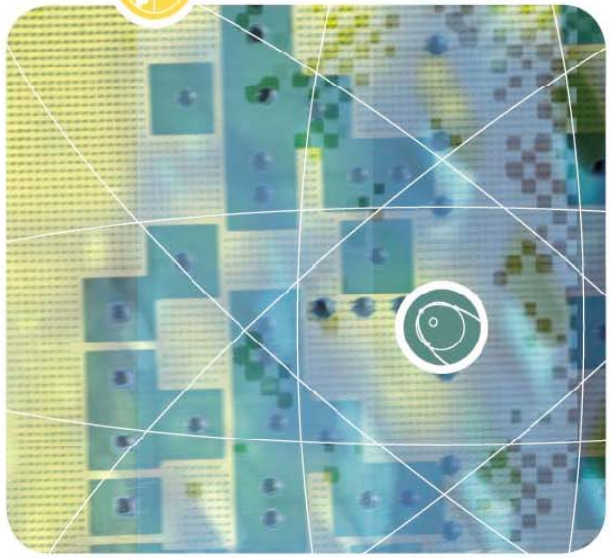
FFI Forsvarets forskningsinstitutt

Options for Digitalization of FMCW UWB Radar

UWB Workshop
Holmenkollen 2010
Mats Jørgen Øyan
FFI

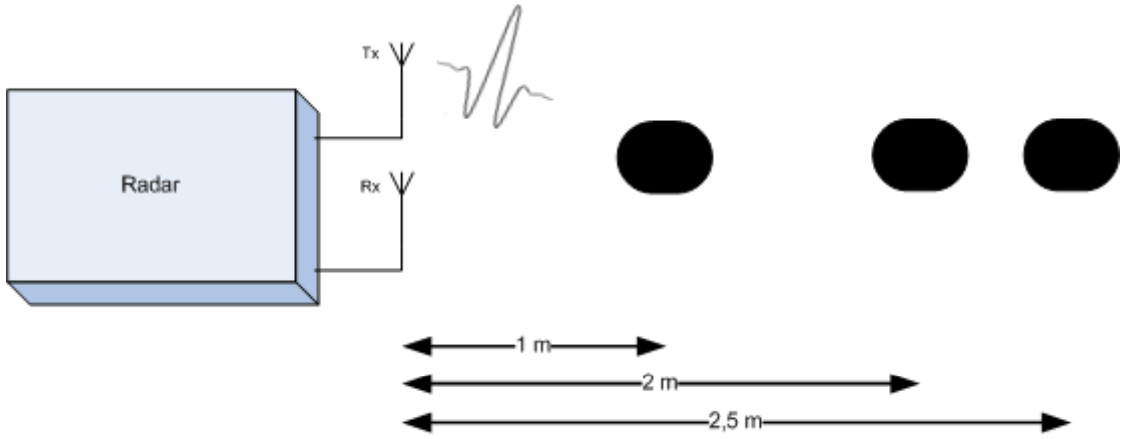


Topics

- **Sampling of different UWB systems**
- The Hubra radar history
- Networked Medical MIMO UWB radar

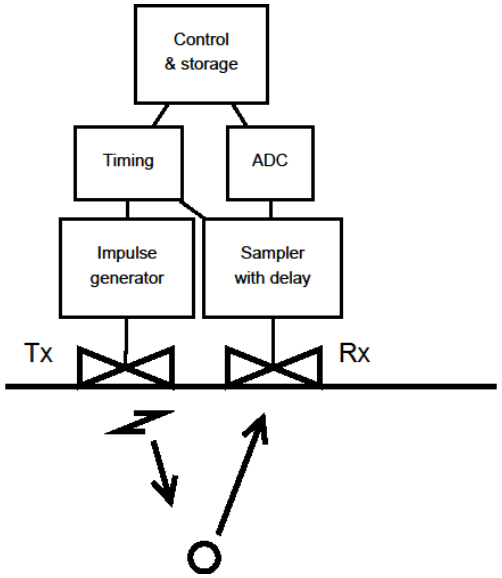
Challenges in sampling UWB systems

- Reduce sampling frequency
  - 3 GHz bandwidth → 6 GHz sampling frequency
- Reduce data volume
  - Range 100 m in air → over 40 000 samples @ 6 GHz
- Dynamic range

