

Advanced Sighting System (One-Shot)

Proposer's Day

By

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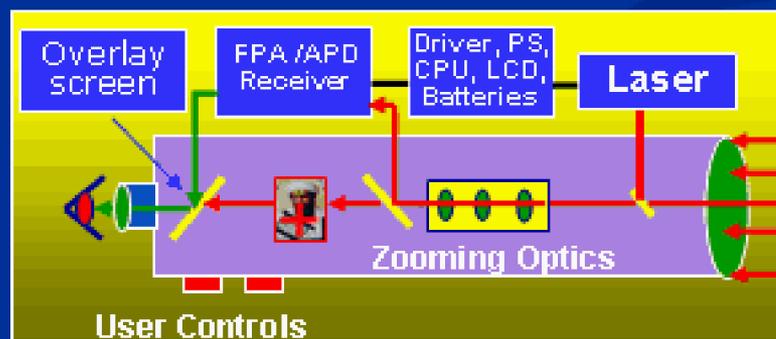
Objectives:

- Develop One Shot System for Snipers
- Compensates Down Range Wind
- Doubles Snipers Operational Range
- Increases 1st Round P_k by $>10x$ @ R_E
- Fits into a Range of Weapons: XM-3; M24; M40; MK11 & others

Performance Goals:

- P_k : $>50%$ at R_E (5 - 40mph)
- Ranging: 50m to 2000m; $\pm 5m$
- Weight: 1.5kg
- Volume: $25 \times 5 \times 2.5 \text{cm}^3$
- Power: >100 hrs Usage / Charge
- Cost: \$7k 1000th unit

DARPA's New
One-Shot



Deliverable
2009

If you can See the Target, you MUST Hit the Target
with the FIRST Shot and Minimum Training

• CONOPS:

- Spotter guides Shooter on Target
- Guesses Range/Crosswind & calculates corrections.
- Shooter identifies target using zoom, indexes corrections & when ready pulls trigger

• Key Problems:

- 1st shot Probability of Kill (P_k) substantially reduced with crosswind
- Two or more shots needed to strike Target at 600m with ~10mph wind
- During Zooming, Shooter must move Eyes off Target
 - Loses hit accuracy; must re-boresight
 - Slows down engagement with Target

