THE REAL-WORLD SAVE

TWO SHOTS TO THE HELMET, ONE INCH APART

The field case study on ballistic performance, backface deformation, and material trade-offs in helmet design.

Whitepaper by

EXECUTIVE SUMMARY

In August 2025, a Special Agent assigned to a DEA Special Response Team was struck twice in the head during an operation from a distance of five feet (approximately 1.5 m). Both 9 mm rounds hit his Busch PROtective AMP-1 TP helmet less than one inch (2.5 cm) apart. Neither round penetrated the helmet. The agent remained operational, completed the mission, and was medically cleared for duty immediately afterward.

The helmet's performance comes down to a straightforward engineering principle: minimize inward shell deformation on impact. Rather than relying primarily on substantial flexing to manage impact energy, the helmet resists deformation and distributes the load in a controlled manner.

Its rigid aramid composite, curved shell geometry, and tuned interior padding worked together to manage both the projectile energy and the force transmitted toward the skull. At the same time, the shell remained structurally intact enough to stop a second round striking only 2.5 cm away.

This paper explains the physics behind that outcome — and why agencies need to evaluate helmets on more than a simple pass/fail result under common test protocols.

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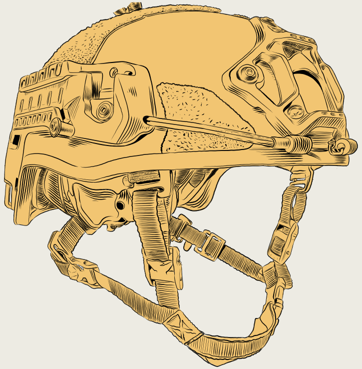

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№1

THE STORY IN DETAIL

On August 29, 2025, an unexpected message arrived in our general inbox.
The subject line was unremarkable. The message was not:

»I was on an operation with the DEA yesterday and took a hit while wearing one of your helmets. Your helmet saved my life – I just wanted to say thank you and send you a photo of my helmet.«

DEA SRT Special Agent M. W.

AMP-1TP ballistic helmet

We had heard about life-saving incidents before—

typically brief reports passed along through training partners or procurement contacts. But never before had an operator contacted us personally, directly, and so soon after the event

Our U.S. team immediately contacted the responsible DEA field office to learn what had happened.

Many details remain confidential because of the ongoing investigation. What was confirmed, however, is that a Special Agent assigned to a Drug Enforcement Administration (DEA) Special Response Team (SRT) in the Southwestern United States was struck twice in the head at close range while serving an arrest warrant. The suspect opened fire with a 9 mm handgun from approximately five feet (1.5 m) away.

Both rounds struck the agent's Busch PROtective AMP-1 TP helmet less than one inch (2.5 cm) apart. Both were completely stopped by the shell.

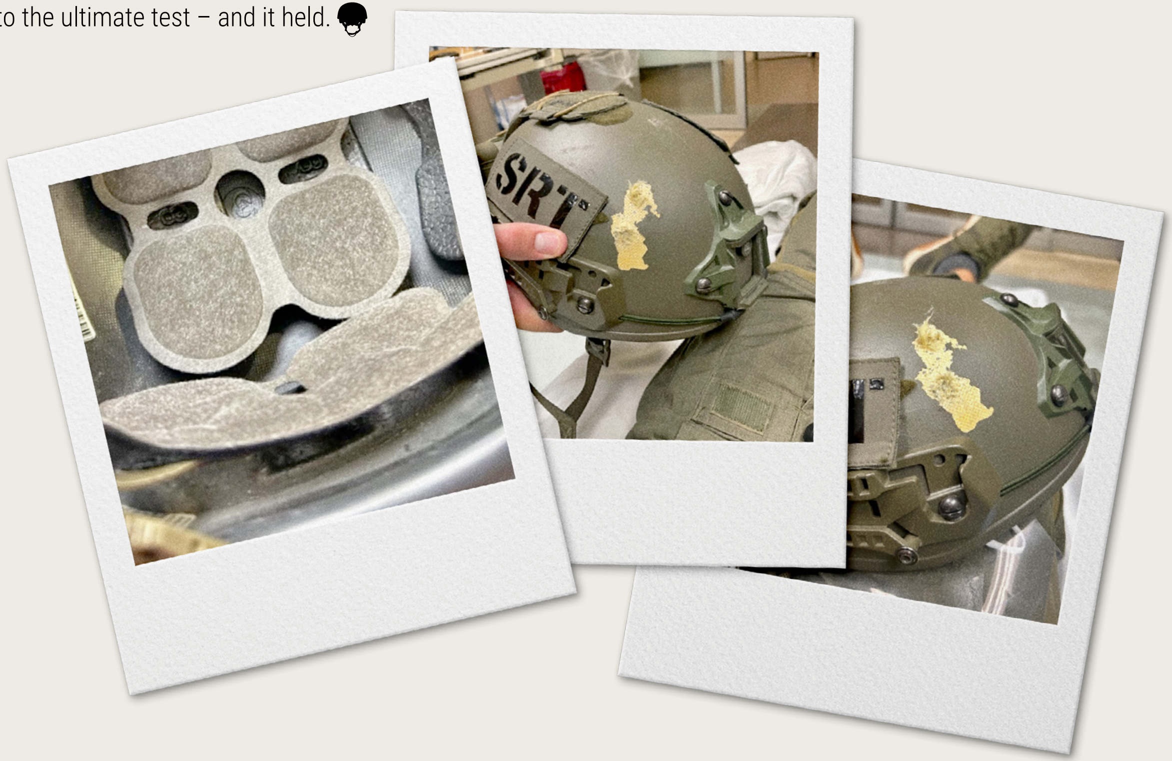
There was no penetration, no perforation—and, most importantly, no injury. Despite two direct hits to the head in a confined, high-stress environment, the agent remained functional, continued to assess the situation, and was able to act effectively. The team completed the operation without injuries, and multiple suspects were taken into custody.

