

Proceedings of the 9th
International Conference on
High Energy Accelerators

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PROCEEDINGS
of the
IXth International Conference
on
High Energy Accelerators

Stanford Linear Accelerator Center
Stanford University, Stanford, California
May 2-7, 1974

International Union of Pure and Applied Physics
National Science Foundation
U.S. Atomic Energy Commission

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FOREWORD

The IXth International Conference on High Energy Accelerators was held at the Stanford Linear Accelerator Center on May 2 - 7, 1974. This conference was attended by 259 delegates from 14 countries, including the United States.

The technical program of the conference was presented during 8 regular sessions on Thursday and Friday, May 2 and 3, and on Monday and Tuesday, May 6 and 7. There were no parallel sessions during these days. In addition to the regular scheduled sessions, several parallel ad hoc sessions were held on Saturday, May 4. Most of these special sessions were arranged during the conference at the request of interested delegates.

During the regular sessions, the following papers were presented orally:

18 invited
8 rapporteur
37 contributed

In addition to these papers, 75 papers which could not be scheduled for oral presentation are published in the conference proceedings.

Reflecting recent trends, considerable emphasis was placed on receiving reports of storage developments during this conference. Sessions 2 and 8 were devoted to this subject with principal emphasis given to experience with existing rings in Session 2 and to future storage rings in Session 8. In addition, beam dynamics in storage rings received considerable attention in Sessions 6 and 9.

Other sessions of the conference were devoted to new large accelerators (Session 1), RF superconductivity and superconducting magnets (Session 3), collective methods of acceleration (Session 4), beam dynamics, new devices and controls (Sessions 6 and 7), and overall perspective talks (Session 9).

In this conference, more emphasis was placed upon the presentation of rapporteur papers than in past conferences. Each rapporteur was asked to divide his/her talk into two parts. The first part was an opening statement giving a state-of-the-art background and setting the stage for subsequent contributed papers. The second part came after the contributed papers and consisted of a summary of future problems and a discussion involving the audience to reconcile divergent points of view.

As an adjunct to the scientific aspects of the conference, the delegates participated in several interesting social events. These included an evening visit to the Lawrence Hall of Science in Berkeley (including a buffet dinner), a Sunday bus trip over the coastal hills to the redwood forests in the Henry Cowell State Park, followed by a visit to the Santa Cruz campus of the University of California where supper was served, and a reception at Hoover House, the home of Stanford University President and Mrs. Richard Lyman.

A separate social program was arranged for the ladies accompanying delegates to the conference. Their activities included a tour of the Sunset Magazine buildings and gardens, a visit to the Allied Arts Center in Menlo Park, an all-day trip to San Francisco, and a tour of the Paul Masson Winery followed by a visit to Old Town in Los Gatos. We are very grateful to Portia Hogg and other members of the Ladies Program Committee for arranging these events.

Many people participated in the planning and functioning of this conference. Because of the large number, it is not practicable to acknowledge each individual contribution. We are very grateful for the advice and assistance of the International Advisory Committee and to the Organizing/Program Committee. The names of members of these committees are given elsewhere in this Proceedings. The Scientific Secretaries were of great assistance to the Chairmen and Speakers and in the editing of remarks made during the technical sessions. Finally, it is fitting to mention several people individually because of their extensive and indispensable contributions to the success of the conference. Coordination of all non-technical aspects of the conference including the editing of the Proceedings was ably handled by Ruth Nelson. Harry Hogg, a member of the Organizing/Program Committee, was principally responsible for the preparation of the program booklet. Joe Cobb was in charge of audio-visual services during the conference; he was assisted by William Johnson. Janette Pearl and Jane Peterson handled the main secretarial duties during the planning and preparation phase, as well as during the conference itself.

