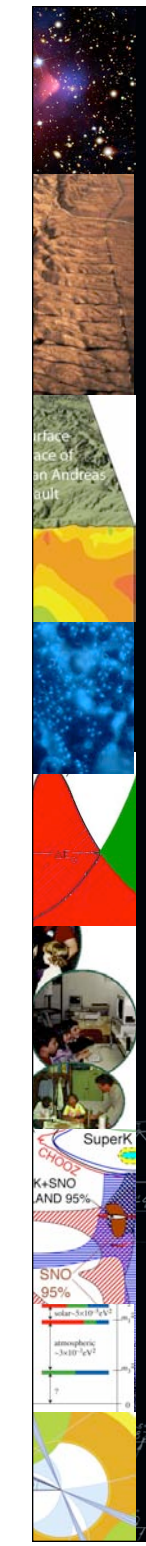
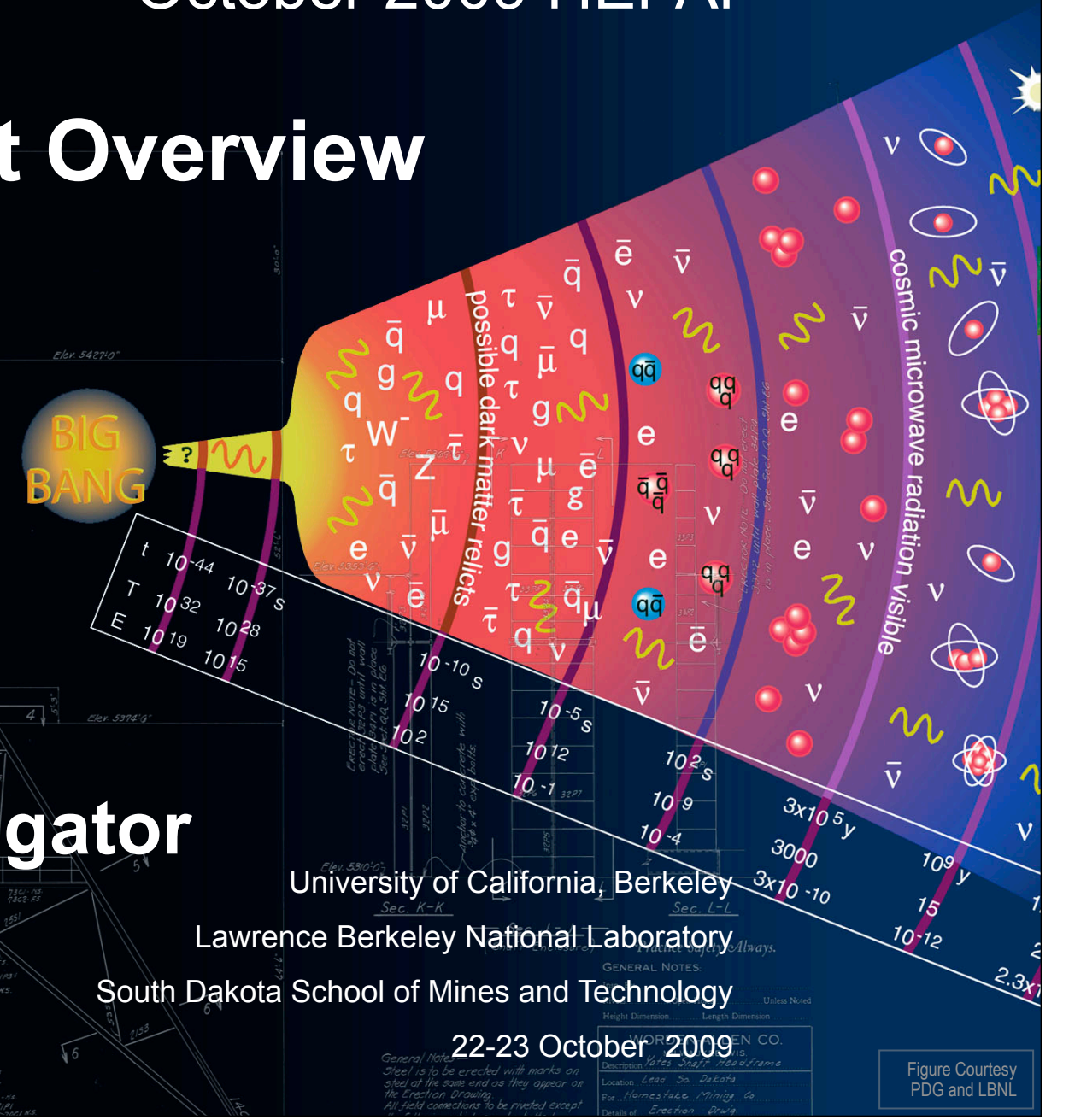
Homestake DUSEL
October 2009 HEPAP

DUSEL Project Overview





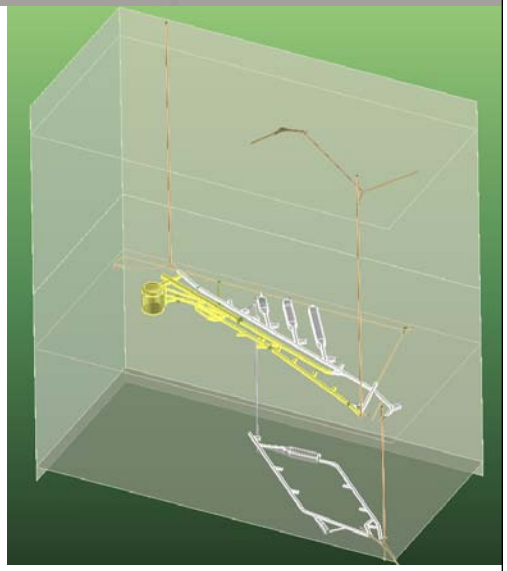
Kevin Lesko
Principal Investigator
UC Berkeley

University of California, Berkeley
Lawrence Berkeley National Laboratory
South Dakota School of Mines and Technology

22-23 October 2009

Figure Courtesy
PDG and LBNL

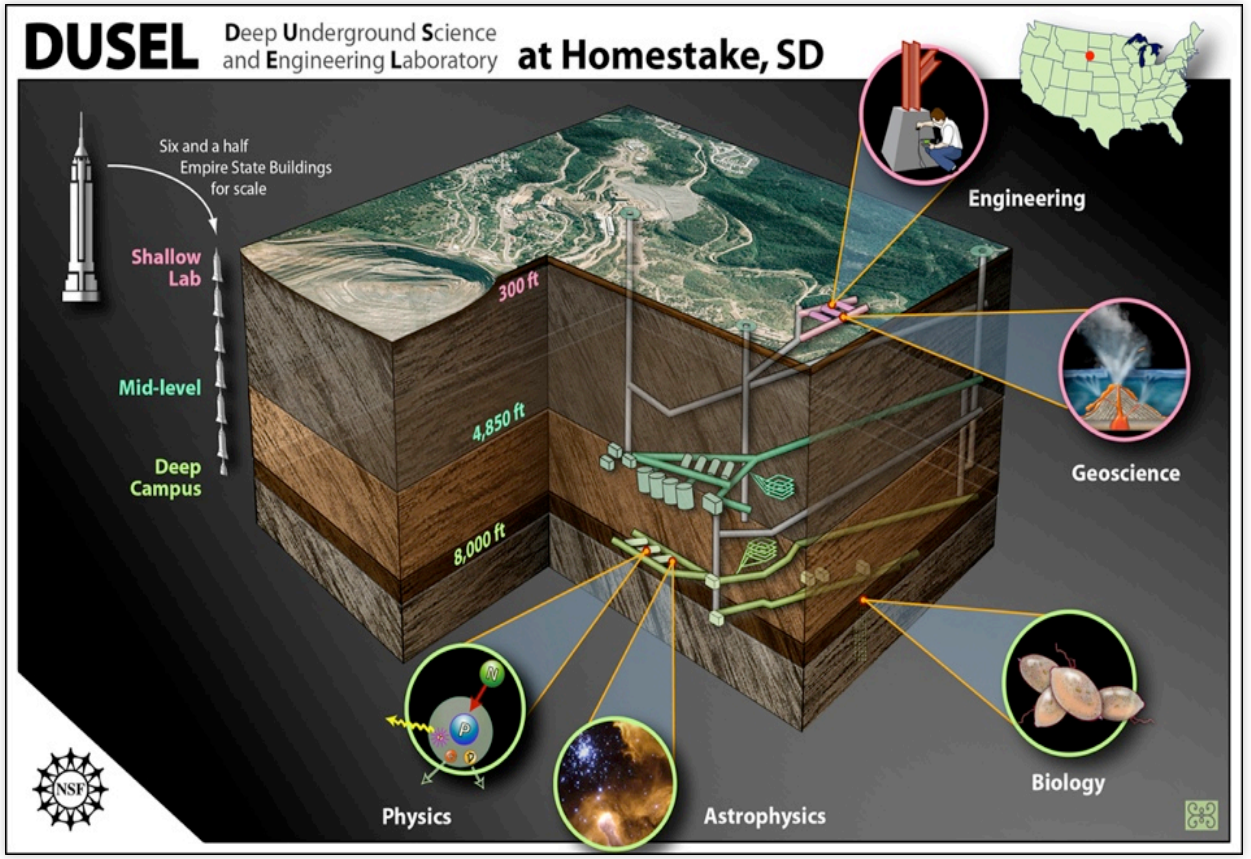
DUSEL Project Overview



- Goals, Scope and Definitions
- Project Organization, Funding and Partnerships
- Requirements for Preliminary Design
- Science Programs and Organization
- Rough Construction Schedule Estimates
- Challenges and Opportunities

Our Goal

To develop a enduring international underground laboratory with a best-in-world class scientific program of research, education and outreach and do it as quickly and cost efficiently as possible



DUSEL: Enabling Transformational, Multidisciplinary Science and Engineering Efforts

World-class, scientific programs exploiting synergisms and maximizing the benefits of a dedicated facility with integral Education and Outreach functions

- Neutrinos - discover new physics, known-unknown physics
- Dark Matter - identify ~25% of the known-unknown universe
- Dark Life - limits of life, life in extremes, life in isolation, new life
- Origin of the Elements - how, where did the elements originate
- Symmetries and High Energy Scale Physics - matter/antimatter asymmetry, the universe at extreme energies and physics of the early universe
- Natural Resources - understanding, probing, predicting
- Engineering - safer, deeper, larger, faster
- Education and Outreach - welcome, attract, excite, engage
- Energy and Carbon Research - imperative societal questions

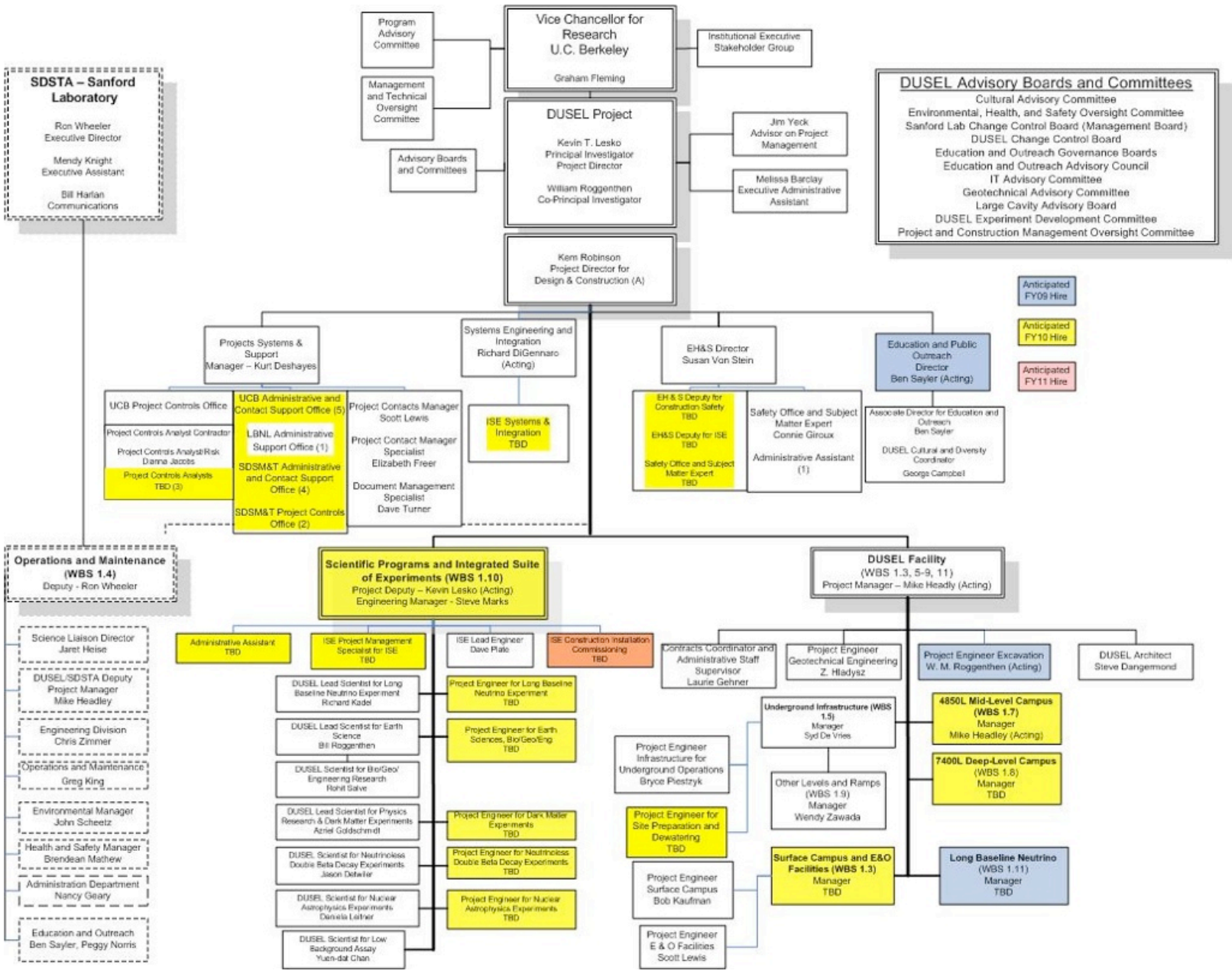
DUSEL Project Scope and Definition: NSF MREFC Proposal

- DUSEL is proposed as a **M**ajor **R**esearch **E**quipment and **F**acility **C**onstruction Project
  - Line-item, multi-year construction project for the facility and an integrated suite of experiments
  - The site is the former Homestake Gold Mine in the Black Hills of South Dakota
  - Facility Planning and Experiment Integration is supported with a Cooperative Agreement between the NSF and UC Berkeley
  - The site is currently being prepared and risks mitigated by the South Dakota Science and Technology Authority (creating the Sanford Lab) with state and private funds

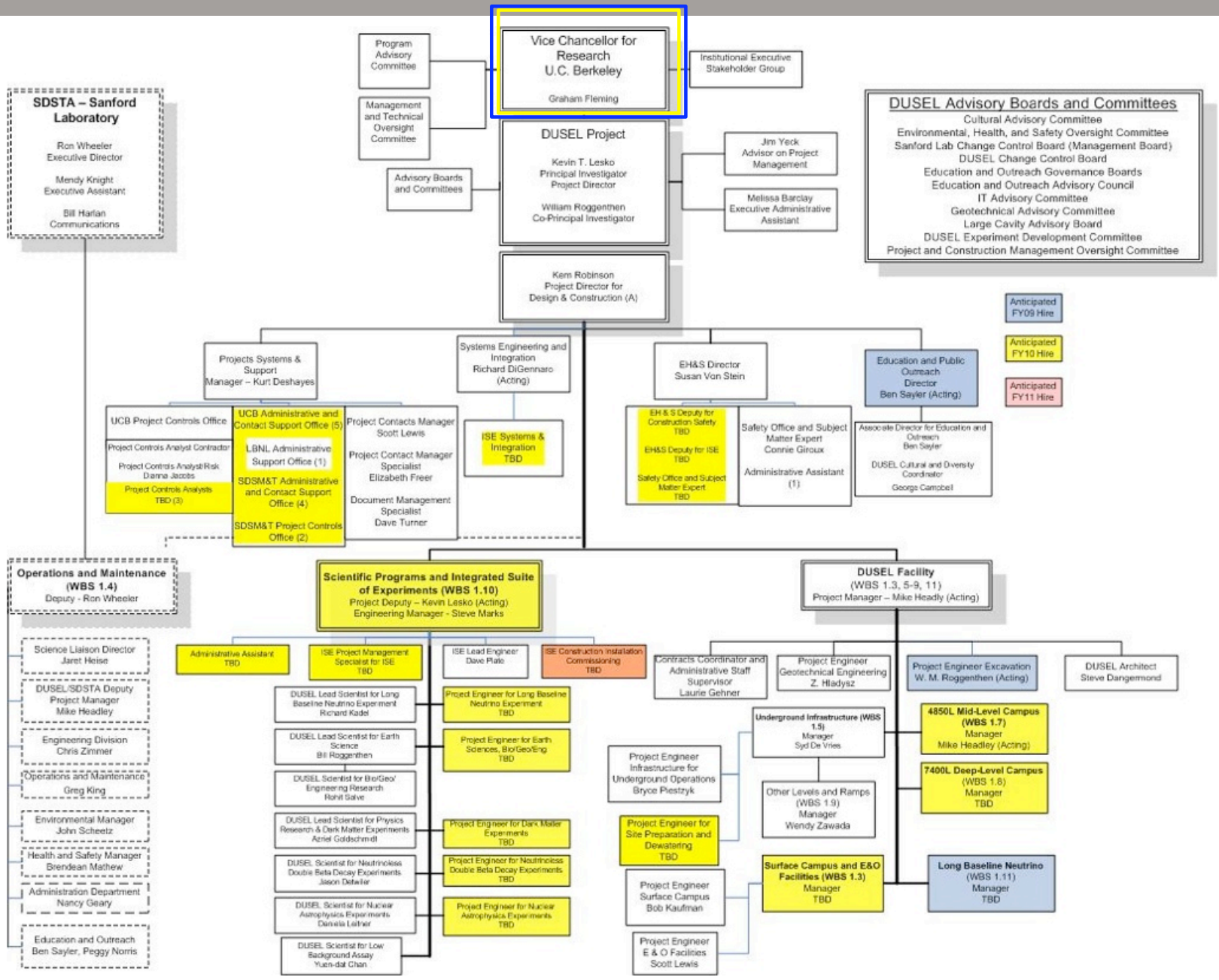
Roles in Developing DUSEL

- DUSEL Project Team
  - Developing the Facility Design
  - Integrating the Experiments with the Facility, including Interface Management
  - Overseeing the Proposals & the Construction Project
  - Ultimately Operating the Facility (Access, EH&S, Experiment Support, ...)
  - $15 + 3M (S3) + $29M (PDR) awards through CY2010
- Site Preparation and Sanford Lab: SDSTA
  - $126M state-controlled funds
- Experimental Collaborations (S4 and others)
  - Enunciating Scientific Research Goals
  - Initially Managing the S-4 Awards & Developing the Experiments
  - Performing Critical R&D
  - Developing Experiment Designs, Project Plans, Hazard Assessments, ...
  - Performing Detector Construction, Installation and Operations
  - $21M (S-4) over three years beginning FY10

