Validation of UrQMD 4.0 and inclusion to SPDRoot analysis chain

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General info about UrQMD generators

To integrate the latest UrQMD MC generator version (4.0) into the SPDRoot framework, it was necessary to verify the correctness of the implementation by comparing the corresponding results of the generation and simulation processes with the parameters listed below.

(UrQMD 3.4 was implemented earlier in a semi-manual mode)

Generation & simulation parameters for UrQMD 3.4 version:

- $\sqrt{s} = 10\ GeV$
- 10 000 O-O collisions (O_8^{16})
- Minimum bias

- #Impact parameter
  IMP 0.0 7.0
- #Equal speed frame (CMS)
  cto 27 0

- For the simulation step - only Straw Tracker was enabled to produce some additional particles by Geant4
- Only 1st generation will be shown in the next 2 slides since we want to see only primary particles (from the generator)

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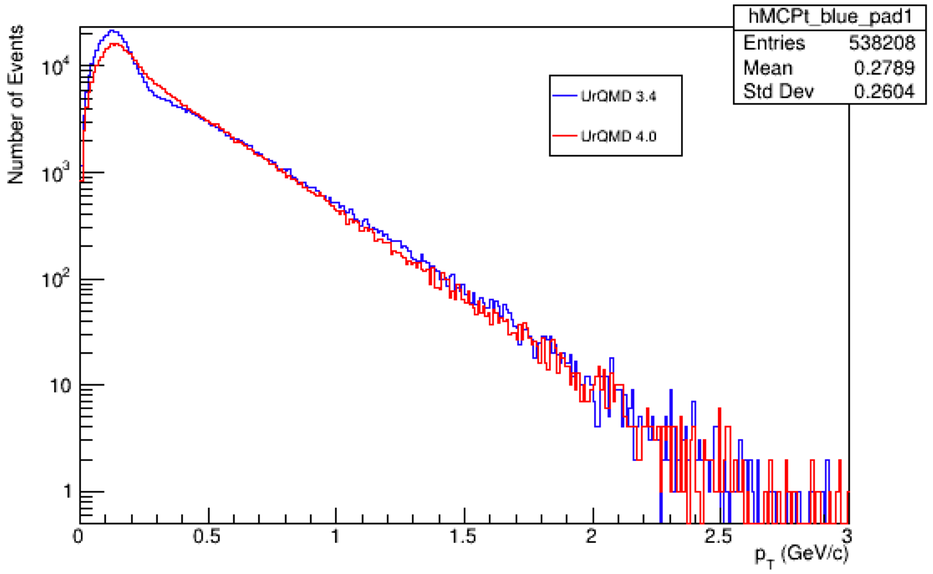
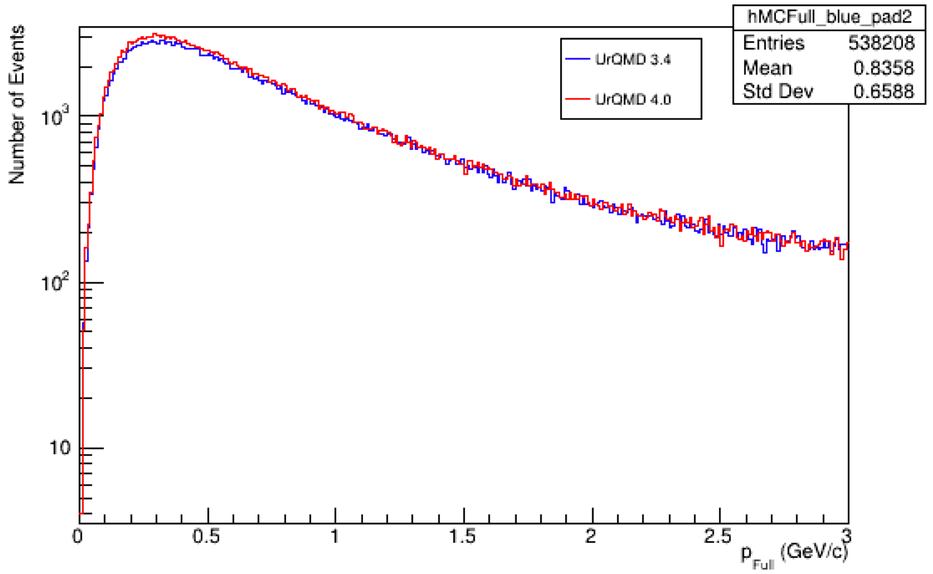
- Minimum bias

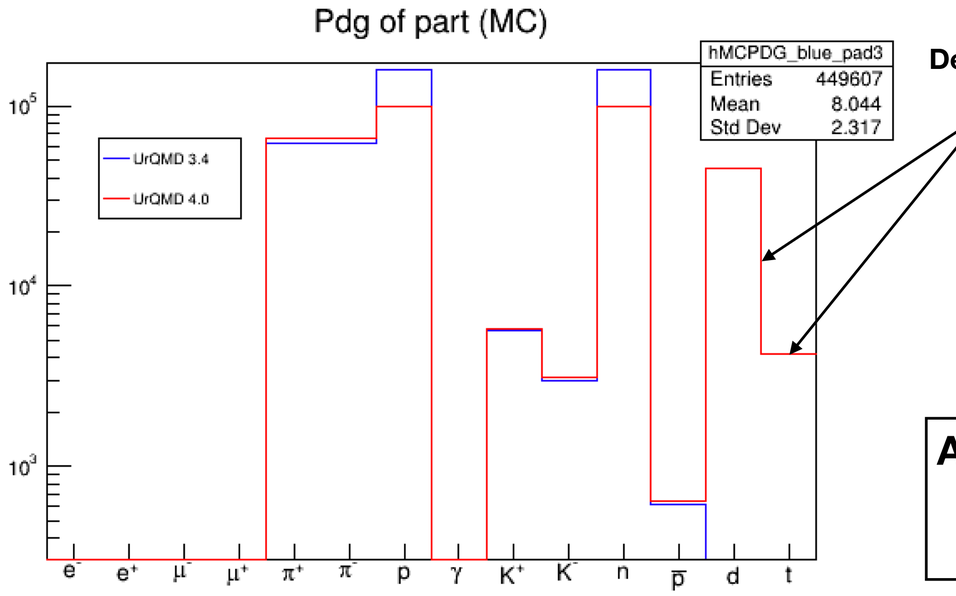
- #Impact parameter
  IMP 0.0 7.0
- #Equal speed frame (CMS)
  cto 27 0
- #Coalescence enabled (to enable light nuclei producing)
  cto 64 1

- For the simulation step - only Straw Tracker was enabled to produce some additional particles by Geant4
- Only 1st generation will be shown in the next 2 slides since we want to see only primary particles (from the generator)

