

NOTE: Page numbers used in this Index refer to the **FIRST PAGE** of the referenced article published in the proceedings. To view the referenced article, go to the Table of Contents and click on the article with the referenced page number located to the left of the paper title.

Cryocoolers 14 Subject Index

ACTDP cryocooler development:

- Ball Aerospace hybrid Stirling/J-T cooler, 41
- Lockheed Martin 4-stage PT w/ flow loop, 33
- NGST hybrid PT/J-T cooler, 21
- As part of NASA programs overview, 7

ADR (*see* Magnetic refrigerators)

Adv. Mechanical Tech., Inc., 477

Air Force Research Lab (AFRL):

- AFRL cryogenic research initiatives, 11
- analysis of pulse tube losses, 293
- Ball SB235 2-stage 35K Stirling perf., 57
- DoD space sensor mission trade-offs, 595
- flow loop for remote cryogenic loads, 573
- multiplate recup. HX for hybrid cooler, 515
- thermo optimization criteria for PT, 285

Air Liquide DTA (France):

- 40-80K high-heat-lift space PT cooler, 75
- 65K-280W high-freq PT cooler, 133
- dilution frig for Planck-HFI, 535
- third-stage cooling from 2-stage 4K PT, 157

AIRS cryocoolers in-space performance, 4, 618

Applications of cryocoolers (*see* Integration with cryocoolers)

Astrium cryocoolers (formerly BAe and MMS), 3

Atlas Scientific:

- flow loop for remote cryogenic loads, 573
- miniature CVD-based Stirling cooler, 95
- multiplate recup. HX for hybrid cooler, 515

Ball Aerospace coolers:

- 4-6K ACTDP hybrid Stirling/J-T cooler, 7, 8, **41**
- HIRDLS cooler on-orbit performance, 5, **615**
- optical refrigerator performance, 539
- SB160 performance comparison, 605
- SB235 2-stage 35K Stirling perf. mapping, 57
- SB235E 2-stage 35K Stirling development, 49

Bearings, flexure springs for linear motors, 335

Brayton cryocoolers (*see* Reverse-Brayton coolers)

British Aerospace (BAe) cryocoolers (*see* Astrium)

Buchwald Consulting, optical cooler summary, 539

Canadian Space Agency, PT modeling tool, 307

CEA/SBT (France):

- 40-80K high-heat-lift space PT cooler, 75
- 65K-280W high-freq PT cooler, 133

CFIC-Qdrive:

- effect of long compressor-PT transfer line, 225

Chesapeake Cryogenics:

- ribbon regenerator perf. in 1-stage GM, 373
- photoetched regenerator for high freq PT, 389

Chiba University (Japan):

- hydrogen liquefaction w/DGAG-based ADR, 637
- Gd-Y alloys for use in ADRs, 549
- optimum pressure ratio of GM cryocooler, 187

Chinese Academy of Sciences, Cryogenics Lab:

- 0.5W/40K PT cooler for IR detector, 83
- 6mm diameter coaxial PT development, 117
- comparison of two types of Stirling cycles, 249
- composition shift of mixed gases in J-T, 453, 459
- CTE-based cryogenic thermal switch, 589
- Gedeon DC flow loss analysis, 205
- gravity effects on high-freq PT perf., 241
- numerical sym. of regenerator in 2-stg PT, 405
- oil-lub compressor with elastic membrane, 361
- phase shift measurement in PT regenerators, 411
- thermoacoustic time-averaged effects, 195
- thermoacoustic-driven pulse tube cooler, 211, 219
- two-stage high-freq PT cryocooler, 177

Claude refrigeration cycle:

- for re-liquefaction of LNG boil-off, 629

Clearance seals (*see* Compressors)

Cleveland State Univ., etched foil regen mat'l, 381

Clever Fellows Innov. Consortium (*see* CFIC-Qdrive)

CNRS, Grenoble, France:

- dilution frig for Planck-HFI, 535
- third-stage cooling from 2-stage 4K PT, 157

Collins-type 10K cryocooler, 477

Compressors:

- flexure springs in linear motors, 335
- Fuji 100W moving-magnet comp. for PT, 327
- gas spring losses thru clearance seals, 345
- oil-lub compressor with elastic membrane, 361
- Contamination effect on cryo load in space, 615
- Convection, gravity effects on PT perf., 241

Creare rev-Brayton coolers:

- circulator for remote cooling, 16
- comparison with PT and Stirling coolers, 605
- NICMOS cooler in-space performance, 4
- recuperative HX for space turbo-Brayton, 525

Cryomech 4K pulse tube cryocoolers:

- PT3S403 3-stage 4K PT, 163
- helium liquefaction using PT415 cooler, 655

Cryo Wave Adv. Tech., thermoacoustic expander, 429

CTE-based cryogenic thermal switch, 589

- Darwin mission 4.5K-5mW sorption cooler, 487
 Dilution refrigerator for Planck-HFI, 535
 Drexel Univ., PT development, 149
 Dutch Space, Darwin sorption cooler, 487
 Dysprosium gadolinium alum. garnet (DGAG), 637
- Eindhoven Univ. of Technology:
 1-D models of pulse tube cooler, 301
 hybrid counterflow PT refrigerator, 257
 new type of PT streaming, 271
- Erbium regenerator materials (*see* Regenerators)
 Estimator for cryocooler performance, 563
 Etched foil regenerator mat'l (*see* Regenerators)
 European Space (ESA/ESTEC) activities:
 40-80K high-heat-lift space PT cooler, 75
 Darwin 4.5K 5mW sorption cooler, 487
 European Office of Aerospace R&D, 285
 Exergy flows (*see* Pulse tube theory and invest.)
- Flexure bearing springs, 335
 Flow loops (*see* Remote cryogenic loads, cooling of)
 Focal plane sensor arrays, overview of, 11, **595**
 Friedrich-Schiller-Universität, Jena:
 9.5K 2W 2-stage coaxial PT devel., 171
 Fuji Electric Systems Co. PT compressor, 327
- Gas-gap heat switches (*see* Heat switches)
 Gas spring losses in linear compressors, 345
 Gedeon Associates:
 etched foil regenerator mat'l, tests of, 381
 miniature CVD-based Stirling cooler, 95
 Sunpower CPT60 60K-2W PT cooler, 123
 Gedeon DC flow loss, 205
 Georgia Institute of Tech.:
 hydrodynam. parameters of regenerators, 397
 Gifford-McMahon Cryocoolers:
 ribbon regenerator perf. in 1-stage GM, 373
 optimization of pressure ratio for, 187
 GIFTS 2-stage PT cryocooler, 7, **65**
 Goddard Space Flight Center (NASA):
 NASA cryocooler program overview, 1
 GOS regenerator material (*see* Regenerators)
 Gravity effects on high-freq PT perf., 241
- Heat exchangers:
 micromachined HX for cryosurgical probe, 505
 multiplate recup. HX for hybrid cooler, 515
 recuperative HX for space turbo-Brayton, 525
 Heat switches, 589
 High temperature superconductor applications (*see*
 Integration of cryocoolers with)
- Hong Ik University, 629
 HTS applications (*see* Integ. of cryocoolers with)
 Honeywell Hymatic, flexure bearing springs, 335
 Hybrid multistage coolers:
 Ball 4-6K ACTDP J-T/Stirling, 41
 Lockheed 6K ACTDP PT w/ flow loop, 33
 NGST 6K ACTDP J-T/PT, 21
 PT/rev Brayton for 10K, 515
 Hydrides (*see* Sorption cryocoolers)
- IAS (France), dilution refrig for Planck, 535
 Ice cream production via flash freezing, 621
 INAF/ISAF (Italy), 497
 Inertance tubes (*see* Pulse tube theory and invest.)
 Infrared detectors, summary of, 11
 Integration of cryocoolers with:
 cryosurgical probes, 505
 CTE-based cryogenic thermal switch, 589
 electric current leads, 443
 flow loops (*see* Remote cryogenic loads)
 ice cream production, 621
 infrared focal planes, 11, **595, 605**
 liquefaction of gases (*see* Liquefaction of gases)
 remote loads (*see* Remote cryogenic loads)
 space instruments (*see* Space instruments)
 spacecraft payloads in general, 595, 605
 Israel Inst. of Tech., CFD model of recip. flow, 317
- J-T cryocoolers:
 Ball ACTDP 6K cooler development, 7, 8, **41**
 composition shift of mixed gases in, 453, 459
 inversion states of J-T effect, 469
 micromachined HX for cryosurgical probe, 505
 micromachined J-T cold stage, 437
 mixed-gas J-T cooler for elect. current leads, 443
 NGST ACTDP 6K cooler devel., 7, 8, **21**
 thermoacoustic expansion valve for, 429
 Jet Propulsion Laboratory (NASA):
 ACTDP 6K cooler contracts, 21, 33, 41
 NASA cryocooler program overview, 1
 Planck sorption cooler FA testing, 497
 Joule-Thomson Cryocoolers (*see* J-T cryocoolers)
- Kapitza cycle for liquefaction of LNG boil-off, 629
 KBSI-NHMFL Collaboration Center (Florida):
 helium liquefaction using PT cooler, 655
 Konoshima Chemical Co.:
 dysprosium gadol'um alum. garnet (DGAG), 637
 multilayer ceramic regenerator mat'ls, 367
 Korea Basic Science Inst., He liquefaction, 655
 Korea Inst. of Science and Tech.:
 cycles for re-liquefaction of LNG boil-off, 629
 Korea Univ. of Tech. and Education, 629
- Liquefaction of gases:
 cycles for use with LNG boil-off, 629
 helium liquefaction using PT cooler, 655
 hydrogen liquefaction using ADR, 637, 645
 zero boil-off in propellant tanks, 563, 583
 Lockheed Martin Space Systems (Denver):
 cooler to provide zero-boil-off propellant, 583
 Lockheed Martin ATC (Palo Alto):
 6K-18K ACTDP PT with flow loop, 33
 10K PT cooler in DoD space application, 602
 55K/140K GIFTS 2-stage PT cooler, 7, **65**
 110K PT cryocooler w/ flow loop, 583
- Magnetic refrigerators:
 dysprosium gadolinium aluminum garnet, 637
 for hydrogen liquefaction, 637, 645

