GENERAL ASTRONAUTICS
ARCA SPACE

CER-500TR
TARGET ROCKET

USER GUIDE

14 October 2024, pre-release version 3

Content

1. Introduction

1.1 Overview

CER-500TR is an ecological, extremely cost effective rocket system, build as a target rocket for military anti-rocket artillery, anti-ballistic, and anti-cruise missiles training.
The rocket could be launched from the ground, from vehicles, directly from the sea, or from a ship.
The rocket vehicle is expendable, however the ground support equipment is fully reusable.
Contrary to al present-day rockets, CER-500TR uses no flammable or explosive propellants, but a mixture of water and hydrogen peroxide 30%-70% making it benign for the environment, simple and cost effective.
Also, the rocket employs no electronics, and it has just a single valve for engine start, making it extremely easy to operate, requiring no prior aerospace training.
Another important feature of the CER-500TR is related to the fact that the amount of propellant in the tank can be adjusted prior to launch, accordingly to the needed flight trajectory.

1.2 Applications

CER-500TR could be used as targets to simulate large rocket artillery, Tactical Ballistic Missiles (TBM), land-targeted cruise missiles, and anti-ship missiles, flying at altitudes up to 30km, ranges up to 50km and speeds up to Mach 2.1.
The range of simulated targets makes the CER-500TR system suitable for users from the ground, naval and air forces.

CER-500TR, second rocket from the right.

2.Product presentation

The CER-500TR is the medium size rocket vehicle from our offer, designed as a target vehicle for military applications.

2.1 Technical characteristics and performances

Characteristic	Data
Diameter (body only)	0.5 m
Diameter over fins	1.9 m
Length	10 m
Dry weight	100 kg
Propellant weight	1,400 kg
Payload weight, maximum	100 kg
Launch weight, maximum	1,600 kg
Engine run time	60 s
Altitude with maximum payload	30 km
Speed with maximum payload	2.1 Mach
Launch angle from horizontal	20 - 90°

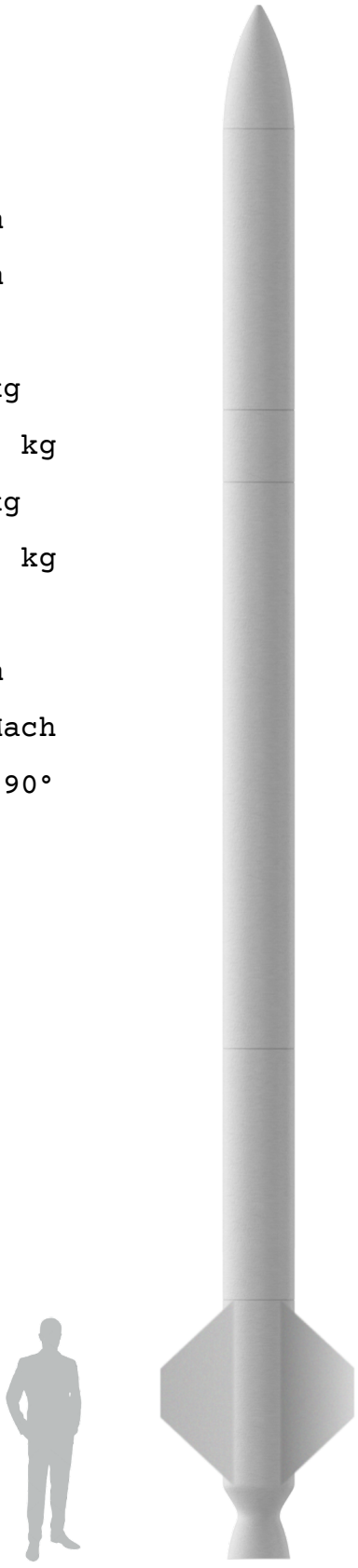


Fig.1 - CER-500TR comparison with a person.

Fig.2 - CER-500TR elements

2.2 Performance data

A series of diagrams are shown below, emphasising the CER-500TR vehicle’s performance.

- Payload vs altitude

The CER-500TR has the capability to carry 100 kg of payload. The below table presents the rocket’s altitude vs payload mass, if launched on a vertical trajectory:

Payload mass	Altitude
0	42 km
50	35 km
100	30 km

- Launch angle vs. altitude vs speed vs time vs. range

The simulations are considering the maximum payload of 100 kg. The launch angle is considered from horizontal.

Launch angle	Altitude	Speed, max.	Max. speed altitude	Flight Time	Range
90°	30 km	2.1 Mach	17 km	222 s	0 km
80°	29 km	2.05 Mach	16.5 km	224 s	10 km
70°	28 km	2 Mach	16 km	226 s	21 km
60°	26 km	1.95 Mach	15.5 km	228 s	28 km
50°	23 km	1.9 Mach	14 km	230 s	38 km
40°	18.5 km	1.8 Mach	12 km	232 s	44 km
30°	14 km	1.65 Mach	9.5 km	236 s	48 km
20°	9 km	1.4 Mach	6.5 km	242 s	50 km

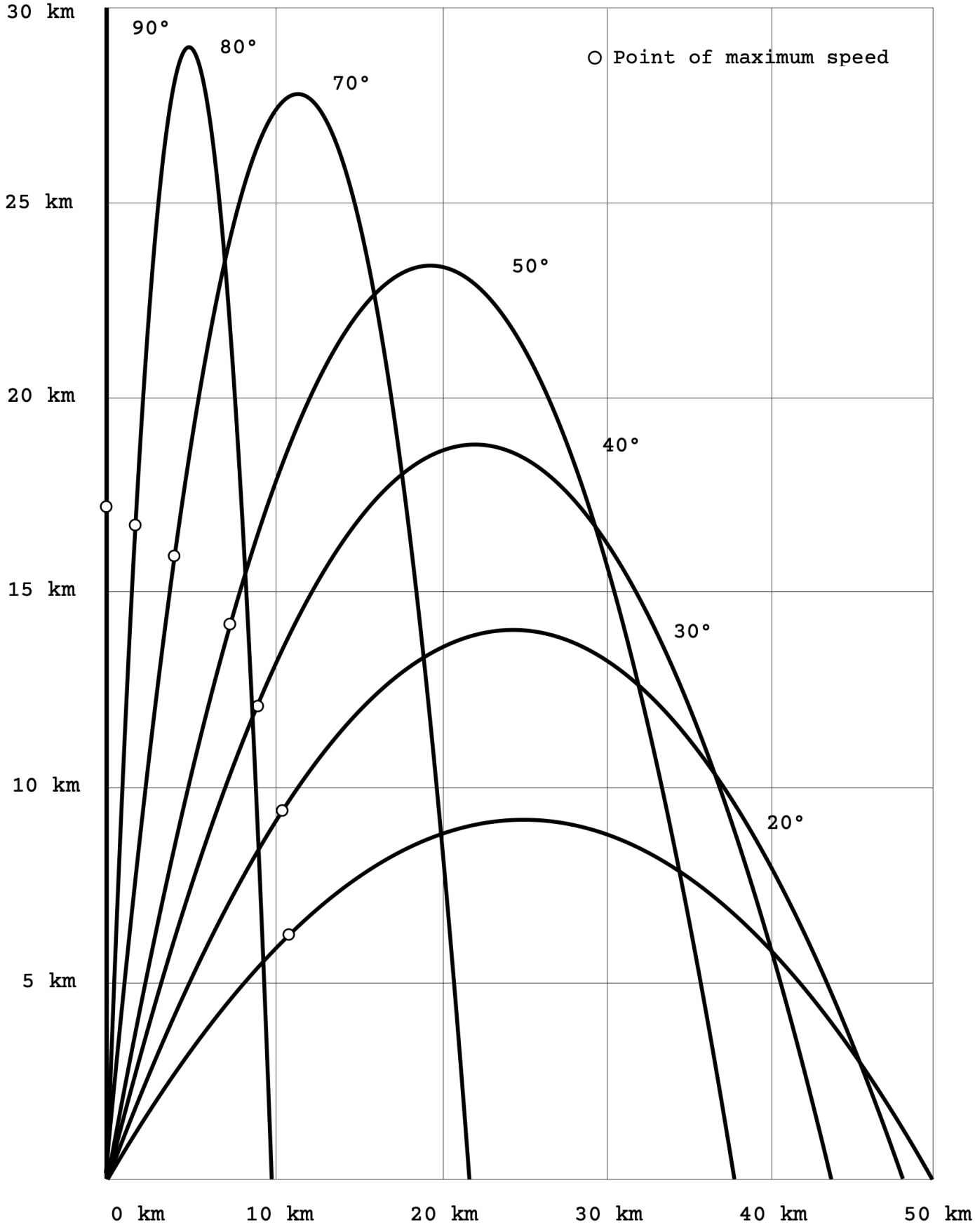


Fig.3 - CER-500TR flight envelope.

- Propellant mass vs. altitude vs. Speed vs. Flight time

The CER-500TR has the capability to be carry 100 kg of payload. The below table presents the rocket's altitude vs payload mass, if launched on a vertical trajectory:

Propellant mass	Altitude	Speed, max	Flight time
1,400 kg	30 km	2.1 Mach	222 s
1,000 kg	17 km	2.0 Mach	135 s
700 kg	11 km	1.8 Mach	96 s
350 kg	6 km	1.6 Mach	68 s

CER-500TR during a test launch.

3. Ground Support Equipment

Each CER version has a dedicated ground support system needed to fuel and launch the vehicle.

3.1 Launch canister

The launch canister has a diameter of 2 m and it is standing 12 m tall. Inside of the canister there are two launch rails on which the rocket is sliding from the engine start until it reaches minimum velocity for stable flight.

3.2 Propellant transfer tank

The propellant transfer tank is a 1,500 litre stainless steel tank that stores the propellant before it is transferred into the rocket prior to the launch.

4. Prerequisites

The CER-500TR system needs three major elements that must be provided locally by the end user in order to be able to launch the rocket:

4.1 Propellant

The propellant for the CER-500TR rocket is a mixture of water and hydrogen peroxide in the 30-70 ratio. The hydrogen peroxide already prepared in this ratio is commercially available everywhere in the world, and sold as hydrogen peroxide 70% concentration.
The user must procure locally 1,400 kg of 70% concentration hydrogen peroxide in order to fuel the rocket for launch. Also, the rocket works with 50% concentration hydrogen peroxide found in stores, but with flight performance loss.

4.2 Pressurant

After the rocket is fuelled, the tank must be pressurised at a pressure of 14 bar, prior to launch.
Various hydrogen peroxide compatible gases could be used. We recommend air from an air compressor (the most affordable option), helium (for the highest rocket performance), nitrogen, argon.

4.3 12V power source

A 12V, 5A external power source is needed.

5. Applications

CER-500TR could be used as target to simulate large rocket artillery, Tactical Ballistic Missiles (TBM), land-targeted cruise missiles, and anti-ship missiles, flying at altitudes up to 30 km and speeds up to Mach 2.1.
The range of simulated targets makes the CER-500TR system suitable for users from the ground, naval and air forces.
The rocket artillery, TBMs, land targeted cruise missiles and anti-ship missiles that the CER-500TR can simulate are presented below.

5.1 List of compatible rocket artillery

The CER-500TR is suitable to simulate the flight of large rocket artillery. CER-500TR is suitable for this taking into account its similar size, weight and flight profile compared to the currently operational rocket artillery.

The following relevant large rocket artillery systems are presented below compared to the CER-500TR:

- BM-30 Smerch - Russia
- Vilkha - Ukraine
- WS-2 - China

- BM-30 Smerch

Characteristic	9M55K rocket	CER-500TR
Diameter (body only)	0.3 m	0.5 m
Length	7.6 m	10 m
Launch weight, maximum	800 kg	1,600 kg
Altitude	N/A	30 km
Speed, maximum	N/A	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	70 km	50 km
Cost/unit	N/A	€39,900

- Vilkha

Characteristic	Vilkha rocket	CER-500TR
Diameter (body only)	0.3 m	0.5 m
Length	7.6 m	10 m
Launch weight, maximum	800 kg	1,600 kg
Altitude	N/A	30 km
Speed, maximum	N/A	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	130 km	50 km
Cost/unit	N/A	€39,900

- WS-2 - China

Characteristic	WS-2 rocket	CER-500TR
Diameter (body only)	0.4 m	0.5 m
Length	N/A	10 m
Launch weight, maximum	1,285 kg	1,600 kg
Altitude	N/A	30 km
Speed, maximum	N/A	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	200 km	50 km
Cost/unit	N/A	€39,900

5.2 List of compatible Tactical Ballistic Missiles (TBMs)

The CER-500TR is suitable to simulate the flight of Tactical Ballistic Missiles (TBMs). CER-500TR is suitable for this taking into account its similar size, weight and flight profile compared to the currently operational TBMs.