In accordance with standard protocol, the agent was taken to a hospital for evaluation. He was immediately cleared for duty:
100% operational, with no further examination required.

His message to us made clear what that meant: he walked away from the scene because the helmet did exactly what it was designed to do.

The photographs he sent us...

... a helmet bearing two unmistakable impact marks – were a powerful reminder that behind every piece of protective equipment is a person trusting it with his or her life. On that day in August, that trust was put to the ultimate test – and it held.



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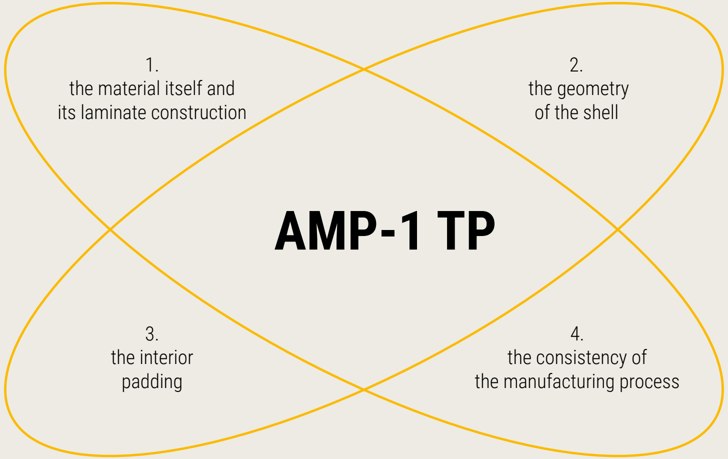
WHY
THE HELMET PERFORMED SO WELL

The agent’s survival was not the result of one clever feature.
It was the result of several design decisions working together as a system under ballistic loading:

good to know



REMOVE ANY ONE OF THOSE FACTORS, AND THE OUTCOME MIGHT HAVE BEEN DIFFERENT.

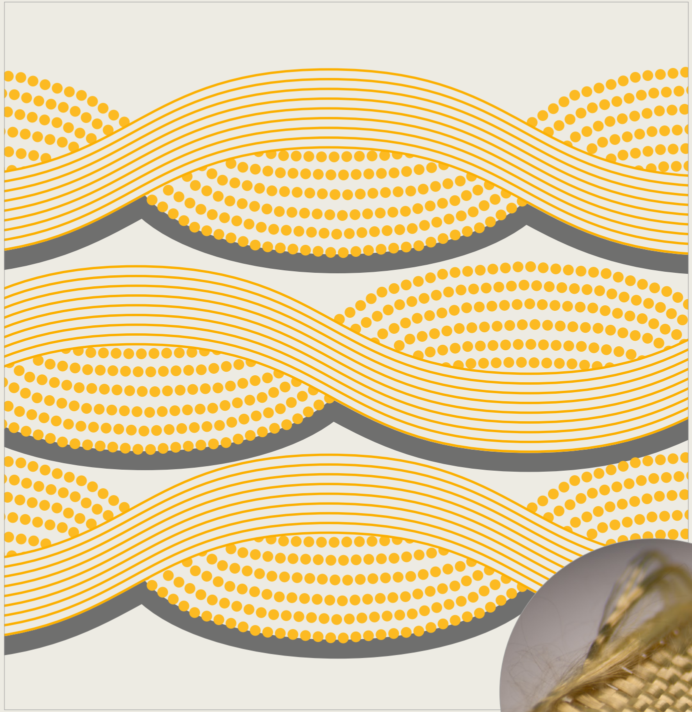
1. The composite:
How the material manages projectile energy

The AMP-1 TP shell is made from multiple layers of aramid fiber bonded with a rigid resin system. Put simply, heat and pressure turn many individual fiber layers into one dense, solid shell. The resin penetrates the fiber layers and bonds them so that, under load, they behave as a unified structural component. This consolidation gives the shell its strength and structural integrity.

commit to memory

WHEN A PROJECTILE STRIKES THE SHELL, ...

