

CONTENTS

Foreword.....	XXV
Samuel C. Collins Award	xxvi
Russell B. Scott Memorial Awards.....	xxvii
Student Awards.....	xxviii
1999 Cryogenic Engineering Conference Board	xxix
Acknowledgments.....	xxx

PART A

PULSE TUBE CRYOCOOLERS (I)

0.5 W Class Two-Stage 4 K Pulse Tube Cryorefrigerator.....	1
C. Wang and P. E. Gifford	
Pulse Tube Developments at CEA/SBT	9
A. Ravex, I. Charles, L. Duband, and J. M. Poncet	
Development of Low-Cost Pulse Tube Cryocooler for HTS Applications	19
S.-Y. Kim, K.-Y. Hong, S.-T. Kim, and W.-S. Chung	
A Contaminant Ice Visualization Experiment in a Glass Pulse Tube	25
J. L. Hall, R. G. Ross, Jr., and A. K. Le	
Application of Co-Axial Pulse Tube Refrigeration System	33
L. W. Yang, L. W. Yan, J. T. Liang, Y. Zhou, Y. S. He, H. Li, W. W. Xu, P. H. Wu, Q. Y. Ma, and Edward S. Yang	
A Compact Liquid Nitrogen Recondenser with a Pulse Tube Cryocooler.....	41
R. Li, A. Ishikawa, T. Koyama, T. Ogura, K. Aoki, and T. Koizumi	
Liquid Nitrogen Pre-Cooled Pulse Tube Refrigerator with Low Temperature Switch Valve and Its Simulation.....	49
W. Dai, W. Sun, J. Liang, Y. Zhou, and R. Wang	
Development of a 5W at 80K Stirling Pulse Tube Cryocooler	57
Y. Hiratsuka, Y. M. Kang, N. Fujiyama, T. Sotojima, and Y. Matsubara	
Performance of TRW New Generation Pulse Tube Coolers	65
C. K. Chan and T. V. Nguyen	

PULSE TUBE CRYOCOOLERS (II)

Hysteretic Loop in Thermoacoustic Oscillations.....	75
G. B. Chen and T. Jin	
Experimental Investigation of Loss Mechanisms in a 4 K Pulse Tube	81
S. L. Zhou, G. Thummes, and Y. Matsubara	
Testbed for the Investigation of Miniature Pulse Tube Cold Heads.....	89
G. Kaiser and A. Binneberg	
Research of Separated Version Two-Stage Pulse Tube Refrigerator	95
L. W. Yang, Y. Zhou, and J. T. Liang	
Test of a Recuperative Pulse Tube Refrigerator with Simplified Perforated Plate Heat Exchanger.....	103
J. T. Liang, W. Sun, L. Yang, S. Bian, and Y. Zhou	
Experimental Study of Heat Transfer Phenomena between Working Gas and Tube Wall in a Pulse Tube Refrigerator	111
K. Takamatsu, M. Shiraishi, M. Murakami, and A. Nakano	
Visualization Study of Secondary Flow in an Inclined Pulse Tube Refrigerator	119
M. Shiraishi, K. Takamatsu, M. Murakami, and A. Nakano	
Experimental Investigation of Some Phase Shifting Types on Two-Stage GM Pulse Tube Cryocooler	127
S. Fujimoto, T. Oodo, Y. M. Kang, T. Kanyama, and Y. Matsubara	
Reduction of Convection Heat Losses in Low Frequency Pulse Tube Coolers with Mesh Inserts	135
S. Kasthuriangan, G. Thummes, and C. Heiden	
Experimental Investigation of Heat Pumping in Thermoacoustic Refrigerator	143
J. V. Lubiez, F. Jebali Jerbi, and M. X. François	
A New Thermally Driven Pulse Tube Refrigerator Operating in Double Travelling Wave Modes	151
E. Luo, H. Liu, J. Liang, and L. Zhang	
Phasor Analysis for Double Inlet Pulse Tube Cryocooler	159
M. D. Chokhawala, K. P. Desai, H. B. Naik, and K. G. Naryankhedkar	
Numerical Study of Gas Dynamics Inside of a Pulse Tube Refrigerator	167
Y. Hozumi and M. Murakami	
Theoretical Analysis of Refrigeration and Losses in a Pulse Tube	175
L. W. Yang, Y. Zhou, and J. T. Liang	
Experimental Investigation on Pulse Tube Refrigerator with Binary Mixtures.....	183
G. B. Chen, J. P. Yu, Z. H. Gan, and T. Jin	

