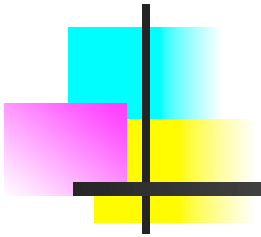

VMC based T2K Beamline Simulation Studies

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Introduction

T2K simulation based on FLUKA (target) + GEANT3 (beamline)

- FLUKA problematic for various reasons (licence, old versions...)
- GEANT3 also not very convenient (old FORTRAN code, 32-bit compilation...)

➡ **At some point, one should migrate all to GEANT4**

- For transition process, extensive comparisons between FLUKA and GEANT4 (target) and between GEANT3 and GEANT4 (beamline) should be made
- Tool needed for easy comparisons between MCs

➡ **TNuBeam Virtual Monte Carlo**

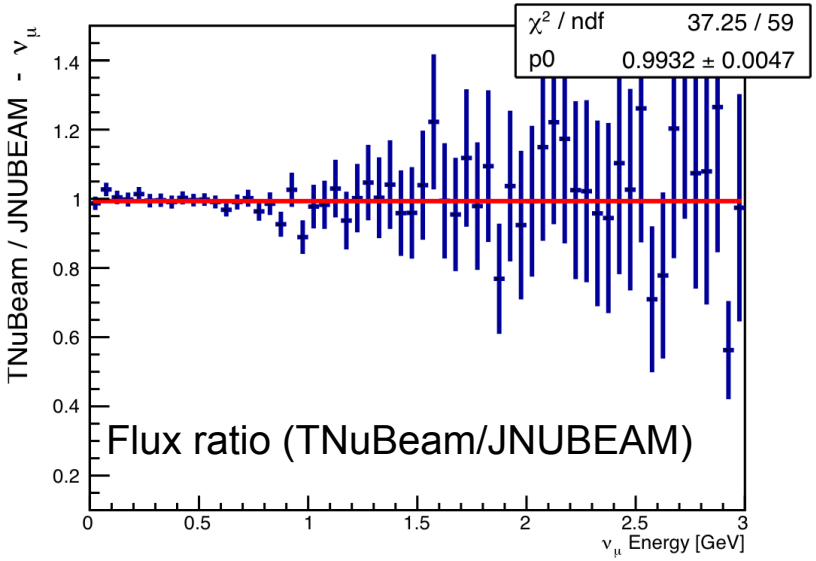
TNuBeam Virtual Monte Carlo

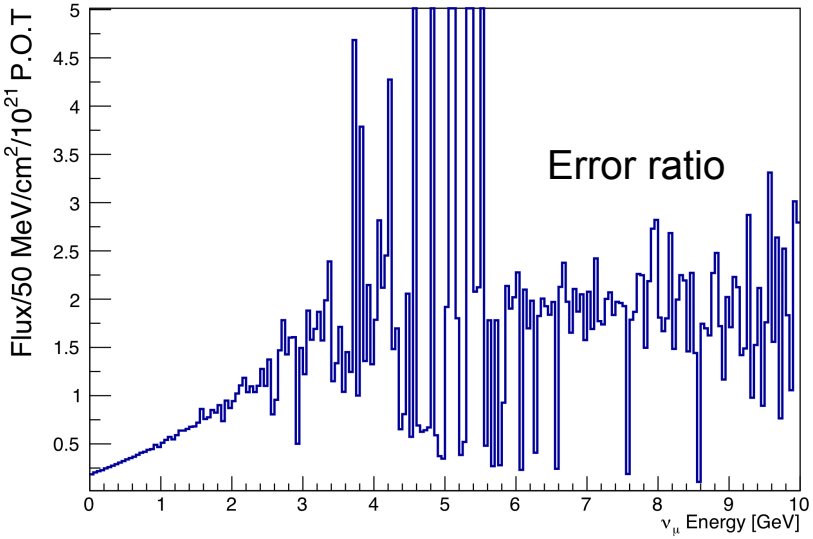
- VMC (Virtual Monte Carlo) is a Root-based C++ framework developed first for ALICE, providing a common interface to different MCs.
- Aimed to run in the same framework FLUKA, GEANT3 and GEANT4, but FLUKA interface not working at the moment
- User is supposed to provide some Classes for detector description, beam definition, output variables, then VMC manages event generation in the same way for GEANT3 and GEANT4.
- TNuBeam is a software developed at LPNHE by A. Robert, B. Popov and L. Zambelli in the VMC framework.
- It provides T2K (target and/or beamline) simulation based on GEANT3 and GEANT4, as well as simulation of various NA61 configurations (Thin Target, Replica Target, ...) and of HARP experiment for comparison with hadron measurements
- It can take FLUKA simulation as input for comparison with T2K (JNUBEAM) simulation

