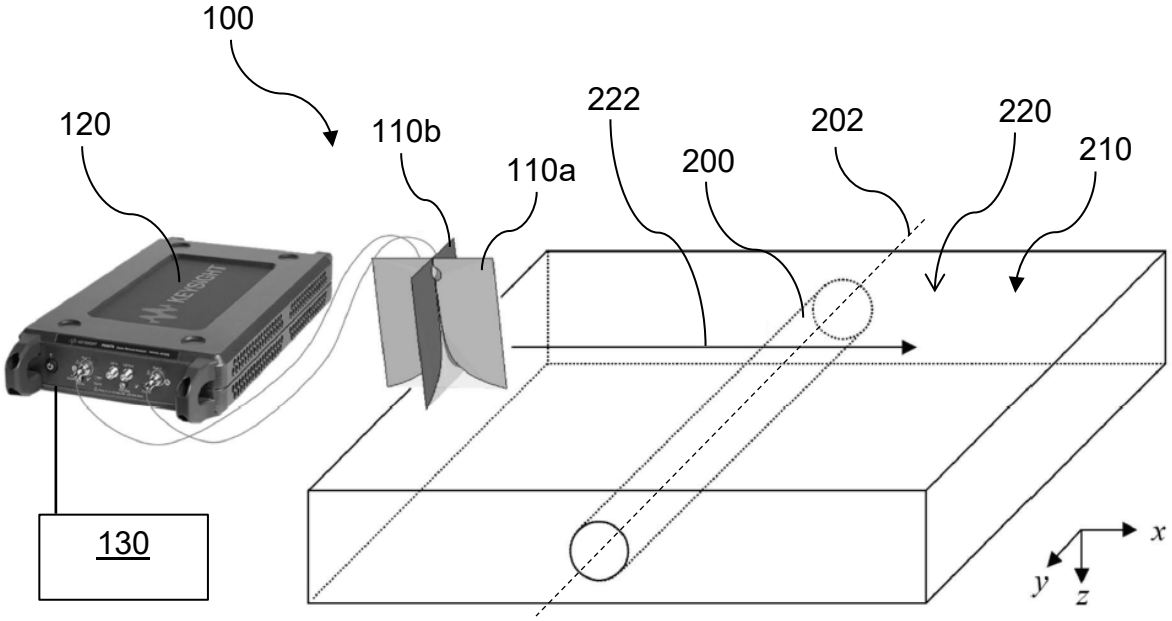


Figure 1A

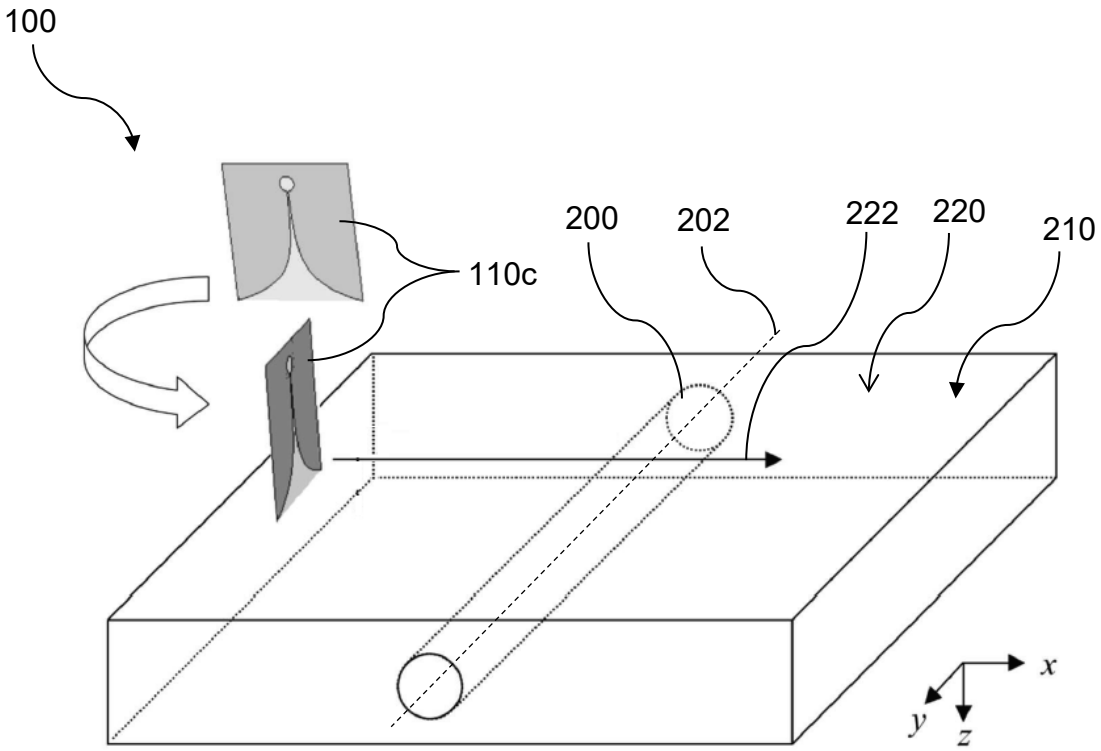


Figure 1B