Fig. 1: Schematic illustration of aramid fibers



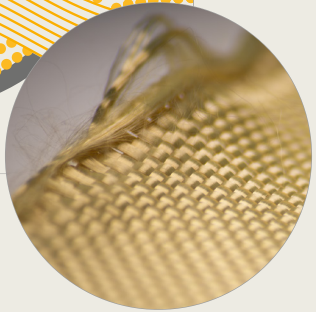


Fig. 2: Photo of the aramid material

… IT'S ENERGY IS MANAGED THROUGH SEVERAL ME-CHANISMS THAT OCCUR ALMOST SIMULTANEOUSLY, WITHIN MILLISECONDS:

A. The fibers stretch and break. Fibers directly in the projectile path carry the greatest portion of the impact load, while surrounding fibers stretch, shift, and shear against one another. **This is where a large share of the projectile's energy is consumed.**

B. The resin cracks and the layers try to separate. The resin between the fiber layers fractures under load, absorbing energy. The layers may also separate slightly; this is known as delamination. A certain amount is intentional: as the layers move somewhat independently, more fibers become involved and the load is distributed. Excessive delamination, however, weakens the surrounding structure.

The AMP-1 TP uses a deliberately rigid resin system to keep that separation controlled – a design choice that supports protection when a second round impacts nearby.

C. The shell flexes briefly as a whole. Beyond the immediate impact point, the shell responds as a structure and distributes the load across a larger area. In the AMP-1 TP, the rigid construction keeps this movement small and controlled rather than allowing the shell to bulge substantially inward. As a result, less of the sudden impact load reaches the wearer's head.

D. Friction generates some heat. As fibers slide against one another and along the projectile, friction consumes a small additional amount of energy.

schematic illustration follows

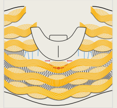
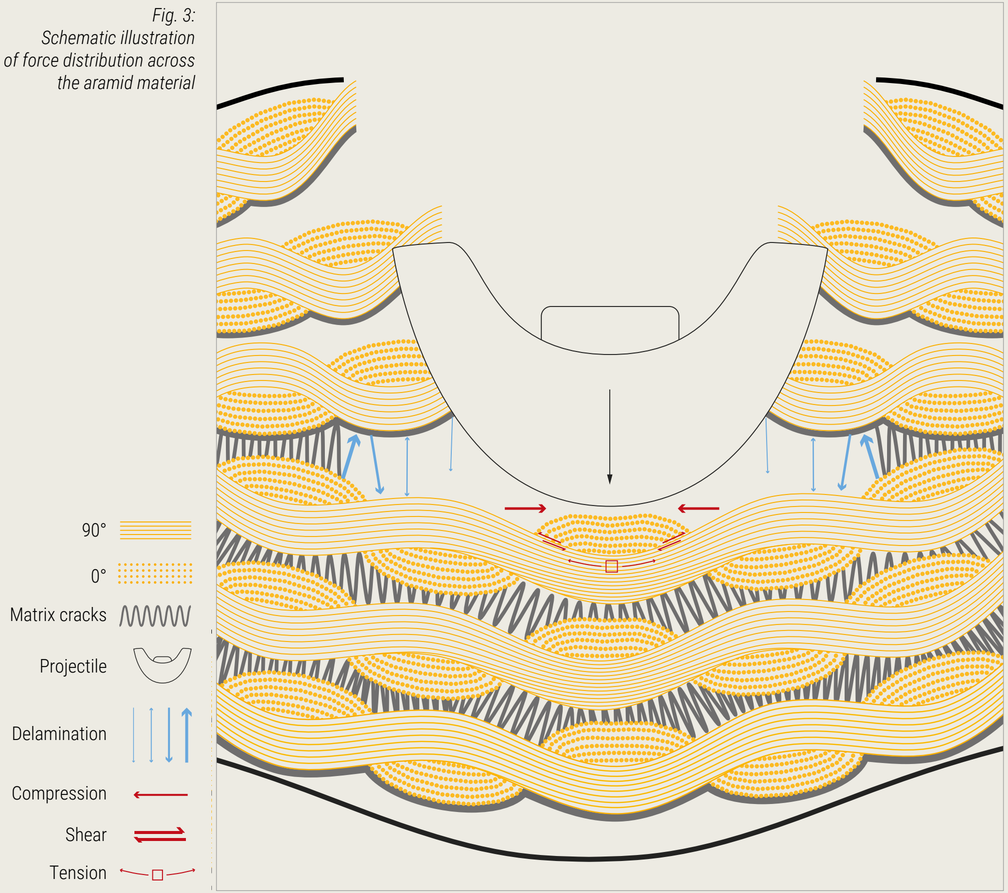


Fig. 3:
Schematic illustration of force distribution across the aramid material



None of these mechanisms occurs in isolation.

The fibers, resin, and shell influence one another: the degree to which fibers stretch and layers separate helps determine how far the shell can move inward. The AMP-1 TP laminate is designed to keep these processes within a rigid, controlled structure. **Put simply, the load should spread through the shell without allowing the shell to deform substantially toward the head.** That principle contributes both to low deformation and to the ability to withstand a second, closely spaced impact.

