LIGO

# 9) Describe the down select process that led to the laser selection in more detail

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# Process

- Interested research groups pursued separate approaches to laser
  - Adelaide, Stanford, Laser Zentrum Hannover
- Three collaborating groups developed joint test document
- Key parameters measured by traveling team to two working prototypes
  - Adelaide not functioning due to continuing technical difficulties
- Round-table discussion of results at Collaboration meeting, LIGO technical management participating
- Choice of baseline made by subsystem leader (Uni Hannover/Max Planck) with LIGO concurrence
- Design pursued by Max Planck with MPI funding
  - Would have pursued any adopted design
  - Ended up with the MPI design
  - Adelaide laser to be used at Gingin
  - Stanford moving away from slab concept to fiber lasers

# Test Plan highlights

- Key Questions:
  - 1) Does the particular concept promise a successful development with high certainty?
  - 2) Can the key technology be transferred to the system developers and manufacturers?
  - 3) What are the potential sources of run time malfunction?
  - 4) Can the effort that is needed to reach LIGO specs be estimated? (e.g. number of work packages, known
  - but not yet solved problems, specialized components of limited availability or components with
  - extraordinary tight tolerances)
  - 5) Are there fringe benefits, e.g. a significant over-fulfillment of specs?

# Tests to distinguish between solutions

- Full 1064 nm output power in main beam
- Pre-modecleaner (PMC) transmission/reflection actuator/error signal
- Single frequency operation
- Power Fluctuations before PMC
- Drift and Jitter of beam axis and other low order beam moments before PMC
- Polarization and polarization fluctuations before PMC
- Reaction of the system to deliberate, power stage pump reduction
- Reaction of the system to a misalignment in one or more degrees of freedom
- Requirements on the master oscillator power / master oscillator power drop
- Start up procedure and time
- Set up procedure/time/effort from pre-assembled parts
- Requirements of resources / efficiency
- Scaling concept
- Technology transfer

