



**24th  
International  
Symposium on  
BALLISTICS**

New Orleans, Louisiana, USA

Sponsored by the Ballistics  
Division of NDIA in  
association with the  
International Ballistics  
Committee



**CONFERENCE AGENDA**

**SHERATON NEW ORLEANS ► NEW ORLEANS, LA**

**SEPTEMBER 22-26, 2008**  
[WWW.NDIA.ORG/MEETINGS/8210](http://WWW.NDIA.ORG/MEETINGS/8210)

The 24<sup>th</sup> International Symposium on Ballistics is jointly organized and supported by the National Defense Industrial Association, USA in conjunction with the International Ballistics Committee

Symposium Co-Chairmen:

Dr. Stephan Bless

Dr. James Walker

### PREVIOUS INTERNATIONAL SYMPOSIA ON BALLISTICS

Orlando, Florida, USA	1974
Daytona, Florida, USA	1976
Karlsruhe, Germany	1977
Monterey, California, USA	1978
Toulouse, France	1980
Orlando, Florida, USA	1981
The Hague, The Netherlands	1983
Orlando, Florida, USA	1984
Shrivenham, UK	1986
San Diego, California, USA	1987
Brussels, Belgium	1989
San Antonio, Texas, USA	1990
Stockholm, Sweden	1992
Quebec City, Canada	1993
Jerusalem, Israel	1995
San Francisco, California, USA	1996
Midrand, South Africa	1998
San Antonio, Texas, USA	1999
Interlaken, Switzerland	2001
Orlando, Florida, USA	2002
Adelaide, South Australia	2004
Vancouver, BC, Canada	2005
Tarragona, Spain	2007

## 24<sup>TH</sup> INTERNATIONAL SYMPOSIUM ON BALLISTICS: SEPTEMBER 22-26, 2008 ► SHERATON NEW ORLEANS NEW ORLEANS, LA

### SYMPOSIUM ATTIRE

Appropriate dress for this symposium is business for civilians (coat and tie) and class A uniform or uniform of the day for military.

### PAPER SELECTION COMMITTEE

Dr. Charles E. Anderson, Jr., USA	Dr. Manfred Held, Germany
Mr. Joseph Backofen, USA	Dr. Bo Janzon, Sweden
Dr. Dennis Baum, USA	Dr. Valeriy Kartuzov, Ukraine
Dr. Stephan Bless, USA	Dr. Michael Murphy, USA
Mme. Manon Bolduc, Canada	Dr. Dennis Nandlall, Canada
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Dr. James Cazamias, USA	Dr. Ake Persson, Sweden
Mr. Pierre Chanteret, France	Dr. Xiangyang Quan, USA
Dr. Sidney Chocron, USA	Mr. Jack P. Riegel, III, USA
Dr. Ian Cullis, UK	Mr. Erick Sagebiel, USA
Mr. Philip Cunniff, USA	Dr. Sikhanda Satapathy, USA
Dr. Andre Diederer, Netherlands	Dr. Douglas Templeton, USA
Dr. Eric Fahrenthold, USA	Dr. James Walker, USA
Dr. William Flis, USA	Dr. Paul Weinacht, USA
Dr. Richard Fong, USA	Mr. Carl Weiss, USA
Dr. Francisco Galvez, Spain	Dr. Joe Wells, USA
Dr. Marc Giraud, France	

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Prof. Dr. Klaus Thoma, Germany  
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Dr. Paul Weinacht, USA

#### *Emeritus Members*

Dr. Bruce Burns  
Prof. Eduard Celens, Belgium  
Dr. Pei Chi Chou, USA  
Dr. Rudi Heiser, Germany  
Dr. Albert Horst, USA  
Dr. Gunther Krauth, Germany  
Dr. Ir. Hans Pasman, The Netherlands  
Dr. E. Schmidt, USA  
Dr. Gustav-Adolf Schroeder, Germany  
Mr. David Scott, UK  
Dr. Alois Stilp, Germany  
Dr. Louis Zernow, USA

#### *Guest Members*

Mr. P. U. Deshpande, India  
Professor Tan Hua, China  
Dr. Carlos Navarro, Spain  
Acad. Victor S. Soloviev, Russia

# MONDAY, SEPTEMBER 22, 2008

**7:00 am - 7:00 pm** Registration Open

**9:00 am - 4:30 pm** Independent Tutorials  
Additional Registration Fee Applies  
*Presented by Professor Dr. Manfred Held*

## AM SESSION

- 9:00 am Warhead Mechanism  
1.1 Blast Charges  
1.2 Shaped Charges  
1.3 Flat Cone Charges
- 10:45 am Coffee Break
- 11:00 am Warhead Mechanism Continued  
1.4 EFP Charges  
1.5 Fragment Charges (Anti-AC/Anti-TBM)

## PM SESSION

- 1:30 pm Overview on Armour for MBT's and APC's  
2.1 RHA  
2.2 Ceramics  
2.3 Glass
- 3:00 pm Coffee Break
- 3:15 pm Overview on Armour for MBT's and APC's Cont.  
2.4 Composites  
2.5 ERA  
2.6 NERA or Bulging  
2.7 Active Defence Concepts

**10:00 am - 4:00 pm** Exhibitor Move In

**5:00 pm** Exhibit Hall Open

**5:00 pm - 7:00 pm** Opening Reception - Exhibit Hall  
*Featuring the New Orleans Spice Jazz Band*

*These tutorials will provide attendees with a better understanding of the many very specialized papers in the 24th International Symposium on Ballistics. Every course attendee will receive a handout of the slides used in the lectures.*

*Prof. Dr. Held is one of the foremost experts in the world in ballistics. The material in this course is drawn from his lectures at the Military University in Munich.*

# TUESDAY, SEPTEMBER 23, 2008

**7:00 am Continental Breakfast & Registration**

**8:00 am Welcome & Administrative Remarks**

**8:10 am - 9:50 am General Session**  
**Chaired by Pieter Nel & Marc Giraud**

**8:10 am** *GS009 A Brief History of Shaped Charges*  
William Walters, USA

**8:50 am** *GS109 Interface Defeat for Unconfined SiC Ceramics*  
Thilo Behner, Germany; Charles Anderson, USA; Timothy Holmquist, USA; Matthias Wickert, Germany; Doug Templeton, USA

**9:10 am** *GS104 Numerical Simulation of Muzzle Exit and Separation Process for Sabot-Guided Projectiles at  $M > 1$*   
Jorn van Keuk, Germany; Arno Klomfass, Germany

**9:30 am** *GS117 Origin and Magnitude of the Pressure and Temperature Increase Behind Defeated Armor*  
Andreas Heine, Germany; Matthias Wickert, Germany

