COZY AIRCRAFT FORUM

Chris Esselstyn's COZY MKIV Blended Winglets

Marc J. Zeitlin

July 31st, 2009

1:45 PM – 2:15 PM

Forum Tent 02 – GAMA Pavilion

What Will I Talk About?

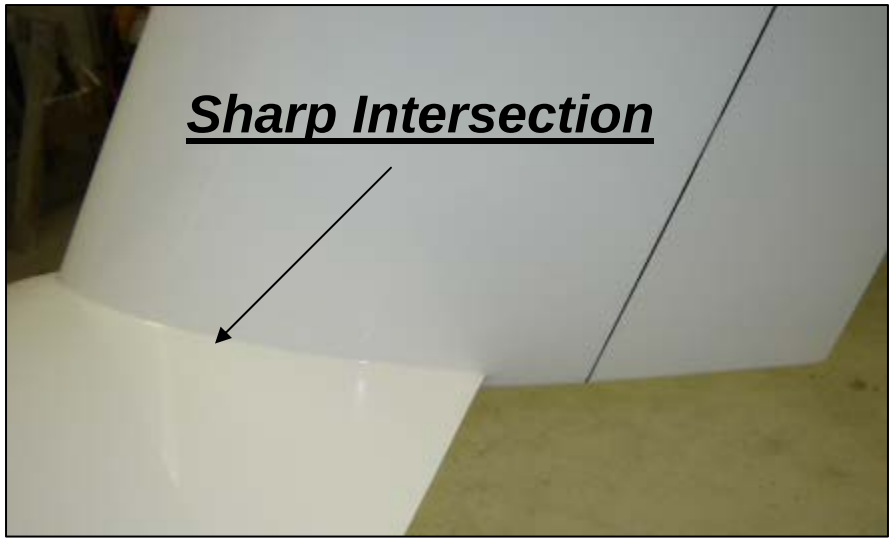
- ***Chris's Plane***
- ***Desire / Plan***
- ***Fabrication / Structure***
- ***Aerodynamics / Results***
- ***Conclusions (MINE)***
- ***Q / A***

Chris' Plane

- 12" Stretch between wing / canard
- IO-540 260 HP
- Retractable Mains and Nose
- 25k ft. service ceiling
- 240 kt. top speed

Desire / Plan

- Similar to Jack Morrison's now defunct E-Racer, wanted drag reduction / efficiency gain from wing/winglet intersection blend
- Wanted outward canted winglets (looks, stability)
- Wanted symmetrical tip airfoil (thought was to reduce tip vortex strength [drag])