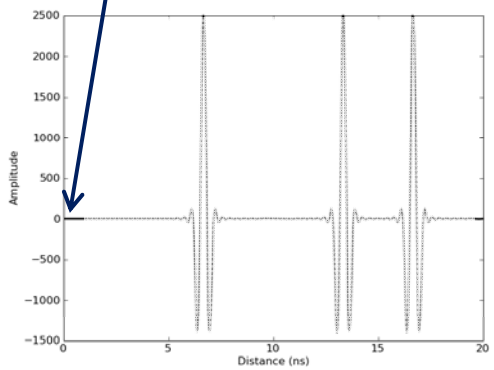


Sampling time domain systems

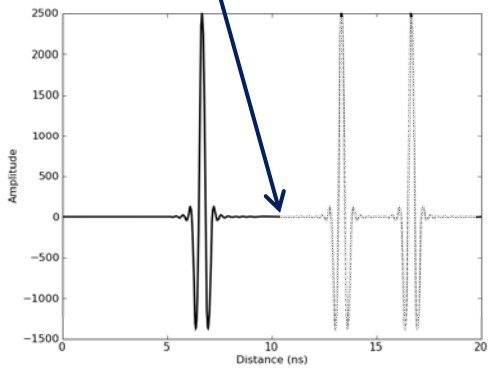
- Stroboscope sampling
  - Many bits → Good dynamic range
  - Bad efficiency

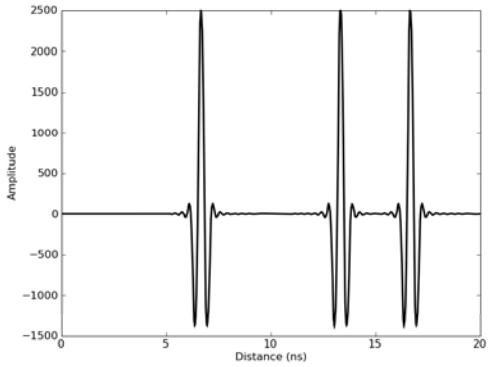


First sample



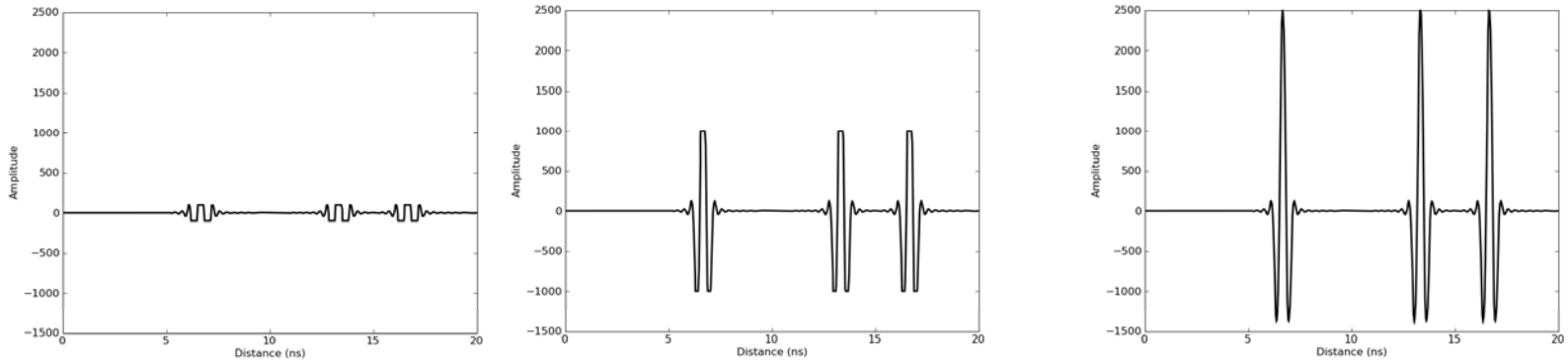
720th sample





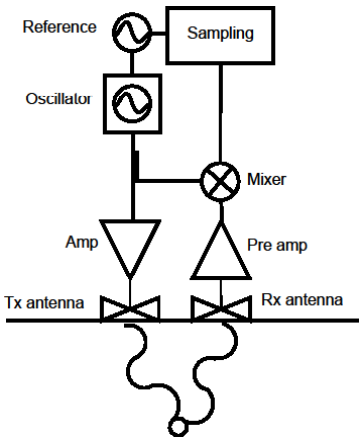
Sampling time domain systems (2)

