GLOBAL DIAGNOSTICS SYSTEM

LSC meeting

LIGO Hanford Observatory

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GOALS

- ❏ Assist the operators in the control room and in the experimental areas to successfully run the experiment.
- ❏ Provide immediate answers:
  - ❍ What is the quality of the GW data written to disk?
  - ❍ Are all of the subsystems working properly?
- ❏ Establish & automate diagnostics procedures.
- ❏ Give assistance to:
  - ❍ learn about the behavior of the instrument,
  - ❍ classify abnormal environmental events,
  - ❍ identify the exact machine state,
  - ❍ correlate the signals of different sensors and,
  - ❍ ultimately, reduce the large amount of measured data to a set of relevant and comprehensible statistical quantities.
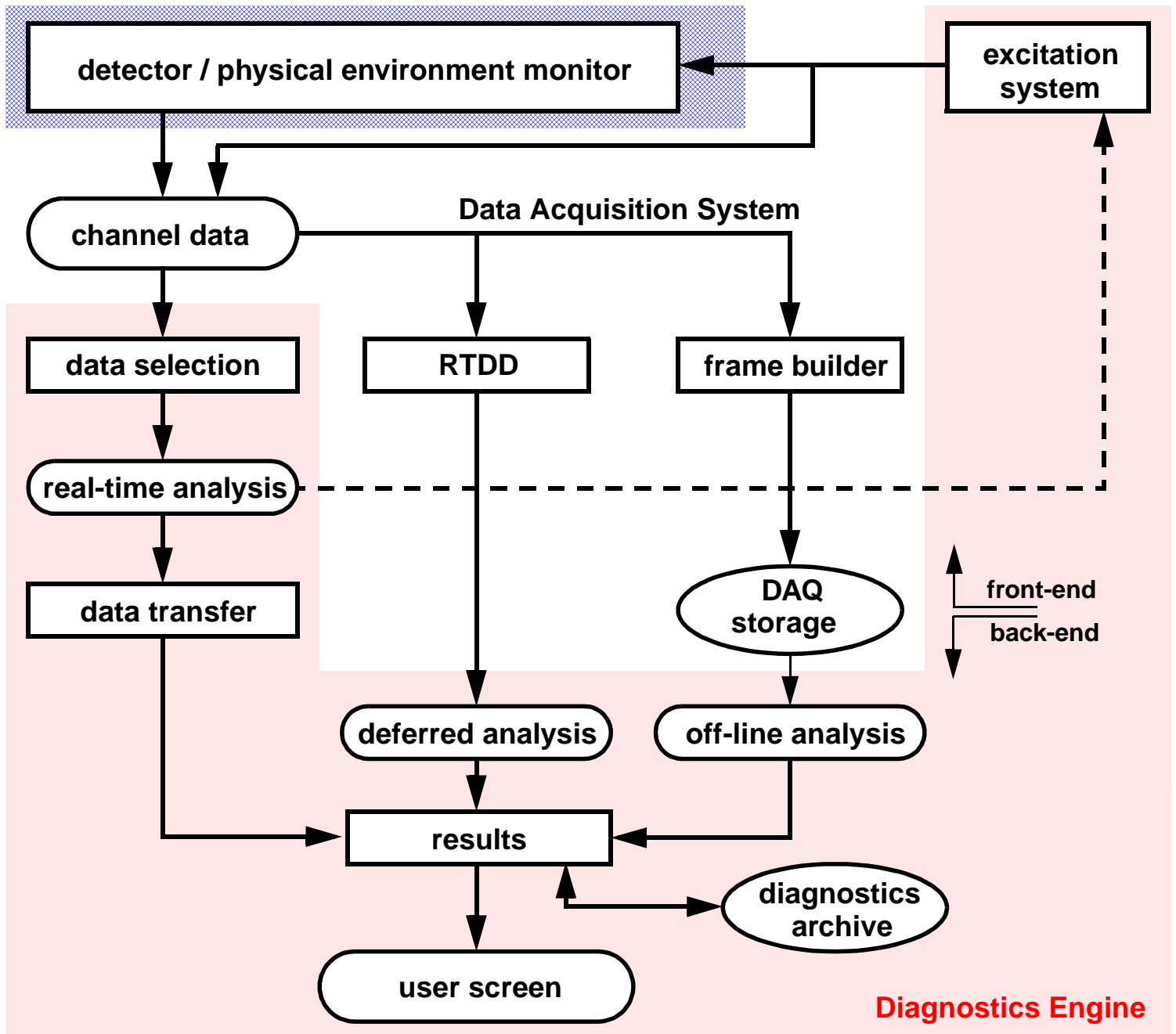
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OVERVIEW
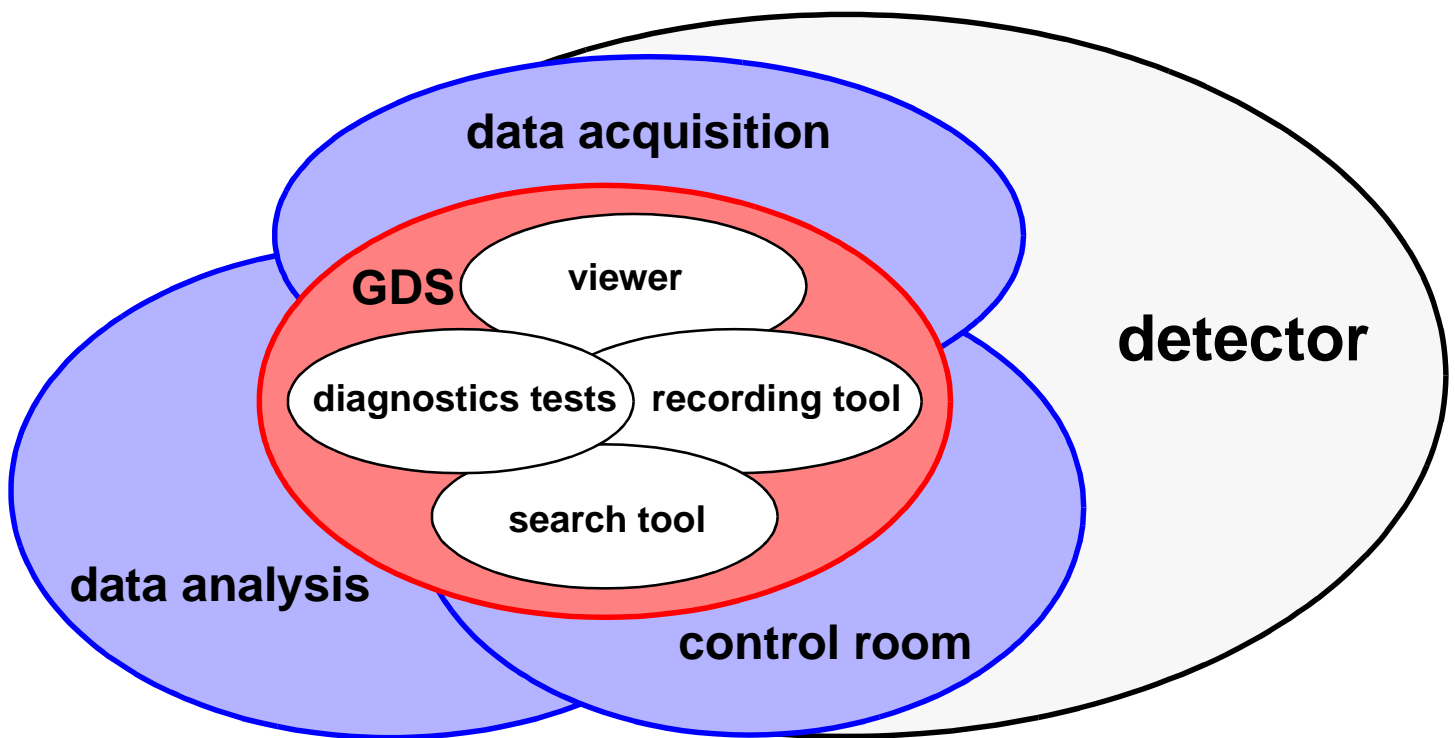
- ❏ Viewing tool (part of DAQS)
- ❏ Recording tool (trend frames)
- ❏ Diagnostics test tool
- ❏ Search tool