Flow-Controlling Devices in Pulse Tubes	189
A. T. A. M. de Waele and H. W. G. Hooijkaas	
Enthalpy Flow in a Pulse Tube Refrigerator.....	197
G. Q. Lu, P. Cheng, and C. T. Hsu	
Analysis of Inertance Tube to Improve the Performance of Pulse Tube Refrigerator	205
L. W. Yang, Y. Zhou, and J. T. Liang	
Influence of a Phase Leading Pressure Wave on Pulse Tube Performance.....	213
H. W. G. Hooijkaas, A. A. J. Benschop, and S. C. M. Aerts	
Thermodynamic Losses in Pulse Tube Coolers—Throttling Irreversibility Including Contamination Effects	221
L. Rohlin, A. K. Le, and T. H. K. Frederking	

G-M AND STIRLING CRYOCOOLERS

Improvement in the Second-Stage Cooling Power of a Two-Stage GM Refrigerator through Modification of the First-Stage Regenerator.....	229
T. W. Wysokinski, I. G. Spearing, P. G. Reedeker, and J. A. Barclay	
Experimental Research on a Precooled Single-Stage G-M Refrigerator Operating at the Liquid Helium Temperature.....	237
L. Zhang, L. Wang, L. Fang, and X. D. Xu	
The Experimental Study of a Single-Stage G-M Refrigerator with the Regenerator Set Outside the Cylinder	245
L. Wang, L. Fang, W. H. Lu, and L. Zhang	
Performance and Qualification of BEI's 600 mW Linear Motor Cooler	251
S. W. K. Yuan, D. T. Kuo, A. S. Loc, and T. D. Lody	
Design of Single Stage and Two Stage Miniature Stirling Cryocoolers Using Cyclic Simulation	259
H. K. Agrawal and K. G. Narayankhedkar	
Cryocooler Life Estimation and Its Correlation with Experimental Data	267
D. T. Kuo, A. S. Loc, T. D. Lody, and S. W. K. Yuan	
Cryocooler Contamination Study	275
S. W. K. Yuan, D. T. Kuo, and A. S. Loc	

J-T AND OTHER CRYOCOOLERS

Optimum Composition Calculation for Multicomponent Cryogenic Mixture Used in Joule-Thomson Refrigerators	283
M. Q. Gong, E. C. Luo, Y. Zhou, J. T. Liang, and L. Zhang	

Enhanced Refrigeration Performance of the Throttle-Cycle Coolers Operating with Mixed Refrigerants	291
M. Boiarski, A. Khatri, and O. Podcherniaev	
The Research and Development of Cryogenic Mixed-Refrigerant Joule-Thomson Cryocoolers in CL/CAS.....	299
E. C. Luo, M. Q. Gong, Y. Zhou, J. T. Liang, and L. Zhang	
Study of Behavior in the Heat Exchanger of a Mixed Gas Joule-Thomson Cooler	307
A. Alexeev, A. Thiel, Ch. Haberstroh, and H. Quack	
Experimental Investigation of a Mixed-Refrigerant J-T Cryocooler Operating from 30 to 60K.....	315
E. C. Luo, M. Q. Gong, Y. Zhou, and L. Zhang	
Flow-Rate Pressure-Dependence of a Fixed-Orifice Joule-Thomson Cryocooler.....	323
B.-Z. Maytal	
Performance Testing of a 4 K Active Magnetic Regenerative Refrigerator.....	329
S. F. Kral and C. B. Zimm	
Models for Scalable Helium-Carbon Sorption Cryocoolers.....	337
C. A. Lindensmith, M. Ahart, P. Bhandari, D. Crumb, C. Paine, and L. A. Wade	

