

**R. Vogt**  
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**Science & Technology Meeting**

# DETECTOR

- **BASELINE CONCEPT** adopted in:
  - Cost Book (September '94)
  - Detector Implementation Plan (December '94)
- **SUBSYSTEMS** currently in various stages of conceptual designs/prototypes:
  - PSL / IOO
  - COC / COS
  - ASC
  - LSC
  - SEI
  - SUS (D)
  
  - CDS
- **SCHEDULE:** Detector installation 98/99.
- **APPROACH:** Design, build, install baseline subsystem *unless* superseded by improved version (within allowed cost and schedule).

**Aggressive "optimization" entails risk for payoff!**

# SEISMIC ISOLATION

- **PROTOTYPES:**

  - Passive stack in 40-m system

  - Active isolators in 5-m system

- **LIGO Passive Stacks (4 layers):**

  - Total cost: \$10.3M

  - Weight:

    - BSC / TMC  $\sim$  3,700 lbs / layer

    - HAM  $\sim$  1,700 lbs / layer

    - BSC / TMC stack plus support:  $\sim$  49,500 lbs

    - HAM stack plus support:  $\sim$  10,800 lbs

  - Cost driver: First resonance mode of top plate  $>$  300 Hz

  - Technical risk: elastomers (creep, contamination)

- **Optimization: Engineering R&D effort ( $\sim$  1 yr) with High Technology Engineering Services, Inc.**

  - Goal:

    - Reduced weight
    - Replacement of elastomers with damped metal springs. Zero elastomer exposure to vacuum.

# HIGH POWER LASERS

- **BASELINE:** Argon ion laser (.514  $\mu m$ , cw, 5W)

## Concerns:

Reliability (downtime, tube life)

Efficiency ( $10^{-4}$ )

Performance (amplitude / frequency noise)

- **OPTIMIZATION:** Replace with diode-pumped Nd-YAG or Nd-YLF solid state laser

## Advantages:

Good wall-plug efficiency

Very reliable (diode lifetime several thousand hours)

Good amplitude / frequency stability

Soft failure mode for fiber-coupled multiple pump sources

- **COMMERCIAL AVAILABILITY:**

- Market in graphics, high speed printing

- R&D in Byer group (Stanford)

- Vendors:

- **SCHWARZ ELECTROOPTICS** (proprietary info!!)

Nd-YLF (less sensitive to temperature fluctuations)

product release within weeks

1047  $nm$ , cw

diode pumped

12–13 W TEM<sub>00</sub>

frequency doubled (multi-frequency) > 5W  
within year

(can be modified for single frequency)

- **SPECTRAPHYSICS**

  - Nd-YAG

  - product release by May (CLEO)

  - 1063 *nm*, cw, multi-frequency

  - 10 W

- **LIGHTWAVE ELECTRONICS**

  - Nd-YAG

  - product release?

  - 1063 *nm*, cw

  - 10 W

- Promising, but not certain for LIGO schedule
- TBD: Analyze IFO performance for intermediate wavelength coating (523 or 519 *nm*) of optics, which would keep SS option open longer with safety of gas laser.

## **SUSPENSION / CONTROL OF OPTICS**

- **Replace magnet sensing and control by electrostatic system.**

**Increase mechanical reliability and reduce noise factors.**

- **Evaluate potential of multi-pendular suspensions, reaction mass, etc.**
- **Part of this work could be contracted to HTES, Inc.?**

# Projections: Diode-Pumped, Single Frequency, cw Laser Sources

	<u>Commercial</u>	<u>State of the Art</u>
<b>IR Laser Sources</b>		
Today:	1 Watt	20 Watts
5 years:	50 Watts	200 Watts
<b>Green Laser Sources</b>		
Today	0.1 Watt	3 Watts
5 year:	10 Watts	50 Watts

