New plots for NUISANCE-MINERvA publication

On behalf of Patrick Stowell, Leo Bellantoni, Luke Pickering, Callum Wilkinson

https://arxiv.org/abs/1903.01558

Clarence Wret

MINERvA Friday Meeting
28 June 2019

Reminder

- Patrick Stowell (Sheffield) did an NPC at FNAL with MINERvA, summer 2017
- Used NUISANCE with GENIE and published MINERvA data to tune and develop an empirical single pion production model
- Discussed:
  - Fitting GENIE parameters to MINERvA data
  - Ad-hoc Q^2 tune to improve GENIE agreement with MINERvA data
  - Data/MC compatibility channel-by-channel
  - Improvements in data releases from neutrino scattering community
- MINERvA and NUISANCE authors: huge effort by Leo Bellantoni
- Went through MINERvA publication review (glaucus link)
- Submitted to PRD, received many comments, prepared response
- Second MINERvA review

Referee #1

- DocDB has link to comments
- Reviewer #1 overall very positive, two comments:
  - Discuss with MINERvA on improving data releases, notably correlations between distributions and cross-sections
  - GENIE's FSI reweighting highlighted as problematic

"This is an important intermediate result, pointing out challenges in modeling of single pion production in neutrino experiments operating in few-GeV energy range"

Awesome!

Referee #2

- Reviewer #2 was very thorough
- Many good (30+) suggestions, but far out of the scope of this paper
  - Suggesting comprehensive model/generator comparisons
  - Why are we using a GENIE version which doesn't have the latest and greatest theory
  - Why are we using a GENIE FSI model which is bad
- Most of these comments were addressed by:
  - We want to make a tune usable for the field
  - Experiments run with this GENIE version and models; the results are not applicable to most experiments if we use a different version
  - Can update the tune with a new GENIE model once experiments move to such: strength of NUISANCE

Example 1 from Referee #2

Neglecting the mass term in the cross-section calculation is known to be an incorrect approximation for antineutrino (e.g.Phys.Rev.D77:053003,2008), a rough quantification of the size of this effect for your antineutrino sample is important to assess the validity of your tuning (e.g.: this effect as a peculiar Enu dependence which is not correctly modeled by the other parameters you consider).

We have added a caveat in the introduction that the model we're using in the paper is not reflective of up to date theory, but has been chosen to reflect the model which is used by many current experiments. We have added a reference to the paper to highlight this potential issue. These studies can be updated once neutrino experiments update to newer models, such as the one you suggested.

We did a comparison, turning lepton mass effects on and off in the NEUT neutrino interaction generator, (for technical reasons it is difficult to do this in GENIE) and found an effect of 1-5%.

Example 2 from Referee #2

It is important to mention the well known short-comings of the hA model, as well as, the inability of any FSI model to have robust prediction/tuning for the pion re-scattered kinematics.

