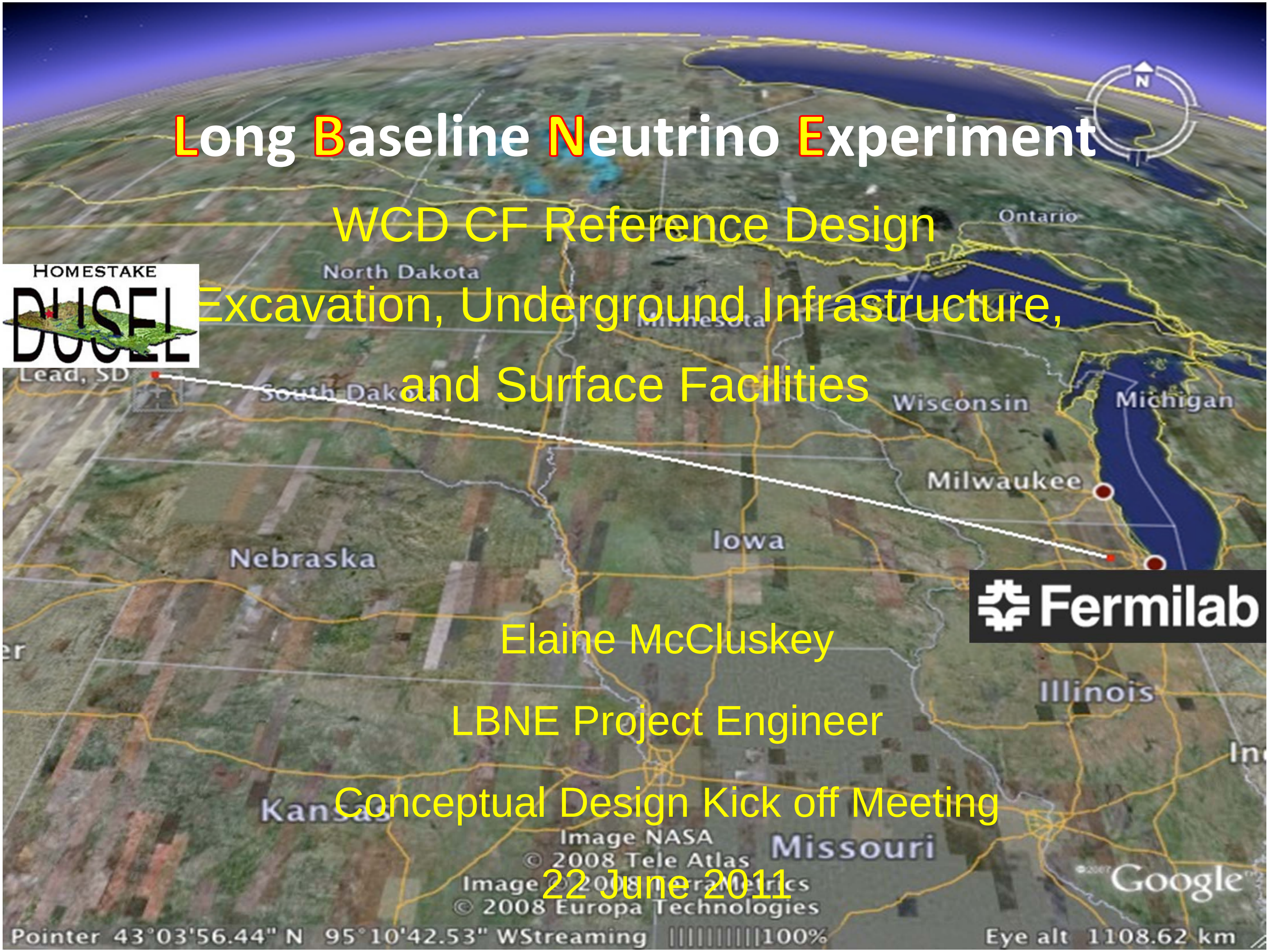

Long Baseline Neutrino Experiment

WCD CF Reference Design

Excavation, Underground Infrastructure, and Surface Facilities

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Conceptual Design Kick off Meeting

