Joint Institute for Nuclear Research (Dubna)

ν_μ CC events purity and efficiency for STT and 3DST configurations

SAND meeting

Artem Chukanov

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Motivation

Check detection efficiency and purity of ν_μ CC interactions in ECAL+3DST+TPC and ECAL+STT configurations

Events for ECAL+3DST+TPC were generated in Dubna with the help of GDML file provided by Guang. Edep-sim program was modified to have a smaller steps in Trajectory.Point class, $\sim$ 1 mm to evaluate particles' momenta at the border of detector volumes

Note

Events are normalized to the 1 week statistics for front ECAL with the following FV:
$|x| < 169\ cm,\ 200 < R < 223\ cm,\ z < 0$
Simulated events number: 1 071 506

CDR geometry

In GDML file active 3DST and TPC volumes did not take into account boxes, supports and electronics

3DST box dimension 252 $\times$ 236 $\times$ 200 cm - from gdml file

Used scintillator dimension 240 $\times$ 224 $\times$ 192 cm - from CDR

For y and z dimensions of TPC we removed 3 cm from each side

FV for primary vertex inside 3DST: 2 cm from each side - exclude interactions in 3DST box (it is necessary to investigate)

CC identification - 3DST

3DST group method:

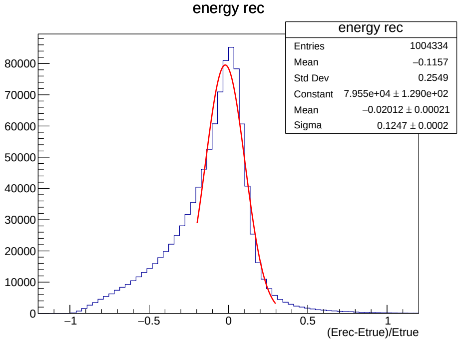
Muon track range cut - 3DST > 20 cm or in TPC > 20 cm (same as in CDR)

Developed method:

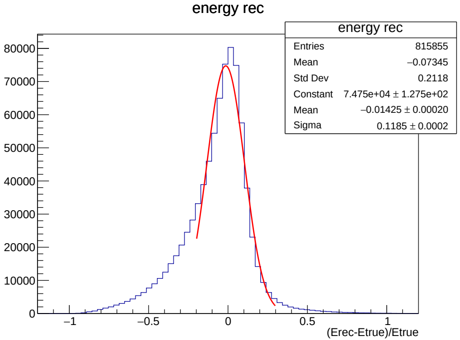
- detector identification: muon is going out of Yoke at z > 0
- for other muons we are applying range cut:
  3DST>100 cm and 3DST+TPC>130 cm
- excluding muon candidates with inelastic interactions in 3DST (more than 1 charged particles outgoing at the end of track with 100% efficiency of secondary charged track reconstruction)

Energy resolution

Muon identification - default method



Muon identification - developed method



Event statistics - CC identification

	Simulated events			Efficiency		Purity
	true CC+NC	true CC	true NC	CC	NC	CC
ECAL	1456517	1 071 507	385010	–	–	–
3DST	546467	399022	147445	–	–	–
ECAL+3DST	2002984	1470529	532455	–	–	–
	Reconstructed events - default method					
ECAL	578252	549609	28643	0.513	0.074	0.950
3DST	426082	391175	34907	0.980	0.237	0.918
ECAL+3DST	1004334	940784	63550	0.640	0.119	0.937
	Reconstructed events - muon identification					
ECAL	469174	460864	8310	0.430	0.022	0.982
3DST	346681	335343	11338	0.840	0.077	0.967
ECAL+3DST	815855	796207	19648	0.541	0.037	0.976

Beam monitoring - $\sqrt{\Delta\chi^2}(E_\nu)$, preliminary

Proton beam parameter	Variation	3DST - 1		3DST - 1		STT (80%)	
		true	rec	true	rec	true	rec
Horn current	+3 kA	9.5	6.2	8.6	6.1	10.4	7.7
Water layer thickness	+0.5 mm	4.3	3.3	4.0	3.2	4.6	3.7
Decay pipe radius	+0.1 m	5.8	4.1	5.0	3.8	6.4	5.0
Proton target density	+2%	5.5	4.5	5.1	4.3	5.9	5.0
Beam sigma	+0.1 mm	3.9	3.2	3.6	3.0	4.3	3.6
Beam off set X	+0.45 mm	1.1	0.7	1.0	0.7	1.2	0.8
Beam theta phi	0.07 mrad θ, 1.57 ϕ	0.7	0.3	0.7	0.3	0.8	0.4
Beam theta	0.070 mrad	0.8	0.3	0.8	0.3	0.9	0.4
horn 1 X shift	+0.5 mm	2.8	1.8	2.6	1.8	3.1	2.3
horn 1 Y shift	+0.5 mm	3.3	2.2	3.0	2.1	3.7	2.7
horn 2 X shift	+0.5 mm	0.6	0.3	0.6	0.3	0.6	0.4
horn 2 Y shift	+0.5 mm	0.6	0.3	0.6	0.3	0.7	0.3

Time scale factor between STT and 3DST configurations - 1.4 – 1.7
For 7 days with STT data taking we need 10 – 12 days of data taking with 3DST to get the same sencitivity
For STT we have 20% less statistics
Only radial distributions are considered

Summary

- there is no difference for beam monitoring between default CC muon identification and range method
- for 7 days with STT data taking we need $\sim$ 11 days of data taking with 3DST to get the same sencitivity
- final results after small improvements in muon identification for 3DST