Considerations for High-Altitude Rocket Flights

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NARCON
Feb 25, 2017

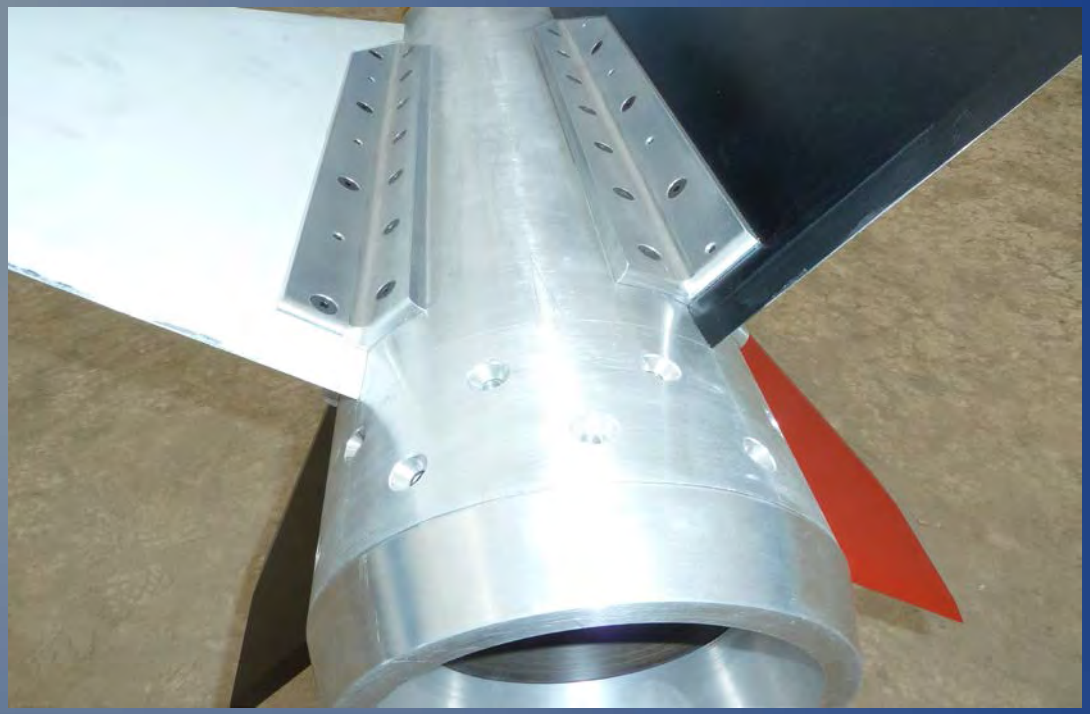

Las Cruces
Alamogordo

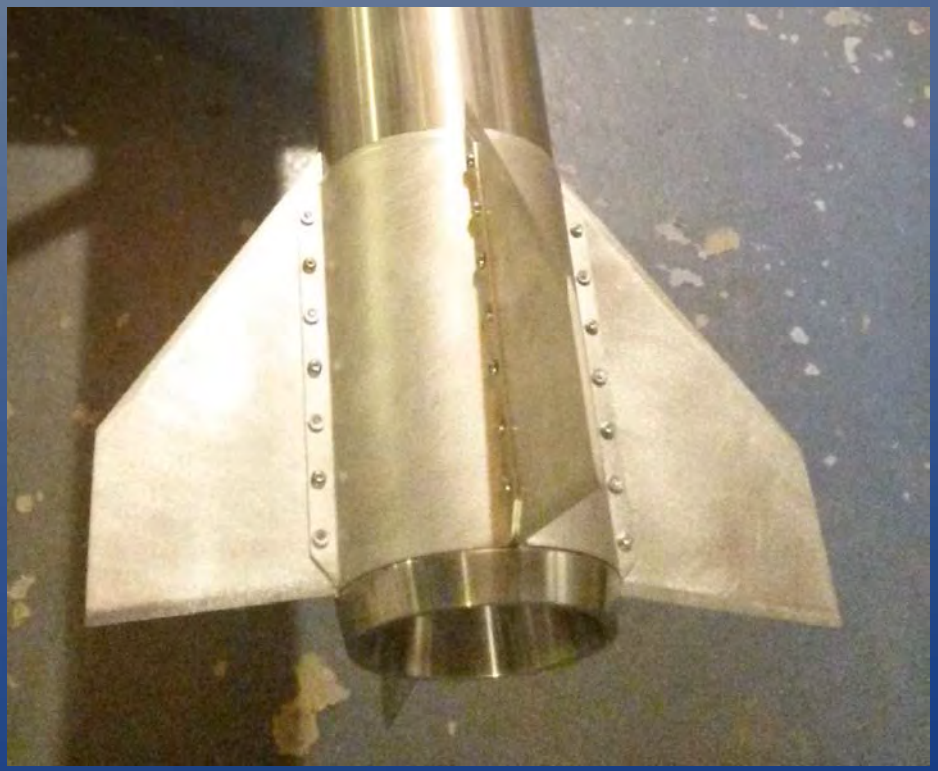
Challenges

- Design considerations
- Waiver/Field Suitability
- Stability
- Structural integrity
- Electronics selection
- Recovery system initiation
- Finding it after the flight!!

Design Considerations

- **Diameter - m**inimum or near-minimum
- **Fin attachment** – surface, fin can
- **Single tube**, not usually broken
- **Motor retention** – forward , Slimline
- **Deployment** – small drogue or DD
- **Nose Cone** – Haack Series, VK ogive
- **Optimize** for altitude?





