Physics requirements for the Near detector

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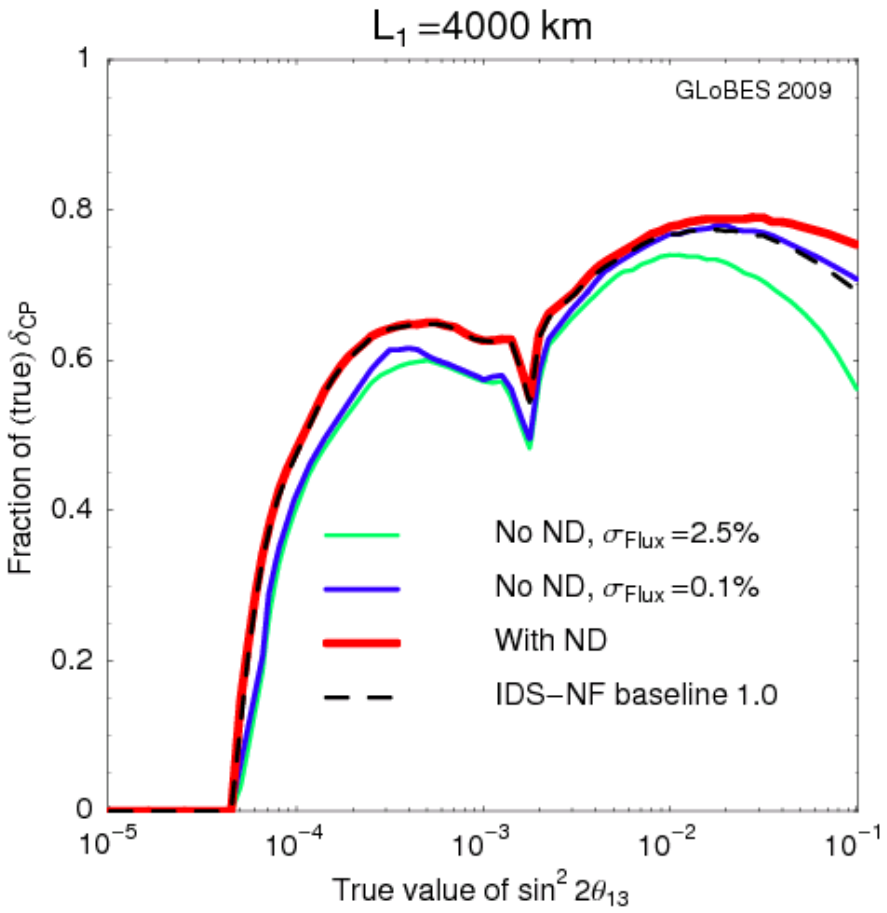
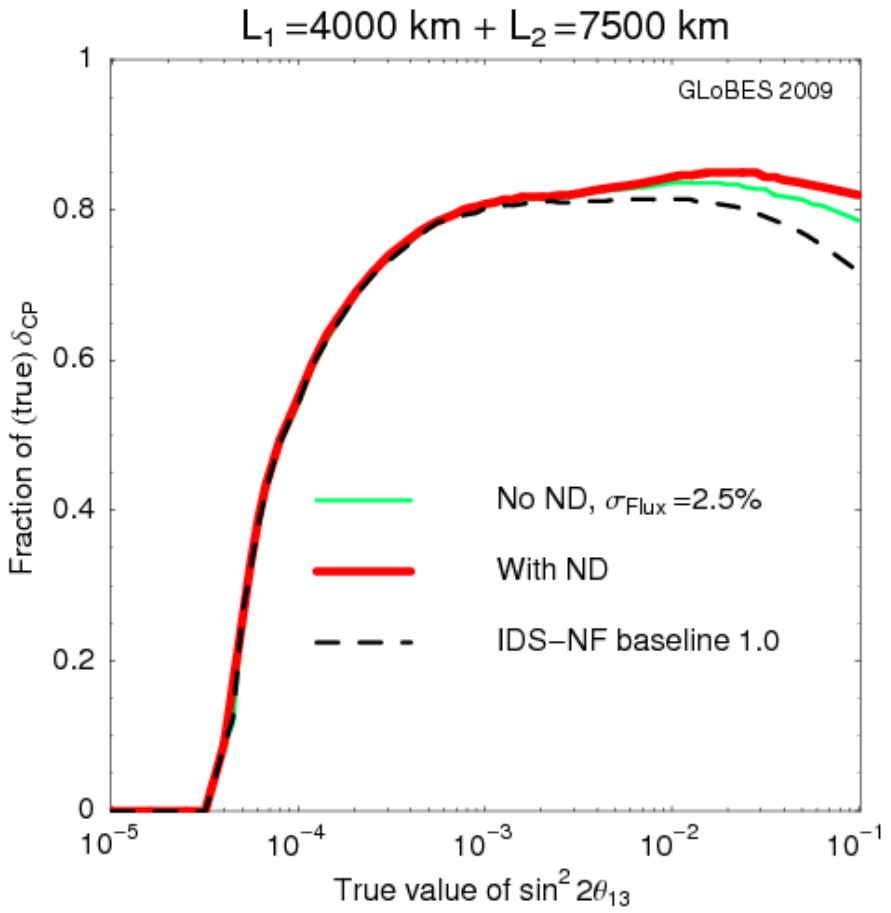
What do we want to measure with the Near detector?

