**Summary**

The next generation experiments in dark matter and neutrinoless double beta decay require unprecedented levels of radiopurity in the target material and all shielding elements. This will require significant new investment in novel assay techniques, ultra-sensitive screeners and an increased throughput in production screening. The community as a whole recognizes that cost-effective, high sensitivity screening of this magnitude can only be achieved if we work together to develop a plan for management and deployment of existing resources, and a model for choosing the best proposals for the future.

Starting in 2009, AARM has established strong connections between diverse underground experiments by organizing around common goals that would benefit from structured cooperation. A series of workshops have brought together experts from around the world to better understand low-radioactivity environments and exploit common resources. The work that has flowed from increased cooperation has advanced simulation physics and technique, improved access to new assay techniques, fostered R&D in neutron background measurements, and created a universal materials assay database. The success of AARM provides a foundation upon which we can build a more tightly–knit consortium, consisting of those sites which have already indicated their willingness to provide assay infrastructure to the whole community under a centrally-managed, community-driven process.

**Purpose**

We plan to reduce the long-term assay costs for all low-background physics experiments, and thereby reduce the attendant risks of budget shortfall, insufficient physics reach, and lagging schedules. Our goals are to

1. Provide cost-effective assay to the community using existing resources.
2. Accommodate fair access to sensitive screening across all experiments.
3. Maintain expertise (personnel and technique) in ultra-sensitive screening
 techniques, such as ICPMS and NAA
4. Reserve shielded space for prototype assay techniques and targeted screening.
5. Establish a community-driven process for increasing the number and type of
 available screeners.
6. Evaluate and secure additional underground space if required
7. Evaluate R&D needs for the future and prioritization of proposals.
8. Explore synergies with other fields, to increase the user base and sustain viability

We believe these goals can be achieved by the creation of a Network or Consortium of low background assay Centers of Excellence, managed by an entity composed of members from these centers. These would be funded as DOE-SC or NSF User Facilities with budgets to cover measurements and analyses, as well as facility maintenance and upgrades. R&D would be funded as needed (via new proposals to the Network) to establish the capabilities needed for next generation experiments. In essence, we seek a way to transition existing facilities into user facilities to retain capabilities that have been built up over many years in the service of individual projects.

The initial suite of centers would consist of the existing deep and shallow underground sites at SURF, KURF, Soudan, LBNL (including Oroville) and the PNNL underground lab which provide sensitive gamma counting via High Purity Germanium (HPGe) spectroscopy and shielded space for new ultra-sensitive screening. In order to provide complementary techniques sufficient for the next generation of rare event searches, the consortium will also include expertise in ICPMS at PNNL and those Neutron Activation Analysis centers already serving this community, specifically UC Davis and the University of Alabama.

While the entity we envision is funded by US sources and managed by US physicists, the collaboration is international in scope, operating in tandem with other assay organizations established by labs in Europe and Asia, and with our regional partner SNOLAB. Shared funding for specific projects can be negotiated via MOU.

**Some Guiding Principles** *(based on community input from AARM, the DURA meeting, and the SLAC cosmic frontier workshop)*

A. The Network will be managed through one Institution, which could be a National Lab or a University. To determine the optimal structure, we must determine the cost and funding agency mix for these two scenarios.

B. The Scientific leadership of the Network will be determined through a board composed primarily of members of the network and will form a constitution which details election procedure and terms of office, as well as distribution of responsibilities.

C. The Scientific leadership will be responsible for directing the overall program. They will assess community needs, determine the method of organizing access to screeners, and recommend new R&D and purchases.

D. Management styles and staffing details at each Center of Excellence may differ, depending on the Institutional constraints and the suite of technology available.

E. Additional resources in the form of technicians and additional equipment will make it possible to extend proprietary expertise to new users.

F. Universities and National Labs with special capabilities will retain the ability to use their facilities for publishable scientific pursuits.

G. University members will be able to train students on assay techniques as part of providing use-for-others.

H. User fees will be determined in a uniform manner across technologies. Details could include subsidized fees for members of the network or the community.