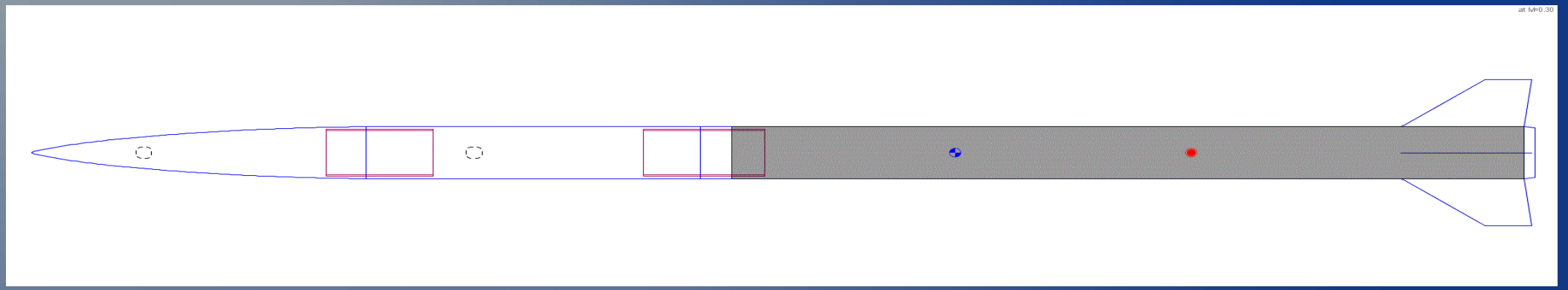
Design Considerations

Relative Efficiency

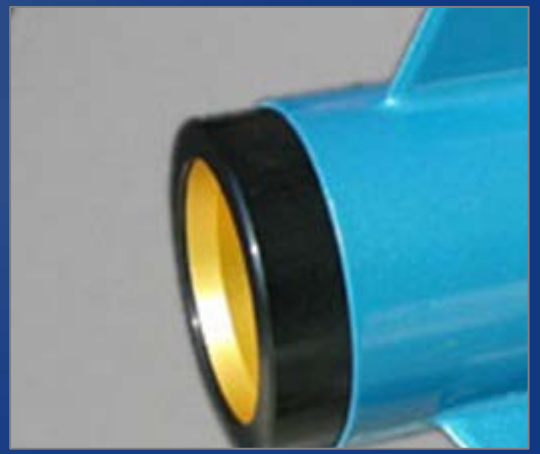
Project	Altitude (M)	Total Impulse	Ratio
ARCAS	60960	40000	1.5
GoFast	116000	480000	0.2
FourCarbYen	32004	34150	0.9
Qu8k	36880	143000	0.3

Design Considerations

- One piece air frame, not usually broken
- Single use or re-usable?

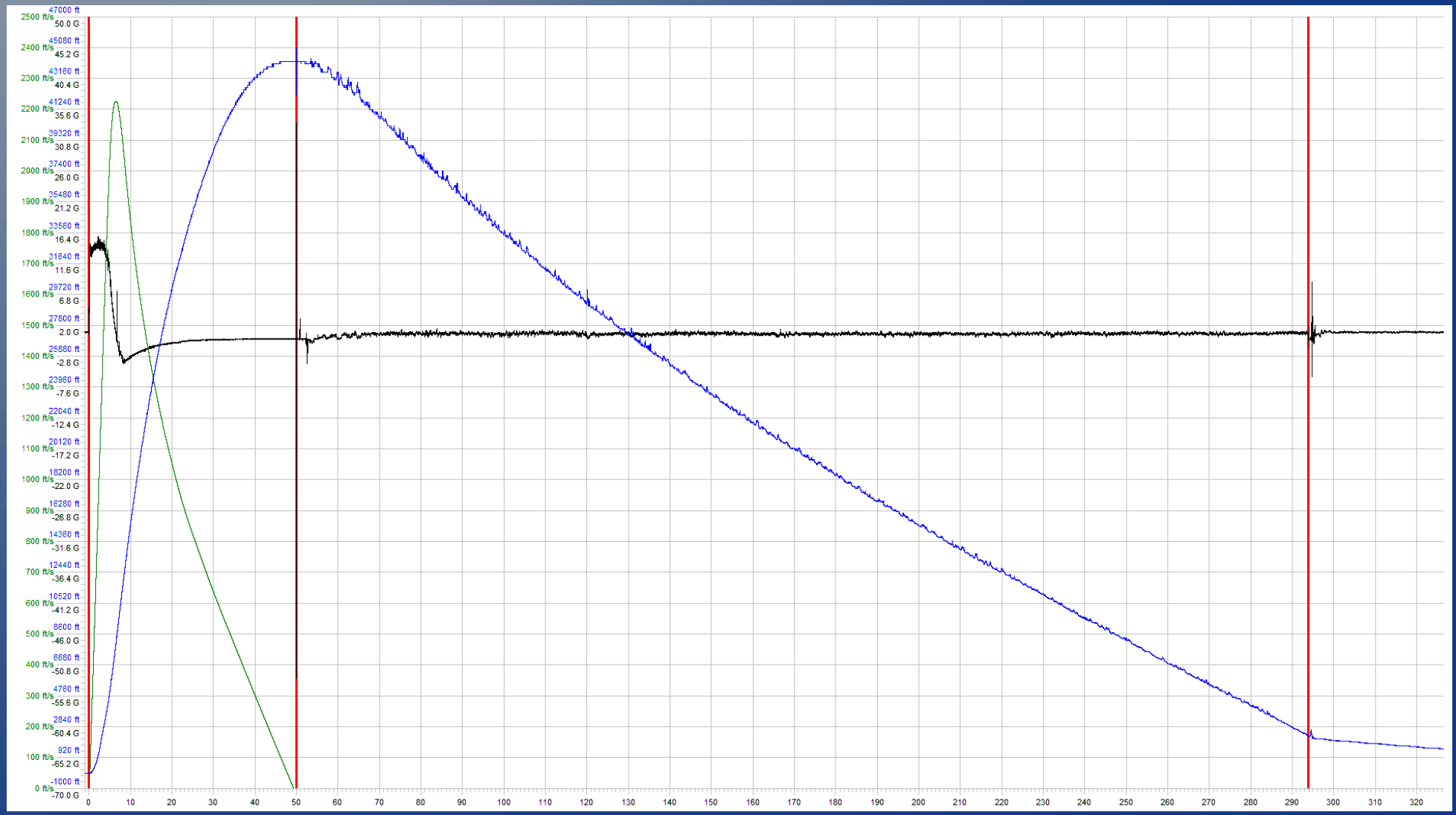


Motor Retention - forward, Aeropak, Slimline



Design Considerations

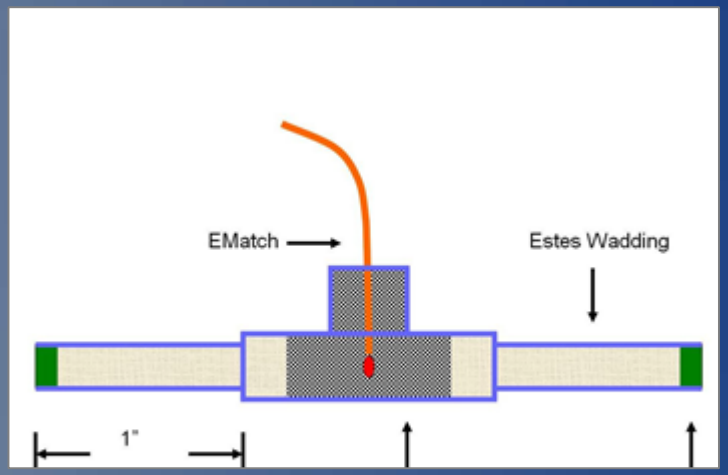
Deployment – drogue/main-only, DD
Altitude, wind dependent
Flight below was 170 fps descent rate



