

海外の情勢 加速器 ν と大型ニュートリノ測定器

中家（京都）

1. 加速器ニュートリノ実験(Ongoing)

- Japan
 - K2K: $\sin^2 2\theta_{13} < 0.26$ ($\delta=0, \theta_{23}=\pi/4$)
 - T2K: $\sin^2 2\theta_{13} < 0.01$ ($\delta=0, \theta_{23}=\pi/4$)
- Europe (CERN – Gran Sasso)
 - OPERA: $\sin^2 2\theta_{13} < 0.06$
- US (FNAL – Soudan, Ash River)
 - MINOS: $\sin^2 2\theta_{13} < 0.06$ (Current: $\sin^2 2\theta_{13} < \sim 0.3$)
 - MOνA : $\sin^2 2\theta_{13} < 0.01$
 - Mass hierarchy: $\sin^2 2\theta_{13} > \sim 0.06$
 - Lq Ar may be a future option...

NOvA



NOvA Far Detector

MINOS Far Detector

Ontario

Minnesota

810 km

Wisconsin

Iowa

Milwaukee

Michigan

Fermilab

Chicago

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168 km

Pointer 43°34'32.84" N 89°04'55.60" W elev 271 m

Streaming 100%

Eye alt 545.86 km

Approximate Schedule of Nona

- May 2007: US DOE CD-1 Approved
- Sep 2007: Cooperative Agreement signed
- Nov 2007: US DOE CD-2/3A review
 - Baseline, advanced procurement
- Dec 17, 2007 R&D funding for FY08 cut to zero.
- July 1, 2008 Supplementary funding restarts progress
- Sept 15, 2008, Oct 24, 2008: CD-2, CD-3A Approved
- April 2009: Reinvestment Act, and FY09 funding approved
- May 1, 2009 Groundbreaking at Ash River
- Fall 2009 Begin Building IPND modules
- Winter 2009/10 Begin building IPND Blocks
- **Summer 2010 Begin operation of IPND (prototype Near Det.)**
- Summer 2010: Beneficial Occupancy of the Far Detector building
- **Winter 2011: Begin to Install FD, Data taking after a few kT installed**
- **2013 Installation Complete**

	T2K (2004~2009)	NOvA (2009~2013)
Accelerator	J-PARC MR 750kW (design) 	FNAL MI 700kW (330kw current)
Neutrino Beam	2.5 degree off-axis $E_{\text{peak}} \sim 700\text{MeV}$ 	$\sim 14\text{mrad}$ (0.8 degree) off-axis $E_{\text{peak}} \sim 2\text{GeV}$
Near Detector	Fine-Segmented multi-type detectors w/ magnetic field (w/ water target) 	Liquid Scintillator segmented detector (similar as the far detector) 
Far Detector	Water Cherenkov 50ktons (22.5 kt fiducial) 295km away	Liquid Scintillator detector 15 kton 810km away 
Near/Far extrapolation	Hadron production will be measured by CERN NA61 	Hadron production will be measured by FNAL MIPP 

NOvA status



T2K versus NO ν A

- T2K
 - Depending on the J-PARC performance
- NO ν A
 - How soon the detector can be built?

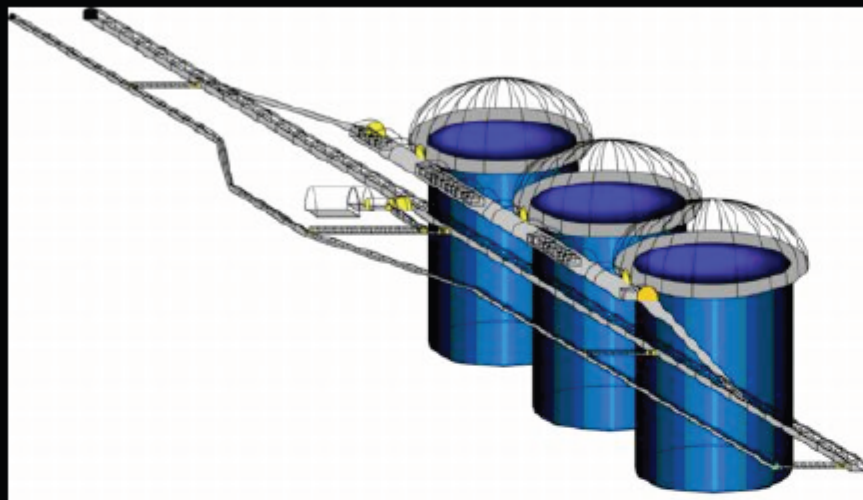
次世代大型ニュートリノ測定器 (Future)