Fabrication / Structure

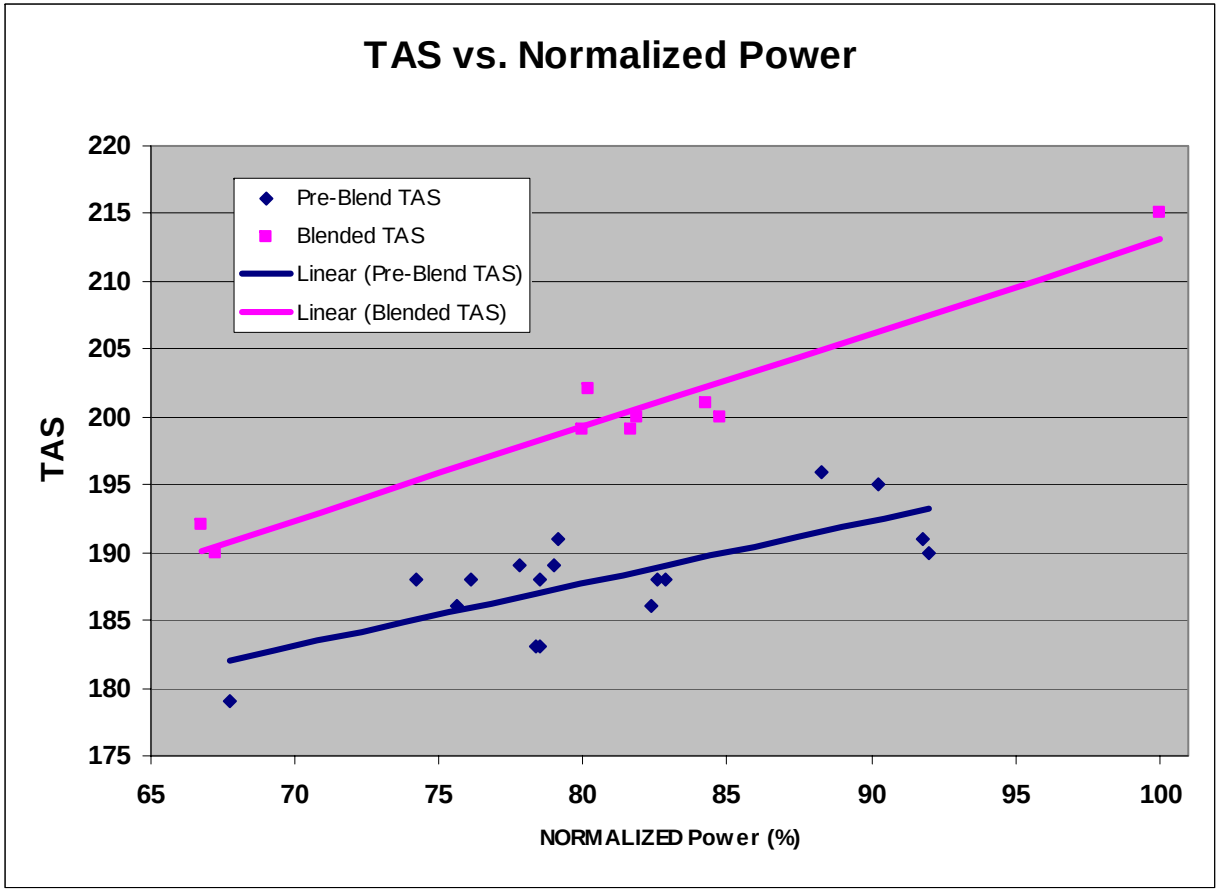
- Cut ~12” off wingtip
- Prep wing spar / shear web
- Carve foam intersection piece
- Winglet in SAME place – still 4” offset from leading edge of wing
- Use same airfoil at root – NACA 0010 symmetric airfoil at tip

Fabrication / Structure

- Similar to wing construction
- Split foam at shear web
- Create cap trough
- Splice shear web to wing shear web
- Layup caps
- Layup skin / reinforcements