UrQMD 3.4 and 4.0 comparison





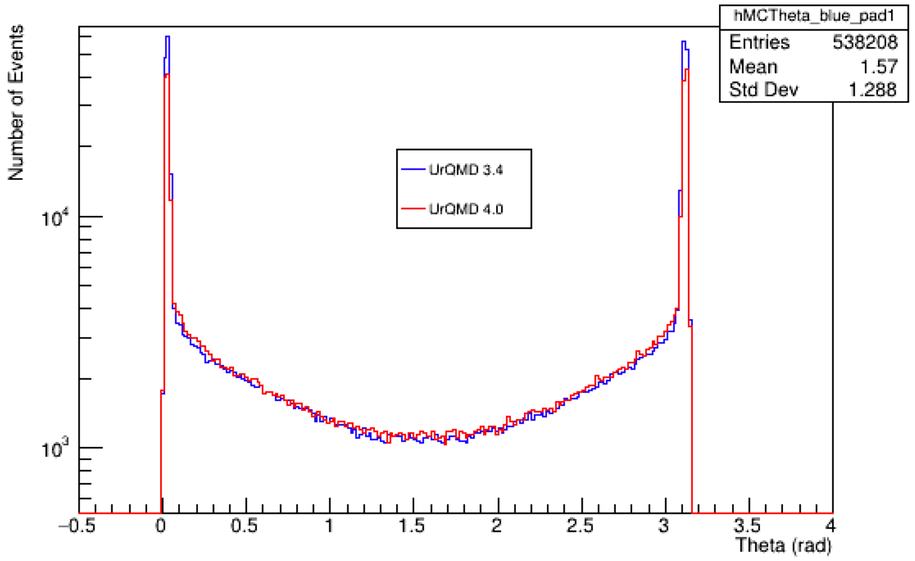


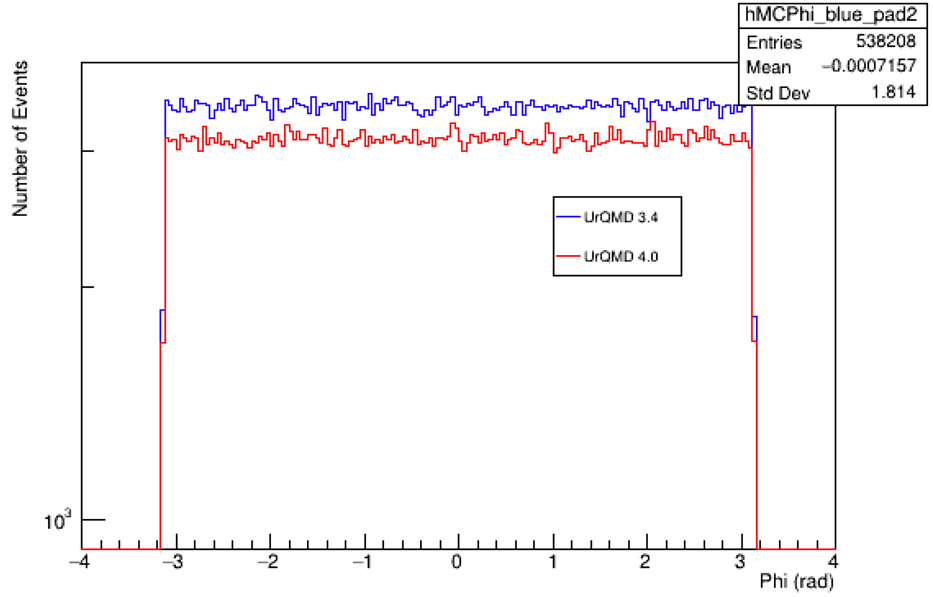
Deutrons and tritons have appeared!

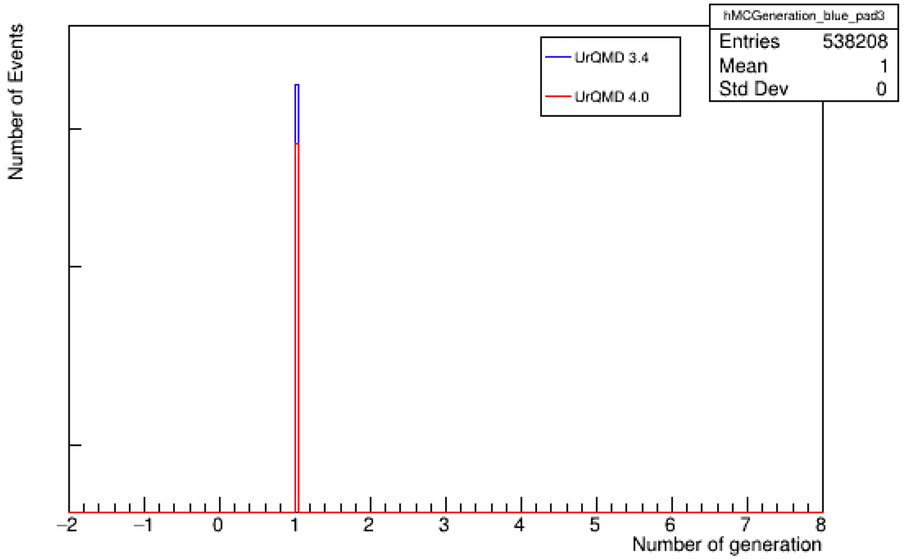
Fig. 1 - MC general information from comparison between UrQMD versions with **generation = 1** cut (primary particles) with coalescence (light nuclei producing) enabled

Also there is a comparison between 3.4 and 4.0 with coalescence (light nuclei producing) disabled on slides 11-14

UrQMD 3.4 and 4.0 comparison







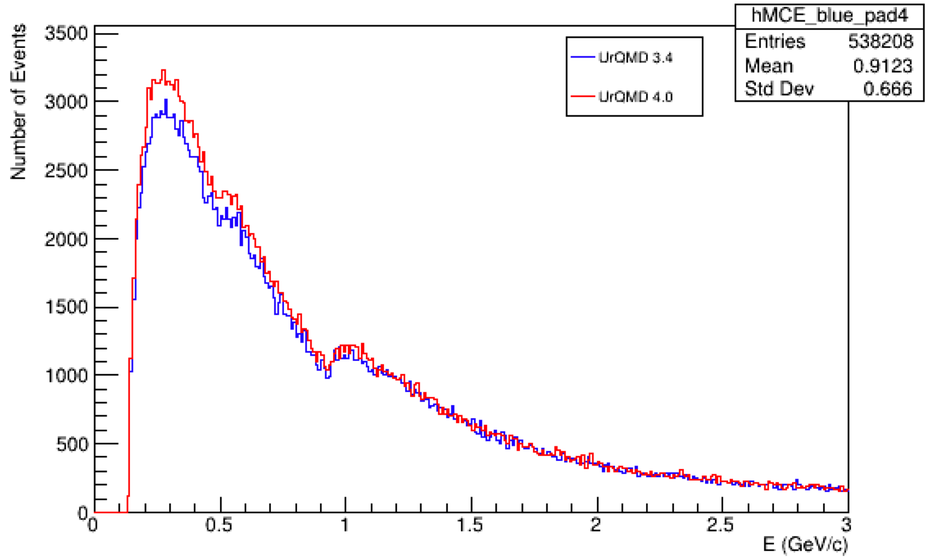


Fig. 2 - MC general information from comparison between UrQMD versions with **generation = 1** cut (primary particles) with coalescence (light nuclei producing) enabled

Also there is a comparison between coalescence (light nuclei producing) enabled and disabled on slides 11-14

Other validations of UrQMD

- An additional validation was performed to confirm success of the generation using UrQMD 4.0 to potentially reveal generation errors, such as the absence of a particles' pdg codes after generation or a mismatch between the pdg code and the UrQMD particle IDs (ityp).

