Input from the interferometer division

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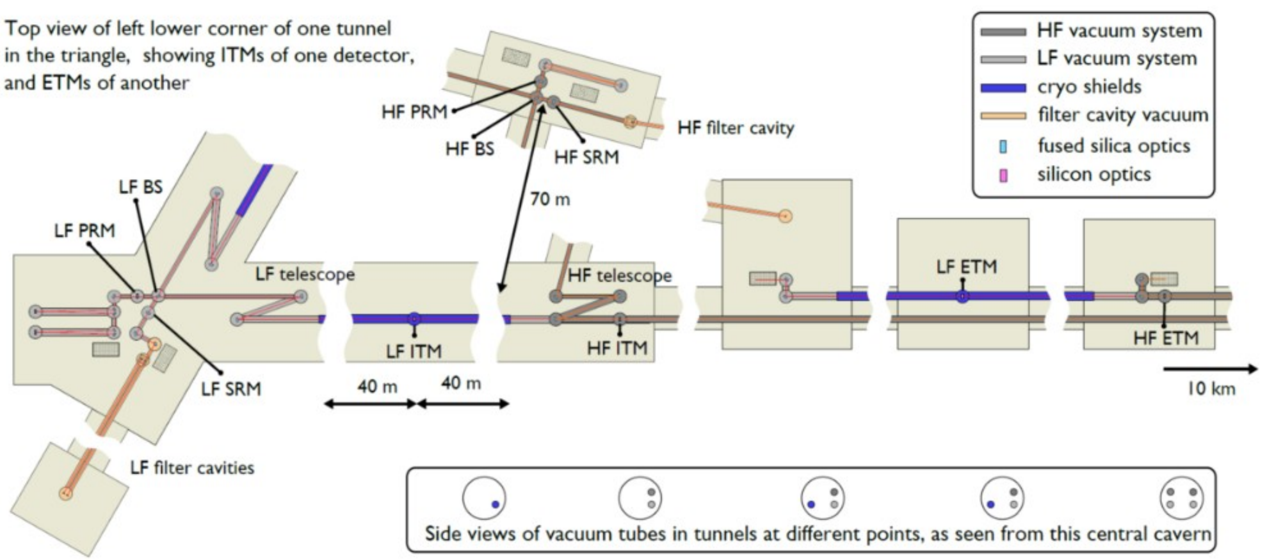
Few contextual words

- very preliminary study of the impact of the wavelength
- some thoughts as a starting point
- focus on ET-LF
- noise budget presentation right after

The overall design will not change

The interferometer will still be a dual recycling Michelson with Fabry-Perot arm cavities.
Recycling cavities topology is also independent of wavelength



Possible implementation of the recycling cavities

The arm cavities

- assuming the same mirrors size for all wavelengths (as a start)
- to keep the clipping loss constant, we must achieve the same beam size on the mirrors
- → different radii of curvature and cavity g-factor

