Coherent Ladar FPA

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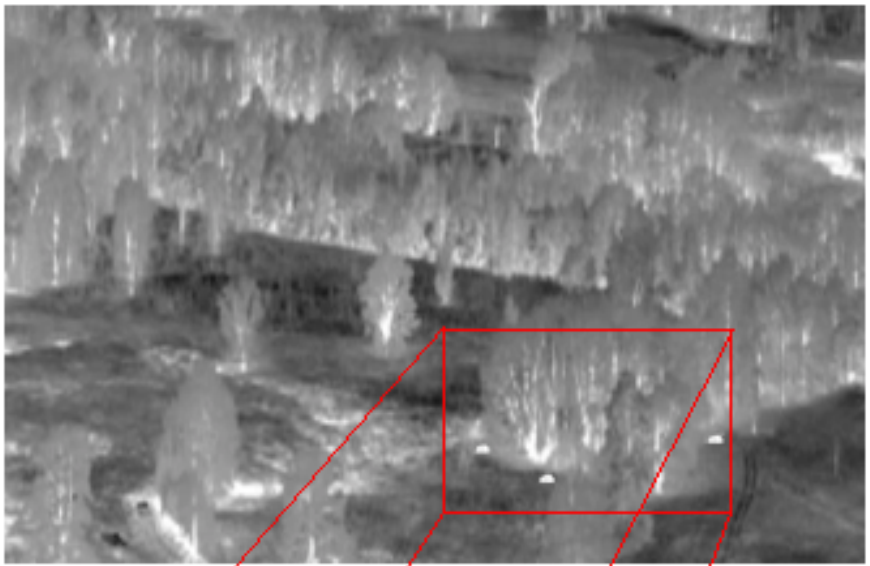
Background

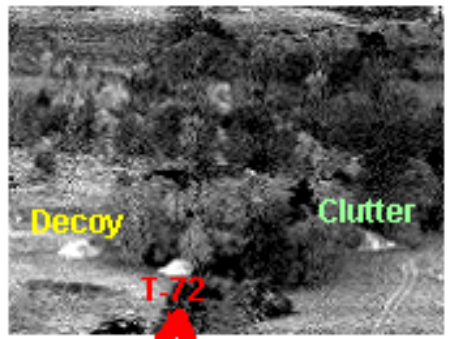
- **EO Combat ID Technology Branch:** *Developing active sensing technologies for the combat identification mission*

- **Active Sensing:** *Development, test, and evaluation of ladars, including 1-D, 2-D, 3-D, and vibration*

- **Coherent FPA:** *Developing both single and multi-mode coherent FPA since 1998*

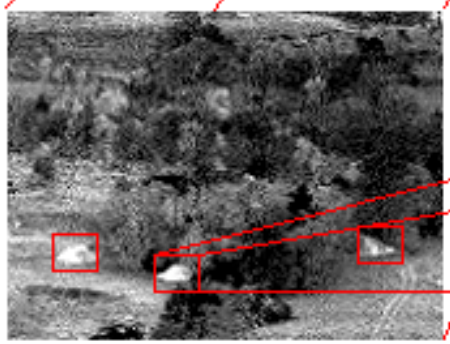
Coherent Sensing Concept



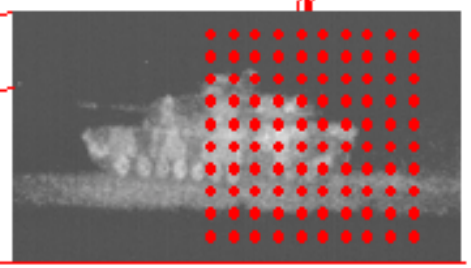


Using multiple discriminates results in high-confidence CID

Search sensor detects and cues



Coherent ladar interrogates cues



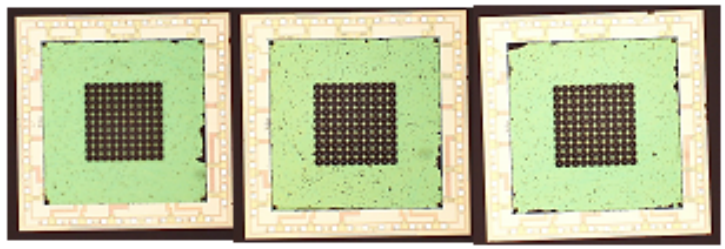
Coherent FPA Approaches

- ***Single–mode**, multiple pixel coherent vibration ladar*
  - *Spatial array of coherent samples; "vibration image"*
  - *May improve ID of vehicles in deep-hide or urban environment*
  - *Possible to detect vehicle signature on ground or structure nearby*
  - *Improve from single pixel to small area search*
- ***Multi-mode**, non-literal and imaging ladar*
  - *Vibration and 2-D ladar (maybe 3-D, flir, or MS)*
  - *Spatially registered multiple signatures*
  - *Using imaging detection, cue and point coherent detectors for identification*

Existing Coherent FPA Projects

- **Single-mode coherent FPA:** *(Phase II SBIR)*
  - *10X10 array, 160 um pitch*
  - *x-InGaAs array bump bonded to ROIC*
  - *Nearly complete*
- **Dual-mode direct/coherent FPA:** *(Phase II SBIR)*
  - *15x15 array with 3x3 coherent, 50 um pitch*
  - *InGaAs array bump bonded to ROIC*
  - *First ROIC foundry run complete*
- ***In-House Project:*** *Establishing a coherent FPA test capability to support detailed evaluations*

