



## EDITORIAL BY THE PRESIDENT

I am looking forward very much to the 30th International Symposium on Ballistics (ISB), which will be held in Long Beach, USA, 11-15 September 2017. I know that symposium co-chairs Sidney Chocron and James Walker have been working hard with

the National Defense Industrial Association (NDIA) to put on a great symposium. I am excited by many of the technical presentations that will be given, either by poster or orally. It will be a tremendous opportunity for networking and learning about the latest developments in the science of ballistics. I look forward to seeing you there.

Elsewhere in this newsletter are details on revisions to the criteria for promotion to Senior and Fellow status within the IBS. The Membership Committee has done a good job in extending the criteria to include recognition of attending courses, lecturing, and active participation in IBS committees. As the IBS has now existed for nearly eight years, I expect many members to become eligible for promotion. Please review the criteria carefully and inform the Membership Committee if you think you or another IBS member might be eligible.

Finally, this is my last Bulletin as IBS President. At the end of the 30th ISB, I will be standing down as President, having served two consecutive terms, the maximum allowed by the IBS Constitution. I thank very much my fellow Board members, all the IBS members (both individual and corporate), and ISB attendees who have assisted me during these three years. I have enjoyed every minute and have made many new contacts and friends. I wish our new President every success in leading the IBS in the future years. In particular, he or she will be taking the ISB to India in 2019 for the 31st ISB. I will continue serving on the IBS Board and giving the new President my full support.

If you have any views on the IBS or wish to help then please contact me. I look forward to hearing from you. My best wishes for a successful 2017.

Clive Woodley, IBS President

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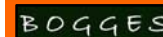
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## HELP NEEDED FROM MEMBERS!

1. **Recruit new members:** spread the word and get your colleagues to join
2. **Get involved:** see the website for a list of committees & projects with contacts
3. **Send or post cool photos:** Wanted: good photos showing ballistic events in each field
  - Interior Ballistics
  - Exterior Ballistics
  - Launch Dynamics
  - Vulnerability
  - Terminal Ballistics & Impact Physics
  - Explosion Mechanics

Upload photos at [www.ballistics.org](http://www.ballistics.org)

As always, remember to be responsible with copyright, sensitive, or restricted information!

## SHARING YOUR INTERESTS WITH OTHER IBS MEMBERS

Have you ever wanted to contact other IBS members who might have interests in similar aspects of ballistics? For example, you might wish to find other people who work on the ignition of charges with a view to collaboration, or just for chatting in general. A new feature has been added to a member's online profile to allow them to list their interests for viewing by other members.

To insert your interests, login to our website, scroll down to beneath "My Membership Information," and click on "Change Contact/Profile Info" to go to your member profile. Scroll down and find a textbox labelled "Interests in Ballistics." Type in your interests and click "Submit".

To look at the list of members' interests, login to the IBS website, scroll down near the bottom, and click on the link labelled "Quick Reports." Under a section labelled "Custom Reports," there is a link labelled "Interests." Click on this and you'll see a list of members and their interests. The list can be printed out directly or a .csv file can be created (open it with a word processor, or with Excel to make a table), allowing you to search for specific interests.

We very much welcome your feedback on this facility. Please email any feedback to Clive Woodley at [membership@ballistics.org](mailto:membership@ballistics.org) and Nicolas Eches at [communications@ballistics.org](mailto:communications@ballistics.org).

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### REMINDER TO YOUNG AUTHORS: THE ROSALIND & PEI CHI CHOU AWARD

The Rosalind and Pei Chi Chou Award for Young Authors is given at each International Symposium on Ballistics. Its purpose is to enrich the program of the Symposium by encouraging young authors to submit papers and attend the Symposium. To be eligible, the Young Author must be 35 years of age or younger at the time of the Symposium. The paper may have multiple authors, but the Young Author must have made a major contribution to the paper. Further, the Young Author must attend the Symposium and give the oral or poster presentation.

