Acoustic Filed Comparison of High Intensity Focused Ultrasound by using Experimental Characterization and Finite Element Simulation

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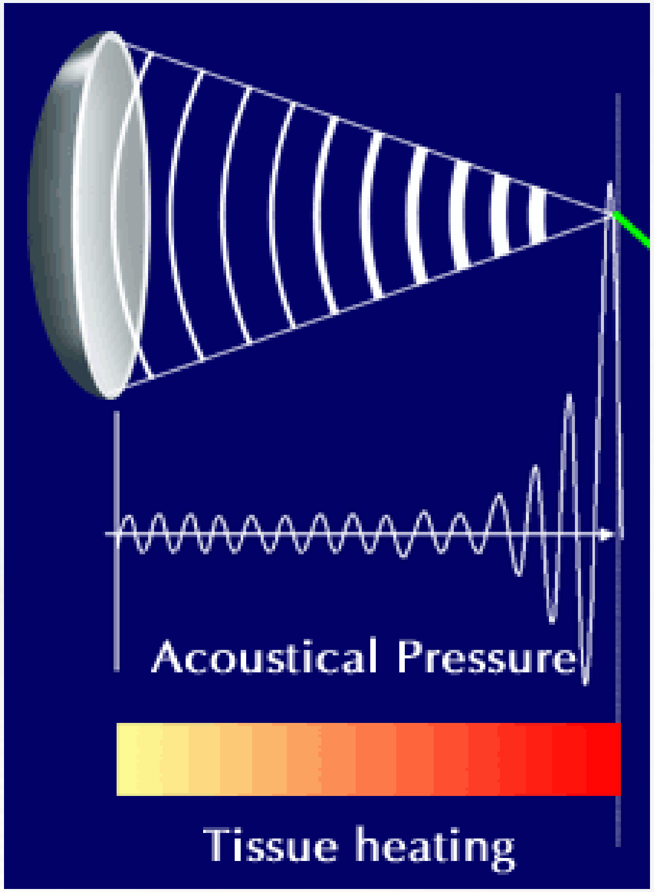
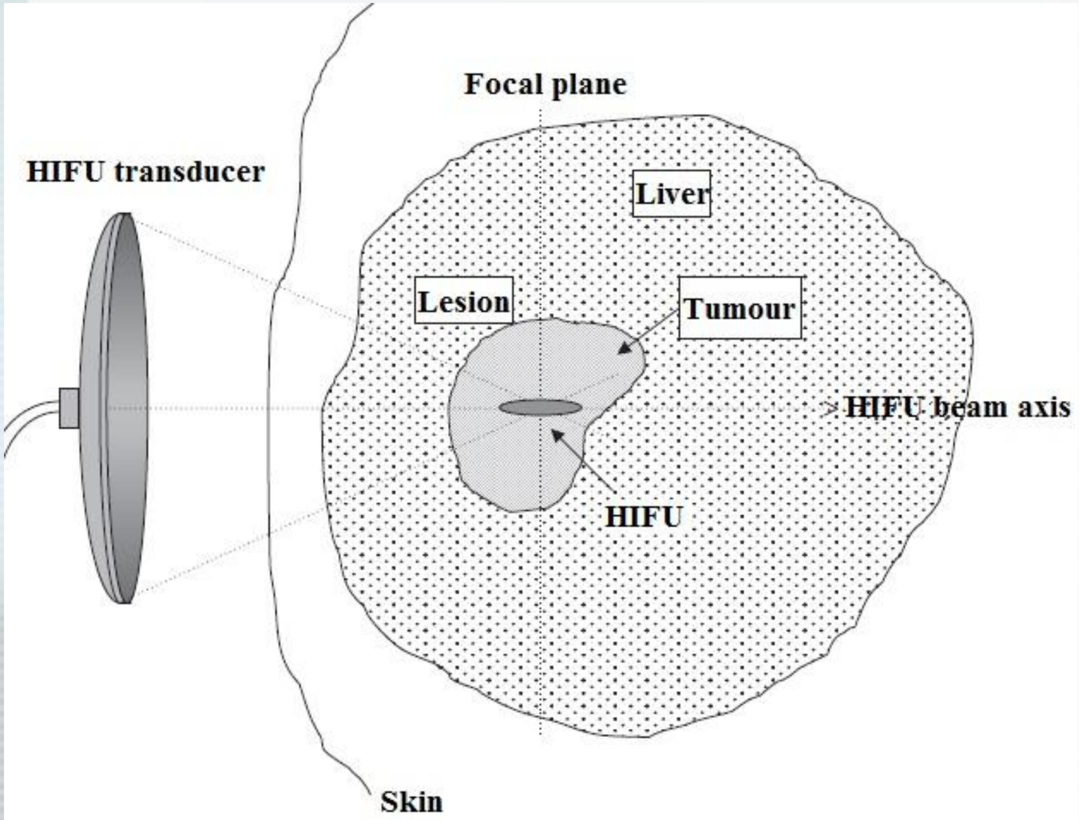
Introduction

High Intensity Focused Ultrasound (HIFU)

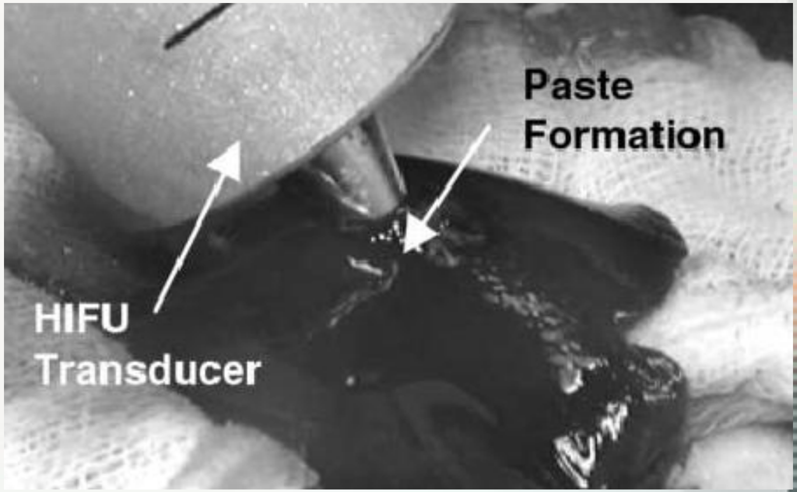


Introduction

Acoustic field characterization is important for the prediction of ultrasound bio-effects in different materials as tissues and for the development of regulatory standards for clinical HIFU devices [1].



