

LSC Data Analysis

Alan G. Wiseman
(LSC Software Coordinator)
agw@uwm.edu

LIGO Scientific Collaboration
University of Wisconsin -- Milwaukee

LSC Data Analysis Goals

- ... to use gravitational wave interferometers to test relativistic gravitation and observe the universe.
 - » **What science is realistically attainable?**
 - » **How do we organize the human resources to accomplish the goal?**
 - » **How do we maintain the integrity of the software?**
 - » **How do we bring the data, the computational resources (hardware) and the people together?**

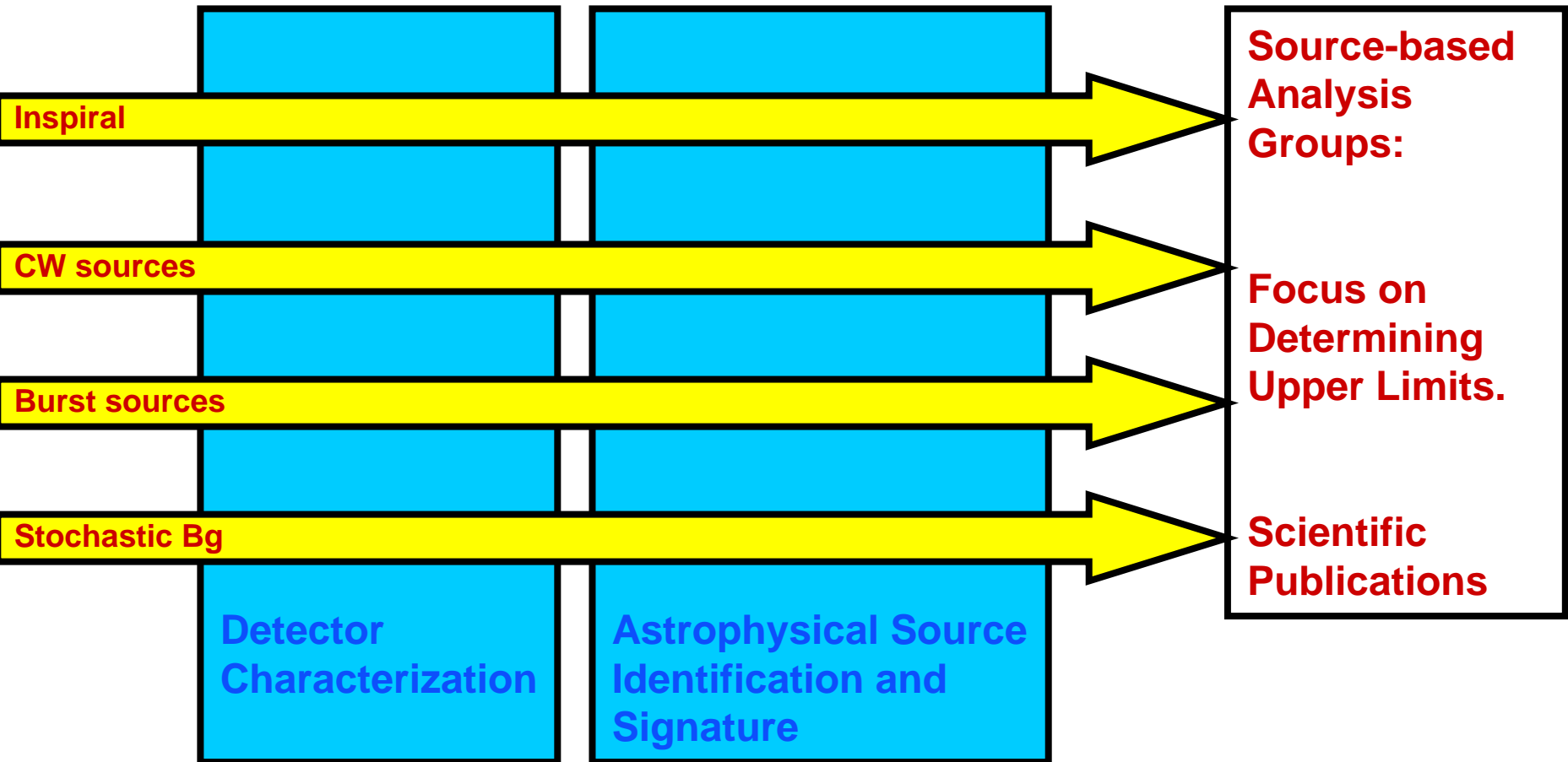
What science is realistically attainable?

