

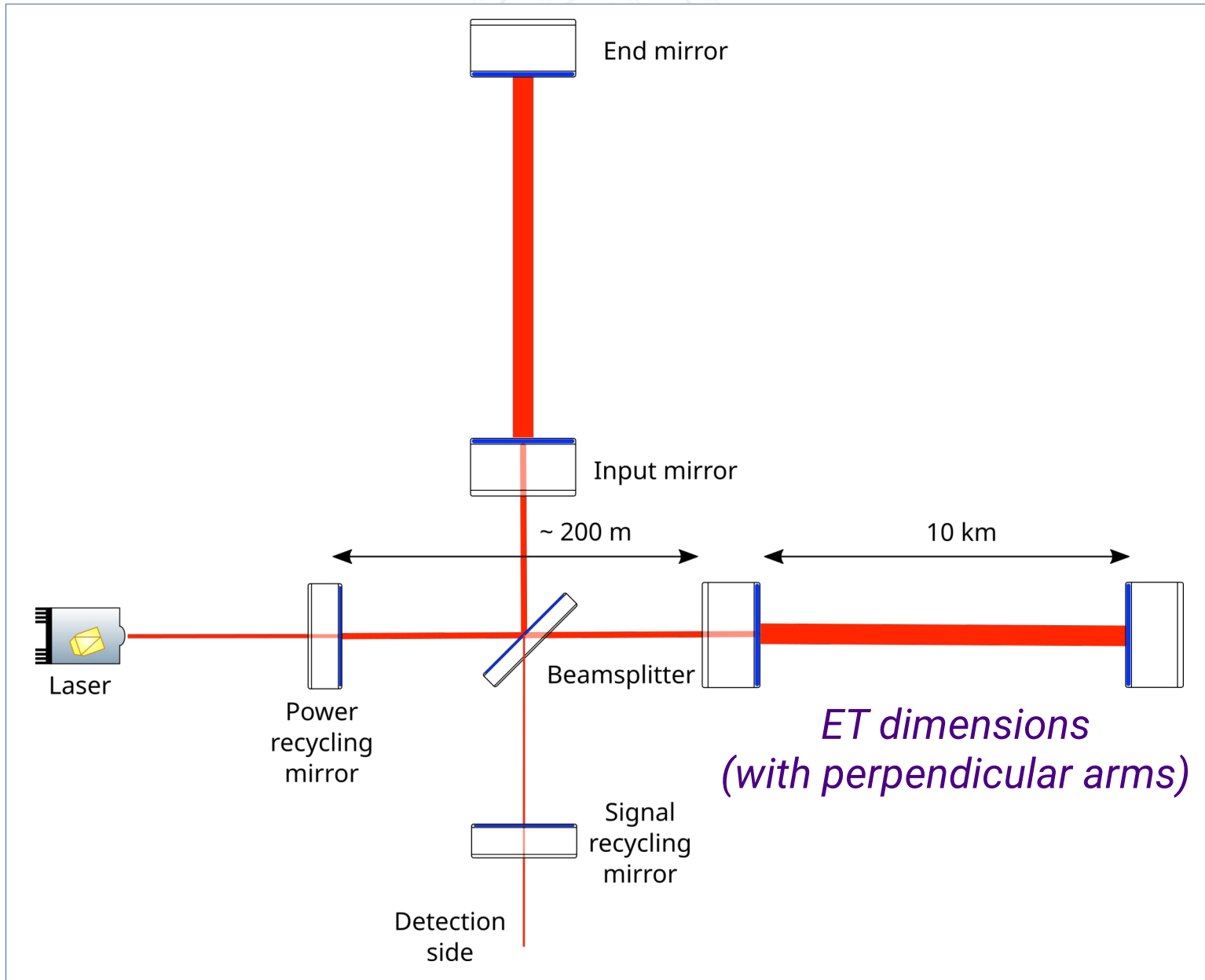


# Introduction to recycling cavities