  The result of such a validation showed that UrQMD revealed <u>exactly 0 mismatching or generational errors</u> across over 500k collisions of O-O

- Also a comparison was conducted between versions 3.4 and 4.0, considering all the generations of particles to see the results of the full chain of the simulation (i.e., to obtain more broad results).

  The results of this validation are shown on the slides 9-10

How to use UrQMD 4.0 in SPDRoot

Everything (generation + simulation) happens in the simulation file.
To generate events with the UrQMD we need to specify path to the config inputfile (e.g. /opt/urqmd-4.0/urqmd-4.0-scripts/inputfile_example_OO_10gev_1k_events.urqmd)

```
TString urqmdInput = "/opt/urqmd-4.0/urqmd-4.0-scripts/inputfile_example_OO_10gev_1k_events.urqmd";
TString urqmdCmd = "urqmd_gen.sh 1 " + urqmdInput;
gSystem->Exec(urqmdCmd.Data());
```

To start simulation we need to specify UrQMD generator as a primary generator

```
SpdUrqmdGenerator* gen = new SpdUrqmdGenerator(input.Data());
primGen->AddGenerator(gen);
run->SetGenerator(primGen);
```

This slide contains preliminary guide on how to use UrQMD 4.0 in SPDRoot (some minor technical adjustments could be applied this week)
The full guide would be available at https://git.jinr.ru/spd/spd-sw/spdroot/-/wikis/home in the end of the week.
Also these slides would be updated at the indico this week

Conclusion

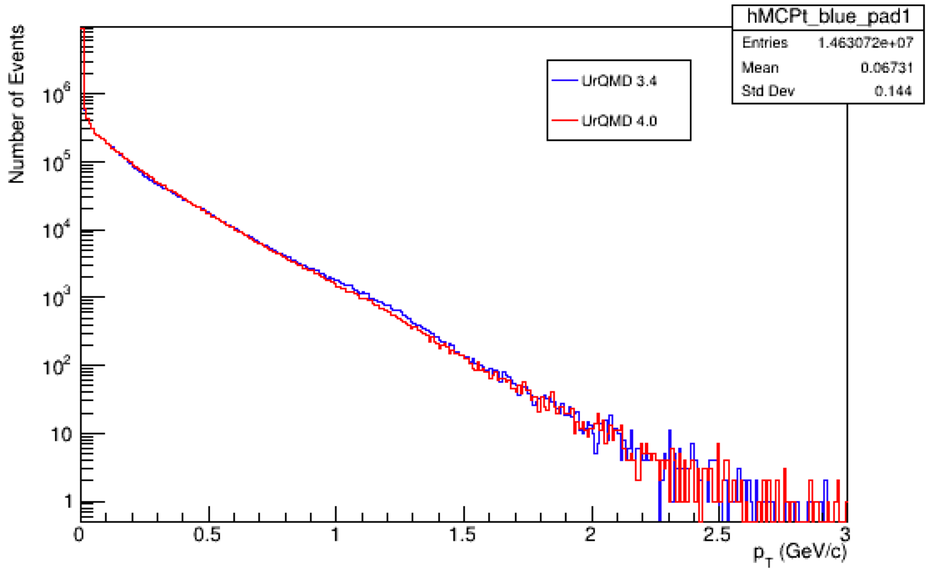
- **UrQMD 4.0 has been integrated into the SPDRoot framework.** The implementation has not yet been merged into the main branch and is currently undergoing final technical testing, with the merge planned for this week.

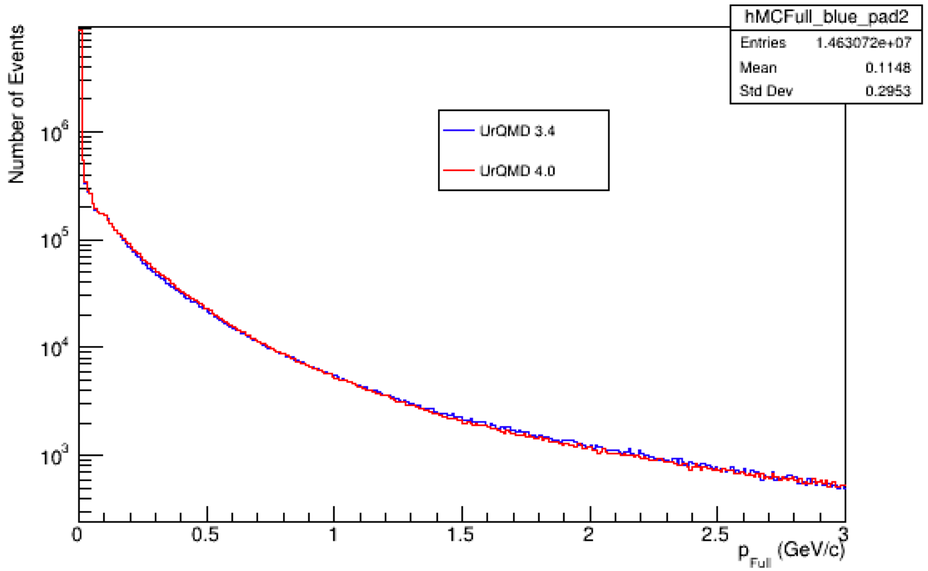
- **Several validation studies have been successfully completed.** The obtained results confirm the correctness and stability of the implemented integration.

