

Neutrino Beam Flux in the ND and ND/FD Extrapolation

Mary Bishai

March 27, 2017

- 1** Flux Characteristics
- 2** N/F Extrapolation
- 3** Beam Systematics

Flux Components in various ND locations

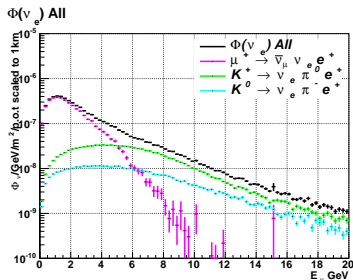
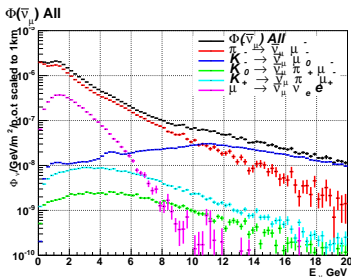
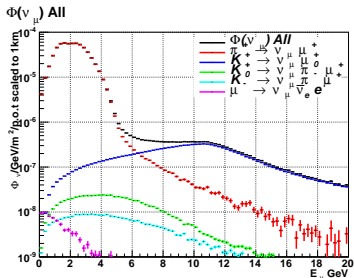
Neutrino
Beam Flux in
the ND and
ND/FD
Extrapolation

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Flux
Characteristics

N/F
Extrapolation

Beam
Systematics



ND 360

Normalized to 1km using baseline as measured to middle of decay channel.

Flux Components in various ND locations

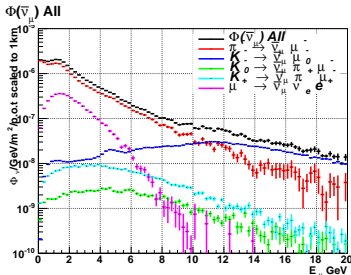
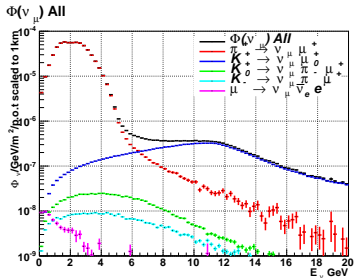
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Flux
Characteristics

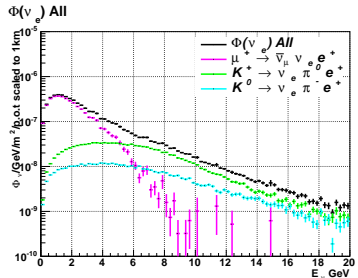
N/F
Extrapolation

Beam
Systematics



ND 380

Normalized to 1km using baseline as measured to middle of decay channel.



Flux Components in various ND locations

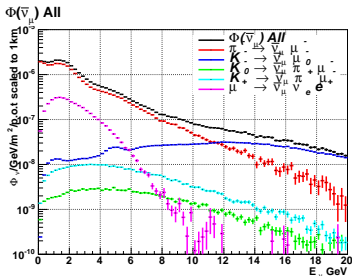
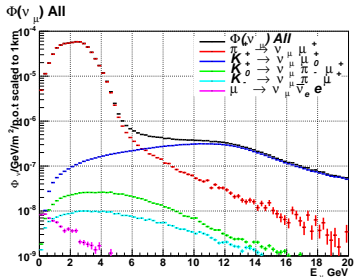
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Flux
Characteristics

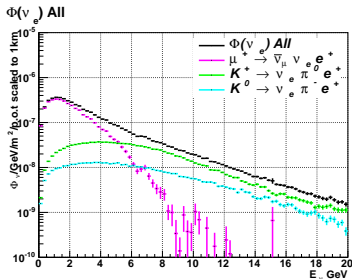
N/F
Extrapolation

Beam
Systematics



ND 570

Normalized to 1km using baseline as measured to middle of decay channel.



