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ADVANCED PROTECTIVE HELMET FOR FORMULA ONE

SNELL HIC CONFERENCE
May 2005

Andrew Mellor

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Q. WHY MORE PROTECTION?

Since accidents of Senna, Ratzenberger, Wendlinger, Hakkinen FIA introduced:

- Extensive survival cell and crashworthiness improvements
- high cockpit sides
- energy absorbing headrests
- collapsible steering columns
- wheel tethers
- HANS system

Is more head protection required?

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Q. WHY MORE PROTECTION?

A. Drivers continue to suffer head injuries

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Q. WHY MORE PROTECTION?

A. Opportunity to use latest composite technologies to advance helmet safety performance and reduce weight

Alternatively, manufacturers may exploit this technology to reduce size of helmets with no increase in safety performance

A. Establish the ‘state of the art’ then transfer technology to all levels of Motor Sport

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AGREED AREAS FOR IMPROVEMENT

Headrest compatibility

Impact attenuation

Crush protection

Penetration

Rotation

Shell hardness

Chinguard impact

Reduced mass (same geometry)

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PERFORMANCE IMPROVEMENTS

Headrest compatibility	50%
Impact attenuation	50%
Crush protection*	50%
Penetration	30%
Rotation**	25%
Shell hardness	50%
Chinguard impact**	50%
Reduced mass	20%

* new dynamic crush test

** new test based on ECE Regulation 22-05

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TEST TOOLS (SNELL and ECE R22)

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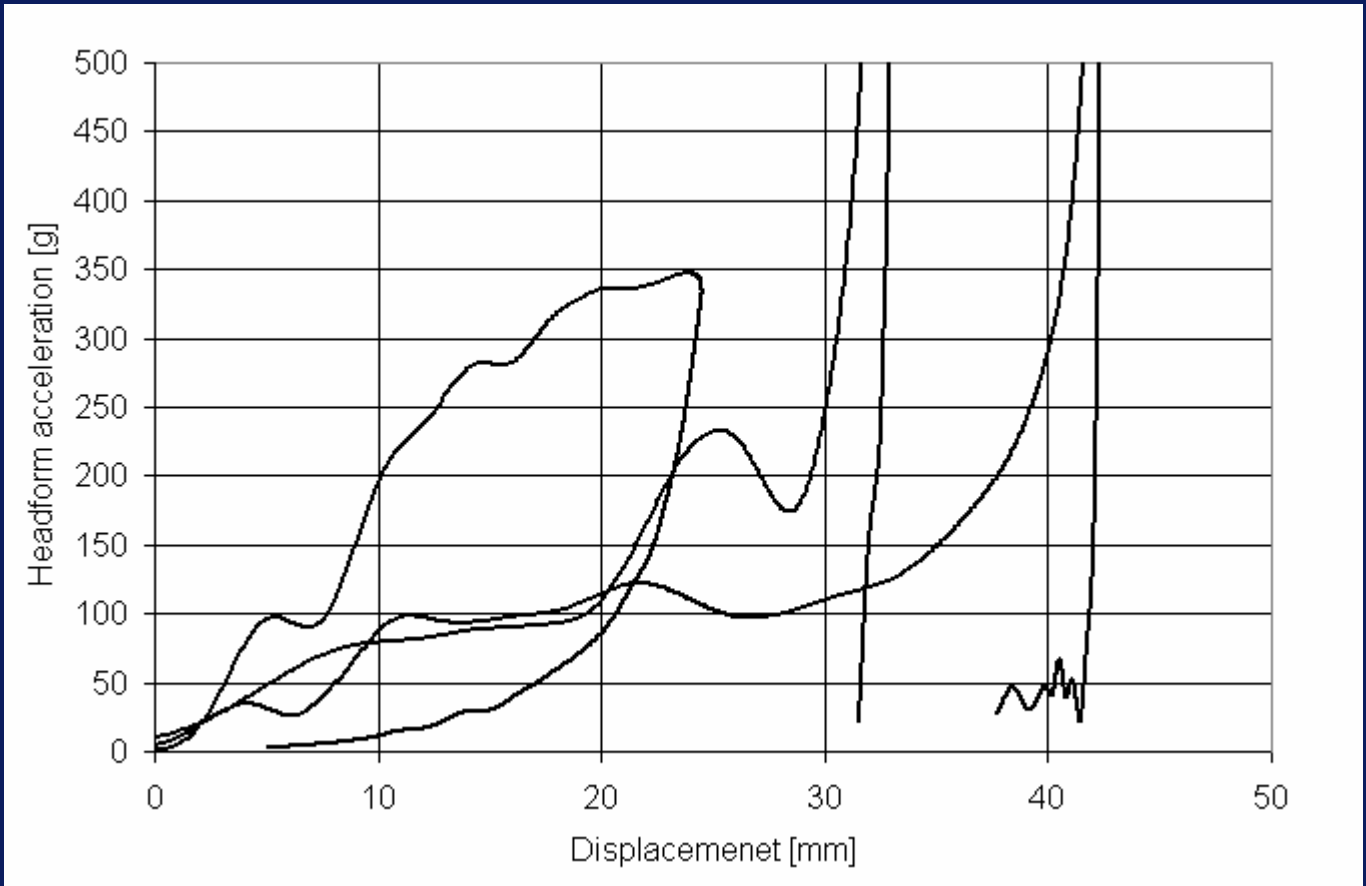
CURRENT HELMET IMPACTS @ 10m/s Hemi-Flat-Edge



