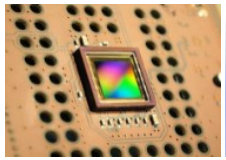
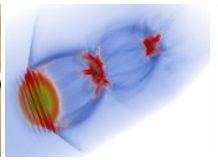
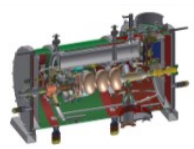




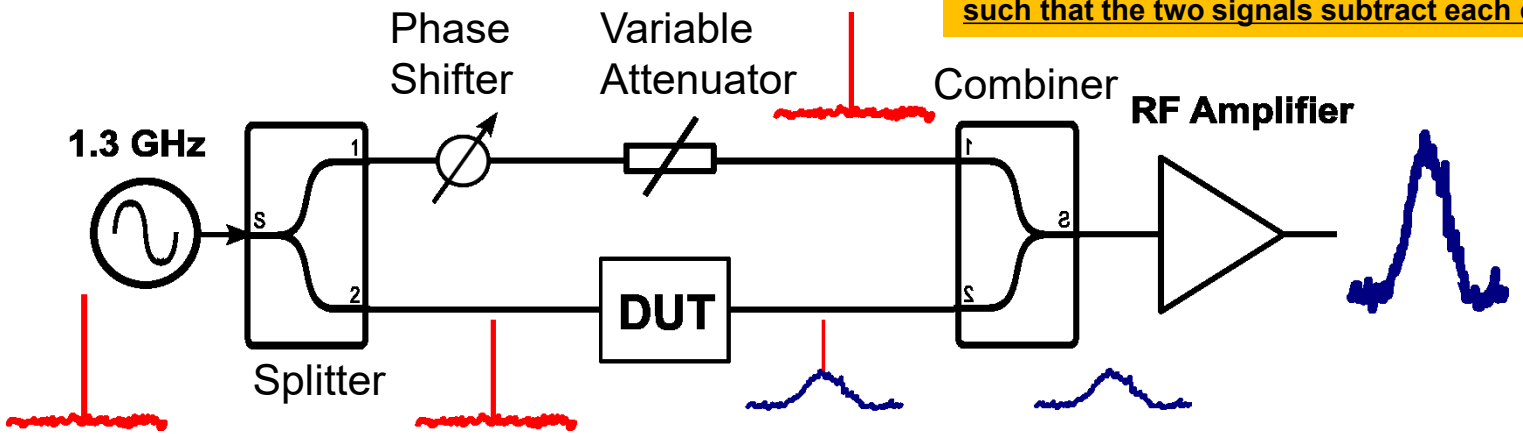
Attosecond RF Receivers Based on Carrier Suppression : Status Report.

Matter & Technologies
ARD-ST3 Annual Meeting - Virtual

Louise Springer, Frank Ludwig, Uroš Mavrič, Holger Schlarb (DESY)
Karlsruhe, Sept. 24, 2020

Basic Principle

Adjust the phase of the phase shifter and the variable attenuator such that the two signals subtract each other in the combiner.



Main advantages:

- The additive noises of the ADC are negligible because the measured signal (noise) is measured at nearly ADC full-scale.
- The 1/f additive noise of the RF amplifier is minimized because there is no carrier.

Flicker noise:
-110 dBc/Hz@10Hz (ADC limited) => -160 dBc/Hz@10Hz

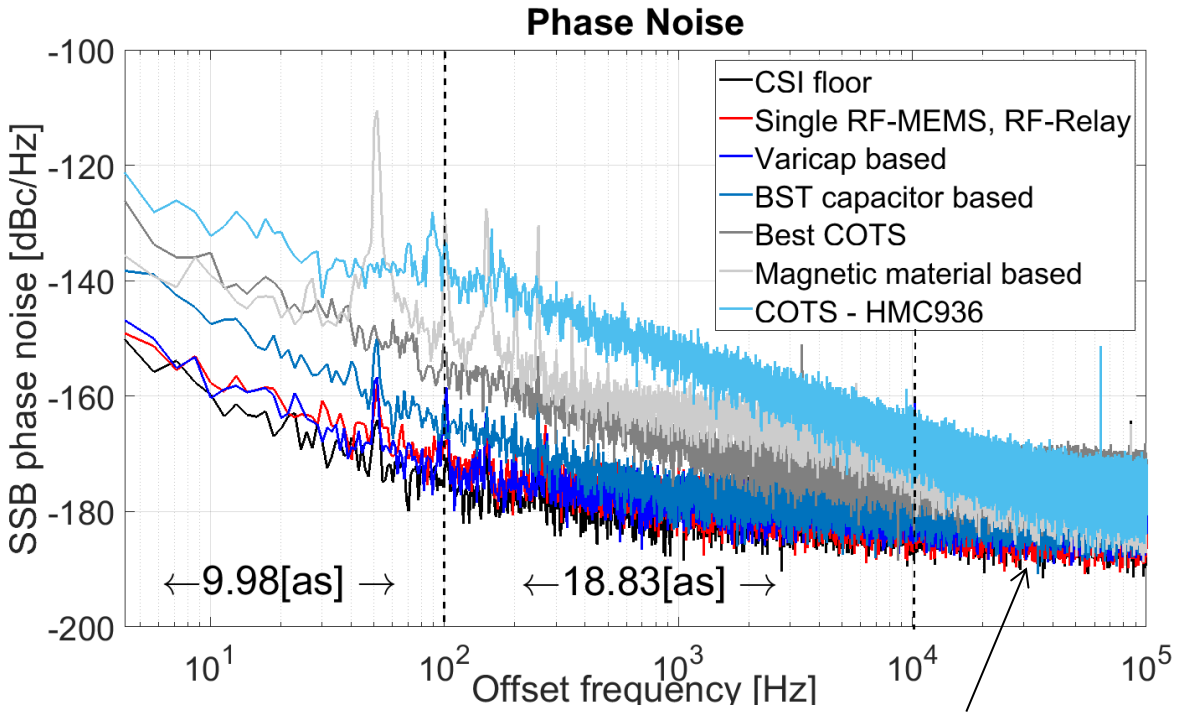
White noise:
-150 dBc/Hz (ADC limited) => -190 dBc/Hz