Design Considerations

BP efficacy at altitude

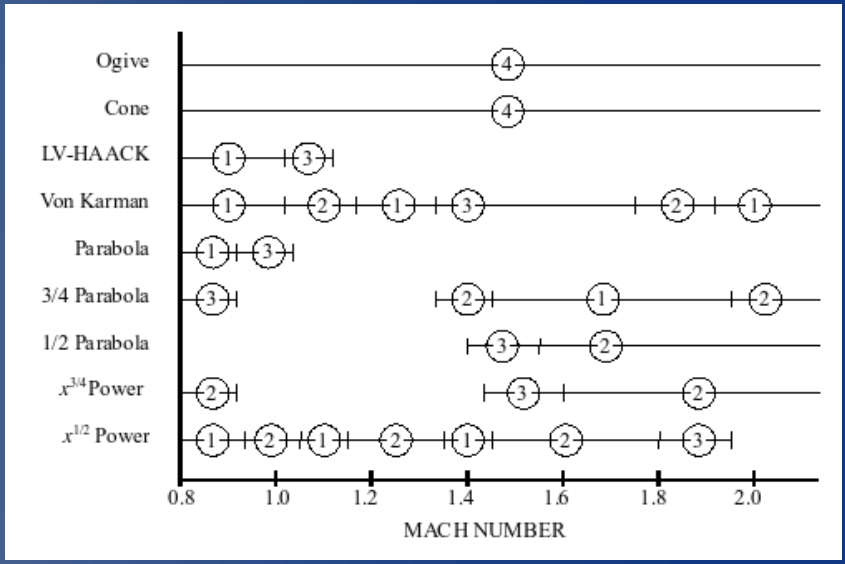
- above 20,000', incomplete combustion
- sealed charge
- “tee” or “cannon”
- “head-end” e-match placement
- CO-2

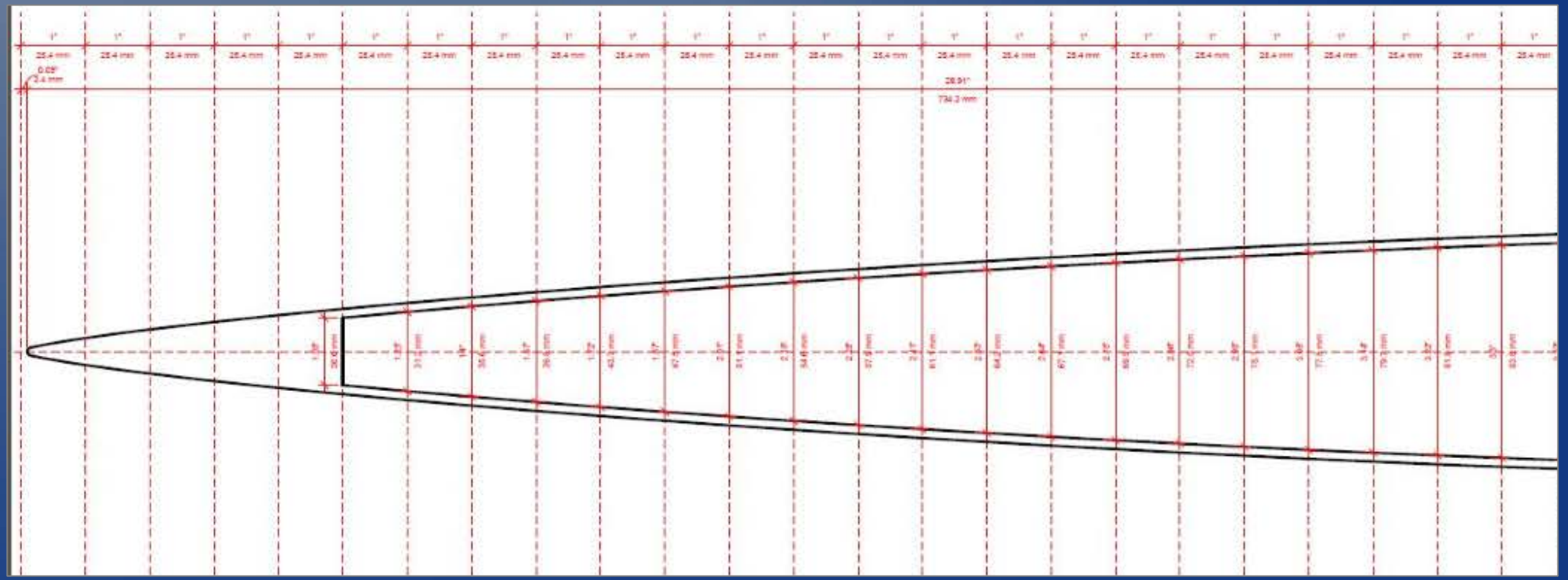

EMatch
Estes Wadding
1"

Design Considerations

Nose Cone

- Haack Series
- Mathematically derived
- Minimizes drag
- Von Karmen min drag for given L:D





Design Considerations

To Optimize or Not?

