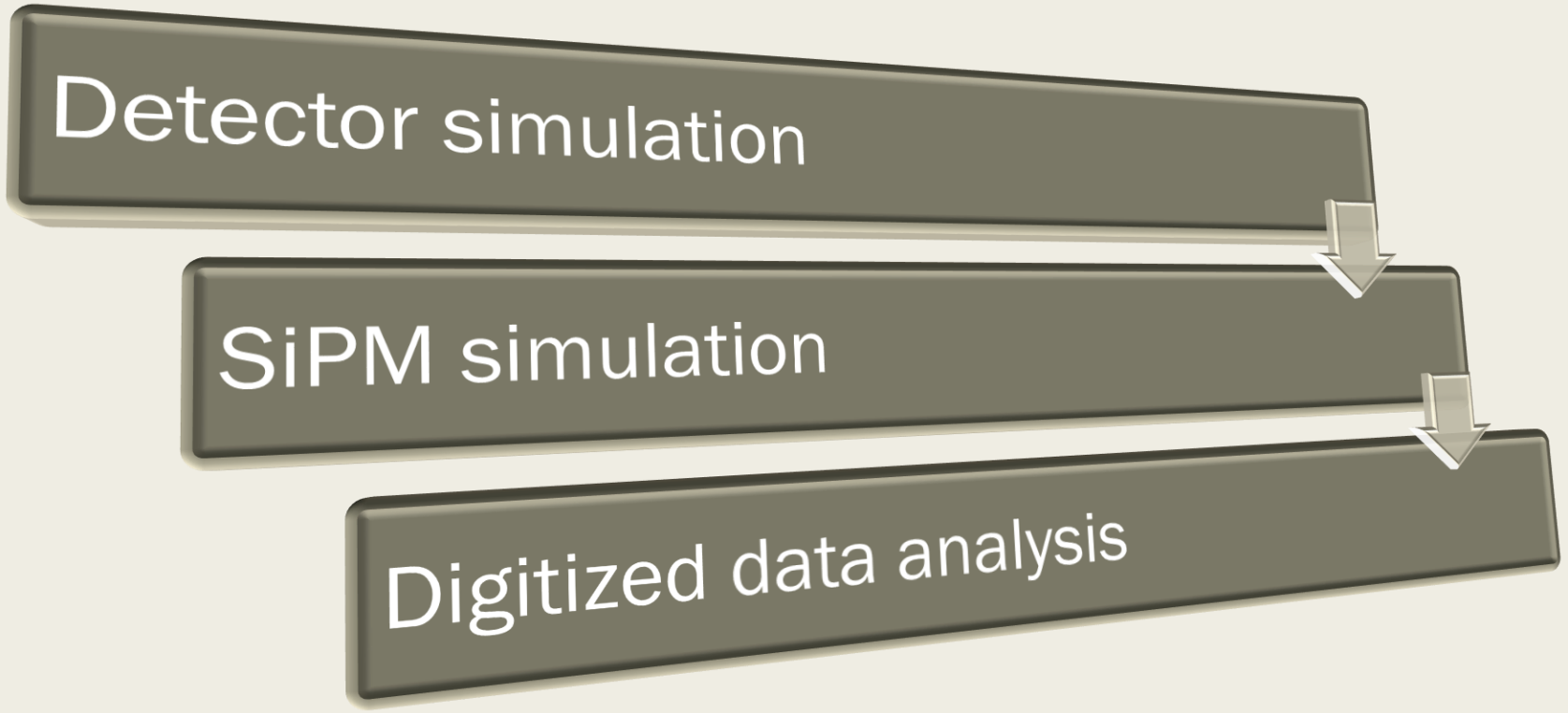
Data analysis
simulation – digitization chain

