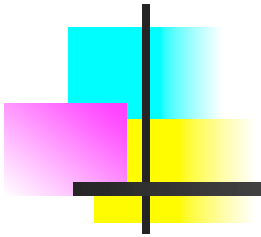

VMC based T2K Beamline Simulation Studies

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T2K-LPNHE meeting, January 22nd, 2019

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

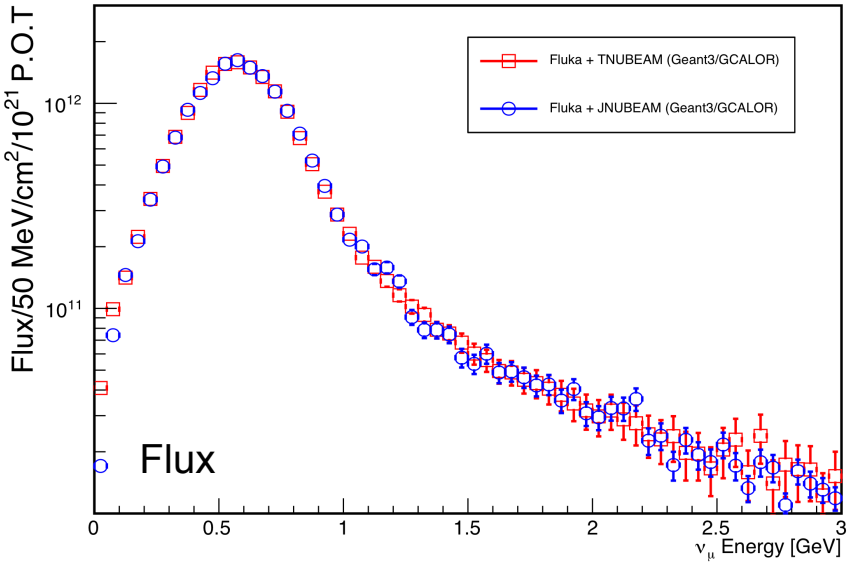
- VMC (Virtual Monte Carlo) is a Root-based C++ framework developed first for ALICE, providing a common interface to different MCs.
- Aimed to run in the same framework FLUKA, GEANT3 and GEANT4, but FLUKA interface not working at the moment
- User is supposed to provide some Classes for detector description, 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