**9:30 am - 5:30 pm Exhibit Hall Open**

**9:50 am - 10:10 am Coffee Break in Exhibit Hall**

**10:10 am - 10:30 am Presentation on Proposed International Ballistics Society**

**10:30 am - 12:10 pm Terminal Ballistics**  
**Chaired by Dennis Nandlall & Sikhanda Satapathy**

**10:30 am** *TB068 Performance and Production of Jacketed Penetrators having Different Jacket Thickness*  
B.J. van der Meer, The Netherlands; Mark Dijkstra, The Netherlands; Erik Carton, The Netherlands

**10:50 am** *TB227 Loading Mechanisms on a Target from Detonation of a Buried Charge*  
Leslie Taylor, USA; William Fourney, USA; Ulrich Leiste, USA; Bryan Cheesman, USA

**11:10 am** *TB167 Predicting the Onset of Lateral Instability of Long Rod Penetrators in a Particulate Target*  
Melissa Hankins, USA; S. E. Jones, USA; Karen L. Torres, USA

**11:30 am** *TB135 A Comparative Study of Penetration Codes for Brittle Materials*  
Sikhanda Satapathy, USA; Anthony Dawson, USA; Gregory Rodin, USA

**11:50 am** *TB200 Radial Jet Dispersion Due to Current Interaction in an Electric Armour Application*  
Patrik Lundberg, Sweden; Patrik Appelgren, Sweden; Melker Skoglund, Sweden; Lars Westerling, Sweden; Tomas Hurtig, Sweden; Anders Larsson, Sweden

**12:10 pm - 12:30 pm Introduction to Poster Sessions**

**12:30 pm - 2:00 pm Lunch - Armstrong Ballroom; 8th Floor**

**2:00 pm - 3:40 pm Warhead Mechanisms**  
**Chaired by Pierre Chanteret & Richard Fong**

**2:00 pm** *WM056 Munitions Effects: A Schematic Overview of Munitions and Warheads, Trends for the Future*  
Andre Diederens, The Netherlands

**2:20 pm** *WM097 Initiation Controlled Multimode Warheads*  
Thomas Falter, Germany

**2:40 pm** *WM203 Combined Effects Aluminized Explosives*  
Ernest Baker, USA; Leonard Stiel, USA; Christos Capellos, USA; Wendy Balas, USA; Jack Pincay, USA

**3:00 pm** *WM134 Multiple Effects Warheads for Defeat of Urban Structures and Armour*  
Anthony Whelan, UK

**3:20 pm** *WM161 Development of the NLOS-LS PAM Warhead*  
Melissa Hobbs, USA; Christopher English, USA; David Hunter, USA; Jim Strom, USA; William Zarr, USA

**3:40 pm - 5:30 pm Terminal Ballistics Poster Session**

**3:40 pm Coffee Break in Exhibit Hall**

**4:00 pm - 5:40 pm Exterior Ballistics & Launch Dynamics**  
**Chaired by Paul Weinacht & Roxan Gayzac**

**4:00 pm** *EB113 Range Extension of Gun-Launched Smart Munitions*  
Frank Fresconi, USA

**4:20 pm** *EB166 Numerical Prediction of Magnus of Spin-Stabilized Projectiles*  
James DeSpirito, USA; Sidra Sifton, USA

**4:40 pm** *EB206 Mine Countermeasure Dart Dispense Modeling & Simulation*  
Gary Prybyla, USA; Michael Dean Neaves, USA; Kevin Losser, USA; James Baltar, USA; William Dietz, USA

**5:00 pm** *EB178 Trajectory Deflection of Fin- and Spin-Stabilized Projectiles using Paired Lateral Impulses*  
Pierre Wey, France; Daniel Corriveau, Canada

**5:20 pm** *LD011 Numerical Analysis of Bi-Metallic Explosive Shock-Loading and Release Experiments*  
Jeremy Kleiser, USA; Brian Plunkett, USA; Lalit Chhabildas, USA

**TERMINAL BALLISTICS POSTER SESSION**

**3:40 pm - 5:30 pm**

**CHAIRMEN: JACK RIEGEL, CARL WEISS & KOEN HERLAAR**

*TB002 Ballistic Performance of Protective Liners*

Moshe Ravid, Israel; Shlomo Birger, Israel; Nimi Shapira, Israel; Avi Ya'akovovith, Israel; Yoav Hirschberg, Israel

*TB008 Non-Invasive Ballistic Impact Damage Diagnostics Capabilities with XCT: Now and in the Future*

Joe Wells, USA

*TB018 Protection Capability of Steel Armor with Liquid Filled Cavities Against Shaped Charge Jets*

Andreas Holzwarth, Germany

*TB020 Deformation and Breakup of Tungsten Alloy Cubes, Cylinders and Spheres on Aluminum Plates*

Karl Weber, Germany

*TB030 Penetration of Tube-Like Projectiles into Metal Targets*

Vladislav Veldanov, Russia; Sergey Fedorov, Russia; Victor Kozlov, Russia; Mikhail Maximov, Russia

*TB031 Penetration Model Taking in Mind Viscosity Properties of the Impacted Body Materials. Comparison with Test.*

Vladislav Veldanov, Russia; Victor Kozlov, Russia

*TB045 The Effect of a Copper Buffer on Interface Defeat*

Timothy Holmquist, USA; Charles Anderson, USA; Thilo Behner, Germany

*TB050 On Penetration/Perforation of Concretes Struck by Rigid Projectiles*

Xiaowei Chen, China

*TB052 Study on the Effect of Reinforcement of Concrete Targets upon the Penetration Performance of a Projectile*

Hak Jun Kim, Korea; Leeju Park, Korea; Hyungwon Kim, Korea

*TB057 Ballistic Impact Experiments of Tungsten Carbide Projectiles onto Tungsten Carbide Targets*

Koen Herlaar, The Netherlands; Andre Diederer, The Netherlands; Gareth Appleby-Thomas, UK; Paul Hazell, UK

*TB058 The Shock Response Of a Cemented Tungsten Carbide*

Koen Herlaar, The Netherlands; Andre Diederer, The Netherlands; Gareth Appleby-Thomas, UK; Paul J Hazell, UK

*TB060 Modeling of Defects in Transparent Ceramics for Improving Military Armor*

Costas Fountzoulas, USA; James Sands, USA; Gary Glide, USA; Parimal Patel, USA

*TB064 Modeling the Influence of Damage in Compression on the Spall Strength of Alumina*

Zvi Cooper, Israel; Miles Rubin, Israel

*TB067 New Analytical Model of Expansion of Spherical Cavity in Porous Plastic Material and Penetration into Such Materials*

Boris Galanov, Ukraine; Valeriy Kartuzov, Ukraine; Sergei Ivanov, Ukraine

*TB080 An Experimental Study of Penetration Behavior of Shaped Charge Jet in Water Filled Targets*

