Type B seismic isolation tower specifications and some proposed solutions.

General dimensioning

The type B vacuum chambers shall be 1.5 m in diameter, shall have a beamline of 1.2 m above ground, have 1 m diameter inline vacuum flanges, suspend 250 mm diameter mirrors 100 mm thick (ex-LIGO) for the three recycler units and a 380 mm diameter 120 mm thick beam splitter.

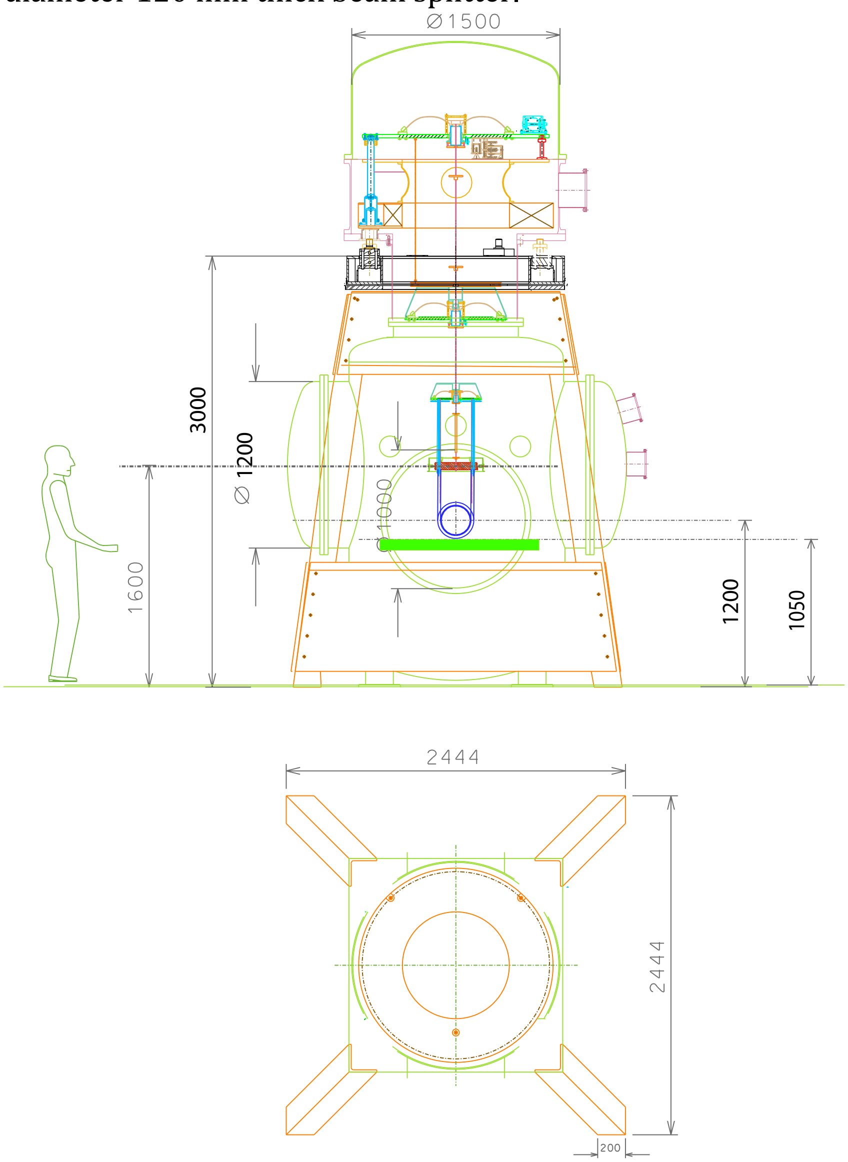


Figure: sketch of the type B seismic attenuator.

The mechanical structure will be built to use the same standardized components of the type-A chains (standard filter, top filter, Inverted pendulum, leveling structure, vacuum dome) and to offer the same facilities (remote control alignments, remote fine positioning, mode damping) designed for speedy interferometer commissioning.

Seismic attenuation requirements

The payload shall be formed by a double pendulum stage.
The payload shall be isolated by two seismic attenuation stages.

The recycler mirror Payload requirements.

In the recycler version of the type-B seismic attenuation tower, due to the vicinity of folded and ghost beams, the mirror recoil mass must be hidden behind the mirror profile.

Additionally, because at the transmitted beam of PR2 and SR2 need to be collected for monitoring reasons, the recoil mass needs to have a minimum central clearance of 6 sigmas = 4*6 = 24 radius. We chose a central clearance of 100 mm diameter. The conceptual mirror-recoil mass design will be an "inline" geometry like the one sketched below.