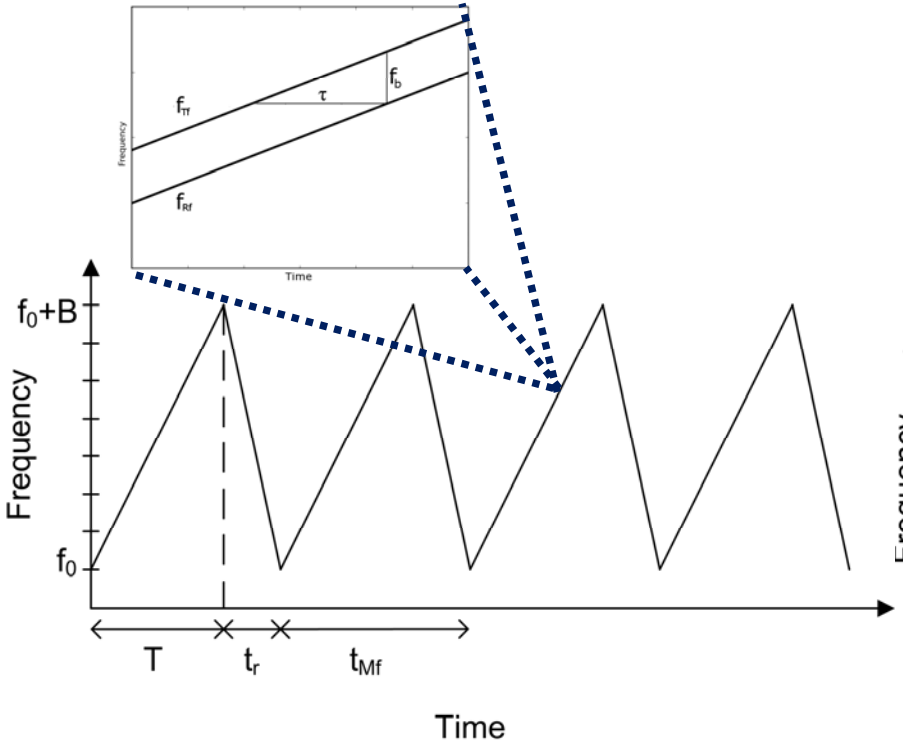
- One bit ADC
  - faster than 16 bit
  - Still have to retransmit impulse

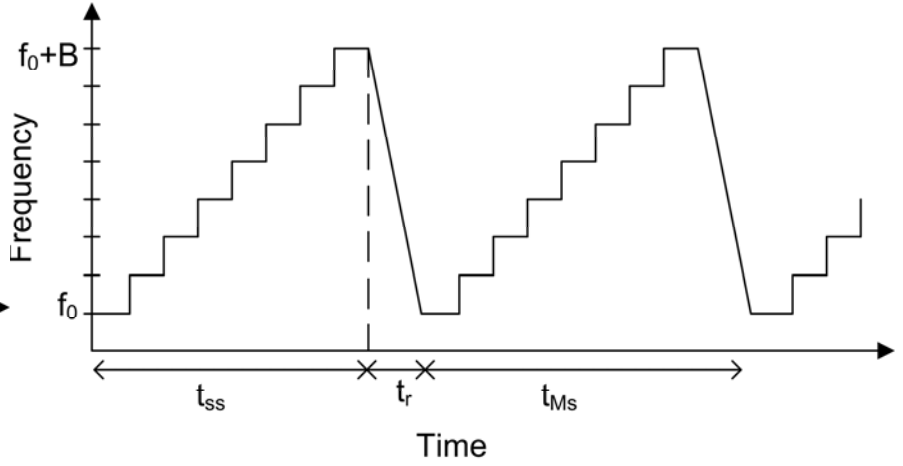


Sampling frequency domain systems

- Frequency Modulated Continuous Wave (FMCW)
  - Sampling requirement reduced to beat frequency
- Step Frequency Continuous Wave (SFCW)
  - Sampling requirement reduced to DC