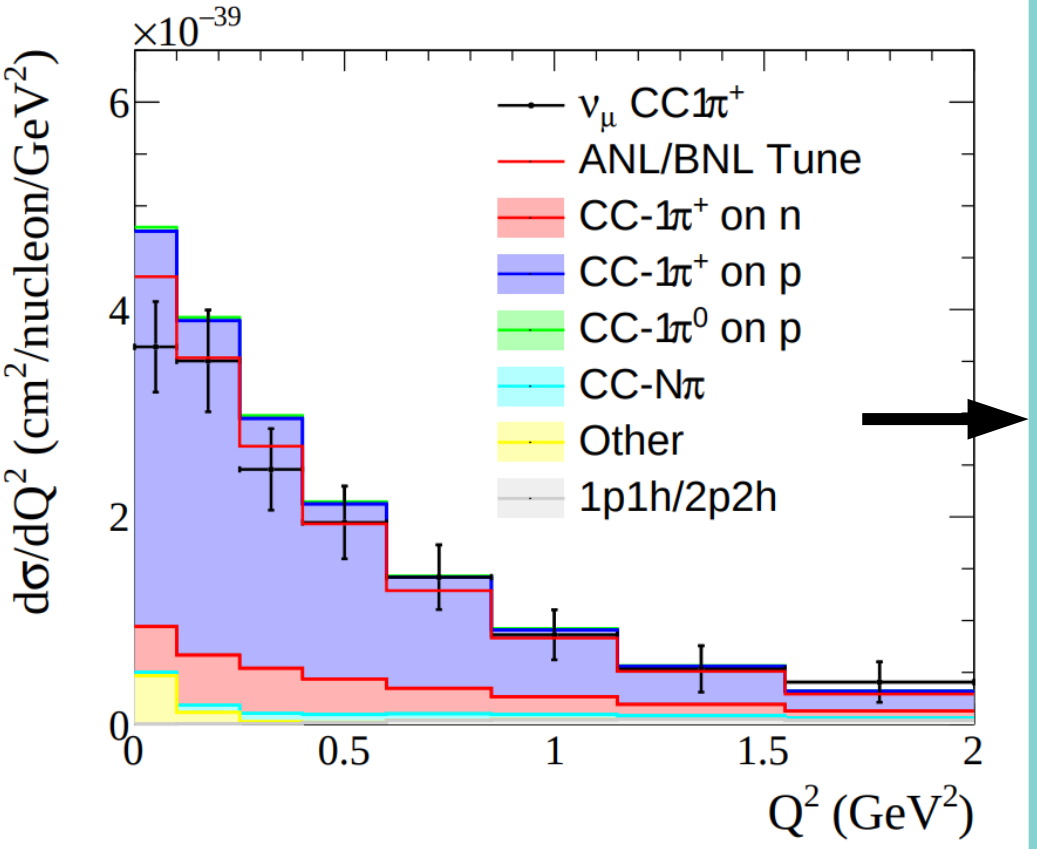
We want, as much as possible in this paper, to limit our discussion of the models to relatively simple descriptions of what is in them and elsewhere refer to the GENIE description. We do not intend to evaluate pros & cons of a model; that is a very interesting subject but it is a big one and we couldn't do it justice in this paper.

We have however inserted references which attempt such gargantuan tasks.

Referee #2

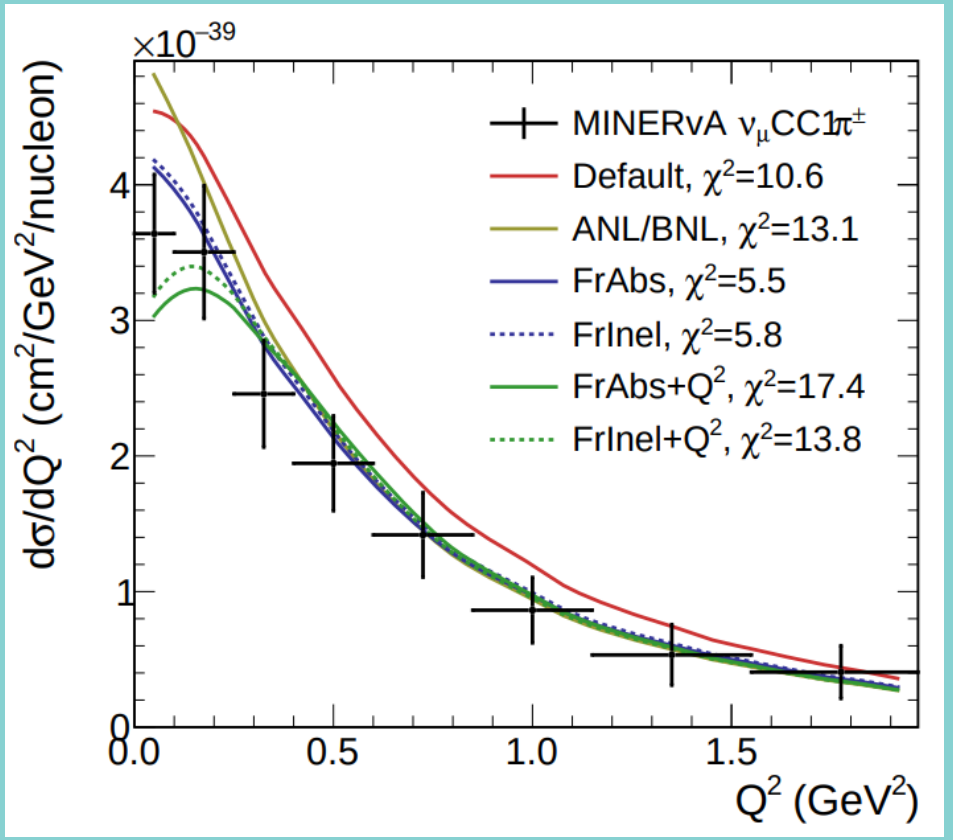
- Reviewer #2 suggested we change some plots
- Previously: showed prediction of default GENIE and ANL/BNL tune against MINERvA Q^2 data
- Suggested we show all the tunes against the data in Q^2 so easier to gauge the effect of the tune
  - We agreed this was a good suggestion

