Several figures in Chapter 13 of the March 2005 NOvA Proposal have been revised as indicated in the text below. Figures 1 - 6 can be easily reached using the bookmarks tab.

----- Original Message -----

From: "Gary Feldman" <feldman@physics.harvard.edu>

To: "Mike Witherell" <witherell@fnal.gov>; "Pier Oddone" <pjoddone@fnal.gov>; "Hugh Montgovery" <mont@fnal.gov>; "Jeff Appel" <appel@fnal.gov>; "Jim Alexander" <jima@lns.cornell.edu>

Sent: Monday, May 02, 2005 12:16 AM

Subject: Error in NOvA Sensitivity Calculations

> Dear Mike and all,
>
> I want to bring to your attention both a small error in the NOvA
> sensitivity calculations and a subtlety which is somewhat larger than
> I previously thought it would be. I discovered these matters in
> reconciling my calculations with independent calculations being done
> by Walter Winter and Patrick Huber, who are doing some global fits.
>
> The signal and background rates were calculated for a 25 kT
> detector. When we decided on a 30 kT detector, I increased the
> signal rates by 20%, but inadvertently failed to increase the
> background by the same ratio. Thus, the background was
> underestimated in my calculations by 0.65 events/year. The
> difference can be seen by comparing the attached Fig. 1, which is
> what I showed the PAC in April, to Fig. 2, which is the corrected
> figure. The sensitivity has decreased between 5 and 14% for the
> pre-PD curves and between 3 and 13% for the PD curves. The greatest
> decrease is for the region of delta for which we are most sensitive
> and the smallest decrease is for the region of delta for which we are
> least sensitive. In other words, the sensitivity curves become
> flatter with delta.
>
> The more subtle issue is what these curves represent sensitivity
> to. The proposal was careful to state that the curves represented
> sensitivity to nu_mu to nu_e oscillations (in the text and figure
> captions, but not the figure titles). In other words, the curves
> represent the limits that one can reject the null hypothesis that
> nu_mu to nu_e does not occur to three sigma. However, this is not
> the null hypothesis that we want to test, because we know that such
> oscillations do indeed exist since they have been measured in the
> KamLAND experiment. The null hypothesis we really want to test is
> that theta_13 = 0. The difference is the direct solar contribution,
> which is 0.48 events/year in NOvA. This effect is larger than the
> error discussed above because the missing background events add to
> both the background and the observed events, whereas the direct solar
> production only adds to the "background"; it is already included in

> the signal. Fig. 3 shows the sensitivity to sin^2(2th_13). It
> differs from Fig. 2 by between 14 and 33% for the pre-PD curves and
> between 19 and 62% for the PD curves. Again, it tends to flatten the
> curves with delta. Given that this is what we are really interested
> in, I think that we should quote the sensitivity to sin^2(2th_13) in
> the future.
>
> This latter consideration does not significantly affect NOvA's
> relative sensitivity compared to that of T2K, since my calculation of
> their sensitivity will also become worse. This is shown in Fig. 4.
> The T2K sensitivity decreases between 11% and 25%. This decrease is
> smaller than that for NOvA simply because T2K is a less sensitive
> experiment. (My calculation for the average T2K sensitivity now
> agrees exactly with their public statements that it is
> sin^2(2th_13) > 0.018. I think this is somewhat of an accident for
> at least three different reasons, which I will not go into here.)
>
> Fig. 5 shows the comparison of NOvA with a "medium reactor"
> experiment. NOvA has better sensitivity for all delta values for the
> normal mass hierarchy and for 70% of delta values for the inverted
> mass hierarchy. Since, as far as I know, there is no theoretical
> prejudice in favor of any particular delta value, it would make some
> sense to adopt a run plan that maximizes the sensitivity for the
> least sensitive value of delta. This is shown in Fig. 6, which
> divides a five-year run equally between neutrinos and anti-neutrinos.
> Now, NOvA has substantially better sensitivity for all delta values.
>
> It will take me a little time to repeat all of the calculations,
> but I will aim at producing a corrected and expanded Chapter 13 of
> the NOvA proposal for the June PAC meeting.
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> Gary
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> **********
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Figure 1

