ALMAZ • ANTEY
CONCERN

Concern VKO Almaz-Antey

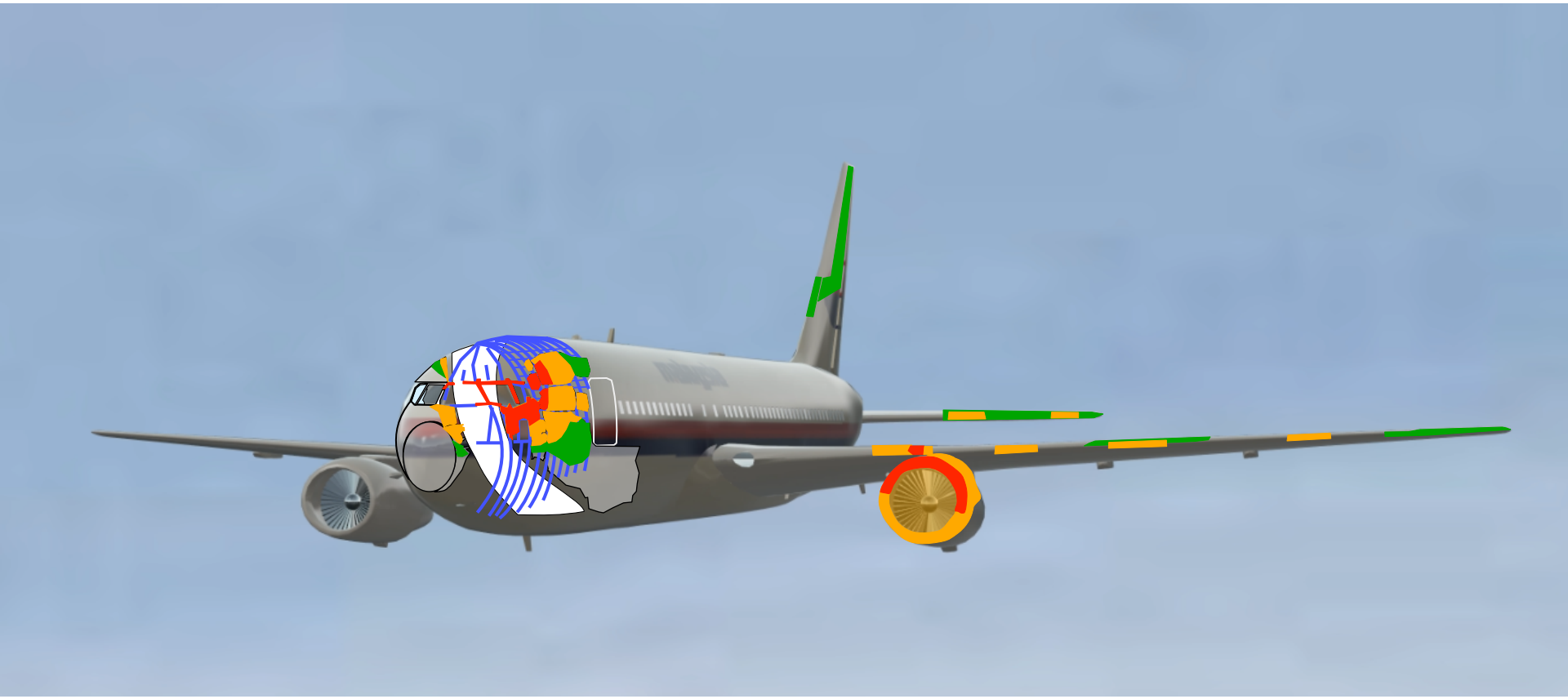
RESULTS OF
Full-scale Real-life Experiment to Analyze Causes of MH17 Aircraft Crash

Moscow– 2015

1. ELABORATE ON TYPE OF MISSILE

2. VALIDATE CONDITIONS AT WHICH MISSILE HIT AIRCRAFT

Damage Assessment of Boeing-777 MH17



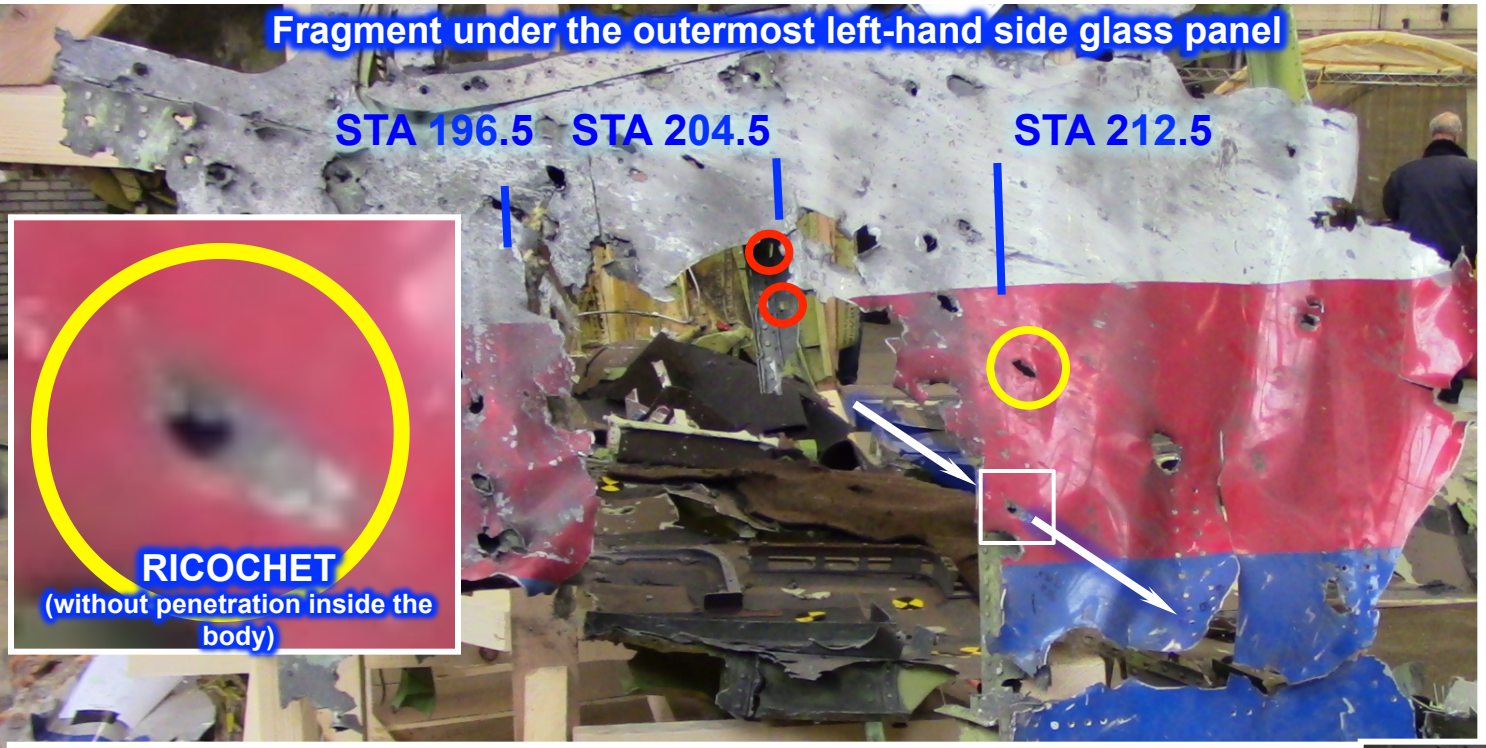
MAIN DAMAGES :

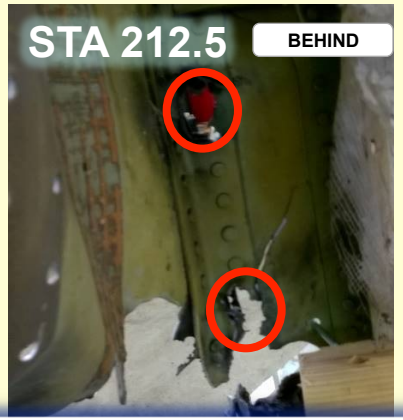
1. Cockpit, primarily the left side
2. Aircraft superstructure, primarily main frames
3. Cockpit internals
4. Left wing
5. Left engine
6. Left section of the stabilizer and empennage (tail fin)

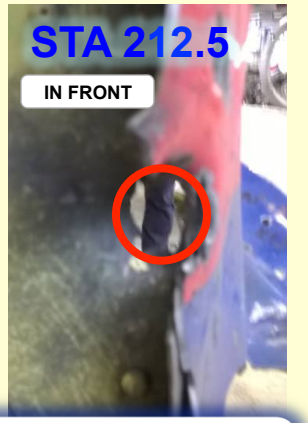
INTENSITY OF STRUCTURAL DAMAGE TO AIRCRAFT:

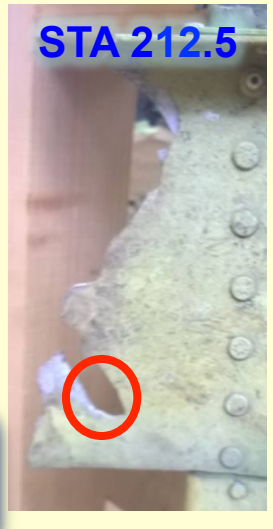
- DESTRUCTION OF AIRCRAFT SUPERSTRUCTURE
- SEVERE DAMAGES
- MODERATE DAMAGES
- SLIGHT (RICOCHETING) DAMAGES

Damages to Left-hand Side of Cockpit



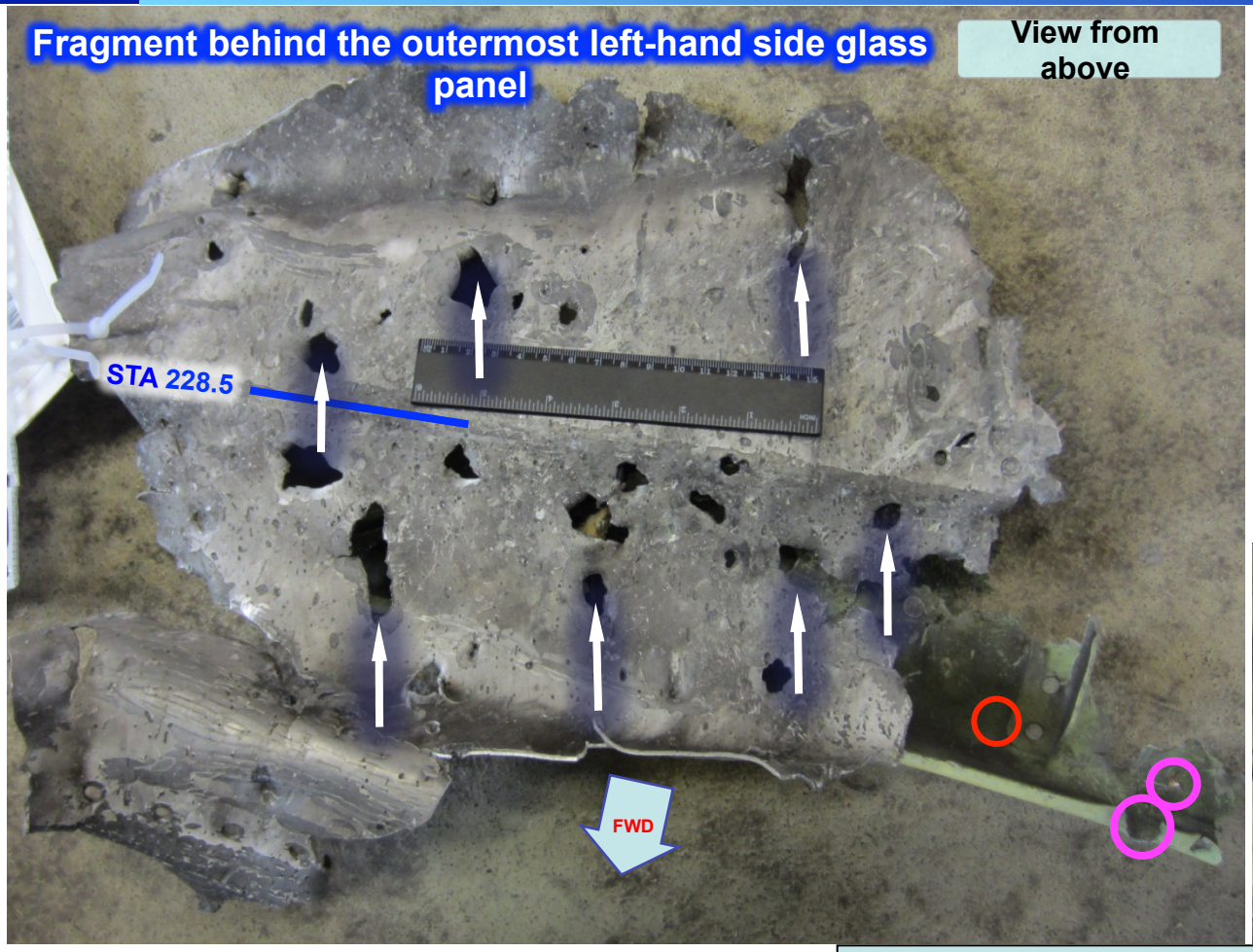




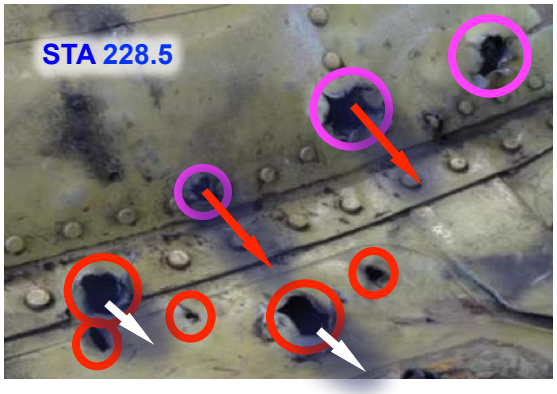


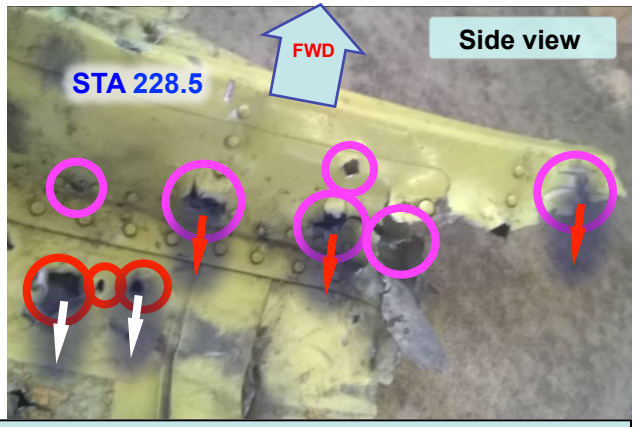
SUB-MUNITIONS WERE MOVING ALONGSIDE AIRCRAFT BODY

Damages to Left-hand Side of Cockpit

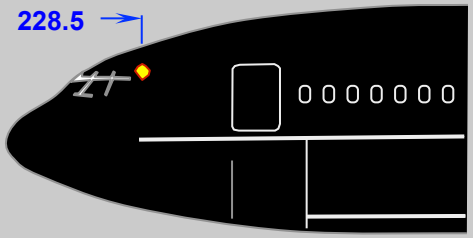


View from inside





Fragment location in the MH17body



LEGEND

228.5 — LAYOUT OF AIRCRAFT SUPERSTRUCTURE ELEMENTS

ENTRY HOLES IN FUSELAGE OUTER SKIN

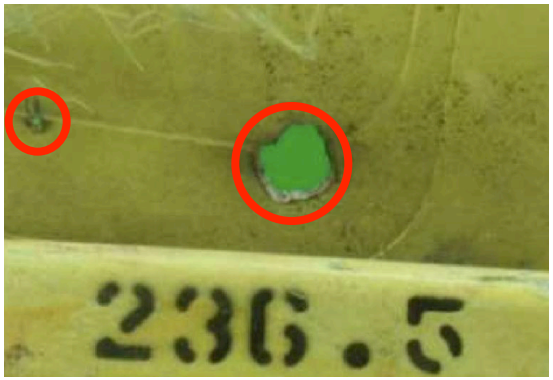
OPEN-END HOLES IN TRANSVERSAL ELEMENTS OF SUPERSTRUCTURE (MAINFRAMES)

WHITE ARROWS INDICATE DIRECTION OF MOVING SUB-MUNIOTOINS (BY ALIGNING WITH ENTRY HOLES IN OUTER SKIN WITH HOLES IN MAIN FRAMES)

RED ARROWS INDICATE DIRECTION OF MOVING SUB-MUNIOTOINS THROUGH TRANSVERSAL ELEMENTS OF SUPERSTRUCTURE (MAINFRAMES)

Damages to Left-hand Side of Cockpit

View from inside



Fragment behind the outermost left-hand side glass panel

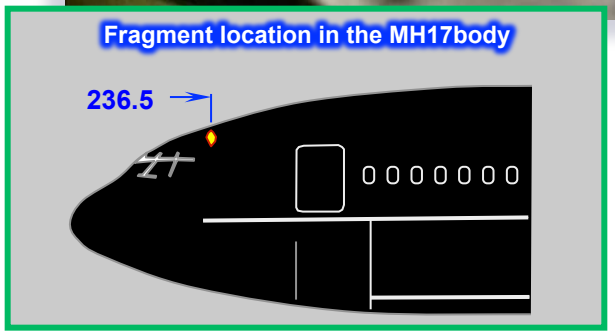
View from outside

Side view

Hole form
DIAMOND
(HIGH INTENSITY)

SUB-MUNITIONS WERE MOVING ALONGSIDE AIRCRAFT BODY

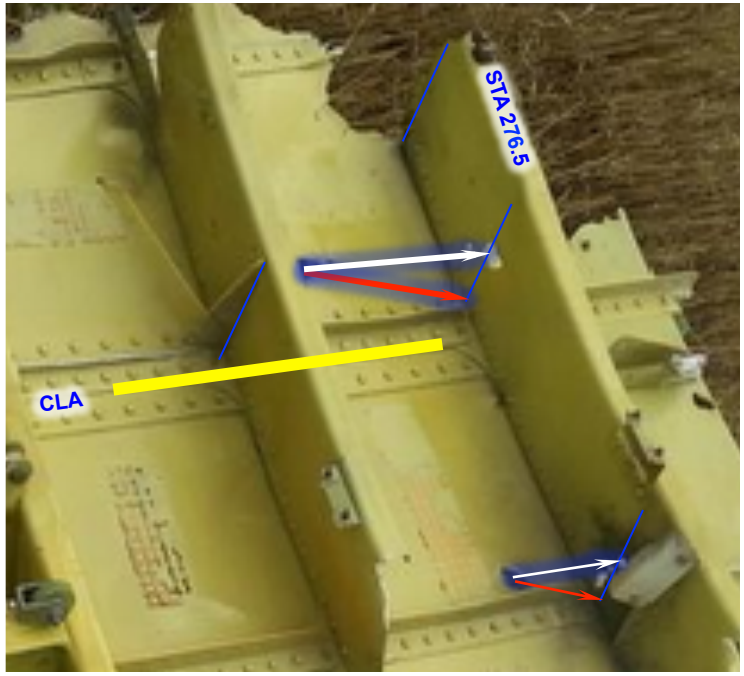
Damages to Left-hand Side of Cockpit

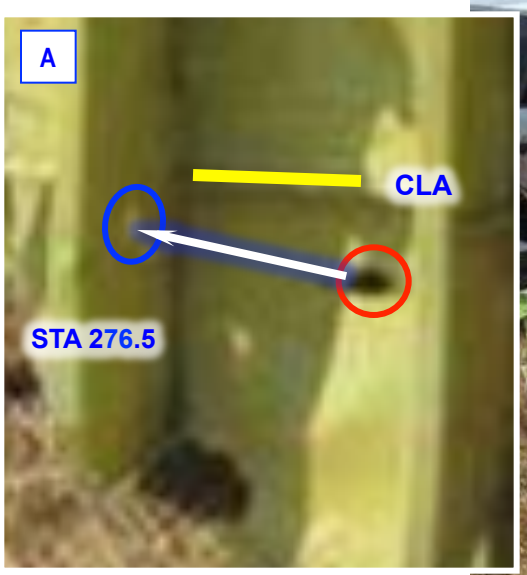


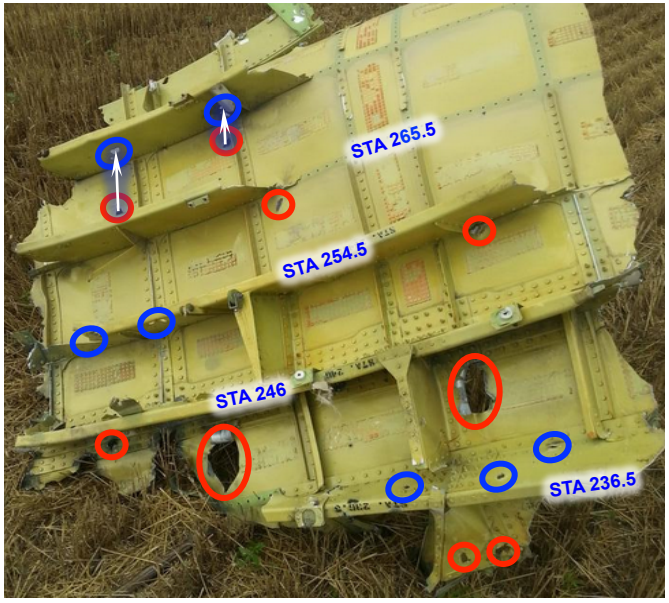
LEGEND

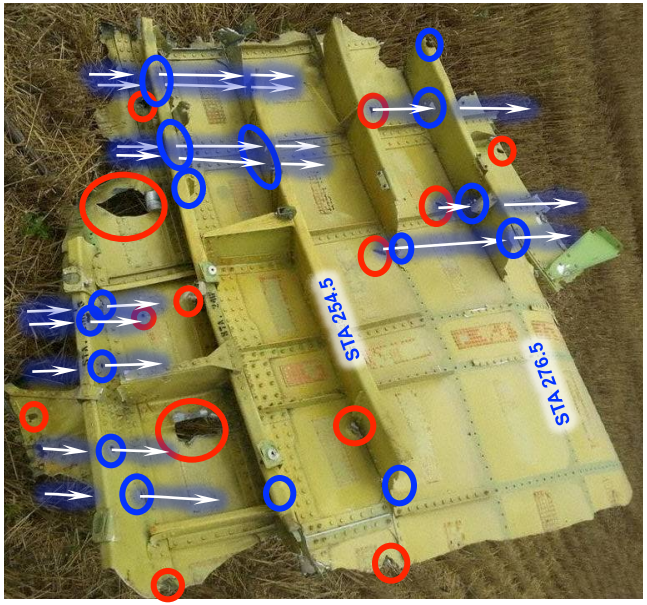
- 236.5 — LAYOUT OF AIRCRAFT SUPERSTRUCTURE ELEMENTS
- ENTRY HOLES IN FUSELAGE OUTER SKIN
- OPEN-END HOLES IN TRANSVERSAL ELEMENTS OF SUPERSTRUCTURE (MAINFRAMES)
- WHITE ARROWS INDICATE DIRECTION OF MOVING FRAGMENTS (BY ALIGNING WITH ENTRY HOLES IN OUTER SKIN WITH HOLES IN MAIN FRAMES)
- RED ARROWS INDICATE DIRECTION OF MOVING DETONATION PRODUCTS

Damages to Roof above Cockpit



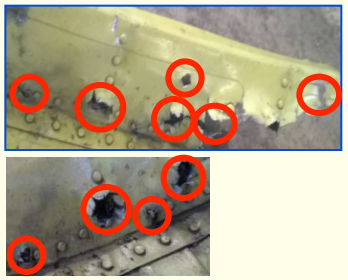






Damages to Traverse Superstructure (Main Frames)

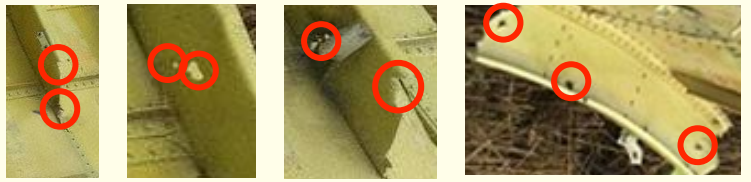
STA 228.5

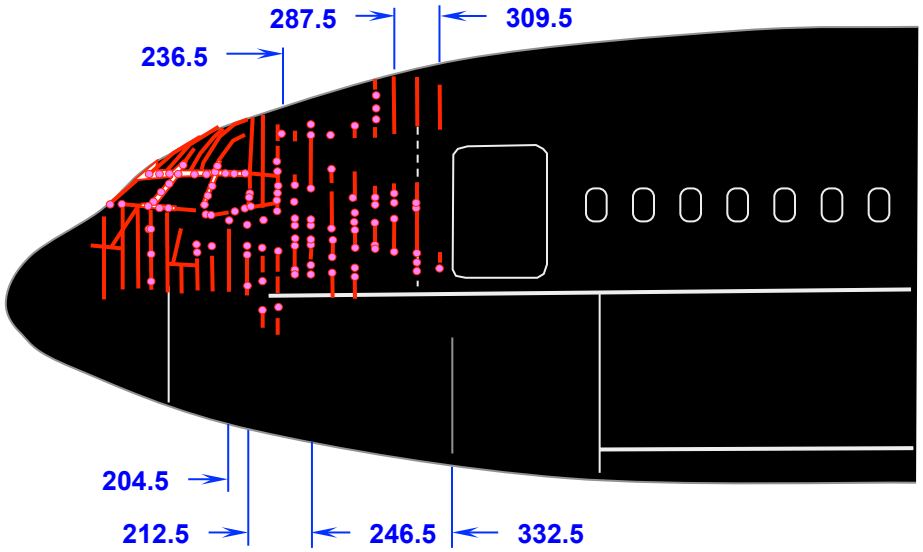


STA 236.5

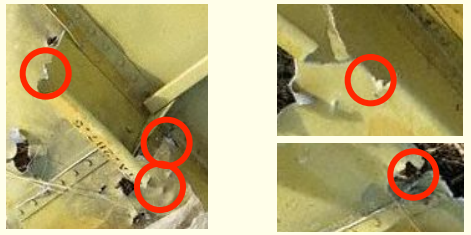
STA 246 – 254.5

STA 265.5 – 276.5





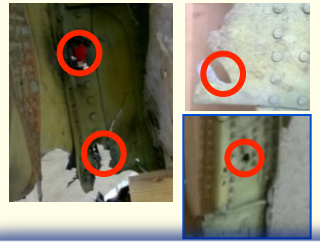
STA 287.5 – 309.5



STA 196.5 – 204.5

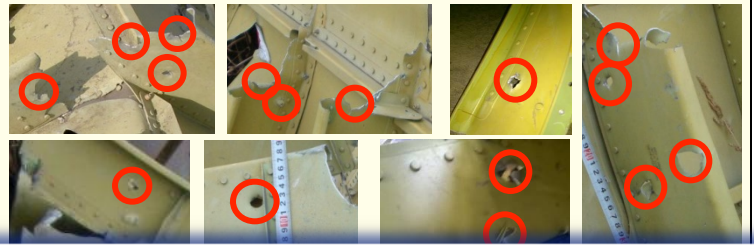
STA 287.5 – 309.5

STA 212.5



STA 228,5

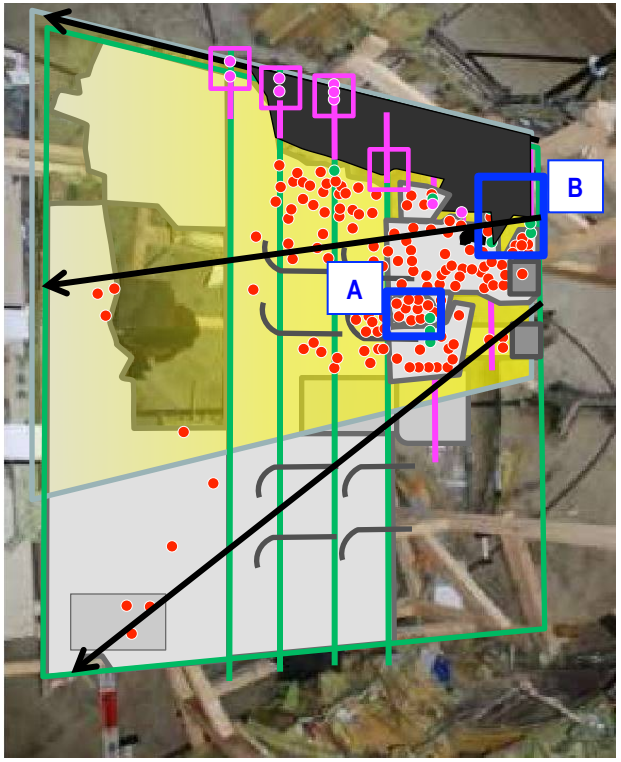
STA 246 – 276.5



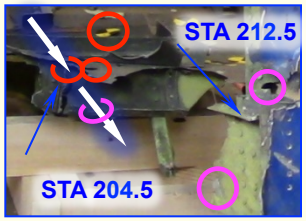
DAMAGES TO SUPERSTRUCTURE (MAIN FRAMES) ARE LOCATED MUCH FURTHER AWAY FROM DAMAGES TO OUTER SKIN

Damages to Cockpit's Internals

Distribution of the damage density over the cockpit floor

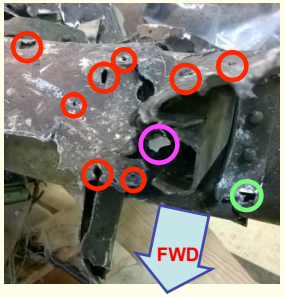


BREAKUP OF MAIN FRAMES



LEFT SIDE OF COCKPIT FLOOR

B



A — **PIC'S CONTROL COLUMN**

Open-end holes on the right-hand side of the control column cannot be made without the body break-up unless the sub-munitions were moving from the left-hand side.

