PROPOSAL TO ESTABLISH

IIT Bombay-Ohio State Frontier Science and Engineering Research Center

Steven A. Ringel

Distinguished University Professor
Neal A. Smith Professor of Electrical Engineering

Associate Vice President for Research
Executive Director, Institute for Materials Research

I. EXECUTIVE SUMMARY AND BRIEF HISTORY

The IIT Bombay – Ohio State Frontier Science and Engineering Research Center (Frontier Center) is an important culmination of a 5+ year collaboration between the Ohio State Institute for Materials Research (IMR) and IIT Bombay that was stimulated by a goal of the Materials and Manufacturing for Sustainability Discovery Theme (M&MS - developed and managed by the IMR), which was to create meaningful connections with Indian institutions where advanced clean tech, sustainable manufacturing, low energy electronics and energy efficiency are prime directives. By connecting with India though OIA's India Gateway office in Mumbai starting in 2014, a portal was created whereby the global imperative of materials for a sustainable future could become immediate for IMR's faculty and students. The connection with IIT Bombay as an academic institution was an ideal match given the complementary strengths of both, the similar strategic goals and the substantial number of existing faculty-faculty collaborations between both universities. Additionally, there exists a notable presence of alums from both institutions currently on the faculty at each. Therefore, in 2014 IMR leadership and faculty started down the path of exploring this relationship, which over time went from some handshakes to home and home visits by presidents of both universities, to an initial MOU signed by both presidents (late 2015), to multiple faculty visits (both directions), joint workshops at both institutions, and finally the initiation of several seed grants in the form of IMR's existing Global Partnership Grant (GPG) program with support from IIT Bombay. With the success of the initial shared grants, and the encouragement by both parties at all levels, in late 2018 IMR and IIT Bombay agreed it was time to scale the initial interactions into a unique, bi-institutional, bi-national joint research center. The formal launch and initial bi-institutional signing to authorize the creation of Frontier occurred on April 10, 2019 in a formal ceremony at IIT Bombay, and since Frontier is operating under the auspices of the IMR, Frontier has already begun its initial ramp starting from Autumn 2019. Programs such as the Frontier Scholar seed program, have started. Partnering companies and government agencies are being engaged as underwriters and project partners. We believe that Frontier can become an exemplar for OSU's future global research enterprise in many other areas. The purpose of this document is to provide a concise description of the mission, goals, focus areas, structure and financial support for Frontier, in support of our request to gain formal center status for Frontier.

II. MISSION

> *The mission of the Frontier Science and Engineering Research Center (Frontier Center) is to create a global community of researchers, students and industry to build on the strengths of the universities in materials, devices, components and systems to advance the creation and translation of knowledge and to educate students for the global economy to improve the well-being of our world.*

The Frontier Center will develop a set of programs (see Appendix A) that will embody the Center's vision to become the exemplar global academic research center of excellence in materials and their applications to systems; and by joining missions to deliver unique impact on society through science and technology advancements. The Inter-Institutional Initiative Agreement, which provides additional detail about the strategic partnership, is captured in Appendix F.

A. The missions of the university (research, teaching, service or outreach) most relevant to the center

The Frontier Center will be a shared, global center of excellence between the Indian Institute of Technology – Bombay (IITB) and the Ohio State University (OSU). The Frontier Center will contribute to the research, teaching, and outreach missions of the university.

Research: Through this new center of excellence, professional researchers from across the globe will connect and foster future project collaborations, while students from both institutions conduct collaborative research through a student exchange and scholarship program. The issues addressed by the Frontier Center will focus within several Center research areas:

1. Renewable and Clean Energy Science and Technology (e.g. solar, energy storage, systems)

2. Advanced manufacturing (e.g. additive, ultralight structures, computation, machine learning, etc.)
3. Electronics (e.g. RF and power electronics, low-energy electronic systems)
4. Photonics (next generation photonic devices/circuits, infrared sensing and imaging)
5. Emergent Materials (e.g. quantum, 2D materials, spin/magnetic phenomena, biomaterials)

The Center has grouped potential IITB – Ohio State faculty pairings for each of the above research areas, with many more possibilities over time.

The unique contribution of the Center is to facilitate interdisciplinary engagement around our most fundamental concerns—engagement that would not otherwise occur in such a productive and deeply reflective way. Bringing together IITB – Ohio State researchers from a variety of disciplinary perspectives opens new avenues for cutting-edge research with complementary expertise that advance the frontiers of science, engineering and translational impact with the private sector.

Teaching: The Frontier Center will contribute to the teaching mission of the institution by providing uncommon, experiential learning opportunities to educate students for the global economy to improve the well-being of our world. Both institutions have designated spaces on their respective campuses for researchers to work together. Benefits to students include interdisciplinary skillset, broader exposure and cultural experience and better post-PhD job opportunities. The Frontier Center is working with OIA to accommodate Frontier Scholars. IITB has arranged for accommodations for Ohio State Frontier Scholars on IITB's campus.

