Stopgap spectrometer analysis plans

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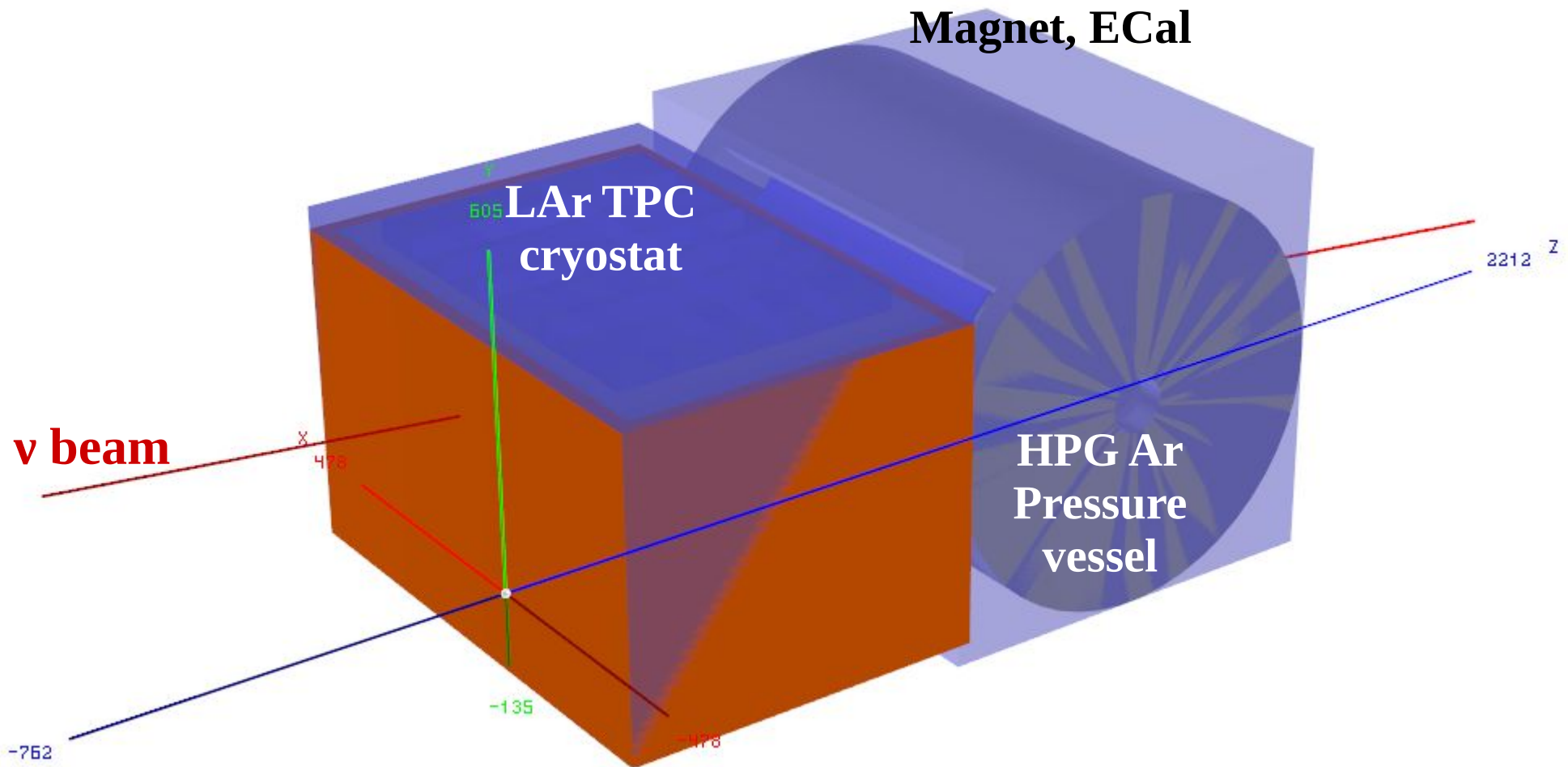16 December, 2019

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What is the stopgap spectrometer

- Baseline plan for DUNE ND is ArgonCube + MPD + SAND/3DST

- As a contingency in the US project, we want to have a backup plan: ArgonCube + muon spectrometer + empty KLOE

- Idea is that this would be the "Day 1" configuration, and it would be upgraded to full MPD+SAND/3DST at some point