22 June 2011

Outline

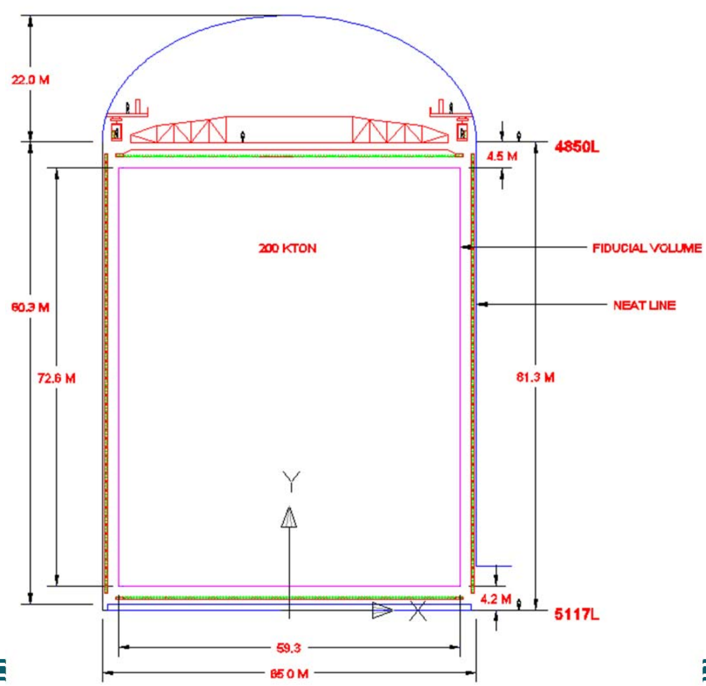
- LBNE motivation for 200kt WCD
- Evolution on caverns>100kt and LCAB input to 200kt WCD
- Comparison of DUSEL PDR WCD & LBNE 200kt WCD designs
- Reference Design for 200kt WCD CF
  - Access and egress
  - Utility spaces
  - Cavern
  - Shafts and waste rock handling
  - Excavation
  - Required spaces
  - Excavation approach
  - UGI
  - Surface Facilities
  - Interfaces with WCD

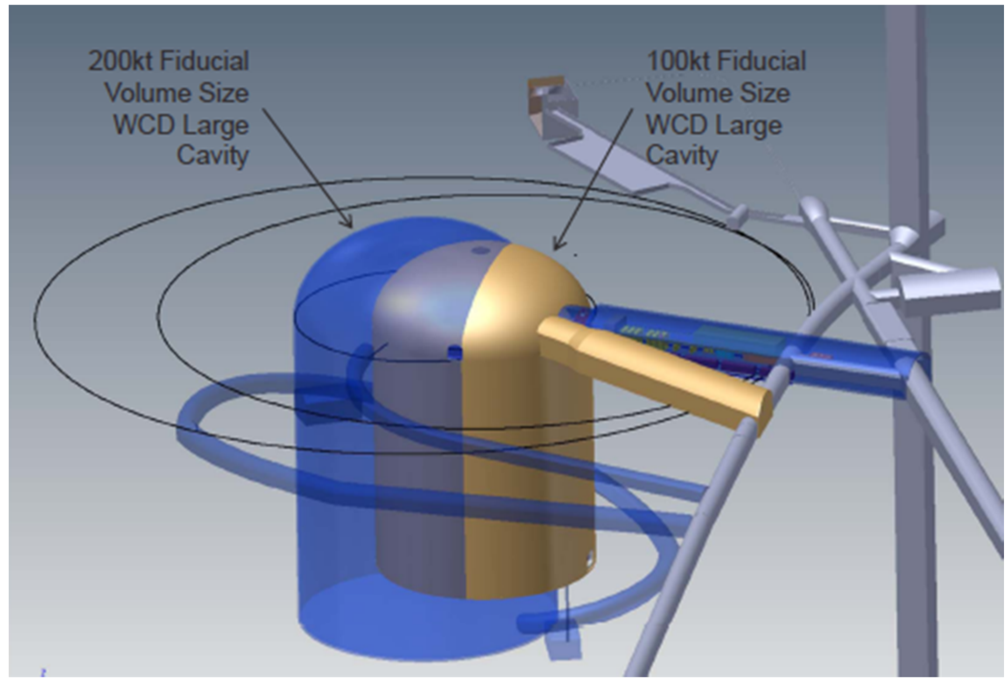
Motivations for single 200kt WCD

- LBNE wants the most detector mass it can afford to build.
- Water Cherenkov detectors (WCD) require the smallest surface to volume ratio to be most cost effective.
- Golder alternative shape/size study determined a single vertical, right cylinder is most cost-effective way to construct the most volume compared to mailbox shape.
- LBNE determined that WCD 200kt mass is close to the minimum that would be able to do the physics of LBNE.
- 2-100kt detectors have proven to be too costly

Size increase from 100kt to 200kt cavern

- 150kt cavern increases cavern width from 55m to 66m, but retains 100kt height of 64m (plus dome)
- 200kt cavern retains 66m width but increases height to 82m (plus dome)