Richard B. Neal, Chairman
Organizing/Program Committee

CONFERENCE COMMITTEES

International Advisory Committee

The scope and format of the Conference followed recommendations made by the International Advisory Committee, members of which are named below:

Dr. John Adams
CERN, Switzerland

Professor Artem I. Alikhanian
USSR Academy of Sciences, USSR

Dr. Alick Ashmore
Daresbury Nuclear Physics Laboratory, Great Britain

Professor G. I. Budker
USSR Academy of Sciences, USSR

Dr. Bruce Cork
Lawrence Berkeley Laboratory, USA

Professor A. P. Lagarrigue
Ecole Normale Supérieure, France

Professor Edward J. Lofgren
Lawrence Berkeley Laboratory, USA

Professor Alexander L. Mints
USSR Academy of Sciences, USSR

Professor A. A. Naumov
High Energy Physics Institute (Serpuukhov), USSR

Professor Wolfgang K. H. Panofsky, Chairman
Stanford Linear Accelerator Center, USA

Professor Wolfgang Paul
DESY, West Germany

Dr. R. Ronald Rau
Brookhaven National Laboratory, USA

Professor Giorgio Salvini
University Degli Studi, Italy

Dr. G. H. Stafford
Rutherford High Energy Laboratory, Great Britain

Dr. William A. Wallenmeyer
U. S. Atomic Energy Commission, USA

Professor Robert R. Wilson
National Accelerator Laboratory, USA

Organizing Committee

All Conference arrangements were handled by the Organizing Committee composed of staff members of the Stanford Linear Accelerator Center and the Lawrence Berkeley Laboratory. The Organizing Committee was structured into the following sub-committees:

Organizing Committee Chairman

Richard B. Neal

Steering Sub-Committee

Richard B. Neal, Chairman
Joseph K. Cobb
Douglas W. Dupen
William B. Herrmannsfeldt
Harry A. Hogg
Charles J. Kruse
Gregory A. Loew
Ruth T. Nelson
Janette E. Pearl

Program Sub-Committee

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Richard H. Helm
Glen R. Lambertson
John R. Rees
Burton Richter
Lloyd Smith

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Gerhard E. Fischer
Charles J. Kruse

Technical Arrangements Sub-Committee

James McEwan Paterson, Chairman
Hermann A. Grunder
Kenneth B. Mallory

Social Events Sub-Committee

William B. Herrmannsfeldt, Chairman
Matthew A. Allen
Roger H. Miller
Phillip L. Morton
Steven J. St. Lorant
Perry B. Wilson

