

University of Massachusetts Dartmouth Center for Scientific Computing and Visualization Research

Annual Report for July 1, 2015- June 30, 2016

1 Goal and Mission

The Center for Scientific Computing and Visualization Research (CSCVR) at UMass Dartmouth unites a group of highly-qualified and well-trained scientists with complementary backgrounds and interests who develop and use computational algorithms to simulate and visualize complex physical problems. The impetus for the formation of the center came from the awareness of our significant multidisciplinary and interdisciplinary expertise in scientific computing, and the desire to leverage existing strengths to build an internationally recognized center of excellence at UMass Dartmouth.

The primary mission of the center is to transcend the traditional departmental boundaries and form a close-knit and collaborative multidisciplinary group that will combine wide range of mathematical, computational, and scientific skills to make significant impact across the field of computational science. Our activities focus on creating a supportive and collaborative environment for computational science.

The CSCVR's website can be accessed at <http://cscvr.umassd.edu>.

1.1 Notable Faculty Accomplishments:

- Robert Fisher (Physics) will be a visiting faculty member at Harvard-Smithsonian Center for Astrophysics Institute for Theory and Computation during the 2016-2017 academic year.
- In Summer 2016 Lance Fiondella (ECE) is a Office of Naval Research, Summer Faculty Fellowship Program Visiting Researcher, Reliability and Maintainability (R&M) Division, Naval Air Systems Command (NAVAIR).
- Mehdi Raessi (ME) and EAS-CSE student Ashish Pathak had two papers published in Journal of Computational Physics on their three dimensional volume-of-fluid (VOF) method.
- In Summer 2016 Gaurav Khanna (Physics) was awarded a new NSF grant to continue his research work on black holes and gravitational waves.
- In January 2016 Gaurav Khanna (Physics), together with colleagues Lior Burko at Georgia Gwinnett College and Anil Zenginoglu at the University of Maryland, published a Rapid Communication in Physical Review D that includes *the first* computer simulation of the interior of a rotating black hole, uncovering the possibility of using them as a portal for hyperspace travel. This work received media attention with full length coverage in *Forbes Magazine*, *Universe Today* and *The Standard Times*.
- In January 2016, Mehdi Raessi (ME) was awarded a Department of Energy grant for research on *Evaporation Sub-Model Development for Volume of Fluid (eVOF) Method Applicable to Spray-Wall Interaction*. This grant is pending DOE foreign national approval.
- In October 2015 Lance Fiondella (ECE) was awarded an NSF grant for research on Robust Algorithms for an Open Source Software Reliability Tool.
- In October 2015, Amit Tandon (Mechanical Engineering) completed an ONR-sponsored expedition to the Indian Ocean that brought together 50 scientists from the U.S. and India to study the conditions that create monsoons, which affect weather around the globe and the agrarian economy for more than one billion people in Indian Ocean nations. The team, led by Dr. Tandon, worked aboard the research vessel R/V Roger Revelle, which is operated by the Scripps

Institution of Oceanography under a charter agreement with ONR. Another team of Indian and U.S. scientists on the Indian research vessel Sagar Nidhi worked jointly with those on the Roger Revelle.

