

BooNE MC status, Feb 5 2016

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The issues to be resolved..

- ✓ At the Jan 19 meeting, we agreed to work on demonstrating better that the most significant change, the one that explain the $\sim 9\%$ reduction of the neutrino flux, ν_{μ} from π decay, is due to changes in the π -Be, π -Al, etc scattering models, elastic and inelastic.
- ✓ While we can change (in v4.p8 and v4p9) the total-cross section via the G4UI data cards, the scattering models, i.e., the shape of the double differential cross on scattering angle and energy loss, is version dependent, as shown about two or three months ago while analyzing the π -C quasi-elastic scattering at 955 MeV/c
- ✓ Quantify the above change wit the adhoc plot is the topic of this discussion.
 - With “hacking” into Geant4 code (G4HadronicProcess class, etc...) ?
 - Instrumenting more our BNB G4 code.

The “Hack proposed ~ 2 weeks ago.

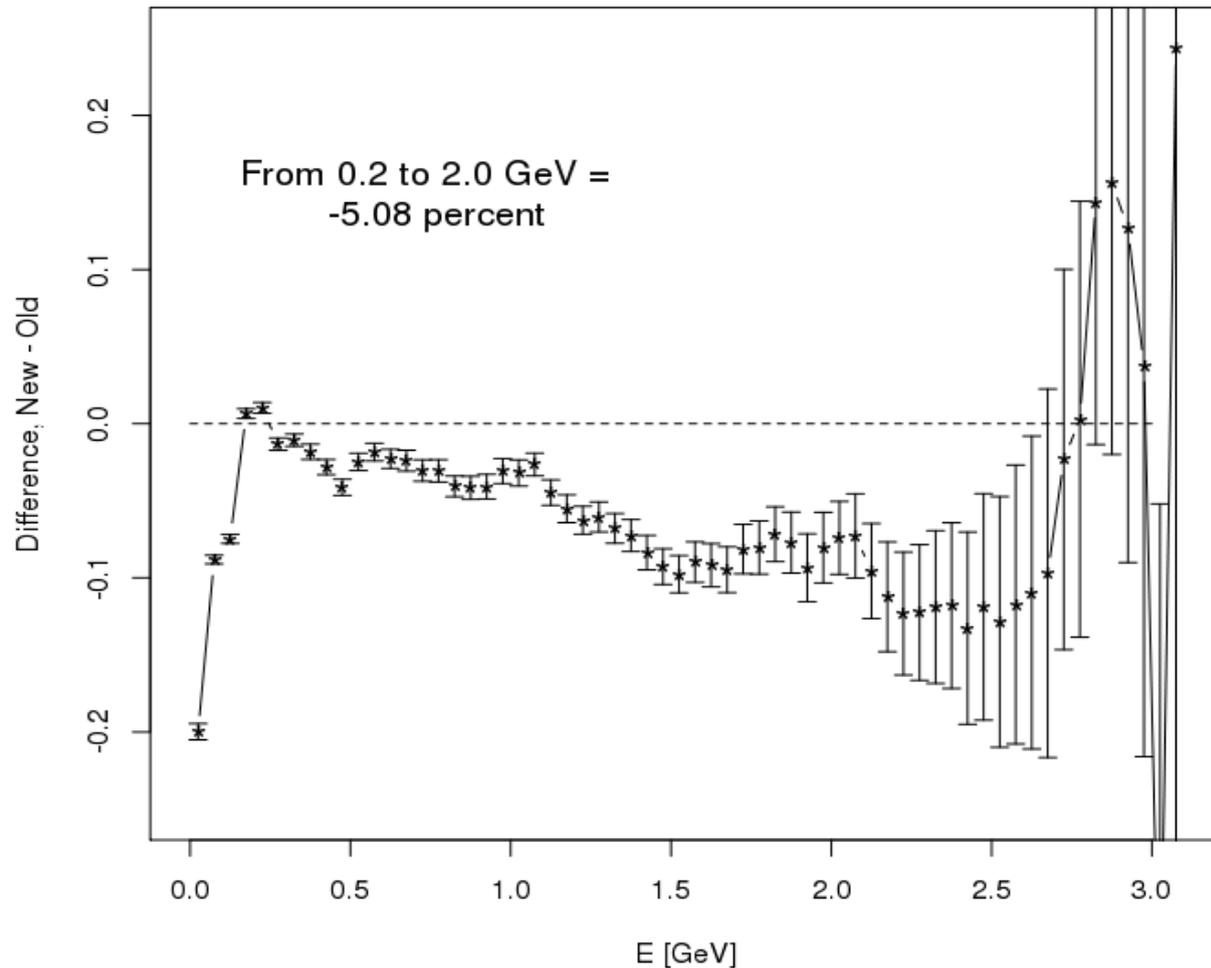
- ✓ Did not work... Yet... please ignore the last plot on the set of slide written for the Jan 19 2016 meeting . This plot was not discussed, I realised the potential side-effects in modifying the volatile G4 tracking stack(s), this is why it was not discussed in great length..
- ✓ If the plots shown later in the talks are not yet convincing enough, then we can rethink it again..

Quantifying “the probability for scattering”

- ✓ Using G4-public tracking/stepping information...
- ✓ Does not tell us everything, but safer, and can be ported across G4 version with minor modification
- ✓ So, back to the thread from last week: Geometry is one slug and the aluminum in the horn... Also, 3 Be slugs, all other volumes made of vacuum.

Horn is Aluminum, ν_μ flux.

Shown on Jan 19 2016...



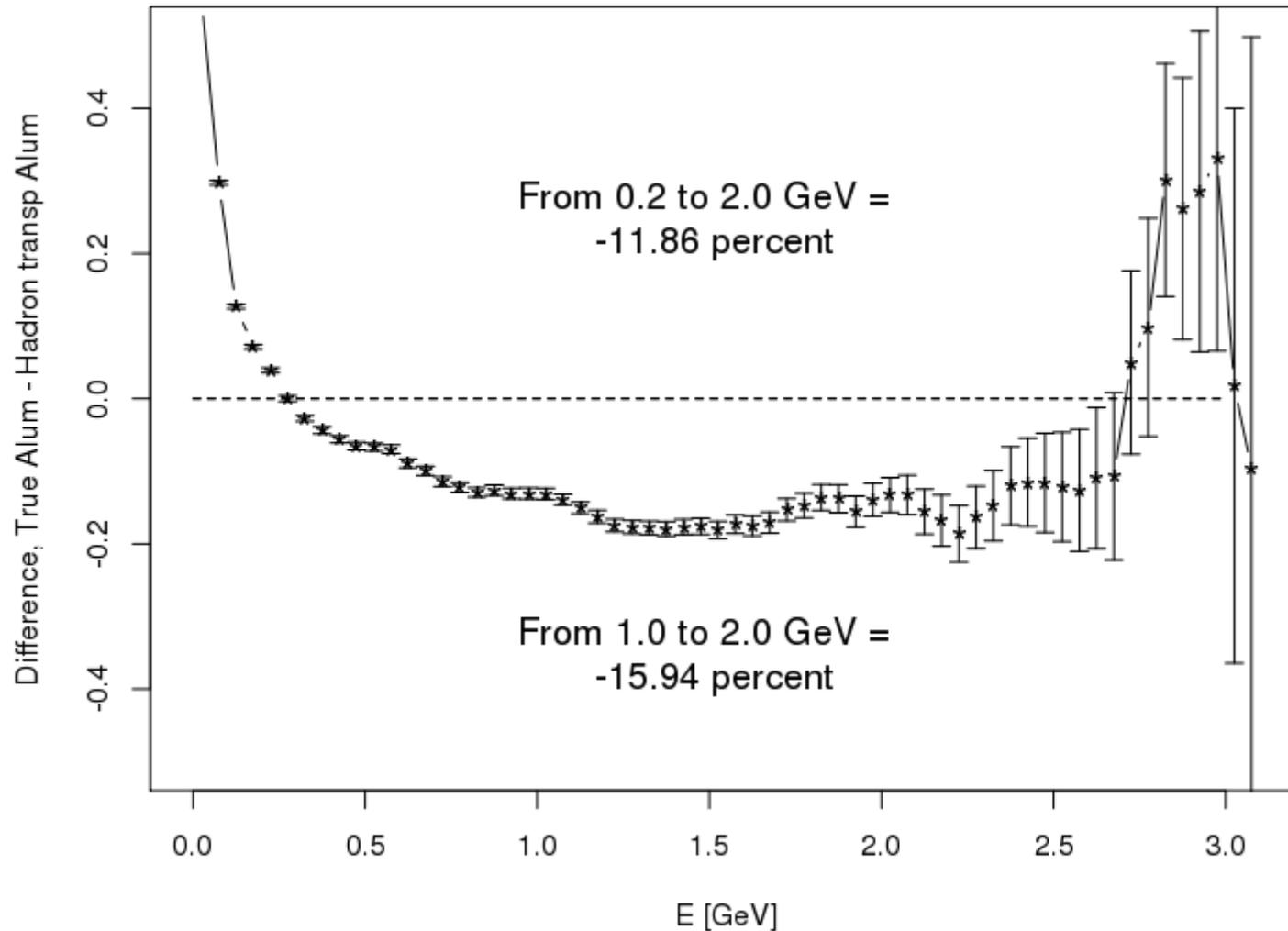
Geometry: one Be Slug (1st one, most upstream) and the Aluminum, Horn)

