The Short Baseline Neutrino Program

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Neutrinos at Fermilab I Briefing to DOE OHEP

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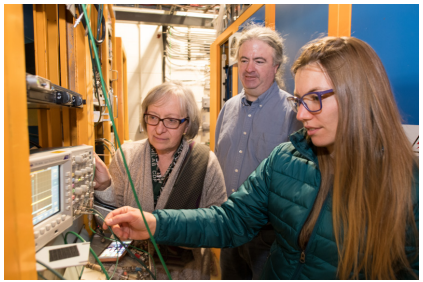
Personal bio

- Ph.D. from Padova University (Italy) in 2010
  Postdoc in Padova 2010-2015
  Joined FNAL in 2015 as Wilson Fellow, now Scientist
- Working on the Icarus detector since 2006
  - Deputy Technical Coordinator
  - Commissioning Coordinator
  - Co-convener of the SBN DAQ and data pre-processing working group

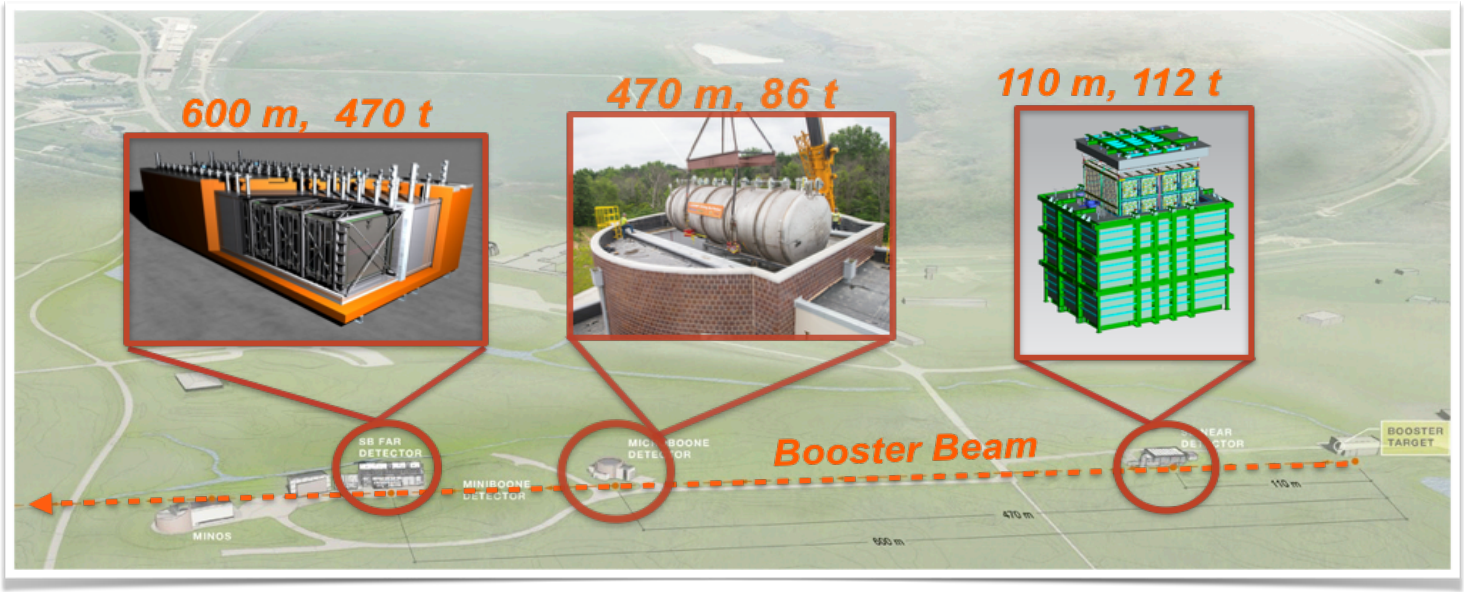


- Strong interest in detector R&D, especially for LAr-TPC
  - Awarded LDRD: “LArCADe: liquid argon charge amplification devices”
  - Proposed LDRDs: magnetization of LAr-TPC and GEM-based readout of high-pressure GAr-TPC for tracking of nuclear recoils
- Other roles
  - LBNC scientific secretary
  - Member of FNAL Detector Advisory Board and Technology Committee
  - Commitment to Education & Outreach