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DESIGN TARGET: LINEAR IMPACT

- Current 300g@7.5m/s
- Target 300g@10m/s

Absorb impact energy over controlled volume of liner material independent of impact surface

STRONG STIFF SHELL – OPTIMISED LINER

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DESIGN TARGET: PENETRATION

- Current 3kg spike falling from 3m
- Target 3kg spike falling from 4m

Tolerate high stress concentration at point of contact.
Dissipate load to liner

STRONG STIFF SHELL (Kevlar net)

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DESIGN TARGET: CRUSH

- Current No requirement
- Target 30% improvement

Absorb kinetic energy whilst ensuring load exerted on drivers head does not exceed tolerance for injury

STRONG DUCTILE SHELL

OPTIMISED LINER

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DESIGN TARGET: OBLIQUE IMPACT

- Current No requirement
- Target 30% improvement

Minimise tangential impact load and maintain angular inertia of helmet

LOW SURFACE FRICTION
LOW NORMAL IMPACT LOAD
MASS AT EXTREMITY

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SPECIFICATION FOR NEW HELMET

SHELL

- Bending stiffness EI — 450 N/m² (10x)
- Bending strength — 1200 Nm (8x)
- Weight — 0.85kg
- Thickness — 5mm (max)
- Outer surface — BARCOL 60

CARBON and KEVLAR
SOLID LAMINATE and SANDWICH CONSTRUCTIONS

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SPECIFICATION FOR NEW HELMET

LINER

- Efficient energy absorption (0.4N/mm²)
- Temperature stability (-20’C to + 50’C)
- Lightweight (<50g/l)
- (Hybrid structure)

EPS EPU EPE RATE-RESPONSIVE
CERAMIC BALLS HONEYCOMB

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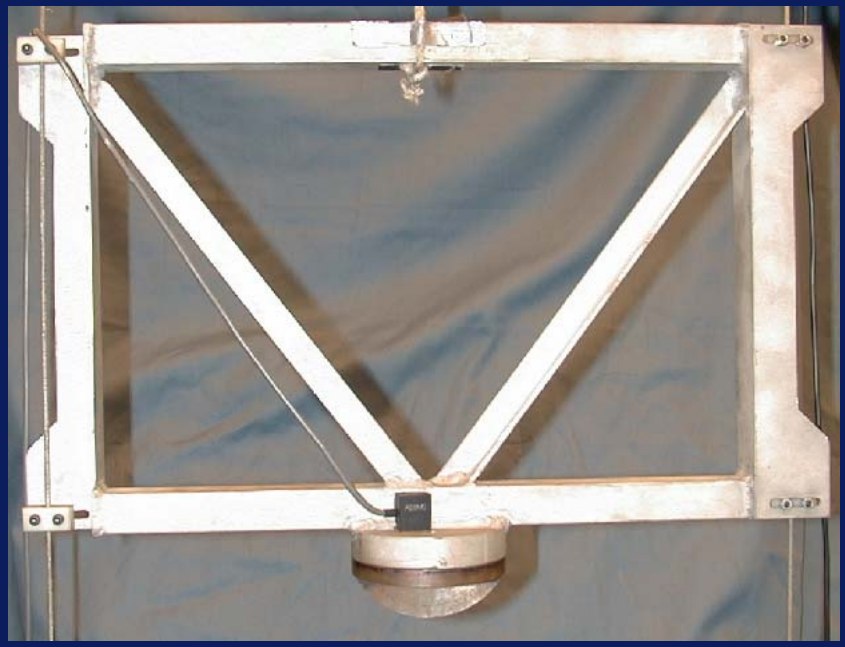
Tests on flat samples to evaluate stiffness, strength and penetration



