Venkatarao Ganni, Ph.D.
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EDUCATION:

Oklahoma State University at Stillwater, 1979
Major: Mechanical Engineering, Thermal Sciences
Degree: Ph.D.

University of Wisconsin at Madison, 1976
Major: Mechanical Engineering, Thermal Sciences
Degree: M.S.

Indian Institute of Technology at Madras, 1973
Major: Mechanical Engineering, Turbo machinery
Degree: M. Tech.

Manipal Engineering College, 1971
Major: Mechanical Engineering
Degree: B. Eng.

RESEARCH INTERESTS:

Thermodynamics, heat transfer, fluid mechanics. Cryogenic plant and system process design and optimization. Sub-system development and optimization; compressors, purifiers, heat exchangers, system test hardware.

EXPERTISE:

Cryogenic process plant and sub-system process equipment development, optimization, design and trade-off studies.

EXPERIENCE:

2016 August - present, FRIB – Director for MSU Cryogenic Initiative

- FRIB 2 K cryogenic system is commissioned and met all the design goals
- The large 4.5K cryo refrigeration system is operating with unprecedented low utilities and operations man power support using of 1.3 MW electric power and 6 GPH of LN2 use to supporting the commissioning of the accelerator cryo sub components; a record

low utility use and unattended operation for this size cryo system, especially during the other accelerator sub systems commissioning stages.
- Commissioned LS1 and LS2 cryo distribution systems and supported the cool down and commissioning of 20 cryo modules
- FRIB 4.5K Cryo system: Commissioned, performance tested and transitioned to the around the clock unattended operation to support, cryo distribution commissioning, cryo module commissioning and the beam operation in the first three cryo modules.
- Maintaining the collaboration with Mechanical Engineering department
- Train the staff and students on engineering and commissioning activities for FRIB cryogenic and support systems
- Teaching some sections of Mechanical Design of Cryogenic Systems: ME414 (fall semesters) and Cryogenic Thermal Systems: ME413 (spring semesters)
- Taught the cryogenic Process Engineering at USPAS, 2018
- Taught the cryogenic Engineering ME940 in the fall semesters 2017

1994-2016 July, Thomas Jefferson National Accelerator Facility (formerly CEBAF, now JLab) - Principal staff engineer in the Cryogenics Systems Group

- MSU-FRIB/Lansing 2 K refrigeration system (2012-2016), process design and supervision of mechanical design of cryogenic system, including compressor system/piping, 4.5-K cold box, 2-K cold box, cryogenic distribution, gas storage, liquid helium storage and purifier sub-systems, Principal Staff Engineer
- JLab Hall-B Cryo Distribution System (2014-2016), planning and design of cryo central distribution system and the cryo cans for the Torus and the solenoid magnets, Principal Staff Engineer
- JLab 12GeV upgrade 2 K refrigeration system (2007-2013), process design, supervision of mechanical design and commissioning of cryogenic system, including new compressor skid design, 4.5-K cold box, 2-K cold box, liquid helium storage and piping, Principal Staff Engineer
- JLab Hall-D 4.5-K cryo system (2011-2013), planning, helium refrigeration and distribution system and the magnet interface can design, Principal Staff Engineer
- NASA-JSC/Houston 20-K helium refrigerator system (2007-2012), process and mechanical design of helium refrigerator system and nitrogen shield thermo-siphon system, Principal Staff Engineer
- BNL/Long Island 4.5-K system (2004-2007), process and mechanical design to reduce total input power from 9.4 MW to less than 5 MW and allow system capacity to automatically match loads stably and efficiently, Senior Staff Engineer
- SNS/Oakridge 2 K refrigeration system (2000-2004), process design, supervision of mechanical design and commissioning lead of cryogenic system, including compressor system/piping, 4.5-K cold box, 2-K cold box, cryogenic distribution, gas storage, liquid helium storage and purifier sub-systems, Senior Staff Engineer
- MSU Cyclotron cryogenic System Upgrade (1999-2000), process design, supervision of mechanical design and commissioning of cryogenic system, including compressor system/piping, 4.5-K cold box and cryogenic distribution, Senior Staff Engineer
- JLab new 2K cold box (1997-1999), process and mechanical design, commissioning and operation, Staff Engineer-III