- **UrQMD 4.0 is expected to become available to all users by the end of this week.**

BACK-UP SLIDES

UrQMD 3.4 and 4.0 comparison





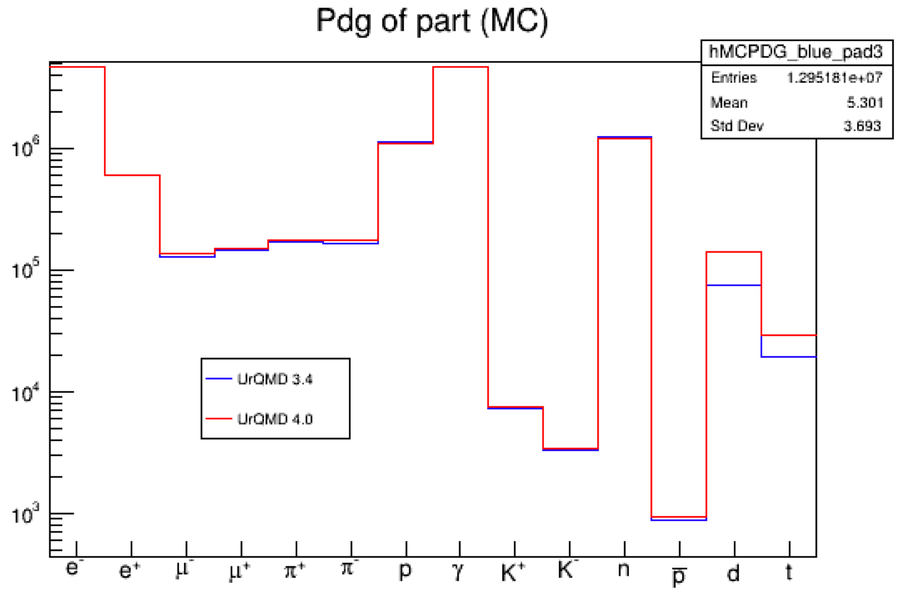
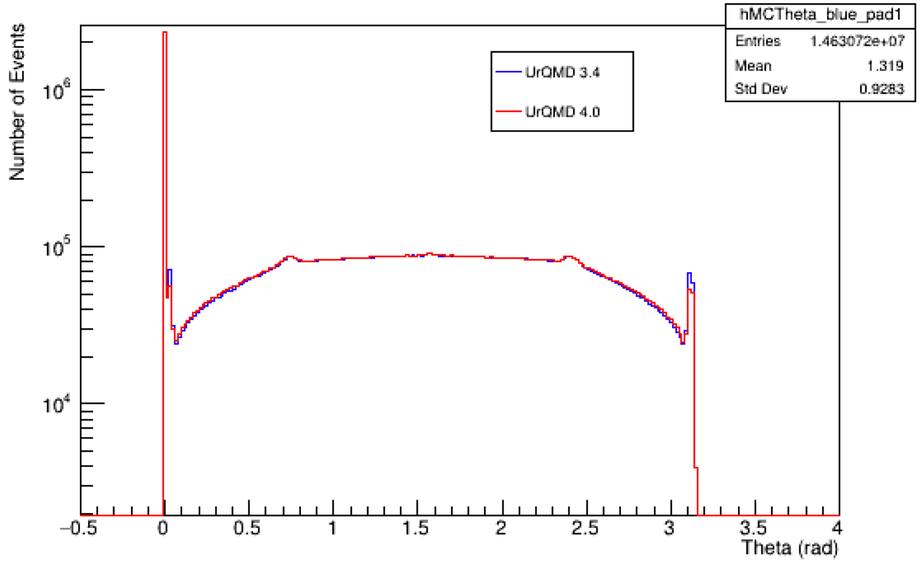
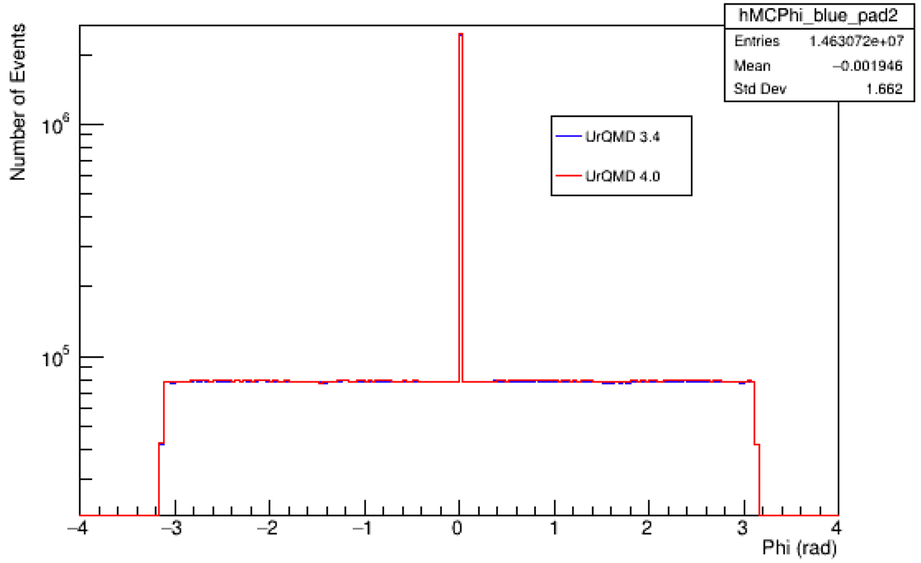
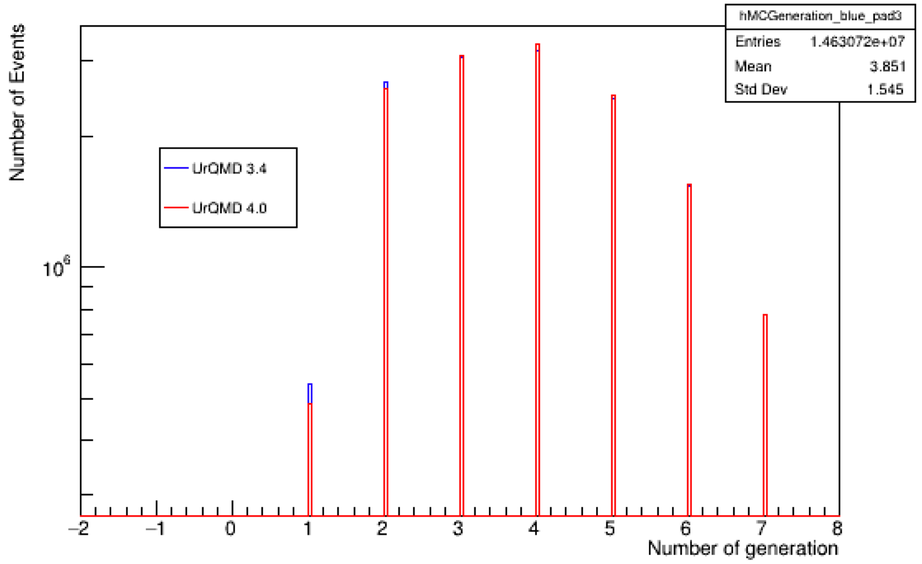


Fig. 3 - MC general information from comparison between UrQMD versions across all the generations of particles with coalescence (light nuclei producing) enabled

