

**GENERAL ASTRONAUTICS
ARCA SPACE**

**CER-160TR
TARGET ROCKET**

USER GUIDE

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1. Introduction

1.1 Overview

CER-160TR is an ecological, extremely cost effective rocket system, build as a target rocket for anti-rocket artillery training.

The rocket could be launched from the ground, from vehicles, directly from the sea, or from ships.

The rocket vehicle is expendable, however the ground support equipment is fully reusable.

Contrary to al present-day rockets, CER-160TR uses no flammable or explosive propellants, but a mixtured 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-160TR 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-160TR could be used as targets to simulate rocket artillery, flying at altitudes up to 20 km, ranges up to 40km and speeds up to Mach 1.9.

The range of simulated targets makes the CER-160TR system suitable for users from the ground, naval and air forces.



CER-160TR

2. Product presentation

The CER-160TR is the lightest rocket vehicle from our offer, designed as a target vehicle for military applications.

2.1 Technical characteristics and performances

Characteristic	Data
Diameter (body only)	0.16 m
Diameter over fins	0.65 m
Length	7.5 m
Dry weight	12 kg
Propellant weight	110 kg
Payload weight, maximum	3 kg
Launch weight, maximum	125 kg
Engine run time	50 s
Altitude with maximum payload	20 km
Speed with maximum payload	1.9 Mach
Launch angle from horizontal	20 - 90°

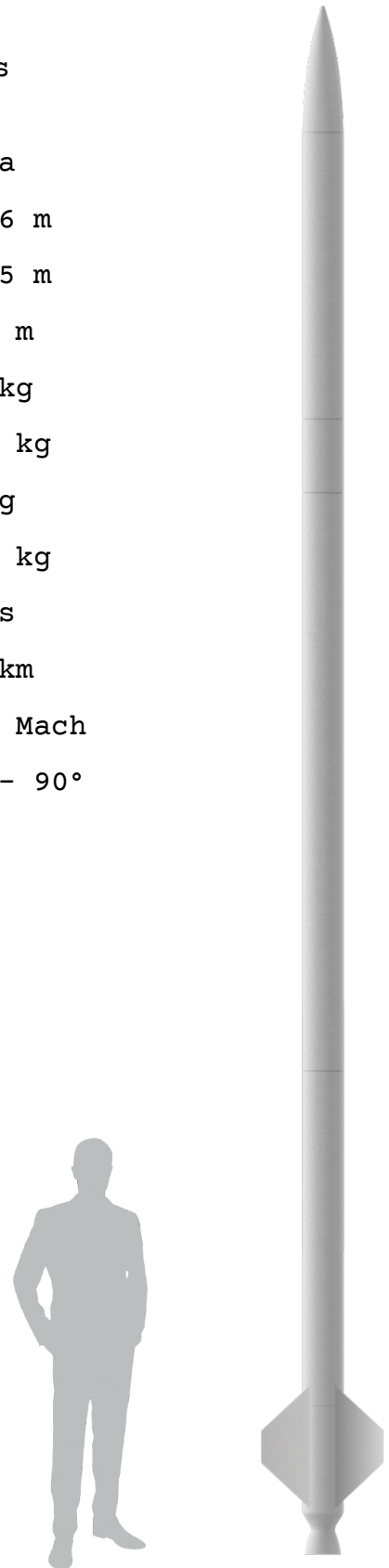


Fig.1 - CER-160TR comparison with a person.