3 manufacturers
Total of 20 laminates

- Conditioning (-20'C and + 50'C)
- Impact tests at 5m/s, 7.5m/s and 10m/s
- Penetration tests at 3m and 4m

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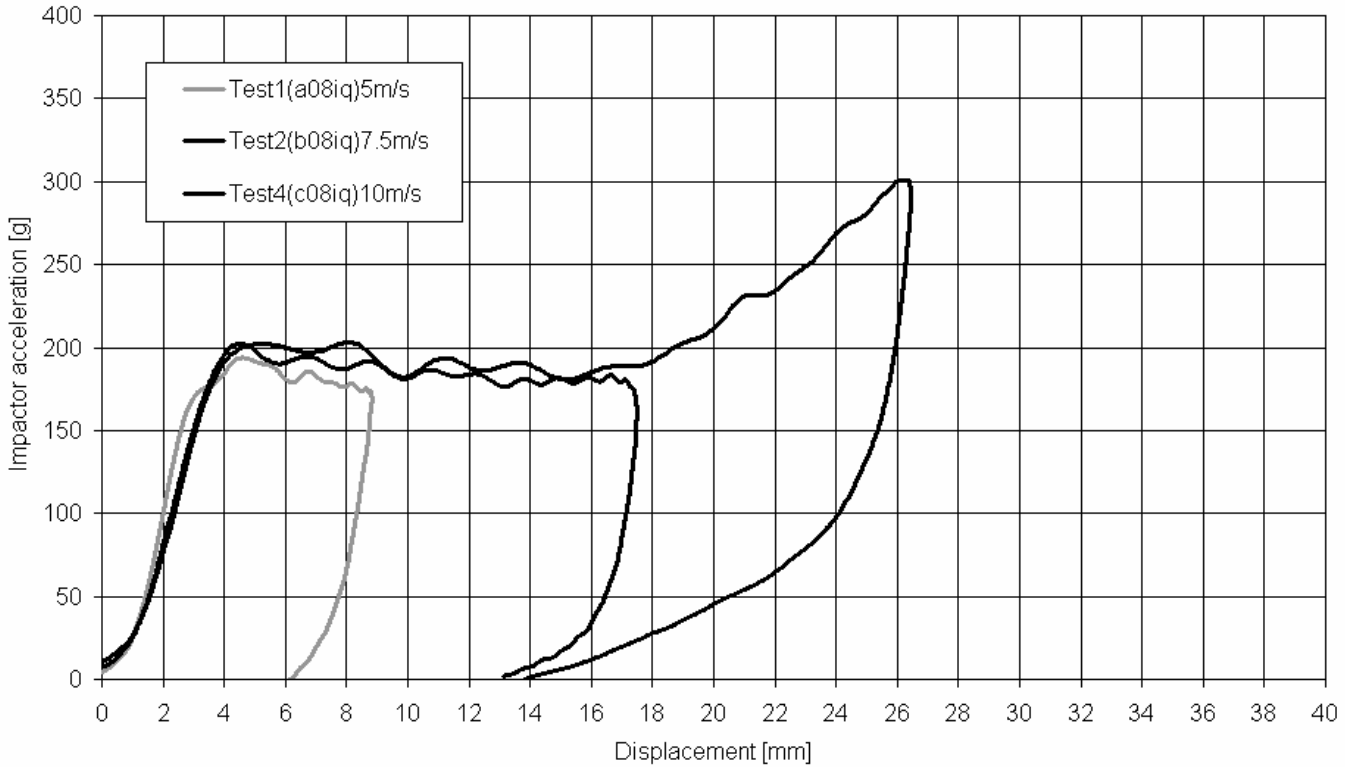
INFINITELY STIFF LAMINATE



