



COMSOL  
CONFERENCE  
2016 SHANGHAI

# 生物颗粒光声功率谱的有限元数值 模拟研究

COMSOL  
CONFERENCE  
2016 上海

参会者：李勇 晋中学院  
方晖 深圳大学

The 2016 COMSOL Conference, Shanghai

# Jinzhong University



Jinzhong University is a local university.

Jinzhong University Located in Shanxi Province of china.

# Welcome to our university



**Beautiful campus**

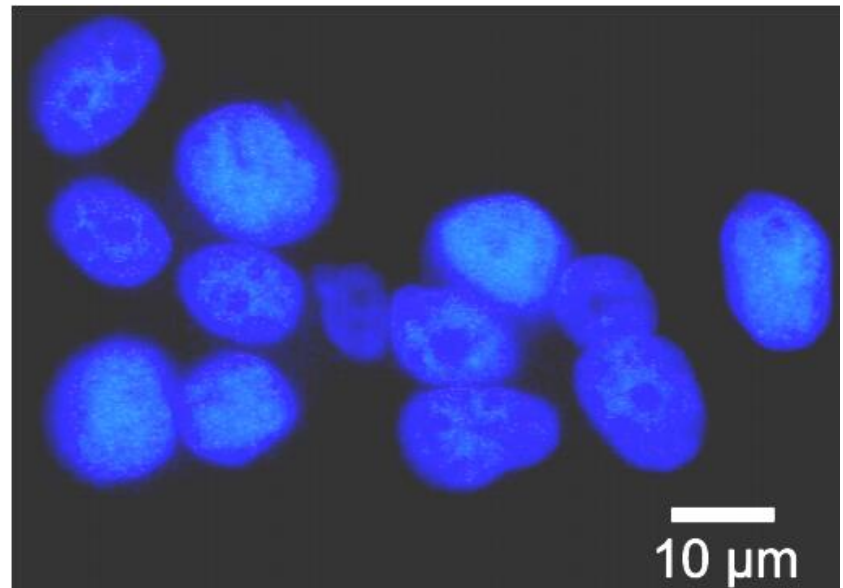
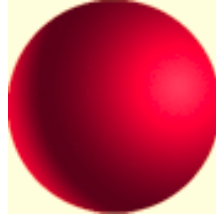
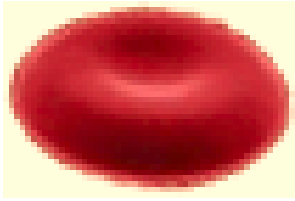
**Friendly and hospitable**

# Lecture outline

1. **Research Background**
2. **Current Research**
3. **Research Prospects**

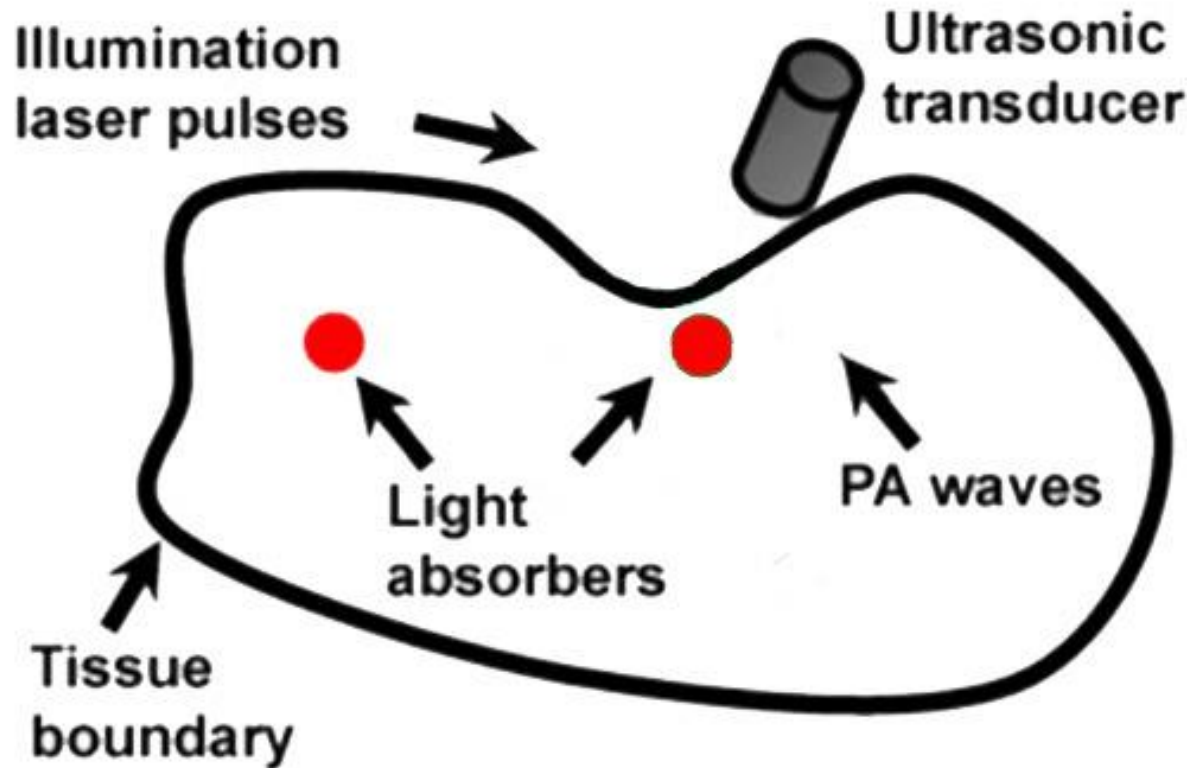
# Research Background

→ 研究目的和意义



# Research Background

→ Photoacoustic effect



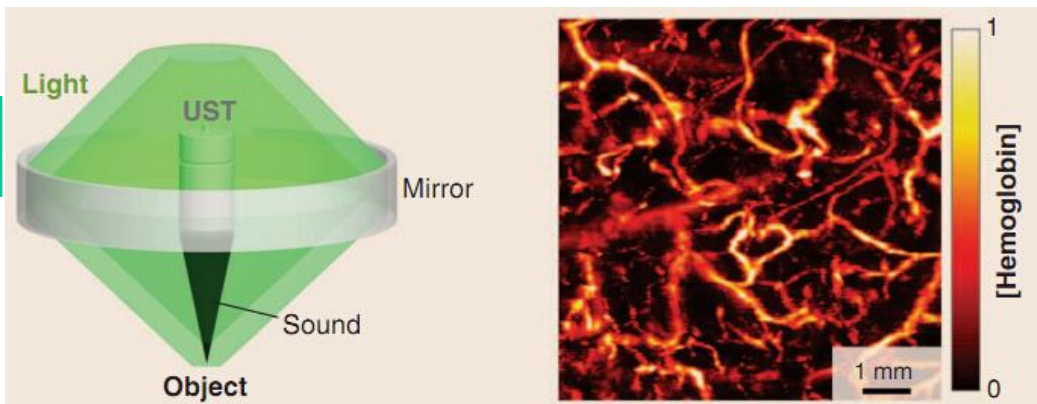
光声效应原理图

Yao J, Wang L V. Photoacoustic tomography: fundamentals, advances and prospects[J]. Contrast media & molecular imaging, 2011, 6(5): 332-345.