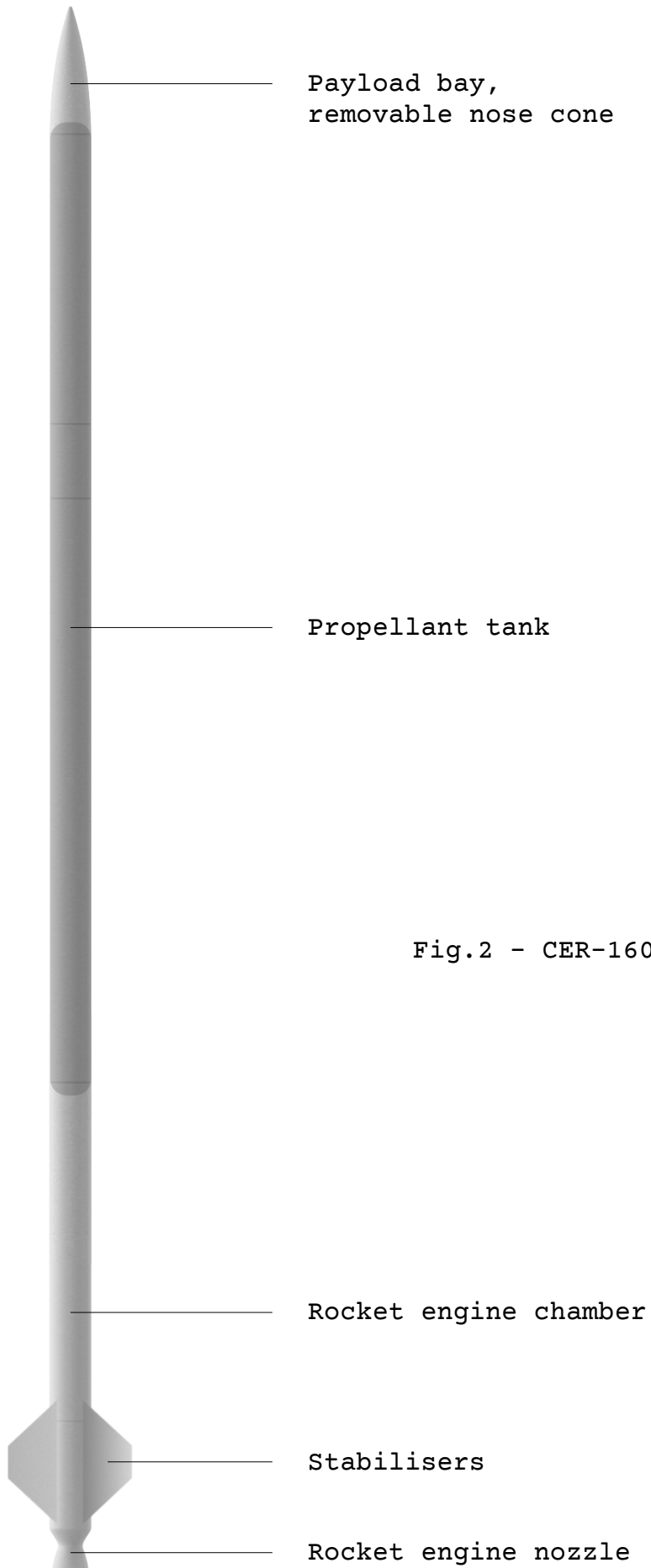


Fig.2 - CER-160TR elements

2.2 Performance data

A series of diagrams are shown below, emphasising the CER-160TR vehicle's performance.

