

Optimization of MRD transverse size

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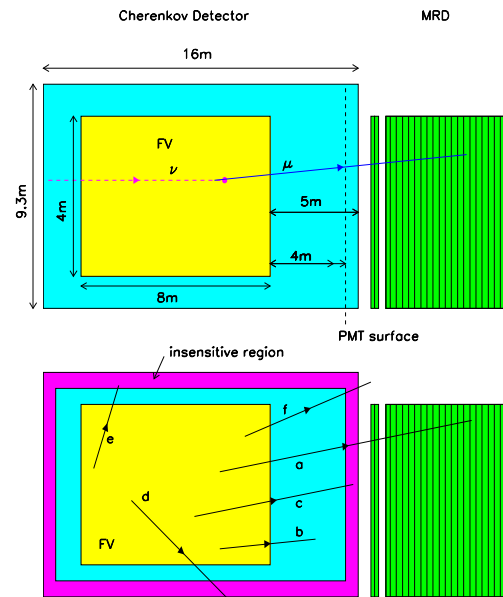
Talk at the T2K 2km meeting, November 10, 2005

Outline

- Motivations
- Muon lateral distribution in MRD
- Optimization and Results
- Conclusions

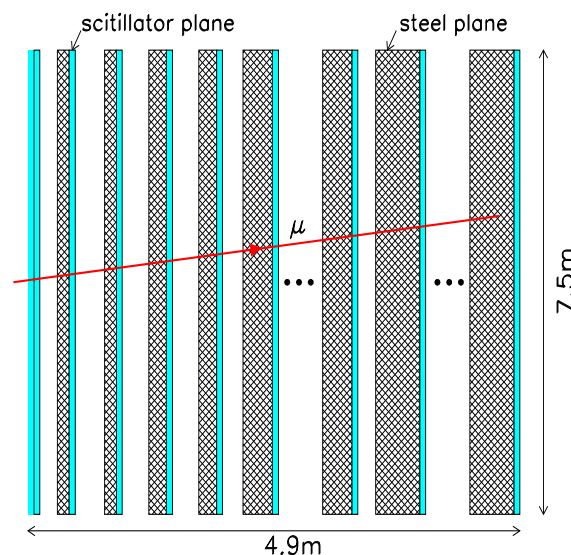
Motivations

The destination of MRD is to measure the spectrum of muons that penetrate into MRD through the vertical wall of the Cherenkov detector (high energy muons).



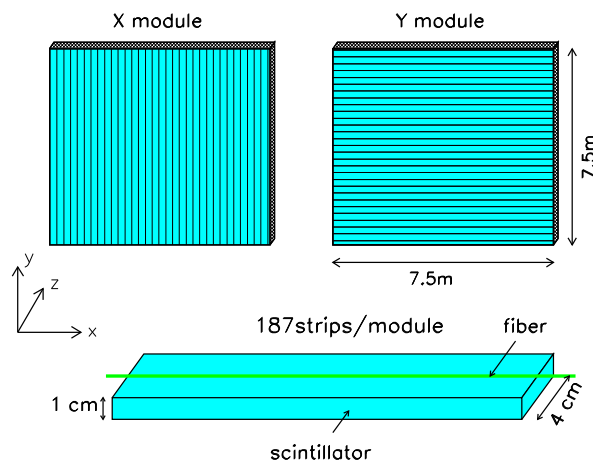
To study the performance of the MRD charge-current neutrino events were simulated in fiducial volume of 1kt detector. It was assumed that K2K MRD square steel sheets can be used for 2km MRD.

