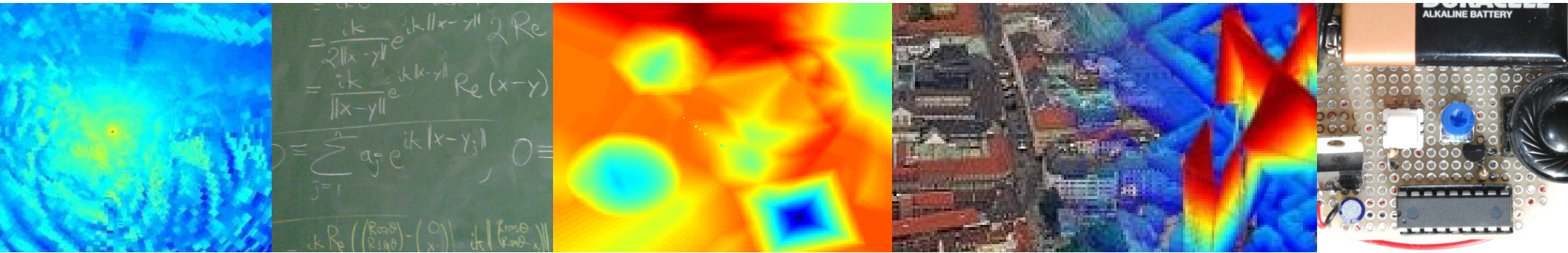


# Research Overview

Fall 2011



Michael Robinson



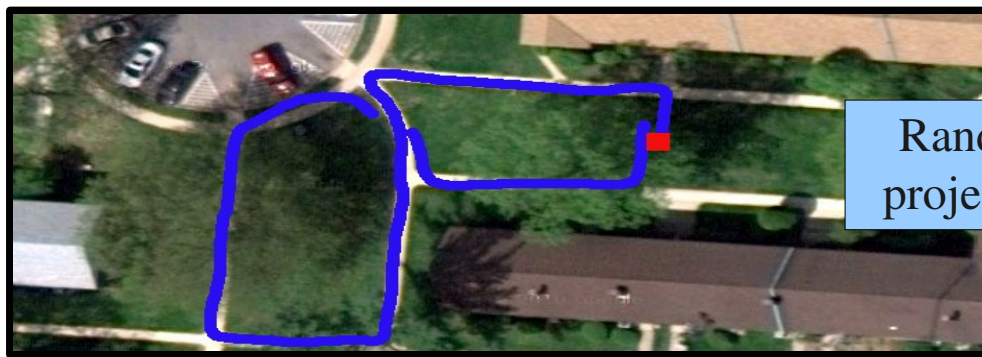
# Active projects & collaborators

---

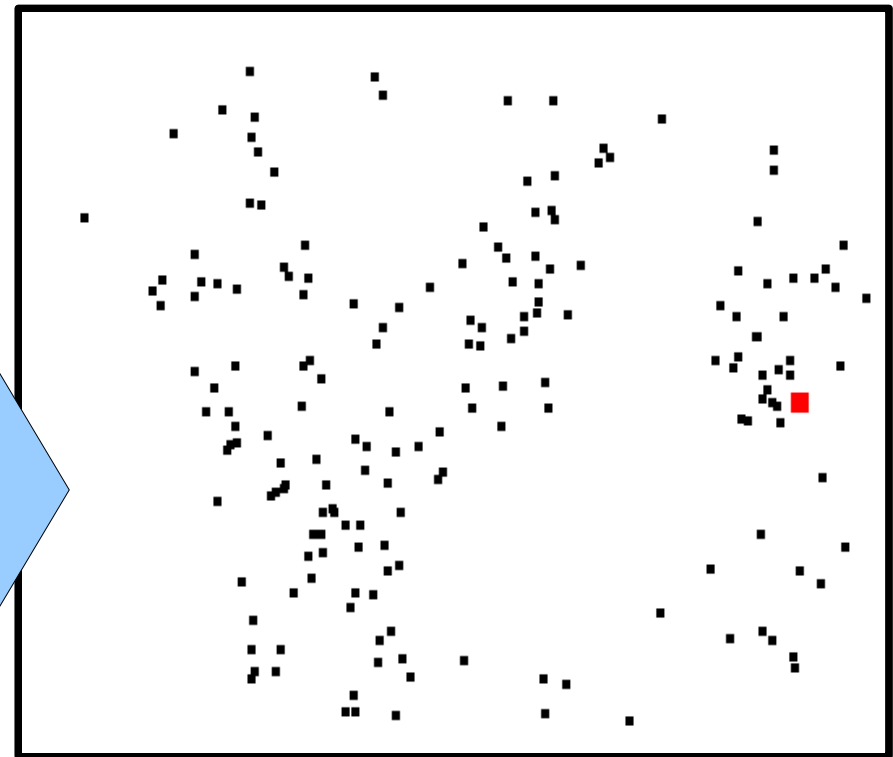
- Topological imaging (DARPA, Penn)
  - Robert Ghrist (Penn)
  - Hank Owen (H.S. Owen, LLC)
  - Rafal Komendarczyk (Tulane)
- Asynchronous networks (DARPA, AFOSR)
  - Robert Ghrist (Penn)
  - Yasu Hiraoka (Kyushu)
  - Justin Curry (Penn)
- Euler calculus & signal processing (DARPA, ONR)
  - Robert Ghrist (Penn)
  - Yulij Baryshnikov (UIUC)
- Compressive sensing & radar (planning stages)
  - Robert Calderbank (Duke)
  - Waheed Bajwa (Rutgers)
  - SRC, inc.

