Military Institute of Armament Technology
POLAND

The numerical optimization of the novel kinetic energy penetrator for tank guns

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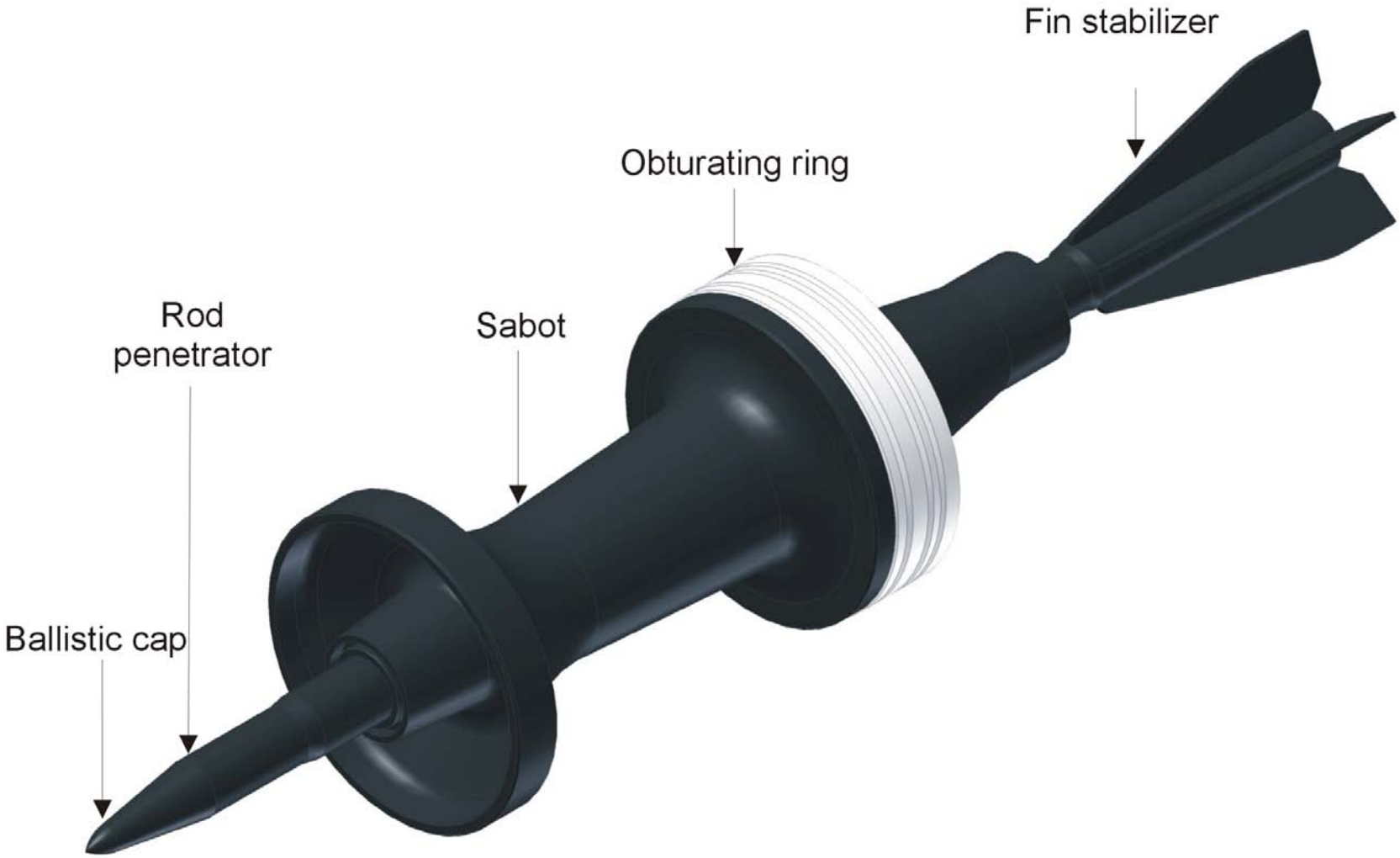
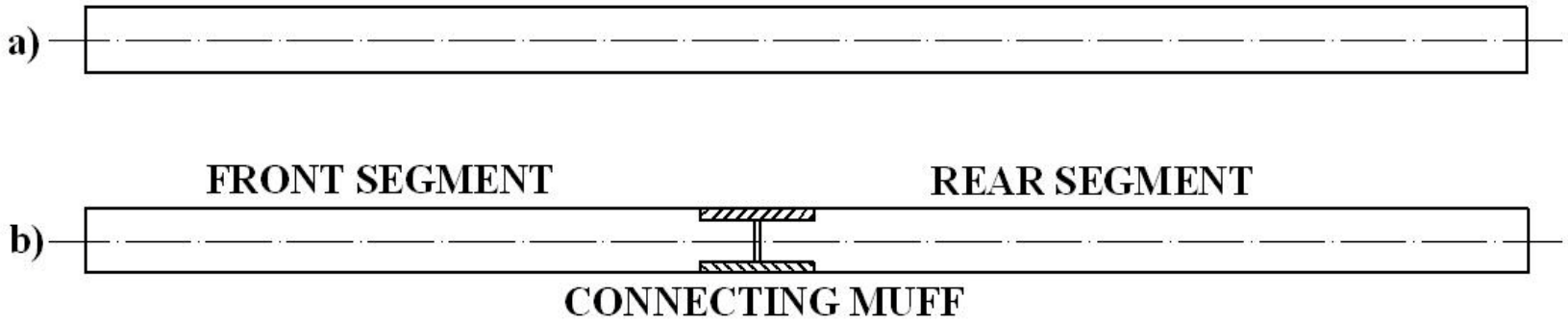
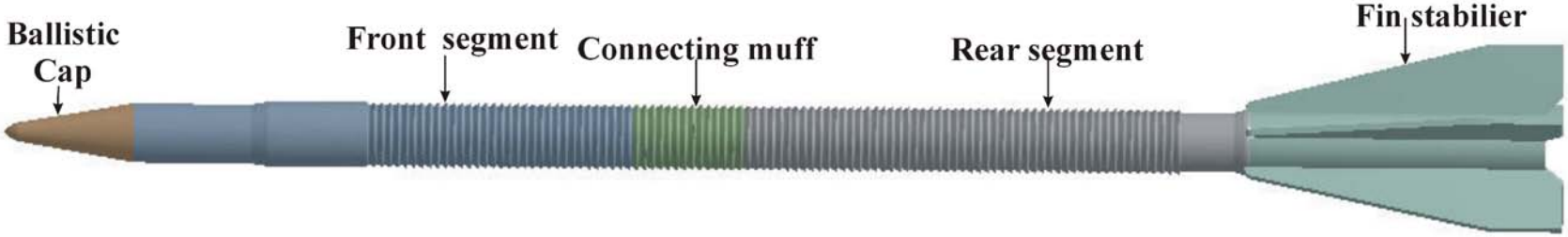