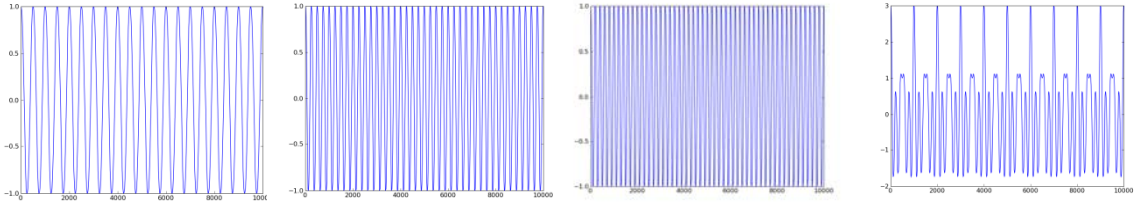


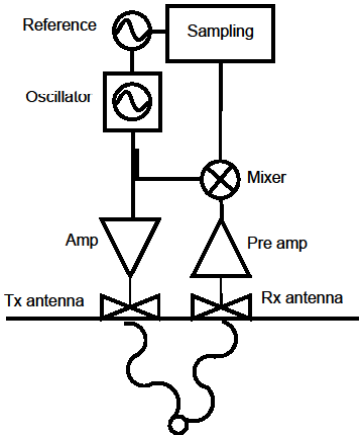




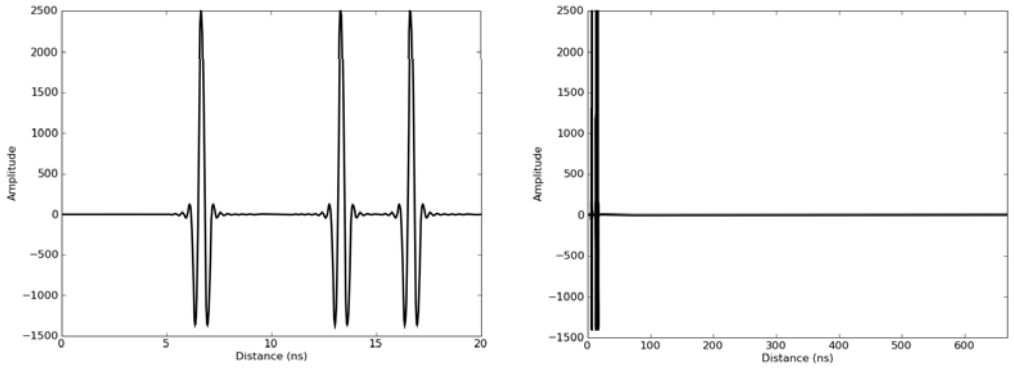
FMCW

- Beat 1 + Beat 2 + Beat 3 = Sampled beat signal





- Fourier transform to time domain:



- Max range → Adjust sweep time (or BW)

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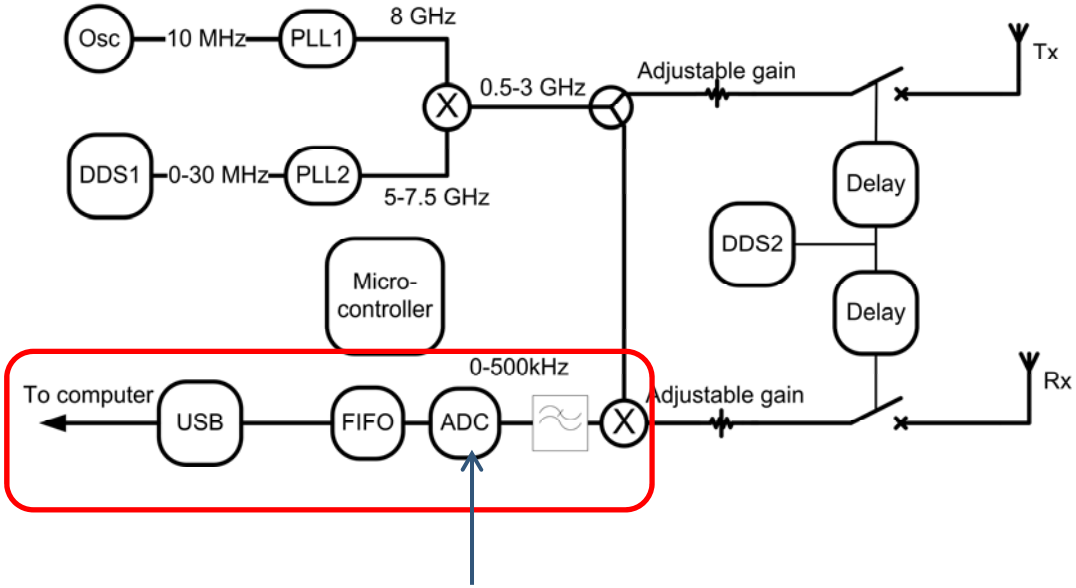
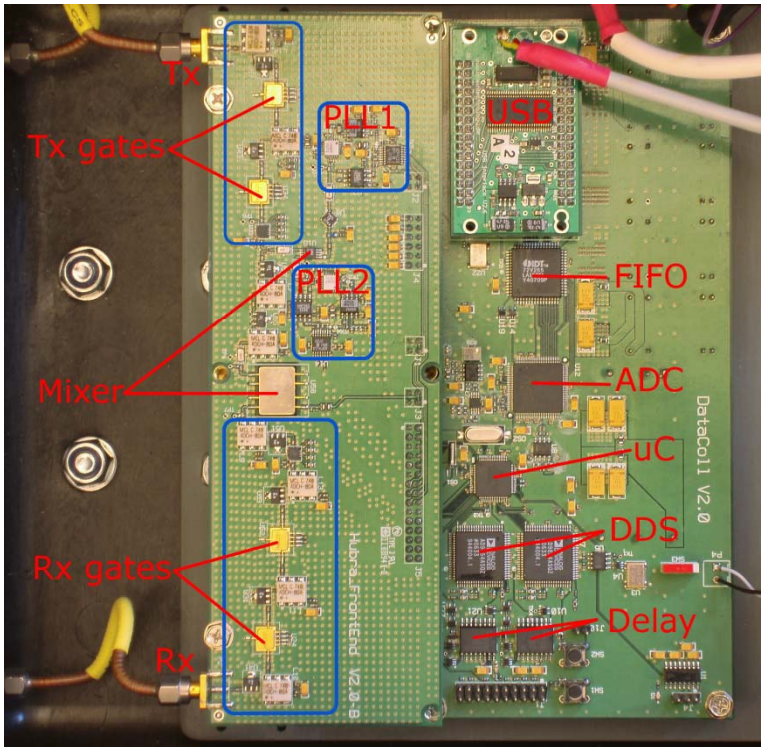
HUBRA