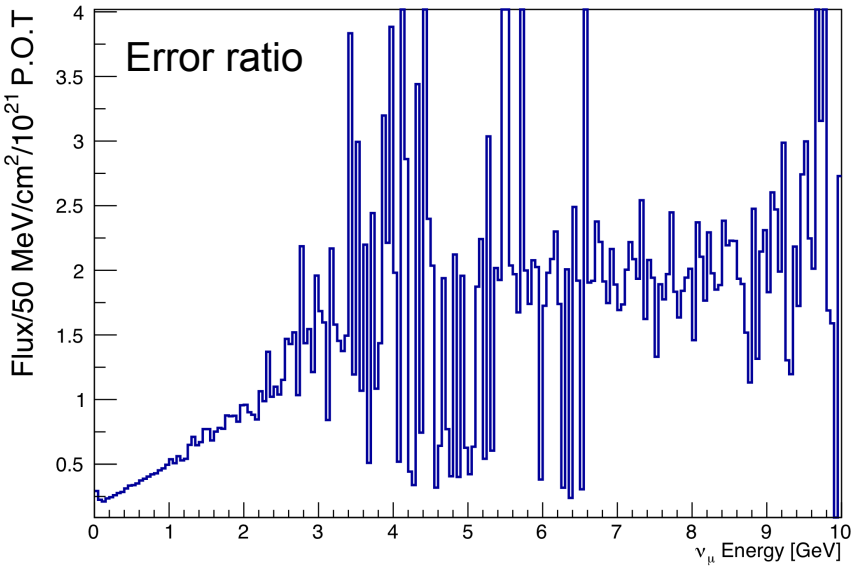
ν flux comparison - TNuBeam vs JNUBEAM

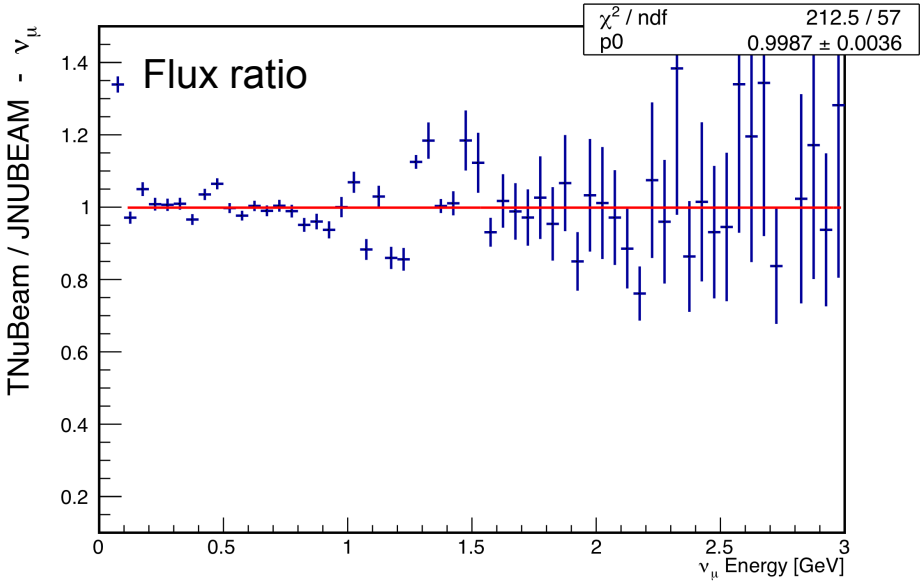
- Target simulation based on FLUKA for both simulations
- Comparison based on ν flux in ND280 detector

Reminder problems observed in first studies

- **Low energy**
- **Error calculation** (error ratio, χ^2 fit)
  → not specific to GEANT3, same in GEANT4
- **Timing** (TNuBeam / JNUBEAM ~ 5)