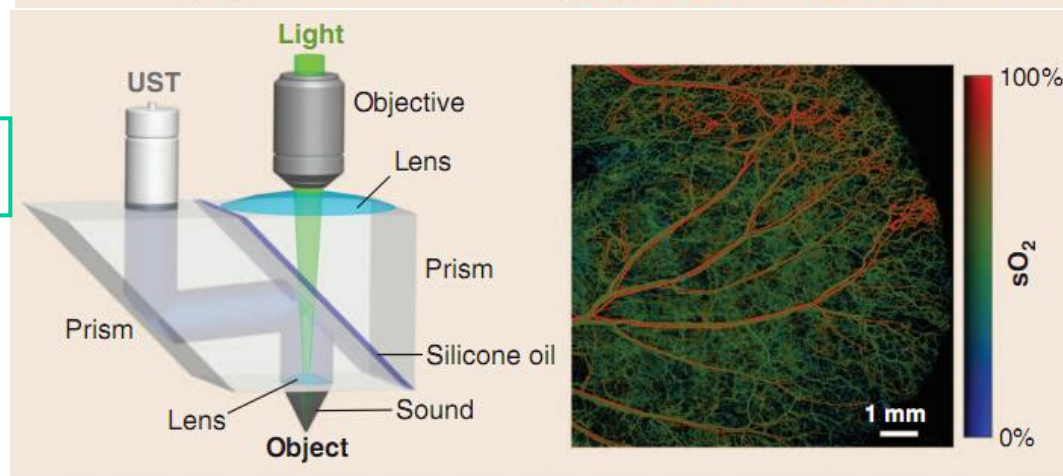
# Research Background

→ 光声显微技术 (PAM)

AR-PAM



OR-PAM

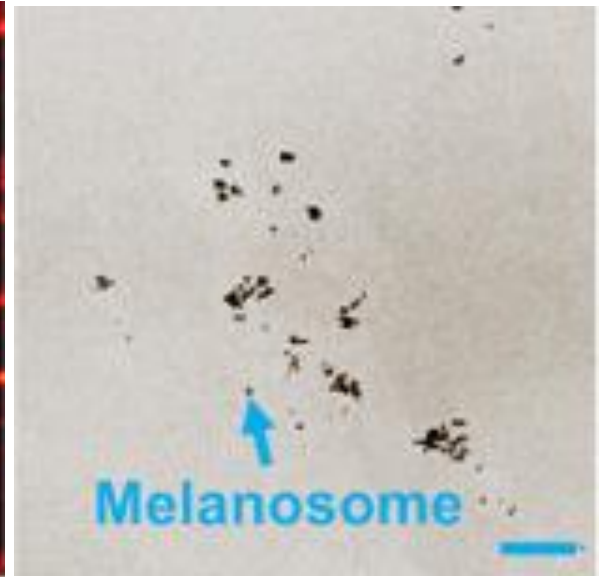
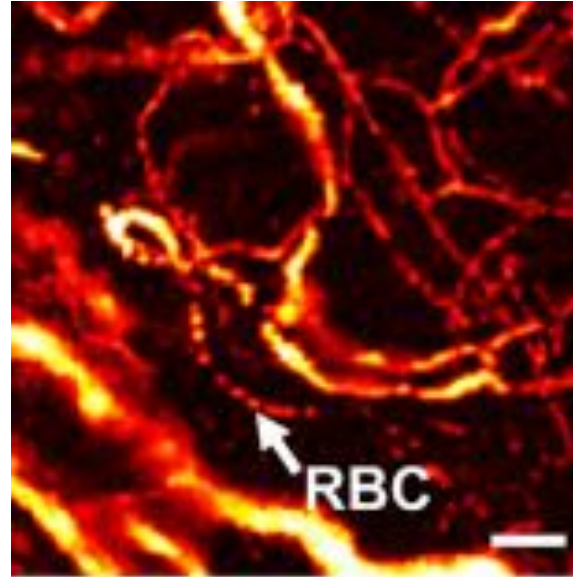
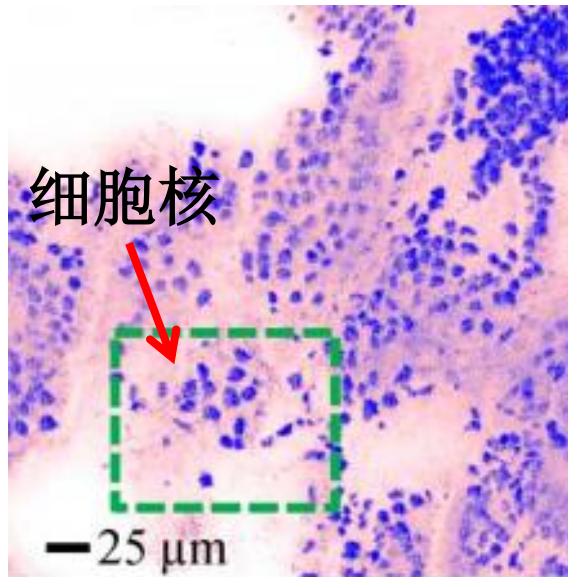


**Photoacoustic Tomography: In Vivo Imaging from Organelles to Organs**

Lihong V. Wang and Song Hu  
*Science* **335**, 1458 (2012);  
DOI: 10.1126/science.1216210

# Research Background

→ 光声显微技术 (PAM)



Biophysical Journal Volume 105 August 2013 841–847

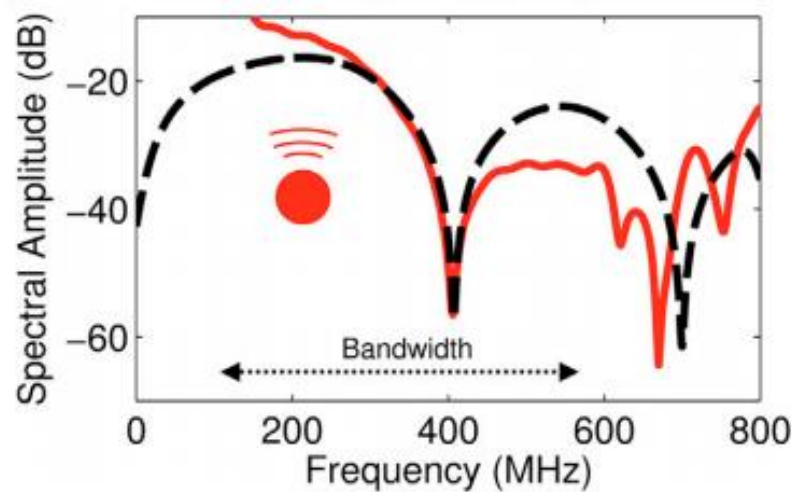
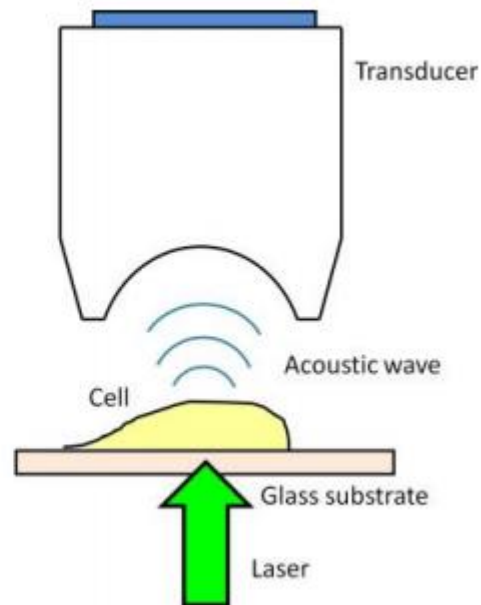
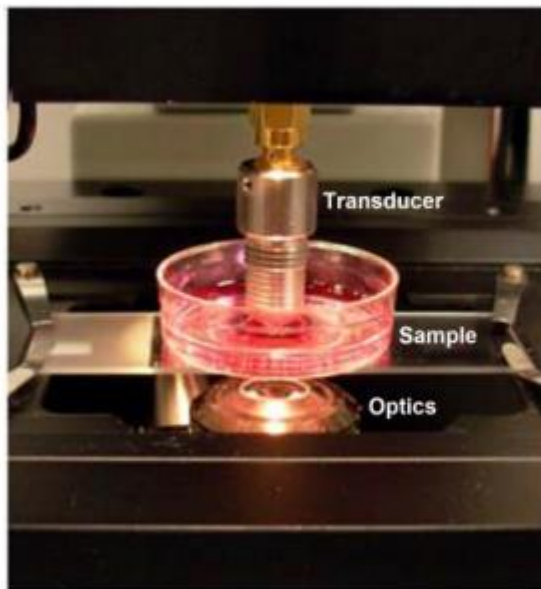
84

**Optical-Resolution Photoacoustic Microscopy: Auscultation of Biological Systems at the Cellular Level**



# Research Background

→ 光声显微技术 (PAM)