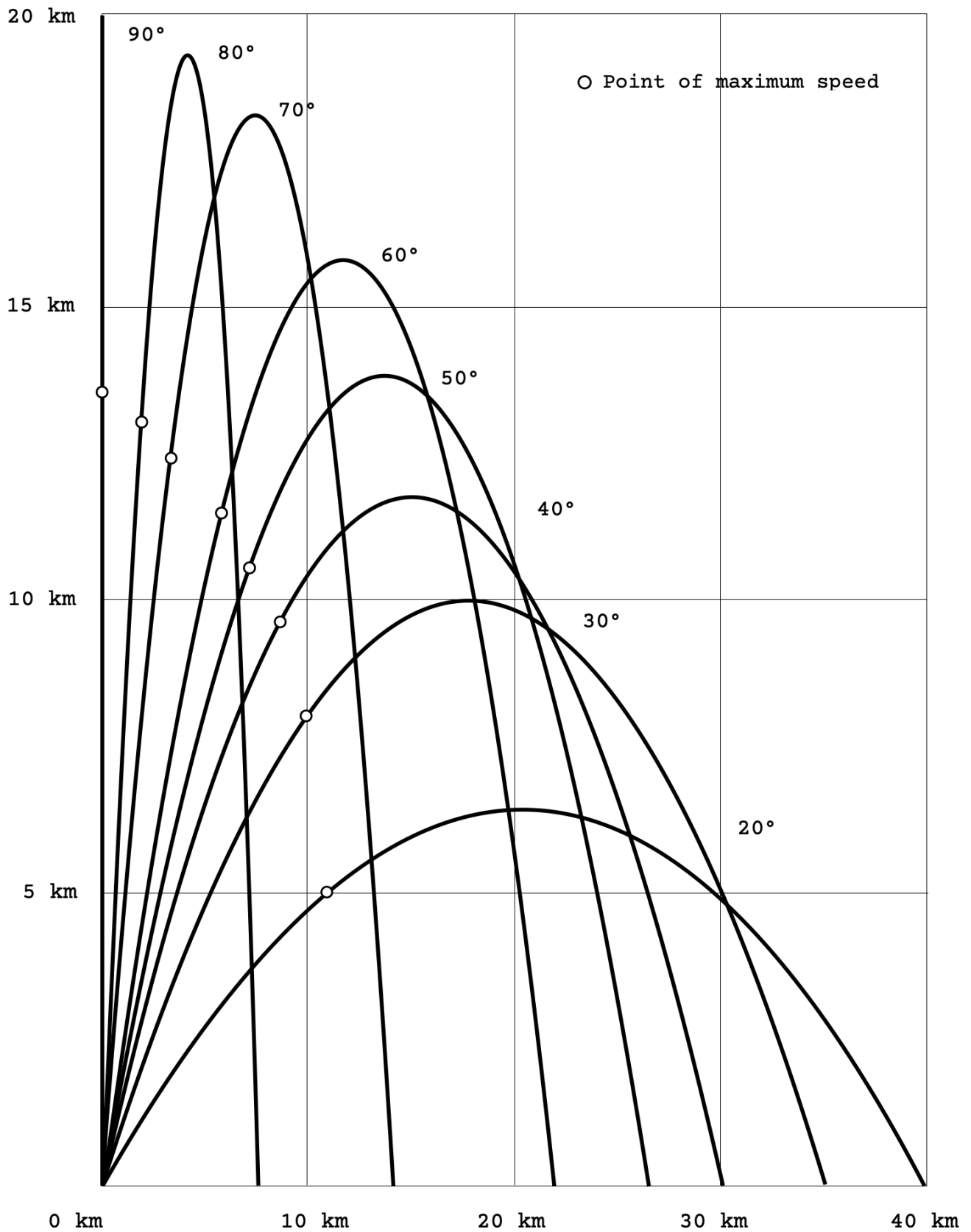


Fig.3 - CER-160TR flight envelope.

- Payload vs altitude

The CER-160TR has the capability to carry 3 kg of payload. The below table presents the rocket's altitude vs payload mass, if launched on a vertical trajectory:

Payload mass	Altitude
0	22 km
1.5	21 km
3	20 km

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

The simulations are considering the maximum payload of 3 kg. The launch angle is considered from horizontal.

Launch angle	Altitude	Speed, max.	Flight Time	Range
90°	20 km	1.9 Mach	170 s	0 km
80°	19 km	1.8 Mach	171 s	7 km
70°	18 km	1.7 Mach	172 s	14 km
60°	16 km	1.6 Mach	174 s	21 km
50°	14 km	1.5 Mach	176 s	26 km
40°	12 km	1.4 Mach	180 s	30 km
30°	10 km	1.3 Mach	188 s	35 km
20°	7 km	1.1 Mach	204 s	40 km

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

The CER-160TR has the capability to be carry 3 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
110	20 km	1.9 Mach	170 s
75	11 km	1.5 Mach	106 s
55	8 km	1.3 Mach	84 s
25	4 km	1.2 Mach	48 s



Fig.4 - CER-160TR during its first 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 0.7 m and it is standing 9.6 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 120 litre stainless steel tank that stores the propellant before it is transferred into the rocket prior to the launch.

