



DESIGN AND
ENGINEERING
LIGHTWEIGHT
STRUCTURES



Flying Whales LCA60T Airship Envelope Development

Rogier Houtman

I n t r o d u c t i o n > T e n t e c h B . V .

Tentech B.V. – design & engineering of lightweight structures

- Textile architecture, ETFE-foil and air inflated structures
- Event structures
- Industry

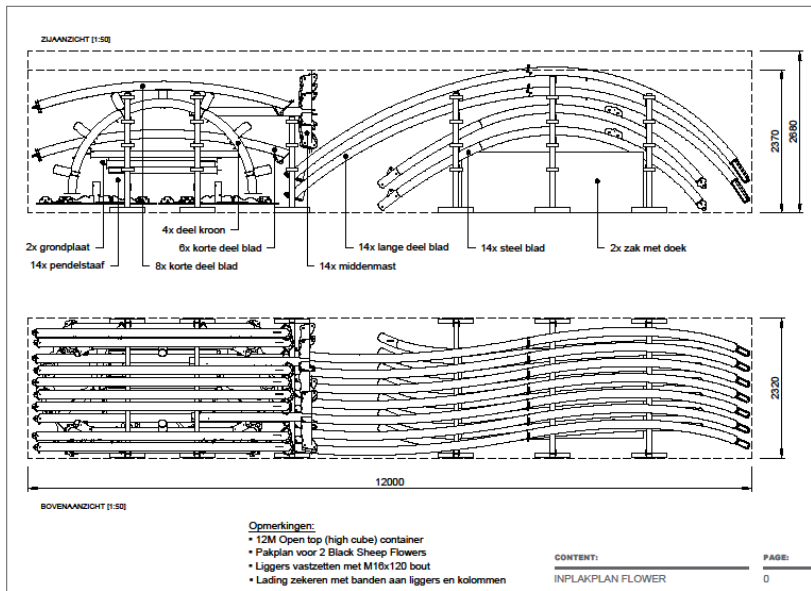






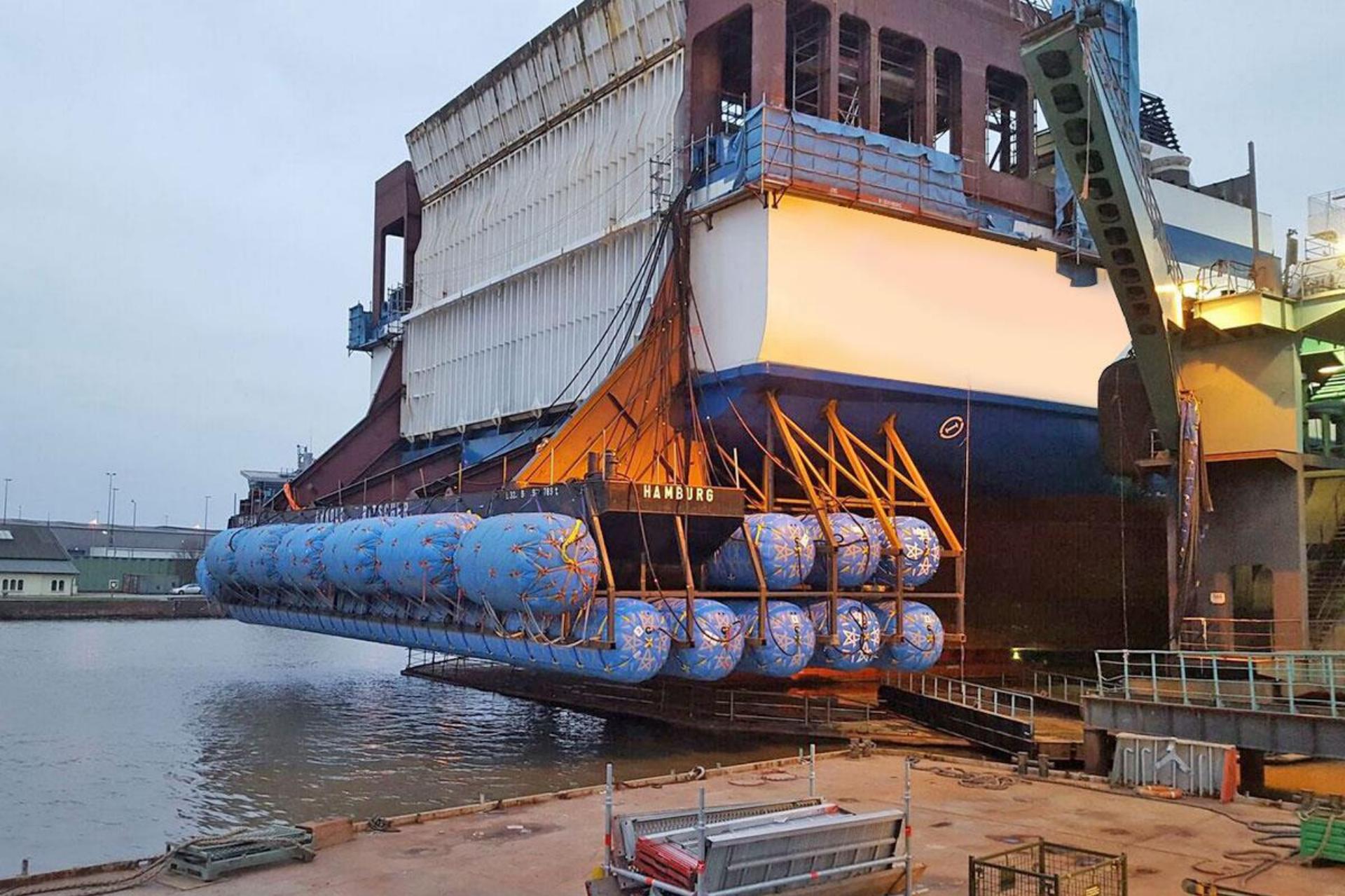














Flying Whales LCA60T Airship Envelope Development

Our client: Higpoint Structures SARL France



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**FLYING
WHALES**

CONNECTING THE LAND-LOCKED WORLD TO THE GLOBAL ECONOMY

« RAISON D'ÊTRE » (Purpose Statement)

Flying Whales purpose is to provide the world with a solution which will both:

- ✓ Contribute to the expansion of economic development by **unlocking** land-locked territories lacking in infrastructure,
- ✓ Contribute to the significant reduction of cargo transport's **environmental** impact.





ONF French National Forest Agency
must increase its logging by:

Short term

1 million m³/year
3.5 million cu ft / year

*“Forestry and timber product industry is **the second contributor** to the French trade balance deficit.”*

France has large additional resources, but out of reach (landlocked areas) with existing solutions.





MARKET NEED
SO FAR
800
LCA60T WORLDWIDE



3 PRODUCTION SITES



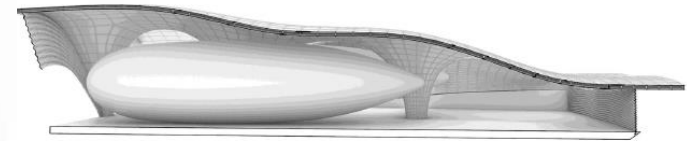
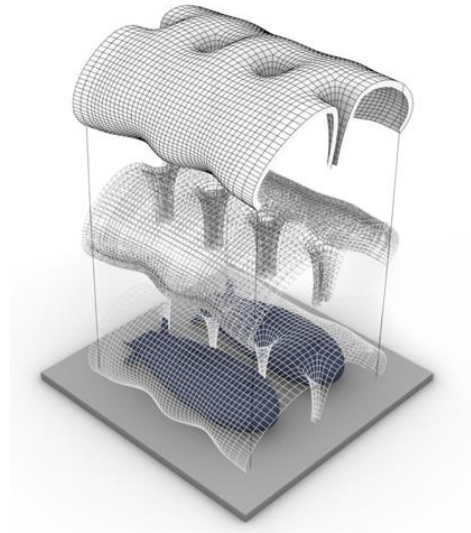
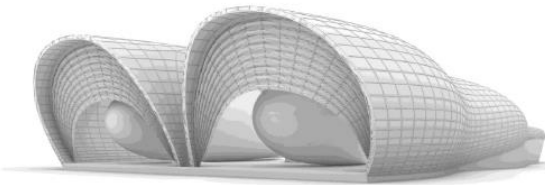
Quebec, Canada



Nouvelle Aquitaine, France



Asia (TBD)



THE LCA60T

60 tonnes point-to-point with almost no environmental impact

Load and unload in hover flight

Point-to-point transport

A rigid structure

For maximum operational security

LCA60T dimensions

200m (L) x 50m (D)



14 helium cells unpressurised

An inert gas, stored, ensuring lift

7 propulsion points

Ensures perfect control
100 km/h
Vertical Take-Off and Landing

A large 60 tonnes payload

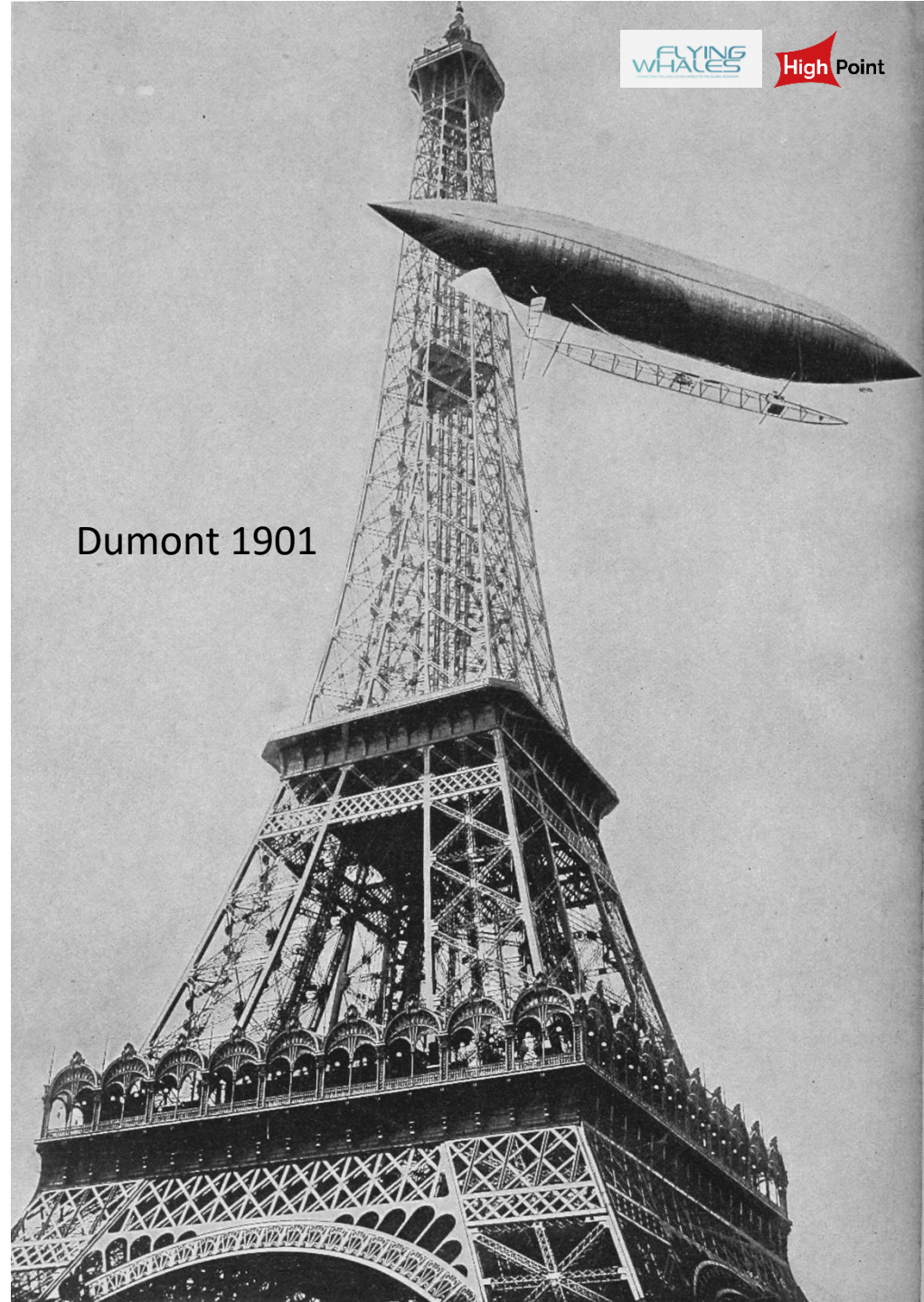
In cargo bay and/or under-sling

A vast cargo bay

96m (L) x 8m (W) x 7m (H)

