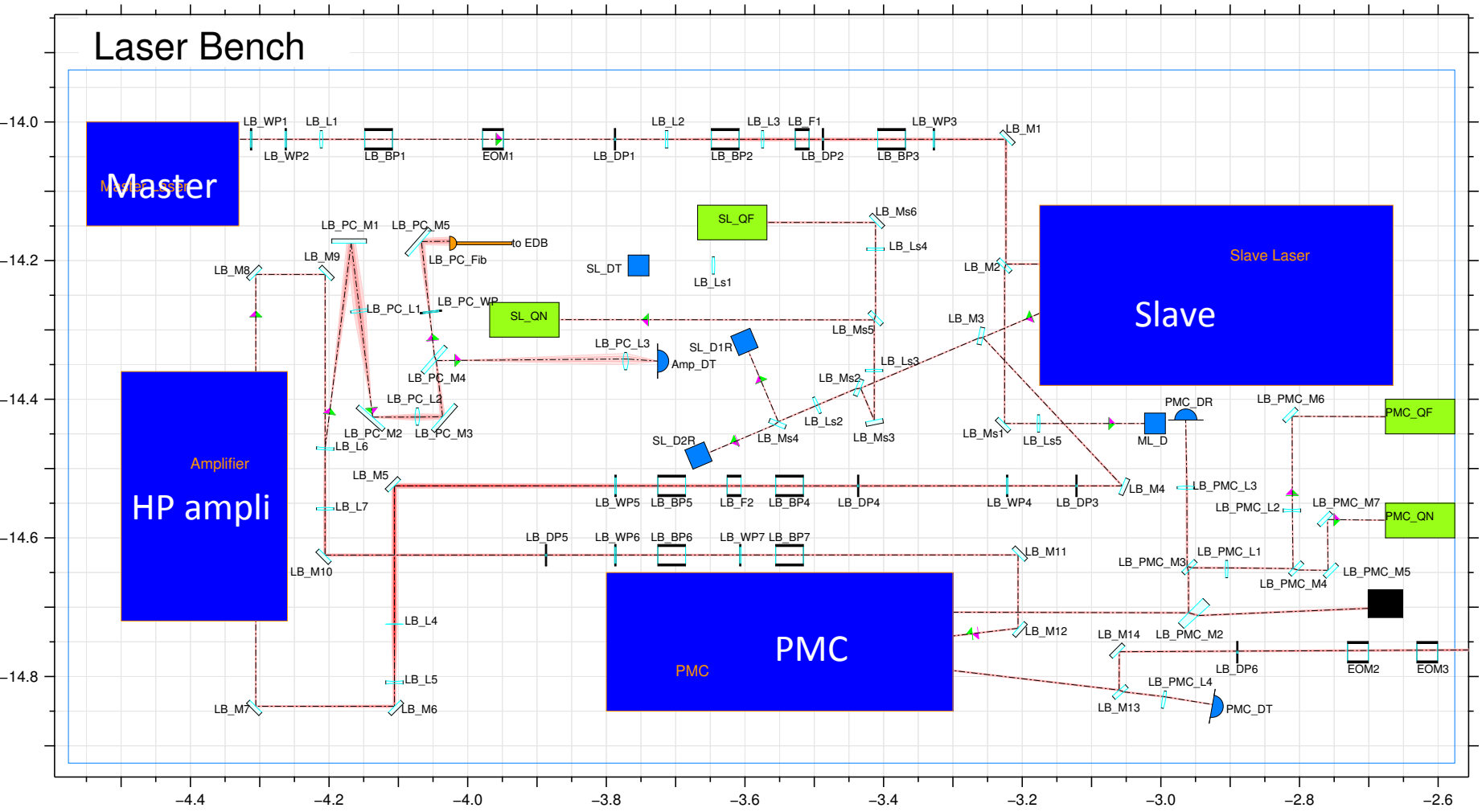
VIR- 0028A-14

Virgo+ laser system: specifications

N. Man for the PSL
ARTEMIS, CNRS (Nice)

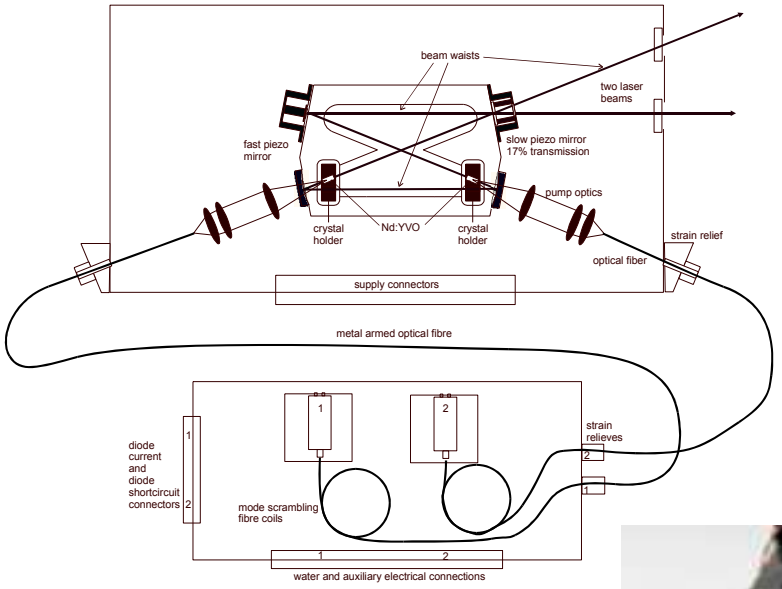
Layout & description
Achievements done in 2007-2010 (F.Cleva & ISYS team)
Status today & Next actions

