Review: however, in the case of the oscillator, the design could be optimized. I am not sure that 50 ohms mini-circuits amplifiers are well fitted for this application. Firstly, these amplifiers are not specifically low phase noise amplifiers. Secondly, HBAR resonators perform much better on different load than 50 ohms. This could also be a possible reason for the discrepancy between the measured loaded Q factor (on 50 ohms) and the observed corner frequency between −30 dB/dec and −10 dB/dec noise on the phase noise measurement data. To improve the results, a semi-integrated oscillator could designed (but this is perhaps the next step ?).

Sustaining amplifiers, exhibiting a measured residual flicker phase noise of −120 dBrad^2/Hz at 1 Hz offset frequency (for the total amplification stage, *i.e.* 2 amplifiers in serial configuration), are not specifically low-phase noise amplifiers but rather wideband, and hence provide the flexibility needed at this development stage to select the resonance of the multimode HBAR while still exhibiting constant impedance as seen from the resonator.

We agree though that optimization could be done for improved phase noise performances.

For a more detailed analysis, Fig. 1 shows the measured oscillator phase noise at $\nu_0 = 2.3$ GHz, the loop-oscillator sustaining amplifier residual phase noise (for a given input power different from the actual one in the oscillator configuration) and the expected Leeson-based oscillator phase noise assuming a loaded Q-factor of 24200, *i.e* a Leeson frequency $f_L = \nu_0/(2 \cdot Q_L) \sim 48$ kHz.

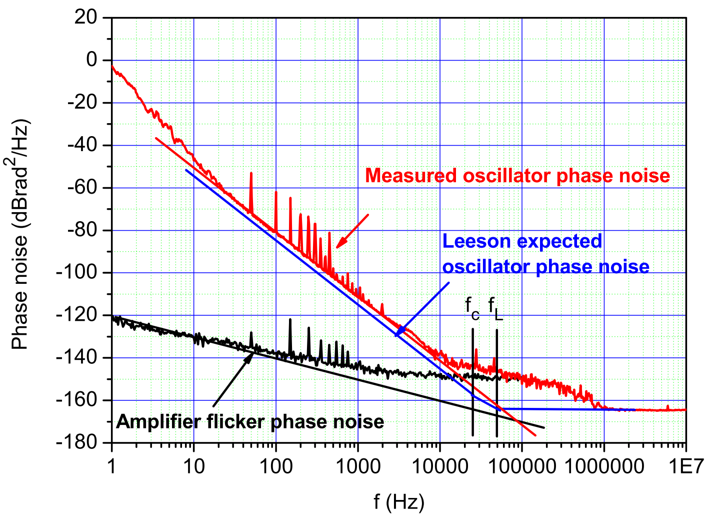

Figure 1: Phase noise analysis of the HBAR oscillator and sustaining amplifier.

The residual flicker phase noise of the sustaining amplifier (2 amplifiers in serial configuration) is measured such that $b_{-1} = -120$ dBrad^2/Hz at a carrier frequency of 2.3 GHz. This flicker phase noise is expected not to depend on the microwave carrier input power where the amplifier phase noise floor decreases with increased input power [R. Boudot and E. Rubiola, IEEE Trans. UFFC, 59, 12, 2613, 2012]. The amplifier phase noise leads to a Leeson-expected oscillator phase noise shown in blue. A discrepancy of about 5 dB is observed on the f^{-3} slope between the expected result and the measured result.

Two reasons are mainly suspected to explain this discrepancy. The first reason, as suggested by the reviewer, is a non-linear behavior of the HBAR resonator with input power or impedance matching, yielding that the resonator loaded Q-factor in actual oscillator loop conditions would be different from the one measured in open-loop conditions with the network analyzer [Gribaldo, IEEE TUFFC, 53, 11, 1982 (2006)]. This could be a possible reason for the discrepancy between the measured loaded Q factor (on 50 Ω load) and the observed corner frequency between −30 dB/dec and −10 dB/dec noise on the phase noise measurement data.

A second possible reason could be that the oscillator phase noise is limited by the residual phase noise of the HBAR resonator itself. Residual flicker phase noise of BAW-FBAR resonators at 2.3 GHz at levels higher than -120 dBrad^2/Hz at 1 Hz offset frequency (higher than our amplifier residual phase noise) were reported in the literature [S. Gribaldo et al., IEEE TUFFC, 53, 11, 1982 (2006)]. In Ref. [E. Ferre-Pikal et al., IEEE TUFFC, 48, 2, 506 (2001)], the residual $1/f$ noise of 2-GHz high-Q thin-film sapphire resonators was measured to be up to -26 dBrad^2/Hz at $f=$ 1 Hz. In Ref. [D. S. Bailey et al.], the FM noise of 640-MHz HBAR resonators was reported such that $S_y(100Hz) \sim -250$ dB relative to 1/Hz. Further studies are under progress to clarify this point. As suggested by the reviewer, the development of a semi-integrated oscillator, optimizing these aspects, could be studied in the future for improved phase noise performances of the HBAR-based oscillator.

In a last point, we note that the excess level of noise on the oscillator phase noise spectrum in the 20 kHz–800 kHz offset frequency range is attributed to the signal source analyzer (Agilent E5052B).