Information on caverns > 150kt

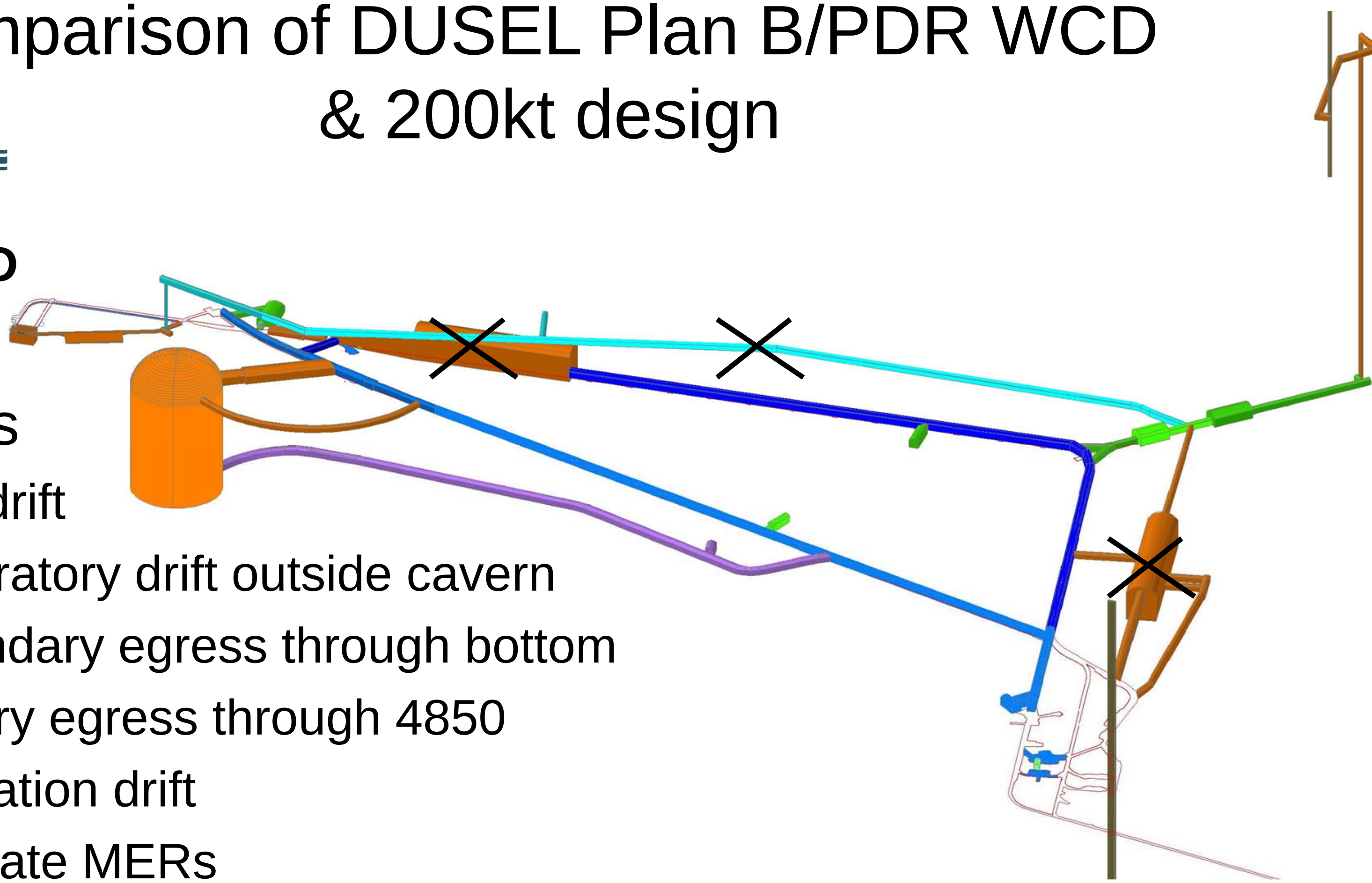
- Golder alternative size/shape study (Sept 2010)
  - Span to 66m is ok
  - Mailbox shape more expensive, hence not pursued by LBNE
  - Vertical, right cylinders 150kt and 300kt examined
- Hoek memo – Review of 90% Design of Large Cavity 1 for DUSEL Project (Sept 2010)
  - Comparison of horizontal elliptical cavern to letter box cavern
  - Not pursued by LBNE due to complications in mounting PMTs
- Hoek memo – Review of Proposal for 65 m Span Cavern (Oct 2010)
  - 150kt cavern with 65m span feasible
  - Several design and construction issues to be addressed
  - 200kt not reviewed

LCAB May 2011 Input to Excavation Design

- The increased size of the 200 Kt cavern, compared to the 100 Kt cavern considered to date, means that access for construction of the dome can be provided by a simple ramp from the 4850 level. Consequently, the halo drift proposed for the 100 Kt cavern is no longer required.
- Based on analyses of rock strength, in situ stresses, and structural features mapped and laser scanned in existing excavations on the 4850 level, it has been concluded that a pattern of 15 m long 50 ton capacity cables on a 2.5 x 2.5 m grid would provide adequate support for any potential gravity driven wedge failures in the rock mass surrounding the 200 Kt WCD cavern.
- The LCAB recommends that the double corrosion protection system that has been proposed for the cavern designs considered to date should be eliminated and that standard cement grout installation procedures should be used.
- Containment of the water within the WCD can be achieved by the installation of a plastic membrane inside the cavern. This membrane would be suspended from the cavern walls with joints between adjacent panels being welded and tested in situ. Some form of continuous attachment of the liner to the cavern walls would be required in order to support the weight of the liner. Placing the membrane directly against the shotcrete lining of the cavern would provide the most effective and economical containment system and no inner concrete lining is required to support the liner or to stabilize the rock mass.