Flux Components in various ND locations

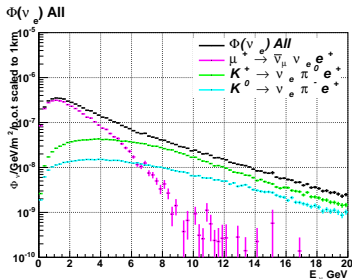
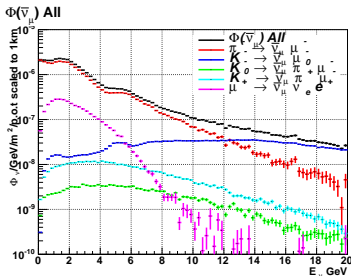
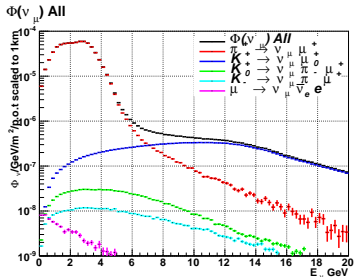
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ND 2km

Normalized to 1km using baseline as measured to middle of decay channel.

Flux Components in various ND locations

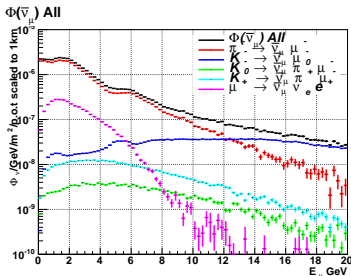
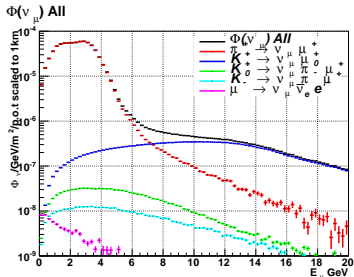
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Flux
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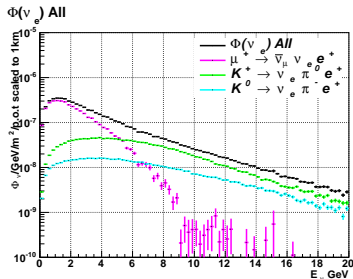
N/F
Extrapolation

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FD 1300km

Normalized to 1km using baseline as measured to
middle of decay channel.



Flux Components in various ND locations

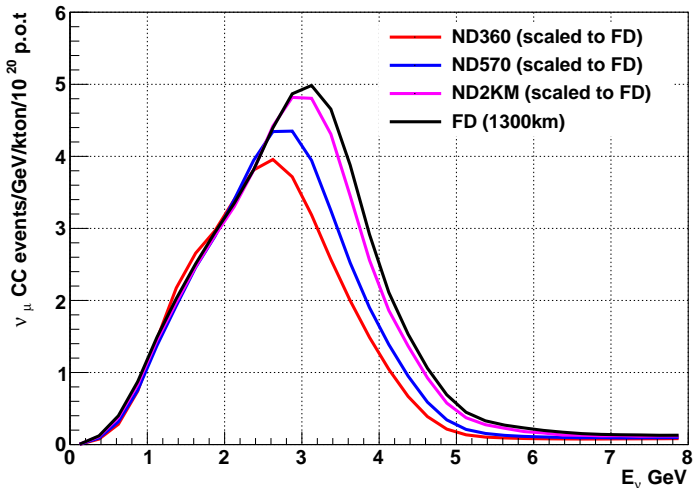
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Flux
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The ν_{μ} CC spectrum - BL scaled to FD from center of decay channel

