JOINT MICROBOONE AND LAR1 SHORT-BASELINE OSCILLATION SENSITIVITIES

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OUTLINE

- MicroBooNE and LAr1 in a near/far detector configuration to look for short-baseline oscillations

  This is potentially a two neutrino beam experiment, with both the BNB and the NuMI beam*

*NuMI beam sensitivities coming soon…

MICROBOONE'S PHYSICS GOALS

- R&D physics
- Cross sections
- MiniBooNE low energy excess
- Short-baseline oscillations

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MICROBOONE'S OSCILLATION SENSITIVITY

○ Oscillation sensitivity assumptions*:

- BNB beam, on-axis
- Two-neutrino oscillations
  $P = \sin^2 2\theta_{\mu e} \sin^2(1.27\Delta m^2 L/E)$
- **80%** reconstruction efficiency (flat in E)
- **3%** nue background **mis-ID** rate
- **3%/sqrt(E[GeV])** EM shower energy **resolution**
- 6% muon energy resolution
- fits exclude low energy range (**E>475 MeV**)

*Same assumptions for LAr1

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MICROBOONE'S OSCILLATION SENSITIVITY

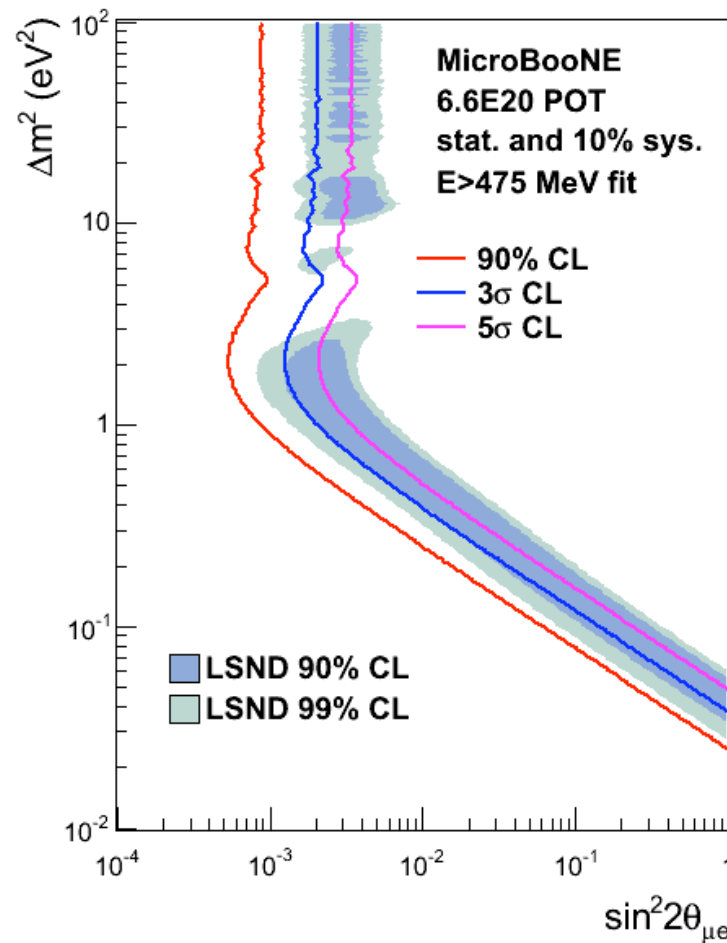## MicroBooNE's sensitivity is statistics-limited
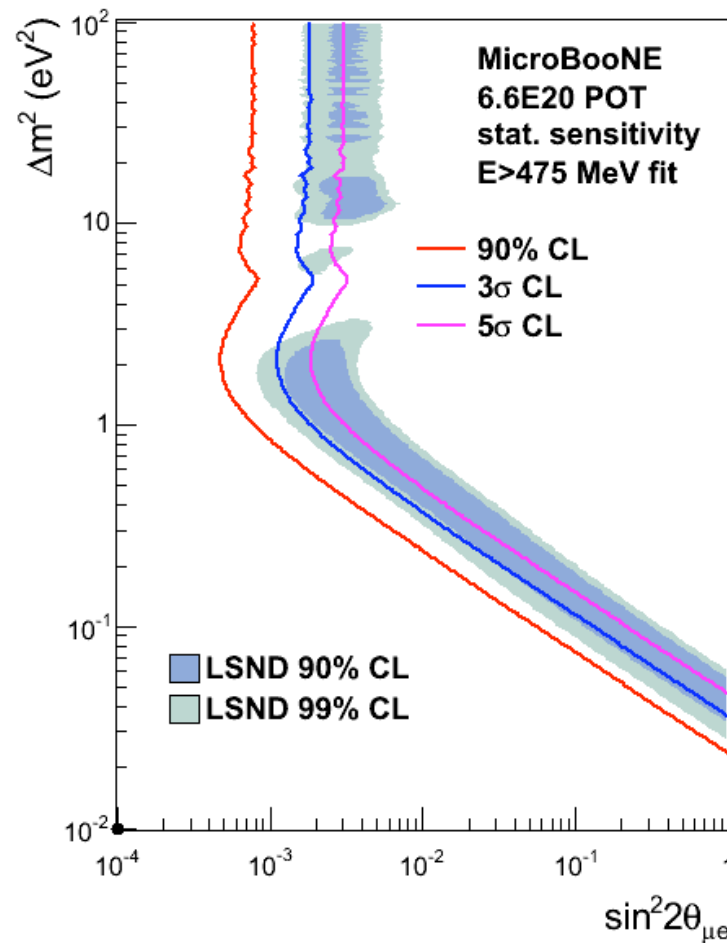
Neutrino mode