SUBJECT INDEX

- Gd-Y alloys for use in ADRs, 549
- La(Fe,Si)₁₃ magnetic refrigerant study, 555
- regenerator materials for (*see* Regenerators)
- refrigerant materials for (*see* Refrigerants)
- Massachusetts Institute of Technology:
 - Collins-type 10K cryocooler, 477
 - Flash-freezing process for ice cream, 621
- Materials:
 - refrigerants (*see* Refrigerants)
 - regenerator (*see* Regenerators)
- Matra Marconi coolers (*see* Astrium coolers)
- Maya Heat Transfer Tech. (Canada), 307
- Microcooler:
 - micromachined HX for cryosurgical probe, 505
 - micromachined J-T cold stage, 437
- MIRI 6K hybrid PT/J-T cryocooler, 7, 21
- MIT (*see* Massachusetts Institute of Technology)
- Mitchell/Stirling, etched foil regenerator mat'l, 381
- Mixed refrigerants (*see* Refrigerants, *and* J-T cryocoolers)

- Nanohmics, Inc. miniature Stirling cooler, 95
- NASA cryocooler program overview, 1
- NASA/GSFC (*see* Goddard Space Flight Center)
- NASA/JPL (*see* Jet Propulsion Laboratory)
- Nat'l High Magnetic Field Laboratory (Florida):
 - helium liquefaction using PT cooler, 655
- Nat'l Inst. for Materials Science (Tsukuba, Japan):
 - dysprosium gadolium alum. garnet (DGAG), 637
 - multilayer ceramic regenerator mat'ls, 367
 - magnetic refrig. for H₂ liquefaction, 637, 645
- Nat'l Inst. of Adv. Indus. Sci. & Tech. (Japan), 277
- Nat'l Inst. of Standards and Tech. (*see* NIST)
- NAVSEA Naval Surface Warfare Center:
 - evaluation of total pressure oscillator losses, 353
- NICMOS reverse-Brayton cooler, 4
- Nissan Motor Co., GM cooler efficiency, 187
- NIST:
 - evaluation of total pressure oscillator losses, 353
 - inertance tube char. using resonance effects, 263
 - rapid cooldown technique for PT coolers, 231
- Northrop Grumman Space Tech. (*previously* TRW):
 - AIRS 55K PT coolers, 4, 618
 - 6 K ACTDP cooler development, 7, 21
 - 10K 3-stage PT cryocooler, 27
 - 77K-1.1W micro PT cooler, 89
 - HCC 35K/85K PT in DoD application, 602
 - HEC cooler performance, 605
 - Mini pulse tube coolers, 3
 - TES/OCO 60 K PT cryocooler, 4, 6, 619

- Orbital-Engineering Co. (Japan), 277
- Optical refrigerator history and overview, 539
- Orientation, effect on performance:
 - convection in pulse tube coolers, 241
- Osaka Univ. ADR for H₂ liquefaction, 645
- Oxford Univ. (*see* Univ. of Oxford)

- Performance estimator for cryocoolers, 563
- Perovskites (*see* Refrigerants)