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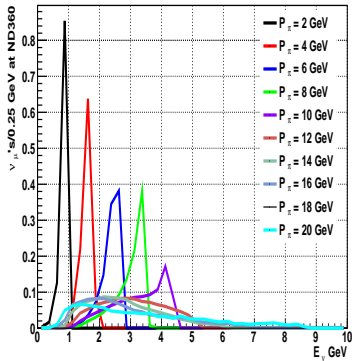
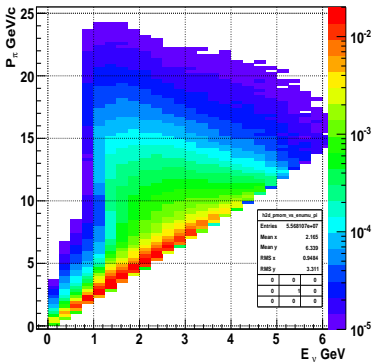
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Flux
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Parent momentum vs E_ν π parent



Parent π Momentum vs ν Momentum at ND574

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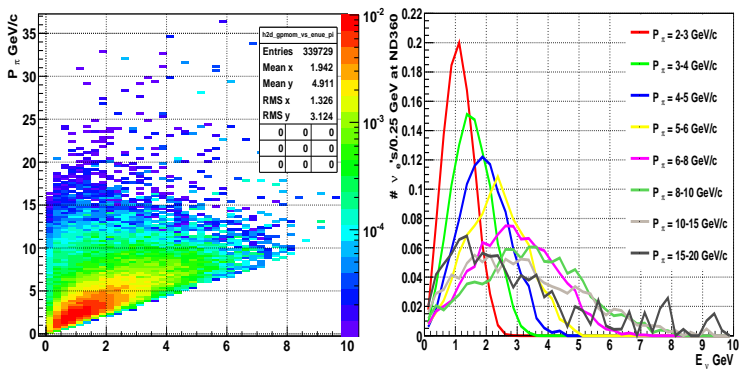
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π grandparent momentum vs E_{ν} from μ parent



Origin of Neutrinos (ND570)

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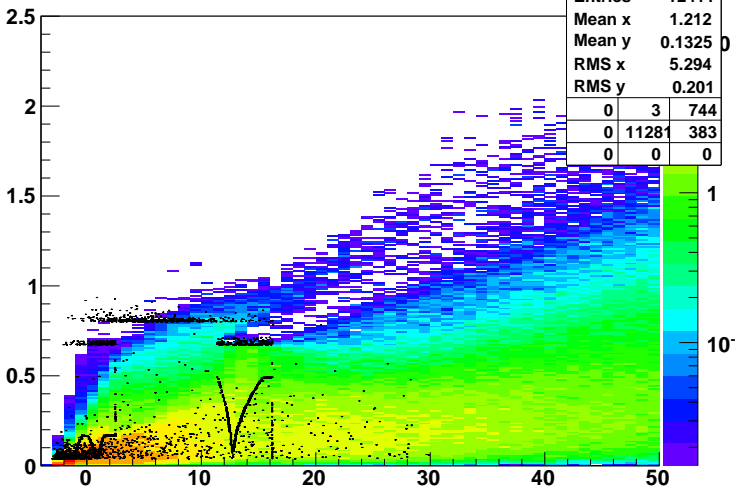
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Flux
Characteristics

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Beam
Systematics

ν_{μ} production radius (m) versus $V_z(m)$, $E_{\nu} = 0.5-1.5$ GeV



Origin of Neutrinos (ND570)

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Beam Flux in
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Extrapolation

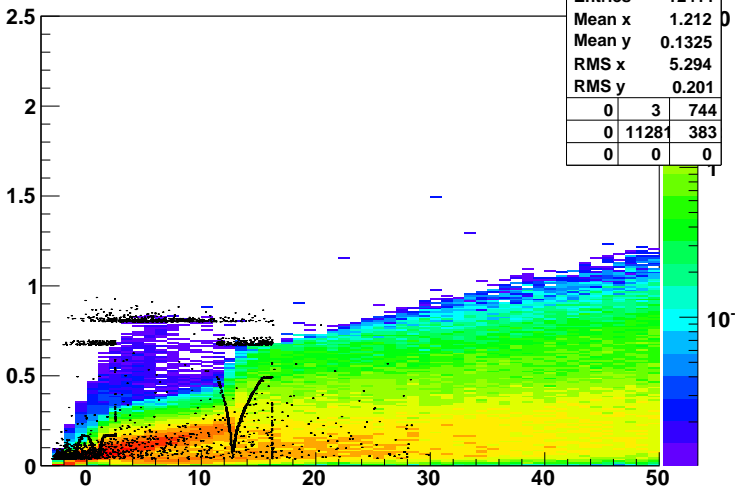
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Flux
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N/F
Extrapolation