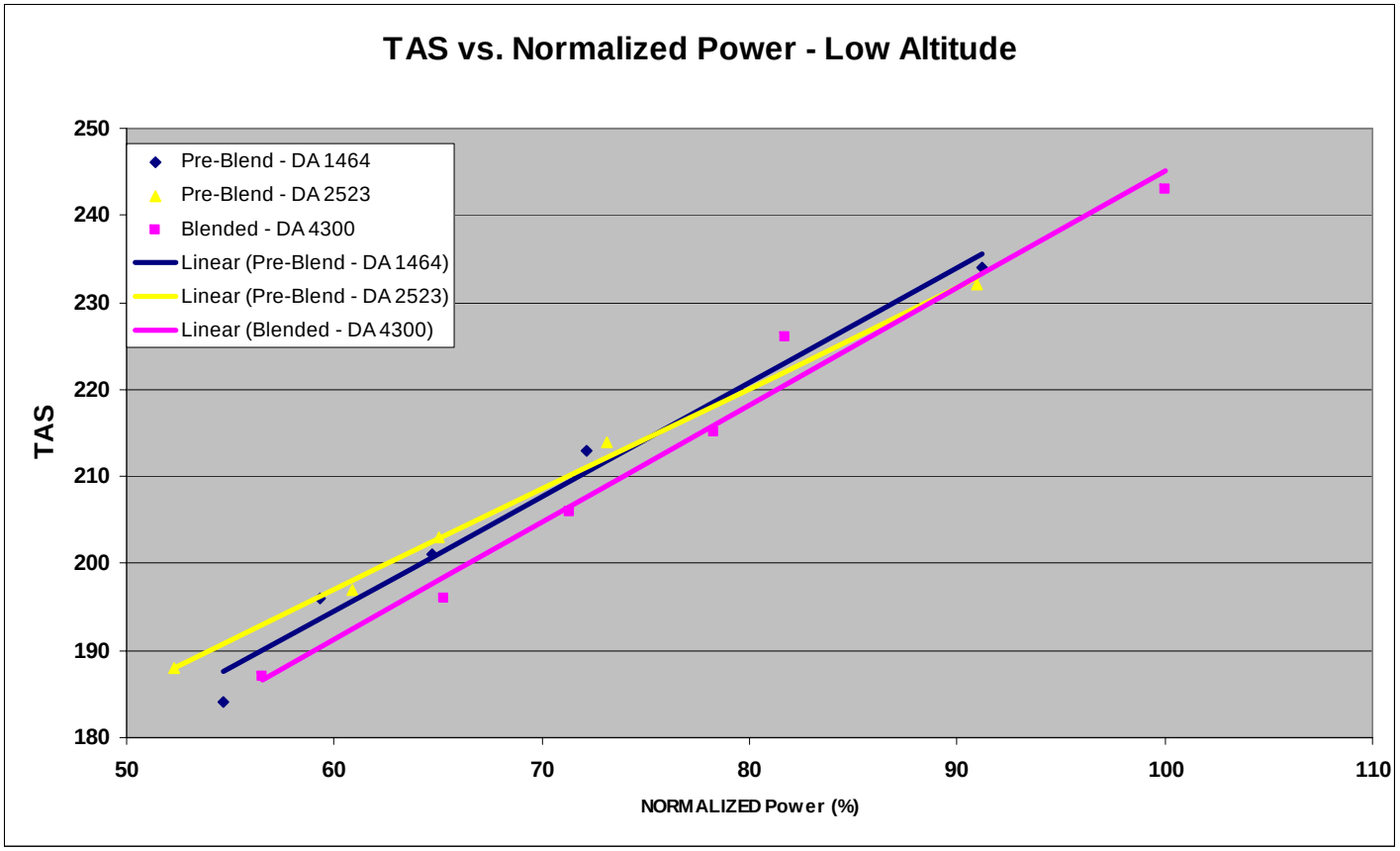
Aerodynamics / Results - Jack Morrison's E-Racer

- Reminder from two years ago
- At same normalized power levels (MP * RPM)
- Note CLEAR TAS increase post blend