- JLab standby refrigeration system (1995-1996), process design, hardware modifications and implementation of a back-up refrigerator to JLab's main 4.5-K helium refrigeration system, Staff Engineer-III
- JLab central helium liquefier (1995), process modifications to allow main 4.5-K cold box to operate stably and with 15% less total power input, Staff Engineer-III
- JLab end station refrigeration system (1994-1995), process design and hardware modifications to allow system capacity to automatically match loads stably and efficiently, Staff Engineer-III
- JLab sub-atmospheric (2-K) system (1994), process design, hardware modifications and implementation to allow sub-atmospheric 2-K operation of an industry designed plant that industry could not commission, Staff Engineer-III

1990-1993, Super-Conducting Super-Collider Laboratory (SSCL) – Head Cryogenic Systems Engineering Group

- Developed the cryogenic system plans for the operating the twelve large helium refrigerators to support the 55 mile Super Collider Accelerator Ring
- Developed the specification and procured, commissioned and operated the 4 kW helium refrigerators to support the magnet testing and magnet string test

1980-1989, CTI/Helix Process Systems (later Koch Process Systems) – Principle process engineer (1980-1984), Head of Cryogenic Process Group (1984-1989)

- Designed helium refrigeration, liquefaction and purification systems for major research institutions which include Brookhaven National Lab (BNL), Fermi National Lab (FNAL), University of Washington, Florida State University Magnet Lab, CEBAF (now Jefferson Lab), Indian Space Research Organization
- Developed the new standard product design (Model 1600) for helium refrigeration and liquefaction systems which are presently marketed by Linde Process Systems
- Implemented process modifications that resulted in improved capacity and efficiency of existing standard product helium refrigeration and liquefaction systems

HONORS:

2019 The Samuel C. Collins Award for outstanding contribution to cryogenic Technology, presented by the Cryogenic Engineering Conference.

2007 White House Closing the Circle Award – Leadership in Federal Environmental Stewardship for reducing the power required by the helium refrigeration/liquefaction systems.

2006 DOE Office of Science Pollution Prevention and Environmental Stewardship P2 "Best in Class Award" for implementation of the Ganni-Floating Pressure Cycle.

2006 NASA Certificate of Appreciation for support of Cryogenic Test Chamber-A at Johnson Space Center for Liquid Nitrogen Reduction.

2005 Fellow of the Cryogenic Society of America - given to a person of distinction in cryogenics who has made notable valuable contributions to the field of cryogenics.

1997 NASA Certificate of Recognition for cryogenic test chamber development for curved panel testing.

INTELLECTUAL PROPERTY

Floating Pressure Ganni Helium Proces Cycle (US patent 7,278,280 and 7,409,834) has resulted in reducing the power demand by more than 10 MW at many of the DOE and other labs (JLab, SNS, BNL, MSU, NASA) which utilize helium refrigeration systems.

The patent pending Helium Screw compressor skid technology is instrumental in extending the efficiency, operational range and reliability.

The 300-80K heat exchanger process in the helium refrigerators was adapted to CHL-II cold box and resulted in 80% reduction in the LN2 use.

Presently CHL-I and CHL-II are operating on Floating Pressure technology with 4.5 MW and 3.0 MW respective power inputs as compared to original 6 MW for CHL-I . These resulted in more than ***$2.5M/ year*** reduction in utilities required for the JLab CHL helium refrigeration systems.

Apparatus for supporting a cryogenic fluid containment system within an enclosure (US patent 5385026 A)

COURSES, INVITED TALKS, THESIS ADVISING

Developed and taught course “Design of Optimal Helium Refrigeration and Liquefaction Systems”, 2017 CEC/ICMC, 2010-2012 Old Dominion University, 2009 CEC/ICMC, 2007 CEC/ICMC, 2005 CEC/ICMC

2016, International Cryogenic Engineering Conference (Delhi, India), “Modifications to JLab 12 GeV Refrigerator and Wide Range Mix Mode Performance Testing Results,” To be presented.

