

The FRIB Theory Center

December 2014

Advances in nuclear theory provide the essential underpinning to understanding nuclei and their role in the cosmos. Theory will play a central role in providing the intellectual framework for the science at FRIB, as well as invaluable guidance to FRIB's experimental program. Over the last few decades, two large nuclear physics user facilities have been constructed, namely JLab and RHIC. These facilities have enabled outstanding discoveries and in both cases, theory centers strongly coupled to the facility were put in place. The JLab and BNL/RIKEN theory centers are internationally recognized as critical contributors to the success of the associated experimental facility.

The idea of an FRIB Theory Center (FRIB-TC) has a strong community context. Already in 2003, the NSAC theory report identified pipeline issues and made specific recommendations to address them. In 2005, the low-energy theory community developed the RIA Theory Bluebook, a document describing a roadmap for the theory of rare isotopes. Following discussions with the Office of Nuclear Physics, the FRIB Theory Users Group conducted a survey of the low-energy theory community in the U.S. that identified specific areas of critical need. The results of the survey were discussed at the 2011 Low-Energy Community Meeting (arxiv.org:1109.5787).

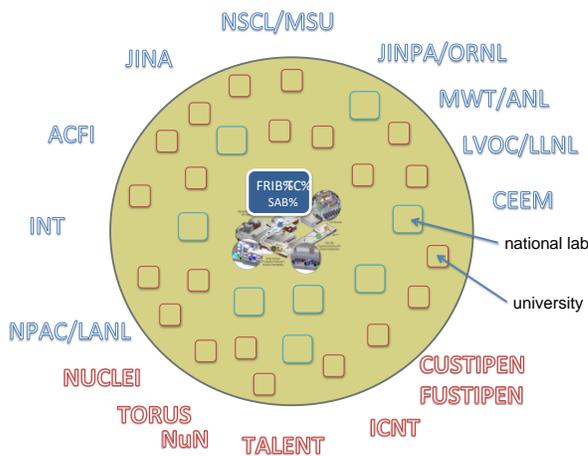
In the Spring of 2013, the NSCL director constituted the FRIB-TC Steering Committee (FRIB-TCSC) with a mandate to determine the required ingredients for a future FRIB theory center, including ramp-up funding options and an appropriate organizational structure, and then to work with the agencies to develop a realistic path forward. At the 2013 Low-energy Community Meeting, the theory membership provided feedback on the key ingredients of a future FRIB-TC. The community supported the work of the FRIB-TCSC and approved a resolution that reads: *We endorse the creation of an FRIB Theory Center with the breadth and excellence to address overarching scientific questions. This Center should promote sustained intellectual growth of the field, develop new collaborations between theory and experiment and play a leading role in educating the next generation of nuclear physicists. Participants of the theory working group encourage the FRIB Theory Center Steering Committee, together with the FRIB/NSCL leadership, to develop an ambitious and comprehensive plan to increase the impact and reach of FRIB and ensure its success.*

Consequently, in May 2014, the FRIB-TCSC submitted a proposal to DOE Office of Nuclear Physics that presents a starting point to pave the way toward realizing the full vision of an FRIB-TC. The proposal envisages an FRIB-TC of broad scope, going beyond the traditional fields of nuclear structure and reactions, and nuclear astrophysics, and exploring exciting boundaries with other areas. The proposed starting point is modest (budget around \$150k) but this would ramp up over the course of 6 years to a significant center (envisaged budget of the order of \$2M), fully functional by the time FRIB beams turn on. For such a theory center to be in place by 2021, it is important to start now.

The planned FRIB-TC introduces two new programs: (i) the national FRIB Theory Fellow program, which will transform the existing FRIB theory fellow program so far at MSU into a national initiative, attracting the best minds and bringing prestige and visibility to the field; and (ii) the FRIB Bridge Faculty program, bringing the opportunity to create permanent positions across the country, which will consolidate the revitalization of the field.

The FRIB-TC will also be the natural home for training the next generation in advanced low energy nuclear theory. It can offer and facilitate cutting-edge nuclear theory education covering advanced approaches and their applications. Computational science has become an essential part of the ongoing nuclear physics research, and the plan is that the FRIB theory center will also provide support to initiatives taking advantage of high-performance computing.

In addition, an important role of the planned center is to communicate the science and reach out to other fields and communities. In coordination with the INT and other institutional partners, it will foster interdisciplinary collaborations and will attract international collaborations and large-scale initiatives. In short, it will bring multiple opportunities to leverage not only effort, but also funds.



The FRIB-TC will be a *distributed* effort, involving universities and national labs nationwide. The diagram shows the schematic organization of the FRIB-TC. It will be managed by a Director and an elected national Science Advisory Board (SAB), which will be composed initially of the current members of the FRIB-TCSC. The various scientific activities will also be distributed nationwide, with larger institutions (FRIB-TC cores; blue boxes) assuming a coordinating role. Institutional partners (blue acronyms*) and collaborations (red

acronyms) are indicated; this list is by no means exhaustive, it merely illustrates the concept. This networked FRIB-TC can unite disconnected efforts within low-energy nuclear theory and beyond, provide a gateway to integrate physicists and computational scientists into collaborations enhancing FRIB science, and stimulate and nurture new and unexpected developments in the FRIB experimental program.

Prepared by the FRIB Theory Center Steering Committee:

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* Some acronyms used: ACFI = Amherst Center for Fundamental Interactions at U. Mass.; CEEM = Center for Exploration of Energy and Matter at Indiana U.; INT = Institute for Nuclear Theory in Seattle; JINA = Joint Institute for Nuclear Astrophysics; JINPA = Joint Institute of Nuclear Physics and Applications at ORNL; LVOC = The Livermore Valley Open Campus at LLNL; MWT = Midwest Theory at ANL; NPAC = Nuclear, Particle, Astrophysics, and Cosmology effort at LANL.