BeAGLE Generator Sample Comparison

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Approach – BeAGLE Comparison

- Raised questions on different t distribution shape and vetoing power between IP-8 studies by Wan and Jihee
- Procedure
  - Checked what BeAGLE version generator being used in studies
  - Ran with the latest version of BeAGLE generator (thanks to Kong)

  Used Wan's + BeAGLE control card + PYTHIA parameters described in *Phys. Rev D 106, 012007*
  - Compared t and fragments' distribution between different samples
  - Also compared with its own "burned" samples (crossing angle + beam effect)

*In BeAGLE, enabled have only J/Psi in every single event which means cross section is overestimated. Since this is not physics plot and only to look for vetoing efficiency using far-forward detectors, it's okay for now.

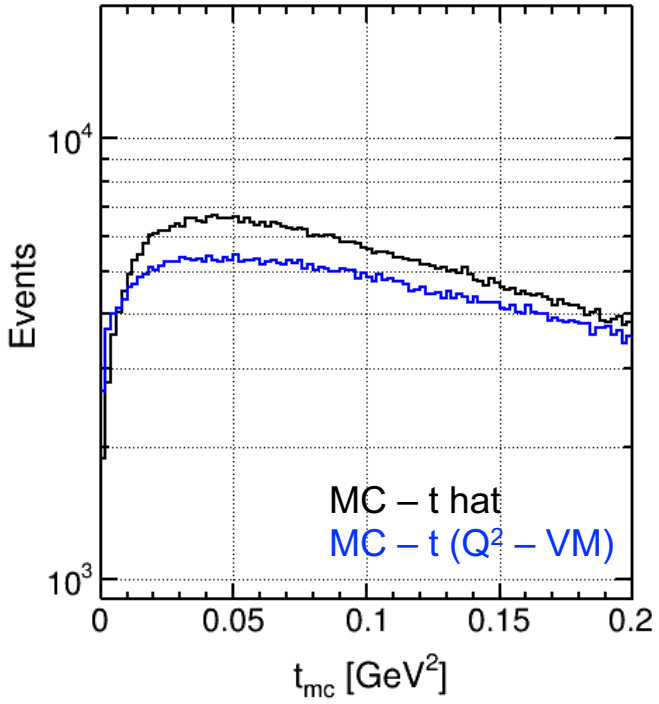
**Wan's original input from /gpfs/mnt/gpfs02/eic/wanchang/Paper_vetoing/Paper_20210513/tau010/20210524_MC/RootFileOutput/SmallRootTree_input_temp_*.root
Latest version of input from /gpfs/mnt/gpfs02/eic/jkim/run-BeAGLE-Jihee/Wan_sample/collision_Q2_min_max_y_min_max_Shd3_ShdFac=1.32_Alldiff9193_Jnodecay_numev.root
Jihee's input from /gpfs02/eic/jkim/JPsi/ePb_18x108.41_tune3_tau10_B1.1_extracted_Jmu_1.hepmc

Since Wan's BeAGLE files were produced

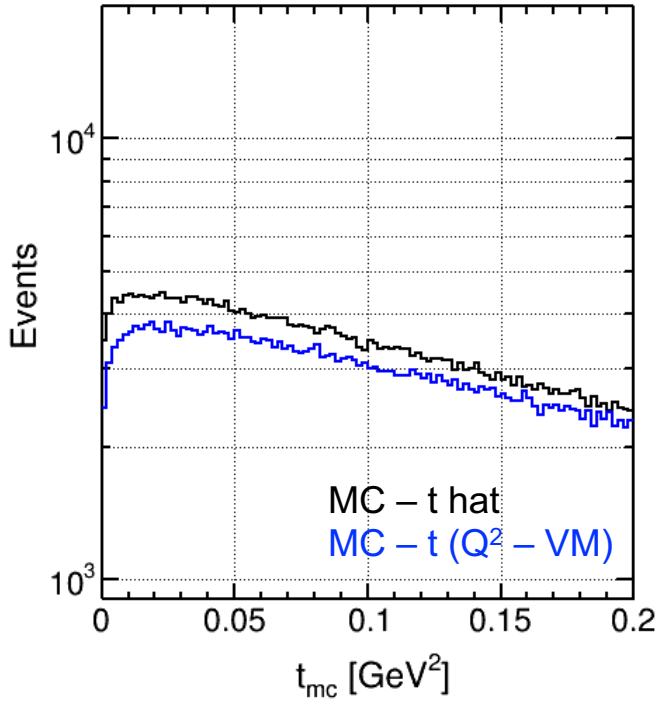
- **BeAGLE version** (https://github.com/eic/BeAGLE/tags)
  - Wan used **1.01.01**
  - Jihee used **1.01.04**
  - The latest version is **1.03.02**
- **Since Wan's files were produced, quite some changes in BeAGLE made**
  - v1.01.02 (May 2021): increased array size in pfshift
  - v1.01.03 (Jun 2021): fixed crash
  - v1.01.04 (Oct 2021): fixed vertex issue for decayed particles
  - v1.02.00 (Aug 2022): PyQM code (energy loss module)
  - v1.03.00 (Jul 2023): added ESTARFIX card (charm meson nuclear potentials to match light mesons - CHARMPOT)
  - **v1.03.01 (Aug 2023): fixed E* (affects diff. breakups)**
  - v1.03.02 (Aug 2023): reduced default printout

t Comparison: Generator Itself

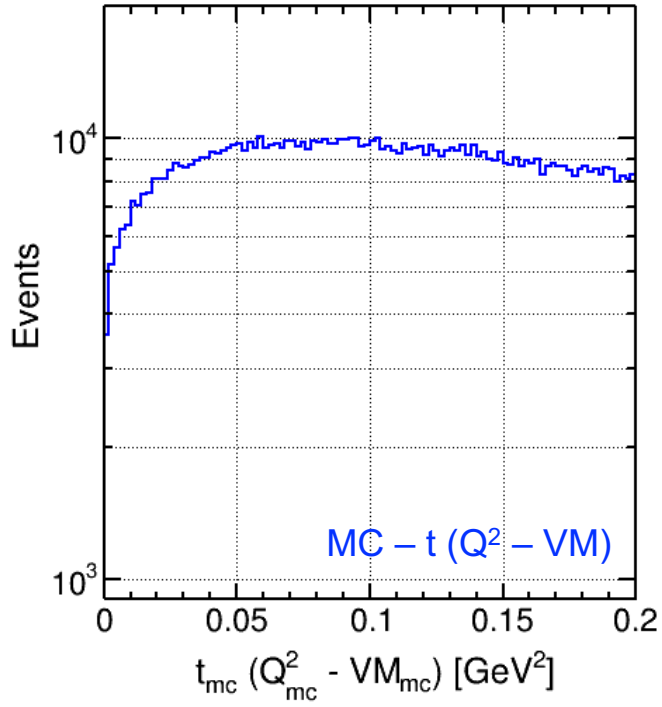
Wan
BeAGLE version **1.01.01**



Wan
BeAGLE version **1.03.02**



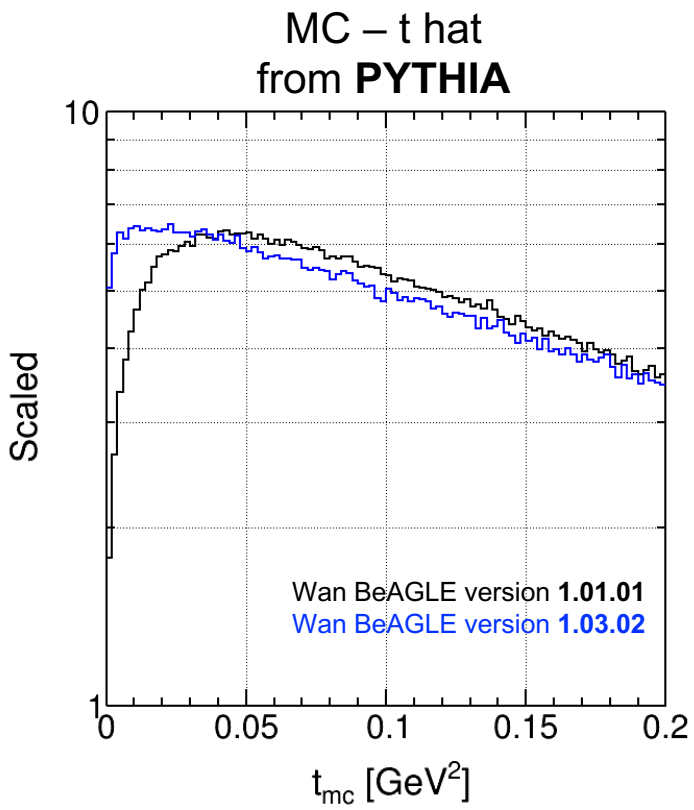
Jihee – Michael Pitt's S3
BeAGLE version **1.01.04**