2015, Work Shop on Science and Technology for Ingot Niobium for SRF Applications, “Helium Refrigeration Systems for Superconducting Accelerators”

2011, Jefferson Lab Cryogenic Seminars (JLab), Cryogenics at JLab, Cycle Design/Carnot Analysis, System Optimization/Ganni Cycle, Liquid Nitrogen Pre-Cooling/2K System Processes, Instrumentation/Controls/Design Overview

2011, Cryogenic Engineering Conference (Spokane, Washington), “Cryogenics for Superconductors: Refrigeration, Delivery and Preservation of the Cold - 100 years of Superconducting Materials, Machines and Cryogens”

2009, Particle Accelerator Conference (Vancouver, Canada), “Optimal Design and Operation of Helium Refrigeration Systems”

2009, Cockcroft Institute and Rutherford Appleton Lab (United Kingdom), “Essential Physics and Technology of Cryogenics for Accelerators”

2009, One session at the CEC/ICMC 2009 was allocated to the papers on Ganni cycle floating pressure technology.

2001, Cryogenic Engineering Conference (Madison, Wisconsin), “Design, Fabrication, Commissioning and Testing of 250 g/s Helium Cold Compressor System,”

Provided research topics and guidance and advisor for four JLab employees for their MS degree and thesis advisor to a Ph.D. candidate.

PUBLICATIONS:

1. F. Casagrande, et al, “FRIB Cryogenic System Status”, *Advances in Cryogenic Engineering*, *IOP Conf. Ser.: Mater. Sci. Eng., to be published, 2019*.
2. V. Ganni, et al, “Cryogenic design of FRIB cryomodule and distribution system and the present status,” *Advances in Cryogenic Engineering*, *IOP Conf. Ser.: Mater. Sci. Eng., to be published, 2019*.
3. P. Knudsen, et al, “Design, fabrication, commissioning and testing of FRIB 2K cold compressor system,” *Advances in Cryogenic Engineering*, *IOP Conf. Ser.: Mater. Sci. Eng., to be published, 2019*.
4. P. Knudsen, et al, “FRIB compression system commissioning and performance test results,” *Advances in Cryogenic Engineering*, *IOP Conf. Ser.: Mater. Sci. Eng., to be published, 2019*.
5. P. Knudsen, et al, “FRIB helium refrigeration system commissioning and performance test results,” *Advances in Cryogenic Engineering*, *IOP Conf. Ser.: Mater. Sci. Eng., to be published, 2019*.
6. N. Joseph, et al, “FRIB cryogenic control system,” *Advances in Cryogenic Engineering*, *IOP Conf. Ser.: Mater. Sci. Eng., to be published, 2019*.
7. D. Kroll, et al, “Freeze-Out Purifier for helium Refrigeration System Applications,” *Advances in Cryogenic Engineering*, *IOP Conf. Ser.: Mater. Sci. Eng., to be published, 2019*.
8. Wei J *et al* 2019 FRIB SC-Linac: installation and phased commissioning *19th International Conference on RF Superconductivity*, Dresden, Germany, June 30 – July 5