2. Shell geometry: Letting shape do part of the work

The helmet's curved geometry also contributes to ballistic performance. First, it makes a perfectly perpendicular impact statistically less likely – the least favorable angle for resisting penetration. Second, the curvature distributes part of the load through tensile and compressive stresses across the shell rather than concentrating it at a single point. In this way, the geometry supports the work of the composite material.

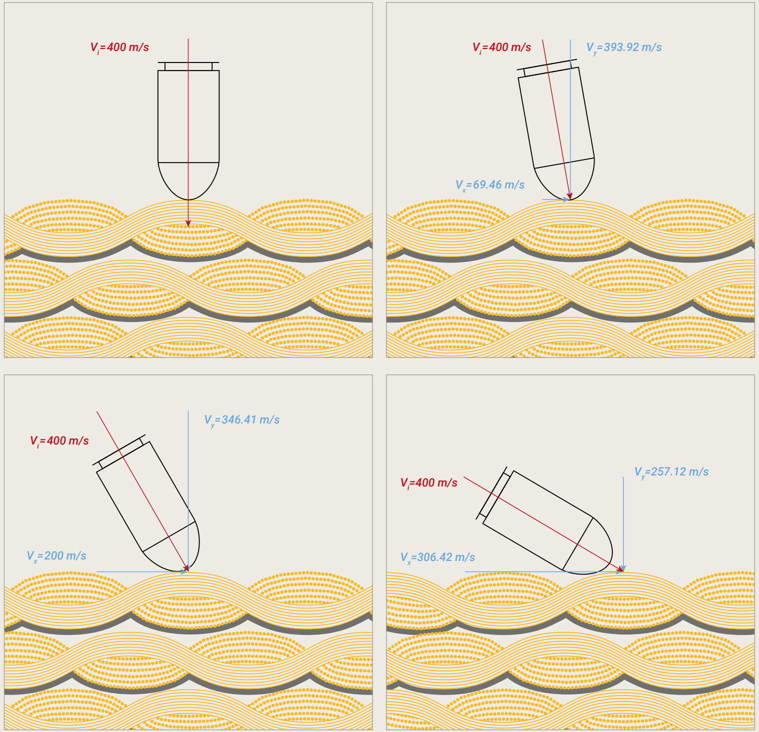


Fig. 4: Original illustration adapted from: Titire, L. & Muntenița, C. (2025). Fig. 2: Components of velocity. In: Ballistic Impact Study of an Aramid Fabric by Changing the Projectile Trajectory. Published January 14, 2025.

3. Padding: Managing what still reaches the head

Even when the shell completely stops a projectile, the impact area can move briefly inward toward the head. **This displacement is known as backface deformation (BFD). It matters because a non-penetrating impact can still cause injury if the shell strikes the head like a hard, fast-moving blow. In other words, "projectile stopped" does not automatically mean "head protected."**

sooo important

!!!

The interior padding has two jobs: fit and comfort day to day, and – under impact – cushioning that inward movement so less force and less sudden deceleration reach the head. The padding is tuned for it: how quickly it compresses, how far it can compress, and what happens when it bottoms out, all matched to the amount of deformation the shell is expected to produce. Because the AMP-1 TP's stiff shell already keeps BFD low to begin with, the padding isn't working overtime compensating for a shell that flexes too much – it is managing a smaller, more predictable problem.

B F D

4. Manufacturing consistency: Why "the same helmet, every time" matters

Composite performance depends heavily on manufacturing consistency. Fiber alignment, resin content, microscopic air pockets (voids), and the curing process all influence how the material behaves under impact. The AMP-1 TP is manufactured under tightly controlled process parameters to deliberately minimize variation between production lots – so that the ballistic behavior described above is repeatable, helmet after helmet.

Bottom line: No single one of these factors stopped both rounds. Their combined effect allowed the helmet to stop two 9 mm rounds fired at close range and striking only one inch (2.5 cm) apart, while keeping the load transmitted to the agent's head within survivable limits and allowing him to remain operational through the completion of the mission.

№3

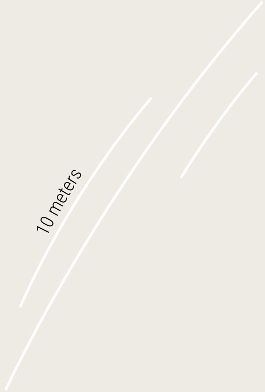
BALLISTICS EXPLAINED:
A CLOSER LOOK

This section goes one level deeper into the physics. At its core, however, there are only two questions:
What reaches the head after the projectile has been stopped?
And how much protection remains after the first impact for a second one?

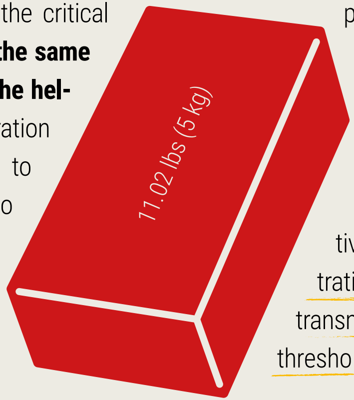
For readers who only want the key takeaway:
A good ballistic helmet must do more than prevent penetration. It must also limit shell movement toward the head and keep the loss of protection after an impact as localized as possible.