**Rationale**

As part of the Snowmass process, the Underground Facilities Frontier, in cooperation with the Cosmic Frontier, will identify the assay needs for all existing and proposed experiments via survey. The results of the survey will be summarized in a White Paper and will provide quantitative evidence supporting point 1 below. It will also form the basis for a quantitative accounting of the cost savings and scope of the Network. For now, we simply list a subsample of the many comments received in response to the question: “what is currently wrong with the way sensitive assay is performed by the underground science community? “

1. The current suite of assay techniques and screeners are already inadequate for current experiments. Ton scale experiments require additional screening now to inform decisions and choices, and more in the future to perform the assay.

2. Availability is often governed by who joins what experiment, effectively shutting some experiments out of sensitive screening techniques.

3. Current use of screeners is inefficient - some are sitting at 50% capacity while need is much greater – A scheduling tool and central management of resources is more cost-effective.

4. Lack of continuity between projects results in loss of personnel and expertise. An example is the ICPMS capability developed at Laurentian University. After purchasing an ICPMS and developing low background techniques that were needed by the community, the capability was lost after the professor changed institutions.

5. Proposals for new experiments without access to assay infrastructure must purchase a dedicated screener or develop a new in-house technique, rather than list an easily evaluated cost per material screened. Two possibilities then ensue:
 A. Infrastructure investment is refused, leaving the experiment without the screening they need and at risk of not reaching their scientific goal.
 B. Infrastructure investment is allowed, in which case the new technique is considered proprietary, but is too late to benefit the experiment in question anyway.

6. Proposals for common infrastructure which come from a single experiment lack credibility. Proposals would be more successful and more broadly applicable if they came from the larger community. However, there is no clearly identifiable funding source for such a model. MRI proposals with a national user base are less likely to be selected in the University pre-proposal stage since they do not benefit the University itself.

7. There is no institutional memory enabling future science. Low background results are only occasionally published, once the experiment itself is complete. An effort to centralize and compile general issues and techniques will enable future scientific advancement without repeating this research.

8. When a collaboration **does** treat their screening as important in its own right, they typically do not release results to the community for years, while preparing a publication. Contrast this with user screening, the results of which can be part of the universal database and immediately available to the community. Open access to data will prevent duplication of effort. The network may be able to promote specific multi-collaboration campaigns to determine the best sources for copper, lead and other commonly used materials.

9. Currently, universities and national laboratories must contract on an individual R&D basis leading to many small contracts, each with their own administrative overheads. The time to negotiate with contracting at each individual University delays research and development. In some cases, the overhead is comparable to the cost of the assay.

10. Lack of sustained support in the field of low radiation techniques discourages young researchers from choosing to concentrate in this area. The pool of new talent could be substantially increased by establishing centers of excellence that highlight research in low background assay and science.

**Costs, Efficiencies, and Enhanced Science**

The largest up-front cost will be the manpower to manage the effort, possibly 1 FTE equivalent, as well as IT and administrative support. Additional technicians at the 6 sites, as well as maintenance, supplies, and sample preparation costs, can be offset by user fees. Travel funds will be required to ensure communication between the members of the distributed management team, as well as to sponsor workshops for the larger community. This function is now being supported by AARM, which could become an advisory board to the Consortium.

Increased assay production will require more screeners, but less than would have been requested individually by each experiment. This type of cost savings can be estimated in terms of down time for screening capacity. Currently ~ 50% of the screeners are running at 50% capacity (the others are fully utilized). This corresponds to the equivalent of 2.5 HPGe devices added to our suite without additional purchase.

With a national user facility for low background materials, researchers will spend less time duplicating known techniques and assay. Improving the productivity of the national research staff will positively benefit nuclear physics, high-energy physics, and national security. The added visibility of a user facility may empower other scientific fields to reevaluate what is possible.

There is also reduced risk that comes with world-class assay. Consider XMASS, the largest liquid xenon dark matter detector. XMASS ended up with an order of magnitude more radioactive background than expected. Resources are being spent to retrofit the detector and XMASS is not expected to achieve its original scientific goals. Rapid and broad dissemination of research results, combined with access to assay and a database of previously assayed materials, will reduce this type of risk for future projects.

The US has spent hundreds of millions of dollars developing low background assay capability over the past fifty years. Prudent management and research can safeguard this capability for future scientific endeavors.