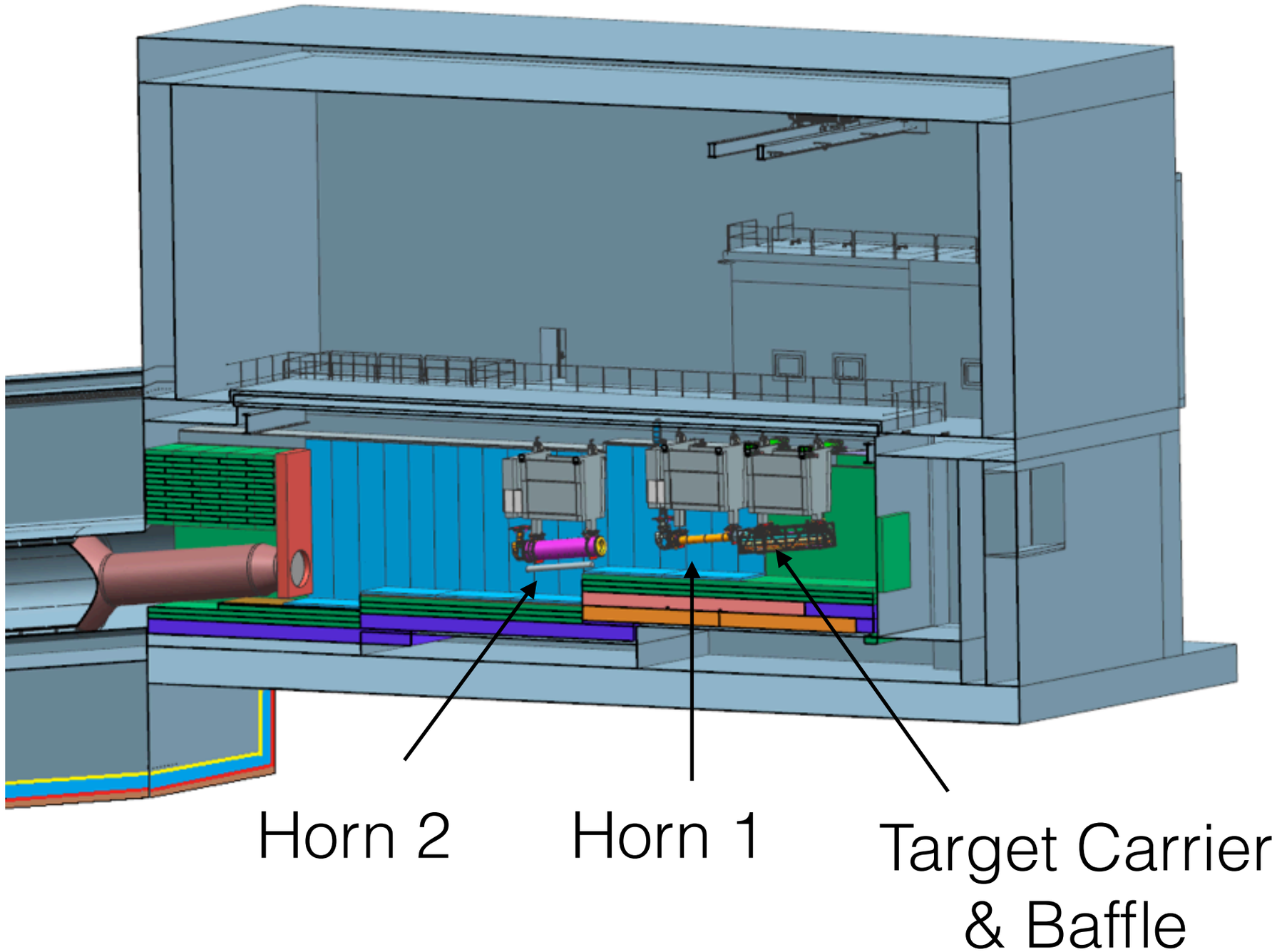
Tau Neutrino Optimization Update

Michael Dolce

DUNE reference design with NuMI style horns



From "LBNF/DUNE CDR Volume 3: The Long-Baseline Neutrino Facility for DUNE"