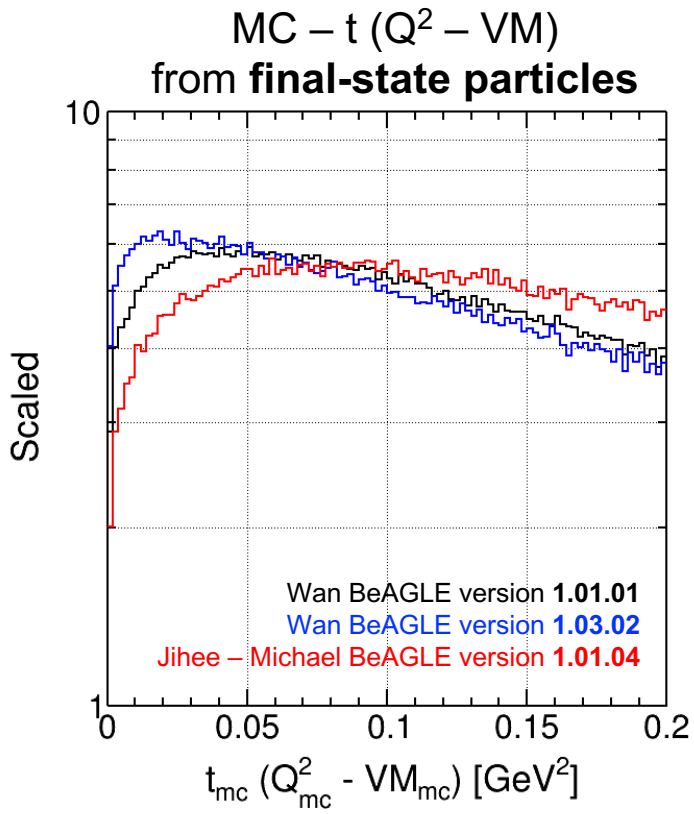


Used different t calculations ($1 < Q^2 < 10$ GeV^2)

- t ("**t_hat**"): Generator provided based on PYTHIA
- t calculated from final-state particles: Smeared from nucleon momentum (used **decaying** J/ψ)
- Wan: read from "**EICTree**" and Jihee: read from "**hepmc"** file

t Comparison: Generator Itself

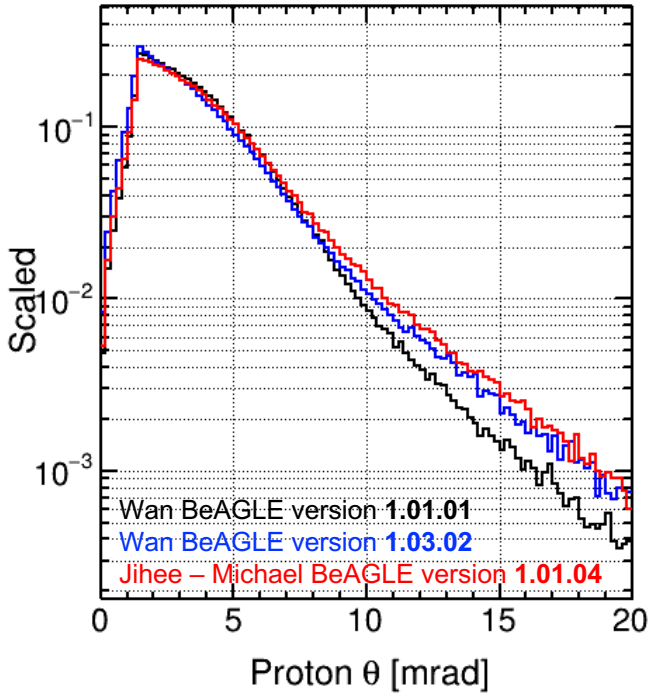




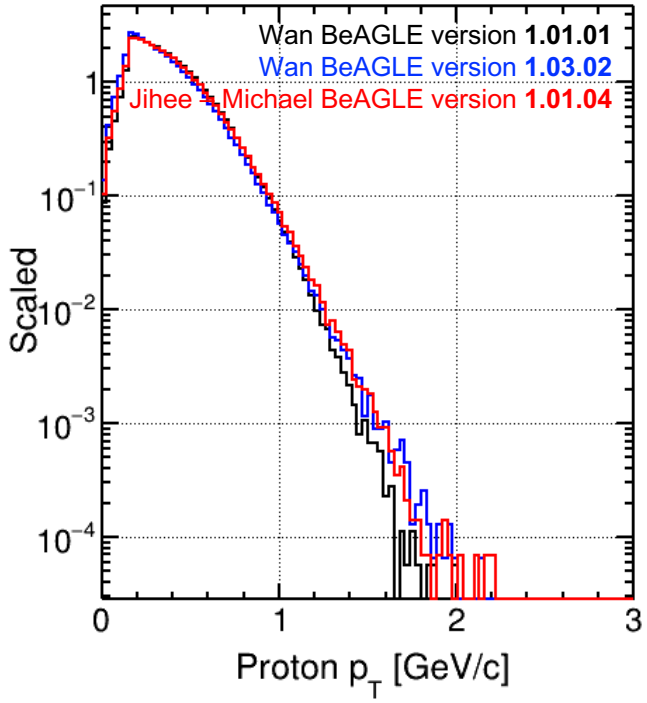
- **Normalized histograms by scaling by 1/integral and taking width into account**
- The latest version of BeAGLE generator shows quite different t distribution comparing to Wan's and Michael's version. This means we must re-generate BeAGLE sample with the newest version.
- Observed different distribution in terms of depth at very low t and slope as t increases

Fragments Comparison: Generator Itself

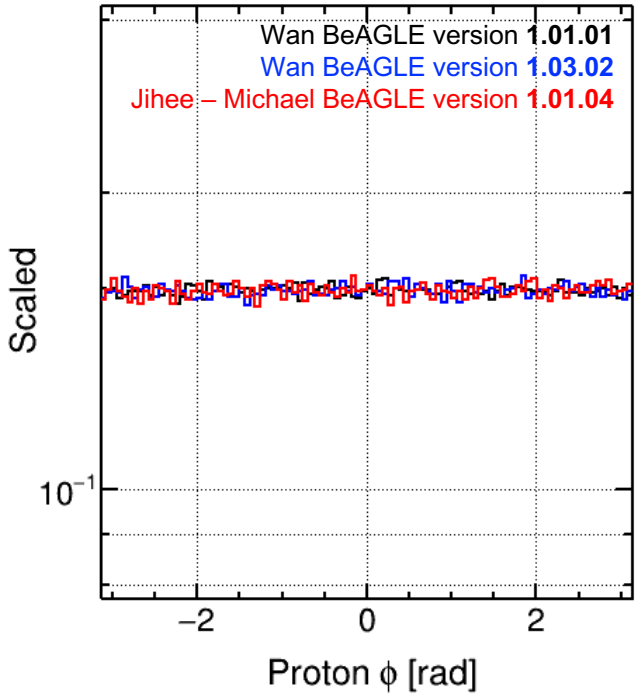
Final-state Protons
Polar Angle



Final-state Protons
Transverse Momentum



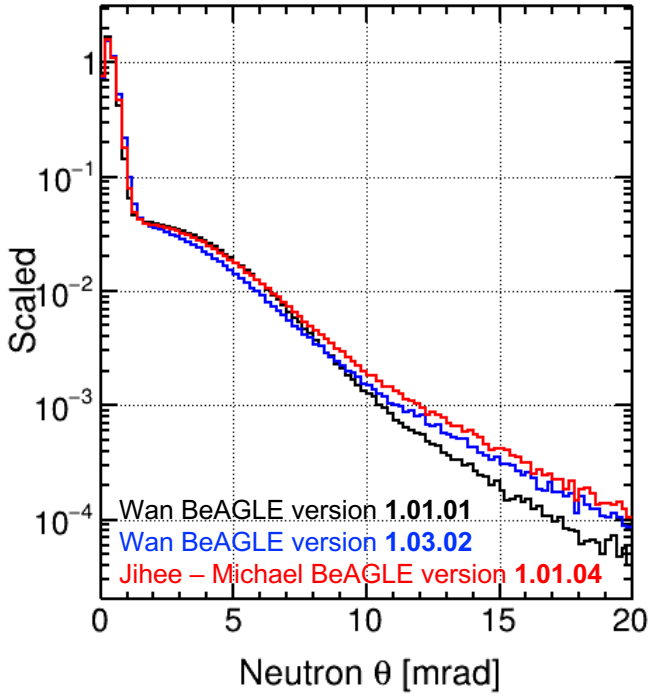
Final-state Protons
Azimuthal Angle



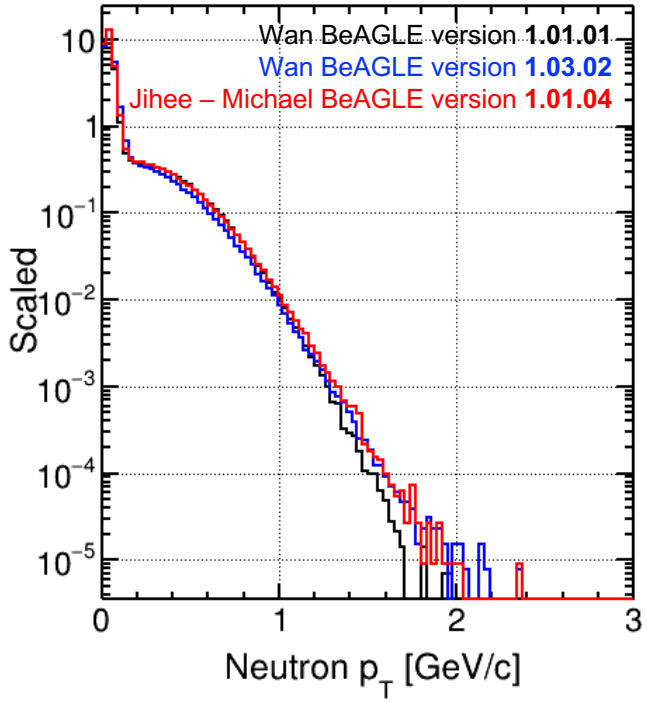
- **Normalized histograms by scaling by 1/integral and taking width into account**
- Regarding far-forward detector acceptance
  - For protons, roman pot detector observes upto 5 mrad and B0 spectrometer observes between 5 and 20 mrad
- By comparing Jihee's to Wan's, Jihee's sample has more protons at higher polar angle

