



# Civil Air Patrol

United States Air Force Auxiliary

*...performing Missions for America*

**ARCHER**  
CAP ADVANCED TECHNOLOGIES



*Presented by*



*Col Drew Alexa, CAP  
Director  
Advanced Technologies  
&  
ARCHER Program  
Manager*



# *ARCHER Overview*

- ◆ ARCHER Concept & Capabilities
- ◆ ARCHER System Components
- ◆ ARCHER Target Detection and Data
- ◆ ARCHER Deployment
- ◆ ARCHER Contractors
- ◆ Multi-Organizational Support
- ◆ Summary



# ARCHER Concept & Capabilities

What is ARCHER?

**A**irborne  
**R**eal-Time  
**C**ueing  
**H**yperspectral  
**E**nhanced  
**R**econ





# ARCHER Concept & Capabilities

- ◆ **ARCHER is a custom-designed system of hyperspectral imaging** hardware and software (HSI).
- ◆ HSI is a technology that allows a sensor on a moving platform to **detect and/or gather reflected radiation** (light) from man-made or natural objects on the ground.
- ◆ Hyperspectral Imaging will **support current and future CAP missions**
  - ▼ Search and Rescue (SAR)
  - ▼ Counter Drug (CD)
  - ▼ Disaster Relief (DR)
  - ▼ Homeland Security (HLS)



# ARCHER Concept & Capabilities

ARCHER executes three separate algorithms for target acquisition and identification:

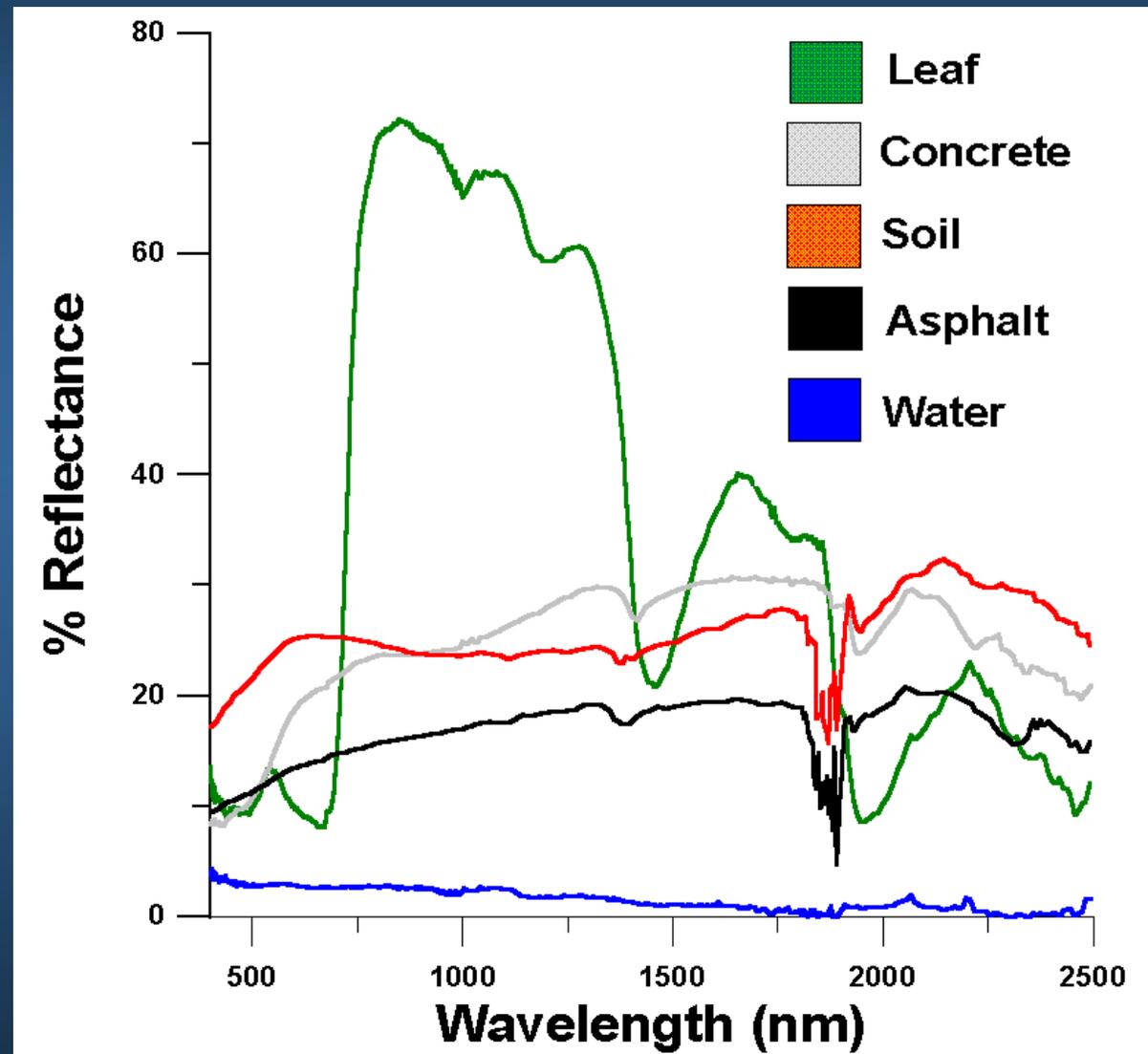
- ◆ **Spectral signature matching:** detects specific spectral signatures using matched filters (find things with known spectral properties)
  - ▼ Potential Missions: Counter Drug, HLS
- ◆ **Anomaly detection:** detects spectral anomalies (things that do not “belong”)
  - ▼ Potential Missions: Search and Rescue, Disaster Relief
- ◆ **Change detection:** detects changes over time through a pixel-by-pixel comparison.
  - ▼ Potential Missions: HLS, Disaster Relief