4. Prerequisites

The CER-160TR 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 CER160 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 110 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

The CER-160TR is suitable to simulate the flight of rocket artillery. CER-160TR is suitable for this taking into account its similar size, weight and flight profile compared to the currently operational rocket artillery.

The rocket artillery that the CER-160TR can simulate is presented below.

5.1 List of compatible rocket artillery

The following relevant rocket artillery systems are presented below compared to the CER-160TR:

- M270 Multiple Launch Rocket System (MLRS) - US
- M142 High Mobility Artillery Rocket System (HIMARS) - US
- BM-27 Uragan - Russia
- Tornado-G - Russia
- TOS-1A - Russia
- LAROM 160 - Israel/Romania
- Pinaka - India
- T-122 Sakarya - Turkey

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- M270 Multiple Launch Rocket System (MLRS)

Characteristic	M26 rocket	CER-160TR
Diameter (body only)	0.227 m	0.16 m
Length	3.9 m	7.5 m
Launch weight, maximum	306 kg	125 kg
Altitude	~ 25 km	20 km
Speed, maximum	2 Mach	1.9 Mach
Speed, terminal	N/A	0.6 Mach
Range, maximum	32 km	40 km
Cost/unit	~ \$100,000	€19,900



- M142 High Mobility Artillery Rocket System (HIMARS)

Characteristic	M31A1 rocket	CER-160TR
Diameter (body only)	0.227 m	0.16 m
Length	3.9 m	7.5 m
Launch weight, maximum	306 kg	125 kg
Altitude	~ 25 km	20 km
Speed, maximum	N/A	1.9 Mach
Speed, terminal	2.5 Mach	0.6 Mach
Range, maximum	92 km	40 km
Cost/unit	~ \$250,000	€19,900



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- BM-27 Uragan

Characteristic	9M27K1 rocket	CER-160TR
Diameter (body only)	0.22 m	0.16 m
Length	5.2 m	7.5 m
Launch weight, maximum	280 kg	125 kg
Altitude	N/A	20 km
Speed, maximum	N/A	1.9 Mach
Speed, terminal	N/A	0.6 Mach
Range, maximum	35 km	40 km
Cost/unit	N/A	€19,900



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- Tornado-G

Characteristic	9M538 rocket	CER-160TR
Diameter (body only)	0.122 m	0.16 m
Length	2.64 m	7.5 m
Launch weight, maximum	70 kg	125 kg
Altitude	N/A	20 km
Speed, maximum	N/A	1.9 Mach
Speed, terminal	N/A	0.6 Mach
Range, maximum	20 km	40 km
Cost/unit	N/A	€19,900



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- TOS-1A

Characteristic	Thermobaric rocket	CER-160TR
Diameter (body only)	0.22 m	0.16 m
Length	3.7 m	7.5 m
Launch weight, maximum	217 kg	125 kg
Altitude	N/A	20 km
Speed, maximum	N/A	1.9 Mach
Speed, terminal	N/A	0.6 Mach
Range, maximum	6 km	40 km
Cost/unit	N/A	€19,900



COMMERCIAL ECOROCKET 160TR - USER GUIDE

- LAROM 160

Characteristic	LAR Mk.IV	CER-160TR
Diameter (body only)	0.16 m	0.16 m
Length	3.4 m	7.5 m
Launch weight, maximum	110 kg	125 kg
Altitude	N/A	20 km
Speed, maximum	N/A	1.9 Mach
Speed, terminal	N/A	0.6 Mach
Range, maximum	45 km	40 km
Cost/unit	N/A	€19,900



- Pinaka

Characteristic	ERR 122 rocket	CER-160TR
Diameter (body only)	0.122 m	0.16 m
Length	2.9 m	7.5 m
Launch weight, maximum	66.5 kg	125 kg
Altitude	N/A	20 km
Speed, maximum	N/A	1.9 Mach
Speed, terminal	N/A	0.6 Mach
Range, maximum	40 km	40 km
Cost/unit	N/A	€19,900



