A Detector Simulation for VLENF

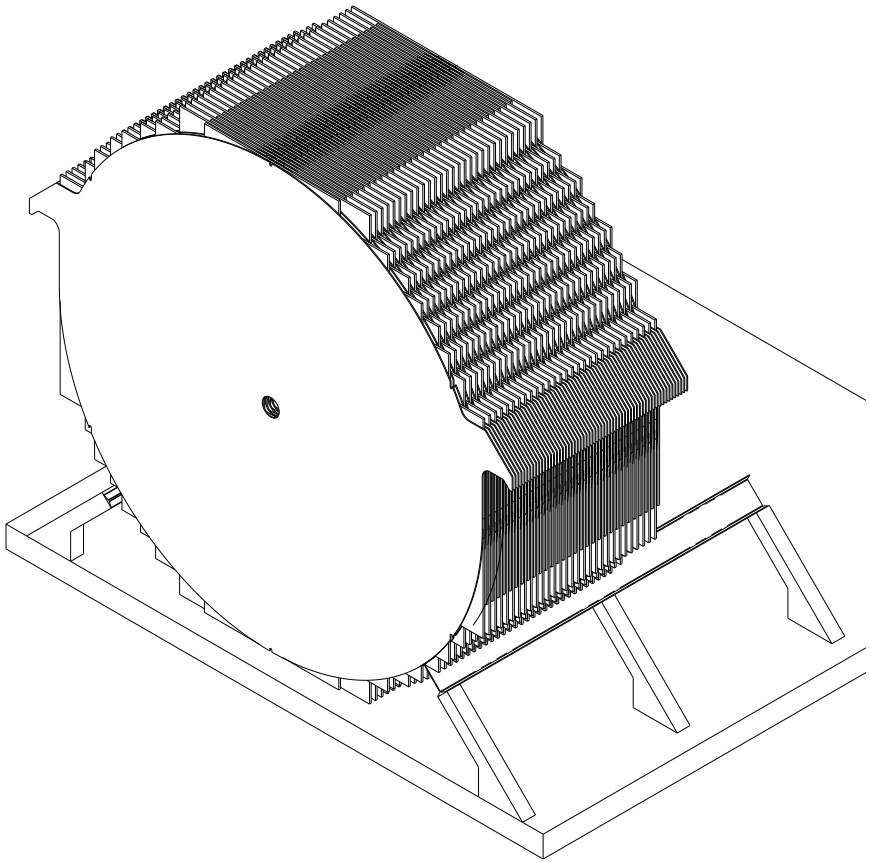
R. Bayes[1], A. Bross[3], A. Cervera-Villanueva[2] , M. Ellis[4,5], A. Laing[1] , F.J.P. Soler[1], Chris Tunnel[6], and R. Wands[3]

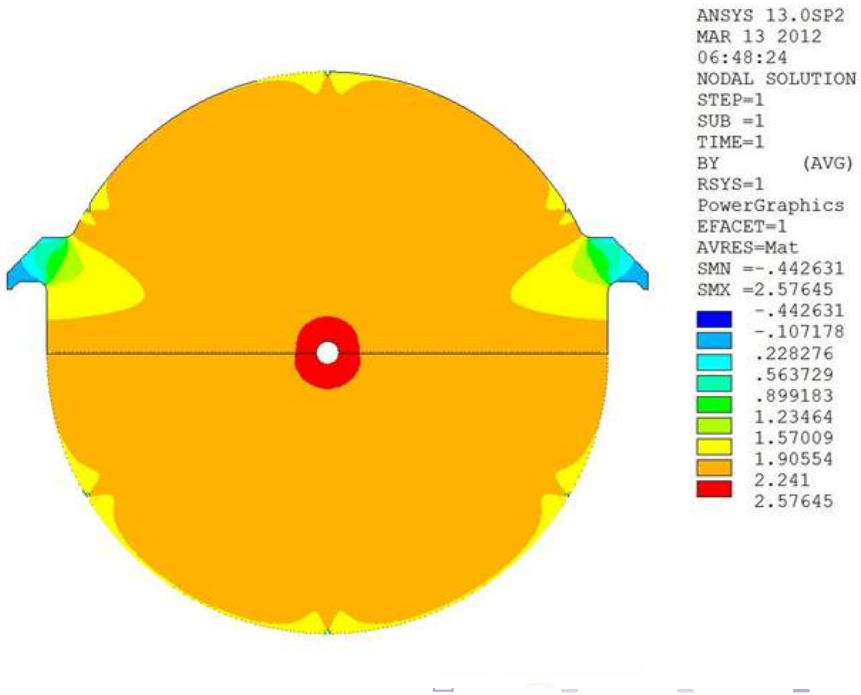
[1]University of Glasgow, [2]IFIC and Universidad de Valencia, [3]Fermilab, [4]Brunell University, [5]Westpac Institutional Bank, Australia,[6]University of Oxford,
on behalf of the IDS-NF collaboration

