HE MM *open hour*
Sept, 2020

Update **Likelihood-framework**
for diffuse flux and pointsource searches

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In collaboration with
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Recap

- Collaboration Meeting June 2020 [slides]
  - General idea of the framework: Framework to do diffuse and pointsource studies
  - KM3NeT detector response: Input for likelihood framework
- Software in development: aanet/ana/search
- Today **NEW**: some first preliminary results using the framework & showing that it works

General idea

Collaboration Meeting June 2020 [slides]

- Make a model H0 & model H1
- In the code, a model consists of several components. These could be:
  - Atmospheric neutrino background
  - Atmospheric muon background
  - Diffuse ($E^{-\gamma}$ flux / Given flux)
  - Point source ($E^{-\gamma}$ flux / Given flux)

To do!

- Based on models one can generate pseudo experiments (and make nice skymaps!)
- Parameters of every component can be fitted to the data based on a model
- Apply statistics to calculate sensitivities/discovery potential

KM3NeT detector response

Collaboration Meeting
June 2020 [slides]

- Input for the likelihood framework
- There is one script to analyse all existing official MC-files and get several histrograms describing the KM3NeT performance
(Effective Area, Response functions etc.)
- Histograms are stored in one TFile (for all flavours separately)
- https://git.km3net.de/rmuller/effective_area
(script + plots + documentation + LOI check)

KM3NeT detector response

- This TFile with histograms is used as input for the just described framework and converted to a so called "**Detector Response**" (/ana/search/DetResponse.hh)

- Currently we use: "effective_area/output/40bins/TFile_alldirections_zen_noanglecut_noloirecocut_f200_b40.root"

```
DetRes_file = "/effective_area/output/40bins/TFile_alldirections_zen_noanglecut_noloirecocut_f200_b40.root"
detres      = ROOT.DefaultDetResponse(DetRes_file)
```

Analysis

E^{-2}

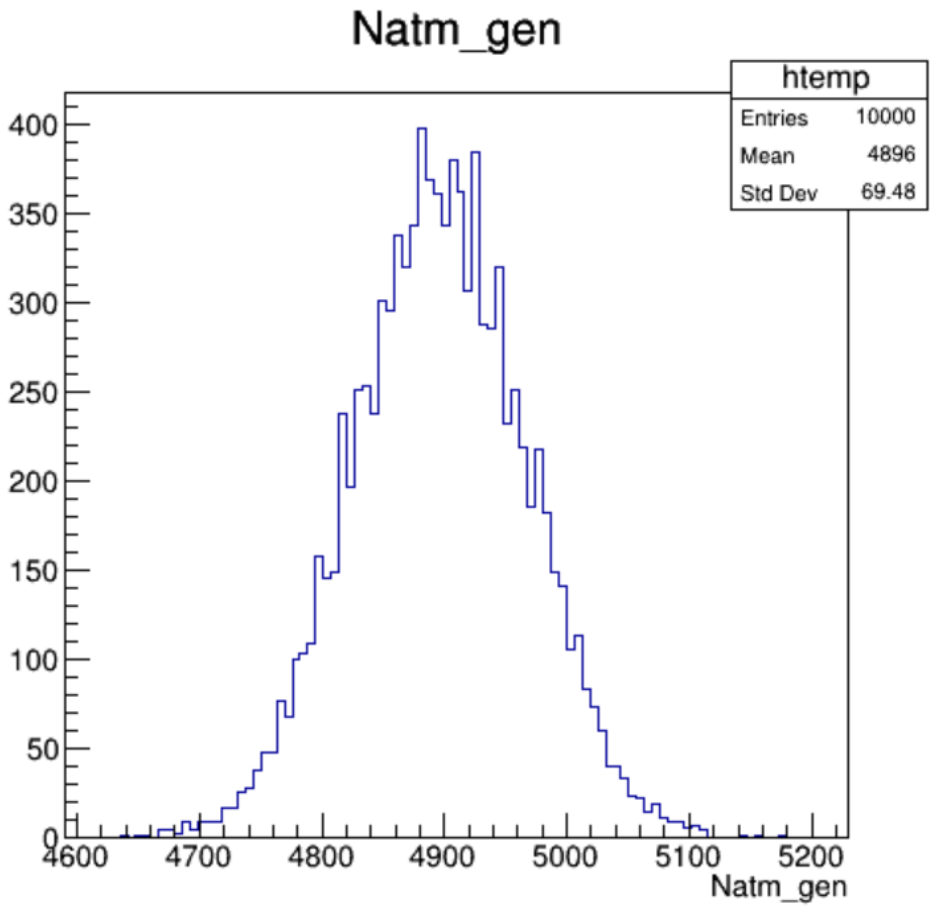
- Search for isotropic diffuse flux on top of neutrino background: **To do!**
  - Signal component = Isotropic Diffuse flux
    - <Ncos_gen> = 200 * t_datatakingyears
  - Background component
    - <Natm_gen> = background.norm.value * t_datatakingyears
      ↳ ~55000 events/yr
- t_datatakingyears = [0.1, 0.5, 1.0] yr
- 10.000 pseudo experiments
- Run with seeds => Pseudo experiments can be reproduced
- Only flavour included: numuCC **To do!**
- For now: NO cut on direction, NO cut on reconstructed angular error, NO cuts on reconstruction parameters like β_0 or Λ **To do!**

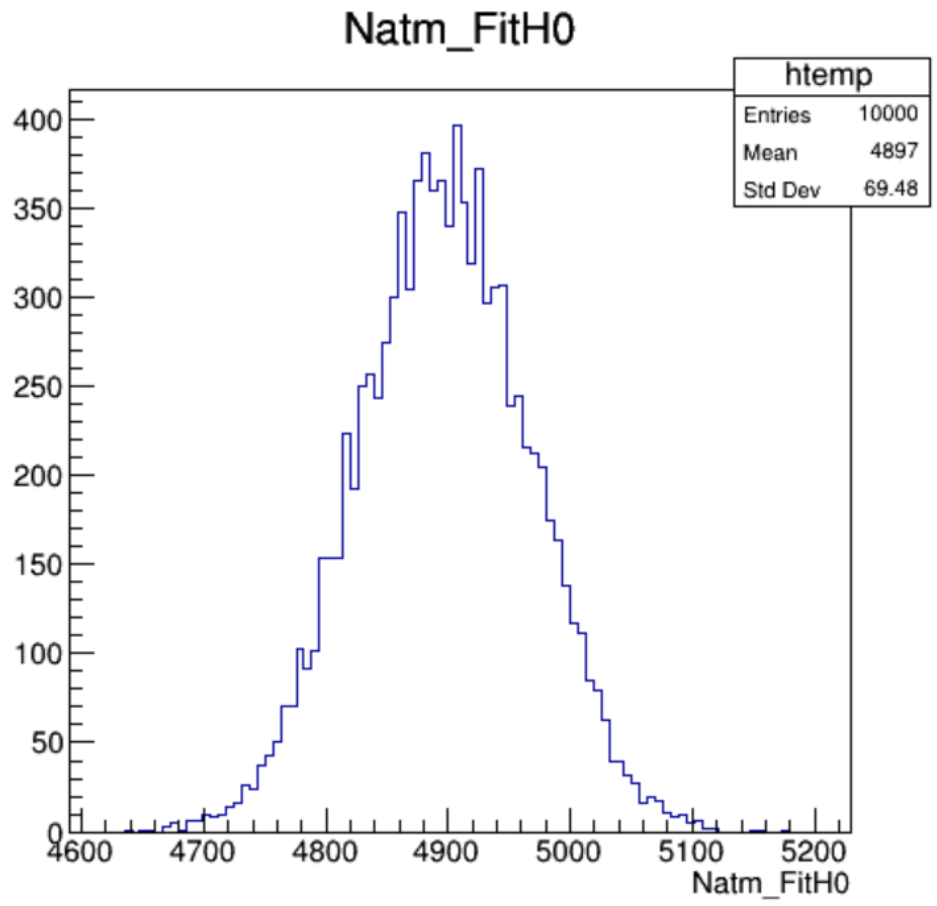
0.1 yr

Pseudo experiments: 0.1yr (bkg)

$\langle N_{cos}^{gen} \rangle = 0$

$\langle N_{atm}^{gen} \rangle = 4896$





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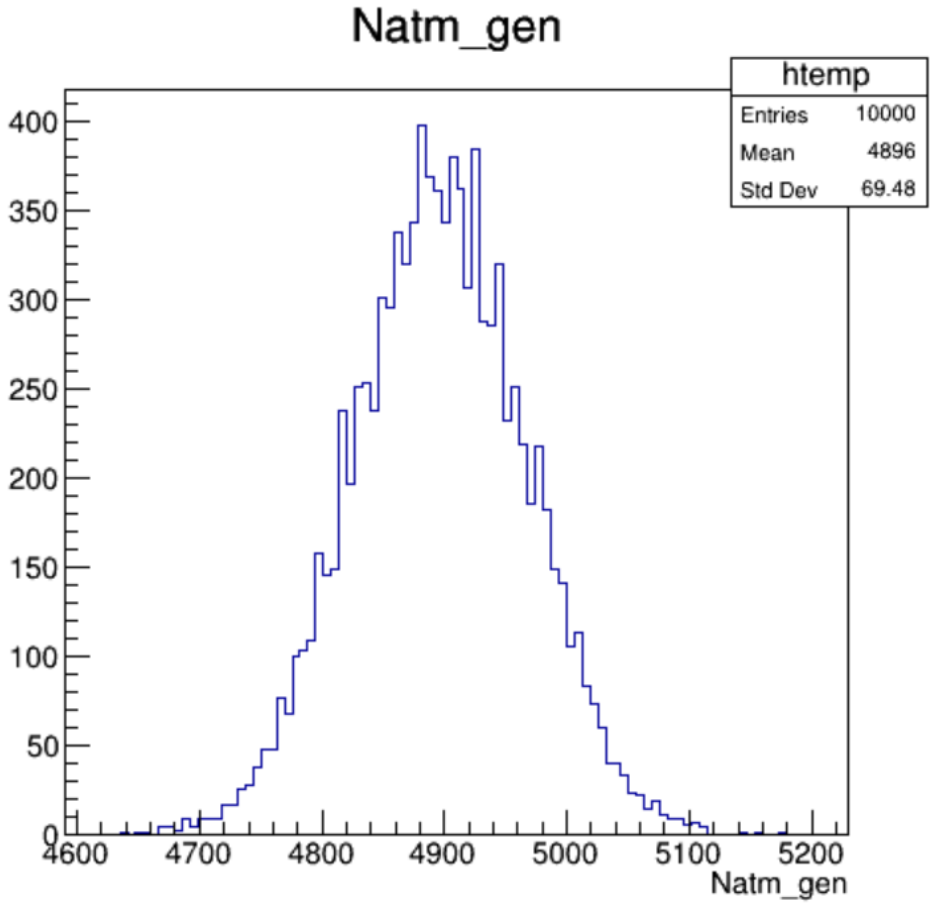

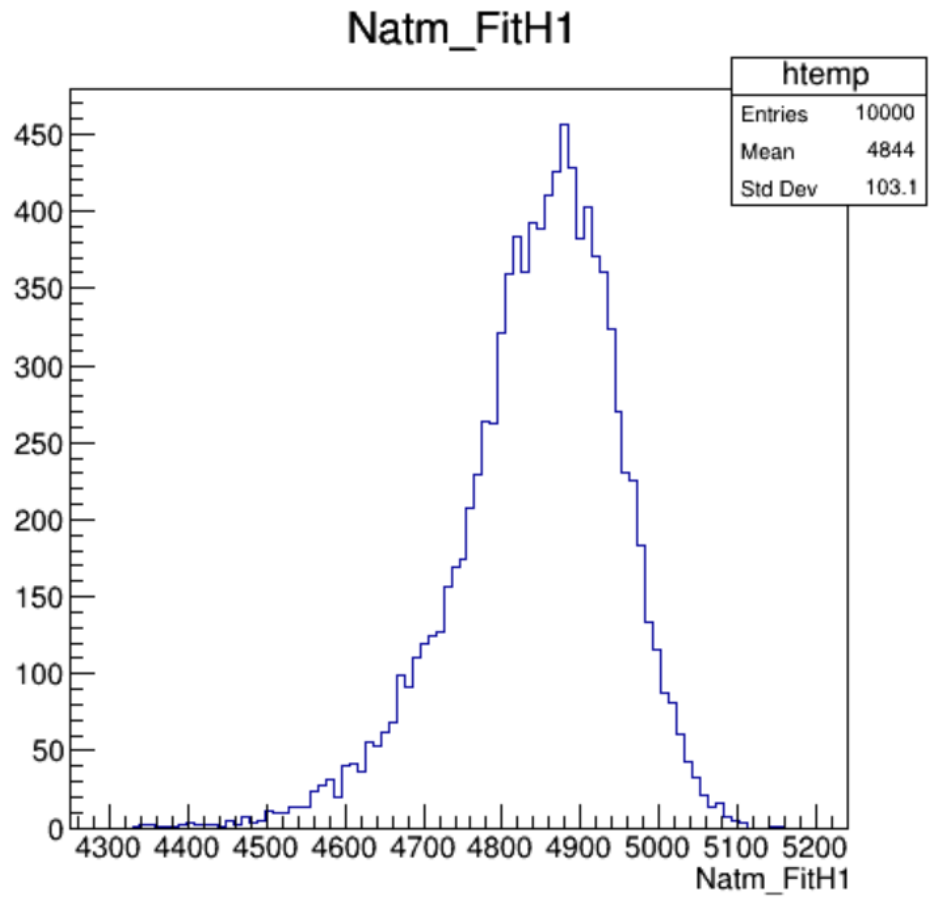

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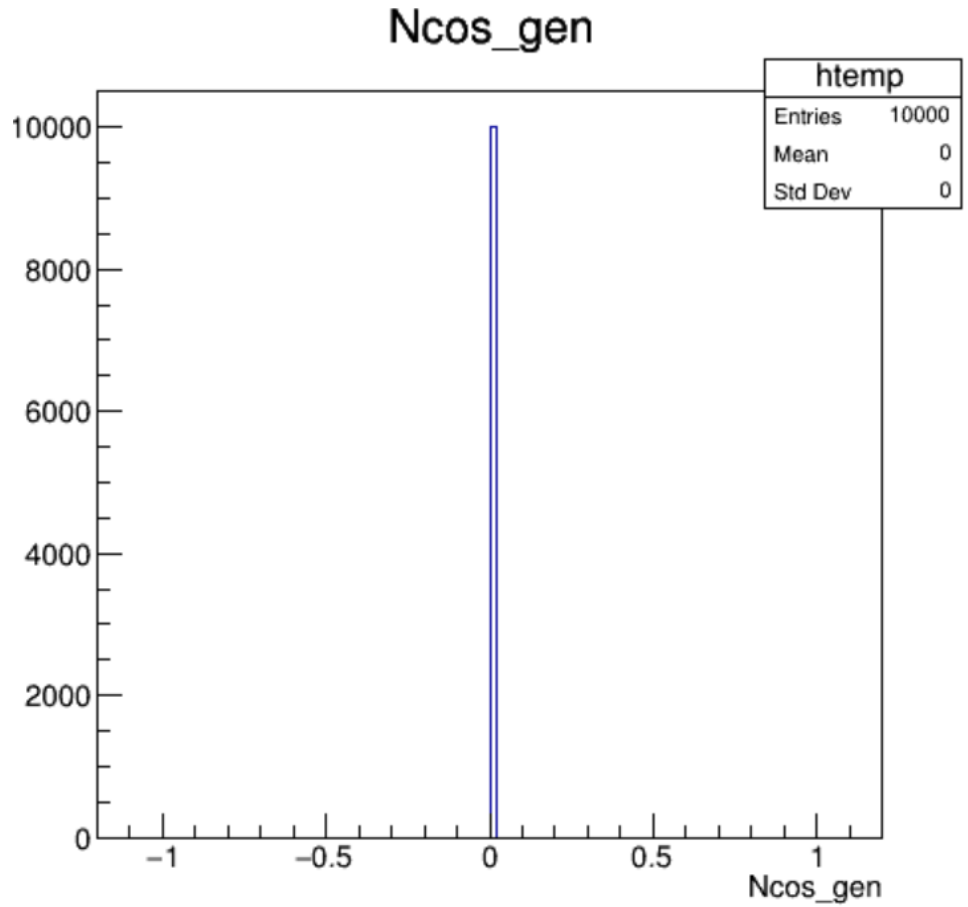

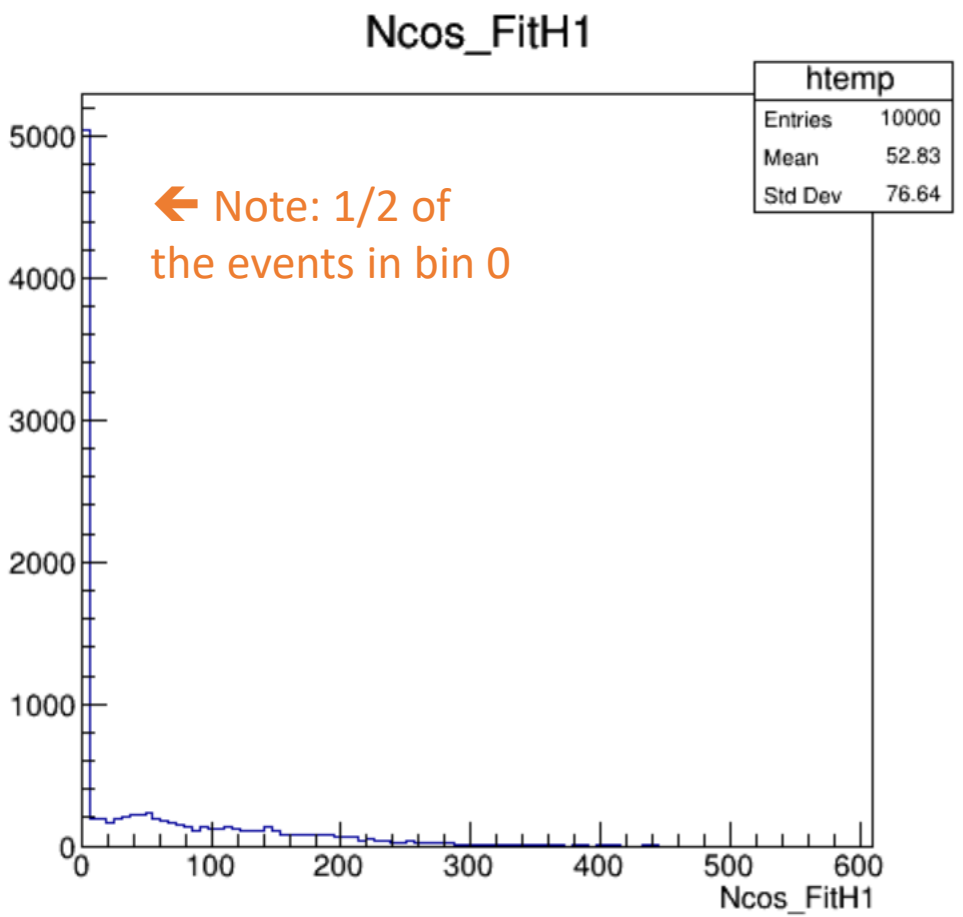

← Note: 1/2 of the events in bin 0

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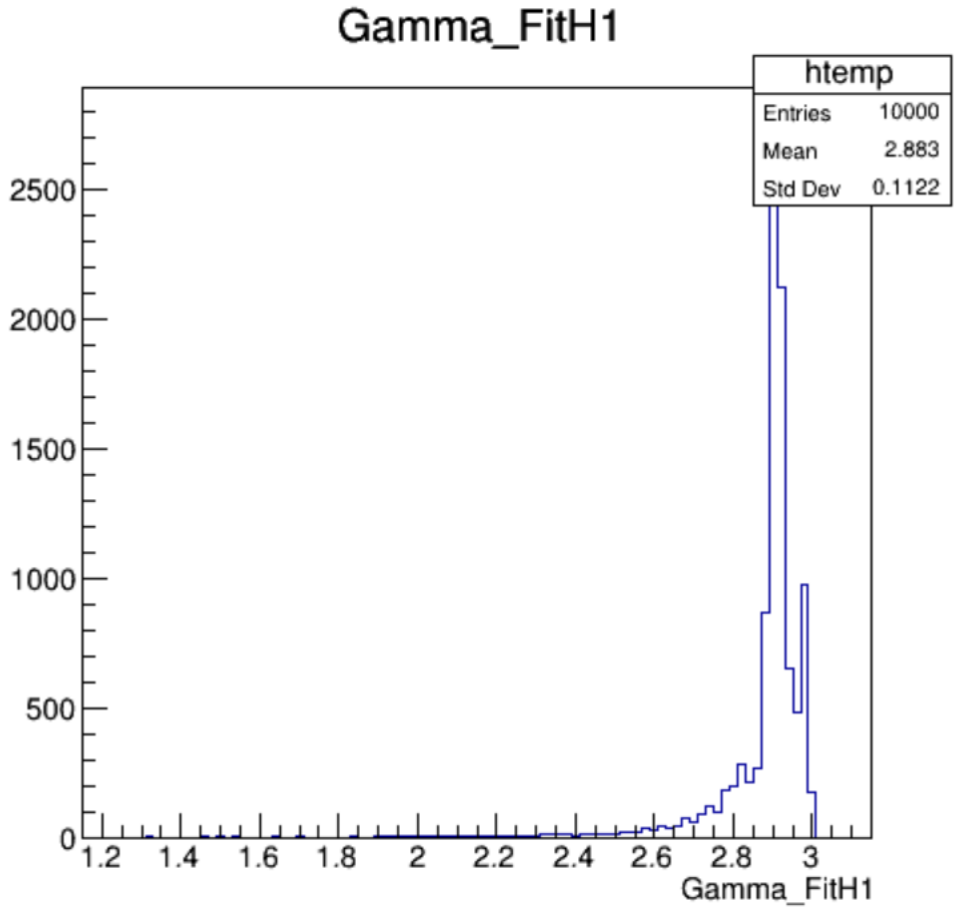

