Lower Surface
Leading Edge Tape

Glider Performance Modification

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Overview

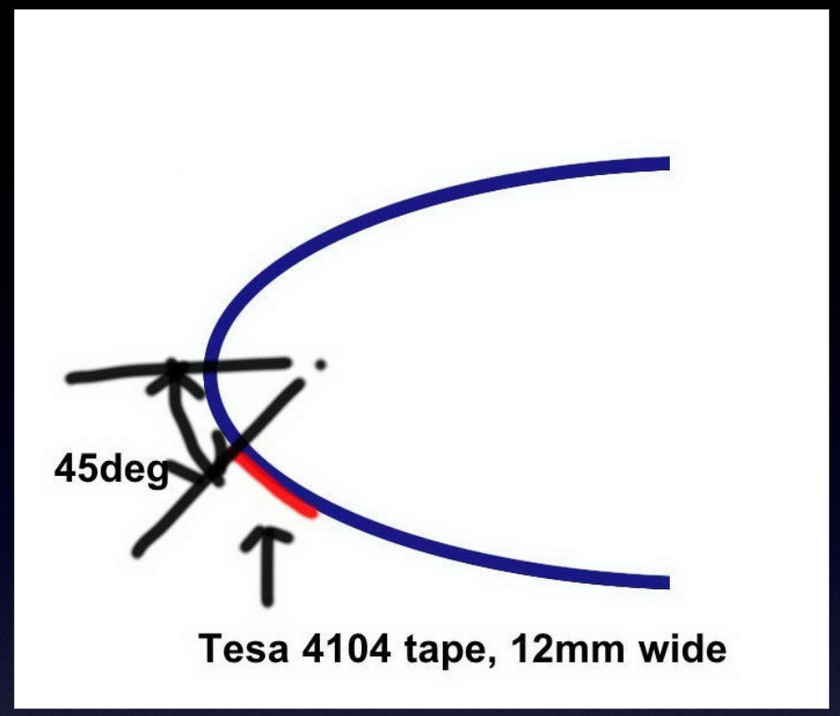
- The Deturbulator Project (www.deturbulator.org) has demonstrated a new way to finesse boundary flows on some glider wings for potentially remarkable performance improvements. But, the tested methods were not reliable or practical for normal use.

- In 2011 it was found that part of the full deturbulator configuration delivered about 15% improvement on a Standard Cirrus glider over the range of normal soaring airspeeds with no losses at any speed.

- That part is merely a strip of tape appropriately placed below the leading edge of the wing.

Tape Specifications and Placement

- Tape Thickness: 64u - 76u (.0025" - .0030")
- Tape Width: 12mm (.5")
- Tape Surface: Glossy Smooth
- Example Tape: Tesa 4104, **White***



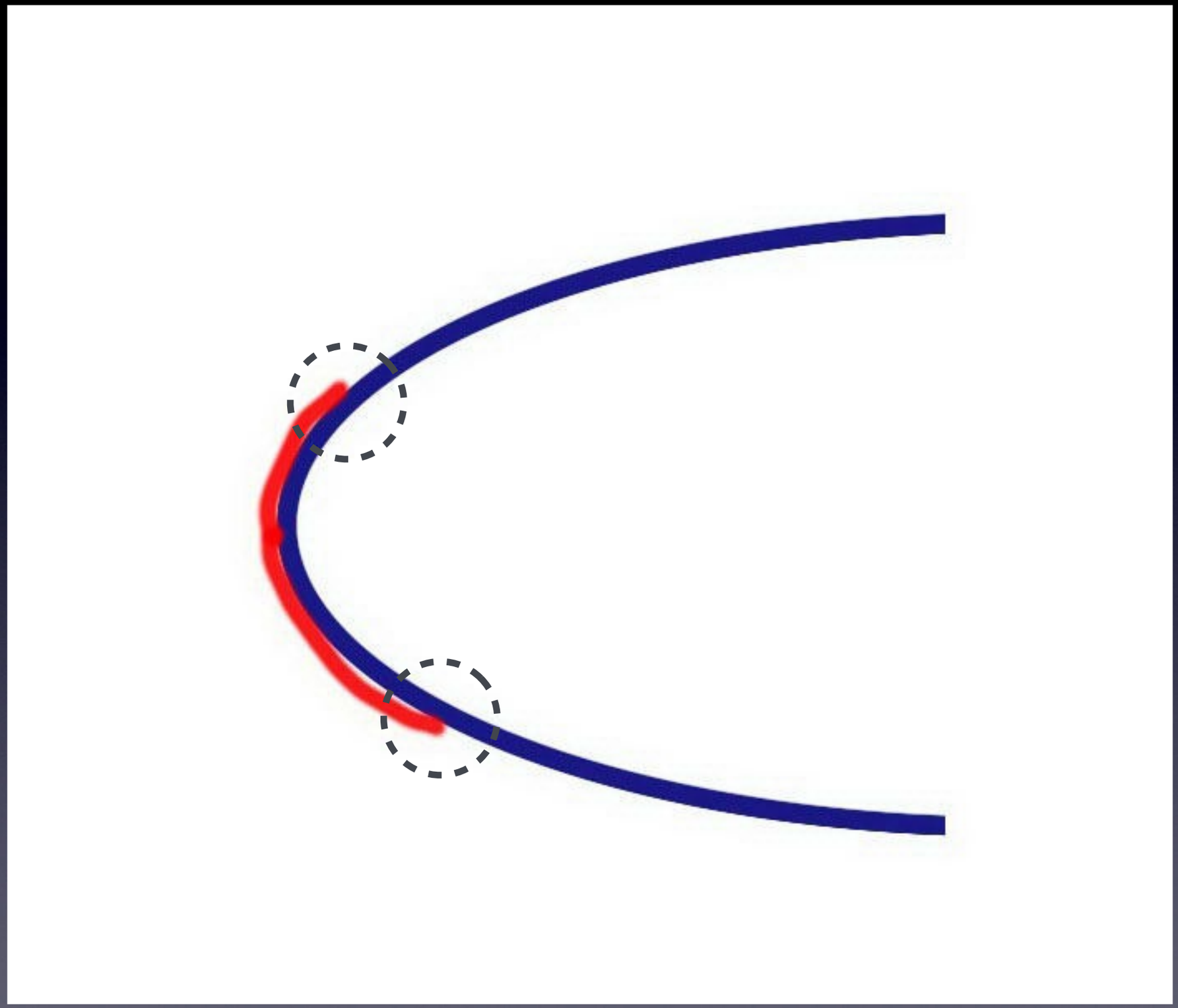
- Source: www.oxaero.com
- Placement: Forward edge 45 degrees under the wing leading edge.
- Airfoils Tested: Wortmann FX S 02-196, Wortmann FX 66-17 A II-182

* **Avoid** Tesa 4104, **Clear** tape. The surface is too rough.