Comparison of DUSEL Plan B/PDR WCD & 200kt design

200kt WCD



- Differences
  - No halo drift
  - No exploratory drift outside cavern
  - No secondary egress through bottom
  - Secondary egress through 4850
  - No ventilation drift
  - No separate MERs

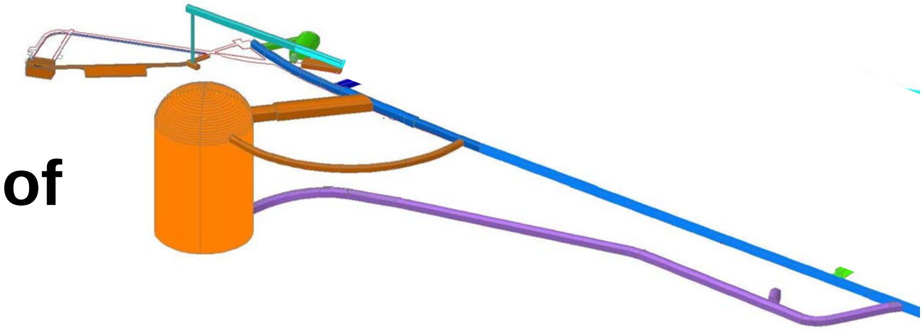
DUSEL Plan B

Other changes associated with 200kt WCD versus DUSEL 100kt PDR

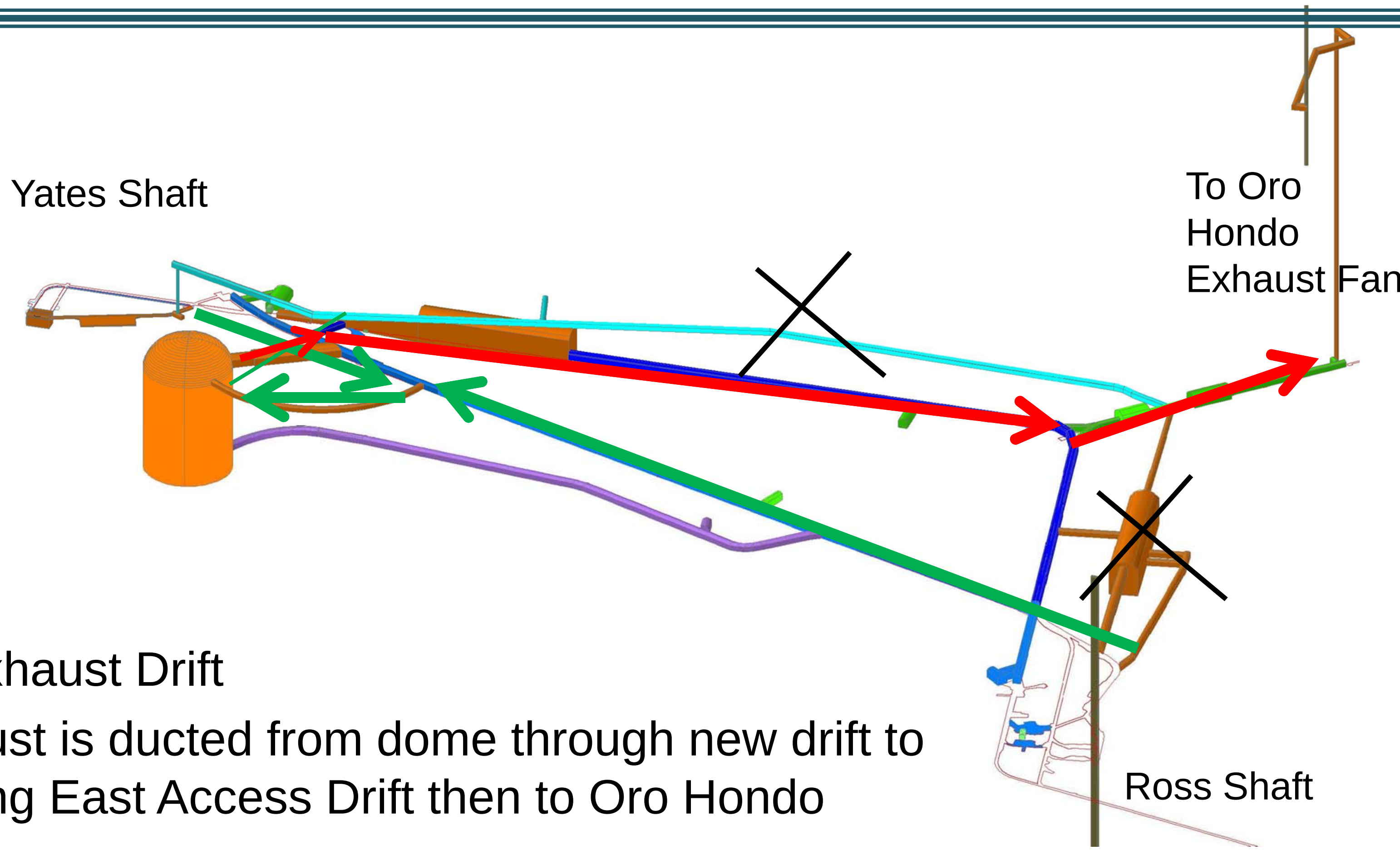
- Conceptual design for WCD with early science only, no other experiments
- Ventilation drift eliminated, use east drift instead
- Access/egress reviewed and simplified
- Concrete vessel deleted
- Water recirc system and electrical room fit into one utility drift
- Single sump not multiple, with access/maintenance relocated to 4850 with well pump
- Other miscellaneous rooms deleted – e.g., powder magazine