# Topological imaging

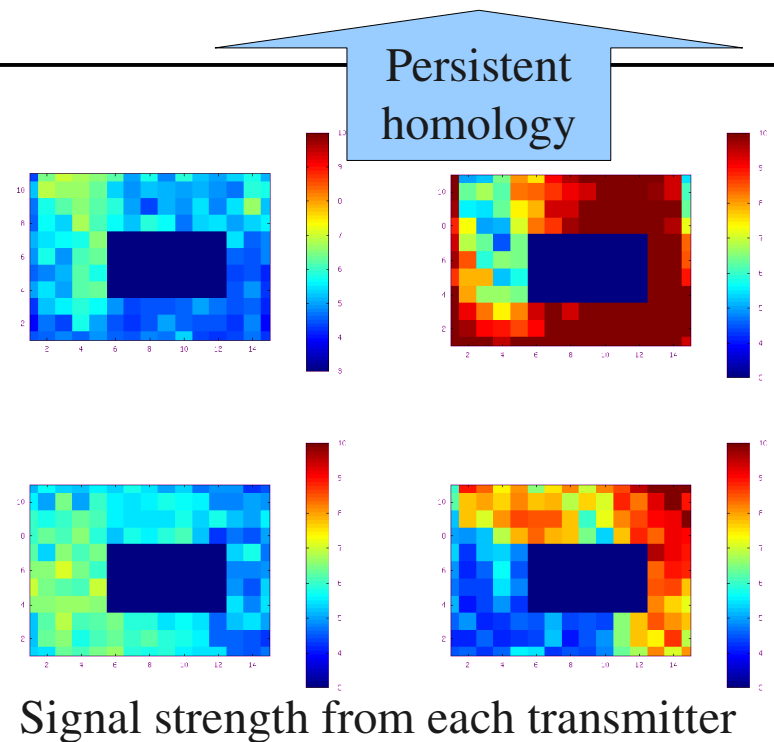
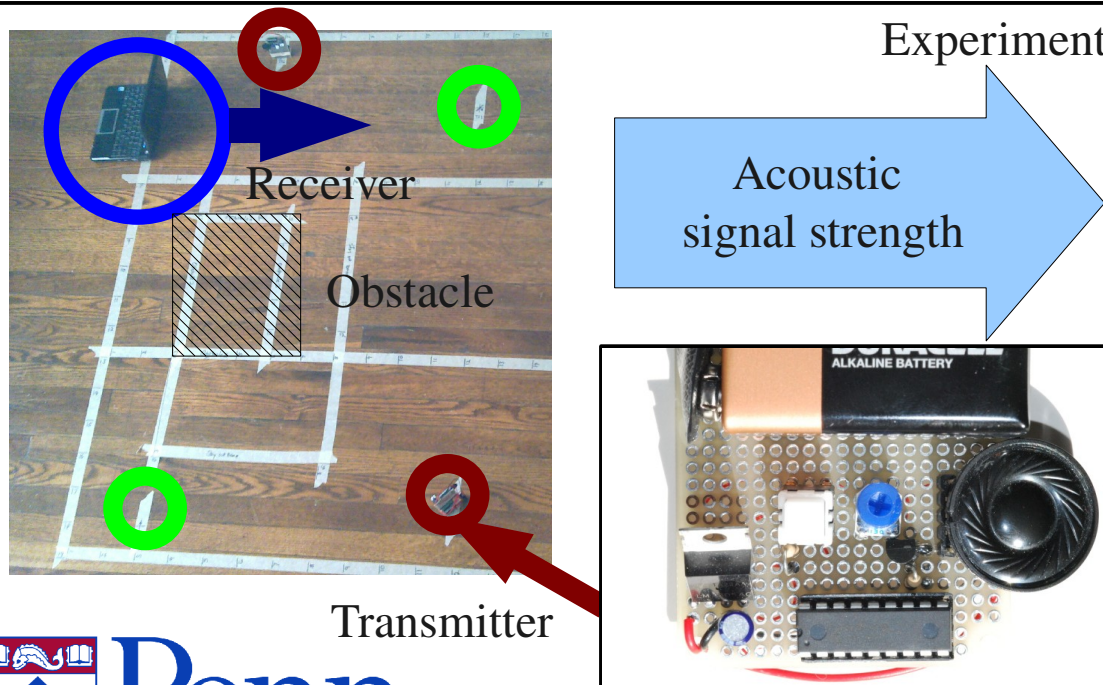
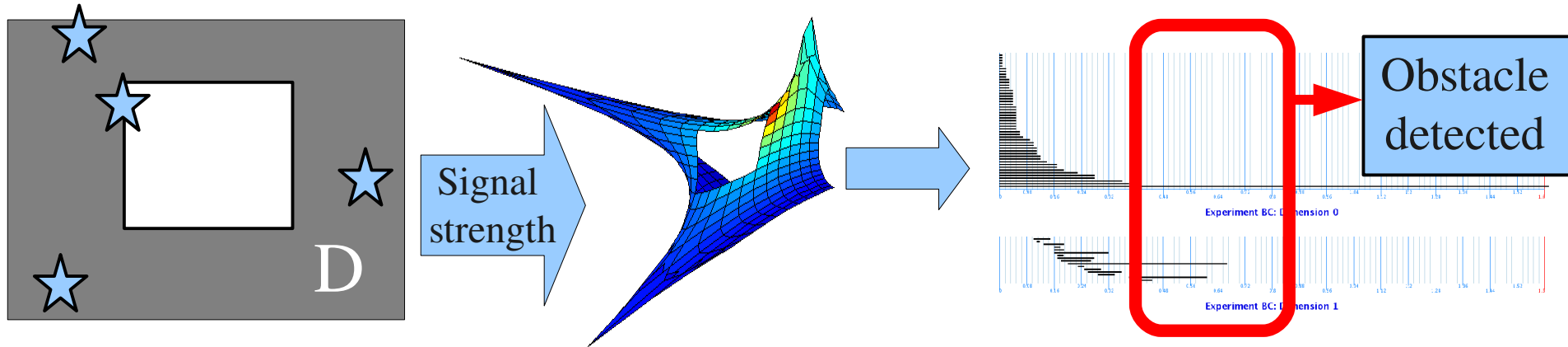
- Goal: measure environment and targets with minimal sensing and opportunistic sources
- Key theoretical guarantees proven
- First generation algorithms
  - Simulated extensively
  - Validated experimentally



(image courtesy of Google)

