Propose – rapid evaluation of non linear ultrasound propagation

$$\nabla^2 p(\vec{r},t) - \frac{1}{c^2}\frac{\partial^2 p(\vec{r},t)}{\partial t^2} = \frac{\beta_n \kappa}{c^2}\frac{\partial^2\left(p^2(\vec{r},t)\right)}{\partial t^2}$$

Quasi linear approximation (moderate pressure), $p = p_1 + p_2$

$$\nabla^2 p_1(\vec{r},t) - \frac{1}{c^2}\frac{\partial^2 p_1(\vec{r},t)}{\partial t^2} = 0$$

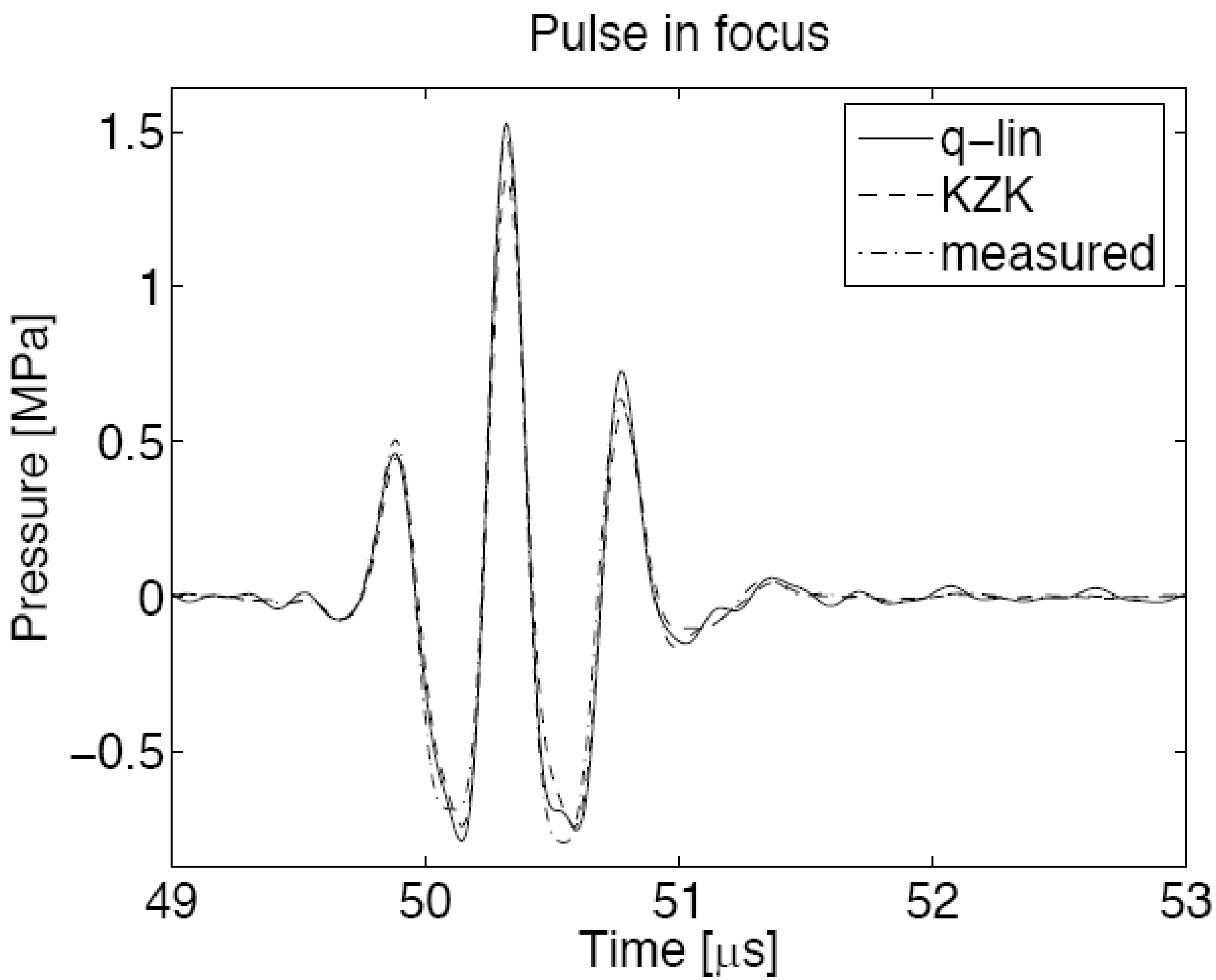
$$\nabla^2 p_2(\vec{r},t) - \frac{1}{c^2}\frac{\partial^2 p_2(\vec{r},t)}{\partial t^2} = \frac{\beta_n \kappa}{c^2}\frac{\partial^2\left(p_1^2(\vec{r},t)\right)}{\partial t^2}$$

