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DESIGNING & BUILDING A WINNING HAMSTER DANCE ROCKET

NARCON 2019
CAPE CANAVERAL, FL
MARCH 1-3, 2019

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SPONSORED BY
TRIPOLI GERLACH
Research Rocketry

What is “Hamster Dance” (HD)?

- A totally unique and “fun” contest invented and organized by Tom Blazanin, Deb Koloms and Dave Rose and held in conjunction with BALLS launches since 2011
- Current rules:
  - 5 pounds maximum liftoff weight
  - Single motor and single stage
  - Research (uncertified) motors only
  - Both motor and airframe must be non-metallic
  - Motor must be assembled by the participant
  - Motor must be single-use
  - 15,000 foot ceiling (DQ if exceeded)
  - Multiple flights OK
- Hamster Dance 8 (HD8) was held during BALLS 27 on Friday, September 21, 2018
- http://www.hamsterdancelaunch.com for more info

HD Prizes

- A plaque, trophy or similar award for the highest flight under the altitude ceiling (the “Alpha Hamster” award), plus a Bruno’s gift certificate, also $100 cash awarded in 2018 at HD8
- Bruno’s gift certificates also awarded for:
  - Best looking rocket
  - Lightest rocket
  - Heaviest rocket
  - Maybe others?
- More prizes coming in 2019 with sponsorships!

HD Prizes

Tom Blazanin presents the ALPHA HAMSTER Award to Gary Dickinson for having the highest altitude (5,648') at HAMSTER DANCE II

HD Challenges

- Many entrants are not familiar with building non-metallic, single use motors
- Requires accurate simulation and design to win
- NO CATOS!!
- Rocket must be recovered from up to 15,000 feet
- Just show up at the contest and fly!

Previous Personal Experiences at HD Events

- First entry (HD2) was an AeroTech Arreaux using a prototype of the 29mm H135W DMS Motor
- Second entry (HD3) was the Arreaux using a higher-solids version of the H135W & airframe mods
- Third entry “CF3D” (HD5) was a 54mm carbon fiber rocket with a prototype K535W DMS motor
- Fourth entry (HD6) was a 38mm fiberglass rocket with a prototype J435WS DMS motor
- Fifth entry (HD7) was the AeroTech Arreaux again with a prototype H181WS DMS motor
- Sixth entry “Famished Hamster” (HD8) was a lightweight 29mm paper rocket with an H11ST endburning motor

HD1 Participants

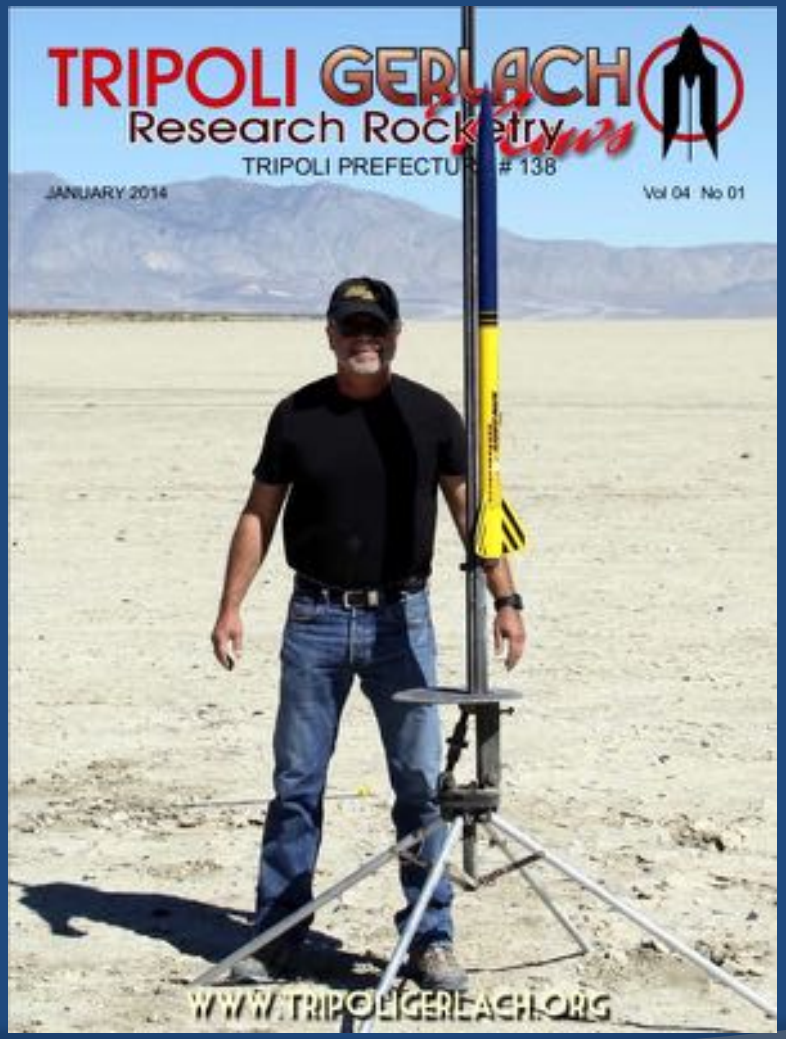
The three flyers: Bill Good, Dave Rose and Larry Benek presented their entries to the RSO for inspection and approval, then out to the pads under hoots and hollers from the spectator section.

