A CONSTANT 67 μR RESOLUTION, FIVE FRAMES PER SECOND CAMERA, SCALABLE FROM 4 MP TO > 1 GP

D. B. Pollock[1]
G. Egnal[2]

1. ECE / Center for Applied Optics, University of Alabama Huntsville, 301 Sparkman Drive, OB400, Huntsville, AL 35899
2.G. Egnal, ArguSight Incorporated, 6350 Rolling Mill Court, Suite 103, Springfield, VA 22152

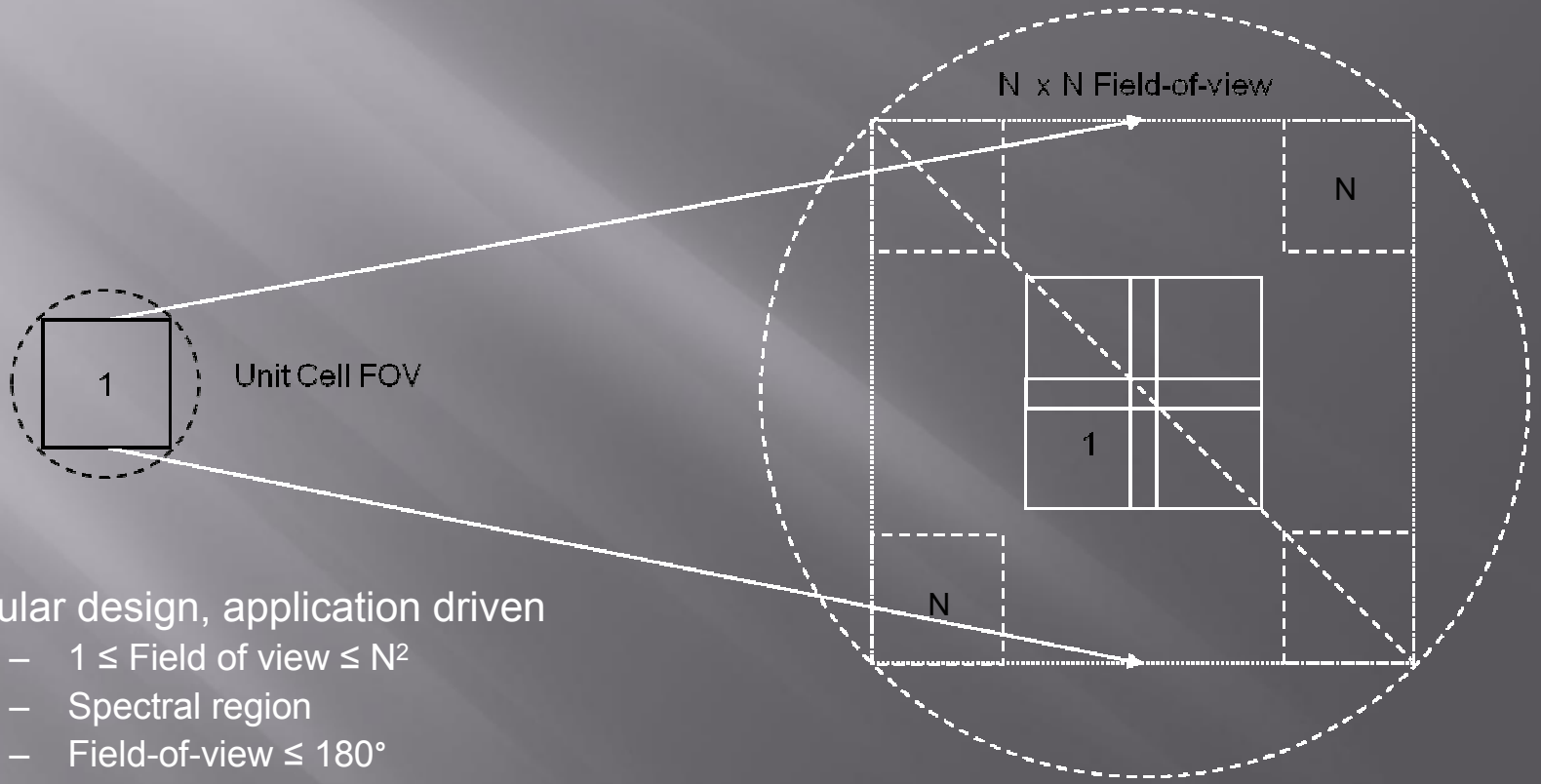
TOPICS

- A Reconfigurable FoV Camera
- High Aerial Density Camera Development
- Applications
- Future Work
- Conclusions

Optical Principles

- A unit cell optical sensor designed for application specific physical attributes
  - Spectral coverage
  - Information content
  - Linearity
  - Uniformity of response
- Replicate the unit cell N times to meet requirements
  - Total information content
  - Spatial coverage

