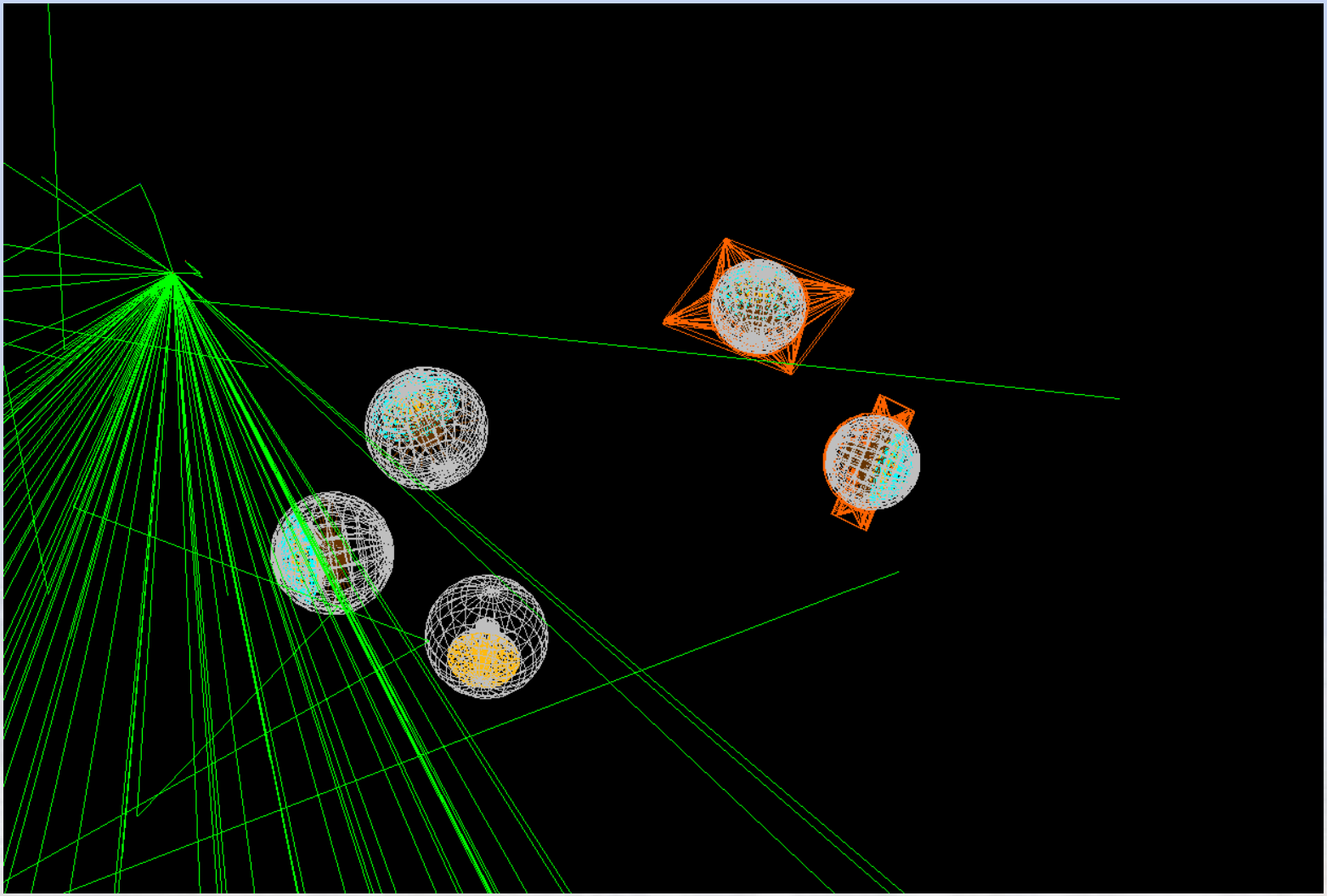
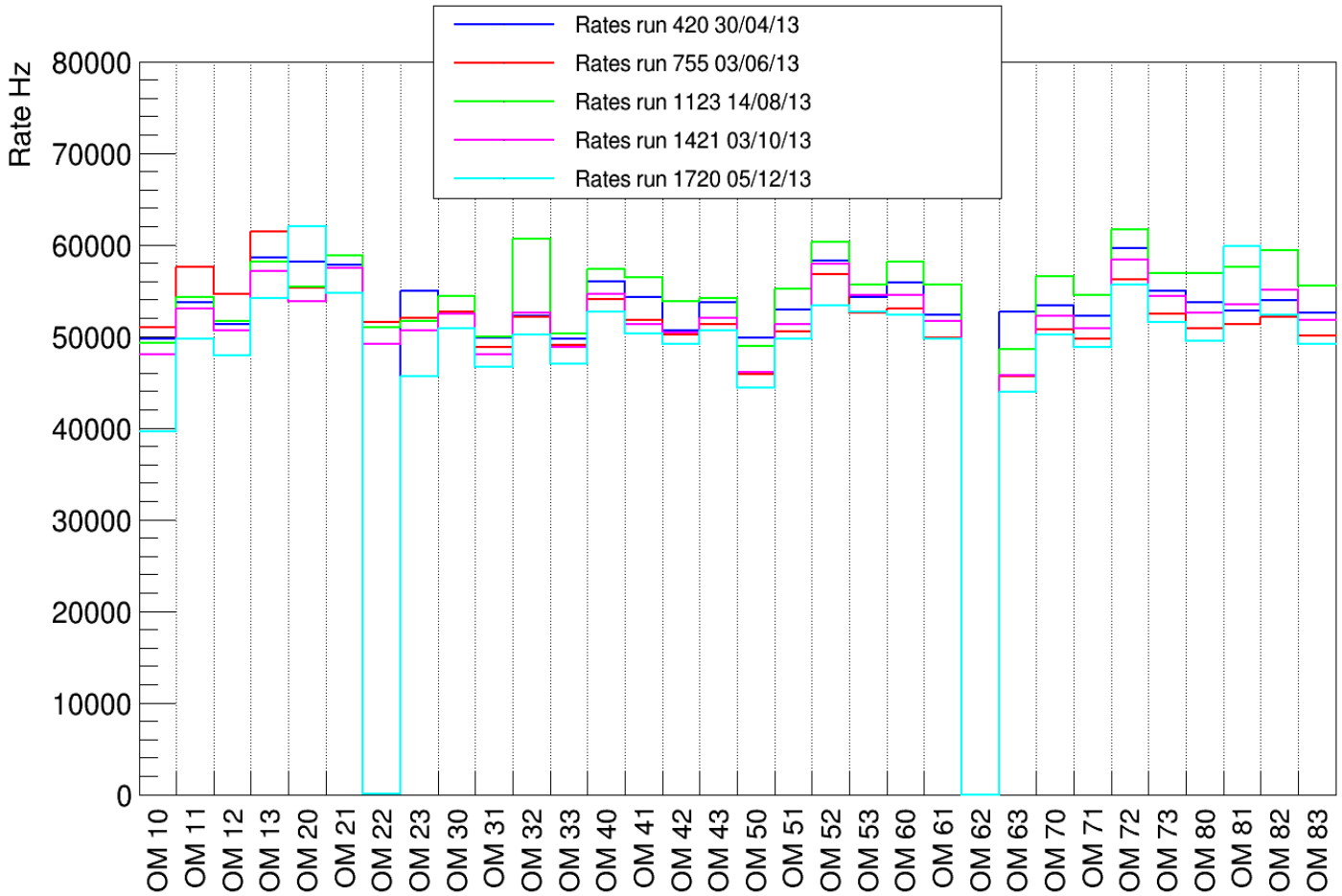
Part I: ^{40}K analysis results