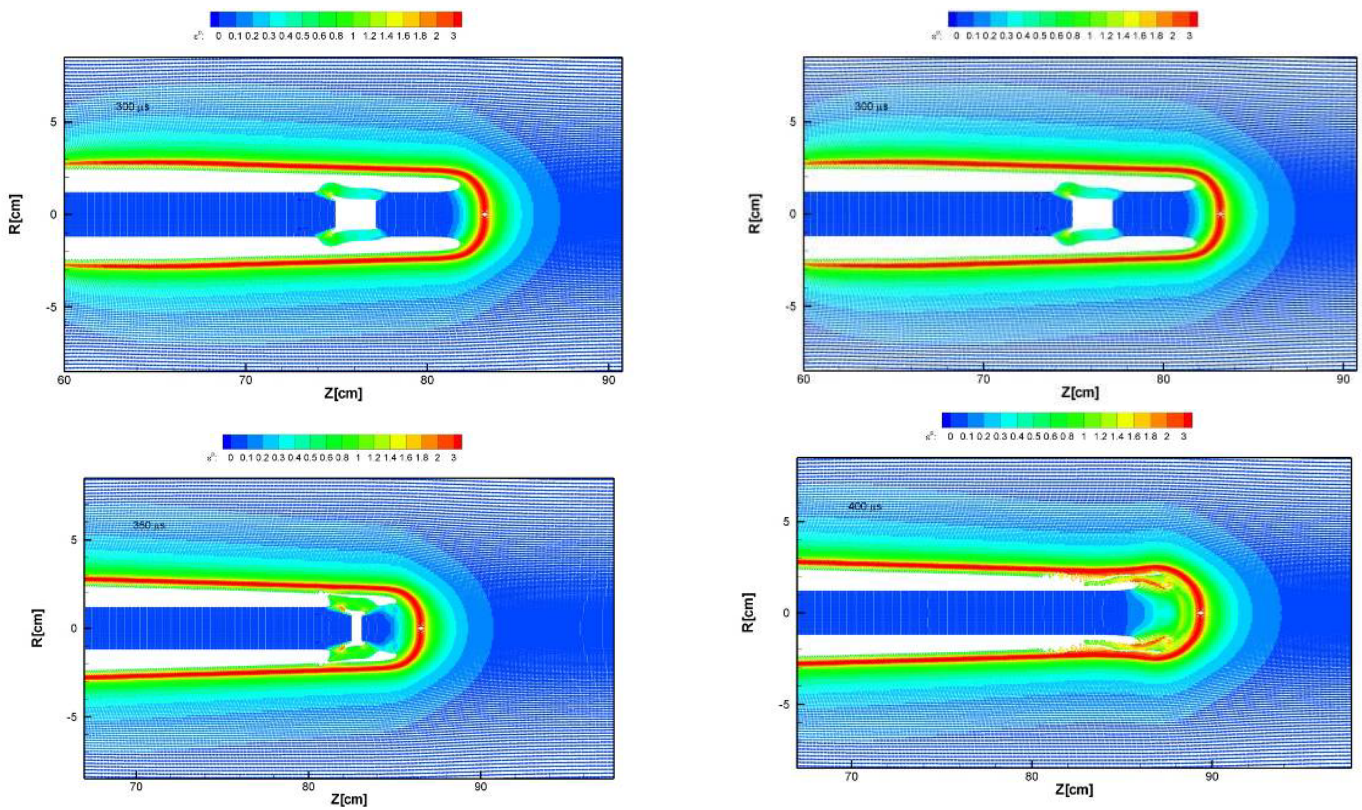
Component parts of the APFSDS projectile.

