Ultra-Wide Band Technologies for Healthcare

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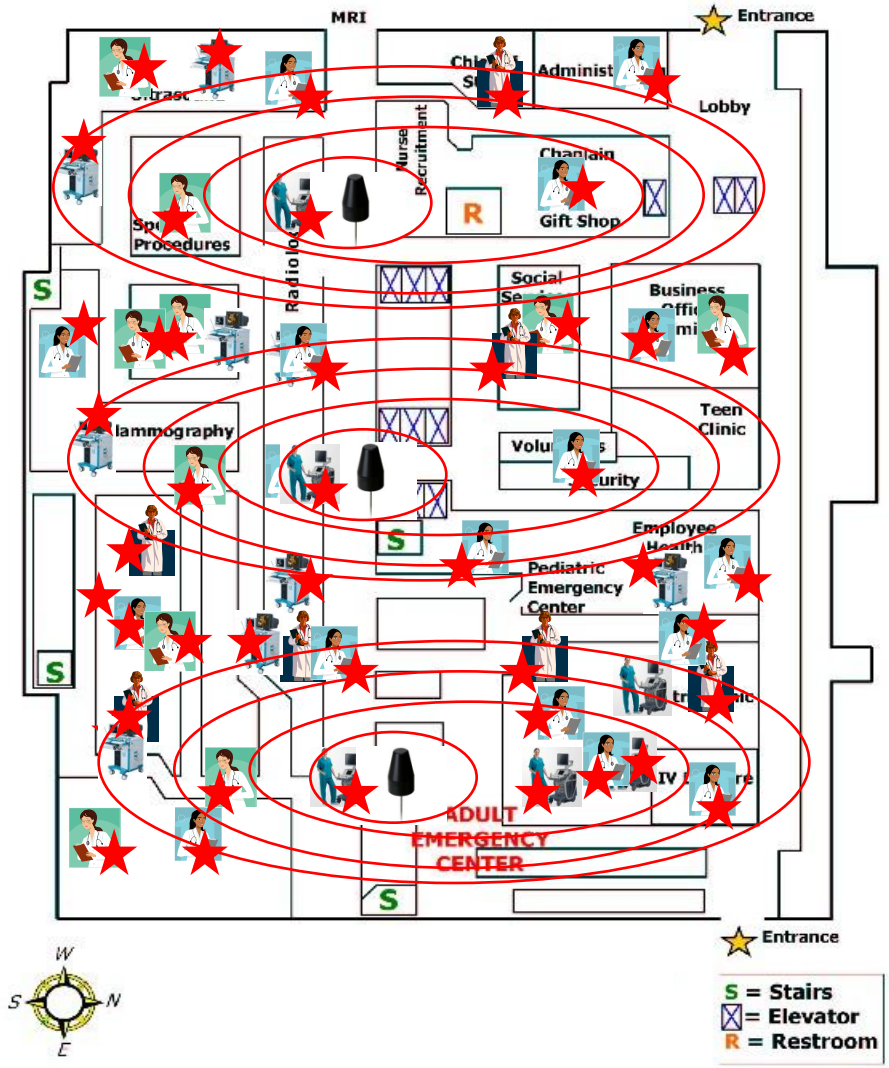
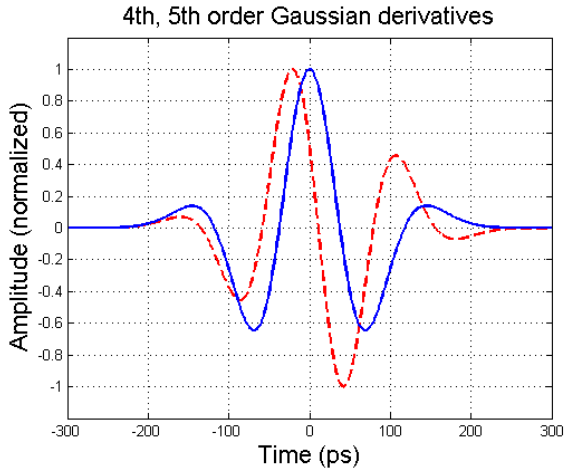
Ultra-Wide Band (UWB) Localization

