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Preliminary design review

Final Project: GPS

System Level Signal Flow

Incoming Signal → Coarse Acquisition → Code Tracking / Carrier Tracking

Output:
- Nav Data

System Level Signal Flow

Incoming Signal

Coarse Acquisition

Code Tracking

Carrier Tracking

Send to Tracking:
- Incoming Signal
- Code Phase
- Doppler
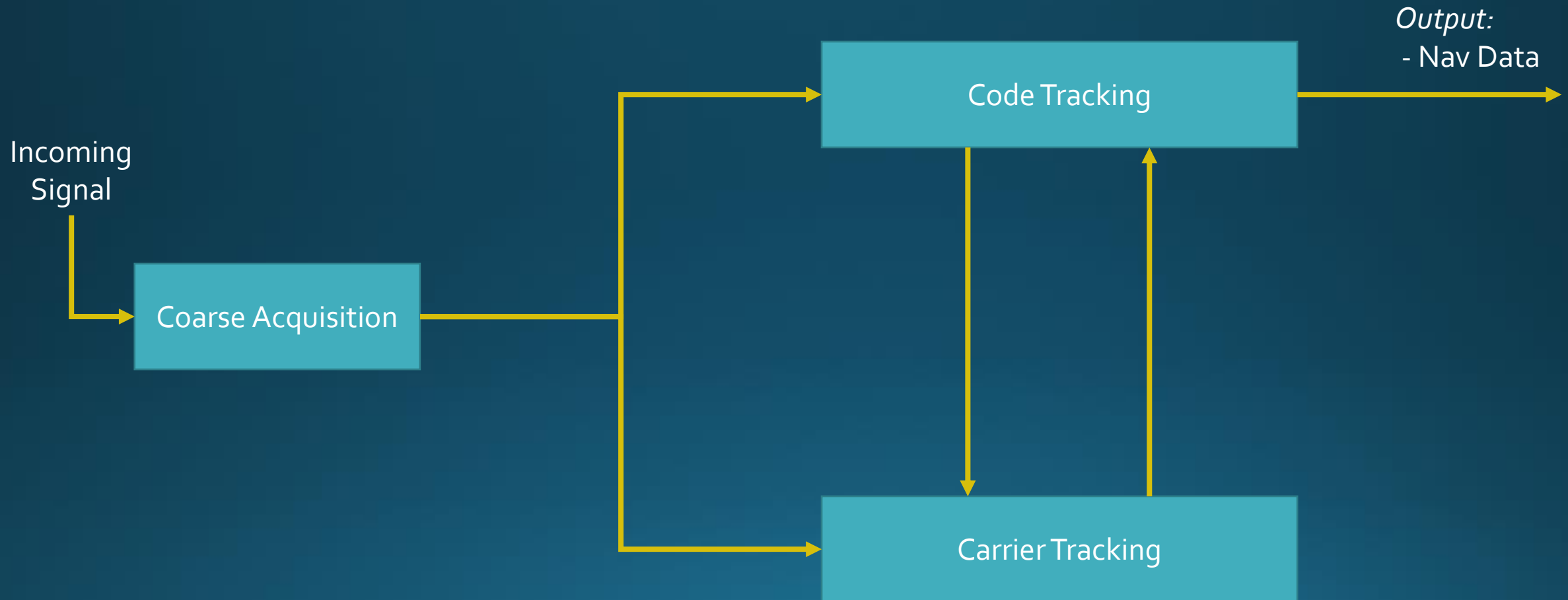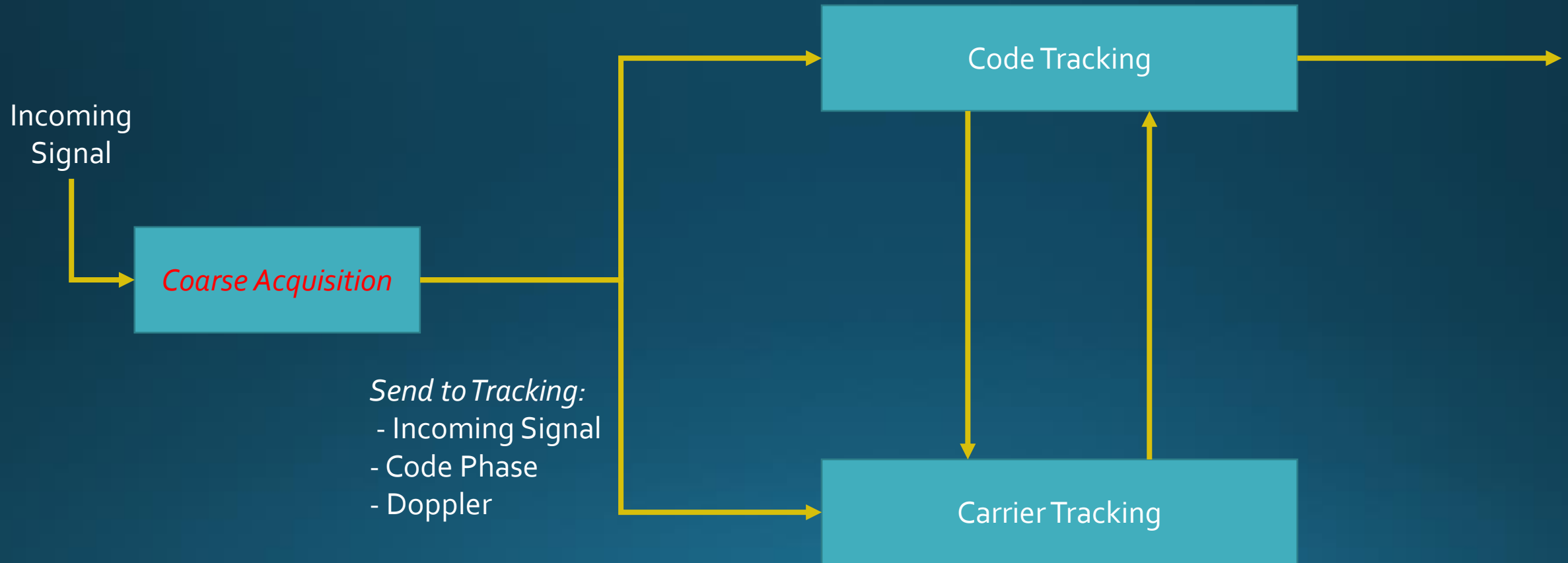
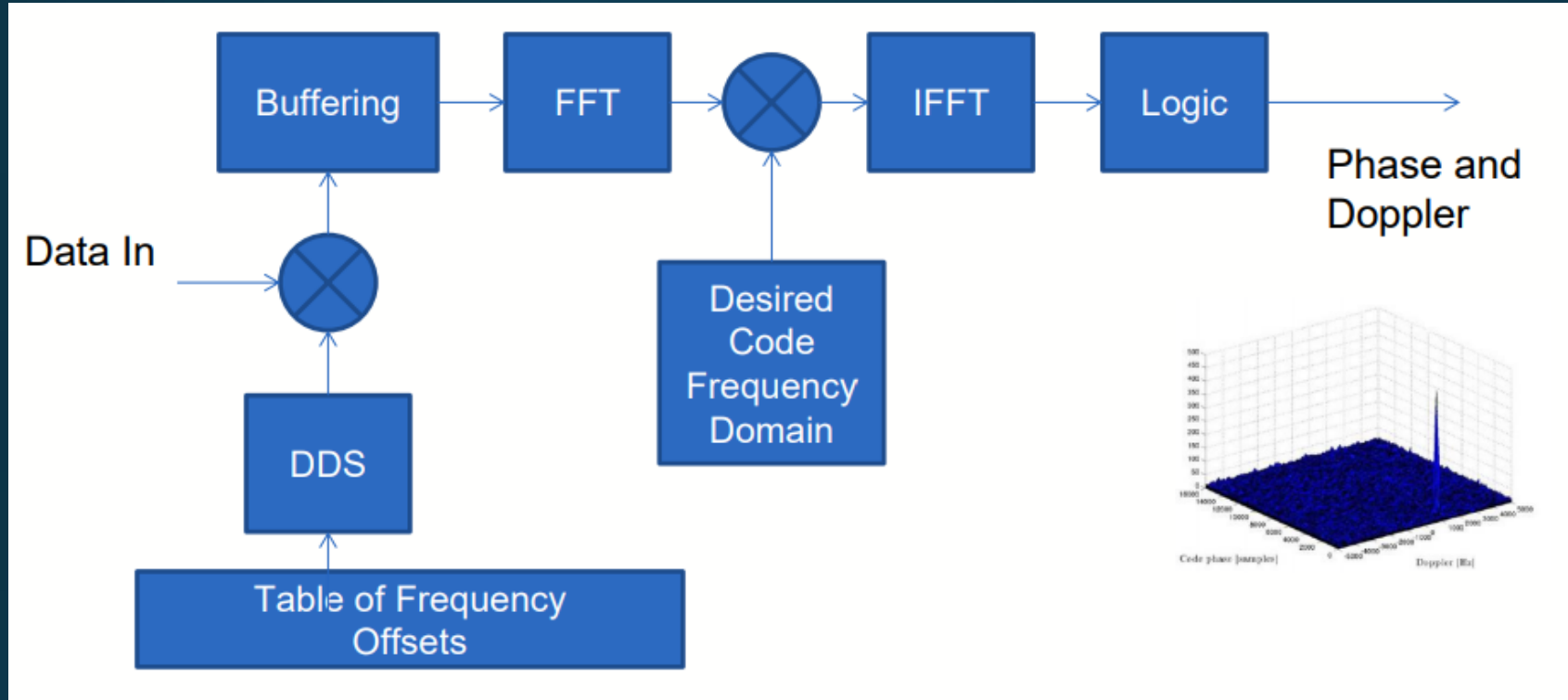| Generate reference code | • Input unique space vehicle number (PRN) to gold code gen |
| Correlate with incoming code | • Search for correlation peak |
| Search space: | • 1023 chips (4092 quarter-chips)
• Doppler space (break down 10 KHz into 20 * 500Hz bins) |

