# System Development for String Analysis During Operation S.A.F.E. Clinics

**Yin-Lin "Jack" Chiu**
Research Associate Coordinator
ychiu@agcenter.lsu.edu

**Roberto N. Barbosa, Ph.D.**
Associate Professor
rbarbosa@agcenter.lsu.edu

Biological and Agricultural Engineering Department
Louisiana State University – Agricultural Center, Baton Rouge, LA

# OPERATION S.A.F.E.

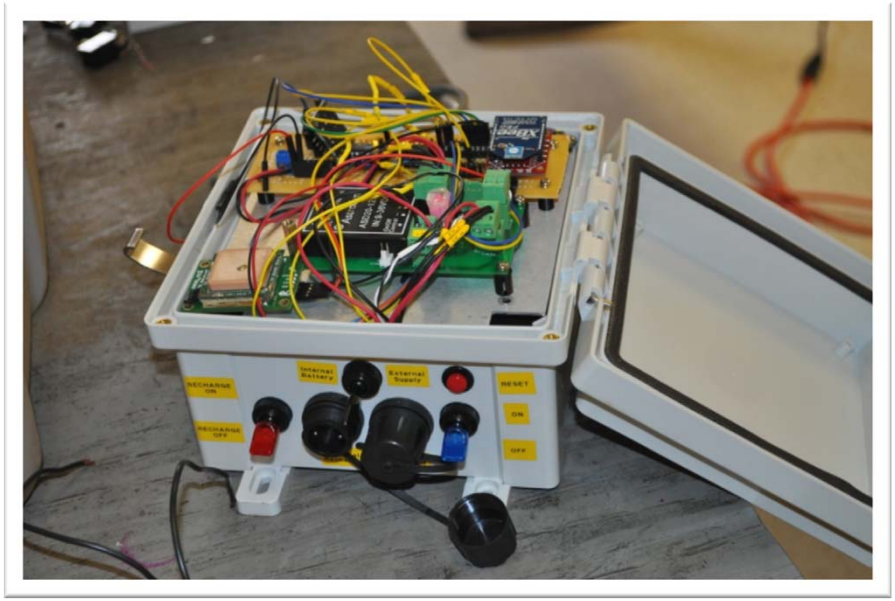

- Fly-ins or clinics are offered nationwide
- Comprehensive program which provides:
  - Education
  - Equipment performance analysis & Recommendations
    - Help pilots fine-tune sprayer equipment
    - Find best combination of swath width and spray method (back/forth, racetrack)
- Several people involved during the fly-in
  - Speed
  - Height
  - Weather
  - String Deposition
  - Other tasks