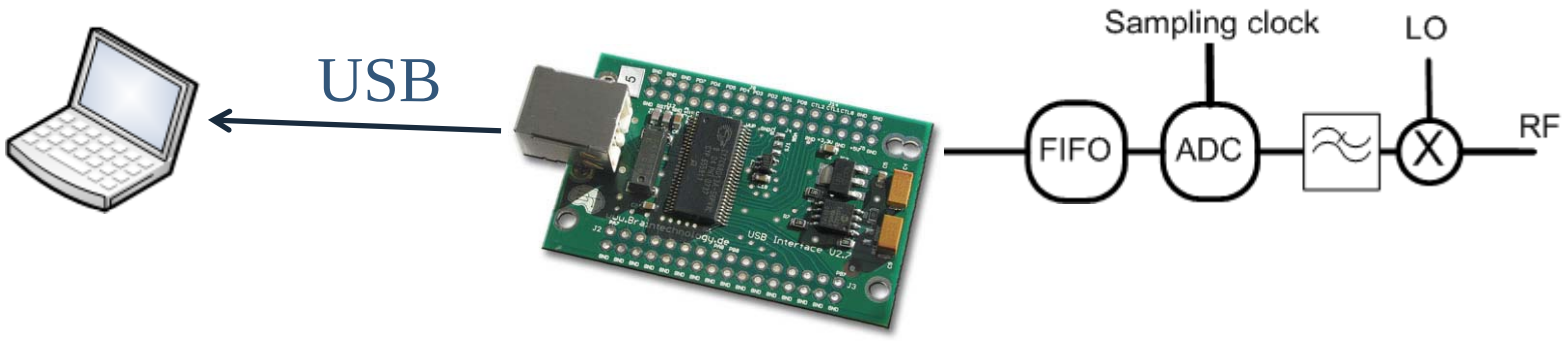
1 MHz
16 bit

Gated FMCW/SFCW
0.5 – 3 GHz



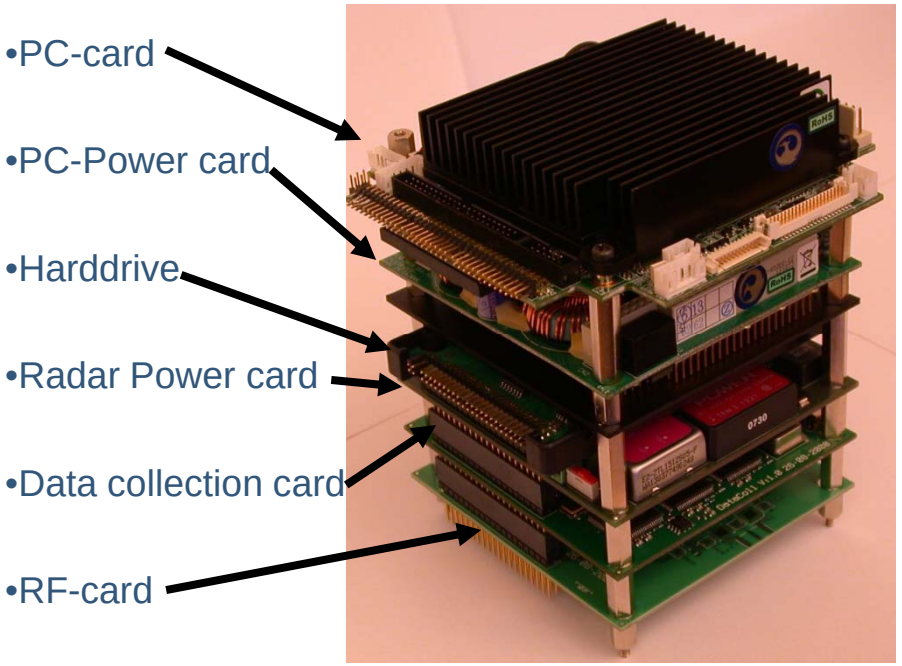
USB

- 480 Mbit/s
- Short cables, max 5 m
- Proprietary drivers and device-side interface



