

RAT with Geant 4.9 / 4.10 Comparison

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2/22/2018

Overview

- Objective: Compare the 2 versions Miniclean RAT to help Miniclean decide whether to make the transition to Geant 4.10
- Comparisons are made on Ar39 and NeutronPMTs simulations
- It seems that these 2 versions produce quite similar results with minor differences
 - Geant 4.10 version produces less EV events
 - There are occasional spikes in the difference of the results
 - Geant 4.10 version generally has smaller output files

RAT and Geant version information

RAT with Geant 4.10

- Geant4 version: 4.10.01.p02
- RAT svn version: 2258

RAT with Geant 4.9

- Geant4 version: 4.9.5.p01
- RAT svn version: 2178

Simulations compared:

NeutronPMTs: https://deapclean.org/rat/trac/changeset/2203/neutron_PMTs.mac

Ar39: <https://deapclean.org/rat/trac/browser/rat/mac/MiniCLEAN/ar39.mac?rev=2203>

EV Cut Parameters

- Total ShellFit PE: 75 – 150
- Radial cut: ShellFit Radius < 295 mm
- F_{prompt} : > 0.681
- L_{recoil} : > 0.373

Neutron PMT

Simulation code: https://deapclean.org/rat/trac/changeset/2203/neutron_PMTs.mac

RAT with Geant 4.10

- Time
 - Event source: 8.8 +/-0.6 sec/event
 - Total: 9.2 +/-0.6 sec/event
- File size: ~35G for 143520 Events
- Simulation size: 143520 Events

RAT with Geant 4.9

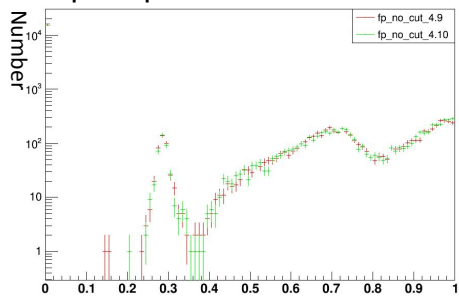
- Time
 - Event source: 12.8 +/- 1.2 sec/event
 - Total: 13.3 +/- 1.2 sec/event
- File size: ~ 36G for 143520 Events
- Simulation size: 143520 Events

*Time is calculated from log of around 25% of smaller-sized jobs run on Wisconsin cluster

