BooNE MC status, Jan. 19 2016

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With help from Zarko Pavlovic

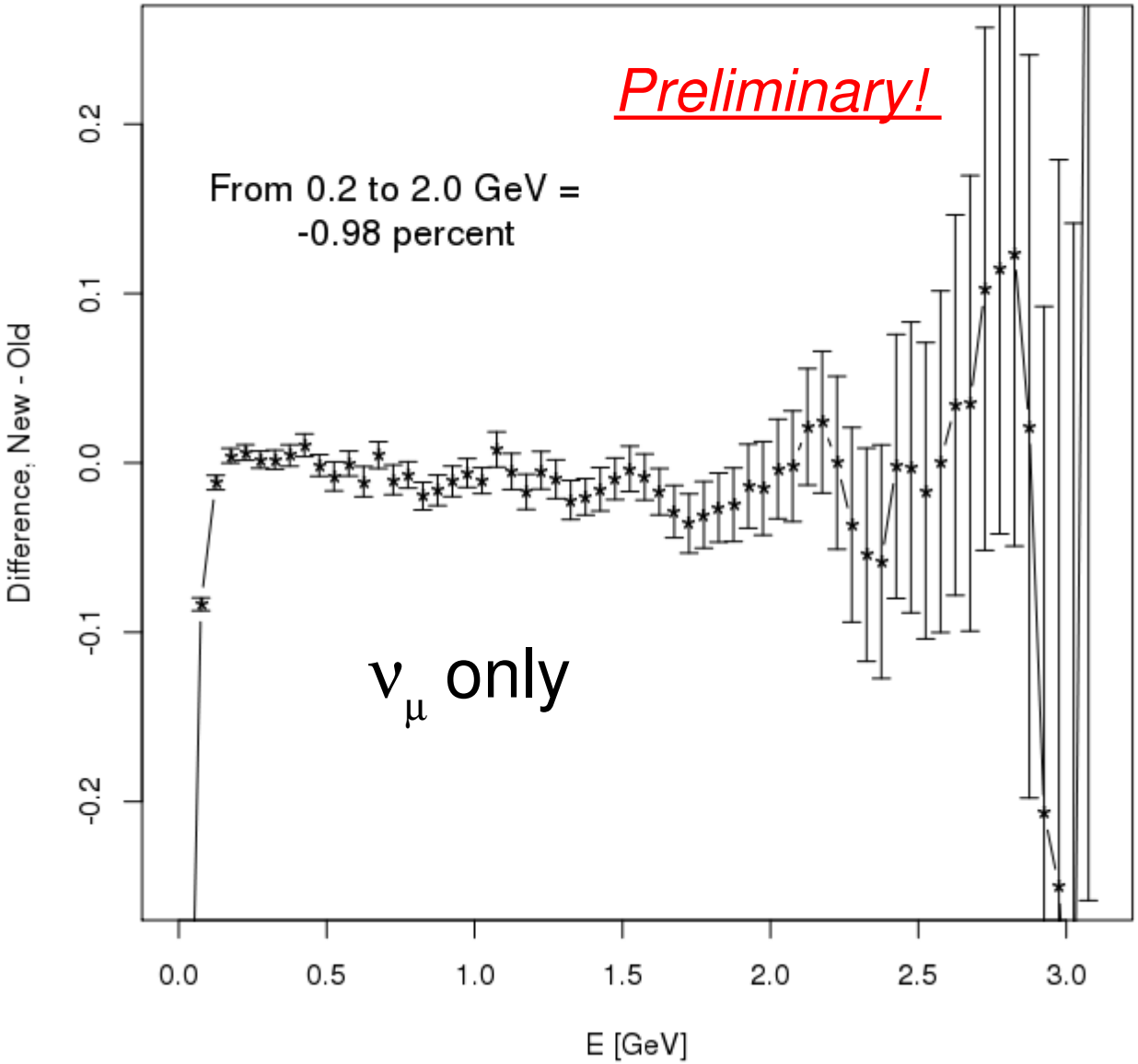
The issues to be resolved..

- A change of ~10% in the G4-predicted ν_μ spectrum from π decay has been observed. It has been proposed that most, if not all, is due to a change in the "effective absorption rate" of pion in Beryllium, Aluminum, iron, etc..., where a pion scatters and changes it's direction and energy substantially, such that it is lost in the outer conductor of the Horn, absorber of walls of the chase & decay pipe.
    - We know the G4 "models" (not total X-sections, that we control) have changed. For the better, but this is (unfortunately) not always well documented in G4 release notes.
    - What are the tests and "confirming" plots we need to produce?
        - New plots to show today..
    - But what else are we missing? Numerous test have been done..

The move to v4.10.x

- A proposal: In addition to the G4 “native” physics list”, we write a HARP based generator for the primary vertex, and the primary vertex alone, and le G4 handles all secondaries and subsequent interactions.
    - Maintainable, as we use only the “public” interfaces.
- Support the old MiniBoone calculation of the flux (Zarko has it, needs to be included in the repository..
- But this not for today...