How the Configuration was Determined

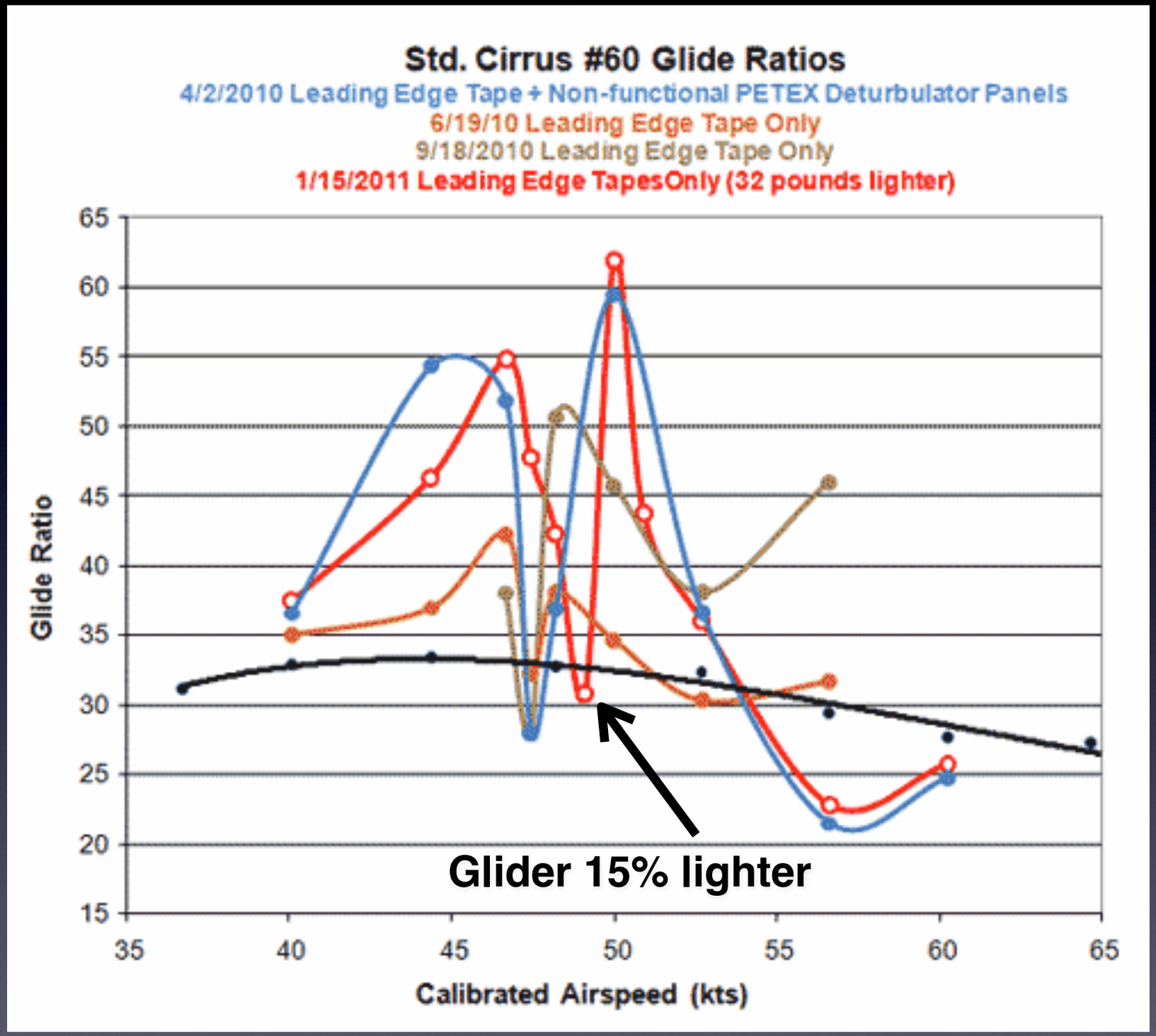
- This mod is the third in a sequence of three leading edge tape configurations that were tested.
- **First:** Two inch tape around the leading edge.
- **Second:** Downward from leading edge.
- **Third:** Downward from 45 degrees under the leading edge.

Two Inch Tape Around the Leading Edge



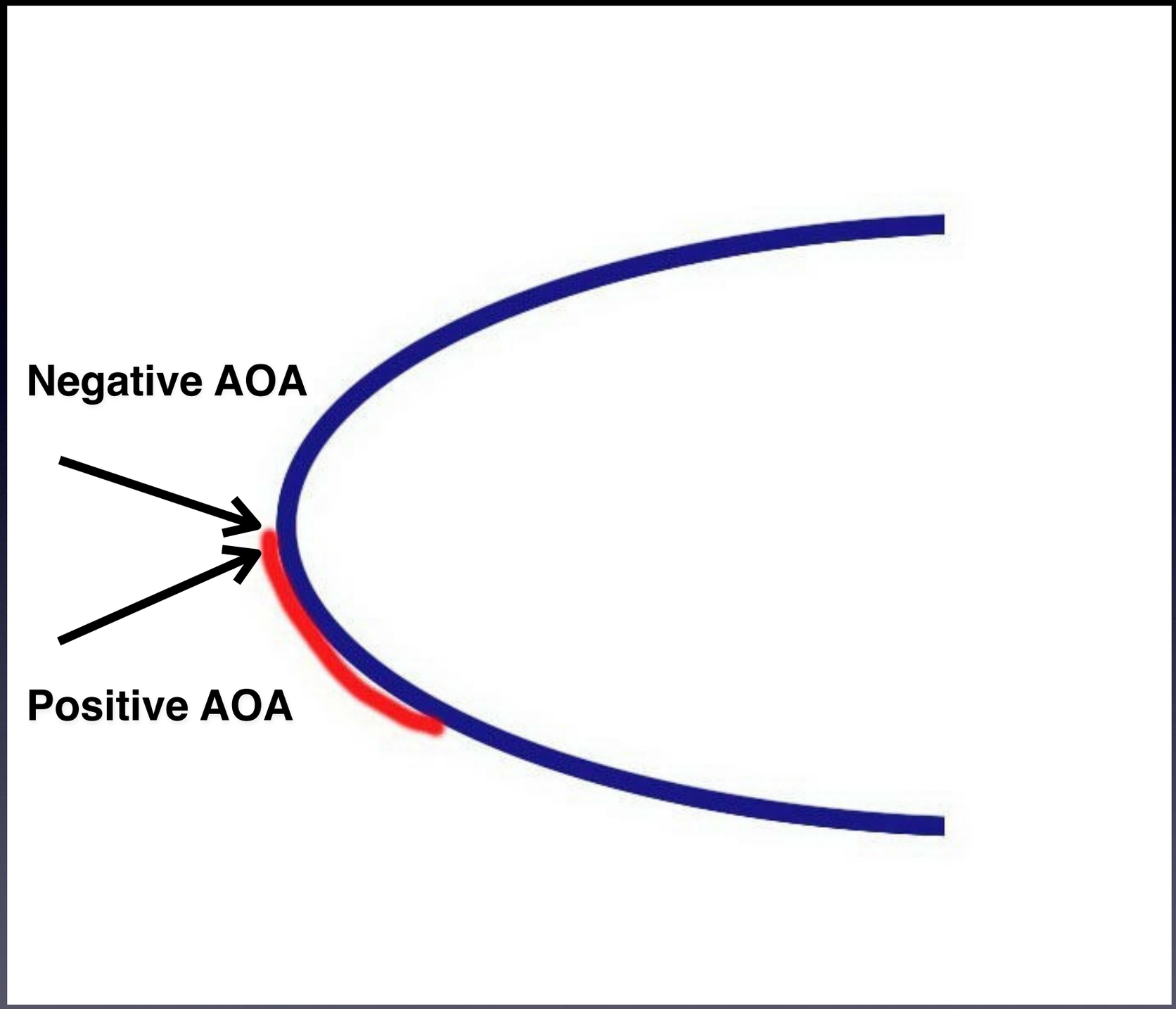
Upper and lower surface rear-facing steps.