HISTORY of AIRSHIPS

- 1709 First Hot Air balloon from paper (Bartolomeu de Gusmao)
- 1784 First propellor on Hot Air Balloon (Jean-Pierre Blanchard)
- 1852 Steam powered airship (Henri Giffard)
- 1883 First electric powered flight (Gaston Tissandier)
- 1900 LZ1 Luftschiff Zeppelin
- 1901 Alberto Santos Dumont flies around Eiffeltower



Dumont 1901

HISTORY of AIRSHIPS

Early 20th century, national development of airship is seen as strategic importance

United Kingdom

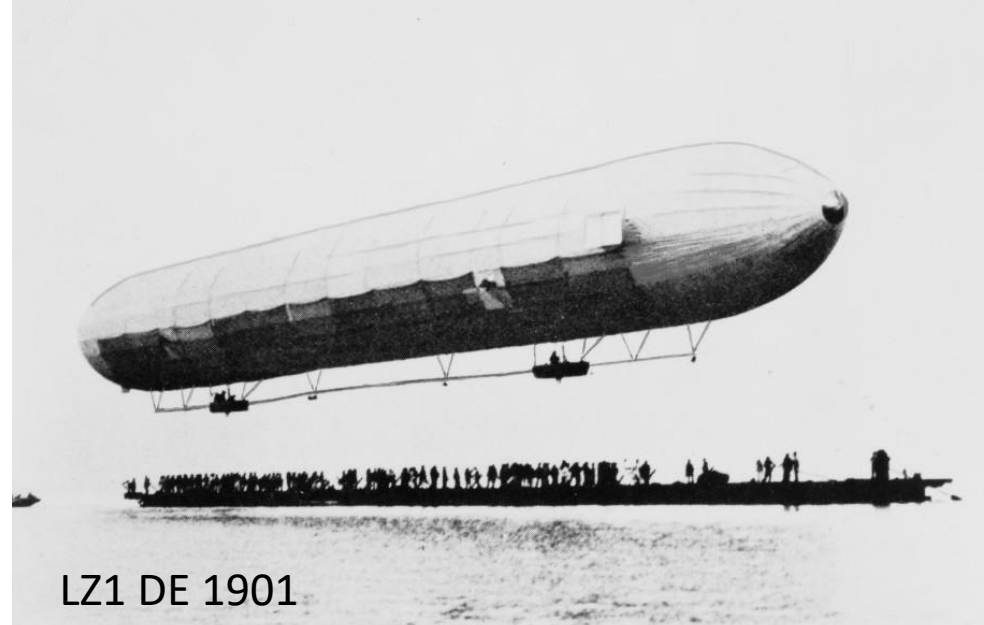
USA

Germany

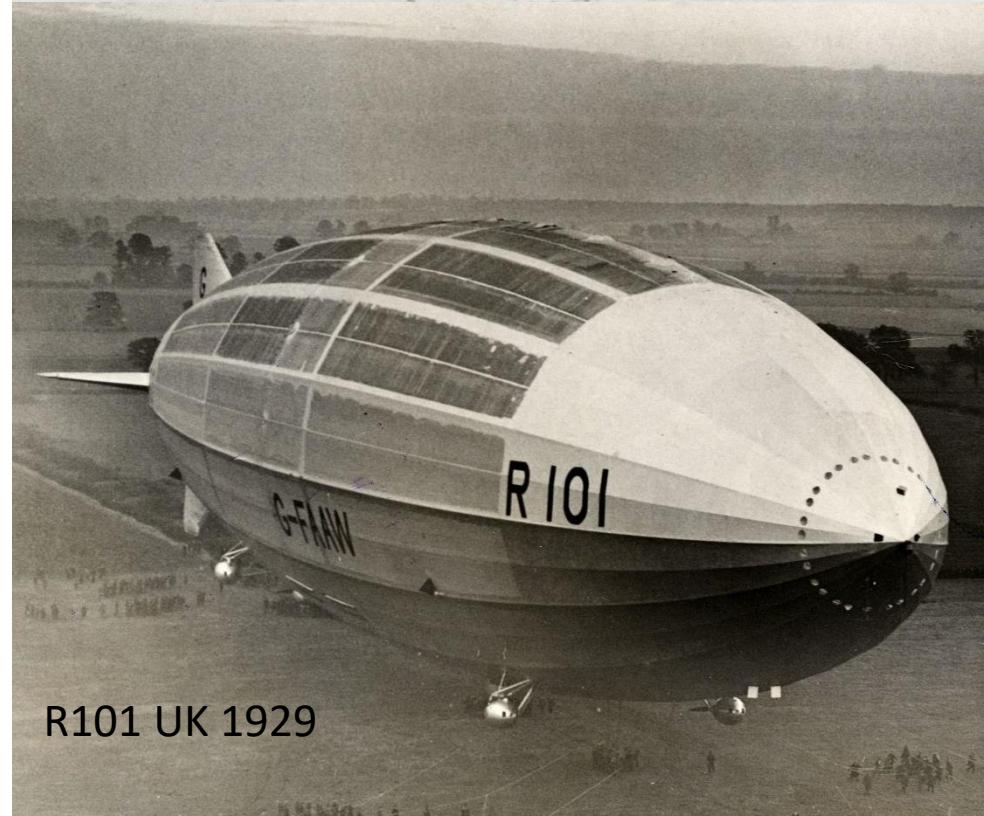
France

Italy

USSR



LZ1 DE 1901



R101 UK 1929



USS MACON 1933



LZ 129 HINDENBURG 1937

HISTORY of AIRSHIPS

After WWII only little development

- GOODYEAR (Blimp)
- ZEPPELIN NT (Semi Rigid)
- CARGO LIFTER (not completed)



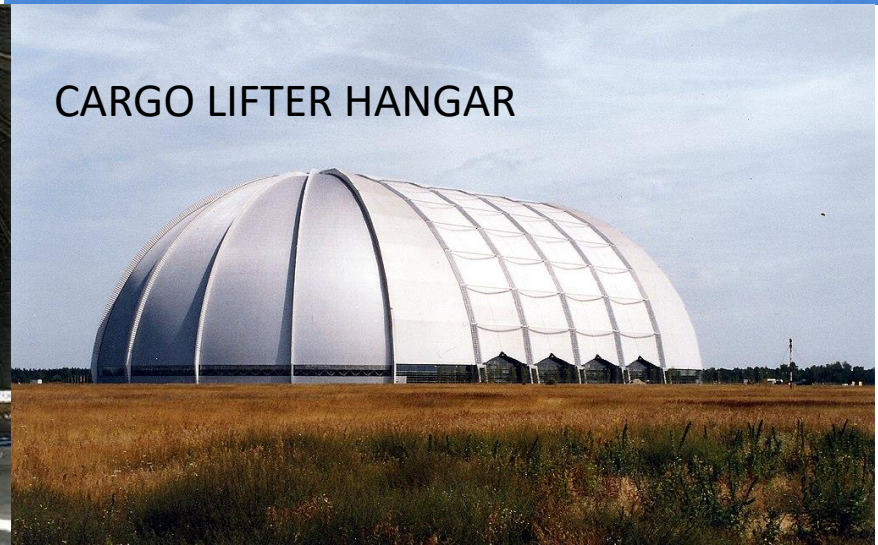
GOODYEAR



ZEPPELIN NT



CL75 AIRCRANE



CARGO LIFTER HANGAR

After WWII only little development

- AIRSHIP LOTTE 1993 – 2008 TAO GROUP



tao

DEFINITION (WIKIPEDIA):

An **airship** or **dirigible balloon** is a type of **aerostat** or **lighter-than-air** aircraft that can navigate through the air **under its own power**.^[1] Aerostats gain their lift from a **lifting gas** that is less dense than the surrounding air.

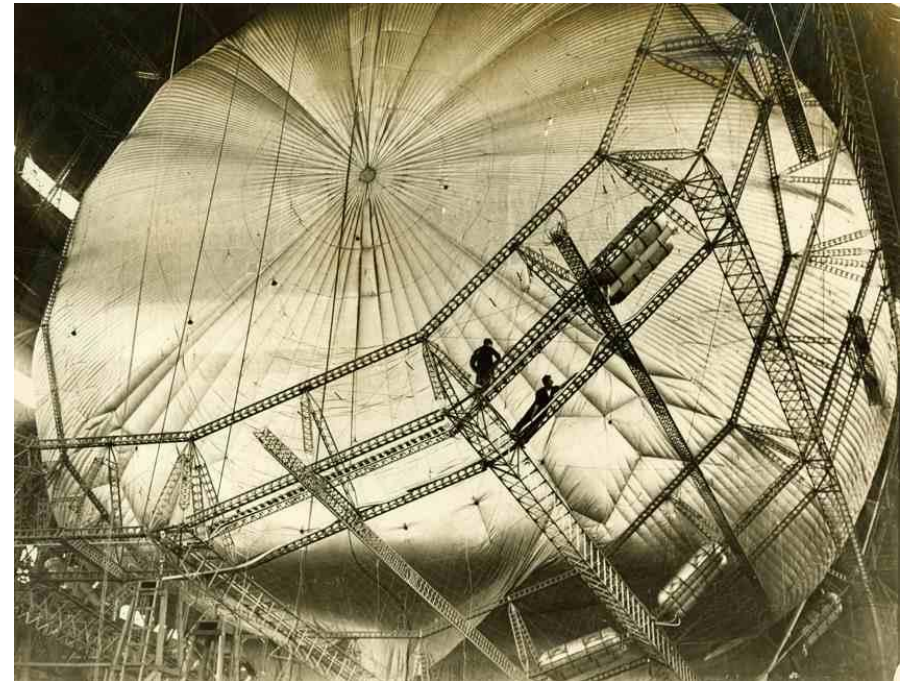
Lifting gas:

Hot Air

Hydrogen

Helium → US EMBARGO in 1930'