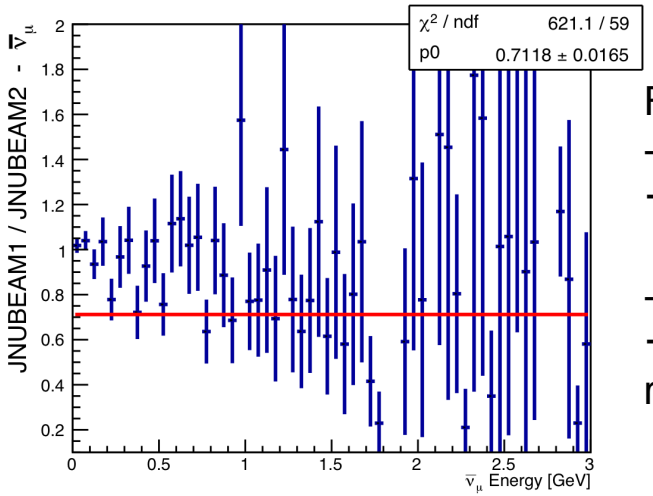
ν flux comparison - TNuBeam (GEANT3) vs JNUBEAM

Status of comparison (ν flux in ND280 detector, target simulation based on Fluka)

- Flux value in agreement at 1% level after adjusting simulation parameters
- Small timing difference (TNuBeam/JNUBEAM ~ 1.5)
- **Problem in error calculation** (error ratio, χ^2 fit)

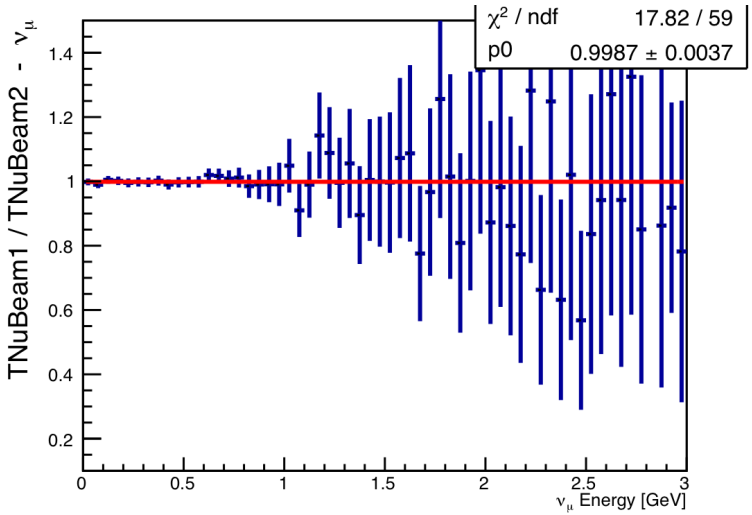






Flux ratio:
- JNUBEAM1/2
→negative weights?

- TNuBeam 1/2
→error calculation and/or random generator?