- Asia (J-PARC +)
 - Hyper-K @ Kamioka
 - Theoretical idea of the detector at Korea
 - Lq. Ar@ . . .
- US (FNAL Proton Driver + DUSEL)
 - Big Water Cherenkov detector
 - Lq. Ar
- Europe (CERN +)
 - Big Water Cherenkov detector
 - Lq. Ar

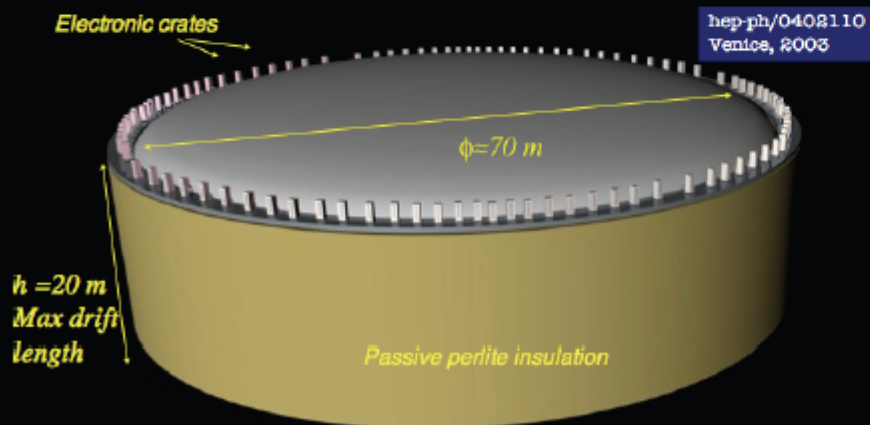
測定器は水チェレンコフと液体アルゴンTPCが主（液体シンチも言っているだけの人はいる？）

ベースラインは各地域の状況による。

LAGUNA Europe



MEMPHYS - H₂O



GLACIER - Liquid Argon

LENA - Liquid Scintillator

DETECTOR LAYOUT

Cavern

height: 115 m, diameter: 50 m
shielding from cosmic rays: ~4,000 m.w

Muon Veto

plastic scintillator panels (on top)
Water Cherenkov Detector
1,500 phototubes
100 kt of water
reduction of fast
neutron background

Steel Cylinder

height: 100 m, diameter: 30 m
70 kt of organic liquid
13,500 phototubes

Buffer

thickness: 2 m
non-scintillating organic liquid
shielding external radioactivity

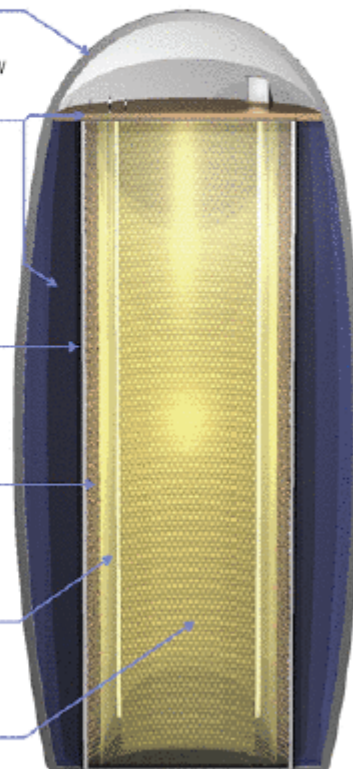
Nylon Vessel

parting buffer liquid
from liquid scintillator

Target Volume

height: 100 m, diameter: 26 m
50 kt of liquid scintillator

vertical design is favourable in terms of rock pressure and buoyancy forces



LAGUNA - Site Selection

LSM - Fréjus	France
SUNLAB	Poland
Pyhäsalmi	Finland
Slanic-Prahova Salt Mine	Romania
LSC - Canfrac	Spain
Boulby Mine	UK
CASO	Italy

