DBD Working Group Summary Report

Rationale (from the DBD Working Group Charter)

"The international stakeholders in neutrinoless double beta decay research who attended the 2nd International Summit on Double Beta Decay (agencies representing Canada, France, Germany, Italy, UK, and USA), herein referred to as stakeholders, agreed that the best chance for an unambiguous, timely discovery is an international campaign with multiple isotopes and more than one large tonne-scale experiment implemented in the next decade.

The stakeholders discussed a scenario that could accomplish that goal by deploying CUPID, LEGEND-1000, and nEXO with one tonne-scale experiment in Europe and one tonne-scale experiment in North America. The stakeholders also recognize that realizing any scenario will require cooperation and coordination among themselves. A framework for coordination will be discussed and researched by the working group."

The participants in the 2nd International Summit appreciated that taking no further action and maintaining the status quo comes with risks, including:

- Low likelihood of realizing the goal of timely measurement
- Reduced probability for unambiguous identification of 0νββ
- Ineffective use of resources

DBD Working Group Approach

- DBD Working Group charge
- Organizational structures reviewed
  - Collaborative
  - Advocacy
  - Coordinated (Network)
- Hybrid structure
- SWOT comparison
- Recommendation

DBD Working Group Charge

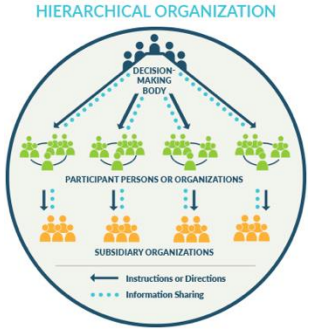
1. Explore organizational frameworks to coordinate an international campaign with multiple isotopes and more than one tonne-scale experiment implemented in the next decade and promote research and development on future efforts in double beta decay.
   a. Consider a broad range of scenarios, including successful deployments of joint venture, consortium, and other possibly relevant organizational frameworks.
   b. Delineate and name at least two possible organizational frameworks that may be plausible to coordinate the international effort on double beta decay and elaborate on:
      i. The organizational structure and reporting lines
      ii. The roles and responsibilities for key personnel in the organizational structure
      iii. The authority (decision making power) the organization would have
      iv. The resources the organization would require to be successful
   c. Perform a strengths, weaknesses, opportunities, and threats (SWOT) analysis on the elaborated organizational frameworks. The optimal organizational framework should:
      i. Align with the shared scientific goal and aim for timely* validation
      ii. Promote a culture of collaboration and resource optimization
      iii. Uphold robust communication and coordination channels
      iv. Be agile enough to adapt to unexpected challenges and/or emerging opportunities
2. Devise a plan to involve additional funding agencies in the international effort on double beta decay

