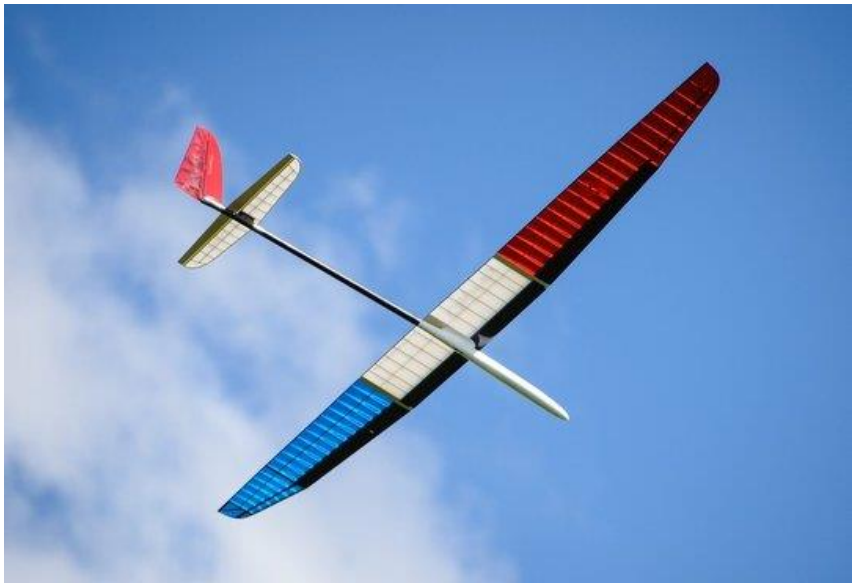
Dynamic Soaring

Spencer Lisenby

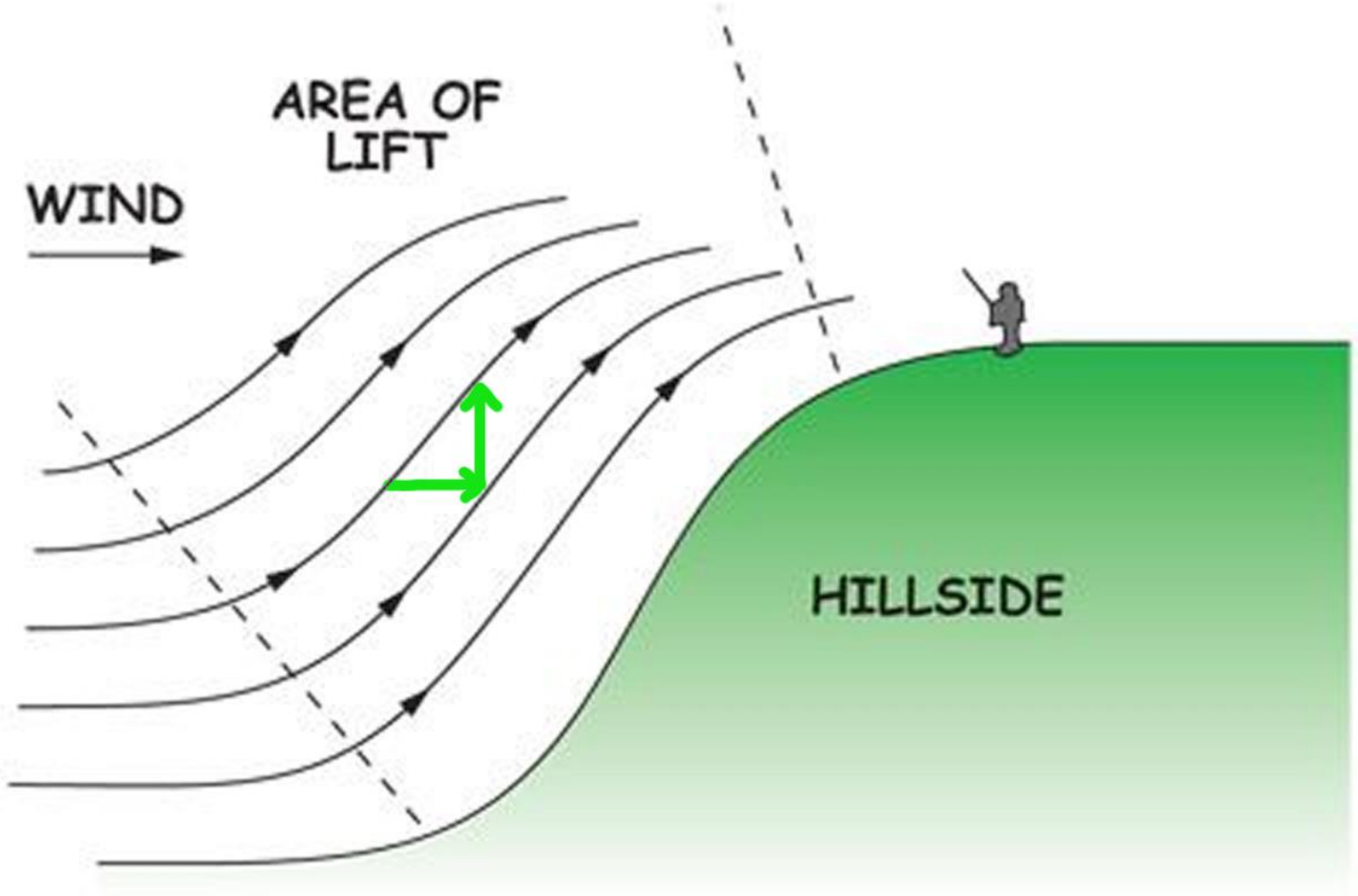
June 2 2017

Radio Controlled Gliders

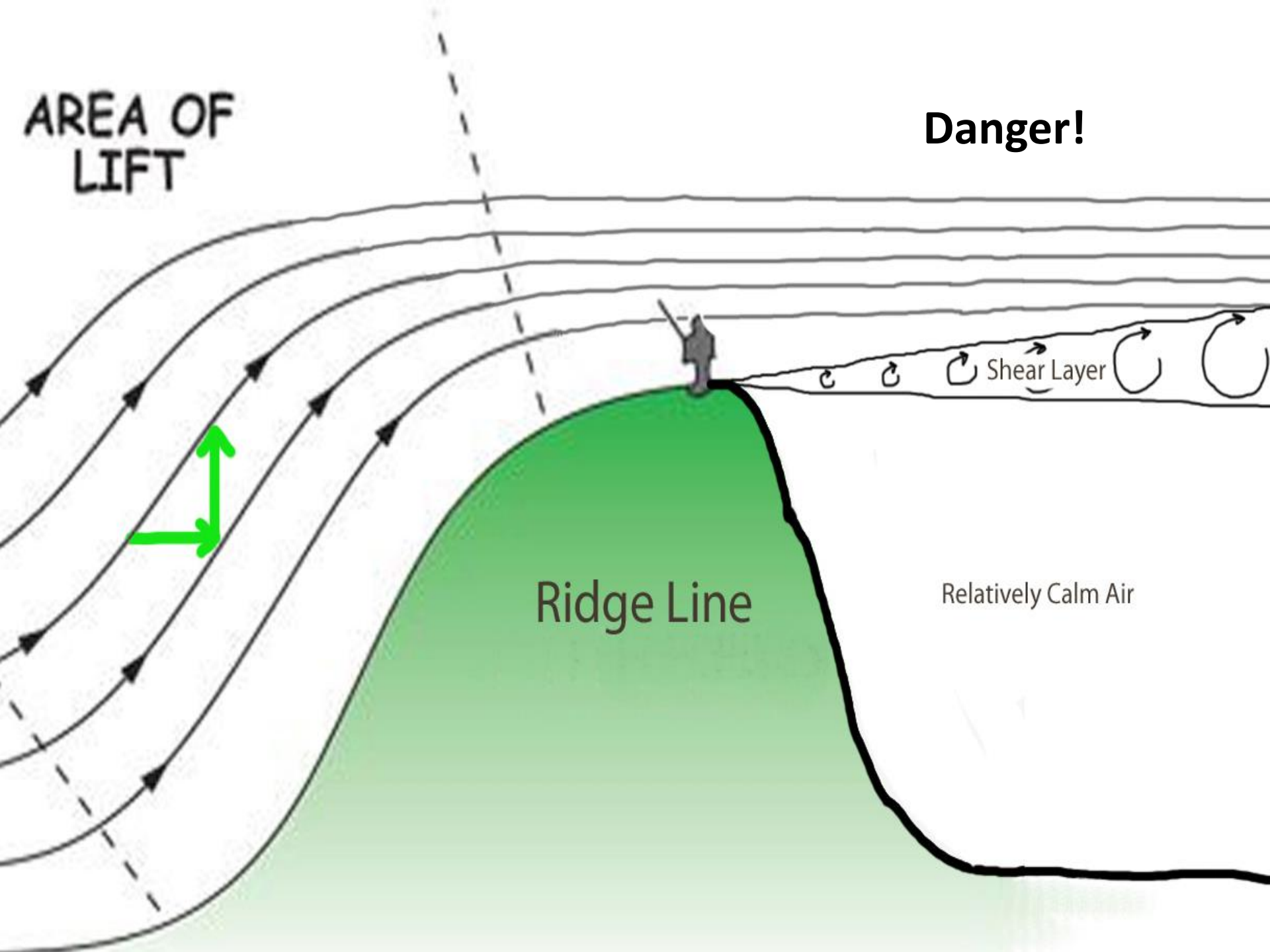


- Light Weight
- Fragile
- Slow Silent Flight
- Relaxing

Slope Soaring



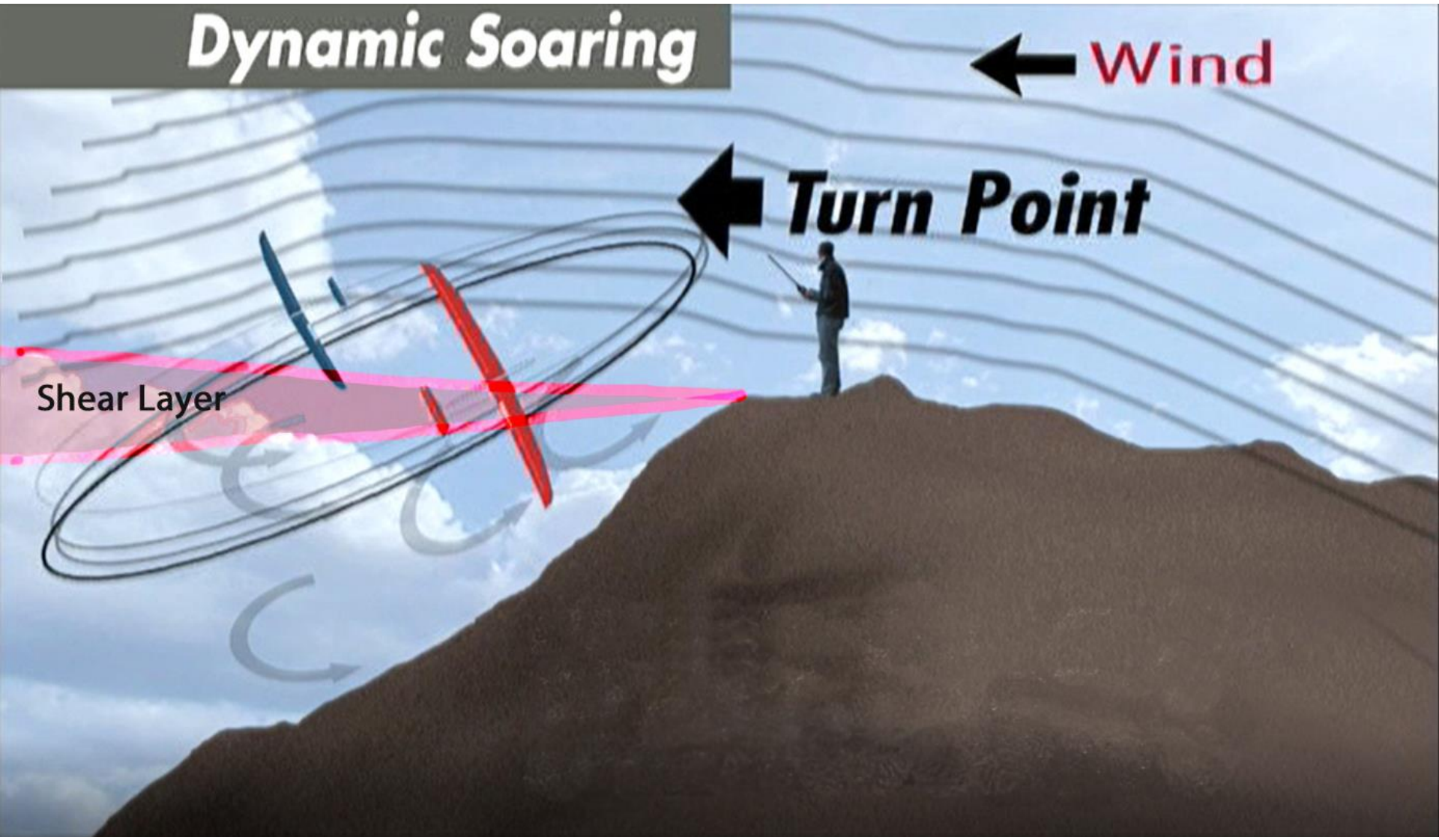
Slope Soaring ~ 1960s


AREA OF LIFT
Danger!