Overall Design



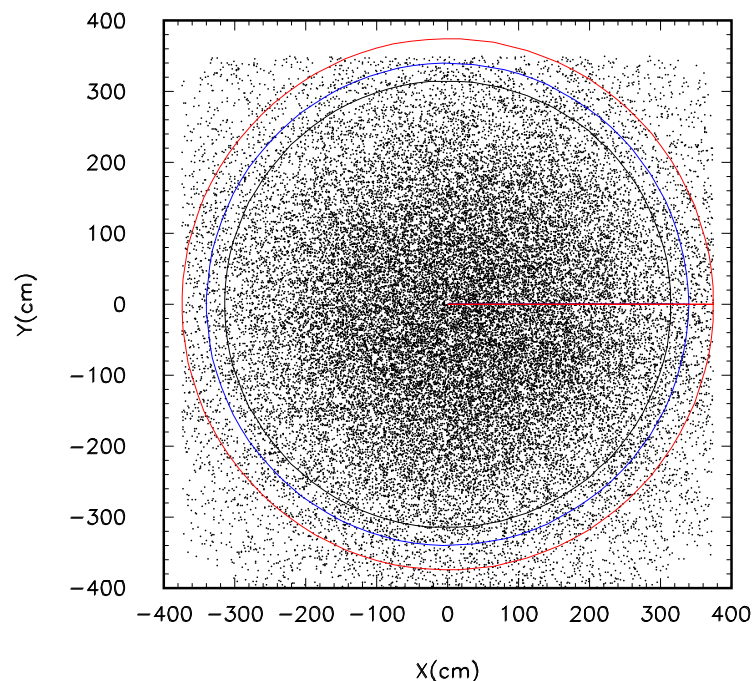
The MRD consists of 22 steel plane followed by a scintillator plane. Before it are placed two scintillator planes. The size of the MRD is $7.5\text{m} \times 7.5\text{m} \times 4.9\text{m}$. The first two steel plates are of 2.5cm thick, the next two planes have thickness of 5cm, the next ten layers are of 10cm thick and the last eight are of 20cm.

Scintillator planes and plastic strips



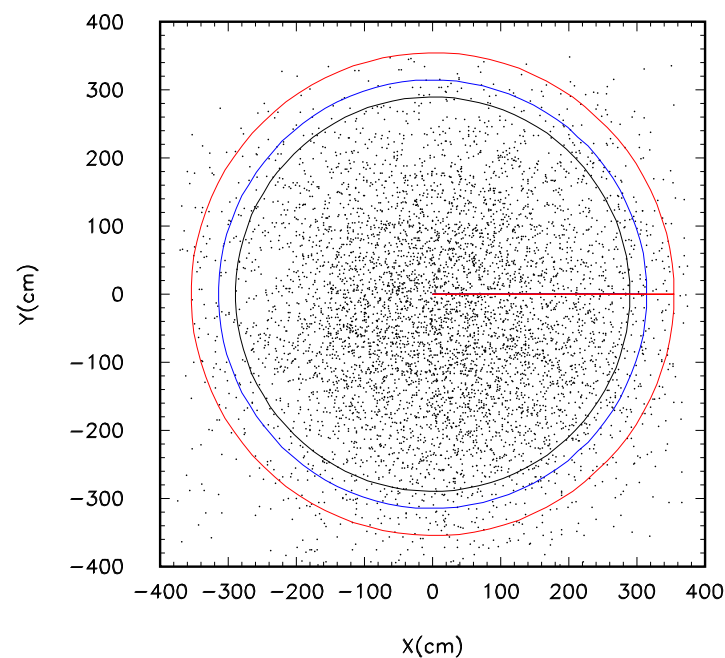
Each scintillator plane is made up to 187 strips, each 4 cm wide by 1cm thick and 750cm long. The orientation of the strips alternates $\pm 90^\circ$ in successive planes (X and Y modules).

