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Payloadproject.com

Heber Concept

Combination propulsion

Rocket + air-breathing propulsion

Content:

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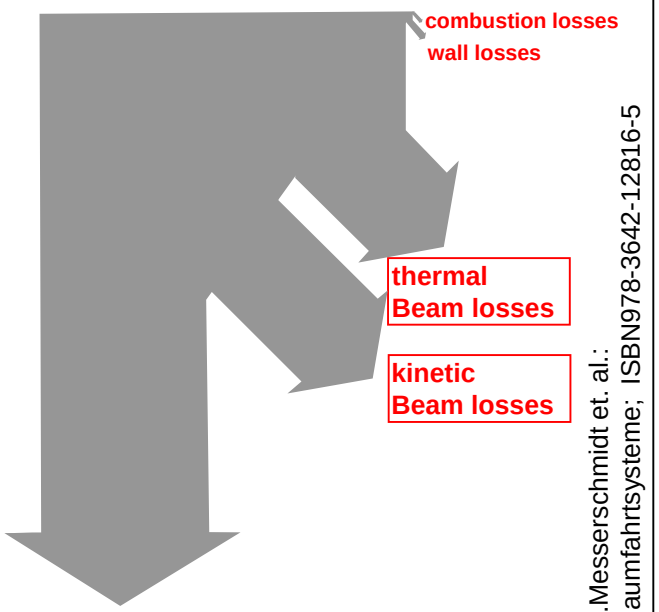
VERTICAL LAUNCHES

GENERAL

State of the art 2021 - Rocket launches from earth with chem. Rockets

technical- example



usable thrust typical 40-70%

approx. 1-4% payload for Low Earth Orbit (LEO)

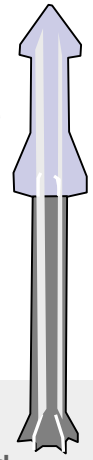
Source: E.Messerschmidt et. al.: Raumfahrtsysteme; ISBN978-3642-12816-5

Dissatisfaction of providers + end customers:

Small suppliers: currently over 100 projects worldwide

→ **Bubble formation**

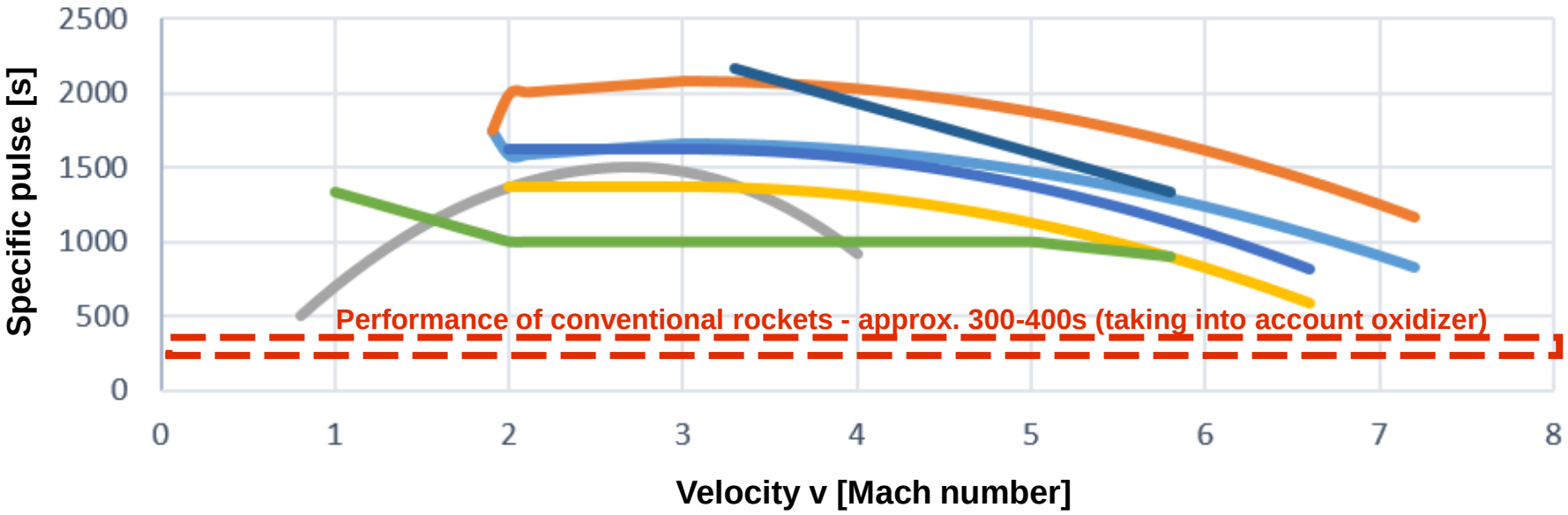
Large supplier → **imminent monopoly**



Type	Electron (Rocket Lab)	Falcon 9 (SpaceEx)	planned Starship (SpaceEx)
Propellant	LOX, RP1	LOX, RP1	LOX, Methan
Take-off mass [t]	13	541	5.000
Payload LEO [t]	0,3	23	>100
Payload LEO [%]	**2,3**	**4,2**	**ca. 2,0**
Cost [US $ million]	7	62	2
spec. cost [$/kg]	**23.333**	**2.719**	**20 (Target: complete recycling)**