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Systematics

ν_{μ} production radius (m) versus $V_z(m)$, $E_{\nu} = 1.5-2.5$ GeV



Origin of Neutrinos (ND570)

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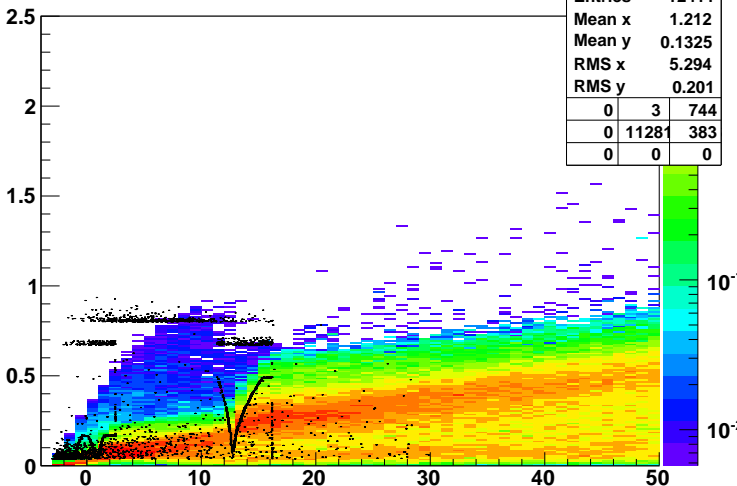
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Flux
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N/F
Extrapolation

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Systematics

ν_{μ} production radius (m) versus V_z (m), $E_{\nu} = 2.5-3.5$ GeV



Origin of Neutrinos (ND570)

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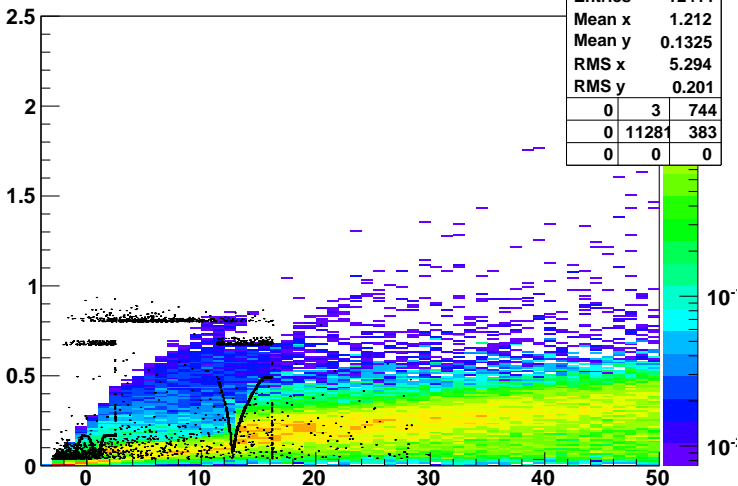
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Flux
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Systematics

ν_{μ} production radius (m) versus $V_z(m)$, $E_{\nu} = 3.5-5.0$ GeV



Origin of Neutrinos (ND570)

