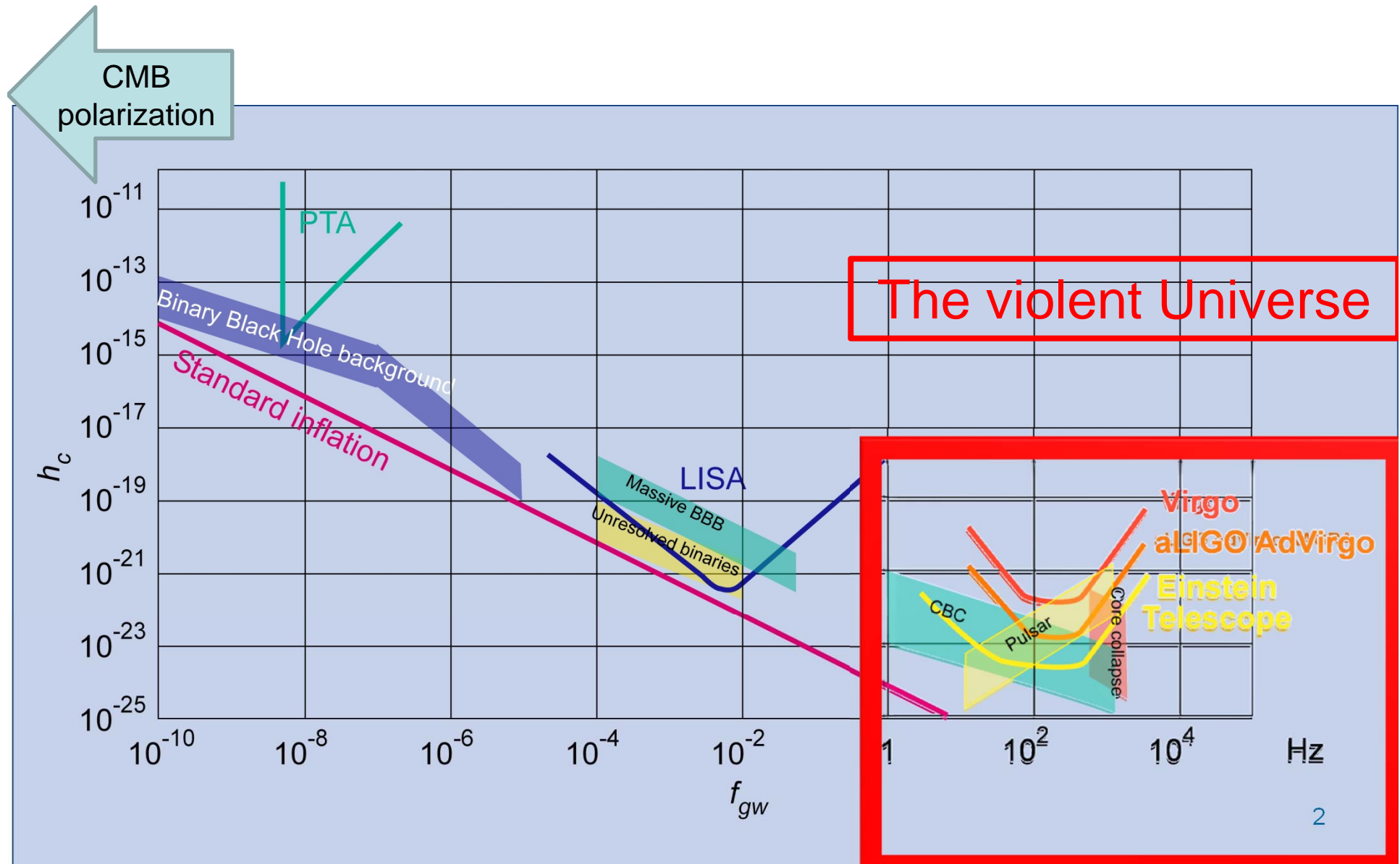


# Setting the stage

Francesco Fidecaro

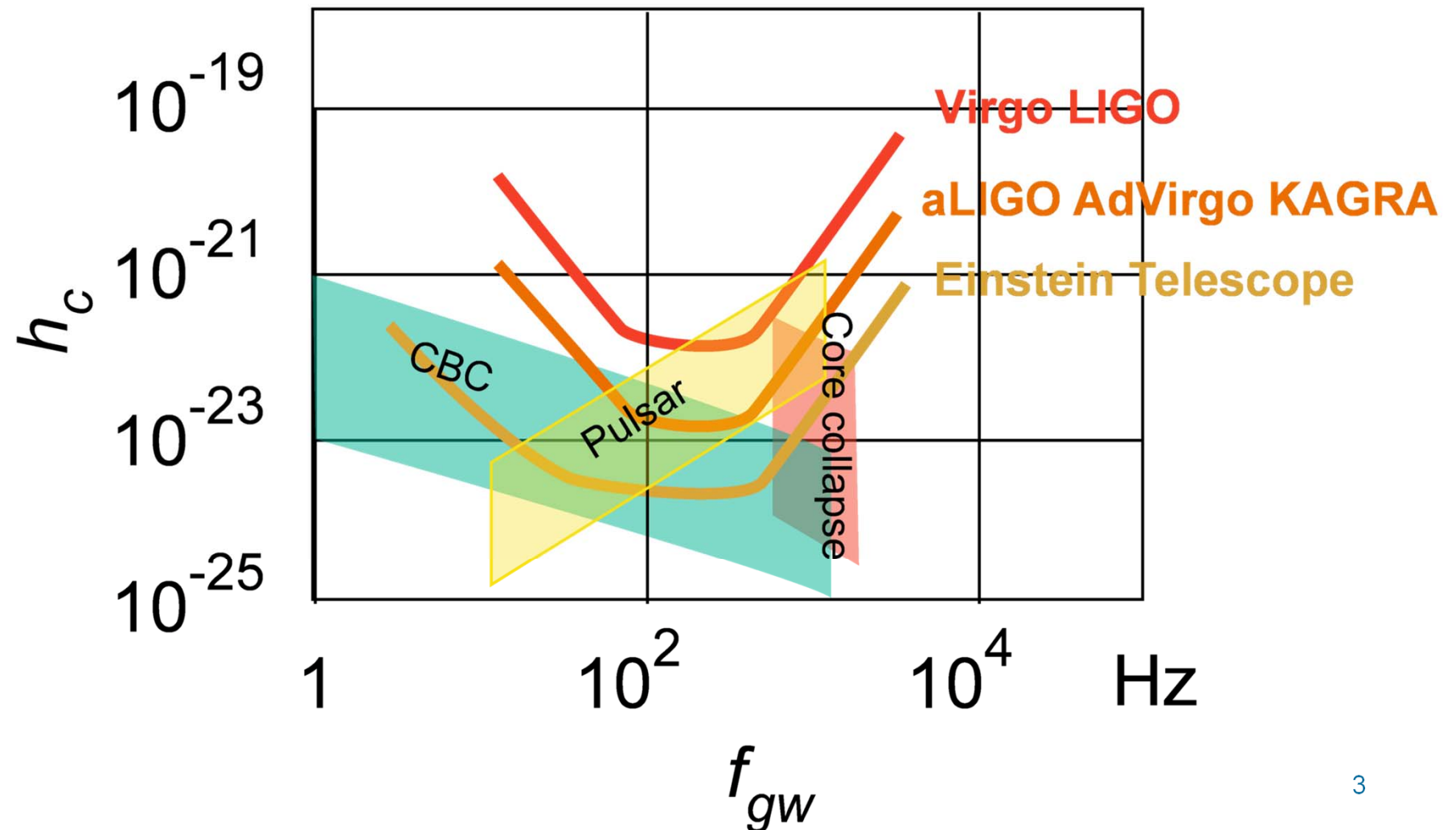
Elba, May 20, 2013

# Gravitational wave spectrum



# The violent Universe

- Ground based km scale interferometers will listen to the violent Universe, where gravity is strong over short distances



## Above 100 Hz

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- Earthbound detectors
- Noise is understood, although not tamed
- Diffused light was an important limitation in 1<sup>st</sup> generation interferometers
  - Lot of effort into reducing effect in the arm cavities
  - Ad hoc remedies in the central (interference) and detection area
- Light intensity limited by thermal lensing
  - Thermal compensation system (axisymmetric)
- 20/13 Mpc horizon (orientation averaged) achieved with 80%+ duty cycle
- Was the thermal noise limit reached?
- Advanced (2<sup>nd</sup> generation) interferometers are on their way, aiming at being online in 2015
- An efficient path to commissioning the detector has to be drafted

