60 GHz Wavelet Generator
for Impulse Radio Applications

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Outline

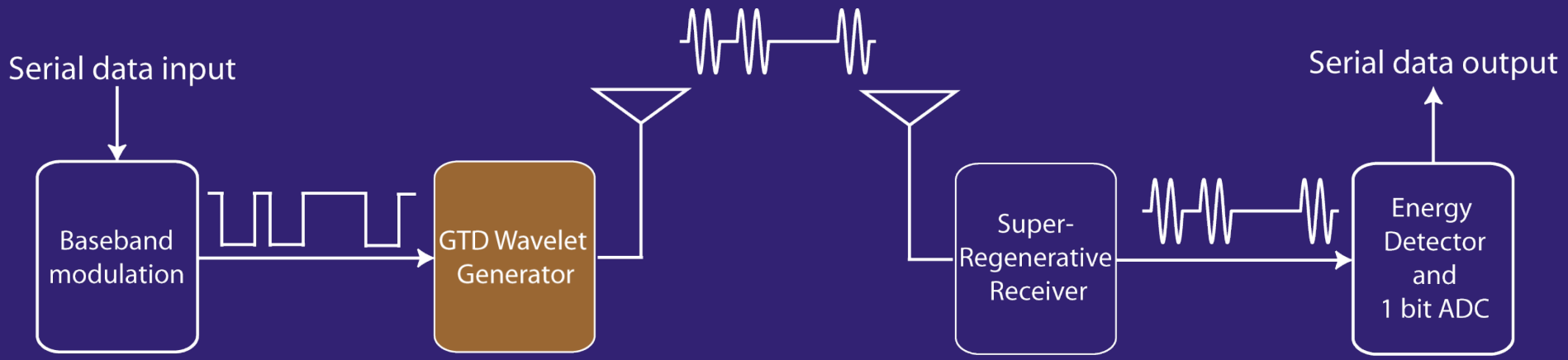
- 60 GHz Ultra-Wideband Impulse Radio
- The Gated Tunnel Diode (GTD)
- The GTD Wavelet Generator
  - Measurement results
  - Wireless impulse radio link
- The super-regenerative wavelet detector
- 60 GHz dielectric resonator antenna
- Summary

Ultra Wideband Impulse Radio

- Impulse radio communication is based on ultra-wideband signals to support Gbit/s data rates

- Possible applications are:
  - High definition multimedia interfaces
  - Simple docking solutions for laptops

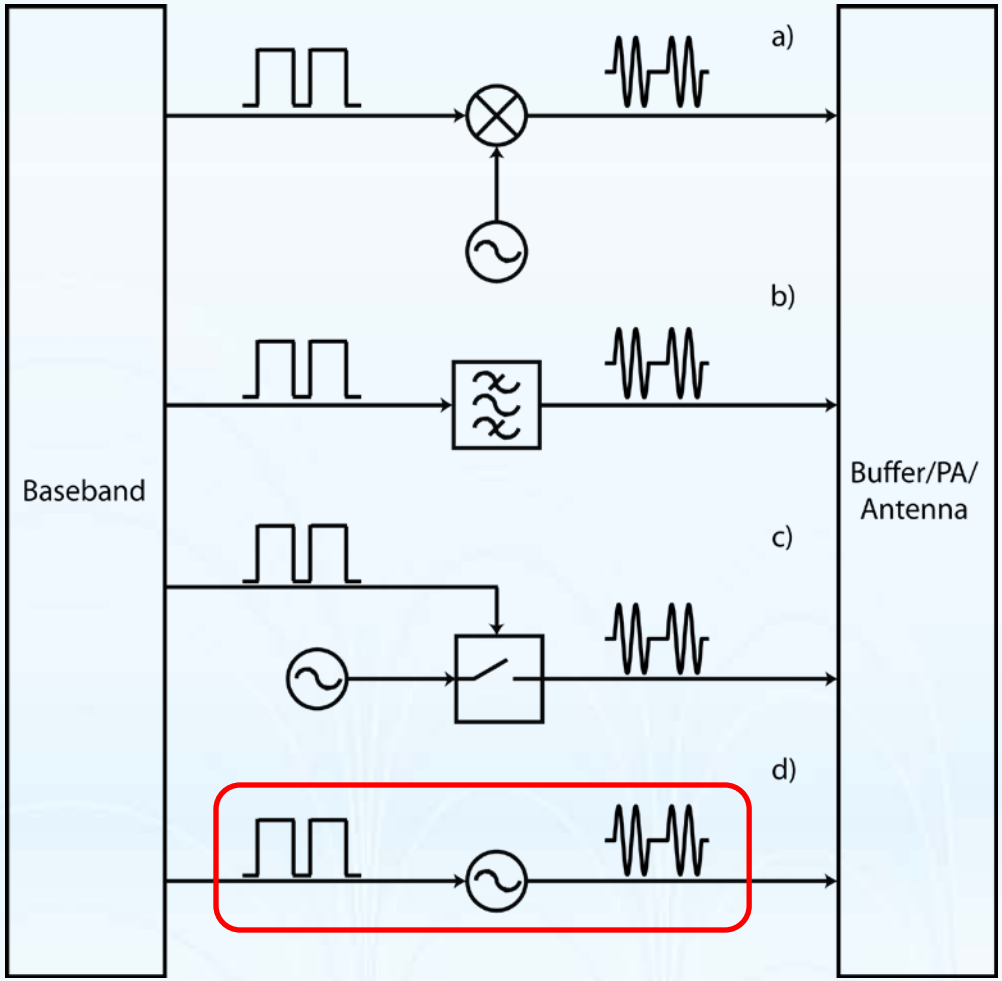
- The technique offers:
  - Low complexity transceivers
  - Low interference