Villa Alessandro – On behalf of Pavia Group

Università degli Studi di Pavia

Simulation and digitization chain



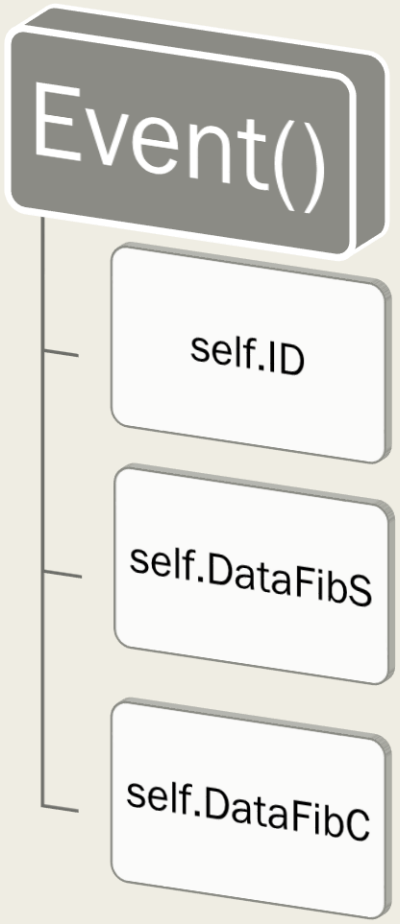
Notes

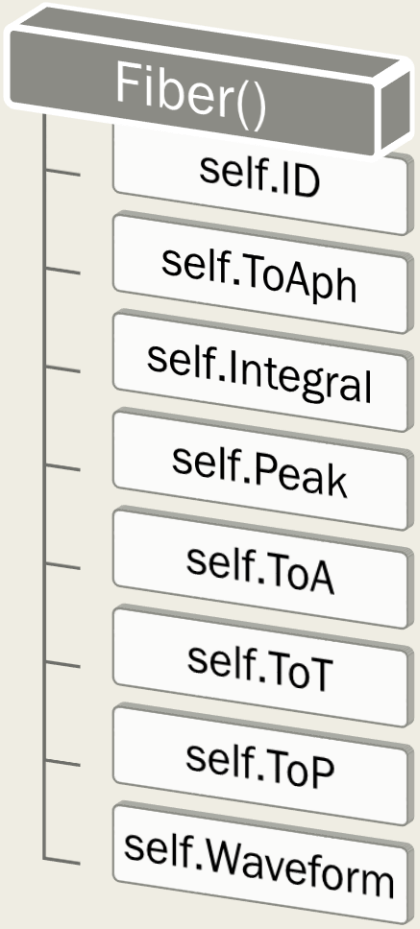
- Error compiling Fortran libraries:
  Error: Keyword argument requires explicit interface for procedure 'findloc'
  src/FortranFunctions.f90 [155] ~~toa = findloc(signalingate > 1.5, .true., dim = 1)~~

- Decreased signal points precision from float32 to float16:
  Launcer.py [39] signals = np.empty((NFIB, SIGPTS), dtype='float16')
- Decreased sampling rate from 10 GHz to 1 GHz:
  Variables.py [70] SAMPLING = 1

- Simulations of **40 GeV electron** and **40 GeV pion** (1000 events each)