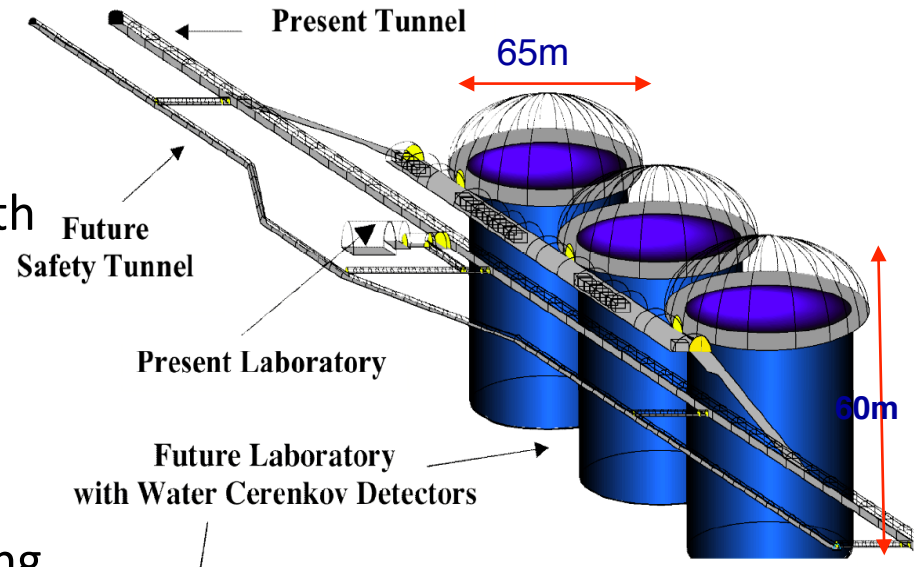
Sept 2009: LSM call for proposals J.E. Campagne LAL and T. Patzak APC will submit proposal to place MEMPHYNO prototype station in LSM tunnel.