# ARChER Concept & Capabilities

## HSI Spectral Technologies

Examples  
of Hyperspectral  
Signatures

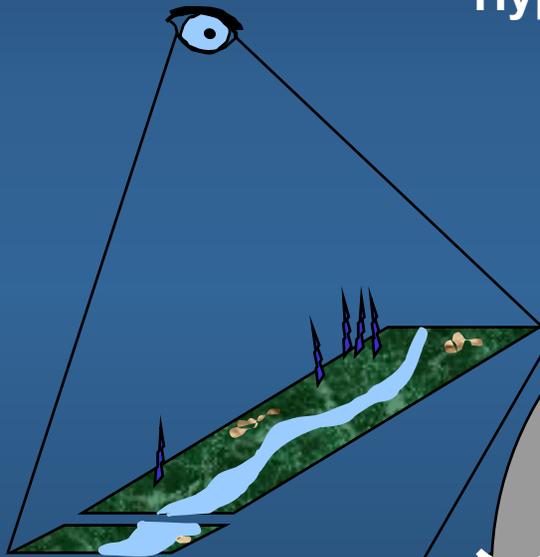




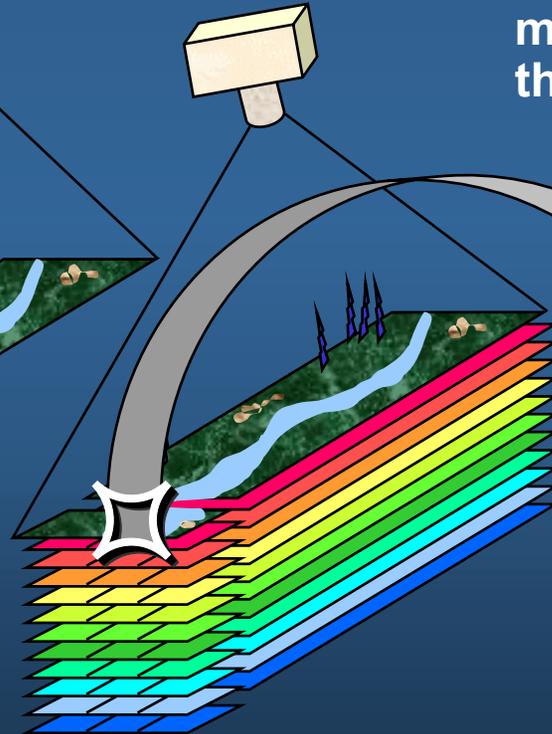
# ARCHER Concept & Capabilities

## How HSI works:

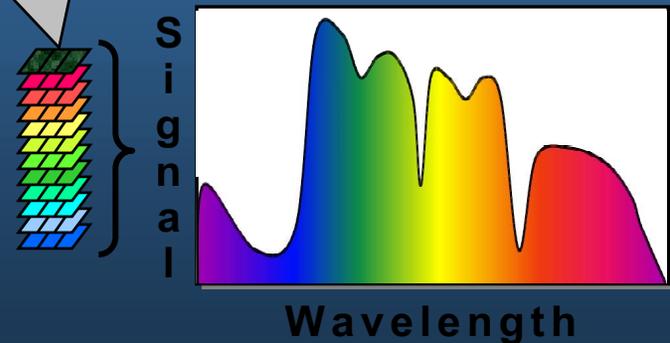
Human Eye



Airborne  
Hyperspectral  
Sensor



Each pixel contains a *continuous spectrum* used to identify the materials present in that particular pixel





# ARCHER Concept & Capabilities

- ◆ ARCHER is a **non-invasive** reflective light technology.
  
- ◆ ARCHER will **NOT** make detections:
  - ▼ Through solid materials (e.g., roofs, buildings, walls, floors, etc.)
  - ▼ Underground
  - ▼ Under snow
  - ▼ Under water
  - ▼ At night