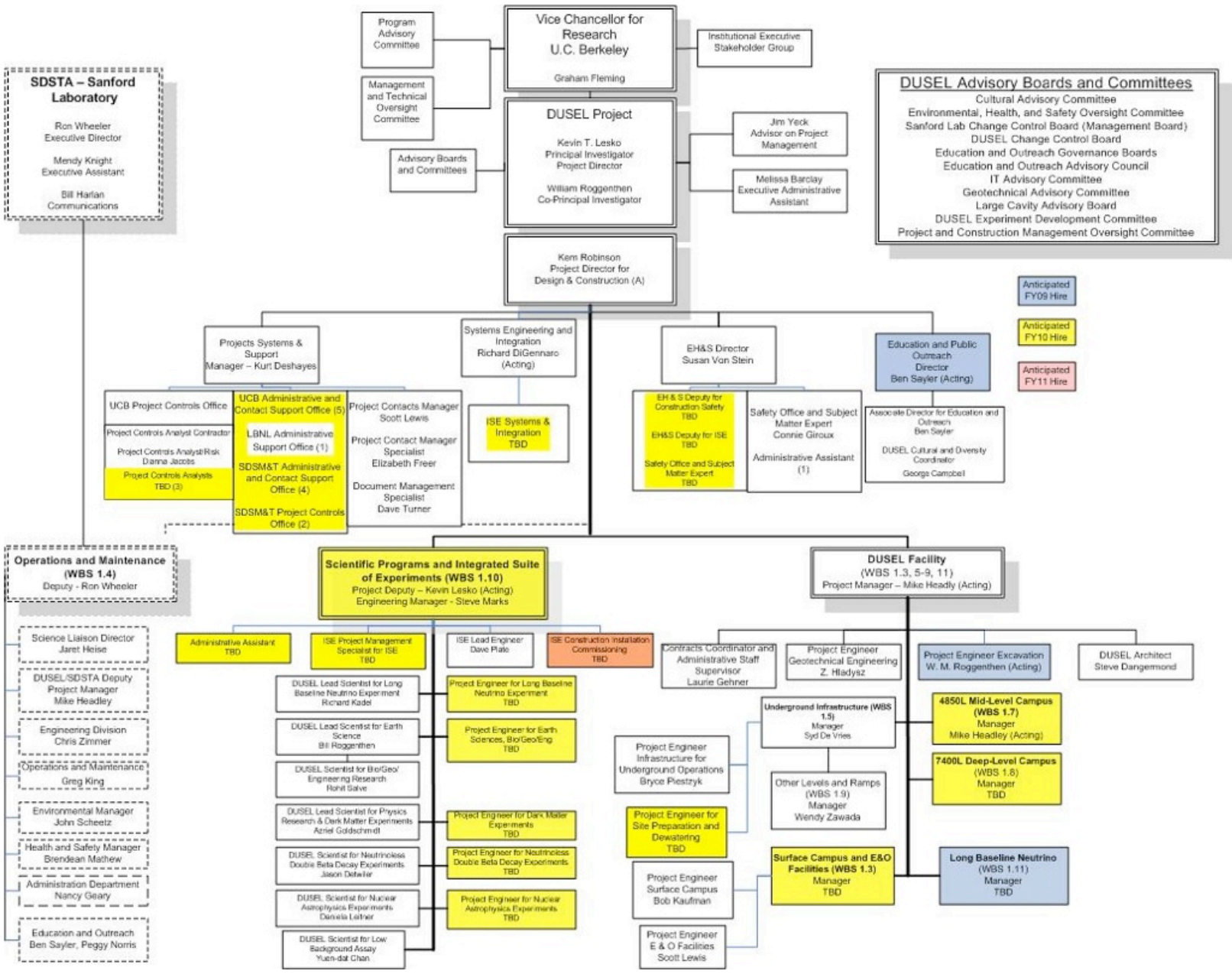
DUSEL Project Organization



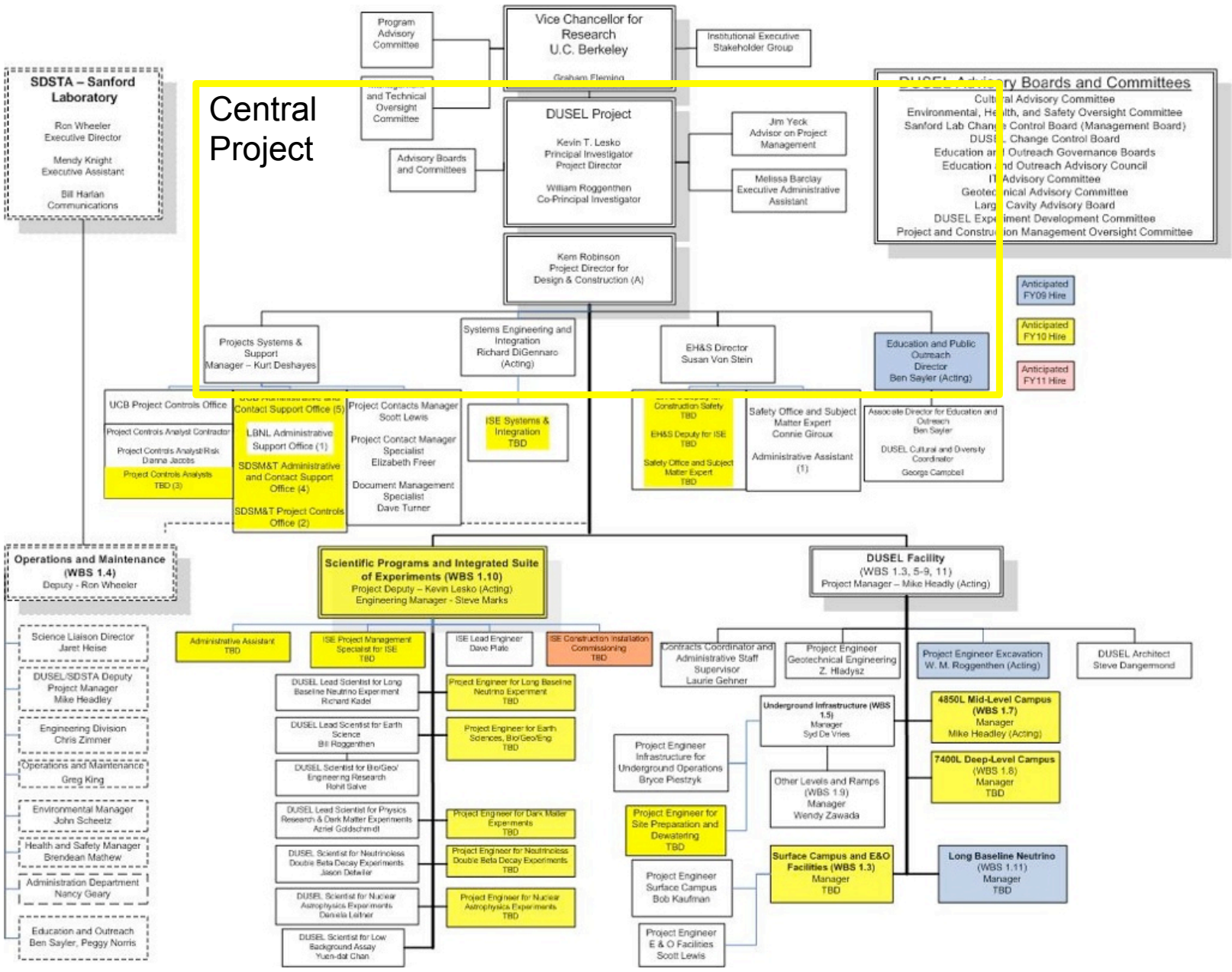
DUSEL Project Organization



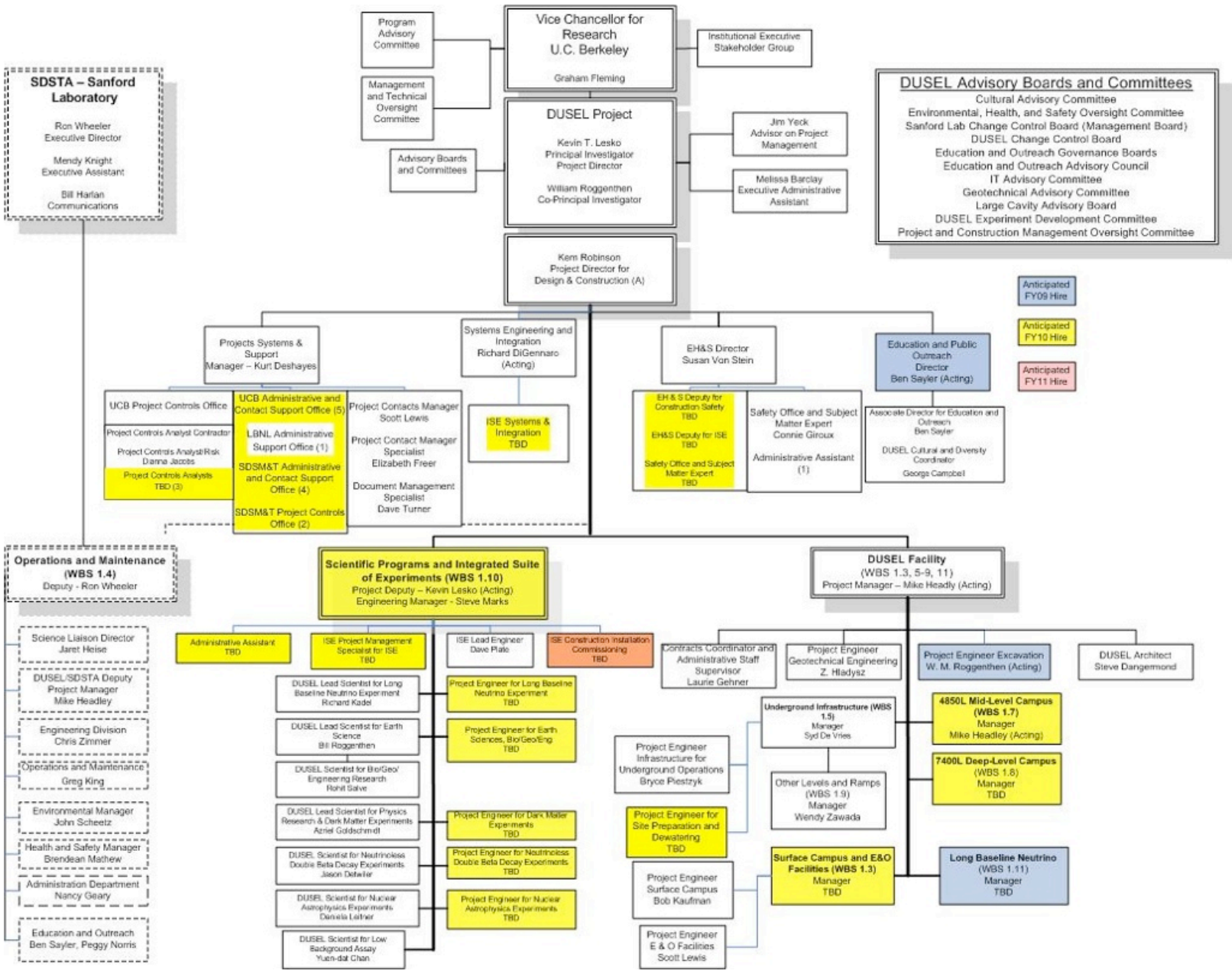
DUSEL Project Organization



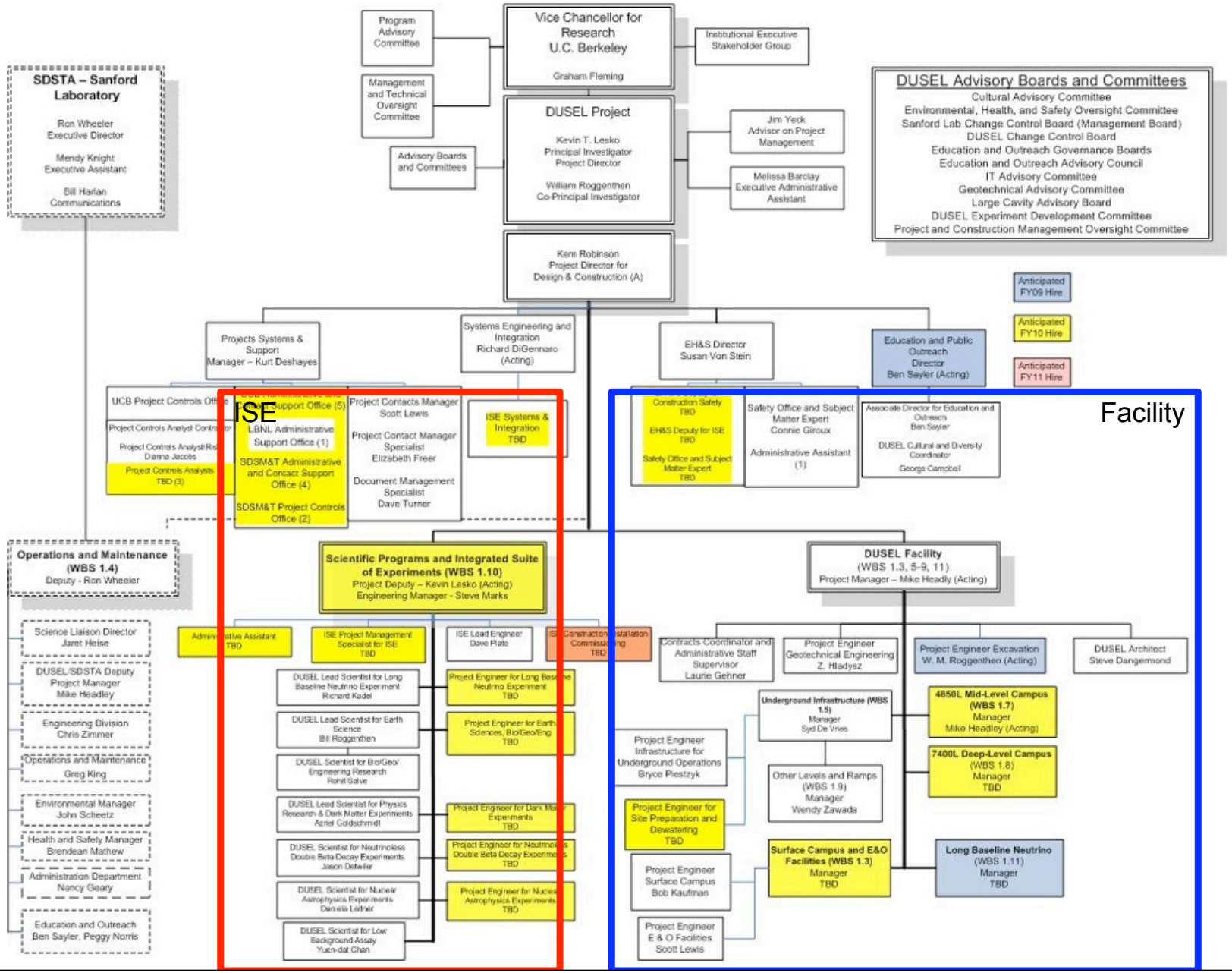
DUSEL Project Organization



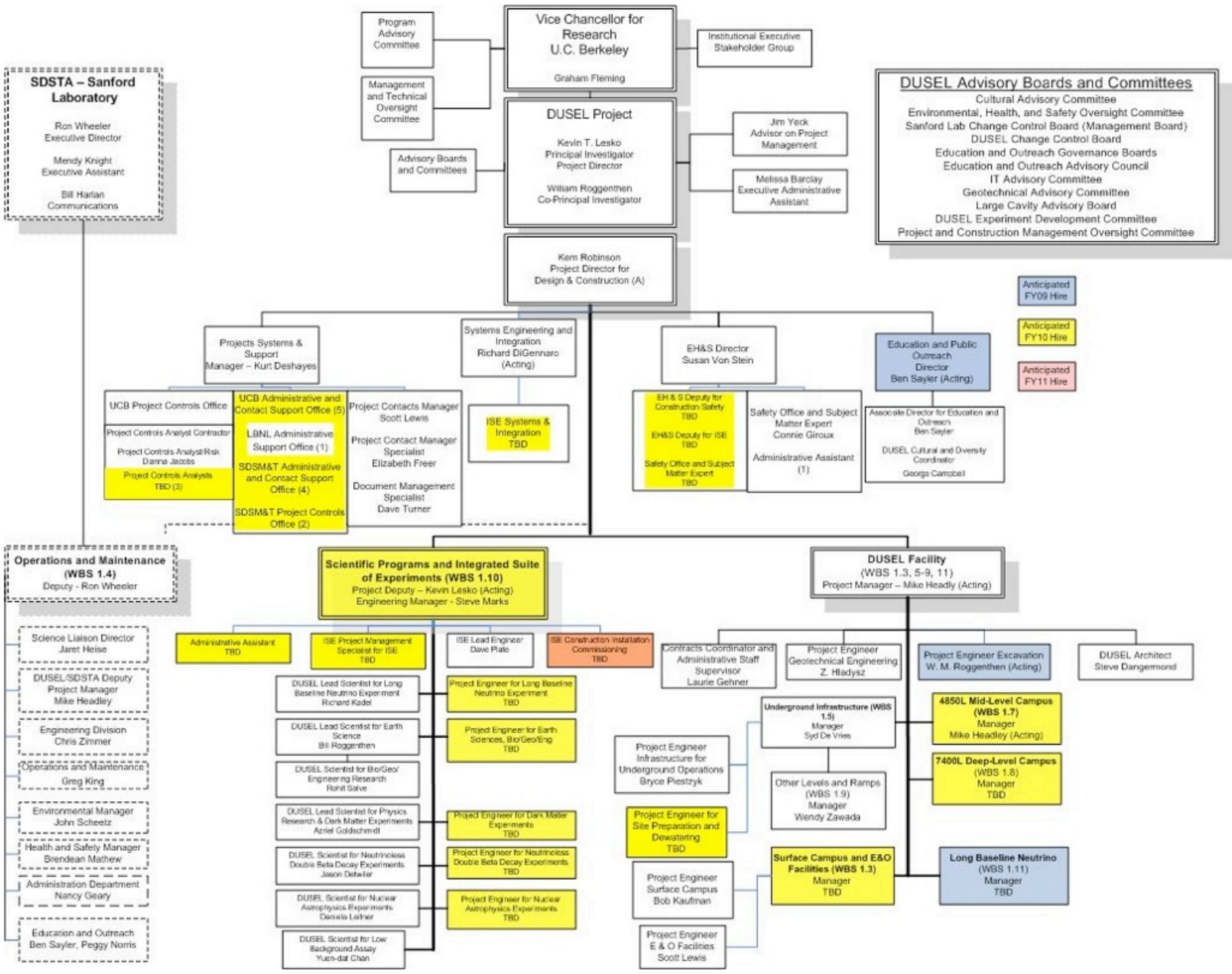
DUSEL Project Organization



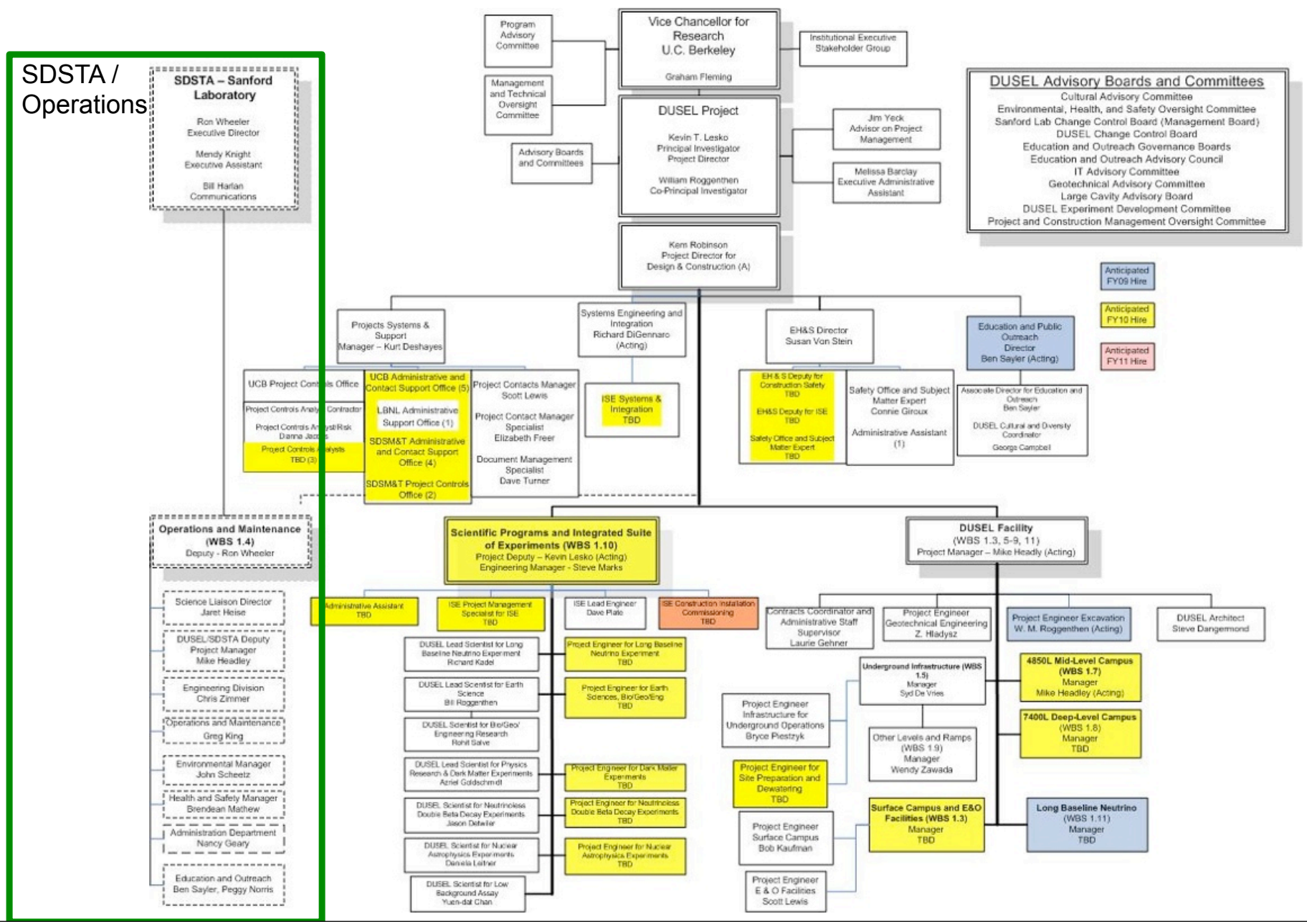
DUSEL Project Organization



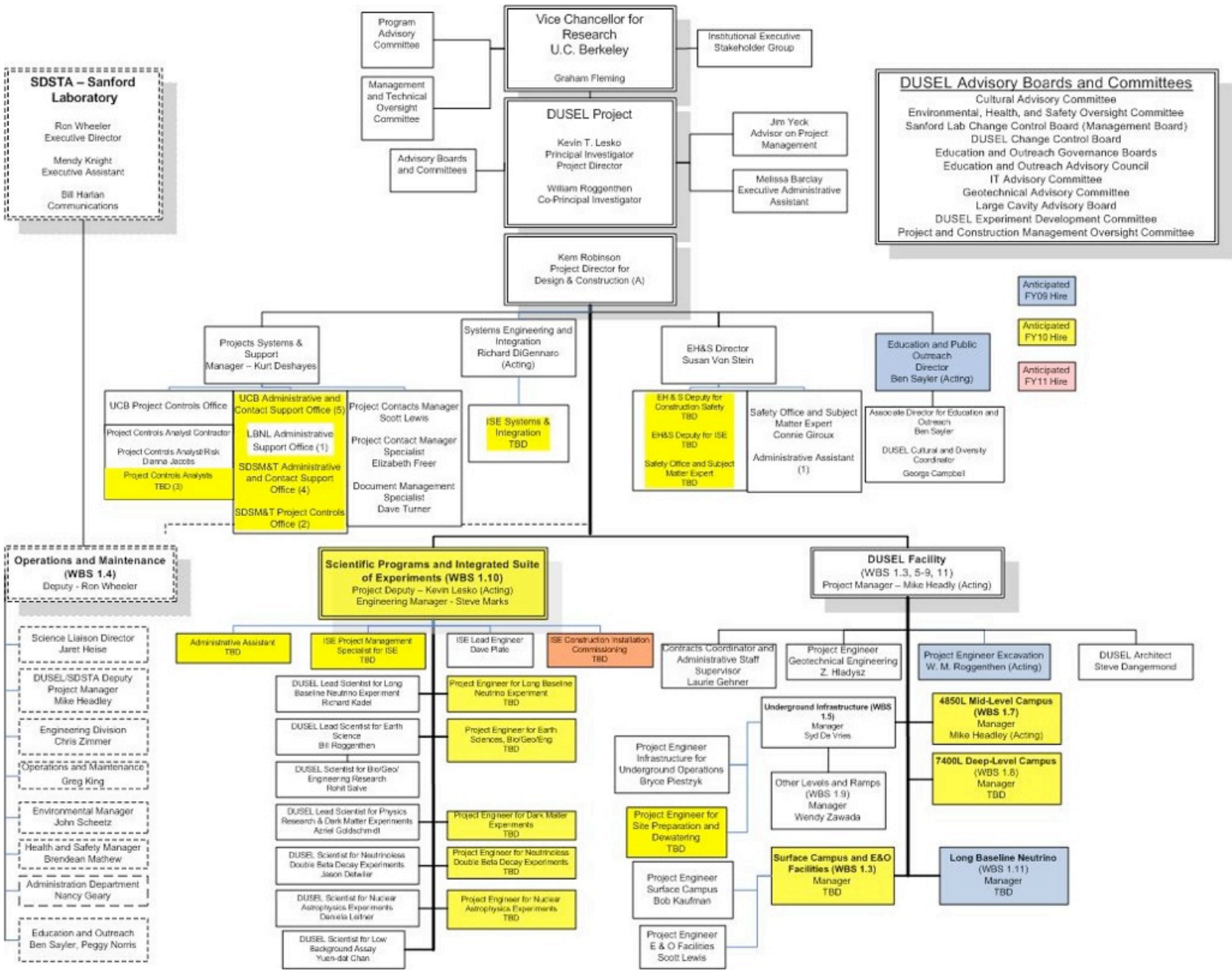
DUSEL Project Organization



DUSEL Project Organization



DUSEL Project Organization



South Dakota and Sanford Lab Participation in Preparing for DUSEL

- Major Financial Support from the State of South Dakota
  - $45M from State (HUD grant and General Fund)
  - $70M from Philanthropic Donation (T. Denny Sanford)
  - Owns the Property (Donation from Barrick)
  - Will exhaust funds ~ end of 2010

