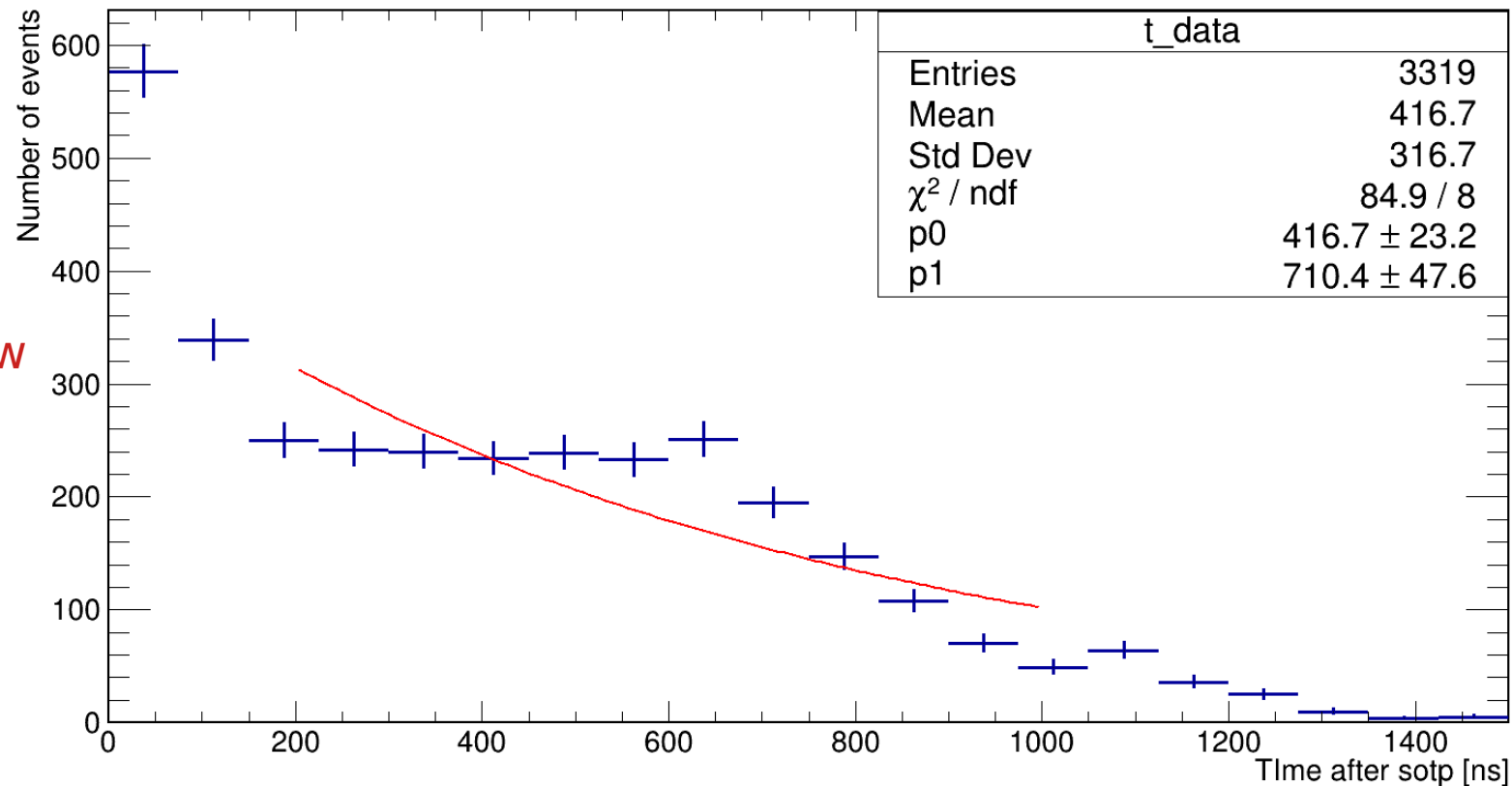
At least two hits 2ns window



Searching for decay signals in ORCA6 data

Cuts applied:

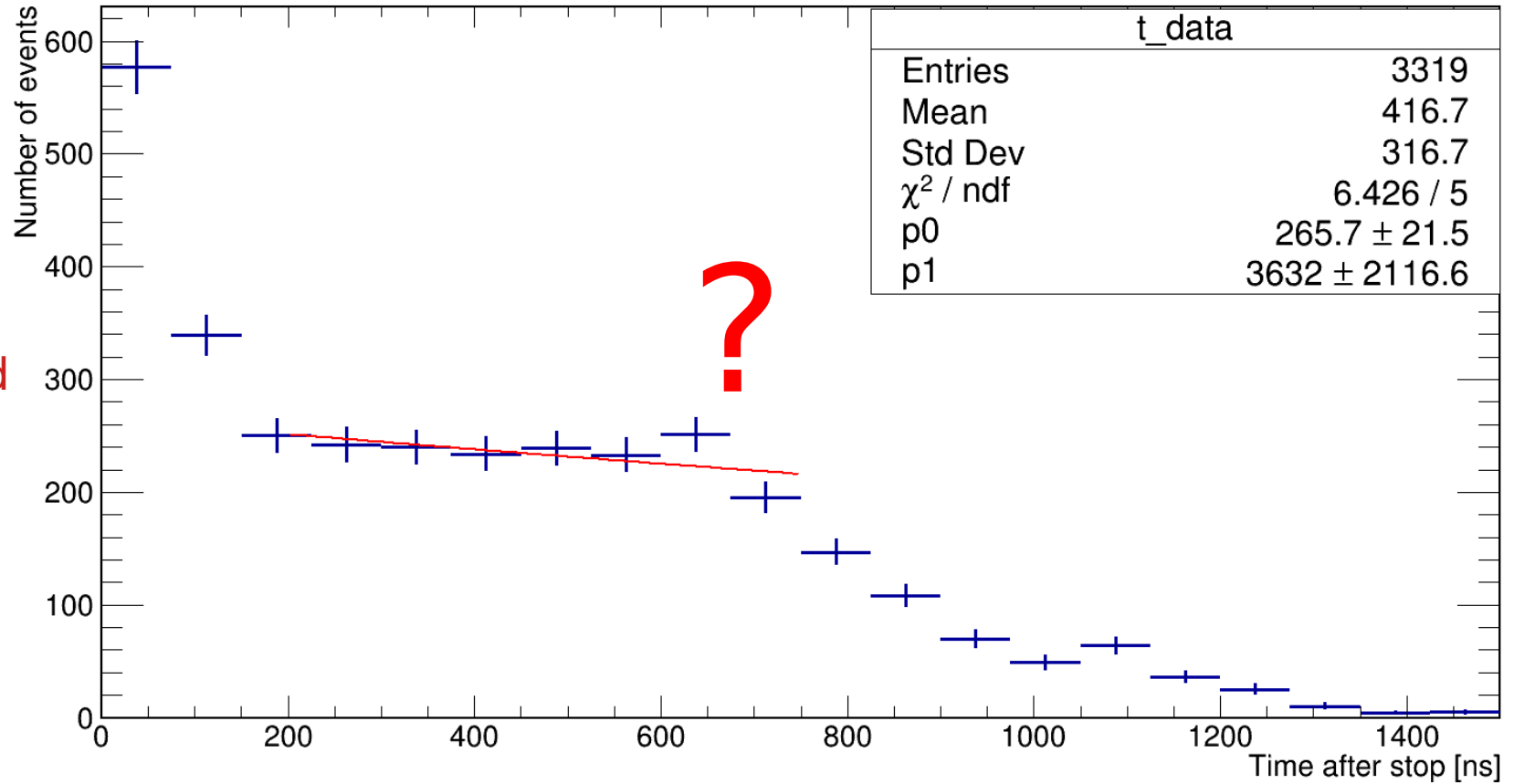
- Likelihood >150
- likelihood over nhits>2
- Floor!=1
- Floor!=2
- dir_z<-0.85
- # of hits of track>50
- At least two hits 2ns window



Searching for decay signals in ORCA6 data

Cuts applied:

- Likelihood >150
- likelihood over nhits>2
- Floor!=1
- Floor!=2
- dir_z<-0.85
- # of hits of track>50
- At least two hits 2ns wind



Summary and Outlook

- ▶ Muon decays MC signals are studied for a single DOM and ORCA6 detector
- ▶ DSTs are made for the data and MC
- ▶ Still struggling to observe the decays for data and reco MC

- ▶ Optimization of the cuts
- ▶ Searches for decays
- ▶ Sum-up the analysis for the ICRC