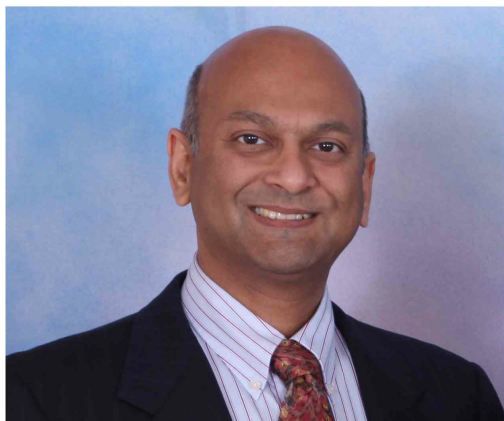Elizabeth Worcester

ICARUS Collaboration Meeting

May 13, 2018

Group Introduction

- BNL's EDG (Electronic Detector Group):
  - ~15 scientific staff, ~10 postdocs
  - Historically rare kaon decay experiments, recently neutrino physics
  - Belle II, Daya Bay, DUNE/protoDUNE, Liquid Argon R&D, ICARUS, g-2, MicroBooNE, PROSPECT, SBND, WbLS R&D
  - Close collaboration with BNL's instrumentation division, particularly on cold electronics for LArTPCs (uBooNE, DUNE/protoDUNE, SBND)
- Current ICARUS members:
  - Milind Diwan
  - Elizabeth Worcester
- Potential additional effort from:
  - Arbin Timilsina (postdoc)
  - Matt Worcester (scientific staff)
  - Technical staff

Current ICARUS Members


- Milind Diwan
  - Senior physicist
  - LBNE Co-spokesperson (2010-2014)
  - Current experiments: Daya Bay, DUNE, ICARUS, Prospect
  - Co-convener of CENF-ND WG1 (Measurement of Neutrino Flux)

- Elizabeth Worcester
  - Physicist
  - Current experiments: Daya Bay, DUNE/protoDUNE, ICARUS, SBND
  - DUNE Deputy Physics Coordinator
  - SBND: BNL PI; Deputy L2 for TPC Electronics
  - protoDUNE Cold Electronics QC Coordinator

