

Pre-stabilized Laser (PSL)

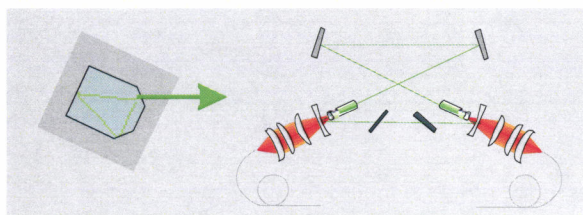
Technical Breakout Presentation **NSF Review of Advanced LIGO Project**

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- **deliver coherent radiation to allow interferometric detection of gravitational waves**
 - » 180W laser with high reliability and low fluctuations
- **reduce temporal and spatial fluctuations of the light**
 - » first layer of power and frequency stabilization before light enters the input optics (IO) subsystem
 - » provide actuator-inputs for further frequency stabilization layers (GW band: modecleaner, long term drift: long interferometer arms)
 - » stabilize laser power downstream of the suspended modecleaner
- **provide control and diagnostic tools and interfaces**
- **define and implement laser safety procedures**

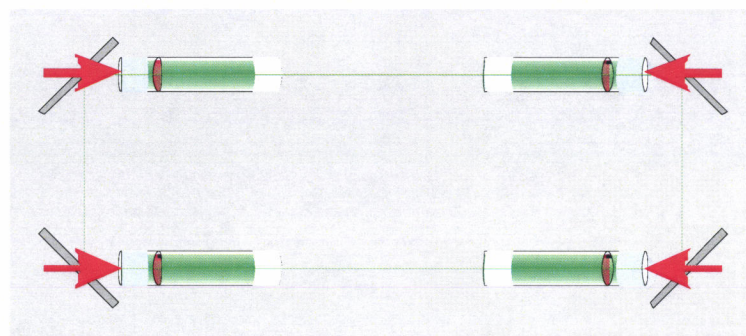
800k\$

Front-end



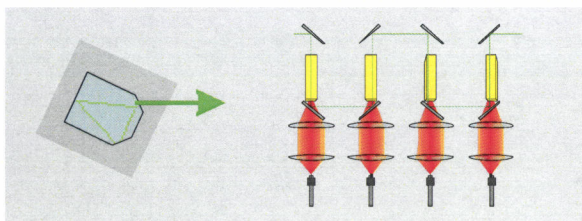
12 W oscillator

high power stage



180 W oscillator

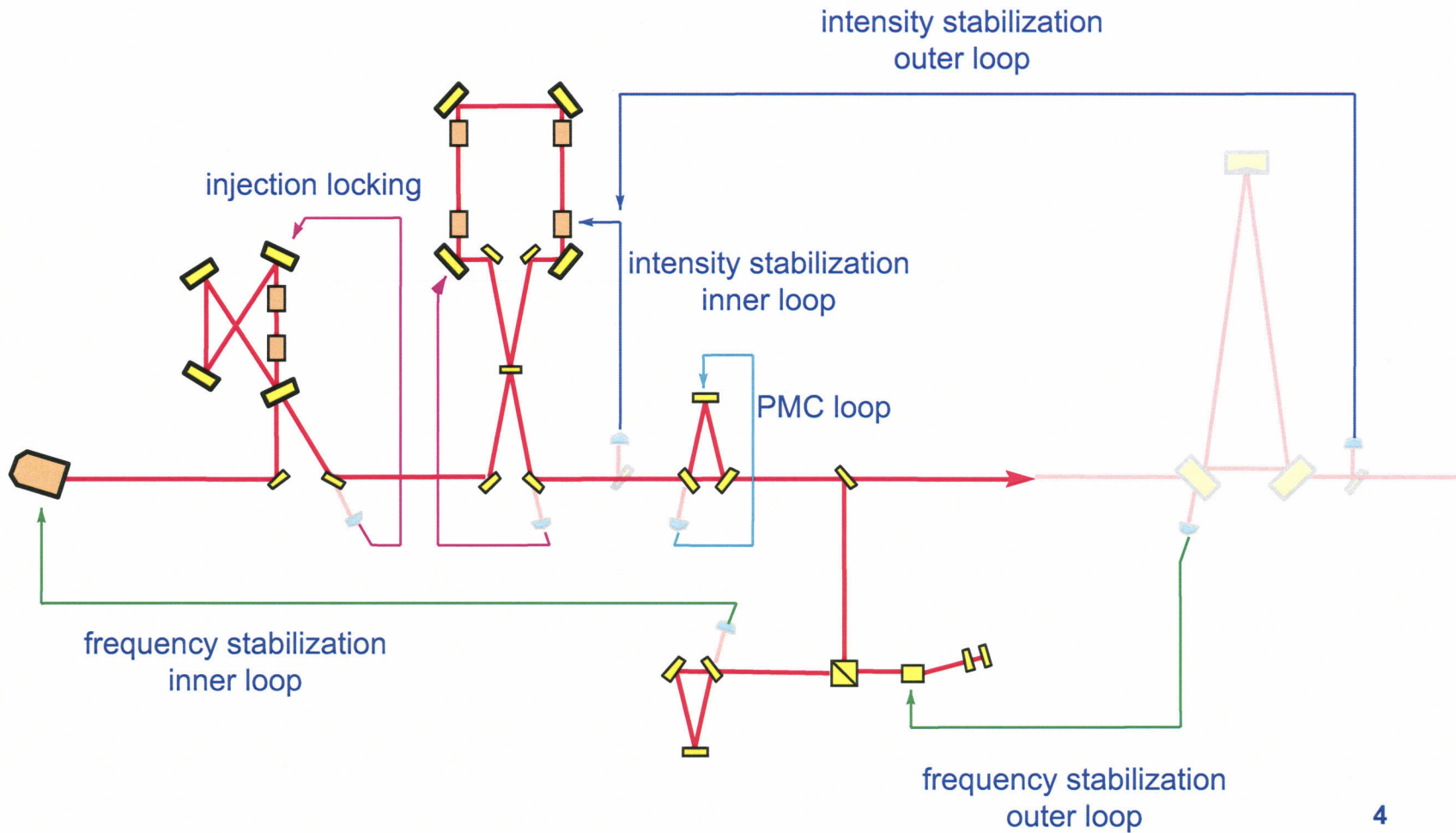
alternative front end

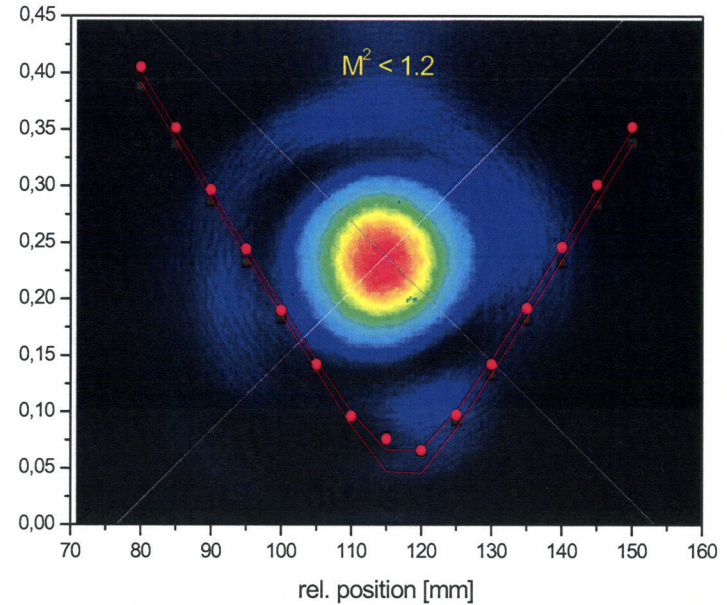
