Introduction in Optics interferometry and applications

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What do I measure ?

Metrology in 3 questions

- What do I measure ? (Length, slopes, electrical currents, ... ?)
- How do I measure it ? (What steps do I take from alignement to climate control...)
- How sure am I that my measurement is what I wanted to measure ? (What's the uncertainty of each measurement step and how do they combine ?)

What do I measure ?

Do I really ?

Metrology in 3 answers

- What do I measure ? Norms, ISO standards, Unit system...
- How do I measure it ? Procedures, procedures, procedures...
- How sure am I that my measurement is what I wanted to measure ? Uncertainty analysis (methode, manpower, environment, instuments, sample)

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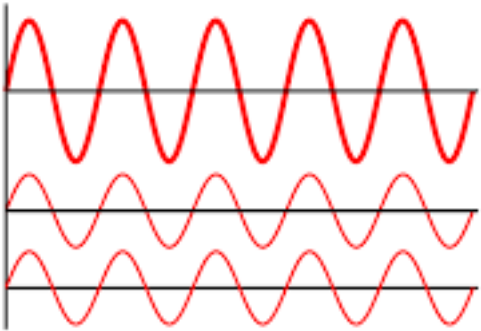
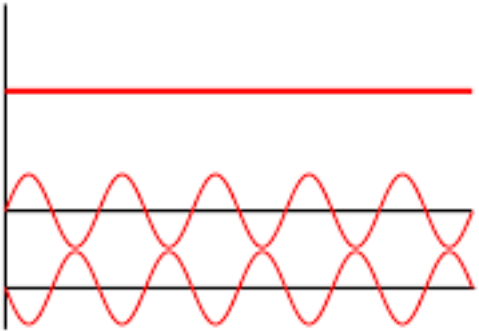
What is interferometry ?

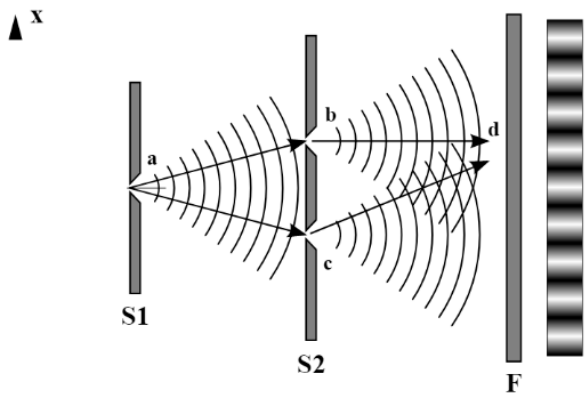
Principle - interference

Say you have two things that behave like waves and are similar :



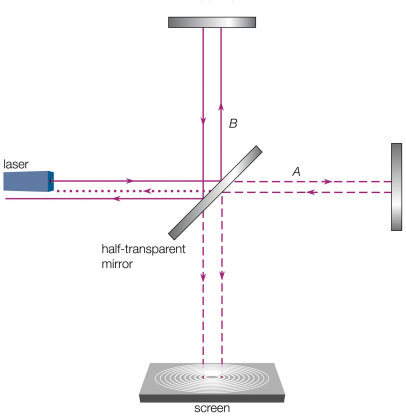


One way to get things to be similar is to split something :



What is interferometry ?

Principle - Michelson interferometer



If the mirrors are perfect and parallel:
flat field with I depending on $(A-B)/\lambda$

VIRGO !

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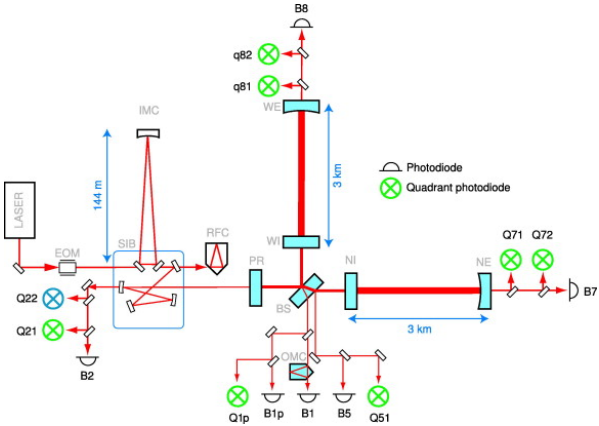
A Michelson interferometer: VIRGO



A few alignement systems and feedback loops
... and 3 km arms !

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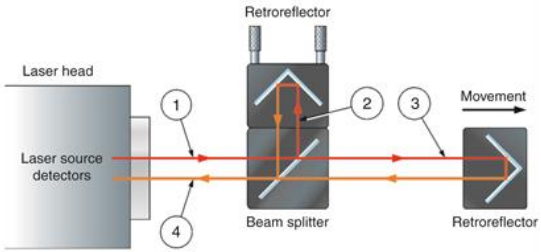
Another Michelson interferometer: renishaw encoders

A variation of the same thing :