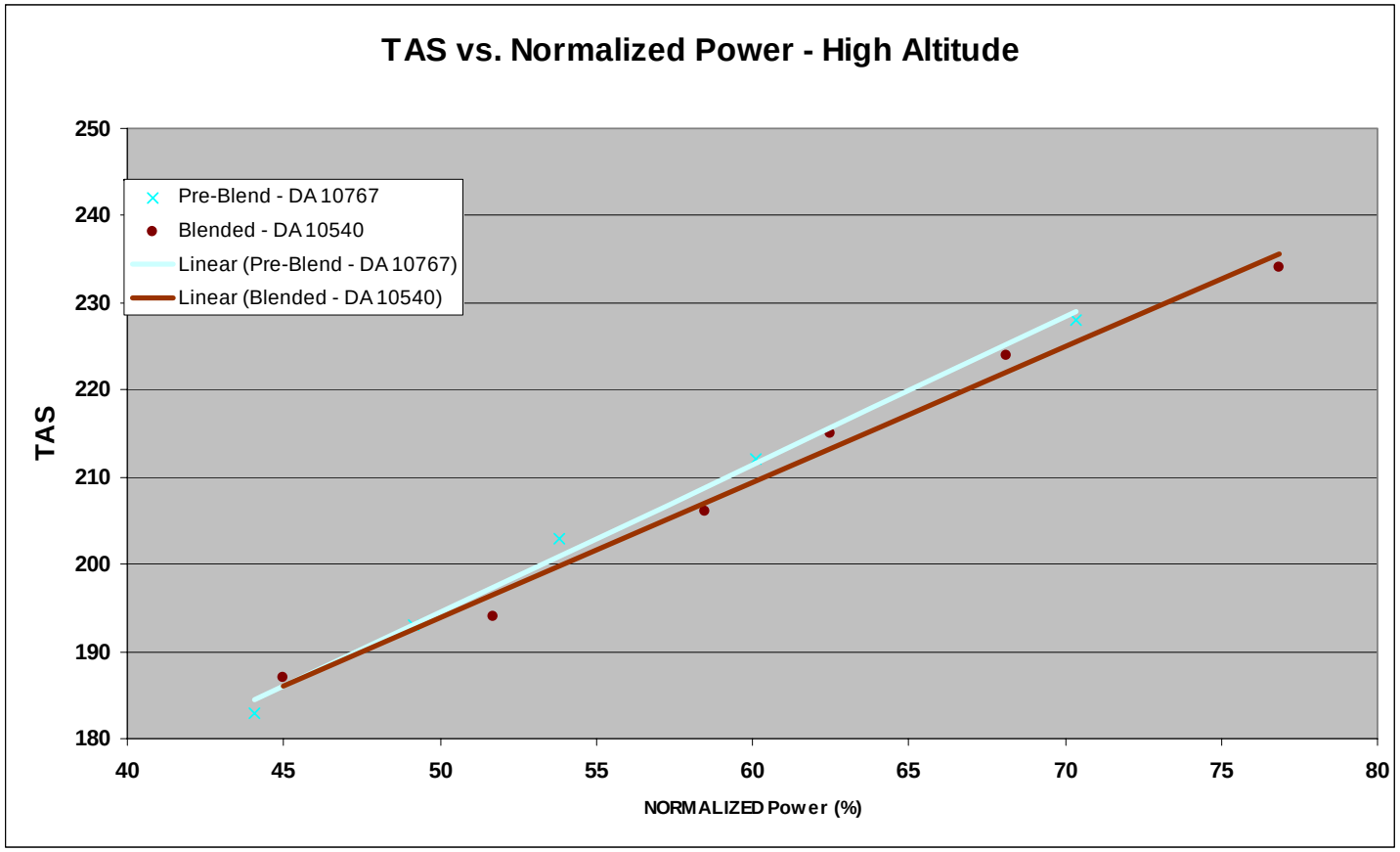
Aerodynamics / Results

- At same normalized power levels (MP * RPM), IAS LOWER than pre-blend
- **NOT** what was expected