Two Inch Tape Around the Leading Edge



Four measurements. Curious notch comes from upper surface tape edge.

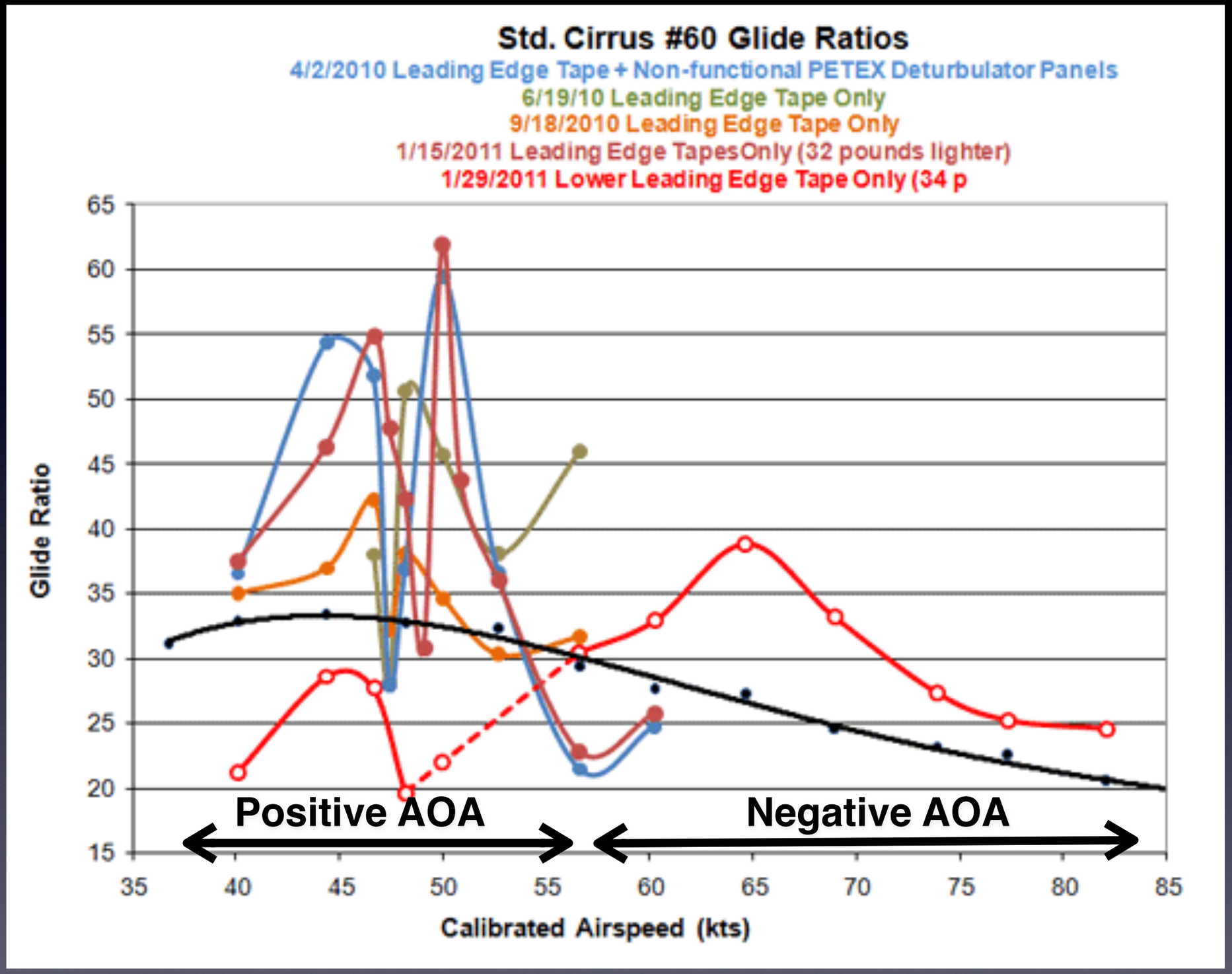
Downward From the Leading Edge



Tested to see the effect of the lower surface tape edge alone.

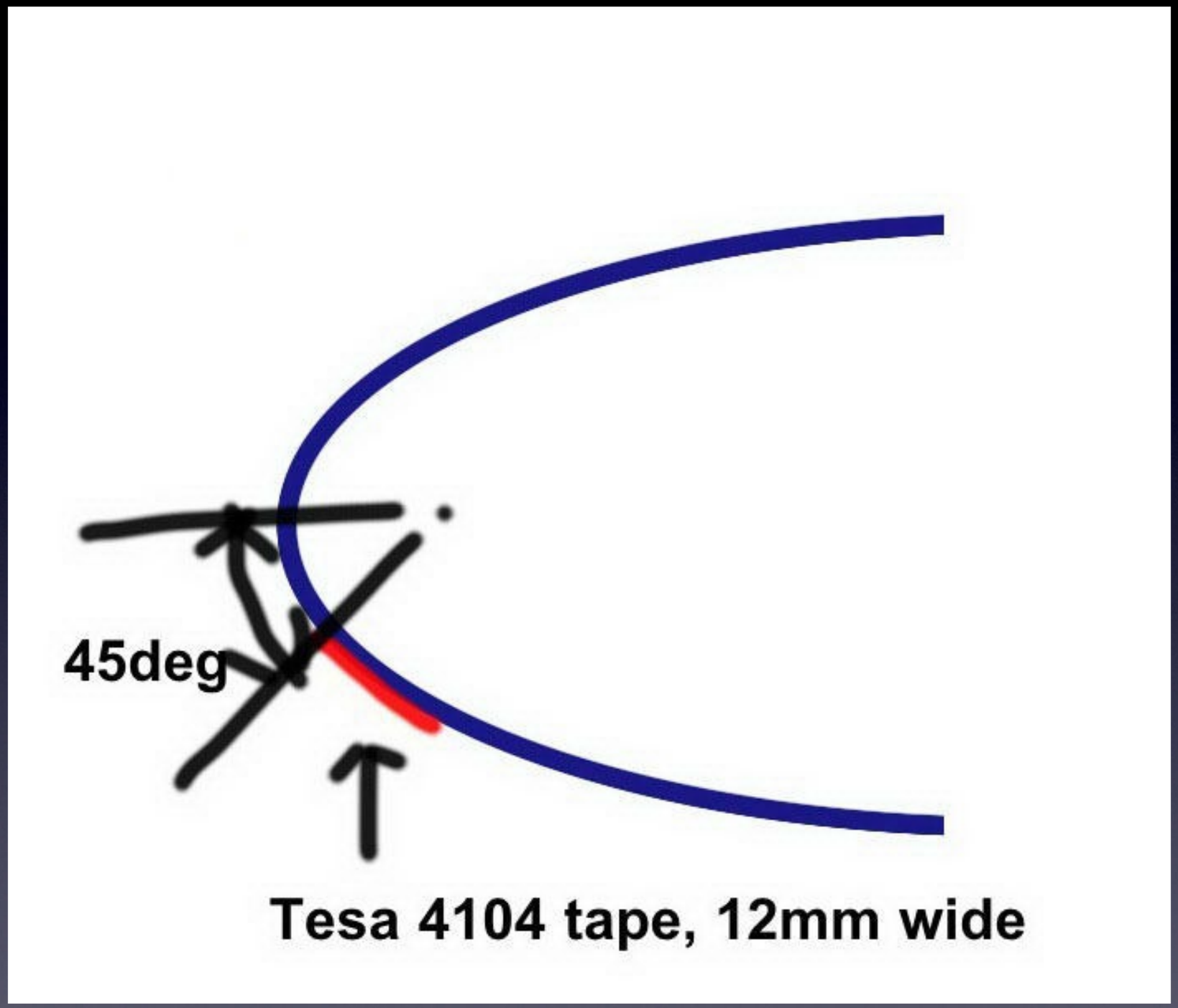
Upper tape edge intended to have no effect, but did.

