Stable Laser Systems

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Comments on different cavity geometries: notched horizontal, vertical midplane and spherical.

The table below compares the measured acceleration sensitivities for different cavities from publications by different groups. The lines in bold refer to designs sold by (or very similar to ones sold by) Advanced Thin Films. There doesn't seem to be one design which is clearly superior. On the whole, all systems for narrow linewidths use a vibration isolation stage, and the thermal noise floor of the cavity can be reached with any geometry (including cylindrical), and if the value of that noise floor is important, then the notched cavity is the longest and has the lowest thermal noise floor (assuming a good choice of mirrors for large beam spot size).

The spherical cavity is held in its supports, so it can be moved and alignment can be maintained. The support design of the spherical cavities is probably not quite optimal yet, though they give excellent results in the groups that use them. The frequency change/unit acceleration of spherical cavities may improve as the mounting structure develops.

Considering the temperature control of the cavity in a vacuum can provided by Stable Laser Systems: the spherical cavities vacuum cans are compact, and the vacuum can arrangement allows for milliKelvin stability temperature control over a wide range of temperatures. The temperature control property can be important, as the ULE material for the spacer can have a zero expansion point at any temperature between 2 C and 40 C, so it is possible to operate at that zero expansion point (which is typically a few degrees C cooler than the spacer zero crossing for fused silica mirrors with ULE rings). The notched cavity vacuum can operates between 14 C and 40 C, so the few ULE spacers which have zero crossing temperatures less than 14 C need extra cooling power (chilled water through the heatsinks) to reach their optimal operating temperature.

Acceleration Sensitivities Summary			Vertical	Horizontal	
	Orientation	Comment	[δf/f / ms^{-2}]	[δf/f / ms^{-2}]	
P Lemond	vertical	100 mm diam	3.5E-12	1.4E-11	Phys Rev A 79 053829 (2009)
G Santarelli	horizontal	100 mm diam	3.0E-12	1.0E-11	Phys Rev A 79 053829 (2009)
A Ludlow	**vertical**	**ATF midplane**	**7.0E-11**	**5.0E-11**	**Opt. Lett. 32 641 (2007)**
U Sterr	horizontal	rather fat	2.9E-12	2.6E-11	Appl. Phys. B 83, 531–536 (2006)
S Webster	**horizontal**	**similar to ATF 50 mm notched 6020-4**	**3.5E-13**	**1.4E-11**	**PRA 75, (011801) (2007)**
	cylindrical	**ATF Cylinder 6010-4**	**1.0E-10**		**calculated**
D Liebrandt	**spherical**	**spherical**	**4e-12**	**2e-11**	**Opt Expr 19 3472 (2011)**