- Partnership to “achieve DUSEL”
- DUSEL assimilates Sanford Lab at MREFC Construction
- Facility Work Initiated (Site Preparation and Risk Reduction)
  - Rehabilitation of Surface and Underground Infrastructure
    - Lifts & Shafts
    - Pumps
    - Facility Stabilization and Rehabilitation
    - Initial Operations, Environment, and Safety Programs
    - Early Science Program

  - Rock Disposal Sites - *Agreement in Principal* with Barrick to use the “Open Cut”, alternative sites identified

South Dakota Science and Technology Authority / Sanford Lab

Board of Directors
Thomas C. Adam, Dave Bozied, Dana Dykhouse, Patricia O. Lebrun, Casey Peterson, Charles V. Shank

Legal Counsel
Tim Engel

AUDIT

Communications Dept
Bill Harlan
Communications Officer

SDSTA
Ron Wheeler – Executive Director
Mandy Knight – Executive Assistant

EH&S Advisory Committee and Susan VonStein - DUSEL EH&S Director

EEAC
Frank Sciulli-Columbia U. (Phys)
Herb Wang-U. of Wisconsin (Geo/Bio)

Sanford Science Center and E&O
Ben Sayler – Director
Peggy Norris – Deputy Director

Administration Dept
Nancy Geary – Chief Financial Officer

- Human Resources
- Accounting
- Information Technology
- Procurement

SDSTA
Ron Wheeler – EH&S Manager

Health & Safety Manager
Brendan Matthew

Environmental Manager
John Scheetz

Training / PPE
Tom Regan

PPE Coordinator
TBD

Site Safety Specialist
Fred Raubach

Industrial Hygienist
Jason Rosdahl

Technical Assistant
Valerie Blevins

Operations Dept
Greg King – Operations Director

DUSEL/SDSTA
Mike Headley – Deputy Project Manager

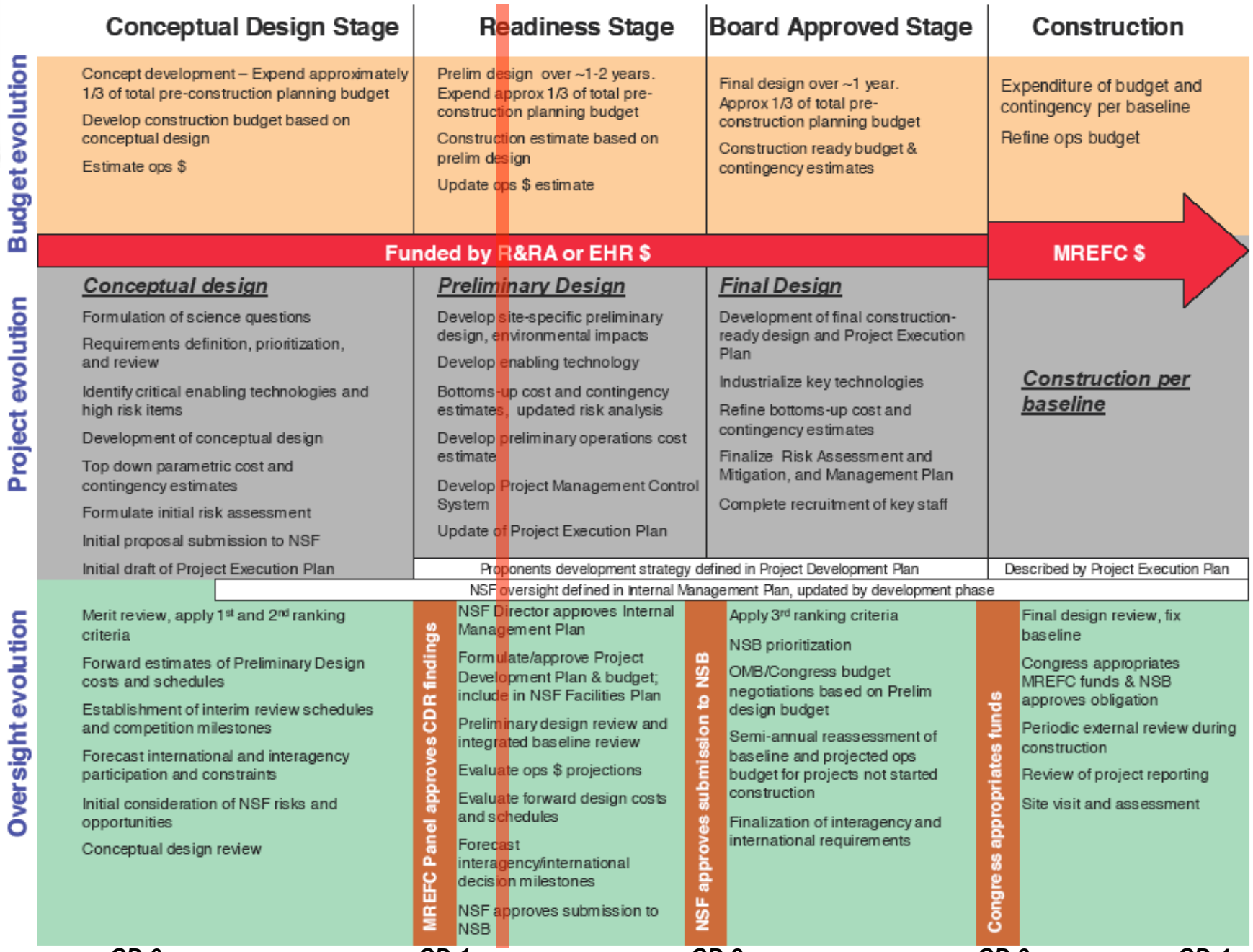
Engineering Dept
Chris Zimmer – Engineering Director

Sanford Laboratory
Jose Alonso – Director

Science Liaison Dept
Jaret Heise – Science Liaison Director

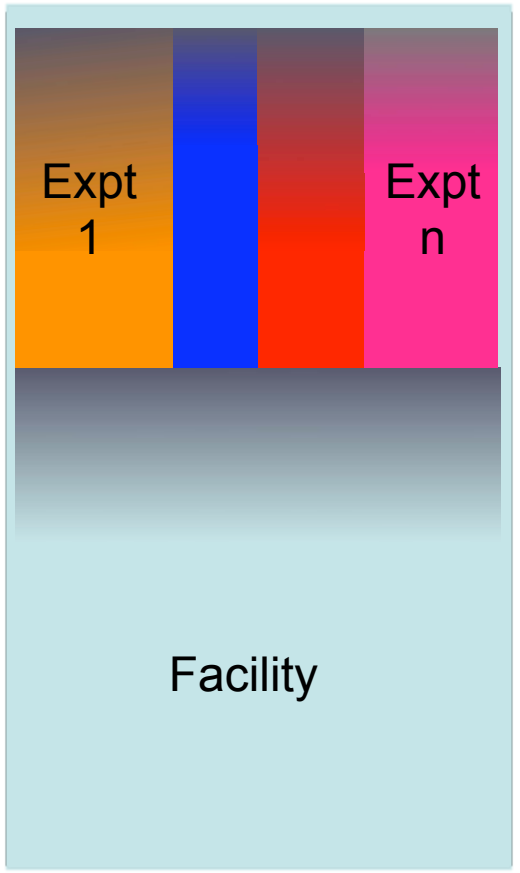
Ron Wheeler 08/24/2009 v13

~ 85 FTEs employed by SDSTA


Conceptual Design Stage
Readiness Stage
Board Approved Stage
Construction
Budget evolution
Concept development – Expend approximately 1/3 of total pre-construction planning budget
Develop construction budget based on conceptual design
Estimate ops $
Prelim design over ~1-2 years. Expend approx 1/3 of total pre-construction planning budget
Construction estimate based on prelim design
Update ops $ estimate
Final design over ~1 year. Approx 1/3 of total pre-construction planning budget
Construction ready budget & contingency estimates
Expenditure of budget and contingency per baseline
Refine ops budget
Funded by R&RA or EHR $
MREFC $
Project evolution
Conceptual design
Formulation of science questions
Requirements definition, prioritization, and review
Identify critical enabling technologies and high risk items
Development of conceptual design
Top down parametric cost and contingency estimates
Formulate initial risk assessment
Initial proposal submission to NSF
Initial draft of Project Execution Plan
Preliminary Design
Develop site-specific preliminary design, environmental impacts
Develop enabling technology
Bottoms-up cost and contingency estimates, updated risk analysis
Develop preliminary operations cost estimate
Develop Project Management Control System
Update of Project Execution Plan
Final Design
Development of final construction-ready design and Project Execution Plan
Industrialize key technologies
Refine bottoms-up cost and contingency estimates
Finalize Risk Assessment and Mitigation, and Management Plan
Complete recruitment of key staff
Construction per baseline
Proponents development strategy defined in Project Development Plan
Described by Project Execution Plan
NSF oversight defined in Internal Management Plan, updated by development phase
Oversight evolution
Merit review, apply 1st and 2nd ranking criteria
Forward estimates of Preliminary Design costs and schedules
Establishment of interim review schedules and competition milestones
Forecast international and interagency participation and constraints
Initial consideration of NSF risks and opportunities
Conceptual design review
MREFC Panel approves CDR findings
NSF Director approves Internal Management Plan
Formulate/approve Project Development Plan & budget; include in NSF Facilities Plan
Preliminary design review and integrated baseline review
Evaluate ops $ projections
Evaluate forward design costs and schedules
Forecast interagency/international decision milestones
NSF approves submission to NSB
NSF approves submission to NSB
Apply 3rd ranking criteria
NSB prioritization
OMB/Congress budget negotiations based on Prelim design budget
Semi-annual reassessment of baseline and projected ops budget for projects not started construction
Finalization of interagency and international requirements
Congress appropriates funds
Final design review, fix baseline
Congress appropriates MREFC funds & NSB approves obligation
Periodic external review during construction
Review of project reporting
Site visit and assessment
CD 0
Approve mission need
CD 1
Approve alternate selection and cost range
CD 2
Approve performance baseline
CD 3
Approve construction start
CD 4
Approve operations start

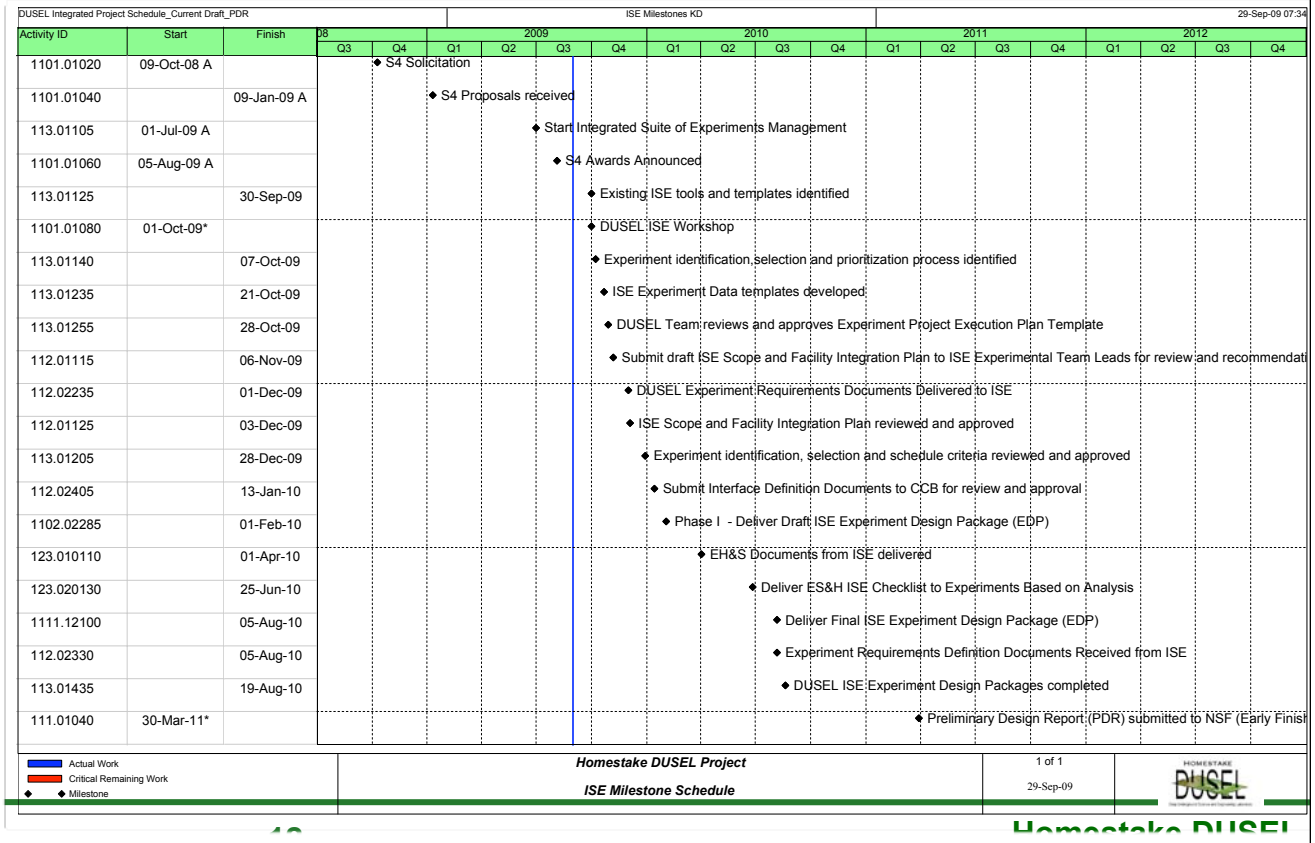
DUSEL MREFC Proposal to be Presented to the National Science Board

- Facility Design at ~ Preliminary Design Level
- Generic Suite of Experimental Designs at ~ Conceptual Level or Better
- Single Proposal describing the Total NSF capital costs (and other components)
- Discussion of the DOE roles and contributions - important mission for the Joint Oversight Group



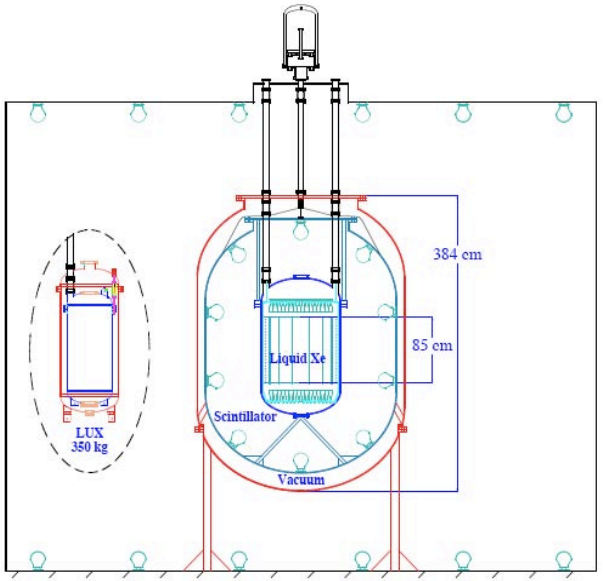
Schedule to Complete Design and Integration - 2011 NSB Consideration

- Synchronized with Science Goals and Resources
  - –Input from the Science Collaborations by April 2010
  - –DUSEL Design Package Assembled with *Generic* Experiments Summer 2010
  - –NSF Reviews
  - –Spring 2011 NSB consideration



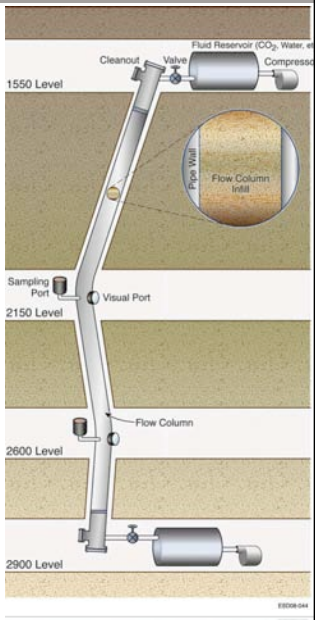
NSF (S4) awardees - Progress in Developing ISE Candidates

- Physics
  - EXO (DBD) - Gratta (Stanford)
  - GE1T (DBD) - Wilkerson (UNC)
  - MAX (DM) - Galbiati (Princeton)
  - LZ20 (DM) - Shutt (Case Western)
  - GEODM (DM) - Golwala (Caltech)
  - COUPP (DM) - Collar (Chicago)
  - LBNE (Long Baseline) - Svoboda (UCD)
  - DIANA (Nuclear Astro) - Wiescher (Notre Dame)
  - (F)AARM (Low Background) - Cushman (Minnesota)



NSF (S4) awardees - Progress in Developing ISE Candidates

- Bio/Geo/Eng
  - Transparent Earth - Glaser (UCB)
  - Fiber Optic Array - Wang (Wisconsin)
  - Fault Rupture - Germanovich (Georgia Tech)
  - THMC (coupled processes) - Sonnenthal (UCB LBNL)
  - CO_2 (Sequestration) - Peters (Princeton)
  - EcoHydro - Boutt (U. Mass)
  - Monitoring - Bobet (Purdue)
- Anticipate additional Proposals in all Disciplines
  - e.g. DOE funded efforts



Scientific Program - other known efforts

Physics

Long Baseline vs (LAr)
Bonnie Fleming - Yale
N-Nbar (vertical shaft)
Yury Kamyshkov - U. Tenn
Atomic Interferometry (vertical shaft)
Mark Kasevitch - Stanford
Gaseous TPCs (DM and DBD)
Dave Nygren - LBNL
Gabriella Sciolla - MIT
Dinesh Loomba - U New Mexico
CLEAN (DM + Solar nu)
Hime- LANL
LENS (Solar vs)
Raghavan - UVa

BioGeoEng

Seismic Arrays
Gary Pavlis - U. Indiana

DUSEL EIP (existing efforts at Sanford)

Majorana Demonstrator (DBD)
Wilkerson - UNC, Elliott - LLNL
LUX (DM)
LUX + Zeplin-3 (= LZS) (DM)
Gaitskell - Brown, Shutt - Case
SD 2010 - Center (u/g xtal production)
Mei - USD
Seismic Arrays
Roggenthen - SDSM&T, Glaser - UCB
Bio sampling
Anderson - BHSU
Hydrochemistry
Stetler - SDSMT
Characterization Efforts
Mei - USD, Grey - Regis, Smith - LBL
DUGL (Gravity Wave)
Mandic - U. Minn

DUSEL Research Association (DuRA)

