Far/Near ratio covariance

A.Murakami

Topic

- I found a problem in jnubeam analysis code (OAWeight) which I used to study F/N covariance (which was reported at last jnubeam workshop).

  - I'm sorry that I failed enough check of inside of code.

Problem

- In 10a analysis, INGRID measurement and survey error of each detectors are considered to estimate the flux error due to off-axis uncertainty.

- But, in current jnubeam code (OAWeight), INGRID not considered. Instead of INGRID, MUMON was considered.

  - 1mrad error for y-position is assigned as MUMON syst. error in this code.

  - I use this code with **no change**, so over estimate.

- I ask Matsuoka-san about this.

  - In his analysis code, INGRID meas. (not MUMON) considered correctly (same as jnubeam technote, his doctor thesis).

    - He estimated flux error due to off-axis with his analysis code for 10a analysis (no problem in 10a flux uncertainty).

  - He forgot to commit his code to repository.

- I ask him to give me his code and I make flux with his code.

Assigned error

In Matsuoka-san's code(for 10a analysis error)

- Deviation of the beam direction by INGRID
  - x-deviation = 0.008 mrad
  - y-deviation = 0.24 mrad
- INGRID measure syst. error (including alignment error)
  - x-err = 0.34 mrad
  - y-err = 0.38 mrad
- Alignment error of SK, ND5
  - 0.0024 mrad in x,y for SK
  - 0.026 mrad in x, 0.038 mrad in y for ND5

Total syst. error of beam direction = {0.34 mrad, 0.45 mrad}
→ 0.44 mrad for off-axis angle uncertainty

Assigned error

In used jnubeam code(OAWeight)

- Deviation of the beam direction by MUMON
  - x-deviation = 0 mrad
  - y-deviation = 0 mrad
- MUMON measure syst. error (including alignment error)
  - x-err = 0.11 mrad
  - y-err = **1.0** mrad
- Alignment error of SK, ND5
  - 0.0024 mrad in x,y for SK
  - 0.026 mrad in x, 0.038 mrad in y for ND5

Total syst. error of beam direction = {0.11 mrad, 1 mrad}
→ 0.95 mrad for off-axis angle uncertainty

±1σ changed flux against nominal

- **(changed flux by 1σ off-axis error)/(nominal flux)**
- **Using current jnubeam code.**

+1σ (+0.95mrad)
-1σ (-0.95mrad)