SUB-MUNITIONS WERE MOVING ALONGSIDE AIRCRAFT BODY

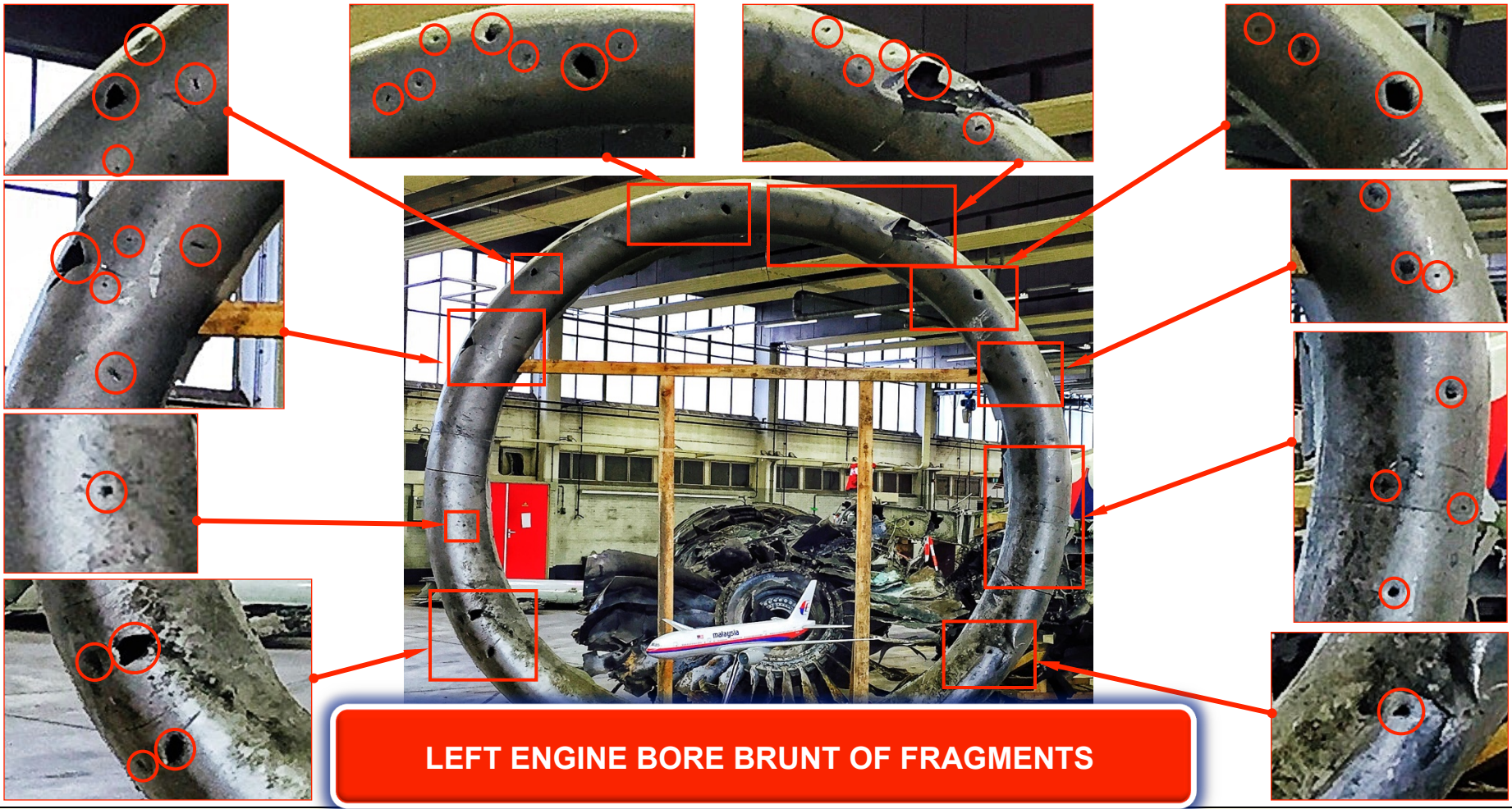
LEGEND

- 212.5 — SUPERSTRUCTURE ELEMENTS (MAIN FRAMES)
- ENTRY HOLES IN COCKPIT FLOOR
- OPEN-END HOLES IN MAIN FRAMES
- BREAKUP OF MAIN FRAMES
- WHITE ARROWS INDICATE DIRECTION OF MOVING FRAGMENTS
- COMPLETE DAMAGE AREA IN COCKPIT FLOOR

Damages to the Left Wing and Left-hand Side of Stabilizer

LEFT WING BORE BRUNT OF SHRAPNELS

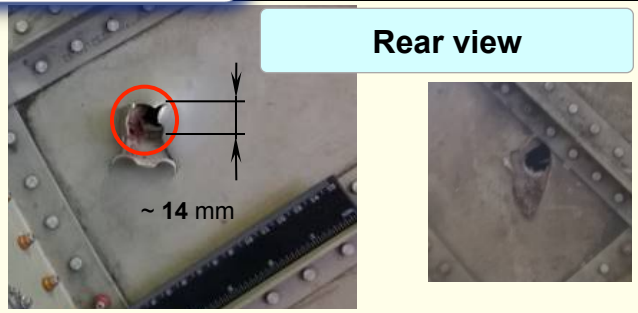
Damages to Left Engine



LEFT ENGINE BORE BRUNT OF FRAGMENTS

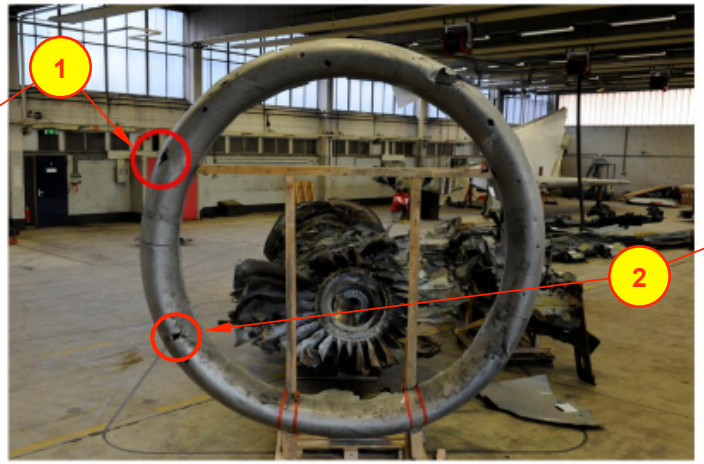
Front view

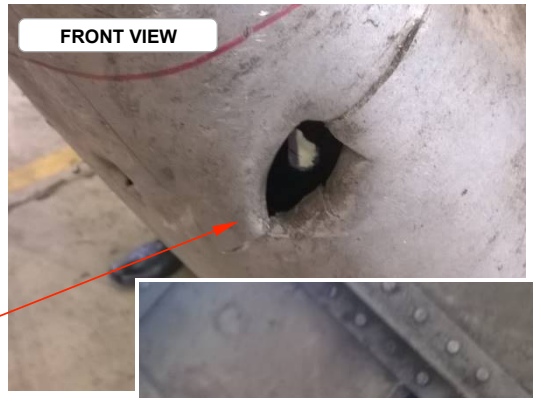
Rear view

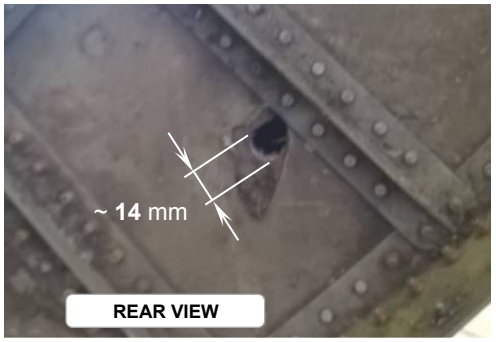


Damages to Left Engine

FRONT VIEW

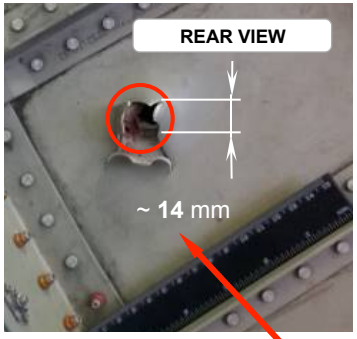


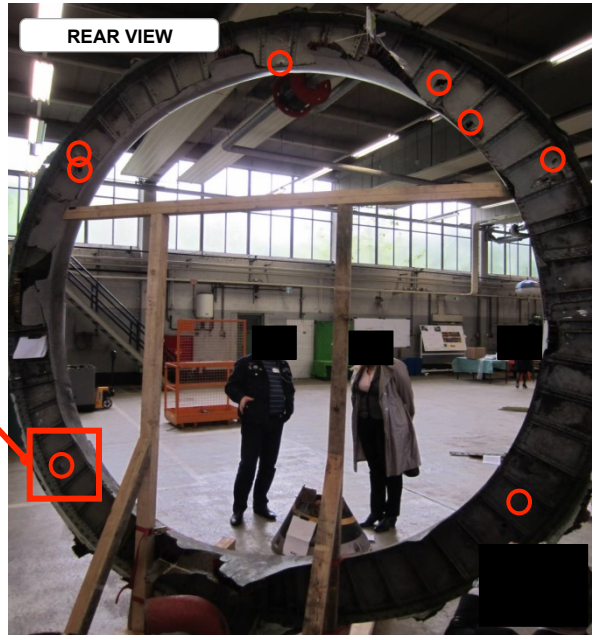




Hole Form
DIAMOND ~ 14 mm

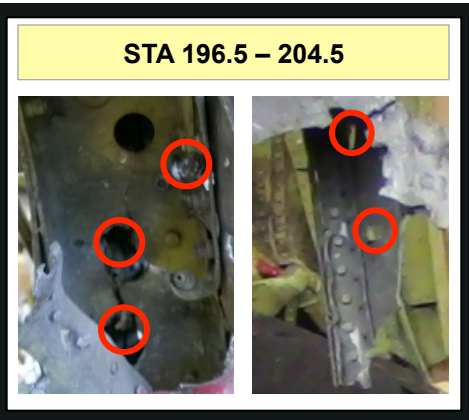
(HIGH INTENSITY)

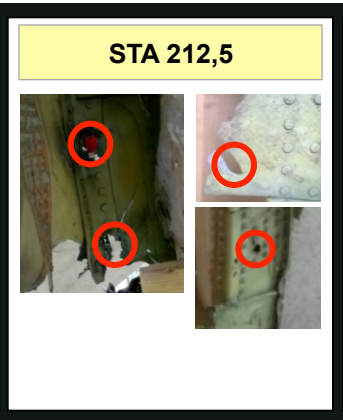


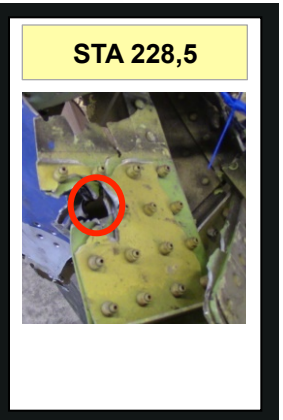


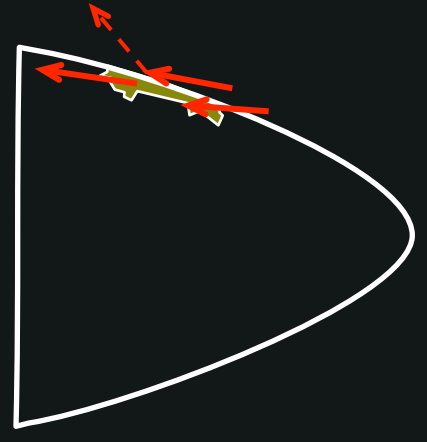
TWO OR MORE ELEMENTS OF THE AIRCRAFT BODY CAN BE PENETRATED ONLY BY HIGH-IMPACT ELEMENTS –PRE-FRAGMENTED ELEMENTS OF HIGH OR LOW DENSITY

Key Conclusions on Aircraft Damages









1. The break-up of the structural members (main frames) in the area of the left-hand side cockpit canopy could be caused only by a submunition moving along the aircraft body.

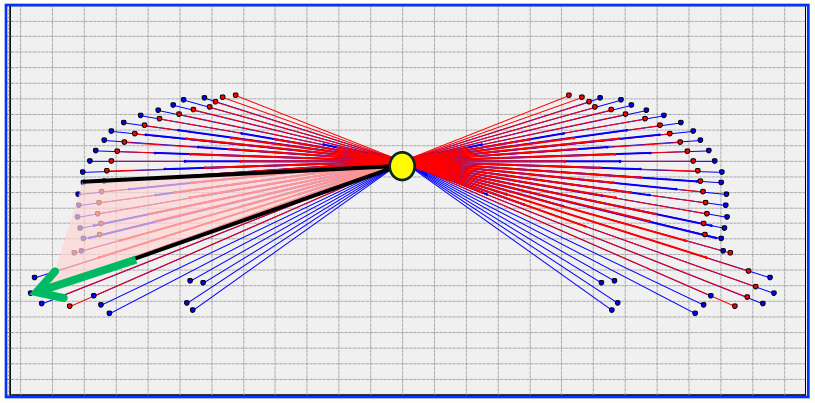
2. The damages to the left engine and left wing were inflicted by the impact of pre-armed submunitions and fragments of the missile body.


SIMULATION

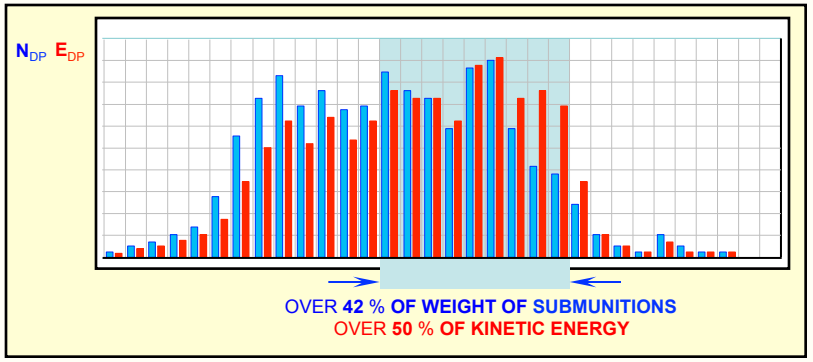
Specific Pattern of Fragments Front Generated by 9N314M WH

Static model of the warhead

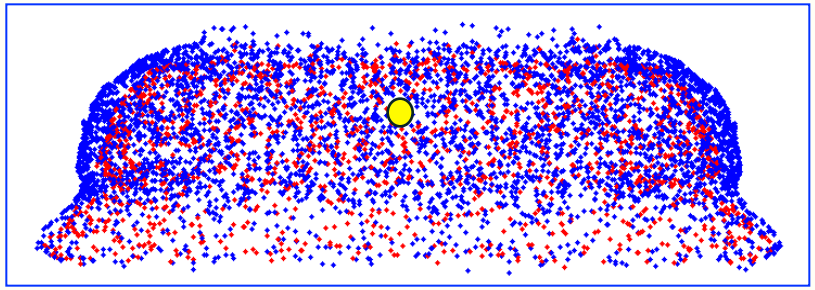
Specific distribution pattern of submunitions



Distribution of density and kinetic energy

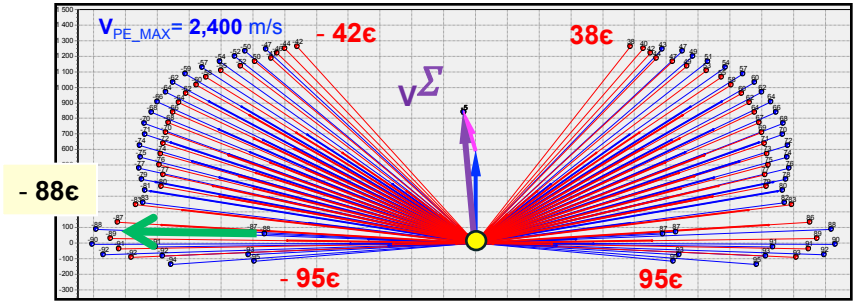


Submunition distribution model



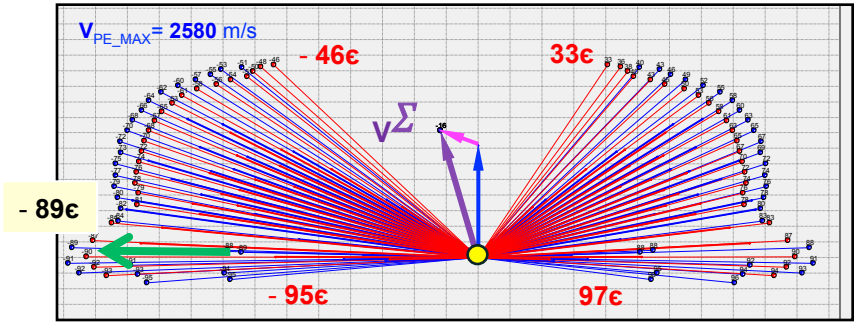
Dynamic model of the warhead

Launch from Snezhnoe scenario



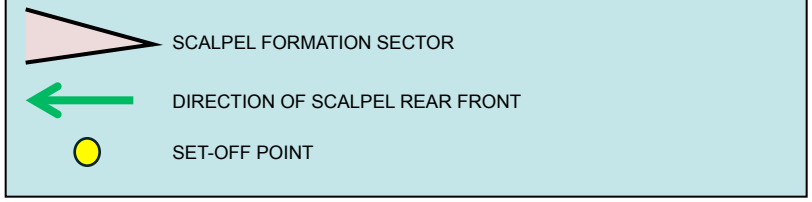
V_{9M38M1}= 600 m/s V_{B777}= 252 m/s

Version presented by Concern VKO Almaz-Antey

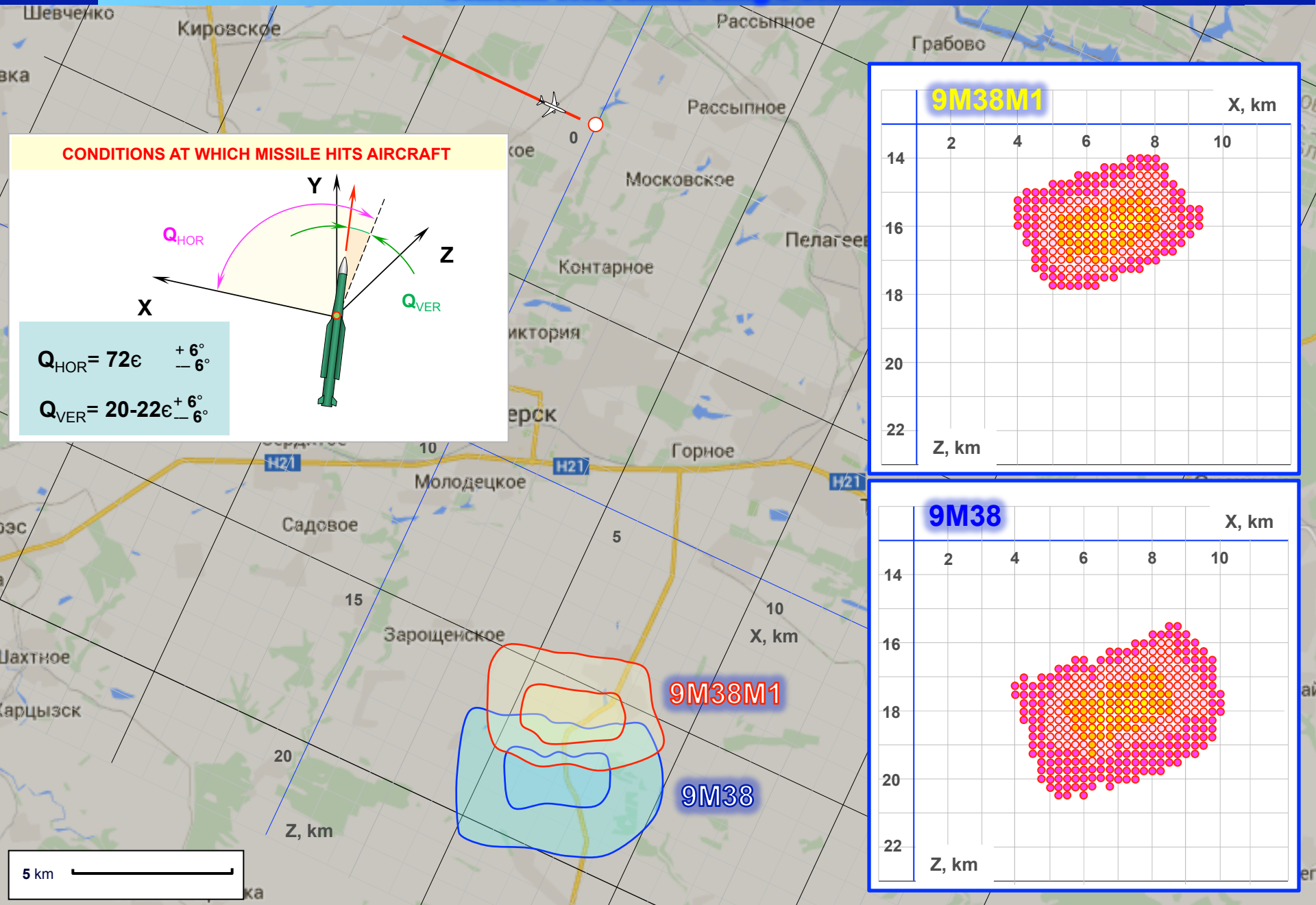


V_{9M38M1}= 730 m/s V_{B777}= 252 m/s

LEGEND



Simulated Results:
Concern VKO Almaz-Antey's Scenario

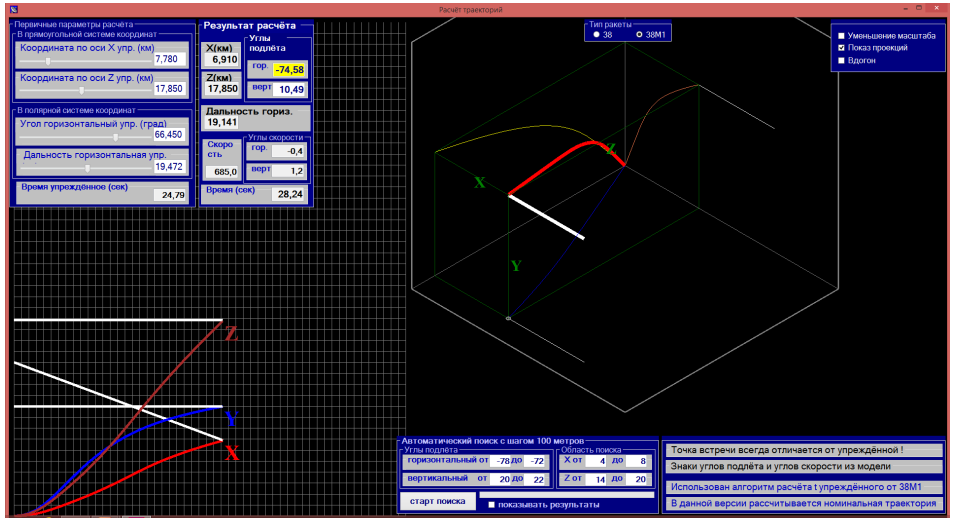


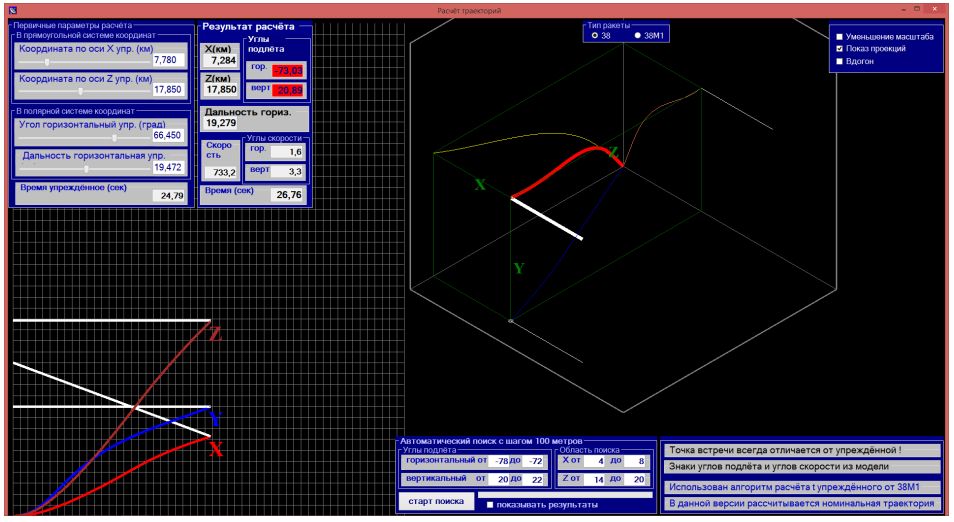
CONDITIONS AT WHICH MISSILE HITS AIRCRAFT