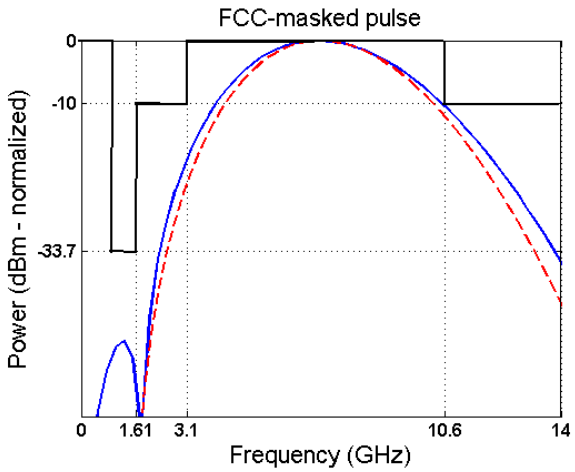
- Precise Location Identification
  - Ultra-wide band technologies for asset tracking
  - UWB well-suited to sensitive hospital environment



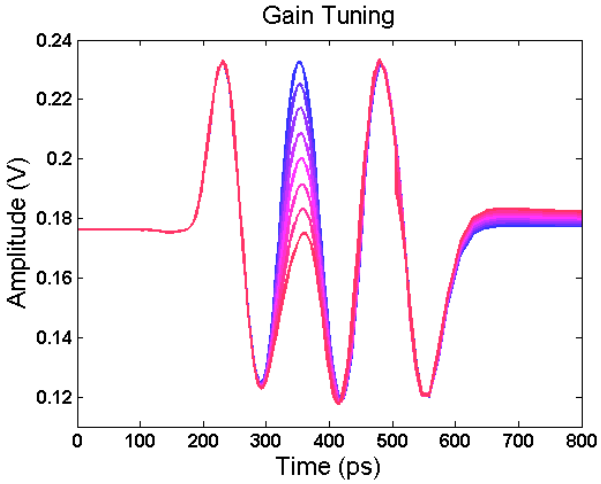
UWB Background

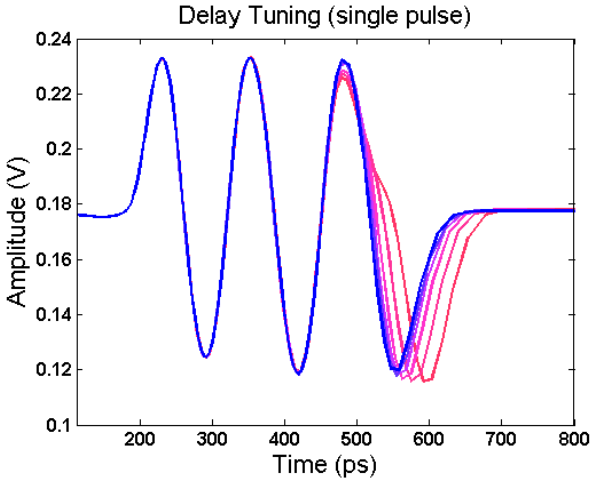
- UWB transmission
  - Low-energy and low-power spectral density
  - Short-range, high-bandwidth, non-interfering
- UWB pulses
  - Modulation format dependent (impulse-radio, multi-band OFDM)
  - Conform to regulations, channel conditions
  - Need for **high flexibility** and dynamic pulse shaping