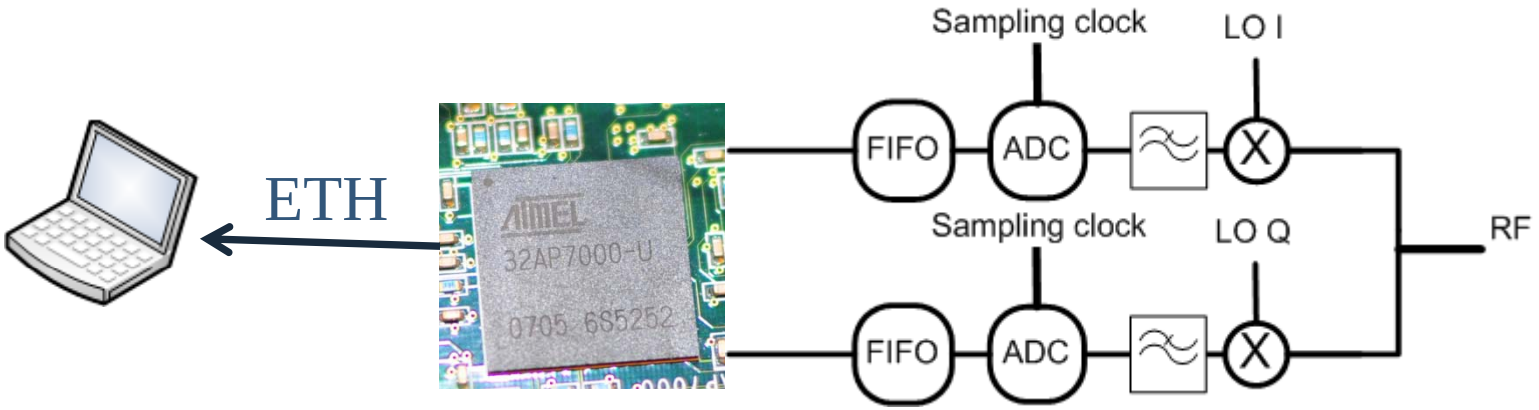
Ku-band

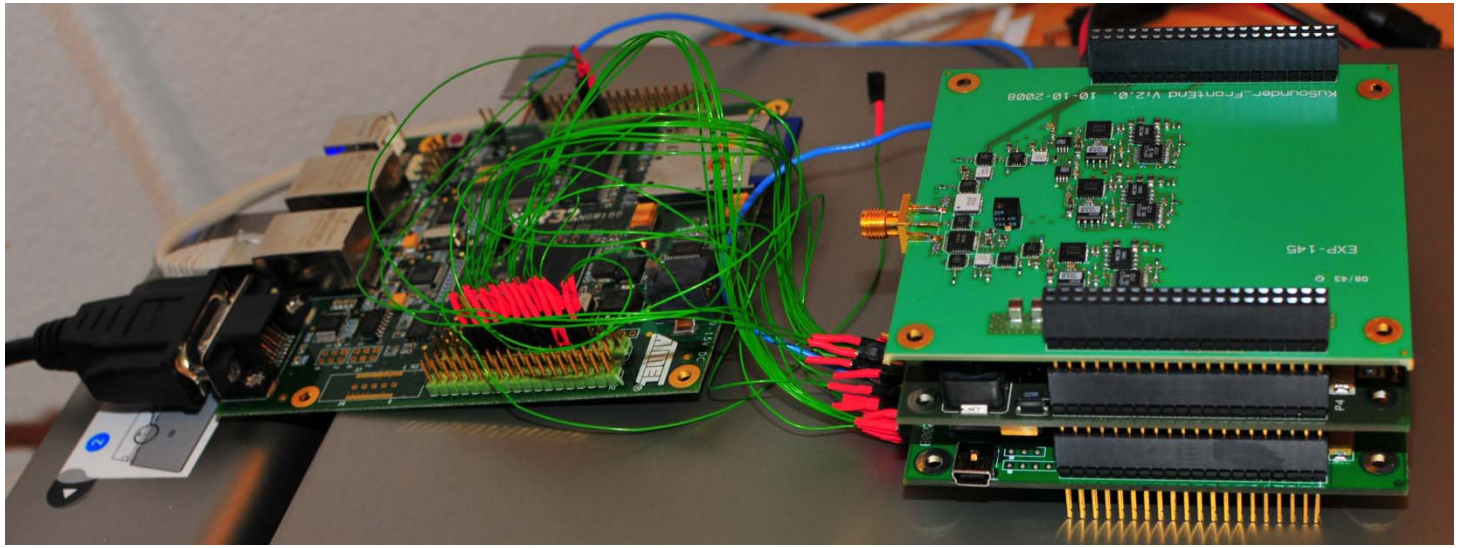
- Waveform
  - FMCW
  - 13.1-14.1 GHz
- Sampling
  - 1 MHz
  - 16 bit ADC
  - **I and Q channel sampling**
  - 32 Mbit/s



Ku-band (2)

- Ethernet for communications





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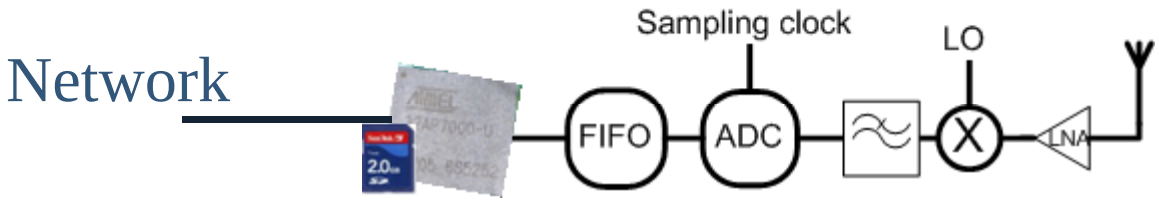
Ethernet