Schematic drawing of HIFU treatment in oncology. Carcinogenic tumor is burned by focalized ultrasonic radiation.

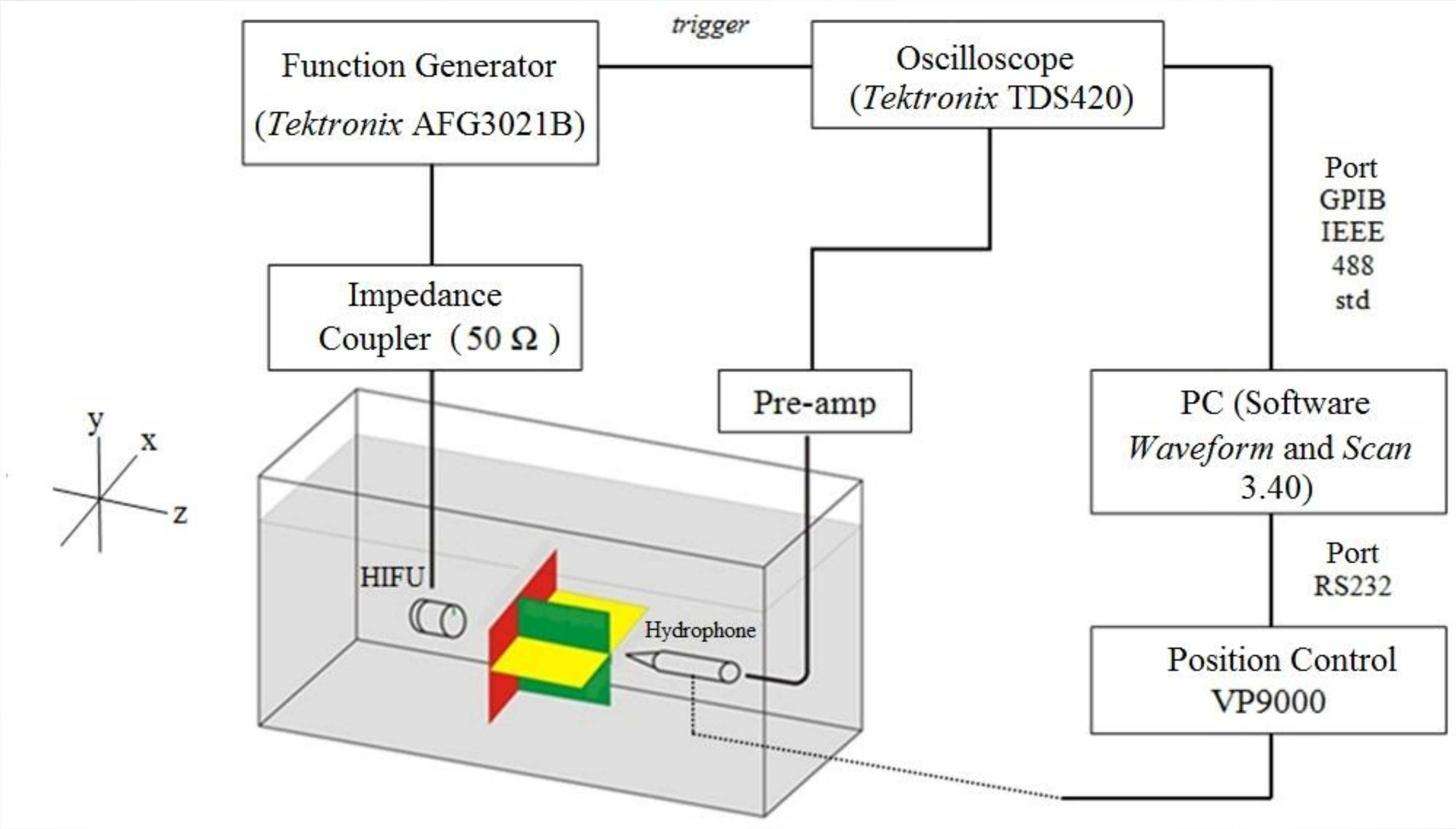


Acoustic hemostasis treatment with HIFU.

Goal

To get a quantitative comparison of HIFU acoustic fields experimentally obtained versus acoustic fields obtained by using COMSOL Multiphysics.

Characterization Methodology



	Step resolution		
	x [mm]	y [mm]	z [mm]
2-30-100/4 (A)	0.5010	0.5010	1
2-20-20/2 (B)	0.1016	0.1016	1

