Bandwidth Considerations for the Project X Fast Kicker

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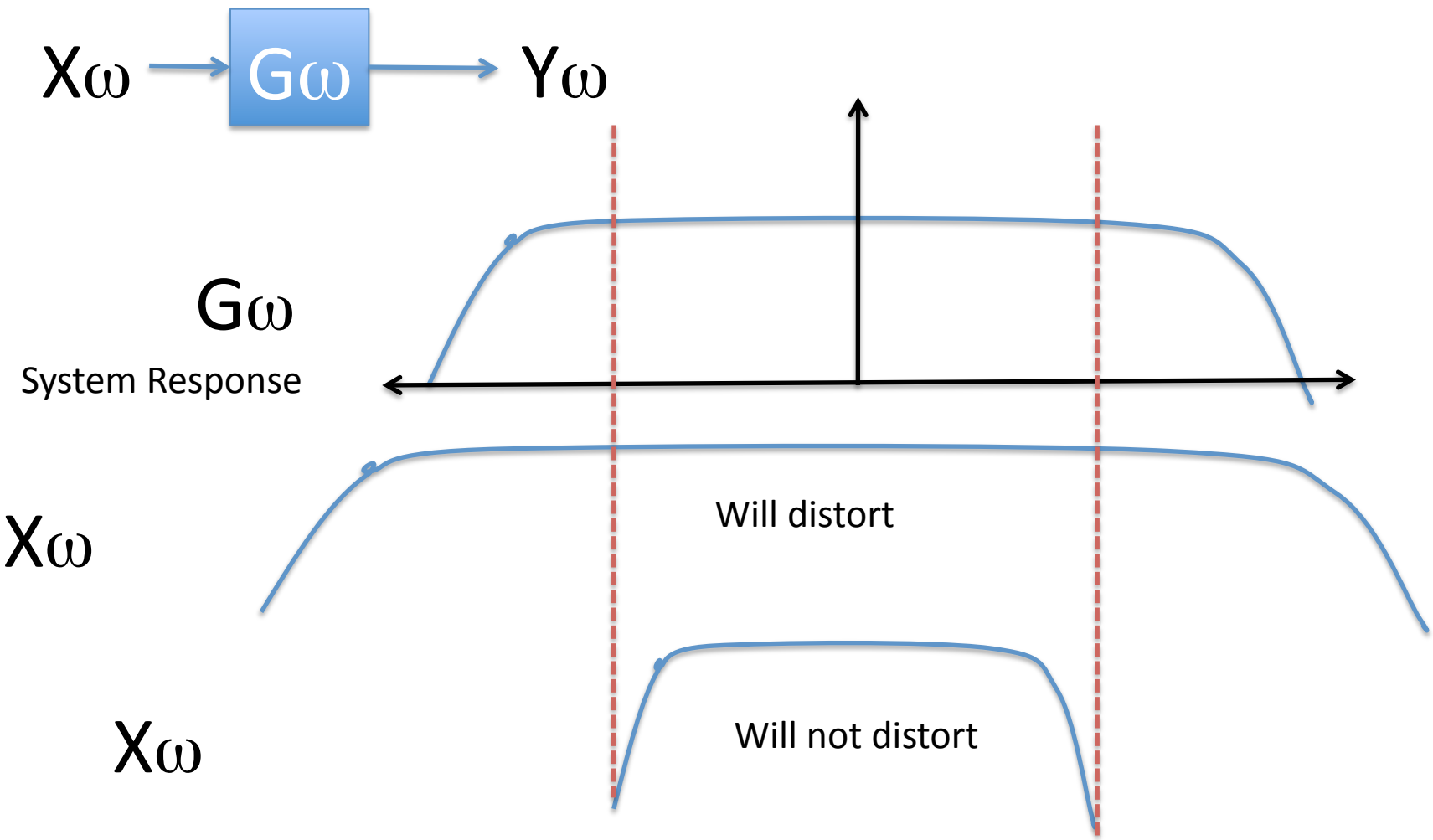
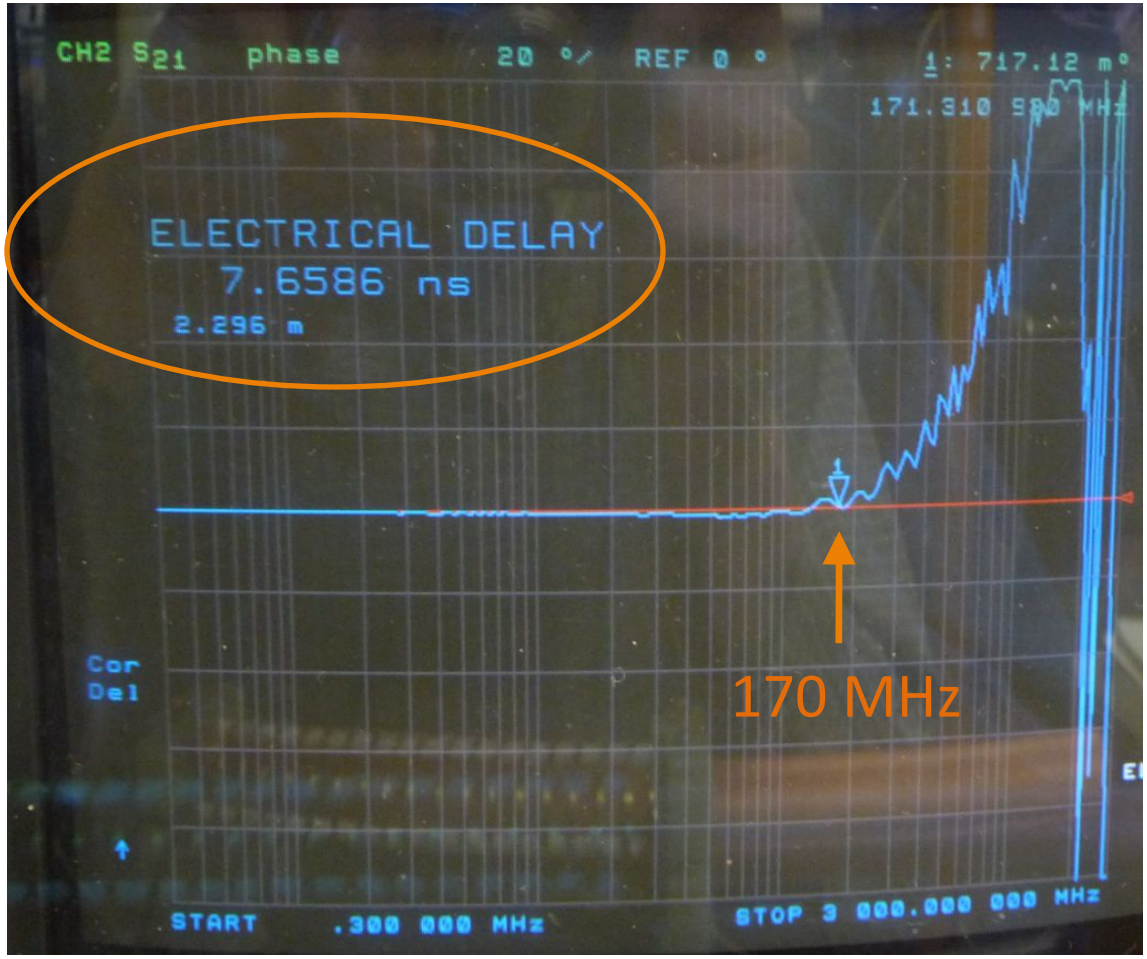
May 3,2011