- Model based on traditional User-facility
  - –Scientifically driven peer-based experiment selection and monitoring
  - –Open Membership in a users' organization
  - –Representative Leadership of the scientific collaborations to laboratory management
  - –Draft Charter has been distributed
- DUSEL Research Executive Committee
  - –runs the DuRA on a day-to-day basis
  - –elected from the Membership of DuRA
  - –propose that DEDC run DuRA for 1 year

Scientific Program Committees

- Sanford Lab PAC (existing)
  - –will continue to oversee Sanford Science Efforts (early science program)
- DUSEL Scientific PAC (being formed)
  - – to reflect the even more diverse science programs at DUSEL
  - – to reflect the international participation in DUSEL
  - – provide guidance in assembly of the *generic* ISE
  - – provide scientific, technical, cost, schedule and management advice to the DUSEL directorate

Selection of the Integrated Suite of Experiments

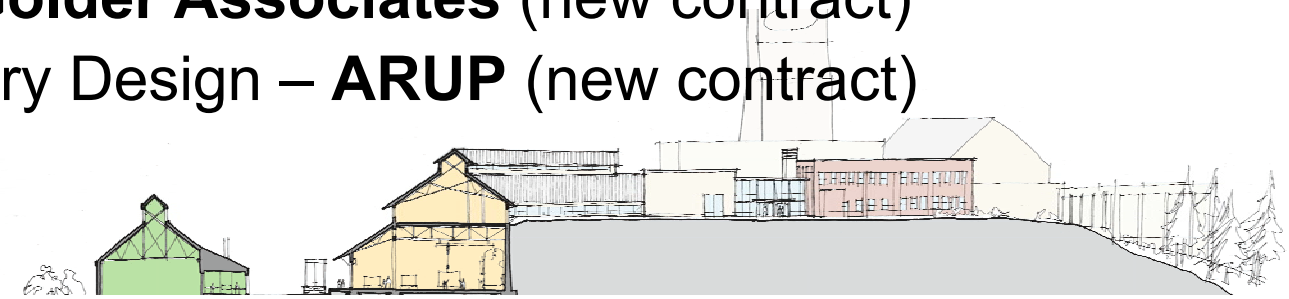
- The MREFC proposal will consist of a facility and a *generic* suite of experiments
  - –permits facility design to continue and to break ground
  - –fixes capital budgets for the suite of experiments and the facility, permits experiment design to lag facility
- Following NSB approval, experiments will be reviewed and selected for construction
  - –approval will follow NSF's peer-review guidelines
  - –review will include significant input from the facility team
  - –we anticipate DOE involvement in the process

NSF - DOE Relationships Maturing

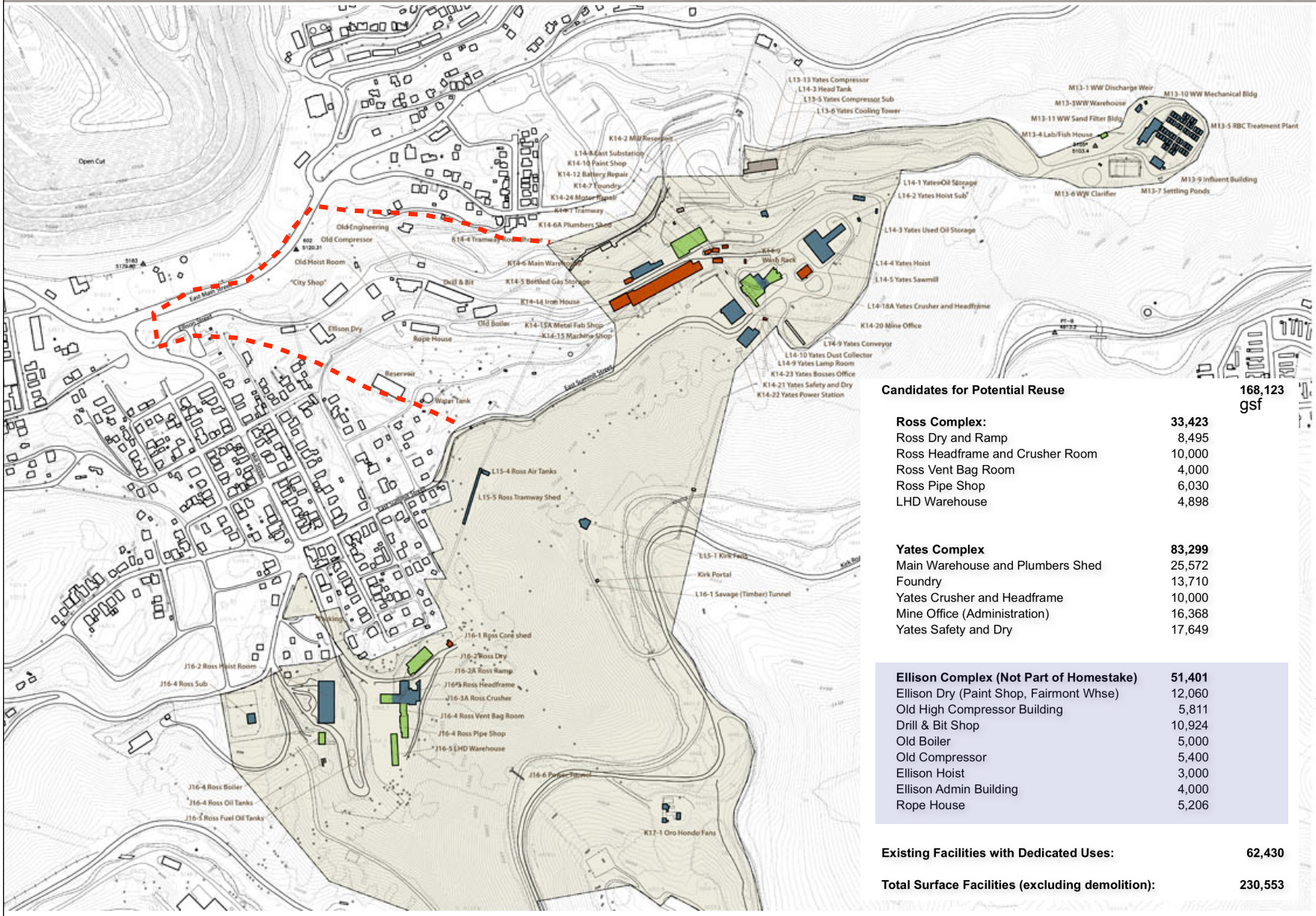
- Joint Oversight Group (JOG) Established
  - DOE: OHEP, ONP
  - NSF: Physics
- Letter of Intent signed by JOG co-Chairs - HEP, NP & Phys
  - DOE & NSF would jointly develop DUSEL Science Programs
- Transmittal to OMB signed by NSF Director and DOE Under Secretary for Science
  - Project would undergo NSF and DOE review protocols
- Long Baseline Neutrino Experiment
  - FNAL (Lead Lab & Beamlines)
  - BNL (Detector)
  - NSF-funded S4 Collaboration (UC Davis, Svoboda)
  - Project Coordination and Senior Management Groups Established

Overview of Assessment and Design Contracts

- Site assessment contracts initiated, focused on risk reduction
  - Selection process considered firm's capacity to also perform design
- Three assessment contracts awarded (prime listed)
  - January 2009 – Geotechnical Engineering Services – **RESPEC**
  - March 2009 – Underground Infrastructure – **ARUP**
  - April 2009 - Surface Campus Infrastructure – **HDR CUH2A**
- Four contracts in negotiations for preliminary design; Currently adjusting scope, schedules, and deliverables to match design funding and schedules
  - Underground Infrastructure – **ARUP** (amendment)
  - Surface Campus Infrastructure – **HDR CUH2A** (amendment)
  - Excavation Design – **Golder Associates** (new contract)
  - Underground Laboratory Design – **ARUP** (new contract)



DUSEL Surface Facilities Plan

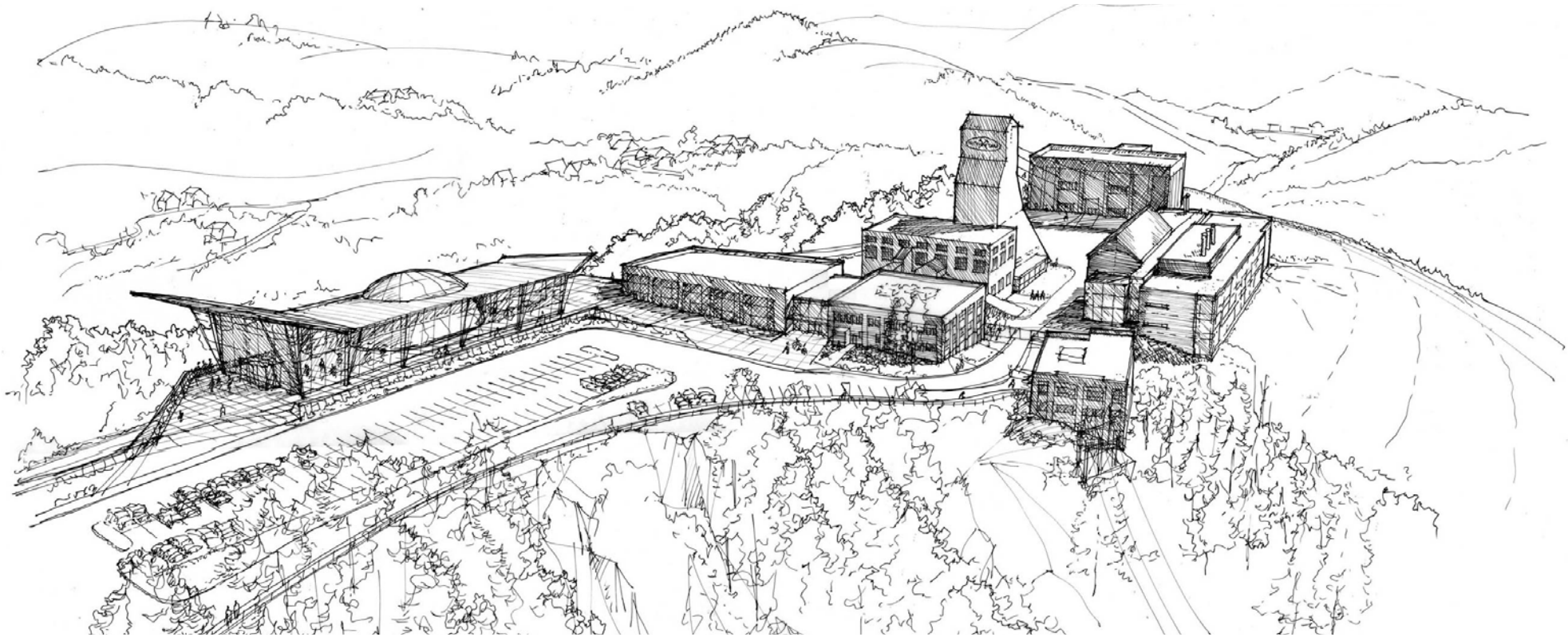


Candidates for Potential Reuse		**168,123** gsf
Ross Complex:	**33,423**	
Ross Dry and Ramp	8,495	
Ross Headframe and Crusher Room	10,000	
Ross Vent Bag Room	4,000	
Ross Pipe Shop	6,030	
LHD Warehouse	4,898	
Yates Complex	**83,299**	
Main Warehouse and Plumbers Shed	25,572	
Foundry	13,710	
Yates Crusher and Headframe	10,000	
Mine Office (Administration)	16,368	
Yates Safety and Dry	17,649	
Ellison Complex (Not Part of Homestake)	**51,401**	
Ellison Dry (Paint Shop, Fairmont Whse)	12,060	
Old High Compressor Building	5,811	
Drill & Bit Shop	10,924	
Old Boiler	5,000	
Old Compressor	5,400	
Ellison Hoist	3,000	
Ellison Admin Building	4,000	
Rope House	5,206	
Existing Facilities with Dedicated Uses:		**62,430**
Total Surface Facilities (excluding demolition):		**230,553**

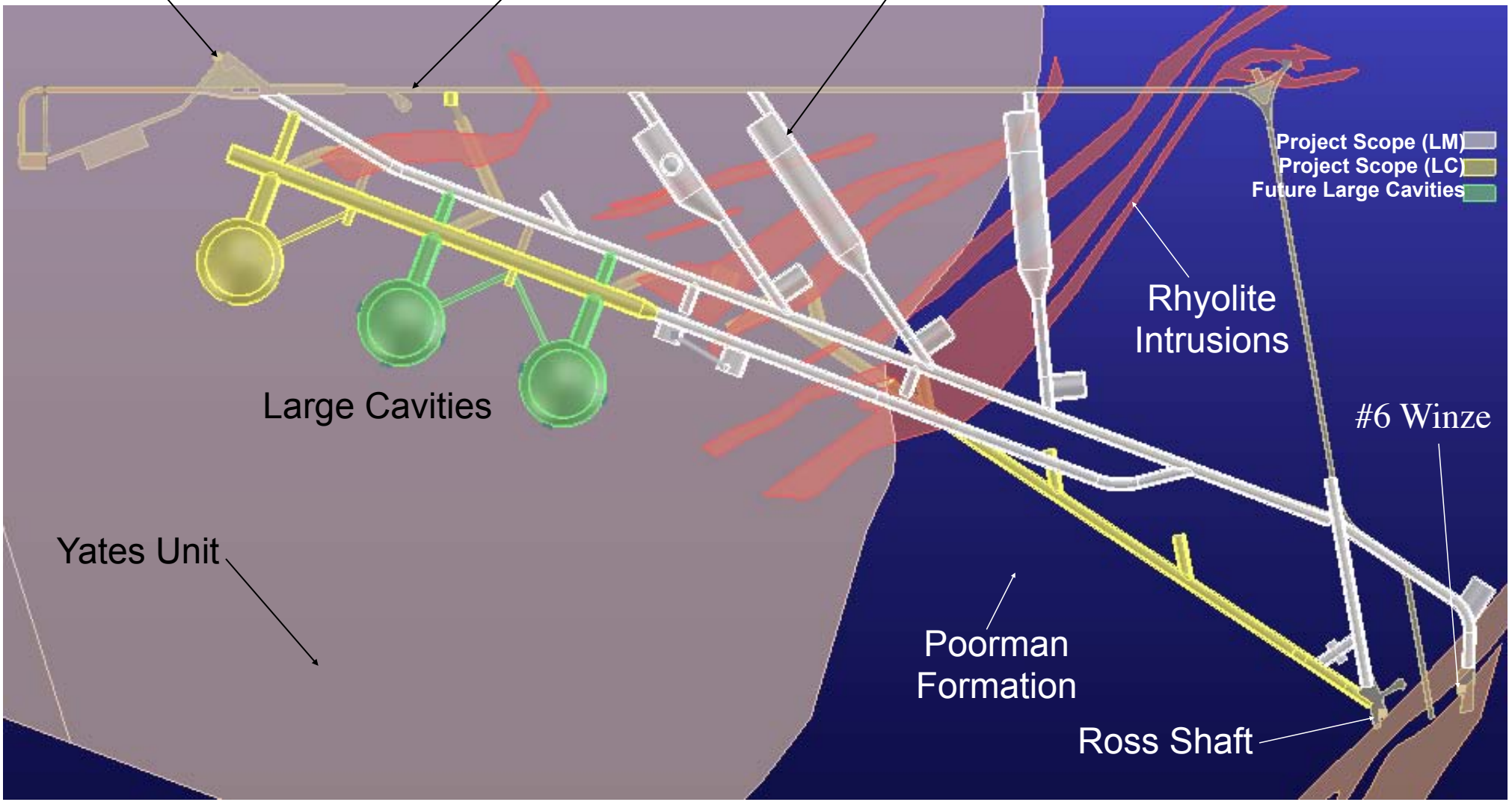
Legend

- Existing Structure - No Action Projected
- Existing Structure - Continue Current Use
- Existing Structure - Candidate for Remodel for New Uses
- Existing Structure - To Be Removed

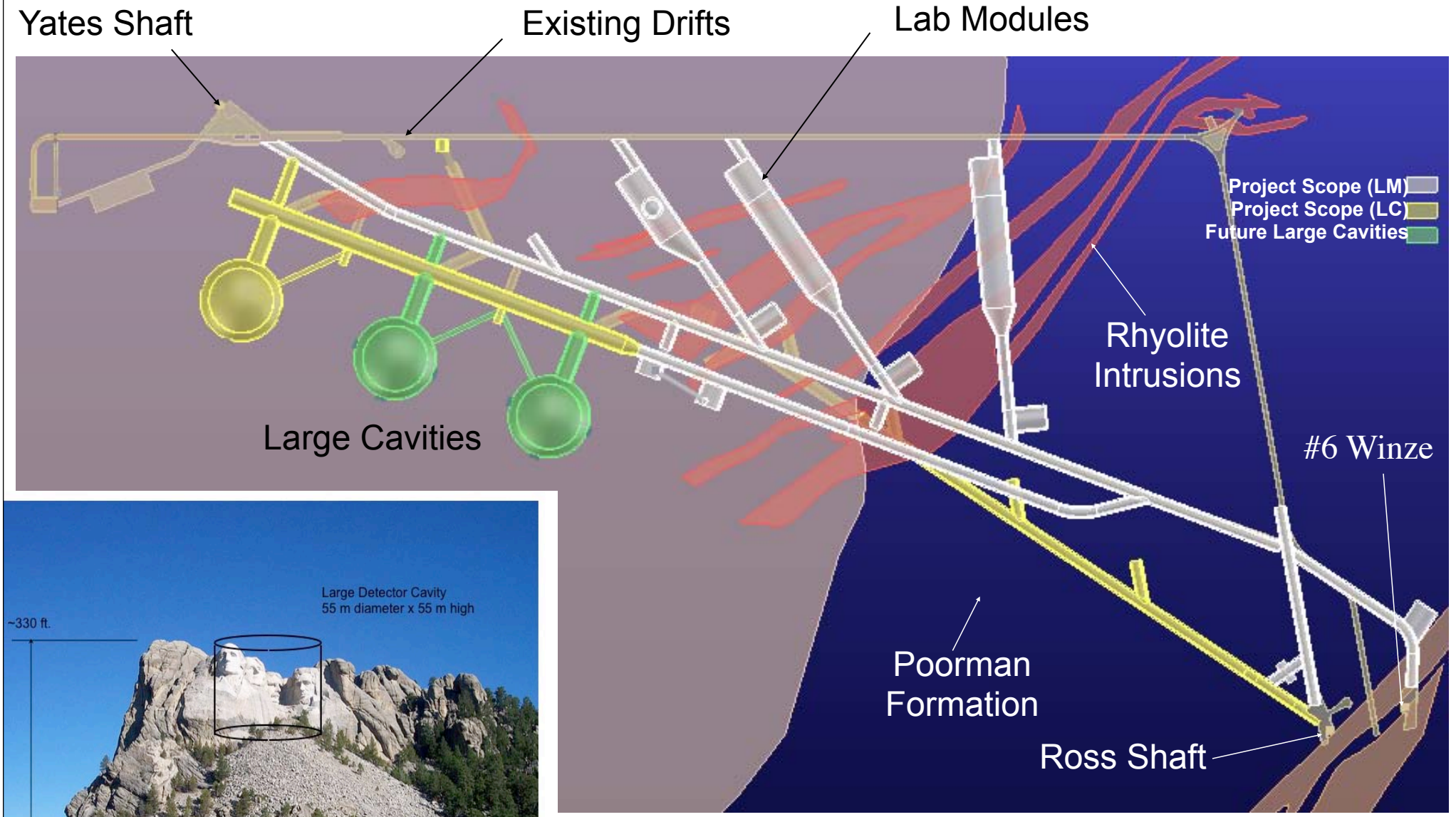
Surface Facility Concepts are Developing



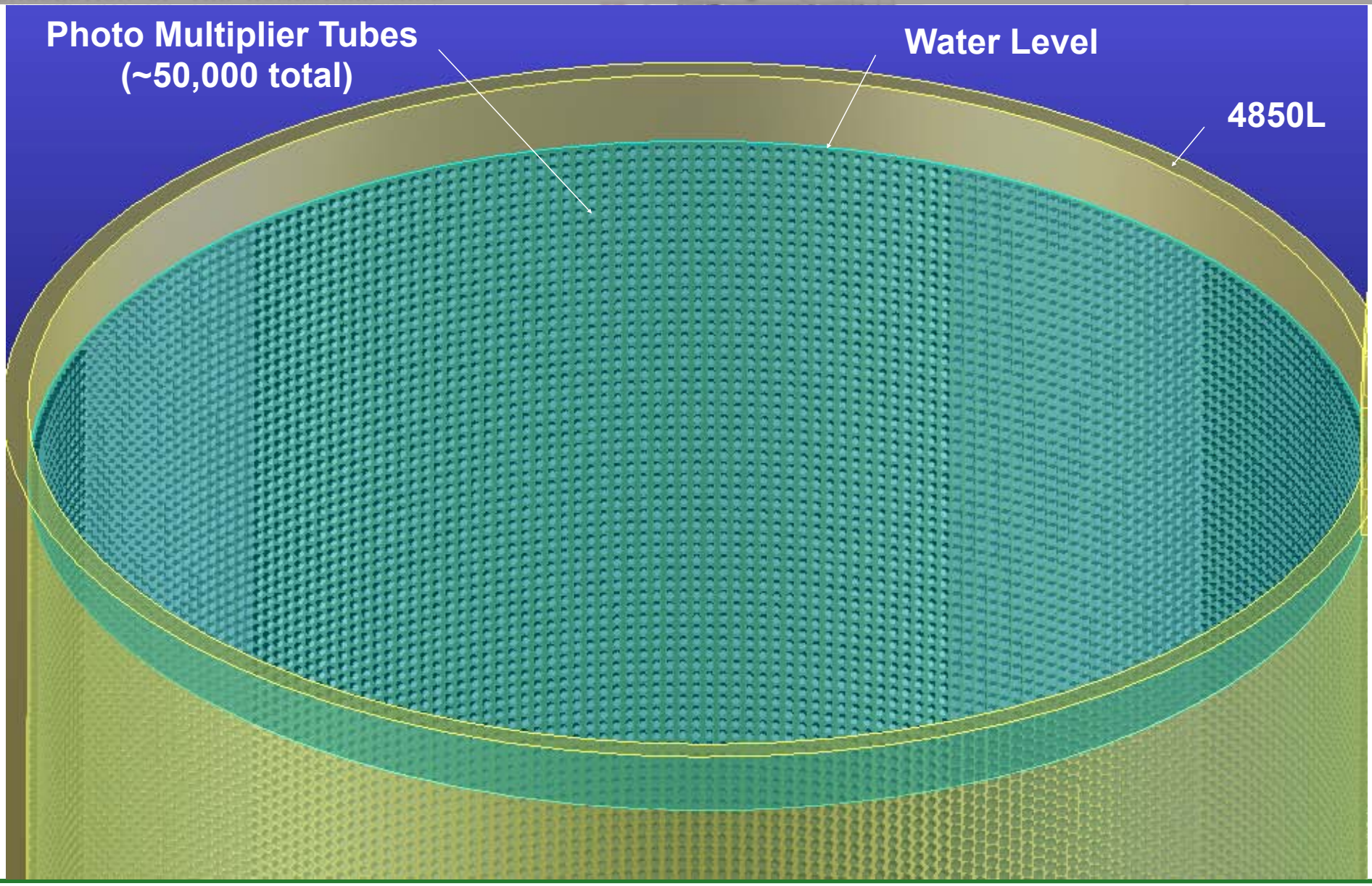
4850 Level Developmental Baseline for PDR:
3 Lab Modules, 1 Large Cavities, and future options for additional Large Cavities