# ARCHER System Components



HSI Aircraft: GA-8 Airvan



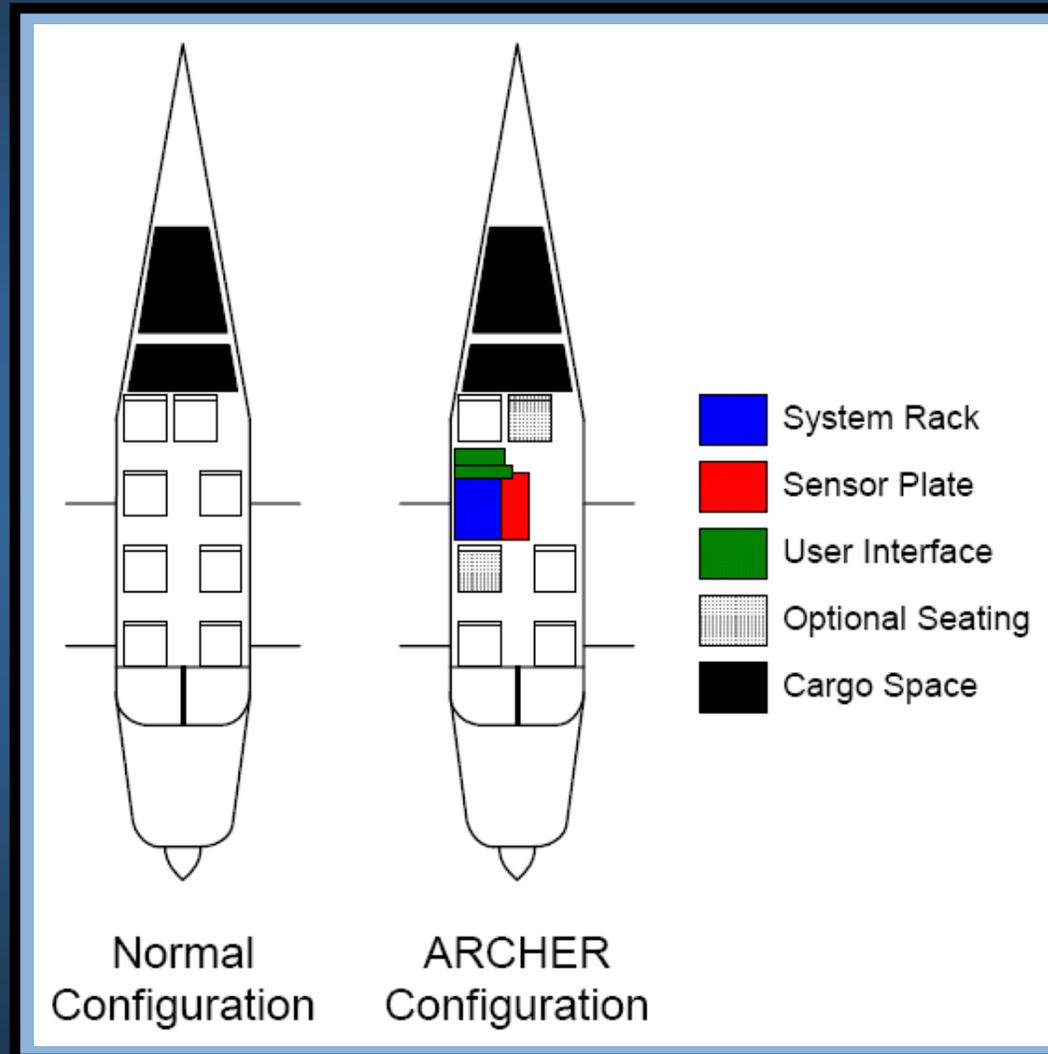
# ARCHER System Components



ARCHER Onboard



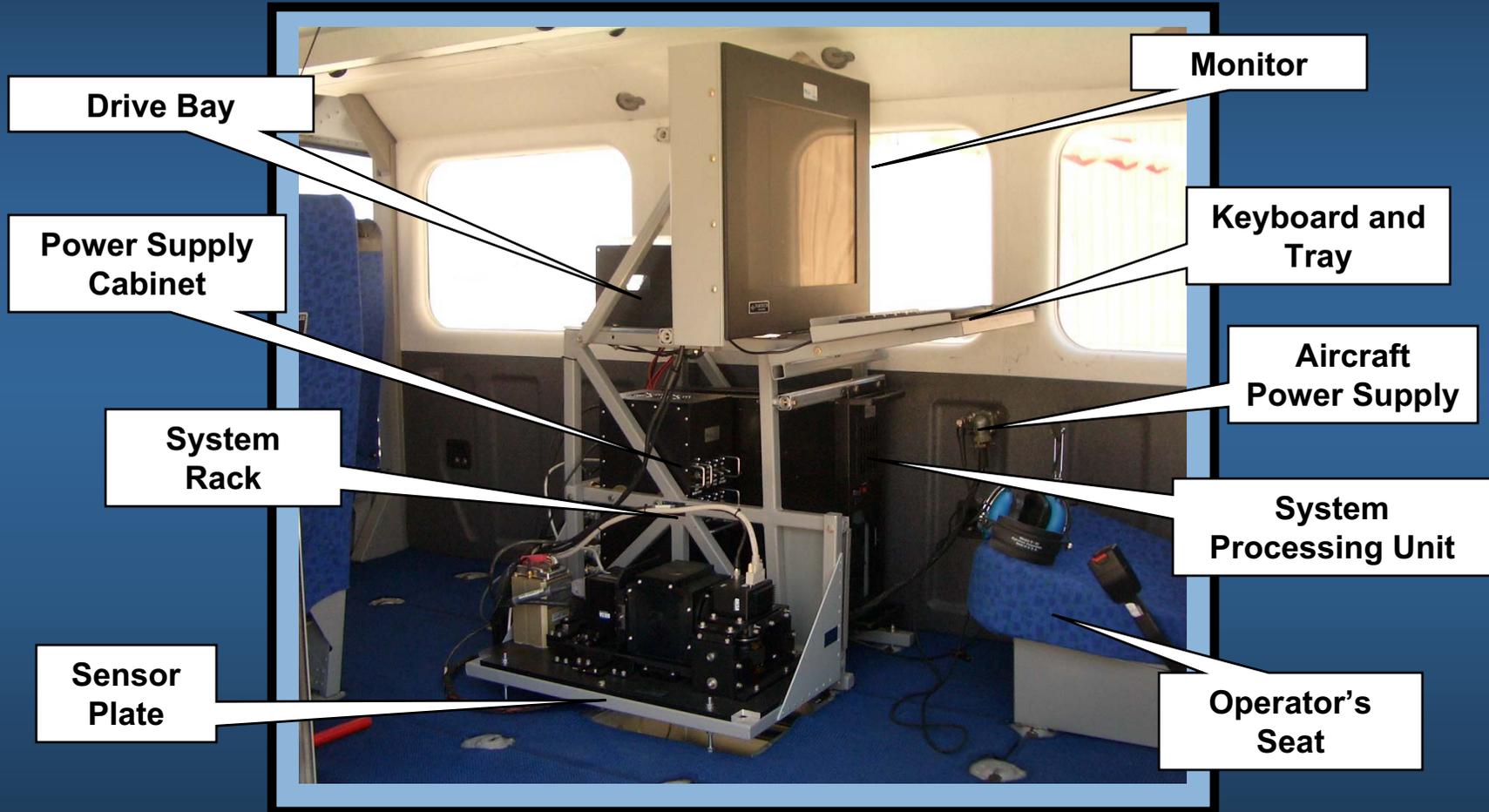
# ARCHER System Components



## ARCHER Install Configuration



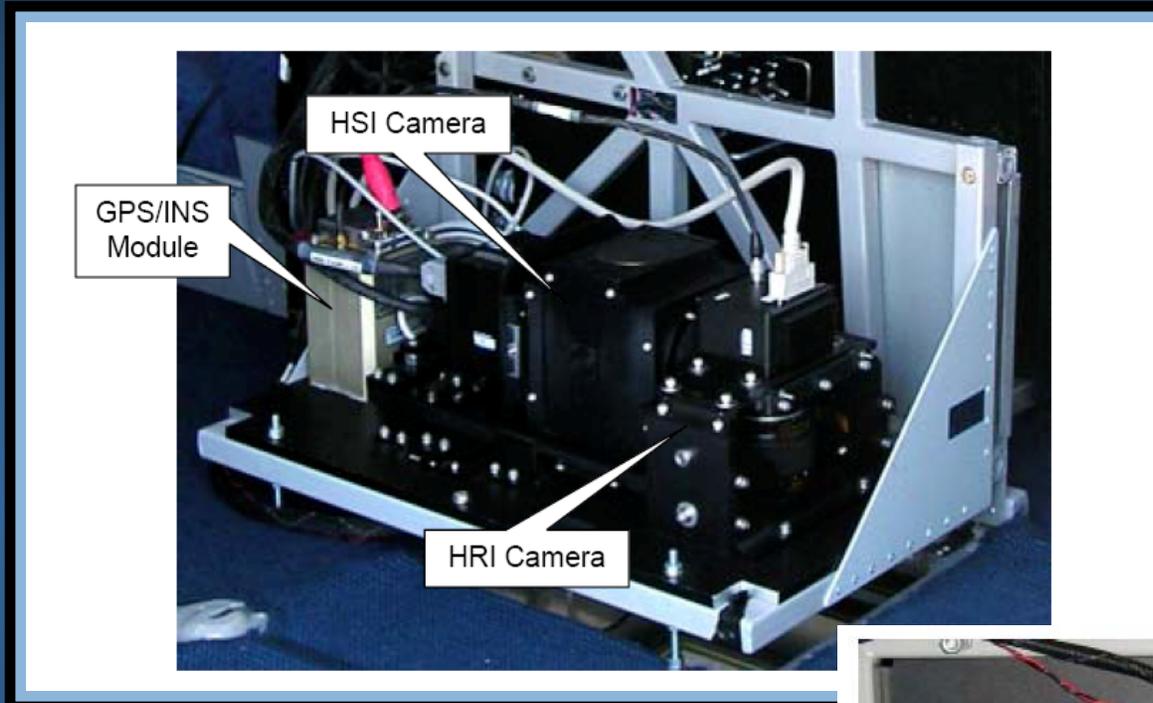
# ARCHER System Components



ARCHER Onboard Components



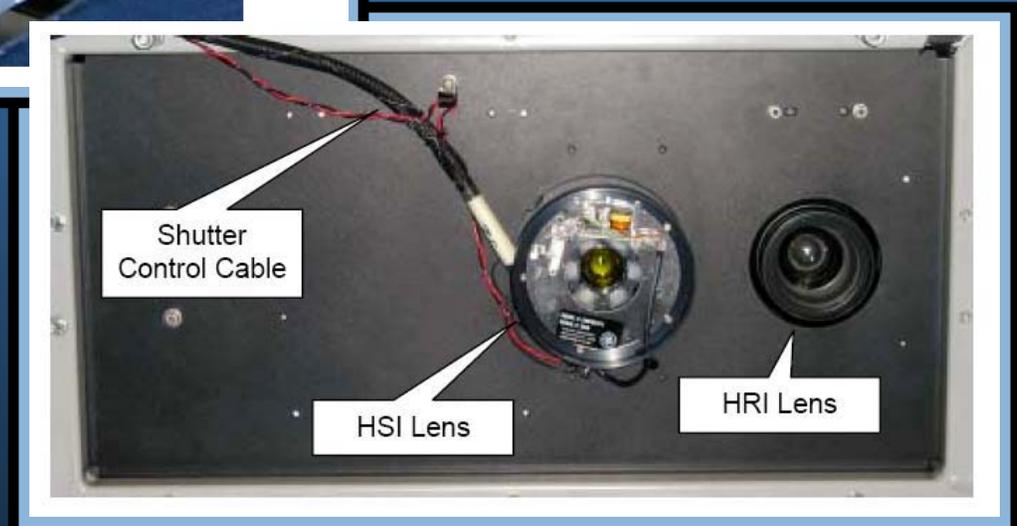
# ARCHER System Components



ARCHER  
Airborne  
Station  
Sensor Plate

## ARCHER Sensor Suite

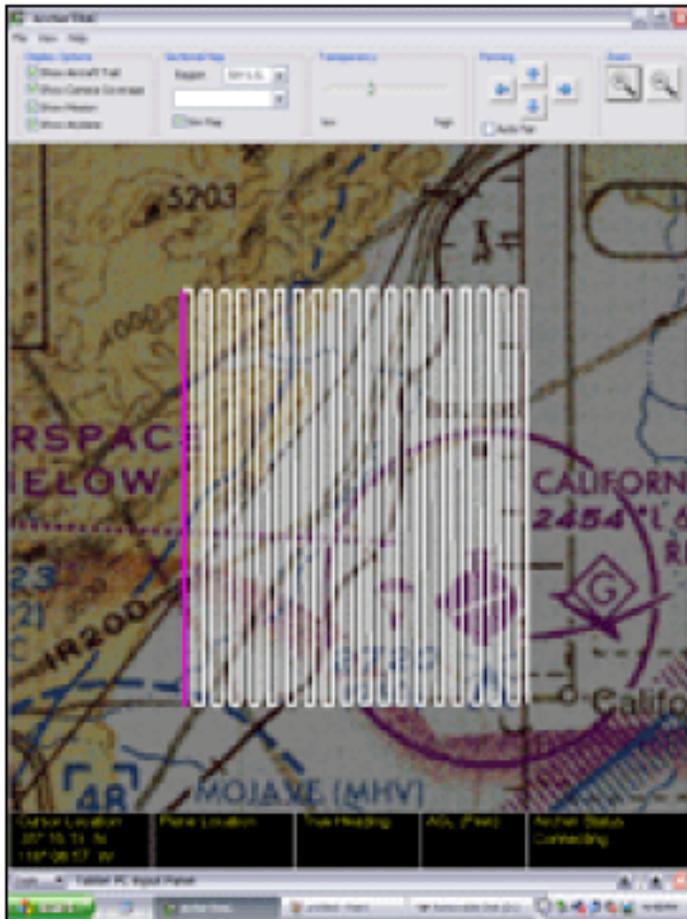
Bottom  
View of  
Sensor  
Plate





# ARCHER System Components

Portion of ARCHER Trac Search Pattern Showing Actual Flight Path and Camera Area Coverage



ARCHER Trac North-South Search Grid



ARCHER Trac Interface



# ARCHER System Components



ARCHER Ground Station



# ARCHER System Components



ARCHER with Ground Station (Packed)



# ARCHER System Components



ARCHER Packed for Transport



# ARCHER System Components



**Hand held field spectrometer** allows for the collection of HSI signatures to be imported into the airborne ARCHER system for match filter detections.