Young Authors are reminded that they must apply for the Award, using a special form available on the IBS website ([http://www.ballistics.org/the\\_rosalind\\_pei\\_chi\\_chou\\_aw.php](http://www.ballistics.org/the_rosalind_pei_chi_chou_aw.php)). Upload your completed application form, along with a copy of your paper (.doc, .docx, or PDF), to <https://mms.ballistics.org/members/form.php?orgcode=IBSO&fid=2374025> Expect an email acknowledgment of receipt within a few days.

Award selection is based solely on the written papers, which are judged on original contribution to the ballistic sciences. The Award consists of a plaque and a stipend, prepared by the National Defense Industrial Association (NDIA). The plaque and stipend are presented by representatives of the International Ballistics Society and the NDIA. For help, contact [ChouAward@ballistics.org](mailto:ChouAward@ballistics.org)

### International Ballistics Society

#### *Periodic Bulletin*

Questions, input, or feedback should be directed to [communications@ballistics.org](mailto:communications@ballistics.org)

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## REVISED PROMOTION CRITERIA FOR SENIOR AND FELLOW MEMBER STATUS

It has been seven years since the initial criteria for promotion to Senior and Fellow levels were proposed by the Membership Committee (MC) and approved by the Board of Directors. In the intervening years, many members have been promoted. However, the MC felt that the eligibility criteria needed revising to take account of members who might attend courses or who give lectures (when lecturing is not part of their normal job). Furthermore, there are many members who volunteer their time by participating in committees, such as the Education Committee, Communications Committee, or by reviewing abstracts, etc. Therefore, the MC decided that such members should be rewarded by accelerating their promotion.

The MC proposed new eligibility criteria to the Board and the Board has approved the following criteria for promotion.

### SENIOR MEMBERSHIP

The following procedures and selection criteria apply for electing Senior Members:

- The person must be a Member and have been continuously a Member of the IBS for at least 8 years
- In the founding years of the IBS, the criterion for a Senior Member should be that they have attended at least 6 ISB (a period equivalent to about 8 years), not necessarily consecutive.
- Accelerated promotion to Senior Member is possible through attendance of ISB courses (or other acceptable courses) or active participation on IBS Committees.
- Nominations may be made by the Member themselves, or an active Fellow, supported by at least two Fellows who are currently Members, together with the evidence.
  - Evidence is expected to include ISB attended, papers published in the proceedings of the ISB and papers published elsewhere on the subject of ballistics.
  - It is anticipated that acceptable criteria for serious consideration of the nomination would be attending ~50% of the ISB and having ~4 relevant papers published over the period.
  - Attending courses or active participation on committees may be expected to reduce the time requirement as follows:
    - one year reduction for 4 courses attended (a course is defined as half a day) (this is capped at one year; i.e., attending more than 4 courses will not reduce the time by more than one year).
    - one year reduction for active participation on a committee for three years (active participation will be determined by the Committee Chair or, if the applicant is the Committee Chair, then by the IBS President).

### FELLOW MEMBERSHIP

The following procedures and selection criteria apply for electing Fellow Members:

- The person must be a current Senior Member or, in exceptional circumstances, a current Member of the IBS.

- Nominations may be made by one Fellow who is currently a Member, and supported by two other current Fellows. As Fellowship is conferred for meritorious accomplishments, the Fellows *should* be from three different countries.
- Nominations shall be supported by written evidence. Evidence is expected to include ISB attended, papers published in the proceedings of the ISB, and papers published elsewhere on the subject of ballistics.
- It is anticipated that acceptable criteria for serious consideration of the nomination would be active involvement in the ISB/IBS for ~20 years, attending ~50% of the ISB and having ~10 papers published over the period.
- Accelerated promotion to Fellow Member is possible through lecturing at ISB courses (or other acceptable courses) or active participation on IBS Committees.
- Lecturing on courses or active participation on committees may be expected to reduce the time requirement as follows:
  - one year reduction for lecturing at two courses (a course is defined as a half day) (this is capped at two years; i.e., lecturing at more than 4 courses will not reduce the time by more than two years).
  - one year reduction for active participation on a committee for three years (active participation will be determined by the Committee Chair or, if the applicant is the Committee Chair, then by the IBS President).