Outreach: The Frontier Center will contribute to the University's outreach mission by creating a global community of researchers, students and industry to advance the creation and translation of knowledge. The Frontier Center will make a real impact on society by bringing together leading researchers who are focused on some of the world's most critical challenges in science and technology. The Frontier Center will be a beacon for attracting companies as stakeholders into the research areas of the center and as such provide important, direct outreach for the participating students.

B. <u>The interdisciplinary nature of the center</u>

The Center will build a global community using existing strengths and collaborations of two leading research universities. The unique contribution of the Center is to facilitate interdisciplinary engagement around our most fundamental concerns—engagement that would not otherwise occur in such a productive and deeply reflective way. Bringing together IITB – Ohio State researchers from a variety of disciplinary perspectives opens new avenues for cutting-edge research with complementary expertise. The new research center will focus on inherently interdisciplinary domains of research as noted above, in Part A, with each drawing from a number of disciplines, including physics, chemistry, electrical engineering, materials science, industrial systems engineering, mechanical engineering, business, and others.

C. <u>The goals of the center that cannot be met within existing academic units</u>

This unique, first-ever multinational academic research center will create a community of thought leaders and next-generation talent with access to global markets to make significant advances in science, technology and society in a way that could not be reached by either partner university alone. Through this new Center, professional researchers from across the globe will connect and foster future project collaborations, while students from both institutions conduct collaborative research through a student exchange and scholarship program. By joining in this shared vision with IIT-Bombay, Ohio State has embarked on an innovative pathway to provide its students and faculty with unusual opportunities to globalize Ohio State's impact. Both universities will benefit by accelerating research and impact on a global scale, attracting external project support from industry and government, and drawing global prestige as the place to invest in frontier research.

III. FACULTY

A. Criteria for selecting the center's faculty membership

- Faculty status at The Ohio State University (We understand this, in accordance with University Rules, to include "persons with regular tenure-track, regular clinical, regular research, auxiliary, and emeritus faculty titles on full or part-time appointments with or without salary).
- Significant research interest in areas related to the focus and mission of the Center.
- Willingness to commit time to participate in and help organize the Center's activities and programs.

B. List of faculty expressing interest in associating with the center and accompanying documentation that their chairs/directors support such involvement.

A list of faculty affiliates of the OSU Frontier Center is compiled in Appendix B.

The Center's efforts to date have involved faculty at a number of levels. Major efforts have been directed by a robust core team of faculty who have dedicated considerable time to the development of the Center. This organizing team includes Steven A. Ringel (Distinguished University Professor and IMR Executive Director), Jay Sayre (Research Associate Professor, Materials and Science Engineering), Sanjay Krishna (Professor, Electrical and Computer Engineering), and Ardeshir Contractor (Associate Professor, Mechanical and Aerospace Engineering). With each programmatic effort, the Center has identified interested faculty who have become involved as appropriate.

C. The extent to which staff and students will be involved and how they will be supported.

Through a multi-year process of winnowing areas of interests and complementary strengths, a range of common topics has emerged, and a technical leadership team has been identified from both institutions to act as one body to support collaborative, integrated teams of faculty and graduate students. These "super-groups" of researchers and innovators will be built around shared Frontier Center Scholars (PhD students) who will connect pairs of faculty, through which multiple, parallel teams of strength will materialize. These scholars will be funded via a competitive process based on jointly proposed research projects, combined with a meaningful research-intensive visitation program for the PhD student scholars and the participating faculty. The center leadership will work closely with the super-groups to manage a portfolio of industrial partners to help inform and translate the research activities into the market and global economy. The Institute for Materials Research administrative staff will support all operations and logistics of the Center.

IV. ADMINISTRATION

A. The name of the director or interim director of the center

Center Co-Directors:

1. Sanjay Krishna, George R. Smith Chair in Engineering and Professor, Electrical & Computer Engineering
2. Ardeshir Contractor, Professor of Practice, Mechanical and Aerospace Engineering

B. The proposed responsibilities of the co-directors

The Frontier Center Co-Directors will have responsibility for:

1. Overseeing the day-to-day operations of the Frontier Center
2. Managing the budget and reporting for the Center

3. Strategic planning for the Center
4. Implementing the recommendations of the Frontier Center Bi-Institutional Oversight Committee
5. Multi-institutional coordination and Center communication.

C. The function(s) and composition of the oversight committee

1. *Bi-institutional Oversight Committee Function:* This committee will review annual and ad hoc reports and advise the Frontier Center leadership on high-level strategies for the enhancement and development of the Center and on ways in which the Center can promote University initiatives. The Oversight Committee will also evaluate the performance of the Center co-directors. Letters of Support from the Oversight Committee are captured in Appendix D. The Bi-institutional Oversight Committee composition for Ohio State includes:

   a) **Morley Stone**, Senior VP for Research

   b) **David B. Williams**, Dean, College of Engineering

   c) **Steven A. Ringel,** Executive Director, Institute for Materials Research

D. The reporting line—the dean, group of deans, or vice president to whom the center will report

1. *Proposal:* The Frontier Center will report to the Bi-institutional Oversight Committee but will be operated within the Institute for Materials Research, itself a university-level institute that umbrellas centers This structure, shown in Figure 1, ensures that decisions that could impact Ohio State Frontier Scholars, faculty or staff reside within Ohio State's control.
2. *Justification:* The Frontier Center must be a University-level center if it is to carry out its broadly interdisciplinary, multi-college mission. Also, unlike IMR, Frontier is supported by 2 universities with a bi-institutional agreement, so it requires this distinction. It is important that it serve as a conduit for collaborative efforts among all academic units of the University: Arts & Sciences; Engineering; Business; Medicine; and others.