NuMI Style Configuration

Beam width/height	1.5 mm
Target shape	“BOX”
Target width	6.4 mm
Target height	20.0 mm
Target density	1.754 g/cm^3

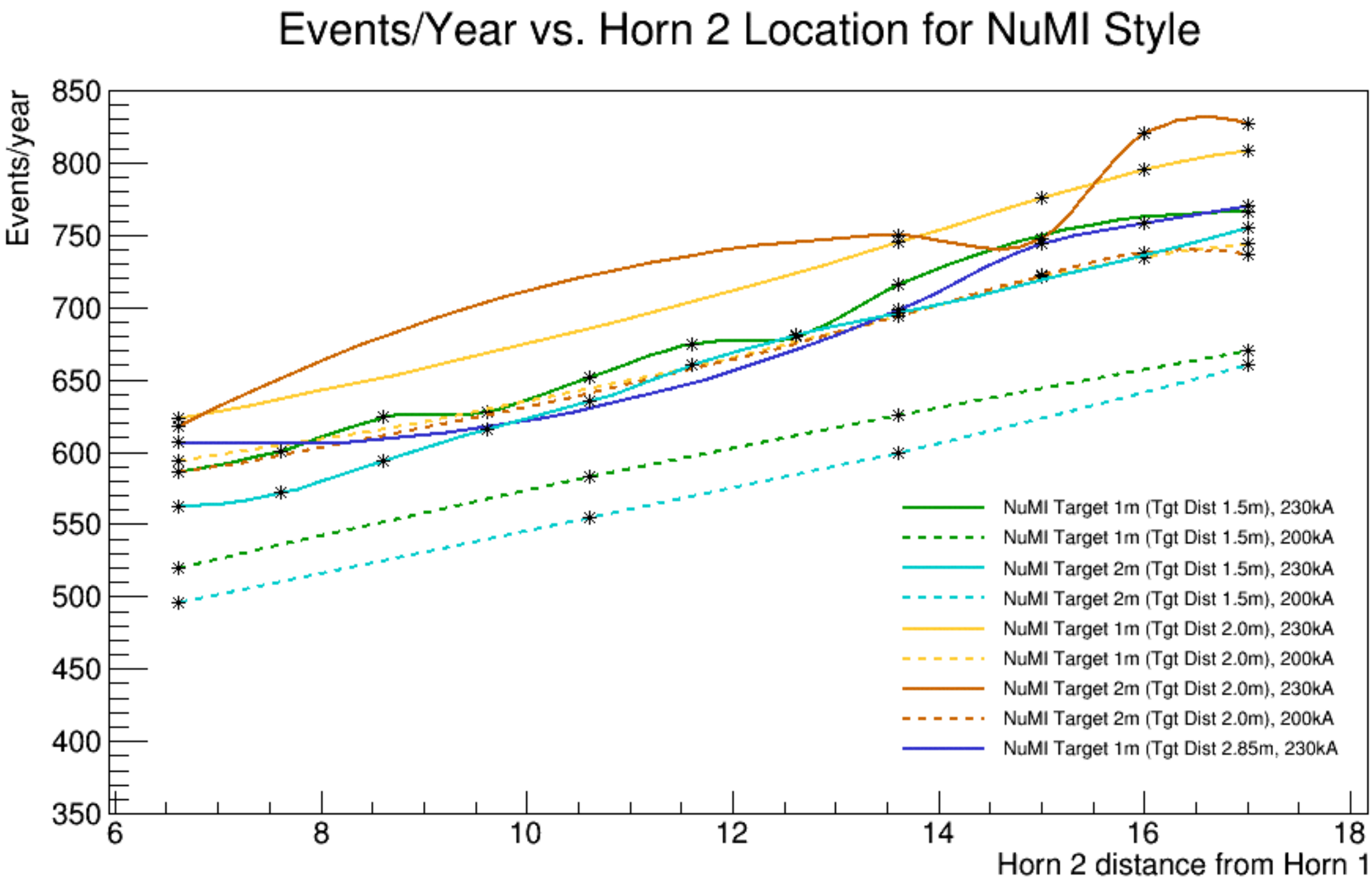