Pseudo experiments: 0.1yr (sig+bkg)

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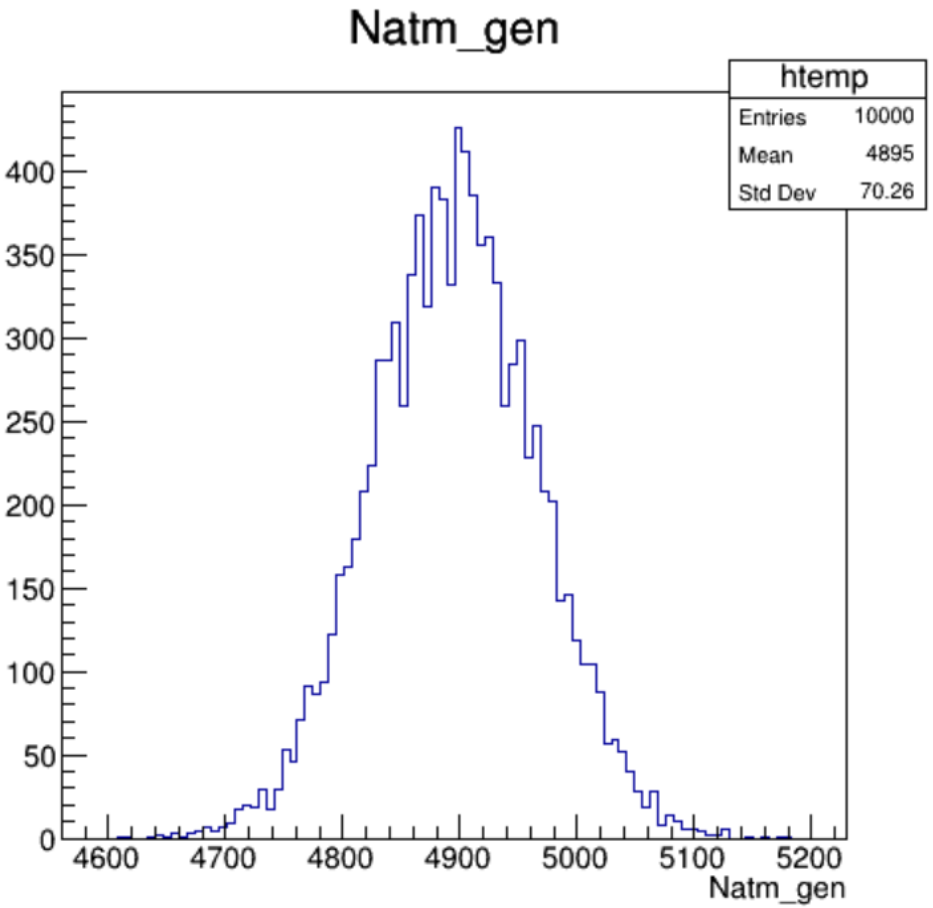

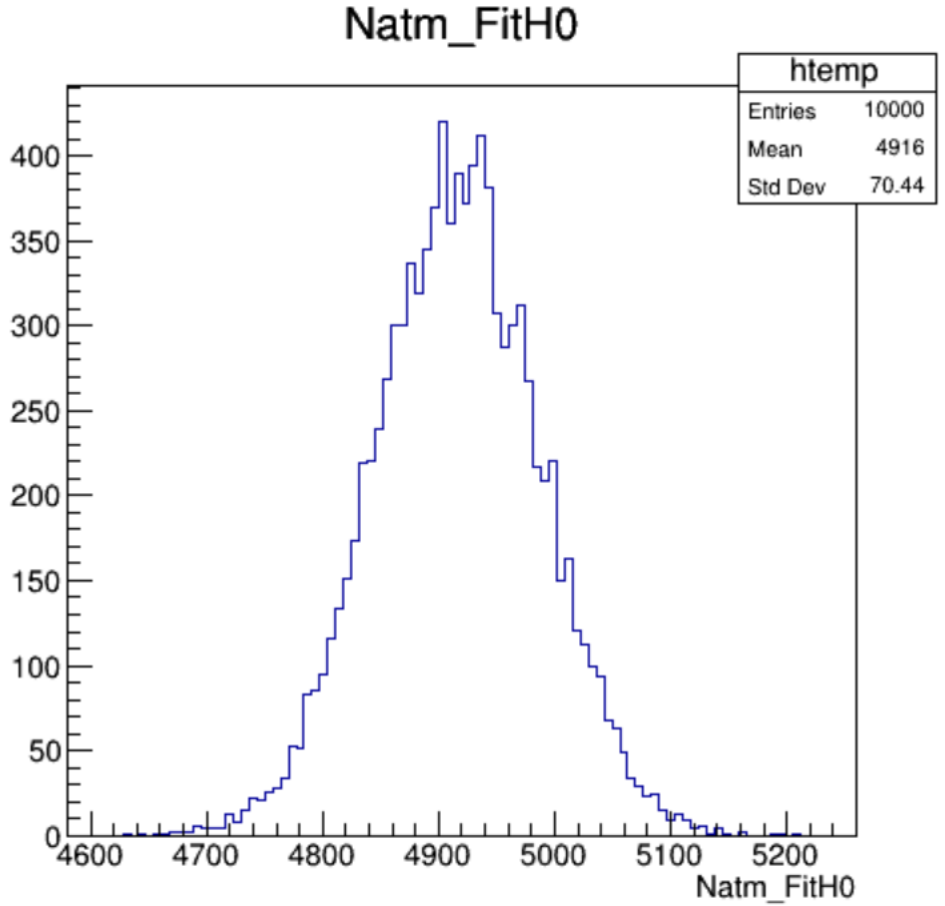

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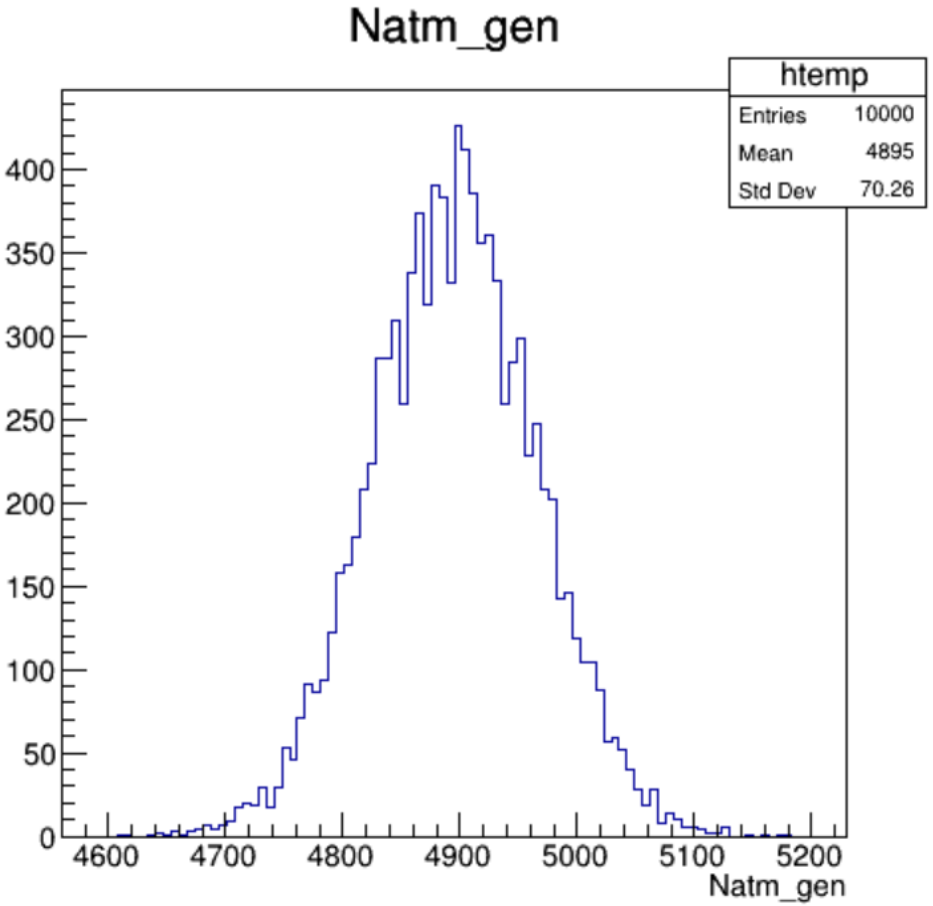

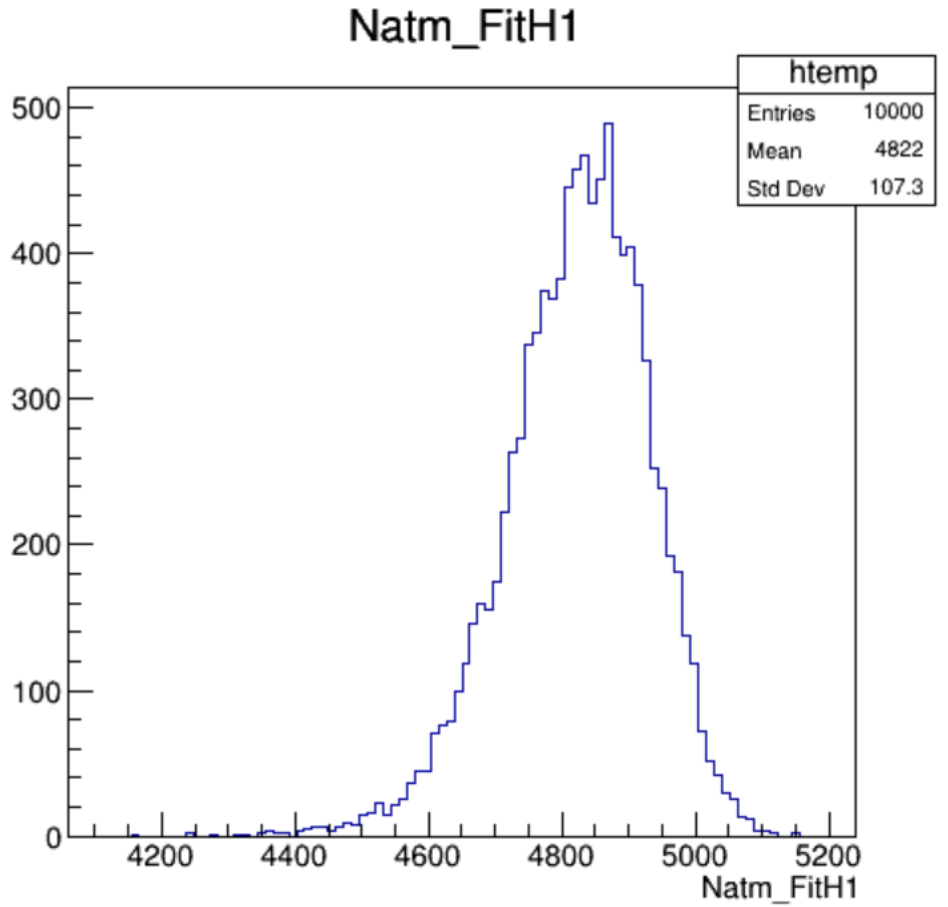

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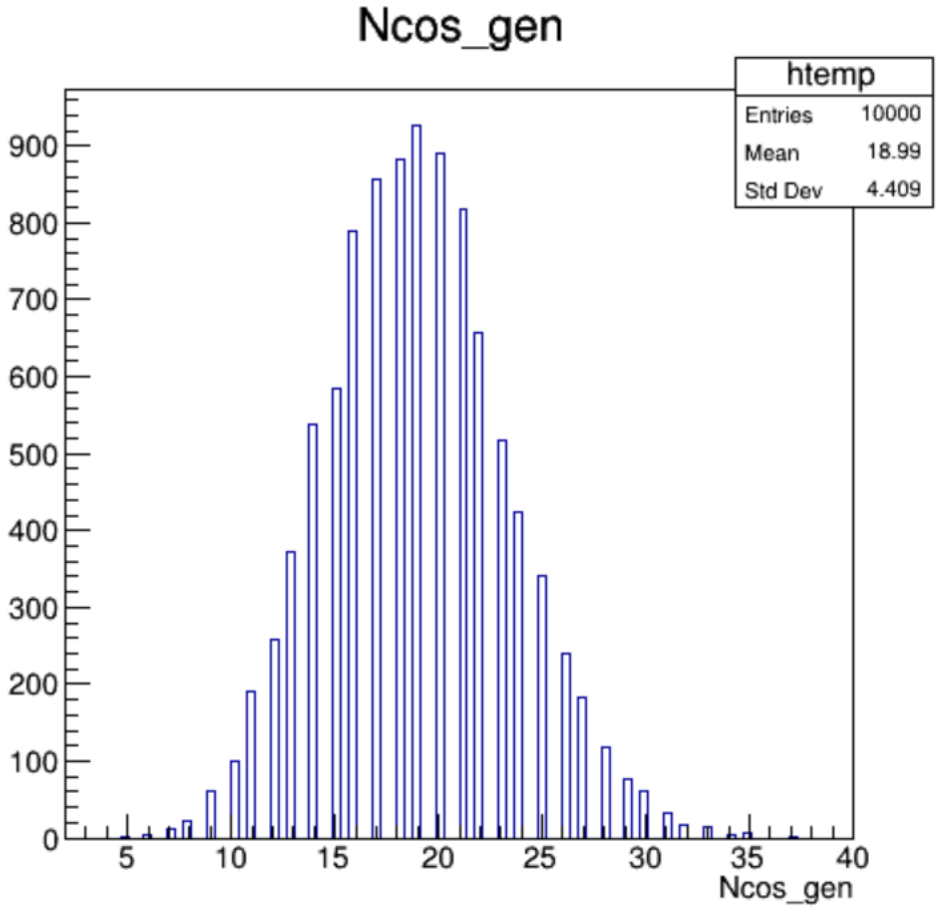

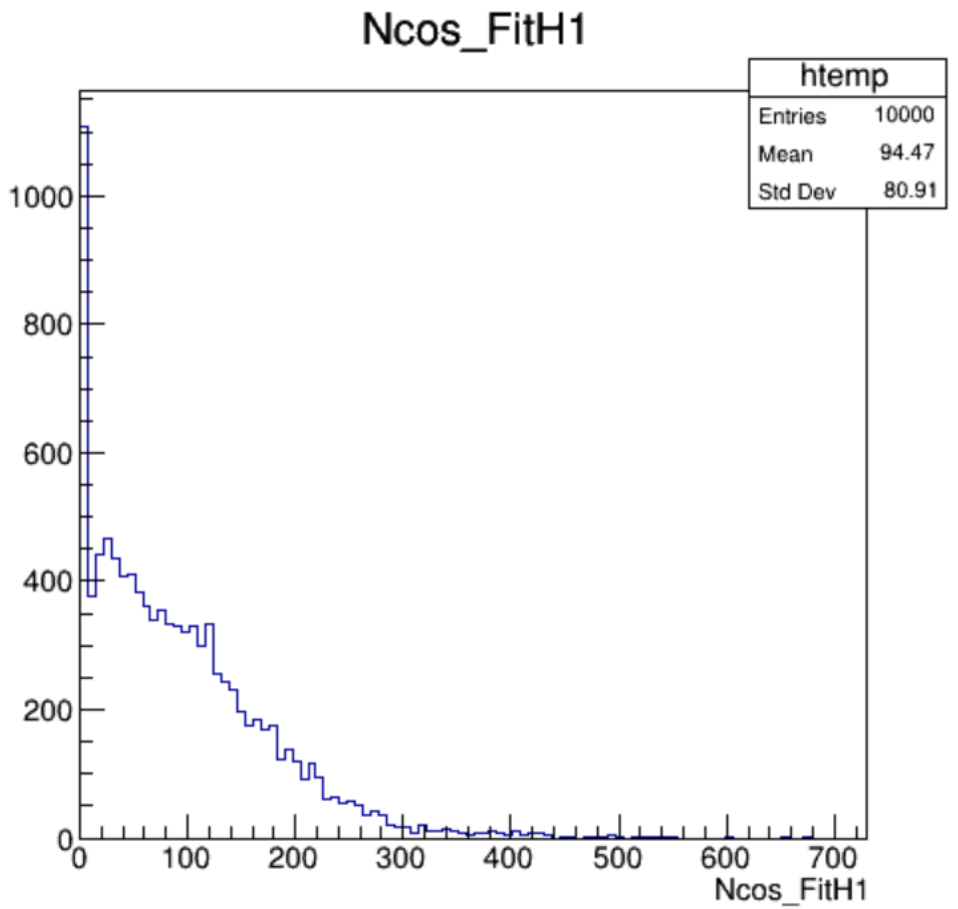

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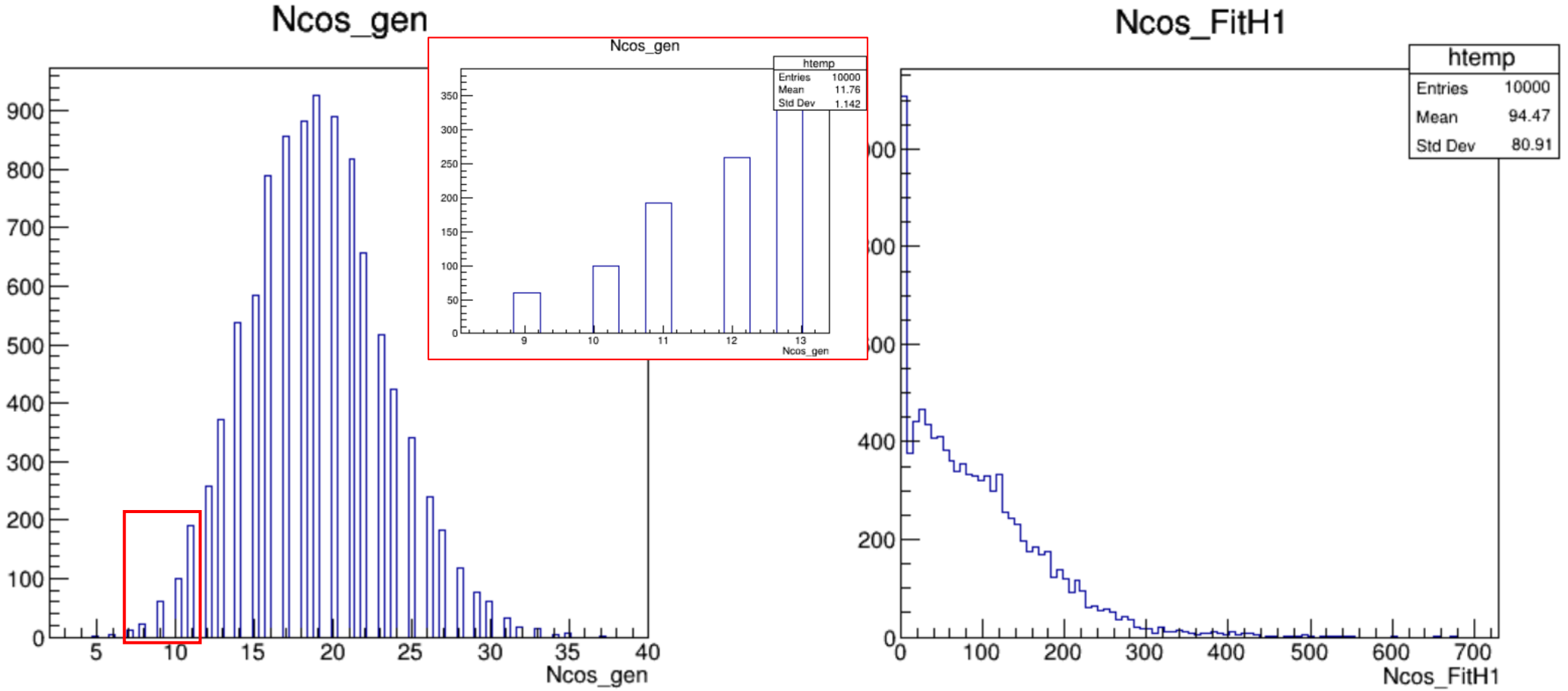

