Status of thermal compensation in Virgo
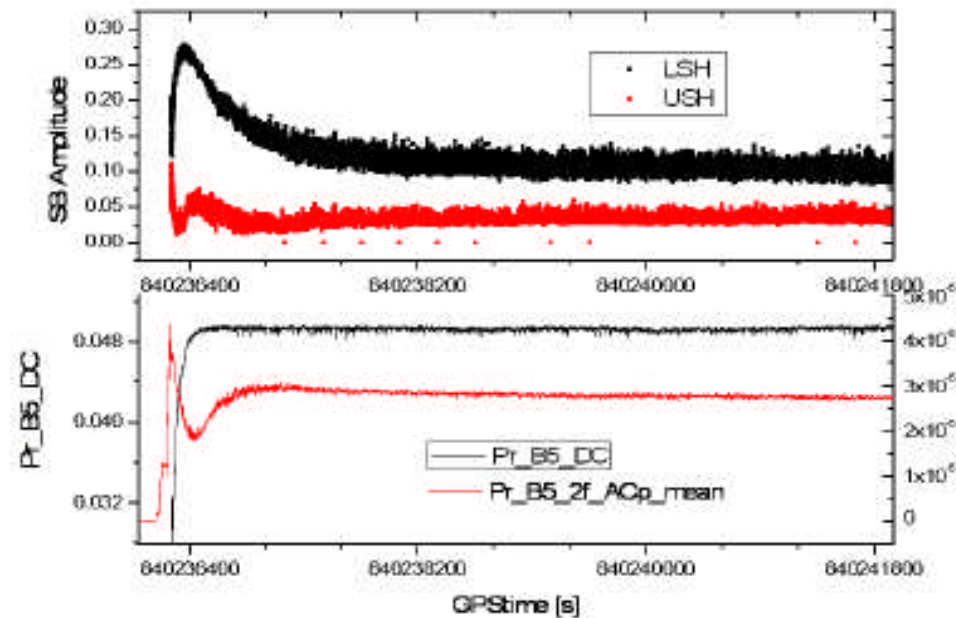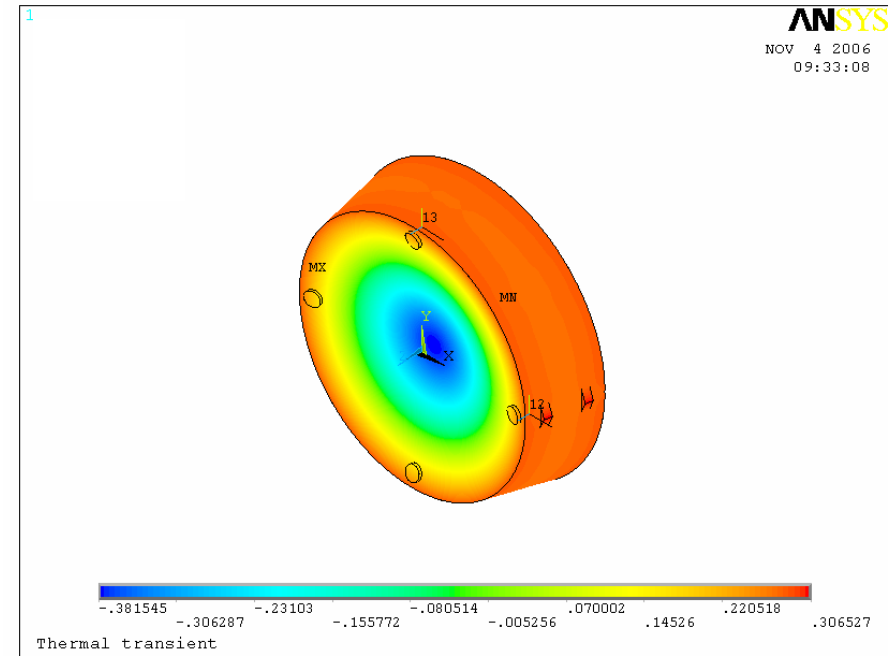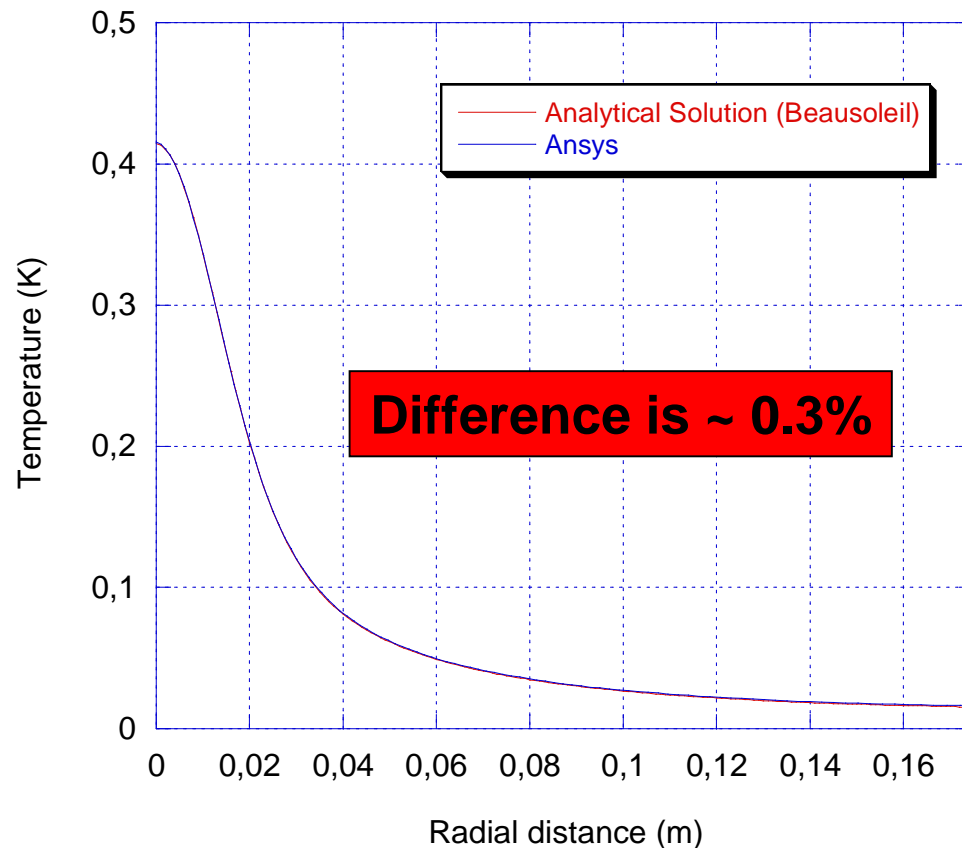
Roma Tor Vergata