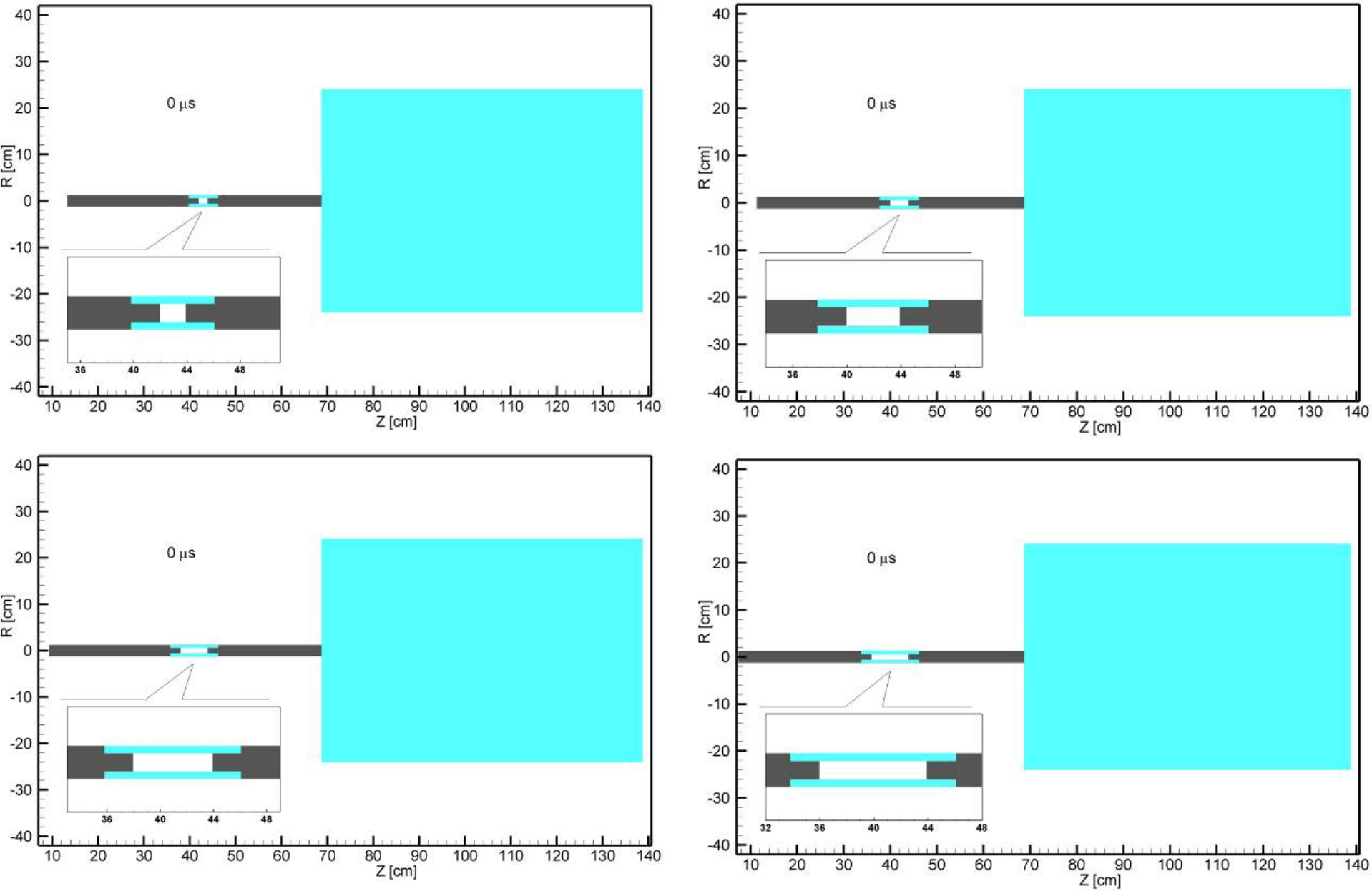




Subcalibre projectile with segmented penetrator (MIAT-Poland)

During 25th ISB in China was present the poster with conception of the of the segmented kinetic energy penetrators for tank guns. The penetrator is composed of two tungsten alloy pieces connected by screwed steel muff. The axial deformation of the connecting muff during penetration process results in decreasing of the distance between tungsten segments. For this reason the rear segment can hit the front segment to give it some additional kinetic energy enhancing penetration depth. During simulations process it was established that for one of the developing variants the penetration depth increases by 10% in comparison with penetration depth of the real penetrator with the same weight and dimension. In the new concept called "*forced segmented penetration*", thanks to application of the 5 cm length connection muff, the penetration depth increased by 10% in comparison with penetrations depth of the monolithic penetrator with the same weight and diameter. This kind of segmented penetration phenomena wasn't presented before.



