HYPERVELOCITY IMPACT SOCIETY

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NEWSLETTER

SCIENTIFIC KNOWLEDGE IS MONEY IN THE BANK

If you have ever driven across northern Arizona, you have probably seen the signs along I-40: "Meteor Crater... the planet's most penetrating natural attraction."

Perhaps the slick promotional billboards enticed you to make a short excursion from your planned trip. Taking the Meteor Crater exit and heading south, you would have seen a low ridge rising from the flat desert ahead. Not realizing that this ridge was actually the raised rim of a three-quarter-mile-wide crater, an earlier generation called the feature "Coon Butte."

When you stand on the rim, you look out across an expansive circular cavity in solid rock that is so wide that it changes the wind patterns and attracts raptors that soar in the updrafts. This big hole is truly one of the natural wonders of the world.

What you may not know is that a century ago Meteor Crater was also the subject of a great scientific controversy, and was a focal point for defining the scientific method and promoting scientific research at the dawn of 20th-century American technological progress. On this, the centennial anniversary of that debate, Meteor Crater serves as a reminder of the importance of scientific knowledge and of the scientific method to our way of life.

In early 1896, the journal *SCIENCE* published an address that Grove Karl Gilbert gave to the Scientific Societies of Washington. Gilbert was the retiring president of the Geological Society of Washington and one of the top scientific thinkers of his time. He had also been chief geologist of the U. S. Geological Survey until recently, when a hostile Congress slashed the Survey's budget in half, abolishing his position and terminating many of his colleagues. His lecture was on the "Origin of Hypotheses," and was a description of the scientific method.

At the center of the scientific method, he said, is the hypothesis, or "the scientific guess." Gilbert used the origin of Coon Butte to illustrate how this works. Four scientific guesses had been made at the time. The first came from a shepherd named Mathias Armijo, who found pieces of iron near the crater and reasoned that an explosion had hurled the metal out of the ground and formed the big hole (one does not have to be a scientist to think scientifically). Geologists who came to visit the site offered two more scientific guesses involving two different types of volcanic processes. A fourth hypothesis was the radical idea that a meteorite had hit the Earth.

Gilbert traveled to the then-remote part of the country and made measurements to test the various ideas. Because so little was known at the time about the physics of meteorite impacts, he predicted that such a cosmic collision would have left a very large piece of iron buried under the crater. His tests failed to find the predicted iron, so Gilbert rejected the impact idea. The small pieces of iron found on the surface by Armijo did prove to be meteorites, but Gilbert concluded that they fell out of the sky in an unrelated event (thereby also rejecting Armijo's idea that they came out of the ground).

Of the two volcanic ideas, one predicted that volcanic rocks would be found in the crater. But the crater had none, so there was only one hypothesis left that had not been eliminated: some type of volcanic steam explosion.

That was the idea that Gilbert accepted as the correct explanation, even though he had arrived at the crater expecting to demonstrate that it was formed by an impact. He already supported the then-unpopular notion that lunar craters were formed by impacts, not volcanos, but a good scientist does not allow personal feelings to get in the way of evidence. However, Gilbert was very careful to point out that there was much that was still not known about meteorites and impacts. He recognized that new facts might be discovered that would overturn his conclusion.

And that is exactly what happened. We now understand that Gilbert overestimated the size of the meteorite that would be needed to pack enough energy to blast out such a big hole: hypervelocity impacts are much more powerful than he realized. Furthermore, even a large

iron meteorite will mostly vaporize in a giant explosion, leaving very few traces. Gilbert had made a mistake by assuming that the impact would leave a lot of buried iron.

It would be many years before a young scientist named Eugene Shoemaker and his colleagues from the U.S. Geological Survey would discover the rare new mineral coesite in the rocks at the crater. This silica polymorph had been synthesized in the high pressure laboratory several years earlier, and its presence in the shocked quartz sandstones of Meteor Crater had been a predicted consequence of the impact. A couple of years later, another high pressure silica polymorph—stishovite—was found as another rare naturally occurring mineral at the crater. These discoveries finally settled the controversy, and partially vindicated a shepherd's original hunch that the hole was formed by some kind of colossal explosion involving iron.

The scientific process is sometimes slow, but it always involves making educated guesses that eventually lead to predictions of things that can be observed and put to a test. If the predictions turn out to be incorrect, the test is still successful as long as scientists learn enough to modify the theory, find a better one, or uncover mistaken assumptions. Unfortunately, even after the successes of 20th-century science between Gilbert's time and now, there are a lot of people that, for whatever reason, still don't understand (or don't like) the scientific form of reasoning. A hundred years after Gilbert's speech, it is more important than ever for working scientists and engineers to communicate basic scientific principles and critical thinking skills to a public who must be scientifically literate for our technologically advanced democracy to work.