- Maximize mass fraction
- Minimize length, drag

Sim Tools

Open Rocket

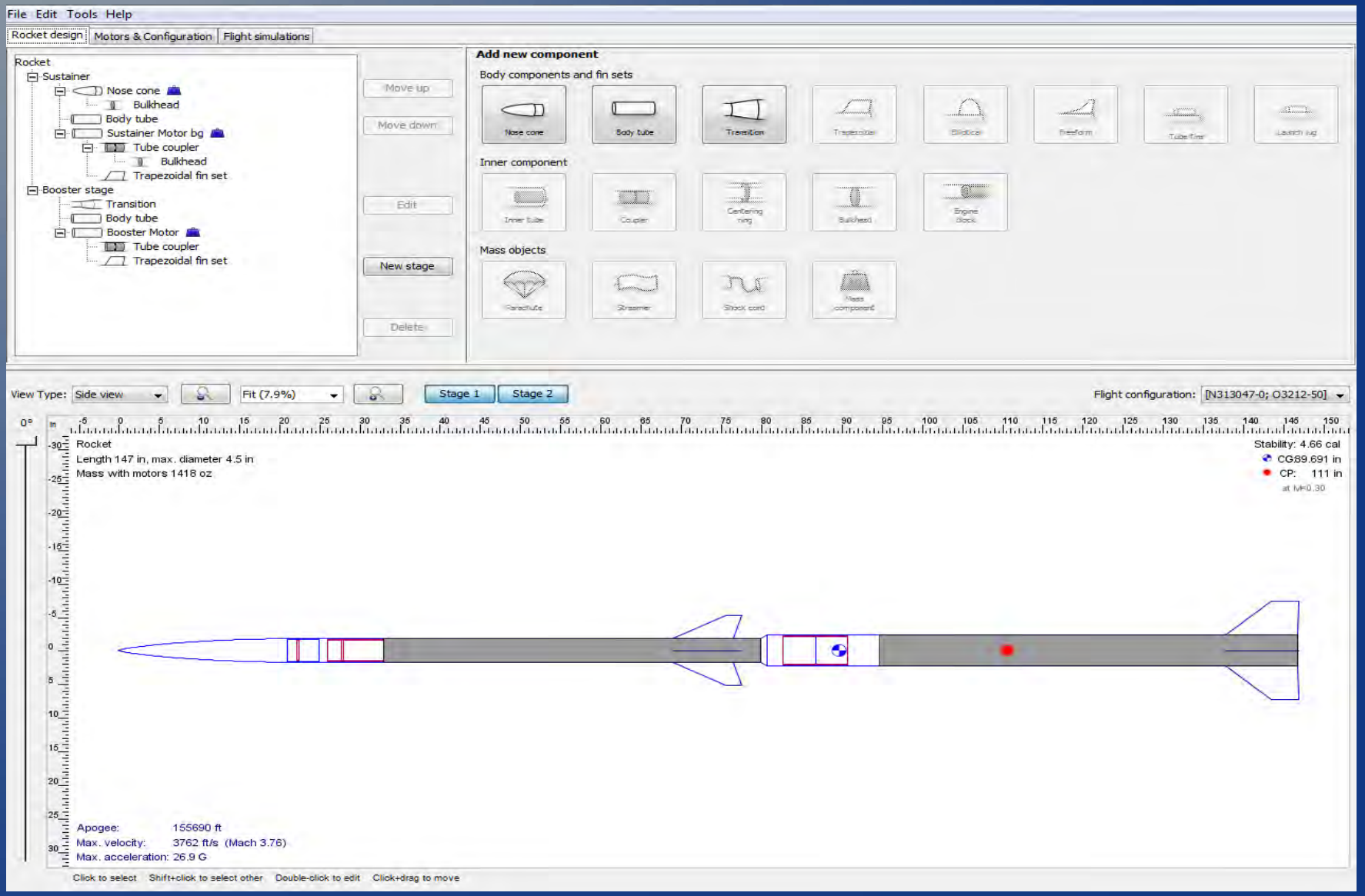
RasAero

RockSim

FinSim

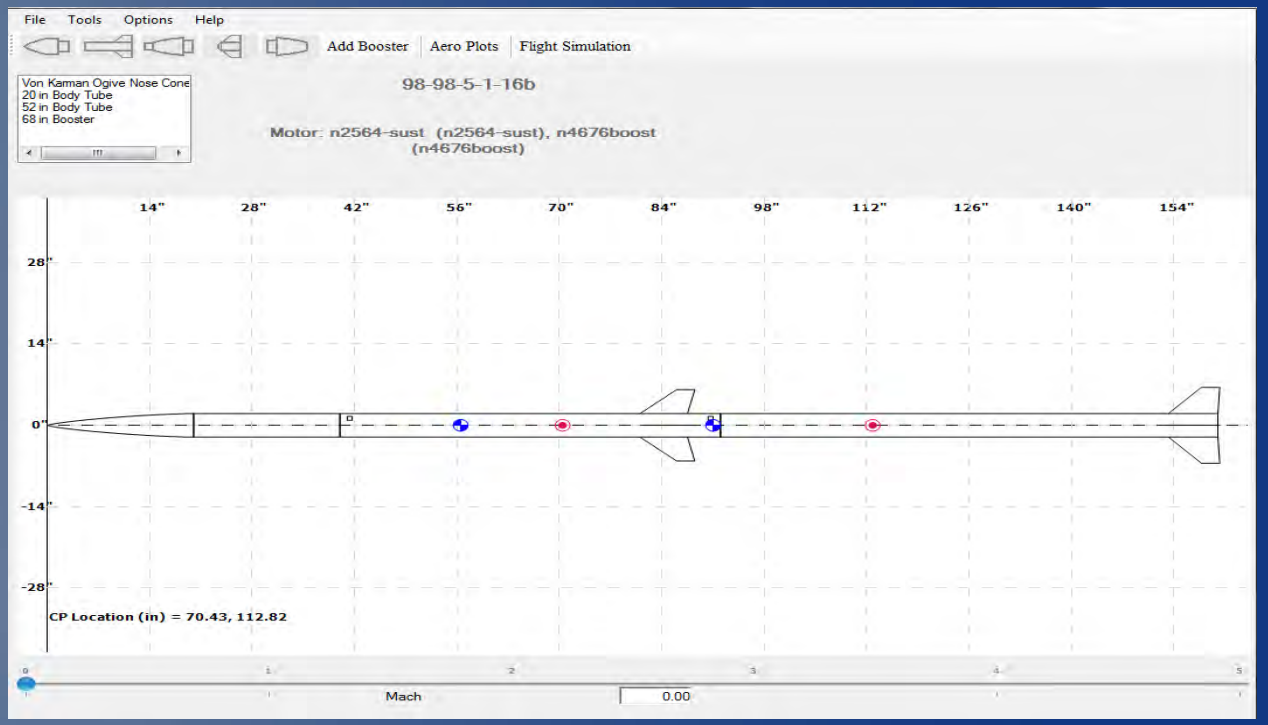
Open Rocket

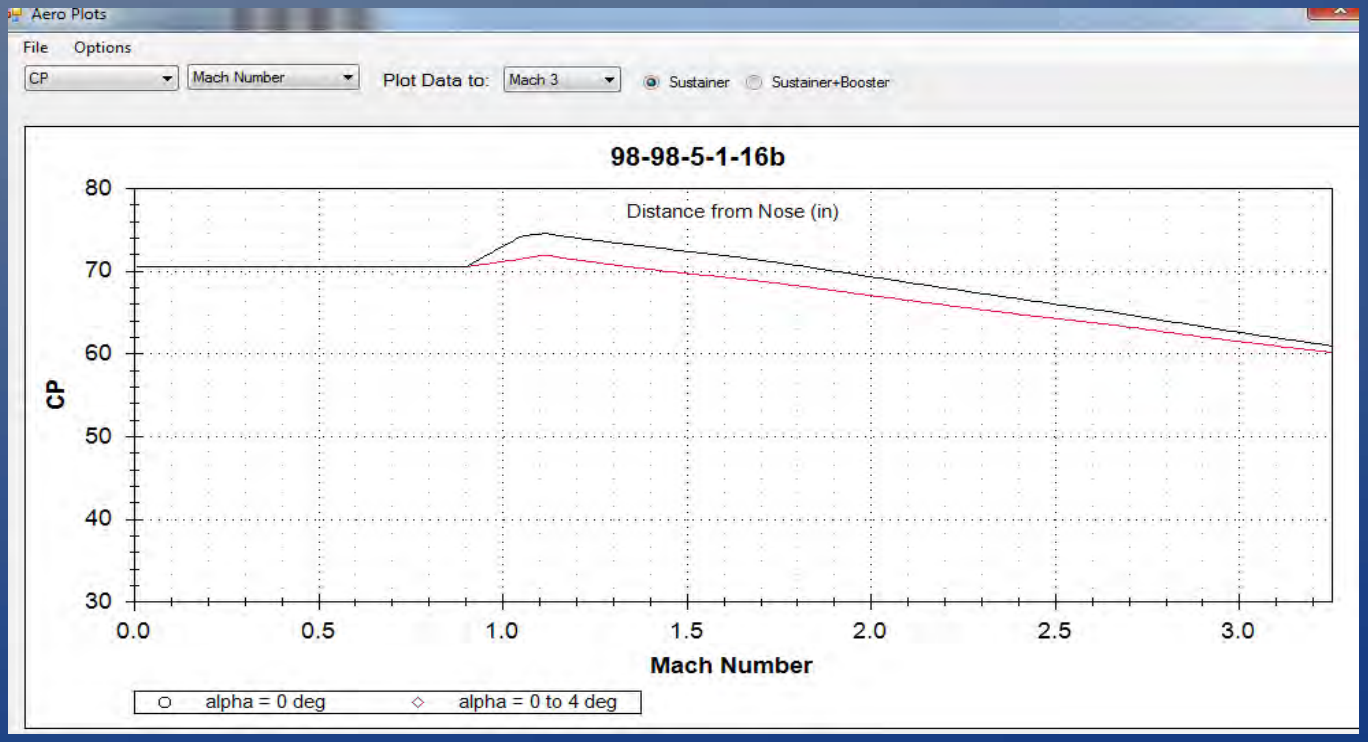
- Good drag, sim estimates
- Nice design tool