R101 GAS CELL



TYPES of AIRSHIP

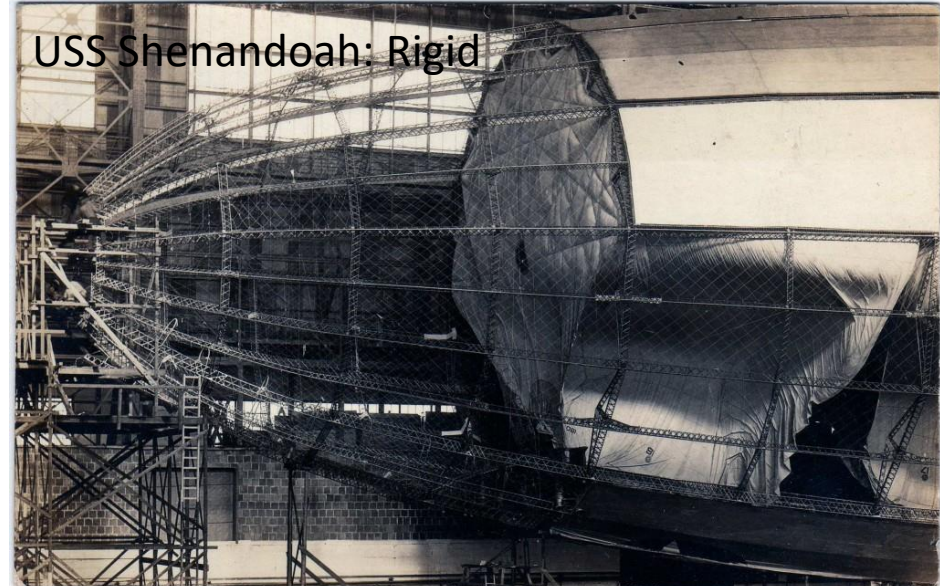


Airship Lotte: Blimp

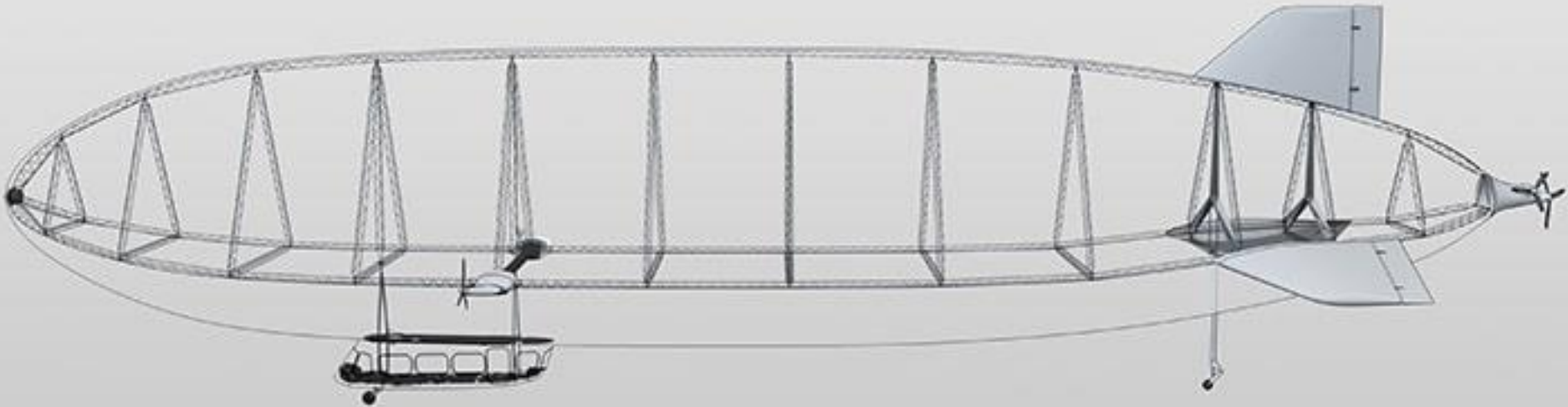
- Non Rigid (Blimp): fully inflated, outer hull structural
- Semi-Rigid: Partially internal supporting structure, outer hull structural
- Rigid: Internal frame carrying gas cells, outer hull non structural



Airship Norge: Semi-rigid



USS Shenandoah: Rigid



ZEPPELIN NT SEMI-RIGID

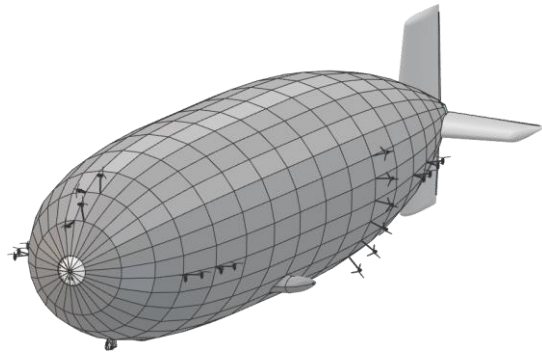
ZEPPELIN LZ129

<https://youtu.be/qFIPC9fWjh8?feature=shared>

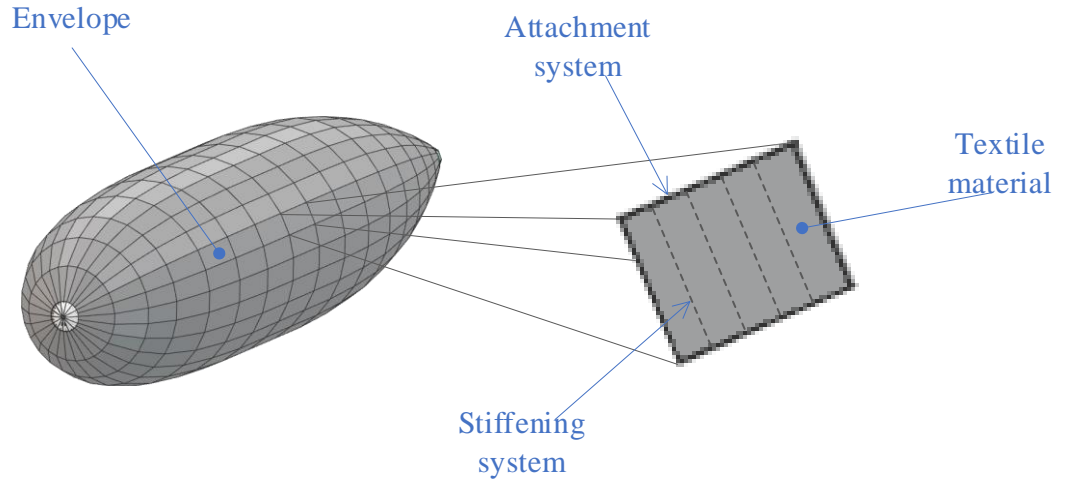
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Airship



