Field Experiment Results of the CARMEL II Laser Crosswind Sensor

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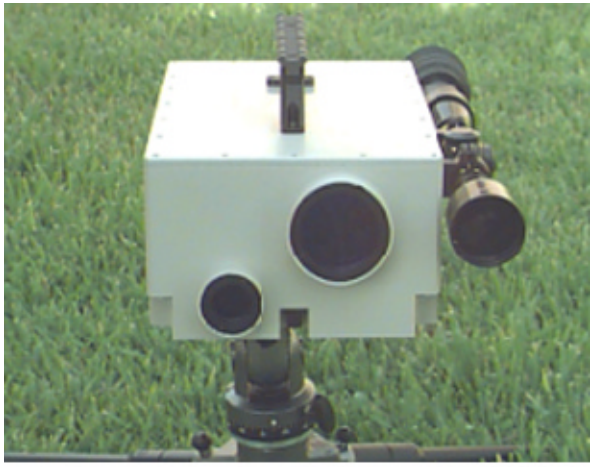
CARMEL II

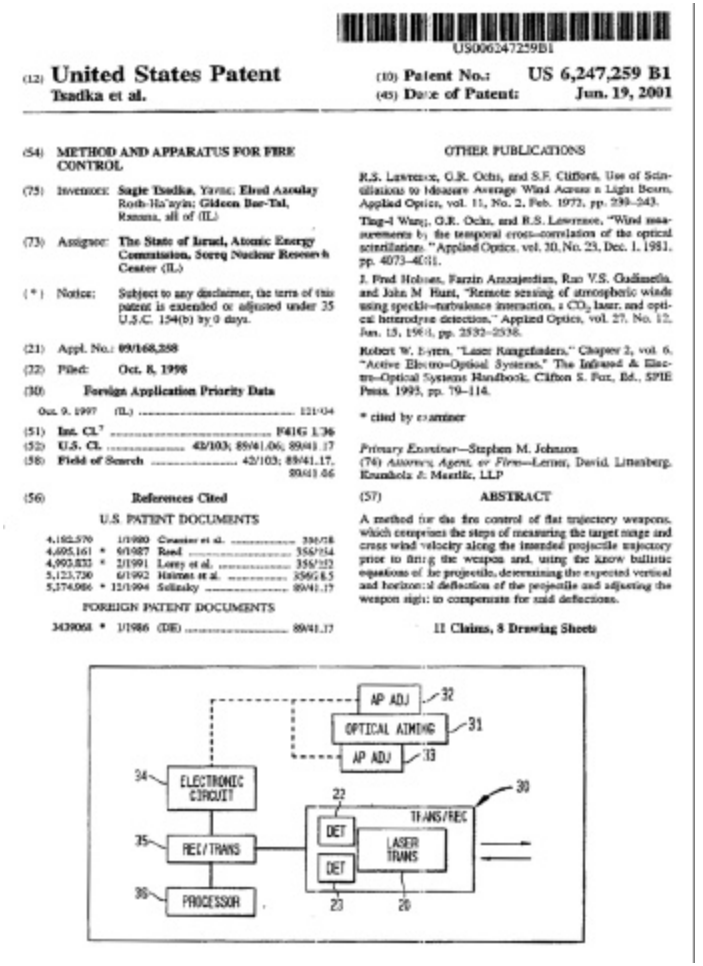
Crosswind **A**nd **R**ange **ME**asurement **L**idar



- 20 cm Wide, 13 cm Tall, 30 Cm Long

CARMEL II

- A unique fire control device
- **Remotely** measures, in **real time**, both
  - **RANGE** to target
  - a path-averaged **CROSSWIND** profile between the shooter and target.
- Can be programmed for different types of munitions and sight parameters
- Correction of crosshairs can be automatic and/or manual
- Patent No.: US 6,247,259 B1(Method and Apparatus for Fire Control) SOREQ NRC



US006247259B1

(12) **United States Patent**
Tsadka et al.