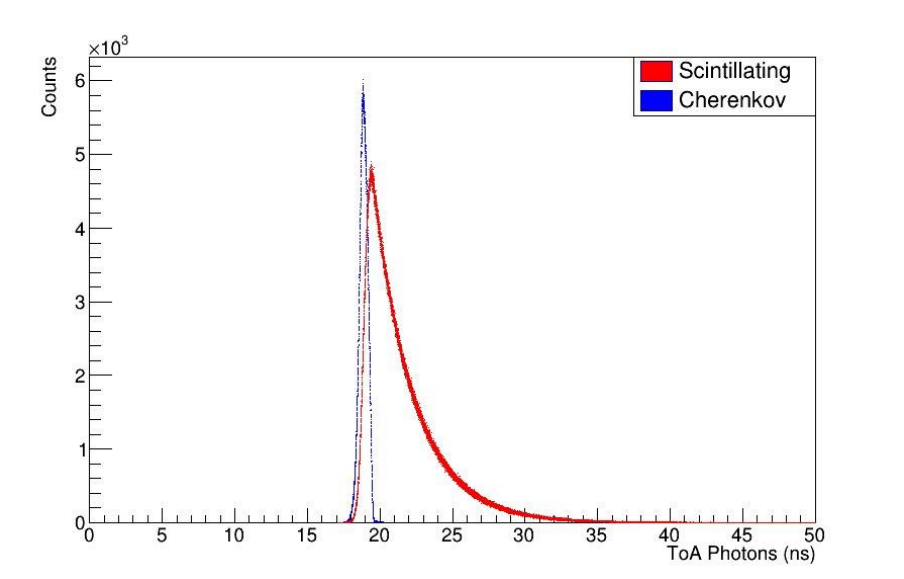
Our Classes


Event()
self.ID
self.DataFibS
self.DataFibC

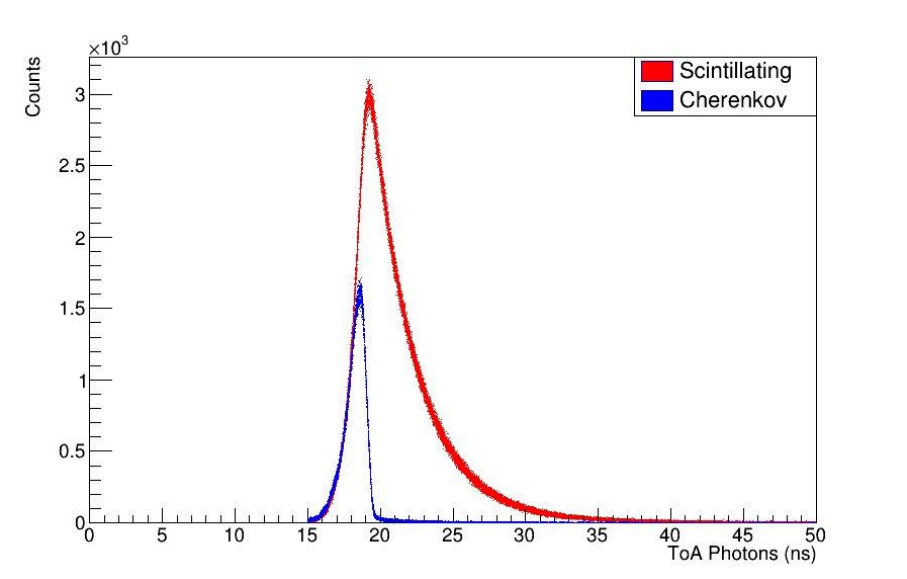

Fiber()
self.ID
self.ToAph
self.Integral
self.Peak
self.ToA
self.ToT
self.ToP
self.Waveform

What are we simulating with Geant4?

Time of arrival of photons
40 GeV electron



Time of arrival of photons
40 GeV pion



Note: Scintillating times show a long tail due to the characteristic emission time of Polystyrene

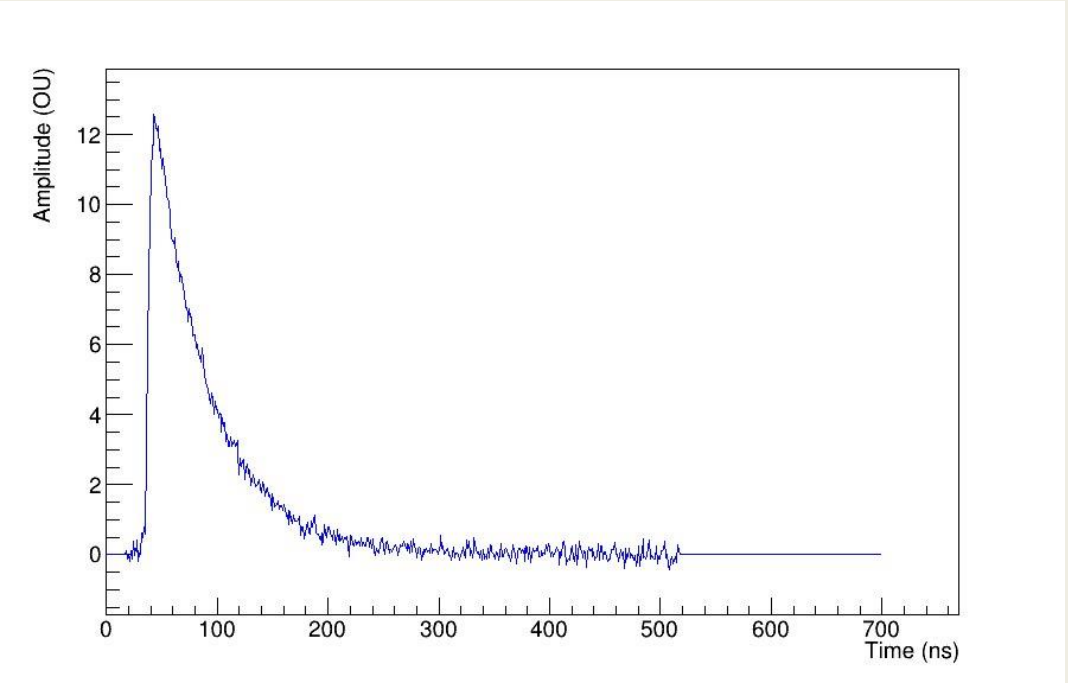
«Standard» signal

Each SiPM gives a signal of 500 ns lenght, but the start is independent from the other SiPMs

We performed a time shift to be consistent with the clock of the simulation

We set the starting time of each SiPM as the time of its trigger plus the time the first photon reach it

So we shifted the signals of each SiPM for the time used by the first photon to reach the SiPM