Fragments Comparison: Generator Itself

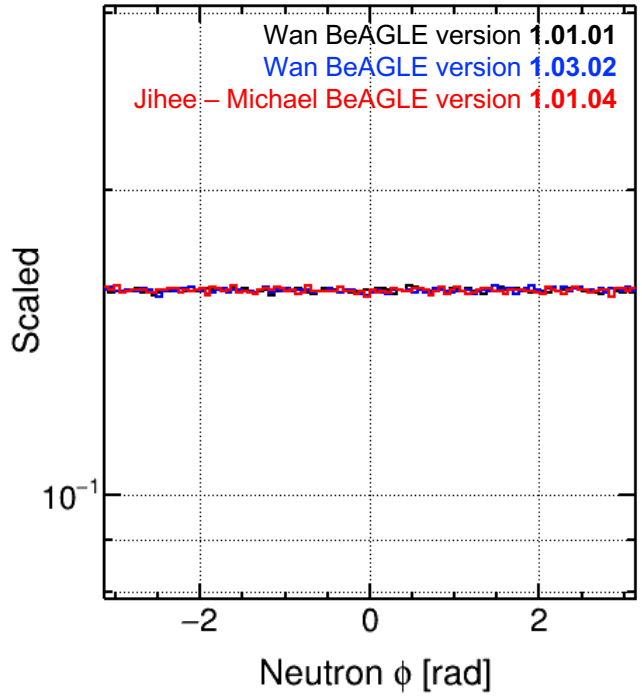
Final-state Neutrons
Polar Angle



Final-state Neutrons
Transverse Momentum



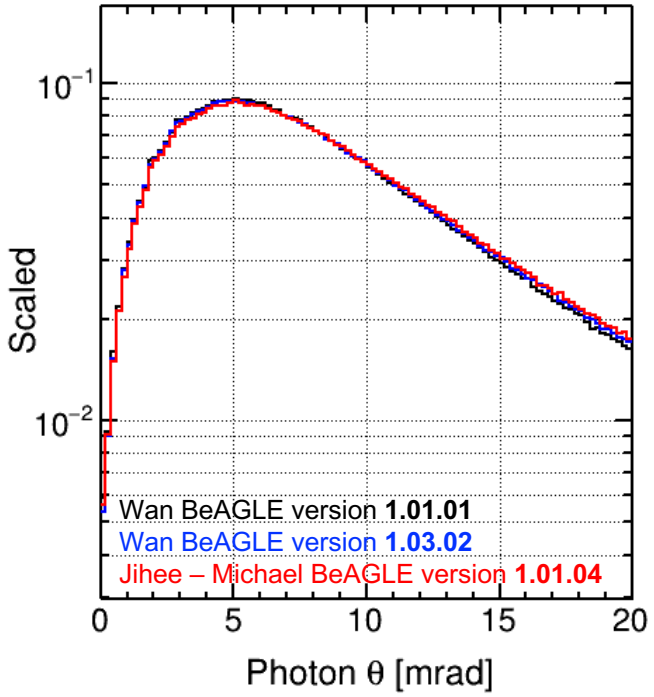
Final-state Neutrons
Azimuthal Angle



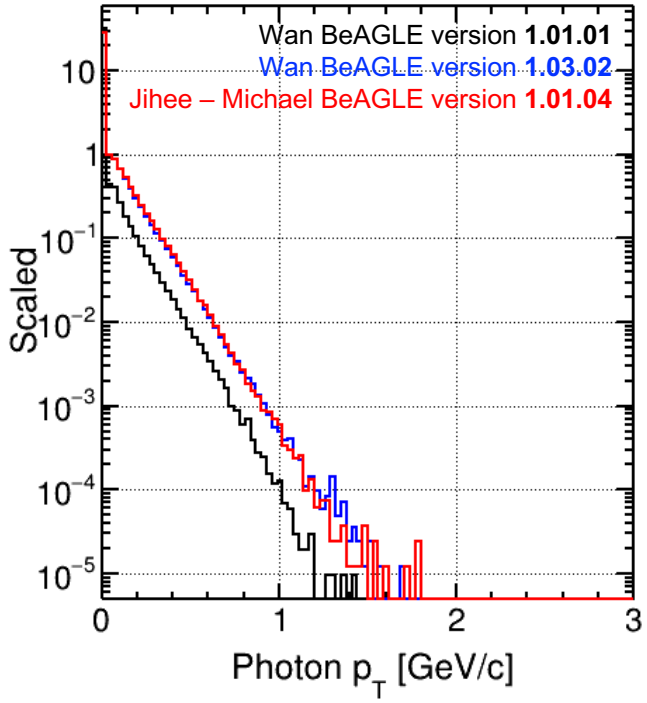
- **Normalized histograms by scaling by 1/integral and taking width into account**
- Regarding far-forward detector acceptance
  - For neutrons, zero-degree calorimeter observes upto 5 mrad
- By comparing Jihee's to Wan's, <u>Jihee's sample has more neutrons at higher polar angle</u>

Fragments Comparison: Generator Itself

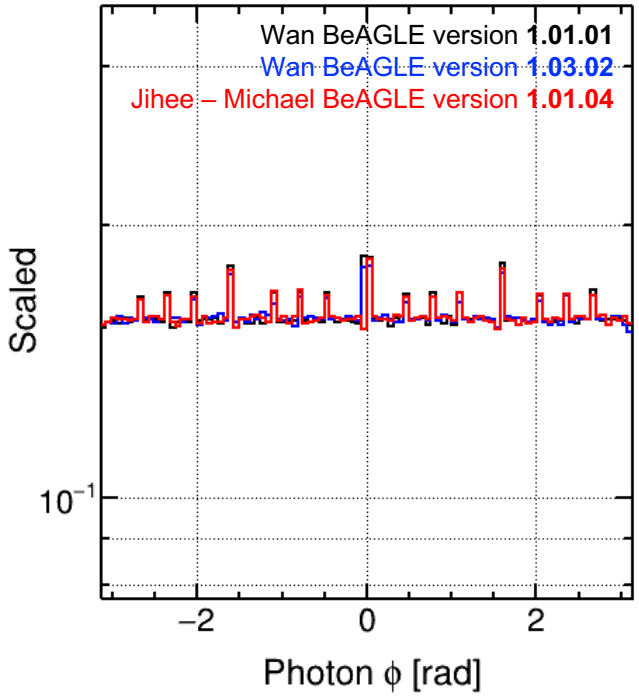
Final-state Photons
Polar Angle



Final-state Photons
Transverse Momentum



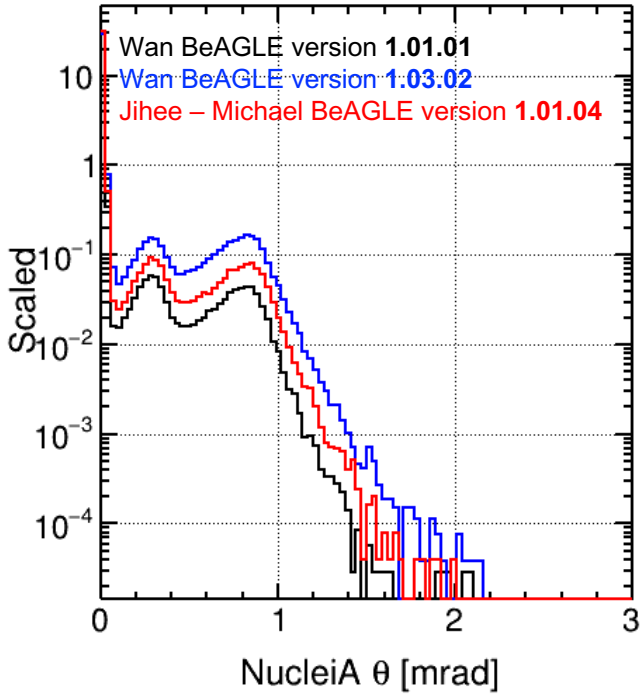
Final-state Photons
Azimuthal Angle



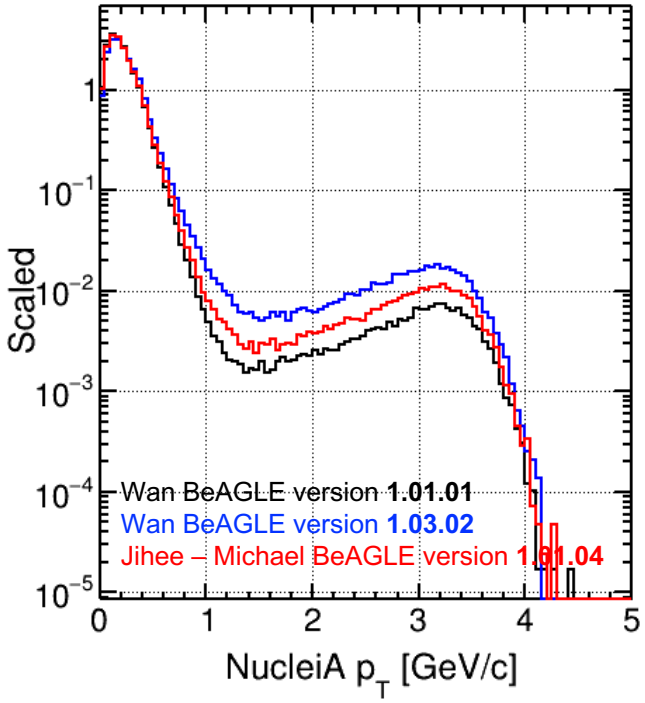
- **Normalized histograms by scaling by 1/integral and taking width into account**
- Regarding far-forward detector acceptance
  - For photons, zero-degree calorimeter observes upto 5 mrad and B0 spectrometer observes between 5 and 20 mrad
- By comparing Jihee's to Wan's, Jihee's sample has more photons in general