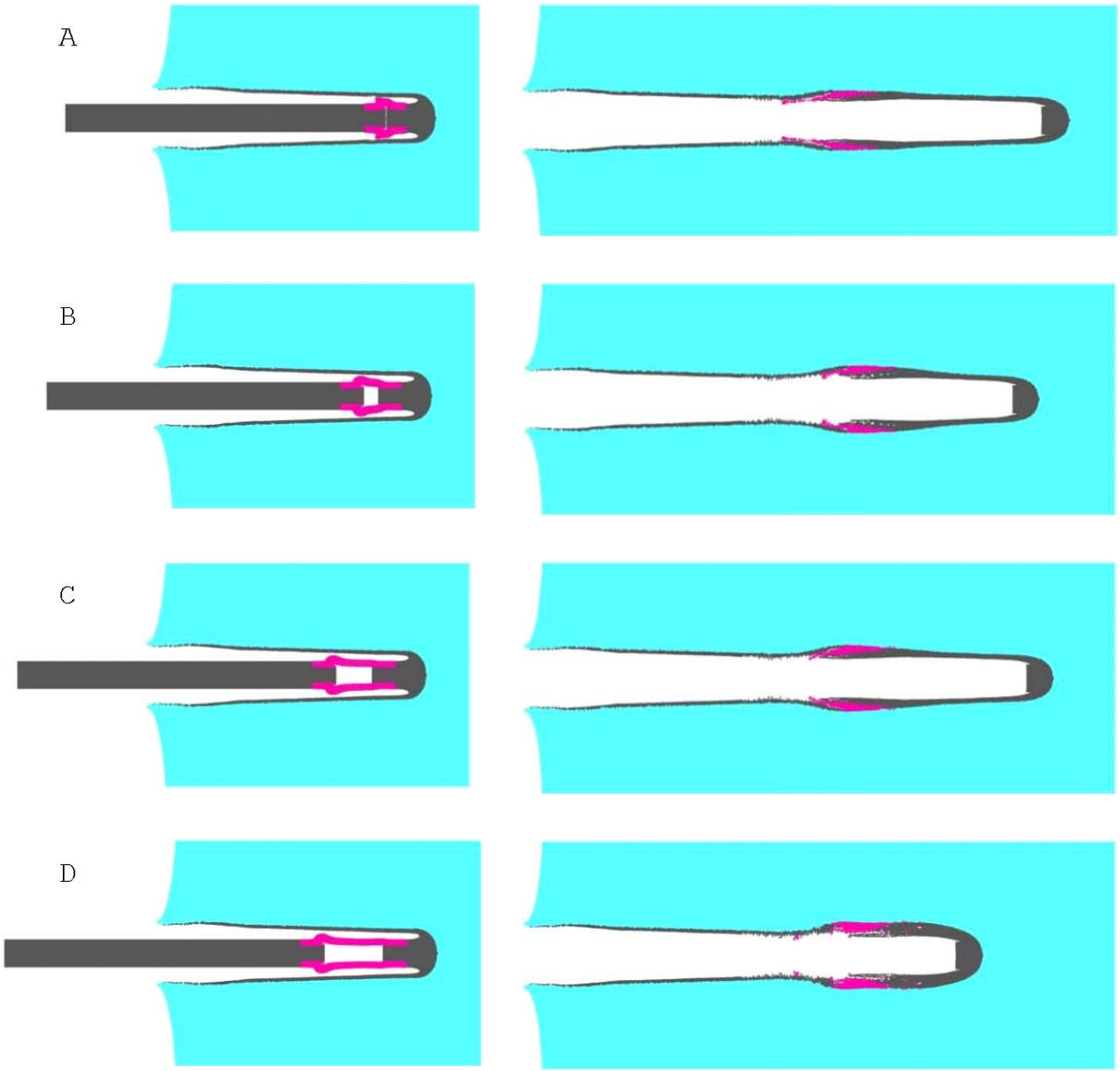


The variants of the segmented penetrators analyzed during optimization.
Distance between tungsten rods: 2, 4, 6, 8 cm.