COMSOL simulations

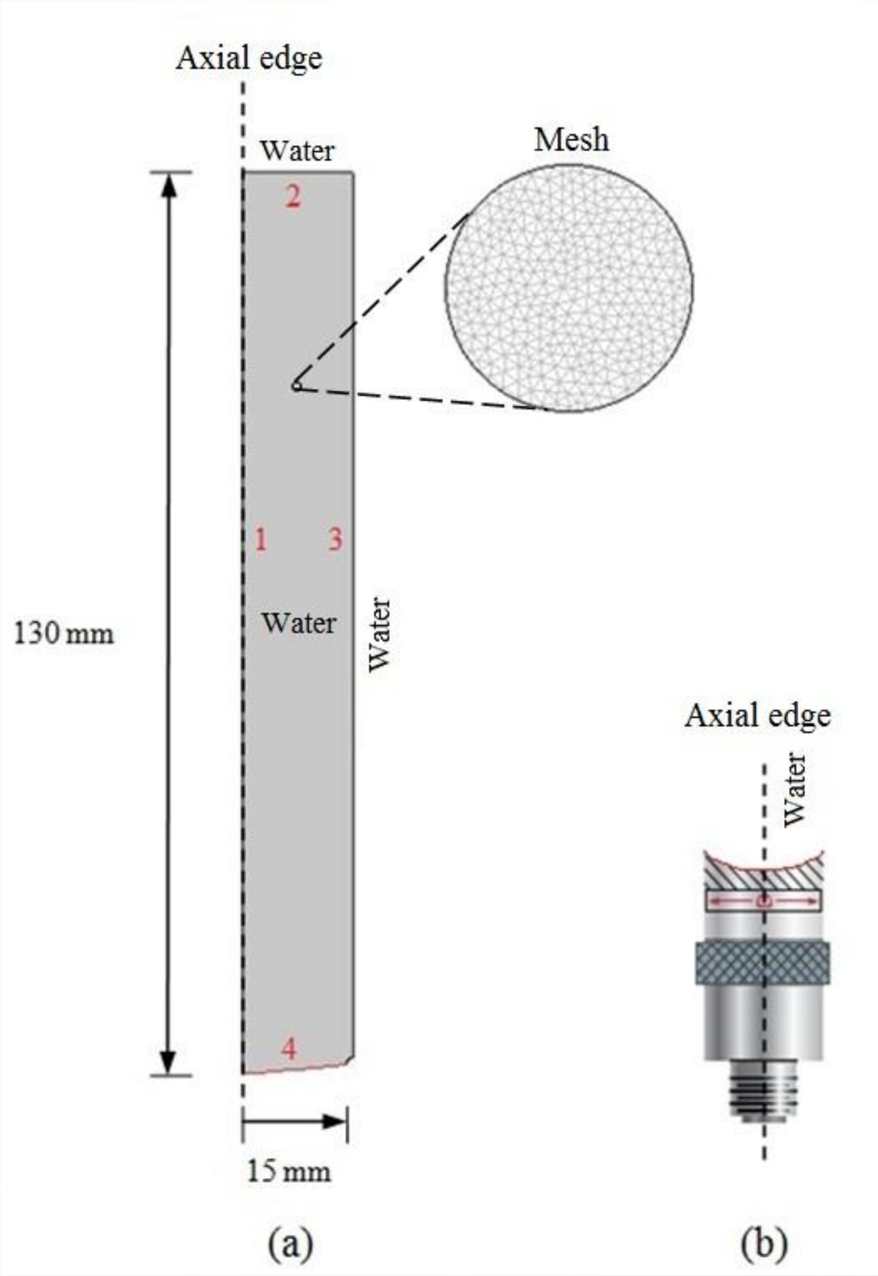
2D axisymmetric Model

Wave equation for harmonic axisymmetric problem

Frequency set as the same way as the experimental.

Boundary conditions were made in order to allow wave propagation.