Comparison with NA61 LT 2010

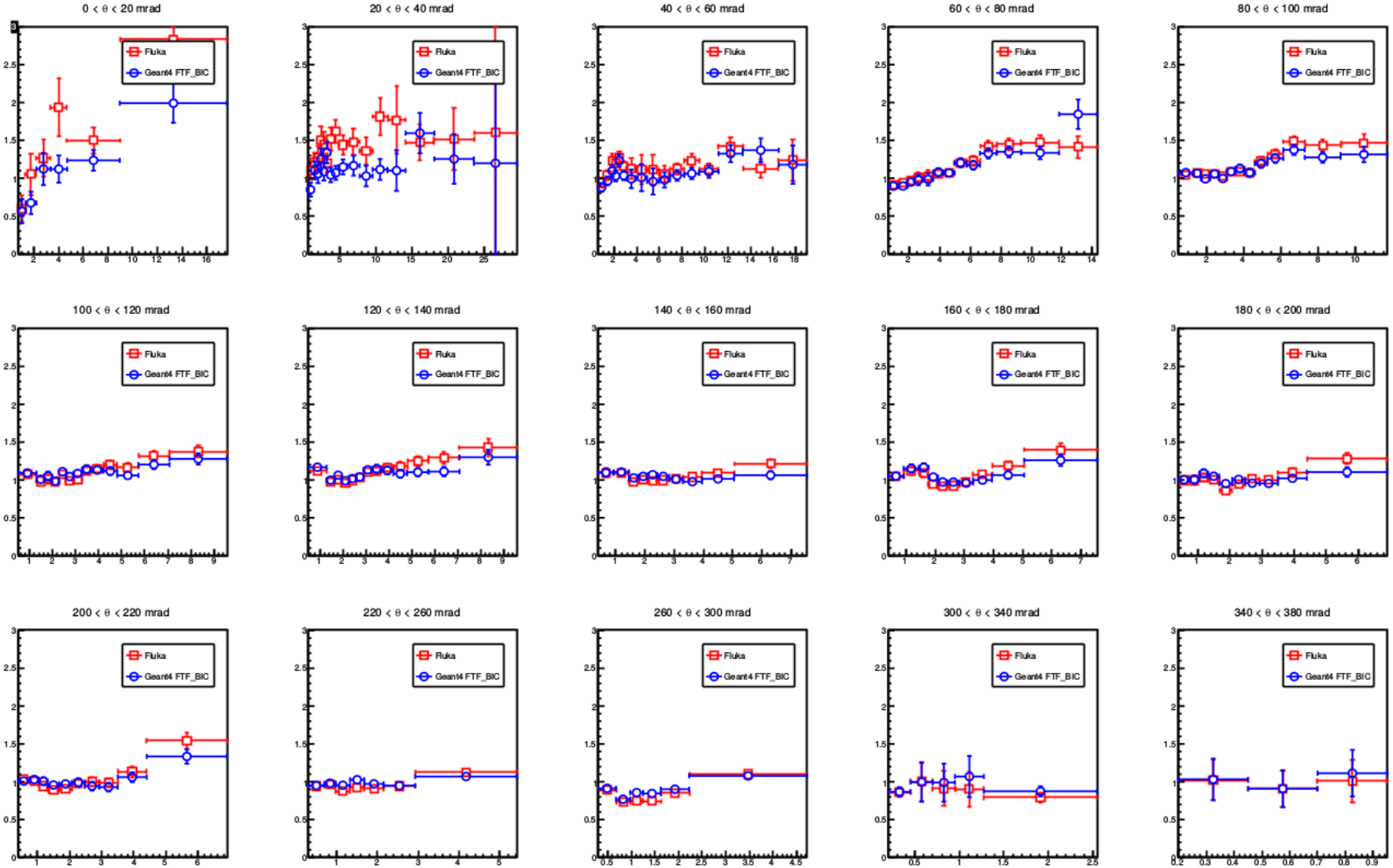
Comparison of MC predictions for hadron production with latest NA61 (2010) results

- Here are shown weights to be applied to MC to correct back to NA61 measurements, i.e. σ_{NA61} / σ_{MC} .

- Identified a cut coming from old Laura's macro when counting P.O.T. *ng>1*
→ removes protons going through target without interacting
→ 14.8 % of protons in MC, 14.2 % expected from simple calculation with graphite interaction length and density
→ not clear why it was there, cut removed at the end of the day
→ see plots for all hadrons at all *z* as attached files