LBNF Style Configuration

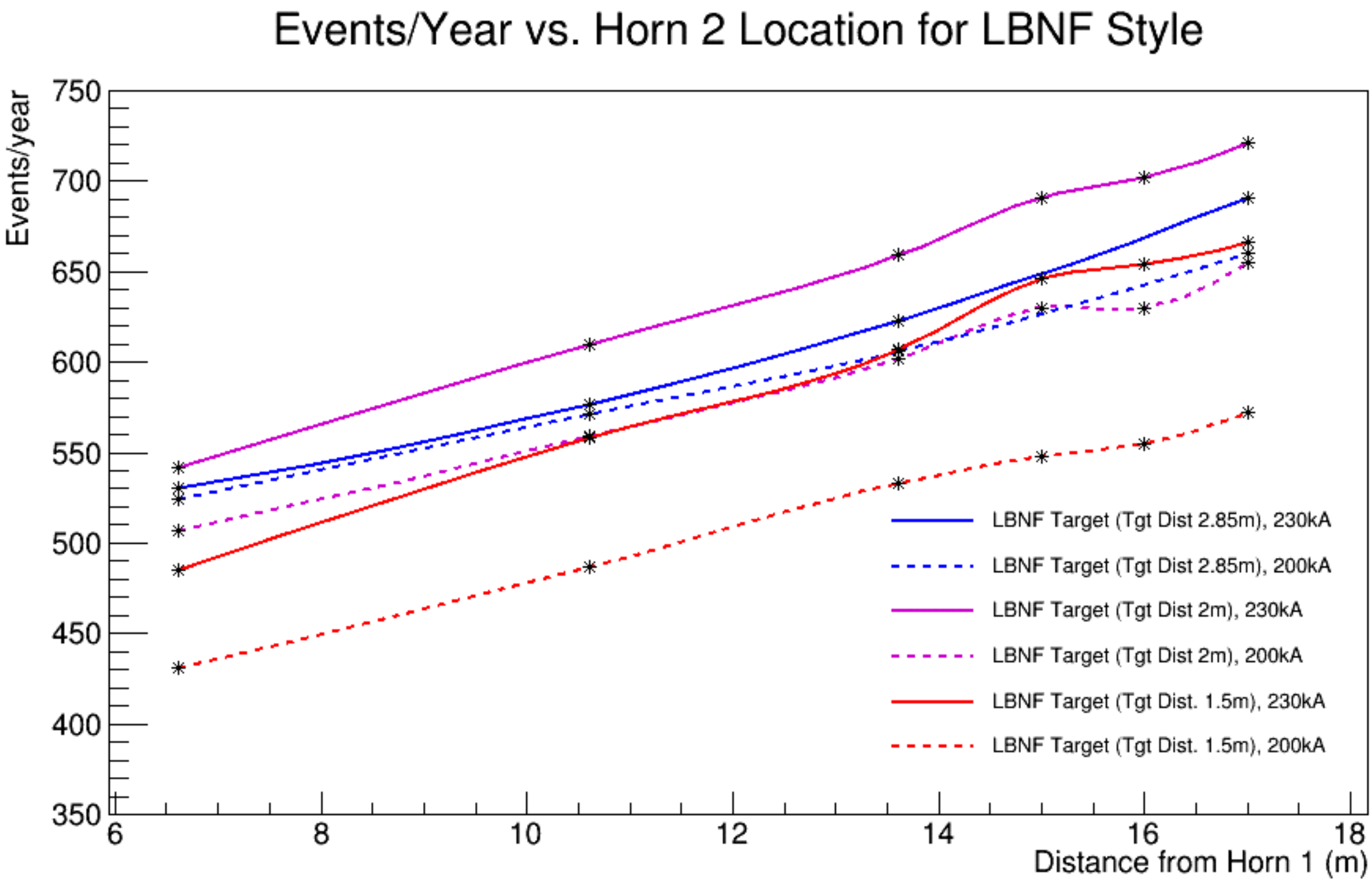
Beam width/height	1.7 mm
Target shape	“BOX”
Target width	10.0 mm
Target height	20.73 mm
Target density	1.754 g/cm^3

