



INTERNATIONAL BALLISTICS SOCIETY

The International Ballistics Society (IBS) promotes the science of ballistics internationally. The IBS provides for technical interchange via an International Symposium on Ballistics and provides professional development for its members by providing opportunities for publication, short courses, student programs, and other activities to promote career development.

Letter from the President



I hope you all had a wonderful holiday time with your family and friends and are now ready for the new year. For all of us we face a new year that will be challenging in many different ways. It will also be a very busy time as we prepare for the 27th International Symposium on Ballistics (ISB) in Freiburg in April. The EMI team, led by Professor Thoma, has been working very hard to make the ISB a resounding success. I also want to bring you up to date with the work the Board and volunteers have been doing to improve our services for you.

Student Awards

One of our first tasks has been to initiate the Students Award scheme. The initial hard work was led by Ken Kuo, who championed the idea of offering bursaries to students studying ballistics science. I would like to acknowledge the debt the Society owes him for his efforts in establishing the principles behind the Student Award. Francisco Galvez has taken over the task to bring the Award scheme to fruition and I am sure you have all seen his letter announcing the awards. We are offering awards to students in each of the 6 ballistics science disciplines who produce the best papers. The award covers the registration fee at the Freiburg symposium and provides \$1000 towards travel and accommodation expenses.

The response to the Student Award scheme has been outstanding and Francisco and his team will have a hard job selecting the winning students.

Education

Jack Riegel and I have been discussing what the International Ballistics Society should embody. In Miami we both recognised that being able to promote on-going training and education for members made the Society stand above an organisation 'that simply organised a symposium'. My vision is to have the Society become an accredited institution that can grant accredited status to Ballisticians.

Jack will be providing more information on the work of the Education Committee in this newsletter and I would urge you to let him or me have your views on whether the Society should offer courses and what these courses might entail. Contact me (president@ballistics.org) or Jack (education@ballistics.org).

Looking to Freiburg ...

As Freiburg is only 2 months away the paper selection process has been completed and Matthias Wickert and Thilo Behner are now moving to have them published and the symposium schedule finalised. The submission of journal papers for the special edition of the Journal of Applied Mechanics (JAM) has also been very encouraging and the quality of the papers is increasing. I would like to thank Bo Janzon for his hard work as the guest editor of JAM. On behalf of the Board I would also like to thank members who have acted as reviewers of abstracts and papers.

If you require a visa in order to attend the 2013 symposium then please make sure you apply in good time and follow the requirements set down by the German Government. Whilst the organisers can provide supporting letters and invitations, they cannot enter into discussions with the German Foreign Ministry on your behalf.

The other new innovation at Freiburg will be the Society's first business meeting, which will be held immediately after the end of the symposium on Friday afternoon. Members will be provided with a packed lunch and the meeting will last for about an hour. This is your opportunity to interact with and be involved in the Society and its business. It will provide you with the chance to **hear** from and **question** the Board and the Society's officers about the Society's finances, membership and plans for the future and make your views heard. It will also be an opportunity to meet the Board and put faces to names. I therefore urge you to attend this important meeting.

ISSUE #4, MARCH 2013

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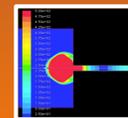
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Help Needed from Members!

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

Please upload photos at
www.ballistics.org

Remember to be responsible with sensitive or restricted information!

Letter from the President, Continued...

Something else I would like you to do is to VOTE in the elections. David Davison, the chair of the Nominations Committee will be talking about the election later in this newsletter, but I want to emphasise how important this election is to the Society. One of the key needs identified at the Tarragona ISB was for any member to be able to become involved in the running of the Society. This election provides this opportunity. Members are putting themselves forward as candidates in the election and they need your votes. By voting you will demonstrate that the Society is a working organisation.

...and Beyond

With regards to future symposia we would be interested in your ideas on possible venues for future ISB. If you have any suggestions please let me know.