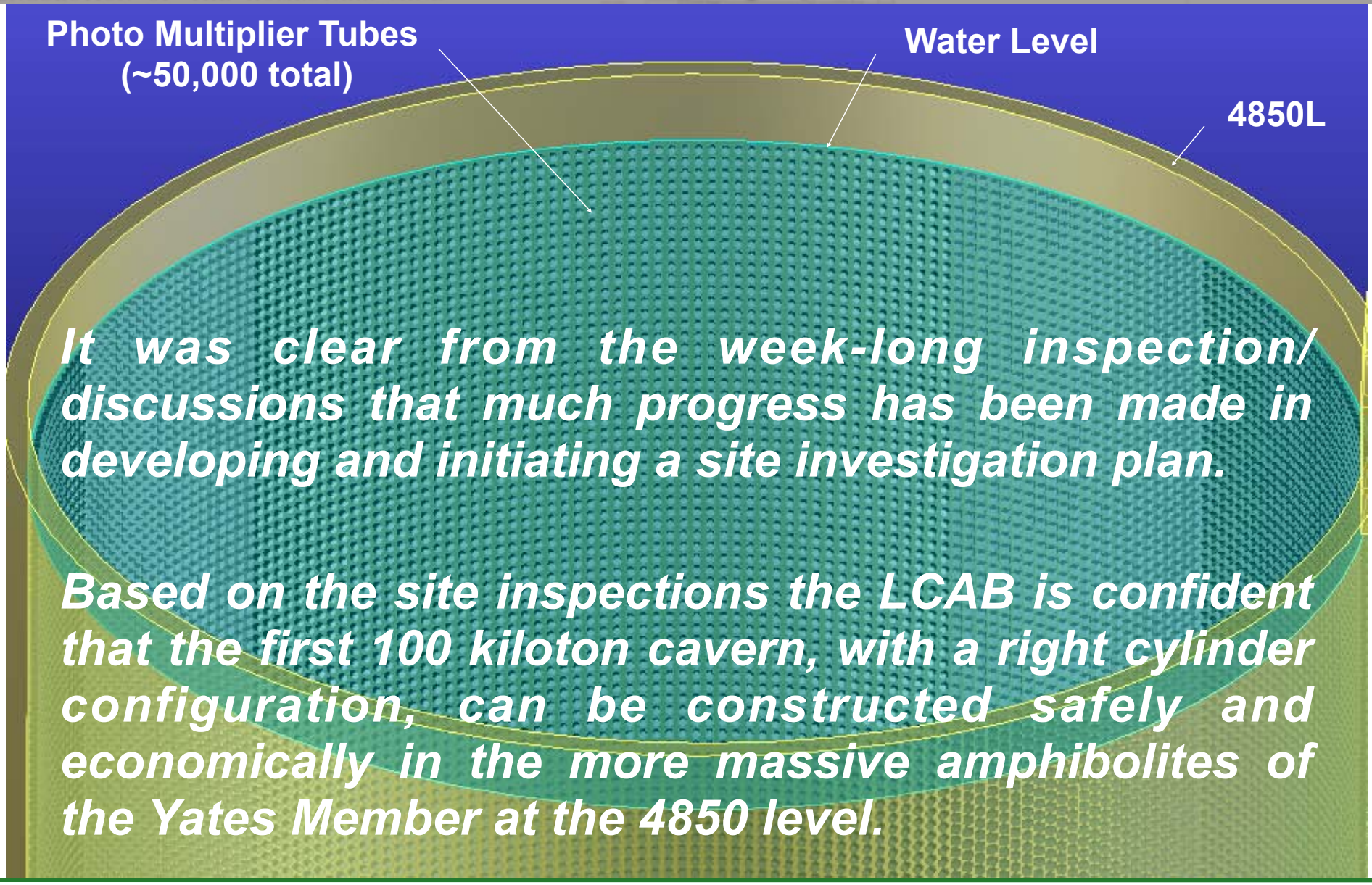
4850 Level Developmental Baseline for PDR:
3 Lab Modules, 1 Large Cavities, and future options for additional Large Cavities



Large Cavity, Water Cerenkov Detector (53m I.D. x 60m vertical)



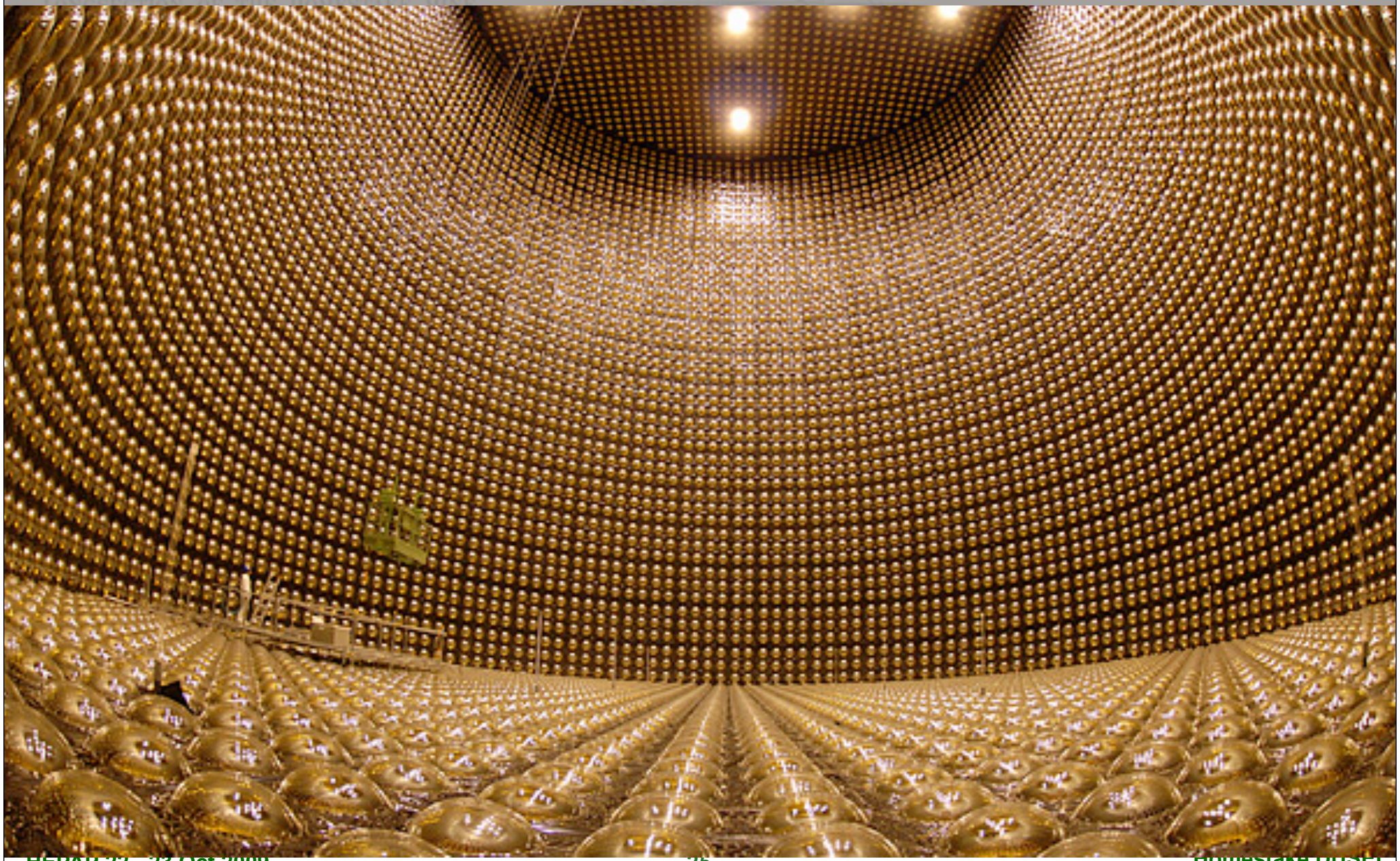
Large Cavity, Water Cerenkov Detector (53m I.D. x 60m vertical)



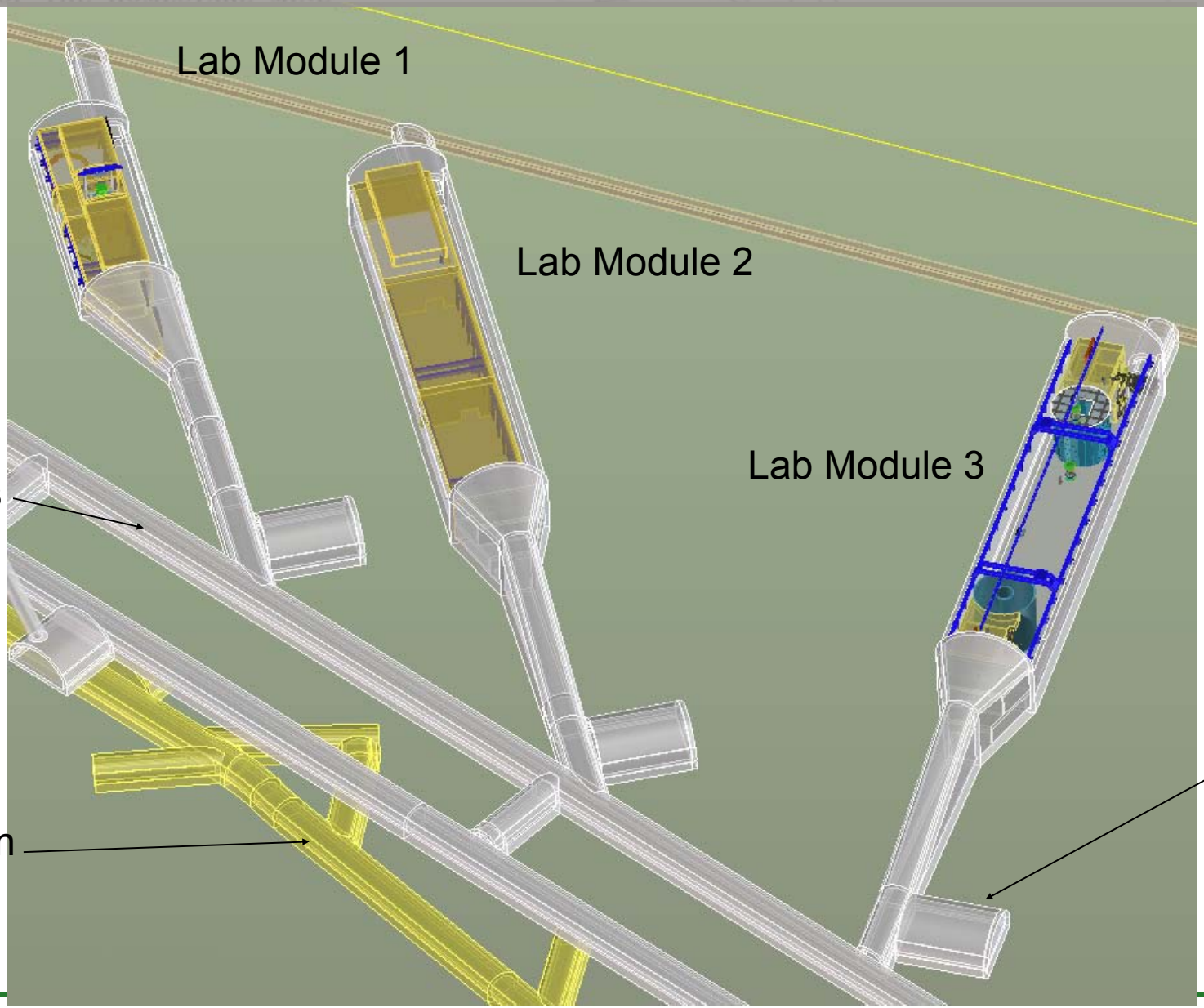
It was clear from the week-long inspection/ discussions that much progress has been made in developing and initiating a site investigation plan.

Based on the site inspections the LCAB is confident that the first 100 kiloton cavern, with a right cylinder configuration, can be constructed safely and economically in the more massive amphibolites of the Yates Member at the 4850 level.

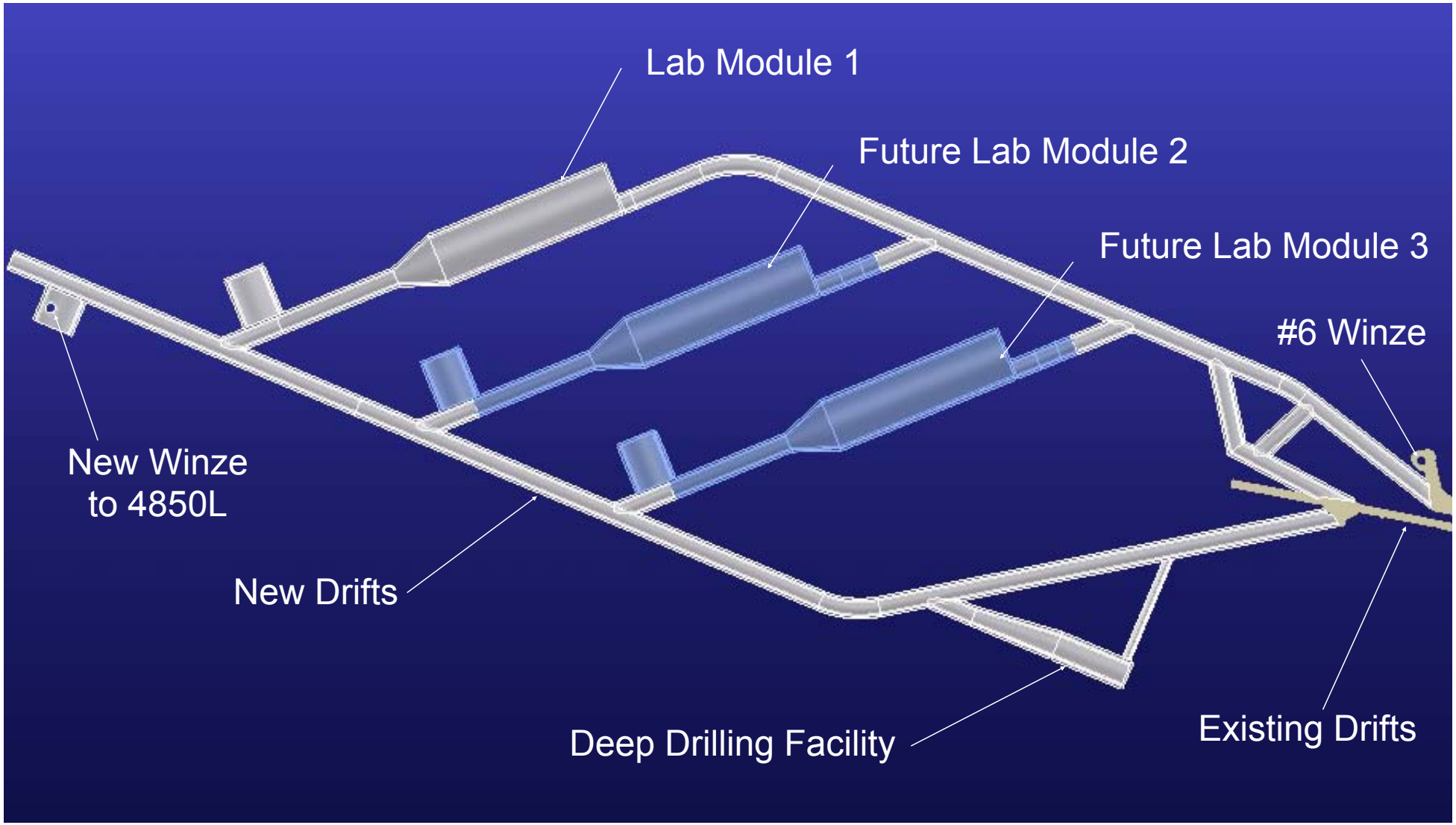
Water Cherenkov Detector, PMT Assembly



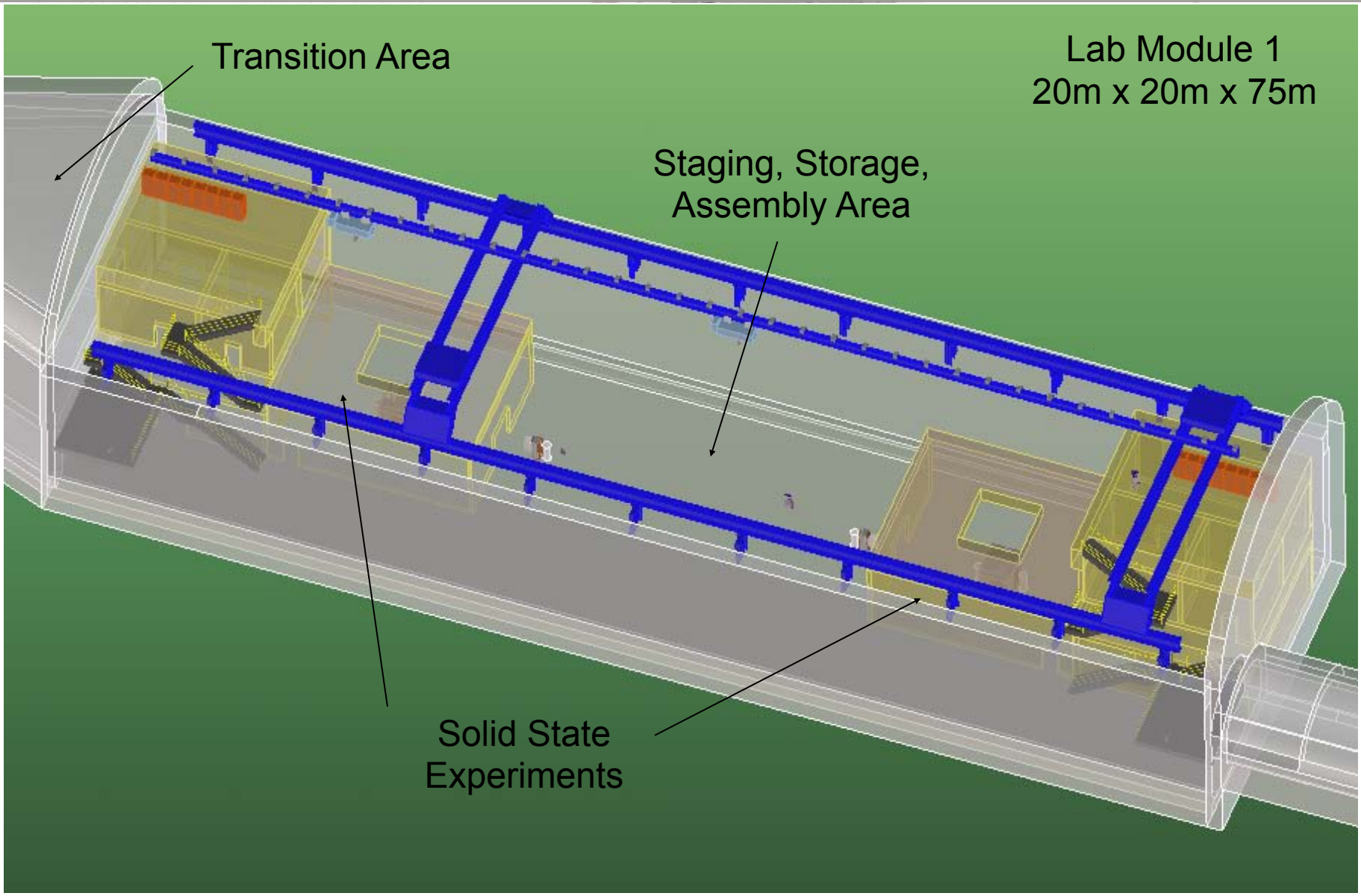
DUSEL Developmental Baseline for Preparation of PDR Campus Development at 4850L, Lab Modules