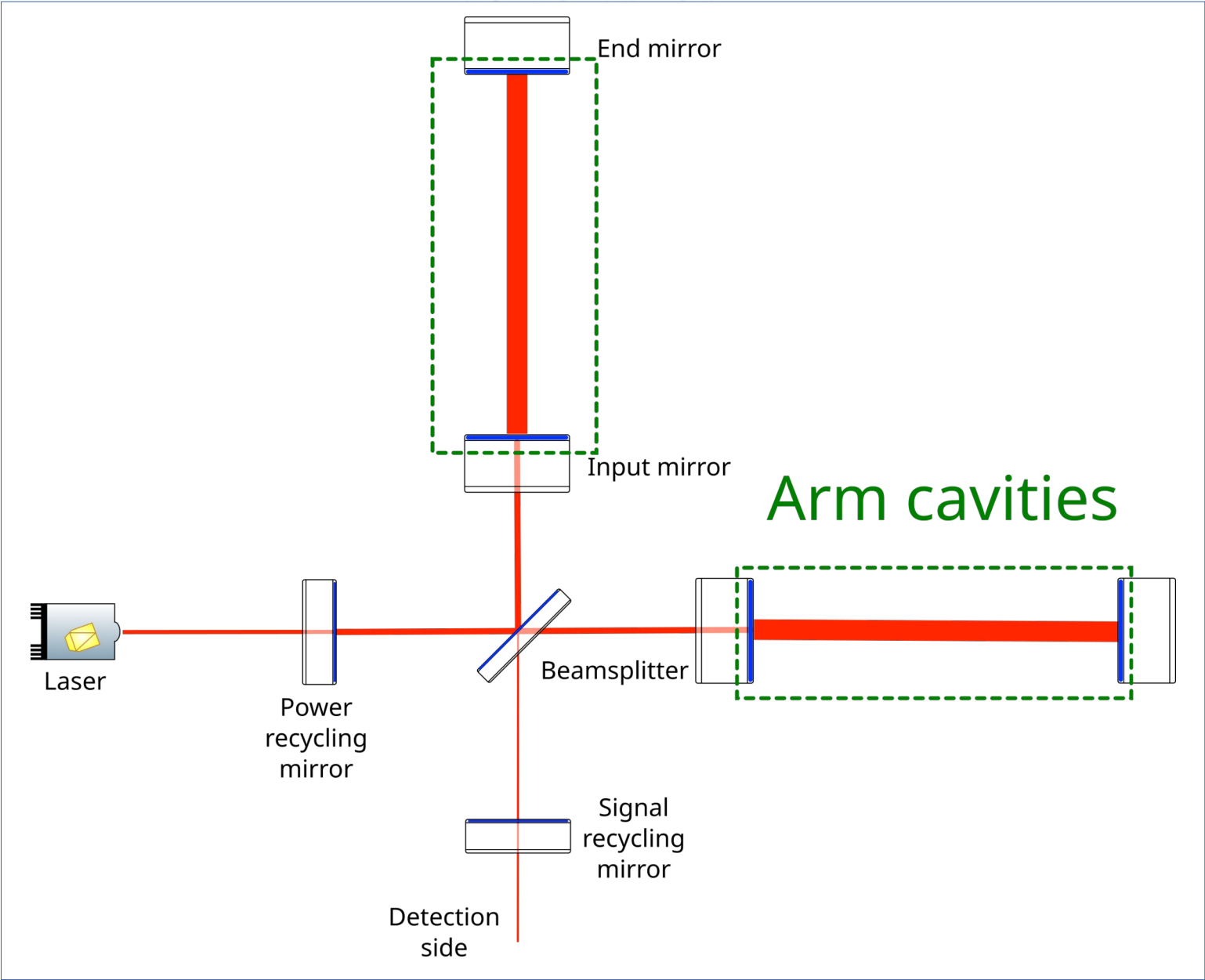
(for people who have never heard of them)

