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ИКИ

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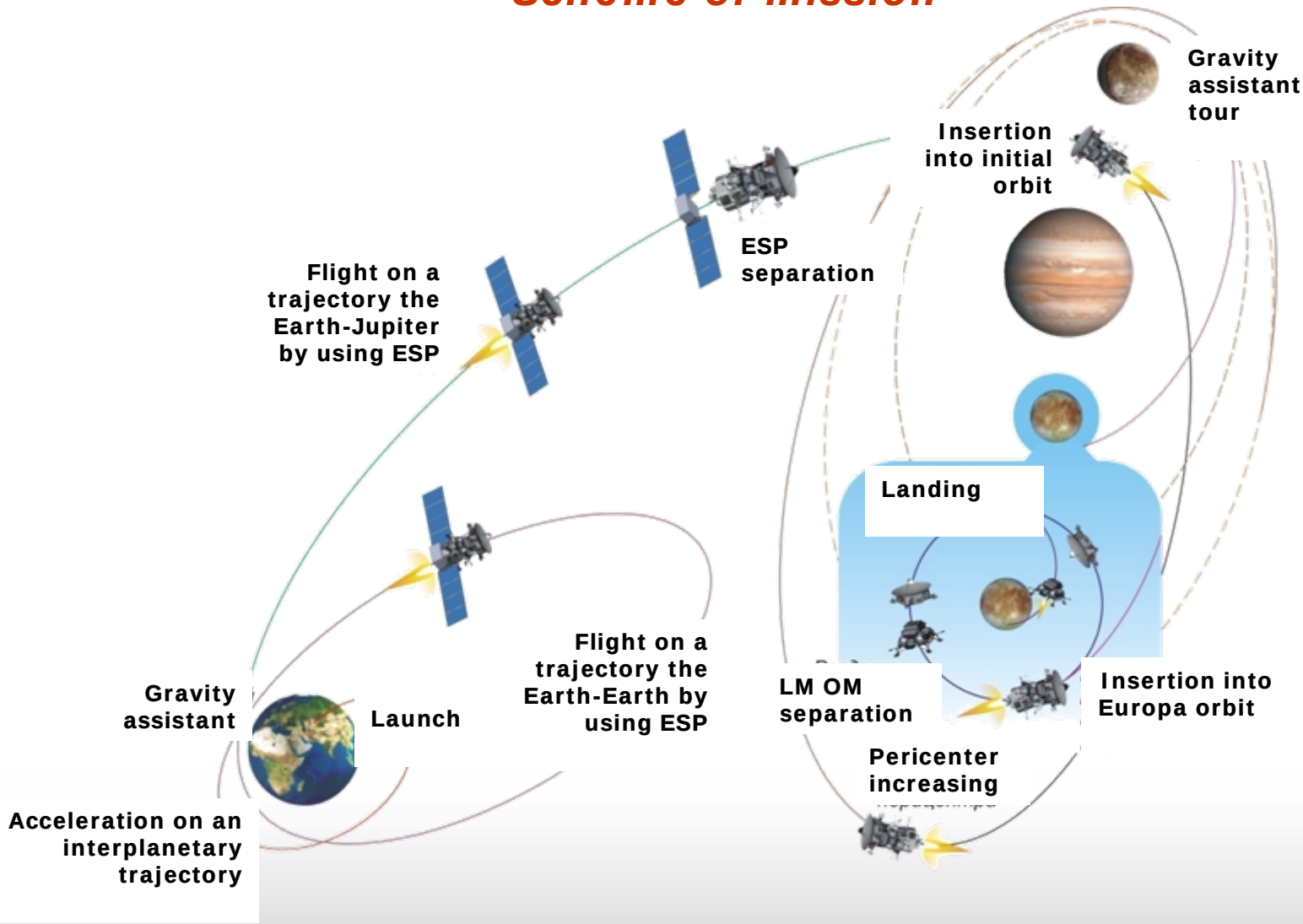
The concept of expedition to Europa, the Jupiter's satellite

