The KPIPE Concept

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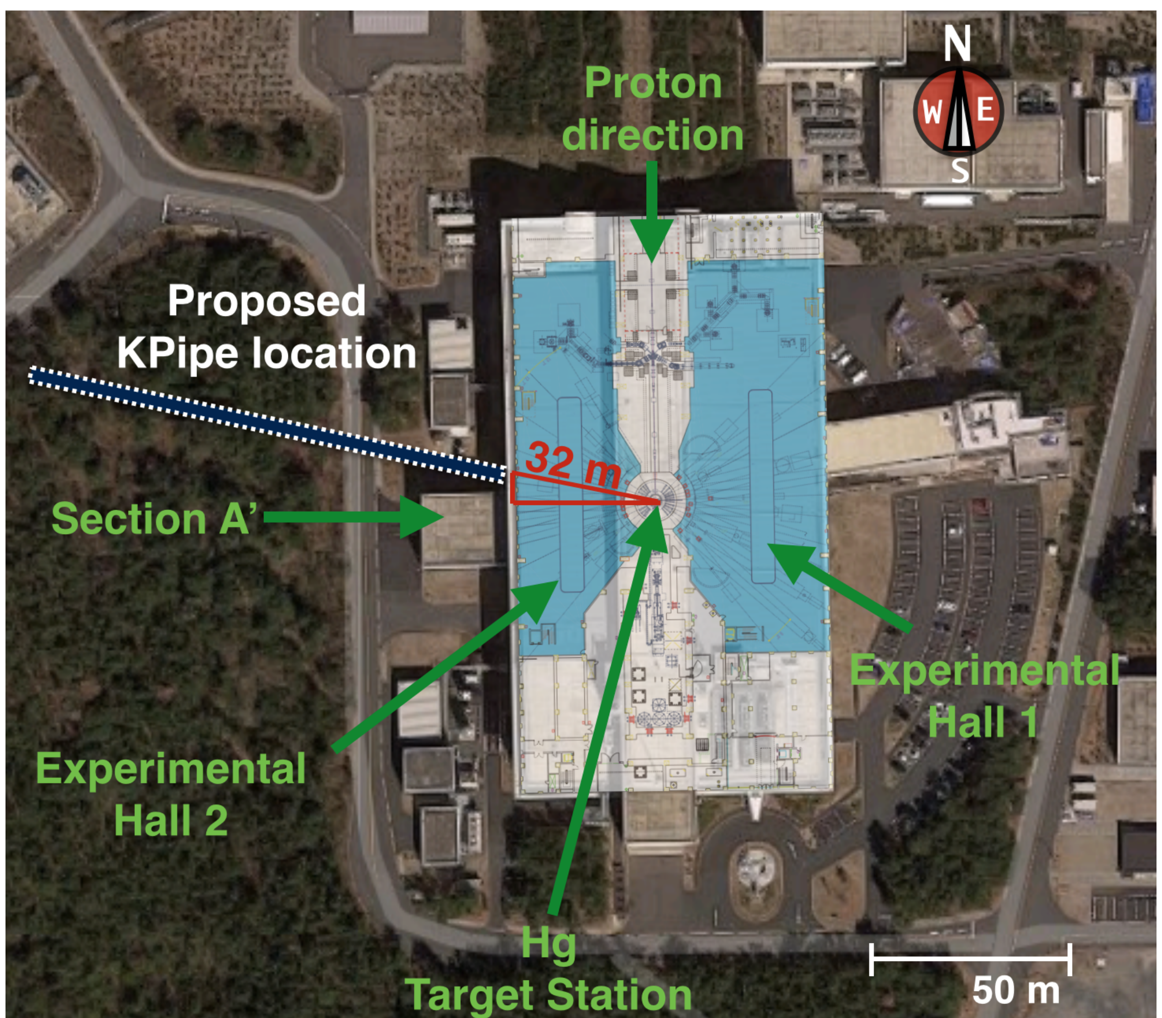
ACE Science Workshop