Site Selection due to 2010

MEMPHYS : MEgaton Mass PHYSics

a brief reminder

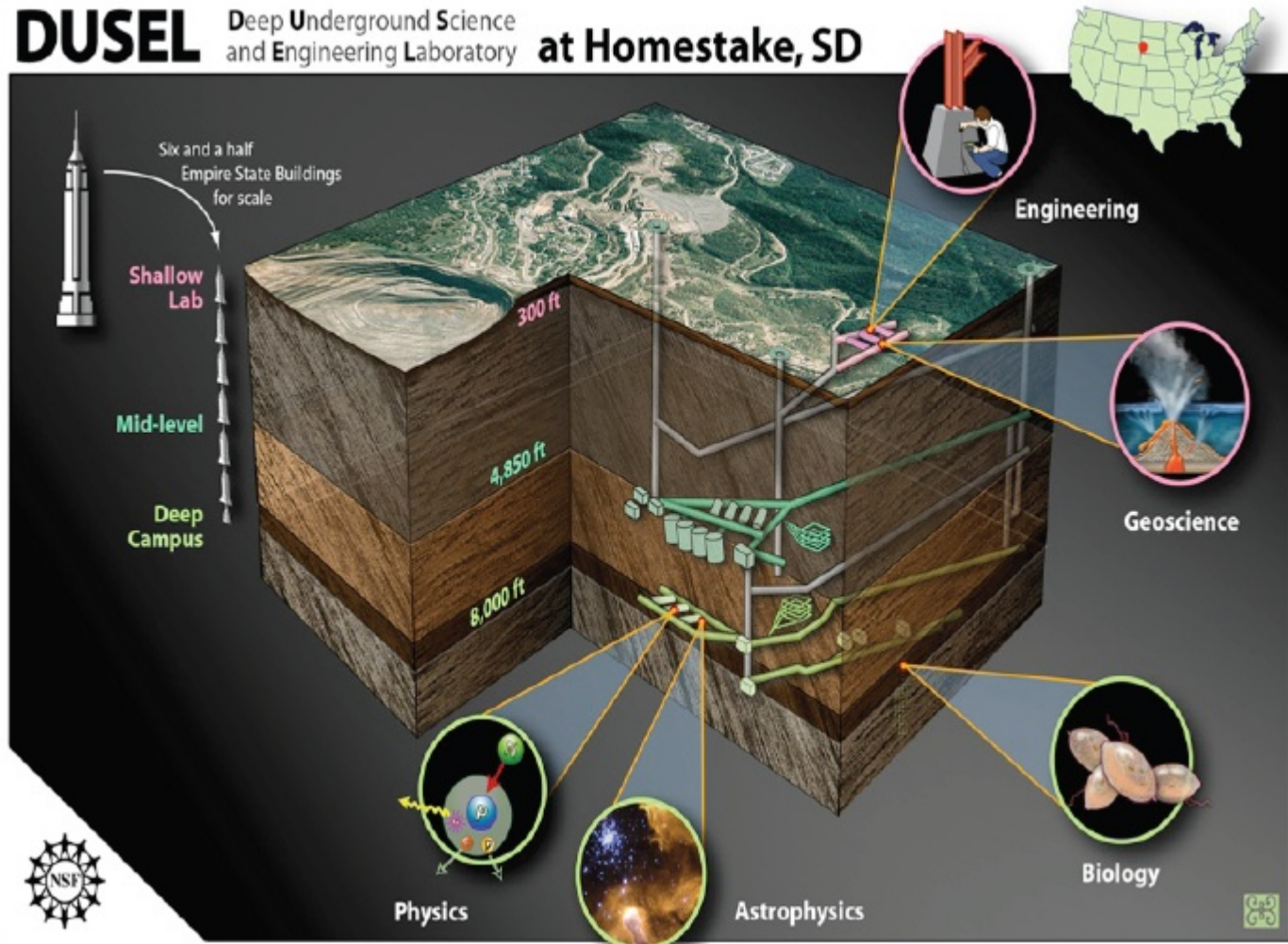
- water Cherenkov (“cheap and stable”)
- total fiducial mass: 440 kt
- 3 cylindrical modules 65 x 65 m
 - size limited by light attenuation length ($\lambda \sim 80\text{m}$) and pressure on PMTs
 - readout : $\sim 3 \times 81\text{k}$ 12” PMTs, 30% geom. cover
 - PMT R&D + detailed study on excavation @Fréjus existing & ongoing