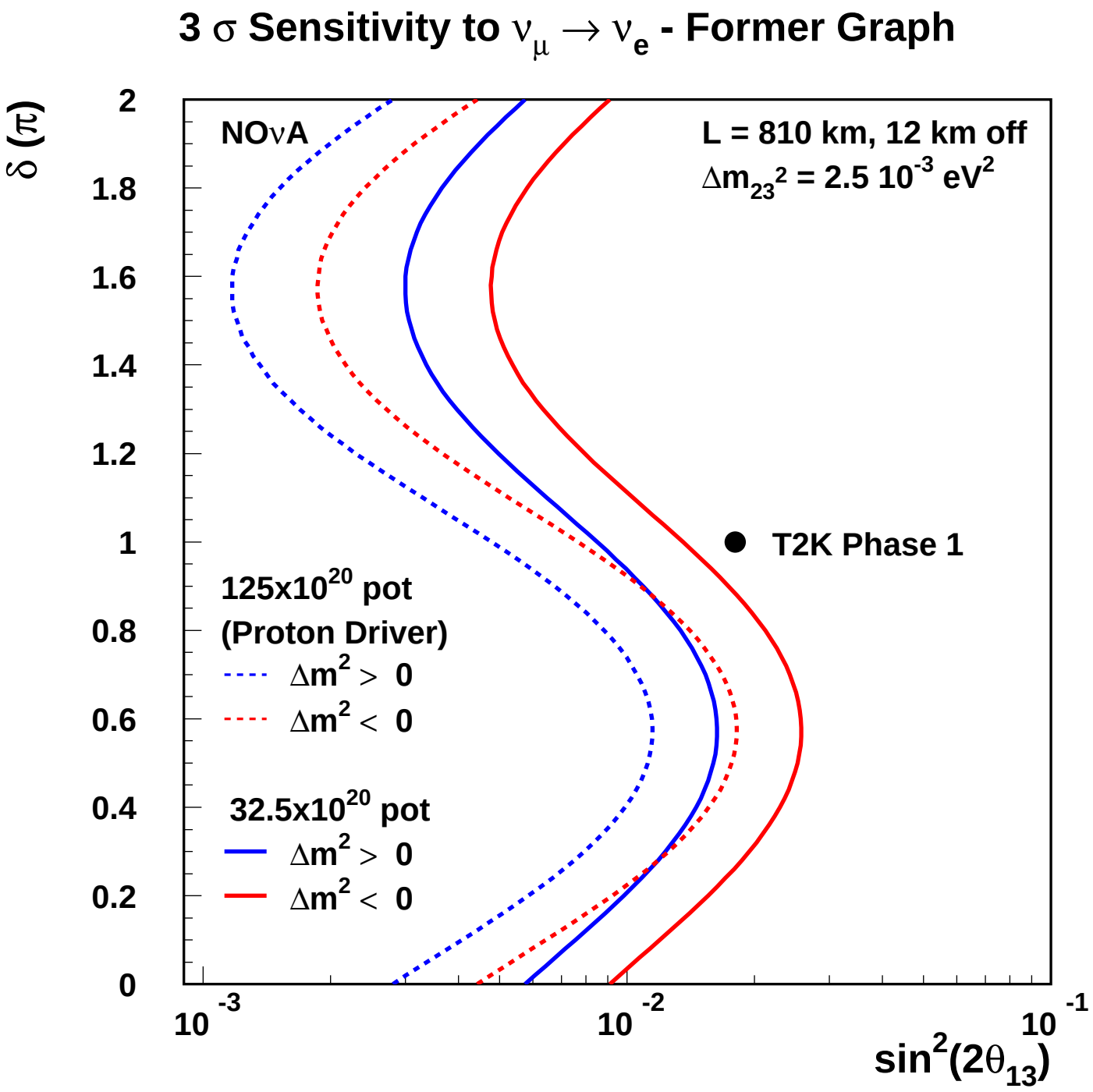

3 σ Sensitivity to ν_μ → ν_e - Former Graph
δ (π)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
NOνA
L = 810 km, 12 km off
Δm23² = 2.5 10⁻³ eV²
T2K Phase 1
125x10²⁰ pot
(Proton Driver)
Δm² > 0
Δm² < 0
32.5x10²⁰ pot
Δm² > 0
Δm² < 0
10⁻³
10⁻²
10⁻¹
sin²(2θ13)