Few word about the analysis

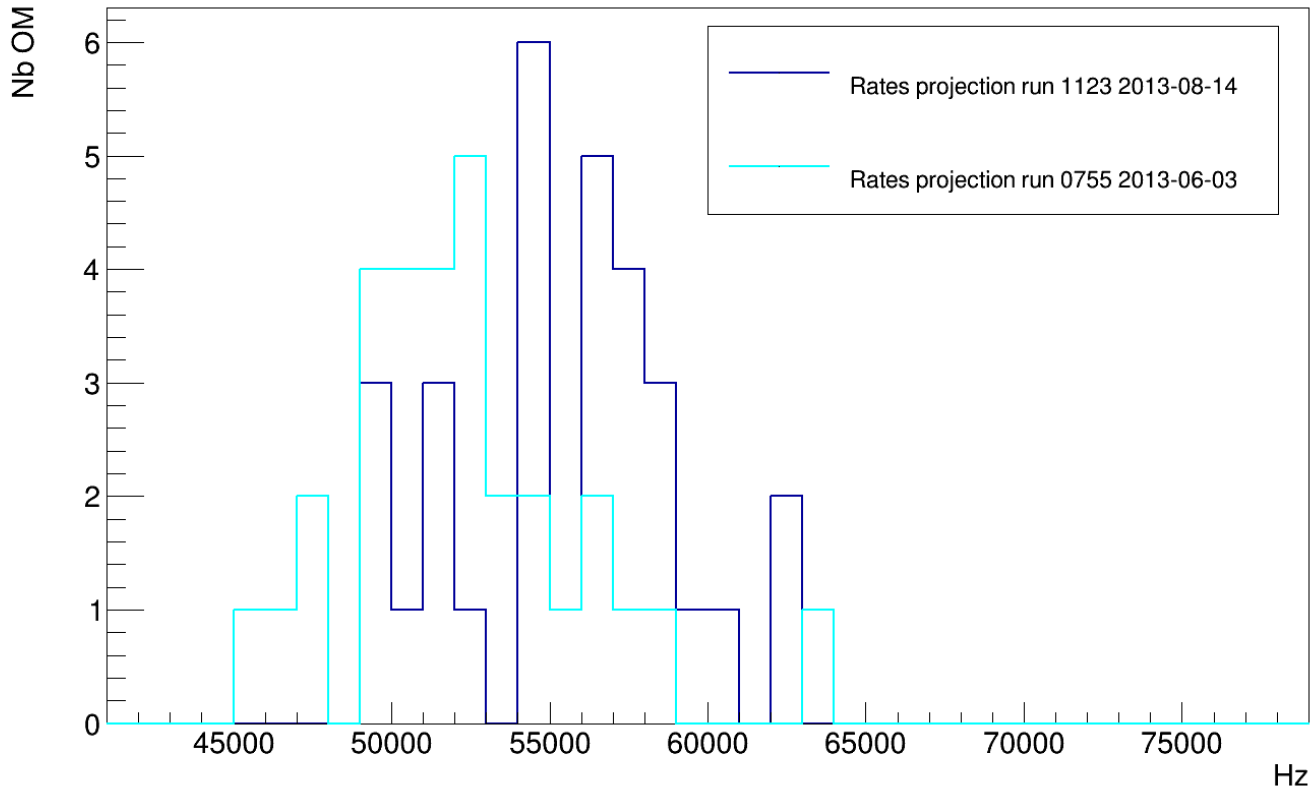
- The used software is NReader
  - Presented in previous collaboration meetings
  - Code and full documentation available here:
    http://www.ge.infn.it/~chugon/NReader/documentation/html/
- Only events from the random trigger are kept
- The data are from April to December 2013

Total rate



Total rate at ~55 kHz. Quite stable in time.

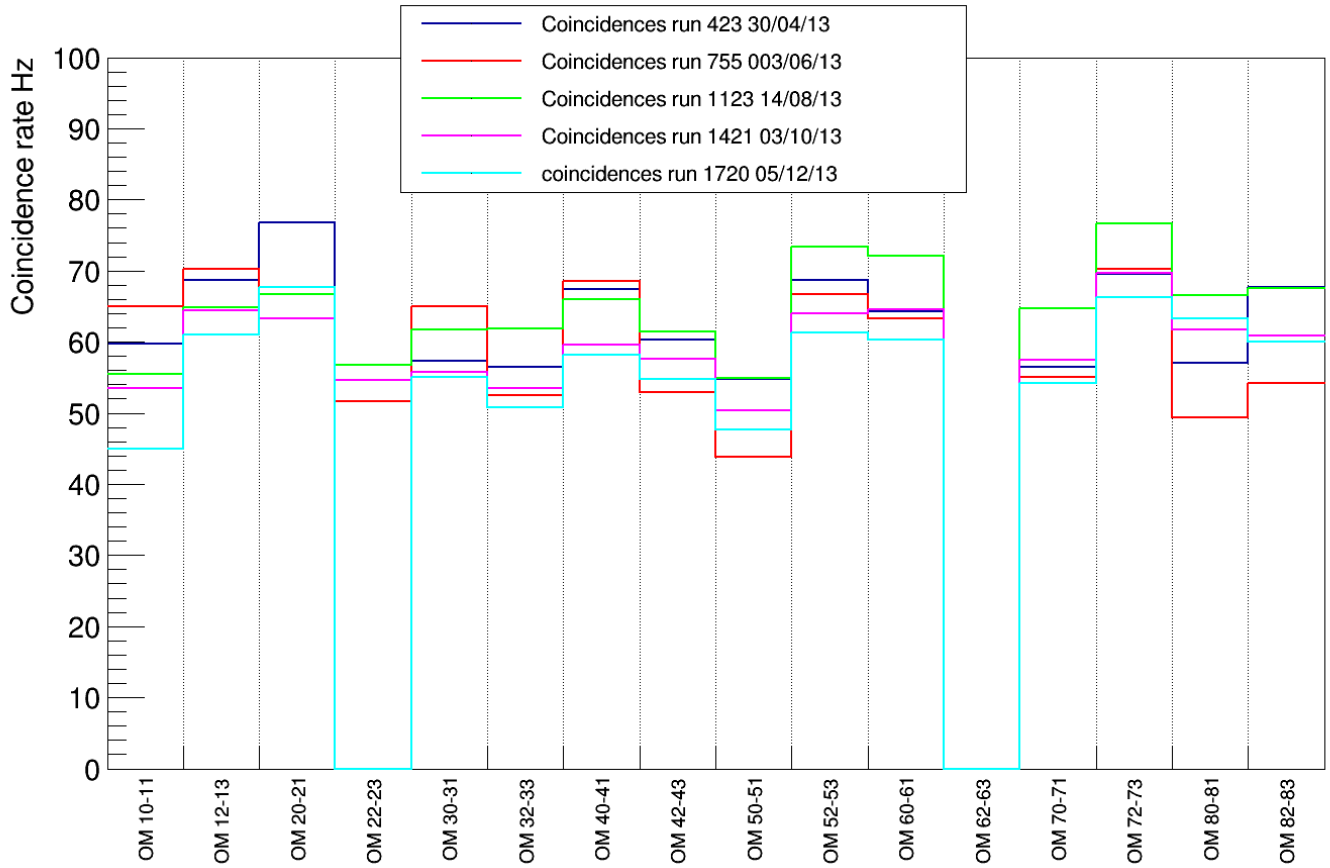
Total rate



Example of projection for two runs

Total rate at ~55 kHz. Quite stable in time.

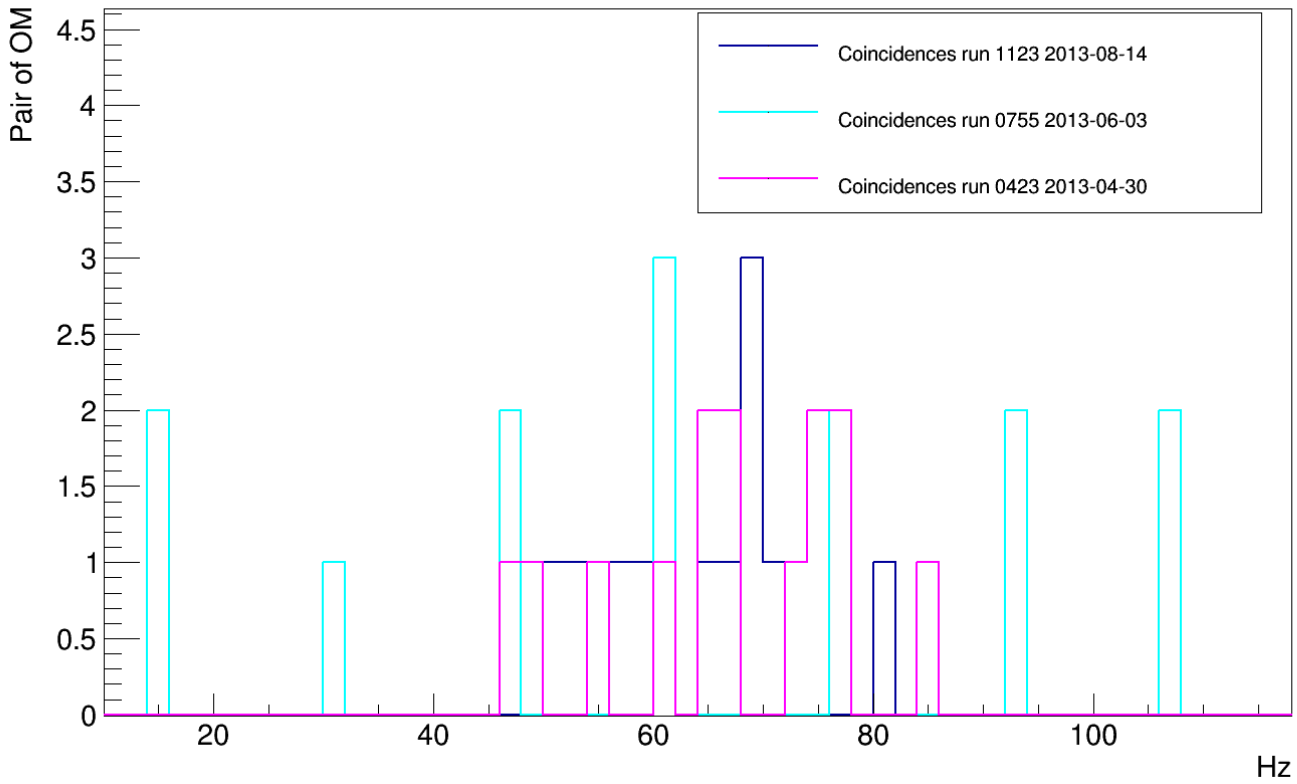
Coincidence rate



Coincidence rate at ~60 Hz. Quite stable in time.