The above data are guidelines only. The IBS reserves the right to vary the requirements to take into account the full experience of the member being considered for promotion.

Nominations must be made to the Membership Committee ([membership@ballistics.org](mailto:membership@ballistics.org)).

If no evidence is provided then the nomination will be declined; evidence may be submitted by any of the nominees.

The criteria for promotion to Ballistic Science Fellow remain unchanged and are described in the Constitution.

The Membership Committee looks forward to receiving your nominations.

Clive Woodley  
IBS Membership Chair

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## AGENDA

**30<sup>th</sup> INTERNATIONAL SYMPOSIUM ON BALLISTICS**, Long Beach, California, 11-15 Sept. 2017

- 30 June 2017: Online publication of *Defence Technology* papers.
- 15 August 2017: PowerPoints due to be uploaded. Deadline for submission of applications for the Chou Award for Young Authors.
- 19 August 2017: Last day to book hotel at special symposium rate.

See the symposium webpage for details: [http://www.ballistics.org/30th\\_isb.php](http://www.ballistics.org/30th_isb.php)

**31<sup>st</sup> INTERNATIONAL SYMPOSIUM ON BALLISTICS**, Hyderabad, India, 4-8 November 2019



# BALLISTICS

## 30<sup>TH</sup> INTERNATIONAL SYMPOSIUM

We are nearing the 30th International Symposium on Ballistics, September 11-15, 2017. As of the first week of July, over 300 papers have been uploaded to the web site. The full program and agenda should be online by the time you receive this newsletter.

The venue is Long Beach, California, part of the greater Los Angeles area. The symposium logo is a play on the famous Hollywood sign nearby.

The Jet Propulsion Laboratory (JPL) is in the area, and we have invited an opening-morning talk on the Juno space mission to Jupiter, which JPL manages. The Juno spacecraft arrived at Jupiter in July 2016. We also have an opening morning talk on the potential improvements to the mechanical properties of fibers and subsequent improvements to body armors.

The opening reception will take place at the Long Beach Convention Center on Monday night. Our main banquet will be Thursday night at the Aquarium of the Pacific, located near the hotel at the marina. There we will dine and tour the aquarium exhibits. There is also a companion program that includes a boat ride to Catalina Island followed by a tour of the island, a tour of the Queen Mary, and a tour of Hollywood and Los Angeles.



**The Hyatt Regency Long Beach, the symposium hotel**

You will find great ocean beaches all along the coast near where we are staying: Long Beach (within walking distance from the hotel), Seal Beach, Huntington Beach, Newport Beach, and Laguna Beach. It is possible to walk, bicycle, roller skate, play volleyball, swim, and surf at the beaches (but be warned, even in summer the Pacific Ocean is cold!). The weather should be very pleasant; in September, the daily high temperatures are typically in the low 80s (28 °C) and the nightly lows are typically in the mid 60s (18 °C).



**Aquarium of the Pacific, venue of the Symposium Banquet**

Nearby attractions include Space X (19 miles), downtown Los Angeles (25 miles), Disneyland (27 miles), Hollywood (31 miles), the La Brea Tar Pits (31 miles), UCLA (32 miles), the Getty Center art museum (33 miles), Universal Studios (34 miles), Cal Tech (34 miles), and NASA's Jet Propulsion Laboratory (40 miles).



**The Hyatt Regency Hotel is to the left, with the round building behind it the conference center and Long Beach itself to the upper right.**

We look forward to seeing you in Long Beach in September for the 30th International Ballistics Symposium.