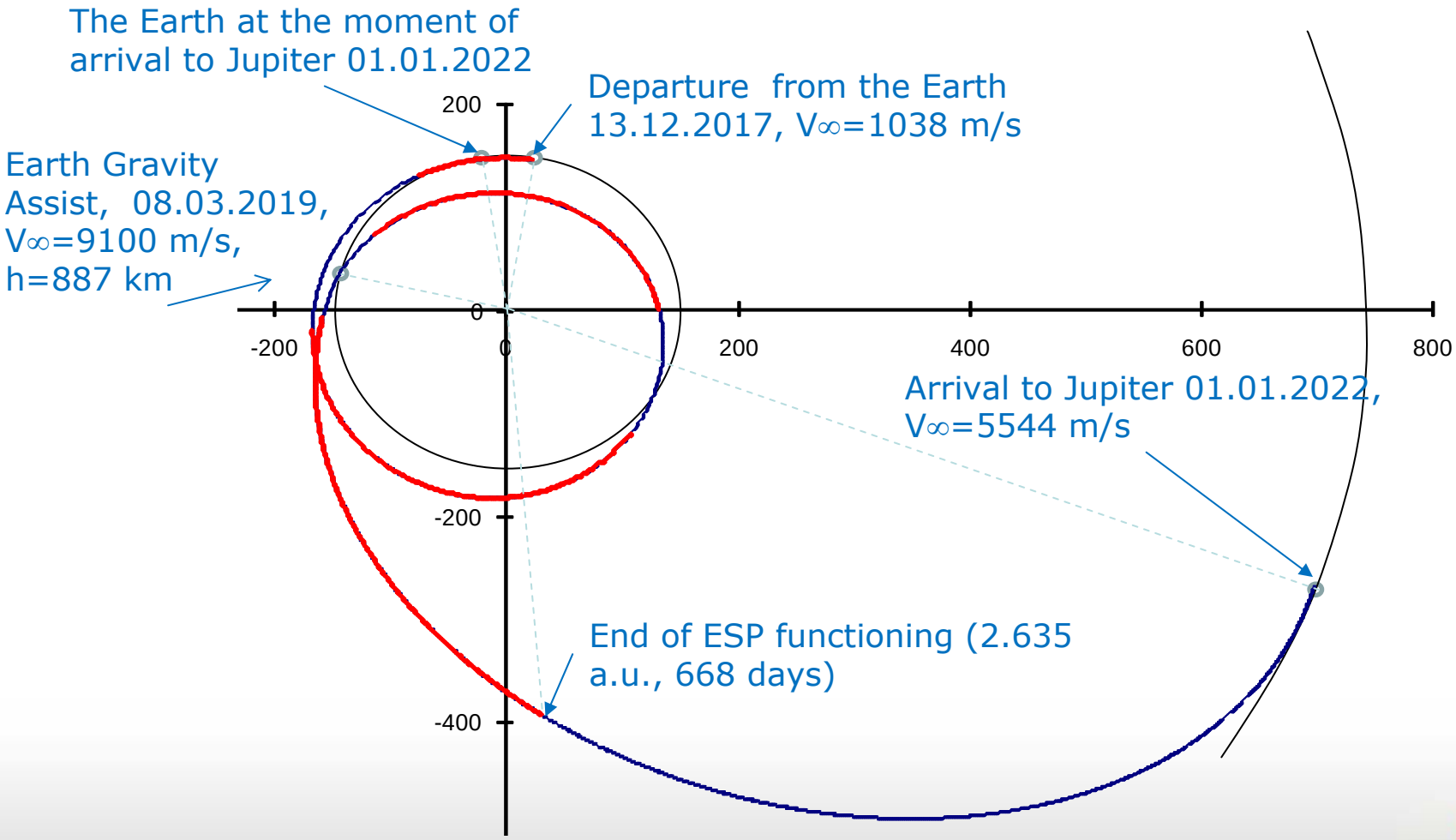
Main stages of mission

- Insertion by using of LV "Proton" into a basic circular orbit in height of 200 km;
- Acceleration by using of USB "Breeze" on an interplanetary trajectory, separation of SC;
- Flight on Earth-Earth trajectory by using of transport module with electric propulsion system;
- Earth Gravity assist;
- Flight to Jupiter by using of transport module with electric propulsion system, TM EPS separation;
- Braking in sphere Jupiter action and insertion on initial high apogee orbit;
- Increasing of initial orbit pericenter to radius of orbit Ganimed;
- Repeated trial flight of galilee satellite for reduction of relative velocity of approach to Europa;
- Insert into a Europa circular orbit in height of 100 km;
- Landing

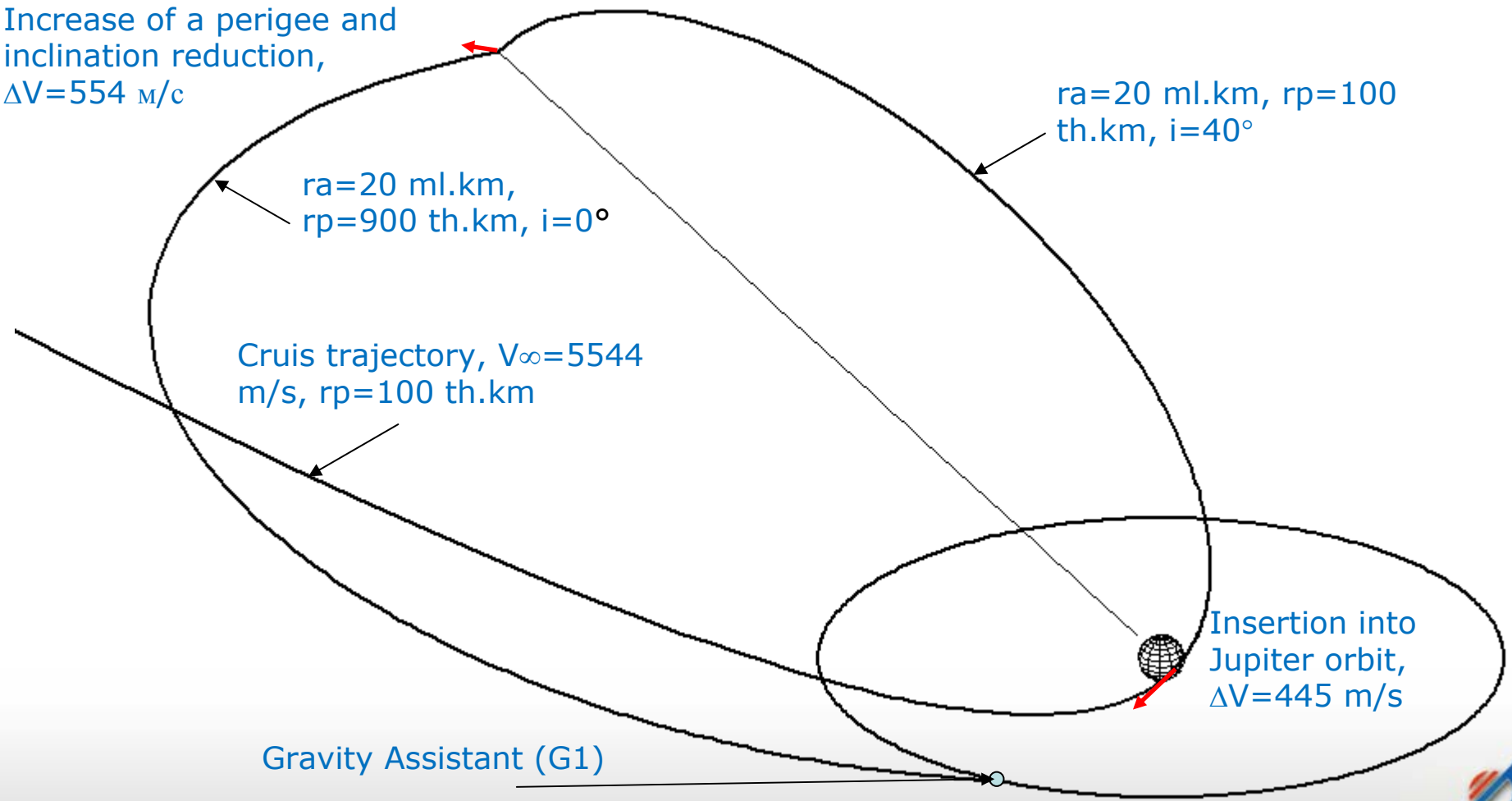
Scheme of mission



Heliocentric section of flight



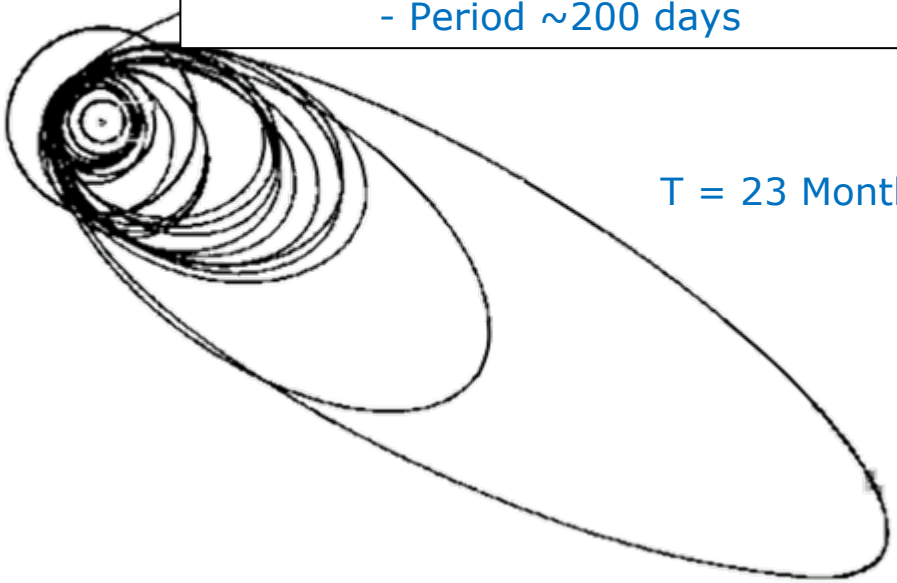
Insertion into Jupiter orbit



Insertion into Europa orbit

Initial orbit:

- Pericenter radius 900 thousand km;
- Apocenter radius 20 million km.
- Period ~200 days

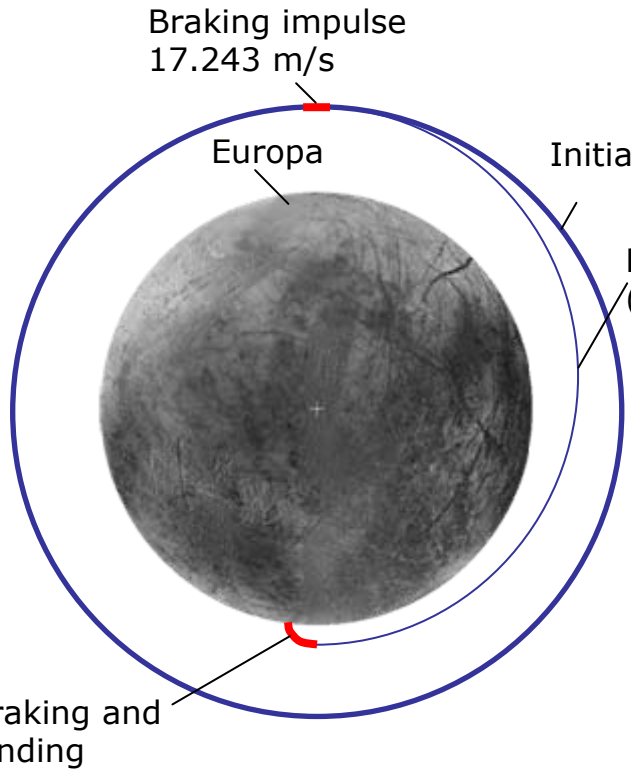


T = 23 Month

	Moon	Height, km	V_∞, km/s	Period, days	r_p, RJ
G1	Ganymede	1500	6.65	71.4	11.8
G2	Ganymede	120	6.48	28.6	11.1
G3	Ganymede	100	6.46	21.5	10.7
G4	Ganymede	100	6.4	24.9	10.9
C1	Callisto	400	6.2	33.4	12.7
C2	Callisto	1909	6.18	37.7	13.3
G5	Ganymede	100	5.04	21.5	12.5
G6	Ganymede	1190	4.92	19.5	12.4
C3	Callisto	3095	5.02	23.9	14.1
G7	Ganymede	958	3.66	14.3	13.2
G8	Ganymede	100	3.67	13.9	13.6
C4	Callisto	1159	3.47	15.1	14.4
G9	Ganymede	2695	2.64	10.7	13.5
G10	Ganymede	1312	2.65	7.2	11.3
G11	Ganymede	2594	2.63	5.6	9.0
E1	Europa	6069	2.36	5.3	8.9
E2	Europa	8773	2.29	5.1	8.8
G12	Ganymede	1139	1.76	5.7	11.0
G13	Ganymede	200	1.76	5.3	9.3
E3	Europa	1451	1.62	5.3	9.3
E4	Europa	1500	1.42	4.7	9.3
EOI	Europa	-	0.57	-	-

Manoeuvres	100 m/s
Corrections during tour	50 m/s
Rendezvous with Europa	145 m/s
Insertion into Europa orbit (h = 100 km)	705 m/s
Total	1000 m/s

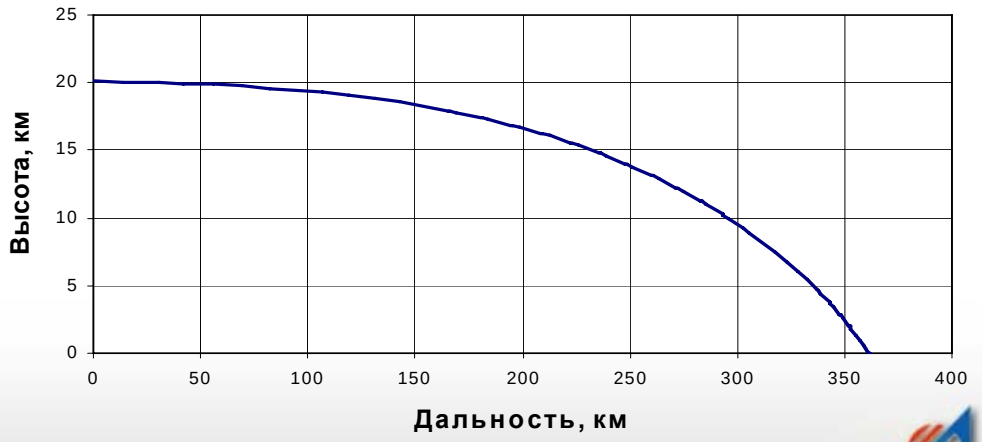
Landing onto Europa surface



Main parameters of landing module

-Trust	3000 N
- Specific impulse	220 s
- Initial mass	1210 kg
- Mass on surface	550 kg
- Propellant mass	660 kg