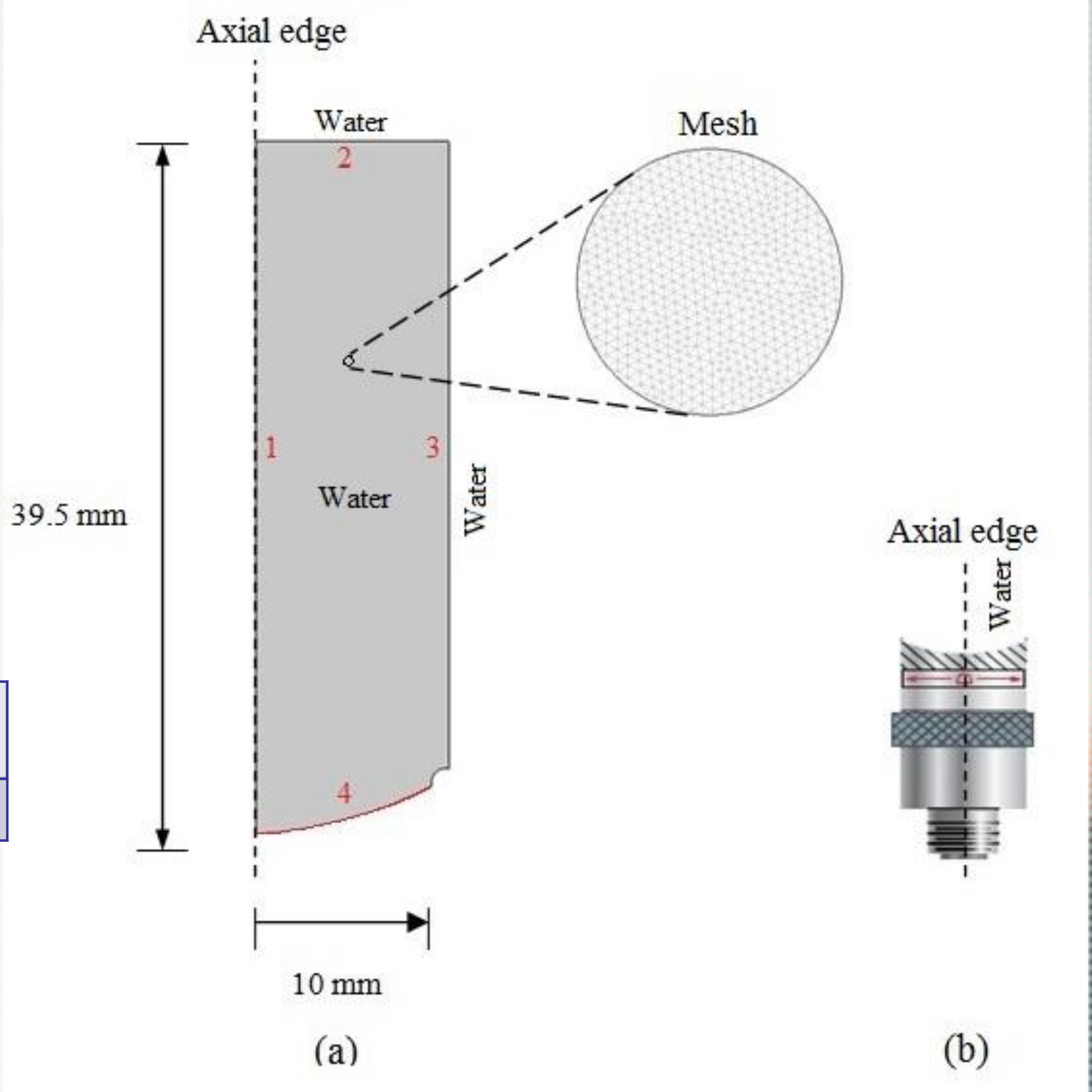
Mesh size = $\frac{1}{5}\lambda$



COMSOL simulations

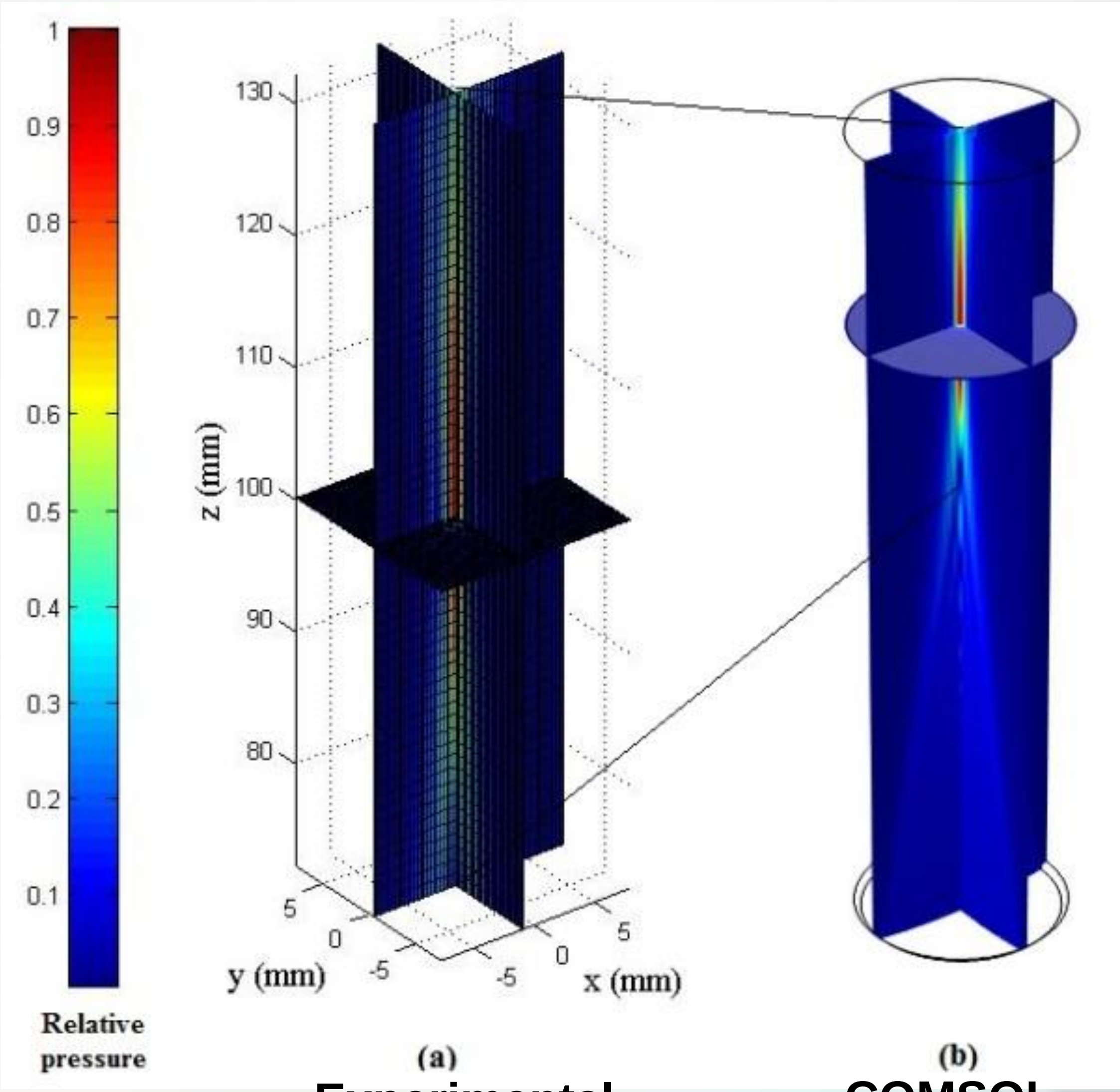
$$\nabla^2 p + \frac{2\pi}{\lambda} = 0 \qquad (1)$$

Material	Velocity, c_S (m s^{-1})	Density, ρ (kg m^{-3})
Water	1500	1000



Comparison methods

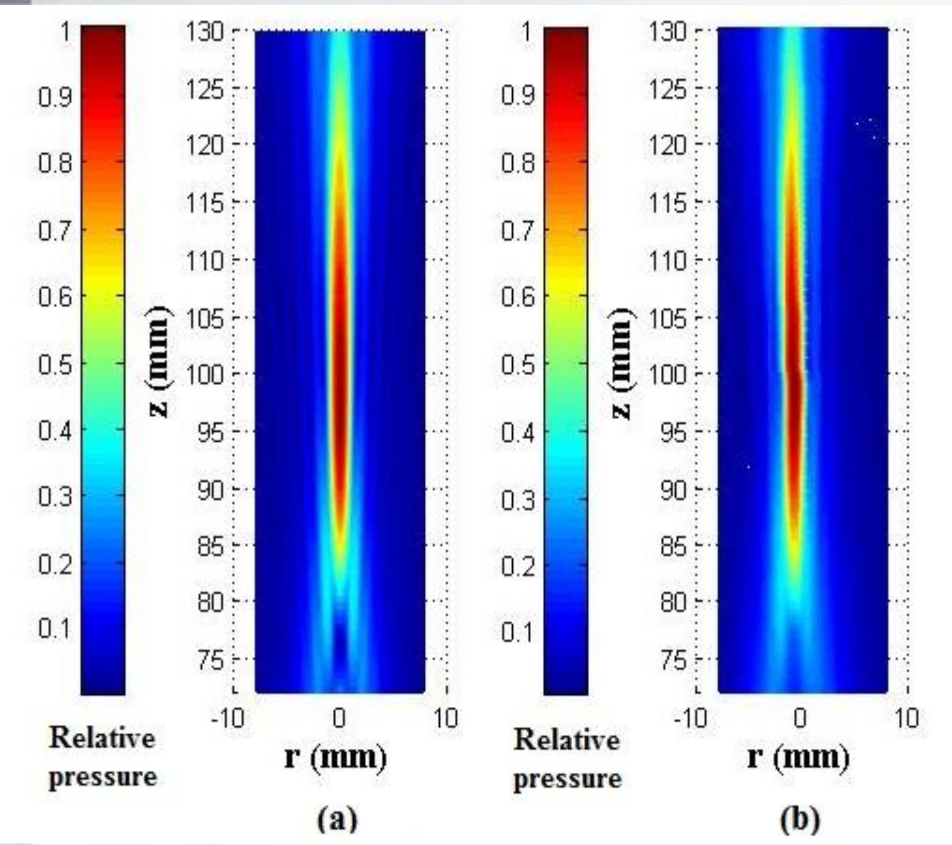
1. Form factor
2. Ellipsoidal shape ratio
3. Euclidean distance