Shear Layer
Ridge Line
Relatively Calm Air

Joe Wurts

Dynamic Soaring with RC glider ~1995

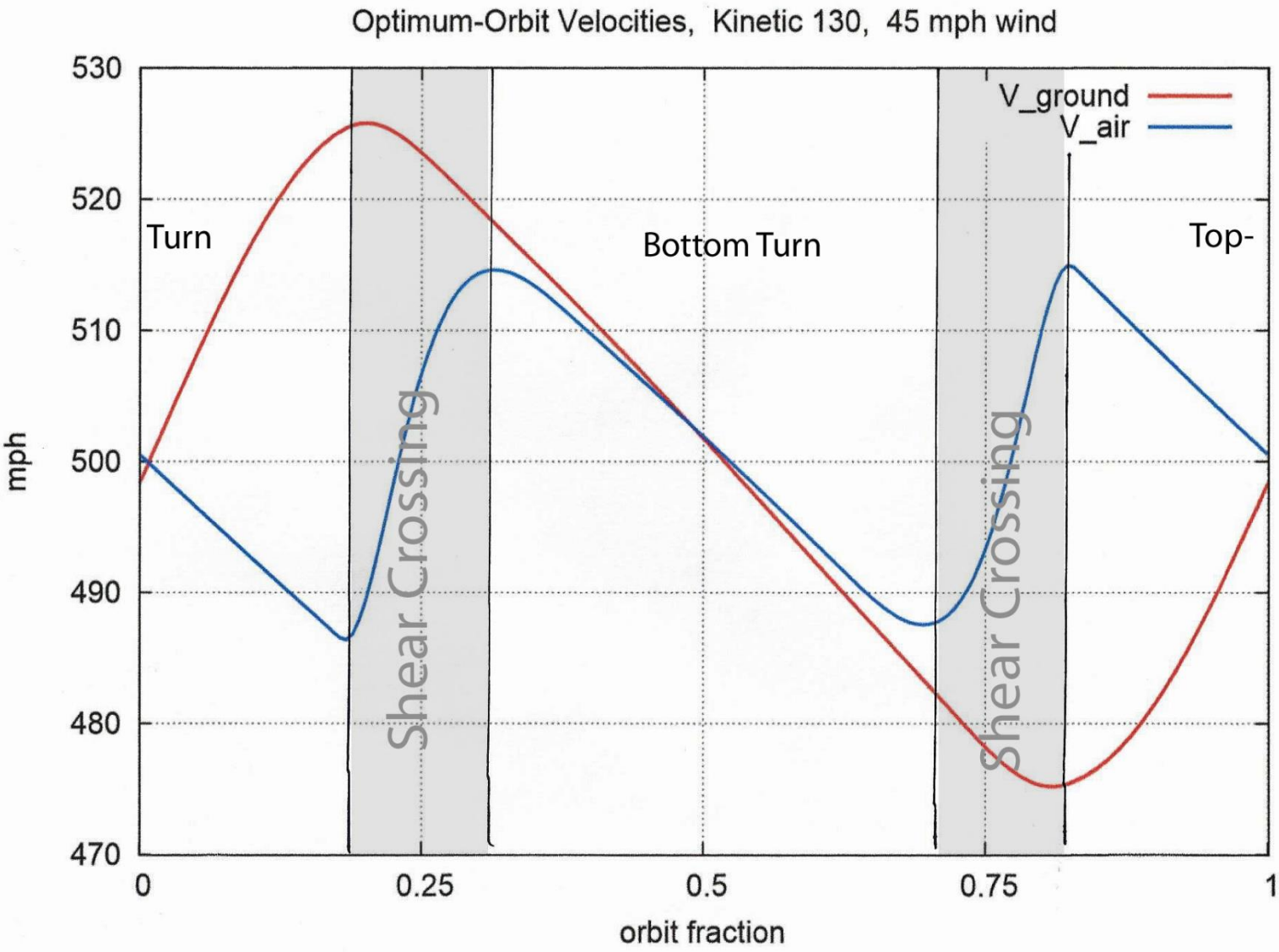
Parker Mountain, California


Dynamic Soaring
Wind
Turn Point
Shear Layer

How does DS work??

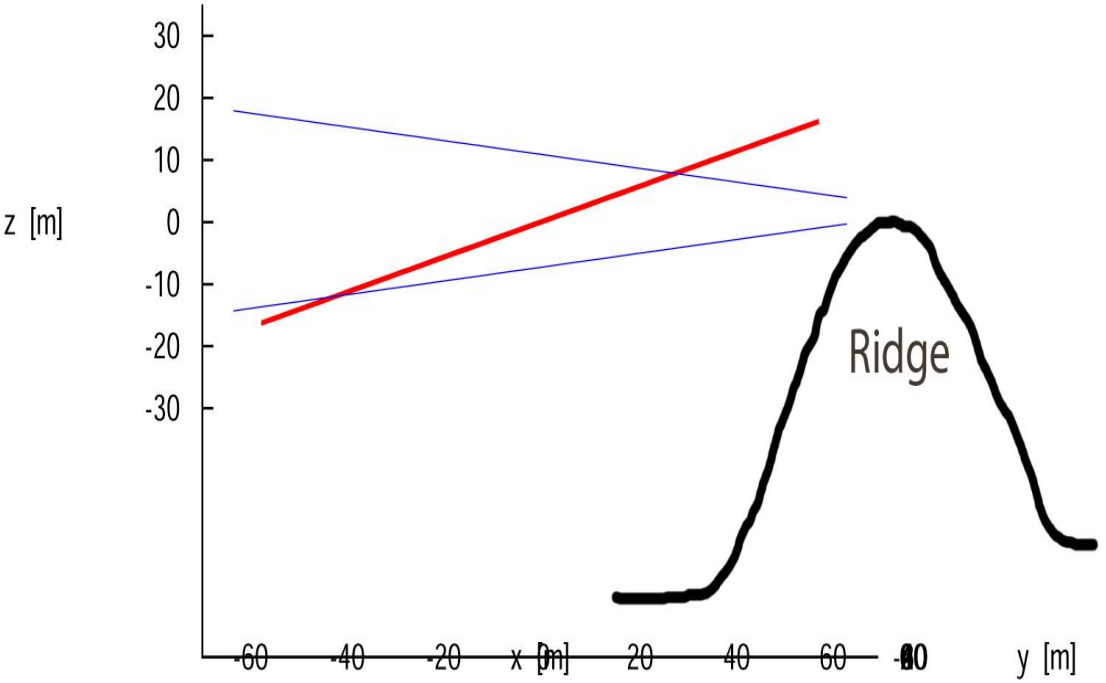
Lets momentarily exclude drag for the following explanation…

Courtesy of Eyytee on Youtube...