IDS-NF Plenary Meeting
April 19, 2012

SuperBIND

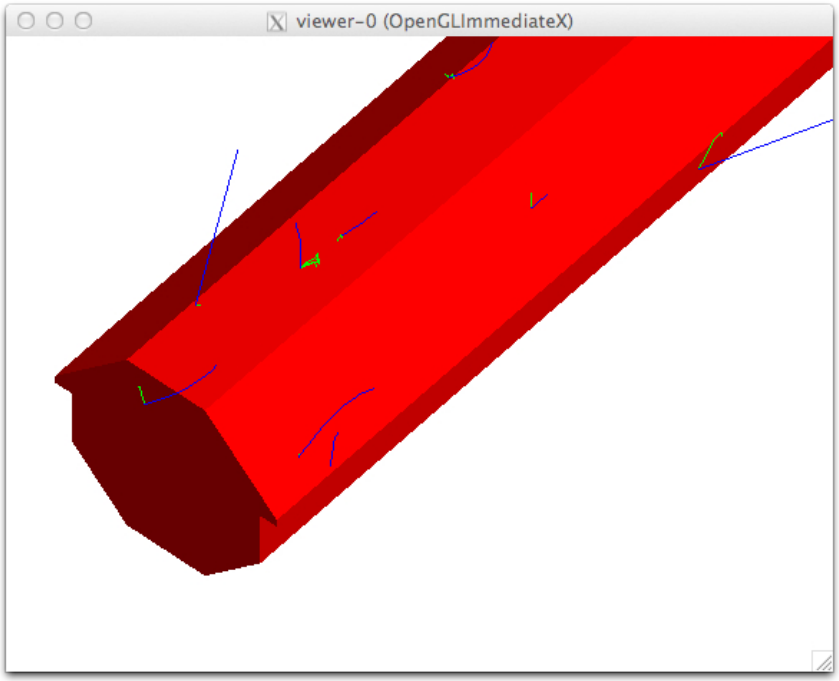
- A magnetized detector needed for charge selection.
- Achieved using MIND with thin steel plates.
- Higher field in plates required to produce comparable bending
- Circular cross-section proposed