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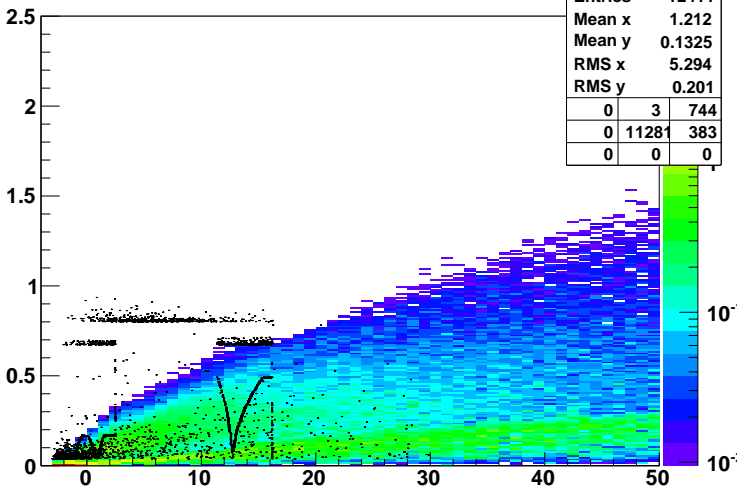
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Flux
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N/F
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Systematics

ν_{μ} production radius (m) versus $V_z(m)$, $E_{\nu} = 5.0-10.0$ GeV



Origin of Neutrinos (ND570)

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Beam Flux in
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Extrapolation

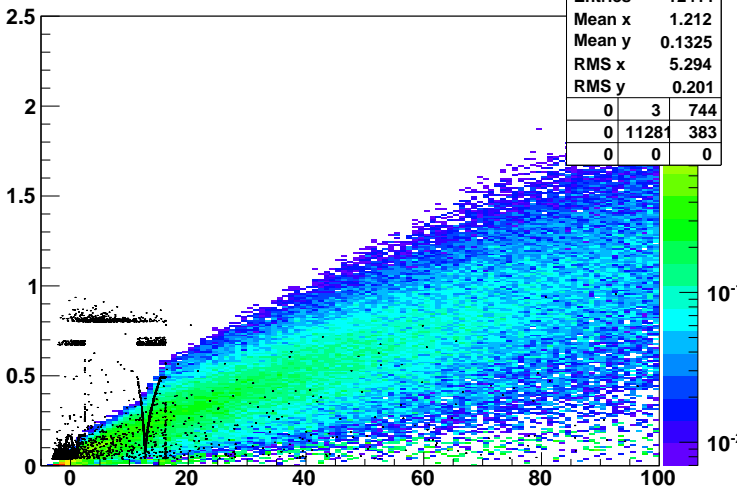
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Flux
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Extrapolation

Beam
Systematics

ν_{μ} production radius (m) versus $V_z(m)$, $E_{\nu} > 10.0$ GeV



Profile of ν Z decay location (1300km)

Neutrino
Beam Flux in
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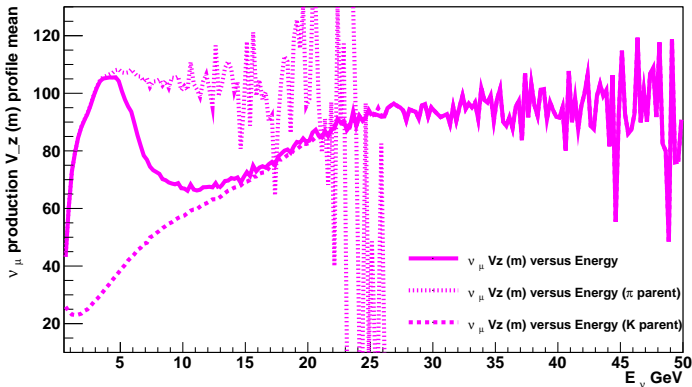
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Flux
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Systematics

ν_{μ} events at FD (1300km)



Center of decay channel is at $Z \sim 110\text{m}$.

