



Ultra-Wide Band Technologies for Healthcare

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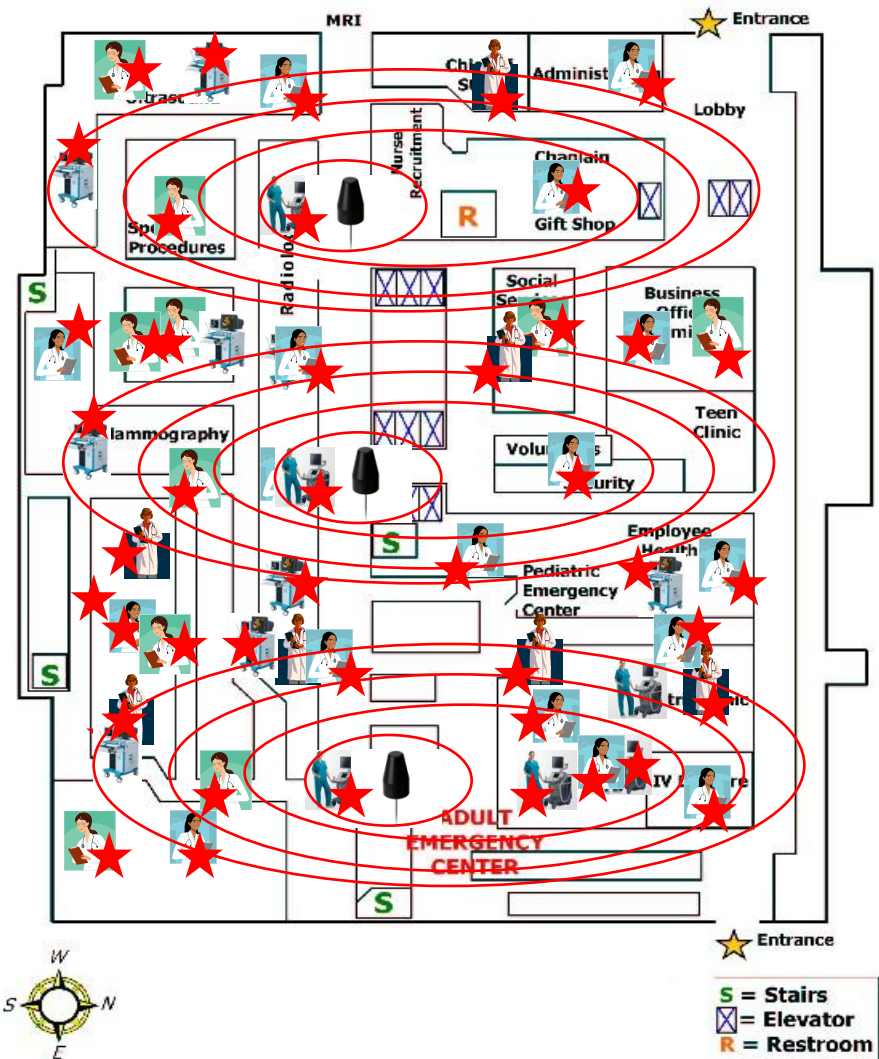
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Saha, and Mr. Amit Khan*