J. Degallaix

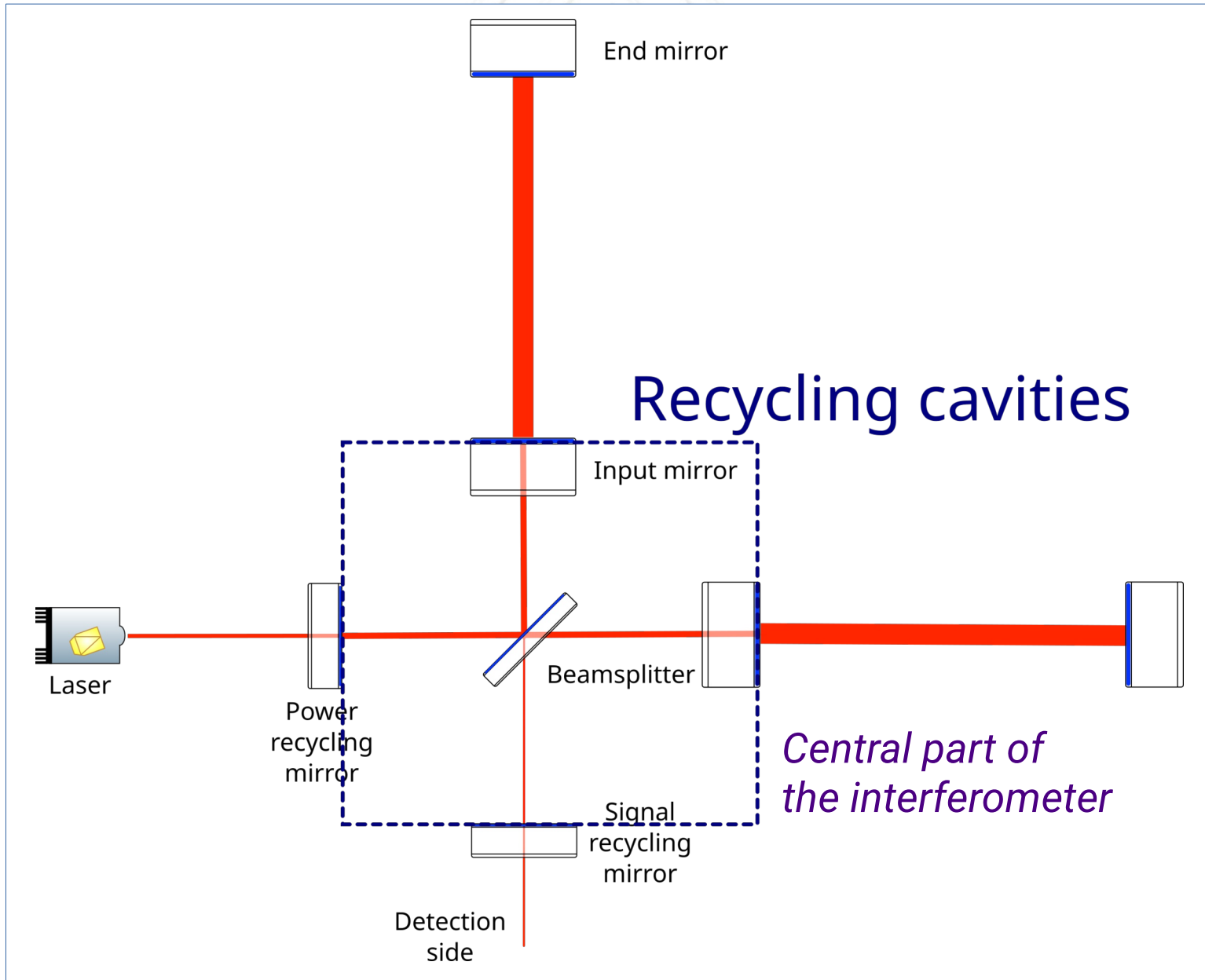
# A simplified GW detector



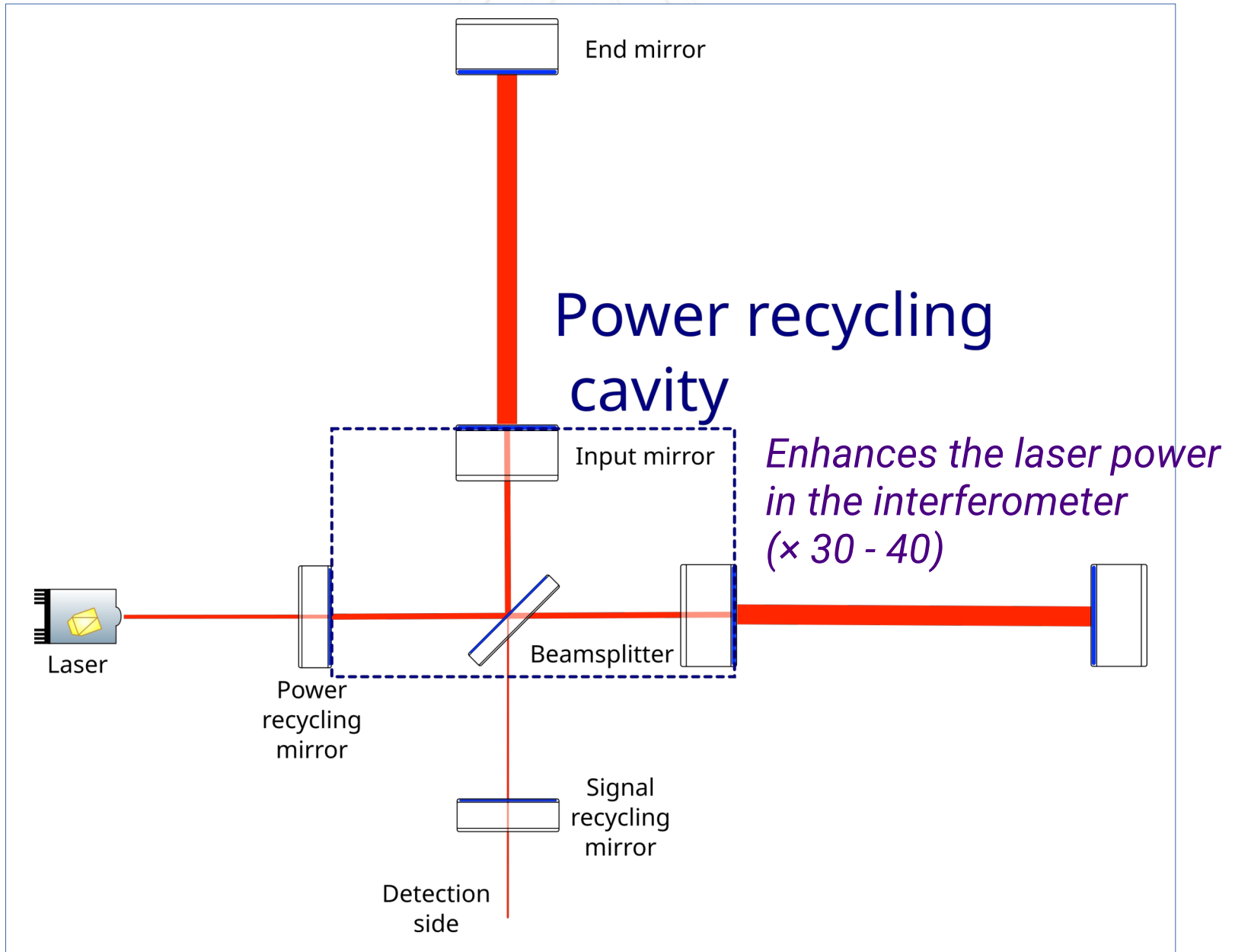
# Several optical resonant cavities



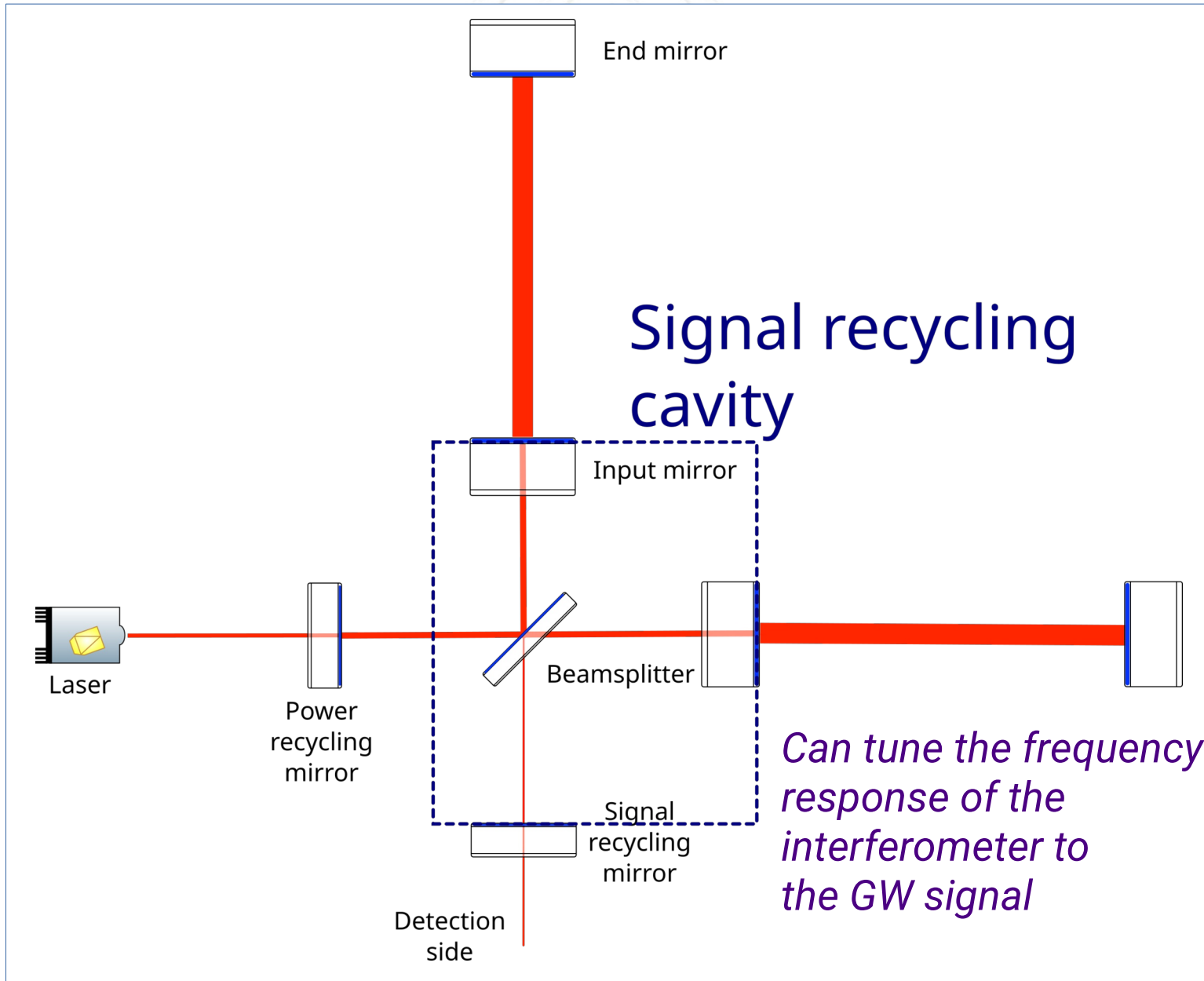
# Several optical resonant cavities



# In fact 2, recycling cavities



# Several optical resonant cavities



# Not a recent idea...

## Experimental Demonstration of Dual Recycling for Interferometric Gravitational-Wave Detectors

K. A. Strain and B. J. Meers