UrQMD 3.4 and 4.0 comparison







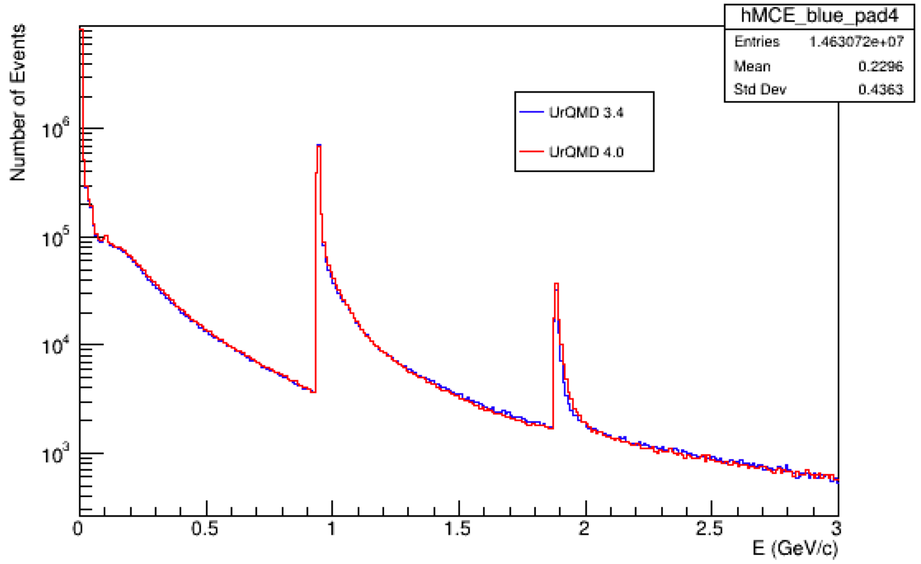
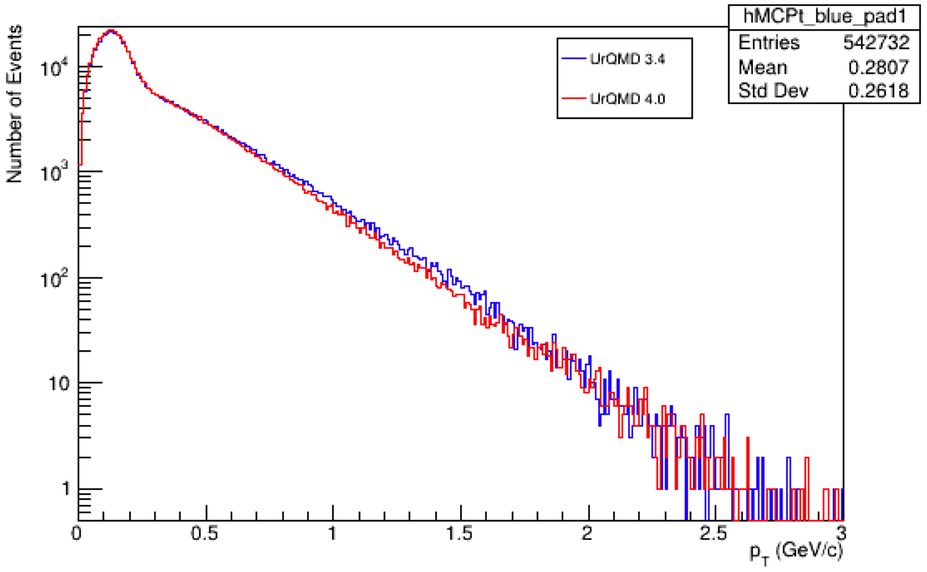
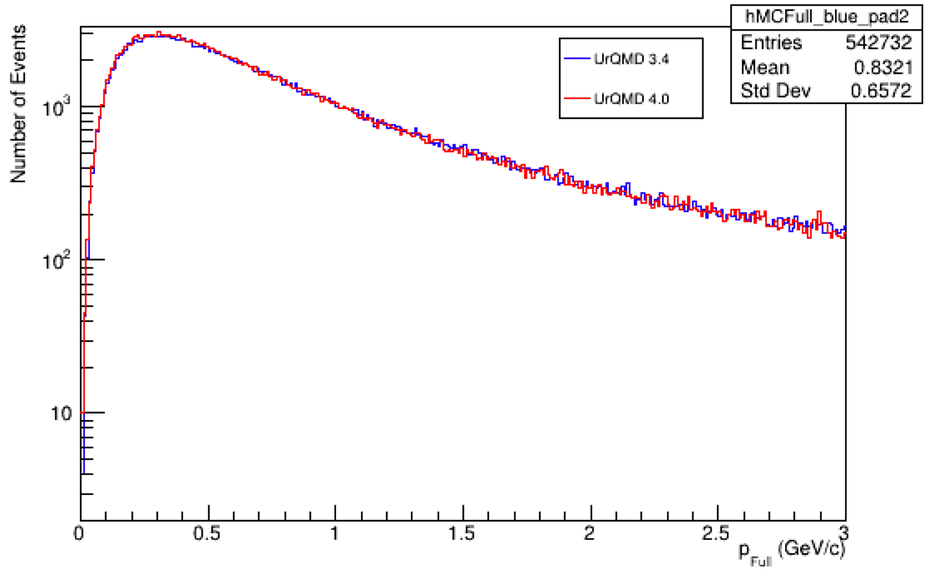
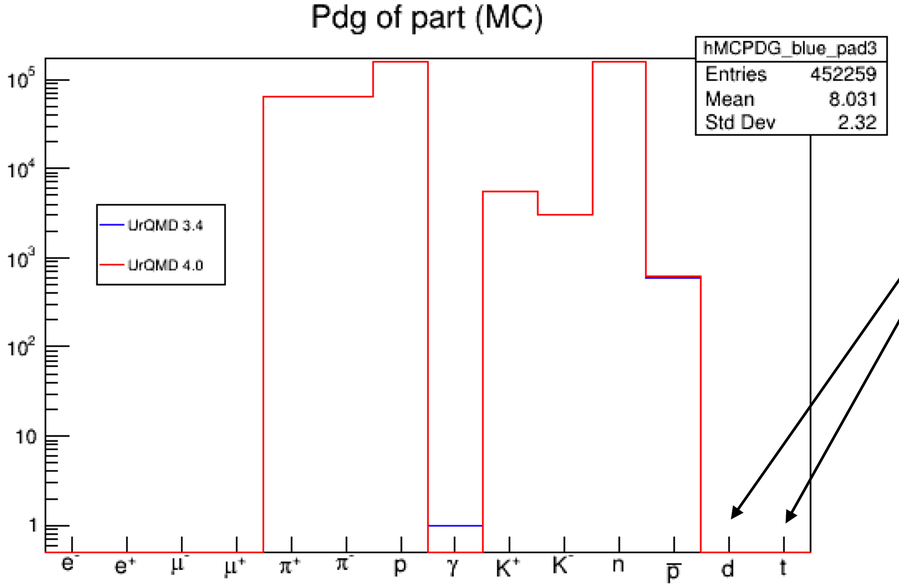