- T-122 Sakarya

Characteristic	TR 122 rocket	CER-160TR
Diameter (body only)	0.122 m	0.16 m
Length	2.9 m	7.5 m
Launch weight, maximum	66 kg	125 kg
Altitude	N/A	20 km
Speed, maximum	N/A	1.9 Mach
Speed, terminal	N/A	0.6 Mach
Range, maximum	40 km	40 km
Cost/unit	N/A	€19,900



5.2 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 systems 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-160TR:

- 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



5.3 Engagement envelope for the presented anti-rocket 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	< 1.3 Mach	< 180 s	< 35 km
LPWS	< 2 km	< 0.6 Mach	< 20 s	< 2 km
MANTIS	< 2 km	< 0.6 Mach	< 20 s	< 2 km
LS-2000	< 3 km	< 0.7 Mach	< 27 s	< 3 km

How to read the table:

Example 1

In the case of the Iron Dome system, the CER-160TR rocket could be intercepted at altitudes up to 10 km, and maximum speeds of Mach 1.3, with a theoretical interception time of 180 s (taking into account the interceptor capability to detect the CER-160TR immediately after launch), while the maximum engagement range is up to 35 km.

Example 2

In the case of LPWS, the CER-160TR rocket could be intercepted at altitudes up to 2 km and a speed of Mach 0.6, with an interception time of 20 s, while the maximum engagement range is also 2 km.

