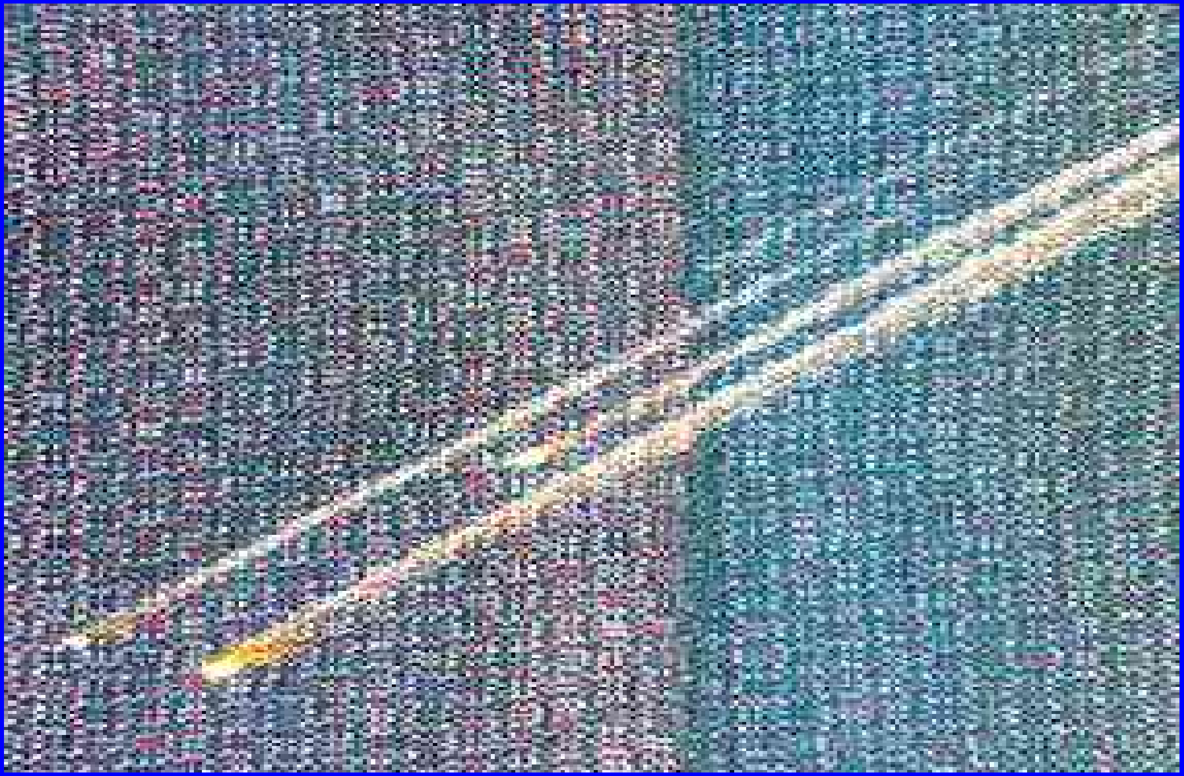
Raumfahrt- Was ist das?



Internationale Junior Universität Salzgitter

20. April 2005

Dr. rer. nat. Jochem Häuser, Professor

Univ. of Applied Sciences

Fakultät Karl-Scharfenberg, Salzgitter

www.hpcc-space.de *jh@hpcc-space.de*

Acknowledgments

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Dipl.-Ing. T. Gollnick and Dipl.-Ing. O. Rybatzki, Univ. of Applied Sciences, Salzgitter helped in the preparation of this talk.

Vorlesung Überblick

Unser Standort

Raumfahrtpioniere

Gefahren in der Raumfahrt

Wie kommt man in den Weltraum

Das Antriebssystem

Trajektorie (Flugbahn)

Aerodynamische Stabilität

Hitzeschutzschild

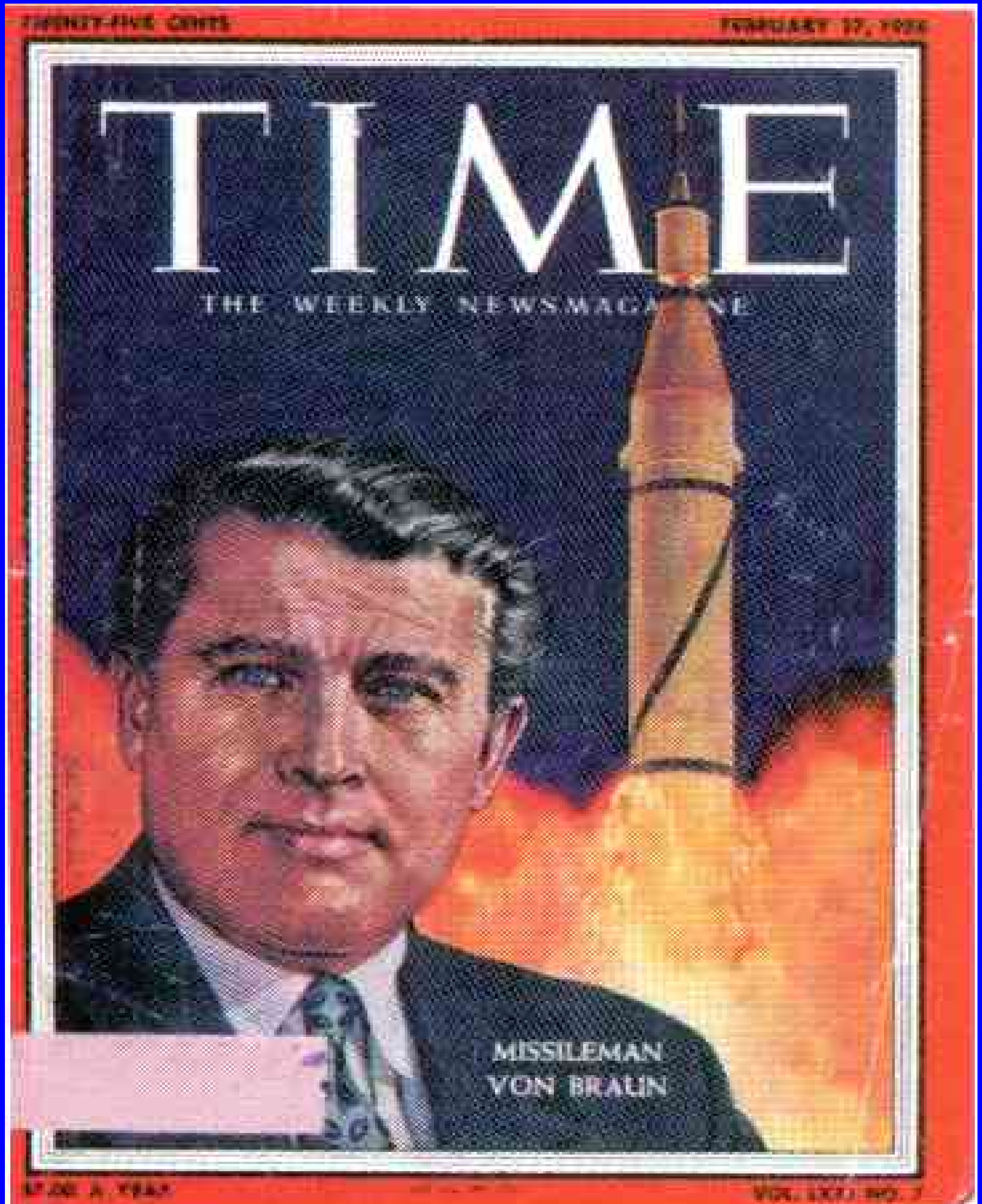
Computer Simulation

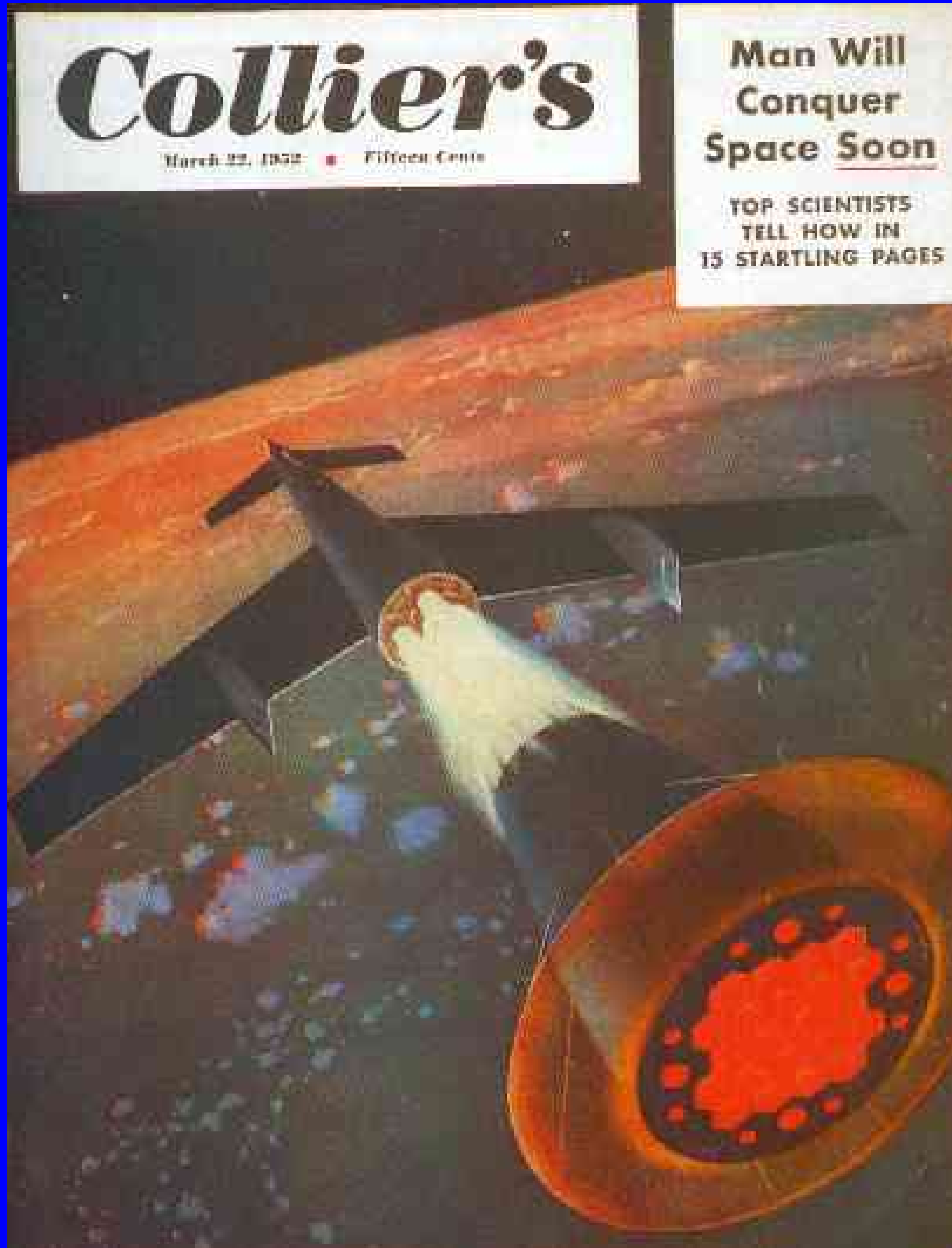
Diskussion und Ausblick, neue Antriebe

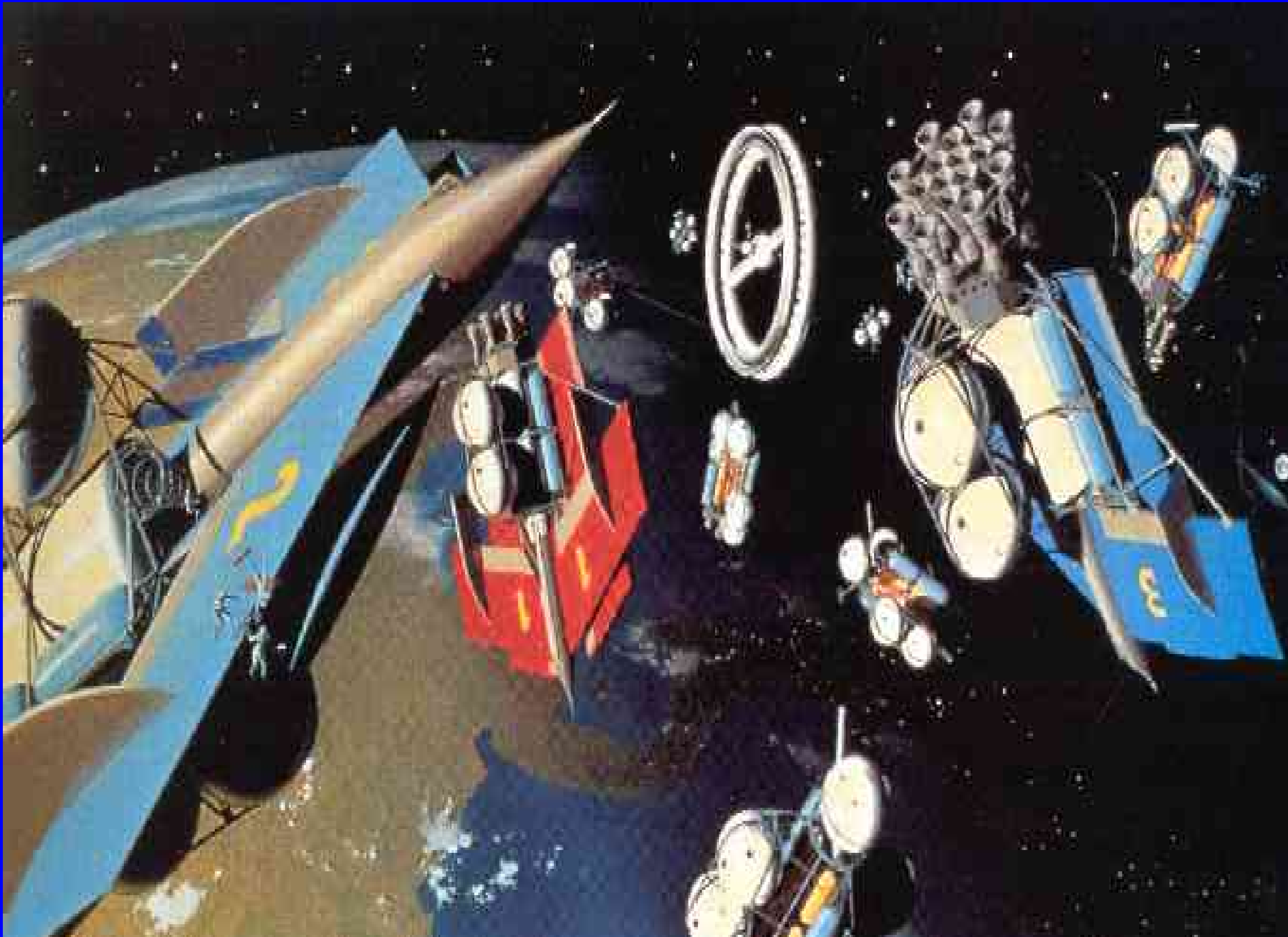

YOU ARE HERE


The Solar System
Saturn
Mars
Venus
Sun
Mercury
Earth
Pluto
Jupiter

Raumfahrtpioniere


TIME
MISSILEMAN
VON BRAUN


Collier's
March 22, 1952 • Fifteen Cents
Man Will Conquer Space Soon
TOP SCIENTISTS TELL HOW IN 15 STARTLING PAGES



THE WHITE HOUSE

WASHINGTON

April 20, 1961

MEMORANDUM FOR

VICE PRESIDENT

In accordance with our conversation I would like for you as Chairman of the Space Council to be in charge of making an overall survey of where we stand in space.