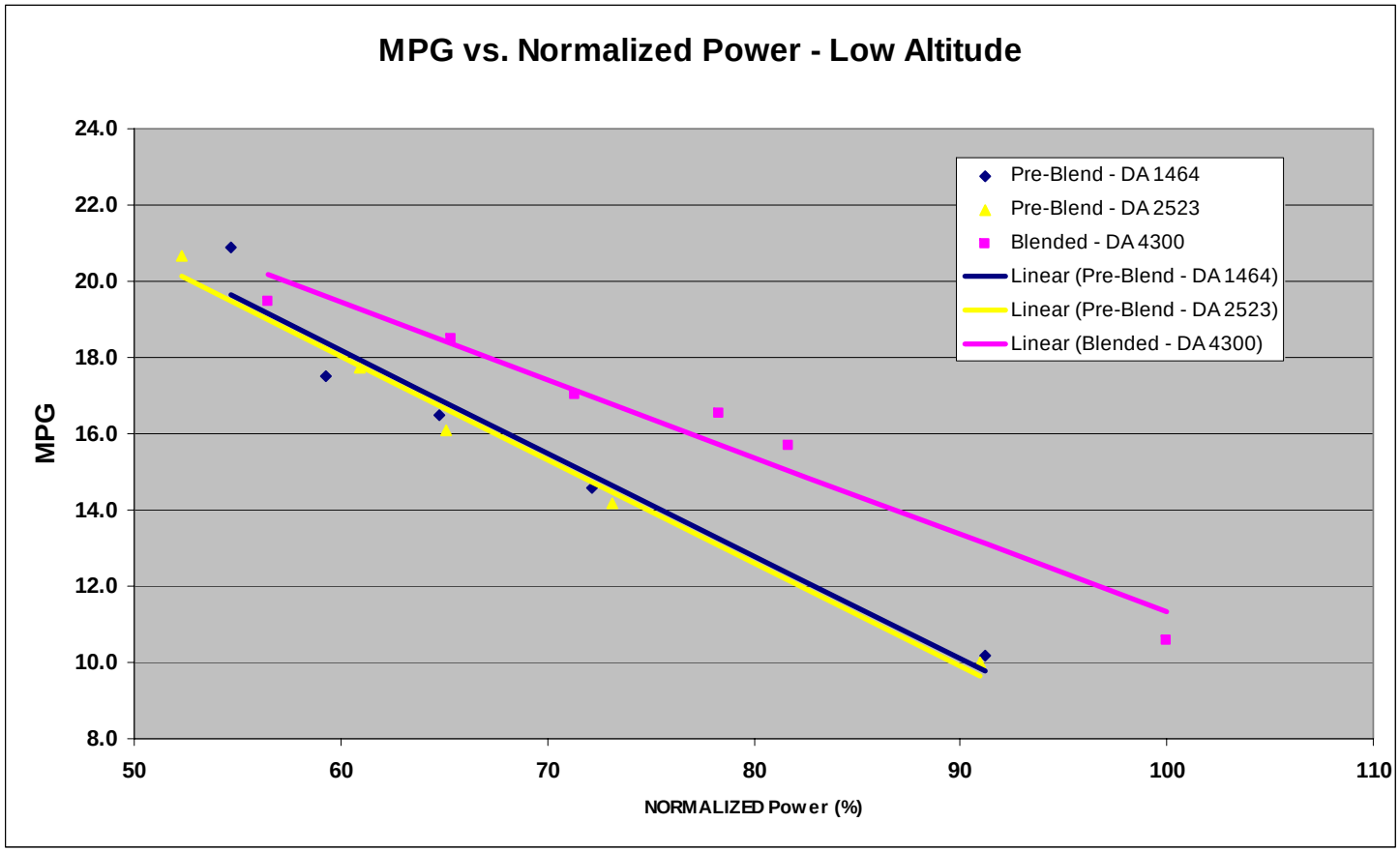
Aerodynamics / Results

- Similar Result at high Density Altitudes, although lower magnitude
- Again, **NOT** what was expected