Downward From the Leading Edge (Red)



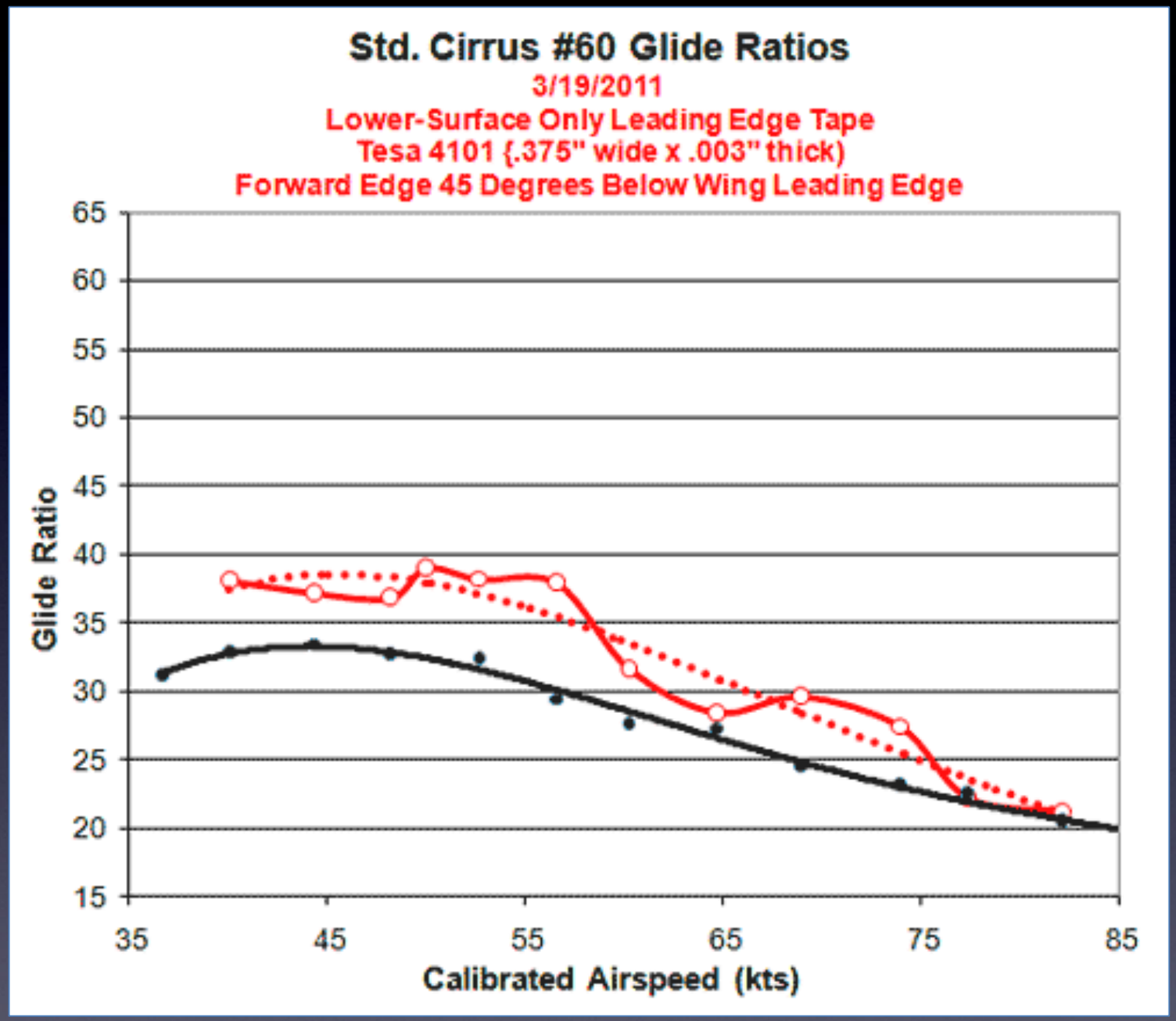
Big loss for all positive AOA speeds. **Notch remains**.
Top tape edge is **step down** for positive AOAs, **hurts**.
Top tape edge is **step up** for negative AOAs, **harmless**.

Downward From 45 Degrees Under the Leading Edge



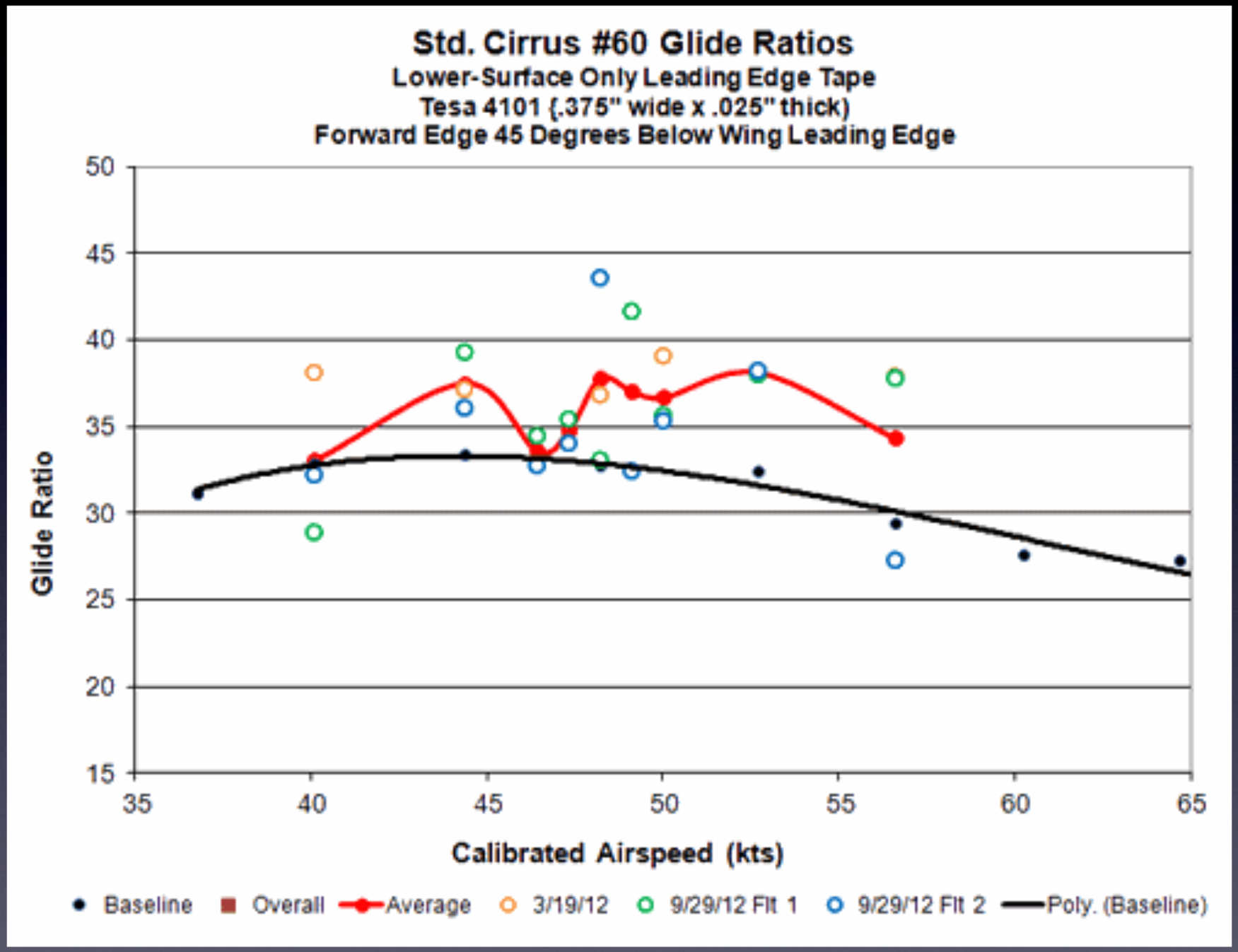
Intended to make the forward tape edge a step up for all AOAs.