E. Worcester Physics Interests

- Long-baseline neutrino oscillation – particularly systematic uncertainty from detector effects and interaction uncertainty – is my primary physics interest
- SBN program very important to DUNE and LBL sensitivity
  - Neutrino interactions on argon
  - LArTPC detector calibration and performance
  - Development of algorithms for LArTPC reconstruction, event selection, oscillation analyses…
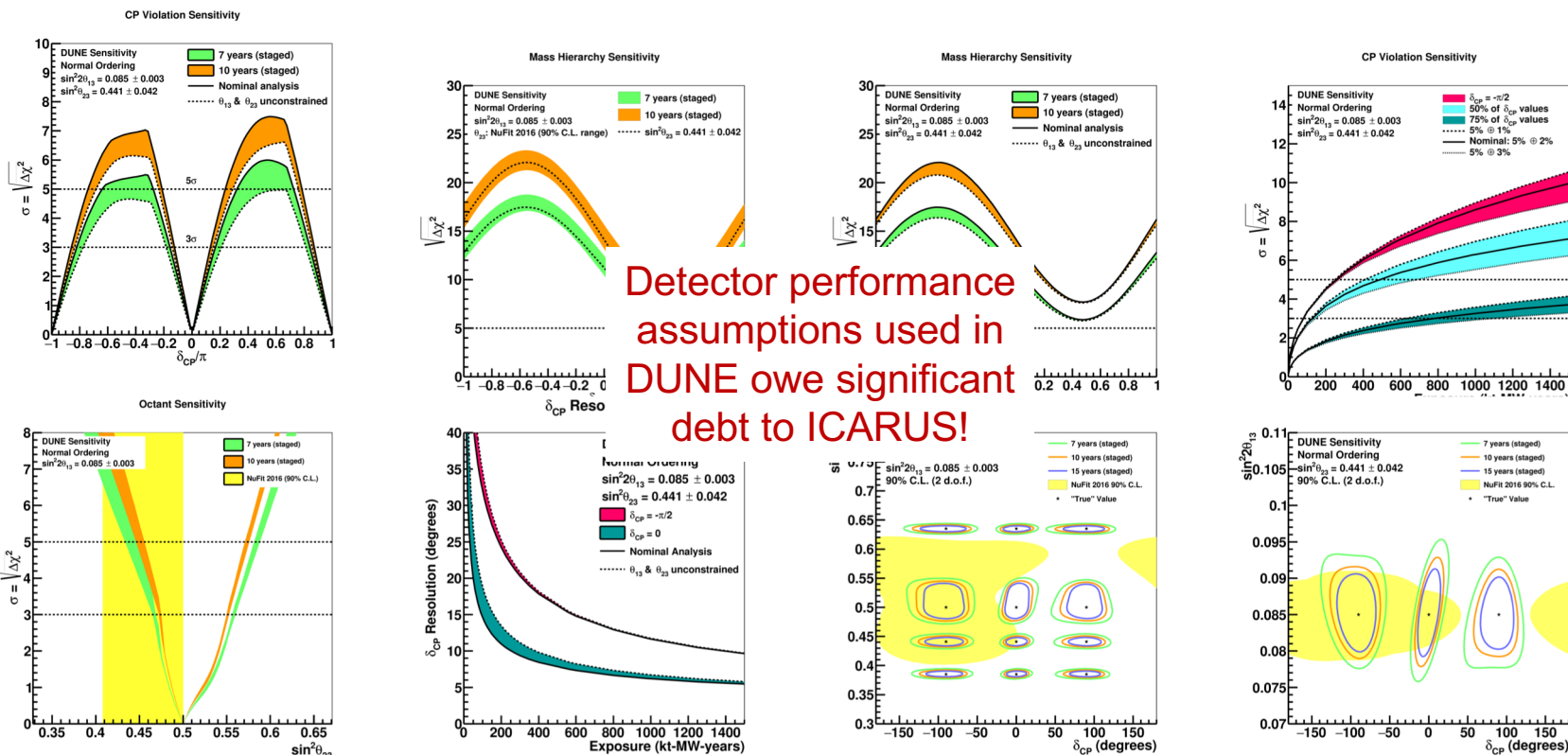
Detector performance assumptions used in DUNE owe significant debt to ICARUS!

Possible Synergistic Contributions

- Space charge effect (LArSoft simulation)
  - Simulation of SCE in protoDUNE developed by Mike Mooney (former BNL postdoc)
  - Arbin Timilsina (BNL postdoc) working on updating code to create field distortion maps and porting implementation to SBND
  - Easy to extend to ICARUS
- Space charge effect (calibration)
  - Mooney, Timilsina, E&M Worcester have worked on protoDUNE SCE calibration scheme using cosmic ray tracks
  - Timilsina has developed TPC-CRT matching algorithms to obtain t_0 tagged sample for use in calibration
  - Matt Worcester developed reconstruction algorithm for Double Chooz Outer Veto (same modules used for protoDUNE CRT and part of ICARUS CRT) – he is working on porting that algorithm to protoDUNE
  - Possible to extend any of these efforts to ICARUS
- CorkisaGen (LArSoft simulation)
  - CORSIKA simulation of cosmics in LArSoft developed by Matt Bass (BNL Goldhaber fellow) for uBooNE/SBND, implemented for protoDUNE by M. Bass and E. Worcester
  - Easy to extend to ICARUS if needed
- Deep learning PID
  - Timilsina working on TensorFlow-based PID in protoDUNE
  - Possible to extend to ICARUS

protoDUNE CRT Analysis (Timilsina)