REGENERATORS: DESIGNS, MATERIALS AND ANALYSES

Design of a New Type Regenerator.....	345
Y. Ishizaki, E. Ishizaki, H. R. Mueller, T. Ohtsuka, and K. Hamaguchi	
A Regenerator that Will Perform at Moderately High Frequency and Below 10 Kelvin for Use in a Pulse Tube Cooler	349
J. M. Lee, A. Kashani, and B. Helvensteijn	
Replacement of Regenerator with a Stack in a Stirling Refrigerator.....	357
S. Zhu and Y. Matsubara	
Wound Profile-Wire Regenerators—Fabrication and Test.....	365
I. Rühlich and H. Quack	
Regenerator Performance Evaluation in a Pulse Tube Cryocooler	373
J. P. Harvey, C. S. Kirkconnell, and P. V. Desai	
Dynamic Behavior in Oscillating Flow Regenerators with Thermal Diffusion Effects....	383
Y. L. Ju, Y. Zhou, and A. T. A. M. de Waele	
Study on the Volumetric Ratio of the Hybrid GM Regenerator over the Cold Chamber Working at 4K	391
L. Wang, X. D. Xu, L. Fang, and L. Zhang	

Refrigeration Capacity of a GM Refrigerator Utilizing HoSb as Its Regenerative Material	397
H. Nakane, T. Hashimoto, T. Numazawa, M. Okamura, T. Kuriyama, and Y. Ohtani	
Measurement of Heat Transfer Coefficients in High NTU Regenerative Heat Exchangers	403
J. A. Ramirez and K. D. Timmerhaus	
Designing Methods of Cryogenic Regenerators for Gas High Purification	411
A. Bornea, I. Cristescu, and M. Peculea	
A Simplified Linearized Thermoacoustic Theory for Regenerative Cryocoolers	419
E. Luo, H. Liu, J. Xiao, Y. Zhou, and Z. Zhang	

CRYOGENIC SPACE APPLICATIONS

Multiple Stage vs. Single Stage Efficiency Calculations for Stirling Cycle Spacecraft Cryocoolers	427
B. J. Tomlinson, Jr.	
Parametric Thermal and Cryogenic Cooling System Models for Space Based Infrared Instruments	435
D. S. Glaister, M. Donabedian, D. G. T. Curran, and S. D. Miller	
Propellant Preservation for Mars Missions	443
P. Kittel and D. W. Plachta	
A Liquefier for Mars Surface Propellant Production	451
L. J. Salerno, B. P. M. Helvensteijn, and P. Kittel	
A Pulse Tube Oxygen Liquefier	457
E. D. Marquardt and R. Radebaugh	
Hybrid Thermal Control Testing of a Cryogenic Propellant Tank	465
D. W. Plachta	
Testing of Densified Liquid Hydrogen Stratification in a Scale Model Propellant Tank	473
J. M. Jurns, T. M. Tomsik, and W. D. Greene	
Flight Test Results for the NICMOS Cryocooler	481
F. X. Dolan, J. A. McCormick, G. F. Nellis, H. Sixsmith, W. L. Swift, and J. A. Gibbon	
INTEGRAL Spectrometer Cryostat Design and STM Performances	489
R. Briet	
Hydrogen Sorption Cryocoolers for the Planck Mission	499
L. A. Wade, P. Bhandari, R. C. Bowman, Jr., C. Paine, G. Morgante, C. A. Lindensmith, D. Crumb, M. Prina, R. Sugimura, and D. Rapp	