Benchmark ν_μ flux, Thin target, V4.8 vs 4.9



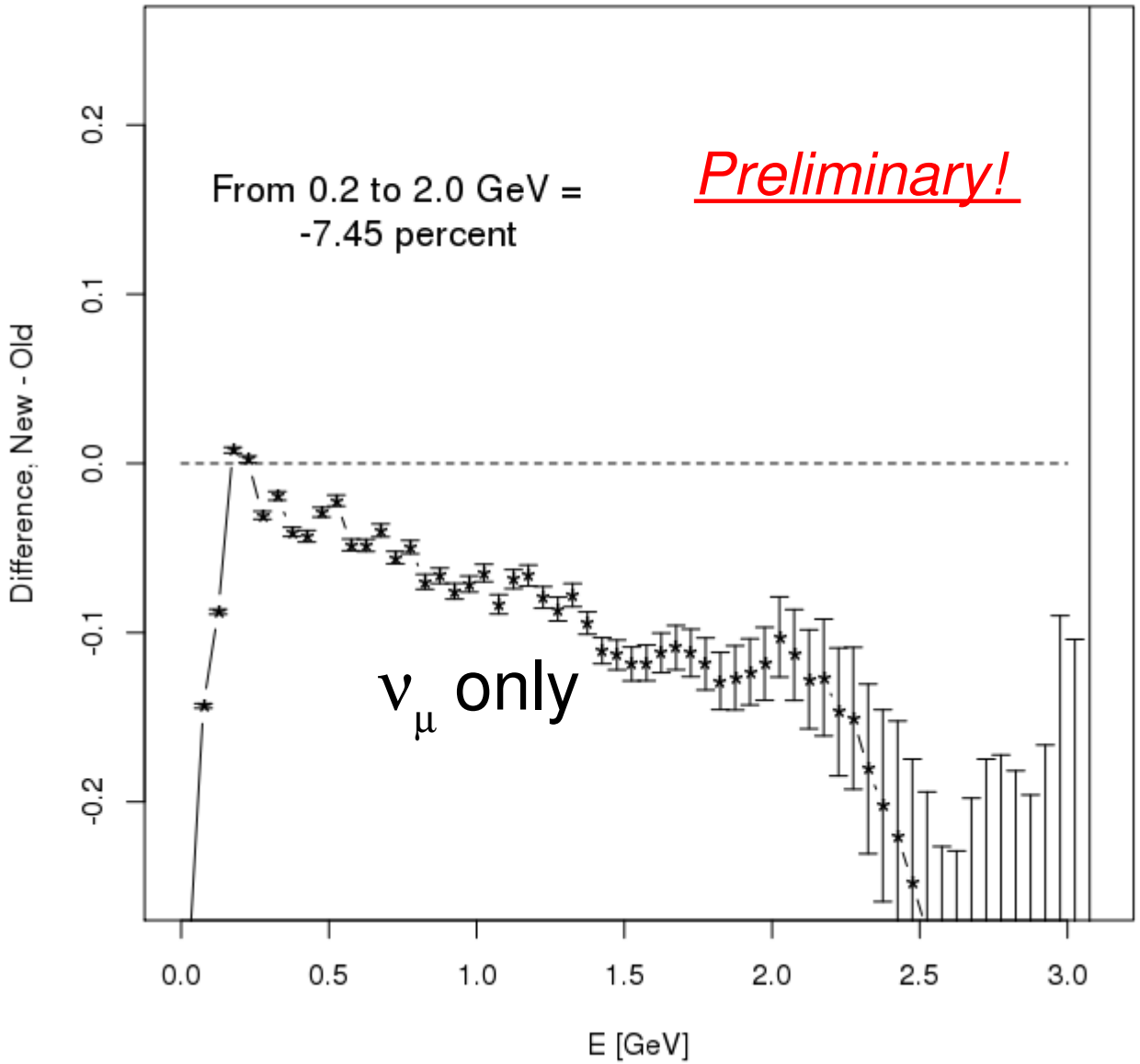
Obtained by (I) running the old BooNE program on a dedicated workstation running SL5, with Geant4 4.8, CERNLIB, (Hbook, etc..).. The genuine code.. (almost!)

(ii) running on lbnegpvm0x, Slf6, Geant4 v4.9.6, same BooNE physics model.. (Except for the elastic & quasi-elastic pi-Nucleus scattering model)

Shown here is the relative difference between the two spectra, New vs Old.

Shown on Jan 6 2016..

Benchmark ν_μ flux, Thick target, V4.8 vs 4.9



In the previous plot, we had only one slug of Beryllium. In addition, no material in the horn, collimator, air... Same geometry, same magnetic field, just no interaction downstream of that 1rst Be slug.

For this plot, we now restore the full geometry.

In both versions,G4 v4.8.1 and v4.9.6

Shown on Jan 6 2016..

Ran a few more cases.