Acquisition

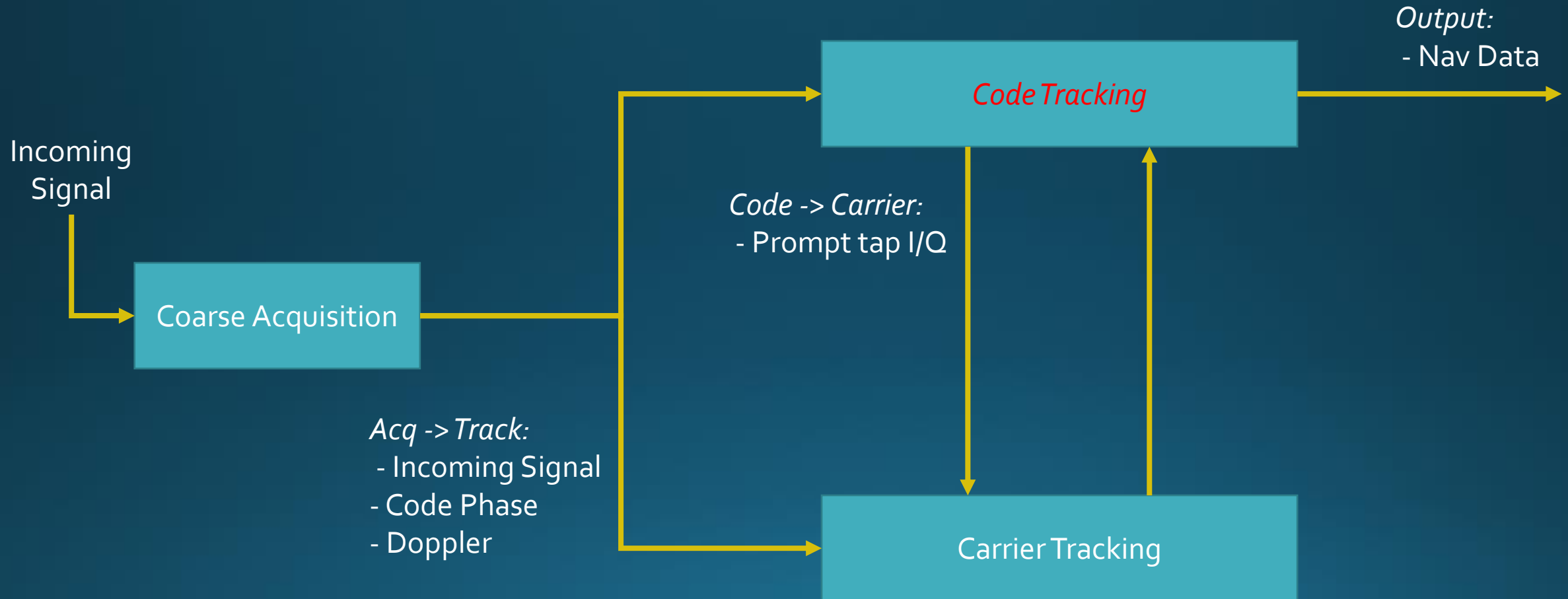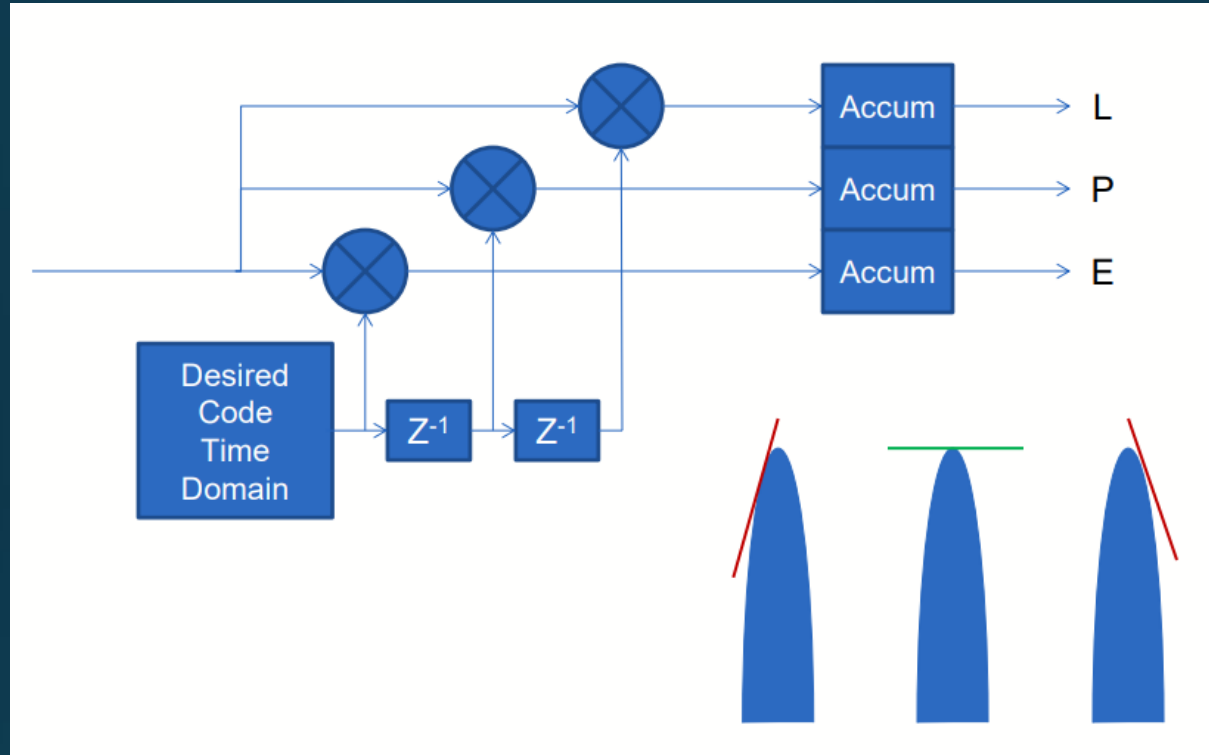• Search method: Parallel Code Search