➔ Goal of payloadproject.com: more payload share for rockets

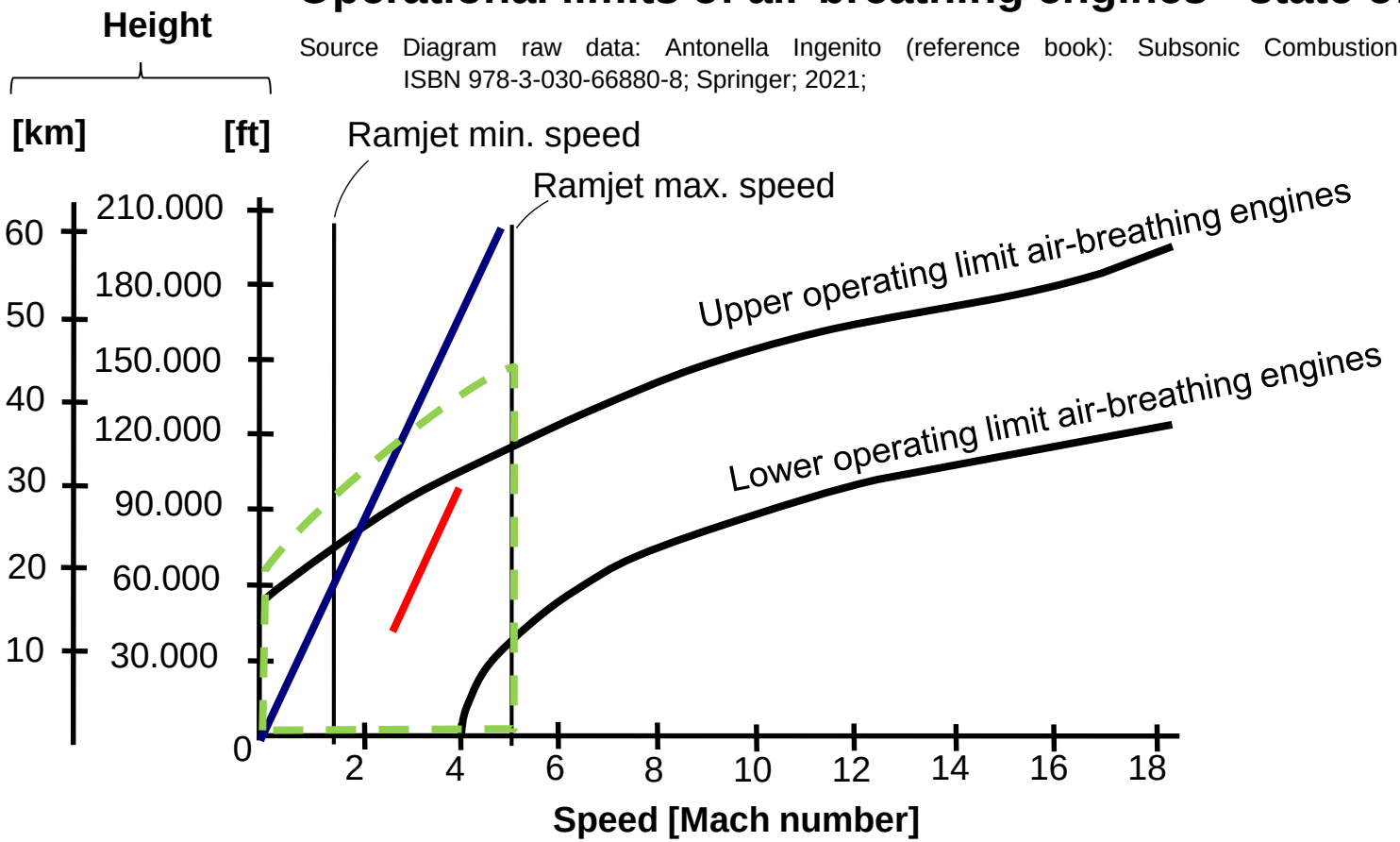
Subsonic jet engine and Ramjets – Overview of the performance



[2] Reinhard Müller: Luftstrahltriebwerke …, ISBN 978-3-322-90325-9
[5] Ernst Messerschmid et al: Raumfahrtsysteme; ISBN 978-3-642-12816-5
[8] THE POCKET RAMJET READER; CHEMICAL SYSTEMS DIVISION; 1978
[9] Antonella Ingenito: Subsonic Combustion Ramjet Design; ISBN 978-3-030-66880-8; S. 6

Operational limits of air-breathing engines - state of the art

Source Diagram raw data: Antonella Ingenito (reference book): Subsonic Combustion Ramjet Design; ISBN 978-3-030-66880-8; Springer; 2021;



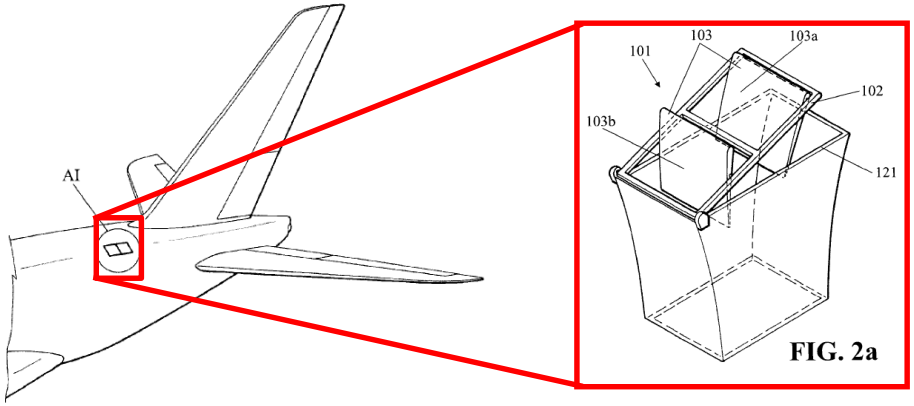
Legend:

Falcon 9, First Stage

NASA „RAM BOOSTER“ – CONCEPT – Deployment Ramjet

Area of interest Heber concept - to be expanded if necessary

Example - patent specification US 9,254,925 B2 from 09.02.2016



Auxiliary drive inlet flap in the stern

adjustable

Example - patent specification US 2010/0044504 A1 from 25.02.2010

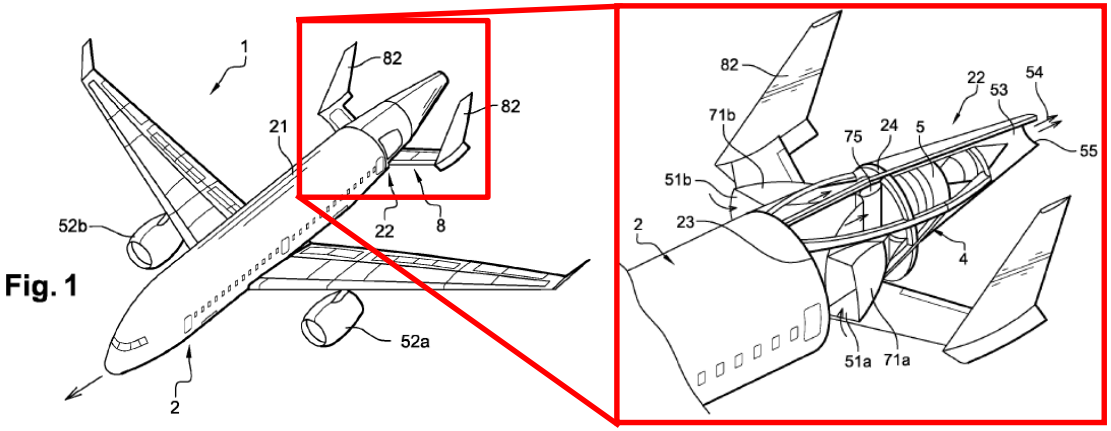


Fig. 1

Auxiliary drive inlet flap in the stern

adjustable

→ for turbine engines in aviation further patents with flaps to auxiliary power units