$55^2 * 10ns = 36$ Hz of random coincidence expected in a 10 ns window
=> ~20 Hz of expected ^{40}K events

Coincidence rate

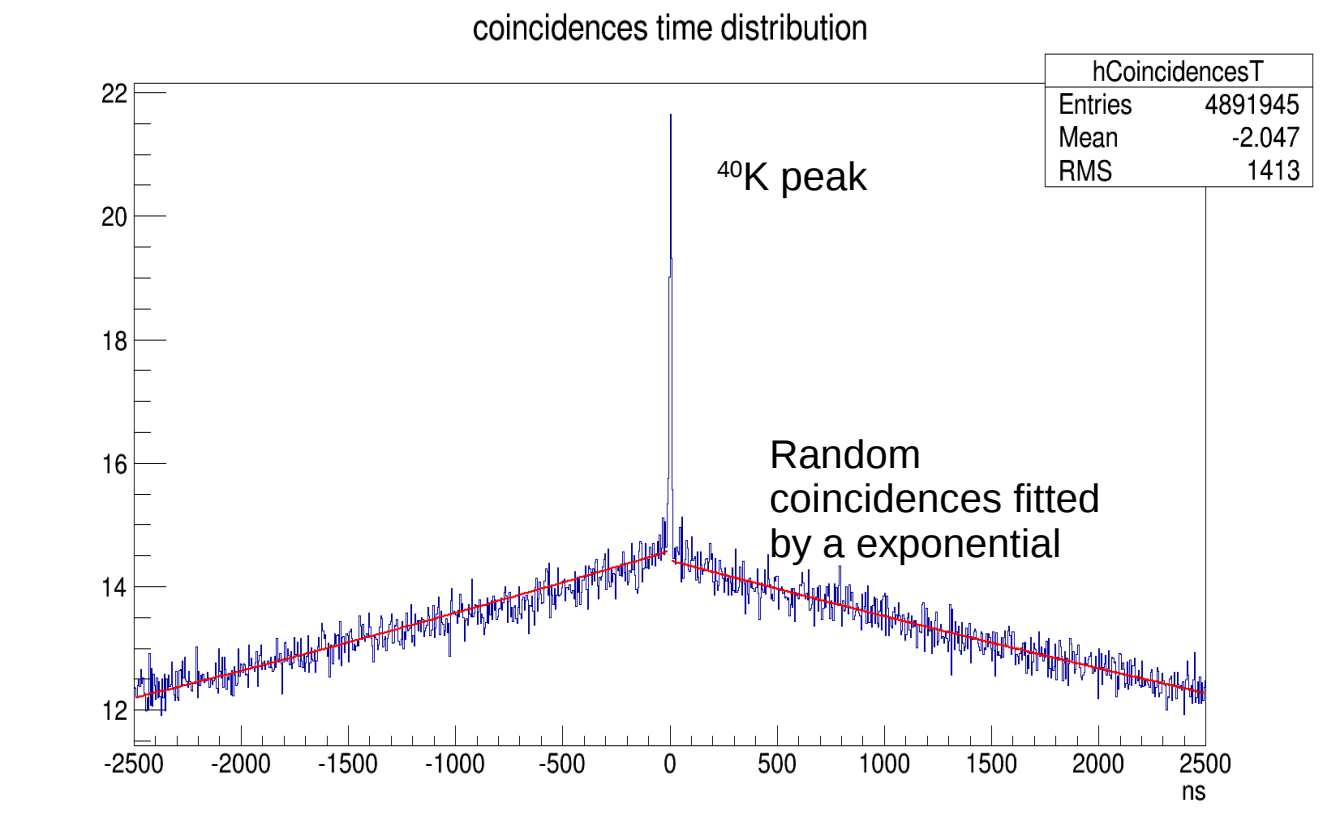


Example of Projection for three runs. The distribution seems straigther with time (PM tuning ?)

Coincidence rate at ~60 Hz. Quite stable in time.

$55^2 * 10ns = 36$ Hz of random coincidence expected in a 10 ns window

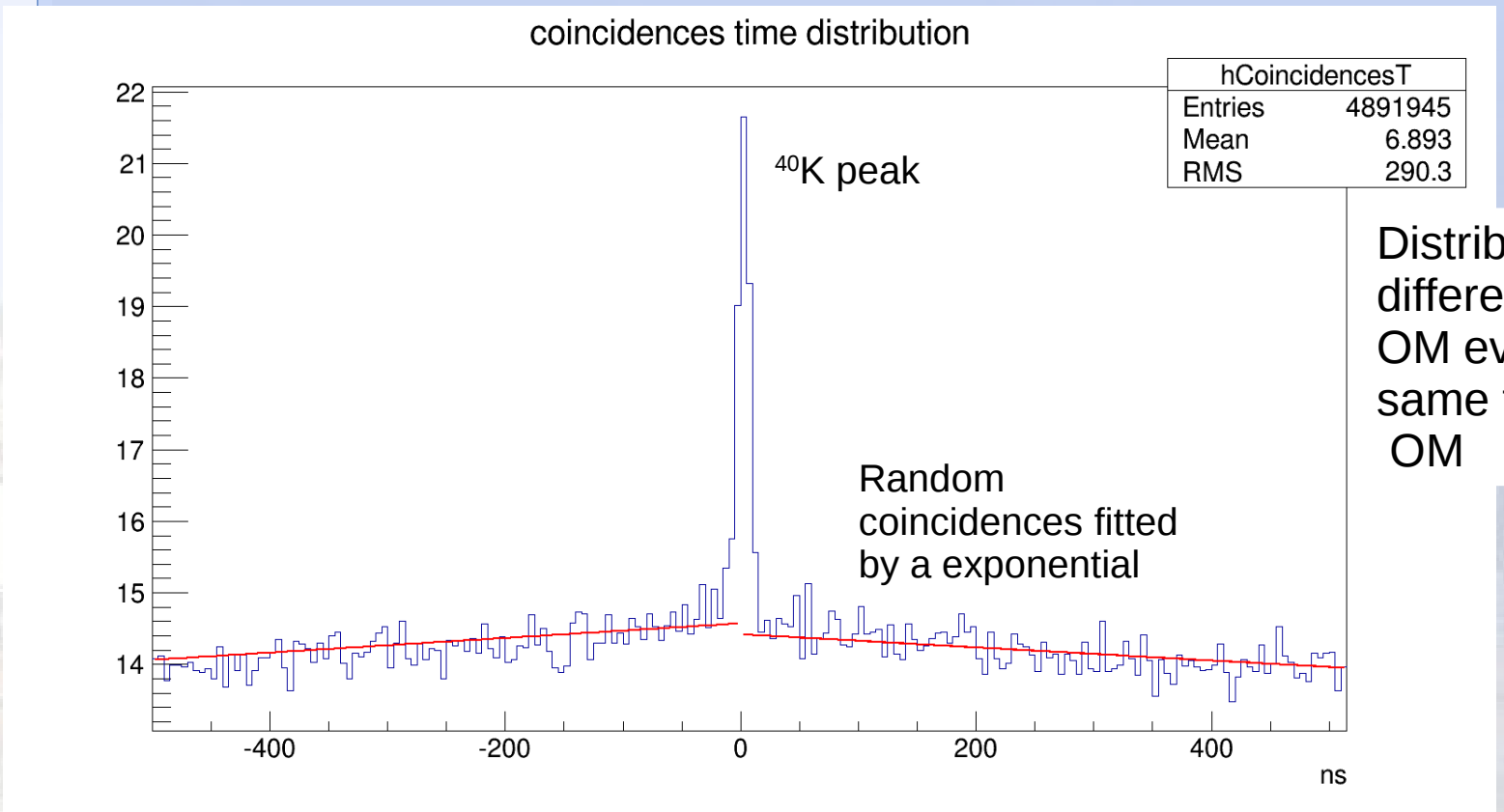
^{40}K estimation from fit



Run 1023 is taken for the illustration.

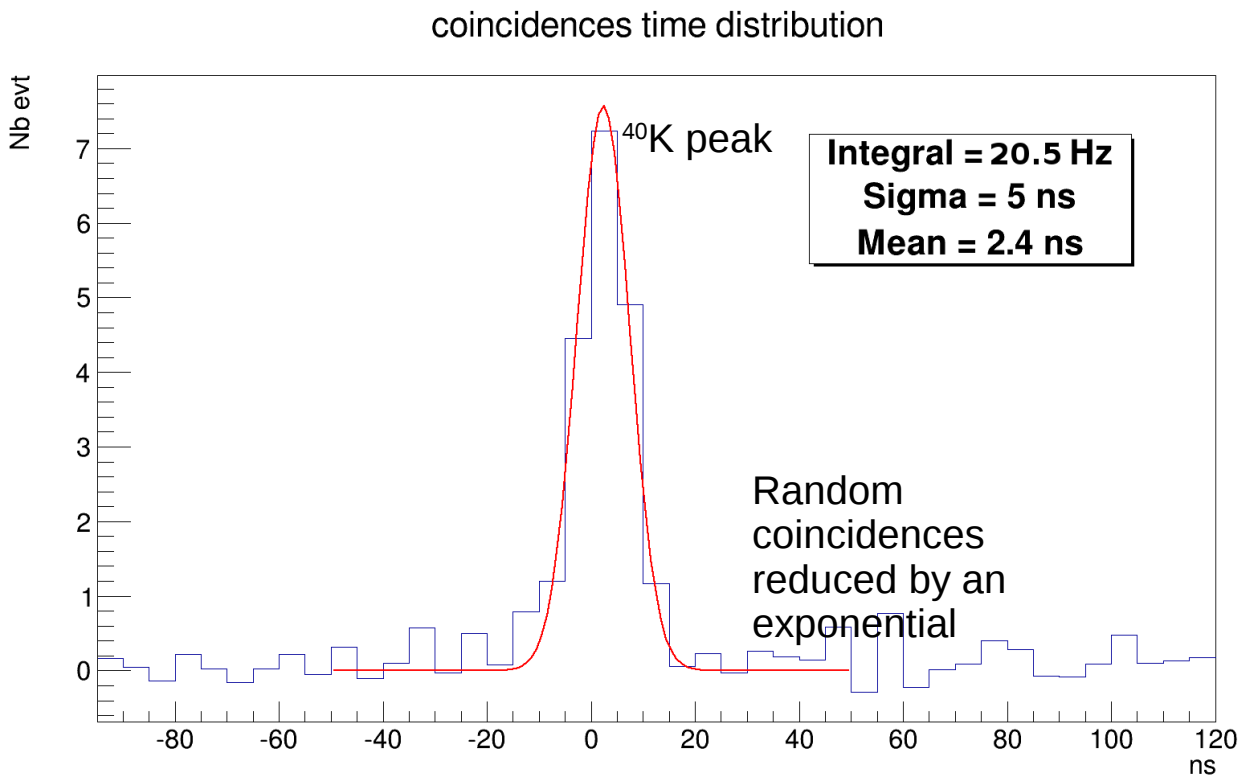
Distribution of difference of times of OM event between same floor same side OM