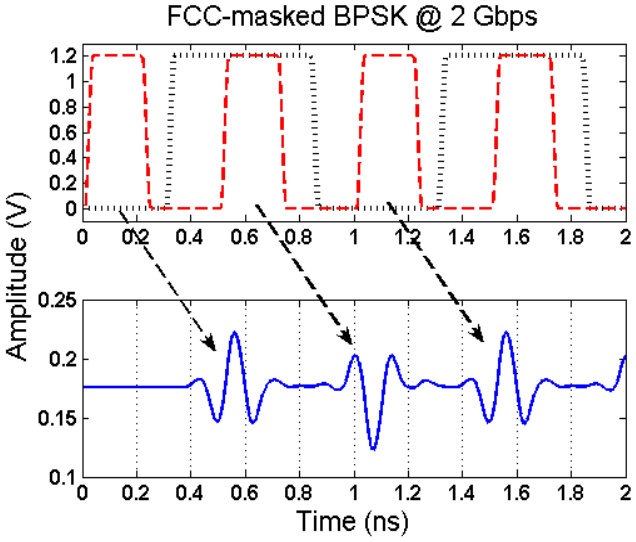


UWB Pulse Generator





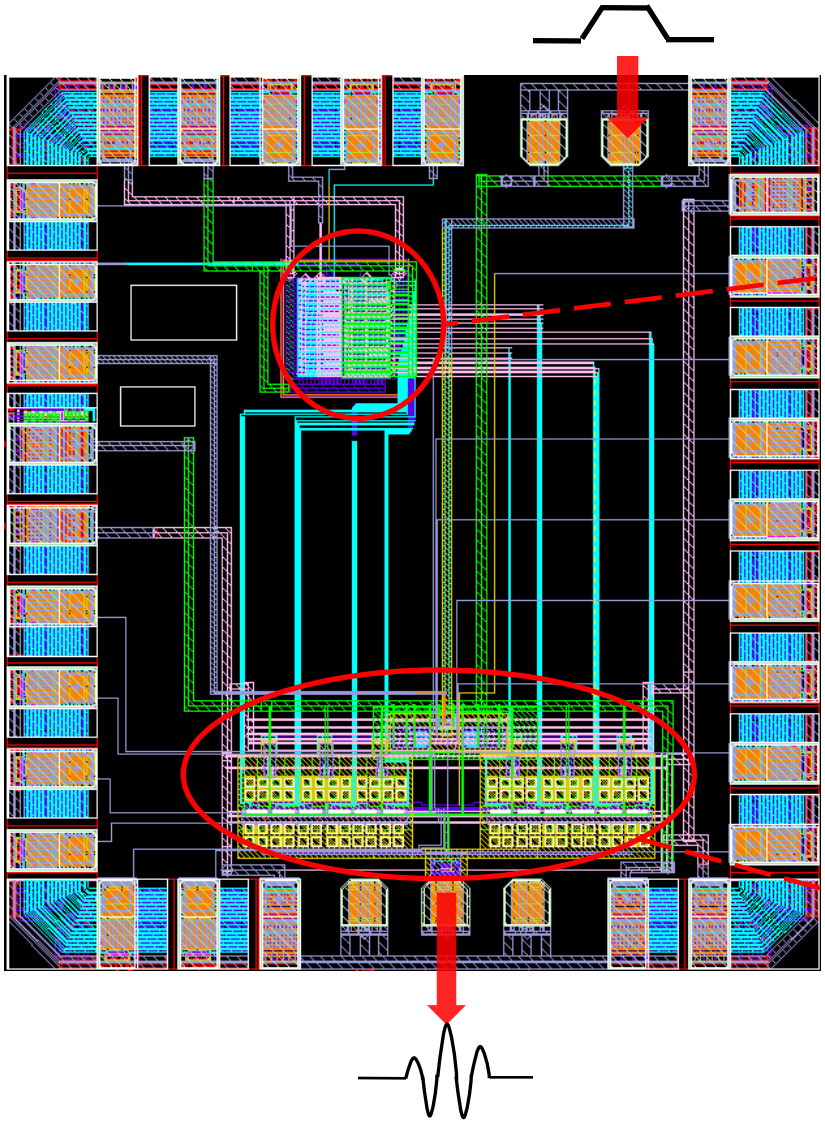
- Pulse combination method
  - Input square-pulse is transformed to UWB pulse
  - Independent programmable digital control of sub-pulse gain & delay
  - Prototype can output any waveform with up to 5 zero-crossings.