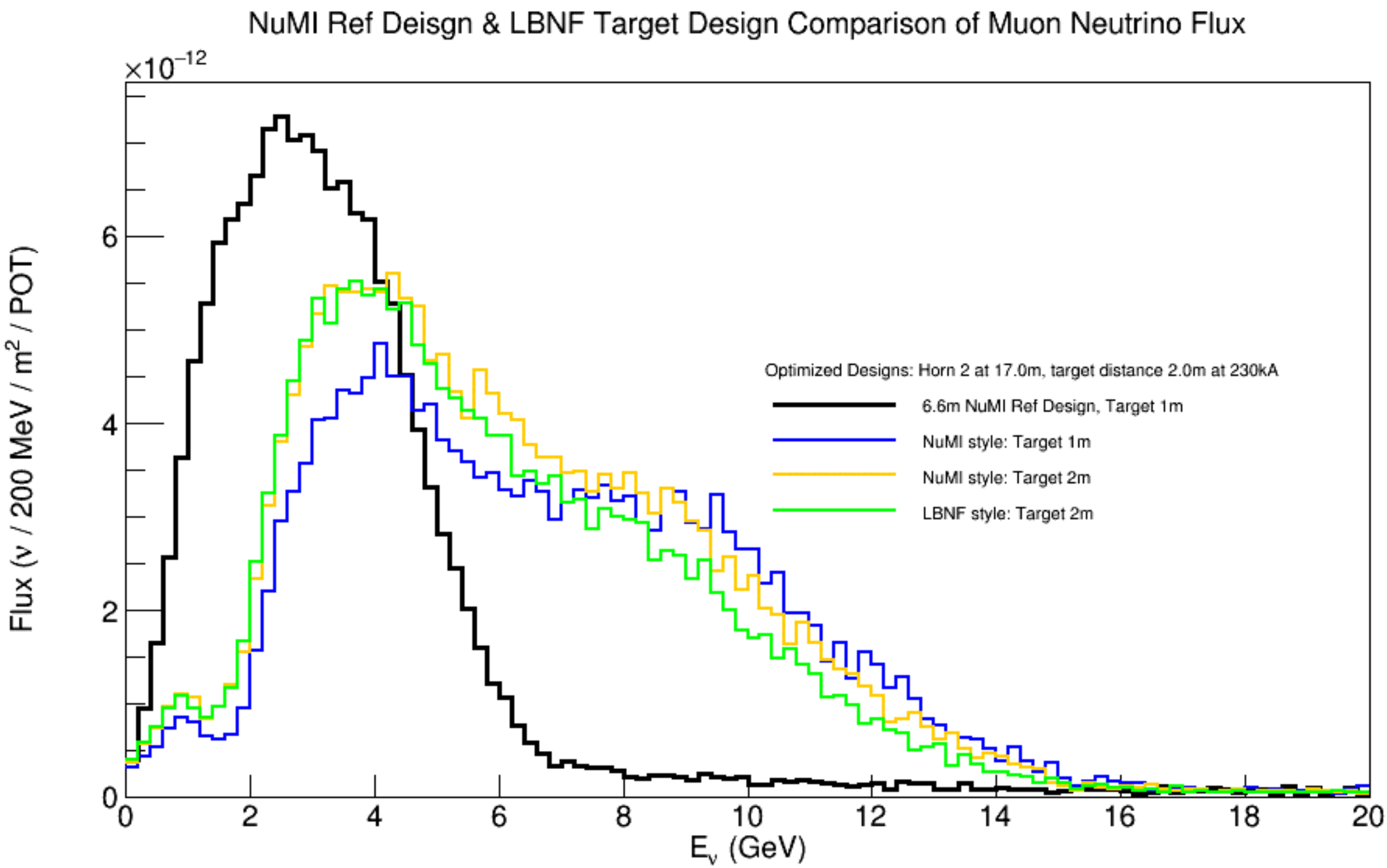
Parameters

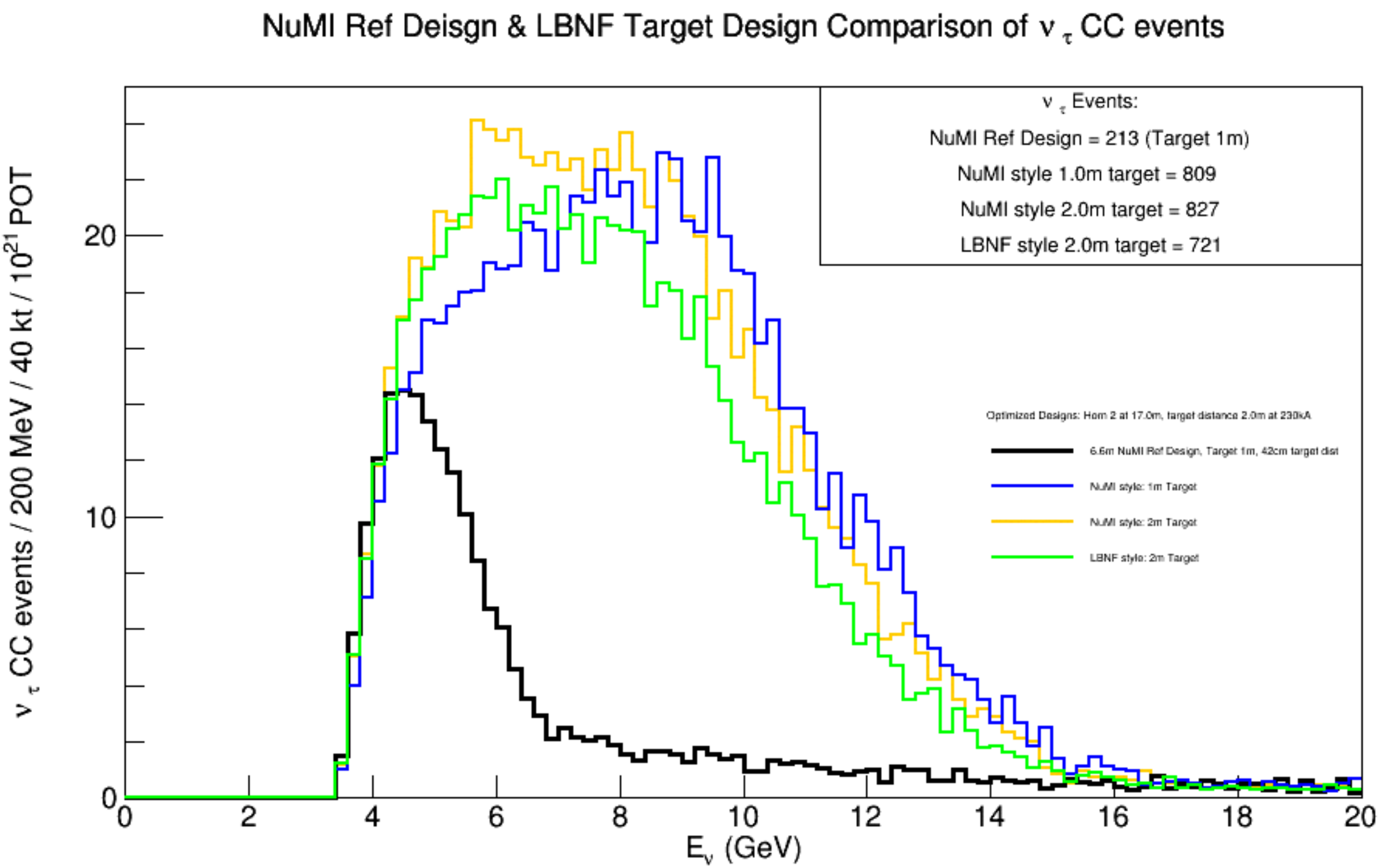
Target length	0.9538 m	2.3719 m	
Target distance to horn 1 (0.42 m)	1.5 m	2.0 m	2.85 m
Horn 2 Location	6.6 m	…	17.0m
Horn 1 & 2 current	200 kA	230 kA	

