

ExSqueez

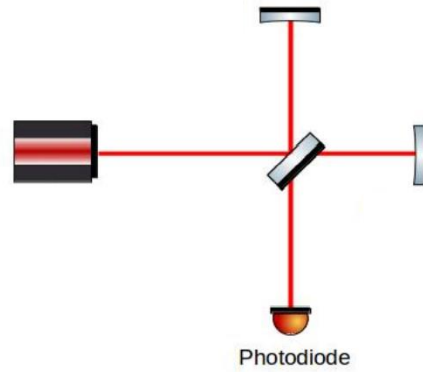
Beating standard quantum limit
for gravitational waves detectors

Aymeric van de walle

Gravitational waves detectors



VIRGO



LIGO

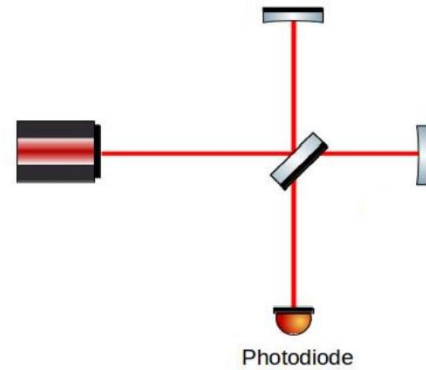


KAGRA

Gravitational waves detectors



VIRGO

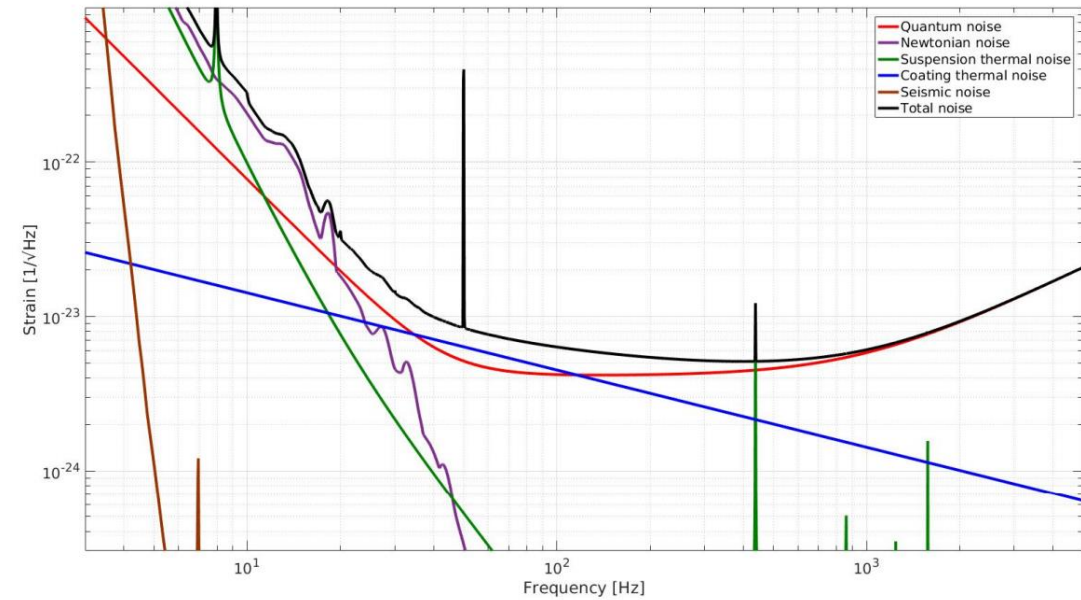


LIGO



KAGRA

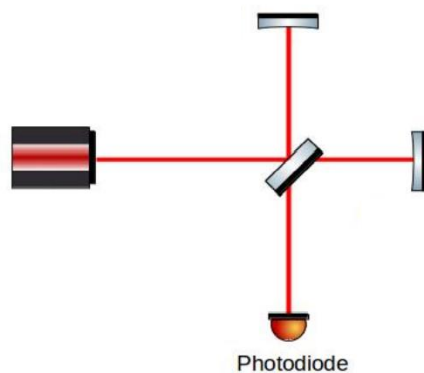
Simulation of the sensitivity curve of the Advanced Virgo detector at design.



