AERODYNAMIC PERFORMANCE INVESTIGATION OF ROCKET AIR BRAKES

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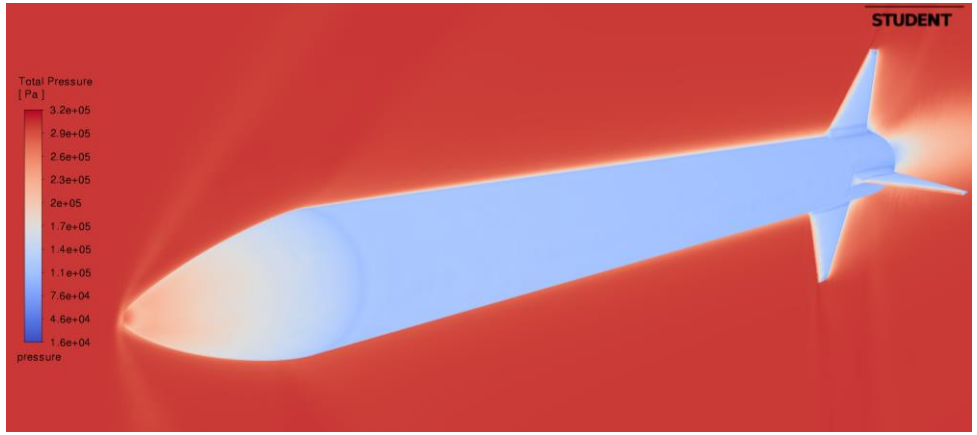
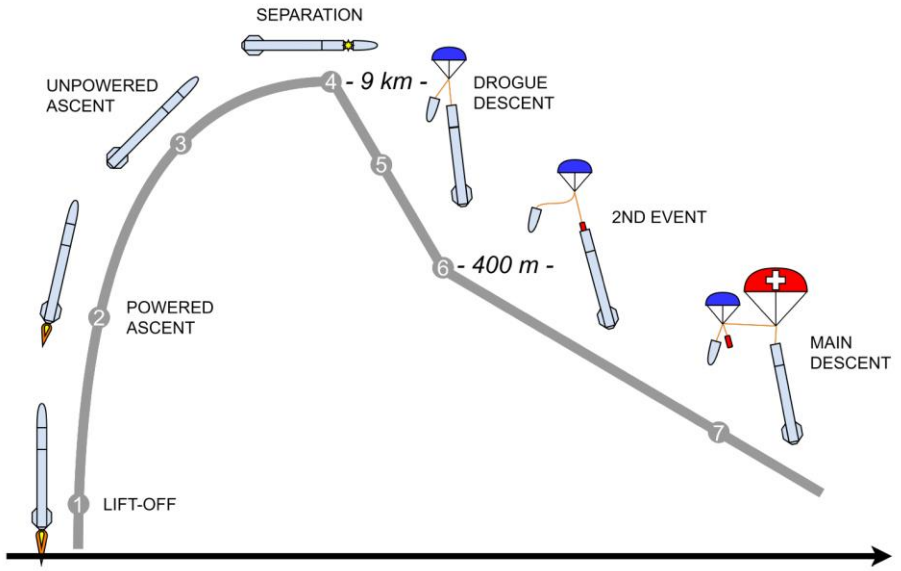
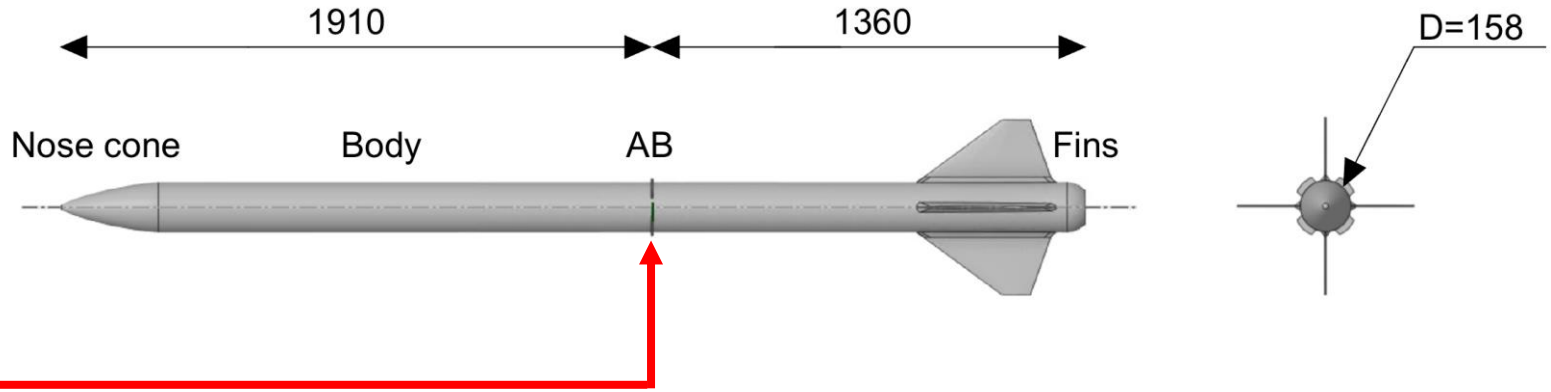