~ 4 % more than just one Be slug.

Let us document this better.

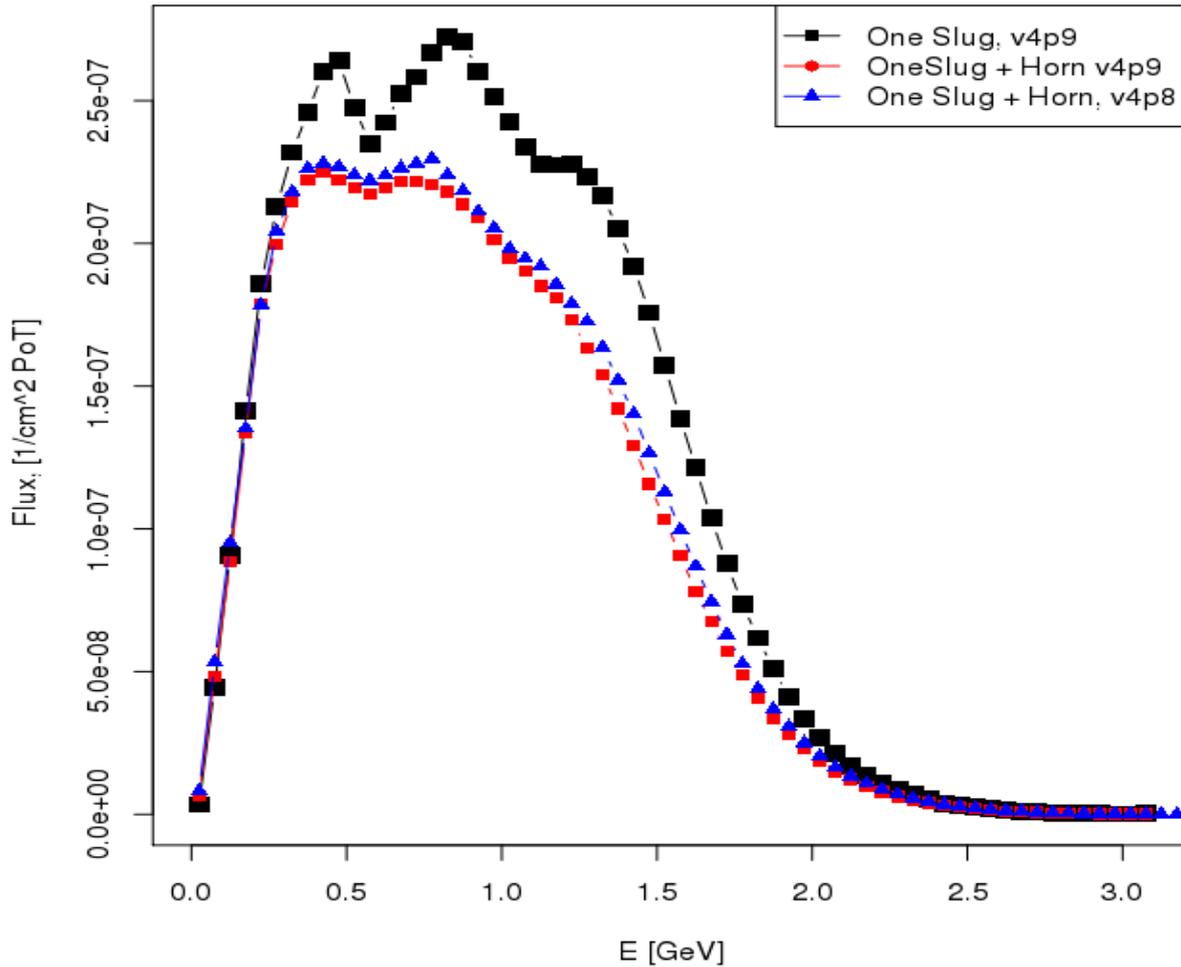
Effective Hadronic absorption in Horn, v4p9

Also shown on Jan 19 2016..



Confirming plots..

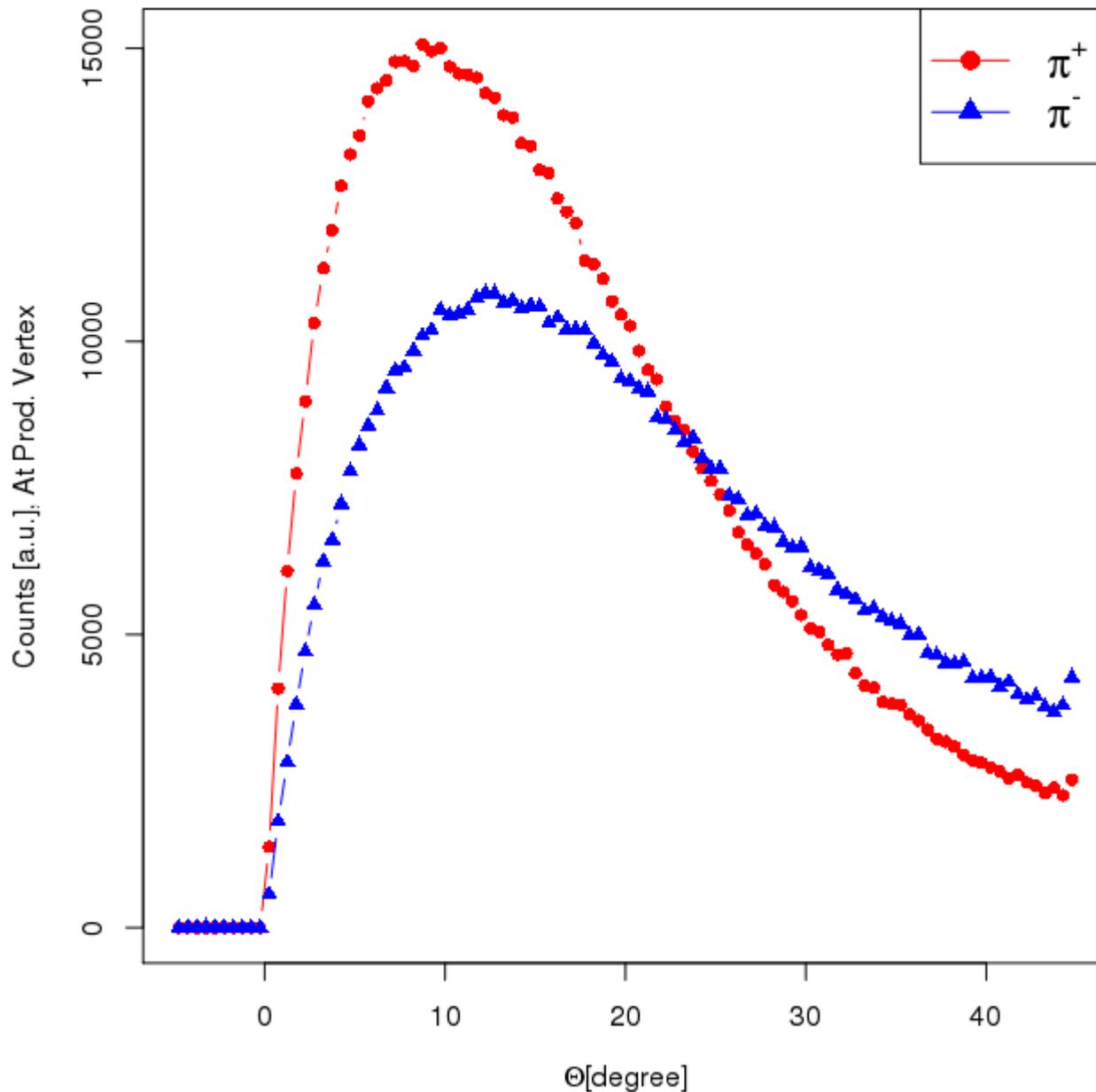
New, Jan 27 2016...