N/F Ratios at Various Locations

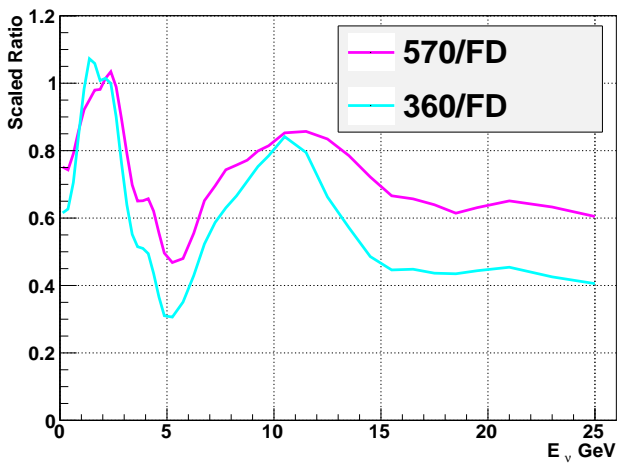
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Extrapolation

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Systematics



BL scaled from center of decay channel ($\sim 110\text{m}$).

N/F Ratios at Various Locations

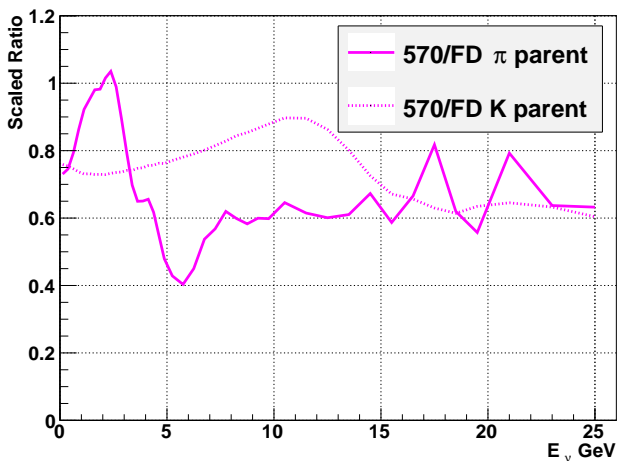
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0-5 GeV N/F dominated by π . > 10 GeV dominated by K^+

N/F Ratios at Various Locations

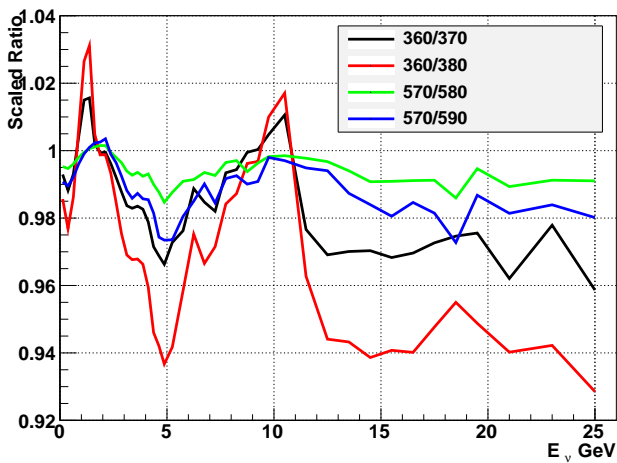
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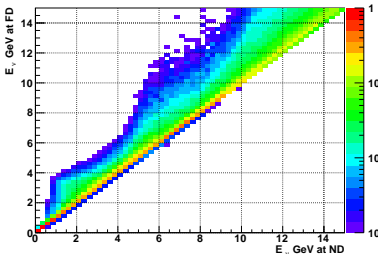


The same N/F effects on a smaller scale 10m apart

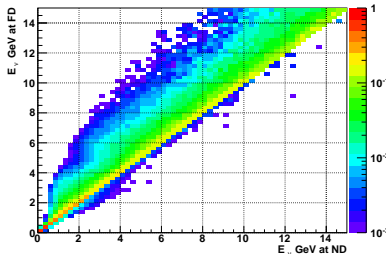
Beam Matrix: $\phi_i^{FD} = \sum_j \underbrace{(\phi_{ij}^{FD} / \phi_j^{ND})}_{\text{Beam Matrix}} \phi_j^{ND}$