Reference Design - Access and Egress

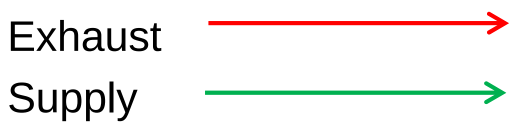
- **Access**
  - **For experiment installation and operations - through utility drift 4850-636**
  - **May need occasional access to bottom of cavern to check bulkhead**
- **Egress**
  - **For experiment installation and operations – through utility drift 4850-636**
  - **Secondary egress through 4850-6xx to west drift**
    - **Spacing at west drift TBD**
- **5117-6xx drift becomes contractor choice in terms of alignment and slope**



Reference Design – Ventilation



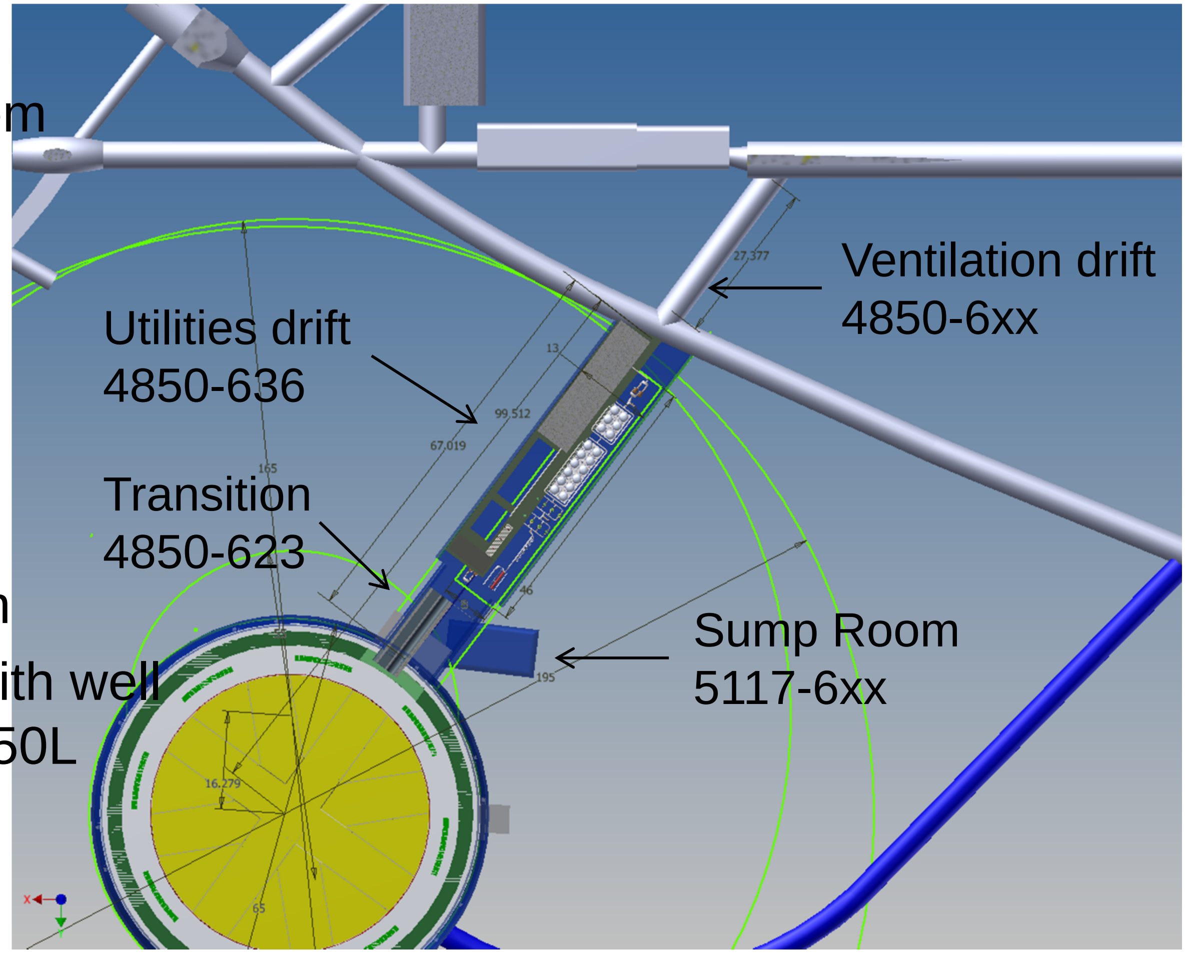
- No Exhaust Drift
- Exhaust is ducted from dome through new drift to existing East Access Drift then to Oro Hondo