Same as before, here we just have
Each ν_{μ} from π decays separately.

Momentum dependent ratio

Are we focusing the p when the
Horn is made of thin air (Vacuum) ?

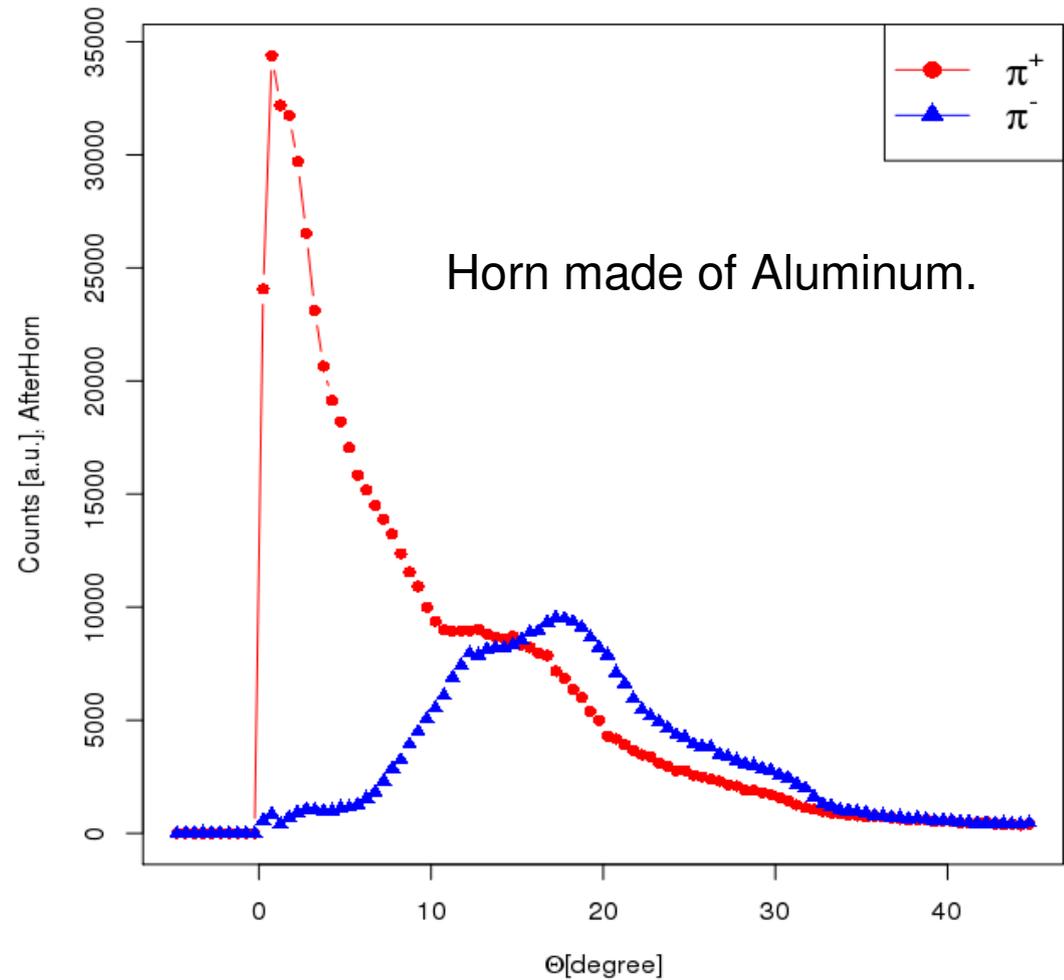
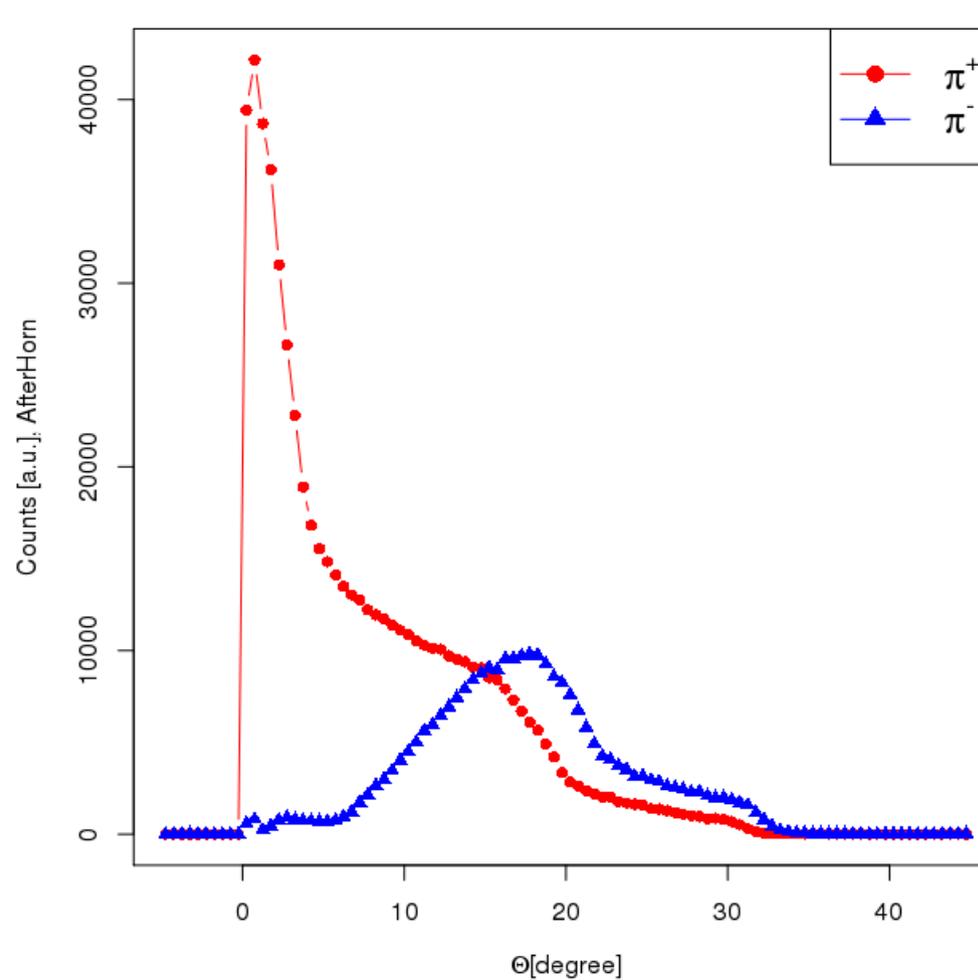