Thermal Performance of the XRS Helium Insert	507
S. R. Breon, M. J. DiPirro, J. G. Tuttle, P. J. Shirron, B. A. Warner, R. F. Boyle, and E. R. Canavan	
Development of the FACET Cryostat.....	515
A. Nash, P. Shields, M. Jirmanus, and Z. Zhao	
A Pulse-Tube Cryocooler for the SKA Radio Telescope	523
X. Deng, P. Mayzus, L. Bauwens, O. R. Fauvel, and G. T. Reader	
Demonstration of a Low Cost Cryocooler on a Long Duration Balloon Mission	531
E. F. James, I. S. Banks, R. B. Ray, and S. H. Castles	
Performance Comparison of M77 Stirling Cryocooler and Proposed Pulse Tube Cryocooler.....	539
R. Z. Unger and J. G. Wood	
Performance of the XRS ADR Heat Switch	545
E. R. Canavan, J. G. Tuttle, P. J. Shirron, and M. J. DiPirro	
Development of Gas Gap Heat Switch Actuator for the Planck Sorption Cryocooler	553
M. Prina, P. Bhandari, R. C. Bowman, Jr., C. Paine, and L. A. Wade	
Development and Space Flight Verification of Cryogenic Flexible Diode Heat Pipes.....	561
D. S. Glaister, P. J. Brennan, M. Buchko, and M. Stoyanof	
Development of a Thermal Isolation Structure for Aerospace Cryogenic Instruments.....	569
A. E. Nash and L. S. Robeck	
Low Vibrational Performance of TRW Second-Generation Pulse Tube Cooler.....	577
C. K. Chan and C. Jaco	
Cryocooler State of the Art for Space-Borne Applications	585
D. G. T. Curran, M. Donabedian, D. S. Glaister, and T. Davis	

OTHER CRYOCOOLER APPLICATIONS

Air Force Research Laboratory Cryocooler Characterization Status and Lessons Learned	595
B. J. Tomlinson, Jr., C. Yoneshige, and N. Abhyankar	
HTS Magnets for Advanced Magnetoplasma Space Propulsion Applications	603
S. W. Schwenterly, M. D. Carter, F. R. Chang-Díaz, and J. P. Squire	
Air Force Research Laboratory Spacecraft Cryocooler Endurance Evaluation Update: FY 98-99	609
B. J. Tomlinson, Jr., C. Yoneshige, and N. Abhyankar	
The Ballistic Missile Defense Organization Cryogenic Cooling Technology Development for Space-Based Infrared System Low.....	617
T. M. Davis, B. J. Tomlinson, and E. Myric	

Applied Cryocooling of a Resistive HTS-Fault Current Limiter.....	627
B. Gromoll, H.-P. Kraemer, J. Niewisch, H.-W. Neumuller, R. R. Volkmar, and S. Fischer	
Tests of a GM Cryocooler and High TC Leads for Use on the ALS Superbend Magnets.....	635
J. Zbasnik, J. Y. Chen, M. A. Green, E. H. Hoyer, C. E. Taylor, and S. T. Wang	