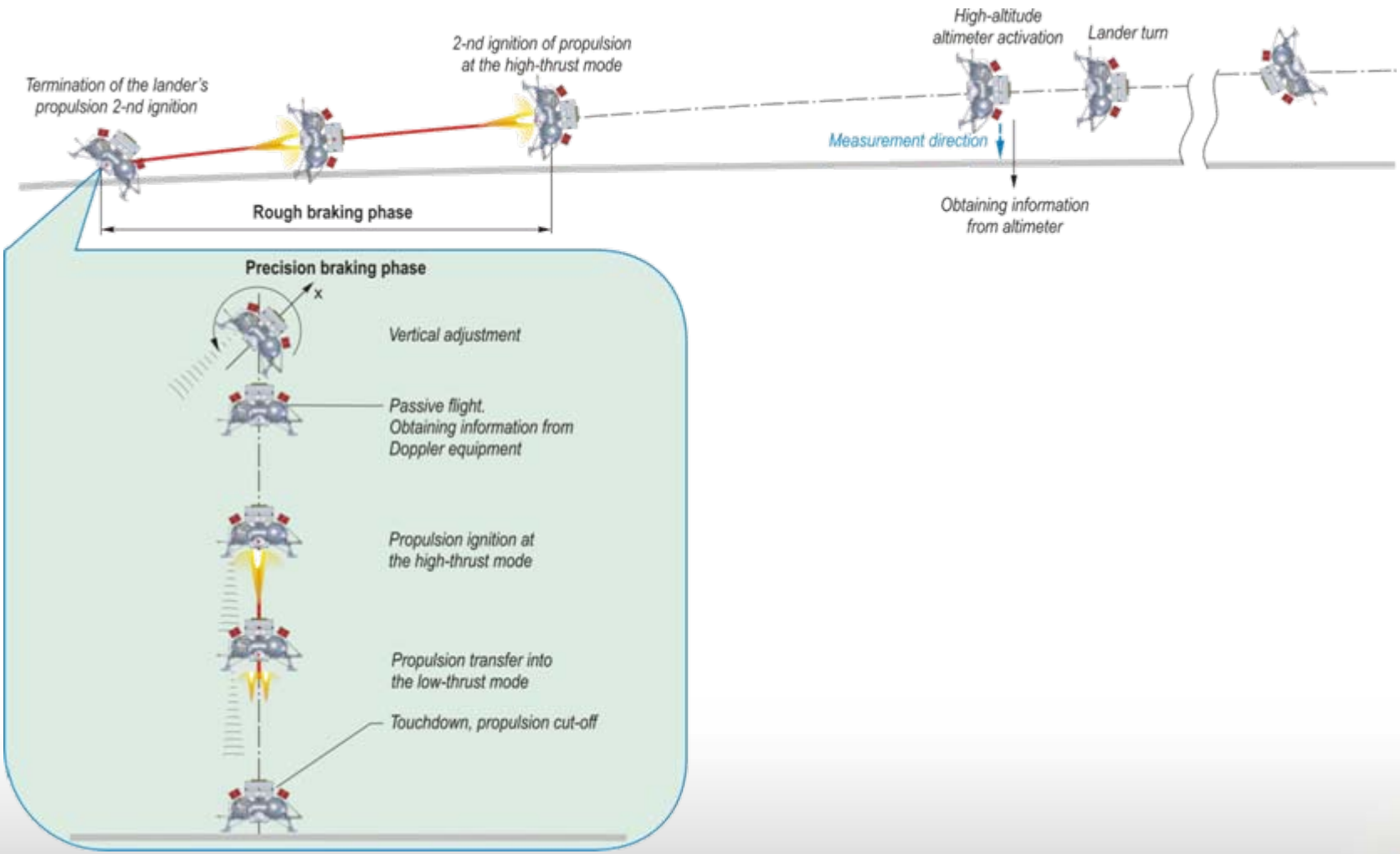
Total value of characteristic velocity ~1600 m/s



Estimation of stability of a polar circular orbit (h=100 km):

~2 Month – without correction maneuvers ;
1 Year – 200 m/s.