Target Design	Parameters	Events
NuMI configuration 1m target length	target distance 2.0m current 230kA	809
NuMI configuration 2m target length	target distance 2.0m current 230kA	827
LBNF configuration 2m target Length	target distance 2.0m current 230kA	721


Events/Year vs. Horn 2 Location for NuMI Style
Events/year
850
800
750
700
650
600
550
500
450
400
350
6
8
10
12
14
16
18
Horn 2 distance from Horn 1
NuMI Target 1m (Tgt Dist 1.5m), 230kA
NuMI Target 1m (Tgt Dist 1.5m), 200kA
NuMI Target 2m (Tgt Dist 1.5m), 230kA
NuMI Target 2m (Tgt Dist 1.5m), 200kA
NuMI Target 1m (Tgt Dist 2.0m), 230kA
NuMI Target 1m (Tgt Dist 2.0m), 200kA
NuMI Target 2m (Tgt Dist 2.0m), 230kA
NuMI Target 2m (Tgt Dist 2.0m), 200kA
NuMI Target 1m (Tgt Dist 2.85m, 230kA


Events/Year vs. Horn 2 Location for LBNF Style
Events/year
750
700
650
600
550
500
450
400
350
6
8
10
12
14
16
18
Distance from Horn 1 (m)
LBNF Target (Tgt Dist 2.85m), 230kA
LBNF Target (Tgt Dist 2.85m), 200kA
LBNF Target (Tgt Dist 2m), 230kA
LBNF Target (Tgt Dist 2m), 200kA
LBNF Target (Tgt Dist. 1.5m), 230kA
LBNF Target (Tgt Dist. 1.5m), 200kA


NuMI Ref Deisgn & LBNF Target Design Comparison of Muon Neutrino Flux
×10^-12
Flux (ν / 200 MeV / m^2 / POT)
E_ν (GeV)
Optimized Designs: Horn 2 at 17.0m, target distance 2.0m at 230kA
6.6m NuMI Ref Design, Target 1m
NuMI style: Target 1m
NuMI style: Target 2m
LBNF style: Target 2m