Three Beryllium slugs instead of one. Everything else is vacuum

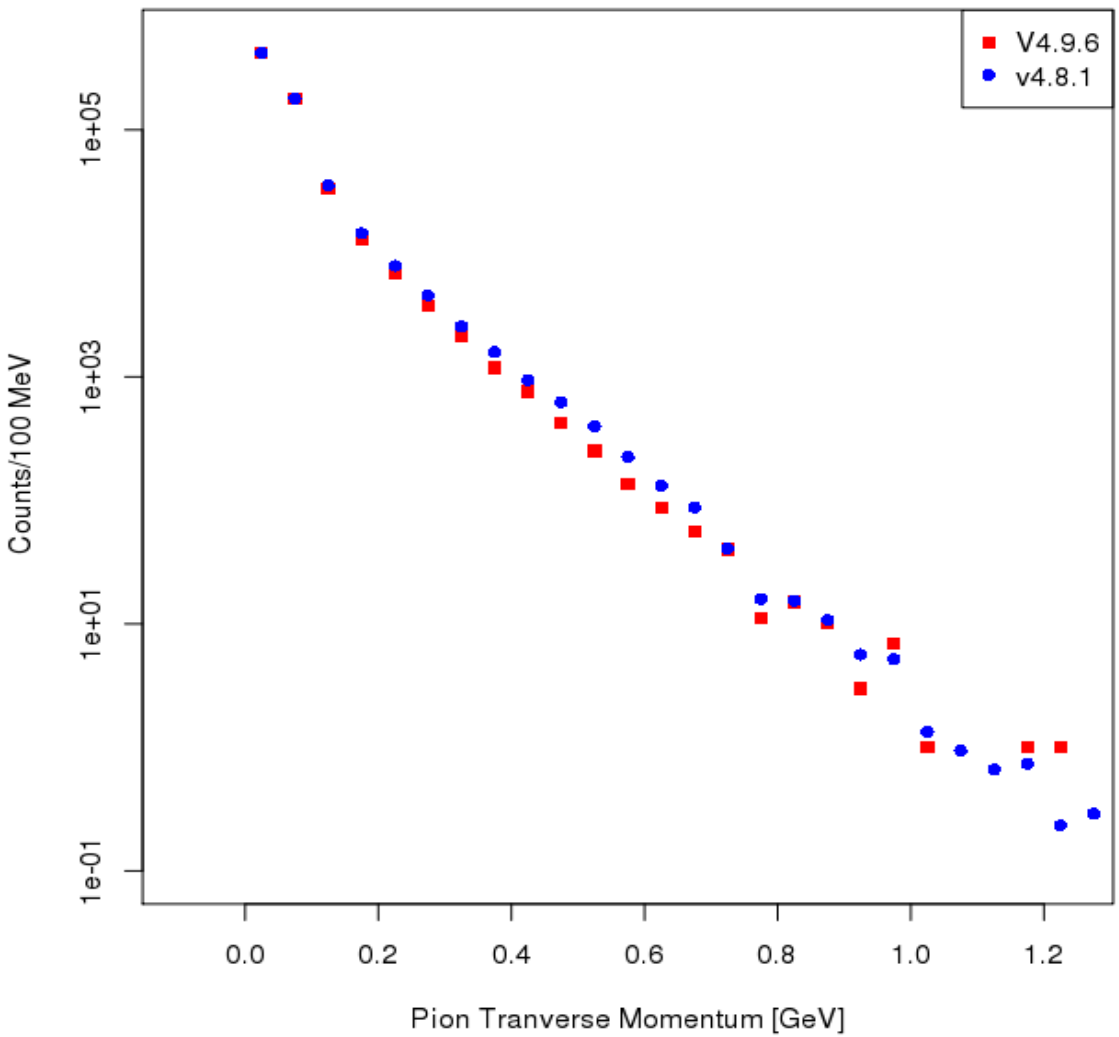
One Beryllium slug, collimator made of steel.

One Beryllium slug, Horn IC/OC made of aluminum.

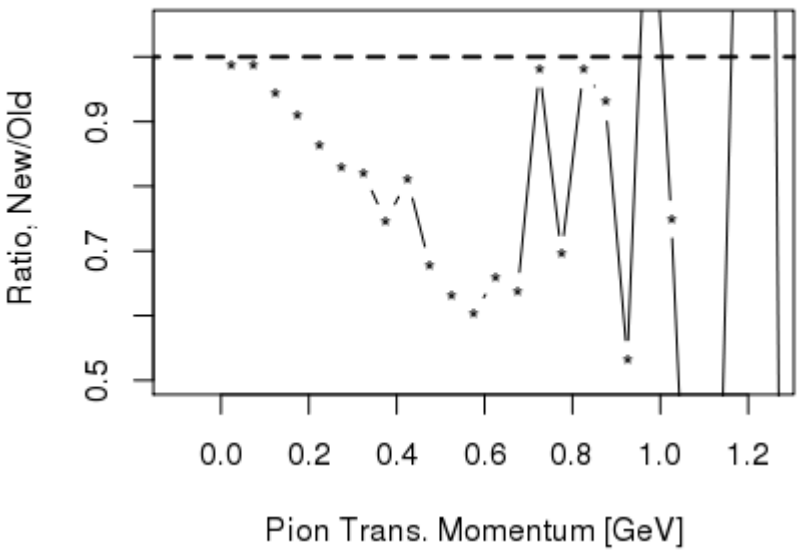
Restoring the scattered meson track to it's parent, in Aluminum

Results from these last three studies.