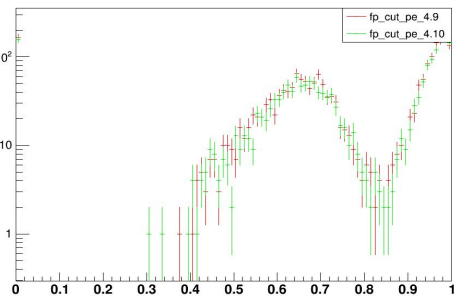
Neutron PMT EV Fprompt

Cut values:
PE: 75 - 150
Pos: < 295 mm

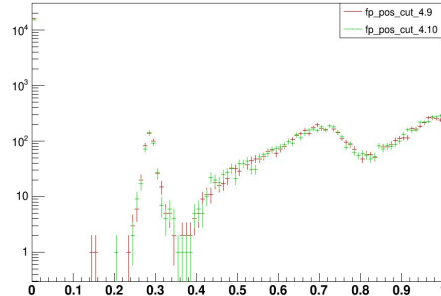
Fprompt with no cut



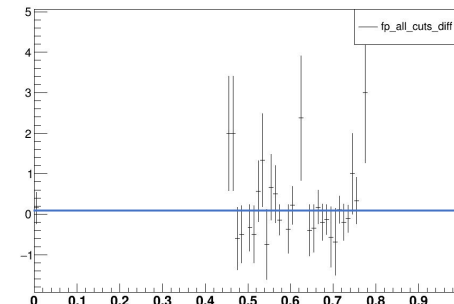
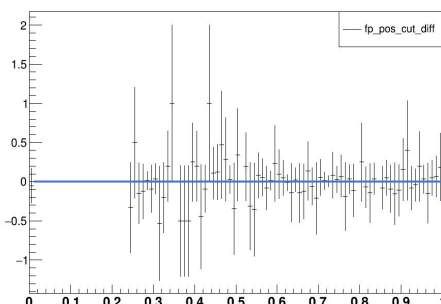
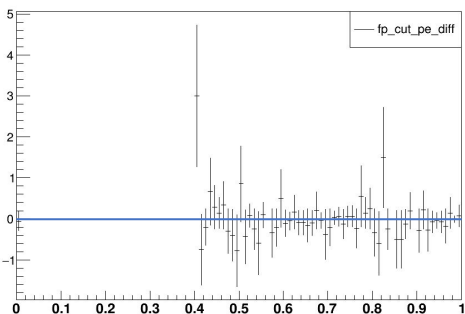
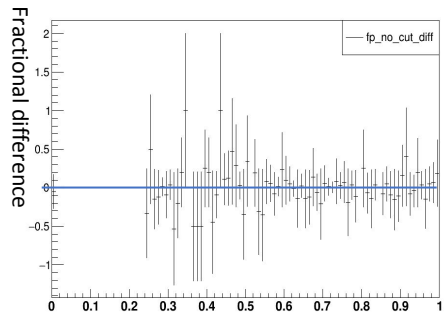
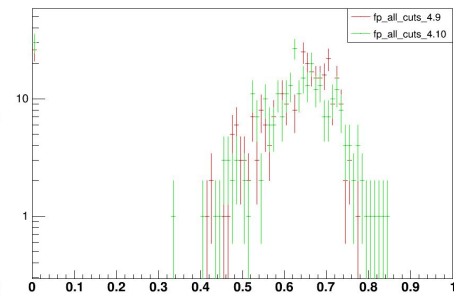
Fprompt only with pe cut



Fprompt only with pos cut



Fprompt with pe and pos cuts



Fp_no_cut_4.9 Entries: 22459
Mean: 0.2178
RMS: 0.3528

Fp_no_cut_4.10 Entries: 21652
Mean: 0.2276
RMS: 0.3591

Fp_cut_pe_4.9 Entries: 2162
Mean: 0.7393
RMS: 0.269

Fp_all_cuts_4.10 Entries: 2052
Mean: 0.7447
RMS: 0.2703

Fp_pos_cut_4.9 Entries: 22459
Mean: 0.2178
RMS: 0.3528

Fp_pos_cut_4.10 Entries: 21652
Mean: 0.2276
RMS: 0.3591

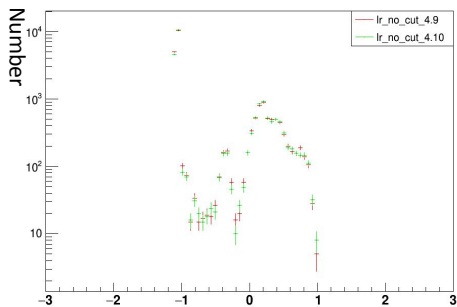
Fp_all_cuts_4.9 Entries: 325
Mean: 0.5897
RMS: 0.1872