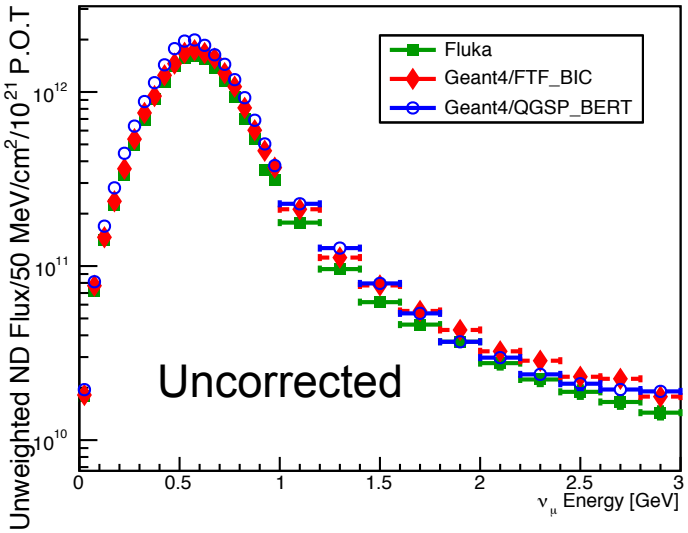
Comparison with NA61 LT 2010

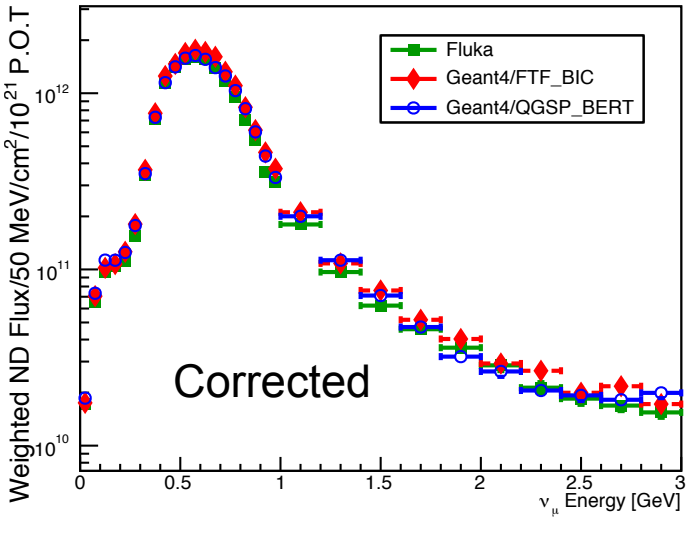
$\sigma_{NA61} / \sigma_{MC}$ π^+ - $0 \leq Z < 18$ - MC weights - no ng cut

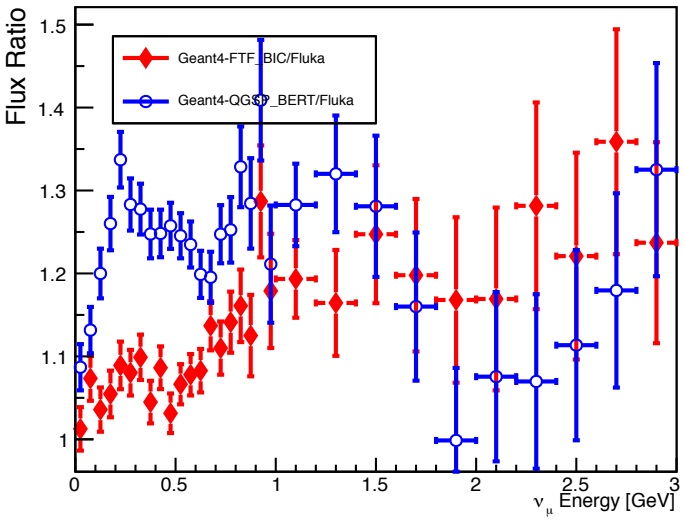


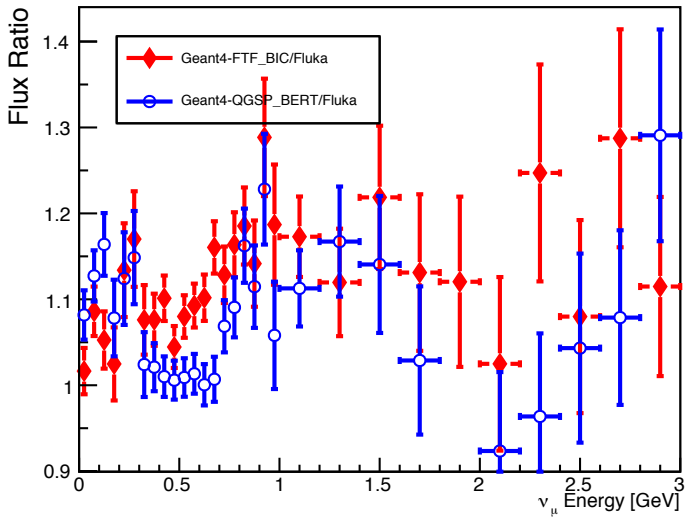
ν flux comparison (NA61 LT 2010 weighted MC - JNUBEAM)

Comparison of ν flux predictions for different target MCs with same beamline simulation (JNUBEAM/GCALOR), with and without NA61 LT2010 weighting









ν flux comparison (NA61 LT 2010 weighted MC)

- Lack of statistics → try to increase number of simulated events from 2M to 40M (= 20 jobs of 2M events)
- TNuBeam GEANT4 worked fine for QGSP_BERT, but crashed after O(100K) events for each FTF_BIC simulation. Try to re-run with older TNuBeam version, to recompile everything, etc... but crash still there
- Another problem appeared when trying to simulate 2M events at a time with JNUBEAM ("RZOUT error" after 500K events). Try to recompile JNUBEAM after increasing size of PAW and GEANT Common blocks, but problem still there...
- Also realised it is not possible to do this type of plots with TNuBeam beamline simulation because TNuBeam rootuple doesn't include neutrino parents history at the moment...

Summary

Work in progress...

- Comparison with NA61 and first plots of ν flux predictions with NA61 LT 2010 weighted target simulations (JNUBEAM)
- Problems pending (and new problems appearing)
  - Negative flux in JNUBEAM? Check TNubeam too...
  - Error calculation/ random generator in TNubeam?
  - Crash in TNuBeam GEANT4/FTF_BIC target simulation?
  - Problem with max number of evts per job in JNUBEAM?
  - Rootuple definition to be changed in TNuBeam