Virgo+ laser bench layout



Produced in Oct 2008

Slave laser

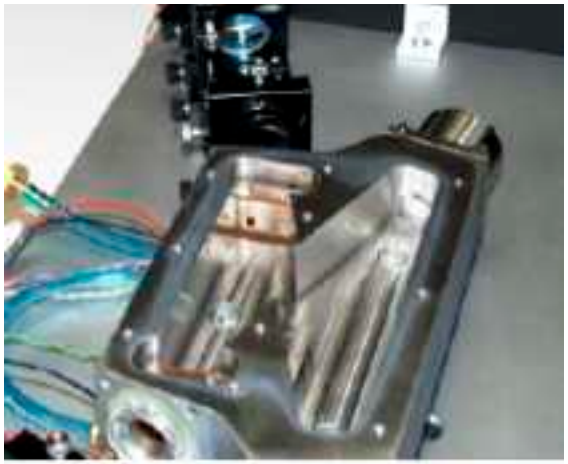


Slave laser head

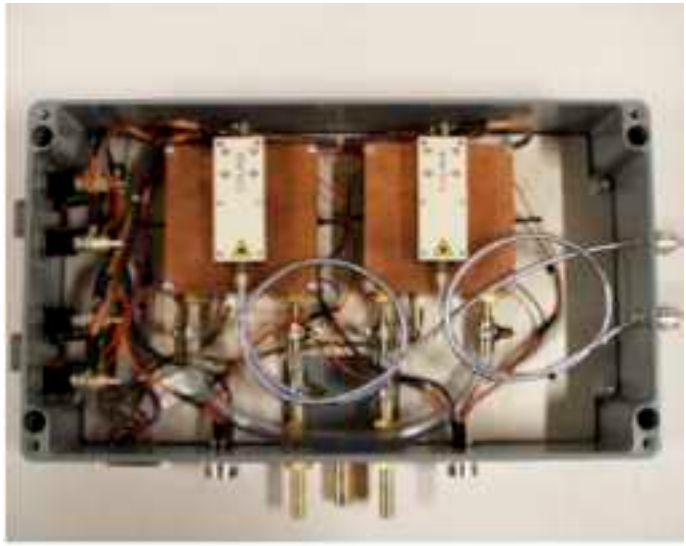
Sub-contracted to LZH (1999):

2x Nd:YVO_4 pumped by fibered laser diode

2 x pzt for controlling resonator length



Monolithic Invar structure
(LT drift 60 mBar)



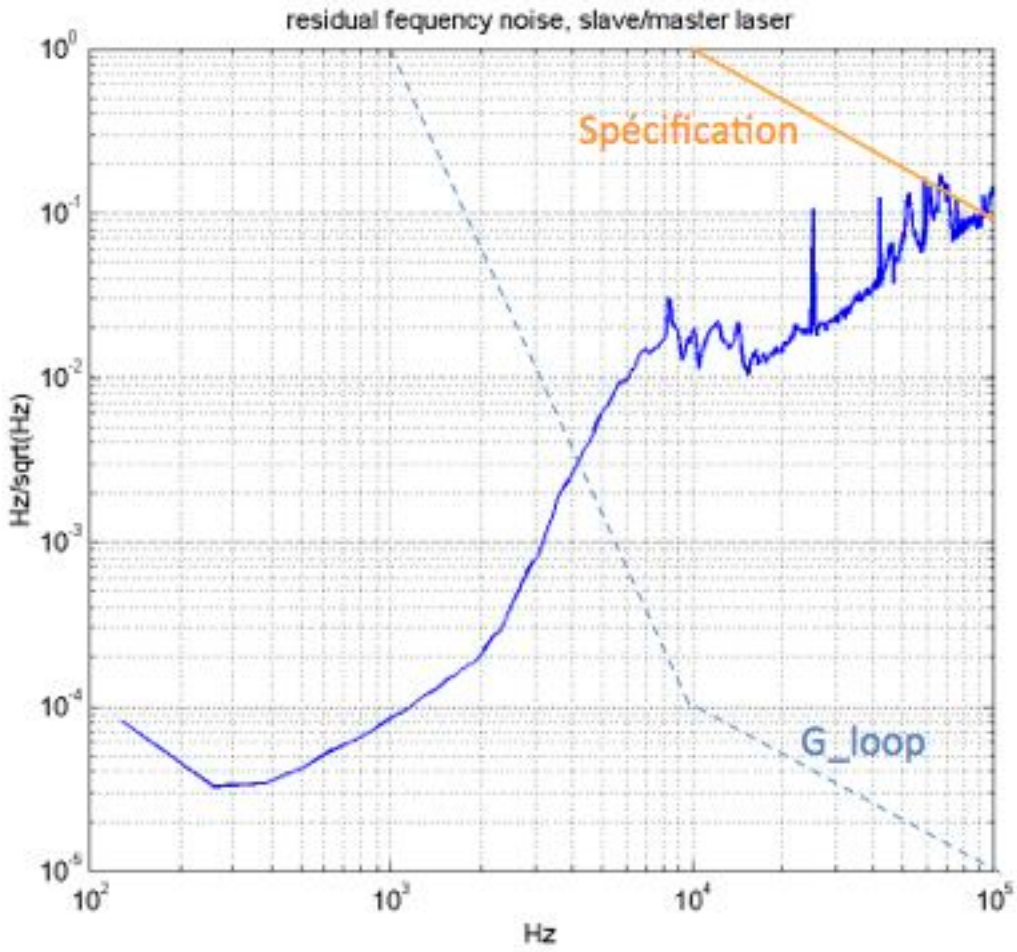
Puming laser diodes box

Injection locking Master->Slave

- Injection force the oscillation of the slave on the same frequency as the Master: for that, inject the Master beam into the slave resonator and adjust slave frequency by tuning its resonator.
- Automatically achieved in what is called the injection locking range (depends on the ratio of the 2 beam intensities)
- Keep the slave frequency in the locking range by a servo-loop acting on the pzts of the slave with the « injection servo ».