Fp_all_cuts_4.10 Entries: 309
Mean: 0.5751
RMS: 0.202

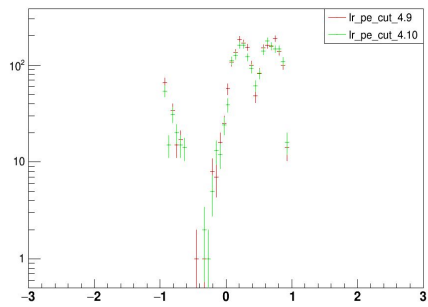
Neutron PMT EV Lrecoil

Cut values:
PE: 75 - 150
Pos: < 295 mm

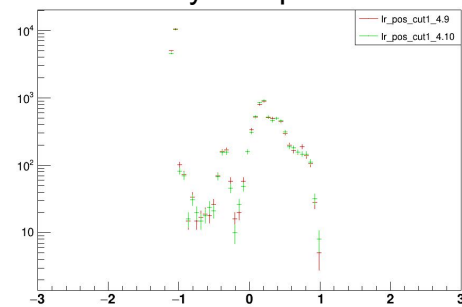
Lrecoil with no cut



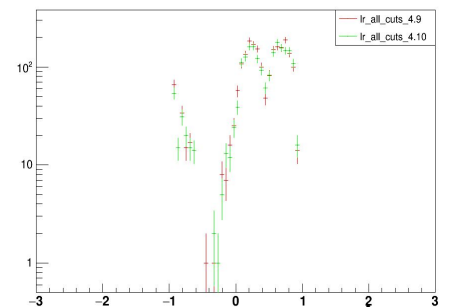
Lrecoil only with pe cut



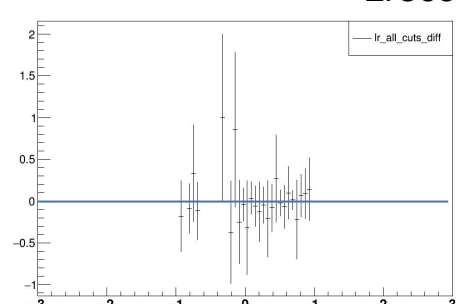
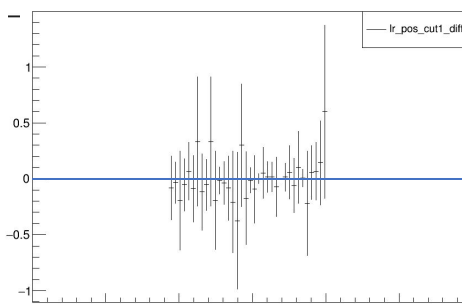
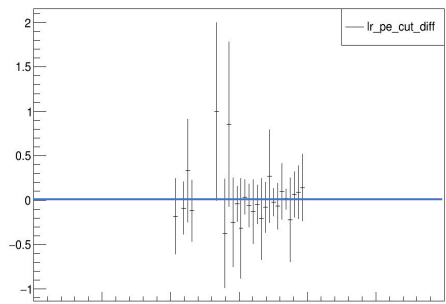
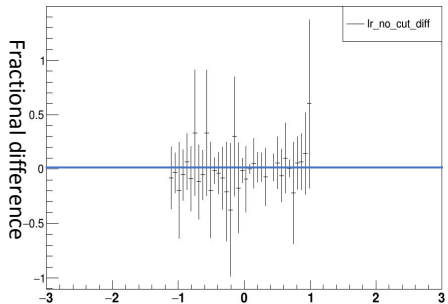
Lrecoil only with pos cut



Lrecoil with pe and pos cuts



Lrecoil



lr_no_cut_4.9		lr_no_cut_4.10	
Entries	22459	Entries	21652
Mean	-0.6777	Mean	-0.6632
RMS	0.6242	RMS	0.6314

lr_pe_cut_4.9		lr_pe_cut_4.10	
Entries	2162	Entries	2052
Mean	0.3595	Mean	0.3715
RMS	0.4263	RMS	0.4242

lr_pos_cut1_4.9		lr_pos_cut1_4.10	
Entries	22459	Entries	21652
Mean	-0.6777	Mean	-0.6632
RMS	0.6242	RMS	0.6314

lr_all_cuts_4.9		lr_all_cuts_4.10	
Entries	2162	Entries	2052
Mean	0.3595	Mean	0.3715
RMS	0.4263	RMS	0.4242