- **Inspiralling binary stars.**
 - known templates, known event rate
- **Continuous waves (pulsar)**
 - known pulsars
 - all-sky, all-frequency pulsar search
- **Burst sources (short duration)**
 - unmodeled (or weakly modeled)
 - unknown sources
- **Stochastic Background**
 - probe of the early universe

Caveat: with Early LIGO configurations “... it is plausible, but not likely” we will see something

Therefore ... Upper Limits

How to organize the human resources to accomplish the goal



Upper Limits Groups

- **Goal:** Do science with engineering (E7) data exactly the way we intend to do science with science-run data.
 - » Use/Test LDAS
 - Each ULG has an LDAS Integration Phase (MDC) built into the schedule
 - » Broad Cross-Section of people (experimentalist, theorists)
 - » Organized around four separate searches: Inspiral, Stochastic Background, Burst, Continuous waves
 - Currently driving motivation for code development within ASIS
 - » Detector Diagnostics
 - Healthy effort (across party lines) to work on diagnostic triggers
 - close interaction with existing detector characterization group.
 - » Publications:
 - Each group has a paper on the schedule
 - » Originated as Internal LSC Proposals

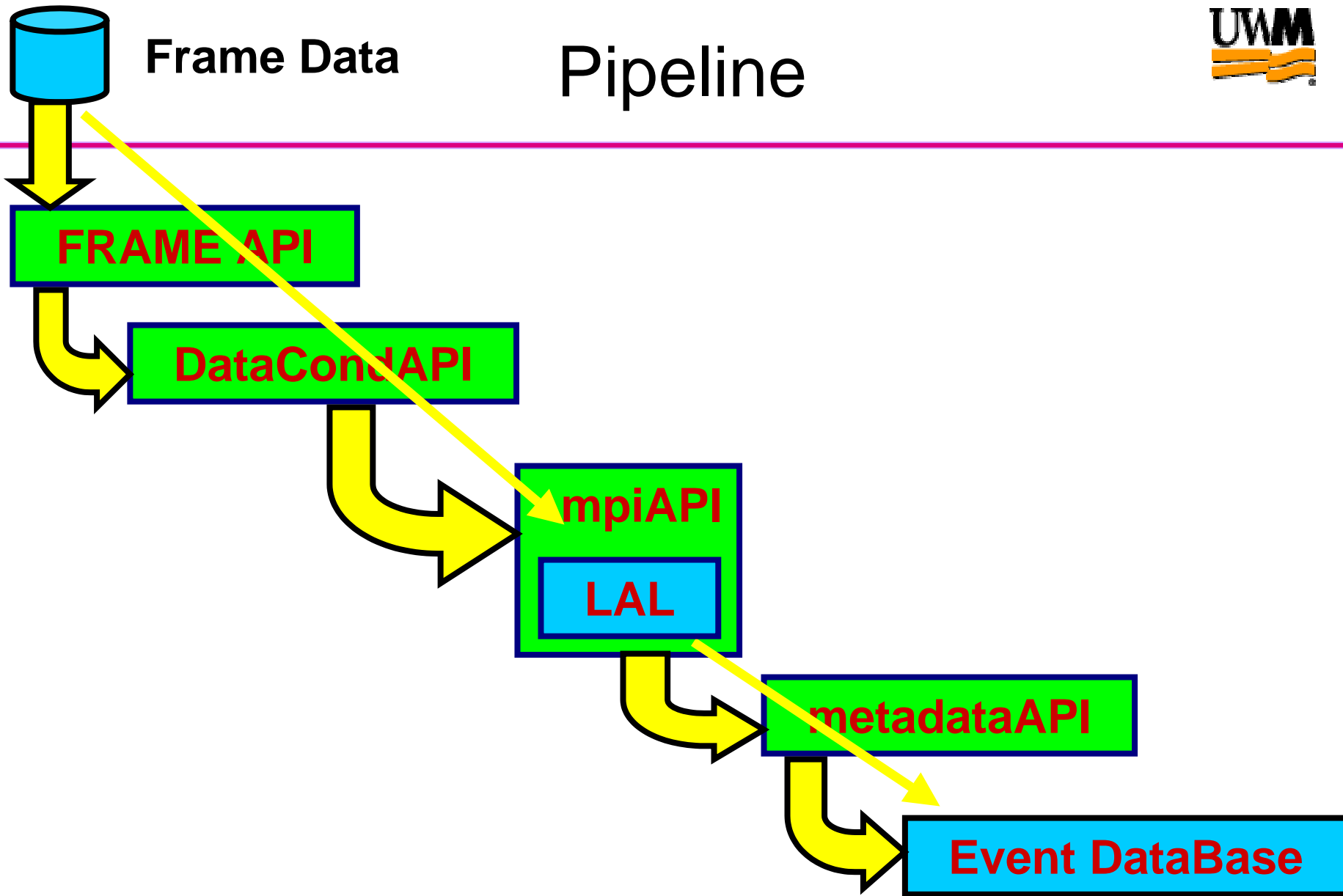
How do we assure integrity of the software?