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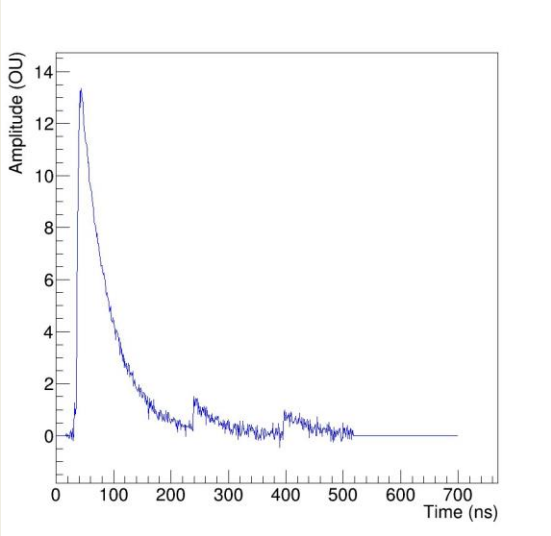
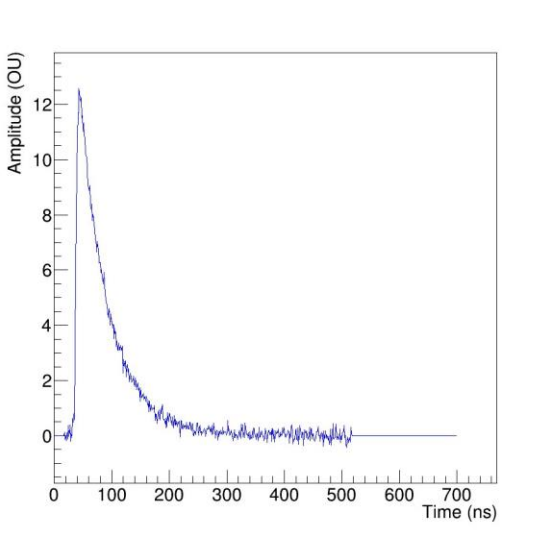
Modifying SiPM parameters