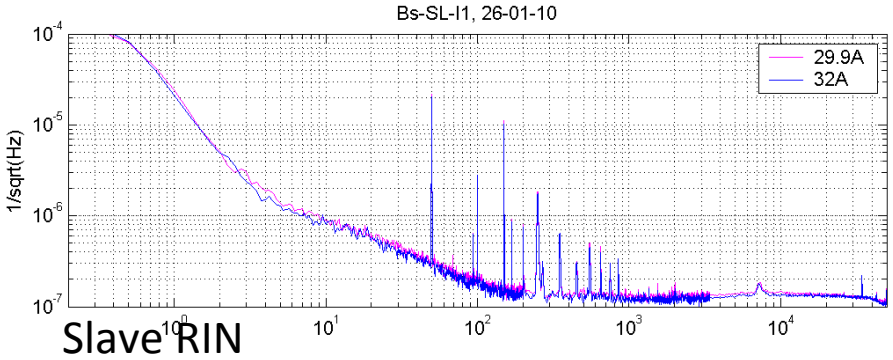
⇒ Injection locked slave laser output (I_1=31.9A;I_2=31.2A) = 23 W;

⇒ Laser amplifier input = 20.5W (2008)

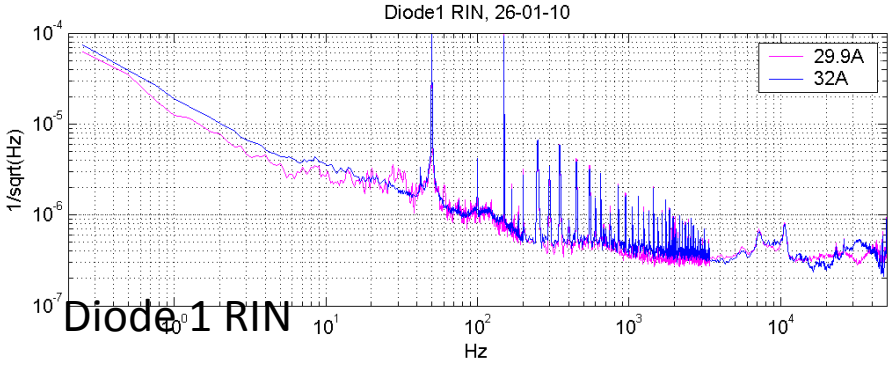


Slave laser RIN

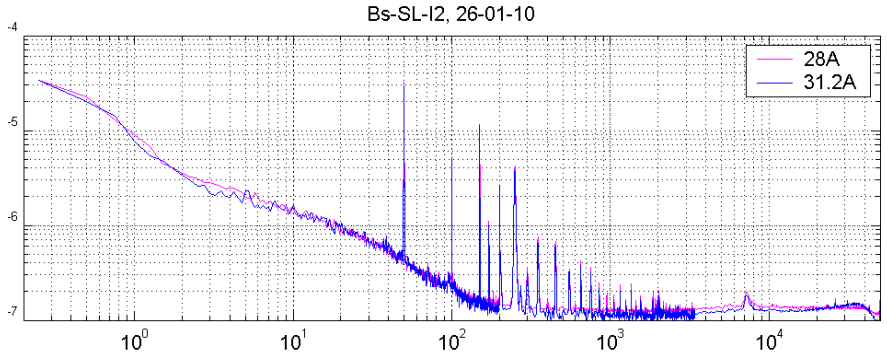
Slave laser RIN depends 1st on Laser diode RIN (2010)

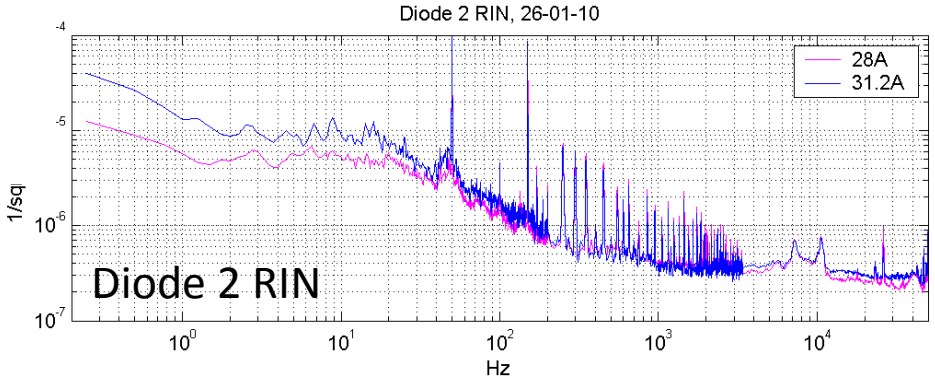


Slave RIN



Diode 1 RIN





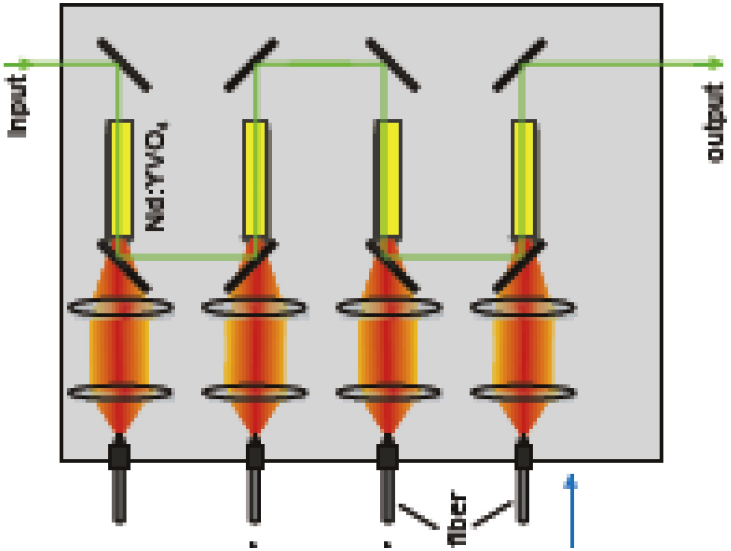
Diode 2 RIN

HP Amplifier

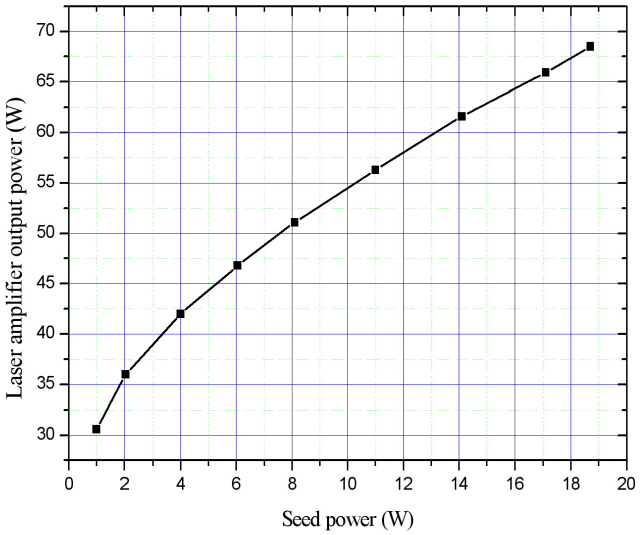
Sub-contracted to LZH (2006)