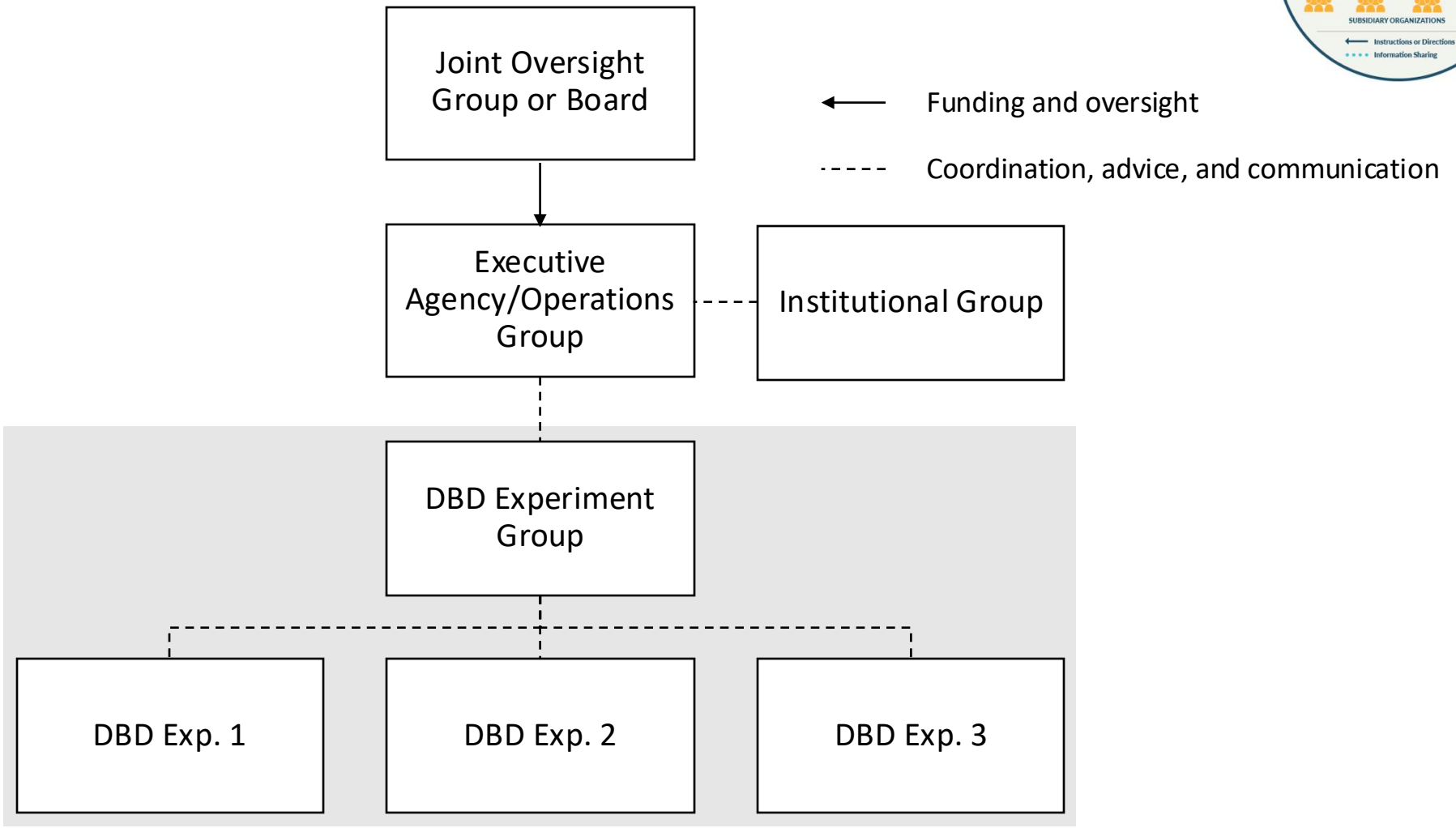
* Original language in charge is “simultaneous” validation

Organizational Structures Reviewed

- Three subcommittees were formed and reviewed the following models:
  - Collaborative
  - Advocacy
  - Coordinated/Network

Collaborative Model: Organization





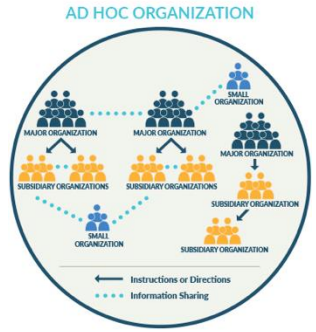
Collaborative Model: Roles and Responsibilities

- A **Joint Oversight Group** (JOG) or Board representing funders would be responsible for overseeing the overall allocation of funding across the portfolio of experiments, and for a contingency fund. It would act as a forum for funding partners to engage with one another, the experiment collaborations, and partner institutions.
- An **Institutional Group** (IG) representing implicated laboratories and partner institutions would support oversight at the lab-level. It would not report into the JOG per se; rather it could support the JOG's mandate with respect to lab-level issues and day-to-day operations.
- An **Executive Agency/Operations Group** (OG) responsible for day-to-day operations and issues would be led by a project/operations manager(s) appointed by the JOG. The manager(s) could be representative(s) from funding agencies providing most of the funding and would collaborate with experiment collaborations on funding allocations and ensure project/research goals are being met. They would oversee the experimental operation and interface with the experiment collaborations on resource needs.
- An **Experiment Group** representing the experiments would be comprised of members from each DBD experiment collaboration. Members could be Project Lead PIs from each collaboration, and/or elected spokespeople who represent and speak for their respective collaborations. This group would communicate scientific drivers and needs of each collaboration to the JOG, IG, and OG.

Collaborative Model: Authority and Resources

- Authority
  - Structure is ultimately driven by science. Scientific decisions made by collaboration and communicated by spokesperson. Scientific plans made by each experiment collaboration.
  - Timely discovery can be guided by JOG, with support from the Operations Group. Operations could also work with the Institutional Group to identify potential resource efficiencies among the experiments where overlaps may exist.
  - Laboratory/facility management provided by lab manager/director.
  - Experimental day-to-day operations provided by operations manager.
  - Institutional Group provides lab-level management and decisions.
- Resources
  - Clear lines of communication, and a means of cooperation and coordination could be established through documents including statements of work and MoUs outlining how groups are to interface within and without the group.
  - Resources from individual collaboration members are used to support their participation. Individual members would likely be self-supported. However, there might need to be a means for supporting members without sufficient resources to participate.