Airframe

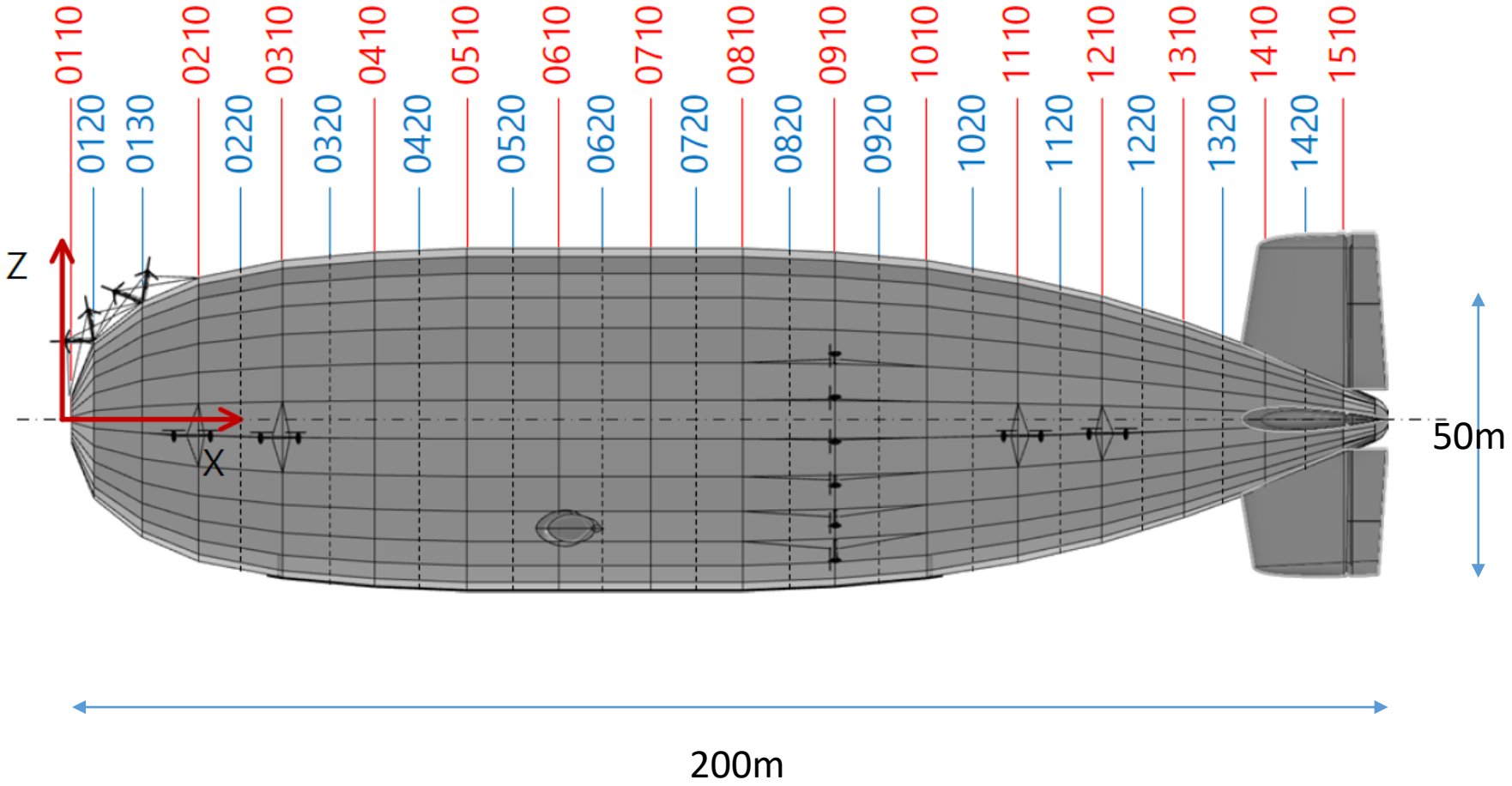
Envelope panel

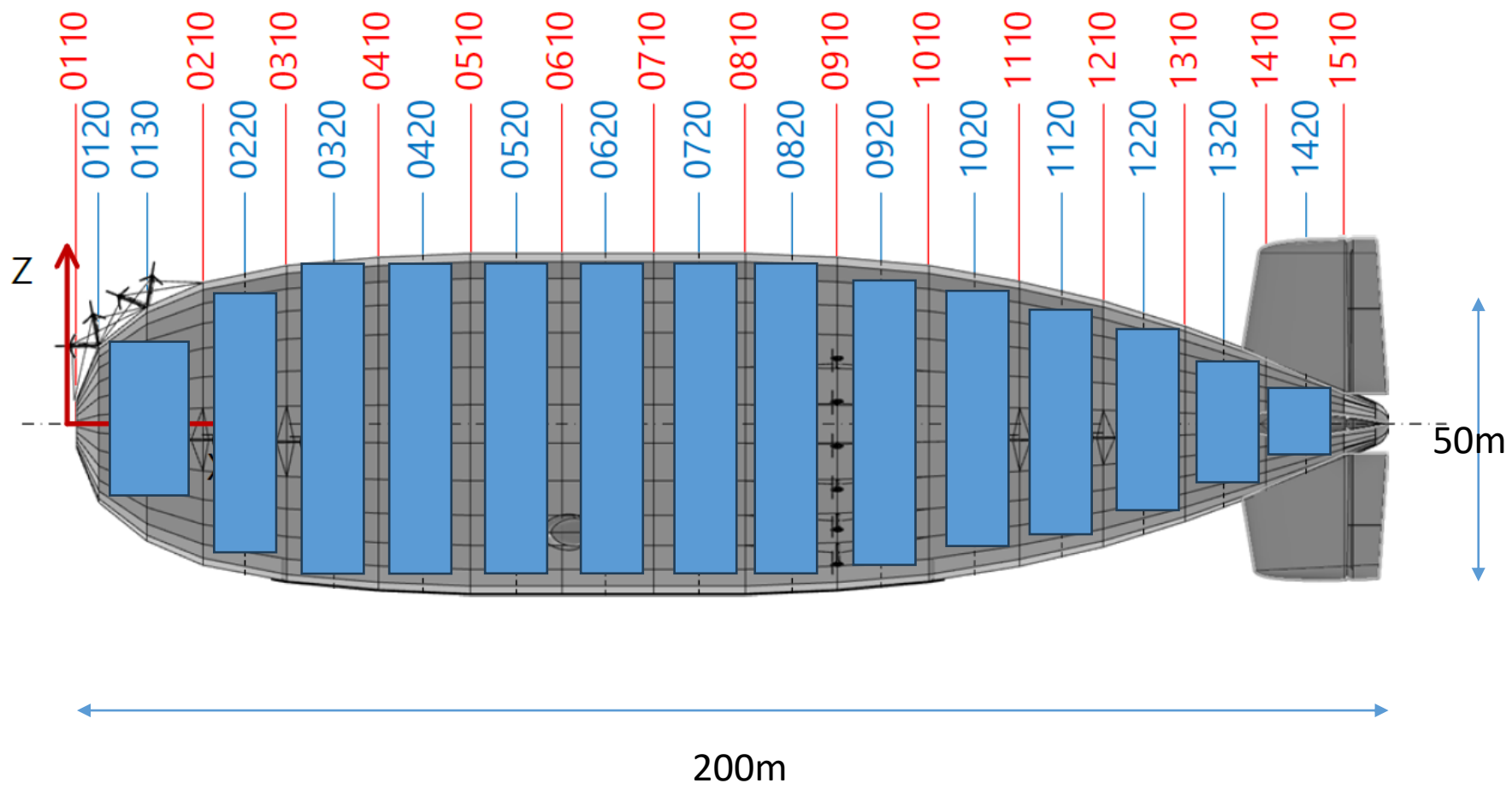
NUMBER

- Number of panels: 438
- Number of panel references: 42

DIMENSIONS

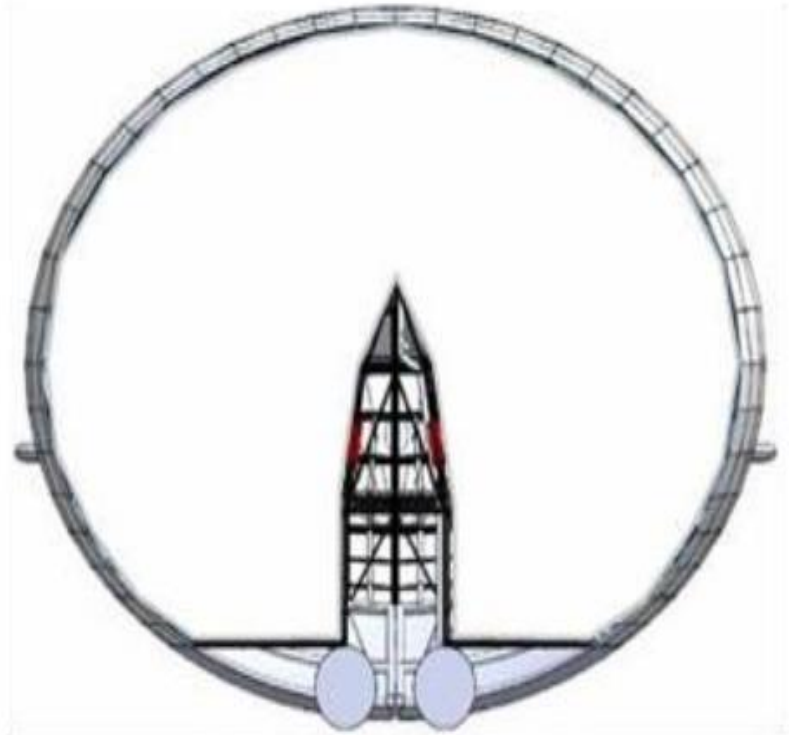
- Envelope surface: 23 600m²
- Maximum panel's length: 13,5m
- Maximum panel's width: 5m
- Length of Attachement: 5500m