Cube corners send light back 180° in an orientation

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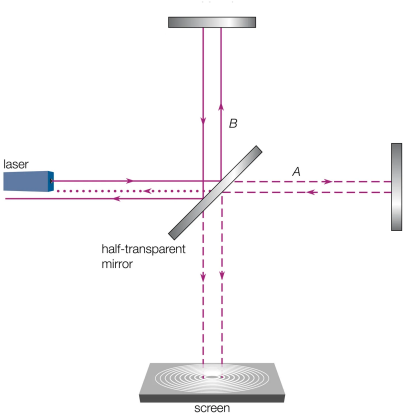
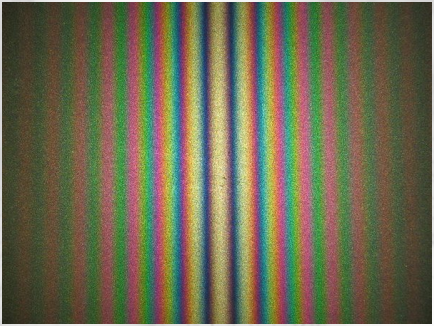
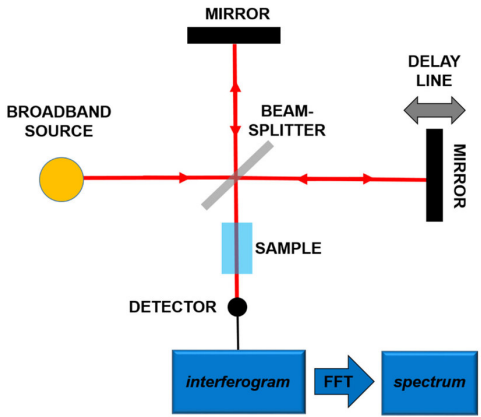
White light Michelson





Fourier spectrometry

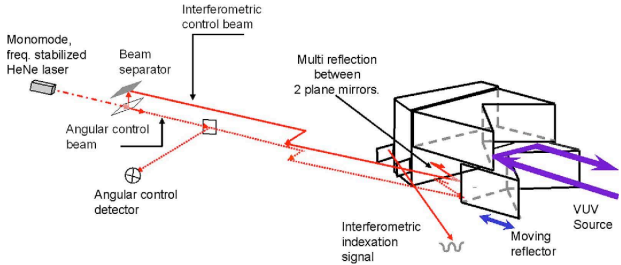


A few things to note :

- Sample under study is not in a given arm !
- Each step gives a structured spectrum
- Absorption computed in reciprocal space : very high resolutions can be obtained (R = 1 000 000 at 20 eV)

Interferometry everywhere

They are everywhere...



The displacement is controled by an interferometric encoder !

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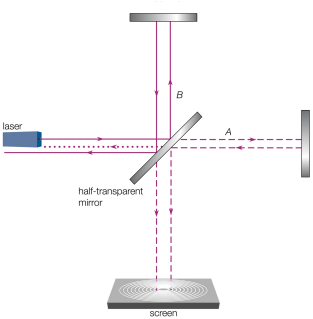
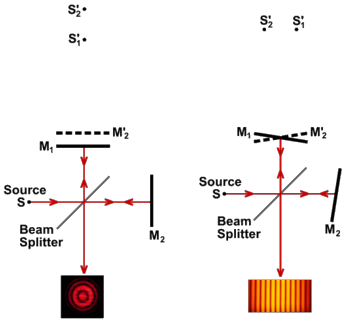
Say the mirrors aren't perfectly aligned, source isn't perfeclty collimated, mirrors aren't perfectly parallel :

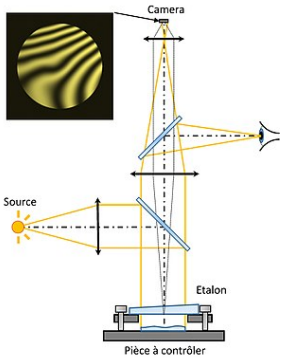




Not a Michelson interferometer !

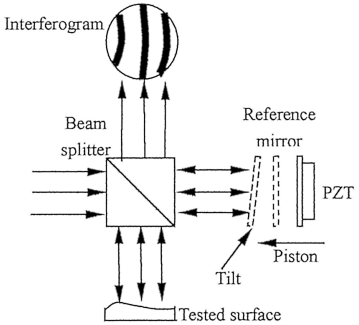
Fizeau interferometer

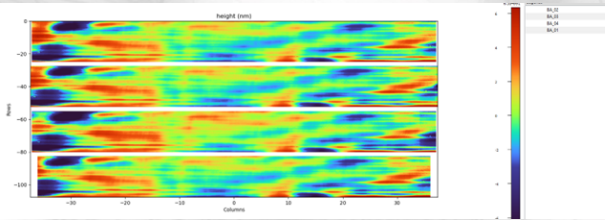
The reference is moved in front of the analyzed mirror :



This allows for beam shaping before the interferometer for zoom capability

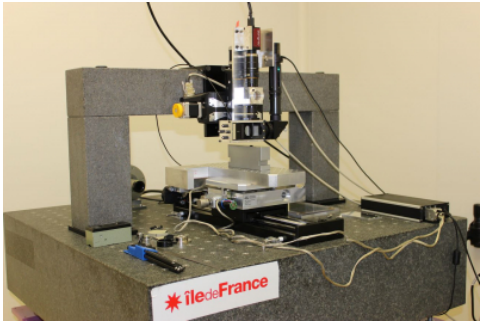
Each pixel gets its own shifted sinewave

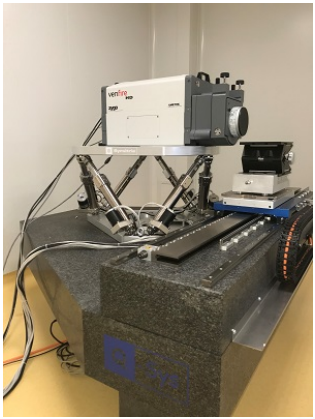




Come to the lab

(and see what's on the slab)





SOLEIL SYNCHROTRON

Thank you for your attention !