KPIPE

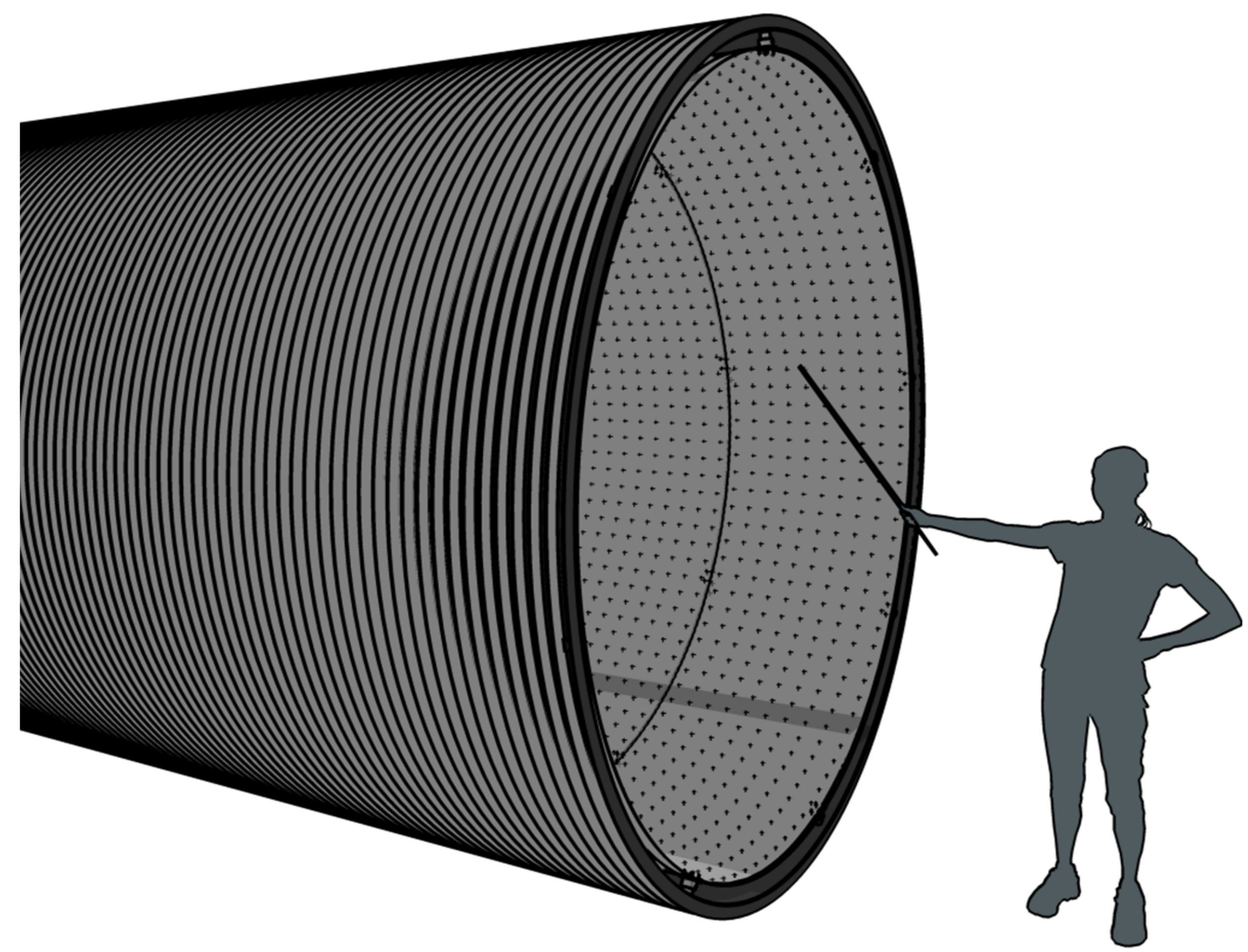
Axani, Collin, Conrad, Shaevitz, Spitz, Wongjirad, Phys. Rev. D 92 092010 (2015)

The idea:

Use a very long liquid scintillator detector to look for ν_μ disappearance (in *L*) using 236 MeV KDAR ν_μ CC events