Neutron PMT EV PE

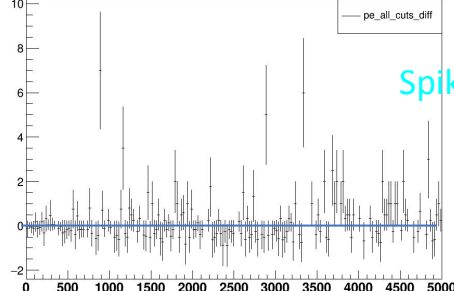
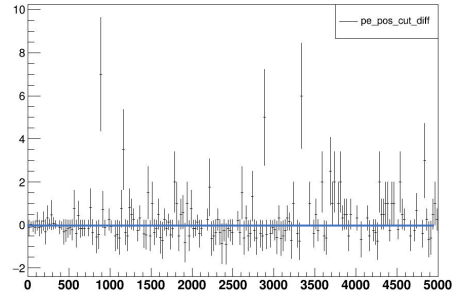
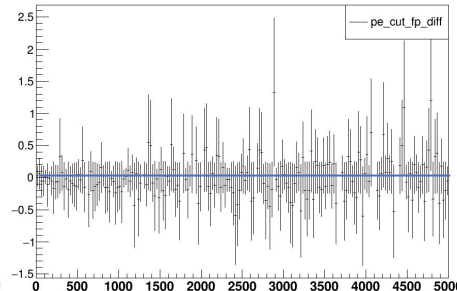
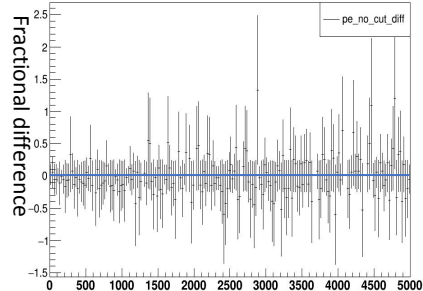
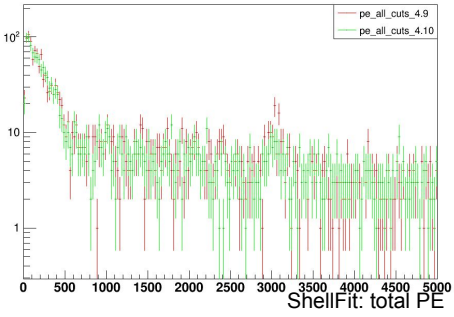
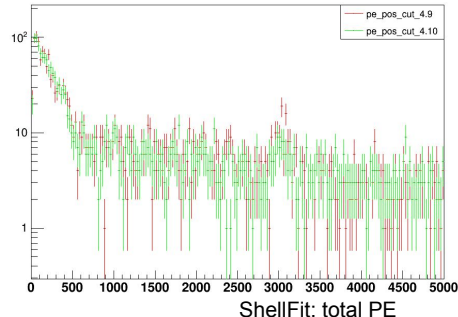
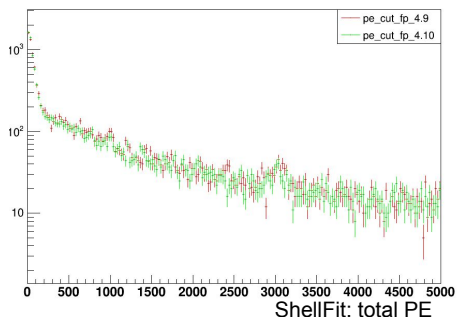
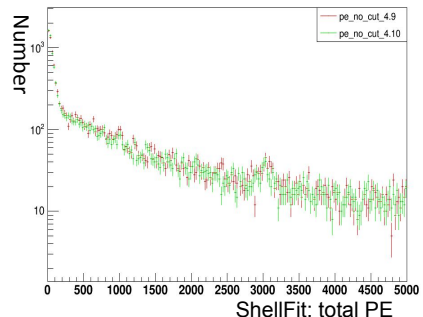
Cut values:
 PE: 75 - 150
 Pos: < 295 mm
 Fprompt: > 0.681t

PE with no cut

PE only with fprompt cut

PE only with pos cut

PE with pos and fprompt cuts



	pe_no_cut_4.9	pe_no_cut_4.10
Entries	22459	21652
Mean	985.6	971.9
RMS	1242	1248

	pe_cut_fp_4.9	pe_cut_fp_4.10
Entries	22459	21652
Mean	985.6	971.9
RMS	1242	1248

	pe_pos_cut_4.9	pe_pos_cut_4.10
Entries	5113	4868
Mean	1266	1254
RMS	1392	1422

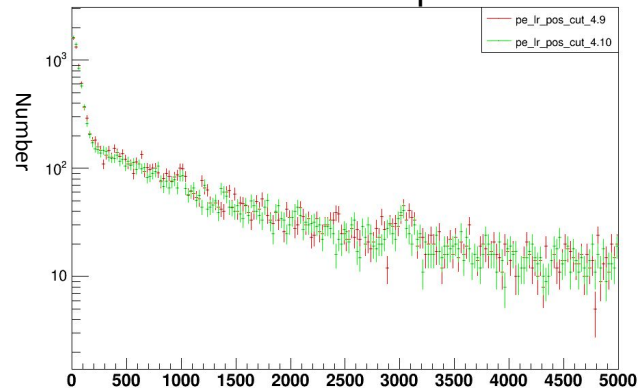
	pe_all_cuts_4.9	pe_all_cuts_4.10
Entries	5113	4868
Mean	1266	1254
RMS	1392	1422