Scientific Secretaries

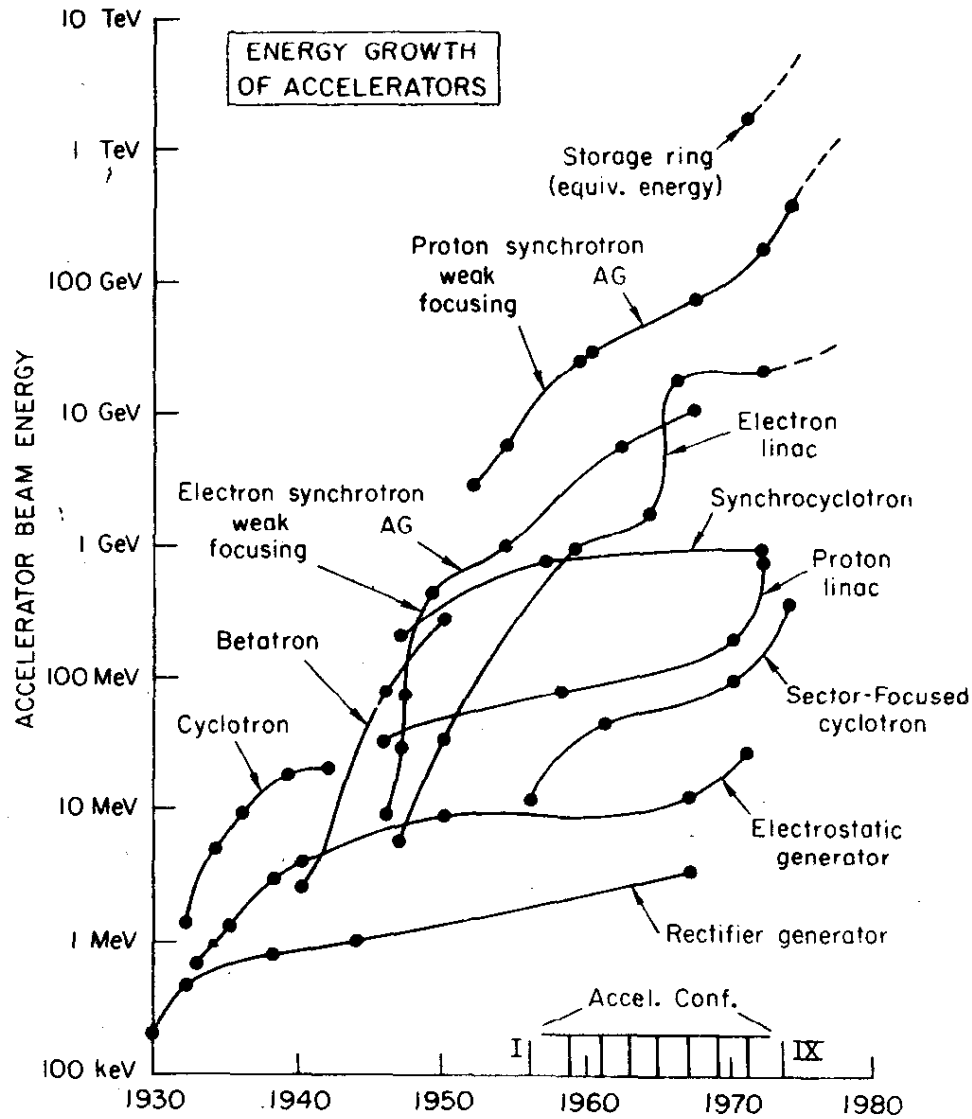
The following persons, staff members of the Stanford Linear Accelerator Center and the Lawrence Berkeley Laboratory, served as Scientific Secretaries:

Kenneth F. Crook
Z. David Farkas
John L. Harris
John M. Hauptman
Roland F. Koontz
Charles J. Kruse
Martin J. Lee
Christoph W. Leeman
Richard M. Mobley
Richard E. Morgado
Vernon G. Price
Daryl D. Reagan
Joseph B. Rechen
Andrew P. Sabersky
Steven J. St. Lorant
John W. Staples

WELCOMING REMARKS

W. K. H. Panofsky

I would like to welcome all of you to the IXth International Conference on High Energy Accelerators. This is the first time this conference has been at SLAC, or even on the West Coast of the United States; we hope that you will be able to avail yourselves of this opportunity to become familiar with the accelerator installations in the San Francisco Bay Area.