The following relevant TBMs that the CER-500TR could simulate are presented below compared to the CER-500TR:

- MGM-140 ATACMS - US
- OTR-21 Tochka-U - Russia
- Prahaar - India
- Abdali-I - Pakistan
- Khan - Turkey
- Lora - Israel
- Fateh-313 - Iran

- MGM-140 ATACMS

Characteristic	M57 rocket	CER-500TR
Diameter (body only)	0.61 m	0.5 m
Length	4 m	10 m
Launch weight, maximum	1,670 kg	1,600 kg
Altitude	50 km	30 km
Speed, maximum	+3 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	300 km	50 km
Cost/unit	~$1,476,000	€39,900

– OTR-21 Tochka-U

Characteristic	OTR-21	CER-500TR
Diameter (body only)	0.65 m	0.5 m
Length	6.4 m	10 m
Launch weight, maximum	2,000 kg	1,600 kg
Altitude	50 km	30 km
Speed, maximum	5.3 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	300 km	50 km
Cost/unit	~$300,000	€39,900

– Prahaar

Characteristic	Prahaar	CER-500TR
Diameter (body only)	0.42 m	0.5 m
Length	7.3 m	10 m
Launch weight, maximum	1,280 kg	1,600 kg
Altitude	35 km	30 km
Speed, maximum	4 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	150 km	50 km
Cost/unit	~$4,500,000	€39,900

– Abdali-I

Characteristic	Abdali-I	CER-500TR
Diameter (body only)	0.56 m	0.5 m
Length	9.75 m	10 m
Launch weight, maximum	1,750 kg	1,600 kg
Altitude	N/A	30 km
Speed, maximum	N/A	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	280 km	50 km
Cost/unit	N/A	€39,900

– Khan

Characteristic	Khan	CER-500TR
Diameter (body only)	0.61 m	0.5 m
Length	8 m	10 m
Launch weight, maximum	2,500 kg	1,600 kg
Altitude	N/A	30 km
Speed, maximum	5 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	280 km	50 km
Cost/unit	N/A	€39,900

– Lora

Characteristic	Lora	CER-500TR
Diameter (body only)	0.624 m	0.5 m
Length	5.2 m	10 m
Launch weight, maximum	1,600 kg	1,600 kg
Altitude	N/A	30 km
Speed, maximum	+5 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	300 km	50 km
Cost/unit	N/A	€39,900

– Fateh-313

Characteristic	Fateh-313	CER-500TR
Diameter (body only)	0.612 m	0.5 m
Length	8.76 m	10 m
Launch weight, maximum	3,245 kg	1,600 kg
Altitude	N/A	30 km
Speed, maximum	> 5 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	500 km	50 km
Cost/unit	$150,000	€39,900

5.3 List of compatible cruise missiles

The CER-500TR is suitable to simulate the flight of cruise missiles in the terminal phase. CER-500TR is suitable for this taking into account its similar size and terminal flight profile compared to the currently operational cruise missiles.
The following relevant cruise missiles that the CER-500TR could simulate are presented below compared to the CER-500TR:

- Tomahawk - US
- Kalibr - Russia
- KH-101 - Russia
- Nirbhay - India

– Tomahawk IV

Characteristic	Tomahawk IV	CER-500TR
Diameter (body only)	0.52 m	0.5 m
Length	6.25 m	10 m
Launch weight, maximum	1,600 kg	1,600 kg
Altitude	50 m	30 km
Speed, maximum	> 0.74 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	+ 1,600 km	50 km
Cost/unit	$1,870,000	€39,900

- Kalibr

Characteristic	3M-14T	CER-500TR
Diameter (body only)	0.533 m	0.5 m
Length	8.9 m	10 m
Launch weight, maximum	2,300 kg	1,600 kg
Altitude	50 m	30 km
Speed, maximum	> 0.8 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	~ 2,500 km	50 km
Cost/unit	$6,500,000	€39,900

- KH-101

Characteristic	KH-101	CER-500TR
Diameter (body only)	0.51 m	0.5 m
Length	7.5 m	10 m
Launch weight, maximum	2,300 kg	1,600 kg
Altitude	< 50 m	30 km
Speed, maximum	0.58 Mach	2.1 Mach
Speed, terminal	0.78 Mach	0.7 Mach
Range, maximum	~ 5,000 km	50 km
Cost/unit	$13,000,000	€39,900

– Nirbhay

Characteristic	Nirbhay	CER-500TR
Diameter (body only)	0.52 m	0.5 m
Length	6 m	10 m
Launch weight, maximum	1,500 kg	1,600 kg
Altitude	50 m	30 km
Speed, maximum	0.9 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	1,500 km	50 km
Cost/unit	$1,500,000	€39,900

5.4 List of compatible anti-ship missiles

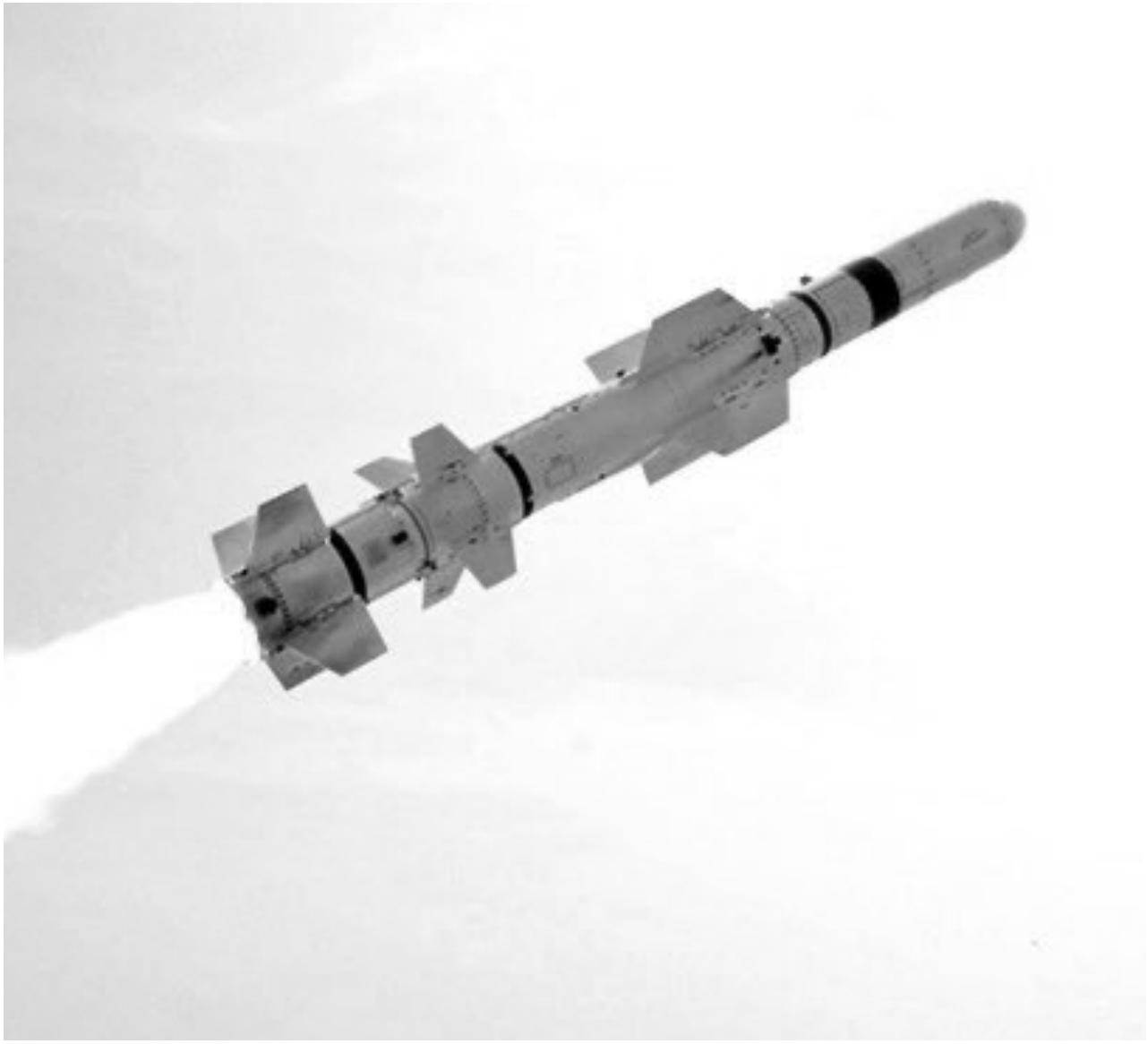
The CER-500TR is suitable to simulate the flight of anti-ship missiles in the terminal phase. CER-500TR is suitable for this taking into account its similar size and terminal flight profile compared to the currently operational anti-ship missiles.
The following relevant anti-ship missiles that the CER-500TR could simulate are presented below compared to the CER-500TR:

- Harpoon - US
- Kh-35 Kayak - Russia
- Exocet - France
- R-360 Neptune - Ukraine
- Abu Mahdi - Iran

Note: Cruise missiles as the Tomahawk and Kalibr presented above also have anti-ship variants.
Below are presented rockets with exclusive anti-ship purpose.

- Harpoon

Characteristic	Harpoon	CER-500TR
Diameter (body only)	0.34 m	0.5 m
Length	4.6 m	10 m
Launch weight, maximum	691 kg	1,600 kg
Altitude	< 50 m	30 km
Speed, maximum	0.71 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	70 km	50 km
Cost/unit	$1,406,812	€39,900

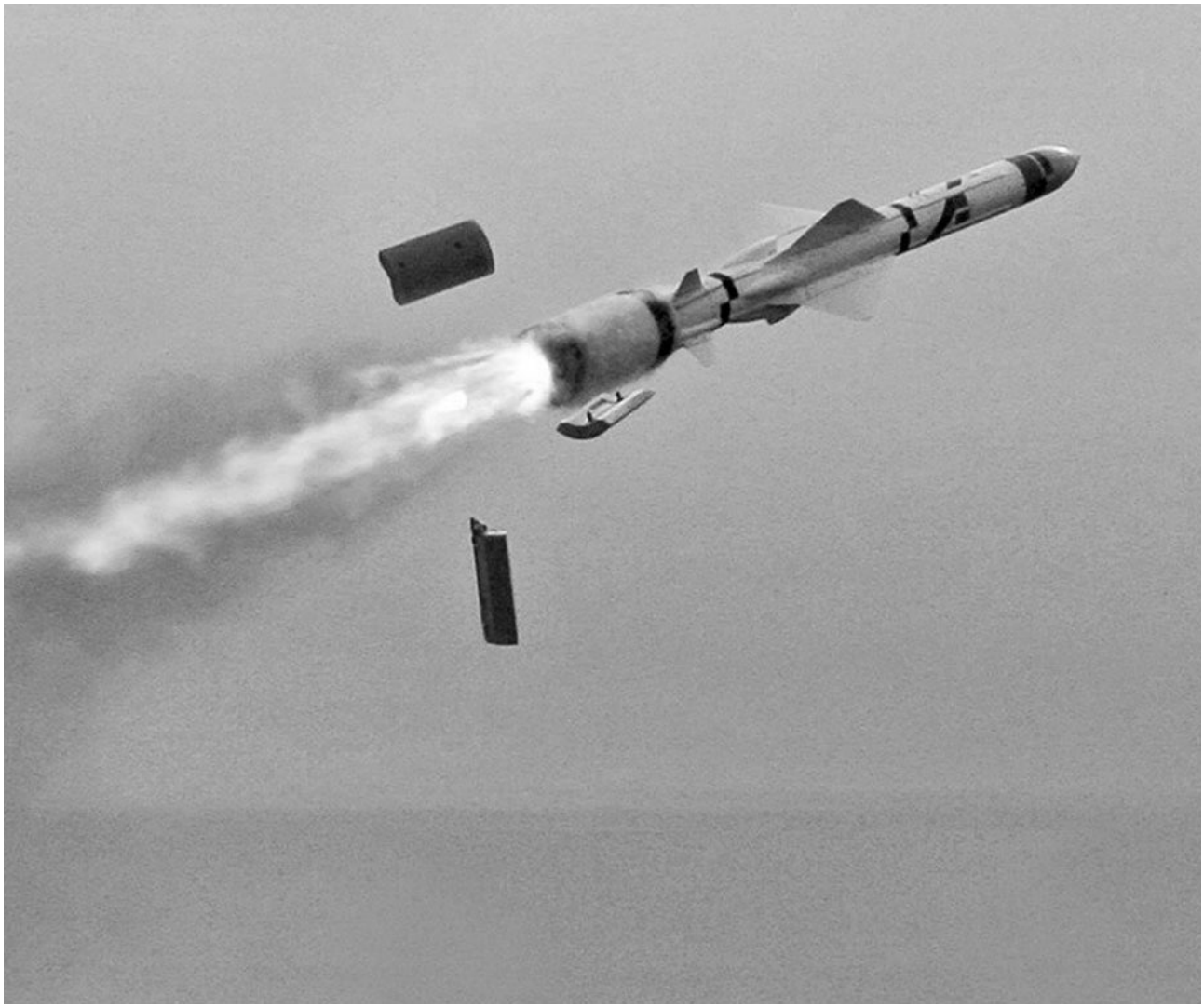


– Kh-35 Kayak

Characteristic	Kh-35	CER-500TR
Diameter (body only)	0.42 m	0.5 m
Length	4.4 m	10 m
Launch weight, maximum	610 kg	1,600 kg
Altitude	15 m	30 km
Speed, maximum	0.85 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	300 m	50 km
Cost/unit	$500,00	€39,900

- Exocet

Characteristic	SM39	CER-500TR
Diameter (body only)	0.35 m	0.5 m
Length	6 m	10 m
Launch weight, maximum	780 kg	1,600 kg
Altitude	< 50 m	30 km
Speed, maximum	0.93 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	70 km	50 km
Cost/unit	~ $3,500,000	€39,900



– R-360 Neptune

Characteristic	R-360 Neptune	CER-500TR
Diameter (body only)	0.38 m	0.5 m
Length	5.05 m	10 m
Launch weight, maximum	870 kg	1,600 kg
Altitude	< 15 m	30 km
Speed, maximum	0.75 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	280 km	50 km
Cost/unit	N/A	€39,900

– Abu Mahdi

Characteristic	Nirbhay	CER-500TR
Diameter (body only)	0.55 m	0.5 m
Length	6 m	10 m
Launch weight, maximum	1,650 kg	1,600 kg
Altitude	< 50 m	30 km
Speed, maximum	0.55 Mach	2.1 Mach
Speed, terminal	N/A	0.7 Mach
Range, maximum	1,000 km	50 km
Cost/unit	N/A	€39,900

5.5 List of compatible anti-rocket artillery systems

Traditionally, it was considered that defending against rocket artillery was not possible.
However the recent technology developments proved that this is in fact possible, and the future defensive hardware will increase this capability.
The rocket launches of palestinian militants towards Israel proved that the technological capabilities to intercept and destroy rocket artillery vehicles that are of small size, are in fact available today in countries like Israel.
Also, countries like China, Germany, Italy and the US also have this capability.
Reportedly Russia successfully intercepted HIMARS rockets using the S300 and Buk air defence systems in Ukraine, but in spite of the said systems capability to intercept HIMARS rockets, the actual claim can not be clearly confirmed.
There’s no doubt that the current conflict from Ukraine clearly indicated the need of anti-artillery rocket systems, and there’s no doubt that such systems will become available in greater number in the years to come.

