



RESEARCH AND INNOVATION CENTER FOR CBRN DEFENSE AND ECOLOGY

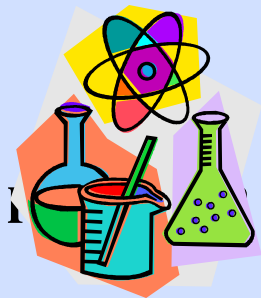
**Research facility subordinated to
Military Equipment and Technologies Research /
General Directorate for Armaments**



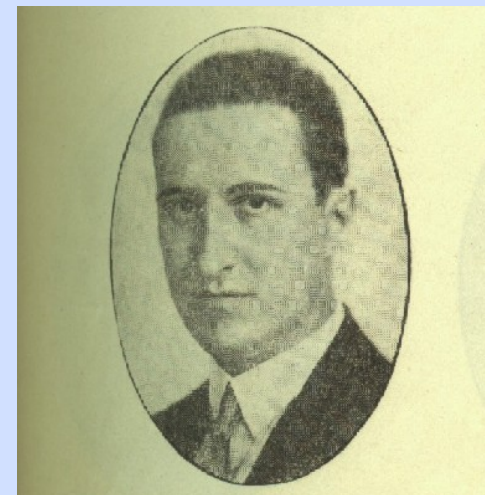
With the approval of the minister of war on the report 665 from October 31st, 1924, issued by General Staff, Section IV ^aGases^o was reorganized as Service for Defense against poisonous gases

This service consisted in:

- *a Research laboratory;*
- a gas mask workshop;
- a School for training



against poisonous gases.







R&D activities

- **Applicative research and technological development:**
 - Technologies and equipment for chemical and radiological detection
 - Technologies, solutions and equipment for chemical, biological and radiological decontamination
 - CBRN protection equipment, both individual and collective
 - **Individual ballistic protection equipment**
 - Energetic materials
 - Special ammunitions
 - Ballistic, pyrotechnic, non-lethal and antiterrorist systems
 - Nuclear control equipment



Bulletproof vest for female personnel

Project: Ergonomic ballistic protection equipment for women from national defense system– FEMBALPROT

UEFISCDI grant: PCCA-2 no. 303/2014

Project duration: 01.07.2014 - 30.09.2017



Project financing

- **Ministry of education, research and innovation,**
by UEFISCDI, and own funds
- **Overall value of the grant:** 330K EUR
 - **UEFISCDI grant:** 284K EUR
 - **Own funds:** 46K EUR



Consortium

Project coordinator

Research and Innovation Center for CBRN Defense
and Ecology

225 Olteniței Av, 4th District, Bucharest

Partners

SC STIMPEX SA, SME

46-48 Teclu Nicolae St, 3rd District, Bucharest

National R&D Institute for Textile and Leather

16 Lucrețiu Pătrășcanu St., 3rd District, Bucharest



Project's objectives

Overall goal – the development of a new ballistic vest for female personnel that was supposed to offer better comfort, mobility and adjustment possibilities, while still maintaining the ballistic properties and resistance similar to the existing bulletproof vests in the Romanian army.

Expected results:

- Studies and scientific reports;
- Technical specifications;
- Experimental models;
- Prototypes;
- Validation of results.



Ballistic protection vests general characteristics

- **Impact resistance** – body protection against bullets and fragments (existing standards)
- **Comfort (or ergonomics)** – abstract concept with a very broad understanding, very subjective. Comfort could be represented as a physical or a psychological feeling.
 - there are no standards for such characteristic, every people having its own understanding of comfort levels

Although ballistic protection vests saved the lives of thousands of police officers, there are studies demonstrating that almost 40% of them don't wear, or are reluctant to wearing ballistic protection vests due to discomfort. The main motivation is related with the adjustment and heat stress generated while equipped.



Identified problems

- Due to changes in legislation, the number of female personnel has increased in the military, but the only ballistic equipment available is the bulletproof vest designed especially for males
- body adjustment issues
- the smallest size available (extra small) is too large or too long for 85% of the female personnel
- there are respiratory impediments as a result of the pressure applied on the bust level by the frontal ballistic package
- the shape is not adapted to the wearer (specific curves)

“Women are not small men”