Communications

Tony Russell will be talking about some new and exciting ways to improve communication. Please take the time to carefully read his contribution in this newsletter and get back to him with your comments and suggestions. This is an area where there is plenty of scope for volunteers to help. So if you have some spare time then get in touch with Tony or me.

Remember to visit our website where you will find new links to future events and other features. It is also a useful way to send messages to other members. In addition don't forget the Archive where you can put articles and photographs concerned with your ballistics research, past symposia or the history of ballistics science. We are always interested in receiving new ideas to improve the website, just drop us an email.

More importantly why not get involved in the Society? We would welcome your support in any way.

Copyright

One of my major activities since becoming President has been to secure the copyright of the proceedings from previous ISB. I am well on the way to achieving this and would like to thank Sam Campagna and the NDIA for transferring the copyright of all the ISB held in North America. This was an extremely generous act on their part. Organisers of ISB held around the world have also generously transferred the copyright to the Society and I extend my thanks to them also.

The ownership of our copyright is an important factor in securing the future of the Society. The ability to freely consult our past research in ballistics coupled with our significant breadth and depth of technical expertise contained within our membership represents a powerful research and development capability within the scientific world. The Board will continue to develop this in the years ahead.

Offering Advice

We recently received a request for advice on a ballistics related problem that was to feature in a court case. The Board decided that it would not be in the Society's best interest to offer an opinion, since this might lead to future litigation leaving the Society and/or members financially liable.

If you get approached with a request for ballistics science related advice please make sure you are covered by professional liability insurance, which is usually provided by your employer. If you do decide to offer advice or an opinion on a personal basis please do not associate your opinion with your membership of the Society.

Saying Goodbye

On the 14th of December Sam Campagna retired from the NDIA after many years of exemplary service. He more than anyone developed and perfected the ISB, which others around the world have sought to emulate and build upon. His vision of how to organize and run an ISB was seminal. From the outset he has been a keen supporter of the Society and its objectives. I would like to acknowledge his support to me and the Board.

In recognition of his service to the International Ballistics Committee, the Society and the ballistics community in general the Board appointed Sam a Fellow of the Society. Jack Riegel and Dennis Baum presented him with his award in Washington at his retirement party.

I hope you find the remainder of this newsletter of interest and will contribute to future ones.

Here's to a very successful ISB in Freiburg

With every good wish.

Ian Cullis
President
International Ballistics Society

Retirement of Sam Campagna



Many of you will know Sam Campagna as ‘The man from the NDIA’ who organized the International Symposia on Ballistics (ISB) when they were held in North America.

In close collaboration with the International Ballistics Committee (IBC) he led the development of the ISB, setting a standard that challenged others responsible for organizing the ISB outside of North America. He introduced a number of new ideas and formats demonstrating the highest level of professionalism at all times. His ability to understand the needs of the members at a symposium were second to none and he could always ‘make things happen’, even at the last minute.

His support to the International Ballistics Society has also been singular and outstanding. As a supporter of the Society from the outset he worked hard with the founding Board of Directors in its creation. At the Miami symposium in 2011 he provided a society booth and helped us run our first general election of board members.

He also recognized the importance and value of the previous ISB proceedings to the Society and transferred the copyright of the proceedings owned by the NDIA to the Society. This singularly generous act encouraged other copyright owners to follow suit to allow the Society to secure the copyright of the vast majority of its knowledge base.

In recognition of his exemplary and singular service to the Society and the IBC the Board elected Sam to an Honorary Fellowship and commissioned a plaque to mark the award on his retirement. Jack Riegel and Dennis Baum presented the Fellowship award, on behalf of the Society, to Sam at his retirement from the NDIA on December 14th in Washington DC.

In addition to mark his retirement Dennis presented Sam with some wine on behalf of the Society in appreciation for the excellent wine he had served at our previous symposia. The President, in his letter to Sam, recognized his role in establishing the International Symposium on Ballistics as the premier venue for researchers to present their work in ballistics science.