Additional EV

Cut values:
 Pos: < 295 mm
 Lrecoil: >0.373

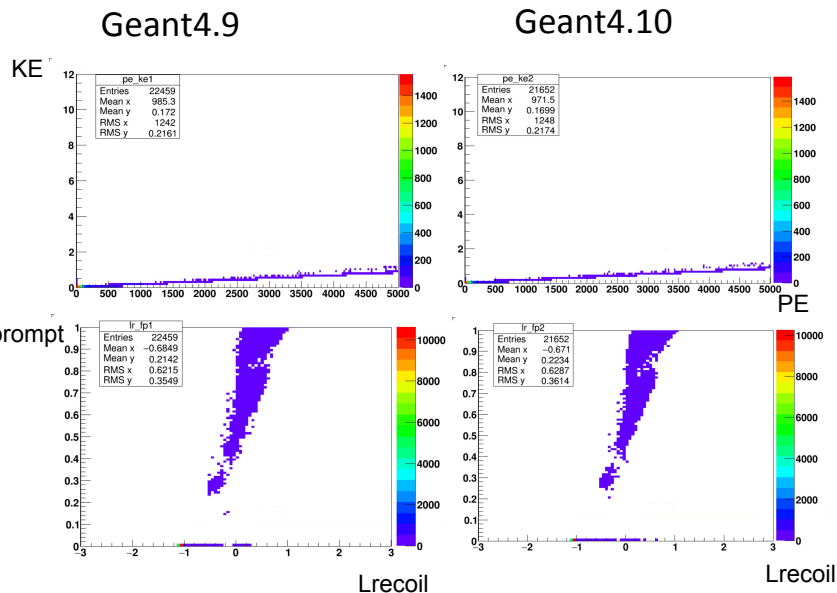
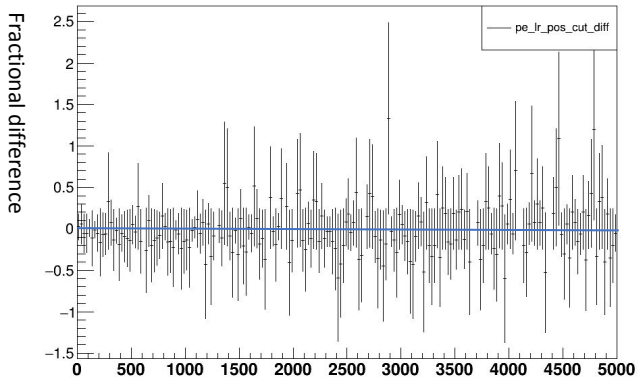
RAT with Geant 4.10 seem to consistently have less EV events than Geant 4.9 version