## Above 100 Hz

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- In the meantime...
- Impressive progress in squeezed vacuum states
  - Potential use for GW interferometers demonstrated
  - Use in GEO 600 with high duty cycle
  - Demonstrated in H1
- Studies are going on aiming at using a frequency dependent squeezing angle
- Will high intensity be superseded by squeezing?
- Every step toward perfect optics improves the picture (less diffused light, HOM, ...)
- Optics simulation is contributing very significantly, need to expand scope and go more and more realistic: interface with .dwg files for quasi static simulations, with filters for dynamic ones

## Above 10 Hz: thermal noise

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- Mirror coatings
- Incremental but very valuable progress made
  - Ti doping
  - Non periodic structures
  - Other coating materials
  - Modeling
  - Bonding and contact surfaces
- Suspensions
- Fused silica
- Sapphire
- Silicon
- Shape and construction

## Above 10 Hz: thermal noise

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- Criogeny
- Long term effort
- Materials for mirrors and suspensions
- Coatings
- Cooling scheme and light absorption
- Vibration levels

## Above 1 Hz: Newtonian noise

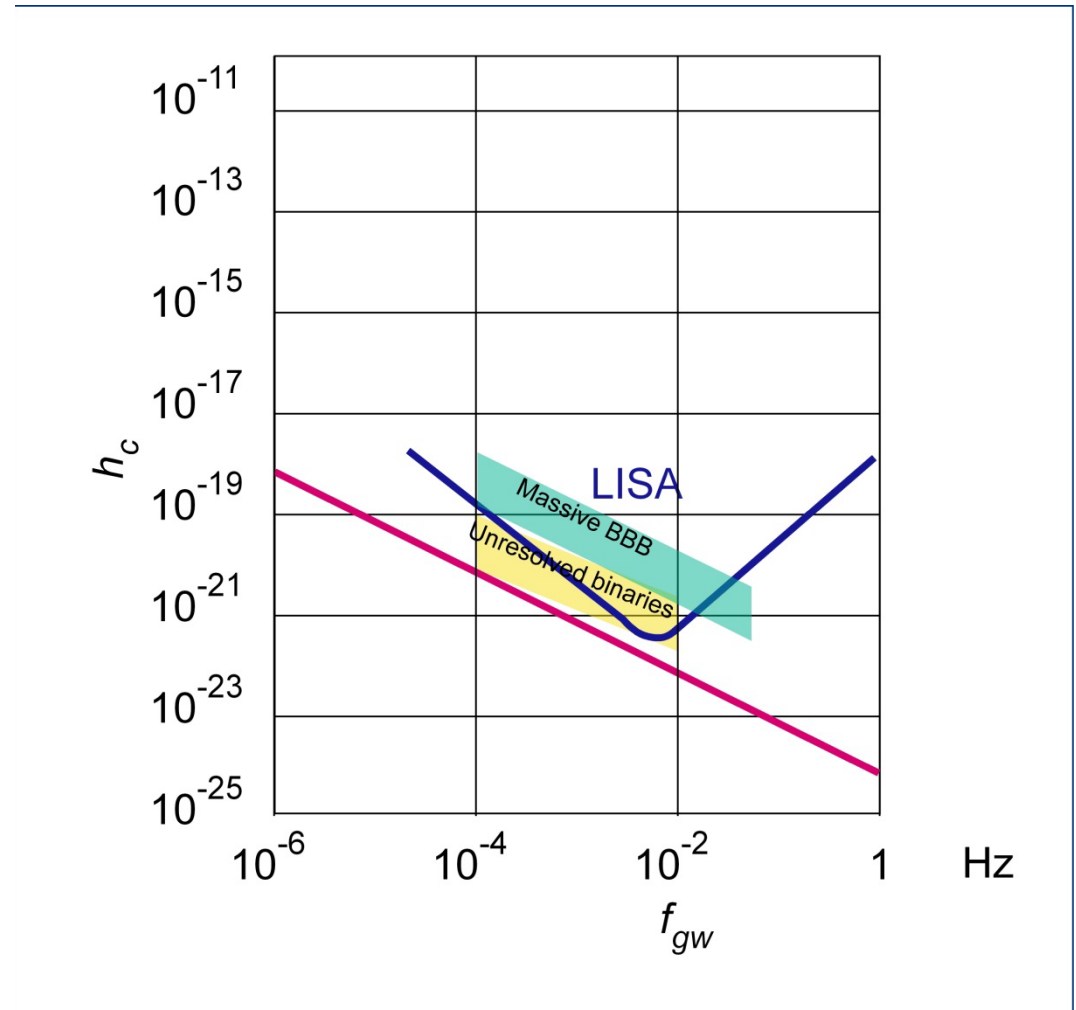
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- Not yet seen but is the limit on Earth
  - Underground detectors
  - Seismically silent places
  - Subtraction
- 
- Atomic fountains and interferometry
  - Long term developement