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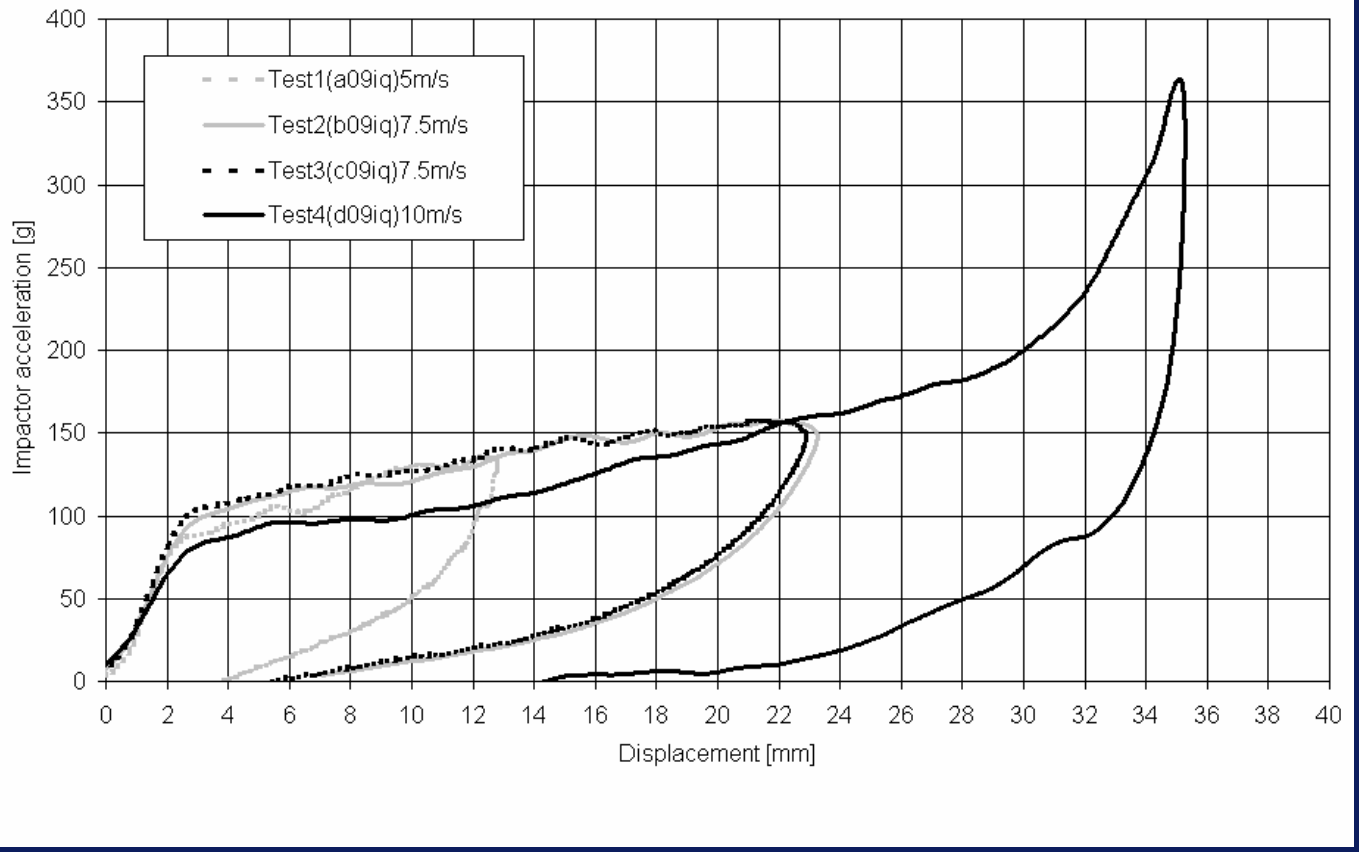
CURRENT SHELL LAMINATE