Fragments Comparison: Generator Itself

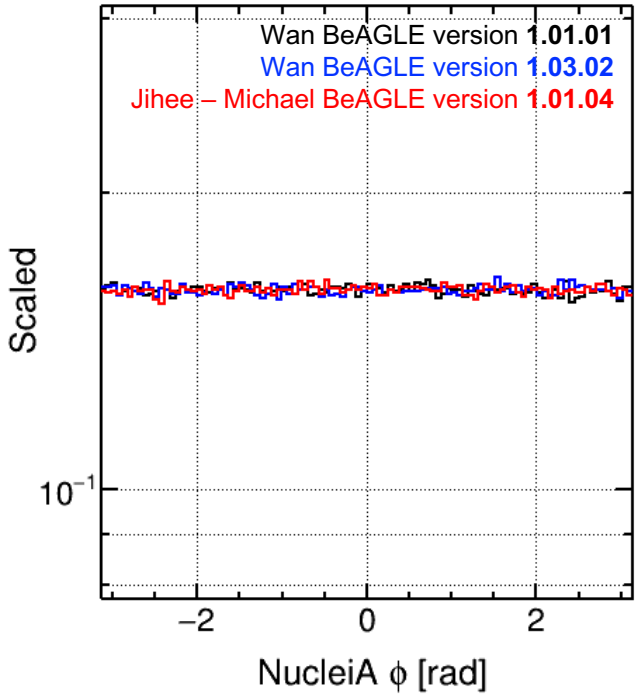
Final-state Nuclei As
Polar Angle



Final-state Nuclei As
Transverse Momentum



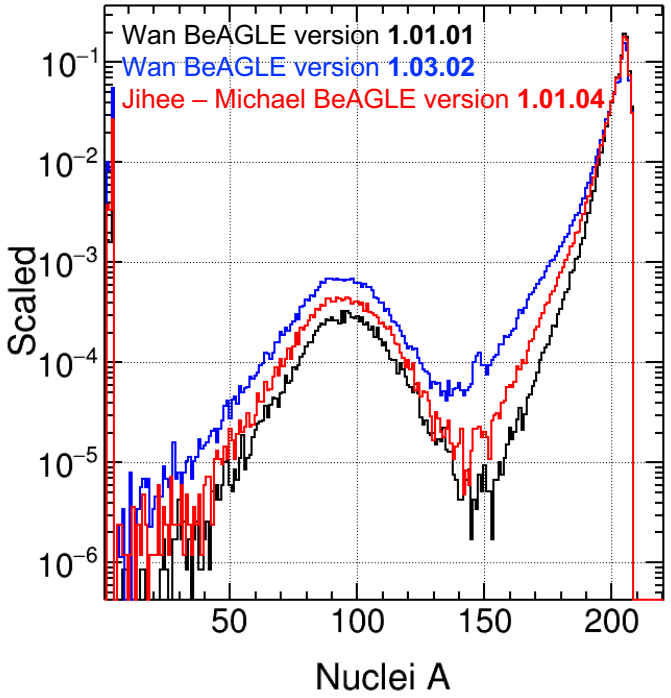
Final-state Nuclei As
Azimuthal Angle



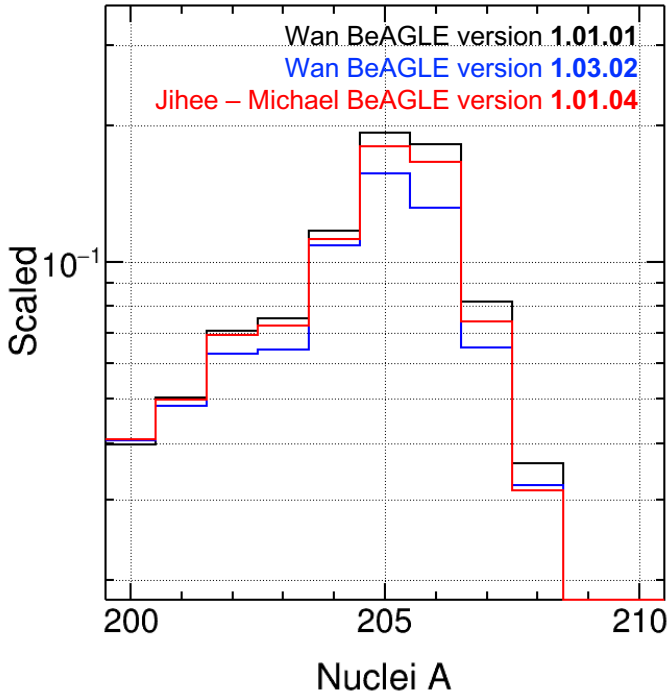
- **Normalized histograms by scaling by 1/integral and taking width into account**
- Regarding far-forward detector acceptance
  - For nuclei As, roman pot detector observes upto 5 mrad
- By comparing Jihee's to Wan's, <u>Jihee's sample has more nuclei As in general</u>

Fragments Comparison: Generator Itself

Final-state Nuclei As
Mass



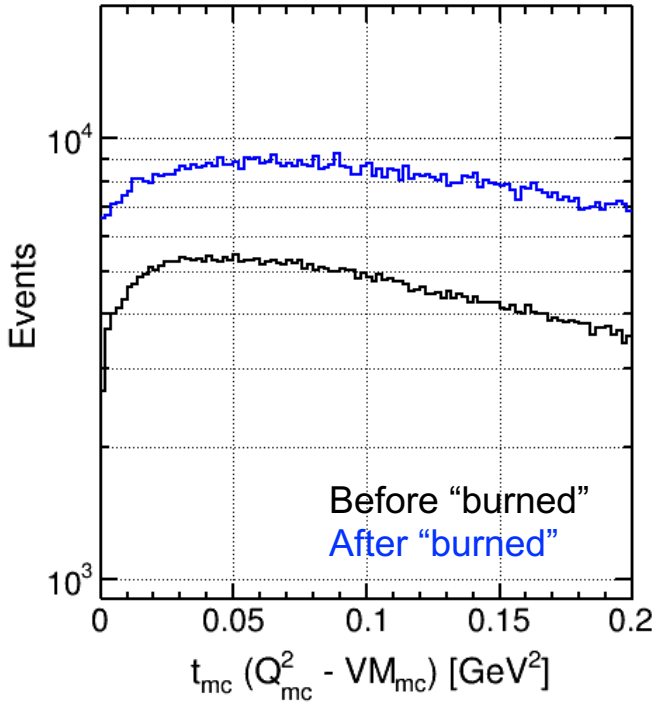
Final-state Nuclei As
Focusing Heavy Mass



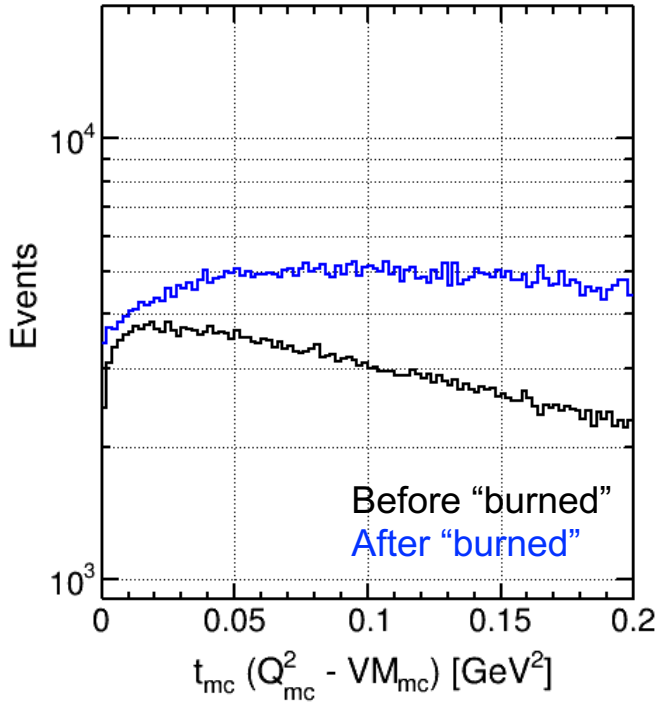
- **Normalized histograms by scaling by 1/integral and taking width into account**
- Regarding far-forward detector acceptance
  - For nuclei As, roman pot detector observes upto 5 mrad
- By comparing Jihee's to Wan's, Jihee's sample has more nuclei As in general, except for very heavy mass region

t Comparison: Before/After “burned”