Project X Technical Meeting

Limiting signal bandwidth to less than the linear system bandwidth eliminates distortion



Network analyzer S21 phase response



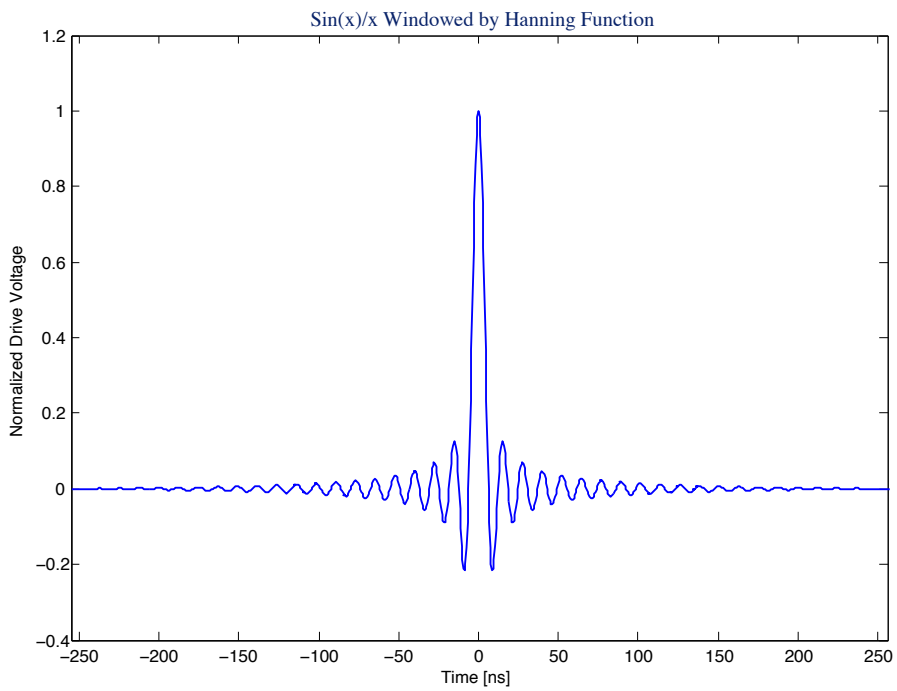
Slide provided
By Greg Saewert

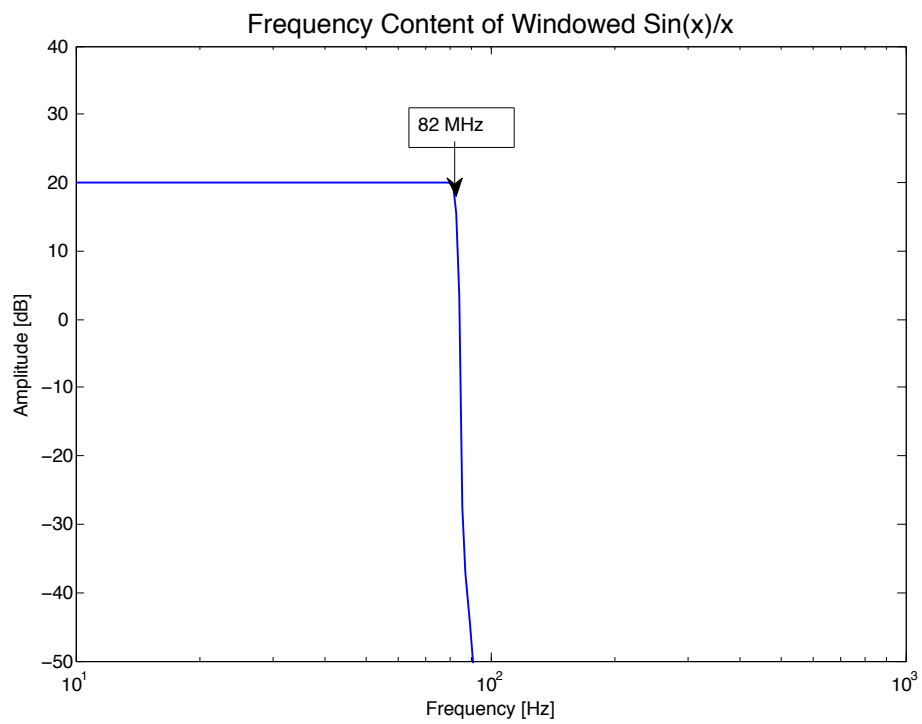
- Sweep range: .30MHz – 3GHz
- Vertical scale: 20 deg/div
- Matching resistor network and cable are calibrated out of the measurement

Nyquist–Shannon sampling theorem

- If a function *x(t) contains no frequencies higher than B*
  hertz, it is completely determined by giving its ordinates at a series of points spaced 1/(2B) seconds apart.
- *For our purposes:*
  - *If a function x(t) can be defined by a series of points spaced 1/(2B) seconds apart, then the bandwidth required to transmit this function is B*
  - *162.5 M symbols per second -> BW = 81.75 MHz*
  - *At least two symbols required, kick out or keep possibly more for fractional beam*