Gravitational waves detectors



VIRGO

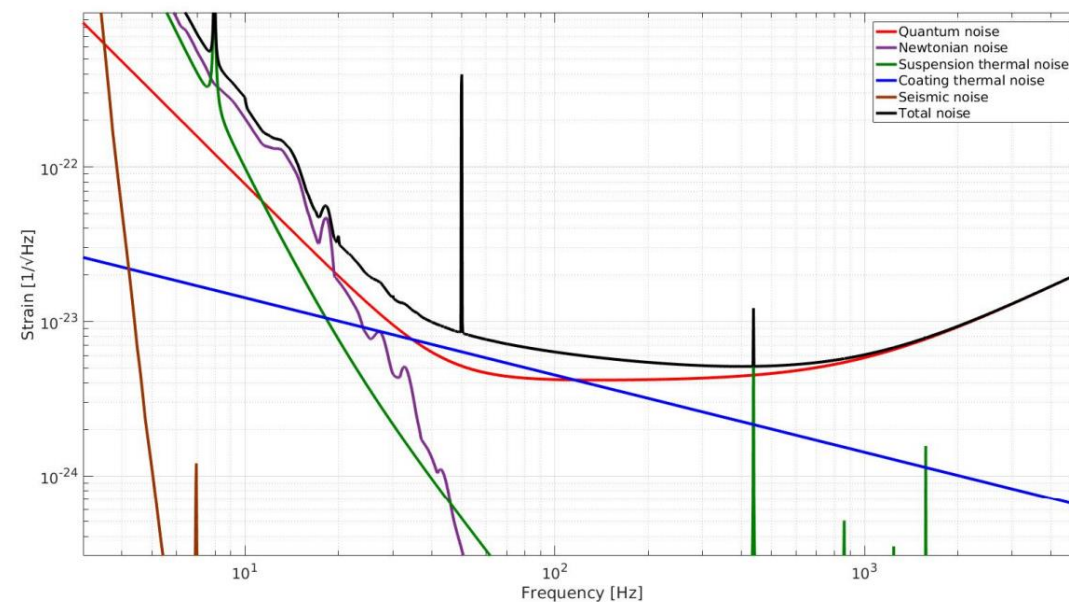


LIGO



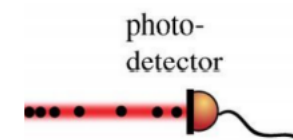
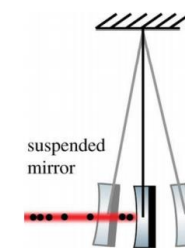
KAGRA

Simulation of the sensitivity curve of the Advanced Virgo detector at design.



Radiation pressure
noise

Shot noise



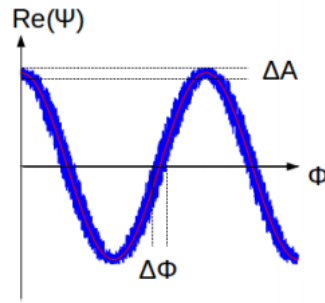
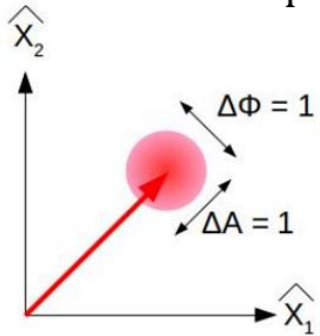
Amplitude