Optimum-Orbit Velocities, Kinetic 130, 45 mph wind
V_ground
V_air
Turn
Bottom Turn
Top-
Shear Crossing
Shear Crossing
mph
530
520
510
500
490
480
470
0
0.25
0.5
0.75
1
orbit fraction

Optimum DS Path

- Constant diameter circle
- Constant lift coefficient (CL)
- Diameter set for best L/D
- Real world results vary

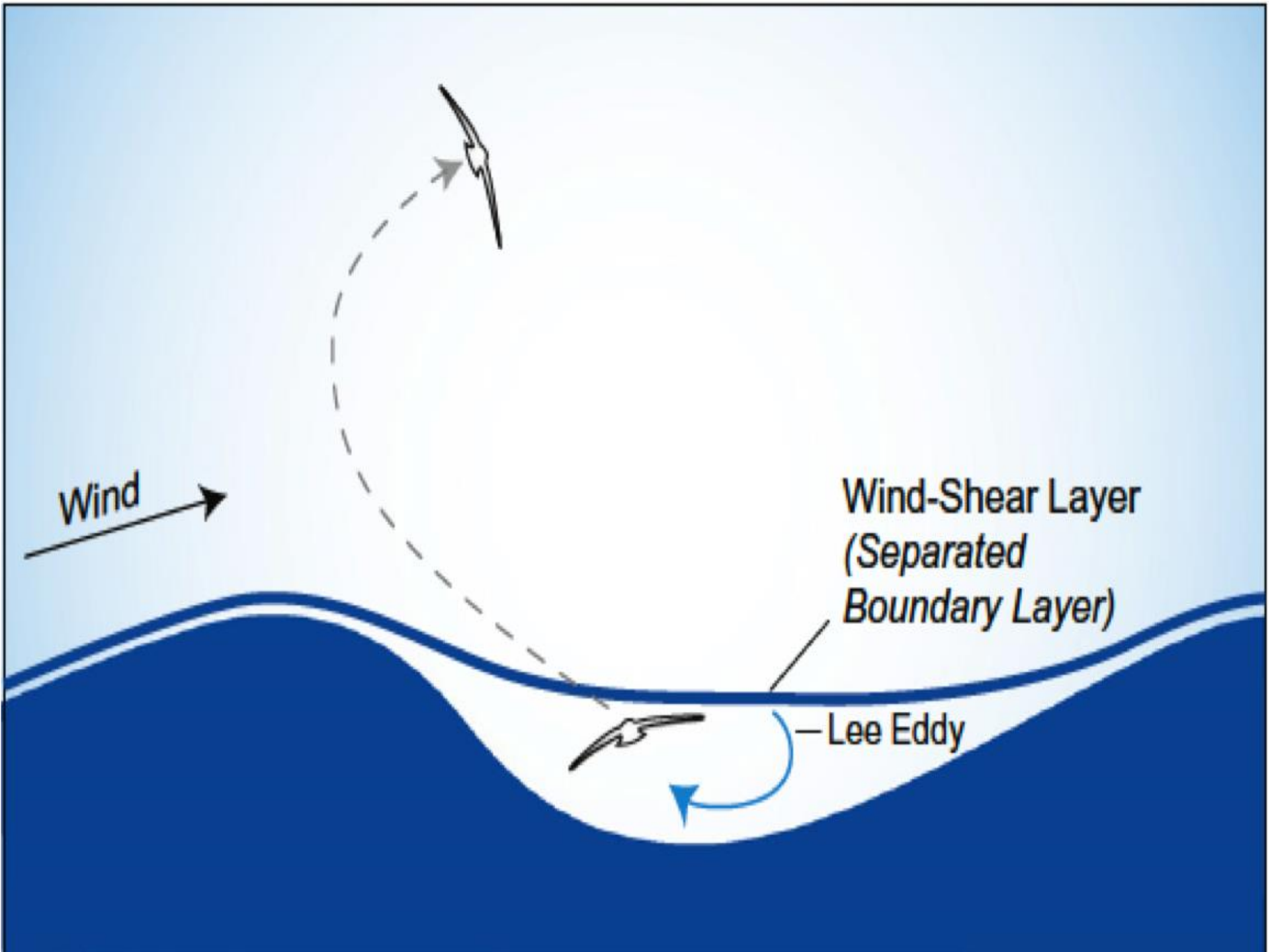


Black Footed Albatross --
The original DSer!

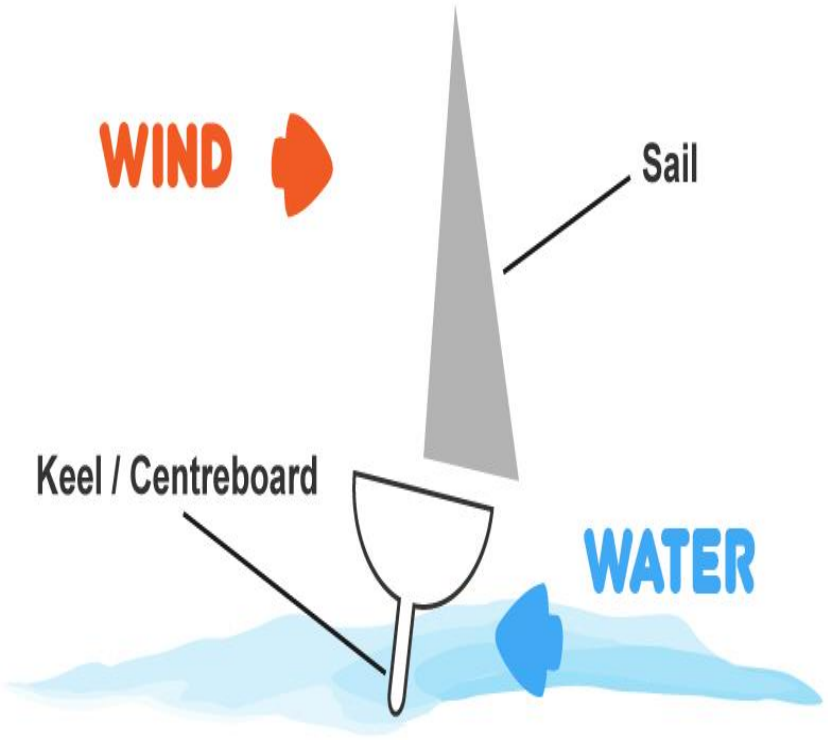
Observed by Lord Rayleigh in 1883 who described the flight path as ‘gust soaring’

Can fly hundreds of kilometers without ever flapping wings using DS and slope soaring

Even Sleeps while Dsing!


Wind
Wind-Shear Layer
(Separated
Boundary Layer)
Lee Eddy

Similar But Different



Early Days of DS

- 1998 - 2003
- Speeds: 150-250mph (240km/hr)
- Foam Gliders vs F3X
- Main failure modes:
  - Spar bending failure
  - Flutter failure

Flutter

- Aerodynamic Loads on Elastic Structure
- Coupling of torsion and bending modes
- Dependent on Stiffness, Mass, and Speed


23 | 49 | 26

The Perfect Formula

- Excitement and Risk
- Engineering Challenge
- Searching for hills and chasing the wind
- Elusive combination of events
- 100% Hooked from the beginning

The 60” Kinetic

T-Tail

HN Airfoil using snapflap

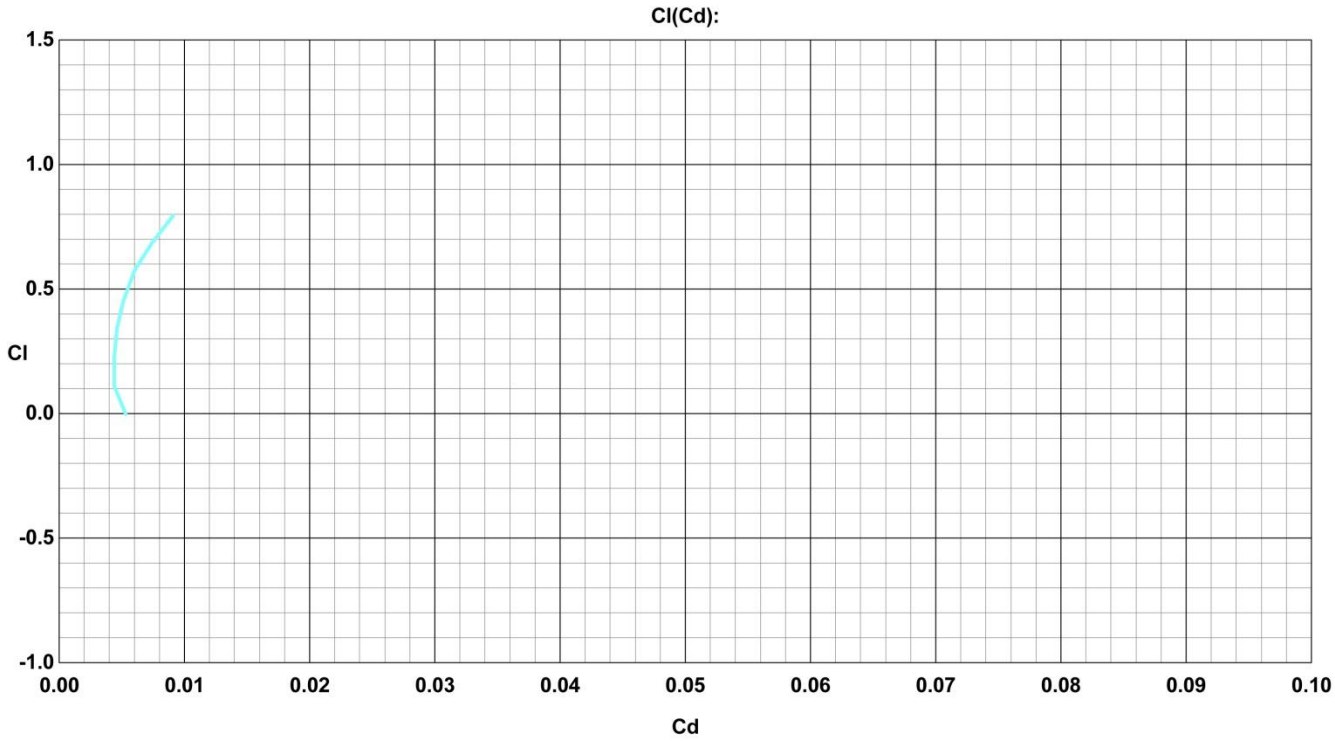
Small fuselage

Quickly broke the 60” record – 250mph (400kph)