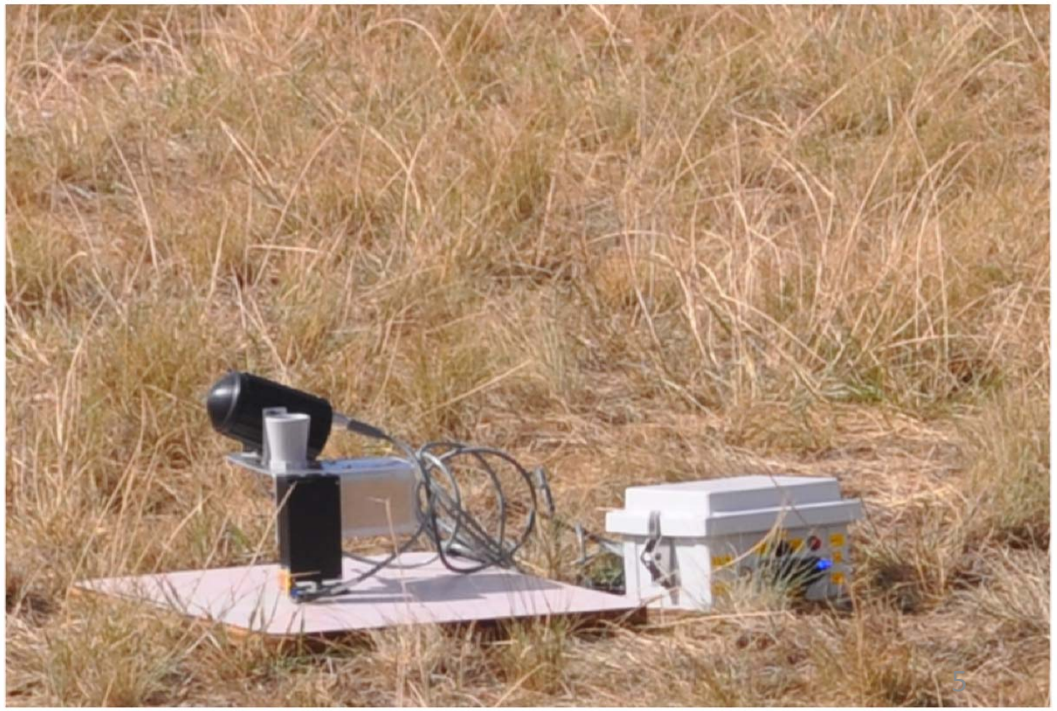
# Problems

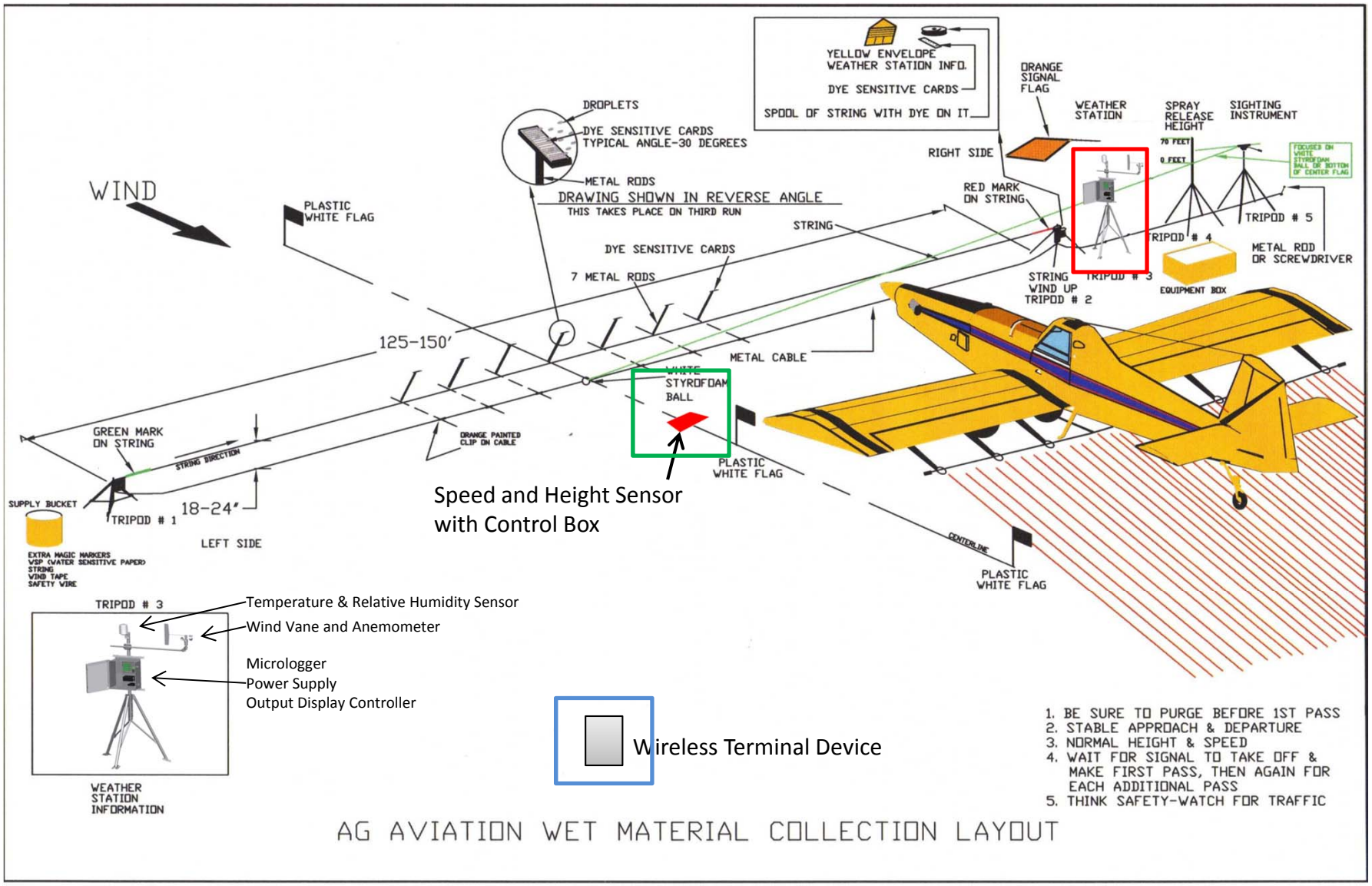
- On-hand personnel:
- Experience Level
- Equipment
  - Precise timing
  - Difficult to maintain
  - Constant adjustments

# Objectives

- Integrated system to automate measurements
  - Aircraft spray release height
  - Aircraft speed
  - Weather Station
- New string analysis system platform
- Record all measurements


RECHARGE ON
RECHARGE OFF
Internal Battery
External Supply
RESET
ON
OFF




YELLOW ENVELOPE
WEATHER STATION INFO.
DYE SENSITIVE CARDS
SPOOL OF STRING WITH DYE ON IT
ORANGE SIGNAL FLAG
WEATHER STATION
SPRAY RELEASE HEIGHT
SIGHTING INSTRUMENT
70 FEET
0 FEET
DROPLETS
DYE SENSITIVE CARDS
TYPICAL ANGLE-30 DEGREES
METAL RODS
DRAWING SHOWN IN REVERSE ANGLE
THIS TAKES PLACE ON THIRD RUN
RIGHT SIDE
RED MARK ON STRING
TRIPOD # 5
TRIPOD # 4
METAL ROD OR SCREWDRIVER
WIND
PLASTIC WHITE FLAG
STRING
DYE SENSITIVE CARDS
7 METAL RODS
STRING WIND UP TRIPOD # 2
TRIPOD # 3
EQUIPMENT BOX
125-150'
METAL CABLE
WHITE STYROFOAM BALL
GREEN MARK ON STRING
STRING DIRECTION
ORANGE PAINTED CLIP ON CABLE
PLASTIC WHITE FLAG
SUPPLY BUCKET
TRIPOD # 1
18-24"
LEFT SIDE
EXTRA MAGIC MARKERS
WSP (WATER SENSITIVE PAPER)
STRING
WIND TAPE
SAFETY WIRE
CENTERLINE
PLASTIC WHITE FLAG
Speed and Height Sensor with Control Box
TRIPOD # 3
Temperature & Relative Humidity Sensor
Wind Vane and Anemometer
Micrologger
Power Supply
Output Display Controller
WEATHER STATION INFORMATION
Wireless Terminal Device
1. BE SURE TO PURGE BEFORE 1ST PASS
2. STABLE APPROACH & DEPARTURE
3. NORMAL HEIGHT & SPEED
4. WAIT FOR SIGNAL TO TAKE OFF & MAKE FIRST PASS, THEN AGAIN FOR EACH ADDITIONAL PASS
5. THINK SAFETY-WATCH FOR TRAFFIC
AG AVIATION WET MATERIAL COLLECTION LAYOUT