7400 Level Developmental Baseline for PDR:
1 Lab Modules with future options for 2 additional Lab Modules



DUSEL Developmental Baseline for Preparation of PDR Campus Development at 7400L, Lab Module 1



Beneficial Occupancy (early estimate)

LONGSECTION OF THE HOMESTAKE MINE

Davis Cavity

2013 onwards

4850 Level

Lab Module 1 - 3

~ 2016 - 2017

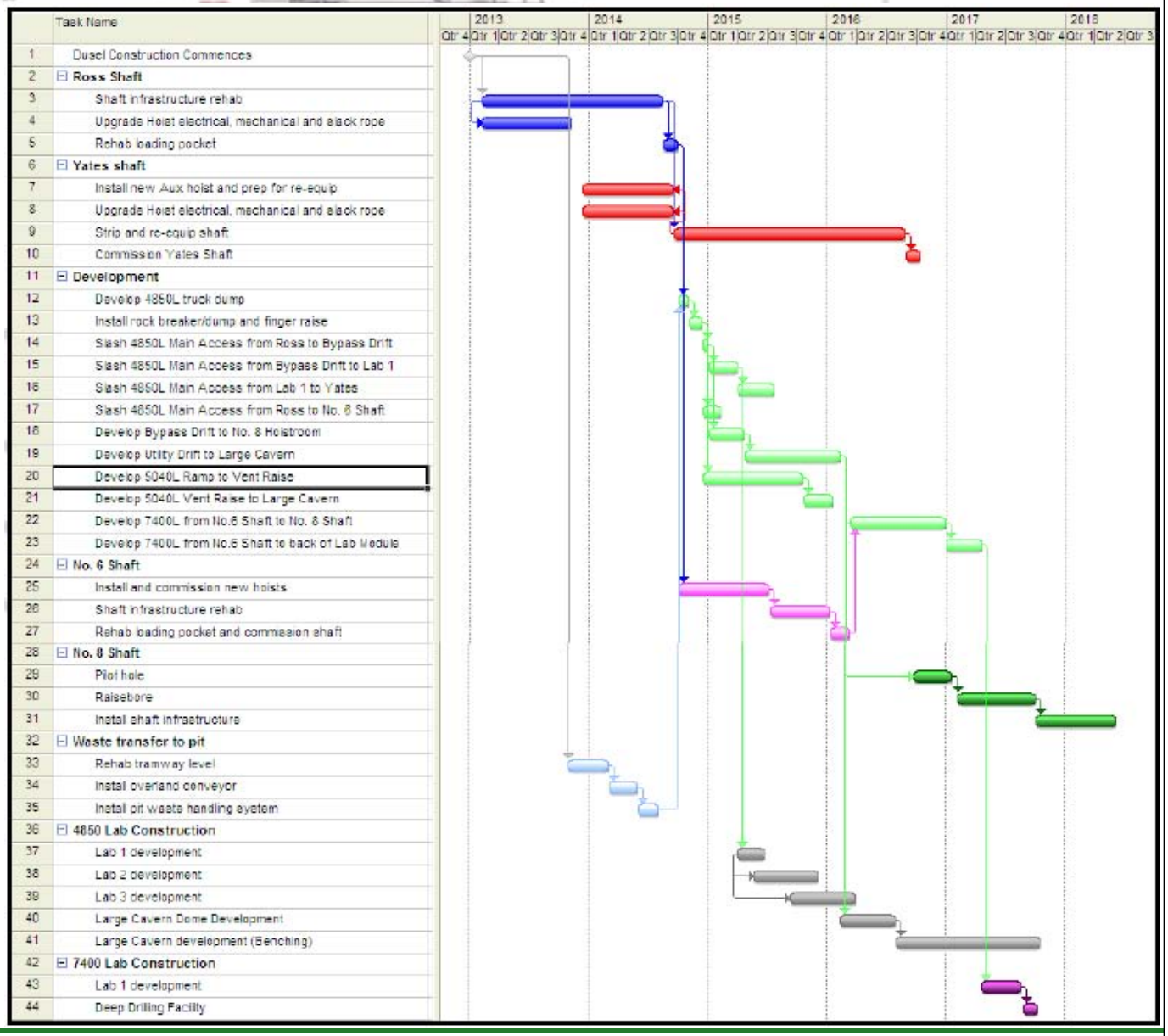
Large Cavity 1

~ 2017 - 2018

7400 Level

Lab Module 4

~ 2018



Challenges and Opportunities

- Preparation and Integration of DUSEL Science Programs with Facility Designs (FY10 - ...)
  - Key hires in Project Controls, Systems Engineering & Integration
  - Adequate support and engagement of the University Groups (Dark Matter, Long Baseline Neutrinos, 0νββ, Assay Facility)
  - Timely engagement of DOE Labs to achieve these Science Goals
- Continuing Site Preparation and Risk Mitigation (SDSTA) (FY10)
  - Ongoing Discussions among DUSEL, SDSTA and Agencies
  - Engage the Joint Oversight Group
- Long-lead items: Ross Shaft upgrade and rehabilitation (FY10)
  - Initiate Discussions between DUSEL and Agencies
  - Engage the Joint Oversight Group
- DOE and NSF Cooperation and Scope Definition (FY10 - ...)
  - Significant Task for the Joint Oversight Group

Summary

- DUSEL Facility Design and Experiment Integration Advancing - on track for a Preliminary Design by end of 2010
- Exceptional, Multidisciplinary Science Program Developing and Integrated into the MREFC Proposal
- Effective, Initial Cooperation demonstrated between the NSF and DOE

Backup Slides

DUSEL has been extensively addressed by the Scientific Communities, Agencies, National Academy Reports

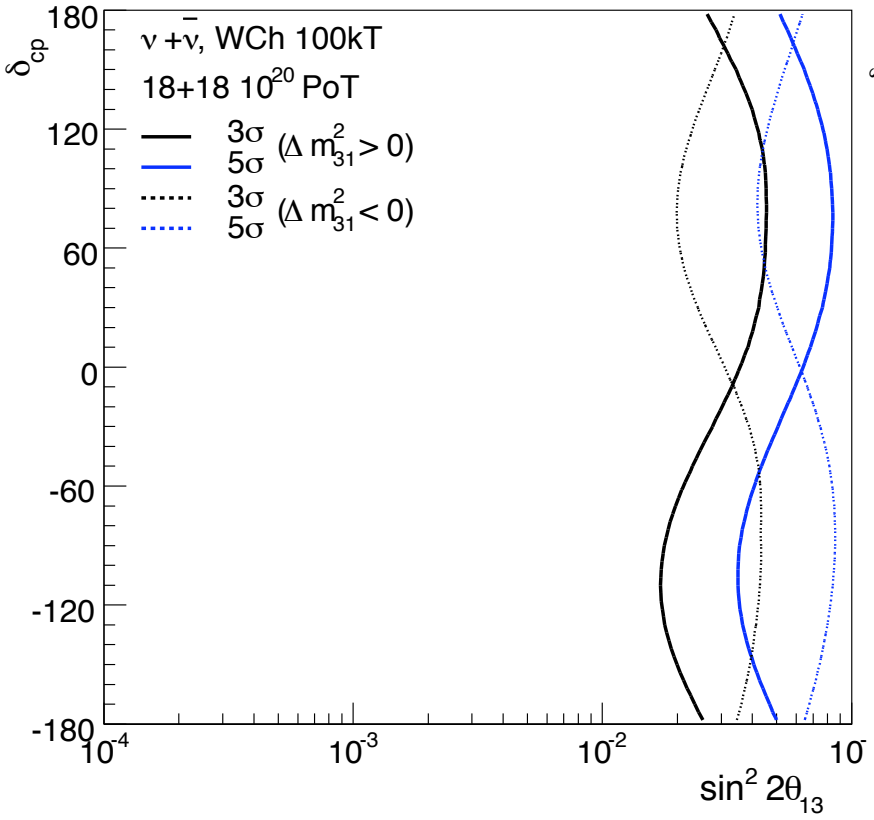
- Bahcall Committee Report 2001
- Nuclear Physics Long Range Plan 2002
- Connecting Quarks to the Cosmos
- HEPAP Long Range Plan 2003
- Neutrinos and Beyond
- EarthLab
- Physics of the Universe
- The Neutrino Matrix
- Earth Scope
- Discovering the Quantum Universe
- Deep Science
- Nuclear Physics Long Range Plan 2007
- 2008 P5 Report

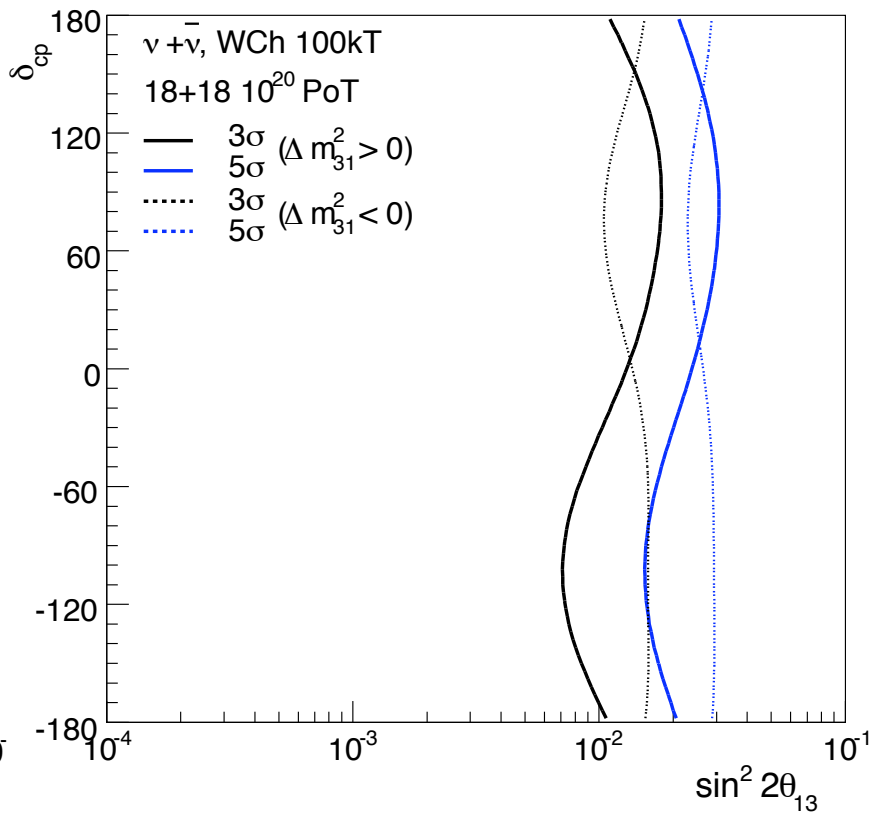
Physics with 100-kt Water Cherenkov Detector & 700kW Beams @ 120 GeV 3 years each $\nu+\bar{\nu}$

Mass Hierarchy

Θ_{13}

$18x10^{20}$ POT each





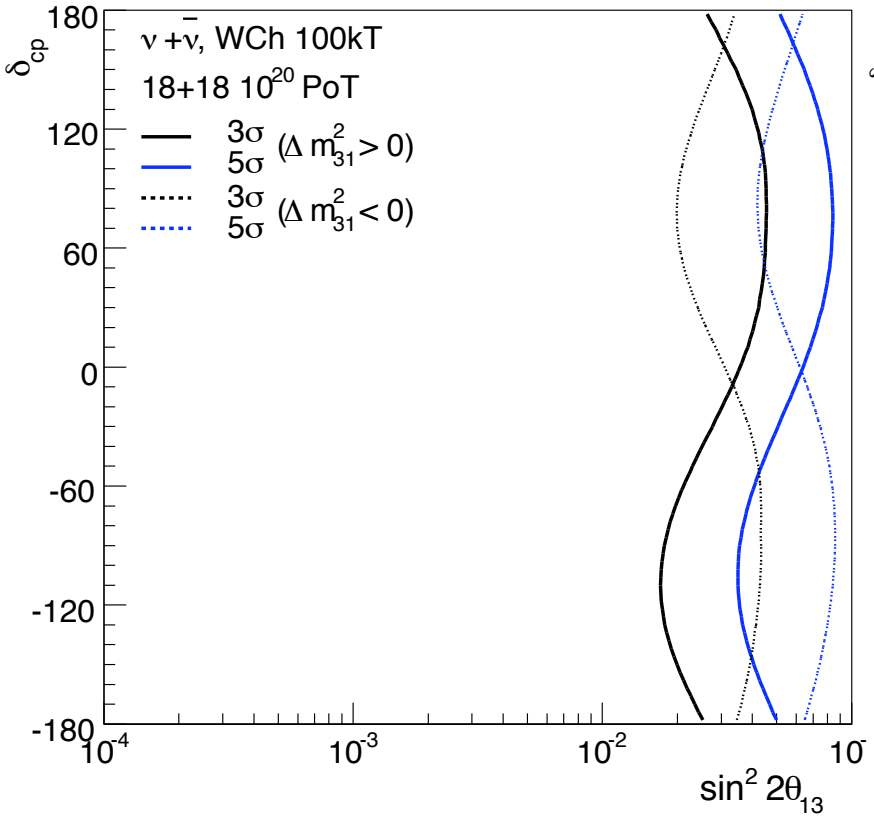
from Mark Dierckxsens
Milind Diwan
Mary Bishal

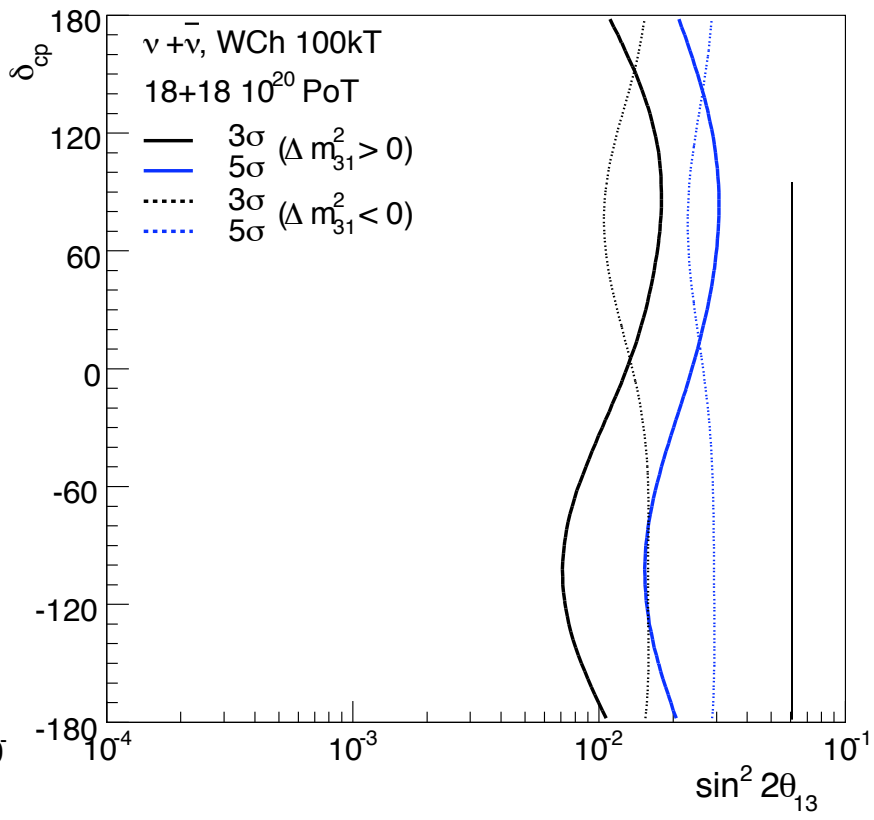
Physics with 100-kt Water Cherenkov Detector & 700kW Beams @ 120 GeV 3 years each $\nu+\bar{\nu}$

Mass Hierarchy

Θ_{13}

$18x10^{20}$ POT each





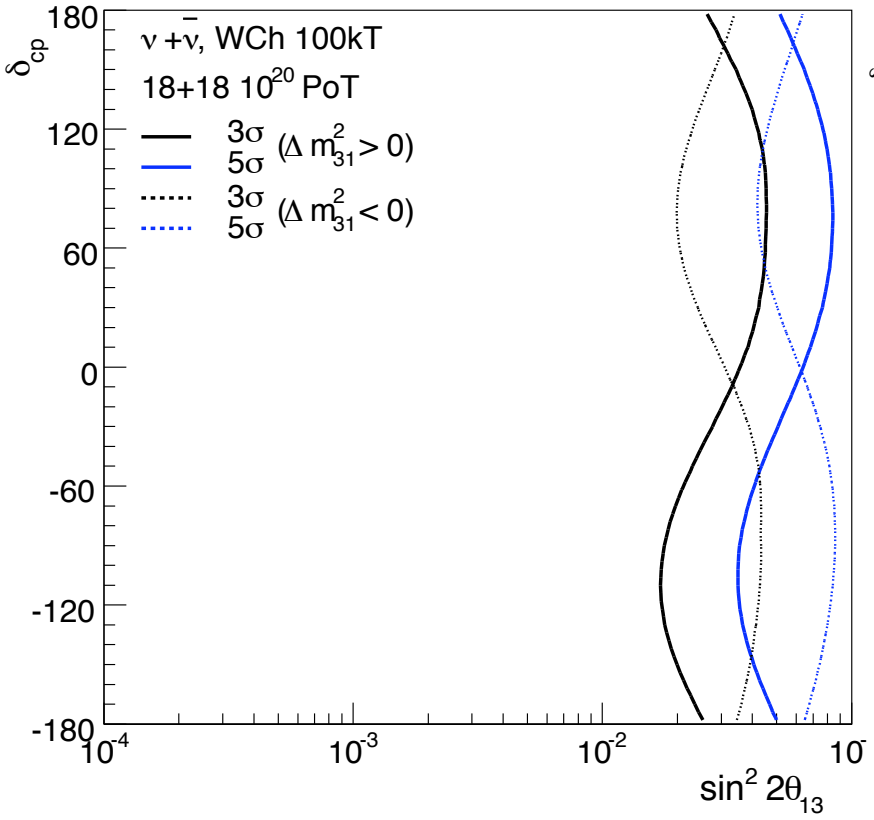
from Mark Dierckxsens
Milind Diwan
Mary Bishal

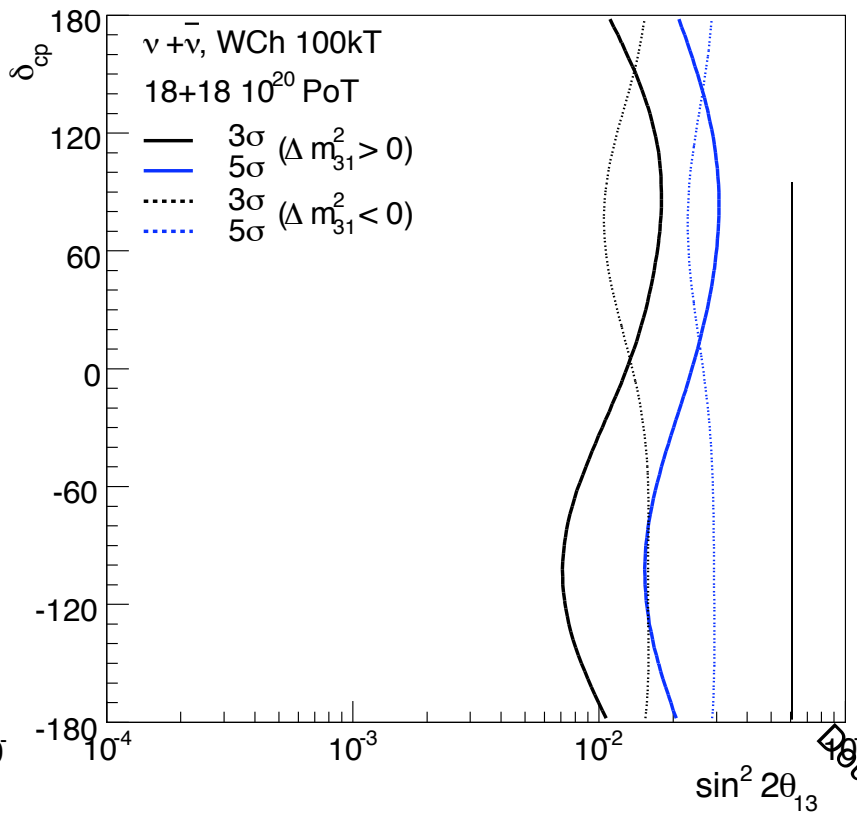
Physics with 100-kt Water Cherenkov Detector & 700kW Beams @ 120 GeV 3 years each $\nu+\bar{\nu}$