SUPERCONDUCTING MAGNETS

A Compact Sweeper Magnet for Nuclear Physics.....	643
A. F. Zeller, D. Bazin, M. Bird, J. C. DeKamp, Y. Eyssa, K. W. Kemper, L. Morris, S. Prestemon, B. S. Sherrill, M. Thoennessen, and S. W. Van Sciver	
Design of an Apparatus for a 5T Conduction Cooled NBTI Solenoid with a 203 mm Room Temperature Bore.....	651
A. M. Rowe, J. A. Barclay, and S. Dost	
Bent Solenoid Simulations for the Muon Cooling Experiment.....	659
M. A. Green, Y. M. Eyssa, S. Kenney, J. R. Miller, and S. Prestemon	
A Cryocooler Directly Cooled 5 Tesla Niobium Titanium Superconducting Magnet System.....	667
N. H. Song, L. Z. Lin, L. Zhang, X. D. Xu, T. C. Wang, Y. R. Cai, B. Q. Fu, and Y. Feng	
Design and Performance of Cooling System of Helical Coils for the LHD.....	675
S. Imagawa, T. Mito, K. Y. Watanabe, H. Tamura, N. Yanagi, H. Sekiguchi, R. Maekawa, T. Satow. S. Satoh, and O. Motojima	
Analysis and Countermeasure for a Problem of Abnormal Voltage Generation in a SMES Magnet.....	683
H. Hayashi, K. Tsutsumi, F. Irie, T. Teranishi, S. Hanai, and L. Kushida	
Safe and Fast Quench Recovery of Large Superconducting Solenoids Cooled by Forced Two-Phase Helium Flow	689
L. X. Jia and M. A. Green	
Simulation of Thermal-Hydraulic Transients in Two-Channel CICC with Self-Consistent Boundary Conditions	697
L. Savoldi, L. Bottura, and R. Zanino	
Research and Development of Superconducting Magnetic Systems for High Power Pulsed MHD-Generators.....	705
E. P. Polulyakh, A. V. Spiridonov, V. A. Afanas'ev, M. I. Kharinov, A. A. Yakushev, and E. Yu. Klimenco	
Small Current Transformer Using Oxide Superconductor for Transport AC Loss Measurement	713
E. S. Otabe, Y. Morizane, T. Matsushita, J. Fujikami, and K. Ohmatsu	

Development of Toroidal Superconducting Magnetic Energy Storages (SMES) for High-Current Pulsed Power Supplies	721
E. P. Polulyakh, L. A. Plotnikova, V. A. Afanas'ev, M. I. Kharinov, A. K. Kondratenco, E. Yu. Klimenco, and V. I. Novicov	

SUPERCONDUCTING MAGNETS: MATERIALS

Test Results for the High Field Conductor of the ITER Central Solenoid Model Coil	729
P. Bruzzone, A. M. Fuchs, G. Vecsey, and E. Zapretulina	
Manufacture and Performance Results of an Improved Joint for the ITER Conductor ...	737
P. Bruzzone	
Temperature Rise and Strain Behavior of Large Helical Device during Coil Excitation	745
A. Nishimura, H. Tamura, S. Imagawa, T. Mito, S. Yamada, H. Chikaraishi, K. Takahata, N. Yanagi, R. Maekawa, A. Iwamoto, T. Satow, S. Satoh, and O. Motojima	
Deformation Behavior of Cryogenic Components in LHD during Cooling Down.....	753
H. Tamura, A. Nishimura, S. Imagawa, T. Mito, R. Maekawa, N. Yanagi, K. Takahata, T. Satow, S. Satoh, and O. Motojima	
Thermal and Stress Analysis of a 0.8 m Diameter HTS Magnetic Separator.....	761
C. M. Rey, W. C. Hoffman, and J. G. Sloan	
Development and Testing of a 3 T BI-2212 Insert Magnet	769
H. W. Weijers, Q. Y. Hu, Y. Viouchkov, E. Celik, Y. S. Hascicek, K. Marken, and J. Parrell, and J. Schwartz	
Design and Performance of a 5 kJ HTS μ -SMES.....	779
J. Paasi, R. Mikkonen, T. Kalliohaka, J. Lehtonen, J. Ollila, L. Söderlund, B. Connor, and S. Kalsi	
Cryostats for the KEKB IR Superconducting Magnets	787
N. Ohuchi, T. Ogitsu, K. Tsuchiya, and S. Nakamura	
Thermal Performance of the Supporting System for the Large Hadron Collider (LHC) Superconducting Magnets	795
M. Castoldi, M. Pangallo, V. Parma, and G. Vandoni	
Cooling Scheme for BNL-Built LHC Magnets	803
K. C. Wu, S. R. Plate, E. H. Willen, R. van Weelderen, and R. Ostojic	
The Cryogenic Supply for the New S. C. Magnets around the Interaction Regions Used for the HERA Luminosity Upgrade.....	811
H. Lierl	
Thermal Hydraulic Performance for a Sextant of RHIC Magnets	817
K. C. Wu, J. Sondericker, M. Iarocci, Y. Farah, C. Lac, A. Morgillo, A. Nicoletti, E. Quimby, J. Rank, M. Rehak, and D. Zantopp	