Register Now for 27th International Symposium on Ballistics

Written by
Matthias Wickert, Manfred Salk, Chairmen of the 27th ISB

There are less than 3 months left until the 27th International Symposium on Ballistics will commence in Freiburg, Germany, on April 22, 2013. We will offer an exciting program with 11 oral presentation and 7 poster sessions. The symposium website www.ballisticsymposium2013.org keeps you updated on the current status of the program.



The website will now also give you an outlook on the symposium tour. We will visit the Haut-Koenigsbourg Castle which is located in France. The castle was reconstructed in about 1900 by an ambitious renovation project of the last German Emperor and offers an authentic insight into 15th century mountain fortresses. After the Treaty of Versailles in 1919, the castle was once again in the possession of France. When you travel to Germany and need a visa, you typically receive a tourist visa which allows you to go to France. Only when you are asked to specify a special visa, please ask for the visa type called Schengen visa.

On the website, an outline of the companion program is also given. Please be aware that the companion program has to be booked separately. It is possible for companions to attend only the social events of the

symposium, but extra companion tours are also offered.

When you register, you will also find the option to take part in tutorial sessions on Monday morning and Monday afternoon. The morning session "Explosion Mechanics I & II" comprises the fundamental warhead mechanisms like blast charges, shaped charges, flat cone charges, EFP charges and fragment charges. The afternoon session "Armor Mechanisms I & II" will provide an overview of armor mechanisms and armor materials for MBTs and APCs like RHA, ceramics, transparent armor, composite armor, explosive reactive armor and active defense concepts. The lectures give an introduction regarding these two areas, which will help the attendees to better understand the partially very specialized papers of the Symposium. Experienced professionals of the International Ballistics Society will give the lectures.

For accommodations, a list of recommended hotels in walking distance from the conference center is given on the website www.ballisticsymposium2013.org. If you are planning on staying overnight before April 21 or after 26, please contact the hotel reservation service as indicated. They will assist you with your hotel room reservation. The hotel contingent is available until March 21. So please do not wait too long with your registration.

We are looking forward to welcoming you in Freiburg and hope that you will have an inspiring symposium.



What are you doing to help grow the membership?

Membership numbers

Currently the IBS has 560 members, of whom 90 are Lifetime Members. We have only six student members so this is an area where the IBS is hoping to improve. The main way we are trying to achieve this is by offering training or educational courses. Details of these are described elsewhere in this newsletter. Meanwhile, we urge

Membership (Continued)

all members to encourage students involved in ballistics to join the IBS. New ordinary members are always welcome. It costs only US\$50, though you might find it better value to become a Lifetime Member. Please encourage your friends and colleagues to join. You could also encourage your employer to join as a corporate member. The IBS welcomes its two newest corporate members: OTT Technologies, South Africa, and the Armament Research and Development Establishment, India.

University Membership

Since the last newsletter, the IBS now has three more University Members: Netherlands Defence Academy, New Mexico Tech and Cranfield University at the Defence Academy, Shrivenham. We warmly welcome all of these.

Other universities have been invited to consider becoming University Members. If you are interested then please contact the Membership Committee for further details.

Senior & Fellow Members

Following the last newsletter, the Membership Committee and Board conducted a review of its members who expressed an interest in promotion to Senior or Fellow level. Everybody who was successful has been informed.

A member's status may be reviewed at any time. However, the onus is on the individual to apply, with support from Fellow Members, as appropriate. If any member is uncertain on their eligibility then please contact the Membership Committee. We are waiting to here from you!

IBS cotton shirts (short sleeve)

These have been very popular with the members and would make a great present. Dozens have been sold at the 26th ISB, at festive occasions and for birthdays.

The IBS still has several blue shirts available for US\$30 each (plus postage). Each shirt has the IBS logo embroidered on the left hand sleeve and the words "International Ballistics Society" embroidered just above the pocket (see photo). Sizes available are M, L, XL and 2XL. Some shirts are available in S size without the pocket for US\$25 (plus postage).