1. Do we have a chance of beating the Soviets by putting a laboratory in space, or by a trip around the moon, or by a rocket to land on the moon, or by a rocket to go to the moon and back with a man. Is there any other space program which promises dramatic results in which we could win?

2. How much additional would it cost?

3. Are we working 24 hours a day on existing programs. If not, why not? If not, will you make recommendations to me as to how work can be speeded up.

4. In building large boosters should we put out emphasis on nuclear, chemical or liquid fuel, or a combination of these three?

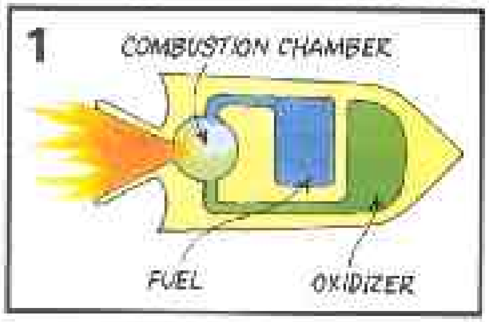
5. Are we making maximum effort? Are we achieving necessary results?

I have asked Jim Webb, Dr. Weisner, Secretary McNamara and other responsible officials to cooperate with you fully. I would appreciate a report on this at the earliest possible moment.

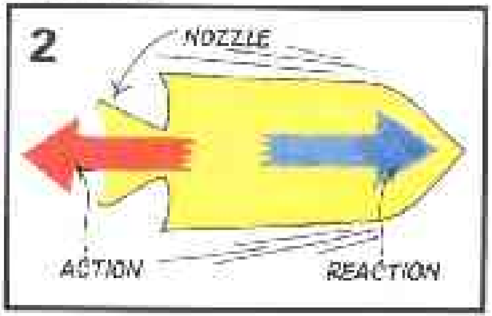
Wie kommt man in den Weltraum

Das Antriebssystem

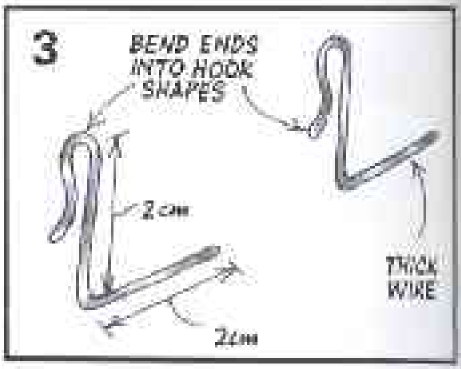
Action, reaction and rocket racers



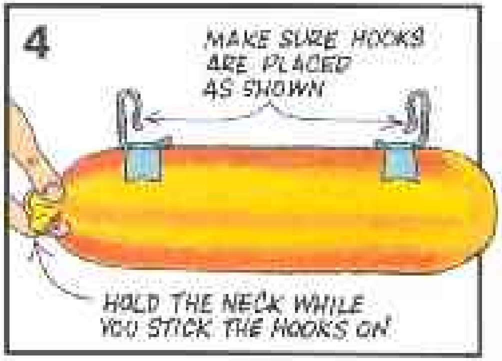
▲ A liquid fuel rocket has fuel and an oxidizer, which are fed to the combustion chamber by gas pressure or, more often, by pumps. They ignite there. The oxidizer is needed to provide oxygen, without which nothing can burn.

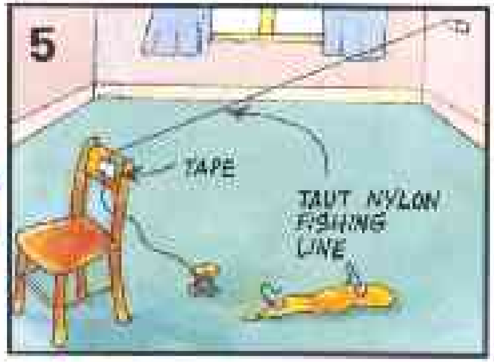


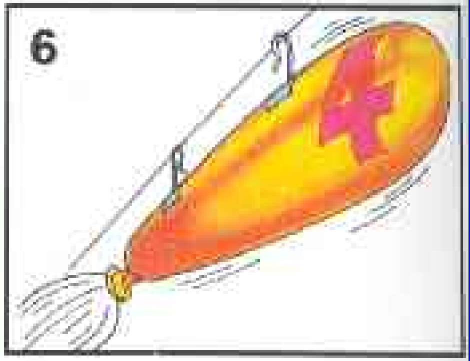
▲ The burning liquids produce a powerful exhaust, which expands backwards through a nozzle. The action of the exhaust causes a reaction of equal pressure pushing in the opposite direction that drives the rocket forward.



▲ This experiment is a quick and simple way of demonstrating the principle of action and reaction. You will need a few sausage-shaped balloons, some thin wire, and a length of nylon fishing-line or thread. Bend the wire as shown.

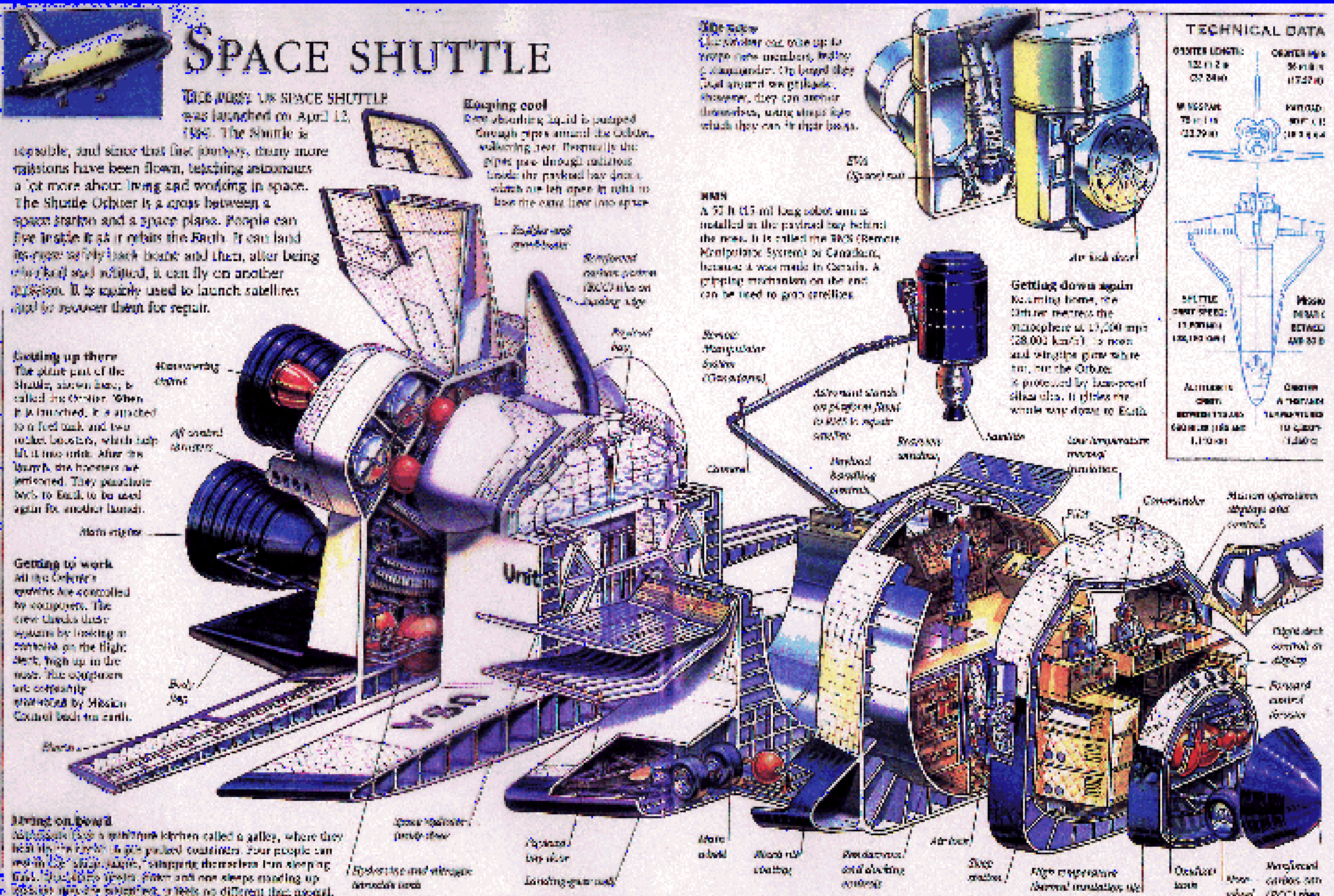






Gefahren in der Raumfahrt

The Columbia STS-107 mission lifted off on January 16, 2003, for a 17-day science mission featuring numerous microgravity experiments. Upon reentering the atmosphere on February 1, 2003, the Columbia orbiter suffered a catastrophic failure due to a breach that occurred during launch when falling foam from the External Tank struck the Reinforced Carbon Carbon panels on the underside of the left wing. The orbiter and its seven crewmembers (Rick D. Husband, William C. McCool, David Brown, Laurel Blair, Salton Clark, Michael P. Anderson, Ilan Ramon, and Kalpana Chawla) were lost approximately 15 minutes before Columbia was scheduled to touch down at Kennedy Space Center. This site presents information about the STS-107 flight, as well as information related to the accident and subsequent investigation by the formal Columbia Accident Investigation Board.


SPACE SHUTTLE
The Shuttle Orbiter is a cross between a space station and a space plane.
It is mainly used to launch satellites
Keeping cool
The crew
RMS
Getting down again
TECHNICAL DATA
Getting up there
Getting to work
Living on board
Payload bay
Remote Manipulator System (Canadarm)
Satellite
Camera
Main engine
Air lock door
Main wheel
Pilot
Commander