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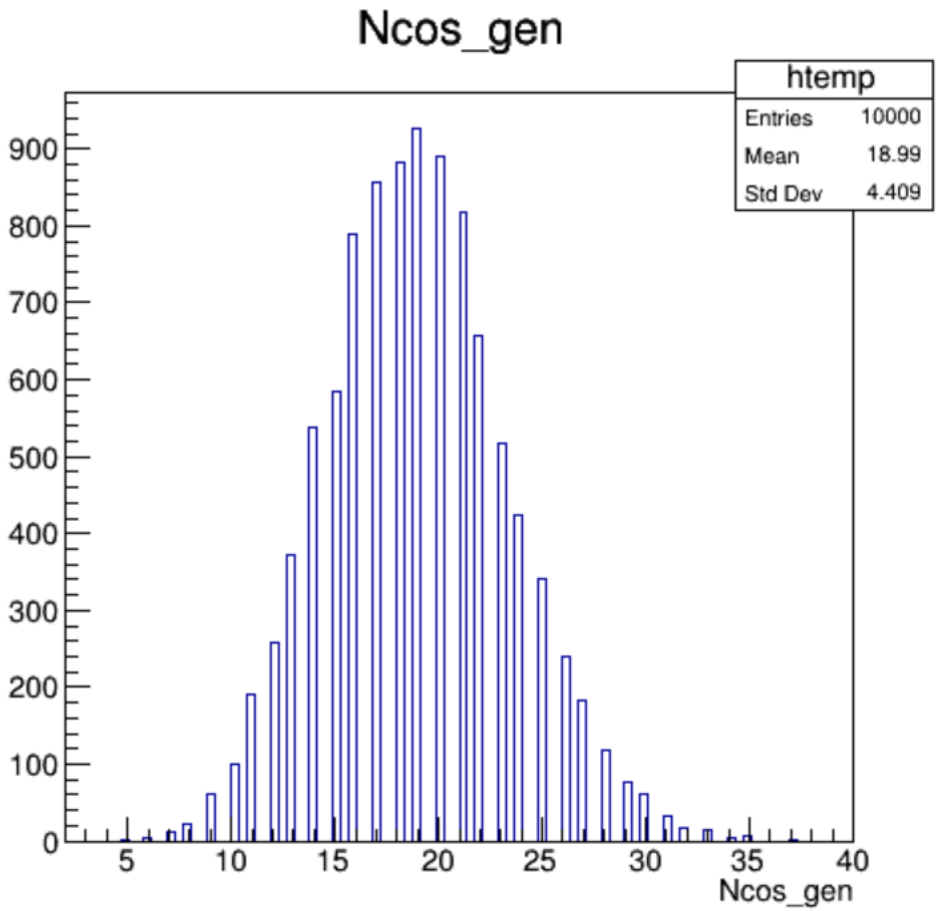

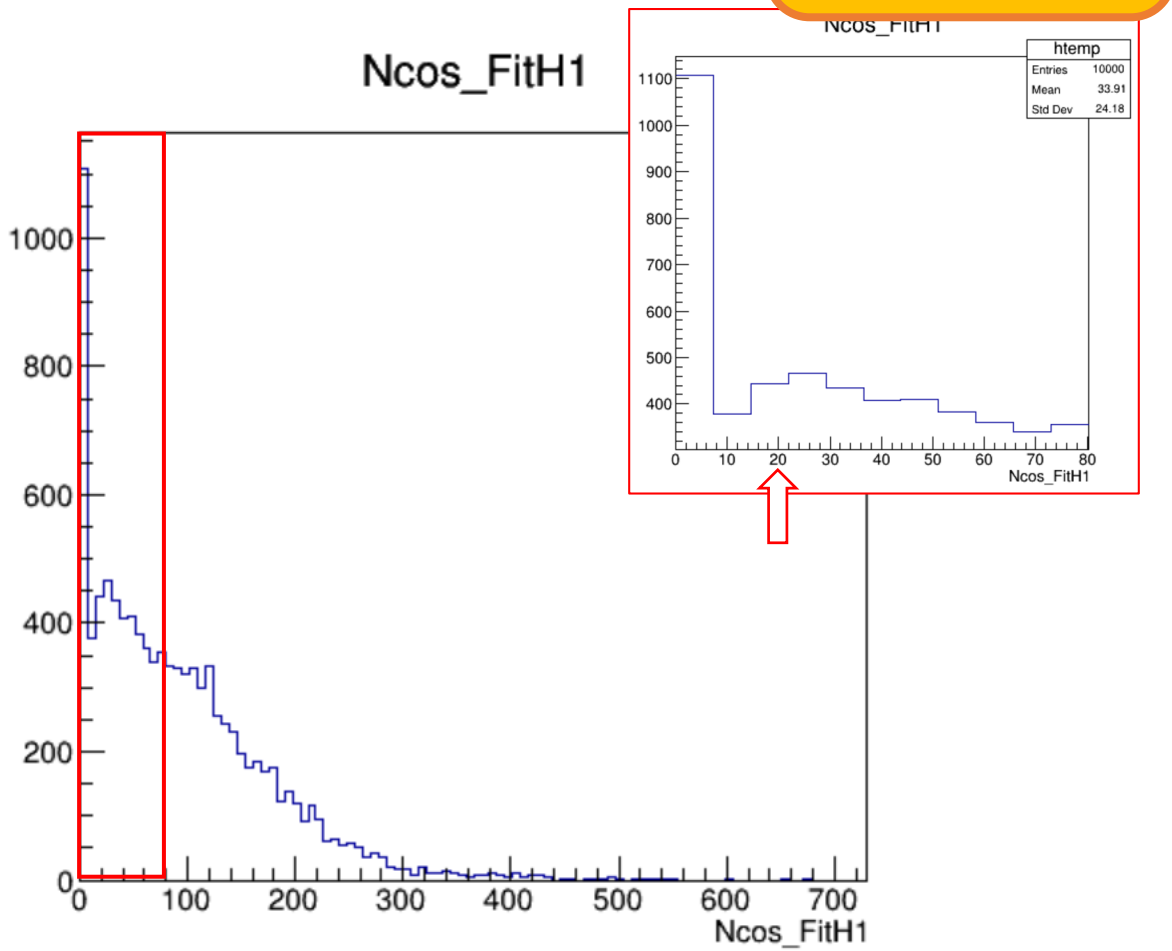

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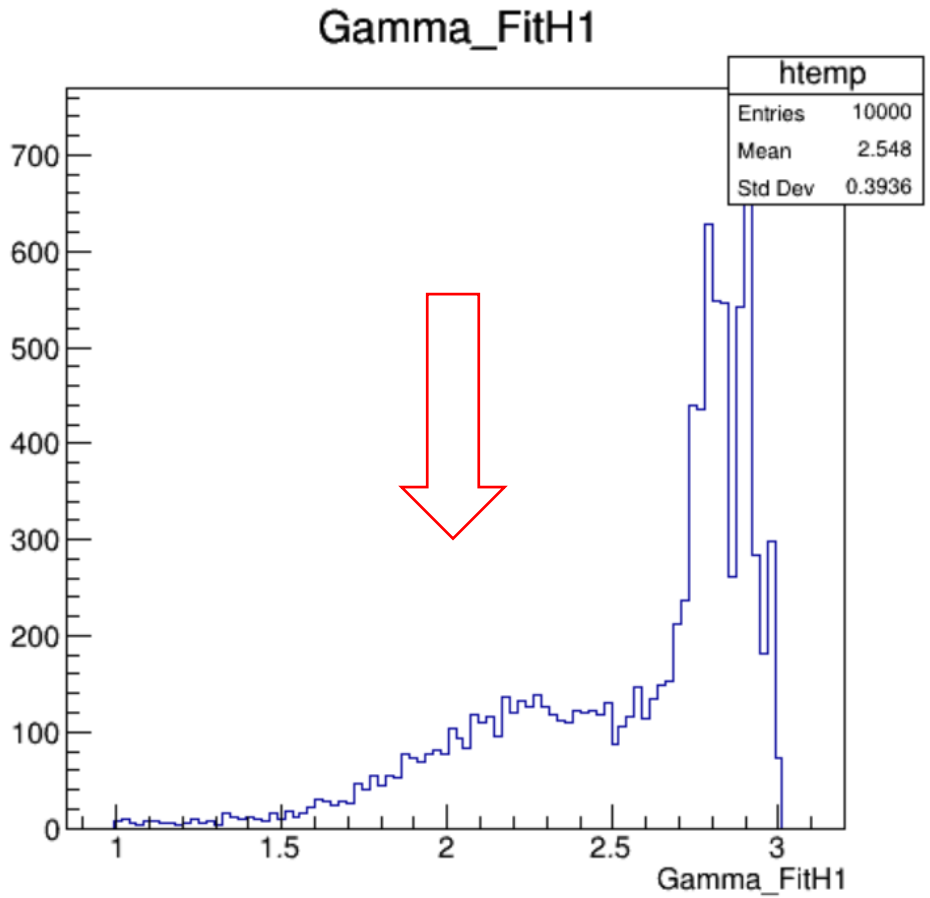

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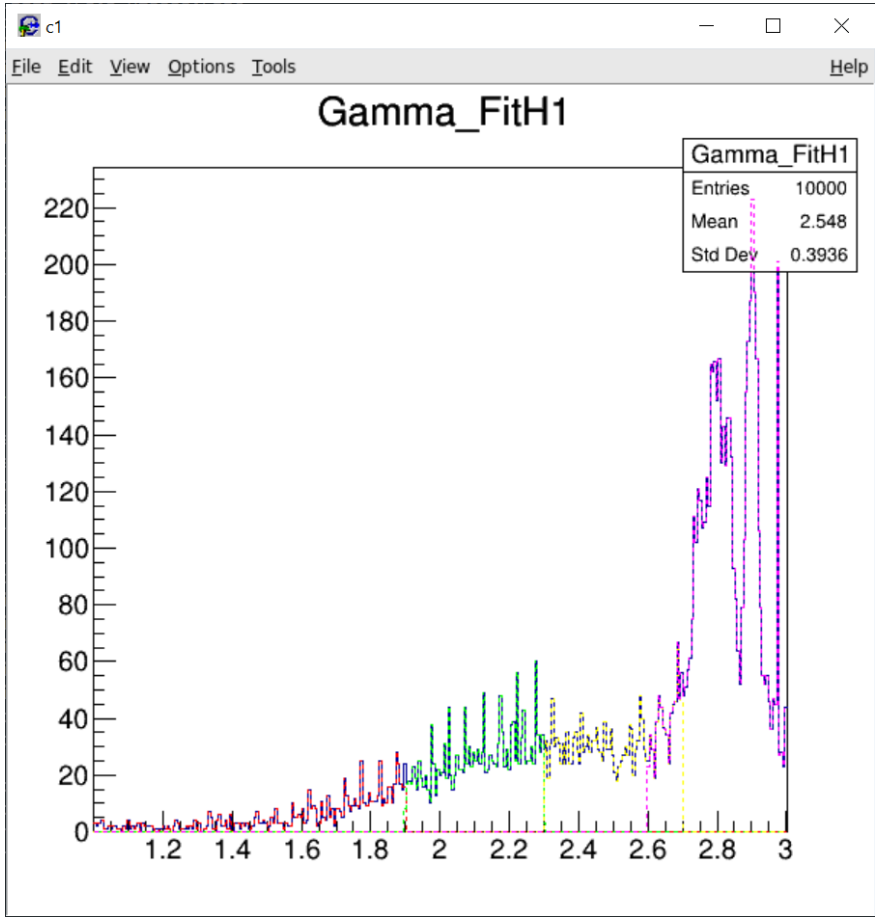

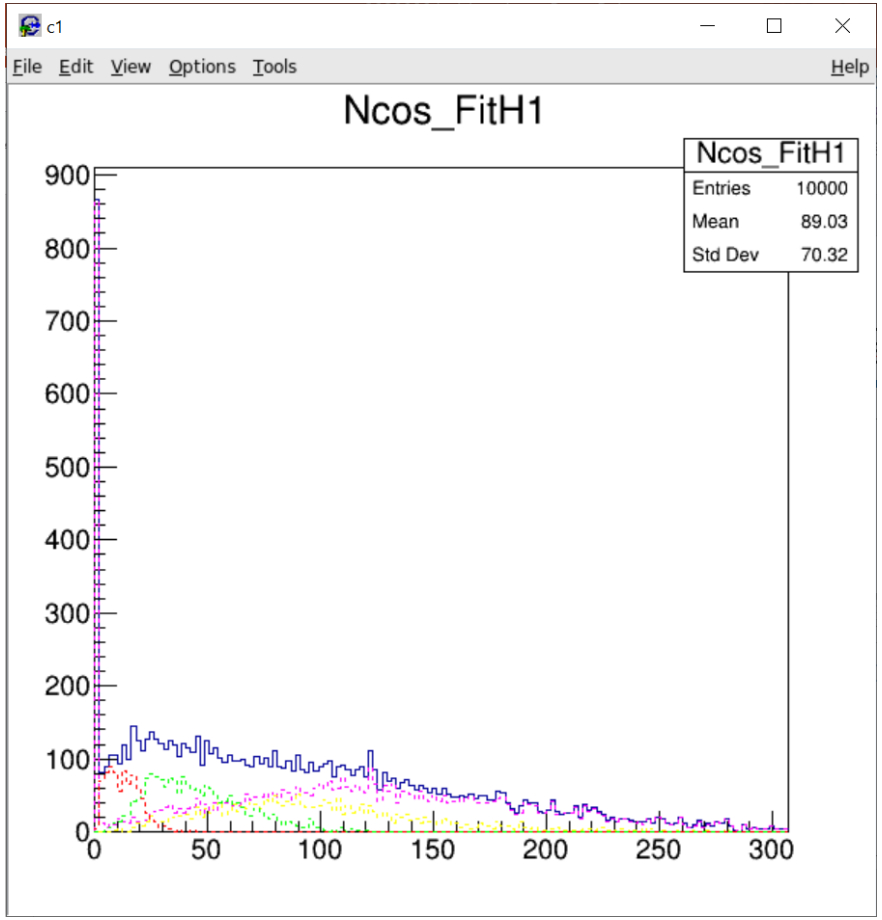

Hypothesis testing: 0.1yr

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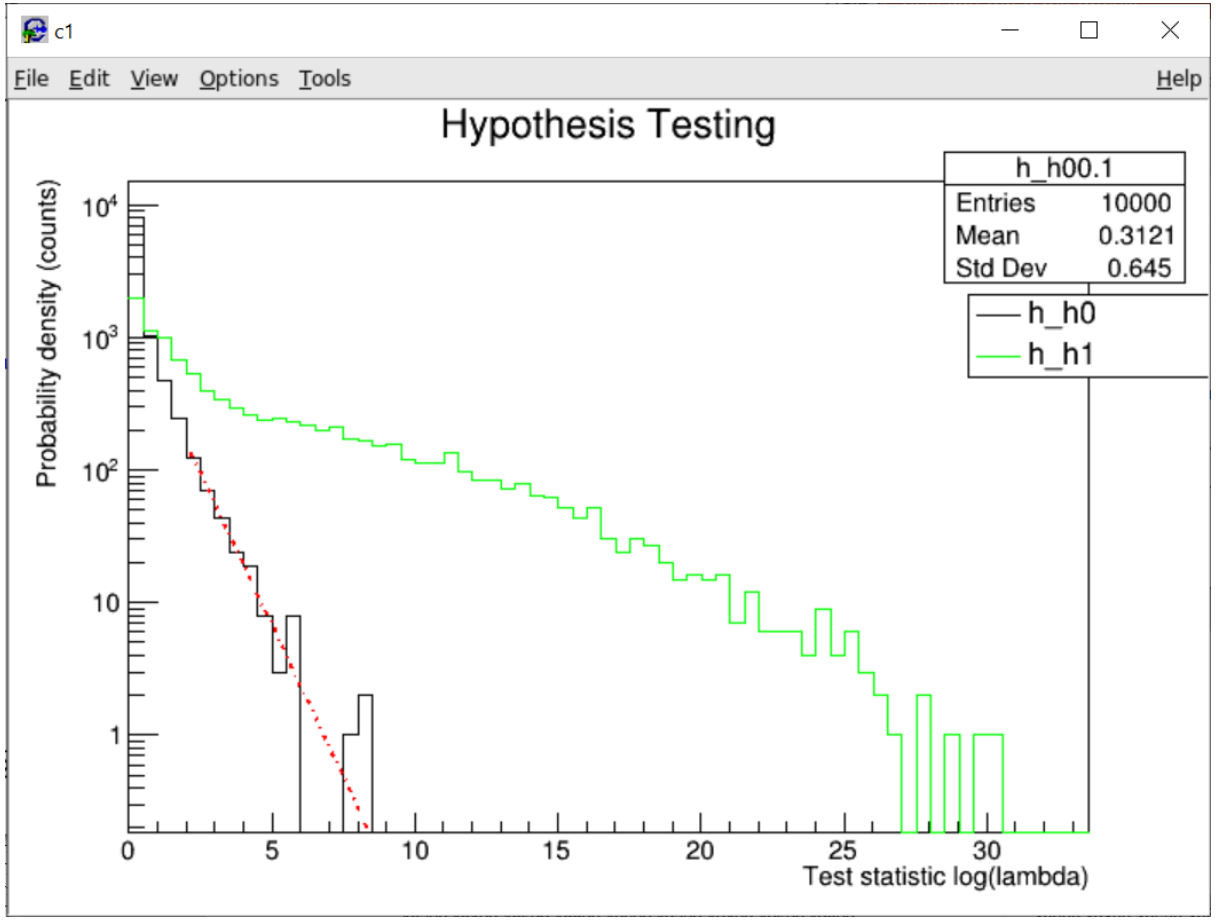

0.5 yr

Pseudo experiments: 0.5yr (bkg)

$\langle N_{cos}^{gen} \rangle = 0$

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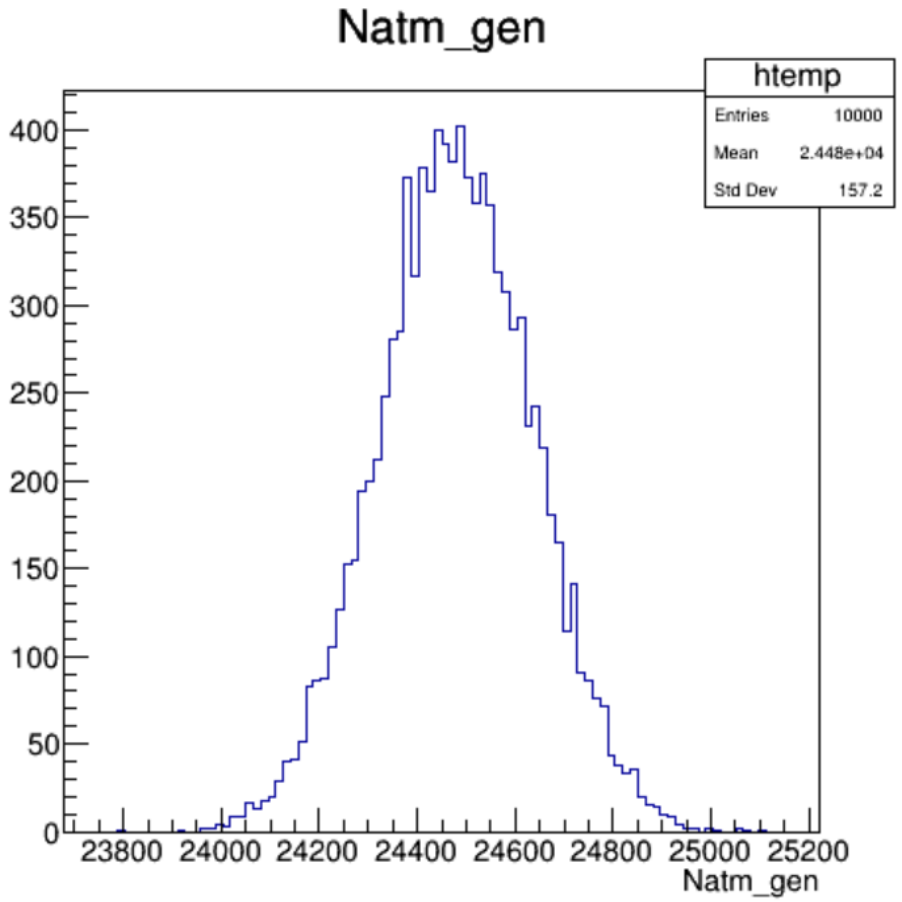