Fig. 4 - MC general information from comparison between UrQMD versions across all the generations of particles with coalescence (light nuclei producing) enabled

UrQMD 3.4 and 4.0 comparison



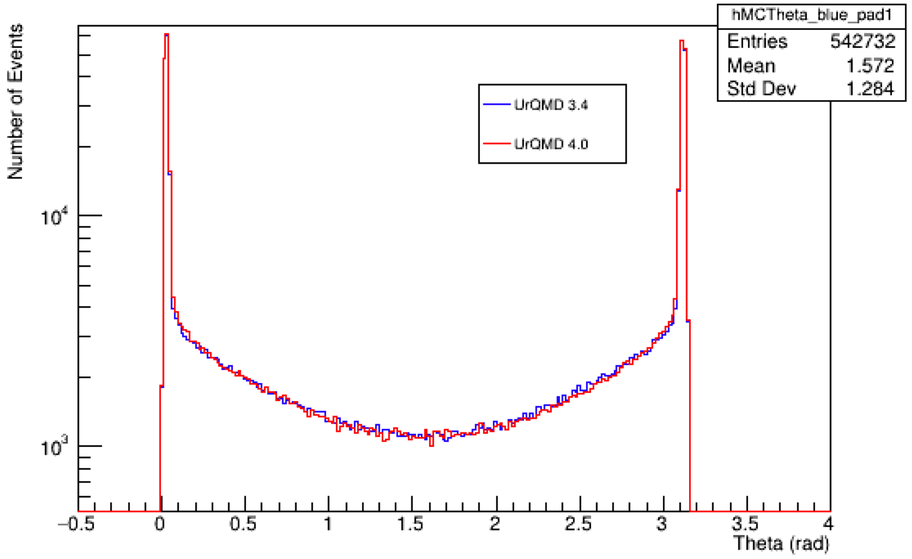


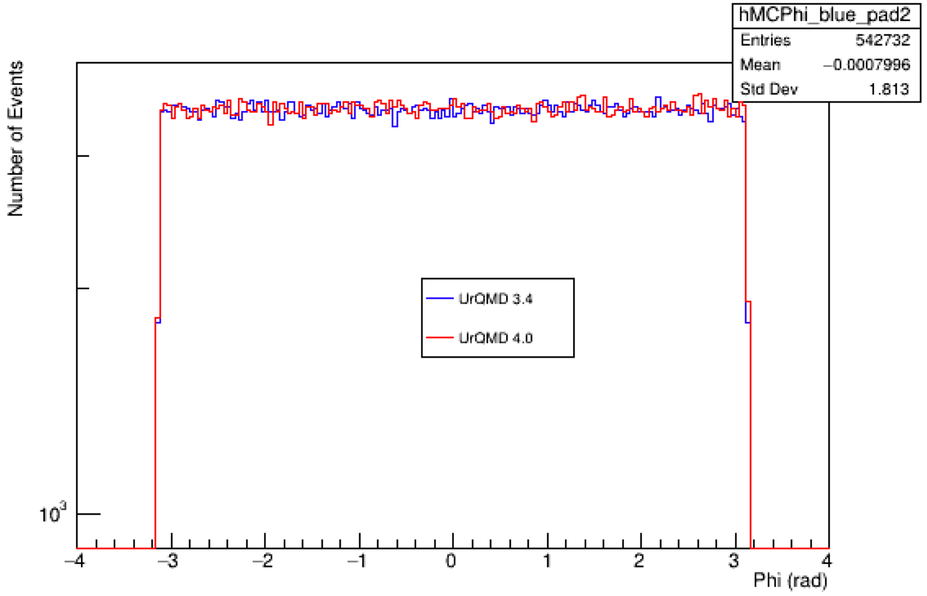


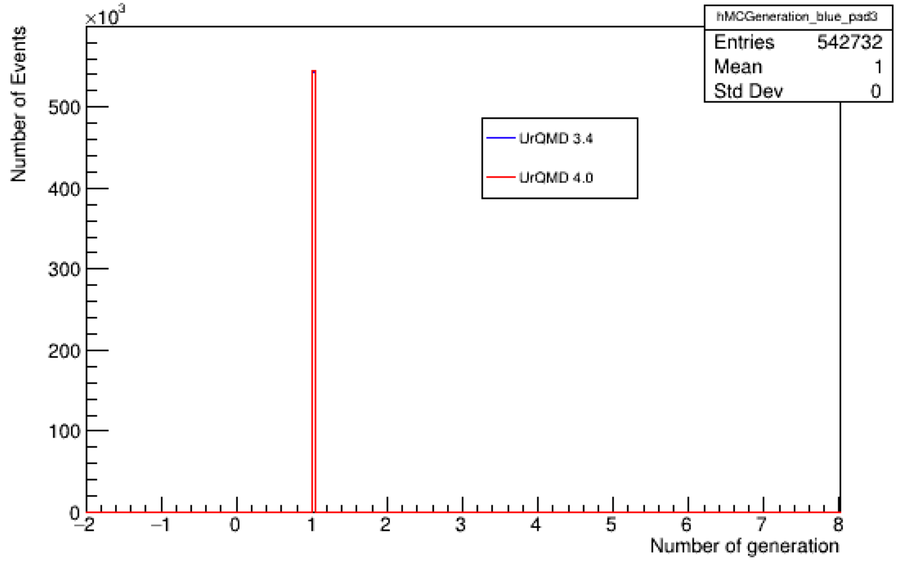
There are no deutrons nor tritons!

Fig. 5 - MC general information from comparison between UrQMD versions with **generation = 1** cut (primary particles) with coalescence (light nuclei producing) disabled