- neutrino flux (through the measurement of neutrino-electron scattering);
- neutrino-beam properties that are required for the flux to be extrapolated with accuracy to the far detectors;
- charm production cross sections over neutrino beam energy range (at least wrong sign muon production rate);
- $\nu_\mu N$ and $\nu_e N$ CC total cross-section and separately (?) deep inelastic, quasi-elastic, and resonant-scattering cross sections;
- Fundamental electroweak and QCD physics (ie PDFs, $\sin^2\theta_W$);
- Non Standard Interactions (NSI) via τ-lepton production;
- sterile neutrino search – how?

Importance of flux knowledge for systematics

2.5% error on flux makes big difference in CP coverage





CP violation discovery reach (3σ CL)

J.Tang, W.Winter, Phys.Rev.D80:053001,2009

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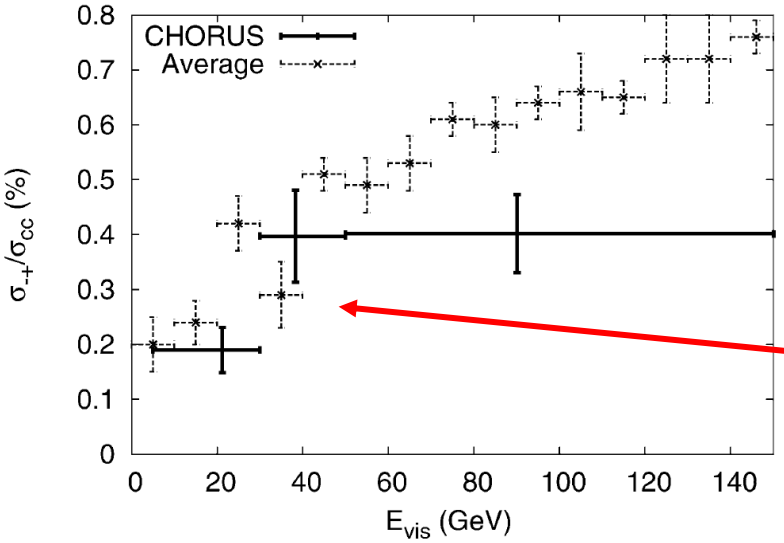
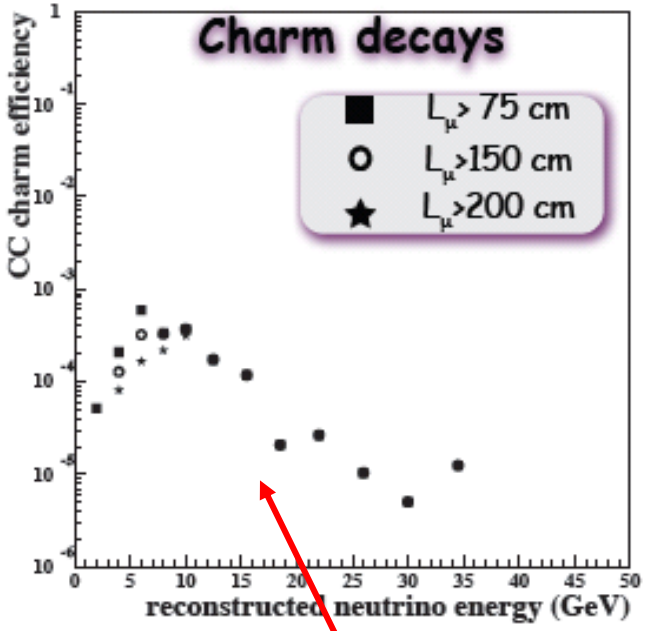
Charm and τ production measurement