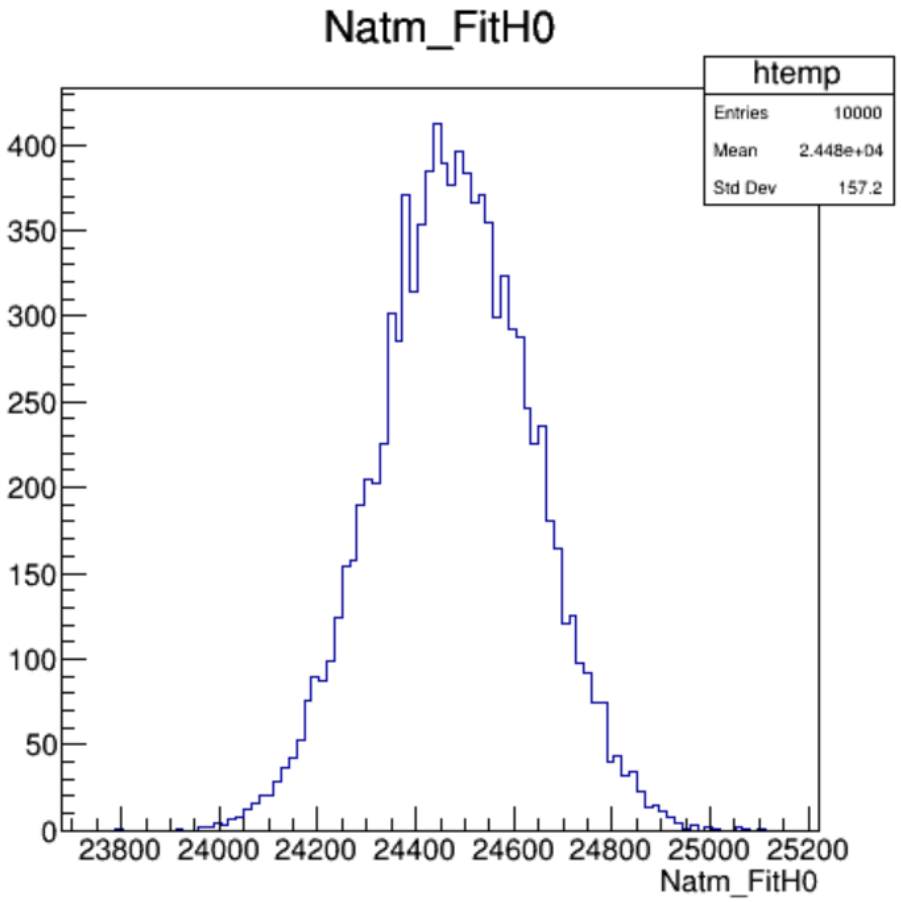

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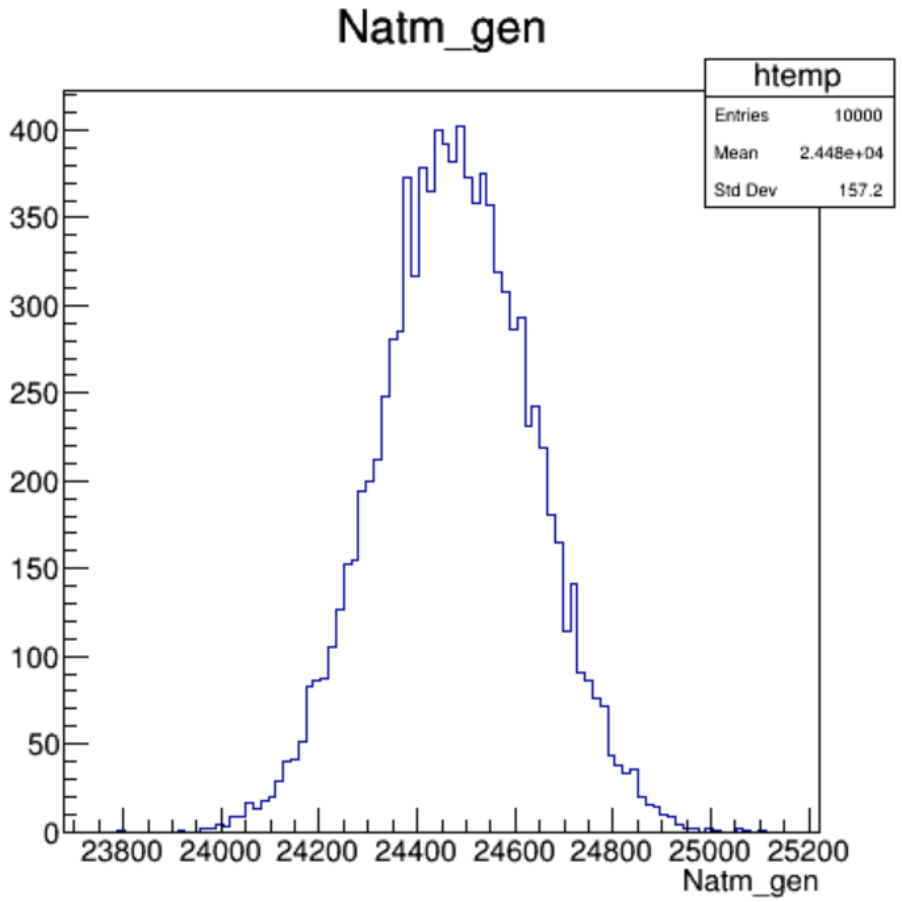

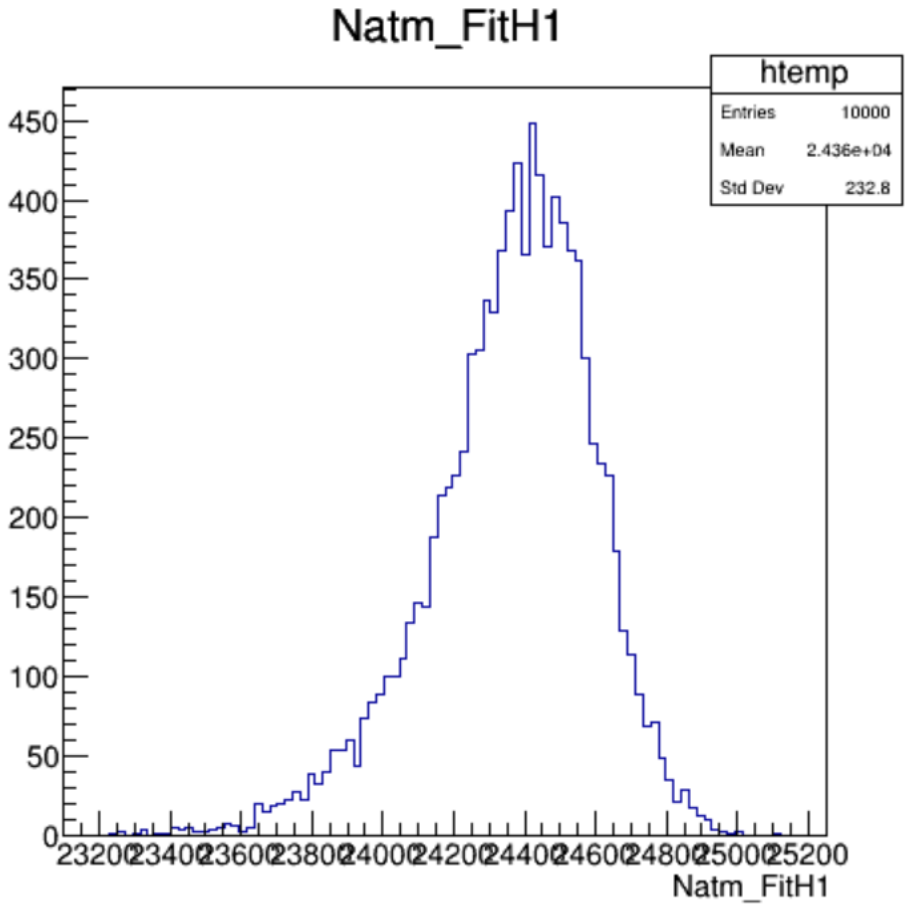

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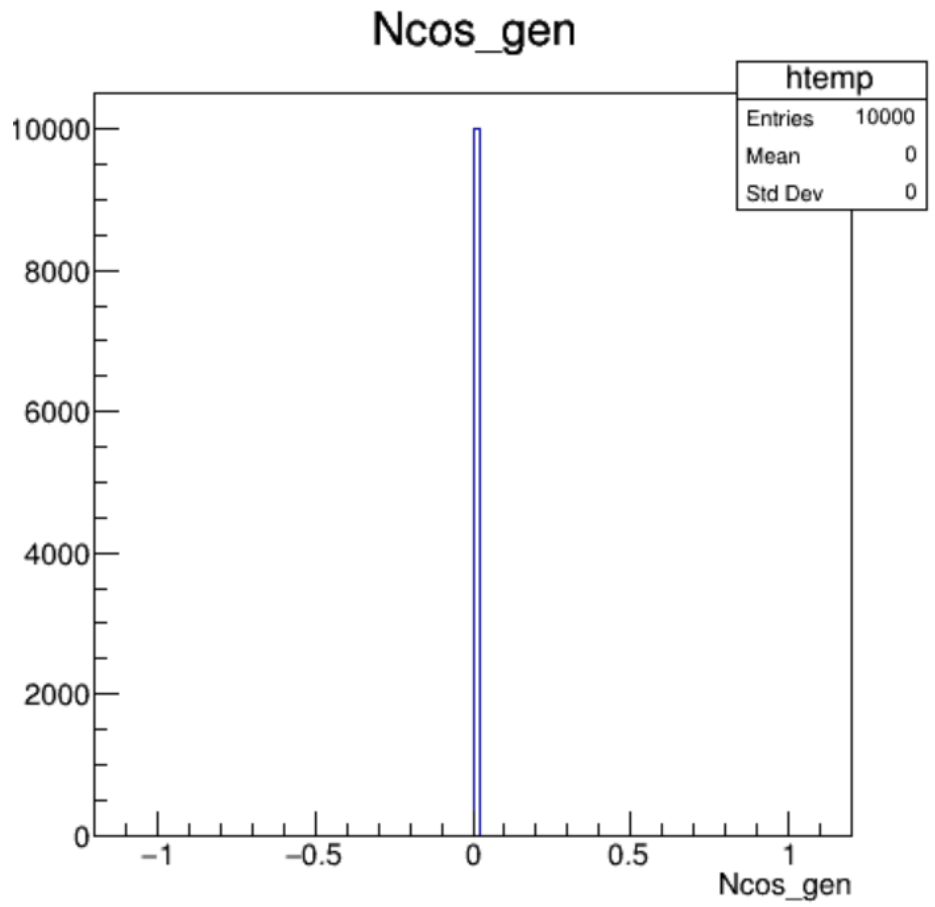

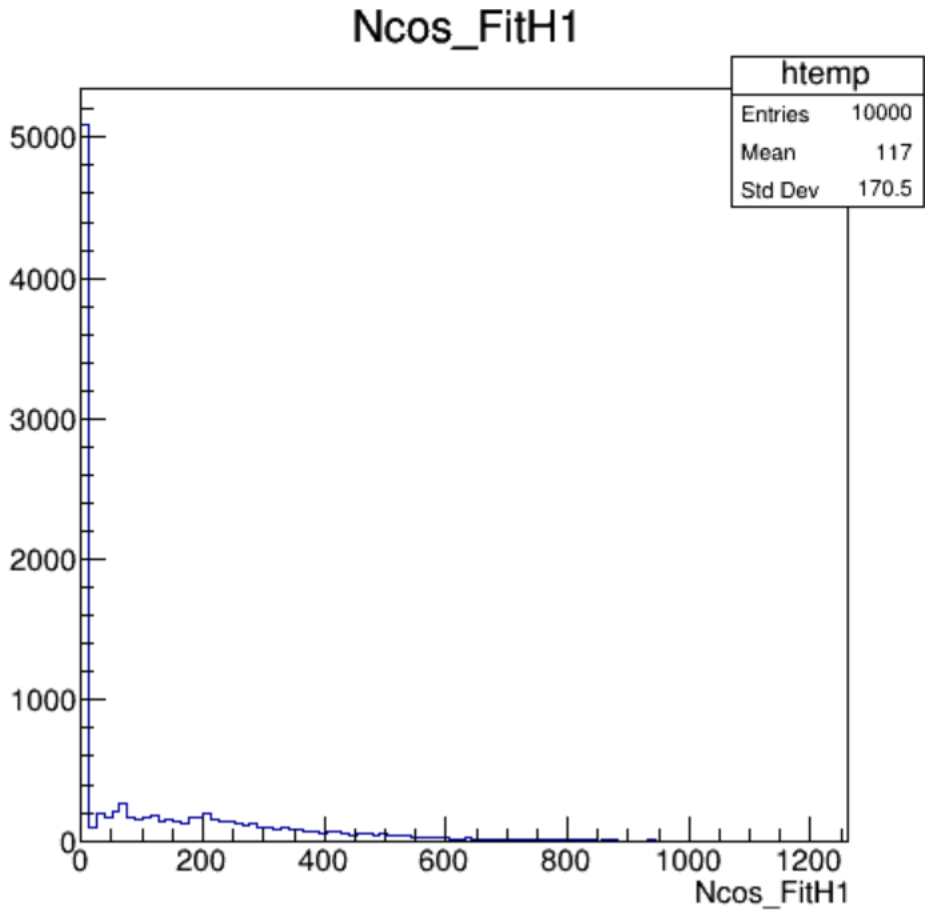

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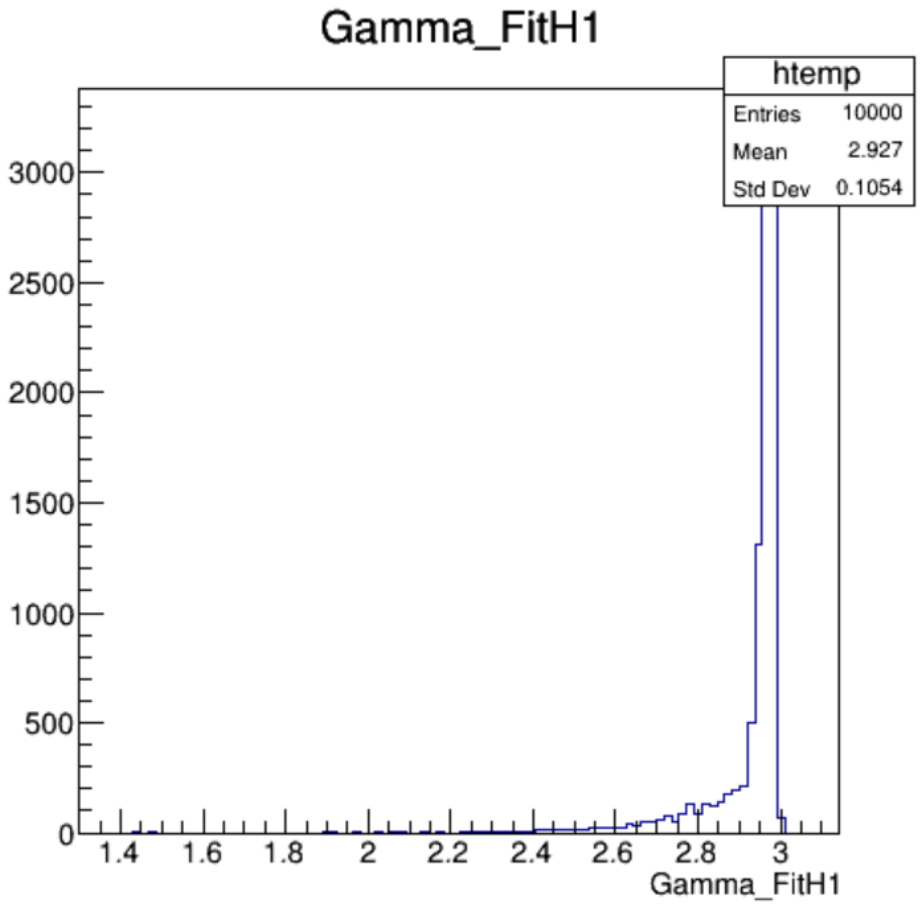

Pseudo experiments: 0.5yr (sig+bkg)

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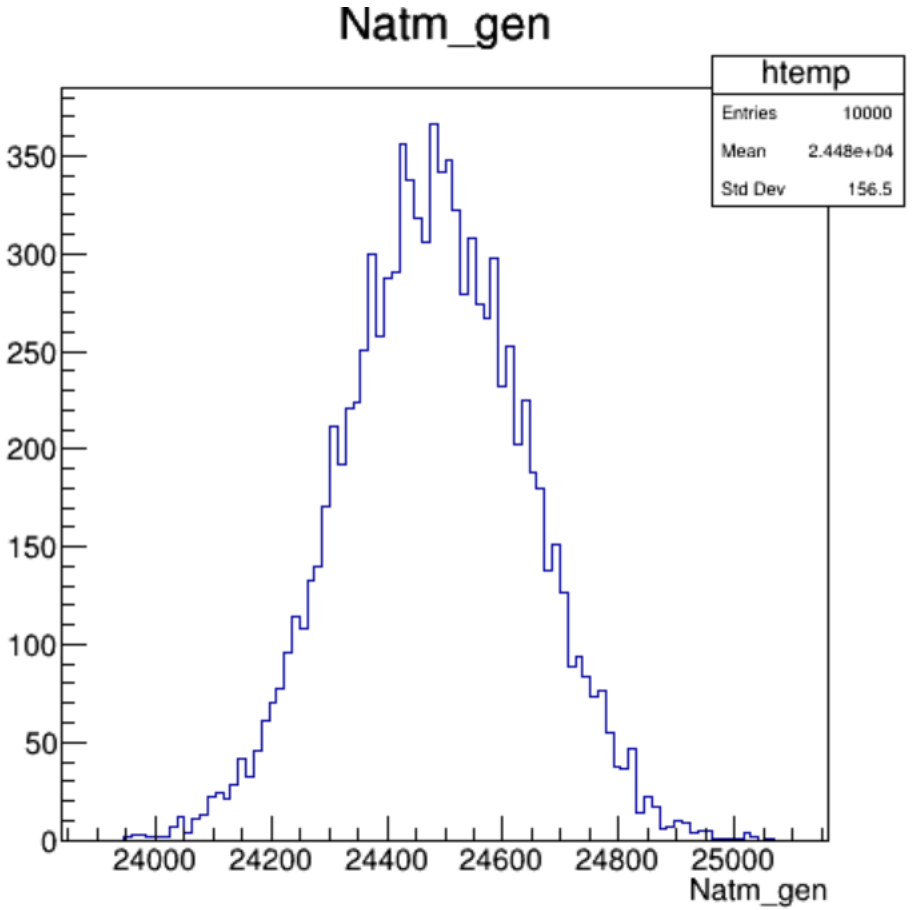