PROJECT DESCRIPTION

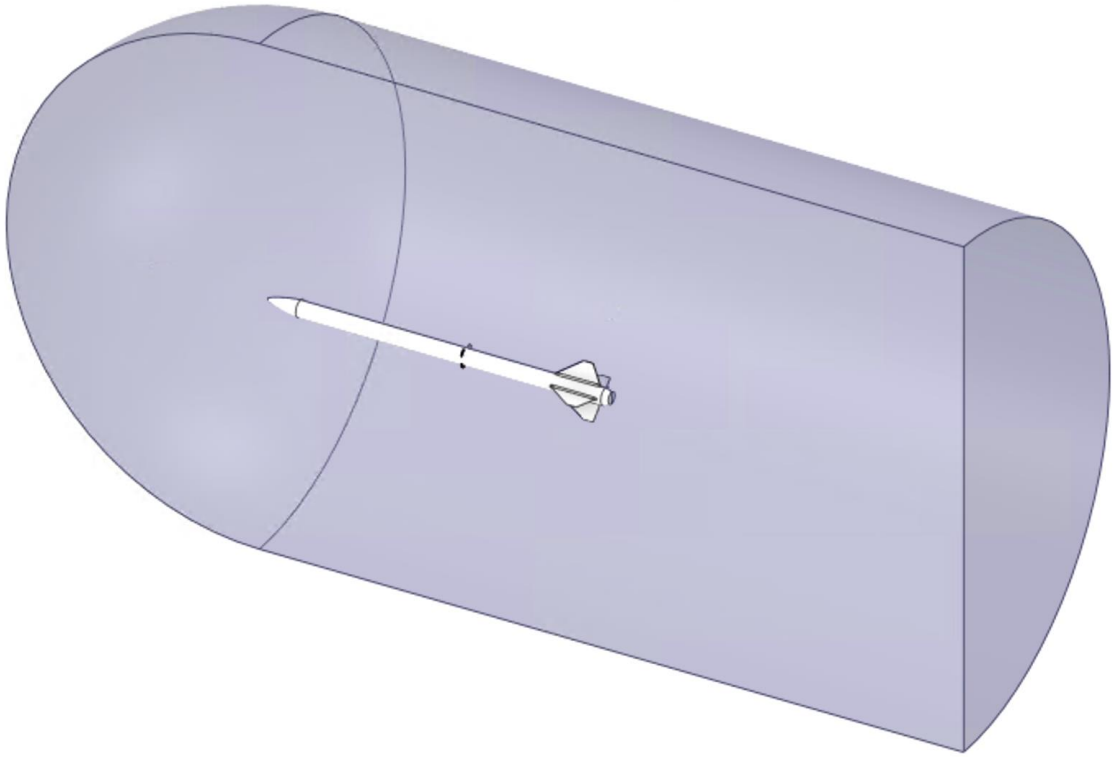
Goal: altitude control of sounding rockets during unpowered ascent using of air brakes