G. K. Gilbert closed his address by explaining that "fertility of invention implies a wide and varied knowledge of the causes of things", and that deep understanding of nature through scientific research is essential. Gilbert told his audience that our "material, social, and intellectual condition" advances in lock step with our "knowledge of natural laws".

He concluded by comparing science to an investment: "Knowledge of Nature is an account at [the] bank, where each dividend is added to the principal and the interest is ever compounded; and hence it is that human progress, founded on natural knowledge, advances with ever increasing speed!"

Since G. K. Gilbert spoke these words, our scientific bank account has led to inventions that his audience in Washington could not have imagined. Our investment has swollen with the advances we associate with modern living, with medical discoveries that have given us longer, healthier, happier lives, and with an unprecedented degree of national security.

We can thank Gilbert and his contemporaries for having the foresight to recognize the importance of this scientific bank account 100 years ago, and for making the effort to convince decision-makers to restore and increase funding for science. We should again ask those in Washington to pass along the American tradition of a strong investment in scientific knowledge, and trust in the scientific method, to future generations. And we should remind them that research spending is money in the bank, not money in a hole.

Mark Boslough
Sandia National Laboratories

This article is an adaptation of a column prepared for the March/April issue of the ***Skeptical Inquirer***, the publication for the Committee for the Scientific Investigation of Claims of the Paranormal. *S. I.* is a lively and entertaining magazine that promotes critical thinking, and is a useful resource for anyone who is concerned with scientific literacy. By the way, *S. I.* is edited by Ken Frazier, who is also editor of the *Sandia Lab News*!

Men stumble over the truth from time to time, but most pick themselves up and hurry off as if nothing happened.
Winston Churchill