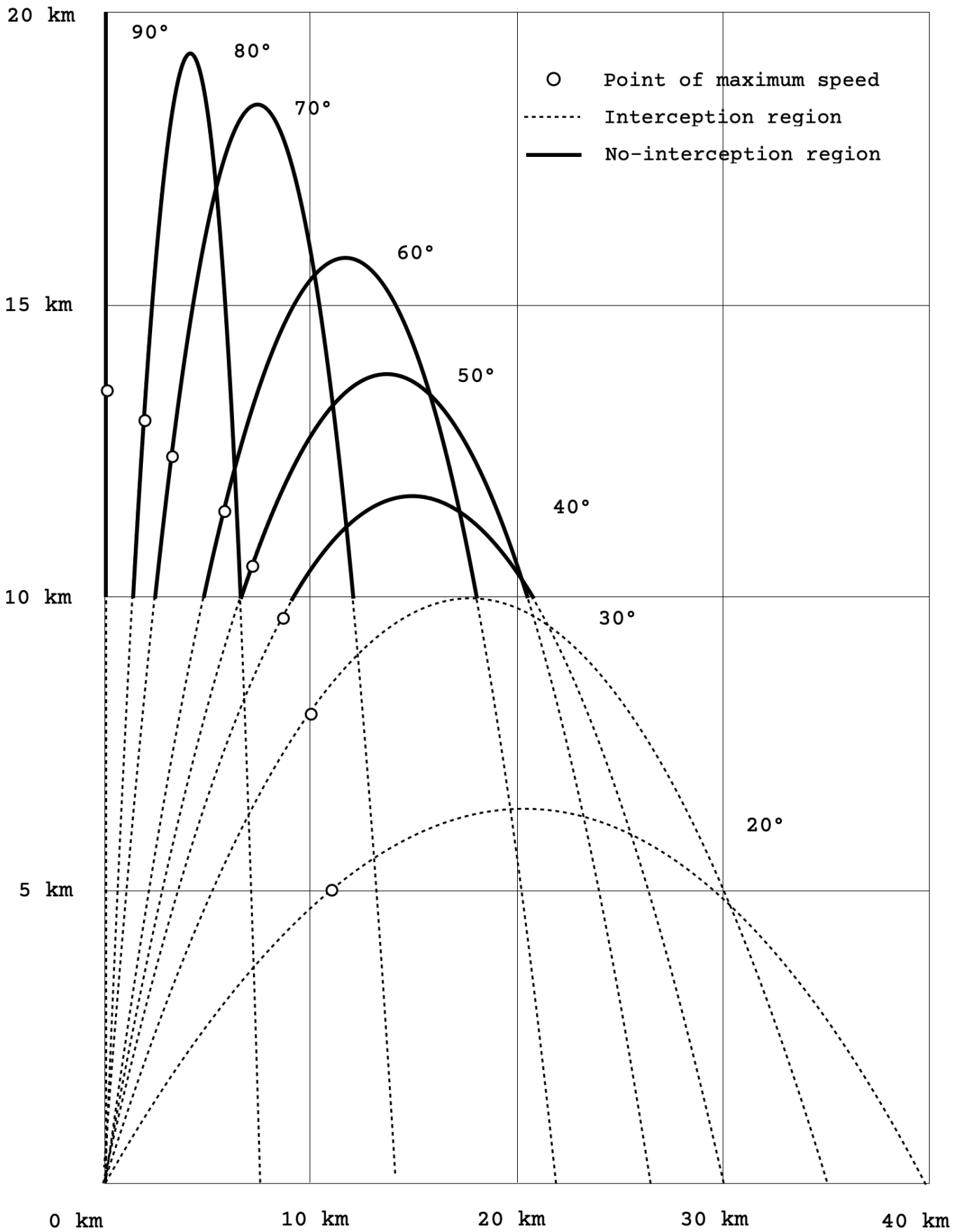


Fig.5 - Iron Dome estimated interception envelope of CER-160TR rocket.