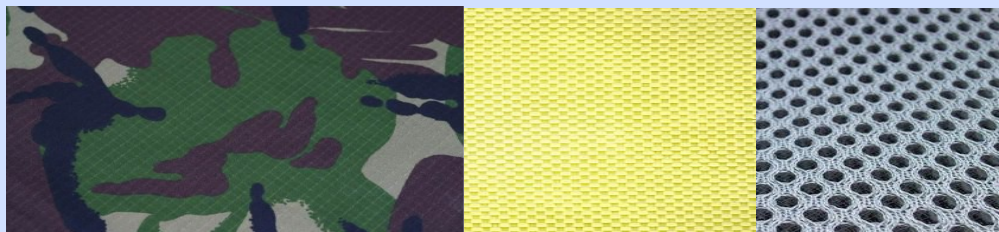
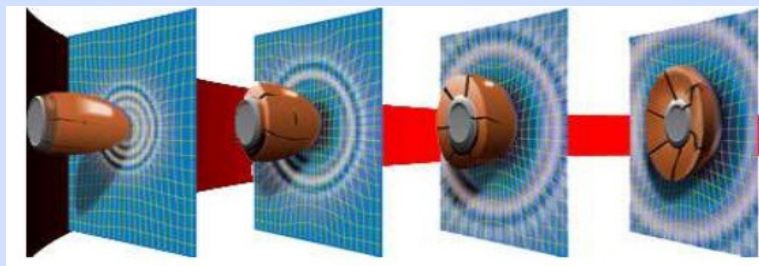
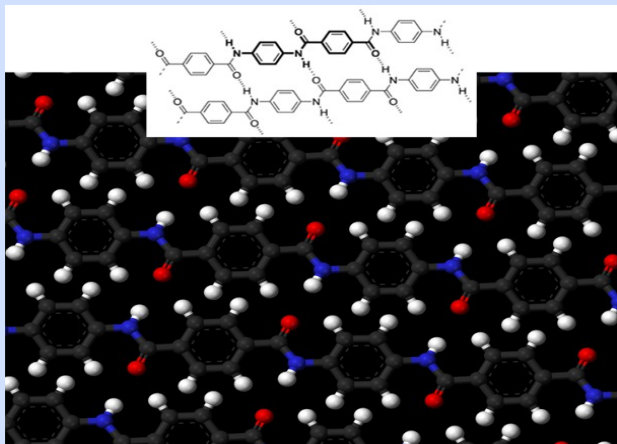
Possible solutions