(10) **Patent No.: US 6,247,259 B1**
(45) **Date of Patent: Jun. 19, 2001**

(54) **METHOD AND APPARATUS FOR FIRE CONTROL**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/168,258**

(22) Filed: **Oct. 8, 1998**

(30) **Foreign Application Priority Data**

Oct. 9, 1997 (IL) 121704

(51) **Int. Cl.**[7] F41G 1/36

(52) **U.S. Cl.** 42/103; 89/41.06; 89/41.17

(58) **Field of Search** 42/103; 89/41.17, 89/41.06

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(57) **ABSTRACT**

A method for the fire control of flat trajectory weapons, which comprises the steps of measuring the target range and cross wind velocity along the intended projectile trajectory prior to firing the weapon and, using the know ballistic equations of the projectile, determining the expected vertical and horizontal deflection of the projectile and adjusting the weapon sight to compensate for said deflections.

11 Claims, 8 Drawing Sheets

CARMEL II Scintillation-based Shooters' "Mirage"

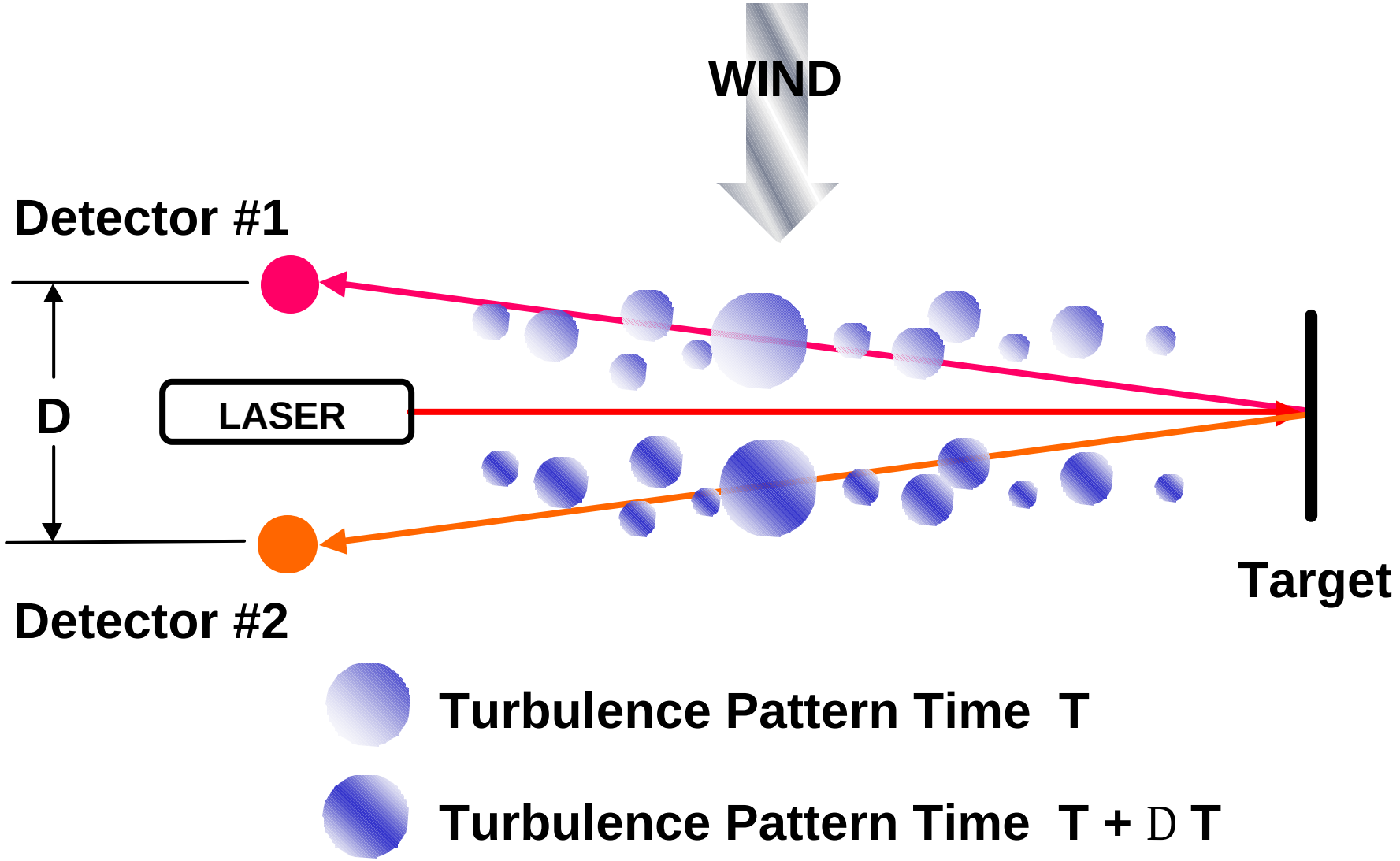
- Scintillation akin to "mirage"
- Mirage :
  - windage method preferred by many shooters
  - defocused scope
  - refraction of light through layers of air of different temperatures and densities
- Shooter views the distortion of light from the target as the distortion-causing turbulence cells drift with the wind.
- Shimmer appears to move with the same velocity as the effective wind.
- Technique works well.
- Fails for winds above 12 mph, at which the movement of the mirage becomes too swift for a shooter to detect.
- Fails at times when mirage is not visible to the shooter, namely, at dawn, dusk, and night.
- Scintillation often still detectable when "mirage" is not.