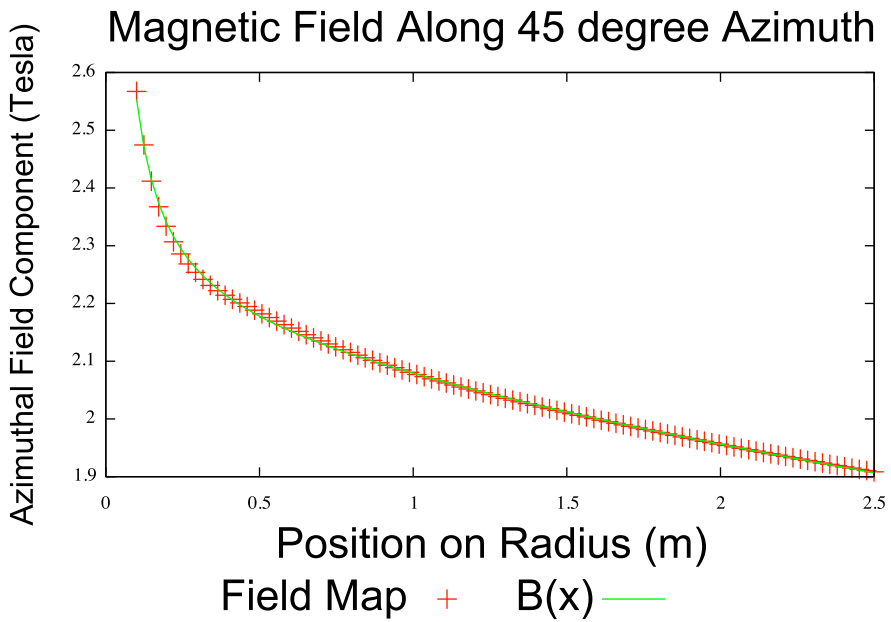




Simulation

- Used the MIND simulation as a starting point
- Assumed detector dimensions 5 m$\times$5 m$\times$10 m.
- Composed of alternating 1 cm Fe Plates and 2 cm Scintillator planes.
  - Detector parameters are flexible — allows for optimization.
- Assume 2 GeV stored muons.
- Parametrization of field map used for simulation and reconstruction.





Reconstruction

- This is the focus of development for MIND

Operation Summary

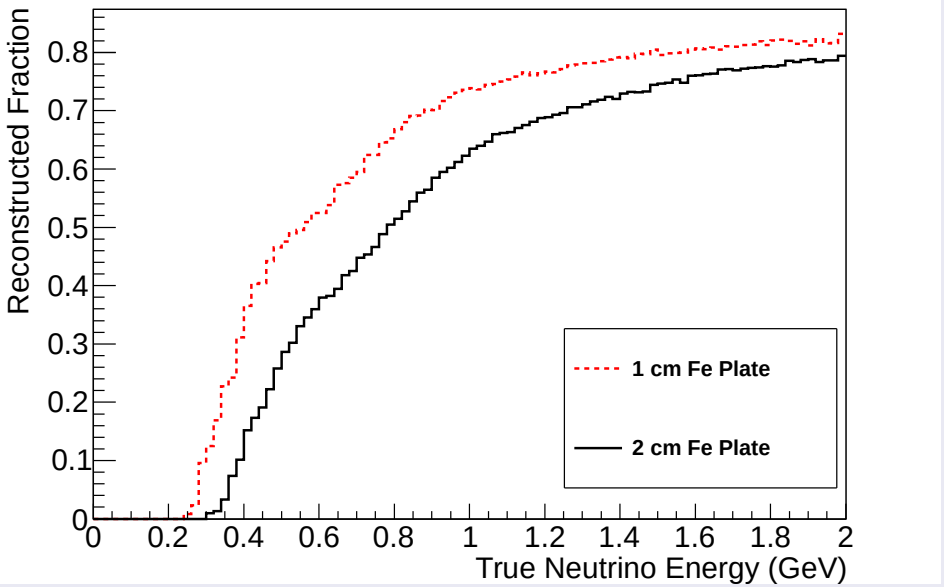
- Digitized detector space points passed to reconstruction.
- Events are sorted into tracks using either Kalman filter or cellular automaton methods.
- Selected tracks are fit using Kalman fitter.

- Reconstruction supported and maintained by IFIC group.
- Treatment of multiple track and high angle track is paramount.