SUPERCONDUCTING CAVITIES (I)

The TESLA Test Facility (TTF) Cryomodule: A Summary of Work to Date	825
J. G. Weisend II, C. Pagani, R. Bandelmann, D. Barni, A. Bosotti, G. Grygiel, R. Lange, P. Pierini, B. Petersen, D. Sellmann, and S. Wolff	
The LHC Superconducting RF System	835
D. Boussard and T. Linnecar	
High Power CW Superconducting Linacs for Nuclear Waste Processing	845
C. Pagani and P. Pierini	
Development of the Superconducting Crab Cavity for KEKB.....	853
H. Nakai, K. Hara, K. Hosoyama, A. Kabe, Y. Kojima, Y. Morita, K. Okubo, H. Hattori, and M. Inoue	
Superconducting Cavities for KEKB Factory.....	861
S. Mitsunobu, K. Akai, E. Ezura, T. Furuya, K. Hara, K. Hosoyama, A. Kabe, Y. Kojima, Y. Morita, H. Nakai, and T. Tajima	
Superconducting RF Cavities and Cryogenics for the CESR III Upgrade	871
E. Chojnacki and J. Sears	
Status and Perspectives of the SC Cavities for TESLA.....	881
C. Pagani for the TESLA Collaboration	
Design of Superconducting Radio-Frequency Cavities for a Continuous-Wave Proton Linac.....	891
R. Gentzlinger, B. Campbell, K. C. Chan, G. Ellis, J. P. Kelley, F. Krawczyk, J. Kuzminski, M. Manzo, R. Mitchell, D. Montoya, B. Rusnak, H. Safa, D. Schrage, and B. Smith	

SUPERCONDUCTING RF CAVITIES (II)

Experimental Investigation of the Thermal Resistance in Niobium Samples for Superconducting RF Cavities.....	899
M. R. Smith, T. Zhang, Y. Xiang, S. W. Van Sciver, J. G. Weisend II, P. Schmueser, and M. Fouaidy	
Friction Measurements for SC Cavity Sliding Fixtures in Long Cryostats.....	905
D. Barni, M. Castelnovo, M. Fusetti, C. Pagani, and G. Varisco	
Dissipated Power Measurements in the A0 SRF Cavity System.....	913
J. D. Fuerst and W. H. Hartung	
Cryostat to Test the Superconducting RF Gun for the Drossel Project.....	919
Y. P. Filippov and A. M. Kovrizhnykh	
An RF-Cavity Fine-Tuning Actuator	925
J. P. Voccio, C. M. Gervais, and N. Kotsifakis	

Vacuum Break-Down in the Beam Tube of Large Accelerators with Superconducting Cavities	933
Ch. Haberstroh, H. Winkler, and H. Quack	
Further Improvements of the TESLA Test Facility (TTF) Cryostat in View of the TESLA Collider	939
C. Pagani, D. Barni, M. Bonezzi, and J. G. Weisend II	
Thermal Optimization of the APT Cryomodule with Regard to the Associated Cryosystem	947
J. A. Waynert, F. C. Prenger, and J. P. Kelley	
Plasma Spray Coating of Niobium Superconducting RF Cavities	953
T. Junquera, S. Bousson, A. Caruette, M. Fouaidy, H. Gassot, and J. Lesrel	