Ultra-Wide Band (UWB) Localization

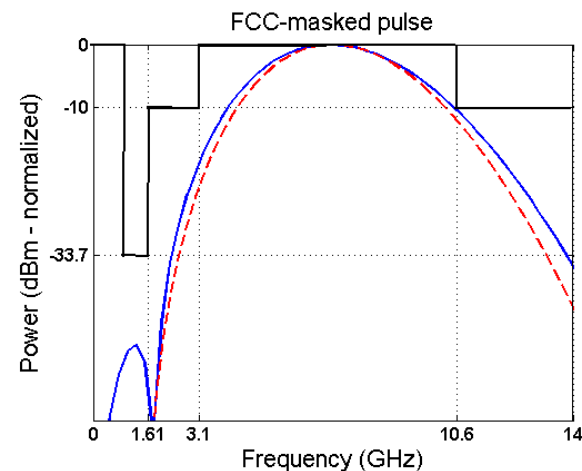
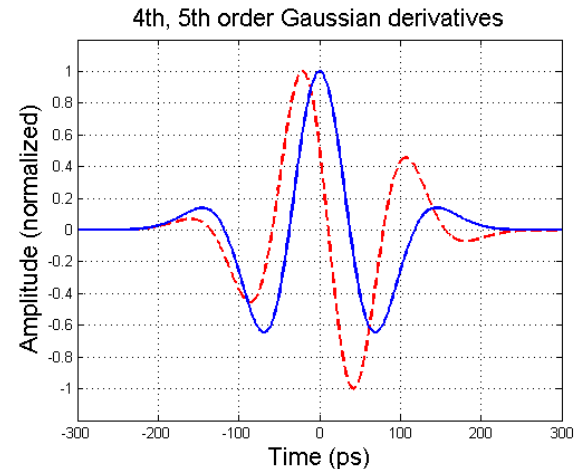
- Precise Location Identification
 - Ultra-wide band technologies for asset tracking
 - UWB well-suited to sensitive hospital environment





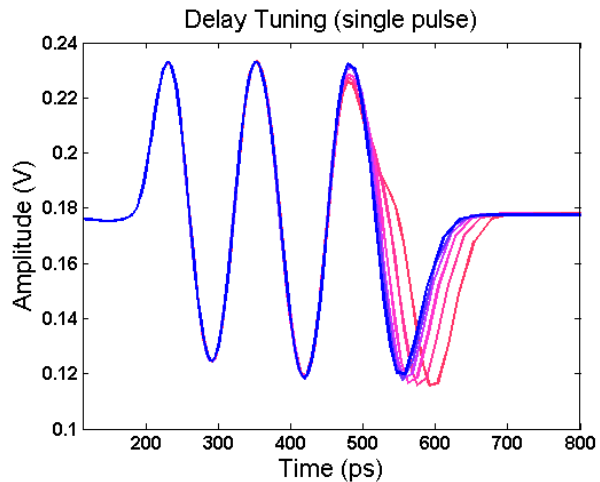
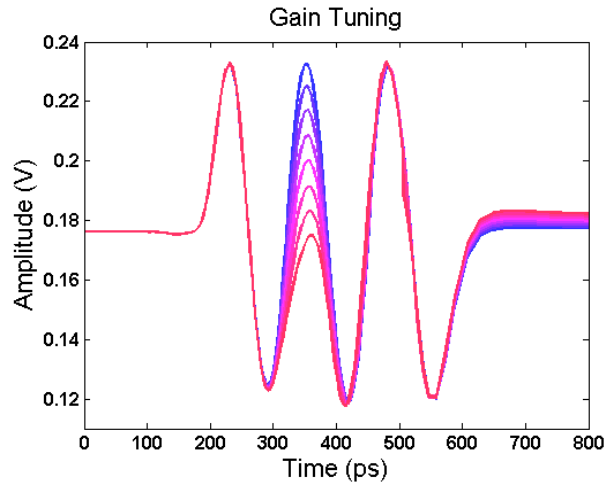
UWB Background

- 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



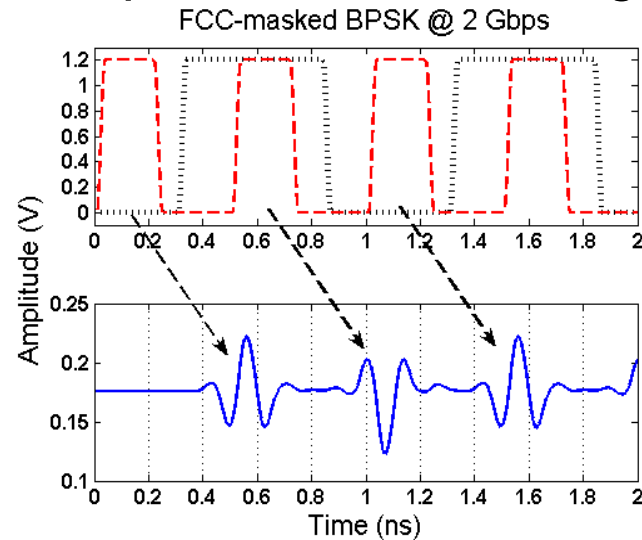


UWB Pulse Generator



• 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.