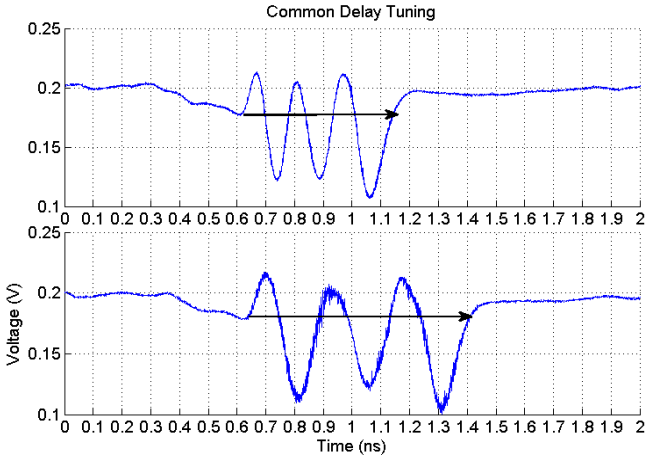
UWB Pulse Generator

Demonstration IC in 90nm CMOS (in testing)

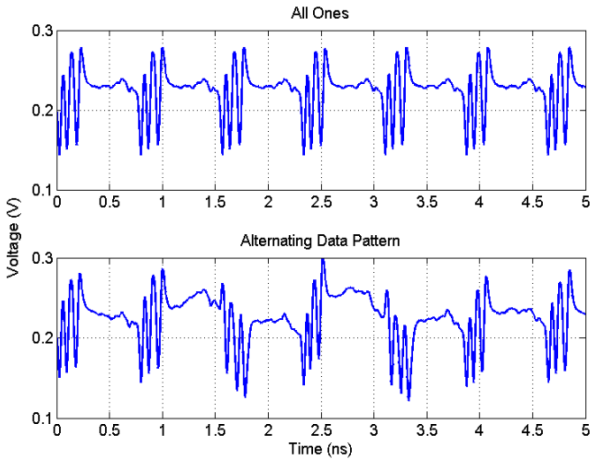
- 1.2 V supply, 50mW @ max data rate
- 1 mm x 1.1 mm
- Max of 2 Gbps modulation
- BPSK, 2-PPM, PSM (pulse-shape modulation) all enabled formats