Angular distributions of pions
 Emitted from the primary vertex,
 P on Be, MiniBoone/HARP model

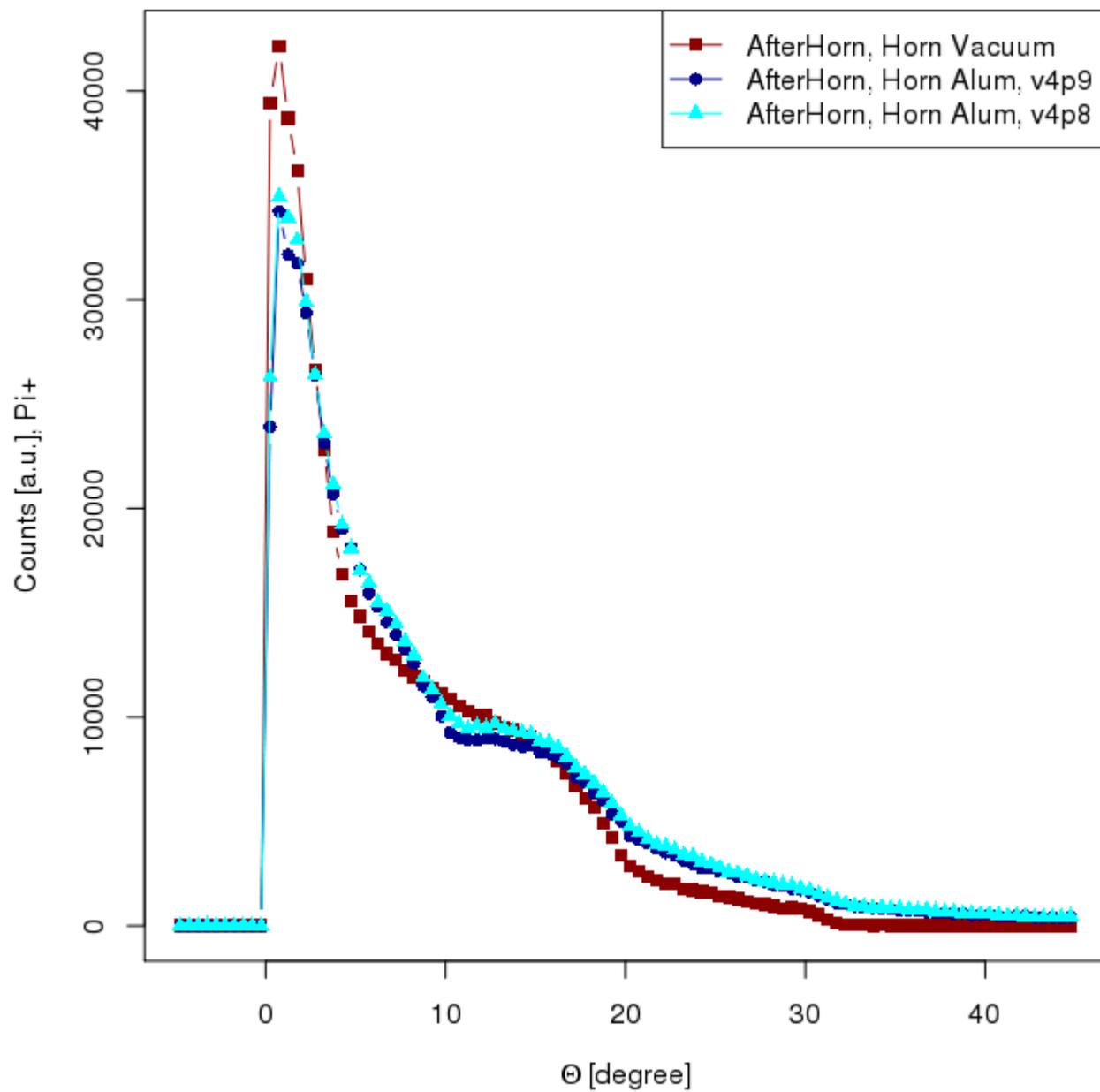
(nothing new here.. Just a
 Reminder on what the angles
 are...
 ..)

Note : “angular distribution” is the
 distribution of the polar angle, pion
 track - beam axis.

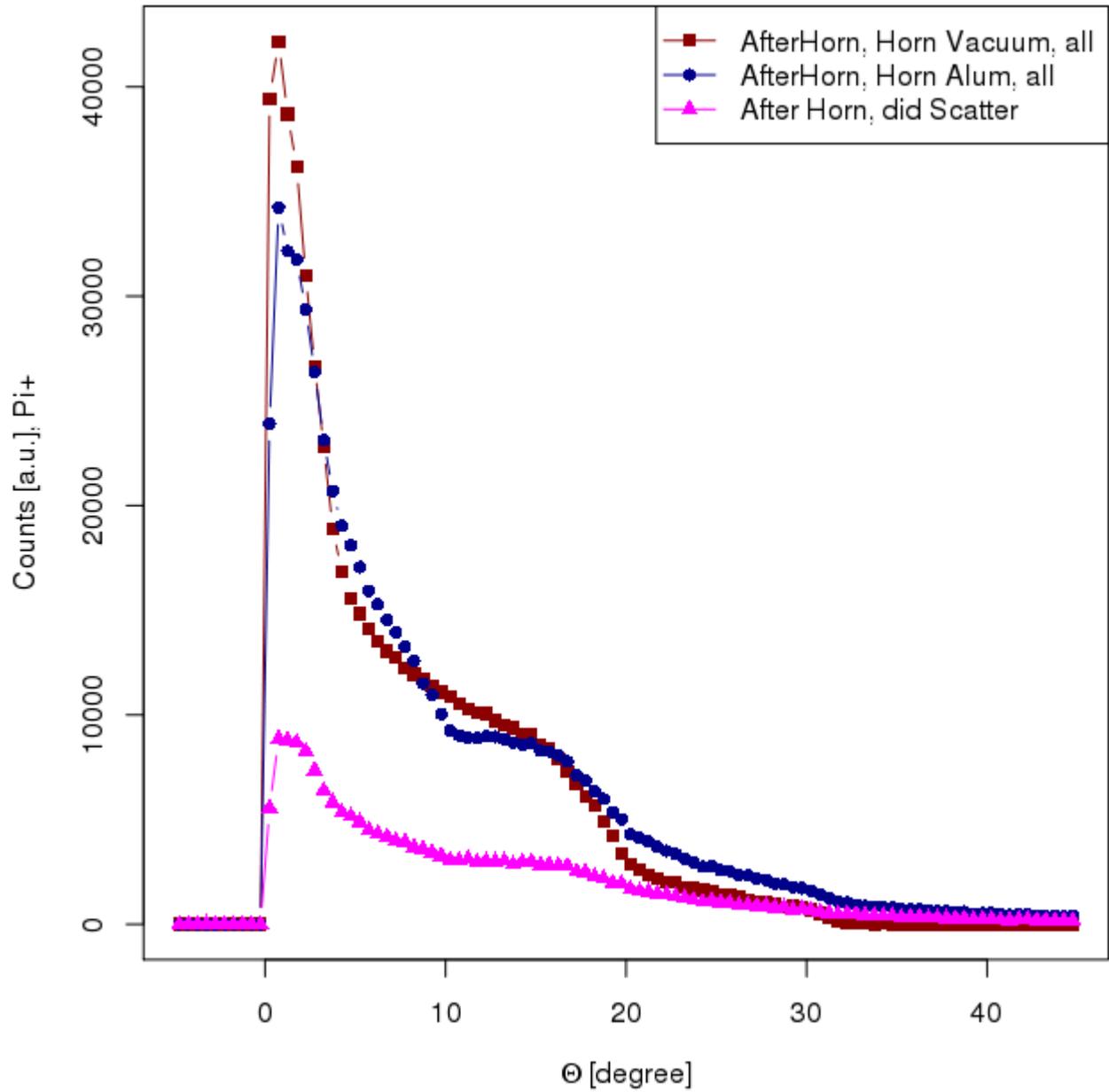
Confirming plots.. Checking focusing of pions.