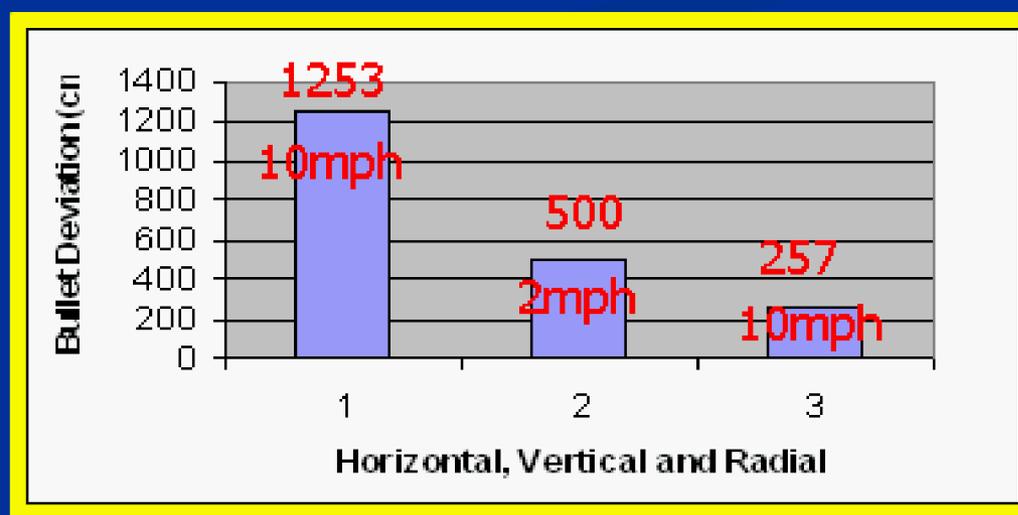
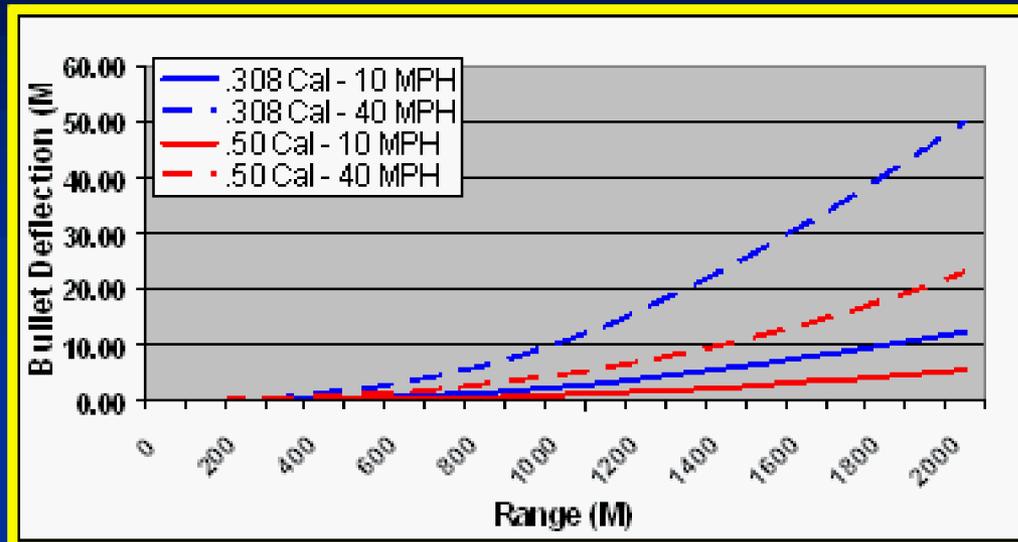
• Other Problems:

- No standoff advantage against enemy
- 2nd shot gives away shooter position
- Train & qualify 6000 rounds / year
- For night operations, the in-line MCP
 - Requires Rifle re-boresighting
 - Reduces Target Kill Range by > 25%
- No Thermal Sight for Smoke/Dust operations



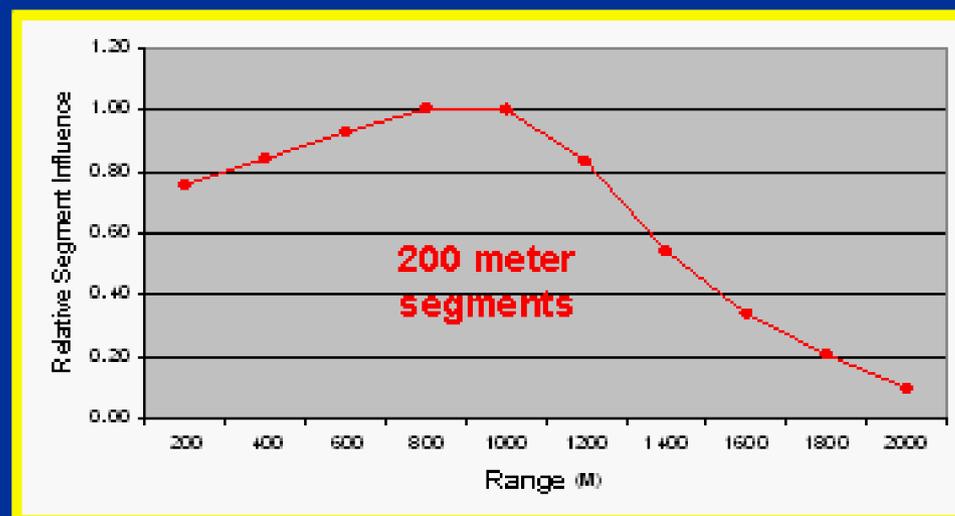
Hitting Target Reliably at even 1/2 Effective Range is Highly Unlikely