Expand Camera Field of View

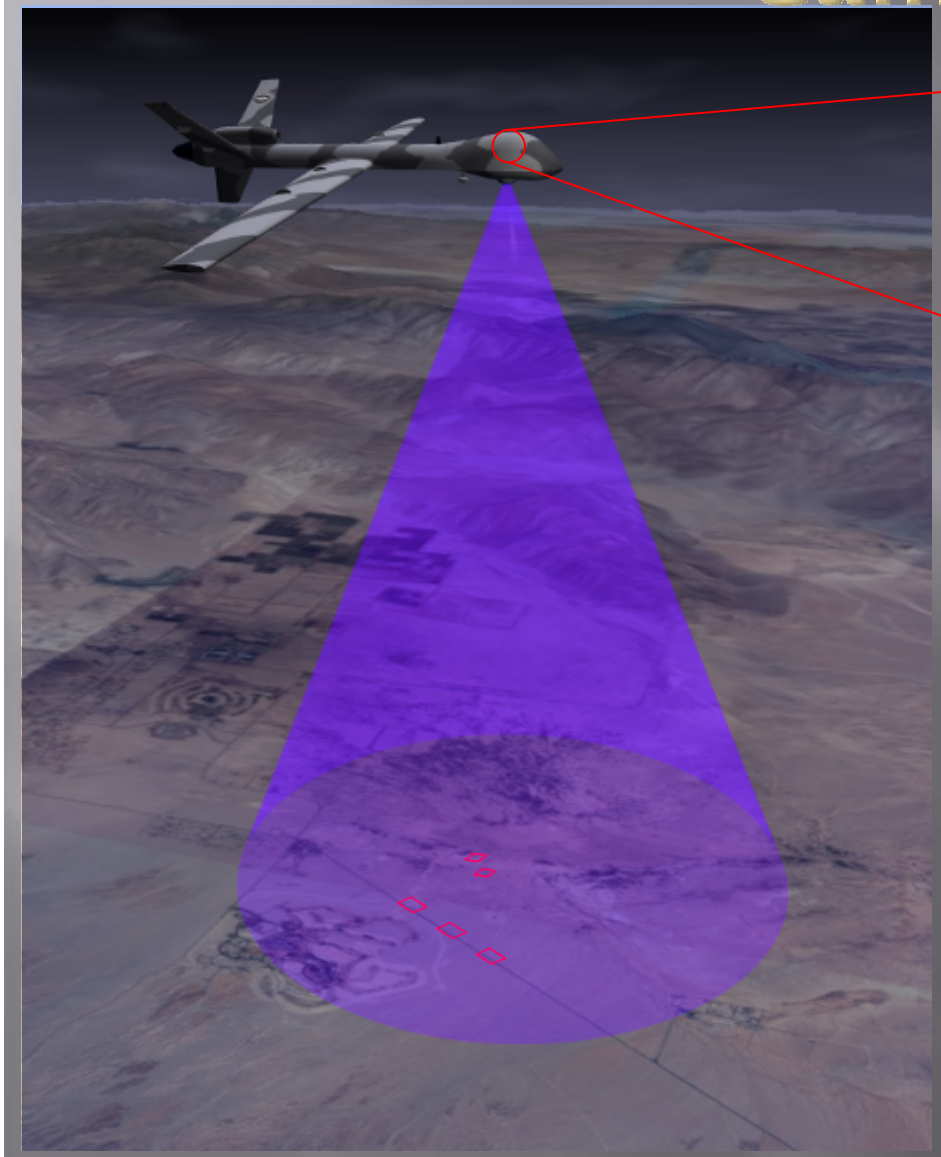


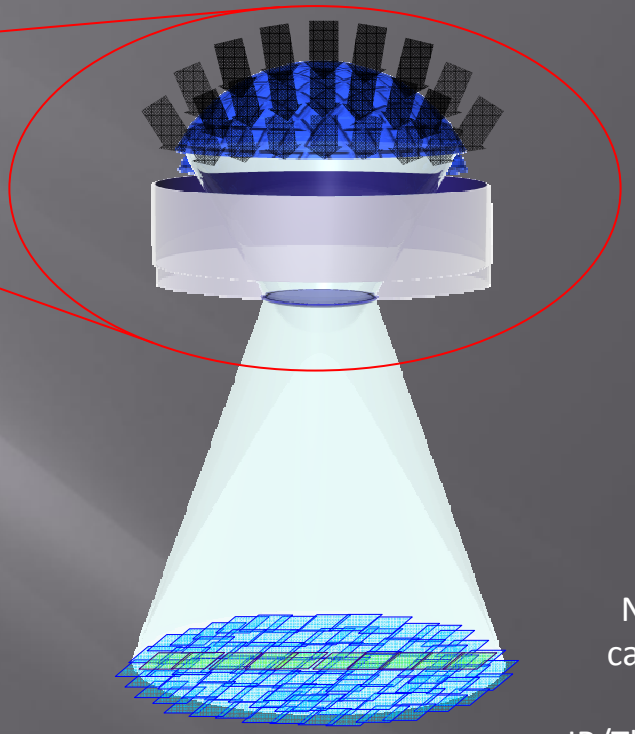
Modular design, application driven

- 1 ≤ Field of view ≤ N^2
- Spectral region
- Field-of-view ≤ 180°
- Sensor-to-sensor overlap, 0 - 100%