## Conclusion

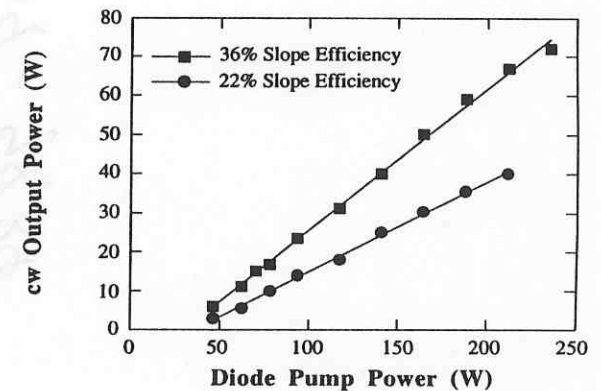
Developed theory and measured noise of 5 W injection locked system

Designed and built a cw, diode-laser-pumped, Nd:YAG laser which emits:

72 W Multimode

40 W TEM<sub>00</sub>

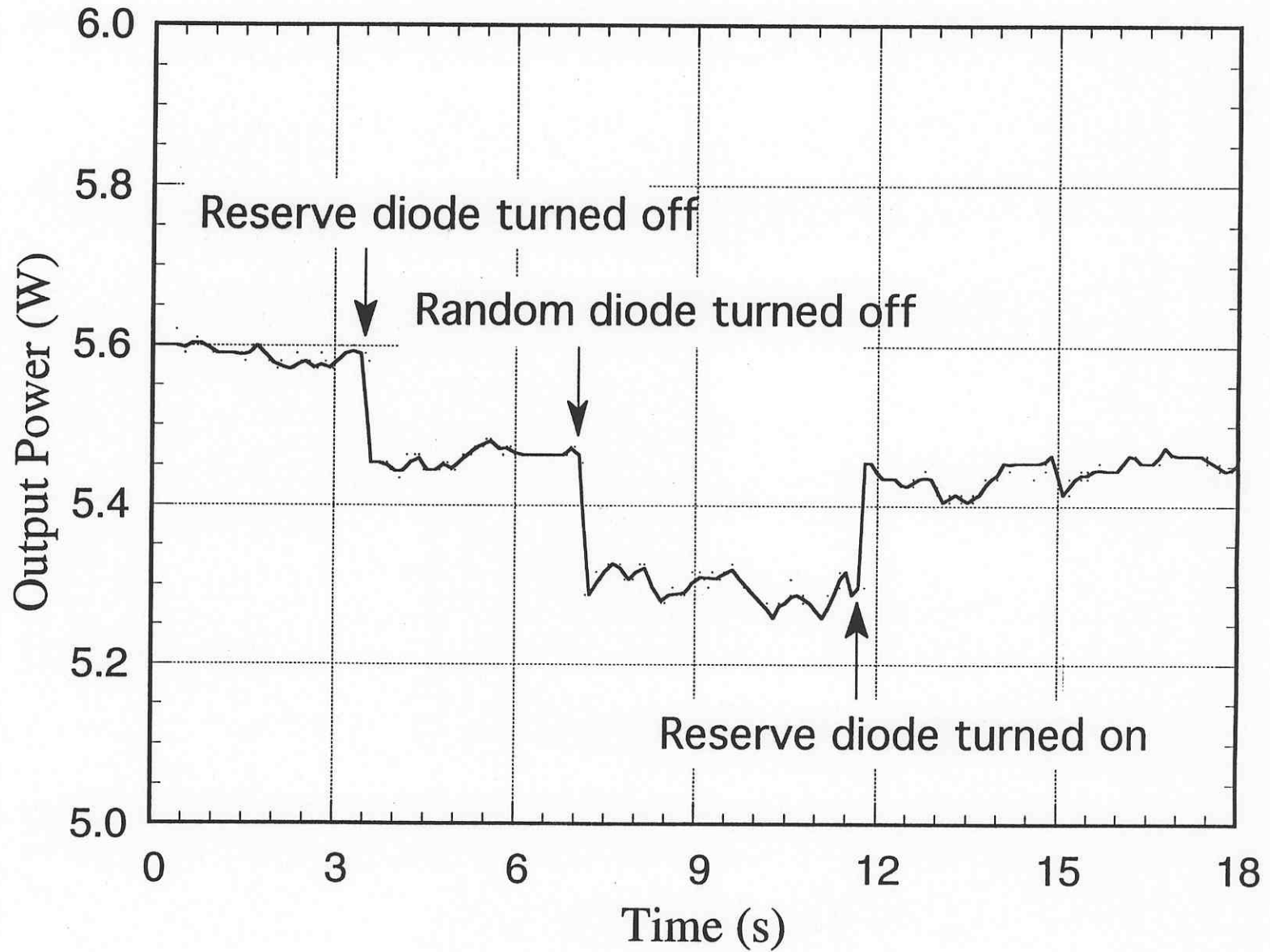
20 W single frequency



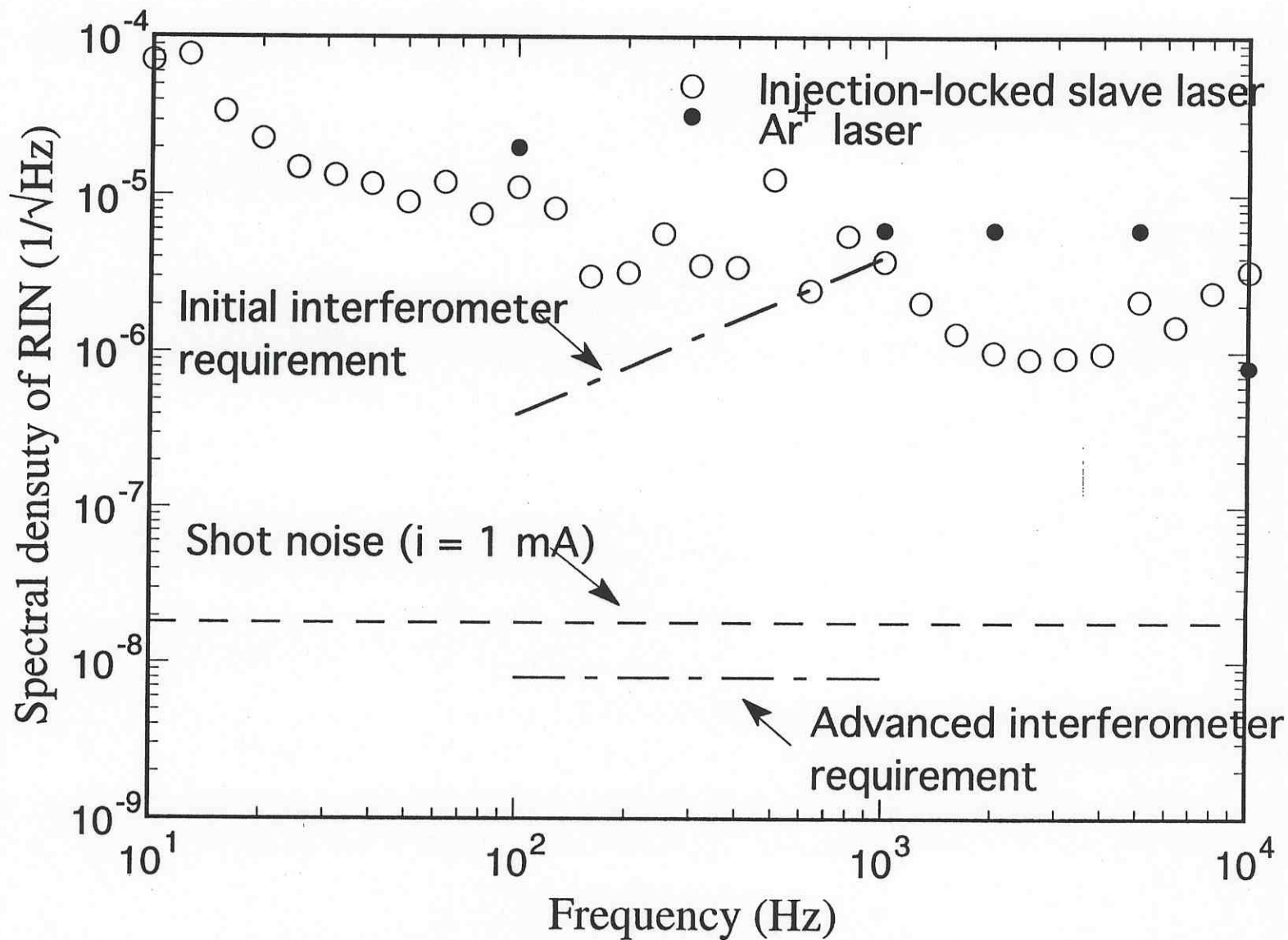
Diode-laser-pumped laser sources meeting LIGO power requirements should exist commercially by 2000