If you are interested in purchasing one or more then please contact the Membership Committee.

Spread the word about the IBS and do your part to grow the membership!

Start today by sending this newsletter on to your friends and co-workers!

Board of Directors Election

David Davison
Nominations Committee

Candidates

A survey of the membership found that 60% reside in North America, 30% reside in Europe, and the remaining 10% reside elsewhere. The Nominations Committee for the 2013 election, has the following membership:

<u>Name</u>	<u>Location</u>
Brown, Ronald	USA
Davison, David	USA
Locking, Paul	UK
Khmelnikov, Evgeniy	Russia
Wang, Zhongyuan	China

Both the Board of Directors and the Nominations Committee represent the diversity of the membership in location and expertise (here gleaned from contributions to recent IBS symposia).

Name	Location	Technical Area(s)					
		IB	EB	LD	VU	TB	EM
Eches, Nicholas	France						
Gkritzapis, Dimitris	Greece		x				
Kaufmann, Hanspeter	Switzerland					x	
Kuo, Ken	USA	x					
Lambert, David	USA						x
Li, Dogguang	China		x				
Lim, Seokbin	USA						
Persson, Ake	Sweden				x	x	x
Riegel, John (Jack)	USA					x	
Rupert, Nevin	USA					x	
Teixeria-Dias, Filipe	Portugal						
Thoma, Klaus	Germany					x	

Current Board of Directors

Name	Location	Term	Technical Area(s)*					
			IB	EB	LD	VU	TB	EM
Baum, Dennis	USA	2016					x	x
Chocron, Sidney	USA	2014					x	
Cullis, Ian	UK	2014				x	x	x
Janzon, Bo	Sweden	2016						
Mayseless, Meir	Israel	2013					x	x
Riegel, Jack	USA	2013					x	
Wang, Zhongyuan	China	2014		x				
Woodley, Clive	UK	2016	x	x	x			
(Open)	-	2013						

*Key: IB = Interior Ballistics, EB = Exterior Ballistics, LD = Launch Dynamics, VU = Vulnerability, TB = Terminal Ballistics/Impact Physics, EM = Explosion Mechanics

Candidate Selection Process The committee started with a list of IBS members who showed interest in response to a global email sent out by Ian Cullis, IBS President. We added candidates from the last election and retiring board members (Mayseless and Riegel). There were twelve candidates who responded prior to the cutoff date of 8 January 2013:

Election IBS members can vote online for the three open seats between the 20th of February and the 14th of April. The election will continue by paper ballot at the 27th IBS symposium site on Monday and Tuesday, the 22nd and 23rd of April. Members will be able to meet and interview candidates during these two days. The Nominations Committee will announce the three new Board members on Wednesday.

Eligibility Members in good standing, eligible to vote in the election of the board of directors include: [1] Lifetime members of the IBS, [2] Persons who became members by attending the symposium of September 2011, [3] Persons who became members after the symposium of September 2011, and [4] Persons who become members by registering for the symposium of April 2013 prior to closure of the ballot box on the 23rd of April (Tuesday). Corporate delegates can vote but student members cannot.



Did you know or do you believe it...

With amazing feats of strength, flexibility, and pain-endurance, the Shaolin monks have created a world-wide reputation as the ultimate Buddhist warriors. Among their feats Shaolin Monks have been reported to throw a needle through a plate of glass. Don't try this at home as ricocheting needles flying around your house can be dangerous (not to mention your family will think your crazy)! I just wonder how many of you will now go off to sabot needles in your ballistics labs and shoot them at glass plates?

Byron Ferguson is known worldwide as a longbow exhibitionist. Some of his amazing accomplishments include splitting playing cards from the side, shooting through diamond rings, bank shots and once shooting 8 dimes out of the air in a row. Among his most notable demonstrations, Byron shows how he can shoot an aspirin that is thrown into the air from several meters away. How is that for target acquisition capabilities?