^{40}K estimation from fit



Distribution of difference of times of OM event between same floor same side OM

^{40}K estimation from fit

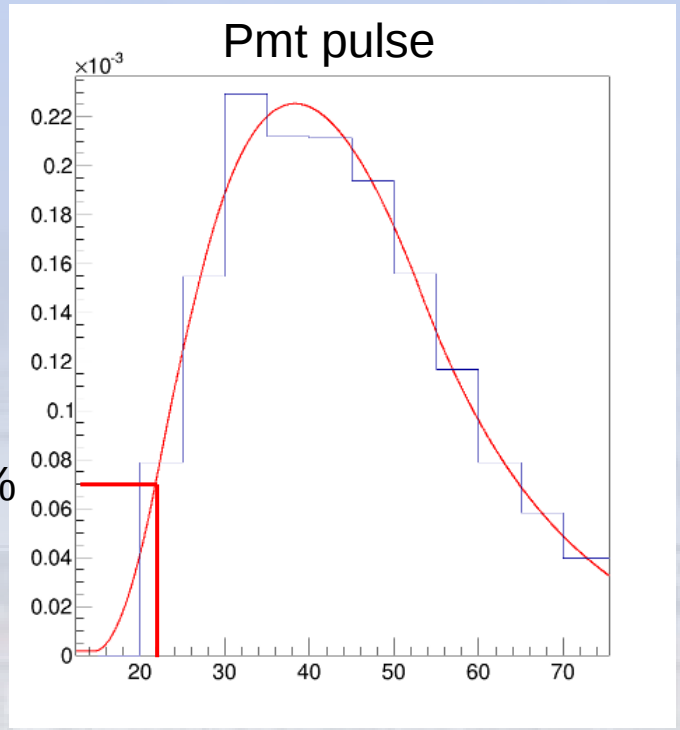


Enough significant bins to be meaningful (should be at least >3 for a Gaussian fit)

Distribution of difference of times of OM event between same floor same side OM

20.5 Hz of ^{40}K coincidences

Bonus slides: test of the Fit Method



30 %

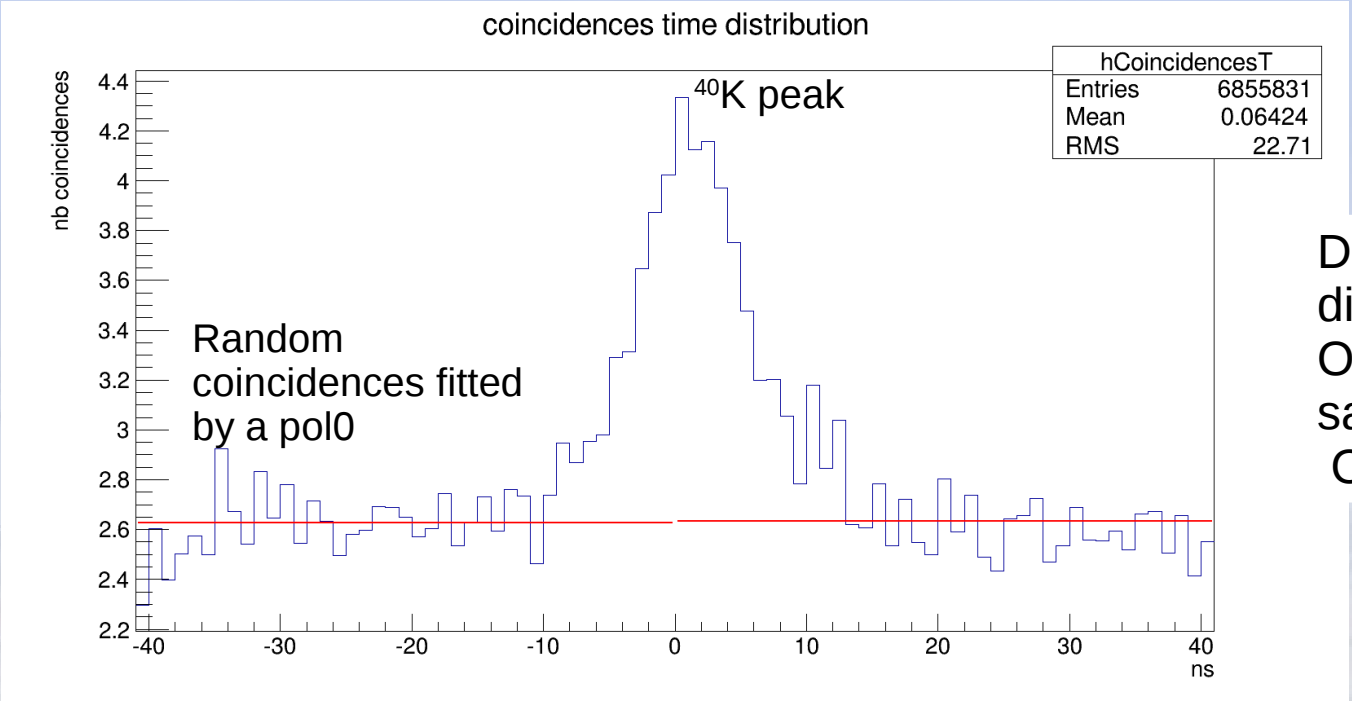
Given by a 3 parts mathematical approach
Permit to take in account the full pulse

Can decrease the resolution from 5 ns to less than 1 ns (see examples)

Successfully used for time calibration tests (see previous collaboration meetings)