Plot change #1



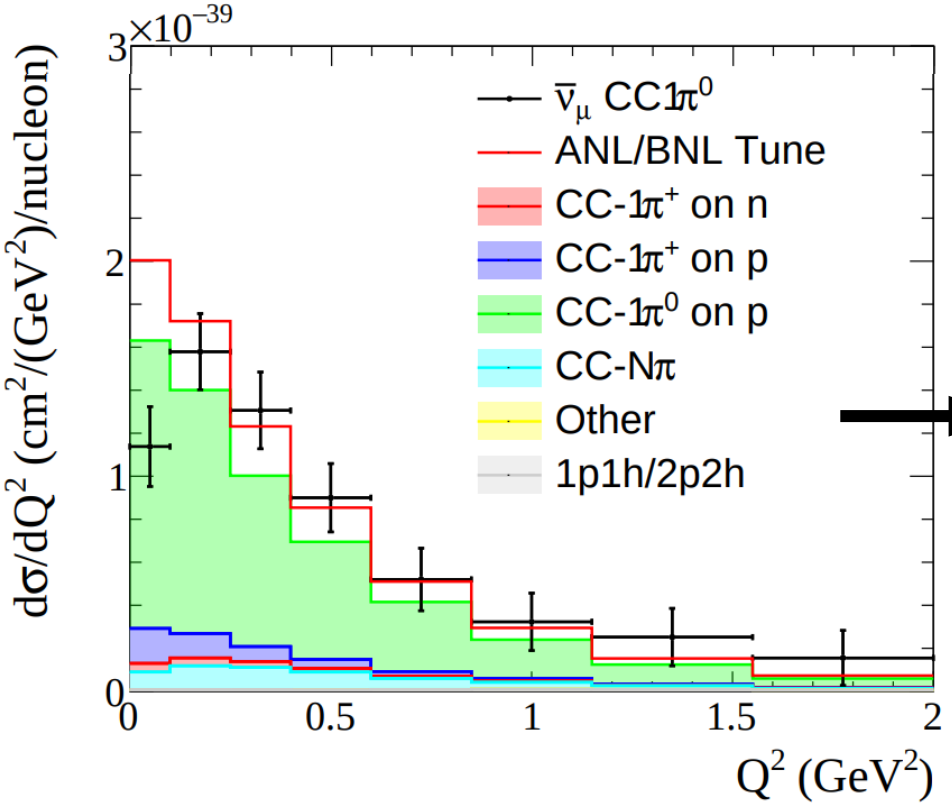
Remove

Proposed for approval

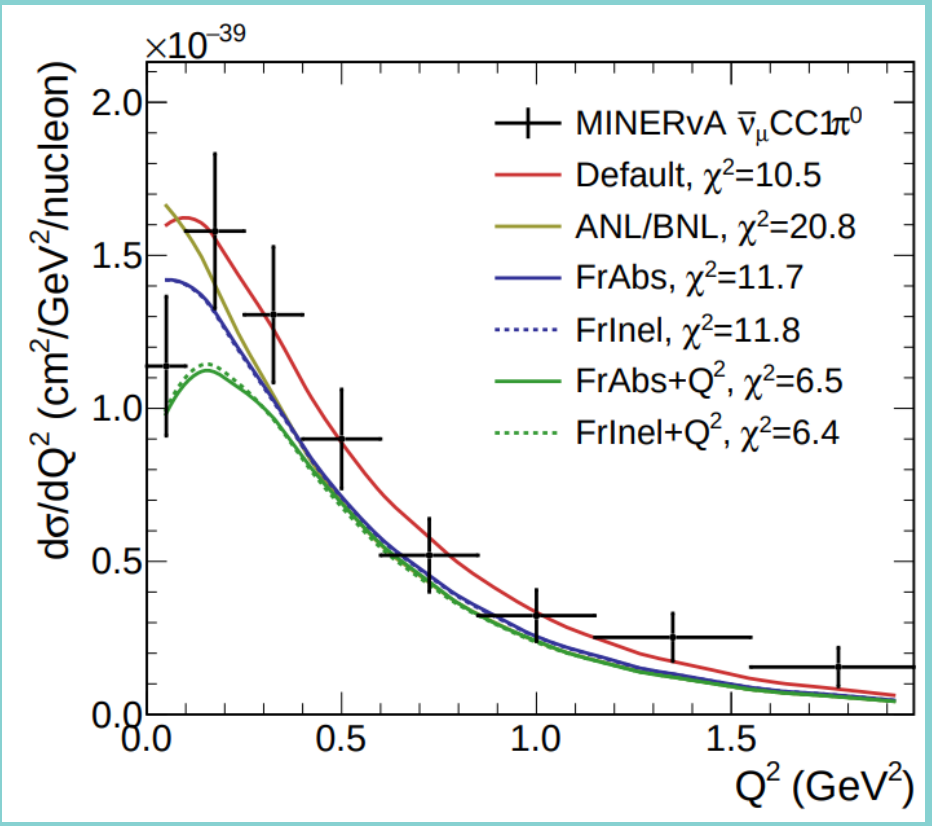


Insert

Plot change #2



Proposed for approval



Remove

Insert

Referee #2

- Reviewer #2 also suggested we show the post-fit covariance matrices
  - Wanted to see how parameters correlate in different tunes
- Oversight by us: can't really use the results without covariance!
- Included these in the publication; one for each fit so four in total