— Measurement

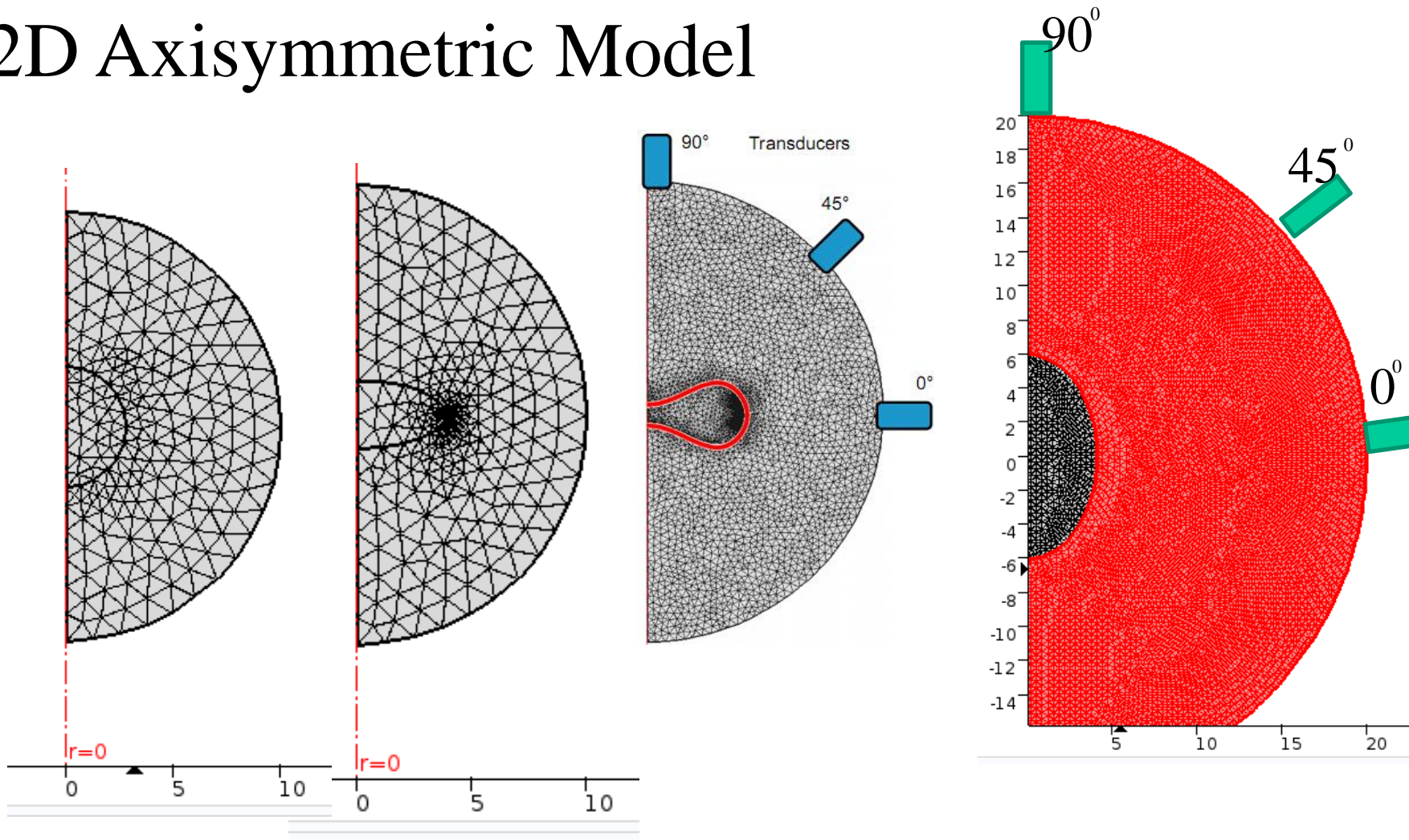
- - Theory

# Lecture outline

1. **Research Background**
2. **Current Research**
3. **Research Prospects**

# Our group's main research

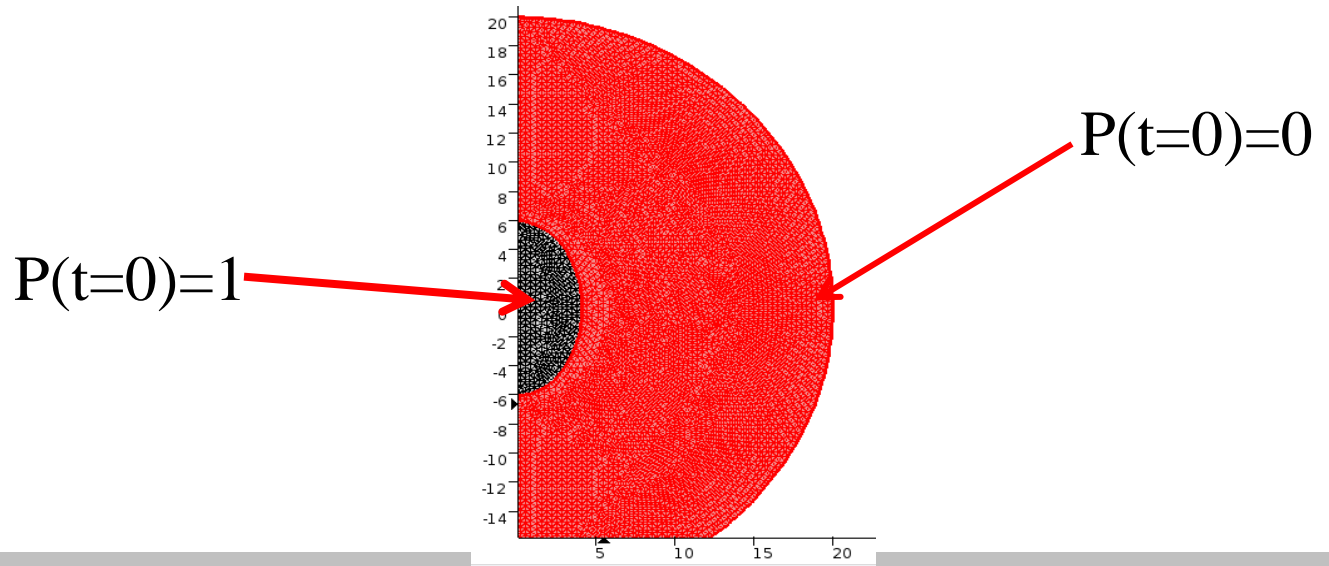
## 2D Axisymmetric Model



# Our group's main research

## Modeling Interfaces

The transient acoustics module is used. The model assumes the biological particles absorbed the laser energy uniformly and instantaneously and was within thermal and stress confinement conditions. The pressure in the biological particle was set to unity and the surrounding coupling fluid pressure was set to zero.



# Modeling Parameters

The parameters used in the model:

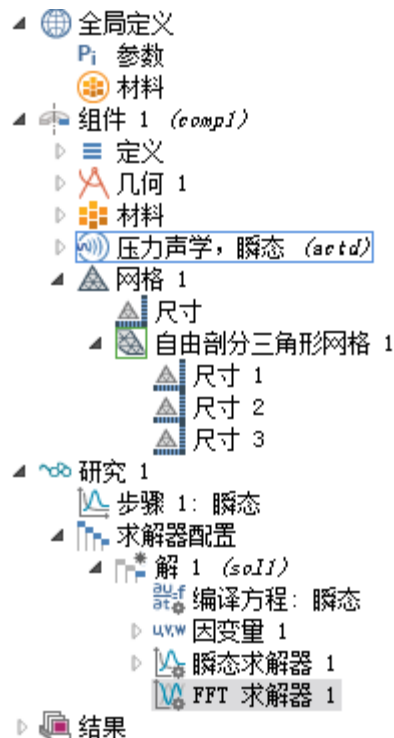
	红细胞（扁椭球）	MCF7细胞核（长椭球）
长轴	7.82 $\mu\text{m}$	12.06 $\mu\text{m}$
短轴	2.94 $\mu\text{m}$	8.44 $\mu\text{m}$
等体积球形直径	5.64 $\mu\text{m}$	9.52 $\mu\text{m}$
内部密度	$\rho_s = 1110 \text{ kg/m}^3$	$\rho_s = 1430 \text{ kg/m}^3$
周围液体的密度	$\rho_f = 1000 \text{ kg/m}^3$	$\rho_f = 1000 \text{ kg/m}^3$
内部声速	$\nu_s = 1650 \text{ m/s}$	$\nu_s = 1607 \text{ m/s}$
周围液体声速	$\nu_f = 1520 \text{ m/s}$	$\nu_f = 1527 \text{ m/s}$
颗粒中心到最外层半径	10 $\mu\text{m}$	20 $\mu\text{m}$