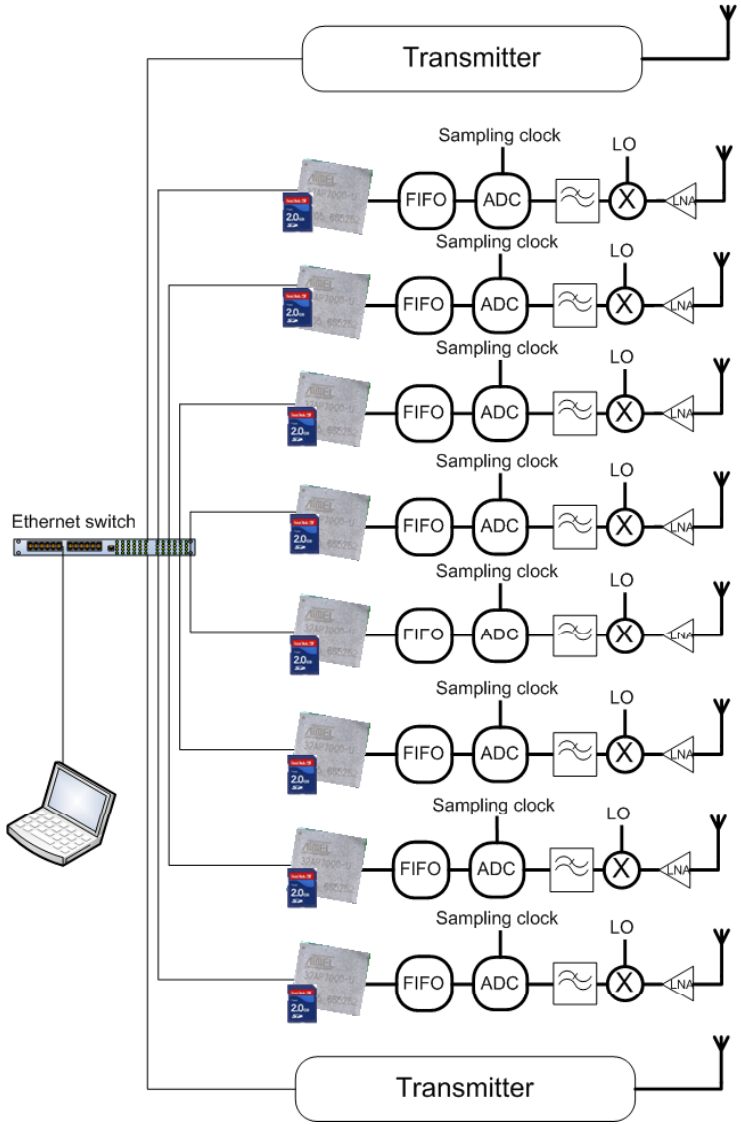
- 10/100/1000 Mbit/s
- 100 meter cable (cat6 gigabit)
- Standard protocols and drivers

AVR32

- Linux
- Kernel driver for reading I and Q channels
- Ethernet driver available
- SD or Compact flash driver available