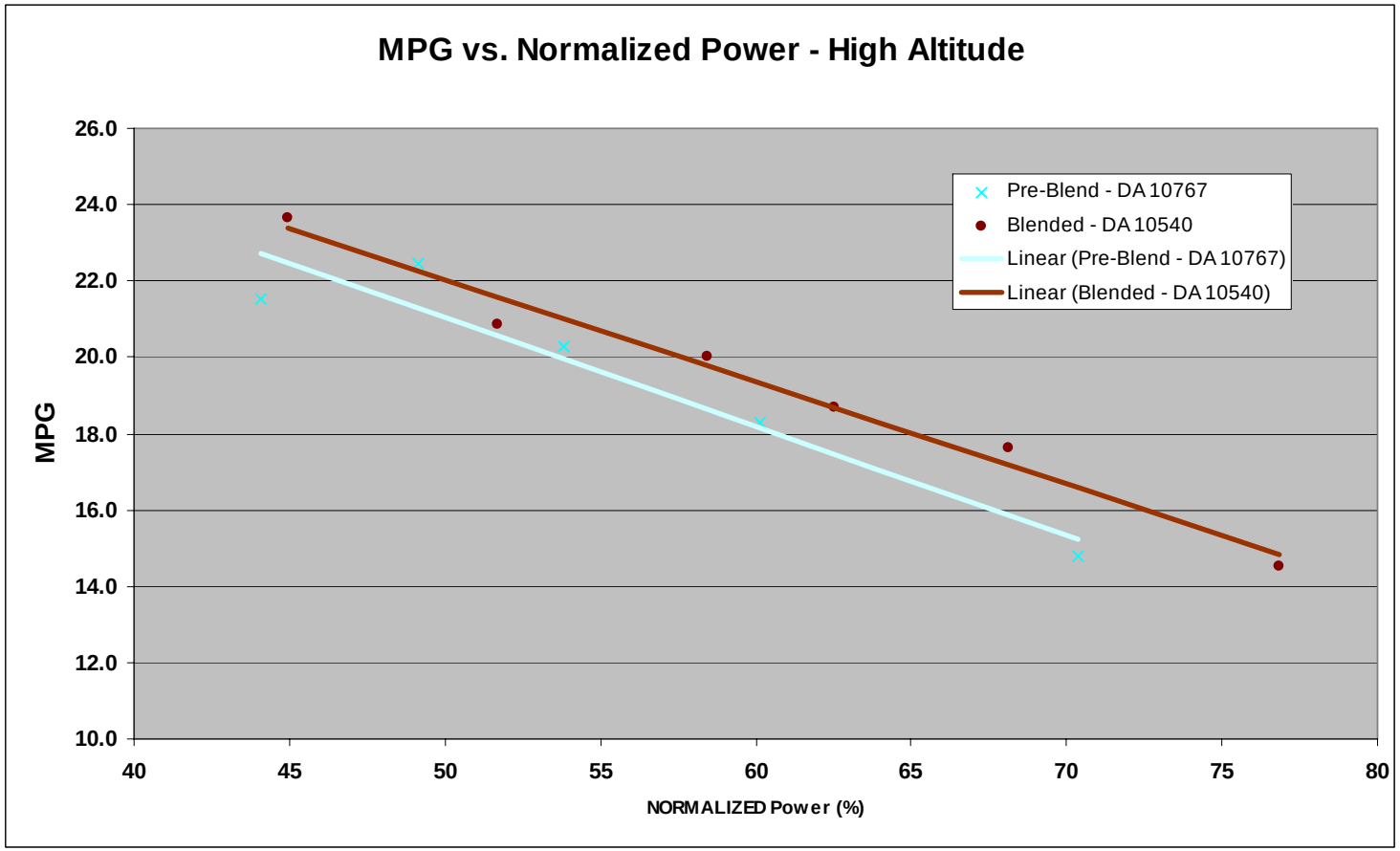
Aerodynamics / Results

- Look at Efficiency rather than IAS – maybe a hint as to what's going on
- Aha – more efficient at lower Density altitudes after blend – seems to conflict with lower IAS's at same normalized power levels