νµ @SK

νµ @ND5
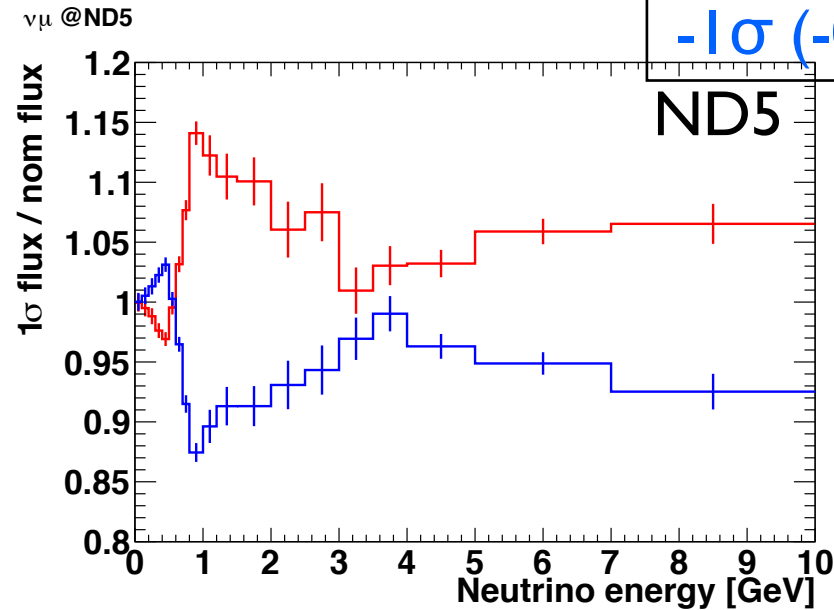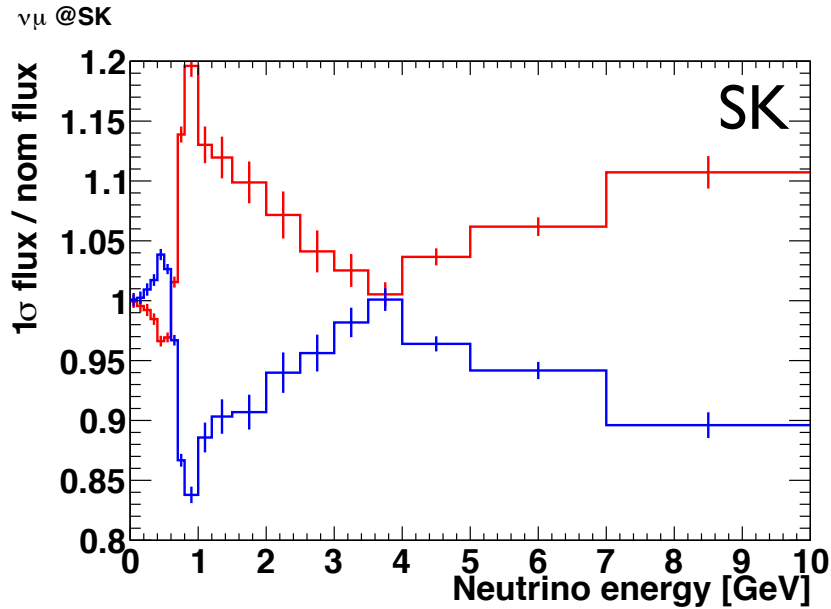
Variation of νµ flux (Matsuoka-san's study, 0.44mrad)
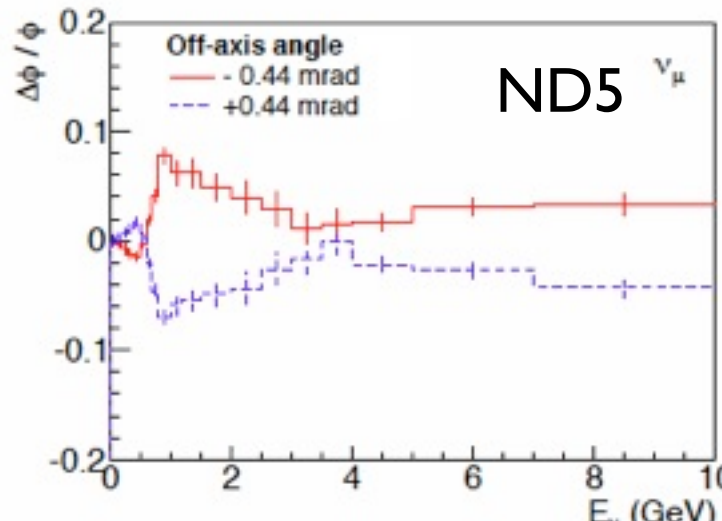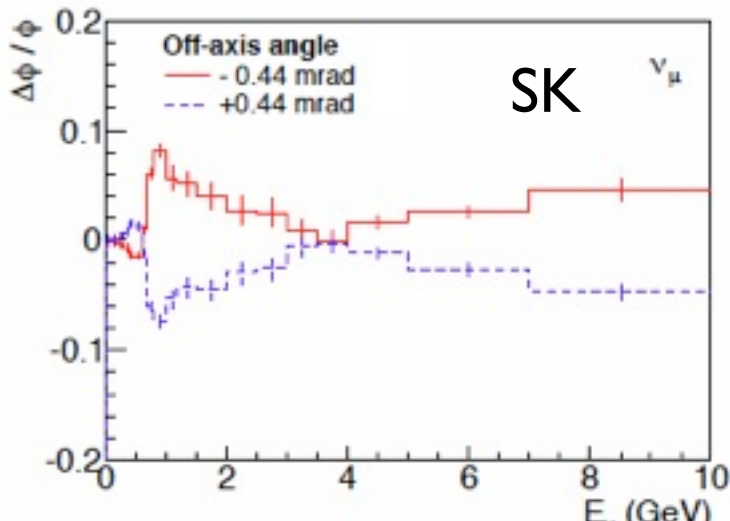
-> Larger than Matsuoka-san's due to diff. of off-axis angle unc.