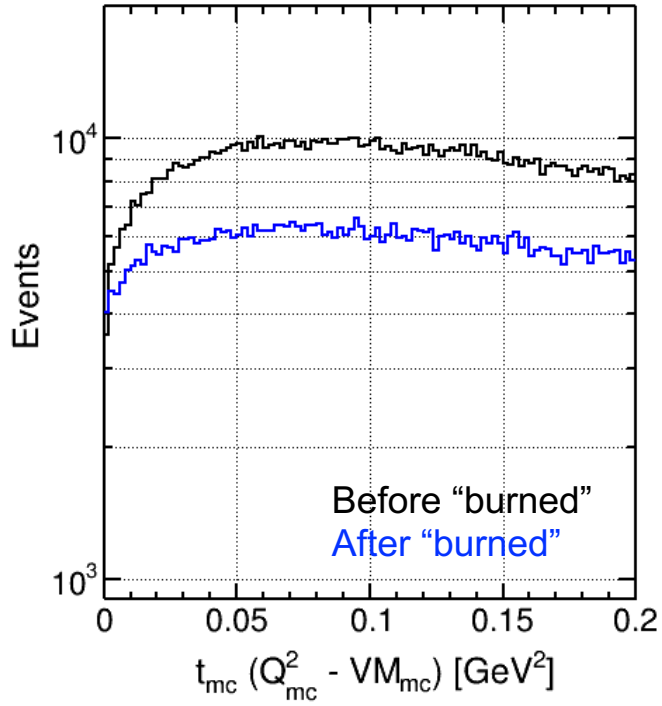
Wan
BeAGLE version **1.01.01**



Wan
BeAGLE version **1.03.02**



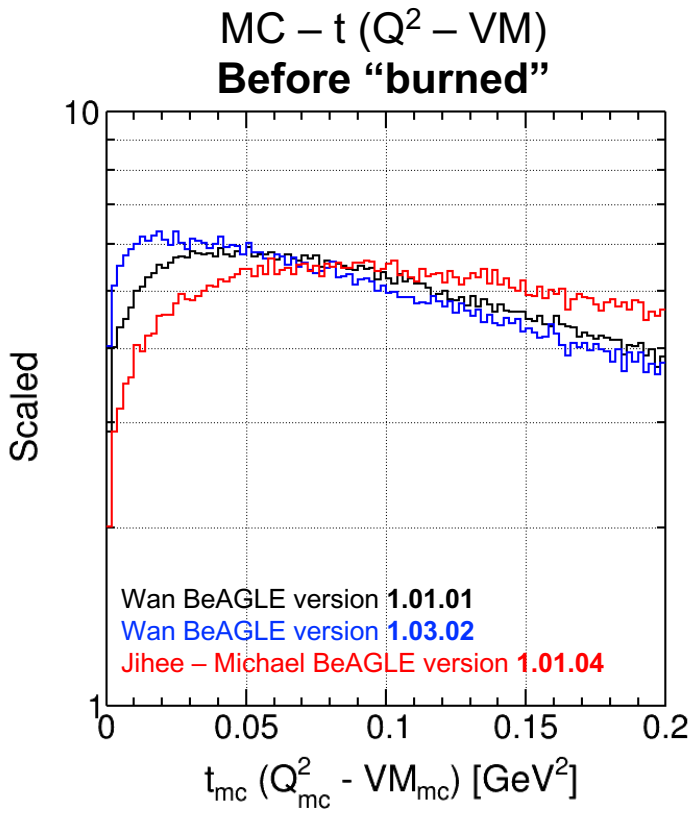
Jihee – Michael Pitt’s S3
BeAGLE version **1.01.04**

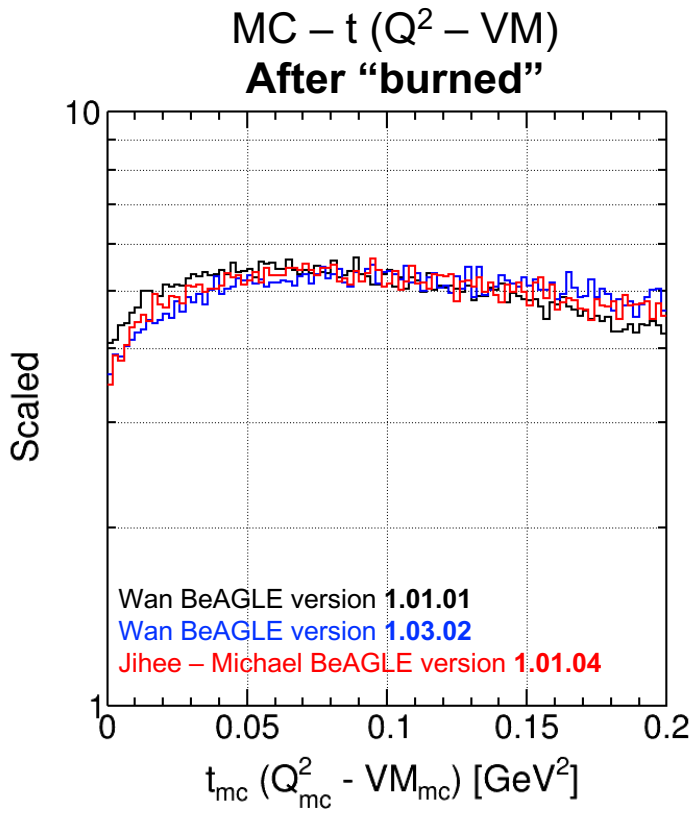


Here t is calculated from final-state particles (Q^2 – VM)

- After “burned”: applying crossing angle (35 mrad) + beam effect (eAu with strong hadron cooling)

t Comparison: Before/After “burned”



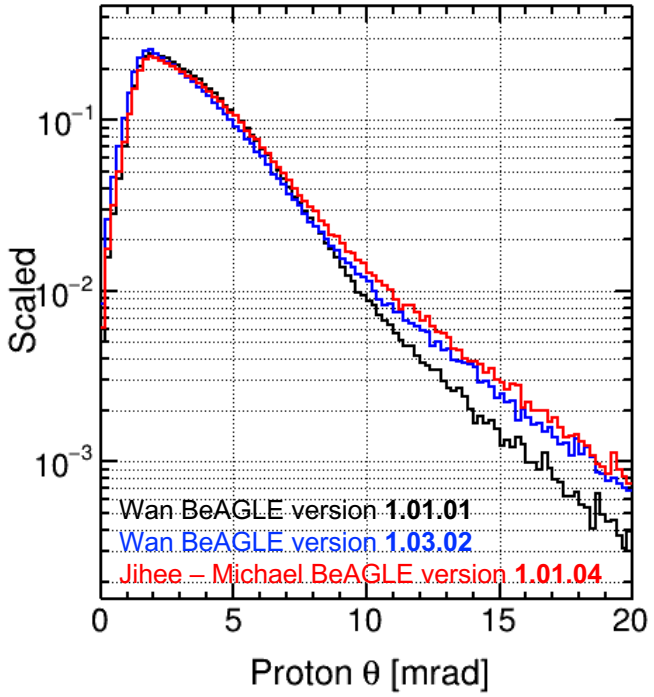


Here t is calculated from final-state particles (Q^2 – VM)

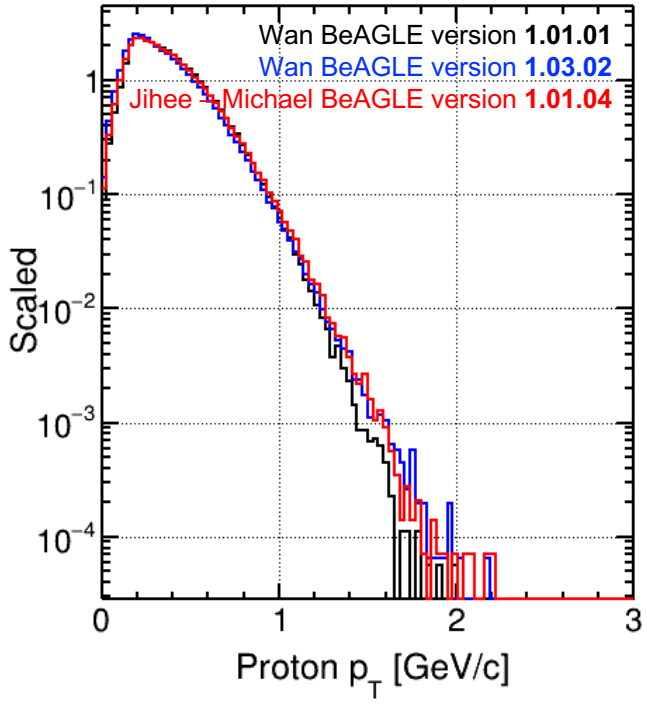
- After “burned”: applying crossing angle (35 mrad) + beam effect (eAu with strong hadron cooling)
- Became similar and flat distribution

Fragments Comparison: After “burned”