- In July 2015, Mehdi Raessi (ME) was awarded an Office of Naval Research grant for research on the role of scale in the development and evolution of stratified shear turbulence, entrainment and mixing.
- In July 2015, Sigal Gottlieb (Math) was awarded an AFOSR grant for research on strong stability preserving time-stepping methods.
- In July 2015, Lance Fiondella (ECE) was awarded a grant from the National Center for Risk and Economic Analysis of Terrorism Events (CREATE) at University of Southern California for his research on *Dynamic Transportation Network Vulnerability Assessment Algorithms*.
- In June 2015, Geoff Cowles was awarded a NOAA Saltonstall-Kennedy (S-K) Grant for his use of archival tagging data to develop geolocation methodologies for North Atlantic groundfish.
- In April 2015, Vanni Bucci (Biology) received an award from the NIH to apply Big Data to design smarter and targeted treatments for infectious intestine diseases.
- In April 2015, Vanni Bucci (Biology) received an award from the National Science Foundation for “ABI Innovation: A new computational framework for the prediction of microbiome dynamics”.
- In April 2015, Lance Fiondella (ECE) was awarded an Army Research Laboratory grant on *Rotorcraft Tradespace Exploration incorporating Reliability Engineering*.
- In March 2015, Lance Fiondella (ECE) was awarded a grant from Systems Engineering Research Center (SERC), a University-Affiliated Research Center of the US Department of Defense, Stevens Institute of Technology, for research on software reliability modeling.
- In March 2015, Sigal Gottlieb (Math) was featured in *BostInno* <http://tinyurl.com/z5jonoz>.
- In February 2015, Robert Fisher (Physics) together with several colleagues including EAS-CSE graduate student Rahul Kashyap, published a paper on *Spiral Instability Can Drive Thermonuclear Explosions in Binary White Dwarf Mergers* in *Astrophysical Journal Letters*.
- In January 2015, Akil Narayan (Math) was awarded an AFOSR Young Investigator Research Program (YIP) grant for a project titled “Optimal and unstructured high-order non-intrusive approximations for uncertain parameterized simulations”. Dr. Narayan has since left the University for a position at University of Utah.

1.2 Major CSCVR Activities

HPC Day Conference. In November 2014 we initiated a UMass system-wide high performance computing (HPC) day conference. This year, in May 2016, we extended the scope of the HPC Day to include Boston University, Harvard University, MIT, Northeastern University, and the University of Massachusetts, all the Universities that participate in the Massachusetts Green High Performance Computing Center (MGHPCC). This one-day event highlighted the research in high performance computing (HPC) at these institutions.

The event featured a total of 11 talks with topics ranging from engineering microbial systems to renewable energy extraction from the ocean. Over 145 attendees registered in this event in total, and 30 student posters were presented. The keynote speaker was Dr. Jeremy Kepner from MIT Lincoln Lab who gave an fascinating and deeply engaging lecture titled “Interactive Supercomputing for High Performance Data Analysis.” The event also featured an interactive Education Panel that included stakeholders from industry and academia to discuss issues associated with HPC education and training. The conference featured a student poster competition, with six awards for student posters were made possible via generous donations by Nvidia, SIAM and MathWorks. The conference lunch was sponsored by Microway Inc.

Interstellar Movie Event. On March 29, 2016 the CSCVR, together with the Physics and Mathematics Departments, welcomed renowned physicist Dr. Kip Thorne for an event on the Hollywood blockbuster *Interstellar*. Dr. Thorne is the originator and one of the executive producers of this 2014 movie, which is based on black holes, spatial wormholes, and other concepts at the forefront of theoretical gravitational physics. Dr. Thorne's visit to campus came at a very important time for the chosen field of Dr. Thorne and many UMass Dartmouth faculty and students. Dr. Thorne recently received international acclaim for a very different achievement beyond Hollywood. He, along with Dr. Rai Weiss of MIT, led a collaboration to build the Laser Interferometer Gravitational-Wave Observatory (LIGO). On February 11, the National Science Foundation, which funded LIGO, announced the breakthrough detection of gravitational waves from the merger of massive black holes in a distant galaxy. This historic news came 100 years after Albert Einstein predicted the existence of gravitational waves. Two screenings of *Interstellar* were scheduled on the day of Dr. Thorne's visit to our campus. Dr. Thorne, the Feynman Professor of Theoretical Physics, Emeritus at Caltech, joined UMass Dartmouth Physics faculty Robert Fisher, David Kagan, Gaurav Khanna, Richard Price, and School for Marine Science & Technology (SMAST) Professor Geoff Cowles in the Claire T. Carney Library Stoico/FIRSTFED Charitable Foundation Grand Reading Room at 4:30 p.m. for a reception followed by a series of talks at 5 p.m. and a panel discussion at 6 p.m. on the science of *Interstellar*. The event drew over 150 people, and highlighted the importance of numerical simulations across the sciences.

Fall 2015 Finite Element Circus. CSCVR affiliates Yanlai Chen and Bo Dong organized the Fall 2015 Finite Element Circus at UMass Dartmouth on October 16th and 17th of 2015.