UrQMD 3.4 and 4.0 comparison







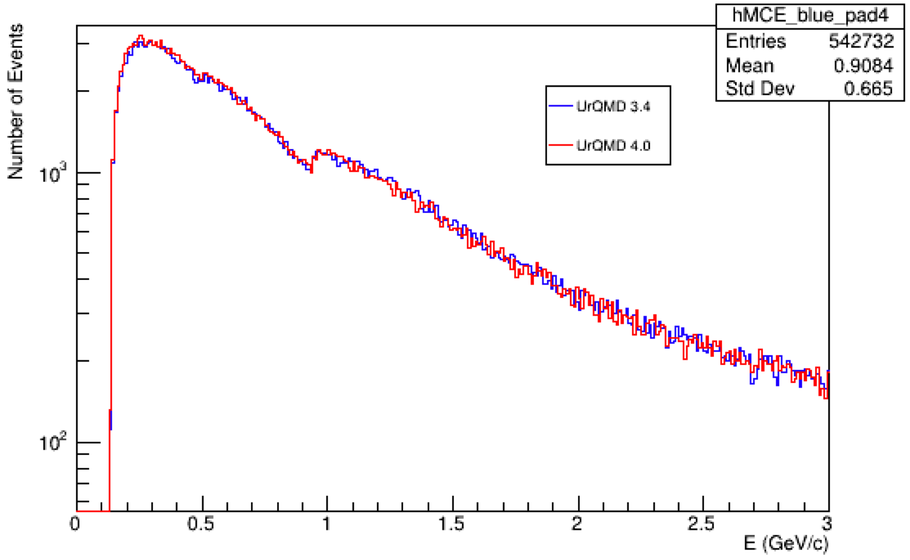
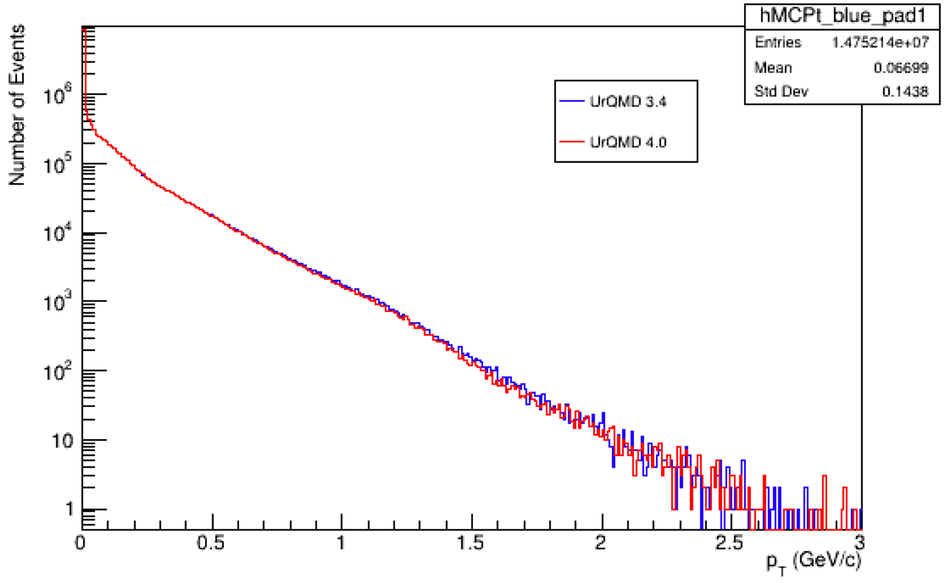
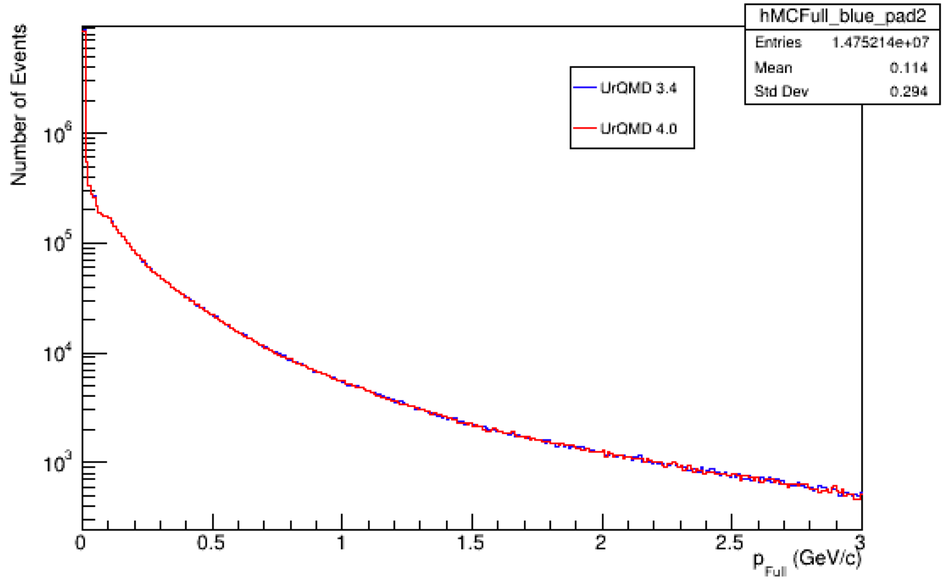


Fig. 6 - MC general information from comparison between UrQMD versions with **generation = 1** cut (primary particles) with coalescence (light nuclei producing) disabled