±1σ changed flux against nominal
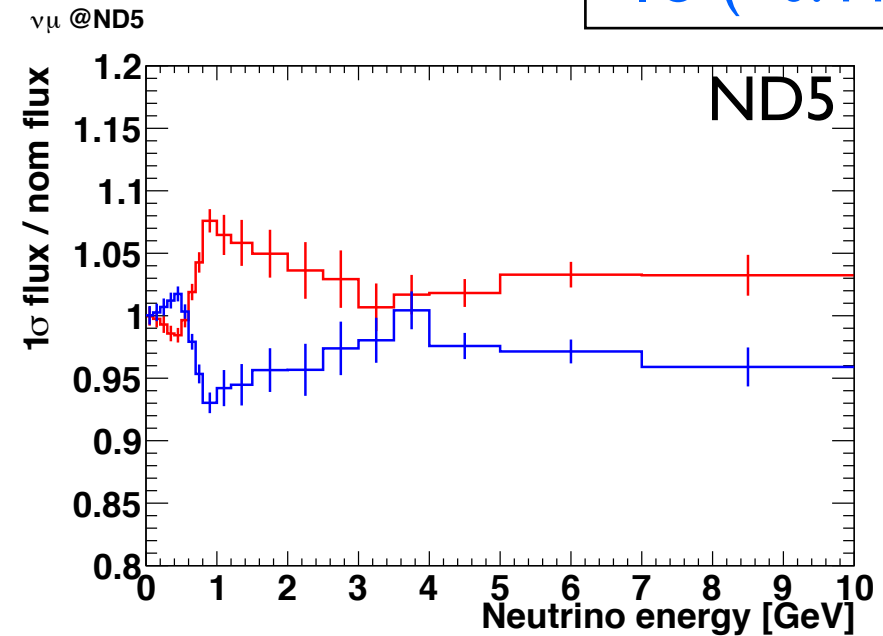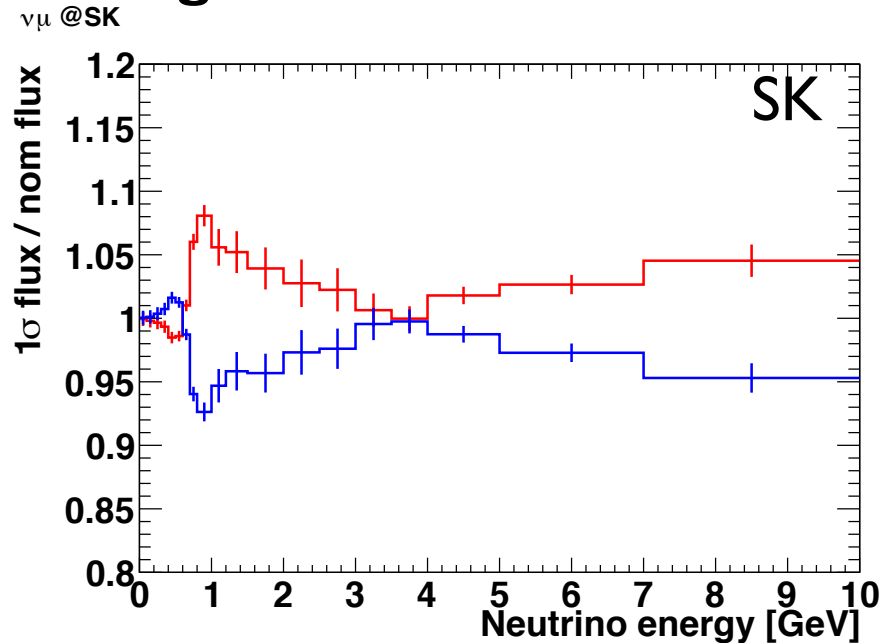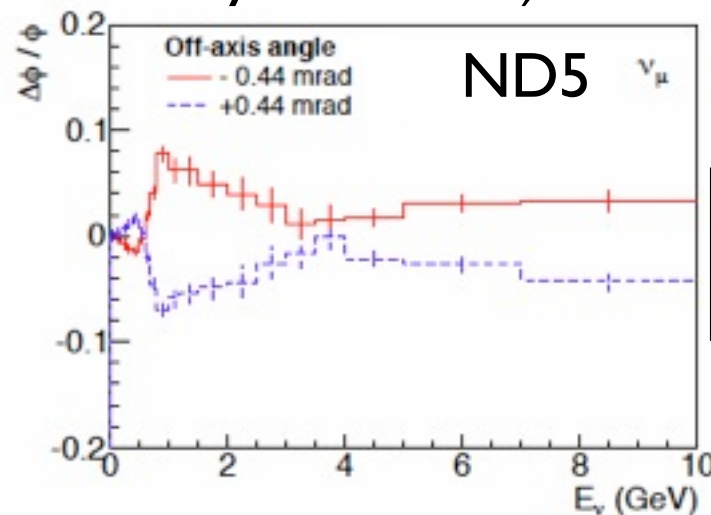
- (changed flux by 1σ off-axis error)/(nominal flux)
- Using Matsuoka-san's code