Iron collimator: effect on transverse momentum

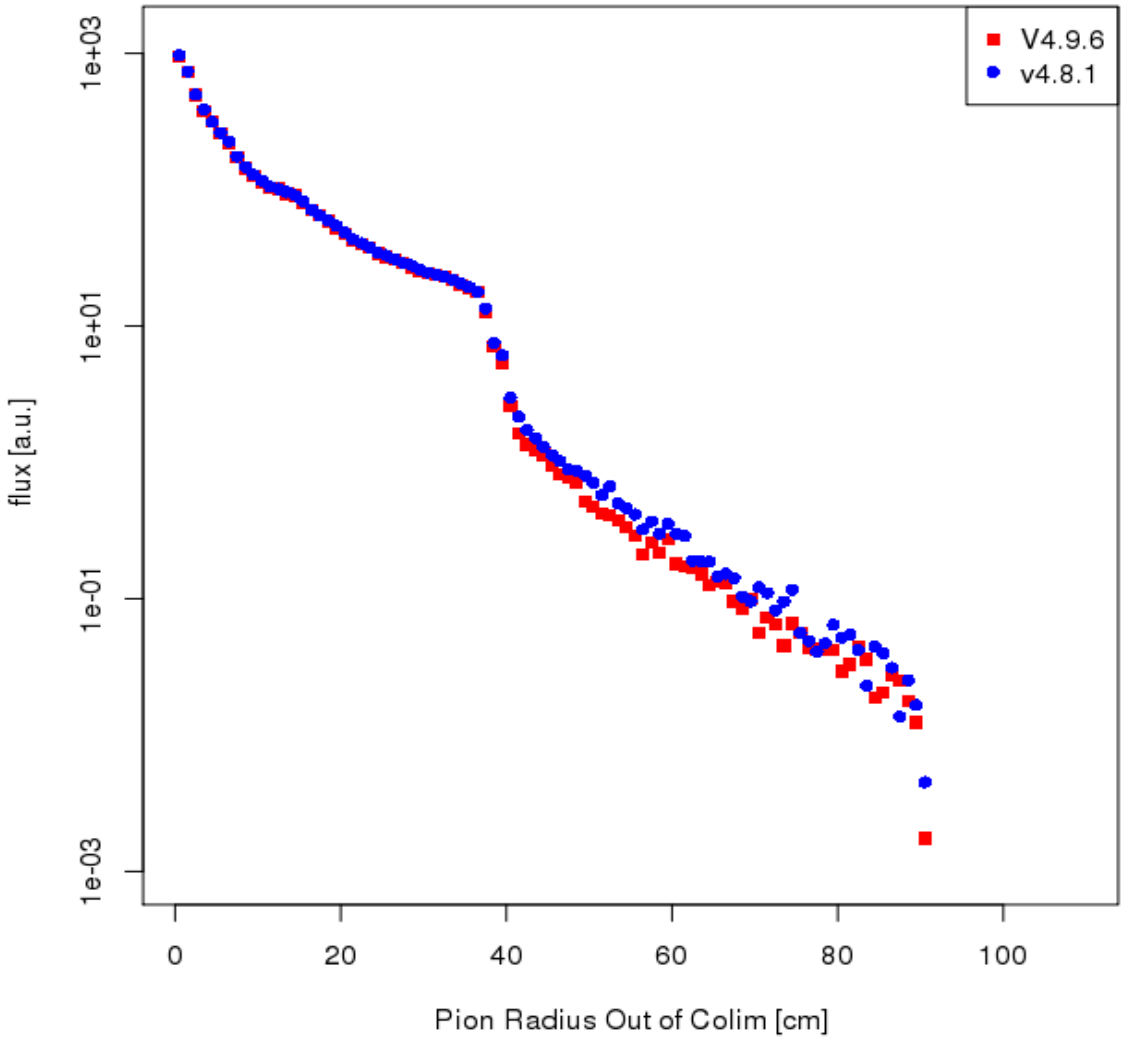


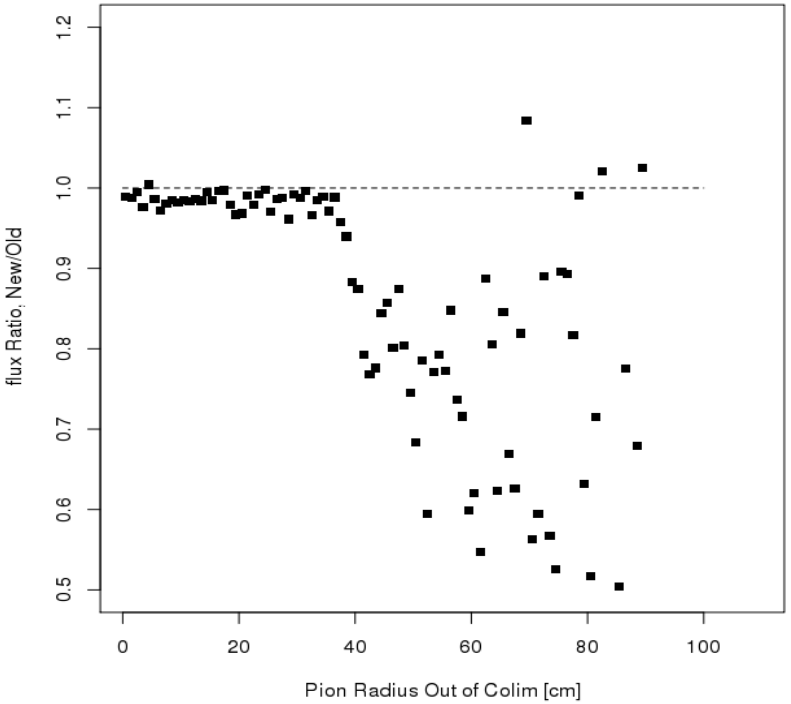
At small transverse momentum, the pion goes through the hole, within <~ 1 %, good agreement