- **Motivation:** measure charm cross-section to validate size of **charm** background in wrong-sign muon signature (charm cross-section and branching fractions poorly known, especially close to threshold).
- **Motivation**: **tau** production in near detector is a signal for non-standard interactions.





Emulsion sheets or silicon strips?

Vertex detector of high granularity is needed.

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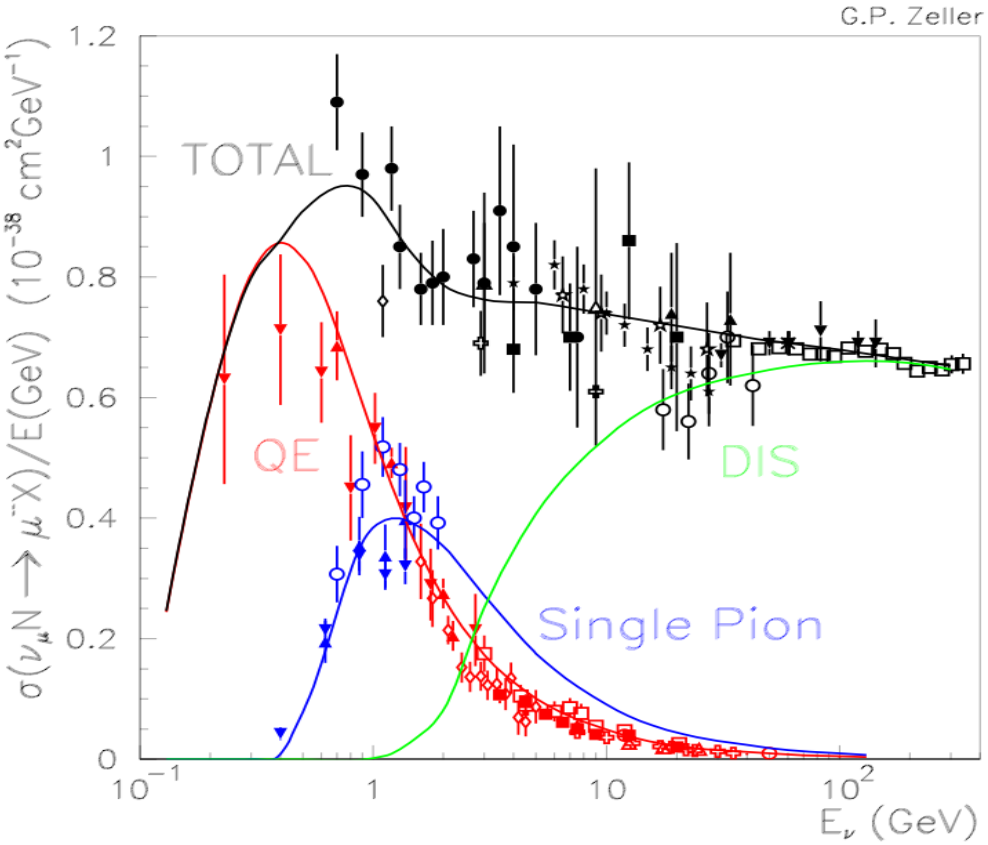
Cross section measurements



Expected cross-section errors from T2K, Minerva, dominated by absolute flux error before Neutrino Factory.