Downward From 45 Degrees Under the Leading Edge
First Performance Measurement



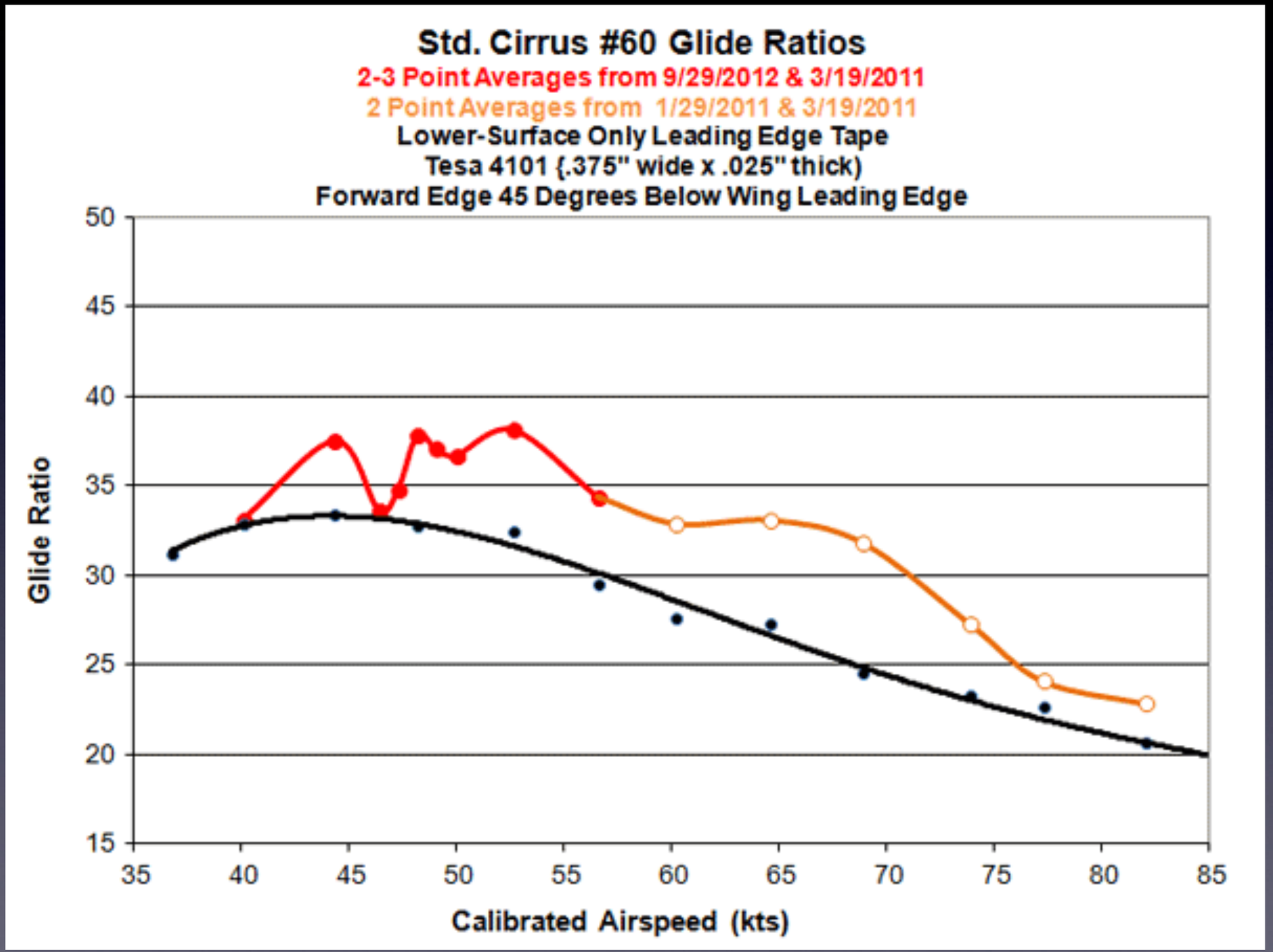
Moving the forward tape edge downward converted the low speed loss to a 15% improvement.

Downward From 45 Degrees Under the Leading Edge
Low Speed 2nd and 3rd Performance Measurements