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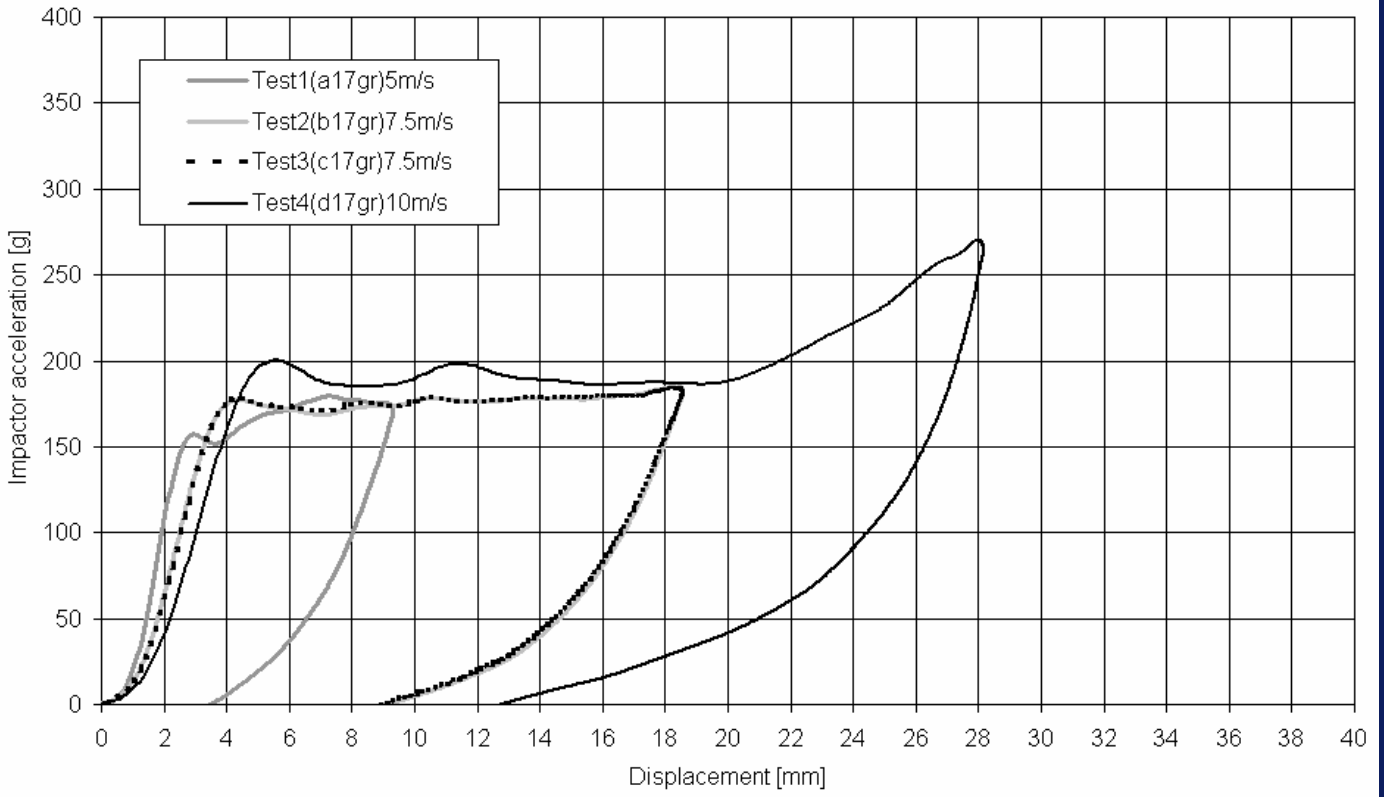
BEST SOLUTION SHELL LAMINATE



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BEST SOLUTION (equivalent to 5mm carbon steel)

Carbon sandwich with foam core (CFT Ltd – UK)

Kevlar improved penetration but reduced strength

Thickness	*4.1mm*	*(Target <5mm)*
Mass	*0.81kg*	*(Target <0.85kg)*
7.5m/s	*185g*	*(Target <200g)*
10m/s	*270g*	*(Target <300g)*
Penetration	*4m*	*(Target >3m)*

FULL GEOMETRY EVALUATION

- 5 laminates (sandwich vs solid)
- Polyethylene foam energy absorber

- *Linear impact tests*
- *Penetration tests*
- *Crush tests*
- *Oblique impact tests*

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BEST SOLUTION

T800 Solid carbon laminate 13 plys @ 0.22mm (<800g)