UrQMD 3.4 and 4.0 comparison





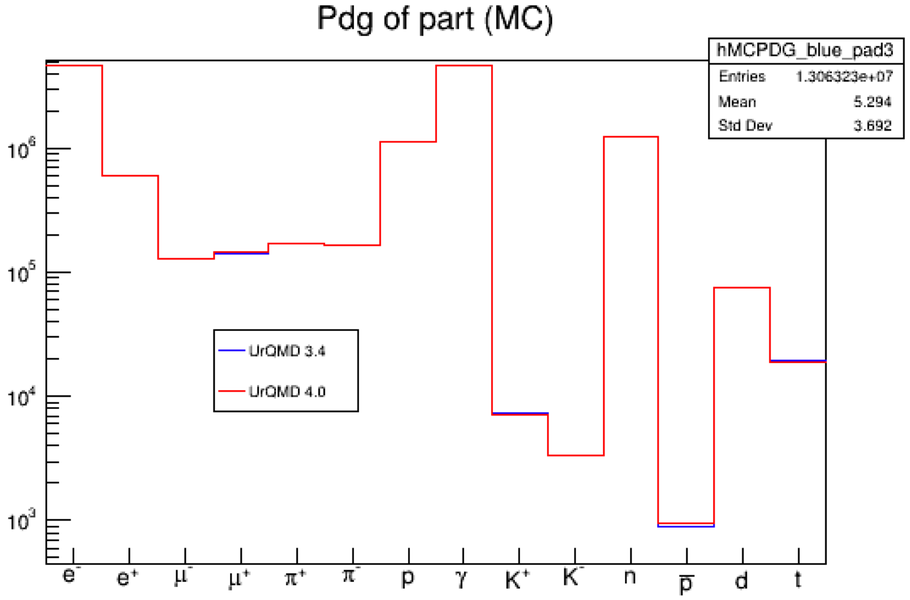
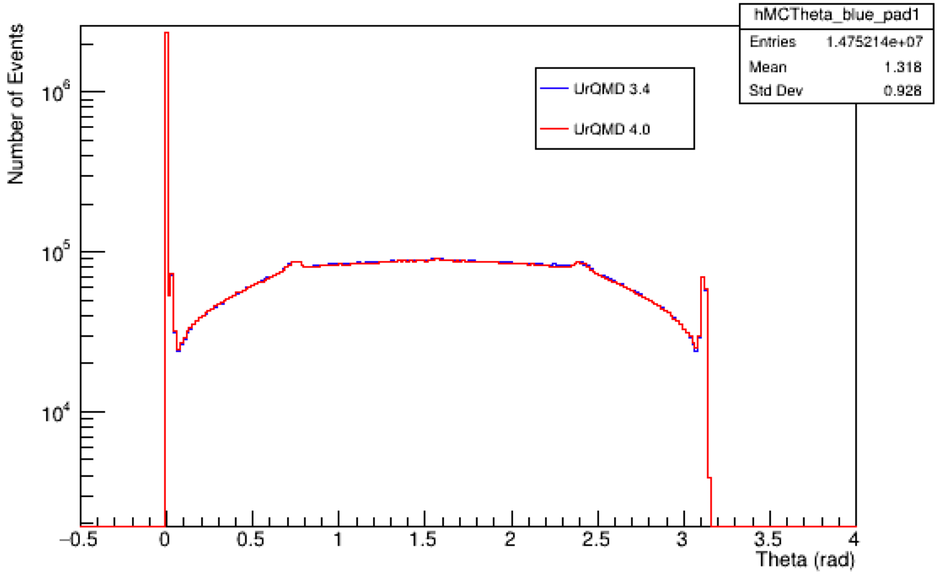
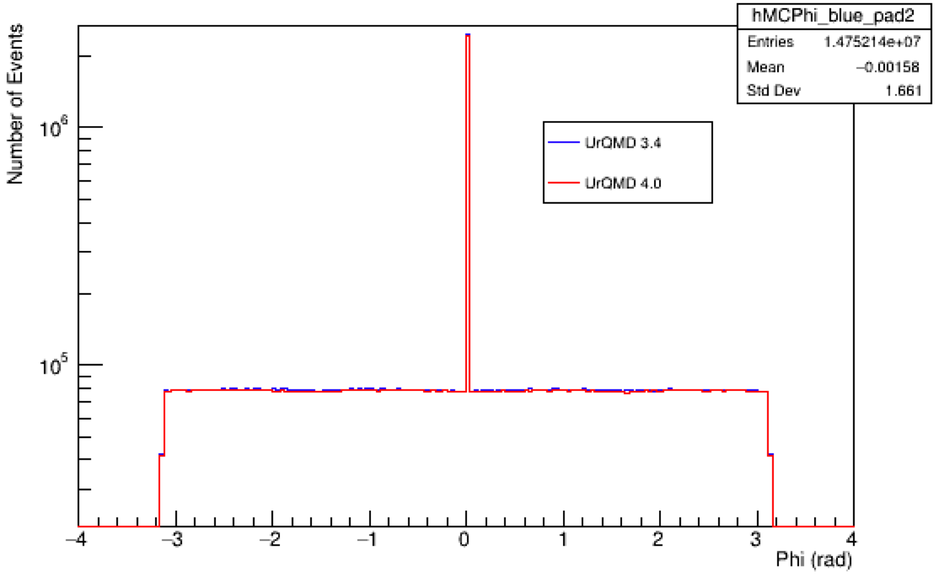
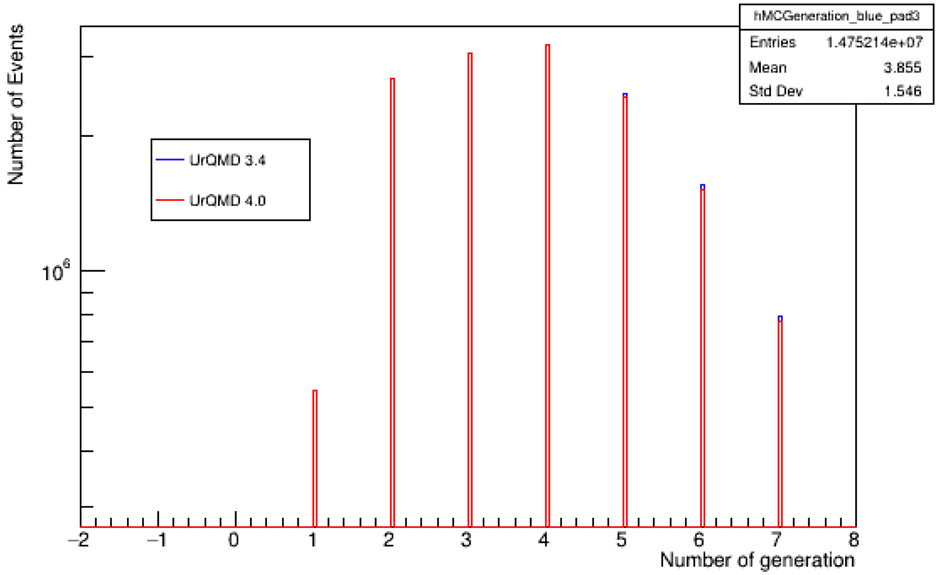


Fig. 7 - MC general information from comparison between UrQMD versions across all the generations of particles with coalescence (light nuclei producing) disabled

UrQMD 3.4 and 4.0 comparison







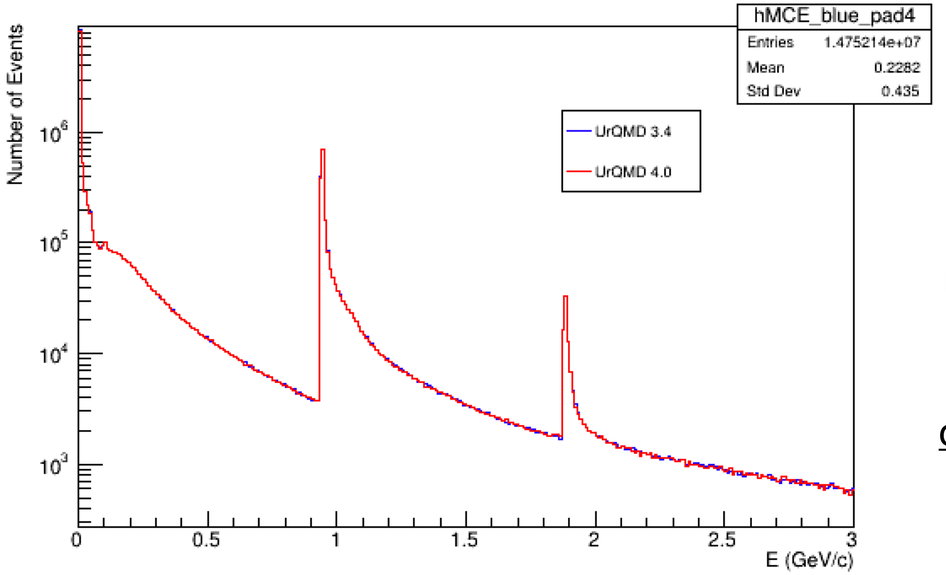


Fig. 8 - MC general information from comparison between UrQMD versions across all the generations of particles with coalescence (light nuclei producing) disabled