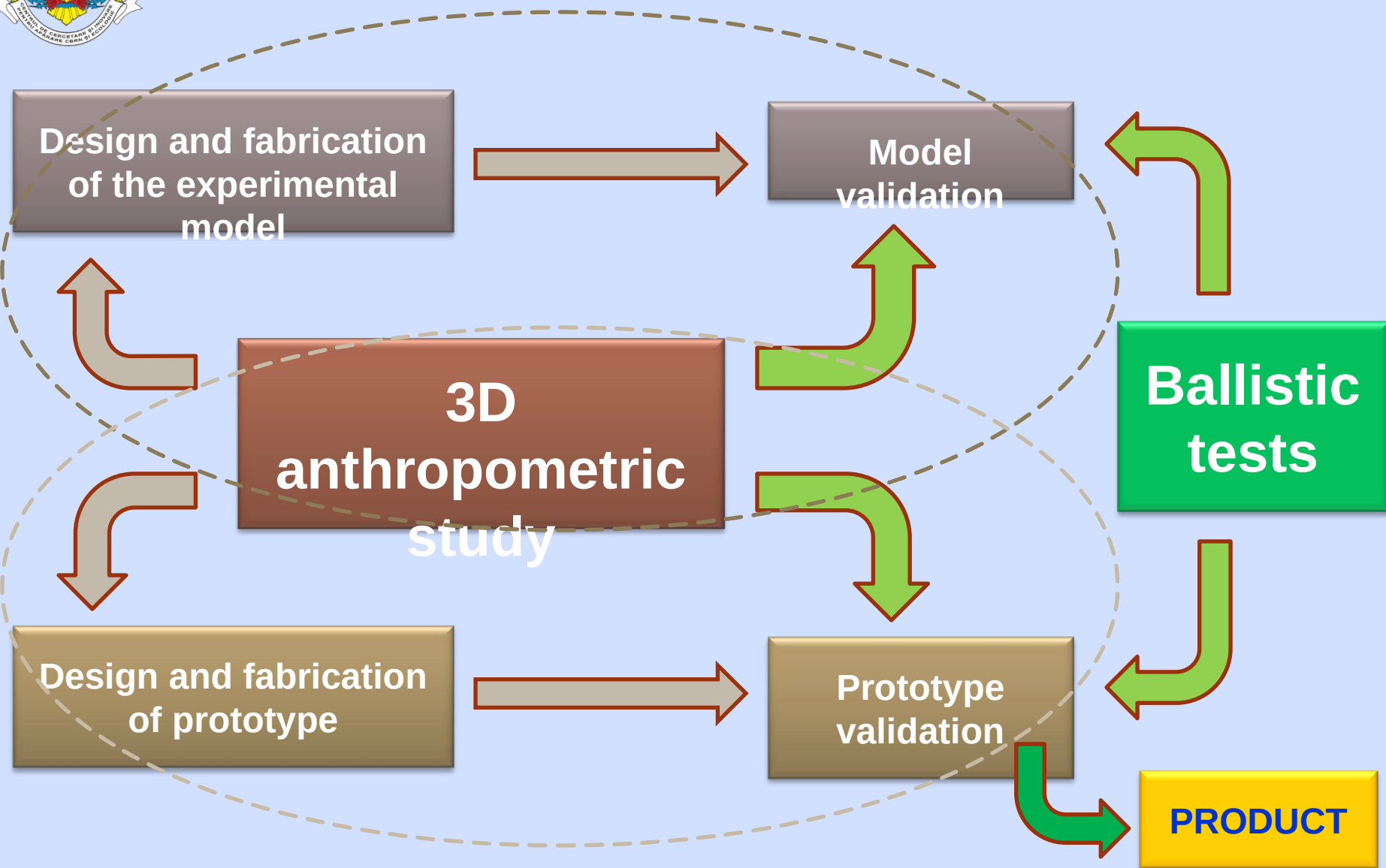
Materials choice

Kevlar (poliparafenilendiamine-tereftalamide)