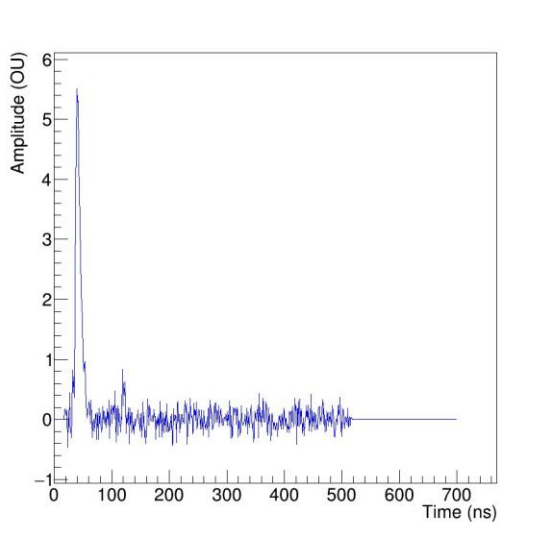
Rise Time = 0.1 ns
Fall Time = 50 ns



Rise Time = 1 ns
Fall Time = 50 ns



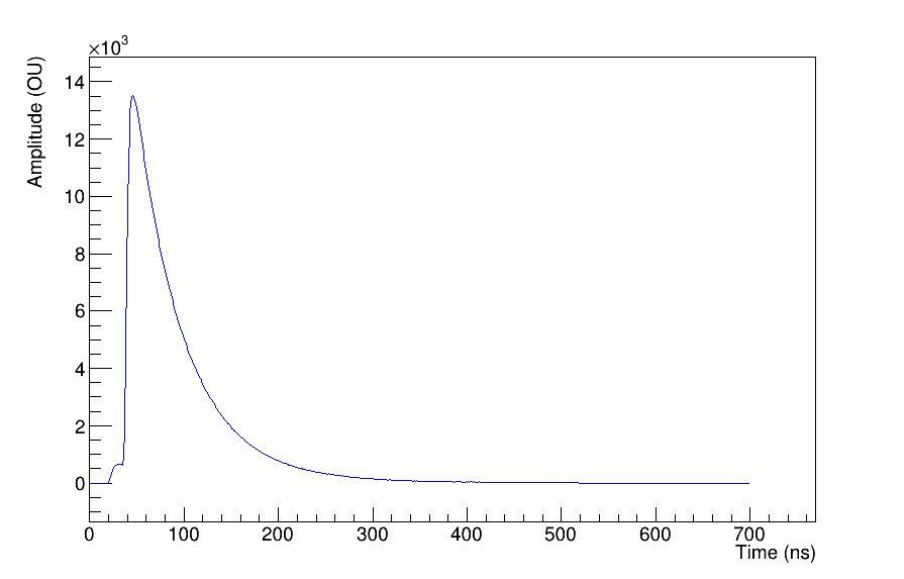
Rise Time = 1 ns
Fall Time = 5 ns



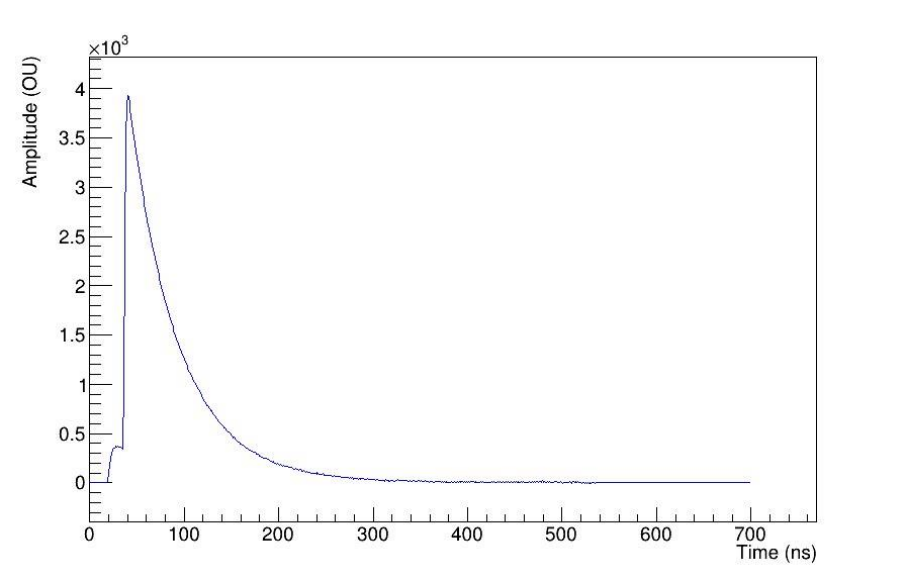
Note: Not fully reproducible signals due to random seed for noise generation

Analog sum of signals (40 GeV electron)

Scintillating fiber

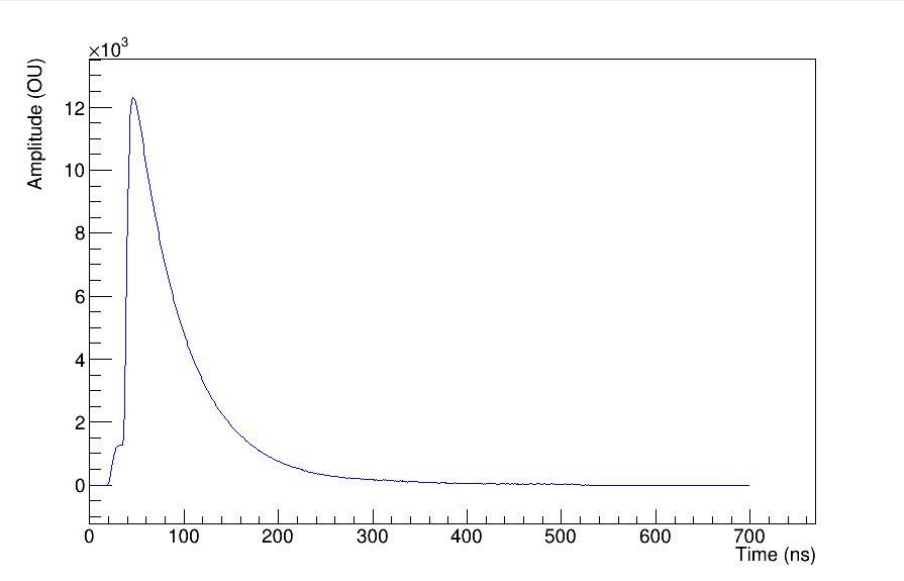


Cherenkov fiber

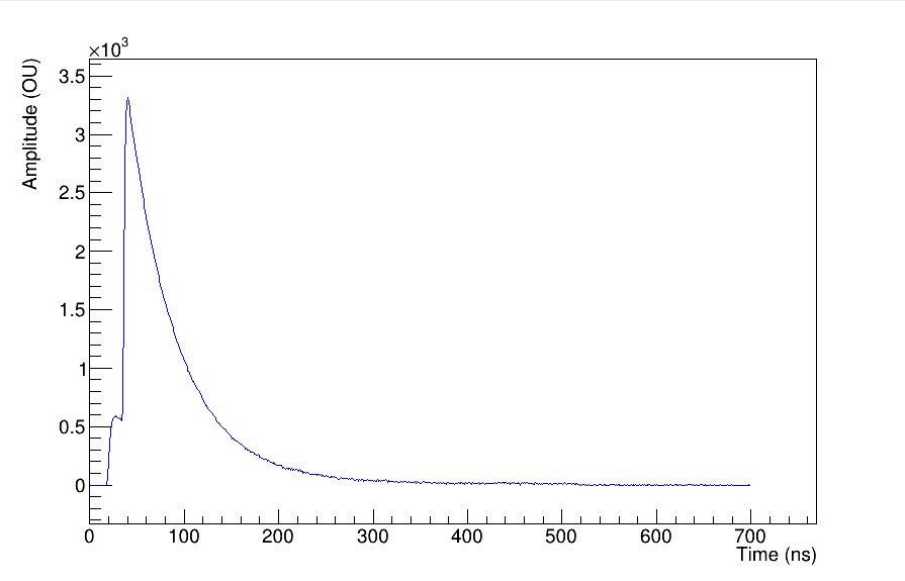


Analog sum of signals (40 GeV pion)