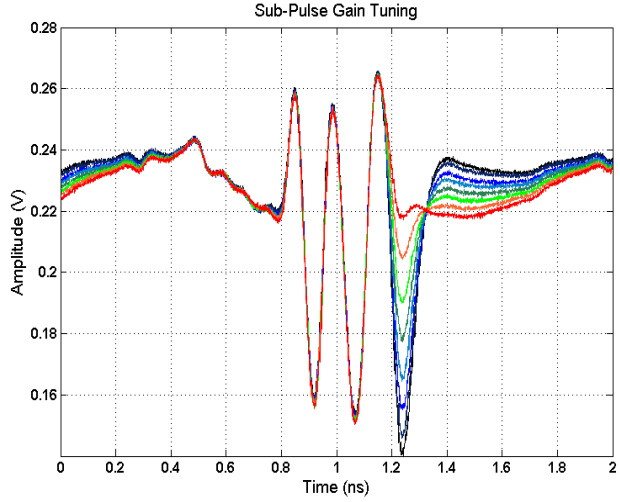
Measured Results



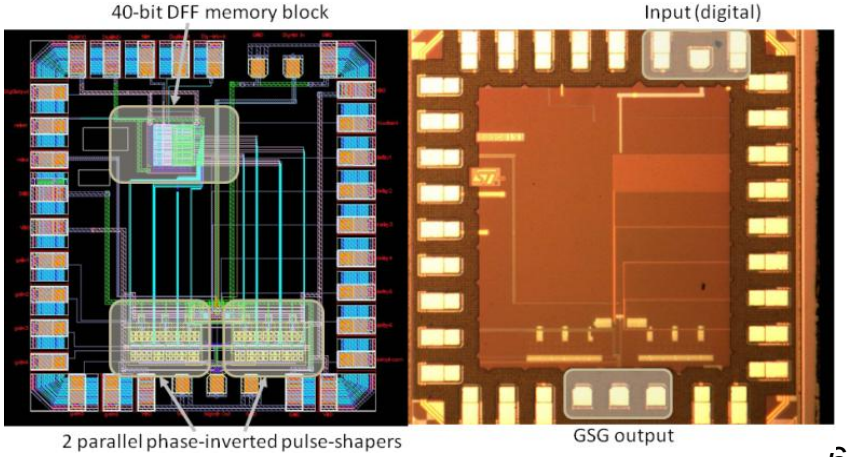
Control of UWB pulse width



BPSK data @ 1.3 Gbps



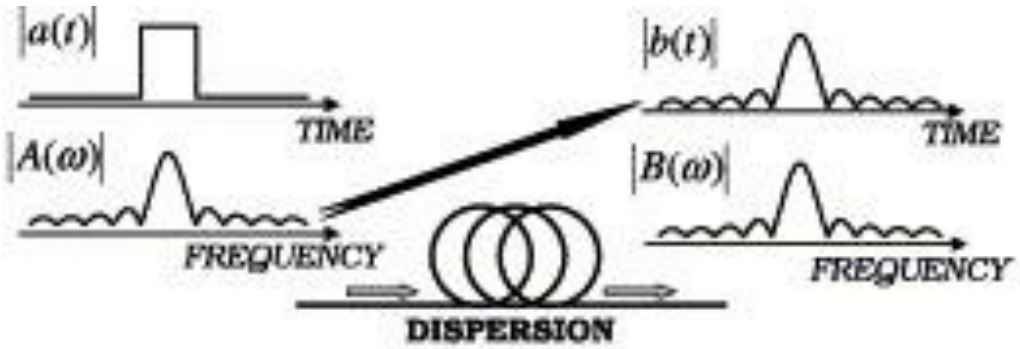
Control of sub-pulse amplitude



Layout and photograph

UWB Signal Processing

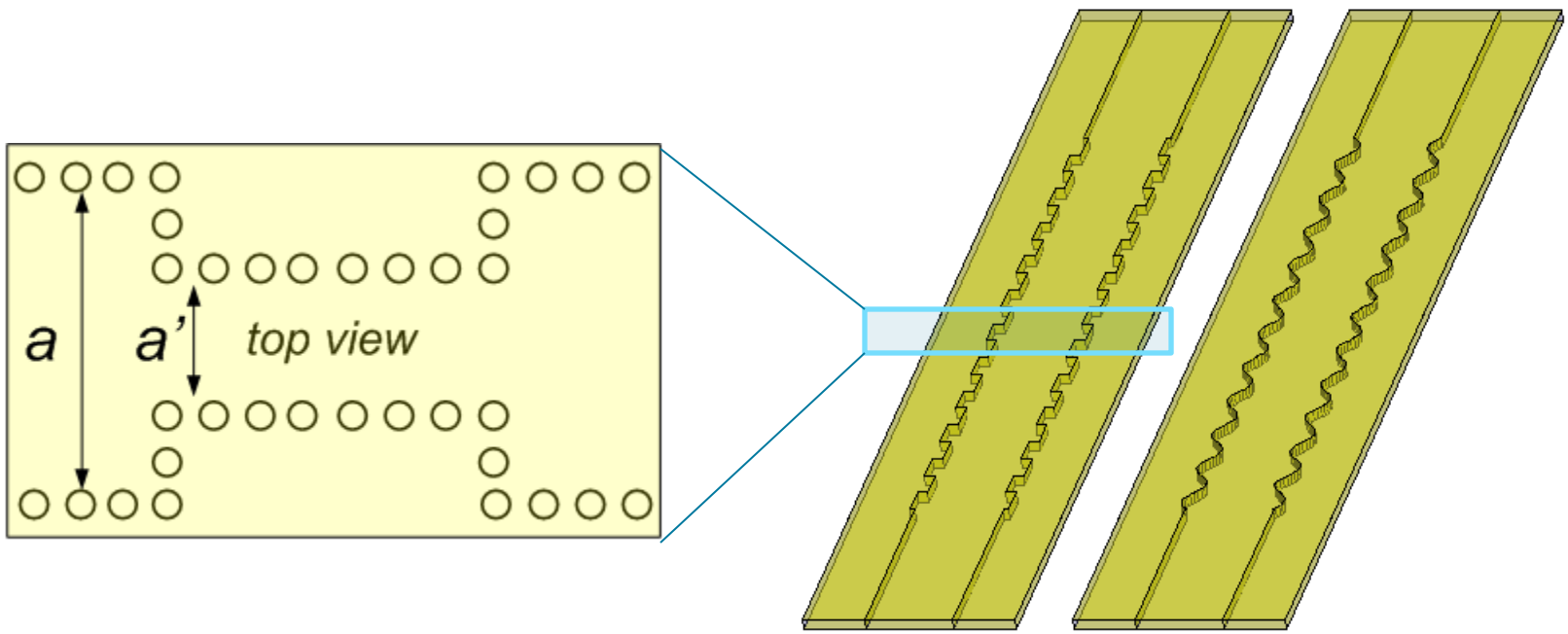
- High signal bandwidths require new toolbox
  - Real-time operations (spectral analysis, delay, synchronization, temporal imaging for ADC/DAC)
  - Can use dispersion to perform signal analysis
    - Mapping of frequency content in the time domain