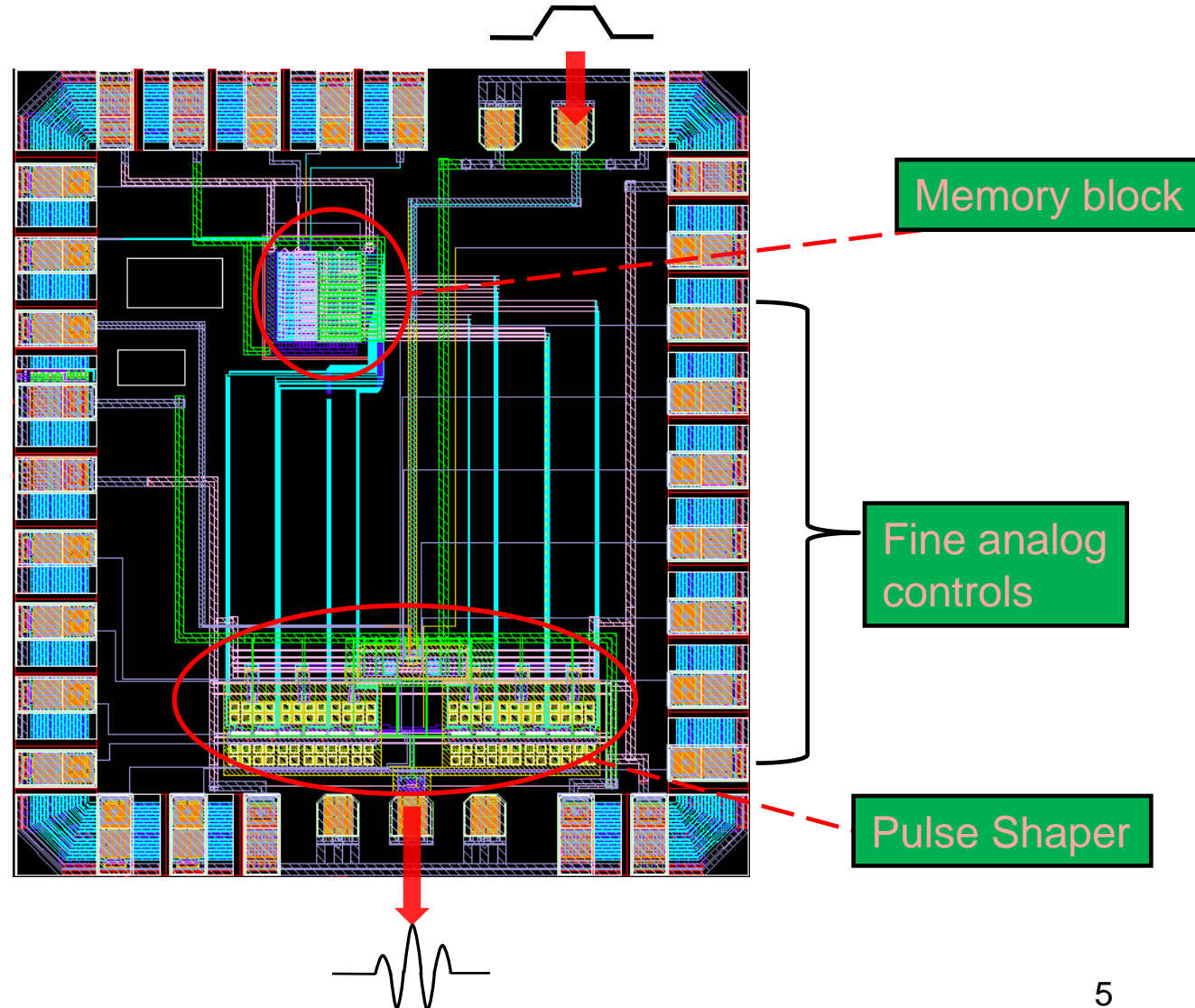




UWB Pulse Generator

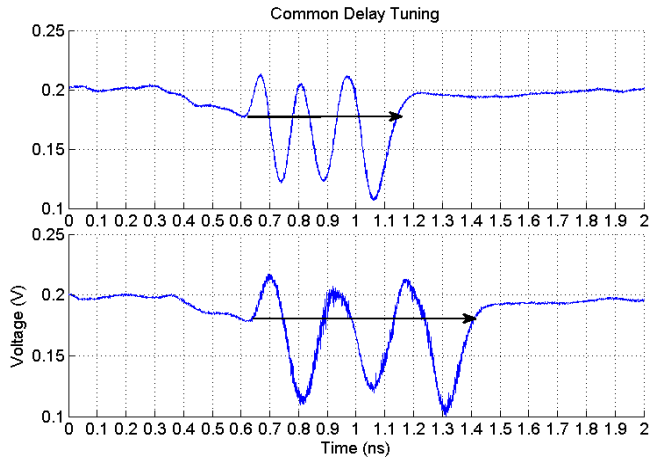
Demonstration IC
in 90nm CMOS
(in testing)