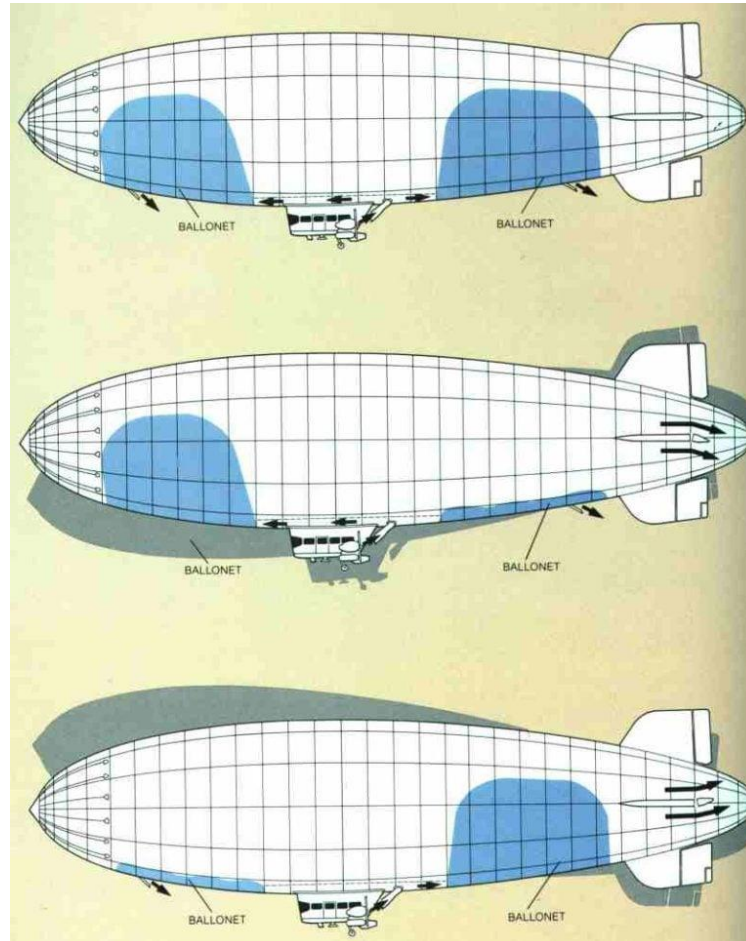




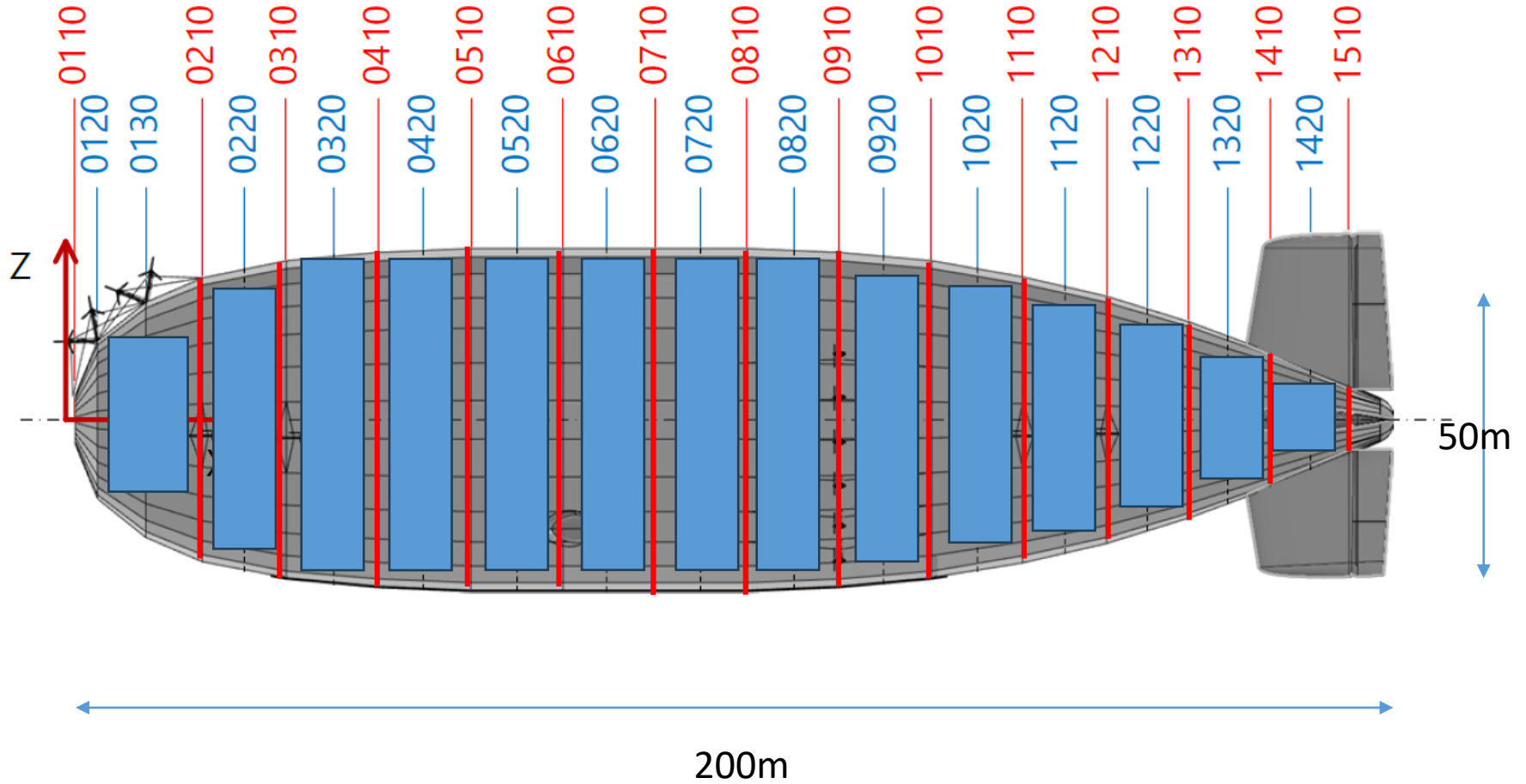
Gas cell shape at ground level

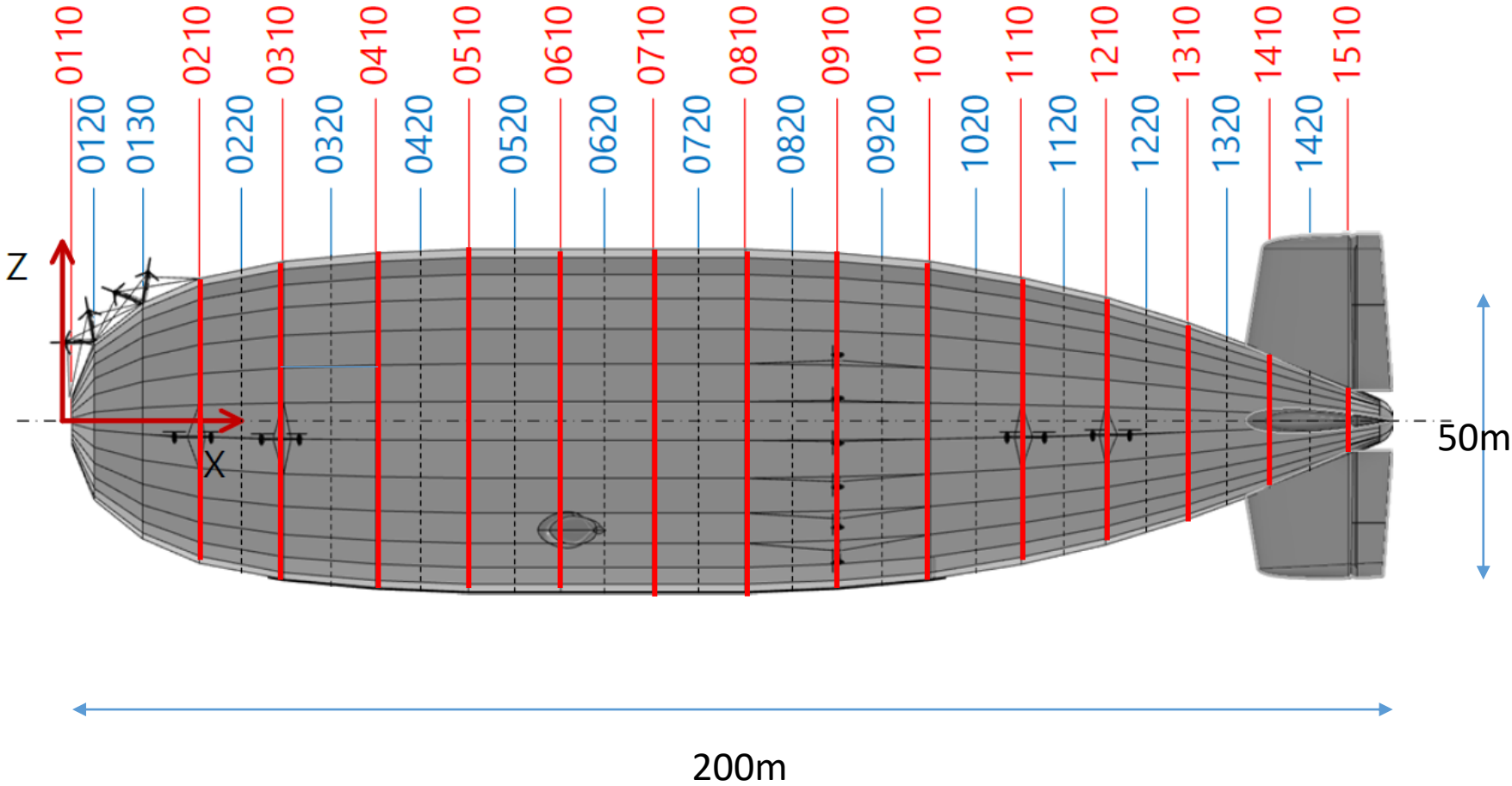


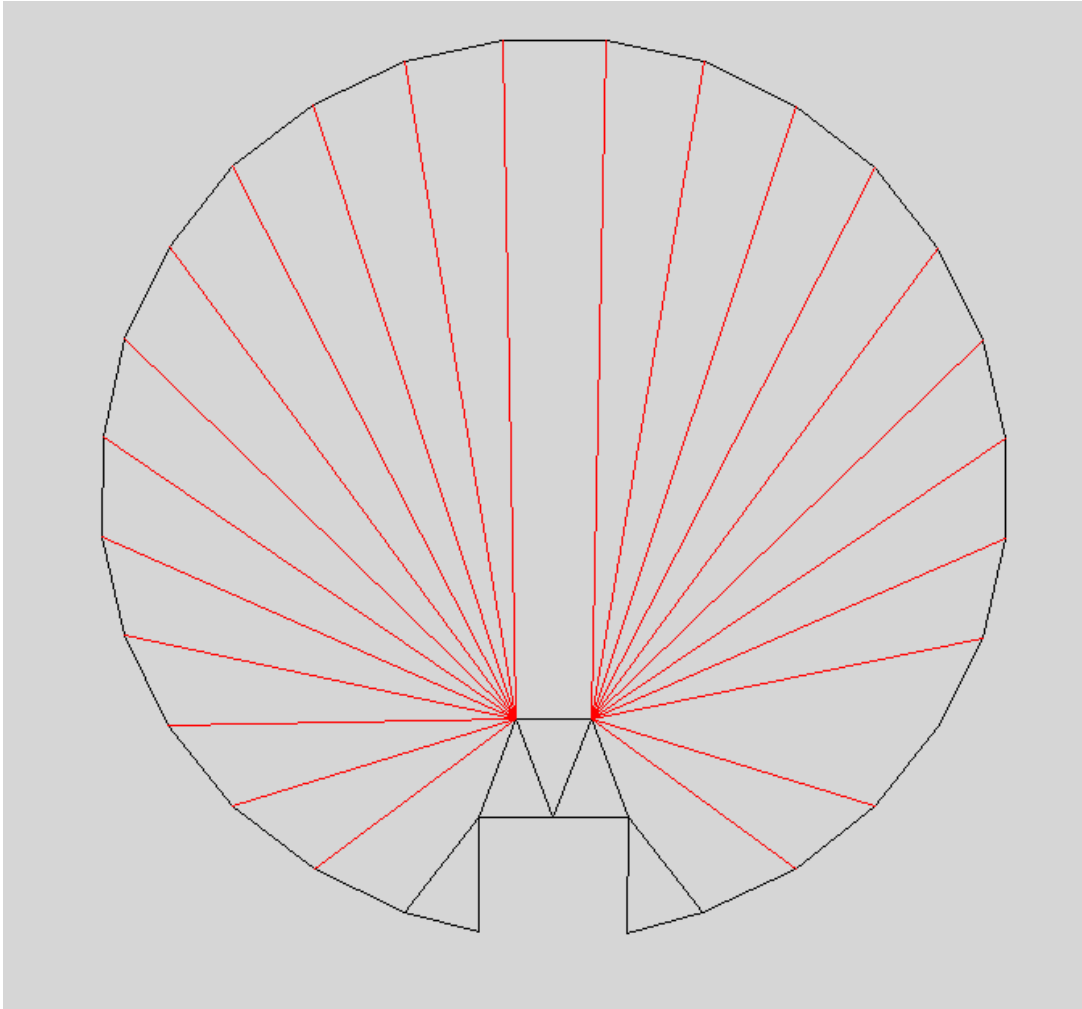
Gas cell shape at 3000m



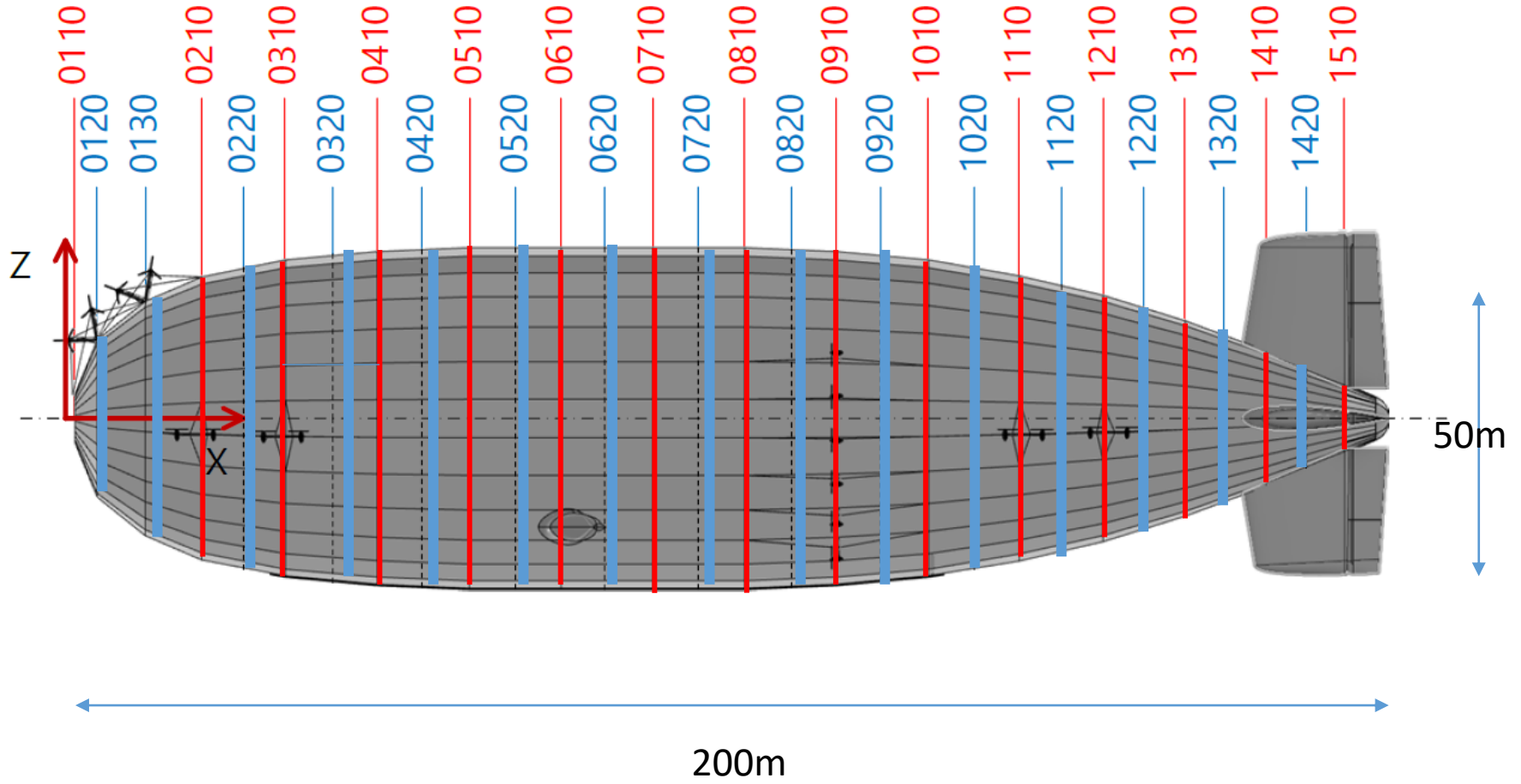
Ballonet for blimps / semi rigid airships