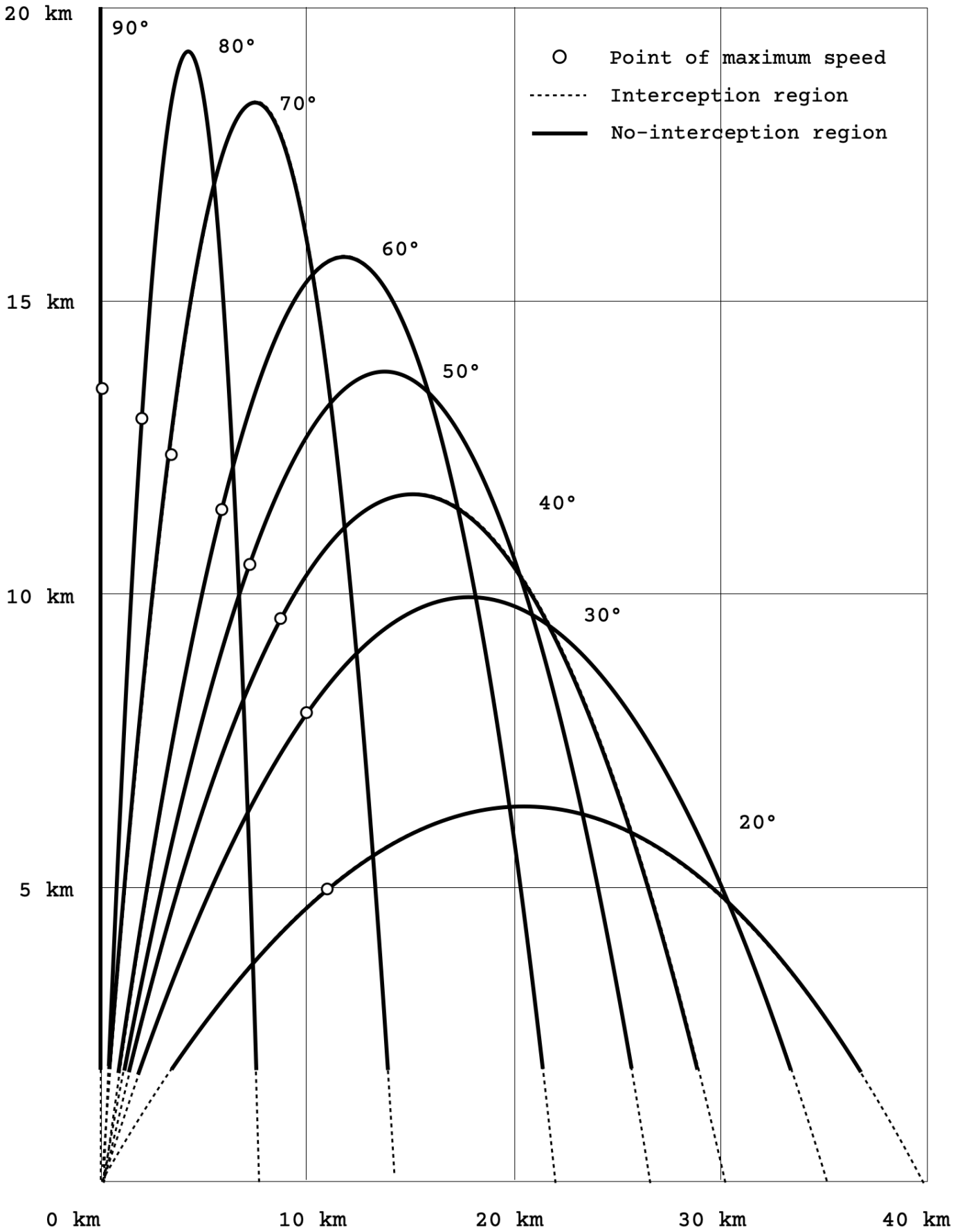


Fig.6 - LPWS and MANTIS estimated interception envelope of CER-160TR rocket.