Advocacy Model: Organizational Structure



Agency 1 | Agency 2 | Agency 3 | ... | Agency N

Advisory Board

Scope for Agency 1

Scope for Agency 2

Scope for Agency 3

Experiment 1

Experiment 2

...

Experiment N

Advocacy Model: Roles and Responsibilities

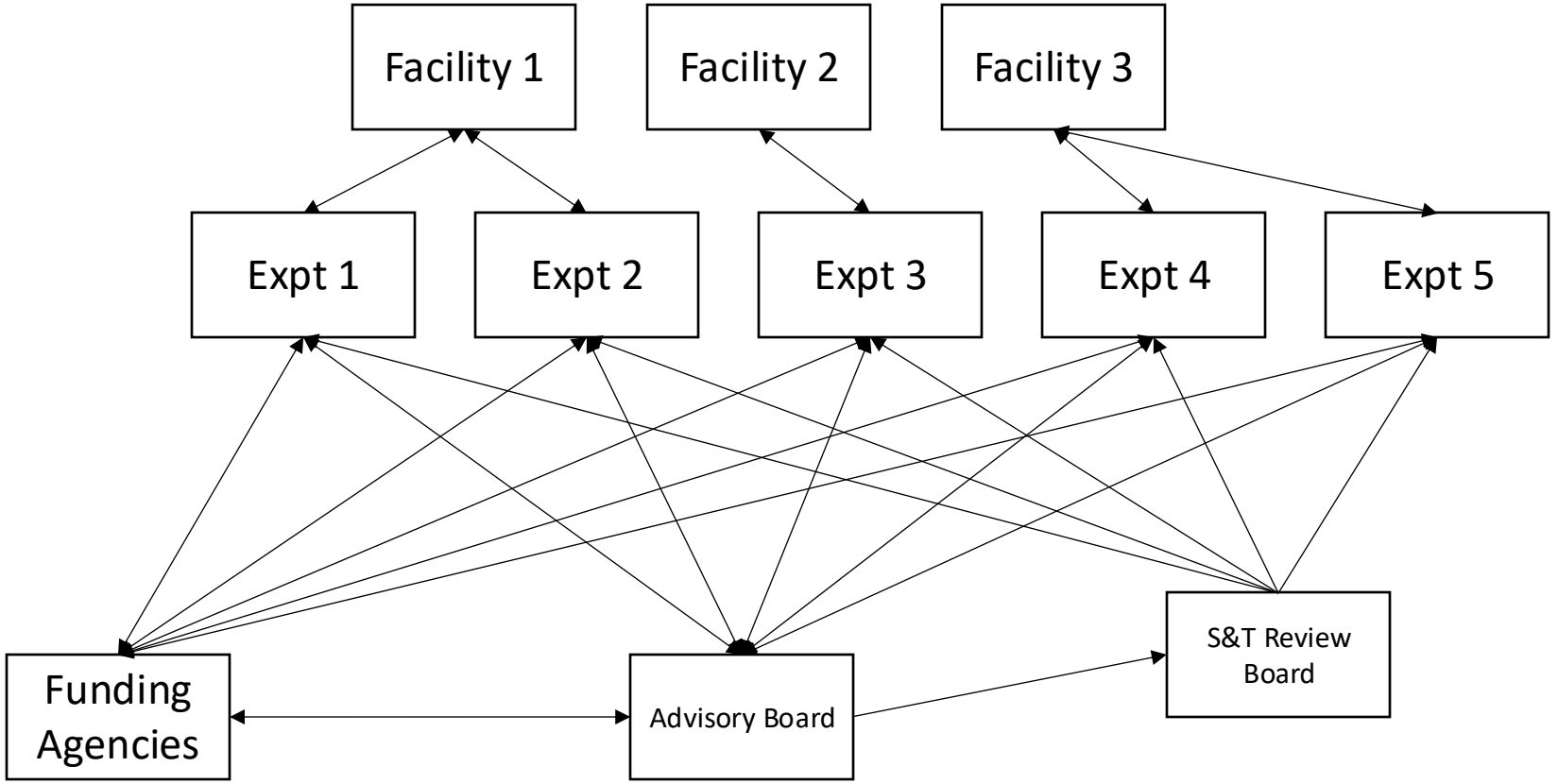
- The Advisory Board would consist of broadly admired members independent of the funding agencies and drawn from adjacent fields.
  - Examples: Art McDonald, Barry Barish, Fabiola Gianotti, Rolf-Dieter Heuer, Pier Oddone, etc.
- The Advisory Board members would be responsible for responding to direction from the Agencies and for the formation and composition of standing and/or ad-hoc subcommittes.
- The Advisory Board could delegate responsibilities to standing and/or ad-hoc subcommittees
  - A Finance subcommittee would be responsible for reporting on the budgets of each experiment and the funding outlook for each agency and stakeholder.
  - A Technical Development subcommittee would be responsible for reporting on the progress of the experiments and opportunities for collaboration or efficiencies of scale.
  - A Coordination/Advocacy/Communication subcommittee would be responsible for stakeholder engagement and other advocacy/PR related activities.
- The **Chair** of the Advisory Board would be the point of contact for the Agencies and would be responsible for convening meetings and leading the process of responding to Agency direction.
- **Subcommittee Chairs** would be responsible for convening meetings and leading the process of responding to delegated actions from the Advisory Board.