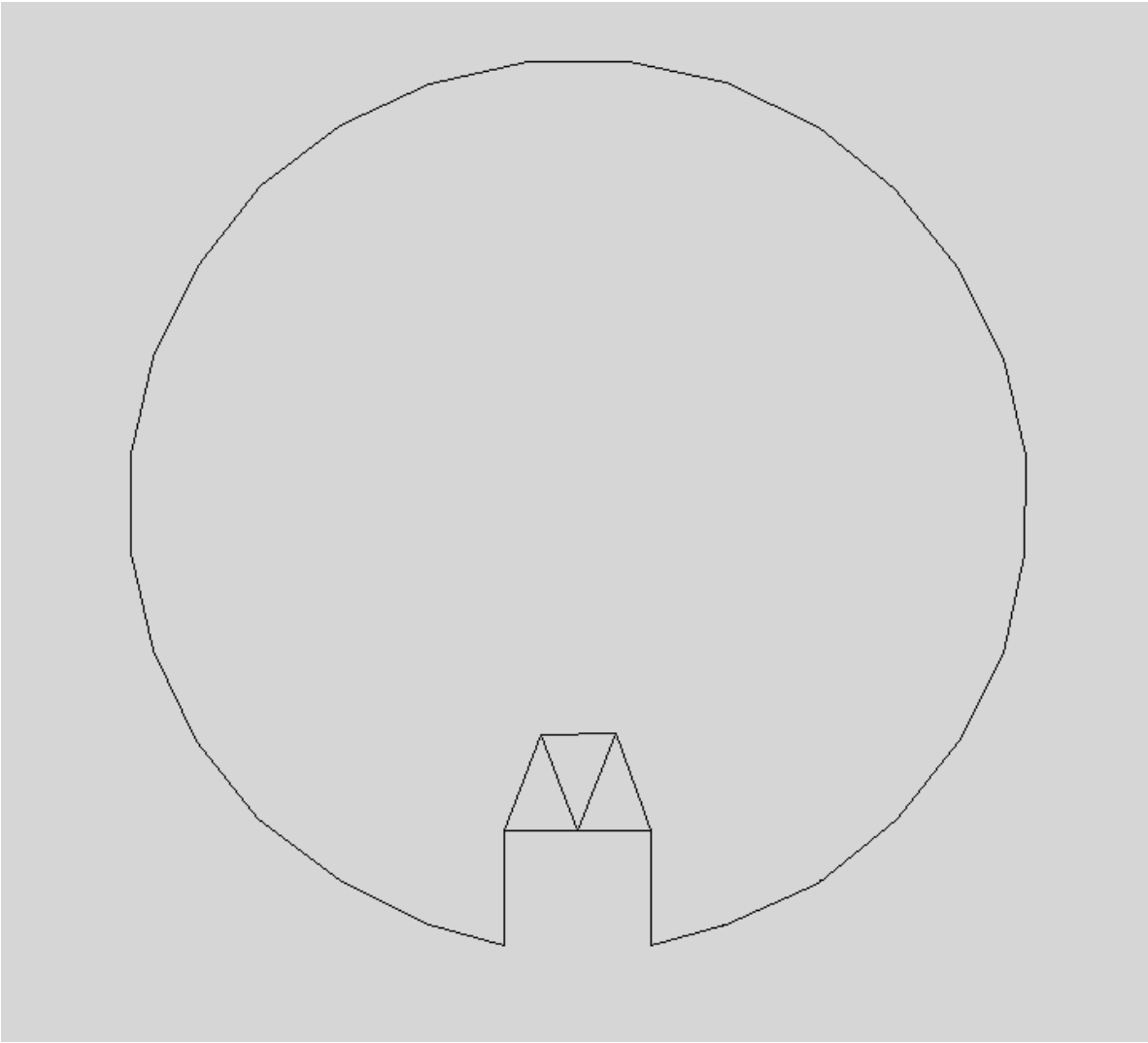


Main Frame

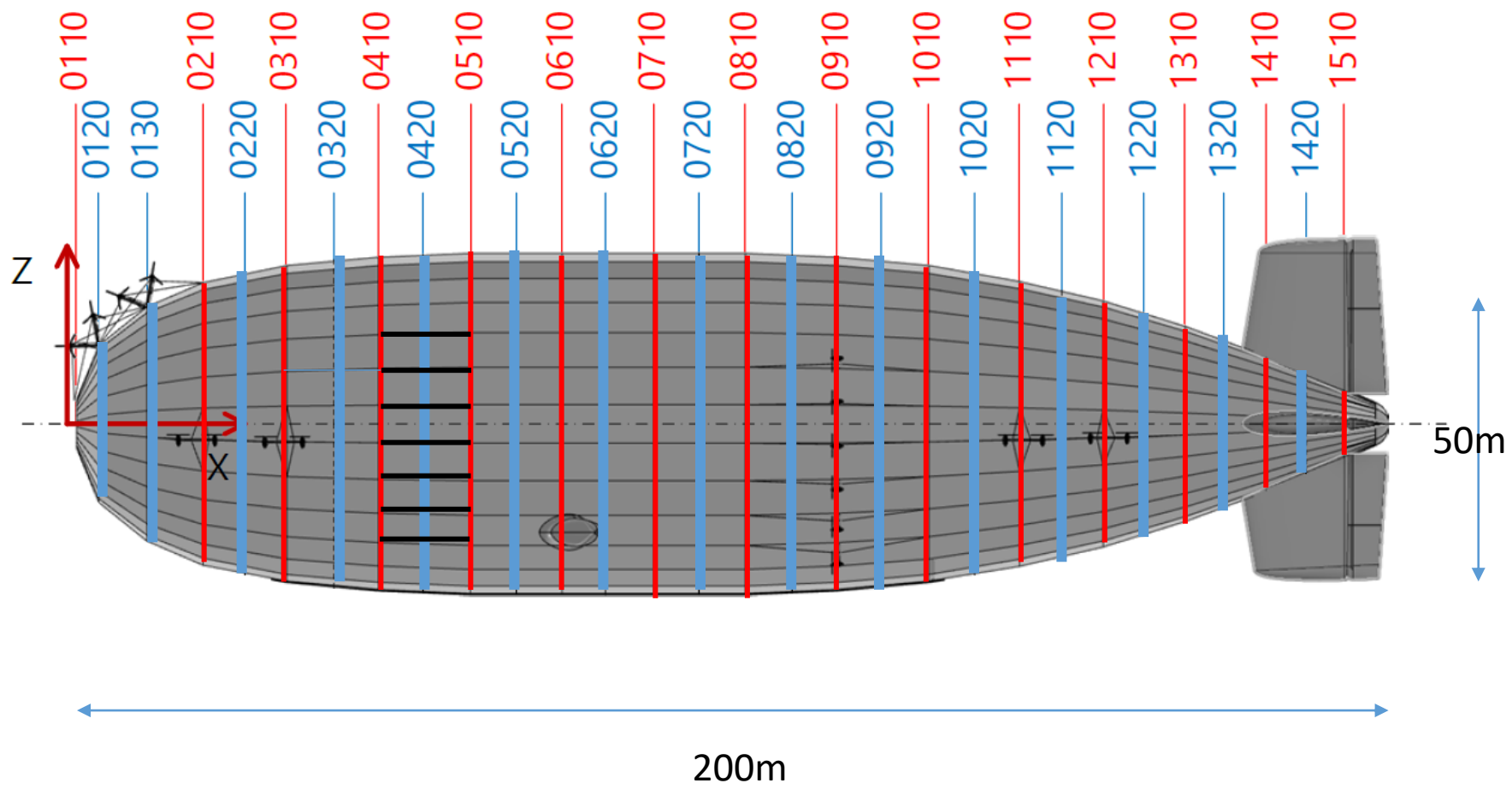


200m

50m



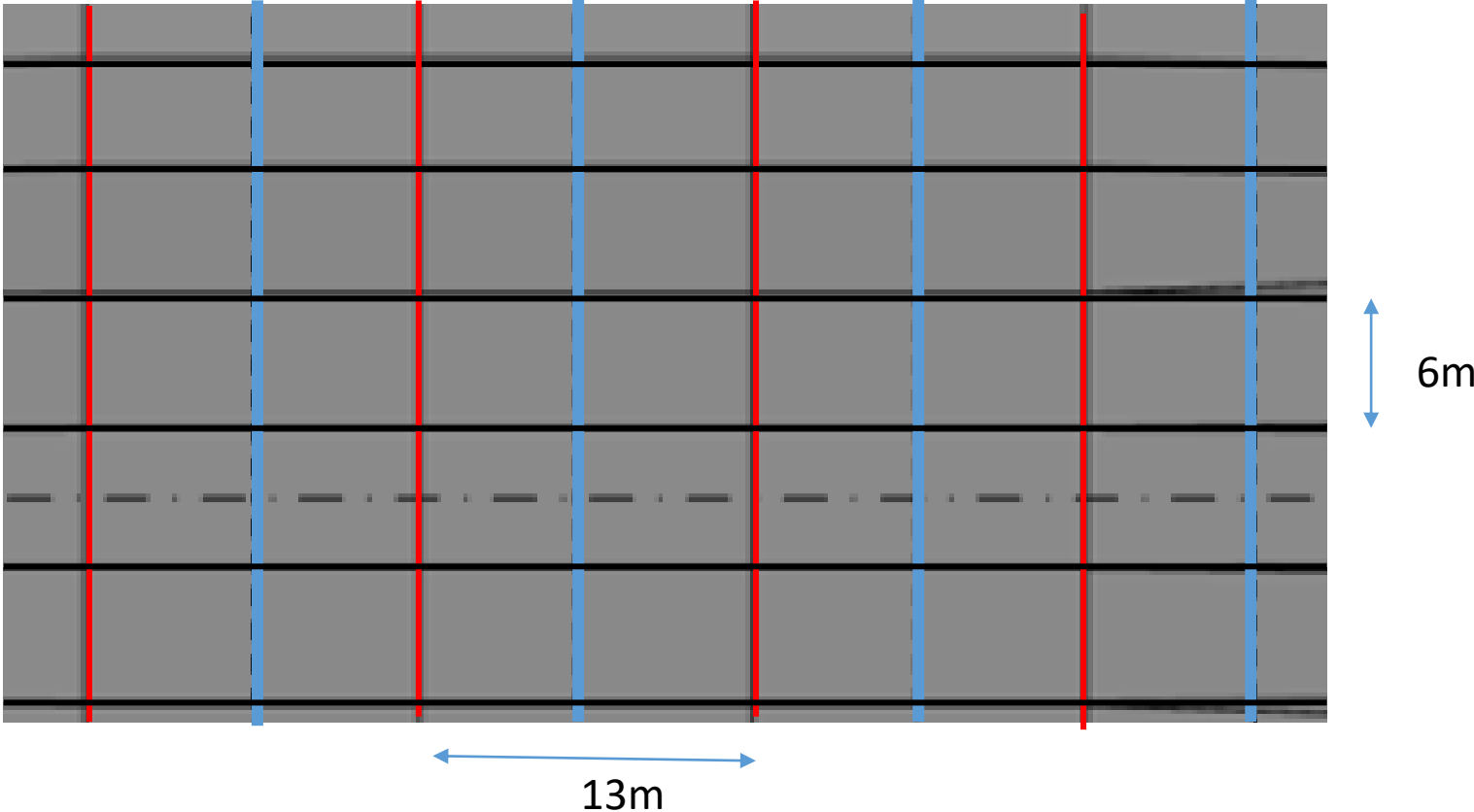
Secondary Frame

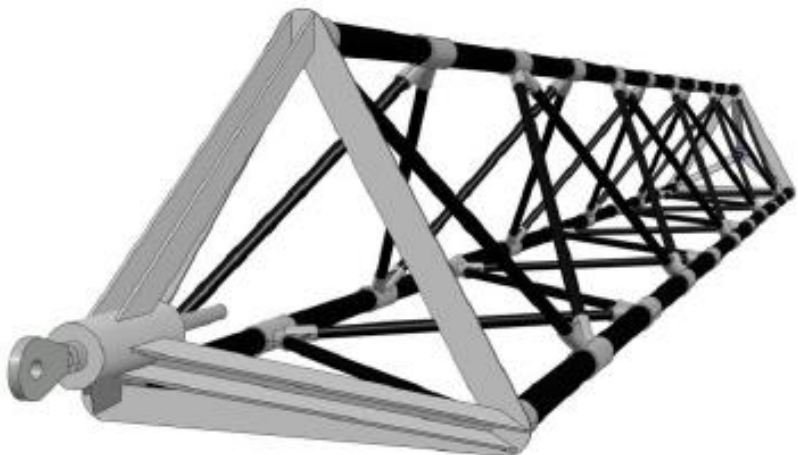




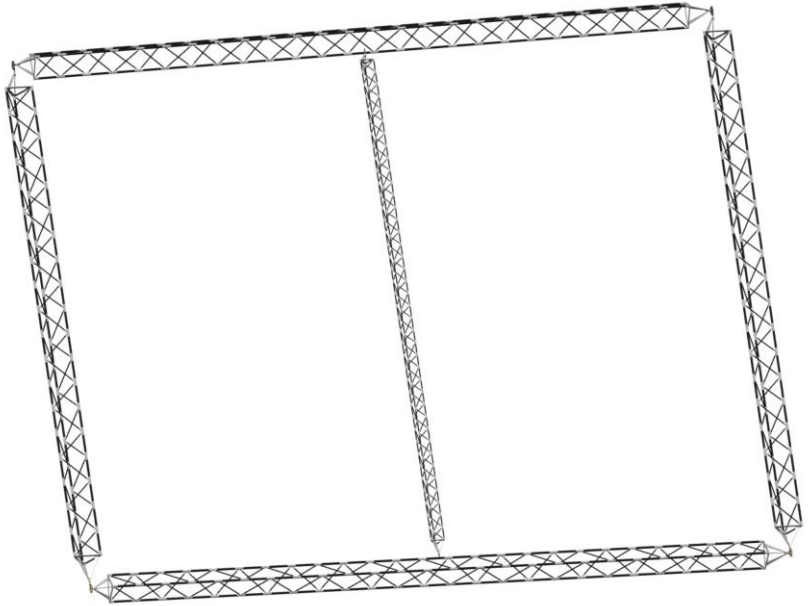
VIRTUAL REALITY DESIGN studio. Tous droits réservés 2023