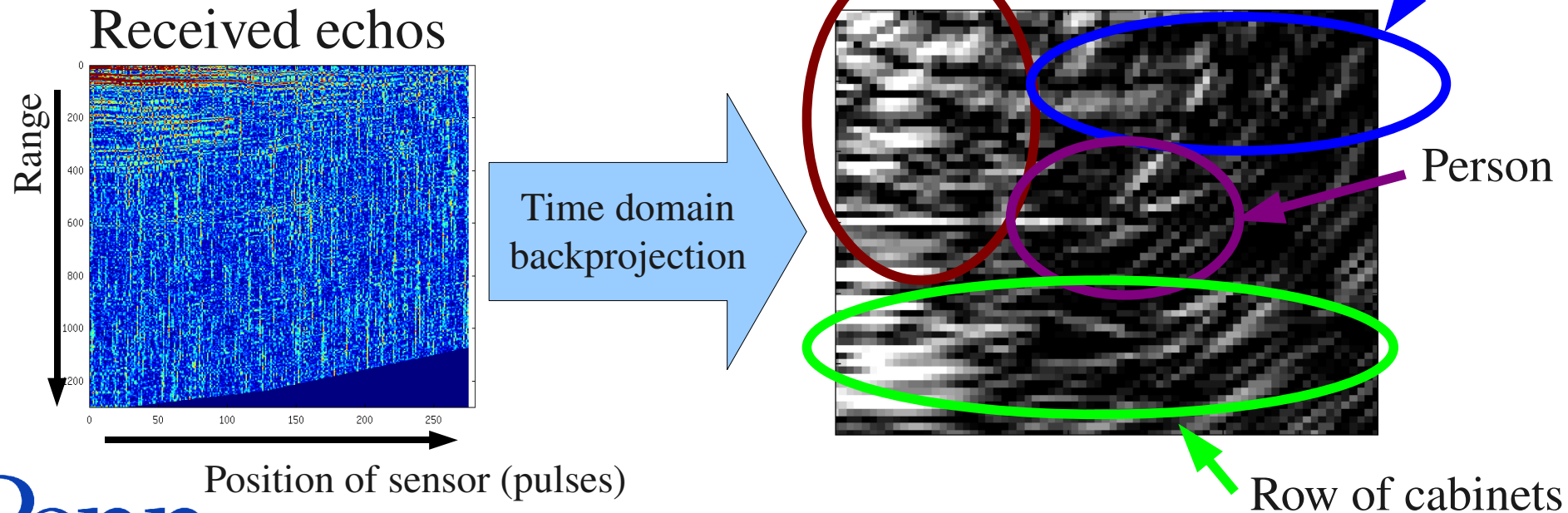


# Topological imaging (cont'd)



# Aside: acoustic imaging

- My acoustic gear is good enough to form bistatic images! (assuming known positions)
  - Transmitter: cellphone with tailored ringtone
  - Receiver: netbook sitting on table
  - Environment: my kitchen



# Asynchronous logic

- Goal: detect semantic behavior structurally, without simulation
- Discovered a suitable invariant
  - Can detect glitches and latching

$H^0(X;F)$  is generated by

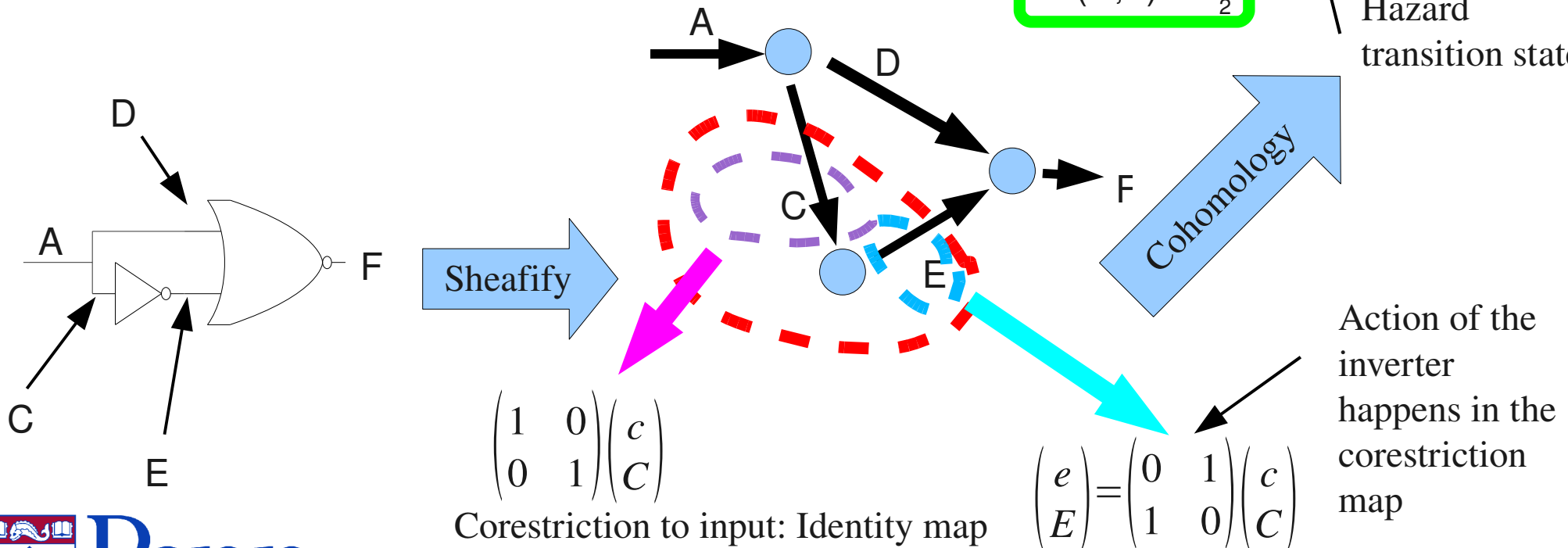
$$\begin{pmatrix} A+C+D \otimes e \\ a+c+d \otimes E \end{pmatrix}$$