•We seek to implement a 60 GHz ultra-wideband impulse radio system

Impulse Radio Transmitters

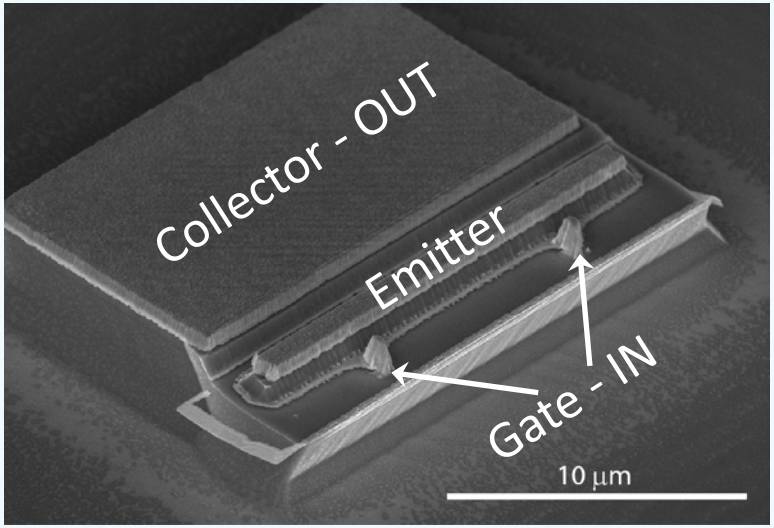
- The transmitter consists of a 60 GHz wavelet generator
- The input signal is a sequence of baseband pulses that represents the symbol that is to be transmitted



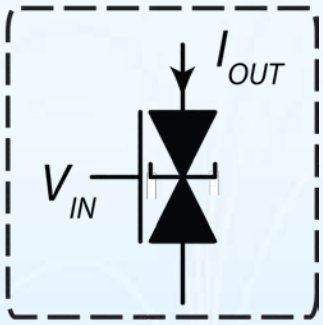
- We use the baseband input to switch an oscillator on and off

The Gated Tunnel Diode (GTD)

- The 60 GHz signal is generated by a resonant tunneling diode (RTD), which exhibits negative differential conductance (NDC)
- The conducting area of the RTD may be controlled by V_{IN}



GaAs	(Å)
$Al_{0.8}Ga_{0.2}As$	16
GaAs	9
$In_{0.2}Ga_{0.8}As$	20
GaAs	9
$Al_{0.8}Ga_{0.2}As$	16
GaAs	