Yes, we are de-focusing the π^- , no problem...



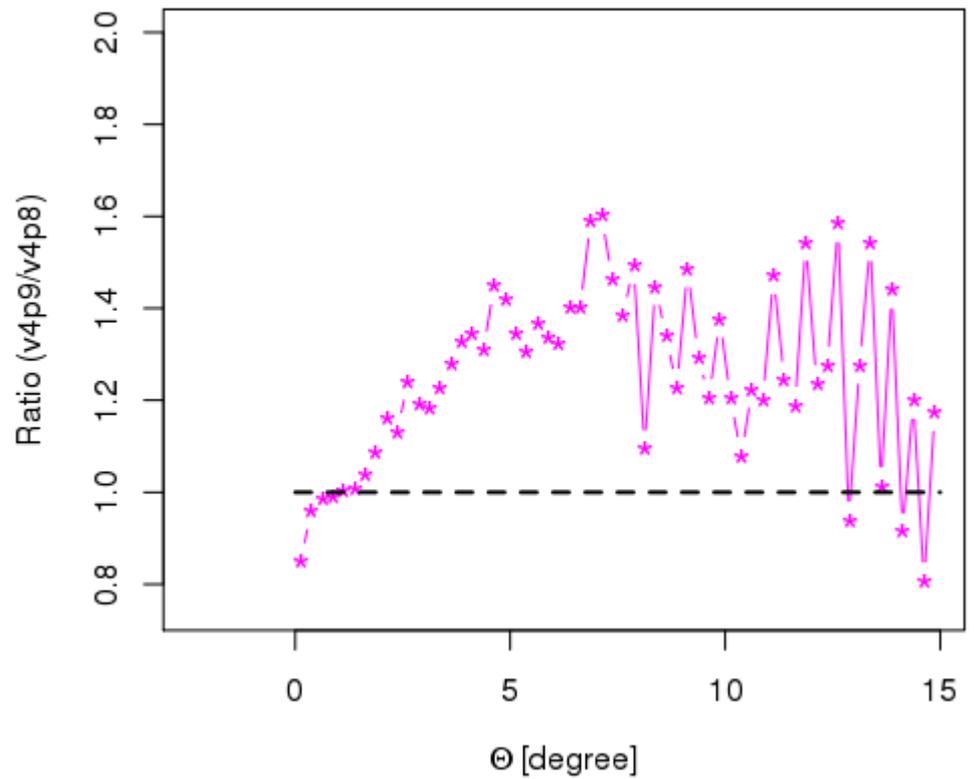
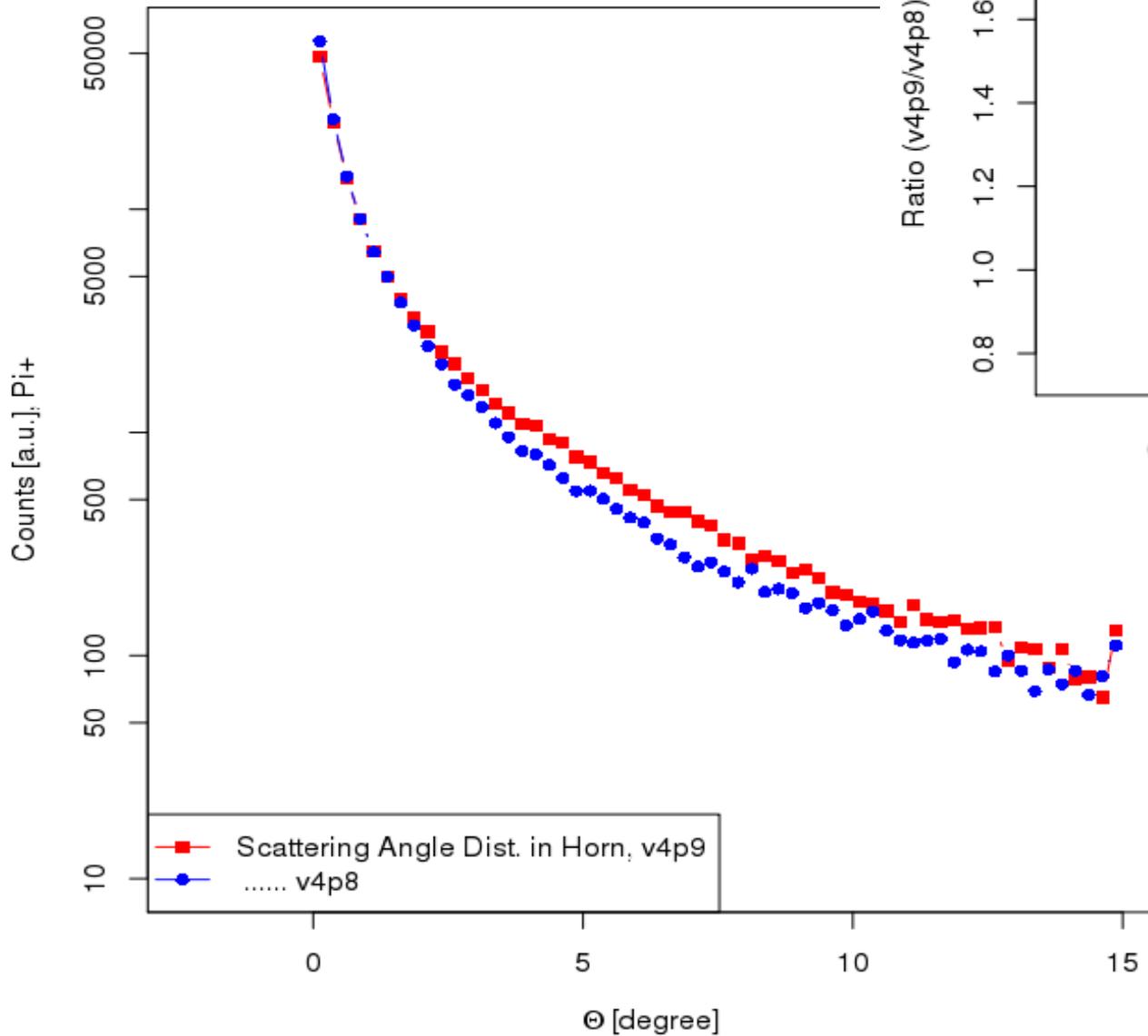
On one frame..



Version 4p9 only

The magenta histogram shows the distribution of angles with respect to the beam axis, for the pions that did scatter in Aluminum.

