Some things for customers to keep in mind when considering small quadrupoles

This information is based on what I know about the Transpector XPR and Ferran's Micropole. And can be used by SRS's sales force to guide customers in the choice between a small quadrupole and a CIS.

Some Specs

MDPP: Faraday Cup: about 10^{-7} to 10-8 Torr (Ferran claims 5 E-9 Torr for the high end unit but I believe that is with background substraction). CDEM (XPR Only) 10^{-10} to 10^{-11} Torr

PPM Levels: No better than 10 ppm even in the absence of spectral overlaps. Ferran claims 1 ppm with background substraction mode.

Filament: Mostly W. Ferran offers $ThO_2 \cdot Ir$ (1500hours lifetime in Air reported). No numbers are reported by other manufacturers for W in air at 10 mTorr.

Sensitivity: $2 \cdot 10^{-6}$ A/Torr for the XPR.

Some of the problems

1. **Zero Blast**: The zero blast problem is severe in the mTorr range and extends all the way into the 4 amu mass value. H_2 is totally lost in the slope of the Zero blast signal and He detectability is seriously affected. The lack of H_2 signal leaves the UHV people out. The low He detectability makes the detection of Small leaks impossible.
2. The best **MDPP** achieved by these devices is 10^{-11} Torr (XPR with CDEM in clean system), therefore UHV users that operate in the $<10^{-9}$ Torr region can expect to be able to go down to 1% impurity detection at best. The FC detectability in the order of 10^{-8} Torr does very little for most High Vacuum systems that are easily pumped down to $<10^{-6}$ Torr w/modern turbo pumps.
3. The **PPM detectability** for these devices is at best 10 ppm even in the absence of spectral overlaps. Things get only worse when spectral overlaps are present. Obviously a CIS system is a much better option here since it can do PPMs even in the presence of overlaps. The CDEM in the XPR cannot be turned on for pressures above 10^{-5} Torr.
4. The entire analyzer is directly immersed in the process gas without any differential pumping. As a result, the detector is more **suceptible to contamination** and reactions with the process gases. Long tern stability studies to determine the effect of different gases and etchants on the analyzer and detector (particularly CDEM) have not been done yet. I suspect serious problems down the road, specially since they recommend

the devices for etch clean processes. In the CIS the analyzer is exposed to 100X smaller pressures than the process, extending the analyzer's lifetime.

5. The CDEM they used can only be turned on under 10^{-6} Torr and with a MDPP of 10^{-11} Torr the best detectability with the CDEM is 10 ppm. During practical application, the number is closer to 100 ppm.
6. The **filament material** often used is W. A W filament in a mTorr of air will last a maximum of 100 hours. Ferran claims 1500 hours for a ThO_2.Ir filament in 1 mTorr of air. Leybold claims that an XPR with a W filament not exposed to air, but rather Ar will last months. The literature I have on filaments indicates that a W filament has the following expected lifetimes at different pressures: 10-20 hours between 10^{-2} and 10^{-3} Torr, 1000 hours at about 10^{-6} Torr. Air inrush will kill the W filament. ThO_2.Ir filaments are unaffected by air[1].
7. **Field Serviceability** is a problem: For the XPR, the filament and the CDEM are very small and can only be replaced in the field by very well trained personnel (As they put it: "Using good eyes and very fine tweezers"). The unit should be looked at as a consumable, or sent back to the factory everytime the filament burns (which will be often). The Ferran is sold as a consumable, you get a new head (for $500) everytime the filament burns.
8. The **linearity range** is also a problem: Leybold claims 10^{-2} Torr maximum pressure. The truth is that the linearity dies above 10^{-3} Torr. They use a Fudge factor to extend the linearity to 10^{-2} Torr. However, the fudge factor is gas dependent and only works for one individual gas at a time. For example using the same factor used to correct N_2 on H_2 gives overestimated pressures above 10^{-3} Torr. So the true linear range is up to 1 mTorr, and the unit can be turned on at 10 mTorr, but its readings can be off by as much as 90%.
9. **Price** is also an issue: The Ferran units are about $4000 and you have to by a new micropole probe when the filament burns at a cost of $500 a pop. The lifetime of the probe will depend on the filament but is at best 1500 hours if routinely operated in the mTorr range. The XPR is about $14000 and serviceability is an issue.

Conclusions:

1. The devices are going to have a hard time finding an application field. My best way to look at them would be as a replacement for an ion gauge when some limited information on partial pressures is needed. However, price, serviceability will make it difficult for them to replace ion gauges any time soon.
2. I can only see them as the real option if space or power are an issue otherwise, you get a much better performance for the value using a real PPR or CIS system.

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[1] For W filament lifetimes consult: Mueller, K.G. (1962) Vak. Tech. **11**. 7