+1σ (~0.44 mrad)
-1σ (~0.44 mrad)

Variation of νμ flux (Matsuoka-san's study, 0.44mrad)

Good agreement

Far(νμ)/Near(νμ) ratio

Nominal
+1σ
-1σ

w/ jnubeam code

Neutrino energy [GeV]

w/ Matsuoka-san's code

Neutrino energy [GeV]

Fractional flux covariance &error

Update combined flux covariance & error

- Just update w/ new fractional flux covariance and error of off-axis which are made by Matsuoka-san's code.

  - Other error is same as one of last beam MC workshop.
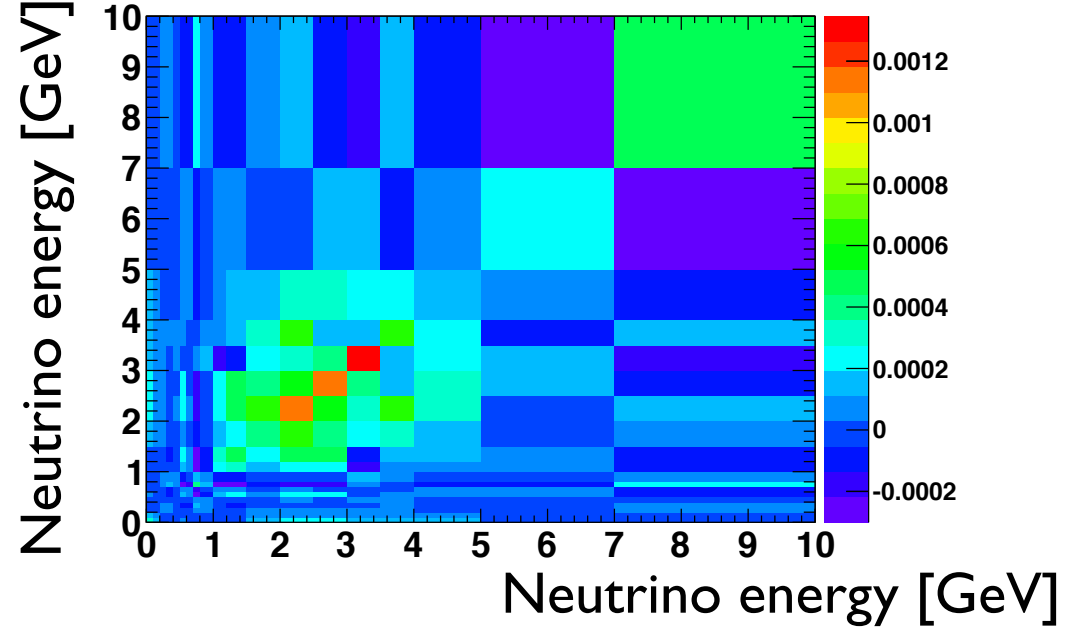