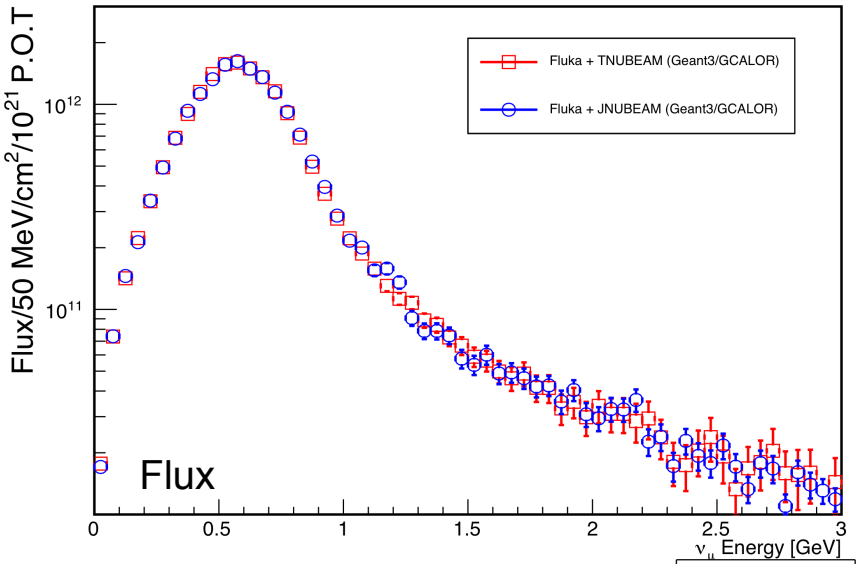


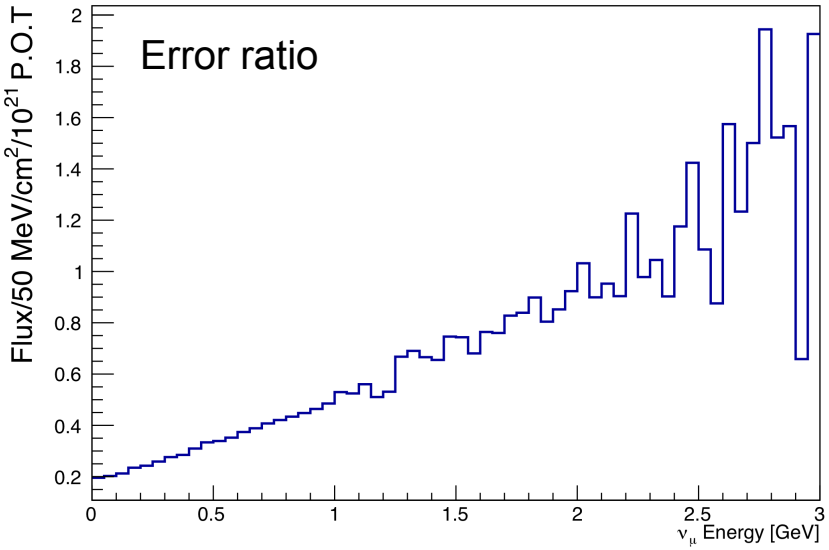
ν flux comparison - TNuBeam vs JNUBEAM

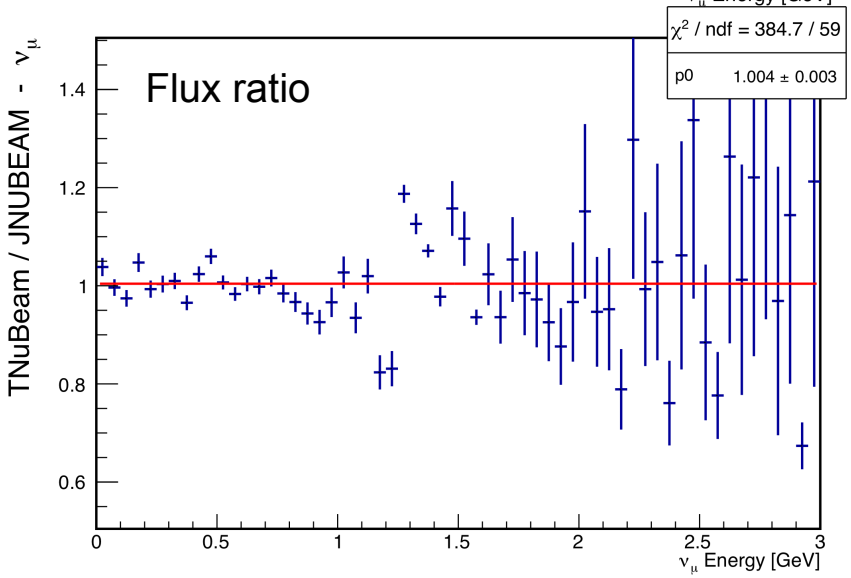
Problems due to different GEANT3 settings?
- parameters PAIR, COMP, PHOT, PFIS, DRAY, ANNI, BREM, MUNU, LOSS
- cuts CUTNEU, CUTHAD, CUTMUO

Different in TNuBeam vs JNUBEAM
→ now all set to identical values

- **Low energy → solved**
- **Error → unchanged**
- **Timing → improved**
  TNuBeam/JNUBEAM ~ 2







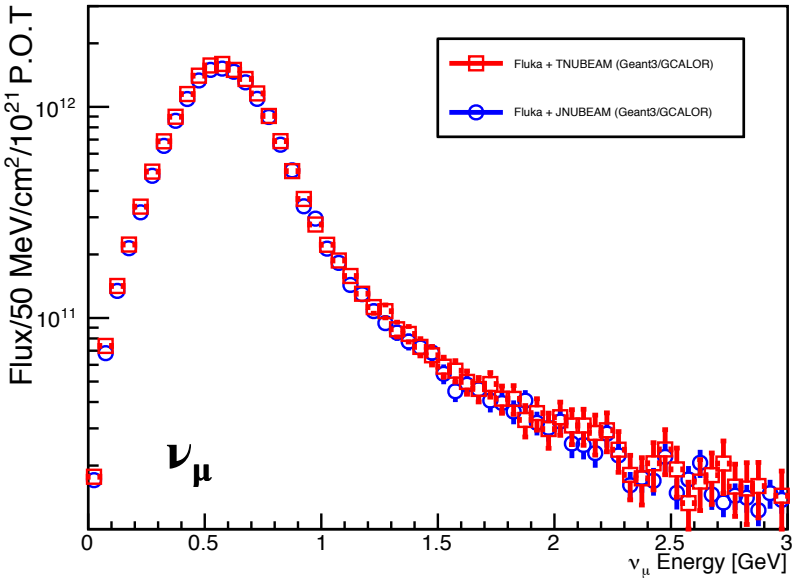
ν flux comparison - TNuBeam vs JNUBEAM

Check effect of double-precision on histogram weight calculation
→ No sizeable effect

