# 3D PHOTOGRAMMETRY FOR PROJECTILE DEFORMATION ANALYSIS

Rafael Rodrigues Cunha[1]*, Sarah Teixeira Costa[1], Rodrigo Henrique de Oliveira Montes[2], Claude Thiago Arrabal[1]

[1] Superintendência da Polícia Técnico Científica do Estado de São Paulo SPTC-SP, Guaratinguetá, São Paulo, Brazil
[2] Superintendência da Polícia Técnico Científica do Estado de São Paulo SPTC-SP, São José do Rio Preto, São Paulo, Brazil
*Author; e-mail: rafael.rrc@policiacientifica.sp.gov.br

INTRODUCTION

- 19,8%
- 70% homicides in Brazil by firearms[1]
- 16,1%
- 13,4% [2]
- 25,2%
- 14,9%
- 10,6%
- 30% solved[3]
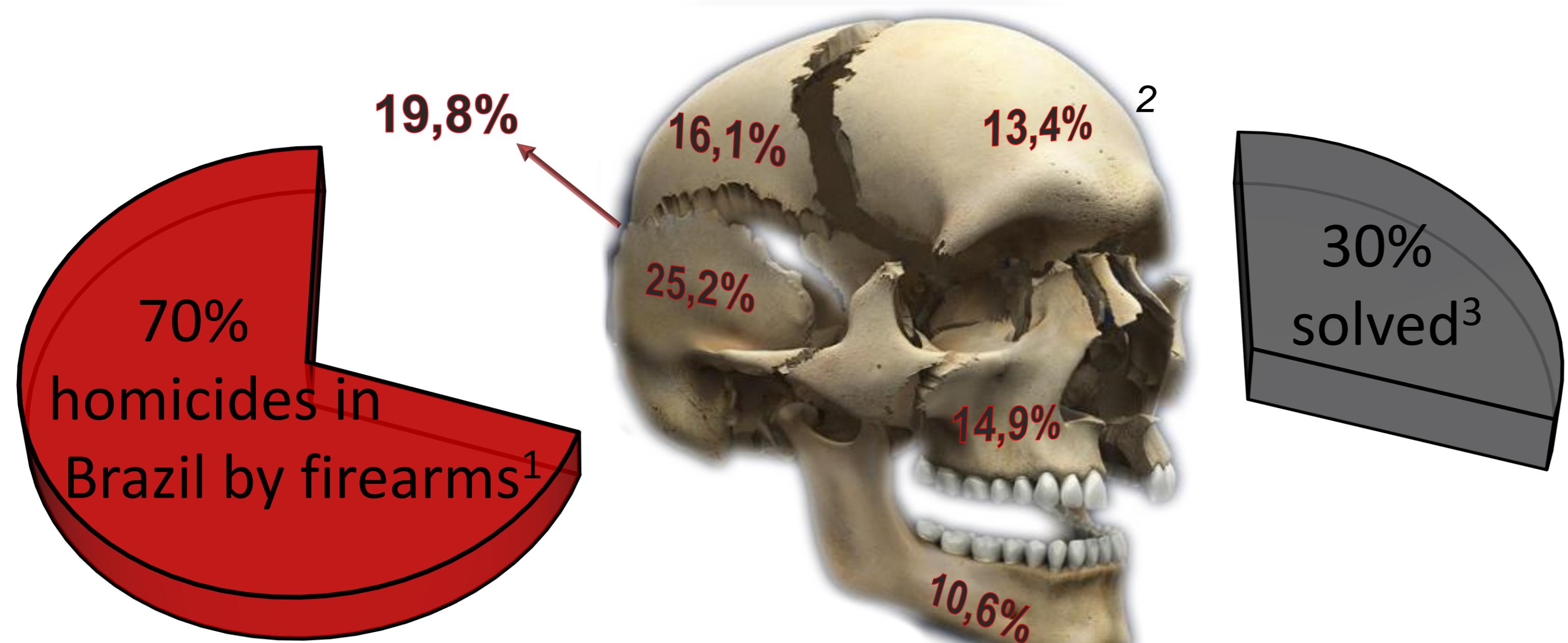
GOAL: Develop a procedure using simple, fast and low-cost photogrammetry technique to assess projectile compression in different targets, calibers, varying shooter distance to establish a relationship within the specific deformation changing.

