

The Physics Potential of a Neutrino Beam from Protvino to KM3NeT/ORCA

KM3NeT/ORCA Detector

115 detection lines
18 DOMs per line
31 PMTs per DOM

rapid deployment
autonomous unfurling
recoverable

Baseline 2590km, beam inclination 11.7°
Deepest point at 134km → Earth crust

IHEP/Protvino
100km South of Moscow
Founded in 1967

Current operation
Protons up to 70 GeV
5 s spill every 9 s
15 kW beam power

Effective Mass : Mtons
 ν_e $\bar{\nu}_e$ ν_μ $\bar{\nu}_\mu$ ν_τ $\bar{\nu}_\tau$ NC

Energy resolution 25-30%

High statistics LBL experiment

Events 3y: $\nu_e = 6600 \pm 900$, $\bar{\nu}_e = 3100 \pm 500$, $\nu_\mu = 3520 \pm 30$, $\bar{\nu}_\mu = 5900$, $\nu_\tau = 1000$, $\bar{\nu}_\tau = 1000$, NC = 1000.

KM3NeT/P2O preliminary

40% variations with δ_{CP}

Beam polarity chosen depending on Neutrino Mass Hierarchy

Sensitivity Estimates

χ^2 fit of event distribution in energy in both track and cascade channel
Various systematics considered : Normalization, Particle-ID uncertainty
 θ_{13} , θ_{23} , ΔM^2 , $\alpha(\text{NC})$, $\alpha(\nu_i)$

Beam Simulation : IHEP Protvino internal note 2015-5
Intensity upgrade : 450kW → $4 \cdot 10^{20}$ p.o.t. per year

NMH 5σ in 1 year

CP-violation confirmed for 50% with 2σ and 75% with 1σ after 3y

δ_{CP} -precision at 20°-40° after 3y

Longest baseline, highest Energy

P2O: 4.5GeV
DUNE: 2.4GeV
NOVA: 1.6GeV
T2K: 0.6GeV
Daya Bay (2km): 4.0 MeV

No degeneracy NMH ↔ CPV
Largest values of $P(\nu_\mu \rightarrow \nu_e)$

T2K HyperK NOVA DUNE P2O

Normal hierarchy
Inverted hierarchy

Smallest neutrino cross section uncertainties

Total
Cross section model
Systematic
Energy scales
FSI
Minerva arXiv:1701.04857

P2O : Intriguing Physics Potential - NMH & CPV
High Statistics, complementary to other projects