RasAero

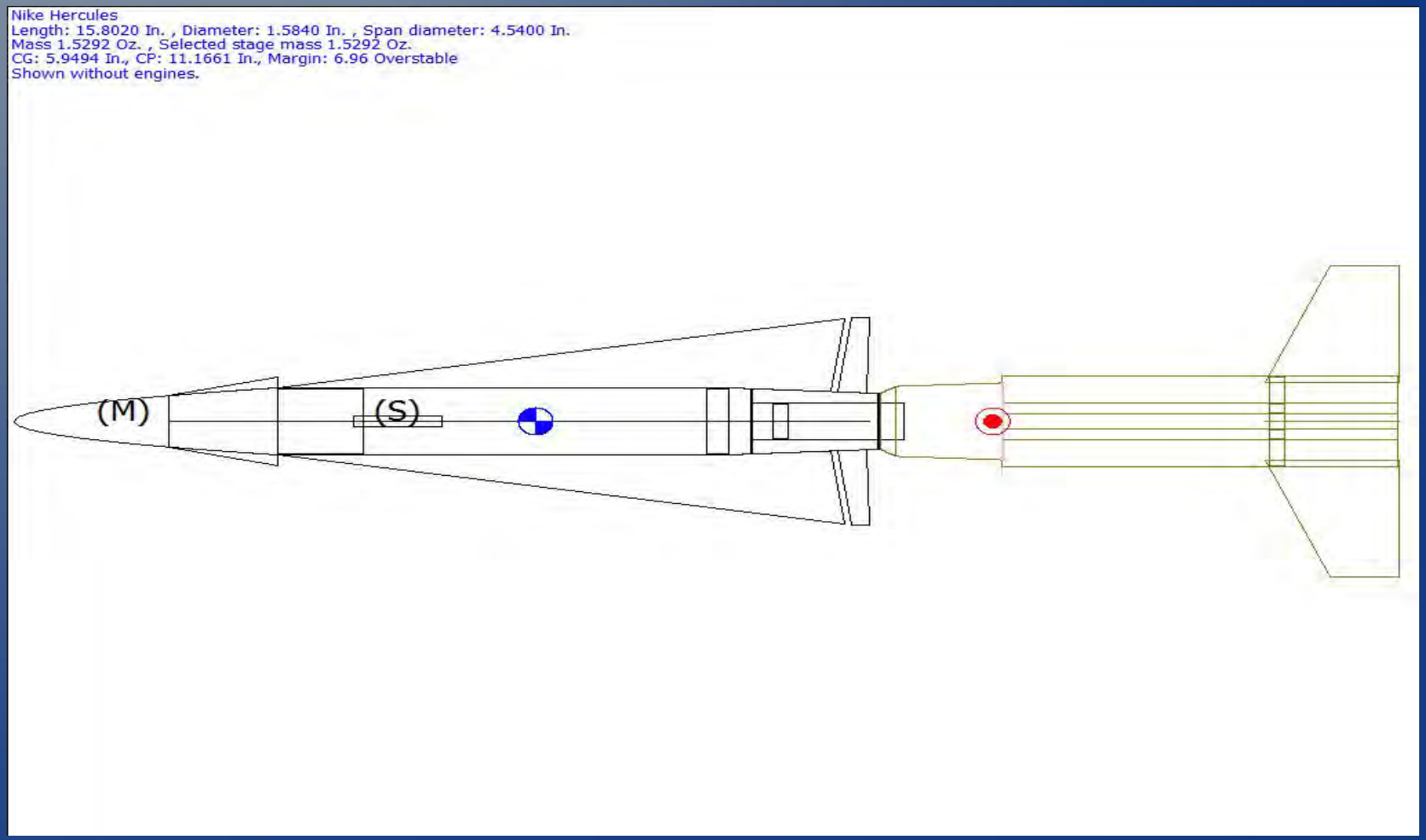
- Detailed aero plots
- 2-Stage Capable (RA II)
- Quirky interface
- Not a design tool
- Optimistic altitude sims





RockSim

- Underestimates altitude
- Overestimates drag
- Good sub-sonic
- Required by TRA for dispersion