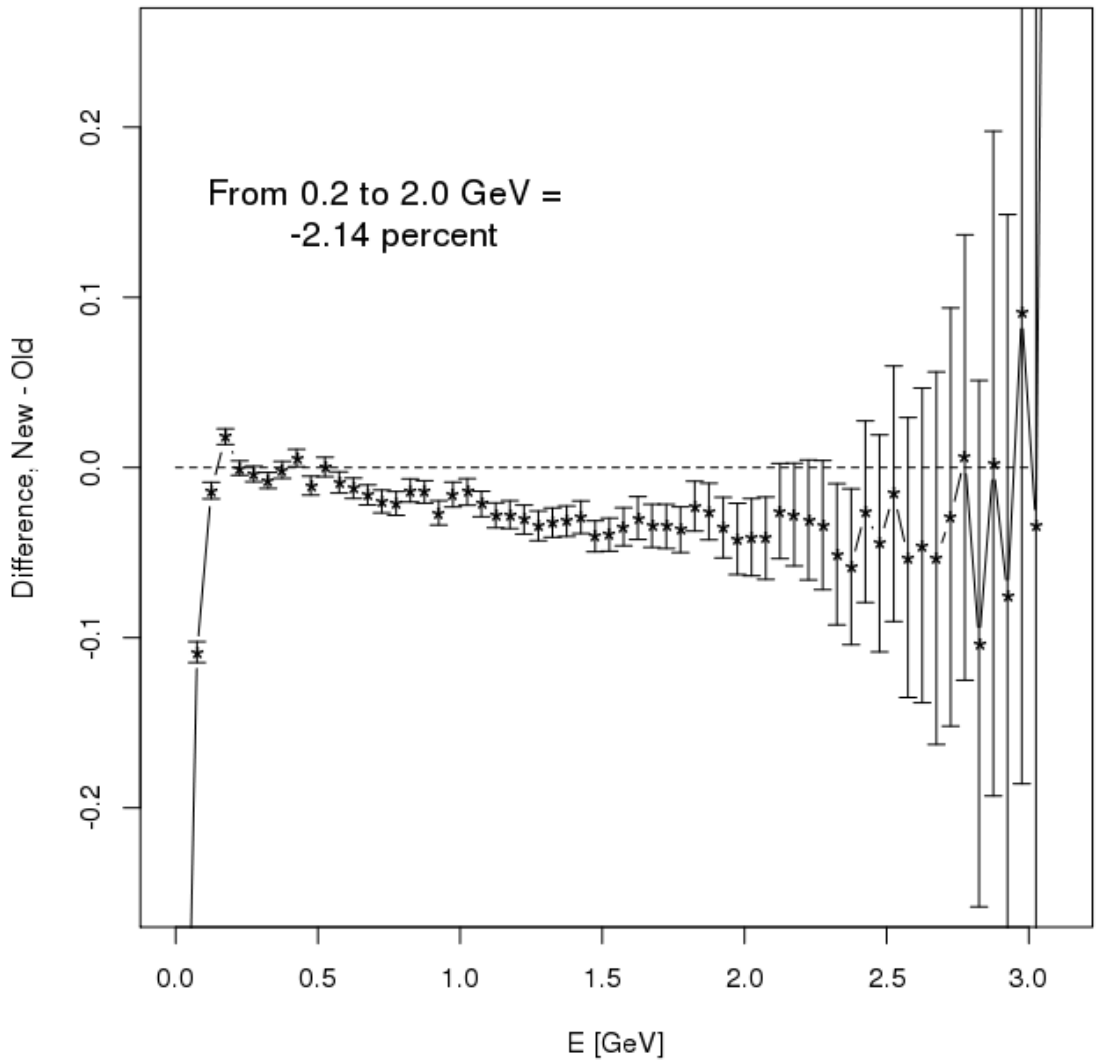
Iron collimator: Geometry.

Radial dependence on the ratio, V4.8, v4.9





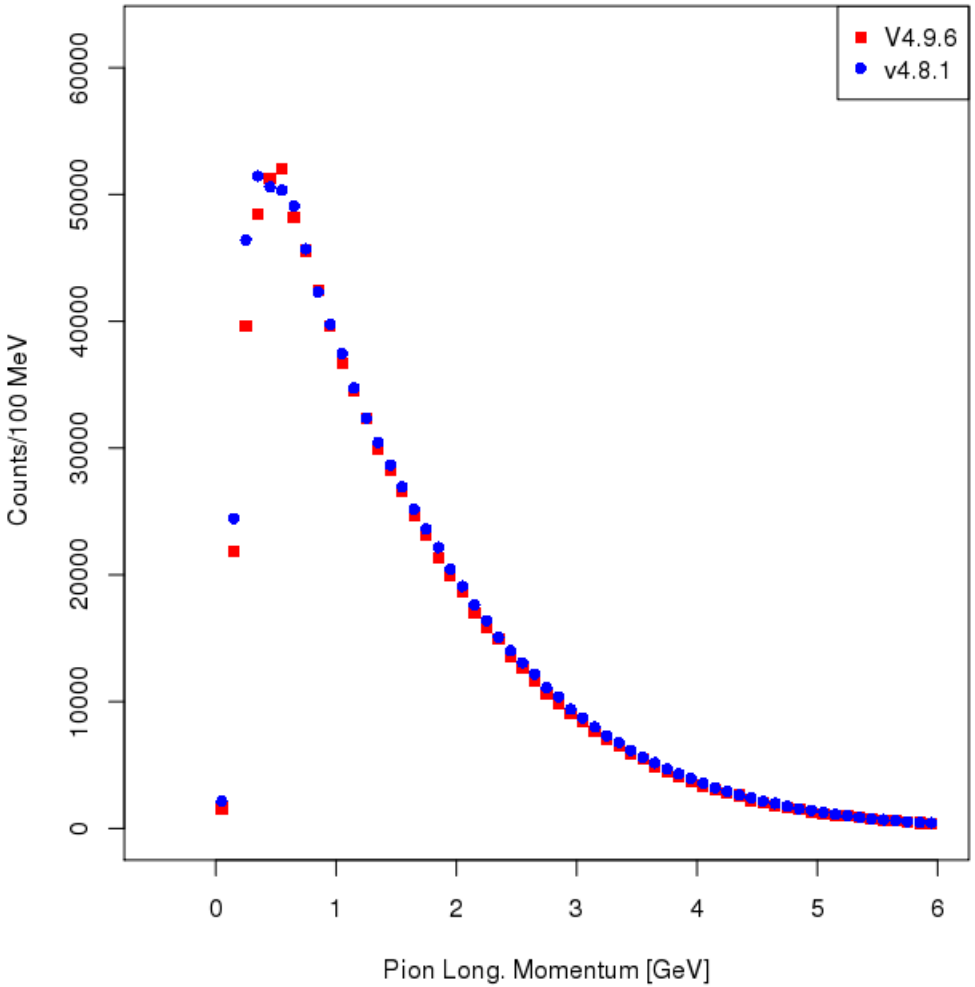
Iron collimator ν_μ flux.