Sized for 8 MW fire ~ 100,000 cfm

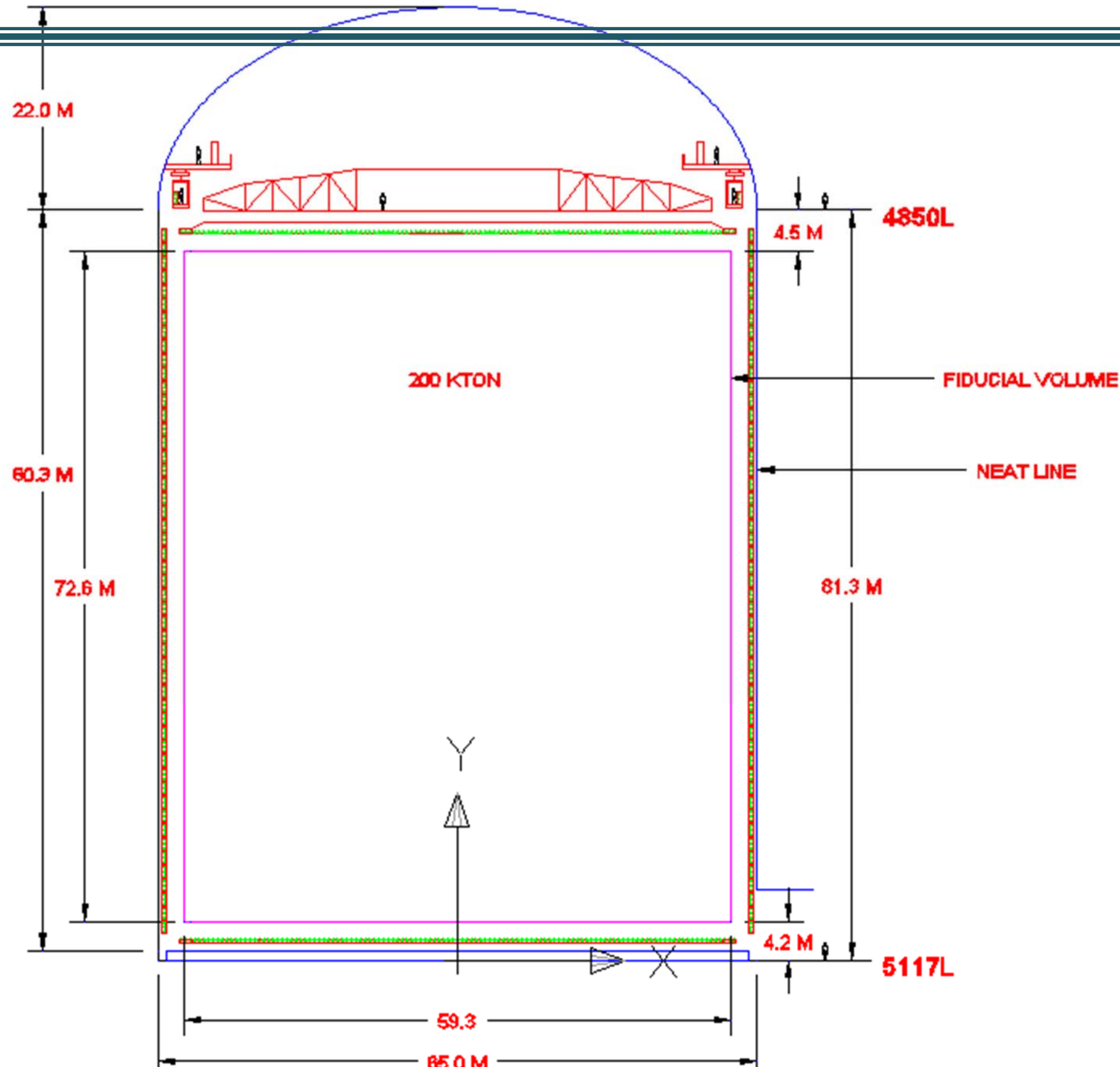
Reference Design – Utility Spaces

- Utilities drift 4850-636
  - Water recirculation system
  - Electrical room
  - Ventilation duct
- Transition 4850-623
  - Sump pump access
- Sump room 5117-6xx
  - Used during construction
  - Reused for operations with well pump accessed from 4850L
- In dome
  - HVAC equipment