7.5m/s	*<190g*	*(current ~270g)*
10m/s	*<230g*	*(current ~ 620g)*
Penetration	*4m*	*(current 3m)*
Mass	*1.3kg*	*(current 1.4kg)*
Crush	*72mm*	*(current 82mm)*
Oblique	*4,200rad/s²*	*(current 5,900rad/s²)*

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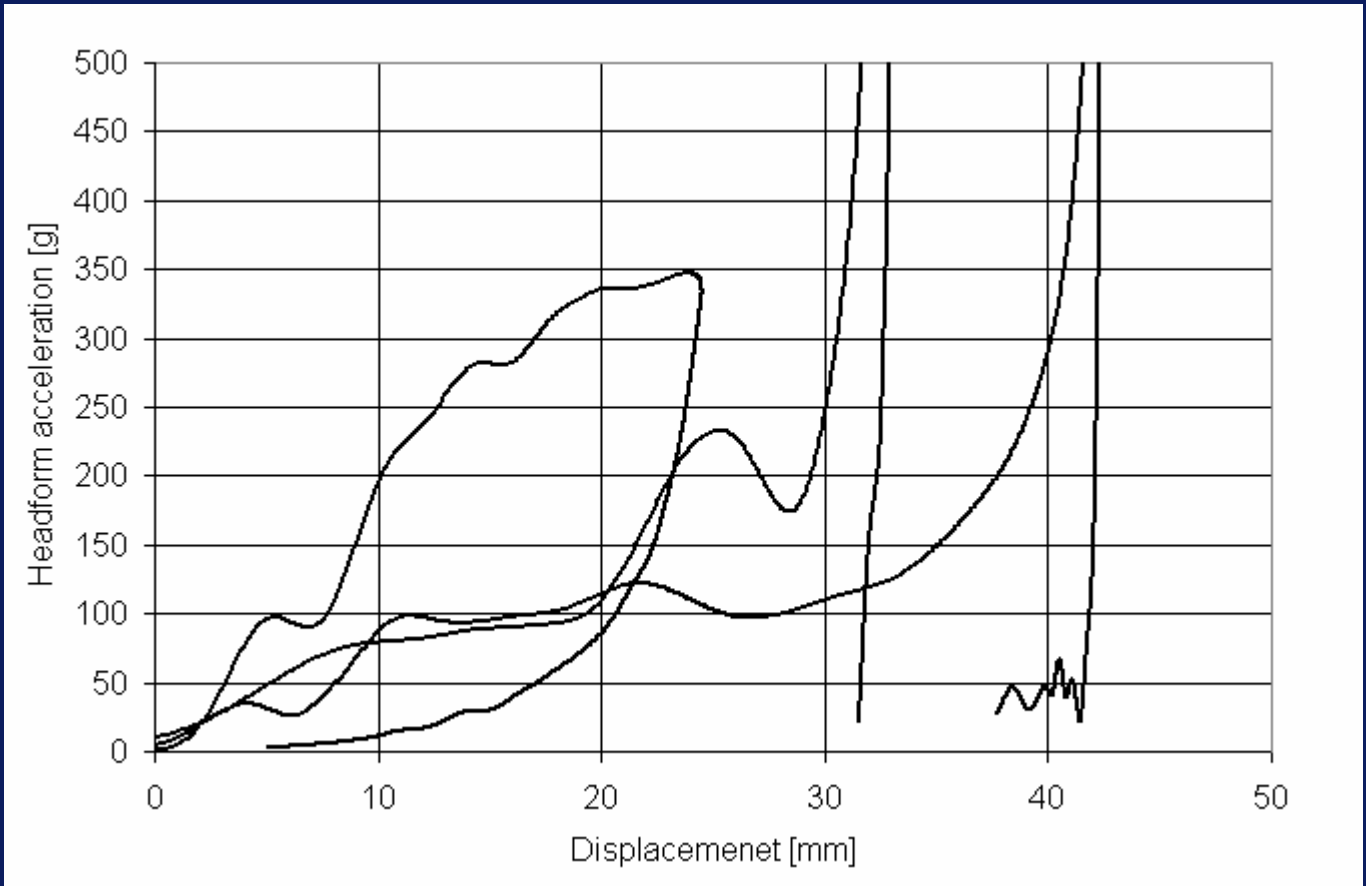
CURRENT HELMET IMPACTS @ 10m/s Hemi-Flat-Edge