The following anti-rocket artillery systems that are combat-proven or tested can be used for training against the CER-500TR:

- Iron Dome - Israel
- MANTIS - Germany
- Land-Based Phalanx Weapon System (LPWS) - US
- LD-2000 - China

– Iron Dome

It seems to be one of the most capable anti-artillery rocket system currently operational with thousands of confirmed kills. The system is capable of intercepting small rockets like GRAD, launched towards Israel by the Palestinian militants.

Characteristic	Data
Diameter (body only)	0.16 m
Length	3 m
Launch weight, maximum	90 kg
Intercept altitude, maximum	10 km
Intercept range, maximum	70 km
Speed, maximum	2.2 Mach
Cost/unit	~ $100-150,000

– Land-Based Phalanx Weapon System (LPWS)

This ground operations system is derived from the well known Phalanx CIWS, operational with various US allied navies around the world. It uses a RADAR controlled M61A1 20 mm Gatling gun with a Max/sustained rate of fire of 4,500 rounds per minute.

Characteristic	Data
Gun caliber	20 mm
Gun type	Gatling
Rate of fire, maximum	4,500 rounds/min
Intercept range	2 km
Cost/unit	~ $5.6 million

- MANTIS

It is a ground-based RADAR controlled gun system that uses a series of six 35 mm automatic guns with a firing rate of 1,000 rounds/minute.

Characteristic	Data
Gun caliber	35 mm
Gun type	Single barrel
Rate of fire, maximum	1,000 rounds/min
Intercept range	2 km
Cost/unit	~ $50 million

- LD-2000

This ground-based gun system is derived from its Chinese naval gun counterpart. It uses a range of RADAR, TV and IR sensors to control the firing sequence, having the capability to discover targets at 10 km using its RADAR and at 6 km using its TV system

Characteristic	Data
Gun caliber	30 mm
Gun type	Gatling gun
Rate of fire, maximum	4,600 rounds/min
Intercept range	3 km
Cost/unit	~ $50 million

5.6 List of compatible anti-TBM systems

Defending against TBMs is a task that was successfully solved in the past decades and currently there is a serious number of anti-TBMs operational systems around the world.

The following anti-TBM systems that are combat-proven or tested can be used for training against the CER-500TR:

- MIM-104 Patriot - US
- S-300 - Russia
- S-400 - Russia
- Arrow 2 - Israel
- David’s Sling - Israel
- HQ-19 - China

– MIM-104 - PAC 3 - Patriot

The Patriot rocket system is one of the most combat-proven systems with a high record of TBMs successful interceptions.

Characteristic	Data
Diameter (body only)	0.255 m
Length	5.2 m
Launch weight, maximum	312 kg
Intercept altitude, maximum	20 km
Intercept range, maximum	20 km
Speed, maximum	4.1 Mach
Cost/missile	~ $2,000,000

– S-300V - 9M82 antiballistic rocket

Another highly successful and combat-proven system is the S-300 that is both land based as well as sea-based.

Characteristic	Data
Diameter (body only)	0.85 m
Length	9.9 m
Launch weight, maximum	5,800 kg
Intercept altitude, maximum	40 km
Intercept range, maximum	30 km
Speed, maximum	~ 7.2 Mach
Cost/missile	~ $2,000,000

– S-400 - 9M96 antiballistic rocket

Similar to the S-300, the S-400 can operate as an anti-aircraft as well as an antiballistic system. The 9M96 rocket is specifically designed to intercept ballistic missiles through direct kinetic impact.

Characteristic	Data
Diameter (body only)	0.24 m
Length	4.75 m
Launch weight, maximum	333 kg
Intercept altitude, maximum	30 km
Intercept range, maximum	120 km
Speed, maximum	~ 2.9 Mach
Cost/missile	N/A

– Arrow 2

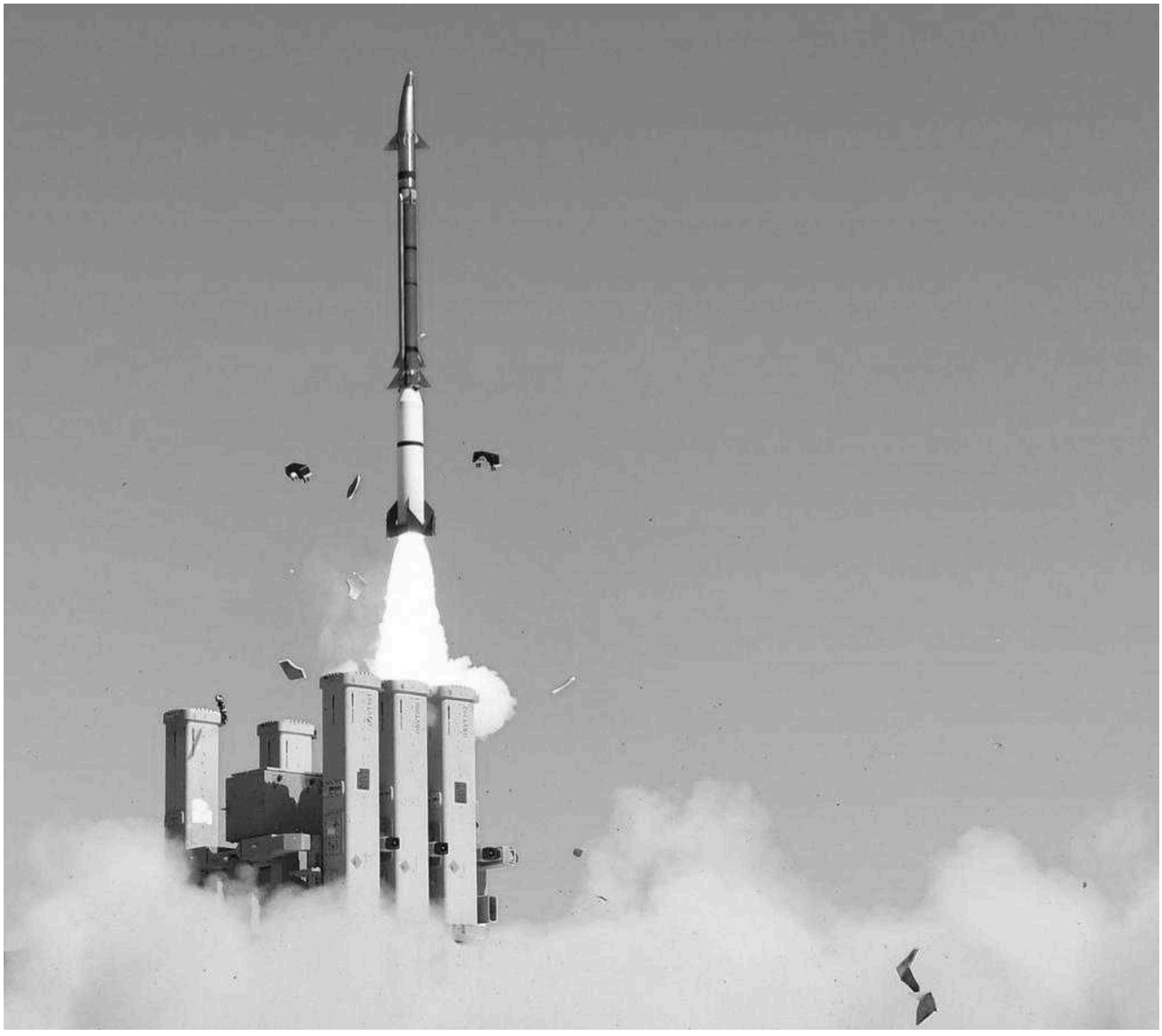
It is a dedicated anti-ballistic rocket system developed by Israel in cooperation with the US.

Characteristic	Data
Diameter (body only)	0.8 m
Length	6.95 m
Launch weight, maximum	1,300 kg
Intercept altitude, maximum	50 km
Intercept range, maximum	100 km
Speed, maximum	9 Mach
Cost/missile	$3,000,000

– David’s Sling

David’s Sling is a medium antiballistic defence system, that fills the gap between Israel’s Iron Dome and the Arrow 2 systems.

Characteristic	Data
Diameter (body only)	0.35 m
Length	4.6 m
Launch weight, maximum	400 kg
Intercept altitude, maximum	15 km
Intercept range, maximum	300 km
Speed, maximum	7.5 Mach
Cost/missile	$1,000,000



5.7 List of compatible anti-cruise missile systems

All above presented anti-rocket artillery systems are compatible to engage and destroy cruise missiles.
Also, from the list of anti-TBM systems, rockets like the Patriot and the S300 are capable of engaging and destroying cruise missiles.
Beside the above mentioned list, below there is an additional list of systems that can engage and destroy cruise missiles and can be used for training against the CER-500TR:

- NASAMS - US
- Buk - 9K37 - Russia
- Kub - 2K12 - URSS
- Spyder - Israel
- MIM-23 Hawk, Phase III - US
- Flakpanzer Gepard - Germany

- NASAMS

It is a surface to air rocket system that can fire the air-to-air AIM-120 AMRAAM as well as the AIM-9X Sidewinder missiles. Below is the data for the AIM-120 missile.

Characteristic	Data
Diameter (body only)	0.178 m
Length	3.65 m
Launch weight, maximum	161.5 kg
Intercept altitude, maximum	21 km
Intercept range, maximum	30 km
Speed, maximum	~ 2.4 Mach
Cost/missile	~ $1,000,000

– Buk –

The Buk system is also designed with the intend to intercept cruise missiles flying at low altitudes. Although the system is capable of operating with a large number of missile variants, below is the data for the 9K37 missile.

Characteristic	Data
Diameter (body only)	0.4 m
Length	5.5 m
Launch weight, maximum	685 kg
Intercept altitude, maximum	25 km
Intercept range, maximum	20.5 km
Speed, maximum	~ 2.6 Mach
Cost/missile	N/A

- Spyder

It is a surface to air rocket system that can fire the air-to-air Python-5 as well as the Derby missiles. Below is the data for the Derby missile.

Characteristic	Data
Diameter (body only)	0.16 m
Length	3.1 m
Launch weight, maximum	105 kg
Intercept altitude, maximum	9 km
Intercept range, maximum	20 km
Speed, maximum	4 Mach
Cost/missile	N/A

– MIM-23 Hawk, Phase III

Although unexpected due to its age, the Hawk rocket system makes this list due to its capability to engage cruise missiles and to the fact that it is still in service with a large number of countries.

Characteristic	Data
Diameter (body only)	0.37 m
Length	5 m
Launch weight, maximum	590 kg
Intercept altitude, maximum	20 km
Intercept range, maximum	45 km
Speed, maximum	2.4 Mach
Cost/missile	$250,000

- Flakpanzer Gepard

Also an old system, the Gepard makes this list as it is still in service with a number of countries and it still proved its relevance in Ukraine where destroyed cruise missiles.

Characteristic	Data
Gun caliber	35 mm
Gun type	2xSingle barrel
Rate of fire, maximum	2x550 rounds/min
Intercept range	5.5 km
Cost/unit	~ $2 million

5.8 List of compatible anti-ship missile systems

The following anti-ship missile systems that are combat-proven or tested can be used for training against the CER-500TR:

- RIM-66M - US
- 9M96 - Russia
- Phalanx - US
- AK-630 - Russia
- Goalkeeper - Holland

- RIM-66M

It is a medium range surface to air missile currently in service with the US Navy, onboard Ticonderoga class cruisers and Arleigh Burke class destroyers.

Characteristic	Data
Diameter (body only)	0.343 m
Length	4.72 m
Launch weight, maximum	707 kg
Intercept altitude, maximum	25 km
Intercept range, maximum	170 km
Speed, maximum	3.5 Mach
Cost/missile	N/A

- 9M96

This rocket is used by the Russian Navy but it can also be found in the inventory of the land forces, used by the S-350 and S-400 systems.

Characteristic	Data
Diameter (body only)	0.24 m
Length	4.75 m
Launch weight, maximum	333 kg
Intercept altitude, maximum	20 km
Intercept range, maximum	40 km
Speed, maximum	N/A
Cost/missile	N/A

– Phalanx

The Phalanx CIWS, is US Navy’s main short range air-defence system and it’s also operational with various US allied navies around the world. It uses a RADAR controlled M61A1 20 mm Gatling gun with a Max/sustained rate of fire of 4,500 rounds per minute.

Characteristic	Data
Gun caliber	20 mm
Gun type	Gatling
Rate of fire, maximum	4,500 rounds/min
Intercept range	2 km
Cost/unit	~ $7 million

- AK-630M-2

This is the Russian equivalent to the US Phalanx CIWS. Although it has a larger caliber and a significantly higher firing rate, it is reportedly less precise compared to the latest versions of US counterpart.

Characteristic	Data
Gun caliber	30 mm
Gun type	Gatling
Rate of fire, maximum	10,000 rounds/min
Intercept range	5 km
Cost/unit	$9 million

- Goalkeeper

Another representative CIWS came from the Netherlands, exhibiting similar rate of fire as the Phalanx and the same caliber as the AK-630.

Characteristic	Data
Gun caliber	30 mm
Gun type	Gatling
Rate of fire, maximum	4,200 rounds/min
Intercept range	2 km
Cost/unit	$25 million

5.9 Engagement envelope for the presented anti-rocket artillery systems

The following table presents the engagement envelopes for the above-presented anti-artillery rocket systems.

System	Engagement altitude	Target speed	Target flight time	Engagement range
Iron Dome	< 10 km	< 2.1 Mach	< 190 s	< 50 km
LPWS	< 2 km	< 0.7 Mach	< 26 s	< 2 km
MANTIS	< 2 km	< 0.7 Mach	< 26 s	< 2 km
LS-2000	< 3 km	< 0.7 Mach	< 34 s	< 3 km

How to read the table:

Example 1
In the case of the Iron Dome system, the CER-500TR rocket could be intercepted at altitudes up to 10 km, and maximum speeds of Mach 1.4, with a theoretical interception time of 190 s (taking into account the interceptor capability to detect the CER-500TR immediately after launch), while the maximum engagement range is up to 45 km.