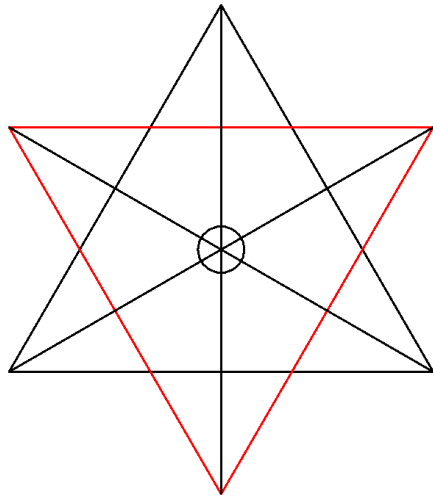
Purlin



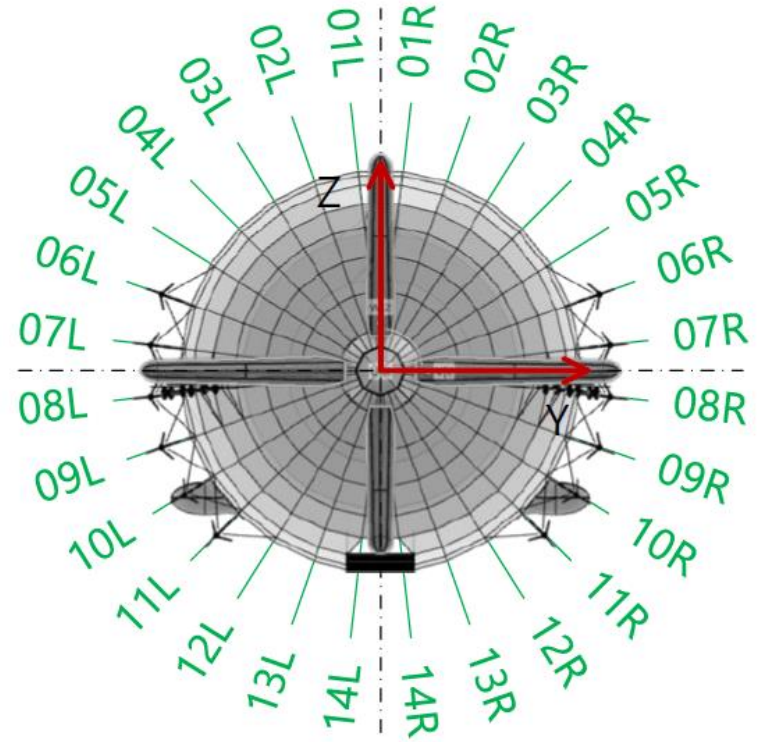
Main Frame

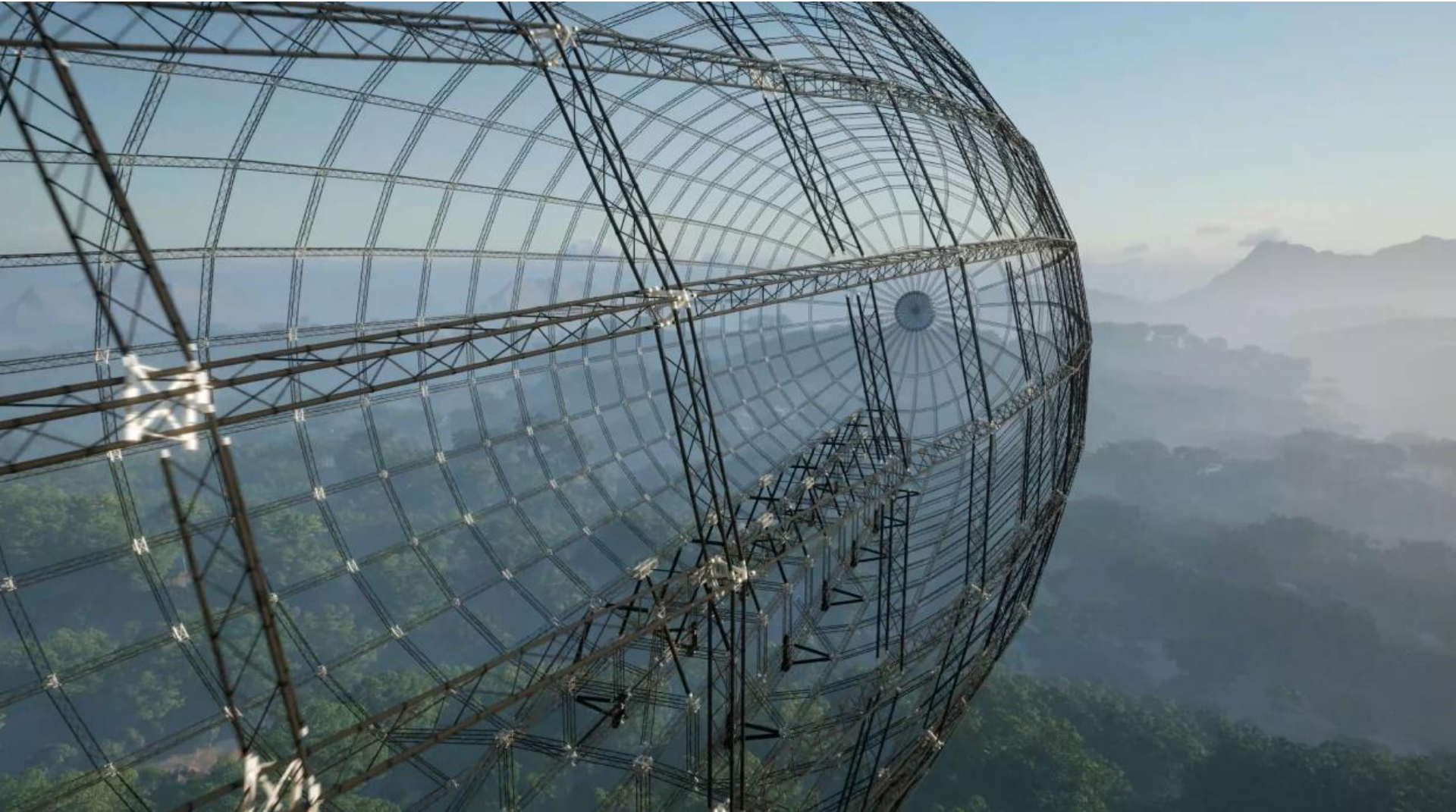
Secondary Frame

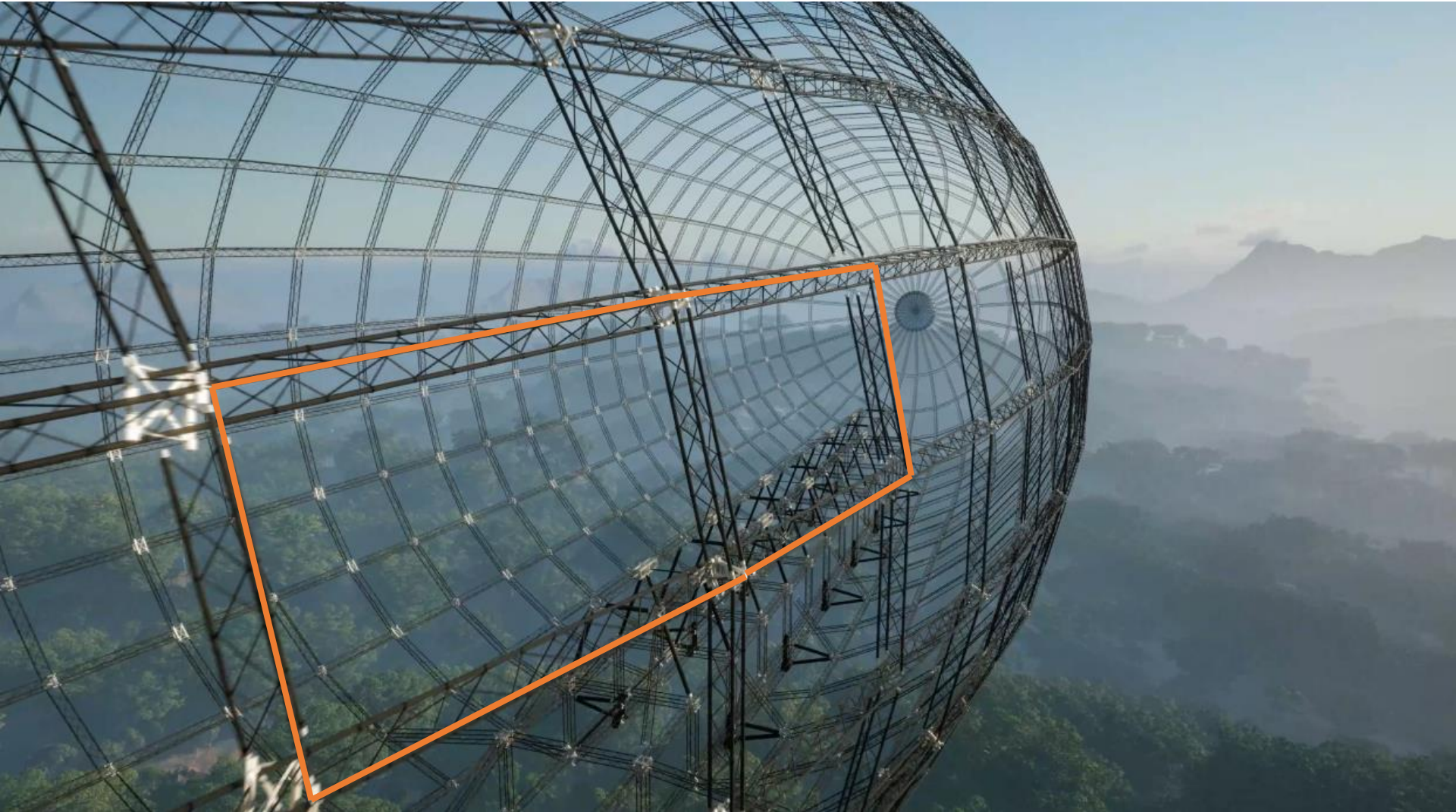
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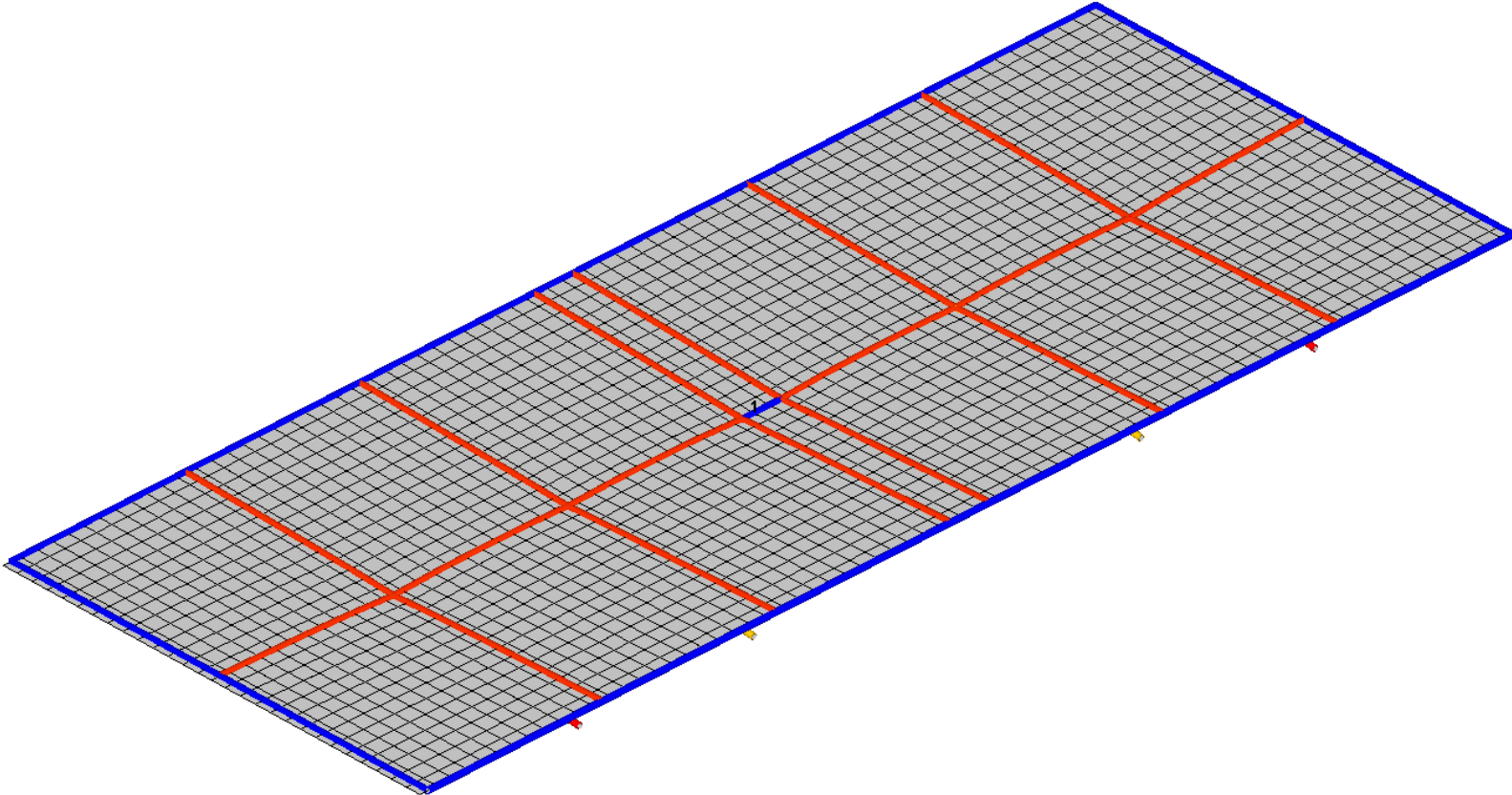