Expected background events (475-1250 MeV): ~150

Expected signal events at LSND best fit (475-1250 MeV): ~70

signal/sqrt(bkgd) = 5.7

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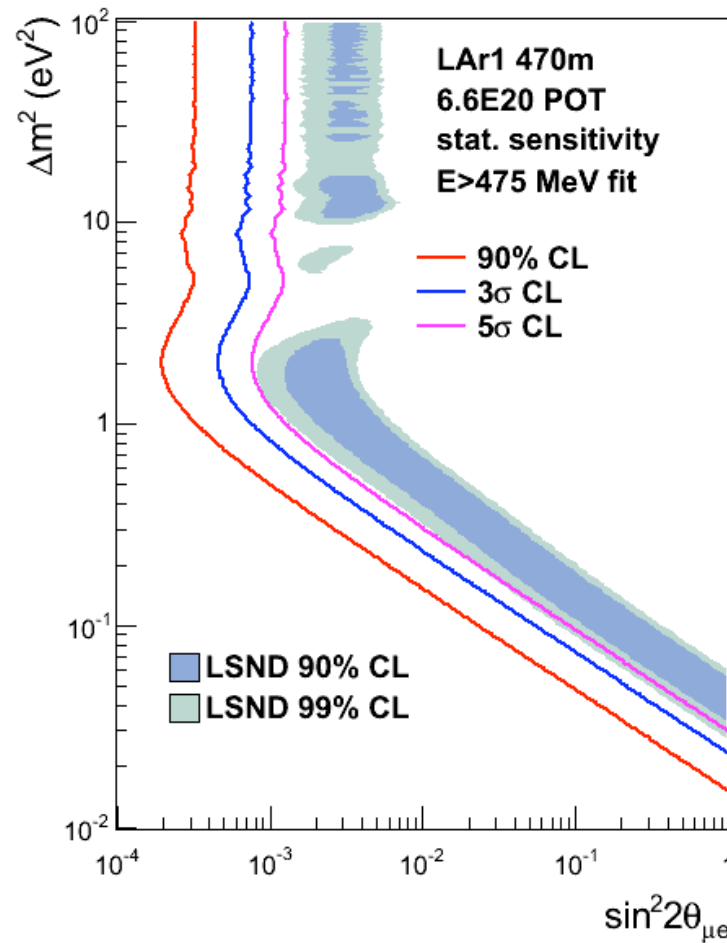
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LAR1'S OSCILLATION SENSITIVITY

LAr1's sensitivity, at same location, is systematics-limited (5.5x larger)

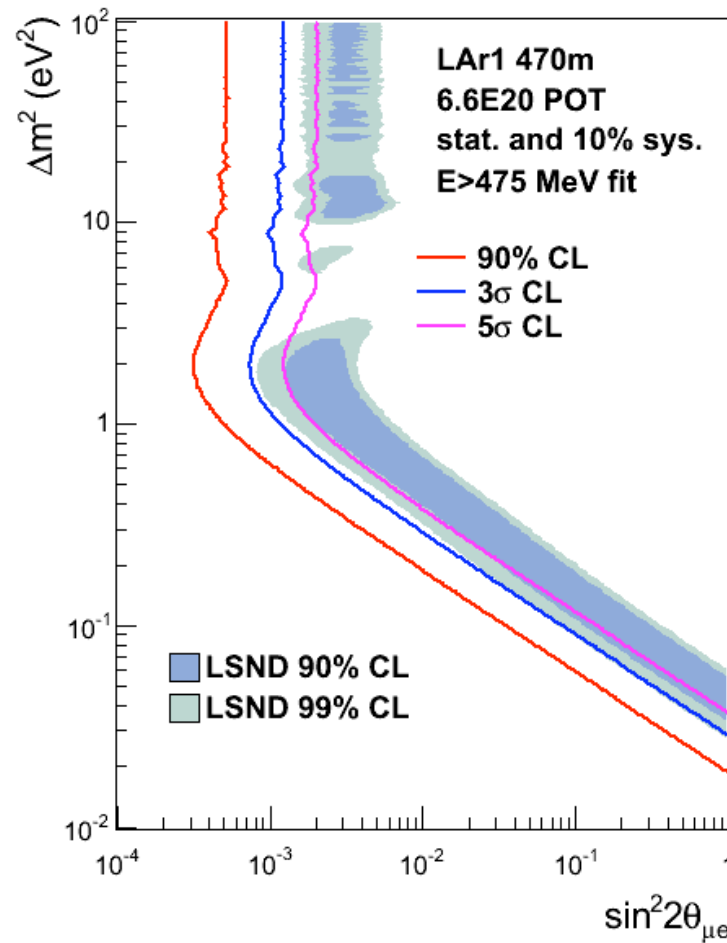**Neutrino mode**

Expected background events (475-1250 MeV):
 ~880
Expected signal events at LSND best fit (475-1250 MeV):
 ~400

signal/sqrt(bkgd) = 13.5

LAr1's Oscillation Sensitivity

LAr1's sensitivity, at same location, is systematics-limited (5.5x larger)