Reference Design – 200kt fiducial volume cavern

Dome height to be determined by excavation design in conjunction with flatter recommendation from LCAB



Reference Design – Shafts & WRH

- Shaft strategy is in transition at DUSEL, where Shaft Refurbishment Analysis has been led by Syd
- WCD CF reference design is
  - Yates shaft: primary access, experiment installation
    - Rehab could be timber replacement or hybrid timber/steel
    - Prefer to have WCD utilities use this shaft, especially water fill piping
      → location of water fill system is at Yates, closer to WCD
  - Ross shaft: secondary egress, WRH shaft
- Waste rock disposal on surface between shafts
- Shafts rehab and WRH are not part of conceptual design scope
- However, excavation to facilitate use of shafts (opening of brow, etc.) should be part of excavation scope

Reference Design – Required Spaces

WCD UNDERGROUND SPACES REQUIRED FOR EXPERIMENT

		FINISHED INSIDE DIMENSIONS			
EXCAVATION #	**DESCRIPTION**	**WIDTH (m)**	**NOMINAL HT (m)**	**LENGTH (m)**	**COMMENTS**
200kt DETECTOR					
4850-614	WCD cavern	65.0	102.3	-	
4850-623	Large Cavity 1 Access and Utility Drift	10.0	8.0	15.0	
4850-636	Large Cavity 1 Access and Utility Drift - Enlarged section	13.0	8.8	~67m	alignment between cavern and west drift to be optimized for space required for water system - see image at right
4850-6xx	Ventilation drift	5.0	5.0	~27.5m	to be aligned with 4850-636 and connect east and west drifts-see image at right
4850-6xx	Egress passageway	as required			routed from cavern to west drift per life safety requirements
4850-6xx	Egress passageway Area of Refuge	as required			
4850-6xx	Yates Area of Refuge	as required			
4850-6xx	Ross Area of Refuge	as required			
5117-6xx	Sump	as required			sized for native and leak waters, and if necessary, used for mucking
5117-601	5060 Ramp	as required			size and alignment per excavation contractor requirements
5117-6xx	Sump discharge borehole	0.5	TBD	-	from 5117-6xx Sump to 4850-623 pump area

- Other spaces could be necessary for construction, life safety, or operations – but are not specified here. Welcome discussion of this today or in project meetings.

Reference Design – Excavation approach for WCD

- Deletion of exploratory drift external to cavern
  - create internally, becomes means to begin excavation of dome
- Dome is flatter, more room for excavation and installation of ground support without halo
- Central borehole in cavern to allow for muck removal expected to be part of excavation strategy
- Bottom mucking drift becomes contractor’s option in terms of size and alignment
- Controlled blasting very important to achieve smoothness necessary for liner application without concrete vessel (Farshid will have more on the liner)
- Bottom of cavern may require ground support to prevent heave
- For this conceptual design, liner design by Golder

Reference Design – UGI

- Power
  - Main power from refurbished East substation at Yates complex
  - Distribution down Yates shaft to electrical room in 4850-636
  - No standby power for experimental equipment
  - No redundant power feeders are required
- Lighting
  - Per experimental needs and for general illumination
- Fire protection
  - Suppression via sprinklers and water mist systems in drifts & cavern
  - Alarms & detection throughout
- Life Safety
  - Areas of refuge at Yates & Ross shafts, along 5117L ramp, along 4850L secondary egress drift – occupancy of 40 (installation) & 10 (ops)
  - Emergency power for hoists and per code for lighting, etc.
  - We expect life safety analysis at conceptual design level

Reference Design – UGI

- Cyberinfrastructure
  - One fiber optic cable to surface from cavern (same as PDR design) for experiment
- Ventilation
  - Doors and sealing as necessary to create proper flow
  - Upgrades to Oro Hondo fan
- Dewatering
  - Not part of conceptual design scope

