


LBNF neutrino flux stability

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Optimizing Run plan

- How long should DUNE-Prism stay at each point?
- Many drivers
 - How long does it take to move from point to point (want to spend more time taking data)
 - Meaningful statistics
 - Running mode (nu/nubar)
 - ...
 - Sample stable beam period?



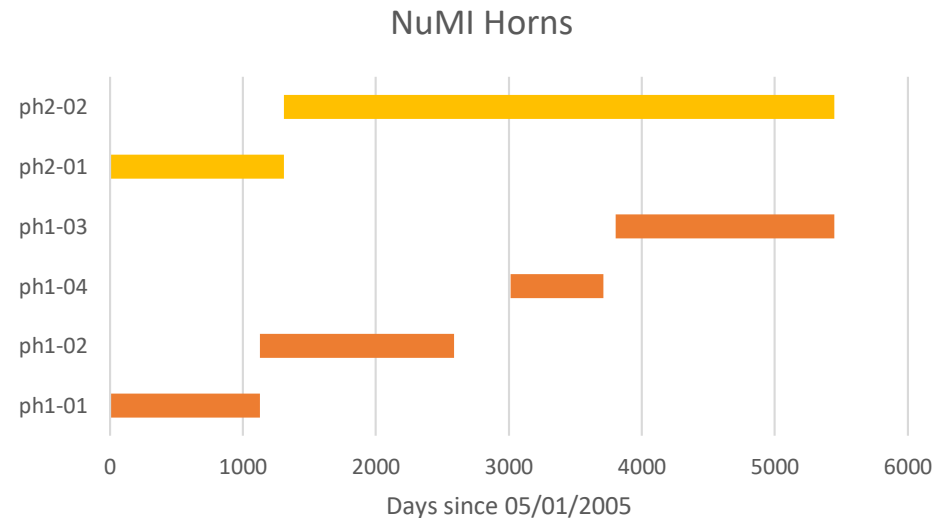
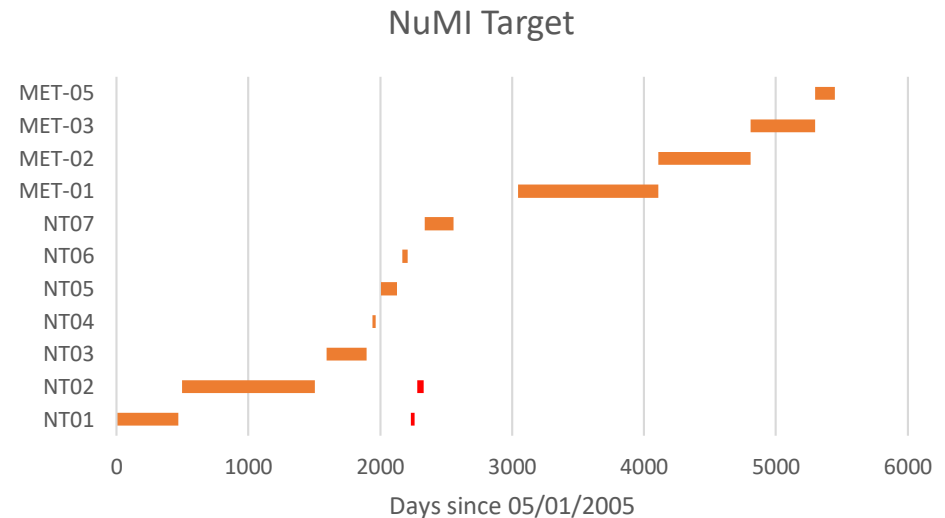
Discuss today if this should be on the list

Flux stability

- A lot of effort is being put to be able to keep beam stable
- However, beamline components will be changed out
 - Target and horns are not designed to last forever
 - Requirements are that they last long enough so we can spend most time running and not changing out components
- Parts can also break or degrade and cause changes in flux
- Upgrade to 2.4MW will come with some redesign