example @ J-PARC MLF



Long LS detector surrounded by SiPMs

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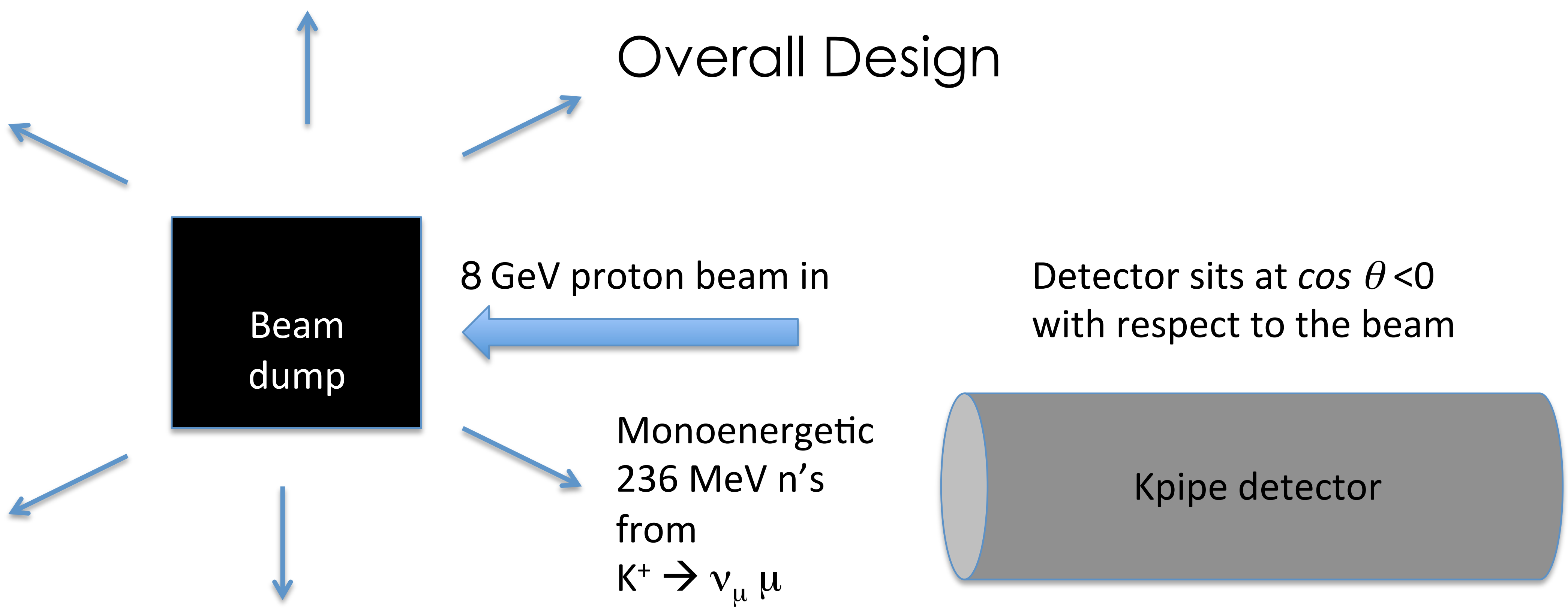
Overall Design