Resonant tunneling barriers

Output current

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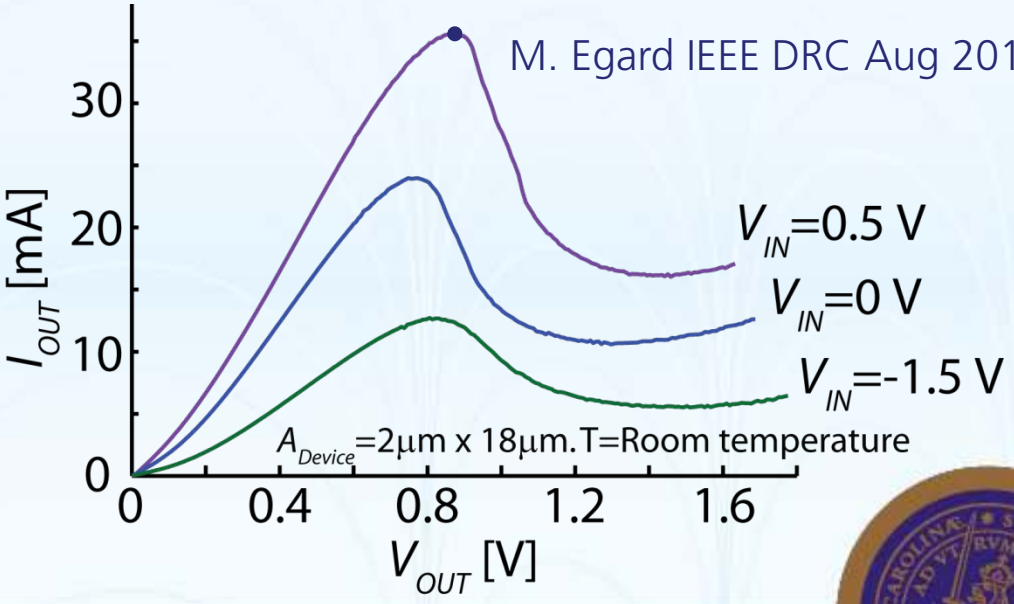
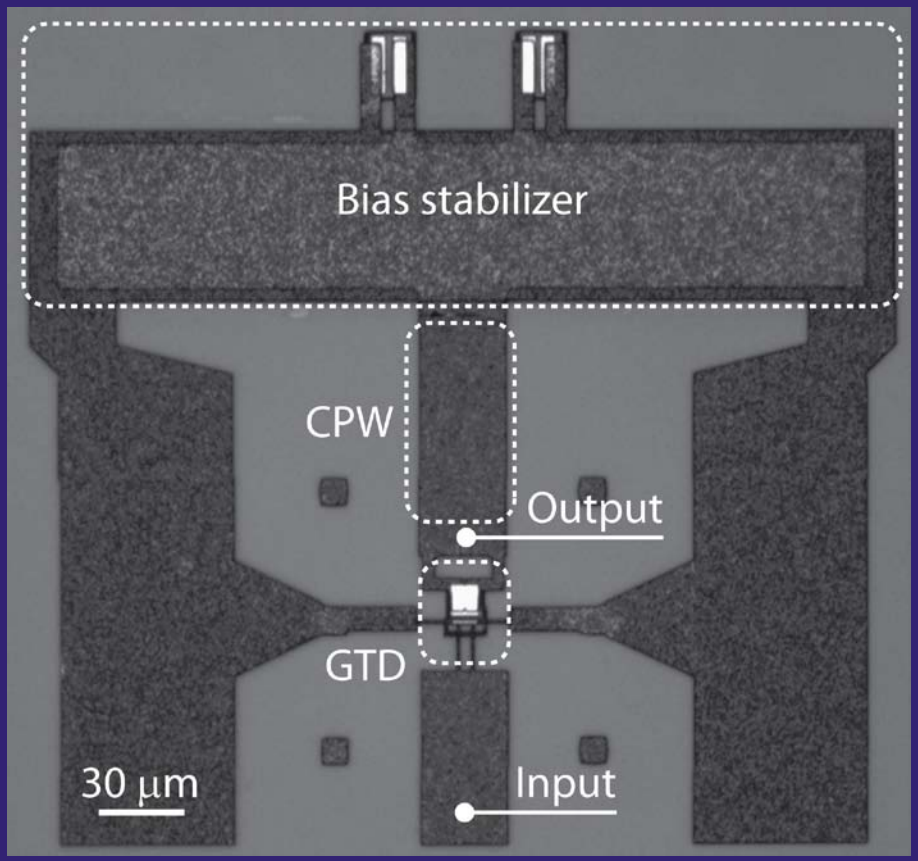
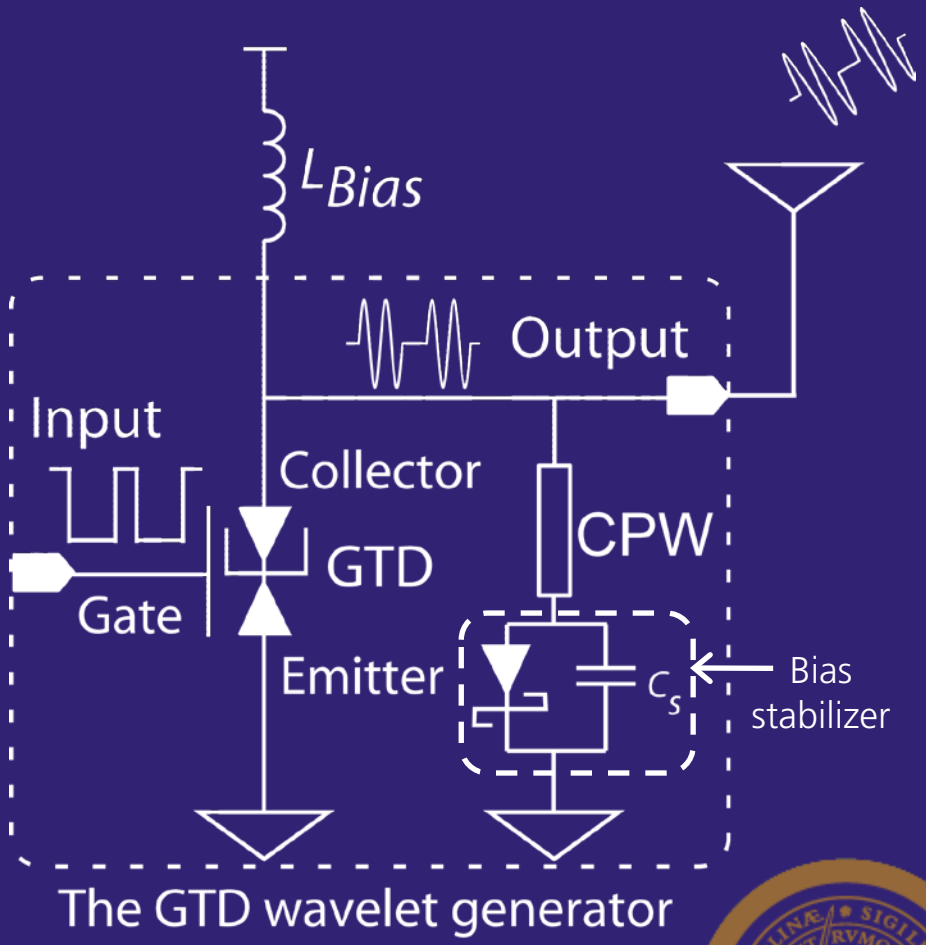


