T2K target

-- Physics design and optimization --

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for



T2K collaboration

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Contents

- Design of current T2K target
- Conceptual ideas for future upgrade of target improvement for CP violation search.





T2K target size

- T2K target was designed in around 2003 to maximize the muon neutrino flux.
 - Solid target in horn system for high intensity beam \rightarrow Graphite
 - Length : L~900mm (~ 2 interaction length)
 - Target diameter is determined to balancing forward pion production and energy deposit concentration.
 - Using simulation (GCALOR, MARS)



Possible optimization in future

• From 2014, T2K starts CP violation search.

→ Reducing "wrong-sign" component is also important. "wrong-sign" : v in v-beam and v in v-beam cause the "fake" CP-Violating effect.

Flux (/cm²/50MeV/10²¹POT

 10^{5}

anti-Neutrino beam

T2K Preliminary

 $-\mathbf{v}_{\mu}$ $-\overline{\mathbf{v}}_{\mu}$ $-\mathbf{v}_{e}$ $-\overline{\mathbf{v}}_{e}$



Majority of wrong sign components are produced by forward π⁻ in v-beam and forward π⁺ for v-beam.
← Not defocused by horns.



Idea of target optimization (1)

- Hybrid target
 - Embed high-density material to reduce the pion outside horn-1 acceptance.



scatter even if the ceramic were to break.



high-density material

535.6 539.6 546.4 647

in graphite

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high-density material

335.6 339.6 546.4 247

in graphite

Idea of target optimization (2)

• "Second target" in horn1 : (L. H. Lam, J. Nugent, P. Soler Univ. of Glasgow) **Current horn setting in T2K**

90 cm graphite



Changed horn setting

90 cm graphite + 75 cm 2nd target





Idea of target optimization (2)

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Summary

- Current T2K target is optimized to maximize the muon neutrino flux for 1^{st} observation of v_e appearance.
 - Csonsidering the balance between the forward pion production and energy deposit concentration.
- For LBL neutrino experiment aiming CP violation search, Reducing "wrong-sign" component is also important.
- Ideas of target configuration change for future upgrade is considered, although it is still very conceptual.