Lec 14: Lock-in amplification

Allows recovery of signals buried in the noise background

Makes use of both amplitude and phase: Phase-sensitive detection

Invention generally credited to Robert Dicke while at MIT

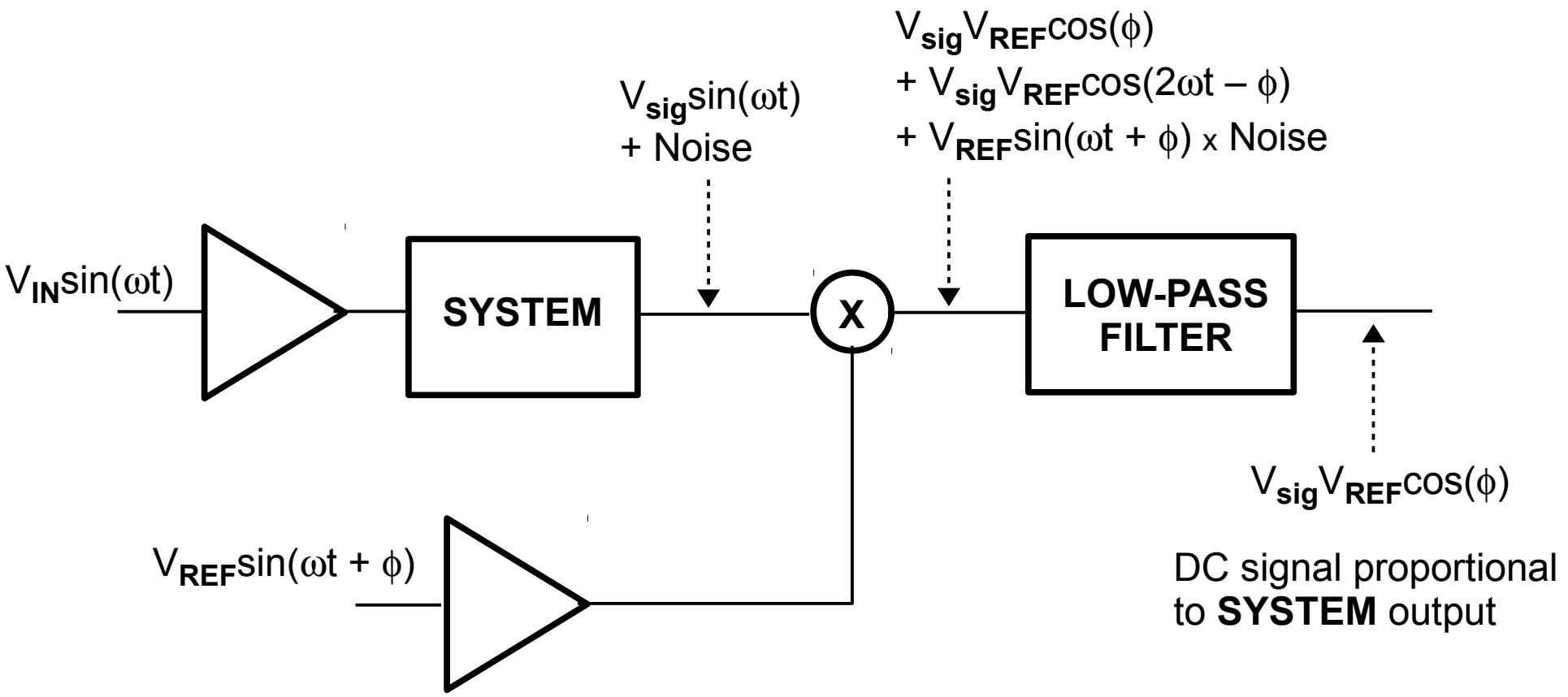
Prof. Robert H. Dicke
Princeton Univ.
(1916—1997)

First commercial lock-in amplifier: Princeton Applied Research (1962)