Patent Pending

High Areal Density Camera

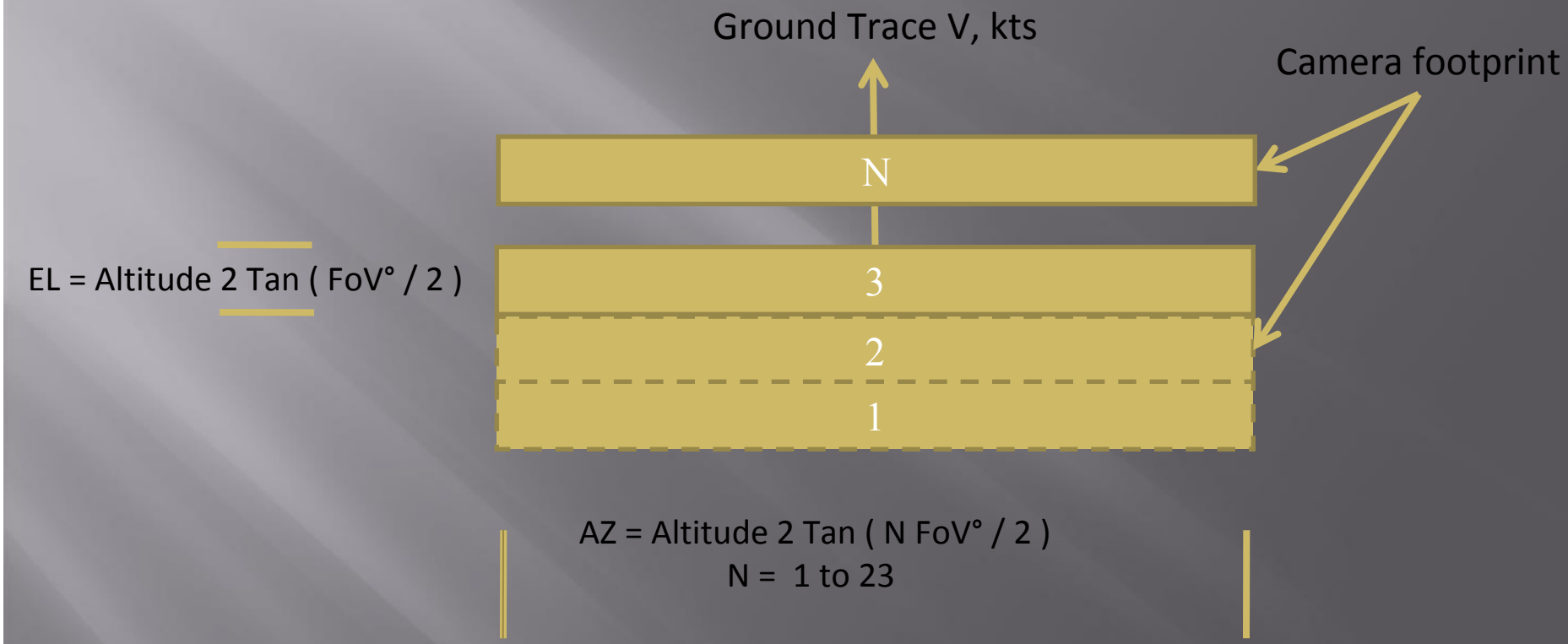




May be scaled and reconfigured to meet various coverage requirements and constraints

Near-future capability can include IR/Thermal, Object Tracking, Event Detection

Multi-spectral "Pushbroom"



Area Rate of Coverage = AZ * EL * Frame Rate, sq ft / s

The Camera System

Sensors

Air System

- Live video to multiple clients
- Stitching
- Image-based stabilization
- Compression
- Storage
- Custom hardware

Ground System

- Video viewer
- Control system
- Offline processing
  - Change detection
  - Full frame mosaics

CAO

3rd Party Air System

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Development

9/18/05
Knoxville, TN
7.6° x 7.6°, 4 Mp

2005

3/30/06
Milwaukee, WI
> 21°, 29 Mp

2006

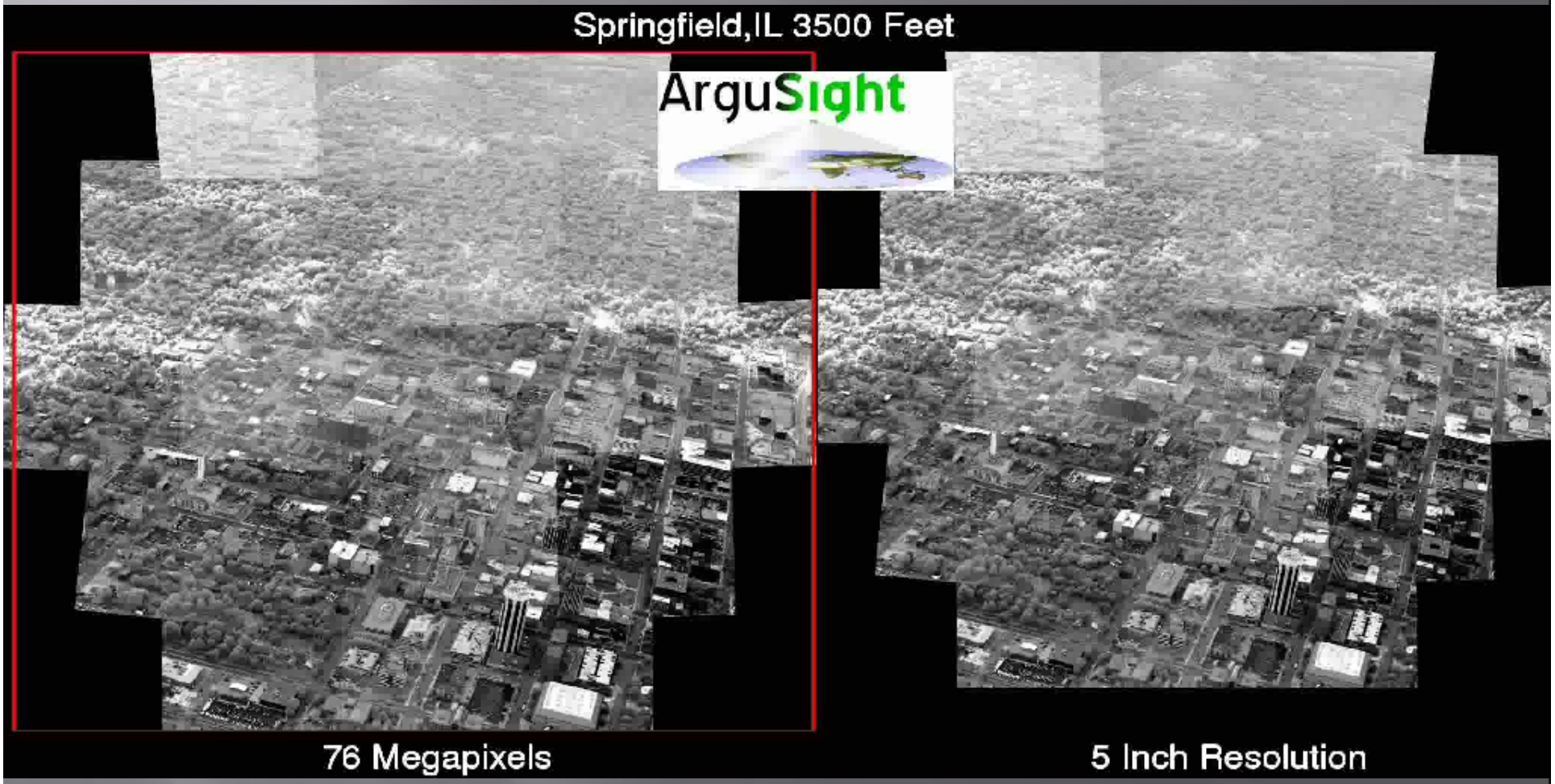
2007, 2008
Springfield, IL – FW
Yuma, AZ – FW & Rotary
> 35°, 80 Mp