# The quiet & violent Universe

- Space based million km scale interferometers will listen to the violent Universe, where gravity is strong over much larger distances
- Approach standard inflation limit
- Galactic binaries can be a background



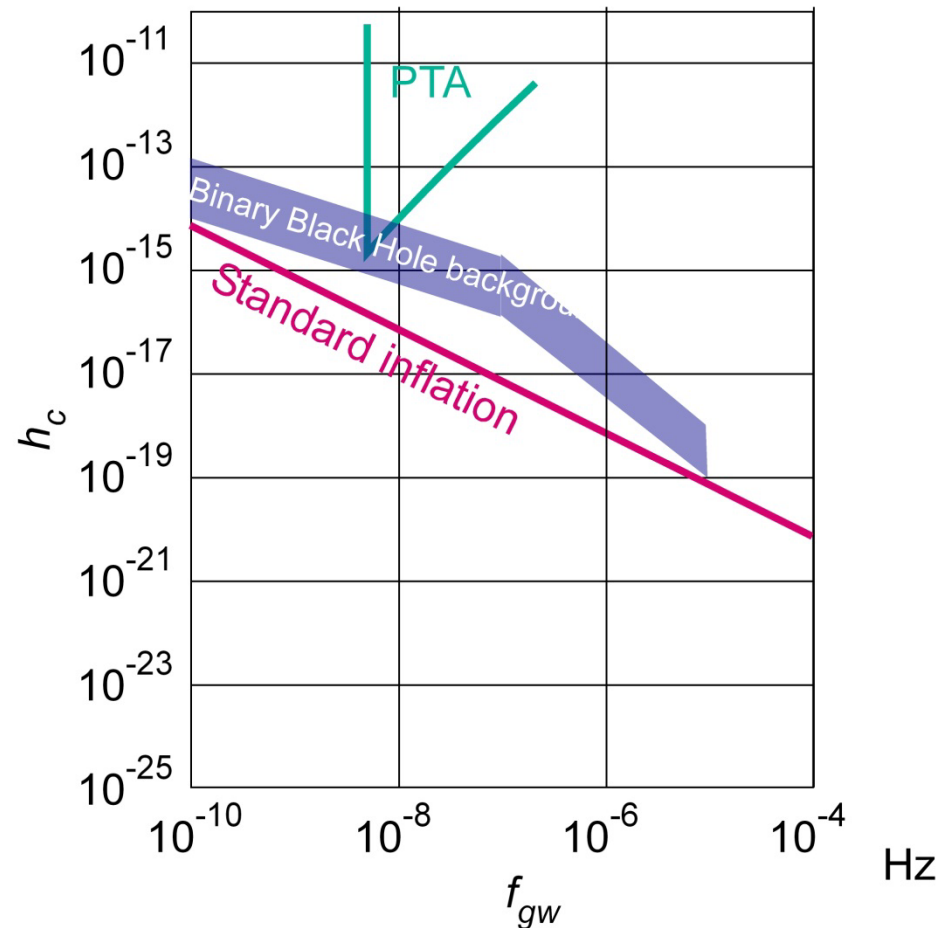
## Around the mHz

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- Earth and even Earth neighborhood have to be avoided
- Still tough experimental challenges
- But maybe tougher is the budget envelope: review mission configuration maintaining the physics goals

# The quiet & early Universe

- Galaxy based kpc scale one way interferometers will listen to the violent Universe, where gravity is strong over much larger distances
- Approach standard inflation limit



## Around the nHz

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- Very suggestive idea of using pulsar as remote clock and compare with local or other remote clock
- Timing capability improvements
- Array building
- Do not forget the analysis effort that is needed

## Not covered (this time)

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- Any idea for the  $\mu\text{Hz}$  ?
- CMB polarization

## Perspective

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- The whole field is approaching recording genuine GW signals
- A full spectrum has to be explored
- In this meeting some new idea may pop up, keep on discussing!