Example - patent specification DE 696 03 232 T2 dated 17.05.1996

Fig. 1

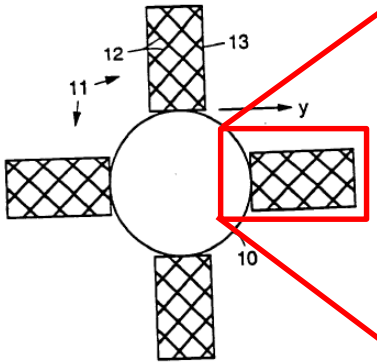
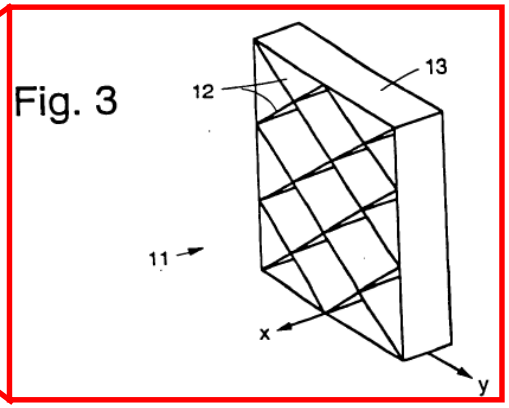


Fig. 3



Aerodynamic/
hydrodynamic environments

support and control surface

adjustable

Example - Grid fins on Falcon 9

Source: SpaceX, Iridium 2

Extendable and adjustable

Especially to control for reuse

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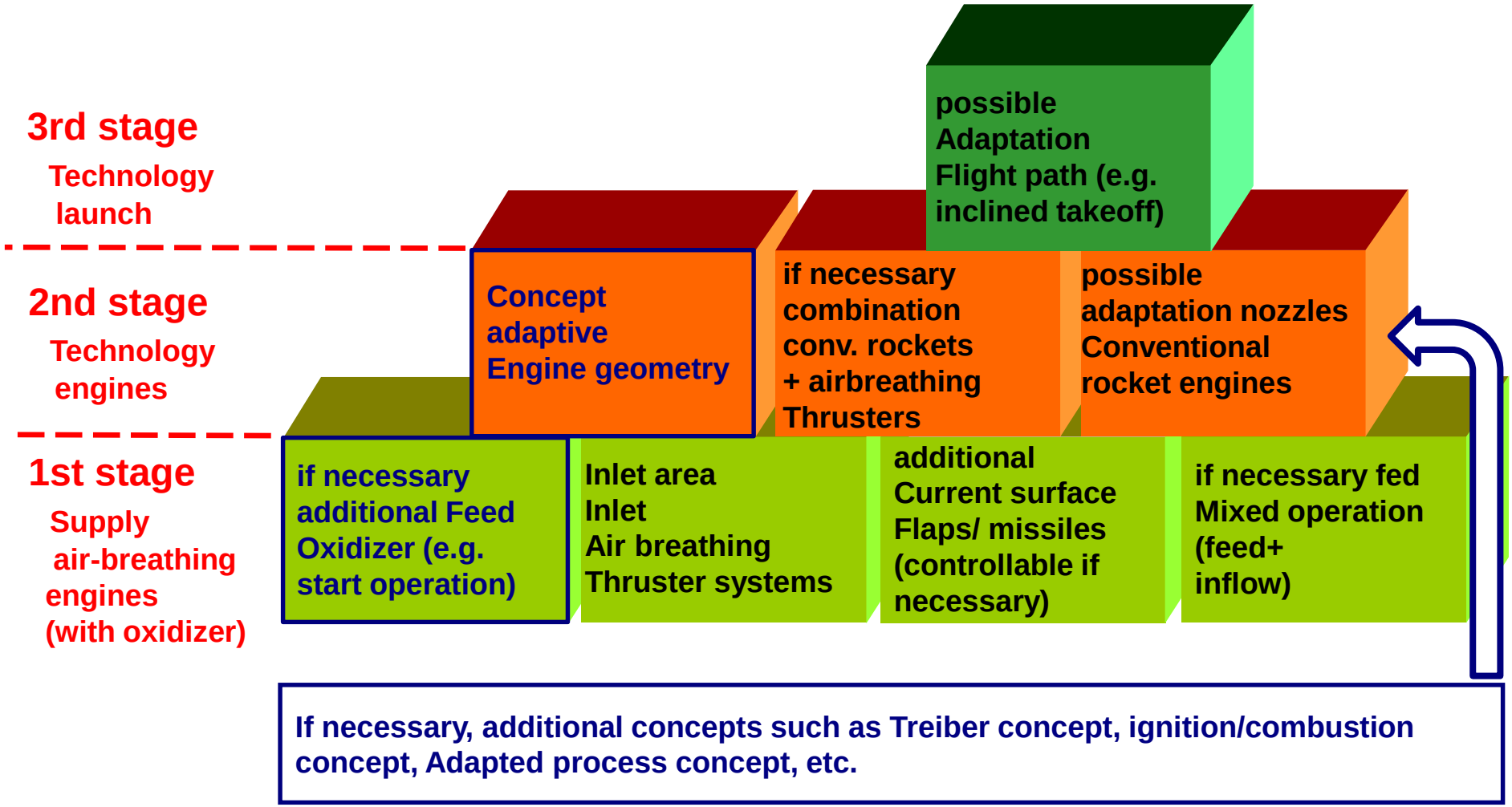
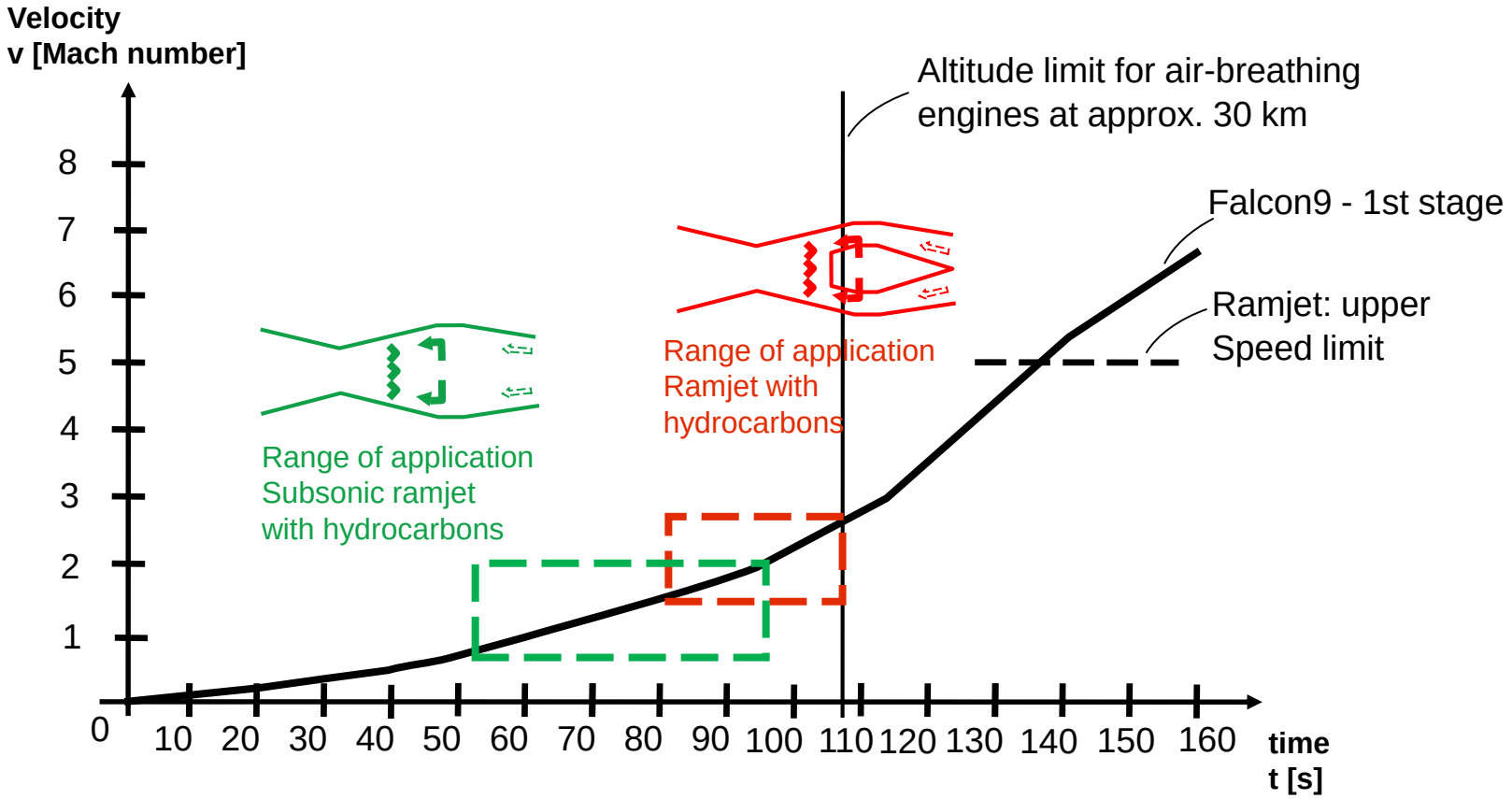
Supplementation by means of independent concepts