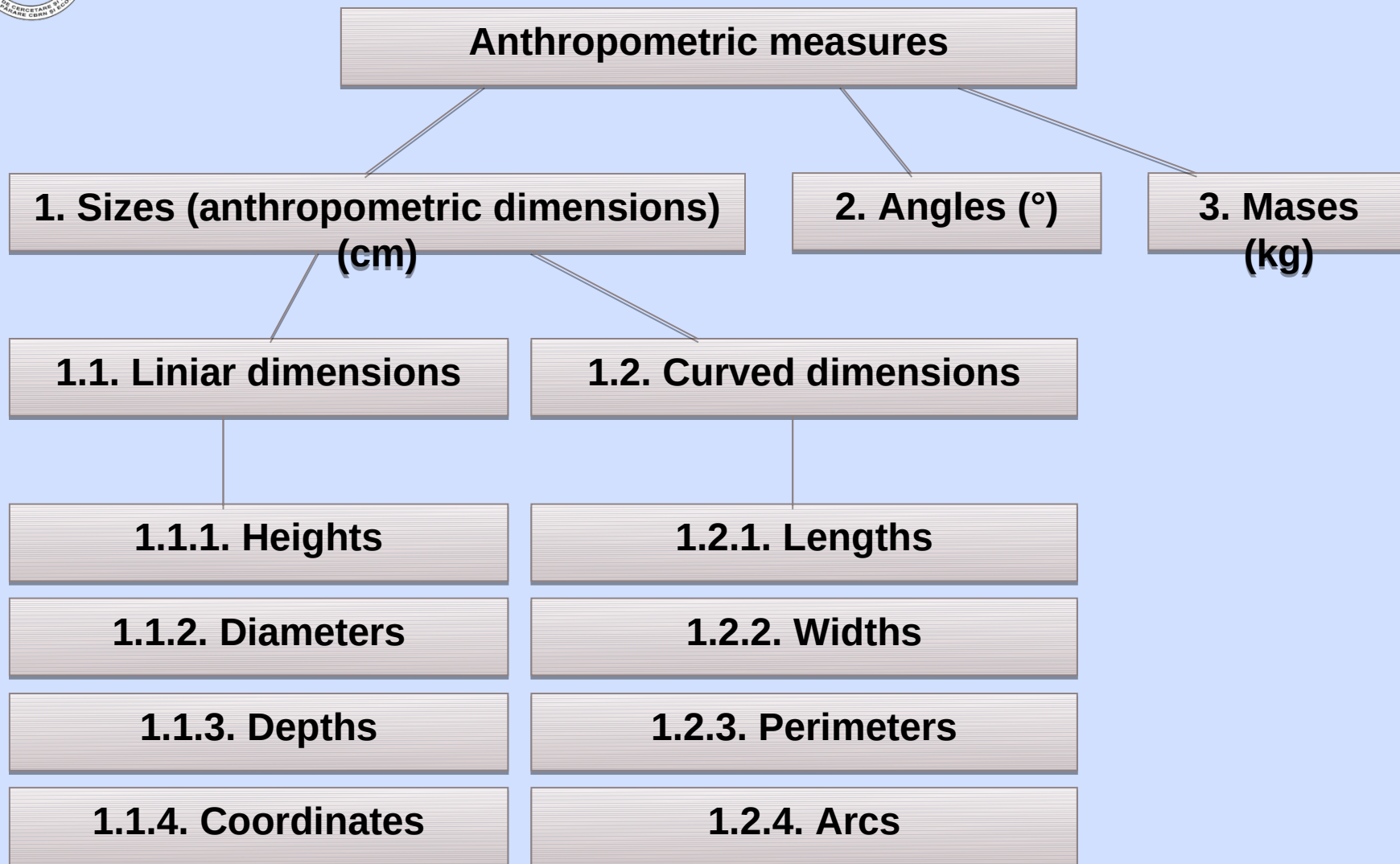


Methodology





3D anthropometric study





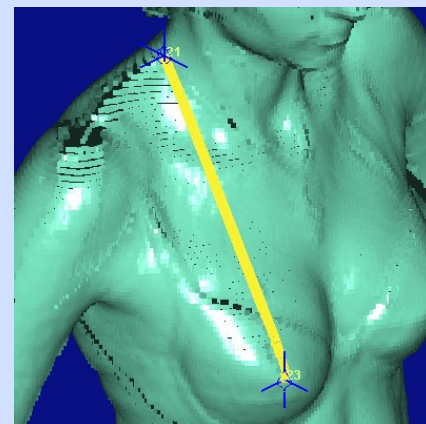
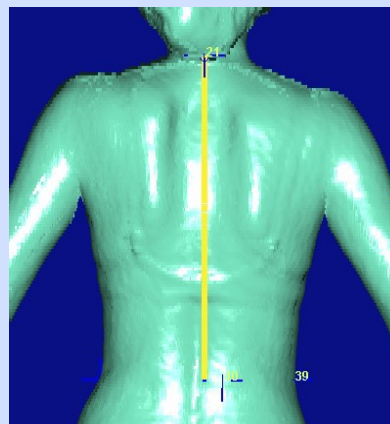
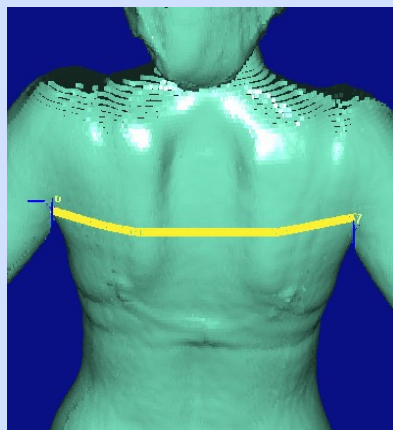
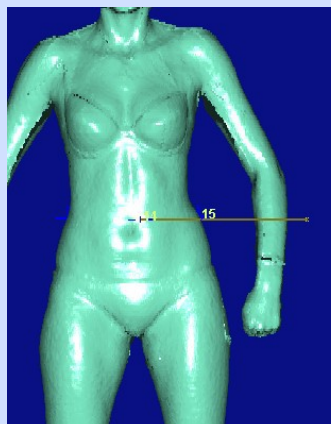
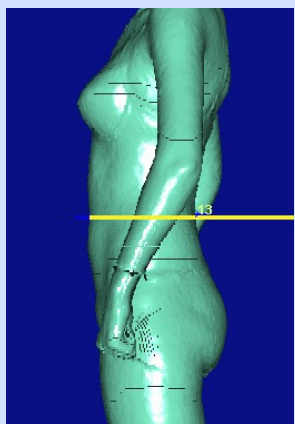
3D anthropometric study

Minimum necessary data:

- bust
- torso length
- shoulders.