The finite element circus is a biannual national conference held at varying locations in the eastern and central parts of the country. It is typically attended by computational mathematics researchers studying the theory and implementation of the finite element methods, which are popular numerical methods for solving equations modeling natural phenomena ranging from weather to stock market. There are couple of interesting traditions of the conference. First, there is no set schedule before the start of the meeting. Instead, speakers are volunteers from the audience who must be present at 1:30pm on Friday when the circus convenes. Given the number of volunteers, the length of a talk is calculated by the ringmasters at the start of the conference and the order is assigned randomly (no speaker can request a specific time to talk). Second, there is typically a Circus Poem written for each circus. Please refer to to the conference wesite <http://www.math.rutgers.edu/~falk/fecircus> for more details.

The UMass Dartmouth's version was supported by the College of Arts and Science, the Office of Research Development, and the CSCVR. It was the first time the circus came to our state in 40 years (Harvard University hosted before UMassD in 1975). There were 71 registered participants from at least 21 states and 3 other countries. The audience is diverse ranging from prominent fellows of multiple professional societies to beginning PhD students. By bringing such an impressive group to campus, the circus raised the profile of our Math department and our university. It showed us not as a small town university, but as a research-oriented university. In the long term, it has the potential to attract new graduate students and new faculty hires.

Ongoing Activities. The CSCVR hosts several gatherings each year including lunches, picnics, seminars, and workshops. We also hold meetings to discuss issues including computational equipment, grant funding opportunities and issues, and welcoming new hires. This year we gathered at the CSCVR to watch the LIGO gravitational waves announcement, joined by many faculty from across the campus. A few weeks later, we hosted (jointly with the Physics Department) a seminar given by Associate Director Gaurav Khanna on gravitational waves. These meetings were well attended, with standing-room only space for the seminar.

1.3 Donations of Hardware to the CSCVR

- in June 2015, the CSCVR received donations of two supercomputers. The key feature of both systems is that they are GPU-accelerated i.e. they use high-end video-gaming graphics-cards to speed up numerical calculations significantly. These make the systems excellent for a large variety of scientific applications. The larger system amongst the two was built in 2012 at cost nearing a million dollars and consists of 180 servers installed in 10 racks, integrated tightly over a fast network.
- In May 2016 the CSCVR received an in-kind “SwitchBlade” grant from Hewlett Packard Enterprise (HPE). The granted equipment consists of an HP SwitchBlade Center chassis that contains the required power and networking infrastructure to support up to 16 high-end blade servers for high-performance computing. Two servers are included in this grant, leaving room for straightforward and low-cost expansion in the future. The granted hardware is valued at \$94K. With the two included servers, the system currently has 64 Intel Xeon E5 processor cores, 512 GB main memory, 2 TB storage connected via a high-speed network. The SwitchBlade system is currently being leveraged to attract new top-notch faculty to the university. These faculty and their students will be affiliated with the CSCVR.

1.4 Publicity:

National

- Sigal Gottlieb, Alfa Heryudono, Saeja Kim, and Cheng Wang were acknowledged in a preface of a book by B. Fornberg and N. Flyer in CBMS-NSF series, as follows: “This book project would not have been possible without the generous help of many organizations and individuals. The Regional Research Conference was supported by NSF under the grant DMS 1040883. . The conference was superbly organized by Saeja Kim, Sigal Gottlieb, Alfa Heryudono, and Cheng Wang. ... ”.
- Saeja Kim (Math) was Invited to participate in ”Mathematics in Data Science,” topical workshop at the Institute for Computational and Experimental Research in Mathematics (ICERM), July 28-30, 2015: Exploring the Role of the Mathematical Sciences in an Evolving Discipline. http://icerm.brown.edu/topical_workshops/tw15-6-mds/
- As noted before, Sigal Gottlieb was featured in *BostInno* <http://tinyurl.com/z5jonz>.
- As mentioned earlier, Gaurav Khanna’s work on the physics of a black hole’s interior “singularity” received nationwide attention via *Forbes* <http://www.forbes.com/sites/johnfarrell/2016/02/10/black-holes-could-be-gateways-after-all/>.
- In July 2016 Khanna’s approach towards “misusing” video-gaming devices for scientific computing received significant exposure through an article published in *HPCWire* <http://www.hpcwire.com/2016/07/14/alternative-supercomputing-misuse-computer>.