- 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

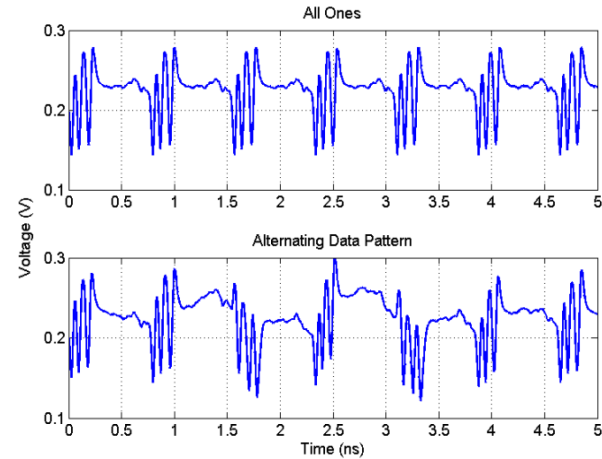




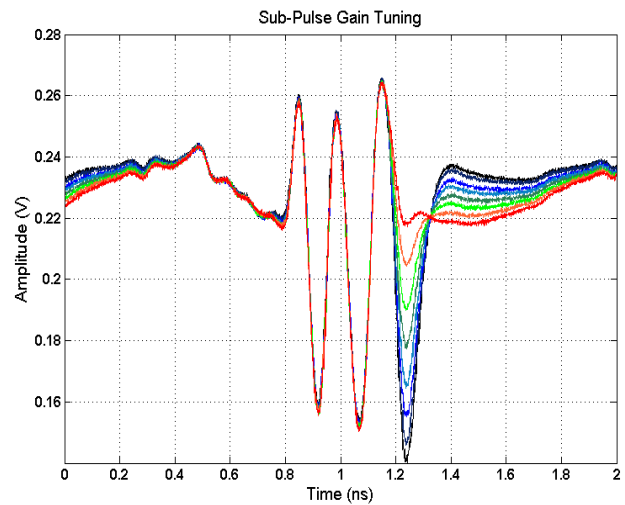
Measured Results



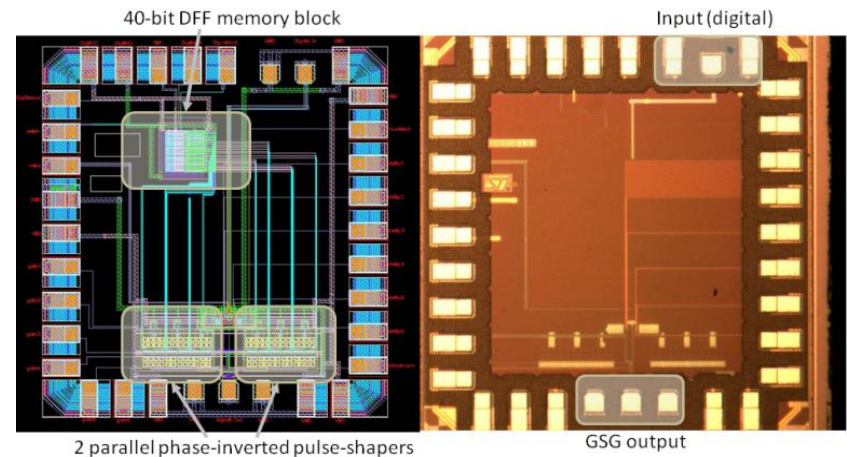
Control of UWB pulse width



BPSK data @ 1.3 Gbps



Control of sub-pulse amplitude

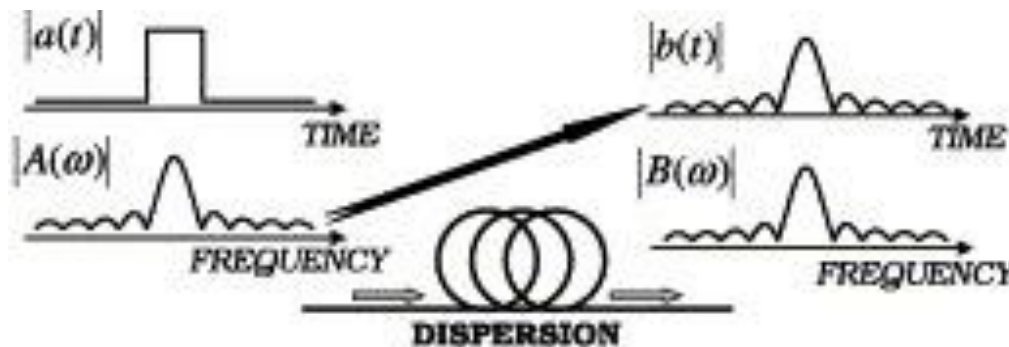