HD2 Participants

HD2 Entry

HD3 Participants

HD3 Entry



"Lightest Rocket" award

HD5 Entry

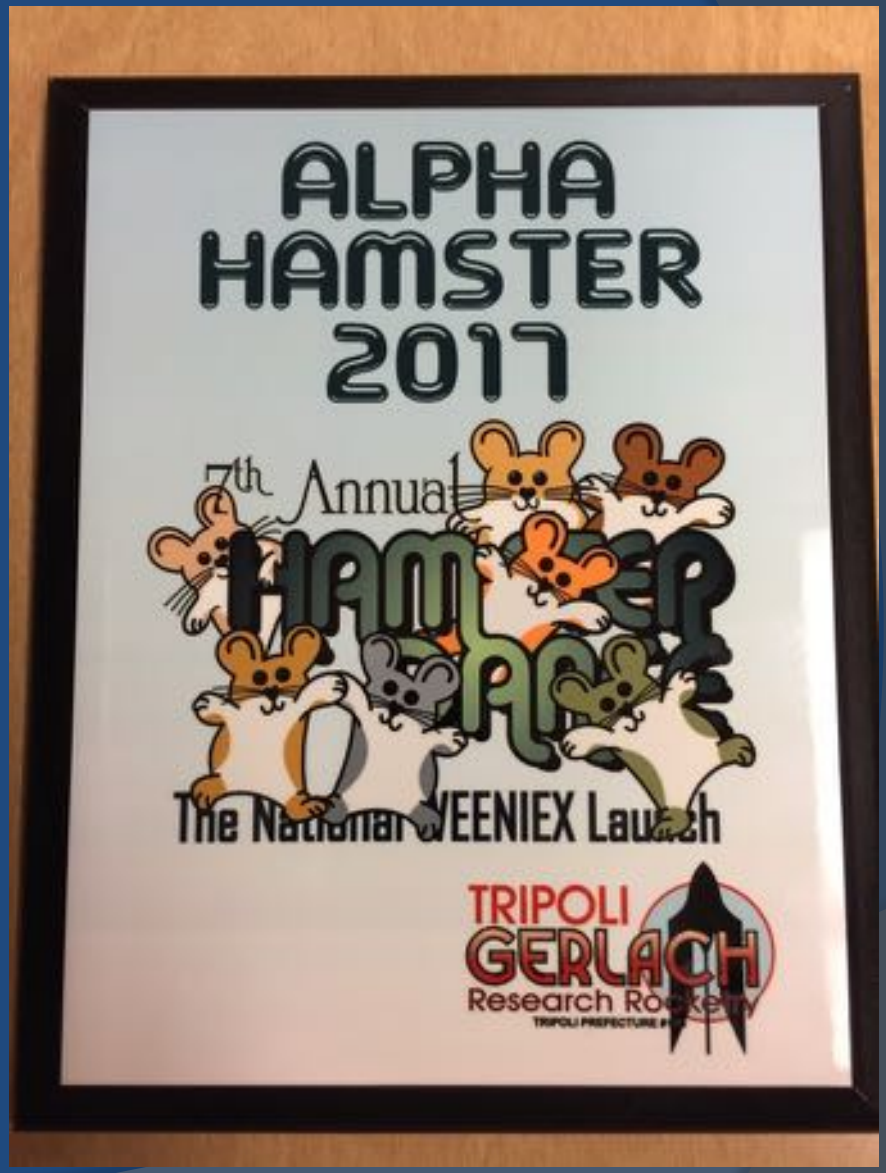
HD6 Entry

Lake stake!!

HD7 Entry

FINALLY!!

H181WS w/HD7 logo



HD8: Designing for Success

- My first entries were mostly flights for fun and I just guessed at the performance
- I won HD7 only because there were few entries and almost everyone else “CATOed”
- HD8 was the first time that I deliberately designed a rocket with a strategy to perform in a specific manner and would use recovery system deployment and tracking electronics to enhance success

HD8 Strategy

- Use a long-burn ‘G’ or ‘H’ motor similar to ones we were developing for BPS.space
- 30mm paper rocket using Quest components
- Design with OpenRocket software
- Create .eng file from actual motor test firing using TCTracer and import into OpenRocket
- Use Altus Metrum “Telemetrum” avionics for electronic deployment, tracking and recovery and to document performance and recover the rocket
- Use a tower or an Apogee 29mm fly-away rail guide to minimize drag and ensure a straight flight
- Streamer and 9” parachute recovery

HD8 Design in OpenRocket

Rocket Design

Rocket
Stages: 1
Mass (with motor): 274 g
Stability: 2.11 cal
CG: 16.464 in
CP: 18.949 in

H11ST-P

Altitude	11866 ft
Flight Time	399 s
Time to Apogee	28.1 s
Optimum Delay	11.9 s
Velocity off Pad	66.7 ft/s
Max Velocity	695 ft/s
Velocity at Deployment	25.9 ft/s
Landing Velocity	29.3 ft/s

Motor	Avg Thrust	Burn Time	Max Thrust	Total Impulse	Thrust to Wt	Propellant Wt	Size
H11ST	11.2 N	16.2 s	29.8 N	181 Ns	4.16:1	101 g	1.13/6.48 in