The GTD Wavelet Generator

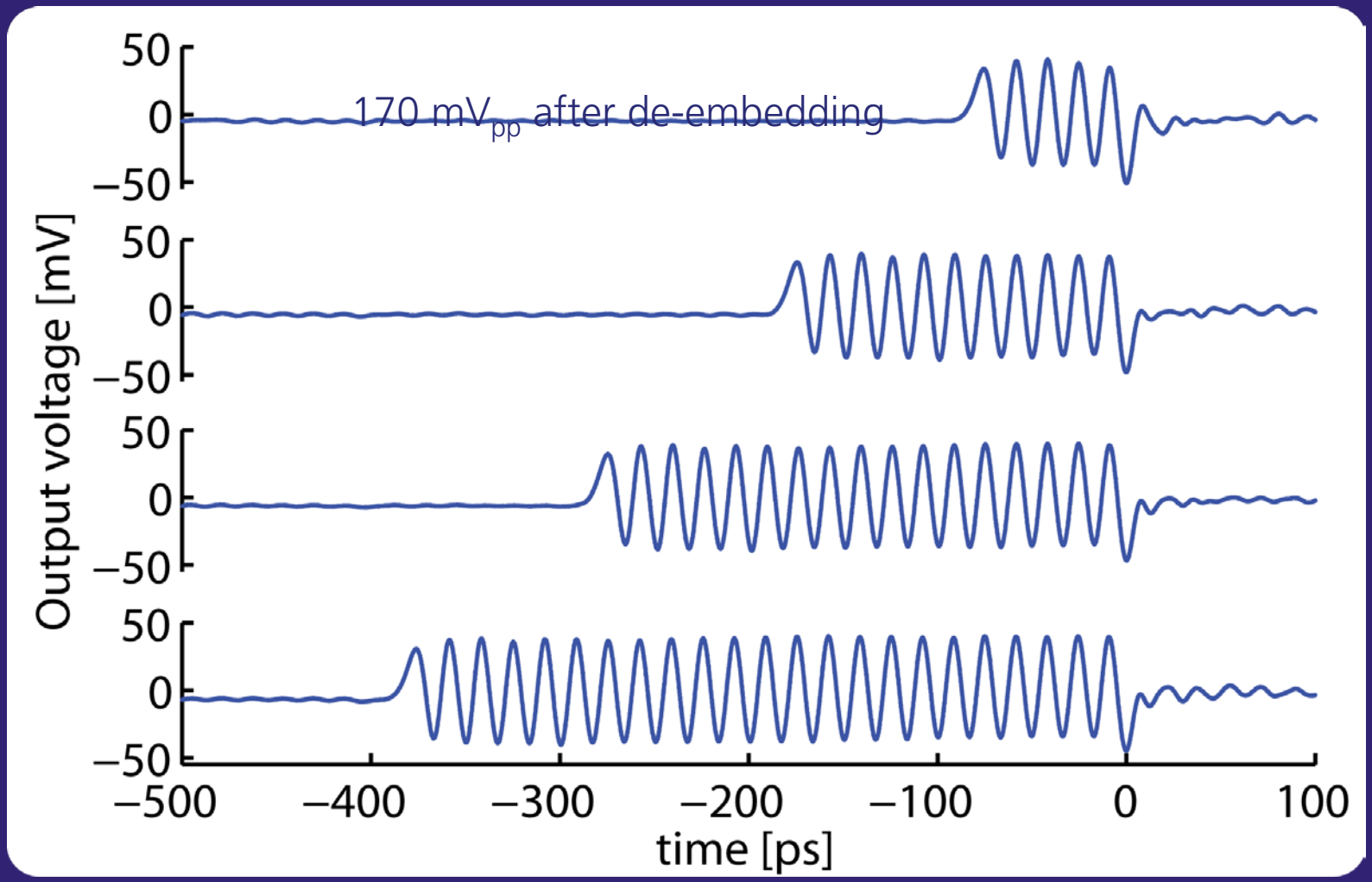
- A LC-tank circuit is formed by integrating the gated tunnel diode in parallel with a coplanar waveguide (CPW)