Neutrino mode

Expected background events (475-1250 MeV):
    ~880
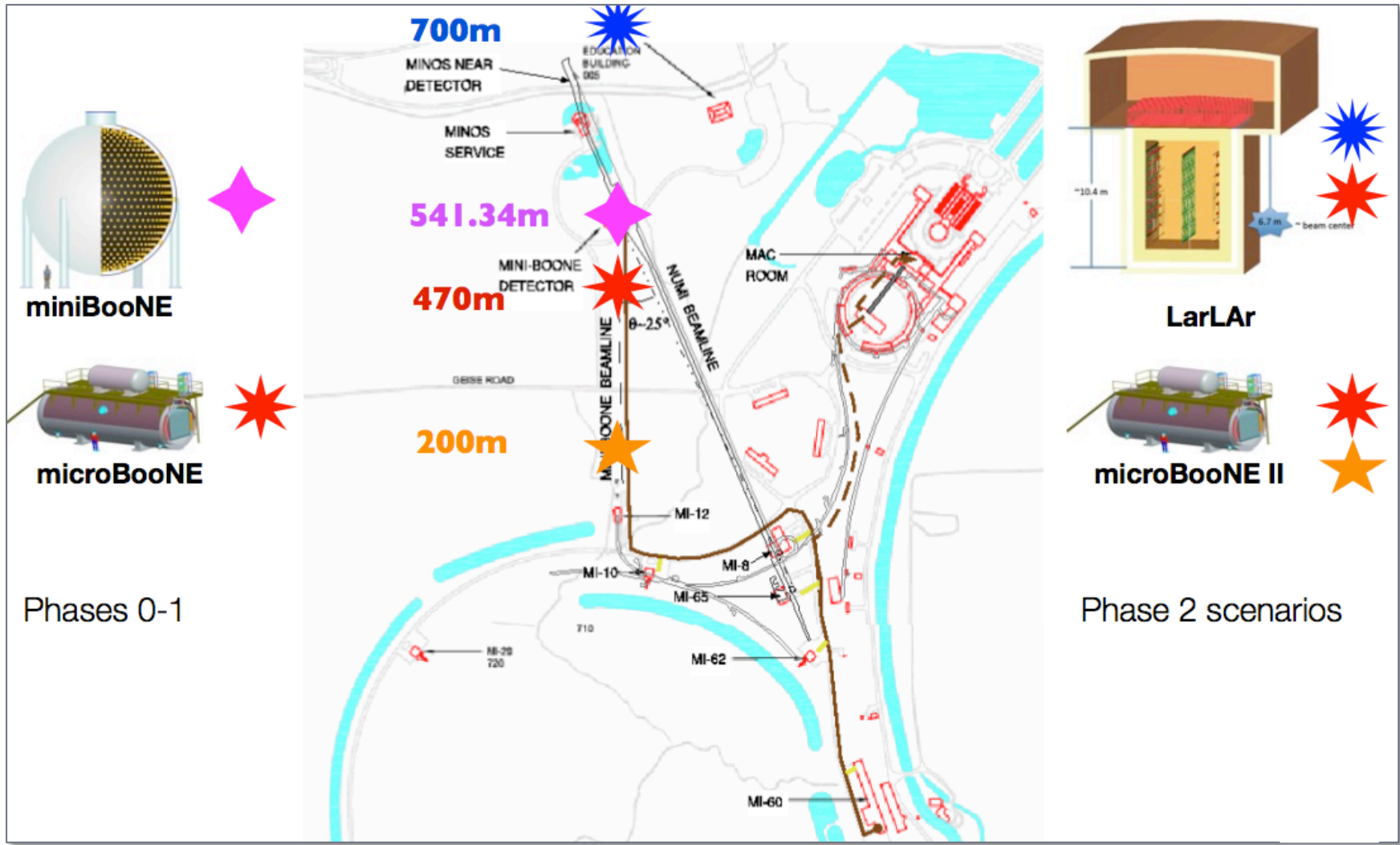Expected signal events at LSND best fit (475-1250 MeV):
    ~400

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It would be great to have LAr1 in the BNB/NuMI beam, with reduced systematics!

- Far detector to MicroBooNE?