Muon lateral distribution in MRD



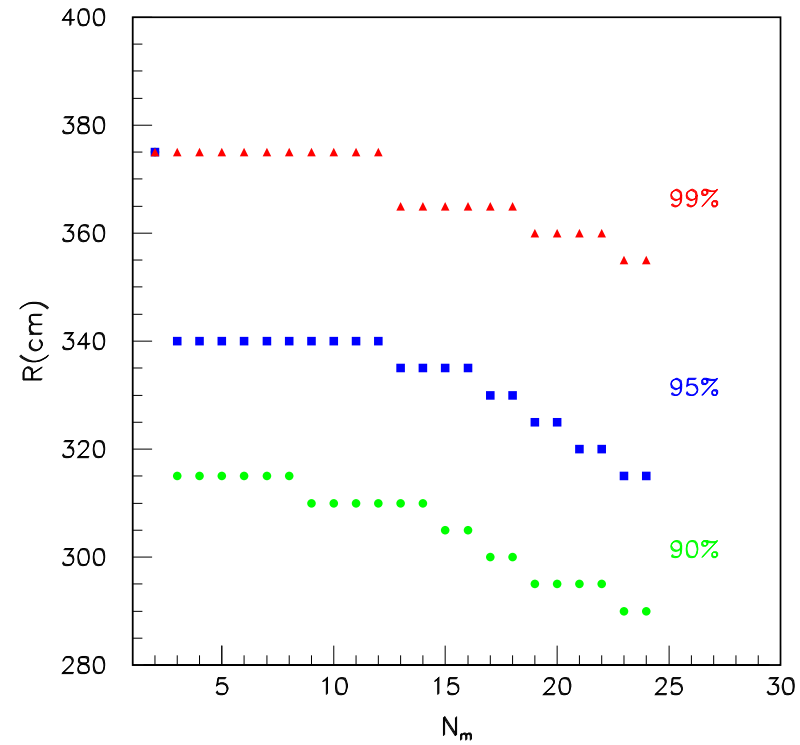
The 3d module:

In the region limited by the red circle 99% of events are accumulated
 $R(99\%)=375\text{cm}$, blue circle - 95% $R(95\%)=340\text{cm}$ and black circle - 90%
 $R(90\%)= 315\text{cm}$.



The 24th module:

In the region limited by the red circle 99% of events are accumulated
 $R(99\%)=355\text{cm}$, blue circle - 95% $R(95\%)=315\text{cm}$ and black circle - 90%
 $R(90\%)= 290\text{cm}$.

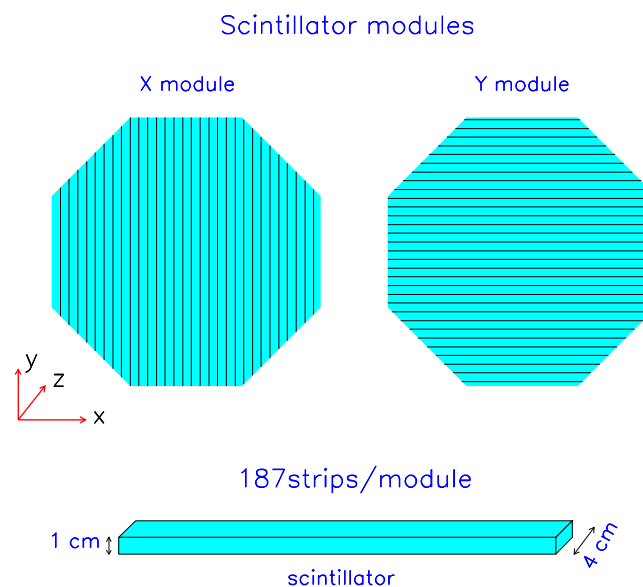


Radii of mudules where 99% , 95%, and 90% of events are accumulated.