3D Body Scanner VITUS Smart XXL





3D anthropometric study

2D Measurement Distribution		Statistic	Measurement Distribution									
	Count	Average	Standard Deviation	Standard Deviation %	Min	Max	Min-AVG	Max-AVG	Range	Range Symmetry	Range %	Range / 2*Standard Dev
3D waist band	99	75,41	6,08	8,07	61,80	94,10	-13,61	18,69	32,30	5,08	42,83	2,65
3D waistband back height	99	99,19	4,49	4,53	90,10	109,80	-9,09	10,61	19,70	1,52	19,86	2,19
3D waistband back to vertical	99	28,33	2,13	7,51	24,40	33,60	-3,93	5,27	9,20	1,34	32,47	2,16
3D waistband front height	99	98,43	4,56	4,63	88,40	109,20	-10,03	10,77	20,80	0,75	21,13	2,28
3D waistband front to vertical	99	47,04	2,17	4,60	42,40	53,10	-4,64	6,06	10,70	1,42	22,75	2,47
3D waistband left to crotch	99	24,99	0,82	3,29	23,10	27,50	-1,89	2,51	4,40	0,62	17,61	2,67
3D waistband right to crotch	99	24,98	0,82	3,29	23,10	27,50	-1,88	2,52	4,40	0,64	17,61	2,68
Across back width	99	35,27	2,69	7,62	30,50	51,60	-4,77	16,33	21,10	11,56	59,83	3,93
Across back width (armpit level)	97	34,22	3,13	9,16	29,30	54,40	-4,92	20,18	25,10	15,25	73,34	4,00
Across front width	99	37,86	2,43	6,43	33,50	48,10	-4,36	10,24	14,60	5,87	38,56	3,00
Ankle girth left	99	24,02	1,14	4,76	21,70	27,90	-2,32	3,88	6,20	1,56	15,81	0,71
Ankle girth right	99	23,95	1,33	5,54	21,60	28,00	-2,35	4,05	6,40	1,70	26,72	2,41
Ankle height	99	7,27	0,29	4,01	6,50	8,00	-0,77	0,73	1,50	-0,03	20,64	2,57
Arm length left	79	54,19	3,56	6,57	44,00	63,20	-10,19	9,01	19,20	-1,18	35,43	2,69
Arm length right	77	55,28	3,64	6,58	48,10	64,00	-7,18	8,72	15,90	1,54	28,76	2,19
Arm length to neck back left	79	73,82	3,73	5,05	64,10	83,60	-9,72	9,78	19,50	0,05	26,41	2,61
Arm length to neck back right	77	75,10	3,67	4,88	68,00	85,70	-7,10	10,60	17,70	3,51	23,57	2,41
Arm length to neck left	79	67,64	3,96	5,86	57,40	76,00	-10,24	8,36	18,60	-1,88	27,50	2,35
Arm length to neck right	77	68,95	3,78	5,48	60,80	77,30	-8,15	8,35	16,50	0,20	23,93	2,18
Belly circumference	99	79,00	5,69	7,21	63,80	92,50	-15,10	13,50	28,60	-1,61	36,20	2,51
Belly circumference height	99	96,87	4,59	4,74	86,30	108,60	-10,57	11,73	22,30	1,15	23,02	2,43
Body height	99	165,16	6,53	3,95	149,30	181,10	-16,06	15,94	32,80	-0,92	19,86	2,51
Breast height	99	119,56	5,35	4,48	109,00	132,50	-11,56	12,94	24,50	1,39	20,49	2,29
Bust point to neck left	98	26,55	1,98	7,44	22,10	31,10	-4,45	4,55	9,00	0,10	33,90	2,28
Bust point to neck right	98	26,53	2,02	7,61	21,30	32,30	-5,23	5,77	11,00	0,55	41,47	2,72
Bust points around neck	98	67,92	4,83	7,11	56,50	82,20	-11,42	14,28	25,70	2,87	37,84	2,66
Bust points width	98	17,50	1,12	6,38	15,20	21,40	-2,30	3,90	6,20	1,61	35,44	2,78
Bust/chest girth	99	88,35	5,25	5,94	75,70	102,20	-12,65	13,85	26,50	1,19	29,99	2,53
Bust/chest girth (horizontal)	99	90,26	5,00	5,54	76,90	106,00	-13,36	15,74	29,10	2,37	32,24	2,91
Buttack girth	99	95,48	5,62	5,89	83,20	111,20	-12,28	15,72	28,00	3,43	29,32	2,49
Buttack height	99	82,35	4,21	5,12	72,80	93,40	-9,55	11,05	20,60	1,50	25,02	2,44