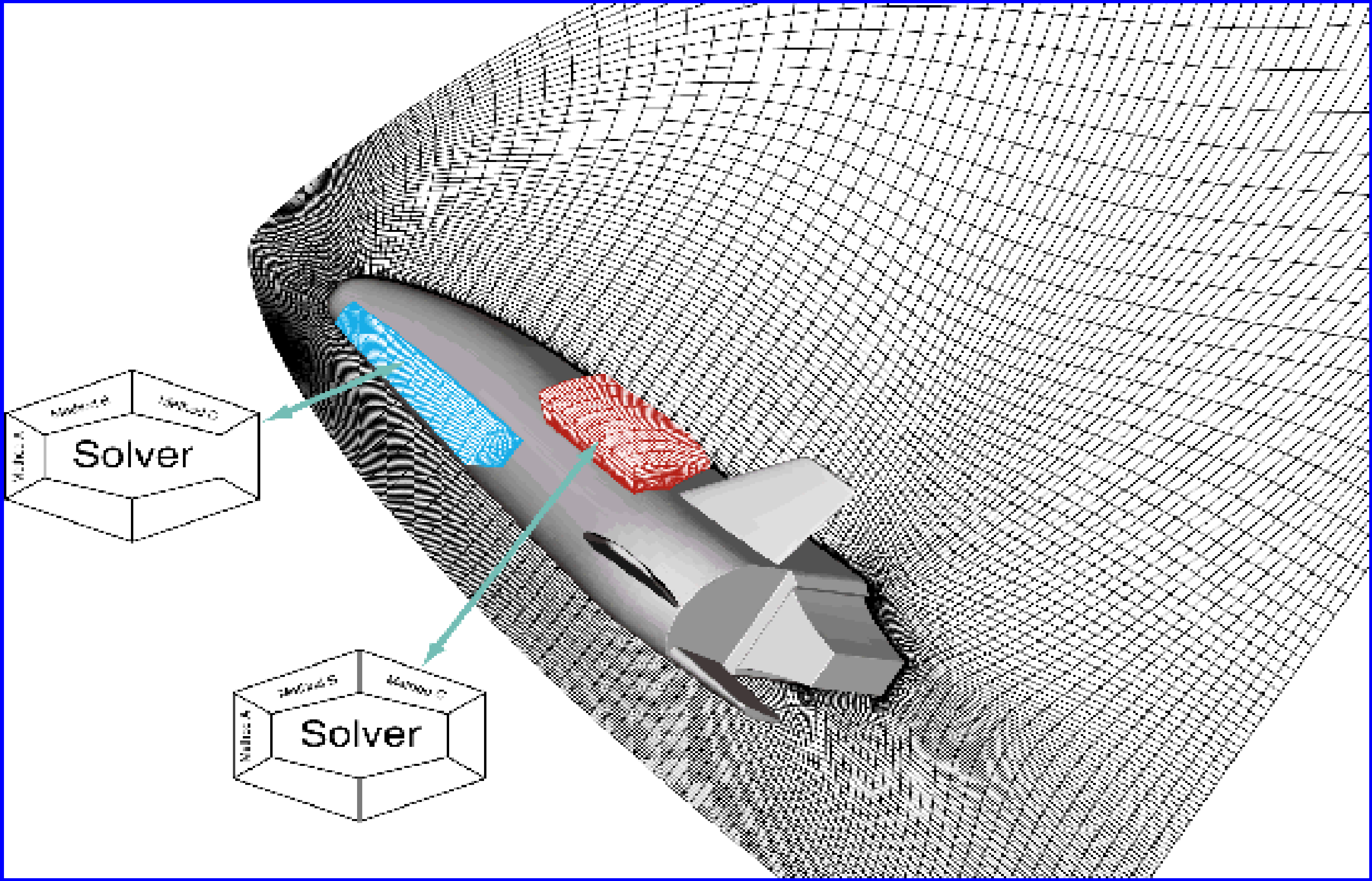
New Concept

Complex Aerothermal/TPS

Vertical Launch and Horizontal Landing - M < 15

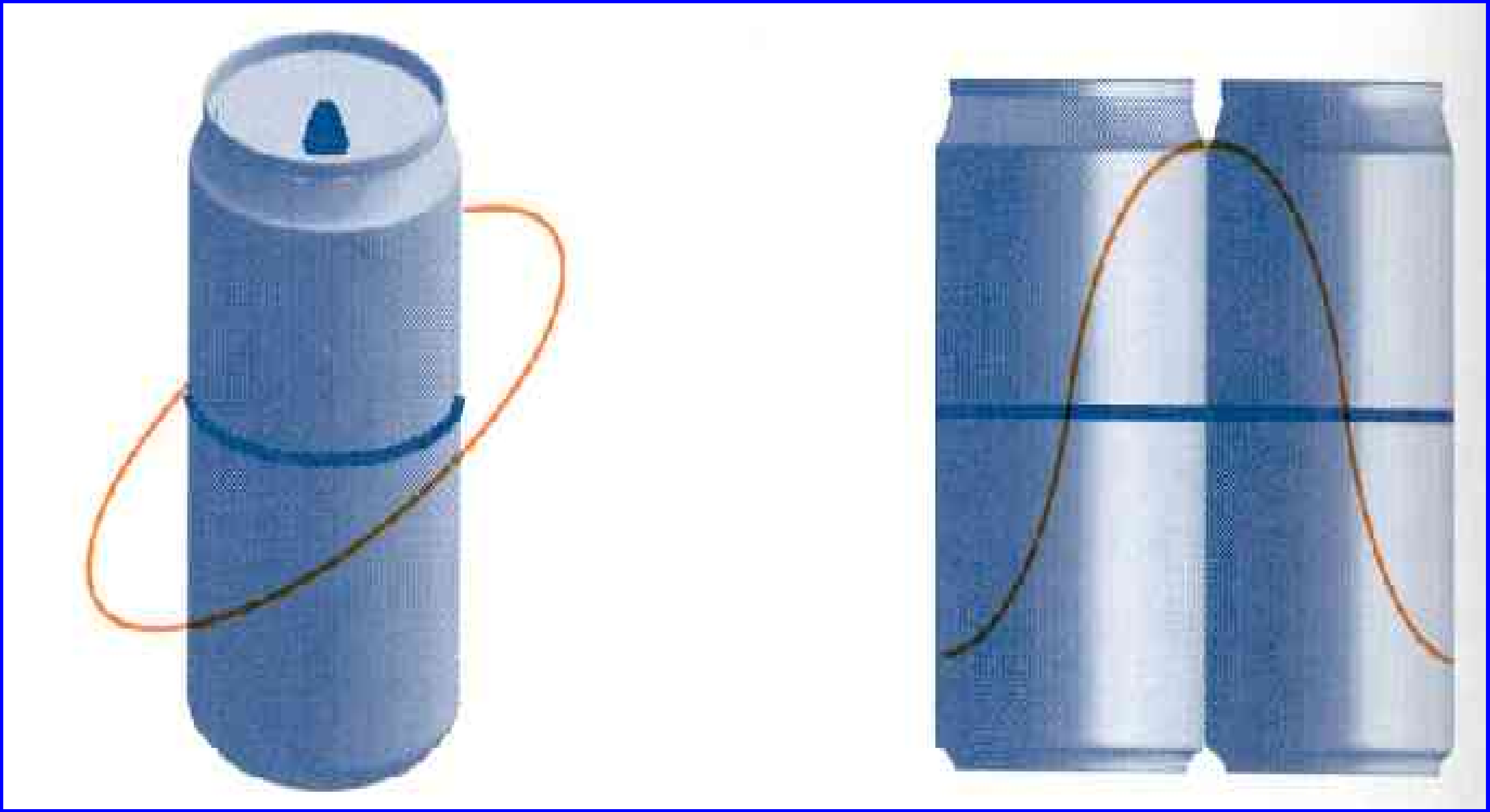
Cost $ 1.25 B

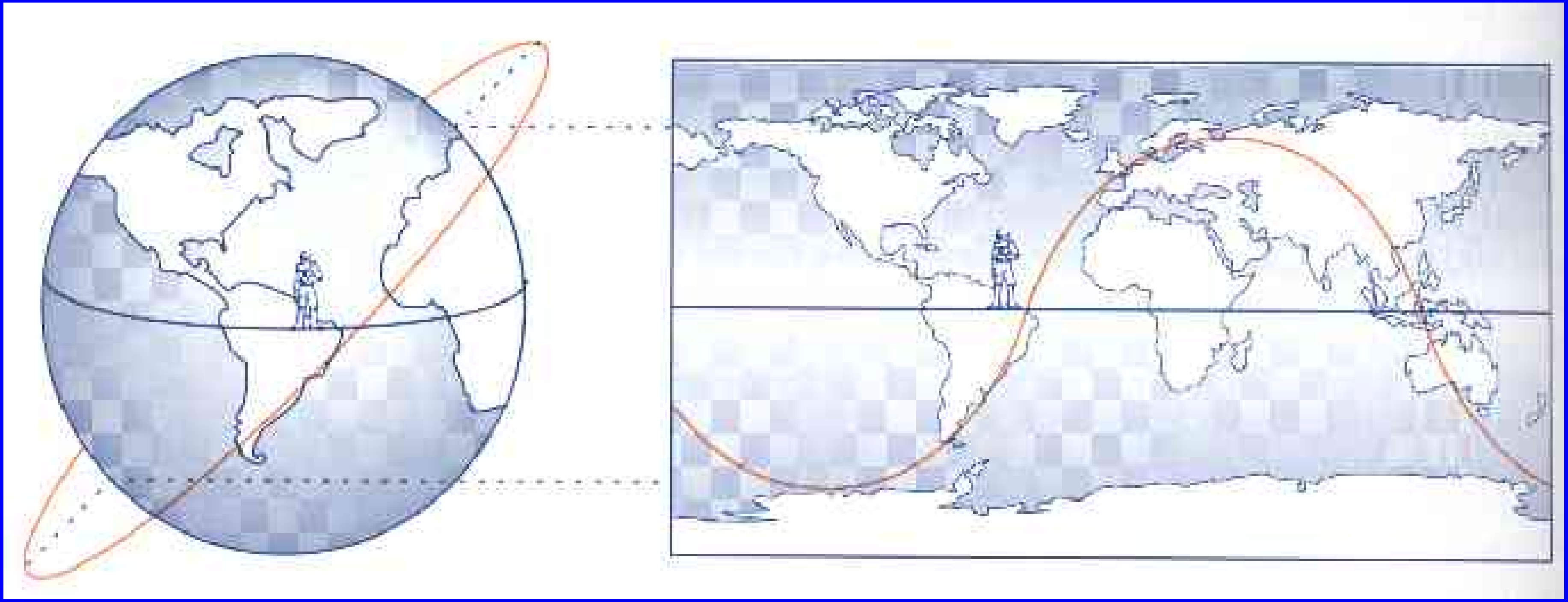
Schedule - 3+ years



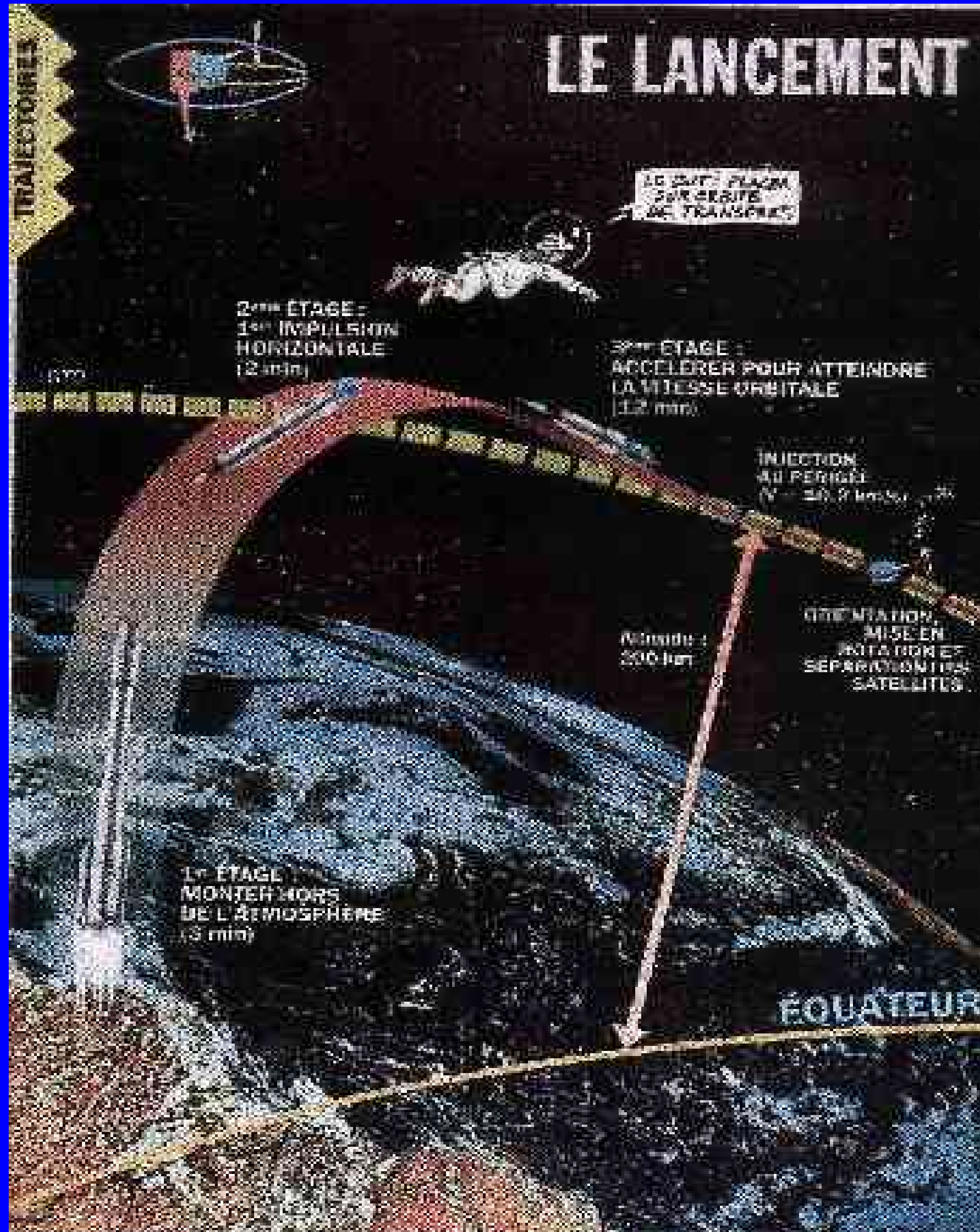
Every solver object contains the data of and the numerics for one block.The solver class is sent from the client to the server that is, different users may use different solvers.

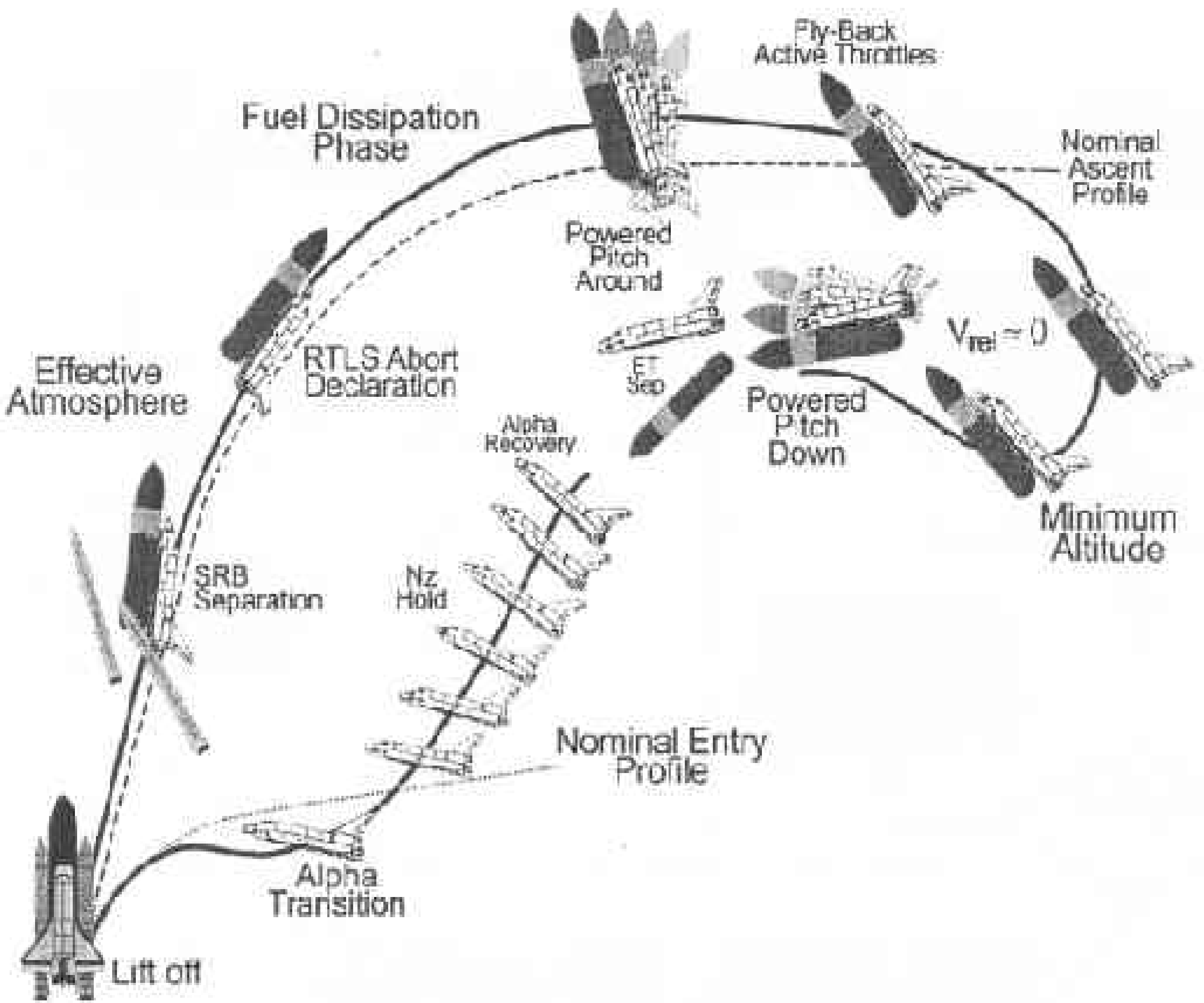
Trajektorie (Flugbahn)






