Atmospheric Neutrino Drivers (and assorted items)

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1) Improvements to the atmospheric neutrino flux drivers

2) Measuring the azimuthal distribution

3) Future work

At the spring collaboration meeting, Costas Andreopoulos summarized the status of tools in GENIE for atmospheric neutrino simulations:

https://indico.fnal.gov/getFile.py/access?contribId=59&sessionId=31&resId=0&materialId=slides&confId=10276

Atmospheric neutrino event generation app

GENIE has an app (**gevgen_atmo**) for atmospheric ν event generation:

```
shell> gevgen_atmo
            <-n number_of_events, -e exposure_in_kton_x_yrs (not implemented)>
            -f flux
            -g geometry
            [-R rotation_from_topocentric_hz_frame]
            [-t geometry_top_volume_name]
            [-m max_path_lengths_xml_file]
            [-L geometry_length_units]
            [-D geometry_density_units]
            [-o output_event_file_prefix]
            [-r run_number]
            [-E energy_range]
            [--seed random_number_seed]
            [--cross-sections xml_file]
            [--event-generator-list list_name]
            [--message-thresholds xml_file]
            [--unphysical-event-mask mask]
            [--event-record-print-level level]
            [--mc-job-status-refresh-rate rate]
            [--cache-file root_file]
            [-h]
```

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New Functionality / Validation

- Add command line options to control size of flux generation surface.
- Validation of new option for user-defined rotation to topocentric coordinate system.
- Add command line option (and validation) for generating with a user-defined power-law type spectrum - GENIE then generates weighted events.
- Have gevgen_atmo do the exposure calculation.
- Inclusion of the Athar et al. atmospheric flux.
  - Introduces new dependence - azimuthal angle (validation)
- Incorporate production height tables, generated production heights and passed through with events.

Athar et al., Phys.Lett. B718 (2013) 1375
   —- Hope to receive flux calculations including local topography (J. LoSecco)

Code Improvements

- Re-do atmos flux driver to calculate event weights by mass fractions (significantly faster than strobing neutrinos through a realistic geometry).
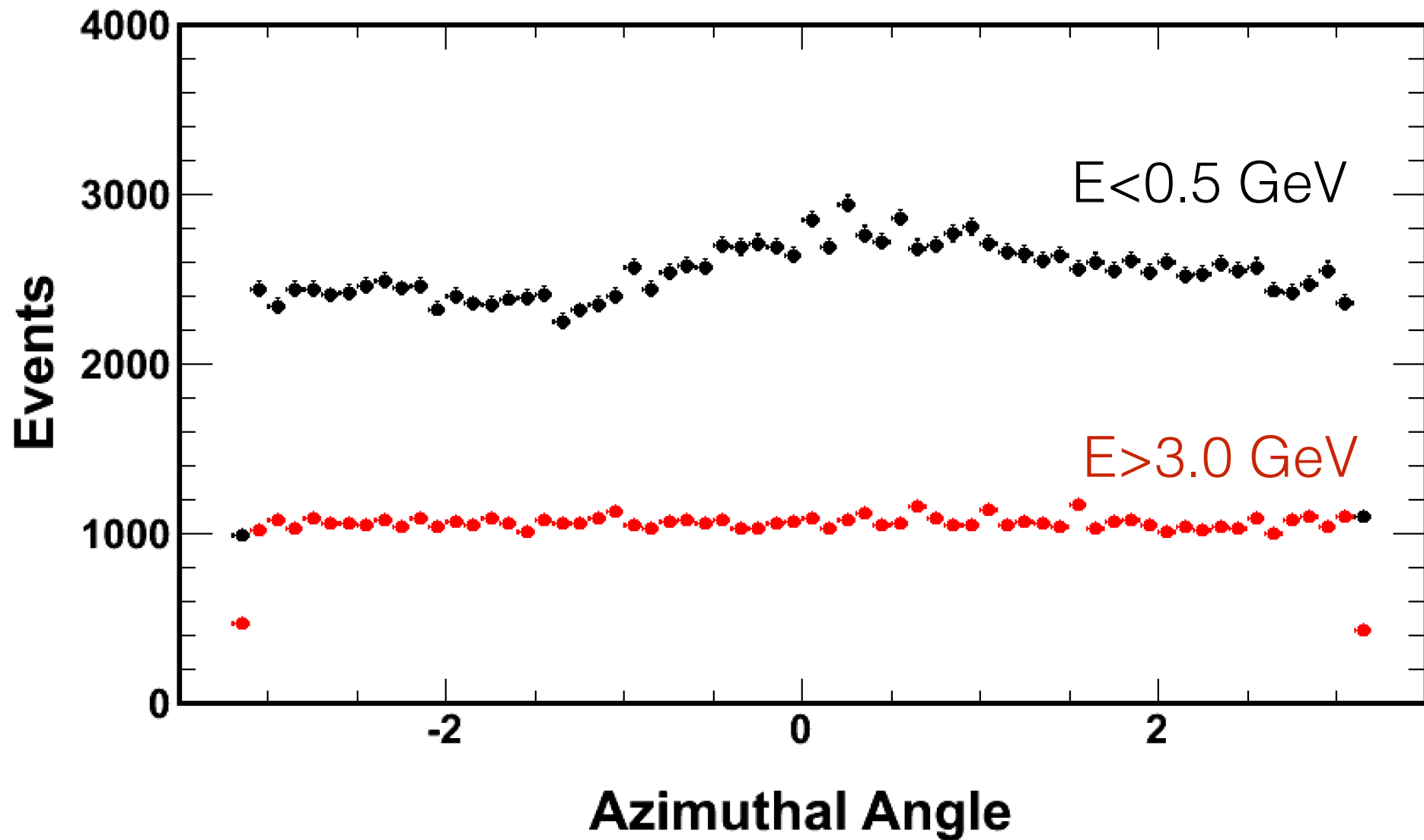
Related Tools