Phase

Standard quantum light state

Heisenberg's relation

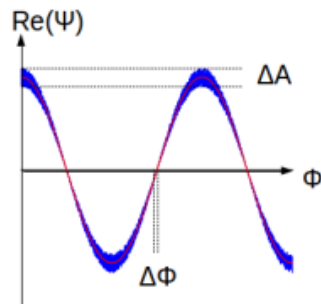
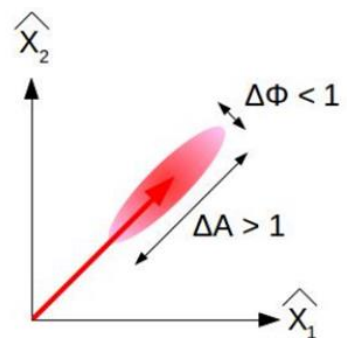
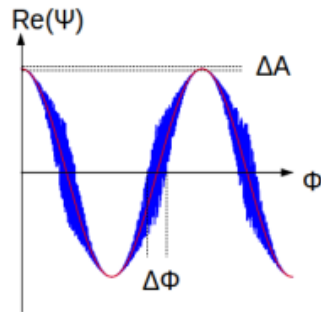
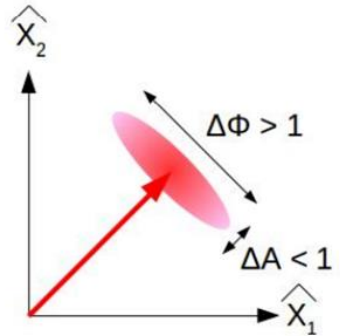
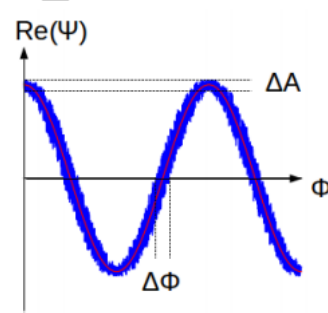
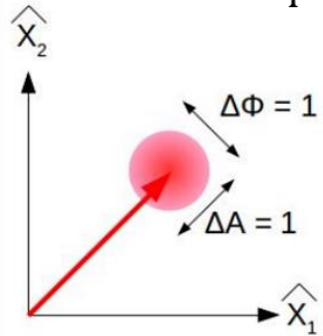
$$\Delta\phi \times \Delta A \geq 1$$



Beating standard quantum limit : Squeezing

Heisenberg's relation

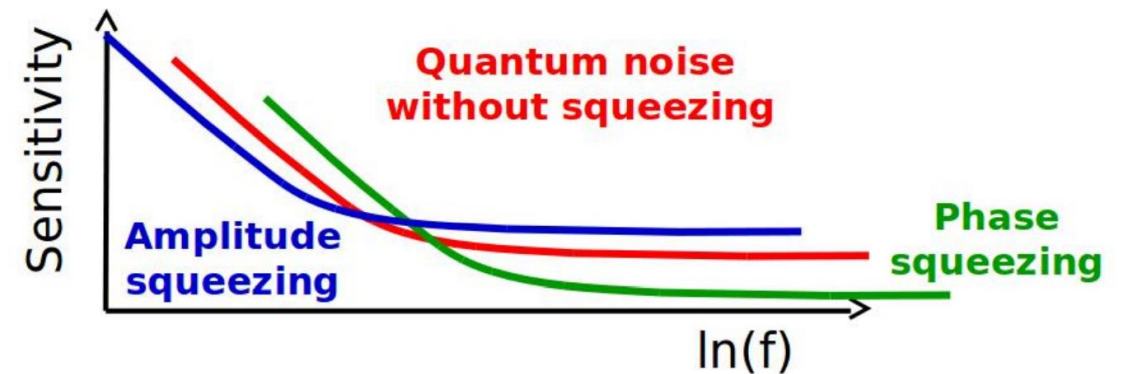
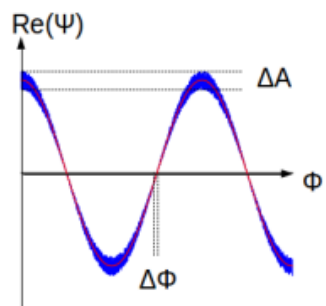
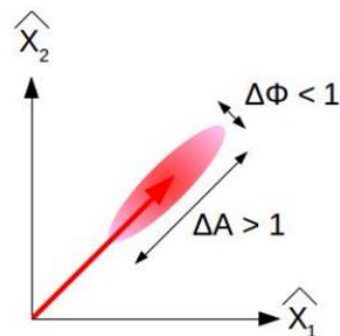
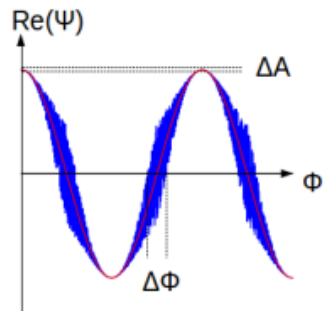
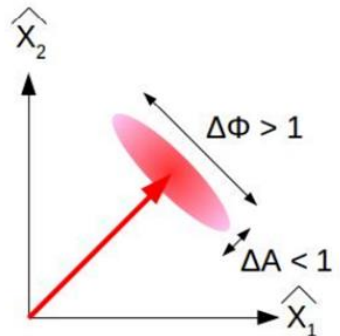
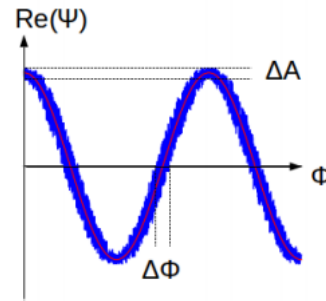
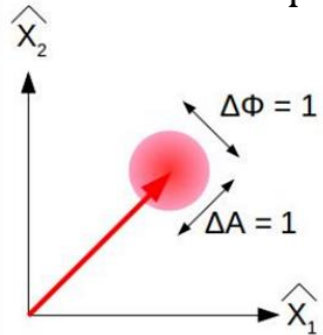
$$\Delta\phi \times \Delta A \geq 1$$