Advocacy Model: Authority and Resources

- The authority of the Advisory Board would come by proxy from the Agencies.
  - The Agencies would make appointments to the Advisory Board.
  - The Advisory Board is reliant on Agency buy-in.
  - Agencies make a “best effort” to adhere to the guidance of the group.
  - Recommendations from the Advisory Board need to be tracked to serve as a “checks and balances.”
- The Advisory Board would have authority to establish and appoint members to subcommittees.
- The Advisory Board presumably would not have a significant budget.
  - Members of the board and subcommittees would serve as volunteers.
  - Common fund for minor initiatives and for support staff to advance the work of the board.

Coordination Model: Organization

Based on example of LaserNetUS



Coordination Model: Roles, Responsibilities, Authority, and Resources

Advisory Board (AB)

- recommends strategies to ensure the achievement of the experiment goals, to attract users, keep the experiments at the frontier of scientific discovery, and establish international leadership in DBD research.
- is advisory to the funding agencies and addresses key strategic issues developed by facility directors and agency representatives.
- consists of approximately 10 members and the Chair appointed by the funding agencies, soliciting input from facility directors and experiment leaders to ensure a balanced representation of scientific and technical expertise.
- meets annually, and reports will be prepared by the Chair and submitted to the facility directors and funding agencies.

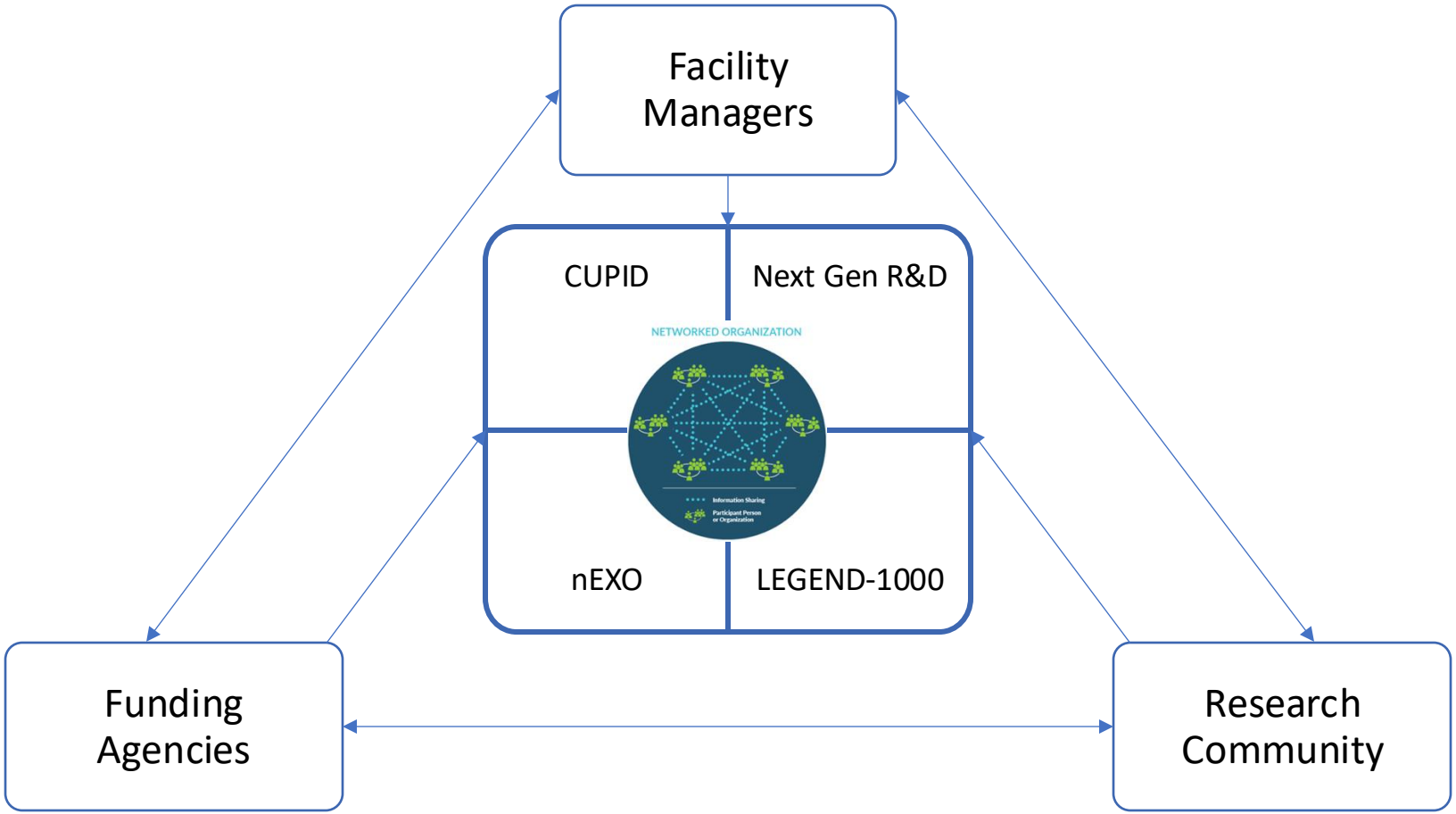
Science and Technology Review Board (STRB)