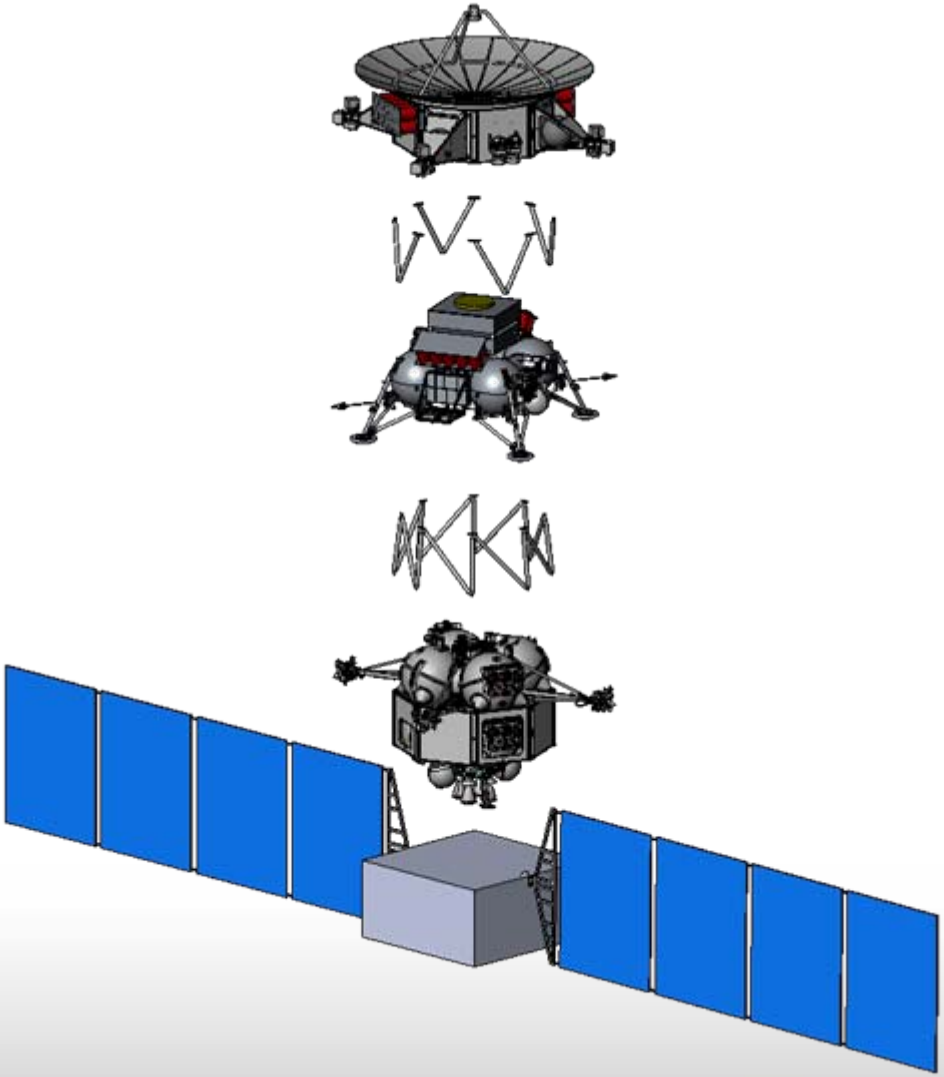
Landing scheme



Flight time-schedule

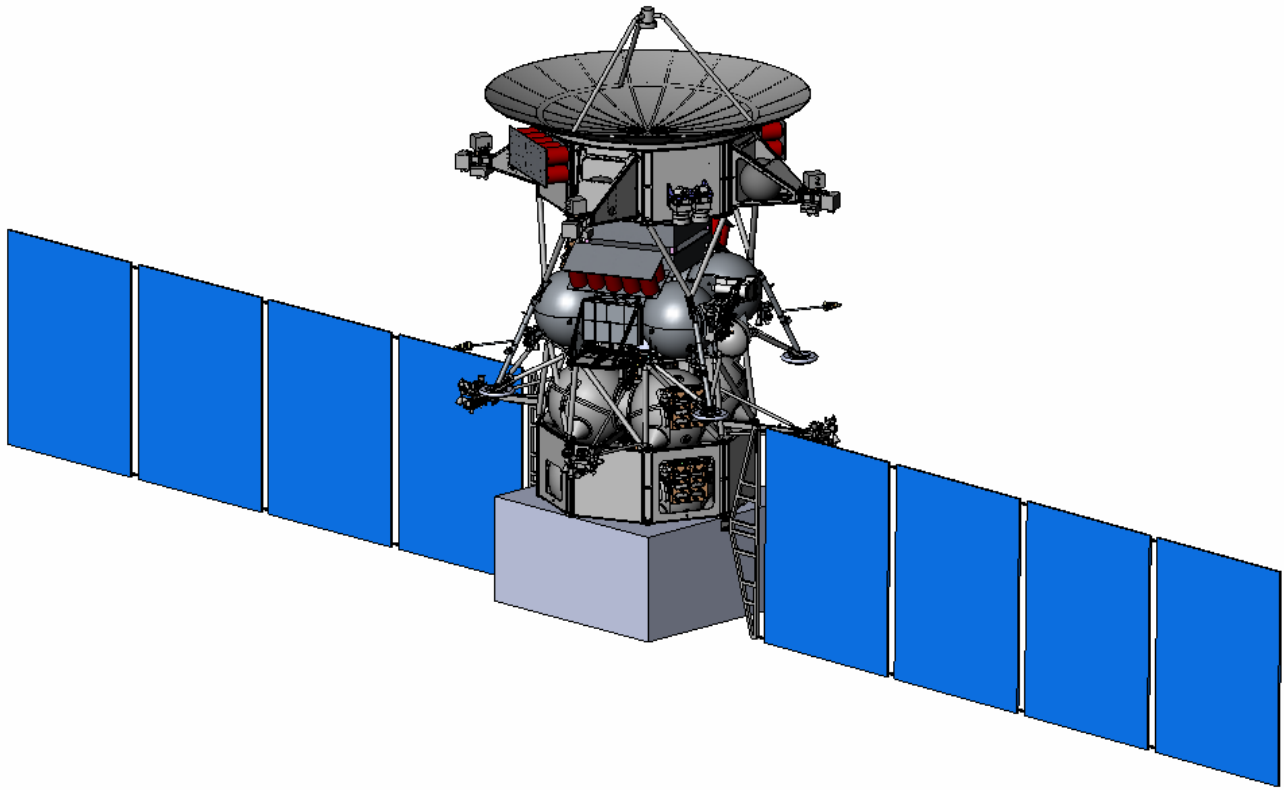
Stage	Date	Duration
Launch	13.12.2017	
Earth Gravity assist	08.03.2019	1.3 years
Arrival to Jupiter	01.01.2022	3 years
Flight in system of Jupiter	January 2022 – December 2023	2 years
Transfer into an orbit of Europa, flight on an orbit, choice of a place of landing	January - March 2024	2 months
Landing	March 2024	
Total		6.5 years

Exploded view of SC



Spacecraft:: Overview

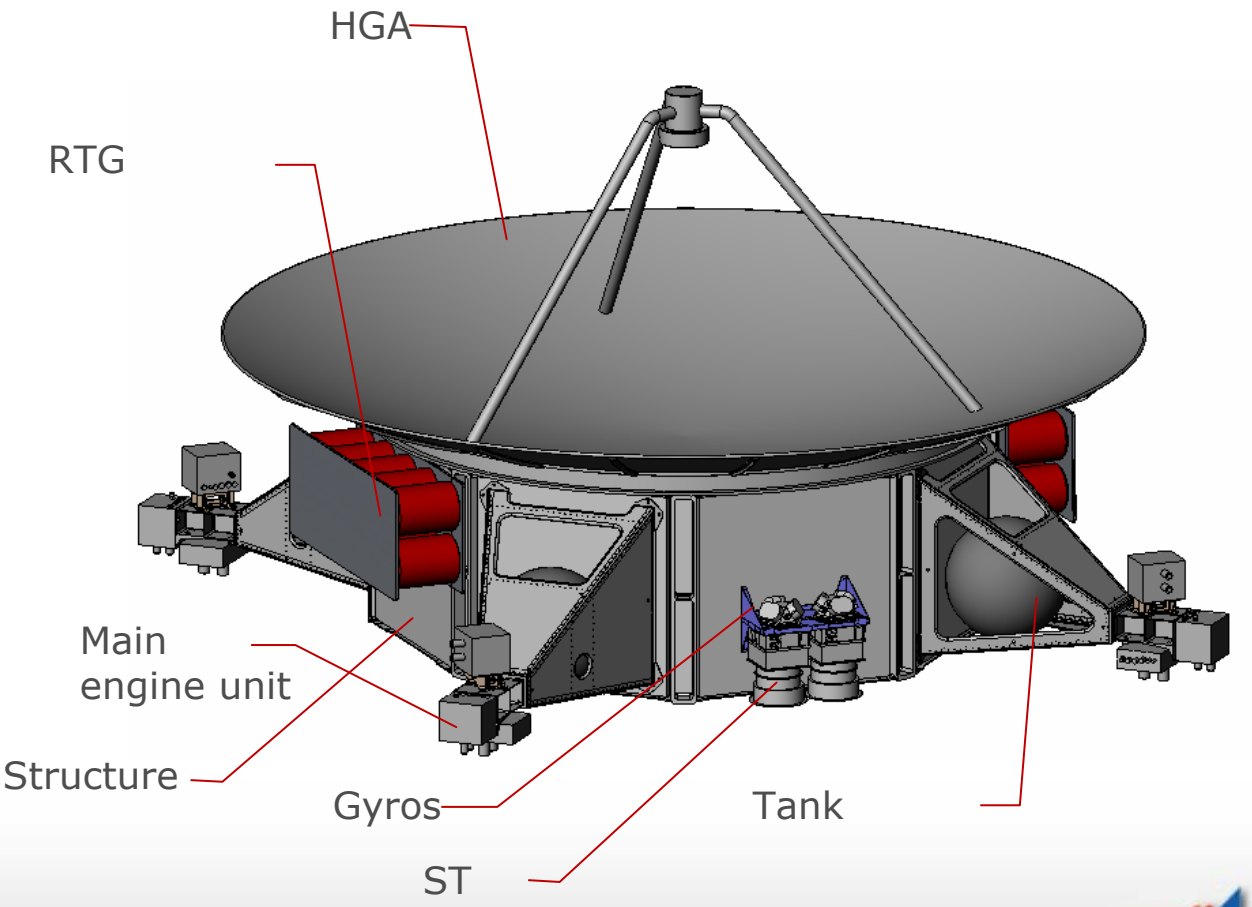
Name	Mass, kg
Orbital module	395
Landing module	550
Propulsion system	385
Electroroket Propulsion system	860
Intermediate structure	70
S/C without propellant	**2260**
EPS propellant	1435
Propulsion system propellant	2005
Landing module propellant	660
S/C with propellant	**6360**



Orbital module

Purpose of the orbital module:

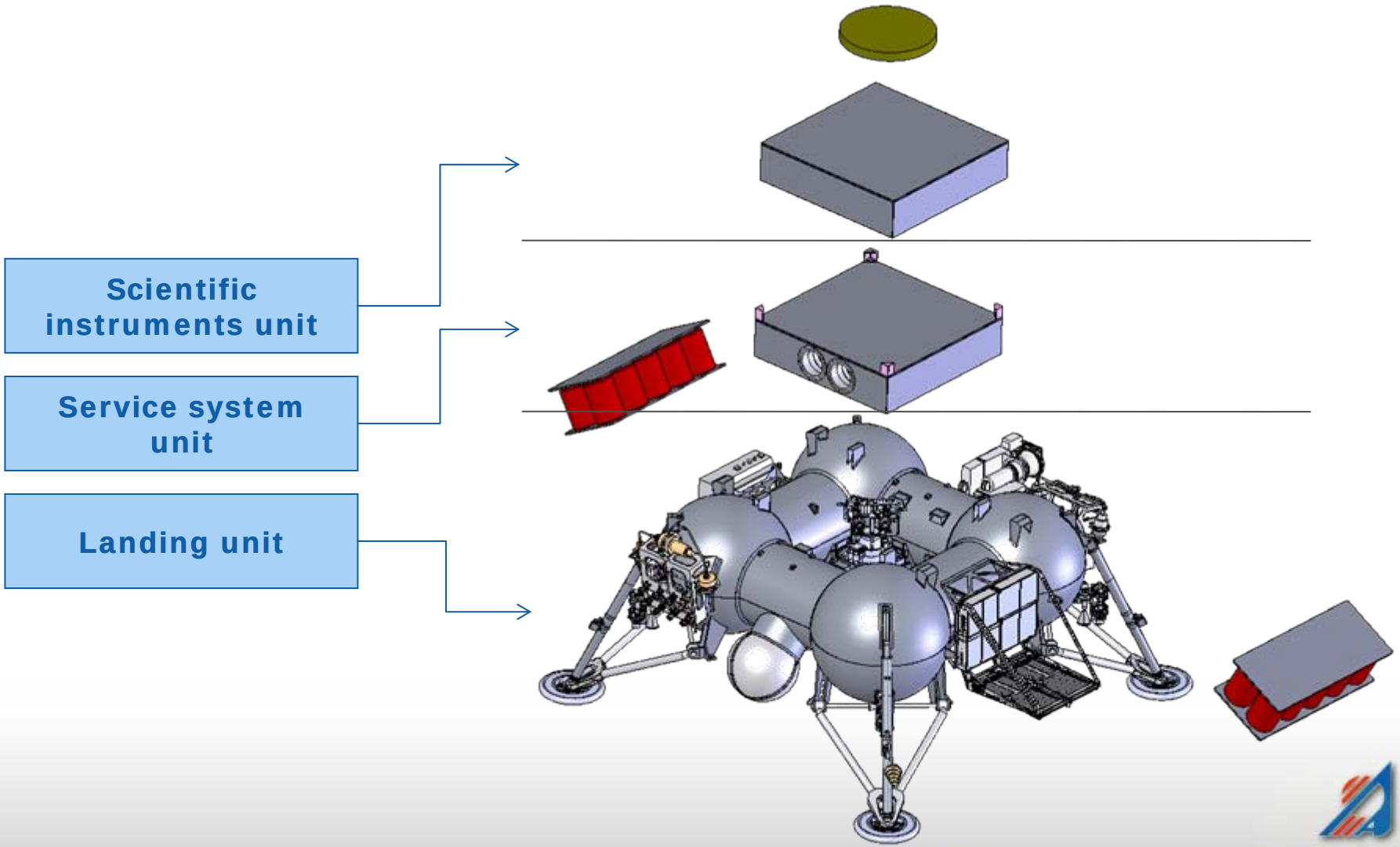
- Realisation of scientific experiments from Europa orbit;
- Selection of a landing area for a lander;
- Providing of data relay from a lander to the Earth.



Orbital:: Mass budget

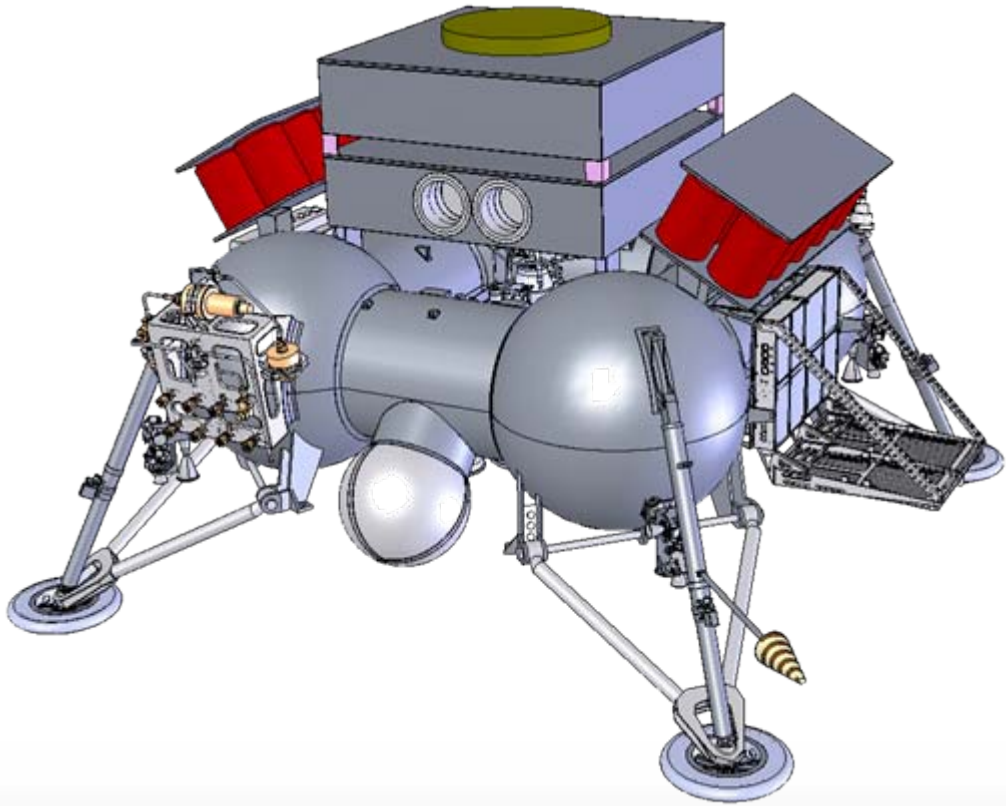
Name	Mass, kg
Structure	80,2
Propulsion system	51,6
Radio system	7,2
HGA, LDA	32,2
Power system	44
Thermal system	20
Cables	20
Scientific instruments	50
Margin	90
Orbital without propellant	**395**