$Q_{HOR} = 72\epsilon^{+6^\circ}_{-6^\circ}$

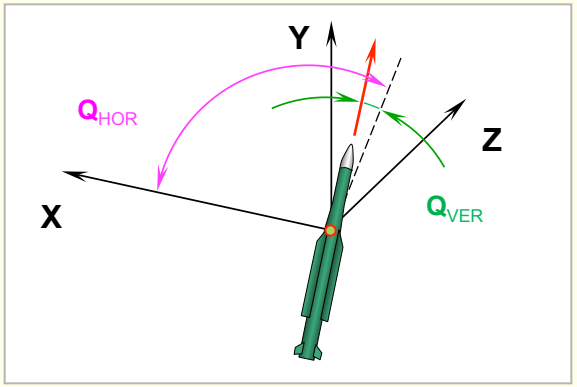
$Q_{VER} = 20\text{-}22\epsilon^{+6^\circ}_{-6^\circ}$

Simulation Results:
Concern VKO Almaz-Antey's Scenario





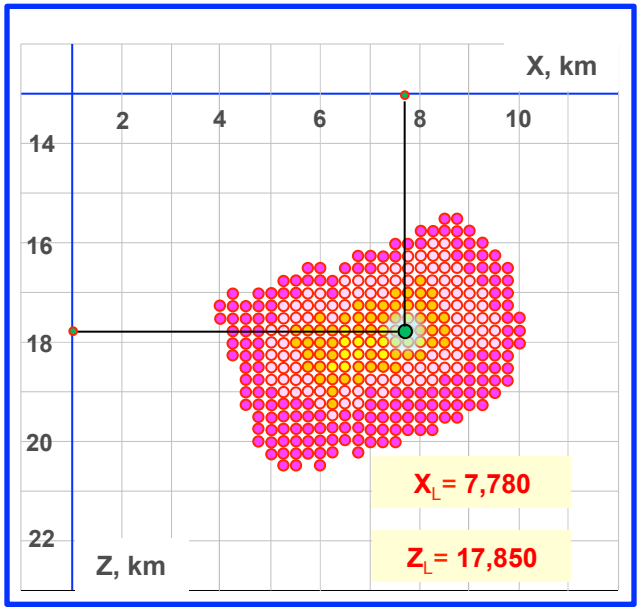
9M38M1



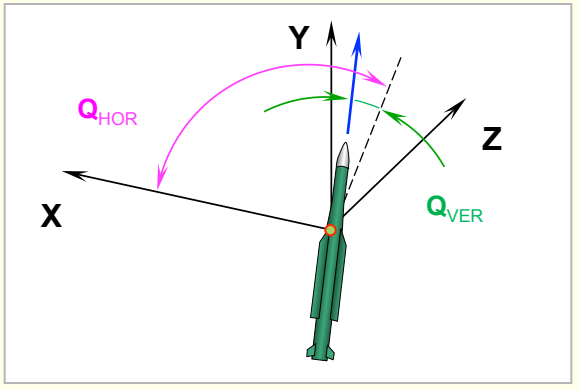
Q_{HOR}= 74.58є

Q_{VER}= 10,49є

V_{9M38M1} ~ 685 m/s



9M38

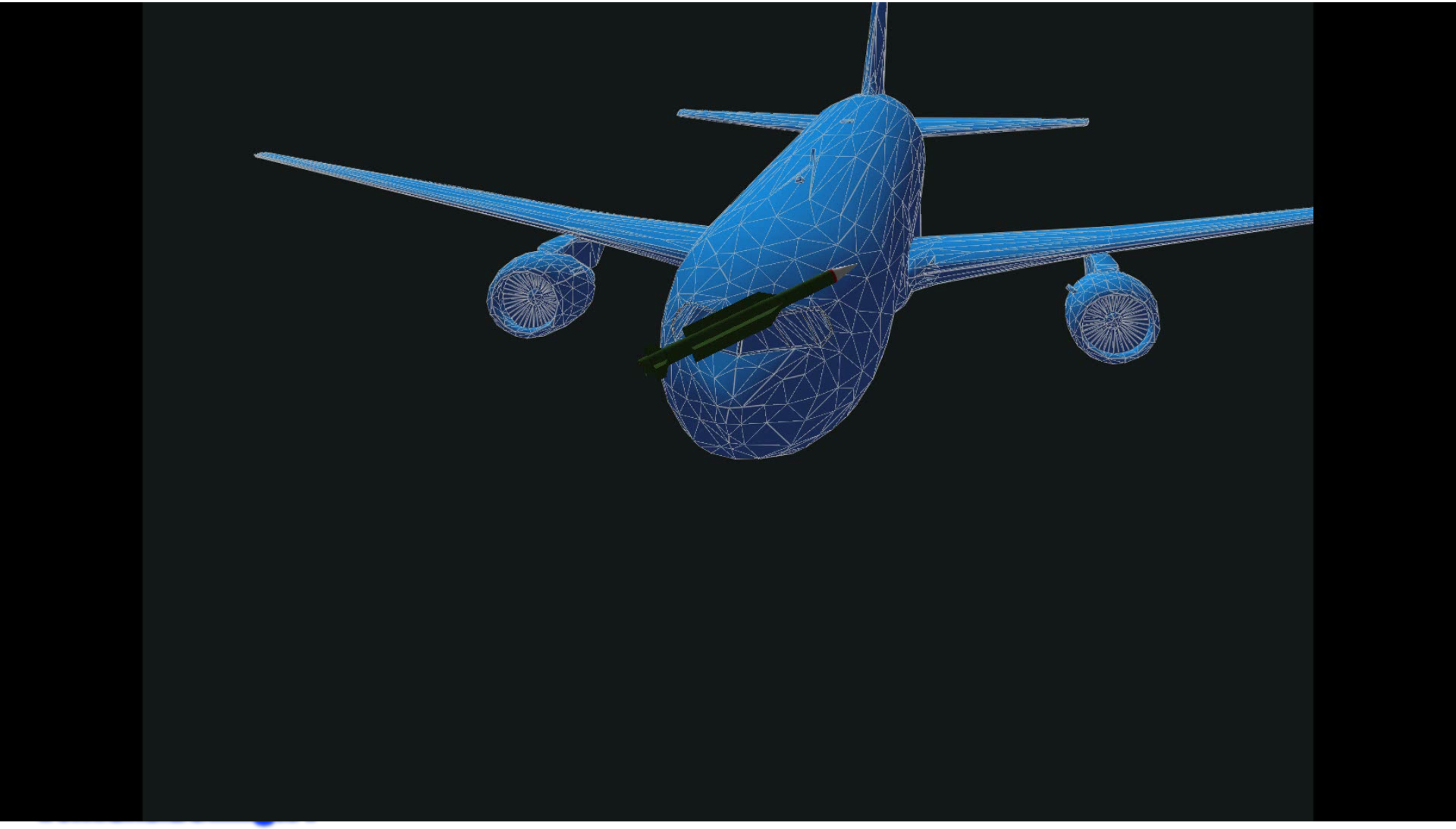


Q_{HOR}= 73.03є

Q_{VER}= 20.89є

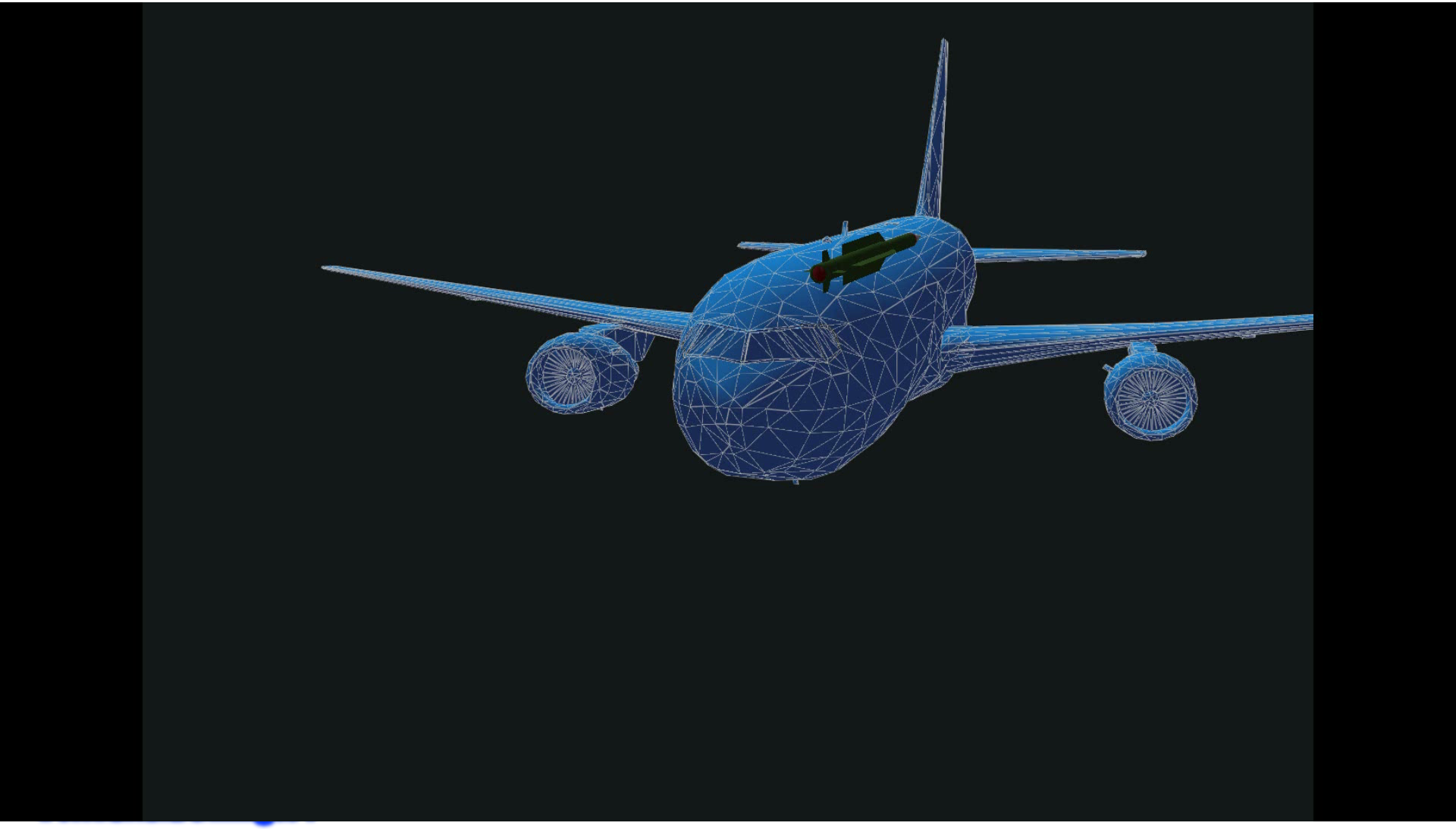
V_{9M38} ~ 733 m/s

Simulation Results:
Concern VKO Almaz-Antey's Scenario



1. Left wing - a minimum of 4 submunitions
2. Left engine - a minimum of 22 submunitions

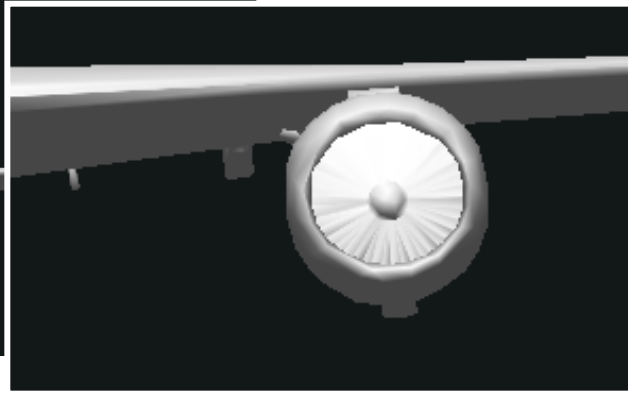
Simulation Results:
'Launch from Snezhnoe' Scenario



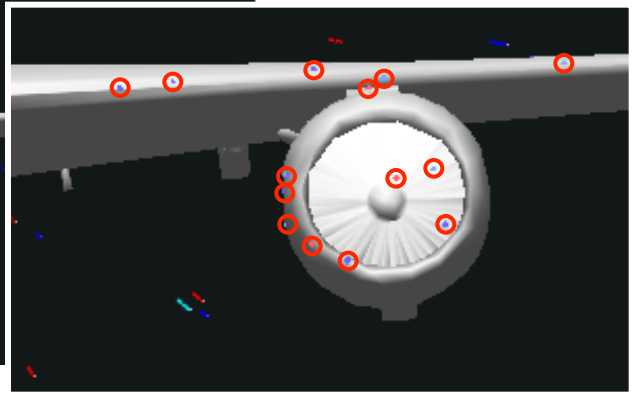
1. Left wing - 0 submunition
2. Left engine - 0 submunition

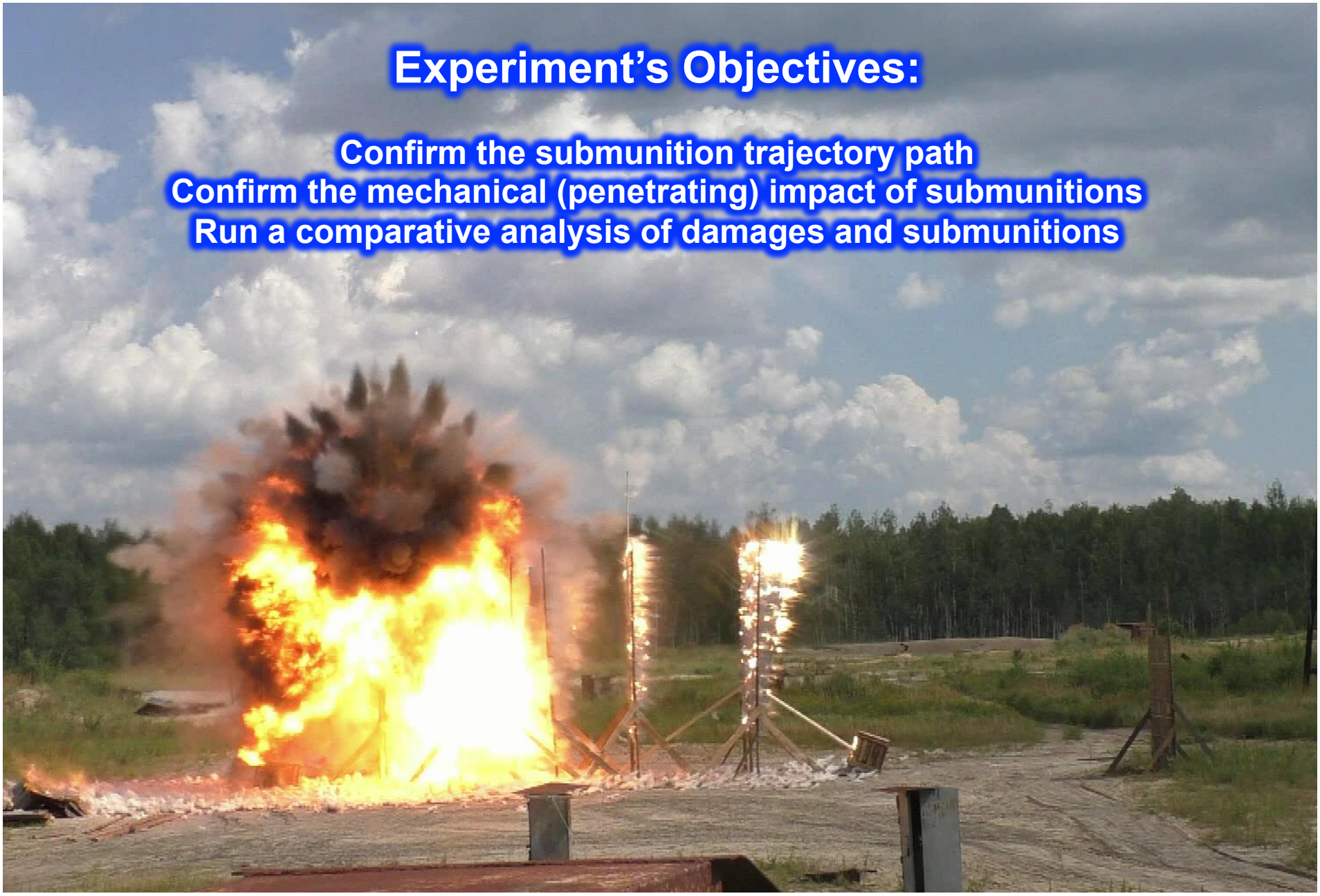
Simulation Results

‘Launch from Snezhnoe’ Scenario



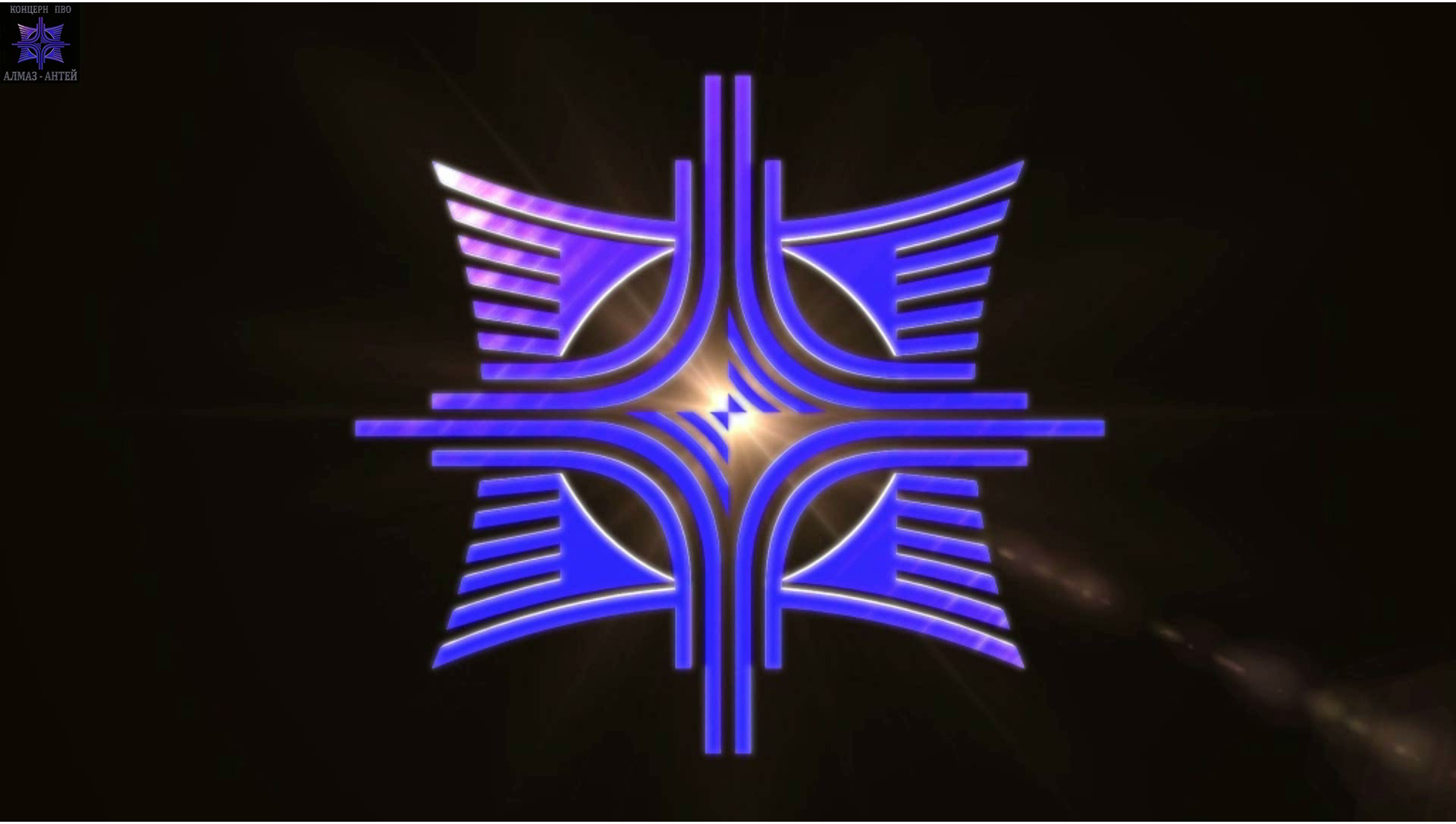
Concern VKO Almaz-Antey’s Scenario




Experiment's Objectives:
Confirm the submunition trajectory path
Confirm the mechanical (penetrating) impact of submunitions
Run a comparative analysis of damages and submunitions

Experiment. Stage 1

КОНЦЕРН ПВО
АЛМАЗ - АНТЕЙ

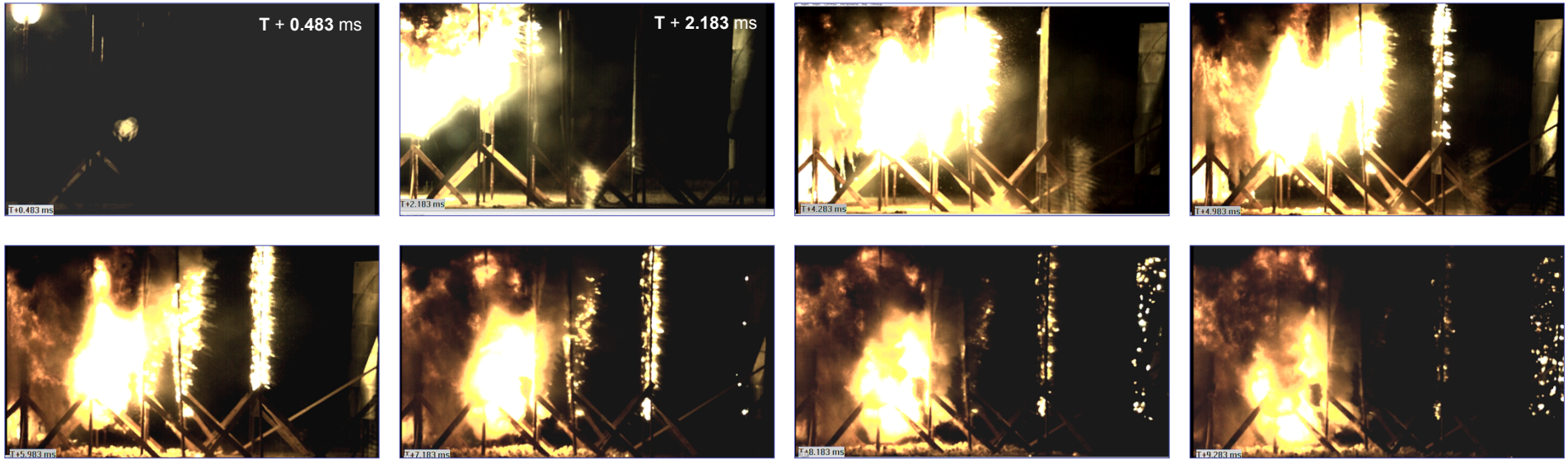


Confirm Mechanical (Penetrating) Impact of Submunitions

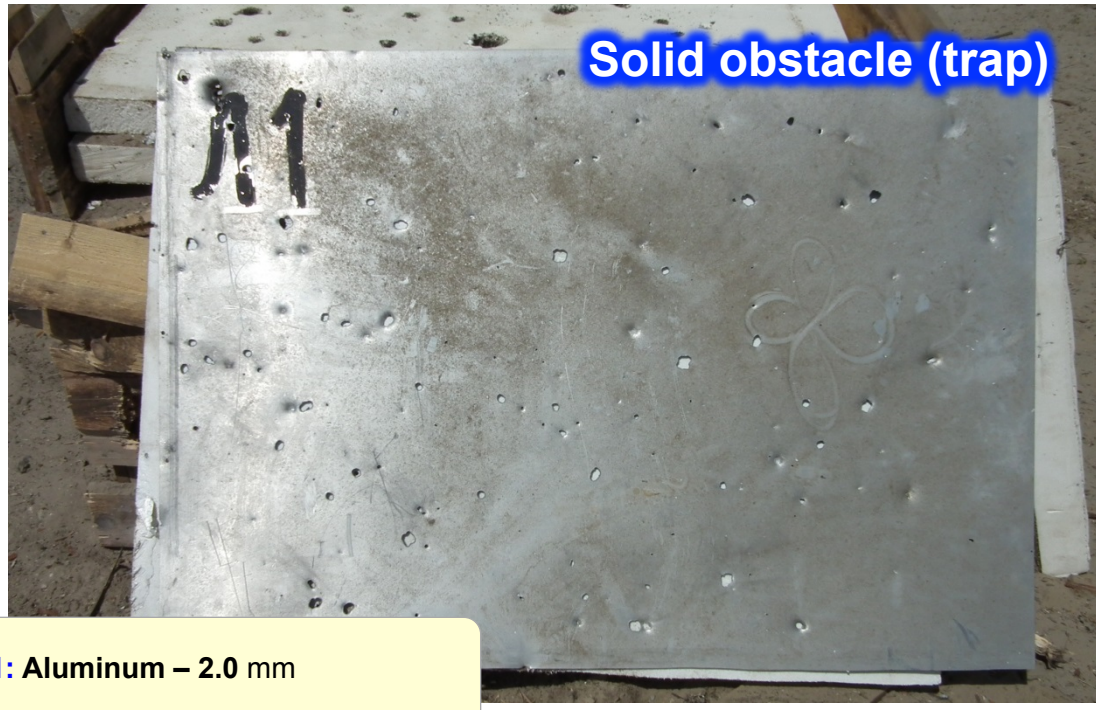
High-speed camera No. 1 10,000 frames/s

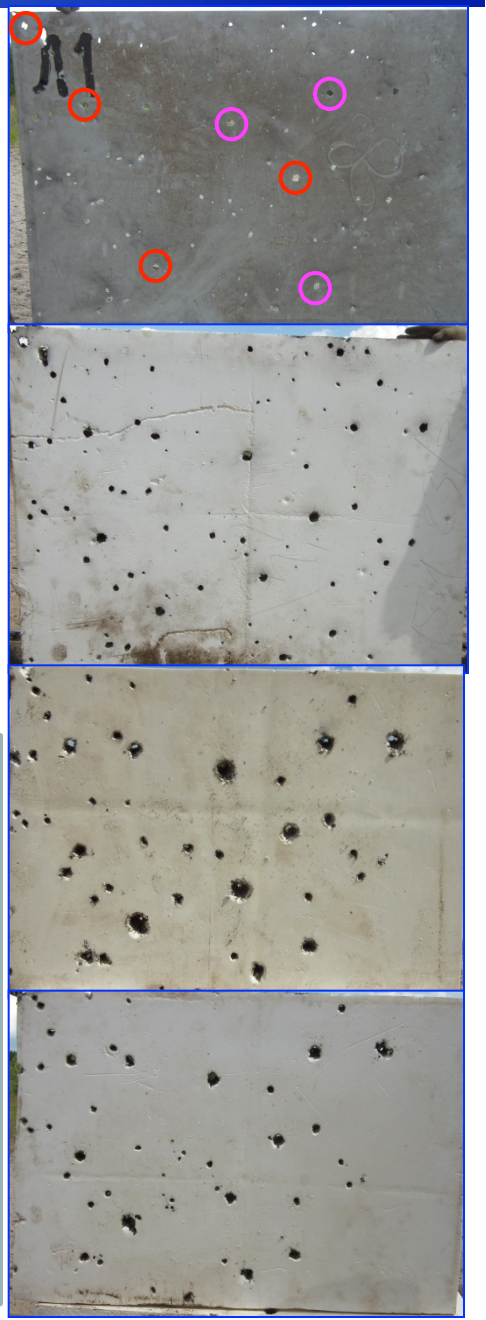
Solid obstacle (trap)