Control of Pulse Width and Pulse Position

60 GHz wavelets



Input pulse length

74 ps

181 ps

280 ps

383 ps

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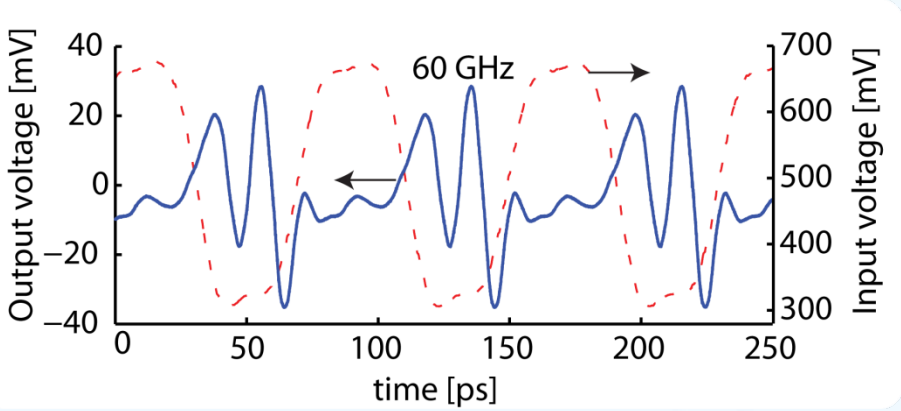
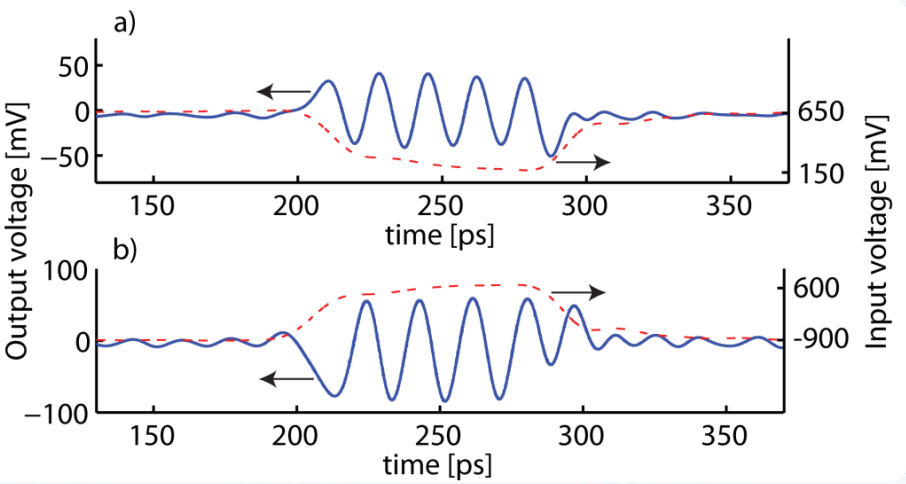
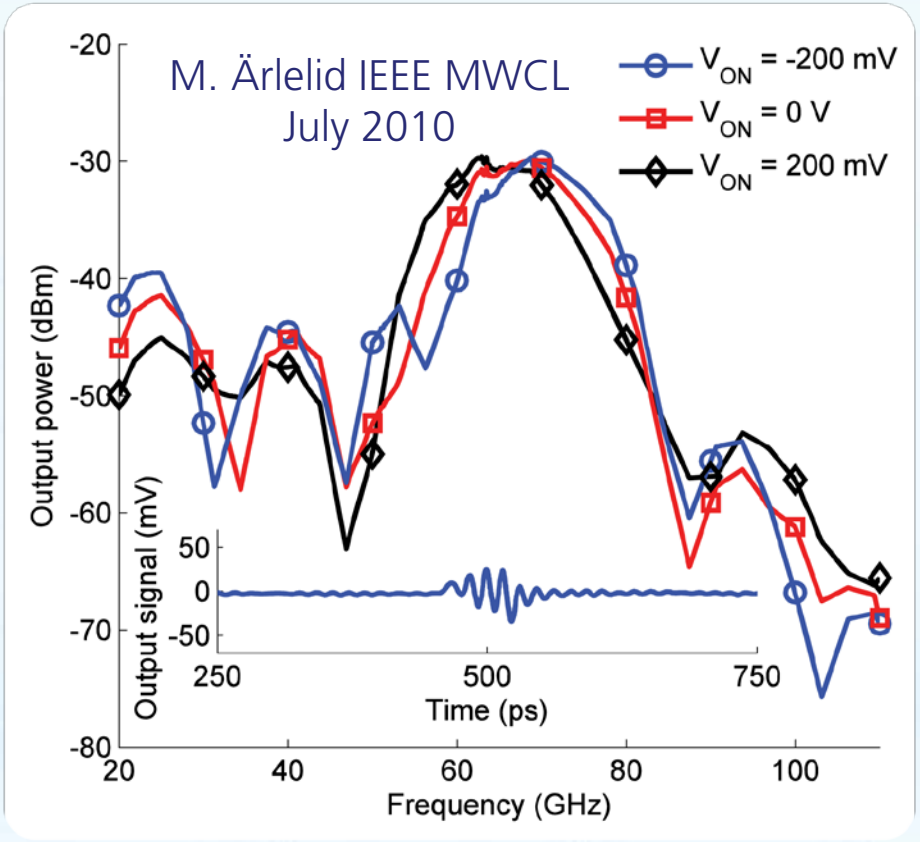
33 ps Short Wavelets at 12.5 Gpulses/s