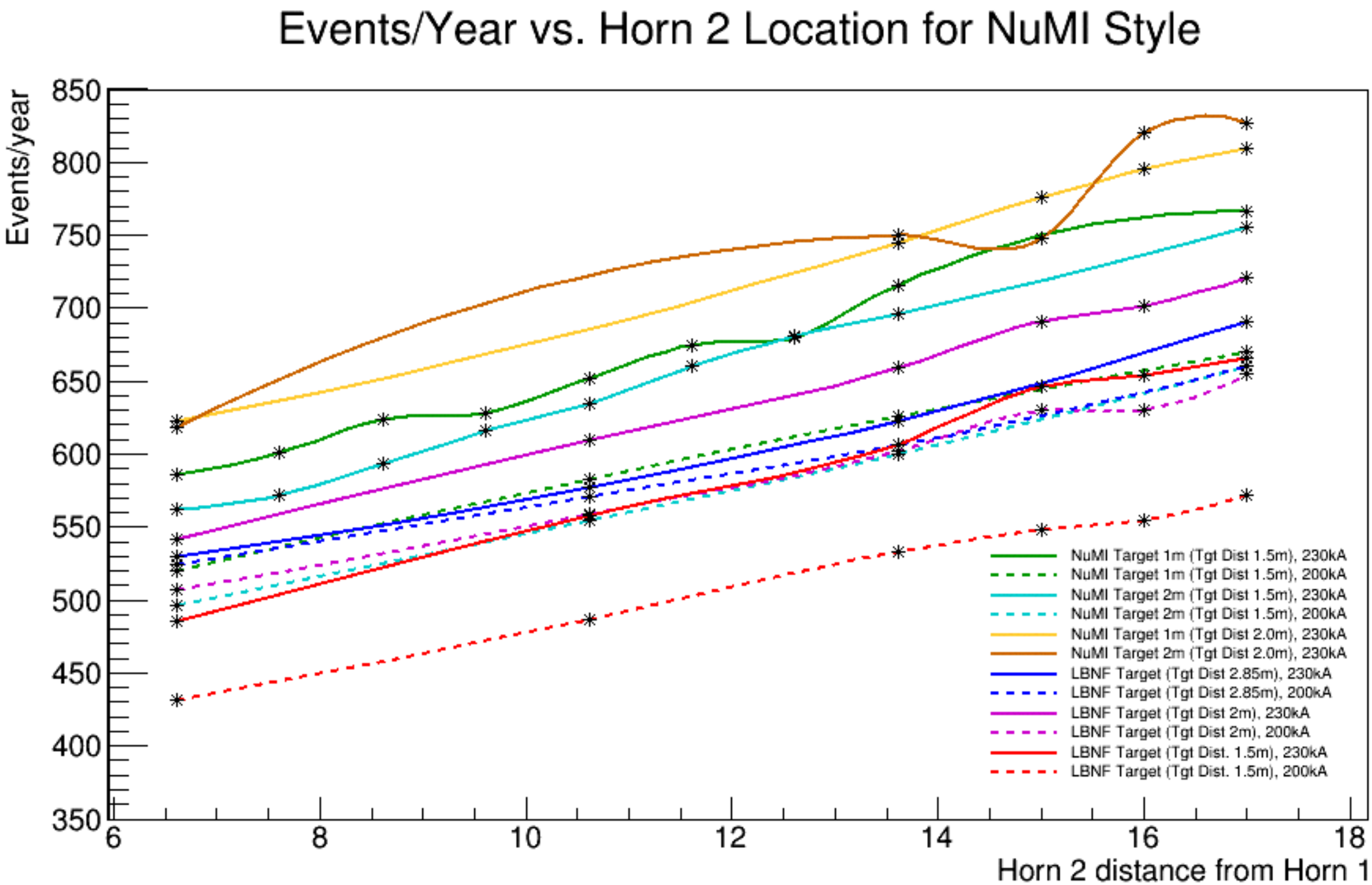

NuMI Ref Deisgn & LBNF Target Design Comparison of ν τ CC events
ν τ Events:
NuMI Ref Design = 213 (Target 1m)
NuMI style 1.0m target = 809
NuMI style 2.0m target = 827
LBNF style 2.0m target = 721
Optimized Designs: Horn 2 at 17.0m, target distance 2.0m at 230kA
6.6m NuMI Ref Design, Target 1m, 42cm target dist
NuMI style: 1m Target
NuMI style: 2m Target
LBNF style: 2m Target
ν τ CC events / 200 MeV / 40 kt / 10^21 POT
E ν (GeV)
0
10
20
0
2
4
6
8
10
12
14
16
18
20

Conclusion

- Of the three configurations thus far, the NuMI style horn is produces more tau neutrinos. Specifically, the 2m long NuMI style target is best.

- Next thing to do is to find an optimized configuration for the LBNF style target of 1m length and see how it ranks compared to the other three designs.

Back up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750
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Horn 2 distance from Horn 1
NuMI Target 1m (Tgt Dist 1.5m), 230kA
NuMI Target 1m (Tgt Dist 1.5m), 200kA
NuMI Target 2m (Tgt Dist 1.5m), 230kA
NuMI Target 2m (Tgt Dist 1.5m), 200kA
NuMI Target 1m (Tgt Dist 2.0m), 230kA
NuMI Target 2m (Tgt Dist 2.0m), 230kA
LBNF Target (Tgt Dist 2.85m), 230kA
LBNF Target (Tgt Dist 2.85m), 200kA
LBNF Target (Tgt Dist 2m), 230kA
LBNF Target (Tgt Dist 2m), 200kA
LBNF Target (Tgt Dist. 1.5m), 230kA
LBNF Target (Tgt Dist. 1.5m), 200kA