Scintillating fiber



Cherenkov fiber

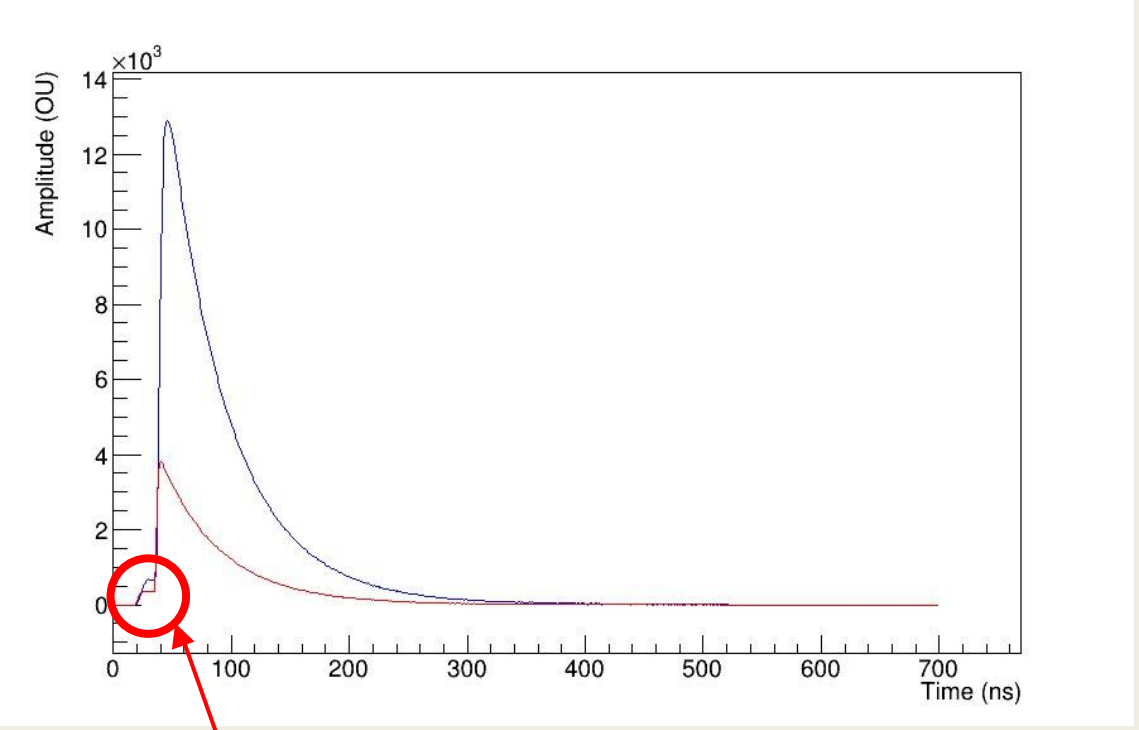


Analog sum of signals in each event

The height shows the difference between scintillating and Cherenkov signals

The Cherenkov peak comes at lower time (40 ns), because scintillating peak is retarded (46 ns) due to the characteristic emission time of Polystyrene

40 GeV electron



Why is there this step?

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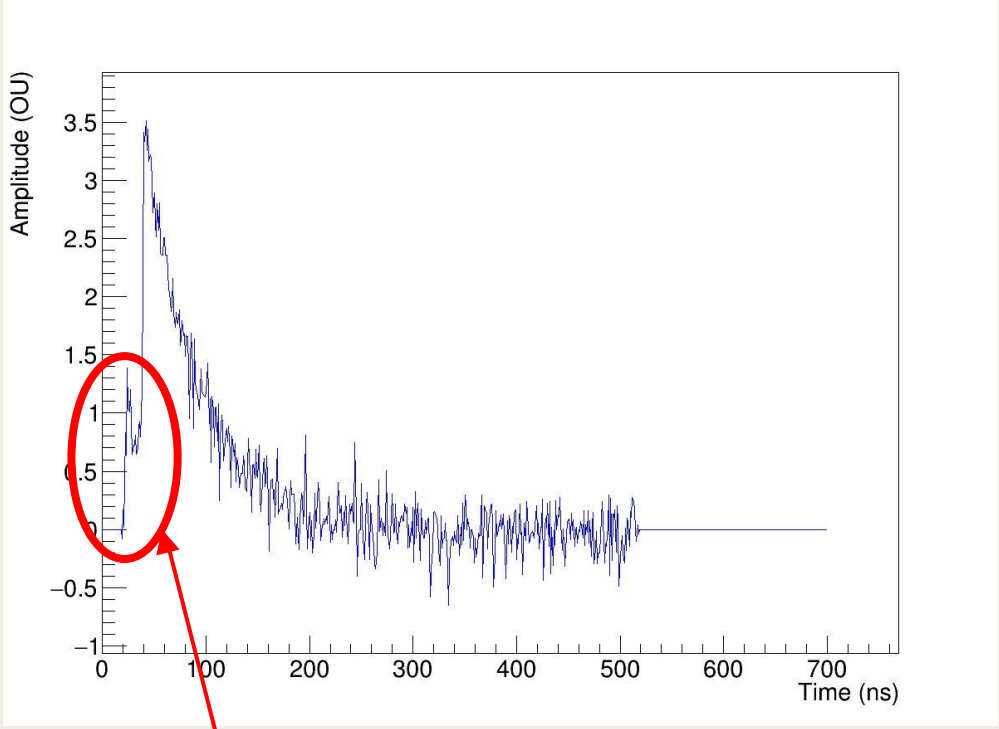
Where the step come from?