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- Excerpts from

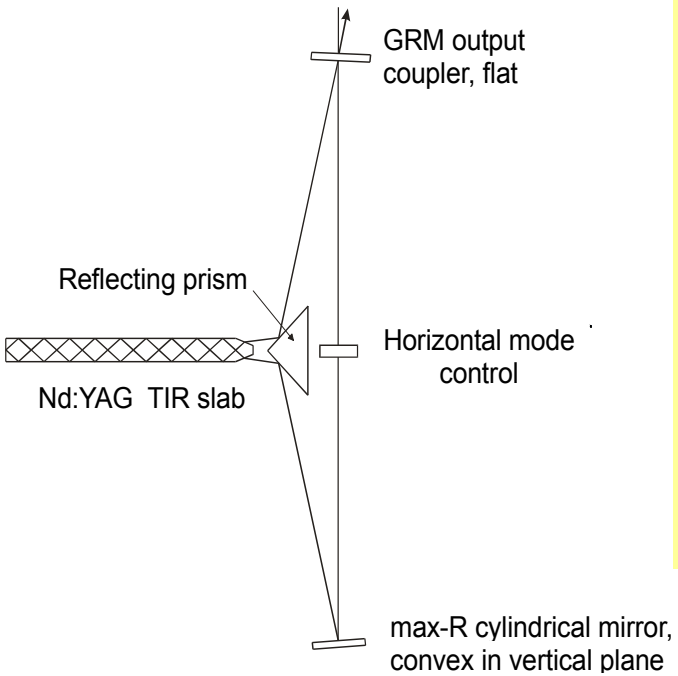
# Lasers Working Group summary

B. Willke

LSC meeting, LLO March 2003

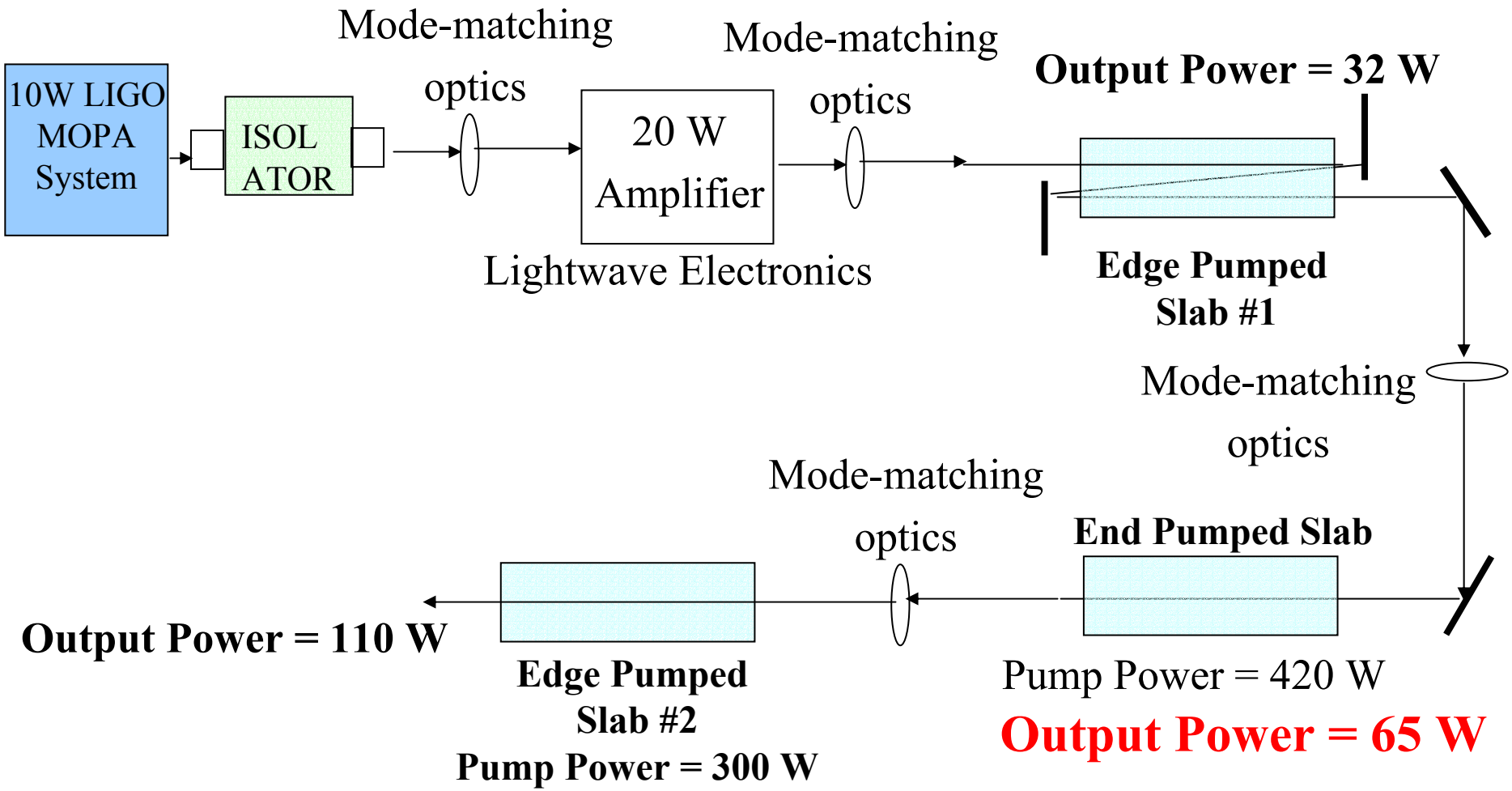
# stable-unstable oscillator - Adelaide

## 100W Laser Configuration



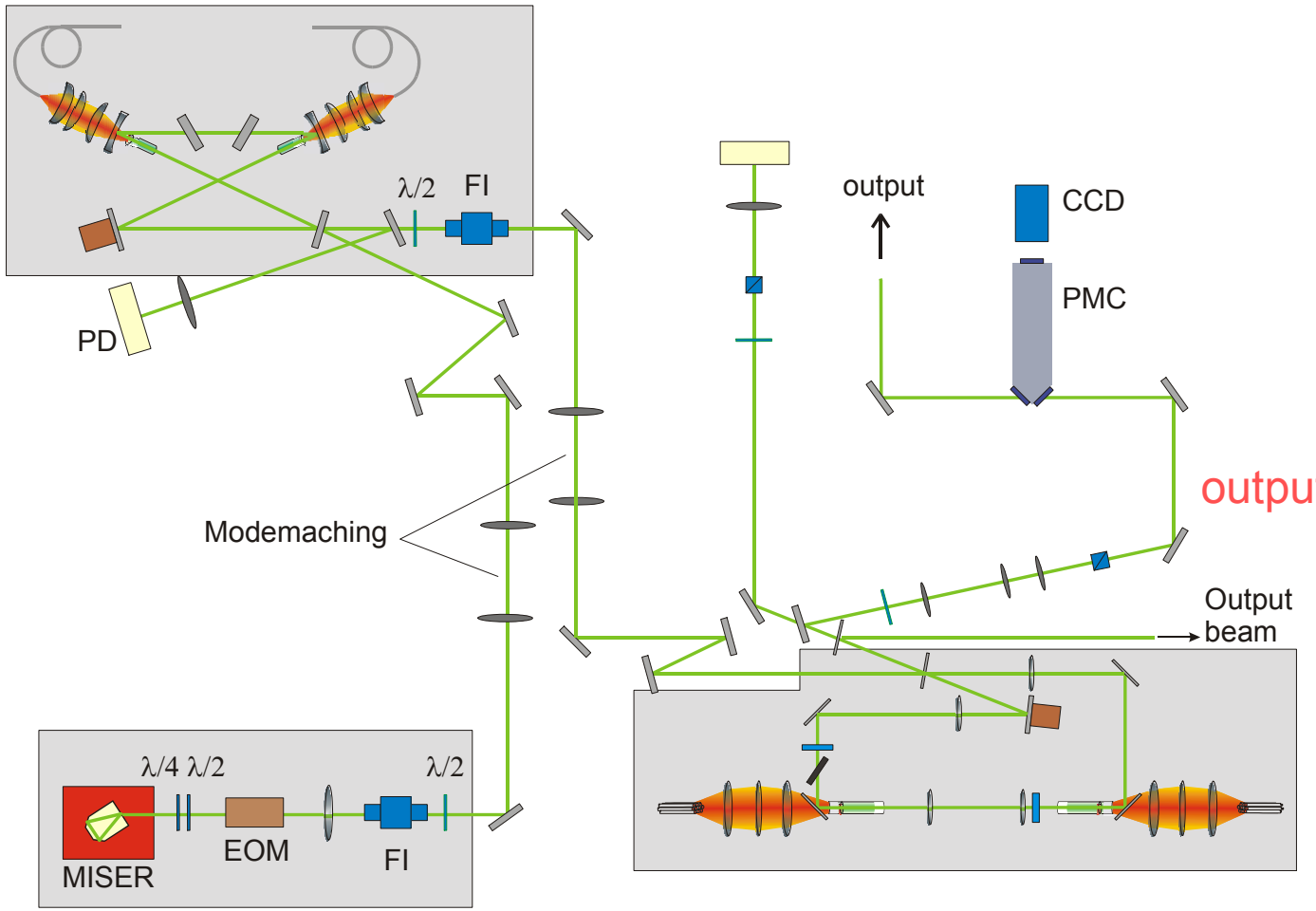

- demonstrated 30W injection-locked stable-unstable oscillator
- technical problems and delays in 100W system
  - inhomogeneous pump light distribution / pump light fluctuations
  - slabs not delivered to specifications
  - birefringence in vertical directions