Dev Raj Saroha, India; Gurmit Singh, India; Virendra Kumar Mahala, India

*TB083 Ricochet of AP Projectiles from Hard Concrete Targets*

Meir Mayselless, Israel; Yehiel Reifen, Israel; David Touati, Israel; Dan Yaziv, Israel; G. Tibon, Israel

*TB089 Numerical Study of the Relations between Material Properties of Tungsten-Alloy Rod and its Ballistic Performance*

Lou Jianfeng, China; He Changjiang, China; Hong Tao, China; Wang Zheng, China; Hang Yihong, China

*TB106 Numerical and Experimental Study of the Defeating the RPG-7*

Stanislav Rolc, Czech Republic; Jaroslav Buchar, Czech Republic; Zbynek Akstein, Czech Republic; Giovanni Cozzani, Italy; C. De Giorgi, Italy

*TB128 New Lightweight Metals for Armors*

Frans van Wegen, The Netherlands; Erik Carton, The Netherlands

*TB132 An Analytical Investigation of the Energy-Volume Relationship Observed in Concrete Targets Penetrated by Shaped Charge Jets*

Milton Frick Maritz, South Africa; Frikkie Mostert, South Africa; Cornelis Tereblanche, South Africa

*TB138 The Effect of Velocity on Jacketed Rod Efficiency*

Brad Pedersen, USA; Stephan Bless, USA; Robert Fromm, USA

**TB141 Preliminary Results From Firings of Glass Shaped Charge Jets into Steel Targets**

Michael Edwards, UK; Rhydian Harries, UK; Euan Henderson, UK

**TB146 An Accuracy and Efficiency Assessment of Beanbags**

Alexandre Papy, Belgium; Fatiha Id-Boufker, Belgium

**TB148 A Comparison of the Ballistic Performance between Rolled Plate in AZ31B-H24 Magnesium & 5083-H131 Aluminum**

Tyrone Jones, USA; Matthew Burkins, USA; Rick DeLorme, USA

**TB149 In Situ Penetration Testing of Darts with 15-Inch Mobile Gas Gun**

Douglas Dederman, USA; James Dykes, USA; John Foster, USA; Damon Burnett, USA

**TB190 How to Model Fracture Behaviour in Long Rod Projectile**

Ewa Lidén, Sweden

**TB192 Concept Analysis and Impact Performance of Kinetic Energy Penetrators against Composite Hard Targets**

A. K. Sharma, India

**TB197 Multiple Hit Performance of 7.62 mm Hardened Steel and 30 mm APFSDS Projectiles in Brick and Reinforced Concrete Walls**

Stephan Lampert, Switzerland; Hanspeter Kaufmann, Switzerland; Dieter Hoffmann, Germany

**TB201 Supersonic Penetration by Wedges and Cones into Dry Sand**

William Flis, USA; David Jann, USA; Lucia Shan, USA

**TB207 Constitutive Properties of Transparent Nylon during High Velocity Impact**

Nicholas Tsantinis, USA; John Song, USA; Jason Parker, USA; Phillip Cunniff, USA

**TB217 Penetration Performance of Geopenetrators in the High Velocity Regime**

Norbert Heider, Germany; Arno Klomfass, Germany; Makfred Salk, Germany

**TB229 Simple Explicit Analysis for the Effect of Ceramic Thickness on the Dwell/Penetration Transition**

Jerry LaSalvia, USA

## WEDNESDAY, SEPTEMBER 24, 2008

**7:00 am Continental Breakfast & Registration**

**8:00 am Administrative Remarks**

**8:00 am - 1:30 pm Exhibit Hall Open**

**8:10 am - 10:10 am Armour & Personal Protection**

**Chaired by Doug Templeton & Eric Fahrenthold**

**8:10 am APP032 Assessment and Measurement of Potential Blunt Trauma Under Ballistic Helmets**  
Celia Watson, UK; Annette Webb, Australia; Ian Horsfall, UK

**8:30 am APP171 Ballistic Performance Assessment of Lightweight Body Armour Material Systems Against IED Threat**  
Gilles Pageau, Canada; Kevin Williams, Canada; Daniel Bourget, Canada; Ming Cheng, Canada; Clint Hedge, Canada; Benoit Anctil, Canada

**8:50 am APP001 Experimental Validation of the Origin of the Bodywork Effect (K-Effect) in the Up-Armouring of Civil and Military Vehicles**  
Frederik Coghe, Belgium; Bernard Kestelyn, Belgium; Marc Pirlot, Belgium

**9:10 am APP075 Half Scale Experiments with Rig for Measuring Structural Deformation and Impulse Transfer from Land Mines**  
Björn Zakrisson, Sweden; Bo Johansson, Sweden; Bengt Wikman, Sweden

**9:30 am APP062 A Computational Study of the Energy Dissipation through an Acrylic Target Impacted by Various Size FSP**  
Costas Fountzoulas, USA; Peter Dehmer, USA; Jian Yu, USA; James Sands, USA

**9:50 am APP163 Simulation of Damage to a Vehicle by Explosion of an Improvised Explosive Device**  
Chris Quan, USA; John Pavon, USA

**8:10 am - 10:30 am** Warhead Mechanisms Poster Session

**10:10 am - 10:30 am** Coffee Break in Exhibit Hall

**10:30 am - 12:00 pm** Terminal Ballistics  
**Chaired by Klaus Thoma & Ake Persson**

**10:30 am** *TB035 High Speed Penetration into Low Strength Concrete Target*  
Vincent Luk, USA; James Dykes, USA; Joseph Bishop, USA; John Ludwigsen, USA; Douglas Dederman, USA; P. A. Taylor, USA

**10:50 am** *TB168 Fragment Penetration Modeling of Anthropometric Ballistic Mannequins*  
William Bruchey, USA; Amy Tank, USA

**11:10 am** *TB230 Effects of Small Caliber Ammunition Through Intermediate Barriers*  
Jeremy Lucid, USA; Chris Gandy, USA

**11:30 am** *TB222 Protecting the New Horizons Spacecraft's Radioisotope Thermoelectric Generator from Potential Fragment Impacts during Launch Self Destruct*  
James Walker, USA; Walt Gray, USA

**12:00 am - 1:30 pm** Lunch - Armstrong Ballroom; 8th Floor

**1:30 pm - 5:30 pm** Tour of the French Quarter (included in attendee registration)

*Conference attendees will be split into 4 groups, determined by bead theme and color given at registration. Groups will convene in the lobby of the Sheraton before taking off for Bourbon Street! Stay with your group to enjoy New Orleans' famous bars and restaurants!*

#### **WARHEAD MECHANISMS POSTER SESSION**

**8:10 am - 10:30 am**

**CHAIRMEN: EITAN HIRSCH, FRIKKIE MOSTERT,  
DAVE LAMBERT**

*WM003 Experimental, Numerical and Analytical Studies on Two Linear Demolition Shape Charges for Two Initiation Modes*