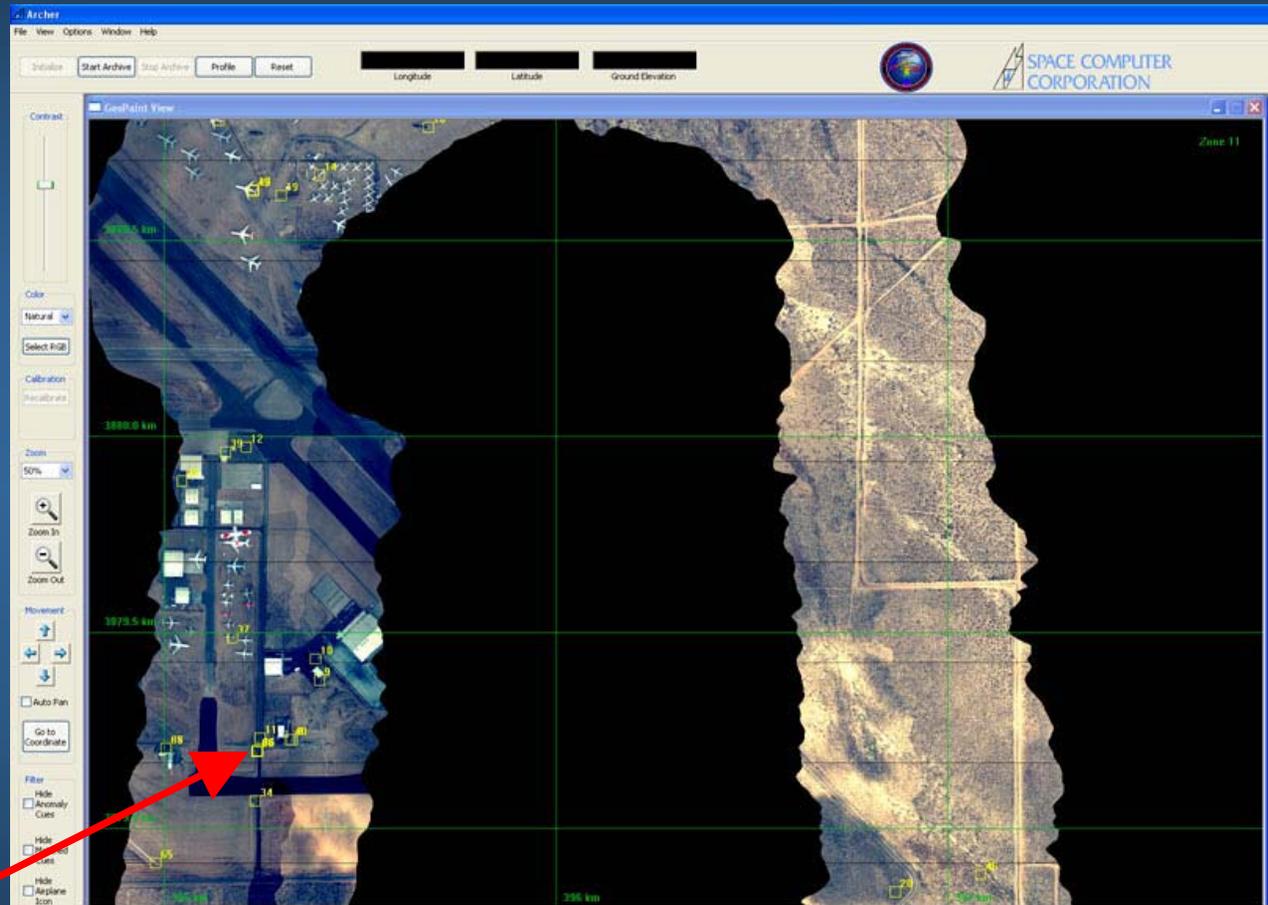
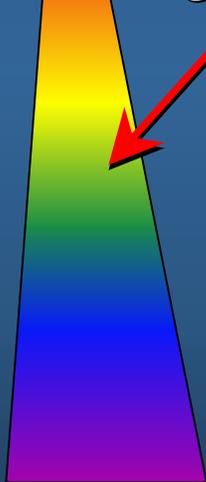
Maxwell AFB Test



# ARCHER Target Detection & Data



Visible  
Hyperspectral  
Imaging  
Sensor



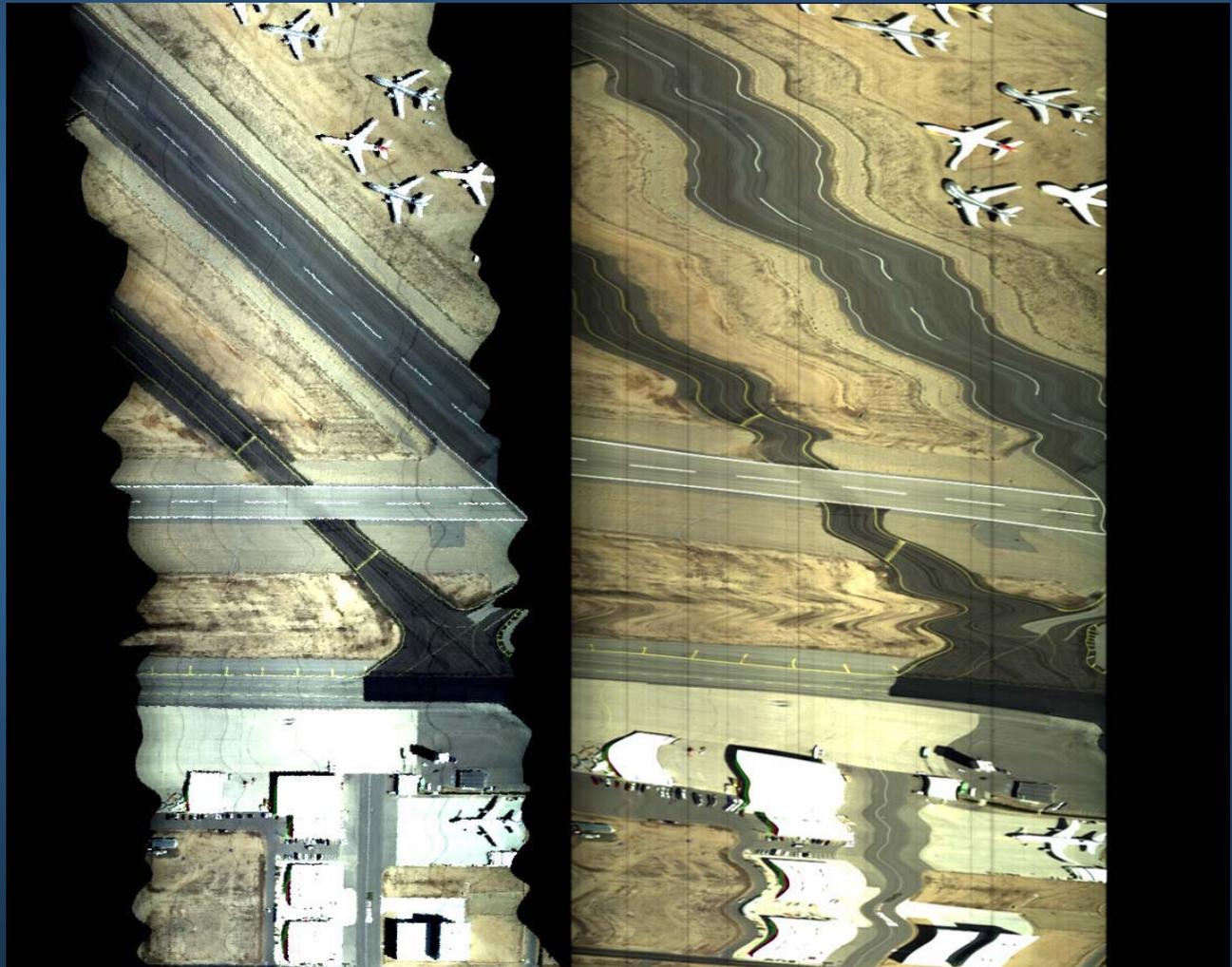
On-Board Hyperspectral Display  
with Real-Time Detection Cues