Mass Hierarchy

Θ_{13}

$18x10^{20}$ POT each





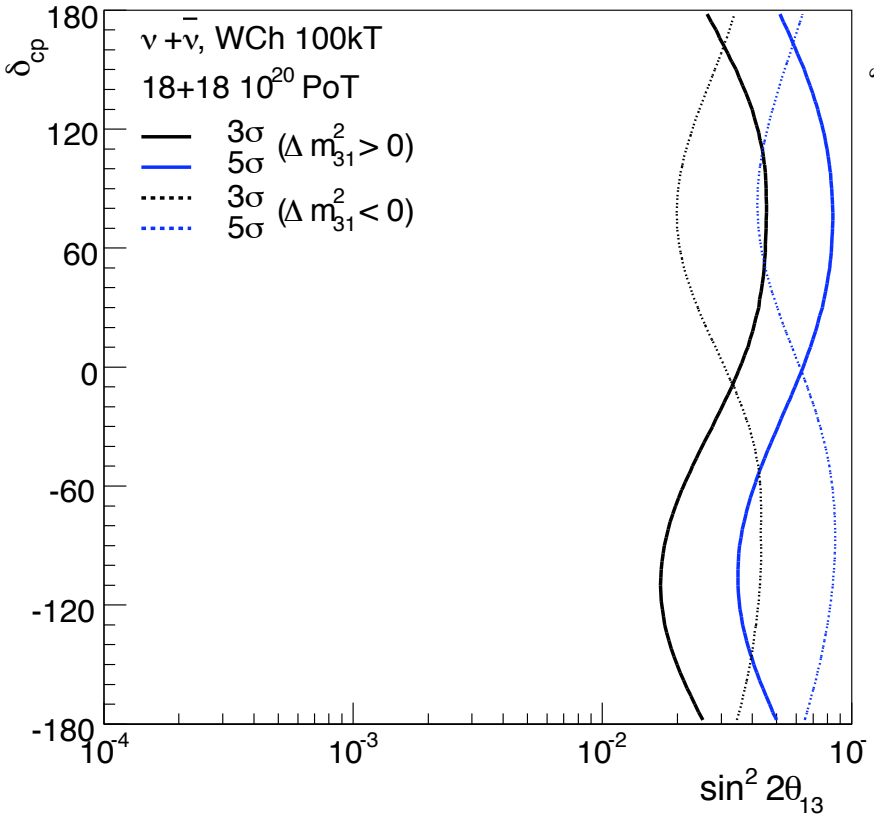
from Mark Dierckxsens
Milind Diwan
Mary Bishal

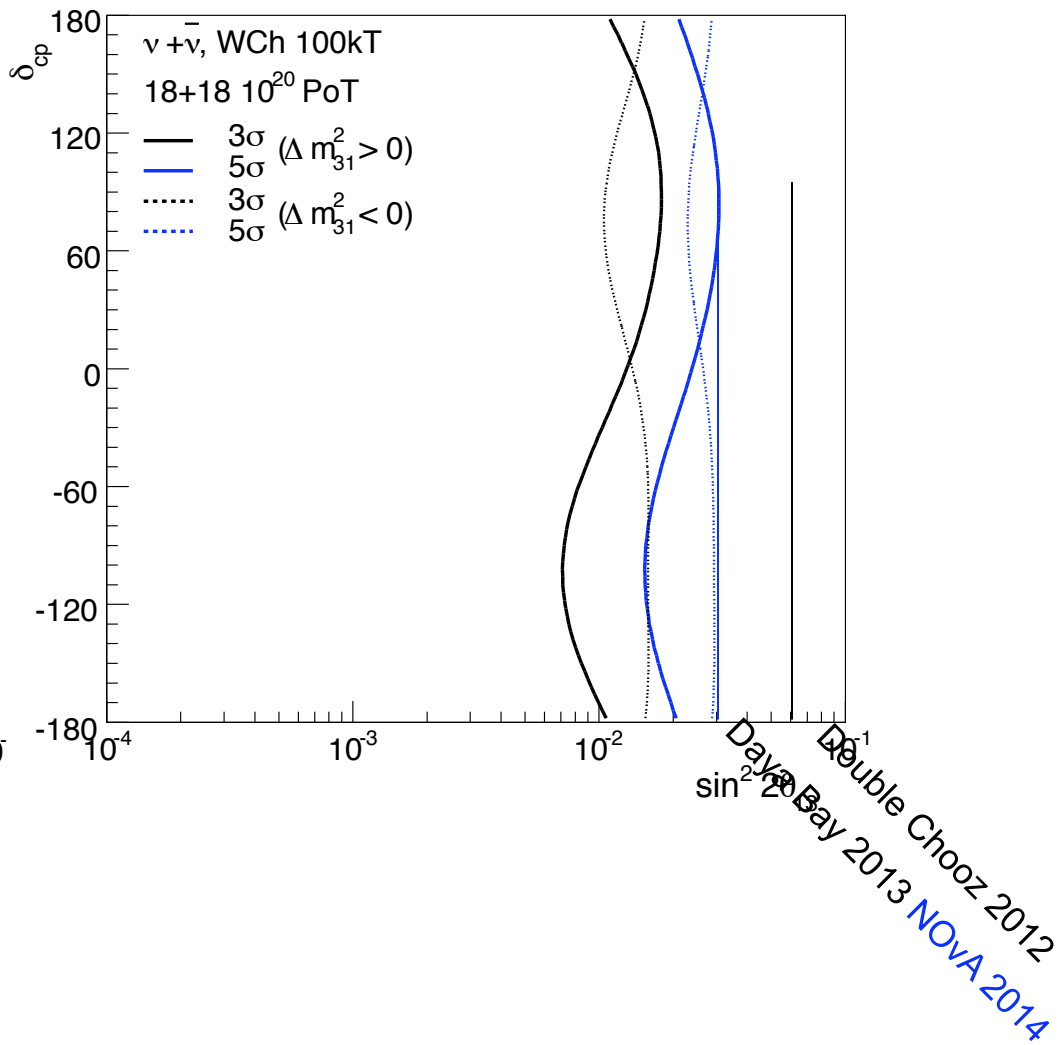
Physics with 100-kt Water Cherenkov Detector & 700kW Beams @ 120 GeV 3 years each $\nu+\bar{\nu}$

Mass Hierarchy

Θ_{13}

18×10^{20} POT each





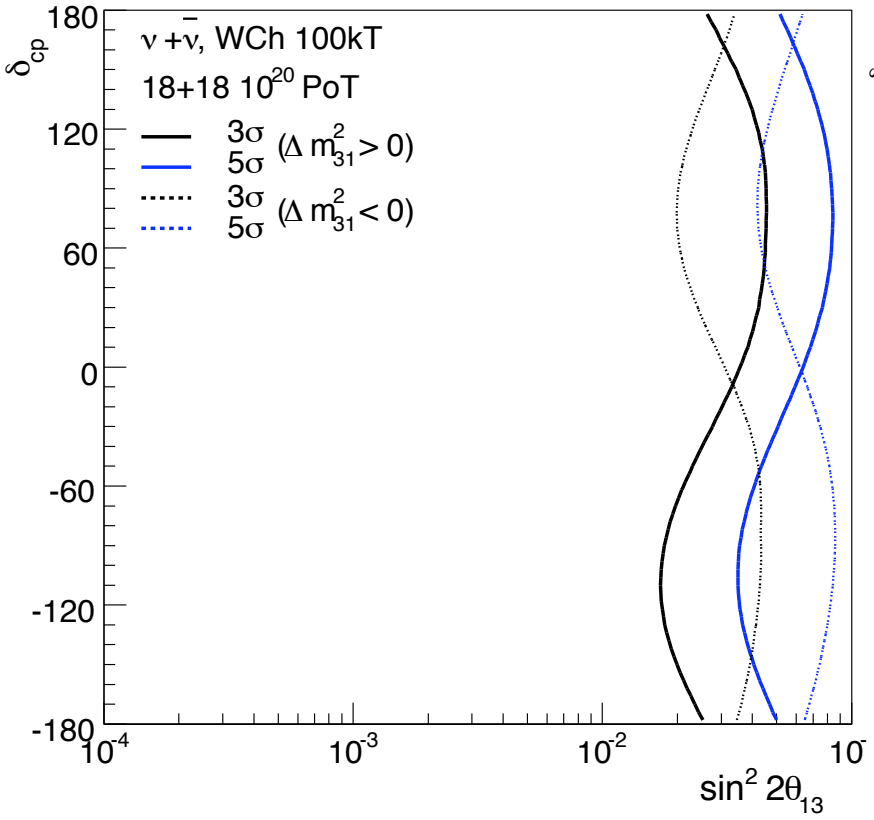
from Mark Dierckxsens
Milind Diwan
Mary Bishal

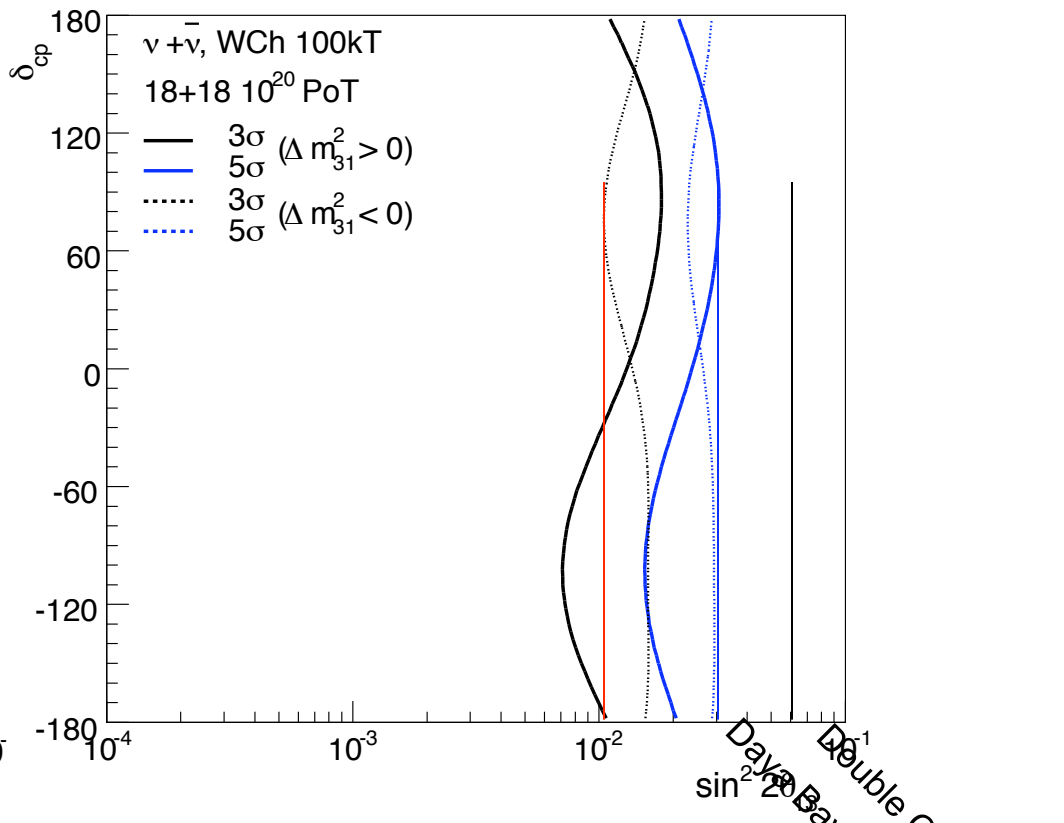
Physics with 100-kt Water Cherenkov Detector & 700kW Beams @ 120 GeV 3 years each $\nu+\bar{\nu}$

Mass Hierarchy

Θ_{13}

18×10^{20} POT each





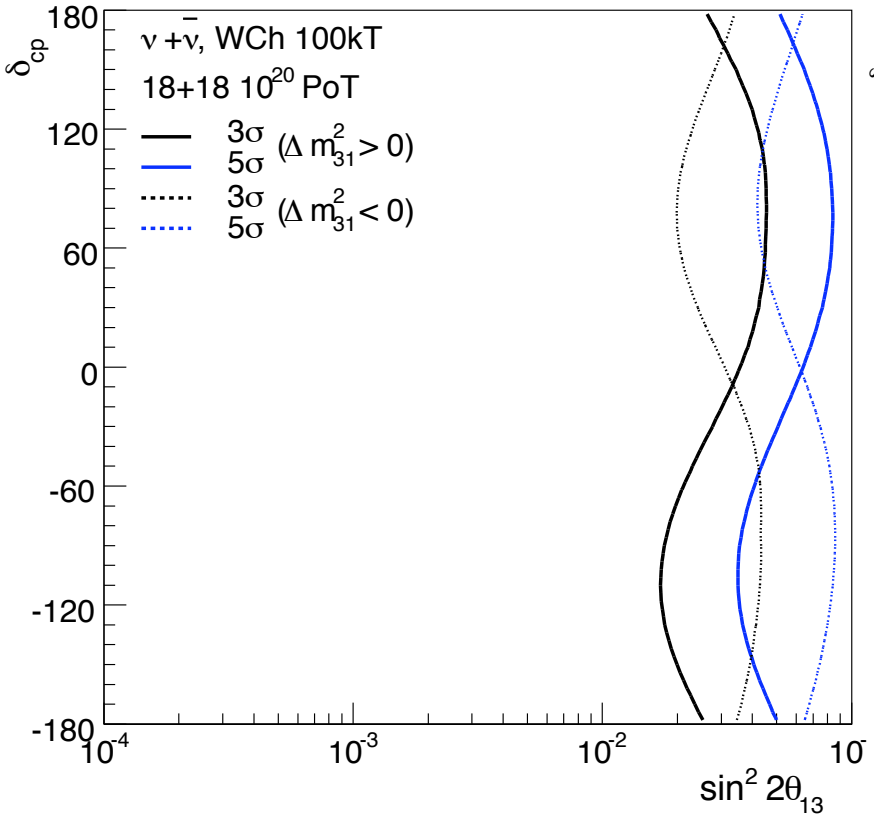
from Mark Dierckxsens
Milind Diwan
Mary Bishal

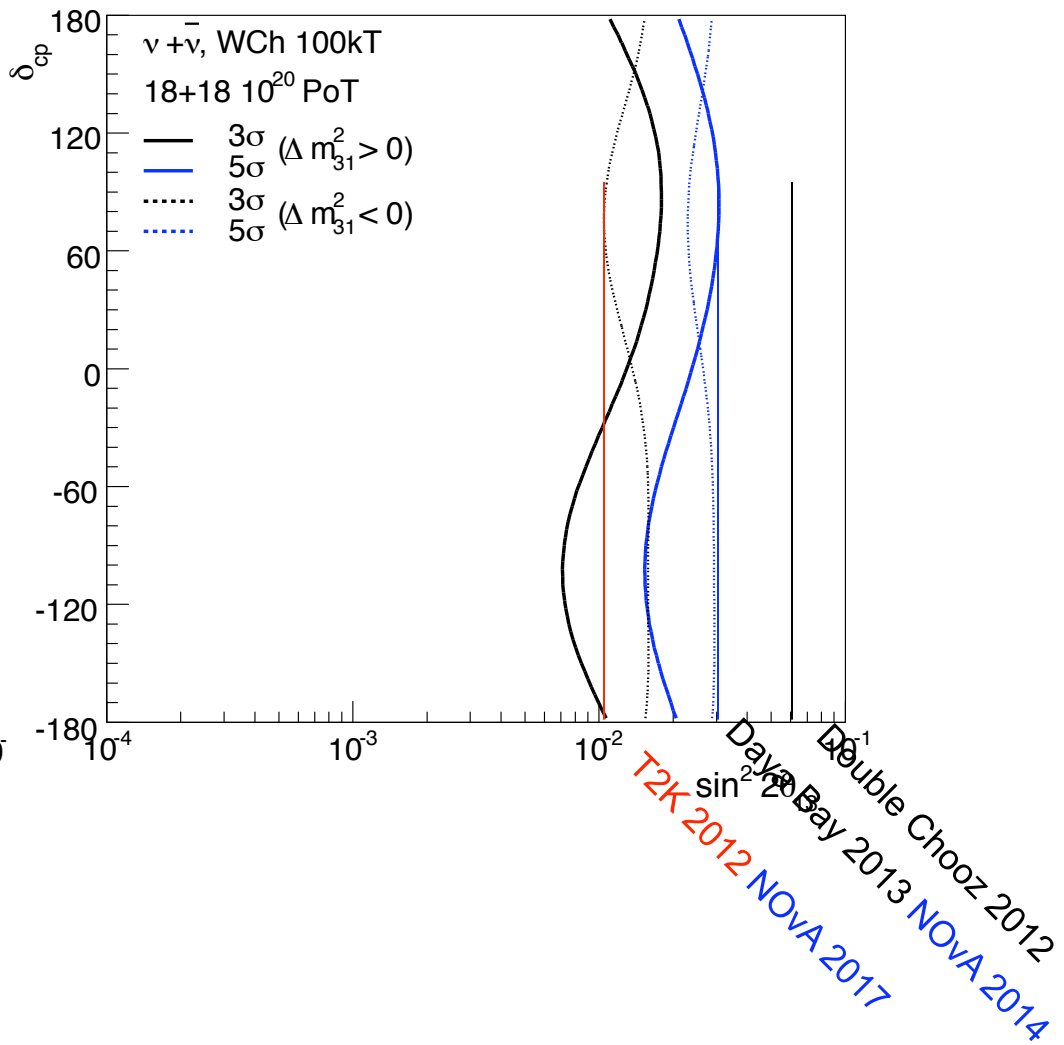
Physics with 100-kt Water Cherenkov Detector & 700kW Beams @ 120 GeV 3 years each $\nu+\bar{\nu}$

Mass Hierarchy

Θ_{13}

18×10^{20} POT each





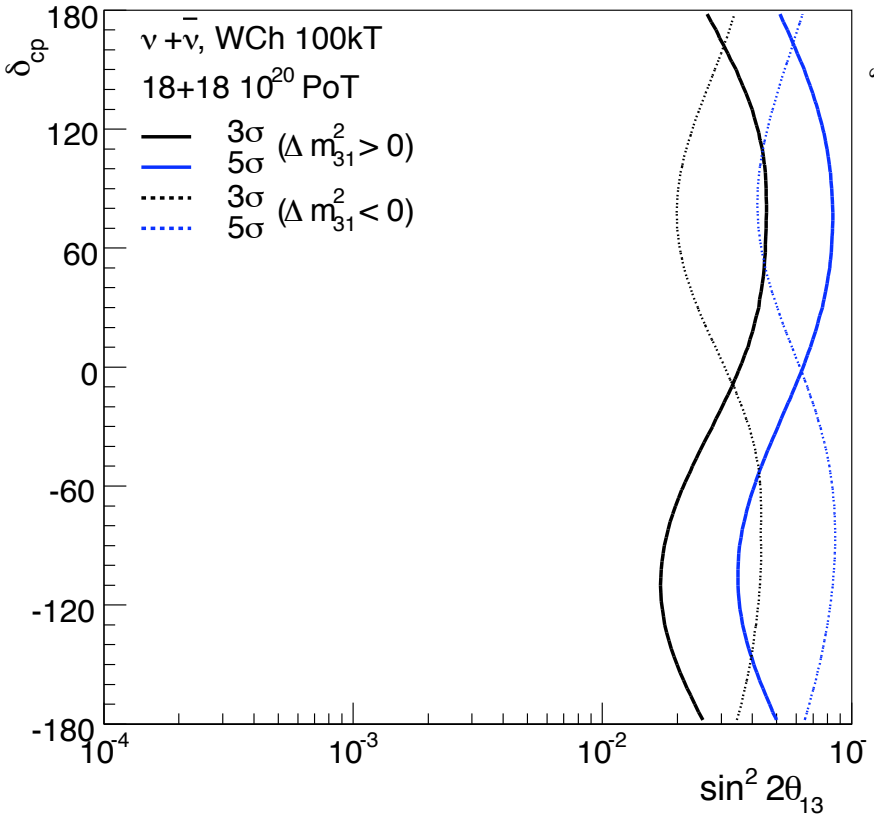
from Mark Dierckxsens
Milind Diwan
Mary Bishal

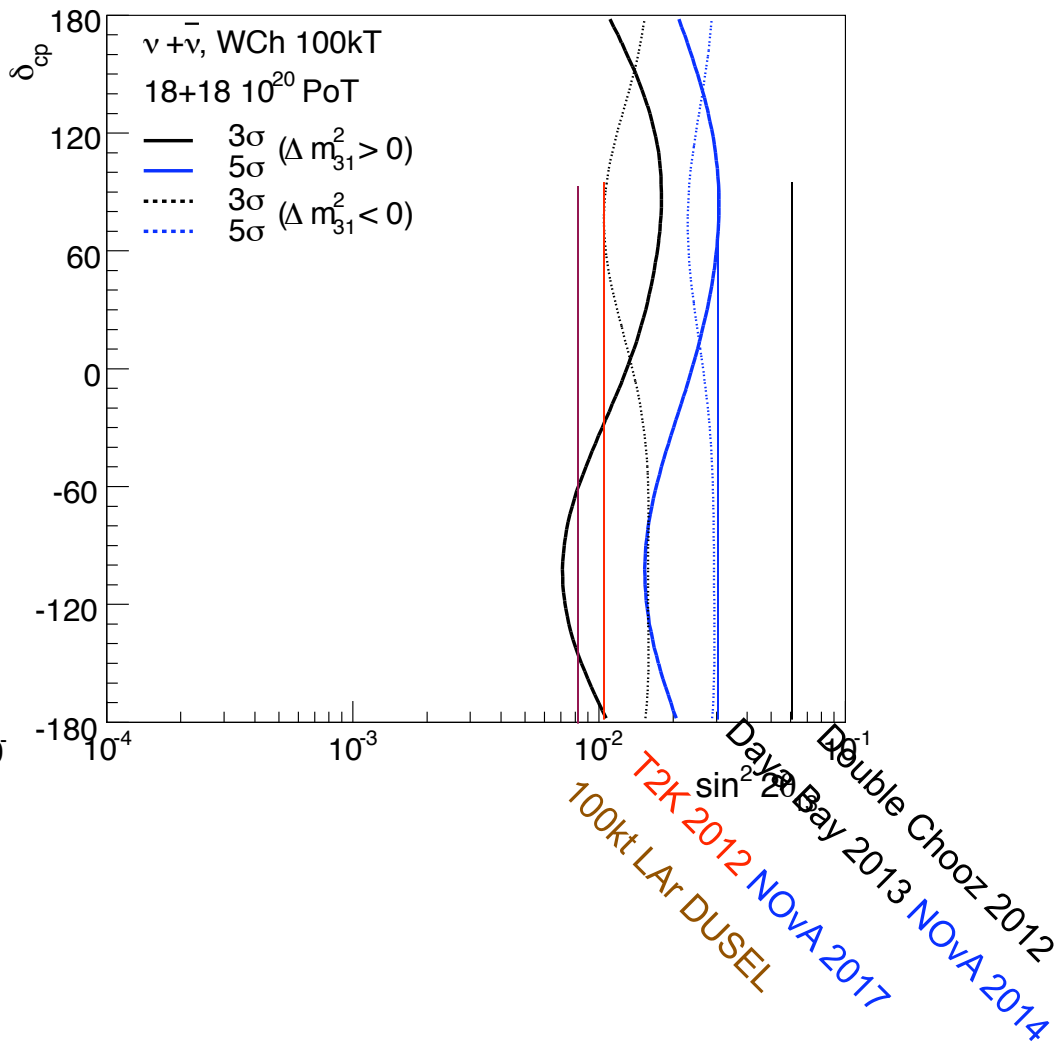
Physics with 100-kt Water Cherenkov Detector & 700kW Beams @ 120 GeV 3 years each $\nu+\bar{\nu}$