Example 2
In the case of LPWS, the CER-500TR rocket could be intercepted at altitudes up to 2 km and a speed of Mach 0.7, with an interception time of 36 s, while the maximum engagement range is also 2 km.

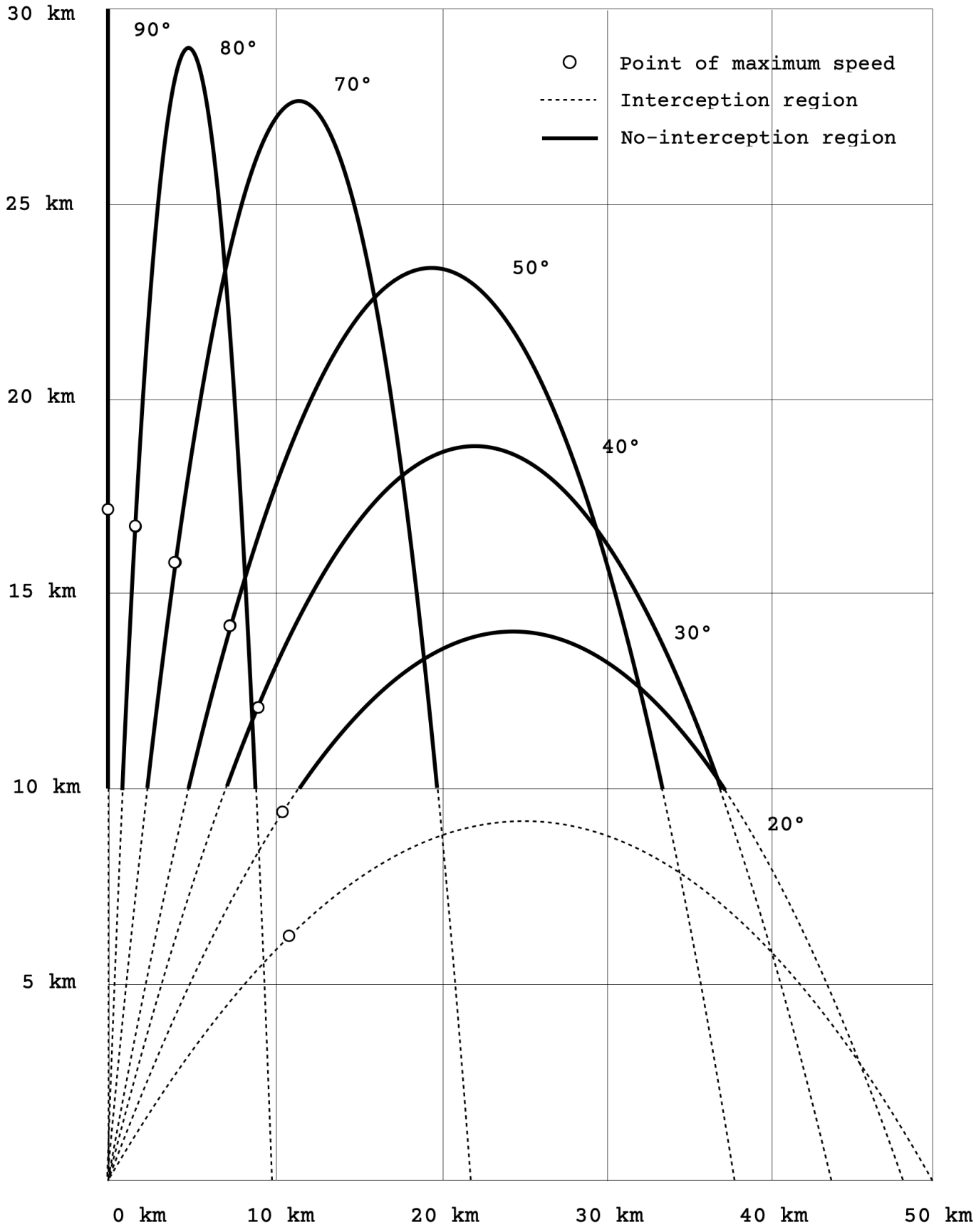


Fig.4 - Iron Dome estimated interception envelope of CER-500TR rocket.

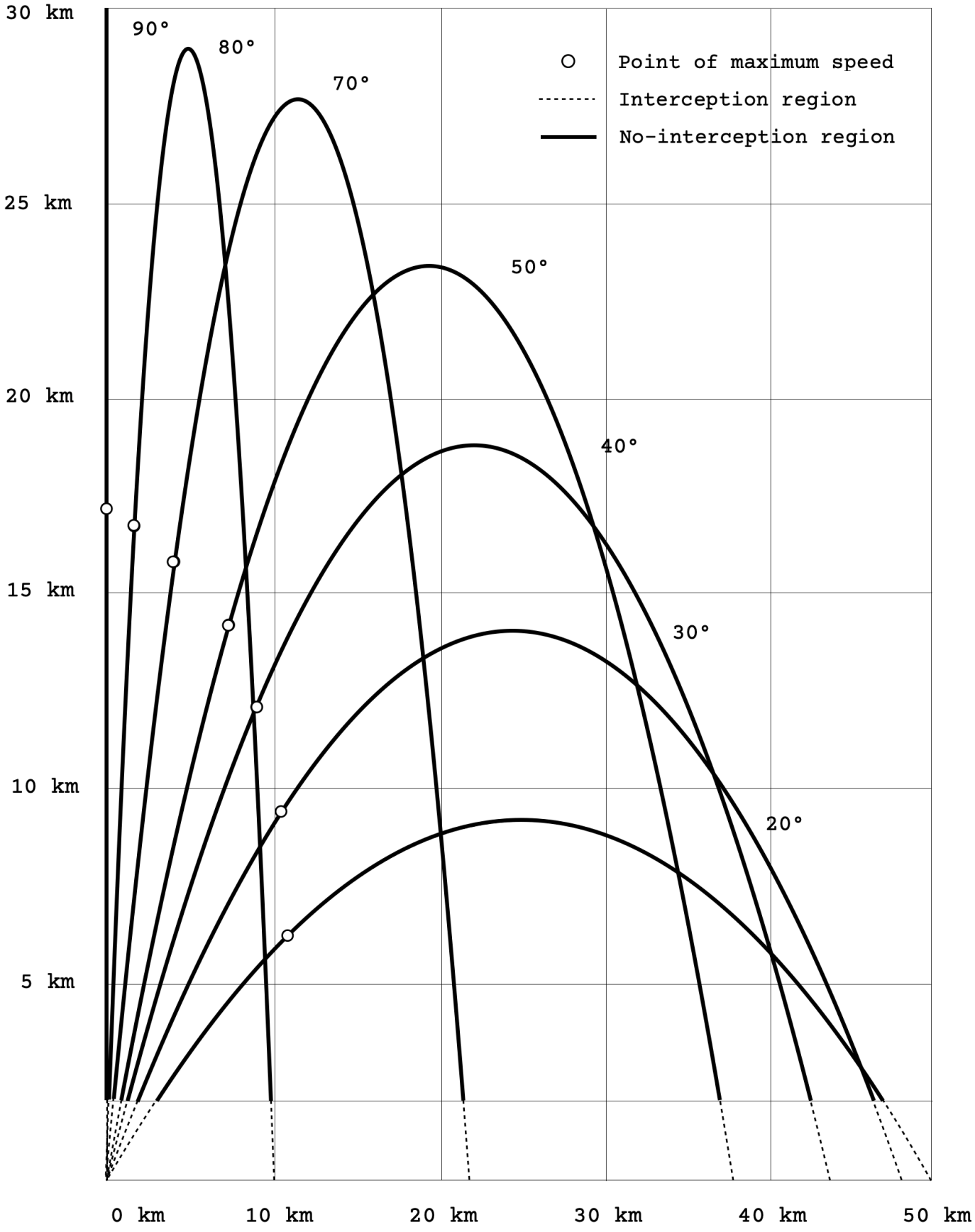


Fig.5 - LPWS and MANTIS estimated interception envelope of CER-500TR rocket.

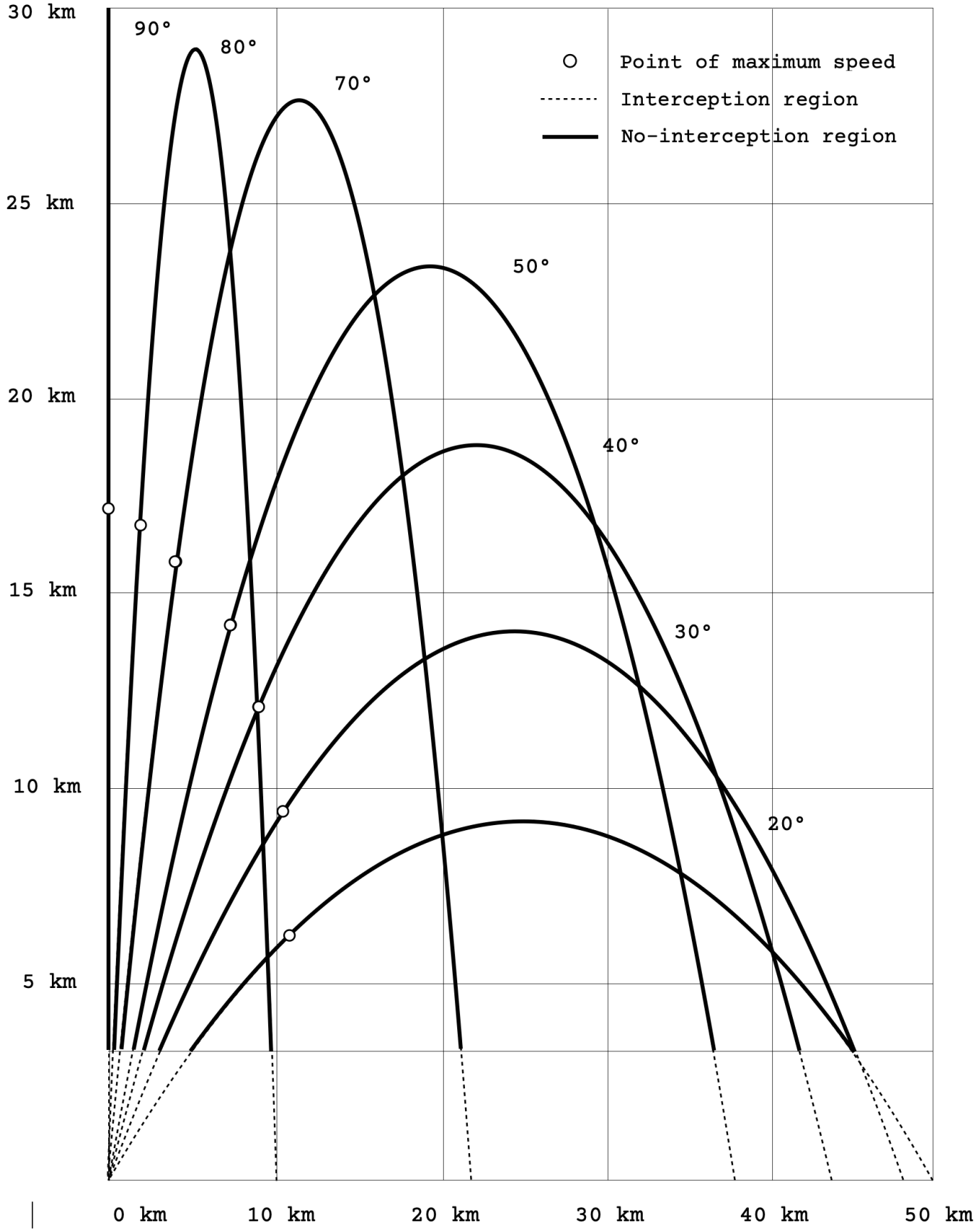


Fig.6 - LS-2000 estimated interception envelope of CER-500TR rocket.

5.10 Engagement envelope for the presented anti-TBM systems

The following table presents the engagement envelopes for the above-presented anti-TBM systems.

System	Engagement altitude	Target speed	Target flight time	Engagement range
MIM-104 - PAC3	< 20 km	< 2.1 Mach	< 180 s	< 20 km
S300 - 9M82	< 40 km	< 2.1 Mach	< 225 s	< 30 km
S400 - 9M96	< 30 km	< 2.1 Mach	< 242 s	< 50 km
Arrow 2	< 50 km	< 2.1 Mach	< 242 s	< 50 km
David’s Sling	< 15 km	< 2.1 Mach	< 242 s	< 50 km

How to read the table:

Example 1
In the case of the MIM-104 - PAC 3 - Patriot system, the CER-500TR rocket could be intercepted at altitudes up to 20 km, and maximum speeds of Mach 2.1, with a theoretical interception time of 180 s (taking into account the interceptor capability to detect the CER-500TR immediately after launch), while the maximum engagement range is up to 20 km.

Example 2
In the case of S-400 equipped with the anti-ballistic 9M96 rocket, the CER-500TR rocket could be intercepted at altitudes up to 30 km and a speed of Mach 2.1, with a theoretical interception time of 242 s, while the maximum engagement range is 50 km. Therefore, the for the whole flight envelope of CER-500TR, in any launch scenario, there is a firing solution for the S-400 - 9M96.