Bandwidth limited signal
Sinx/x windowed by Hamming function

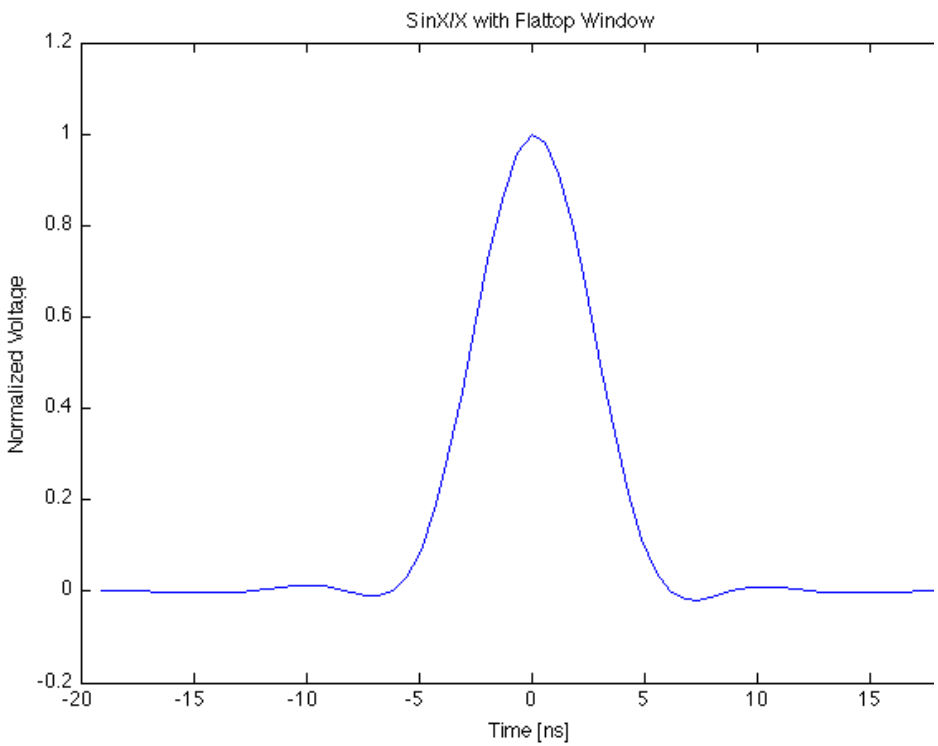


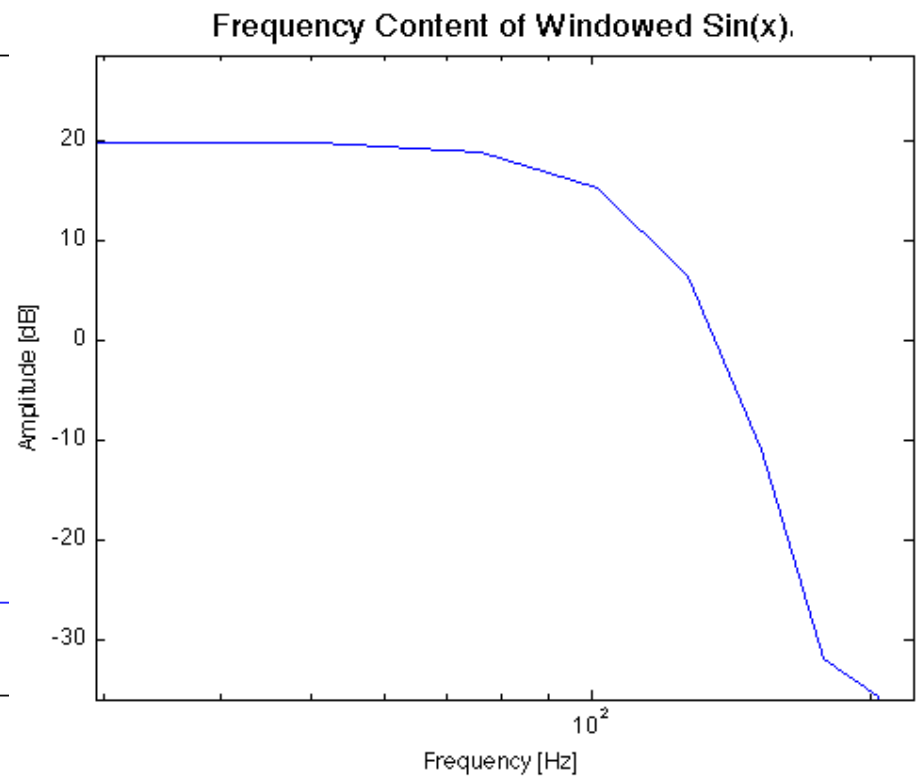


Gentle windowing provides for a brick wall filter response

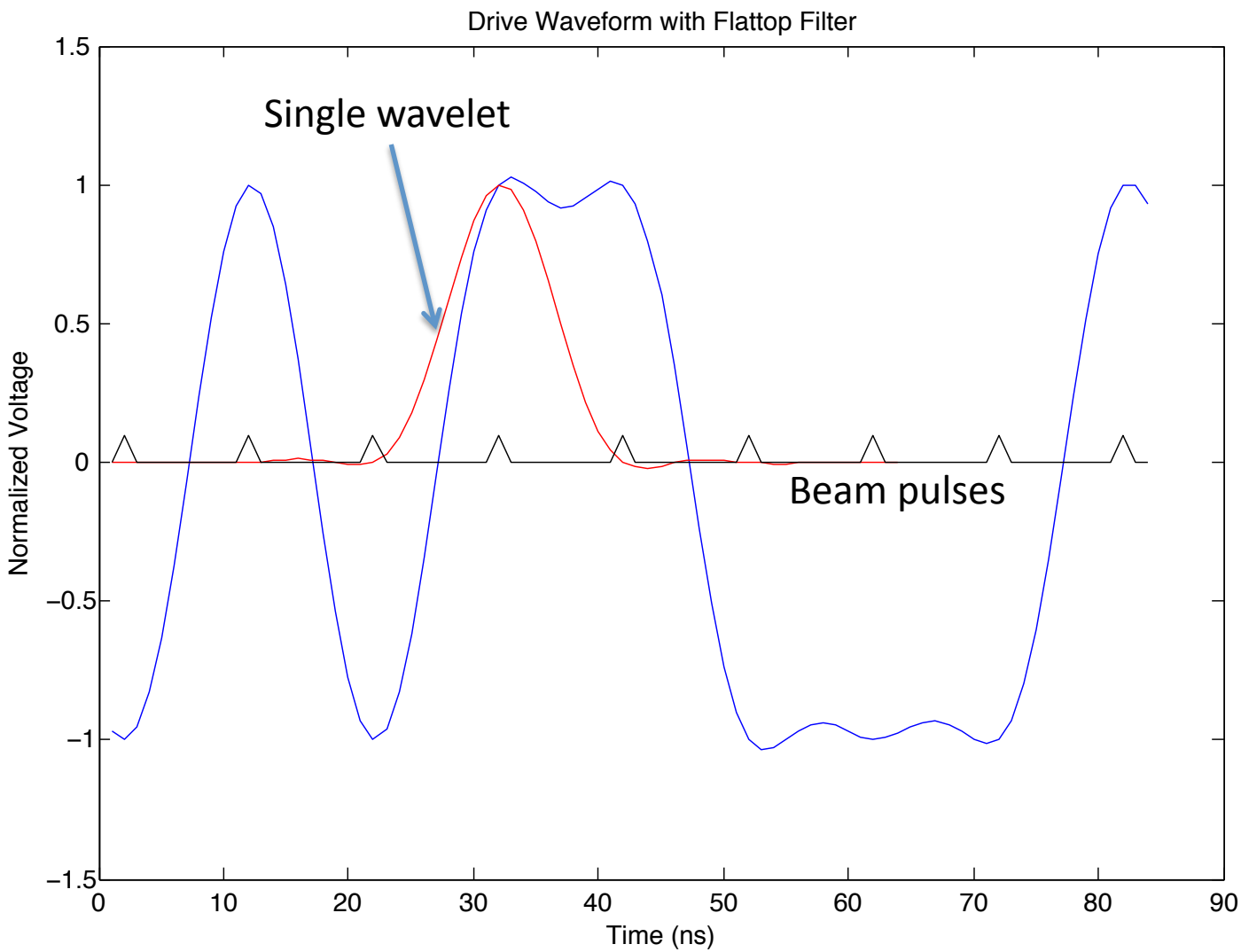
64 sample sinx/x with flattop window

Reduced overshoot but with larger spectral leakage





Sum of multiple waveforms
Value = +-1.0



Other thoughts

- A cascode design a power MOSFET on the drive stage and tube on the top makes for the best impedance match, lowest capacitance and best power capability
- Using small copper tubing for the spiral would allow for water cooling and would allow the coil to intercept some beam (<2.1 MeV)
  - This would allow for closer spacing and higher fields
- Large steps between electrodes require higher bandwidth -> small spiral diameter
- Lumped element structures are a possibility too