EXPERIMENTAL

FMJ (120)
- 9mm LUGER
- .40 S&W
- .38 SPL
- .380 AUTO

Targets
- Clay and Concrete Brick
- Dense wood
- PlyWood+clay brick
- Steel plate

Distances
- 5m
- 10m
- 20m
- 30m
- 40m

Analysis
- 4262 files
- 13.3 GB
- Calibration cubes
- 3DF Zephyr
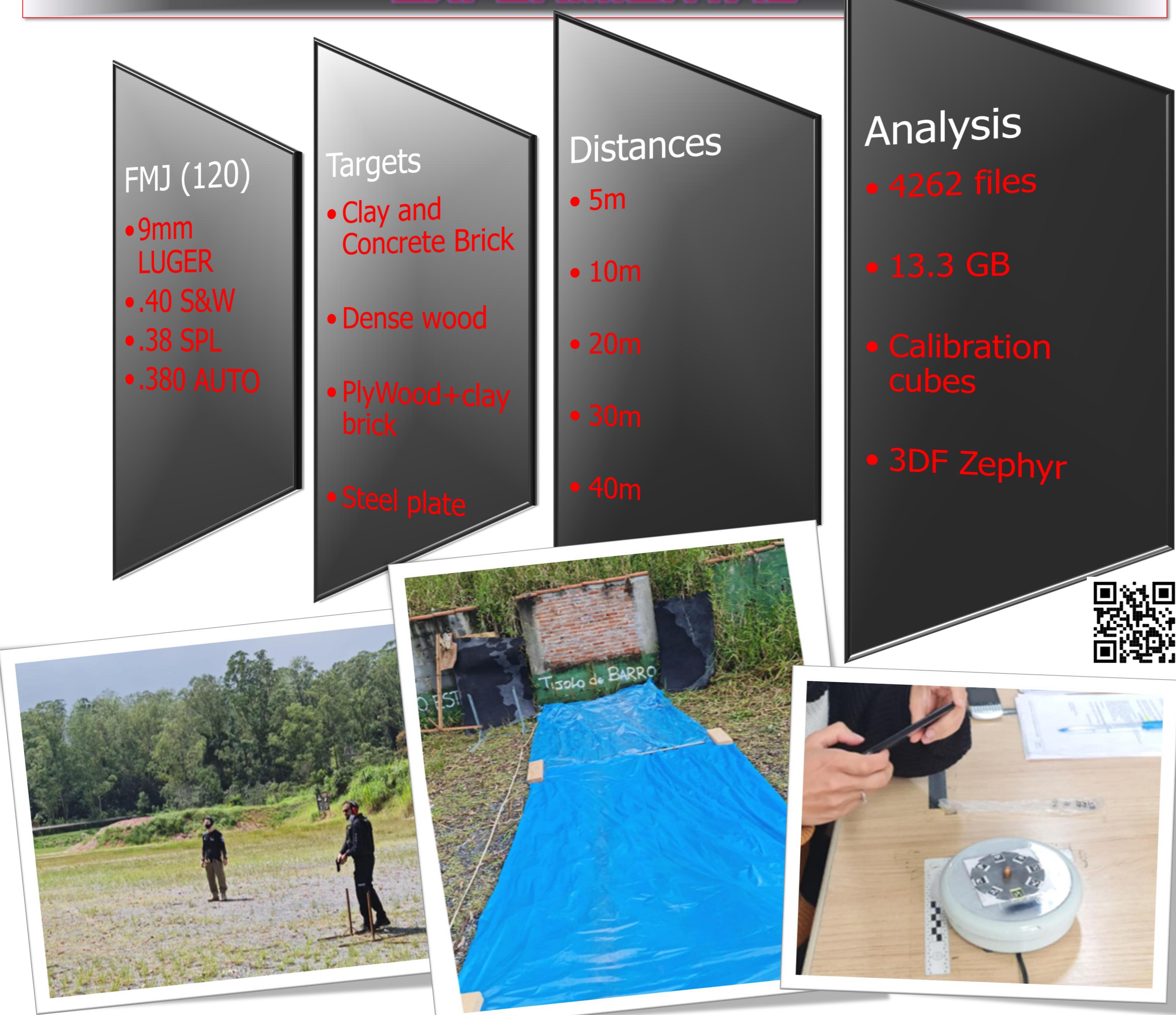
RESULTS AND DISCUSSIONS

Photogrammetry

Figure 1. Photogrammetry of 9mm Luger shots against clay brick. No deformation was calculated for projectiles after hitting steel plates targets due fragmentation.