Layout and photograph



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

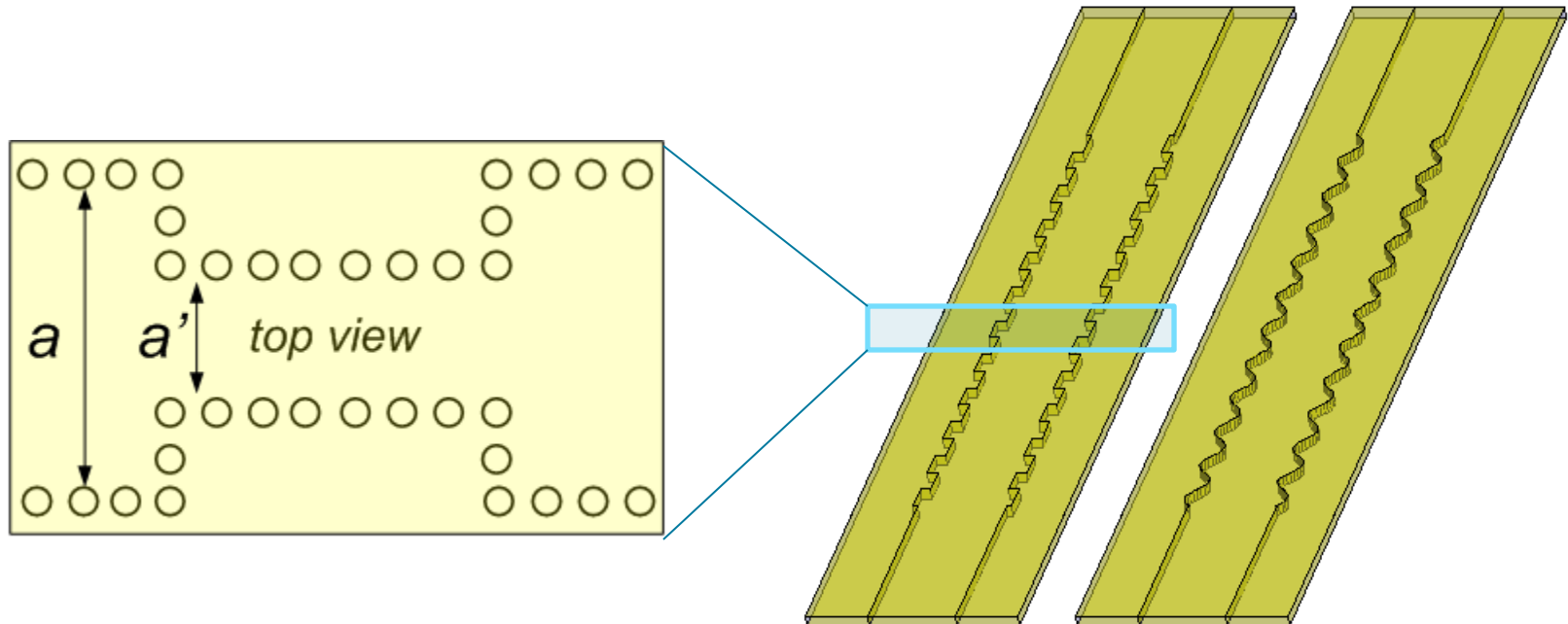


Can we implement microwave broadband dispersion to do this?



Dispersion from an SIW

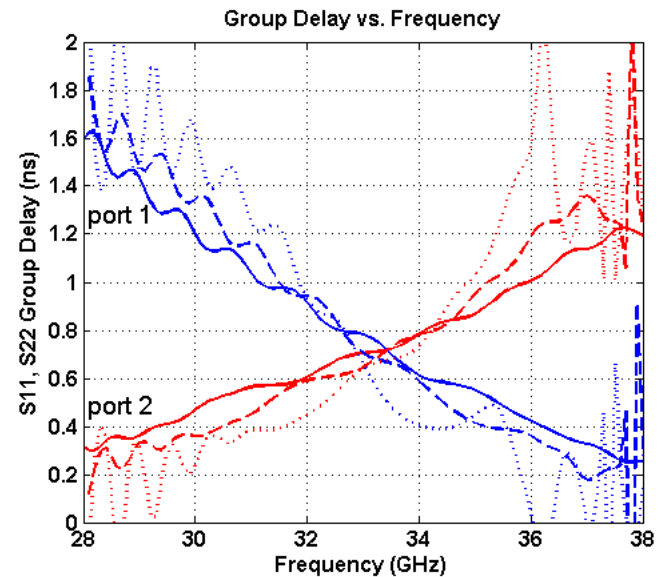
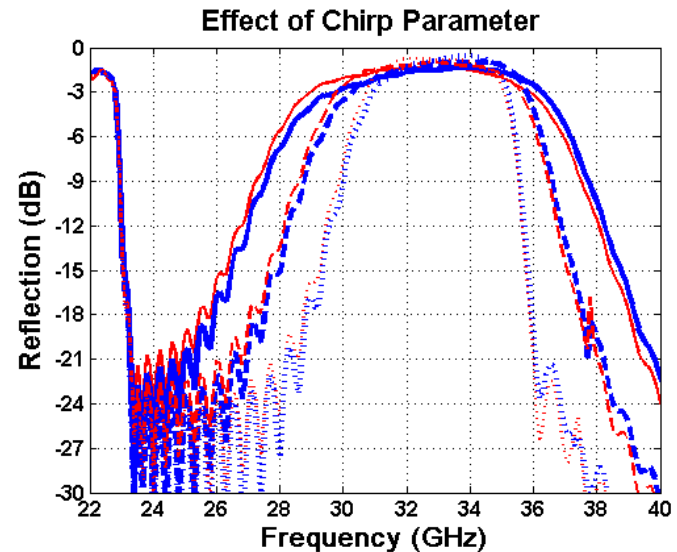