9. Miller S *et al* 2019 FRIB cavity and cryomodule performance, comparison with the design and lessons learned *19th International Conference on RF Superconductivity*, Dresden, Germany, June 30 – July 5
10. F. Casagrande, et al, "FRIB Cryogenic System Status", *Advances in Cryogenic Engineering*, *IOP Conf. Ser.: Mater. Sci. Eng., 2017*.
11. P. Knudsen, et al, "Equivalent Isentropic Expansion Efficiency of a Real Fluid Subjected to Constant Pressure Drop and Heat Transfer," *Advances in Cryogenic Engineering*, *IOP Conf. Ser.: Mater. Sci. Eng., 2017*.
12. N. Hasan, et al, "Application of ASST-A Helium Refrigeration System for JLab ESR," *Advances in Cryogenic Engineering*, *IOP Conf. Ser.: Mater. Sci. Eng., 2017*.
13. P. Knudsen, et al, "Modifications to JLab 12 GeV Refrigerator and Wide Range Mix Mode Performance Testing Results," International Cryogenic Engineering Conference (Delhi, India), 2016.
14. V. Ganni, "Helium Refrigeration Systems for Superconducting Accelerators", American Institute of Physics, New York (2016).
15. V. Ganni, et al, "FRIB Cryogenic Distribution System Status", *Advances in Cryogenic Engineering*, *IOP Conf. ser.: Mater. Sci. Eng., Vol 101 (2015) 012034*.
16. K. Dixon, et al, "FRIB Cryogenic Plant Status", *Advances in Cryogenic Engineering*, *IOP Conf. ser.: Mater. Sci. Eng., 101 (2015) 012071*.
17. P. Knudsen, V. Ganni, "Testing of a 4K to 2K heat exchanger with an intermediate pressure drop", *Advances in Cryogenic Engineering*, *IOP Conf. ser.: Mater. Sci. Eng., 101 (2015) 012105*.
18. P. Knudsen, et al, "Commissioning and Operational results of Helium Refrigeration System at JLab for the 12GeV upgrade", *Advances in Cryogenic Engineering*, *IOP Conf. ser.: Mater. Sci. Eng., 101 (2015) 012125*.
19. P. Knudsen, et al, "Commissioning and Operational results of the 12 GeV Helium Compression System at JLab", *Advances in Cryogenic Engineering*, *IOP Conf. ser.: Mater. Sci. Eng., 101 (2015) 012126*.
20. M. Howell, et al, "2K Pump down studies at SNS", *Advances in Cryogenic Engineering*, *IOP Conf. ser.: Mater. Sci. Eng., 101 (2015) 012128*.
21. P. Knudsen, et al, "Performance Testing of JLab 12 GeV helium screw Compressors", *IOP Conf. ser.: Mater. Sci. Eng., 90, 012072 (2015).*
22. V. Ganni, et al, "Commissioning of Helium Refrigeration System at JLab for 12 GeV Upgrade", *Advances in Cryogenic Engineering* 59, American Institute of Physics, New York (2014).
23. P. Knudsen, et al, "Commissioning of Helium Compression System at JLab for 12 GeV Refrigerator", *Advances in Cryogenic Engineering* 59, American Institute of Physics, New York (2014).
24. V. Ganni, et al, "Helium Refrigeration Considerations for Cryomodule Design", *Advances in Cryogenic Engineering* 59, American Institute of Physics, New York (2014).
25. V. Ganni, et al, "Application of JLab 12 GeV Helium Refrigeration System for the FRIB Accelerator at MSU", *Advances in Cryogenic Engineering* 59, American Institute of Physics, New York (2014).
26. V. Ganni, et al, "FRIB Cryo Distribution System", *Advances in Cryogenic Engineering* 59, American Institute of Physics, New York (2014).

27. N. Laverdure, et al, "The Hall-D Solenoid Helium Refrigeration System at JLab," *Advances in Cryogenic Engineering* 59, American Institute of Physics, New York (2014).
28. K. Dixon, et al, "Linac Cryo Distribution System Maintenance and Upgrade at JLab", *Advances in Cryogenic Engineering* 59, American Institute of Physics, New York (2014).
29. J. Homan, et al, "Commissioning of a 20K Helium Refrigeration System for NASA-JSC Chamber-A", *Advances in Cryogenic Engineering* 59, American Institute of Physics, New York (2014).
30. J. Homan, et al, "Commissioning of the Liquid Nitrogen Thermo-Siphon System for NASA-JSC Chamber-A", *Advances in Cryogenic Engineering* 59, American Institute of Physics, New York (2014).
31. J. Wei, et al, "The FRIB Project – Accelerator Challenges and Progress", *HIAT 12*.
32. Ting Xu, et al, "Integrated Thermal Analysis of the FRIB Cryomodule Design", *HIAT 12*.
33. M. Johnson, et al, "Design of the FRIB Cryomodule", *IPAC2012*.
34. V. Ganni, et al, "Cryogenics for Superconductors: Refrigeration, Delivery and Preservation of Cold", *Advances in Cryogenic Engineering* 57, American Institute of Physics, New York (2012), 15-27.
35. P. Knudsen, V. Ganni, "Process Options for Nominal 2-K Helium Refrigeration System Designs", *Advances in Cryogenic Engineering* 57, American Institute of Physics, New York (2012), 800-813.
36. P. Knudsen, et al, "Options for Cryogenic Load Cooling with Forced Flow Helium Circulation", *Advances in Cryogenic Engineering* 57, American Institute of Physics, New York (2012), 790-799.
37. V. Ganni, P. Knudsen, "Response to Remarks Regarding the Optimal Design and Operation of Helium Refrigeration Systems", *Advances in Cryogenic Engineering* 57, American Institute of Physics, New York (2012), 832-834.
38. E. Yukesek, et al, "Performance Validation of Refrigeration Recovery for Experimental Hall High Target Loads", *Advances in Cryogenic Engineering* 57, American Institute of Physics, New York (2012), 1751-1756.
39. T. Xu, et al, "Status of Cryogenic System for SNS's SRF Test Facility at ORNL", *Advances in Cryogenic Engineering* 57, American Institute of Physics, New York (2012), 1085-1091.
40. P. Knudsen, et al, "Refrigeration Recovery for Experimental Hall High Target Loads", *Advances in Cryogenic Engineering* 55, American Institute of Physics, New York (2010), 201-206.
41. J. Homan, et al, "The Liquid Nitrogen System For Chamber A, a Change from Original Forced Flow Design to a Natural Flow (Thermosiphon) System", *Advances in Cryogenic Engineering* 55, American Institute of Physics, New York (2010), 207-214.
42. P. Knudsen, et al, "Helium Refrigeration Liquid Nitrogen Pre-cooling component Parameter Sensitivity Analysis", *Advances in Cryogenic Engineering* 55, American Institute of Physics, New York (2010), 215-222.