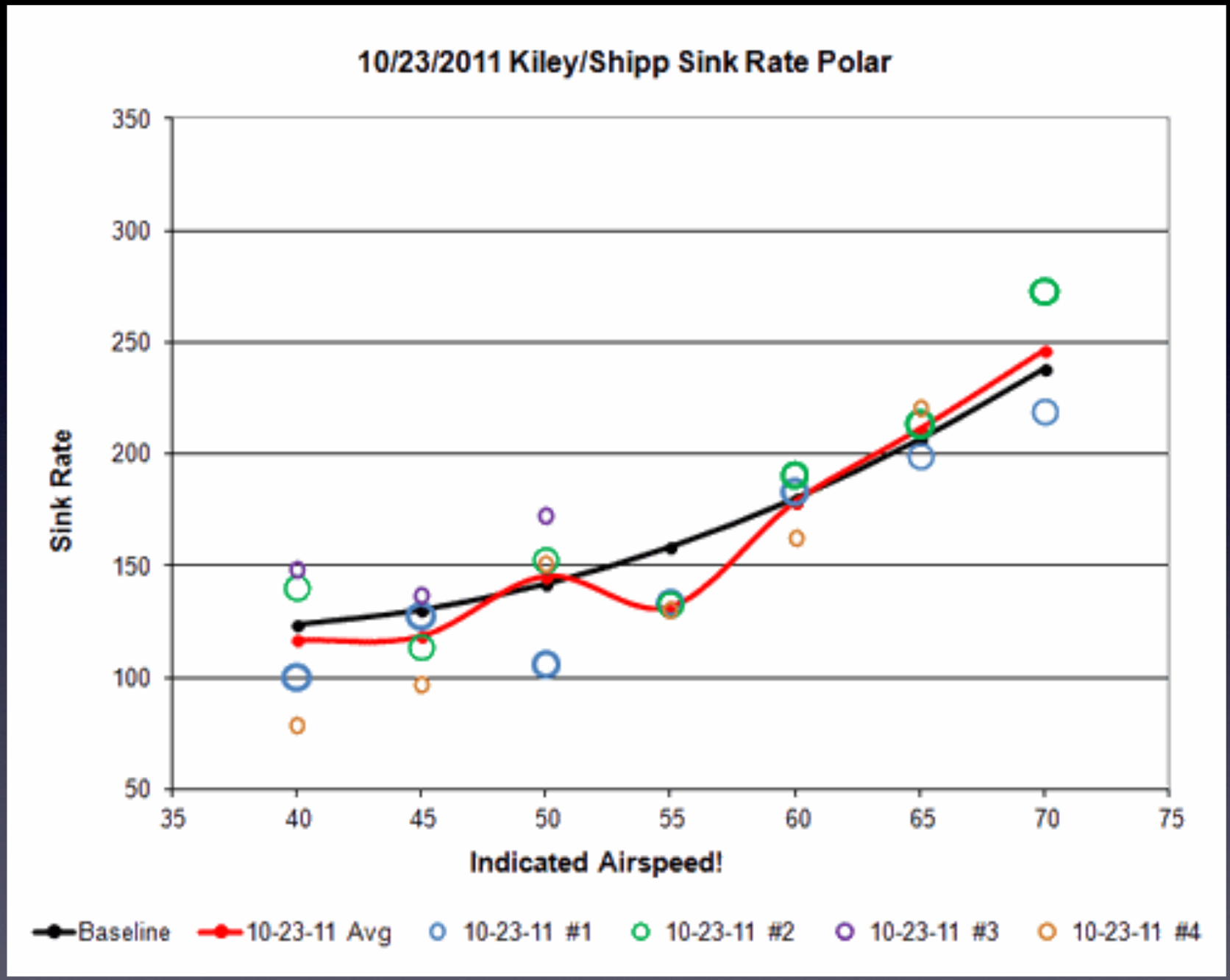


Performance below 60 KIAS confirmed and better defined to reveal a notch, resembling the top surface effect.

Downward From 45 Degrees Under the Leading Edge
Overall Average of Performance at All Speeds

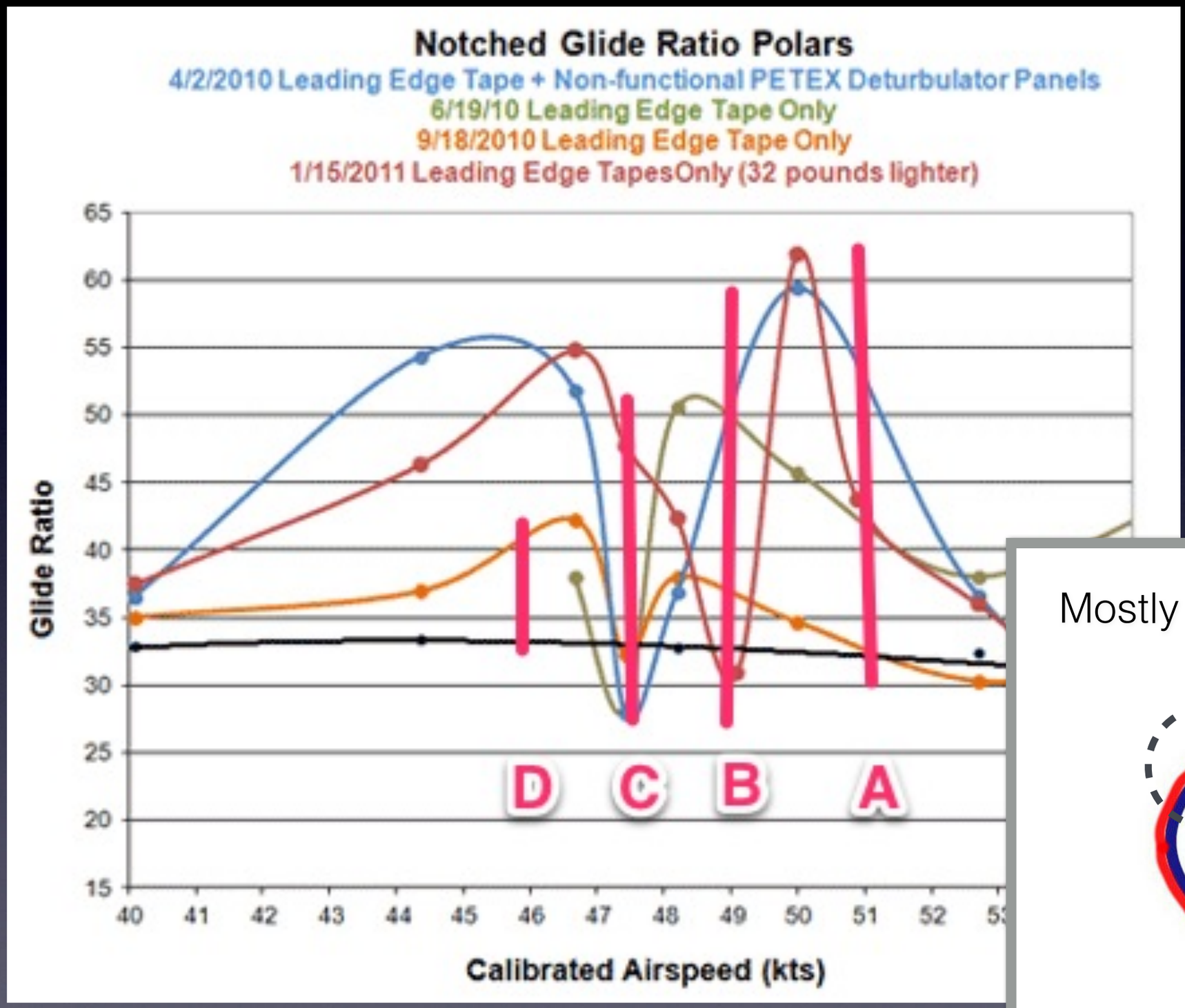


Downward From 45 Degrees Under the Leading Edge
Independent Measurements by Kiley/Shipp

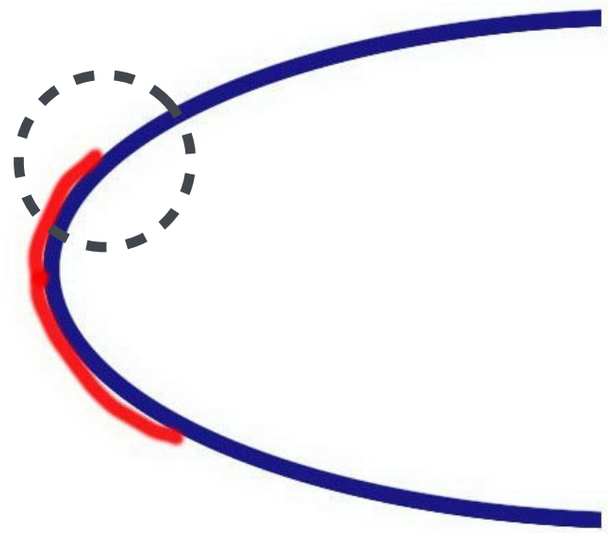


Measurements on Aaron Kiley and Tom Shipp's Standard Cirrus Appear to Show a Notch Too.