*We are in the process of optimizing LAr1 baseline. Sensitivities shown next assume LAr1 at 700m location (both detectors on-BNB-axis)
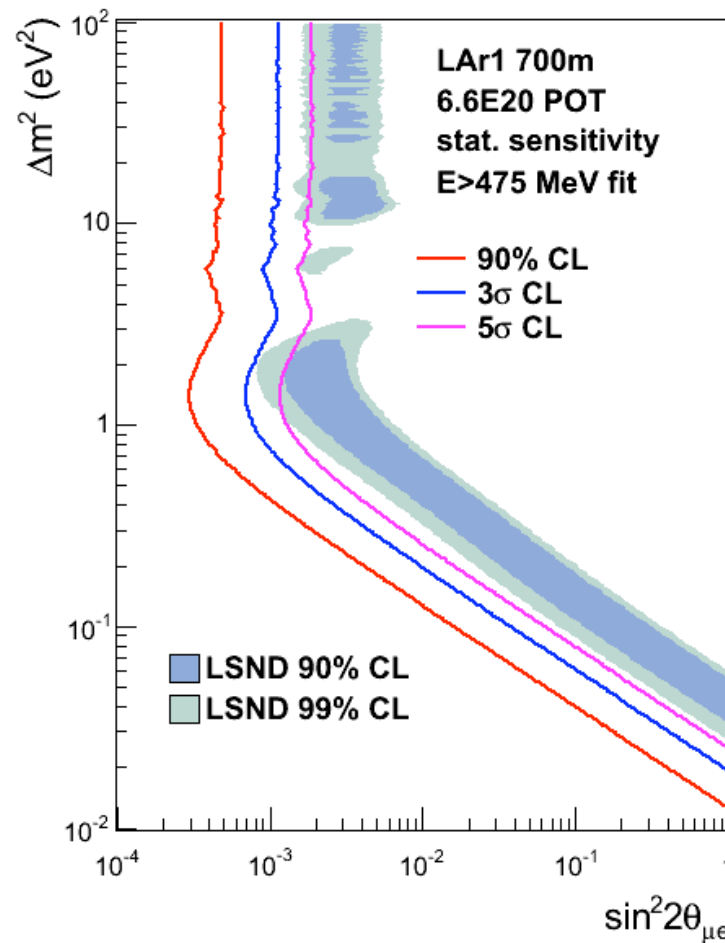
POSSIBLE DETECTOR CONFIGURATIONS

LAr1's Oscillation Sensitivity

At 700m, LAr1 sensitivity ~equally limited by systematics and statistics

Neutrino mode

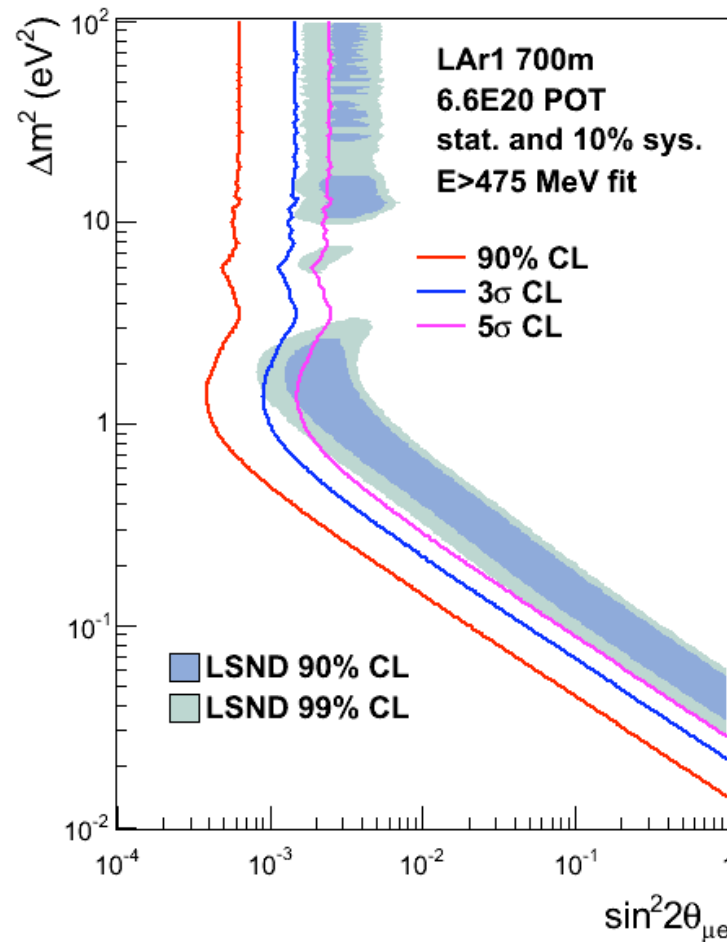Expected background events (475-1250 MeV):
    ~370
Expected signal events at LSND best fit (475-1250 MeV):
    ~230

signal/sqrt(bkgd) = 12.0

LAr1's Oscillation Sensitivity

(@ 700m)