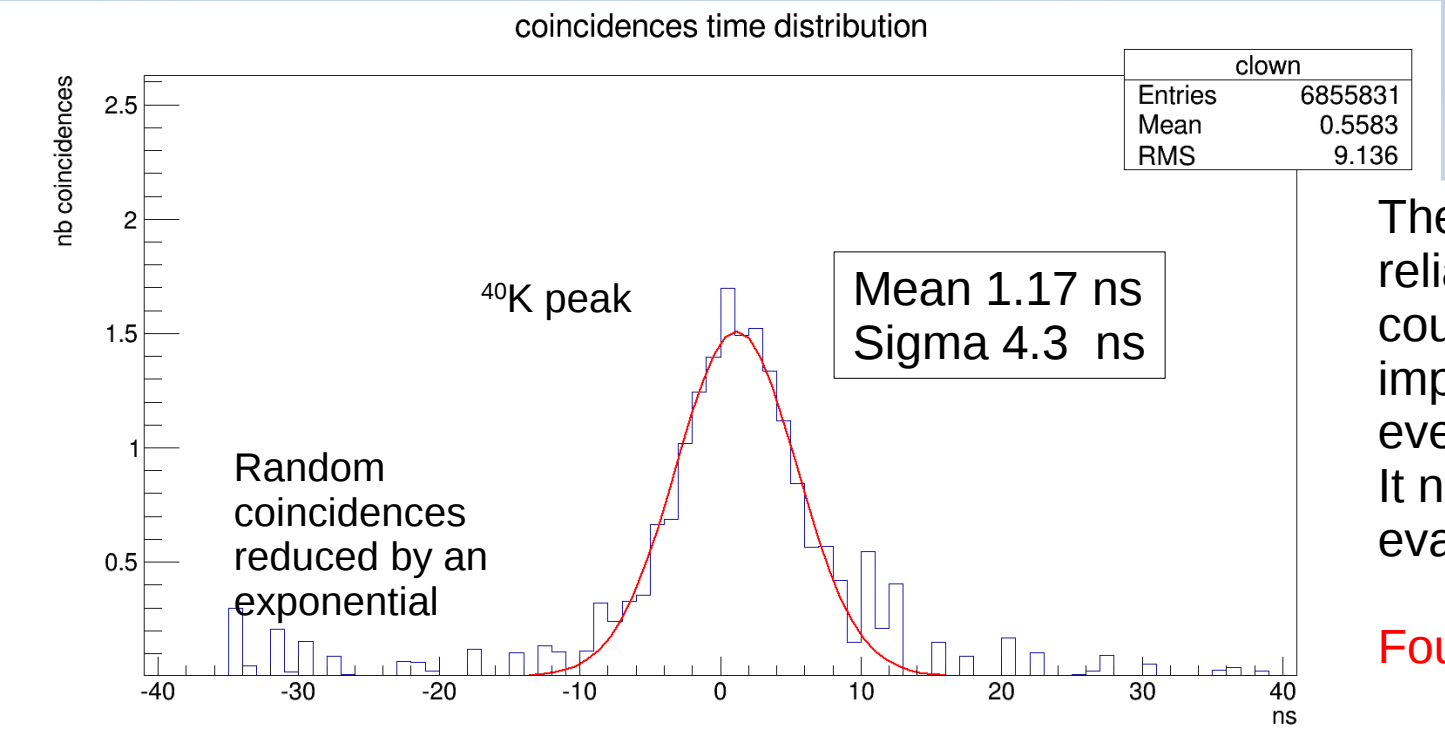
Can be tested thanks the ^{40}K peak

Fit Method



Distribution of difference of times of OM event between same floor same side OM

Fit method



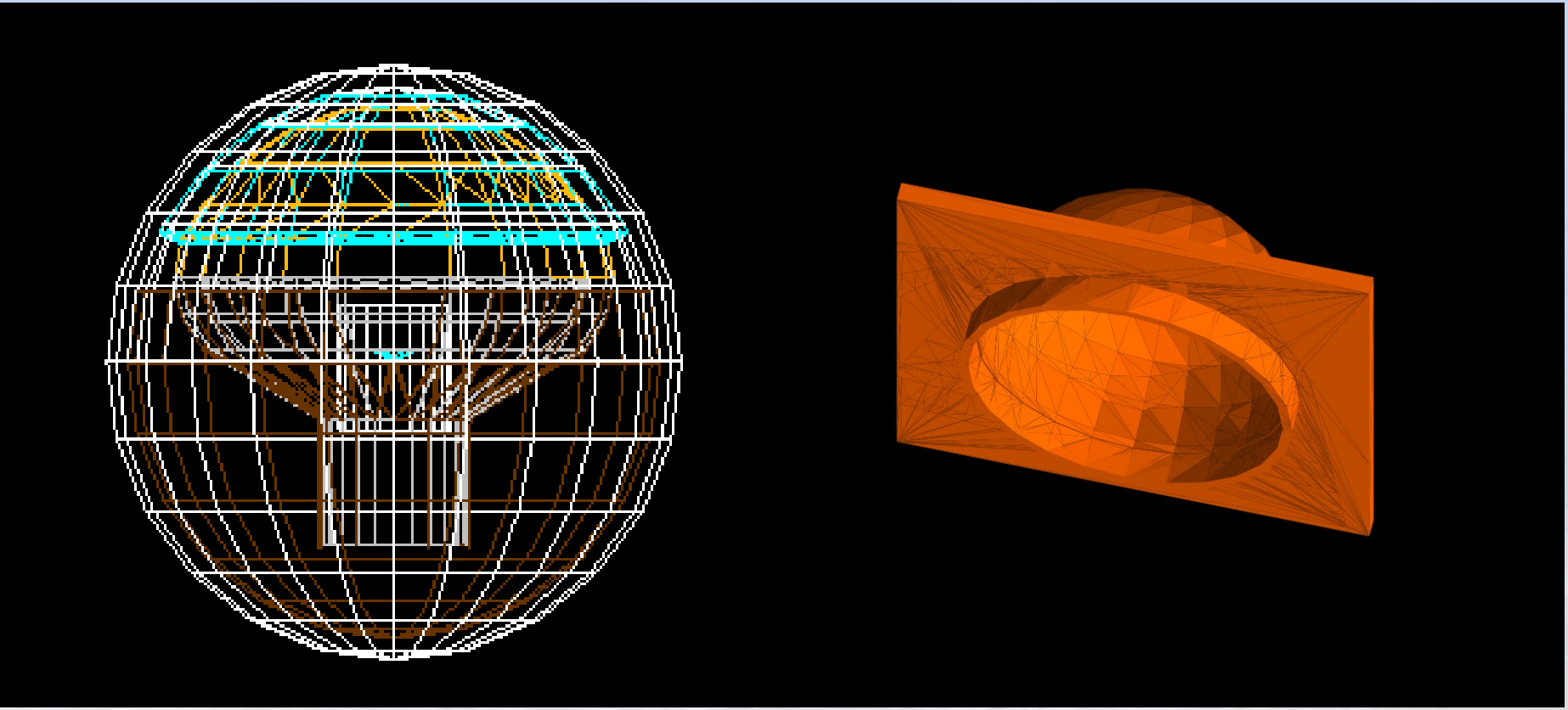
The integral is not reliable (some fit couldn't be done, it implies loss of events)
It needs a loss rate evaluation.

Found ~20 Hz

Conclusion

- As we will see from the simulation, we observe an higher rate on NEMO
- The total rate and coincidence rate looks quite stable during the time
- The fit method give coherent timing (the total value cannot be easily extracted because all the pulses cannot be fitted)

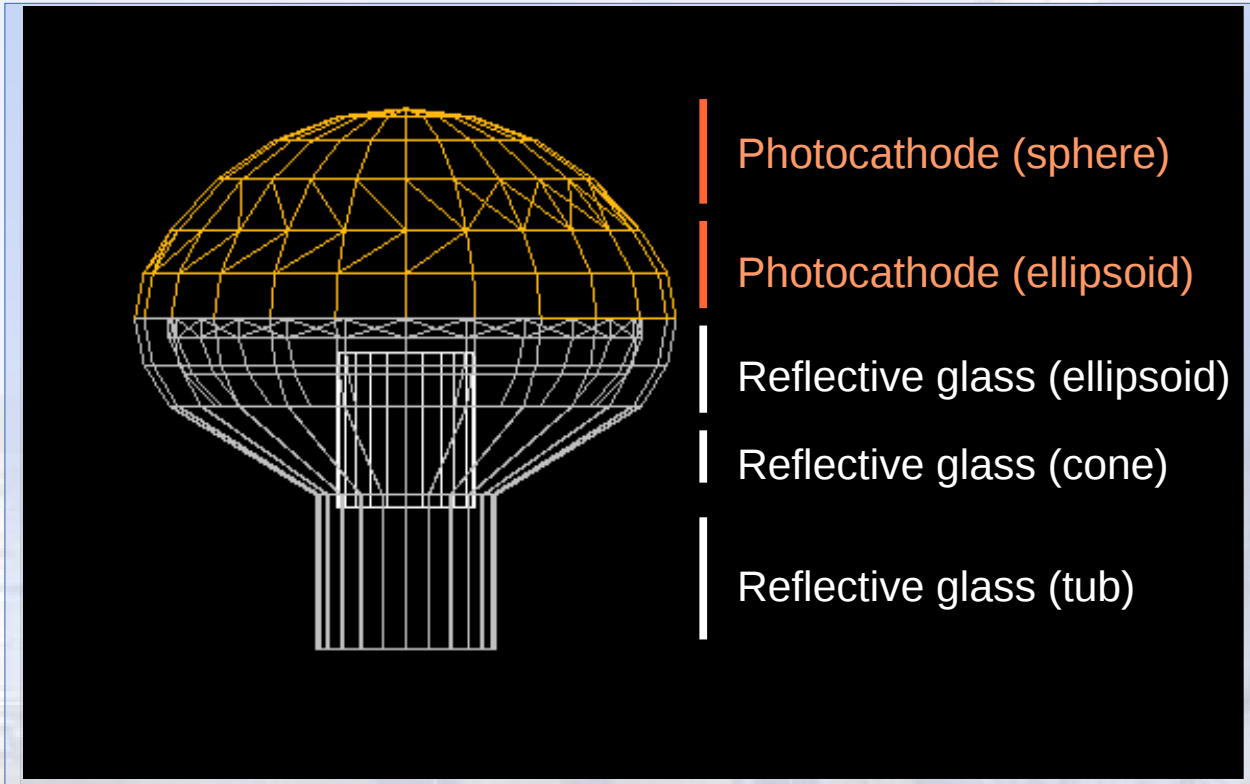
Part II: ^{40}K GEANT4 simulation



Overview

- Geometry definition
  - Glass and PM/OM
  - Inside (reflective areas, dinods...)
- Collection efficiency simulation based on Scans (Alex and Oleg)
- Simulation of K40
  - Illustration
  - Results

Precise geometry



Only geometry is modified
It will use exactly the same physics model

It uses mathematics calculation
for each component's size/position, based on the Hamamatsu specifications

Eg : piece of sphere angle and small radius of ellipsoids :

$$\alpha = \arcsin\left(R_{sphere} / p_{sphere}\right)$$

$$b_{ellips} = \sqrt{\left(\frac{\left(Bulb^2_{thick}\right)}{\left(4*\left(1-p^2*a^2\right)\right)}\right)};$$

p is the projection of the photocathode, R its radius, a and b the big and small radius of the ellipsoid. Bulb is the full ellipsoid z size