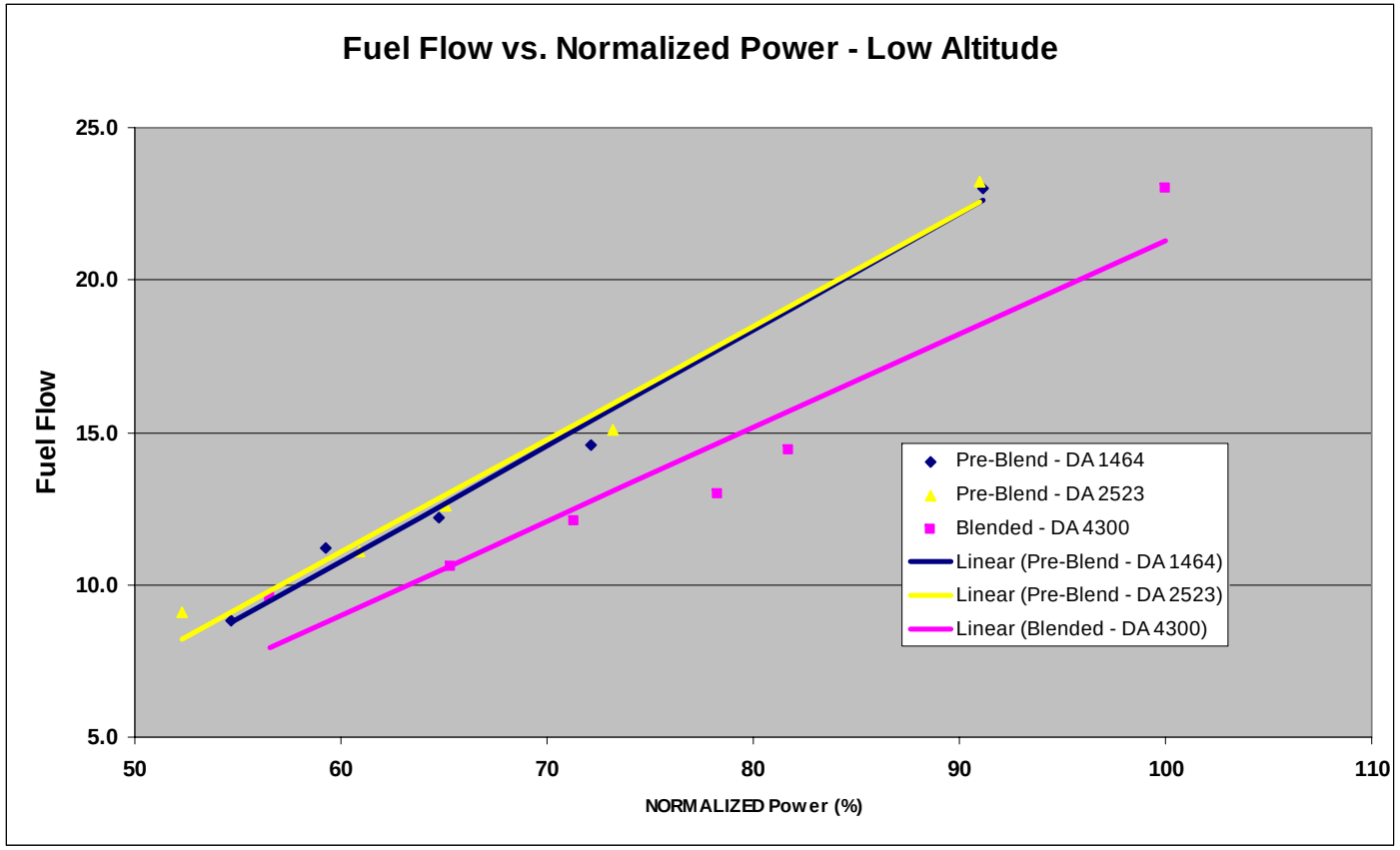
Aerodynamics / Results

- Same effect, albeit smaller, at high Density Altitudes
- More efficient after blend