Figure 2

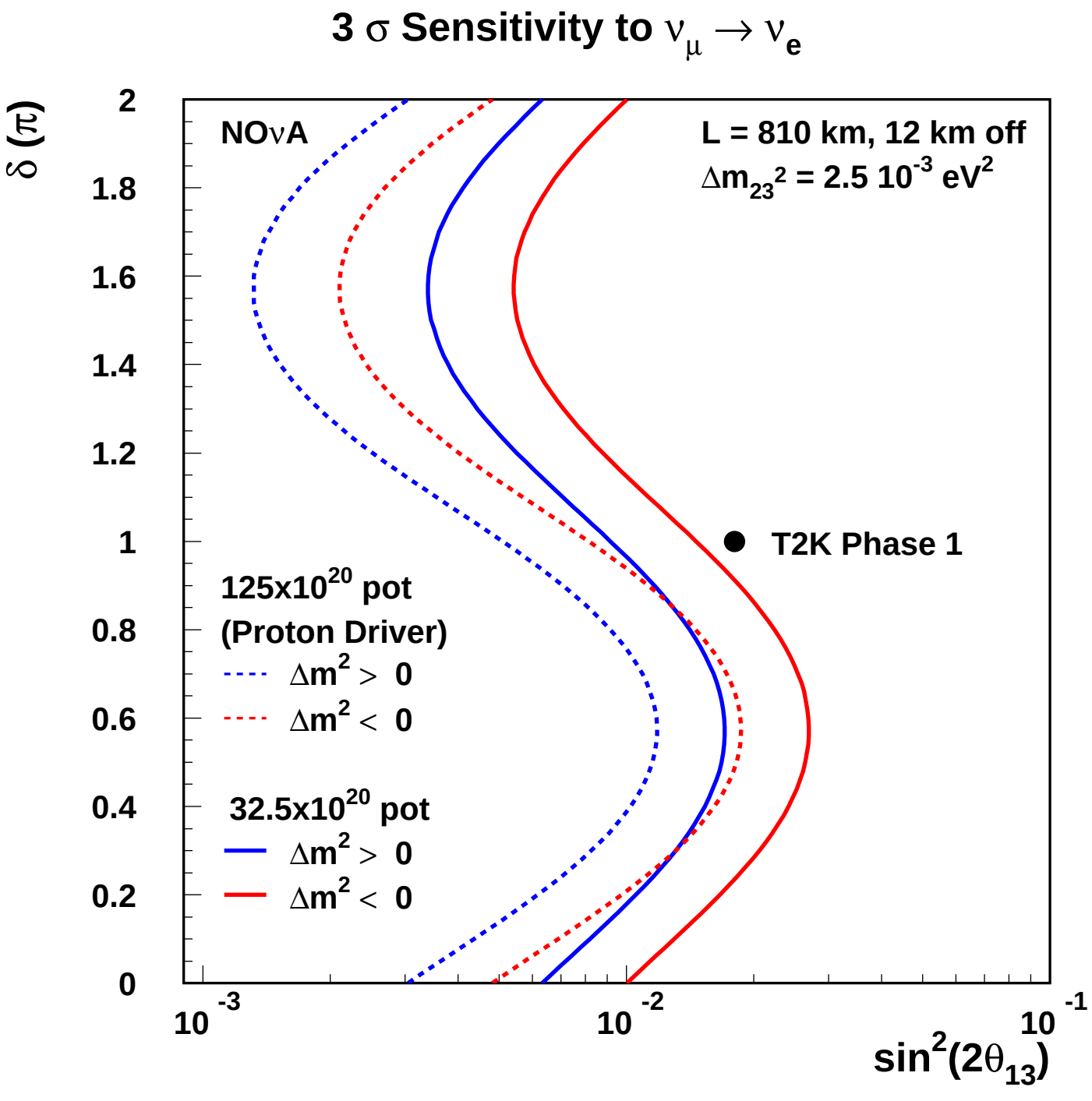

3 σ Sensitivity to ν_μ → ν_e
NOνA
L = 810 km, 12 km off
Δm_23^2 = 2.5 10^-3 eV^2
T2K Phase 1
125x10^20 pot
(Proton Driver)
Δm^2 > 0
Δm^2 < 0
32.5x10^20 pot
Δm^2 > 0
Δm^2 < 0
δ (π)
sin^2(2θ_13)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
10^-3
10^-2
10^-1