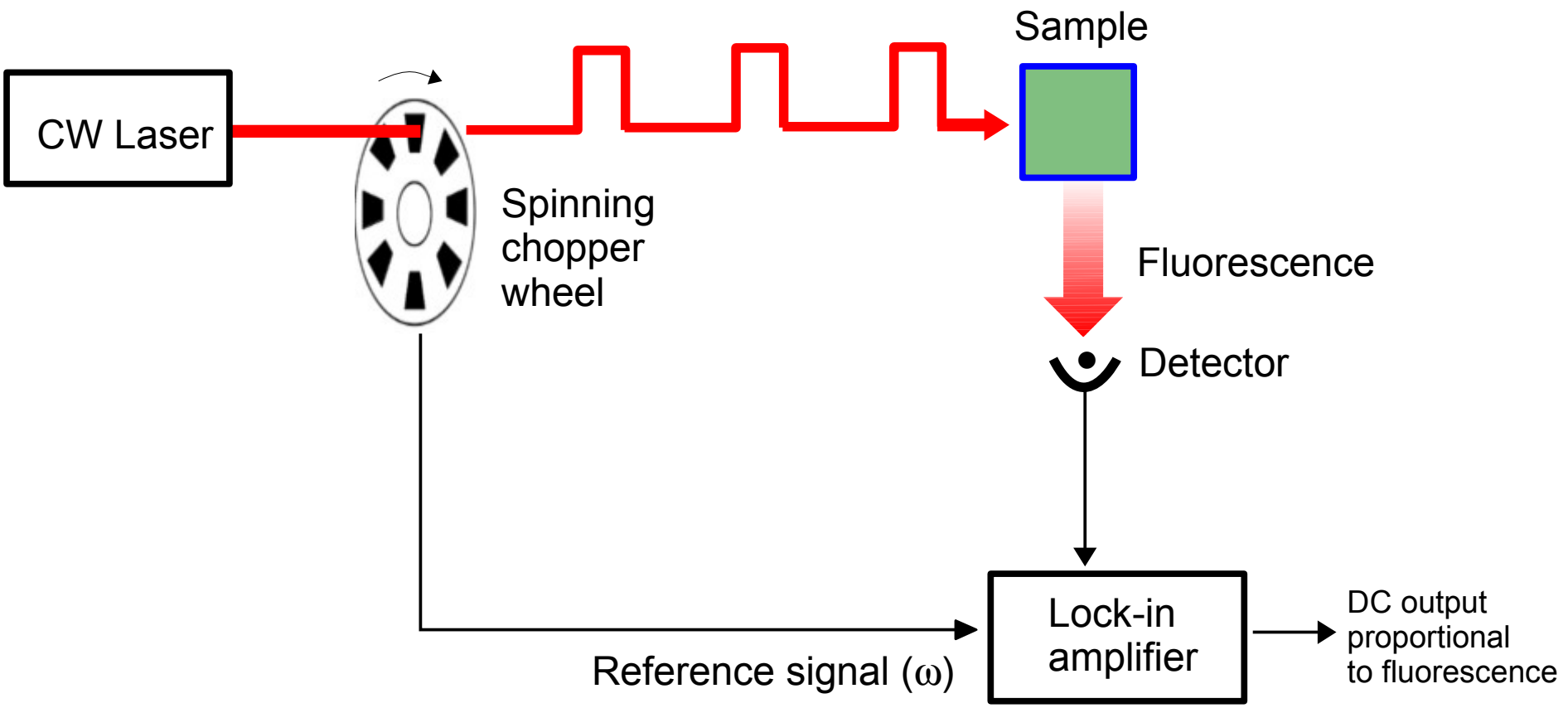
Modern digital signal processing has greatly improved performance