PE with Lrecoil and pos cuts

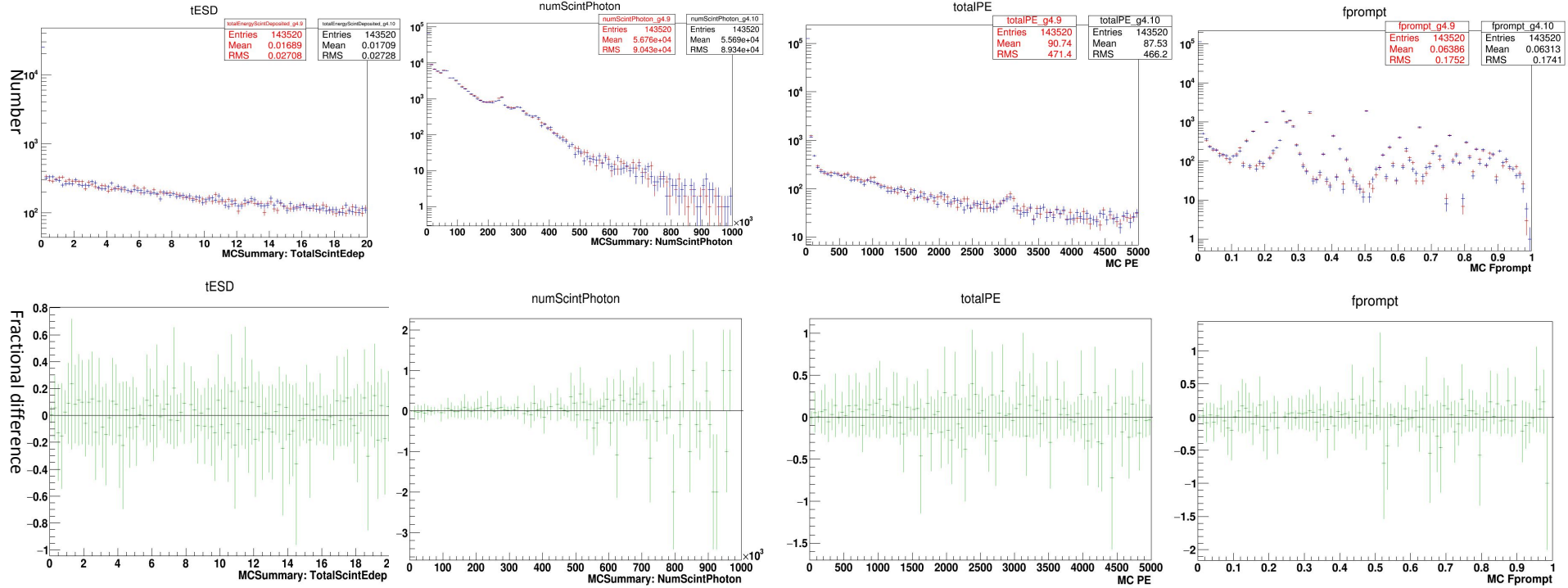


pe_lr_pos_cut_4.9	
Entries	22459
Mean	985.6
RMS	1242

pe_lr_pos_cut_4.10	
Entries	21652
Mean	971.9
RMS	1248



Neutron PMT MC



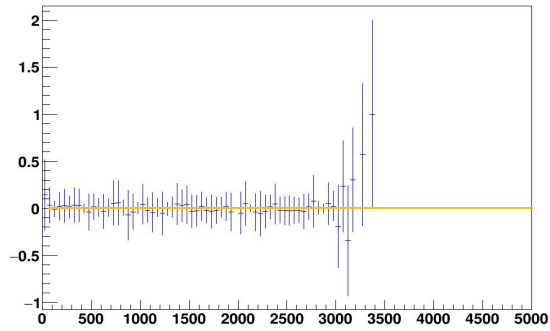
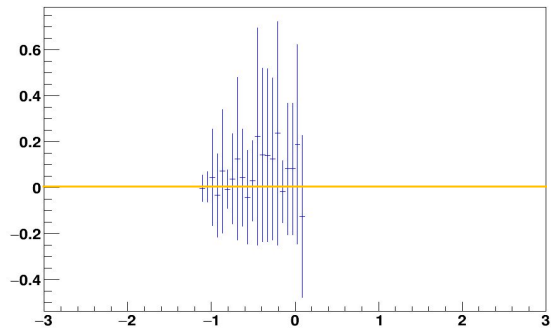
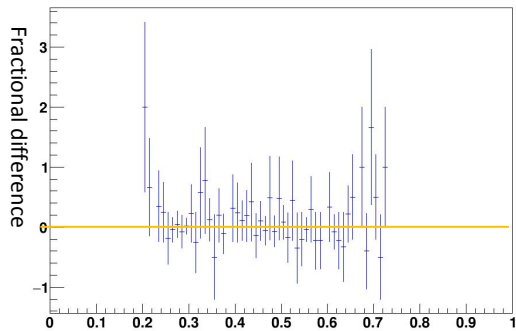
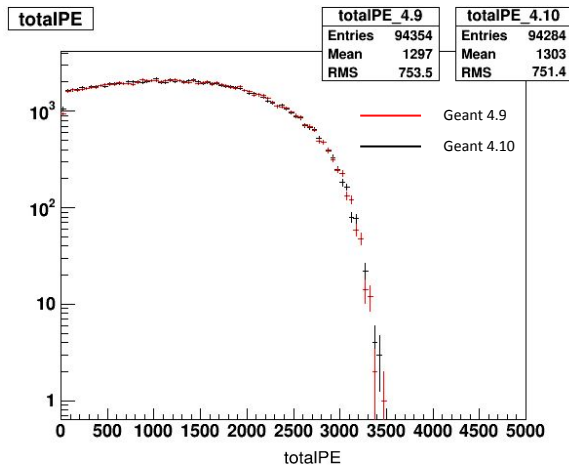
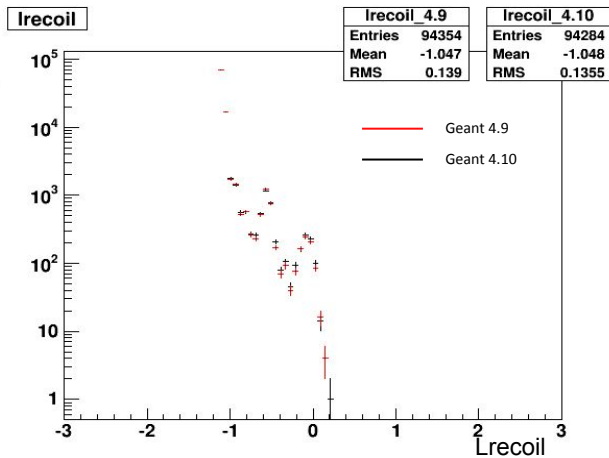
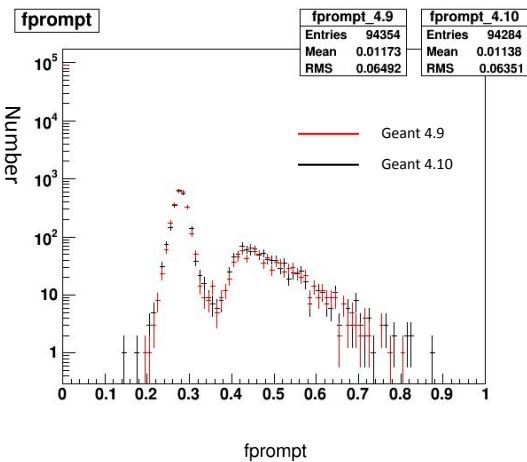
Total Scintillation energy deposited Number of photons