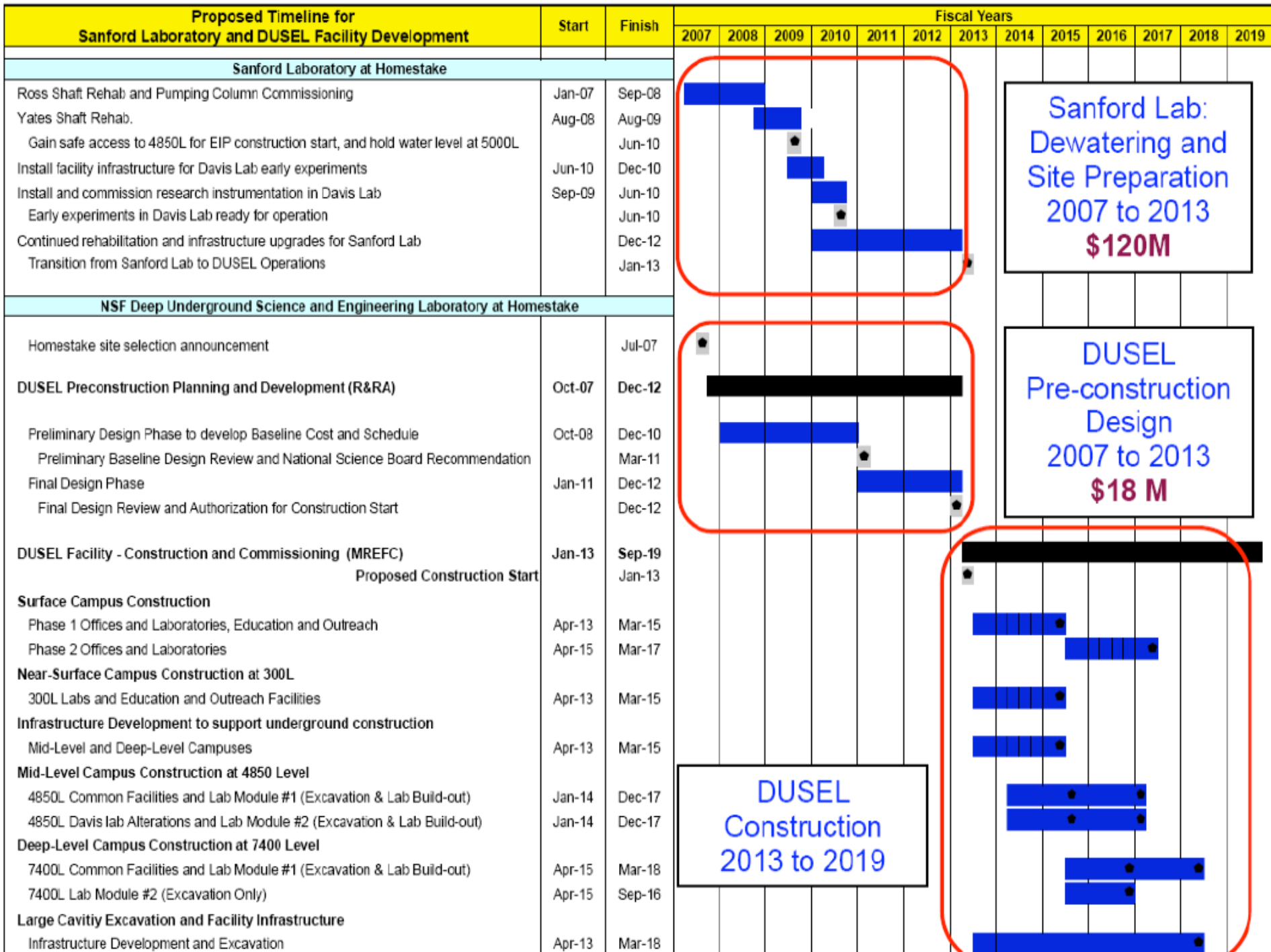


physics goals :

- proton decay searches
- superNovae core collapse and diffuse neutrinos
- precision measurement of neutrino oscillations with beams and solar neutrinos

US (DUSEL) [$\sim 1300\text{km}$ away from FANL]