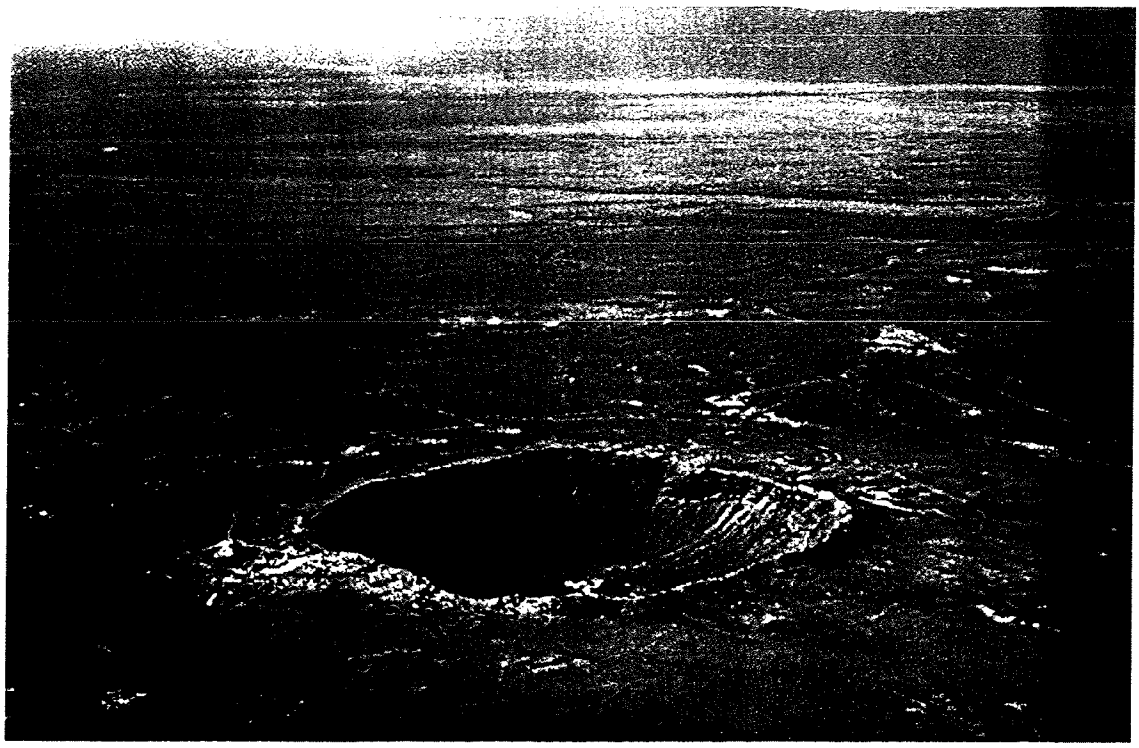
1994 HVIS

Dr. Eugene Shoemaker

Dr. Eugene Shoemaker is one of the founders of the discipline now called Planetary Geology. A selection of his many honors includes the National Medal of Science; Whipple Award of the American Geophysical Union; Leonard Medal of the Meteoritical Society; Kuiper Prize of the American Astronomical Society; Barringer Award of the Meteoritical Society; Gilbert Award of the geological Society of America; Arthur L. Day Medal of the Geological Society of America; and the NASA Medal for Scientific Achievement.

He is a Fellow of the Geological Society of America, Mineralogical Society of America, American Geophysical Union, American Academy of Arts and Sciences, as well as a member of the National Academy of Sciences. He has also been awarded honorary doctorates from several universities. These and many other honors are a testament to Gene's many and seminal contributions to planetary science and the role of impact processes in the solar system.

Gene was born in Los Angeles and received a B.S. and M.S. from Princeton before going to Cal Tech and receiving a M.A. and then his Ph.D. in 1960. One of Gene's early research topics was Meteor Crater and he was one of the first to attempt to quantitatively model the impact responsible. He was the co-discoverer of



The Great Meteor Crater in Arizona (aerial photo courtesy of D. Roddy)

Drs. Gene and Carolyn Shoemaker
1994 Hypervelocity Impact Symposium
Santa Fe, NM, October 17, 1994
Carolyn is holding their honorarium Nambé plate.

coesite at Meteor Crater in 1960. This was about the beginning of the space program and Gene rocketed in that direction and has never looked back. He organized the U.S.G.S. Astrogeology Branch in Flagstaff in 1961, was a leader of Projects Ranger and Surveyor to the Moon, established a time scale for the lunar geology, help train the Apollo astronauts, and was the Principal Investigator for the Apollo geological field investigations associated with the lunar landings. The list seems nearly endless. There was little associated with the lunar and planetary exploration part of the space program in which Gene was not a leader and key contributor. More recently he was a key participant in the Voyager mission and the Science Team Leader for Clementine. Gene recently "officially retired" from the U.S.G.S. (although you can still catch him in his office there if you're quick enough!). Gene is now on the staff at Lowell Observatory in Flagstaff.

Not long before the *1994 Hypervelocity Impact Symposium*, "Shoemaker" became a household name because of the incredibly exciting impacts of the fragments of the Shoemaker-Levy 9 (SL-9) comet into the planet Jupiter. It must be noted that there were two Shoemakers involved in the discovery of the comet SL-9. For a long time Gene and his wife Carolyn have worked as a team, and it was Carolyn who actually first spotted the comet in the photographs. Carolyn is widely recognized and highly respected as an astronomer in her own right. [Editor's note: In December, on the quiz show *Jeopardy*, the Final Jeopardy Clue was: Category: Famous Women Scientists; Clue: Carolyn Shoemaker has discovered more of these, 32, than any other living person. Answer: (in the form of a question, natch!): What are comets? Now, it is no longer clear which of the two Shoemakers is the most famous—Final Jeopardy is PRETTY SERIOUS!] The *Hypervelocity Impact Society* was truly privileged to have Gene and Carolyn Shoemaker as well as David Levy, the co-discoverer of SL-9 and one of the world's most highly regarded amateur astronomers, as participants at the *1994 Hypervelocity Impact Symposium*.

Here's a variation of the old question concerning falling trees in a forest. If there was no-one present at the beginning of the universe, was there a big bang?

SOCIETY NEWS

1996 Hypervelocity Impact Symposium

The next *HVIS* is scheduled for October 7-10, 1996, in Freiburg, Germany. Hosts and coordinators for the Symposium will be the Ernst-Mach-Institut (EMI) and Institute de St. Louis (ISL). The Symposium Chairmen and Technical Chairmen are listed near the end of the Newsletter. More information is provided later in the Newsletter.

Student Grants

A limited number of Student Grants are available for the *1996 Hypervelocity Impact Symposium*. These grants are being made available by the Hypervelocity Impact Society to encourage student interest and participation in this technology.

The Student Grants cover transportation and lodging for the symposium, up to a limit of $1000. Free registration and a copy of the proceedings are also provided. In addition, the students will have a short introductory meeting with HVIS Board and committee members.