CARMEL II

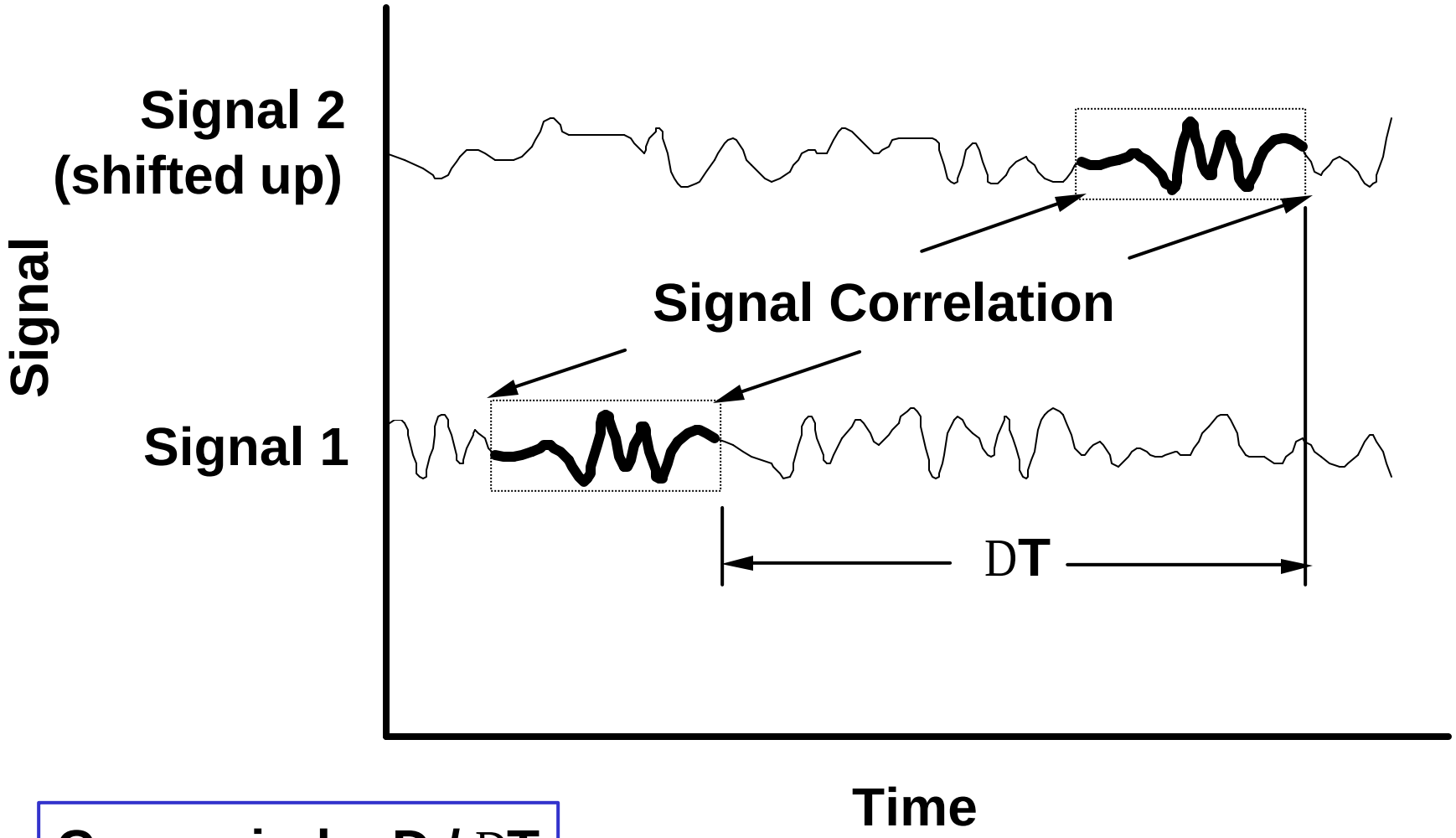
Principle of Operation

- Target is illuminated by a compact, covert-wavelength laser aligned with the gun.
- Atmospheric Turbulence induces temporal power fluctuations on the laser pulse reflected from the target.
- The system measures these fluctuations using horizontally spaced detectors.
- The time lag of the two detectors' intensity correlation function corresponds to the crosswind.