43. V. Ganni, P. Knudsen, "Optimal Design and Operation of Helium Refrigeration Systems Using the Ganni Cycle", *Advances in Cryogenic Engineering* 55, American Institute of Physics, New York (2010), 1057-1071.
44. J. Homan, et al, "Floating Pressure Conversion of Two 3.5kW, 20K Helium Refrigerators", *Advances in Cryogenic Engineering* 55, American Institute of Physics, New York (2010), 1072-1079.
45. P. Arnold, et al, "Large Scale Refrigeration Plant for Ground Testing the James Webb Telescope at NASA Johnson Space Center", *Advances in Cryogenic Engineering* 55, American Institute of Physics, New York (2010), 1080-1086.
46. D. Arenius, et al, "Overview and Status of the 12 GeV Cryogenic System Upgrade at JLAB", *Advances in Cryogenic Engineering* 55, American Institute of Physics, New York (2010), 1087-1091.
47. V. Ganni, et al, "Compressor System for the 12 GeV Upgrade at Thomas Jefferson National Accelerator Facility", *Proceedings of the 23rd International Cryogenic Engineering Conference*, Wroclaw, Poland, July 19-23, 2010, 859-863.
48. P. Arnold, P. Knudsen, "4.5 K Refrigerator Cold Box System for the 12 GeV Upgrade at Thomas Jefferson National Accelerator Facility", *Proceedings of the 23rd International Cryogenic Engineering Conference*, Wroclaw, Poland, July 19-23, 2010, 853-857.
49. V. Ganni, "Optimal Design and Operation of Helium Refrigeration Systems", in *Proceedings of the 23rd Particle Accelerator Conference* (PAC09), Vancouver, BC, Canada, WE4RA101, May 2009.
50. V. Ganni, et al, "Screw Compressor Characteristics for Helium Refrigeration Systems", *Advances in Cryogenic Engineering* 53, American Institute of Physics, New York (2008), 309-315.
51. R. Than, et al, "RHIC Cryogenic System at BNL, Review of the Modifications and Upgrades since 2002 and Planned Improvements", *Advances in Cryogenic Engineering* 53, American Institute of Physics, New York (2008), 578-587.
52. D. Arenius, et al, "An Overview of the planned JLab 12 GeV Helium Refrigeration Upgrade", *Advances in Cryogenic Engineering* 53, American Institute of Physics, New York (2008), 588-593.
53. P. Knudsen, et al, "Process Study of Nominal 2K Refrigeration", *Advances in Cryogenic Engineering* 53, American Institute of Physics, New York (2008), 846-858.
54. D. Hatfield, et al, "SNS Cryogenic Systems Commissioning", *Advances in Cryogenic Engineering* 51, American Institute of Physics, New York (2006), 1436-1443.
55. P. Knudsen, et al, "Simplified Helium Refrigerator Cycle Analysis Using the 'Carnot Step' ", *Advances in Cryogenic Engineering* 51, American Institute of Physics, New York (2006), 1977-1986.
56. A. Sidi-Yekhlef, et al, "The RHIC Refrigerator System at BNL, Phase III of the Systems Performance and Operations Upgrade for 2006", *Advances in Cryogenic Engineering* 53, American Institute of Physics, New York (2006), 2010-2017.
57. F. Casagrande et all, "SNS 2.1K Cold Box Turndown Studies", Proceedings of EPAC (2006), Edinburgh, Scotland
58. F. Casagrande et all, "Status of the Cryogenic System Commissioning at SNS", Particle Accelerator, IEEE Conference - PAC , (2005)