4 pumping fibered 10-12m laser diodes

4 x Nd:YVO_4 crystals



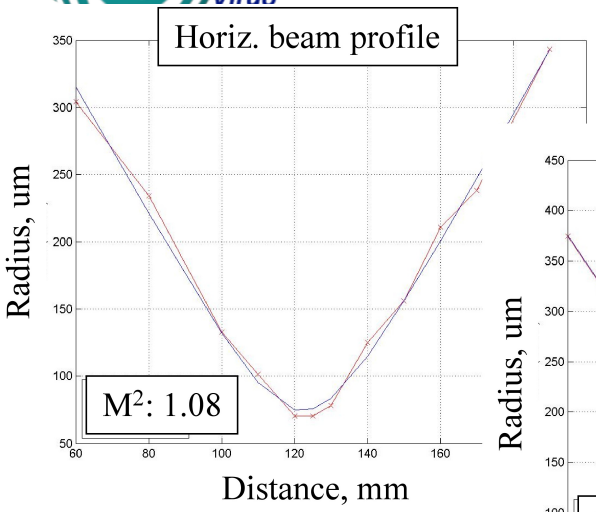
$I_1 = I_2 = 55\ A\ ;\ I_3 = I_4 = 47\ A$

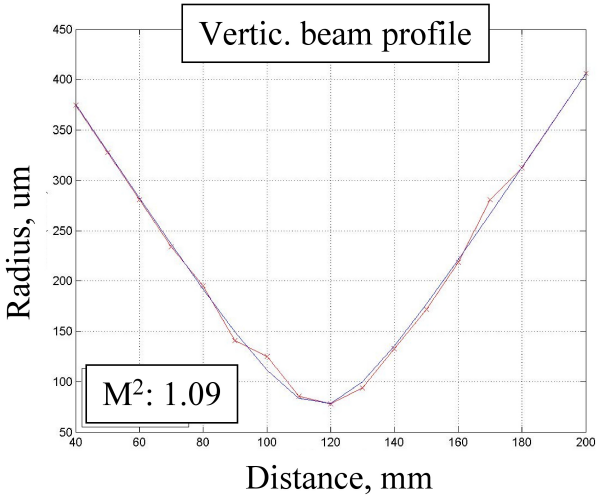


18W Slave gave 67 W Amplifier output

PSL team

HP amplifier beam profile



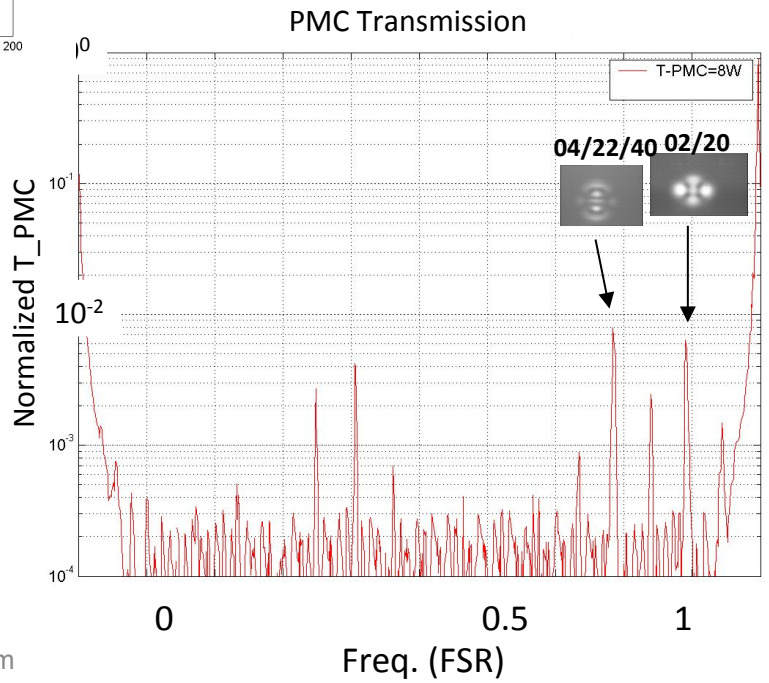


→ **Beam quality within VIRGO spec.**
(61W available in TEM00)

