The frequency modulation SPM (FM-SPM) configuration que consists in adding a feedback mechanism between the Signal Demodulator SD (lock-in, PLL or phase detector) and the QTF excitation signal. In traditional AM-SPM (see Appendix) the signal coming from the QTF is analyzed with a lock-In amplifier which provides the amplitude R that in turn feeds the PI controller. The excitation voltage driving the QTF in this case is constant in frequency and amplitude and serves both to drive the QTF and as a reference to the SD. The next step, taken by the FM-SPM, is to include the phase diffence ( ) between the excitation signal and the measured signal as variable to be controlled, by adding an embedded feedback loop which sole purpose is to keep that diferrence constant at 90 degrees.

K(φM -φR)

Setpoint (90°)

ASin(ωMt+φM)

ASin(ωRt+φR)

ΔfR

Setpoint (Δf0)

PID

Frequency control

Signal Demodulator

Lock In , PLL, Phase detector)

Piezo

VCO

PID

Phase control



Setpoint (90°)



Fig. 14. The new feedback loop for FM-SPM includes a feedback inner loop (double line arrows) to keep the phase constant at 90 degrees.