Mass Hierarchy

Θ_{13}

$18x10^{20}$ POT each





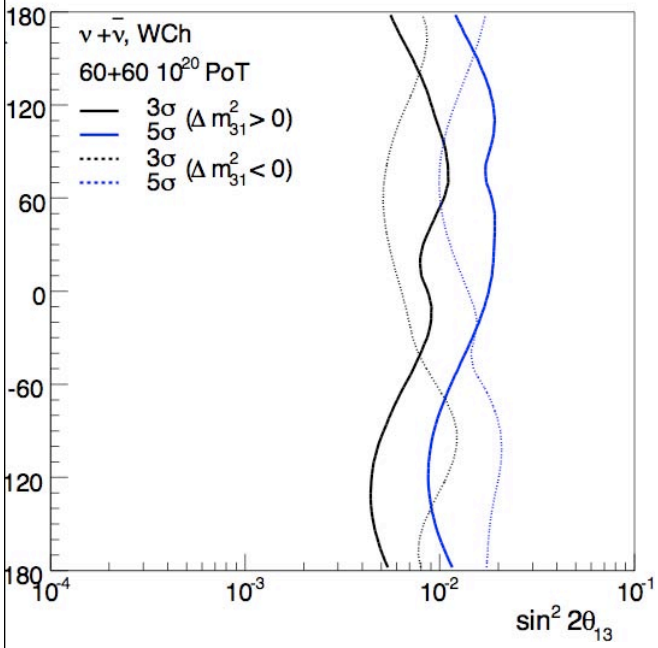
from Mark Dierckxsens
Milind Diwan
Mary Bishal

Physics with 300-kt Water Cherenkov Detector & 2 MW Beams @ 120 GeV 3 years each $\nu + \bar{\nu}$

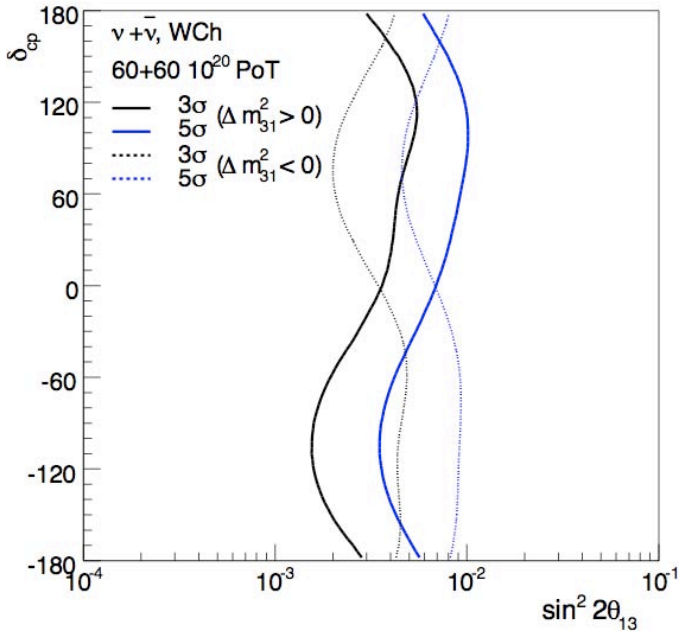
1kt LAr ≈ 3kt H_2O

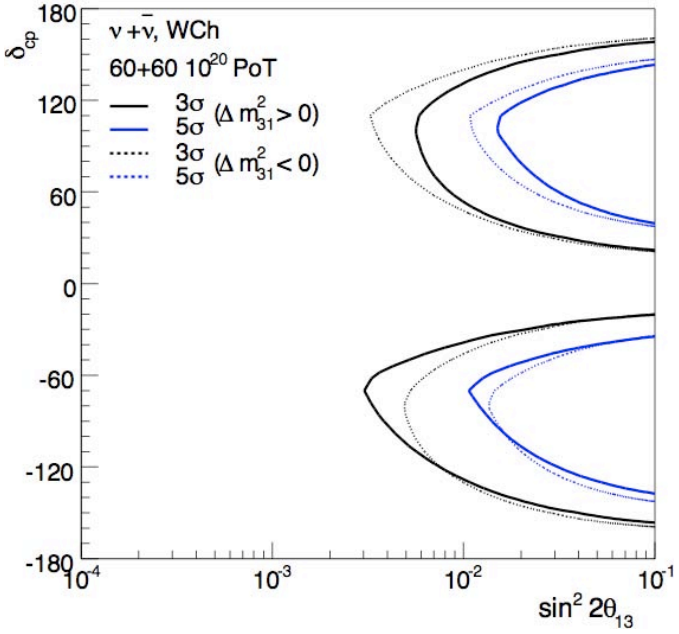
Exclusion of CP Violation

Mass Hierarchy



θ_{13}





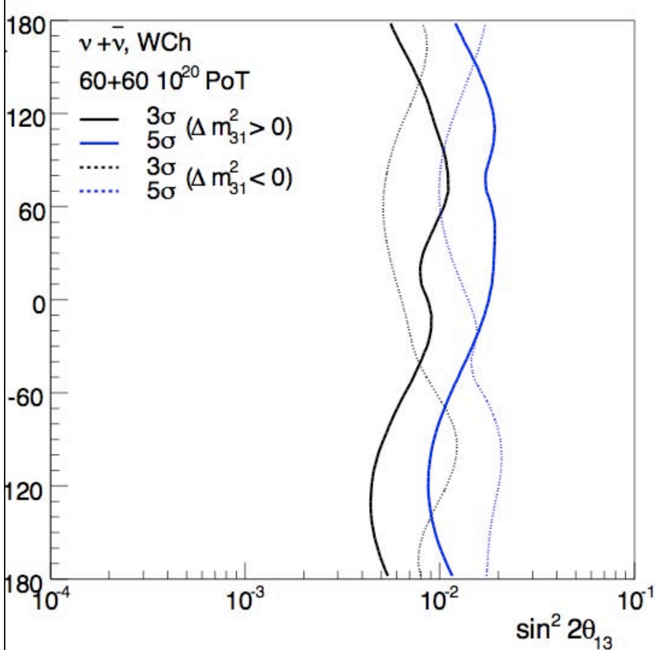
60x10^{20} POT each

Physics with 300-kt Water Cherenkov Detector & 2 MW Beams @ 120 GeV 3 years each $\nu + \bar{\nu}$

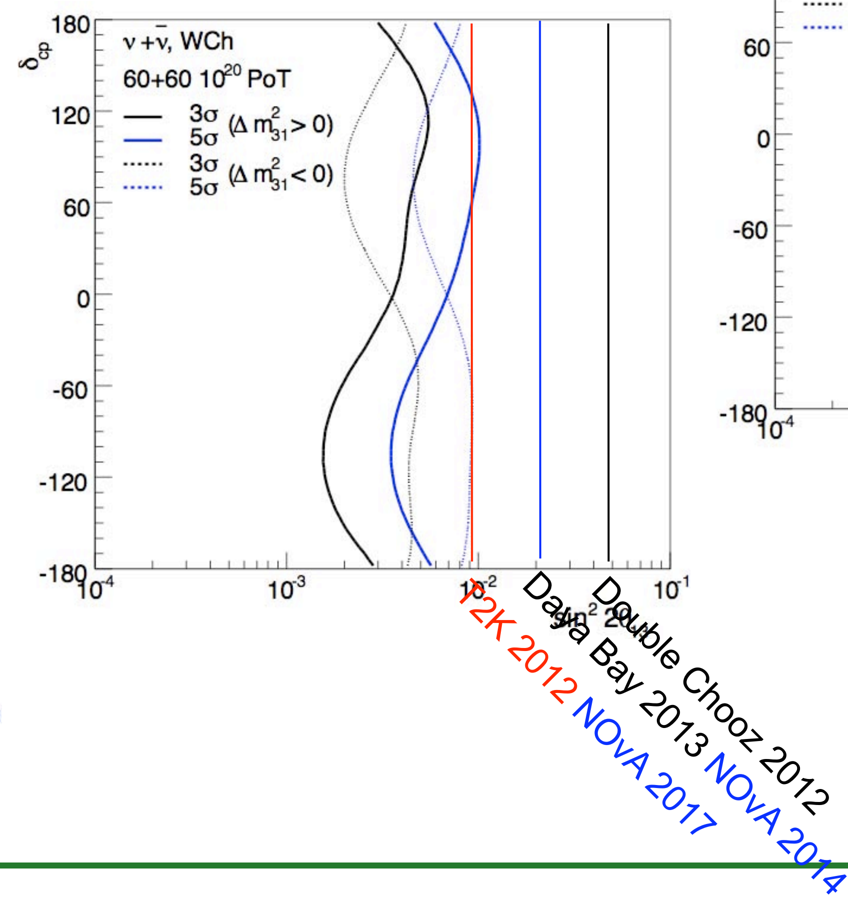
1kt LAr ≈ 3kt H_2O

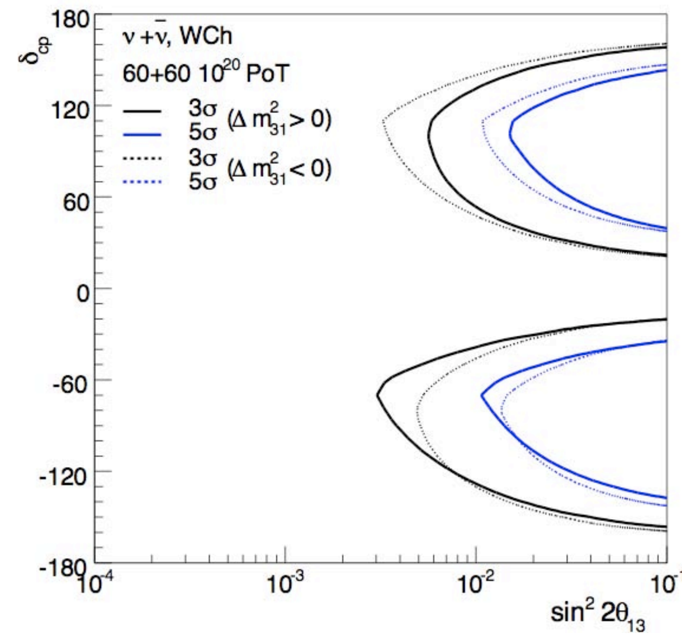
Exclusion of CP Violation

Mass Hierarchy



θ_{13}





60x10^{20} POT each

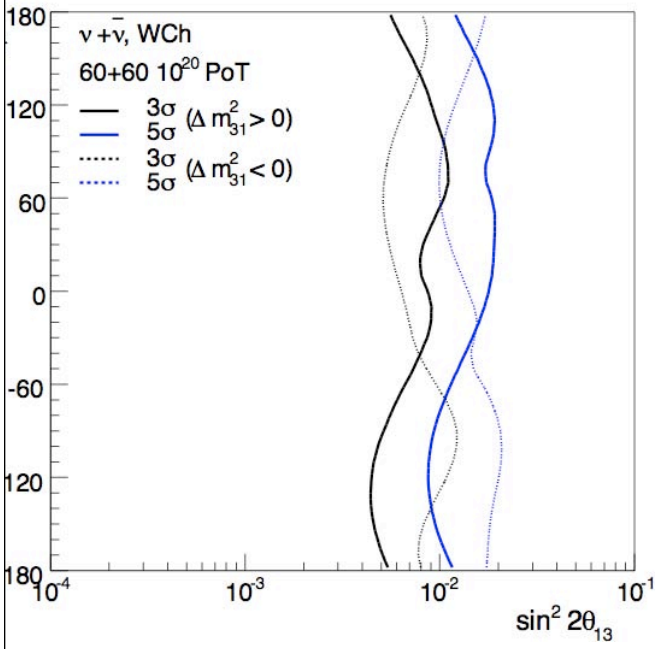
Physics with 300-kt Water Cherenkov Detector & 2 MW Beams @ 120 GeV 3 years each $\nu + \bar{\nu}$

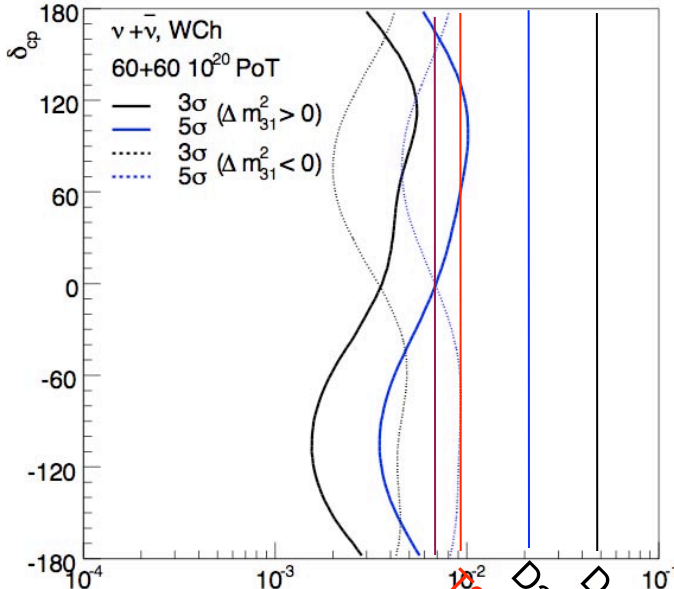
1kt LAr ≈ 3kt H_2O

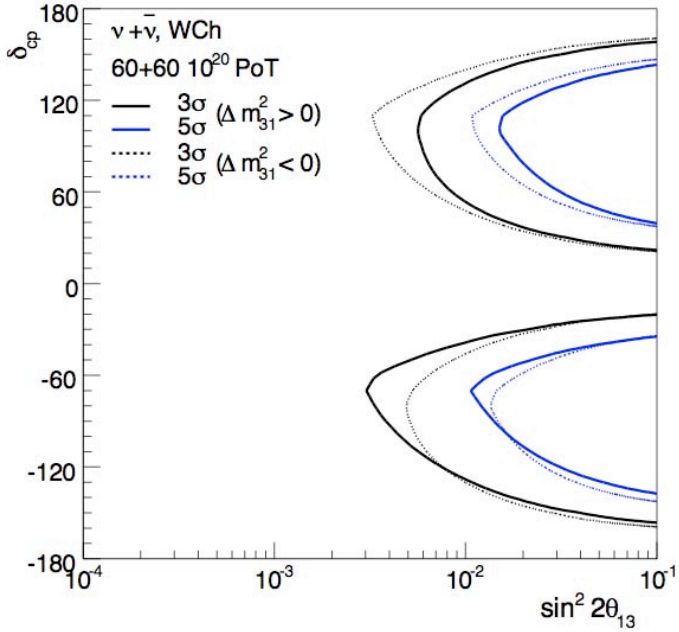
Exclusion of CP Violation

θ_{13}

Mass Hierarchy





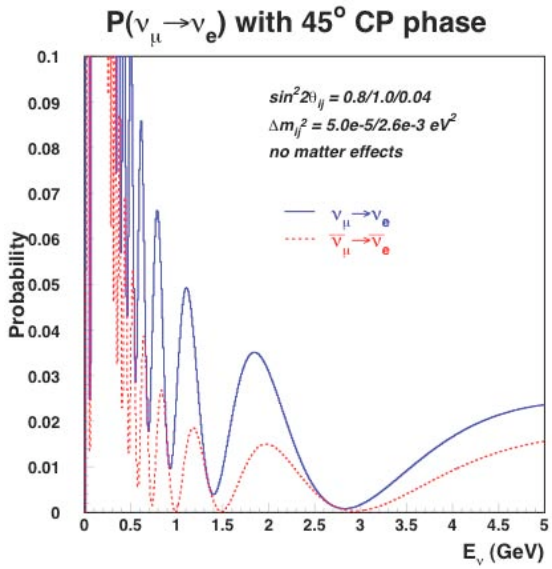


T2K 2012
NOvA 2017
100kt LAr DUSEL
Daya Bay 2013
NOvA 2014
Double Chooz 2012

60x10^{20} POT each

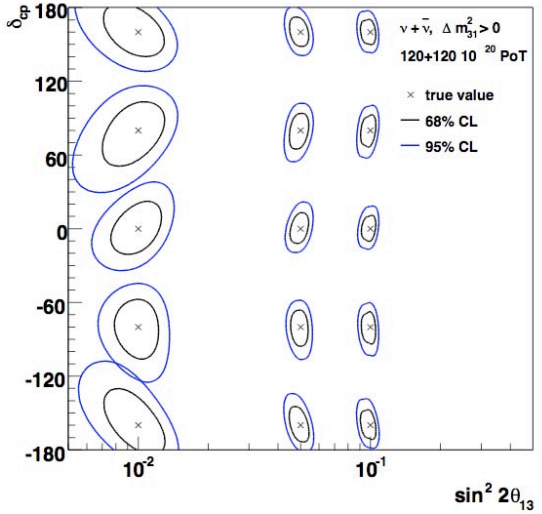
Long Baseline Neutrino, Nucleon Decay, and Ancillary Programs

- Long Baseline Neutrinos and Nucleon Decay
- Discovery
  - Neutrino mass hierarchy
  - θ_{13}
  - CP violation
  - Nucleon Decay
- Diverse Program
  - Full MNSP Matrix
  - Atmospheric and Solar Neutrinos
  - Supernovae Neutrinos
  - Test Exotic Models
- World-class Programs

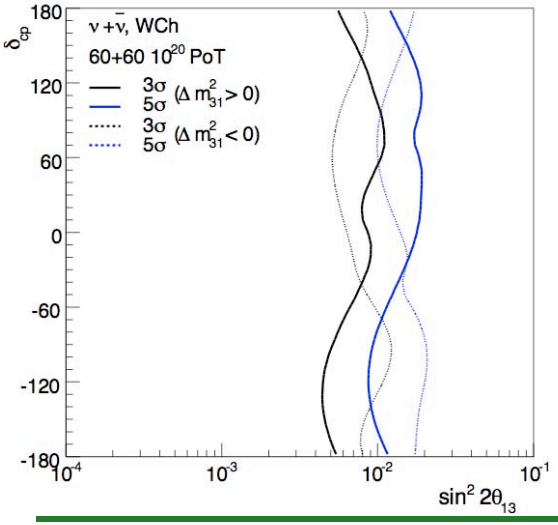


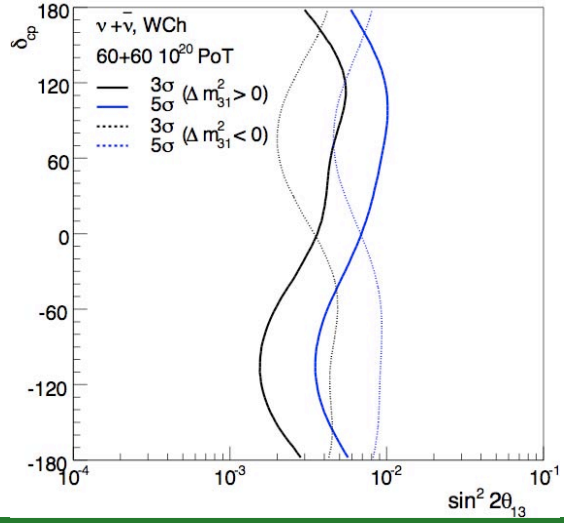
Reach in θ_{13}

CP Violation



Reach in Mass Hierarchy





Geotechnical Advisory Committee

Committee Charter:

Reporting to Ziggy Hladysz, Manager for Geotechnical

- Advise and recommend on geotechnical matters, focusing on underground excavations
- Monitor the safety and stability of all DUSEL excavations during construction and over the service life of such
- Provide guidance and advisory role in the development of an Integrated Geotechnical Plan
- Review of current geotechnical contracts

Meeting Members:

- William Pariseau, CHAIR, Univ. of Utah, Chris Laughton, FNAL, Doug Tesarik, NIOSH, Frank Hansen, Sandia NL, Herb Wang, Univ. of Wisconsin, Joe Wang, LBNL (retired)

Large Cavity Advisory Board

- Committee reports to the PI
- Review the design strategies, plans for preliminary and final designs, and the baseline design for excavation; as well as reviewing the development of cost parametrics for comparing designs and development plans in response to experimental requirements including depth, geology, volume, cavity cross section and progress through the elements listed above in adequate detail to integrate the large-scale excavations into the baseline report.
- Evert Hoek - Chair, John MacDonald, Ed Cording, Derek Martin