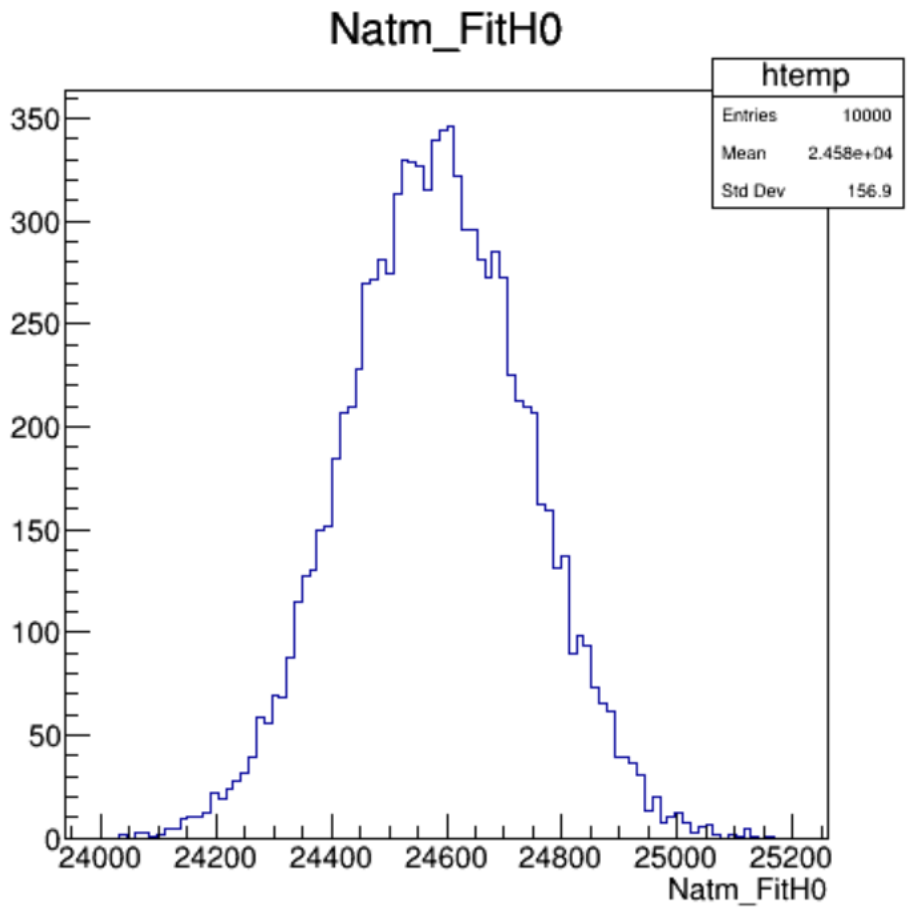

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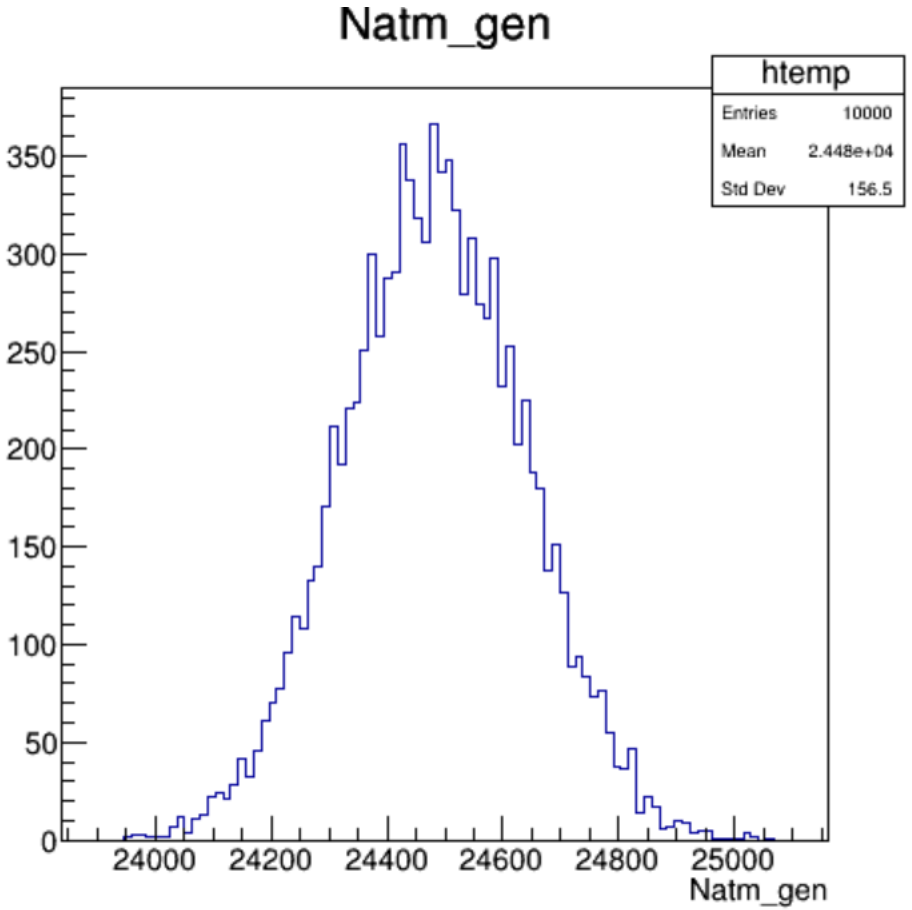

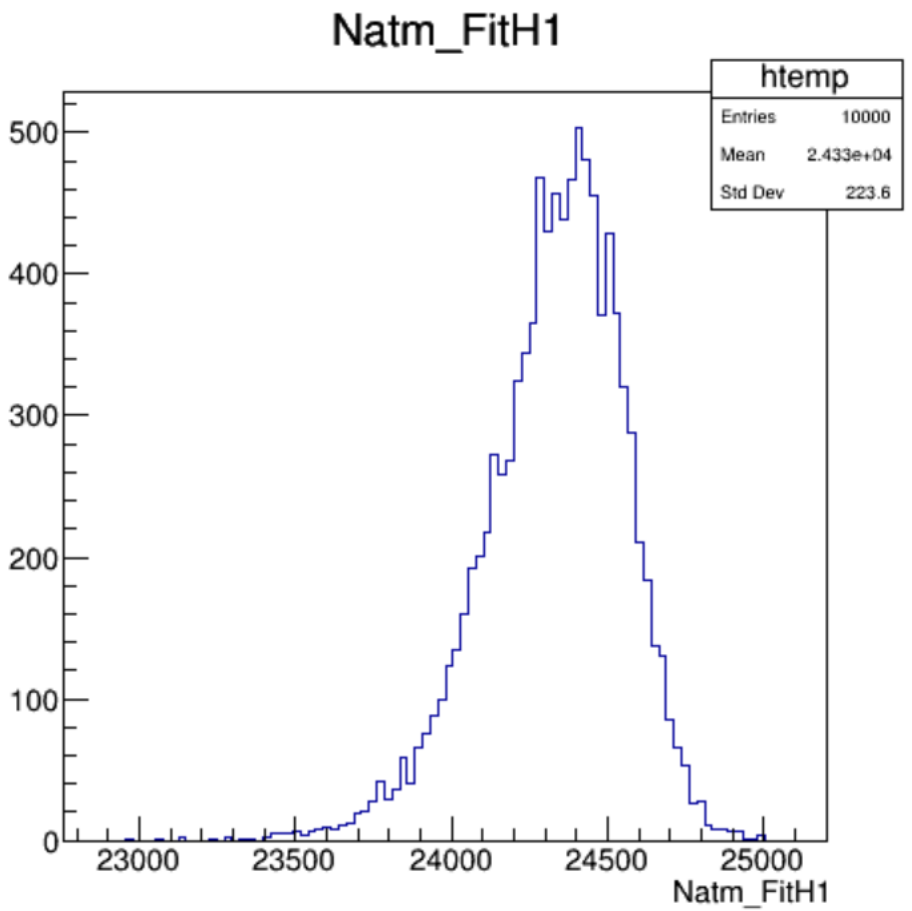

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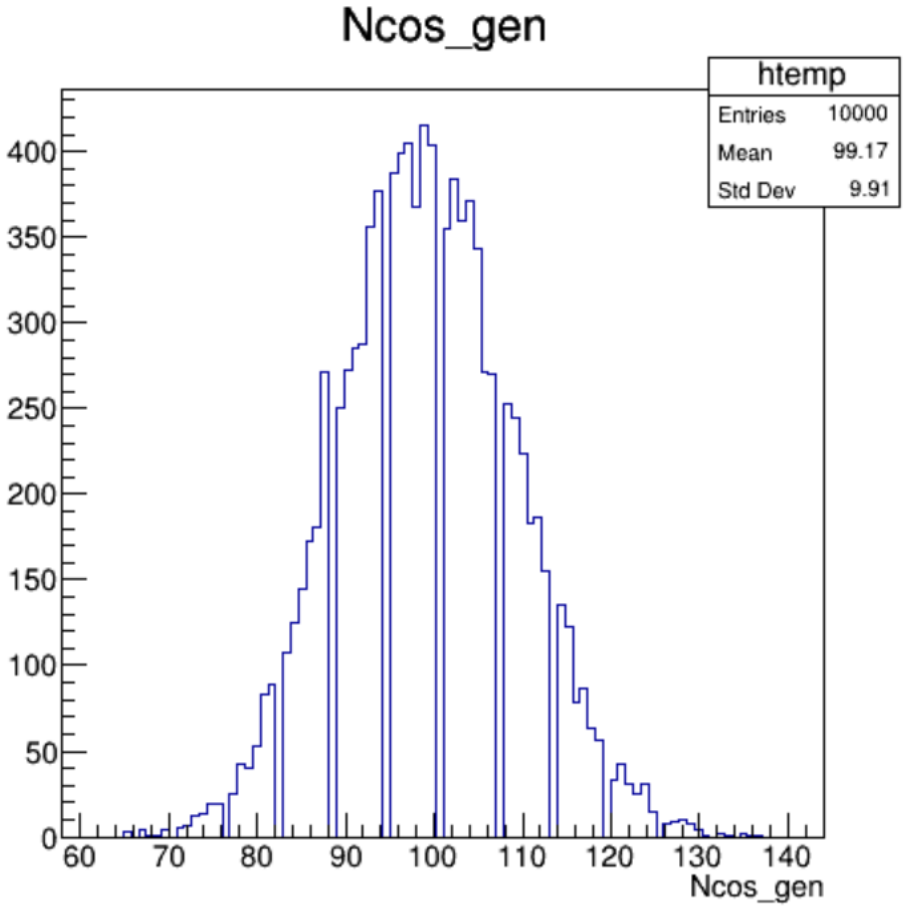

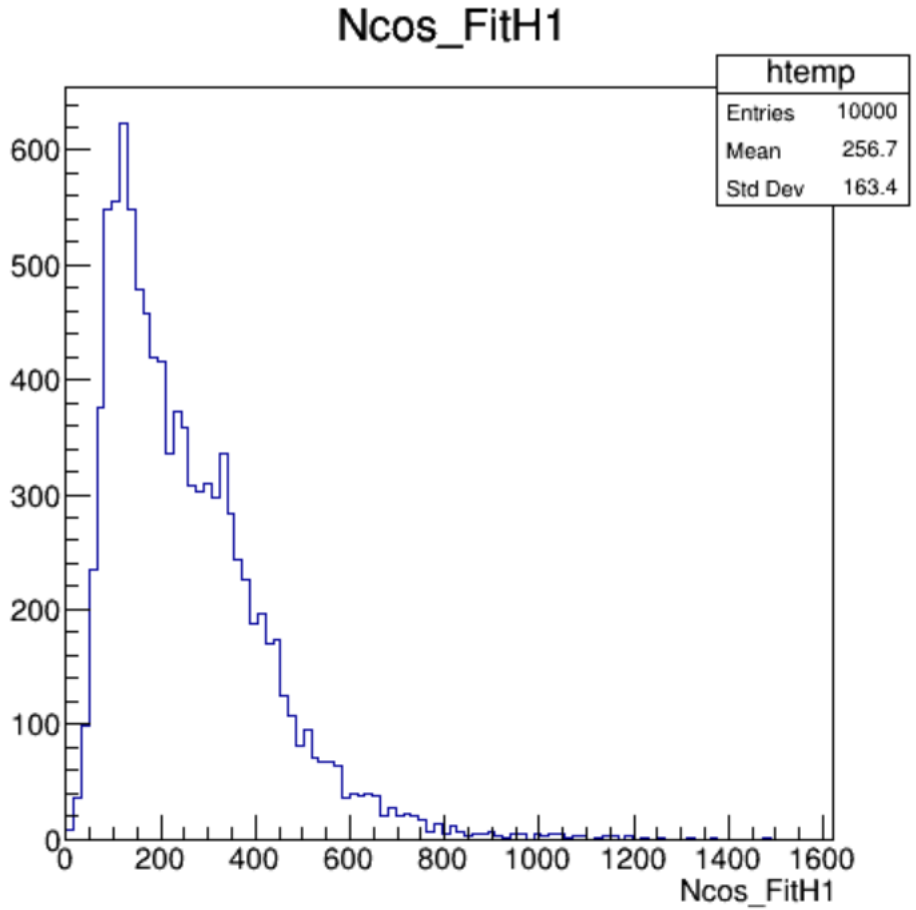

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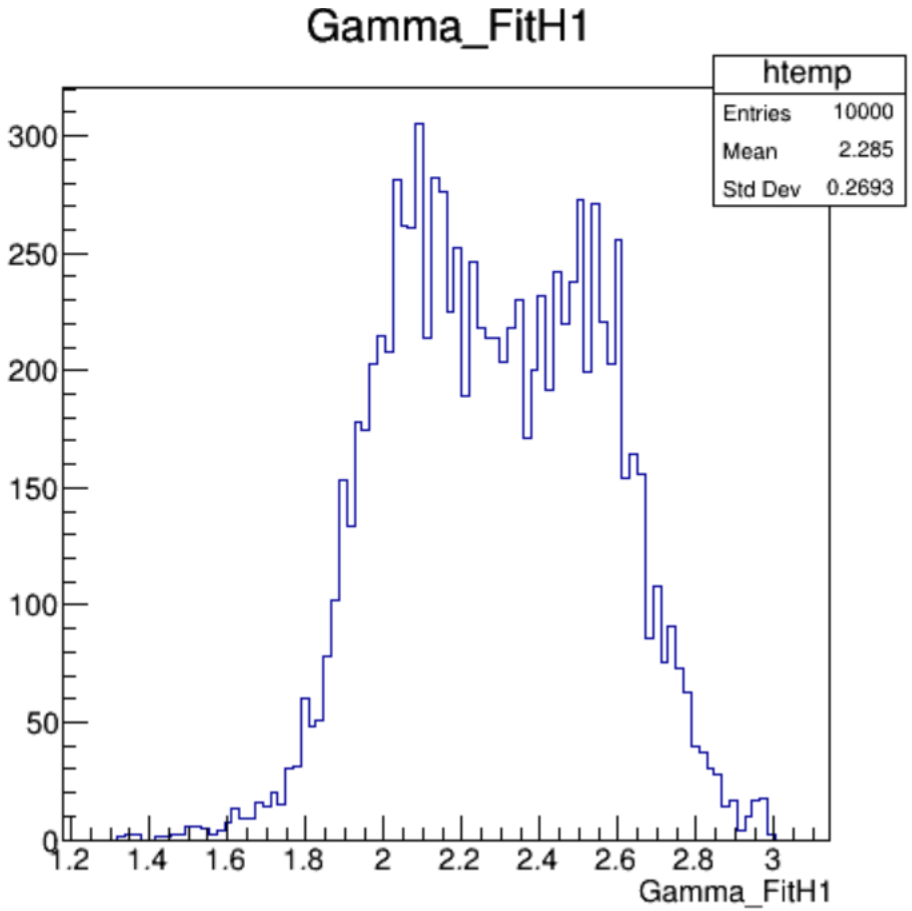

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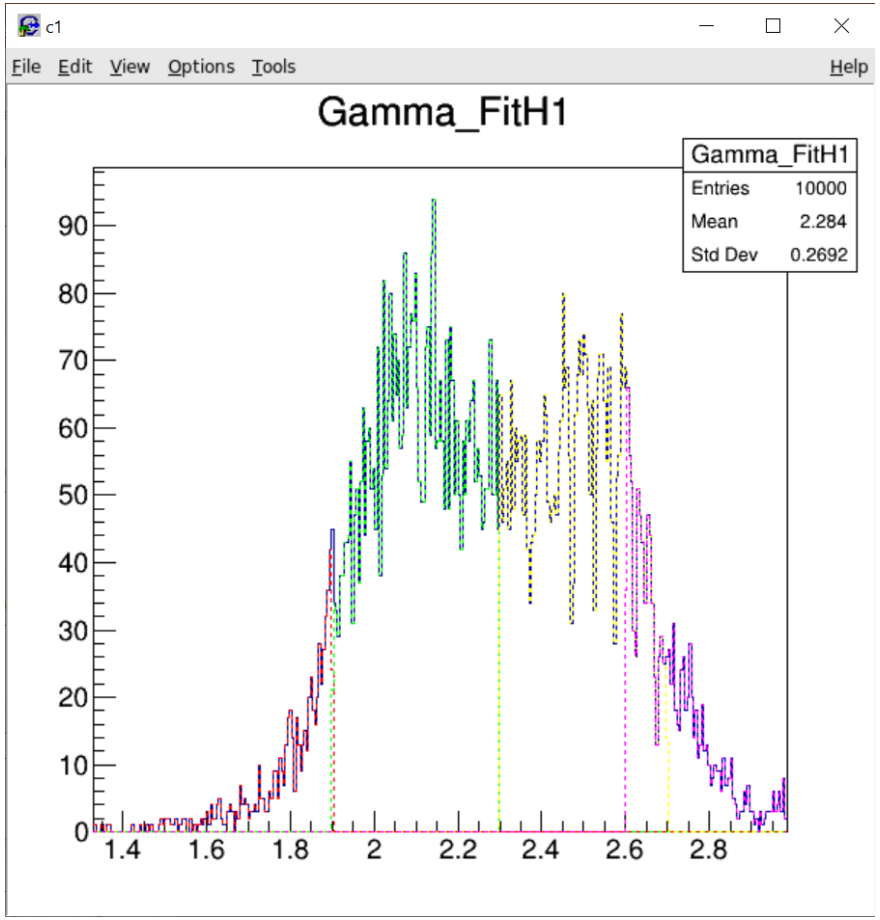

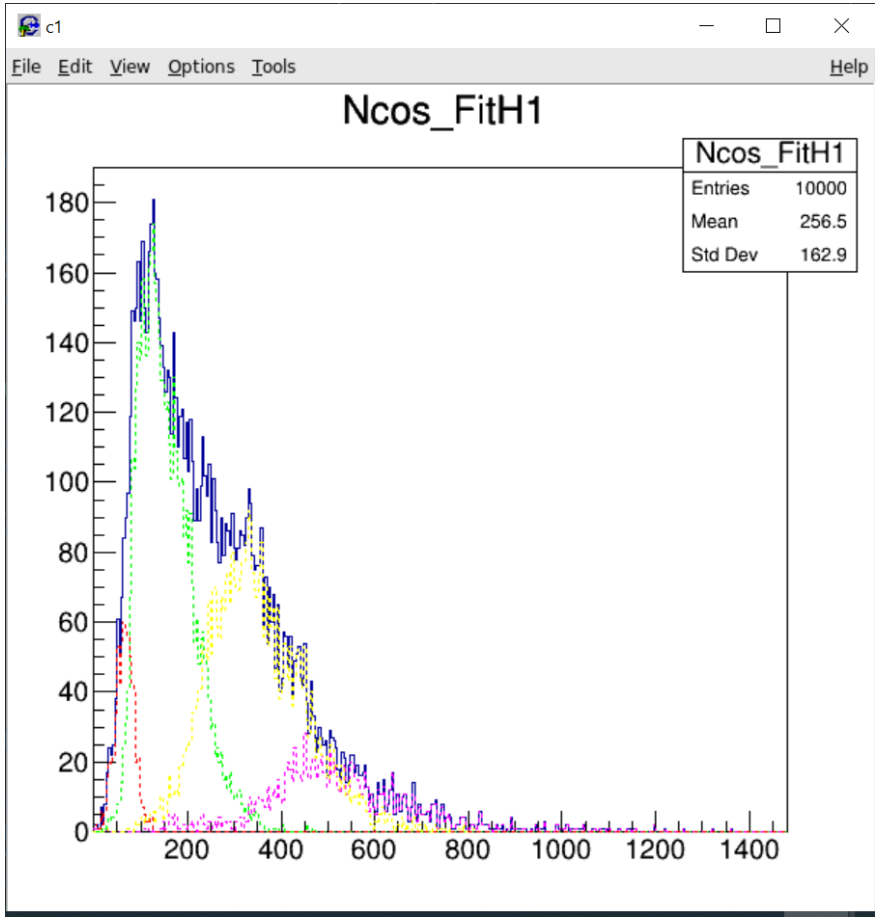

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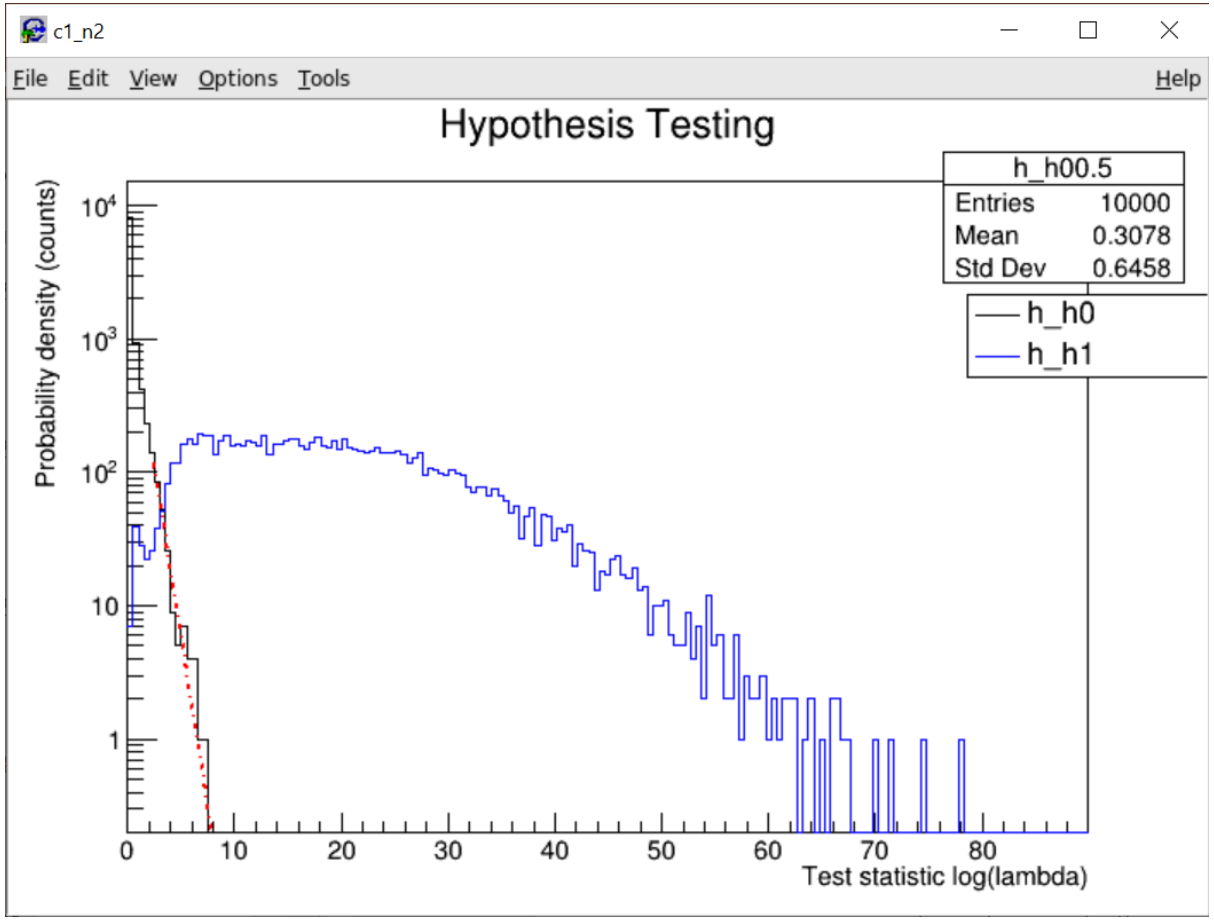