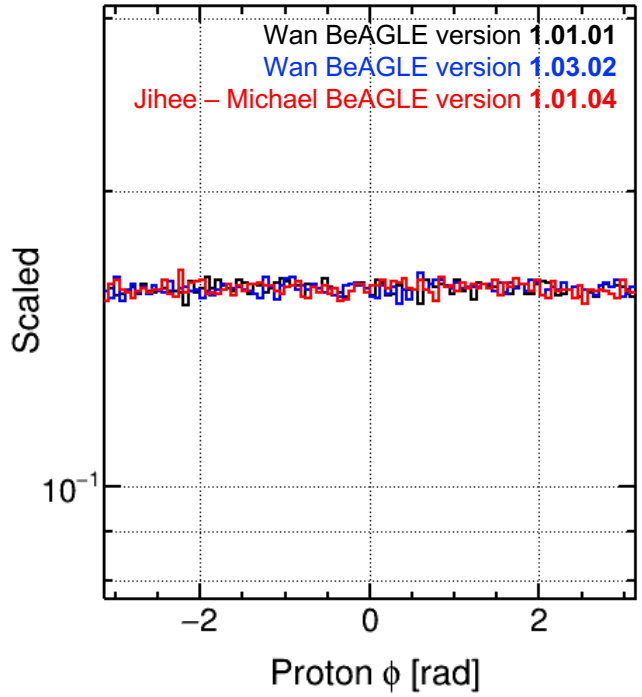
Final-state Protons
Polar Angle



Final-state Protons
Transverse Momentum



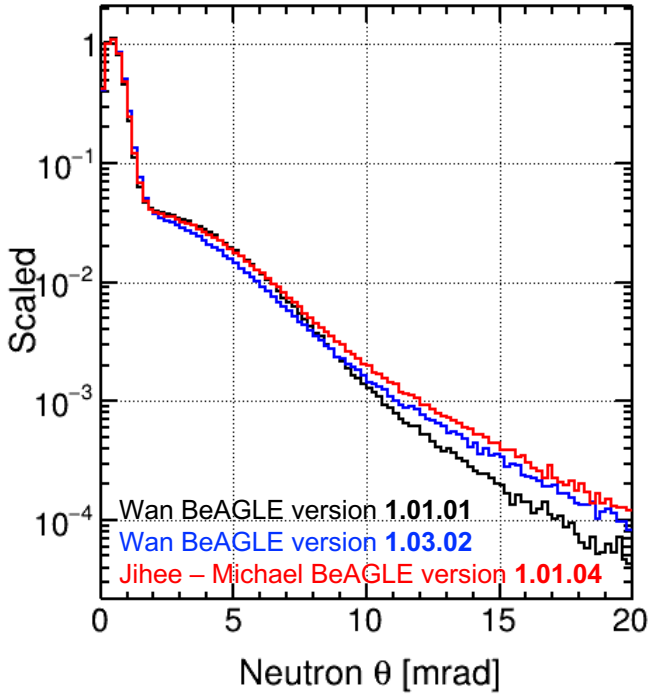
Final-state Protons
Azimuthal Angle



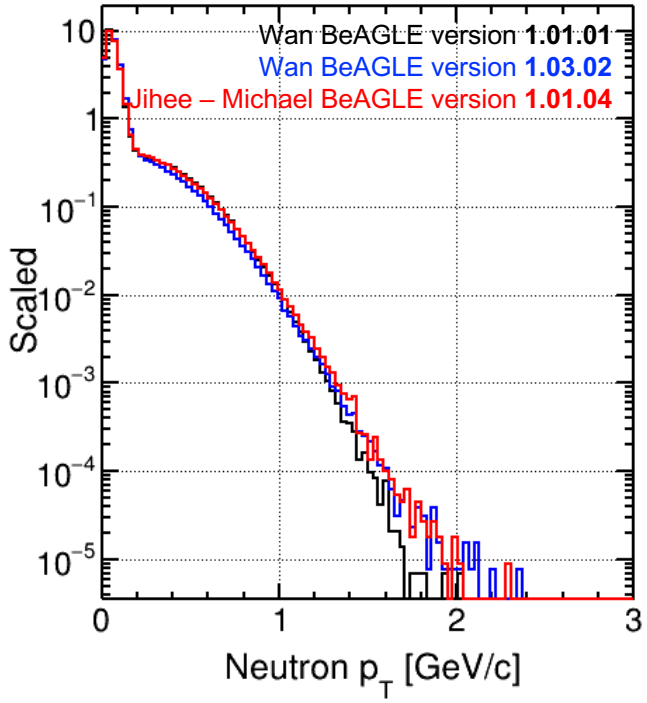
- **Normalized histograms by scaling by 1/integral and taking width into account**
- Regarding far-forward detector acceptance
  - For protons, roman pot detector observes upto 5 mrad and B0 spectrometer observes between 5 and 20 mrad
- By comparing Jihee’s to Wan’s, Jihee’s sample has more protons at higher polar angle

Fragments Comparison: After “burned”

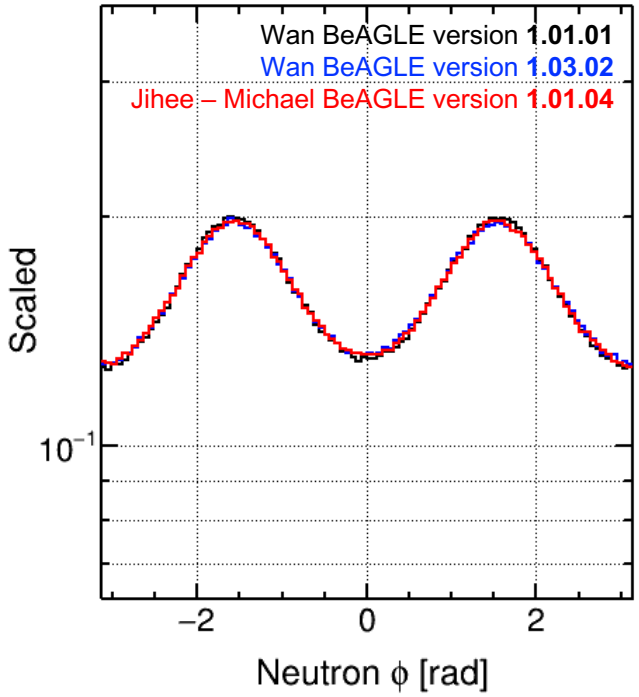
Final-state Neutrons
Polar Angle



Final-state Neutrons
Transverse Momentum



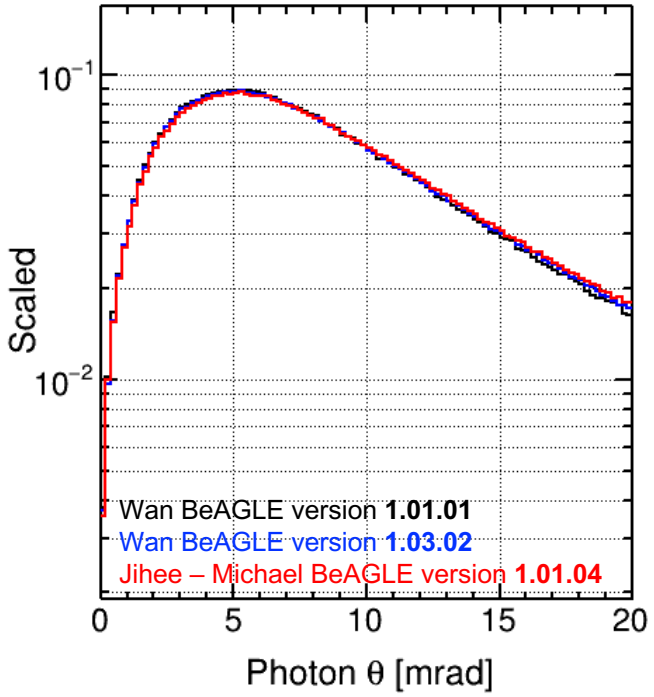
Final-state Neutrons
Azimuthal Angle



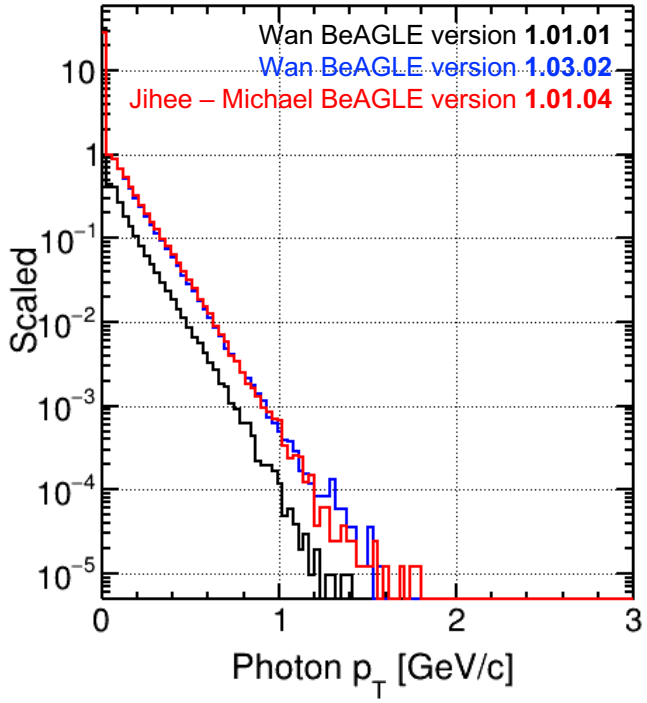
- **Normalized histograms by scaling by 1/integral and taking width into account**
- Regarding far-forward detector acceptance
  - For neutrons, zero-degree calorimeter observes upto 5 mrad
- By comparing Jihee’s to Wan’s, Jihee’s sample has more neutrons at higher polar angle