# Our group's main research

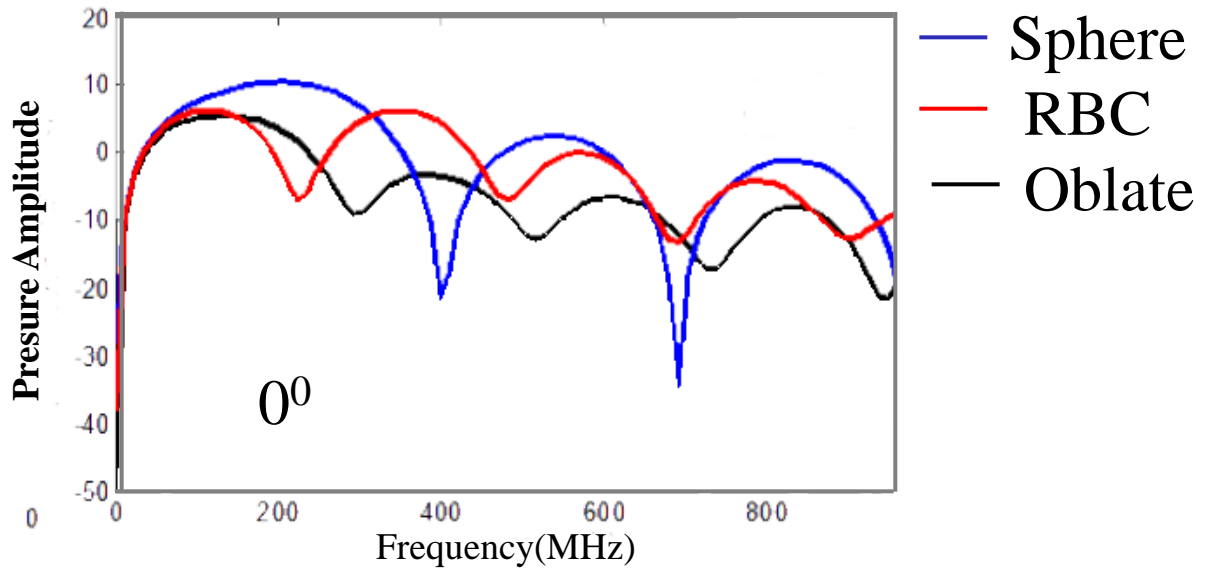
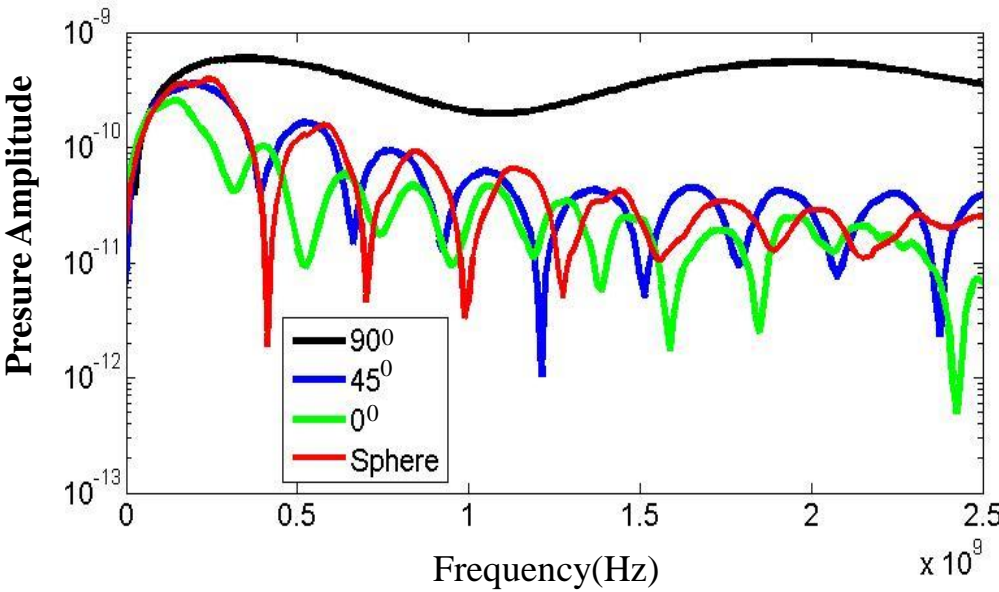
## Boundary Conditions and Mesh

1. 球面辐射边界。

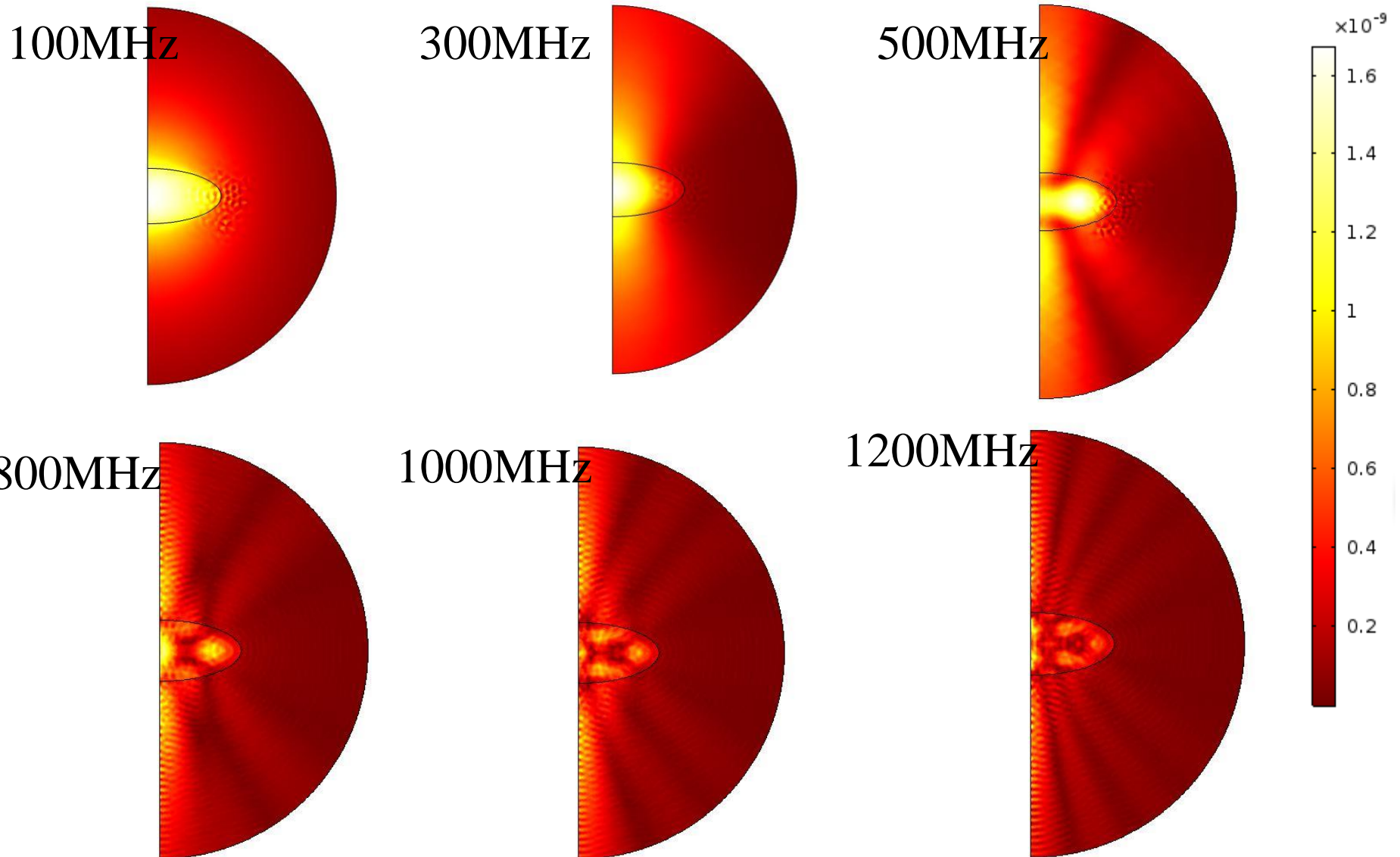
2. A mixed mapped and triangular Mesh is used to mesh the domain。