Configuration of the successive variants

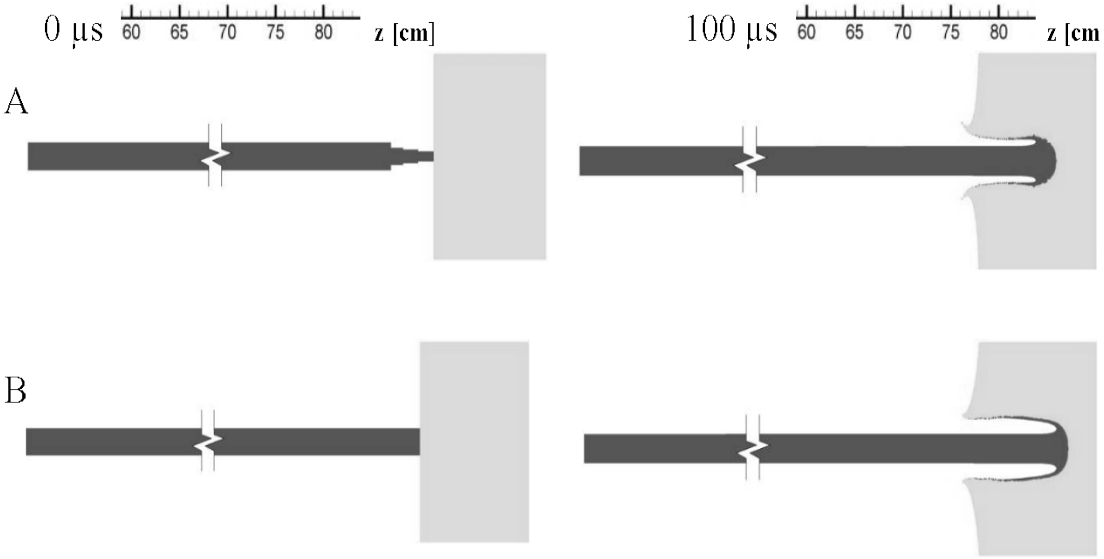
Variants number	Penetrator diameter d [cm]	Penetrator length l [cm]	Hit velocity v(m/s)	Penetrator weight m [g]	Depth of Penetration DOP [cm]	Distance between tungsten rods z [cm]
A	2,3	55,4	1550	3597	46,80	2
B		57,4		3635	44,30	4
C		59,4		3672	45,51	6
D		61,4		3710	39,23	8