- Crosswind Error can be Very Large
- Depends on Velocity, Range & Bullet type
- Data from Snipers & PRODAS Simulations confirm findings
- Snipers miss targets at ranges > 300m even with 10mph crosswind
- Vertical, Head-on tail winds & Spin make the errors worse.
- Require minimum 2D Crosswind measurements including ballistic corrections



● Really Large; 0.308 deviates ~3 or 15m at 1.2km for 10 or 40mph wind

- For non-uniform wind along 2km range, Ballistics Simulations conducted with 100 to 400m segments show that 200 meter may be the optimum size.
- More often profiling will provide more accurate hit results



- YES. 1st 3/4 of the Range Critical due to lever arm effect
- Profile more often if Back Scatter SNR & timing would allow

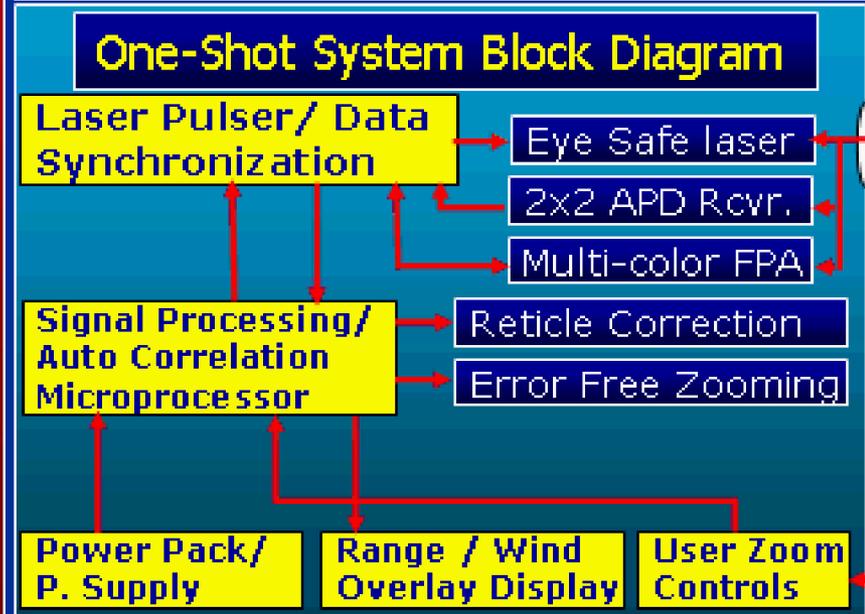
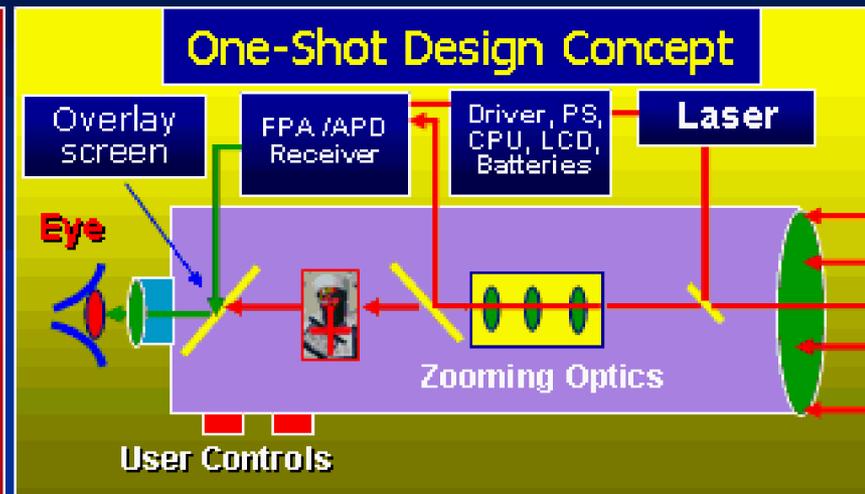
- Measure downrange Wind & Range & Compensate Bullet Trajectory. Investigate:

- Concept #1: Time Correlation of Eddies
- Concept #2: Target Imaging through Eddies

- Ranging to Target comes for Free if crosswind compensated

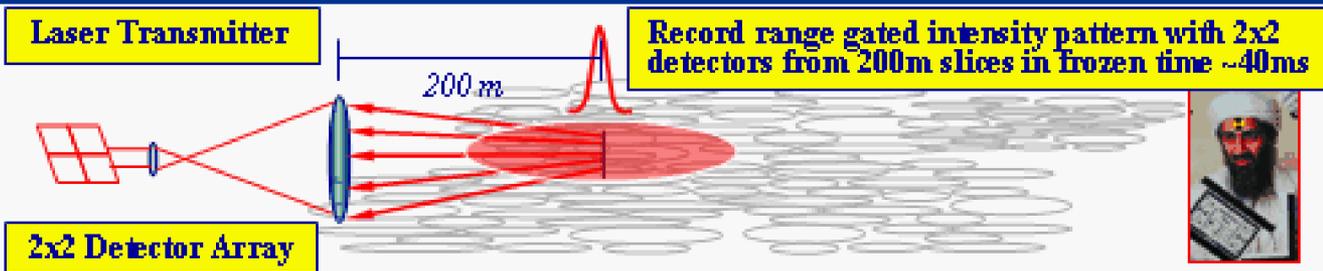
- Mount Sight Seamlessly on:

- Rifles: XM-3, M40A3, M24, MK11 & M82A1

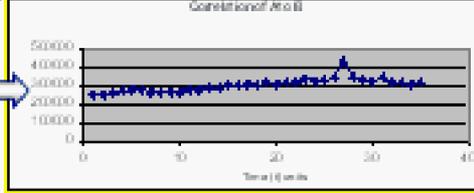
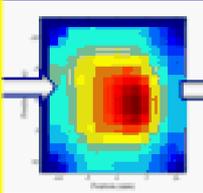
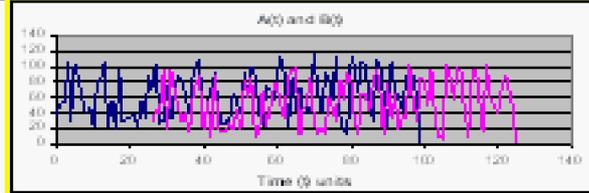


One Unit for Day/Night Operation and Weapons providing 10X improvements

- Solution: Profile down range 2D Wind Using Laser and Detectors
- Approach: Measure range gated (sliced) Aerosol Back scattered laser signal by 2x2 APD Detector Array
- Turbulence Eddies/ Aerosol that move with wind phase modulate laser signal producing Intensity Patterns
- Eddies do not dissipate over Frozen Time (FT) = Beam Ht. / Velocity
- Cross correlation of patterns over FT provides time peak
- Wind velocity = Collection Aperture Separation / Time