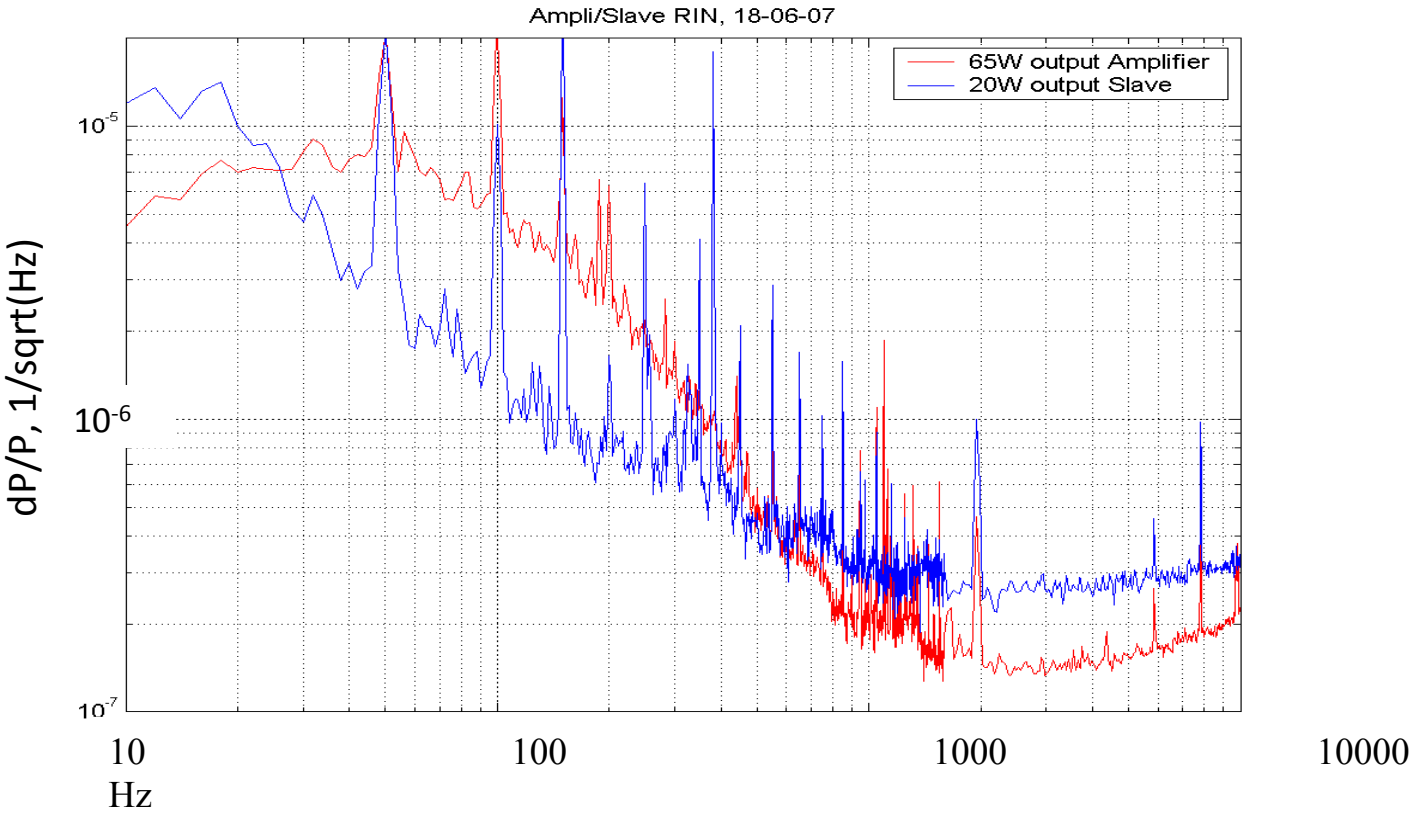
M2 < 1.1 on both directions

Coupling on cavity (pmc):

* Contrast on reflection = 94.7%
- Should be possible to optimize matching up to 96.2%