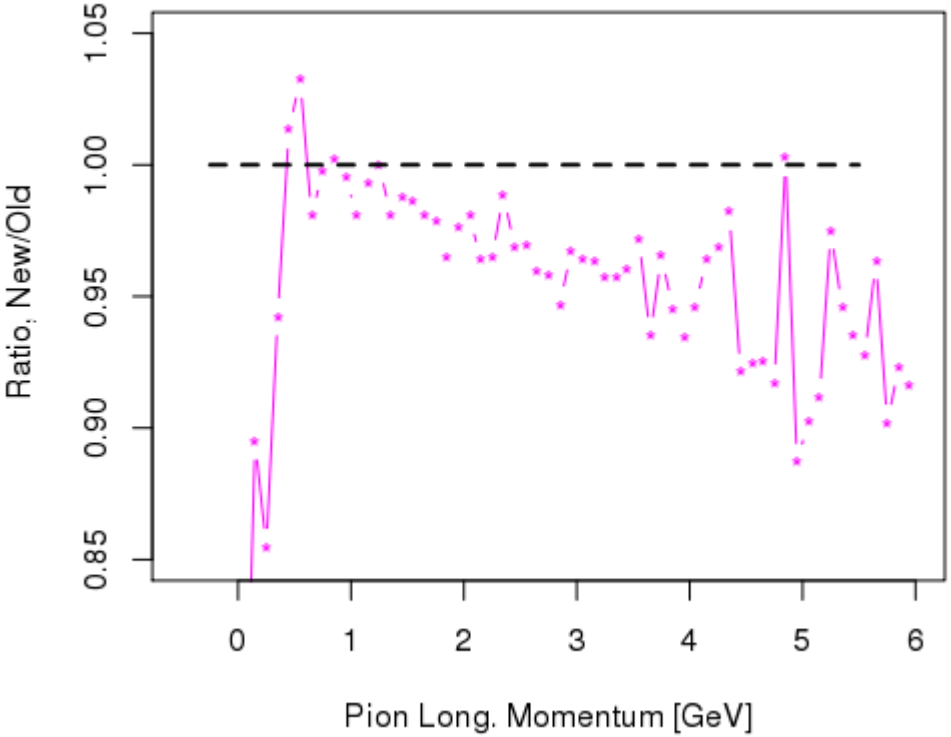


~ 1 % more than just one Be slug.

Horn's Aluminum : effect on Pz

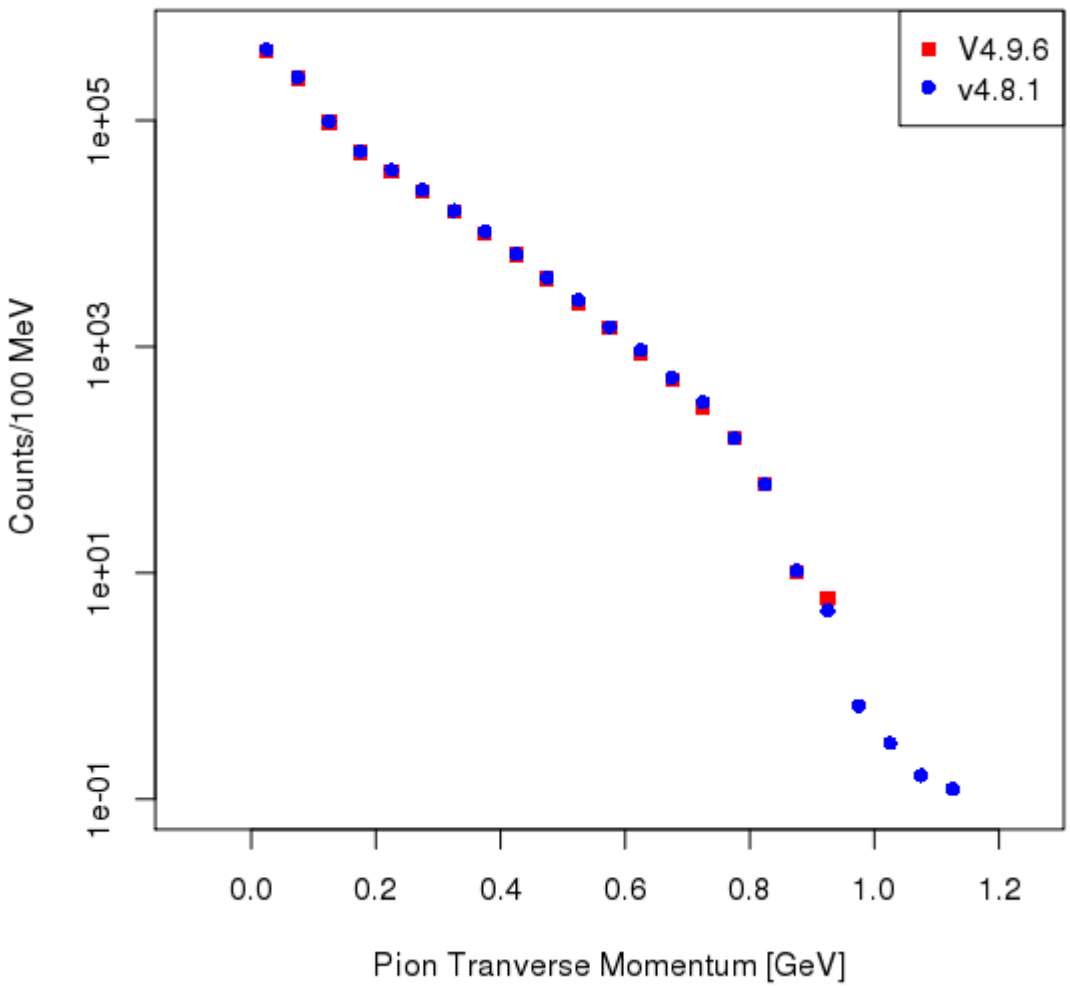
Like on slide 7, look at the pion Ntuple recorded just after the collimator. (We also have an virtual detector just after the horn..)