- Responds to requests from the Advisory Board to evaluate of specific scientific opportunities and technical resource needs. It provides unbiased recommendations for ensuring efficient and effective use of existing and planned resources.
- consists of 10-20 experts with a balanced representation the collaborations. The chair is responsible for selecting new members.

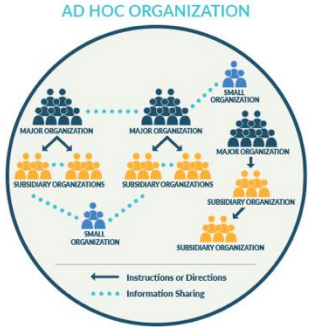
- Resource Requirements
  - Effective communications strategy
  - Community engagement and outreach
  - Established set of (complementary) technical capabilities
  - Buy-in and shared vision from funding agencies, facility director, and collaborations to realize mission

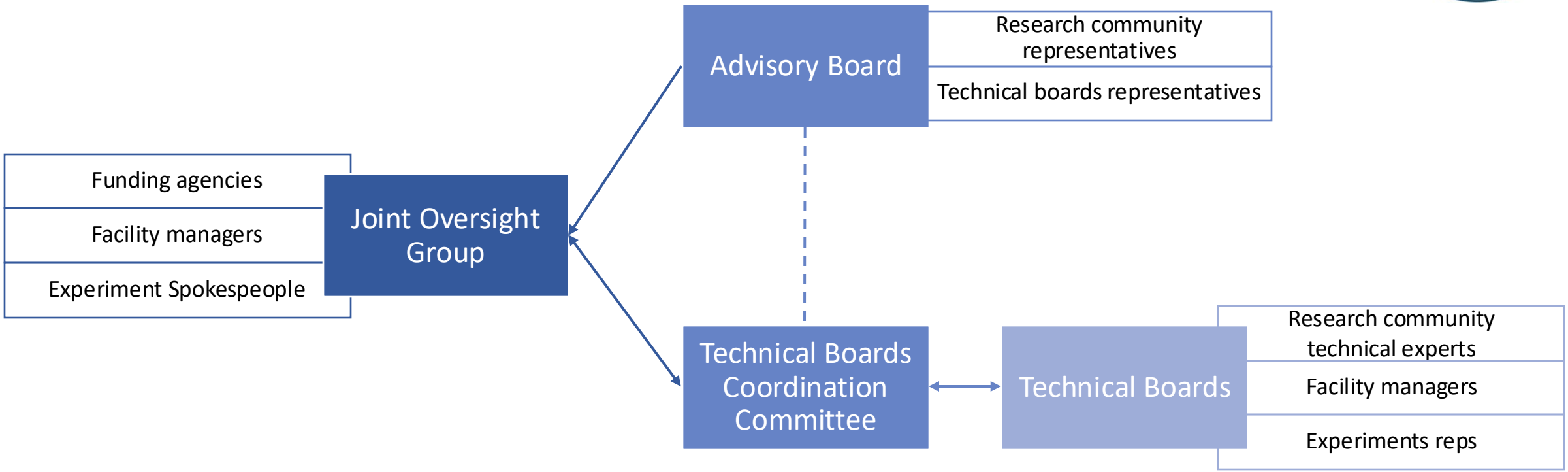
Hybrid Model Stakeholder View: Interconnections

- Stakeholder responsibilities to experiments
  - Funding agencies (define mission and provide resources)
  - Facility managers (host technology and provide resources)
  - Collaborations (address mission and deliver technology)
- Enabling an interconnected network of experiments, funding agencies, facility directors, and collaborators



Hybrid Model Governance: Managing Entities, Stakeholders, and Interfaces





Individual experiments maintain autonomy. Governance model provides “tool” for funding agency coordination.