(1) pure, mono-energetic flux of muon neutrinos

(2) long detector to measure the oscillation wave

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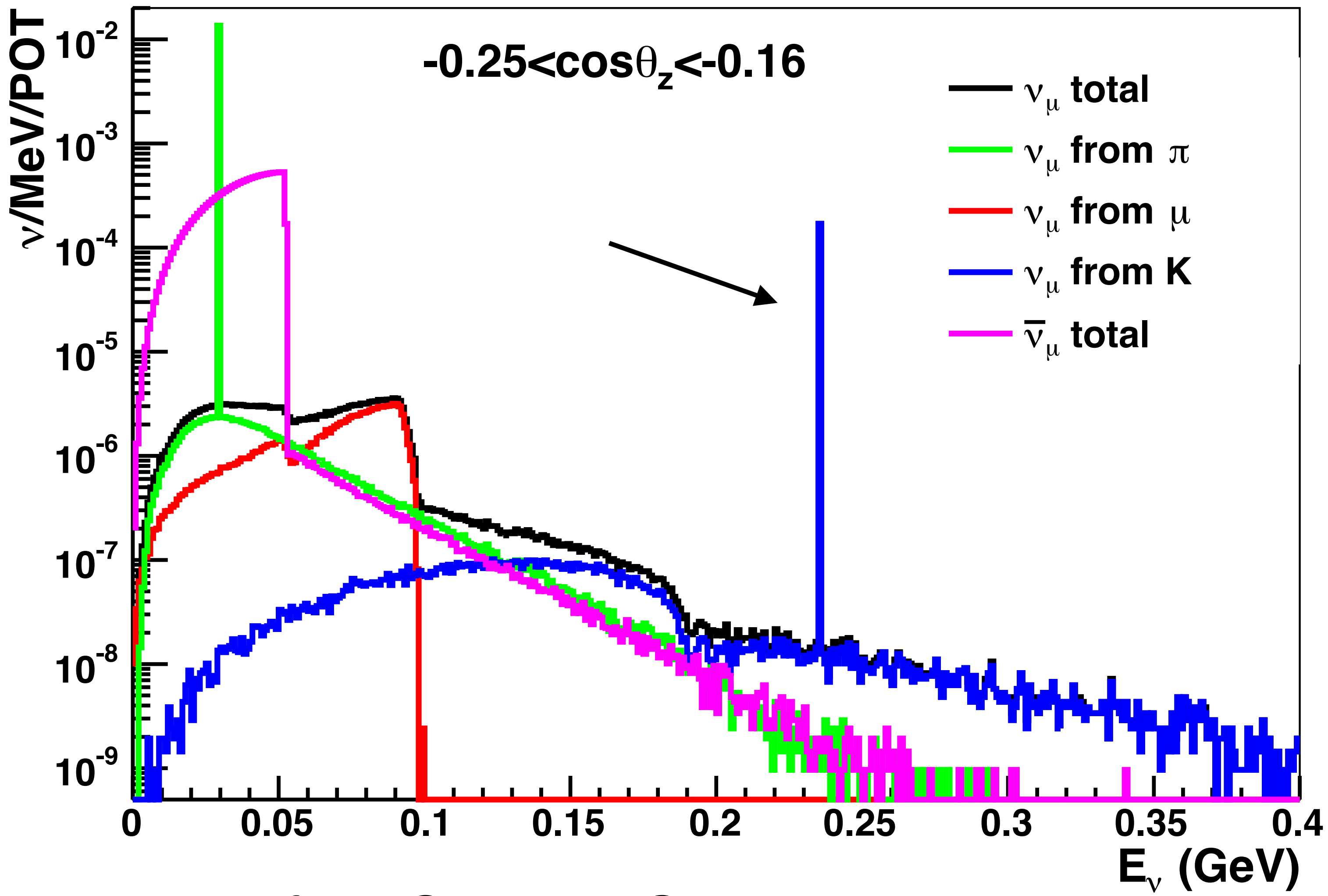
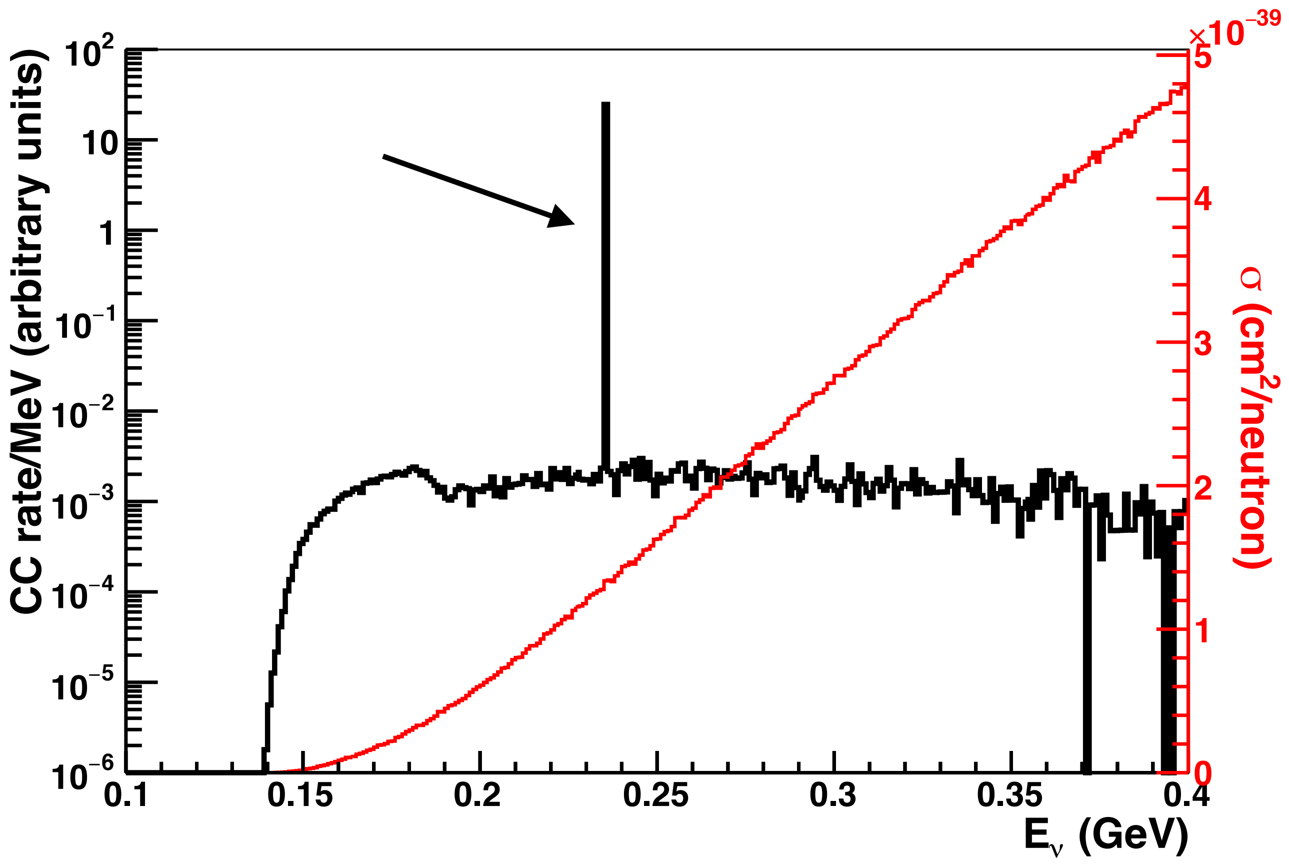
A very pure flux of KDAR neutrinos!