Short Baseline Neutrino Program at Fermilab

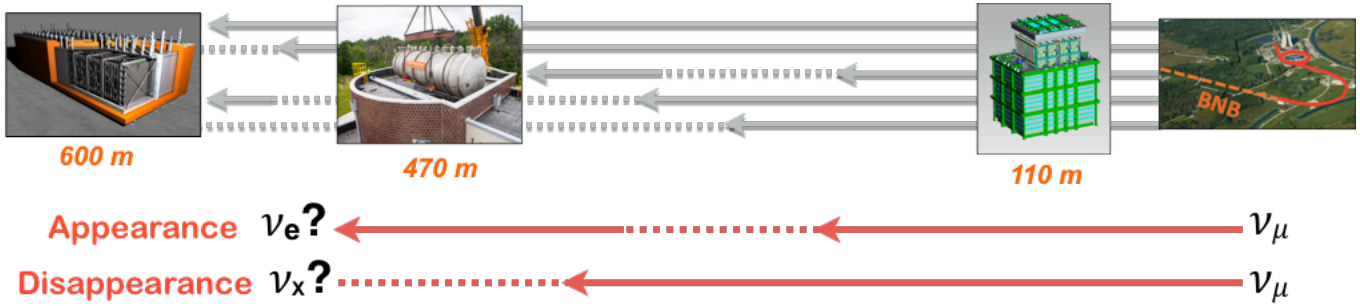
Program aimed at solving the “sterile neutrino puzzle”, i.e. the possible existence of a fourth type of neutrino not interacting via weak force.

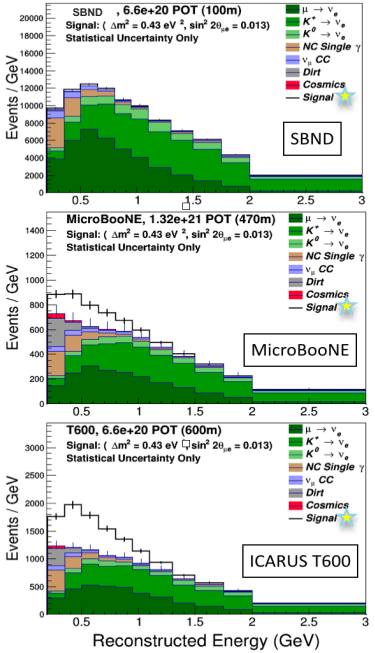
- Well characterized FNAL Booster ν beamline.
- Three detectors based on the same liquid argon TPC technique.



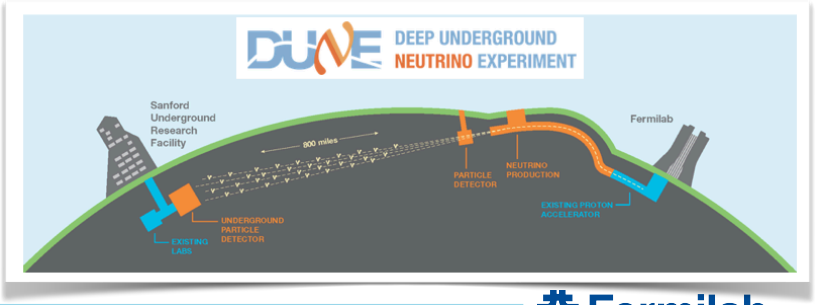
SBN goals

- Search for short baseline oscillations both in appearance and disappearance channels.





- Lay the ground for future long baseline program (DUNE):
  - Further develop LAr-TPC detector technology
  - Further develop software tools and infrastructure for simulation and reconstruction
  - Measure ν-Ar cross sections at energies relevant to DUNE