**Sidney Chocron and James Walker**

**Chairs of the 30<sup>th</sup> International Symposium on Ballistics.**

## 30TH ISB TUTORIAL PROGRAMME

On behalf of the IBS's Education Committee, I would like to encourage you to participate in the tutorial program that will be offered at the 30th International Symposium on Ballistics on Monday, September 11, 2017, the day before the technical sessions begin. The courses, to be conducted in the Long Beach Convention Center, the Symposium venue, will provide an introduction to their areas of ballistics science and are aimed at managers, practitioners, students, and experts from other fields.

They offer a unique opportunity to listen to world leading ballisticians talking about their respective fields of study. The planned duration of the courses is half a day so there are two parallel sessions, with EB101 and VS101 in the morning and DE101 and TB101 in the afternoon. The fee for one half-day course is \$250 and for a full day of two courses is \$450. This includes the presentation slides and/or a handbook on the course material.

- **EB101 - Introductory Exterior Ballistics**

by Dr. Uwe Chalupka (Helmut Schmidt University, Hamburg, Germany)

EB101 provides an insight into the physics, modelling methods and experimental techniques of the exterior ballistics of non-powered projectiles. It covers all fundamental aspects from forces and torques acting on the projectile, stability of projectile flight, atmospheric and earth models or the numerical integration of the equations of motion.

Dr. Chalupka earned a Ph.D. in the field of exterior ballistic measurements and is currently teaching exterior ballistics at the University of the Federal Armed Forces of Germany. He has worked on national and international projects, such as the NATO Armaments Shareable Software Suite S4. If you need to understand how a projectile gets to its target and how to control it, then this is the course for you!

- **VS101 - Introduction to Vulnerability and Survivability**

by Heinrich Dorsch (IABG GmbH, Ottobrunn, Germany)

VS101 presents a broad overview on vulnerability and survivability covering fundamental theories and the mathematical and statistical methods, modelling and simulation techniques required for predicting the outcomes of a ballistic engagement. The experimental verification of these methods is also an important element of the course. A list of relevant textbooks and literature. The goal is to understand the systematic assessments of operational capabilities in terms of lethality of munitions, weapon systems vulnerability and the survivability of platforms in defined scenarios.

Mr. Dorsch has 37 years of experience in vulnerability and survivability. He is the head of the department for vulnerability and lethality at IABG and is one of the developers of the German Vulnerability/Lethality code UniVeMo. He has numerous publications and teaches in conjunction with the target and weapon planning process for the German Armed Forces. If you need to understand what happens when a weapon system engages with a threat, then this is the course for you!



**• DE101 - Introduction on Detonics and Energetic Materials**

by Dr. Ronald E. Brown (University of Illinois, Urbana, IL, USA)

DE101 presents a broad overview of detonics and energetic materials covering underlying physical and chemical phenomena, fundamental theories and methods, experimental and diagnostic techniques, modelling and simulation aspects, as well as relevant textbooks and literature. The course objective is to enable the attendees to understand the behaviour of inert and energetic materials under shock and impact and their role in the initiation of high explosives.

Dr. Brown is currently a professor at the University of Illinois and has published numerous scientific papers, holds several patents, and was awarded industrial awards in recognition of his work in the field of detonics and energetic materials. He is a Founding Fellow of the IBS and a long-standing participant the International Symposium on Ballistics. If you want to understand energetic materials and how to use them, then this is the course for you!

**• TB101 - The Science of Armour Materials**

by Dr. Ian Crouch (Armour Solutions Pty Ltd, Trentham, Australia)

TB101 covers the fundamental aspects of terminal ballistics, including the basic physics of impact and shocks, the material behaviour, and the simulation techniques used in the field. The course covers traditional monolithic armours, laminated materials, and layered structures, fibres, textiles, and composites as well as glasses and ceramic armour.