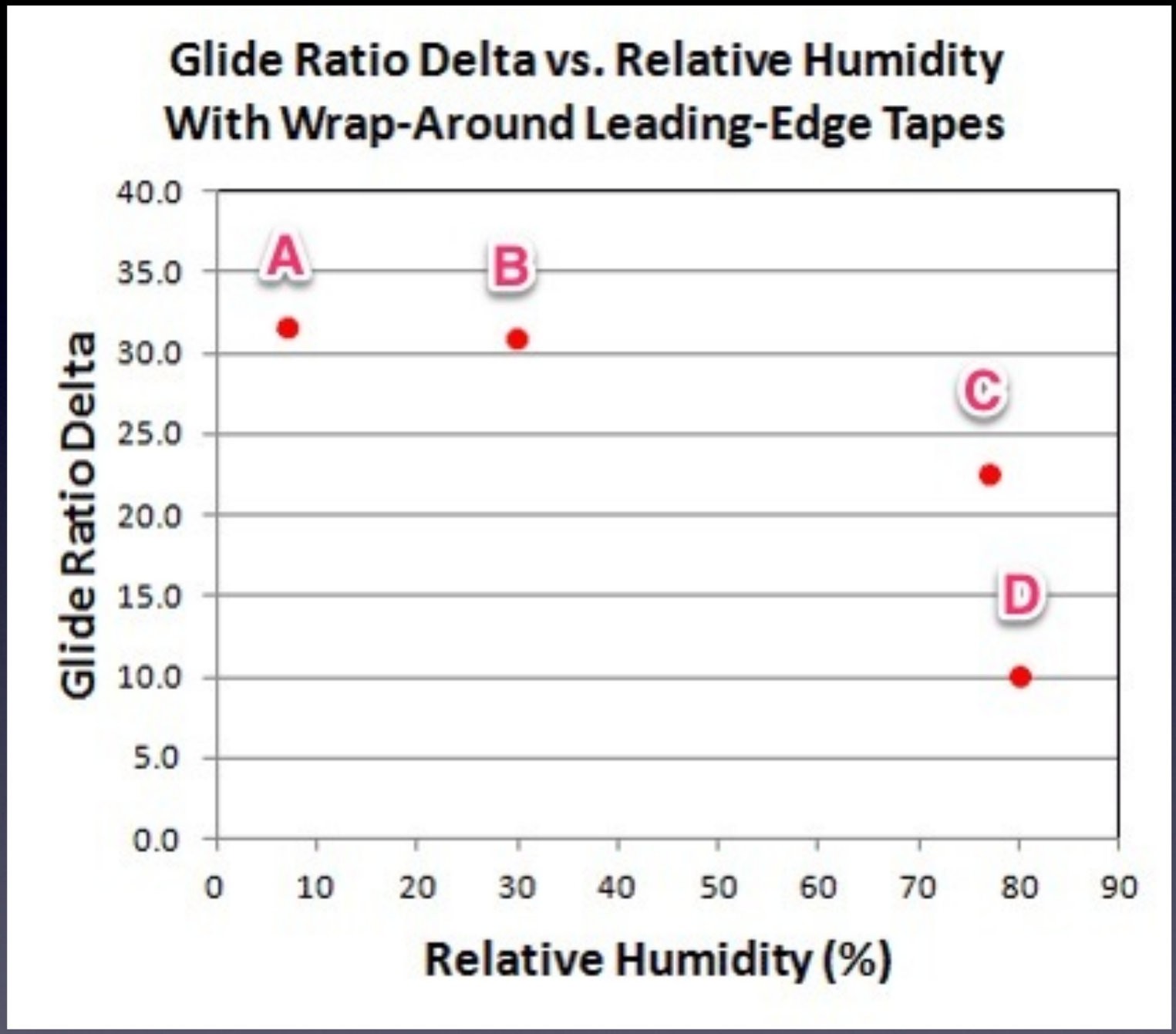
Minimum Skin Friction Criterion?
Performance Deltas Vary



Mostly upper tape edge effect.