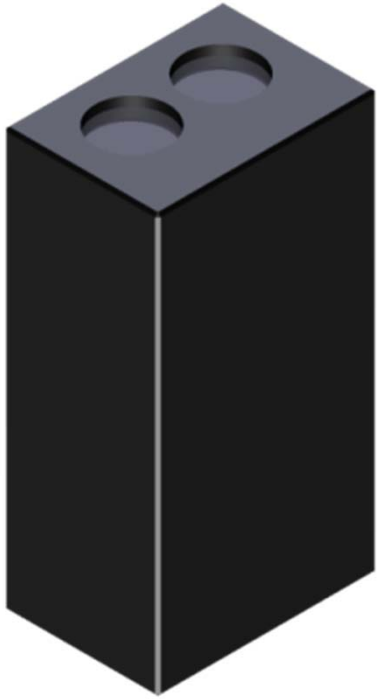
# In Field Data Collection

Aircraft Traveling 142 MPH
(208 Feet/Second)

- Speed Measurement
  - Approximately 1000 Feet to obtain a lock
  - ~5 seconds to acquire 1 reading.
- Height Measurement
  - Approximately 100 Feet to obtain a sight.
  - Less than 1/10 second
    - Locate aircraft in scope
    - Align sight, aircraft spray boom and graduated scale
    - Determine height
- Weather Information
  - Several seconds to retrieve information from weather station then document it
  - Difficult to record weather events that occurred the instant aircraft fly's passed string.