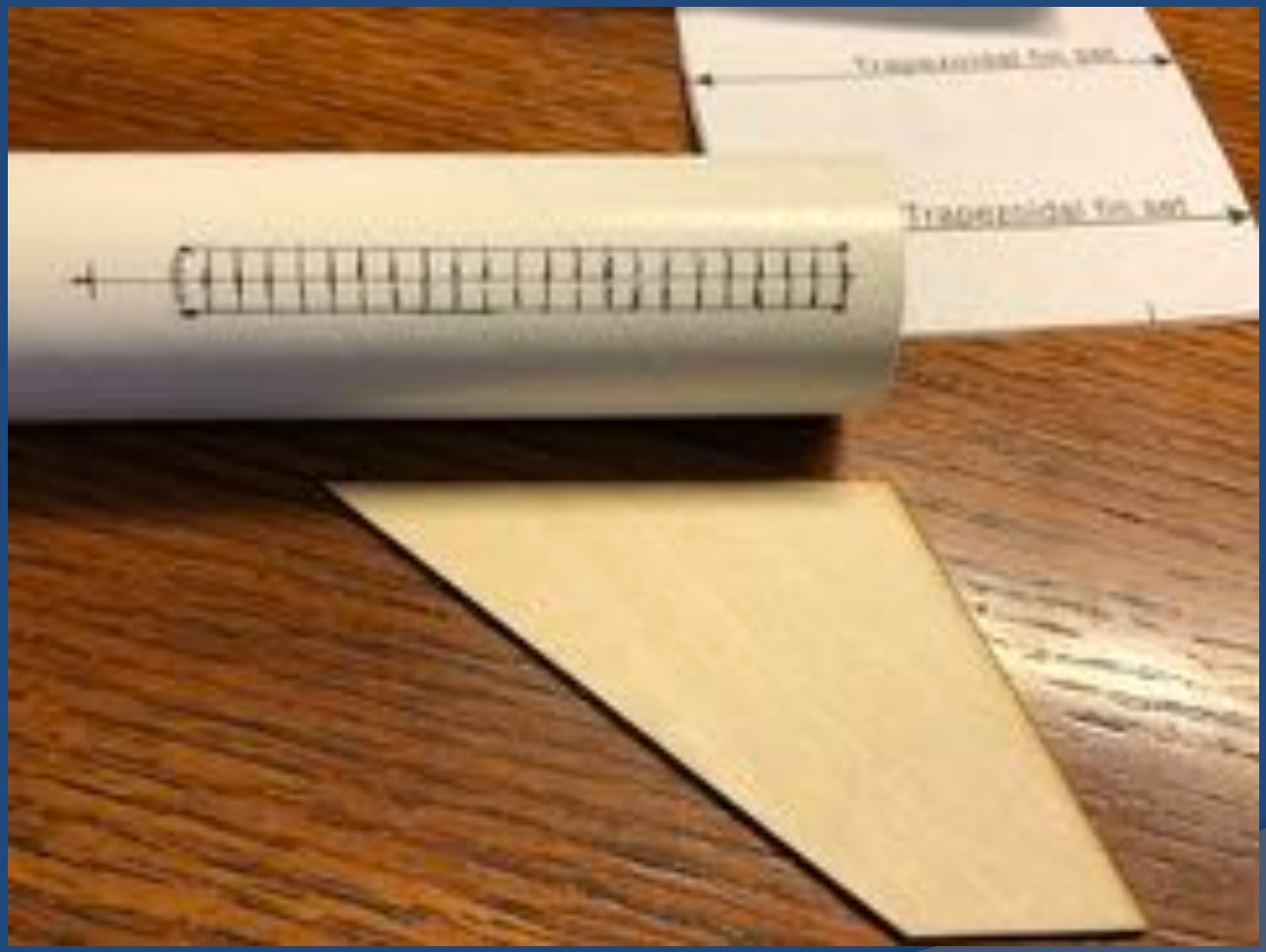
HD8 Components

Parts Detail

Sustainer

	Nose cone	Polystyrene (1.05 g/cm³)	Ogive	Len: 3.3 in	Mass: 10 g
	Payload tube	Cardboard (0.68 g/cm³)	Dia_{in} 1.14 in Dia_{out} 1.18 in	Len: 6.25 in	Mass: 5.08 g
	TeleMetrum Bulkhead	Cardboard (0.68 g/cm³)	Dia_{in} 0.938 in Dia_{out} 1.14 in	Len: 1 in	Mass: 3.67 g
	Bulkhead Plate	Polystyrene (1.05 g/cm³)	Dia_{out} 0.938 in	Len: 0.079 in	Mass: 0.936 g
	Antenna Tube	Cardboard (0.68 g/cm³)	Dia_{in} 0.188 in Dia_{out} 0.25 in	Len: 5.5 in	Mass: 1.31 g
	TeleMetrum		Dia_{out} 1 in		Mass: 17 g
	Battery		Dia_{out} 0.984 in		Mass: 11.3 g
	Tube coupler	Polystyrene (1.05 g/cm³)	Dia_{in} 1.03 in Dia_{out} 1.13 in	Len: 1.95 in	Mass: 5.69 g
	Coupler Bulkhead	Polystyrene (1.05 g/cm³)	Dia_{out} 1.03 in	Len: 0.079 in	Mass: 1.13 g
	Body tube	Cardboard (0.68 g/cm³)	Dia_{in} 1.14 in Dia_{out} 1.18 in	Len: 13 in	Mass: 10.6 g
	Streamer	Ripstop nylon (67 g/m²)	Length 120 in Width 2 in	Len: 2 in	Mass: 10.4 g
	Parachute	Ripstop nylon (67 g/m²)	Dia_{out} 9 in	Len: 0.984 in	Mass: 5.99 g
	Shroud Lines	Elastic cord (round 2 mm, 1/16 in) (1.8 g/m)	Lines: 6	Len: 11.811 in	
	Shock cord	Thread (heavy-duty) (0.3 g/m)		Len: 72 in	Mass: 0.549 g
	Trapezoidal fin set (3)	Fiberglass (1.85 g/cm³)	Thick: 0.063 in		Mass: 18.1 g