Air Brake (AB): deployed radially, these plates generate additional drag, thus decelerating the rocket

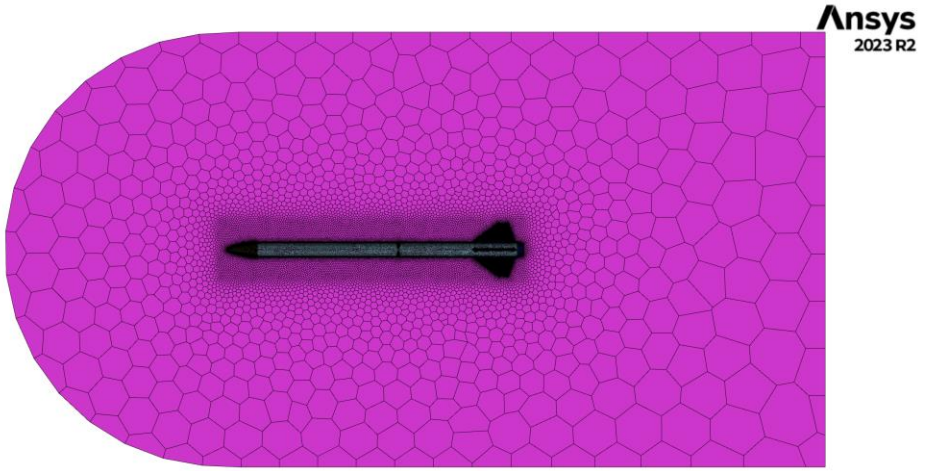




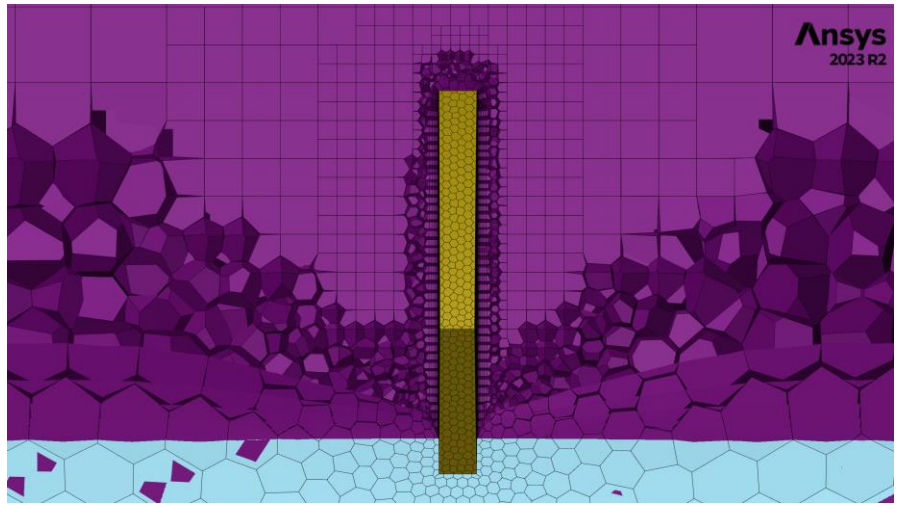
MODEL STRUCTURE



HALF C-SHAPED DOMAIN



POLY-HEXCORE MESH

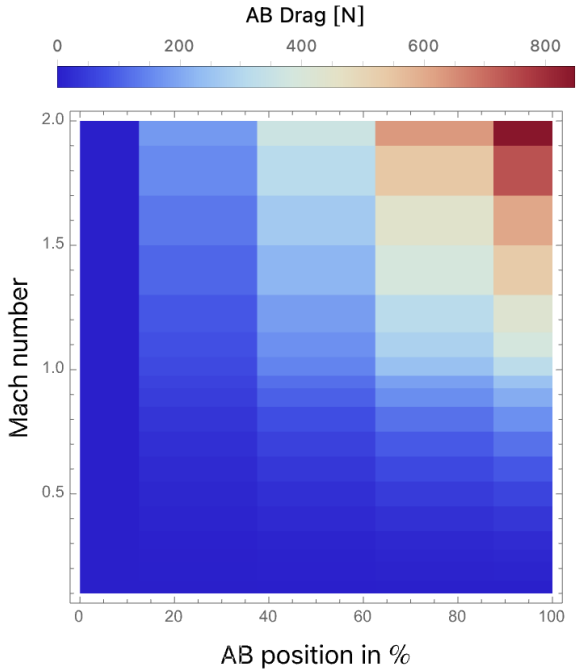


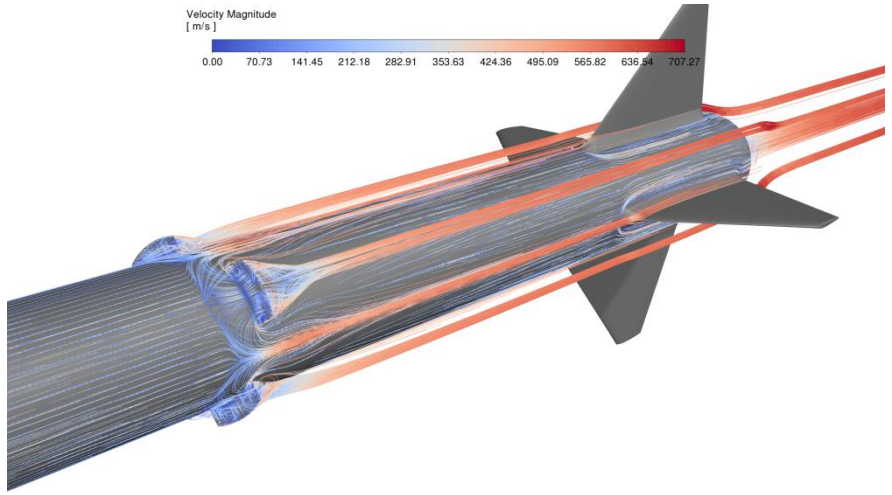
MESH AROUND AB

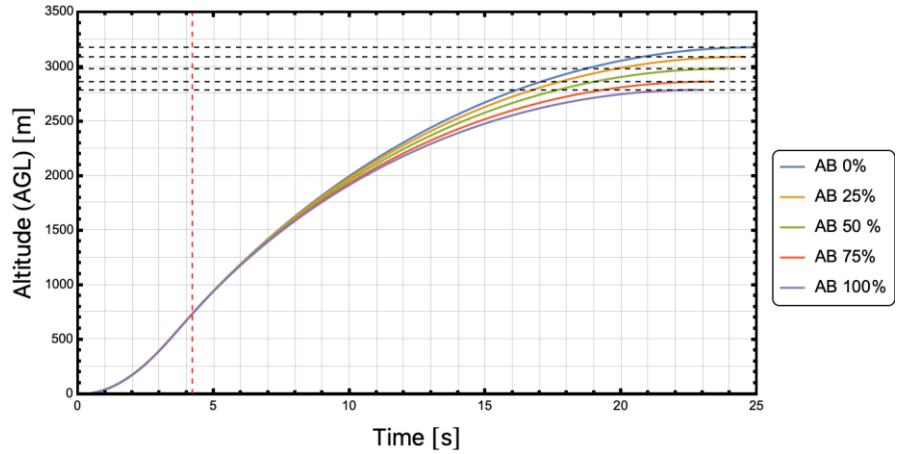
SIMULATION PREFERENCES

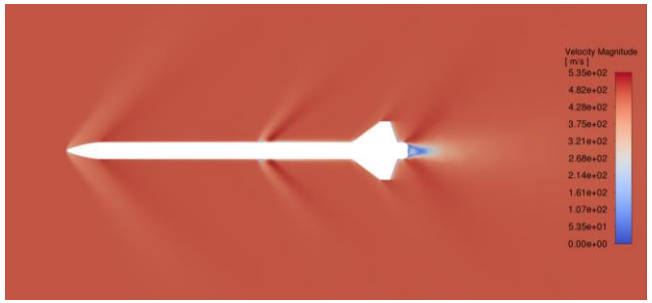
- Total of 85 cases with different AB deployment (0-100%) and Mach numbers (0.1-2.0)
- Steady-state pressure based solver
- $k - \varepsilon$ turbulence model with enhanced wall treatment