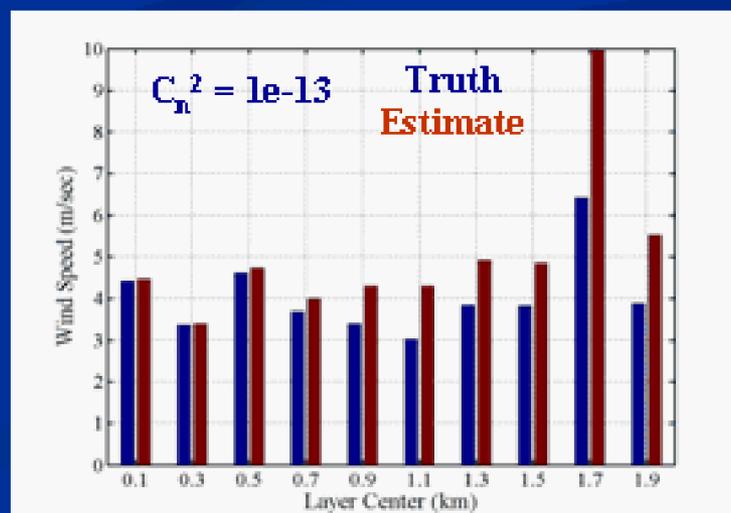
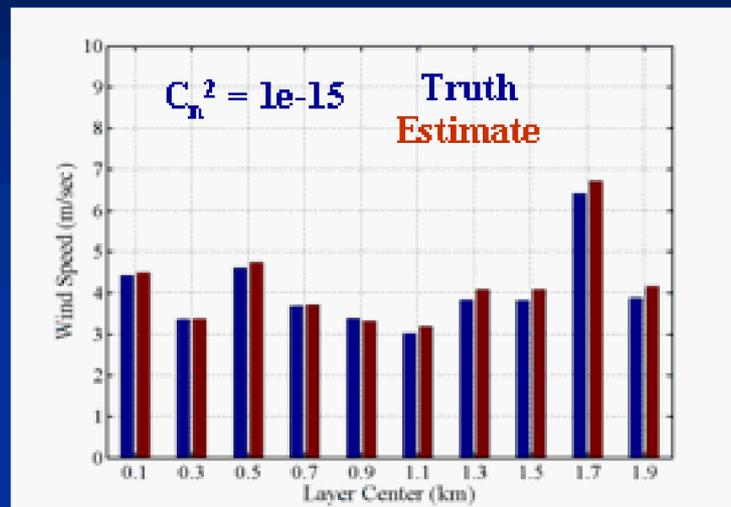


• Compute Time Cross-Correlation of 2k Pulses (50 kHz, 0.04sec)/Slice & 0.4 sec for 10 slices
 • For Cost reduction; Trade off 2x2 detectors with placement of Laser beam in 4 positions