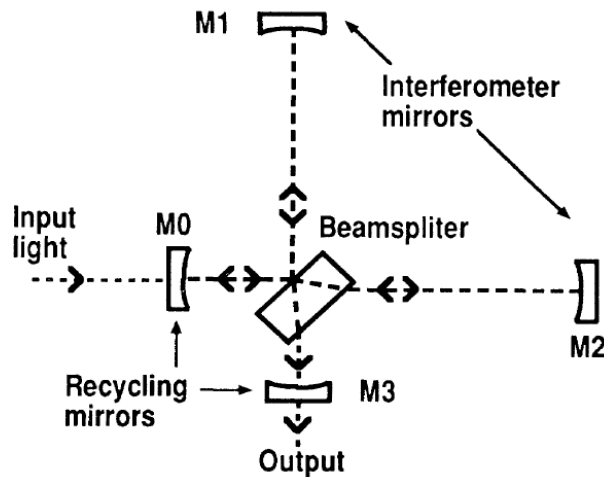


FIG. 1. Simplified optical arrangement of an interferometer with dual recycling.  $M_0$  resonates the laser power while  $M_3$  resonates the signal sidebands.

## Demonstration of light recycling in a Michelson interferometer with Fabry-Perot cavities

Peter Fritschel, David Shoemaker, and Rainer Weiss

*Applied Optics - 1992*

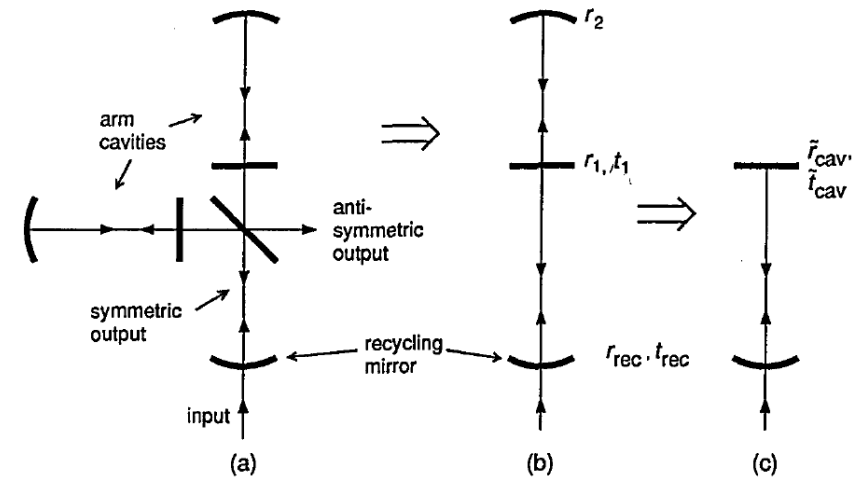


Fig. 1. (a) Optical elements of a recycled Michelson interferometer with Fabry-Perot cavities in the arms. (b) When the interferometer is operating at the dark fringe of the antisymmetric output, the two arms and beam splitter are modeled by one arm cavity, creating a three-mirror cavity. (c) The arm cavity is then modeled by a single mirror, having reflection and transmission coefficients of a Fabry-Perot cavity. The tilde denotes a complex quantity.