60” Kinetic
Airfoil Polar No Camber

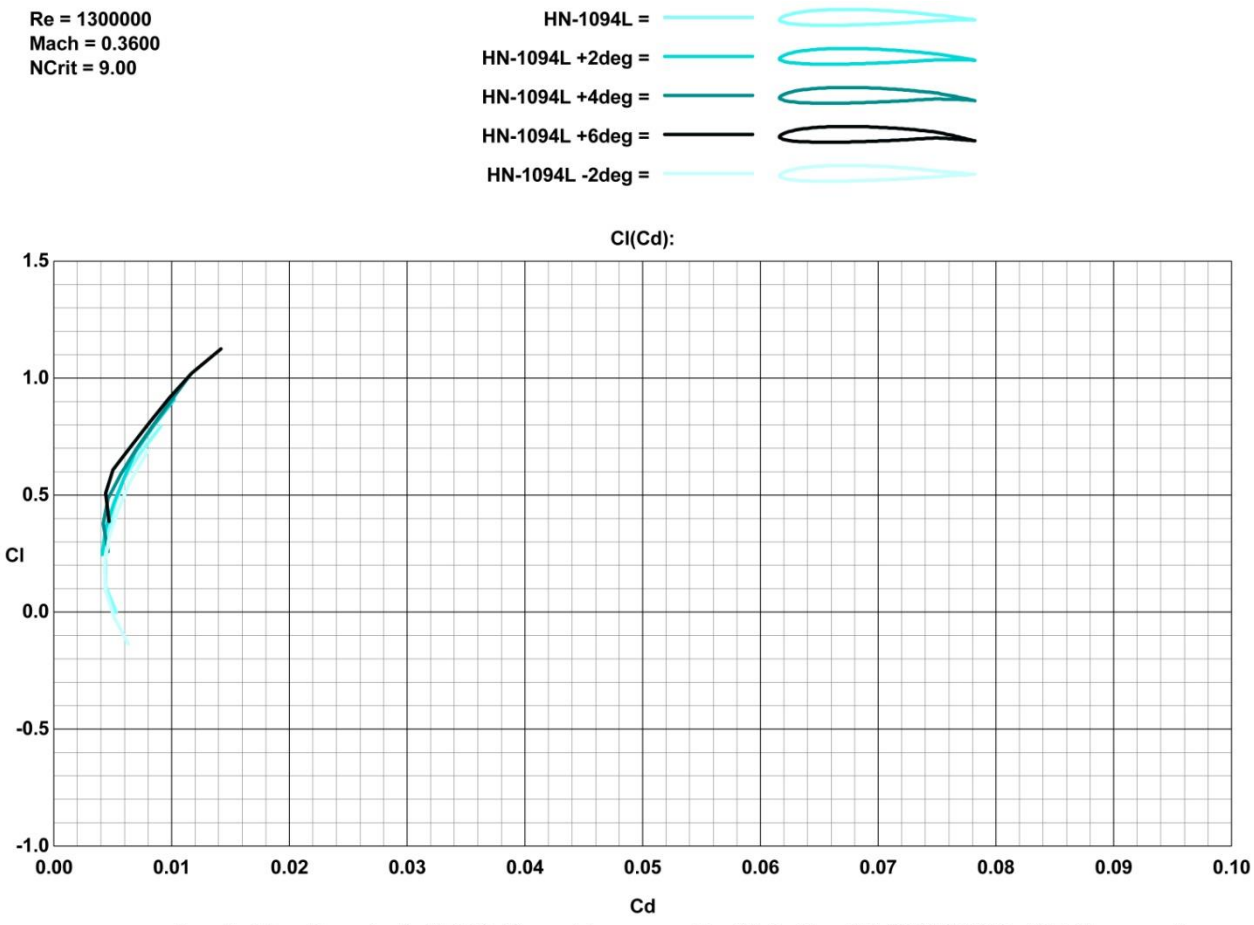
Re = 1300000
Mach = 0.3600
NCrit = 9.00

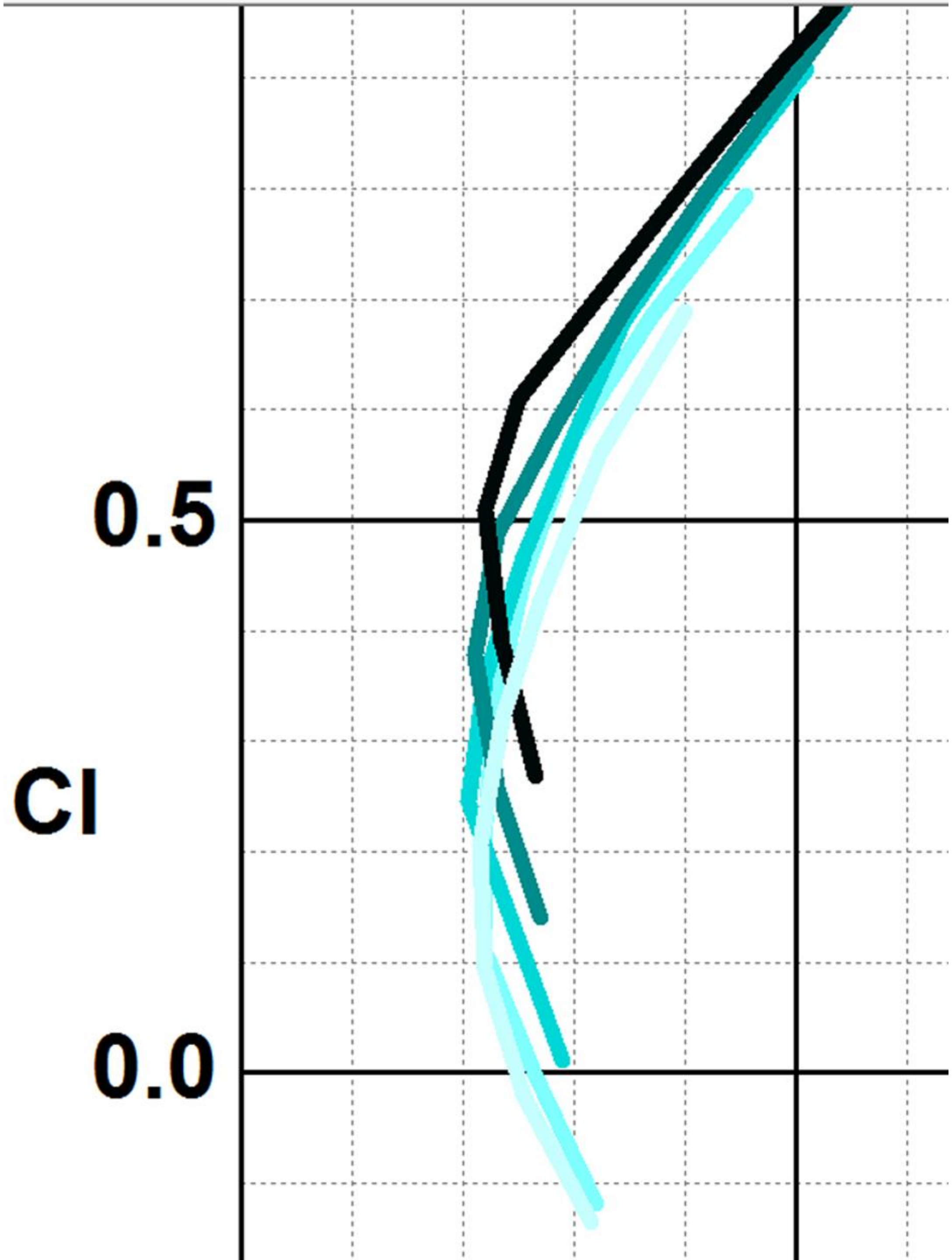
HN-1094L =



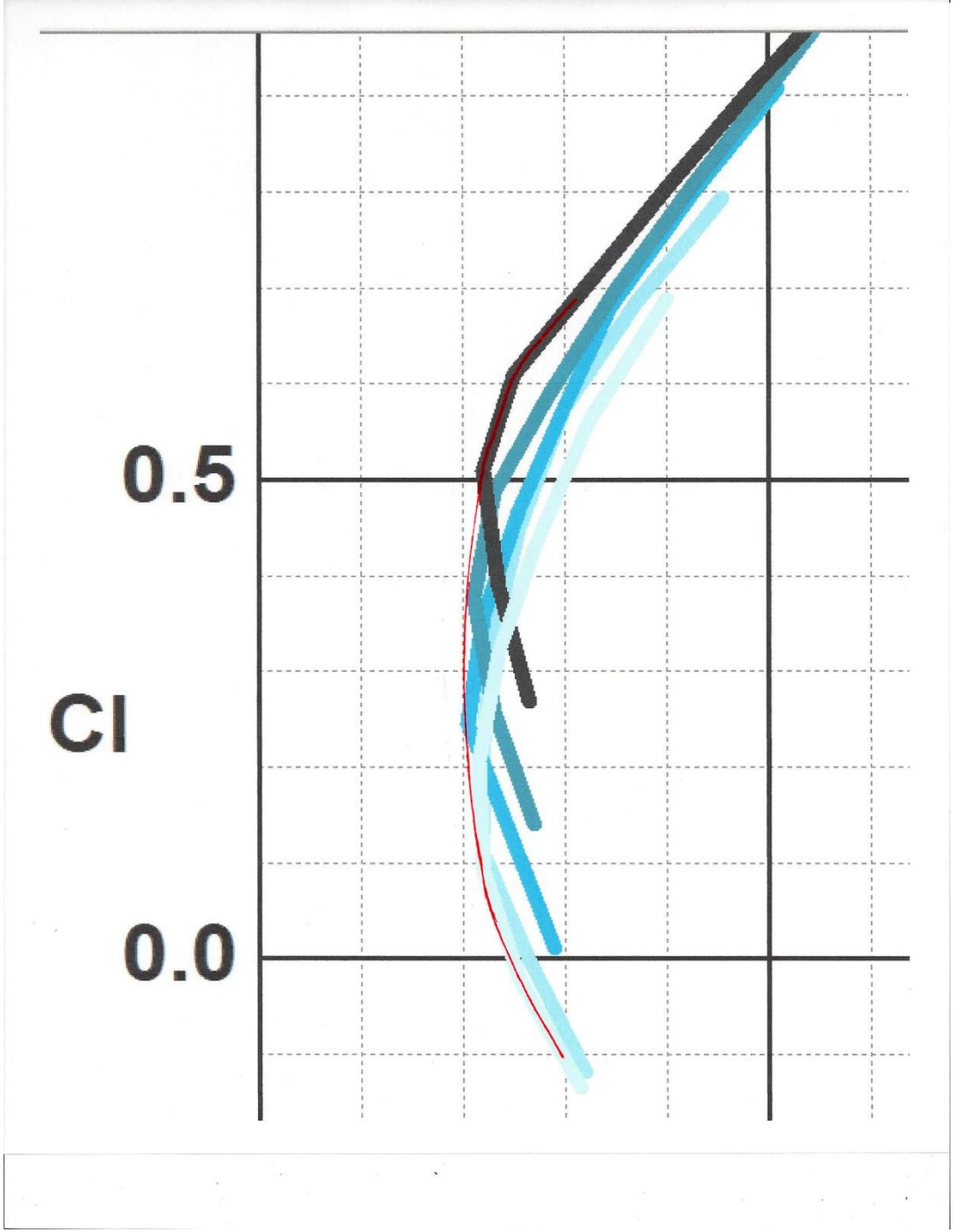
 - Drawn by Profili 2.30a Pro on data processed by XFoil -