Student Grants are available to students interested in hypervelocity impact. It is intended that these grants will be primarily for graduate students, although undergraduate students may apply. The application will consist of a letter of recommendation from the Student's Advisor. This letter should be limited to a maximum of three pages, and should include the following:

- Names, address, and telephone numbers of both the Student and the Advisor;
- A brief overview of the student's academic background and record;
- A description of future academic work to be pursued by the student;
- A discussion of why the symposium would be helpful for the student.

The selections will be made by the HVIS Educational Outreach Committee. The applications must be received by 1 June 1996. Selection and notification will be made by 1 August 1996. The application should be sent to:

Dr. Gordon R. Johnson
Alliant Techsystems, Inc.
Mail Station MN11-1614
600 Second Street NE
Hopkins, MN 55343
USA

Constitution and Bylaws

If you wish a copy of the *Constitution and Bylaws of the Hypervelocity Impact Society*, please request a copy from Charlie Anderson (phone: 210-522-2313; fax: 210-522-3042; e-mail: canderson@swri.edu). E-mail or fax is preferred; please include your address, and if you are connected to the Internet, your e-mail address.

To get something done, a committee should consist of three people, two of whom are absent. — Anonymous

Extra Copies of the 1994 HVIS Proceedings

Extra copies of the *1994 HVIS* proceedings, Volume 17 of the *International Journal of Impact Engineering*, can be obtained at $100.00 per copy. If you wish one or more additional copies, please send a check to:

Dr. Lalit Chhabildas
Sandia National Laboratories
P.O. Box 5800 MS 0821
Albuquerque, NM 87185-5800

Checks should be made out to the Hypervelocity Impact Society, and must be prepaid. Please include your name and address with submittal of the check. Phone (505-844-4147) or fax (505-844-0918) orders will be accepted provided the check follows promptly.

Standing Committees

Near the end of the Newsletter, there is a list of the standing committees. As with all positions within the Society, committee membership is voluntary; there are no funds available to cover time or expenses. We thank these people for their time and dedication. It is the Society members that MAKE the Society.

Never let the computer know you're in a hurry. The hazard, of course, is that the machine will sense your impending deadline and choose the most inconvenient moment to crash.

ELECTIONS FOR THE BOARD OF DIRECTORS

The HVIS Board of Directors is the governing body of the Society, and as such administers the property and funds, appoints the committees, determines member privileges and dues, conducts the publication program, and determines and arranges for Society meetings.

In accordance with the Constitution of the Society, two positions on the Board of Directors will be open this October at the time of the *1996 Hypervelocity Impact Symposium*. The Nominations Committee intends to propose a slate of six candidates and send ballots to the Society membership this summer. The results of the voting will be announced at the *1996 HVIS* in Freiburg.

Should you wish to nominate someone for the Board, please contact one of the members of the Nominations Committee; names and addresses are given on the last page of the Newsletter.

Don Shockey
Chairman, Nominations Committee

CALL FOR NOMINATIONS: DISTINGUISHED SCIENTIST

The Awards Committee is soliciting nominations for the 1996 Distinguished Scientist award. The criterion for the award is "significant and lasting contributions to the science of hypervelocity ballistics." Alex Charters was the first to receive this award at the 1989 meeting in San Antonio, Texas. Alois Stilp and Volker Hohler received the award jointly at the 1992 meeting in Austin, Texas; Jim Asay received the award at the 1994 meeting in Santa Fe, New Mexico. The next award will be presented at the 1996 meeting in Freiburg, Germany. If you know of someone whom you would like to nominate, please send his name along with a short letter of recommendation to any of the Nominations Committee members.

James Wilbeck
Chairman, Awards Committee

Names and addresses of all committee members are on the last page of the newsletter.

1996 HYPERVELOCITY IMPACT SYMPOSIUM

The Paper Selection Committee met in Freiburg at the end of January to review and discuss the submitted abstracts, and to be informed about progress in planning of the Symposium. Dr. A. J. Stilp, the Symposium Chairman, welcomed 23 experts in the field of hypervelocity impact from eight different countries: Belgium, France, Germany, Israel, the Netherlands, Russia, the UK, and the USA. One hundred twenty-eight abstracts were submitted for consideration. The abstracts were written by authors of the following countries: USA (54), Russia (30), Germany (10), UK (4), France (3), Japan (3), Israel (2), China (1), Italy (1), Sweden (1), and The Netherlands (1). This was a very encouraging response considering that the Symposium will be held outside the USA for the first time. And looking at the topics of the abstracts, a high scientific level can be expected for the conference.