# ARCHER Target Detection & Data

Rectified Image

Unrectified Image



ARCHER  
Real-Time  
Onboard  
Data  
Georectification



# ARCHER Target Detection & Data

The screenshot displays the ARCHER software interface. The main window shows a satellite image with several detection boxes. A red box highlights a match filter detection, and a yellow box highlights an anomaly detection. The interface includes a 'Chip Viewer' table with columns for ID, Source, MSI Frame #, MSI Pixel #, MSI Line #, MSI Pixel #, Score, Longitude, Latitude, Easting, Northing, Zone, and Date. The table lists 13 rows of data, including sources like 'Anomaly' and 'MF Cloud Cover (In.)'. Below the table is a 'Thumbnail Views' section showing a grid of small images. To the right, there is a 'Target Spectrum' plot showing a graph of intensity versus wavelength (nm) from 500 to 1000. The plot includes a 'Connect Spectra' button and a 'Target' line. Below the plot is a 'Comments' section with a text area and a 'Send' button. The interface also features a 'View Filter' section with buttons for 'Metaspectral', 'Echocromatic', and 'Show Target Reticle', and a 'Special Library' section with a 'Get' button.

ID	Source	MSI Frame #	MSI Pixel #	MSI Line #	MSI Pixel #	Score	Longitude	Latitude	Easting	Northing	Zone	Date
313	Anomaly	16249	452	194992	5454	19.4	-118.075320	35.076048	401 968048	3862 227953	11	10/21/2004 11 03 19 AM
314	Anomaly	16251	409	203832	5034	22.3	-118.076762	35.066238	401 968228	3879 781436	11	10/21/2004 11 03 11 AM
315	Anomaly	16256	37	203932	557	20.3	-118.067072	35.056176	401 263302	3879 806633	11	10/21/2004 11 01 12 AM
316	Anomaly	16249	196	203936	2316	15.9	-118.068036	35.056168	401 437442	3879 806639	11	10/21/2004 11 01 12 AM
317	Anomaly	16255	425	203302	5206	29.4	-118.075545	35.065568	401 279763	3879 847963	11	10/21/2004 11 01 13 AM
318	Anomaly	16345	368	203268	4427	33.4	-118.073679	35.058337	401 434959	3879 892070	11	10/21/2004 11 01 14 AM
319	Anomaly	16290	124	203569	7088	21.1	-118.081525	35.065584	401 293307	3879 881750	11	10/21/2004 11 01 15 AM
320	Anomaly	16361	318	203832	3845	24.6	-118.076296	35.057308	401 582961	3879 930720	11	10/21/2004 11 01 17 AM
321	Anomaly	16363	303	203248	3206	23.0	-118.073921	35.057503	401 521729	3879 928427	11	10/21/2004 11 01 18 AM
322	MF Cloud Cover (In.)	16368	432	203256	5171	20.3	-118.073929	35.055589	401 711823	3880 941520	11	10/21/2004 11 01 19 AM
323	Anomaly	16367	439	203464	5253	34.9	-118.073969	35.059061	401 710250	3880 912686	11	10/21/2004 11 01 20 AM