60” Kinetic
Airfoil Polar with Camber




0.5
CI
0.0

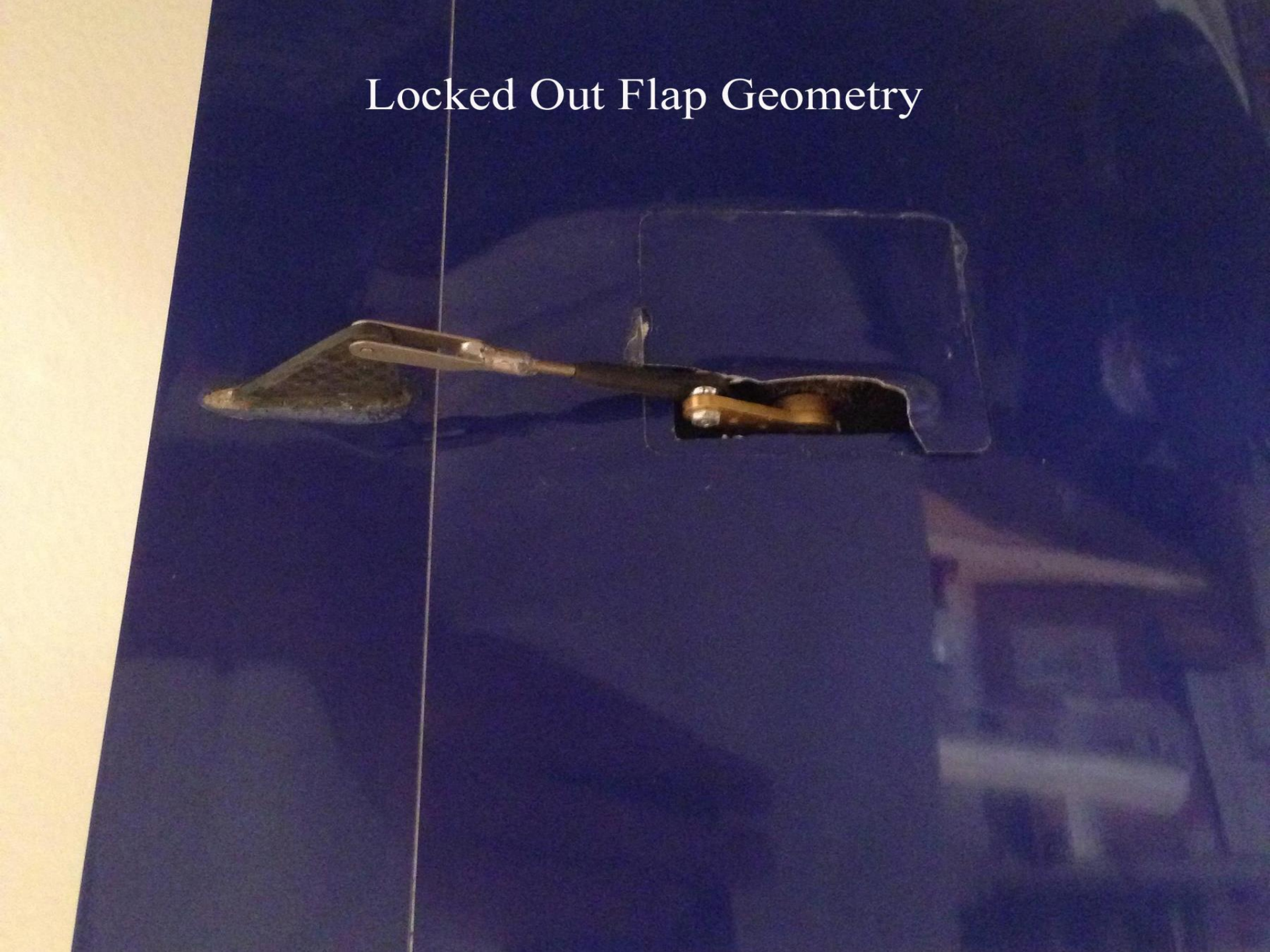
Red Curve =
Effective polar using snapflap



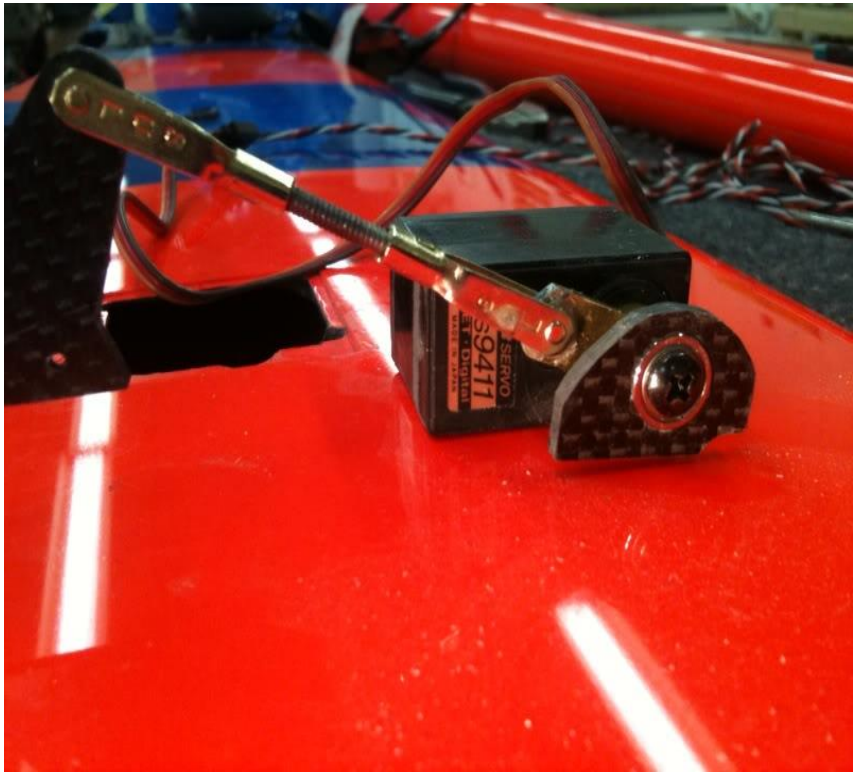
Solutions for Going Faster

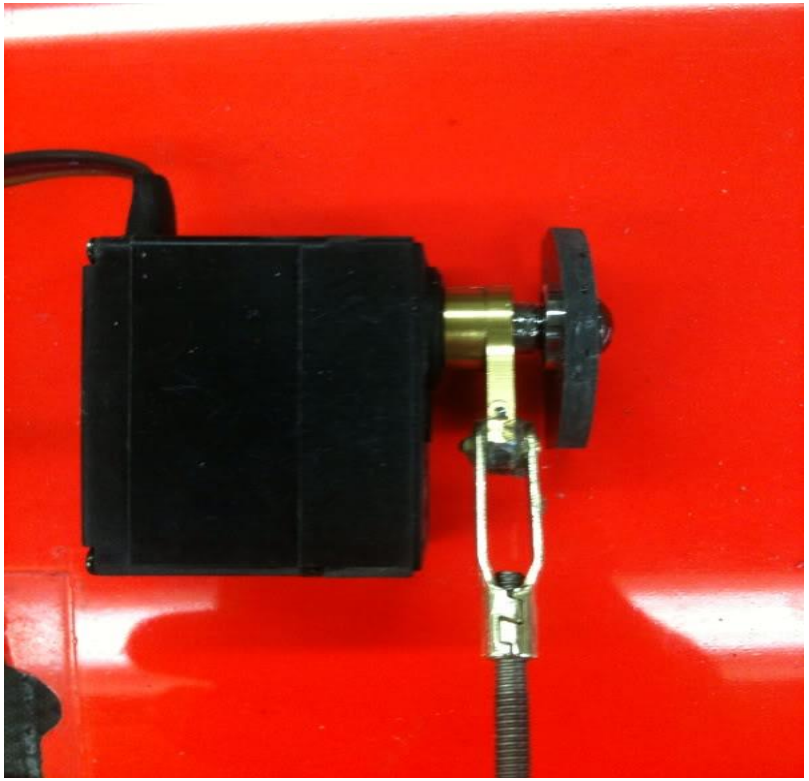
- 2006 - 2010
- ~300 – 400mph (480-640kph)
- More carbon / higher modulus
- Locked-out flap servos
- 3rd Bearing support for servos
- Span-loaded ballast
- Improved radar guns

Locked Out Flap Geometry



Locked out Flaps with 3rd Bearing





Span-loaded Ballasting

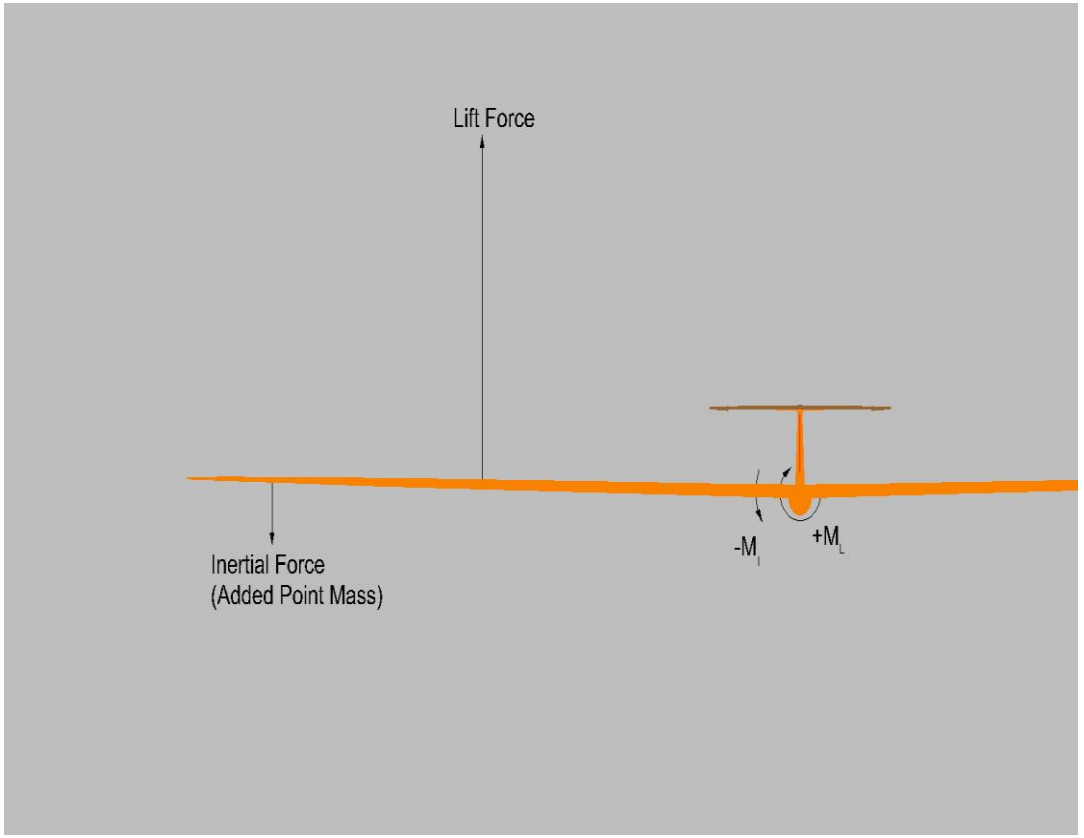
Reduced Bending Moment =

Easier to build

Increased Roll Inertia =
Easier to fly

Larger Circles =

Easier to fly



Long Awaited High Speed Radar

Falcon DS - 575mph

Stalker Pro II – 850mph

Bigger = Better

PROs-

- Easier to see
- More stable in turbulence
- Higher Reynolds numbers = more efficient