TRAJECTOIRES
LES ORBITES
APOGEE
ORBITE BASSE
ORBITE ELLIPTIQUE
PERIGEE
TRAJECTOIRE
HYPERBOLIQUE


LE LANCEMENT
TRAJECTOIRES
2ème ETAGE :
1ère IMPULSION
HORIZONTALE
(2 min)
3ème ETAGE :
ACCELERER POUR ATTEINDRE
LA VITESSE ORBITALE
(12 min)
INJECTION
AU PERIGEE
1er ETAGE
MONTER HORS
DE L'ATMOSPHERE
EQUATEUR

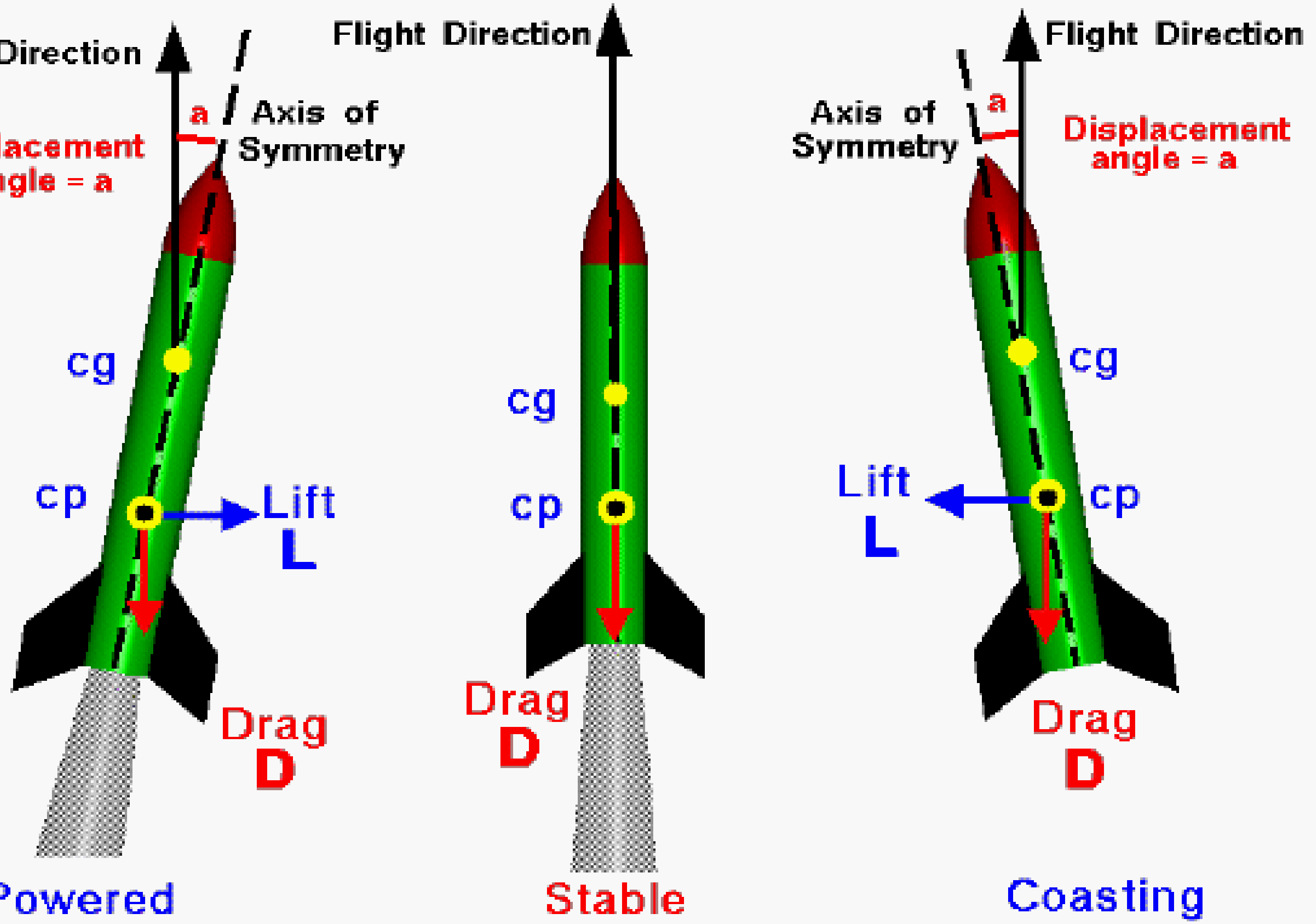


Fly-Back
Active Throttles
Fuel Dissipation
Phase
Nominal
Ascent
Profile
Powered
Pitch
Around
$V_{rel} = 0$
RTLS Abort
Declaration
Effective
Atmosphere
ET
Sep
Powered
Pitch
Down
Alpha
Recovery
Minimum
Altitude
SRB
Separation
Nz
Hold
Nominal Entry
Profile
Alpha
Transition
Lift off