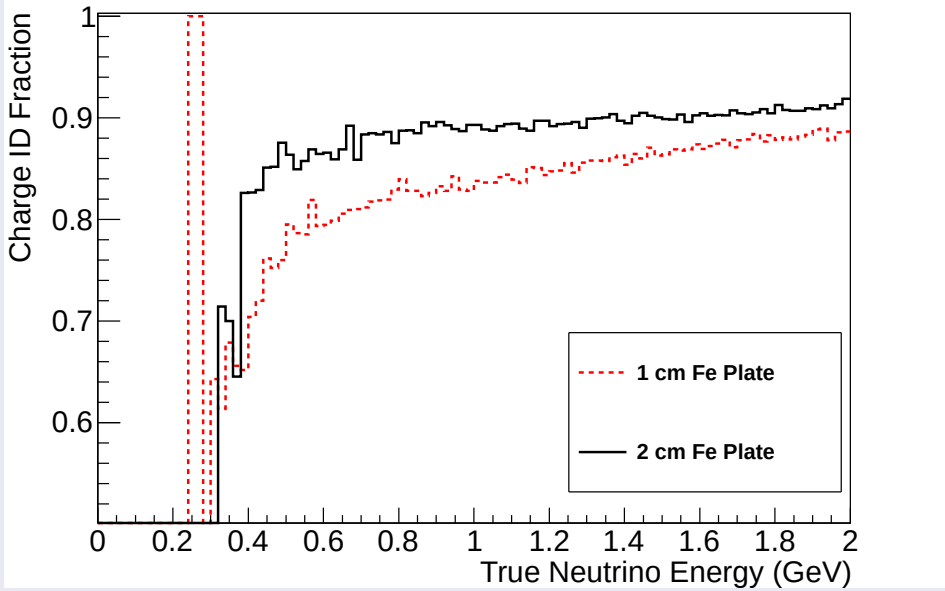
Charge selection optimization: Plate Thickness

- Original proposal called for 1 cm plates
- Doubling plate thickness improves charge identification
  - Same magnetic field used
  - Effective magnetic field increases by 3/2