Main Frame

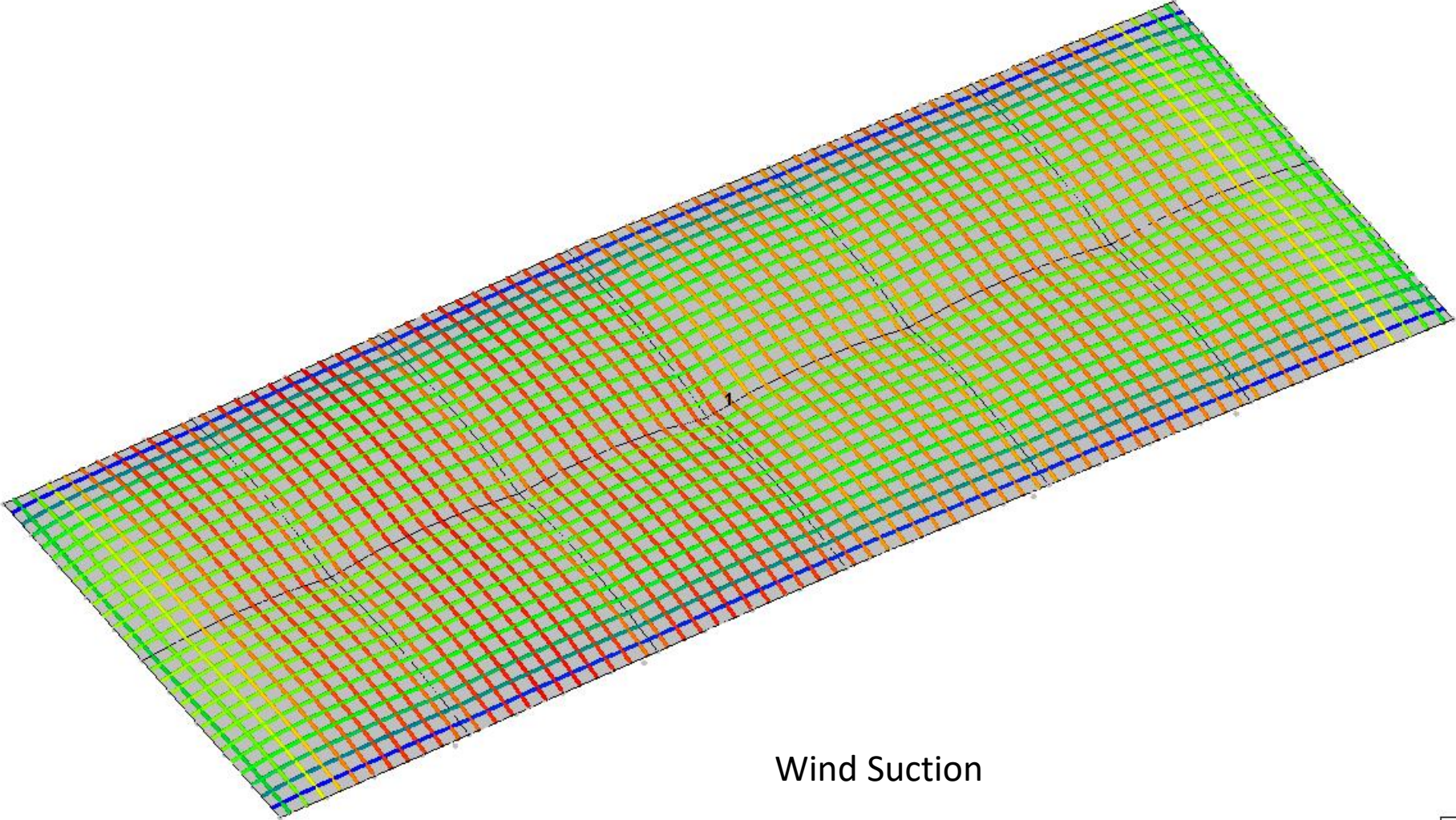






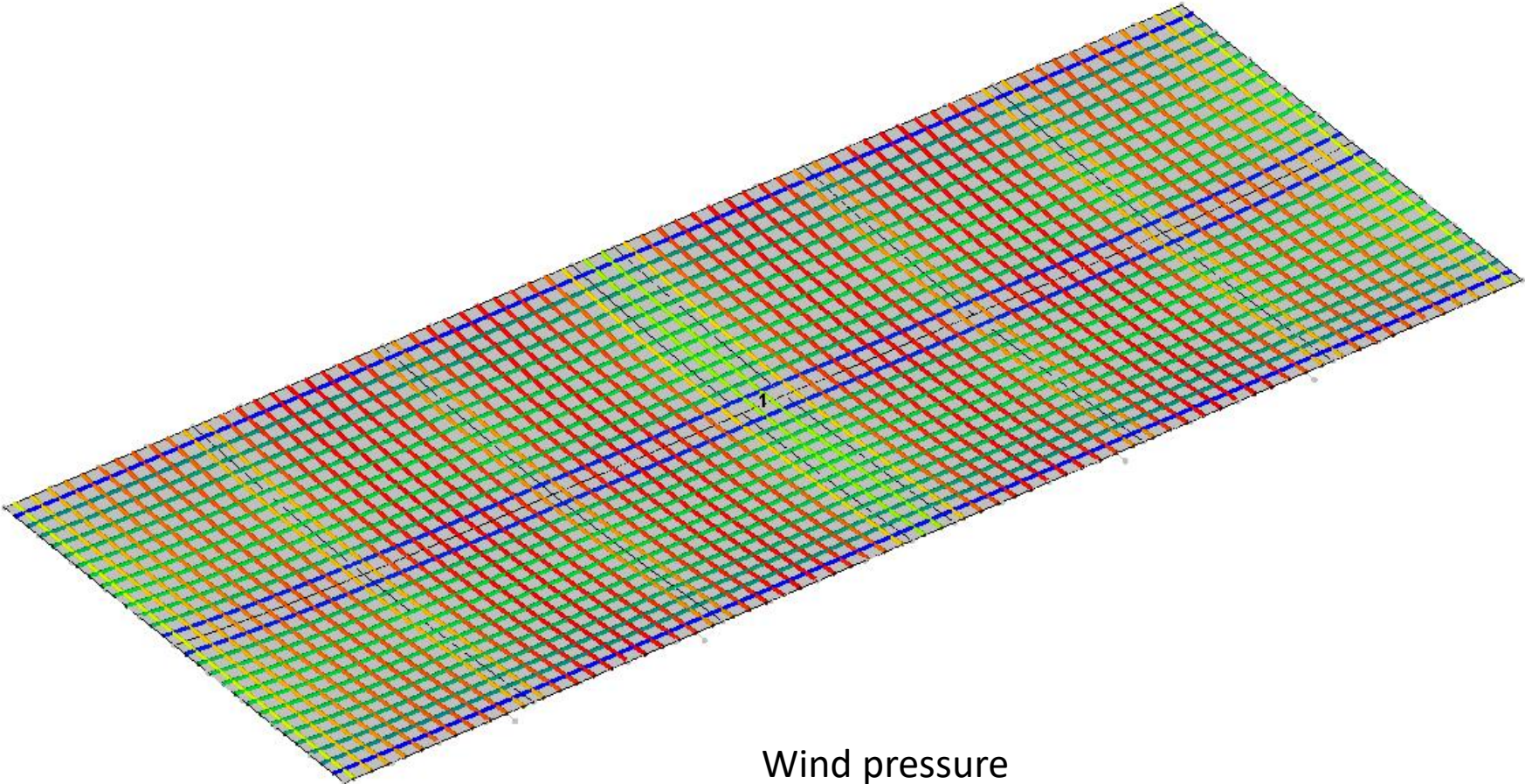


Envelope Panel



Wind Suction

Ma



Wind pressure

Challenges

- It has been done already in the past
- Lightweight
- Interfaces
- Water tightness
- Ventilation / internal pressure
- Tolerances
- Pretension level / eigenfrequency / ageing
- Lightning
- Costs
- Fire retardancy behavior