- Energy equation turned on
- Working fluid: air with ideal gas & Sutherland viscosity model
- Boundary conditions:
  - Pressure far-field, with values based on standard atmospheric model at 3000 m ASL
  - No-slip wall
  - Symmetry

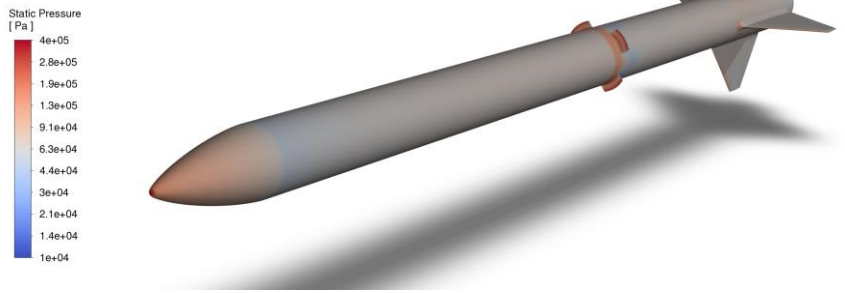
RESULTS

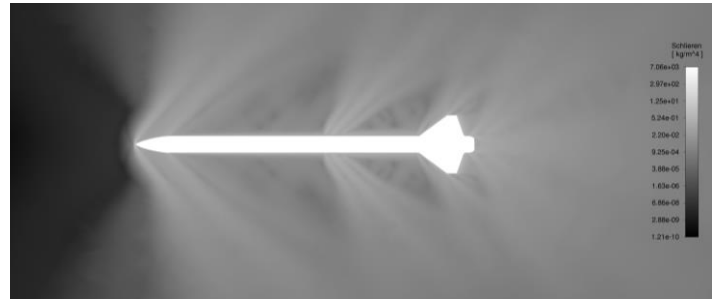

AB Drag [N]
0
200
400
600
800
Mach number
2.0
1.5
1.0
0.5
0
20
40
60
80
100
AB position in %


Velocity Magnitude
[m/s]
0.00
70.73
141.45
212.18
282.91
353.63
424.36
495.09
565.82
636.54
707.27


Altitude (AGL) [m]
3500
3000
2500
2000
1500
1000
500
0
0
5
10
15
20
25
Time [s]
AB 0%
AB 25%
AB 50 %
AB 75%
AB 100%


Velocity Magnitude
[m/s]
5.35e+02
4.82e+02
4.28e+02
3.75e+02
3.21e+02
2.68e+02
2.14e+02
1.61e+02
1.07e+02
5.35e+01
0.00e+00


Static Pressure
[Pa]
4e+05
2.8e+05
1.9e+05
1.3e+05
9.1e+04
6.3e+04
4.4e+04
3e+04
2.1e+04
1.4e+04
1e+04



CONCLUSION

- Total of **85 cases** with different AB deployments and velocities
- **Peak efficiency** of AB at **Mach 0.8** (over 80%)
- Static stability of rocket remains unaffected
- Maximum of **800 N** generated drag
- Trajectory simulations:
  - Apogee: 3182 m → 2790 m (full AB deployment)
  - **12.3% relative change in apogee**
  - AB system is capable of significantly decreasing the apogee