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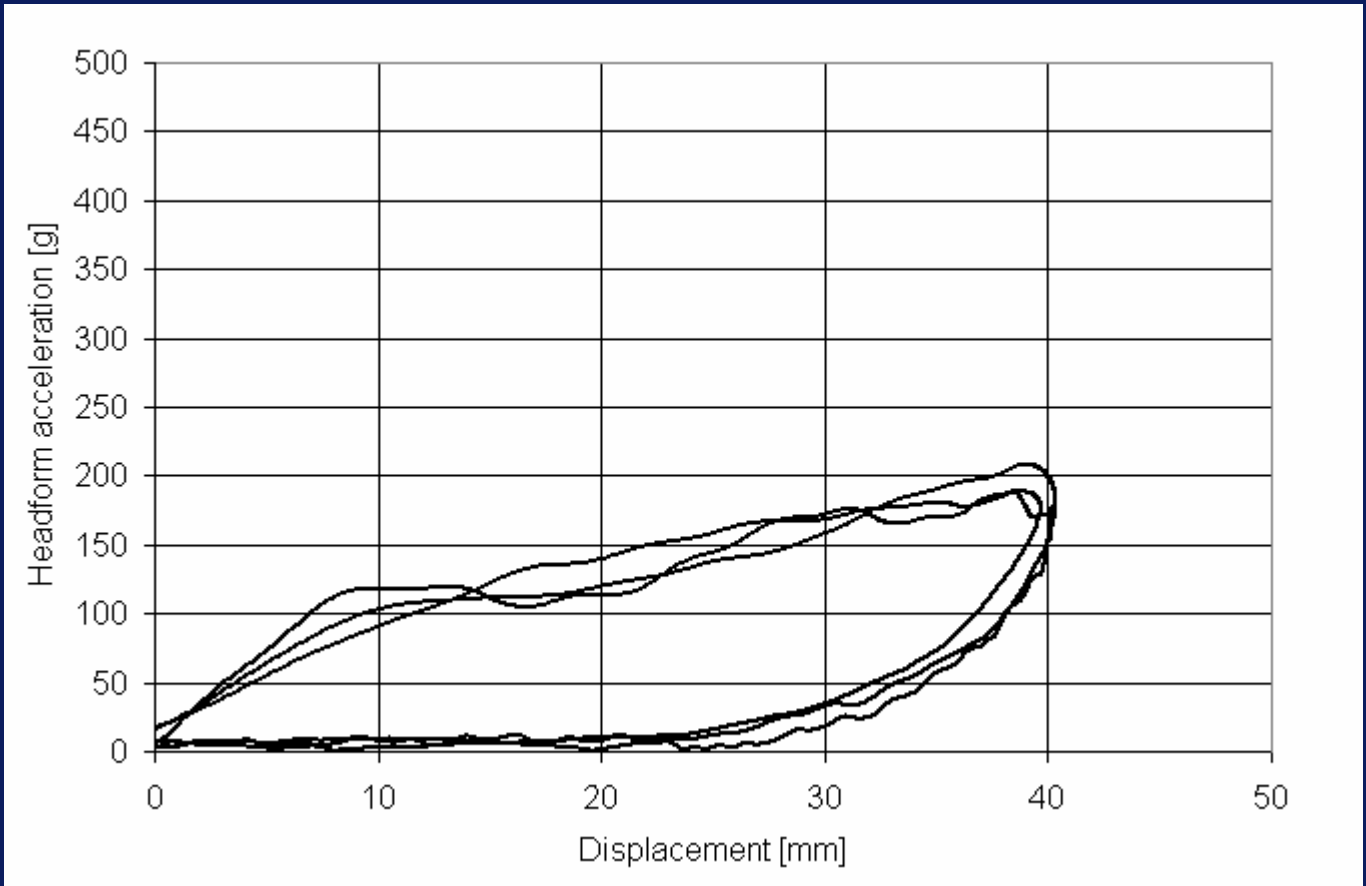
ADVANCED HELMET IMPACTS @ 10m/s Hemi-Flat-Edge