Acquisition

- Parallel Code Search: Returns Code Phase and Doppler
- Isolate correlation spike on phase/frequency axes
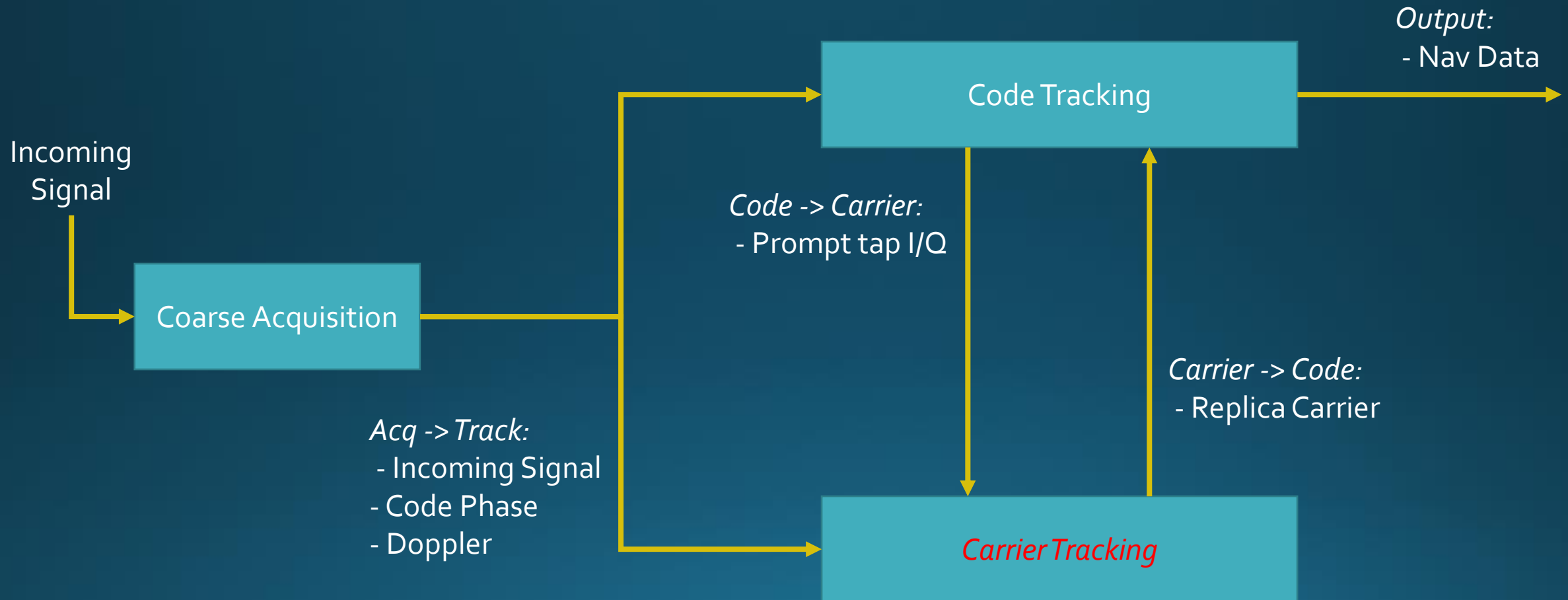
System Level Signal Flow
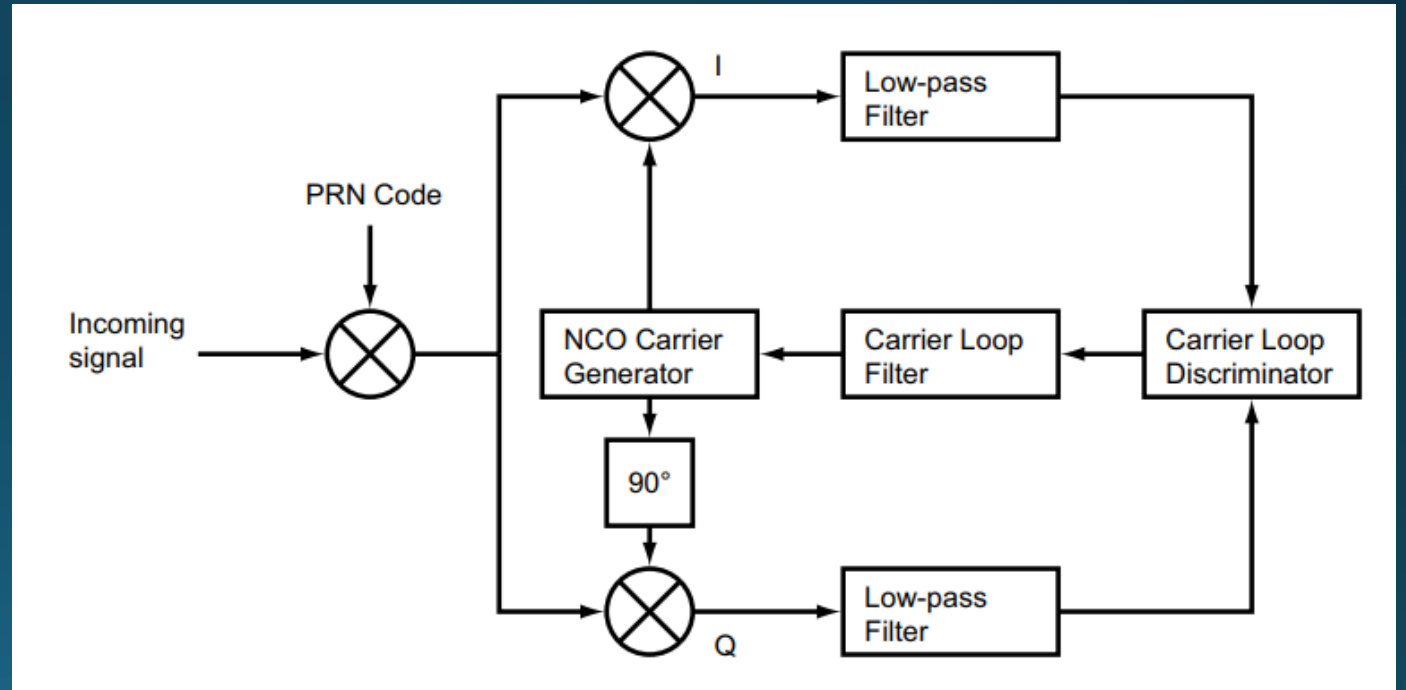
Code Tracking