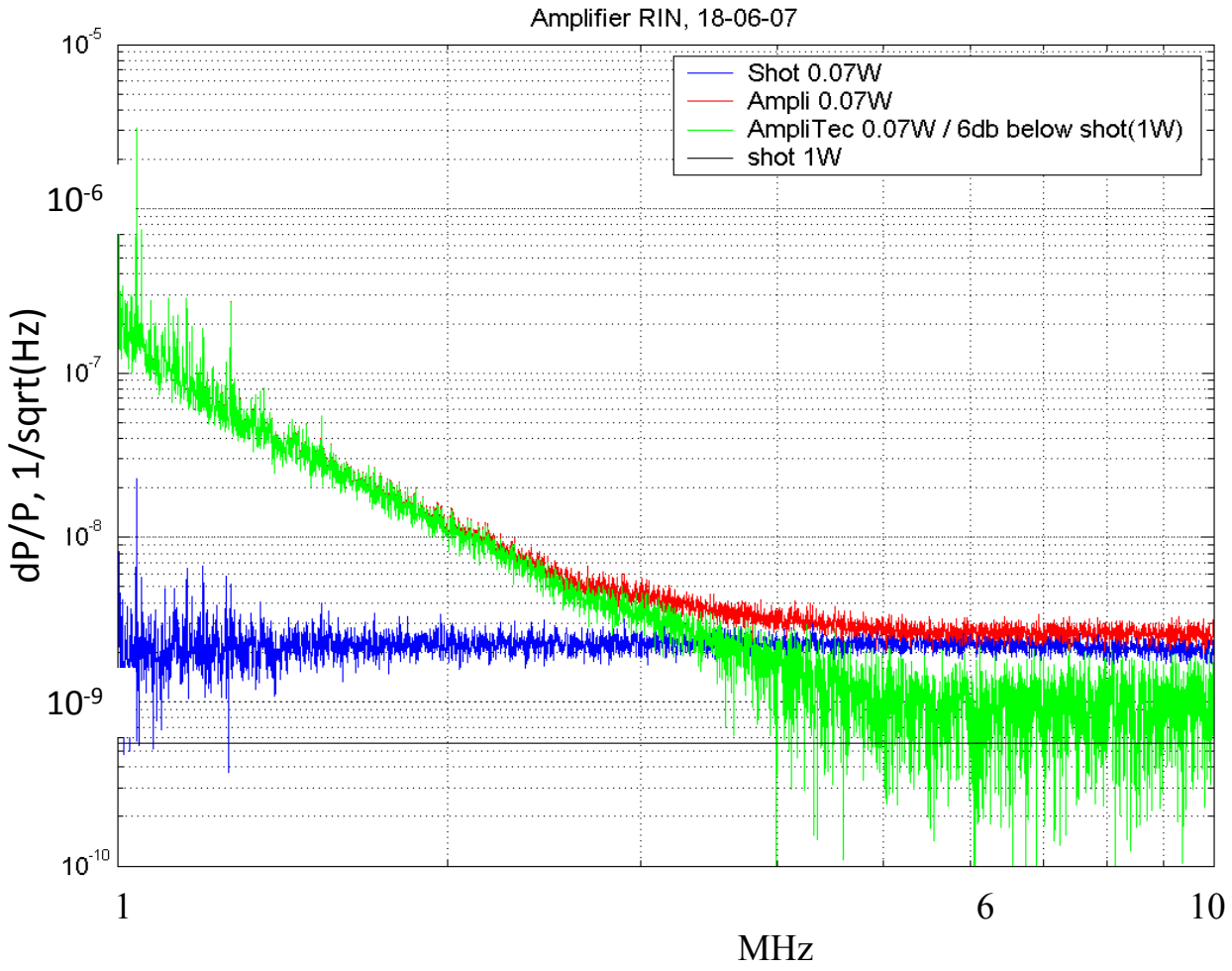
HP amplifier RIN in detection range



Free-running RIN of HP amplifier : in the specs taking into account the Pstab possible gain

HP Ampli RIN in RF range

→ **Amplifier RIN(6MHz) : 6db above shot noise (1W): needs of a pmc**



PMC functions & specs

- 2 functions:

  In frequency to filter out the extra RIN @ 6MHz

  - In spatial to filter out the HOM in the laser beam

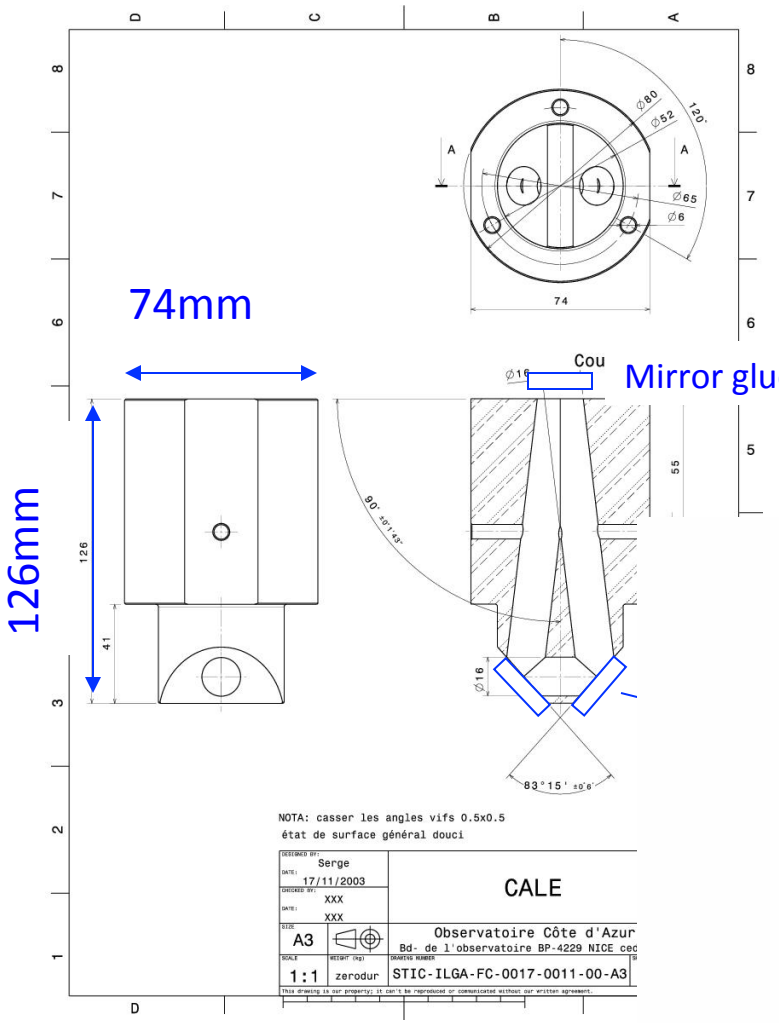
- Specs:

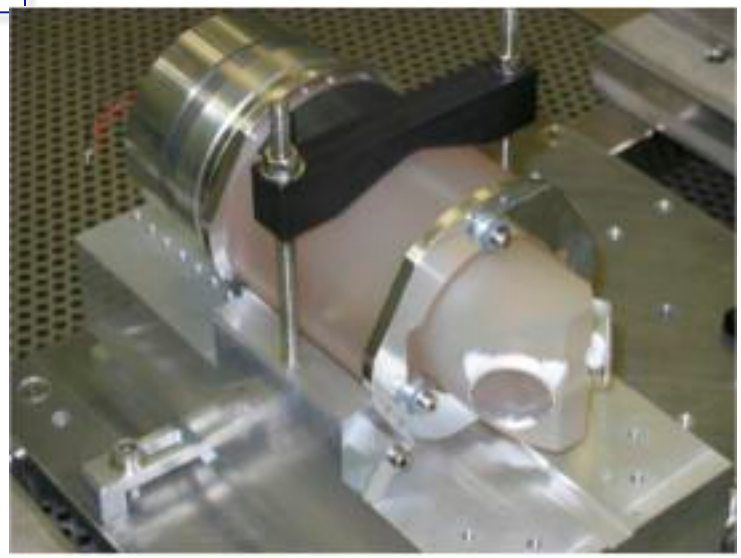
  Low" finesse: 500, (optical flux in PMC: 2.4MW/cm2,
  Losses< 1.4%, assuming 30ppm losses / 3mirrors)

  - Length = 0.13m (main spacer mechanical resonance above 10kHz)
  - End mirror curvature 4m, (waist size 500μm, low degeneracy)
    - Filtering @ 6.25MHz is 15dB

- Design:
- Triangular zerodur cavity
- Controlled by 1 pzt
- Vacuum tank with Brewster window