ND360

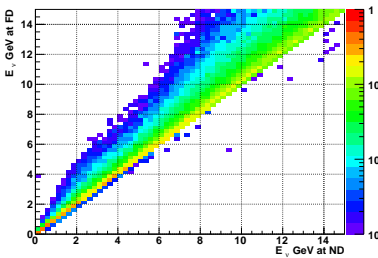
Normalized FD/ND ν_μ flux ratio



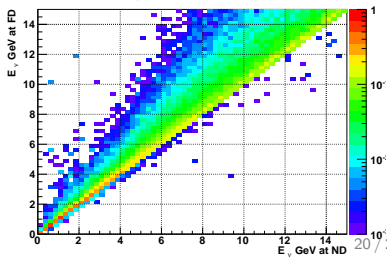
Normalized FD/ND $\bar{\nu}_\mu$ flux ratio



Normalized FD/ND ν_e flux ratio



Normalized FD/ND $\bar{\nu}_e$ flux ratio



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Flux
Characteristics

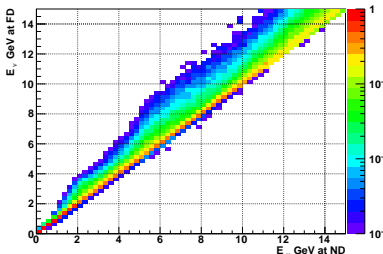
N/F
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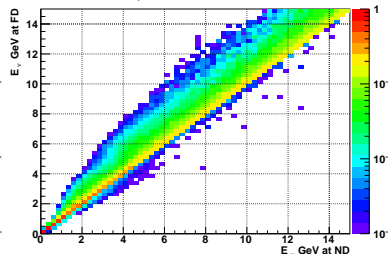
Beam Matrix: $\phi_i^{FD} = \sum_j \underbrace{(\phi_{ij}^{FD} / \phi_j^{ND})}_{\text{Beam Matrix}} \phi_j^{ND}$

ND570

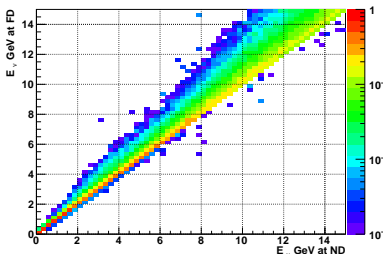
Normalized FD/ND ν_μ flux ratio



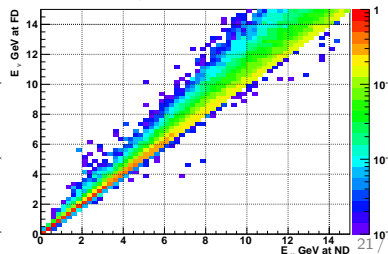
Normalized FD/ND $\bar{\nu}_\mu$ flux ratio



Normalized FD/ND ν_e flux ratio



Normalized FD/ND $\bar{\nu}_e$ flux ratio



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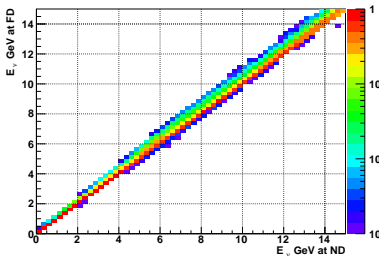
N/F
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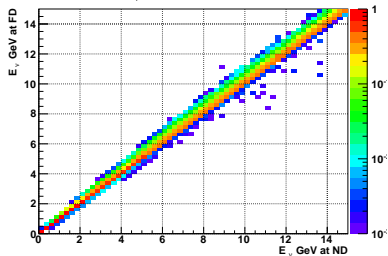
Beam Matrix: $\phi_i^{FD} = \sum_j \underbrace{(\phi_{ij}^{FD} / \phi_j^{ND})}_{\text{Beam Matrix}} \phi_j^{ND}$