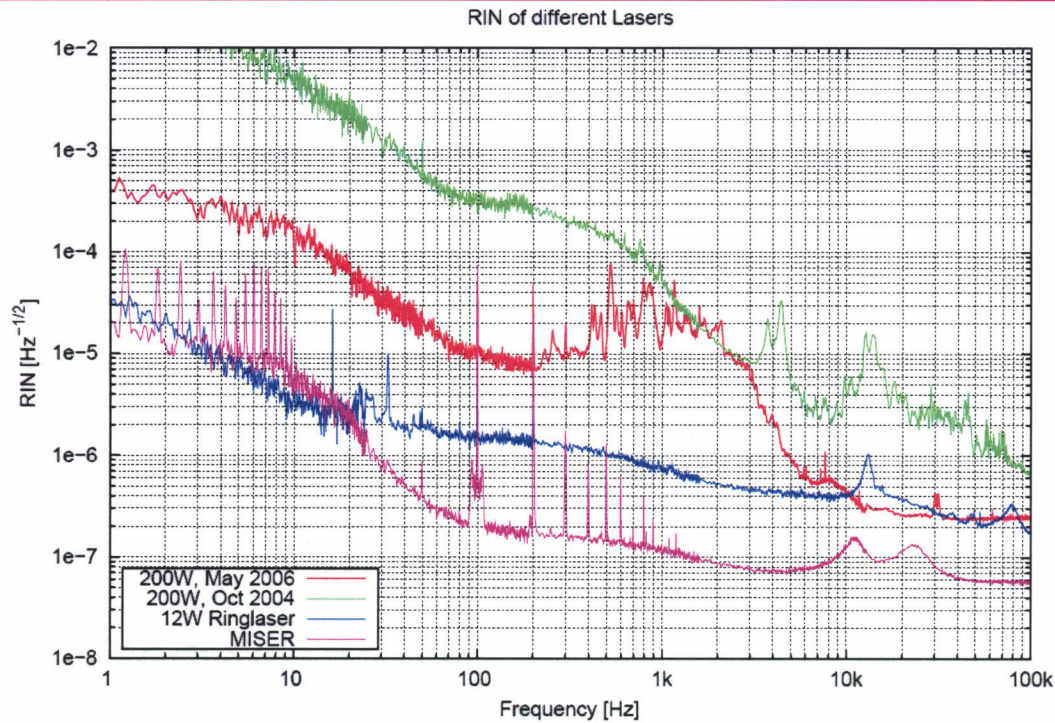


35 W amplifier

- stable front end - determines laser frequency (DC and fluctuations)
- high power stage – determines spatial profile and laser power (DC and fluctuations)
- injection locking combines system

300k\$



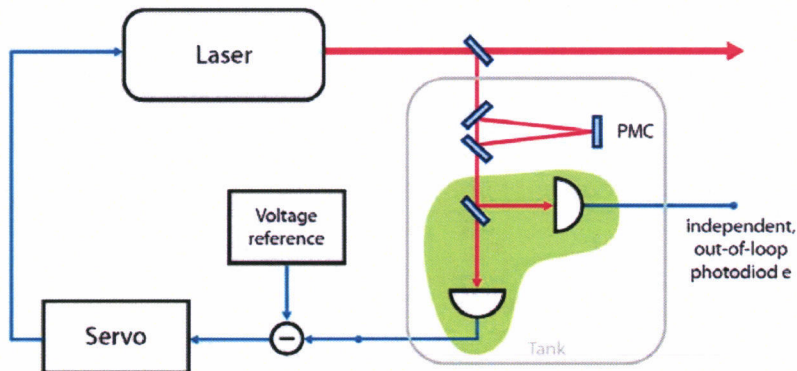


achieved:

- 180W output power
- good spatial profile
- power fluctuations are close to requirements

to verify:

- RIN at modulation frequency
- higher order mode content
- pointing fluctuations



Seifert et al., Opt. Lett. accepted for publication (2006)