This type of step appears in several signals

It is greater than the electronic noise and it comes 10~15 ns earlier than the expected peak

Is it part of the pySiPM simulation or it is just a bunch of early photons?

Further analysis will be done to evaluate the conditions under which two following photons are distinguishable



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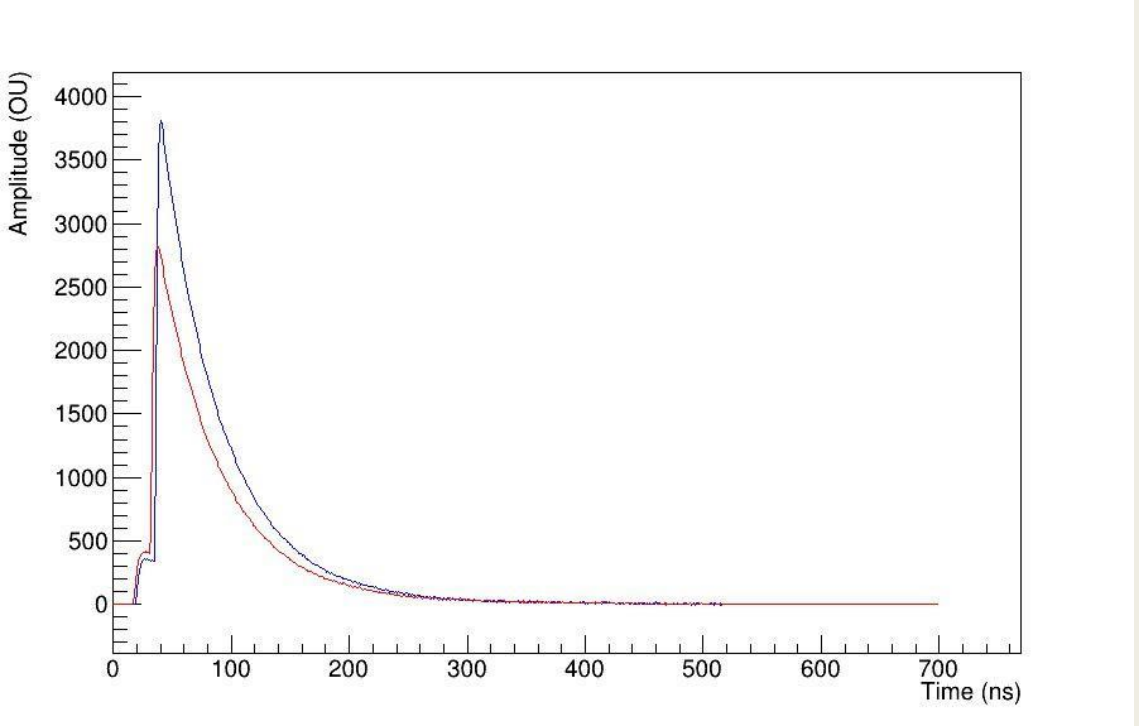
Analog sum of signals in one event

Here is shown the sum of Cherenkov signals generated from both electron and pion

The two peaks are separated for 3 ns (t_pion = 37 ns, t_electron = 40 ns)

Further analysis will be done to evaluate the possibility to distinguish electron and pion from this distribution