LIGO-G070350-00-Z

Thermal Lensing

- Observed in Virgo through reduction of the sidebands gain.

Building and validating the FE model

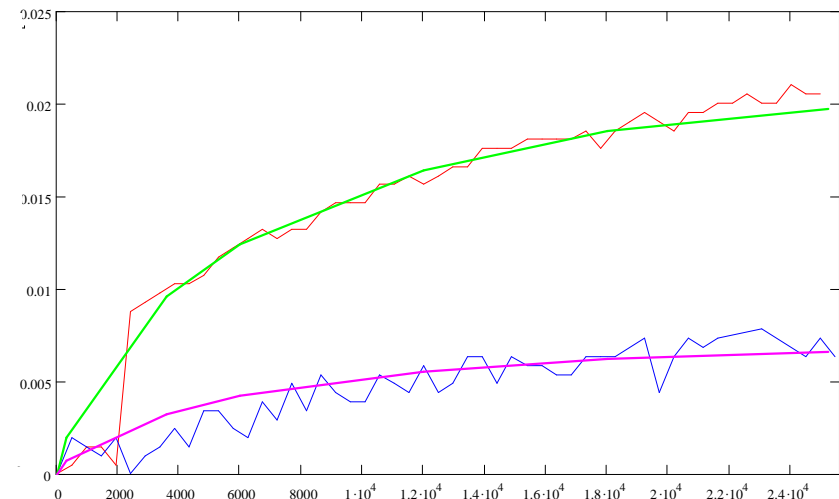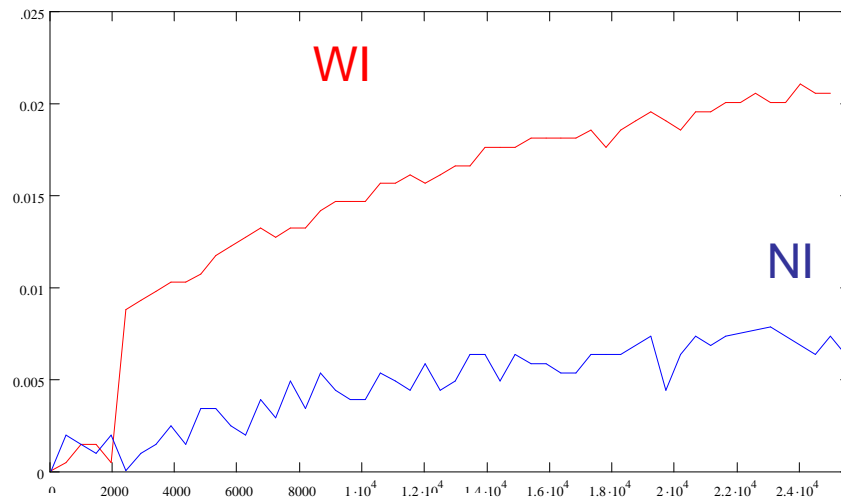Comparison with analytical solution
Beausoleil (LIGO-P020026-00-D)

- DRUM MODE
- ANSYS FEM f= 5584.15 Hz
- Experimental value f= 5584.7 Hz

Difference is 0.55Hz less than 0.01%

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Evaluating the losses of the ITMs

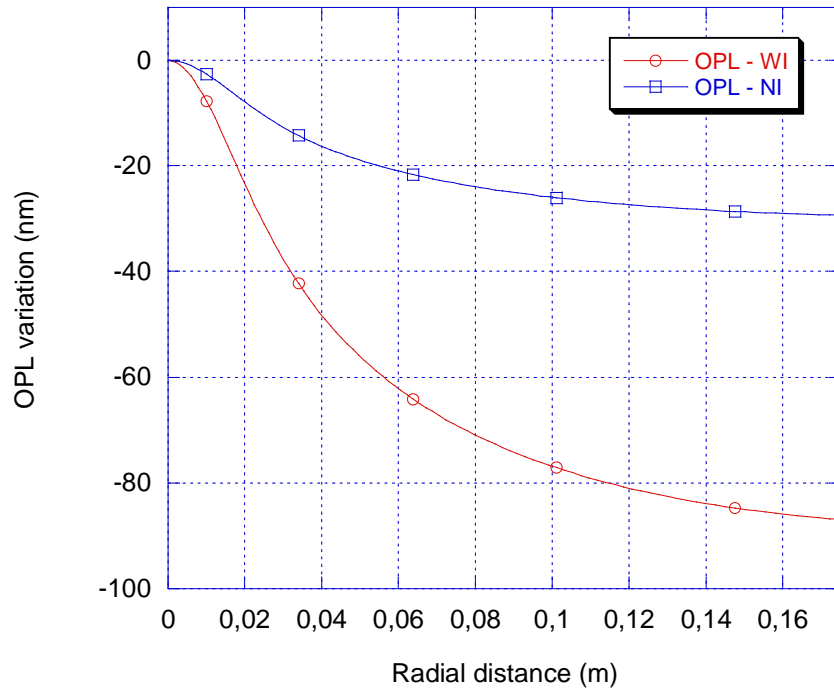Red and blue curves experimental frequency shifts   green and pink FEM results