Fragments Comparison: After “burned”

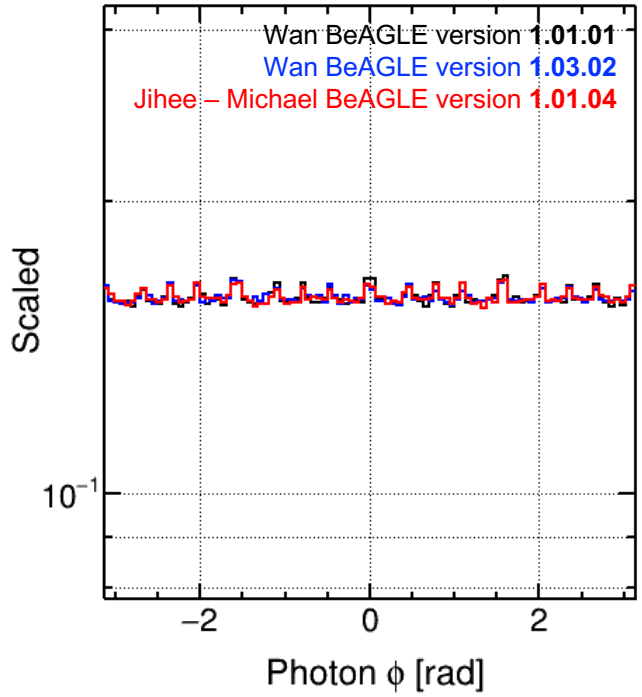
Final-state Photons
Polar Angle



Final-state Photons
Transverse Momentum



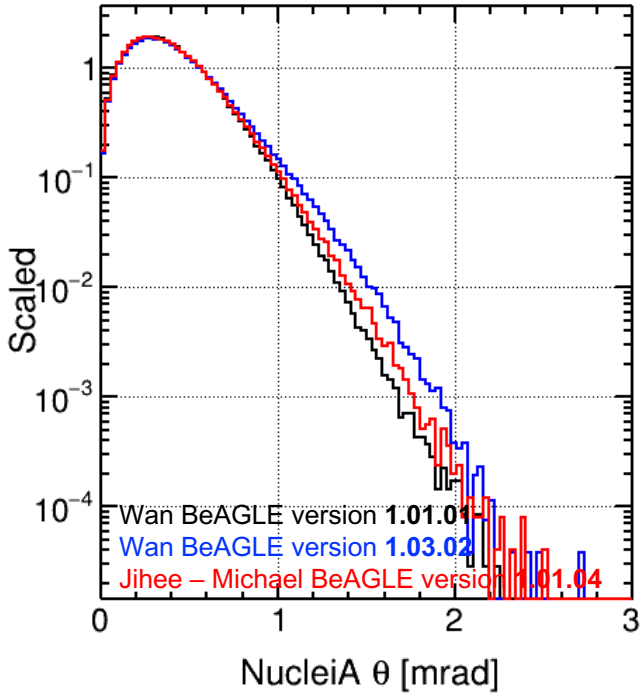
Final-state Photons
Azimuthal Angle



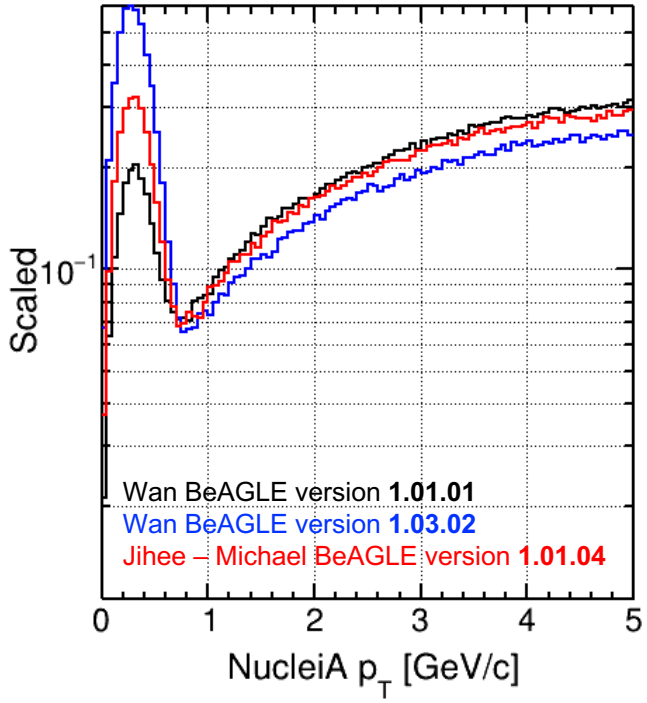
- **Normalized histograms by scaling by 1/integral and taking width into account**
- Regarding far-forward detector acceptance
  - For photons, zero-degree calorimeter observes upto 5 mrad and B0 spectrometer observes between 5 and 20 mrad
- By comparing Jihee’s to Wan’s, Jihee’s sample has more photons in general

Fragments Comparison: After “burned”

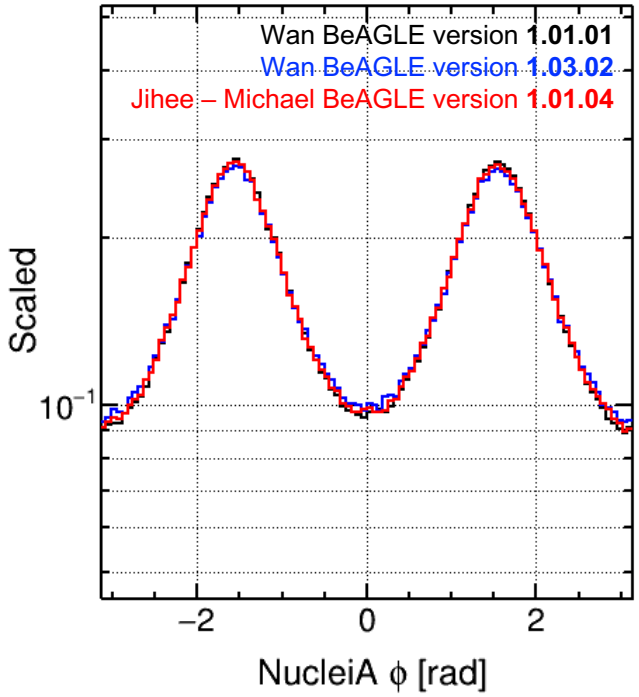
Final-state Nuclei As
Polar Angle



Final-state Nuclei As
Transverse Momentum



Final-state Nuclei As
Azimuthal Angle

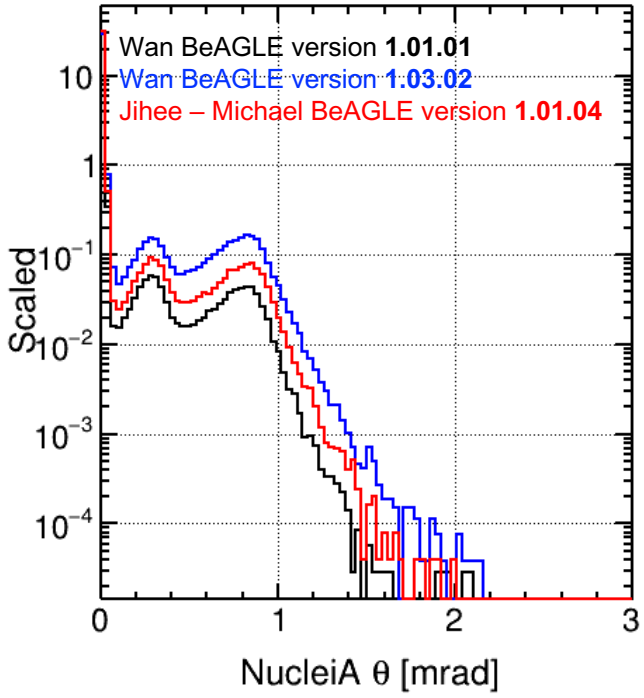


- **Normalized histograms by scaling by 1/integral and taking width into account**
- Regarding far-forward detector acceptance
  - For nuclei As, roman pot detector observes upto 5 mrad
- By comparing Jihee’s to Wan’s, Jihee’s sample has more smaller p_T nuclei As, but Wan’s has larger p_T nuclei As