- Early, Prompt, Late (EPL)
  - Pipe in generated reference code and additional delayed copies
  - Multiply with received code and accumulate
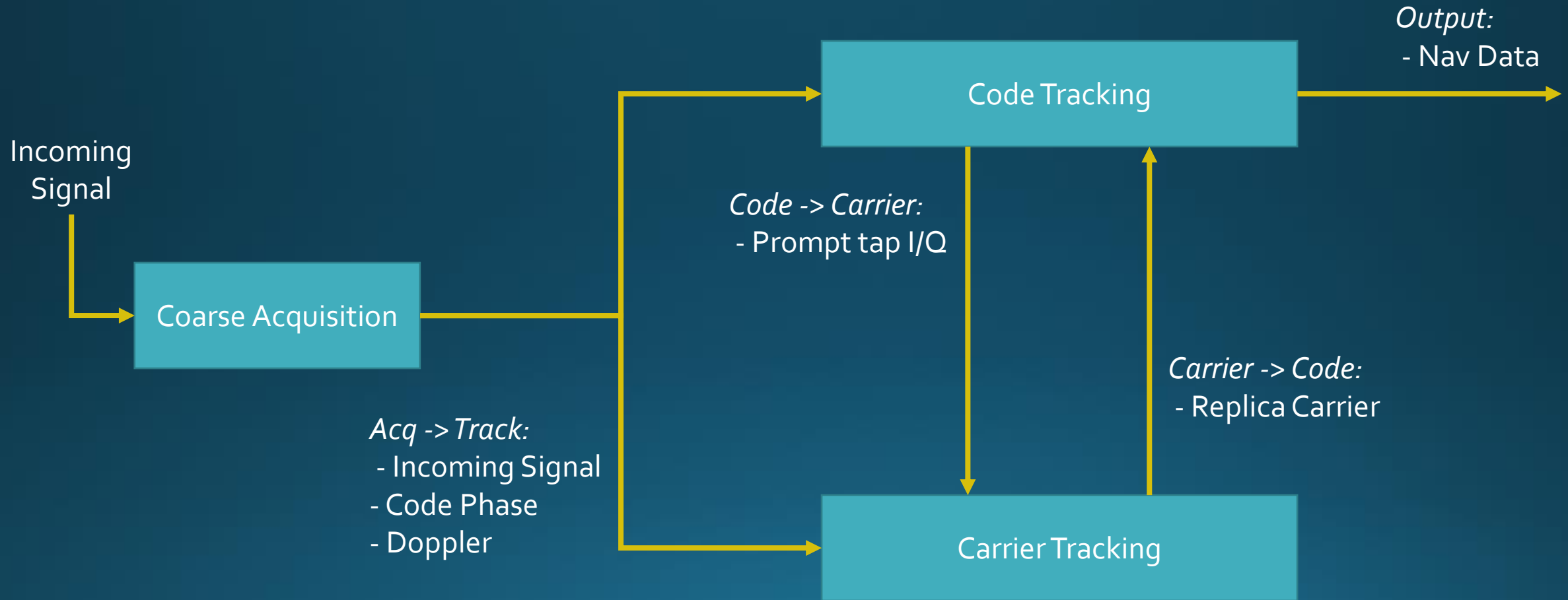
System Level Signal Flow

Carrier Tracking

- Costas PLL: Measure phase error, adjust local oscillator
- Capable of tracking despite BPSK phase changes

Combined Tracking

System Testing

- Creating Testing Data:
  - Generate gold code
  - Generate known data bits, spread with gold code

- Impairments to Introduce:
  - Doppler: Simulate constant carrier frequency offset (no drift)
    - +/- 5 kHz
  - Symbol offset

System Testing

- Test 1: Clean C/A test
  - Acquire and track a noiseless, zero-doppler C/A signal.

- Test 2: Doppler shift
  - Acquire and track a noiseless C/A signal with constant Doppler shift.

- Test 3: Missing signal sequences
  - Acquire and track a noiseless, zero-doppler C/A signal.
  - Signal goes dark part-way into transmission, resumes later
  - Re-acquire and re-establish tracking.
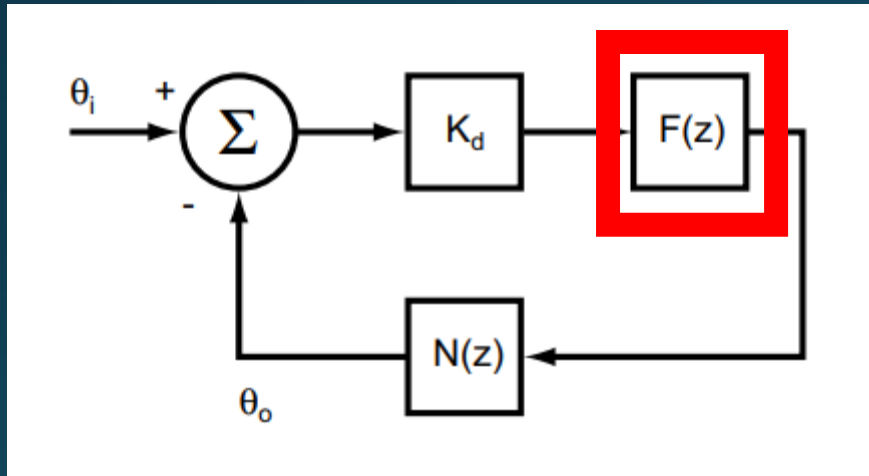
Thanks! Questions?

