



# Civil Air Patrol

United States Air Force Auxiliary

*...performing Missions for America*

**ARCHER**  
CAP ADVANCED TECHNOLOGIES



# 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)
  - ◆ Disaster Relief (DR)
  - ◆ Homeland Security (HLS)
  - ◆ Counter Drug (CD)



# 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)
  - ◆ Requires an **exact** sample of the color for best operation
    - ◆ May be obtained via overflight (recommended) or handheld spectrometer
    - ◆ Varying weather conditions and shadows can impact spectrometer readings
  - ◆ Potential Missions: SAR, DR, HLS
- ◆ **Anomaly detection:** detects spectral anomalies (things that do not “belong”)
  - ◆ Does not work well in an urban environment
  - ◆ Potential Missions: SAR, CD, HLS, DR
- ◆ **Change detection:** detects changes over time in a pixel-by-pixel comparison
  - ◆ Comparisons of similar time periods and recent data yields better results
  - ◆ Potential Missions: HLS, DR, SAR, CD



# *ARCHER Concept & Capabilities*

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- ◆ ARCHER is a **non-invasive** reflective light technology
  - ◆ Works best on clear days when the sun is high
  - ◆ Sorties are typically conducted at mid-day to support this
  
- ◆ ARCHER will **NOT** make detections:
  - ◆ Through solid materials (e.g., roofs, buildings, walls, floors, etc.)
  - ◆ Underground
  - ◆ Under snow
  - ◆ Under water
  - ◆ Under trees
  - ◆ At night
  - ◆ Will not detect small objects (less than 1 meter square when operating at 2500 ft) such as missing persons



# *ARCHER Concept & Capabilities*

- ◆ A search detection mission crew is **four** members
  - ◆ Mission Pilot
  - ◆ Co-pilot (or very experienced Observer)
  - ◆ ARCHER Operator
  - ◆ ARCHER Trac Technician (or a second ARCHER Operator)
- ◆ Multiple mission sorties often require multiple crews
- ◆ Additional analysis of mission search data can be conducted after the mission on the ARCHER ground station but requires another ARCHER operator
- ◆ Only **qualified** ARCHER operators or trainees under supervision may operate the airborne systems or the ground station
  - ◆ There is no on-the-job or other local training available for non-qualified operators; trainees are designated by CAP national headquarters, and are generally personnel that require more time completing a formal class before being fully qualified



# *ARCHER Concept & Capabilities*

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- ◆ Time to search  $\frac{1}{4}$  of a CAP grid (3.75 x 3.75 nm) is approximately 2.5 hrs
  - ◆ Turns are made OUTSIDE of the grid
- ◆ Normal search altitude is 2,500' AGL
- ◆ Normal search speed is 90-100 knots
- ◆ The ARCHER Operators or ARCHER Trac Technicians will determine track spacing (normally 25% overlap)