FMCW MIMO UWB Medical Radar



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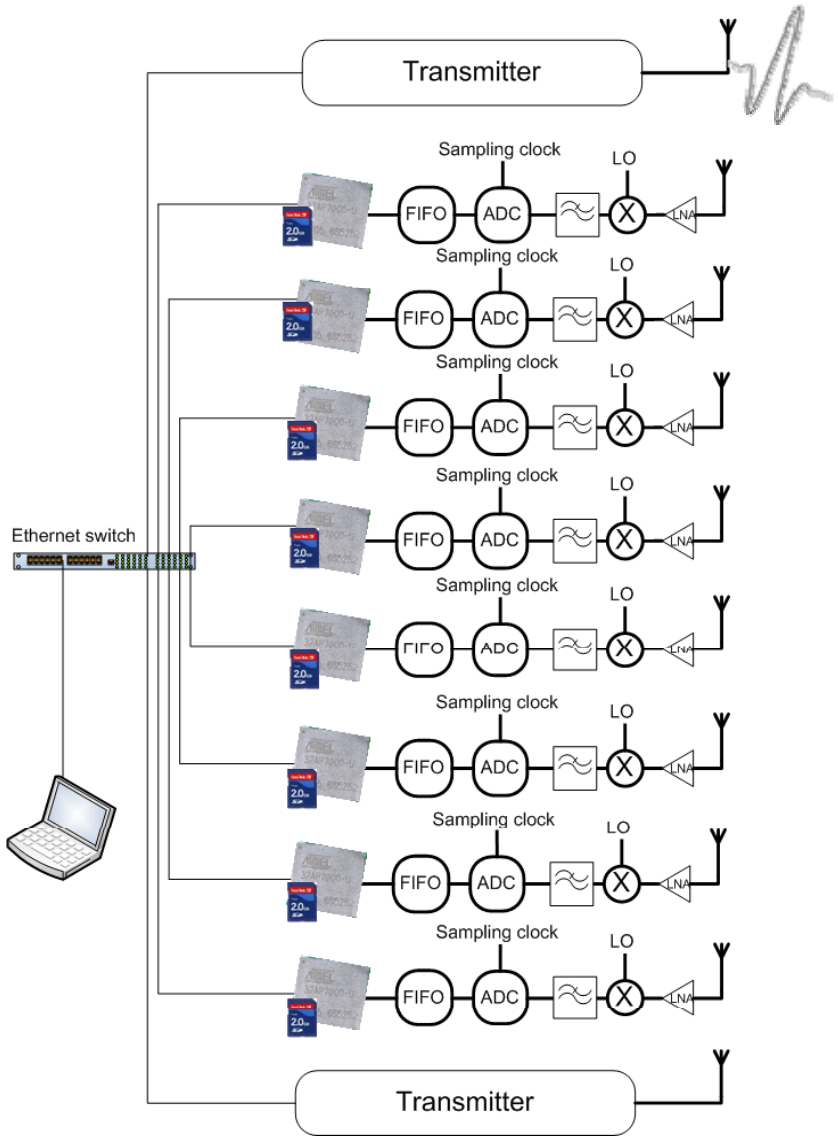
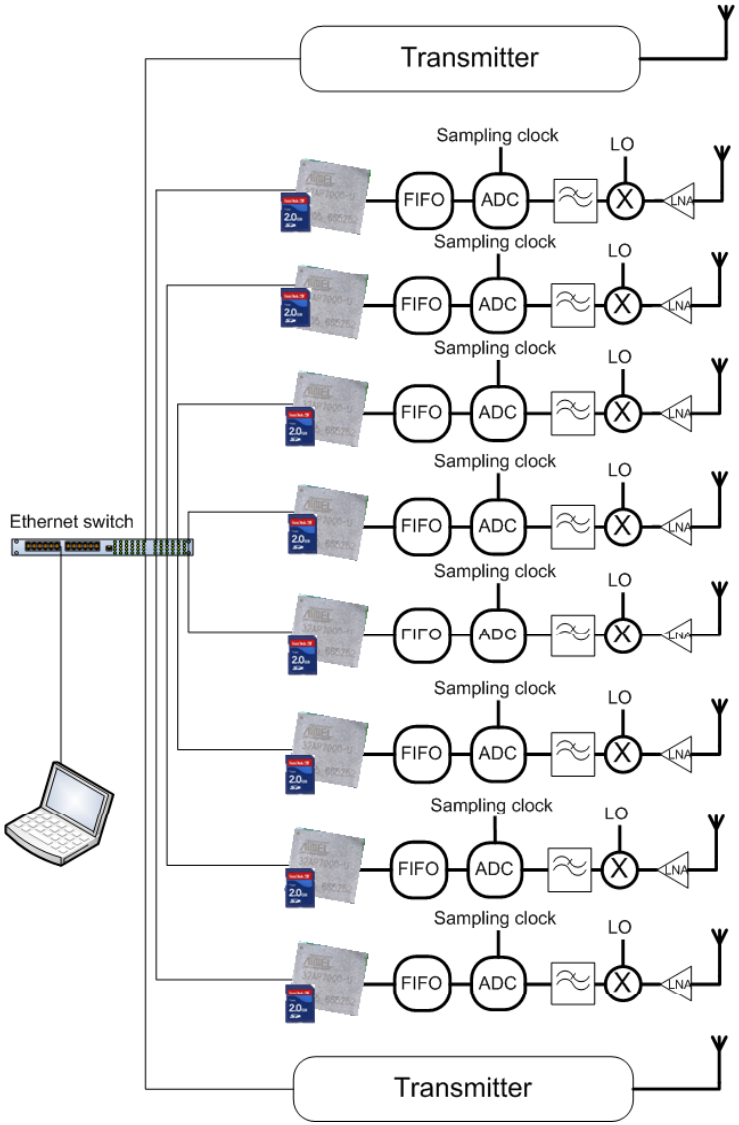
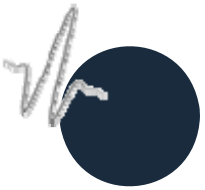


FMCW MIMO UWB Medical Radar





Performance

- Network (values from Atmel):
  - Tx (TCP): 56 Mbit/s
  - Rx(TCP): 43 Mbit/s
- Network measured:
  - Tx: 23 Mbit/s
- SD measured:
  - 11Mbit/s

Summary

- UWB techniques:
  - Reduce sampling requirements
  - Reduce data volume
  - Improve dynamic range
- FFI is designing a new radar
  - MIMO
  - FMCW
  - UWB
  - Network based
  - Scalable

Questions/comments?