# Red blood cell

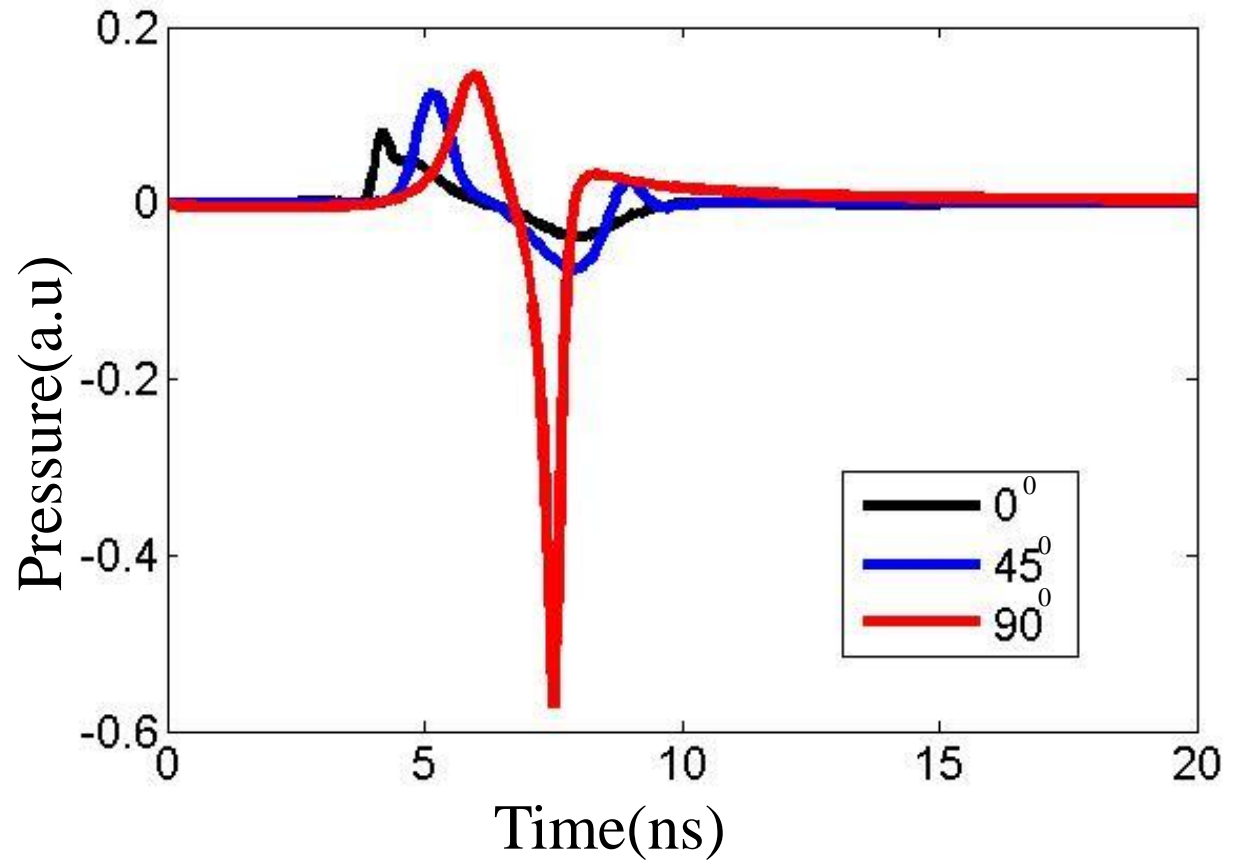
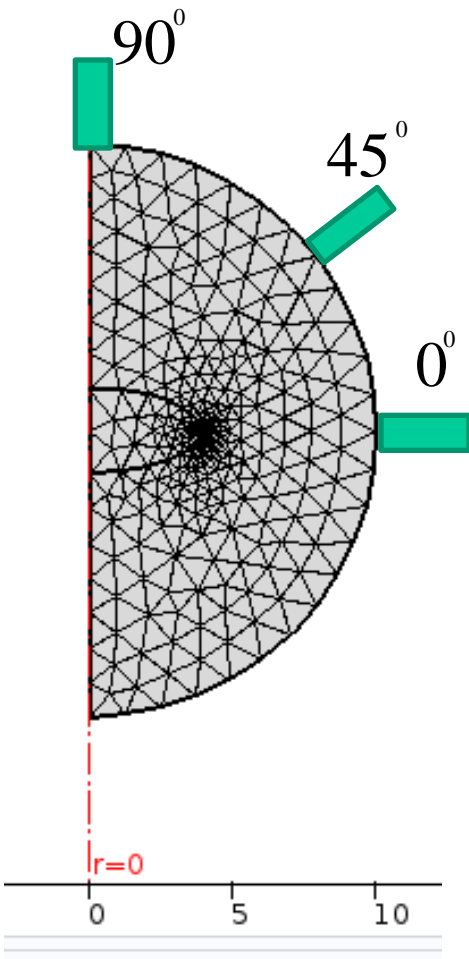