2007

Fully
Operational
Data Collections

2008

Wide FOV
High Resolution Video Camera

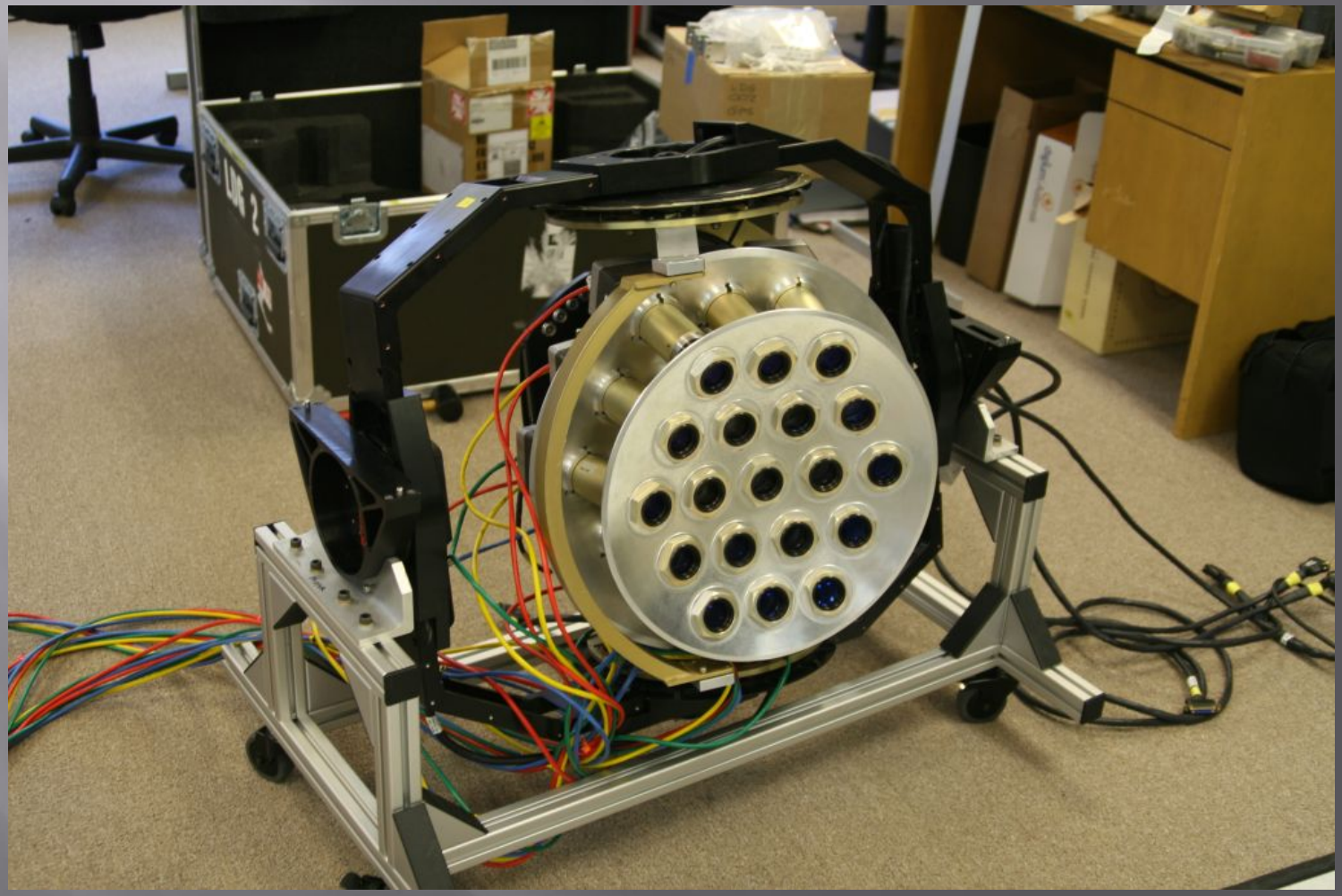


~.5 mile diameter

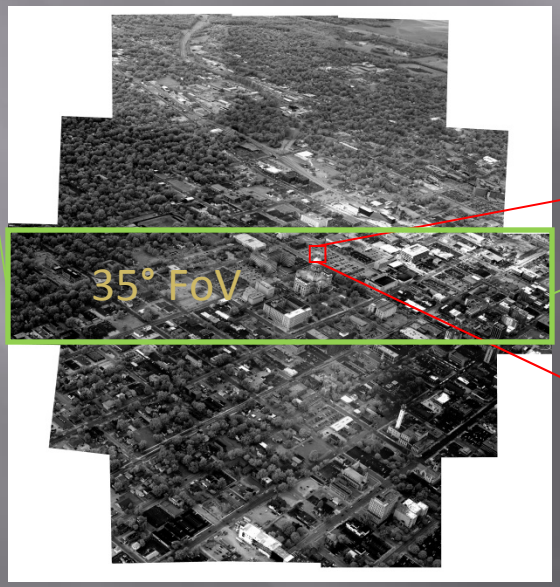
Helicopter, Image Stabilized w/o Gimbals

~ 1.2 mile diameter. *Note – blending not performed to highlight stitching

35° FoV, 80 Mp



Pushbroom Emulated 7.6° x 35° FoV Imagery

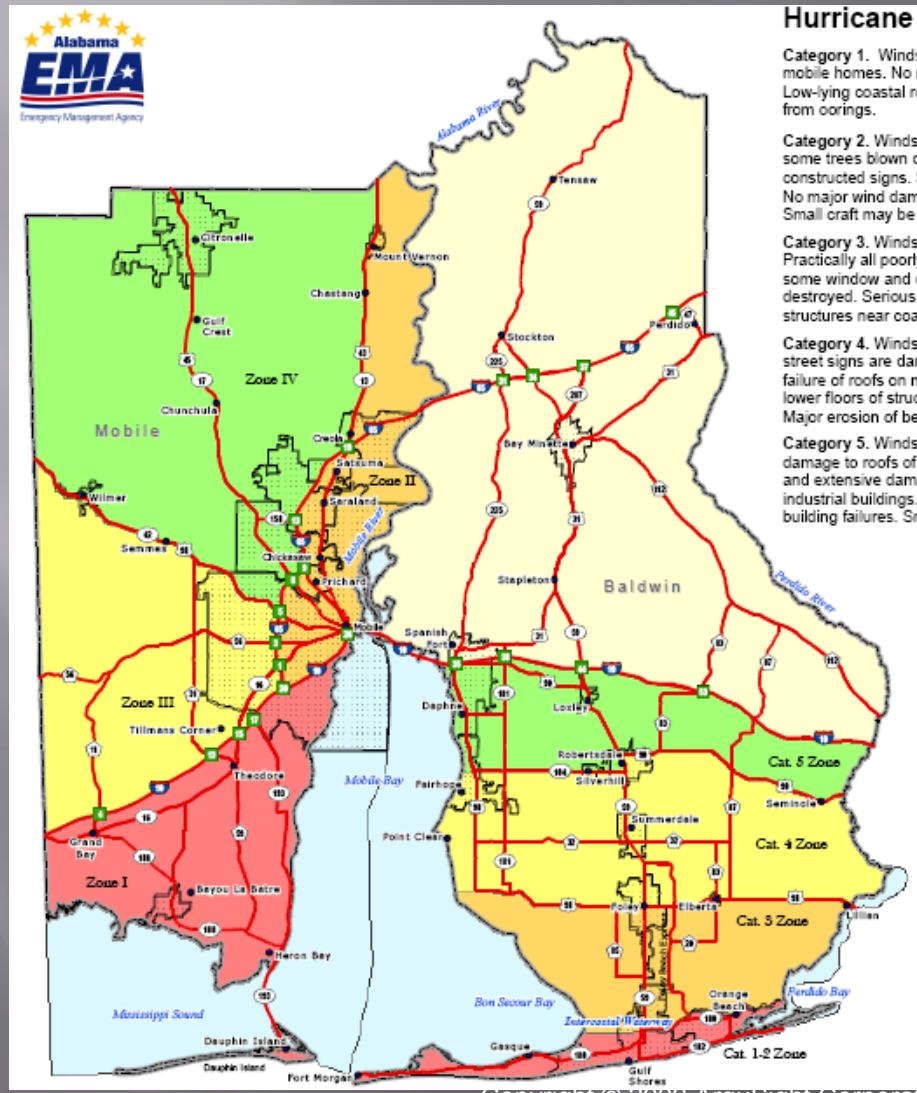


Digital Zoom, 23° off nadir

Observable Feature, Swath Width

Altitude	Observable Feature	Swath Width		
k ft, AGL	Inch	Ft	Mi	M
3	2.4	1.8E+3	0.35	6.E+02
4	3.2	2.4E+3	0.46	7.E+02
5	4.0	3.1E+3	0.58	9.E+02
6	4.8	3.7E+3	0.69	1.1E+3
7	5.6	4.3E+3	0.81	1.3E+3
8	6.4	4.9E+3	0.93	1.5E+3
9	7.2	5.5E+3	1.04	1.7E+3
10	8.0	6.1E+3	1.16	1.9E+3
11	8.8	6.7E+3	1.27	2.1E+3
12	9.6	7.3E+3	1.39	2.2E+3
13	10.4	7.9E+3	1.51	2.4E+3
14	11.2	8.6E+3	1.62	2.6E+3
15	12.0	9.2E+3	1.74	2.8E+3
16	12.8	9.8E+3	1.85	3.0E+3
17	13.6	10.4E+3	1.97	3.2E+3
18	14.4	11.0E+3	2.08	3.4E+3
19	15.2	11.6E+3	2.20	3.5E+3
20	16.0	12.2E+3	2.32	3.7E+3

Image EMA Evacuation Zones in Less than a day.