E. The main components of a pattern of administration for the center (to be formally completed/approved within a year of center establishment)

The FRONTIER Center will be operated by IITB and by the Institute for Materials Research at Ohio State. IITB and Ohio State will each follow their respective university's policies and guidelines for the establishment of the Center, including procedures for establishment, operations, and oversight.

1. *Leadership Team:* A joint Center Leadership Team will be formed from selected faculty at both institutions, which will be responsible for steering technical directions, establishing competitive reviews, processes and protocols, enabling workshops, funding decisions, etc., and will be supported logistically by IITB and Ohio State-Institute for Materials Research (IMR) leadership.
2. *Co-Directors:* Co-Directors from Ohio State will report to the Bi-institutional Oversight Committee. The Co-Directors will serve as the approver of financial transactions when possible.

Figure 1 displays the organizational structure of the Frontier Center. It should be noted that the title of "Director" at IITB is used to only identify the IITB president of the university. Therefore, the equivalent of the OSU Co-Directors at ITTB are simply co-PIs.

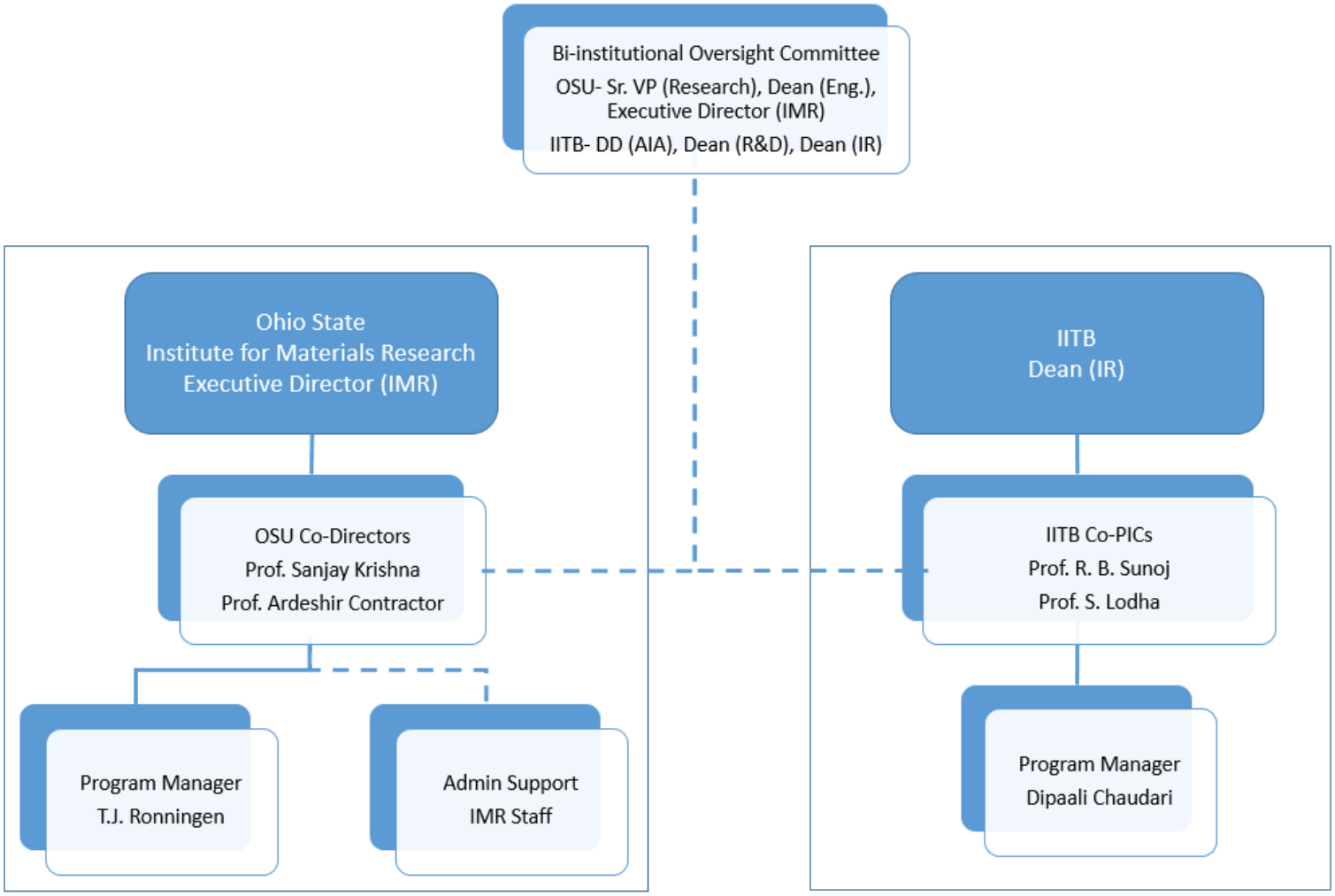

Figure 1: Frontier Center Organizational Chart

V. BUDGET/FUNDING

A. Expected annual budget

Table 1 summarizes the budget resources allocated by Ohio State units, which totals $975k over 4 years. The Resource Commitment Approval for the Center is captured in Appendix E. There is an initial ramp-up period, and then a ramp down in year 4 to a steady state internal value, since we anticipate significant external industry and government support to come to Frontier as early as year 2. At full funding (including an equivalent amount from IIT Bombay, matching the OSU budget schedule), but not counting any expected support from external industry and government sources, the budget will support approximately 15-30 Frontier Scholars inclusive from both institutions. This range is a result of anticipating many Frontier Scholars will already be partly supported by existing research projects at either institution, for which cases Frontier funding will be prorated to augment existing funding. The major budget categories for the OSU component are: (a) support of Frontier Scholars (travel, living expenses for up to 6 months, visa, insurance, and for OSU students at IIT Bombay, one semester tuition/fees; (b) research costs; (c) travel support for each faculty project supervisor to visit the other institution (one time); and (d) nominal support for the Frontier Co-Directors and program manager. This does not include significant in-kind contributions from IMR (business operations, program management, compliance support, logistical support, public relations, etc.).

Table 1: Funding Schedule

	FY20	FY21	FY22	FY23	Total
Office of Research	$ 81,250	$ 125,000	$ 95,000	$ 23,750	$ 325,000
College of Engineering	$ -	$ 75,000	$ 125,000	$ 125,000	$ 325,000
Institute for Materials Research	$ 81,250	$ 125,000	$ 105,000	$ 13,750	$ 325,000
Total	**$ 162,500**	**$ 325,000**	**$ 325,000**	**$ 162,500**	**$ 975,000**

B. Funding sources and one-time and recurring costs