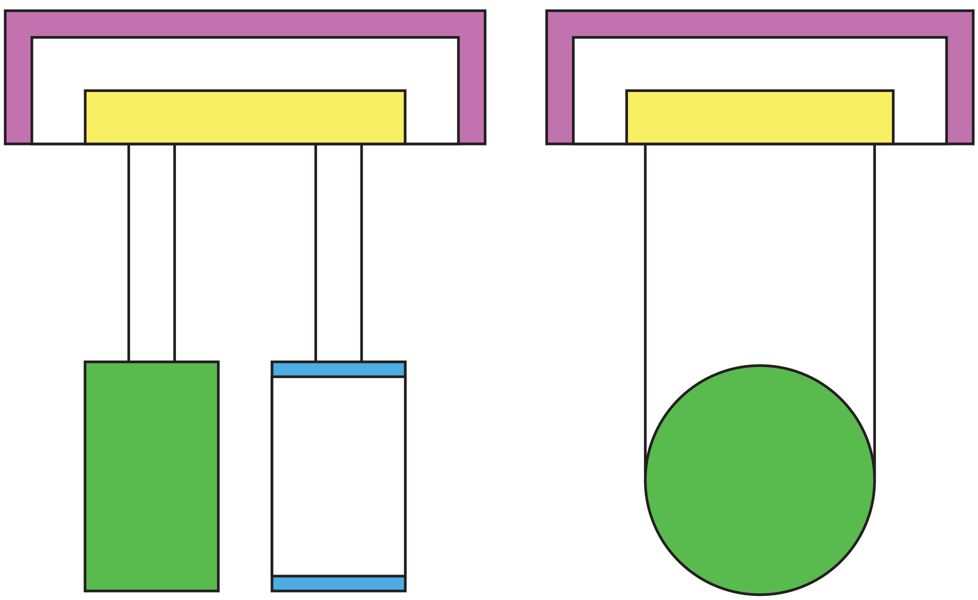


Figure: In-line geometry of the recycler mirrors. Side and front view.
At least 5 cm clearance is required to make space for the OSEMs that control the mirror (green) and the intermediate mass (yellow). In the test masses no electrically conducing plane or body should be closer than 5-6 diameters from any control coil (Virgo had to re-do their marionettas for this reason). It is not clear how much this constraint can be released for the recycler mirrors.

To minimize translation-tilt coupling, it is likely advantageous to mount the mirror in axis with the suspension wire, with the recoil mass sitting behind, balanced by a forward ballast mass on the intermediate mass. Not too much extra mass will be needed because the recoil mass will be lighter than the mirror.