# Automated Sensors

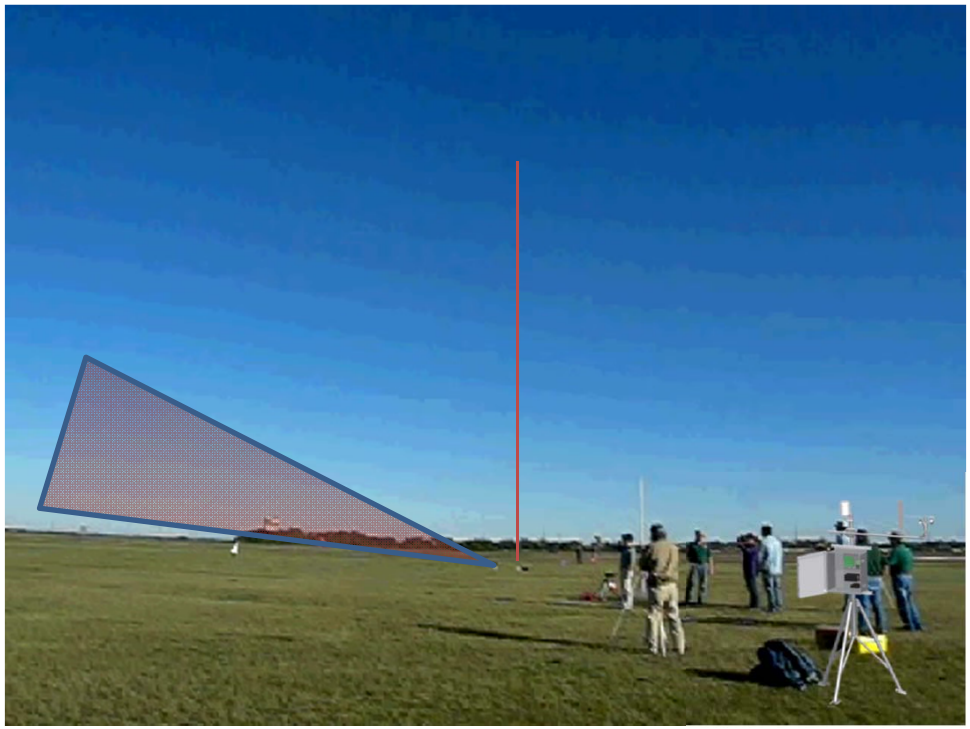
Stalker Stationary Speed Sensor

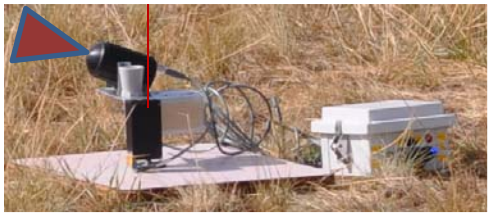


MDL Distance Sensor

Automated Weather Station

# Automated Data Collection



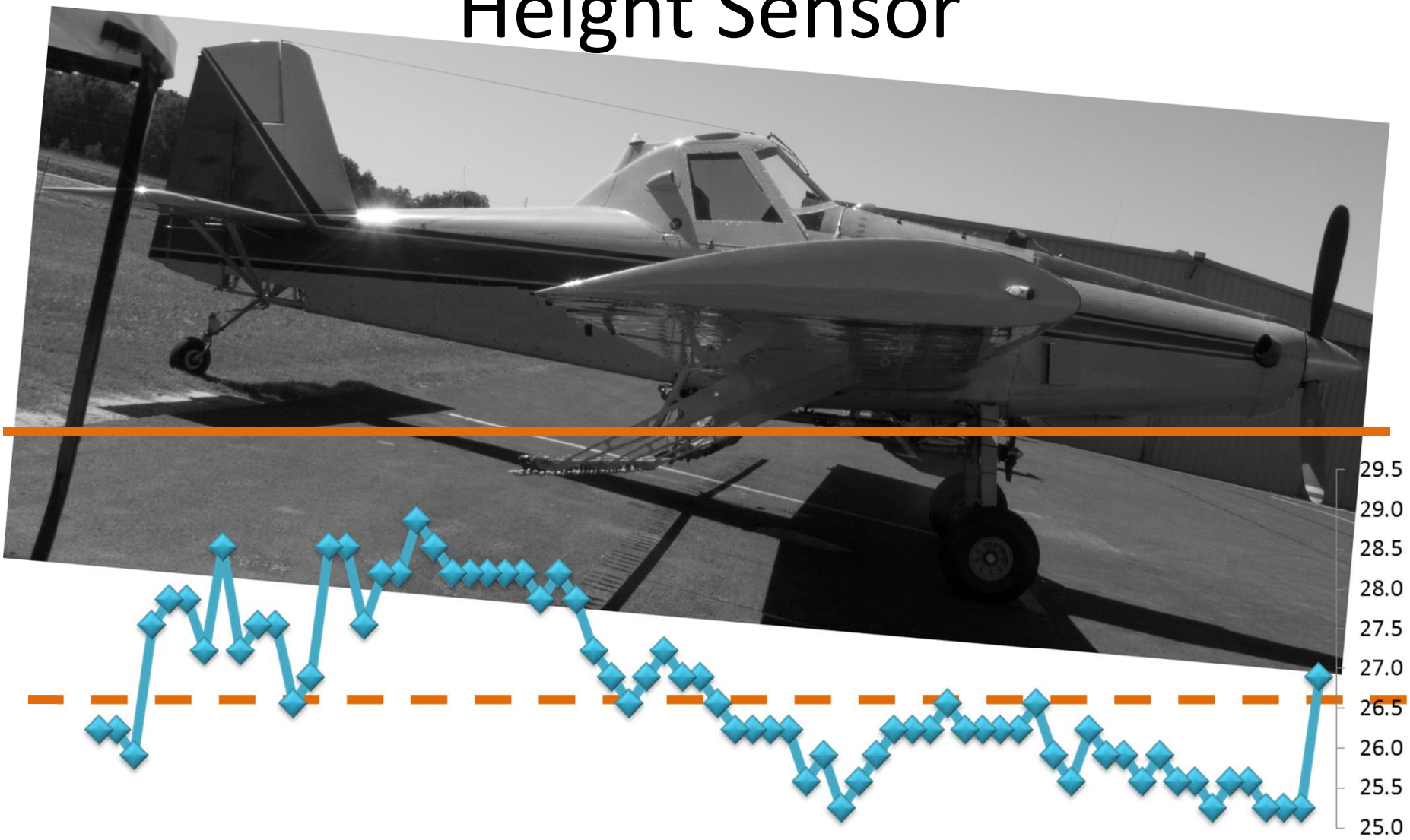


| | |
|---|---|
| Aircraft Speed: | 128 MPH |
| Aircraft Height: | 15 Ft |
| Wind Speed: | 1.4 MPH |
| Wind Direction: | 66°ENE |
| Temperature: | 63.7 °F |
| Humidity: | 60 % |

# Speed Sensor Comparison

| Aircraft # - Pass | Manual Sensor (MPH) | Automated Sensor (MPH) |
|---|---|---|
| Aircraft 1 – A | 142 | 141 |
| Aircraft 1 – B | 134 | 134 |
| Aircraft 2 – B | 128 | 128 |
| Aircraft 2 – C | 130 | 128 |
| Aircraft 3 – A | 137 | 137 |
| Aircraft 3 – B | 139 | 139 |