NuMI experience

- Targets/horns break and need to be changed out
 - Water leaks, He leak, stripline fractures, stripline hardware failures, upgrades,...
 - Sometimes can wait till shutdown, but sometimes not
- Ideally changing the components does not change spectrum, but sometimes there are slight design changes, new alignment,
- Time between swaps varied from days to couple years

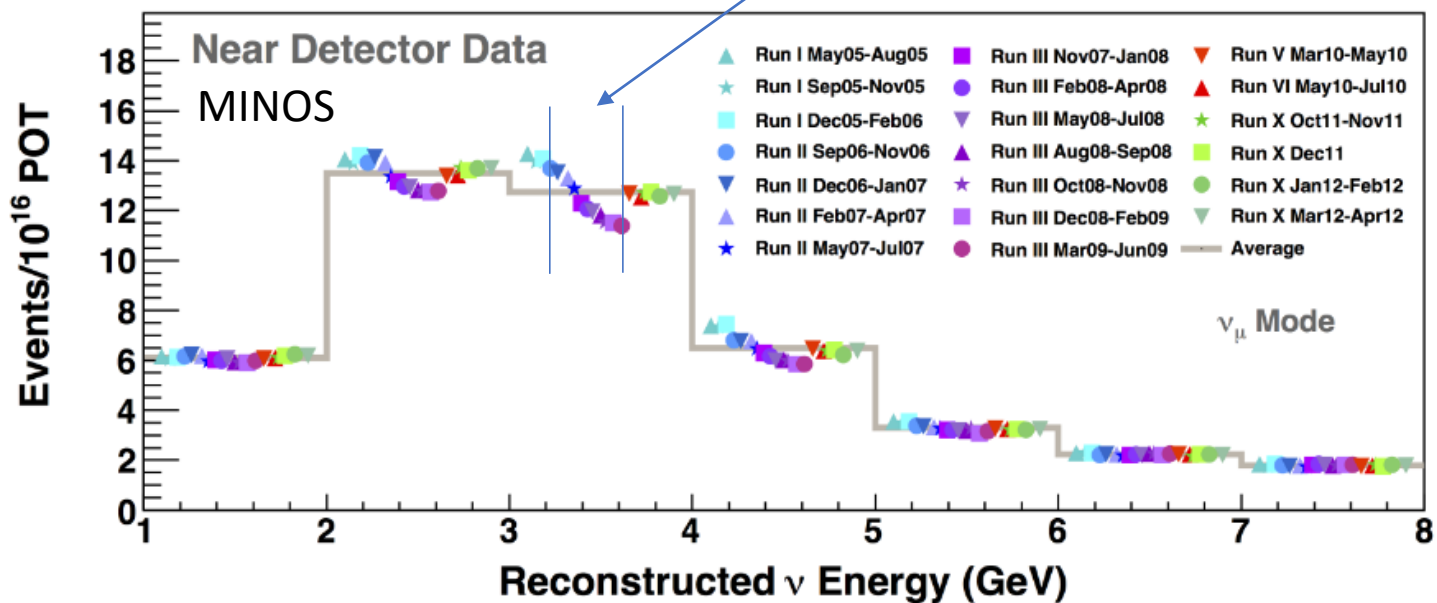
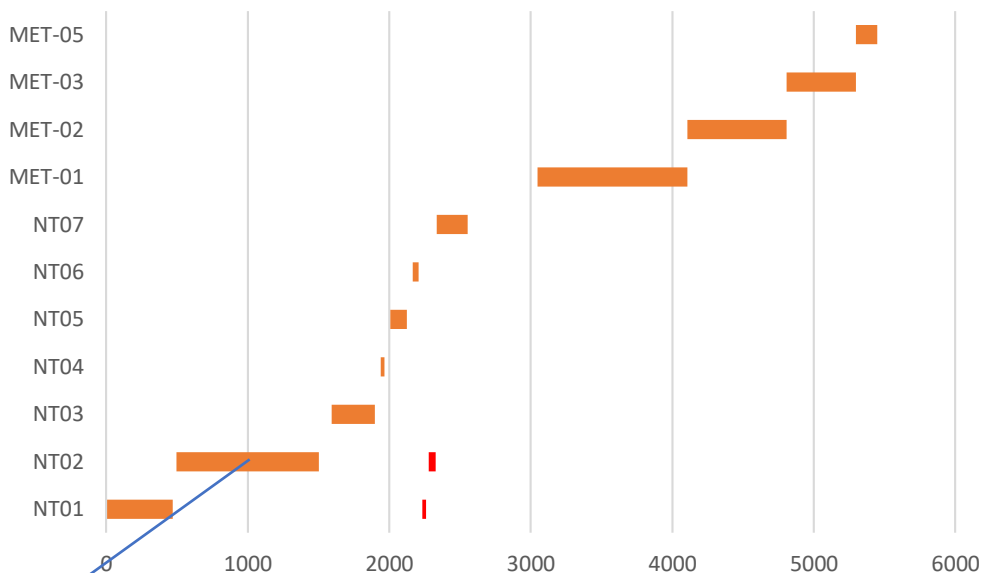