Single-Mode Coherent FPA



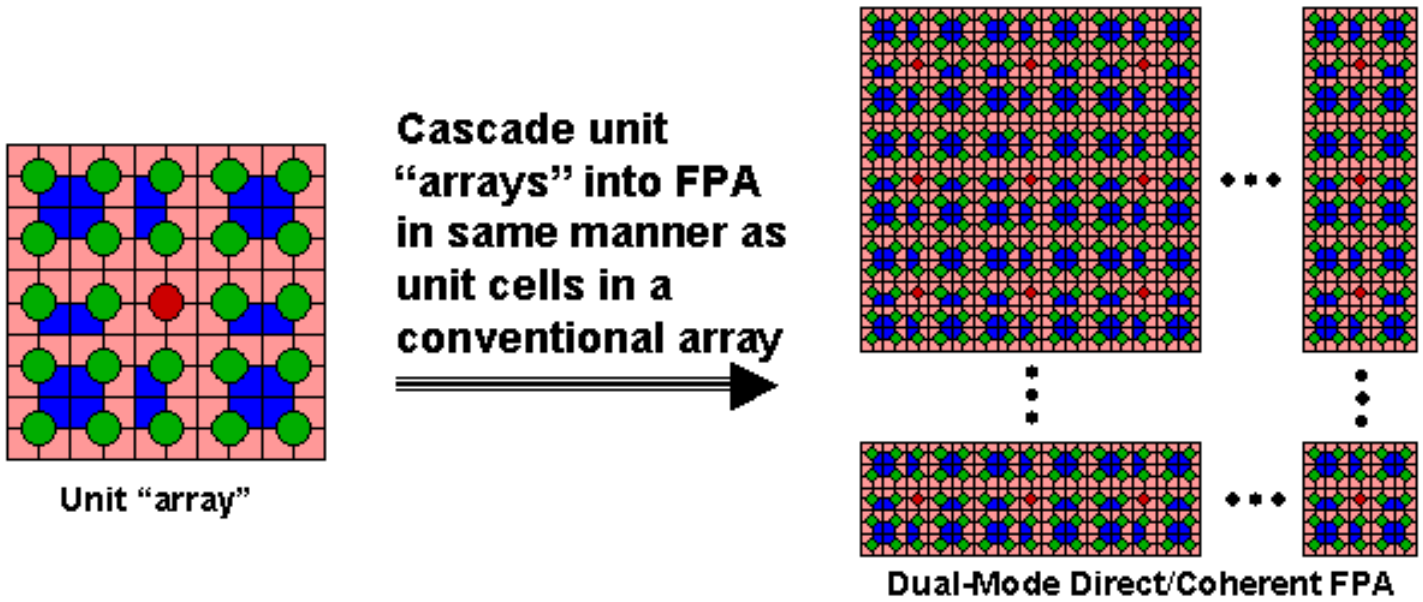
First Three Hybrid x-InGaAs Coherent FPA

- *Developed under a SBIR Phase II with Coherent Technologies, Inc.*
  - *ROIC subcontracted to Advance Scientific Concepts*
- *Based on the SULAR architecture funded by the Navy*
- *12 FPA hybridized, 10X10 array of x-InGaAs*
  - *6 with lenslets, 6 without (address low fill factor)*
  - *6 AC coupled, 6 DC (address high MO power)*
- *32 time samples per waveform (programmable), 400 MHz sample rate*
- *Initial tests successful, more complete testing over next year*

Single-Mode Coherent FPA Challenges

- *Detector size versus unit cell size*
  - *Very low fill factor*
- *Timing clock jitter and drift*
  - *Timing errors equate to phase error*
- *MO consuming unit cell's dynamic range*
  - *For our configurations about 1 mW MO CW*
- *Number of waveform samples*
  - *Here more is better; > 100 samples per waveform*
  - *Programmable sampling pattern per waveform*
- *Each detector requires an independent sampling trigger to accommodate the varying range across the FOV*

Multi-Mode Coherent FPA



- *15X15 InGaAs array, uniform 50 um pitch*
  - *3X3 coherent cells every 5th cell*
- *100 um coherent ROIC unit cells mixed with 30 um direct detection ROIC unit cells in a non-uniform array*

Multi-Mode Coherent FPA Challenges

- *Direct and coherent unit cell sizes different*
  - *Uniform detector pitch needed for imaging mode*
- *Coherent versus imaging detectors*
  - *Coherent needs fast response = high dark current*
- *Timing jitter and drift*
  - *Timing errors equate to phase error*
- *MO consuming unit cell's dynamic range*
  - *For our configurations about 1 mW MO CW*
- *Number of waveform samples*
  - *Here more is better; > 128 samples per waveform*
  - *Programmable sampling pattern per waveform*
- *Each detector requires an independent sampling trigger to accommodate the varying range across the FOV*

In-House Coherent Test & Evaluation

- *Establish an in-house coherent FPA test capability*
- *Provide an independent government evaluations*
- *Support in-house research*
- *Approach*
  - *Start with residuals from 10X10 coherent FPA contract*
  - *Build upon base to include programmable stimulus and acquisition electronics, as well as, pulsed and CW transmitters*
- *Funding and staffing established for FY04*
- *First test results in March 04*

Top Level Requirements

- **Sampling Rate (0.5 GHz or better):** *For our doublet pulse configuration, multiple samples across the two about 7nS pulses separated by about 100 uS are required*
- **Intensity Knowledge (8-bit??):** *The return shape is needed to support matched filter signal processing*
- **Handle High MO Powers (10 times return):** *For our systems the return is mixed with about a 1 mW MO*
- **Programmable Sampling Windows:** *It is more desirable to obtain dense sampling only during the return pulses*

Summary

- ***AFRL/SNJM pursuing coherent arrays since 1998***
- ***Single pixel ladar developments can be leveraged when coherent FPA ready***
- ***Limited funding; using SBIR process***