At NF, with modest size targets one can obtain very large statistics, but is <1% error achievable? What precision do we need?

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Near detector design requirements

- Vertex detector for charm and τ production (NSI)
- Low Z high resolution tracker for flux and cross-section measurement (ν_μ and ν_e)
- Magnetic field for better than in MIND muon momentum measurement
- Muon catcher and capability for and e^+/e^- identification
- Good resolution on neutrino energy (much better than in Far Detector) for flux extrapolation – how much better?

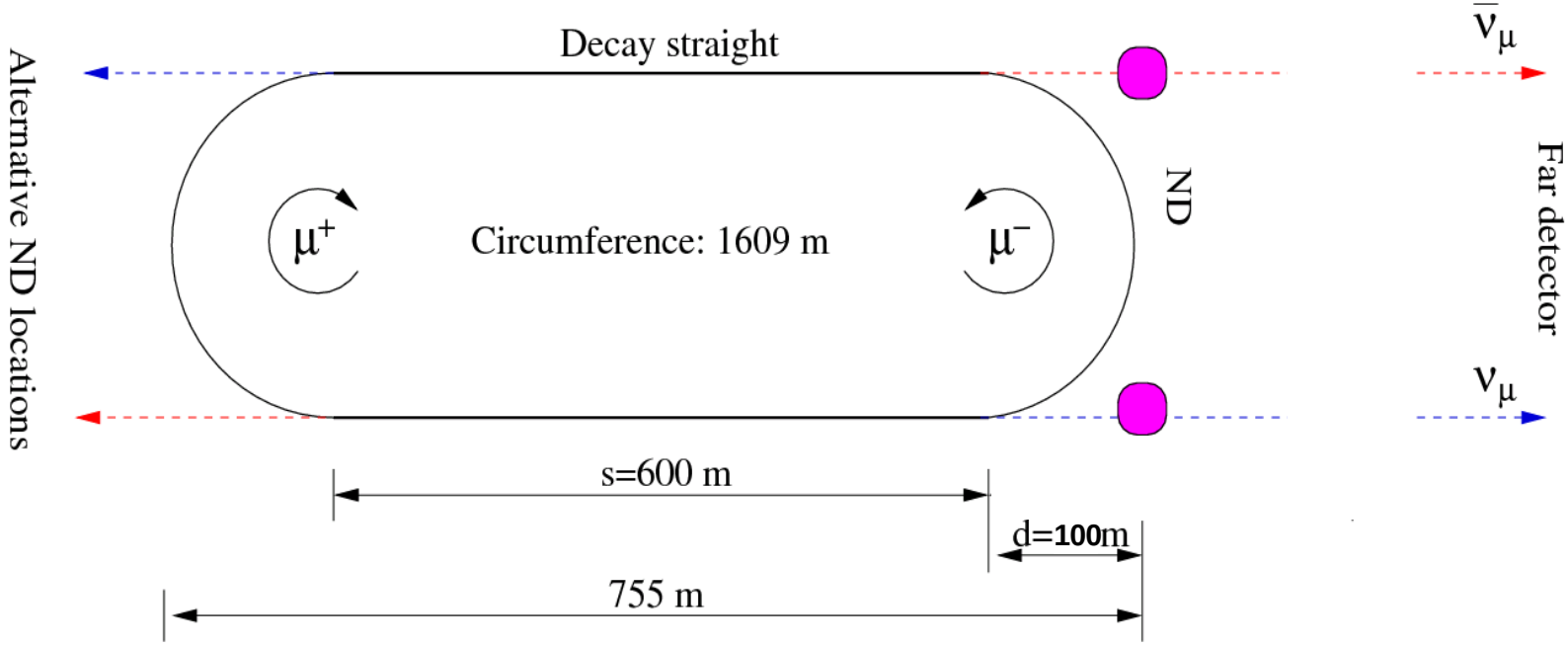
Neutrino Factory Near Detector(s)