# ARCHER System Components



HSI Aircraft: GA-8 Airvan



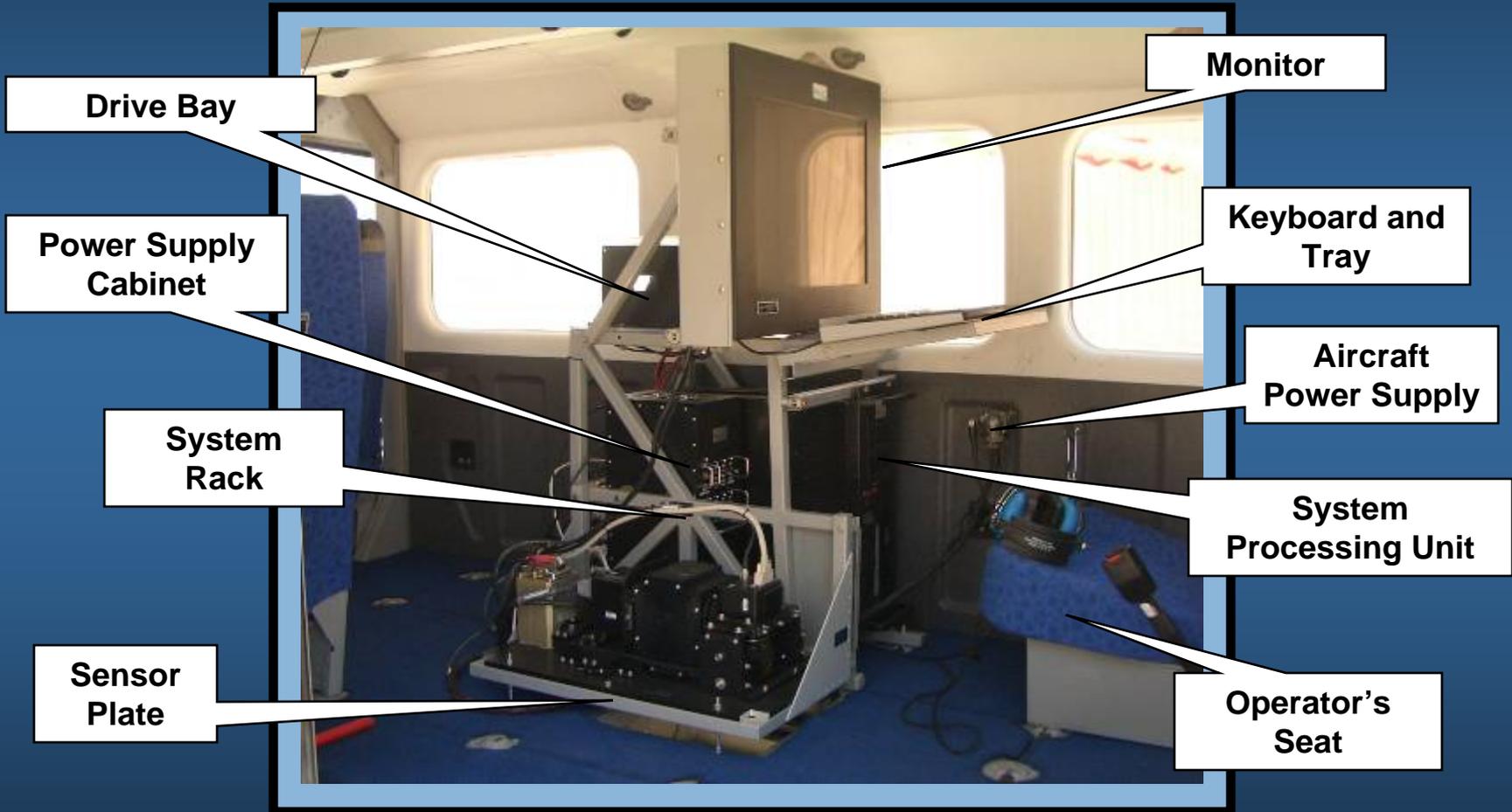
# ARCHER System Components



ARCHER Onboard



# ARCHER System Components

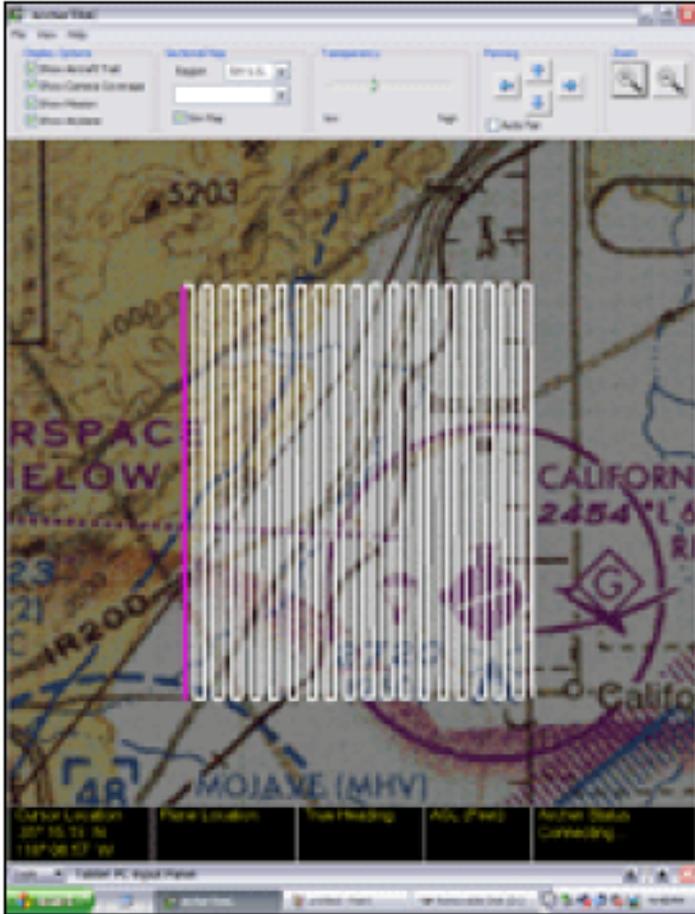


ARCHER Onboard Components



# 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  
(Crew must deploy with 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

**1 assigned to each of the 8 CAP regions**



# ARCHER Target Detection Example

ID	Source	HSI Frame #	HSI Pixel #	HSI Line #	HSI Pixel #	Score	Longitude	Latitude	Easting	Northing	Zone	Date
329	Anomaly	163683	303	205136	4439	15.4	-118.07075	35.056403	401.546701	3886.051954	11	10/21/2004 11:05:25 AM
329	Anomaly	163683	166	204196	2102	15.3	-118.06704	35.057223	401.446001	3879.970206	11	10/21/2004 11:05:26 AM
330	Anomaly	163621	29	203792	484	14.9	-118.063073	35.059589	401.237475	3880.198676	11	10/21/2004 11:05:27 AM
331	Anomaly	163689	295	205429	312	14.9	-118.060027	35.057963	401.551249	3879.993331	11	10/21/2004 11:05:28 AM
332	Anomaly	163795	396	203790	3473	14.8	-118.070693	35.056669	401.520445	3880.103391	11	10/21/2004 11:05:29 AM
333	Anomaly	163424	56	203308	798	14.9	-118.064495	35.057113	401.292639	3879.912269	11	10/21/2004 11:05:30 AM
334	Anomaly	163629	491	203546	909	13.1	-118.071919	35.059099	401.773482	3880.054248	11	10/21/2004 11:05:31 AM
335	Anomaly	163633	43	203936	716	12.6	-118.062373	35.063202	401.290796	3880.044881	11	10/21/2004 11:05:32 AM
336	HF Crest Canyons	163759	83	204709	879	20.2	-118.070999	35.059362	401.712299	3880.042446	11	10/21/2004 11:06:09 AM
121	HF Crest Canyons	9669	617	116212	4907	13.9	-118.070444	35.062061	401.730374	3880.043403	11	10/21/2004 10:45:01 AM