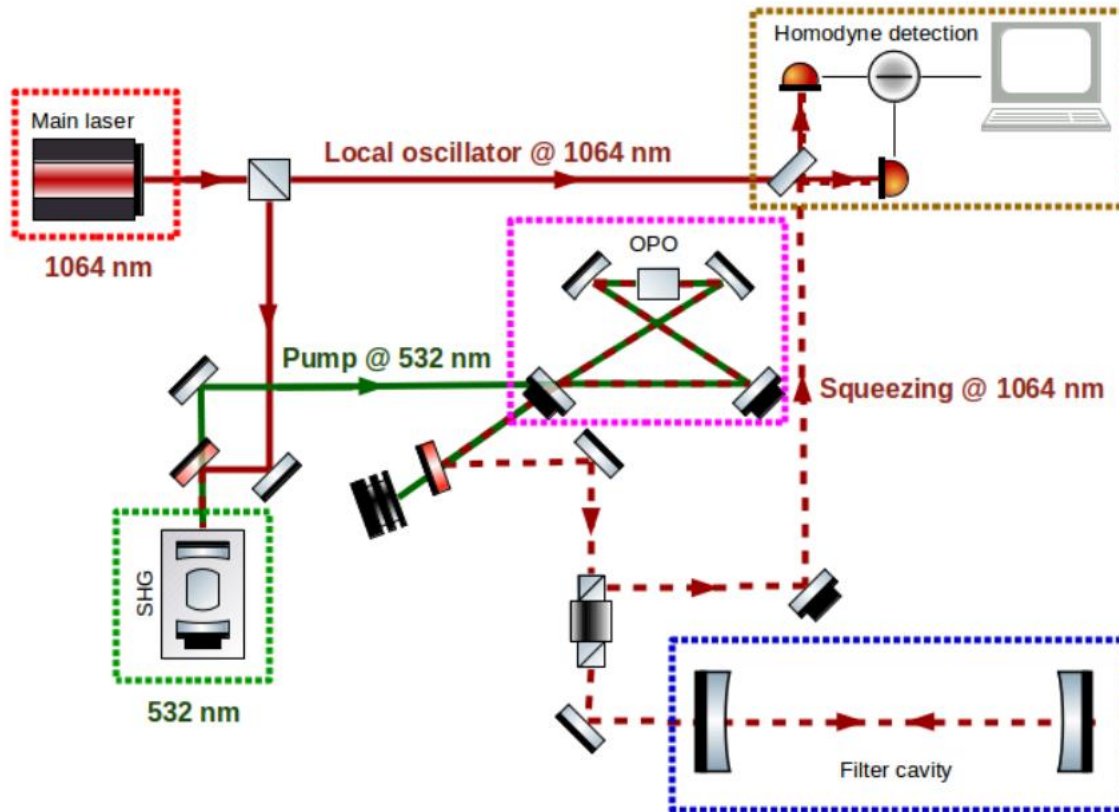
Beating standard quantum limit : Squeezing