Build Process: Fin Mounting



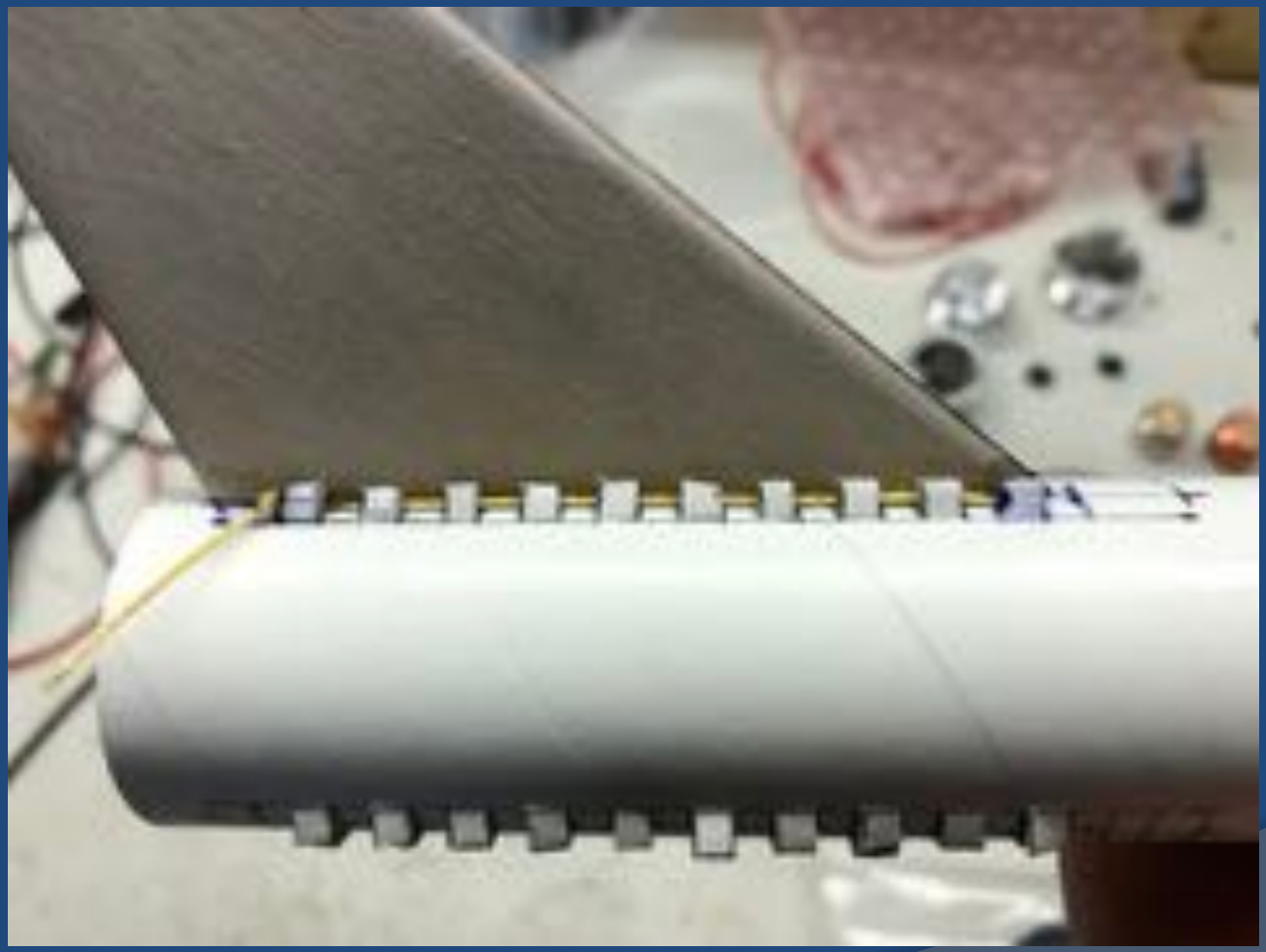
Build Process: Fin Mounting

Build Process: Fin Mounting

Build Process: Fin Mounting

Build Process: Fin Mounting

Build Process: Shock Cord



Build Process: Fin Mounting

Build Process: Fins Tacked On

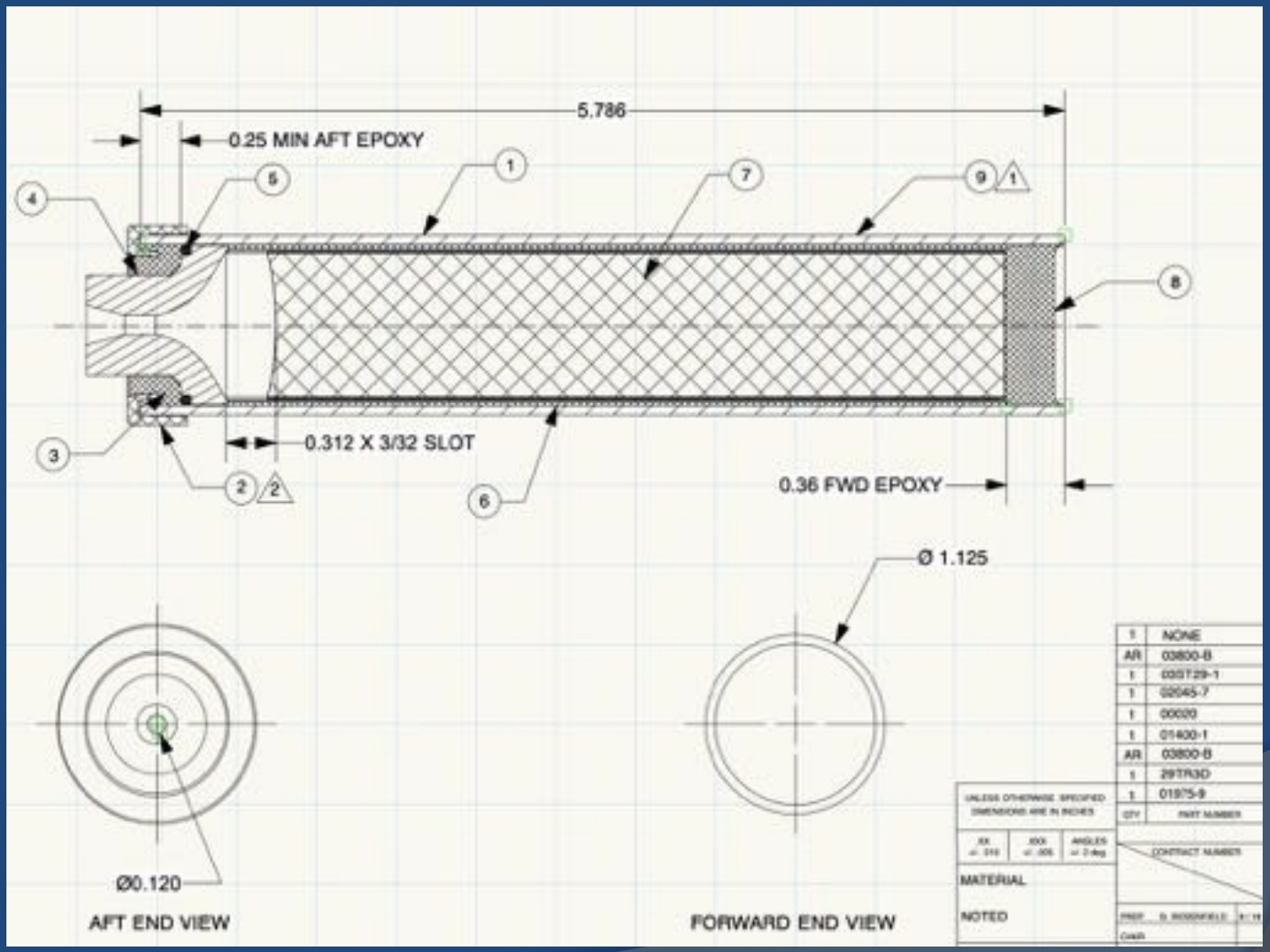
Build Process: Epoxy Fillets

Motor Development & Testing

Motor Development & Testing