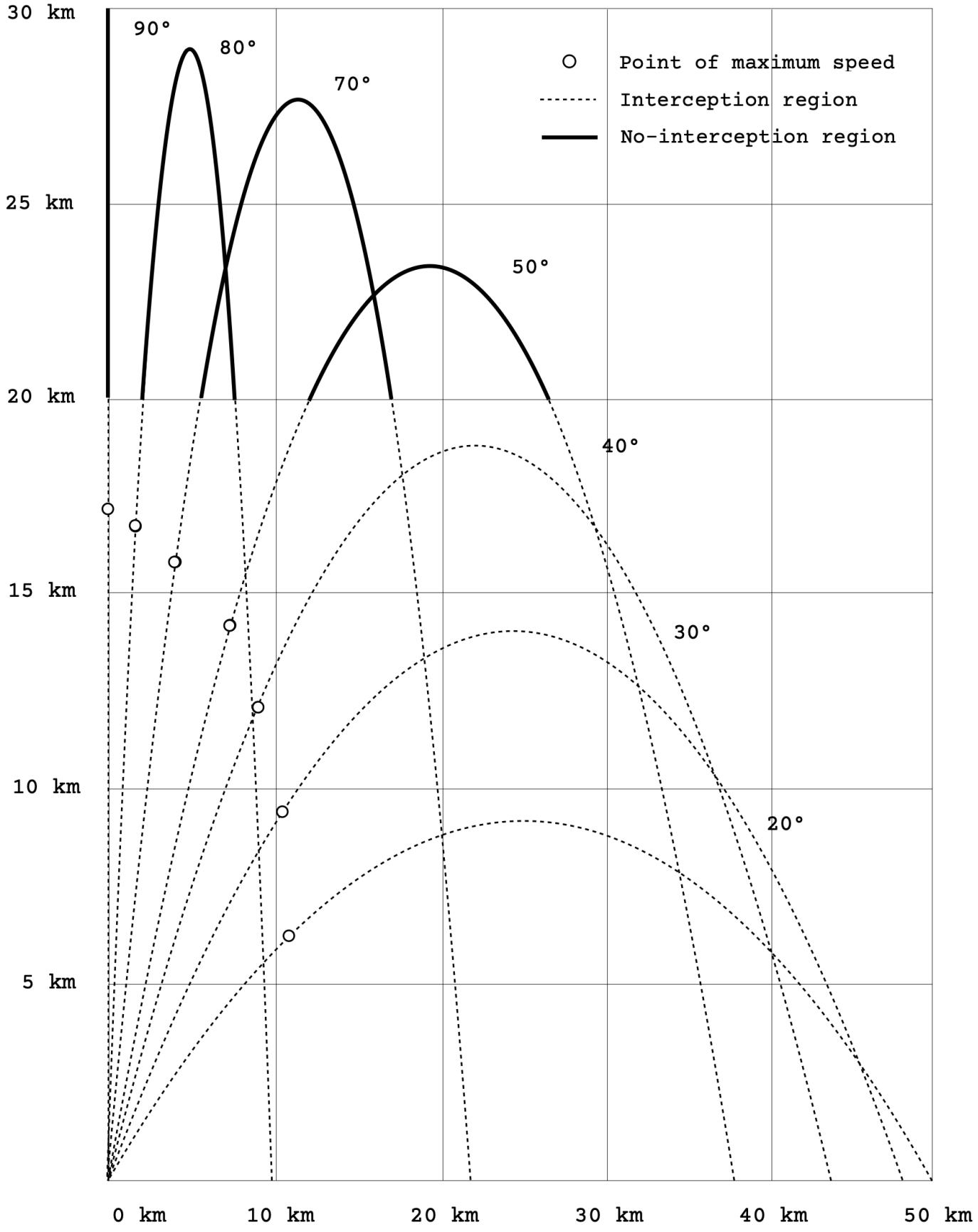


Fig.7 - MIM-104 - PAC 3 - Patriot, estimated interception envelope of CER-500TR rocket.

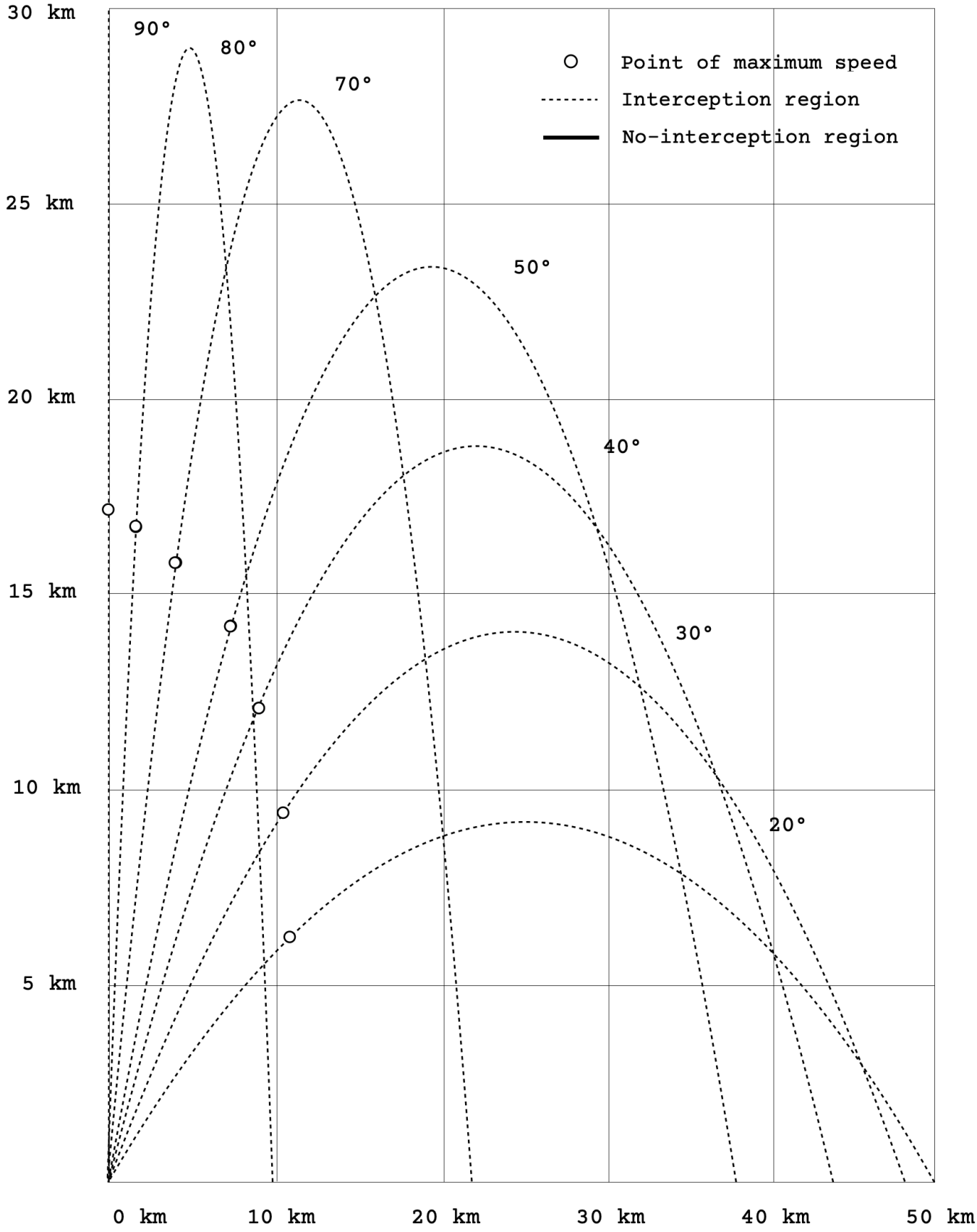


Fig.8 - S-300V - 9M82, S-400 - 9M96 and Arrow 2, estimated interception envelope of CER-500TR rocket.

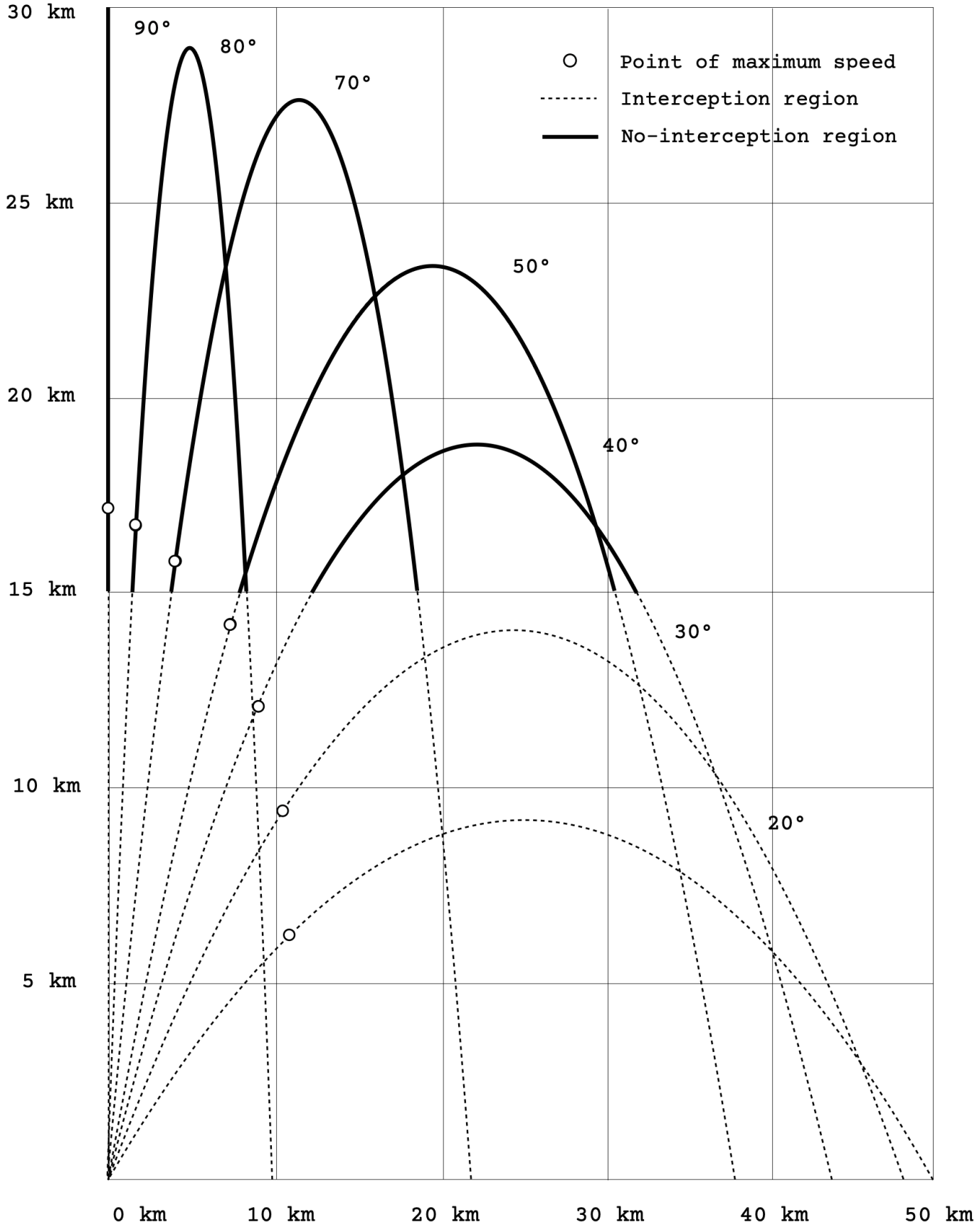


Fig.9 - David's Sling, estimated interception envelope of CER-500TR rocket.

5.11 Engagement envelope for the presented anti-cruise missile systems

The following table presents the engagement envelopes for the above-presented anti-cruise missile systems.

System	Engagement altitude	Target speed	Target flight time	Engagement range
NASAMS	< 21 km	< 2.1 Mach	< 225 s	< 30 km
Buk	< 25 km	< 2.1 Mach	< 180 s	< 20.5 km
Spyder	< 9 km	< 2.1 Mach	< 180 s	< 20 km
MIM-23 - III	< 20 km	< 2.1 Mach	< 235 s	< 45 km
Gepard	< 5.5 km	< 0.7 Mach	< 36 s	< 5.5 km

How to read the table:

Example 1
In the case of the MIM-23 Phase III suystem, the CER-500TR rocket could be intercepted at altitudes up to 20 km, and maximum speeds of Mach 2.1, with a theoretical interception time of 235 s (taking into account the interceptor capability to detect the CER-500TR immediately after launch), while the maximum engagement range is up to 45 km.

Example 2
In the case of the Gepard system, the CER-500TR rocket could be intercepted at altitudes up to 5.5 km and a speed of Mach 0.7, with an interception time estimated at 36 s, while the maximum engagement range is 5.5 km.