At 700m, LAr1 sensitivity ~equally limited by systematics and statistics

Neutrino mode
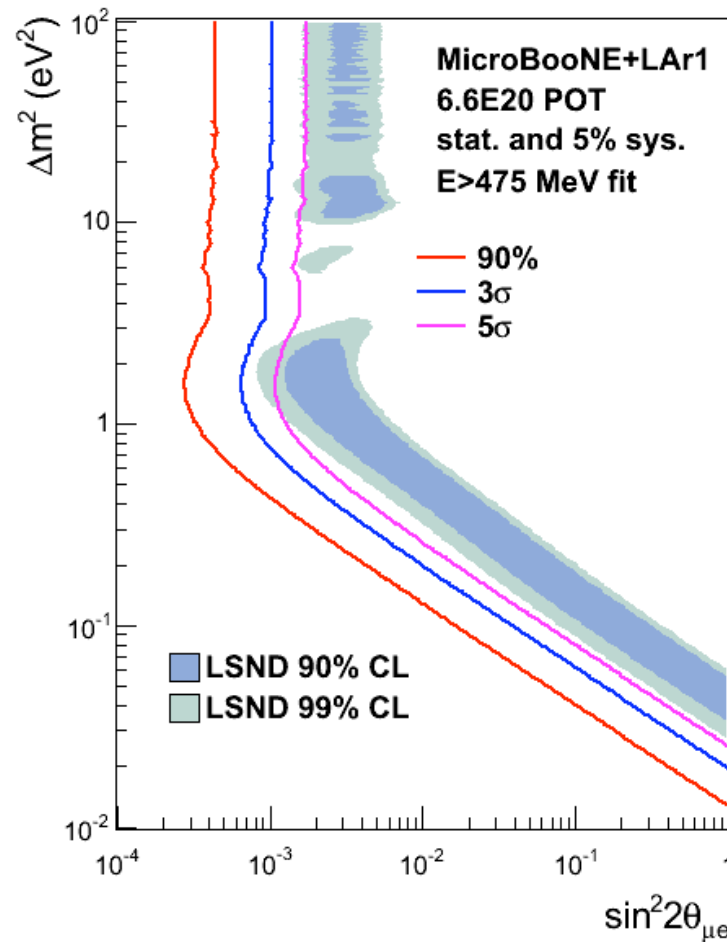
Expected background
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COMBINED MICROBOONE + LAR1 SEARCH

(ASSUMING 5% UNCORRELATED SYSTEMATIC UNCERTAINTIES)

With MicroBooNE as a near detector, LAr1 comfortably covers the LSND 90% allowed region at 5σ :

Neutrino mode

COMBINED MICROBOONE + LAR1 SEARCH

(ASSUMING 2% UNCORRELATED SYSTEMATIC UNCERTAINTIES)

With MicroBooNE as a near detector, LAr1 comfortably covers the LSND 90% allowed region at 5σ :
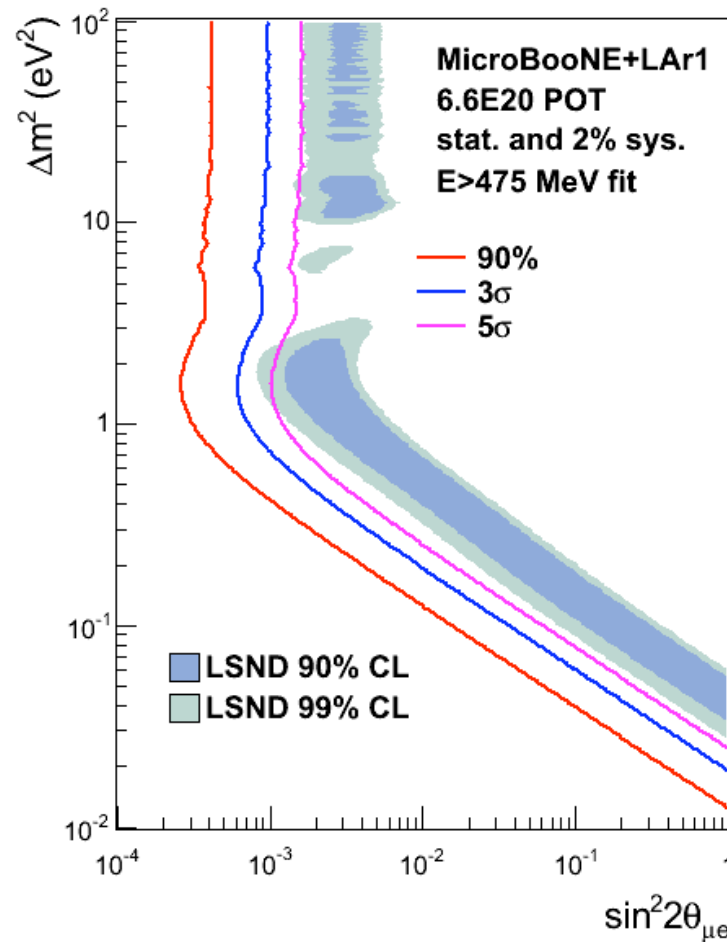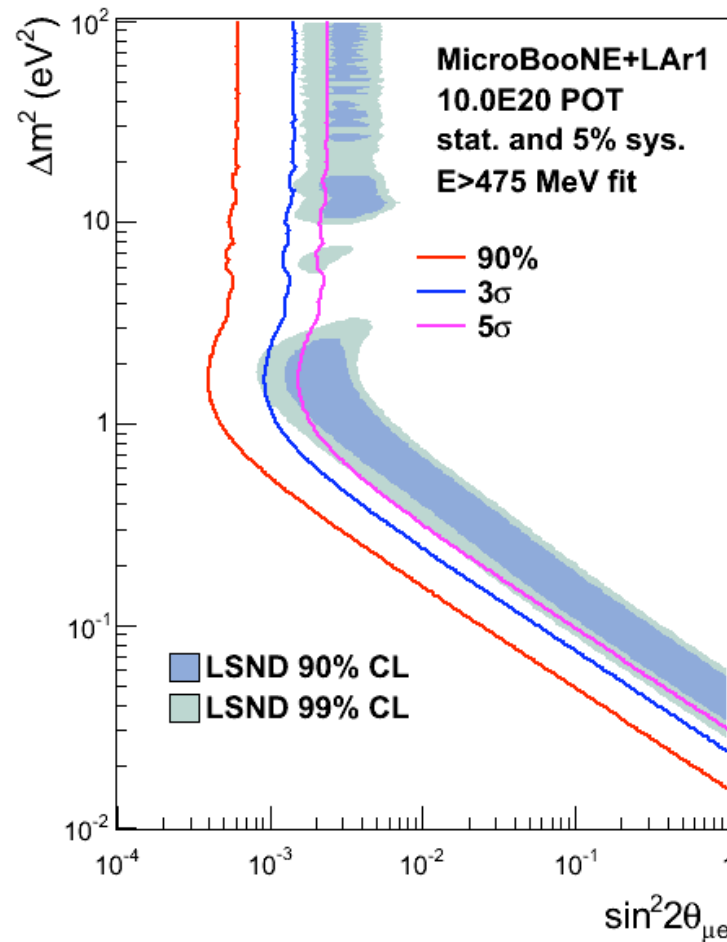
Neutrino mode