Octagon module

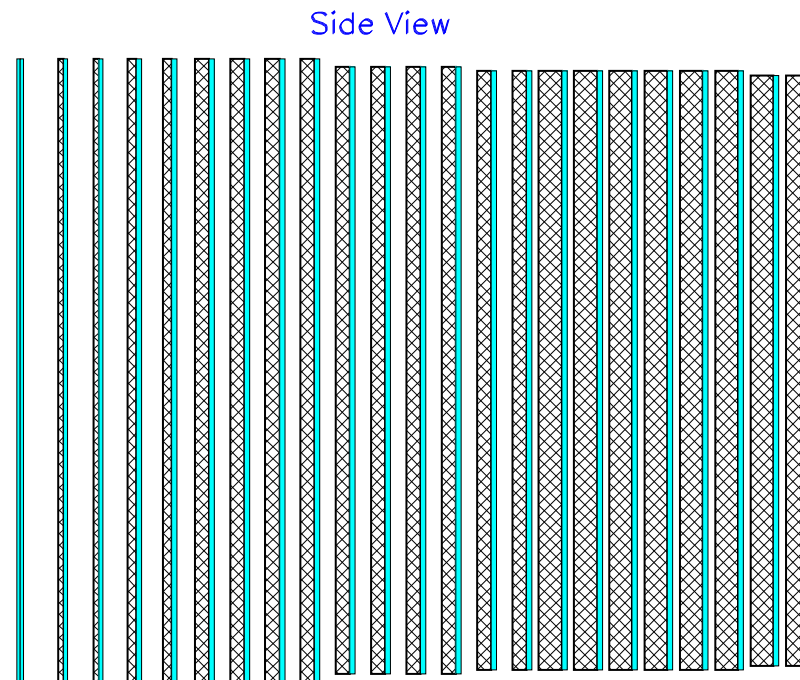
K2K MRD steel sheets will be used in an other detector. The optimization of lateral size and form of 2km MRD modules is need. The main parameter is WD&MRD efficiency/MRD square at the fixed energy and angular resolutions.

Octagon form of modules is more preferable than square one.



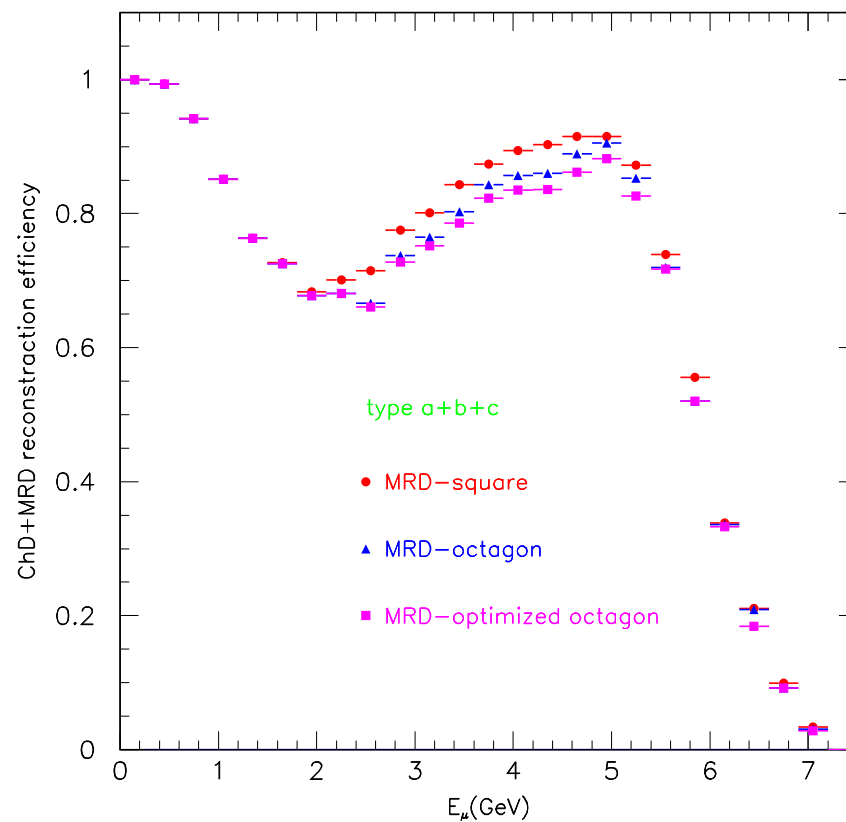
Two configurations of MRD were studied.