- Phase change materials (*see* Thermal Storage)
- Planck space mission:
 - JPL 20K-1W sorption cooler, 6, 497
 - Sub-Kelvin dilution refrigerator, 535
- Praxair:
 - 300W at 80K, 19% Carnot PT cooler, 141
- Propellant liquefaction and densification (*see* Liquefaction of gases)
- Pulse tube cryocoolers:
 - 4K 3-stage Cryomech cryocooler, 163
 - 9.5K 2W Friedrich-Schiller Univ., 171
 - 10K 3-stage NGST, 27
 - 20-40K 2-stage at Univ. of Giessen, 177
 - 40K-0.5W PT cooler for IR detector, 83
 - 40-80K high-heat-lift Air Liquide for space, 75
 - 55K-1.5W AIRS, 4
 - 65K-2.5W Fuji for HTS devices, 327
 - 65K-280W high-freq PT cooler, 133
 - 77K-1.1W NGST micro PT cooler, 89
 - 80K-0.2W w/6mm dia. coaxial PT, 117
 - LM-ATC 6K ACTDP PT w/ flow loop, 33
 - LM-ATC 55K/140K GIFTS cooler, 7, 65
 - LM-ATC 110K PT w/ flow loop, 583
 - NGST 18 K precooler for ACTDP, 21
 - NGST 35K/85K HCC 2-stage PT, 602
 - NGST 60K HEC 1-stage PT perf., 605
 - NGST 77K-1.1W micro PT cooler, 89
 - Praxair 300W at 80K, 19% Carnot, 141
 - Sunpower CPT60 60K-2W PT cooler, 123
 - thermoacoustic-driven PT coolers, 211, 219
- Pulse tube theory and investigations:
 - 1-D models of pulse tube cooler, 301
 - 6mm diameter coaxial PT development, 117
 - AFRL analysis of pulse tube losses, 293
 - CFD model of reciprocating flow, 317
 - comparison of 2 types of PT/Stirling cycles, 249
 - Drexel Univ. low cost PT, 149
 - hybrid counterflow PT refrigerator, 257
 - hydrodynam. parameters of PT regenerators, 397
 - inertance tube char. using resonance effects, 263
 - integrated modeling tool for, 307
 - gravity effects on high-freq PT perf., 241
 - numerical sym. of regenerator in 2-stg PT, 405
 - phase shift measurem't in PT regenerators, 411
 - rapid cooldown technique for PT coolers, 231
 - regenerator studies, generic (*see* Regenerators)
 - second-law based thermo optimization, 285
 - streaming of new type found in PT, 271
 - study of Gedeon DC flow loss, 205
 - third-stage cooling from 2-stage 4K PT, 157
 - total pressure oscillator losses, 353
 - transfer line, effect of large comp-PT dist., 225
 - Univ. of Giessen invest. of 2-stage PT, 177
 - visualization of 2nd flow in inclined PT, 277

- Rafael, Ltd., 469
- Rapid cooldown technique for PT coolers, 231
- Rare earth compounds (*see* Regenerators)
- Raytheon Space Systems (*formerly* Hughes Aircraft):
 - cryocooler selection for opt. payload perf., 605