The usual “stable” states

$$A+a+C+c+d \otimes e + D \otimes E$$

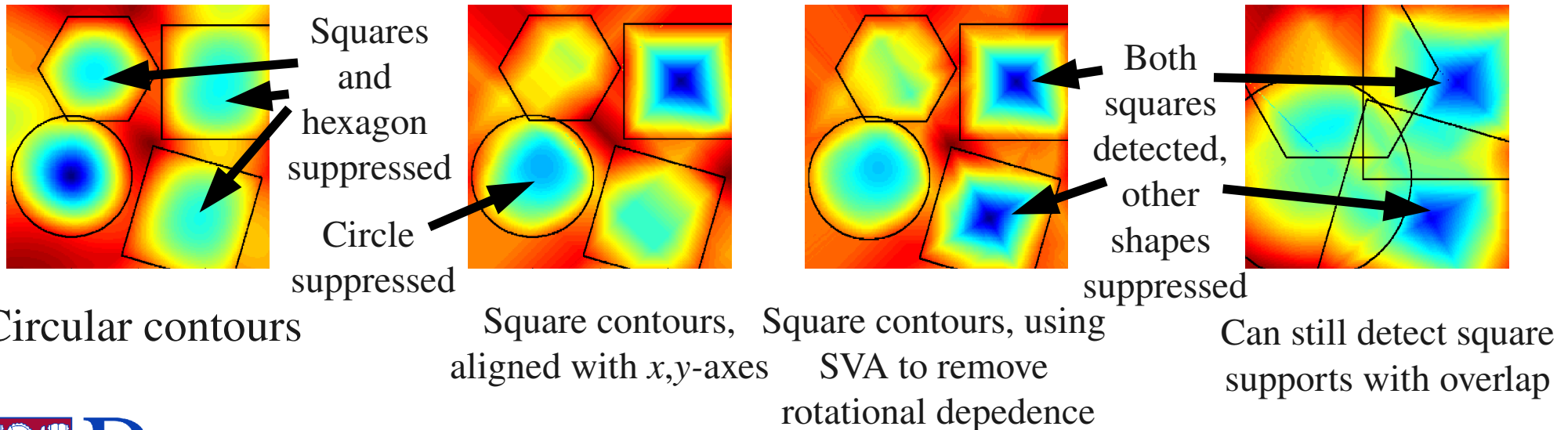
$$H^1(X;F) \cong \mathbb{Z}_2$$

Hazard transition state



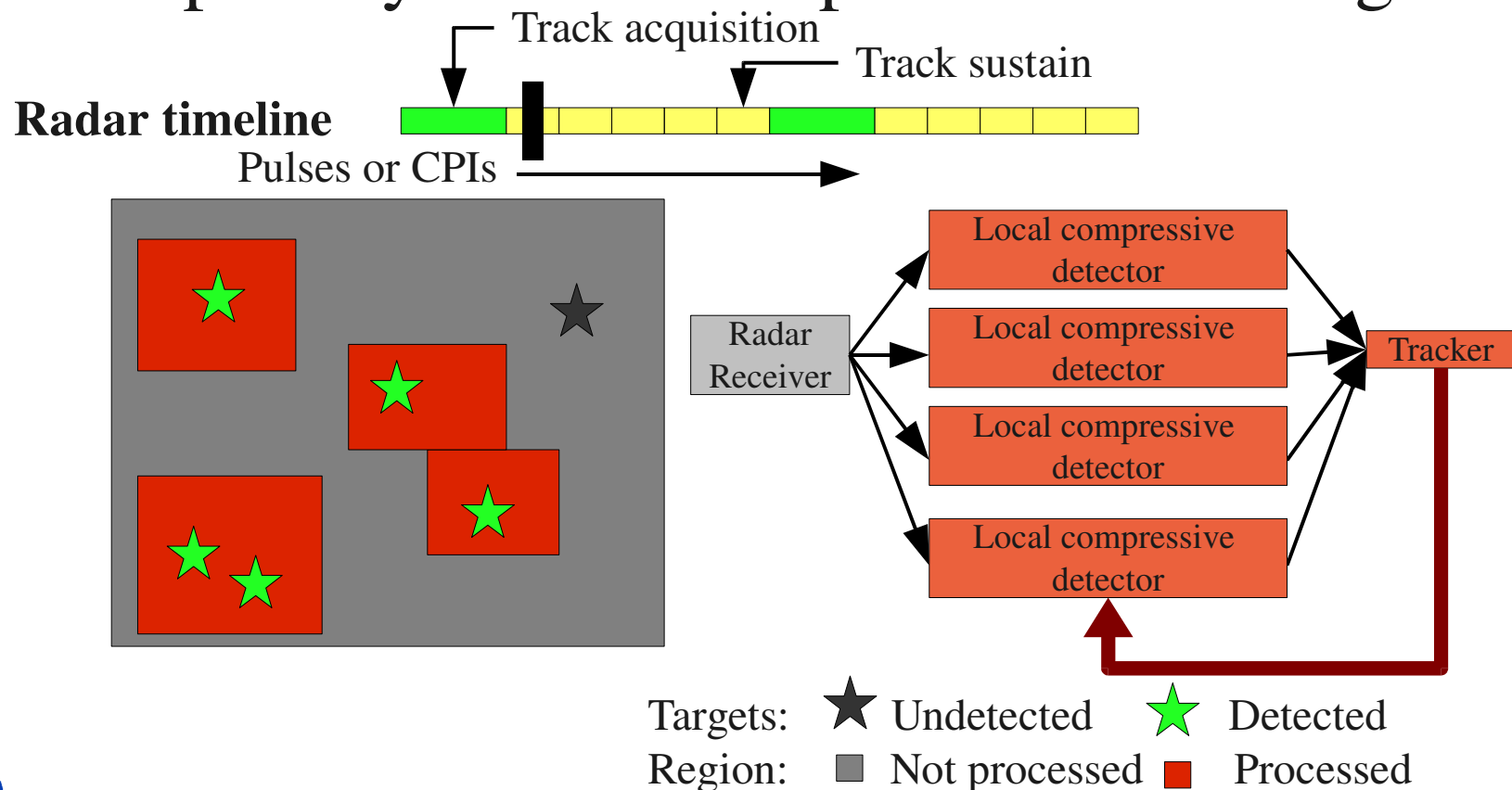
# Euler signal processing

- Exploit very new results in the Euler calculus
  - A new theory of integration (discovered in 1970s)
- Integral transforms discovered for
  - Shape detection that ignores underlying coordinates
  - Coordinate-free localization



# Compressive sensing & radar

- Goal: reduce computational load of track sustainment
  - Free up timelines for other processing
- Tool: Spatially focused adaptive thresholding



# For more information

---

Michael Robinson

[robim@math.upenn.edu](mailto:robim@math.upenn.edu)

[mrobinson@srcinc.com](mailto:mrobinson@srcinc.com)

Preprints and demos available from my website:

<http://www.math.upenn.edu/~robim>