MicroBooNE+LAr1
6.6E20 POT
stat. and 2% sys.
E>475 MeV fit

— 90%
— 3σ
— 5σ

LSND 90% CL
LSND 99% CL

Δm^2 (eV^2)

$\sin^2 2\theta_{\mu e}$

With room for improvement with reduced systematic uncertainties.

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COMBINED MICROBOONE + LAR1 SEARCH

In antineutrino mode, 5σ coverage of LSND 90% CL allowed region can be achieved for >10E20 POT.

Antineutrino mode

COMBINED MICROBOONE + LAR1 SEARCH

Given current best-fit from <u>antineutrino SBL</u> data sets:
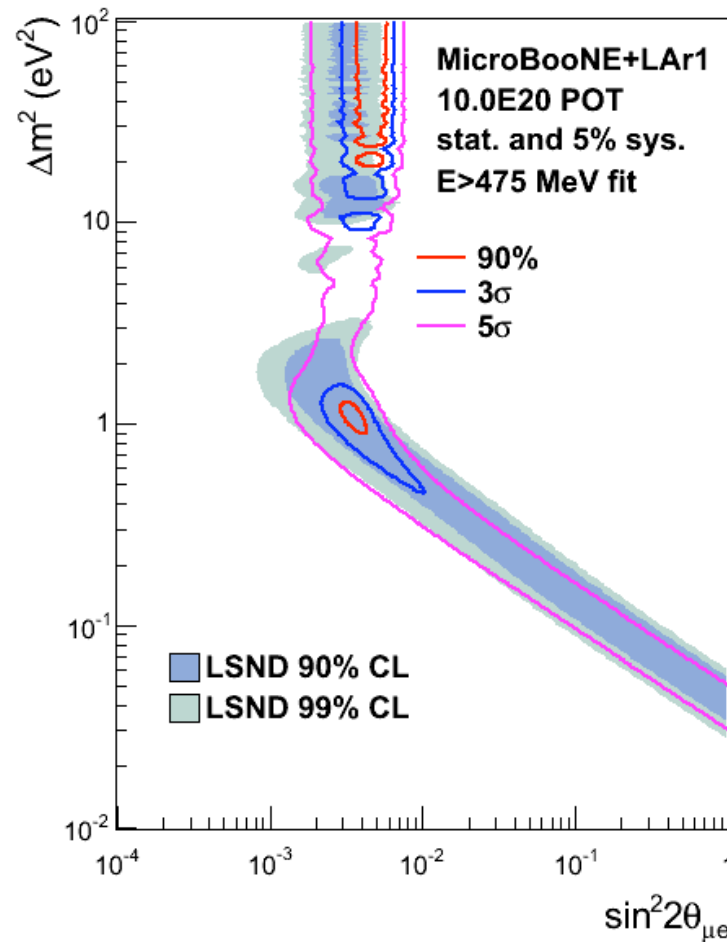
Antineutrino mode

Assumed signal:

$\Delta m^2 \quad \sim 1 \text{ eV}^2$
$\sin^2 2\theta_{\mu e} \sim 0.004$

→ **5σ signal**

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FINAL REMARKS

○ A joint MicroBooNE/LAr1 search
can <u>definitively</u> test LSND oscillation signal,
potentially with two independent beams

○ A short-baseline appearance search is just one
example of physics which can be studied with a
MicroBooNE/LAr1 near/far configuration

  • E.g., additional L-dependent information in the event
    of an electron-like excess in MicroBooNE

○ One must consider feasibility (i.e. cost, schedule
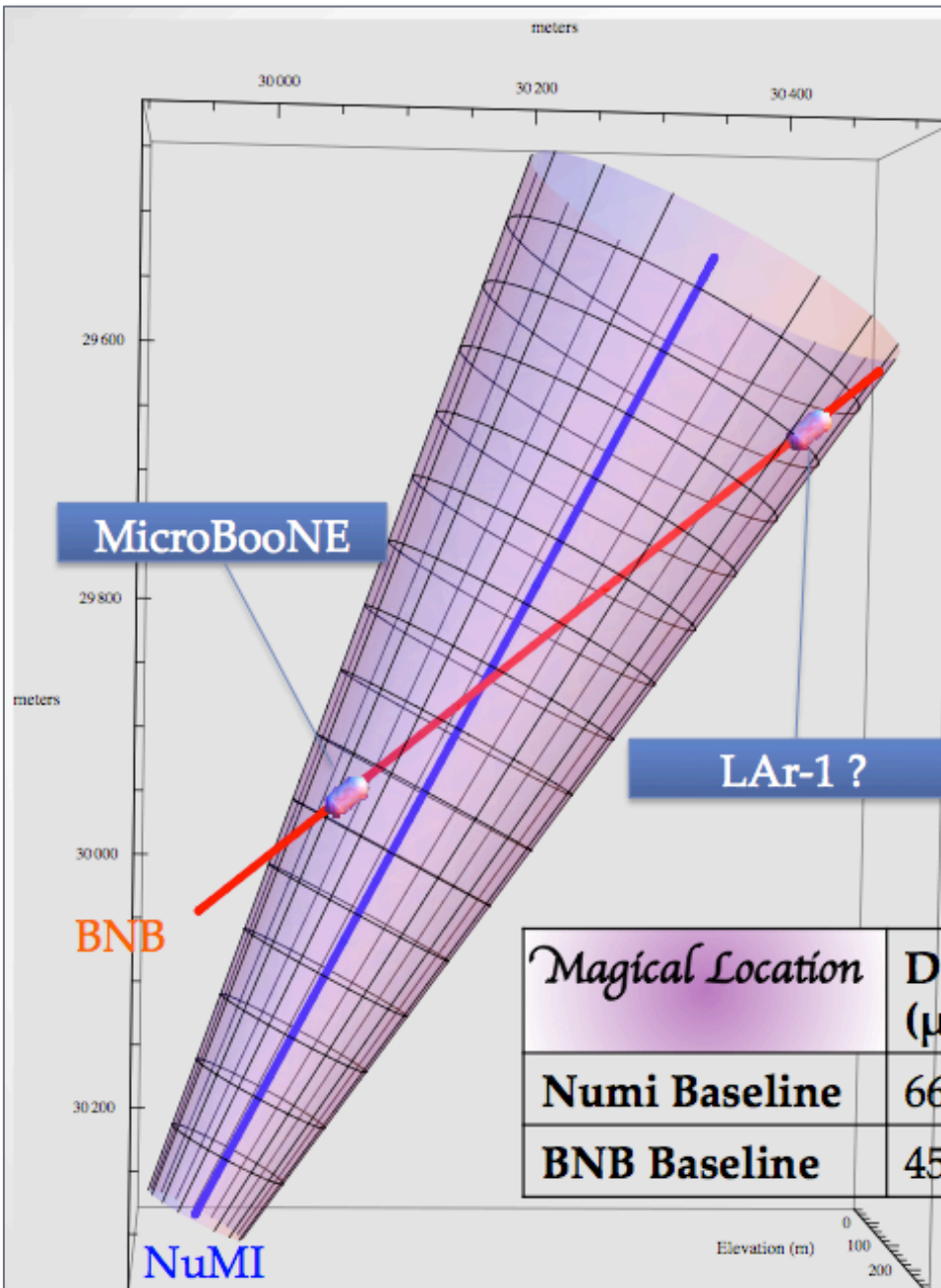constraints)