# Experimental Setup for 100W demonstration

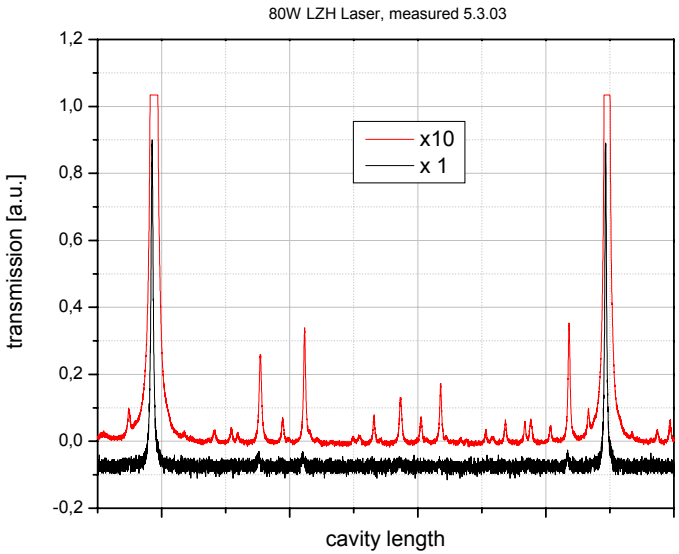


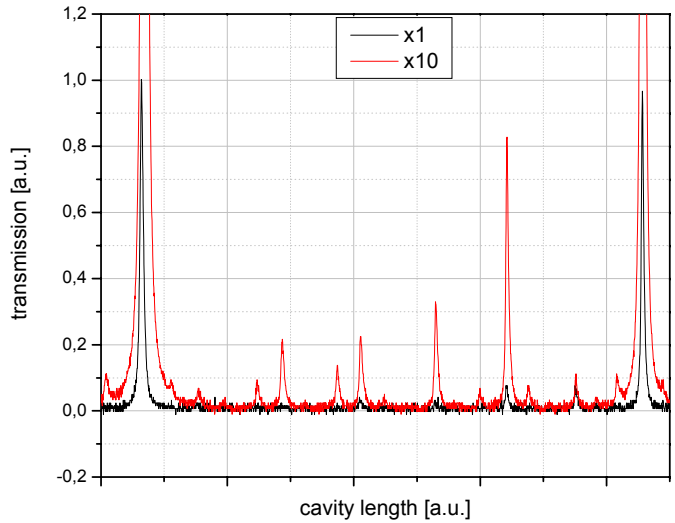
# High Power Locking Scheme

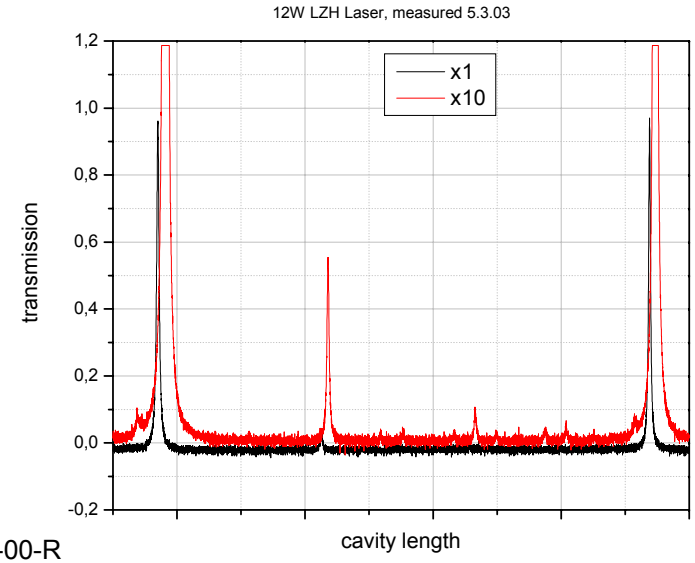
## *Setup*



# spatial profile – scanning cavity

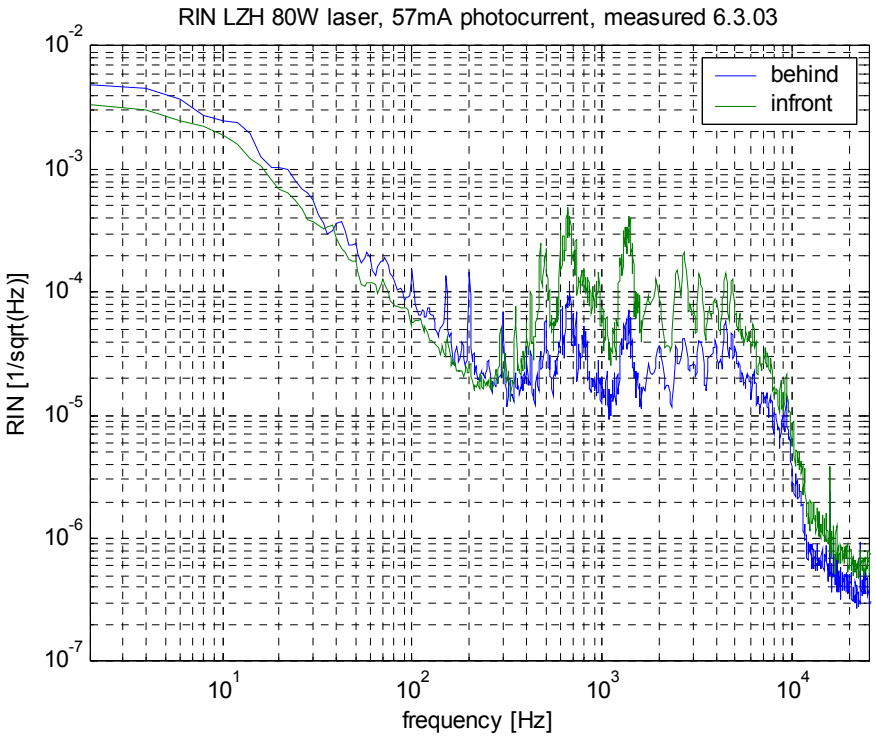


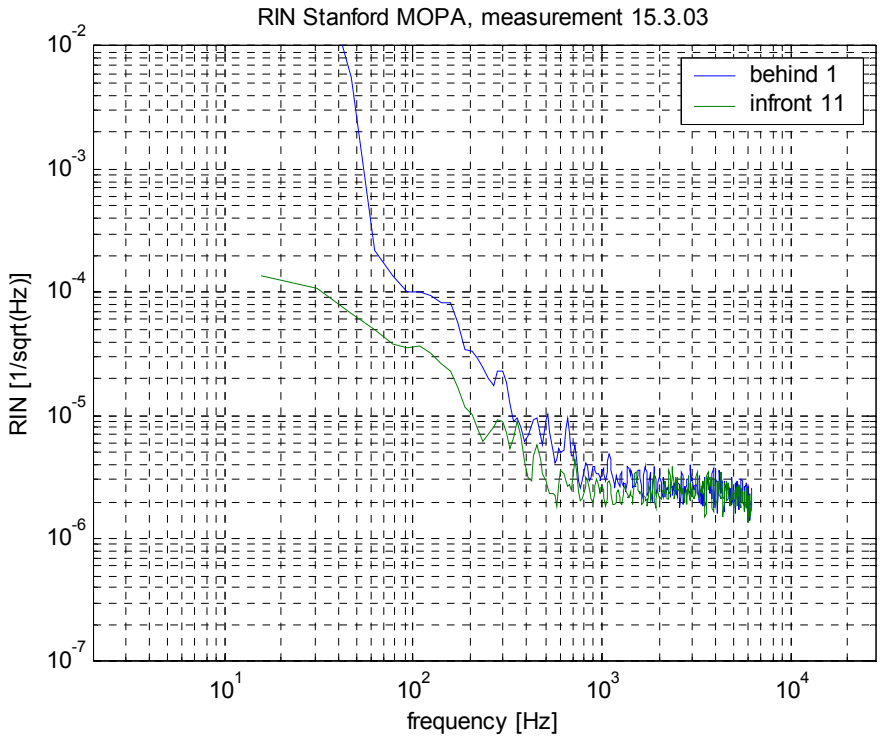




| | mode count | locked |
|---|---|---|
| Oscillator: | T=81% | T=74% |
| MOPA: | T=84% | T=73% |

# RIN – GW band


RIN LZH 80W laser, 57mA photocurrent, measured 6.3.03
behind
infront
RIN [1/sqrt(Hz)]
frequency [Hz]


RIN Stanford MOPA, measurement 15.3.03
behind 1
infront 11
RIN [1/sqrt(Hz)]
frequency [Hz]

# laser power

| (Stanford) | oscillator LZH | MOPA |
|---|---|---|
| output power | 80W | 65W |
| power fluctuations (over 10s) | high | low |
| RIN - GW band / RF | similar | |
| higher order mode content | similar | |
| fluctuations between power in higher order modes | low | high |

# downselect

- performance of MOPA / oscillator at current power levels is similar
- scaling concept to 200W level: risks involved in all systems
- most efficient choice (delays, costs) for conceptual design phase (to be performed at Laser Zentrum Hannover) is to choose
  injection-locked stable-rod oscillator
- LSC will support the MOPA / injection-locked stable-unstable development at Stanford and Adelaide as back-up solutions for the PSL