A listing of the papers with their topics are given in the Table: 110 papers were accepted, 18 papers were rejected, and 8 papers were ask to combine into 4 papers. The rejections were, in almost all cases, due to the fact that the theme of the abstract did not fit into the topics of the HVIS and, therefore, the Committee recommended that they should be presented at other conferences. Tentatively, 56 papers were selected for oral presentation, 48 for poster presentation. However, it was noted that final acceptance of a paper occurs only

after submission of a draft manuscript and peer review. Furthermore, the conference time schedule will permit only 40 to 45 oral presentations, so final decision will wait until review of the draft manuscripts. The Committee would like to point out that the decision about oral or poster presentations does not indicate any qualitative classification of the paper; both oral and poster presentations are on the same scientific level. Besides the papers in the regular program, there will be the Distinguished Scientist Keynote, and three planned plenary talks.

In addition to the paper selection activities, the Committee was informed by the Organizers about the state of planning for the Symposium. About 15 exhibitors are expected. The exhibitors are research institutes and firms who will give information about their work and the progress in experimental techniques.

The Committee inspected the *Konzerthaus*, the congress center where the meeting will be held. This building is still under construction, with completion in the late spring/early summer. Because the costs are at the upper limit for a city like Freiburg, there was a heated political discussion in Freiburg, but finally a pro decision was made. Freiburg hopes to improve its image and attractiveness by offering this congress center for national and international guests, from neighboring France and Switzerland, and from all over the world. For this reason, the Organizers were able to arrange a reception by the city of Freiburg in the historical trade center built in the 16th century, on Tuesday, October 8, at 6:30 p.m. A banquet is organized for Wednesday night; special food and wine from the area will be offered. A highlight of the banquet evening will be a talked by Professor Stöffer from the Humboldt University in Berlin. He is a geologist and will speak about "The Nördlinger Ries Formation by a Great Impact Event."

On Thursday, after the end of the technical sessions, a tour with the museum train will be organized to the Kaiserstuhl, which is an old volcanic area, the warmest place in Germany and famous for its wines. The tour includes a reception at the Badischer Winzerkeller in the small town of Breisach, near the Rhine, to taste local wines. *[Editor's note: Clearly, this last event will permit us to continue discussions of the symposium's topics in an informal and conducive atmosphere!]* The Organizers hope that these special events will contribute to a successful *1996 HVIS* in Freiburg.

An attractive companion program will also be offered. There are various possibilities, since Freiburg and the Black Forest are a tourist region and close to France and Switzerland.

The Organizers would also like to mention the 47th Meeting of the Aeroballistic Range Association to be held one week later at the French-German Research Institute in Saint Louis, France. Saint Louis can be reached in one hour by car from Freiburg. This invites the attendees to extend their stay in the nice region of the cities Freiburg - Basie - Mulhouse.

A. J. Stilp; V. Hohler; E. Schneider

NOTES FROM THE EDITOR

News About Members

Don Curran was elected Vice-Chair of the Executive Committee of the APS Topical Group on Shock Compression of Condensed Matter. Stephan Bless was elected to the Executive Committee.

Journal Subscriptions

As a service to our membership, we have negotiated a special subscription price for the ***International Journal of Impact Engineering***. The Journal is now being published eight times a year. The subscription cost for HVIS members is $95.00 for 1996 (Volume 18); this is approximately one-quarter the regular subscription costs. If you are not already signed up for the journal and wish to receive the subscription, please remit a check for $95.00, payable to the Hypervelocity Impact Society, and send the check with the mailing address for where you want to receive the Journal, to:

Dr. Charles E. Anderson, Jr.
Southwest Research Institute
P. O. Drawer 28510
San Antonio, TX 78228-0510.

You will receive all issues for the current year with your subscription.