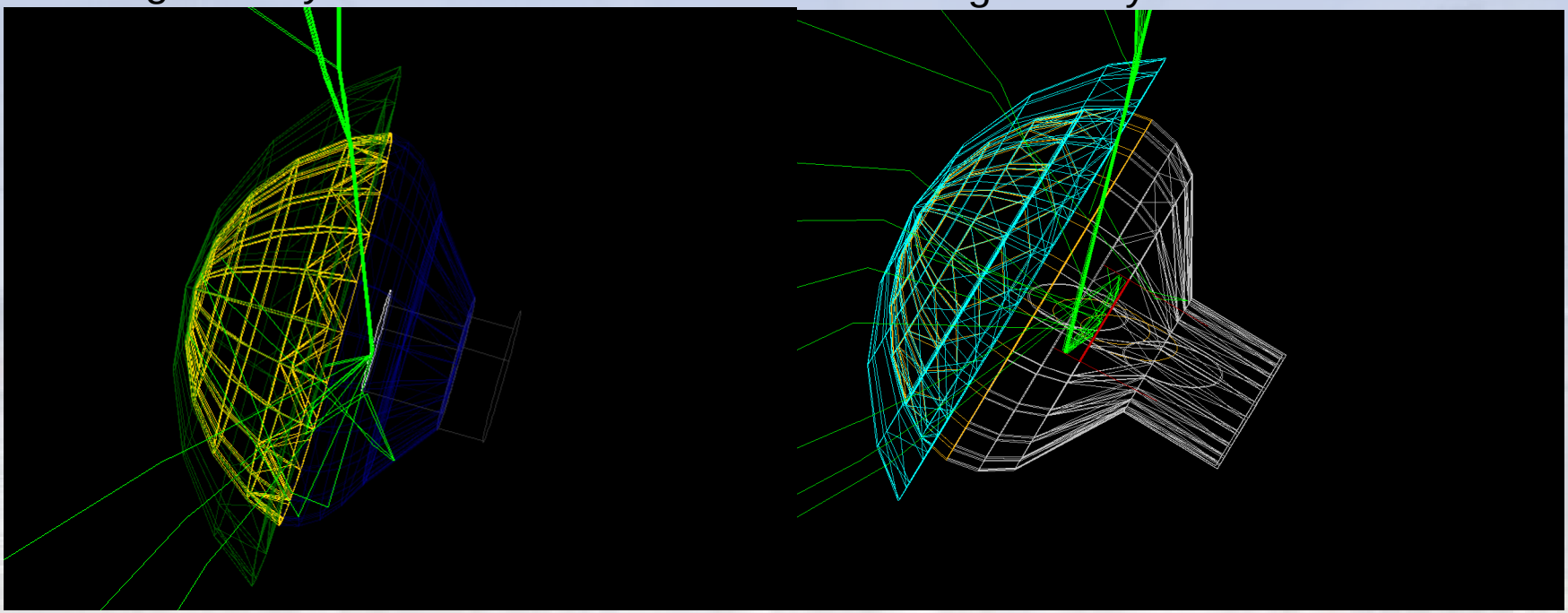
Based on some parameters,
any Antares' like PMT shape can be tested

Precise geometry, in details

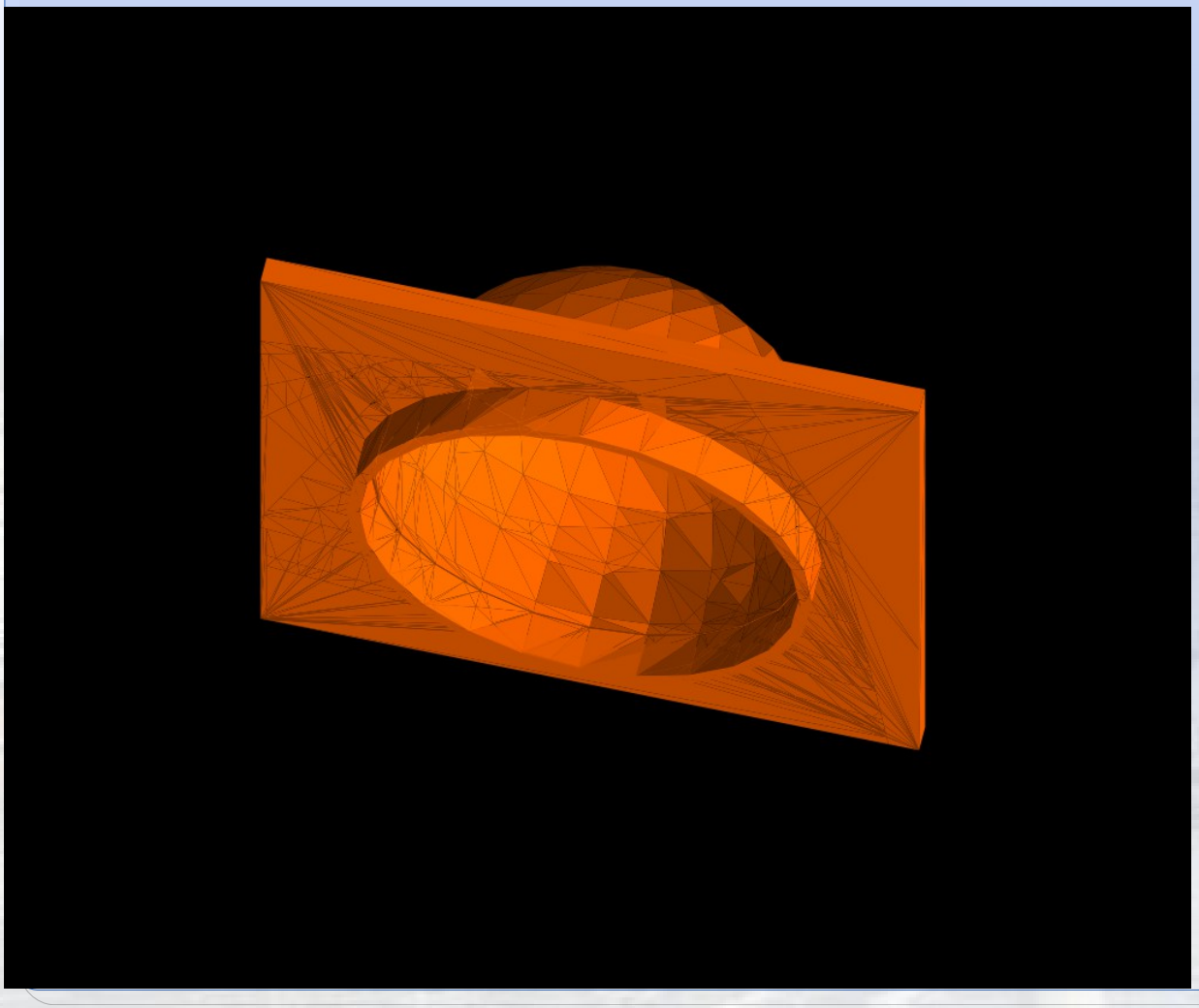
New improvements
Internal structure :
- Dinods tube
- dinod cap
- dinod grid

Old geometry

New geometry



Cap simulation



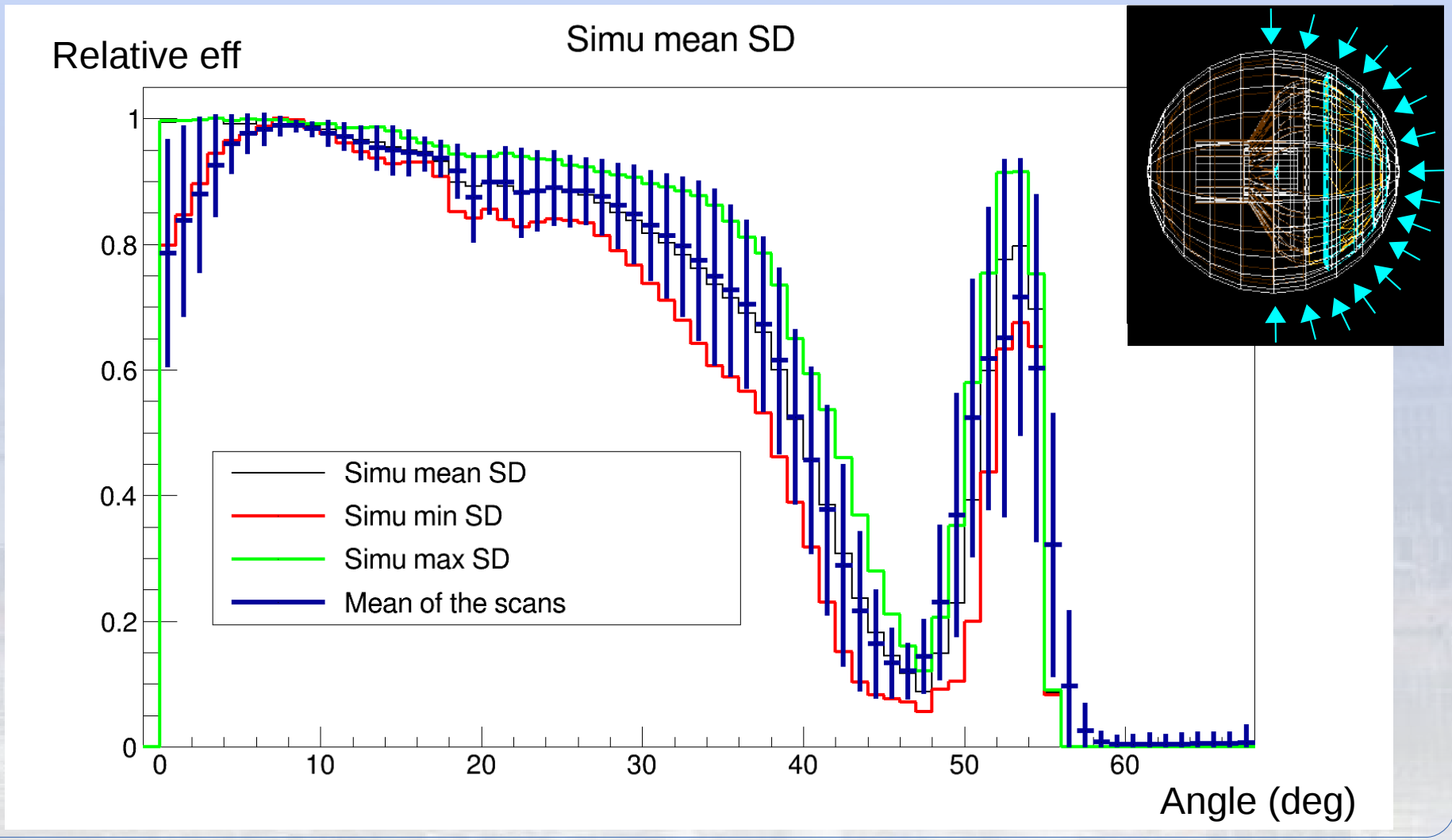
The NEMO OM is placed inside an “Hat” which hide the back and a part of the border