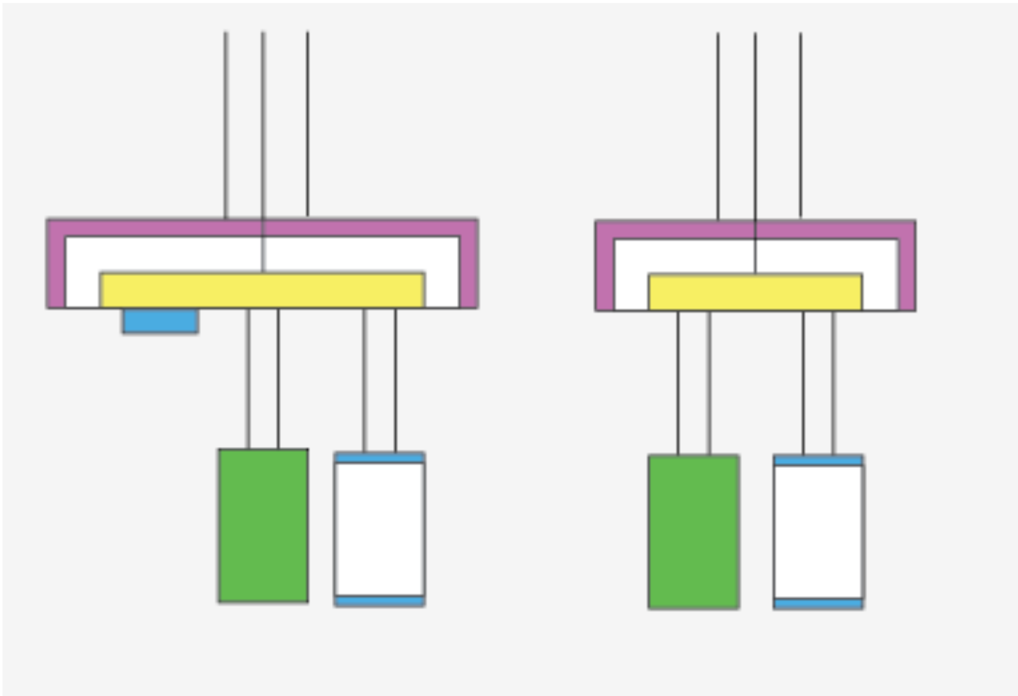
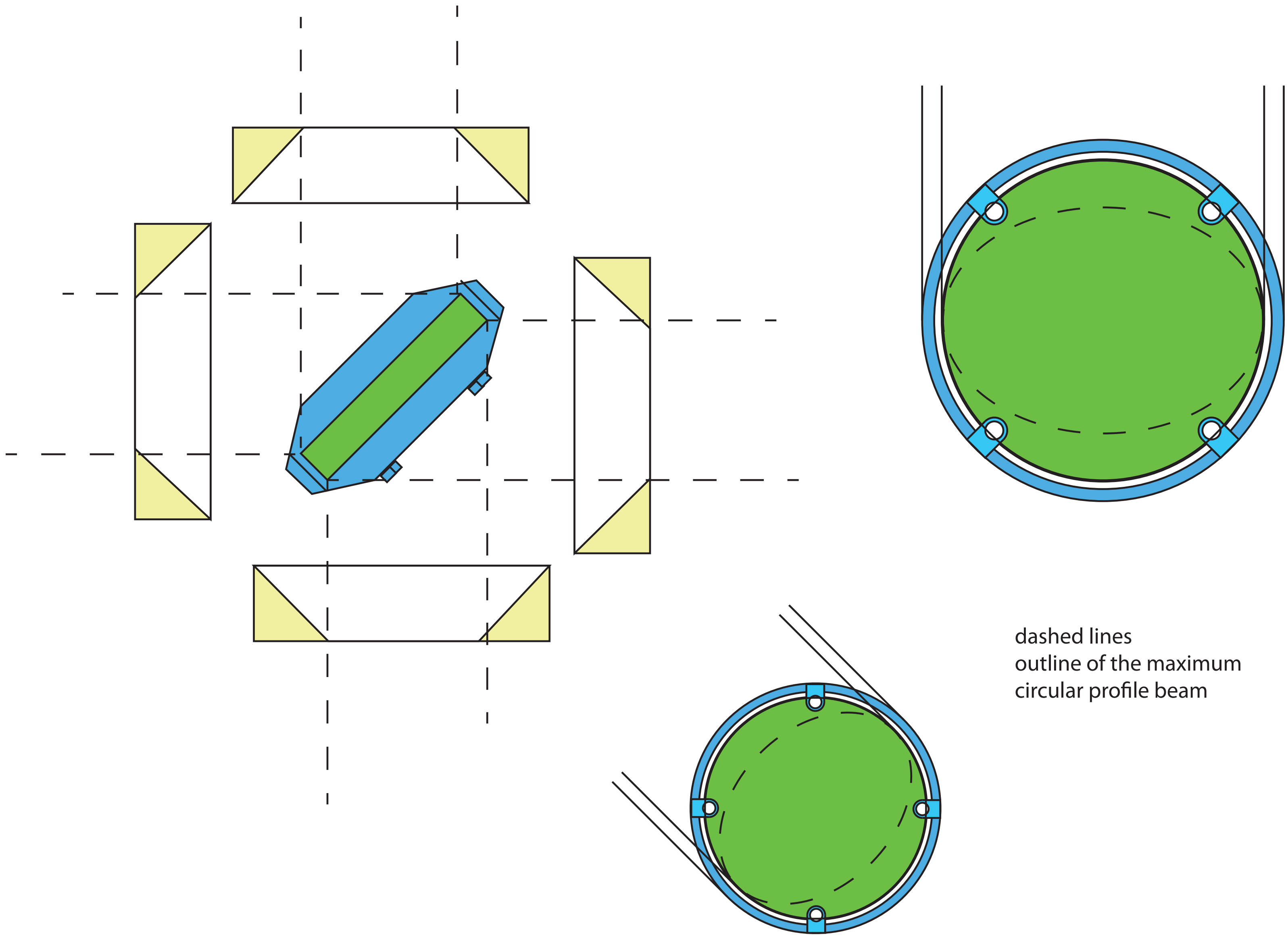


Figure: Two options to choose from for the recycler mirror controls.
On the left the mirror sits at the center, with its recoil mass behind, and a ballast mass in front of the intermediate mass. In this configuration the suspension vertical degree of freedom does not mix with the mirror tilt mode
On the right a similar geometry with the mirror on one side and its recoil mass on the other of the suspension point .