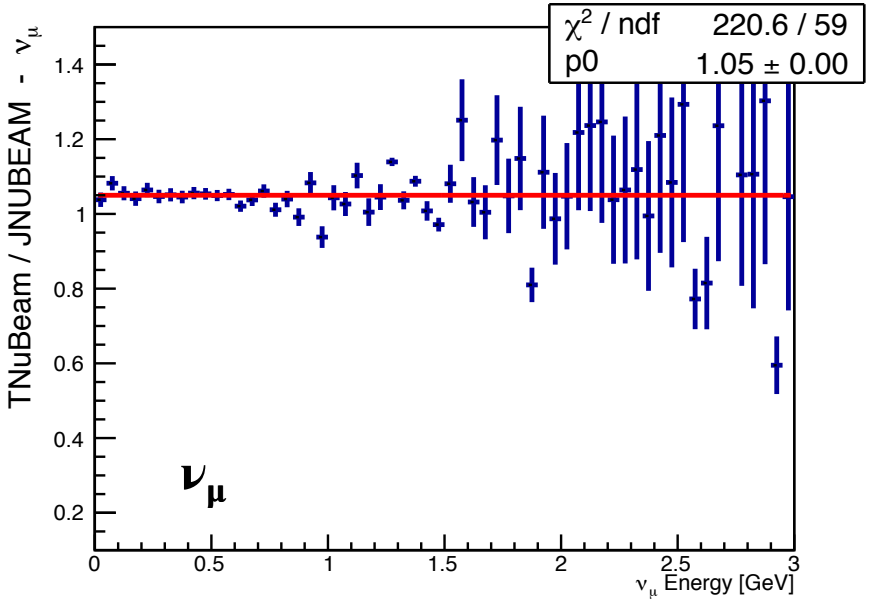
One cut in JNUBEAM (not GEANT3 standard, indeed unspecified in TNuBeam) still different in previous studies:
- CUBD (cut-off on kinetic energy in Beam Dump) = 1.0 Gev in JNUBEAM
→ now set to 0.0001

- **Low energy → no change, still OK**
- **Error ratio unchanged but χ^2 fit improved (far from perfect though) → see next slides**
- **Timing → improved** (JNUBEAM slower -> TNuBeam/JNUBEAM ~ 1.5)
- **But strange observation on JNUBEAM: cut-off value CUBD reduced → 5 % lower cross-section ???**