Natural Heterogeneity

.380 AUTO   9mm Luger   .38 SPL   .40 S&W
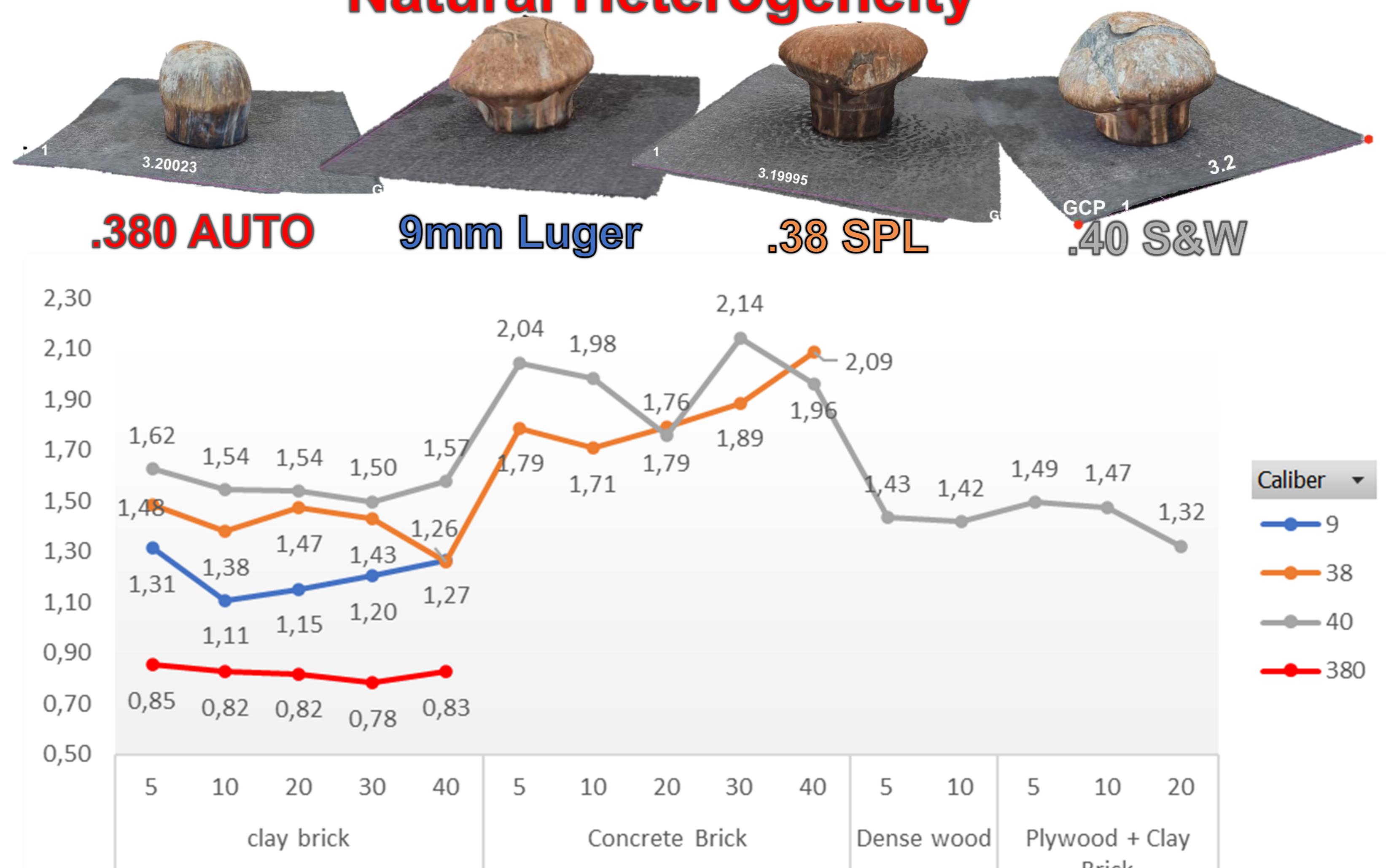
Figure 2. Mean deformation in each material and distances.

Table 1. Deformation with distances for each caliber.

Material	Distances				
	5 m	10 m	20 m	30 m	40 m
Clay Brick	1.28	1.26	1.30	1.23	1.24
Concrete Brick	1.92	1.82	1.77	2.01	2.02
Dense Wood	1.43	1.42	-	-	-
Plywood + ClayBrick	1.49	1.47	1.32	-	-
Total	1.48	1.41	1.41	1.49	1.41

Table 2. Bootstrap multiple comparison tests.

Groups	Calibre	Mean	Groups	Material	Mean
A	.40 S&W	1.656	A	Concrete Brick	1.902
A	.38 SPL	1.600	B	Dense wood	1.427
B	9 mm LUGER	1.211	B	Plywood + Clay Brick	1.400
C	.380 AUTO	0.822	B	clay brick	1.264

Table 3. Bootstrap multiple comparison tests.

ANOVA	GL	SQ	QM	F	P-value
Distance	4	0.125	0.031	0.548	0.70065
Caliber	3	10.008	3.336	58.40	0.00000
Residue	98	5.597	0.057		

CONCLUSIONS

Photogrammetry has shown the expected result concerning lower mass and energy with smaller deformations. The .380 AUTO deforms less than 9mm Luger, showing potential to differentiate both, while .40 S&W and .38 SPL present similar deformation.

On the other hand, distinct distances from 5m to 40m did not affect the volume of the slugs (p-valor >0.05).

REFERENCES

[1] BRASIL, Min da Saúde. Banco de dados do Sistema Único de Saúde-DATASUS
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ACKNOWLEDGEMENTS