Joint Oversight Group (JOG): Composition, Roles, Responsibilities, and Authorities

- Composition: funding agencies, facility managers, and experiment spokesperson
  - Propose threshold for funding agencies participation
    - Agencies not meeting threshold could participate as non-voting member of the JOG
  - Threshold for experiment participation?
  - Chair shall be a funding agency representative
    - elected by funding agency reps on JOG, 2-year term, non renewable
- Roles: oversight and coordination/communication
- Responsibilities: appointing advisory board, appointing technical boards coordinating committee chair, charging advisory board and technical coordination committee, devise subcommittee structure as appropriate to carry out authority, allocation of discretionary funds (possibly through a subcommittee composed of funding agency representatives only)
- Authority: funding agencies
- Cadence: meets at least twice per year

Advisory Board: Composition, Roles, Responsibilities, and Authorities

- Composition: research community representatives and technical representatives
  - No less than 10, nor more than 20
  - Appointed by the JOG, 3-year term, non renewable
  - Chair of JOG and chair of technical boards oversight committee would be ex-officio
- Roles: strategic vision, advice and oversight, advocacy and engagement
- Responsibilities: respond to charges from JOG, strategic planning
- Authority: derived from the JOG
- Cadence: at least quarterly

Technical Boards Coordination Committee : Composition, Roles, Responsibilities, and Authorities

- Composition: research community representatives, facility managers, and experiment representatives
  - One representative (chair) from each technical board
  - One representative from each facility, could be delegated by facility managers
  - One representative from each experiment, could be delegated at experiment director
  - Propose that chair is appointed by the JOG, 2-year term, renewable
  - On voting actions, members should recuse themselves from voting on actions that directly impact their technical board, facility, or experiment
- Roles: technical coordination advice and resource management
- Responsibilities: respond to charges from JOG, seek opportunities for resource optimization, including internal and external sources, creation and dissolution of technical boards, charge technical boards
- Authority: derived from the JOG
- Cadence: monthly

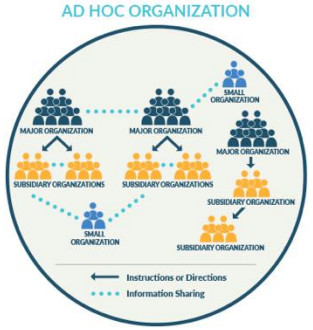
Technical Boards: Composition, Roles, Responsibilities, and Authorities

- Composition: research community representatives, facility managers, and experiment representatives
  - Size would be unrestricted, and based on interest
  - Chair elected by participants of the technical board, limited terms
  - Chair would be a member of the technical boards coordination committee
- Roles: innovation and cooperation
- Responsibilities: respond to charges from the technical boards coordination committee, organize workshops, coordinate technical effort of the research community to the benefit of the wider experimental efforts, broaden participation
- Authority: derived from the technical boards coordination committee
- Accountability: to the technical boards coordination committee
- Cadence: as warranted

Optional Resource Review Board: Composition, Roles, Responsibilities, and Authorities

- Option to add a Resource Review Board at part of the Governance Model. This would be implemented through a phased approach, where the RRB would be introduced once project operations begin.
- The amount of discretionary funds available would likely drive the need for an RRB
- Composition:
  - Funding agency representatives
  - Agencies not meeting JOG threshold could participate as non-voting member of the RRB
- Roles: Fiscal and agency coordination
  - Could provide an avenue for “in camera” funding agency discussions
- Responsibilities: incentivize advancement toward the shared goal of timely discovery and to motivate resource optimization.
- Authority: funding agencies

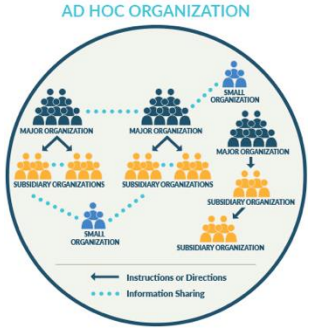
Optional Resource Review Board: Phase 1



Initially, the JOG would be the primary forum for convening funders, facility managers, and experiment spokespeople with responsibilities as previously described.