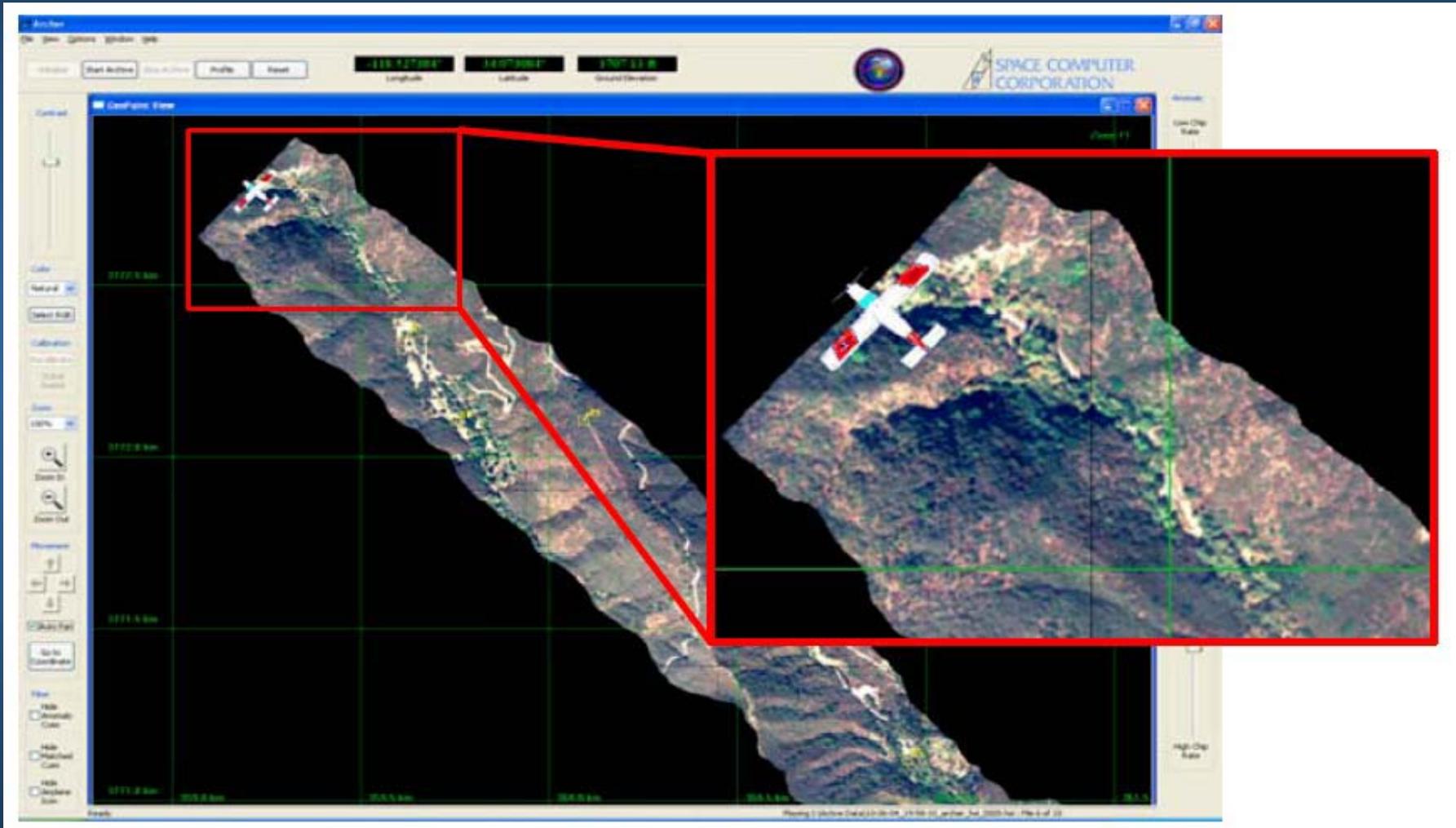
Red box – match filter detection

Yellow box - anomaly detection

**Multiple Cue Detections:  
Algorithms are applied in real-time, and require little user input.**



# ARCHER Target Detection & Data



ARCHER Geo-Paint™ Window



# ARCHER Target Detection & Data

The screenshot displays the ARCHER Chip Viewer Window interface. It features a 'Sortable Chip List' at the top with columns for Name, Altitude, Longitude, and Latitude. Below the list is a 'Scrolling Chips' section showing a grid of small satellite images. A 'High-Resolution Image of Selected Chip' is shown in a larger view on the left. On the right, there are 'Chip Viewer Command Buttons' (Zoom, Pan, etc.), a 'Target Spectra' graph showing spectral data, and a 'Chip Comments' text area. A red box highlights the 'Chip Viewer Command Buttons' and 'Target Spectra' area.

Sortable Chip List

Scrolling Chips

High-Resolution Image of Selected Chip

Chip Viewer Command Buttons

Target Spectra

Chip Comments

ARCHER Chip Viewer Window



# ARCHER Target Detection & Data

## Ground Truth Target Geolocation



Mojave, CA Test:  
Target Deployment





# ARCHER Target Detection & Data

ID	Source	HSI Frame #	HSI Pixel #	HSI Line #	HSI Pixel #	Score	Longitude	Latitude	Easting	Northing	Zone	Date
329	Anomaly	163683	303	205136	4430	15.4	-118.079576	35.054803	401.548301	3080.051954	11	10/21/2004 11:07:25 AM
329	Anomaly	163633	166	203496	2210	15.3	-118.080764	35.057223	401.448501	3079.970206	11	10/21/2004 11:08:26 AM
330	Anomaly	163621	29	203792	404	15.0	-118.083073	35.059589	401.237475	3079.989676	11	10/21/2004 11:09:27 AM
331	Anomaly	163669	205	203420	3112	14.9	-118.080027	35.057903	401.551910	3079.993339	11	10/21/2004 11:09:28 AM
332	Anomaly	163795	306	203792	3473	14.8	-118.079903	35.056979	401.520445	3080.033391	11	10/21/2004 11:09:29 AM
333	Anomaly	163424	56	203308	798	14.9	-118.082435	35.087113	401.293839	3079.912295	11	10/21/2004 11:09:30 AM
334	Anomaly	163629	491	203590	5056	13.1	-118.077187	35.059089	401.732402	3080.054248	11	10/21/2004 11:09:31 AM
335	Anomaly	163633	49	203590	716	12.6	-118.082373	35.059302	401.290796	3079.944081	11	10/21/2004 11:09:32 AM
336	HF Crested Cuckoo (S)	163759	63	204738	879	20.2	-118.077950	35.059362	401.712290	3080.042406	11	10/21/2004 11:09:39 AM
141	HF Crested Cuckoo (S)	9660	612	119521	4907	13.9	-118.077644	35.056260	401.732074	3080.043630	11	10/21/2004 10:48:41 AM
141	Anomaly	116399	360	143376	424	31.9	-118.076790	35.059171	401.810081	3080.134900	11	10/21/2004 10:48:41 AM

Mojave, CA Test:  
Anomaly Detection



Ground Truth Image of Target





# ARCHER Target Detection & Data

ID	Source	HSI Frame #	HSI Pixel #	HRI Line #	HRI Pixel #	Score	Longitude	Latitude	Easting	Northing
50	MF Wright Flyer	70205	331	842460	3996	31.9	-86.354359	32.372947	560.736669	3581.958464
51	MF Wright Flyer	70577	151	846924	1902	33.8	-86.350184	32.373379	561.129122	3582.008713
52	MF Wright Flyer	70593	379	847116	4555	31.8	-86.351363	32.374949	561.017146	3582.182117
53	MF Wright Flyer	70391	99	844692	1298	31.3	-86.351456	32.372205	561.010247	3581.877936
54	MF Wright Flyer	70672	35	848064	553	97.5	-86.348640	32.373005	561.274639	3581.968190
55	MF Wright Flyer	70732	148	848784	1868	31.5	-86.348788	32.374125	561.259898	3582.092201
56	MF Wright Flyer	70779	235	849348	2879	263.7	-86.348907	32.374780	561.248330	3582.164745
57	MF Wright Flyer	70804	340	849648	4101	34.5	-86.349321	32.375541	561.208883	3582.248863
58	MF Wright Flyer	70499	362	845988	4357	30.5	-86.352088	32.374424	560.949269	3582.123491
59	MF Wright Flyer	70859	307	850308	3717	231.5	-86.348680	32.375554	561.269153	3582.250760
60	MF Wright Flyer	70922	339	851064	4089	36.1	-86.348487	32.376072	561.286975	3582.308306

View Options:  
  
  
  
 Show Target Reticle  
  
  
 Send Selected Chip:  
 Email  
 Spectral Library  
 Archer TRAC

Target Spectra  
 Corrected  
 3500  
 3000  
 2500  
 2000  
 1500  
 1000  
 500  
 500 600 700  
 Wavelength

Comments:  
 2/11/2005 5:26:43 PM  
 Longitude = -86.348487  
 Latitude = 32.376072  
 HSI File: F:\Feb 10 2005 Acceptance Tests-Maxwell AFB\Feb Frame 722, Pixel 339

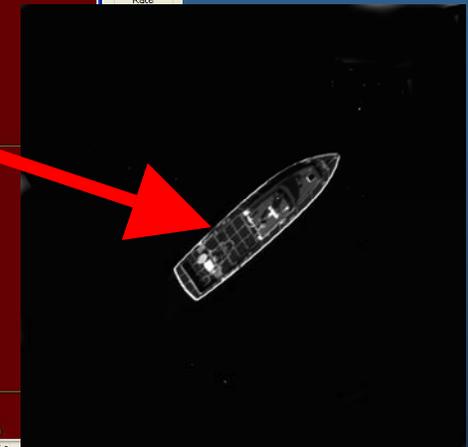
Maxwell AFB Test: Match filter detection of display aircraft in front of CAP Headquarters using spectral signature collected by the hand held spectrometer.