Rules:

- 1. The scientific search engine must be LAL-compliant software. [LAL= LSC Algorithm Library]**
 - Reusable data structures
 - fault tracking
 - Documentation requirements
 - Functions have a prescribed interface (LDAS)
- 2. LIGO Data products in ... LIGO Data products out.**
- 3. Entire analysis pipeline must be tested in a Mock Data Challenge. [Blind injection of signals.]**
- 4. Stable software environment, e.g. CVS, Software Change Control Board, bug tracking**

Pipeline



Mock Data Challenges

- Each is undertaken as a working group
- Monitored by the Software Coordinator and Committee

1) Data Conditioning MDC **Sam Finn.** [Done]

2) MPI MDC (wrapperAPI) **Patrick Brady.** [Done]

3) Database MDC **Peter Shawhan.** [Done]

4) Scientific Inchpebbles [Spring- Summer 2001].

» Sequential Integration of all the search algorithms into the LDAS system

-- Inspiral: Patrick Brady [May 01]

-- Stochastic Background: [Sept 01]

-- Burst (unmodeled sources): [Sept 01]

-- Continuous Waves (pulsar): [Now]

5) Archive MDC

6) Integrated Science MDC

How do bring the people and the compute cycles together?



- **Currently: (in)formal agreements to share hardware**
e.g. Burst/Stochastic MDC took place at MIT,
Monte Carlo for Burst Search is taking place at UWM
- **In the future:**
 - **Grid Computing**
 - **Development of (non LIGO Lab) Tier II centers at PSU and UWM**
 - **Mirrors of large data sets**
 - **Provide access (hardware and data) for LSC members**
 - **Provide resources for exploratory work**

LSC Data Analysis Why? Scope Goals



- ... to use gravitational wave interferometers to test relativistic gravitation and observe the universe.

Chapter 2

- » What science is realistically attainable?

Chapter 3

- » How do we organize the human resources to accomplish the goal?