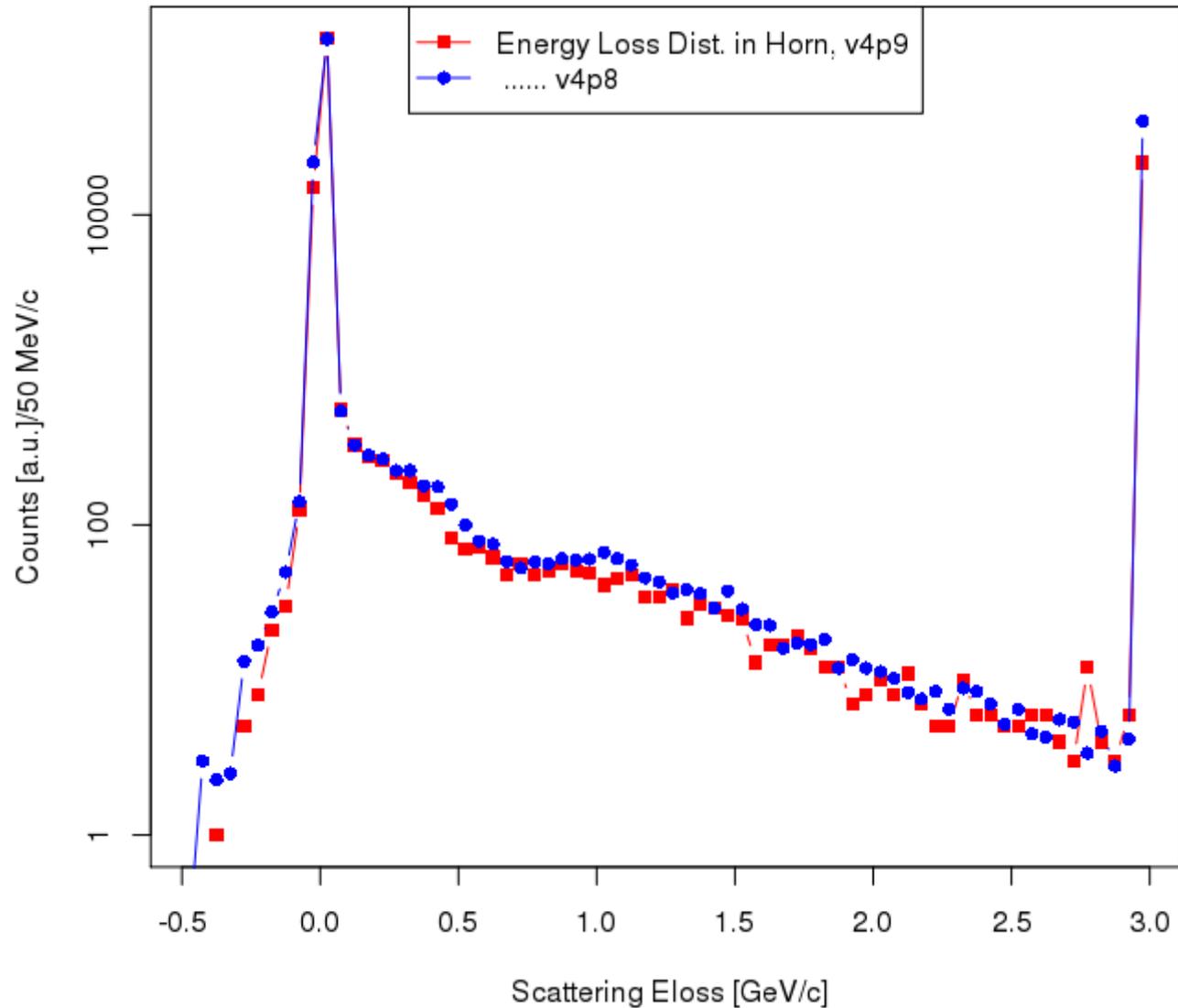
Scattering angle..



New Ntuple allows us to study the distribution of the changes of angles, $\Delta P_t / P_Z$, where the ΔP_t is the sqrt of $(dP_x^2 + dP_y^2)$, dP_x, dP_y is the change in transverse momentum at the step where a Hadronic scattering occurred.

The changes of a few mRad don't matter..

Changes of a few degree do ...



Difference in energy loss distribution between v4p8 and v4p9 are less pronounced..

Exceptt when the Aluminum boosts the pions in the quasi-elastic process...

See negative energy losses)

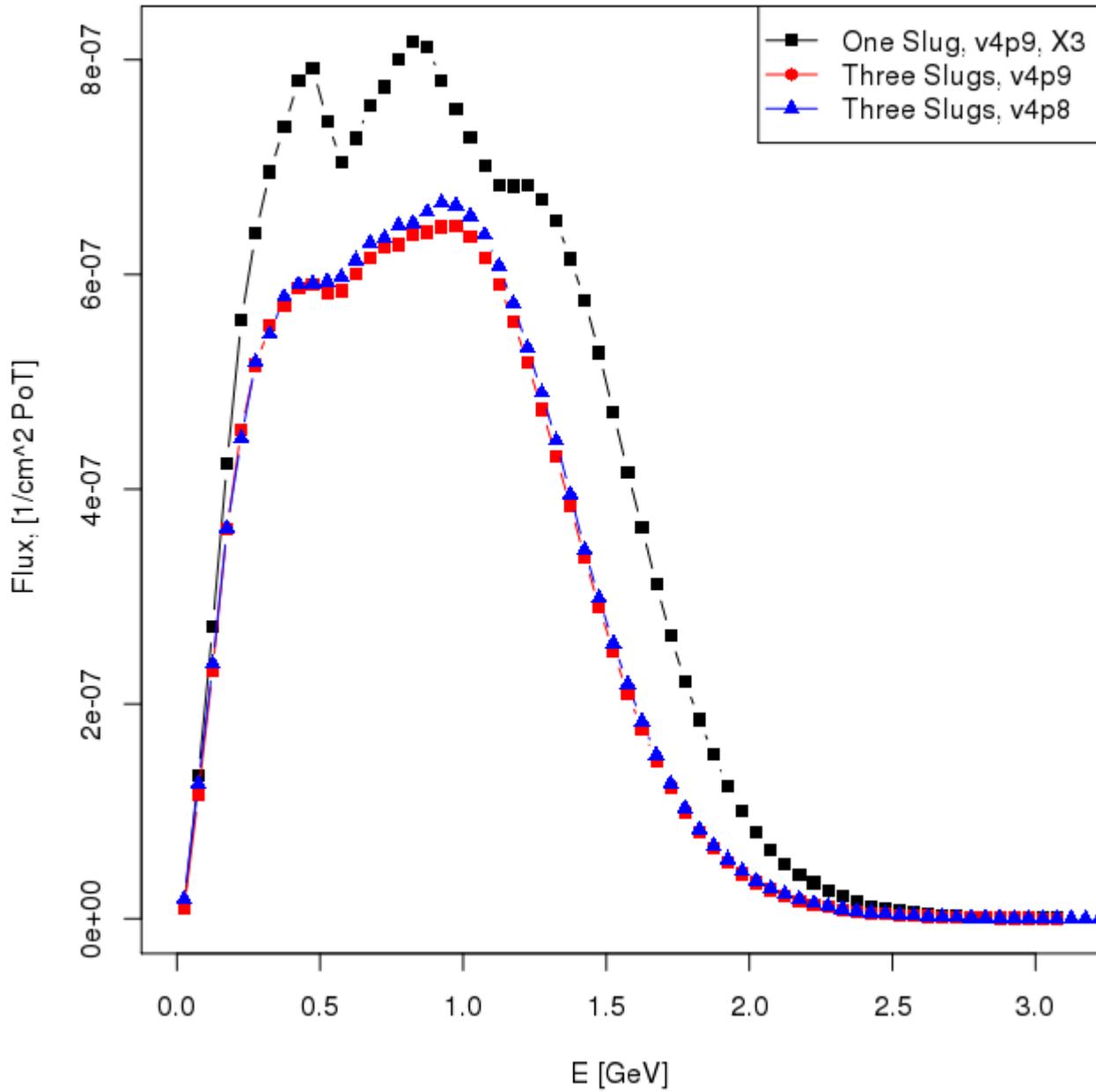
(Is this physical? Small probabilities, anyways..)