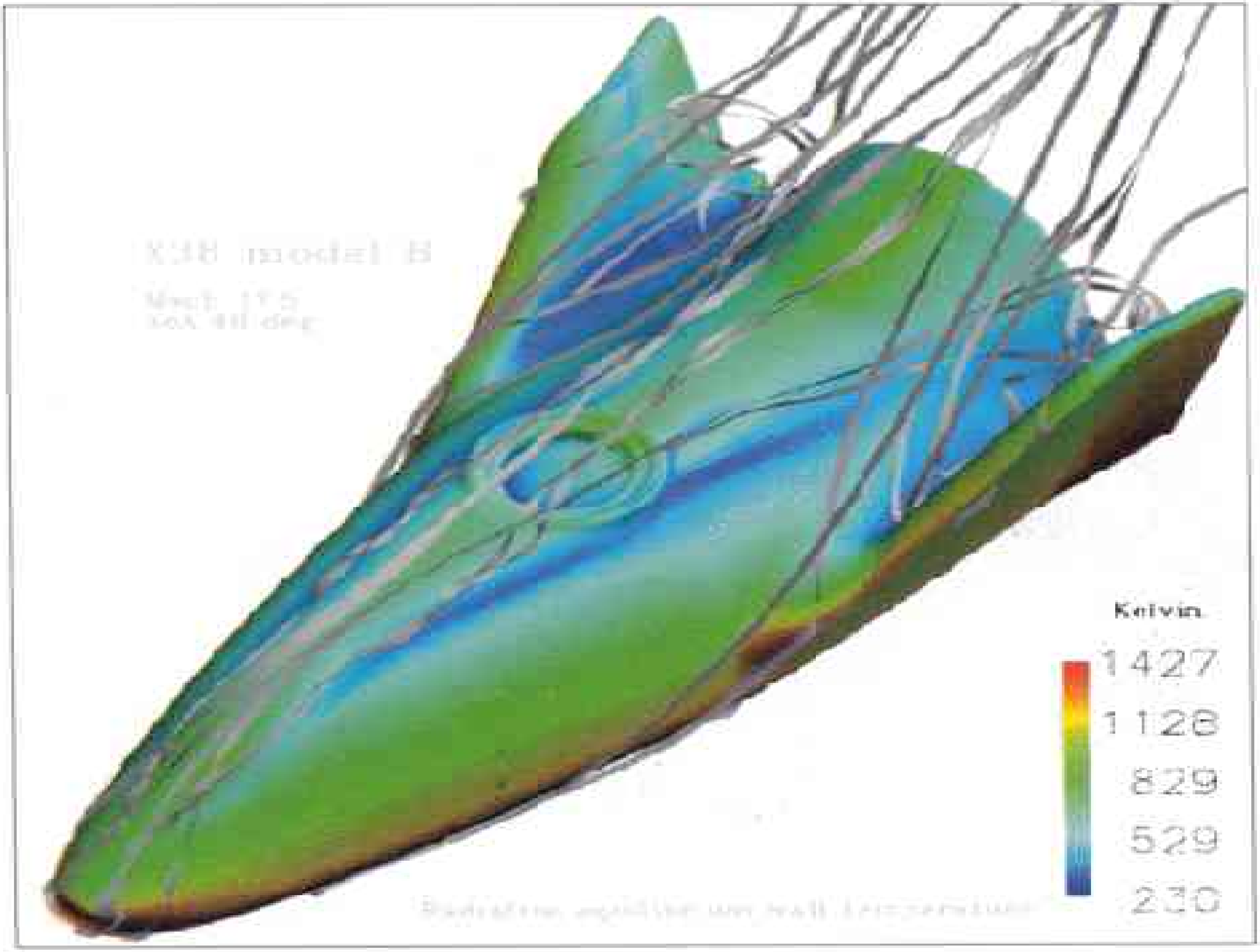
Aerodynamische Stabilität

Stability of a Model Rocket

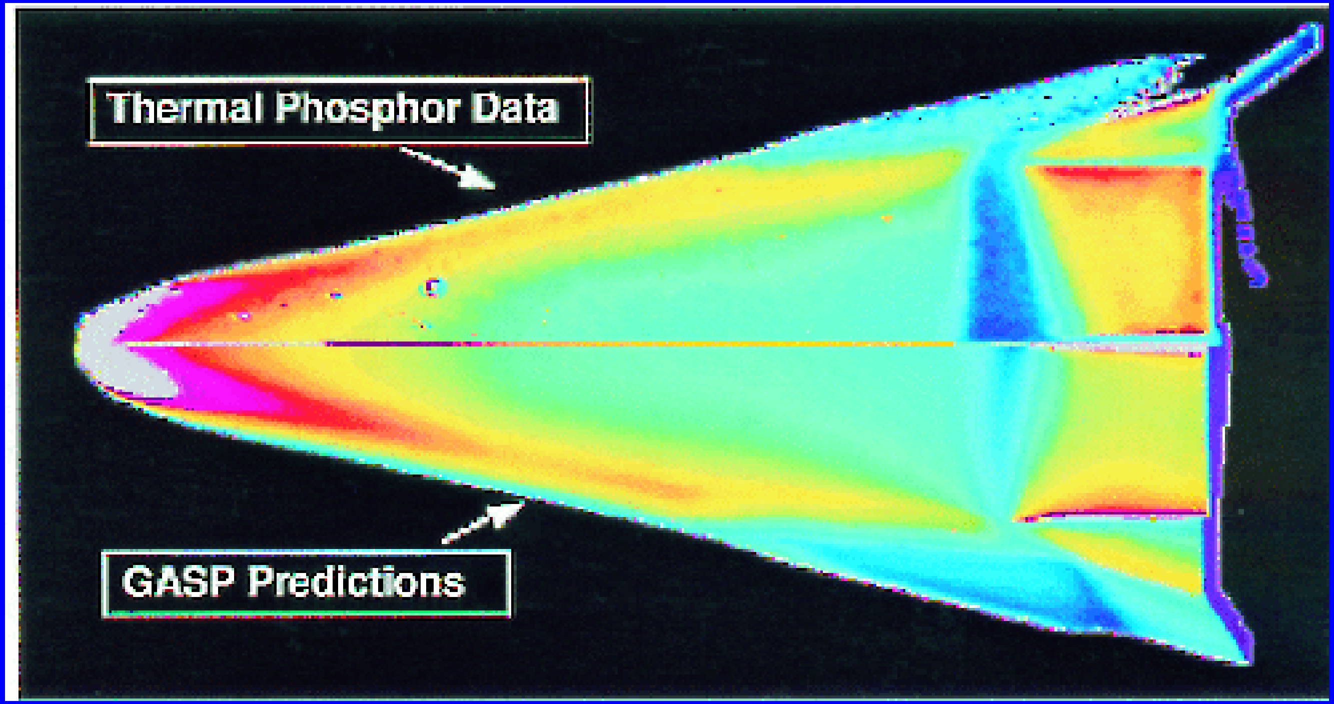
Glenn
Research
Center

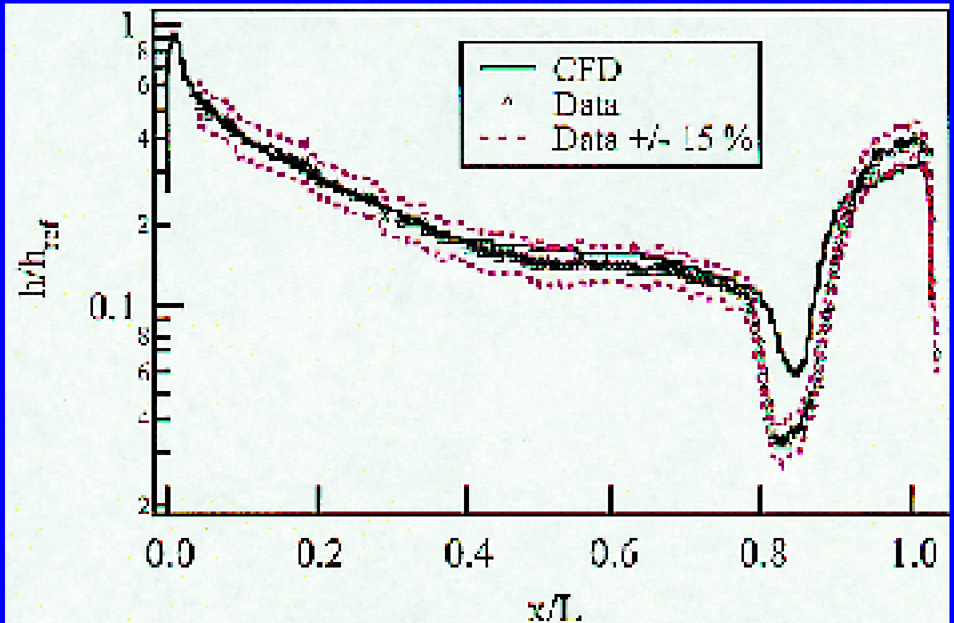


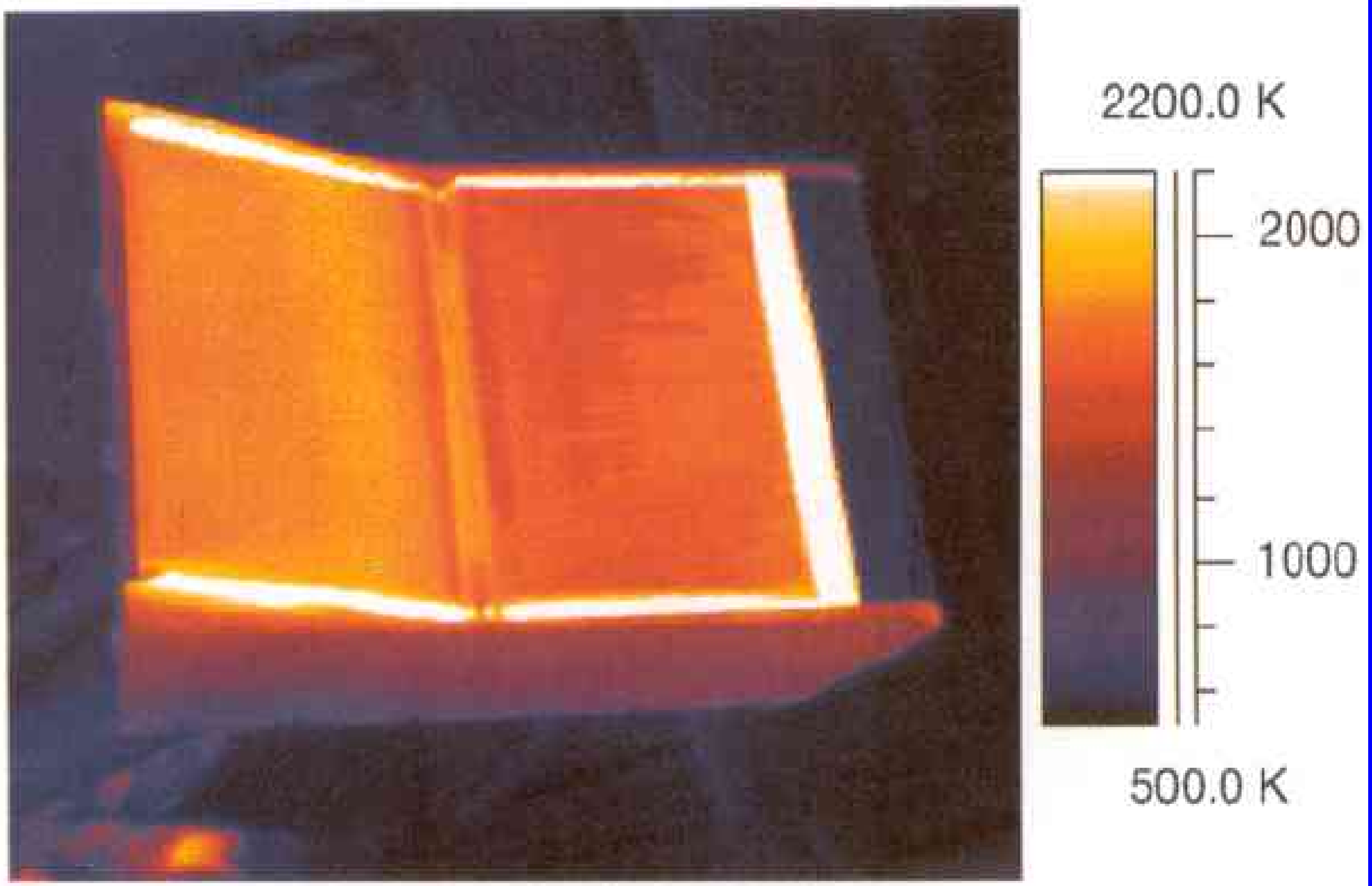
Hitzeschutzschild

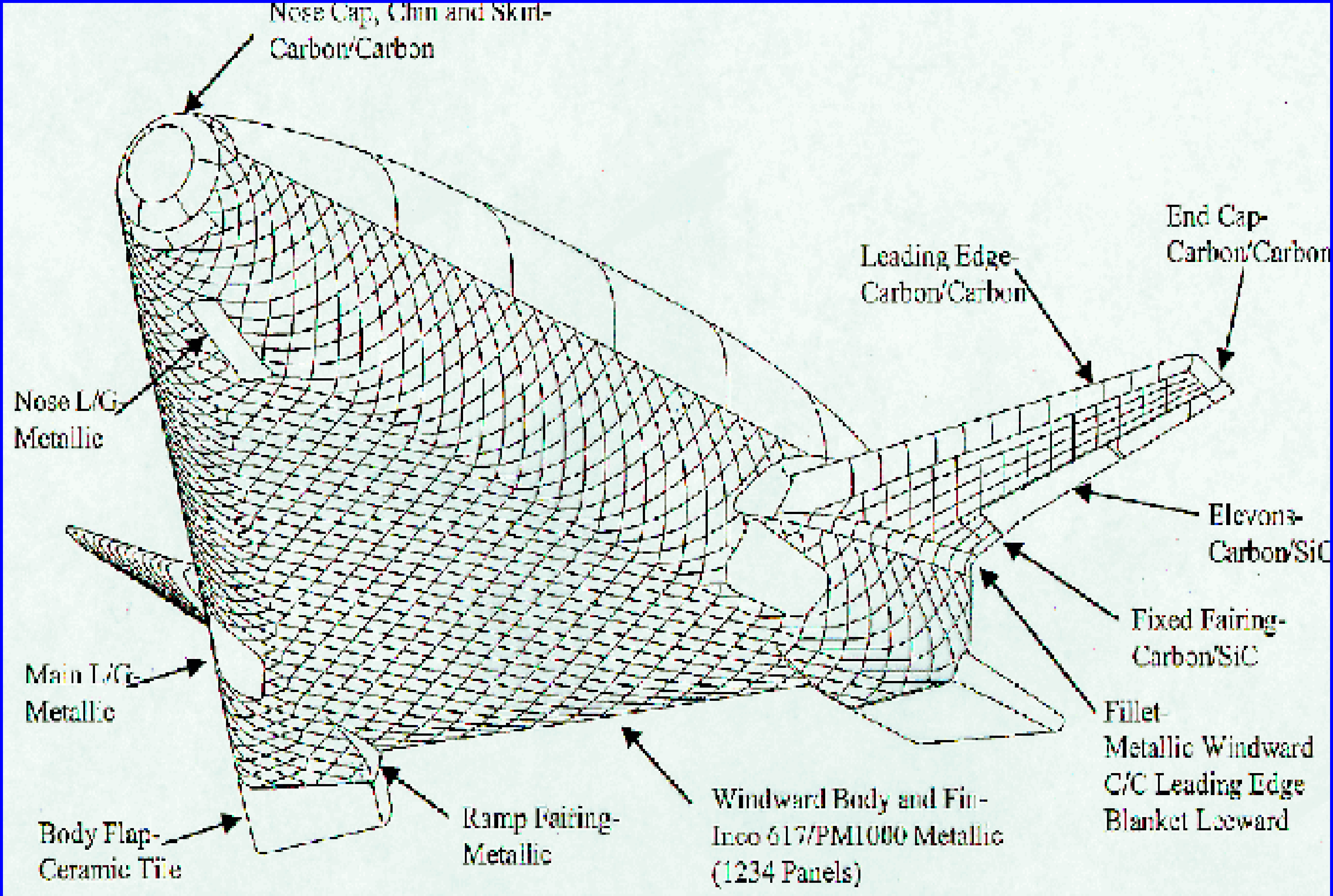

X38 model B
Kelvin
1427
1128
829
529
230

X-38 Comparisons M=10



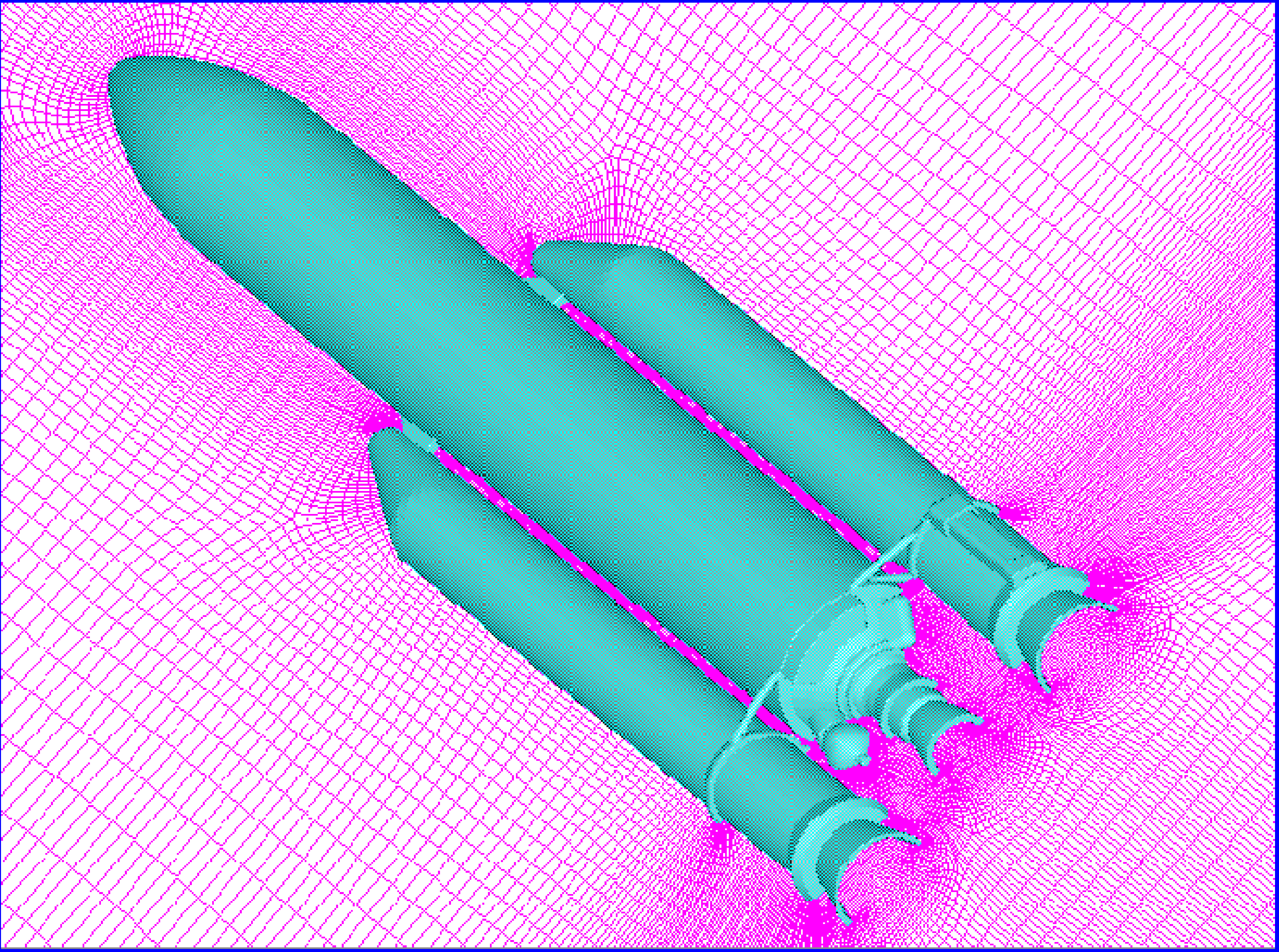


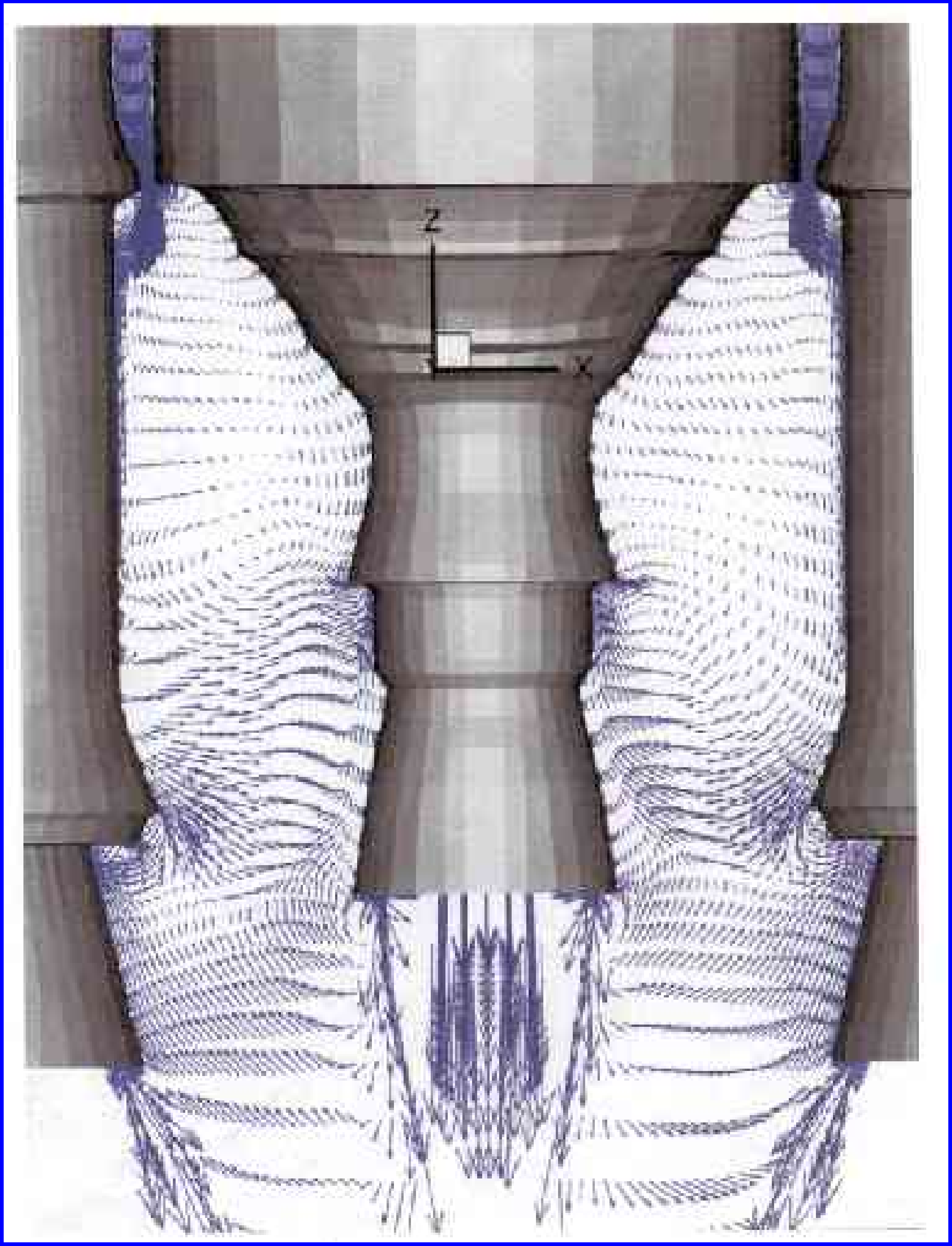

2200.0 K
2000
1000
500.0 K



Nose Cap, Chin and Skirt-
Carbon/Carbon
End Cap-
Carbon/Carbon
Leading Edge-
Carbon/Carbon
Nose L/G-
Metallic
Elevons-
Carbon/SiC
Fixed Fairing-
Carbon/SiC
Main L/G-
Metallic
Fillet-
Metallic Windward
C/C Leading Edge
Blanket Leeward
Body Flap-
Ceramic Tile
Ramp Fairing-
Metallic
Windward Body and Fin-
Inco 617/PM1000 Metallic
(1234 Panels)

Computer Simulation




Z
X

Diskussion und Ausblick