Shakeel Abbas Rofi, China; Huang Fenglei, China

*WM004 Experimental and Numerical Investigations on the Formation and Penetration of Jet Projectile Charges against Concrete Targets*

Shakeel Abbas Rofi, China; Huang Fenglei, China; Zhang Leilei, China

*WM010 Softening of Shaped Charge Jet Particles While Penetrating Air*

Joe Backofen, USA

*WM019 Lethality Enhancer Against TBMs with Demanding Submunition Payloads*

Werner Arnold, Germany; Ernst Rottenkolber, Germany

*WM022 Optimisation of Fragmentation Warheads*

Lawrence Davey, UK; John Curtis, UK; Andrew Bowden, UK

*WM029 Near Field Impulse Loading Measurement Techniques for Evaluating Explosive Blast Performance*

Thuvan Piehler, USA; Avi Birk, USA; Richard Benjamin, USA; Vincent Boyle, USA; Eugene Summers, USA; Stephen Aubert, USA

*WM040 Study on Virtual Prototyping Design Method for Conventional Warhead*

Yang Yunbin, China; Qian Lixin, China; Sun Chuanjie, China; Zhou Yan, China

*WM094 Influence of Peripheral Frame Parameters on Fragments Dispersion*

Alex Zlatkis, Israel; Natanel Korin, Israel; Ilan Azulay, Israel; David Touati, Israel; Evgeny Gofman, Israel

*WM101 Multi-Purpose Projectile Concept to Balance the Conflicting Requirements for Peace Support Operations*

Gawie De la Bat, South Africa; Jean Louis Du Plessis, South Africa; Donovan Wilson, South Africa; Dieter Peters, South Africa; Johan Mare, South Africa

*WM155 Development of the M982 Excalibur Unitary Warhead*

Richard Szczepanski, USA; Terry Young, USA

*WM156 Development of Fielding of the Guided Multi-Launch Rocket System (GMRLS) Unitary Warhead*

Renita Friese, USA; Richard Tuznik, USA; Tracey Westmoreland, USA

*WM164 Small EFP Charge for Armor Development*

David Davison, USA; Dan Pratt, USA; James Bustamante, USA

*WM185 The Effect of Corner Turning on Wave Shaper Performance*

Andreas Helte, Sweden; Jonas Lundgren, Sweden; Håkan Örnhed, Sweden

*WM189 SDSC – A Structure Destroying Shaped Charge*

Lippe Sadwin, Israel; Eitan Hirsch, Israel

*WM193 The Jetting Cavity Test – A Multi Parameter Material Properties Measurement Tool*

Sergi Chanukaev, Israel; Eitan Hirsch, Israel

*WM202 Warhead Venting Design Technology Development*

Timothy Madsen, USA; Ernest Baker, USA; Stanley DeFisher, USA; Nausheen Al-Shehab, USA; Daniel Suarez, USA; Brian Fuchs, USA

*WM204 PIMS: Particle Impact Mitigation Sleeves*

James Pham, USA; Arthur Daniels, USA; Ernest Baker, USA; Koon-Wing Ng, USA; David Pfau, USA

*WM212 Effects of Computational Zoning on Resolving Partitioning and Jet Formation from Small Caliber Nitromethane Shaped Charges*

Ronald Brown, USA; Hung Cao, USA; Richard Zamberlan, USA; Dave Gerace, USA; Pedro Freitas, USA; Jose O. Sinibaldi, USA; Andreas Holzwarth, Germany

*WM214 Frangible Munitions for Reduced Collateral Damage*

Michael Minnicino, USA; Ryan Emerson, USA

## THURSDAY, SEPTEMBER 25, 2008

**7:00 am Continental Breakfast & Registration**

**8:00 am Administrative Remarks**

**8:10 am - 9:50 am General Session**  
**Chaired by Zhongyuan Wang & Ed Schmidt**

**8:10 am** *EB139 Numerical Computations of Dynamic Pitch-Damping Derivatives using Time-Accurate CFD Techniques*  
Jubaraj Sahu, USA

**8:30 am** *GS195 Impact Effects of Light Shaped Charge Rockets with Ignition Failure on Thin Metal Armour Plates*  
Hanspeter Kaufmann, Switzerland; Stephan Lampert, Switzerland

**8:50 am** *GS137 Consideration of the Ignition Delay of Gun Propellants*  
Clive Woodley, UK; Michael Taylor, UK; Steve Fuller, UK; Steve Gilbert, UK; Joseph Gransden, UK

**9:10 am** *GS046 Electromagnetic Artillery*  
Jerome Tzeng, USA; Ed Schmidt, USA

**9:30 am** *GS232 U.S. Army Tactical Wheeled Vehicle Vulnerability Test & Evaluation Methodology*  
Stephanie Koch, USA

**9:30 am - 3:30 pm Exhibit Hall Open**

**9:50 am - 10:10 am Coffee Break in Exhibit Hall**

**9:50 am - 11:50 am Exterior Ballistics; Interior Ballistics; Launch Dynamics Poster Sessions**

**10:10 am - 12:00 pm Warhead Mechanisms**  
**Chaired by Chris Quan & Michael Murphy**

**10:10 am** *WM085 The Appendix*  
Eitan Hirsch, Israel; Meir Maysel, Israel

**10:30 am** *WM256 Behind Armour Effects at Shaped Charge Attacks*  
Manfred Held, Germany

**10:50 am** *WM211 Effect of Detonation Front Inversion on Directed Energy Output*  
Ronald Brown, USA; Dimitrios Fanaras, USA; David Amondson, USA; Ronald Williams, USA; James Stork, USA; John Gamble, USA; Jose O. Sinibaldi, USA

**11:10 am** *WM016 Warhead Filling and Casing Interactions Affect the Blast Field Performance*  
Paul Locking, UK; Dennis Flynn, UK; J. Dunnett, UK

**11:30 am** *WM234 Reaction of Metal Fragments from Cased Explosive Charges*  
Laura Donahue, Canada; Robert Ripley, Canada; Jeff Leadbetter, Canada; Yasuyuki Horie, USA; Fan Zhang, Canada

**12:00 pm - 1:30 pm Lunch - Armstrong Ballroom; 8th Floor**

**1:30 pm - 3:30 pm Armour & Personal Protection; Wound Ballistics & Vulnerability Poster Sessions**

**1:30 pm - 3:10 pm Interior Ballistics & Launch Dynamics**  
**Chaired by Don Carlucci & Ken Kuo**

**1:30 pm** *IB098 Numerical Simulation of Projectile Acceleration Process Using Solid/Gas Two-Phase Reacting Flow Model*  
Hiroaki Miura, Japan; Akiko Matsuo, Japan; Yuichi Nakamura, Japan