An initial 4-year seed period will be established via equitable support from both institutions. The number of Center Scholars fully or partly supported by the Center will be approximately between 15 and 30. The Office of Research, Institute for Materials Research and College of Engineering will be funding the Ohio State expenses during the initial 4-year period. Both institutions will provide resources to support the center in an equitable fashion.

C. Existing or new equipment, space, and facilities to establish the center

Initially anticipated space needs will be minimal. The Center itself can function as a virtual entity, without dedicated space, and still accomplish many of its objectives. The Co-Directors are faculty members, provided office space by their tenure homes. Other faculty involved with the Center will also have office space provided by their home departments. The staff to support the Center activities are housed within the Institute for Materials Research (IMR).

Both institutions have designated spaces on their respective campuses for researchers to work together. At Ohio State, researchers will be based at Nanotech West on west campus, in space operated by the Institute for Materials Research and in Caldwell Lab on Ohio State's main campus.

D. The sustainability of the center—possibilities for external funding, and details of related funding proposal submissions

The majority of Center-driven projects expect to receive support from external sources during the 4-year period. Several different funding models being pursued, one of which is building a Center Fee into the project funding, where the Center Fee supports Center Operations. Several companies have shown interest in a Member Model, where Industry partners pay a Membership Fee to have access to the Center and ongoing project research.

VI. EVALUATIVE CRITERIA AND BENCHMARKS

The Frontier Center will be evaluated using a variety of criteria based on the various aspects of its mission.

Establishing a Community of Researchers Focused on identified Center research areas: The Frontier Center should increase interdisciplinary collaboration on research related to its areas of focus, both between faculty affiliated with the Center and between those faculty and other OSU researchers not affiliated with the Center.

Metrics:

1) *# collaborative publications*
2) *# collaborative grant awards*
3) *Diverse topics*

Contributing to the Success of Grant Applications: The Frontier Center should provide proposal development support when pursuing funding opportunities from both Government and Industry sources.

Metrics:

1) # contracts from government sources

2) # contracts from industry sources

National Impact: The Center should establish a national reputation as a leading bi-national and bi-institutional academic research center. Should be a "go-to" center for funding sources.

Metrics:

1) US Embassy and Consulate representative visits to Frontier at either IIT Bombay and/or Ohio State locations; meetings at U.S. consular offices and embassy in India and periodic meetings in D.C.

2) Attract Indian industry to US

3) Attract top Indian talent to US

4) Provide global culture opportunities for US students

Funding: The Frontier Center should establish strong evidence of significant external support.

Metrics:

1) # seed grants leading to external support

3) Mix of private and public funding

We provide a list of proposed external evaluators of the Frontier Center in Appendix C.