# Red blood cell

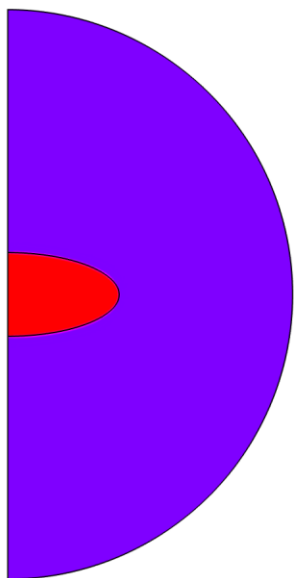




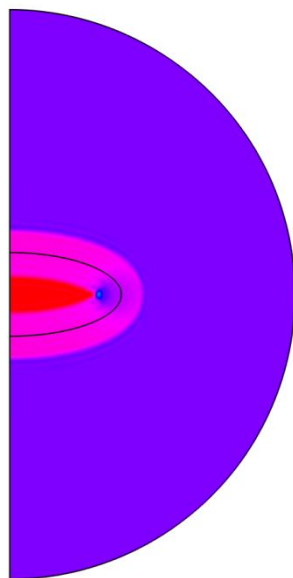
# Red blood cell



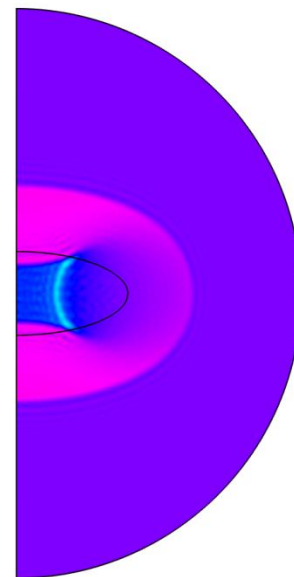
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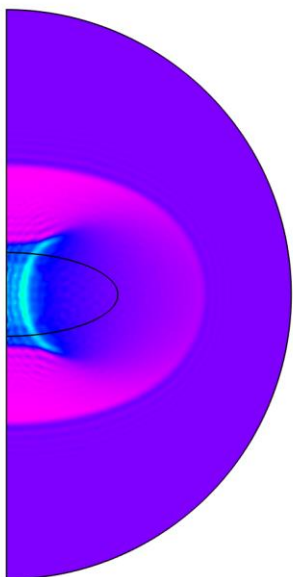
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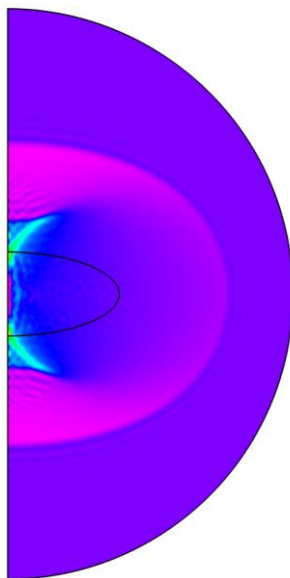
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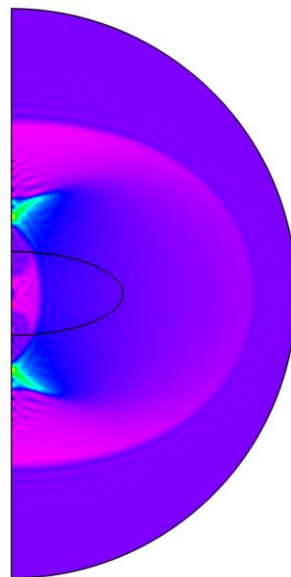
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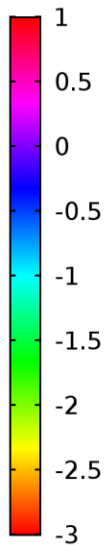
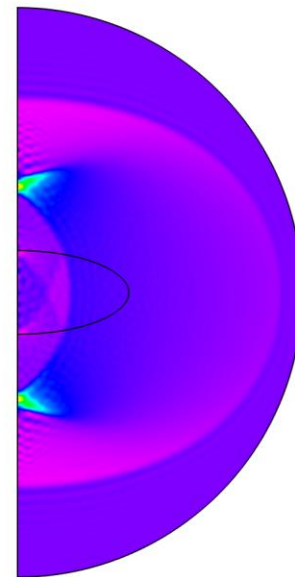
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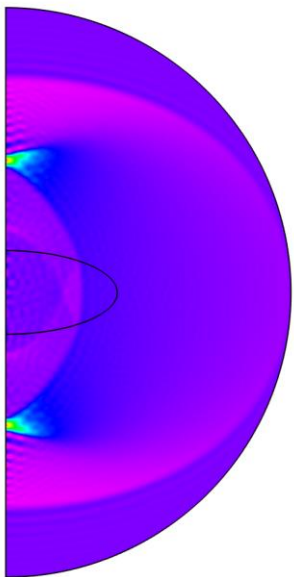
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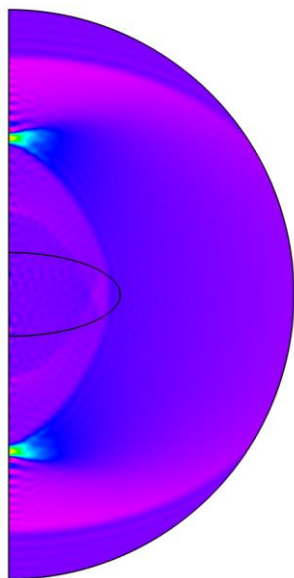
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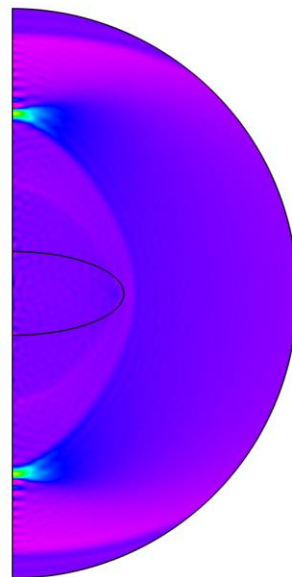
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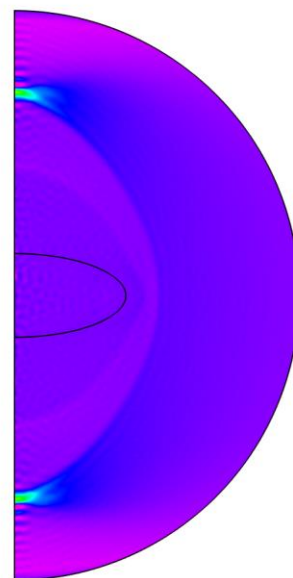
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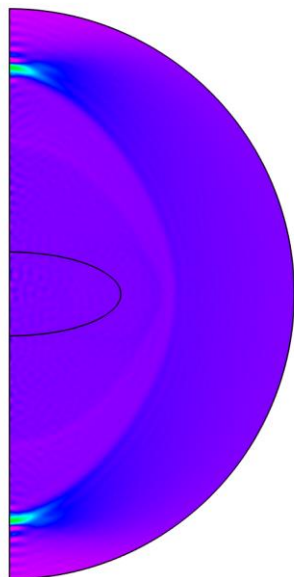
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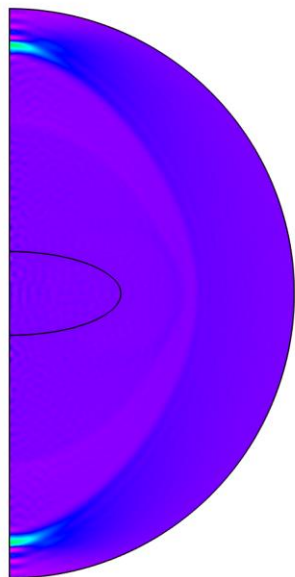
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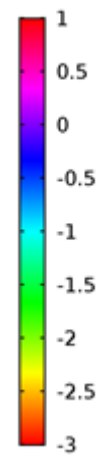
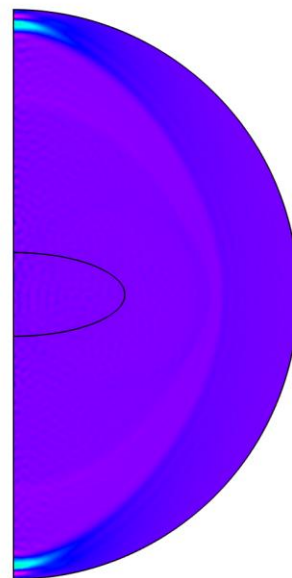
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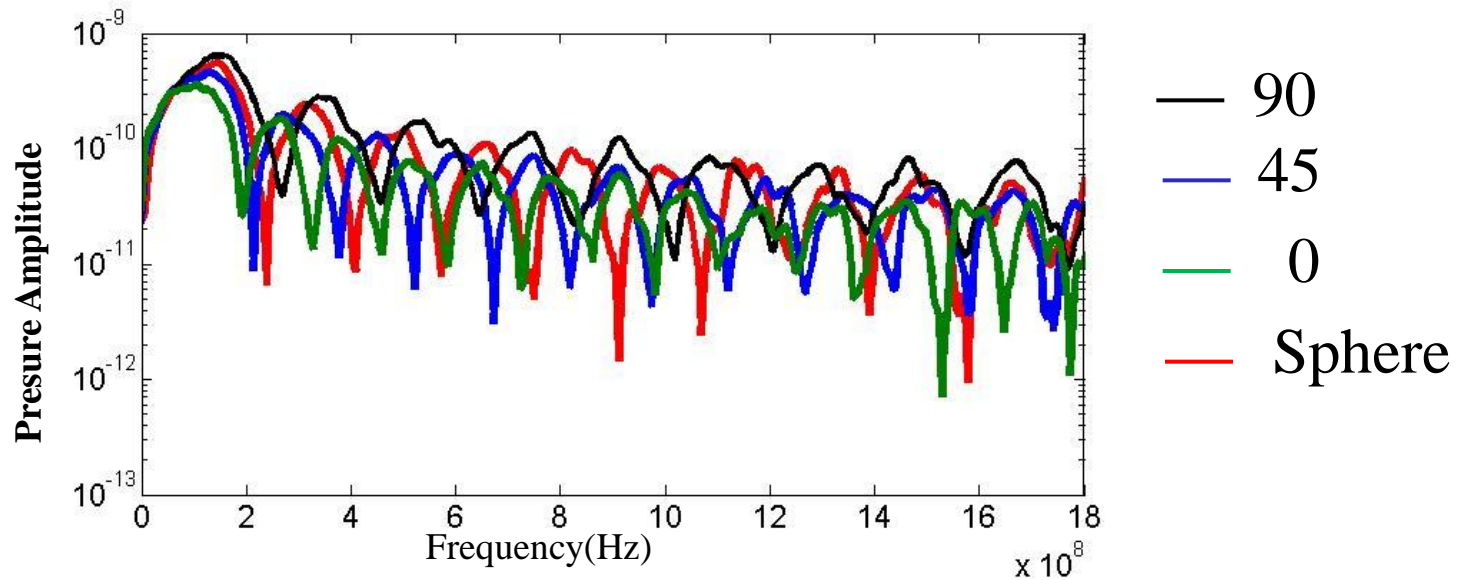
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时间=7ns 表面: 总声压场 (Pa)