Heisenberg's relation

$$\Delta\phi \times \Delta A \geq 1$$



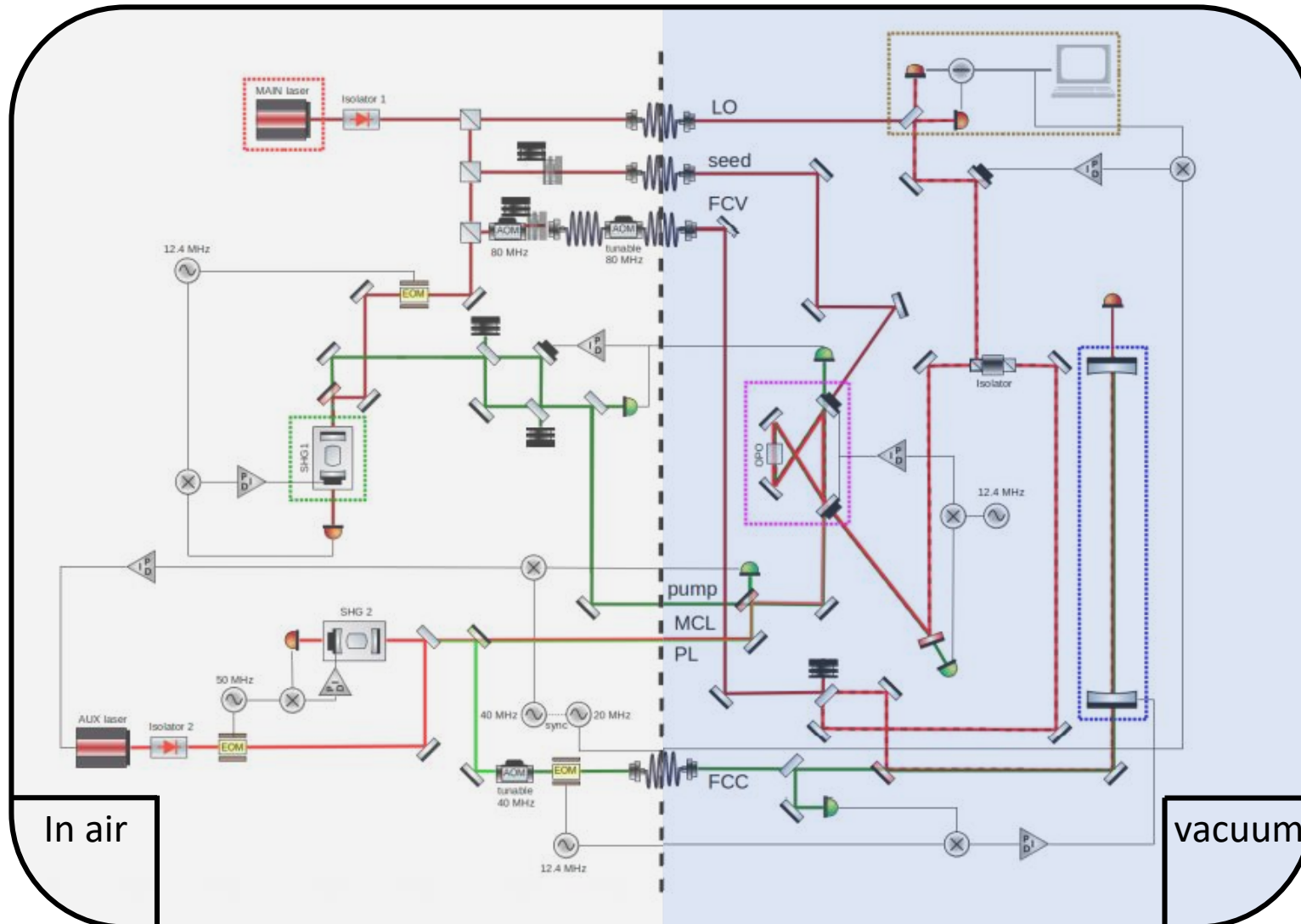
Exsqueezer : frequency dependant squeezing in vacuum.