Plot addition #1

Proposed for approval

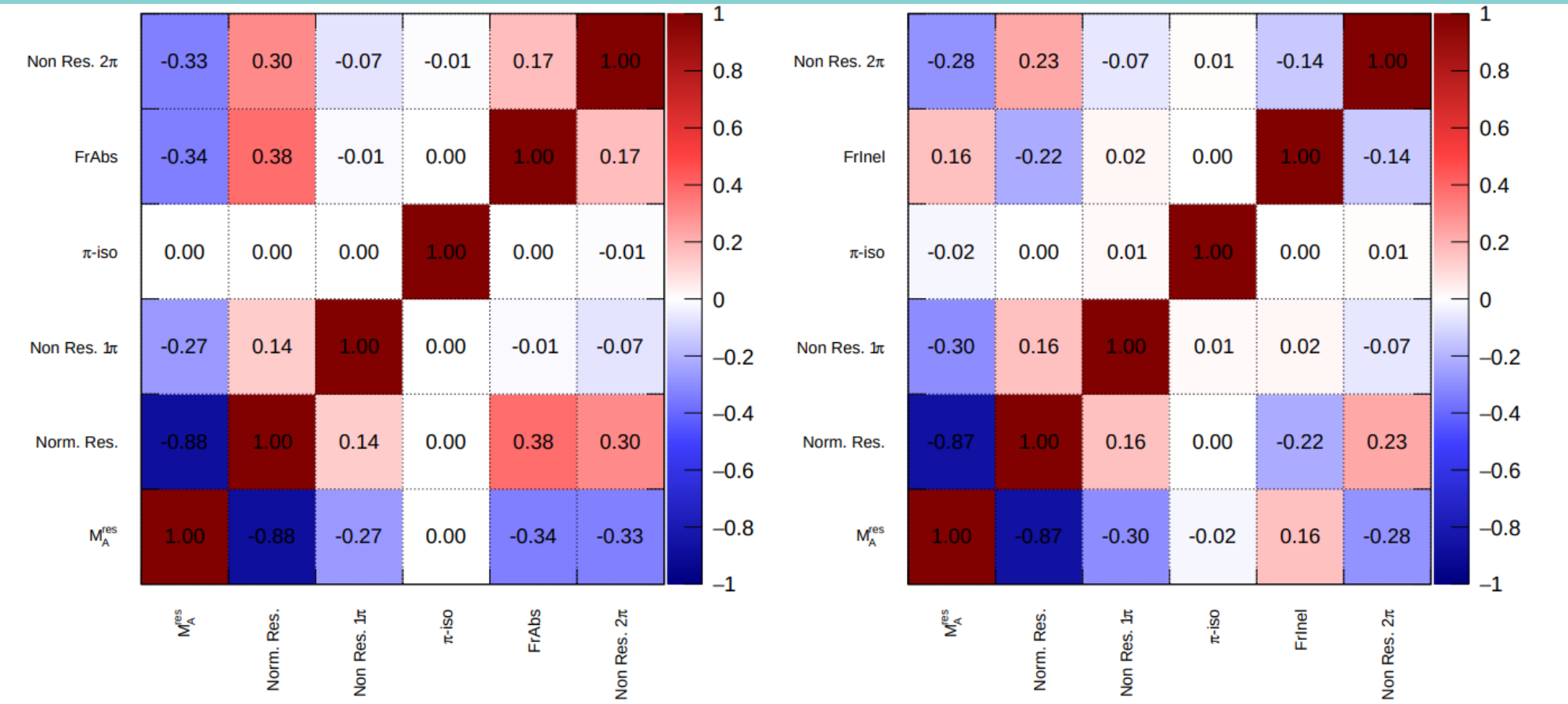
