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BANQUET SPEAKER

Professor I. I. Rabi, Nobel Laureate
Columbia University
Subject: Scientist and Society

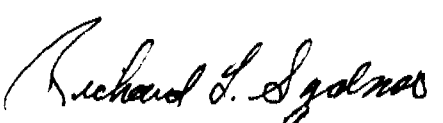
FOREWORD

These proceedings contain the papers presented at the Fourteenth Annual Precise Time and Time Interval Applications and Planning Meeting which was held on November 30 through December 2, 1982 at NASA Goddard Space Flight Center. The discussions following the presentations are also included. There were 252 registered attendees, of which 34 were from 13 foreign countries.

The objective of the meeting was to give the various sectors of the PTTI community (managers, systems engineers, program planners and industry) a forum for presentation and discussion of current and future programs and requirements, a general and in-depth review of plans and trends in PTTI applications, a review of new time and frequency developments which influence PTTI applications and an opportunity to discuss results, accomplishments and problem areas in the application of PTTI technology.

This year the emphasis on planning and applications with panel discussions by leaders in these fields was supplemented with a panel of the Distinguished Scientists who were originators of the various techniques which are at the heart of the field of frequency and time. The technical and political history of the developments was very timely and interesting. A further addition to this year's meeting was the opening of the new exhibit on atomic clocks at the National Museum of American History. All PTTI attendees were invited to a reception at the museum on the last evening of the PTTI meeting.

The Executive Committee wishes to express its appreciation of the excellent work of the Session Chairmen and the Technical Program Committee under the leadership of Dr. N. F. Yannoni. The quality of the program remains excellent as is evidenced by the increasing registration and continuing support of our sponsors. The key to the success of a meeting such as this depends on the unstinting support of the volunteers. We are fortunate to have such support by the secretaries and other personnel. In particular, the efforts of Mr. S. C. Wardrip must be recognized, as well as the hospitality of the Goddard Space Flight Center.



RICHARD L. SYDNOR
General Chairman

IN MEMORIAM

ANDREW R. CHI

From its inception, Andy Chi was an active, vocal and respected member of the PTTI Executive Committee. His background in the field of frequency and time, coupled with long and varied association with many national and international technical organizations, gave Andy a unique set of skills which complemented and enhanced the expertise embodied in the other Committee members.

Andy was born in Tiensin, China on September 12, 1920. He earned his B.S. degree in physics and mathematics from Western Maryland College in 1944, the M.A. in physics from Columbia University in 1946, and continued in graduate studies at Columbia until 1947. From that time until 1953, he was Instructor in physics at the Cooper Union School of Engineering in New York City.

Andy began his work in frequency and time in 1953 at the U.S. Army Signal Research and Development Laboratories, Fort Monmouth, New Jersey as a physicist doing research in the fundamental properties of quartz. His work contributed to the understanding of crystal growth and the effects of impurities injected into the crystal lattice. At the Naval Research Laboratory, beginning in 1957, Andy studied atomic resonance devices and precision frequency standards. Andy and his colleagues at the National Bureau of Standards developed the atomic gas cell frequency standard using optical pumping techniques. He was part of the group which first identified the hyperfine transition frequencies of Rubidium-87 and Cesium-133. The hyperfine transition of Cesium-133 eventually became the basis for the definition of the International System (SI) of the unit of time, the SI second.

In 1963, Andy joined the Goddard Space Flight Center and became head of the Timing Systems Section. He was fundamental in organizing the first symposium for the purpose of defining the short-term frequency stability of precision oscillators. He chaired both the symposium and the Technical Program Committee. Andy contributed to the Apollo Program as a member of the Navigation Working Group. Further work included developing NASA's time code standards and a time synchronization technique using the OMEGA Navigation System's Very Low Frequency transmissions.

DEDICATION

The Executive Committee and officers of the PTTI wish to dedicate these proceedings to the memory of Andy Chi, whose untimely death has deprived us of a good friend, tireless co-worker, and trusted councillor. Andy spent most of his professional life in the frequency and time area and was active in the PTTI from its beginning. His guidance and help will be greatly missed.

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CALL TO SESSION

Dr. Richard L. Sydnor
General Chairman
Jet Propulsion Laboratory

CHAIRMAN SYDNOR: I welcome you all to the Fourteenth Annual Precise Time and Time Interval Planning Meeting. I think you'll find that this year we have a very interesting and enjoyable meeting plan. If you haven't noticed yet, there is a reception to be held Thursday evening. I hope most of you can come to that. It's being held at the Smithsonian downtown. It's the opening of the Atomic Clock Exhibit. I realize that this extends some of your trips but I think it will be quite worthwhile. We've had some bad news this year. Andy Chi died unexpectedly. He has been a major contributor to this meeting for a number of years and as a consequence we're dedicating this year's proceedings to him. We will all miss him very much.

I'd like to introduce the host, John J. Quann, Deputy Director, NASA Goddard Space Flight Center.

WELCOME ADDRESS

John J. Quann
Deputy Director
NASA Goddard Space Flight Center

MR. QUANN: Thank you, Dr. Sydnor. I was hoping I would be able to say, "good morning, ladies and gentlemen," but it appears I can say, "good morning, lady and gentlemen." On behalf of NASA and the other sponsoring agencies, it's my pleasure to welcome you to the Fourteenth Precise Time and Time Interval Applications and Planning Meeting. This is the seventh time Goddard has hosted the PTTI, and it's been a pleasure to do so each time. Just before you came in, I was curious as to whether or not NASA had anything to do with picking the acronym of PTTI and tried to pronounce it, but I don't think you can pronounce this with any sort of reasonableness, although NASA has in the past been able to create some things that the first time I heard them pronounced, I couldn't believe. There was one called the Heat Capacity Mapping Machine, which turned out to be HCMM. The first time I heard HCMM pronounced, I could not believe that anybody could actually do it. There were scores of others, but I'm not sure how you'd say it. This is a difficult one. I'd like to acknowledge the attendance of several people from other countries. Your presence here makes the PTTI meetings that much more meaningful. Goddard looks forward to continued cooperation with each of you and, of course with the people at home. I think it's significant to note that of the 32 papers in the program, 8 will be presented by authors from other countries. This worldwide participation is evidence of the importance that the PTTI community and the attendees place on these annual meetings. I encourage you to continue the cooperative effort. I'd also like to welcome Professor Rabi and the other distinguished visitors who will participate in the panel discussions that are scheduled for the next three days.

So, once again, I thank you for coming and for the opportunity to greet you, and I wish you a very successful three days. Thank you.

OPENING COMMENTS

Dr. Nicholas F. Yannoni, Chairman
Technical Program Committee
Rome Air Development Center

DR. YANNONI: Good morning. I'd like to second all the welcomes you have heard today. We hope this will be a very nice meeting. The first activity of the meeting is going to be what we call the Planner's Panel. And I want to introduce to you the members of that panel. As I do so, perhaps they would come up and sit here. The Chairman of the panel is Mr. John Cittadino who is from the Office of Secretary of Defense and Director of Theater and Tactical C^3. Accompanying Mr. Cittadino is Dr. Tom Goblick from Lincoln Laboratories. And Dr. Harris Stover from Defense Communication's Engineering Center and Dr. Michael Garvey from Frequency and Time Systems. I'd like also to introduce to you, although for many of you he needs no introduction, Dr. Gernot Winkler from the U.S. Naval Observatory, who will take over the Chairmanship of the morning session. Thank you.