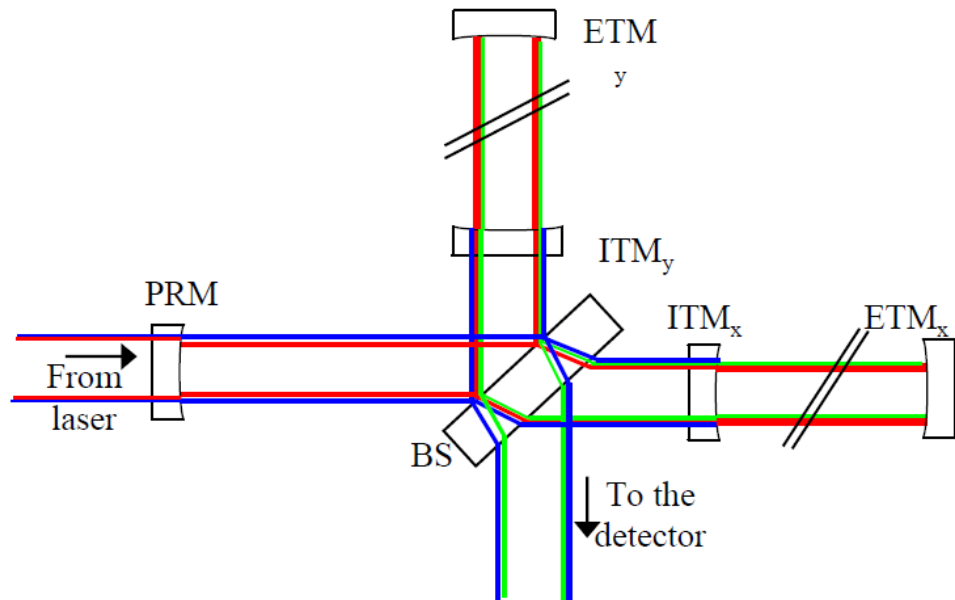
Power recycling: LIGO, Virgo, TAMA

Dual recycling: GEO, Adv. LIGO, Adv. Virgo, KAGRA

# Cavity geometry

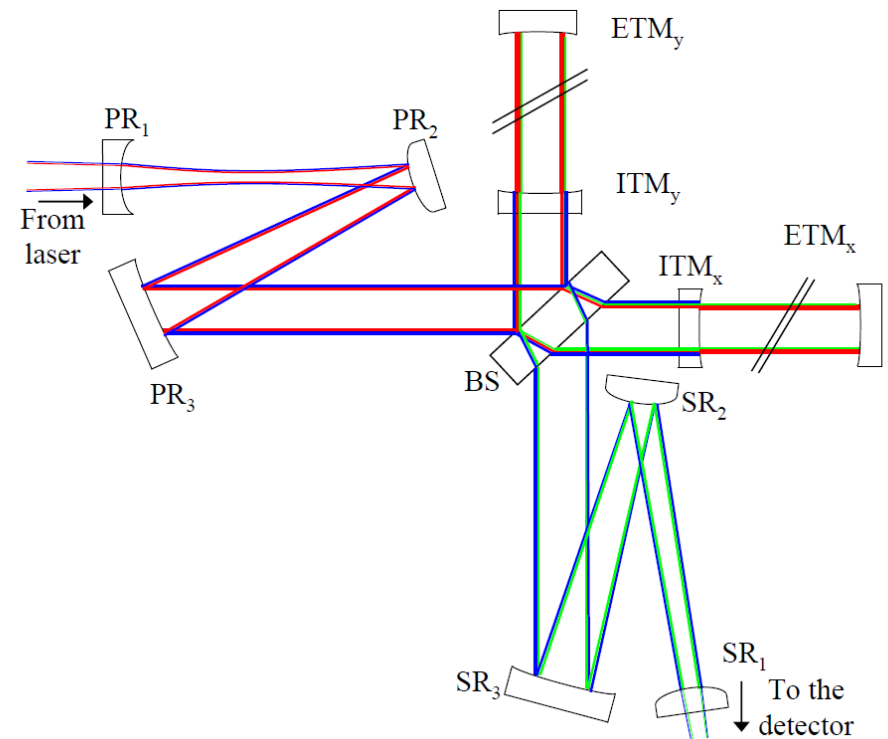


## Marginally stable



- More compact
- No focusing element
- More sensitive to aberrations
- Required telescopes before/after

## Stable



- with focusing element
- easier to simulate
- relax the telescopes magnification before/after