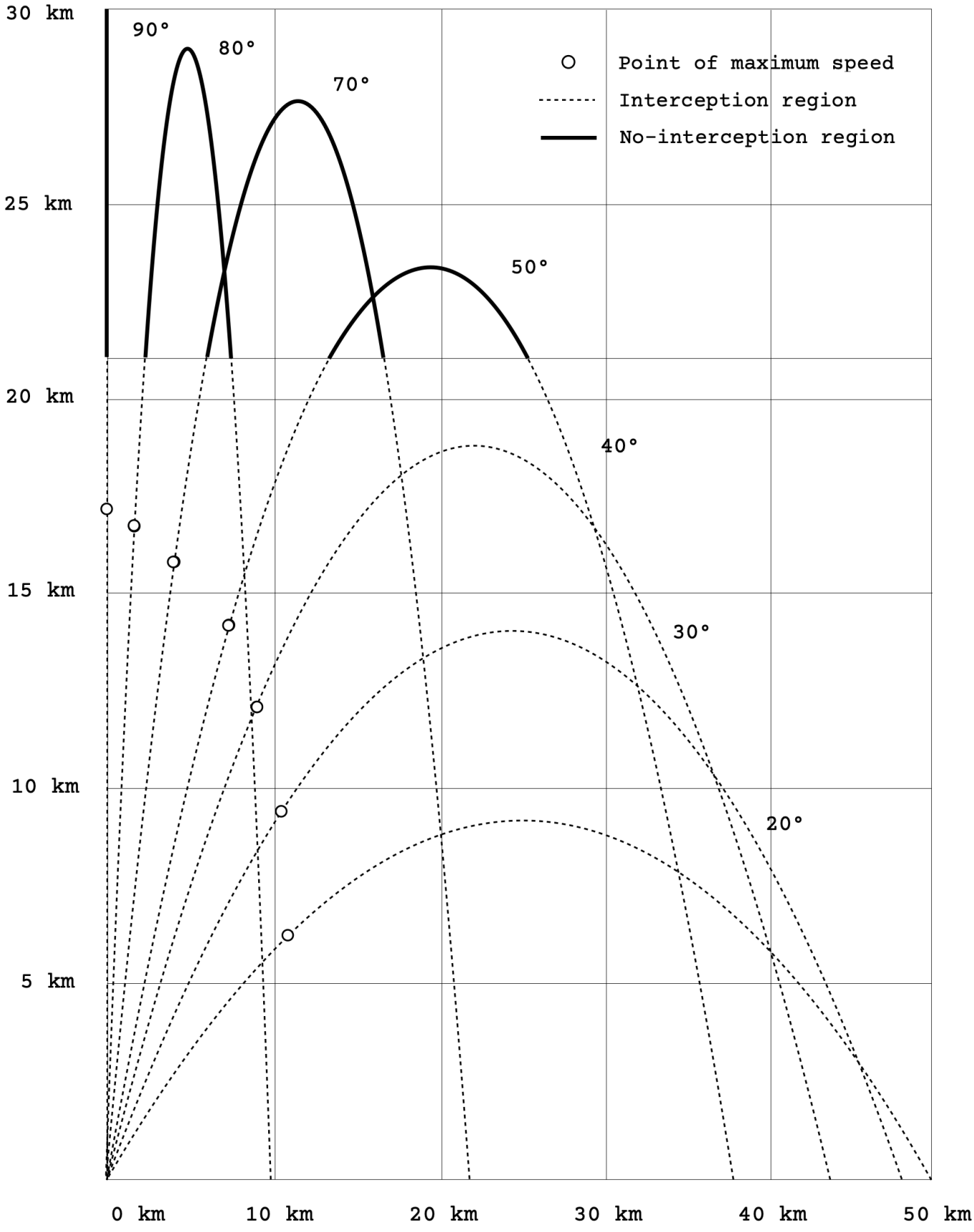


Fig.10 - NASAMS, estimated interception envelope of CER-500TR rocket.

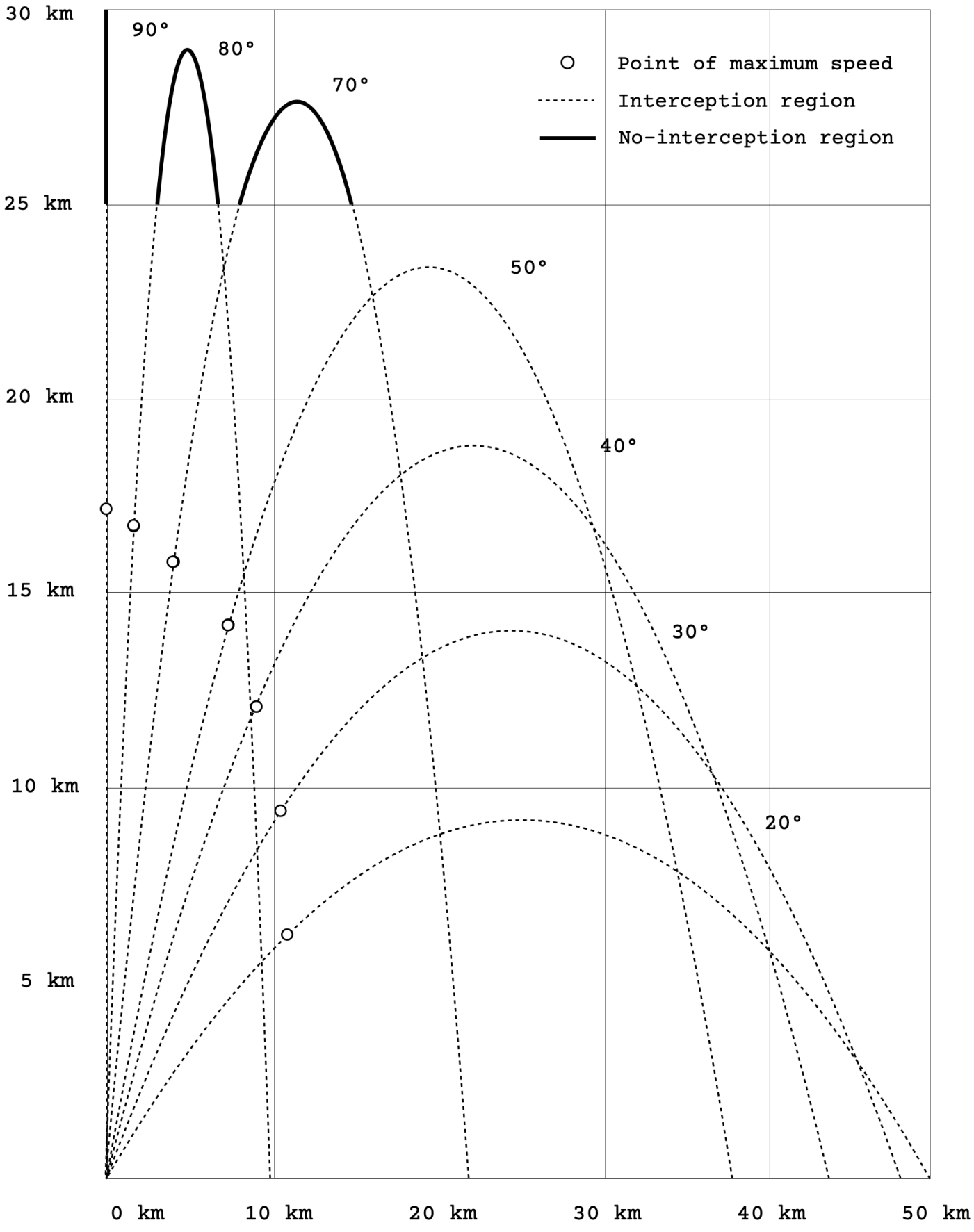


Fig.11 - Buk, estimated interception envelope of CER-500TR rocket.

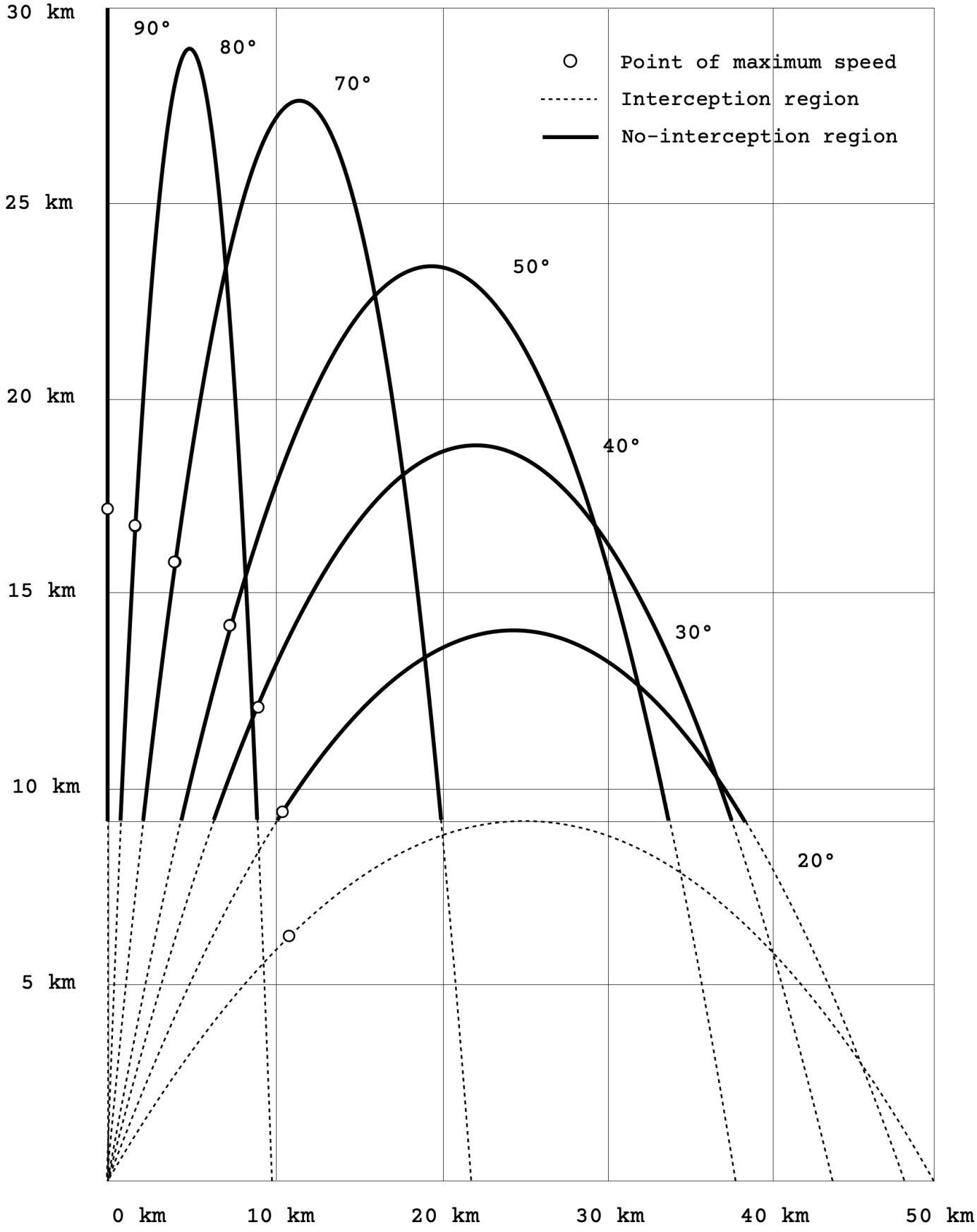


Fig.12 - Spyder, estimated interception envelope of CER-500TR rocket.

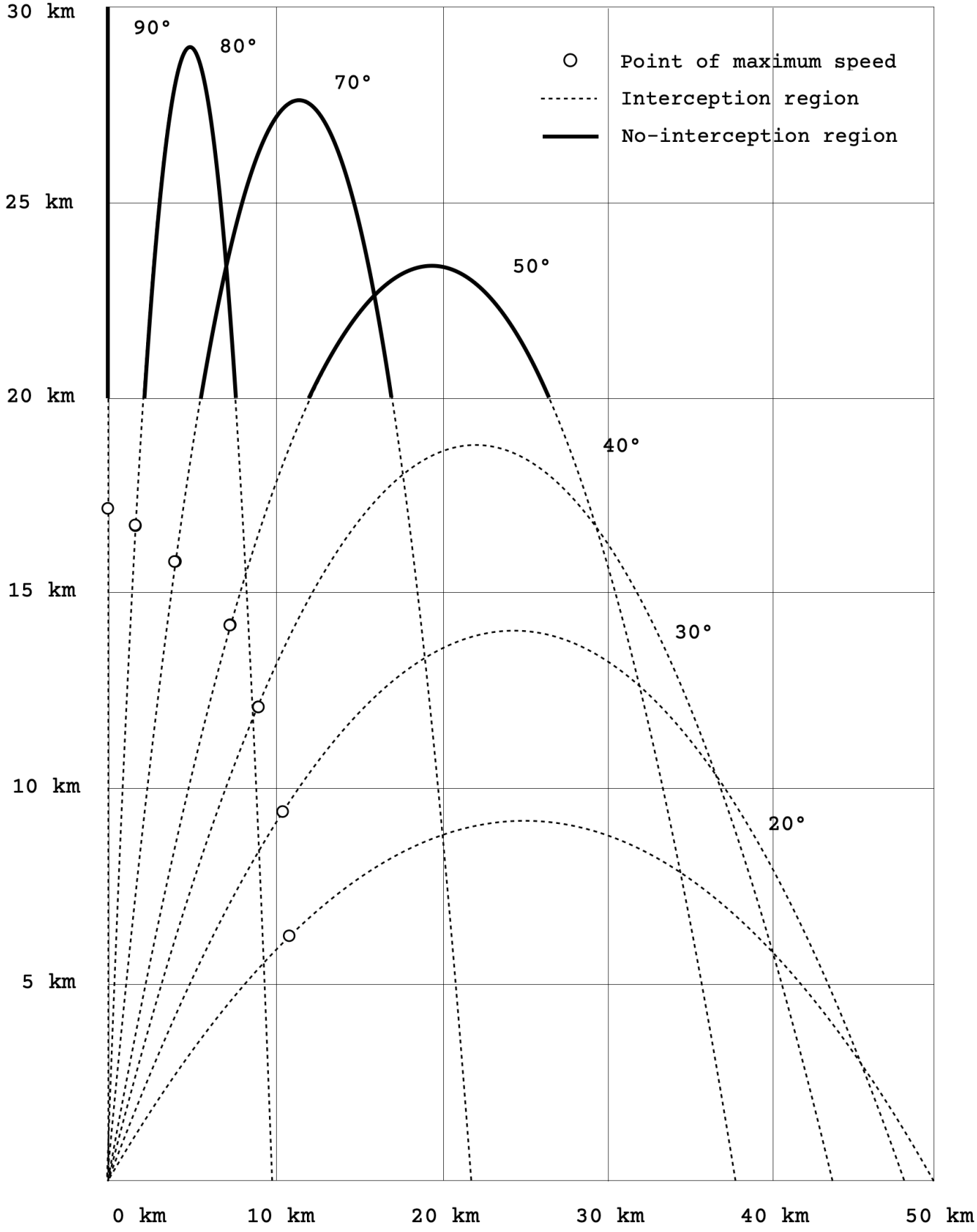


Fig.13 - MIM-23 - Hawk - Phase III, estimated interception envelope of CER-500TR rocket.

