

I did the global simulation with the filter cavity and without the filter cavity.

For both of the simulation, the parameters used as below, the starting point is the position we have in the optical scheme, then I tried to slightly moved some of them for the without filter cavity case, in order to have a similar result as we can observe now, then we could take these values to simulate the one with only the input mirror.

Items	Parameter	Position on the scheme	Position in the simulation	Distance from last item
Beam splitter	first one after SHG	0	0	0
AOM Lens 1	f = 100mm	2.5cm	3.5cm	3.5cm
AOM Lens 2	f = 250mm	34cm	33.8cm	30.3cm
AOM Lens 3	f = 250mm	67cm	66.1cm	32.3cm
Faraday Isolator	Beam extraction port	81cm	81cm	14.9cm
2inch mirror	f = -30cm	4.785m	4.815m	4.005m
PR suspension	f = 3m	7.51m	7.51m	2.659m
Input Mirror	f = (-) 218.35	12.41m	12.41m	4.9m
End Mirror	f = -218.25	312.41m	312.41m	300m

* The input mirror focal length is negative in the without filter cavity case, and positive in the filter cavity case

1) The simulation with filter cavity

Beam size at different position

Position	Size
2inch mirror	896 μ m
Input mirror	9572 μ m
Final beam waist inside the cavity	4027 μ m

The final beam waist position is **180.88m**, the middle point of the cavity should be around 162.41m.

2) The simulation without filter cavity

In this case after the input mirror, I just let the beam keep propagating and put again telescope and simulate the beam back until the bench.

So we need to add more information about the reflected path. According to the result in last simulation, we have the distance between each component, but in order to have a reasonable reflected beam on the beam, I also shifted a bit some of the components.

Items	position from last simulation	Position in this simulation
PR suspension(2nd)	17.31m	17.31m
2inch mirror(2nd)	19.969m	20.076m
Faraday Isolator	23.974m	23.974m

The beam size on different position of this reflected path shows in the table below

Position	Beam size
PR suspension(2nd)	9839 μ m
2inch mirror(2nd)	959 μ m
Faraday Isolator	1129 μ m

If we consider the 100mm lens used to do the measurement is 40~50cm from the Faraday Isolator beam extraction port, then it position should be around 24.374 and 24.474.

Lens position	Beam waist size	Beam waist position	Distance between waist and lens
24.374m	14.606 μ m	24.475m	10.1cm
24.424m	14.543 μ m	25.525m	10.1cm
24.474m	14.479 μ m	24.575m	10.1cm

I took three point in this range and also move the lens slowly in the full range, there is no dramatic changing in the beam waist size and the distance between the waist and lens.

I also tried to change the focal length of this lens, the result shows in the next table.(Lens position is fixed at 50cm from the FI)

Focal length	Beam waist size	Beam waist position	Distance between waist and lens
75mm	10.835 μ m	24.549m	7.5cm
125mm	18.139 μ m	24.6m	12.6cm
150mm	21.814 μ m	24.626m	15.2cm
200mm	29.213 μ m	24.677m	20.3cm
500mm	74.938 μ m	24.995m	52.1cm

From this result, the distance between the waist and the lens is almost the same as the focal length of the lens.