APPENDIX A

PROPOSED PROGRAMS OF THE FRONTIER CENTER

Below we describe the programs planned for the Center. The programs listed will be developed with a staffed and funded Center. Our efforts over the past few years give us confidence that there is significant interest in the development of these programs.

Student Exchange and Scholarship Program

The intellectual vitality of an ambitious Center requires an active and engaged community of researchers and students. The Frontier Center will support the next-generation of scientists and innovators through its doctoral student-based fellowship program. Each year, between 15 and 30 co-supervised PhD students from both institutions will spend approximately one semester at the partner institution, as members of the partner faculty group. Faculty co-advisors are expected to spend 1-2 weeks at the partner institution, preferably coinciding with the visit of the co-supervised research scholars. Competitive scholarships will be awarded to aid student costs related to research projects, travel and visitation to the partner institution, living expenses and tuition fees.

Frontier Center Workshops / Webinars

Frontier Center workshops and webinars will provide resources for colloquia, panel discussions, and workshops that promote the mission of the Center, and government agencies and/or industry sponsors will fund many of these events. IITB and Ohio State will each host approximately one workshop annually.

Industry – Academia Meet	Dec.13, 2019
IUSSTF (Indo-US Science and Technology Forum)	Dec. 14-15, 2019
Annual Materials Week Conference	May 2021, 22
Webinars	Quarterly

APPENDIX B
OHIO STATE AFFILIATES OF THE FRONTIER CENTER
(FACULTY, EXCEPT WHERE NOTED)

Name	Department	College
Anant K. Agarwal	Electrical and Computer Engineering	Engineering
Shamsul Arafin	Electrical and Computer Engineering	Engineering
Aaron R. Arehart	Electrical and Computer Engineering	Engineering
Hanna Cho	Mechanical and Aerospace Engineering	Engineering
Anne Co	Chemistry and Biochemistry	Arts and Sciences
Ardeshir Contractor	Mechanical and Aerospace Engineering	Engineering
Glenn S. Daehn	Materials Science and Engineering	Engineering
Vicky Doan-Nguyen	Materials Science and Engineering	Engineering
Nima Ghalichechian	Electrical and Computer Engineering	Engineering
Joshua Goldberger	Chemistry and Biochemistry	Arts and Sciences
Perena Gouma	Materials Science and Engineering	Engineering
Tyler J. Grassman	Materials Science and Engineering	Engineering
Michael Groeber	Integrated Systems Engineering	Engineering
Abhishek Gupta	Electrical and Computer Engineering	Engineering
Jay A. Gupta	Physics	Arts and Sciences
P. Chris Hammel	Physics	Arts and Sciences
Edward D. Herderick*	Center for Design and Manufacturing Excellence	Engineering
David Hoelzle	Mechanical and Aerospace Engineering	Engineering
Jinwoo Hwang	Materials Science and Engineering	Engineering
Mahesh S. Illindala	Electrical and Computer Engineering	Engineering
Ezekiel Johnston-Halperin	Physics	Arts and Sciences
Waleed Khalil	Electrical and Computer Engineering	Engineering
Jung-Hyun Kim	Mechanical and Aerospace Engineering	Engineering
Asimina Kiourti	Electrical and Computer Engineering	Engineering
Sanjay Krishna	Electrical and Computer Engineering	Engineering
Chun Ning Lau	Physics	Arts and Sciences
Alan A. Luo	Materials Science and Engineering	Engineering
David W. McComb	Materials Science and Engineering	Engineering
Tawfiq Musah	Electrical and Computer Engineering	Engineering
Roberto C. Myers	Materials Science and Engineering	Engineering
Michael G. Poirier	Physics	Arts and Sciences
Siddharth Rajan	Electrical and Computer Engineering	Engineering
Mohit Randeria	Physics	Arts and Sciences

Steven A. Ringel	Electrical and Computer Engineering	Engineering
Giorgio Rizzoni	Mechanical and Aerospace Engineering	Engineering
Jay Sayre	Materials Science and Engineering	Engineering
Jami J. Shah	Mechanical and Aerospace Engineering	Engineering
Soheil Soghrati	Mechanical and Aerospace Engineering	Engineering
Patrick Woodward	Chemistry and Biochemistry	Arts and Sciences
Fengyuan Yang	Physics	Arts and Sciences
Shiyu Zhang	Chemistry and Biochemistry	Arts and Sciences
Wei Zhang	Materials Science and Engineering	Engineering
Hongping Zhao	Electrical and Computer Engineering	Engineering
Ji-Cheng Zhao	Materials Science and Engineering	Engineering