141	Anomaly	118399	363	143376	4324	31.9	-118.070765	35.059171	401.819881	3880.134903	11	10/21/2004 10:48:41 AM

Mojave, CA Test:  
Anomaly Detection



Ground Truth Image of Target





# ARCHER Target Detection Example

ID	Name	Alt	Area	Per																
1	Area	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
2	Area	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
3	Area	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
4	Area	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
5	Area	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
6	Area	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
7	Area	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
8	Area	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
9	Area	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
10	Area	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Hurricane Katrina:  
Roof Damage



# ARCHER Target Detection Example

The screenshot displays the ARCHER software interface. On the left is a satellite map of a rural area with a dirt runway. A red arrow points from a small inset on the map to a larger, zoomed-in view of a blue aircraft on the runway, which is circled in red. To the right of the map is a data table with columns for ID, Name, Alt, Lat, Lon, Alt, Sum, Length, Lat, Lon, Alt, Date, and Date. Below the table are several small thumbnail images and a larger zoomed-in image of the aircraft. On the far right, there is a 'Target Details' panel with a line graph showing 'Altitude (ft)' vs 'Time (sec)'. The graph has two lines: a red line for 'Target Altitude' and a green line for 'Ground Plane'. The red line shows a peak around 2000 ft, while the green line stays below 1000 ft. Below the graph are various control buttons and a 'Comments' field.