**1:50 pm** *IB015 Two-Dimensional Modelling of Modular Charge Gun Firings*  
Clive Woodley, UK; Steve Fuller, UK

**2:10 pm** *IB110 Numerical Simulation of Interior Ballistics Processes of a High Speed Counter-Mass Propelling Gun*  
Xiaobing Zhang, China; Weiping Zhou, China; Haiqing Li, China

**2:30 pm** *LD027 Launch Dynamics Environment of a Water Piercing Missile Launcher*  
Jon Yagla, USA; John Busic, USA; Samuel Koski, USA; Chris Weiland, USA

**2:50 pm** *LD065 Experiments with Gun Launched Penetrators into Gelatin Target Materials*  
John Stubberfield, UK; Nicholas Lynch, UK; Clive Woodley, UK; Alan Hepper, UK

**3:10 pm - 3:30 pm** Coffee Break in Exhibit Hall  
**3:30 pm - 8:30 pm** Exhibitor Move Out (Exhibit Hall CLOSED)

**3:30 pm - 5:10 pm** Wound Ballistics & Vulnerability  
**Chaired by Phil Cunniff & Joe Backofen**

**3:30 pm** *WB053 The Validation of a Thoracic and Abdominal Test Rig for BABT Soft Body Armour Testing*  
Kate Hewins, UK; Ian Horsfall, UK; Celia Watson, UK

**3:50 pm** *WB005 Using LS-Dyna to Estimate After-barrier-effectiveness of Small Arms Projectiles*  
Mark Minisi, USA

**4:10 pm** *WB240 An Overview of the Operational Requirement-based Casualty Assessment (ORCA) Model and its Military Applications*  
William Mermagen, USA; Patrick Gillich, USA

**4:30 pm** *WB242 Survivability Measures for Evaluation of Personnel in Military Systems*  
Natalie Eberius, USA; Patricia Frounfelker, USA; Kelly Benjamin, USA

**4:50 pm** *WBI44 Diagnostic Techniques for Multiphase Blast Fields*  
Richard Ames, USA; Michael Murphy, USA

**7:00 pm - 9:00 pm** Symposium Banquet - Armstrong Ballroom; 8th Floor (included in attendee registration)

Join us for an evening of New Orleans-inspired food, traditional jazz music, and dancing!

**INTERIOR BALLISTICS POSTER SESSION**

**LAUNCH DYNAMICS POSTER SESSION**

**EXTERIOR BALLISTICS POSTER SESSION**

**9:50 am - 11:50 am**

**CHAIRMAN: CHRIS VAN DRIEL**

*IB049 Effects of Condensed Phases in Primer Output on Charge Ignition in Small Ammunition*

Lang-Mann Chang, USA; Anthony Williams, USA

*IB051 A Study on the Erosion Characteristics of K9 Thunder 155mm 52Cal. SPH (Self Propelled Howitzer)*

Jae Kab Kim, Korea; Byung Doo Choi, Korea; Seong Ho Park, Korea; No Seok Park, Korea; Yeon-Sik Cho, Korea

*IB054 The Effect of a Balanced Breech 120 mm Tank Gun System on Gun Dynamics and Firing Accuracy*

Eugene Adamovski, Israel; Ilan Azulay, Israel; Yoav Gur, Israel; Davis Touati, Israel; Boris Manilov, Israel

*IB074 Ignition Behaviour of LOVA Propellant*

Chris Van Driel, The Netherlands

*IB078 Linking Ignition and Transient Loading on a Medium Caliber Projectile*

Richard Beyer, USA; Albert Horst, USA

*IB090 Medium Caliber Lead Free Electric Primer*

Robert Brewer, USA; Sarah Ford, USA; Kelvin Higa, USA

*IB098 Numerical Simulation of Projectile Acceleration Process Using Solid/Gas Two-Phase Reacting Flow Model*

Hiroaki Miura, Japan; Akiko Matsuo, Japan; Yuichi Nakamura, Japan

*IB131 Interior Ballistics Characterization of a 40-mm Cartridge*

Andrew Brant, USA; Joseph Colburn, USA; Anthony Williams, USA

*IB147 Combustion Model for TAGzT and TAGzT Mixtures*

Clint Conner, USA; William Anderson, USA

*IB151 Revised Model for RDX Combustion*

William Anderson, USA; Gabriel da Silva, USA; Clint Conner, USA; Rubik Asatryan, USA; Joseph Bozzelli, USA

*IB169 The Effects of Igniter Design on the Interior Ballistic Performance of Deterrent Coated Propellants*

Thelma Manning, USA; Kelly Moran, USA; Steven Ritchie, USA; Joseph Colburn, USA; Barrie Homan, USA; Carlton Adam, USA; Michael Ellis, USA; D. Park, USA; E. Rozumov, USA; S. M. Gilbert, USA; C.R. McMurray, USA

*IB196 Experimental and Numerical Study of Reduction of Pressure Wave in Large Caliber Gun Chamber*

Yuichi Nakamura, Japan; Hiroaki Miura, Japan; Akiko Matsuo, Japan

*IB219 Matching Internal Ballistics Code Fidelity to Gun System and Analysis Complexity*

Martin Pocock, UK; T. Melvin, UK; I. Robertson, UK; C. Woodley, UK; Chris Guyott, UK

*IB223 Collection and Modelling of 155mm Artillery Projectile In-Bore Ballistic Data*

George Yorke, USA; Don Carlucci, USA

*IB249 Study for the Bore Resistance Factors Due to Friction and Engraving in NATO STANAG 4367, Edition 3*

James Matts, USA; Ari Tuomainen, Finland

*LD013 A Case Study on Flight Failure of a Supersonic Spinning Rocket and Successful Problem Solving through Modal Analysis & Testing*

K M Rajan, India; Anil Datar, India; Surendra Kumar, India

*LD024 Balloting in a Frenet Frame*

Satoru Shoji, Japan

*LD081 3D Unsteady Intermediate Ballistics Modelling: Muzzle Brake and Sabot Separation*

Roxan Cayzac, France; T. Alziary de Roquefort, France; E. Cayette, France

*LD165 Occasion-to-Occasion Tank Gun Error Sources*

Mark Bundy, USA; Jim Garner, USA; Dave Webb, USA; Paul Durkin, USA

*EB039 Miss to Hit*

Petrus Karsten, South Africa; Chris Botha, South Africa

*EB059 Mathematical Modeling of Lift Sabot Separation Process*

Ravindra Shriram Acharya, India; Smita D. Naik, India

**EB076 Dual Mode Mortar Munition System**

Yanina Rubenchik, Israel; Haim Yahia, Israel; Boris Manilov, Israel; Aron Pila, Israel; David Touati, Israel; Albert Mamane, Israel; Yuval Levy, Israel