European Expert Program
European Space Agency

The EXPERT (European eXPErimental Re-entry Testbed) in-flight research programme aims to improve understanding of critical aerothermodynamic phenomena and includes wind tunnel, flight and CFD simulations. The EXPERT programme is setup to enhance the aerothermodynamic tools for design. Three launches with the Volna launcher are proposed with three expendable ballistic, re-entry test vehicles. EXPERT has been examined by EADS under the FESART study (Feasibility study for low cost flight validation).

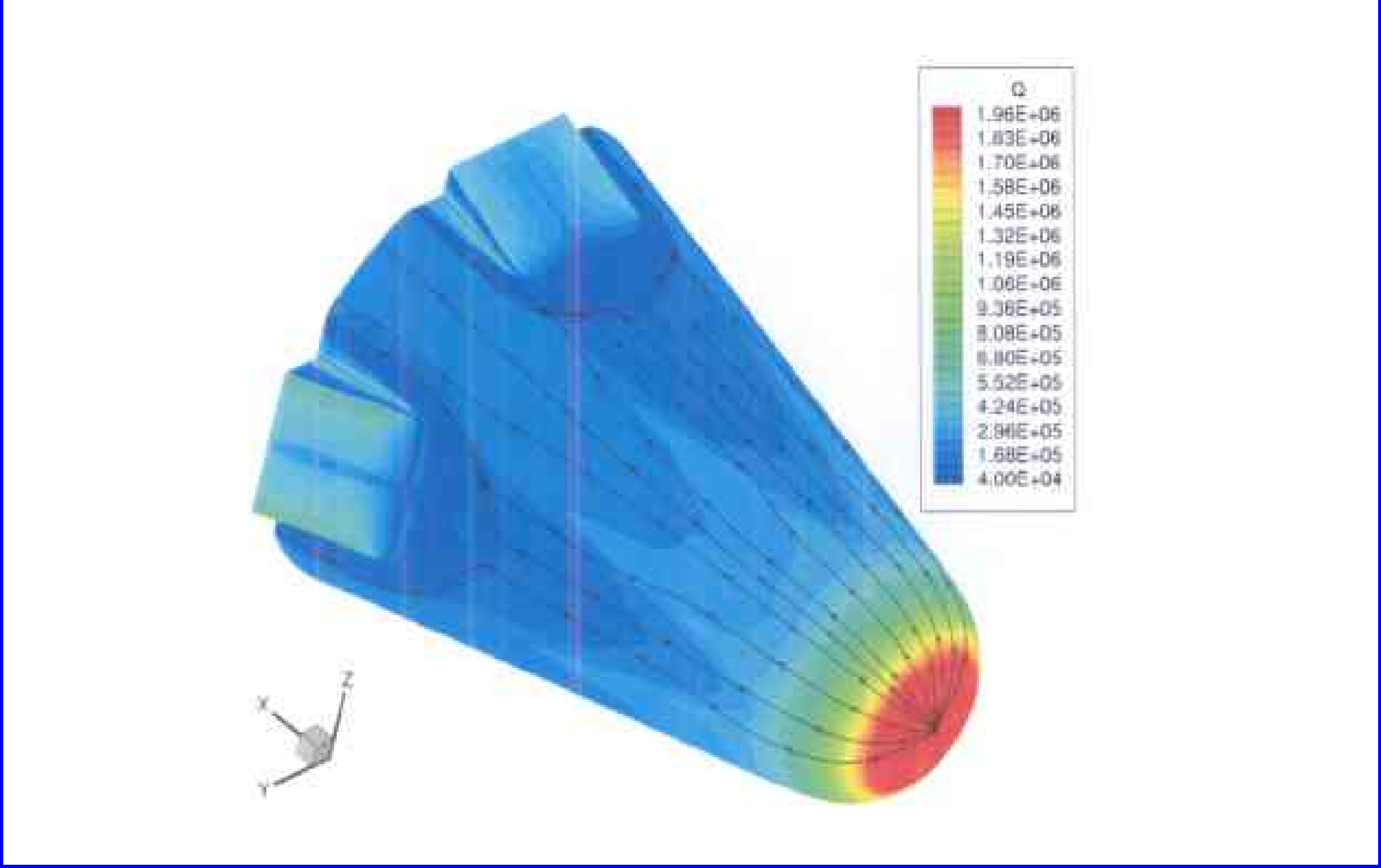
(a)

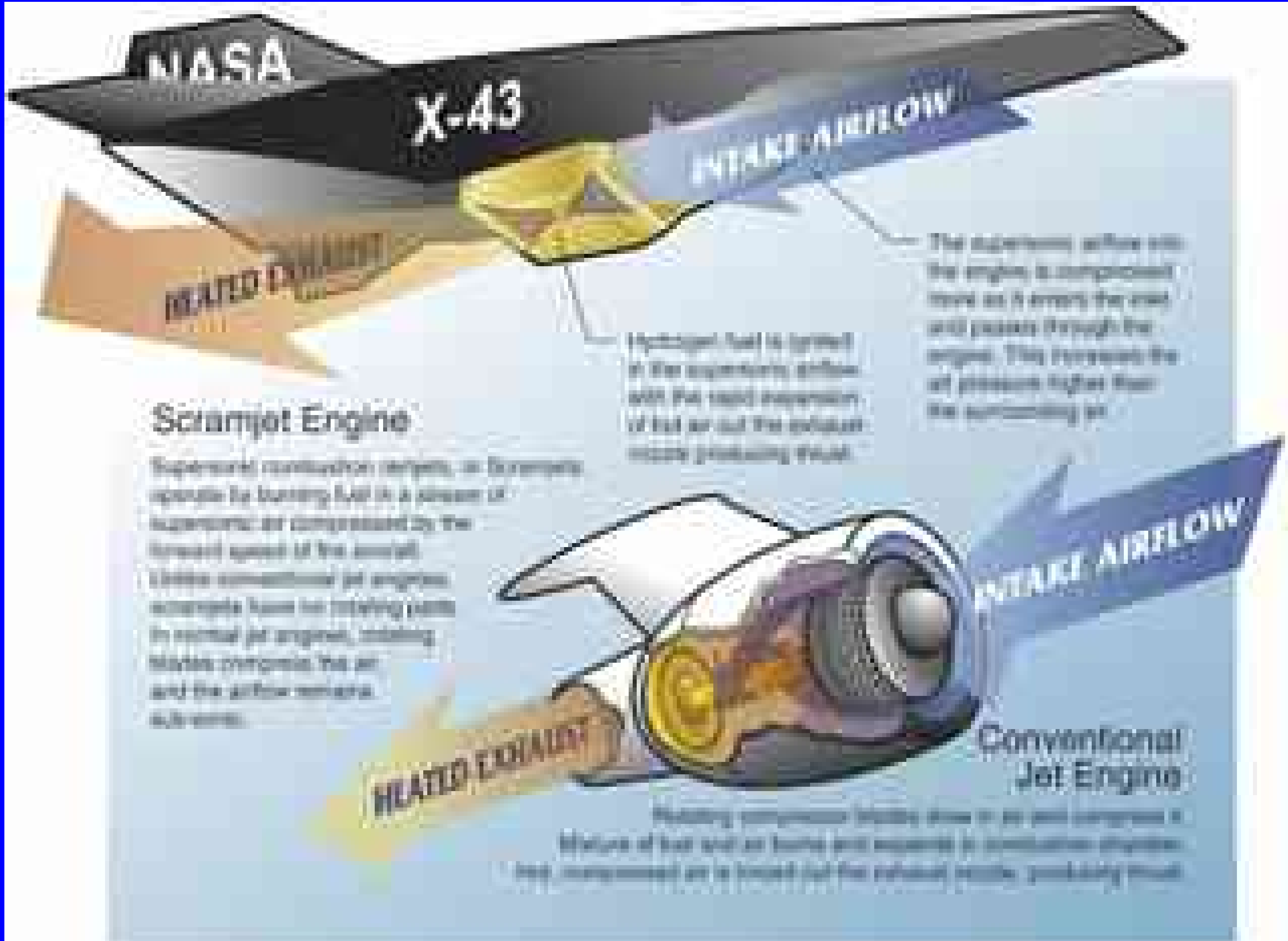
Equipment Bay
PL available volume
Fuel tank of the 2nd stage
Oxidizer tank of the 2nd stage
Propulsion subsystem of the 2nd stage
Oxidizer tank of the 1st stage
Fuel tank of the 1st stage
Propulsion subsystem of the 1st stage

(b)