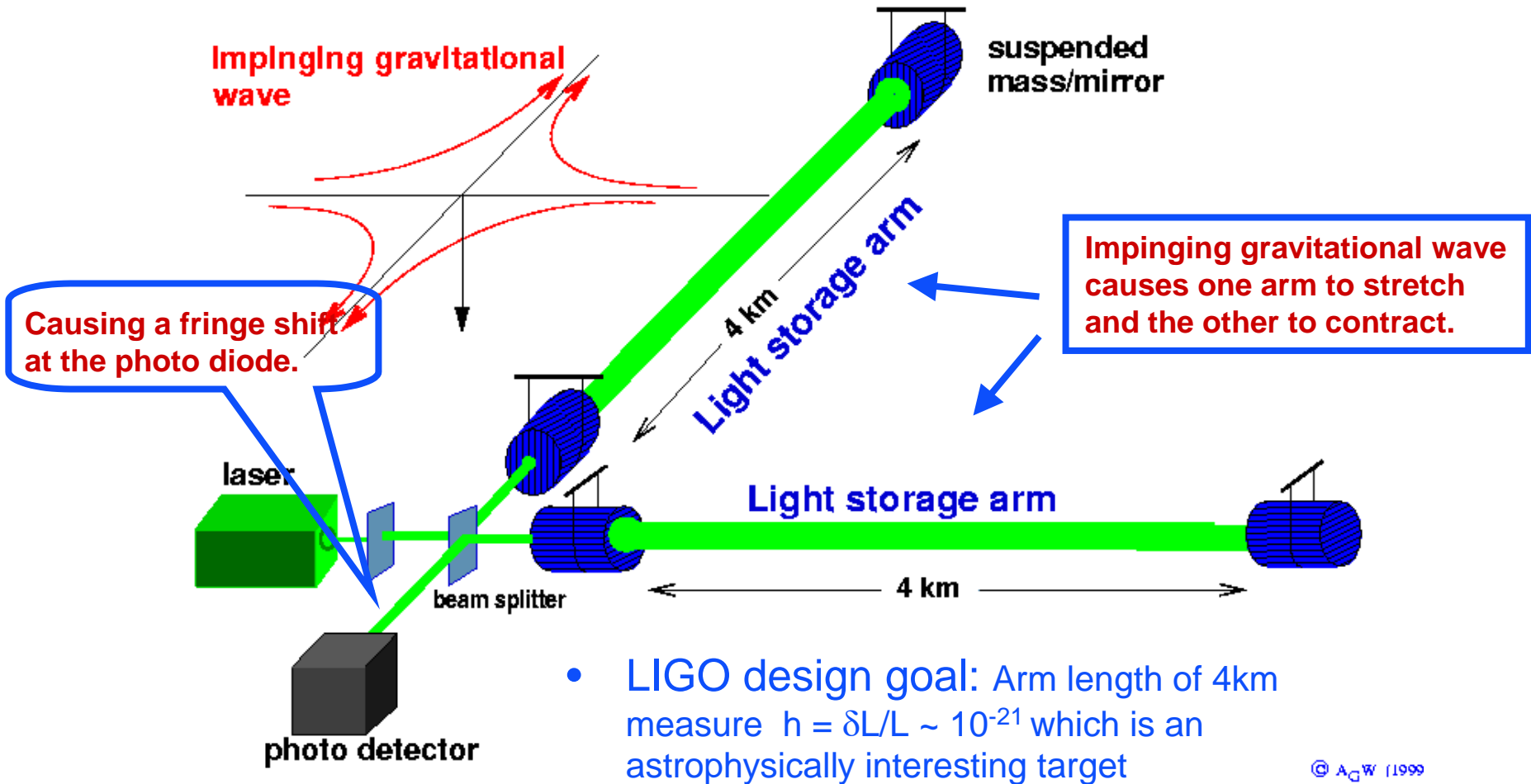
Chapter 4

- » How do we maintain the integrity of the software?

Chapter 5 and 6

- » How do we bring the data, the computational resources (hardware) and the people together?

How LIGO Works



- LIGO design goal: Arm length of 4km measure $h = \delta L/L \sim 10^{-21}$ which is an astrophysically interesting target

© A.G.W. (1999)

The Grid in Grid Computing

- Analogy with the electrical power grid
 - » you don't care where or how power for your toaster is generated
 - » you just want results (toast!)
- Grid computing to provide robust, uniform, access to distributed high performance computing resources
 - » don't necessarily know (or care) from where cycles are delivered
 - » you just want to do science
- Evolve to include access to computing resources AND data
 - » robust access to data, both raw or "real" and derived or "virtual" data