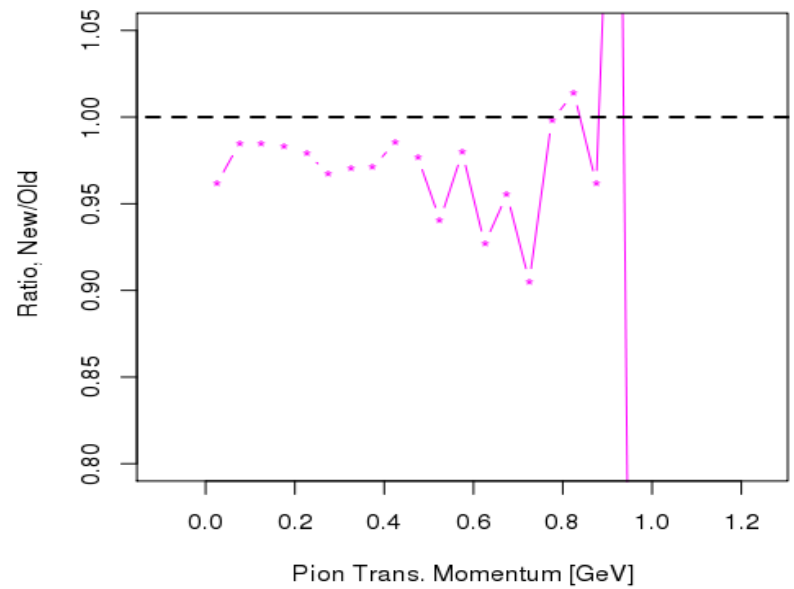




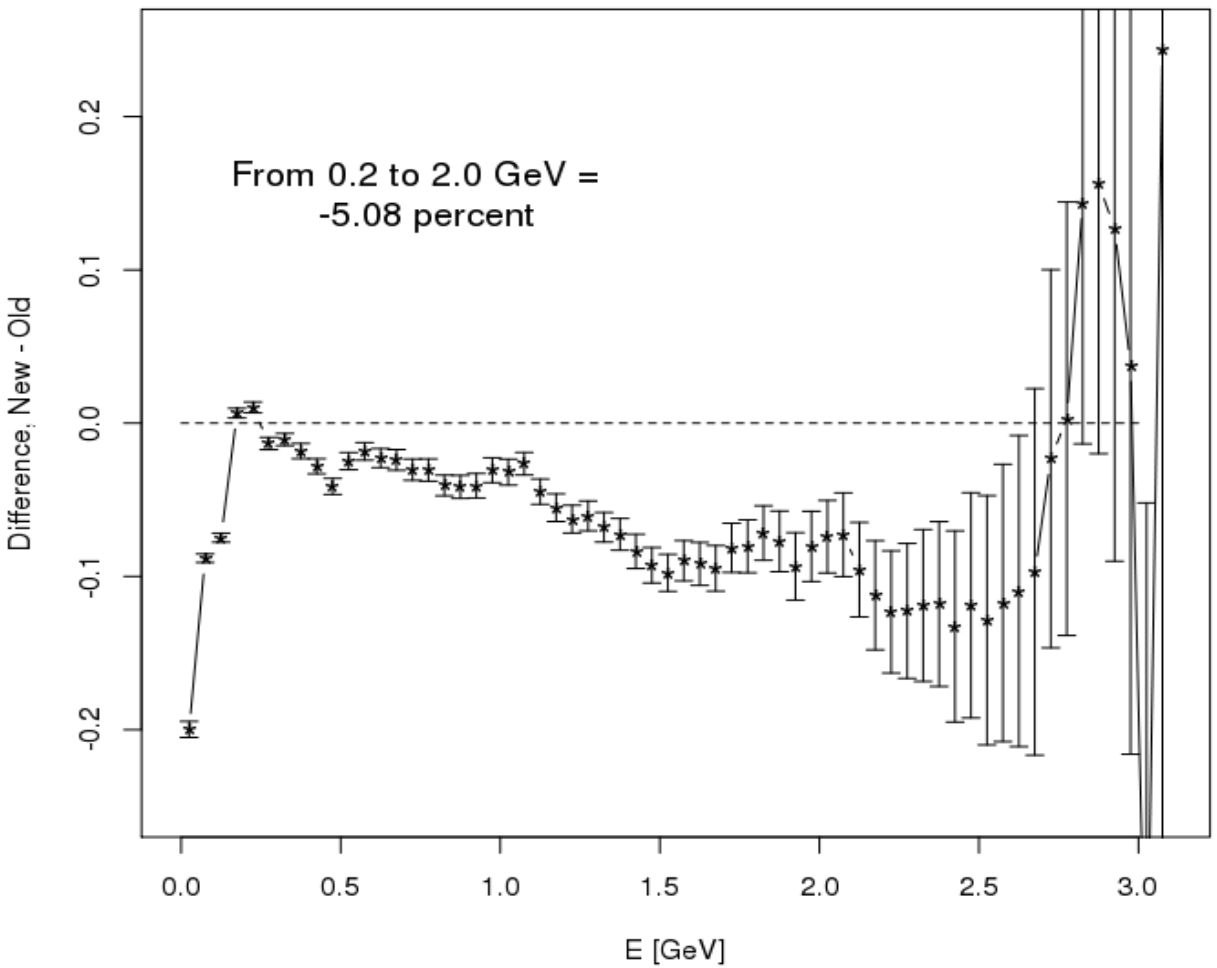
Horn's Aluminum : effect on Pt

Like on slide 7, look at the pion Ntuple recorded just after the collimator. (We also have an virtual detector just after the horn..)