How much energy are we actually talking about?

A typical 9 mm full-metal-jacket round (124 grain / 8 grams) fired from a duty handgun travels at approximately 1,115–1,214 ft/s (340–370 m/s) and carries roughly 460–550 joules of kinetic energy. As an everyday comparison, that is approximately the kinetic energy of a 11.02 lbs (5 kg) brick falling from three stories — about 32.81 feet (10 meters). The critical difference is that the projectile transfers that energy in a fraction of a second over an area smaller than a coin. At the five-foot distance involved in this incident, the projectile loses virtually no velocity in flight. The helmet therefore had to manage nearly the full muzzle energy — twice, with only one inch (2.5 cm) between impacts.



Stopping a projectile means managing and redirecting its energy and momentum. But the critical point is this: **stopping a projectile is not the same as protecting the person wearing the helmet.** A helmet can prevent penetration and still deliver a dangerous blow to the skull if the shell moves inward too far and too locally. The design objective is therefore twofold: prevent penetration while also keeping the load transmitted to the head below the injury threshold.



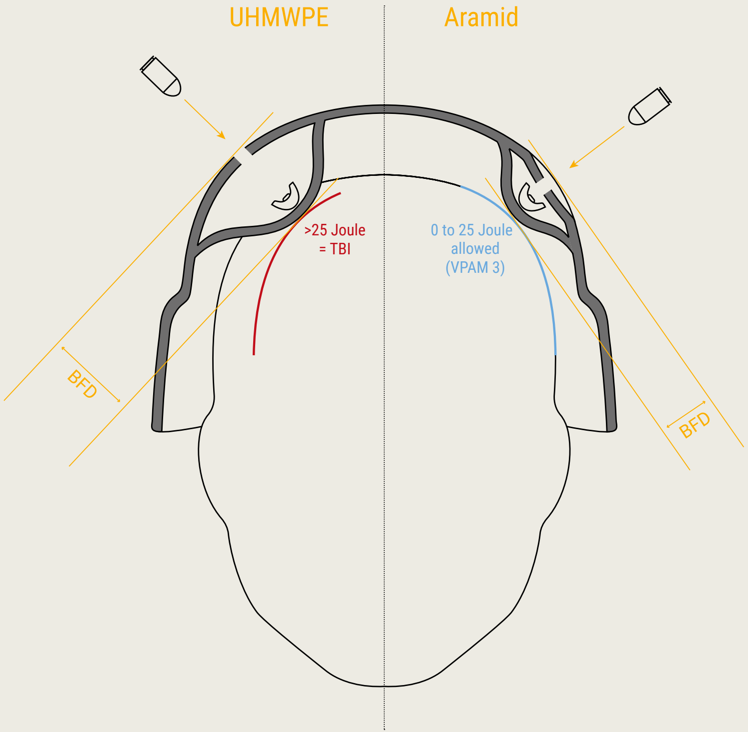


Fig. 5: Schematic illustration of backface deformation

Fig. 6: Ballistic test head showing visible trauma resulting from deformation of the helmet's inner surface

Where does the energy actually go?

The composite manages energy through the mechanisms described above, acting together: fiber stretching and breakage, resin cracking, slight layer separation, shell flexing, and friction.

Some of these mechanisms consume energy directly: fiber breakage, resin cracking, and friction convert kinetic energy into material damage and heat. **Other mechanisms primarily redistribute the load:** layer separation and shell flexing bring additional material — and therefore additional fibers — into the response.

The key is the balance between energy absorption and deformation. More movement can involve more material in the response, but it can also increase displacement toward the head.

A more flexible composite typically permits more movement and can therefore involve more fibers in distributing the load — at the cost of greater backface deformation. A more rigid composite, such as the construction used in the AMP-1 TP, emphasizes the opposite: less deformation and a more localized damage zone. For a helmet designed against handgun threats, this engineering tradeoff favors control and predictability over theoretically maximizing energy absorption. The incident described here shows why that tradeoff can matter.

Backface deformation:
The metric that actually drives injury risk

very important!

Backface deformation (BFD) describes how far the inside surface of the helmet shell moves toward the head during impact. Even when the projectile is stopped, that movement can cause injuries such as skull fractures, localized brain contusions, or traumatic brain injury. The severity depends on the magnitude, speed, and spatial concentration of the displacement.

How far the shell moves inward depends on its stiffness. A very rigid shell deflects only slightly; energy is consumed through damage within the material itself — broken fibers and cracked resin — rather than through substantial physical movement of the shell toward the head. A shell that is too flexible — whether because of a compliant resin, extensive delamination, or simply insufficient material — can produce dangerous BFD values even if it technically stops the projectile, because it moves too far inward before the projectile is fully arrested.

The AMP-1 TP is deliberately designed as a low-deformation system: aramid fibers in a rigid resin matrix that resists both shell flexing and excessive layer separation. In this incident, that produced the outcome that mattered — no signs of head trauma and immediate medical clearance of the agent.