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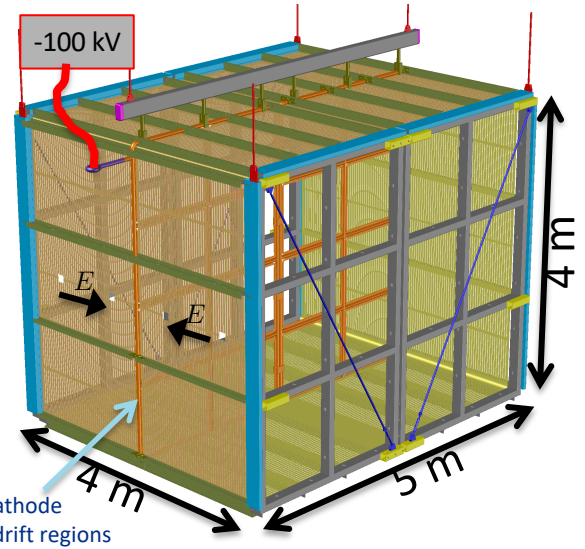
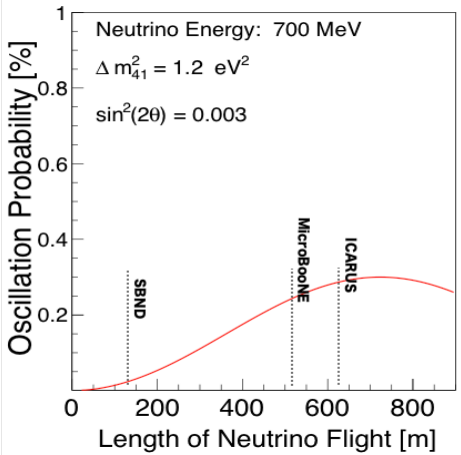
The near detector: SBND

- 260 t of LAr, 112 t active mass, 110 m from the source.
- 2 TPCs with 2 m drift and 3 wire planes.
- 112 8” PMTs coated with TPB.
- 120 8” PMT (96 coated with TPB, 24 uncoated) and 192 ARAPUCA modules same as DUNE’s





Expected data taking 2022

- Characterization of ν beam before the onset of oscillations, addressing one of the dominant systematic uncertainties.
- ~ 1.5 million ν_μ CC and ~12,000 ν_e CC interactions per year: largest data sample of ν-Ar interactions in the world, including energies relevant to 1st and 2nd DUNE oscillation peaks

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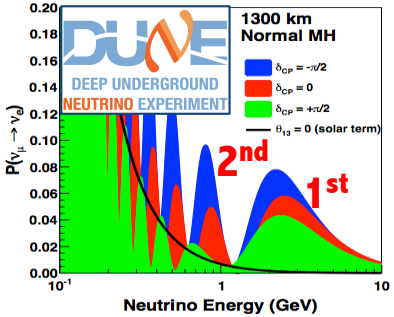
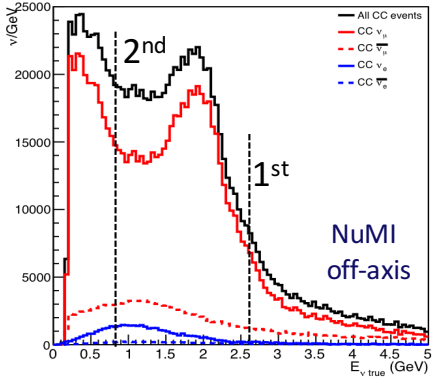
The far detector: ICARUS

- 760 t of LAr, 476 t active mass, 600 m from the source.
- 4 TPCs with 1.5 m drift and 3 wire planes.
- 360 8” PMTs coated with TPB.
- Almost full CRT coverage.

Currently in commissioning phase!





- High sensitivity to oscillated neutrinos → precision search.
- ~ 10^5 NuMI off-axis events/year, high statistics for both 1st and 2nd DUNE oscillation peaks.