Strict Requirements on RF components:

Phase shifters and attenuators can define the noise floor of the setup if not chosen properly.

Integrated jitter expected to be reduced by >30 dB (~ 10fs -> ~100as)

Investigations of various implementations of phase shifters

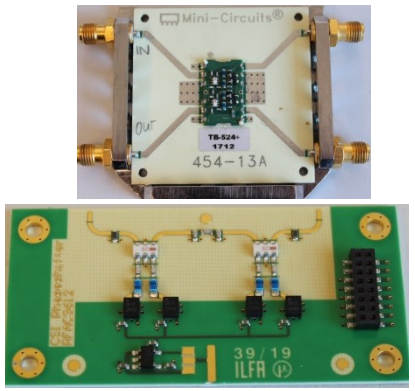


Floor Limited by carrier power. Improvements are on-going.

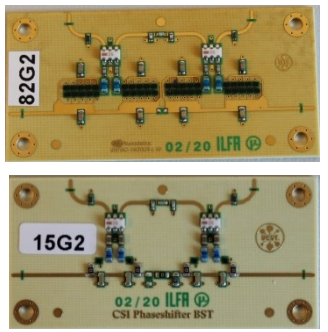
Conclusions:

- Investigated continuous and discrete phase shifters near CSI floor , <30 as [10Hz,10kHz]
- More complex attenuators and phase shifters (360 deg, high power) are in development.