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DIAGNOSTICS TEST EXAMPLES

- ❏ Coupling of laser frequency noise into the gravitational wave band
- ❏ Parasitic Interferometers
- ❏ Coupling of beam jitter into the GW band
- ❏ Optimization of the modulation depth
- ❏ Mode matching into the interferometer
- ❏ Determining the alignment sensitivity matrix
- ❏ Cavity ring-down measurements
- ❏ Sensitivity to seismic, acoustic, magnetic, etc.
- ❏ Determining wire resonances
- ❏ Beam centering
- ❏ Pendulum coupling of vertical to horizontal
- ❏ Diagonalize servo feedback paths

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DIAGNOSTICS TEST ENGINE

detector / physical environment monitor

excitation system

channel data

Data Acquisition System

data selection

RTDD

frame builder

real-time analysis

data transfer

DAQ storage

front-end

back-end

deferred analysis

off-line analysis

results

diagnostics archive

user screen

Diagnostics Engine

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DIAGNOSTICS TEST TEMPLATES

- ❏ Time series measurement

- ❏ Power spectrum measurement

- ❏ Sine response

- ❏ Swept sine response

- ❏ Triggered pulse response

- ❏ Two-tone intermodulation test

- ❏ Harmonic distortion

- ❏ Pseudo-random stimulus / power spectrum measurement

- ❏ Pseudo-random stimulus / cross spectrum measurement

- ❏ Parameter sweep

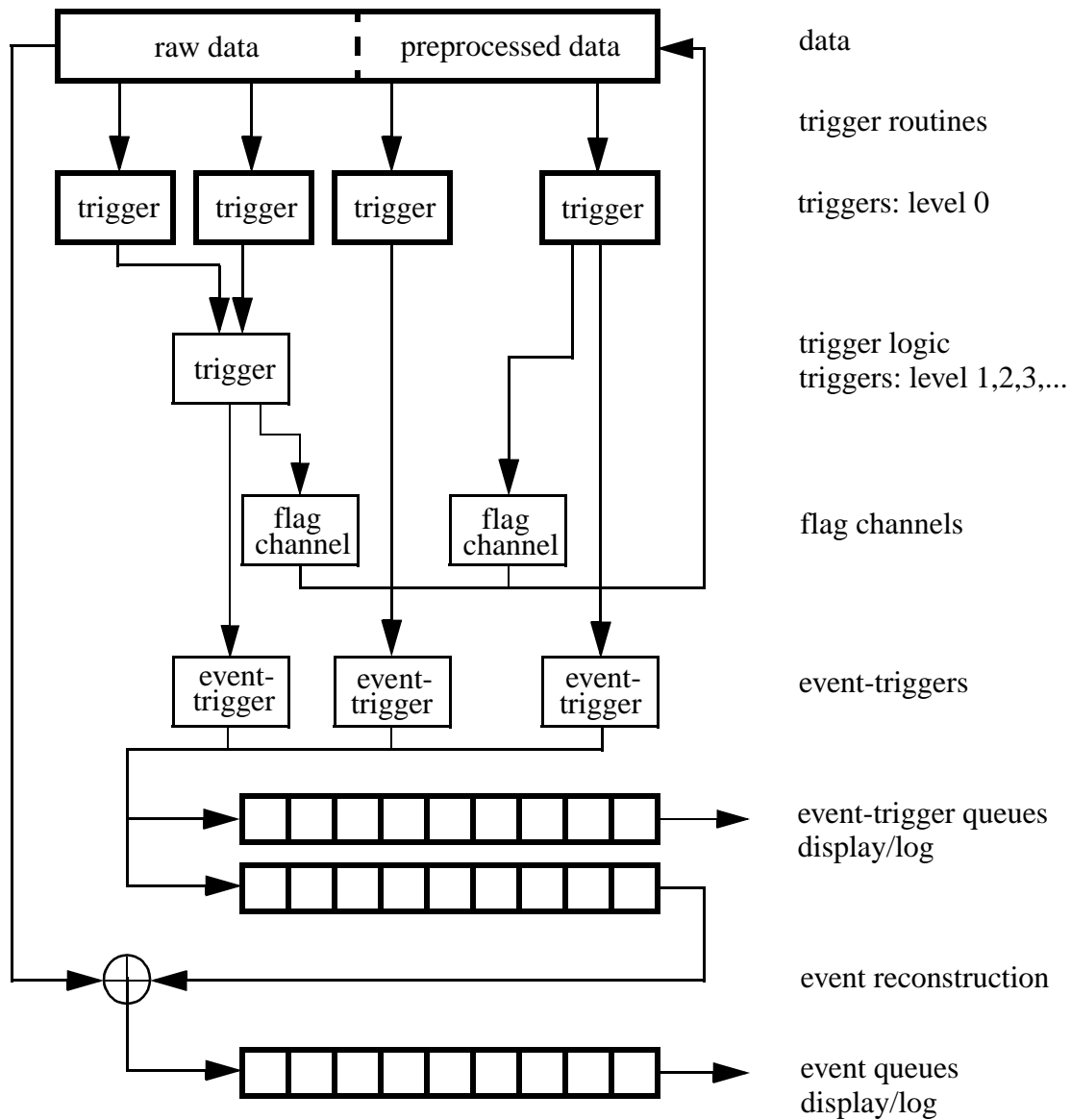- ❏ Parameter optimization

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SEARCH TOOL

- Fast access to raw data
- Compute engine for FFTs
- Channel monitoring
  - Time trace signal level