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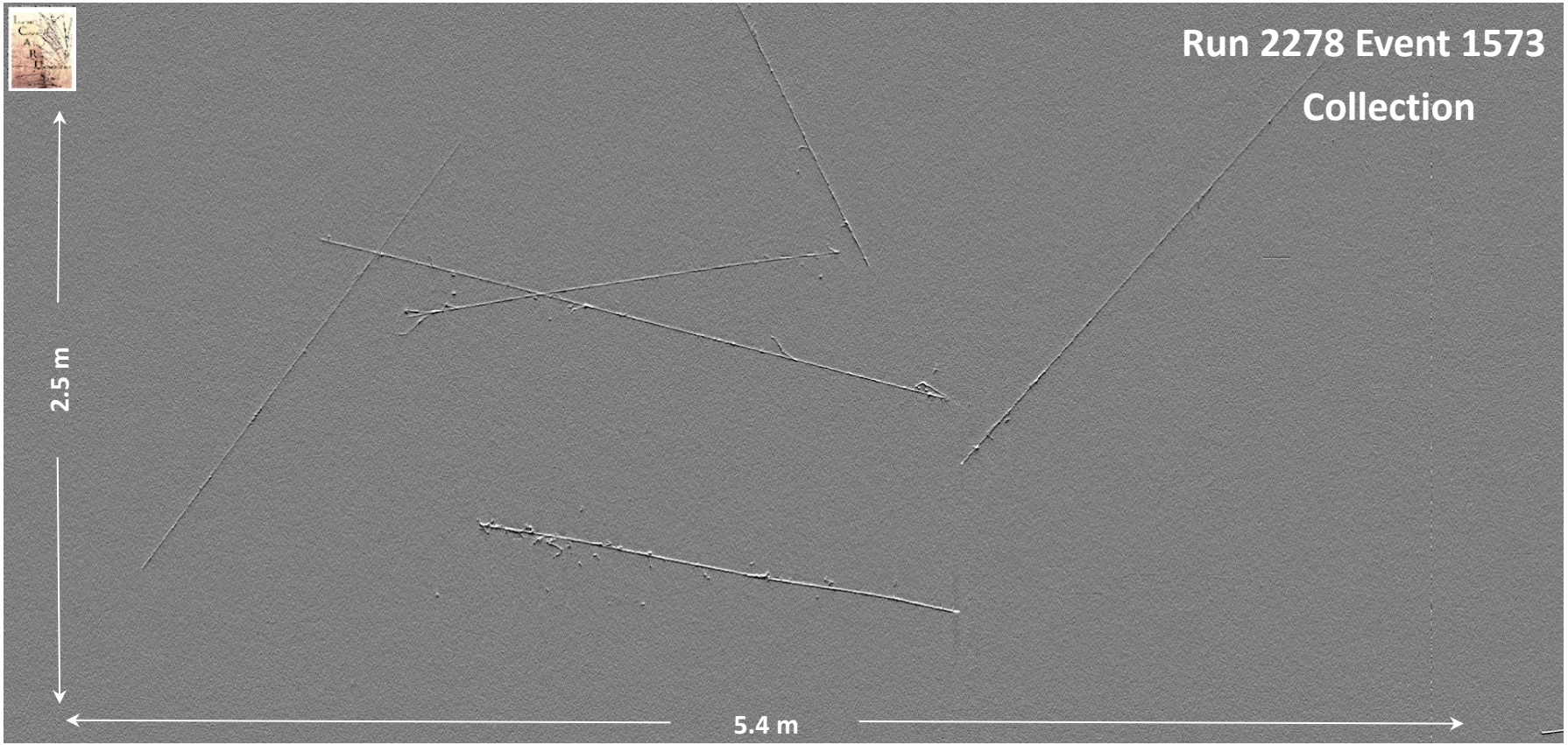
First events from the ICARUS detector