Hurricane Categories

ADECA
building better alabama communities
Alabama Department of Economic and Community Affairs

Category 1. Winds of 74 to 95 miles per hou
mobile homes. No real wind damage to other
Low-lying coastal roads inundated, minor pie
from oorings.

Category 2. Winds of 96 to 110 miles per ho
some trees blown down. Major damage to e
constructed signs. Some damage to roofing materials of buildings; some window and door damage. No major wind damage to buildings. Considerable damage could occur to piers. Marinas flooded. Small craft may be torn from moorings.

Category 3. Winds of 111 to 130 miles per hour. Foliage torn from trees; large trees blown down. Practically all poorly constructed signs blown down. Some damage to roofing materials of buildings; some window and door damage. Some structural damage to small buildings. Mobile homes destroyed. Serious flooding at coast and many smaller structures near coast destroyed; larger structures near coast damaged by battering waves and floating debris.

Category 4. Winds of 131 to 155 miles per hour. Many shrubs and trees are blown down and most street signs are damaged. Extensive damage to roofing materials, windows, and doors. Complete failure of roofs on many small residences. Complete destruction of mobile homes. Major damage to lower floors of structures near shore due to flooding and battering by waves and floating debris. Major erosion of beaches.

Category 5. Winds greater than 155 miles per hour. Shrubs and trees are blown down; considerable damage to roofs of buildings and all signs are damaged or destroyed. There would be very severe and extensive damage to windows and doors. Complete failure of roofs on many residences and industrial buildings. Extensive shattering of glass in windows and doors would occur. Some complete building failures. Small buildings overturned or blown away. Complete destruction of mobile homes.

Hurricane Evacuation Zones

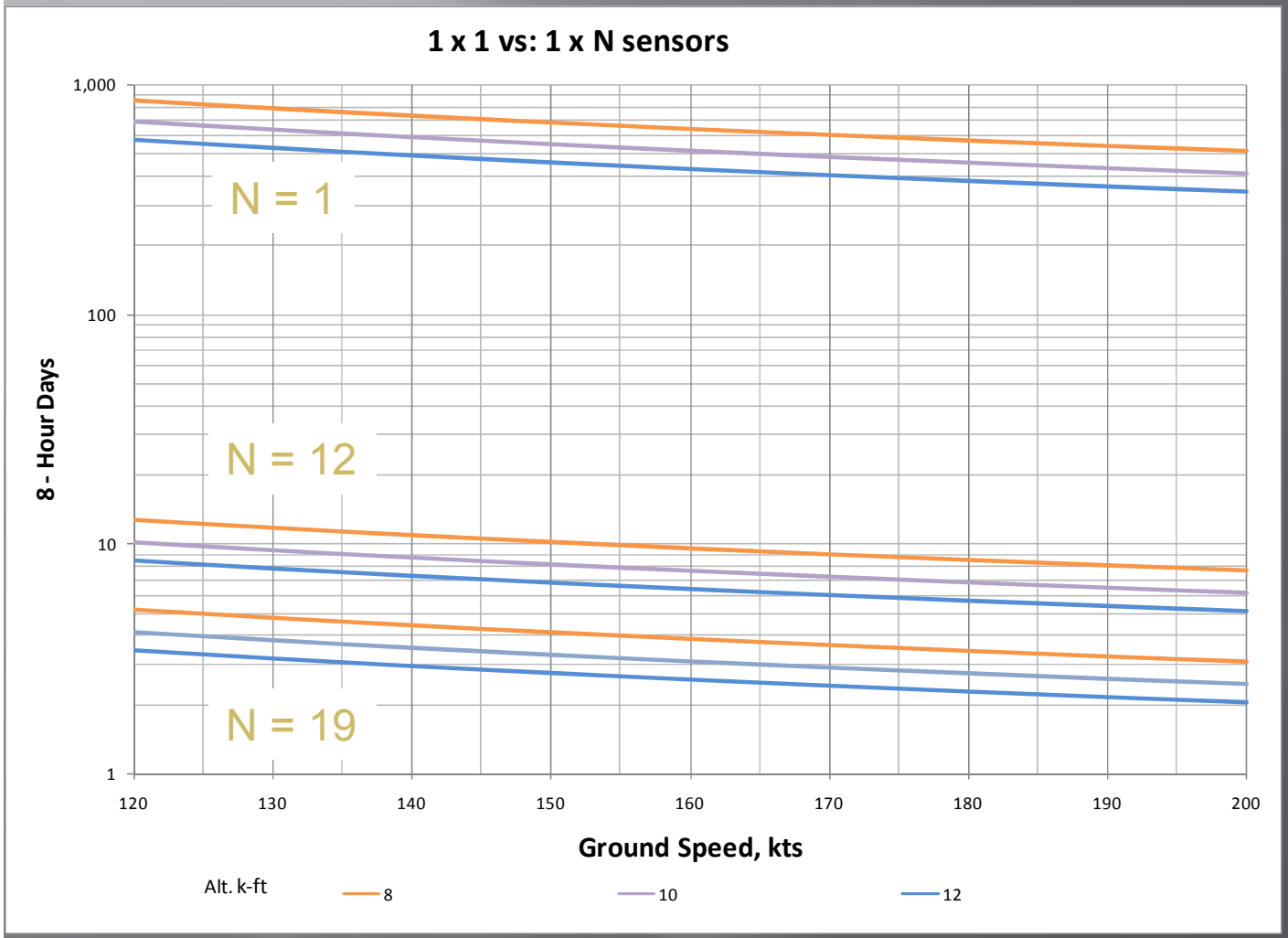
Mobile

Zone I South of Interstate 10	**Zone II** North of Interstate 10 East of Interstate 65 East of US 43
Zone III North of Interstate 10 South of US 98 West of Interstate 65	**Zone IV** North of US 98 West of Interstate 65 West of US 43