LOOSE ANALOGY: Finding someone in a crowded stadium

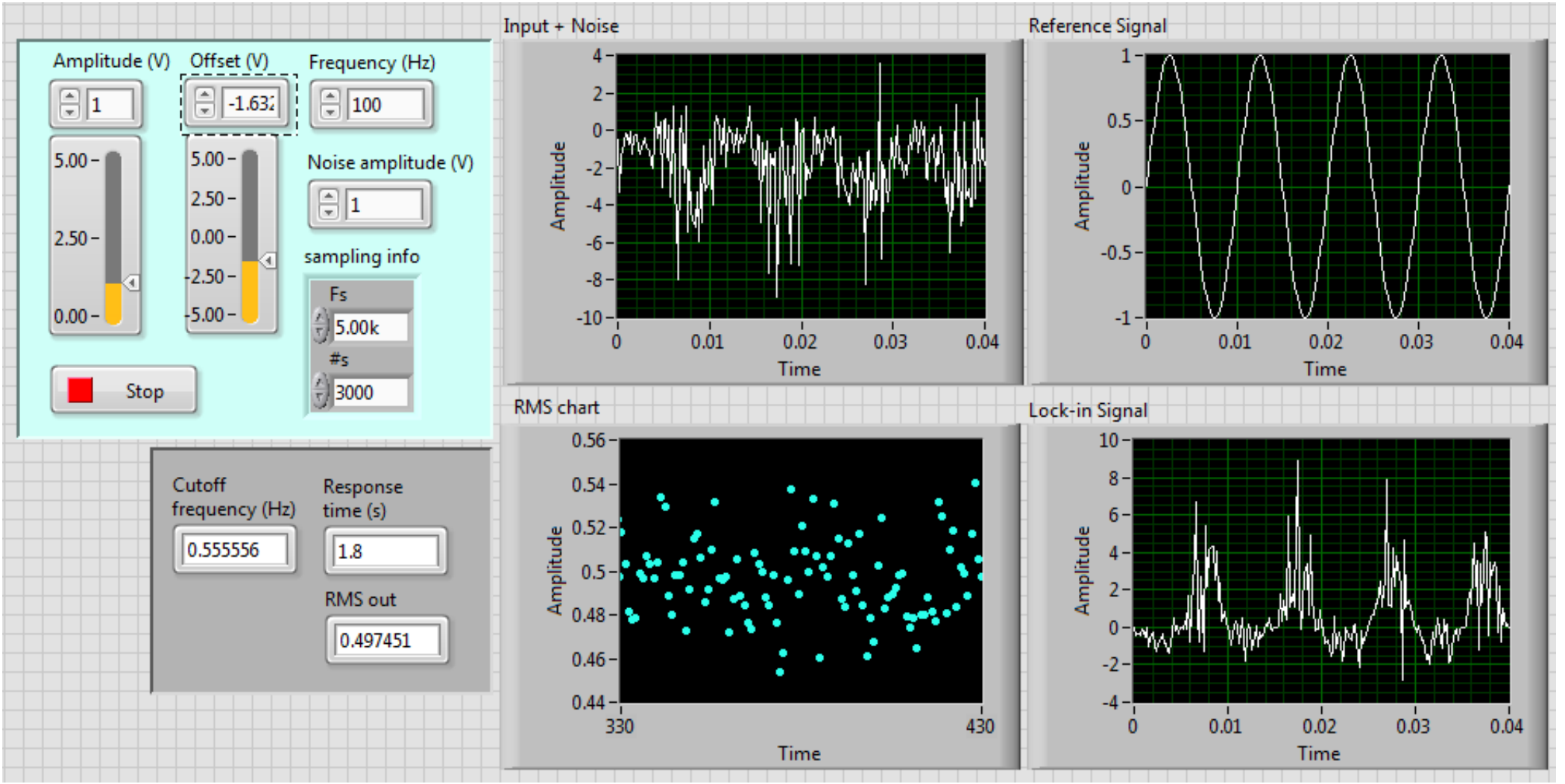
THE CONCEPT


$V_{sig}V_{REF}\cos(\phi)$
+ $V_{sig}V_{REF}\cos(2\omega t - \phi)$
+ $V_{REF}\sin(\omega t + \phi)$ x Noise
$V_{sig}\sin(\omega t)$
+ Noise
$V_{IN}\sin(\omega t)$
SYSTEM
X
LOW-PASS FILTER
$V_{sig}V_{REF}\cos(\phi)$
$V_{REF}\sin(\omega t + \phi)$
DC signal proportional to **SYSTEM** output