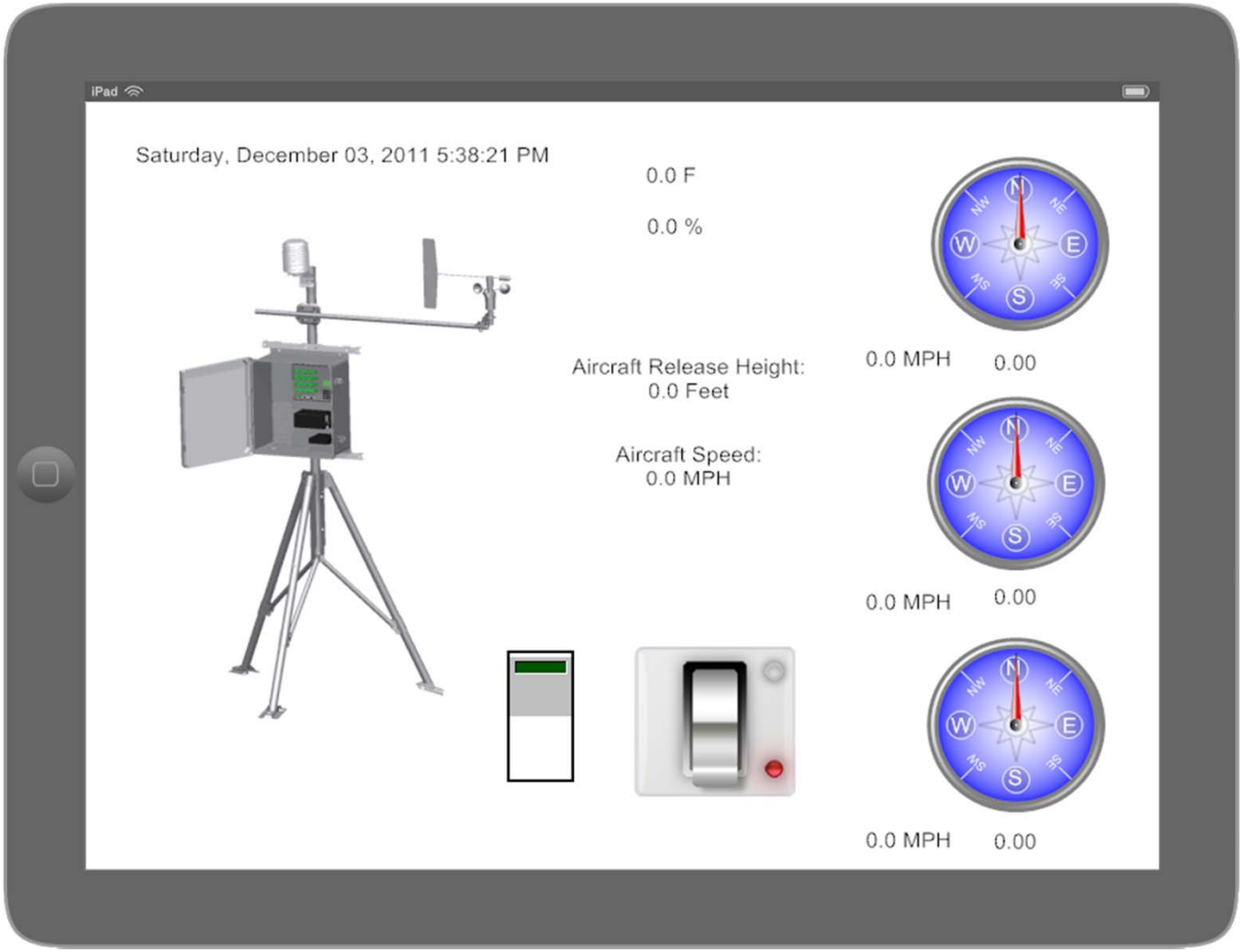
# Height Sensor



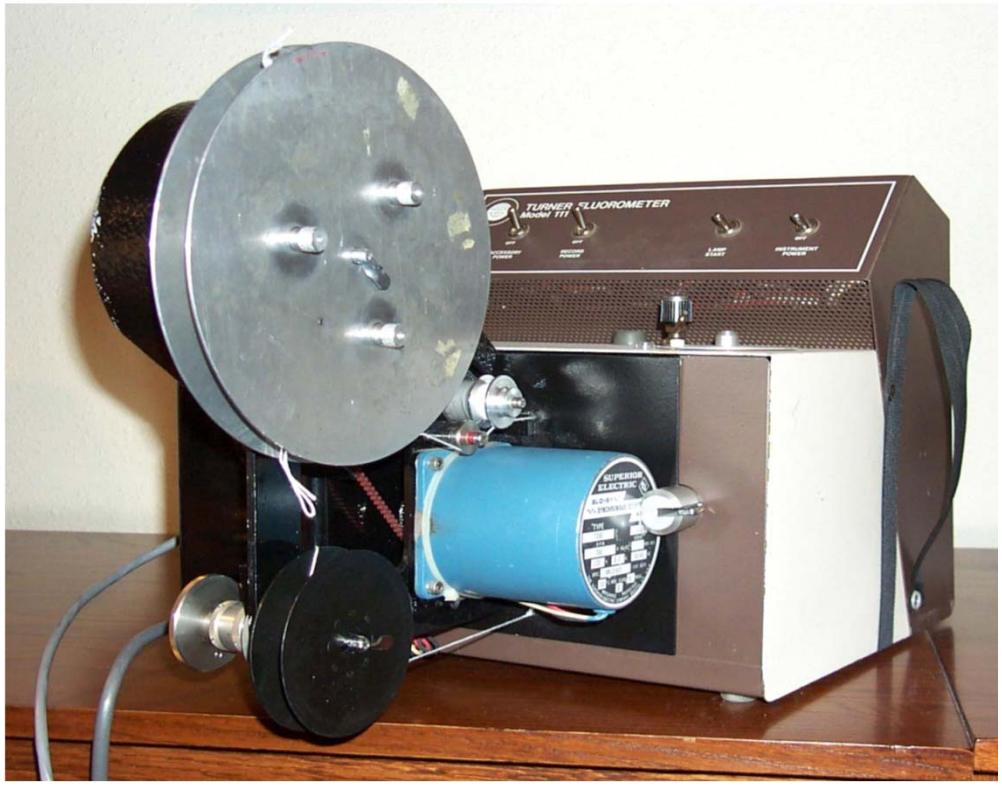
# Height Sensor Comparison

| Aircraft # - Pass | Manual Sensor (Feet) | Automated Sensor (Feet) |
|---|---|---|
| Aircraft 1 – B | 25 | 25.3 |
| Aircraft 1 – C | 20 | 20.0 |
| Aircraft 2 – A | 15 | 21.0 |
| Aircraft 2 – C | 14 | 14.1 |
| Aircraft 3 – A | 25 | 24.0 |
| Aircraft 3 - B | 18 | 15.1 |