Featured Works from IBS Members

A numerically based model for the effect of the entrance phase on rigid projectile penetration

(from Terminal Ballistics, Springer, 2012, by Z. Rosenberg and E. Dekel)

It is a well known fact that the resistance to penetration of rigid projectiles is considerably lower around the impact face of the target, as compared with that at deep penetrations. This phenomenon has been termed the entrance phase effect which can be very important for short projectiles at ordnance velocities. At such impact velocities these projectiles do not penetrate more than a few diameters and the whole penetration process is influenced by the entrance phase. In contrast, the penetration process of long rigid rods is governed mainly by the asymptotic value of the target's resistance to penetration at deep penetrations. It has been shown (see Terminal Ballistics) that for ogive and spherical nosed projectiles the entrance phase dominates the process up to a penetration depth of about 6 and 3 projectile diameters, respectively. Obviously, the influence range of the entrance phase is much larger than its dominance range, as was demonstrated in the book cited above.

In order to account for the gradual increase of the resistance to penetration, from the impact face to deep penetration, a numerically based model was constructed. The model is based on the fact that the retarding stress (R_t) on a rigid projectile at deep penetrations, is constant, depending on the target's properties (strength and Young's modulus) and on the projectile's nose shape. This issue has been elaborated in Chapter 3 of Terminal Ballistics. With a constant stress (deceleration) on the projectile, its penetration depth is given simply by:

$$P/L = \rho_p V_0^2 / 2R_t \quad (1)$$

It is clear that in the dominance range of the entrance phase the value of the resisting stress increases gradually towards its asymptotic value at deep penetration (R_t). In order to account for this increase let us define an effective resisting stress for the entrance phase (R_{eff}) and use Eq. (1) in order to account for the enhanced penetration of the projectile:

$$P/L = \rho_p V_0^2 / 2R_{eff} \quad \text{with } R_{eff} < R_t \quad (2)$$

We can rewrite Eq. (2) in the following way, using the projectile's diameter (D):

$$P/L = (P/D) \cdot (D/L) = (\rho_p V_0^2 / 2R_t) \cdot (R_t / R_{eff}) \quad (3)$$

which can be rewritten as:

$$(P/D) \cdot q = (\rho_p V_0^2 / 2R_t) \cdot (L/D) = I_F \quad \text{with } q = R_{eff} / R_t \quad (4)$$

Up to this point we have only defined two new parameters q and I_F , without changing the nature of the equations. The parameter q expresses the ratio R_{eff}/R_t of the respective resisting stresses. The parameter $I_F = q(P/D)$, is a measure of the penetration capability of the given projectile into the target, ignoring the entrance phase effect. This parameter has been called the Impact Factor by several workers who used similar expressions for the penetration capability of rigid projectiles.

The next step was to perform several simulations with short projectiles with ogive and spherical nose shapes, impacting aluminum and steel with different strengths. The resulting penetration depths were analyzed in terms of P/D as a function of I_F and it turned out that two universal curves can be constructed,

for ogive and spherical nosed projectiles, which should account for all the different impacts of these projectiles at different targets. The numerically based curve for the ogive nosed projectiles can be described by the following expressions:

$$P/D = 1.32 + 1.2I_F - 0.008I_F^2 \quad \text{for } I_F \geq 1.0 \quad (5a)$$

$$P/D = 2.5I_F^{0.5} \quad \text{for } I_F \leq 1.0 \quad (5b)$$

The following figure shows the agreement between the model predictions and the experimental results of Chocron et al (Proceedings of the ISB - 1999, p.319) for 0.3"APM2 projectiles impacting 6061-T6 aluminum targets. It is clearly seen that the model accounts very well for the data in this case, for which all the data points are within the influence range of the entrance phase. Similar agreements were obtained for other sets of data, as described in our book Terminal Ballistics cited above.