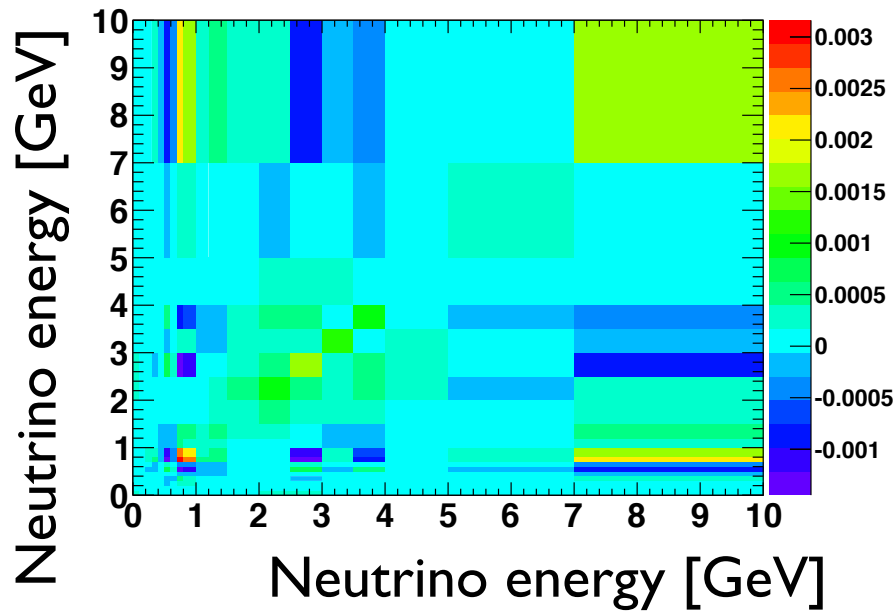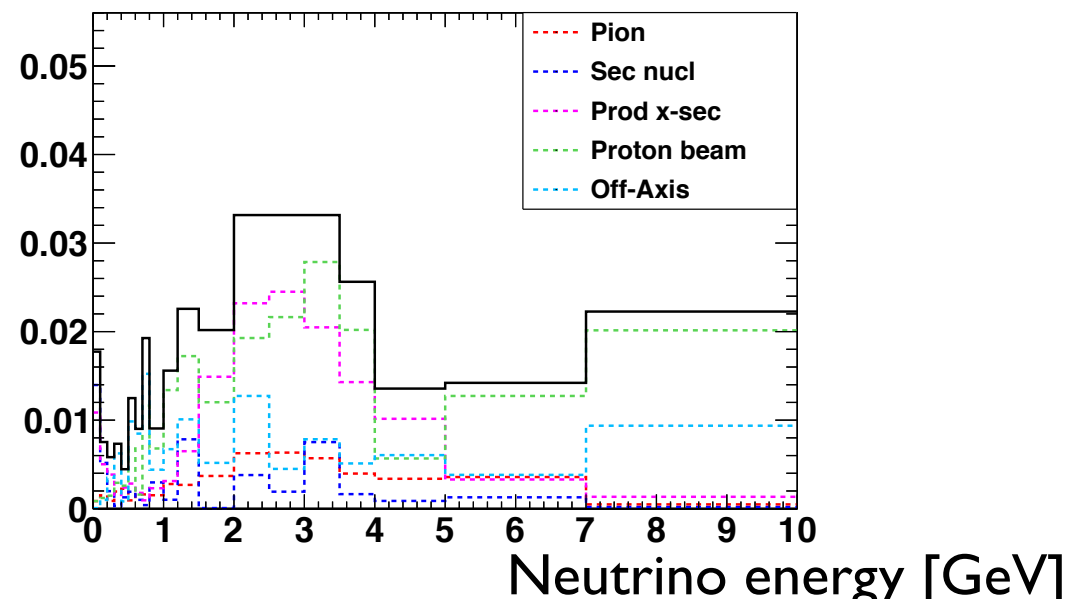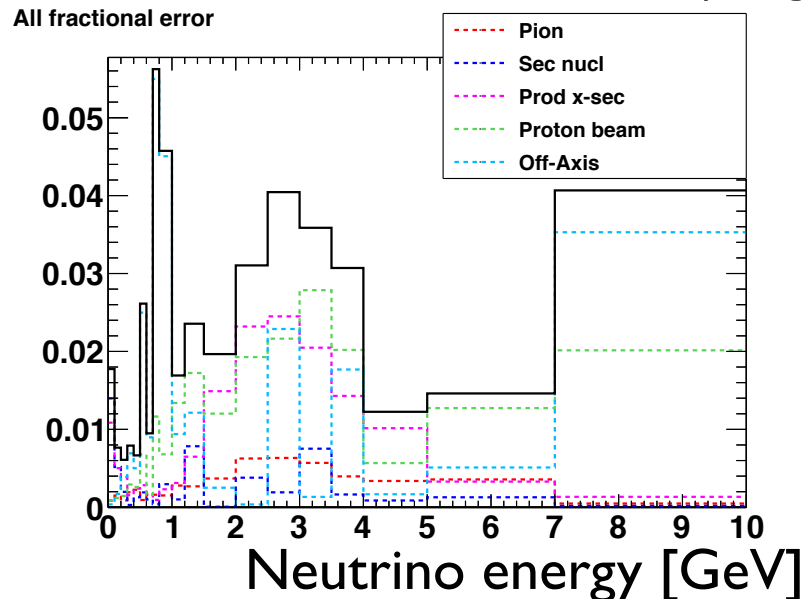
Combined fractional covariance & error.
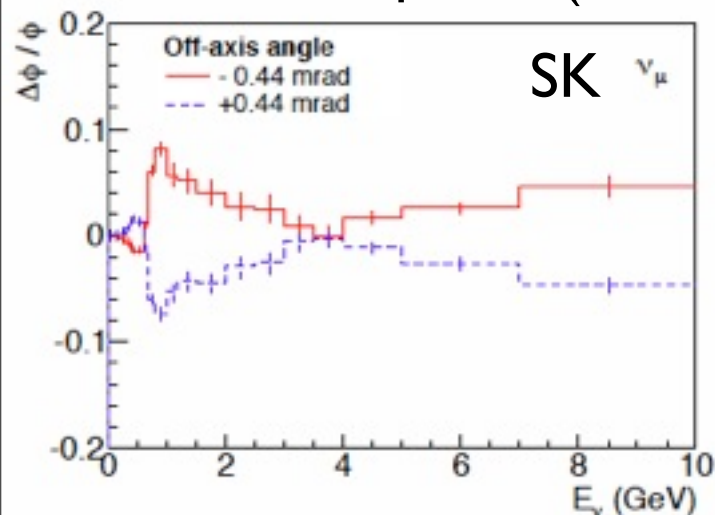
Fractional covariance matrix
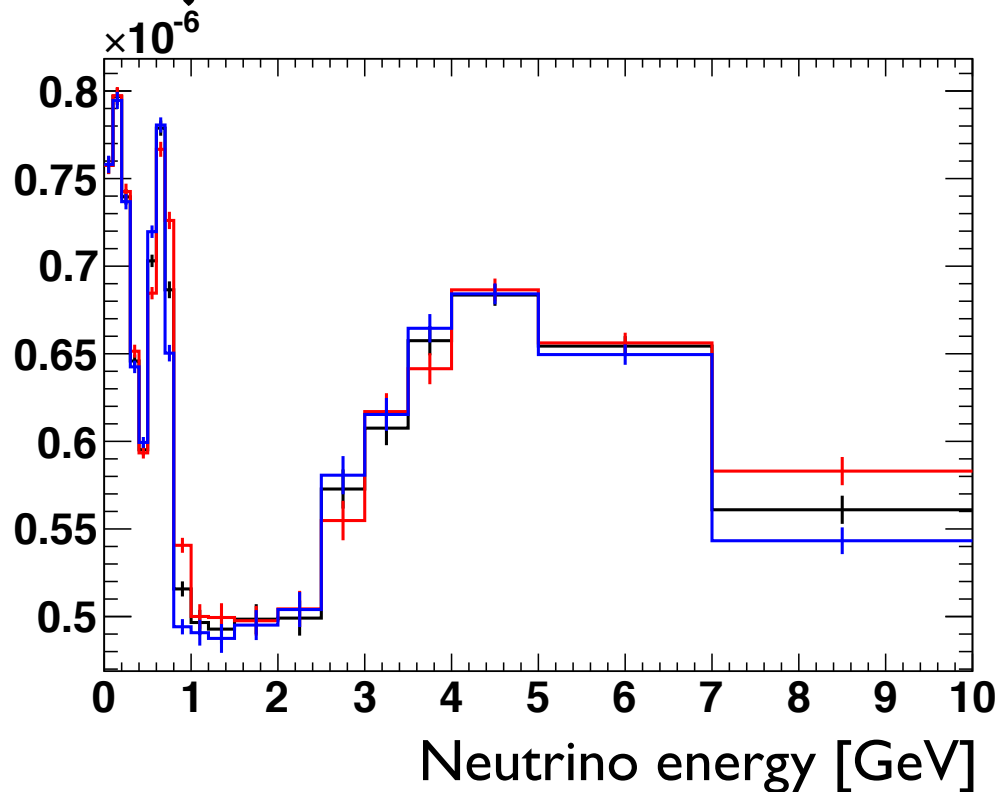
w/ jnubeam code