59. P. Guard, et al, "The Development of Automatic Sequences for the RF and Cryogenic Systems at the Spallation Neutron Source", 10th ICALEPCS Int. Conf. on Accelerator & Large Expt. Physics Control Systems. Geneva, (2005)
60. D. Arenius, et al, "Cryogenic System for SNS", *Advances in Cryogenic Engineering* 49, American Institute of Physics, New York (2004), 200-207.
61. J. D. Wilson, et al, "Determination of the Optimal Operating Parameters for the JLab's Cryogenic Cold Compressor System", *Advances in Cryogenic Engineering* 49, American Institute of Physics, New York (2004), 257-264.
62. A. McCartney, et al, "Cryogenic System upgrade for the National Superconducting Cyclotron Laboratory", *Advances in Cryogenic Engineering 47*, American Institute of Physics, New York (2002), 207-212.
63. V. Ganni, et al, "Design, Fabrication, Commissioning and Testing of 250 g/s Helium Cold Compressor System", *Advances in Cryogenic Engineering* 47, American Institute of Physics, New York (2002), 288-304.
64. E. F. Daly, et al, "SNS Cryomodule Heat Loads and Thermal Design", *Advances in Cryogenic Engineering* 47, American Institute of Physics, New York (2002), 531-539.
65. G. J. Laughon, et al, "APT Cryogenic System", *Advances in Cryogenic Engineering* 45, Kluwer Academic/Plenum Publishers, New York (2000), 1317-1322.
66. D. Arenius, et al, "Commissioning and Operation of the CEBAF End Station Refrigeration System", *Advances in Cryogenic Engineering* 41, Plenum Press, New York (1996), 633-639.
67. W. C. Chronis, et al, "Procurement and Commissioning of the CHL Refrigerator at CEBAF", *Advances in Cryogenic Engineering* 41, Plenum Press, New York (1996), 641-648.
68. W. A. Fietz, et al, "Cryogenic Systems for the SSC and Status of their Development", *Advances in Cryogenic Engineering* 39, Plenum Press, New York (1994), 689-700.
69. V. Ganni, et al, "Design Verification and Acceptance Tests of the ASST-A Helium Refrigeration System", *Advances in Cryogenic Engineering* 39, Plenum Press, New York (1994), 779-787.
70. R. Carcagno, et al, "A Methodology to Describe Process Control Requirements", *Supercollider* 5, Plenum Press, New York (1994), 307-310.
71. V. Ganni, et al, "Operating Modes of the SSC Sector Station Cryogenic System", *Supercollider* 5, Plenum Press, New York (1994), 459-463.
72. V. Ganni, et al, "Operating Modes and Control Philosophy of the SSCL MTL Cryogenic System", Supercollider 5, Plenum Press, New York (1994), 921-930.
73. M. McAshan, et al, "84 K Nitrogen System for the SSC", *Supercollider* 4, Plenum Press, New York (1994), 207-217.
74. B. Zhang, et al, "Conceptual Design of the SSC Cryogenic Transfer Lines", *Supercollider* 4, Plenum Press, New York (1994), 453-460.
75. D. P. Brown, et al, "Operational Tests of the BNL 24.8 kW, 3.8 K Helium Refrigerator", *Advances in Cryogenic Engineering* 31, Plenum Press, New York (1986), 627-633.
76. V. Ganni, et al, "Capacity Upgrade of the EXELL Helium Liquefier Plant", *Advances in Cryogenic Engineering* 31, Plenum Press, New York (1986), 699-707.

2019 Samuel C. Collins lifetime achievement Award

2005 Cryogenic Society of America – Fellow of the Society

Signing of JLab licensing of the Ganni Floating Pressure Process Cycle Technology to Cryogenic Plants and Services, Division of Linde BOC, LLC

2007 White House Closing the Circle Award – Leadership in Federal Environmental Stewardship