- Developed algorithm to match CRT hits with TPC tracks
  - 40% efficiency for ~100% purity (want clean sample for use in calibration)
  - Makes use of both tracks and light in TPC
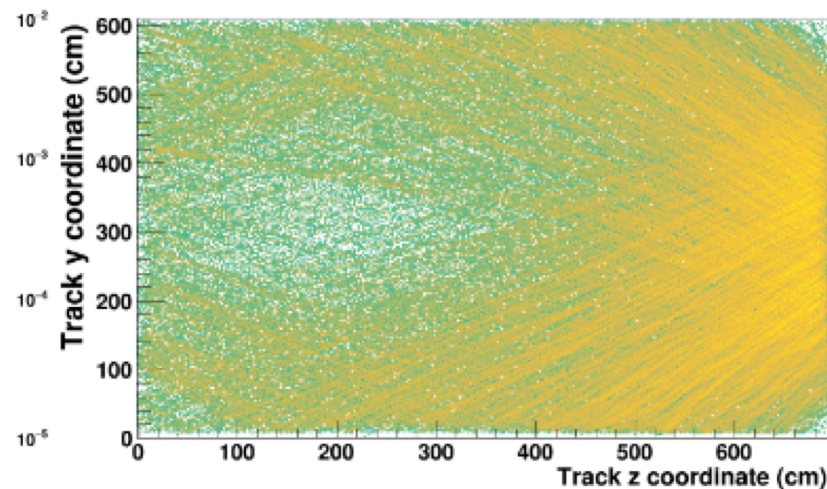 - Studying volume coverage for different geometry choices for CRT

$z = -4\text{ m}$ Y vs X Coverage   Y vs Z Coverage $z = -4\text{ m}$
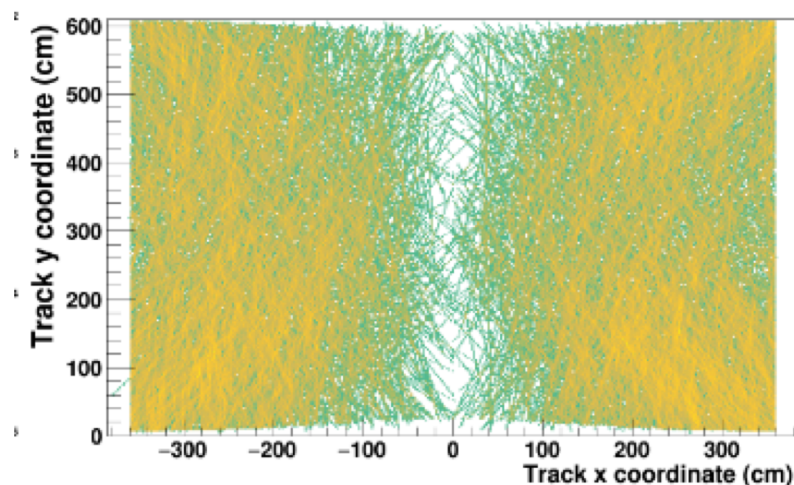
More Speculative Possibilities

- TPC Electronics Testing/Commissioning/Monitoring
  - Timilsina, Worcesters have significant experience testing LArTPC electronics (protoDUNE, SBND)
  - No specific experience with ICARUS system, but some tools and experience could transfer
- CRT Testing/Commissioning/Monitoring
  - M. Worcester built the Double Chooz CRT modules
  - Timilsina helped out with ICARUS installation of Double Chooz CRT modules in 2017 and is involved in protoDUNE CRT group
- As-needed technical support or extra hands
  - BNL has extensive engineering/technical resources, many individuals experienced with LArTPCs
  - Timilsina/Worcesters available for 1-2 week trips to Fermilab to help with installation/commissioning activities

Summary

- EDG is a large group involved in a diverse set of experiments in the neutrino/intensity frontier program

- ICARUS effort is currently very small

- uBooNE, SBND, DUNE/protoDUNE efforts producing many simulation/analysis tools that could be useful for ICARUS

- We would like to get involved in ICARUS commissioning/operations

  - Probably not realistic to take on major system responsibilities

  - Do have significant experience/expertise to offer, particularly on electronics and CRT

  - Do have extensive engineering/technical resources at BNL

  - Do have ability to send people to Fermilab for 1-2 weeks at a time

  - Please contact Elizabeth if you see a good place for us to pitch in