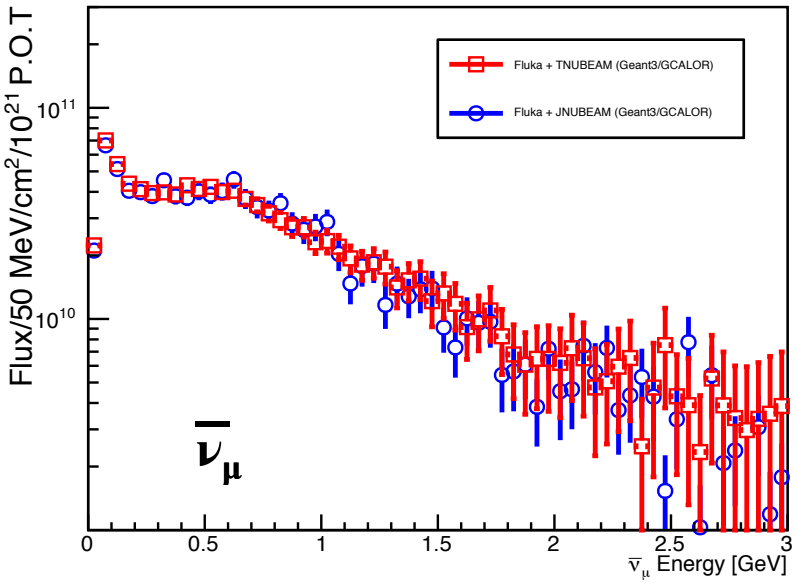
ν flux comparison - TNuBeam vs JNUBEAM

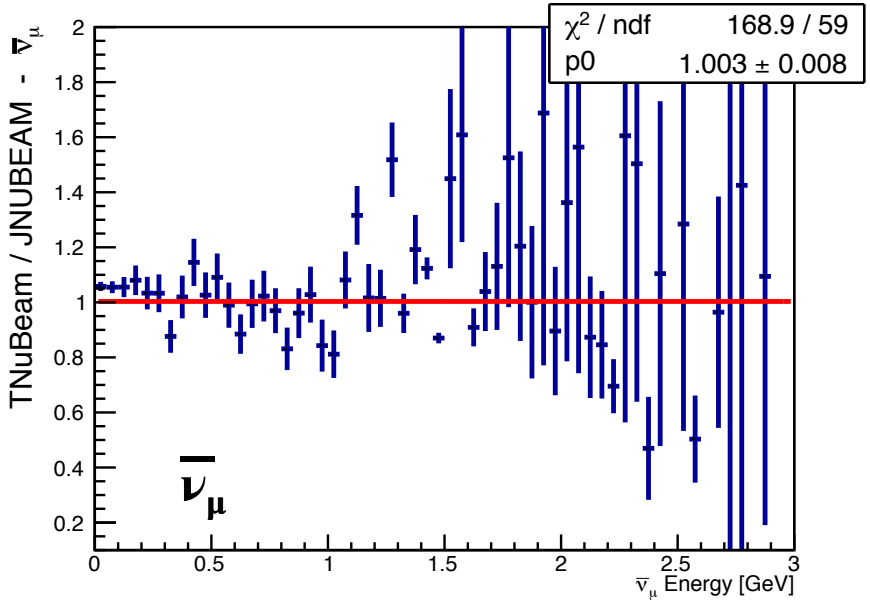


Flux

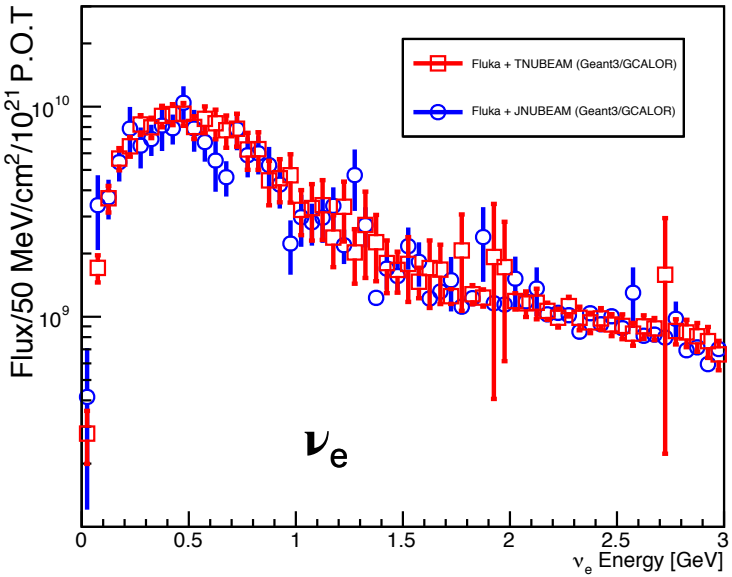


Flux ratio

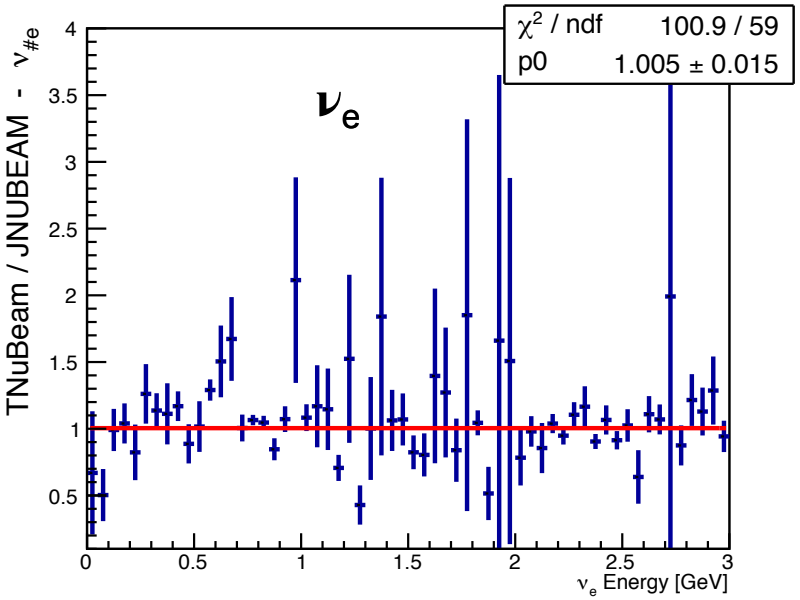




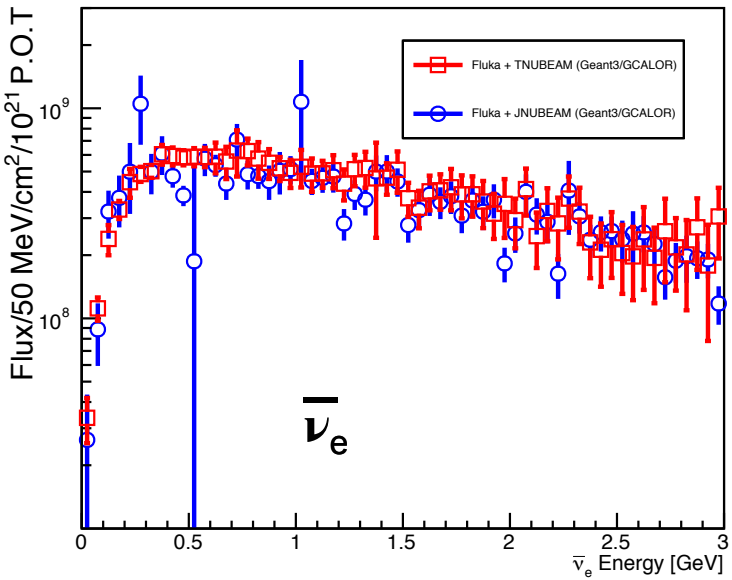
ν flux comparison - TNuBeam vs JNUBEAM

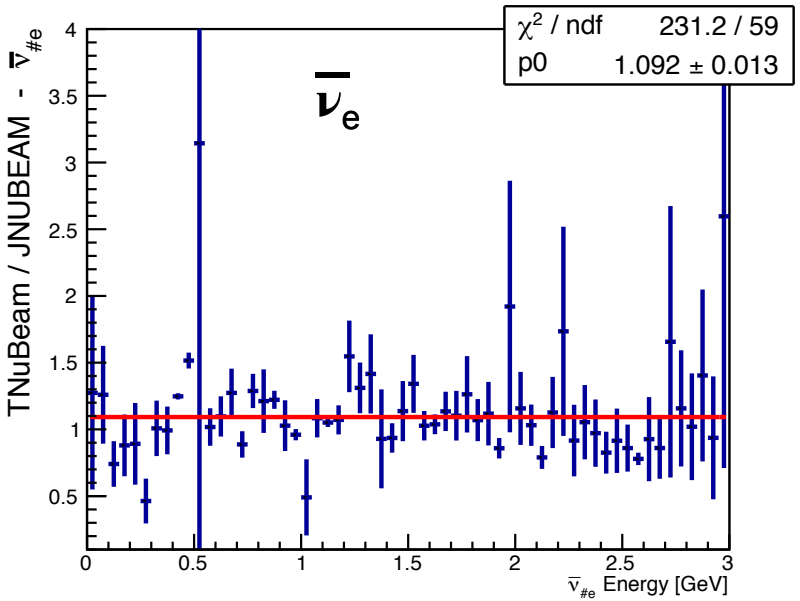


Flux



Flux ratio





TBC

In progress...

- Investigate CUBD change effect on JNUBEAM
- Test statistical self-compatibility of TNuBeam & JNUBEAM
- Compare TNuBeam vs JNUBEAM by process
- Compare MC predictions with latest NA61 (LT 2010) results
- Improvement of TNuBeam structure and user interface still under development.