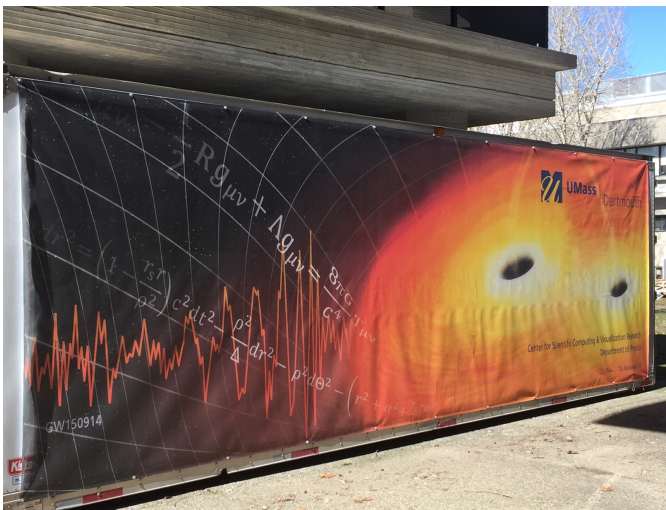
Local

- Our event *Interstellar: The Real Science Behind the Movie* was featured on the SouthCoast Today <http://www.southcoasttoday.com/article/20160329/NEWS/160329387>. This event featured CSCVR faculty Gaurav Khanna, Robert Fisher, and Geoff Cowles, joined by CSCVR Scientific Advisory Board member Richard Price and renowned physicist Kip Thorne.
- Saeja Kim (Math) was invited by Dan McCready at Townsquare Media New Bedford/Fall River, to give a live phone interview about Pi Day on WBSM radio. The interview, with Phil Paleologos, aired on Monday March 14, 2016. <http://wbsm.com/wbsm-celebrates-pi-day/>

- Robert Fisher (Physics) gave an interview for NPR WCAI Living Lab Interview, on February 1, 2016.

On Campus

- The refrigerated shipping container which is used as housing for the cluster (widely featured in a variety of news outlets including the New York Times) received a beautiful mural, designed by a Physics undergraduate students.
- The CSCVR Summer 2015 Newsletter featured the news that CSCVR researchers are now exploring the potential of Qualcomm Snapdragon technology in the context of very high-efficiency scientific supercomputing. They are using Inforce Computings SBC as an initial test system.



- The approach is strongly application-driven they are using full-scale astrophysics and computational mathematics research codes to evaluate the technology in depth. In particular, Prof. Khannas black hole simulation code, that computes the details of the process of a star being captured by a large black hole, was run on the Snapdragon processor and its overall performance compared with traditional computer systems. However, the Snapdragon processor cores offer nearly 30 times higher power-efficiency compared with traditional supercomputer servers! This was well beyond expectations and there is currently great enthusiasm at the CSCVR about pursuing this approach, potentially with Qualcomms assistance.
- Robert Fisher gave a ARNIE talk on Feb 3, 2016 on *The Once And Future Universe: Understanding Our Place in the Cosmos with Exploding Stars*. <http://www.umassd.edu/news/video/arnietalk-robertfisher.html>
- Saeja Kim (Math) served as a one of four panelist at the EMIRGE(Empowering Massachusetts Innovation and Research in Graduate Education) conference Women in STEM Roundtable, April 30, 2016, at Woodland Commons.
- Saeja Kim served as a panelist at the annual STEM4Girls, 6th annual STEM outreach event, on May 21, 2016.

1.5 Education

The Center for Scientific Computing and Visualization Research promotes the mission of the University by providing undergraduate and graduate students with high quality discovery-based educational experiences that transcend the traditional boundaries of academic field or department. The CSCVR faculty were instrumental in establishing the “Computational Science and Engineering” option in the newly created “Engineering and Applied Sciences” umbrella Ph.D. program at the UMass Dartmouth campus. There are currently 30 students in the entire EAS program, of whom 15 are in the CSE track and advised by center affiliates. Two CSE students have graduated from the program recently. This program played a major role in the university achieving national doctoral research university status earlier this year. It is likely to play an even more significant role in the future in order for the campus to maintain that notable status. The CSCVR supports doctoral students in this track at various

levels including: providing office space, computational resources, specialized coursework, access to a large team of computational researchers for advising and consultation, access to a variety of research projects, regular seminars series and in some cases, even fellowship funding.