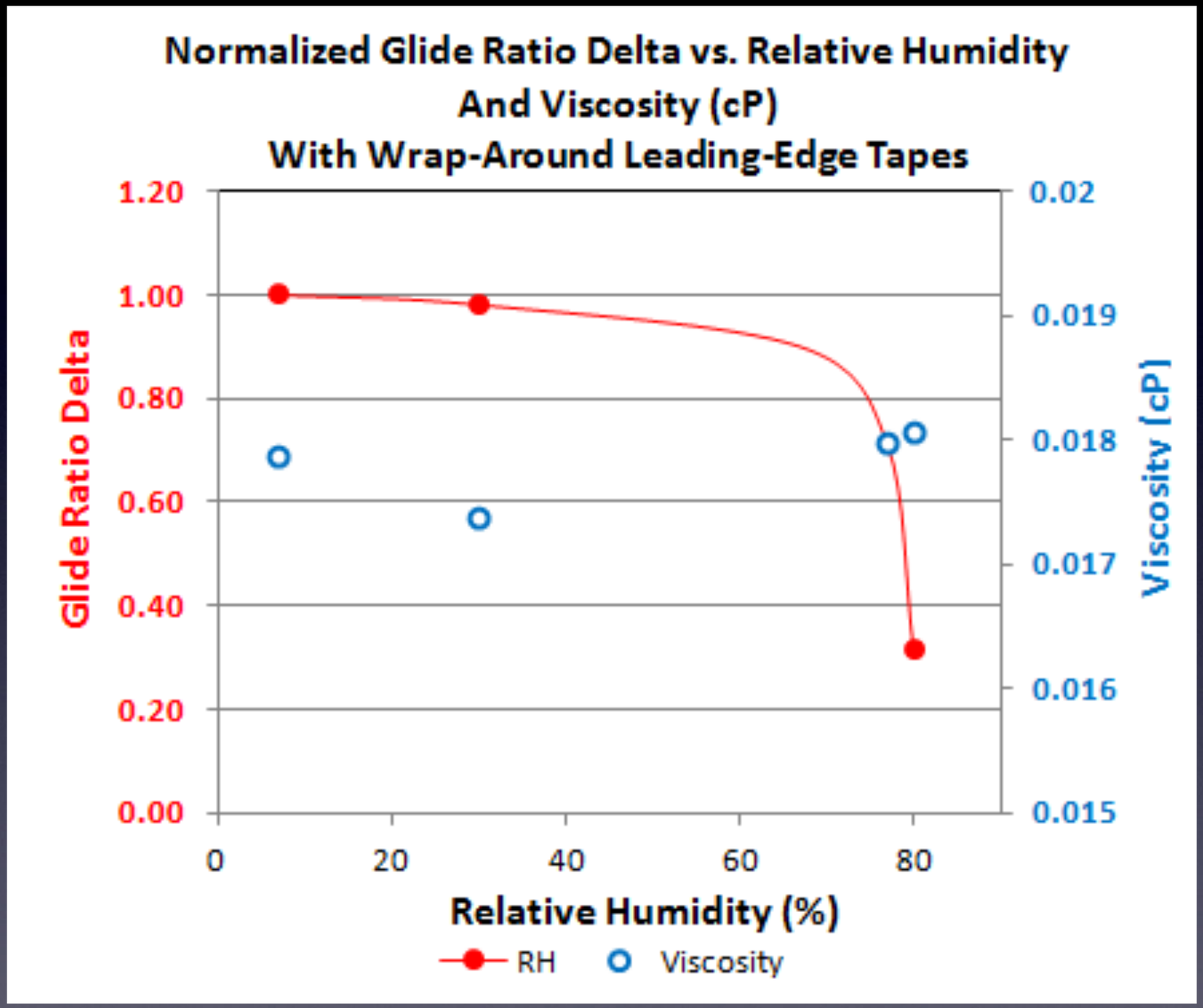


Minimum Skin Friction Criterion?
Humidity Dependence



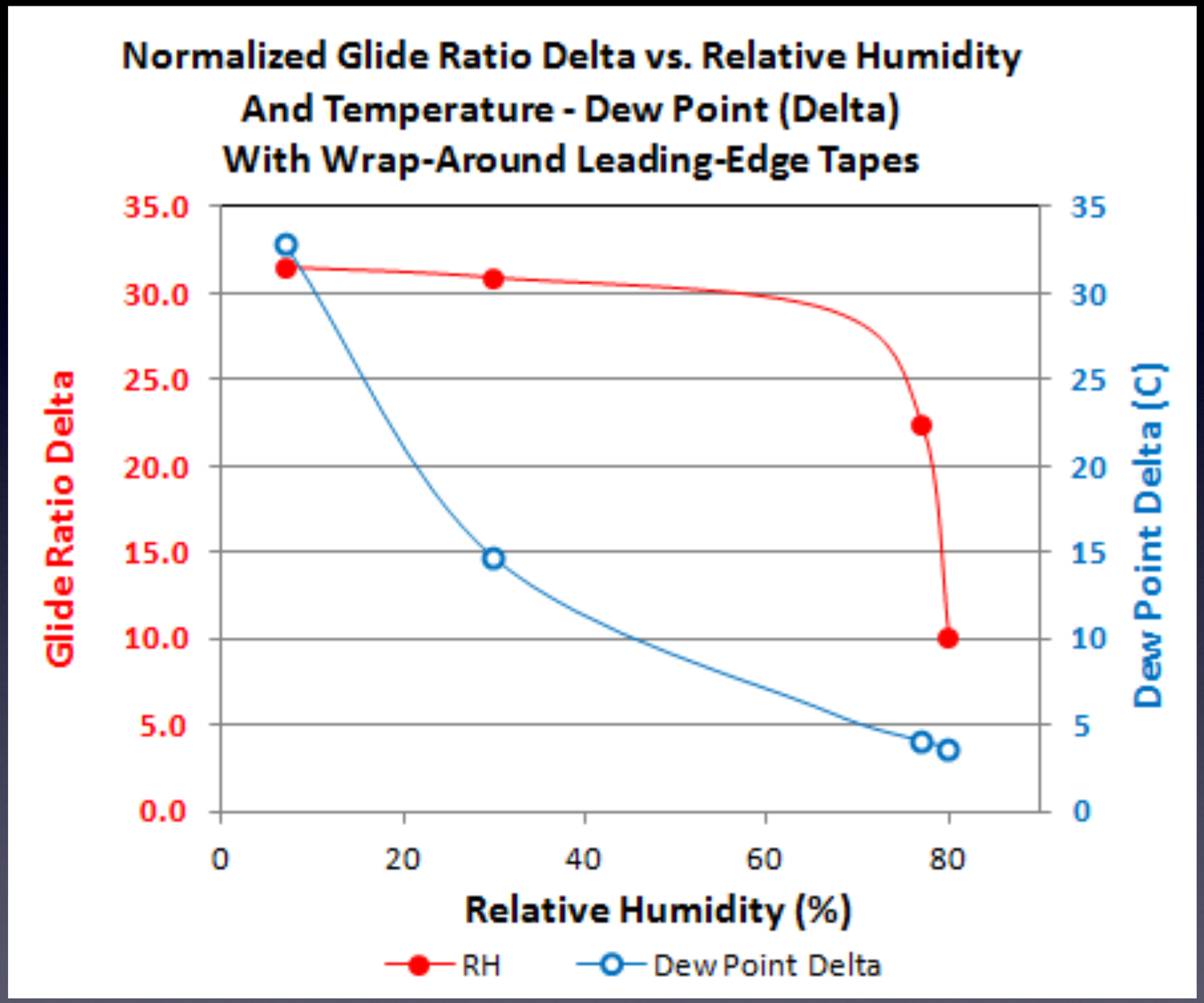
Measurements are regional, not immediate to the glider.

Minimum Skin Friction Criterion?
Viscosity Does Not Correlate



Humidity dependence is not due
to properties of the air alone.

Minimum Skin Friction Criterion?
Nearness to Dewpoint Temperature Correlates!



This correlation suggests an effective change in skin friction.

Minimum Skin Friction Criterion?
Vortical Separation Layer?

Current thinking is that a thin layer of vortical flow is needed to marginally separate the flow, allowing it to accelerate less hindered by skin friction. Tiny vortices require strong shear stress, so the zero-slip condition on the wing surface must hold. High relative humidity may reduce skin friction and weaken the zero-slip condition.

This is not a realistic simulation,
only a demonstration of vortical flow.

Installation Instructions
Step 1: Prepare Wing Surface

- Remove wax from forward 50% of lower wing surface.

- Polish that area with a slightly abrasive polish, like Stahl-Fix*.

- Clean wing surface with a solvent like 3M Adhesive Remover. This is safe to use even after the tape has been applied.

* Available from Knauff & Grove. Soft Scrub is more abrasive and may remove the humidity dependence. Stahl-Fix is the only product that has been tested.

Installation Instructions
Step 2: Level the Wings

Level the wings fore and aft so that the leading edge is the same height from the floor as the trailing edge.

Installation Instructions
Step 3: Mark a Guidline

Mark a guideline 45 degrees below the nose of the wing from the root to the tip. This will be used for locating the forward edge of the tape.

Wrap carbon paper around the base of an inclinometer and place it beneath the leading edge of the wing at an angle of 45 degrees. Then, slide it along the wing while maintaining the 45 degree angle. Alternatively, on a Standard Cirrus wing, you may mark the 45 degree point at the Root, Aileron (inboard end) and Tip and then stretch a line between them.

Installation Instructions
Step 4: Apply the Tape

Apply the tape so that the forward edge follows the guideline. Avoid all wrinkles and bubbles. Also, of course, make sure the tape's edges are not damaged in any way.

Installation Instructions
Step 5: Inspection and Smoothing

Complete the job by pressing the tape down firmly and smoothing any roughness or sharpness on the edges. It is not necessary for the rear edge to be sharp. A rounded edge works fine.

Testing

- **Best:** Sink rate measurements.
- **Second Best:** Parallel flying vs. other glider.
- **Third Best:** Cruising/climbing with other gliders.
- **Fourth Best:** Consistent change in final glides.

Manuals:

Sink-Rate Flight Testing With Your Flight Data Recorder
Parallel-Flight Testing With Your Flight Data Recorder
Available at www.deturbulator.org/files.asp

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