Horn is Aluminum, ν_μ flux.



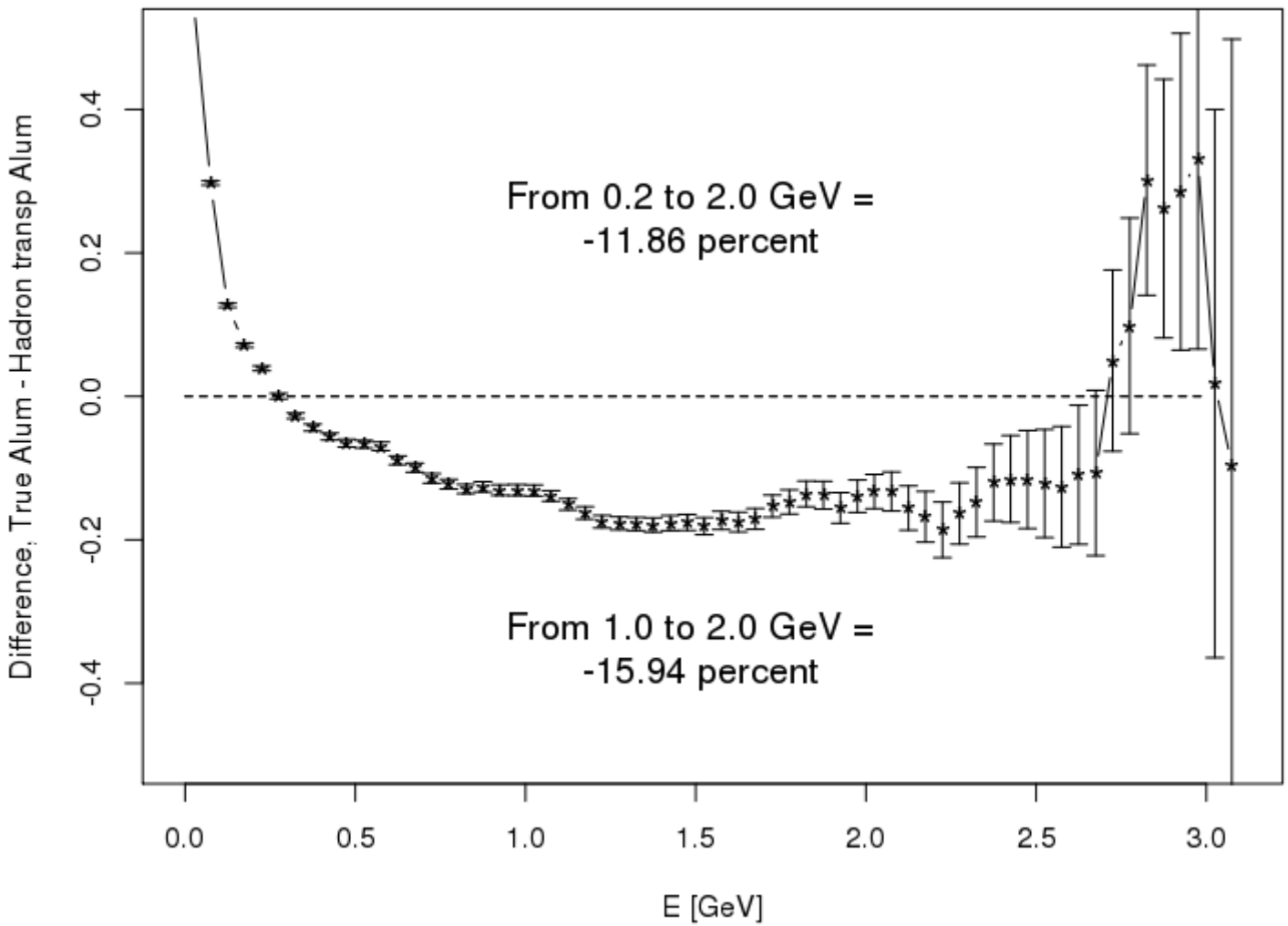
~ 4 % more than just one Be slug.

It all adds up..

Restoring the pion track after scattering.

- Suppose there is a more subtle difference between the step size (dictated by geometry, ionization, multiple scattering, hadronic interactions) and the accuracy of tracking, v4.8 and v4.9
  - *Regarding hadronic interaction, one could make the Aluminum "hadronic transparent", while not changing the step size, by restoring the original track after any hadronic interaction...*
  - *Should give the same as neutrino flux as with horn is made of vacuum, except for multiple scattering difference, which are known to be small, v4.8, vs v4.9*
  - *Not possible without "hacking" into the G4 code (G4HadronicProcess). Tricky, and error prone...*

Restoring the pion track after scattering.

- Status: running...under v4p9. … Got the plot an hour ago...
  - *Having difficulties under v4.8 : if meson is restored, the event, on occasion, goes into infinite loop..*
  - *Kill those processes, but some of the HBOOK ntuple are corrupted. Either a problem in the hacked v4.8 version of G4, or in BooBeamNT, or both..*
  -

Effective Hadronic absorption in Horn, v4p9