1.0 yr

Pseudo experiments: 1yr (bkg)

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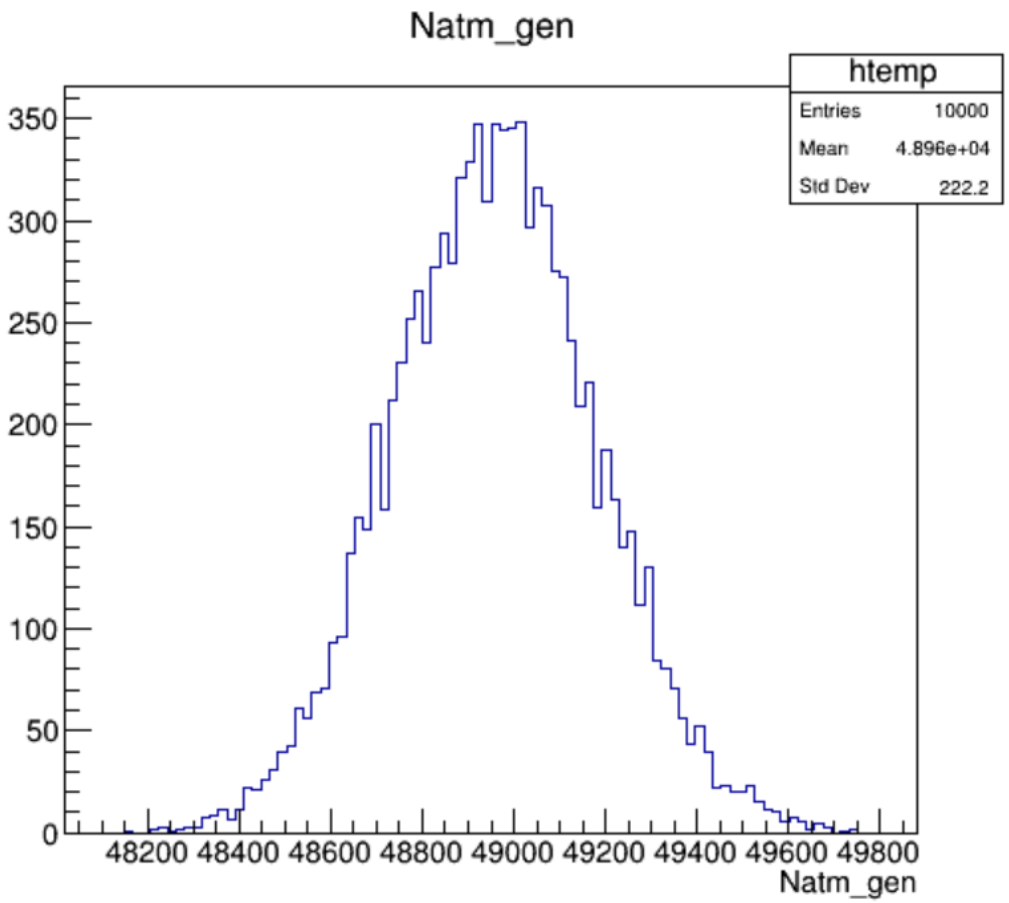

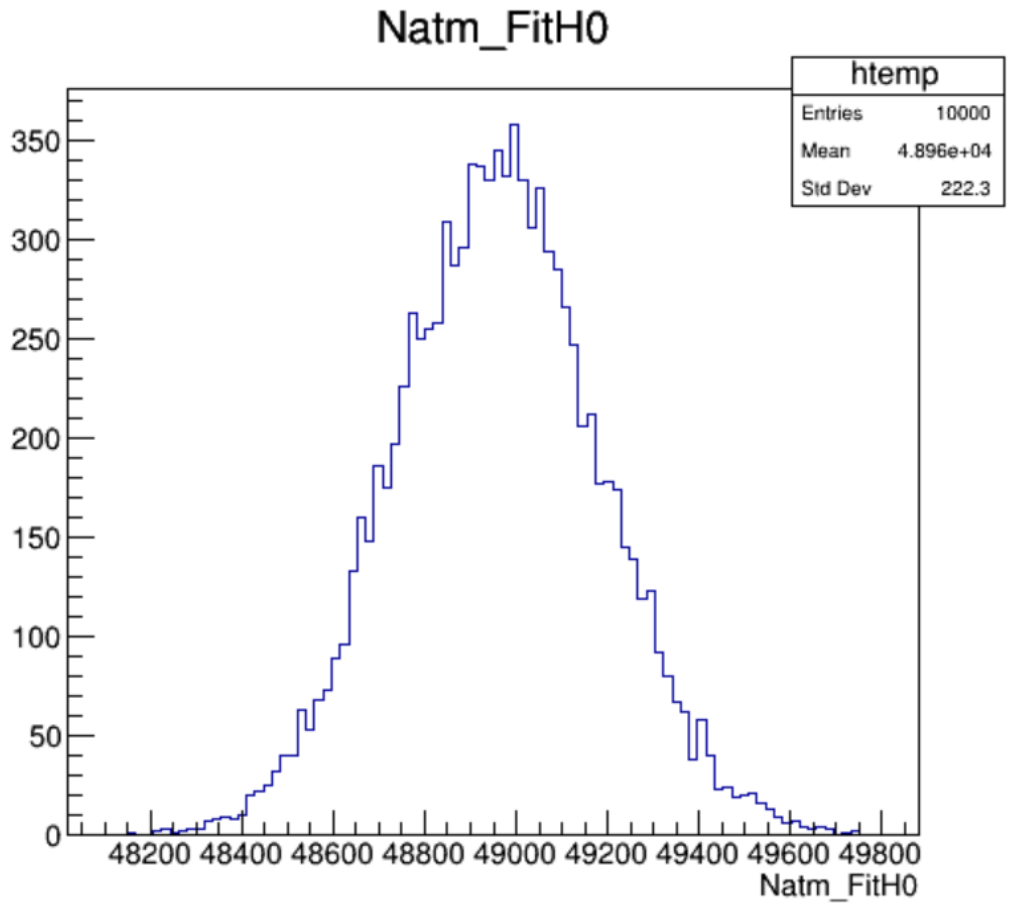

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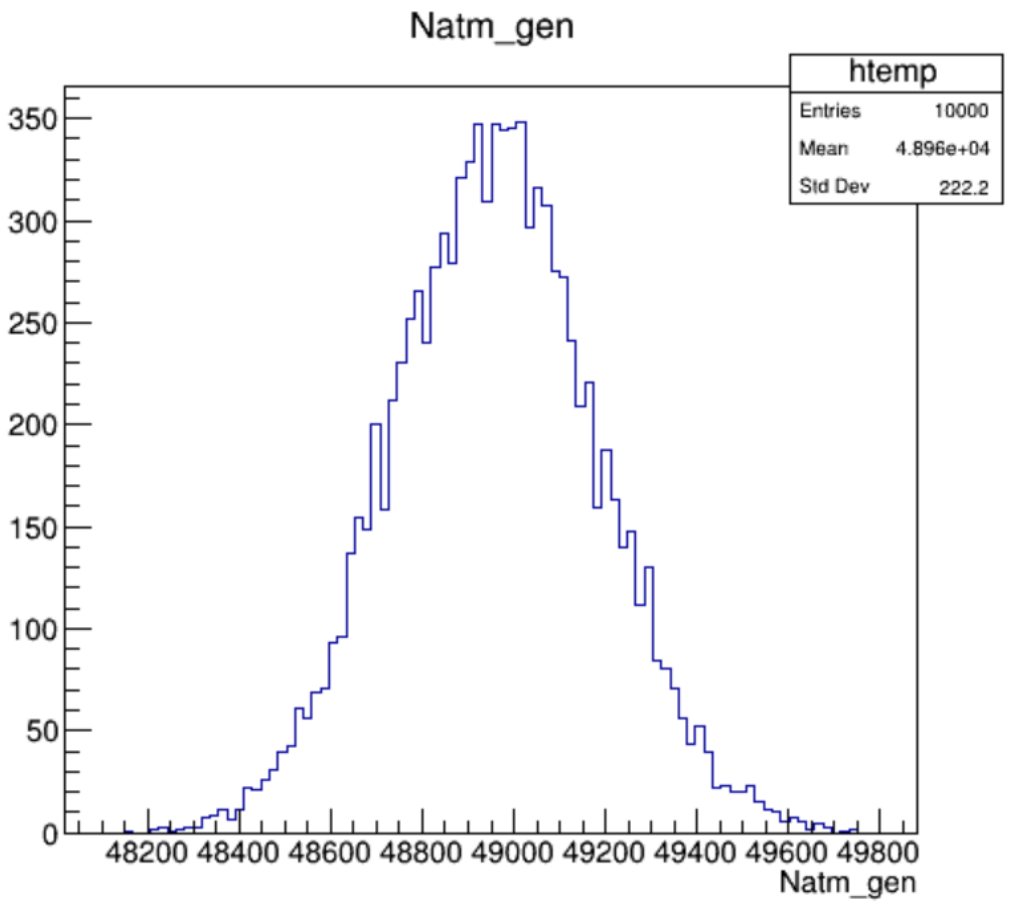

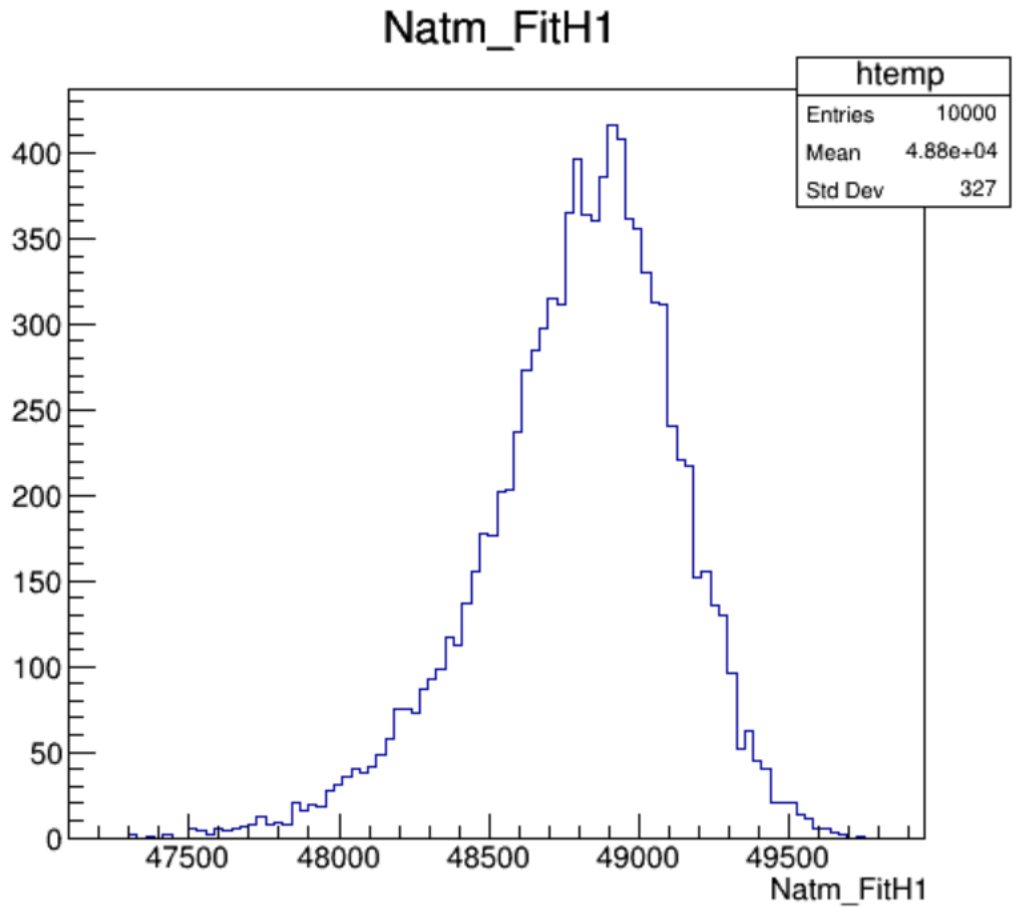

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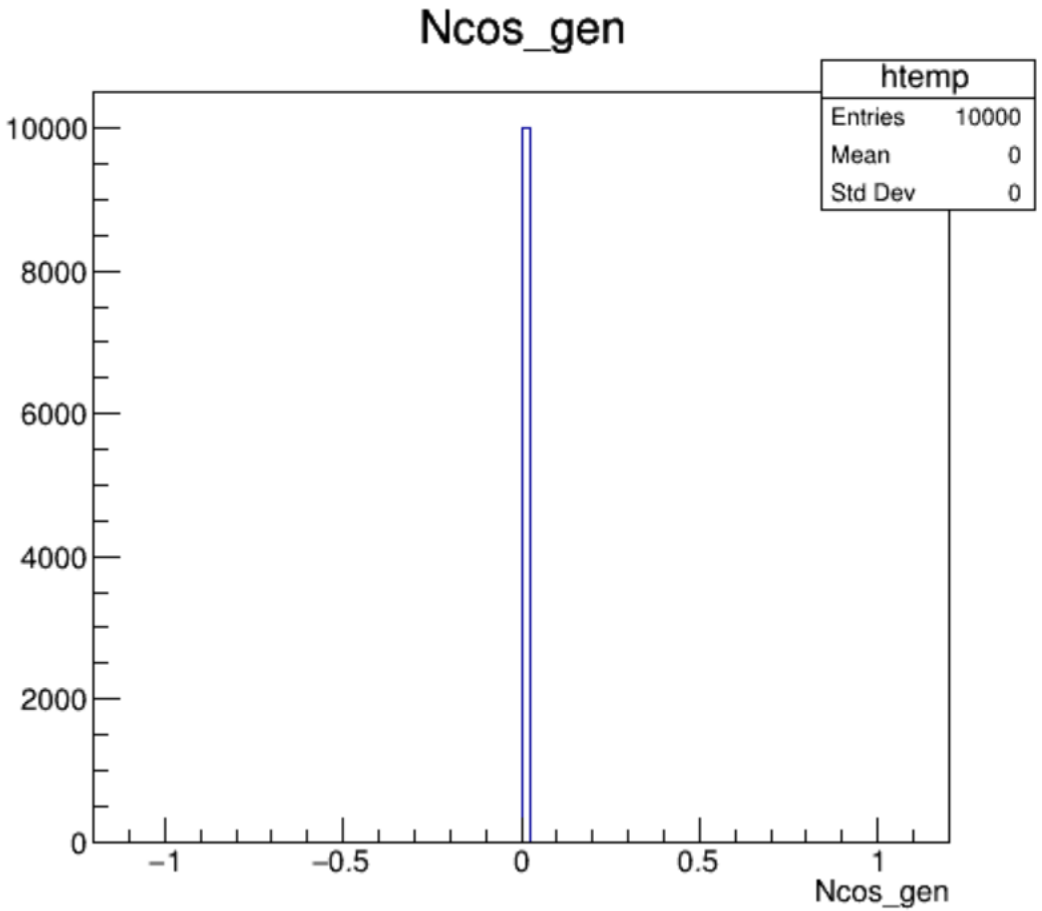

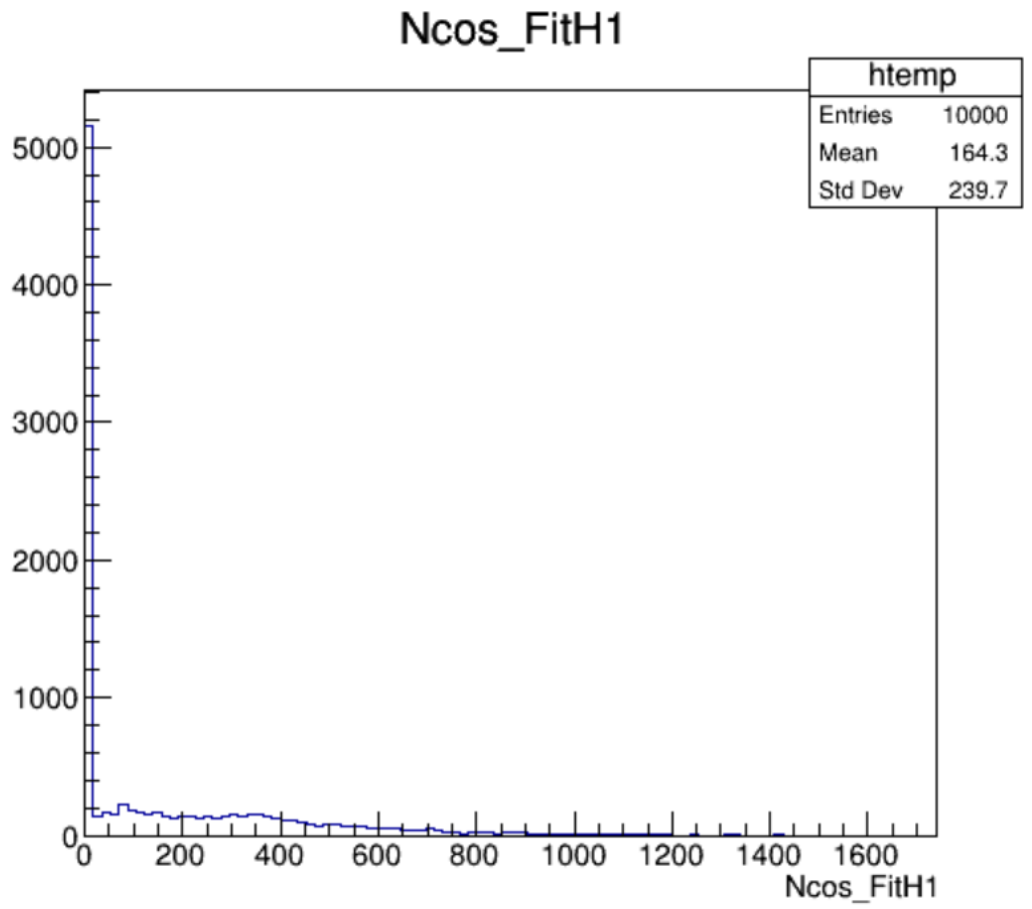

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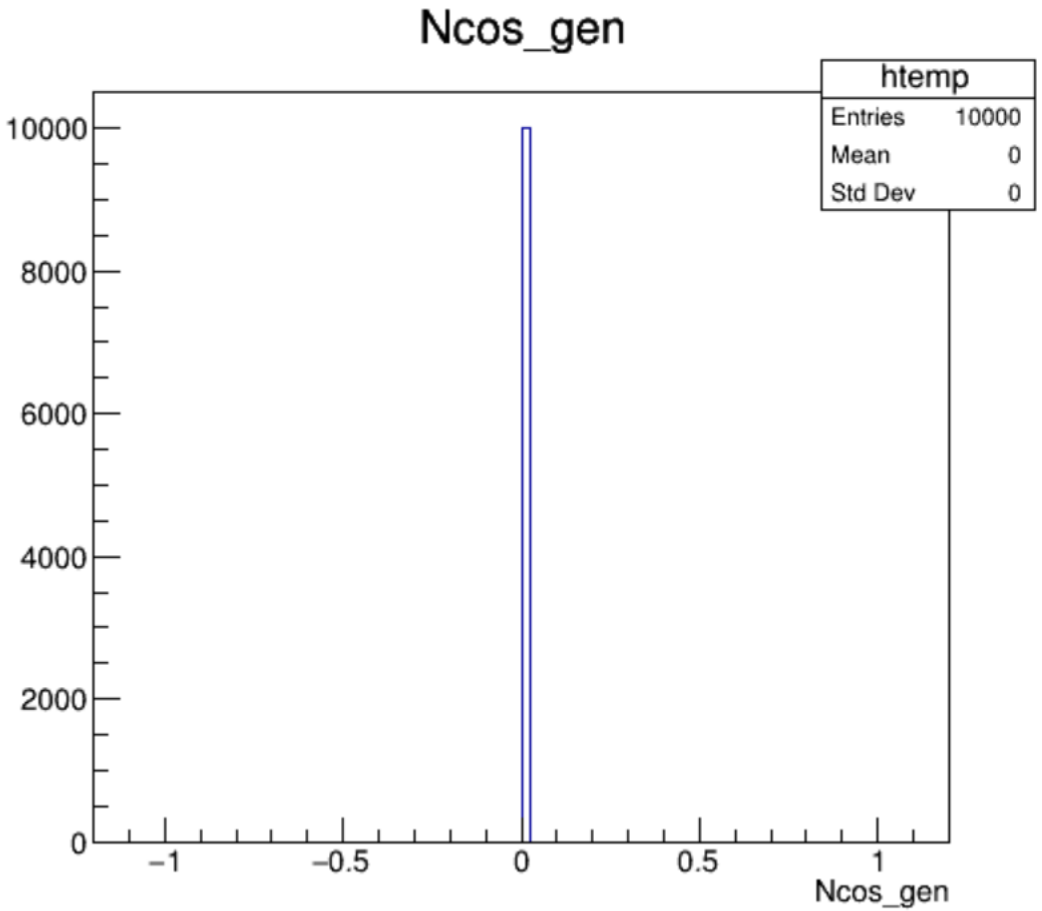