Landing module:: Exploded view

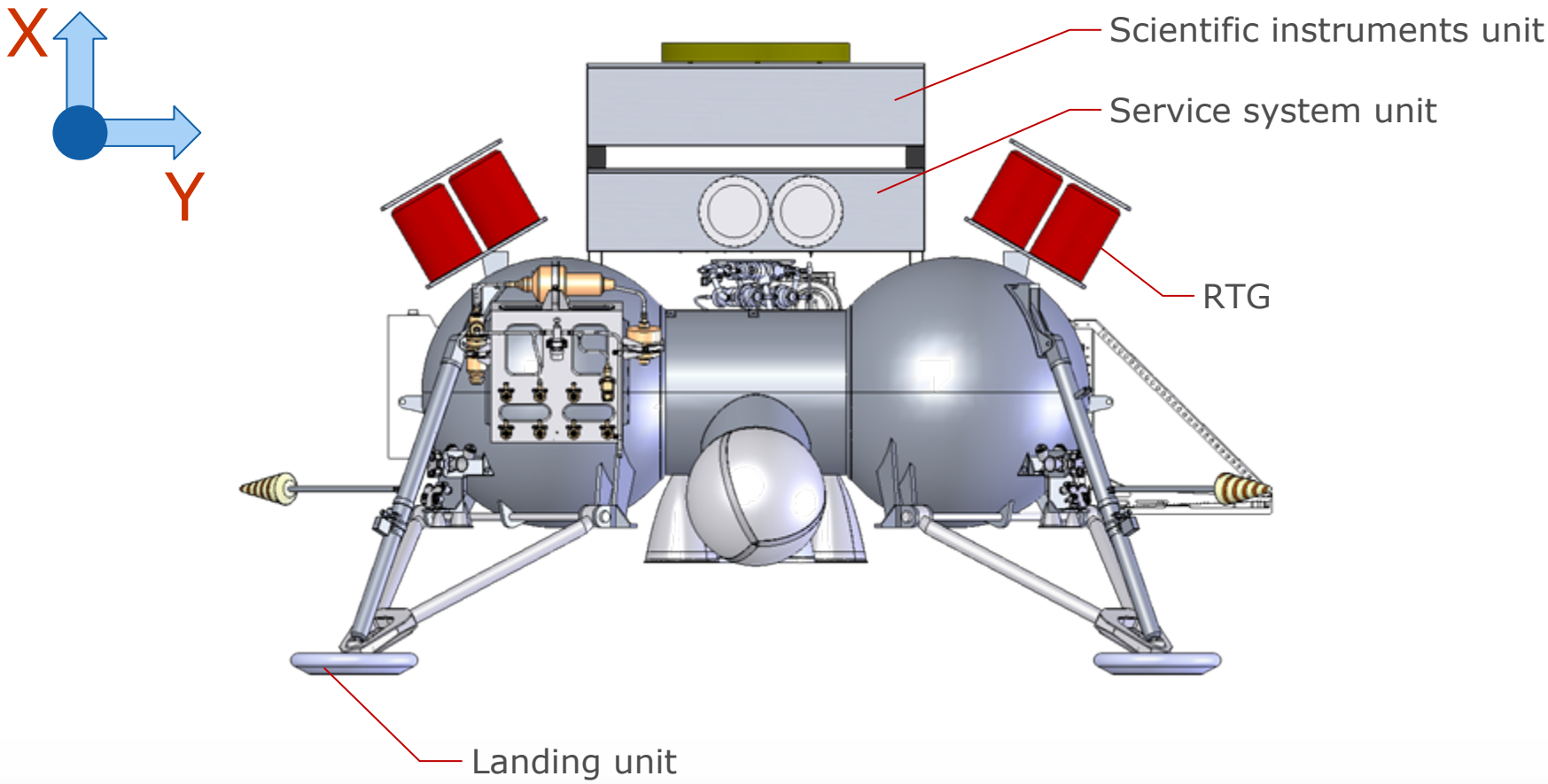


Landing module:: Mass budget

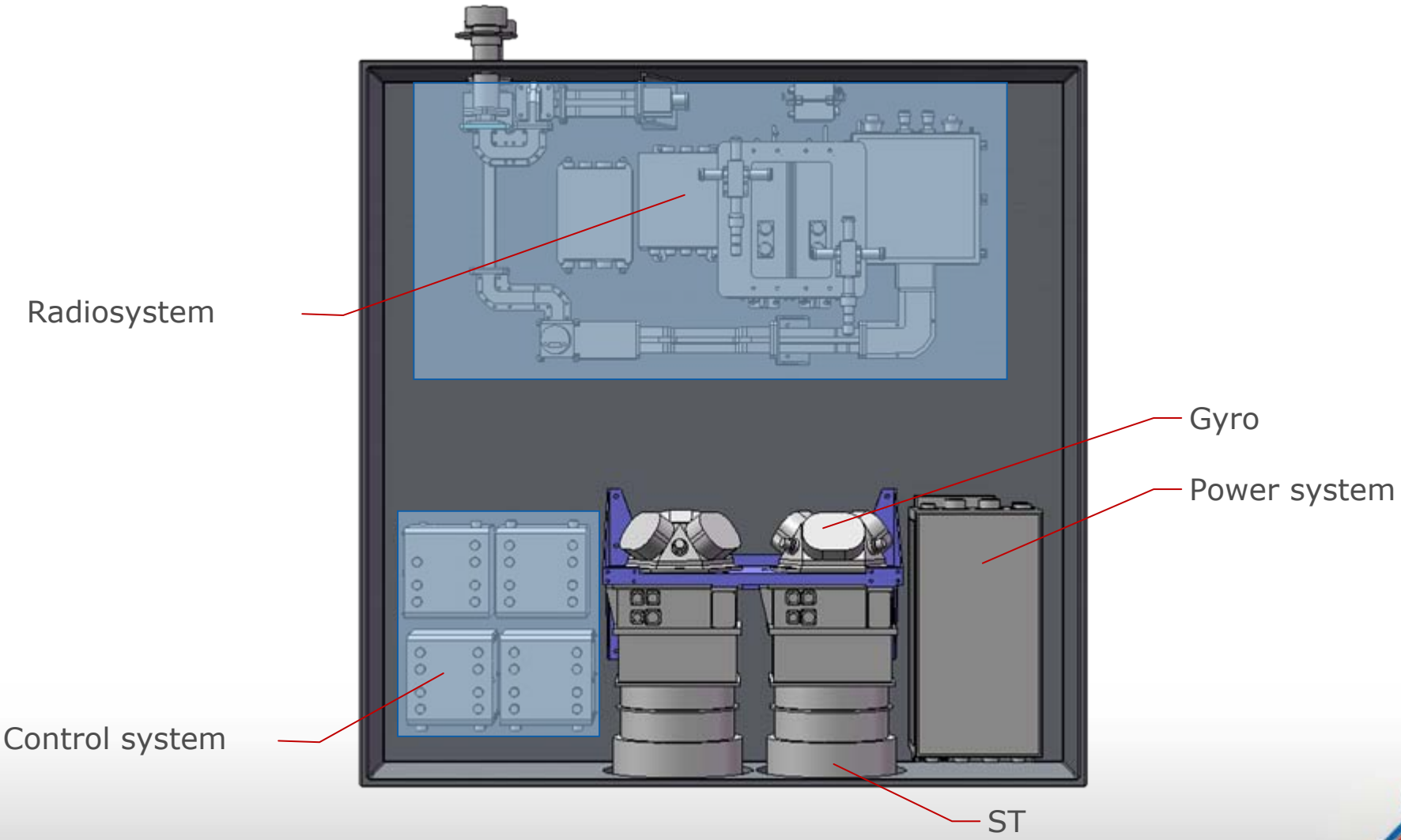
Name	Mass, kg
Propulsion system	167
Control system	41
Radio system	7,2
Antennas	2,2
Power system	44
Thermal system	20
Cables	20
Structure	119,5
Landing unit	12
Scientific instruments	*70*
Margin	47,1
Landing module without propellant	**550**



