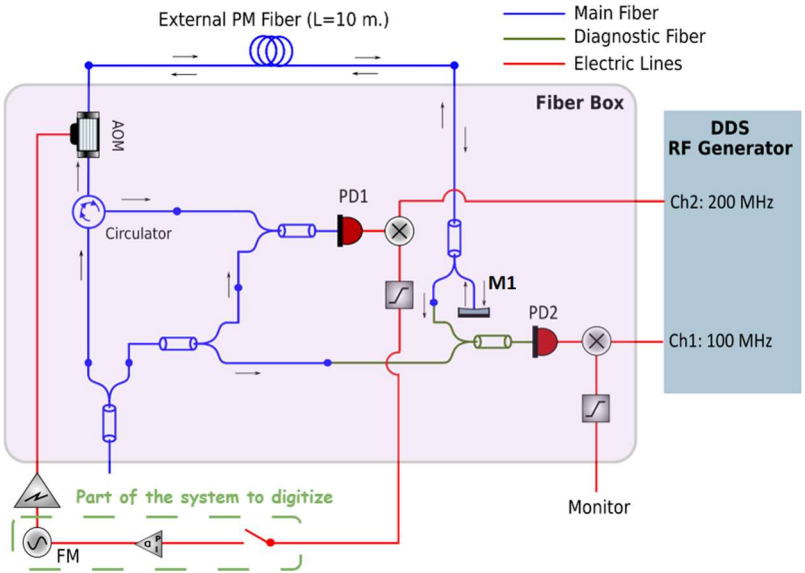
Low-latency digital control of an all-in-fiber phase noise reduction loop for VIRGO Squeezer



- GW detectors widely employ control systems to tackle «technical noise» sources, however sensitivity is so extreme that the quantum nature of photons starts to play a role
- Squeezed light is used for reducing this quantum noise
- Reference beam for the squeezing process needs to be transported to the «injection» room using optical fibre
- Phase noise is caught along the way due to mechanical stresses occuring in audio and infrasound ranges

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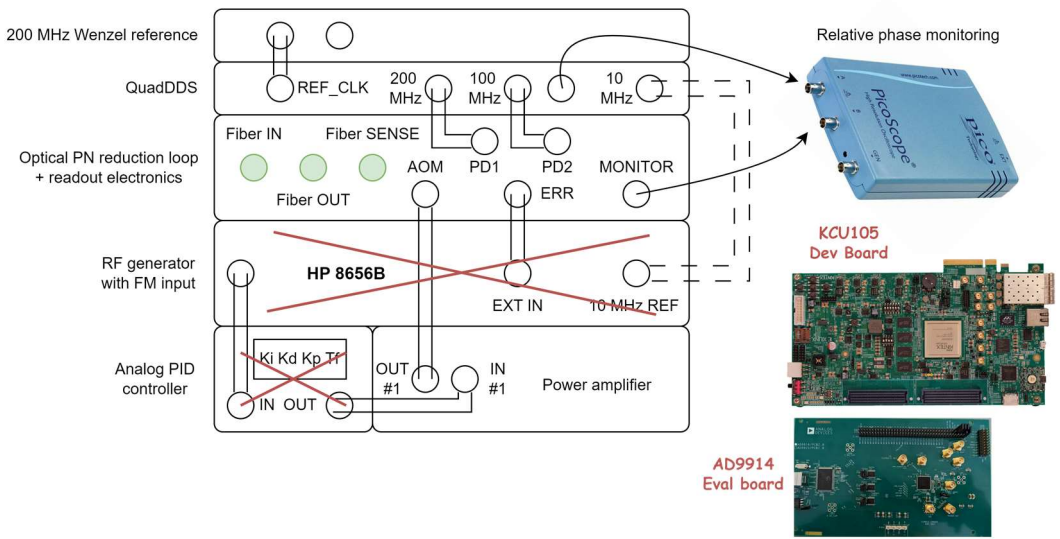
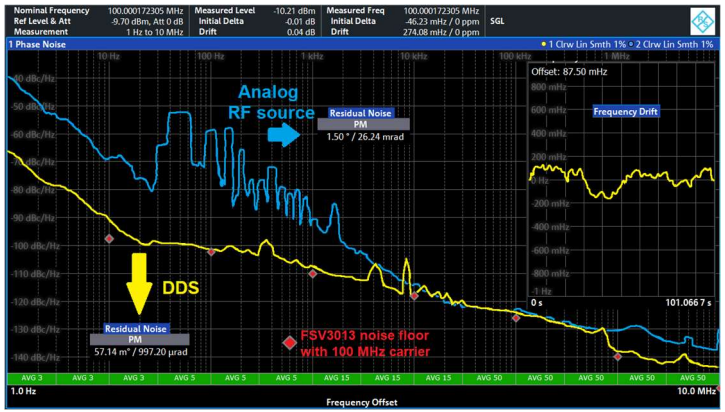
- ❑ Electro-optical setup aims to compensate this noise using an AOM to shift light's instantaneous frequency
- ❑ Original analog FM source substituted with DDS
- ❑ Original analog PID module implemented digitally with an FPGA running @ 100 MHz clock