Baldwin

Category 1-2 Zone South of Intercoastal Waterway	**Category 3 Zone** South of US Highway 98
Category 4 Zone South of State Route 104 East of State Route 59 from AL-104 north to US-90 South of US Highway 90	**Catagory 5 Zone** South of Interstate 10

Image Entire State in Days not Years



State Area = 52,423 Sq miles
Camera = 7.6 ° x N
Endlap = 50%
Overlap = 30%
Array overlap = 10%
Swath Width = 0.4, 6.4, 15.7 km

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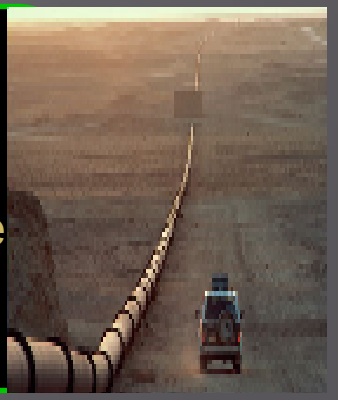
Stationary or In Motion

Disaster Response

Border Security

Critical Infrastructure



Port Security

Special Security Events

Counter Terrorism

Multiple Platforms

Fixed Wing

UAV

UAV

Rotary Wing

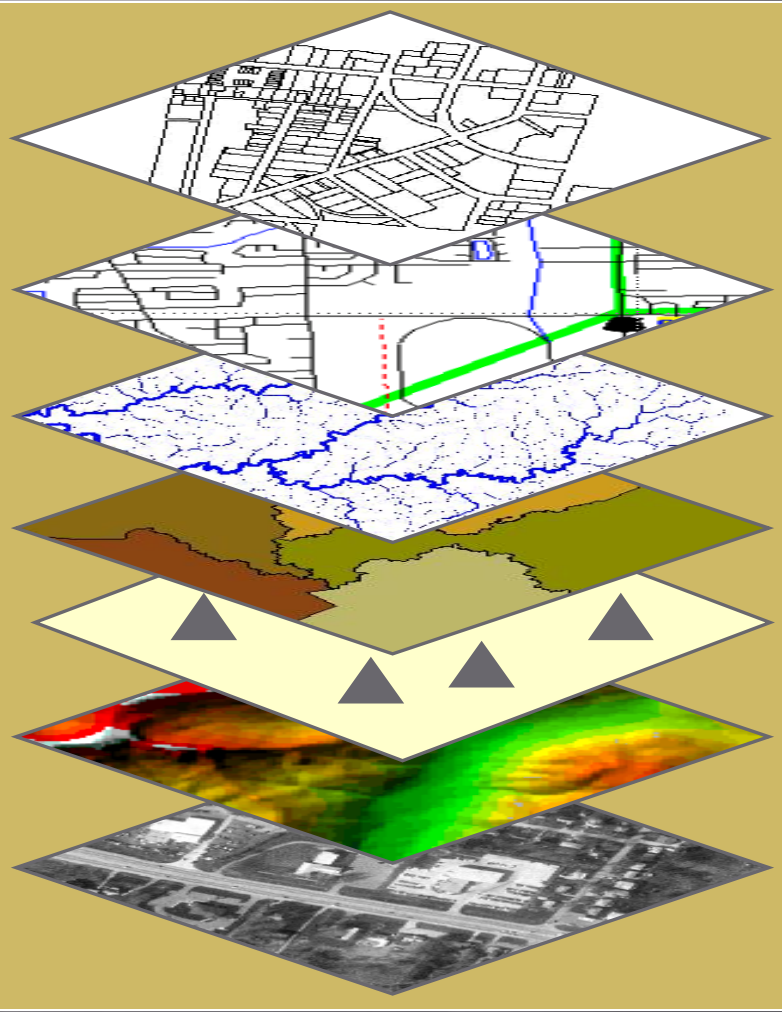
Air Ship

Aerostat

Potential Benefactors

- Department of Revenue
- Department of Transportation
- Department of Economic and Community Affairs
- FEMA and State Emergency Management
- Environmental Management
- Conservation and Natural Resources
- Department of Finance
- Regional Development Councils
- U.S. and State Geological Survey
- U.S. and State Department of Agriculture
- U.S. and State Department of Homeland Security