Figure 3

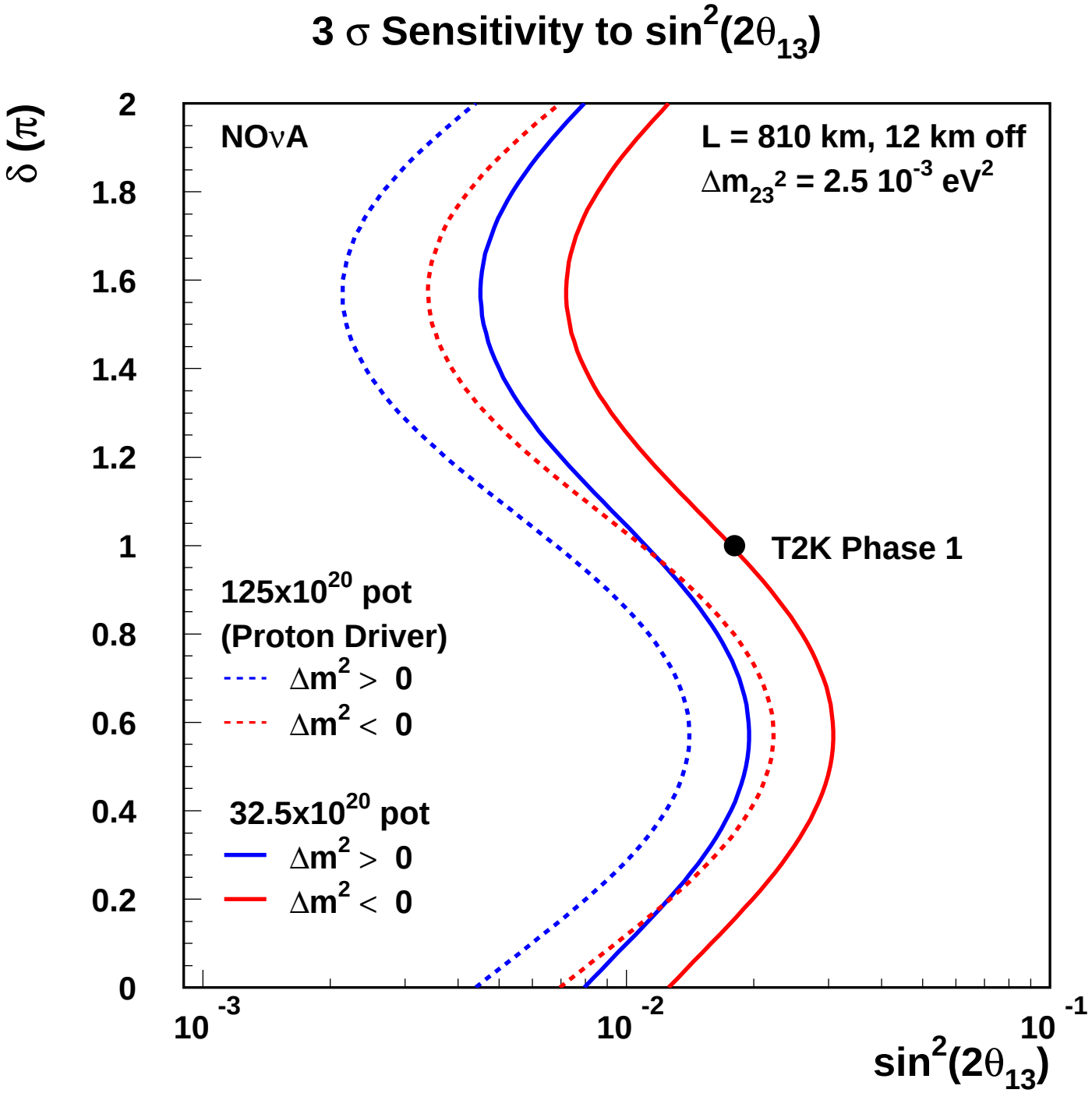

3 σ Sensitivity to sin²(2θ13)
δ (π)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
NOνA
L = 810 km, 12 km off
Δm23² = 2.5 10⁻³ eV²
T2K Phase 1
125x10²⁰ pot
(Proton Driver)
Δm² > 0
Δm² < 0
32.5x10²⁰ pot
Δm² > 0
Δm² < 0
10⁻³
10⁻²
10⁻¹
sin²(2θ13)