# ARCHER Target Detection & Data

The screenshot displays the ARCHER software interface. At the top, the title bar reads "Archer" and the menu bar includes "File View Options Window Help". Below the menu bar, there are buttons for "Initialize", "Start Archive", "Stop Archive", "Profile", and "Reset". The status bar shows coordinates: "118° 18.63' W" (Longitude), "33° 38.63' N" (Latitude), and "909.67 ft" (Ground Elevation). The main window is titled "GeoPaint View" and shows a satellite map of the California coast. A red and white airplane icon is positioned over the map, with a red arrow pointing to a small red square on the coast. The map has a grid with labels such as "3723.6 km", "3723.4 km", "3723.2 km", "3723.0 km", "378.4 km", "378.6 km", "378.8 km", "379.0 km", and "379.2 km". On the right side, there are sliders for "Anomaly Threshold", "Low Chip Rate", "High Chip Rate", "Matched Threshold", and "Low Chip Rate". The bottom of the screenshot shows the Windows taskbar with several open applications: "Archer", "ARCHER\_IN\_NE\_Test", "Mojave\_10\_04", "Microsoft PowerPoint...", "Microsoft Word - PDF...", "S idit", "Screenshot.JPG - Paint", and "Windows Task Manager". The system tray shows the time as "3:53 PM".

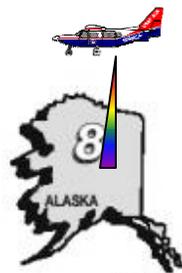
CA Coast  
Testing:  
Coastal  
over  
water  
detection





# ARCHER Deployment

## HSI Airborne Asset Distribution



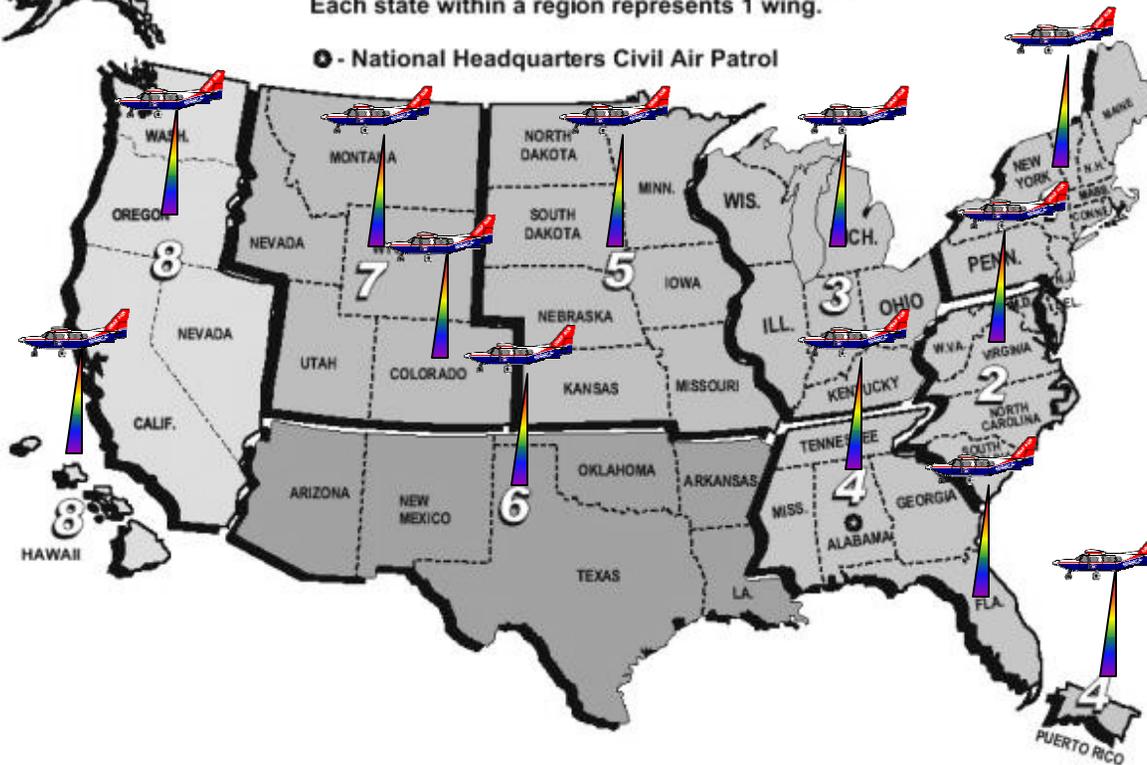
1. NORTHEAST REGION
2. MIDDLE EAST REGION
3. GREAT LAKES REGION
4. SOUTHEAST REGION
5. NORTH CENTRAL REGION
6. SOUTHWEST REGION
7. ROCKY MOUNTAIN REGION
8. PACIFIC REGION

HSI  
Asset



CAP is organized into eight geographic regions.  
Each state within a region represents 1 wing.

● - National Headquarters Civil Air Patrol





# ARCHER Contractors

- ◆ **Gippsland Aero** – Traralgon, Victoria, Australia
  - ▼ GA-8 Aircraft, Rack System & Camera Port
- ◆ **NovaSol** – Honolulu, HI
  - ▼ ARCHER Hardware (Airborne & Ground)
- ◆ **Space Computer Corp.** – Los Angeles, CA
  - ▼ ARCHER Operating System & Software



# *Multi-Organizational Support*



**Air Force Research Lab (AFRL)**

**Naval Research Lab (NRL)**



**USCG Research & Development  
Center**



**United States Coast Guard  
Headquarters**





## Summary

### CAP History in the Making...

- ◆ Funding for **ARCHER** was provided to CAP by Congress under the 2002 Defense Appropriations Act.
- ◆ **ARCHER** is the **largest cooperative, multi-organizational project** CAP has undertaken in its 63-year history.
- ◆ **ARCHER** will be the **nation's first fully deployed hyperspectral imaging system**.
  - ▼ Deploying **16 complete systems nationwide**
  - ▼ Supporting a wealth of **real-world applications**
  - ▼ Enhancing CAP's **core mission capabilities**
  - ▼ Establishing CAP as a **force multiplier**



*Just the beginning...*

*Civil Air Patrol ...performing missions for  
America through advanced technology*



**Thank You**

*Col Drew Alexa, CAP  
Director, Advanced Technologies  
&  
ARCHER Program Manager*