In the simulation presented, this element is integrated

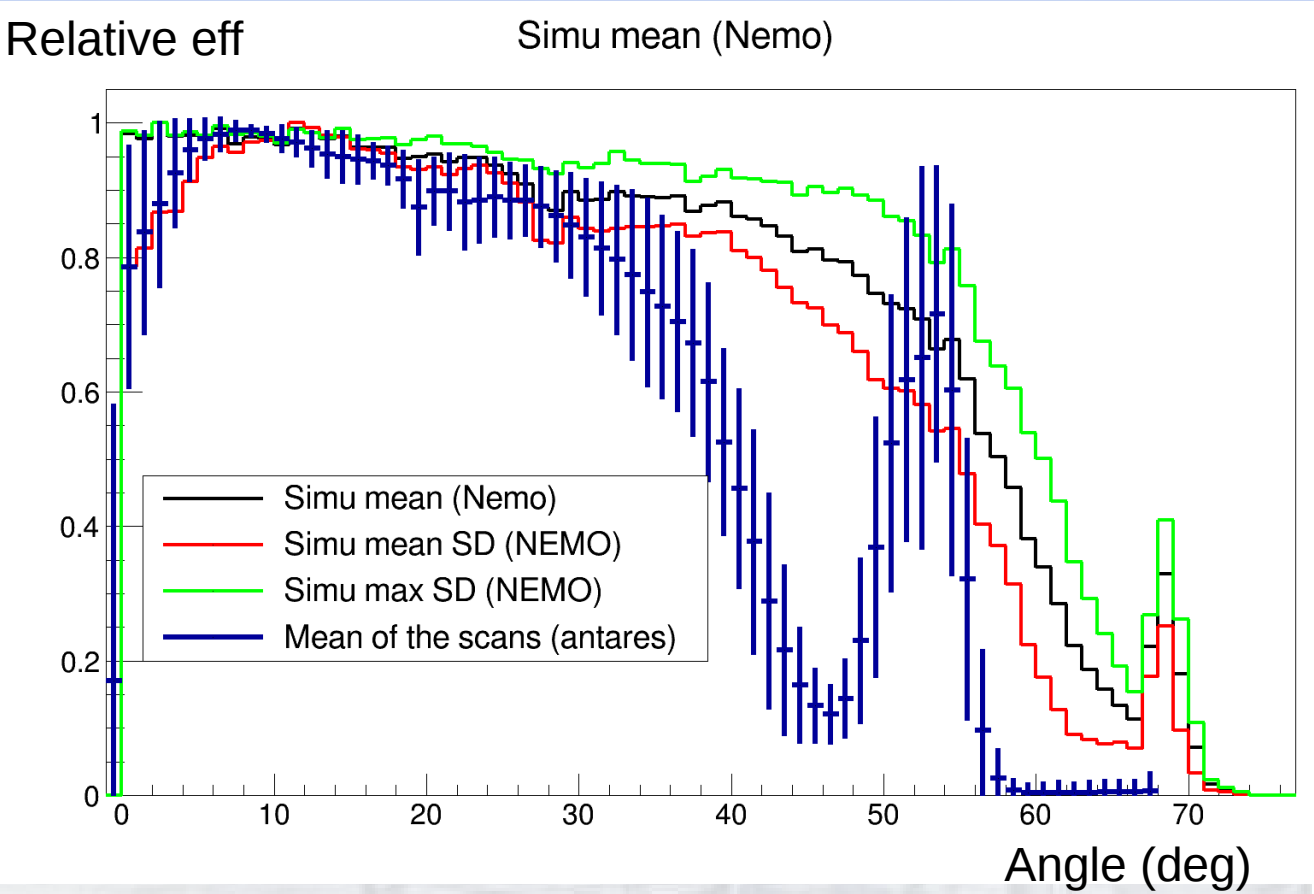
Collection efficiency from scans

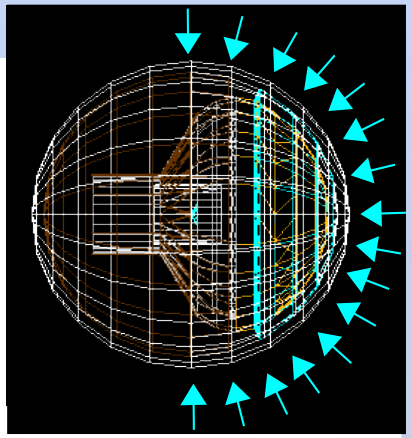
- Only ANTARES module experimental input
- Start from eta_theta = 1
- Assume that the difference is intrinsic of the PM
  - Photocathode inhomogeneity
  - Electron collection
- Tabulate the ratio between simulation and experimental inputs, report to the PM position.
- Use the ration as the theta_eta function

Scan fit of simulation to ANTARES modules



Scan fit of simulation to ANTARES modules

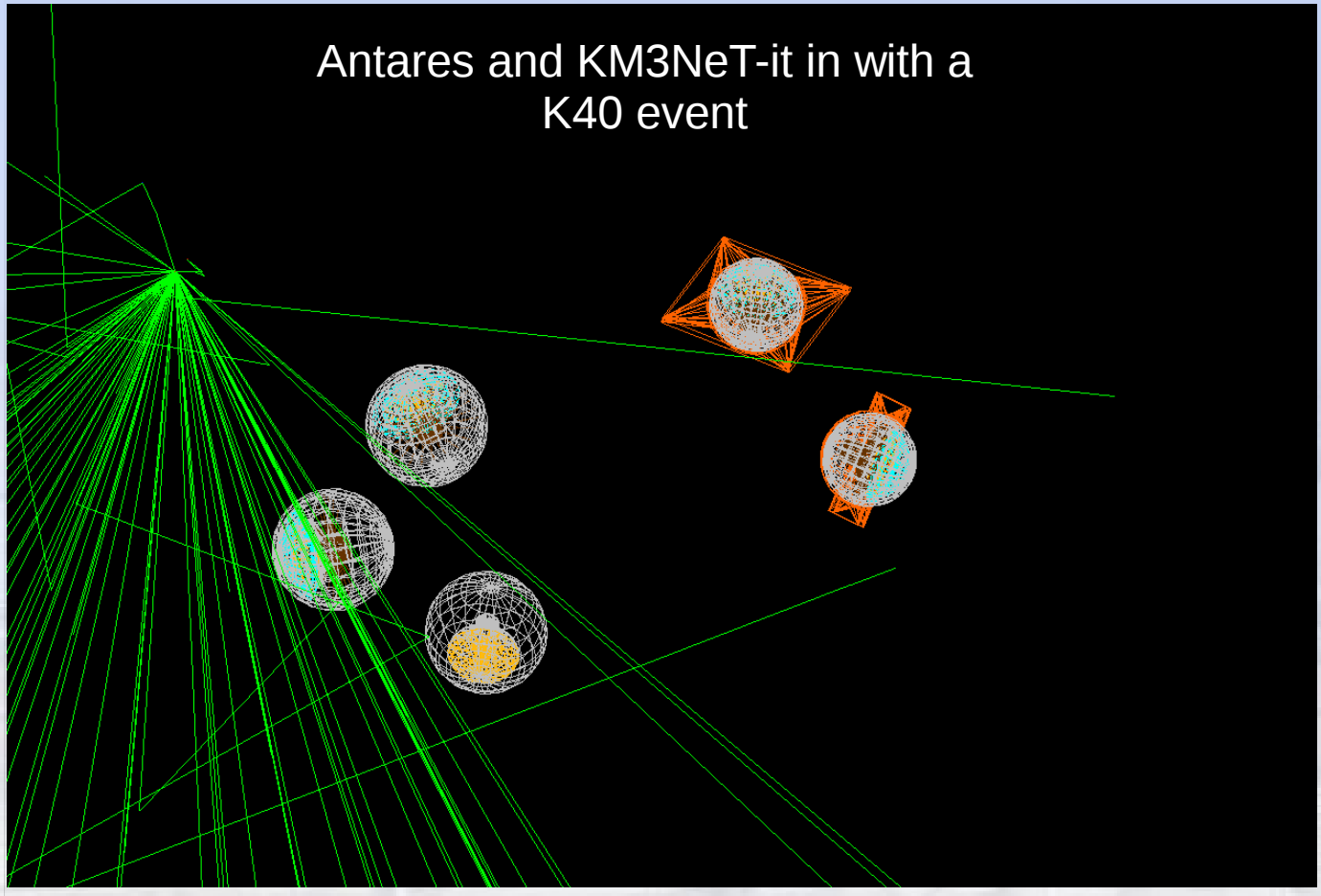




With the same PM electron collection, bigger efficiency expected (lens effect)