- Muon spectrometer might be like MINOS or BabyMIND – measures muon charge & momentum but no other physics program beyond that

- Implications for LBL analysis:
  - Somewhat worse resolution for LAr muons
  - Loss of HPgTPC samples

- Goals:
  - Show that basic LAr-only ND+FD analysis is OK
  - Show what physics would be missing from loss of HPgTPC samples

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Reminder: ND geometry in TDR analysis

Magnet, ECal

LAr TPC cryostat

ν beam

HPG Ar Pressure vessel

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Reminder: TDR analysis ND

- LAr sample only – no explicit HPgTPC events

- But uses HPgTPC for muon reconstruction

- Don't really need full geometry description, end-to-end simulation of muon spectrometer

- Just use HPgTPC as a stand-in, but worsen the assumed resolutions

  - No K0 sample for energy scale calibration

  - Poorer muon momentum resolution

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Study details

- Repeat LAr ND +FD analysis with worsened ND resolutions

  - Tracker muon momentum resolution 3% → 20%

  - Increase resolution uncertainty from 2% → 5%

  - Increase energy scale uncertainty from 1% → 3%

- Reproduce Asimov sensitivities, parameter constraints

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ND neutrino energy resolution
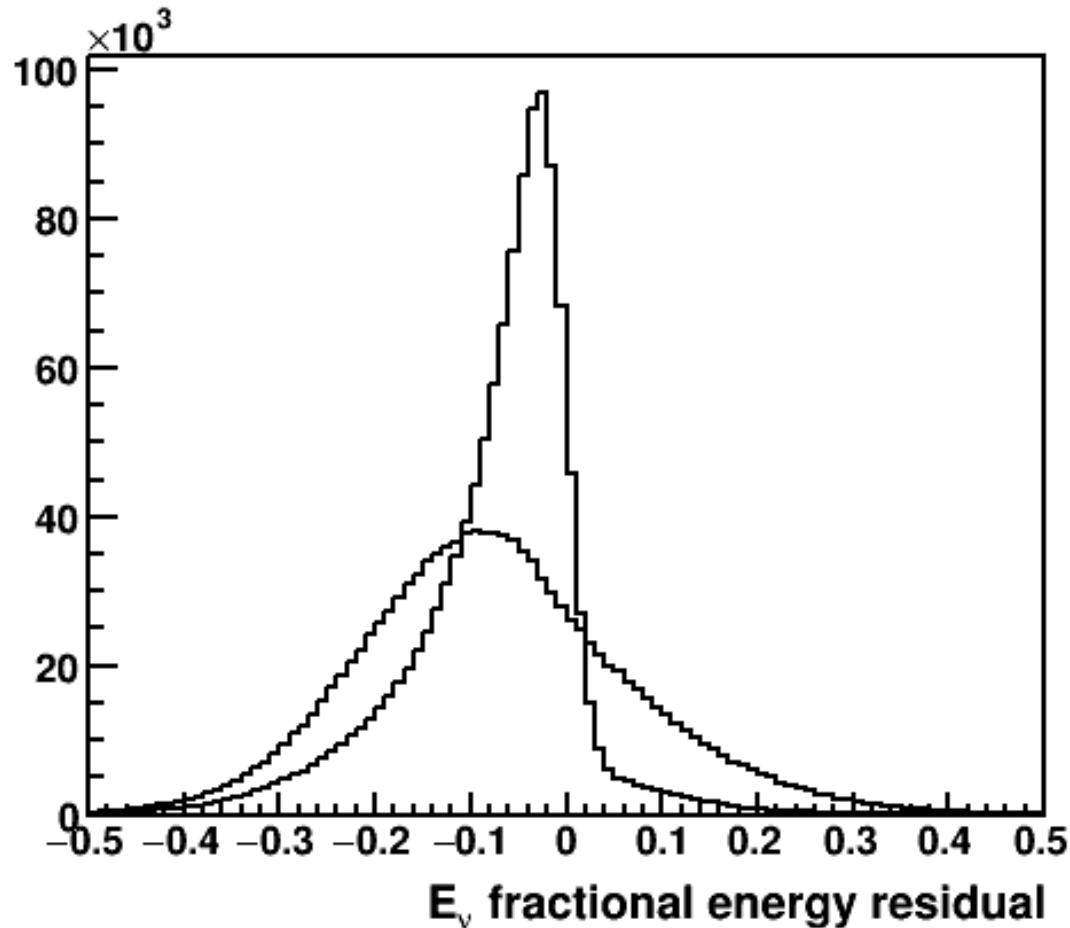
- Narrow peak is the neutrino energy residual from the TDR analysis