**EB082 Computational Fluid Dynamics Modeling of a Course Corrected Artillery Projectile at Transonic Speeds**

Jubaraj Sahu, USA; Karen Heavey, USA; Richard Buretta, USA

**EB086 NATO Shareable Software Developing into True Suite Supporting National Operational, Fire Control Systems**

André Sowa, USA

**EB087 NATO Testing in Turkey Shows Benefit of Meteorological Forecast Data to Indirect Fire Support**

André Sowa, USA; Birger Hansen, Denmark; Sevsay Aytar Ortaç, Turkey

**EB088 Liquid Payloads Impact on the Trajectory of Spinning Projectiles**

Gene Cooper, USA; Mark Costello, USA

**EB096 Aerodynamic and Ballistic Analysis of Rifled Mortar Munition**

Hyunsung Jung, Korea; Ui Chang Hwang, Korea; Joo-Sung Kim, Korea

**EB118 Research of Aerodynamic Structure and Correctional Ability for One-Dimensional Trajectory Correction Projectile**

Zhongyuan Wang, China; Xiaobing Zhang, China; Jinguang Shi, China; Wenjun Yi, China; Zhiming Qiu, China

**EB120 Algorithm Scheme for Tightly Integrated GPS/IINS Navigation System in Large Dynamic Occasions**

Lee Beig, China

**EB194 Fast Safety Checks for Numerical Trajectory Calculations**

Alexander Kuhrt, Germany; Hendrik Rothe, Germany

**EB255 On The Stagnation Point Reynolds Number of Supersonic Projectiles**

William Reinecke, USA

**ARMOR & PERSONAL PROTECTION POSTER SESSION**

**1:30 pm - 3:30 pm**

**CHAIRMEN: EWA LIDEN, ERICK SAGEBIEL & VELERIY KARTUZOV**

**APP007 On the XCT Diagnostics of Ballistic Impact Damage in a B<sub>4</sub>C Ceramic Body Armor Plate**

Joe Wells, USA; Nevin Rupert, USA

**APP012 Numerical Simulation of Mine Detonation Beneath a Generalized Add-On Armor Structure**

Sharon Peles, Israel; David Touati, Israel; Avi Neuberger, Israel; Ilan Azulay, Israel

**APP034 Nondestructive Damage Assessment of Alumina Structural Ceramics**

Raymond Brennan, USA; William Green, USA; James Sands, USA; Jian H. Yu, USA

**APP044 Advances in Ballistic Performance of Commercially Available Saint-Gobain Sapphire Transparent Armor Composites**

Christopher Jones, USA; Jeff Rioux, USA; John Locher, USA

**APP055 Armour Materials: A Preview into a Resource-Poor Future, Implications for the Development of Armour Materials**

Andre Diederer, The Netherlands

**APP062 A Computational Study of the Energy Dissipation through an Acrylic Target Impacted by Various Size FSP**

Costas Fountzoulas, USA; Peter Dehmer, USA; Jian Yu, USA; James Sands, USA

**APP066 Analysis of Terminal Metallic Armor Plate Free-Surface Bulging**

Edward Rapacki, USA

**APP099 Collateral Damage Caused by Reactive Armour Protection Against PG-7-Like Threats**

Martin van de Voorde, The Netherlands; Koen Bakker, The Netherlands; Frans van Wegen, The Netherlands

**APP105 Response of the Plate to the Buried Blast Mine Explosion**

Stanislav Rolc, Czech Republic; Jaroslav Buchar, Czech Republic; Josef Kratky, Czech Republic; Rolf Graeber, Czech Republic; Jaroslav Pechacek, Czech Republic; M.Havlicek, Czech Republic

**APP121 Effect of Ceramics, Fibre Reinforced Plastics and Aluminium Used as Confinement Plates for Explosive Reactive Armours**

Stefano Bianchi, Switzerland; Hanspeter Kaufmann, Switzerland; André Koch, Switzerland

**APP122 Ballistic Protection of Fragment Vests Against IED Threat**

Hans Broos, The Netherlands; M.J. van der Jagt-Deutekom, The Netherlands; M.J. van de Voorde, The Netherlands

**APP126 Experimental Tests and Numerical Calculations using ALE and SPH Approaches on Mine Blast Effects on Structure**

Geneviève Toussaint, Canada; Amal Bouamoul, Canada

**APP140 Investigation of a Methodology for Producing Variable Damage in Structural Armor Ceramics**

William Green, USA; Jian Yu, USA; Raymond Brennan, USA; James Sands, USA

**APP153 High-Speed Photographic Study of Wave Propagation and Impact Damage in Novel Glass Laminates**

James McCauley, USA; Elmar Strassburger, Germany; Parimal Patel, USA; Doug Templeton, USA; Arun Varshneya, USA

**APP160 Structure, Properties and Dynamic Response of Polypropylene Fibers and Textiles**

Michael Sennett, USA; Elizabeth Welsh, USA; Peter Stenhouse, USA; Phillip Cunniff, USA; Thomas Godfrey, USA; Deana Archambault, USA

**APP163 Simulation of Damage to a Vehicle by Explosion of an Improvised Explosive Device**

Chris Quan, USA; John Pavon, USA

**APP170 Hybrid Particle-Element Simulation of Body Armor Impact Physics**

Kwon Joong Son, USA; Eric Fahrenthold, USA

**APP172 A Possible Approach in Support of the Characterization of Body Armors**

Nevin Rupert, USA

**APP183 Ballistic Impact Performance of Clothing Items Under Impact by Munition Fragments**

Phillip Cunniff, USA

**APP184 Variability in Ballistic Impact Performance due to Projectile Physical Properties and Dimensions**

Phillip Cunniff, USA

**APP186 The Importance of Off-Normal Obliquity Impact Performance to the Casualty Reduction Potential of Ballistic Protective Helmets**

Phillip Cunniff, USA

**APP187 Assessment of the Ballistic Impact Performance of Variable Response Armor Systems**

Phillip Cunniff, USA

**APP188 The Effect of Preform Shape on Ballistic Impact Performance, Coverage and Seam Density in Combat Helmets**

Jason Parker, USA; Phillip Cunniff, USA

**APP198 Developing Simulation Capabilities to Link Textile Manufacturing to Ballistic Performance**

Bryan Cheeseman, USA; Chian Yen, USA; Brian Scott, USA; Bruce LaMattina, USA; Yuyang Miao, USA; Youqi Wang, USA

**APP199 Ballistic Testing of SSAB Ultra-High Hardness Steel for Armor Applications**

Matthew Burkins, USA; William Gooch, USA; Dwight Showalter, USA; Rosmari Stockman Koch, Sweden

**APP209 Ballistic Properties of Hybrid Systems for Transparent Armor Applications**

John Song, USA; Nicholas Tsantinis, USA; Roy Paulson, USA

**APP220 Characterizing Collateral Damage to Dismounted Troops and Other Personnel located near Active Counter Measures**