- Octagon. All modules are 750cm high. (MRD I)
- Octagon. The first 10 modules are of 750cm high, the next 4 are of 730cm, the next 8 are of 720cm and the last 2 layers are of 710cm high. (MRD II)



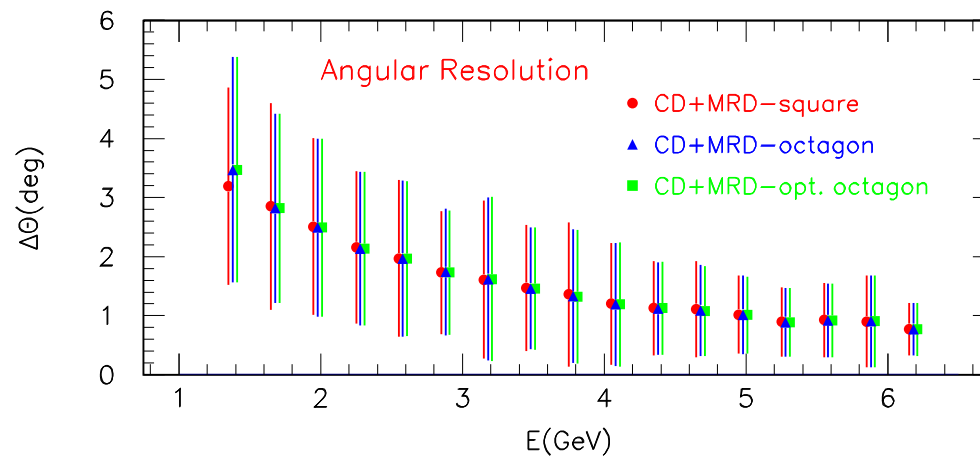
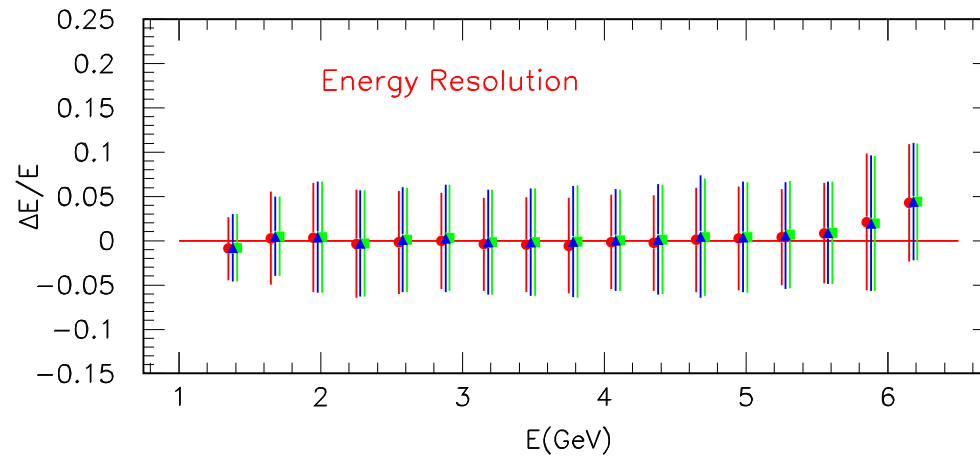
Result

WD & MRD reconstruction efficiency



Efficiency of (MRD I) configuration is diminished of 4% and (MRD II) - of 6%.

WD & MRD energy and angular resolution



MRD steel and scintillator

- Square modules
All modules are of 750cm high. Steel - 1214.296 t, scintillator - 13.905 t
- Octagon (MRD I)
All modules are of 750cm high. Steel - 1006.085 t, scintillator - 11.52 t
Economy of 17% .
- Octagon (MRD II)
Modules sizes are optimized. Steel - 942.935 t, scintillator - 11.02t
Economy; steel of 22% , scintillator of 21%.

Conclusion

- The lateral size of MRD was optimized using charge-current neutrino events simulated and reconstructed in 1kt detector.
- Two configurations of MRD were studied.
 - a) Octagon modules of 750cm high.
Economy of steel and plastic is of 17% and efficiency is reduced on 4% .
 - b) Octagon modules with optimized highs.
Economy of steel is of 22%, economy of scintillator is 21% and efficiency is reduced on 6% .