Can we implement microwave broadband dispersion to do this?

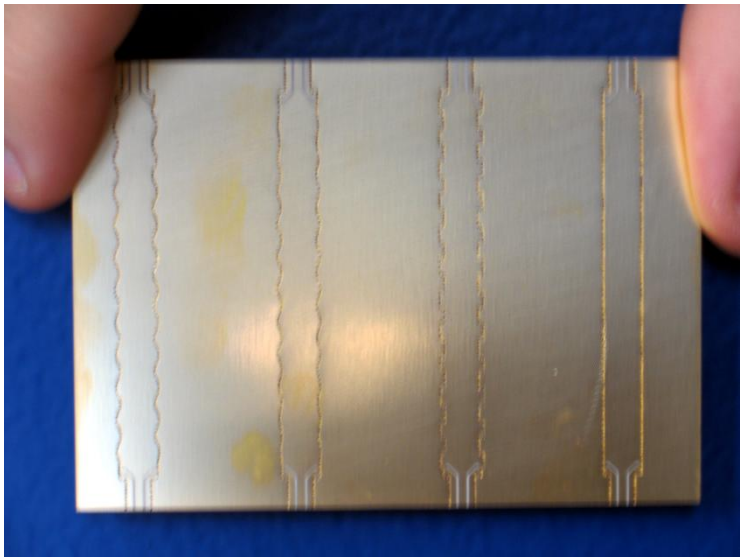
Dispersion from an SIW

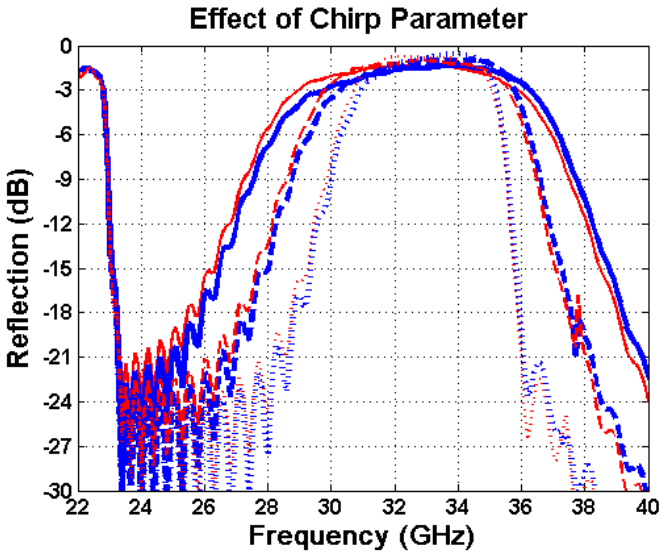
- A substrate integrated waveguide (SIW) is made with a “via” fencepost sidewall (holes filled with metal)
- Easy fabrication (planar) compared to regular waveguides
- Can create a periodic resonant bandgap by “wiggling” the walls
- These are called “electromagnetic bandgaps” (EBGs)