High-speed camera No. 2 10,000 frames/s



Confirm Mechanical (Penetrating) Impact of Submunitions





1: **Aluminum – 2.0** mm

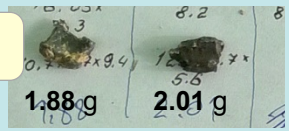
2: **Solid foam – 260.0** mm

3: **Boards – 750.0** mm

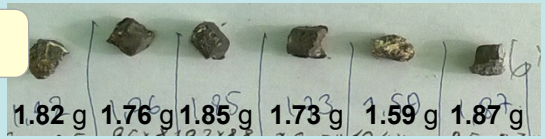
Collected fragments

I-BEAM
13x13x8.2mm

DIAMOND
8x8x5 mm



DIAMOND
6x6x8.2 mm



Confirm Mechanical (Penetrating) Impact of Submunitions

Retrieval of the submunitions from the solid obstacle (trap)

MECHANICAL (PENETRATING) IMPACT BY I-BEAM FRAGMENTS IN DURAL EQUIVALENT:

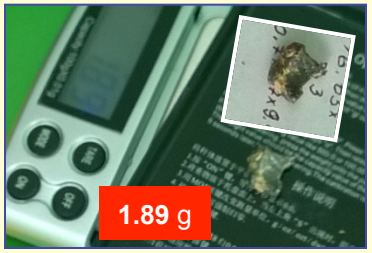
12.2 – 26.3 mm (DEPENDING ON ENTRY ANGLE)

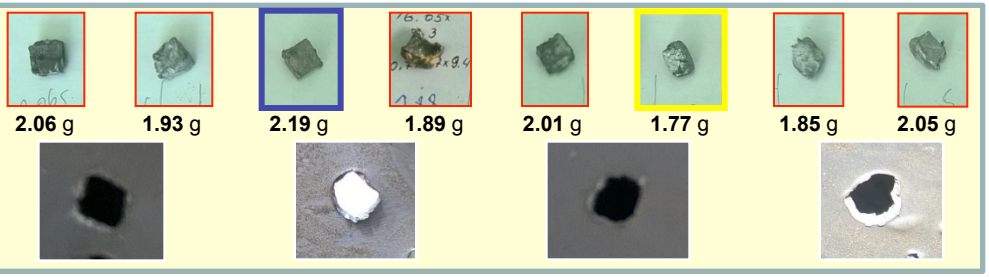
I-BEAM (13x13x8.2 mm)

8.10 $^{+0,6}_{-0.1}$ G

DIAMOND (8x8x5 mm)

2.35 $^{+0.15}_{-0.15}$ G

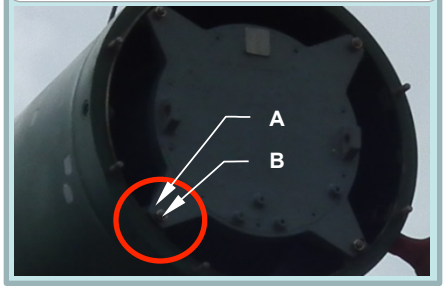


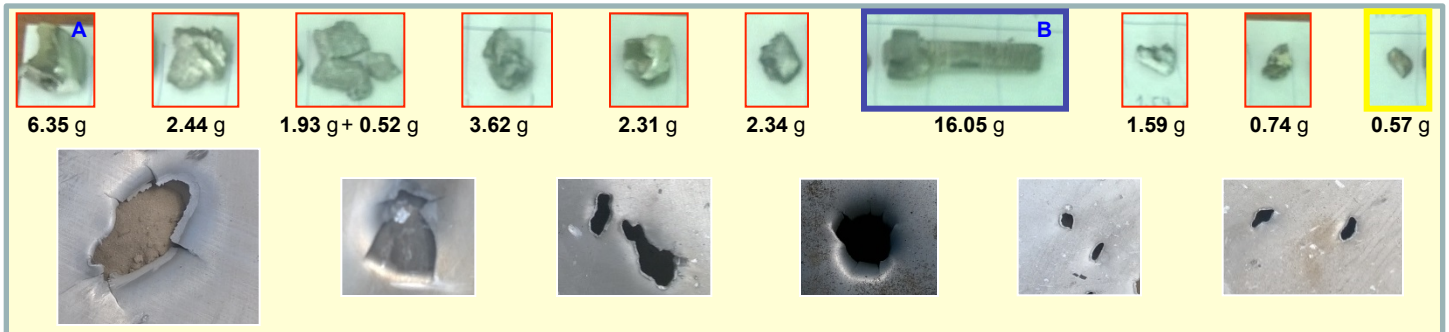


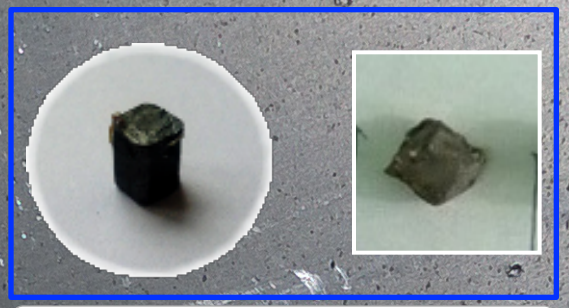
DIAMOND (6x6x8.2 mm)

2.10 $^{+0.01}_{-0.17}$ G

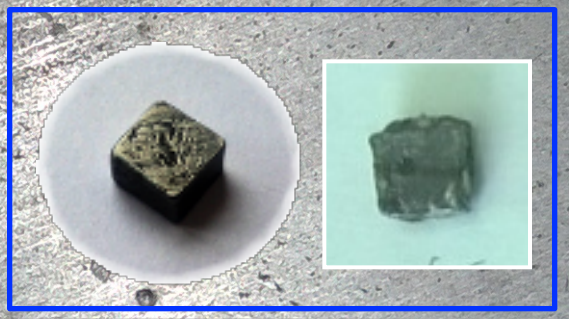
BODY FRAGMENTS







DIAMOND (6x6x8.2 mm)

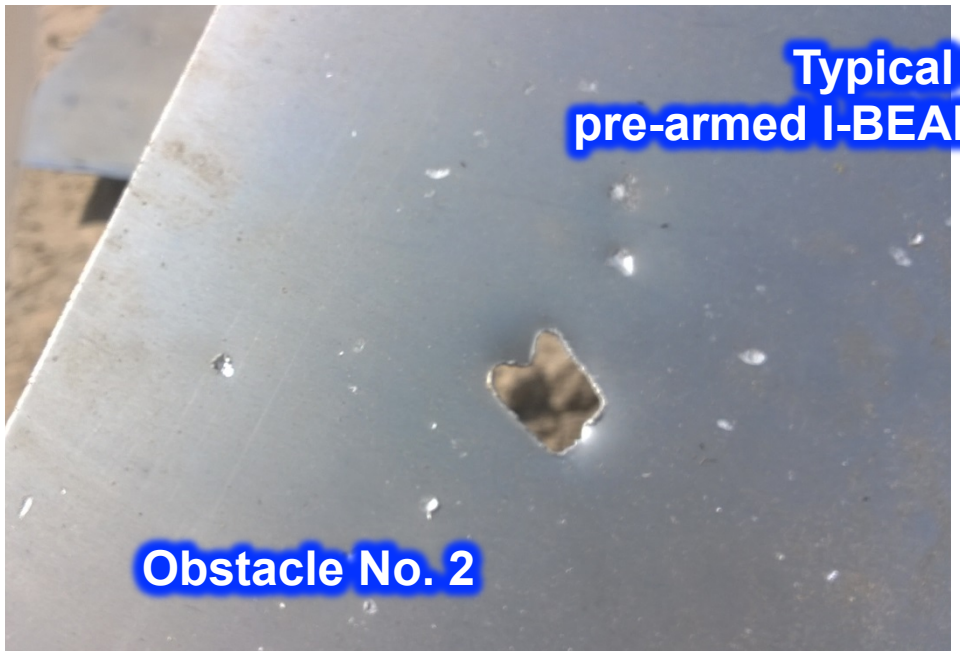


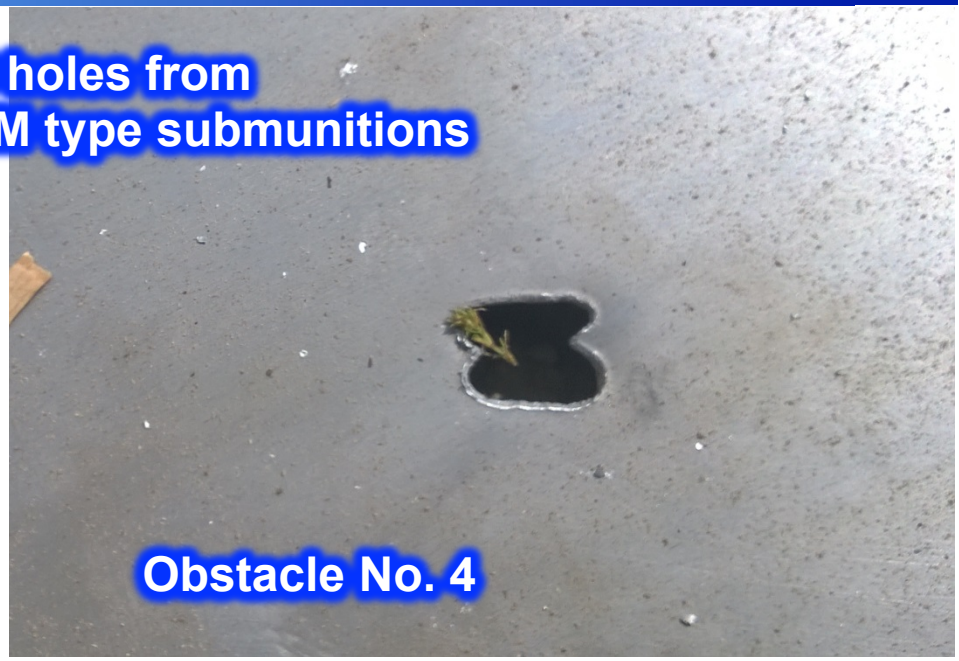
DIAMOND (8x8x5 mm)

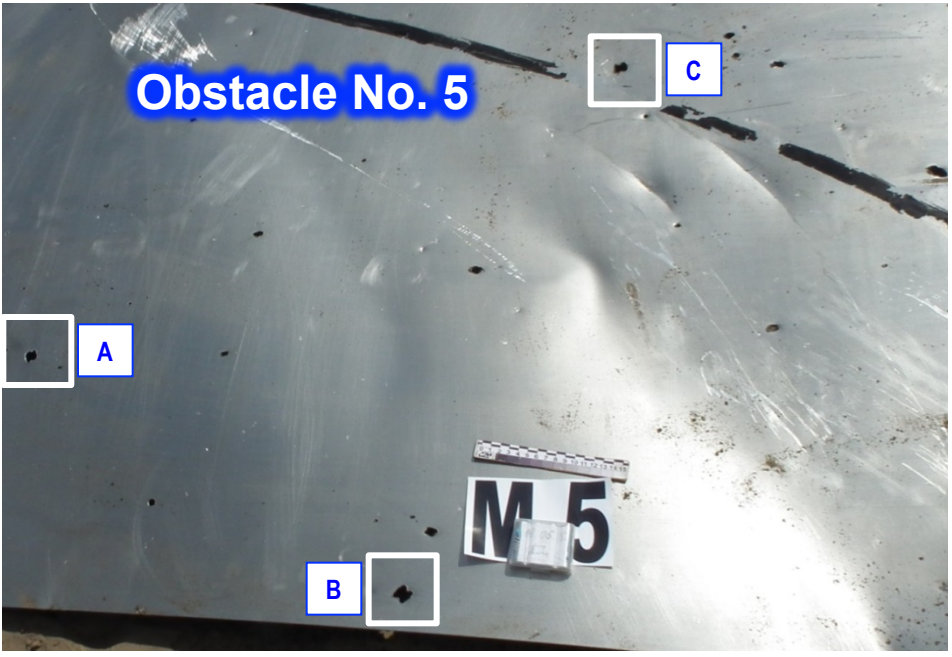
I-BEAM (13x13x8.2 mm)

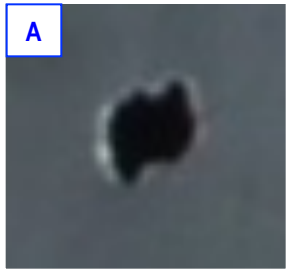
Typical holes from pre-armed submunitions

Typical holes from pre-armed I-BEAM type submunitions

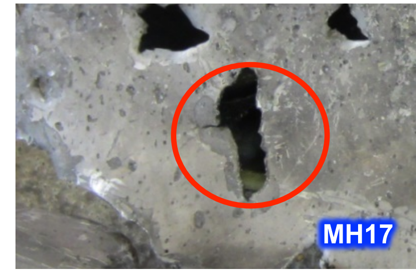


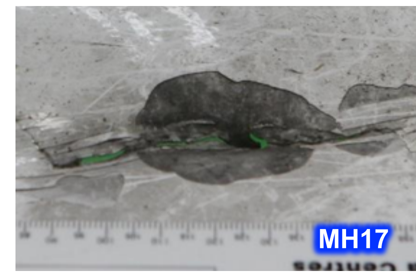


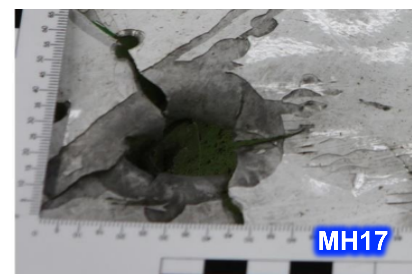




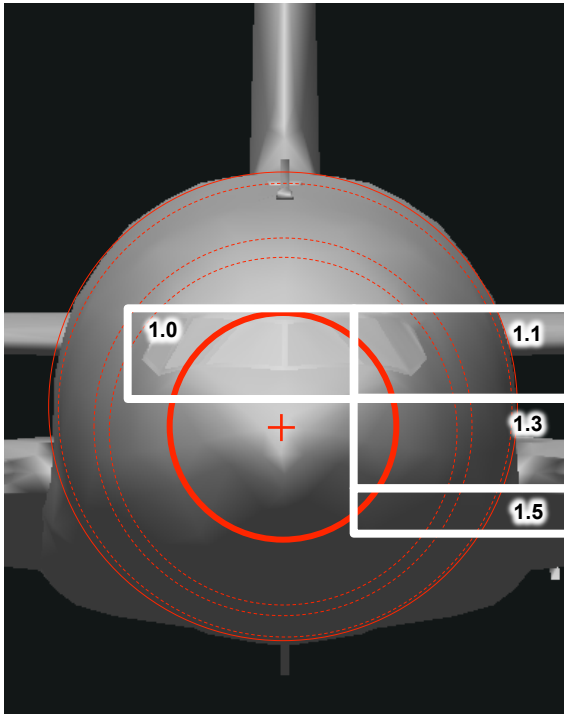
Exterior Appearance of Holes from Warhead Fragments

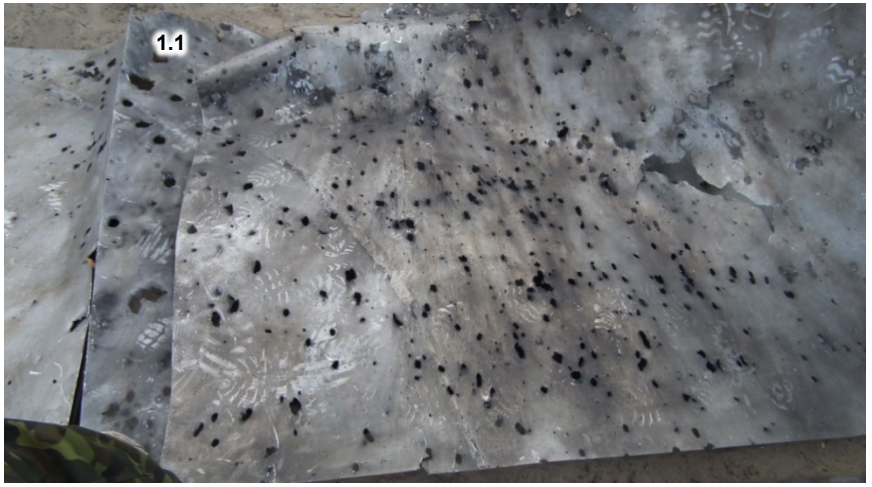


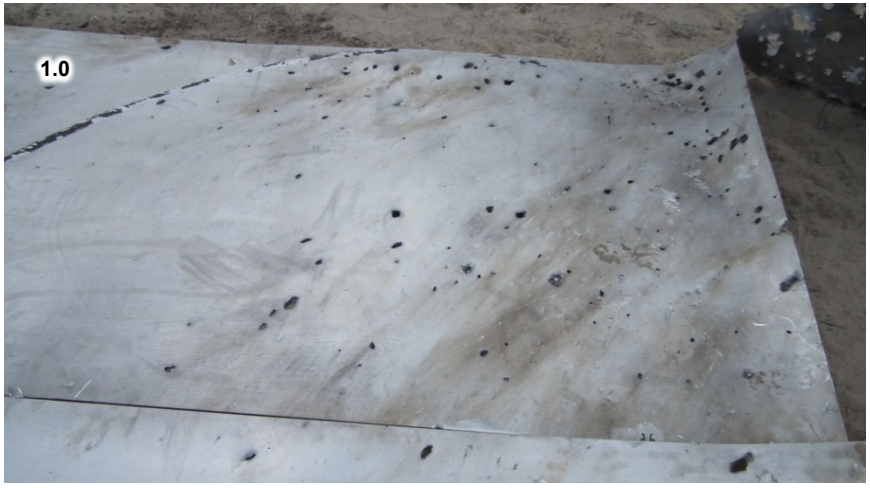


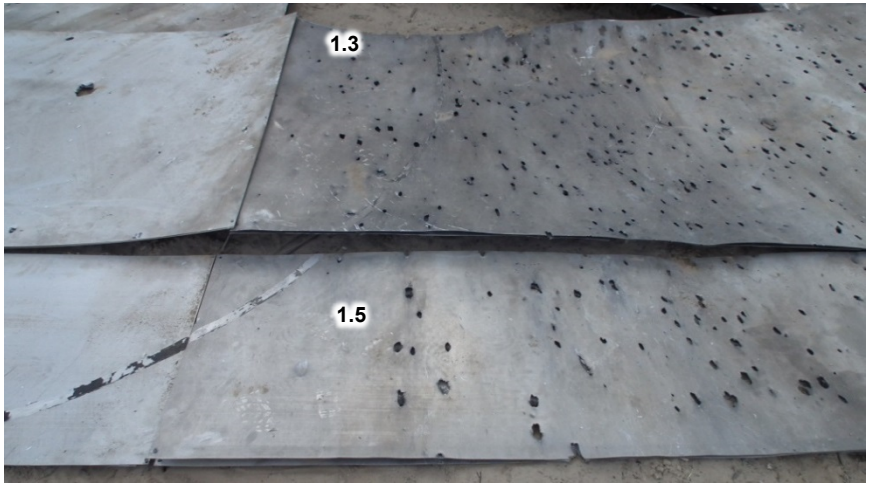


Damage Assessment

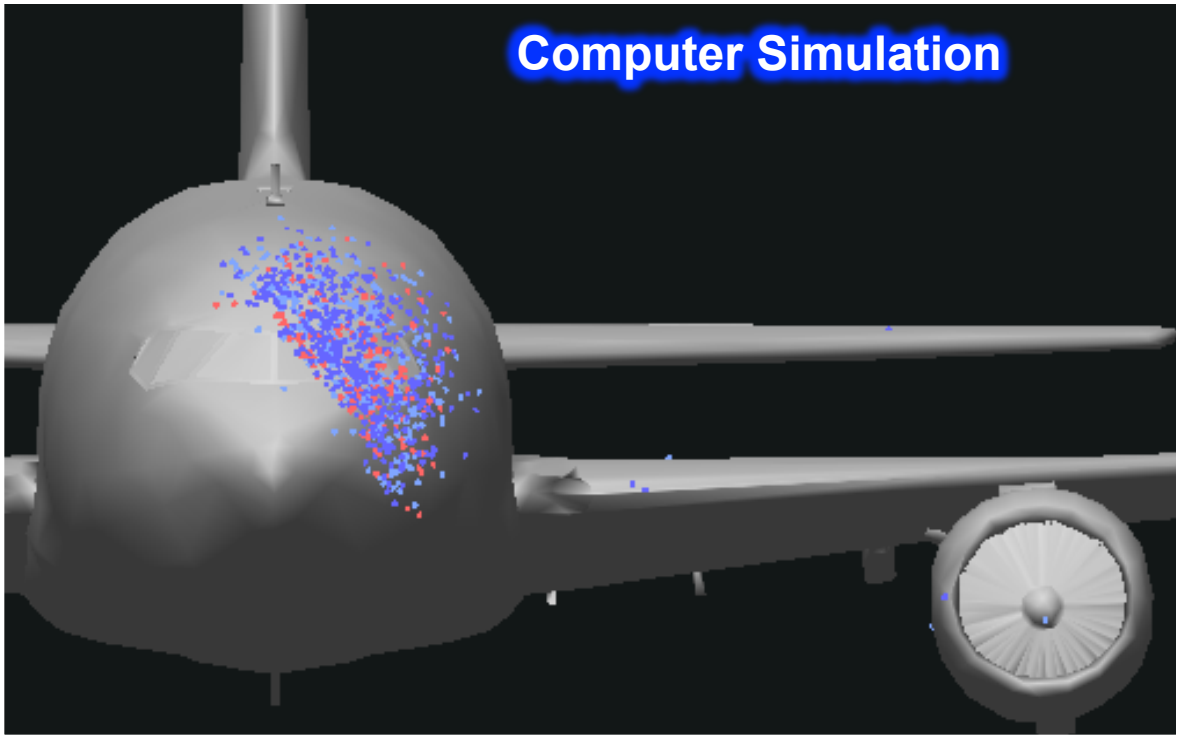


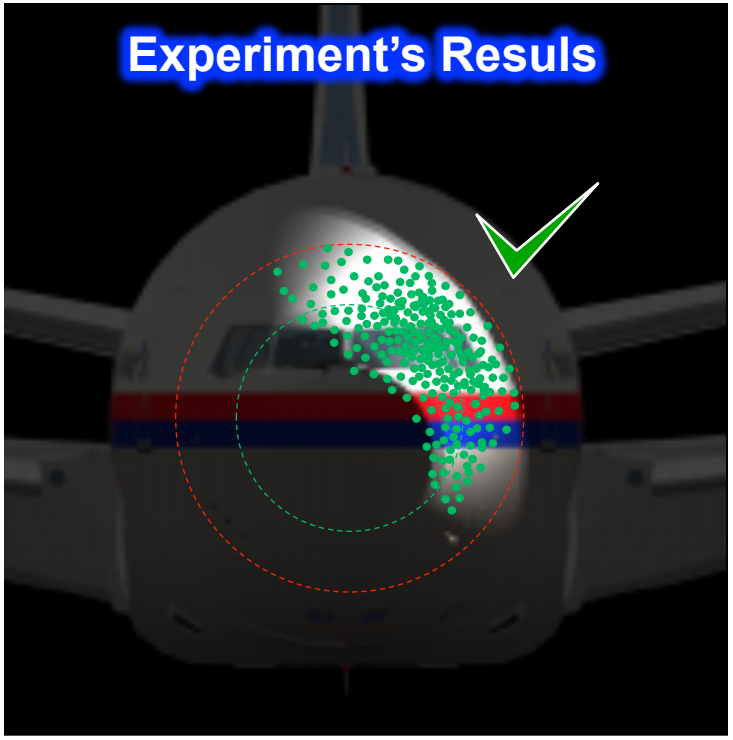


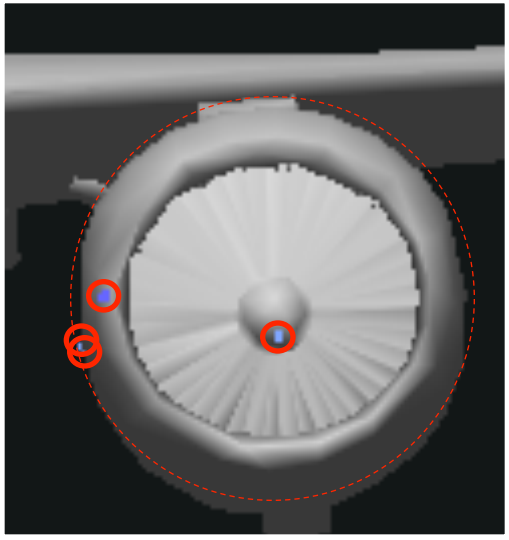


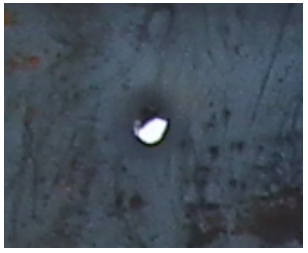


Stage One Results of Experiment









Pre-armed Submunitions (Experiment: Stage 1)

DIAMOND (6x6x8.2 mm)