EXAMPLE: LASER SPECTROSCOPY



LabView Lock-in Simulation: Assignment 14



Alternative solution to race conditions in LabView:
FUNCTIONAL GLOBAL VARIABLES

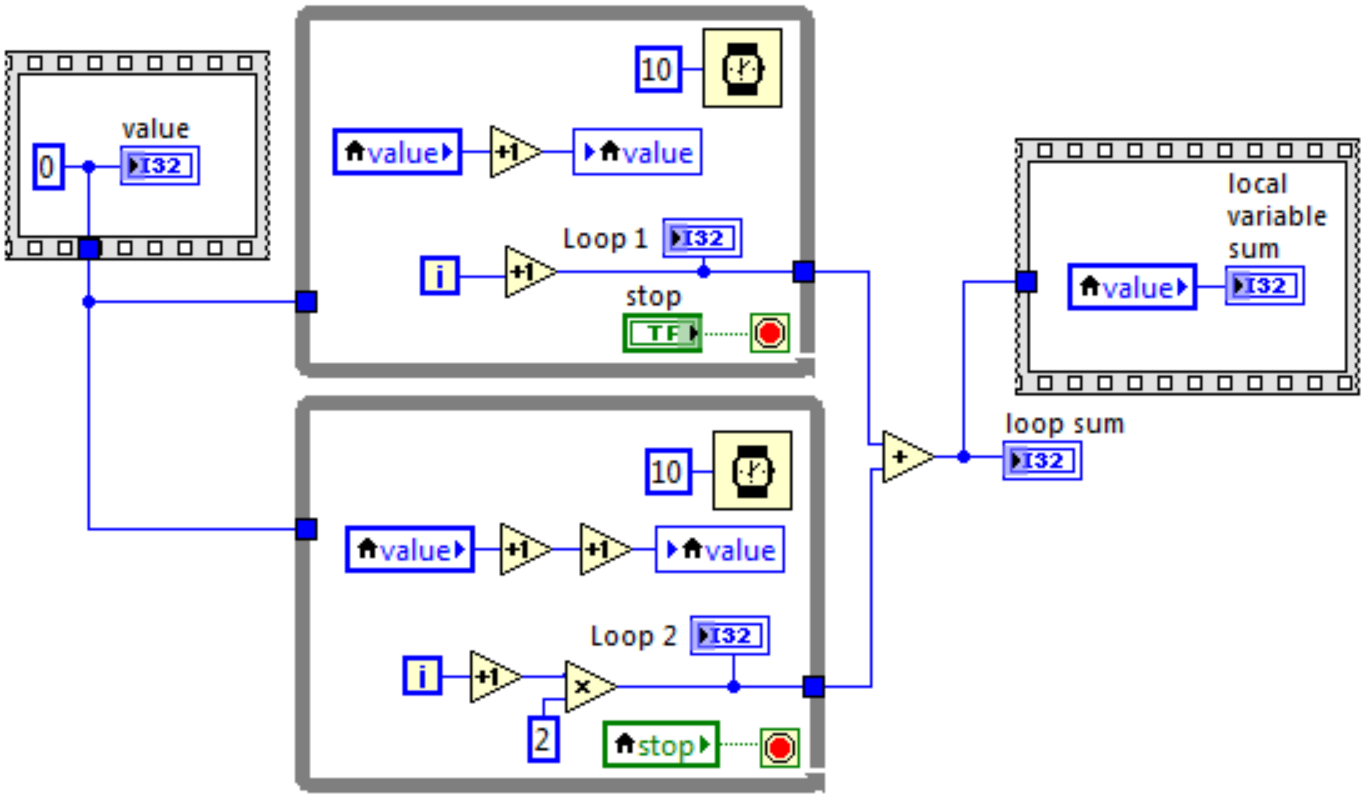
Non-reentrant Sub-VI with:

* Control (input) and/or Indicator (output)
* Enum control of case structure (eg. read/write)
* Uninitialized shift-register
* Loop that runs only once

Example of race condition in parallel loops

Read/write may not happen in desired sequence

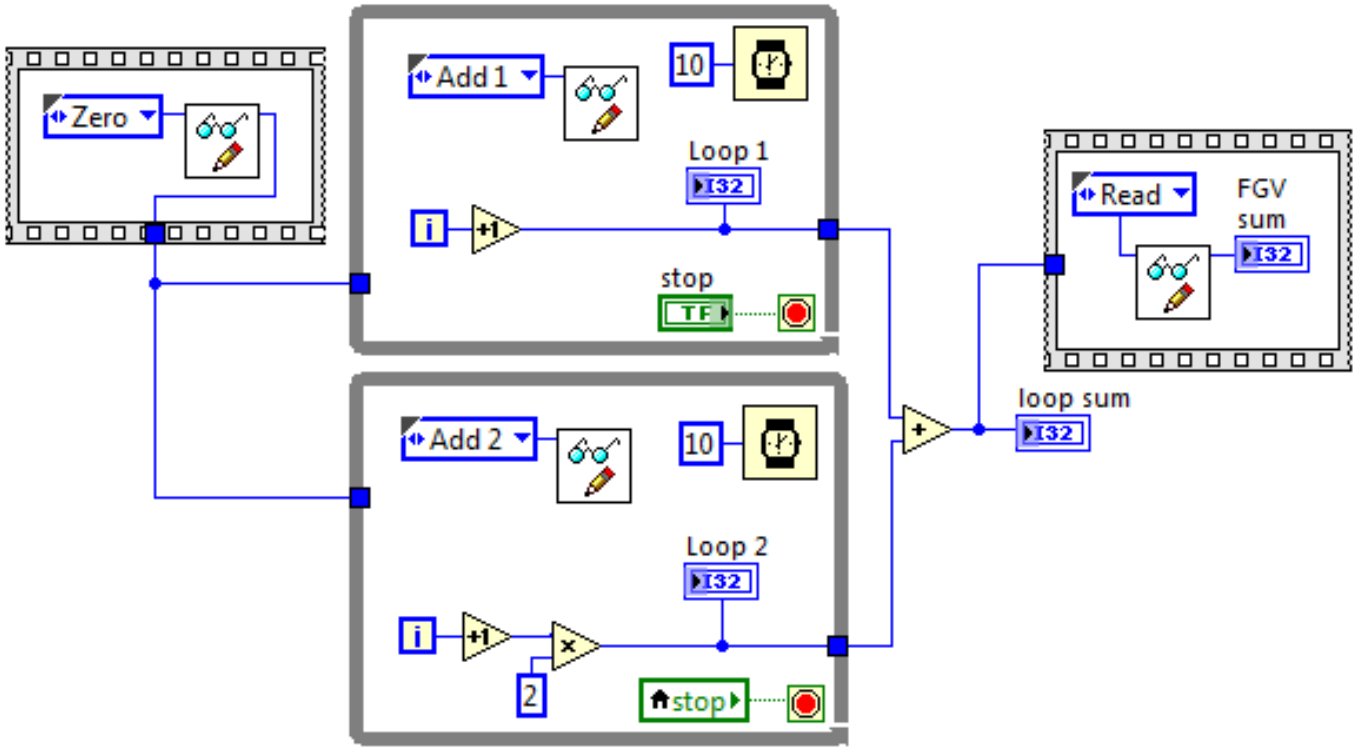
Can write to 'value' variable simultaneously



Functional Global Variable eliminates this race condition

Sub-VI protects variable from being written simultaneously

Replace the read/write local variables with single FGV



Customized Sub-VI serves as Functional Global Variable

Enum selects 1 of 4 possible states to determine operation: **0**, **+1**, **+2**, or **Read**

Uninitialized shift register holds the current value for each FGV call

FGV can't be accessed by simultaneous calls