ITMs effective losses

WI 7.70 ppm   **NI 2.30 ppm**

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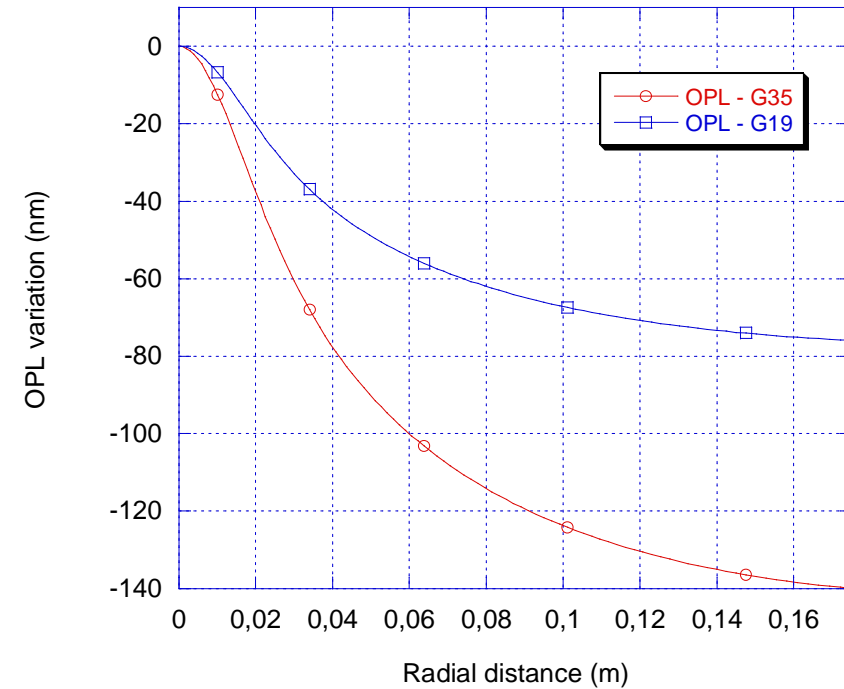
Thermal Lensing

Current Thermal lensing

Thermal lensing in Virgo+, P_{las}=25W; Finesse=150 (nominal losses)

Parameters as in R. Flaminio
VIR-NOT-EGO-1390-324

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TL Compensation

- ## Different solutions already investigated (LIGO):
  - Heating ring
  - Shielded heating ring
  - CO_2 laser

- ## Proposed TCS for Virgo+: annular heating of ITMs with dc CO_2 laser

  Desirable properties:
  - It is easily adaptable as new understanding of the ITF is realized
  - It does not require a significant vacuum incursion to install as this would lead to significant down time to the instrument

- "Annular" profile
  - from simulations: reasonable parameters to compensate inner radius~2.5 cm, outer radius~14 cm

TCS Power requirements

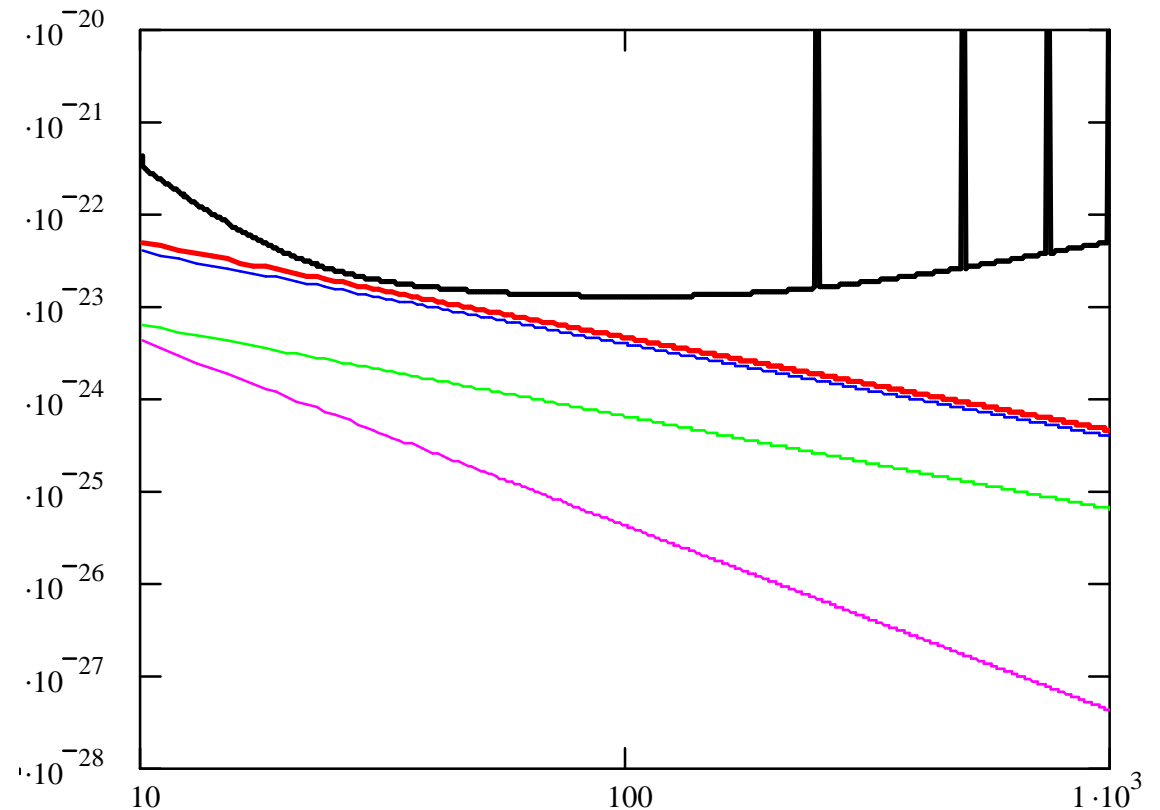|	
Virgo now on WI mirror (losses 7.70ppm)	~1.8 W
Virgo (nominal losses)	~0.4 W
Virgo+ (G_{rec}=19) (nominal losses)	~1.5 W
Virgo+ (G_{rec}=35) (nominal losses)	~2.8 W