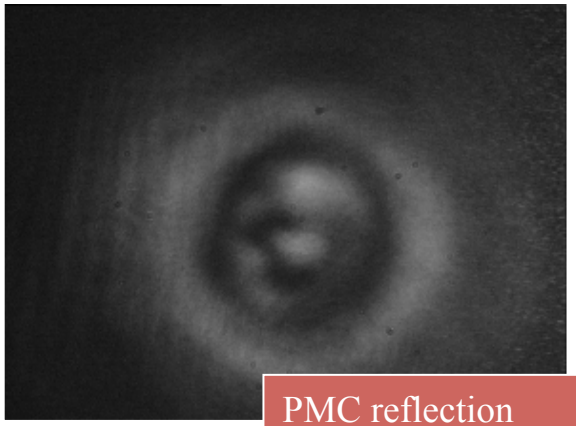
PMC Virgo +


74mm
126mm
Mirror glued on piezo
NOTA: casser les angles vifs 0.5x0.5
état de surface général douci
Serge
17/11/2003
XXX
XXX
CALE
A3
1:1
zerodur
Observatoire Côte d'Azur
Bd- de l'observatoire BP-4229 NICE cedex
STIC-ILGA-FC-0017-0011-00-A3




Total internal reflection
Pickup prisms adjusted
50W

PMC results



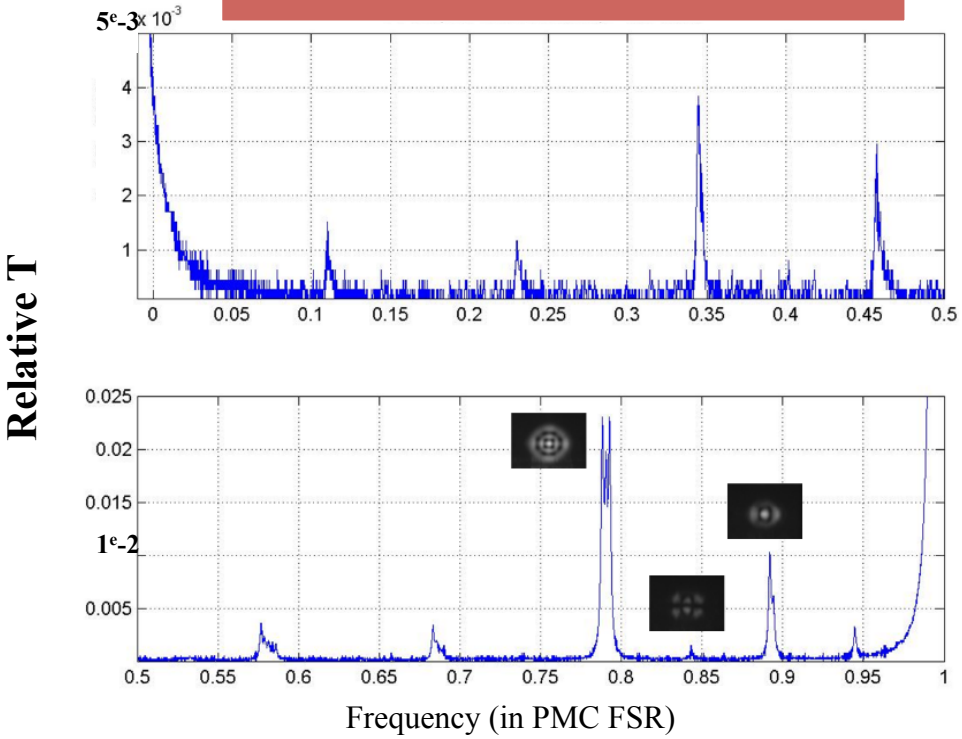
PMC reflection

→ Amplifier beam high order modes content < 6%

* Amplifier full power redirected towards PMC:

→ T = 90%, (with 57.4W incident / 51.6W transmitted)