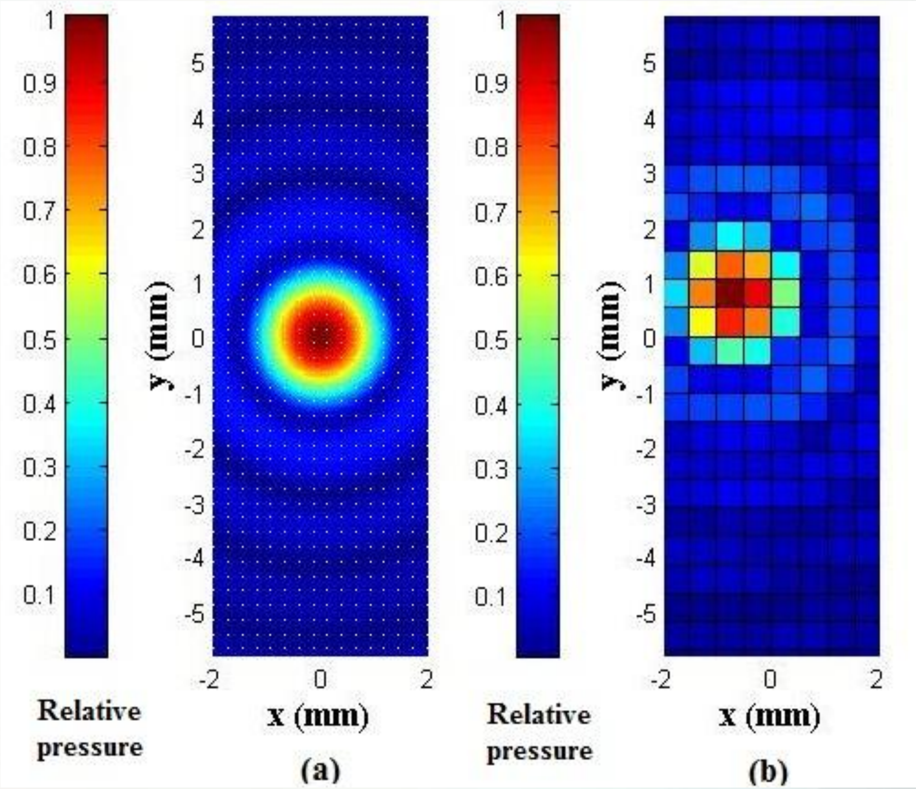
Experimental

COMSOL v. 4.3a

Results transducer A

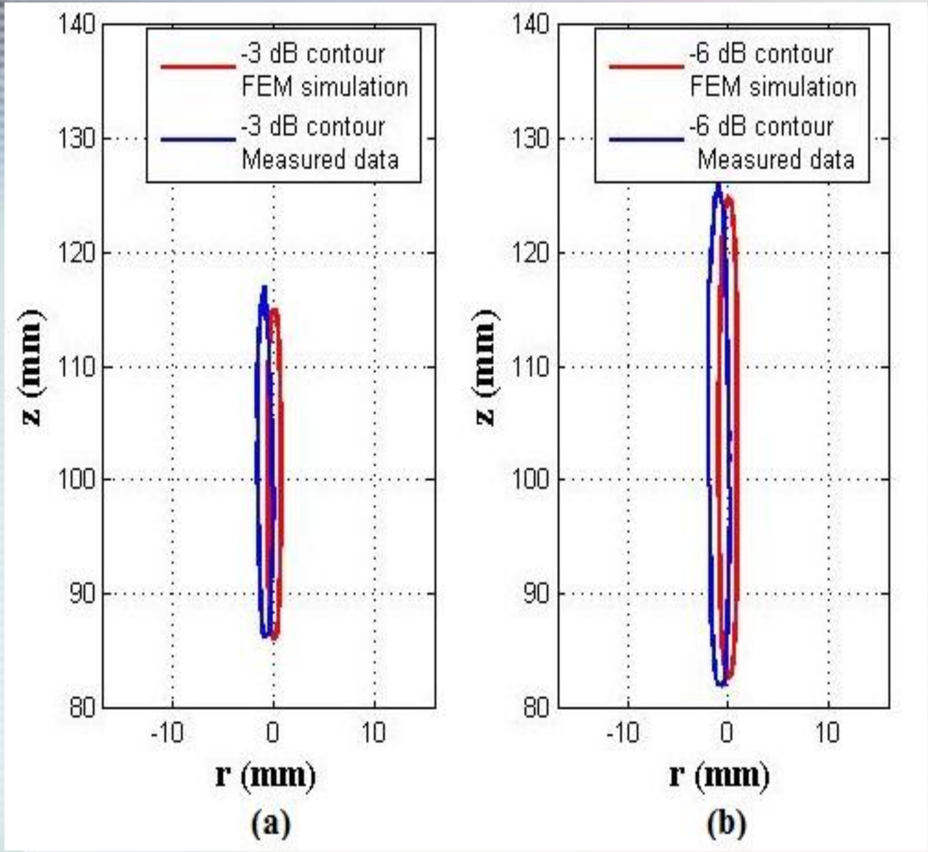


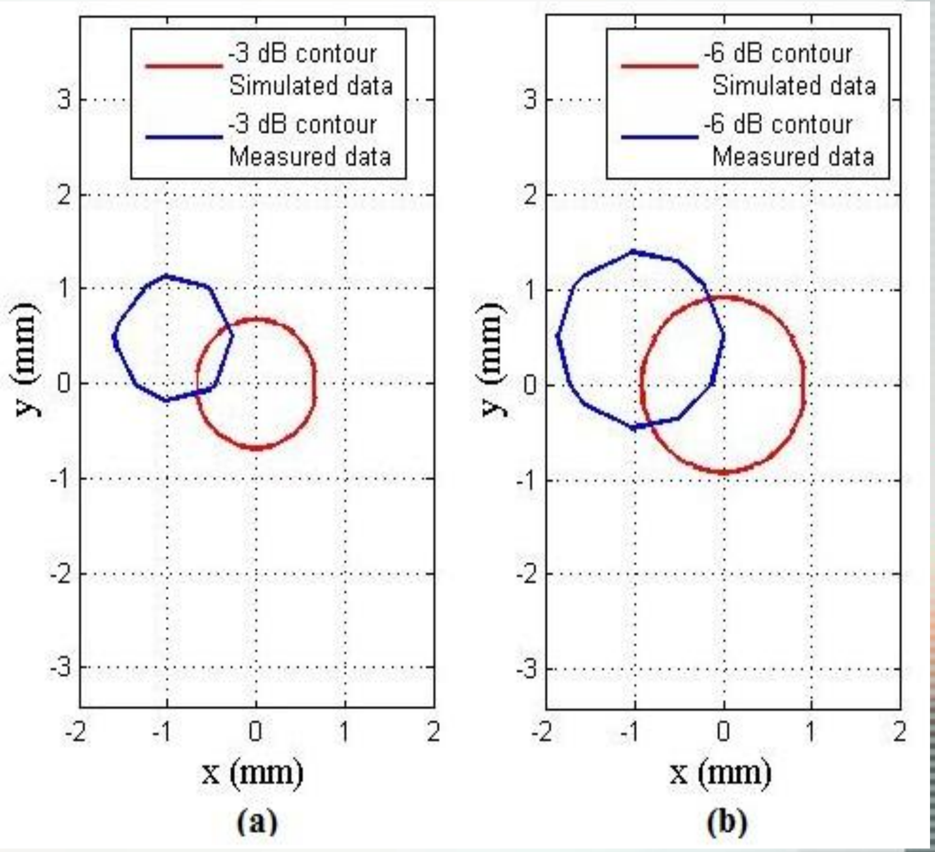