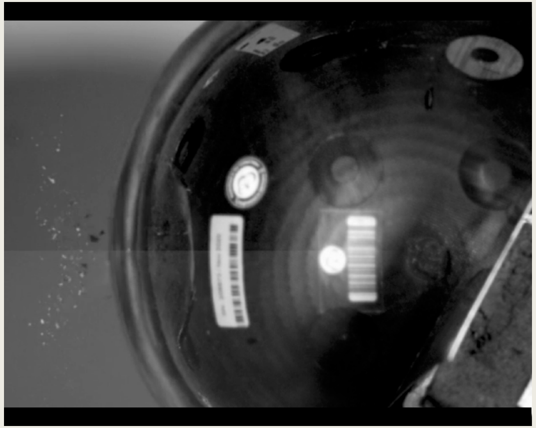


Fig. 7: Screenshots from high-speed camera footage. Shown is the Busch PROtective ***aramid helmet*** *after impact from a 9mm round.*

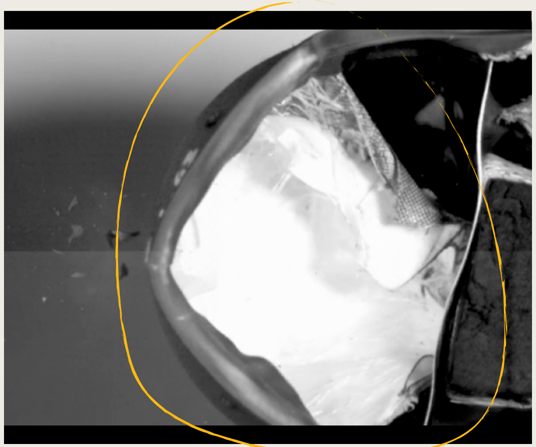


Fig. 8: Screenshots from high-speed camera footage. Shown is a ***UHMWPE helmet*** *after impact from a 9mm round.*

Multi-hit performance:
Why the second round is the real test

Within the industry, closely spaced multi-hit scenarios are sometimes dismissed as more of a laboratory construct than something likely to occur in the field — the argument being that real-world impacts would be farther apart, or that the wearer would already be down after the first hit, making close-spacing performance largely irrelevant outside the lab. This incident is a real-world counterexample. Two rounds struck only one inch (2.5 cm) apart, at close range, during an actual operation.

This is where the one inch (2.5 cm)spacing becomes especially important. Two impacts this close together are a harder test than either impact alone: the first round is stopped, but in the process, it damages fibers, resin, and potentially the bond between layers. The second round therefore does not encounter an undamaged shell; it strikes a structure that already contains localized damage.

This is where the low-deformation design pays off a second time, and the logic follows directly from the previous section: a shell that flexes less during the first impact sustains less collateral damage. Less shell movement means less fiber loading around the edge of the impact zone, less cracking, and less delamination spreading inward. The practical result is that the damaged area around the first impact remains small and contained, leaving enough intact material nearby to stop a second, closely spaced round.

BFD control and multi-hit performance are therefore not two separate strengths of the AMP-1 TP. They are two outcomes of the same design decision: keeping shell damage localized and structurally controlled.

THIS IS WHERE THE LOW-DEFORMATION DESIGN PAYS OFF A SECOND TIME.

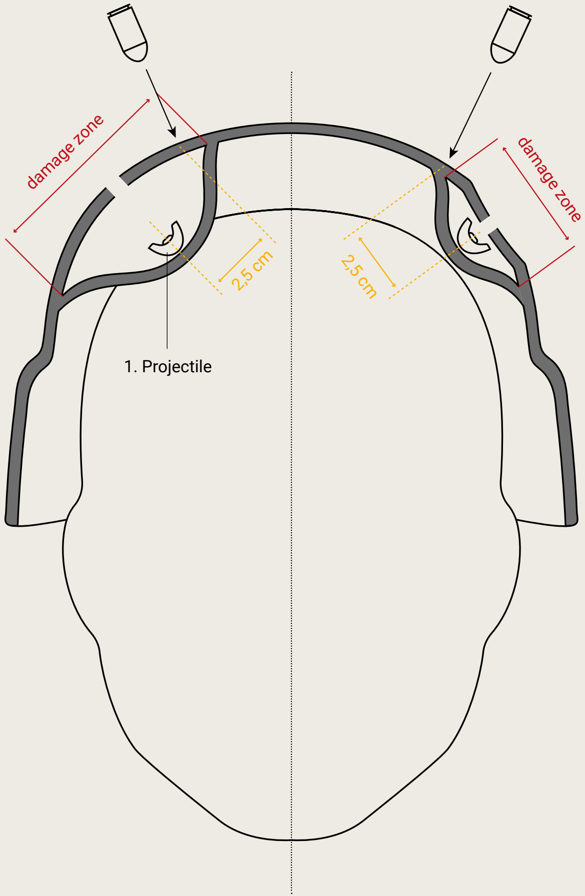


Fig. 9:
Damage zone:
Schematic
Illustration

№4

ARAMID vs. UHMWPE
WHY MATERIAL SELECTION IS NOT ONE-SIZE-FITS-ALL

Aramid and UHMWPE

(ultra-high-molecular-weight polyethylene) are both proven ballistic materials; neither is inherently superior to the other. One point is therefore important for the comparison that follows: fiber type alone does not determine performance. Fiber quality, resin system, consolidation, laminate architecture, and loading conditions matter as well. The question here is not "Aramid or UHMWPE — which is better?" but a narrower one: **Why was this particular aramid construction well suited to a low-deformation law-enforcement helmet facing closely spaced multiple impacts?**