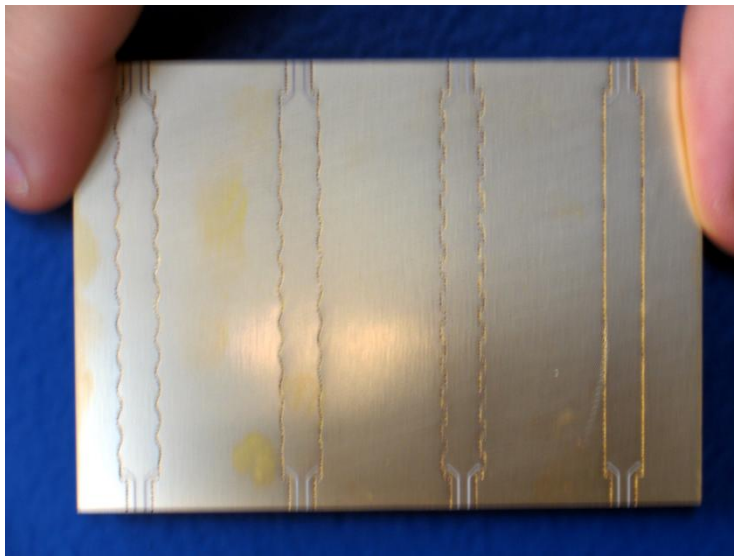
- A substrate integrated waveguide (SIW) is made with a “via” fencepost sidewall (holes filled with metal)
- Easy fabrication (planar) compared to regular waveguides
- Can create a periodic resonant bandgap by “wiggling” the walls
- These are called “electromagnetic bandgaps” (EBGs)