Cons-

- Structural problems
- Expensive

100” Kinetic DP

- New Laminar Airfoil from Dirk Pflug
- Strong 13.5 : 1 Aspect Ratio Wing
- 3piece wing - span loading with joiners
- New World Record on Maiden Flight – 309mph (~500kph)
- Set 11 more World Record Speeds – Up to 498mph (~800kph)

Laminar Flow Airfoils

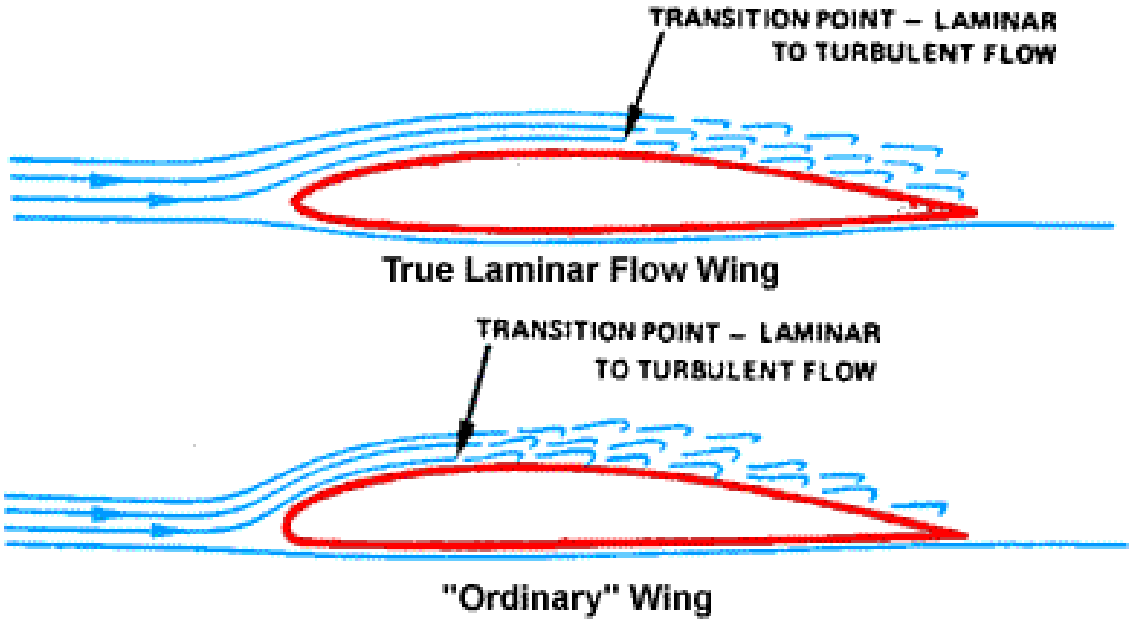
Reduced Drag

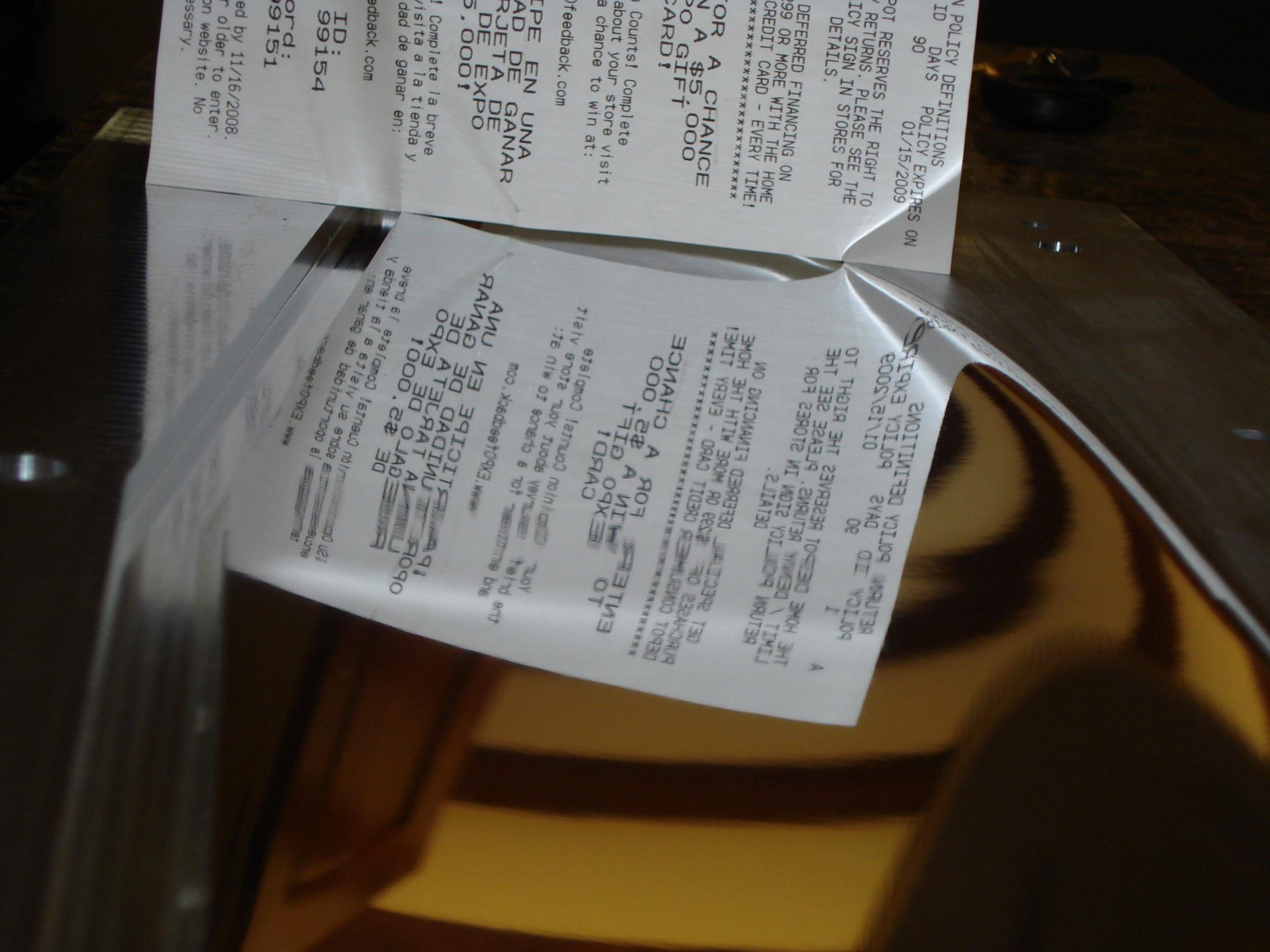
Transition Near Max Thickness

Max Thickness Moved Aft for Extended Laminar Run

Near Perfect Surface required

Top Quality CNC Moulds




POLICY DEFINITIONS
DAYS POLICY EXPIRES ON
90
01/15/2009
RESERVES THE RIGHT TO
RETURNS. PLEASE SEE THE
SIGN IN STORES FOR
DETAILS.
DEFERRED FINANCING ON
OR MORE WITH THE HOME
CREDIT CARD - EVERY TIME!
FOR A CHANCE
$5,000
Counts! Complete
about your store visit
a chance to win at:
feedback.com
Complete la breve
visita a la tienda y
dad de ganar en:
ed by 11/16/2008.
or older to enter.
on website. No
ID:
99154
99151