33 ps short wavelets at 12.5 Gpulses/s



Input signal used to control center frequency

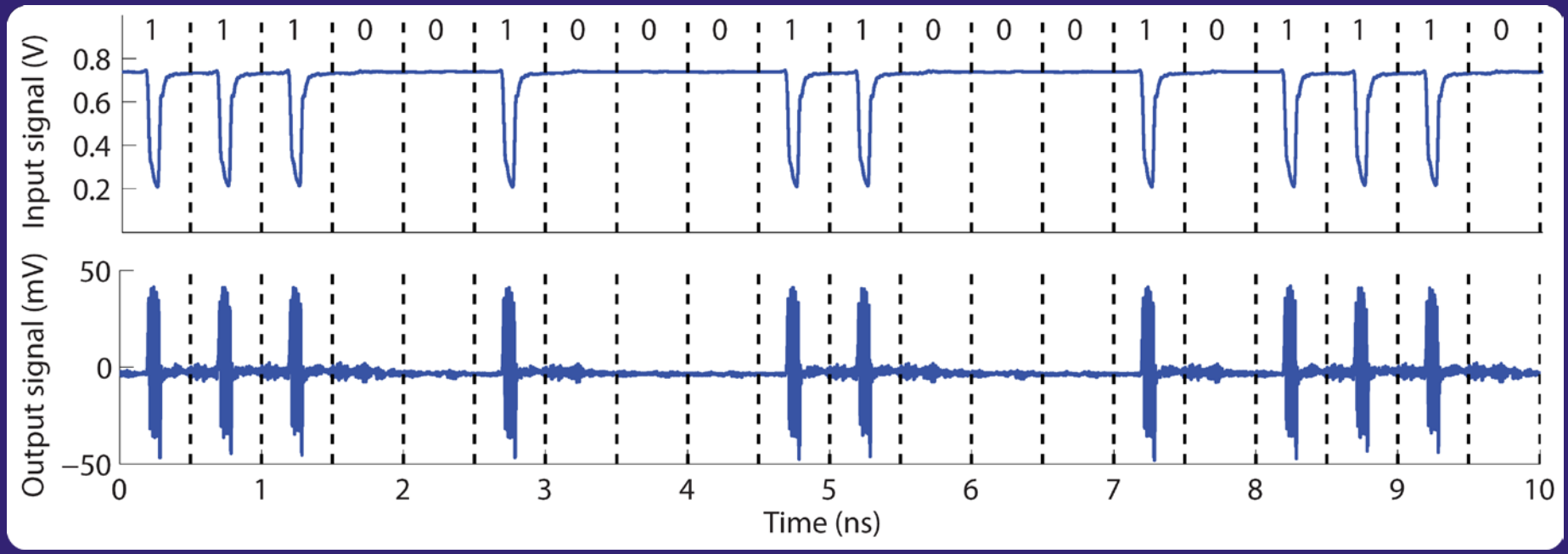


Center frequency 65.2 GHz - 70.3 GHz

Bi-phase signals generated by reversing the polarity of the baseband pulse

2 Gpulses/s on-off keying at 60 GHz

- The GTD wavelet generator supports impulse radio modulation schemes such as:
  - OOK, PPM, and BPSK



100 ps pulse length, 162 mV_{pp} with losses embedded

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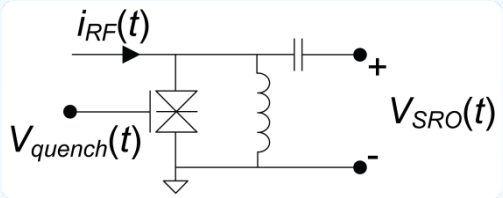
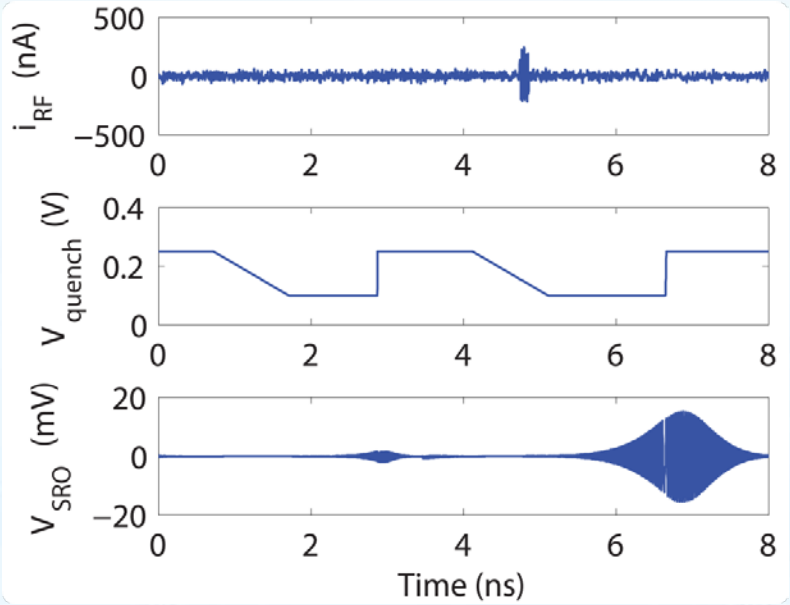
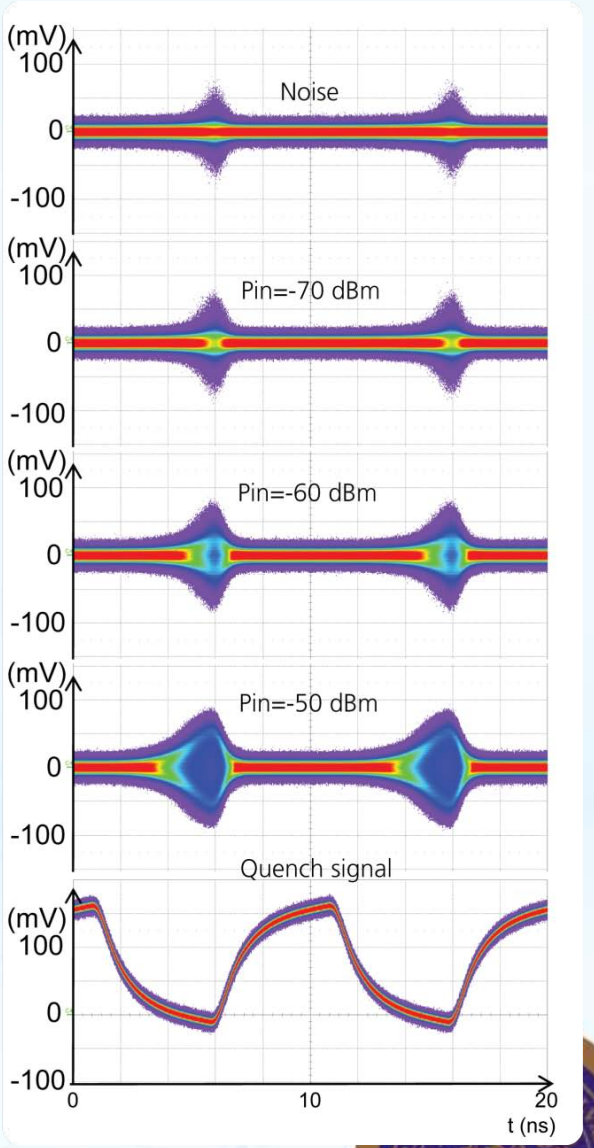
Super-Regenerative Oscillator (SRO) Wavelet Detector