ID	Name	Alt	Lat	Lon	Alt	Sum	Length	Lat	Lon	Alt	Date	Date
1	Archer	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
2	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
3	Archer	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
4	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
5	Archer	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
6	Archer	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
7	Archer	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
8	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
9	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
10	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
11	Archer	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
12	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
13	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
14	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
15	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
16	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
17	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
18	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
19	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0
20	MP MIL, SeaPlane	10000	33.0000	-111.0000	10000	10000	10000	33.0000	-111.0000	10000	2005/06/11 11:08:12.0	2005/06/11 11:08:12.0

Unidentified Aircraft Beside Dirt Runway



# ARCHER Target Detection Example

The screenshot displays the ARCHER software interface. The main window shows a satellite image with a red circle highlighting a target area. A red arrow points from the main image to the circled area. The interface includes a table of data points, a thumbnail view, and a spectral analysis graph.

ID	Icon	HSI Line	HSI Fl.	HSI Line	HSI Fl.	Min Score	Max Score	Latitude	Longitude	Easting	Northing	Time	Zone
43	MF Chip 44	28754	441	244028	5105	35.1	70.3	37.610287	-91.146128	663.629605	434.209204	15	200711.07 21.52.27 Z
44	MF Chip 44	28276	380	26024	4905	35.3	35.9	37.608957	-91.149005	663.299602	414.027615	15	200711.07 21.52.36 Z
45	MF Chip 44	28276	390	26124	4895	35.5	37.6	37.609033	-91.150000	663.246174	414.019424	15	200711.07 21.52.36 Z
46	MF Chip 44	29451	353	351413	4157	36.2	37.1	37.608345	-91.151922	663.131919	413.362472	15	200711.07 21.52.39 Z
47	MF Chip 44	29537	441	35444	5003	35.1	58.0	37.607160	-91.155958	663.157380	413.934436	15	200711.07 21.52.41 Z
48	MF Chip 44	29561	241	264733	2900	36.2	67.9	37.606969	-91.152866	663.923700	413.362944	15	200711.07 21.52.41 Z
49	MF Chip 44	31174	385	374089	4138	35.1	40.0	37.606700	-91.154095	662.280578	413.097918	15	200711.07 21.52.59 Z
50	MF Chip 44	31256	113	375012	1596	28.9	36.1	37.602919	-91.168413	661.697296	413.246205	15	200711.07 21.53.09 Z
51	MF Chip 48	31941	310	380204	3100	37.8	43.3	37.595295	-91.170232	661.536286	412.798091	15	200711.07 21.53.21 Z
52	MF Chip 44	32350	387	380203	4027	37.8	52.4	37.594761	-91.172941	661.296025	412.423731	15	200711.07 21.53.28 Z
53	MF Chip 44	32423	232	389877	2863	36.0	69.9	37.595821	-91.174257	661.130984	412.585044	15	200711.07 21.53.29 Z

The interface also features a 'Thumbnail View' with several small images labeled 'Chip 230' through 'Chip 232'. A 'Spectral Analysis' graph shows 'Corrected Spectra' with 'Target' and 'Shade' lines. The 'Comments' section contains the following text:

```
200711.07 21.53.21 Z
Latitude = 37.607285
Longitude = -91.170232
HSI File: E:\01-1-SATNO-20071107_154811_archer_h1_0008.hsi
Name: S41_Fuel 110
```

Missouri F-15 Accident



*For more information contact...*



*Civil Air Patrol  
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