Possible optical layout

AXICON
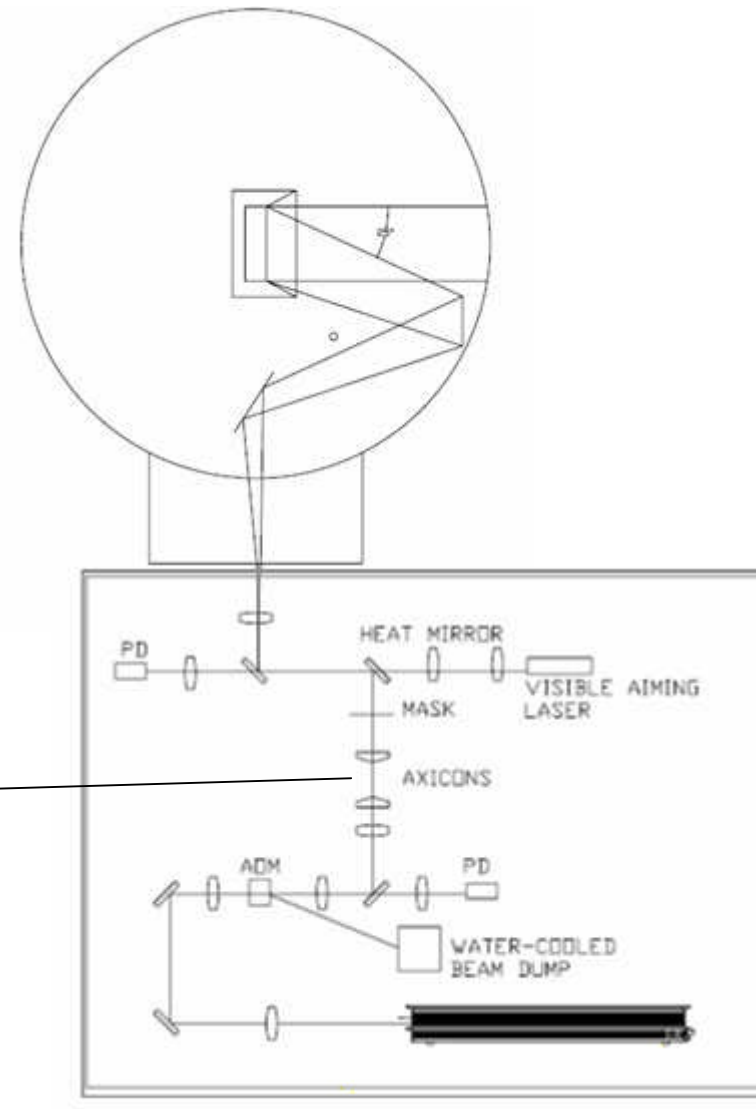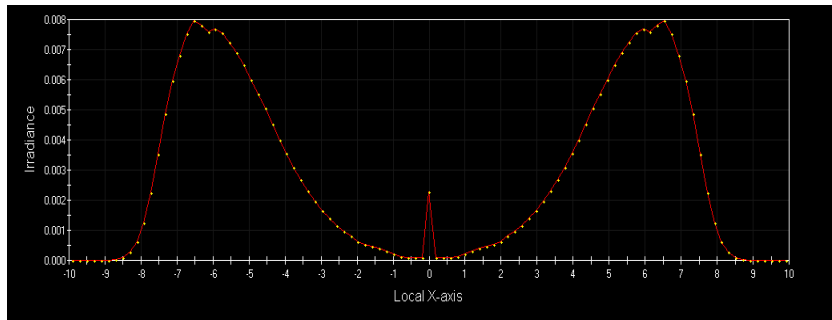
Noise budget

Evaluation of TCS noise injected in Virgo+, if RIN is stabilized @ $3\times10^{-7}/\sqrt{Hz}$.

All sources taken into account.