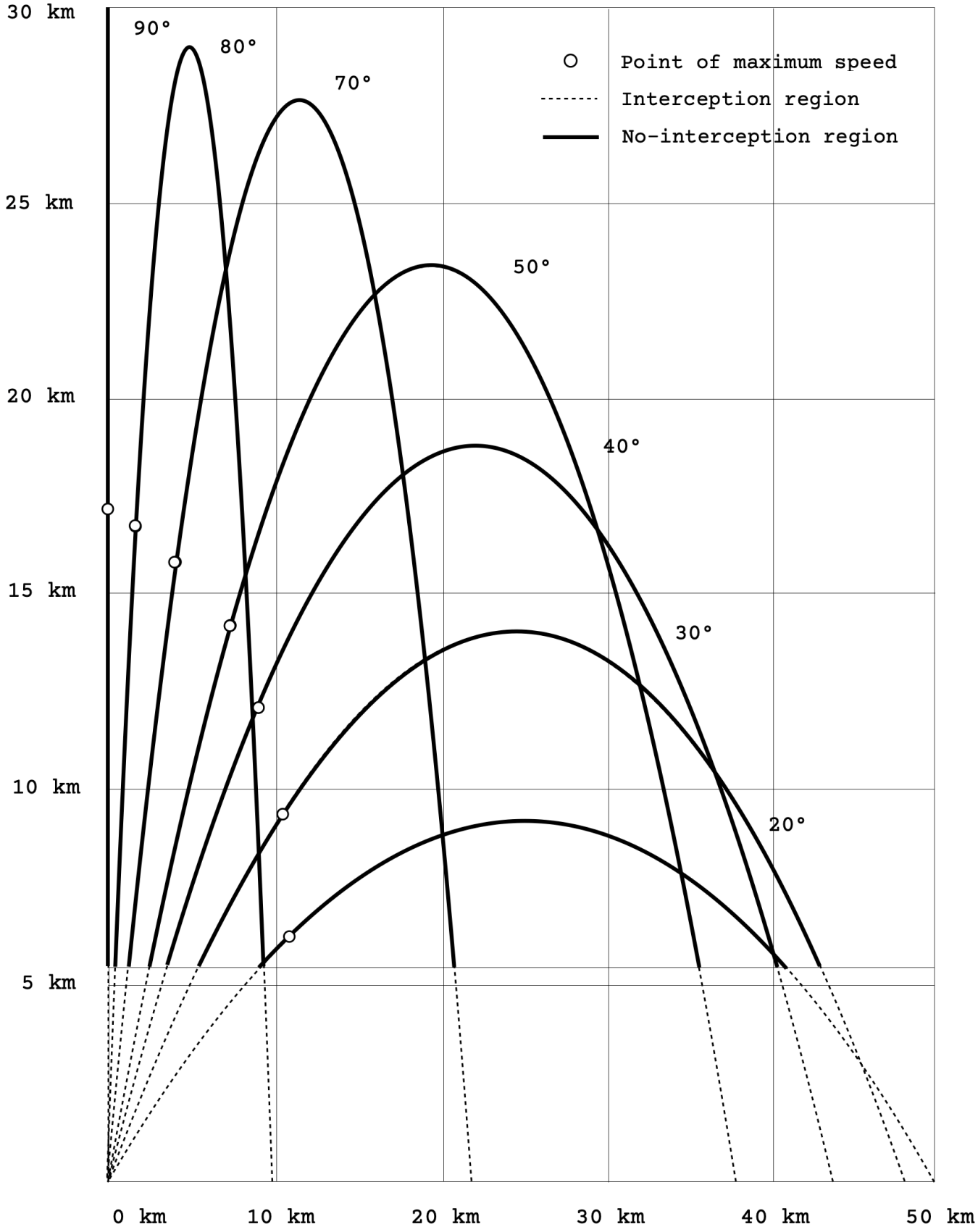


Fig.14 - Flakpanzer Gepard, estimated interception envelope of CER-500TR rocket.

5.12 Engagement envelope for the presented defensive anti-ship missile systems

The following table presents the engagement envelopes for the above-presented defensive anti-ship missile systems.

System	Engagement altitude	Target speed	Target flight time	Engagement range
RIM-66M	< 25 km	< 2.1 Mach	< 242 s	< 170 km
9M96	< 20 km	< 2.1 Mach	< 230 s	< 40 km
Phalanx	< 2 km	< 0.7 Mach	< 26 s	< 2 km
AK-630M-2	< 5 km	< 0.8 Mach	< 34 s	< 5 km
Goalkeeper	< 2 km	< 0.7 Mach	< 26 s	< 2 km

How to read the table:

Example 1
In the case of the AK-630M-2 CIWS, the CER-500TR rocket could be intercepted at altitudes up to 5 km, and maximum speeds of Mach 0.8, with a theoretical interception time of 34 s, while the maximum engagement range is also up to 5 km.

Example 2
In the case of the Phalanx CIWS, the CER-500TR rocket could be intercepted at altitudes up to 2 km and a speed of Mach 0.7, with an interception time of 26 s, while the maximum engagement range is also 2 km.

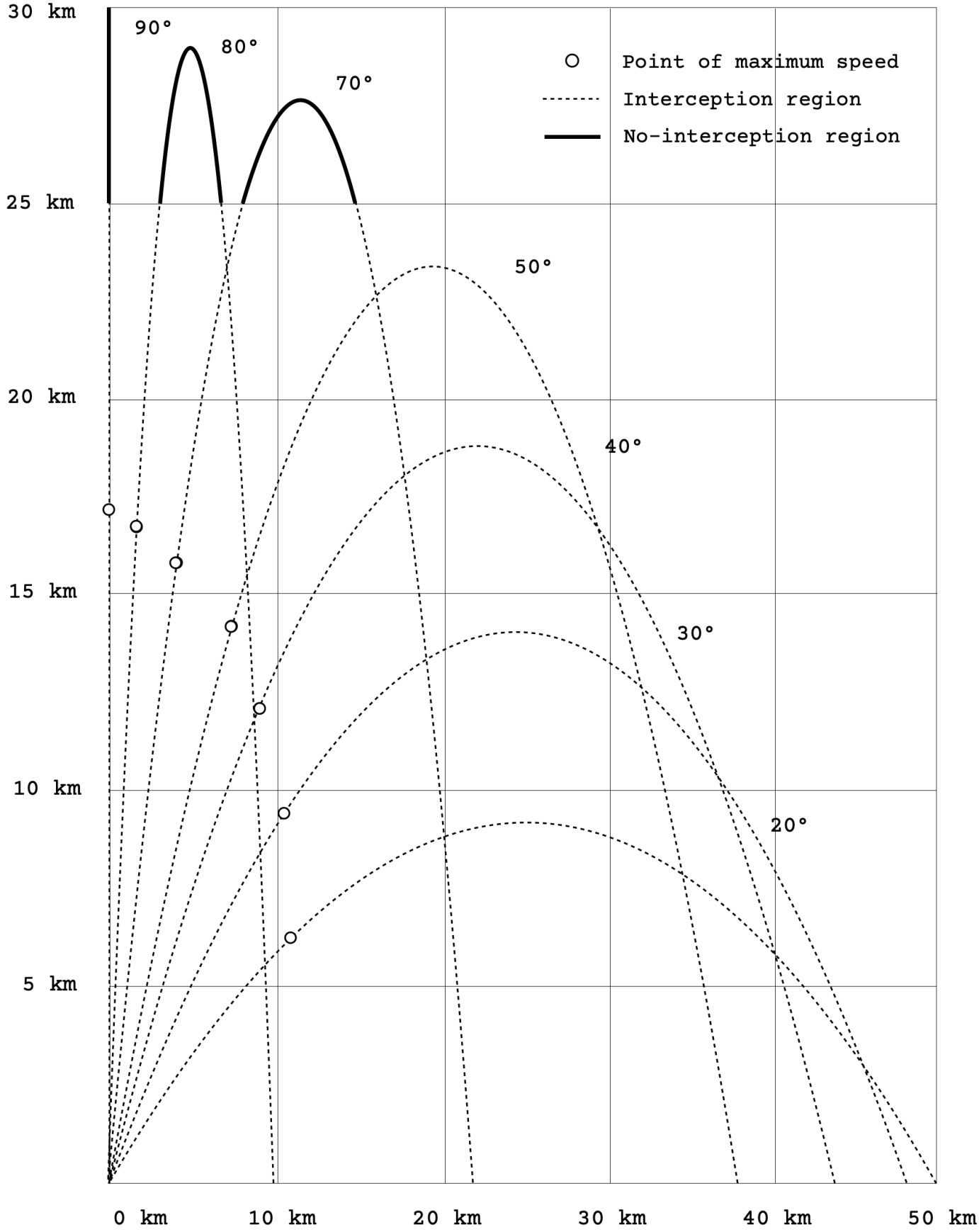


Fig.15 - RIM-66M, estimated interception envelope of CER-500TR rocket.

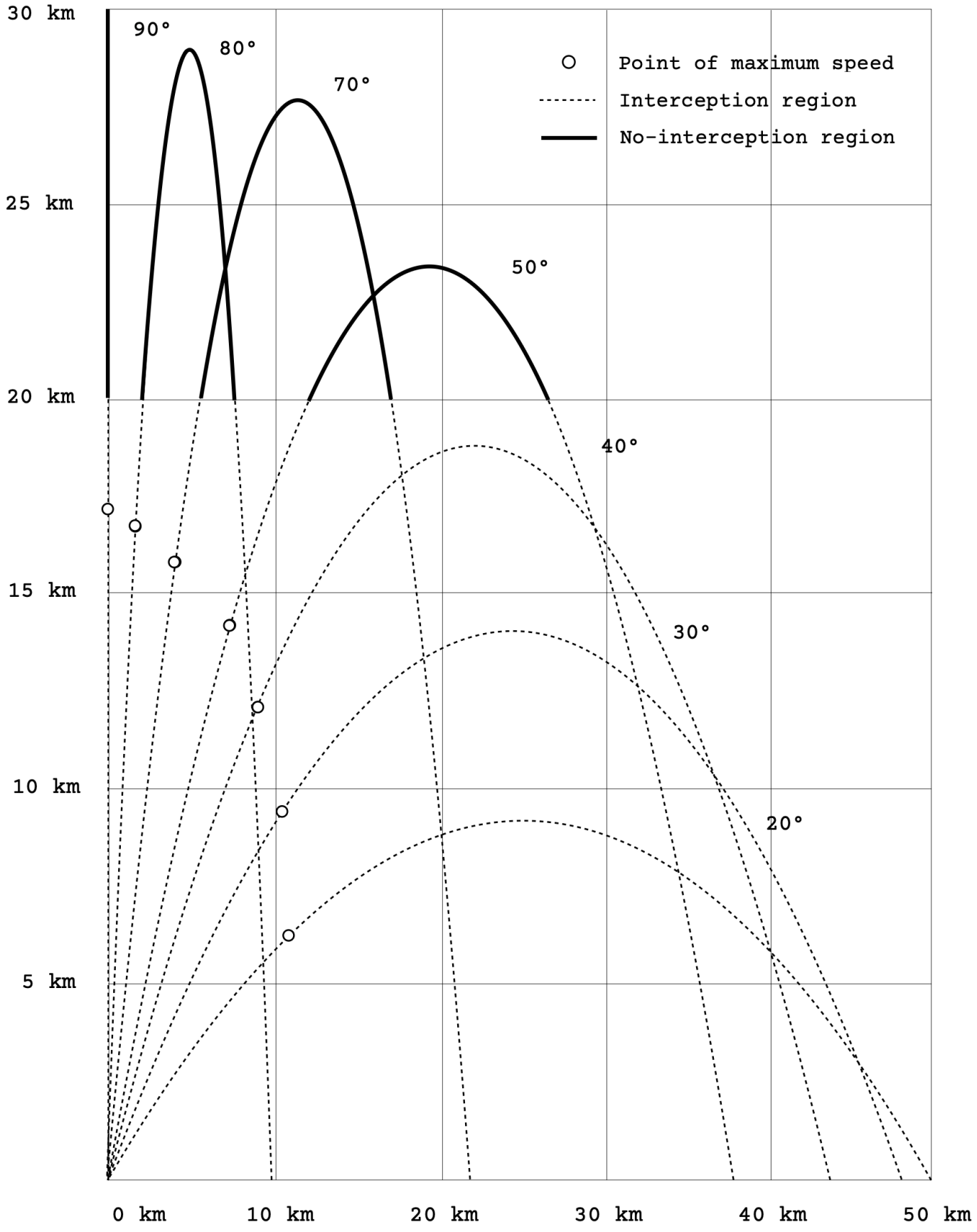


Fig.16 - 9M96, estimated interception envelope of CER-500TR rocket.