ET-LF Arm cavity design

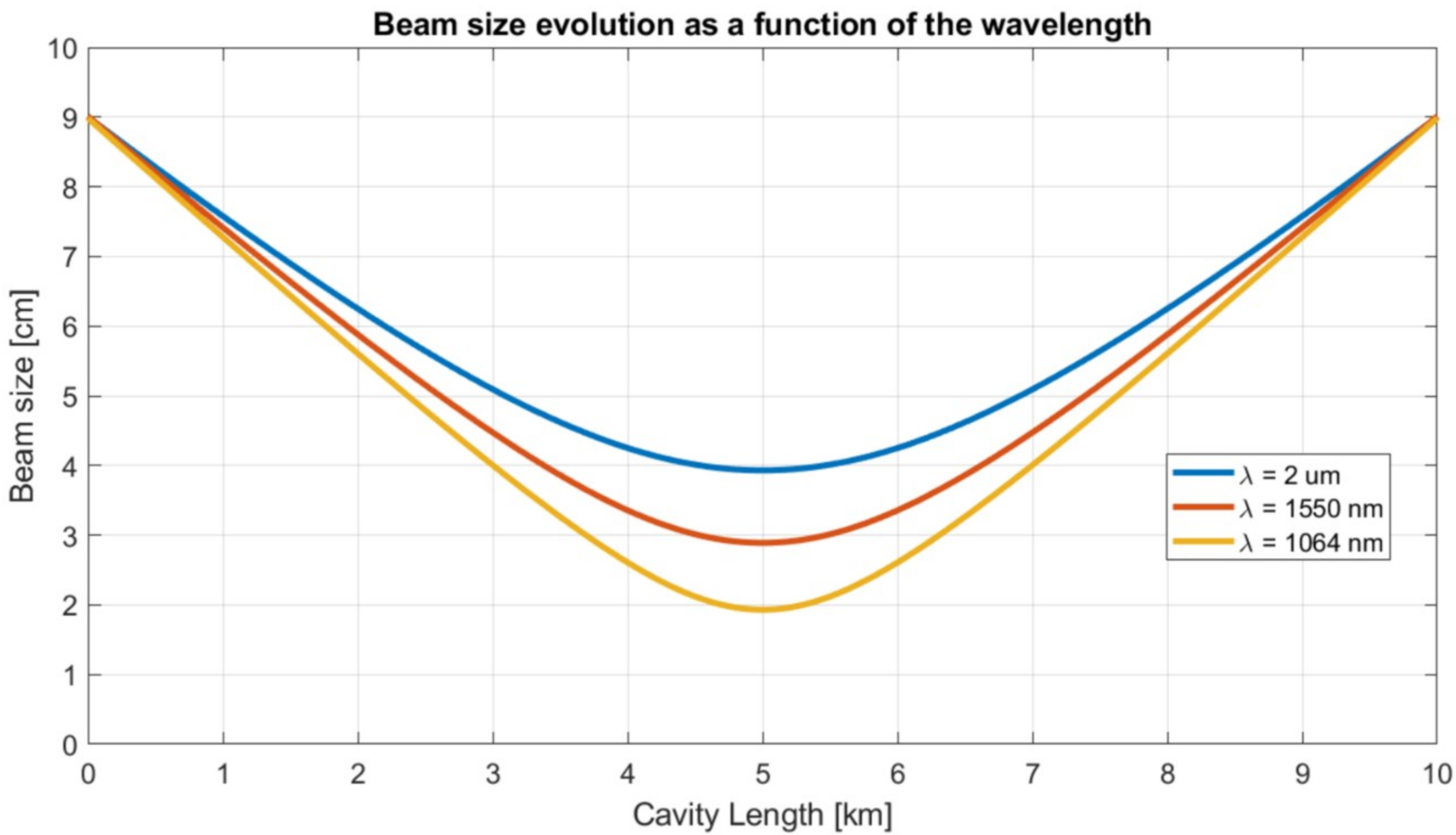
Estimate of the RoC of the ET-LF arm cavity mirrors for different wavelengthes Assumption: mirror is 450 mm in diameter and we are looking for a 9cm beam radius on the mirror (to have similar clipping losses). Cavity is symmetric so the waist is right in the middle.

Wavelength [nm]	RoC [m]	Beam radius on ITM / ETM [cm]	Waist radius [cm]	cavity g-factor	Comment
1064	5240	9.0	1.93	0.825	Only with sapphire substrates
1550	5580		2.89	0.627	Nominal configuration
2000	6180		3.93	0.382	

proposition on the wiki

(for comparison for AdV,
arm cavity g-factor: 0.87)

Beam radius along the 10 km arm



The Recycling Cavities (RC)

- different arm cavities RoC → update also the telescopes
- do we have to change the lengths of the RC ? still an open question (resonance of SB frequencies)
- could be an issue if the suspensions are fixed
- with curved optics in transmission, the refractive index of the substrate will matter

Optical losses due to scattering

Advantages for longer wavelength as light scattered scaled as:

$$\mathcal{L} = \left(\frac{4\pi\sigma}{\lambda}\right)^2$$

Surface height RMS of the mirror

Amount of scattered light by one mirror

Wavelength

As a very crude model, from 1 um to 2 um, the amount of scattered light could be divided by 4.

Other considerations – to be investigated

- due to the low power in the arm cavities: parametric instability and alignment instability due to radiation pressure may not be an issue (highly dependent on the cavity g-factor)
- for the calibration with the laser (photon calibrator), needs a laser well calibrated in power which is reflected by the end mirror
- required photodiodes for the sensing (single, quadrant), EOM, AOM,… (for 2 μm)
- likely need to use auxiliary lasers for the lock acquisition derived from the main ones, with additional requirement for the TM coating.

Conclusion

- no showstopper found so far from the (preliminary) optical design investigation for the 3 proposed wavelengths
- very preliminary results as many aspects must be considered
- design must anticipate a possible change of wavelengths for future upgrades