w/ Matsuoka-san's code
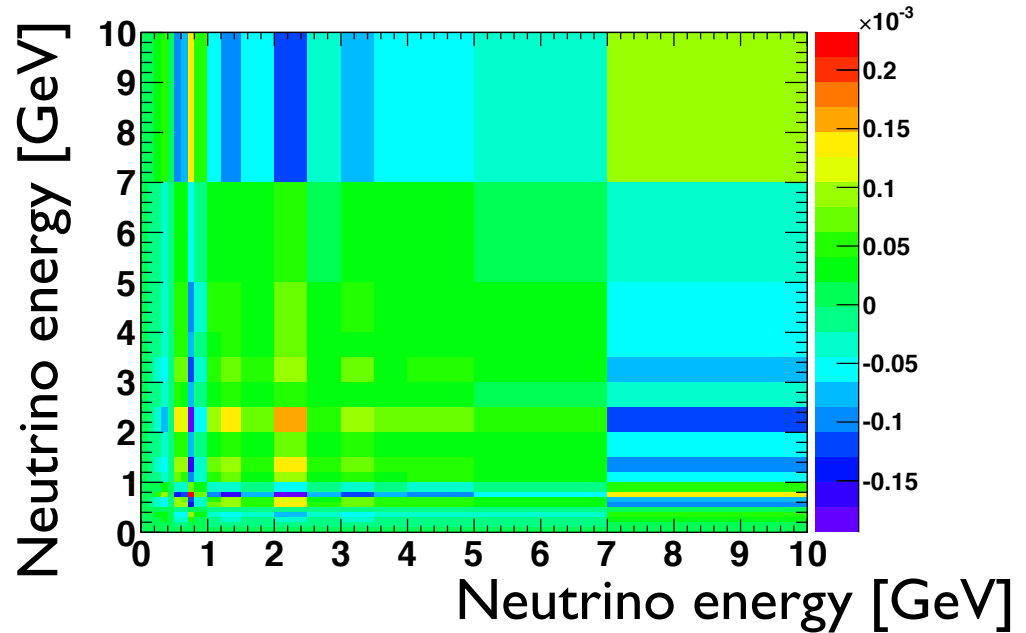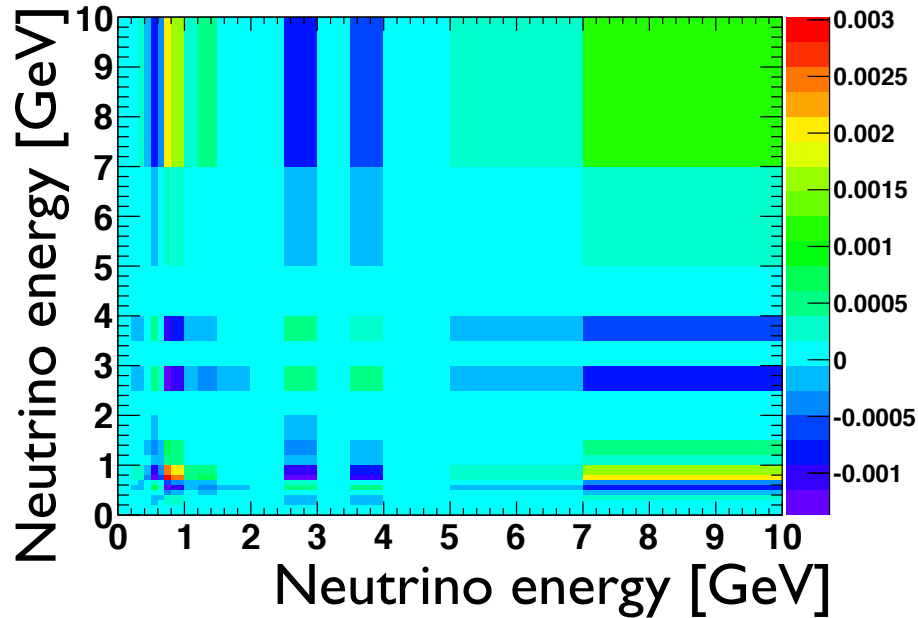
Fractional error = √(diagonal of fractional covariance matrix)