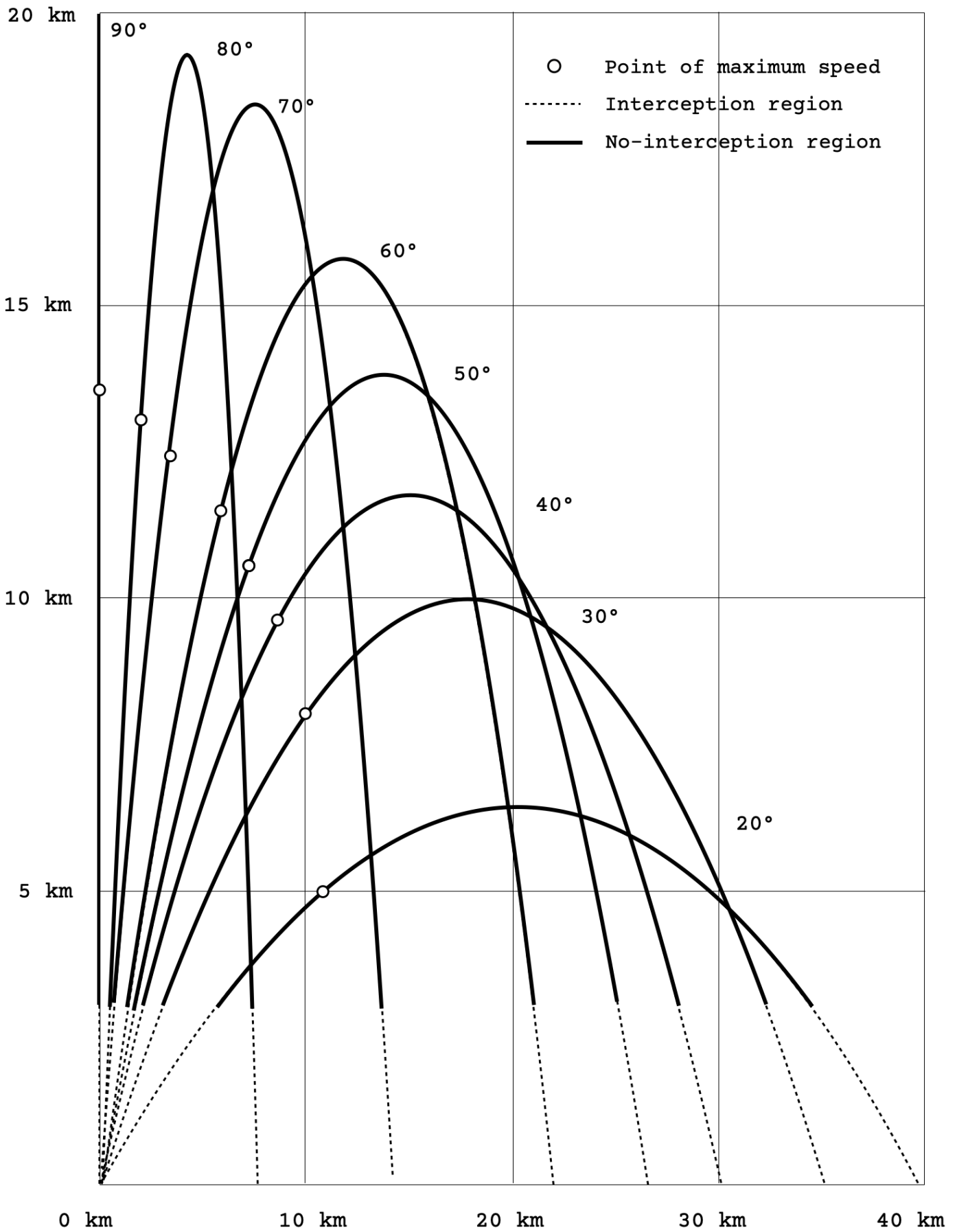


Fig.7 - LS-2000 estimated interception envelope of CER-160TR rocket.

6. Launch options

The product can be launched 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.

7. Payload integration

The CER-160TR 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 160 mm diameter is available for the payload bay with a height of the cylindrical part of 500 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.



8. 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.

8.1 Complete CER-160TR system

Component	Price [€]	Price [€] if purchased in AMiE
CER-160TR rocket	19,900	17,900
Launch canister	6,900	6,200
Propellant transfer tank	2,900	2,600
Adjustable angle support	13,900	12,500
TOTAL	43,600	39,200

* 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.

8.2 Orders including more CER-160TR rockets

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

9. Licensing

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

10. Order and Shipment

To place an order for the CER-160TR 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-160TR complete systems with one CER-160TR rocket each.

The order will be ready for shipment depending on the order size. Usually for a complete CER-160TR 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.

11. Purchase eligibility

In general, a rocket falls into the category of a dual use product.

However, due to CER-160TR'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.

12. FAQ

12.1 Operations

How difficult is to prepare the CER-160TR system for launch?

The CER-160TR 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-160TR rocket?

The CER-160TR 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-160TR 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 goggles and gloves during manipulation. In case of contact with your eyes and skin, always have fresh water closely available and apply abundant 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.

12.2 Features

Is the CER-160TR system reusable?

The CER-160TR 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-160TR 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-160TR system a completely unsuitable option for military offensive use.

12.3 Launch approvals

Do I need a launch clearance for the CER-160TR 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.

12.4 Eligibility

Who is eligible to purchase the CER-160TR system?

In general, a rocket falls into the category of a dual use product.

However, due to CER-160TR'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.

12.5 Reservations and orders

How can I order the CER-160TR system?

The CER-160TR system will be available for purchase starting with March 2024. However, if you want to reserve one, you can do it by placing a preorder at contact@arcaspace.com

A 10% down payment is required to reserve the system. The deliveries for the systems will be made in the order of reservations.

How long it will take until I'll receive my CER-160TR system once ordered?

The order will be ready for shipment depending on the order size. Usually, for a complete CER-160TR 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-160TR system?

Immediately after you placed an order and paid for a CER-160TR system our company will start preparing and implementing the fabrication process and a refund will no longer be an option.

Will I get a discount for a CER-160TR system if paid with the AMiE token?

Yes, you will get a 10% discount if you'll pay for the CER-160TR system with the AMiE Token.

What is the cost of delivery for the CER-160TR system?

It depends on what region it needs to be shipped from Romania. For instance, for the delivery of an CER-160TR system, to North America, the shipment costs around €9,000. For deliveries in Europe, the cost is significantly lower.

13. 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-160TR 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-160TR PRODUCT.

14. Contact

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