MC TotalPE

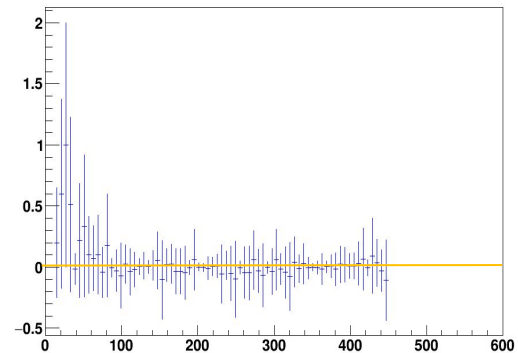
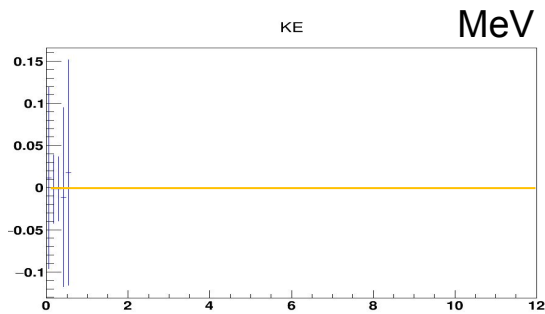
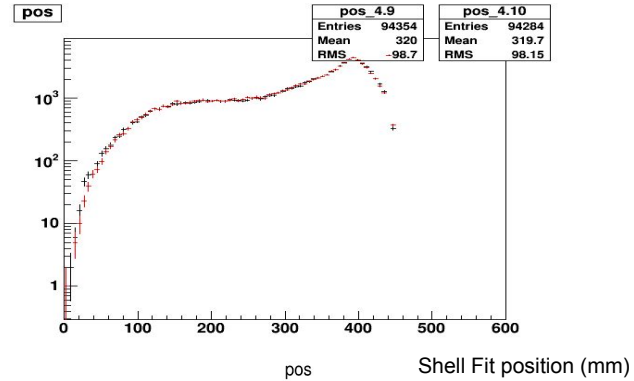
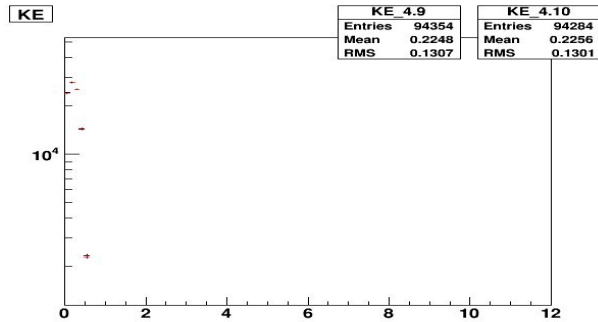
MC Fprompt

Ar39 test

Simulation code: <https://deapclean.org/rat/trac/browser/rat/mac/MiniCLEAN/ar39.mac?rev=2203>



Additional Ar39 plots



*Probably wrongly made bins here

Result

- RAT with these 2 versions of Geant4 seem to conform well
- There are spikes in EV events that may require further inspection
- RAT with Geant 4.10 is faster and produces slightly smaller output files