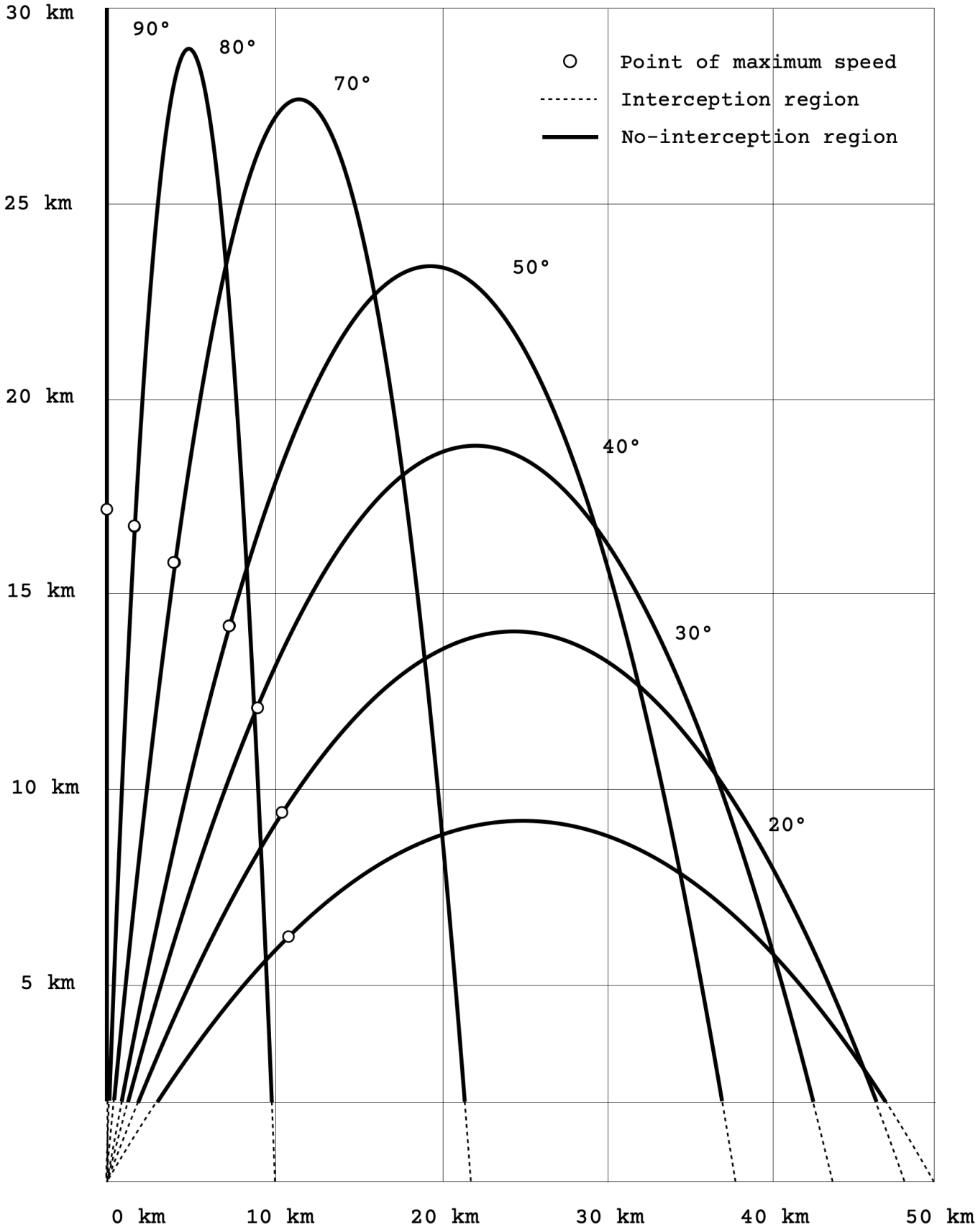


Fig.17 - Phalanx and Goalkeeper CIWS, estimated interception envelope of CER-500TR rocket.

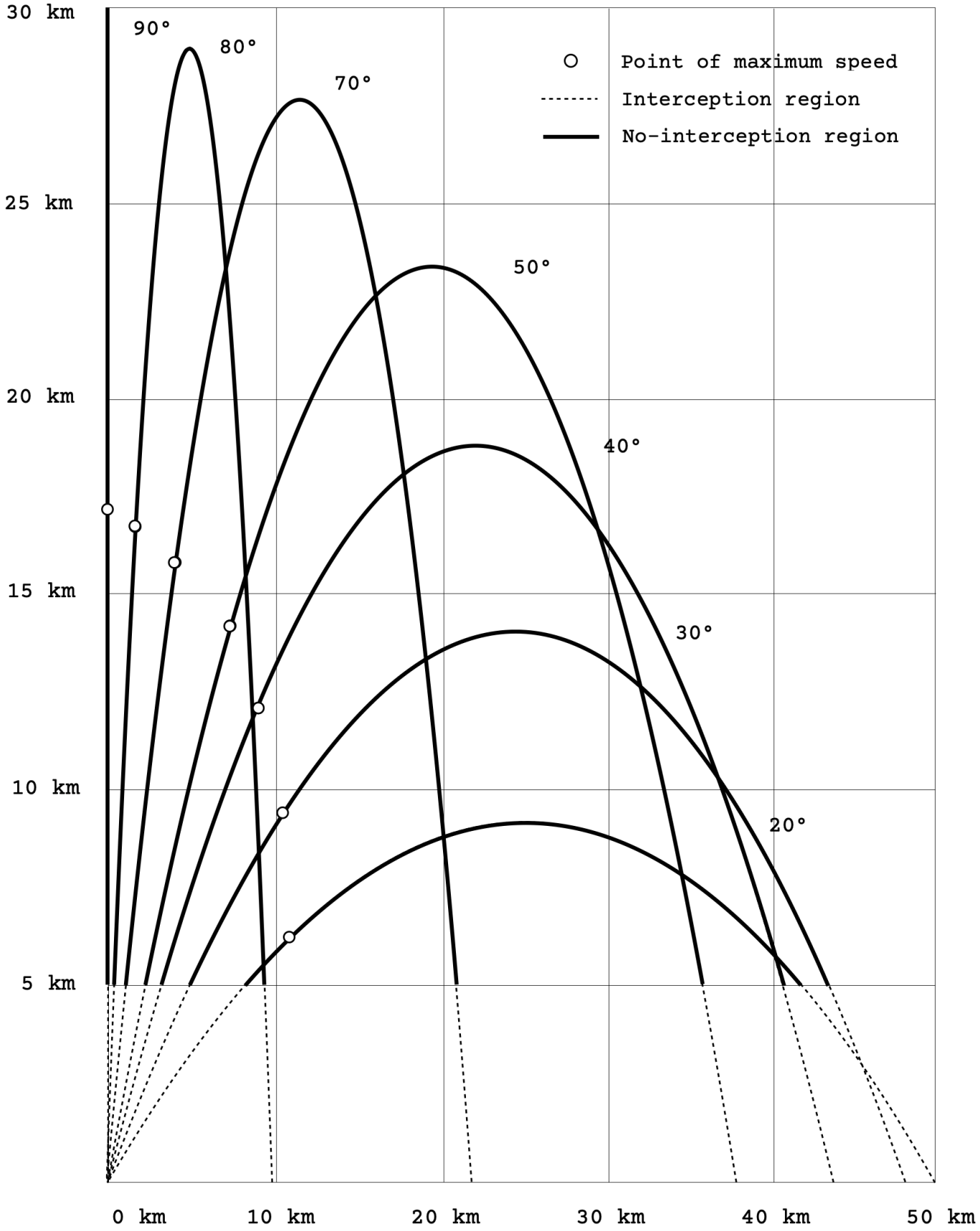


Fig.18 - AK-630M-2 CIWS, estimated interception envelope of CER-500TR rocket.

6. Launch options

The product can be launchd from:

- ground - in this case, the vehicle will be firmly fixed to the ground inside dedicated military launch ranges. The target vehicle could be placed in the same firing range as the interceptor, or in a different firing range.

- terrestrial vehicles - it will require a special order to fit the system on a vehicle. The multiple launcher configuration is also possible, allowing the operator to launch multiple targets at very short interval.

- from ships - taking into account the benign nature of rocket engine’s exhaust gases, the vehicle could be launched from the decks of naval ships. The ship that is intercepting could be the same that is launching the target. Also, a different ship than the one that is performing the interception could launch the target from a further distance.

- directly from the sea - the rocket could be launched directly from the sea, while being placed in the water by the ship that is performing the interception, or by a different ship.

6. Payload integration

The CER-500TR vehicle has a detachable nose cone to allow the purchaser to accommodate the desired payload via the payload interface during the ground preparations for launch.
The 500 mm diameter is available for the payload bay with a height of the cylindrical part of 700 mm.
Although the rocket can fly without any avionics onboard, the payload space allows the integration of various equipment, such as telemetry hardware and optional Luneburg lens radar reflector for a specifically desired RADAR signature.

7. Prices

All prices are given in EURO. However, those who will pay in AMiE, ARCA Space's own crypto token will benefit from a 10% price discount.

7.1 Complete CER-500TR system

Component	Price [€]	Price [€] if purchased in AMiE
CER-500TR rocket	39,900	35,900
Launch canister	19,900	17,900
Propellant transfer tank	3,900	3,500
Adjustable angle support*	24,900	22,400
TOTAL	88,600	79,700

* If the rocket will be launched exclusively vertical, the adjustable angle support might not be required.

NOTE: The price of additional options including painting for the rocket, launch canister, custom avionics, etc is not included in these prices.

7.2 Orders including more CER-500TR rockets

For orders including more complete systems or rockets, discounts will apply.

8. Licensing

General Astronautics could license the product fabrication and sale to third parties, presumably a valid fabrication control and technology use is secured.

9. Order and Shipment

To place an order for the CER-500TR system, send us an email at contact@arcaspace.com
The shipment will be made in standardised, 6m long containers. Each container could accommodate two CER-500TR complete systems with one CER-500TR rocket each.
The order will be ready for shipment depending on the order size. Usually for a complete CER-500TR system, with a single rocket, the shipment will start 30 days after the payment was received.
For larger orders, the shipment date will be communicated before the payment.

10. Purchase eligibility

In general, a rocket falls into the category of a dual use product.
However, due to CER-500TR's limited features, like the lack of guidance system, the use of liquid propellant leading to a long launch preparation time, and the engine's performance three to four times less than in the case of a regular military rocket, the product's application as a weapon and therefore as a dual use product is a non-realistic prospect.
However, we reserve the right to sale the product depending on our internal specific criteria.
Don't hesitate to contact us and we will promptly inform you if we can go forward with your purchase request.

11. FAQ

11.1 Operations

How difficult is to prepare the CER-500TR system for launch?

The CER-500TR system is very easy to operate and prepare for launch. Follow the instructions from the User Guide and Operation Manual that are provided together with the product and the process should be straightforward.

How difficult it is to mount the payload in a CER-500TR rocket?

The CER-500TR rocket came with a removable nose-cone and the access to the interface plate is made by unscrewing the bolts that are keeping the cone in place.

What propellant does the CER-500TR system use?

The CER system uses a mixture of 30-70 water and hydrogen peroxide, commercially available as hydrogen peroxide 70%. A concentration of 50% is also an option but with a performance loss.

How much does the hydrogen peroxide 50% and 70% costs?

Depending on the region, for hydrogen peroxide 70% prices are between €1 to €2 per kg while for 50% concentration, prices are between €0.5 to €1 per kg.

How difficult is to procure hydrogen peroxide 70%?

The hydrogen peroxide 70% is commercially available and easy to procure in virtually any part of the world. 50% hydrogen peroxide is also available in stores.

How dangerous is hydrogen peroxide 50% and 70%?

You must avoid ingesting hydrogen peroxide 50-70% or getting in contact with your eyes and skin, by wearing googles and gloves during manipulation. In case of contact with your eyes and skin, always have fresh sweet closely available and apply abundent sweet water on the the contact region. The skin will become white on the contact region and it will regain the normal color in around two hours.
Please read carefully the Safety Data Sheet that will be provided with the product.

11.2 Features

Is it possible to mate the Reentry target Vehicle (RTV) with the CER-500TR?

Yes, the CER-500TR can accommodate one RTV as payload.

Is the CER-500TR system reusable?

The CER-500TR rocket is not reusable after flight. However, the launch canisters and the propellant transfer tanks as well as the accessories are reusable.

Is it possible to use the CER-500TR system as weapon?

The lack of guidance system and any form of avionics onboard, as well as the use of liquid propellant leading to non-responsive operation, makes the CER-500TR system a completely unsuitable option for military offensive use.

11.3 Launch approvals

Do I need a launch clearance for the CER-500TR rocket?

It depends on what altitude do you plan to launch it and on the country on which you intend to launch it. The legislation may vary from country to country. We strongly advise you to contact your Military Aviation Authority, and seek guidance, prior to launch.

11.4 Eligibility

Who is eligible to purchase the CER-500TR system?

In general, a rocket falls into the category of a dual use product.
However, due to CER-500TR’s limited features and characteristics, like the lack of guidance system, the use of liquid propellant leading to a launch preparation time longer than in the case of regular military rockets and the engine’s performance three to four times less than in the case of a military rocket, the product’s application as a weapon and therefore as a dual use product is a non-realistic prospect.
In spite of this, we reserve the right to sale the product depending on our internal specific criteria.
If the purchaser’s country of origin is currently involved in combat activities, then the purchase request might be denied.
Please don’t hesitate to contact us and we will promptly inform you if we can go forward with your order.

11.5 Reservations and orders

How can I order the CER-500TR system?

The CER-500TR system will be available for purchase starting with March 2024. However, if you want to reserve one, you ca do it by placing a preorder at contact@arcaspace.com
The deliveries for the systems will be made in the order of reservations.

How long it will take until I'll receive my CER-500TR system once ordered?

The order will be ready for shipment depending on the order size. Usually, for a complete CER-500TR system, with a single rocket, the shipment will start 30 days after the payment was received. For larger orders, the shipment date will be communicated before the payment.

Can I get a refund after I placed an order for a CER-500TR system?

Immediately after you placed an order and paid for a CER-500TR system our company will start preparing and implementing the fabrication process and a refund will no longer be an option.

Will I a get a discount for a CER-500TR system if paid with the AMiE token?

Yes, you will get a 10% discount if you'll pay for the ERC-500TR system with the AMiE Token.

What is the cost of delivery for the CER-500TR system?

It depends on what region it needs to be shipped from Romania. For instance, for the delivery of an CER-500TR system, to North America, the shipment costs around €19,000. For deliveries in Europe, the cost is significantly lower.

12. Legal considerations, risks disclaimer

PLEASE READ THE ENTIRETY OF THIS “Legal Considerations, Risks and Disclaimer” SECTION CAREFULLY.

The issuer is solely responsible for the content of this User Guide. This User Guide has not been reviewed or approved by any competent authority in any member state of the European Union. To the best knowledge of the issuer, the information presented in this User Guide is correct and complete without any significant omission.

The information shared in this User Guide is not all-encompassing or comprehensive and does not in any way intend to create a direct or indirect contractual relationship. The primary purpose of this User Guide is to provide potential product buyers with pertinent information so as to help them thoroughly analyse the CER-500TR project and make an informed decision.

IF YOU ARE UNCERTAIN AS TO ANYTHING IN THIS USER GUIDE, WE STRONGLY URGE YOU NOT TO PURCHASE THE CER-500TR PRODUCT.

13. Contact

General Astronautics, ARCA Space
COSMOBAZA,
Stoenești, Romania

contact@arcaspace.com