Dr. Crouch is an armour consultant with Armour Solutions Pty Ltd as well as an adjunct professor at RMIT University in Melbourne. He brings 40 years of experience, including 19 years with the DSTL and 21 years in the Australian defence industry and research organizations. He has more than 100 publications and is the editor and principal author of "The Science of Armour Materials". If you want to understand the basics of protection, this is the course for you!

You can register for the courses when you register for the 30th ISB on the IBS webpage.

[http://www.ballistics.org/30th\\_isb.php](http://www.ballistics.org/30th_isb.php)

There is also supplemental information about the lecturers and the content of the tutorials.

We hope that you will enjoy the offered courses and are looking forward to meet you there.

Best regards,

**Dr. Markus Graswald**  
Education Committee Chair

30th International Symposium on Ballistics



**SAVE THE DATE!**  
**4-8 NOVEMBER 2019**  
**HYDERABAD, INDIA**





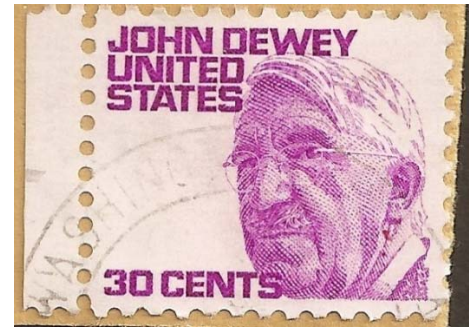
## DID YOU KNOW ... ?

... that **Dr. Jane M. Dewey** (1900-1976), once chief of Terminal Ballistics at the Ballistic Research Laboratories (now part of the US Army Research Laboratory) was the daughter of **Prof. John Dewey**, the well-known author, social psychologist, and education reformer? One of her many contributions to ballistic science has come to be known as the **Slade-Dewey equation**, which empirically relates the critical impact velocity  $V_t$  for initiating detonation of a secondary solid explosive to the diameter  $d$  of an impacting projectile,<sup>1</sup>

$$V_t = \frac{A}{\sqrt{d}} + B$$

where  $A$  and  $B$  are constants. Note that, for very large velocities, such as in shaped charge jets, the constant  $B$  becomes relatively negligible, and this equation becomes equivalent to the well-known **Held's criterion**, which posits a critical value of  $V^2d$  for each explosive.

... that **Prof. Ernst Mach**, the famous Austrian physicist and philosopher who studied shock waves and helped advance the development of supersonic flight, performed many experiments with flying bullets? He and his son Ludwig photographed the projectiles using a *schlieren* ("streak") optical system to visualize the pattern of shock and rarefaction waves at various conditions. One of his photographs is the inspiration of the design of our society's logo.

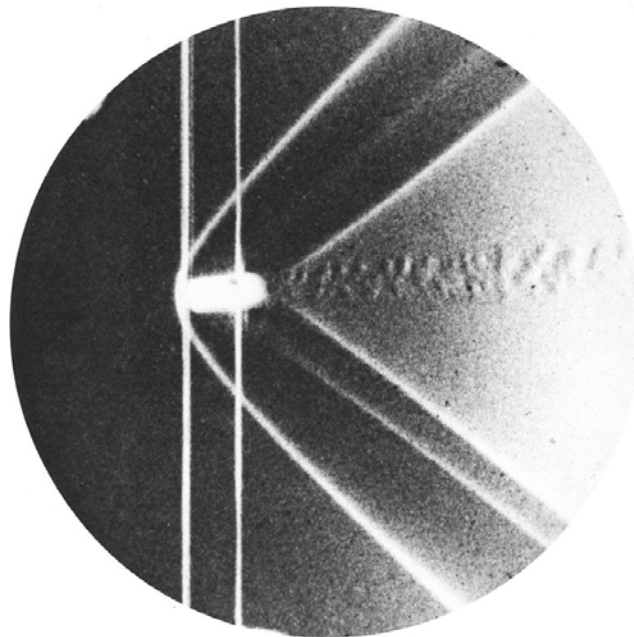


(image: Wikipedia)



**Ernst Mach**

(images: Wikipedia)



**Schlieren image**

... that the **Long Beach Sports Arena** features one of artist Robert Wyland's "Whaling Walls," titled *Planet Ocean*, a mural depicting life-size whales? Measuring 11,000 m<sup>2</sup> in area when it was painted in 1992, it was then the world's largest, according to the *Guinness Book of Records*.