=> more background events expected (single and coincidences)

Simulation of K40

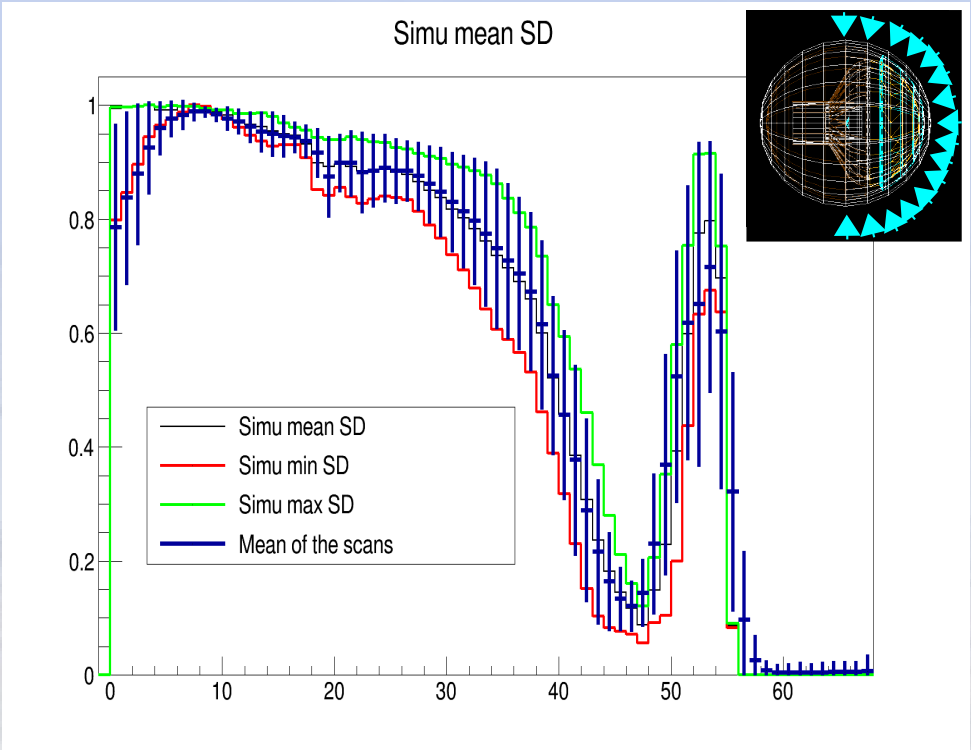


Antares as a reference and KM3NeT-it done

Simulated the trio

Results for the mean and the two limits

Preliminary results



Antares results for 15.8 Hz expected:

Minimum value: 14.87 Hz

Mean value: 24.57 Hz

Max value: 51.09 Hz

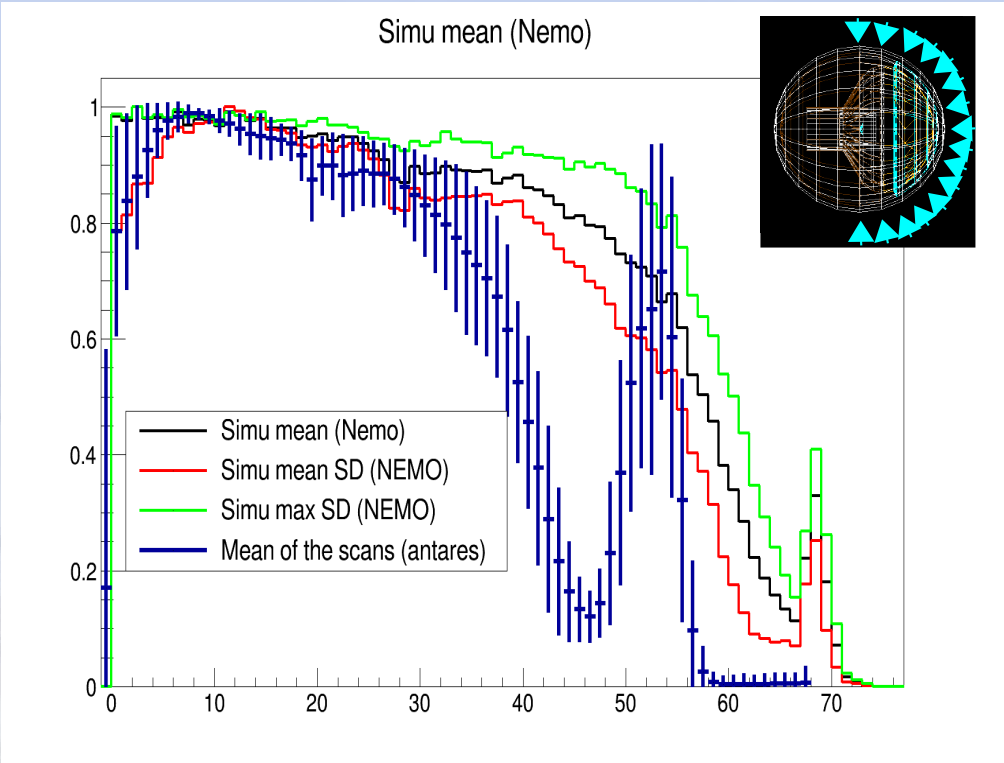
The minimum fit with experimental value.

The effective area is ~77cm^{-2}

The mean for ANTARES fit with Iaroslav results. The effective area is 96 cm-2

The maximum value seems too huge to be physics

Preliminary results

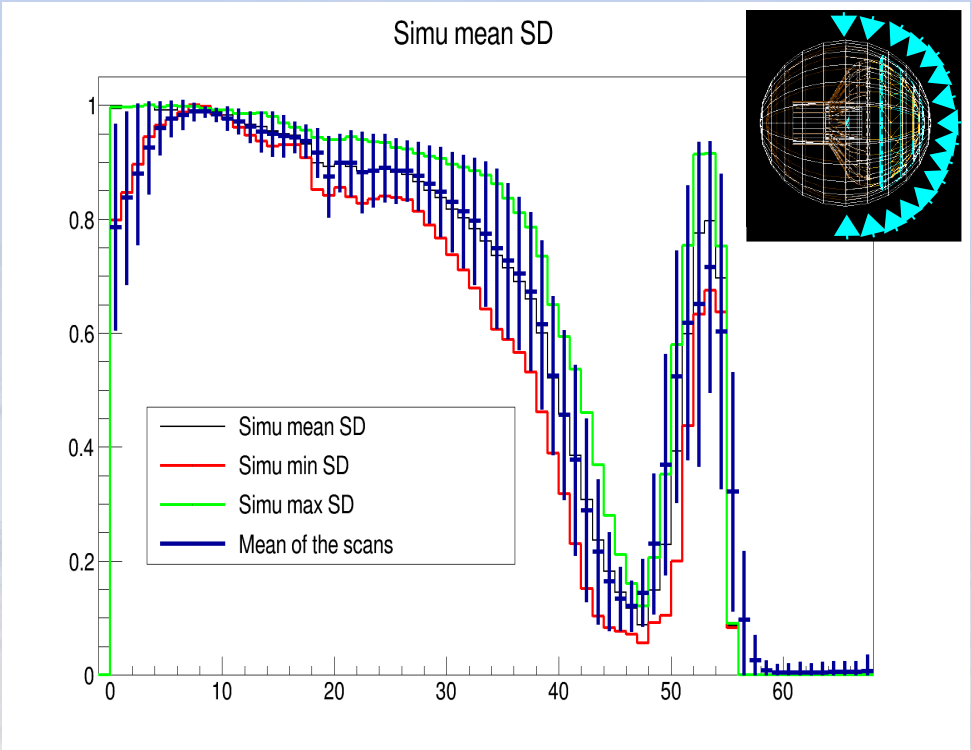


Antares results for 15.8 Hz expected:
Minimum value: **14.87 Hz**
Mean value: 24.57 Hz
Max value: 51.09 Hz

KM3NeT-it results for ~20 Hz expected:
Minimum value: **19.4 Hz**
Mean value: 36.86 Hz
Max value: 77.6 Hz

The minimum fit with experimental value.
The mean is much stronger than the expected value
The maximum value seems too huge to be physics

Preliminary results
with an effective area of 80cm^2



Antares results for 15.8 Hz expected:
Minimum value: 6.79 Hz
Mean value: **14.22 Hz**
Max value: 32.66 Hz

KM3NeT-it results for ~20 Hz expected:
Minimum value: 11.64 Hz
Mean value: **26.19 Hz**
Max value: 51.41 Hz

The minimum fall very low from experimental value.
The mean is much closer to the expected value. ANTARES is a bit low and NEMO a bit high
The maximum value seems huge but was seen

But be careful!!!

The rescaling of the collection efficiency is not like the fitting of experimental value!
That's why:

- The rescaled value does not give the same results as the minimum of the fit
- We see a so different effect on NEMO and ANTARES

We are very dependent on parameters like HV and threshold!
We miss experimental input!! for NEMO and ANTARES!

Conclusion for simulation

- Bigger photon detection efficiency expected from NEMO
  - 40K rate should be around 20 Hz. Validated by the data analysis
- Perspective on KM3NeT-it and fr
  - 3 inches PM under development
- Encouraging results for simulation for Antares
  - Needs work on the total electron collection efficiency. (Use of 80 cm^2 of effective area for the OM as reference, as in km3 simulation)

Overview

Title 1

Title 2