Outer detector subsystem

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Plan for LNGS meeting

- Breakout session 1:
  - Present proposed WBS and L3 assignments
  - Discuss strategy for the next 6 months
- Breakout session 2:
  - Overview of current OD simulation status — Sally
  - Further discussion

Today's session

- Discuss context for 2025 effort (charge)
- Discuss straw man WBS for OD
- Identify major decision points (containment, target material, coverage etc)
- Suggested approach
  - WBS dictionary
  - Identify interfaces
  - Preliminary costing
- Suggested assignments
- Timeline

Charge

- To revisit the items defined at Level 3 to assess if this is the right organization, whether it fully captures the scope, and whether there is a more optimal or natural way to capture the scope (that is, don't feel bound by the existing L3 list).
- We ask that you develop the preliminary design concepts, taking into consideration what approaches are "settled" versus what options should still be considered. What work (R&D, design studies, engineering, simulations, prototyping, etc) will be needed to select among them?
- What are the interfaces to work out between other L2 areas and how do their designs and consideration of options impact your area? (We envision significant cross-L2 discussions.)
- As you define the design space, what is the material and equipment cost (aka, M&S, invest, hardware) and what is the basis for your estimate, lab and facility infrastructure needs, engineering/technical staff needs?
- Likewise, review the draft WBS dictionary (this is a list of definitions and more detailed explanations we started) and better define the subsystem elements, what is included / excluded. Articulate which elements are site specific and to which site.

V0 proposed WBS

L2	L3		Description / migrate to WBS dictionary
1.07	**Outer Detector System**		
	1.07.01	System Engineering & Management	
	1.07.02	Water tank / outifitting and systems	*Water tank, related infrastructure, and purification system. At Boulby, excludes water tank shell - facility provided. Includes fixtures for muon veto photosensors and reflective coating.*
	1.07.03	Optical modeling and simulations	*Integrated optical design including consideration of backgrounds from media and readout system*
	1.07.04	Modelling and simulation of fluid flow	*Engineering design of internal fluid flows for outer detector systems*
	1.07.05	Neutron detector medium and purification systems	*Medium and purification systems. Technology to be determined. exclude initial prep of Gd and online purification of Gd; and excludes optical system.*
	1.07.06	Neutron detector Vessel	*Vessel to hold neutron detection medium if needed. Might be an optical separation, not a vessel; informed by PMT / light collection system*
	1.07.07	Gadolinium system	*Initial prep of Gd and online purification of Gd*
	1.07.08	Neutron photosensor system	*Photosensor system for neutron detection, might be different depending on choice of media; includes cabling, and includes feedthroughs within this L2.*
	1.07.09	Reflectors & mechanical structures	*Structure to hold photosensor, and reflectors for neutron detector system*
	1.07.10	OD Optical calibration	
	1.07.11	Muon photosensor system	*Photosensor system for muon detection; includes cabling, and includes feedthroughs within this L2.*
	1.07.12	Radioscreener	*Dedicated screening system and effort for neutron detector medium*

UK WBS

WP2	OUTER DETECTOR		
2	**WP management**	Burdin	Shaw
2.0.0	Managing to cost, schedule & quality		
2.0.1	Work-package reporting		
2.0.2	Technical reviews		
2.0.3	Interface definition and control		
2.0.4	Procurement oversight		
2.0.5	International partner engagement		
2.1	**Outer Detector (Pre-Construction)**	Burdin	Shaw
2.1.0	WP management		
2.1.1	OD mechanical design		
2.1.2	OD fluid process design		
2.1.3	OD optical design		
2.1.4	OD FE electronics design		
2.1.5	OD calibration design		
2.1.6	Muon detector design		
2.1.7	OD photosensor module design		
2.1.8	OD material compatibility		
2.1.9	Radioscreener and prototyping		
2.1.10	Hazard analyses		
2.2	**Water system**	Coleman (Liverpool)	
2.2.1	Supply		
2.2.2	Purification		
2.2.3	Assay		
2.2.4	Radioassay		
2.2.5	Discharge		
2.2.6	Tank interfaces		
2.2.7	Tank insulation		
2.2.8	Cooling plant		
2.2.9	Pipework		

2.3	**Liquid scintillator system**	Burdin (Liverpool)
2.3.1	Procurement	
2.3.2	Transportation	
2.3.3	Safety and inventory	
2.3.4	Storage	
2.3.5	Filling system	
2.3.6	Purification	
2.3.7	Assay	
2.3.8	Radioassay	
2.3.9	Nitrogen purge & blanket	
2.4	**Gadolinium system**	Burdin (Liverpool)
2.4.1	Procurement	
2.4.2	Safety and inventory	
2.4.3	Storage	
2.4.4	Filling system	
2.4.5	Purification	
2.4.6	Assay	
2.4.7	Radioassay	
2.5	**Photosensors**	Shaw (Edinburgh)
2.5.1	Procurement	
2.5.2	Testing (QA)	
2.5.3	VD bases	
2.5.4	Internal cabling	
2.5.5	HV supply and external cabling	
2.5.6	HV software and controls	
2.5.7	Tank flanges	
2.6	**Reflectors & mechanical structures**	Burdin (Liverpool)
2.6.1	Procurements	
2.6.2	Reflectors	
2.6.3	Photosensor supports	
2.6.4	Installation	