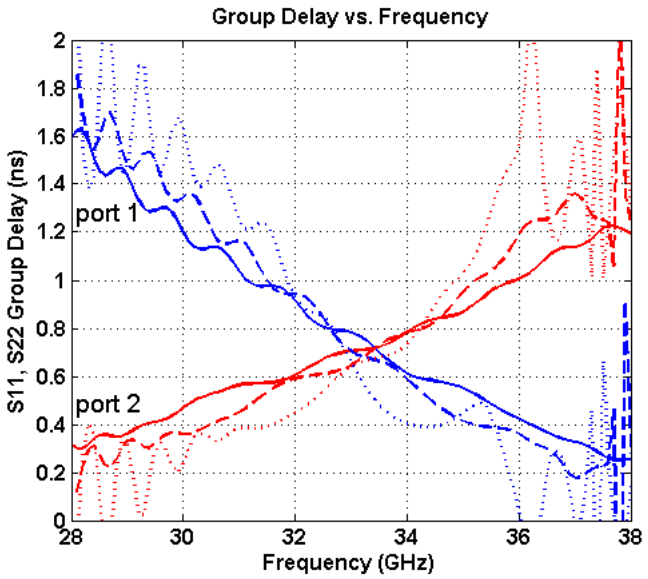


Dispersion from an SIW

- Group delay and bandwidth can be set by controlling the chirp parameter of an EBG
- Pictured: different chirp settings affect the bandwidth (top right) and delay slope (bottom right)

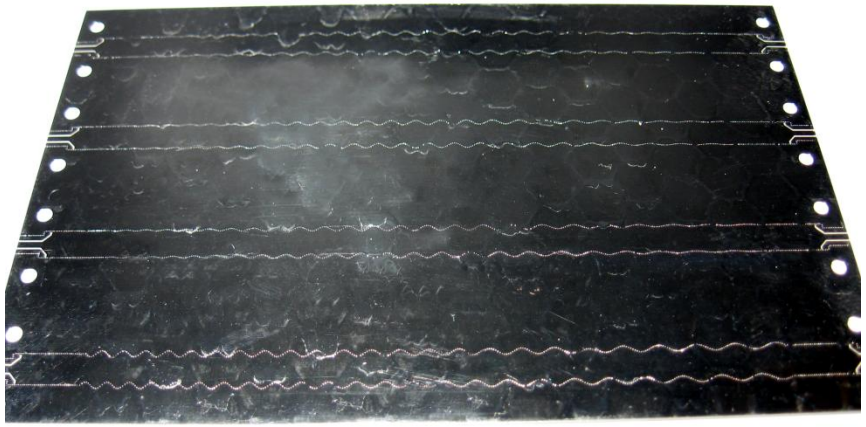


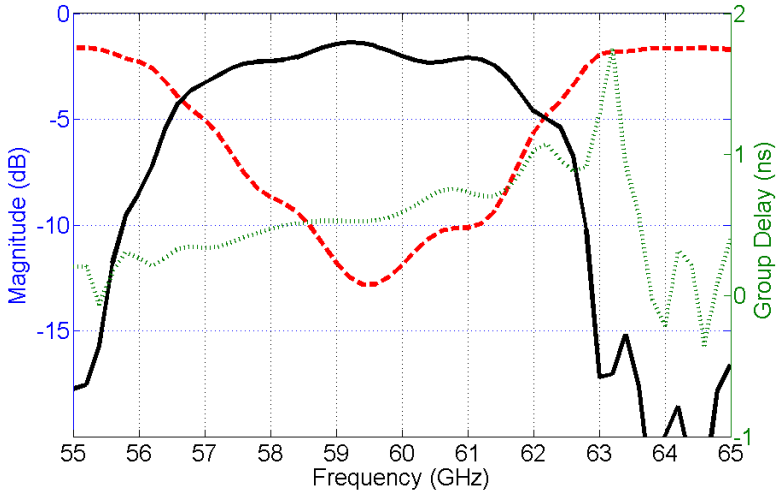




Dispersion from an SIW

- 60 GHz area
  - Have demonstrated these concepts at 60 GHz where UWB is being investigated for short-range wireless links
  - Pictured: chirped EBG in SIW with 5 GHz bandwidth, +0.11ns/GHz dispersion slope.