Professional Preparation Activities. We have been mentoring our students in a group setting as well as individually. This mentoring has formal aspects, such as a required research ethics class geared toward students in the computational science, and a research seminar class where students report on seminars they have attended and practice giving seminars and critiquing themselves and their colleagues. We also hold reading groups on particular topics that are open to interested students. Our students are also involved in running a SIAM student chapter and its attendant activities.

Student accomplishments or internships Board members suggested that we work to place talented students at National Labs for summer internships. We have been successful in doing so:

- Ph.D. student Rahul Kashyap presented a poster at Sackler meeting at Harvard in May, 2016, and a talk at the ICRAnet meeting in Pescara, Italy in June, 2016.
- Leah Isherwood had a summer internship at NUWC in summer 2015 and in summer 2016.
- Tiffany Ferreira had a summer internship at MIT Lincoln Laboratory in summer 2015.
- Sidafa Conde had a summer internship at Sandia National Lab (New Mexico) in summer 2015 and in summer 2016.
- Jiahua Jiang has a summer internship at Sandia National Lab (California) in summer 2016.
- Venkateswaran Shekar, 2016 summer internship at Pacific Northwest National Lab (PNNL)
- Saikath Bhattacharya, 2016 summer internship at University of Maryland (UMD) Center for Advance Lifecycle Engineering (CALCE).
- Jimmy Rodriguez, General Dynamics Land Systems (GDLS) summer internship.
- Graduating M.S. student Pranav Dave admitted to numerous Ph.D. programs including some fellowships, accepted an offer from physics Ph.D. program at Georgia Tech.
- Ashish Pathak won the Best Poster Award of the High Performance Computing (HPC) Day 2016 meeting.
- Tiffany Ferreira won a Sigma Xi poster award at the Sigma Xi event on campus.
- Izak Thuestad was the only undergraduate student (Physics) to win one of the best poster awards at the HPC Day 2016 meeting on-campus.

2 Total Revenue

Source	Amount
Indirect cost distribution	\$27,528.16
Gift (Microway sponsorship for HPC Day)	\$2,715.00
Gift (large computer cluster, estimated value:)	\$120,000.00
Gift (small computer cluster, estimated value:)	\$4,800.00
Gift ("SwitchBlade" grant from HPE, value:)	\$94,000.00
Total	\$249,043.16

3 Total Expenditures by category

This year, as in previous years, Dean Peck covered the Director's stipend and course release from his College budget. Also, Dean Peck received funds from the UMass President's office for innovative hardware for the CSCVR. These funds paid for large video displays, the innovative mobile device supercomputer Elroy (described below), storage and memory upgrades for the large donated cluster, and some smaller visualization hardware.

As the center did not receive its own budget allocation this year, we spent money infrequently. Our major source of funds was indirect cost distributions, which we have been saving up until we have sufficient funds for substantial needs. In the table below we report each of our expense this year from the center IDC account:

Code	Expense detail (see additional sheet)	Amount	Description
AP	Conference Misc & Temp Space	\$493.75	Center Fall workshop luncheon
AP	Conference Misc & Temp Space	\$1,900.00	Interstellar event refreshments
AP	Non employee expenses	\$286.24	Travel reimbursement for seminar speaker
AP	Conference Misc & Temp Space	\$3561.38	Refreshments for HPC conference
AP	Lab supplies	\$471.60	Storage unit for Elroy, the mobile device cluster
ONL	Furnishings/Equip under \$5,000	\$576.99	New LCD projector for CSCVR room
ONL	IT Equipment under \$5,000	\$429.00	Replacement disk for IBM iDataPlex cluster
ONL	CampusSvc	\$775.00	For HPC conference
PRT	May 2016 Prinshop Chargebacks	\$78.60	Brochures for HPC conference

4 Employees and Consultants

4.1 Unofficial Staff

Although the center does not officially have any administrative assistants, Ms. Jill Peters (Math) and Ms. Deborah Raposa (Engineering) have been very helpful to us. In particular, Ms. Raposa has assisted us with purchases for the CSCVR, and Ms. Peters with purchases and conference/event organization.