- Validation of the upgoing-muon application gevgen_upmu
  - gevgen_upmu needs a realistic geometry option
  - gevgen_umpu needs a to be interfaced with a realistic dE/dx model (already in GENIE).
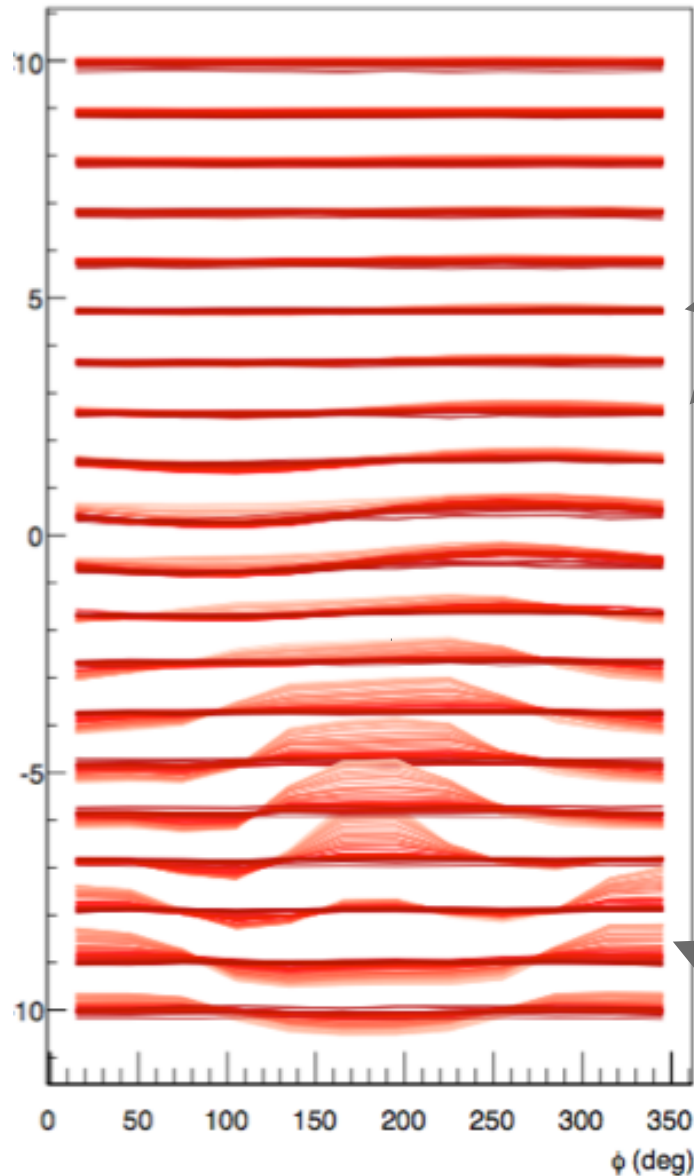
Tested running with the Honda fluxes

E<0.5 GeV

E>3.0 GeV

cos(Zenith Angle)