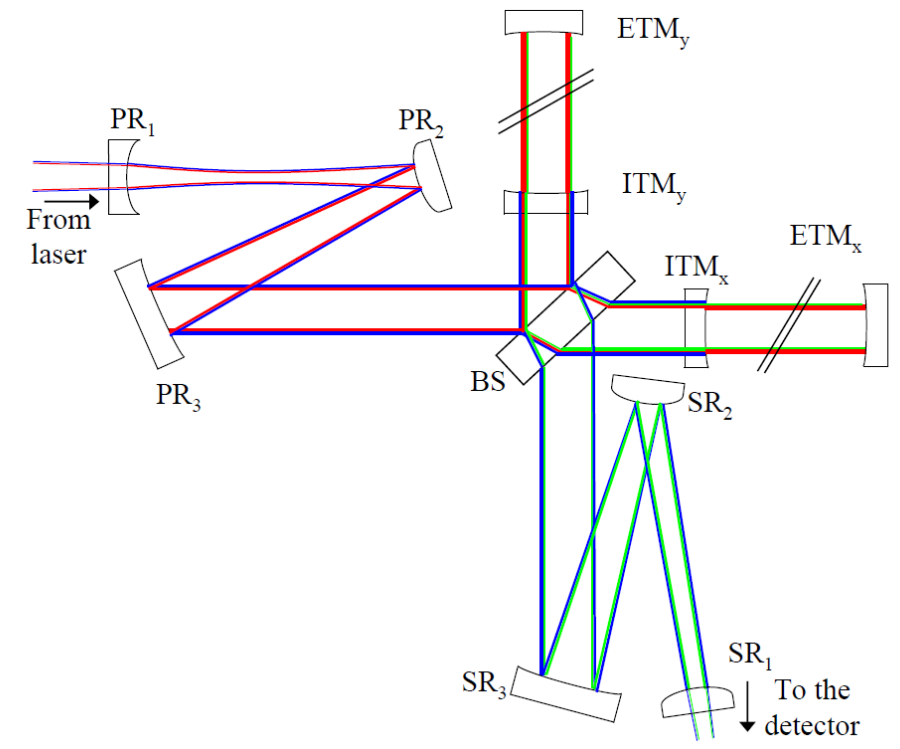
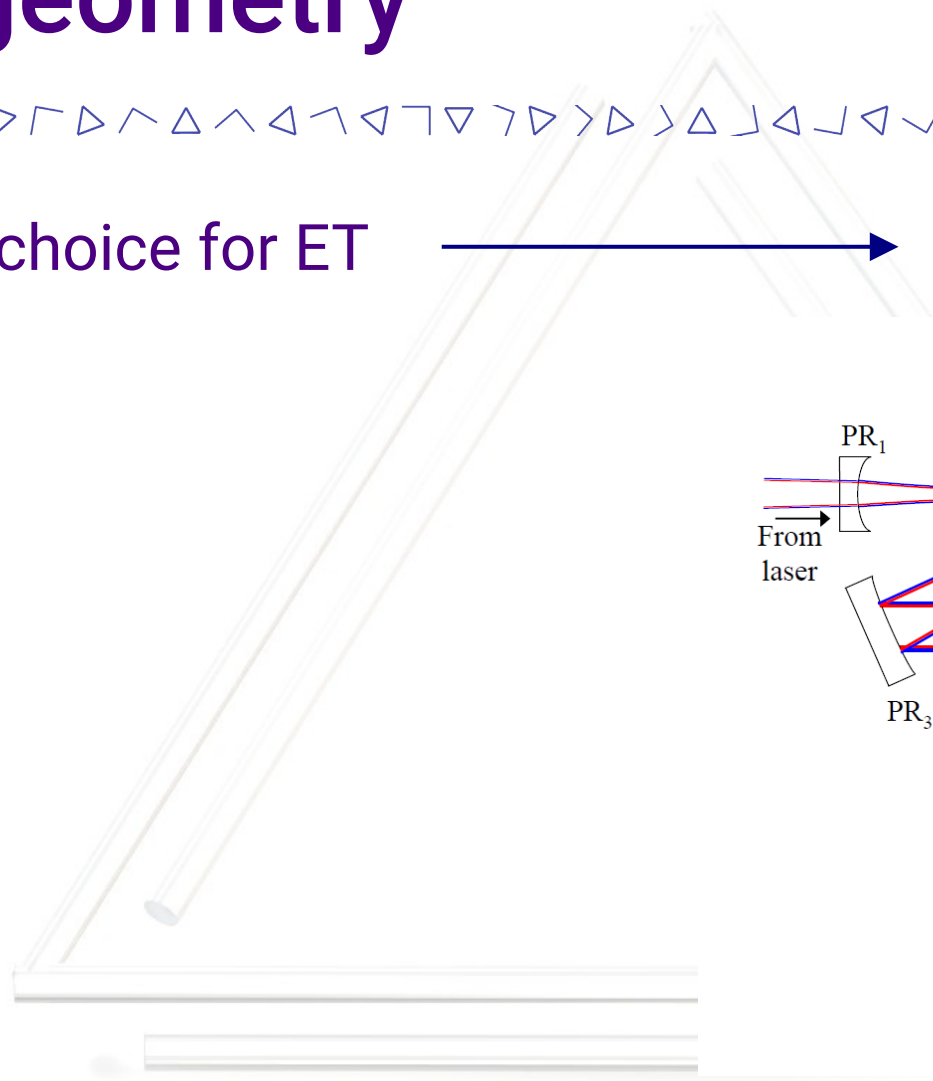
# Cavity geometry