Same components

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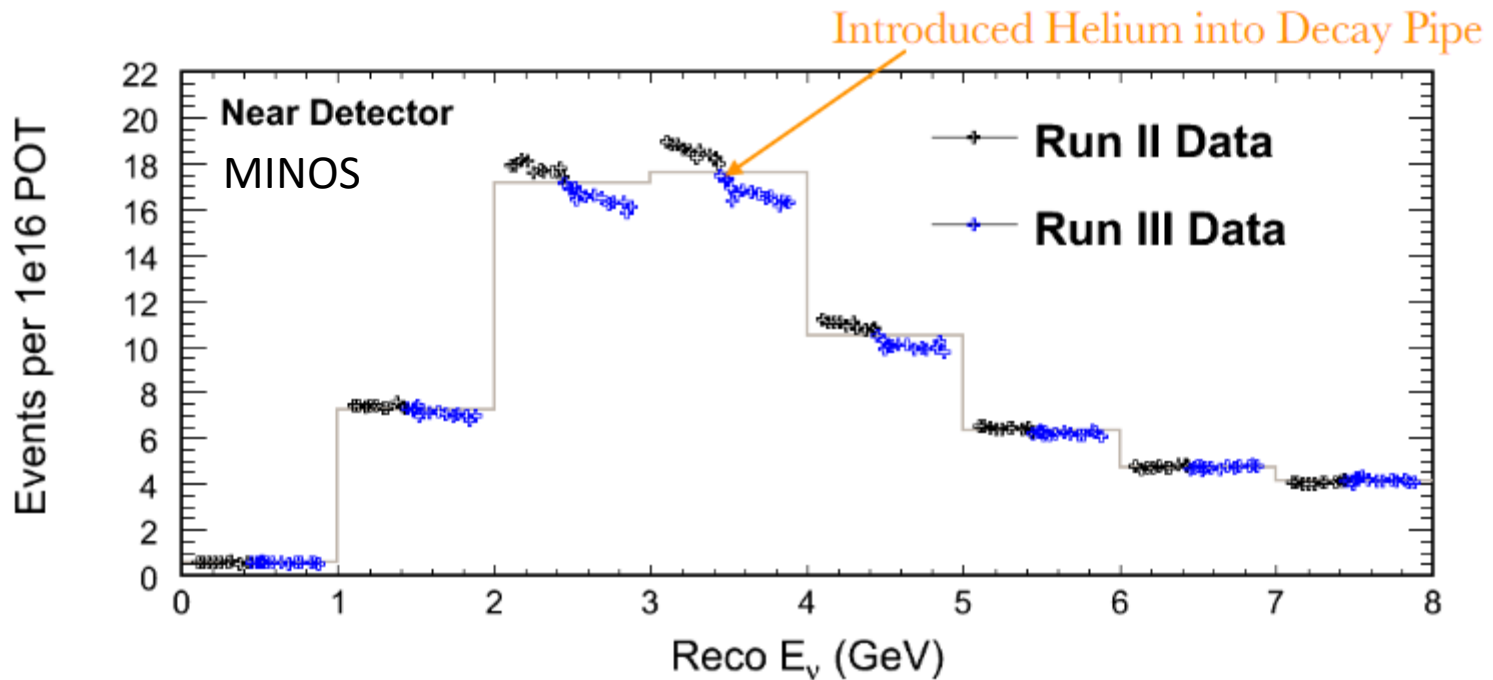
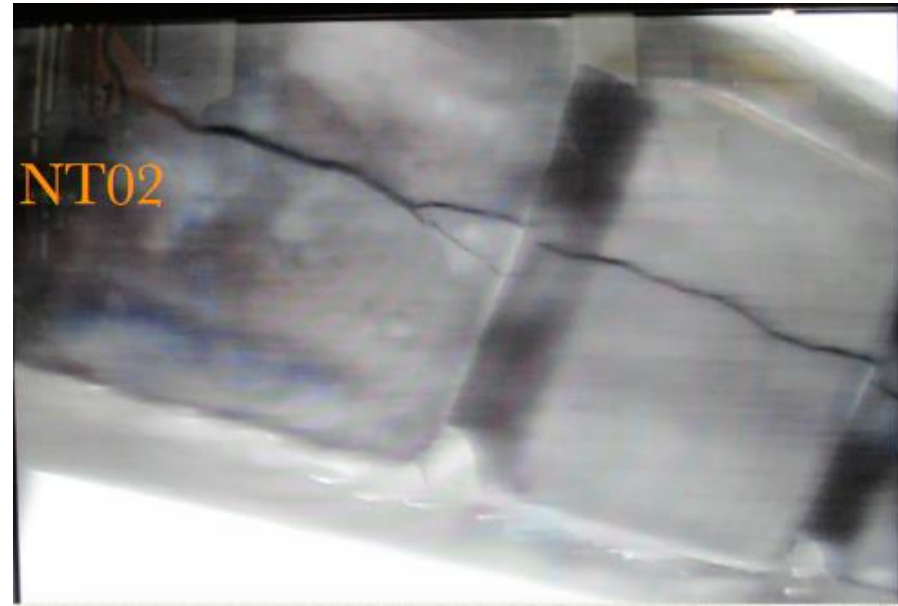
Stable beam