Summary

- Use Matsuoka-san's code for estimation F/N error due to off-axis.

  - The max error size reduce from ~5% to ~1%

- Need to investigate the reason of the F/N error structure (off course about other error source).

  - It is one of reasons for non-smooth shape of F/N fractional error that MC stat. seems to be not enough.

    - In this study, use all of official 10d flux files for SK and ND5.

- If no problem about new result, I want to commit his code into repository.

  - Should I commit his code at first?

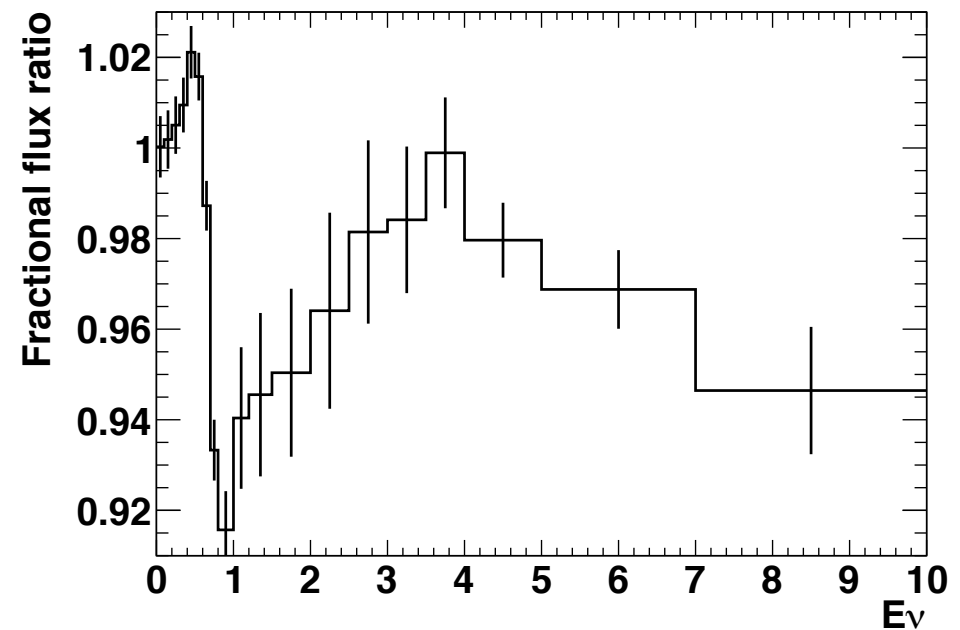 - If any question & comment, please tell me.

Back up

Comparison for fractional flux

(+1σ fractional flux by Matsuoka-san' code) / (+1σ fractional flux by jnubeam code)

(+0.44mrad fractional flux) / (+0.95mrad fractional flux) @ND5
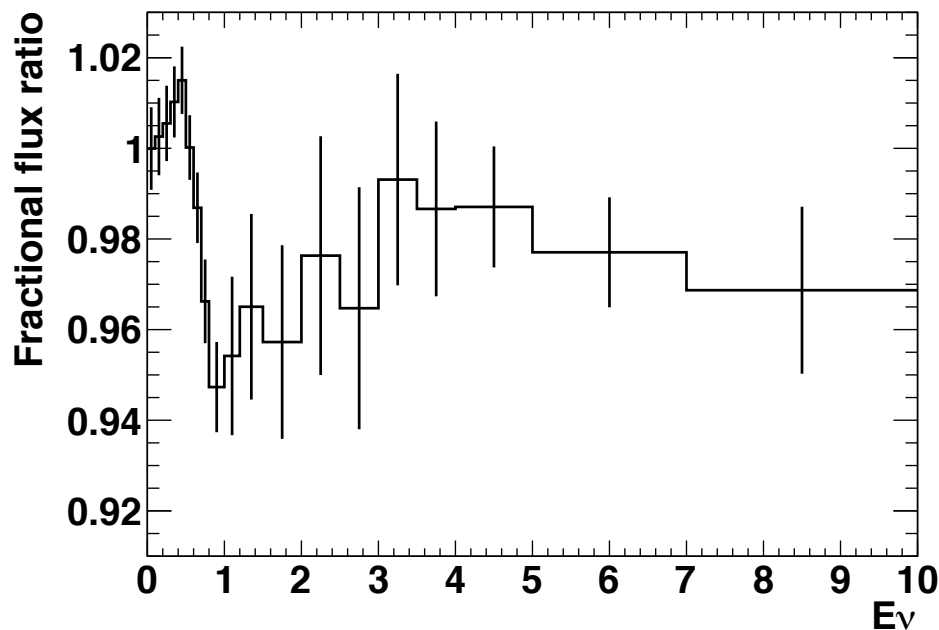
(+0.44mrad fractional flux) / (+0.95mrad fractional flux) @SK

→ The difference does not depend on off-axis difference linearly