Preferred choice for ET



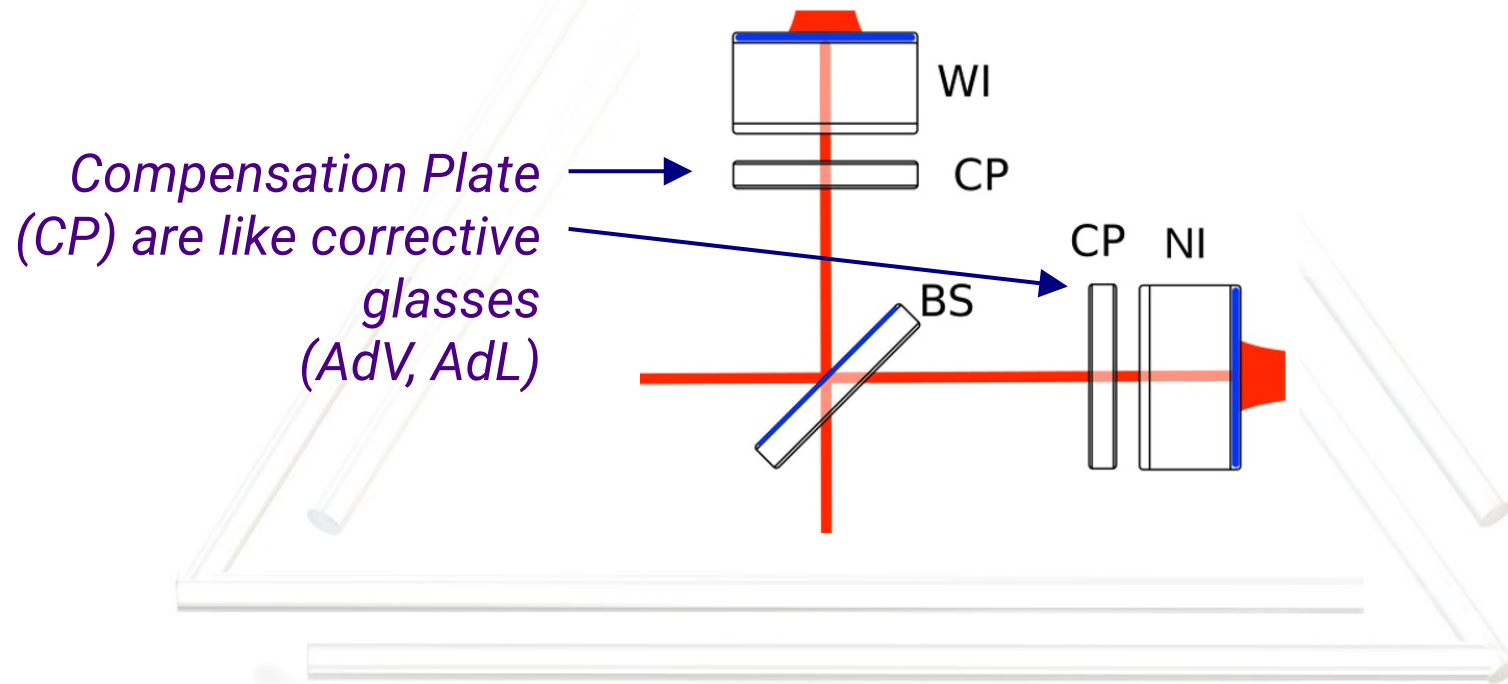
Stable



- with focusing element
- easier to simulate
- relax the telescopes magnification before/after

# Other considerations

- Optical loss less critical in the recycling cavities (compared to the arms)
- Could add element to control/ tune the interferometer



- two more longitudinal degrees of freedom to control (+ alignment)
- add complexity to the control of other cavities
- could provide pick off beams for control

# Conclusion



- Recycling cavities contribute to improve the sensitivity of the detector and are mandatory.
- Design is a transverse work as it could impact other divisions/Wps.
- And so this meeting today, before we enter in the more comprehensive simulation/design work.