Aim :

- Testing new source of squeezing generation
- Improvement of VIRGO sensibility for around 2025
- Implication in Einstein Telescope

Exsqueezer : frequency dependant squeezing in vacuum.



Exsqueezer =

2 Lasers

7 Beams

1 Mach-Zehnder

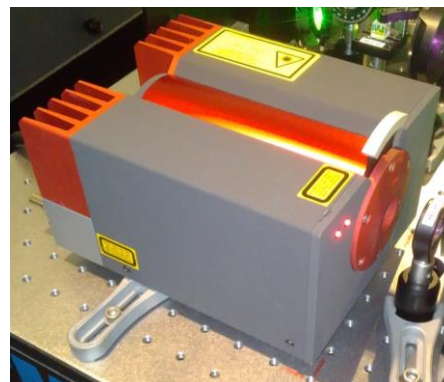
4 cavities = 2 SHG

1 OPO

1 filter cavity

9 Loops

Hardware



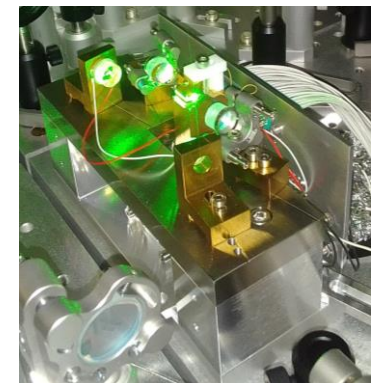
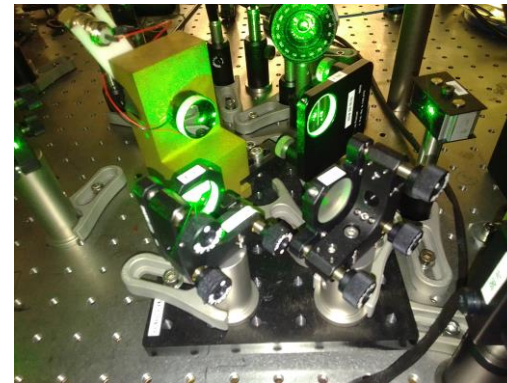
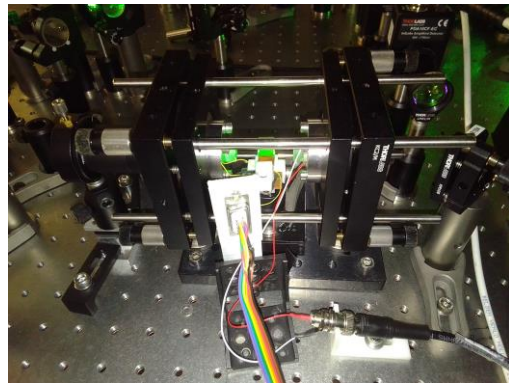
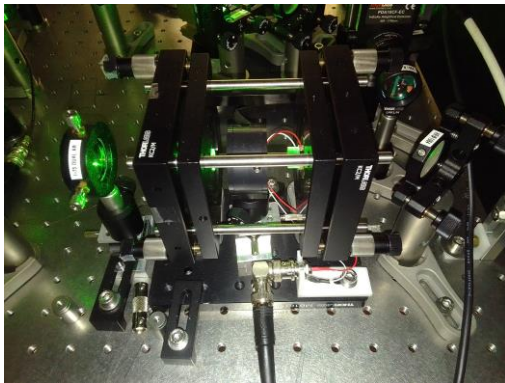
10 years old