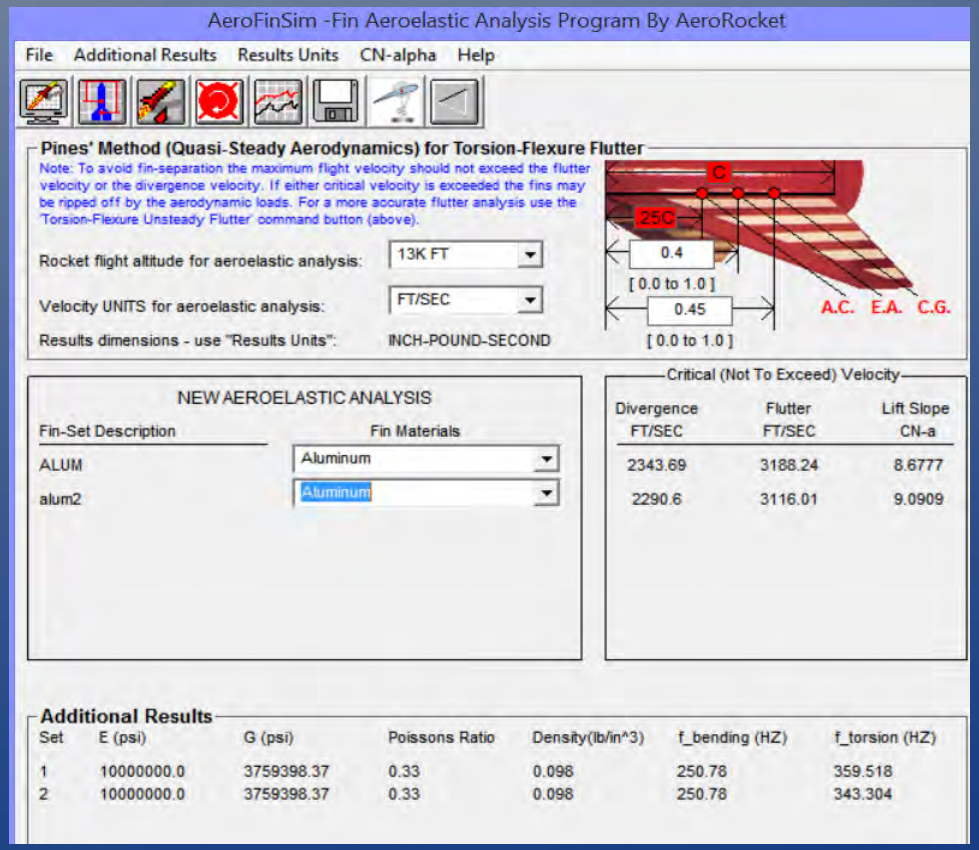


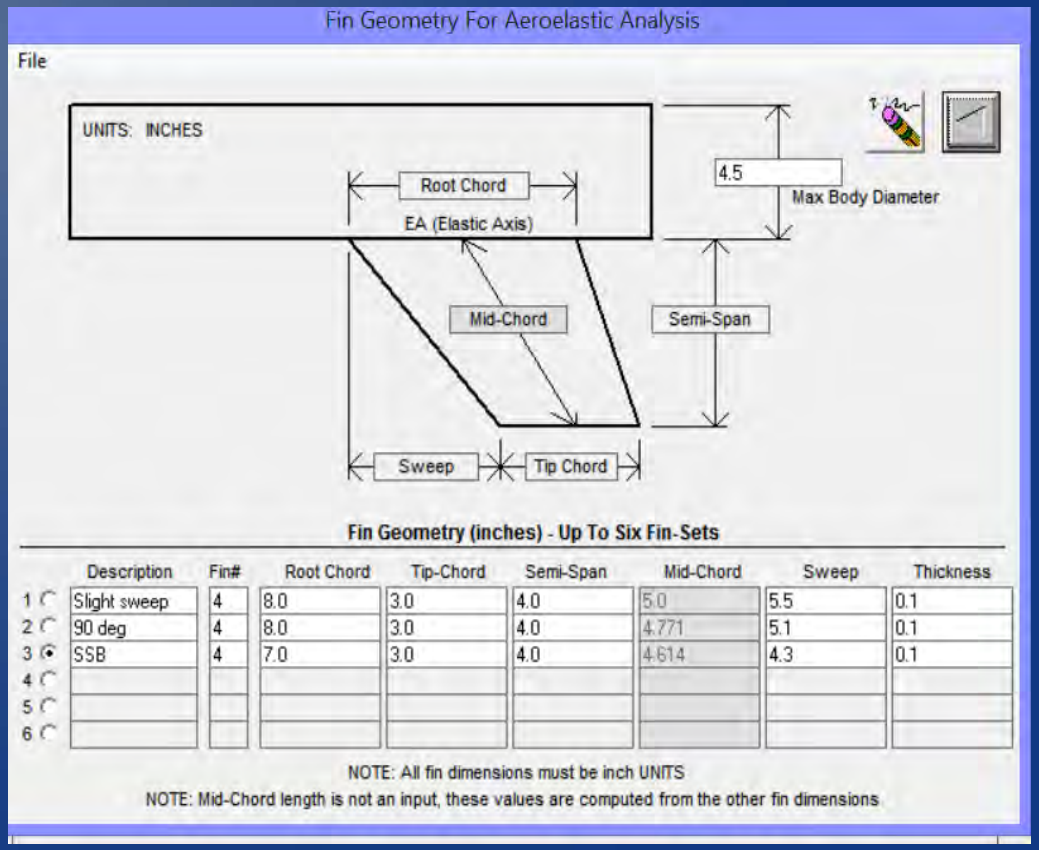
Fin Sim

Structural Analysis
- Computes max bending
- Computes lift, drag
- Displays highest speeds