Original exterior view of pre-armed SM

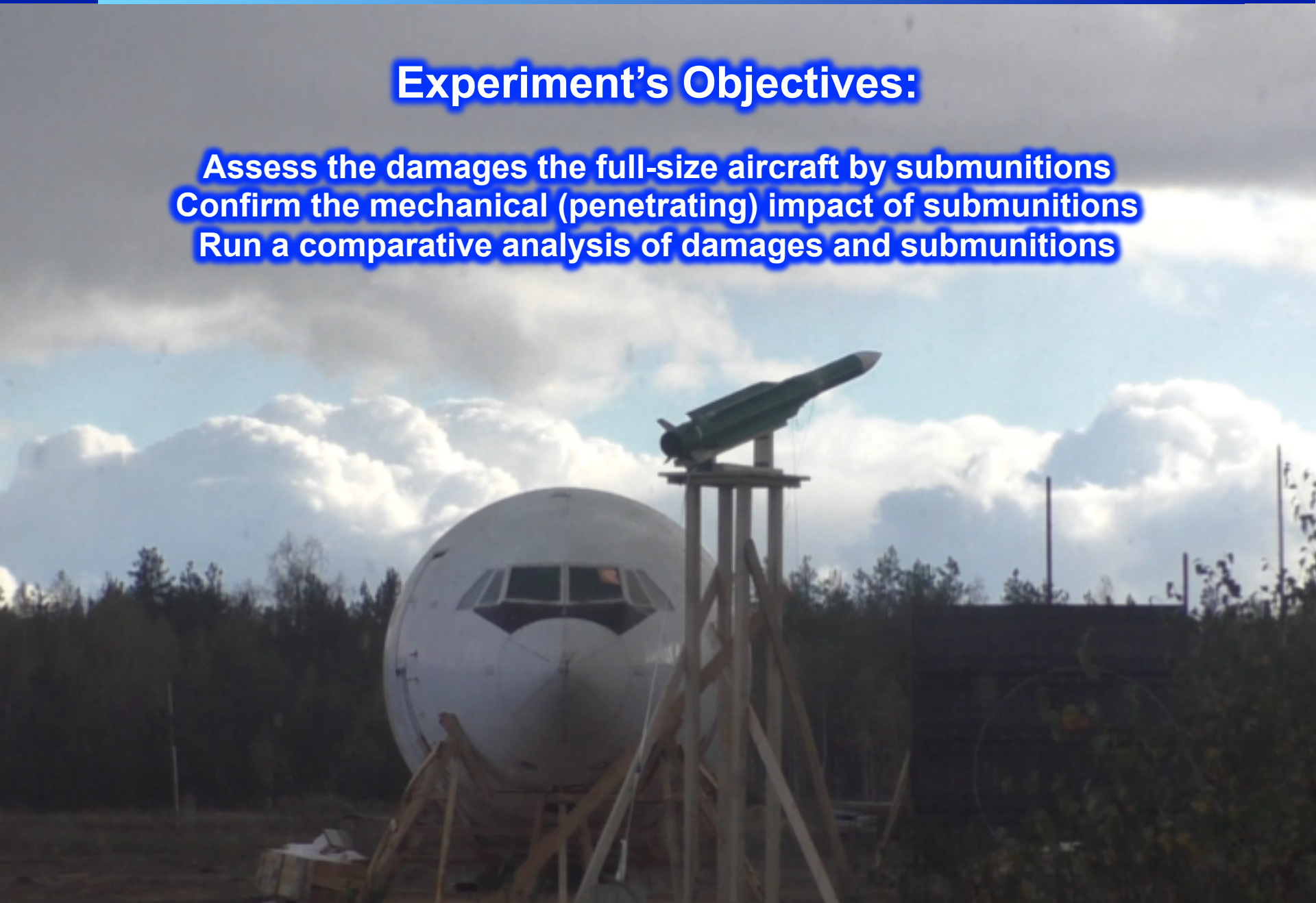
DIAMOND (8x8x5 mm)

Original exterior view of pre-armed SM

I-BEAM (13x13x8.2 mm)

Original exterior view of pre-armed SM

I-BEAM (13x13x8.2 mm)

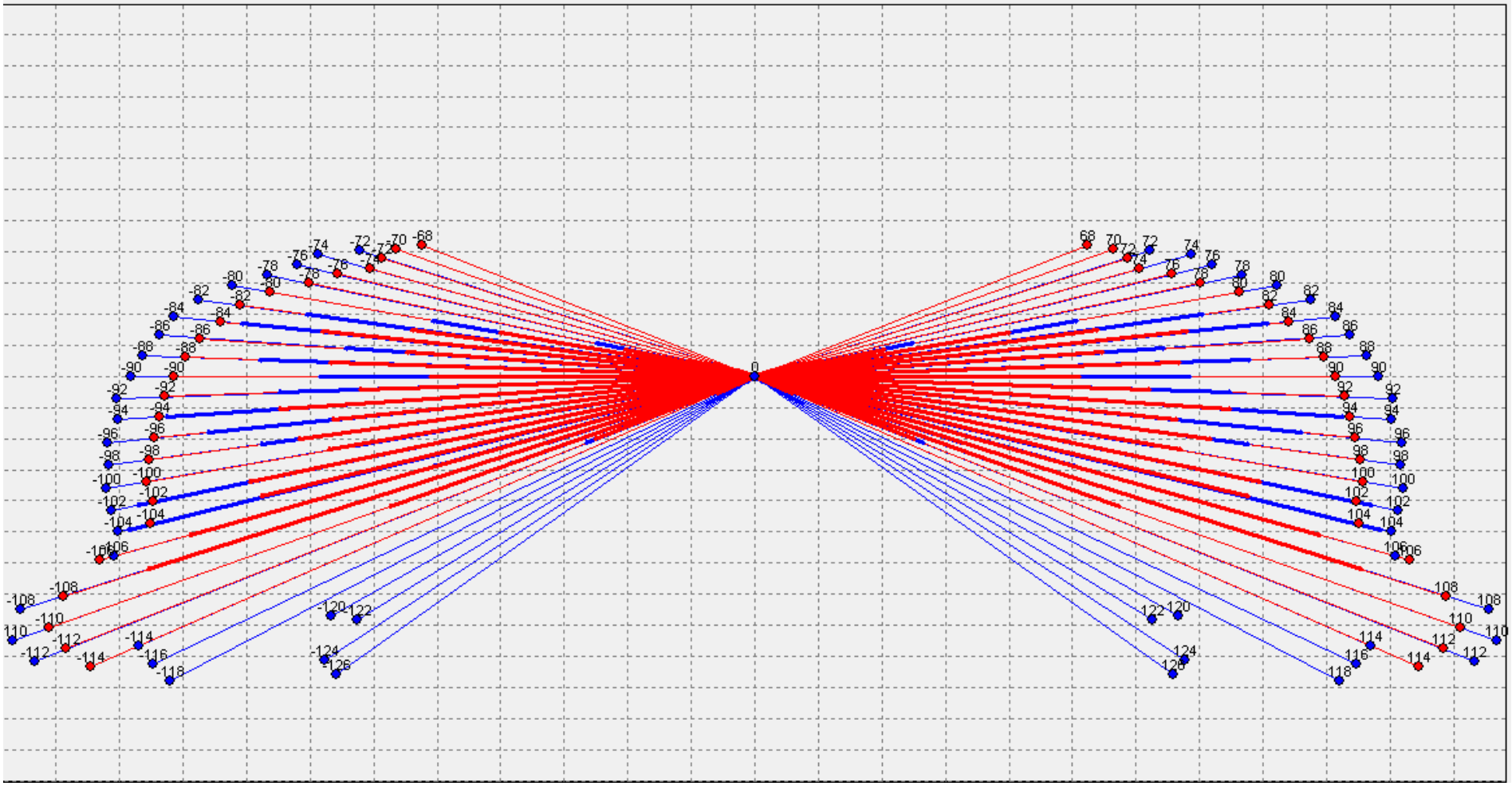


Experiment's Objectives:

Assess the damages the full-size aircraft by submunitions
Confirm the mechanical (penetrating) impact of submunitions
Run a comparative analysis of damages and submunitions

Velocity Analysis of Pre-armed SM, Missile and Aircraft

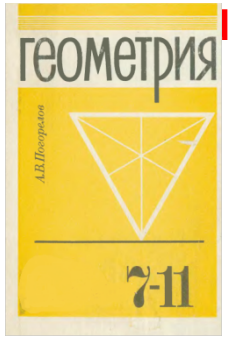
FRAGMENTS FRONT: Static Position

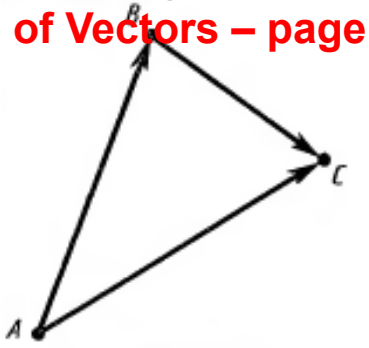


V_{9M38M1}= **0** m/s V_{B777}= **0** m/s

Calculation of Fragment Velocity and Dispersion Radius

"Geometry Textbook for 7-11-year school students,
5th edition, A. V. Pogorelov, 1995
8 year, paragraph 10,
lition of Vectors – page 159





$$\overline{AB}+\overline{BC}=\overline{AC}.$$

" Такой способ получения суммы двух векторов называется *«правилом треугольника»* сложения векторов. "

"LAUNCHING ANTI-AIRCRAFT MISSILES, 3rd Edition, F.K. Neupokoev, 1991, Chapter 5. Area of Potential Damage to Target – page 188

$$\overrightarrow{V_{\text{оск.д}}} = \overrightarrow{V_{\text{р}}} + \overrightarrow{V_{\text{оск}}}$$

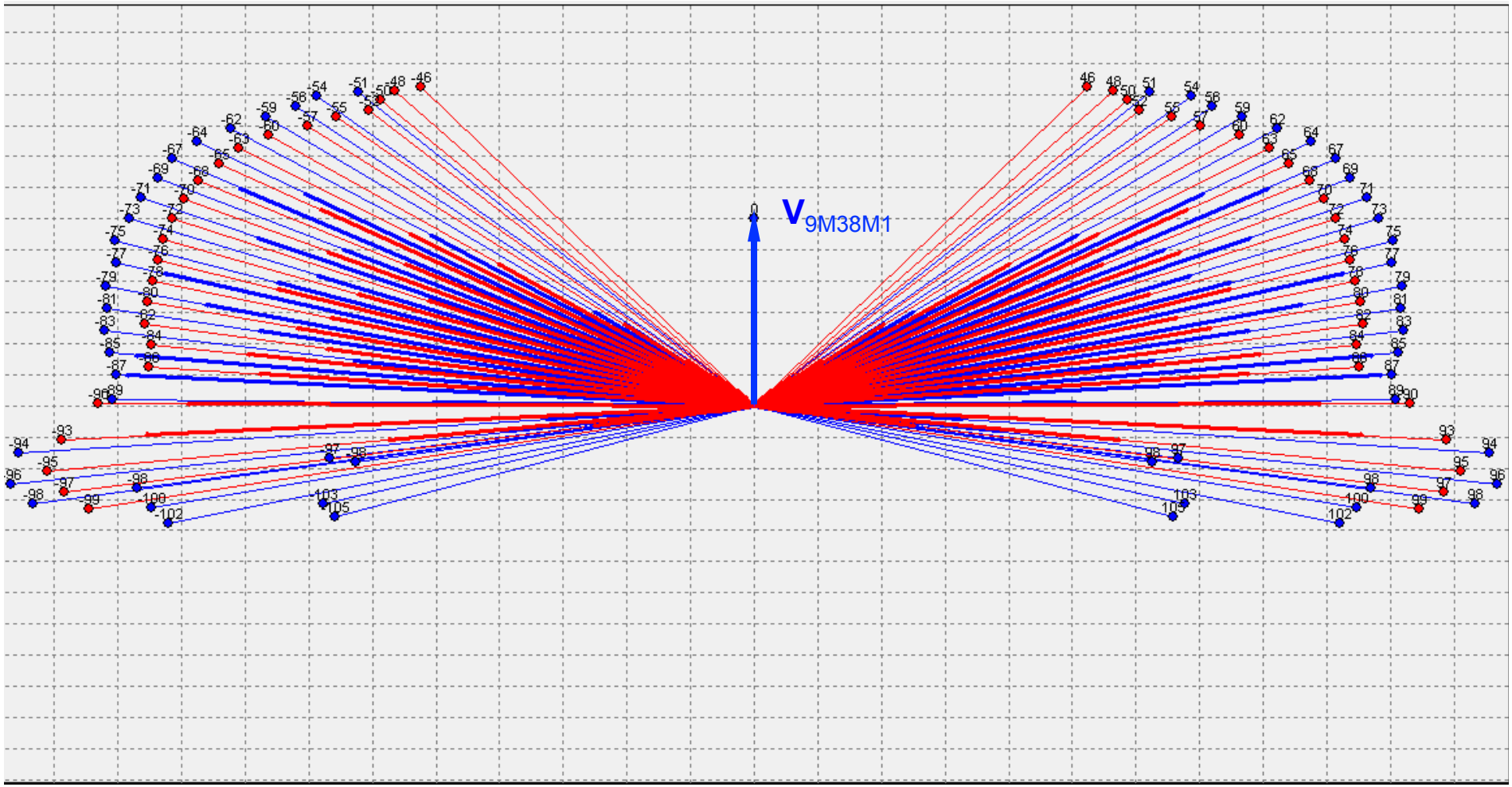
"Once the warhead is detonated, travel speed will geometrically be added to the target's own speed generated by fragments using the warhead power. "

Fragment of the program code that includes the addition of the projected velocity vectors of low-intensity submunitions of a surface-to-air missile and aircraft

```
for (int i = 0; i < size; ++i)
                {
                                V.push_back(Point((LightSplintersInitialPositionType1VectorAfterTurn[i].x + time *
(LightSplintersVelocityType1VectorAfterTurn[i].x + MissileVelocityArray.x + PlaneVelocityArray.x)),
(LightSplintersInitialPositionType1VectorAfterTurn[i].y + time * (LightSplintersVelocityType1VectorAfterTurn[i].y +
MissileVelocityArray.y + PlaneVelocityArray.y)), (LightSplintersInitialPositionType1VectorAfterTurn[i].z + time *
(LightSplintersVelocityType1VectorAfterTurn[i].z + MissileVelocityArray.z + PlaneVelocityArray.z))));
                }
```

Velocity Analysis of Pre-armed SM, Missile and Aircraft

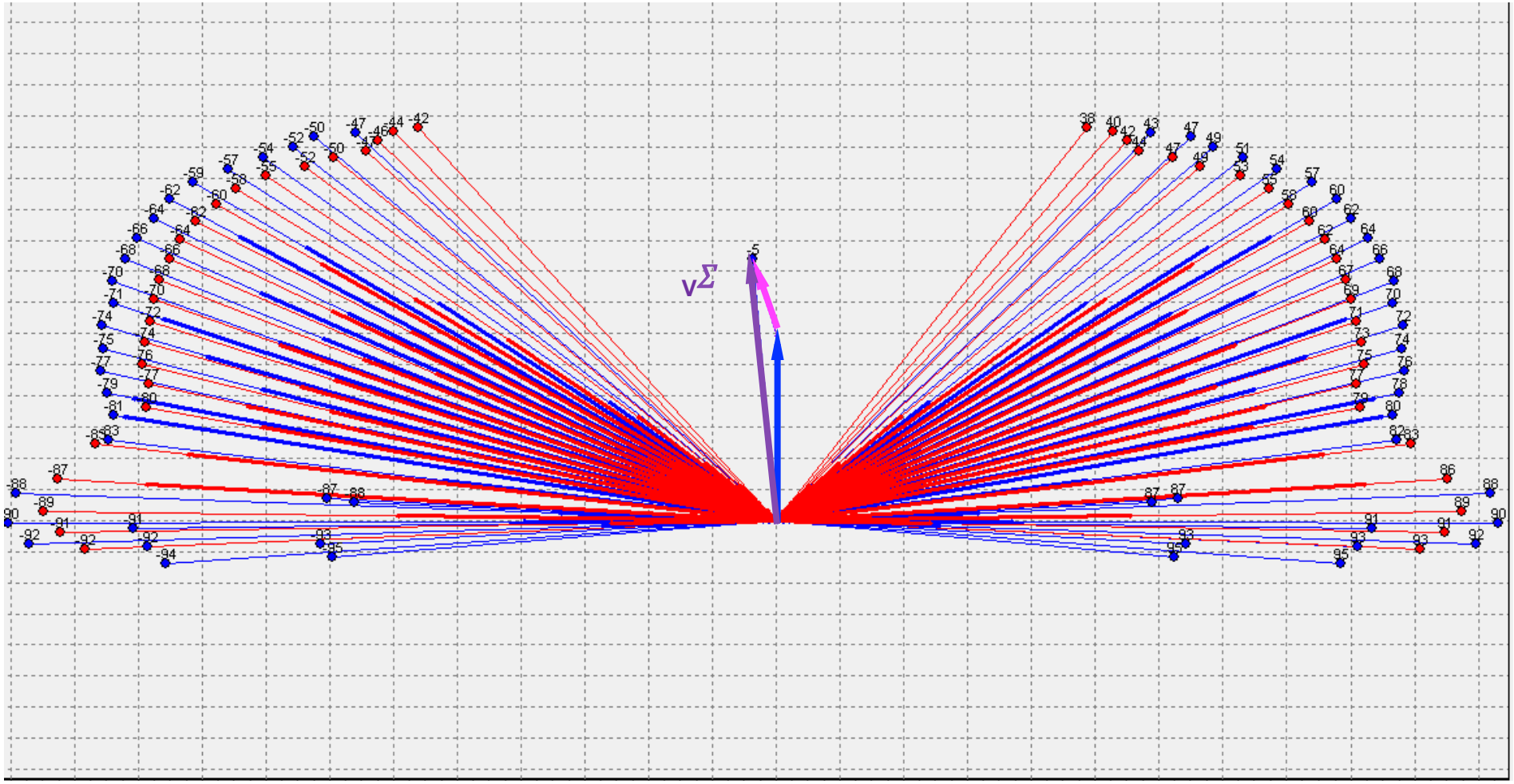
FAGMENTS FRONT : Based on Missile velocity 600 m/s



V_{9M38M1}= **600** m/s V_{B777}= **0** m/s

Velocity Analysis of Pre-armed SM, Missile and Aircraft

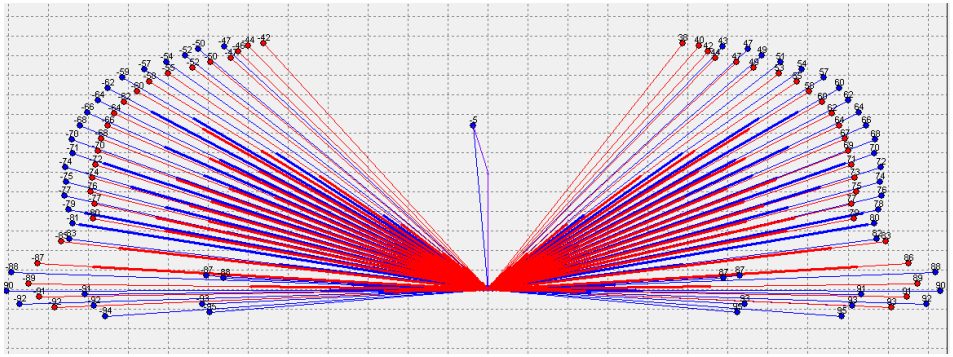
FAGMENTS FRONT : Dynamic Position
(Missile Velocity 600 m/s, B777 Velocity 252 m/s)



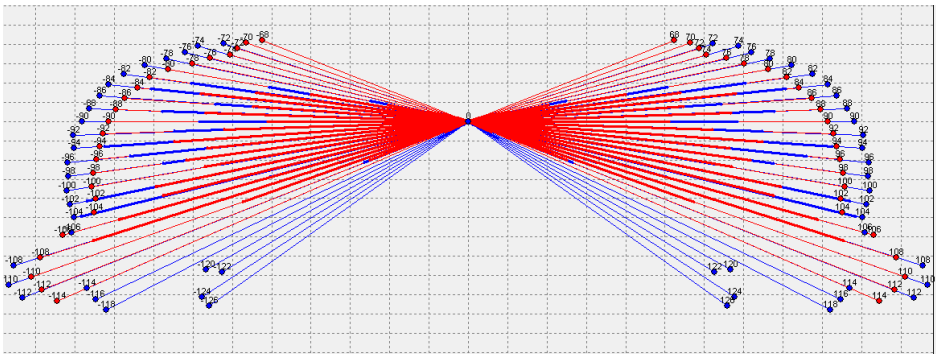
V_{9M38M1}= **600** m/s V_{B777}= **252** m/s

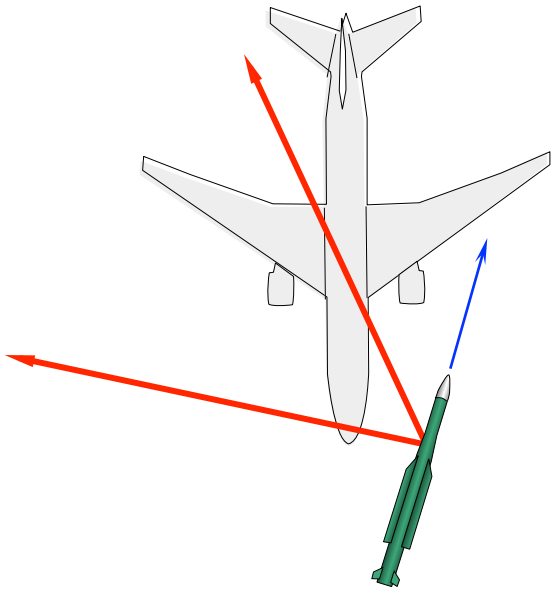
Obtaining Adjustment Corrections

Dynamic Position (Missile Velocity 600 m/S, Aircraft Velocity 252 m/s)

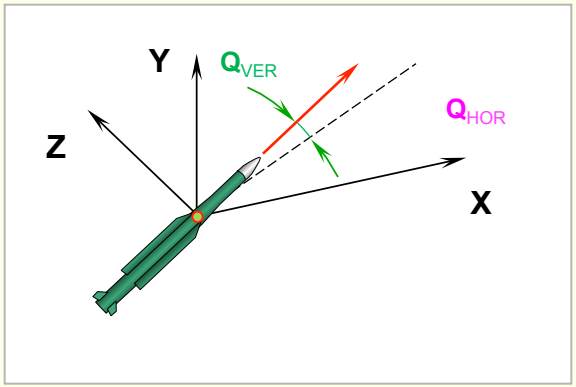


Static Position (Missile Velocity 0 m/s), Aircraft Velocity 0 m/s)





COLLISION PARAMETERS

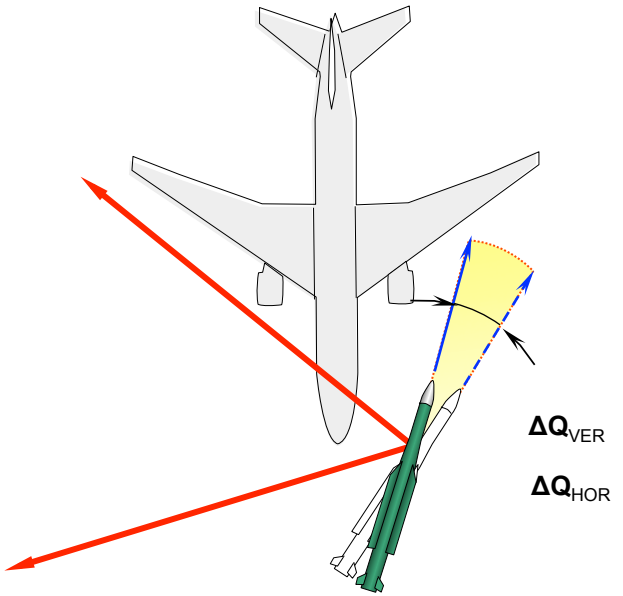


Q_{HOR}= 17ϵ

Q_{VER}= 7ϵ

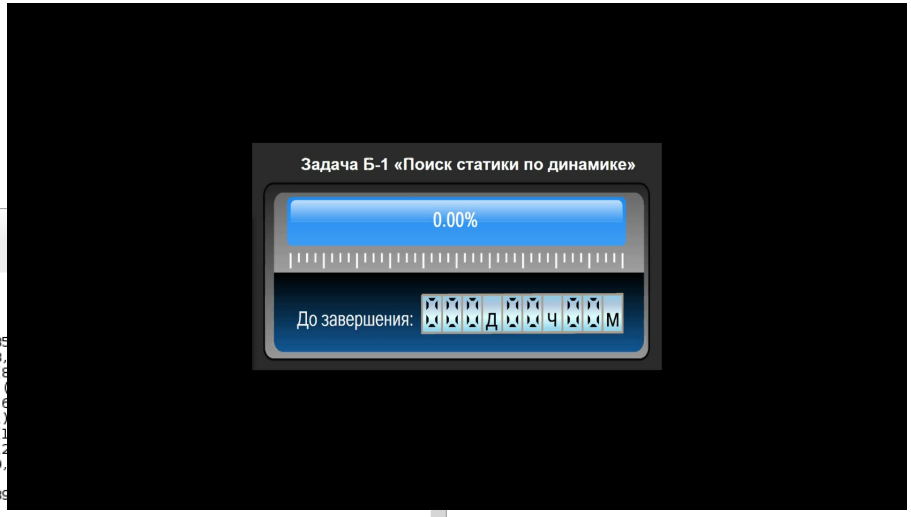
V_{9M38M1} ~ **600** m/s

$V_{AIRCRAFT}$ = **252** m/s



Dynamic-to-Static Position Conversion

Calculations results of Target-86 airframe damage to provide dynamic-to-static position conversion (9M38M1 SAM and IL-86 airframe)