1. Heat resistance

UHMWPE fibers begin to soften and melt at approximately 275–302 °F (135–150 °C) — well below aramid, which can withstand temperatures approaching 932 °F (500 °C) before decomposing. Under normal storage and use, this rarely matters. It becomes relevant under sustained heat exposure — for example, a helmet left for extended periods in a hot vehicle or direct desert sun — and during manufacturing, where UHMWPE composites require lower processing temperatures, limiting the range of resin systems available to designers.

2. How much the shell deforms on impact

Many UHMWPE helmet laminates — particularly highly consolidated unidirectional constructions — can flex more under ballistic loading than a comparably constructed rigid aramid shell. Put simply, that can involve more fibers in absorbing and distributing the load, while also producing greater displacement on the back face. The magnitude of that effect depends on the specific construction.

That does not mean UHMWPE helmets cannot achieve good BFD control — they can, through additional material, different laminate architectures, or hybrid constructions. The key point is that matching the deformation performance of a rigid aramid shell typically requires tradeoffs elsewhere, such as weight, cost, or manufacturing complexity.

3. Delamination is not automatically a flaw — It is a design variable, not a defect

One nuance is worth stating clearly because it is often misunderstood: a less rigid bond between layers is not necessarily a manufacturing defect. Layer separation is itself one of the mechanisms by which a composite can absorb and redistribute energy, allowing the layers to move somewhat independently and bringing more fibers into the response.

That mechanism behaves differently depending on the scenario. For a single, isolated impact, greater delamination can be beneficial because it brings more material into the response. With closely spaced impacts, however, extensive delamination after the first strike can weaken precisely the area needed to stop the second projectile. The rigid resin system in the AMP-1 TP deliberately limits that spread, trading some single-hit efficiency for greater reliability under multiple closely spaced impacts — a tradeoff suited to the intended mission profile of a law-enforcement helmet.

UHMWPE composites tend to exhibit more delamination per impact — partly because polyethylene's chemically inert surface is more difficult to bond and partly because more compliant resin systems are often used. That can be beneficial for a single impact, but it can reduce durability under closely spaced multiple hits. Aramid's stronger and more tunable fiber-to-resin bond gives designers finer control over this behavior.

4. Multi-hit resilience

This is the factor most directly connected to the DEA incident. As described above, greater deformation during the first impact creates a larger damage zone, leaving less intact material nearby. The magnitude of this effect depends heavily on the specific construction — but with two rounds only one inch (2.5 cm) apart, the AMP-1 TP's rigid, low-deformation architecture and its tendency to keep damage localized were significant factors in the outcome.

5. Manufacturing: Forming the shell

Woven aramid is generally easier to drape into the complex curved geometry of a helmet without wrinkling or creating uneven thickness. UHMWPE — particularly in cross-plied unidirectional formats — is stiffer in-plane and more difficult to form into tight helmet curvature without local thickness variations or fiber misalignment. This is an engineering and manufacturing challenge that can be solved, but it increases the complexity required to achieve consistent performance across the entire shell. variation or fiber misalignment. This is a manufacturing challenge that can be engineered around, not a fundamental flaw in the material, but it adds complexity to achieving consistent performance across every part of the shell.

Aramid vs. UHMWPE

Heat tolerance	**HIGH CEILING** Holds up to roughly 932°F (500°C) before breaking down. Unaffected by a hot vehicle, desert sun, or high-temperature processing.	**SOFTENS EARLY** Significantly softens around 275–302°F (135–150°C) Rarely an issue day-to-day, but it caps the processing temperatures and resin systems available to designers and limits the high heat tolerance in hot storage locations, like vehicles.
Deformation under impact	**LOW FLEX** A stiff resin system resists shell flex, keeping backface deformation — the force that actually reaches the head — small and controlled.	**MORE FLEX, MORE EFFICIENCY** Low resin content and unidirectional layup favor fiber engagement, but often at the cost of more pronounced inward "coning" on impact.
Multi-hit resilience	**CONTAINED DAMAGE** Less shell movement (BFD) on the first hit means less fiber strain at the edges of the impact zone — leaving more intact material for a second hit nearby.	**DEPENDS ON CONSTRUCTION** A larger first-hit deformation can widen the damage zone. Achievable multi-hit control, but often requires added material or hybrid layups.
Delamination behavior	**TUNABLE BOND** A strong, chemically bondable fiber surface gives designers finer control over how much the layers separate — a dial, not a defect.	**DELAMINATES MORE READILY** Polyethylene's inert surface is harder to bond to, and softer resins are common. Can help absorb a single hit, but works against durability across closely spaced hits.
Formability	**DRAPES EASILY** Woven fabric conforms naturally to a helmet's complex curvature without wrinkling or uneven thickness.	**STIFFER IN-PLANE** Unidirectional cross-ply formats resist forming into tight curvature — a manufacturing challenge that needs to be engineered around, not necessarily a flaw.