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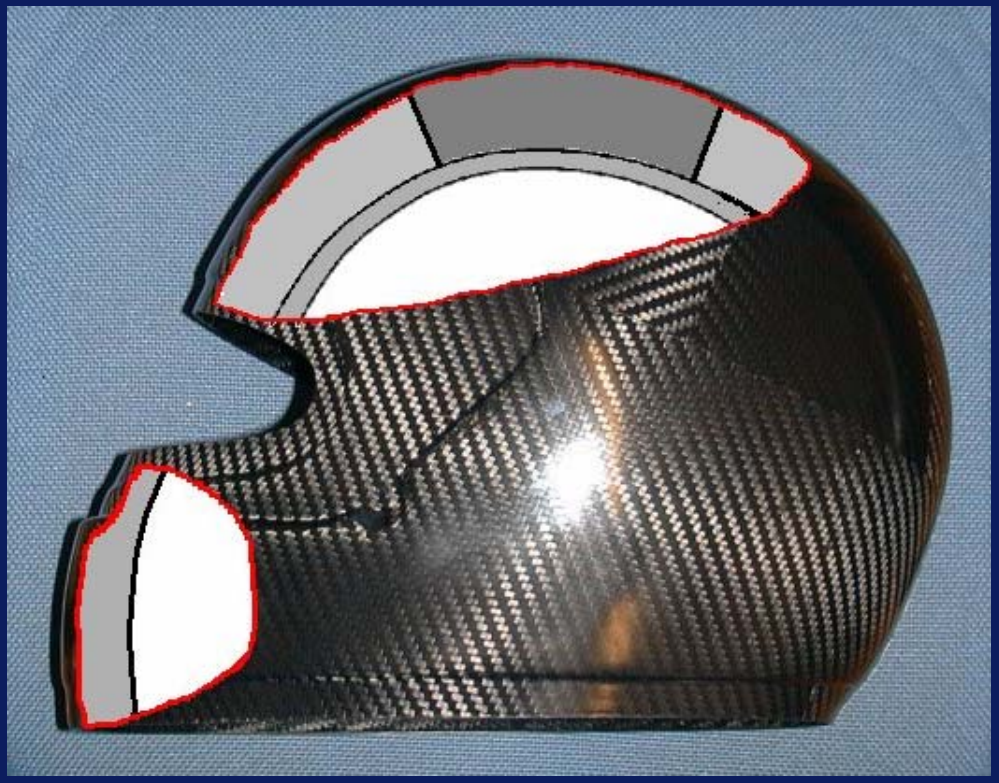
ADVANCED PRODUCTION HELMET



Partnership FIA-TRL-CFT-SPORTS BELL Europe

6 variants of shell laminate

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BEST SOLUTION ACHIEVED ALL PERFORMANCE OBJECTIVES

- SHELL
  T1000 11 ply carbon fibre with UD reinforcement
  Shell (only) mass 670g

- LINER
  Hybrid EPS 25g/l and 30g/l
  with PP interface between shell and liner
  Rate responsive comfort padding fitted after certification
  Chin guard padding (to ECE Reg 22-05)

  Rate responsive comfort padding
  (fitted after homologation for further protection)

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DEVELOPMENT AND AGREEMENT OF NEW STANDARD

- March 2003. Draft FIA standard proposed (complimentary to Snell)
- May 2003. Meeting of FIA helmets group
  - Repeatability and reproducibility
  - Energy vs performance consistency / Hardness
  - Technology transfer to second manufacturer (Schuberth Engineering)
- November 2003. Performance agreement with BELL and SE
- December 2003. FIA 8860-2004 to World Council
- January 2004. SE and BELL achieved FIA and Snell
- May-June 2004. Arai and SPARCO achieved FIA and Snell
- 1 July 2004. Successful introduction to Formula One (4 manufacturers)

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FIA 8860-2004 vs SNELL SA2000

	Snell SA2000	FIA 8860
Impact attenuation	150J (300g)	225J (300g HIC 3500)
Crush protection	-	500J
Penetration	3kg@3m	4kg@3m
Rotation	-	ECE Reg 22
Hardness	-	BARCOL 60
Chinguard test	‘Crush’	ECE Reg 22

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FUTURE WORK

- Transfer of technology and cost reduction
- Helmets for young drivers

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