10 years old

Ref	Mephisto S	Mephisto	Mephisto	Mephisto
Wavelength (nm)	1064	1064	1319	1064
Emission type	CW	CW	CW	CW
Power	500 mW	2 W	500 mW	1 W

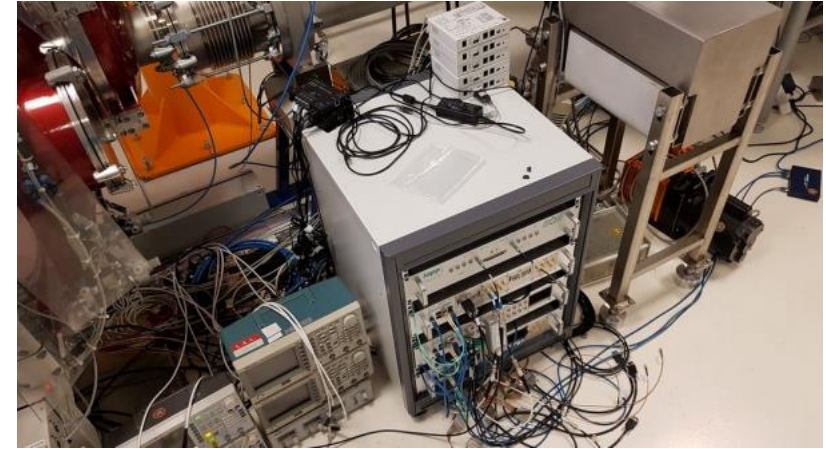
Hardware

- 2 SHG : Wavelength conversion from 1064nm to 532 nm
- 1 MZ : Power stability
- 1 OPO : Squeezing generation



Hardware

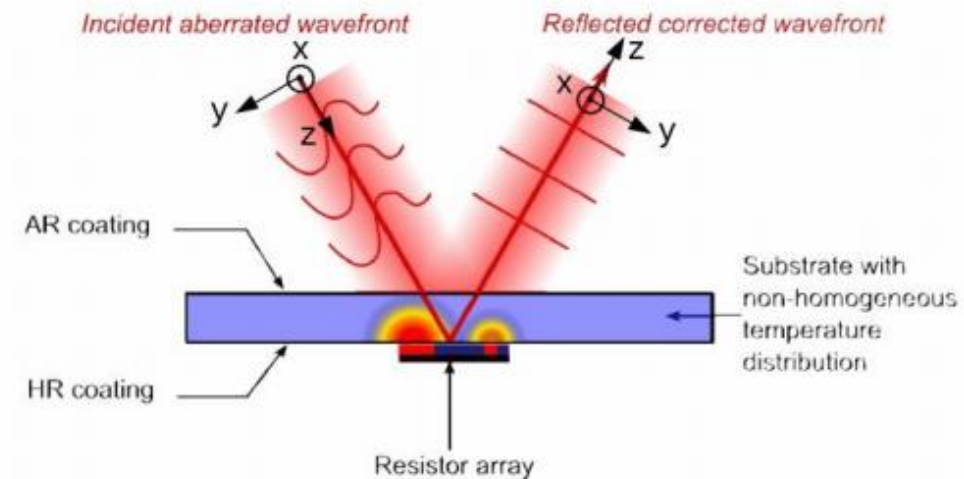
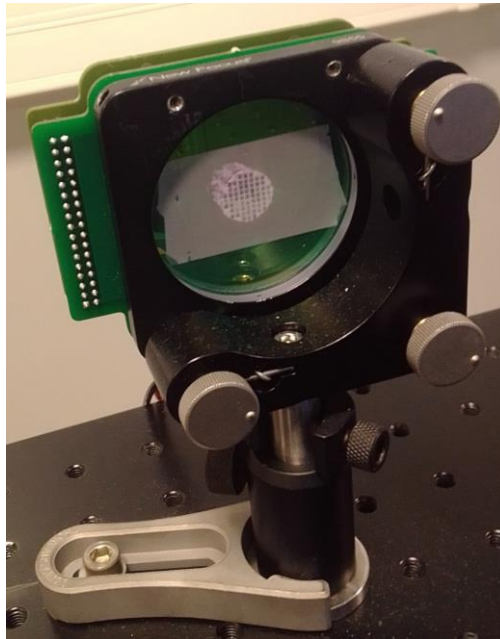
- Virgo electronics
- Redpitaya
- Acces to a wavefront characterization