* Non-Faculty

APPENDIX C

PROPOSED EXTERNAL EVALUATORS FOR THE FRONTIER CENTER

Name	Title	Affiliation
Gene Fitzgerald	CEO and Director Board Chair Merton C. Flemings - SMA Professor, Materials Science and Engineering	Singapore-MIT Alliance for Research and Technology MIT
Kieran Drain	Chief Operating Officer	Soraa, Inc.
John Frank	Director of R+D, Engineering	Saint-Gobain Crystals
Tim Sands	President	Virginia Tech
Shalendra Porwal	Ex-CEO	Battelle India
Chris Hammel	Professor (Physics, Electrical & Computer Engineering) Ohio Eminent Scholar Director - Center for Emergent Materials: an NSF MRSEC	Ohio State
Dave McComb	Professor and Ohio Research Scholar, Materials Science and Engineering	Ohio State
Fengyuan Yang	Professor, Physics Director of Exploration of Novel Complex Materials Center	Ohio State
Siddharth Rajan	Professor, Electrical & Computer Engr. Professor, Materials Science Engineering	Ohio State
Mike Mills	McDougal Professor, Materials Science Engineering Chair, Materials Science Engineering	Ohio State
Sheikh Akbar	Professor, Materials Science Engineering	Ohio State
Ezekiel Johnston-Halperin	Professor, Physics	Ohio State

Note: Additional US academics are currently being considered.

APPENDIX D

LETTERS OF SUPPORT FOR ESTABLISHMENT OF THE FRONTIER CENTER

THE OHIO STATE UNIVERSITY

Office of Research

208 Bricker Hall
190 North Oval Mall
Columbus, OH 43210-1321

614-292-1582 Phone
614-292-6602 Fax

research.osu.edu

Morley Stone, PhD
Senior Vice President for Research
stone.816@osu.edu
614-247-8356 Phone

May 15, 2020

Steven A. Ringel, PhD
Associate Vice President for Research
Executive Director, Institute for Materials Research
E337 Scott Lab
201 W 19th Avenue
Columbus OH 43210

Dear Professor Ringel,

I am writing to express my strong support for the proposal to formally establish the Indian Institute of Technology Bombay - Ohio State Frontier Science and Engineering Research Center (aka Frontier Center). The efforts of you and your colleagues associated with the Institute for Materials Research (IMR) and the Materials and Manufacturing for Sustainability (M&MS) Discovery Theme program are to be commended for creating a vibrant plan to establish this bi-institutional center that will significantly amplify Ohio State's global research presence and impact.

The Frontier structure and programs are well-designed, and they are based on a strong history of collaborating with IIT Bombay via programs within the IMR/M&MS, in full coordination with the OIA Gateway in India since 2015. The existence of these efforts, which already included multi-year collaborative research, several home-and-home workshops held on both campuses, the attraction of third party funding, and the presence of at least 50 engaged faculty from both sides speaks volumes toward Frontier being a sustained center of excellence that firmly places an Ohio State research footprint in India. This is fully aligned with the Office of Research's desire to extend and expand the university's research impact and engage with some of the world's top research institutions. Frontier will continue to improve our faculty and student experience and quality, it will help to attract some of the best and brightest students that we often lose to higher-ranked institutions by lowering the barrier of awareness to Ohio State, and it will enable new engagements with industry and governmental bi-national programs that are aligned with Ohio State's research strengths and strategic growth.

The initial topical areas targeted by Frontier, including quantum information, advanced materials and manufacturing, energy and power electronics among them, are all prime focus areas aligned with recent investments by Ohio State. The connection of these with IIT Bombay's strengths, with an eye toward amplifying a corporate engagement strategy for joint project support over time, presents a model of great interest to the Office of Research that can be evaluated for future partnerships between the university and international partner institutions. This fact, the alignment of Frontier's research directions with many of the front line strategic directions and recent investments made by the University, and the huge impact possible on our research students and faculty have made me very keen to see the success of Frontier. I am therefore delighted to reiterate my strongest support for Frontier Center's formal establishment.

Sincerely,

Morley O. Stone

Morley O. Stone, PhD
Senior Vice President for Research

THE OHIO STATE UNIVERSITY

College of Engineering

Office of the Dean

122 Hitchcock Hall
2070 Neil Avenue

Columbus, OH 43210

(614) 292-2836 Phone
(614) 292-9615 Fax

May 6, 2020

Professor Steven A. Ringel
Associate Vice President for Research
Executive Director, Institute for Materials Research
E337 Scott Lab

Dear Professor Ringel,

I enthusiastically endorse and support your team's proposal to formally establish the Indian Institute of Technology Bombay - Ohio State Frontier Science and Engineering Research Center. Since 2014, we have worked together on advancing OSU's relationships with both industry and academic entities. It is very gratifying to see that work, which is a significant focus area of the Materials and Manufacturing for Sustainability (M&MS) Discovery Theme program, come to fruition. The topical areas of the Frontier Center, as noted in your proposal to CAA, align perfectly with the College of Engineering's strategic plans and investment directions in terms of research topics (e.g., manufacturing, materials, energy) and our desire to create additional global experiences for our students. Congratulations on making this happen!

A critical pathway to ensure success is to leverage internal resources to attract significant external partnerships for the benefit of our research and innovation enterprise. This course of action helped to sustain Frontier through external support early on and will continue to do so well into the future. Creating a diverse team from both OSU and IIT-Bombay as the core collaborators for external touchpoints, especially to the industry, is an innovative model and one that is appropriate for Ohio State's first global research center. By using center management operations in place at the Institute of Materials Research (IMR), Frontier can move quickly, and their global aspect will continue to expand IMR's existing global partnership grant (GPG) program.