- Broad peak is what you get with the 20% muon momentum resolution

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ND covariance matrix updated with worse energy scale
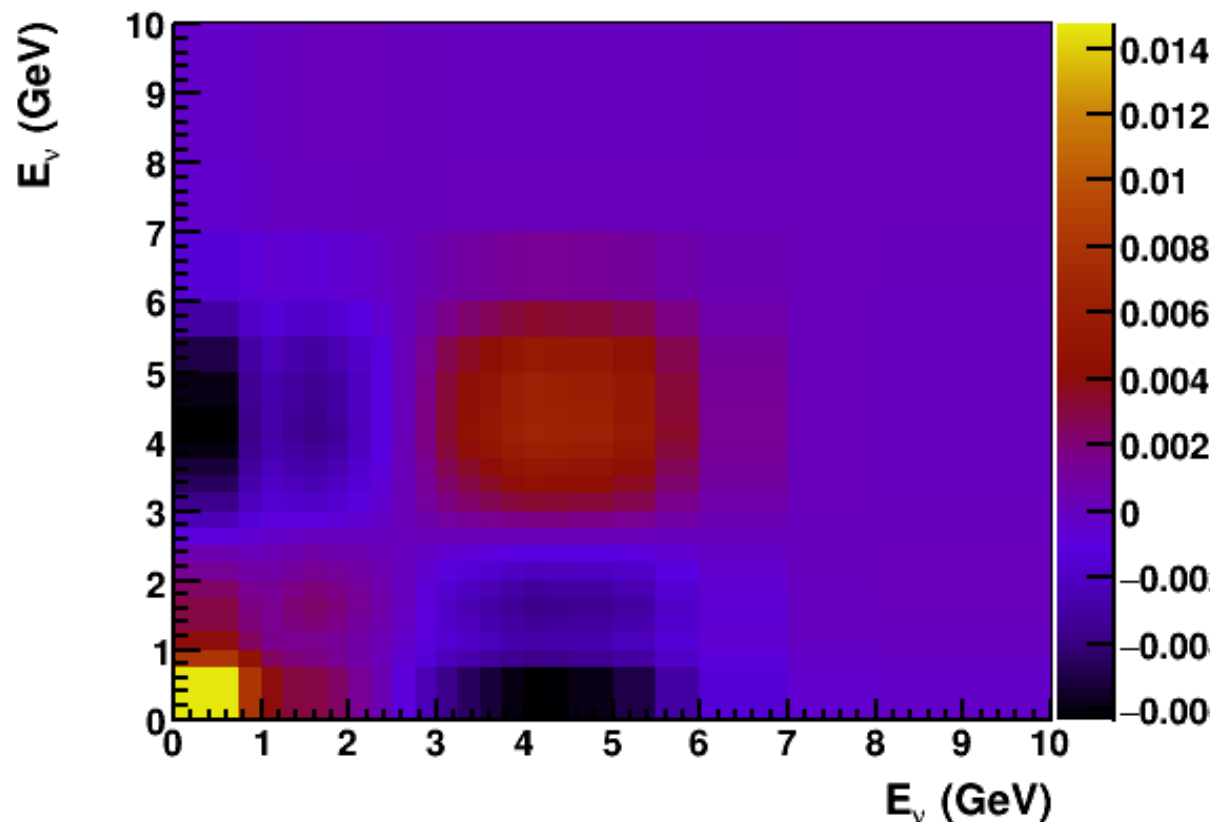
- ND detector uncertainty is implemented with covariance matrix

- Remade covariance matrix with 3% energy scale uncertainty

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Result: parameter constraints

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Comment

- Parameter constraints get very slightly worse

- ND still has very high statistics, provides very tight constraints

- Still need to produce sensitivities, but this suggests the reduction will be minimal

- Conclusion: if we know the cross section model up to the assumed uncertainties, then the LAr + spectrometer measurement is sufficient

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Major to do

- Demonstrate examples of model variations that we would not be able to resolve without HPgTPC

- See Seb's talk

- We would benefit from having one more concrete example

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