Spin Stabilized
- Canted fins

Flutter & Divergence Velocity
- Up to 6 fin sets
- Pines or Theodorsen

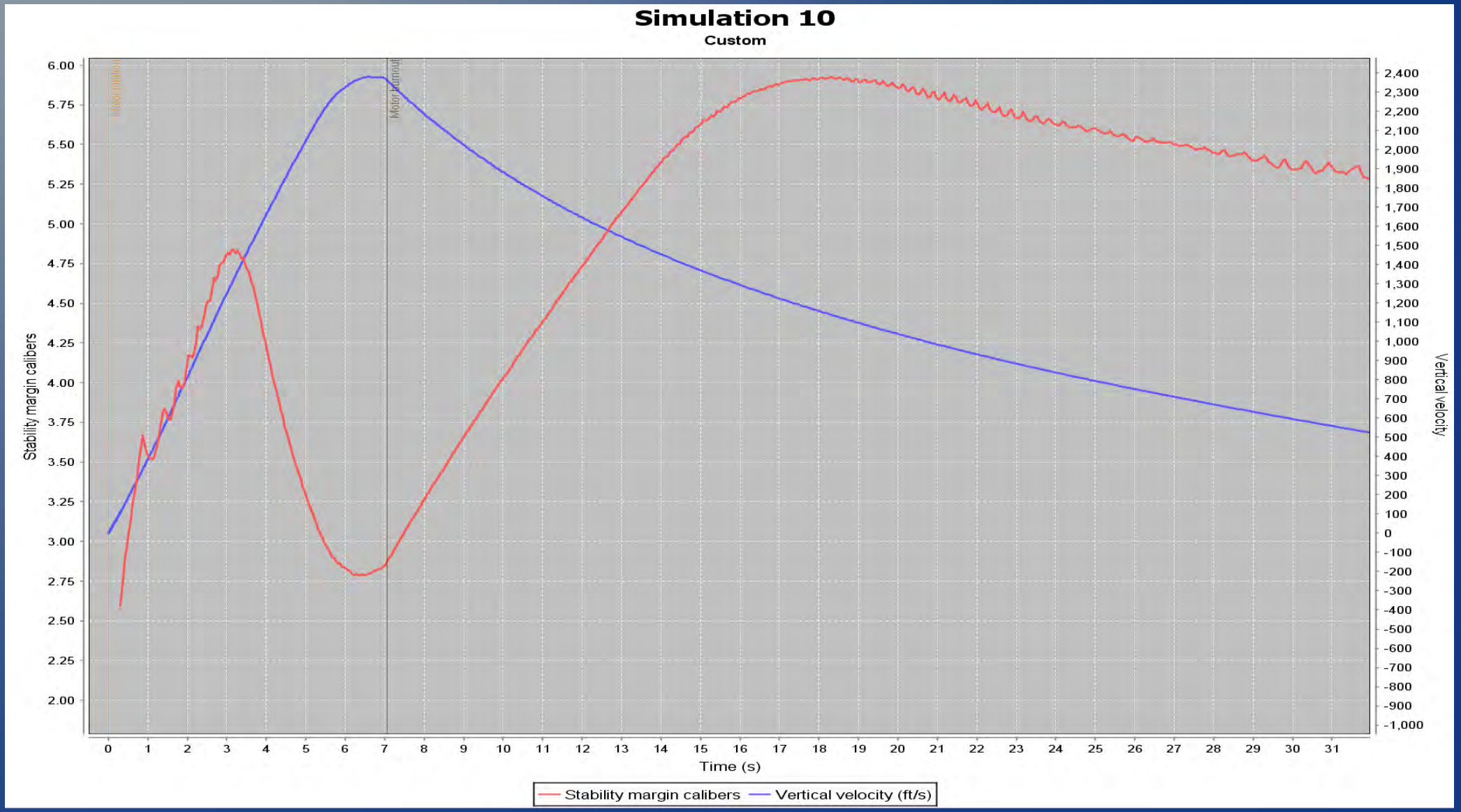




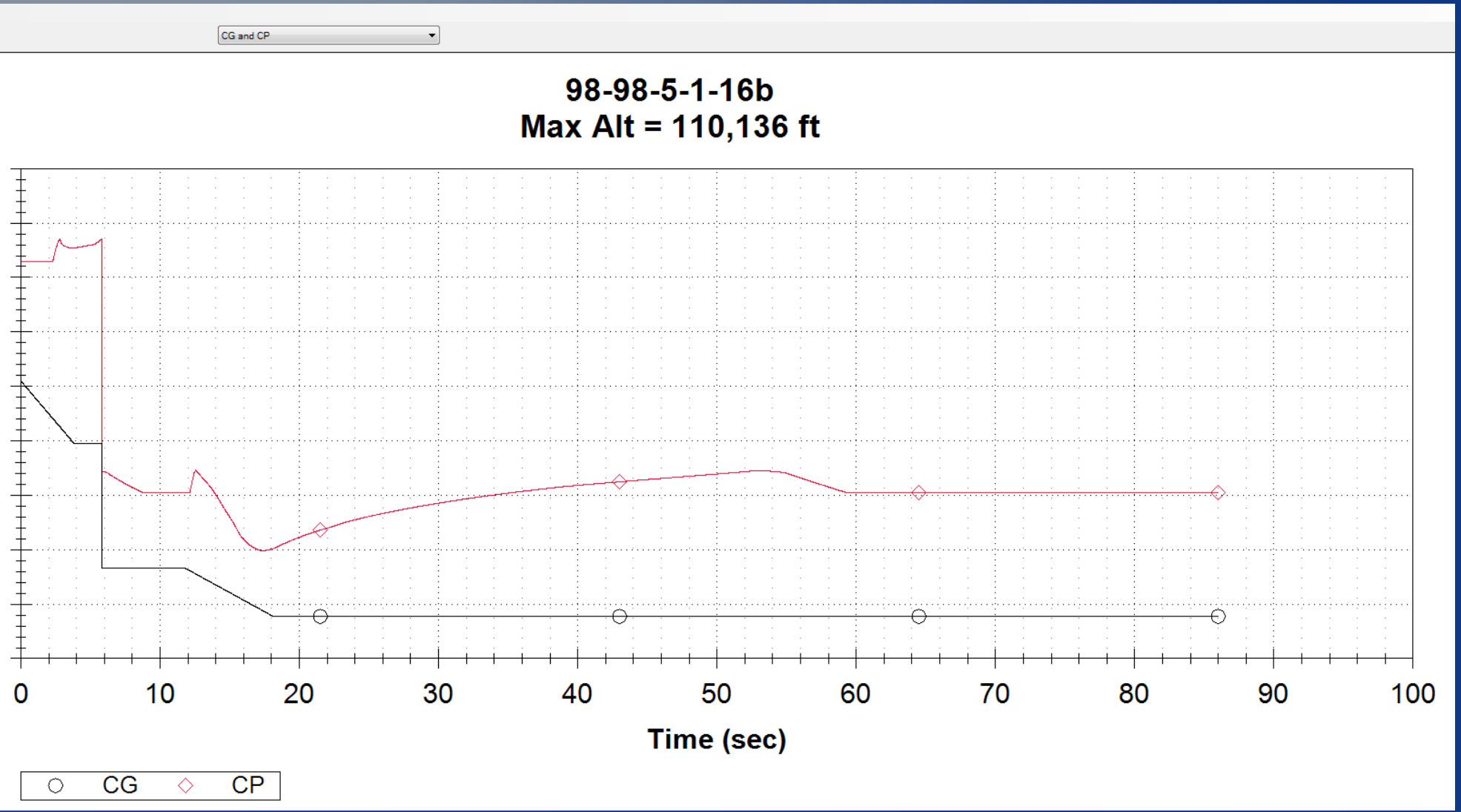
Stability

Stability vs Time

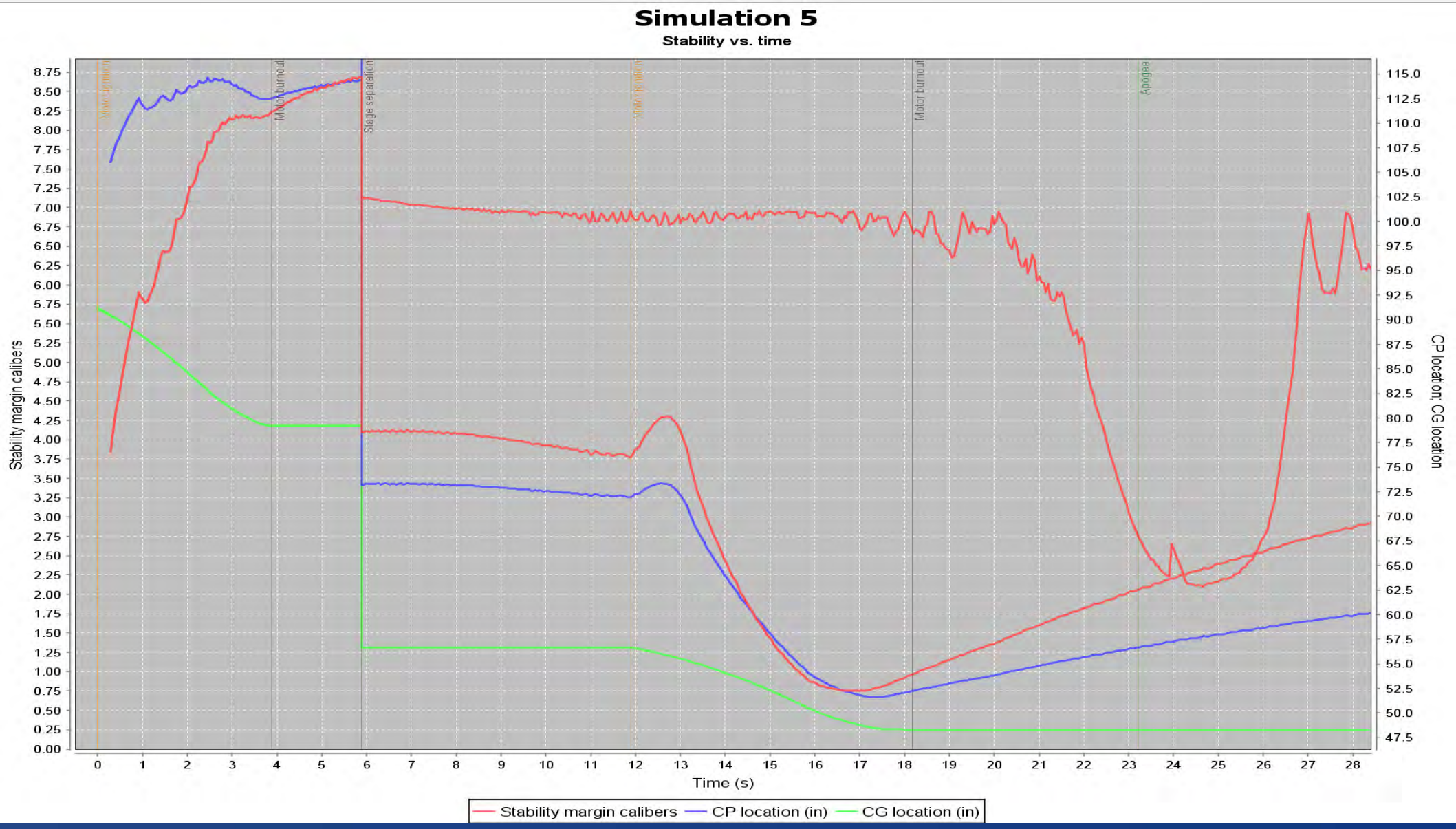
Stability vs Velocity



CP vs CG 2-Stage



Stability - 2-Stage



Stability 2-Stage

Structure Materials

Airframe & Fins

- Composites
  - Carbon fiber vs fiberglass
    - Convolute vs filament wound
    - Cost & weight
- Aluminum

Nose Cone

- Usually fiberglass
- RF Transparent

Electronics

Accelerometers

- Apogee accuracy, integration errors

Barometric

- Mach lockout
- Some newer units Mach-immune