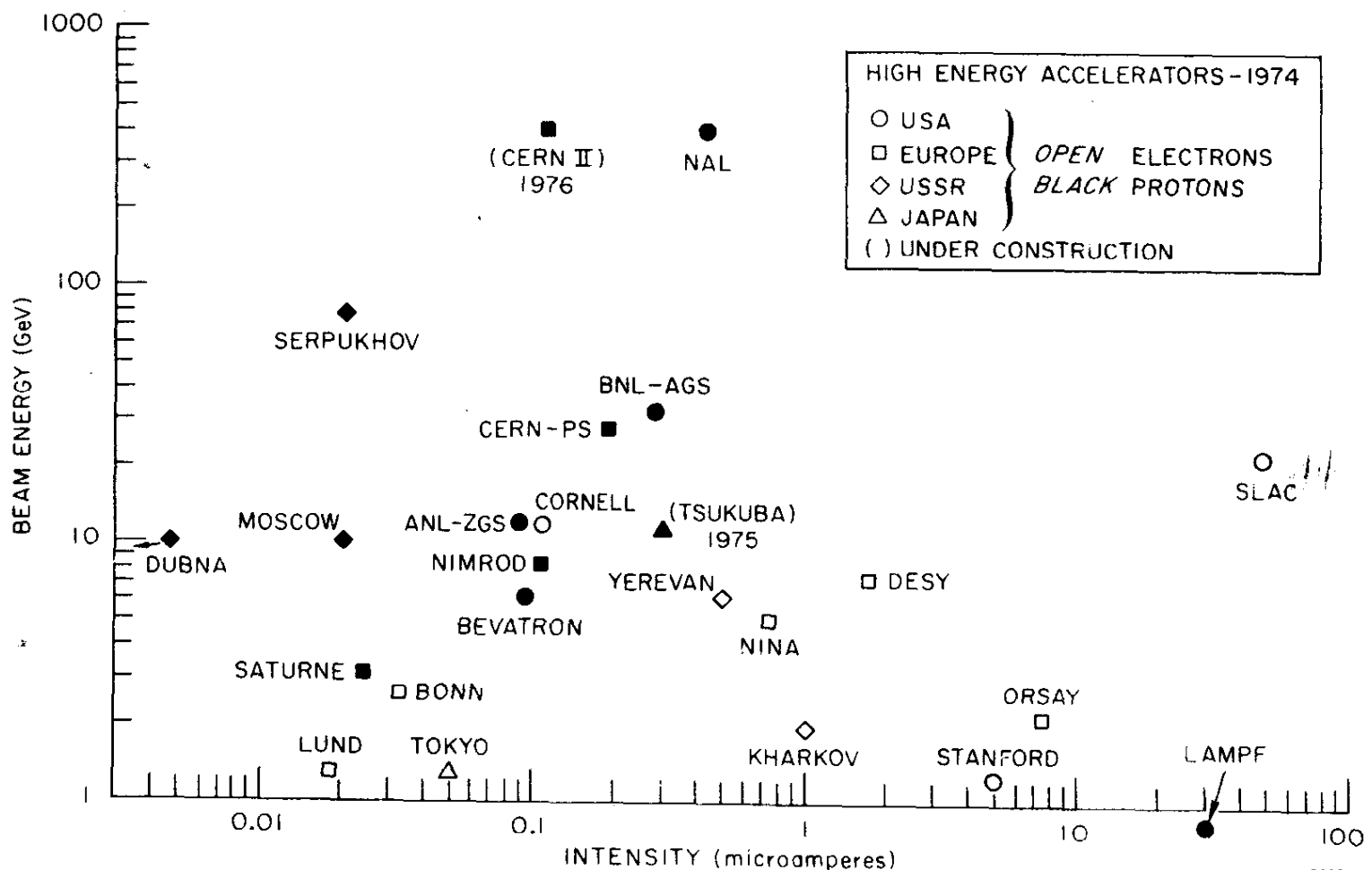


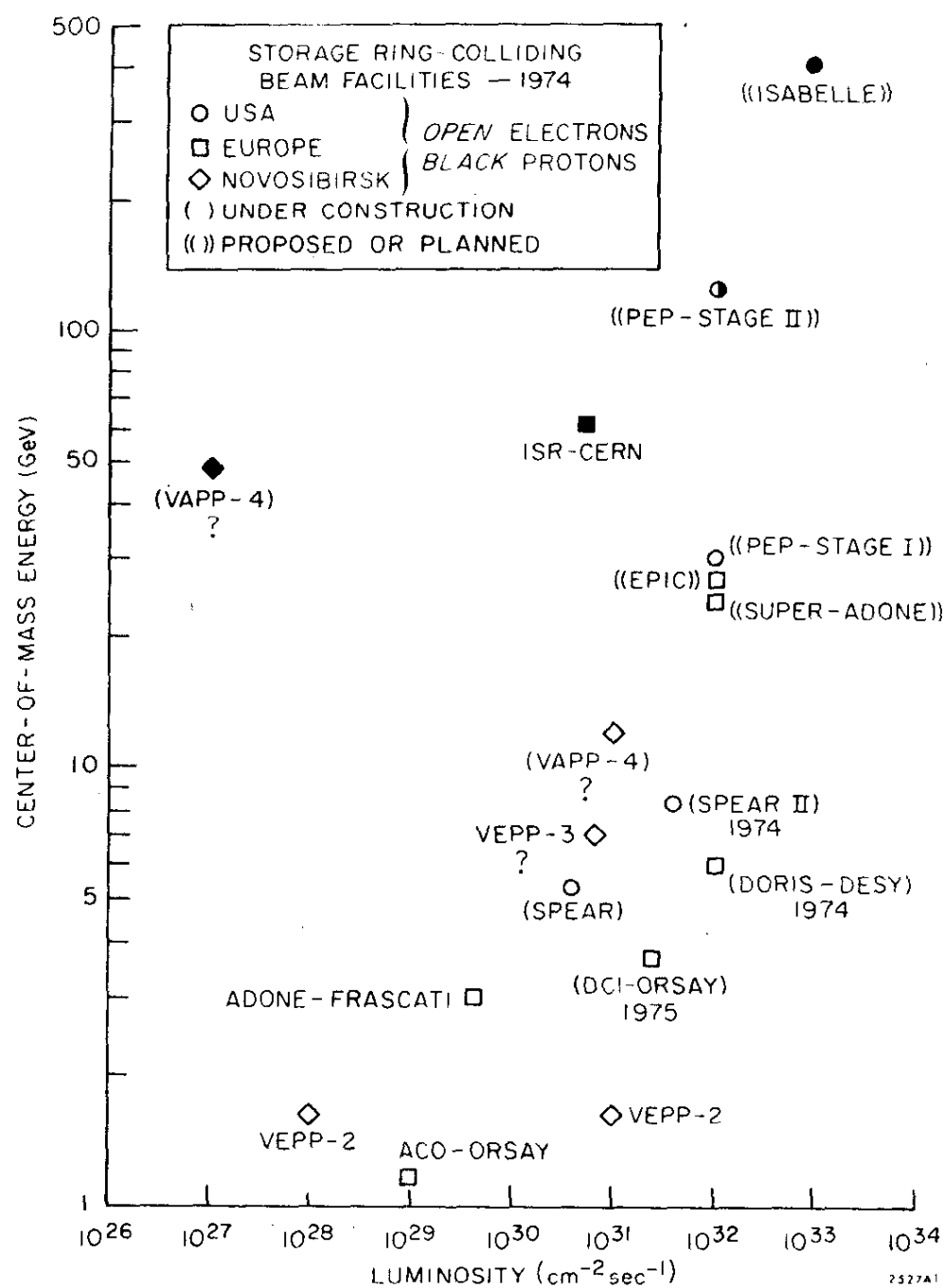
There has been much discussion about the interval between these conferences; the last conference was held two and a half years ago, and two-year intervals preceded that gap. To some this may appear to be too frequent, but I should like to remind you that the accelerator art is rapidly evolving indeed. The first figure is a chart which shows the growth over time of equivalent laboratory energy attained by accelerating or colliding beam devices. Note that if the exponential growth shown on this chart has continued, then the laboratory energy has risen by a factor of 2.6 since the time when this conference was last convened! At this rate "energy doublers"—whether for protons or electrons—will have to be built awfully fast!

Probably the most significant aspect of this chart is the clear indication it gives of the past richness of new ideas for the acceleration and storage of particles. Whenever any one technique appeared to saturate in terms of the energy which could be attained at reasonable cost, new ideas came to the forefront. I believe most elementary particle physicists would agree that the entire field of particle physics has been paced by the opportunities offered by accelerator technology rather than by the demands of high energy physicists. Today, however, I can not quite be sure whether this is still the case. Let me briefly review the situation.