Probability to observe a π^+

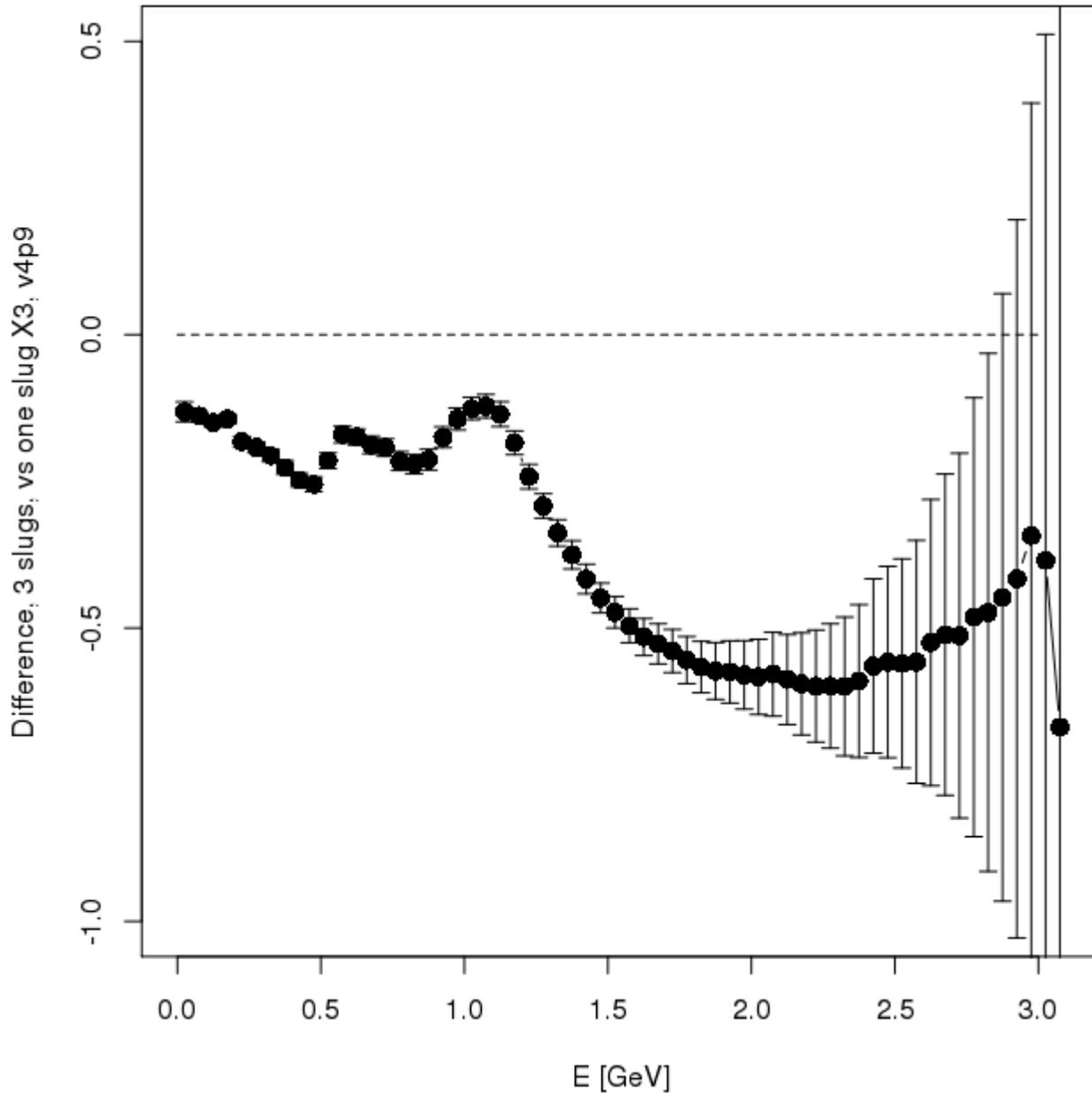
Location/ quantities..	Probability/PoT (%)
π^+ Production in a 30 deg cone, $P_z > 0.5$ GeV	37.2
π^+ Observed at Z 2.001 m (after horn), all radius	16.0
π^+ Observed at Z 2.001 m (after horn), < 35.0 cm.	14.0
π^+ Scatters in target or Horn Alum, $R < 35.0$ cm	19.0
..... Inelastic scatters..	8.0
.... Quasi elastic	2.5
... Elastic (all angles)	8.9
... Elastic, scattering angle > 2 degree	2.5
.... Elastic, scattering angle > 5 degree	1.4

For version v4.9 This depends on the scattering models. The above classification
 Is also version dependent...Bottom line: the relative probability for a “significant scatter”
 upstream of end of the horn, to the “relevant” p flux there is about $\sim (8+2.5+2)/14 \sim 80\%$

Also ran the 3 slug comparison of neutrino flux



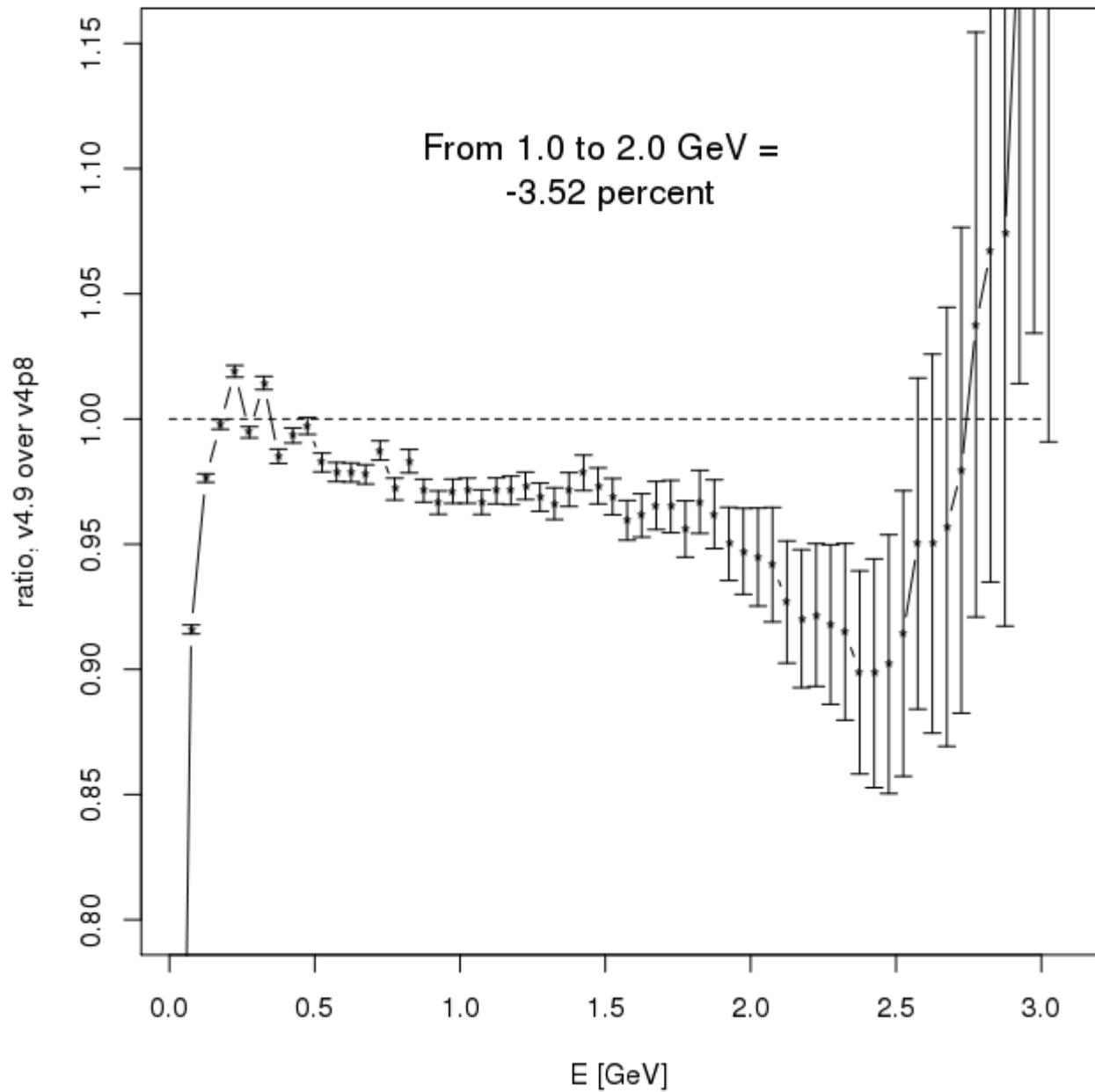
Effect of the acceptance + Absorption, one slug vs 3 slugs on the ν_μ spectrum from pion decay.