PMC transmission, 51.6W

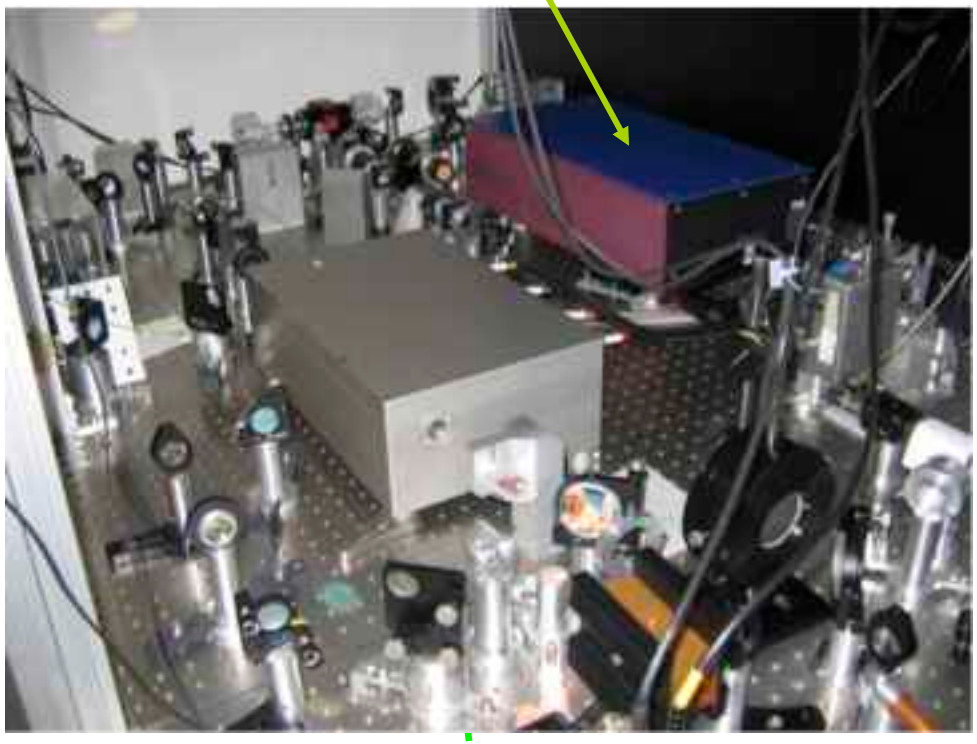


V+ laser bench

Pre Mode Cleaner

4 pump diodes fiber of HP amplifier

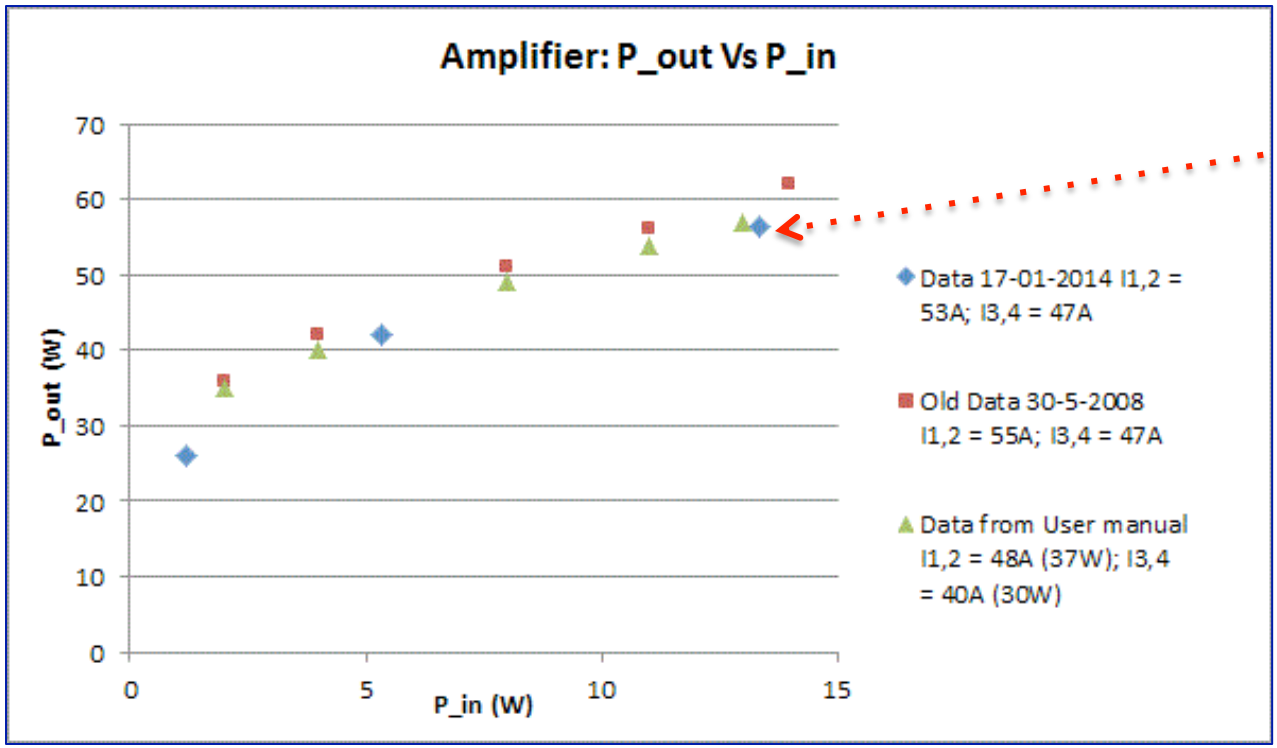
Slave laser



Output Input

Status of V+ laser bench

V+ laser bench installed (+ cabling+ water pipes + air flow…) in new clean room (end of Dec):
Pumping diode of Slave laser re-connected : output 19W nominal but power drops to 15.7W today due to 1 aged diode
HP amplifier could be re-used (15th Jan) and delivers 56W for 13 W input: diodes seem all OK



56W with 13W input

HP laser output vs Input from slave laser: compatible with previous results in 2008 and the ones given by the manufacturer

P stab status & specs

P stab: the 2 vacuum boxes: 1x [4-Photodiodes'] & 1x [Electronics'], produced & delivered this week

RECALL OF SPECS:

RIN in the detection band:

From F.Cleva (05/13) VIR-0211A-13

We go on for 4*100mA (512mW) on 2 sets of {2 PDs in parallel}: (PD1 + PD2) & (PD3 + PD4)

Assuming (PD1 + PD2) is Out of Loop, & an elec. noise floor of 7^{e}-10/sqrt(Hz) @30Hz

-> OoL RIN (PD1+PD2) = **2.0^{e}-9/sqrt(Hz)**
-> IL RIN (PD3+PD4) = **1.44-9/sqrt(Hz)**

Assuming (PD1+PD2+PD3+PD4) is In Loop, & elec. noise floor of 7^{e}-10/sqrt(Hz) @30Hz
-> IL RIN = **1.13^{e}-9/sqrt(Hz)**

→a 4 PDs scheme is compliant with AdvV (updated specif)

Specifications:

- AdvV specification (from VIR-0419A-12): 1.22^{e}-9/sqrt(Hz) @ 30Hz
- AdvV specification (from TDR): 2.35^{e}-9/sqrt(Hz) @ 30Hz

P stab specifications 2/

RECALL OF SPECS :

RIN at modulation frequencies:

From F.Cleva (05/13) VIR-0211A-13

Shot noise limited for 0.1W at 6.27/ 8.36/ 56.4 MHz:

*→ It means the technical RIN less or equal to sqrt(3.2^{e}-19*0.08A) / 0.08A = **2^{e}-9 /sqrt(Hz)** ,*
(assuming 0.8A/W for the photodiodes)

*Assuming one V+ like PMC, the specification becomes **1.2^{e}-8/sqrt(Hz)@ 6MHz***
*Assuming two V+ like PMC, the specification becomes **6.9^{e}-8/sqrt(Hz)@ 6MHz***

(Pole=1.07MHz, finesse 500, half length 0.14m)

Next

Next things to do:

- Continue with the PMC, align and check out as long as the lasers are working
- Acquire monitorings of the laser parameters in order to diagnose the failures and to prepare the LT tests.
- Replace the slave diodes when necessary (new laser diodes purchased) or asap if it does'nt slow down the pace
- Prepare spare pieces for the power stab boxes in parallel
- Comply with the Deadline of V+ laser bench given by IMC lock critical path
- Put together again the list of components and the documention