GIS Input



Land Ownership

Transportation

Surface Waters

Boundaries

Geodetic Control

Elevation

Aerial Imagery

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Continue Development

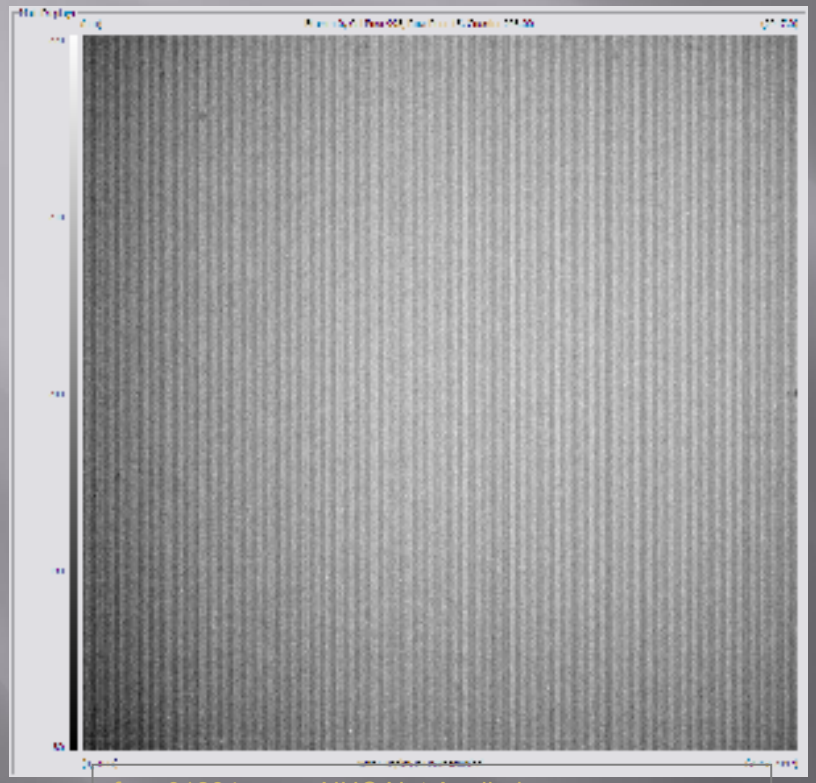
- Local Flight Demonstration
- Miniaturize Camera
- Incorporate color
- Calibrate Camera
- Tailor functionality to specific requirements.

Remove Correlated Errors

- GIS Compatibility
- Mapping Linearity Uncertainty 1-σ, μr-$Hz^{-½}$
  - Corrected, 35 μr
  - Uncorrected, 55 μr
- Data non-uniformity, Precision 1-σ
  - Corrected, 3%
  - Uncorrected, 11%
- Data SI Traceability pending complete calibration.

Non-Uniformity Correction

NUC applied pixel-by-pixel to “middle” level frame (frm_01284.pgm)
Middle is in quotes because its statistical characteristics are actually very near the high level file



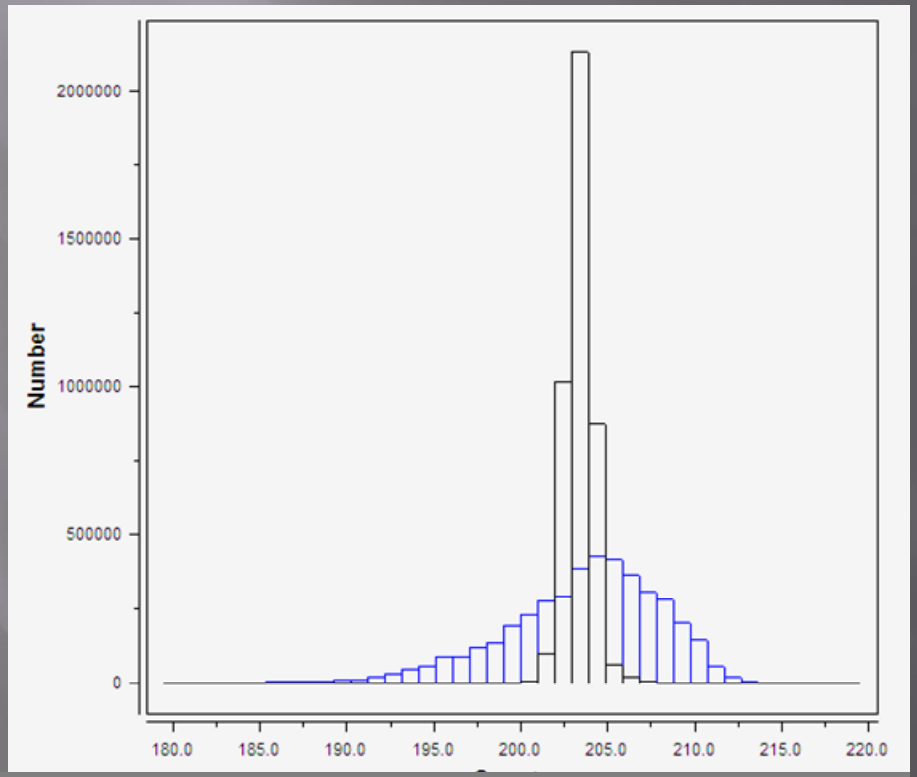
frm_01284.pgm –NUC Not Applied
Color scale: 180-220 counts
Over Full Array - Mean: 204.23 Stdev: 4.43

frm_01284.pgm –NUC Is Applied
Color scale: 180-220 counts
Over Full Array - Mean: 204.23 Stdev: 0.79

Note the 82% reduction in the standard deviation

"Before and After" Comparison

Histograms full array. Blue: w/o NUC, Black: w / NUC Applied
NUC applied pixel-by-pixel to "middle" level frame (frm_01284.pgm)



Without NUC - Mean: 204.23 Stdev: 4.43
With NUC - Mean: 204.23 Stdev: 0.79

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Conclusion

- A respected team of Corporate, State and University personnel are contributing to the development.
- Correlated errors correctable.
- Versatile, accurate and supports multiple applications.
- Information content uniform .
- Large areas mapped in days instead of years.

Acknolwedgements

- The Alabama Department of Economic and Community Affairs
- Frontier Technology Incorporated