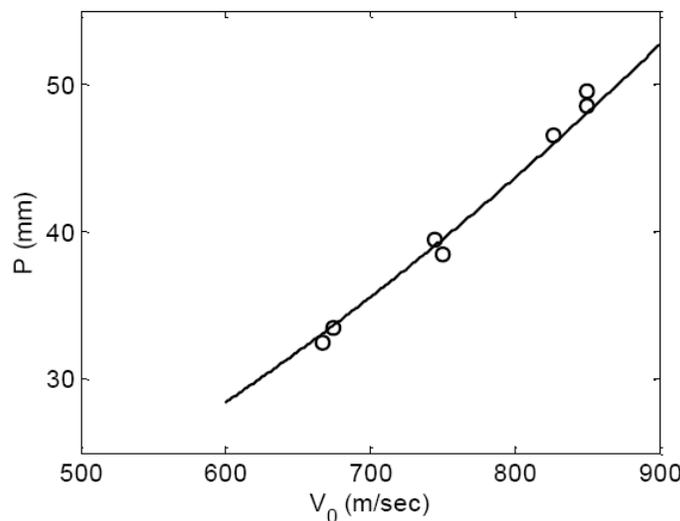


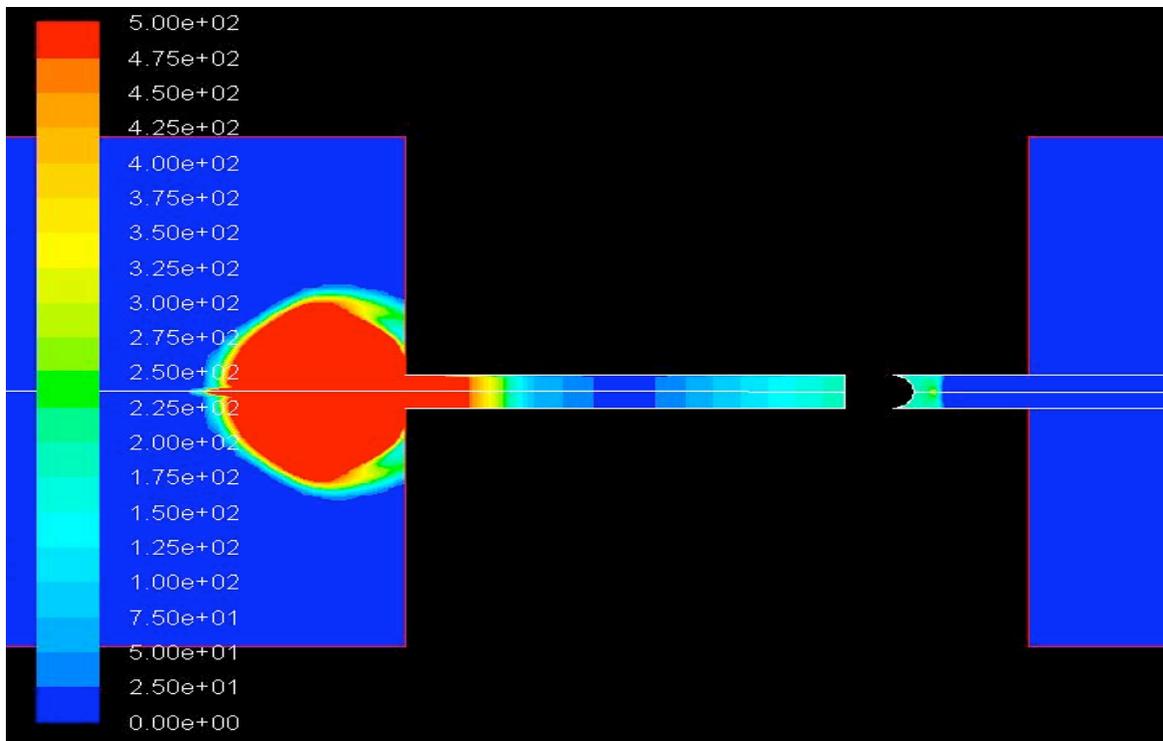
Figure 1. Comparing the model's predictions (curve) with penetration data (circles) of 0.3"APM2 projectiles impacting 6061-T6 targets.

