Detector System Integration

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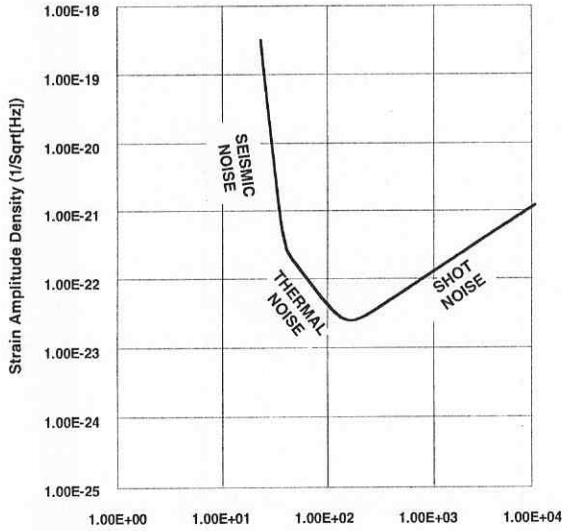
Starting Point: Science Requirements Document



- 3 limiting noise sources, no specifics
- all other sources 'technical'
- Gaussian noise (shown here); non-stationary noise; availability also specified

Scope of task

Objective

- coordinate subsystems to deliver SRD performance

Aspects of Detector System Integration activity

- establishing requirements flowdown, trades between subsystems
- establishing interfaces between subsystems, and to facilities
- ensuring consistency with LIGO noise model
- special roles
  - optics layout
  - vacuum cleanliness procedures
  - calibration specification
  - negotiating configuration changes
  - chairing Design Requirements Reviews

Point of departure

- DRRs for subsystems (individual subsystem leaders)
- environmental/interface input, e.g.,
  - seismic, acoustic noise
  - facility slab stability
  - Vac Eq interfaces
- noise flow-down tree

Difficulties in practice

Idealized project:

- establish top-level requirements (e.g., SRD)
- determine trade-offs by 'costs' (scientific value, $, manpower, time)
- lay down requirements for subsystems
- design, engineer, build, success

LIGO: Technology/Physics limits

- can not freely determine performance
- some aspects are at the limit of technology, esp. Thermal Noise
- almost requires a bottoms-up, not top-down, approach

Transition to 'phase C'

- approximate and first-cut designs in place
- realistic solutions, compromises, time/money considerations important

Approach:

- participate in DRD development
- keep other subsystems in view (effectively the flowdown procedure)
- extract subsystem requirements for SYS DRD
- extract noise models for LIGO model
- organize interfaces using database tools
- Do it fast.

Example: Shot Noise

Most DHS effort to date on this.

Primary tools:

- FFT model (Bochner, Hefetz, Kells)
- Shot noise model (Fritschel, Regehr)
- Small signal frequency response (Yamamoto, Regehr, Weiss)
- Modal decomposition model (Mavalvala, Sigg, Fritschel, Hefetz)
- Propagation of laser noise (Camp)
- Small signal servo model (Sievers)

Trades between subsystems

- PSL (laser power, beam quality, frequency/intensity noise)
- IOO (efficiency, spatial/temporal filtering, servo configuration)
- COC
  - carrier recycling gain
  - sideband transmission
  - carrier contrast defect
  - sideband modal purity at antisymmetric port
  - reflected carrier at recycling mirror
  - AR coating reflectivity
  - GW frequency response
- LSC (power handling, dynamic range, servo configuration)

Status

Design Requirement Documents/Reviews

- completed: ASC, SUS, Ar PSL, COC, CDS (global) DRD/DRR
- SEI, LSC, PEM April/May
- IOO, YAG PSL, ASC 2 Summer/Fall
- first order consistency of requirements in place

Modeling

- primary noise sources (Seismic, Thermal, Shot) in place
- initial parameter list established

Interfaces

- individual subsystems have published their interfaces as perceived
- first Internal Interface Control Document draft circulating (SUS-COC)
  - support from/consistency with LIGO System Integration

SYS Design Requirements Document

- partial draft, primary noise sources addressed
- to be reviewed in May