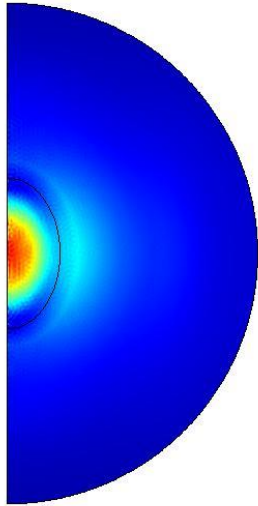


# MFC7 cell nuclei

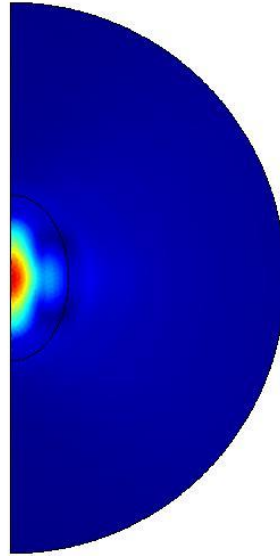


# MFC7 cell nuclei

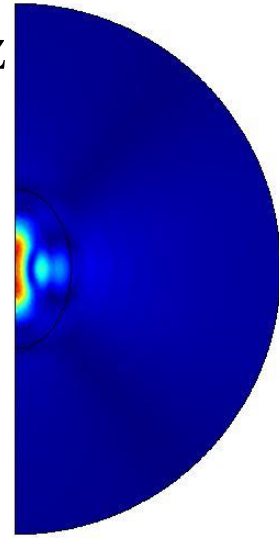
100MHz



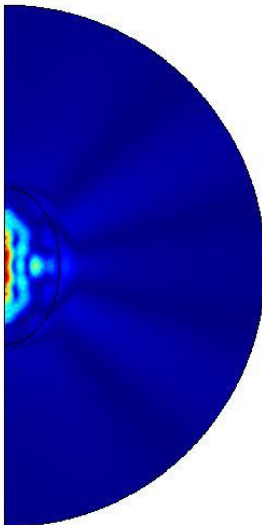
300MHz



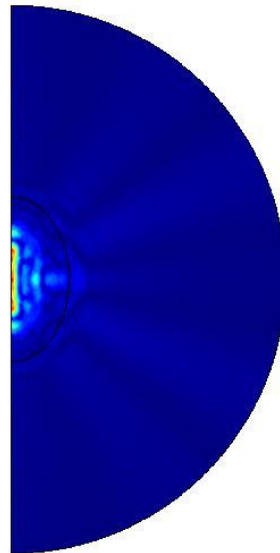
500MHz



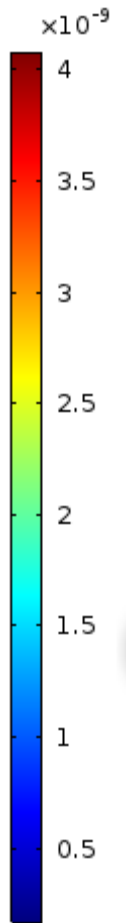
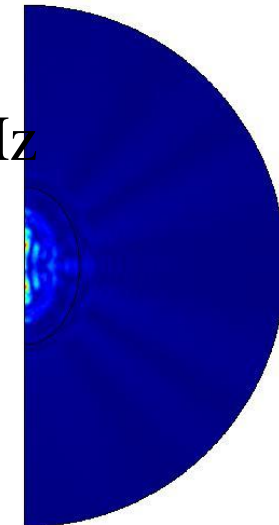
800MHz



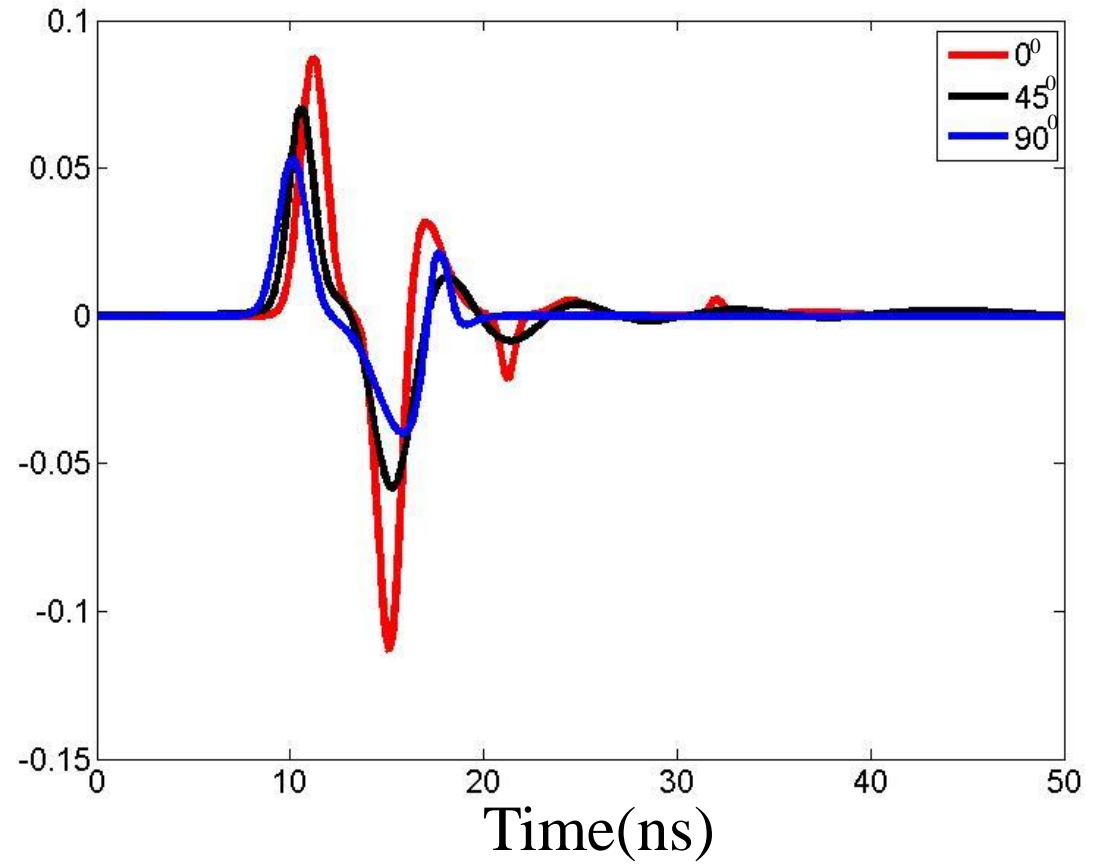
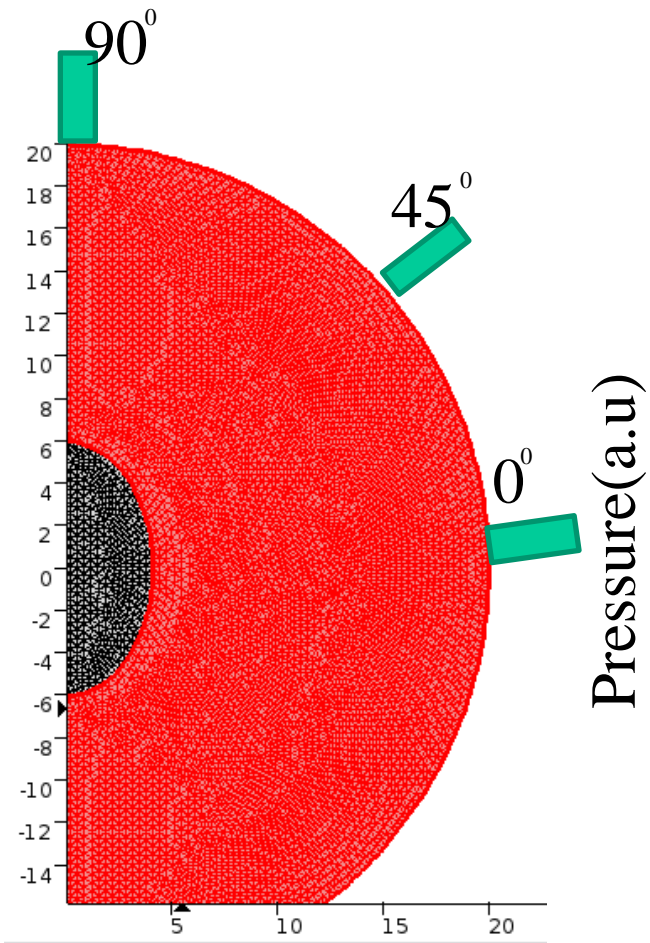
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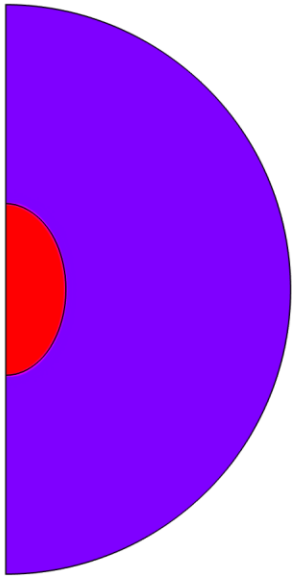
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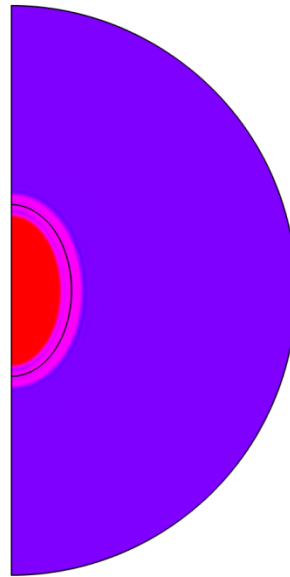
# MFC7 cell nuclei