Total
Flexural
Thermoelastic+Thermorefractive
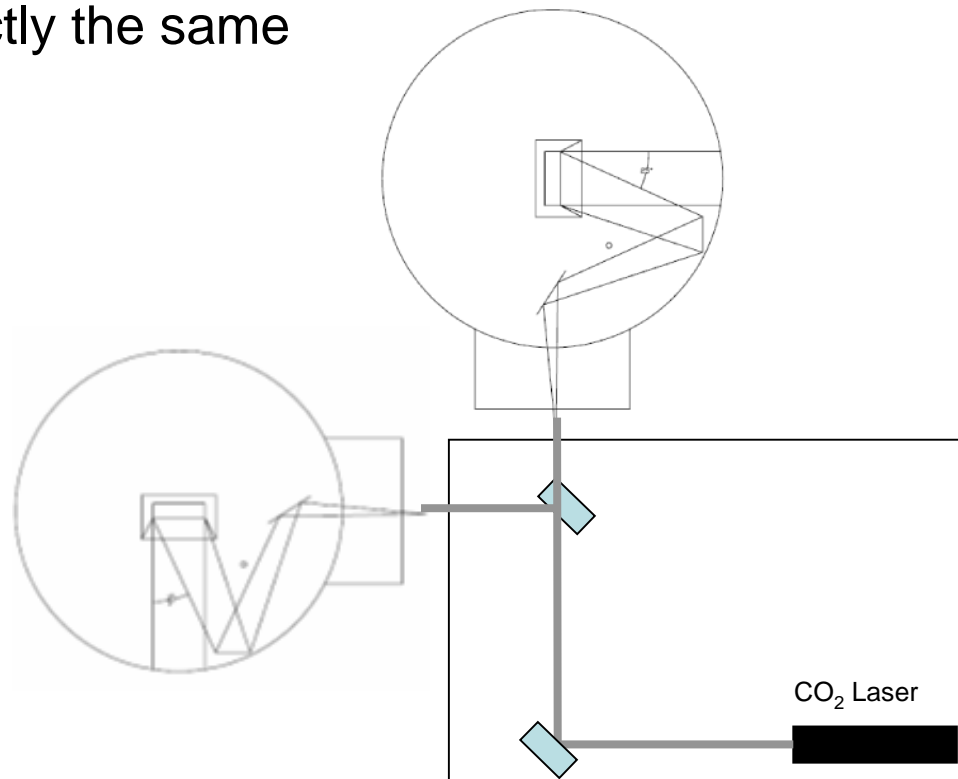**Radiation pressure**

How to reduce TCS noise

1. The obvious: reduce RIN

How to reduce TCS noise

1. The obvious: reduce RIN

2. Shine both ITMs with the same laser

   - Noise cancellation is complete only if the power injected on the ITMs is exactly the same
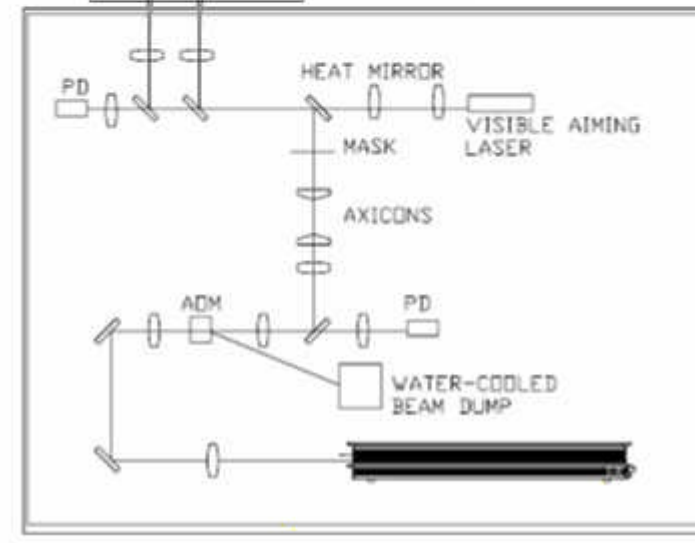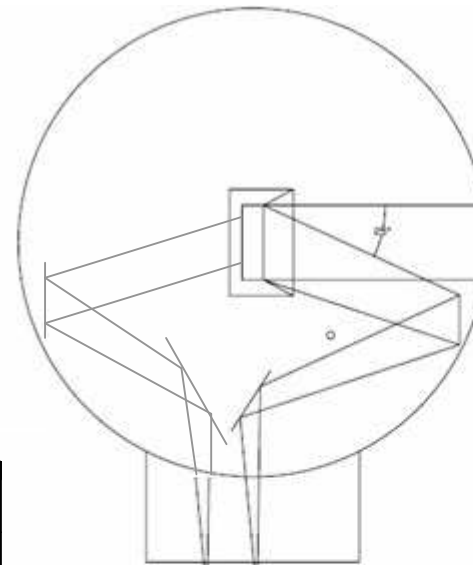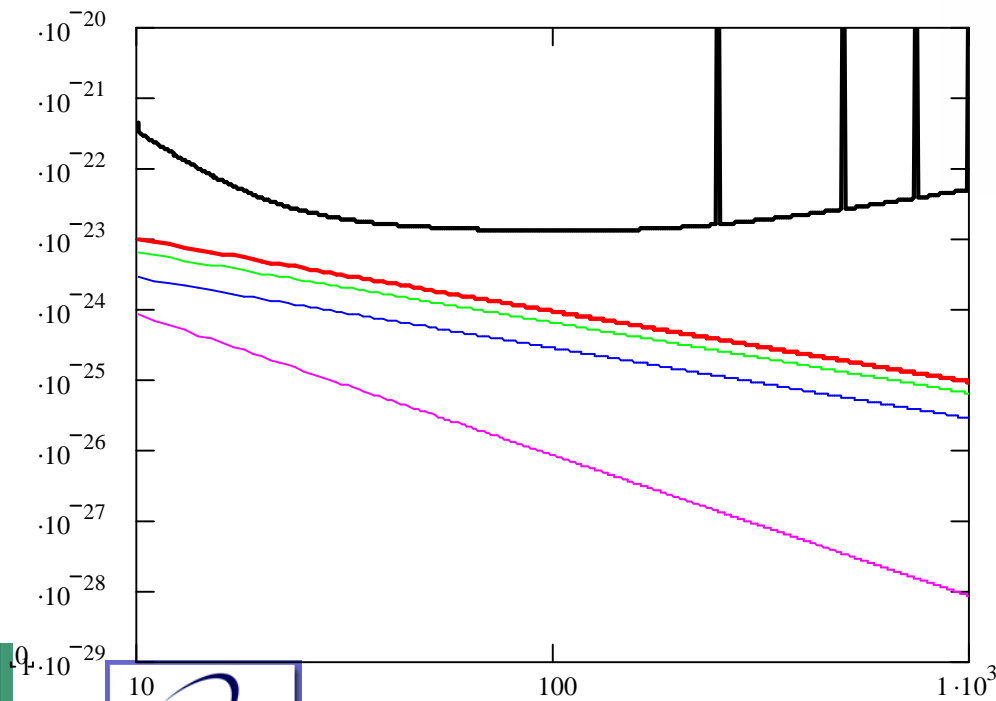