Landing
Takeoff
PACIFIC OCEAN

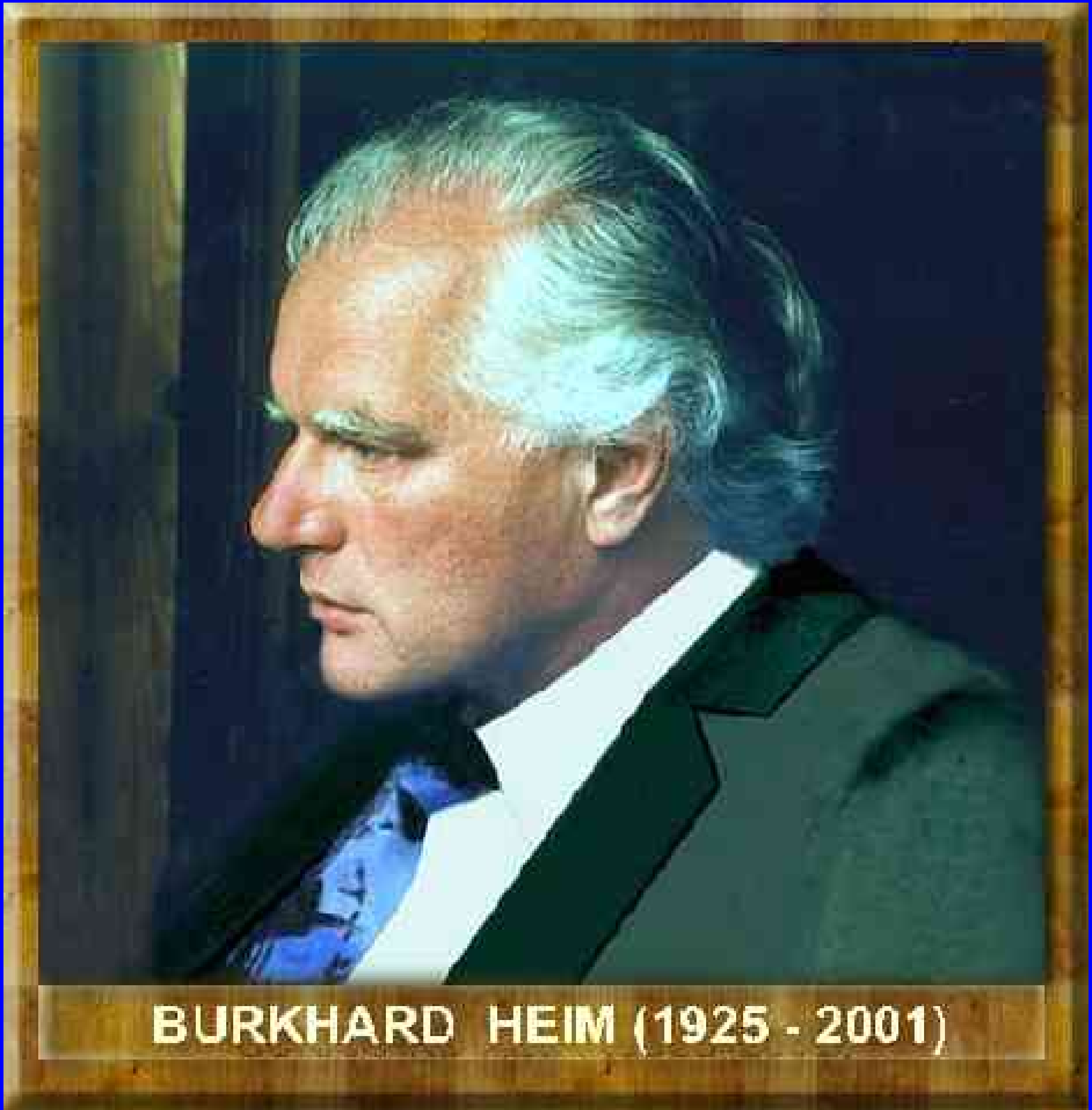

Takeoff
Landing
ARCTIC OCEAN
RUSSIA

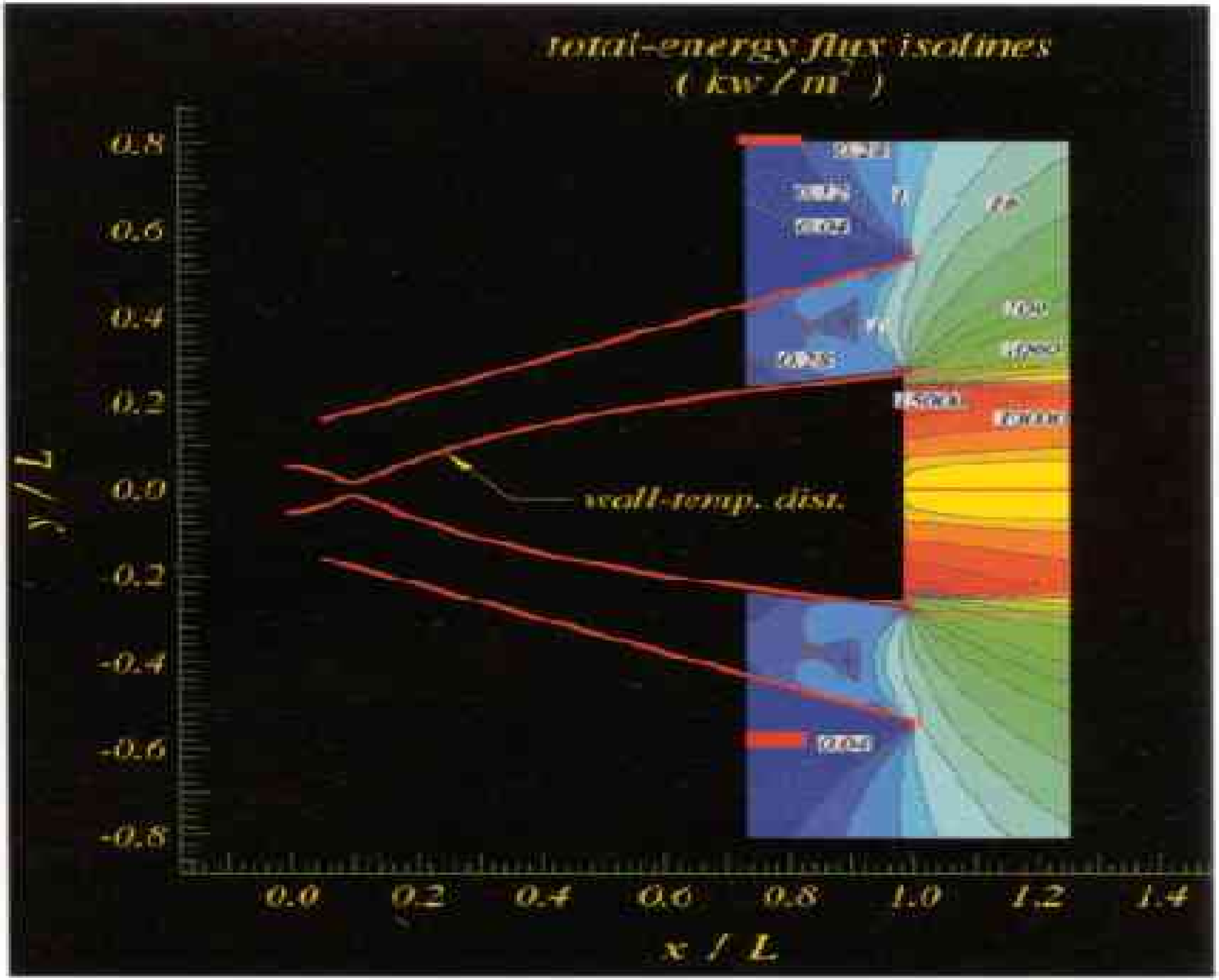

Q
1.96E+06
1.83E+06
1.70E+06
1.58E+06
1.45E+06
1.32E+06
1.19E+06
1.06E+06
9.36E+05
8.08E+05
6.80E+05
5.52E+05
4.24E+05
2.96E+05
1.68E+05
4.00E+04
X
Y
Z



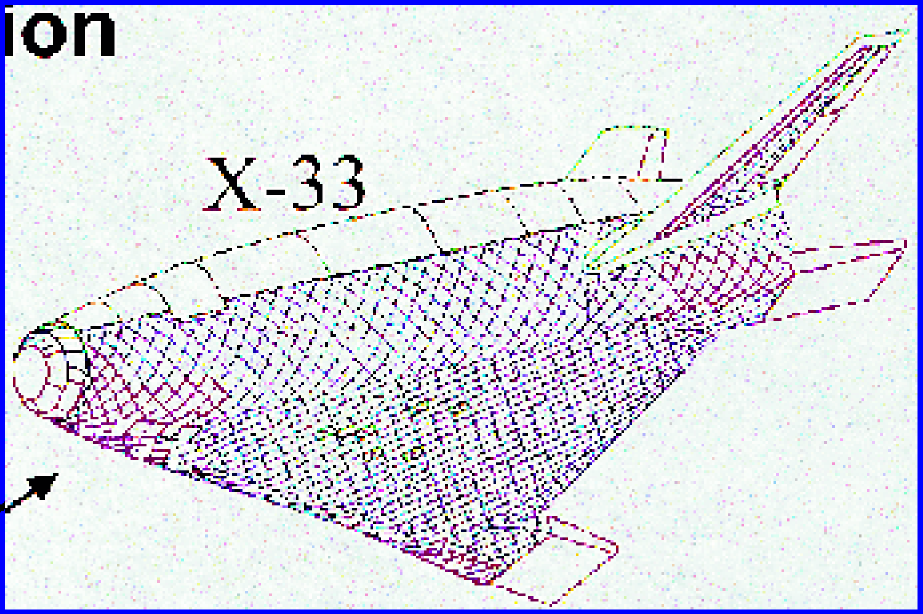
NASA
X-43
INTAKE AIRFLOW
HEATED EXHAUST
Scramjet Engine
INTAKE AIRFLOW
HEATED EXHAUST
Conventional Jet Engine

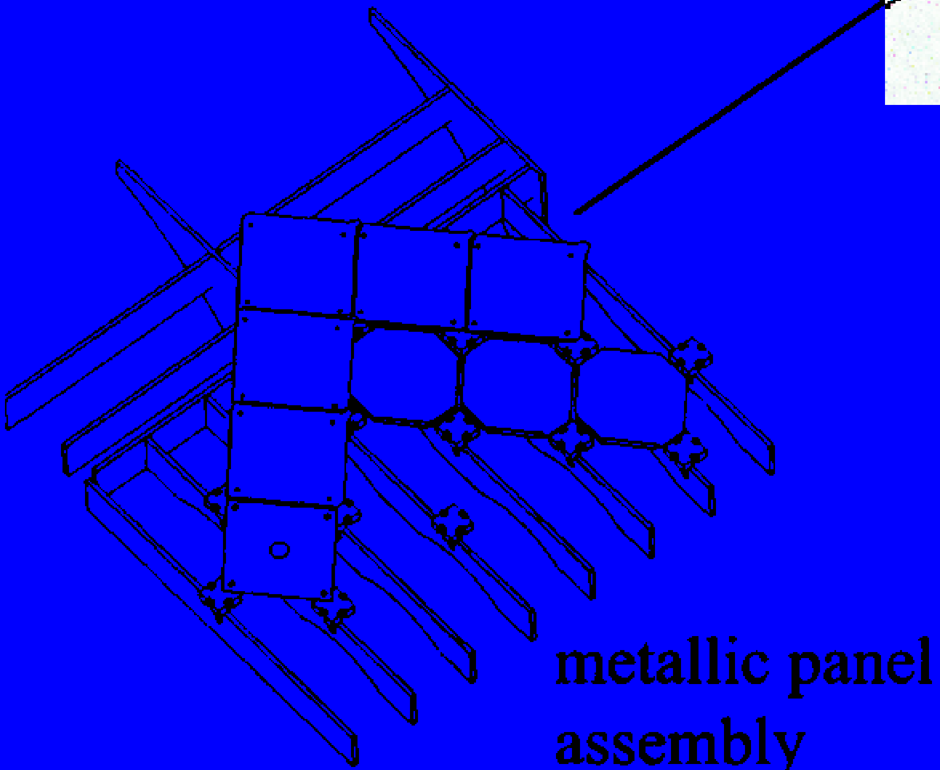
Space Transportation Revolutionary?




total-energy flux isolines
(kw / m)
wall-temp. dist.
y / L
x / L
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4

Metallic Panels are components of X-33 TPS Panels are of sandwich honeycomb construction