4.2 Internal Board of Center Affiliates

Alireza Asadpour (Assistant Professor of Civil Engineering)

Ramprasad Balasubramanian (Professor of Computer and Information Science).

John R. Buck (Professor of Electrical and Computer Engineering)

Vanni Bucci (Assistant Professor of Biology)

Geoffrey Cowles (Associate Professor in the Dept. of Fisheries Oceanography)

Yanlai Chen (Assistant Professor of Mathematics)

Gary Davis (Professor of Mathematics)

Bo Dong (Assistant Professor of Mathematics)

Lance Fiondella (Assistant Professor of ECE)

Robert Fisher (Associate Professor of Physics)

Sigal Gottlieb (Professor of Mathematics)

Adam Hausknecht (Professor of Mathematics)

Alfa Heryudono (Associate Professor of Mathematics)

Gaurav Khanna (Professor of Physics)

Firas Khatib (Assistant Professor in the Computer and Information Science Department)

Saeja Kim (Professor of Mathematics)

Steven Leon (Chancellor Professor Emeritus of Mathematics)

Maricris Mayes (Assistant Professor of Chemistry)

Akil Narayan (Assistant Professor of Mathematics)

Mehdi Raessi (Assistant Professor of Mechanical Engineering)

Amit Tandon (Professor of Mechanical Engineering and Estuarine and Ocean Sciences)

Mazdak Tootkaboni (Assistant Professor of Civil Engineering)

Cheng Wang (Associate Professor of Mathematics)

Jay Wang (Associate Professor of Physics)

4.3 External Scientific Advisory Board

One of our first objectives once the center was approved was to create a scientific advisory board comprised of leaders in the field of scientific computing and related sciences to assist in directing the CSCVR's research agenda, advise on research directions and trends in the field, and help identify appropriate collaboration and funding opportunities. Our current scientific advisory board consists of:

Mark Barnell, AFRL (Rome, NY)

Marsha Berger, NYU, <https://cs.nyu.edu/berger/>

Jack Dongarra, University of Tennessee and Oak Ridge National Lab

<http://www.eecs.utk.edu/people/faculty/dongarra/>

Paul Fischer, UIUC, <http://mechanical.illinois.edu/directory/faculty/fischerp>

Ian Foster, Argonne National Lab, <http://www.ci.anl.gov/people/profile.php?id=285>

Antony Jameson, Stanford University, <http://aero-comlab.stanford.edu/jameson/>

Kirk Jordan, IBM, <http://researcher.watson.ibm.com/researcher/view.php?person=us-kjordan>

Randy LeVeque, University of Washington, <http://faculty.washington.edu/rjl/>

Robert Panoff, Shodor Foundation, <http://www.shodor.org/about/board/panoff/>

Stanley Osher, UCLA, <http://www.math.ucla.edu/~sjo/>

Richard Price, University of Texas, <http://www.phys.utb.edu/~rprice/rprice.html>

Chi-Wang Shu, Brown University, <http://www.dam.brown.edu/people/shu/>

Alex Pothén, Purdue University, Director of a DOE-funded Petascale Computing Group <http://www.cs.purdue.edu/homes/apothén/>

5 Physical Space Occupied

5.1 Physical facilities

The center facility is in the Textiles building room 105 (TXT105). The center room renovation was completed in summer 2013 and provides an attractive and inviting work and collaboration space for faculty and students to congregate and has served as a catalyst for a number of new multidisciplinary projects. The CSCVR facility has spaces for students and visitors to work and flexible collaboration spaces that can be used for seminars, large and small group meetings, lunches, and informal gatherings. The computer clusters belonging to the CSCVR are housed in the data center, and in a refrigerated container with a new mural designed by a Physics undergraduate.