Solve the two equations with k space approach, utilizing the Fraunhofer approximation of linear field in focal plane for a focused transducer

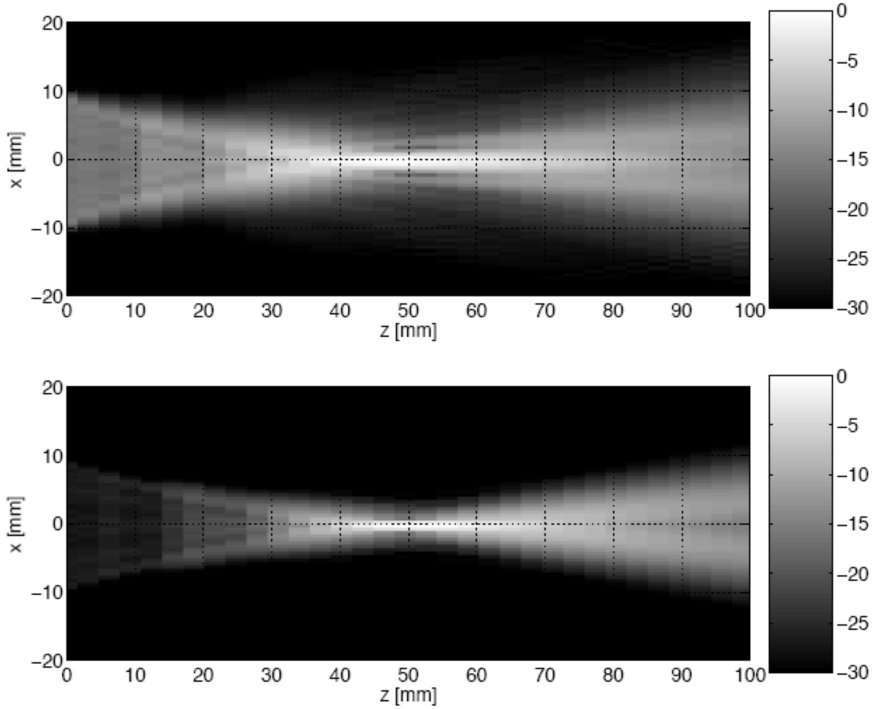
Comparison, propose, reference method and measurement

Pulse in focus

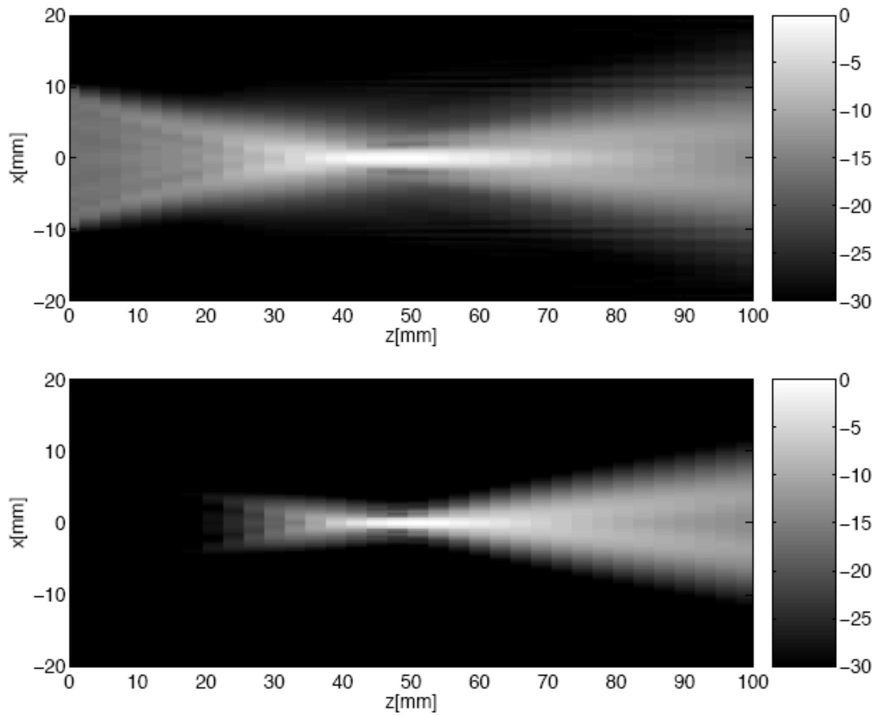
Rectangular aperture at 2.5MHz



Comparison propose and reference method



Reference,
Upper fundamental
Lower 2.harmonic



Propose,
Upper fundamental
Lower 2.harmonic