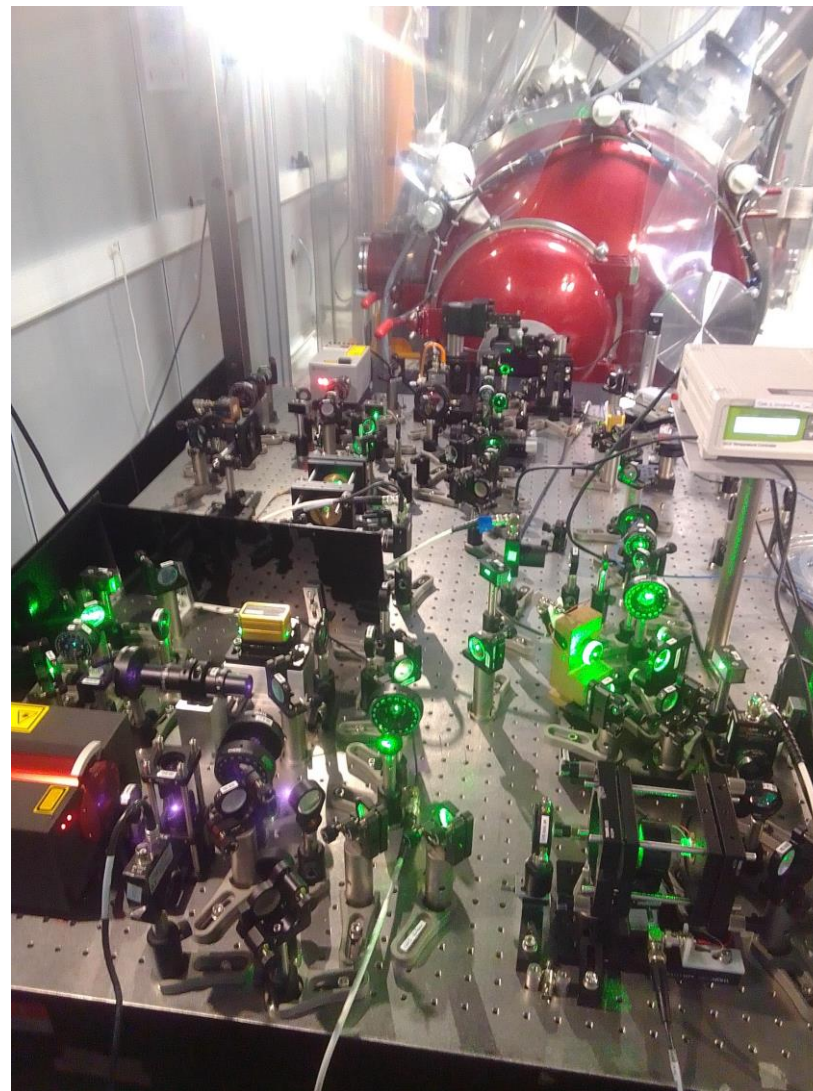
VIRGO
Electronics and soft

Adaptive optics : Deformable mirrors

- Aim to correct beam wavefront after a long propagation
- Vacuum compatible
- Thermistor matrix + back face coating



Thanks for your attention



Team composition

- | | | |
|------------------------|----------------------------|---|
| • Nicolas Leroy | Chargé de recherche (+HDR) | |
| • Manuel Andia | Maître de conférence | |
| • Aymeric van de Walle | Ingénieur de recherche | |
| • Angélique Lartaux | Chargé de recherche | (handicap recruitment starting in november) |

With the support of IJCLAB teams :

- | | |
|-------------|---------------|
| - Vacuum | - Informatics |
| - Mechanics | - Electronics |