Задача Б-1

Файл Правка Вид Поиск Терминал Справка

```
$ ./run.sh
Число площадок = 1547
Число осколков 10763
Пораженные площадки для эталона
(0,2) (15,1) (23,1) (253,1) (315,1) (487,2) (489,3) (510,3) (511,5) (512,9) (513,11) (515,11) (516,8) (525,3) (526,1) (53
19) (584,25) (585,33) (586,15) (587,11) (588,17) (589,6) (590,7) (592,1) (593,4) (594,11) (595,30) (599,28) (600,13) (613,
(621,3) (623,1) (624,3) (625,1) (790,8) (791,1) (830,2) (831,4) (832,4) (835,1) (839,1) (840,1) (842,2) (843,6) (844,3) (8
2,9) (863,6) (864,17) (865,13) (866,9) (867,6) (868,26) (869,21) (870,6) (871,7) (872,5) (873,4) (874,1) (875,6) (876,3)
3) (900,1) (901,3) (902,3) (903,4) (904,4) (905,2) (907,1) (908,10) (909,7) (910,5) (911,1) (912,8) (913,1) (914,3) (915,6
67,1) (974,2) (975,2) (976,1) (977,2) (988,1) (993,2) (994,6) (995,2) (996,3) (1009,3) (1011,1) (1012,1) (1013,9) (1025,1)
1) (1037,2) (1062,2) (1063,3) (1064,4) (1067,2) (1069,2) (1073,1) (1081,5) (1082,1) (1083,2) (1084,6) (1085,1) (1093,1) (1
(1151,1) (1152,1) (1156,2) (1164,3) (1172,2) (1173,1) (1177,1) (1198,12) (1201,10) (1207,1) (1222,2) (1235,1) (1236,2) (12
1259,1) (1261,2) (1262,6) (1278,1) (1284,1) (1301,4) (1302,1) (1304,3) (1305,7) (1308,1) (1310,3) (1316,2) (1317,2) (1319,
3,4) (1477,2) (1478,1) (1501,2) (1502,2) (1503,5) (1504,3) (1505,5) (1506,7) (1507,7) (1508,4) (1510,1) (1511,1) (1512,6)
) (1523,4) (1524,14) (1528,2) (1530,23) (1531,60) (1532,8) (1533,48) (1534,12) (1535,23) (1536,15) (1537,5) (1538,4) (1539
Выполнено 14464800 из 14464800
Пораженные площадки для лучшей аппроксимации
(0,1) (488,1) (489,4) (492,1) (510,4) (511,7) (512,11) (513,9) (515,10) (516,1) (525,3) (526,2) (535,7) (542,9) (579,14) (580,15) (581,1) (582,8) (583,10) (584,27) (585,20) (
586,13) (587,9) (588,20) (589,8) (590,12) (592,1) (593,17) (594,17) (595,27) (598,1) (599,30) (600,21) (613,8) (614,1) (615,4) (616,4) (617,2) (619,2) (620,3) (621,5) (624,2)
 (625,1) (628,1) (774,1) (789,1) (790,2) (791,1) (830,1) (831,1) (832,6) (833,2) (835,1) (836,1) (838,1) (839,2) (840,2) (842,1) (843,1) (844,2) (858,6) (859,6) (860,15) (861
,20) (862,8) (863,12) (864,9) (865,11) (866,7) (867,10) (868,16) (869,26) (870,3) (871,7) (872,6) (873,2) (874,7) (875,4) (876,1) (877,2) (878,1) (879,1) (880,1) (881,1) (896
,4) (897,3) (898,1) (900,3) (901,3) (902,1) (903,3) (904,3) (905,2) (906,1) (907,4) (908,8) (909,1) (910,5) (911,5) (912,4) (913,2) (914,4) (915,9) (916,7) (941,1) (945,1) (9
50,5) (951,5) (952,1) (974,3) (975,5) (976,1) (977,1) (985,1) (987,1) (988,1) (990,1) (994,3) (995,5) (996,1) (1009,1) (1010,1) (1011,1) (1012,1) (1013,4) (1024,1) (1026,1) (
1028,6) (1031,6) (1032,2) (1033,5) (1034,5) (1035,1) (1036,1) (1062,3) (1063,1) (1064,3) (1068,1) (1069,3) (1073,1) (1081,1) (1084,6) (1085,1) (1093,5) (1117,1) (1119,2) (112
8,1) (1130,1) (1142,5) (1151,2) (1152,1) (1164,2) (1172,3) (1198,9) (1201,10) (1209,1) (1222,4) (1237,1) (1238,4) (1252,1) (1253,5) (1254,3) (1255,3) (1257,7) (1261,4) (1262,
8) (1263,4) (1299,1) (1301,2) (1304,3) (1305,3) (1308,2) (1311,3) (1316,2) (1317,1) (1319,4) (1320,1) (1363,1) (1365,1) (1374,1) (1375,1) (1393,1) (1415,5) (1443,3) (1471,1)
(1477,2) (1501,1) (1502,1) (1503,7) (1504,4) (1505,5) (1506,8) (1507,11) (1508,2) (1510,1) (1511,1) (1512,4) (1515,1) (1517,1) (1518,1) (1519,1) (1523,1) (1524,4) (1530,23) (
1531,26) (1532,9) (1533,34) (1534,18) (1535,24) (1536,10) (1537,3) (1538,2) (1539,2)
Отличающиеся площадки
approximation[488] = 1 approximation[492] = 1 approximation[598] = 1 approximation[628] = 1 approximation[774] = 1 approximation[789] = 1 approximation[833] = 2 approximation
[836] = 1 approximation[838] = 1 approximation[877] = 2 approximation[906] = 1 approximation[952] = 1 approximation[985] = 1 approximation[987] = 1 approximation[990] = 1 app
roximation[1010] = 1 approximation[1024] = 1 approximation[1026] = 1 approximation[1036] = 1 approximation[1068] = 1 approximation[1128] = 1 approximation[1209] = 1 approxima
tion[1252] = 1 approximation[1263] = 4 approximation[1299] = 1 approximation[1311] = 3 approximation[1320] = 1 approximation[1363] = 1 approximation[1393] = 1 approximation[1
471] = 1
etalon[15] = 1 etalon[23] = 1 etalon[253] = 1 etalon[315] = 1 etalon[487] = 2 etalon[623] = 1 etalon[847] = 2 etalon[848] = 1 etalon[944] = 3 etalon[967] = 1 etalon[993] = 2
etalon[1025] = 1 etalon[1037] = 2 etalon[1067] = 2 etalon[1082] = 1 etalon[1083] = 2 etalon[1097] = 1 etalon[1120] = 1 etalon[1156] = 2 etalon[1173] = 1 etalon[1177] = 1 etal
on[1207] = 1 etalon[1235] = 1 etalon[1236] = 2 etalon[1259] = 1 etalon[1278] = 1 etalon[1284] = 1 etalon[1302] = 1 etalon[1310] = 3 etalon[1336] = 1 etalon[1478] = 1 etalon[1
513] = 1 etalon[1522] = 2 etalon[1528] = 2
Ошибка = 85
$
```

Число площадок = 1547

Число осколков 10763

Выполнено 14464800 из 14464800

Number of triangular areas forming the cockpit canopy surface

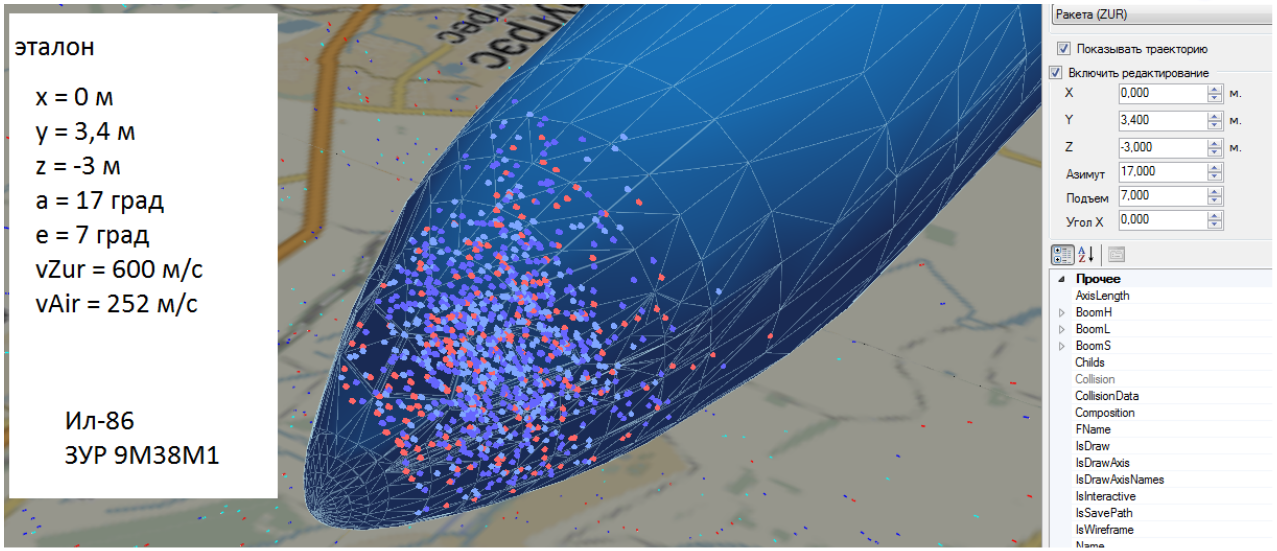
Number of calculated fragments (pre-armed fragments + body fragments)

Number of processed options– OVER 14 millions

Fragment Coverage Area

Dynamic Position (Missile Velocity 600 m/s, Aircraft Velocity 252 m/s)

Q_{HOR}= 17є
Q_{VER}= 7є
V_{9M38M1} ~ **600** m/s
$V_{AIRCRAFT}$ ~ **252** m/s

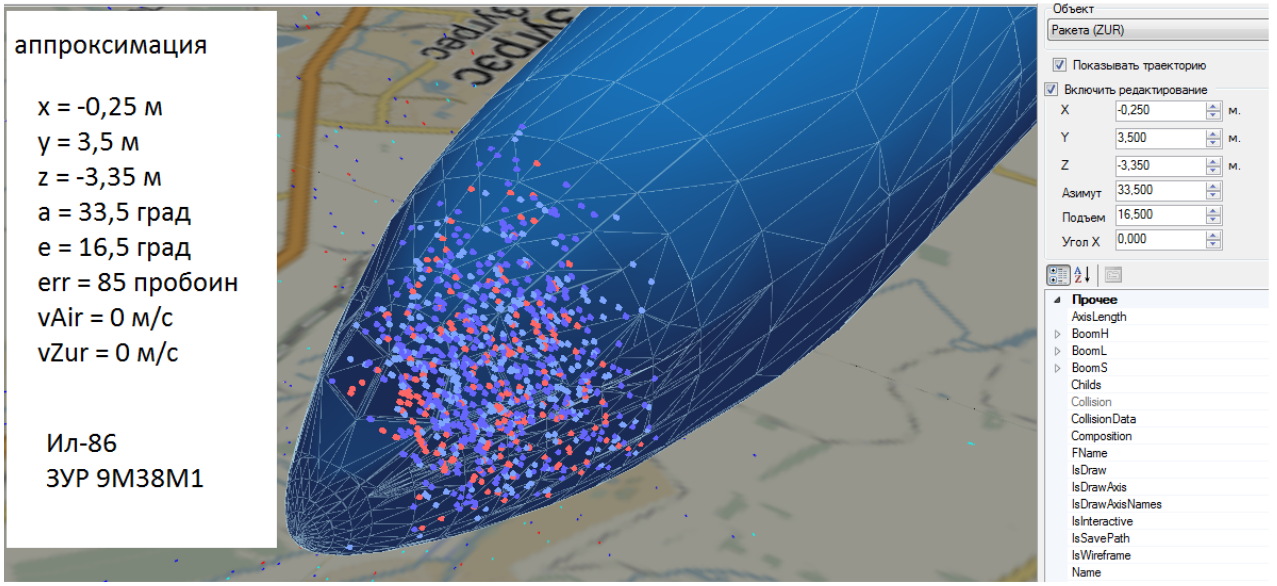


Static Position (Missile Velocity 0 m/s, Aircraft Velocity 0 m/s)

Q_{HOR}= 33.5є
Q_{VER}= 16.5є
V_{9M38M1} - **0** m/s
$V_{AIRCRAFT}$ - **0** m/s

ADJUSTMENT CORRECTIONS

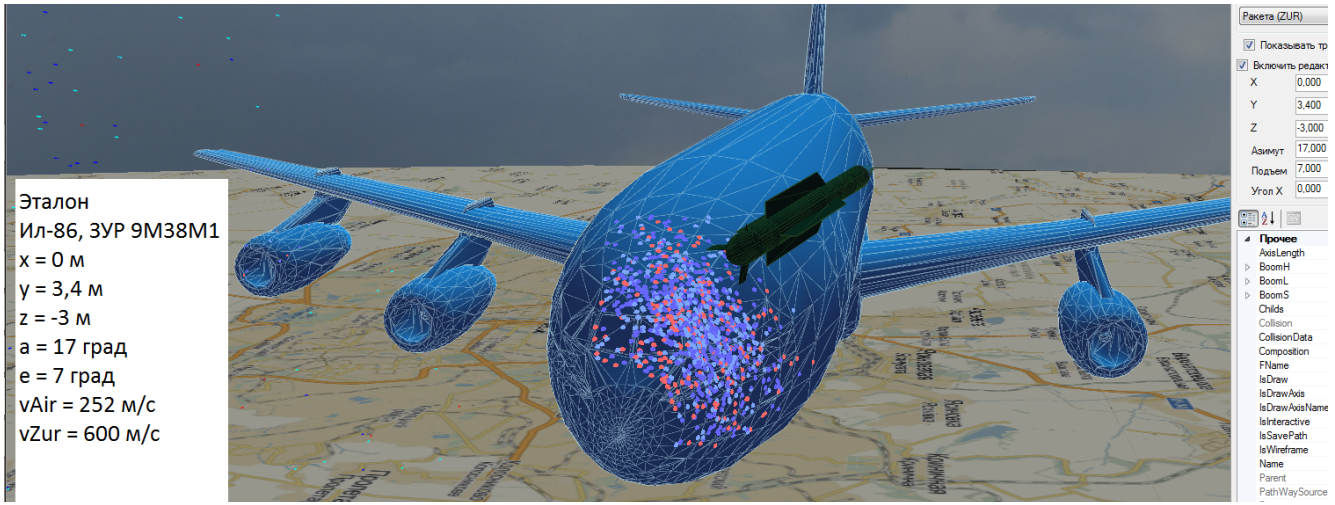
Q_{HOR}= + 16.5є
Q_{VER}= + 9.5є



Fragment Coverage Area

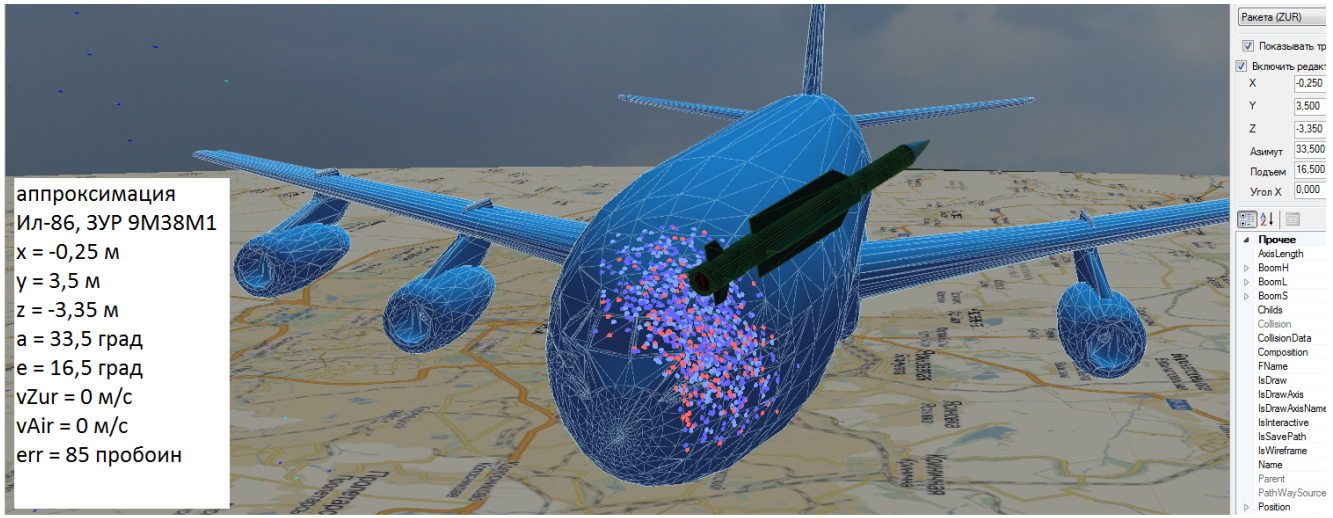
Dynamic Position (Missile Velocity 600 m/s, Aircraft Velocity 252 m/s)

Q_{HOR}= 17є
Q_{VER}= 7є
V_{9M38M1} ~ 600 m/s
$V_{AIRCRAFT}$ ~ 252 m/s



Static Position (Missile Velocity 0 m/s, Aircraft Velocity 0 m/s)

Q_{HOR}= 33.5є
Q_{VER}= 16.5є
V_{9M38M1} - 0 m/s
$V_{AIRCRAFT}$ - 0 m/s



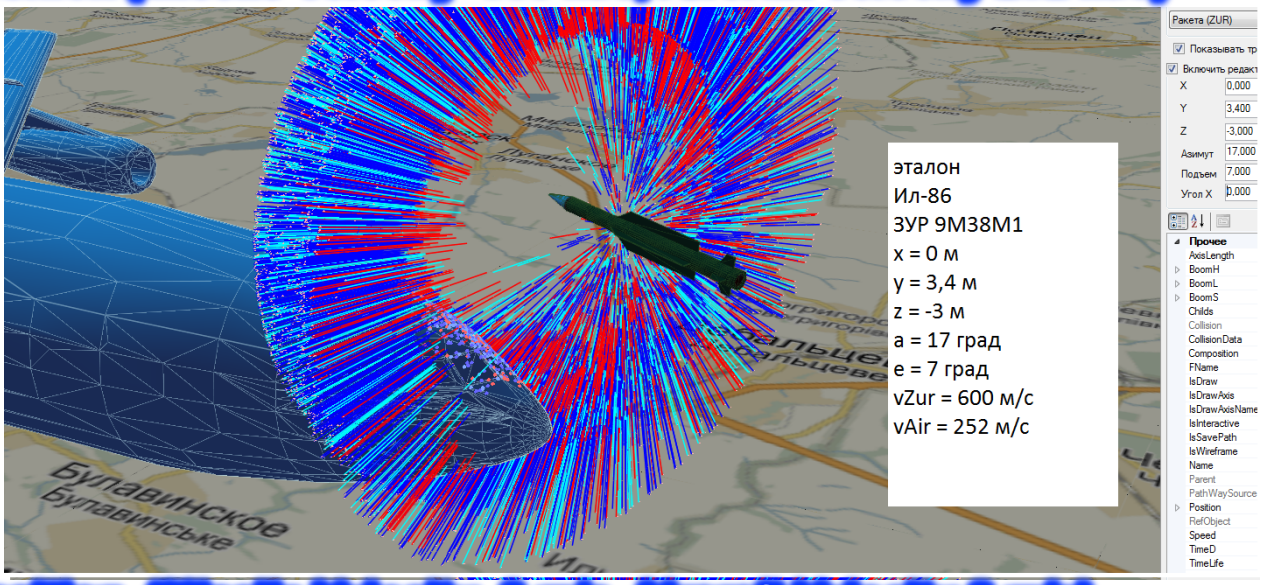
ADJUSTMENT CORRECTIONS

Q_{HOR}= + 16.5є
Q_{VER}= + 9.5є

Entry Hole Angles of Submunitions

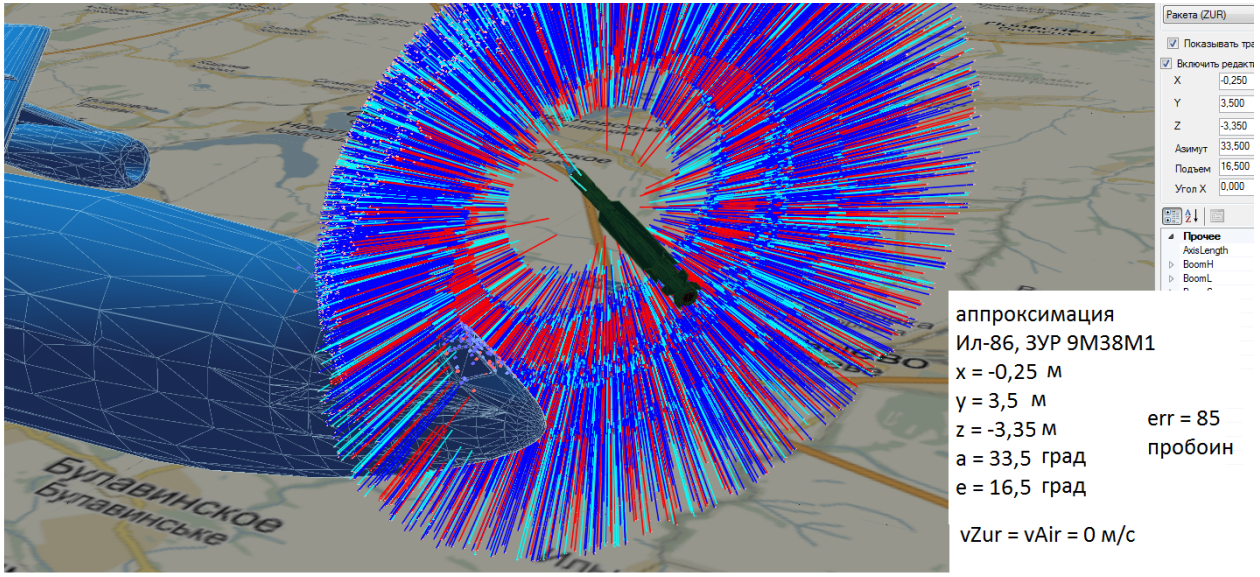
Dynamic Position (Missile Velocity 600 m/s, Aircraft Velocity 252 m/s)

Q_{HOR}= 17є
Q_{VER}= 7є
V_{9M38M1} ~ 600 m/s
$V_{AIRCRAFT}$ ~ 252 m/s



Static Position (Missile Velocity 0 m/s, Aircraft Velocity 0 m/s)

Q_{HOR}= 33.5є
Q_{VER}= 16.5є
V_{9M38M1} - 0 m/s
$V_{AIRCRAFT}$ - 0 m/s

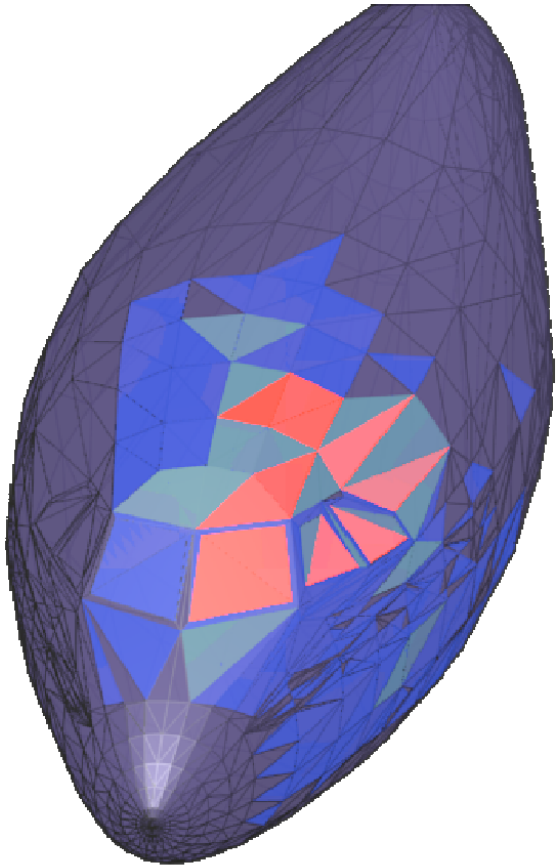


ADJUSTMENT CORRECTIONS

Q_{HOR}= + 16.5є
Q_{VER}= + 9.5є

Distribution of sub-munitions

Dynamic Position (Missile Velocity 600 m/s, Aircraft Velocity 252 m/s)



Эталон, ИЛ-86, 15.09.15

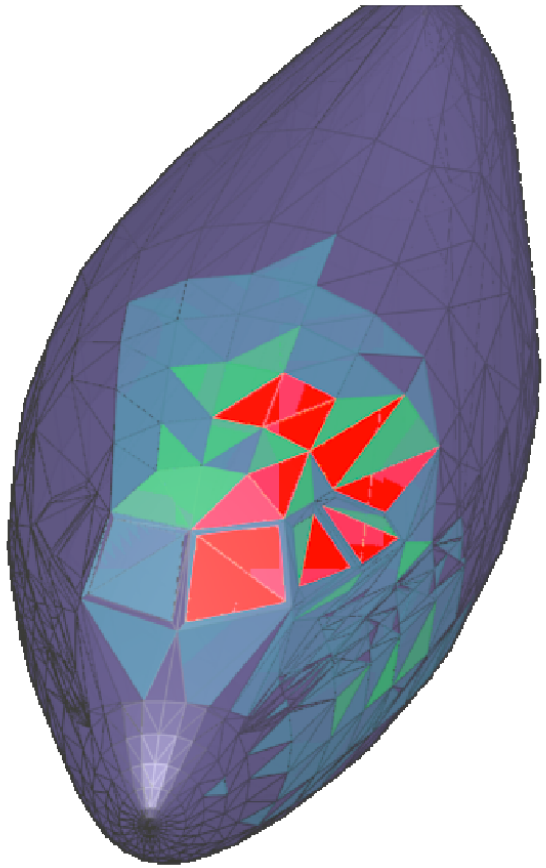
распределение осколков по площадкам

на площадку приходится не менее 20 пробоин

на площадку приходится не менее 10 пробоин

на площадку приходится менее 10 пробоин

Static Position (Missile Velocity 0 m/s, Aircraft Velocity 0 m/s)



ИЛ-86
расчет 3, 15.09.15

err = 85 м
x = -0,25 м
y=-3,35 м
a = 33,5 град
e = 16,5 град

перебор вокруг точки
(0; 3,5; -3,3; 29; 14)
0,3 с 0,05
5 с 0,5

на площадку приходится не менее 20 пробоин

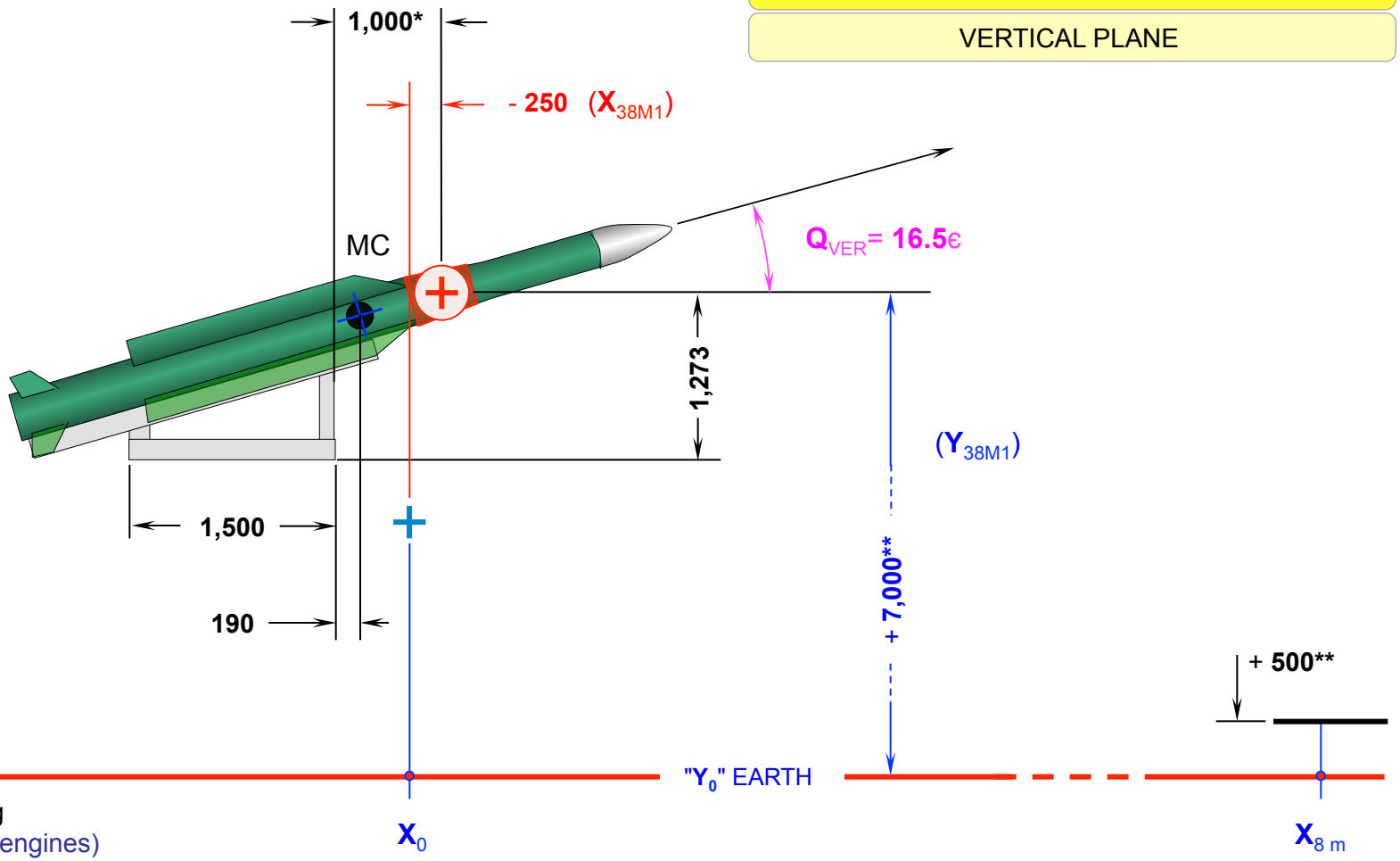
на площадку приходится не менее 10 пробоин