COMSOL **Experimental**



COMSOL **Experimental**

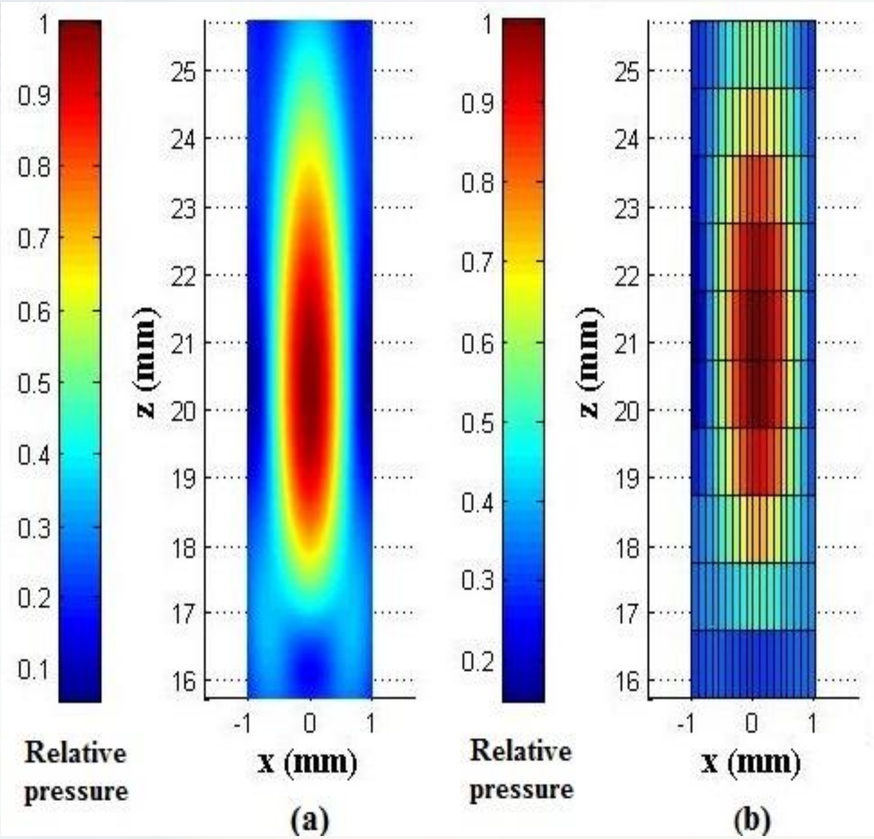
Results transducer A



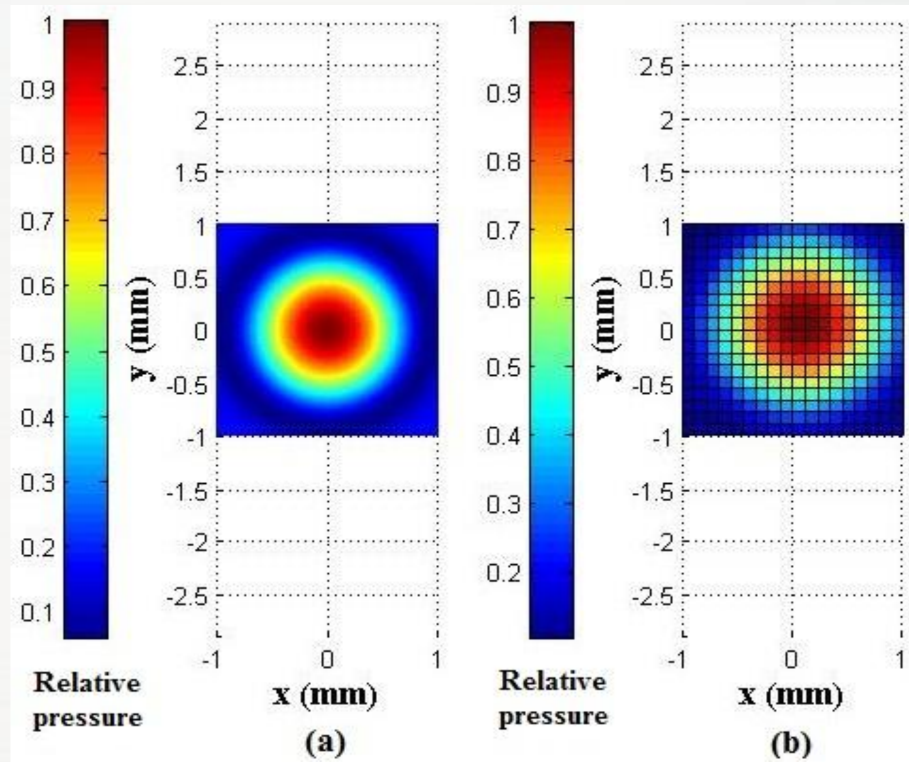


Fc = 92.5%
Er = 88.3%
Ed = 0.70 ± 0.34 mm