  - Band limited power
  - New spectral features
  - Time trace rate of change
  - Dead channel (RMS)
- Triggering & Flag channels
  - Highly configurable
  - Simple to complex trigger logic and dependency
  - Flag channels written back to DAQ for archival
  - Event triggers
  - Event queues & reconstruction
- Data capture & analysis

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TRIGGER EXAMPLES

❏ Excess GW noise

❏ Beam intensity

❏ Laser source AM & FM noise

❏ Modulation depths & frequencies

❏ Servo control & error signals

❏ Narrow band features

❏ Actuator saturation

❏ Photodiode temperature, bias & dark current

❏ Earthquake

❏ Vibration

❏ Weather

❏ Excitation system off?

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DIAGNOSTICS SEARCH ENGINE

raw data	preprocessed data				data
					trigger routines
trigger	trigger	trigger	trigger		triggers: level 0
	trigger				trigger logic triggers: level 1,2,3,...
	flag channel	flag channel			flag channels
event-trigger	event-trigger	event-trigger			event-triggers
					event-trigger queues display/log
					event reconstruction
					event queues display/log

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DIAGNOSTICS ARCHIVE

❏ Trend frames

❏ Parameter files

  ❍ Channel monitoring thresholds

  ❍ Trigger bank configuration

  ❍ Diagnostic test operating parameters

❏ Diagnostics tests

  ❍ transient data for deferred analysis

  ❍ test descriptions & results

❏ Diagnostic events

  ❍ Complete reference

  ❍ Data or parameterization

❏ Other data

  ❍ Video

  ❍ Oscilloscope traces

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