CARMEL
Principle of Operation (cont.)



CARMEL
Principle of Operation (cont.)

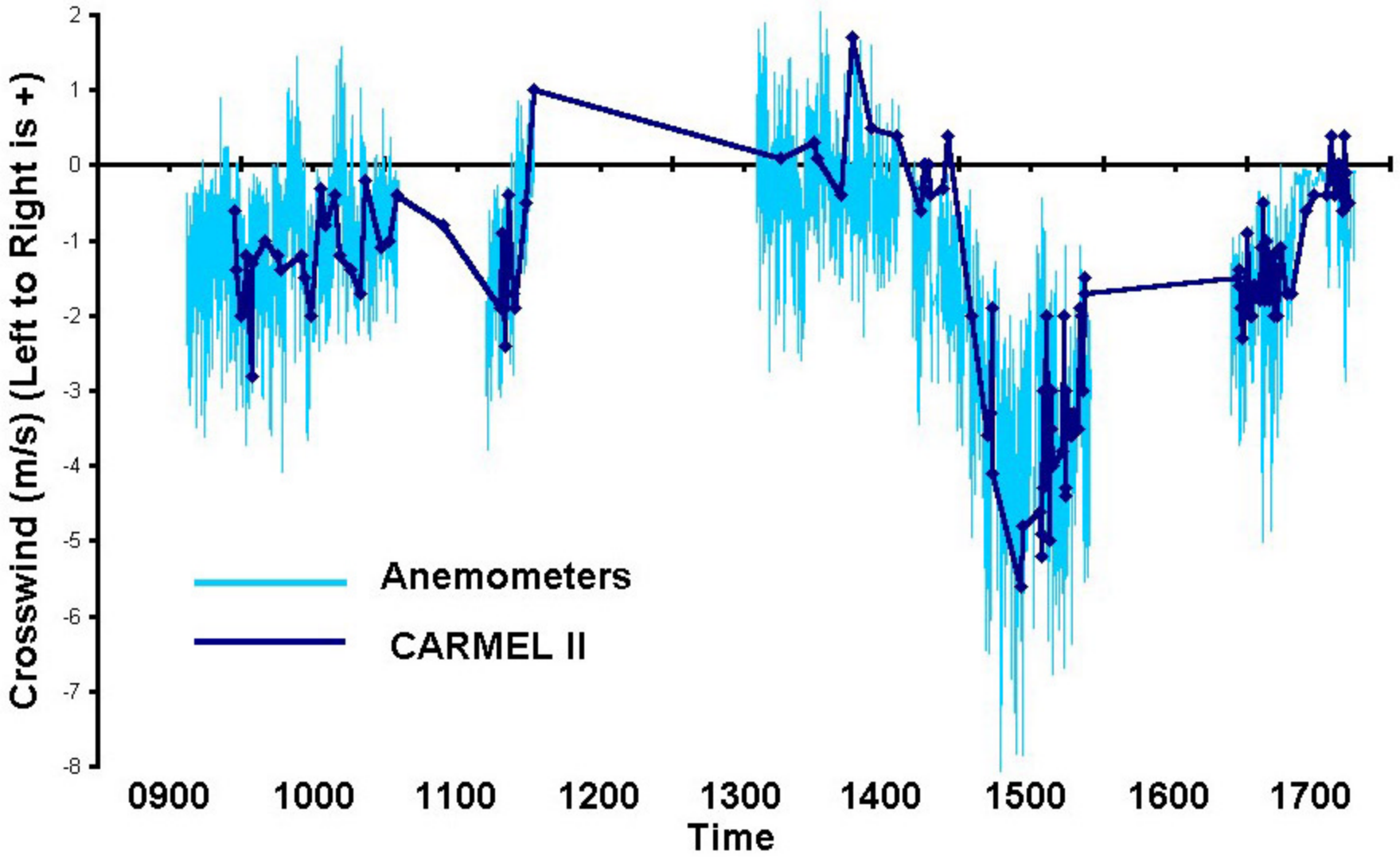


Crosswind = D / DT

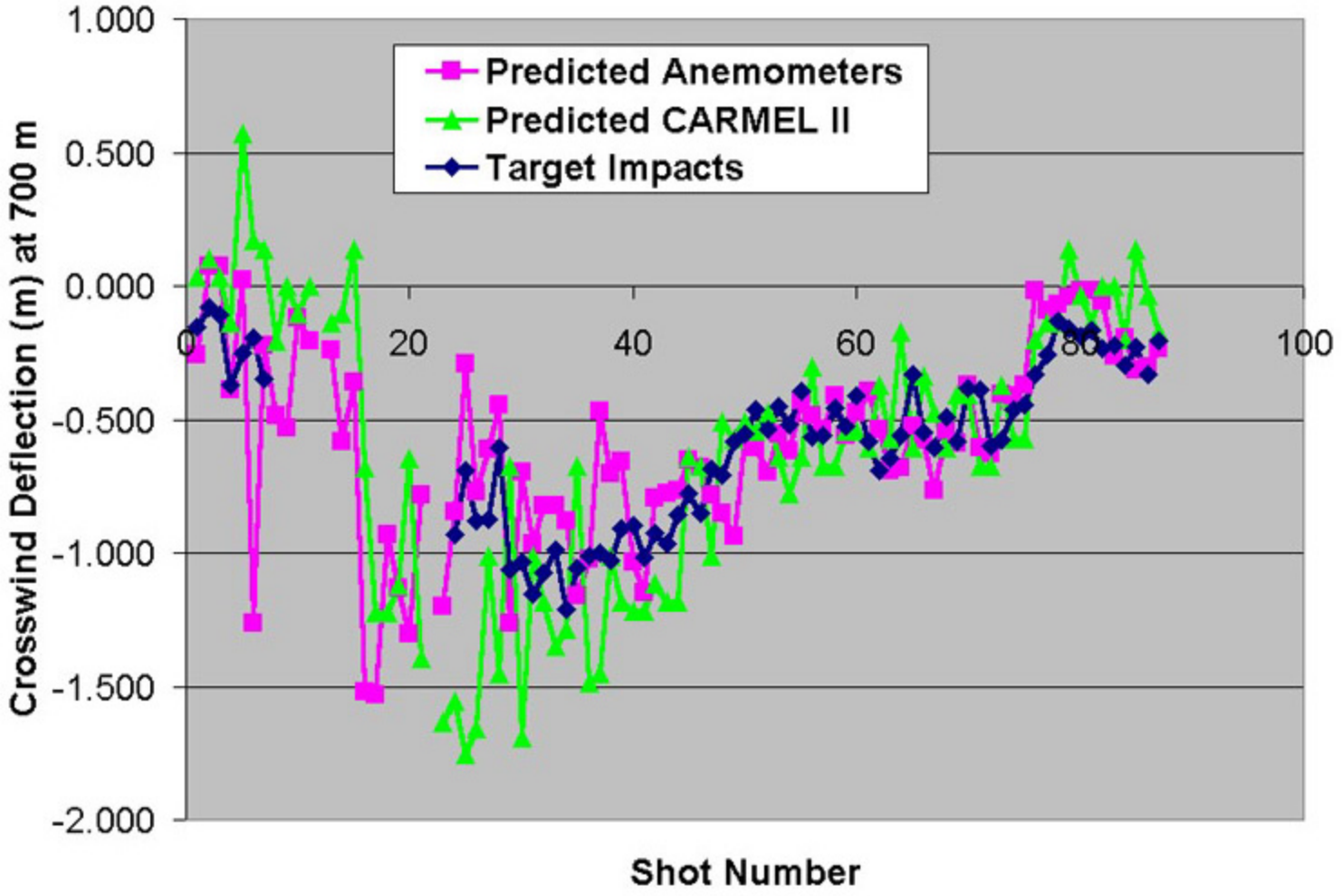
Dec. 2001, APG Field Experiment

- Week long test over which we hoped
  - for varied wind conditions
  - to operate through at least one dusk
- M24 rifle locked in Franklin rest
- 7.62mm NATO BALL ammo
- Target 700m
- Anemometers at 6, 55, 125, 310m
- Turbulence Measurement
- Electronic Scoring system in front of target
- Shot at known aimpoints
- Recorded Impacts
- Compared actual with predicted crosswind deflections