- hydrodynam. parameters of regenerators, 397
- RS1 Stirling cooler performance, 605
- Recuperative heat exchangers (*see* Heat exchangers)
- Refrigerants:
 - dysprosium gadol. alum. garnet (DGAG), 637
 - La(Fe,Si)₁₃ magnetic refrigerant, 555
- Regenerators:
 - CFD model of reciprocating flow, 317
 - counterflow regen. for PT refrigerator, 257
 - dimensional analysis for regenerator design, 419
 - etched foil material, tests of, 381, 389
 - hydrodynam. parameters of regenerators, 397
 - lead-plated wire mesh for low temp., 171
 - multilayer ceramic materials for, 367
 - numerical sym. of regenerator in 2-stg PT, 405
 - phase shift measurem'ts in PT regenerators, 411
 - ribbon regenerator perf. in 1-stage GM, 373
- Re-Liquefaction of gases (*see* Liquefaction of gases)
- Remote cryogenic loads, cooling of using:
 - Creare turbine circulator, 16, 17
 - hybrid PT/rev Brayton, 515
 - LM-ATC PT w/ flow loop, 33, 583
 - long PT transfer line, 225
 - low-pressure J-T bottom stage, 21, 41
 - rectified pulse tube, 573
- Reverse-Brayton cryocoolers:
 - comparison with PT and Stirling coolers, 605
 - NICMOS operation on HST, 4
 - recuperative HX for space turbo-Brayton, 525
 - hybrid PT/rev Brayton for remote loads, 515
- Ricor, Ltd.:
 - K508 cooler in space applications, 5
 - K527 miniature linear split Stirling, 105
- Shanghai Inst. of Tech. Physics, 40K PT cooler, 83
- Shinyong Heavy Industries Co.:
 - cycles for re-liquefaction of LNG boil-off, 629
- Sorption cryocoolers:
 - all-micromachined cold stage, 437
 - Darwin 4.5K 5mW sorption cooler, 487
 - Planck 20K-1W cooler FA testing, 497
- Space cryocooler overviews:
 - AFRL space cryo research initiatives, 11
 - cryocooler selection for opt. payload perf., 605
 - DoD space sensor mission trade-offs, 595
 - NASA cryocooler mission summary, 1
- Space Dynamics Laboratory, GIFTS PT testing, 65
- Space instrument missions:
 - ABI, 7
 - AIRS, 4, 618
 - AMS-2, 6
 - ASTER, 3
 - CRISM, 5
 - Darwin, 487
 - GIFTS, 7, 65
 - HIRDLS, 5
 - Hyperion, 3
 - ISAMS, 2
 - Messenger, 5
 - MIRI (JWST), 7, 21
 - MOPITT, 3
 - NICMOS, 4
 - OCO, 6
 - Planck, 6, 497, 535
 - RHESSI, 3
 - Saber, 3
 - TES, 4, 618
- Stirling cryocoolers:
 - Astrium/MMS 50-80K on MOPITT, 3
 - Ball 15K precooler for ACTDP hybrid, 41
 - Ball SB160 1-stage 60K Stirling perf., 605
 - Ball SB235 2-stage 35K Stirling perf. mapping, 57
 - Ball SB235E 2-stage 35K Stirling devel., 49
 - comparison of two types of Stirling cycles, 249
 - Oxford Univ. 80K ISAMS Stirling, 2
 - miniature CVD-based Stirling cooler, 95
 - Raytheon RS1 in space applications, 605
 - Ricor K508, 5
 - Ricor K527 mini linear split Stirling, 105
 - Sunpower M77B on RHESSI, 3
 - Sunpower M87 on AMS-2, 6
- Sub-Kelvin coolers:
 - dilution refrigerator for Planck-HFI, 535
- Sumitomo Heavy Industries:
 - Multilayer ceramic regenerator mat'l, 367
- Sunpower, Inc.:
 - CPT60 60K-2W PT cooler, 123
 - etched foil regenerator material, 381
 - M77B Stirling cooler on RHESSI, 3
 - M87 Stirling cooler on AMS-2, 6
- Superconductor applications (*see* Integration of cryocoolers with)
- Switch, cryogenic thermal (*see* Heat switch)
- TES cryocoolers in-space performance, 2, 4, 618
- Thales Cryogenics:
 - 40-80K high-heat-lift space PT cooler, 75
- Thermal switch (*see* Heat switch)
- Thermoacoustics:
 - expansion valve for recuperative systems, 429
 - nonzero time-averaged effects, 195
 - thermoacoustic-driven PT coolers, 211, 219
- Throttle cycle (*see* J-T cryocoolers)
- Tokyo Inst. of Tech., GM cooler efficiency, 187
- Toshiba Corp.:
 - Gd-Y alloys for use in ADRs, 549
 - La(Fe,Si)₁₃ magnetic refrigerant study, 555
- Transfer line (*see* Pulse tube theory and investigations)
- TRW (*see* Northrop Grumman Space Tech.)
- Turbo Brayton coolers (*see* reverse Brayton coolers)
- U.S. Naval Academy, optical cooler summary, 539
- Univ. of Alicante (Spain), 487
- Univ. of Birmingham, flexure bearings, 335
- Univ. of Giessen, 2-stg high-freq PT cryocooler, 177
- Univ. of Michigan, micromachined HX, 505
- Univ. of New Mexico,
 - analysis of pulse tube losses, 293
 - thermo optimization criteria for PT, 285

SUBJECT INDEX

Univ. of Oxford:

- gas spring losses in linear compressors, 345
- ISAMS Oxford cooler performance, 2
- NGST 77K-1.1W micro PT cooler, 89

Univ. of Tsukuba, flow visualization in PT, 277

Univ. of Twente:

- all-micromachined J-T cold stage, 437
- Darwin 4.5K 5mW sorption cooler, 487

Univ. of Wisconsin:

- dimensional analysis for regenerator design, 419

flow loop for remote cryogenic loads, 573

mixed-gas J-T cooler for elect. current leads, 443

micromachined HX for cryosurgical probe, 505

multiplate recup. HX for hybrid cooler, 515

Zero-boil-off cryogen storage (*see* Liquefaction of gases)

Zhejiang Univ.:

char. of iner. tubes using resonance effects, 263

eval. of total pressure oscillator losses, 353