If necessary, additional concepts such as Treiber concept, ignition/combustion concept, Adapted process concept, etc.

Velocity time history of a Falcon9 takeoff



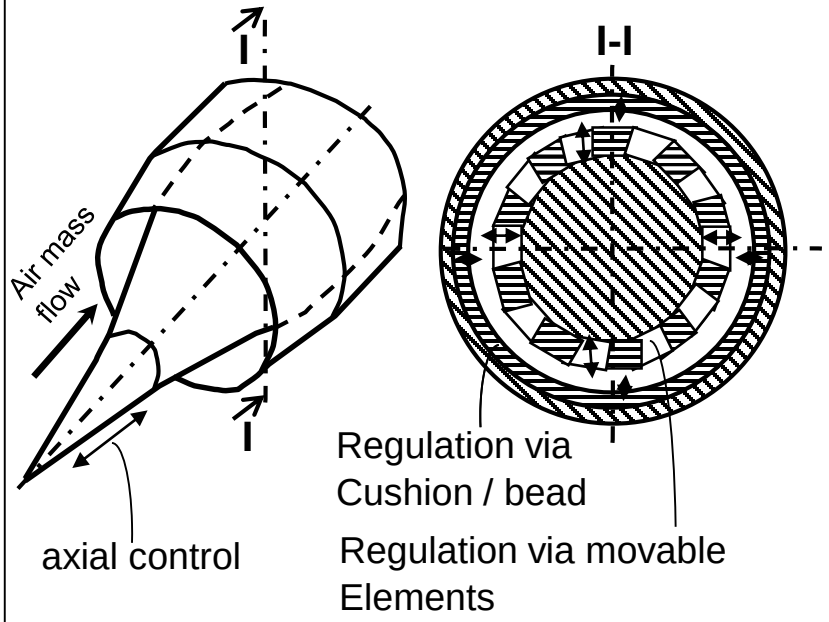
Extension through Heber concept

Additional oxidizer feed, if necessary

Air-breathing engines generally designed for narrow range only

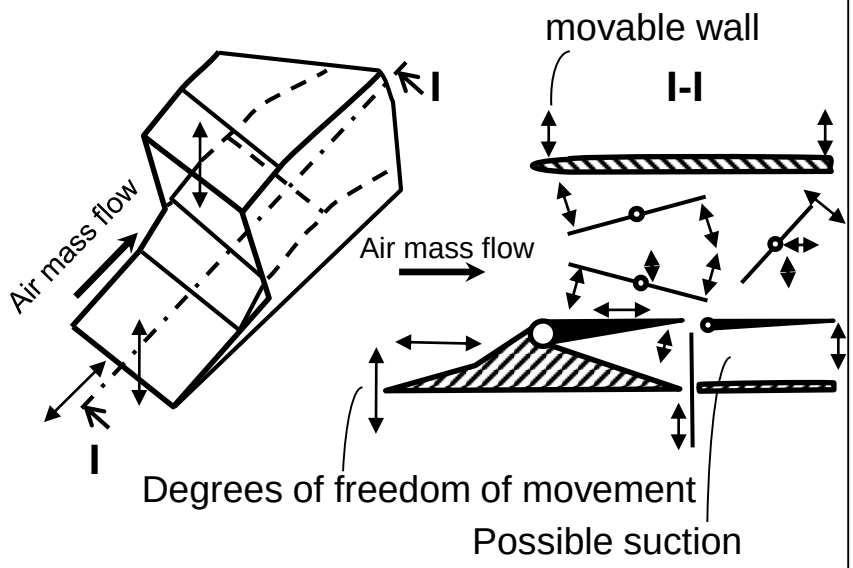
→ Inlet decisive, e.g. to prevent flushing over

Axial symmetrical inlet



→ **uniform control according to the limited reasonable possible according to the state of the art**