- DDS chip features parallel port for FTW programming
- Digital controller implemented as IIR filter via «emulation» of the analog PID tuned with Ziegler-Nichols procedure
- Modulator latency cut by 5 times
  → enchanced noise reduction bandwidth
- Integrated phase noise of RF source from 20 to <1 mrad (in the range 1Hz÷10MHz)
- 16-bit ADC allows to fully exploit phase accumulator granularity of DDS



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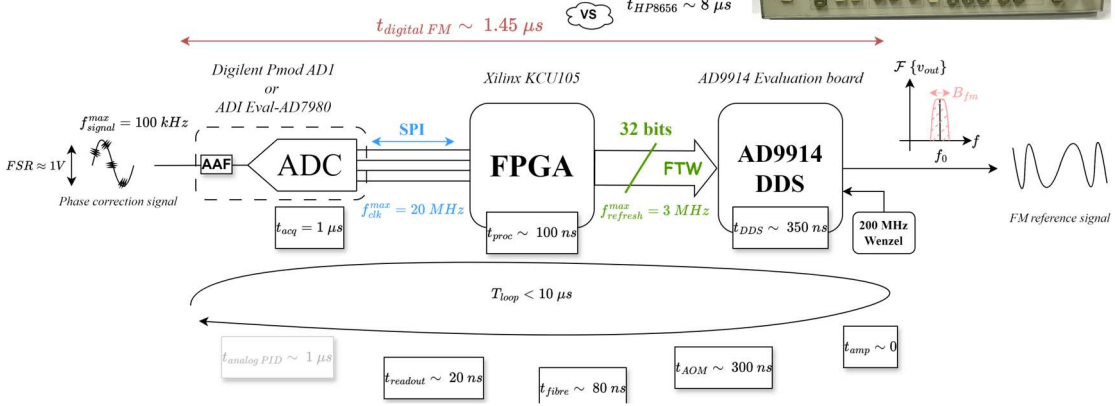

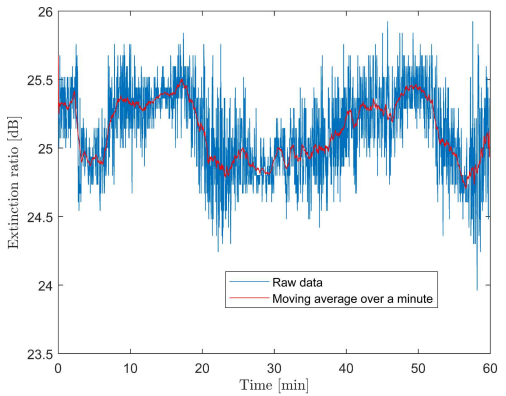

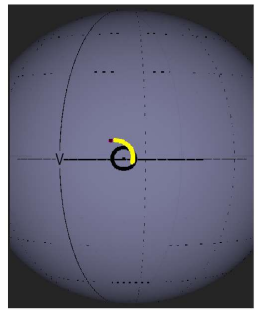

Polarization state on the Poincarè sphere

❖ Other issues of environmental nature (temperature)