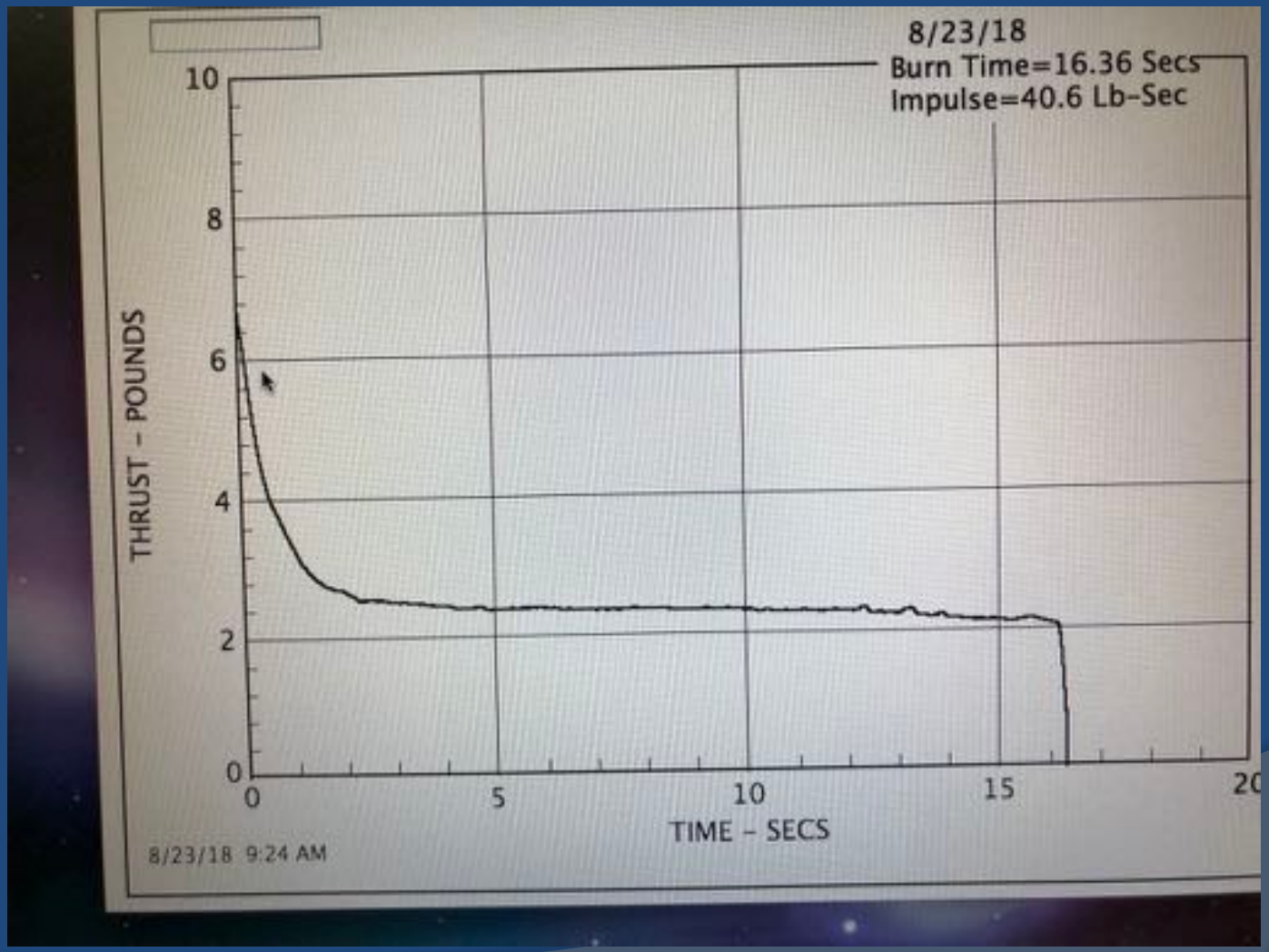
- Initially, I was going to use the G12 endburner that I was designing for Joe Barnard at BPS.space for his TVC rockets
- However, the OpenRocket simulation showed that the G12 and rocket combination would “only” fly to about 10,000 ft
- I designed a new motor with a couple extra seconds of burn to hopefully propel the rocket to about 12,000 ft or more