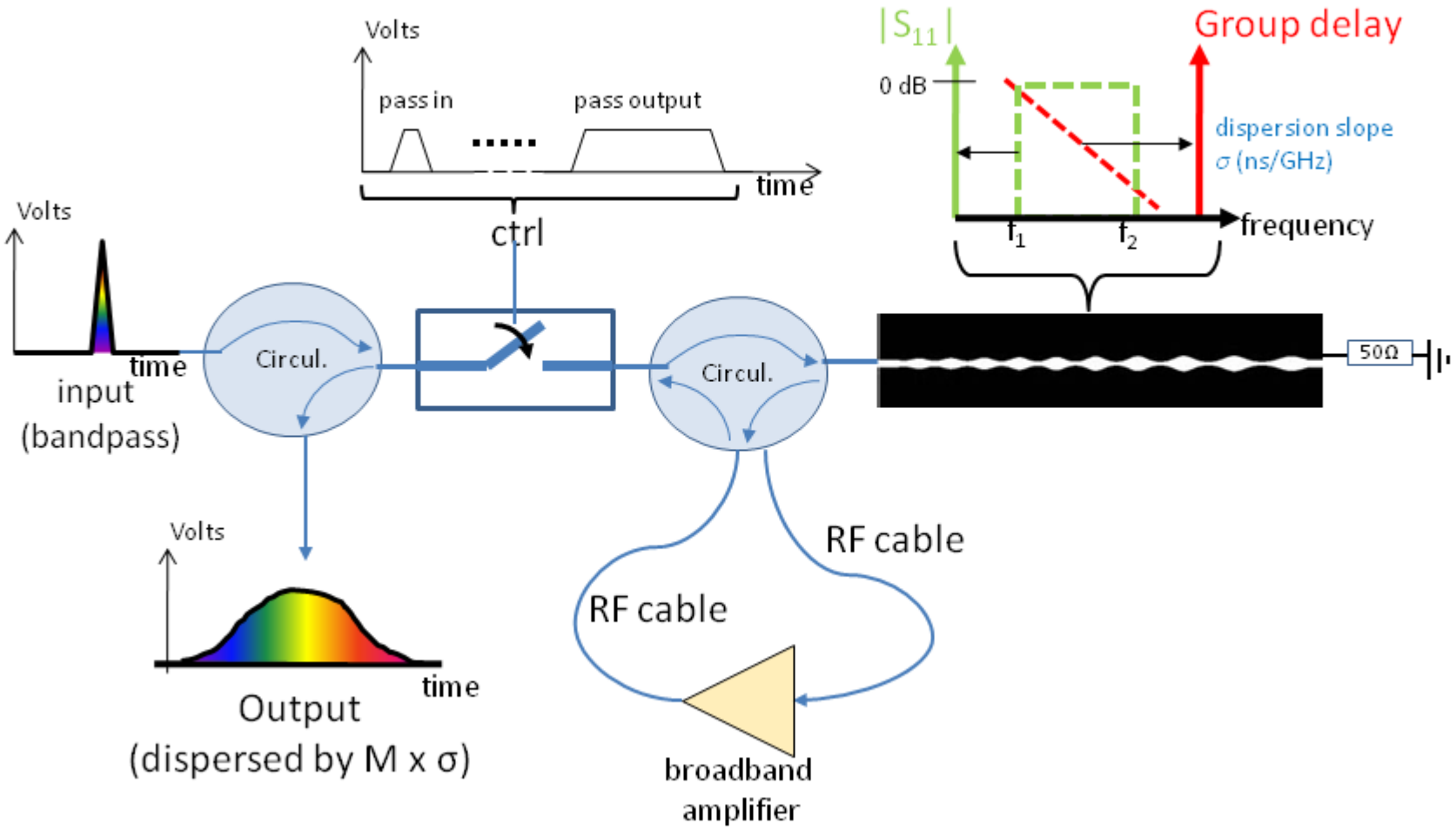




Extended Dispersion

- Increased UWB dispersion from a single EBG
  - UWB signal processing should be able to operate on long time-windows (or continuously)
  - Existing EBGs can only provide finite dispersion (limited by practical fabrication length, losses…)
  - A recirculating configuration allows several passes through the dispersion

Extended Dispersion



Conclusions

- Ultra-Wide Band Concepts
  - Are promising for tracking assets (human and physical)
  - Can be integrated into existing communications systems.
  - Scalable to higher data rates for improved performance.