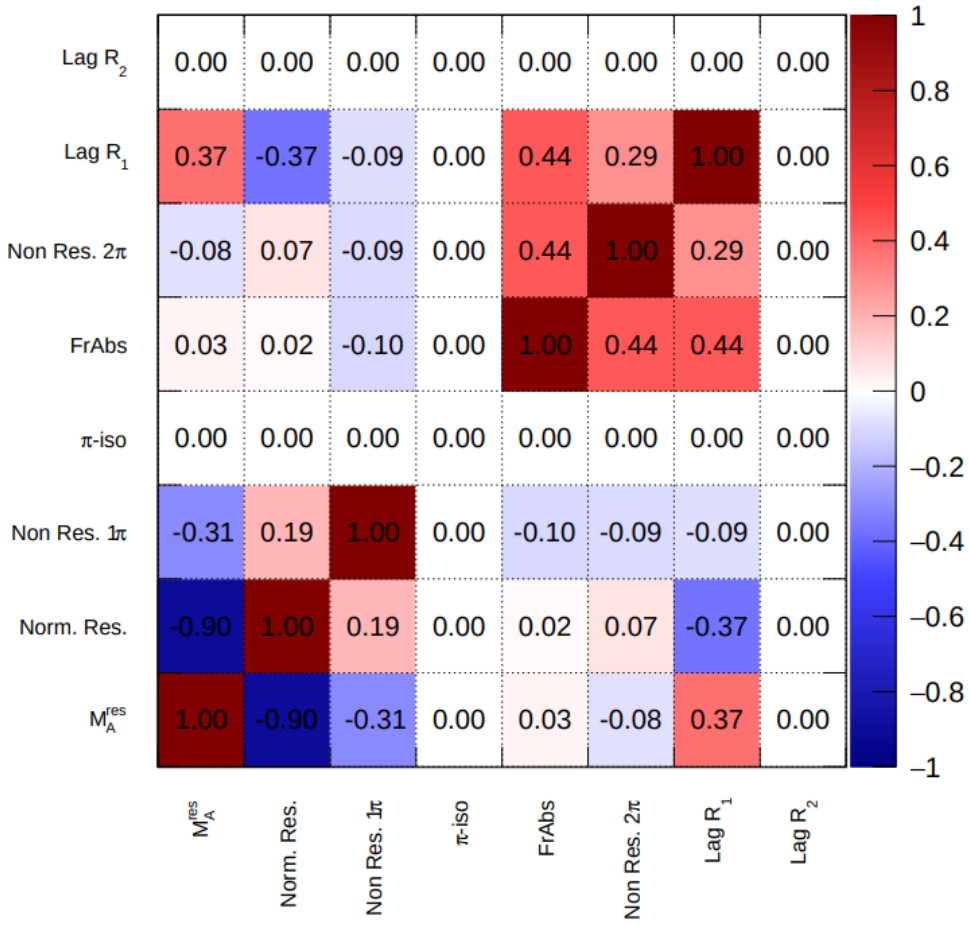