- The SRO is based on the same circuit implementation as the wavelet generator



- The cycle of the super-regenerative oscillator (SRO) may be divided into three parts:
  - 1) Sampling
  - 2) Build-up
  - 3) Quench





- Continuous wave measurement of the super-regenerative oscillator output voltage eye diagram

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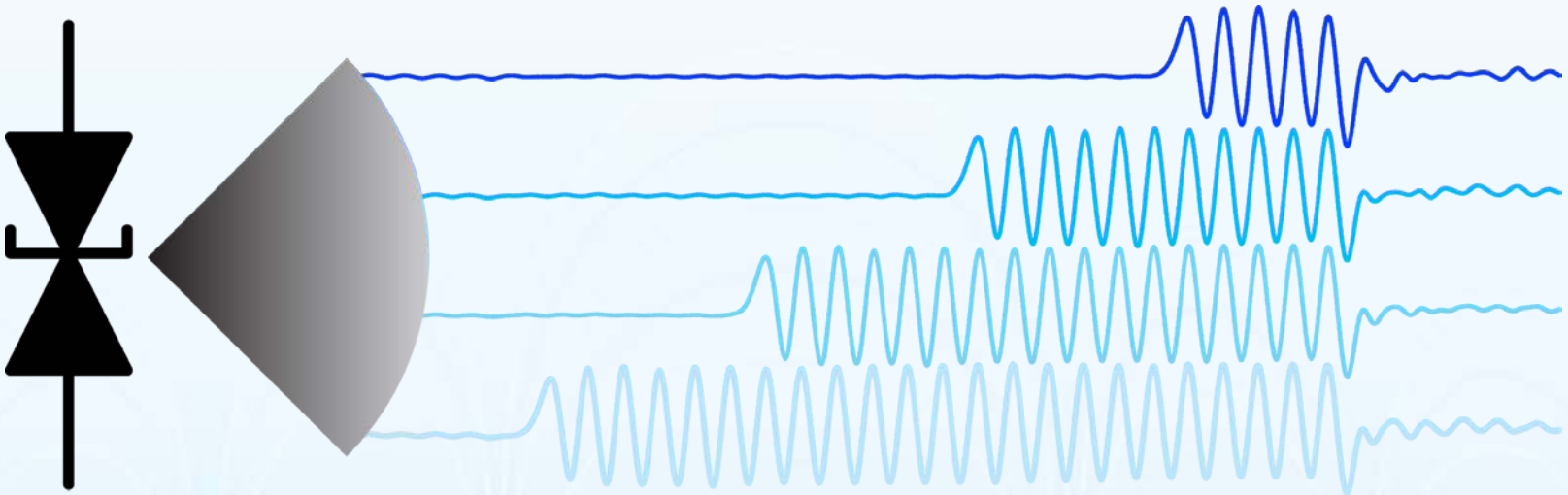
Summary

- 33 ps short 60 GHz wavelets at 12.5 Gpulses/s
- Rapid startup of coherent wavelets
- Support for impulse radio modulation schemes such as OOK, BPSK, and PPM
- 4 Gbit/s IR-OOK and 12.5 Gbit/s ASK wireless link
- Wavelet detection using a super-regenerative oscillator
- Future work:
  - Integrate compact antenna
  - Extend technology to higher frequencies

Thank you for your attention



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