The next two figures will show the laboratory energies and intensities of conventional accelerators and center-of-mass energies and luminosities of colliding beam devices. The data in these figures have been taken directly from the Catalog of High Energy Accelerators which compiles the information submitted by the various laboratories to this conference.* As you can see, the past advances have indeed been striking. However, we do not now discern how any genuinely new ideas appear to relate to the next generation

*The recent intensity record of 10^{13} particles/pulse reached by NAL has been included. Data on most Soviet installations is derived from earlier information.





of future accelerating devices. The various proposals for future accelerators and colliding beam devices which are appended to the catalog are based on what I might call parametric studies, that is, optimization of established principles and techniques rather than exploitation of genuinely new ideas. This does not mean that new ideas are absent; however, the effort needed to demonstrate whether, for instance, collective acceleration is promising for very high energy devices has proven to be so great that one cannot be too optimistic. So possibly for the next generation of accelerators or storage rings history may not repeat. It may be that the open problems of elementary particle physics rather than new technology will determine events. I can say that particle physics today has rarely been in a more "expectant" condition. Recent results, particularly at high momentum transfers, from the ISR, from the SPEAR hadron cross sections, from the high energy neutrino experiments at NAL, and from the initial evidence on neutral currents in the weak interaction all cry out for exploitation at higher energies and luminosities. So there is indeed great urgency about the further steps that might be taken in the evolution of accelerators and storage rings; I hope that the work of this conference can contribute to the wisdom of decisions in this respect.

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Scientific Secretaries: Andrew P. Sabersky, Stanford Linear Accelerator Center
John L. Harris, Stanford Linear Accelerator Center

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Yu. M. Ado, V. I. Kotov, K. P. Myznikov, A. A. Naumov, R. M. Suljaev, V. A. Tepljakov, E. F. Trojanov, V. I. Zaitsev, and A. A. Zhuravlev, Institute for High Energy Physics, Serpukhov	1
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Scientific Secretaries: Martin J. Lee, Stanford Linear Accelerator Center
Charles J. Kruse, Stanford Linear Accelerator Center

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M. Month, Brookhaven National Laboratory 402

"Intra-Beam-Scattering"

A. Piwinski, DESY 405

"Detailed Study of the Beam-Beam Interaction at the Orsay Storage Ring (ACO)" M. Bergher, J. Buon, A. Jejcic, J. Le Duff, P. Marin, M. Sommer, and H. Zyngier, Orsay	410
"Non-Linear Beam-Beam Effect Computer Simulation" A. Renieri, Frascati	414
"Two-Dimensional Resonance Effects Due to a Localized Bi-Gaussian Charge Distribution" A. G. Ruggiero, National Accelerator Laboratory	419
"Instabilities Detected in Saturne" J. Faure, G. Leleux, J. L. Lemaire, and R. Vienet, Saclay	424
"Stochastic Effects in Longitudinal Phase Space" I. Gumowski, CERN	429
"Gamma-Transition-Jump Scheme of the CPS" W. Hardt, CERN	434
"Dipole Two-Beam Instability in Circular Beams with Azimuthal Non-Uniformity" P. R. Zenkevich, D. G. Koshkarev, Institute for Theoretical and Experimental Physics, Moscow	439
"The Interaction of a Long Intensive Electron Bunch with a Passive Cavity" G. V. Voskresensky and V. N. Kurdjumov, Radiotechnical Institute of the USSR Academy of Sciences, Moscow	444

SESSION 7 - BEAM DYNAMICS: THEORY, EXPERIMENTS, NEW DEVICES and CONTROLS

Chairman: David A. Gray, Rutherford High Energy Laboratory

Scientific Secretaries: Kenneth F. Crook, Stanford Linear Accelerator Center
Richard E. Morgado, Lawrence Berkeley Laboratory