Numerical optimization of the distance between tungsten rods

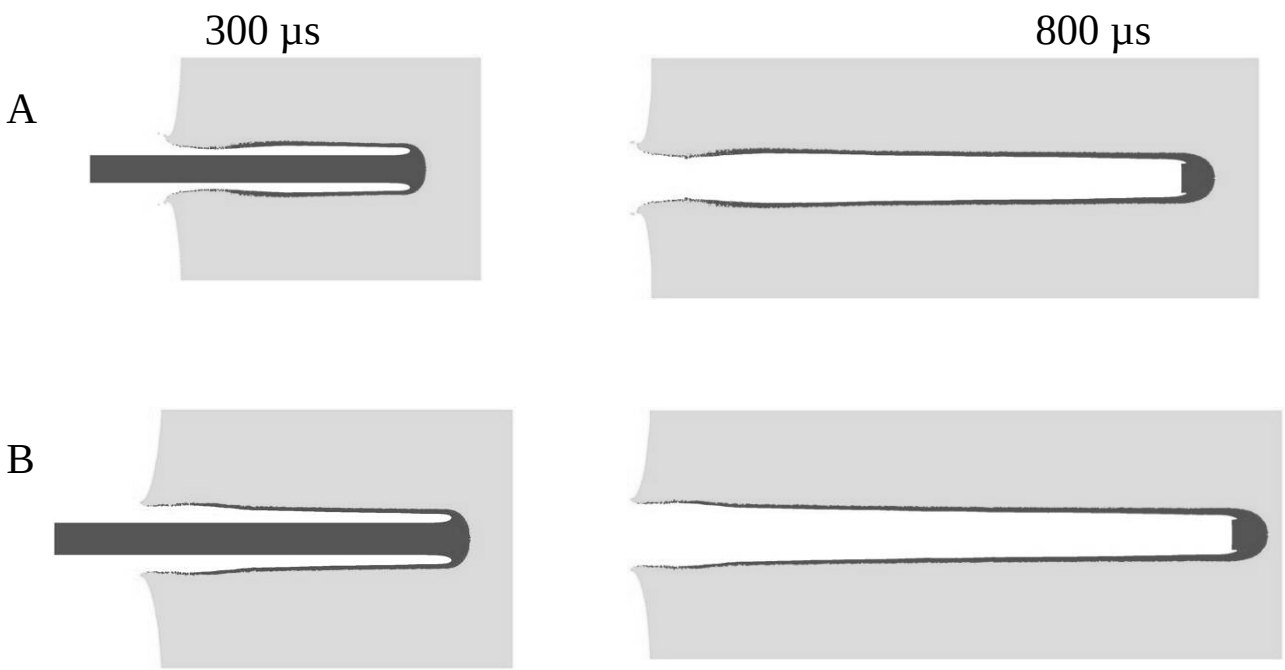


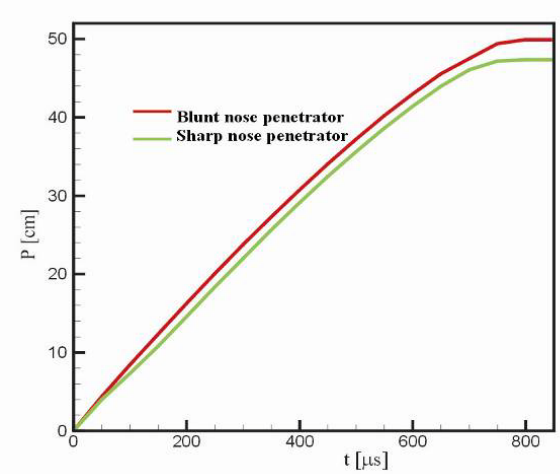
During optimization process it was established that for B variant the penetration depth is similar to the depth for penetrator C. For A variant the penetration depth increases about 5% in comparison with the penetration depth of B and C variants. The penetration depth for variant D decreases about 10% in comparison with the penetration depth of B and C variants. The probable reason is the phenomenon of slowing down of the long connection muff because of getting stuck inside the penetration crater.

Analyses of penetration process with different shapes of the penetrator nose



It is visible that the crater is thinner and shallower for the sharp nose penetrator. It is necessary to be told that the weight of the sharp nose penetrator is about 5% lower in comparison with the blunt nose penetrator





Conclusions

On the base of the numerical results the following conclusions may be drawn:

1. **During optimization process it was established that for B variant the penetration depth is similar to the depth for penetrator C. For A variant the penetration depth increases about 5% in comparison with the penetration depth of B and C variants. The penetration depth for variant D decreases about 10% in comparison with the penetration depth of B and C variants. The probable reason is the phenomenon of slowing down of the long connection muff because of getting stuck inside the penetration crater.**
2. **During analyses of penetration process with different shapes of the penetrator nose it turned out that the crater is thinner and shallower for the sharp nose penetrator in comparison with the blunt nose penetrator.**
3. **According to conclusions 1 and 2 it was decided to develop and produce the subcalibre projectiles with the A and B penetrator variants. For both variants the blunt nose will be applied. The firing test of APFSDS-T rounds with the novel segmented penetrators will be conducted on the Military Institute of Armament Technology (*MIAT*) testing ground. During these tests the projectiles will be fired from ballistic gun to *RHA* plates to compare the penetration depth.**

The results of the firing test will be presented in the next paper.