Dispersion from an SIW

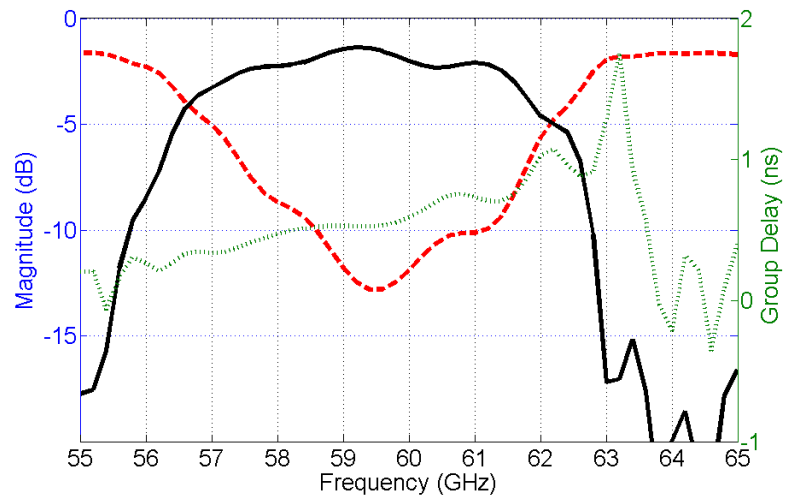
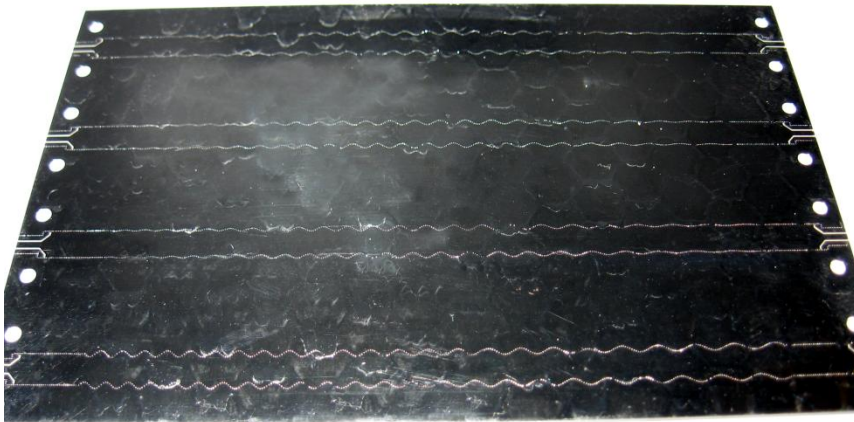
- Group delay and bandwidth can be set by controlling the chirp parameter of an EBG
- Pictured: different chirp settings affect the bandwidth (top right) and delay slope (bottom right)





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, $+0.11\text{ ns/GHz}$ dispersion slope.