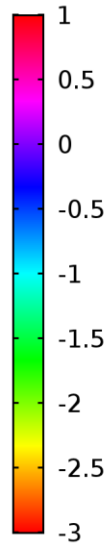
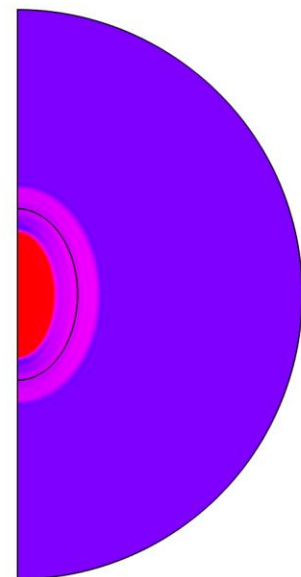
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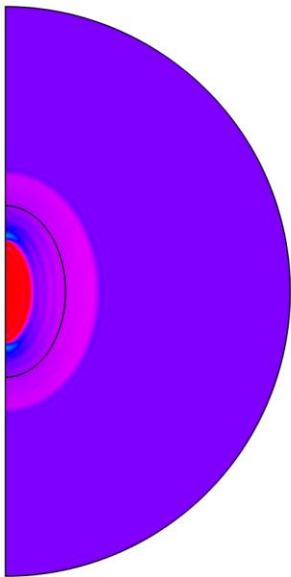
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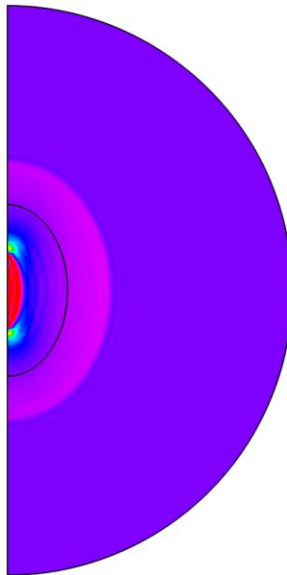
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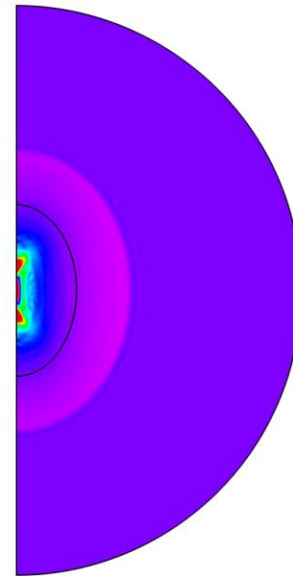
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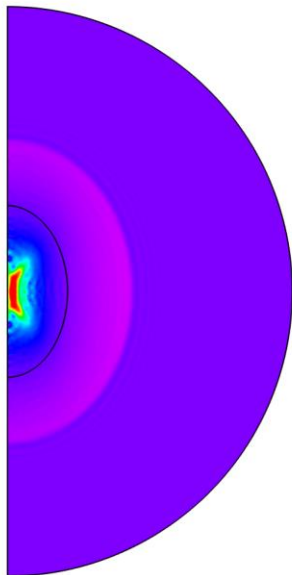
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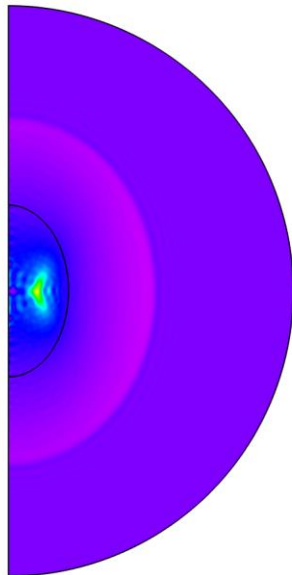
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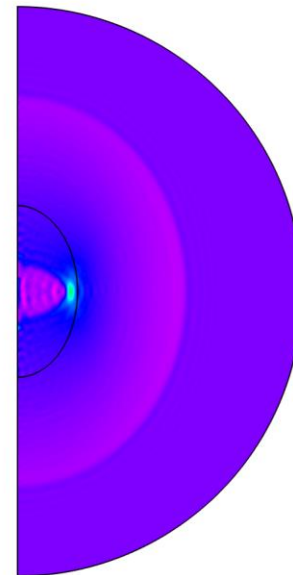
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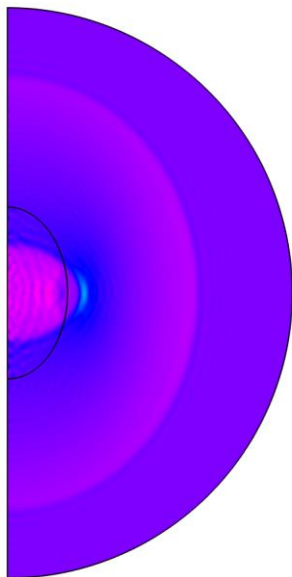
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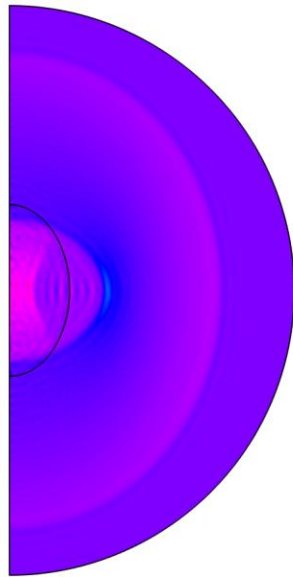
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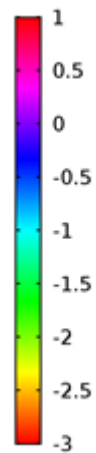
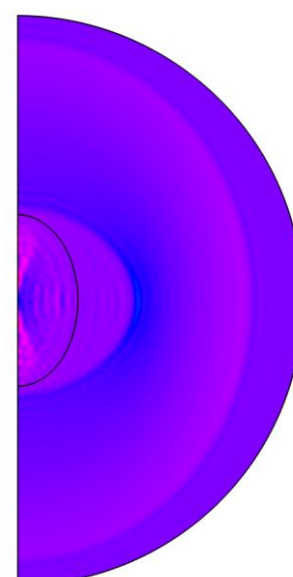
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时间=7 ns 表面: 总声压场 (Pa)



时间=8 ns 表面: 总声压场 (Pa)





# Lecture outline

1. **Research Background**
2. **Current Research**
3. **Research Prospects**

1. 3D Model。

2. 多物理场耦合：The electromagnetic wave equation、transient heat transfer 、 an acoustic pressure

*Thank You !*