Timers

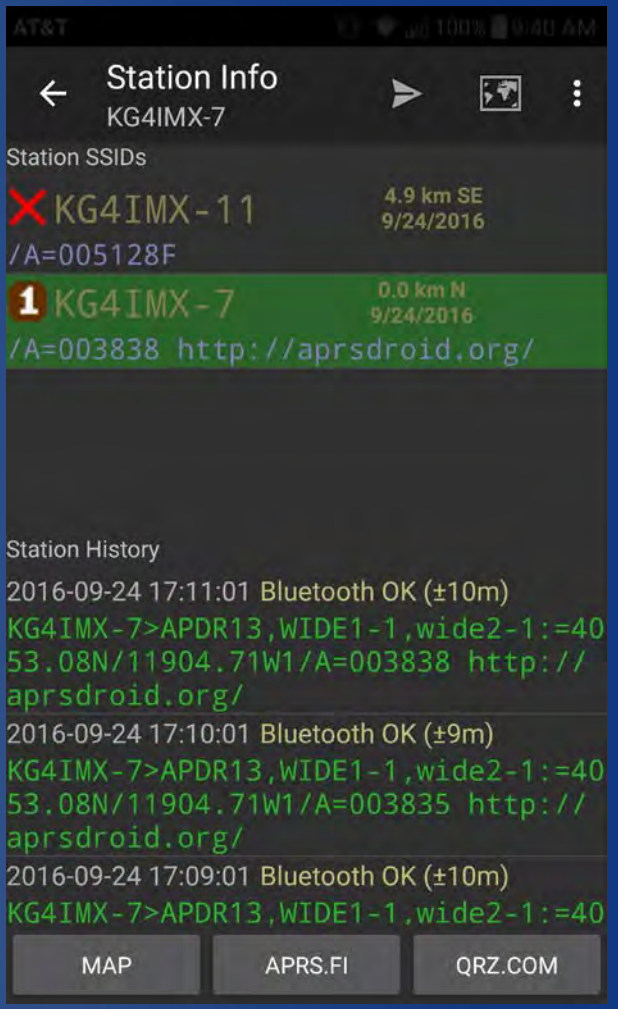
- Depend on accurate sims

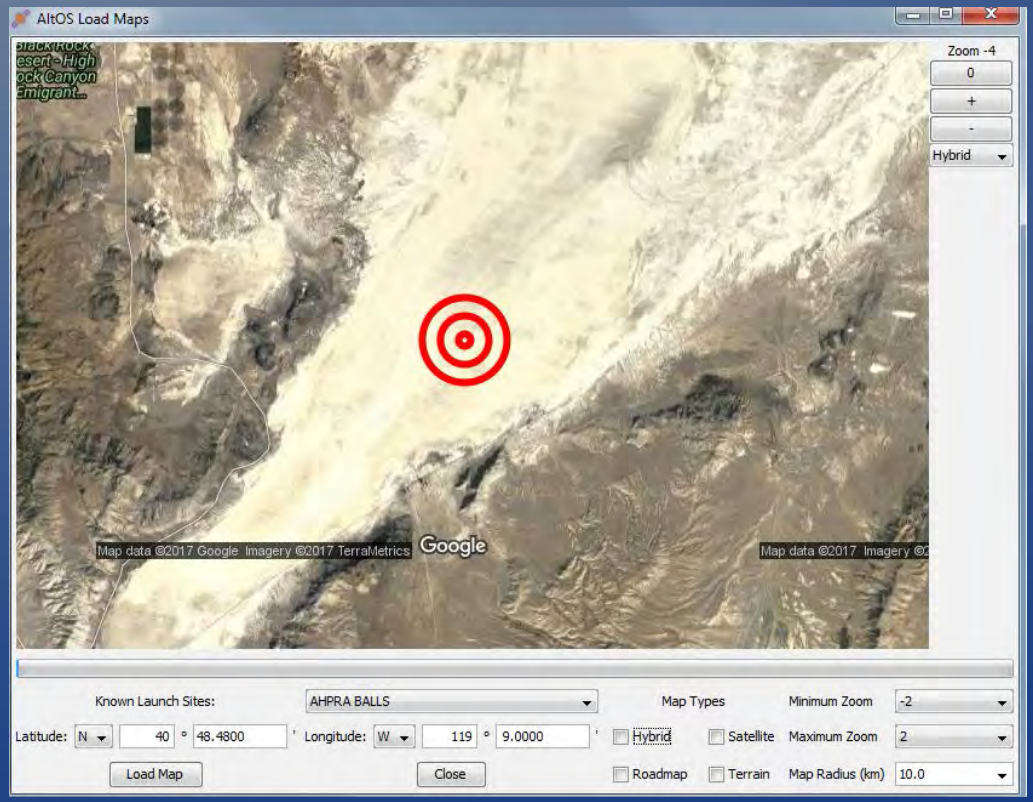
GPS

- Licensed vs non-licensed
- Big Red Bee
- Aim Xtra
- Tele GPS
- TLA
- GPS-1
- KATE

Beacons

- Beeline
- Walston





Resouces

- http://www.aerorocket.com/finsim.html
- http://openrocket.sourceforge.net/
- http://www.rasaero.com/
- http://www.aeropac.org/
- http://forum.ausrocketry.com/
- http://www.rimworld.com/nassarocketry/fabrication/nosecones/spreadsheet.html
- https://www.apogeerockets.com/Rocket_Software/RockSim
- http://www.bigredbee.com/
- http://altusmetrum.org/
- https://fruitychutes.com/
- http://prolinerocketry.com/store/index.php