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5.2 Computational Resources

iDataPlex CPU/GPU cluster The CSCVR has high performance computing facilities consisting of an IBM cluster with a total of 80 nodes (640 CPU cores), with 64 Nvidia Tesla GPU cards, networked with QDR Infiniband, and providing over 50 TB of NAS storage.

This equipment was purchased in 2011 by two federal grants: an AFOSR DURIP grant and an NSF MRI award, as well as startup funds for new faculty members, Mehdi Raessi and Mazdak Tootkaboni. Our computational facilities reflect our emphasis on, and expertise in, GPU computing. At last count, the computational facility now supports 20 faculty investigators and 28 postdoctoral, graduate student, and undergraduate student users. Additionally, it has been utilized in several undergraduate and graduate courses in the Mechanical Engineering, Mathematics, and Physics departments.



The cluster has very high utilization (over 80%) and has completed over *1 million* separate compute jobs since its installation.

Playstation cluster: UMass Dartmouth pioneered the use of Sony PlayStation3s for astrophysics research back in 2007 when Gaurav Khanna of the Physics Department created a computer cluster of 16 PS3s and ran his black hole research simulations at supercomputer-level performance. These facilities were significantly augmented 2 years ago when Dr. Barnell’s group at the Air Force Research Lab (AFRL) at Rome, NY granted CSCVR nine full racks (396 units) of Sony PlayStation 3s for research computing. This equipment transfer was done under Gaurav Khanna’s CRADA (AFRL) agreement.

ARNiE: In 2015 we received donations of two supercomputers that were built and used for mining Bitcoins, in response to the New York Times article on Prof. Gaurav Khanna’s novel use of PlayStations for his computational research in black hole astrophysics. The larger system amongst the two was built in 2012 at cost nearing a million dollars and consists of 180 servers installed in 10 racks, integrated over a gigabit network. This cluster (now called ARNiE, after our campus’ mascot) nodes have 8-core Intel Core i7 CPUs, an Nvidia CUDA “Fermi” GPU and 24 GB of main memory. The cluster also has 130 TB of attached (available) storage that was recently upgraded to 200 TB.

Elroy: The CSCVR recently debuted a new innovative prototype supercomputer built entirely of mobile-devices (in particular, Nvidia Tegra X1 components used to build tablets) dubbed “Elroy”. The system’s total raw compute capacity is 16 teraflop/s and consumes just over 300W total power. The unique feature of this 32-node system is its extremely high power efficiency – an order-of-magnitude larger than traditional systems. This was made possible by leveraging recent, very significant power-efficiency related advances that have been cleverly engineered into current cell phones and other mobile devices (to prolong battery life). Power-efficiency is a limiting factor in large scale supercomputing as well, due to the expenses associated to large power consumption and corresponding cooling requirements. Elroy demonstrates a unique approach towards potentially meeting this challenge. This project was a result of a collaborative effort between the CSCVR and UMass Dartmouth CITS.

MGHPCC: The Massachusetts Green High Performance Computing Center (MGHPCC) is a data center dedicated to research computing, operated by five of the research-intensive universities in Massachusetts: Boston University, Harvard University, MIT, Northeastern University, and the University of Massachusetts. The University of Massachusetts system acquired a shared HPC cluster, which came online at the very end of 2013 that currently sports over 16,000 processing CPU cores and a large amount of memory. Unfortunately, this cluster was designed primarily for scientists in the life sciences,

and CSCVR affiliates have found that their codes scale poorly on these machines, and in fact are faster on our old local machine by a factor of 10 (and if our GPUs are included, a factor of 100). Gaurav Khanna and Sigal Gottlieb are working closely with the UMass Dartmouth administration and the UMass President’s office to advocate for the needs of the CSCVR researchers. To date, they met with the MGHPCC systems administrators and isolated a part of the UMass cluster to test the scalability of typical CSCVR affiliates codes, and discovered that the problem is not easily fixable. They have since met with UMass Dartmouth senior administration members to discuss solutions and to recommend hardware purchases. At this time, it seems that investing in local hardware would be significantly more cost efficient. The parameters and recommendations for such investment is in discussion.