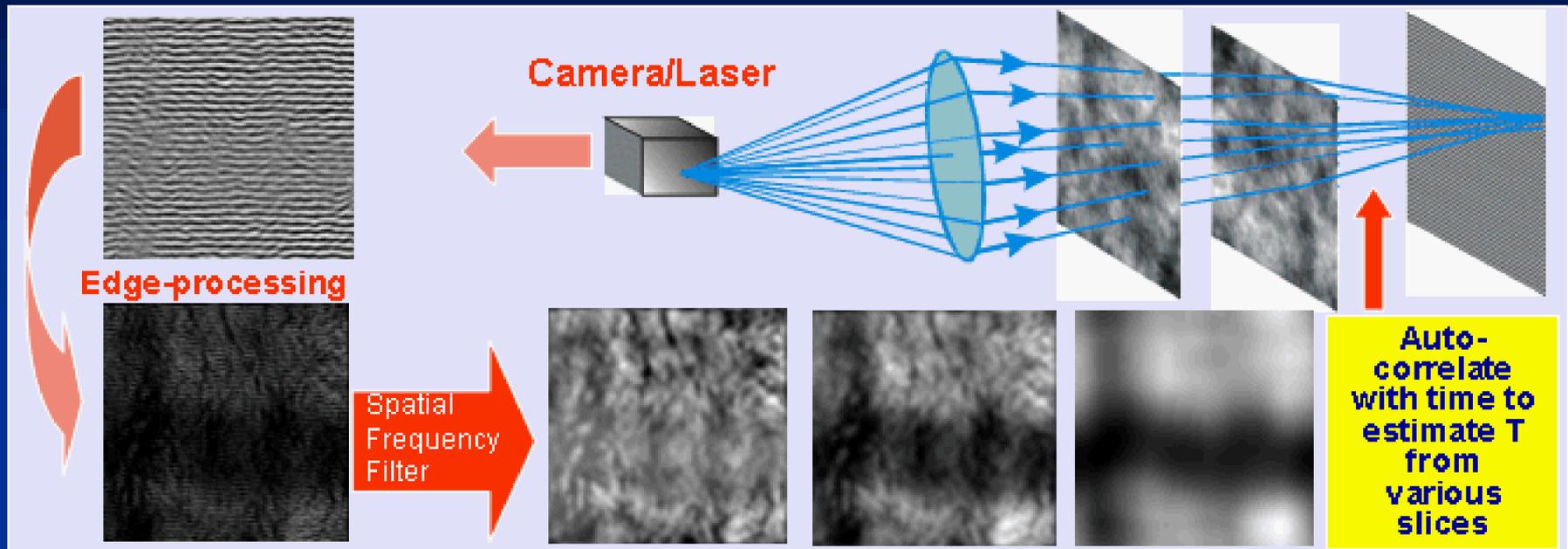


Profiling Down Range Wind Increases Hit Accuracy

- In weak turbulence (speckle dominated), 2x2 System achieves accurate profiling with 200 m intervals for estimation of X component of wind
- Greatest accuracy achieved in first half of path (less than 0.2 m/sec)
- As expected, small degradation in accuracy observed near target (still less than 0.5 m/sec)
- In stronger turbulence, accuracy is degraded at long ranges due to "noise" associated with turbulence from other layers – more averaging may resolve



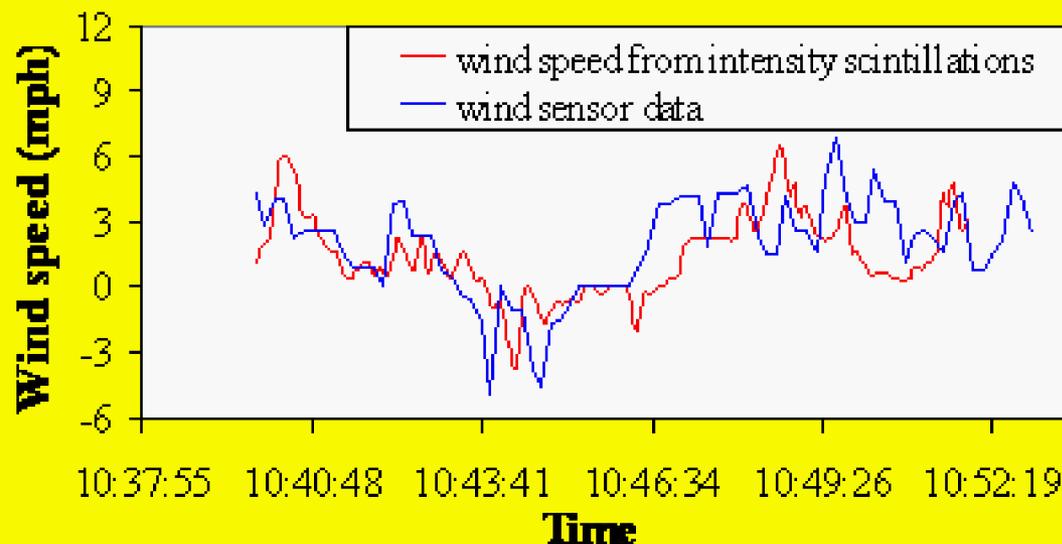
Solution #2 Crosswind: Target Imaging Through Eddies



- **Approach:** Image Target through Turbulence Eddies using a high speed Camera & Laser
- Light returning from Target through Atmosphere is phase distorted by Turbulence Eddies
- Atmosphere contains wide distribution of Eddy Spatial Frequencies (small & large bubbles)
- High speed Camera records images of Target as a function of time
- Image processing separates large and small areas of scintillated Target Image
- Correlation of specific scintillated areas provides Time for wind movement at that range.
- **For profiling down range wind, utilize the characteristic that Large scintillated areas arrive from Target end while Smaller from Receiver end**
- **Key Advantages:** 1) Require <10x lower Laser Power than Concept #1 because light is collected from Target instead of Aerosol. 2) Could Use Same Camera for Imaging.