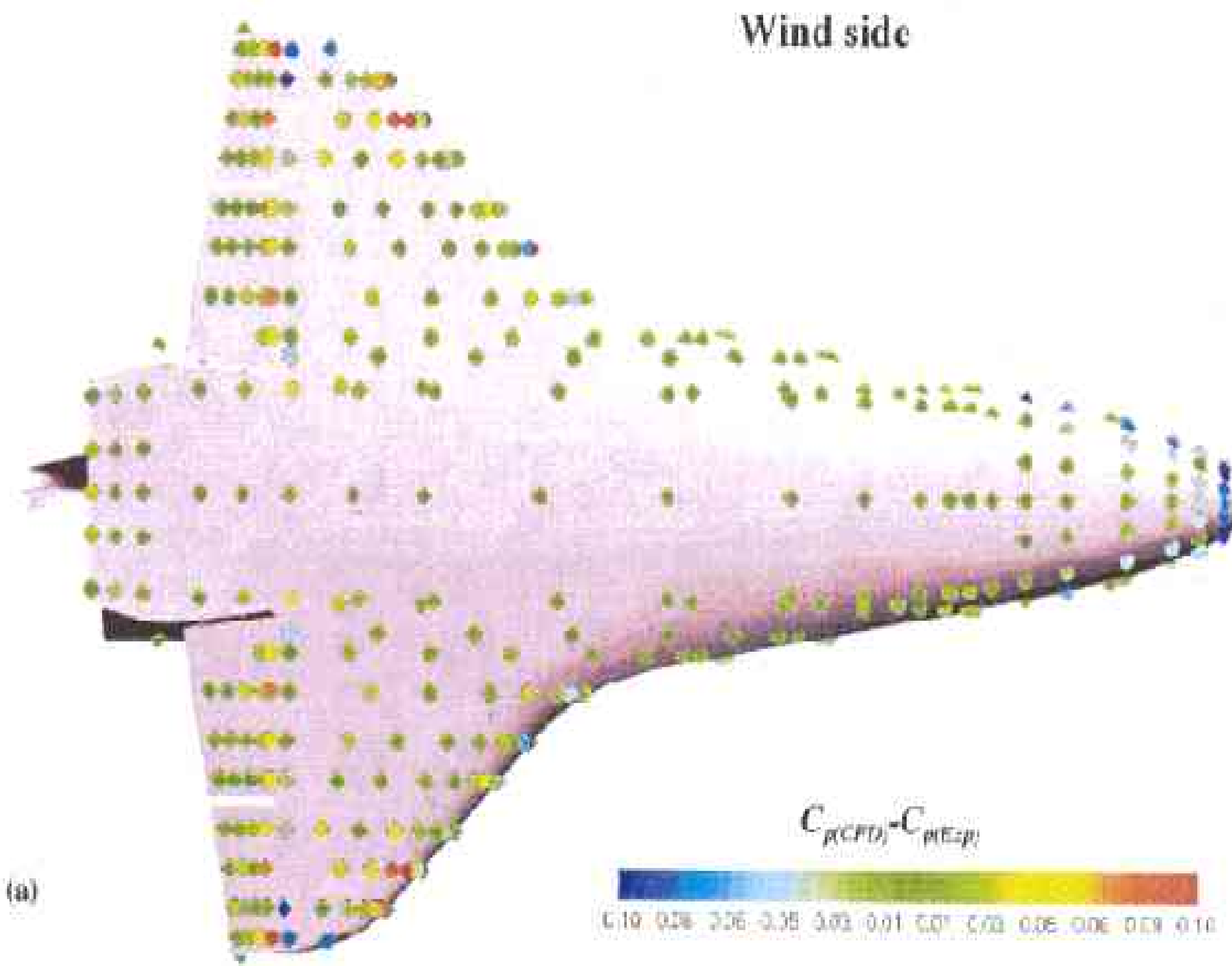


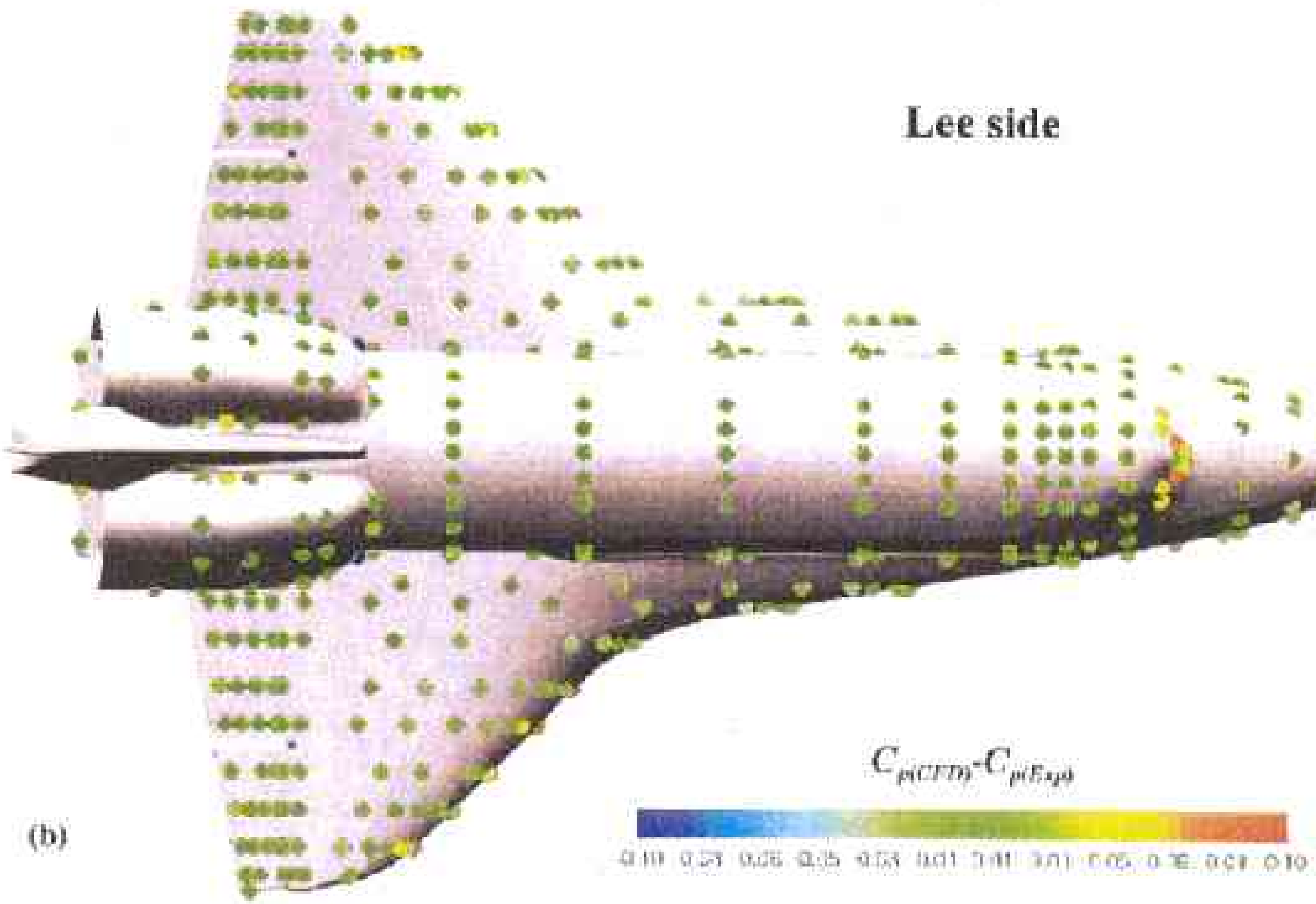


metallic panel assembly

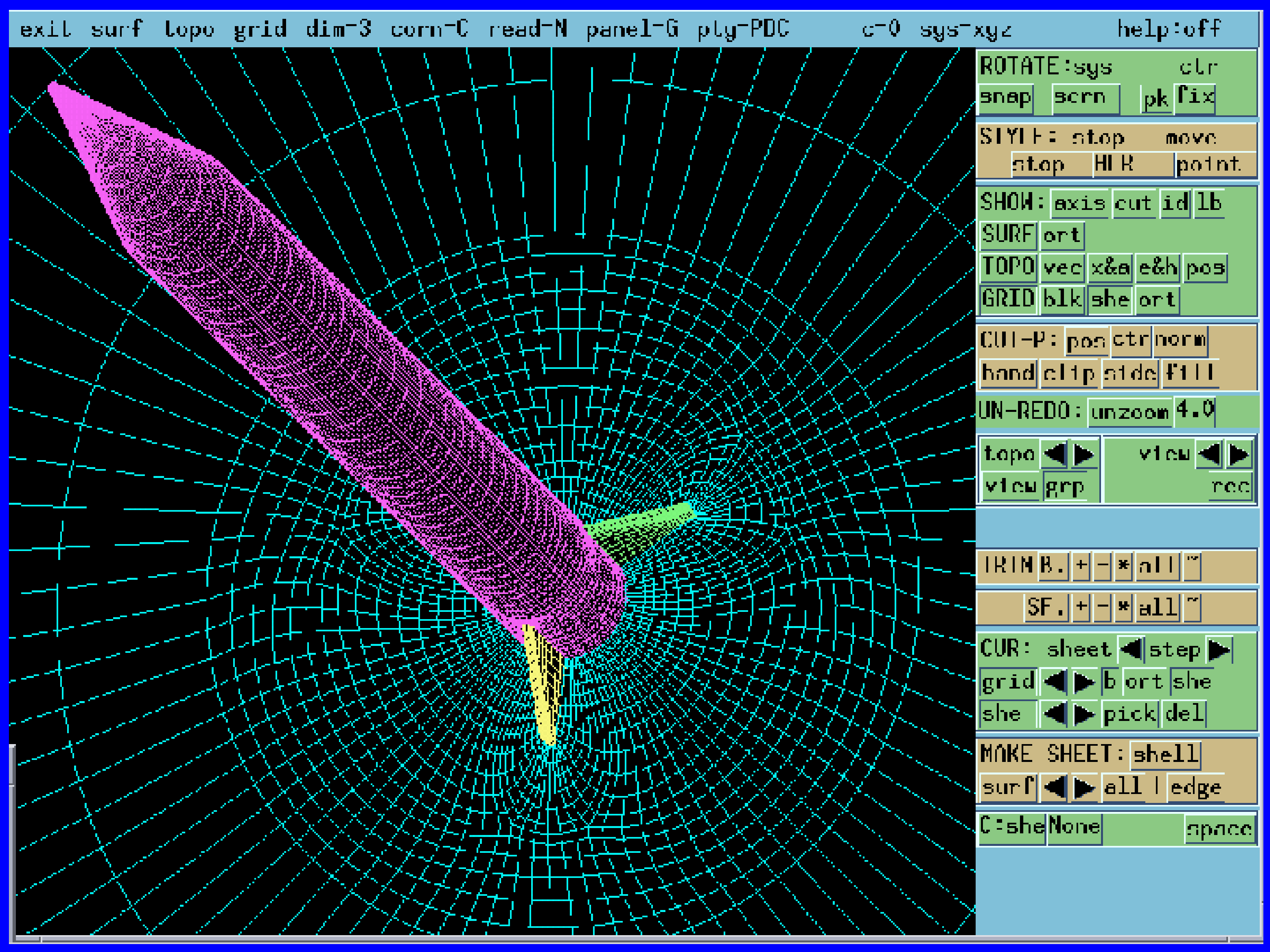
Panels thermoelastically deform due to aerothermal heating

Change in surface shape due to bowing affects hypersonic flowfield ***coupled fluid-structure interaction***

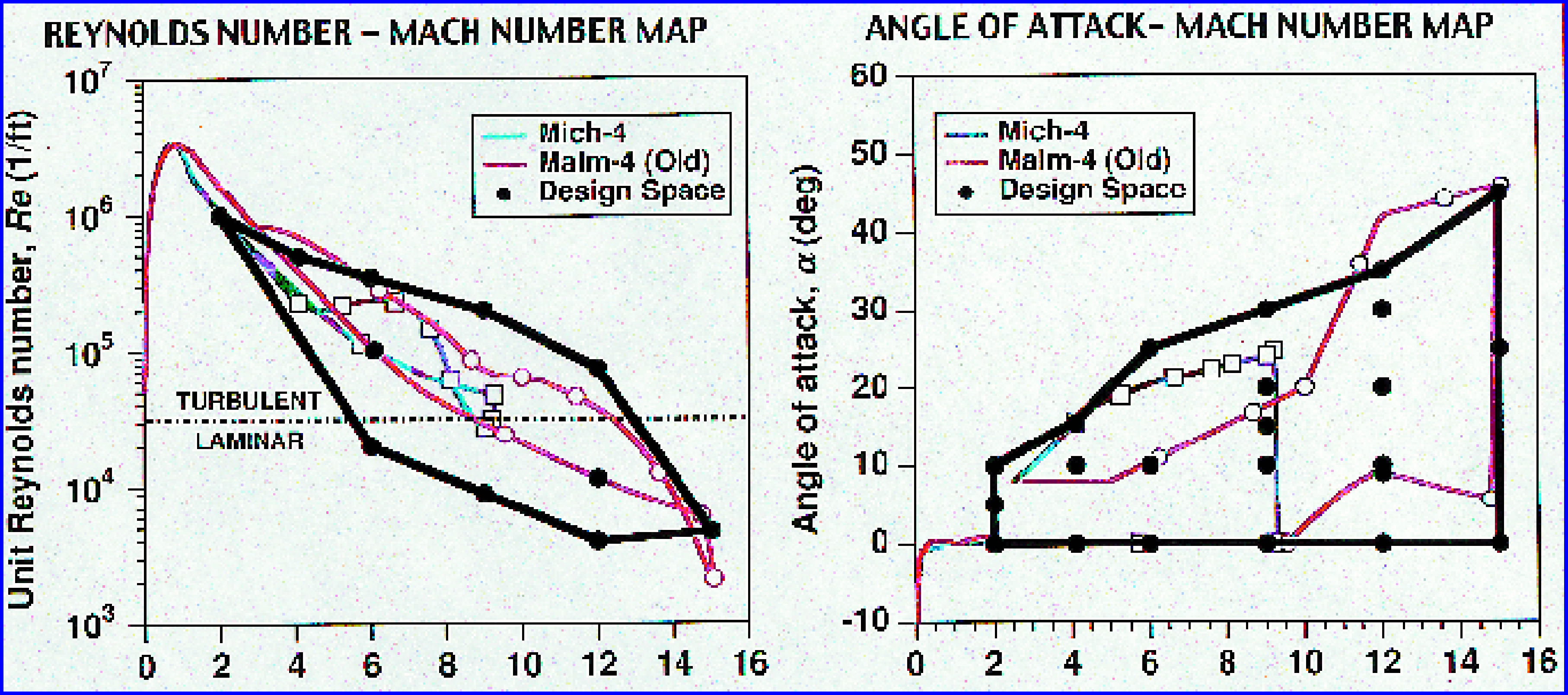

Wind side
(a)



Lee side
$C_{p(CFD)}-C_{p(Exp)}$
(b)



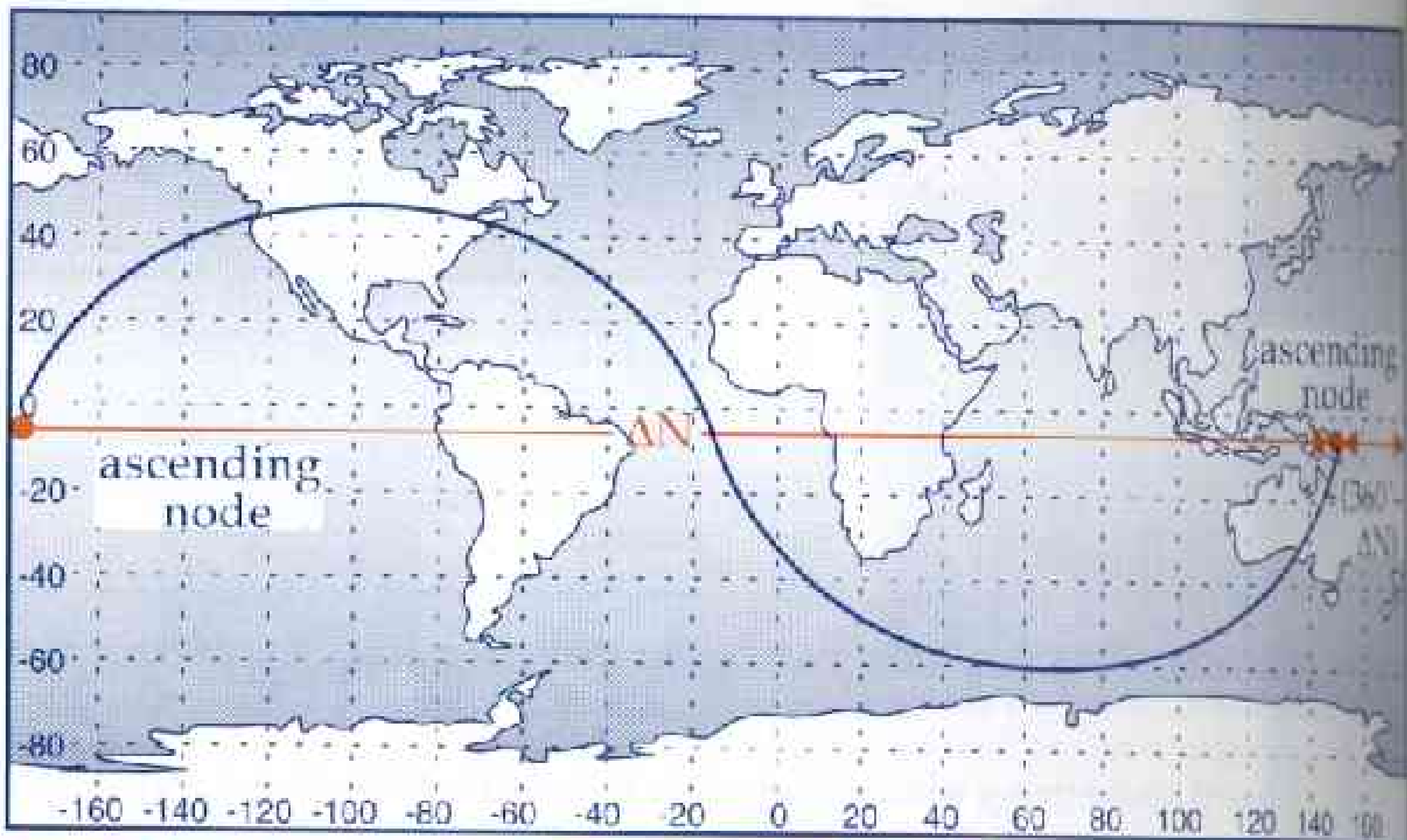
exit surf topo grid dim-3 corn-C read-N panel-G plt-PDC c-0 sys-xyz help:off
ROTATE:sys clr
snap scrn pk fix
stop HLR point
SHOW: axis cut id lb
SURF ort
TOPO vec x&a e&h pos
GRID blk she ort
pos ctr norm
hand clip side fill
UN-REDO: unzoom 4.0
topo view
view grp rec
SF. + - * all ~
CUR: sheet step
grid b ort she
she pick del
MAKE SHEET: shell
surf all | edge
C:she None space



Wall assumed to be fully catalytic

Surface emissivity of 0.8 for C-C (Nosecap/Canted.Fin L.E./Elevons) and

0.6 for Metal/Blanket



80
60
40
20
-20
-40
-60
-80
-160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140
ascending node
AN
ascending node