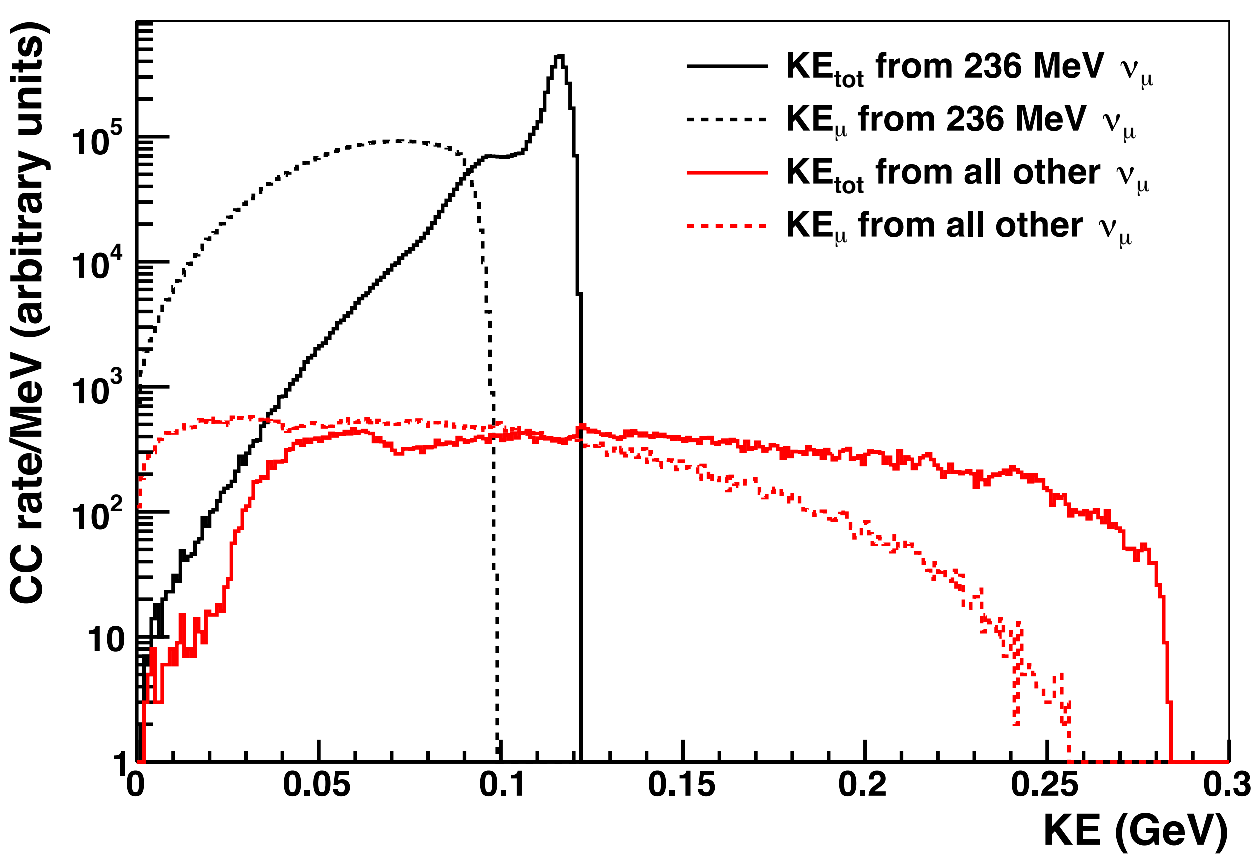


example flux @ J-PARC MLF

The beauty of KPIPE

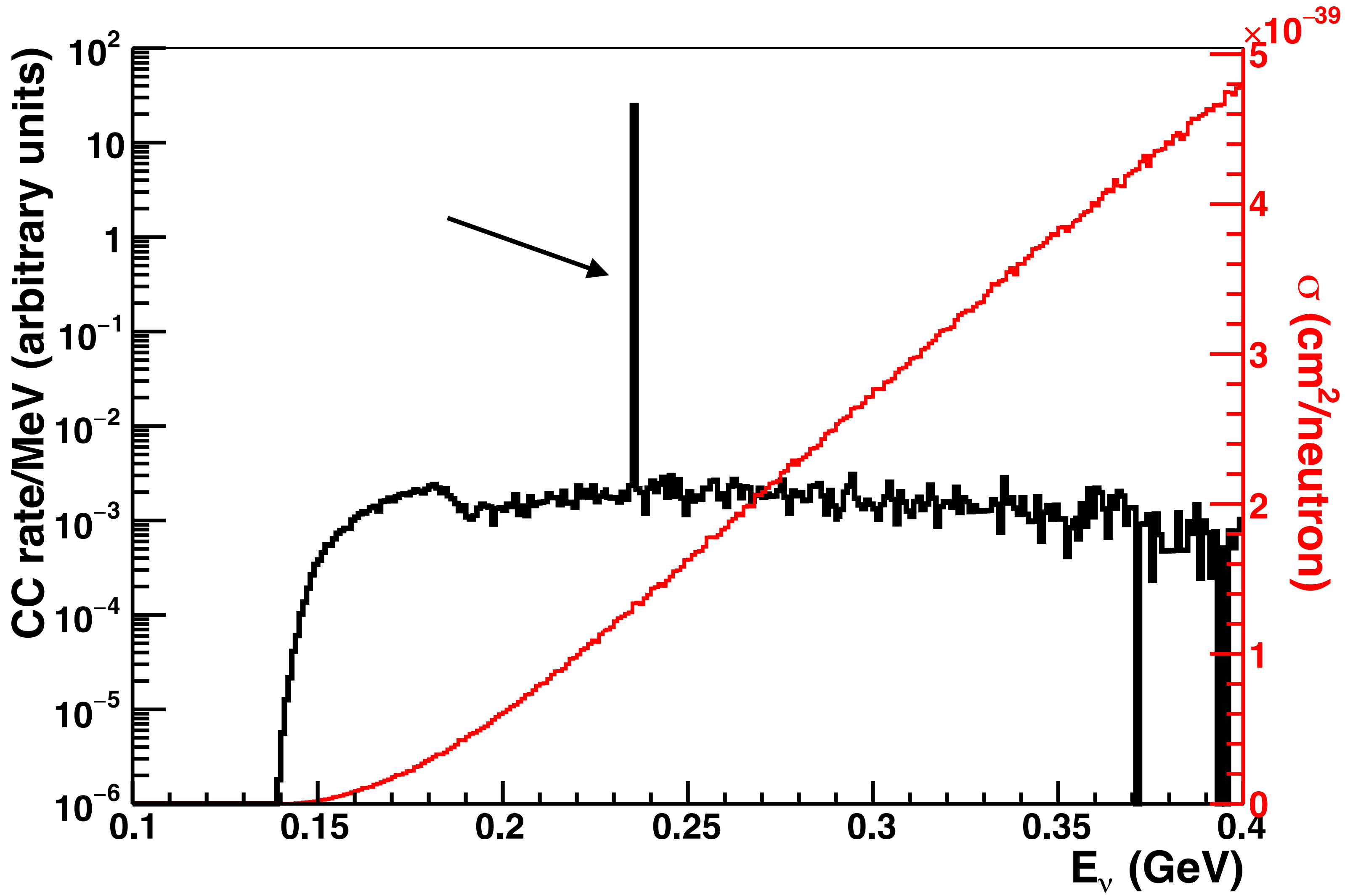
If you detect a muon-neutrino event, you can be 98.5% sure that it was a 236 MeV muon neutrino!