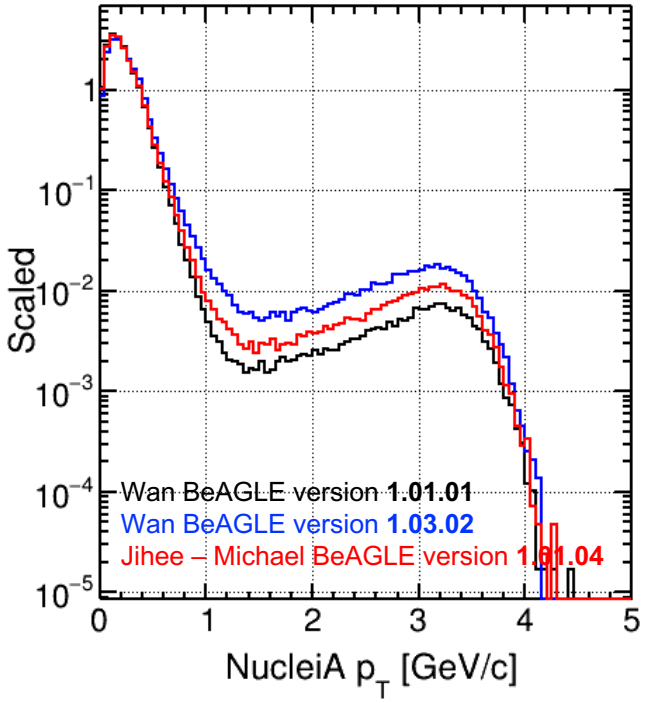
Copied from slide #9

Fragments Comparison: Generator Itself

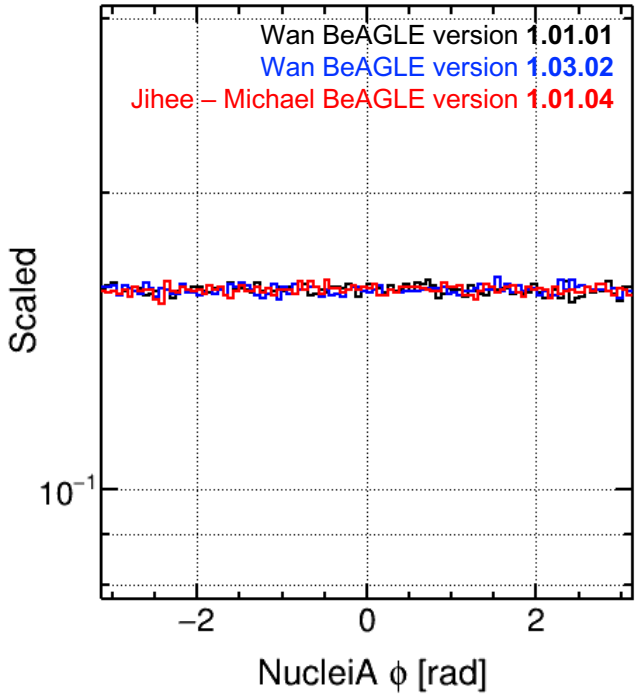
Final-state Nuclei As **Polar Angle**



Final-state Nuclei As **Transverse Momentum**



Final-state Nuclei As **Azimuthal Angle**



- **Normalized histograms by scaling by 1/integral and taking width into account**
- Regarding far-forward detector acceptance
  - For nuclei As, roman pot detector observes upto 5 mrad
- By comparing Jihee's to Wan's, Jihee's sample has more nuclei As in general

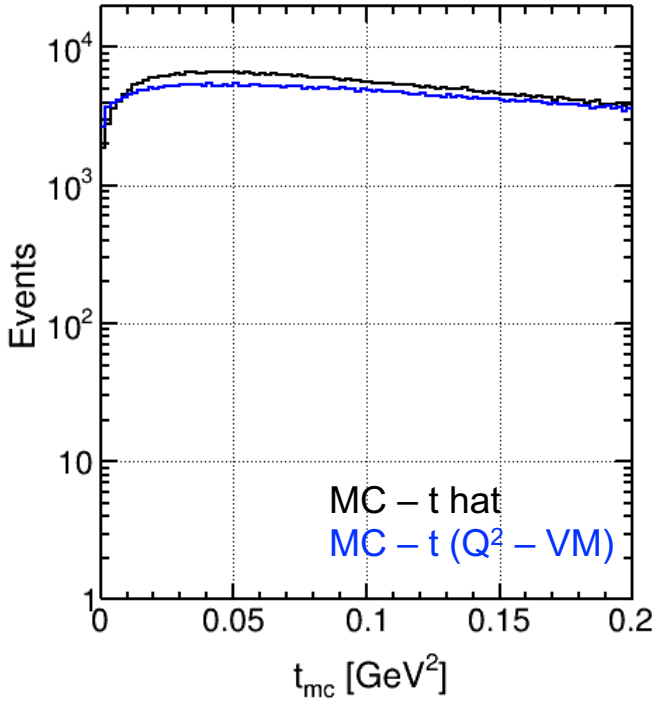
To-Do List

- **Run IP-8 DD4hep simulation with three different sample to evaluate vetoing power**
- **Run BeAGLE generator with the latest version (1.03.02). Will benefit for further studies in ePIC and Detector 2. Already shared run cards with Kong so that we can finalize configuration for BeAGLE.**

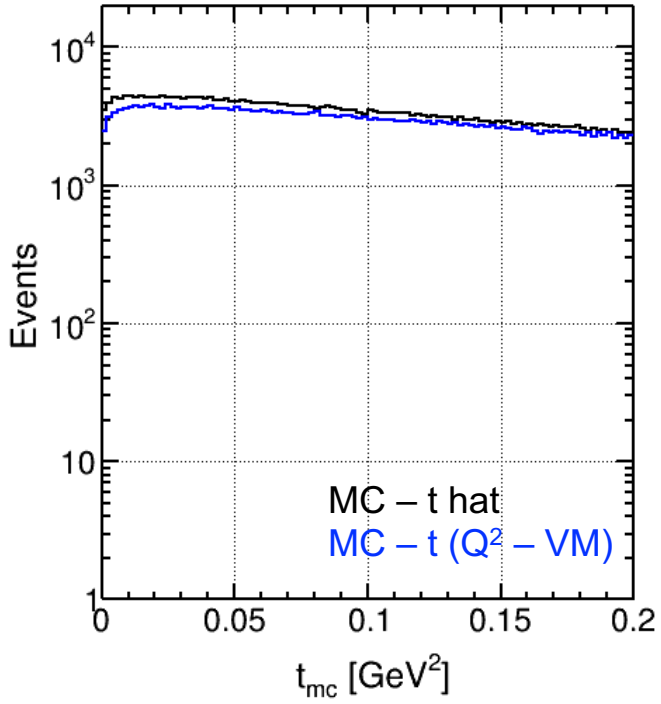
Backup Slides

t Comparison: Generator Itself

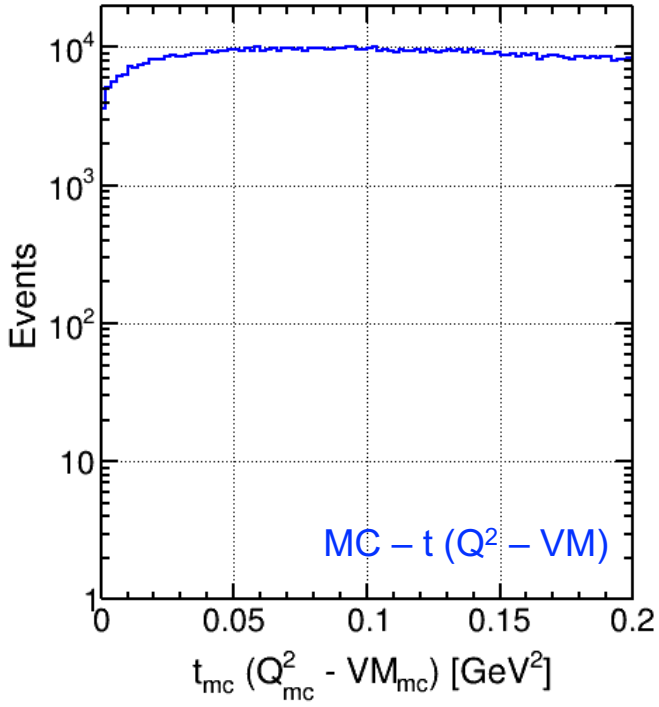
Wan
BeAGLE version **1.01.01**



Wan
BeAGLE version **1.03.02**



Jihee – Michael Pitt's S3
BeAGLE version **1.01.04**



Used different t calculations ($1 < Q^2 < 10$ GeV^2)

- t ("**t_hat**"): Generator provided based on PYTHIA
- t calculated from final-state particles: Smeared from nucleon momentum (used **decaying J/ψ**)
- Wan: read from "**EICTree**" and Jihee: read from "**hepmc"** file

Comparison: Pythia Card

*VMD (vector meson dominance)

	Wan (Original)	Jihee (S3VJn003)
MSEL (desired subset of processes or restrict flavors/kinematics)	2 (lepton-hadron: Deeply Inelastic Scattering: QCD jets)	0 (full user control in MSUB)
MSUB(91) : elastic scattering	- (MSEL=2 elastic component included)	1 (included)
MSUB(93) : single diffraction (AB → AX)	- (MSEL=2 diffractive component included)	1 (included)
MDCY(C443,1)	-	0 (turn off J/Psi decays)
MSTP(13)	1	- (default 1)
MSTP(14) structure of incoming photon beam/target	30 (standard QCD physics default)	2 (only VMD included)
PARP(2) (min CMS energy for event as a whole that program will accept to simulate)	5	2
PARJ(3) extra suppression of strange diquark production	0.4 (default)	-
MSTU(16) for particles produced by a fragmenting parton sysytem	2 (??)	- (default = 1)
xmin and xmax	1.2e-4, 0.04	1e-6, 1.00
Switch for shadowing: genShd	-	3
Switch for quenching 1:on, 0:off	-	1 (**needs to be 0**)
Set sigma to 1.32=4.306=5.7mb	-	SHDFAC 1.32
Lepton beam type	-11	-
Proton and electron beam energy	820., 27.5	-
ymin and ymax	0.02, 0.6	-
Q2min and Q2max	3.0, 254	-