Activities which include workshops, funding from the IUSTTF, several seed projects, and an initial MOU signed by President Drake, date back to 2015 when your team first engaged with IIT Bombay, Indian industries, in conjunction with the India Global Gateway office in Mumbai. I am delighted to see this thoughtful and deliberate use of limited internal resources that leverage prior investments to IMR and

M&MS. With at least 50 faculty engaged and your first round of 6 jointly funded projects with IIT Bombay, you are off to a great start!

The Frontier Center will offer a new dimension to the faculty and student experience at Ohio State with respect to global research and impact. The presence of this center will be an important asset to the College of Engineering and very useful in attracting top-quality students. Having a vehicle to attract the best and brightest from India's top academic institution is critical to our College's growth and creates an opportunity to achieve an even higher level of quality. Frontier's unique position as a bi-national and bi-university entity is as valuable as it is innovative. I offer my most substantial support for the formal establishment of the Frontier Center.

Sincerely,

David B. Williams, Ph.D., Sc.D.
Monte Ahuja Endowed Dean's Chair
Dean of the College of Engineering

APPENDIX E

RESOURCE COMMITMENT APPROVAL OF THE FRONTIER CENTER

THE OHIO STATE UNIVERSITY

MEMORANDUM

RE: **Resource Commitment Approval Memo**
Date: **June 6, 2019**
To: **Office of International Affairs**
Subject: **International Agreement with the Indian Institute of Technology, Bombay, India**

I hereby authorize International Partnerships, Office of International Affairs to approve the above referenced agreement, with the below funding schedule, on behalf of The Office of International Affairs in the OnBase Contract Management Portal. I have reviewed the agreement for financial and personnel commitments and bid waiver requirements.

Is a bid waiver required? (If so, please attach) **YES** **NO**

FUNDING SCHEDULE

	FY20	FY21	FY22	FY23	Total
Office of Research	$ 81,250	$ 125,000	$ 95,000	$ 23,750	$ 325,000
College of Engineering	$ -	$ 75,000	$ 125,000	$ 125,000	$ 325,000
Institute for Materials Research	$ 81,250	$ 125,000	$ 105,000	$ 13,750	$ 325,000
Total	**$ 162,500**	**$ 325,000**	**$ 325,000**	**$ 162,500**	**$ 975,000**

The referenced agreement has my approval, and I authorize the Office of International Affairs to upload and approve it in the Ohio State OnBase system.

DocuSigned by: Brad A. Harris E619572C4AF3402... 6/6/2019
Brad Harris — Date
Chief of Staff, Research Administration

DocuSigned by: Marie Mendenhall-Mead 08BCAE28E1CF4B5... 6/6/2019
Marie Mendenhall-Mead — Date
Chief of Staff, College of Engineering

DocuSigned by: Steven Ringel 3C36528619AA4FC... 6/6/2019
Steven Ringel — Date
Executive Director, Institute for Materials Research

DocuSigned by: Linda Dawn Montaño 6BBCCE5C265F4BD... 6/10/2019
Linda Montaño — Date
Sr. Director of Business Operations and Administration, Office of International Affairs

APPENDIX F

INTER-INSTITUTIONAL AGREEMENT OF THE FRONTIER CENTER

THE OHIO STATE UNIVERSITY

INTER-INSTITUTION INITIATIVE AGREEMENT

BETWEEN

THE INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY, INDIA

AND

THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO, USA

The purpose of this Inter-Institution Initiative Agreement is to outline and agree upon plans for a formal strategic partnership between Indian Institute of Technology Bombay (hereafter referred to as "IITB") and The Ohio State University on behalf of its Institute for Materials Research, (hereafter referred to as "Ohio State") to create a Joint Center for collaborative research that furthers the stated goals within the referenced Master Memorandum of Understanding (MOU).

Both parties come to the following agreement and approve:

(1) IIT Bombay and Ohio State will create the joint IIT Bombay Ohio State Frontier Center for Science and Engineering Research – FRONTIER, which will support PhD students from both institutions as Frontier Center Scholars to be co-advised by partner faculty.

(2) The FRONTIER Center will be operated by IITB and by the Institute for Materials Research at Ohio State. IITB and Ohio State will each follow their respective university's policies and guidelines for the establishment of the Center, including procedures for establishment, operations, and oversight.

(3) A joint Center leadership team will be formed from selected faculty at both institutions, which will be responsible for steering technical directions, establishing competitive reviews, processes and protocols, enabling workshops, funding decisions, etc., and will be supported logistically by IITB and Ohio State-Institute for Materials Research (IMR) leadership.

(4) A bi-institutional oversight committee will be formed that will conduct an annual review of the Center.

(5) An initial 4-year seed period will be established via equitable support from both institutions. The number of Center Scholars fully or partly supported by the Center will be approximately between 15 and 30.