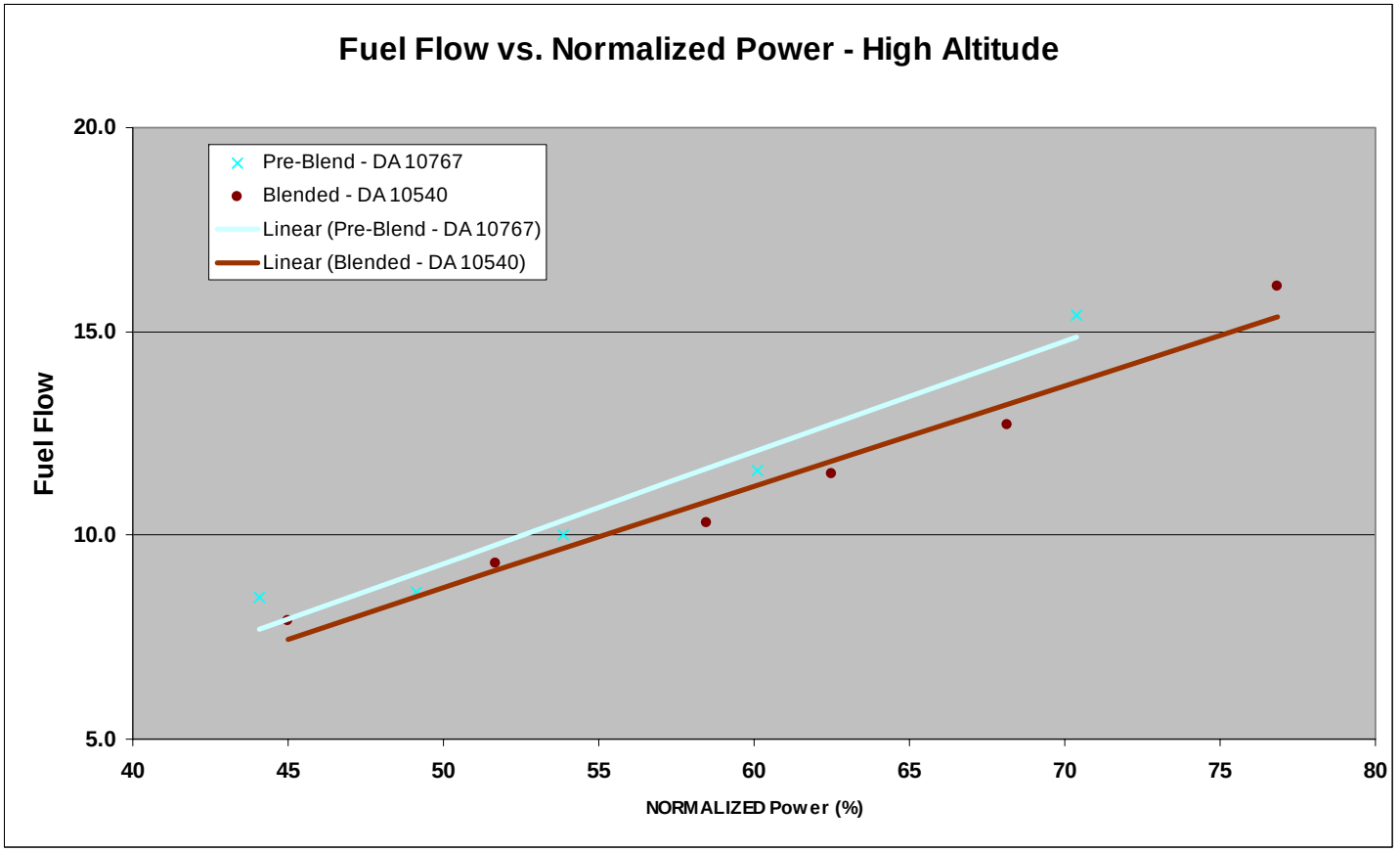
Aerodynamics / Results

- Look at Fuel Flow - AHA! At same normalized power levels, fuel flow is substantially different after blending
- How can this be – FF vs. power setting is **NOT** dependent upon aerodynamics – purely an engine issue



Aerodynamics / Results

- Same effect, albeit smaller (to be expected given efficiency differences) at high Density Altitudes
- Lower fuel flow at similar normalized power settings post-blend



Conclusions (MJZ's)

- Aerodynamic Differences from (my) perceived optimum
  - Left original 4" winglet leading edge offset – would have recommended moving winglet forward to align leading edges
  - Relatively small radius – would have made blend radius at least 12" internal
  - Tip symmetry effect unknown – aerodynamicist indicated could be higher or lower drag, depending on complex interrelationships

Conclusions (MJZ's)

- No change in efficiency due to aerodynamics – if anything, aerodynamic efficiency is slightly worse (see slides 7 and 8) with lower TAS's at similar power settings
- Why was there no aero improvement?
  1. Jack's E-Racer started in worse place
     - E-Racer aligned leading edge with sharp intersection
     - Left LE's aligned, which is better for these blended winglets
  2. Chris started in better place – less potential for improvement
     - Long-EZ/COZY offset winglet is better for sharp intersection
     - Left LE's offset – not as good for blended winglets / separation drag
  3. Used somewhat smaller blend radius – not getting full attachment of flow in intersection

Conclusions (MJZ's)

- If MPG/efficiency is better (with higher top end speed), it's related to engine
  - What engine changes occurred between pre-blend / blend runs?
  - What measurement inaccuracies could there be in IAS, FF, MPG, etc.?
  - What instrumentation/calibration changes may have occurred in the engine instrumentation?
  - What propeller changes may have occurred?
  - Chris states the only engine related change was an induction system modification to improve airflow

- Clearly **NOT** what Chris would have wanted to see with respect to Aerodynamics, but he should be happy with whatever engine change has occurred, if any…

Questions & Answers

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- Website: http://www.cozybuilders.org/