Figure 4

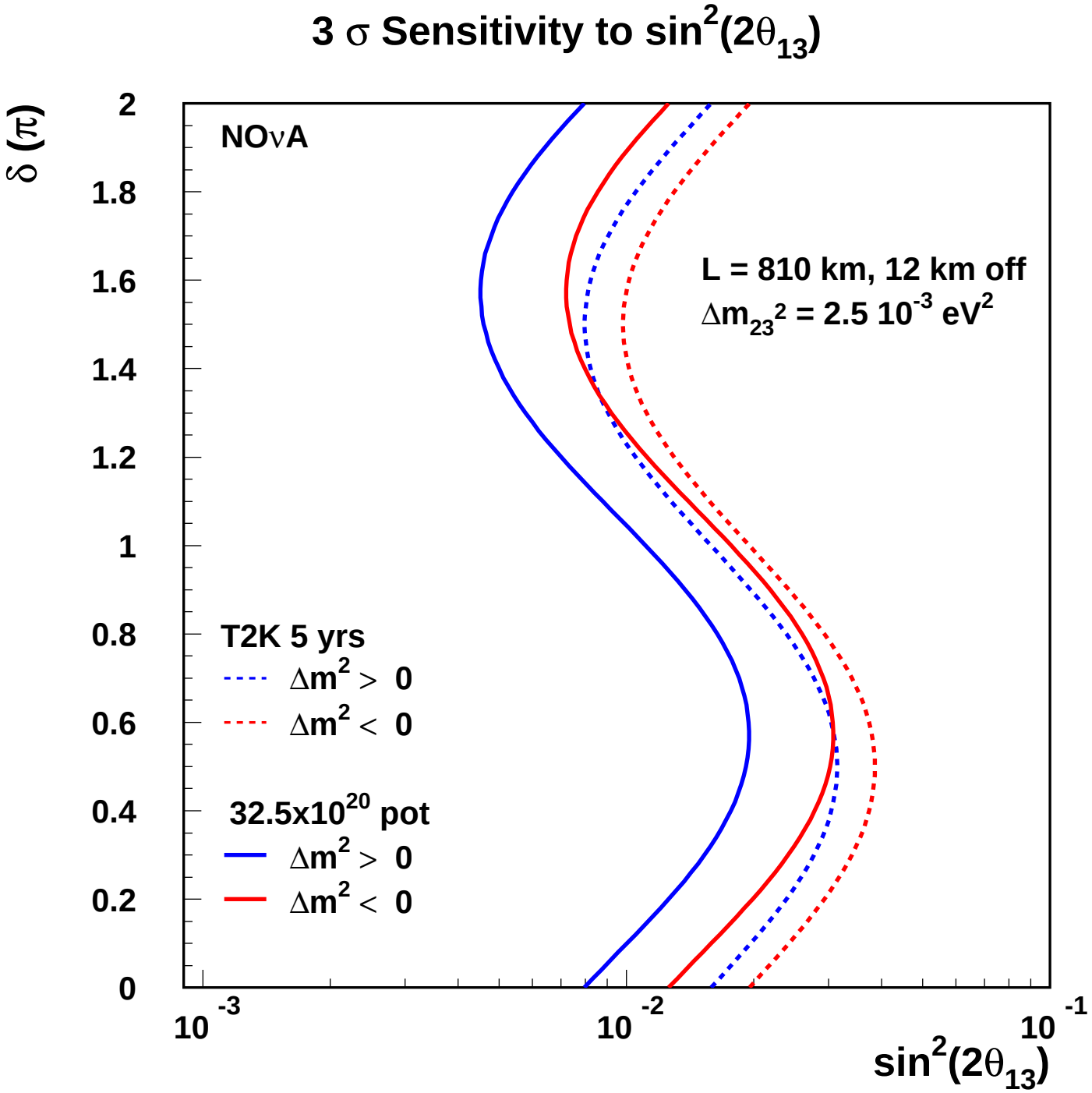

3 σ Sensitivity to sin²(2θ13)
δ (π)
NOνA
L = 810 km, 12 km off
Δm23² = 2.5 10⁻³ eV²
T2K 5 yrs
Δm² > 0
Δm² < 0
32.5x10²⁰ pot
Δm² > 0
Δm² < 0
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
10⁻³
10⁻²
10⁻¹
sin²(2θ13)