Aramid vs. UHMWPE

Where aramid earns it's place:
Low-deformation, closely-spaced multi-hit scenarios — exactly the profile a police helmet needs. This is the construction behind the AMP-1 TP.

Where UHMWPE earns it's place:
Strength-to-weight is decisive — particularly in rifle-rated plates and lightweight vehicle armor.

The takeaway:
This isn't a scorecard with a winner. It's a set of trade-offs, and the right material depends on the threat profile a helmet is built to survive. **For a handgun-threat police helmet facing the possibility of close-ly spaced multi-hit engagements, this comparison is why aramid — in a stiff, deliberately low-deformation construction — was the right call.**

assess correctly!

Why this mattered for the AMP-1 TP

Returning to the incident: the agent survived because the helmet — its composite, geometry, and padding working together — did three things.

- **At each impact,** it resisted deformation and managed projectile energy through controlled fiber and resin damage while distributing the load across a broader area rather than through localized inward shell flexing.
- **It kept damage from the first impact** localized and preserved enough structurally intact material to stop a second round only one inch (2.5 cm) away.
- **It kept the agent operational** throughout the mission, with no subsequently identified head trauma.

The point is not that aramid is inherently superior. UHMWPE offers real advantages in other applications — particularly rifle-rated body armor plates and lightweight vehicle armor, where strength-to-weight ratio is critical. The point is to use the right material for the job, not one material for every job. Material selection therefore is not one-size-fits-all; it depends heavily on the threat profile of the mission.

What this means for evaluating helmets

The August 2025 incident is a single data point — but one that shows very clearly what to look for when comparing helmets on specification sheets. A data sheet may state that a helmet stops a 9 mm round. For real-world protection, however, it also matters how the projectile is stopped, how far the shell moves inward in the process, and how much protection remains after the first impact.

A few questions every manufacturer should be able to answer:

"What is your BFD — not just your pass/fail result?"

Passing a penetration test demonstrates that a projectile did not penetrate. It does not automatically tell you how far the helmet shell deformed toward the head while stopping it. Ask for specific backface-deformation values against relevant test standards — not merely a pass/fail statement. **The AMP-1 TP has been tested to:**

- **NIJ IIIA**
  no backface-deformation test protocol
- **VPAM 3, HVN**
  Max. backface deformation: 25 Joule
- **DEA-FBI Ballistic Helmet Testing Protocol**
  Max. backface deformation: 20 mm (front), 15 mm (sides, back, crown)

„How do you test multiple hits – and at what spacing?“

A single-hit test says little about the protection that remains after a nearby first impact. This incident demonstrates that closely spaced multi-hit scenarios do occur in real operations: two rounds, one inch (2.5 cm) apart, at close range, during an actual field operation. Ask how close together impacts are tested and whether that testing has been independently verified.

I need to reach out to our lab.

„Is this performance repeatable, or is it a best-case sample“

Ballistic composite performance depends heavily on manufacturing consistency – fiber alignment, resin content, and cure quality. A single test result from a single sample tells you little about the helmet you will actually receive. Ask about lot testing and process controls, not just the primary certification.

double-check

„What tradeoff was made, and is it the right one for the threat“

As this paper has shown, every material and design decision involves a tradeoff – stiffness versus fiber engagement, delamination versus structural integrity, weight versus BFD control. In ballistic design, there is no “everything at once.” A credible manufacturer should be able to explain which tradeoffs it made and why, in relation to the actual threats your personnel face, rather than presenting its helmet as universally optimal.

very important

The DEA agent who contacted us was issued a helmet in which every design decision had been made deliberately with a specific threat profile in mind. The helmet performed in exactly the kind of scenario for which those design choices were relevant: two 9 mm rounds at close range, only one inch (2.5 cm) apart. **That is the standard we design to** — and the standard we recommend applying to procurement decisions.

incredible

sales@busch-protective.com

I have to contact these Busch guys immediately and request a live shoot. BTW: show my team the multi-hit case!

Busch PROtective

Busch PROtective, founded in 1981, is a manufacturer of head protection systems for police and police special units. Busch PROtective is best known for its innovative approach to developing and producing top-quality helmet systems.

The AMP-1 TP by Busch PROtective is the world's first helmet system certified under the new "FBI-DEA Testing Protocol." Busch PROtective's customer portfolio includes police special units in Europe, Asia, North and South America, and Australia.

Among the company's biggest achievements is an exclusive supply contract to deliver ballistic helmet systems to the U.S. Department of Justice, which includes the FBI, DEA, and U.S. Marshals. In 2025, the contract was secured for the second consecutive time.

Busch PROtective

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PROTECT
WHAT
MATTERS