WG4: Connections to other GARD roadmaps; synergies with non-HEP

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Speakers at previous WG4 session:

Ferdinand Willeke:	Synergy Between EIC and Accelerators for High Energy Physics
James Rosenzweig:	Synergies With Linac-Based Light Sources
Michael Borland:	Synergies With Ring-Based Light Sources
Daniel Ratner:	AI/ML for Accelerator Applications
Bruce Carlsten:	Synergies With NNSA Applications
Thomas Roser:	High-Performance Accelerators with Reduced Energy Consumption
Ritchie Patterson:	Center for Bright Beams

ABP synergies are broad, essentially everything is cross-cutting

Grand challenges apply to all categories of research machines.
(1) Beam Intensity, (2) Beam quality, (3) Beam control, (4) Beam prediction

It is in everyone's best interest to collaborate/co-develop/support:

- Education of the next generation
- Facilities dedicated to testing accelerator concepts
- Development of theoretical and computational/machine learning tools

Recommendation:

A broad platform of cross-participation in these areas *be encouraged with funding* where possible

All (or most) machines – some examples of cross-cutting issues

Energy efficient accelerator and colliders are key to future development

Beam stability

Phase space manipulations

Beam compression dynamics not fully understood − this is an important research topic

Injection/extraction design

Gas scattering

Modeling, Measurement, and Machine learning

Machine Learning (ML) can benefit from beam physics and more cross talk is needed

Measure first and then control −

measurement is easier and can be put to novel use when control is not possible

Use of ML needs diagnostics with improved accuracy and resolution

Parallel multi-objective optimizations, accurate linear and nonlinear modeling

Achieve strict correspondence between what is designed and what is built

EIC machines – some examples of cross-cutting issues

Collision regions have similar issues to HEP colliders:

- Beam-beam tune shift
- Crossing angle/crab crossing
- Interaction region design

EIC *storage rings*

- Beam cooling
- Beam lifetime
- Intrabeam scattering

There may be more in overlap in future HEP machines than there is now with

- Preservation of spin dynamics

Light sources – some examples of cross-cutting issues

Alignment tolerance of fourth generation storage ring is similar to challenges faced by HEP colliders

Achieving better vacuum

Synchrotron radiation -> related issue radiation damage

Low emittance diagnostics, fast diagnostics

Precision timing

Miniaturization

Other collaborations and Education

NNSA – (National Nuclear Security Administration)

There are many areas for collaboration, but sometimes we don't know what NNSA is interested in. *More collaboration/information exchange would be beneficial.*

(Example concerns: flexible (sub-ps to sec) linac pulse structure; high-resolution, multiple time, multiple view (3D) measurements.)

NSF funded CBB is great for training students. *How could the accelerator science program at NSF be restarted?* The CBB cutting edge research connects to HEP machines – *collaboration/information exchange is beneficial.*

Some research is not now connected to HEP but may be in the future:

Example: **ERL for HEP** (e+e- collider)?

Some questions for discussion

- In what areas is it *essential* to have a *universal* platform of cross-participation? (Education, facilities, theory, computation/ML tools.) Could currently existing mechanisms be improved? Are there new mechanisms we should aim for, and what specific steps might be taken?

- Where collaboration across non-HEP programs is *beneficial* but not as universally broad, are the formal mechanisms to encourage collaboration adequate? (IPAC, conferences, DPB) Are there *other specific potential useful mechanisms* that might be implemented in the future?

- What will strengthen our field? (NSF restart?)

- How can beam physics be more strongly connected to other GARD thrusts?

- How can we keep the door open to non-traditional areas? This includes new ideas, and non-HEP efforts that may be much more applicable to HEP machines in the future (ERLs, spin dynamics).