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Backup slides 18
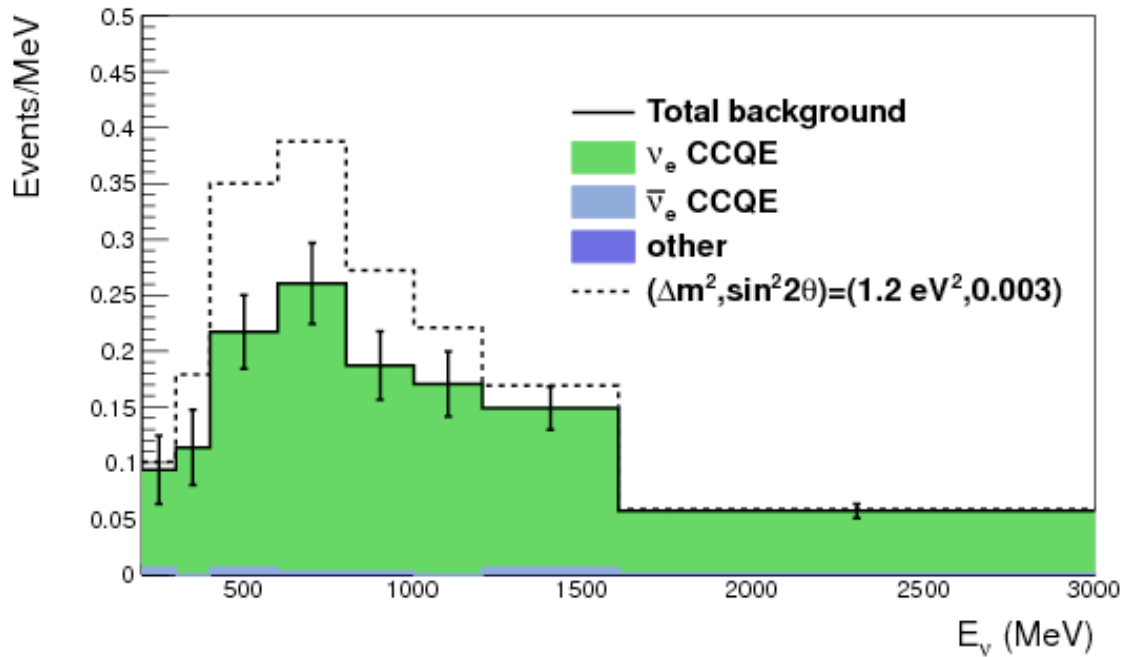
Slide by Geoff Mills

Two Detectors & Two Neutrino Beams

Locate a far detector for μ BooNE such that it is:
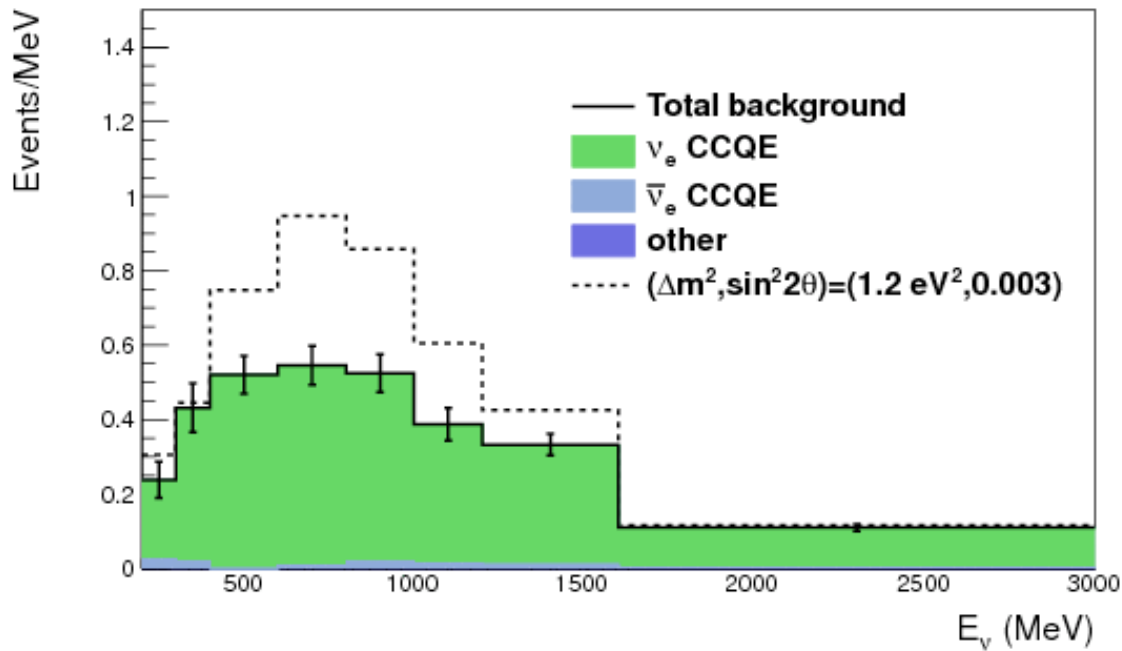
- on-axis for the BNB
- at the same off-axis angle

Magical Location	Detector 1 (μBooNE)	Detector 2 (LAr-1)
Numi Baseline	667 m	1110 m
BNB Baseline	450	925

MicroBooNE at 470m
Neutrino mode
6.6E20 POT

Error bars: bkgd stat

LAr1 at 700m
Neutrino mode
6.6E20 POT

Error bars: bkgd stat

(note different y-axis)

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