- MINOS Run II and III taken with same target



Flux stability

- Two issues during those two runs
 - Target degraded
 - Had to introduce He into decay pipe
- 3 year period during which beam slowly changed

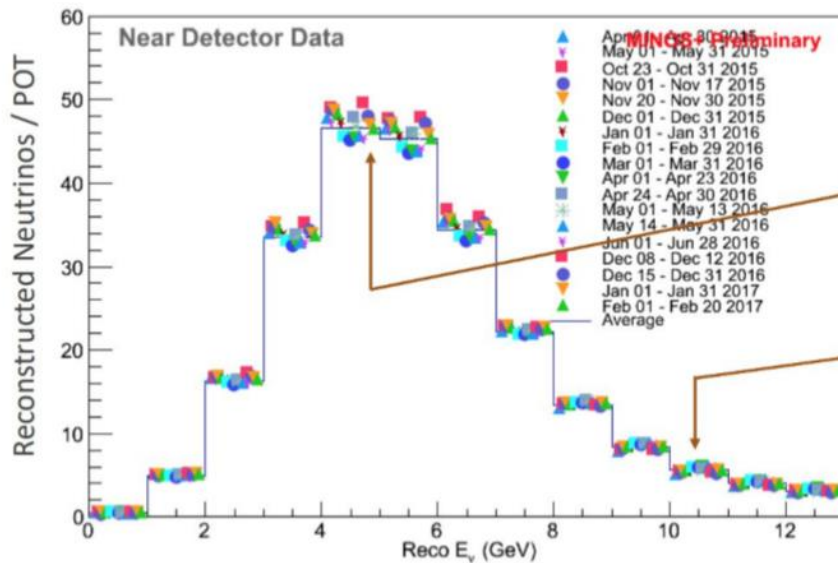


Horn tilt

- Broken bushing caused horn to tilt 1-2mm

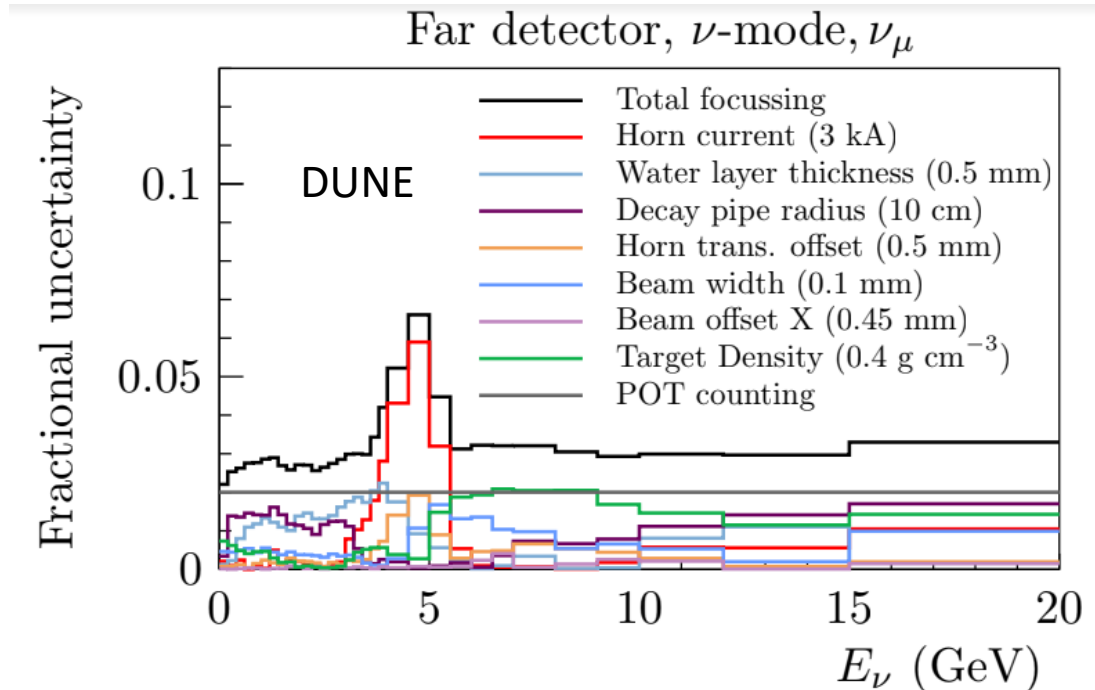


Neutrino Energy Spectrum Stability (PQ and NQ)



Running conditions

- Flux sensitive to:
 - Primary beam position, width
 - Horn current
- These can/will change over time as well
- Simulate these effects



LBNF

- Learn from NuMI, but pushing the boundary with higher power, and more things that can break
 - Complicated target design and 3 horns
- Expect sometimes problems will be fixable, but sometimes choice may be made to just run as is (possibly with degrading flux)
- Can't guarantee beam will stay stable
 - We need to have instrumentation able to diagnose issues (on-axis, off-axis spectrum, muon monitors, beamline instrumentation)
 - In practice diagnosing problems always took long time
 - Build analysis that can take into account changes in flux

Conclusion

- It is impossible to predict how often the flux will change
- Need to design our analysis to be able to handle this
- Need to be able to disentangle effects and understand changes in the beam using on-axis, off-axis neutrino flux, and muon monitors
- Other drivers in optimizing run plan probably are more important

Muon monitors

- NuMI making a lot of progress in using muon monitors for diagnosing beamline problems
- On DUNE, working on understanding the capabilities