CO$_2$ Laser

How to reduce TCS noise

1. The obvious: reduce RIN
2. Shine both ITMs with the same laser
   - Noise cancellation is complete only if the power injected on the ITMs is exactly the same
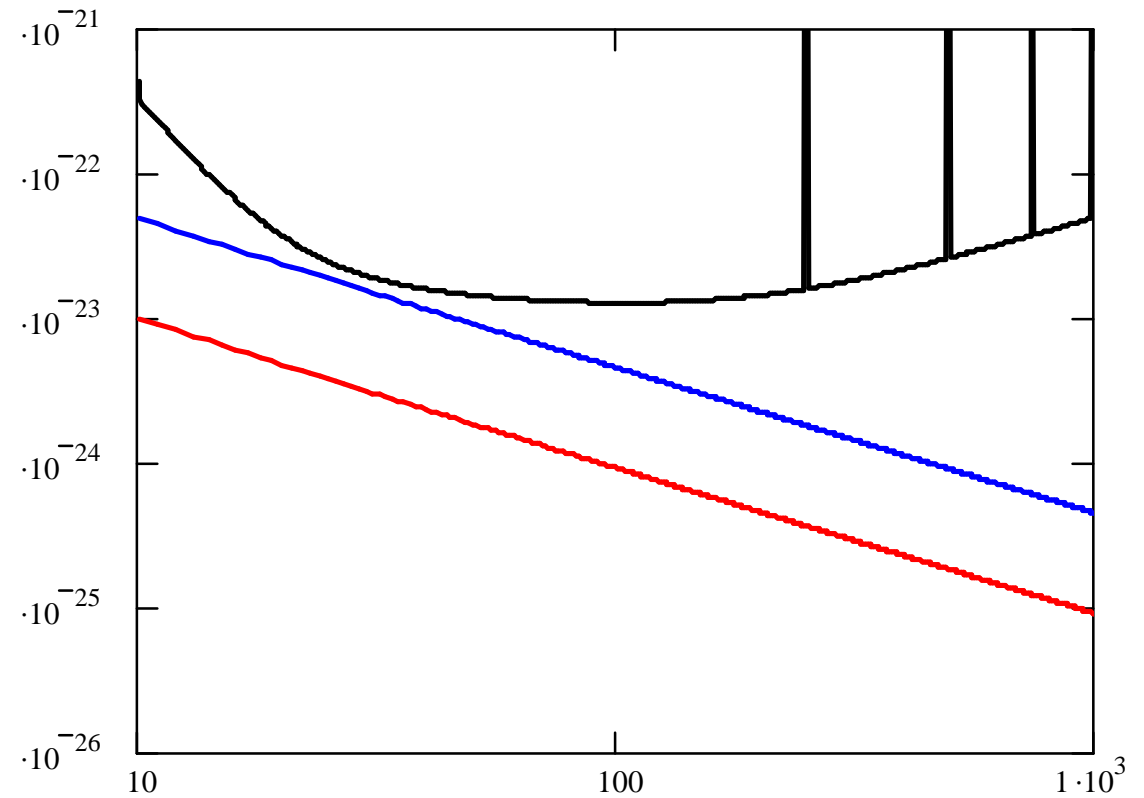3. Shine both sides of the ITMs (credit to P. Willems)
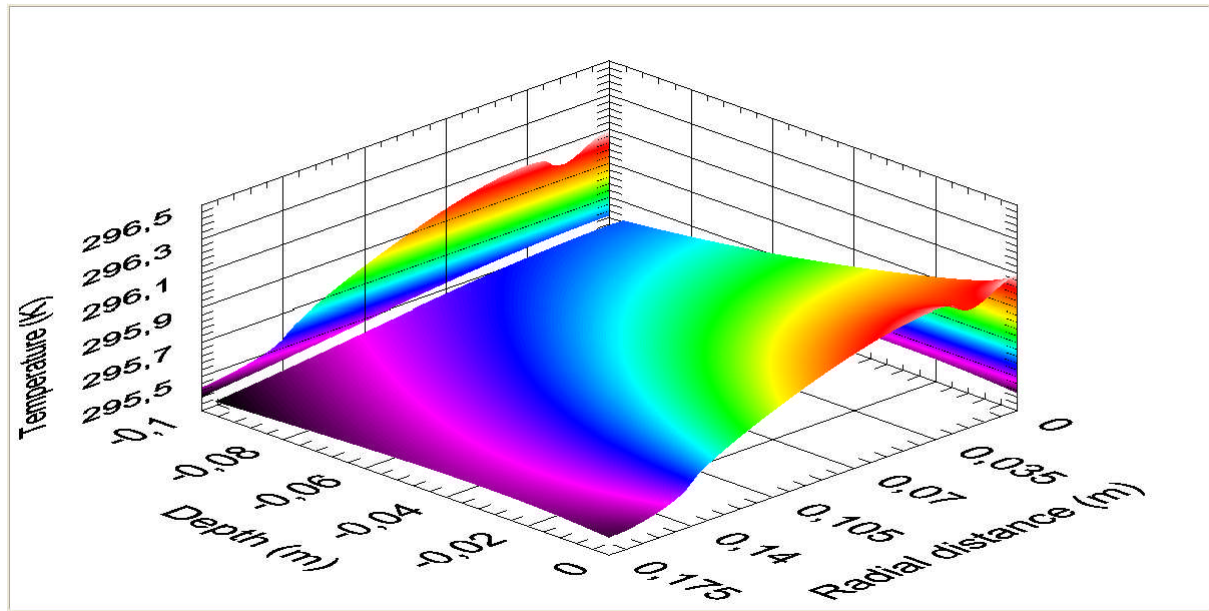
Noise reduction