Motor Development & Testing

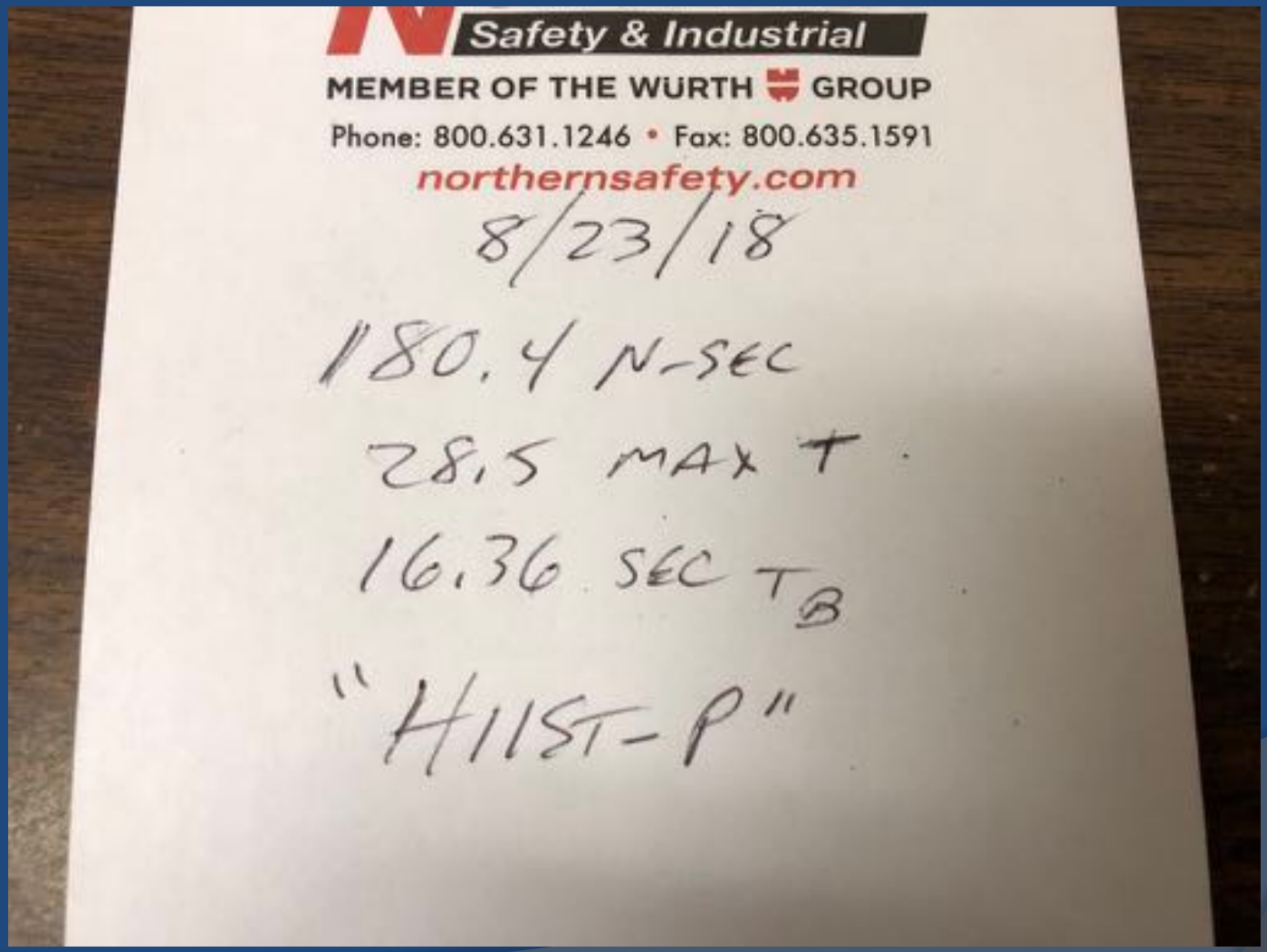


Motor Development & Testing

Motor Development & Testing

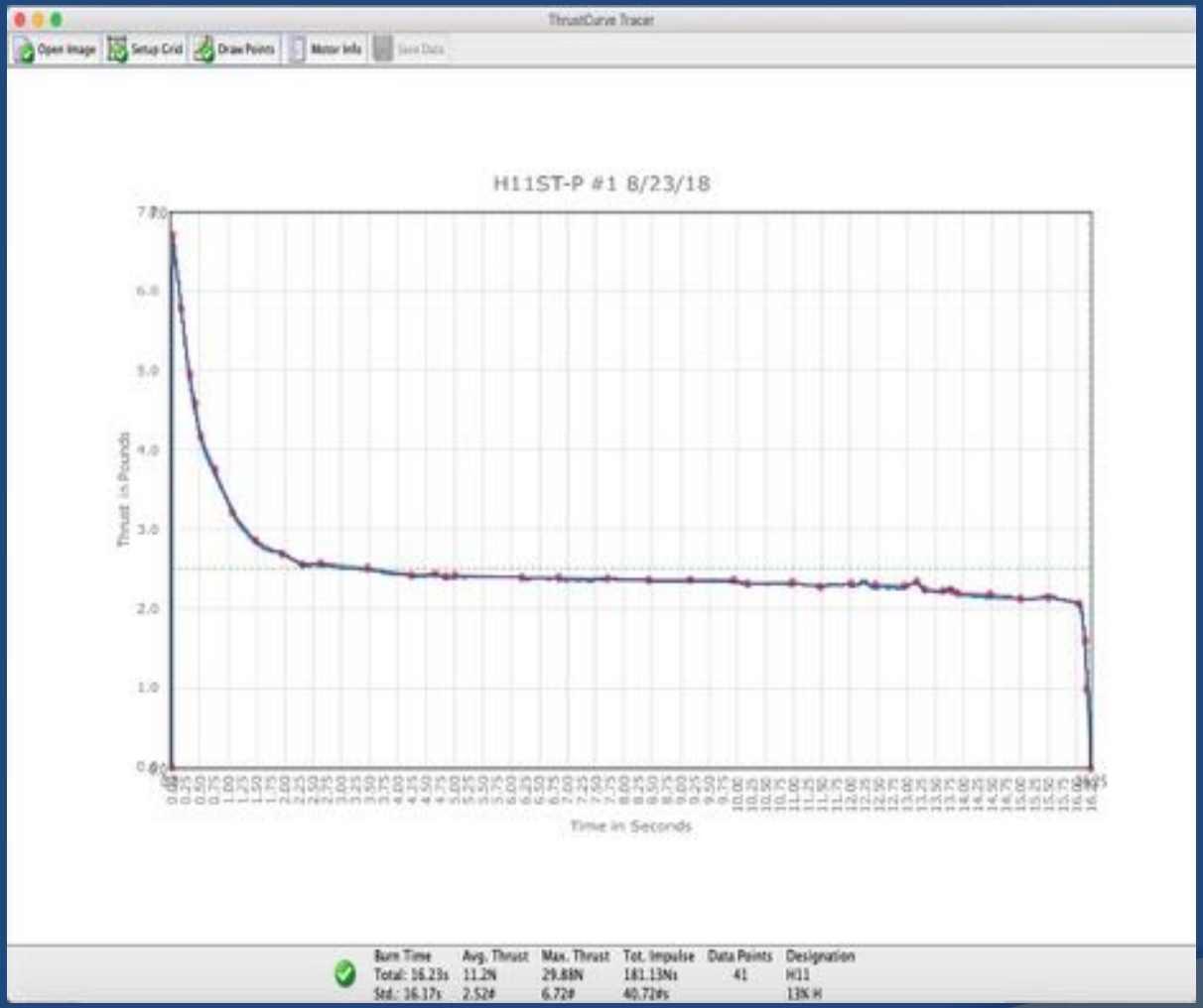


Motor Development & Testing



Motor Development & Testing

Motor Development & Testing




```
; Super Thunder endburner
H11ST-P 28.6 164.5 P 0.101 0.17200000000000001 AT
   0.034 29.79
   0.134 26.74
   0.235 23.832
   0.352 20.924
   0.57 18.016
   0.905 15.533
   1.156 13.831
   1.508 12.625
   1.692 12.2
   1.927 12.2
   2.161 11.703
   2.312 11.419
   2.546 11.419
   2.965 11.278
   3.485 11.136
   3.956 10.994
   4.423 10.994
   4.657 10.852
   4.841 10.71
   5.126 10.781
   6.198 10.781
   6.818 10.568
   7.438 10.568
   7.974 10.497
   8.477 10.639
   8.979 10.426
   9.515 10.568
  10.018 10.497
  10.487 10.497
  11.006 10.285
  11.459 10.285
  11.945 10.356
  12.229 10.356
  12.464 10.072
  12.933 10.214
  13.05 10.285
  13.251 10.285
  13.352 10.001
  13.67 10.001
  13.771 10.001
  13.871 9.859
  14.491 9.646
  14.96 9.717
  15.463 9.788
  15.965 9.292
  16.082 9.079
  16.166 5.532
  16.233 0.0
```