Patricia Frounfelker, USA; Kathleen Doonan, USA

**APP236 Ballistic Evaluation of Aluminum 2139-T8**

Bryan Cheeseman, USA; Matthew Burkins, USA; William Gooch, USA

**APP244 Impact of Soldier Helmet Configuration on Survivability**

Natalie Eberius, USA; Patrick Gillich, USA

**WOUND BALLISTICS & VULNERABILITY POSTER SESSION**

**1:30 pm - 3:30 pm**

**CHAIRMEN: BO JANZON & JOE WELLS**

**V041 V/L TARVAC BBN Based Understanding of Combat Damage and Operational Readiness Consequences to Assess Proportional Fire Power (Lethality)**

Theo Verhagen, The Netherlands; M.F.G. van der Wurff, The Netherlands; Th.P.J. Van Rijn, The Netherlands; L.J. van Peteghem, The Netherlands

**V042 (In)Sensitive Ammunition Impact on V/L TARVAC Modelling**

Theo Verhagen, The Netherlands; R.H.B. Bouma, The Netherlands; R. Boeschoten, The Netherlands

**V043 Munition – MOUT Effects Modelling: Embedding Experimental Research in V/L TARVAC Assessment**

Theo Verhagen, The Netherlands; M.J. van de Voorde, The Netherlands; E. van Meerten, The Netherlands; Th.P.J. van Rijn, The Netherlands

**V123 Comparison of Methods to Measure the Blast Impulse Loading of an Explosive Charge**

Pieter Smith, South Africa; Frikkie Mostert, South Africa; Izak Snyman, South Africa

**V124 Terminal Ballistics of HE Ammunition for Counter-RAM Systems**

Markus Graswald, Germany; Hendrik Rothe, Germany

**V142 Perspectives on the Requirements, Development, and Outputs of an X-Ray Computed Tomography Image Processing Application for Ballistic Impact Analysis in Armor Samples**

Jeffrey Wheeler, USA; Nevin Rupert, USA; Joe Wells, USA

**V173 Damage Assessment Method of Complex Shape Surface Target Based on Image Manipulation**

Lu Yonggang, China

**V245 Lethality of Bursting Munitions and Their Effect on Survivability**

Natalie Eberius, USA; Kathleen Doonan, USA

**V254 The Measurements of Overpressure of Thermobaric Grenade and Analysis of its Power**

Chen Hao, China; Tao Gang, China

**WB005 Using LS-Dyna to Estimate After-barrier-effectiveness of Small Arms Projectiles**

Mark Minisi, USA

**WB006 Simulating Ordinance Gelatin Impacts Using LSDyna; Correlations and Challenges**

Mark Minisi, USA

**WB069 Computational and Experimental Study of Paintball Impact Ocular Trauma**

Walt Gray, USA; James Walker, USA; William Sponsel, USA; Carl Weiss, USA

**WB071 Theoretical Study of the Motion of a Rigid Gyro-Stabilized Projectile into Homogeneous Dense Medium**

Nestor Nsiampa, UK; Gunther Dyckmans, UK

**WB114 Ensemble Effect for the Penetration by Non-Metallic Particles**

Matthias Wickert, Germany

**WB116 How to Quantify the Effects of Non-lethal Kinetic Weapons**

Philippe Drapela, Switzerland; Stephan Lampert, Switzerland; R. Lorenzo, Switzerland

**WB218 U.S. Army Research Laboratory Support to the Small Arms Capabilities Based Assessment**

Gregory Dietrich, USA; James Newill, USA; William McLaughlin, USA

**WB241 A New Small Caliber Evaluation Methodology Using Operational Requirement-based Casualty Assessment (ORCA)**

Patrick Gillich, USA; Timothy Myers, USA

## FRIDAY, SEPTEMBER 26, 2008

**7:00 am** Continental Breakfast & Registration

**8:00 am** Administrative Remarks

**8:10 am - 9:30 am** General Session

***Chaired by Francisco Galvez & Dennis Baum***

**8:10 am** *TB020 Deformation and Breakup of Tungsten Alloy Cubes, Cylinders and Spheres on Aluminum Plates*  
Karl Weber, Germany

**8:30 am** *GS023 Predicting Hazard Response Scenarios in Weapon Systems*  
Ian Cullis, UK; I.H. Brown, UK; P.D. Church, UK; P. Gould, UK; V.E. Ingamells, UK

**8:50 am** *GS130 Experimental Validation of a Kevlar Fabric Model for Ballistic Impact*  
Chian Yen, USA; Tusit Weerasooriya, USA; Paul Moy, USA; Brian Scott, USA; Bryan Cheeseman, USA

**9:10 am** *GS205 Shaped Charge Penetration of Gas Saturated Sandstone*  
Brenden Grove, USA; Jeremy Harvey, USA

**9:30 am - 9:50 am** Coffee Break

**9:50 am - 12:00pm** Terminal Ballistics

***Chaired by James Cazamias & Patrik Lundberg***

**9:50 am** *TB025 Penetration Resistance of Glass and a Glass Ceramic*  
Stephan Bless, USA; Don Berry, USA

**10:10 am** *TB111 Long-Rod Penetration into Intact and Pre-Damaged SiC Ceramic*  
Charles Anderson, USA; Thilo Behner, Germany; Dennis Orphal, USA; Arthur Nicholls, USA; Timothy Holmquist, USA; Matthias Wickert, Germany

**10:30 am** *TB058 The Shock Response Of a Cemented Tungsten Carbide*  
Koen Herlaar, The Netherlands; Andre Diederer, The Netherlands; Gareth Appleby-Thomas, UK; Paul J Hazell, UK

**10:50 am** *TB038 GRC's Impact Behavior*  
Alejandro Enfedaque Diaz, Spain; David Cendón Franco, Spain; Francisco Gálvez Díaz-Rubio, Spain; Vicente Sánchez Gálvez, Spain

**11:10 am** *TB237 Experimental Determination of Strain in Fabrics under Ballistic Impact*  
Sidney Chocron, USA; K. Samant, USA; Arthur Nicholls, USA; Carl Weiss, USA; James Walker, USA; Charles Anderson, USA

