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The Josephson junction as a source of nonlinearity for superconducting circuits has become ubiquitous in quantum science and engineering. Introducing exotic circuit elements that only allow pairs of Cooper pairs to tunnel allows new properties to be uncovered, sparking interest for metrology and qubit protection. We present novel circuits obtained with an effective implementation of such an element. First, we show experimental progress on an alternative species of weakly-anharmonic oscillator where the nonlinearity comprises large displacements in phase space. In this experiment, we explore the new regime of large phase fluctuations, where the Josephson cosine potential is dominated by mixing terms even higher than fourth order. We expect peculiar effects in this extreme limit, such as the alternation of the sign of the oscillator frequency shift for each added photon, and even nonlocal quantum dynamics. Then, we discuss the design of a qubit based on the Cooper-pair pairing property [1] and its protection against various decoherence mechanisms.

[1] W.C. Smith et al., *npj Quantum Inf* 6, 8 (2020)