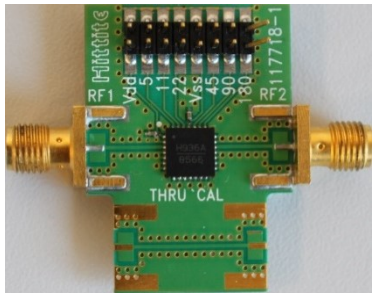
Varicap-based



BST-based

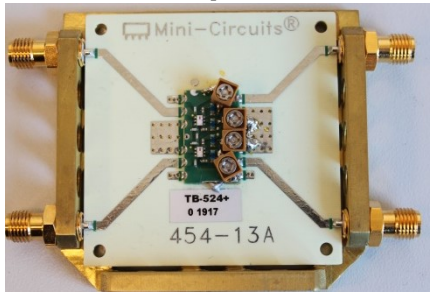


Based on COTS phase shifters

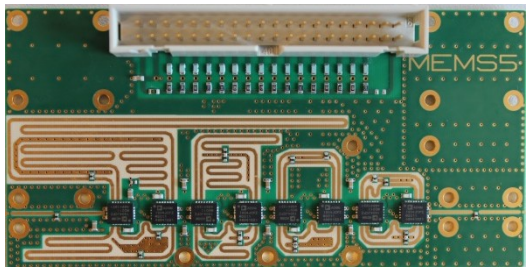


Magnetic material based

Based on mechanically tunable capacitors



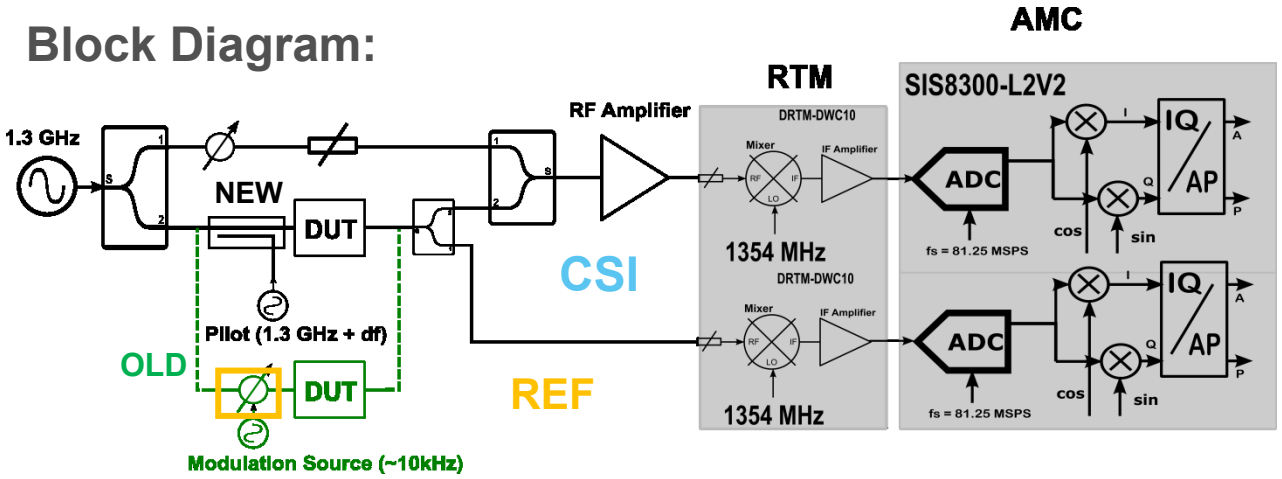
MEMS based



HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

Phase and amplitude calibration method with pilot tone

Block Diagram:

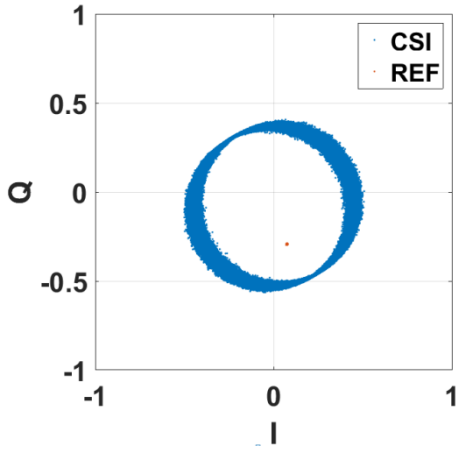


Non-invasive method. A free-running pilot is injected into the signal path over a coupler.

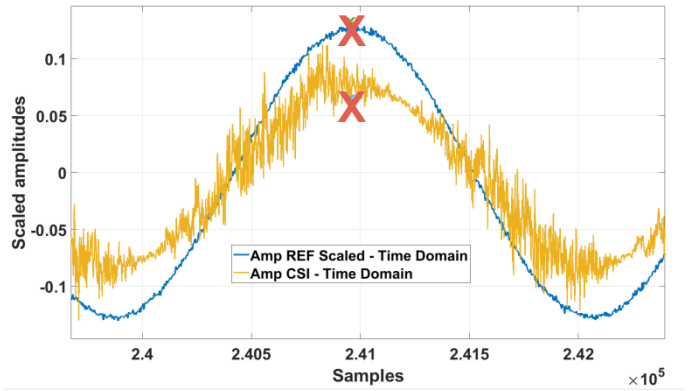
Advantages of the new method:

- → Removal of the phase shifter in the main path which should further decrease the 1/f noise
- → Lower loss in the main path means better measurements resolution (-180dBc/Hz - IL)

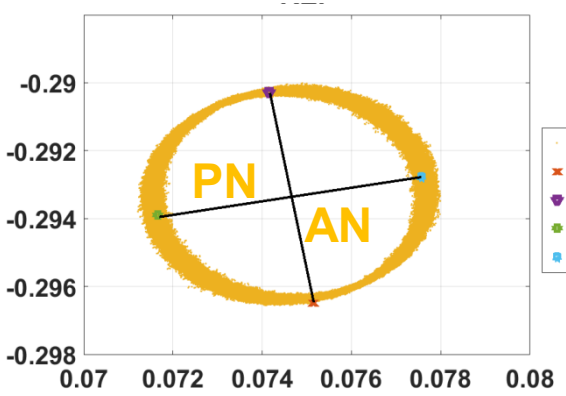
I. Measure both channels



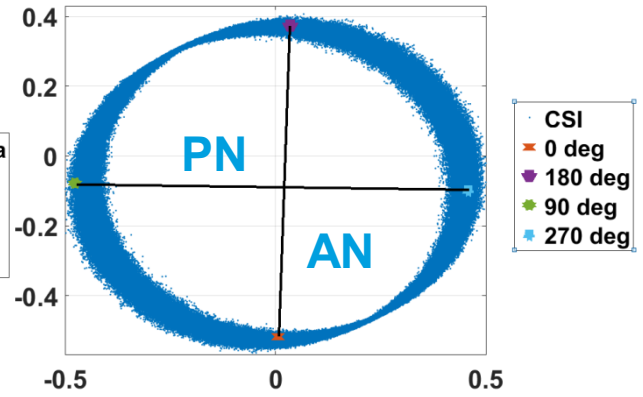
II. Search in time domain the maximum point (X) on the amplitude response of the REF channel



III. Determine the AN angle (and PN angle) of the REF channel



III. Use the same time samples to determine the AN, PN angles for the CSI channel



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