E_μ = 25 GeV ±80 MeV

Straight section length = 600 m

Muon angular spread 0.5 mrad

Decay straight dip angles of the two racetracks are 18° and 36°→ Near detectors will be at depths of 264 and 502 m, respectively.



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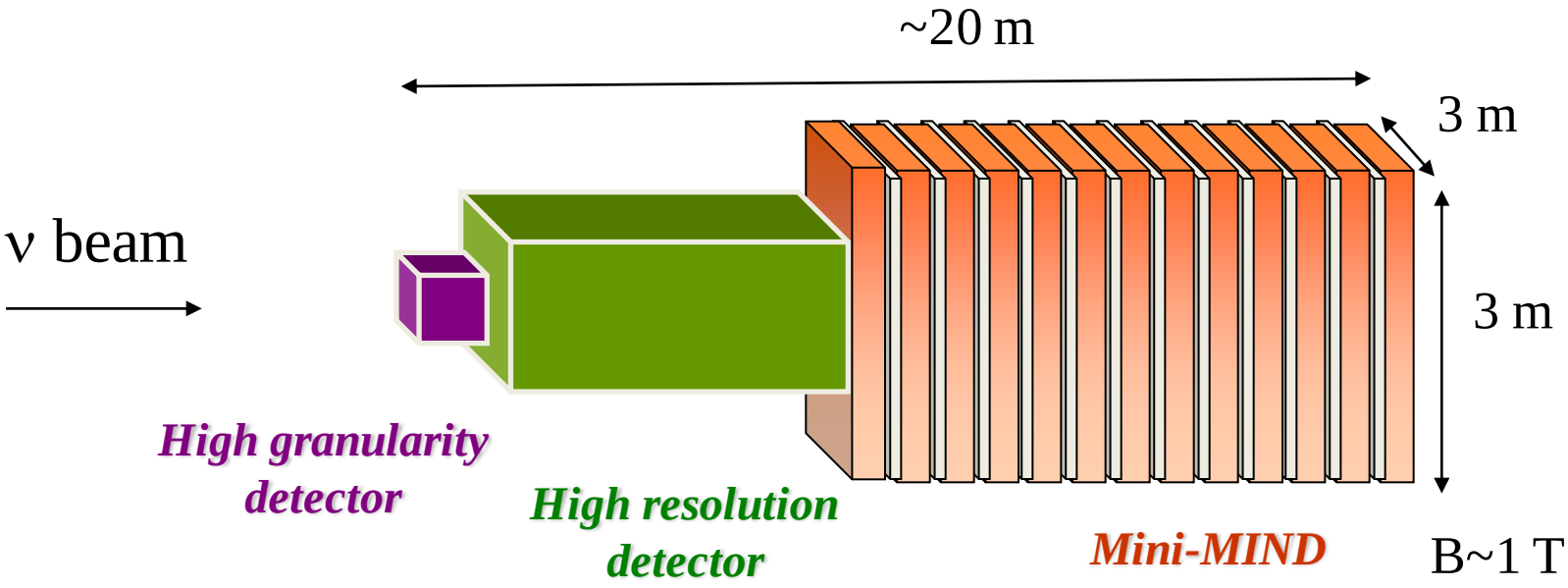
Block diagram design

Near Detector design will have three sections:

- High granularity detector for charm/tau measurement;
- High resolution detector (**Scintillating Fibres tracker** or **Straw Tube tracker**) for precise measurement of the event close to the vertex;
- Mini-MIND detector for muon measurement.



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