Tested running with the Honda fluxes

E<0.5 GeV

E>3.0 GeV
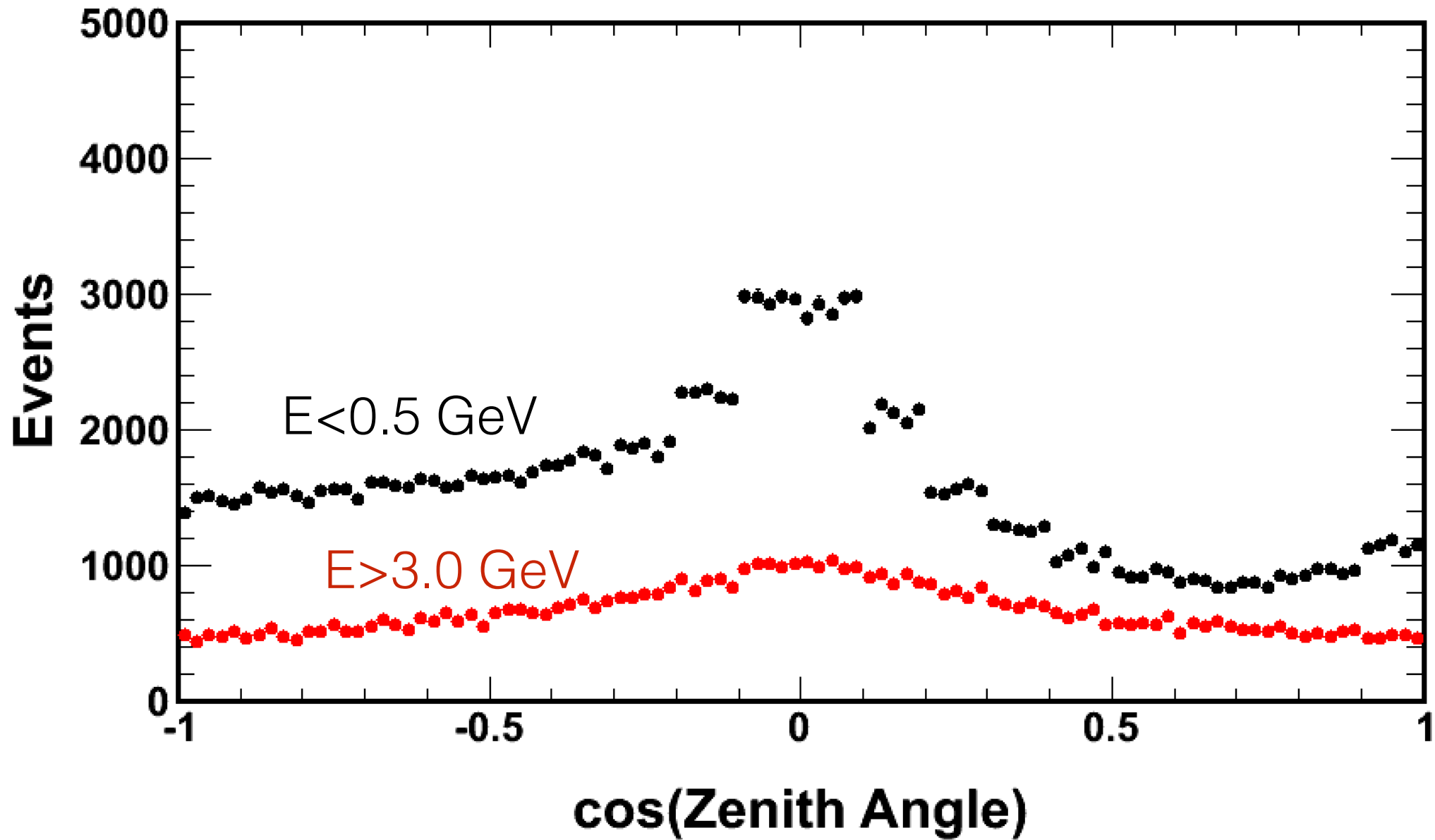
Azimuthal Angle

Events

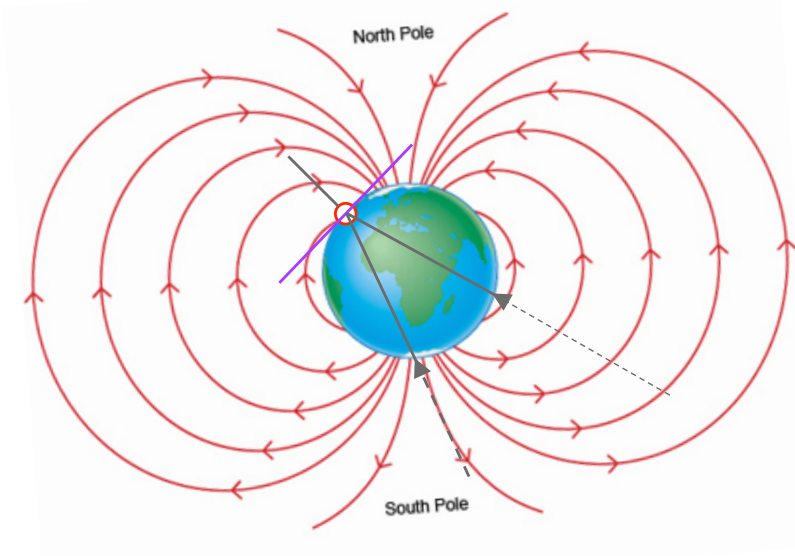# Azimuthal Angles -an early opportunity to provide an in situ demonstration of our detector's capabilities?
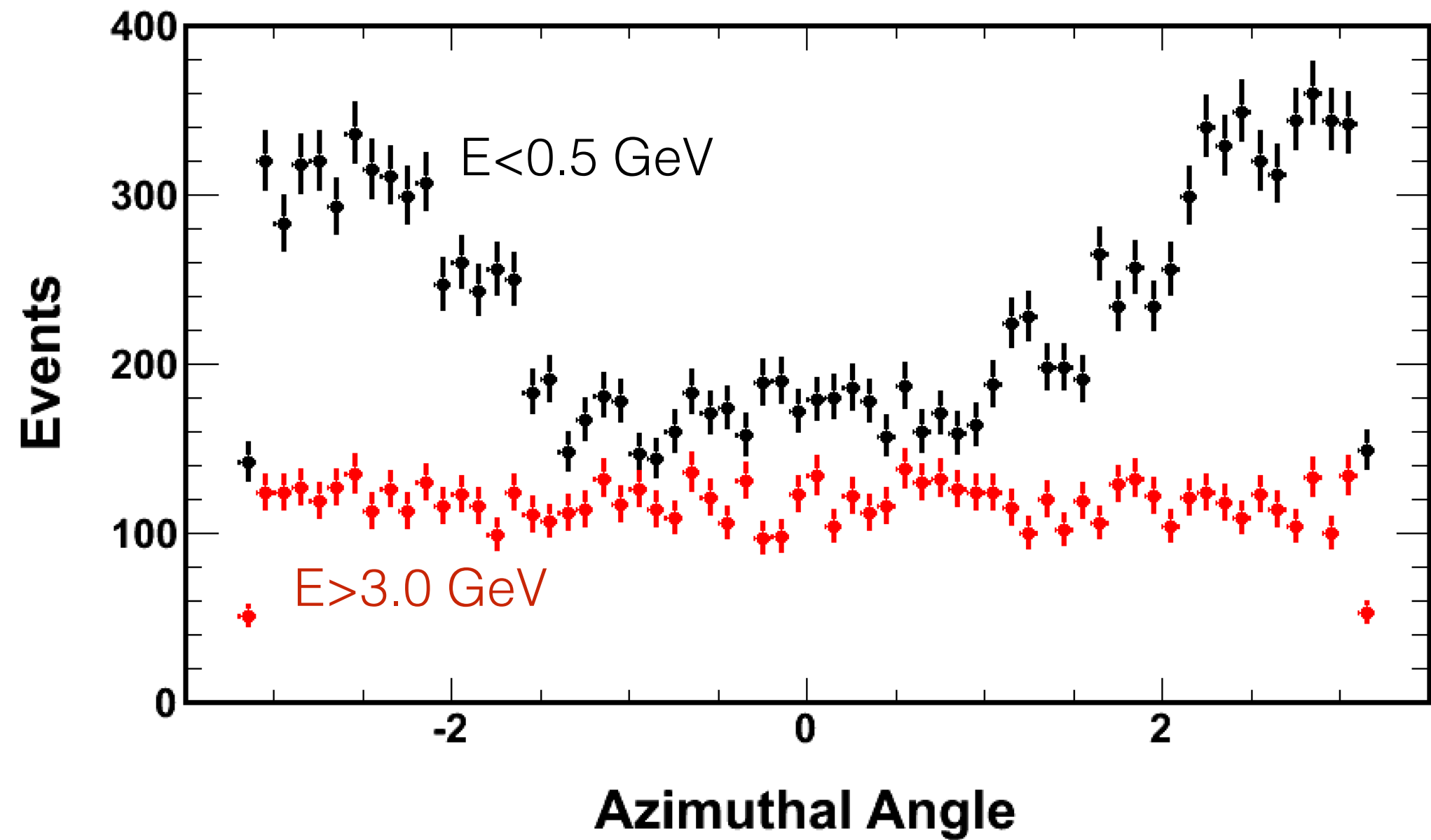
L. Fantini, G. VanWinkle

Bartol/Honda flux ratio for electron neutrinos (Here Bartol is averaged over azimuthal angle)

Bands correspond to different zenith angles.

Colors within a band correspond to 10 bins of neutrino energy from 0-10 GeV (light to dark).

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E<0.5 GeV

E>3.0 GeV

Events

Azimuthal Angle

Conclusions

There has been some recent developments, mainly from the GENIE core team, to make improvements to the atmospheric flux drivers.

These additions are expanding our ability to explore physics opportunities, like measuring the azimuthal distributions.

Lots of scope for contributions (small and large).