Landing module:: Overview



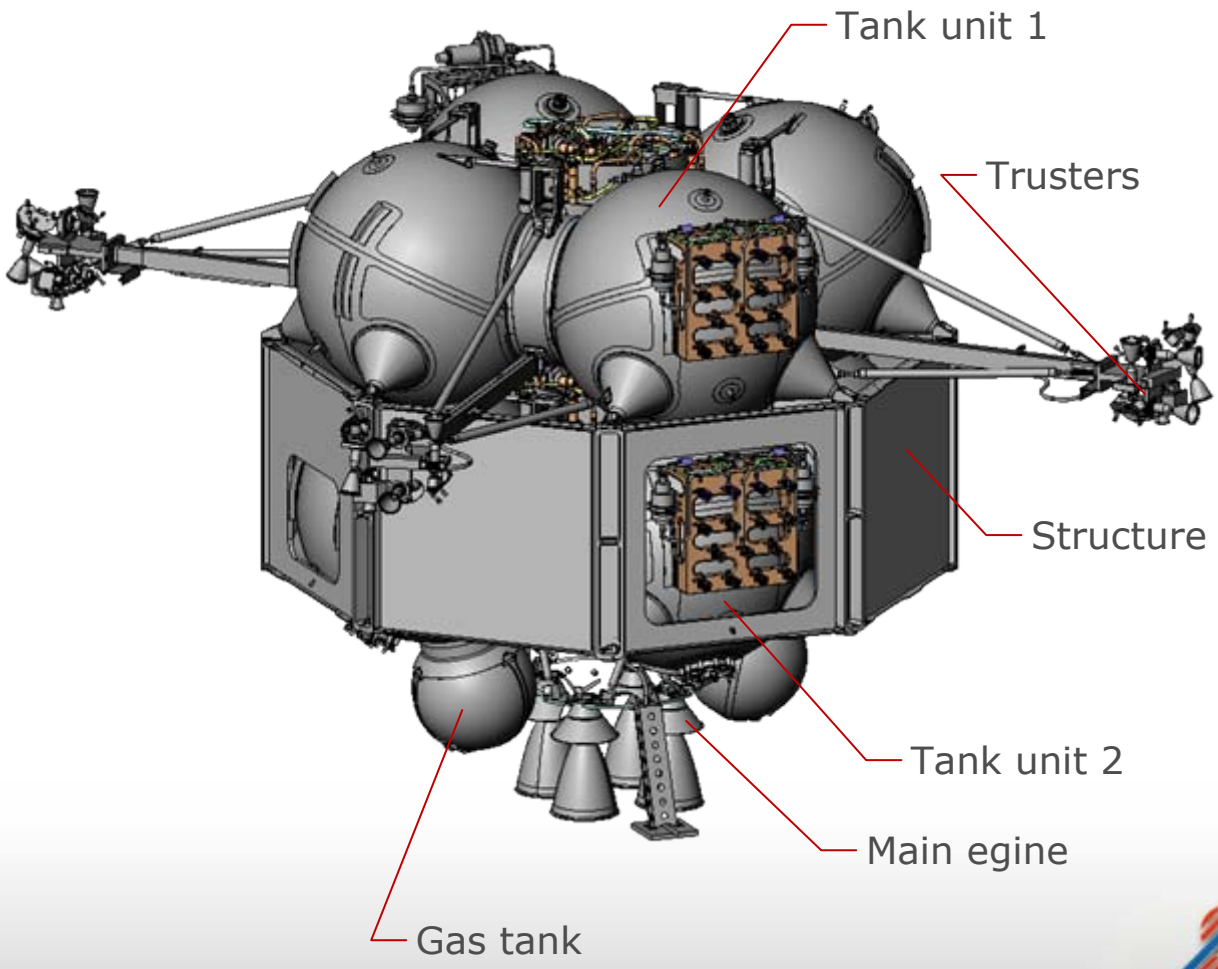
Landing module:: Service system unit



Propulsion system:: Overview

Purpose of propulsion system:

- Providing of corrections during interplanetary cruise;
- Creation of a necessary of braking velocity for insertion into an orbit of Europa.



Propulsion system:: Mass budget

Name	Mass, kg
Tank unit	215,2
Gas tank	45,8
Main engine structure	2
Valve panel	5,5
Loading panel	5
Valve unit	11,1
Tubing	20
Main engine support	16,8
Truster structure	32
Radiator	1,1
TA	3,5
Margin	25
Total	**383**

Radio communication

P 2500 Ussuriisk, Transmitter power 10 W

Transmission rate, bit/s	4	128	512	32000
LDA link margin, dB	-12,88	-29,08	-39,08	-47, 78
HGA link margin, dB	32,82	16,62	6,62	-2,08

P 2500 Ussuriisk, Transmitter power 40 W

Transmission rate, bit/s	4	128	512	32000
LDA link margin, dB	-6,86	-23,06	-33,08	-41, 76
HGA link margin, dB	38,84	22,64	12,64	3,94

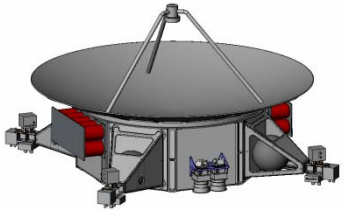
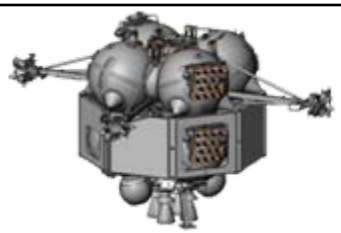
THA 1500 MO, Transmitter power 40 W

Transmission rate, bit/s	4	128	512	32000
LDA link margin, dB	-7,56	-23,76	-33,76	-42, 46
HGA link margin, dB	38,14	21,94	11,94	3,24

ESA, Transmitter power 40 W

Transmission rate, bit/s	4	128	512	32000
LDA link margin, dB	-12,56	-28,76	-38,76	-47, 46
HGA link margin, dB	33,14	16,94	6,94	-1,76

Adoption matrix

	**FOBOS SAMPLE RETURN**
	**LUNA-RESURS**
	**FOBOS SAMPLE RETURN**