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H. T. Edwards, National Accelerator Laboratory	447
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"Extraction for the Main Ring at NAL" R. A. Andrews, H. T. Edwards, H. E. Fisk, F. Hornstra, J. D. McCarthy, H. Pfeffer, C. H. Rode, and J. Walton, National Accelerator Laboratory	456
"BNL Fast Shaving Extraction System" L. Blumberg, G. Bagley, G. Bennett, J. Claus, J. Curtiss, R. Frankel, H. Hsieh, J. Keane, G. Levine, L. Repeta, J. Schuchman, and A. Soukas, Brookhaven National Laboratory	462
"Simulation of Simultaneous Beam Sharing Between Internal Targets and Slow Ejection at the CPS" M. Bell and W. Kubischta, CERN	467
"Expected Energy-Spread in the Extracted Beam of Saturne II" H. Bruck, J.-L. Laclare, and G. Leleux, Saclay	471
"Injection and Trapping of the Beam at 800 MeV in the CPS" D. Boussard, M. Bouthéon, B. Carpenter, P. Lefèvre, and J. P. Potier, CERN	475
"The CERN PS Booster: Design Expectation Confronted with Reality, Two Years after Start-up" The PSB Staff (Reported by K. H. Reich), CERN	480
Rapporteur Talk - "Computer Control of Accelerators" M. C. Crowley-Milling, CERN	485
"User's Assessment of the Computer Controls System of the CERN PS Booster" G. Baribaud, G. Benincasa, A. Daneels, P. Heymans, C. Metzger, F. Pedersen, M. Rabany, K. Schindl, and J. Stark, CERN	490

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F. Beck, CERN	499
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J. T. Hyman, CERN	503
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P. Wolstenholme, CERN	508
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M. J. Knott, L. G. Lewis, H. H. Rabe, Argonne National Laboratory	511
"PHASOR: A Control Computer Method for Displaying Amplitude and Phase of Ripple Components in the Ring Magnet Voltage"	
L. G. Lewis, and A. D. Valente, Argonne National Laboratory	516
"Initial Experience with a Multi-Processor Control System"	
K. B. Mallory, Stanford Linear Accelerator Center	521
"The CPS Improvements, 1965-1973 - An Assessment"	
The CPS Staff, CERN	524
"Simultaneous Steering of H^+ and H^- Beams at LAMPF"	
K. R. Crandall and W. E. Jule, Los Alamos Scientific Laboratory	529
"Fusion Reactions in Colliding Beams"	
J. P. Blewett, Brookhaven National Laboratory	531
"Will Negative Hydrogen Ion Sources Soon Replace Proton Sources in High Energy Accelerators?"	
Th. Sluyters and K. Prelec, Brookhaven National Laboratory	536

SESSION 8 - FUTURE STORAGE RINGS AND MAJOR ACCELERATOR PROJECTS

Chairman: Kjell Johnsen, CERN

Scientific Secretaries: Vernon G. Price, Stanford Linear Accelerator Center
Christoph W. Leeman, Lawrence Berkeley Laboratory

Invited Paper - "ISABELLE Design Study of Intersecting Storage Accelerators"	
H. Hahn, Brookhaven National Laboratory	537
Invited Paper - "Design and Status of EPIC"	
EPIC Machine Design Study Group of the Rutherford and Daresbury High Energy Laboratories (presented by G. H. Rees)	548
Invited Paper - "The Proton-Electron-Positron Project - PEP"	
L. Smith, Lawrence Berkeley Laboratory-Stanford Linear Accelerator Center Joint Study Group	557
Invited Paper - "The PEP Electron-Positron Ring - PEP Stage I"	
J. R. Rees, Lawrence Berkeley Laboratory-Stanford Linear Accelerator Center Joint Study Group	564
"ISABELLE Antiproton Option"	
C. Baltay, Columbia University; and R. Chasman, H. W. J. Foelsche, H. Hahn, M. Month, and A. Van Steenbergen, Brookhaven National Laboratory	572
"SLED: A Method of Doubling SLAC's Energy"	
Z. D. Farkas, H. A. Hogg, G. A. Loew, and P. B. Wilson, Stanford Linear Accelerator Center	576
"A Preliminary Design of Tri-Ring Intersecting Storage Accelerators in Nippon, TRISTAN"	
T. Nishikawa, National Laboratory for High Energy Physics,	584