# Wireless Terminal Interface



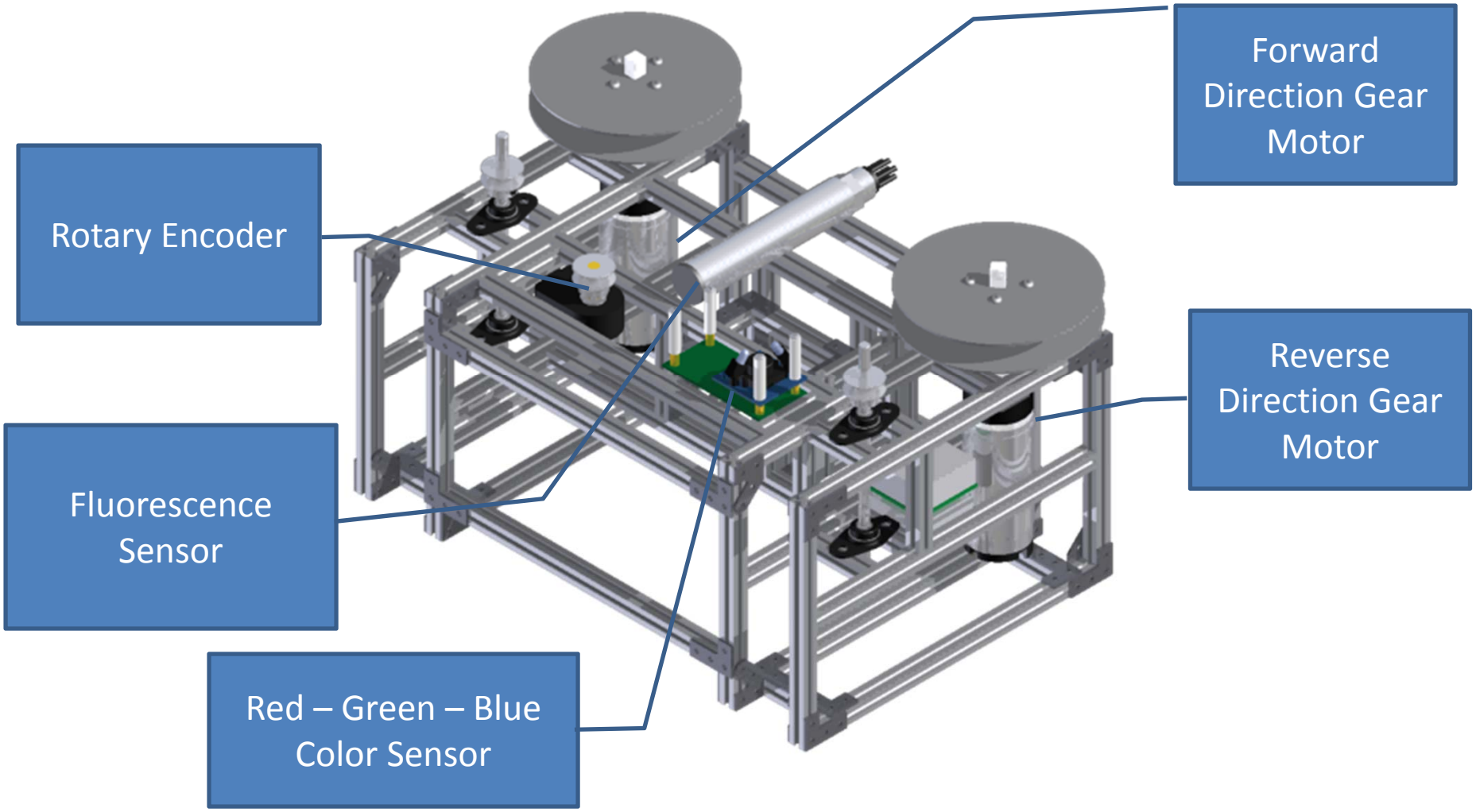
# String Analysis Machine (Currently Used Model)