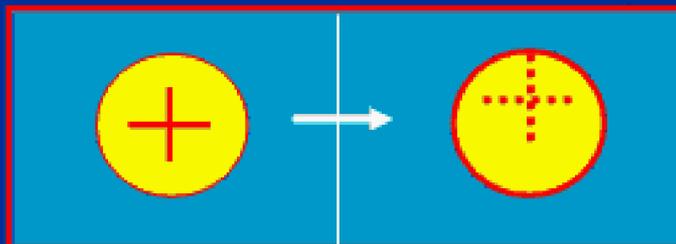
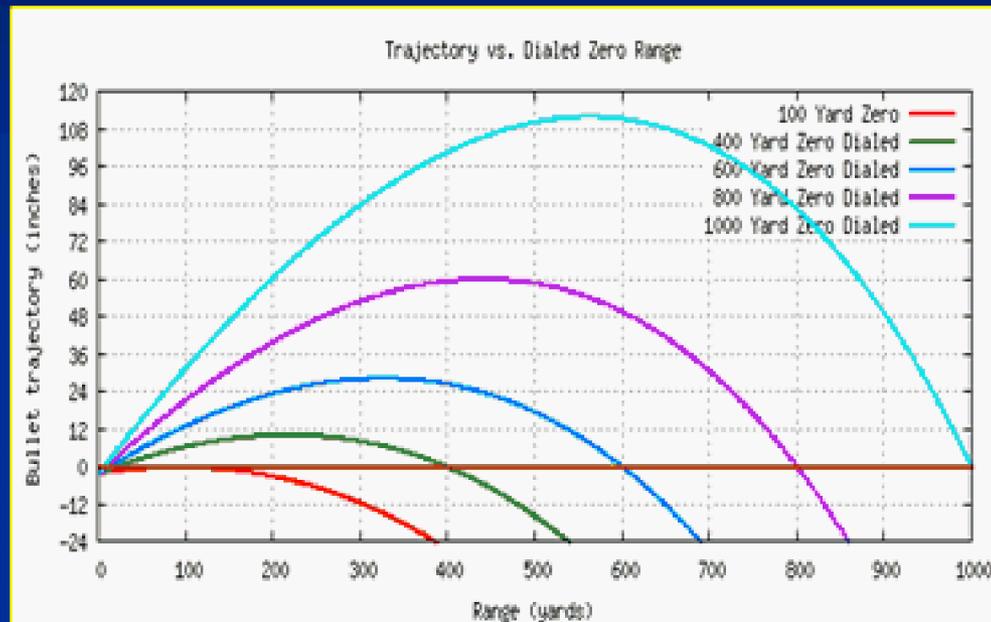
Profiling 20 200m segments with 1mph accuracy reduces 3mil error to 0.1mil

- ARL conducted experiments at 2.3 km (one way) to estimate crosswind by Imaging Target with a high speed Camera. No laser was used.
- Compared Crosswind data with anemometer which is graphed below



Field data at 2.3km looks promising

Shooter/Spotter Guess Range to Target



- $4\text{ft}/3000\text{ft} = 1.33 \text{ mil dot}$
- Ranging Error $\sim 1.33 \text{ mils}$ in Elevation at $\sim 1000\text{m}$

- No Guessing Wind Velocity or Range to Target
- Minimal Training at Sniper School
- No Math calculations for Spotter/ Shooter to perform under stressed conditions for adjusting Rifle Clicks
- Less than 1 sec to engage & pull the trigger
- Reduced workload for Spotter to identify other targets

One Shot Accomplishes Mission Efficiently & Successfully

Does it work?

Metrics are
CLASSIFIED

Questions?