Reference Design - Surface facilities

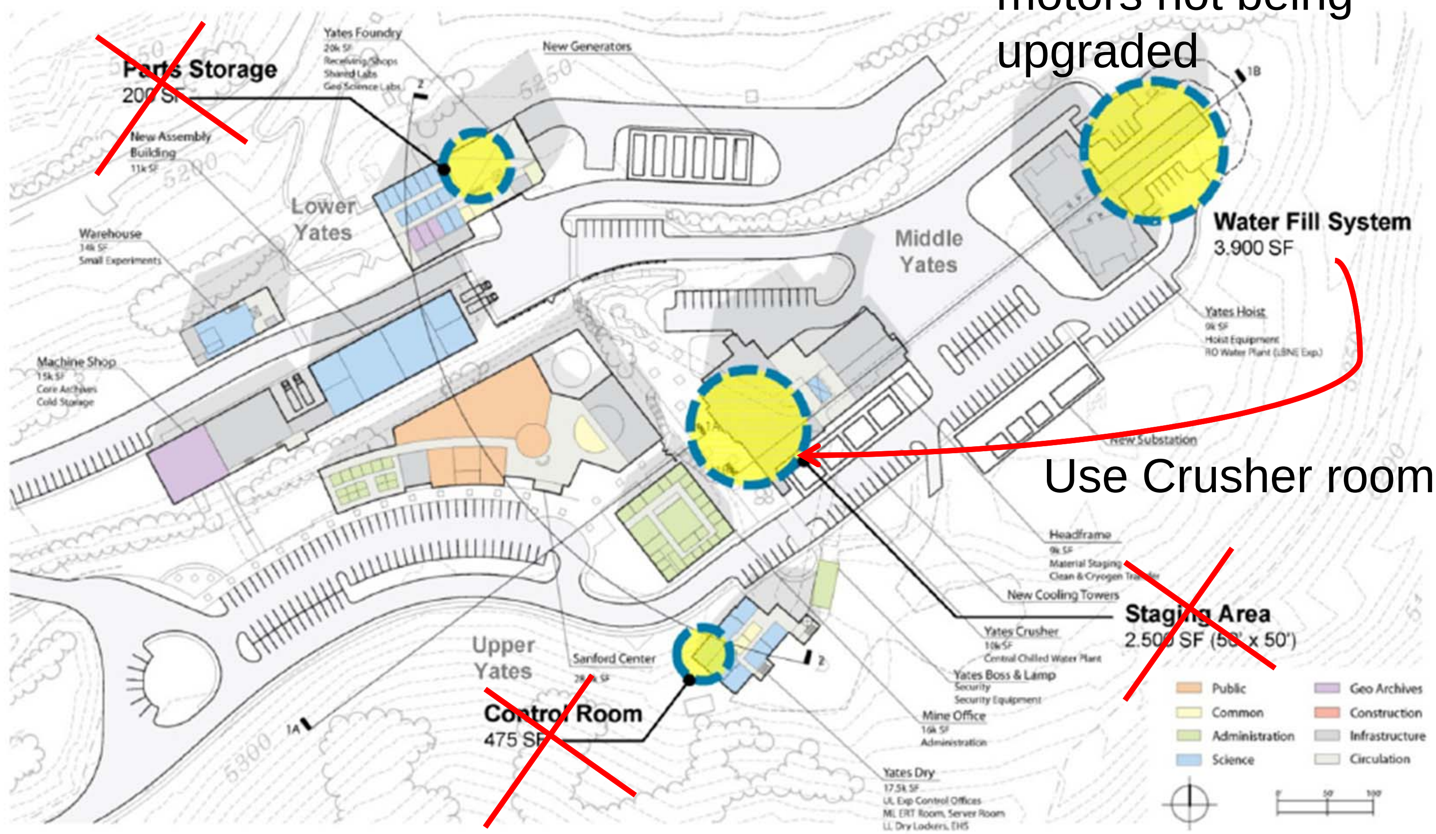
- Space for water purification system – see next slide
- Surface infrastructure for water, power, cyberinfrastructure
- Utilities distributed through Yates shaft – dependent on shaft upgrade schedule?
- Shaft heating upgrades
- Campus-wide communications systems
- Assume Ross surface facilities remain for Ross shaft access and facilities operations support
- No control room on site
- Ross and Yates Hoist and Headframe structural repairs as previously recommended

Reference Design - Surface buildings

- Change since HDR Surface Study 2010: 3 of 4 required experimental spaces eliminated

MG room no longer available since motors not being upgraded

SURFACE FACILITIES PLAN



Water fill system surface location dependent on being able to run water pipes down shaft in that location – prefer Yates site due to proximity to WCD at 4850

Use Crusher room?

Reference Design – Interfaces with Detector

- Water containment – liner requirements and quality control
- PMT support/stabilization – possible embedments into wall through liner, floor support requirements
- Deck support – similar to PDR
- Layout of utility drift with both CF and WCD equipment, routing of utilities including exhaust duct, possible mezzanine
- Integration of drainage layer discharges to single sump and understanding of requirements for sampling, etc (Gd option impacts)
- Beneficial occupancy staging – can one room be completed prior to others to enable beginning of experiment staging, etc.

Summary

- 200kt WCD conceptual design will be similar to PDR design, and uses PDR design as starting point.
- Changes to space requirements resulted from LBNE and early science being only experiments, plus VE work to streamline needs versus wants.
- Some prior PDR scope is not included in this design effort – shafts, WRH, dewatering
- LBNE conceptual design does not need to be at PDR level of completion.