TCS laser shines:
1. Front face of the ITM
2. Both faces of the ITM
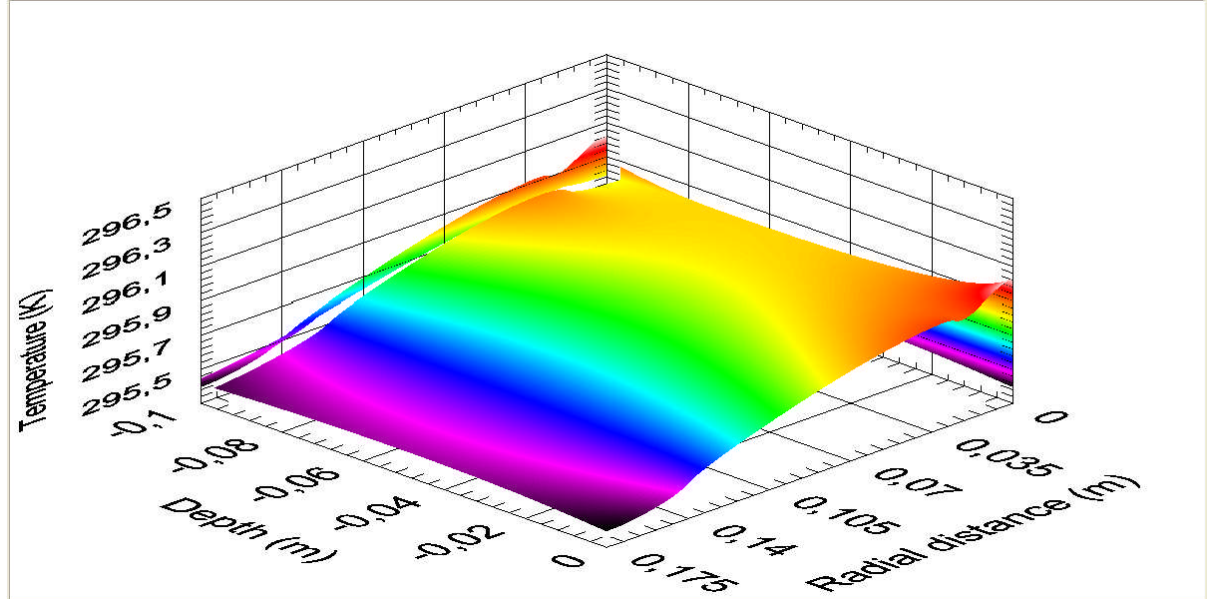
Total noise reduced by a factor of 5