<sup>1</sup> D.C. Slade & J. Dewey, "High-Order Initiation of Two Military Explosives by Projectile Impact," Ballistic Research Laboratory, Report No. 1021, July 1957.

... that **Meteor Crater**, the well-known geologic feature in northern Arizona, takes its name not from the fact that it was created by the impact of a meteorite, but from the nearest post office, which was in the now-defunct trading-post town of Meteor City?<sup>2</sup> It was originally named the **Canyon Diablo Crater**, after a nearby arroyo, and recovered fragments of the meteorite are officially called the Canyon Diablo Meteorite. Scientists refer to the site as **Barringer Crater**, in honor of geologist **Daniel Barringer** (1860-1929), who was the first to hold that it was created by a meteorite impact, when most others believed the site to be an extinct volcano.<sup>3</sup> The impactor is believed to have been a mass of nickel and iron about 50 metres across traveling at a velocity estimated at 12 to 20 kilometres per second.



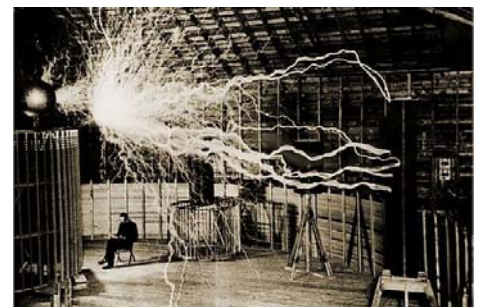
**Meteor or Barringer Crater**  
(image: Wikipedia)



**Daniel Barringer**  
(image: Public Domain)

... that the flat tip seen on some projectiles is known as a *meplat*? Sharpshooters and competitive shooters prefer flat-tipped projectiles because their aerodynamic characteristics are more repeatable from round to round.

**A ballistician who lived in Kuwait  
Needed a better equation of state  
For the stuff he was using  
As propellant and fuzing,  
To determine its grain size and weight.**



(image: Library of Congress)

<sup>2</sup> <http://www.theroute-66.com/meteor-city.html>

<sup>3</sup> J. Paul Barringer, Daniel's son, relates the story that his father arranged to have the post office's town so named. See J.P. Barringer, "Acceptance of the Special Award," *Meteoritics*, 1993, Vol. 28, <http://adsabs.harvard.edu/abs/1993Metic..28....9B>

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NUMERICS is proud to support the International Ballistics Society as a Corporate Member.

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China Ordnance Society

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The purpose of the China Ordnance Society is to serve the defense construction and economic development by organizing science and technology workers and to promote and develop scientific ideas and disciplines. Its main task is to organize academic exchange, publish academic periodicals, promote the development of science and technology, propagate scientific information and popularize scientific knowledge.

The Society has general members, senior members and fellows and so on. It has all together 22562 members, among which more than 585 are senior members and 34 are fellows.

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R3 Technology, Inc. is proud to support the International Ballistics Society. Jack served as the founding president of the IBS and previously served as the Chairman of the 12th ISB, in addition to other positions. R3 Technology provides technical services, business development support, and short courses.

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The Fraunhofer Institute for High-Speed Dynamics, known under the name Ernst-Mach-Institut (EMI) is one of the 60 institutes of the German Fraunhofer society. Fraunhofer is a non-profit organization which specialises in applied research and has close links to German government authorities. It is the biggest research organization in its field in Germany and one of the essential European research organizations.