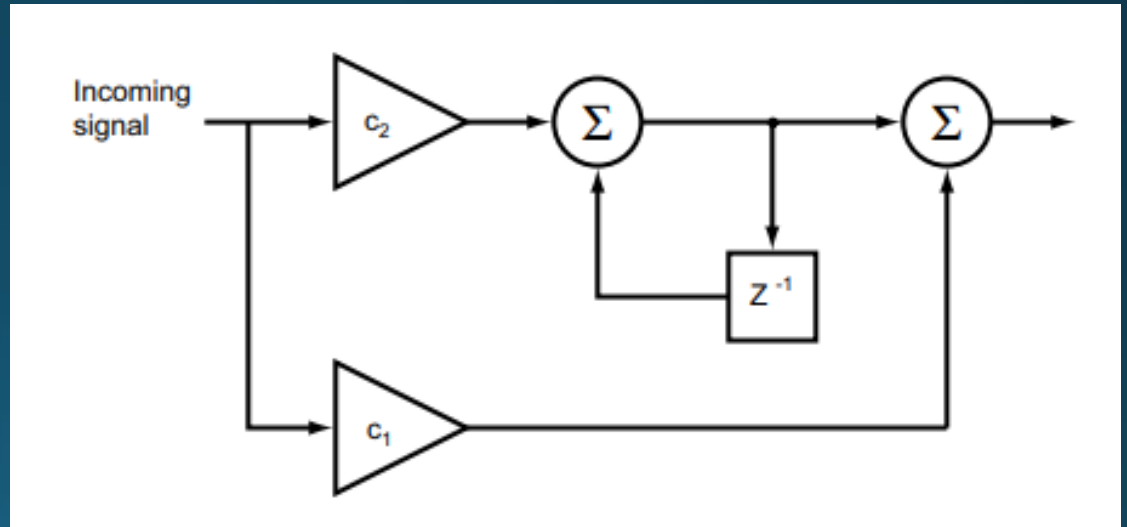From Borre and Akos
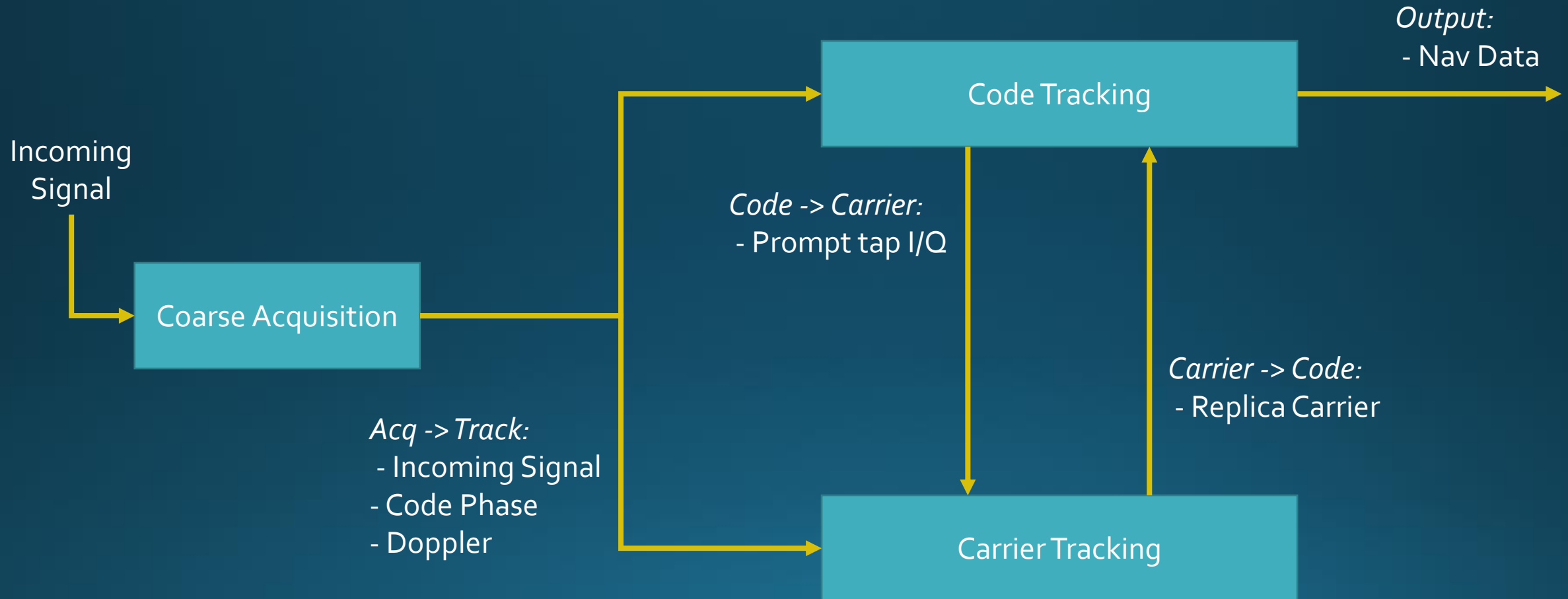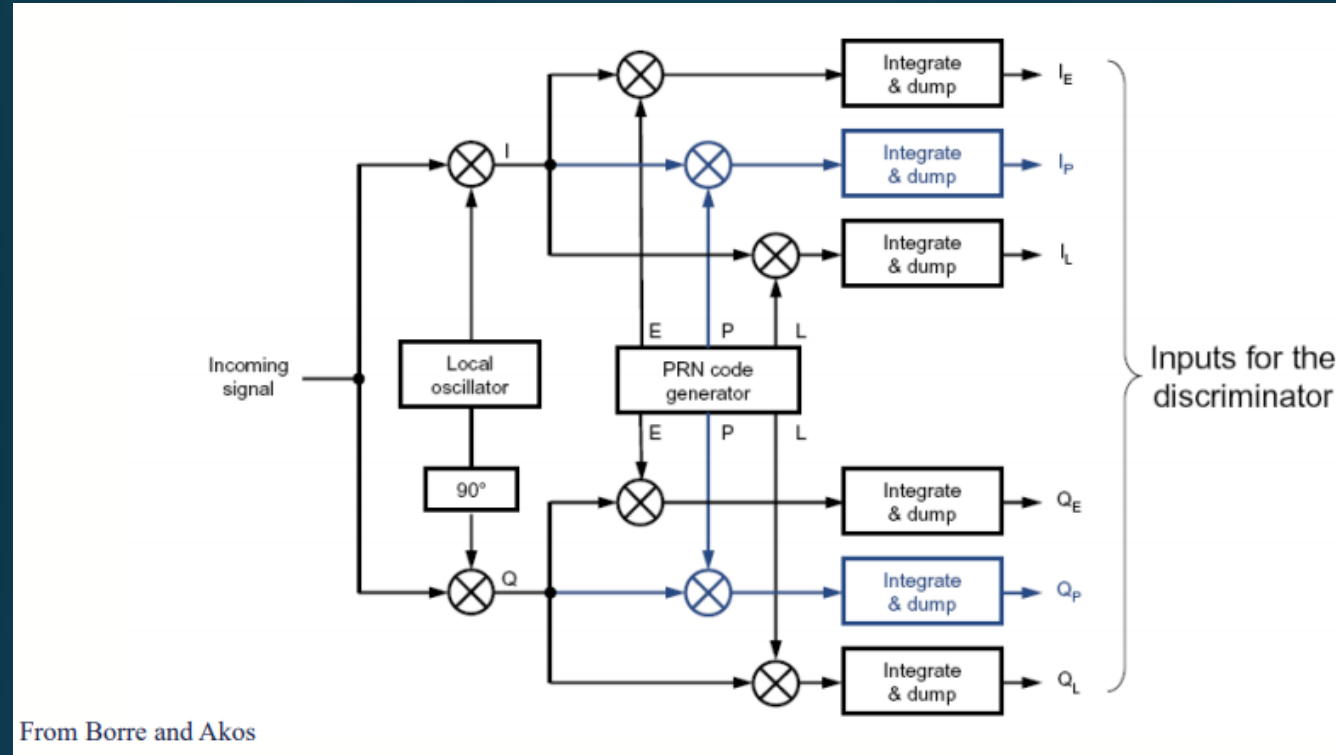
Code Tracking Loop

- Initial state: Carrier phase unknown
- Normalized early minus late power discriminator

Carrier Tracking: Loop Filter

Digitized second order PLL

F(z): First-order loop filter

Constants c1, c2 from loop parameters

From Bertelsen, Borre, Rinder

Batch Processing

- Break long signals up in time
  - 20 Repeating chipping sequences (1ms) for every BPSK data symbol (50hz, 20ms)
  - Sum the energy in successive 1ms frames through Energy Detector