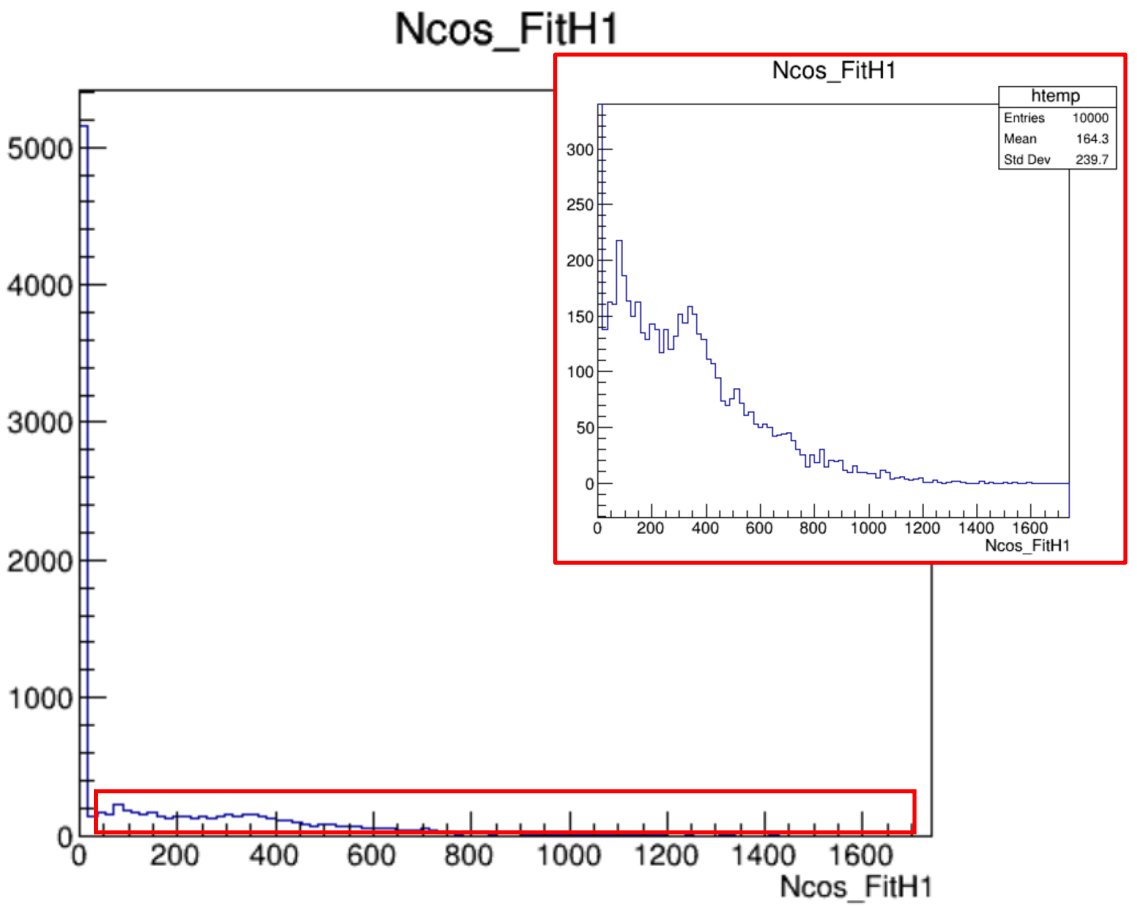

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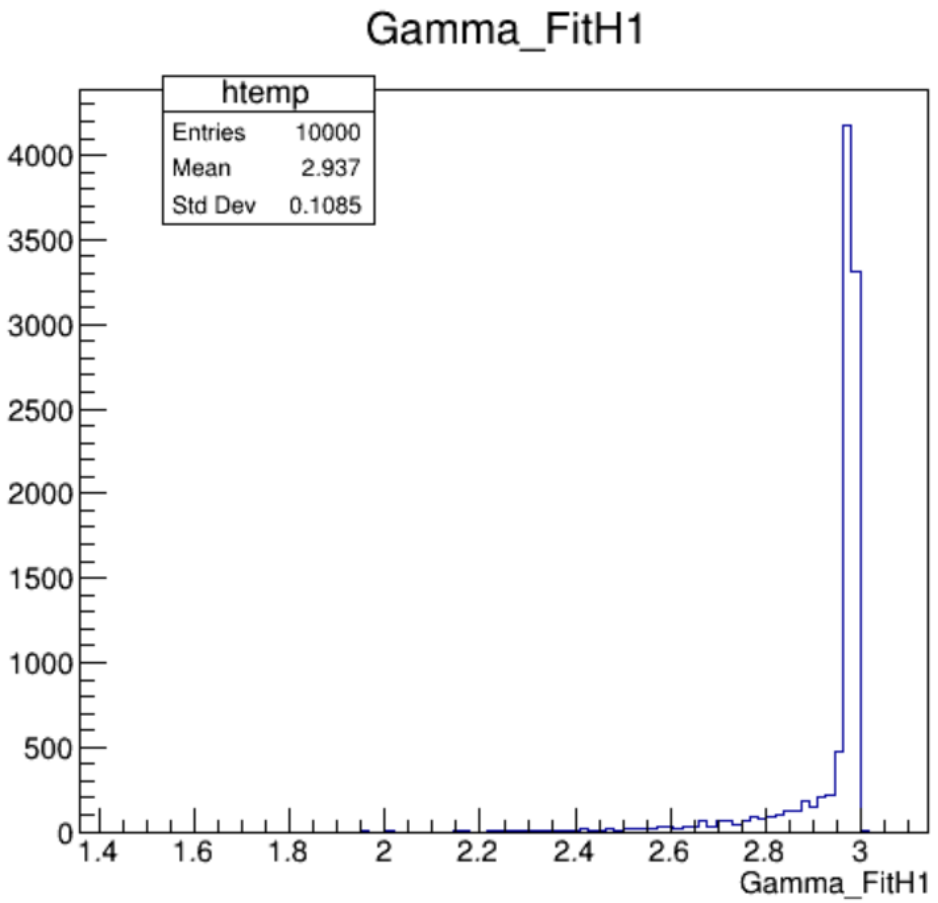

Pseudo experiments: 1yr (sig+bkg)

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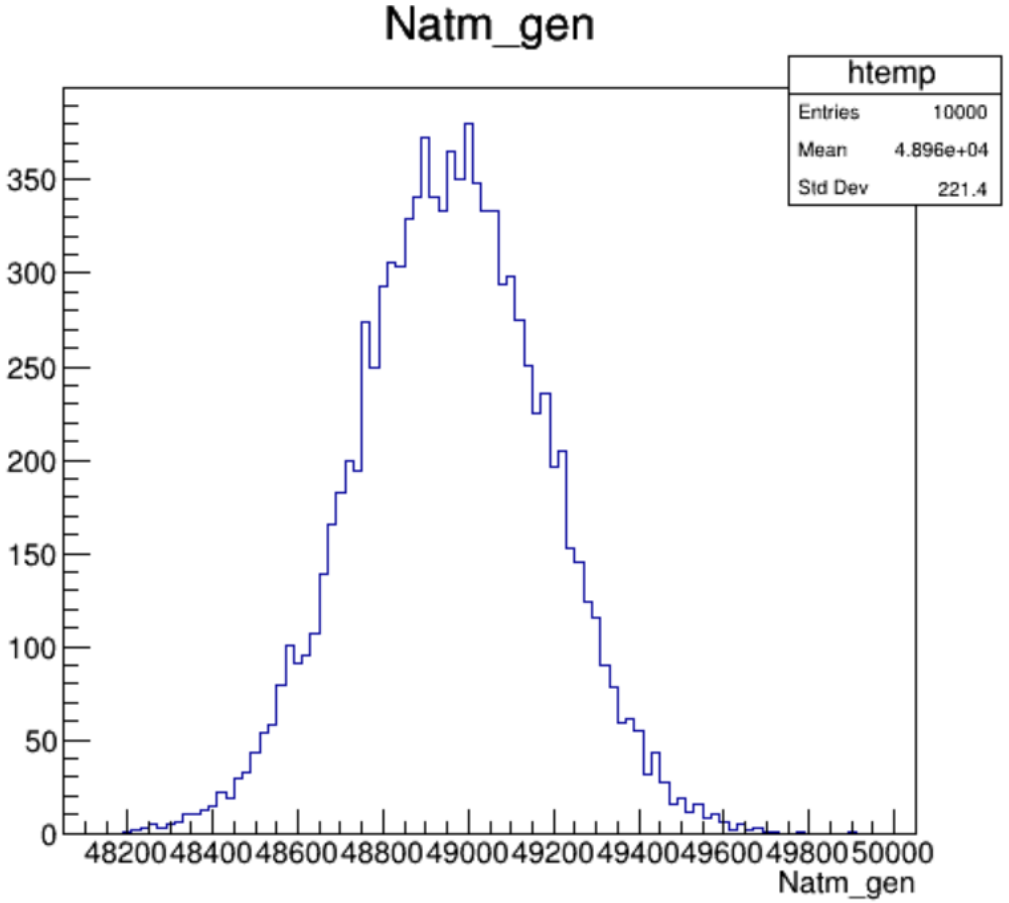
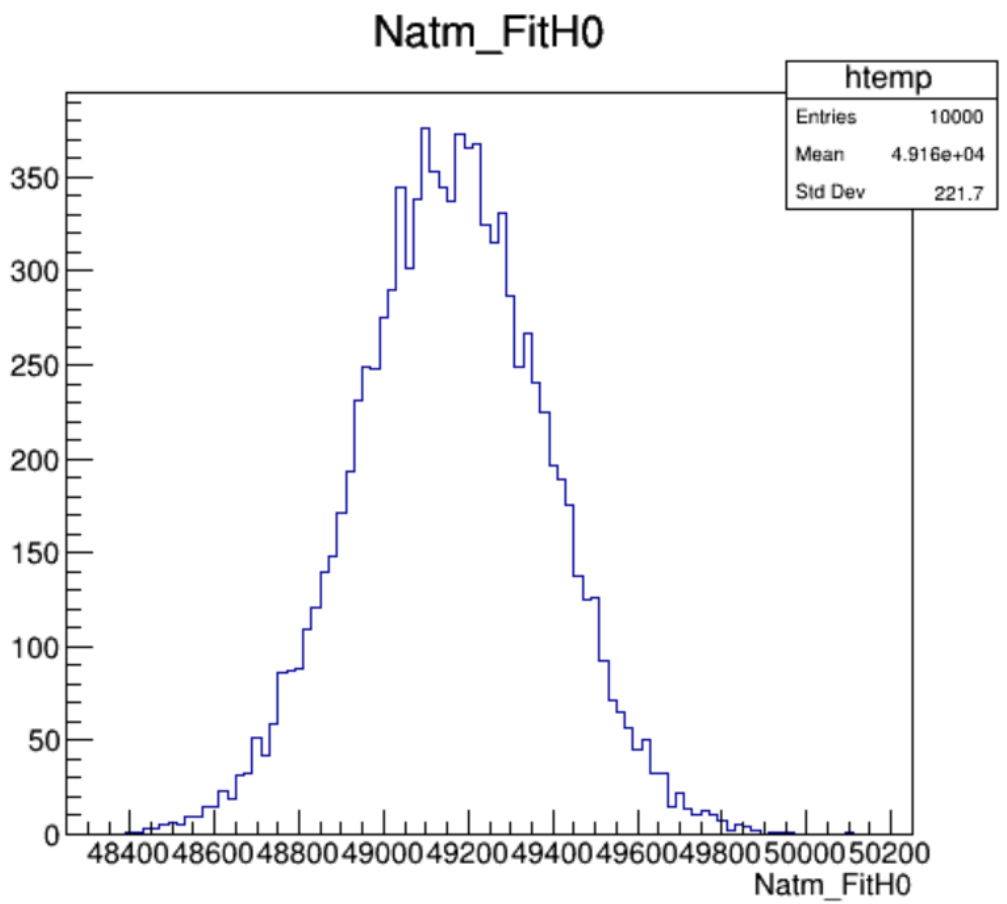
$\langle N_{atm}^{gen} \rangle = 48960$

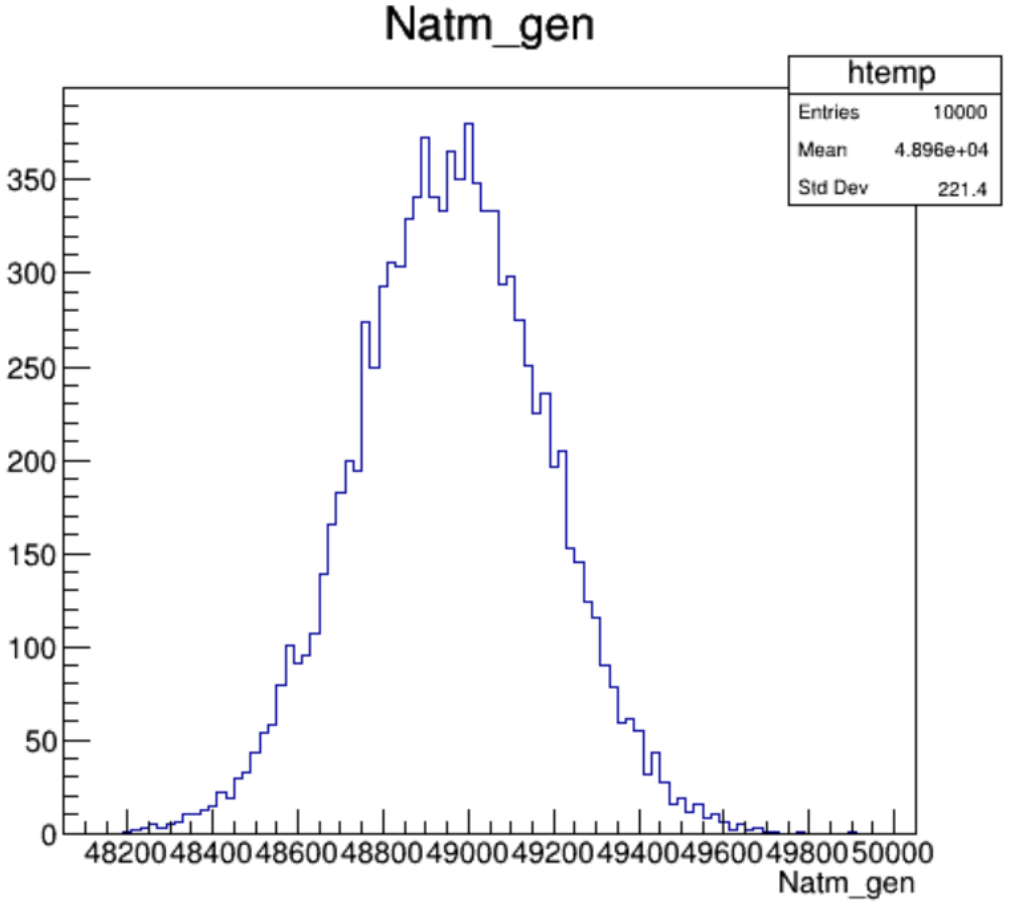


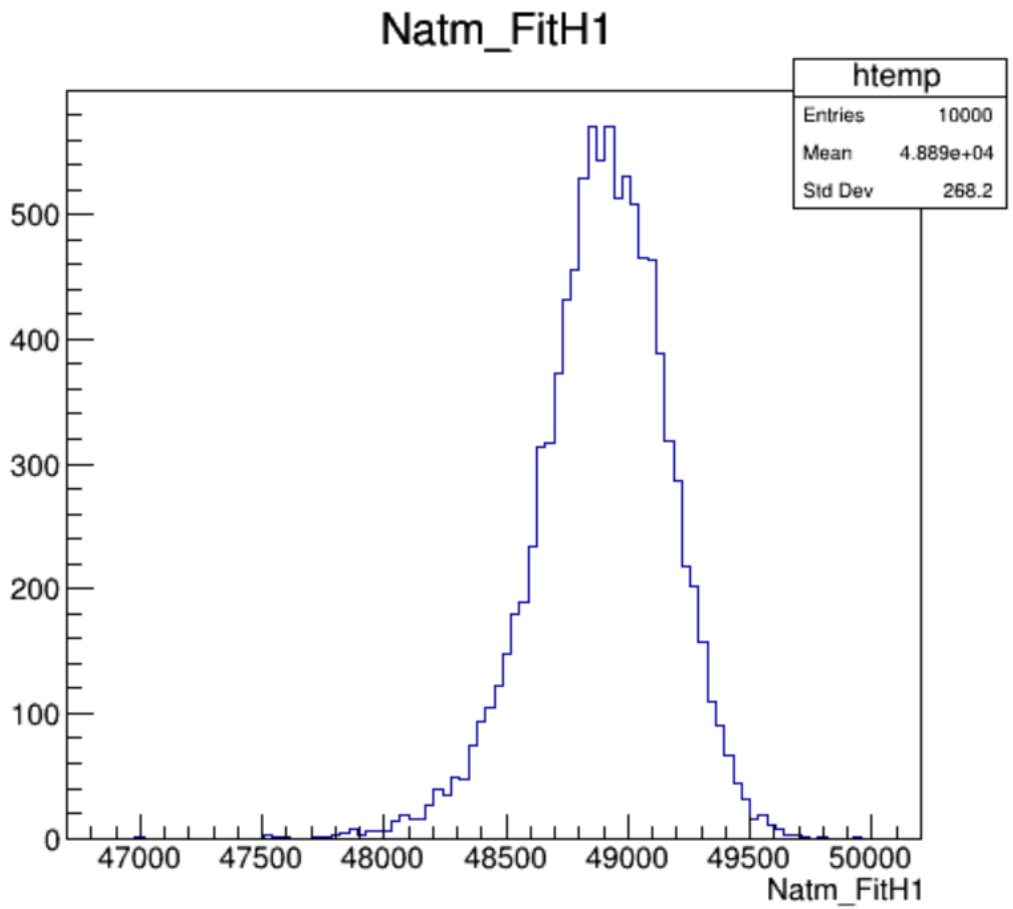


Pseudo experiments: 1yr (sig+bkg)