Abstract Submissions for *1996 HVIS*

	Totals	Accepted	Rejected
Launchers and Diagnostics	13	12	1
Planetary Impact	10	9	1
Penetration Mechanics	26	20	6
Fracture and Fragmentation	9	9	0
Debris Shields & Spacecraft Impact	20	20	0
Penetration Phenomenology	21	17	4
Analytical Modeling	3	0	3
Numerical Algorithms & Simulations	26	23	3
TOTALS	128	110	18

HVIS STANDING COMMITTEES	Chairs
Awards Committee	James Wilbeck (Kaman Sciences)
Educational Outreach Committee	Gordon Johnson (Alliant Techsystems)
Membership Committee	Hal Swift (UDRI)
Nominations Committee	Don Shockey (SRI)
Publications Committee	Charles Anderson (SwRI)

1996 Hypervelocity Impact Symposium

Symposium Chairmen	A. J. Stilp (EMI), G.-A. Schröder (EMI), and H. Schulte (ISL)
Technical Chairmen	V. Hohler (EMI) and E. Schneider (EMI)

HVIS & IBC DATABASES

Åke Persson of Dynamec Research AB, Sweden, has developed a PC database (it operates under DOS or under WINDOWS) that includes the titles, authors, and the full abstract of all 400 papers published in the *HVIS-57, -59, -60, -62, -63, -65, -86, -89, -92* and *-94* symposia. The search program allows the user to search for words or parts of words, or combinations thereof, in the whole text. This database is fully compatible with the DTX/BALLISTICS database for the 15 *International Ballistics Symposia* organized during the period 1974-1995. Such a database might be of considerable interest to our membership. The prices are as follows:

1. **DTX/HVIS (10 symposia)**
   - Full price $395.00
   - HVIS attendees $160.00

2. **DTX/BALLISTICS + HVIS (15 + 10 symposia)**
   - Full price $645.00
   - IBC or HVIS attendees $260.00

3. **HVIS upgrade for DTX/BALLISTICS holders**
   - Full price $195.00
   - IBC or HVIS attendees $100.00

The price for future upgrades with abstracts from new symposia is $50.00.

If you are interested, you should contact:

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CALENDER OF RELATED CONFERENCES AND SYMPOSIA

Meeting	Location	Dates
First Australian Congress on Applied Mechanics	Melbourne, Australia	February 19-21, 1996
6th International Conference on Numerical Combustion	New Orleans, LA	March 4-6, 1996
Materials Research at High Pressures, APS Meeting	St. Louis, MO	March 18-22, 1996
Insensitive Munitions Technology Symposium	San Diego, CA	March 19-21, 1996
7th TARDEC Ground Vehicle Survivability Symposium	Monterey, CA	March 26-28, 1996
8th EML Symposium	Baltimore, MD	April 21-24, 1996
Bombs & Warhead Technical Symposium	Monterey, CA	May 13-15, 1996
Space '96: The 5th Int. Conf. & Exposition on Engineering, Construction, and Operations in Space	Albuquerque, NM	June 1-6, 1996
Fourth Annual Conference of the CFD Society of Canada	Ottawa, Ontario	June 2-4, 1996
5th Gordon Research Conference on Energetic Materials	New Hampton, NH	June 16-21, 1996
Gordon Conference on Research at High Pressure	Meriden, NH	June 23-28, 1996
IUTAM Symposium	Dublin, Ireland	June 30 - July 5, 1996
SUSI '96: 4th Int. Conf. Structures Under Shock and Impact	Udine, Italy	July 3-5, 1996
ASME Fluids Engineering Division Summer Meeting	San Diego, CA	July 7-11, 1996
Structures Under Extreme Loading Conditions: ASME PVP Conference	Montreal, Canada	July 21-26, 1996
3rd International Conference on Composites Engineering	New Orleans, LA	July 21-27, 1996
Characteristics and Consequences of Orbital Debris and Natural Space Impact Conference (SPIE Symposium)	Denver, CO	August 4-9, 1996
DOD Explosive Safety Board (DDESB) Meeting	Las Vegas, NV	August 20-22, 1996
FRAGBLAST'5: 5th Int. Symp. on Rock Fragmentation by Blasting	Montreal, Canada	August 25-29, 1996
Int. Conf. on Shock Waves in Condensed Matter	St. Petersburg, Russia	September 2-6, 1996
16th International Symposium on Ballistics	San Francisco, CA	September 23-25, 1996
Symposium on Structures Response to Impact and Blast	Tel Aviv, Israel	October 6-11, 1996
1996 Hypervelocity Impact Symposium	Freiburg, Germany	October 7-10, 1996
47th Aeroballistic Range Association Meeting	ISL, St. Louis, France	October 14-17, 1996
IMPLAST '96: Symposium on Plasticity and Impact Mechanics	New Delhi, India	December 11-14, 1996
XVI AIRAPT Conference	Kobe, Japan	1997
1997 APS Topical Conference on Shock Waves in Condensed Matter	Amherst, MA	July 27-August 1, 1997
11th Detonation Symposium	Aspen, CO	August 30-September 4, 1998

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