**Southwest Research Institute (SwRI)** is a non-profit engineering R&D center. The main facility is a 1200-acre campus in San Antonio, Texas where over 3000 employees perform contract research for both government and industry. SwRI's Engineering Dynamics Department in the Mechanical Engineering Division works on armor and impact physics.

1. SwRI maintains multiple indoor and outdoor ballistic range facilities, where small and medium arms are tested against various armor configurations.
2. At a facility further out of town large explosive tests, including land mines, IEDs, and arena tests are performed to assess the survivability of vehicles and structures.
3. Low, medium, and high-strain-rate laboratory testing facilities provide the ability to characterize materials and then develop constitutive models for use in computational tools.
4. SwRI has extensive experience with the three primary software tools used for ballistics and explosive-loading: CTH, LS-DYNA, and EPIC. SwRI has modified all three for new constitutive models and boundary conditions.

Thus, SwRI's numerical work is directly applicable and available to the armor community. The armor and shielding program at SwRI has been funded over the years by the Army, Navy, Air Force, Marines, Department of Energy, NASA, and DARPA.

Please, visit [www.engineeringdynamics.swri.org](http://www.engineeringdynamics.swri.org) for more information or [www.swri.org/PMSC/default.htm](http://www.swri.org/PMSC/default.htm) for the Penetration Mechanics weeklong course taught every year.



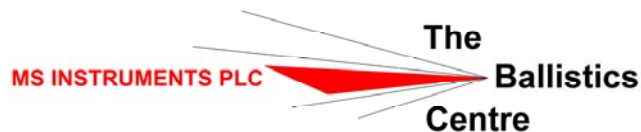
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## CORPORATE SPONSORS



NEXTER GROUP is a leading actor in the land-defence industry. Today it is the principal partner of the French Army, and its equipment is used in over 100 countries.

In a world of constantly changing threats, the Group's 2,700 employees listen carefully to customers to provide the solution best adapted to their specific needs.

Innovation, protection and adaptability are the key guidelines by which NEXTER designs its products and services.

With nearly 11% of annual sales dedicated to research and development, NEXTER introduces increasingly innovative and high-quality products onto the world market while meeting customers' deadlines and budgets.

Descending from Giat Industries, NEXTER is continuing a long tradition that could be considered to start in the XVII<sup>th</sup> century, during the reign of Louis XIV in France, when the Royal Arsenal was created at the Bastille.

### QinetiQ



Making a difference  
by doing things differently.

We welcome and support  
the work of the International Ballistics Society.

- We employ more than 13,000 people worldwide.
- Our scientists and engineers solve some of the world's most important problems.
- We are the UK's largest research and technology organization.
- We are the world's leading supplier of military robotics.
- More than 75% of our workforce carry high-level national security clearances.

## CORPORATE SPONSORS

**Earth, Horizon, Space ...  
WEIBEL Scientifics Reaches Further**

Weibel Scientific is the global leader in the market for advanced Doppler radar systems. For over fifty years, we have been designing, manufacturing, and delivering cutting-edge velocity and position measuring instruments to customers around the world. On a daily basis, Weibel radars are used to protect lives on the ground, in flight, and in space.

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**THIS NEWSLETTER NEEDS YOU!**

The newsletter is a primary means of keeping you informed about the life of the society, and about the main events it organizes. You can participate in making this bulletin more lively and closer to your fields of interest by proposing technical papers about works you have performed, or facts about ballistics you are aware of. For instance, if in browsing the web you find sites related to ballistics you think are interesting, funny, or worthy of sharing, do not hesitate to send a message to [communications@ballistics.org](mailto:communications@ballistics.org). However, be careful not to infringe any copyright or classification rules.

Also, we all belong to lots of different organizations, industries, and laboratories. It could be interesting for other members if, from time to time, one of you made a short informative presentation of its organization. This presentation should contain more information than advertising, and have the same obvious requirements about copyrights and classification.

Any other type of contribution is obviously welcomed!

Thanks in advance!