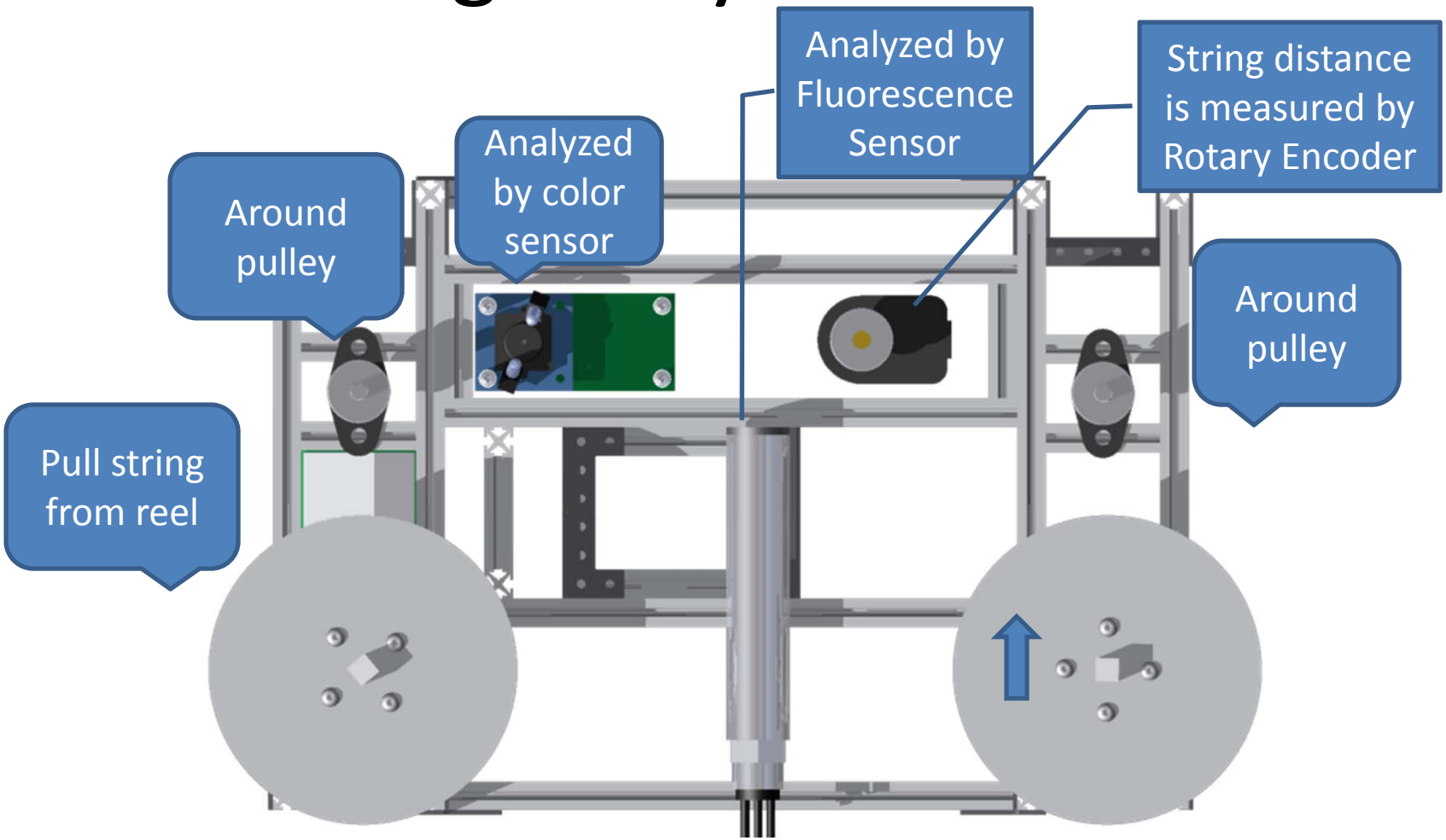

***WRK String Analysis Door & Model 111 Turner Flourometer***

Image from SAFE2009 Manual "Chapter 9, Equipment and Supplies" document.

# String Analysis Machine (New Prototype Model)



# String Analysis Machine



# Experimental Setup - Aircraft

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | | 31 | | 32 | 33 | 34 | | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Standard Nozzle Setup on a 64 position spray boom.

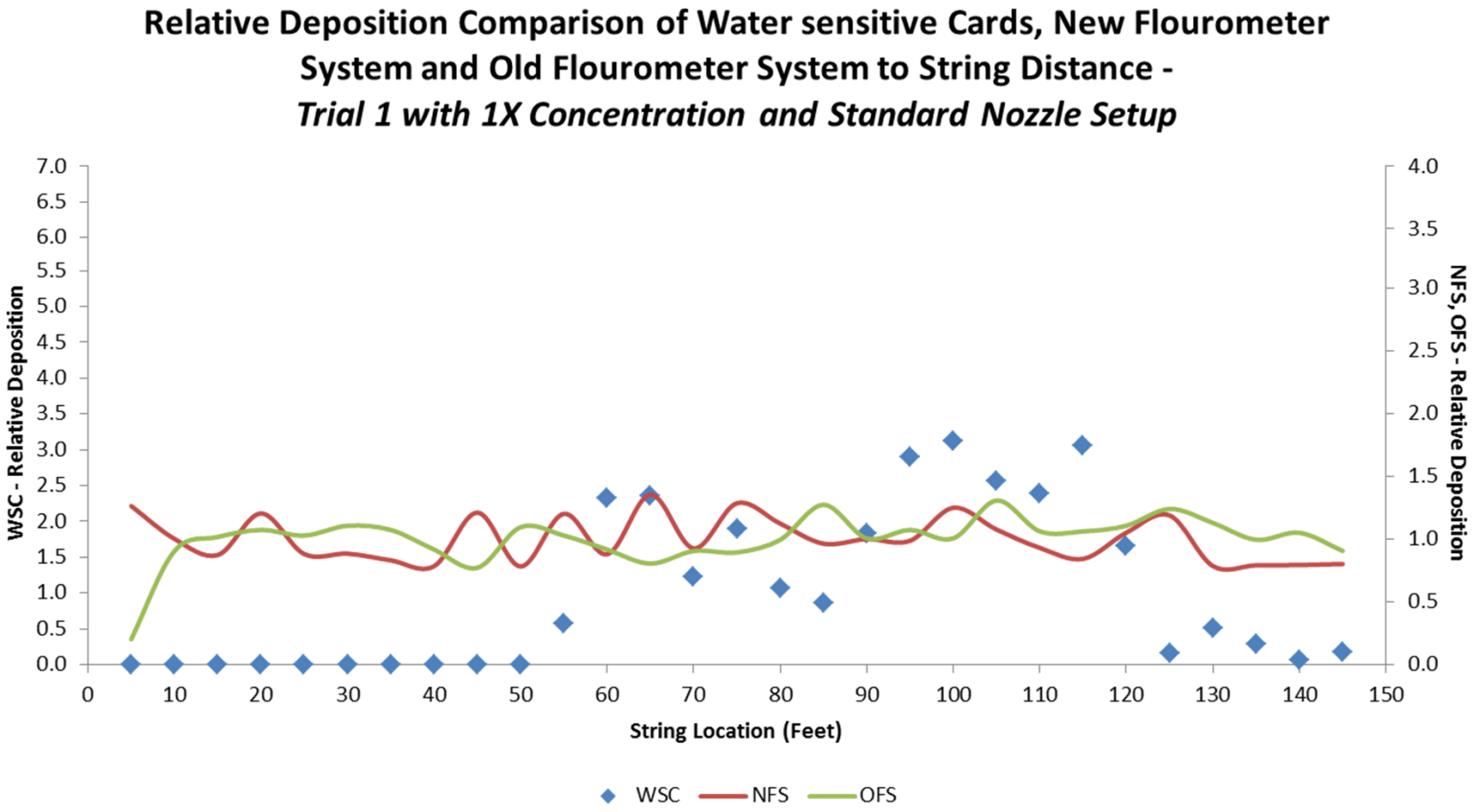
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | | 31 | | 32 | 33 | 34 | | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | X | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Modified Nozzle Setup on a 64 position spray boom.