Build Process: 1st Payload Config

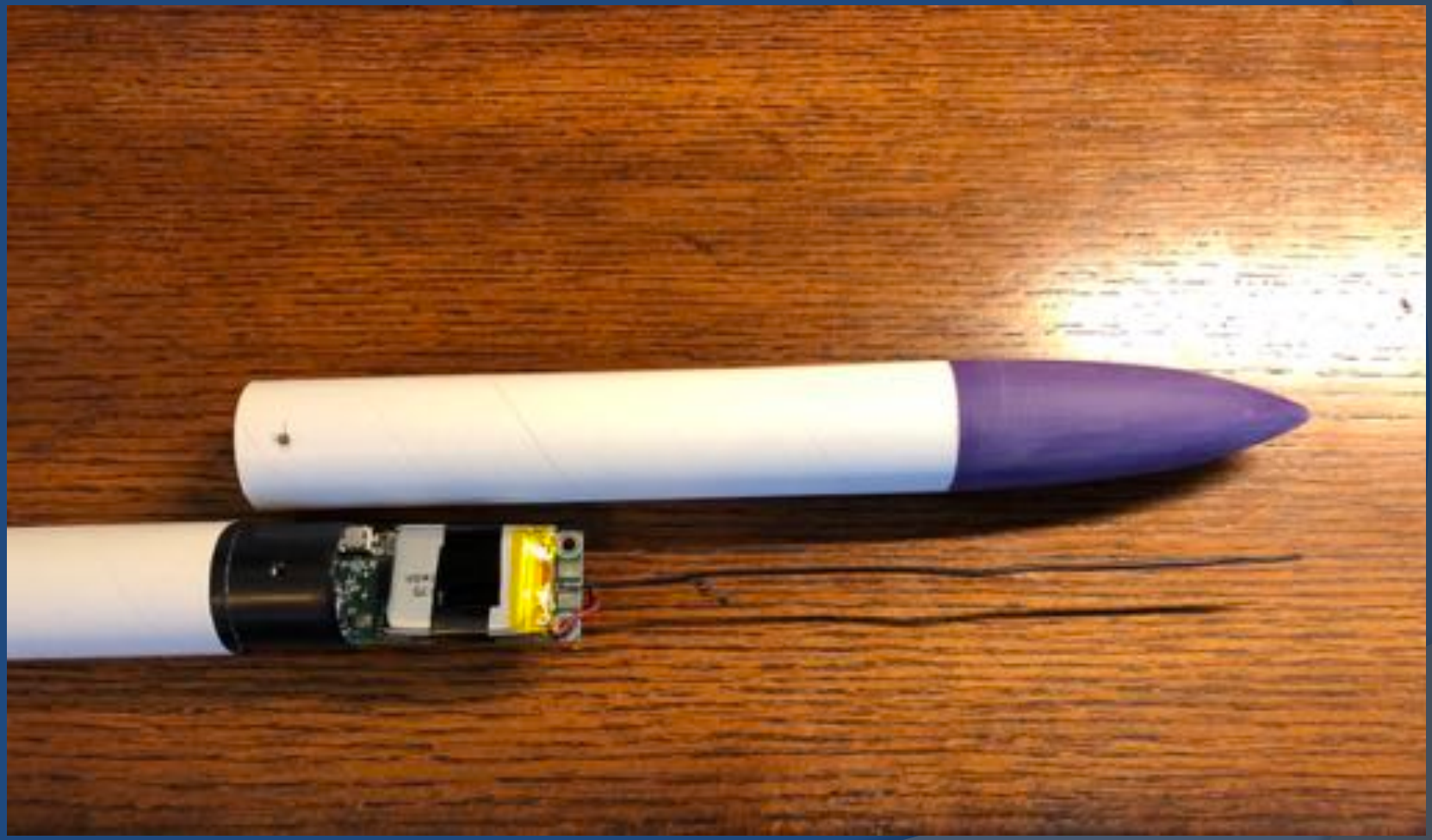
Build Process: Payload Attach

Avionics Mounting

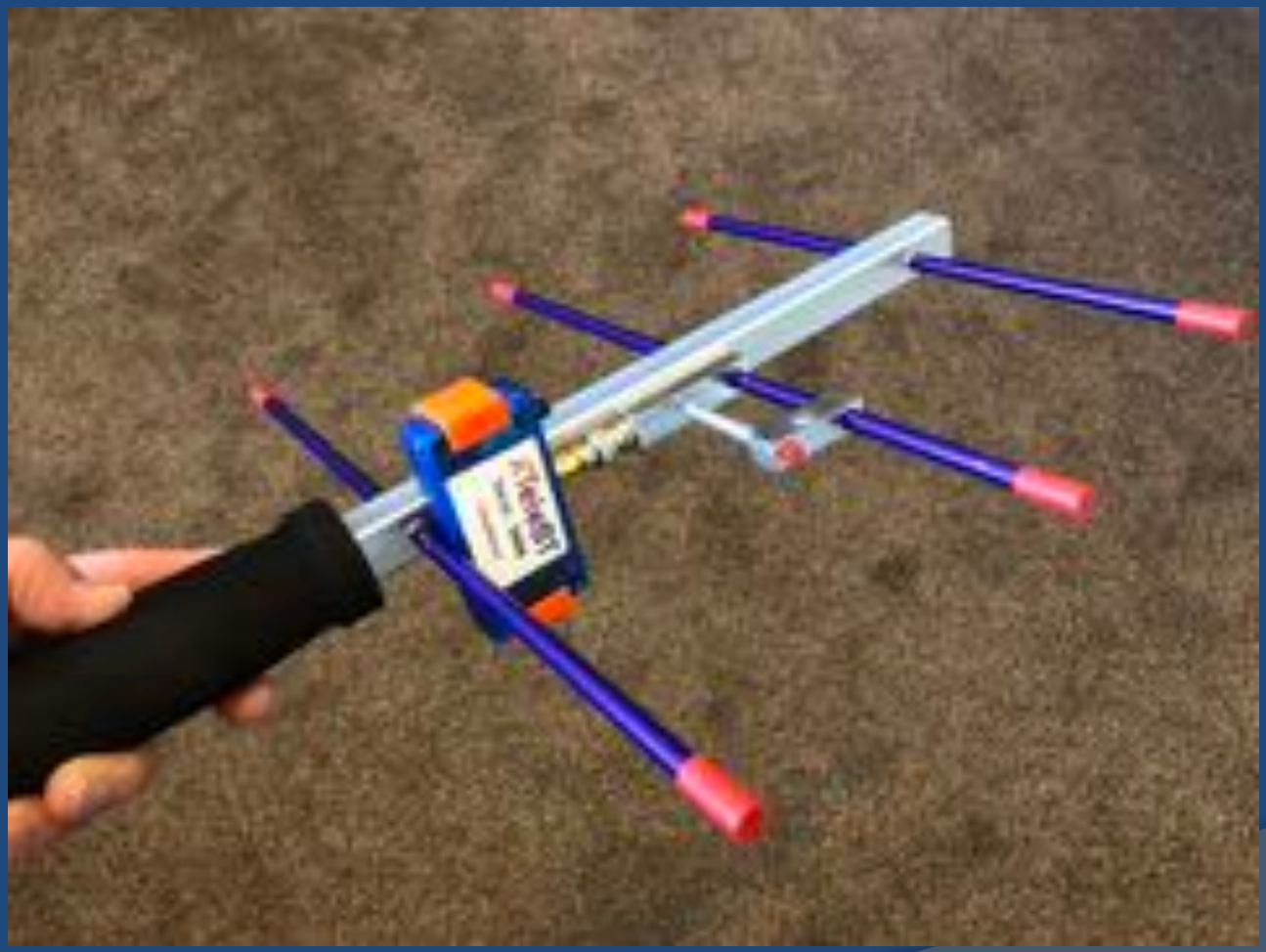
Build Process: 2nd Payload Config

Avionics Mounting

Avionics Battery Attachment



Altus Metrum “TeleBT” Receiver



Build Process: Painting

Build Process: Painting

Painted and Prepped at Bruno's

Ready for Flight

Apogee Fly-Away Rail Guide

On the Pad With the Fly-away Rail Guide

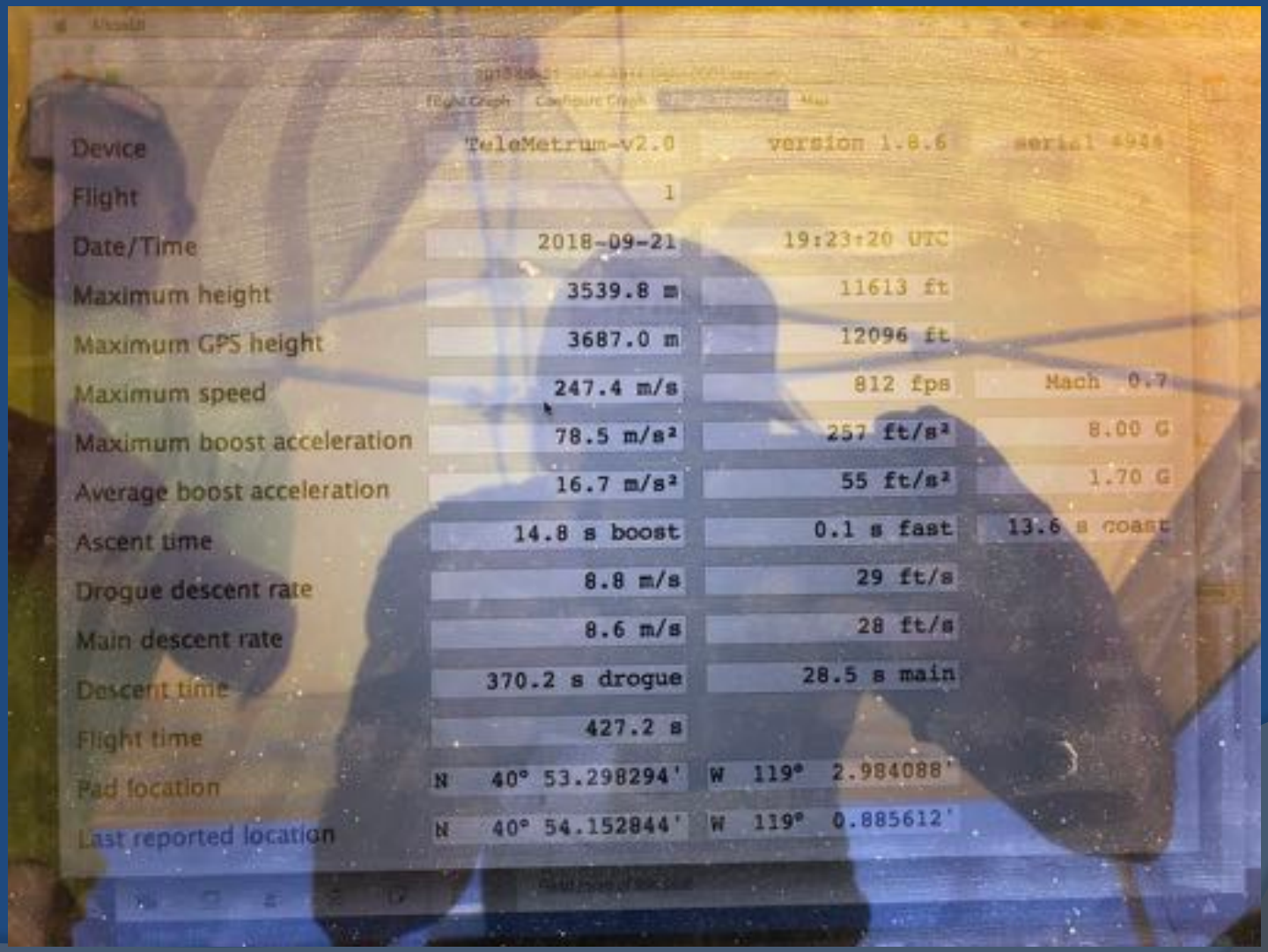
Charlie Making Final Adjustments

Landing & Recovery

Post-Flight Inspection

Downloading the Data

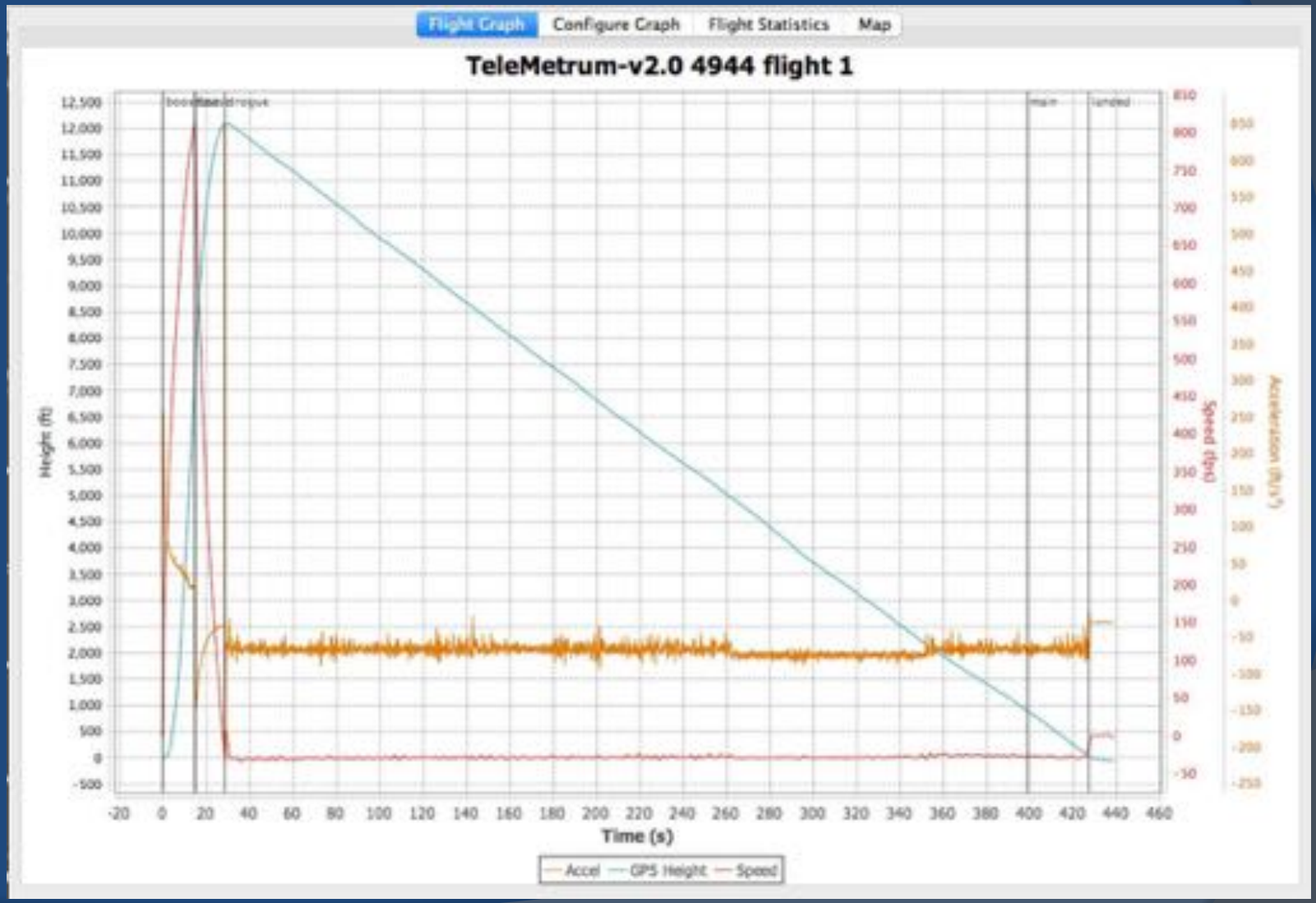
First Look


Device TeleMetrum-v2.0 version 1.8.6
Flight 1
Date/Time 2018-09-21 19:23:20 UTC
Maximum height 3539.8 m 11613 ft
Maximum GPS height 3687.0 m 12096 ft
Maximum speed 247.4 m/s 812 fps Mach 0.7
Maximum boost acceleration 78.5 m/s² 257 ft/s² 8.00 G
Average boost acceleration 16.7 m/s² 55 ft/s² 1.70 G
Ascent time 14.8 s boost 0.1 s fast 13.6 s coast
Drogue descent rate 8.8 m/s 29 ft/s
Main descent rate 8.6 m/s 28 ft/s
Descent time 370.2 s drogue 28.5 s main
Flight time 427.2 s
Pad location N 40° 53.298294' W 119° 2.984088'
Last reported location N 40° 54.152844' W 119° 0.885612'

Results

- Stuck the landing on a fin! No damage
- 12,096’ AGL per GPS data (11,866’ sim)
- Landed ~2.4 miles from launch site
- Maximum speed 812 ft/sec (695 ft/sec sim)