"The Super-Adone Electron-Positron Storage Ring Design" F. Amman, M. Bassetti, A. Cattoni, R. Cerchia, V. Chimenti, D. Fabiani, A. Marra, M. Matera, C. Pellegrini, M. Placidi, M. A. Preger, A. Renieri, S. Tazzari, F. Tazzioli, and G. Vignola, Frascati	588
"Bunched Beam Intersecting Storage Accelerators for Proton-Proton Collisions" M. Month, Brookhaven National Laboratory	593
"Insertions for Colliding-Beam Storage Rings" W. W. Lee and L. C. Teng, National Accelerator Laboratory	599
"Resonance Crossing in a Proton Synchrotron; Application to ISABELLE" R. Chasman, Brookhaven National Laboratory; A. Garren, Lawrence Berkeley Laboratory; R. L. Gluckstern, University of Massachusetts; and F. E. Mills, National Accelerator Laboratory	604
"Main Ring Magnet System of KEK PS" A. Ando, K. Endo, T. Kasuga, M. Kihara, and E. Takasaki, National Laboratory for High Energy Physics,	610
"Saturne II: Proposal of a Renovated Proton Facility at Saclay" H. Bruck, J.-L. Laclare, G. Leleux, and the "GERMA" Group	615
"The Electron Pulse Stretcher EROS" N. R. Heese and R. Servranckx, University of Saskatchewan	618
"Preliminary Design Considerations for the Stage I PEP Lattice" R. H. Helm and M. J. Lee, Stanford Linear Accelerator Center	622
"Design Considerations for a High Energy Electron-Positron Storage Ring" H. Wiedemann, DESY	629
"High-Intensity Storage Rings for Meson Factory" G. I. Batskikh, A. A. Vasiliev, A. A. Kuzmin, R. A. Meshcherov, B. P. Murin, V. S. Rybalko, Radiotechnical Institute of the USSR Academy of Sciences, Moscow; and Yu. Ya. Staviiskiy, Institute of Physics and Energetics	633
"Trends of the Development of Strong Current Cyclic Accelerators - Meson Factories" V. P. Dzhelepov, V. P. Dmitrievsky, and V. V. Kolga, Joint Institute for Nuclear Research, Dubna	638
"First Beam Tests with the 590 MeV Ring Cyclotron at SIN" J.-P. Blaser and H. A. Willax, Swiss Institute for Nuclear Research	643
"Basic Design Considerations on an Electron Beam Stretcher" H. Herminghaus, Mainz	648

SESSION 9 - OVERALL PERSPECTIVE TALKS

Chairman: Karl Strauch, Harvard University

Scientific Secretaries: Z. David Farkas, Stanford Linear Accelerator Center
John M. Hauptman, Lawrence Berkeley Laboratory

Invited Paper - "Trends in Elementary Particle Theory" M. Gell-Mann, California Institute of Technology (unfortunately this paper not available)	
Invited Paper - "The Next Step: Accelerators vs Storage Rings" L. M. Lederman, Columbia University	650
Invited Paper - "Perspectives on Colliding Beams" E. Keil, CERN	660
Rapporteur Talk - "Synchrotron Radiation Sources" S. P. Kapitza (presented by V. V. Elyan), Institute for Physical Problems, Moscow	671
Invited Paper - "Astrophysics and Elementary Particle Physics" R. Ruffini, Princeton University	675