6 Projected Budget and Goals for Coming Year

The ongoing budget crises at UMass Dartmouth have resulted in inadequate funding: the University has not yet established a budget for the CSCVR, and we have been currently operating through the generous support of the Dean of Engineering Robert Peck. He has advocated for us and provided us with funds from his own budget to cover the necessary basic needs, and also obtained funding from the UMass President’s office for computer and visualization hardware. We have managed to accomplish much on these limited funds: first and foremost, we are providing close mentoring of the junior faculty in research and grantsmanship and we are often told that this was a major contribution to their success in receiving grants, retention and to their general sense of well-being in their departments. CSCVR affiliates are among the most successful researchers on campus, as evidenced by innovative publications and success in attaining grant funding. Second, the CSCVR has increased its visibility on and off campus, resulting in increased awareness of our strengths in high performance computing and attracting significant donations of hardware. We have created an identity as a center of multidisciplinary scientific computing that is now recognized nationally. This has greatly benefitted us in attracting new hires.

6.1 Requested Budget for 2016-2017

The funds for the CSCVR support twenty faculty affiliates and close to thirty students and postdoctoral researchers. This budget is an investment in multi- and inter-disciplinary research.

Director’s Stipend	\$15,000
Course buyout	\$15,000
2 Research Assistants (\$20K stipend + waiver)	\$70,000
Startup (seed funding; course buyout)	\$30,000
Operations (travel, workshops, marketing, etc.)	\$18,000
Total	\$148,000

6.2 Goals

The following are our priorities for the coming year:

- Increase our visibility both within the campus and outside, through seminars and conferences.
- Create and maintain mentoring and collaboration opportunities for center affiliates, through regular seminars, workshops, lunches, and other informal events (picnics), as well as meeting with junior faculty to create mentoring relationships.
- Work towards hiring a computer technician. While this has not yet been possible, we will be partnering with the Computing and Information Technology Services (CITS) to support a doctoral student as a technician, hopefully this coming academic year.

- Continue to advocate, with Dean Peck's help, that the University fund the center at the levels proposed when the center was approved. The budget challenges have been severe, and has included budget cuts. We are hopeful that the budgetary situation will improve and that the new budget will reflect the campus' strategic focus on prioritizing research activities.
- Focus on education in the computational sciences at the undergraduate and graduate level. Scientific Advisory Board member Dr. Richard Price joined our campus in a formal capacity to develop new opportunities for undergraduate and graduate students in our programs. We will also be applying for NSF funding to continue to provide our students with excellent educational opportunities.
- Maintain and upgrade our computational facilities. Thanks to associate director Gaurav Khanna and Dean Peck, we are also maintaining our current computational facilities. We are also working with the CIO Holger Dippel and Andrew Darling to ensure that the University Data Center be regularly updated to ensure stability of our electrical and cooling system.
- Establish an agreement with the International Center for Relativistic Astrophysics Network (ICRAnet) in Pescara, Italy. Remo Ruffini, the director of ICRAnet has built a network spanning institutes in Italy, Brazil, Armenia, and the Vatican, and there are plans to extend it to Israel (working with Tsvi Piran) and other locations in South America. We are exploring a cooperative agreement which would be the basis for exchanges of faculty and students and other activities.
- Formulate a strategic spending plan in line with the initial center proposal that will inform us how to best use the CSCVR funds which are a portion of the indirect cost recovery from affiliate's grants.

In the original CSCVR proposal that was approved by the University administration, we mentioned that the Center will require funding for a Director and an Associate Director, administrative and technical support staff, seed funding for Center affiliates, and graduate research assistants. We also mentioned that funding will be required for travel and course releases. Our original funding model was based on University funding for the first three years, and later we would expect that many of the costs will be covered through successful Center research grants. However, the CSCVR has not received any independent funding from the University, and although Dean Peck has generously funded the director's stipend and course release continually, two years of a graduate fellow, and other CSCVR needs as they arise, the lack of a predictable annual budget has led to difficulties in budgeting and building the momentum that would help bring in significant funds.

The donated computer cluster has helped us in this regard, and we intend to focus on building toward more donations. We also have the portion of the indirect cost recovery from affiliate's grants, currently at approximately \$40,000. To date, we used this account for small expenses such as funding workshops, conferences, and other CSCVR activities. In the coming year, we will use these funds to help cover the budget.