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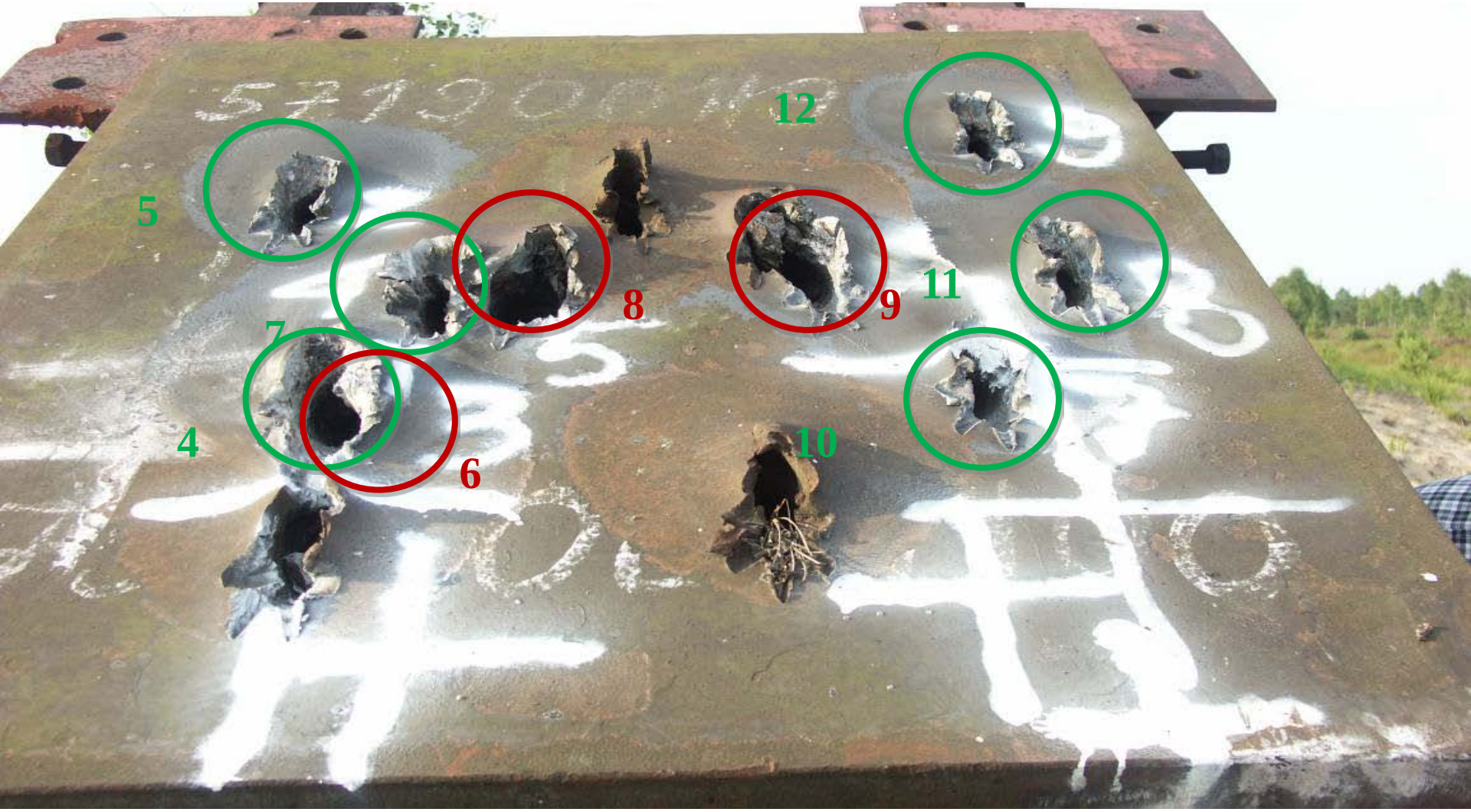
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