на площадку приходитс менее 10 пробоин

Baseline Data for Experiment's Target Layout

PLACEMENT ON CRADLE

VERTICAL PLANE



M_{38M1} = 342.6 kg
(with exhausted engines)

BAY CENTER 2 (ALIGNMENT POINT)

PRODUCT MASS CENTER

"0" OF TARGET (CROSSING OF CENTER LINE AND OBJECT'S NOSE PART)

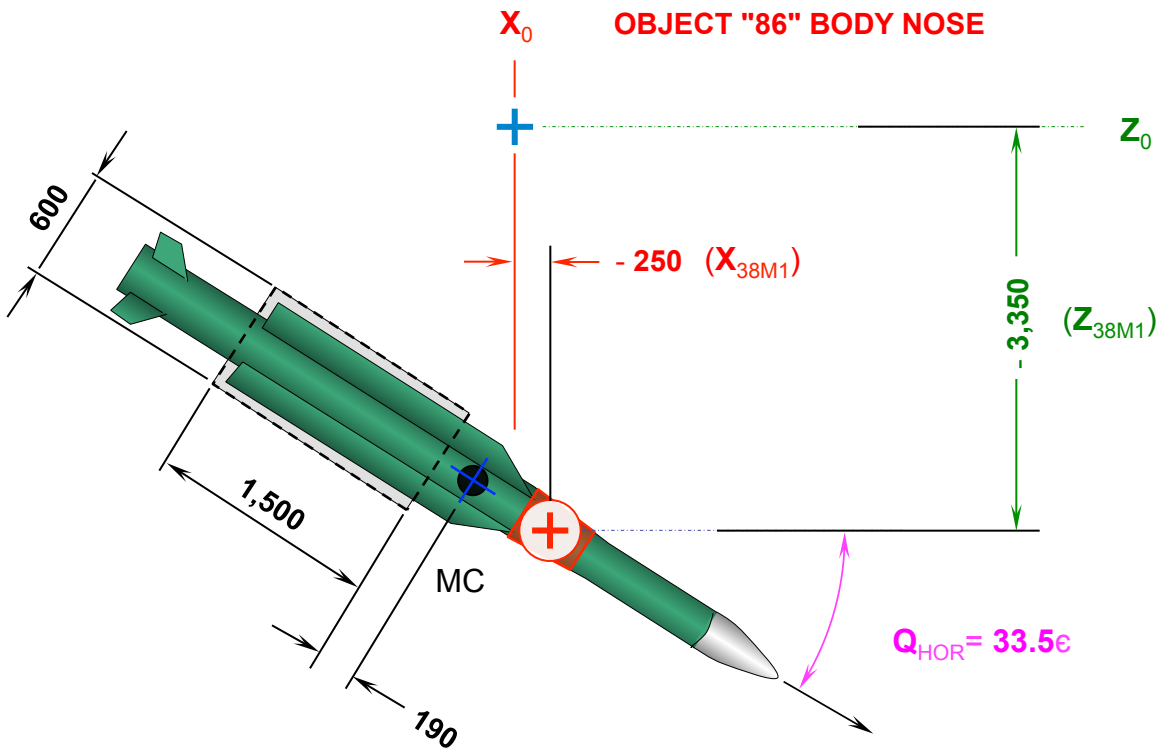
* - all in mm

** - at a height of object cradle 500 mm at 8 m

Baseline Data for Experiment's Target Layout

PLACEMENT ON CRADLE

HORIZONTAL PLANE

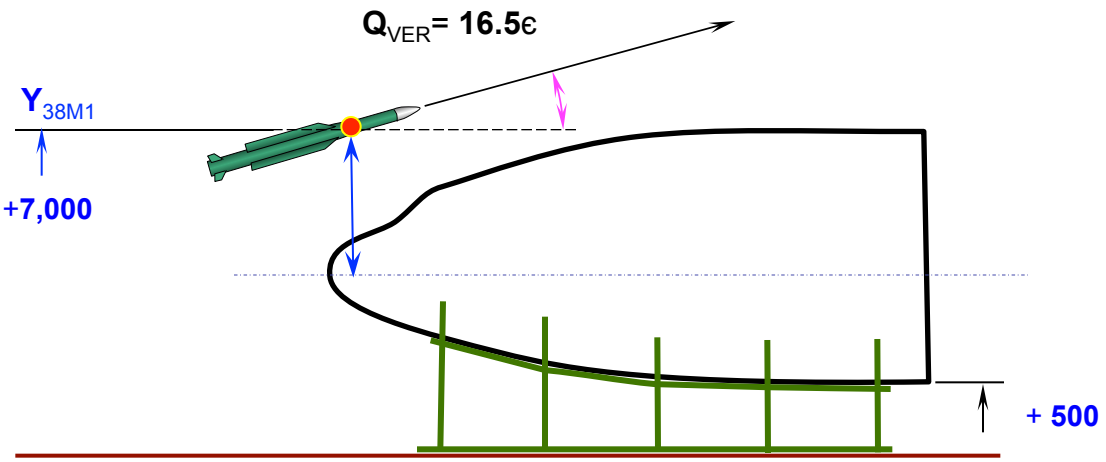


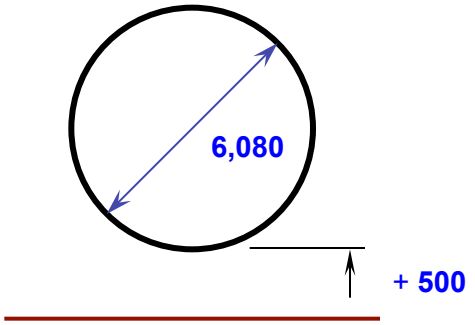
M_{38M1} = 342.6 kg
(with exhausted engines)

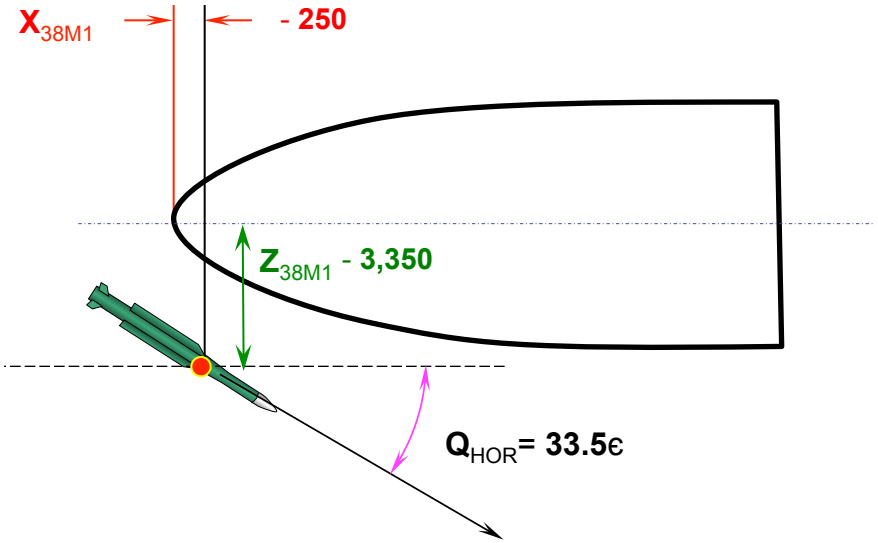
- BAY CENTER 2 (ALIGNMENT POINT)
- PRODUCT MASS CENTER
- "0" OF TARGET (CROSSING OF CENTER LINE AND OBJECT'S NOSE PART)

* - all in mm

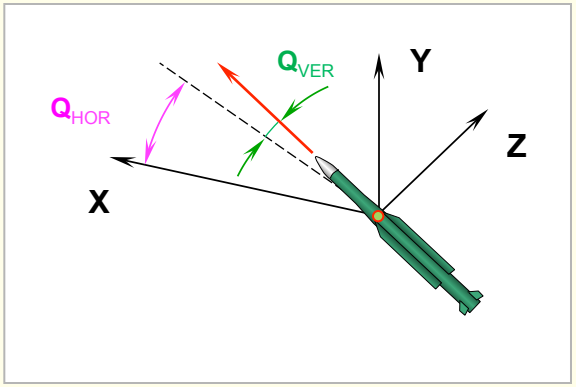
Baseline Data for Experiment's Target Layout







9M38M1



Q_{HOR}= 33.5є Q_{VER}= 16.5є

Preparatory Work for Experiment

Product 9M38M1

Warheaf 9N314M

9M38M1 MISSILE ARMED AND IS 40 SECONDS INTO FLIGHT

Preparatory Work for Experiment

Installation of Target No. 1 (nose part)

Target No. 2 (left engine)

Installation of the test bench

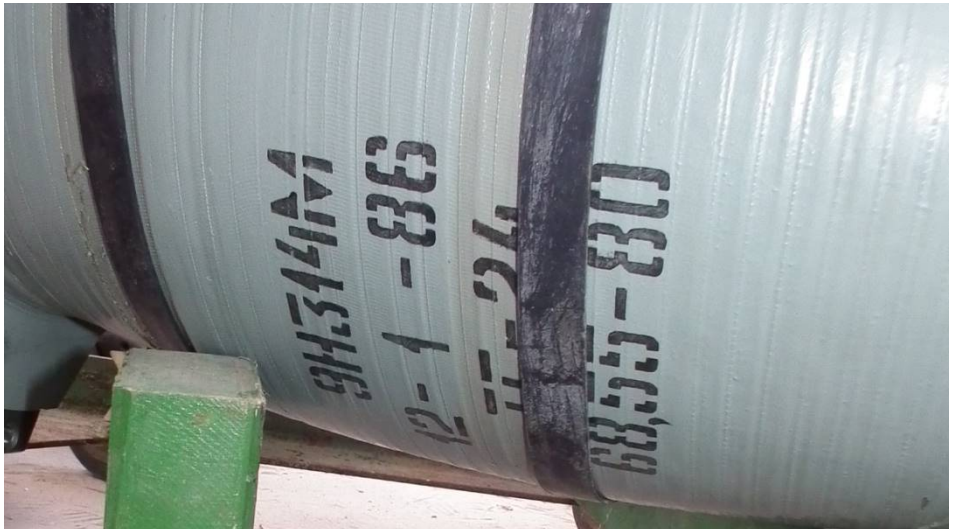
Preparatory Work for Experiment

Unloading of product 9M38M1

Final preparation stage of warhead 9N314M

Preparatory Work for Experiment

Insertion of the warhead into Product 9M38M1



Final stage preparation of Product 9M38M1

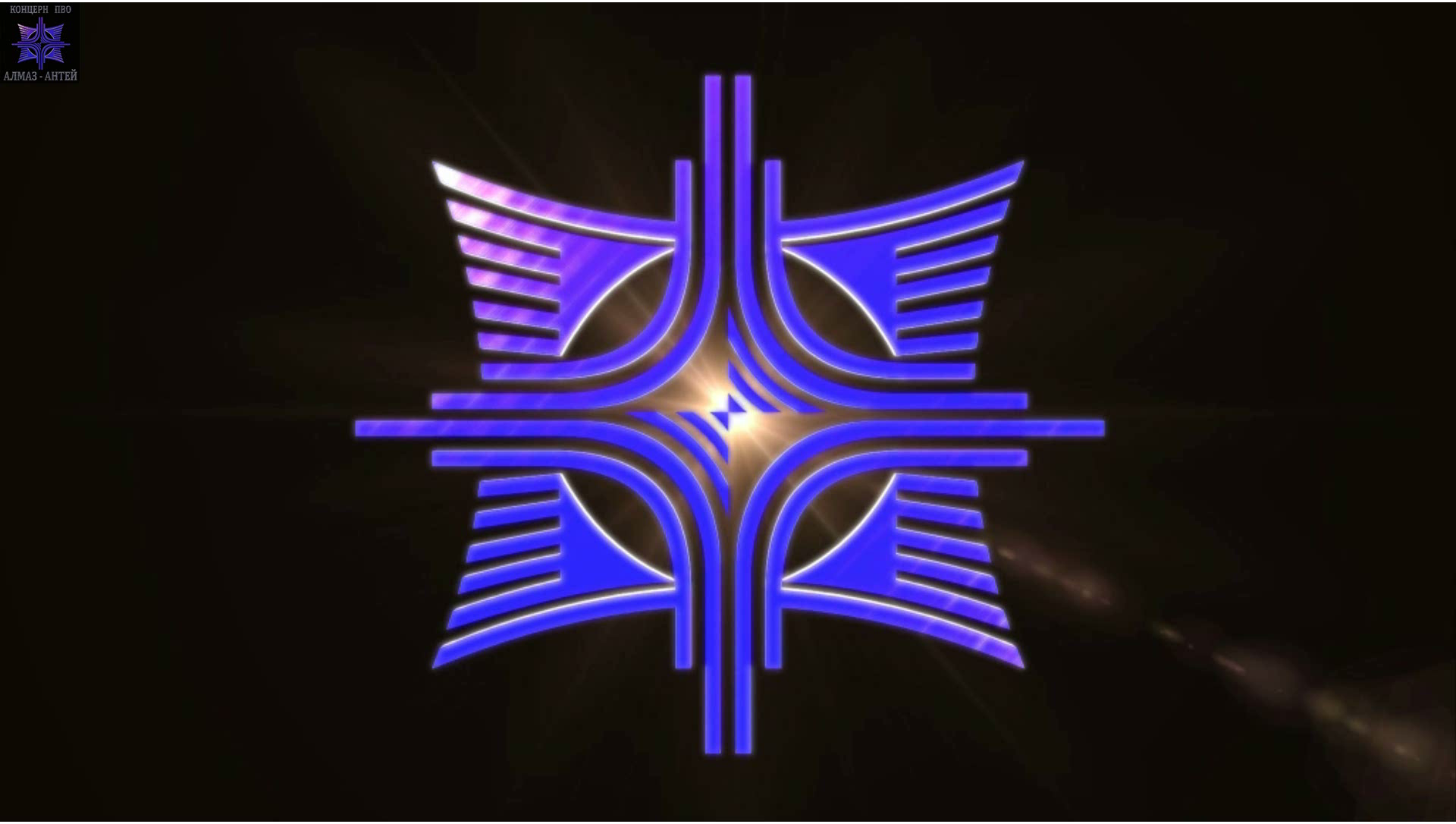
Installation of Product 9M38M1 onto the test bench

Preparatory Work for Experiment

Deployment of Product 9M38M1

Experiment: Stage 2

КОНЦЕРН ПВО
АЛМАЗ - АНТЕЙ



Damage Analysis

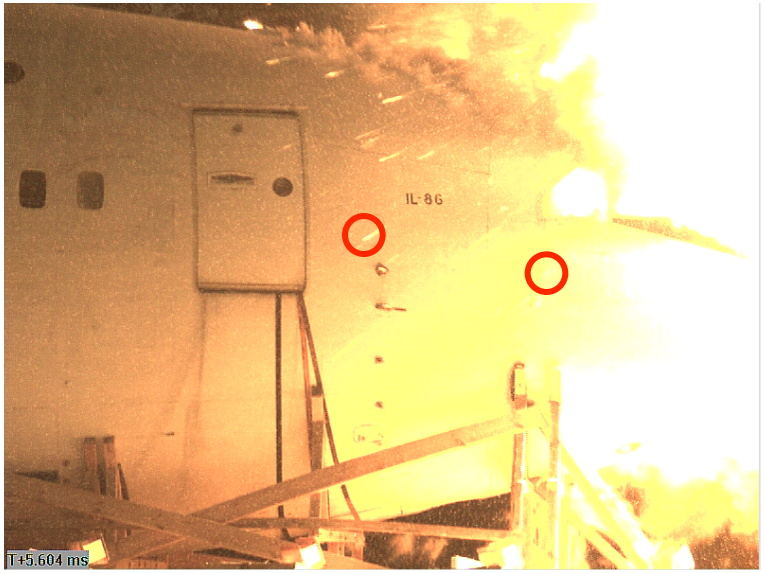
Cockpit (left view)

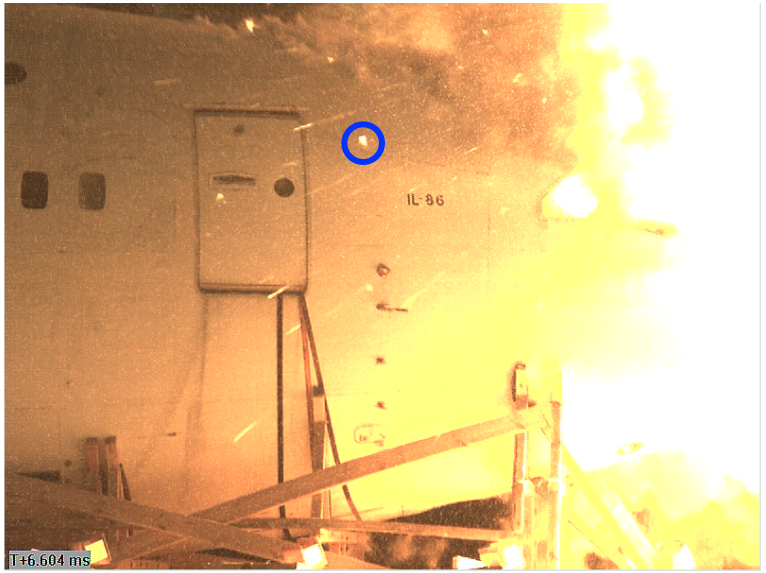
Cockpit (view from inside)

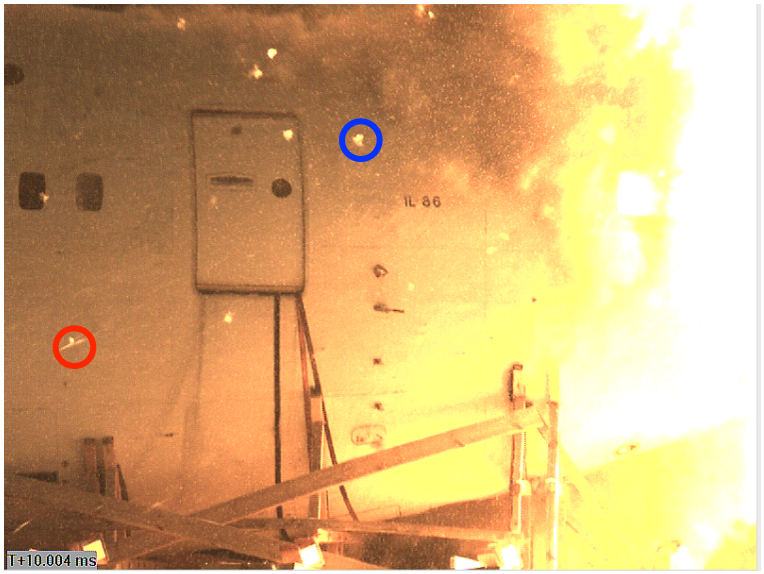
Cockpit (front view)

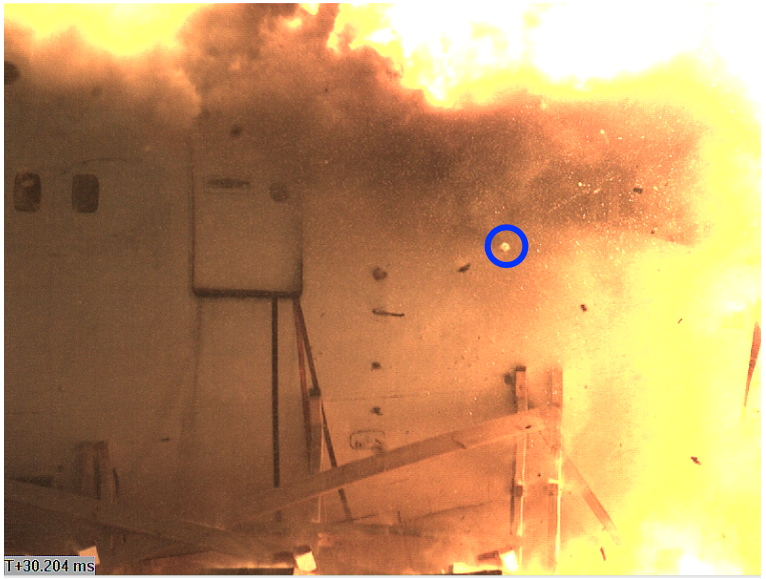
Cockpit (top view)

Hole in Starboard Side







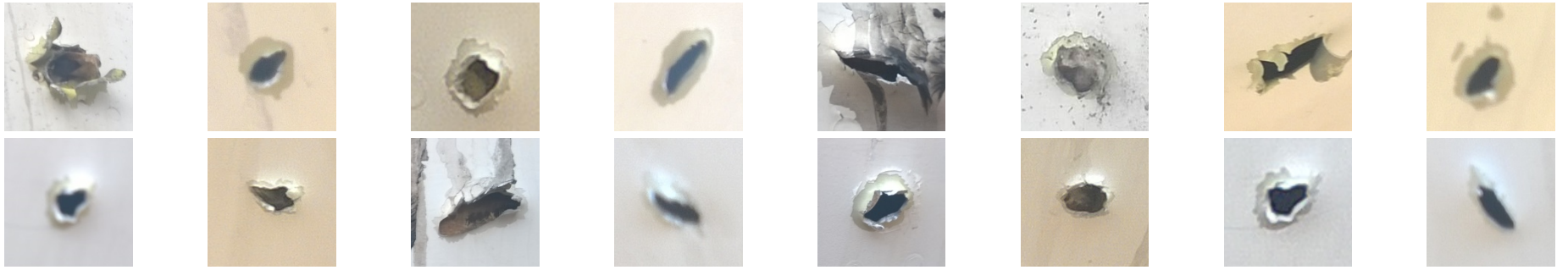


FRAGMENTS RETAINING HIGH VELOCITY

FRAGMENTS LOSING HIGH VELOCITY

Damages

Exit holes on the right-hand side

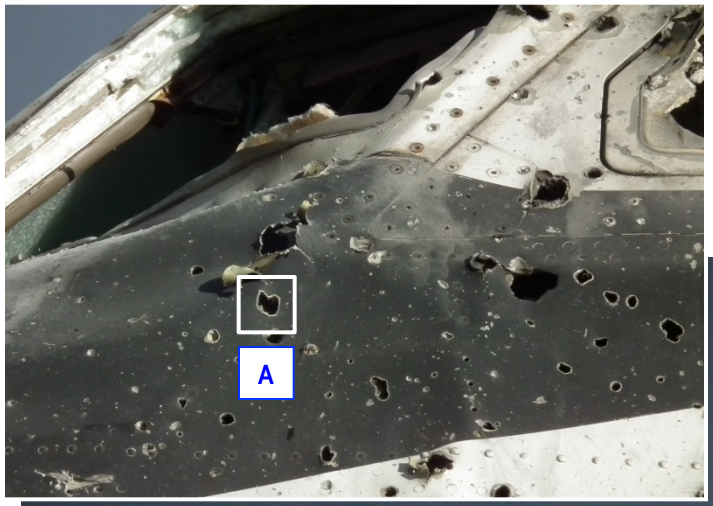


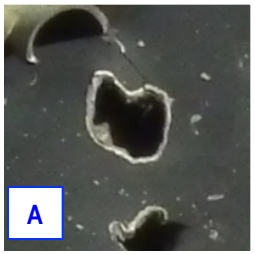
Damage Analysis

Cockpit (left view)

Отсутствие рикошетов в районе остекления кабины экипажа на левом борту

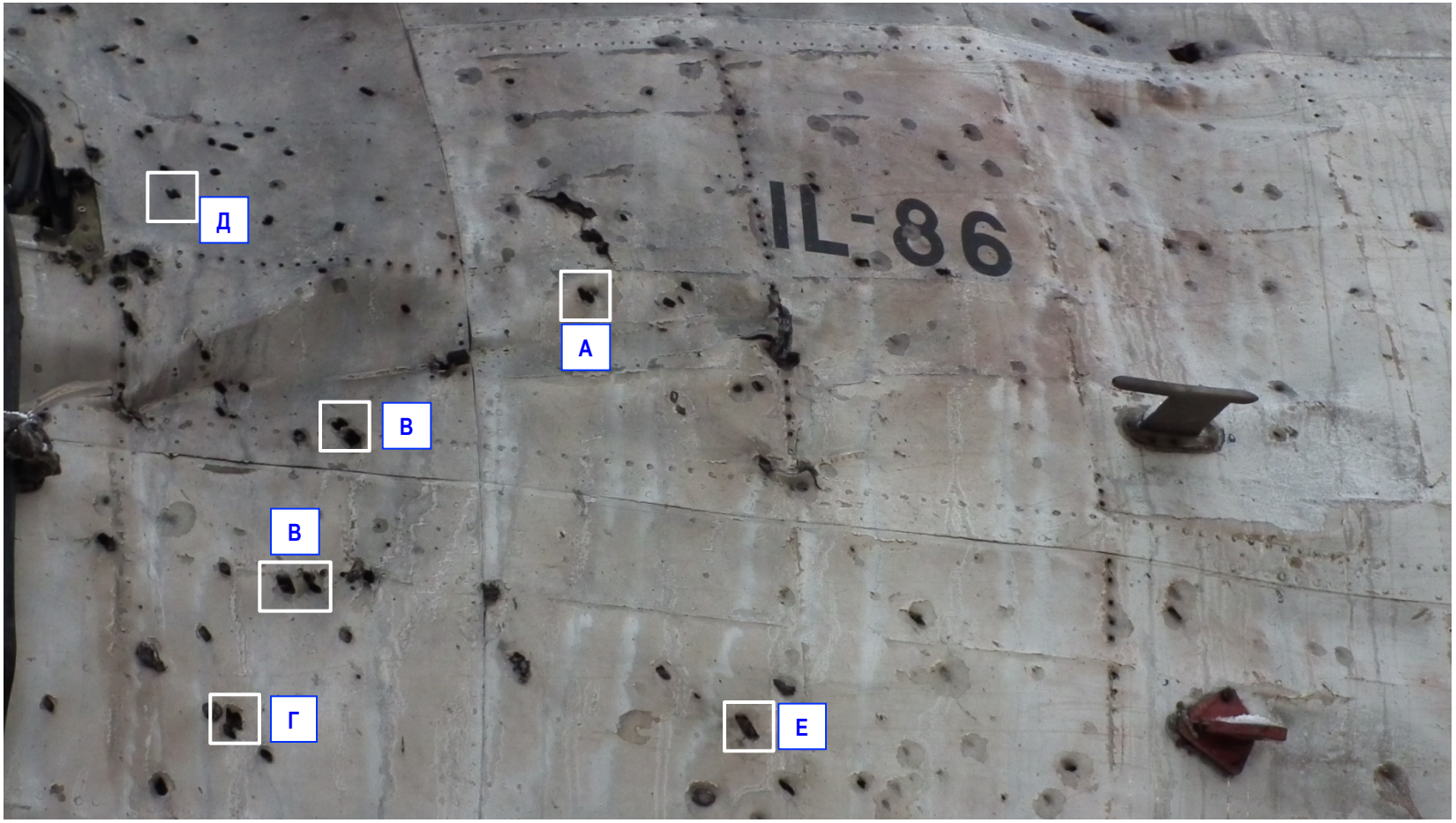
Damage Analysis



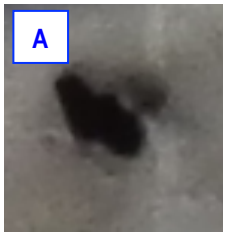


Typical holes from I-BEAM submunitions (13x13x8,2 mm)