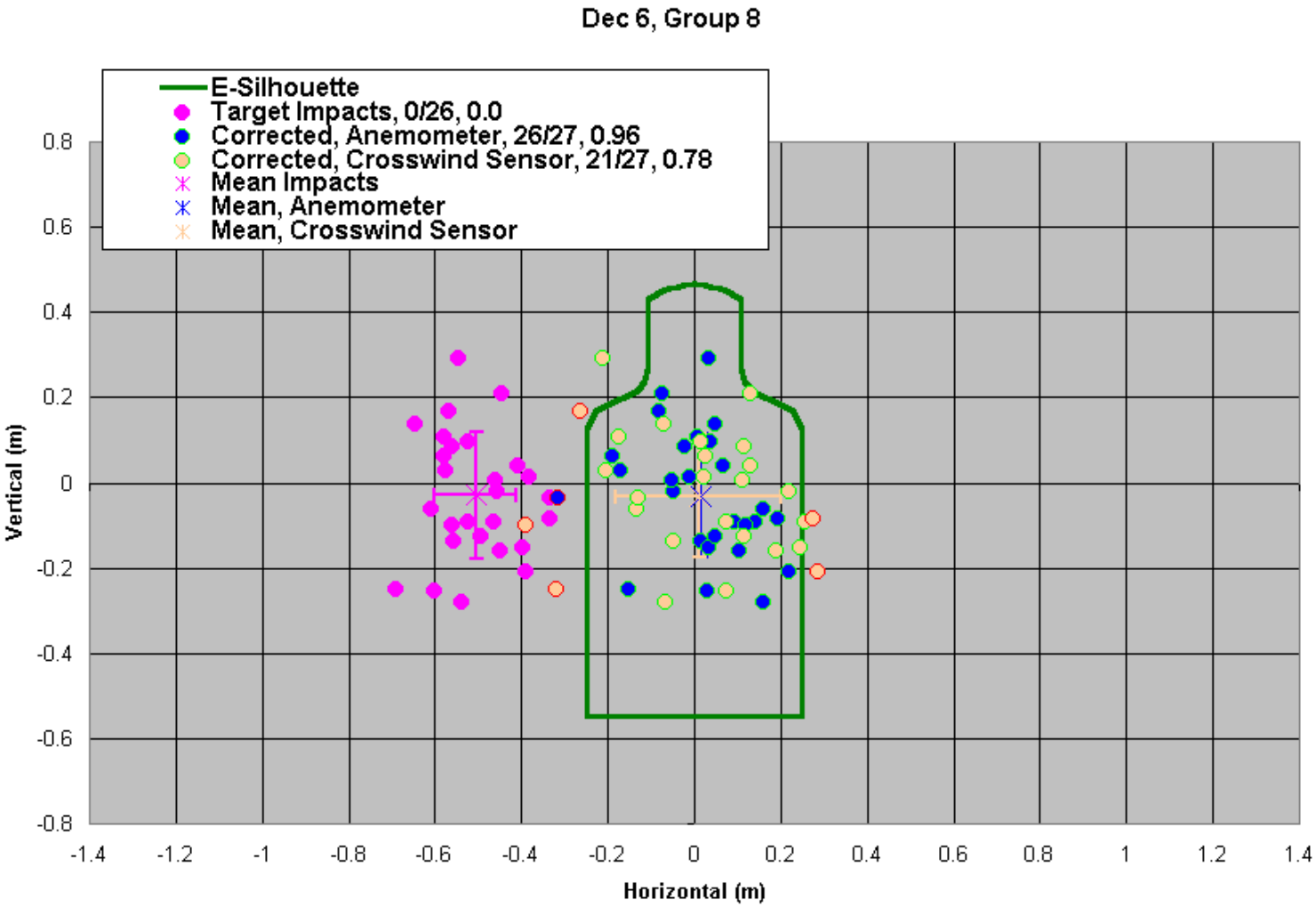
Crosswind vs. time



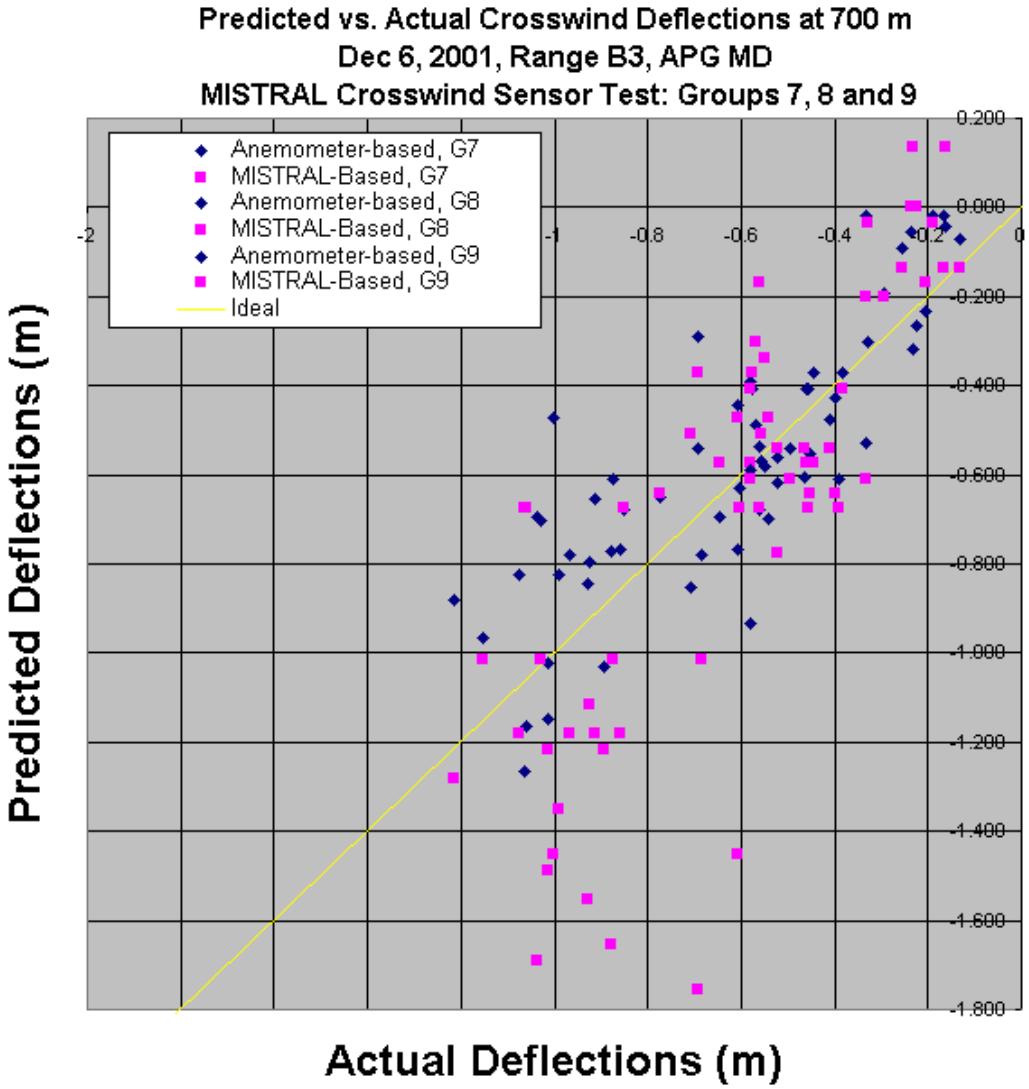
Crosswind vs Shot



Shot Groups


Dec 6, Group 8
E-Silhouette
Target Impacts, 0/26, 0.0
Corrected, Anemometer, 26/27, 0.96
Corrected, Crosswind Sensor, 21/27, 0.78
Mean Impacts
Mean, Anemometer
Mean, Crosswind Sensor
Vertical (m)
Horizontal (m)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1.4
-1.2
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4

Predicted vs. Actual



CARMEL III
Custom Configurations

- Stand Alone:
  - System Off-weapon
  - Range and Crosswind Measurement Presented to Operator on a Digital Display
- Semi-integrated:
  - Off-weapon
  - Ballistic Corrections Computed from Measured Data for Selected Ammunition Type
  - Weapon's sight aim-point is controlled by the system
- Fully Integrated:
  - System integrated into weapon sight
  - Full Fire Control Capabilities
  - Automatic aim-point configuration

CARMEL III
(Rifle-Mounted Version)