FIG. 10. Correlation matrix from from tuning GENIE parameters in NUISANCE with FrAbs included as a fit parameter (top) and with FrInel included as a fit parameter (bottom).

Also included in data release (root file)

Plot addition #2

Proposed for approval



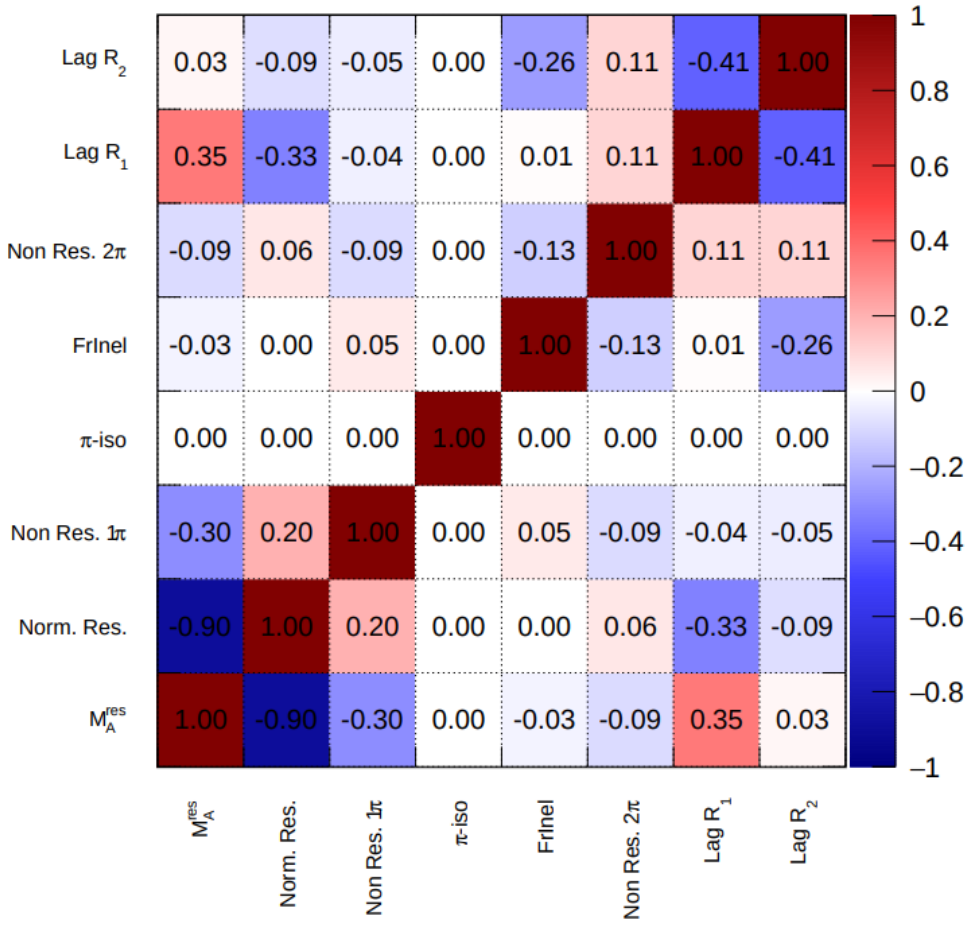


FIG. 13. Correlation matrix from tuning GENIE parameters with an ad hoc low-Q^2 supression with FrAbs included as a fit parameter (top) and with FrInel included as a fit parameter (bottom).

Also included in data release (root file)

New comments

- No large changes in paper content
  - Rewording
  - Moving around text
  - Adding some quantitative numbers for (previous) qualitative statements
- The plots presented herein

- Given small changes: comments by a week's time

July 5 2019

Thanks!