Cherenkov fibers



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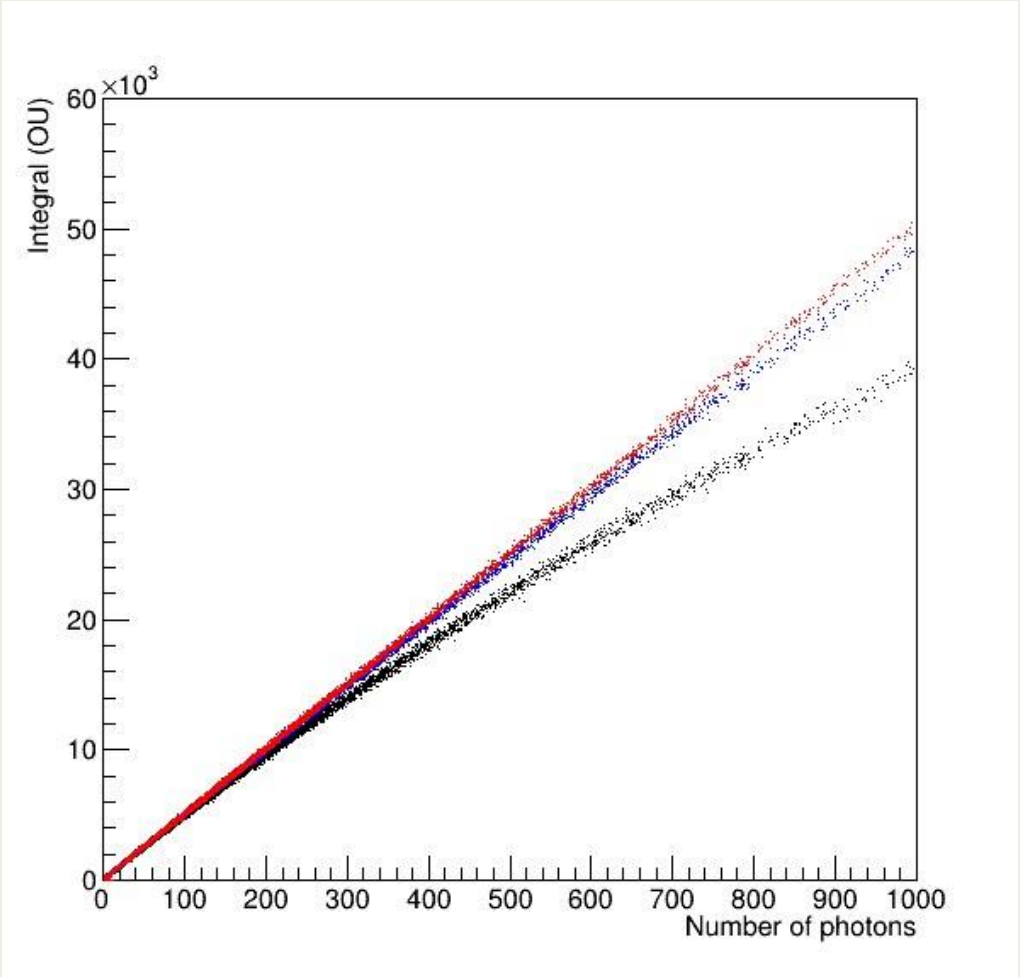
Correlation between integral and number of photons from Geant4 (PDE)

Three configurations of SiPM parameters:

- SIZE = 1 mm CELLSIZE = 25 µm
- SIZE = 1 mm CELLSIZE = 10 µm
- SIZE = 1 mm CELLSIZE = 1 µm



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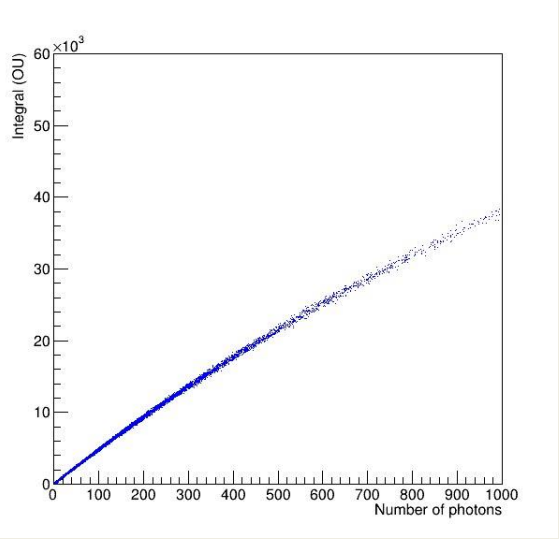
Modifying SiPM noise

DCR = OFF
Crosstalk = 1 %
Afterpulse = 3 %

DCR = 200 kHz
Crosstalk = OFF
Afterpulse = 3 %

DCR = 200 kHz
Crosstalk = 1 %
Afterpulse = OFF



Further analysis using correlation coefficient to quantify noise influence

Questions

- Which unit of measure are used for integral and signal amplitude?
- Why is ToA not filled correctly?
- Is it possible to fix random seed of noise events in order to have completly reproducible signals?
- Photons ToA from Geant4 is approximately 18~20 ns, why signals ToA are peaked at 69~70 ns?
- pySiPM options «–NDCR» «–NXT» return error:
  ValueError: failed to create intent(cache|hide)|optional array-- must have defined dimensions but got (-1,)

- Are there any further results you would like to see?