Beam splitter payload requirements

The recoil mass of the beam splitter has to be concentric to the mirror and clear the view on al four sides. A possible beam splitter/recoil mass configuration is sketched below.

Figure: Beam splitter reaction mass configuration.
The four beam limiting suspended baffles are shown as well.



dashed lines
outline of the maximum
circular profile beam

Seismically isolated optical bench requirement.

The vacuum chamber must also house a seismically isolated optical bench, 150 mm below the beamline carrying relay mirrors for the pickoff beams and auxiliary optics.

At least two stages of seismic isolation are required.

Provisions must be made for suspending seismically isolated baffles for safe scattered light dumping. These baffles may be suspended from the chamber's ceiling.

Access and pickoff beam requirements

The vacuum chamber will have 1.2 m diameter side flanges for access.
Three 150 mm viewports shall be located above the beampipe, to route monitor beams and for observations. Additional viewports can be added at a later time on the side doors, if need arises. Unlike the forward and backward looking viewport, which need to be above the beamline, these viewport may be at the beamline level.

Longitudinal and lateral separation requirements.

The largest offset between type B towers (i.e. between PRM and PR3 and SRM and SR3) will be 260 mm while their minimal longitudinal separation will be 2360 mm. This will produce a non negligible jog between PRM and PR3 and between SRM and SR3
A study on three ways how to do the job is shown below:

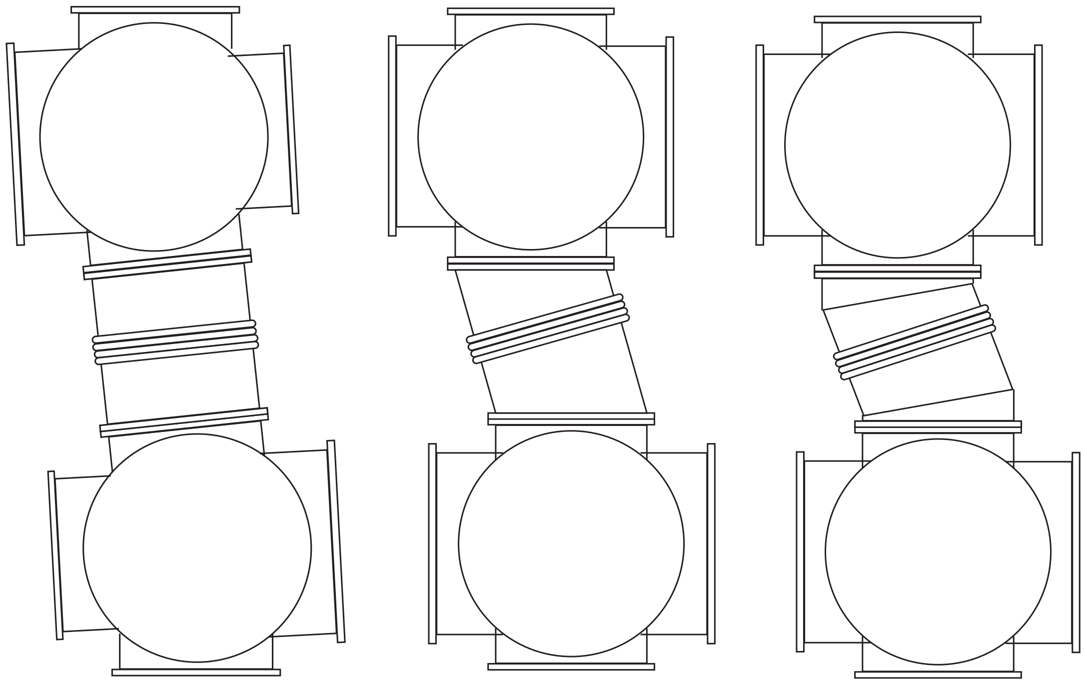


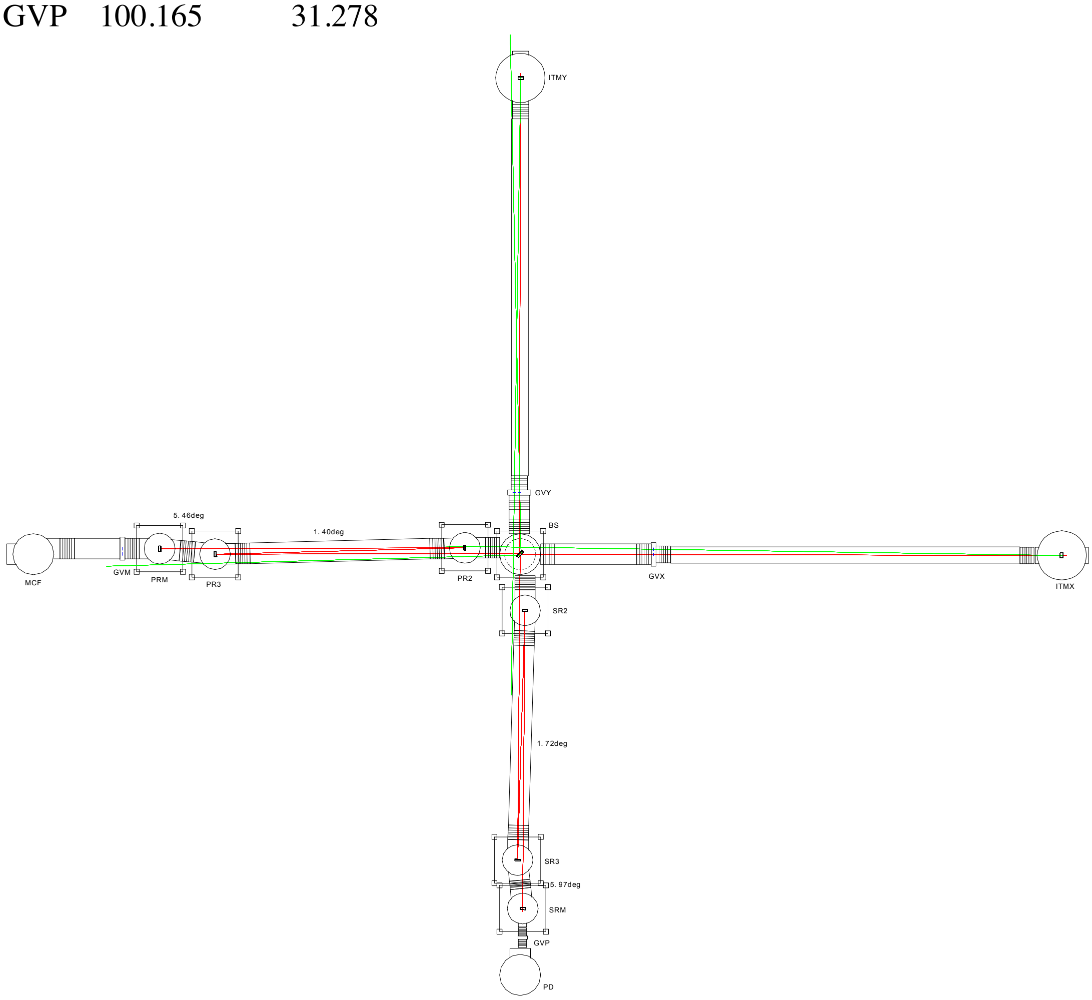
Figure: Three options to achive te dogleg between PRM and PR2.
In the case on the left, the beamline flanges have been rotated, one by plus and one by minus three degrees.
In the two cases on the right the flanges of the towers are kept straight and the dogleg lateral shift is obtained with shaped spools of different type.
In the first case the tressle structure holding the IP pre-isolator will have to be wider to account for the shifted space between the flanges. Additionally the access port on the "inside" side has been reduced from 1200 to 1000 mm diameter.
A choice between these options have to be made before designing the tressle structure.

Longitudinal tuning requirements

To match the requirement of the radiofrequency sidebands, all towers must be moveable along the beamline by 500 mm.

Table 1 Position of the mirrors in the central station: The type-B attenuation towers are shown in blue

	X	Y
ITMX	126.414	49.895
ITMY	100.060	73.152
BS	100.042	49.958
PRM	82.490	50.220
PR2	97.349	50.260
PR3	85.187	49.962
SRM	100.165	32.696
SR2	100.282	47.215
SR3	99.918	35.057
MCF	76.342	49.958
PD	100.042	29.458
GVX	106.542	49.946
GVY	100.007	52.958
GVM	80.678	50.220
GVP	100.165	31.278



Fugure: beam layout