130” Kinetic DP

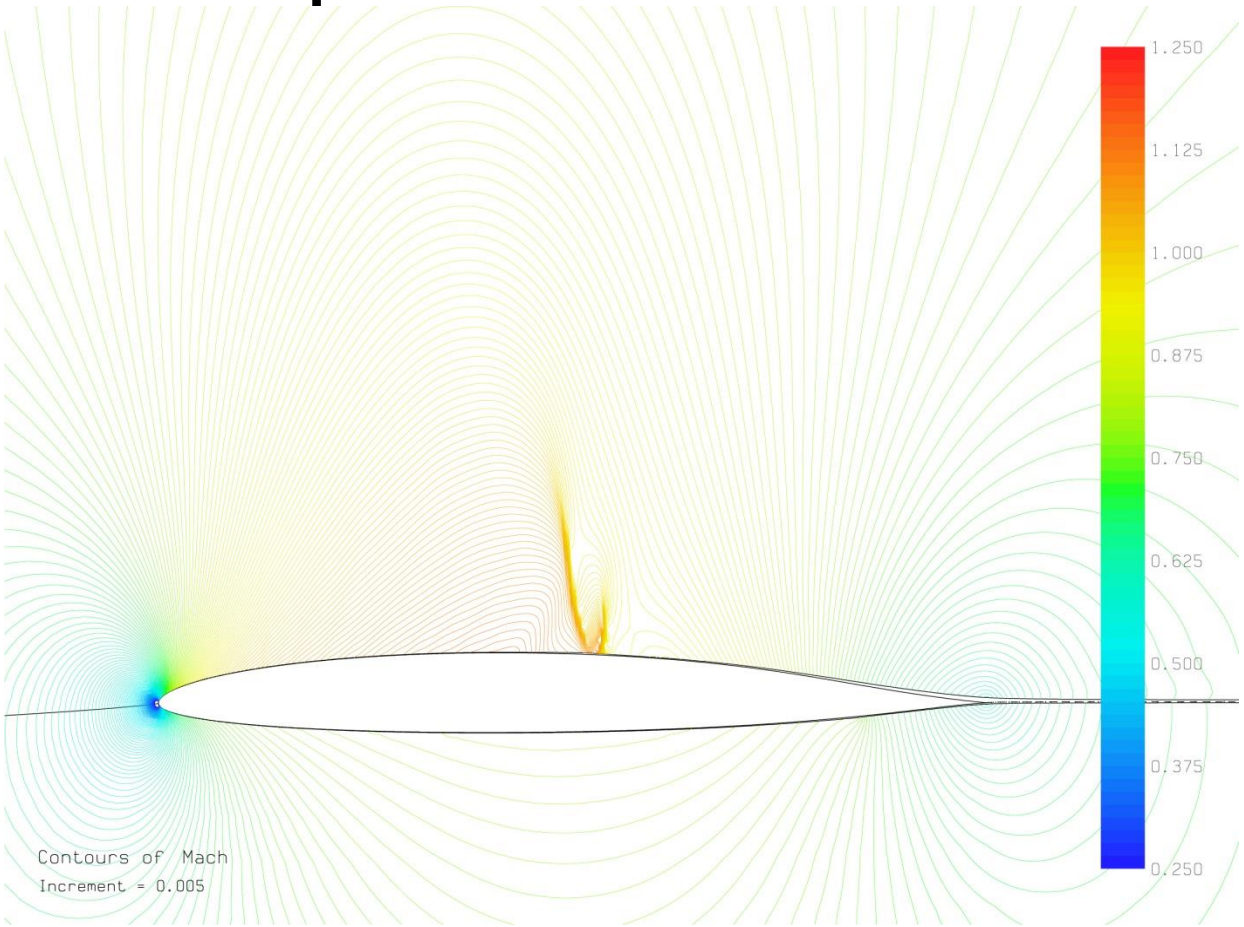
- Extended Center Panel
- Increased Aspect Ratio from 13.5:1 to 17.5:1
- 10-15% Faster than 100” Kinetic DP
- Top Speed =
  513mph (825kph)
  (previous world record)

2m Kinetic DP

2m Kinetic DP

- Dirk Pflug laminar flow airfoils
- Aspect ratio = 17:1
- Designed for higher lift coefficients
- Design rewards aggressive piloting
- 120+ G
- Ballast D-box
- 462mph
  (2m Record)

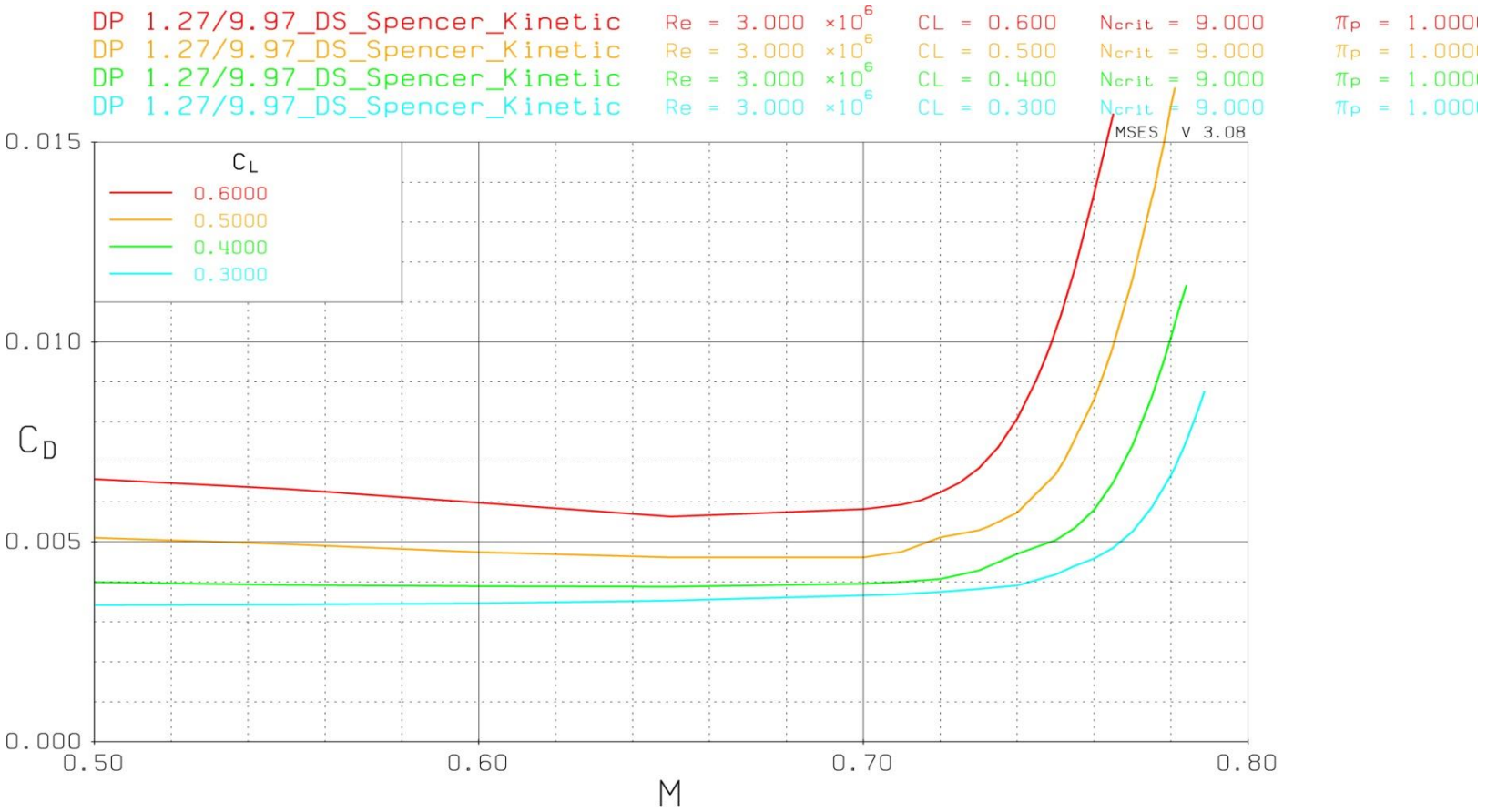
Transonic Complications
Supersonic Airflow



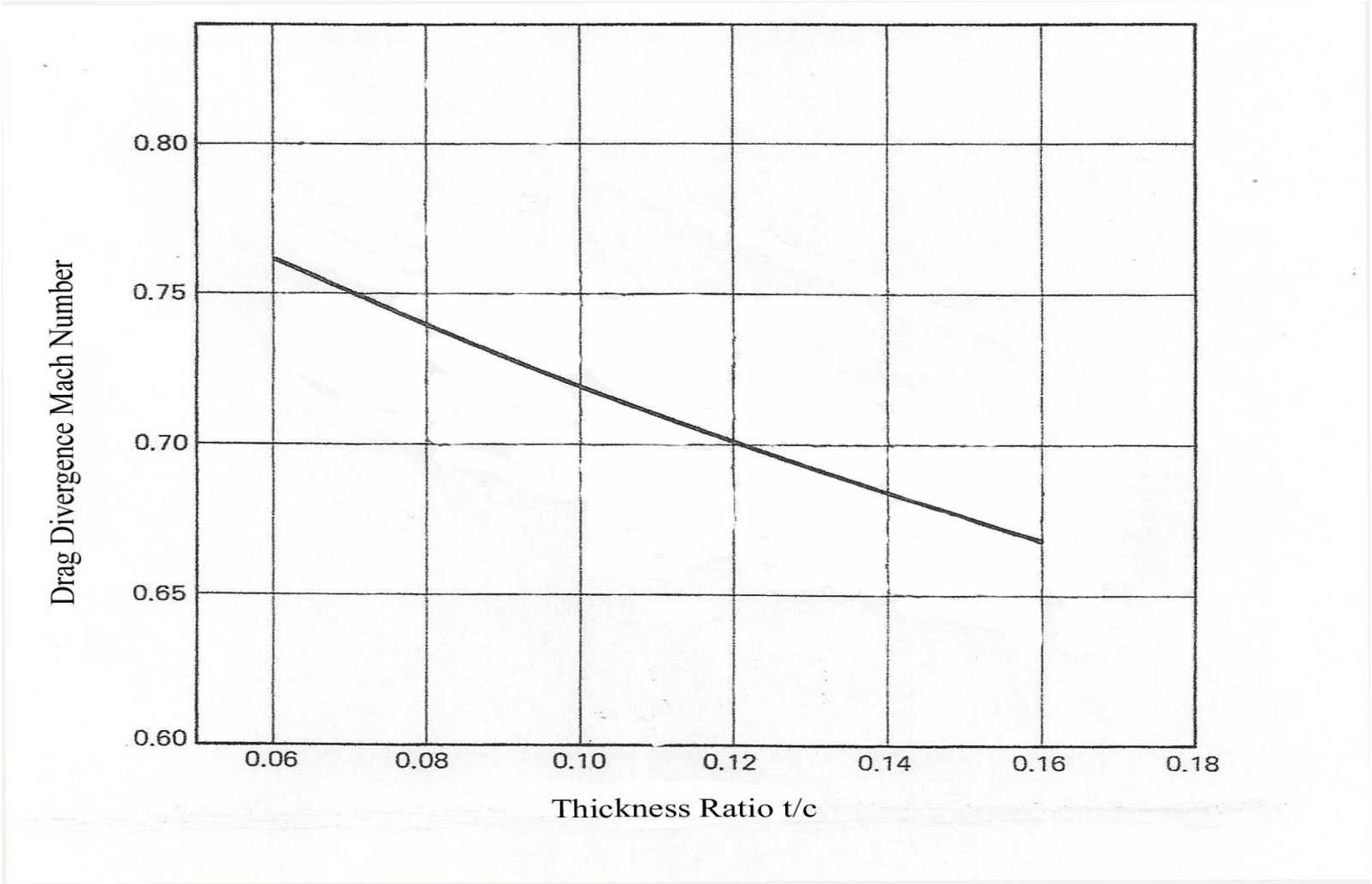
- Vehicle Mach = 0.73
- Local Mach ~1.25 or greater than 900mph (1450kph)!