Results transducer B

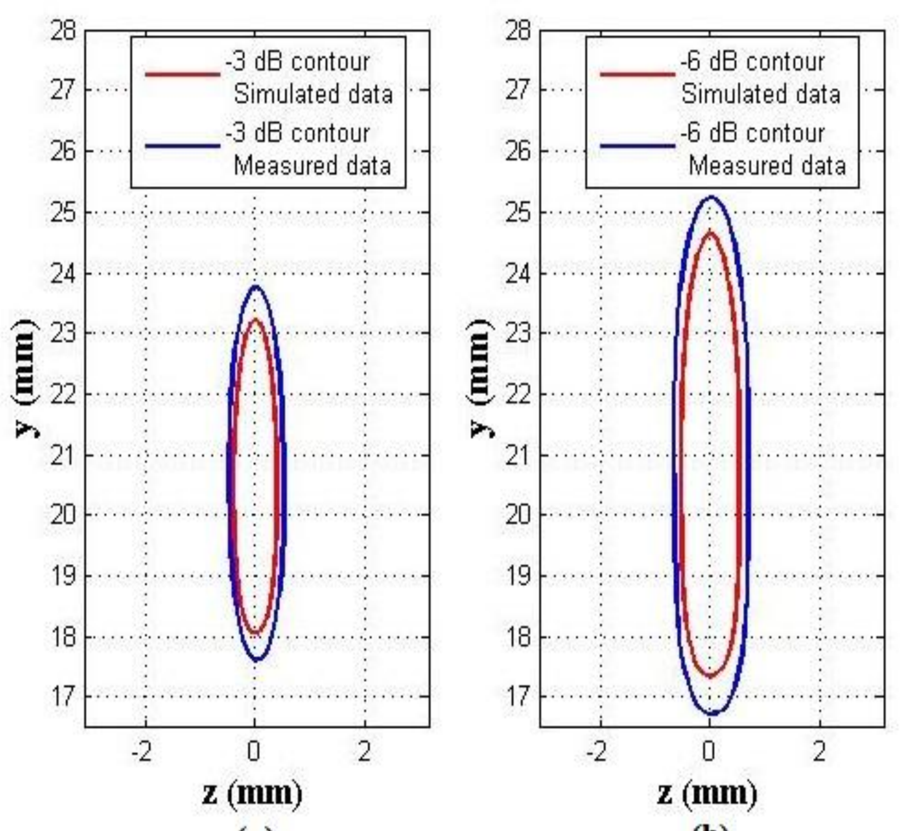


COMSOL Experimental

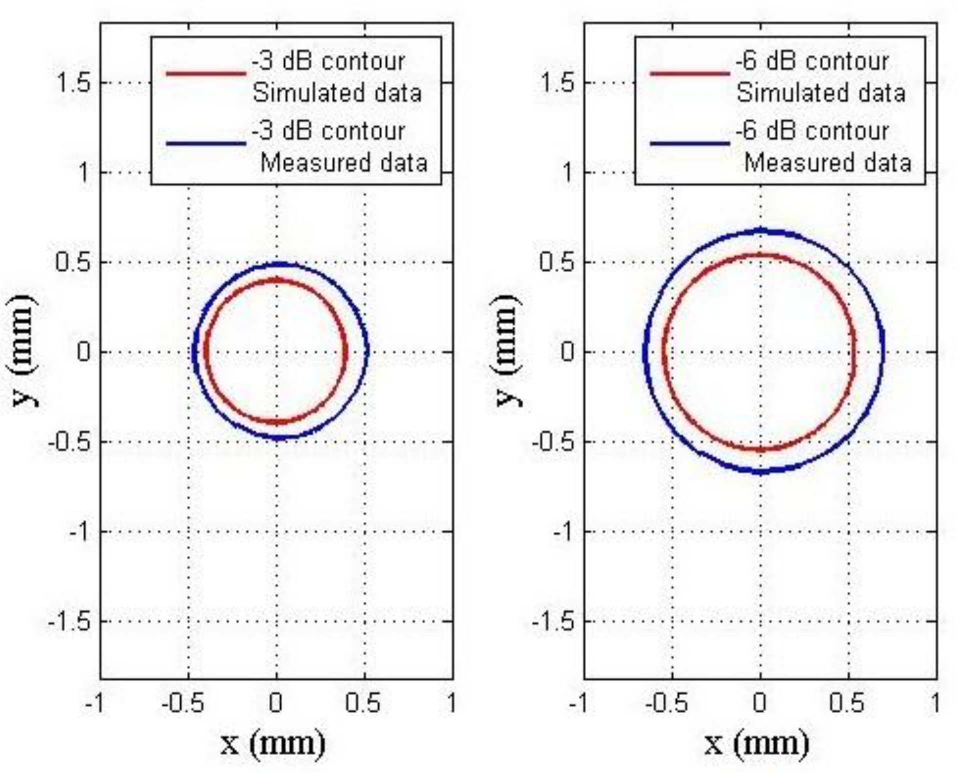


COMSOL Experimental

Results transducer A



(a) (b)