Simulation of Reactive Gas-Liquid Flow in a Recoilless Rifle

Carlton Adam
US Army ARDEC, Picatinny Arsenal, NJ

Recoilless rifles are a class of weapons that, upon launching a projectile, eject some kind of material from the rear of the gun in order to counterbalance the recoil momentum generated by the projectile. The ejected material, usually referred to as a countermass, may be a solid or liquid slug, or simply the same propellant gas used to drive the projectile. The latter is typically vented through a nozzle to increase the counter-recoil force it generates.

Since a solid slug countermass does not deform much during the interior ballistic cycle, it behaves essentially like a rigid projectile and the equations governing its motion are very straightforward. When propellant gas is vented to be used as a countermass, the system may be treated as unsteady single-phase flow through a nozzle, for which many robust analytical techniques are available.



ANSYS Fluent model of a gas-only recoilless rifle system showing gas velocity magnitude. Expansion plume can be seen to the far left; projectile can be seen still in-bore with a shock developing in front of it.

The liquid countermass system is quite different however. In this case, the gas and liquid are able to mix, thus creating a complex multi-phase flow structure. Mixing also generates a large free-surface area between the two phases, and since the temperature of the propellant gas may be well above the boiling point of the liquid (typically aqueous salt solutions), liquid at the free surface will vaporize and may also exert a quenching effect on the propellant combustion. These two processes can have noticeable effects on the weapon's interior ballistics and muzzle blast. It is therefore desired to develop simulation tools with which to analyze and characterize this reactive multiphase flow.

An effort is currently underway to develop a numerical model of the interior ballistics of a liquid countermass recoilless gun system. This model will be distinguishable from existing interior ballistic models by its treatment of unusual processes such as gas-liquid interface tracking, phase changes due to vaporization, and propellant grains extinguishing upon contact with liquid. The ultimate goal of this effort is to develop a predictive model of the recoilless gun using a first-principles approach.

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SECRAB is owned and managed by Professor Bo Janzon.

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中国兵工学会
China Ordnance Society

Founded in April, 1964 and affiliated with the China Association for Science and Technology, the China Ordnance Society is an academic social group composed of science and technology workers for China Ordnance.

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.

Southwest Research Institute (SwRI) is a nonprofit 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
for more information or
www.swri.org/PMSC/default.htm
for the Penetration Mechanics
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R3 Technology, Inc

TEL 703 879-4501

JRIEGEL@R3-TECHNOLOGY.COM

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.

Talk to us at the 27th ISB in Freiburg.

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Fraunhofer EMI

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.

Bisalloy Steels, producer of Bisplate, is Australia's sole manufacturer of armour steel plate products for military applications.

In addition to having produced over 3500 tonnes of steel for the Australian Bushmaster program, Bisalloy Steels also supplies huge amounts of armour plate for US Vehicle programs such as MTRV's (Medium Tactical Vehicle Replacements), MRAPs (Mine Resistant Ambush Protected vehicles) and M-ATV's (MRAP – All Terrain Vehicles)

Bisalloy Steels is honoured to be a founding member of the International Ballistics Society.



www.bisalloy.com.au

BAL : The Department of Weapon Systems & Ballistics of the Belgian Royal Military Academy

The department of weapons systems & ballistics is unique as it is the only place in Belgium to teach courses in ballistics and weapon systems on a university level. The department is equipped with a modern laboratory containing a 102 m in-door range.



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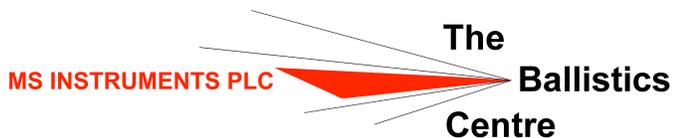


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Questions, input or feedback should be directed to communications@ballistics.org

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