- Maximum boost acceleration 8.0 G
- Average boost acceleration 1.7 G
- Descent rate 28 FPS (29 FPS sim)
- Flight time 427.2 seconds (399 sec. sim)

TeleMetrum Data Plots



2D Ground Track

3D Flight Track

HD8 Plaque

Afterthoughts

- Rocket and motor performed amazingly close to prediction
- Gary Dickinson scored second place with only a 603 foot difference between our flights! He used a long-burn motor as well
- Other entrants had CATOs or didn't show up
- The experience of using the TeleMetrum, TeleBT and the iPhone interface was incredible…an entirely new dimension of hobby rocketry for me

HD9 Plans

- Tom had stated that they might increase the altitude ceiling to 20,000 feet for HD9
- If that happens then it would be very difficult to reach that altitude with a 29mm rocket
- If the ceiling remains at 15,000 feet I was planning to use a somewhat longer 29mm endburning motor with about the same burn time but higher thrust
- Otherwise, a 38mm (or larger) motor and rocket will be necessary!

Credits & Thanks

- Karl Baumann for helping with the motor prototype testing
- Chris Short for advising me on the Altus Metrum avionics and for his help on the range
- Tom, Deb & Dave for organizing the contest
- Suppliers: Altus Metrum, Apogee Rockets, Top Flite parachutes, Balsa Machining (fins), Arrow Antennas, Quest (tubes and coupler)
- OpenRocket & TCTracer software, Google Earth Pro

See You at HD9! Questions?