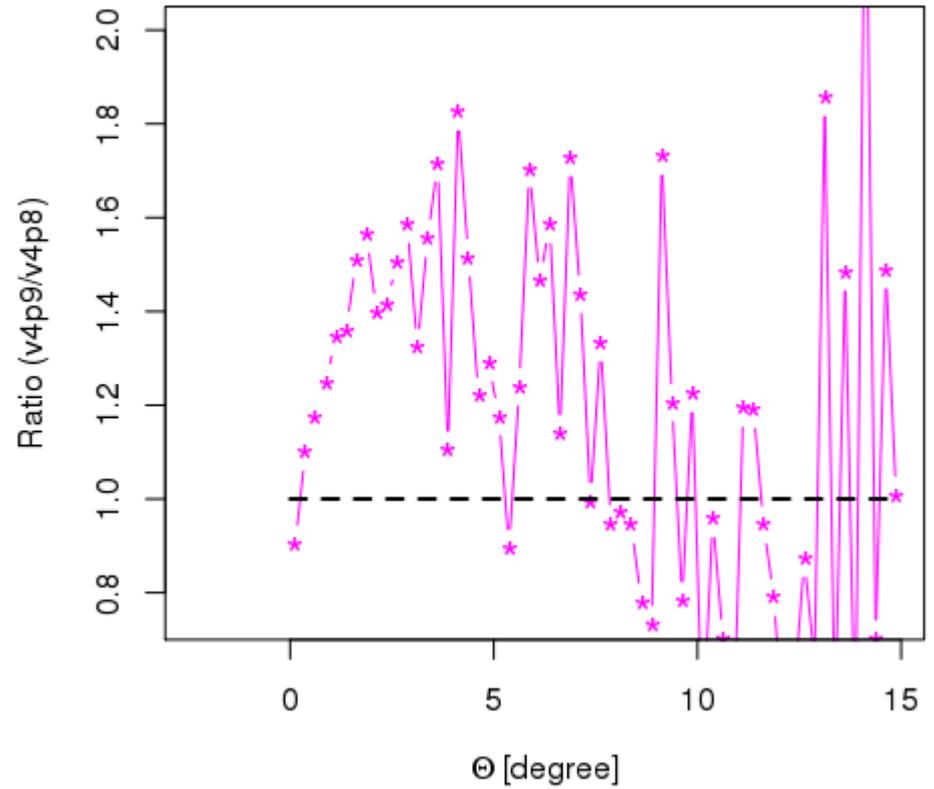
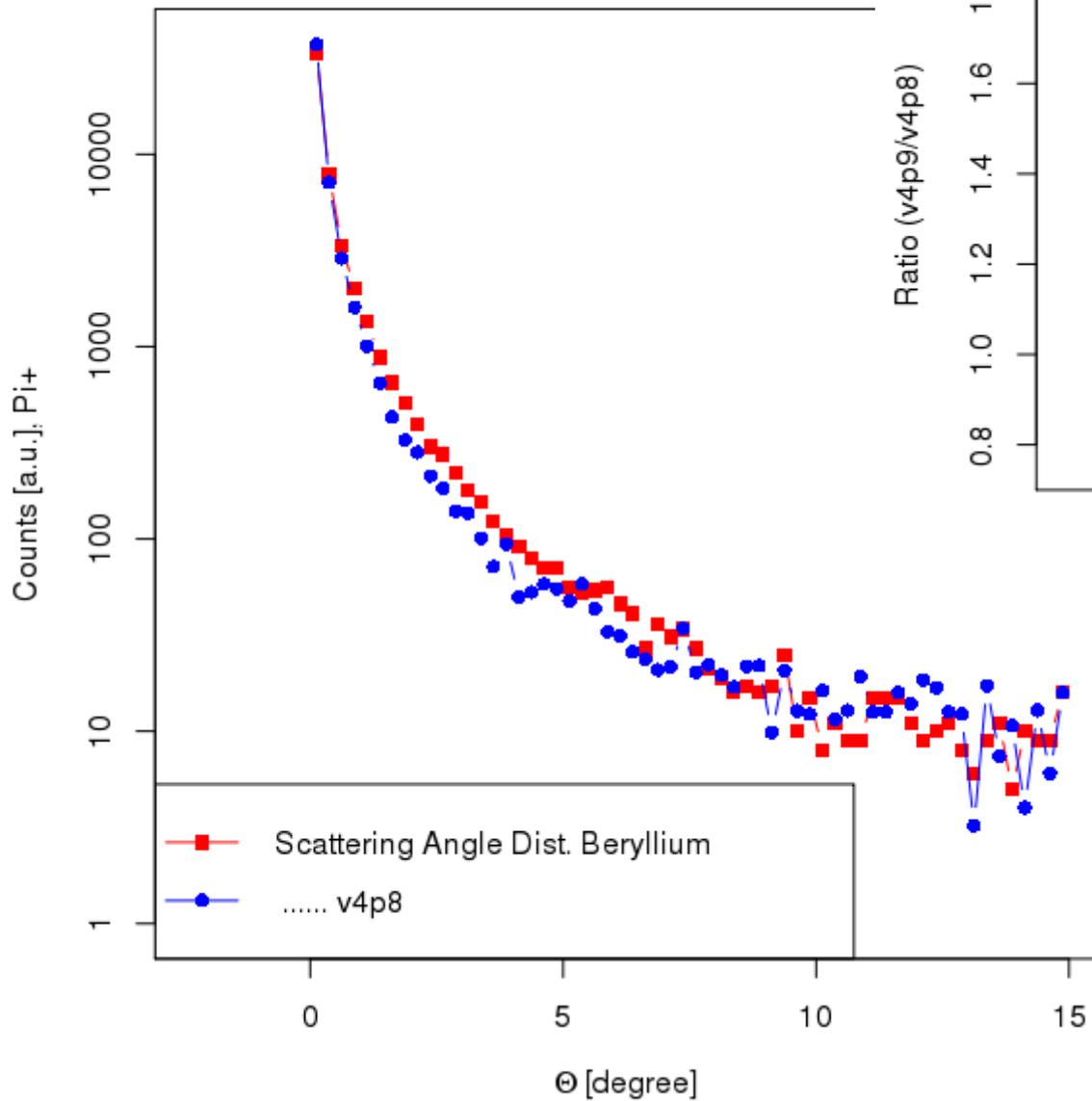
The difference between 3 slugs and one slug (renormalized by a factor 3) is shown here.

Unfortunately, not all the effect is attribute to absorption, particularly at high momentum, where the pions are less focused if they are produced further downstream

Probably ~ 20 % due to absorption in the target.



The difference between 4.9 and 4.8 ..



The difference in the scattering angles, v4p9 vs v4p8, are quite similar to those observed in Aluminum.