Level inlet

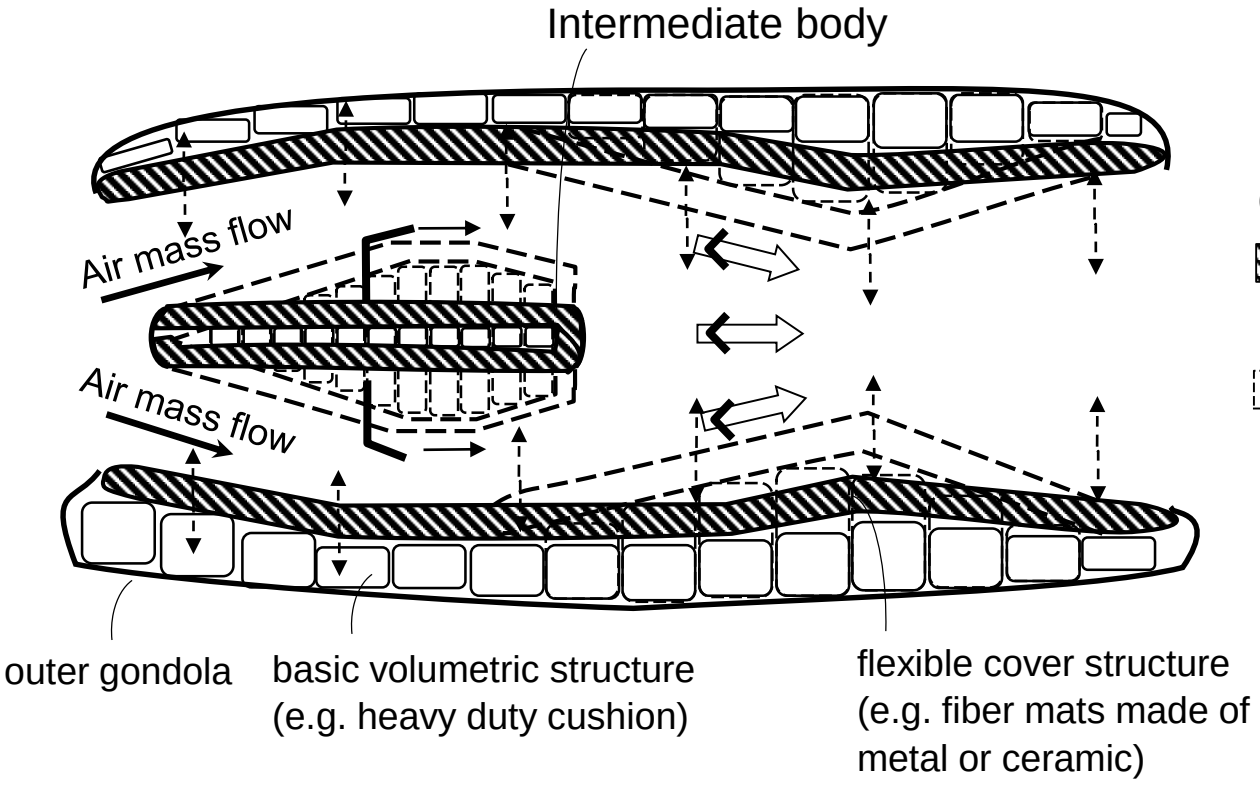


→ **uniform control according to State of the art simplified**

→ Control via level inlet advantageous

Air-breathing engines generally designed for narrow range only
Regulation demanding complex and difficult

→ Separate concept for adaptive engine geometry
Goals: light, simple and flexible



Legend Basic geometries:

Subsonic jet engine (approximate)

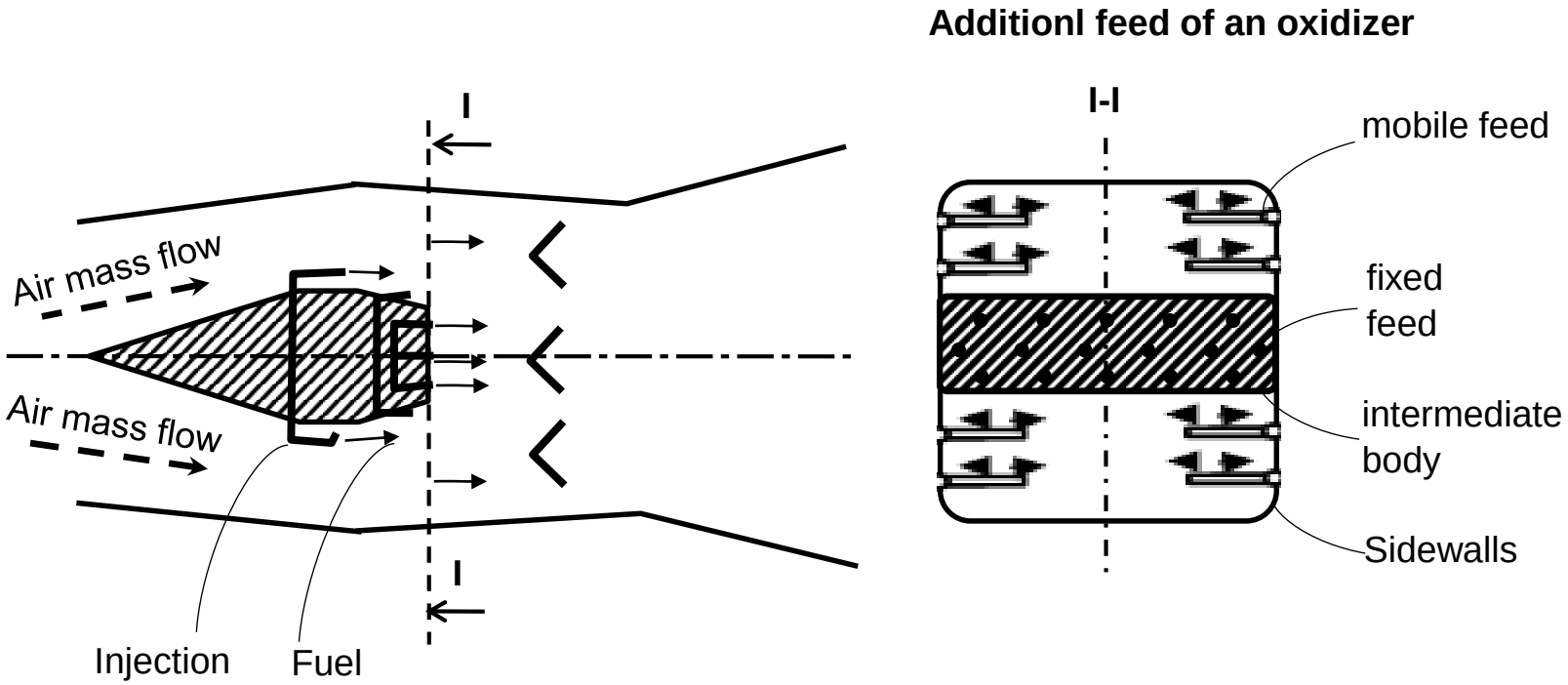
Ramjet

Ramjets generally not self-launching

→ **special solution additional feed of a carried oxidizer (already patents state of the art)**

→ **separate concept with movable geometries**

Geometry



separate adapted process concept:
Adaptation to changing conditions by combining Treiber concept + combustion concept.

separate Treiber concept:
Target adjustment temperature, pressure if necessary

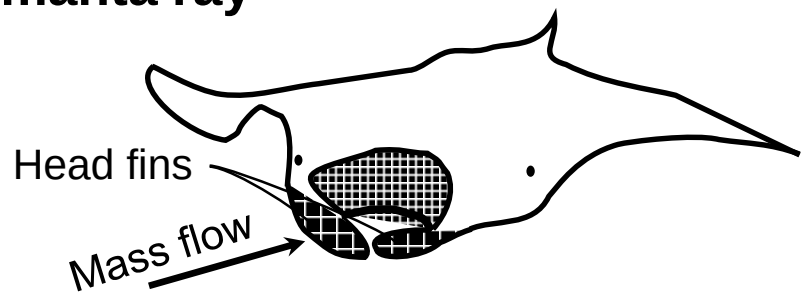
separate combustion and ignition concept:
contactless electromagnetic ignition (e.g. microwaves)