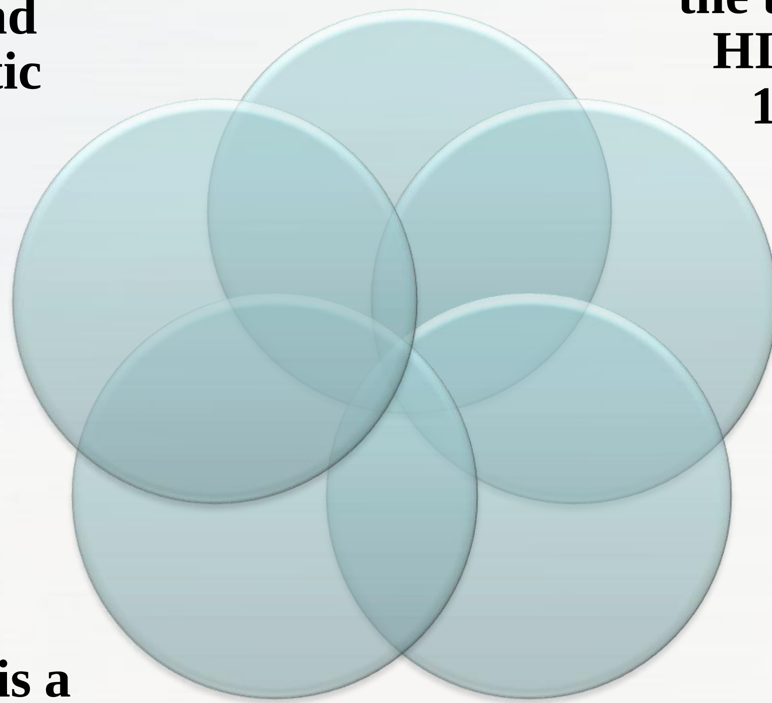
(a) (b)

Fc = 65.9%
Er = 93.4%
Ed = 0.18 ± 0.18 mm

Conclusion

A high level of similarity was obtained between characterized and simulated acoustic fields.

Percentages of similarity are above 80 % in the transducer HIFU 4-30-100/4.



Percentages of similarity are above 60% in transducer HIFU 2-20-20/2.

This paper shows a great approach to start new models that involve the same HIFU transducers in applications as cancerous tissue ablation.

FEM simulation is a helpful method to simulate ultrasound propagation waves and heating.

Thanks for your attention

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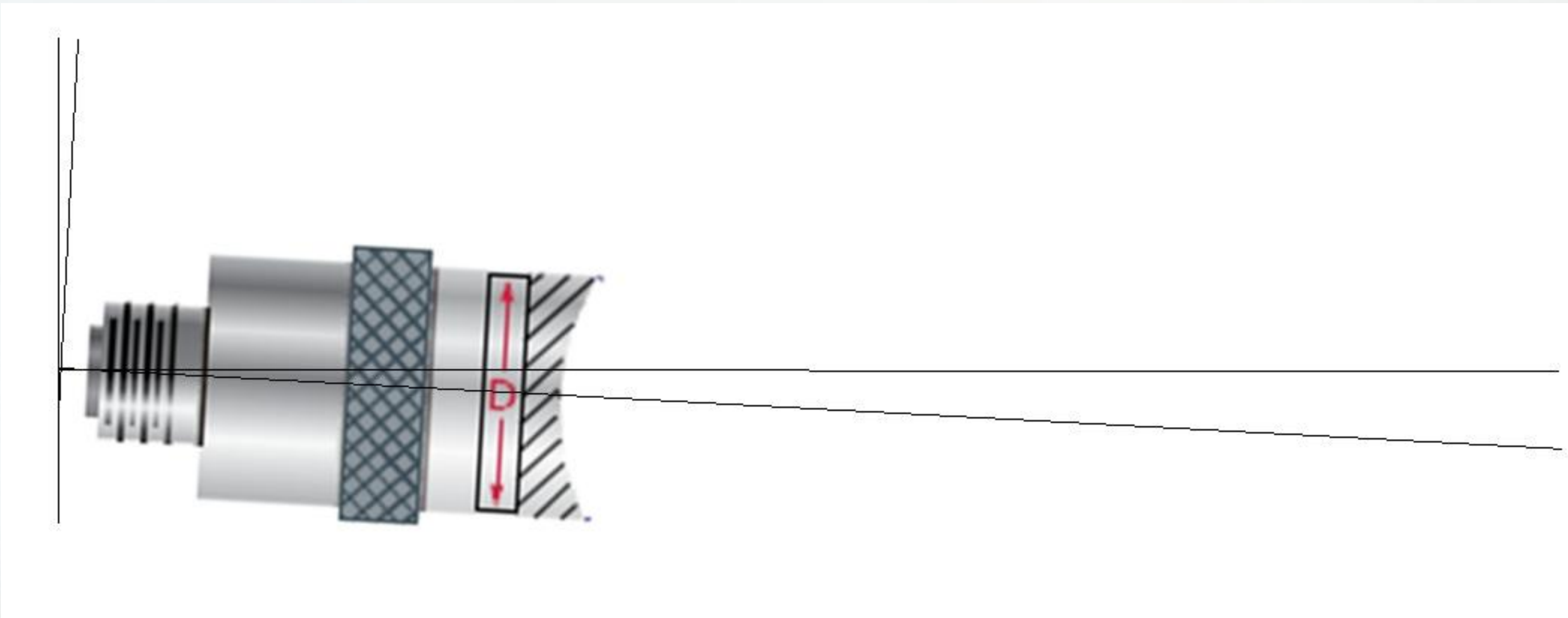
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