Figure 5

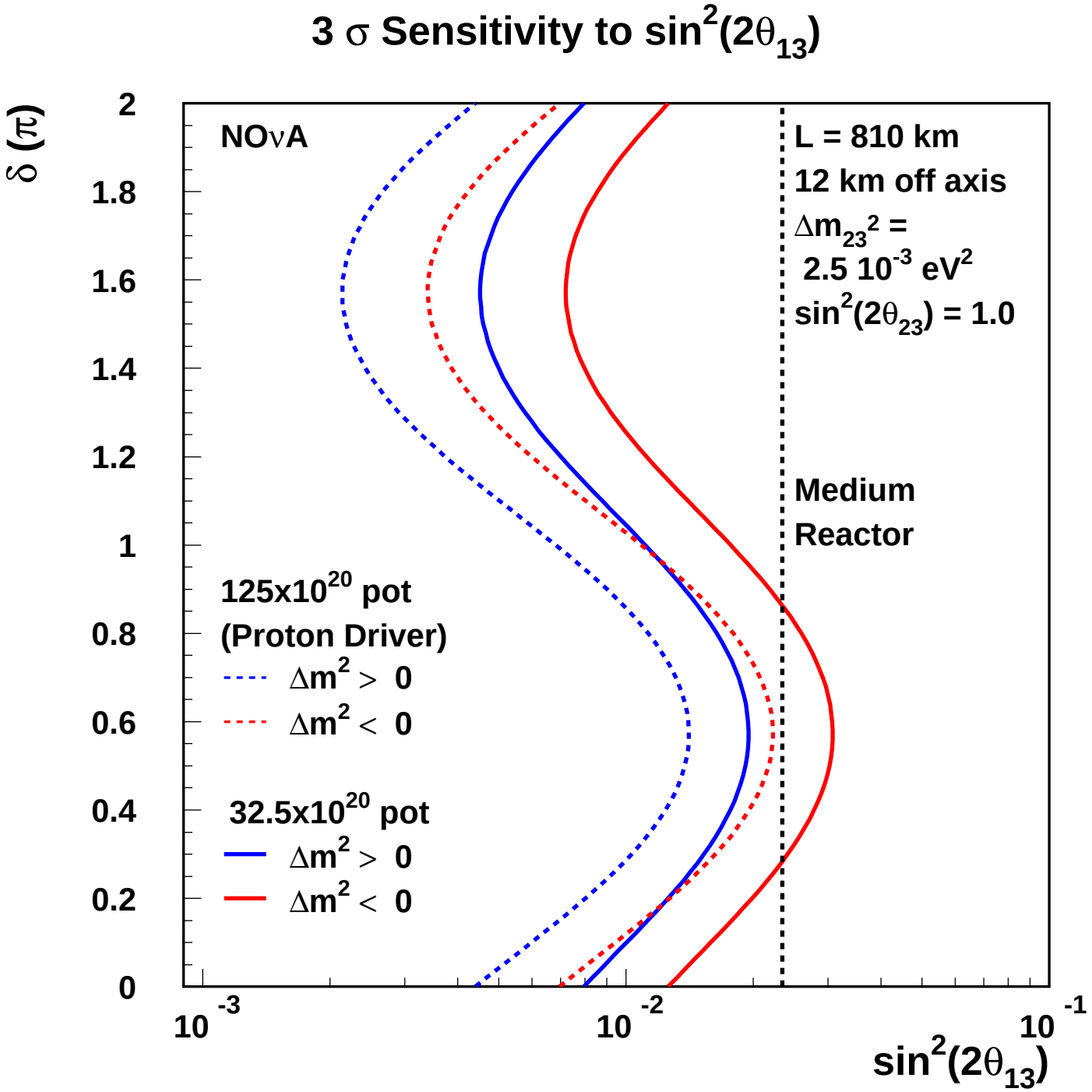
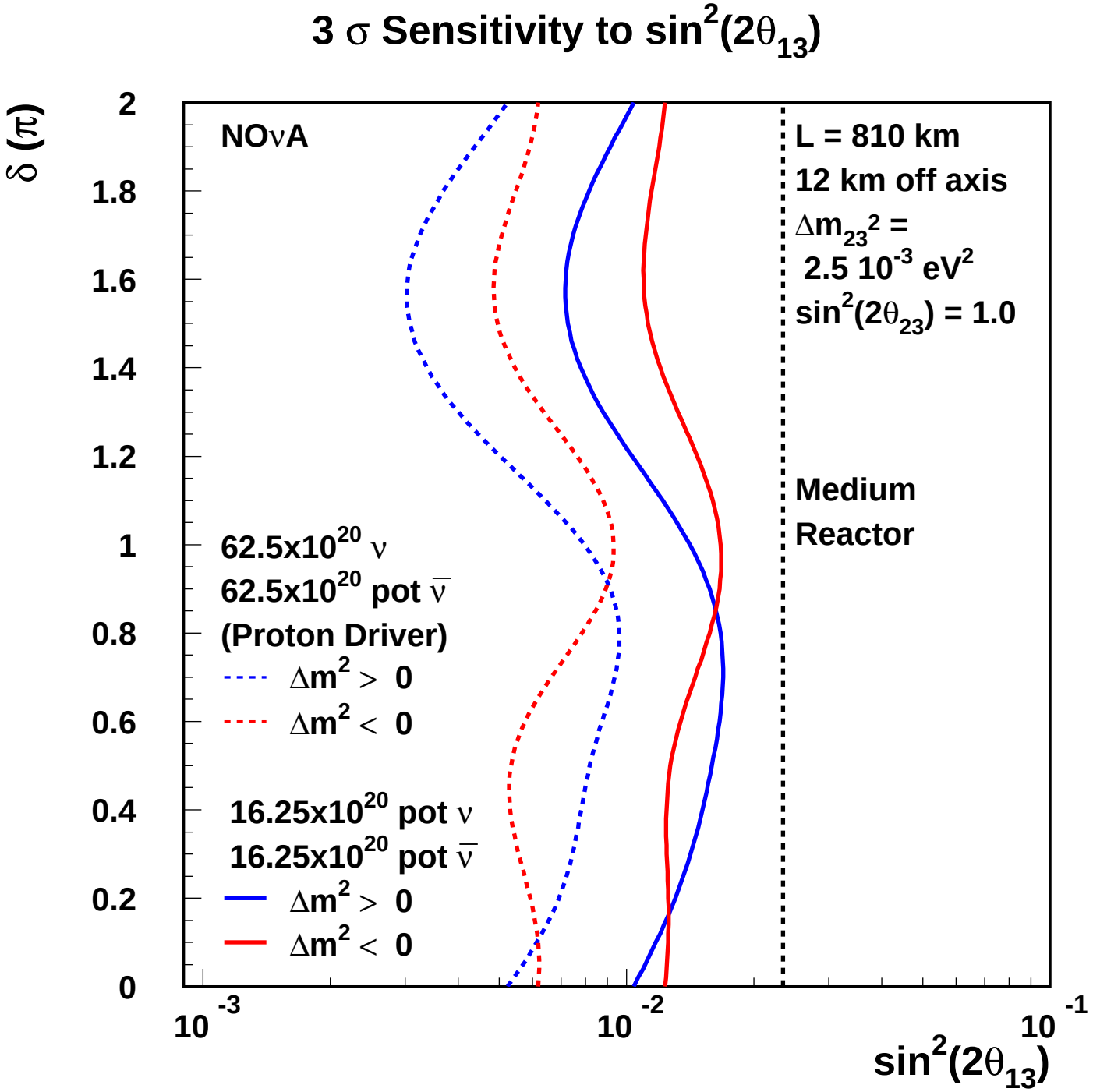

3 σ Sensitivity to sin²(2θ13)
δ (π)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
NOνA
L = 810 km
12 km off axis
Δm23² =
2.5 10⁻³ eV²
sin²(2θ23) = 1.0
Medium
Reactor
125x10²⁰ pot
(Proton Driver)
Δm² > 0
Δm² < 0
32.5x10²⁰ pot
Δm² > 0
Δm² < 0
10⁻³
10⁻²
10⁻¹
sin²(2θ13)

Figure 6


3 σ Sensitivity to sin²(2θ13)
δ (π)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
NOνA
L = 810 km
12 km off axis
Δm23² =
2.5 10⁻³ eV²
sin²(2θ23) = 1.0
Medium
Reactor
62.5x10²⁰ ν
62.5x10²⁰ pot ν̄
(Proton Driver)
Δm² > 0
Δm² < 0
16.25x10²⁰ pot ν
16.25x10²⁰ pot ν̄
Δm² > 0
Δm² < 0
10⁻³
10⁻²
10⁻¹
sin²(2θ13)