Account

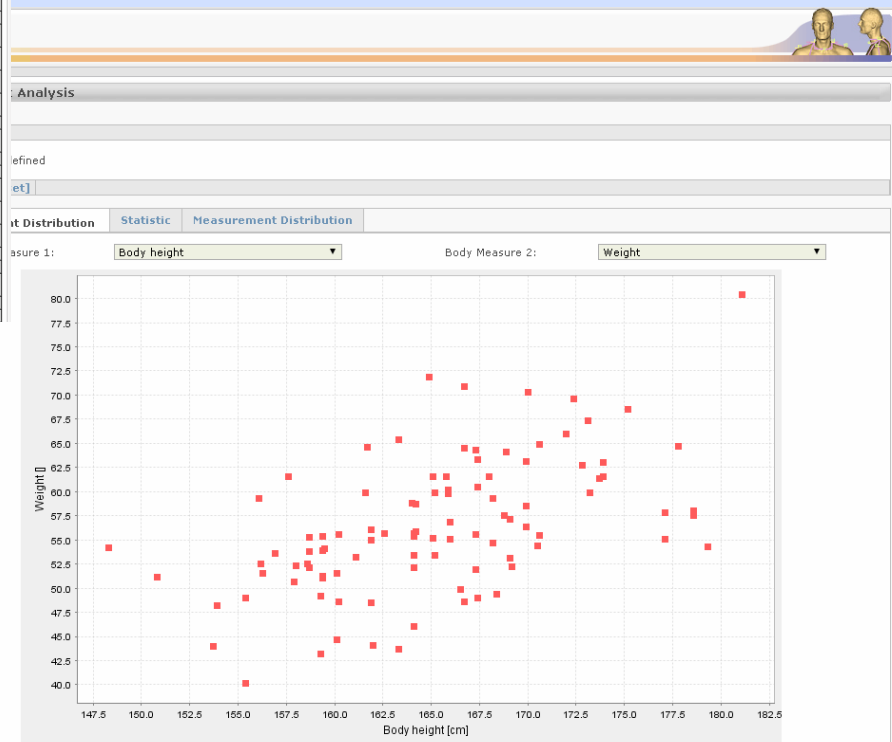
Logged in as
admin
(Administrator)

Logout
Change Password

Language

Evaluation group 369 people:

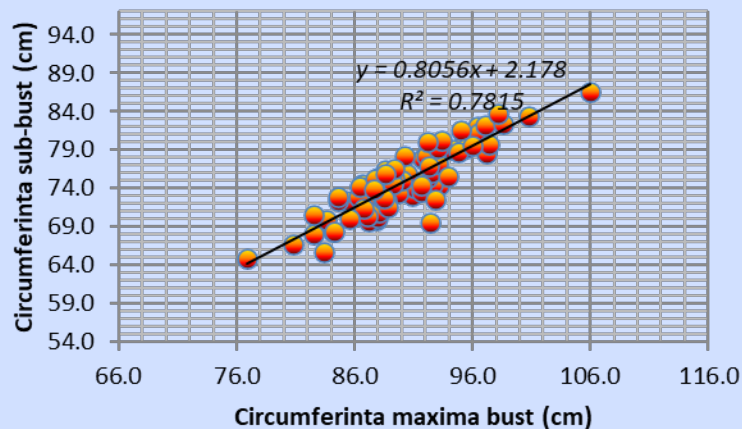
- 256 subjects 20-29 ani
- 113 subjects 30-39 ani



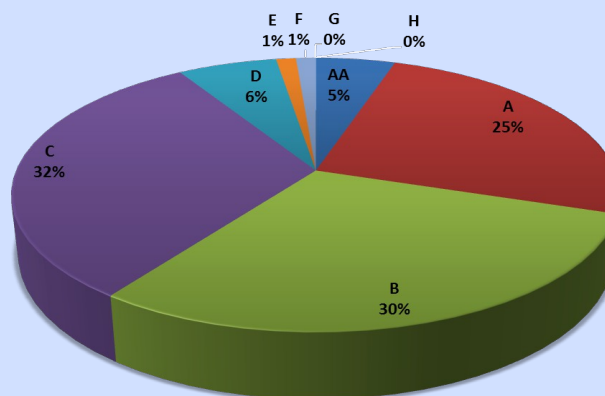


3D anthropometric study

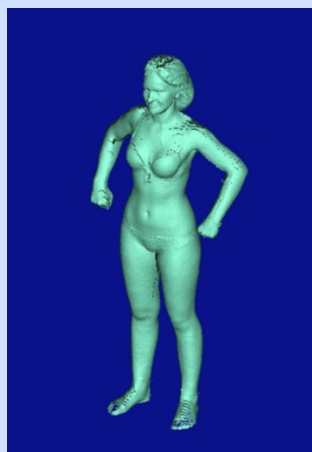
Nor de puncte circumferinta bust / sub-bust a esantionului analizat si dreapta de regresie



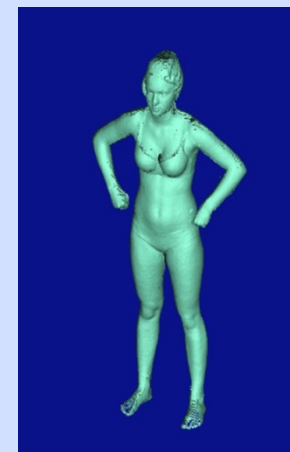
Distributia marimii cupei pe esantionul analizat