- Joint Oversight Group
  - Funding agencies
  - Facility managers
  - Experiment spokespeople
- Advisory Board
  - Research community representatives
  - Technical boards representatives
- Technical Boards Coordination Committee
- Technical Boards
  - Research community technical experts
  - Facility managers
  - Experiments reps

Optional Resource Review Board: Phase 2



Once the necessity arises, the RRB would be established and comprised of funders. The RRB would be the primary forum for coordination among funding agencies.

- Advisory Board
  - Research community representatives
  - Technical boards representatives
- Joint Oversight Group
  - Funding agencies
  - Facility managers
  - Experiment spokespeople
- Resource Review Board
  - Funding agencies
- Technical Boards Coordination Committee
- Technical Boards
  - Research community technical experts
  - Facility managers
  - Experiments reps

The JOG would continue overseeing the Advisory Board, Technical Board Coordination Committee, and other sub-committees that may be established.

SWOT Comparison

Strengths Compared

Criteria	Collaborative	Advocacy	Coordination	Hybrid
Goal of timely measurement	The JOG provides the structure to establish funding parameters to help drive toward a two-experiment solution for timely measurement.	Aim for simultaneous validation enabled through a well-defined charge and diverse Advisory Board membership.	Focus on science; STRB recommends strategies to ensure the achievement of shared goals.	JOG can help coordinate timely measurement, while AB can recommend strategies to ensure achievement. AB can also advocate to attract more partners to help achieve goal.
Culture of collaboration and resource optimization	Inherently collaborative through shared resources. Resource optimization is ensured through a process that enables scientific output and operations to reallocate resources.	Recommendations of the (external) Advisory Board may be viewed as less driven by self-interest and could carry more political sway with decision makers.	Optimize resource use among facilities. Emphasis on community building. Distributed knowledge acquisition and decentralized problem solving.	Stakeholders well-represented in multiple collaborative forums. Technical Boards support inter-experiment collaboration and resource optimization. Option to promote collaboration through RRB and common pool of funds.
Robust communication and coordination	Encourages frequent communication, shared productivity tools, conferencing, and meetings	Easy to maintain robust communication and coordination channels.	Pluricentric system as opposed to the unicentric system, involving a "large" number of interdependent actors who interact with each other to produce an outcome.	Means of communication and coordination are clear, and stakeholders are represented where relevant. Model provides numerous forums for stakeholders to directly communicate with one another and the experiments.
Agile	Few limitations to increased membership and decisions on resources are largely decentralized, allowing for more agile responses	Strong model to promote and attract new funders and partners through a subcommittee on communications and advocacy.		Highly agile and responsive; few limitations to increased membership and decisions and resources are decentralized.

Weaknesses Compared

Criteria	Collaborative	Advocacy	Coordination	Hybrid
Goal of timely measurement	Shared scientific goal may not necessarily be agreed upon by all members. Independent goals and visions of the collaboration may not align with those of the facility or laboratory.	Limited ability to influence collaborations, absent significant resources. Experiments and host labs will mostly be self-interested and seek to guard their resources.	Limited scalability to multiple funding sources. Funding agencies only tangentially engaged.	Lack of authority to manage conflicts of interest.
Culture of collaboration and resource optimization	Voices and input may be limited for members with fewer experiment participants or resources	Creating a sense of shared purpose may be challenging. Not best placed to advise on initial budget allocations and funding formulae across experiments.		Vulnerability to lack of trust and unwillingness to share critical information.
Robust communication and coordination	Communication of resources to the laboratory or facility may be difficult and cumbersome. Large, infrequent meetings may result.			Will require active management to uphold communication and coordination channels; requires trust, commitment and reciprocity from all parties, and can be fragile
Agile		May be limited by lack of internal leadership and may be too ponderous, as model is not well-equipped to exhibit autonomy beyond a given charge or assignment at hand.		