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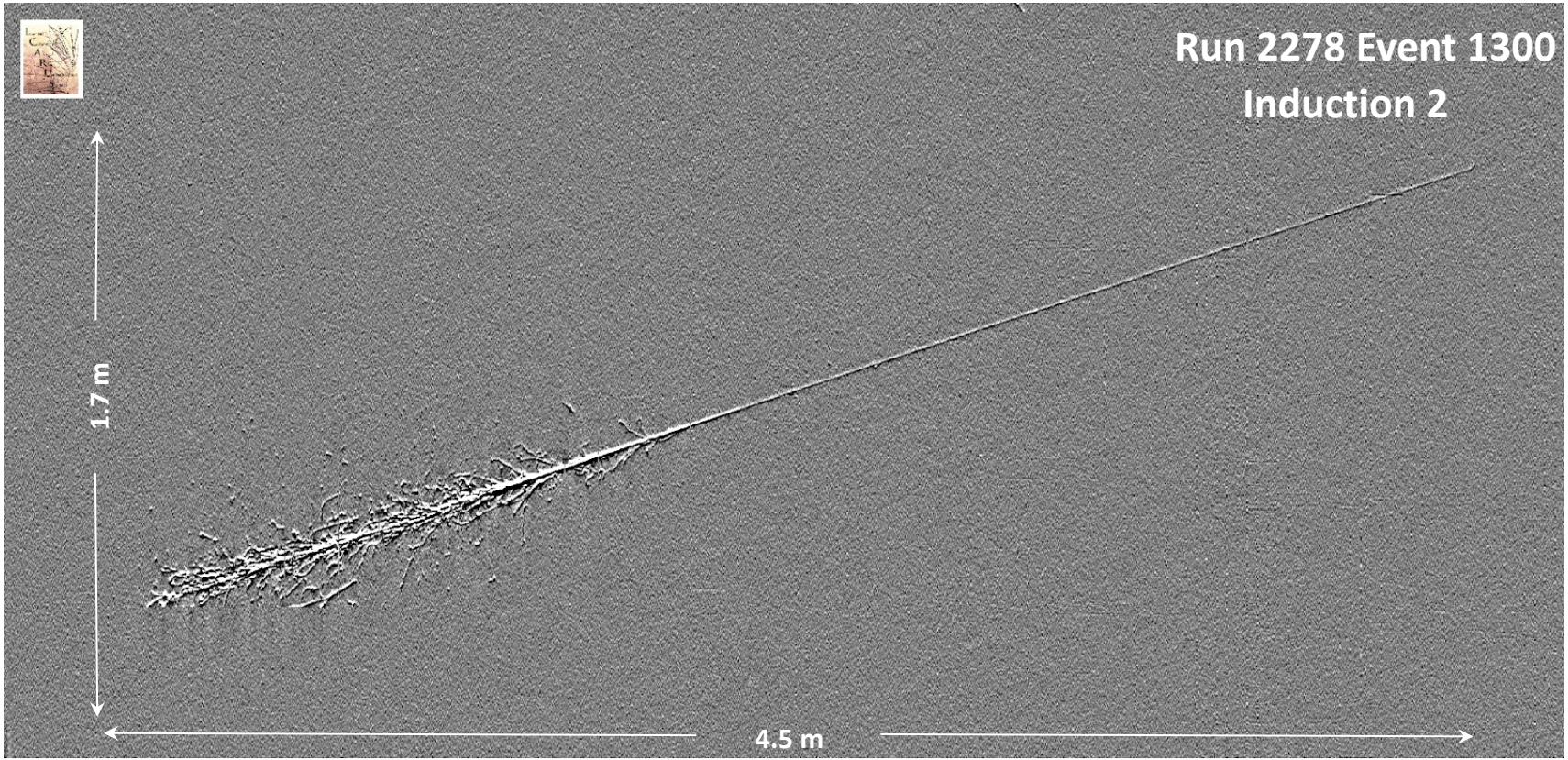

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Leadership roles of Fermilab scientists/post-docs

- Project/Program management
  - **Project/Program managers:**
    P. Wilson (SBN Program Coordinator), **C. James** (Deputy SBN Program Coordinator)
  - **Technical Coordinators (TC):**
    R. Acciarri (SBND Installation Coordinator and detector assembly co-coordinator), **A. Fava** (ICARUS Deputy TC and Commissioning Coordinator), **B. Howard** (former ICARUS Deputy Commissioning Coordinator), **C. Montanari** (ICARUS TC), **A. Schukraft** (SBND Technical Coordinator), **M. Stancari** (SBND Commissioning Coordinator),
- Experiment leadership
  - **Spokespersons:**
    O. Palamara (SBND co-spokeperson), **S. Brice** (SBN Oversight Board chair)
  - **Working Group Conveners:**
    M. Betancourt (SBN CRT), **A. Fava** (SBN DAQ), **W. Ketchum** (SBN DAQ and SBN Software Infrastructure), **O. Palamara** (SBN Analysis), **G. Savage** (SBN slow-controls), **J. Zennamo** (SBN Software Infrastructure)
- Several early career scientists in leadership roles, building competences for tomorrow!

Contribution of Fermilab group to the SBN research plan

- ~30 Fermilab scientists and post-docs play key roles in SBN research program.
- Driving force for joining SBND and ICARUS efforts in all common aspects (DAQ, slow-controls, CRT, analysis).
- **M. Betancourt, M. Del Tutto, A. Fava, B. Howard, W. Ketchum, O. Palamara, M. Stancari, M. Wospakrik, J. Zennamo** and **J. Zettlemoyer** give important contributions to SBN analysis in:
  - multi-detector oscillation studies;
  - cross section measurements (high-statistics with the BNB and off-axis with NuMI);
  - Physics beyond the Standard Model;
  - simulation, reconstruction, calibration development for SBN LArTPCs and beyond.
- **O. Palamara** & **P. Machado** initiated in FY18 a series of SBN-Theory meeting, bringing together theorists and SBN experimentalists to jointly develop new ideas for the possible detection of unconventional neutrino-sector and dark-sector physics signals in the SBN neutrino experiments. Overlap with DUNE physics.