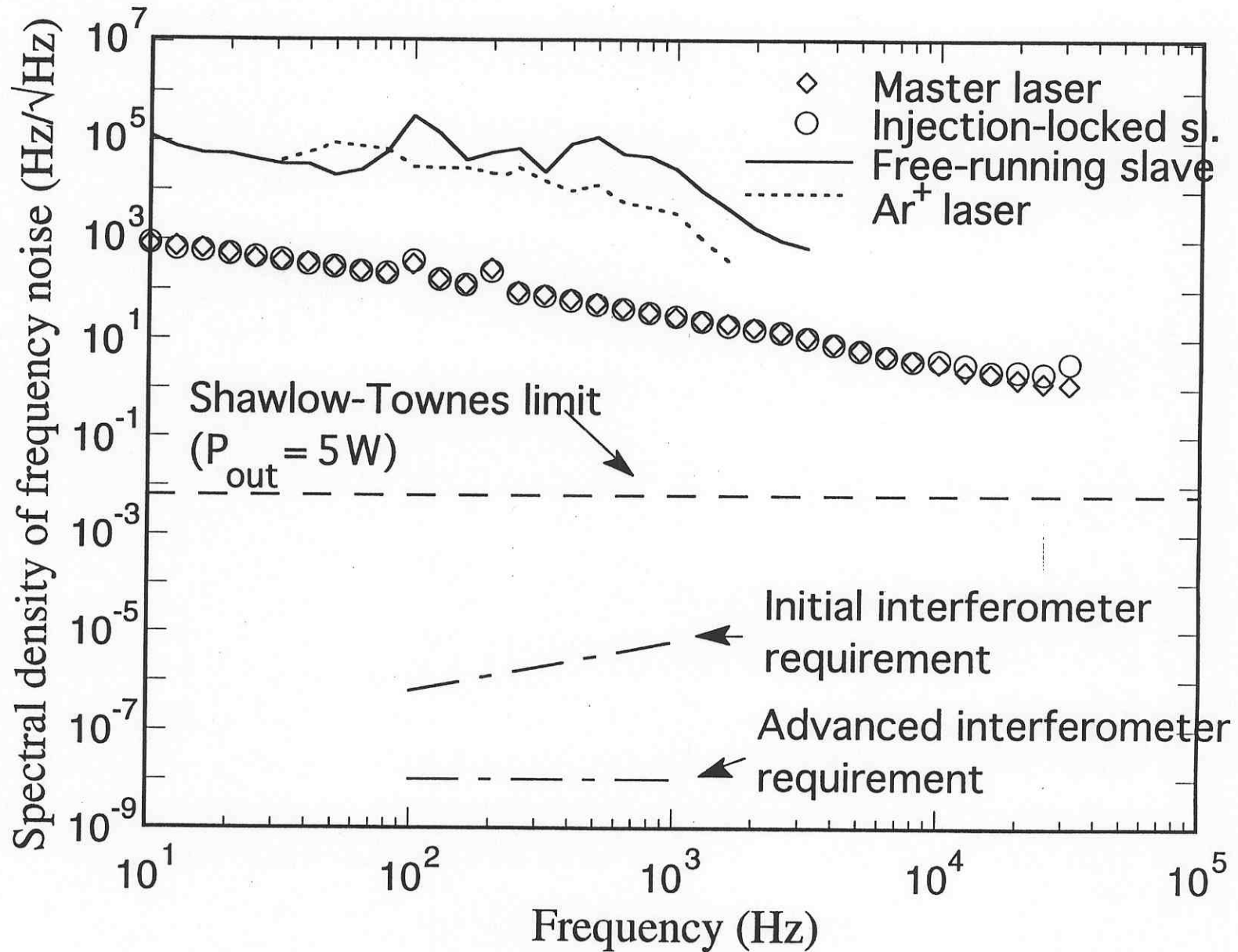
# System Reliability Test



# Intensity Noise Summary



# Frequency Noise Summary



# Schematic of Laser Head