Adaptation of ignition & combustion to changing conditions and increase of flame velocity
or reduction of combustion chamber temperatures

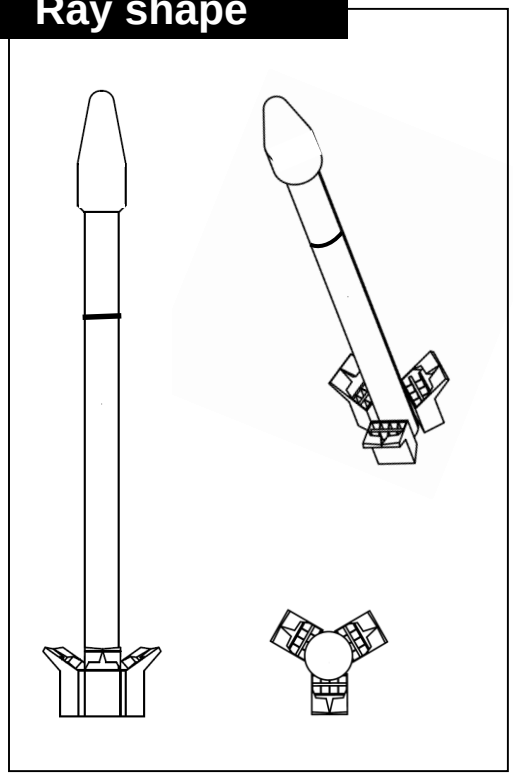
Model of nature / similarity theory: manta ray