ND2km

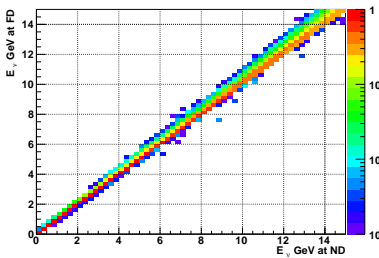
Normalized FD/ND ν_μ flux ratio



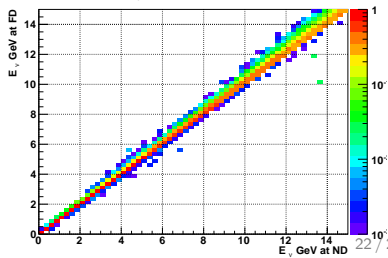
Normalized FD/ND $\bar{\nu}_\mu$ flux ratio



Normalized FD/ND ν_e flux ratio



Normalized FD/ND $\bar{\nu}_e$ flux ratio



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Vary Horn Current

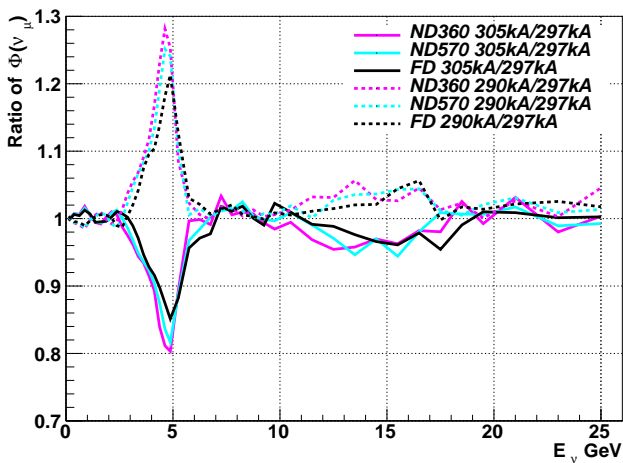
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The nearer the detector - the *more sensitive* to focusing effects

Vary Horn Current

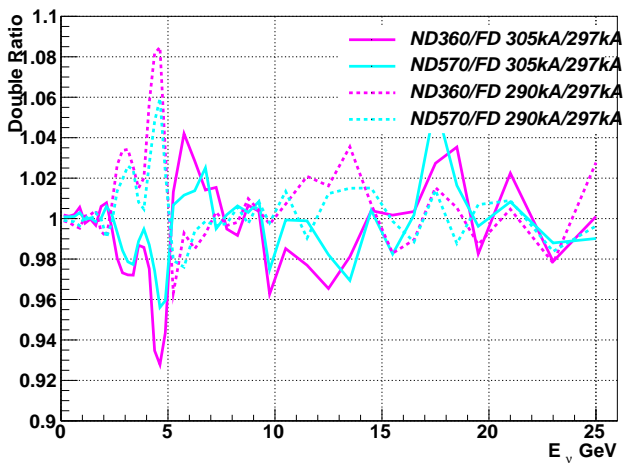
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Focusing effects have the smallest cancelation in $N \rightarrow F$

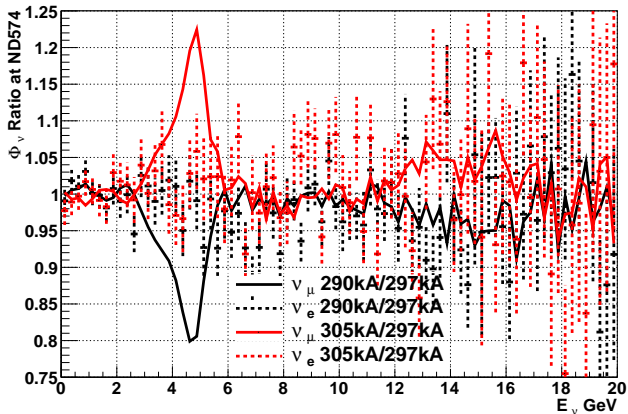
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Focusing effects have smaller effects on $\Phi(\nu_e)$