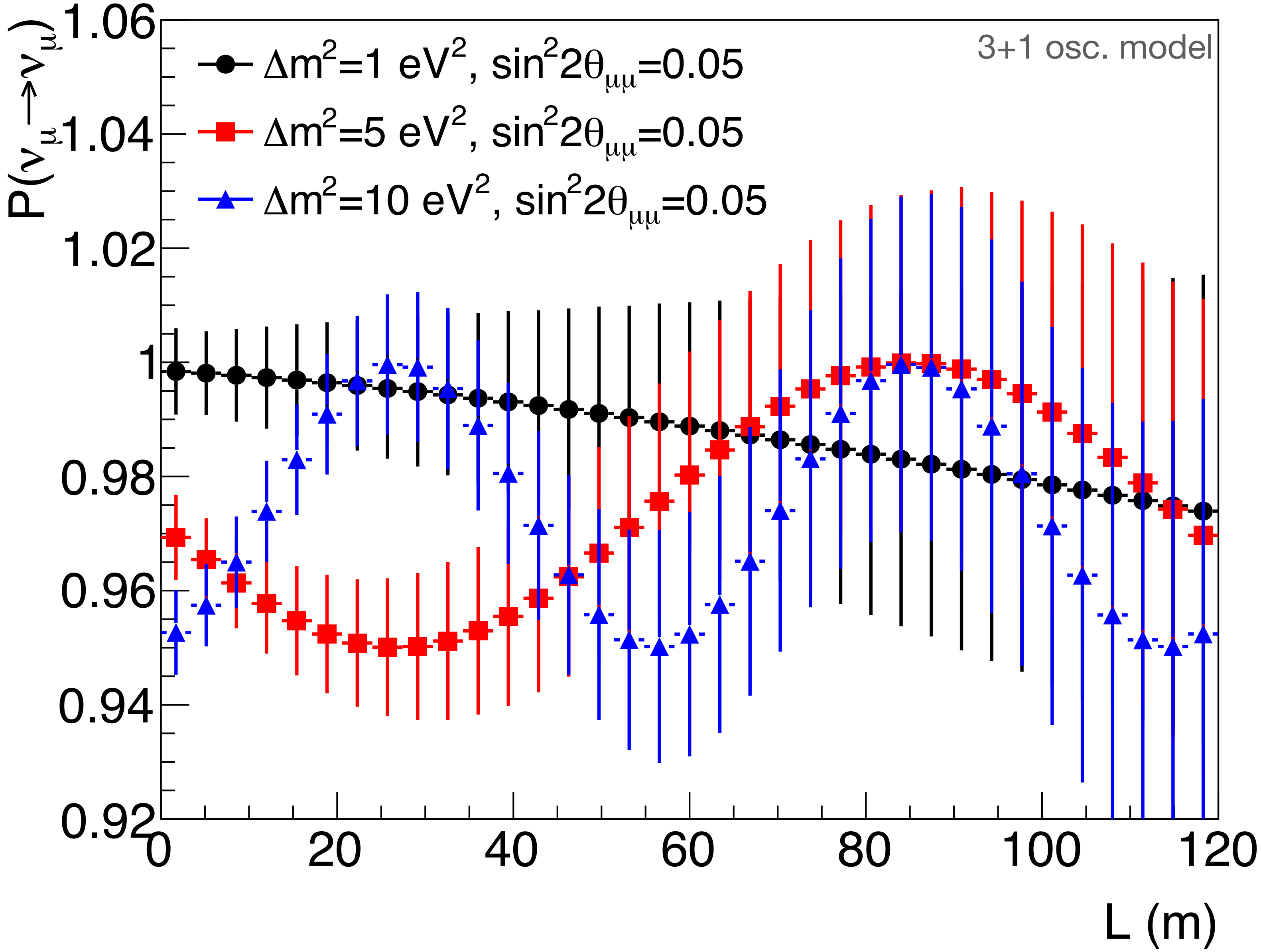
The beauty of KPIPE

Since you know the energy of the neutrino, you don't need to worry about energy resolution. KPIPE calls for 0.4% photocoverage.
Estimated cost of experiment: $4.5M