Compressibility Issues

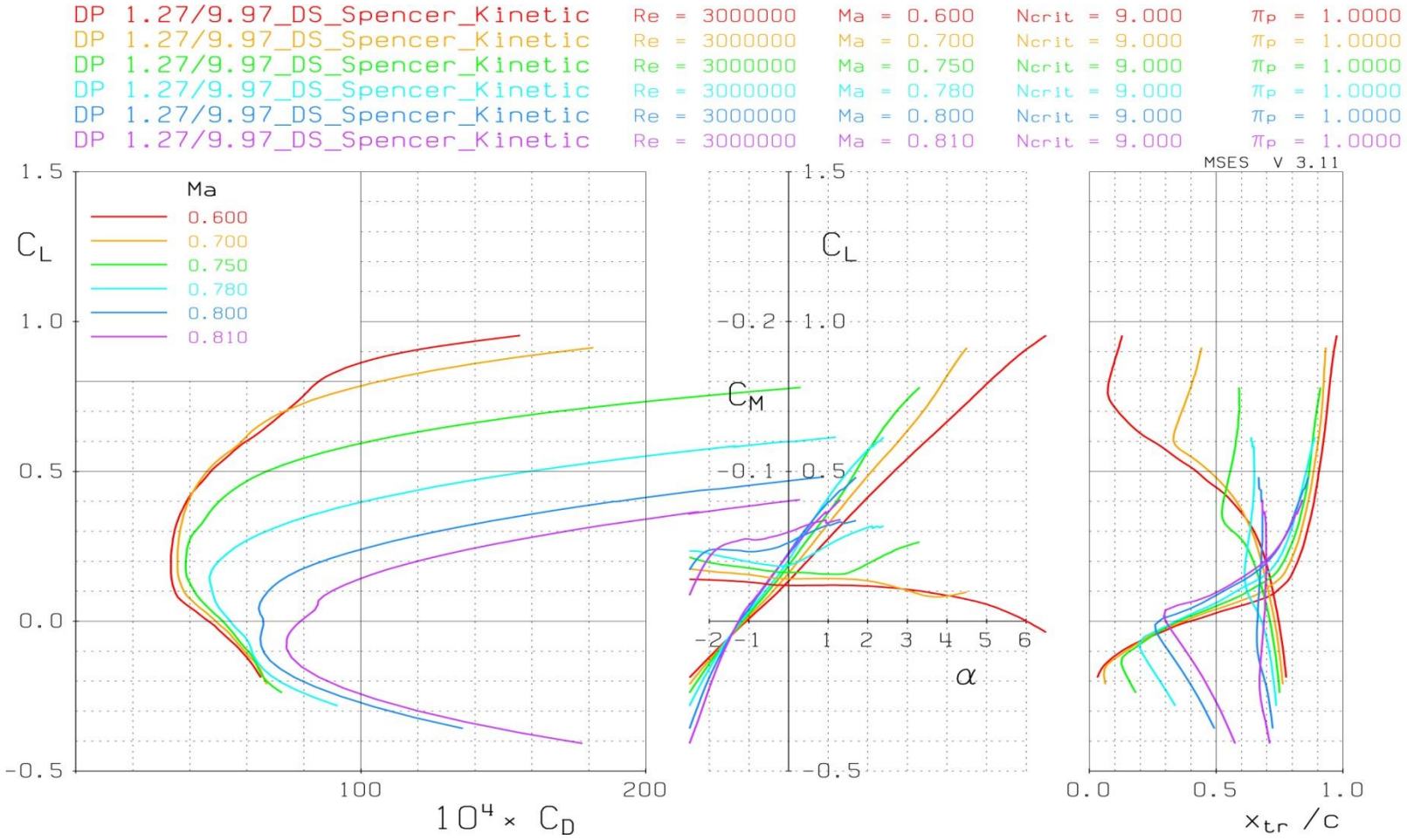
- Drag Divergence Mach Number



Transonic Effect of Thickness to Chord Ratio



Decreasing CLmax



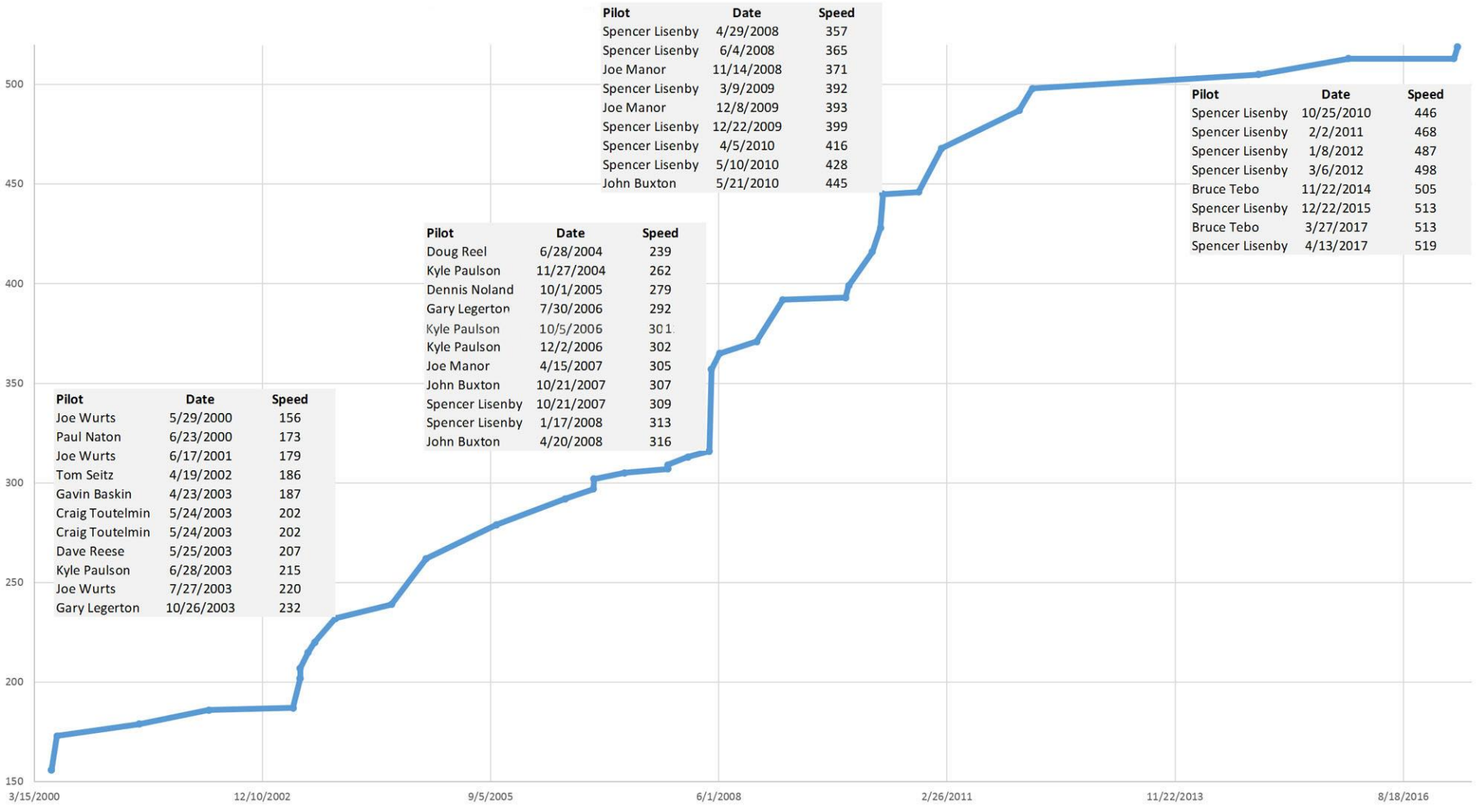
Swept Wing Kinetic

Transonic DP

- Aspect ratio = 22.5 : 1
- 1 piece wing
- Increased taper ratio
- Special DP airfloils
- Wing transonically optimized using MSES at Stuttgart University
- Designed to reach 575mph
- Set Current World Record Speed of 519mph (835kph) on April 13, 2017

Kinetic Transonic DP,
Spencer Lisenby,
Bird Springs Pass,
4-14-2017
519 MPH

Dynamic Soaring Records History



Pilot	Date	Speed
Joe Wurts	5/29/2000	156
Paul Naton	6/23/2000	173
Joe Wurts	6/17/2001	179
Tom Seitz	4/19/2002	186
Gavin Baskin	4/23/2003	187
Craig Toutelmin	5/24/2003	202
Craig Toutelmin	5/24/2003	202
Dave Reese	5/25/2003	207
Kyle Paulson	6/28/2003	215
Joe Wurts	7/27/2003	220
Gary Legerton	10/26/2003	232

Pilot	Date	Speed
Doug Reel	6/28/2004	239
Kyle Paulson	11/27/2004	262
Dennis Noland	10/1/2005	279
Gary Legerton	7/30/2006	292
Kyle Paulson	10/5/2006	301
Kyle Paulson	12/2/2006	302
Joe Manor	4/15/2007	305
John Buxton	10/21/2007	307
Spencer Lisenby	10/21/2007	309
Spencer Lisenby	1/17/2008	313
John Buxton	4/20/2008	316

Pilot	Date	Speed
Spencer Lisenby	4/29/2008	357
Spencer Lisenby	6/4/2008	365
Joe Manor	11/14/2008	371
Spencer Lisenby	3/9/2009	392
Joe Manor	12/8/2009	393
Spencer Lisenby	12/22/2009	399
Spencer Lisenby	4/5/2010	416
Spencer Lisenby	5/10/2010	428
John Buxton	5/21/2010	445

Pilot	Date	Speed
Spencer Lisenby	10/25/2010	446
Spencer Lisenby	2/2/2011	468
Spencer Lisenby	1/8/2012	487
Spencer Lisenby	3/6/2012	498
Bruce Tebo	11/22/2014	505
Spencer Lisenby	12/22/2015	513
Bruce Tebo	3/27/2017	513
Spencer Lisenby	4/13/2017	519

Reflexes

The Human Factor

- Constant CL means constant diameter orbit
- As speed increases, orbit time decreases
- Minimum orbit time ~2sec
- Choice response time ~0.45sec
- In 0.45sec plane travels over 100m!

What’s Next ?

- Push Transonic DP past 575mph (925kph)
- Work on new swept wing design
- Pursue practical application for DS tech

What else might be done with DS?

Robotic Albatross

DS the Jetstream

New Ideas?

Exploration of Mars