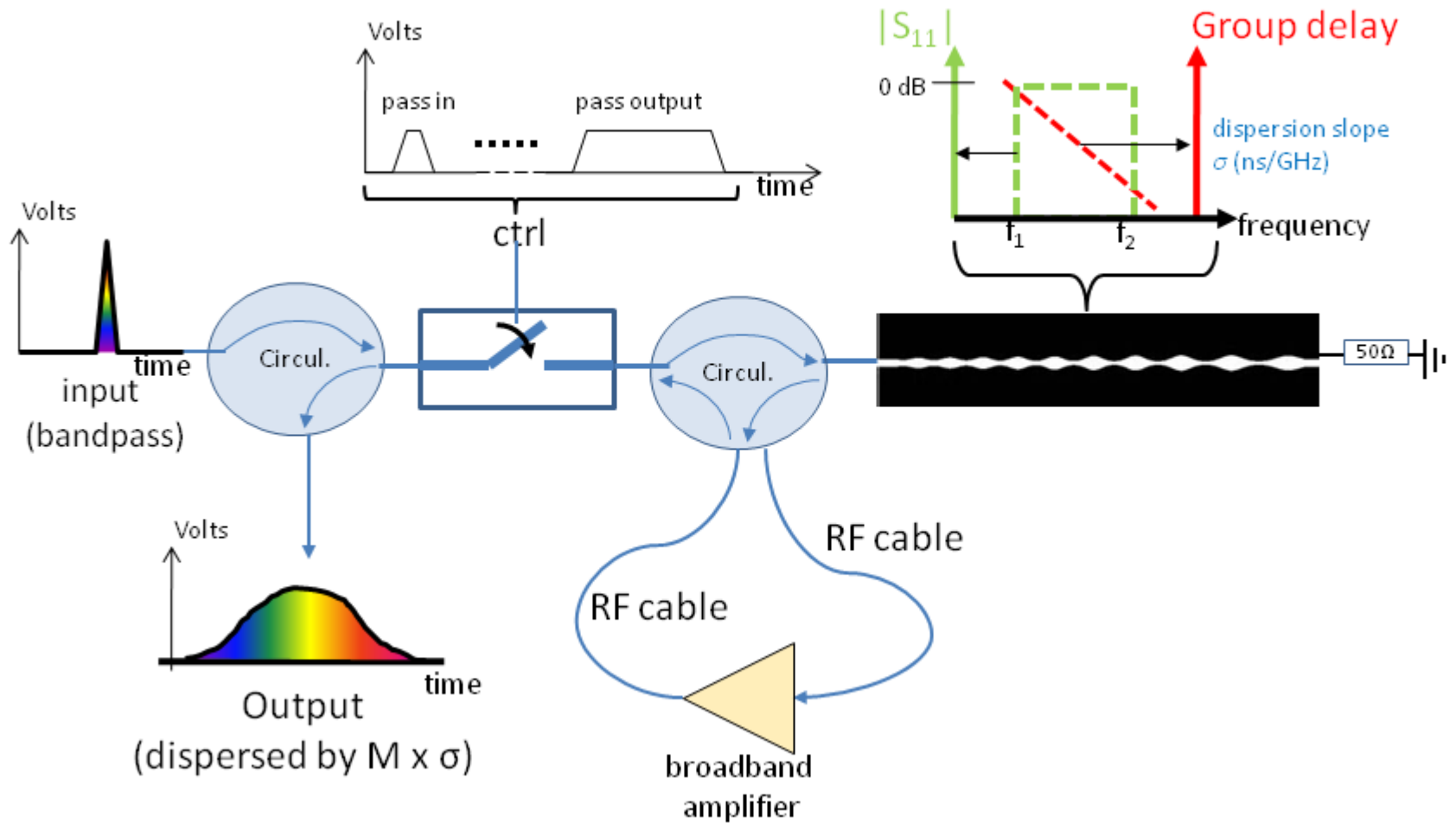


Extended Dispersion

- 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.