KPIPE cost document: http://hdl.handle.net/1721.1/98388

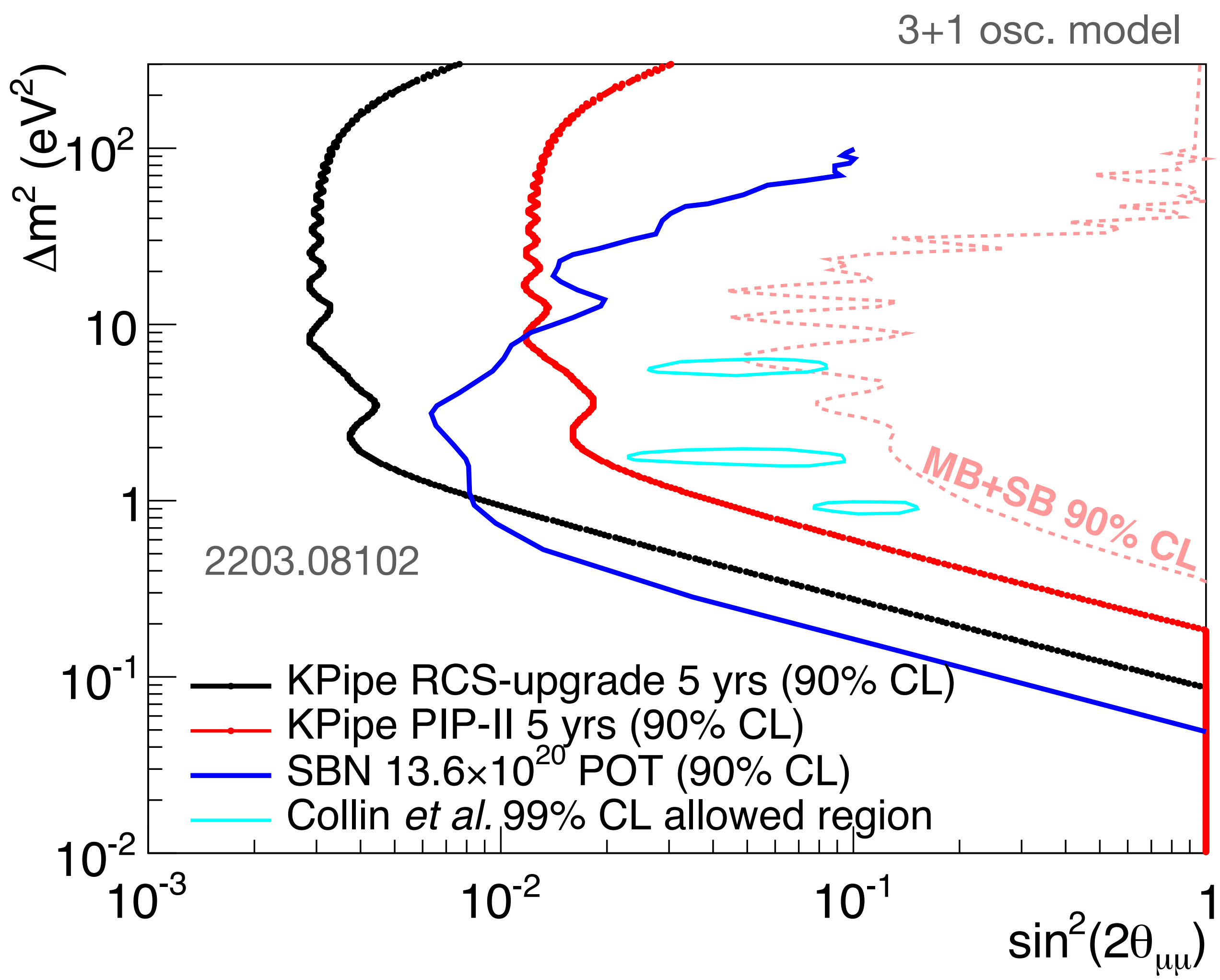
KPIPE; what would a signal look like?



E_ν=236 MeV

KPIPE sensitivity

Experimental assumptions	
Detector length	120 m
Active detector radius	1.45 m
Closest distance to source	32 m
Liquid scintillator density	0.863 g/cm^3
Active detector mass	684 tons
Primary proton energy	8 GeV
Target material	Hg or W
KDAR ν_μ yield (MARS15)	0.07 ν_μ/POT
ν_μ CC σ @ 236 MeV (NuWro)	1.3×10^{-39} cm^2/neutron
KDAR signal efficiency	77%
Vertex resolution	80 cm
Light yield	4500 photons/MeV
Uptime (5 years)	5000 hours/year
ν_μ creation point uncertainty	25 cm
PIP-II era assumptions	
Proton rate (0.08 MW)	1.0 $\times 10^{21}$ POT/year
Beam duty factor	1.6×10^{-5}
Cosmic ray background rate	110 Hz
Raw KDAR CC event rate	2.7×10^4 events/year
RCS upgrade era assumptions	
Proton rate (1.2 MW)	1.5 $\times 10^{22}$ POT/year
Beam duty factor	5.3×10^{-5}
Cosmic ray background rate	360 Hz
Raw KDAR CC event rate	4.0×10^5 events/year



KPIPE sensitivity

- Strong sensitivity at high-Δm^2.
- Highly complementary to SBN program.
- Extremely cost-effective.
- Basic requirements: high power, low duty factor (~10^{-5}).