Reconstructed Events



Fraction with Correct Charge ID

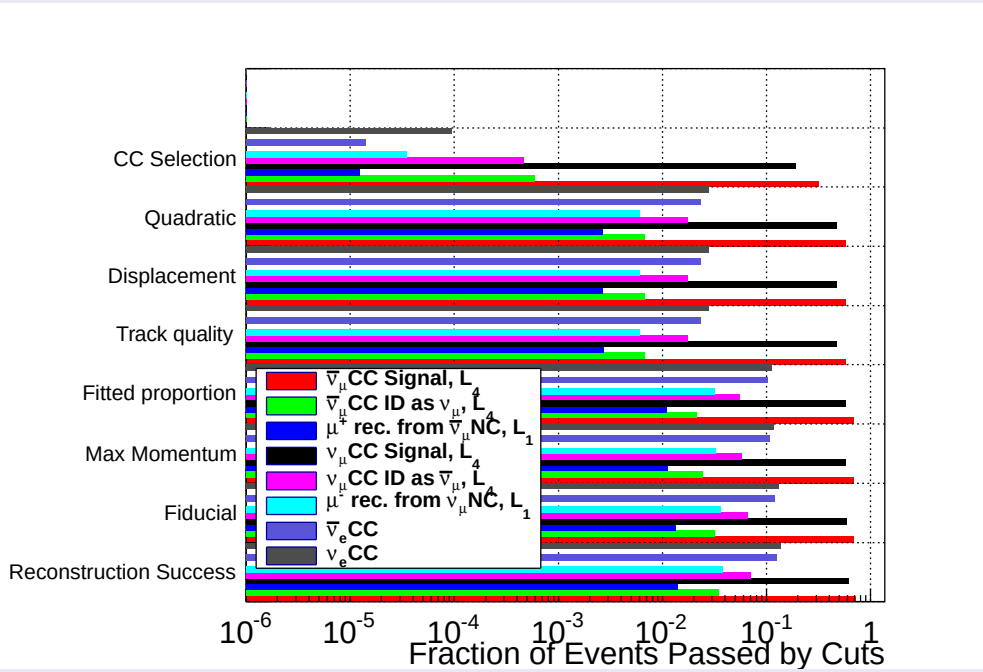


Analysis for SuperBIND

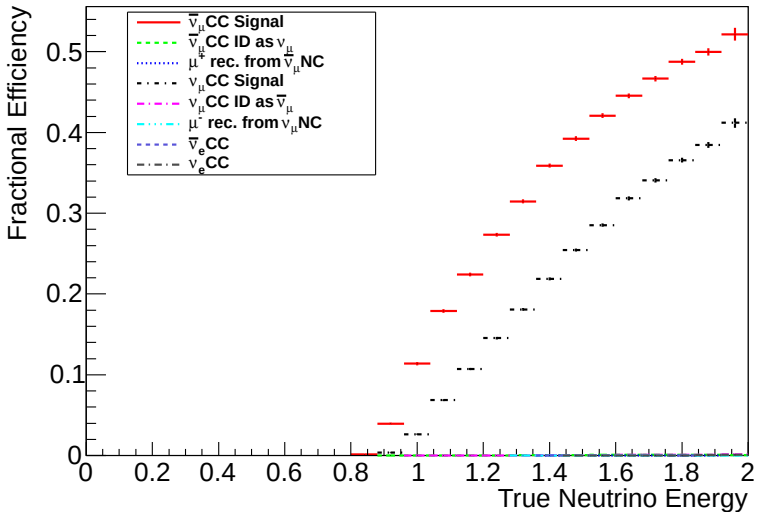
- Have appropriated Golden Analysis from MIND.

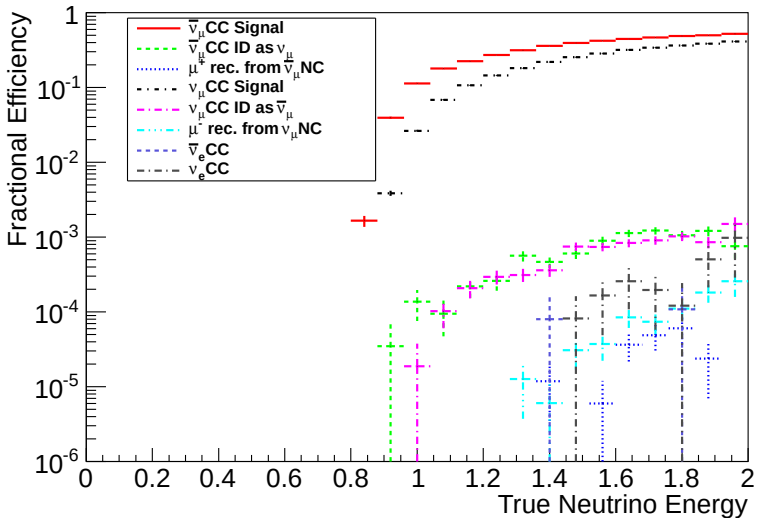
Heavily modified with respect to MIND IDR analysis.

- Suppressed or Removed some cuts:
  - Displacement of track in Z and R
  - Quadratic refit of track
  - Kinematic cut on Q_t and E_{rec}
- Retuned Track quality and CC Selection cuts in response to low ν energy.



Golden Analysis Efficiencies and Background Suppression





- Efficiency limited by CC Selection.
- Also removes "NC-like" CC backgrounds.
- Uses number of hits in trajectory.
- Removes events with $p_z < 1$ GeV/c.

Alternative: multi-variate analysis

- Use energy deposition.
- Reduce reliance hits in trajectory.
- Still a work in progress.

Conclusions

- A working simulation of the VLENF detector exists.
- Details of the design still to be implemented
  - Plate Geometry.
  - Scintillator bars.
- Important elements are present.
  - Realistic magnetic field.
  - Layered Steel and Scintillator.
- Reconstruction and analysis need the most development
  - Known issues in reconstruction/event classification.
  - Efficiency limited by basing NC rejection on energy dependent quantity.
- Issues mitigated if stored μ energy increased to 3 GeV from 2 GeV.