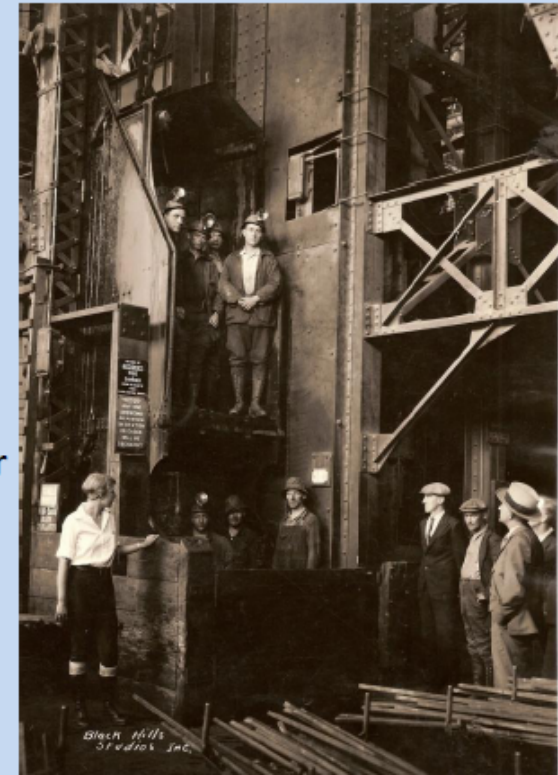


Major Milestones

- Large Cavity Design Supplement **May 2009**
- Proposal to Prepare Preliminary Facility Design & Integrate the Suite of Experiments: **submitted 15 May 2009**
- NSF Solicitation to Develop Experiments (S-4) Results: **anticipated ~ July 2009**
- S-4 Work Shop in South Dakota: **1-5 Oct 2009**
- Preliminary Design Complete: **fall 2010**
- Presentation to NSB: **spring 2011**
- Construction Start: **2nd Quarter 2013**

Institutional Board

- **ANL:** M. Goodman
- **Boston:** E. Kearns
- **BNL:** M. Diwan
- **Caltech:** R. McKeown
- **UC Davis:** R. Svoboda
- **UC Irvine:** H. Sobel
- **UCLA:** H. Wang
- **Chicago:** E. Blucher
- **Colorado State:** N. Buchanan
- **Columbia:** L. Camilieri
- **Drexel:** C. Lane
- **Duke:** K. Scholberg, C. Walter
- **FNAL:** R. Rameika
- **Indiana:** M. Messier
- **INFN(Catania):** R. Potenza
- **Kansas State:** T. Bolton
- **LLNL:** A. Bernstein
- **LANL:** C. Mauger
- **LBL:** R. Kadel
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- **Minnesota(Duluth):** A. Habig
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- **RPI:** J. Napolitano
- **S. Carolina:** C. Rosenfeld
- **U. Texas:** K. Lang
- **Tufts:** H. Gallagher
- **Wisconsin:** K. Heeger
- **Yale:** B. Fleming

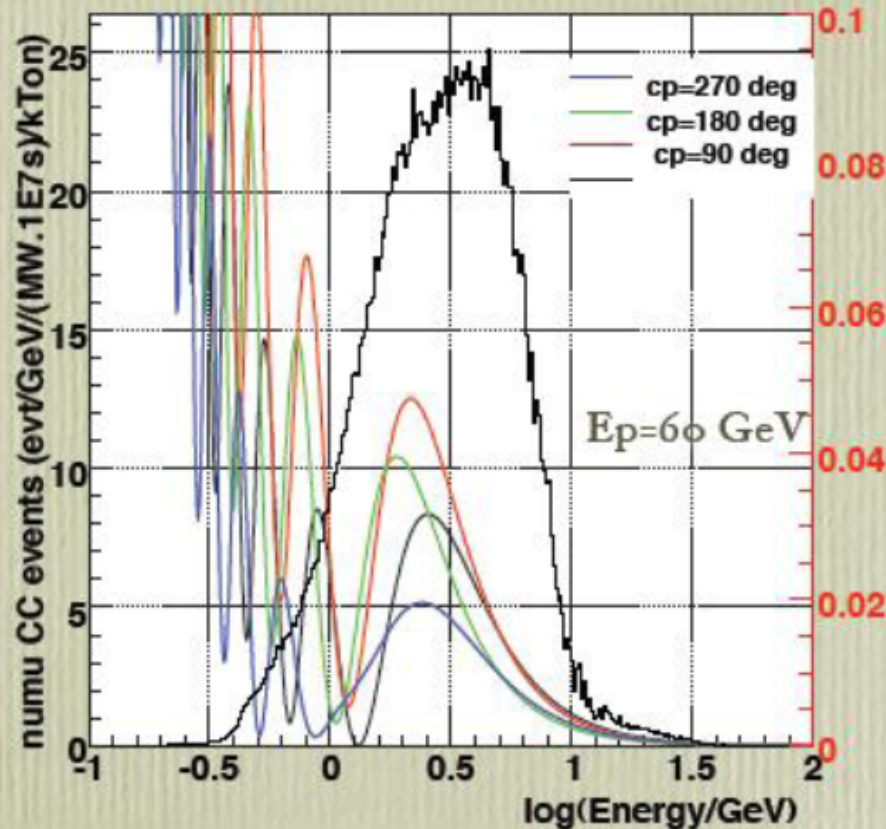


Current Issues:

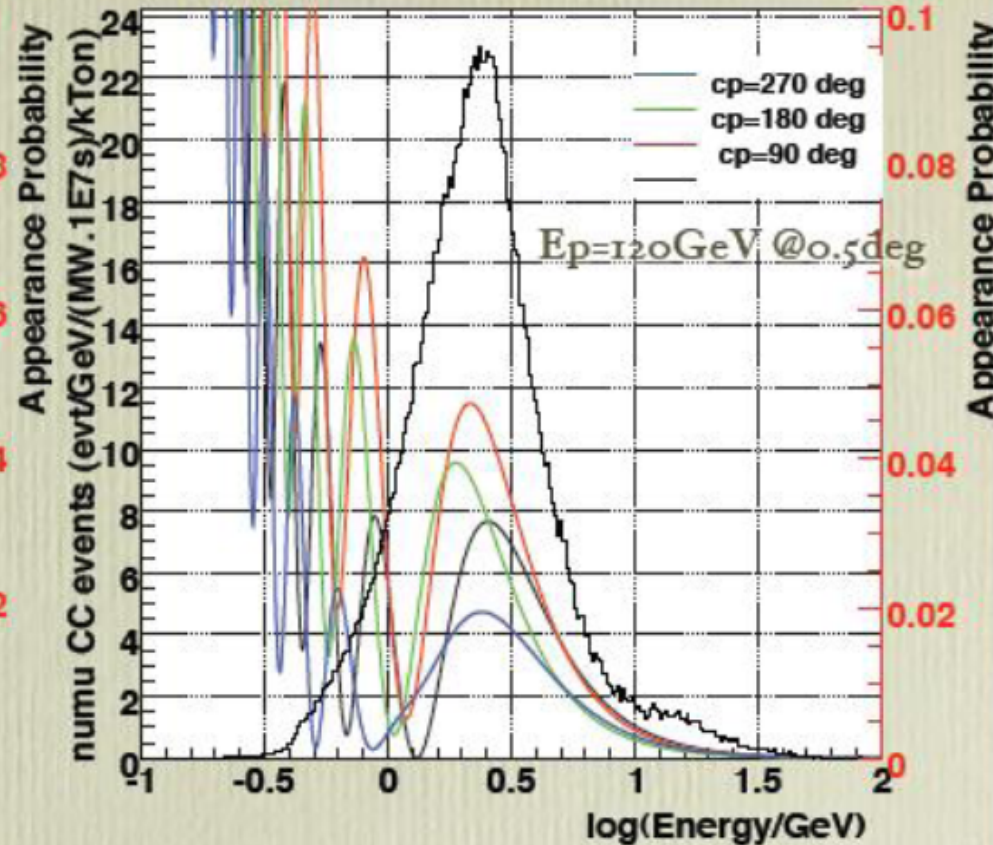
Depth Document
Election of Chair
Mission Statement
White Paper
Collaboration Governance

Spectra FNAL to DUSEL (WBLE:wide band low energy)

numu cc (param) 1300km / 0km



numu cc (param) 1300km / 12km



- 60 GeV at 0deg: CCrate: 14 per ($\text{kT} \cdot 10^{20} \text{ POT}$)
- 120 GeV at 0.5deg: CCrate: 17 per($\text{kT} \cdot 10^{20} \text{ POT}$)

Work of M. Bishai and B. Viren using NuMI simulation tools

日本でも次期計画を主導するWGが必要

Neutrino and Nucleon decay Detector working group
を構成

- 東北大：井上
- KEK：西川、小林、長谷川、丸山、田中
- 東大：相原
- 東大ICRR：塩澤、鈴木、梶田、金行、中畑、森山、竹内、早戸
- IPMU：中村
- 名大：伊藤
- 京大：中家、市川、横山