Front heating

Front & back heating

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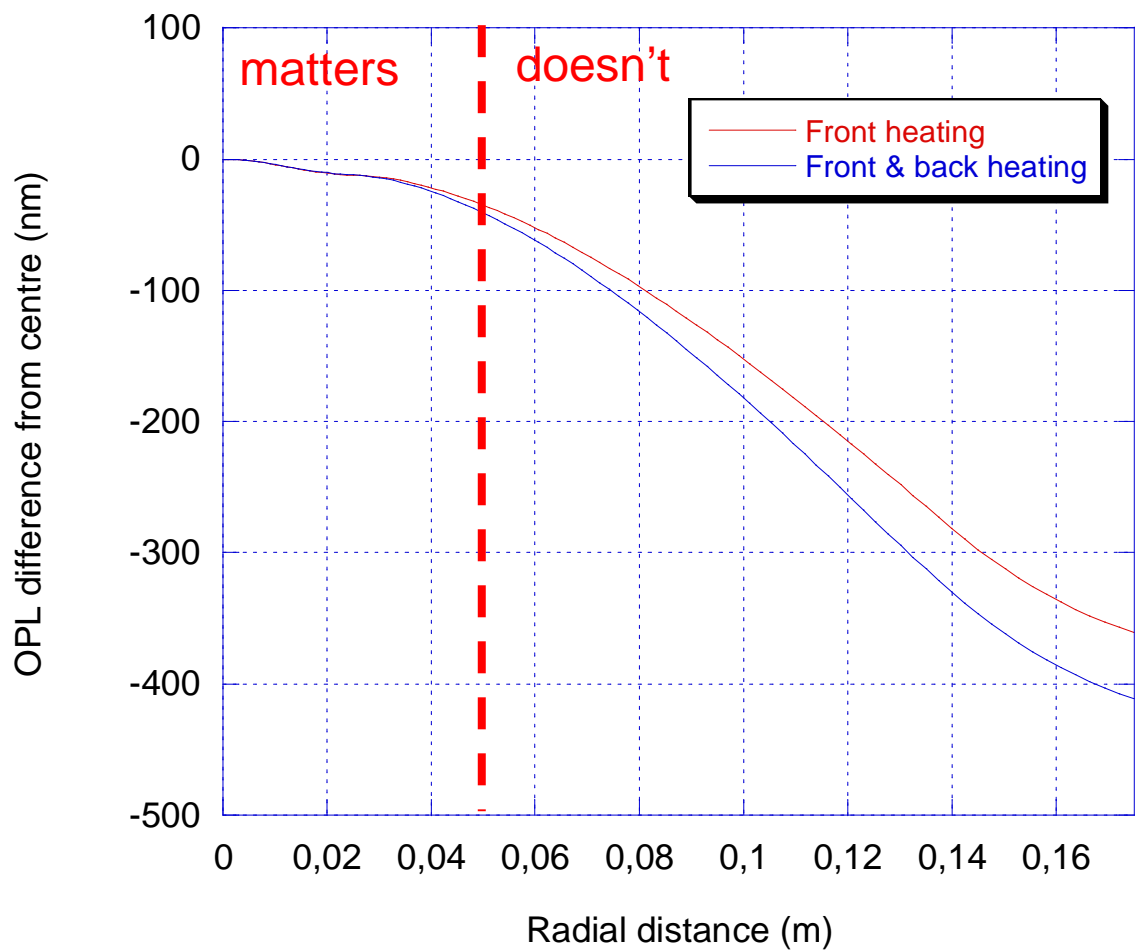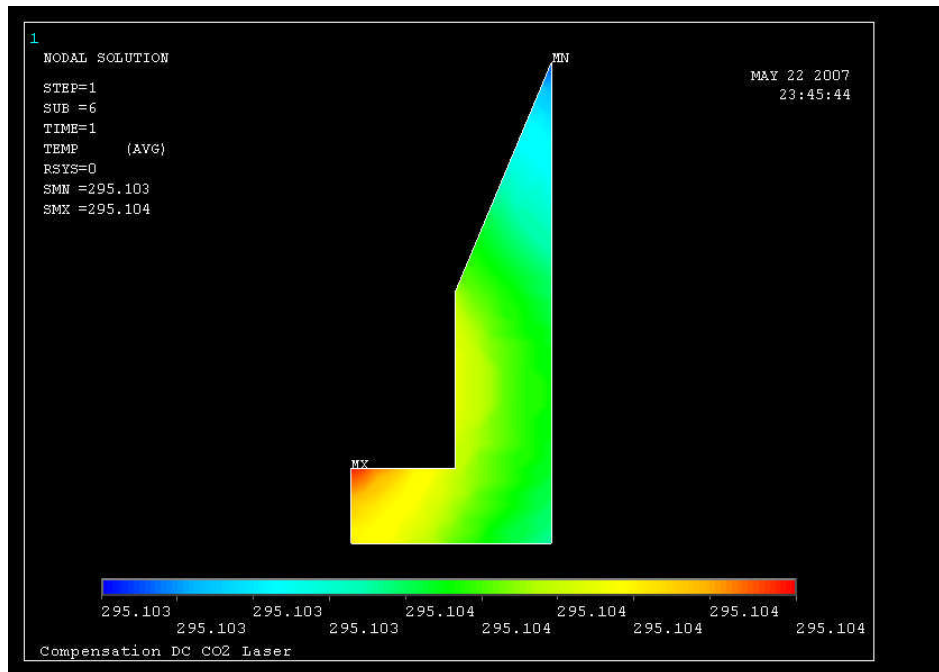
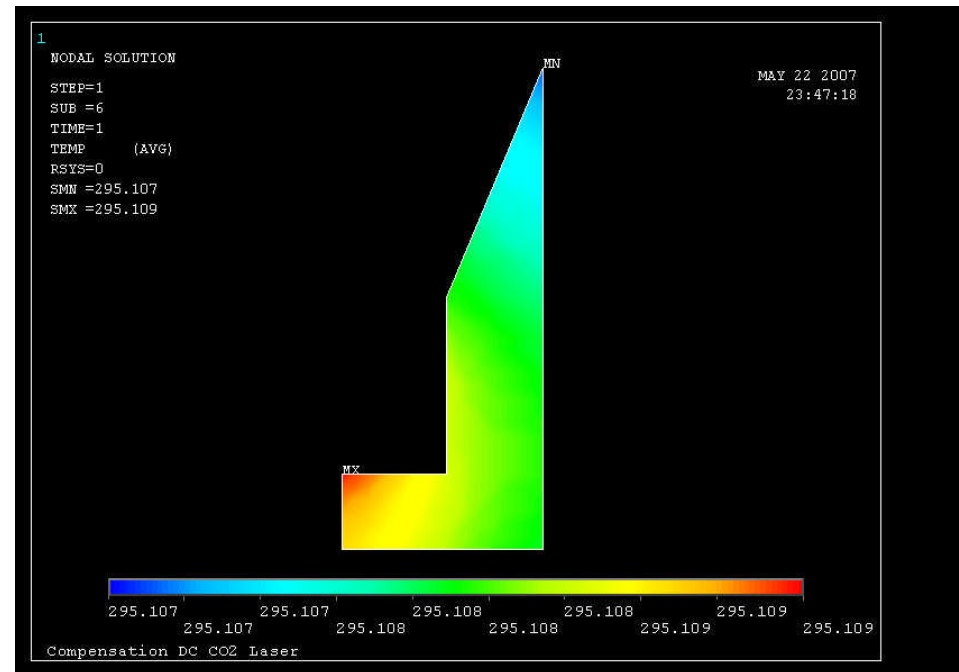No change in the quality of the compensation

Reaction mass temperature field

Front heating

Front & back heating

Virgo path toward TCS

Possible strategy for TCS implementation:

- First step:
  - Install TCS on Virgo after the Science Run
  - Time scale: system ready by December 2007/January 2008
- Second step:
  - TCS for Virgo+, stabilized CO_2 laser, improved projector(?)
  - Time scale: TCS ready by half 2008

Production Plan												
	2007						**2008**					
Tasks and Deliverables	Jan-Feb	Mar-Apr	May-Jun	Jul-Aug	Sep-Oct	Nov-Dec	Jan	Feb	Mar	Apr	May	Jun
Tasks												
TCS requirements definition	■	■										
TCS Laser			■	■	■	■	■	■	■	■	■	
Optical Imaging System		■	■	■	■	■						
TCS Servo												
TCS characterization	■	■	■	■	■	■	■	■	■	■	■	
Deliverables												
TCS requirements definition			■									
TCS Laser for Virgo							■					
Optical Imaging System						■	■					
TCS for Virgo+											■	■
TCS Servo												

The End

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