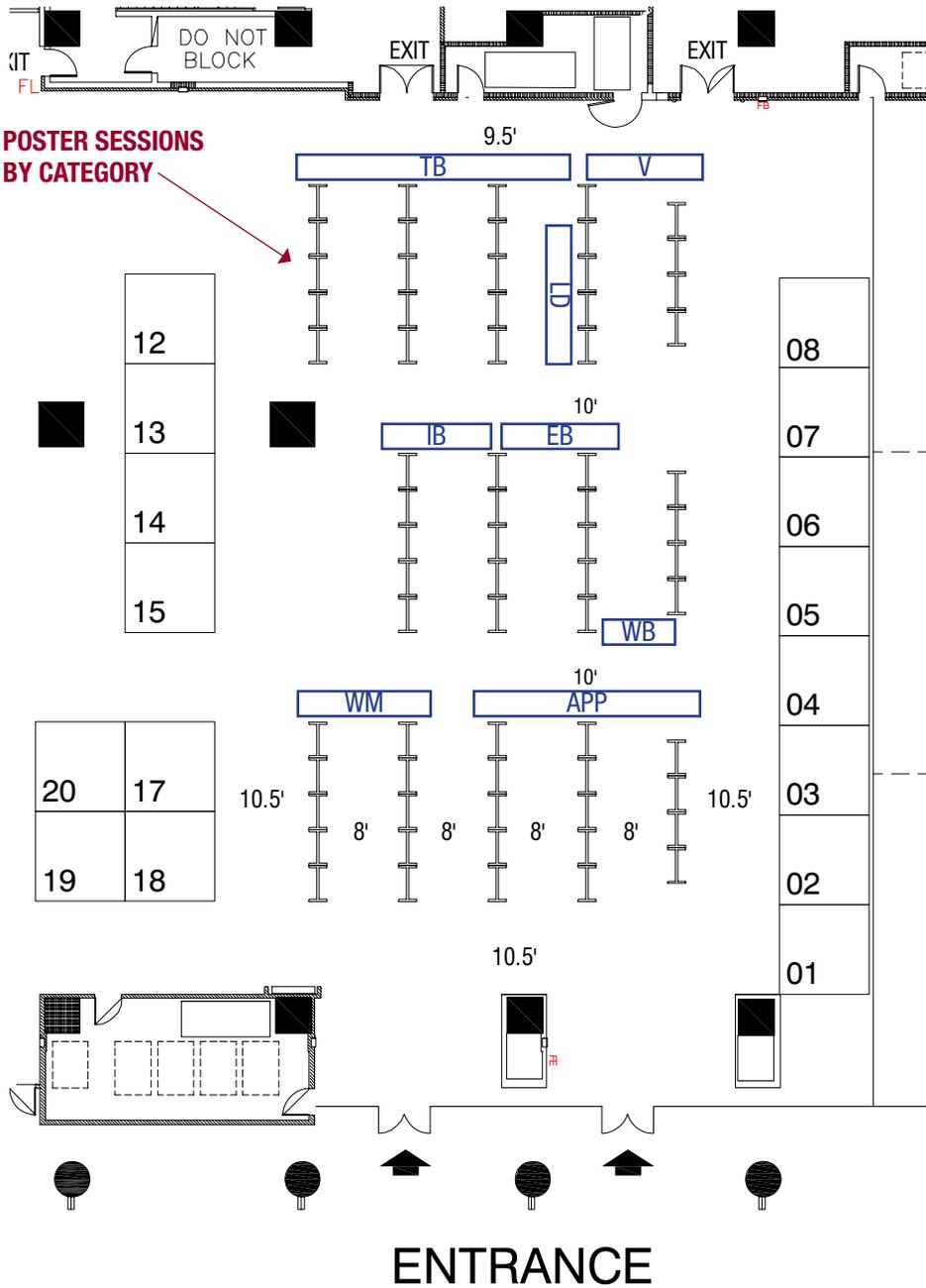
**11:30 am** *TB248 The Mechanics of Projectile Arrest for Compliant Cross Plyed Unidirectional Laminates*  
Brian Scott, USA; Bryan Cheeseman, USA

**12:00 pm - 12:30 pm** Presentation of Awards

**12:30 pm - 12:45 pm** Future Symposia Announcements

- ▶ 25th International Symposium on Ballistics - China
- ▶ 26th International Symposium on Ballistics - USA

**12:45 pm** Symposium Adjourns



**POSTER SESSIONS BY CATEGORY**

ANSYS, INC.....	4
ARROW TECH ASSOCIATES.....	14
DRS DATA & IMAGING SYSTEMS.....	6
FRAZER-NASH CONSULTANCY.....	5
KISTLER INSTRUMENTS.....	3
MS INSTRUMENTS PLC.....	7
25 <sup>TH</sup> IBC - BEIJING.....	8
NATIONAL TECHNICAL SYSTEMS CORP.....	15
NEW LENOX MACHINE CO. INC.....	13
PHOTO-SONICS, INC.....	1
SAINT-GOBAIN CERAMICS & PLASTICS, INC.....	12
UTRON, INC.....	2
WEIBEL.....	17

## PROMOTIONAL PARTNERS

### Arrow Tech

Formed in 1987 Arrow Tech Associates Inc. has been providing world-class support in ammunition design and analysis including structural analysis, dynamic analysis, weapons system simulation.

Throughout history there has been a need for rapid, accurate analysis of ammunition performance. With strong skills in both engineering analysis and software development, we have been able to answer this need for our customers. Arrow Tech has been a crucial and integral team member on many weapon system design teams in both civilian and government industry ranging from Olympic Archery to Artillery Systems and everything in between.

In 1992 Arrow Tech decided to make available our internal engineering software tools that we used to accomplish our design and analysis tasks and thus the first commercially available comprehensive ammunition design package came into being. PRODAS, (Projectile Rocket Ordnance Design and Analysis Software) is now one of the most widely used and advanced ammunition design toolkits available, with over 500 users worldwide and continual development and improvements.

Analysis modules help the user estimate mass properties, predict aerodynamics and stability, fly trajectories including guided projectiles and simulate interior ballistics, in bore balloting, or rocket motors. The latest release of PRODAS captures over 45 years of experience within the industry.

Arrow Tech is proud to be a co-sponsor of this year's International Ballistics Symposium with the NDIA in New Orleans. Please feel free to stop by our booth (#14) as we look forward to talking to our current and future customers.

### Foster-Miller, Inc.

LAST® Armor, the largest approved supplier of armor for fixed-wing aircraft in the United States, supports C-130s, C-17s and C-5s with add-on armor. LAST® Armor also makes a unique add-on armor appliqué system for armored vehicles and rotary-wing aircraft that installs without any cutting, welding or drilling on the base vehicle. LAST® tactical vehicle armor kits can be sent forward to deployed vehicles and the simple installation can be performed by the vehicle crew itself. It is most often affixed using a patented, high-strength Velcro® hook-and-loop fastening system.

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### Weibel

Weibel Scientific A/S is a designer and manufacturer of scientific measurement equipment for testing and experimental applications. Its customers include armies, navies, and air forces; test ranges; research and development establishments; ordnance industries; and security forces. Weibel's products include Doppler radar-based equipment ranging from small compact Doppler radar systems to high-performance, on-line, 3-D Doppler radar tracking systems for long-range (>1,000 km) flight analysis. Weibel Doppler radar systems are based on the most up-to-date radar, computer, and software technologies, and incorporate such unique features as self-calibration and multi-object tracking. Weibel Scientific manufactures all mechanical parts, electronics and software in house in its company owned facility just outside of Copenhagen, Denmark.



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**ARROW TECH**