movable head fins

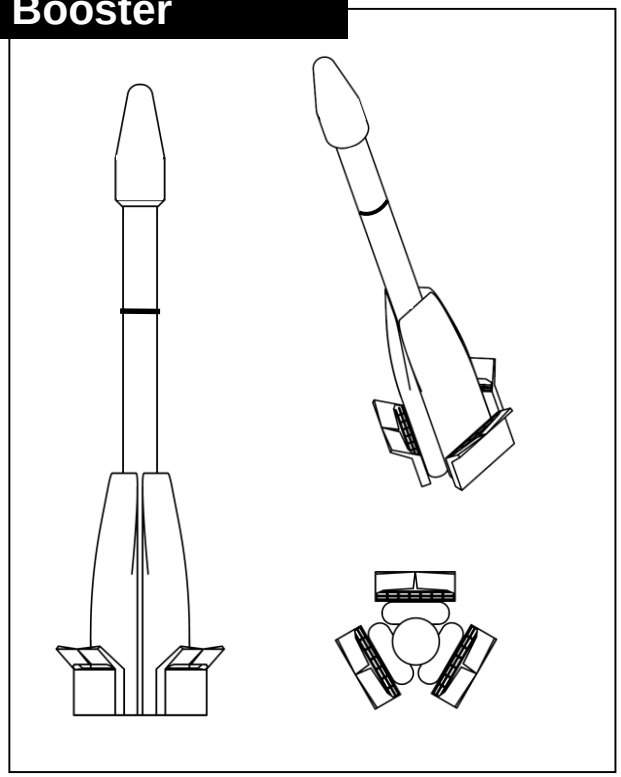
open passage



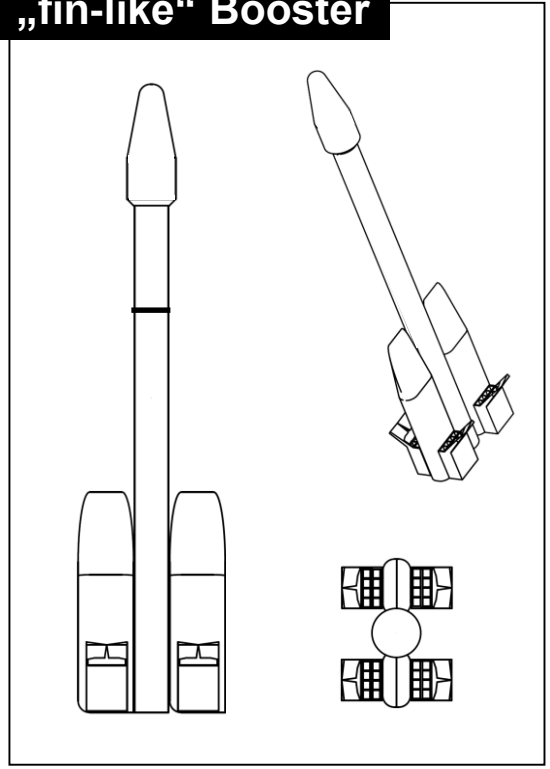
Ray shape



Booster

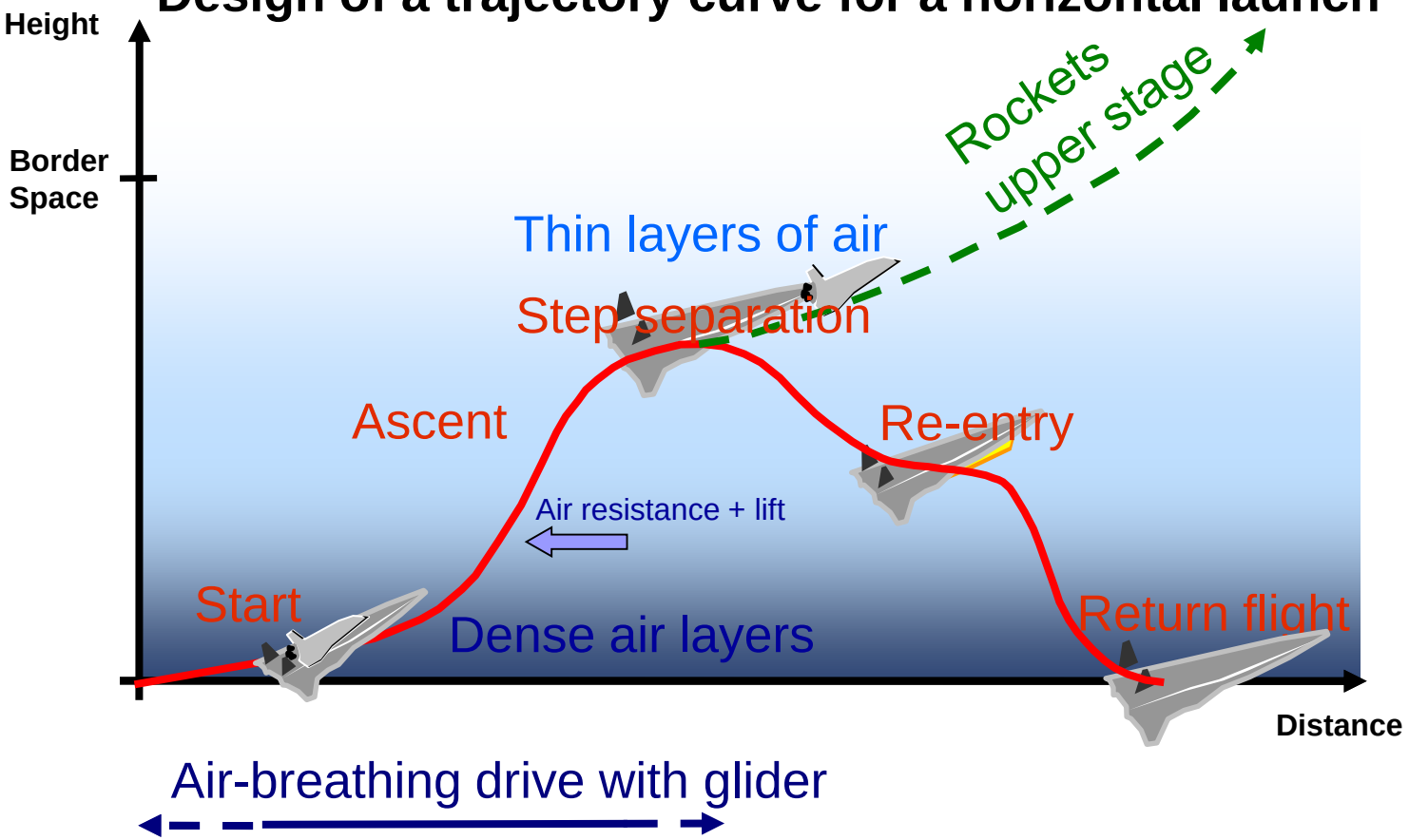


„fin-like“ Booster



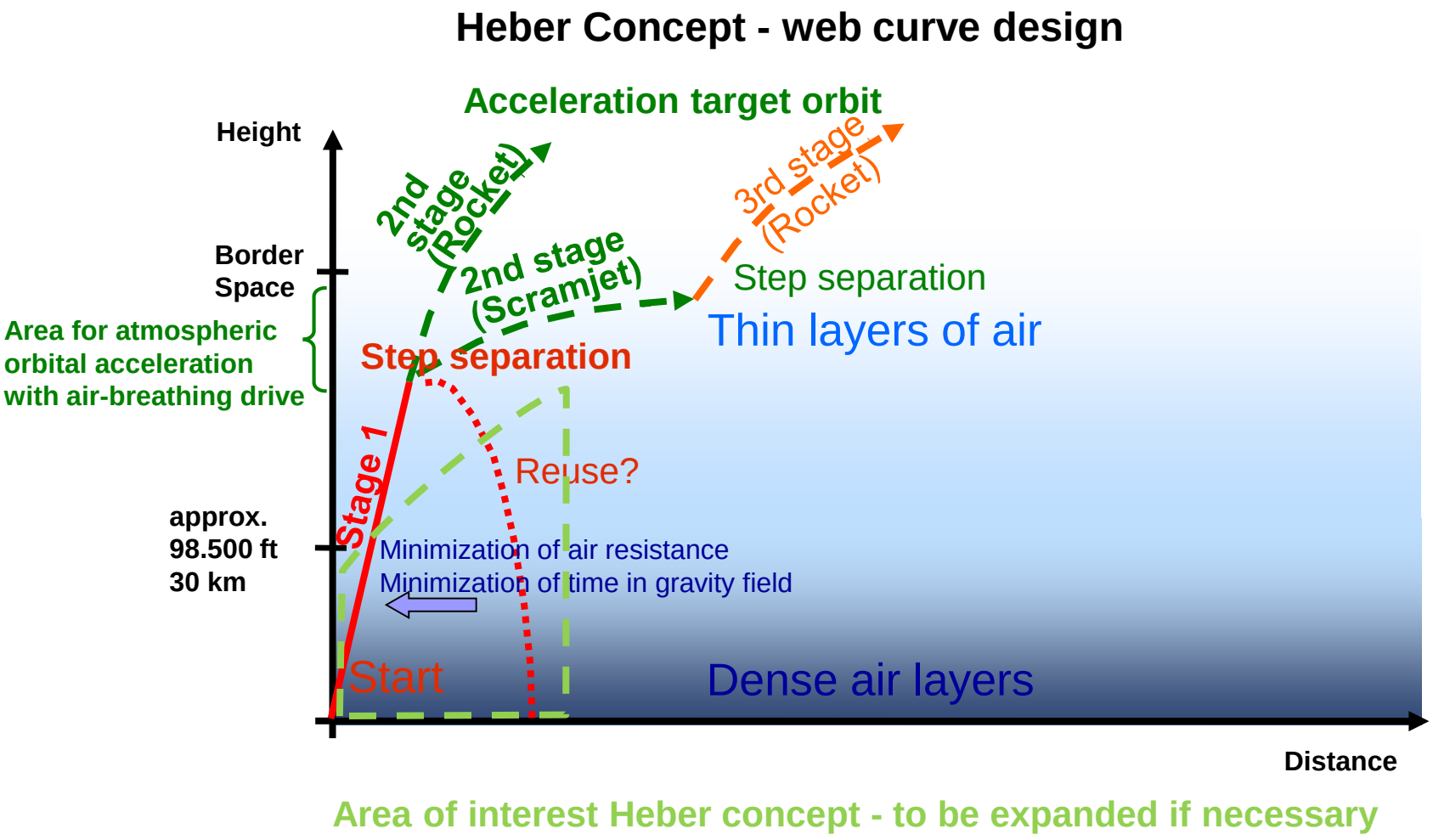
➔ Concept: horizontal takeoff to use buoyancy force

Design of a trajectory curve for a horizontal launch*



*Source: Bahnkurve nach: Dipl.-Ing. Mirko Hornung (Dissertation): „Entwurf einer luftatmenden Oberstufe und Gesamtoptimierung eines transatmosphärischen Raumtransportsystems“; 07.06.2002; Universität der Bundeswehr München