$\langle N_{cos}^{gen} \rangle = 199$

$\langle N_{atm}^{gen} \rangle = 48960$





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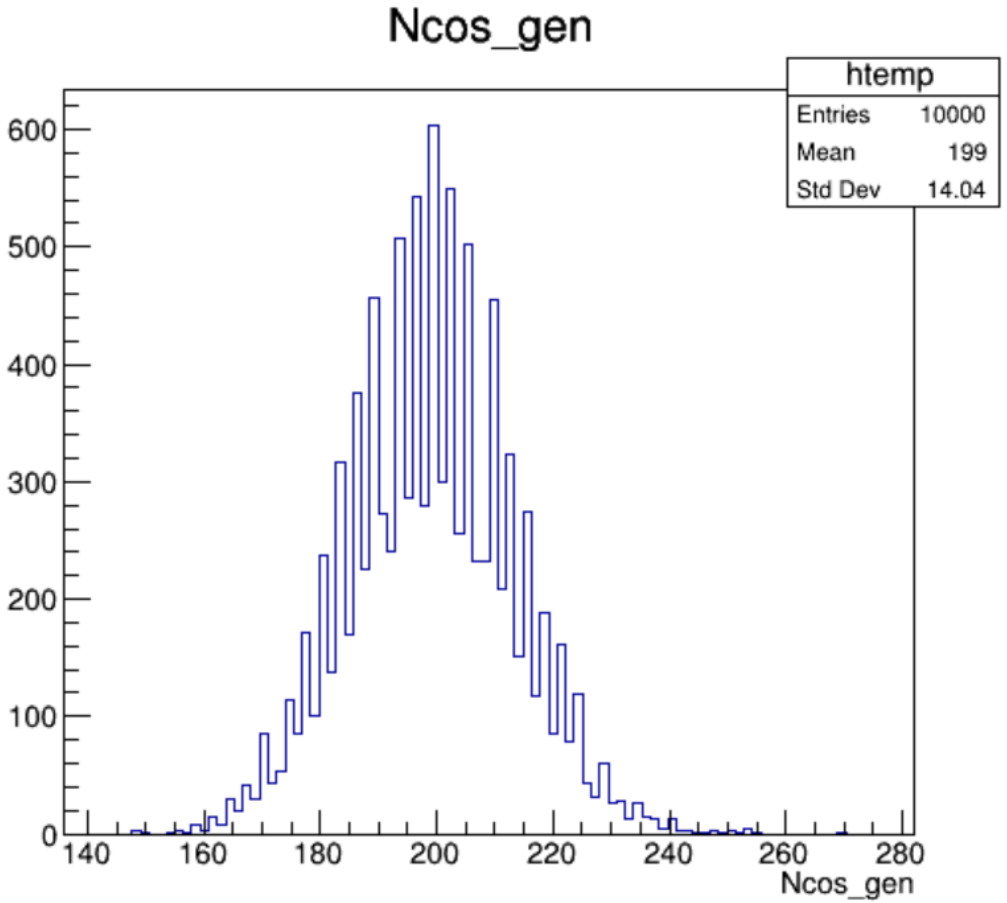
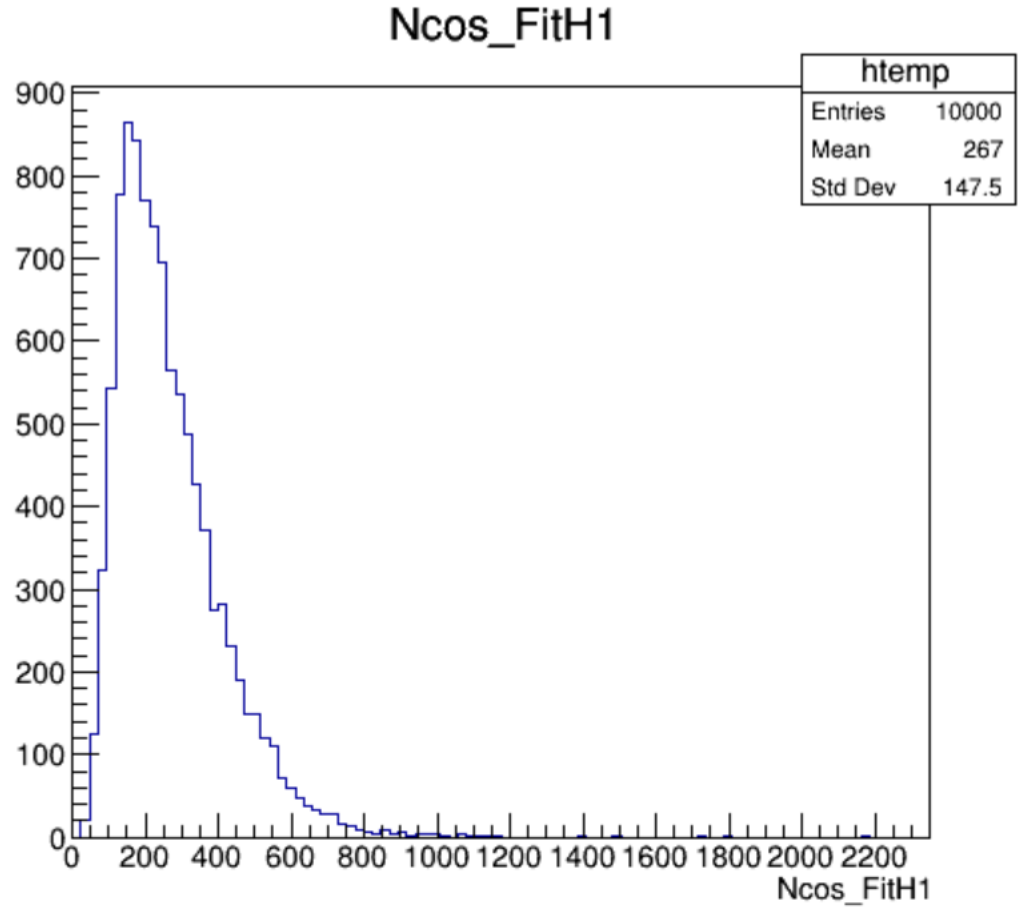
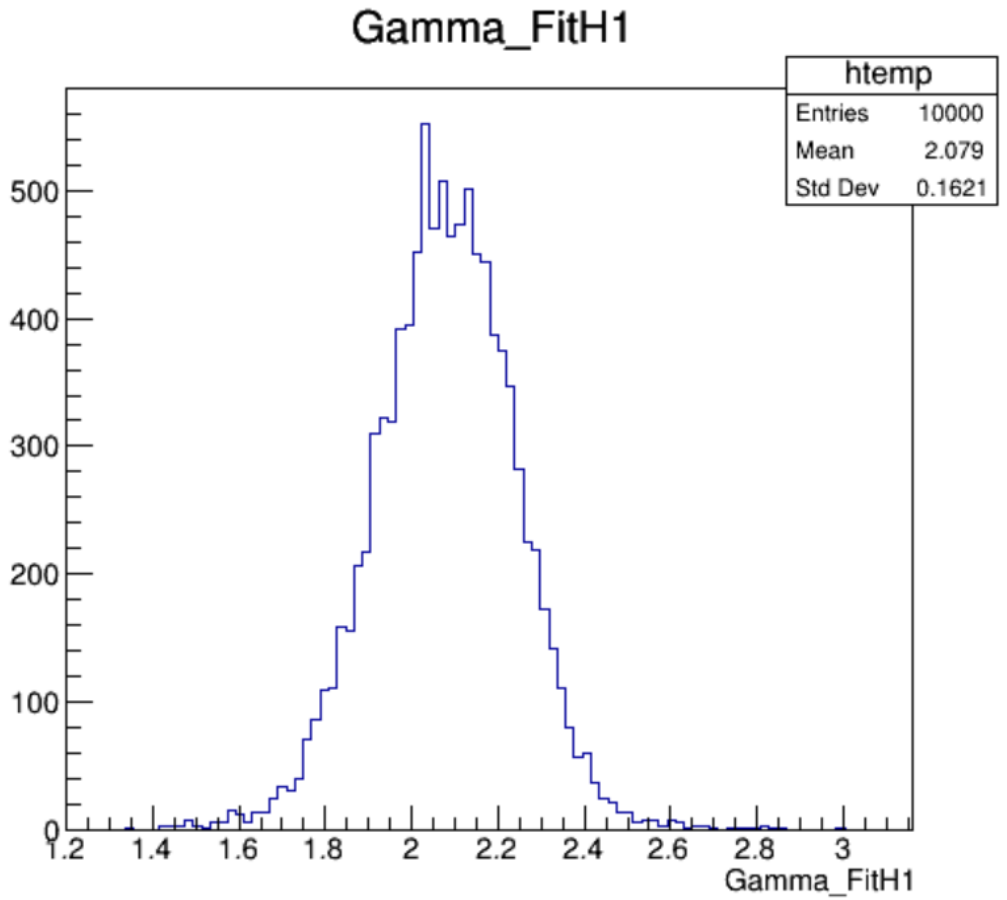




Pseudo experiments: 1yr (sig+bkg)

$\langle N_{cos}^{gen} \rangle = 199$

$\langle N_{atm}^{gen} \rangle = 48960$



Pseudo experiments: 1yr (sig+bkg)

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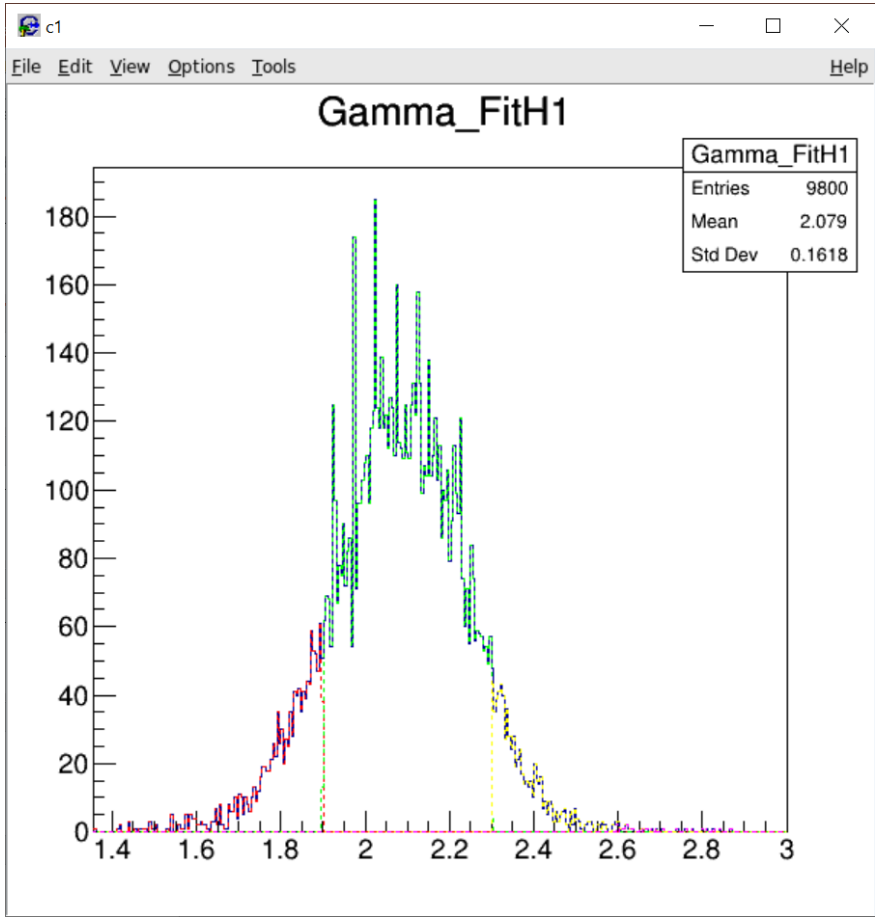
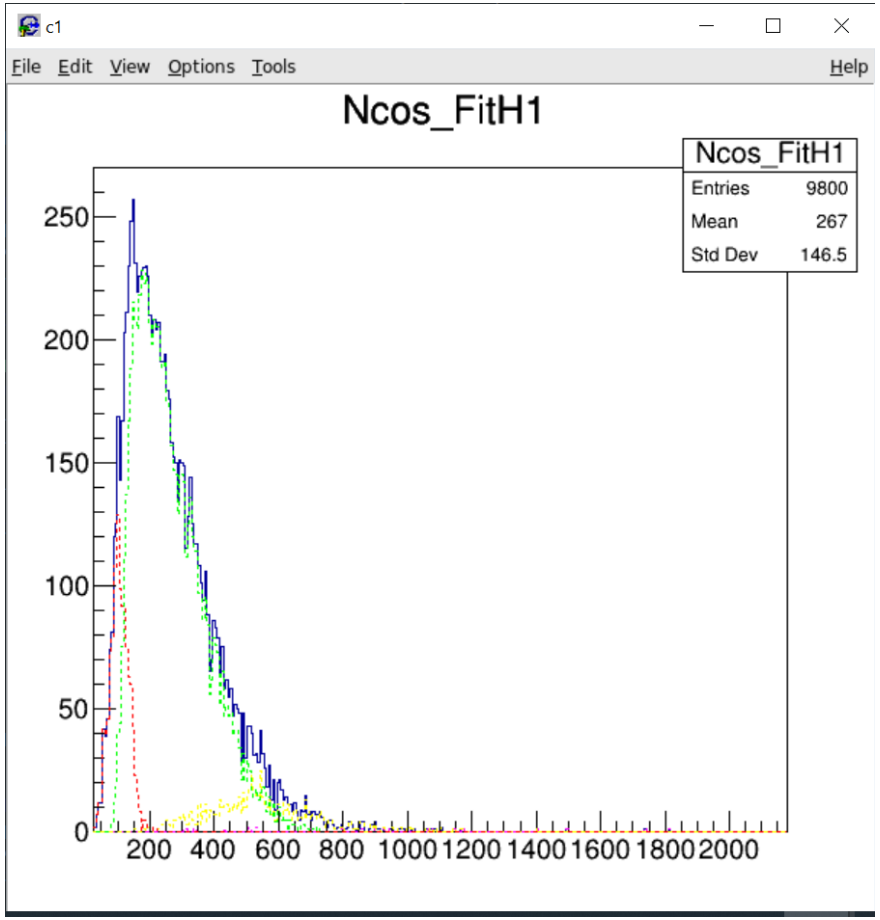
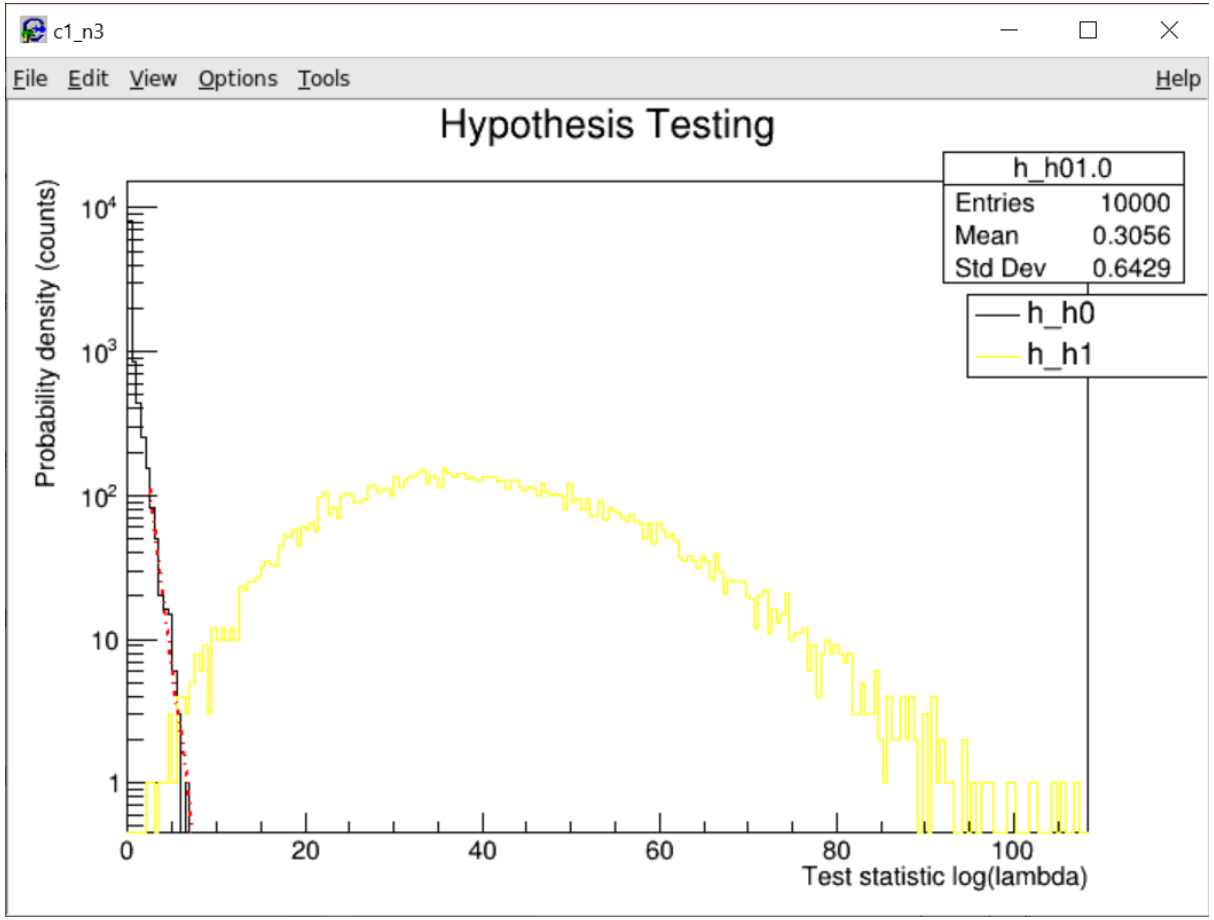




Hypothesis testing: 1.0yr

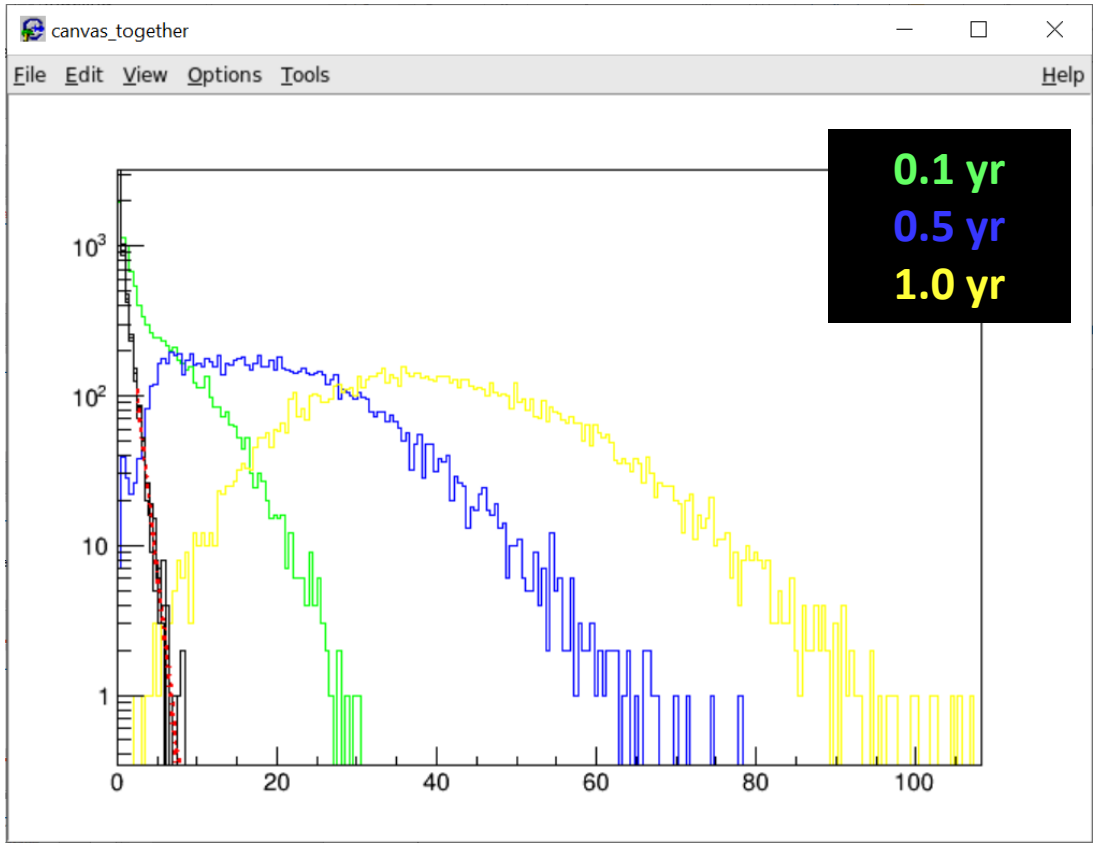
$\langle N_{cos}^{gen} \rangle = 199$

$\langle N_{atm}^{gen} \rangle = 48960$



Sensitivity / Discovery potential

Hypothesis testing all together



- Given hist H1 & median H0:
  - Compute CL-value
- Given hist H0 & median H1:
  - Compute p-value

```
t_years   :  ['0.1', '0.5', '1.0']
p_values  :  [0.02451010830324910 2, 0.0, 0.0]
cl_values :  [0.00113935891463841 02, 0.0, 0.0]
```

- Use fit & continuous integral instead of hist…!

To do!

To Do

- Cuts should be applied: direction, reconstruction parameters like β_0 or Λ etc?
- Background: add muon background
- Flavours included: all nu/anu and e/mu/tau
- Clever ways to improve the signal to background ratio (like HESE & use of muon bundles to 'veto' accompanying neutrinos)

- Compute sensitivity & discovery potential using fit & continuous integral instead of hist…!

- Check results with LOI
- Do point-source analysis
  - Vary <Nsig> on top of Background
  - Add more & different sources
  - WORKING!

- Present results @ collaboration meeting
- **Poster presentation in Januari at a Dutch event**