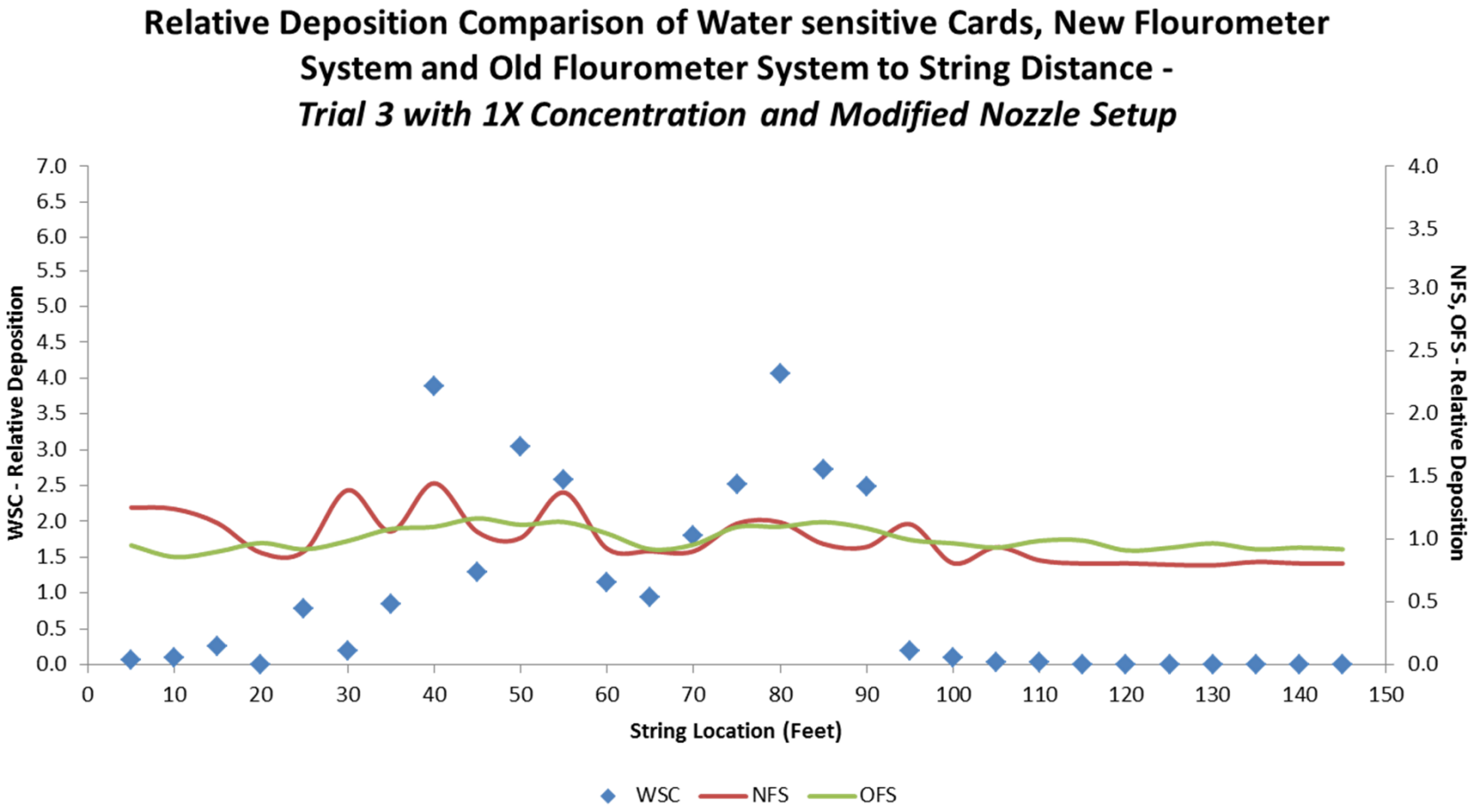
| 1…64 | Spray Nozzle Position from left to right facing rear of plan |
|---|---|
| | Active nozzles on left side of aircraft |
| | Empty locations on spray boom |
| X | Non-nozzle component |
| | Active nozzles on right side of aircraft |
| | Inactive nozzle |

| 1X Concentration |
|---|
| 10.2 Grams of Fluorescent Red Dye Tracer - Cole-Parmer (SI 00298-26) |
| 20 Gallons water |
| |
| **2X Concentration** |
| 20.4 Grams of Fluorescent Red Dye Tracer - Cole-Parmer (SI 00298-26) |
| 20 Gallons water |

# String Analysis



# String Analysis



# Current Status Recap

- Speed Sensor
  - Capture aircraft speed data
  - Stores all data during clinic operation
  - View max value on wireless terminal
- Height Sensor
  - Capture aircraft height information
  - Stores all data during clinic operation
  - View values on wireless terminal
- Weather Station
  - Capture and report
  - Triggered events
  - View information on wireless terminal
- String Analysis System Platform
  - Reuse the existing string reel
  - Motor drive system that allows forward and reverse operations for string
  - Battery operation
  - Modular design

# Future goals

- Lower cost weather station
- Universal application for wireless terminal
- Develop software for string analysis interpretation and recommendations

# Questions?