Damage Analysis

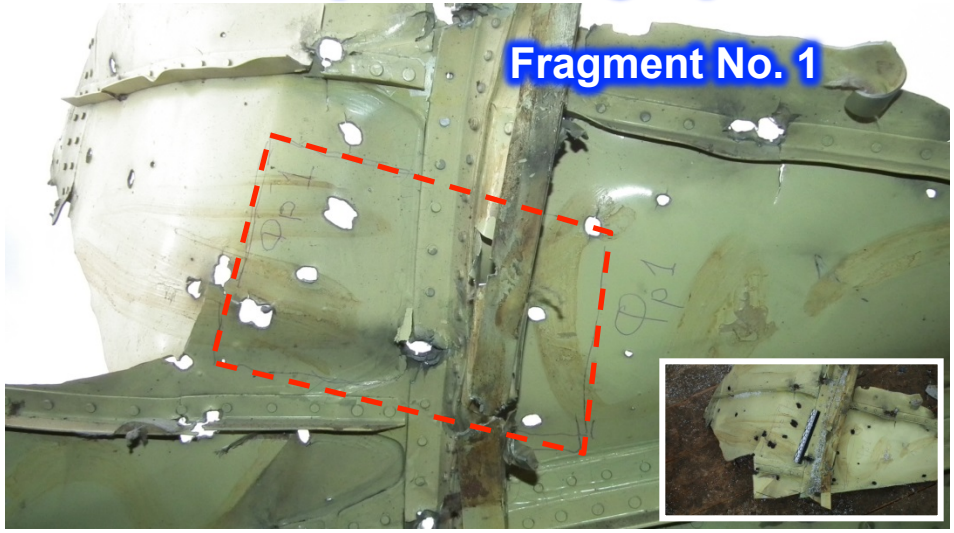


Typical holes from I-BEAM submunitions (13x13x8,2 mm)

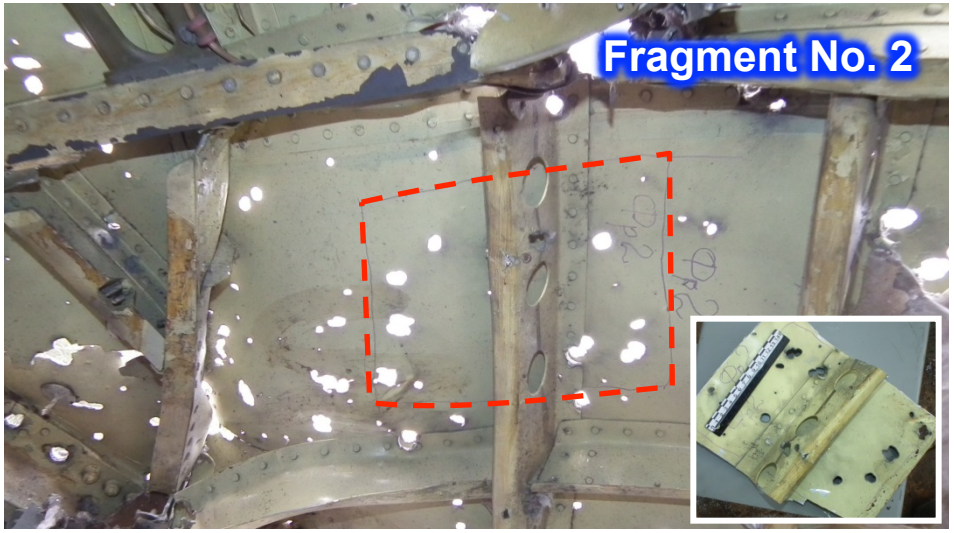


Damage Analysis

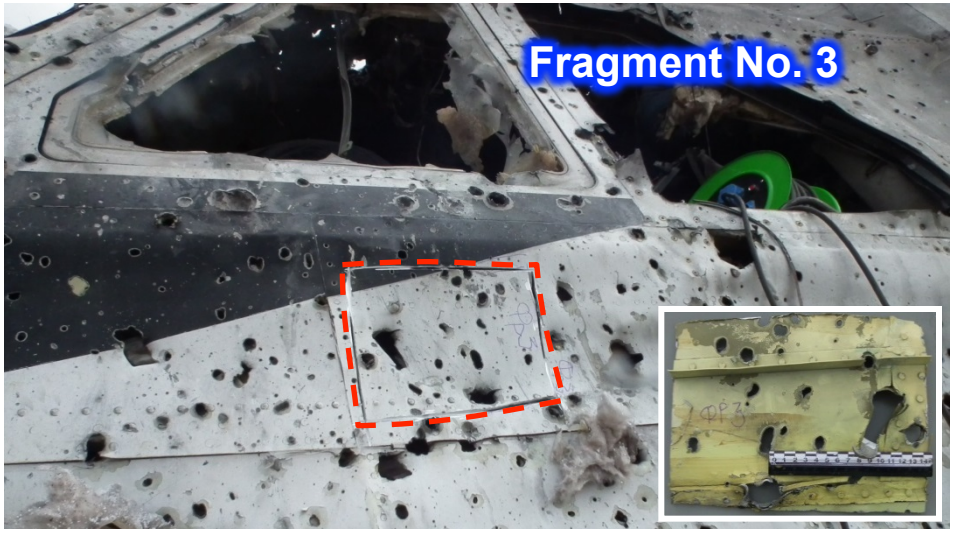
Roof structural member (complete with the main frame) of the cockpit behind the left glass panel



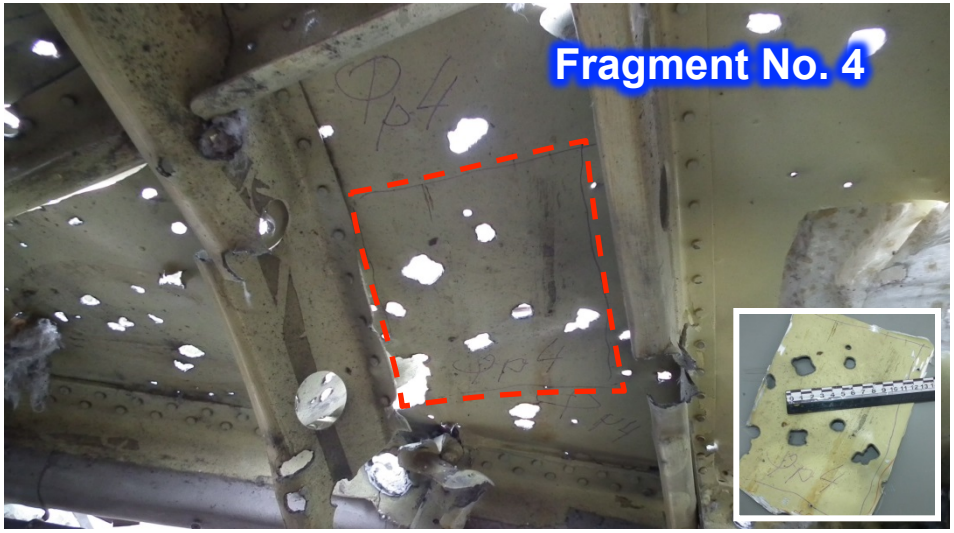
Roof structural member (complete with the stringer) of above the PIC's seat



Port side structural element in the area of the PIC's side window



Roof structural member above the PIC's seat



Damage Analysis

Port side structural element behind the PIC's seat

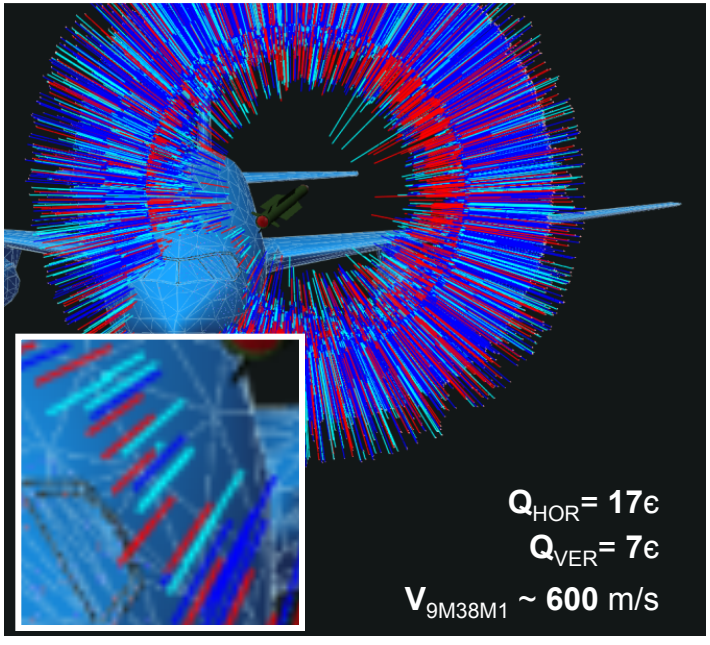
Locations of Fragments Collection

Damage Analysis

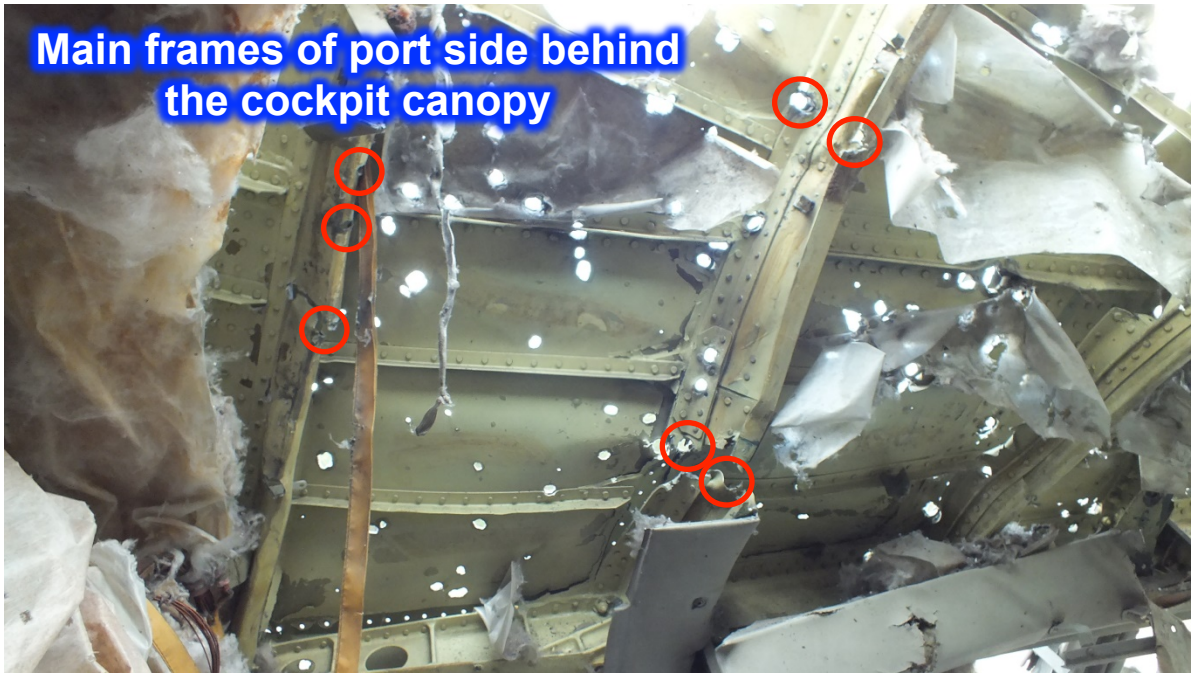
Open-end hole in the stringers

Damages to Superstructure

Stimulation Results



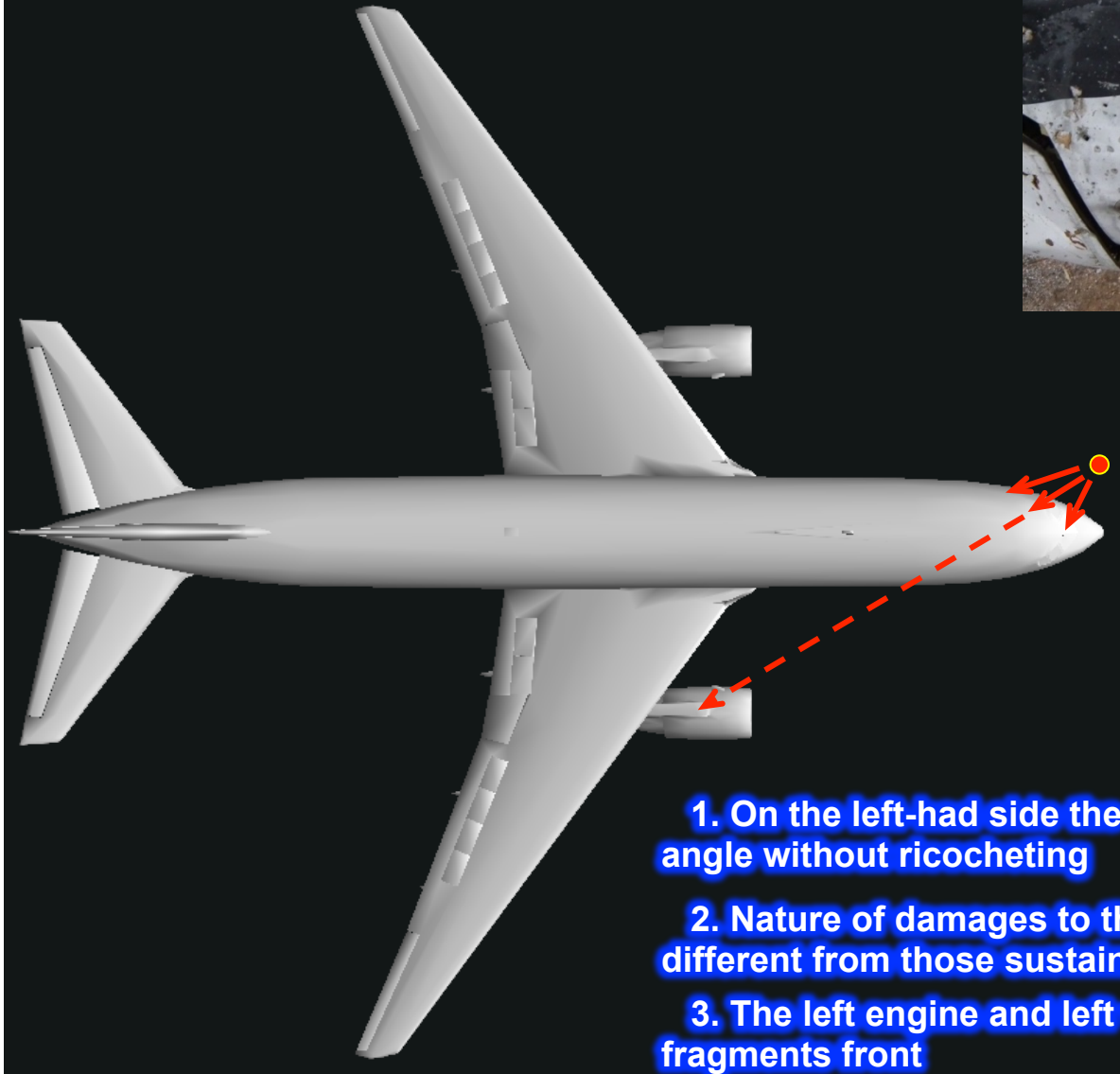
Main frames of port side behind the cockpit canopy

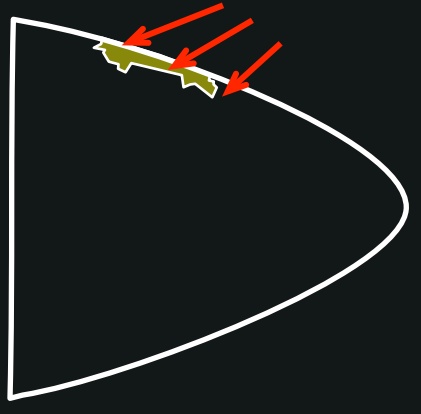


Break-up of main frames

Damage Analysis

Key Conclusions on Damages to Aircraft





1. On the left-had side the cockpit canopy the SM entered at angle without ricocheting

2. Nature of damages to the aircraft superstructure is totally different from those sustained by MH17

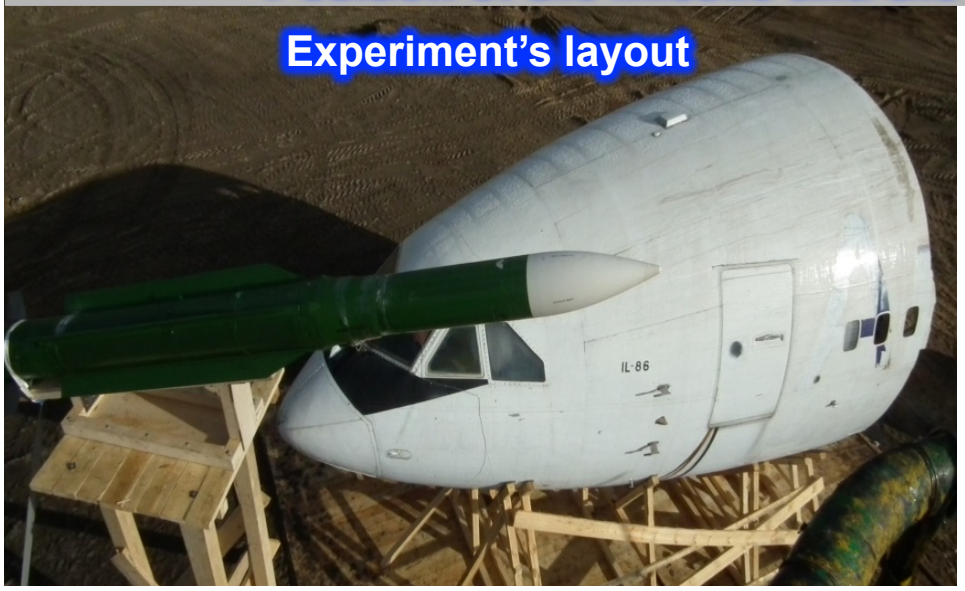
3. The left engine and left wing are outside of the impact by the fragments front

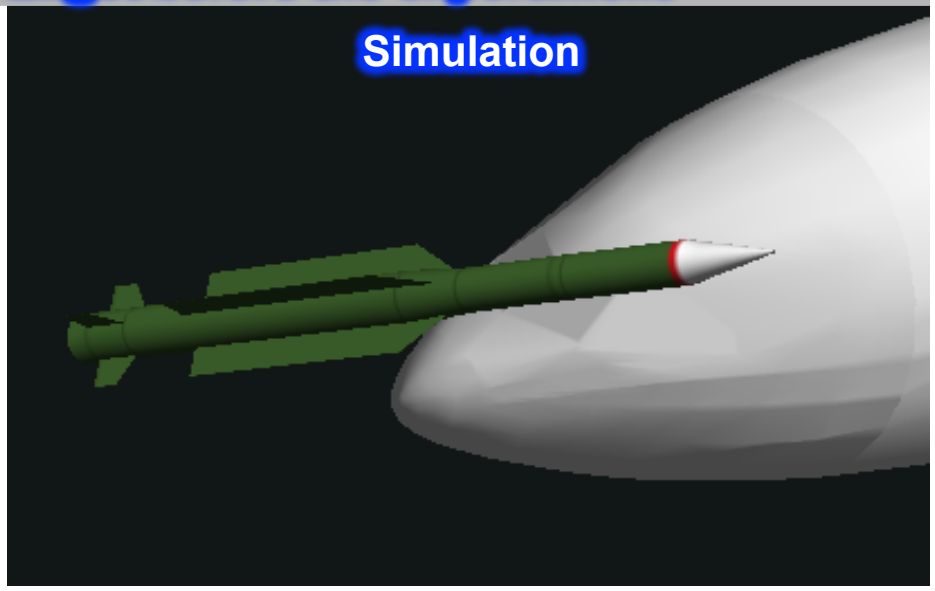
Missile Fragments

Missile Fragments

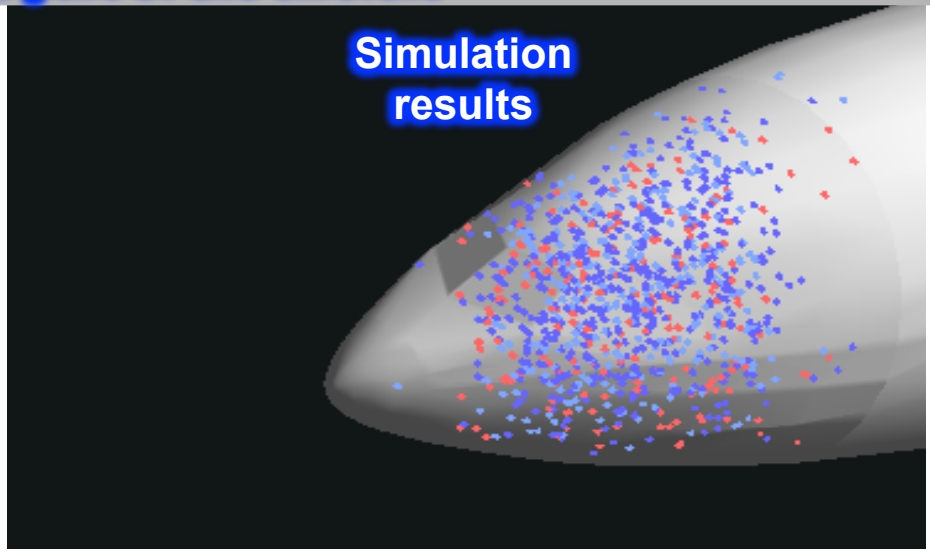
Verification of Simulation Results

Position of the missile and the target before the experument





Damages to the nose part of the aircraft

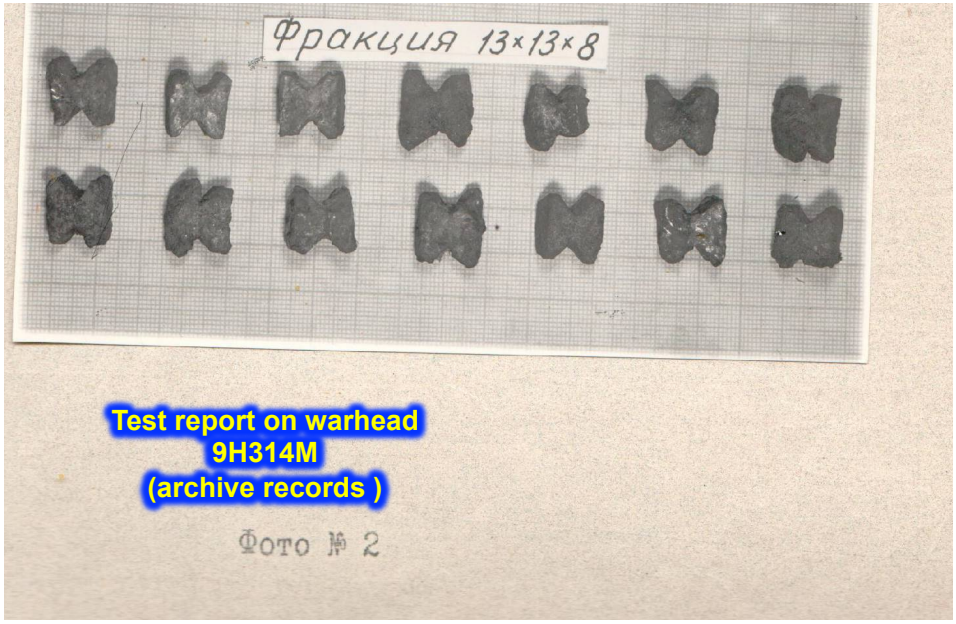


Retrieval of the I-BEAM submunition

Pre-armed Submunitions (Experiment: Stage 2)

Pre-armed Submunitions

I-BEAM (13x13x8.2 mm)



Test report on warhead 9H314M (archive records)

Original exterior view of IBEAM pre-armed SM

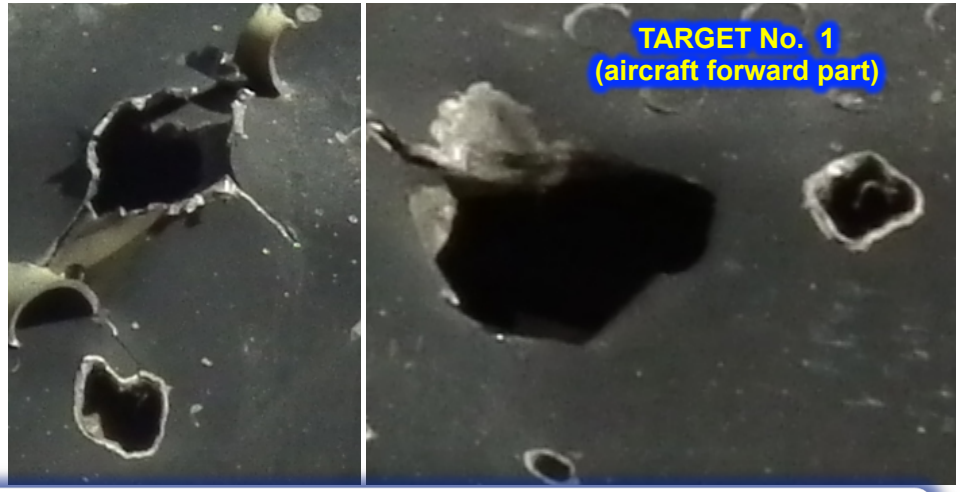
Frame Submunitions

Retrieved from the traps of the shield target

Retrieved from Target No. 1 (aircraft forward part)

Size comparison of pre-armed submunitions and fragments of the warhead body

Size comparison of holes made by submunitions and fragments of the warhead body



DAMAGES TO THE ENGINE ARE DELINEATED BY COMBINATION OF ARMED SUB-MUNITIONS AND FRAGMENTS OF WARHEAD BODY BAY IMPACTING IN MAIN FIELD OF DEBRIS

ELABORATION ON TYPE OF MISSILE

Type of Missile – 9M38 complete with warhead б9Н314 (without I-beams)

VALIDATION OF COLLISION PARAMETERS OF MISSILE AND AIRCRAFT

The parameters of the missile colliding into the aircraft obtained by the Concern's team have been validated during the full-size real life experiment.

The most probable location of the missile launch is Наиболее the area to the south of Zaroshchenskoe.