➔ Concept: Vertical takeoff lowers air resistance and gravitiy



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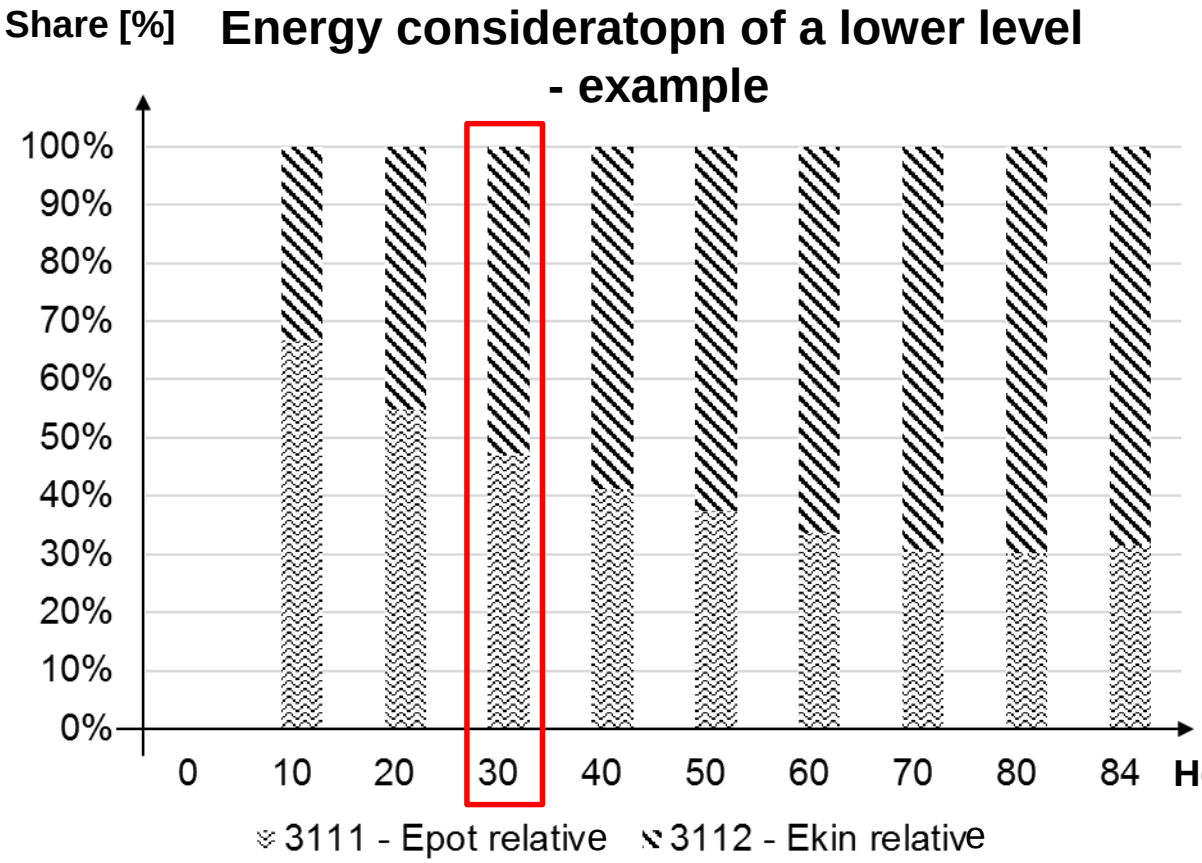
Further

Atmospheric density drops to approx. 1.5 % up to an altitude of 98.500 ft / 30 km (International Standard Atmosphere - ISA)

→ in an example of rocket launching, up to an altitude of approx. 98.500ft 30 km, predominantly chemical energy is converted into potential energy



In the example at 98.500 ft / 30 km altitude:

approx. Mach 2.7
Inclination approx. 60° rough

if necessary further Acceleration with lower inclination to further reduce the oxidizer further reduce

- Separate air-breathing auxiliary engines / "boosters" can be disconnected prematurely from lower stage to reduce load

  design of auxiliary engines for lower efficiency under changing conditions, e.g. strongly fluctuating pressure in lower air layers;

  Utilization of the incoming atmosphere

- Optimization of rocket engines for extended burn duration at reduced external pressure in higher air layers.

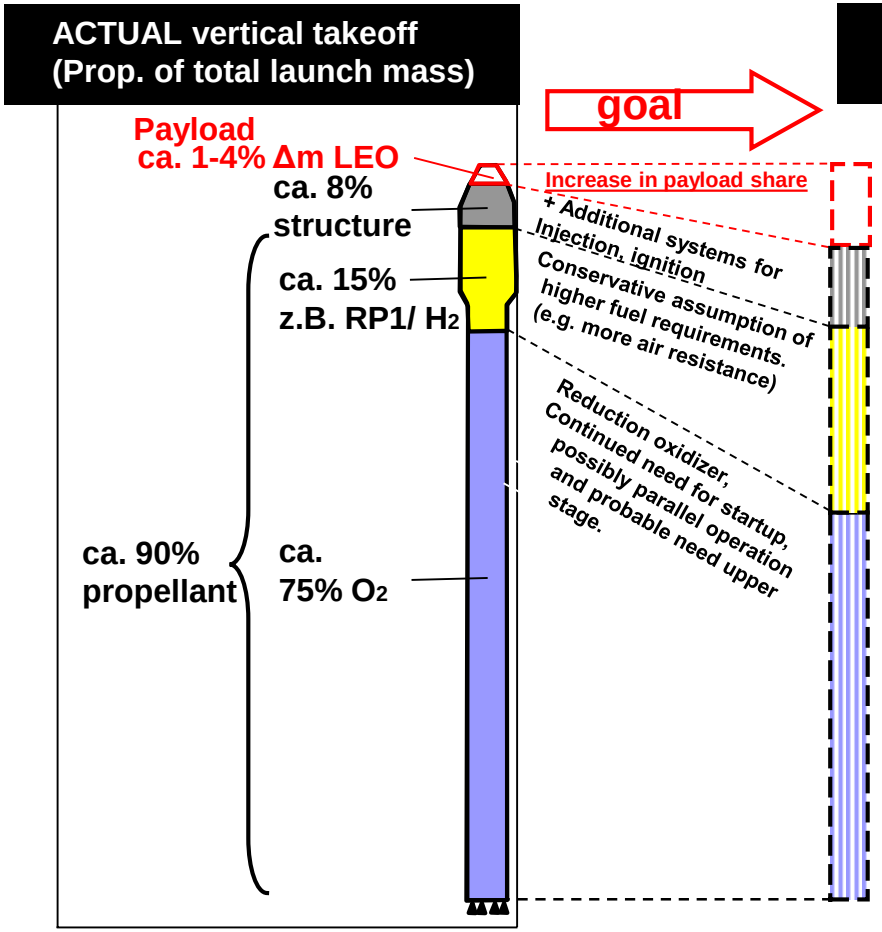
  (e.g. for Merlin 1D of Falcon 9 max. approx. 18 % difference of specific pulse between sea level and optimization to vacuum)

- higher launch thrust (rockets + air breathers if necessary) for lower gravity losses

- Alternatively, also boosters / fins to be further developed for wings

  → energetic acceleration flights

Summary - when used in Heber concept: variable additional injection = limitation of energetic losses



Advantages:

- Less oxidizer (e.g. oxygen) to carry and accelerate
- more engines in launch phase mean higher thrust
- Design of air-breathing engines for varying external pressure and optimization of lower stage for low external pressure possible
- less drag compared to horizontal takeoff (singer)
- Combination with subsequent horizontal flight possible