Bra cup A



Bra cup B



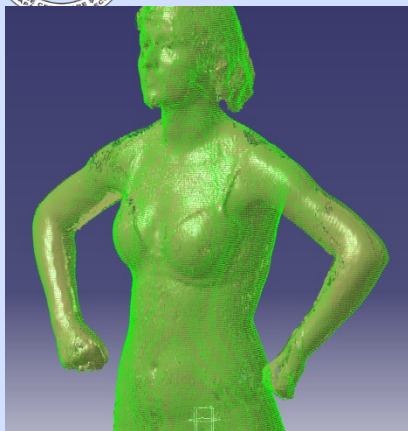
Bra cup

C

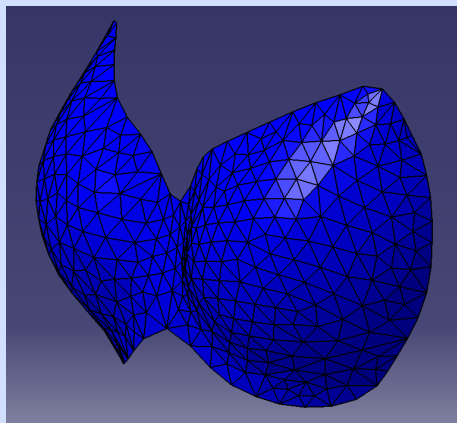
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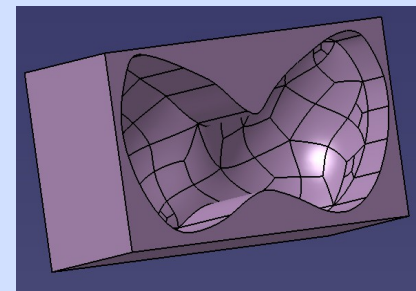
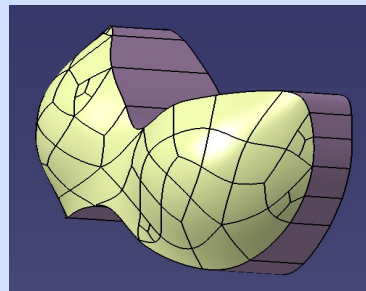
Design and production of experimental model



Avatar generation



CAD transfer



Design and production of molds

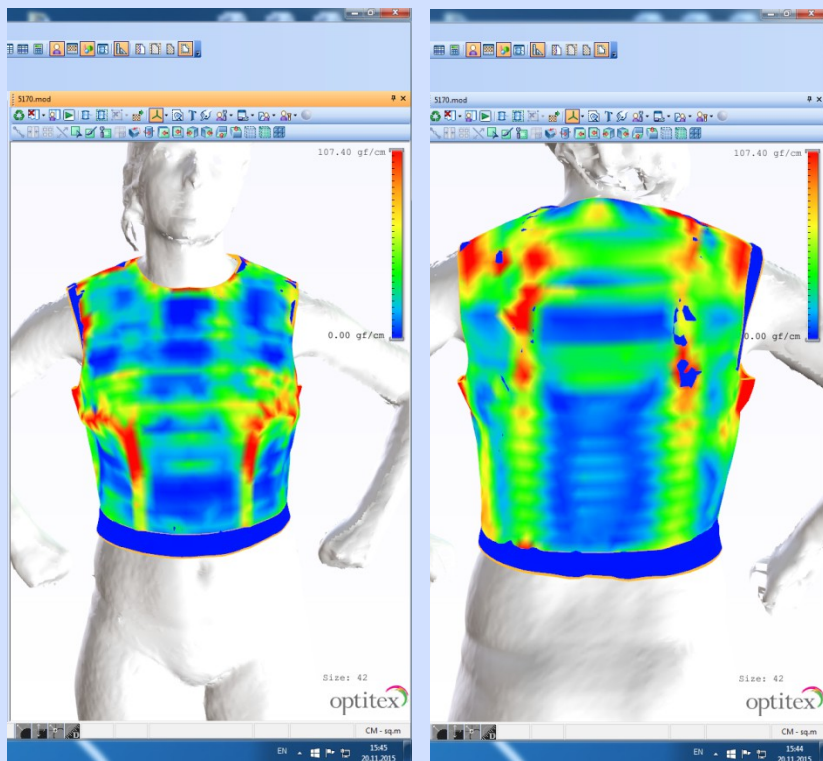


Experimental model

Technical solution – Heat deformation mold, using a chemical reagent compatible with Kevlar (polyglycol with high degree of polymerization), in order to obtain a permanent deformed matrix, identically for every layer of ballistic panel, such as the ballistic properties remain the same