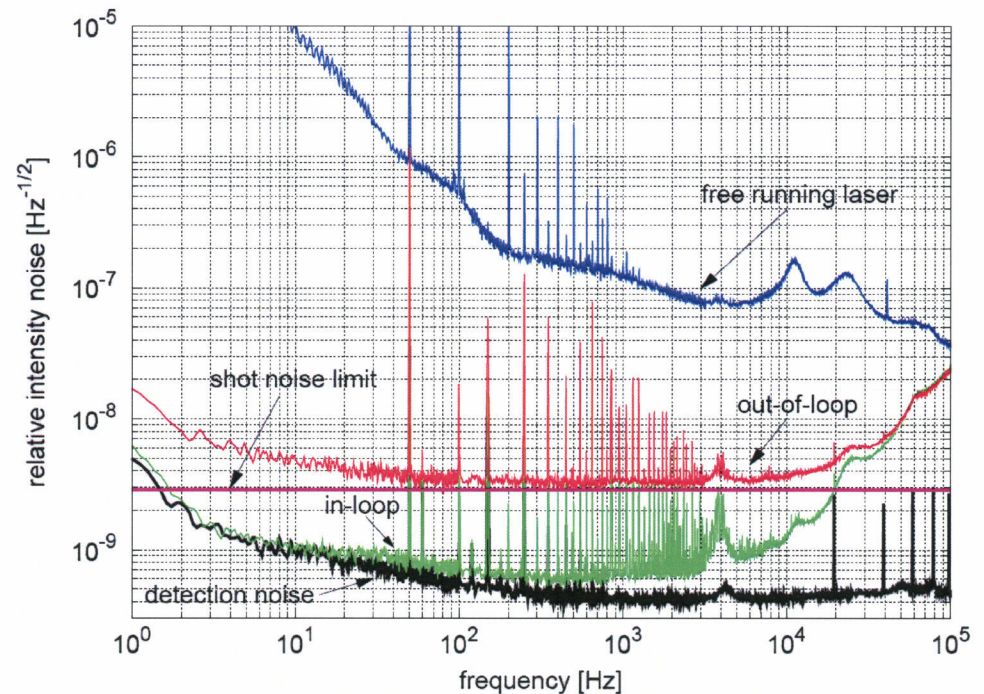
Rollins et al., Opt. Lett. 29 1876 (2004)

Abbott et al., Rev. Sci. Instr. 72 1346 (2000)

Nocera et al., Clas. Quant. Grav. 21 S481 (2004)

achieved:

- frequency noise requirement (LIGO)
- $RIN = 3 \cdot 10^{-9} / \sqrt{\text{Hz}}$ above 20Hz (in table top experiment)
- diagnostic breadboard in final design phase



next steps:

- design spatial filter (pre- modecleaner)
- design power stabilization loop (sensing outer loop, cross over)

- **develop 180W laser and stabilization**
 - » **functional prototype** (physics to specs)
 - demonstrate requirements
 - long term tests
 - » **engineering model** (fit/form/function)
- **transfer engineering model to MIT test interferometer (LASTI)**
 - » integrate and test outer power stabilization loop
 - » interface test
 - » training of LIGO personal
 - » implementation of laser safety plan
 - » keep system as second layer spare
- **fabricate reference system** using final components and final fabrication procedure
 - » keep system in Hannover as reference for AdvLIGO “lifetime”
- **fabricate observatory PSLs** and spares
- **fabricate outer-loop components, order infrastructure components** (laser enclosure, laser diode enclosure, ...)

- **long term damage / aging / dust**
 - » don't re-use components of prototypes but run these system while next design iteration is in progress
 - » extensive acceptance test of components
- **performance of outer loop power stabilization**
 - » early identification of technical limitations (sensing, pointing, ...)
 - » work with photo diode vendors
 - » relax requirement by trading RIN with arm-mismatch
- **interface mismatch**
 - » interface document, LASTI test, (use front end in possible LIGO upgrade)
- **keep expert knowledge after end of project funding (2010)**
 - » transfer know-how to AEI staff
 - » get follow up project for LZH