2.7	**Muon detector**	De Santo (Sussex)
2.7.1	Photosensors	
2.7.2	Supports	
2.7.3	Internal cabling	
2.8	**Electronics**	Cussans (Bristol)
2.8.1	Front-end amplifiers	
2.8.2	Break-out boxes	
2.8.3	External signal cabling	
2.9	**Calibration**	Burdin (Liverpool)
2.9.1	Optical systems	
2.9.2	Radioactive sources	
2.9.3	Control hardware	
2.9.4	Control software	
2.1	**Radioscreener**	Shaw (Edinburgh)
2.10.1	Production of the radioscreener	
2.10.2	Transportation to Boulby	
2.10.3	Operation in Boulby	
2.11	**Integration engineering**	Bridges (Liverpool)
2.11.1	Integration plan	
2.11.2	Technical coordination 2.2, 2.3, 2.4 and Boulby	
2.11.3	Material preparation	
2.11.4	Packaging, shipping and storage	
2.11.3	Assembly and installation	
2.11.4	Safety coordination	

Our proposed WBS

L2	L3		Description / migrate to WBS dictionary	Possible L4s			
1.07	**Outer Detector System**						
	1.07.01	System Engineering & Management					
	1.07.02	Optical modeling and simulations	*Integrated optical design including consideration of backgrounds from media and readout system*	muon veto modeling	neutron detector modeling	background rejection studies	other physics studies
	1.07.03	Water tank / outifitting and systems	*Water tank, related infrastructure, and purification system. At Boulby, excludes water tank shell - facility provided. Includes fixtures for muon veto photosensors and reflective coating.*	Water tank	Water purification	Photosensor support structure	Photosensors
	1.07.04	Neutron detector containment and support	*If needed, containment vessel for neutron detector + support systems for vessel and PMTs, support for optical separation between volumes*	Optical separation for neutron detector	Photosensor support structure	Potential inner containment for (Wb)LS	Feedthroughs
	1.07.05	Neutron detector medium and related systems	*Medium - Gd-water, Gd-WbLS, Gd-LS. Production, circulation etc*	(Wb)LS purification for inner vessel	(Wb)LS recirculation for inner vessel [[fluid flow sims at L5]]	(Wb)LS provision for inner vessel	water, as/if needed for outer vessel
	1.07.06	Gadolinium system	*Initial prep of Gd and online purification of Gd*	Gd purchase	Initial Gd purification	Gd recirculation needs	
	1.07.07	Neutron photosensor system	*Photosensor system for neutron detection, might be different depending on choice of media; includes cabling, and includes feedthroughs within this L2.*	PMT choice	PMT purchase	PMT testing	PMT cabling
	1.07.08	Reflectors	*Reflector needs and design*	Reflector need (choice)	Reflector design	Purchase	
	1.07.09	Readout	*Frontend electronics and readout for muon veto and neut*	HV for OD	Muon veto readout	Neutron detector readout	Triggering
	1.07.10	OD calibration	*Calibration systems for OD - optical and source*	Deployment system	In-situ light injection system	Suite of deployable sources	
	1.07.11	Radioscreener	*Dedicated screening system and effort for neutron detector medium*	Design & production	Low background deployment	Background measurements	
	1.07.12	Slow controls					

Decision points

Decisions:							Notes
Neutron detector medium	Gd-H2O		(Gd)-WbLS		(Gd)-LS		
Do we need inner containment	Yes	No	Yes	No	Yes	No	Trigger rate limitation?
Coverage							Determine minimum for each scenario assuming no reflectors
Reflectors (yes/no and coverage)							Determine max # PMTs that can be removed if adding reflectors
Recirculation req							For each target material

- All design options should meet requirements for OD veto efficiency
- Currently using 95%, need to confirm with reqs task force
- Potential NLDBD program may add additional reqs, TBC
- Site choice may add additional reqs / constraints
    - Consider ramifications of such decisions

Approach

- 1-2 people assigned to each L3
  - *Note: temporary assignment for this exercise, just like the L2s*
  - *L3s with major decisions carried may result in parallel structures*
- Ask these L3s to work through this exercise
  - Develop WBS dictionary
  - Identify any additional decision points
  - Identify interfaces
  - Develop preliminary costing

Timeline

- L2/L3 assigned in June
- Present plan at LNGS
- Discuss
    1. WBS, assignments, decisions
    2. Plan for cost estimates
- SMEs meet monthly to discuss progress
- Interleaved with full OD meetings
- Project-level update in Sept
- All info due by Dec

Assignments

	1.07.01	System Engineering & Management
Sally + Gabriel	1.07.02	Optical modeling and simulations
Sergey	1.07.03	Water tank / outifitting and systems
Sally + Gabriel	1.07.04	Neutron detector containment and support
Minfang + Marco	1.07.05	Neutron detector medium and related systems
Uwe	1.07.06	Gadolinium system
Kai + Sally	1.07.07	Neutron photosensor system
Scott	1.07.08	Reflectors
Gabriel	1.07.09	Readout
Ryan + eng support	1.07.10	OD calibration
Scott	1.07.11	Radioscreener
Marco	1.07.12	Slow controls