Experimental model validation

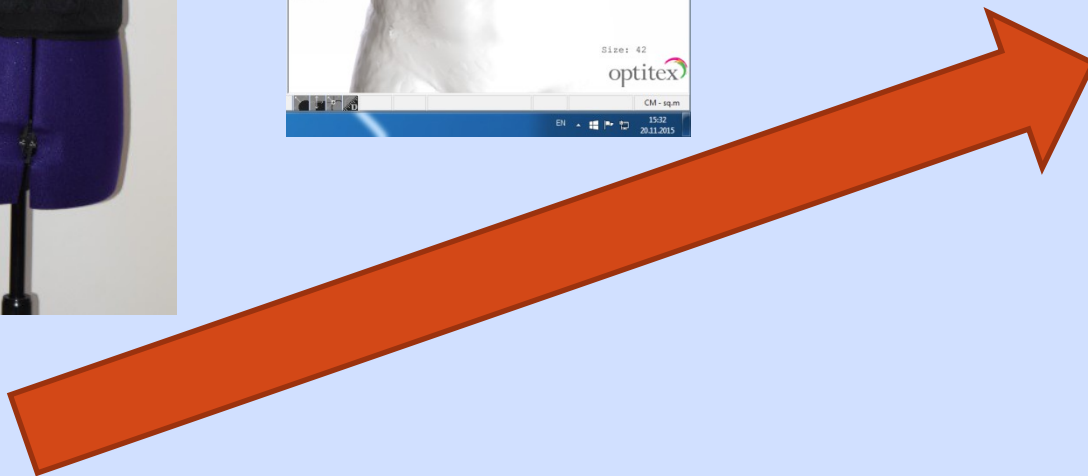
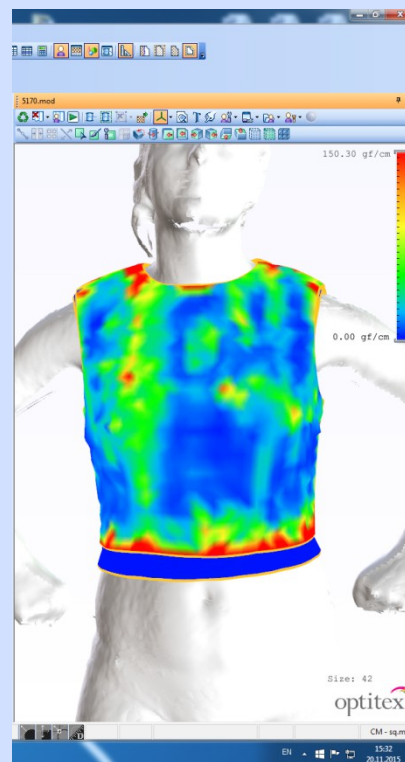
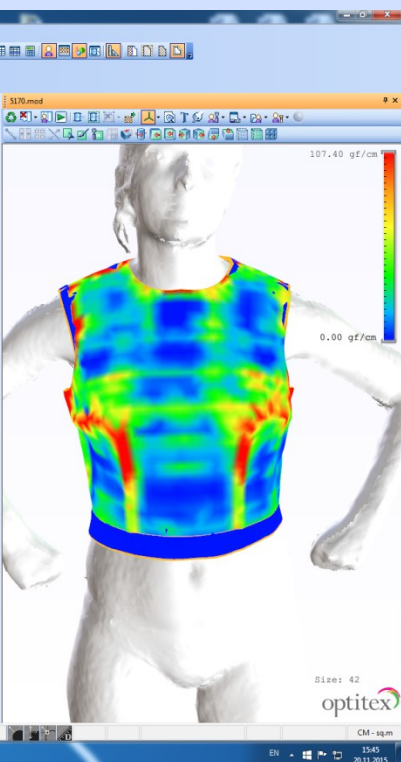


3D simulation of the vest on avatar





Design and production of prototype





Prototype validation





Comparative results

Characteristic	Existing bulletproof vest	Ballistic vest for female personnel
General ballistic protection, acc. NIJ 01.01.04	IIIA	IIIA
Ballistic protection in torso area, , acc. NIJ 01.01.04	IIIA	IIIA
Comfort in upper torso area	+	+++
Adjustment possibilities	+	++++
General comfort	+	++++



Thank you for your attention!