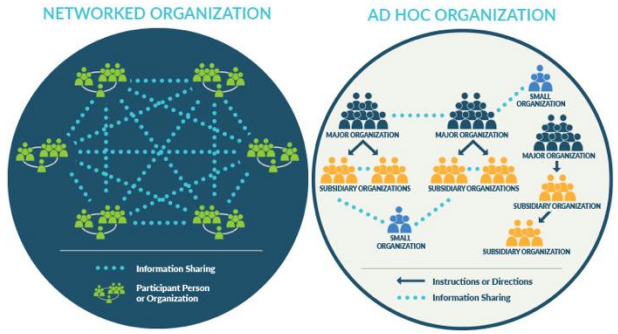
Opportunities Compared

Criteria	**Collaborative**	**Advocacy**	**Coordination**	**Hybrid**
Goal of timely measurement	Bottom-up approach can result in experts informing new directions, initiatives, projects, equipment, studies, etc. that evolve rapidly as a result of the large interest of the group	Selection of members could increase advisory body's clout, particularly if members are drawn from adjacent fields and are broadly admired, e.g. Art McDonald, Barry Barish, Fabiola Gianotti, Rolf-Dieter Heuer, Pier Oddone, etc.	Identifying the need for and prioritizing implementation of new capabilities.	Networked approach can strengthen the importance of reaching a common scientific goal. Competitions and incentives can further drive the aim of timely measurement.
Culture of collaboration and resource optimization	Implicit incentive to strengthen the collaboration either through improving and increasing resources, improving interactions, or increasing the size of the collaboration.		Compliance is ensured through trust, benefits and political obligation.	Horizontal structure promotes inter-relationships and trust.
Robust communication and coordination	Opportunities exist to develop optimized productivity and communication tools relevant to the experimental work itself.		Decisions based on negotiation rationality as opposed to the substantial rationality that governs state rule and the procedural rationality.	Any number of technical boards could be created to support coordination on specific areas of expertise.
Agile			Clear path for growing facility participation.	Participation is encouraged through personal promotion.

Threats Compared

Criteria	Collaborative	Advocacy	Coordination	Hybrid
Goal of timely measurement	Individual members may gain significant influence and steer the group into generally undesired directions.	Motivations of the members may be biased by more parochial interests.		
Culture of collaboration and resource optimization	Collaborations may fragment as interests vary, resulting in multiple collaborative frameworks operating independently and possibly with opposing goals or methods.	Communication and coordination (organizational burden) can create the aura of work getting done while wheels are spinning.	Competition v. collaboration. Facility decommitments.	Lack of incentive for stakeholders to strengthen participation in the overall network and commit to collaborating with one another; risk of siloing.
Robust communication and coordination				Risk of poor information flow and miscommunication, excessive meetings, and risk that personal shortcomings (e.g. impatience, procrastination, micromanagement) could interfere with overall network coordination.
Agile	Variations in annual funding and resources may make individual members' participation or contributions unstable.		Funding agencies have no direct say in driving direction facility priorities.	

Recommending a Hybrid Approach



- As seen from the SWOT analysis, there is likely no "perfect" organizational structure for the proposed International Observatory for DBD
- But the hybrid model presents an opportunity to apply a highly agile structure to coordinate an international campaign for DBD.
  - It brings together advocacy and science-driven strengths of all the models examined and introduces a degree of flexibility that could support scalability even if resources are limited.
  - Option of RRB creates an opportunity for funders to establish a common pool of discretionary funds that could be used to incentivize advancement toward the shared goal of timely discovery and to motivate resource optimization.
  - The agility of the hybrid model and horizontal structure supports the future inclusion of additional funders seeking to join the effort.
  - Structure supports advocacy and provides a clear avenue to engage and involve additional funding agencies in the international effort on double beta decay

Conclusions

- The DBD Working Group has addressed the charge, exploring organizational frameworks to coordinate an international campaign with multiple isotopes and more than one tonne-scale experiment implemented in the next decade and promote research and development on future efforts in double beta decay.
- Four organizational structures reviewed and analyzed: Collaborative, Advocacy, Coordinated (Network), and Hybrid
- Consideration the features of the DBD landscape, the working group recommends that the community consider implementing a hybrid, interconnected network organizational framework for the DBD "virtual observatory."
- The DBD working group also suggests that a contest is held within the community to name this new entity.

DBD Working Group

- Nigel Smith (TRIUMF, Canada) Convenor
- Nathalie Besson (CAE, France)
- Graham Blair (STFR UKRI, UK)
- Oliviero Cremonesi (INFN, Italy)
- Olivier Gagnon (CFI, Canada)
- Marcella Grasso (IN2P3, France)
- Valerie Harbour (NSERC, Canada)
- Milan Konopek (ISED, Canada)
- Eva Luc (ISED, Canada)
- Paul Mantica (DOE, US)
- Allena Opper (NSF, US)
- Paul Sorensen (DOE, US)
- Daniel Quinn (ISED, Canada)
- Jacek Swiebodzinski (PT.DESY, Germany)

DBD Working Group Meeting Cadence

- Regular “monthly” meetings (10 to date)
  - September 8, 2023
  - September 27, 2023
  - November 7, 2023
  - December 4, 2023
  - February 2, 2024
  - March 4, 2024
  - April 5, 2024
  - June 6, 2024
  - September 23, 2024
  - January 24, 2025
- Ad-hoc subcommittee meetings