(6) Center Scholars will spend approximately 4-6 months each year at the host institution as a co-supervised PhD student after being agreed by the host faculty. Faculty members from both organizations will jointly discuss and agree upon the co-supervision of a doctoral student and the initiation of the process of including the faculty member from the Host institution as a co-supervisor shall be the responsibility of the faculty members at the Home institution.

(7) Faculty co-advisors are expected to spend 1-2 weeks at the partner institution, preferably coinciding with the visit of the co-supervised research scholars.

(8) Both institutions will provide resources to support the center in an equitable fashion. The resources will be managed by Center leadership and will have the following primary uses: (a) PhD Center Scholarships to cover stipend, benefits and tuition, (b) travel-related costs associated with visitation periods to the partner institution for both Center Scholars and faculty co-advisors of Center Scholars, (c) bi-annual workshops (one per year at each institution) to engage broader range of faculty, (d) partial offsetting of project-related costs (e.g. consumables, lab fees), and (e) partial offsetting of center administrative costs .

(9) Both institutions will identify dedicated space for the Center to be co-located at IITB and Ohio State and lab space will be provided by the host faculty advisor.

(10) Subject to university procedures and departmental approval, faculty participants will be awarded adjunct status (or similar) at the partner institution in the appropriate department and faculty partners would participate in final dissertation committees as appropriate.

(11) Institutional Facilitation

- Home institution:
  - IITB: IITB will provide one-time round-trip airfare, visa charges and travel insurance to its co-supervised Center scholars for their visit to Ohio State. IITB will continue to provide regular IITB stipend to its Center scholars during their stay at Ohio State. IITB will provide round-trip airfare, visa charges, medical insurance, per diem and hotel accommodation charges to IITB Center faculty once a year for a maximum of two weeks for their visit to Ohio State, preferably coinciding with the visit of their co-supervised Center scholars.
  - Ohio State: Ohio State will provide one-time, round-trip, economy airfare, visa charges and health insurance to its co-supervised Center scholars for their visit to IITB. Ohio State will continue to provide their regular Ohio State graduate student stipend to its Center scholars during their stay at IITB. Ohio State will provide round-trip, economy airfare, visa charges, and per diem to Ohio State Center faculty for a maximum of two weeks per year to visit IITB, preferably coinciding with the visit of their co-supervised Center scholars. If Ohio State Center faculty opt to stay outside of the IITB guesthouse, those costs will be covered by those faculty.
- Host institution:
  - IITB: IITB will provide one-time accommodation to visiting Center scholars from Ohio State during their visit to IITB. This will include boarding, living expenses, administrative fees and medical insurance. IITB will cover project-related research costs for work done at IITB. IITB will provide accommodations in its guest house for lodging of Ohio State Center faculty.
  - Ohio State: Ohio State will provide visiting scholar status in the appropriate academic department, subject to the approval of the department and to applicable university procedures. This status will include health insurance required for international scholars, appropriate visa, as well as support to cover lodging and living expenses. Ohio State will cover project-related research costs for work done at Ohio State.

(12) The processing for the visiting research scholars will be administered by the office of Dean International Relations at IIT Bombay and by the Institute for Materials Research at Ohio State working in conjunction with the host department and following the established procedures set forth by the Ohio State Office of International Affairs. To ensure efficient liaising between Ohio State and IITB including participation in annual workshops and tracking of Ohio State personnel while in residence at IITB, the India Gateway will have a non-technical, liaison position on the Center leadership team (see clause 3).

(13) A four (4) year schedule will be established, which includes an initial ramp-up period. The majority of Center-driven projects are expected to be receiving support from external sources during the 4 year period.
(14) Agreements pertaining to rights in developments in intellectual property among the universities and industry partners developed through this Center will be established later.

This Initiative Agreement shall enter into force after the signature of both parties and will cover the subsequent four (4) year duration, whereupon its terms will be revisited in the light of experience, with the expectation that it be renewed on a mutually agreeable basis, for a further three (3) years at a time. The agreement, as a component of the Master MOU, can either serve to extend the Master MOU date to match by signature here, or, if it is deemed that a new MOU is required by the termination date of the current Master MOU, this Initiative Agreement will carry over into the renewed Master MOU. The Initiative Agreement may be terminated by either party by giving six (6) months' written notice to that effect.

Indian Institute of Technology Bombay
Mumbai, India

18/6/19
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Director
Indian Institute of Technology Bombay

The Ohio State University
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6-6-19
Steven A. Ringel Date
Associate Vice President for Research
Executive Director, Institute for Materials Research
The Ohio State University

Morley O. Stone 6/6/19
Morley Stone Date
Senior Vice President for Research
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The Ohio State University

11 JUNE 2019
Gil Latz Date
Vice Provost for Global Strategies and International Affairs
The Ohio State University

Michael Papadakis 6/13/19
Michael Papadakis Date
Senior Vice President of Business and Finance & Chief Financial Officer
The Ohio State University