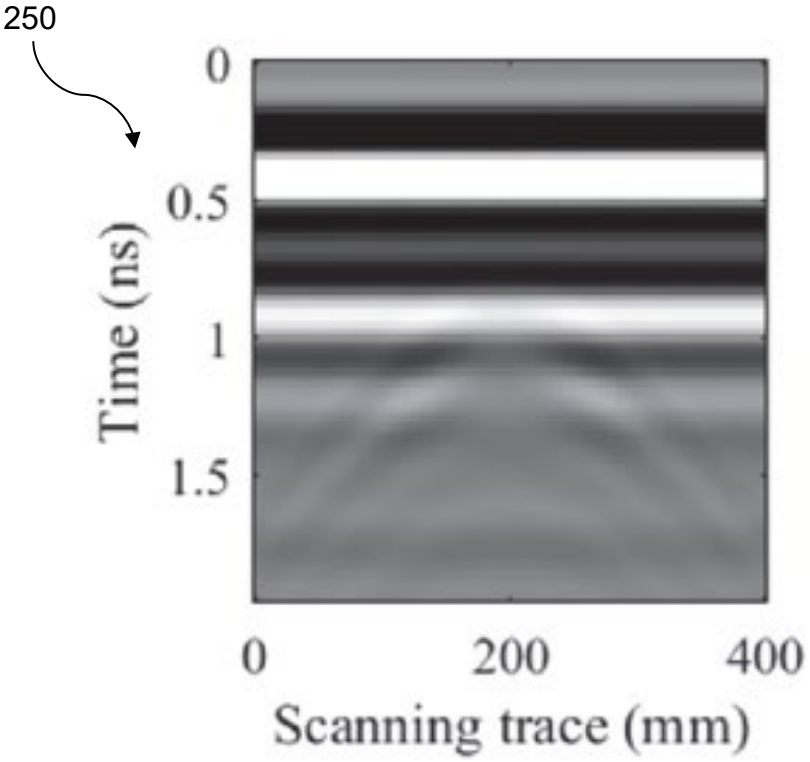


Figure 2A

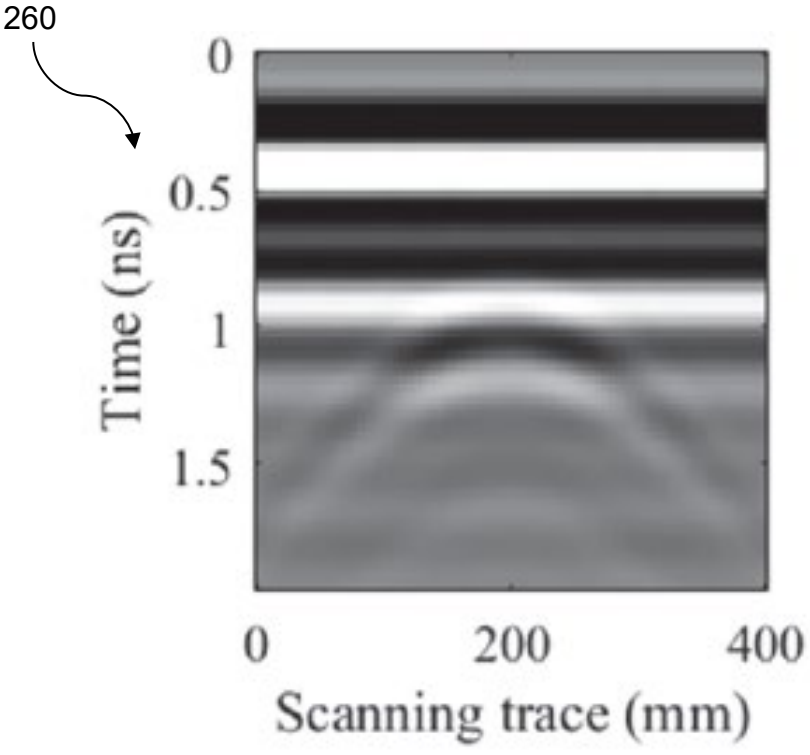


Figure 2B

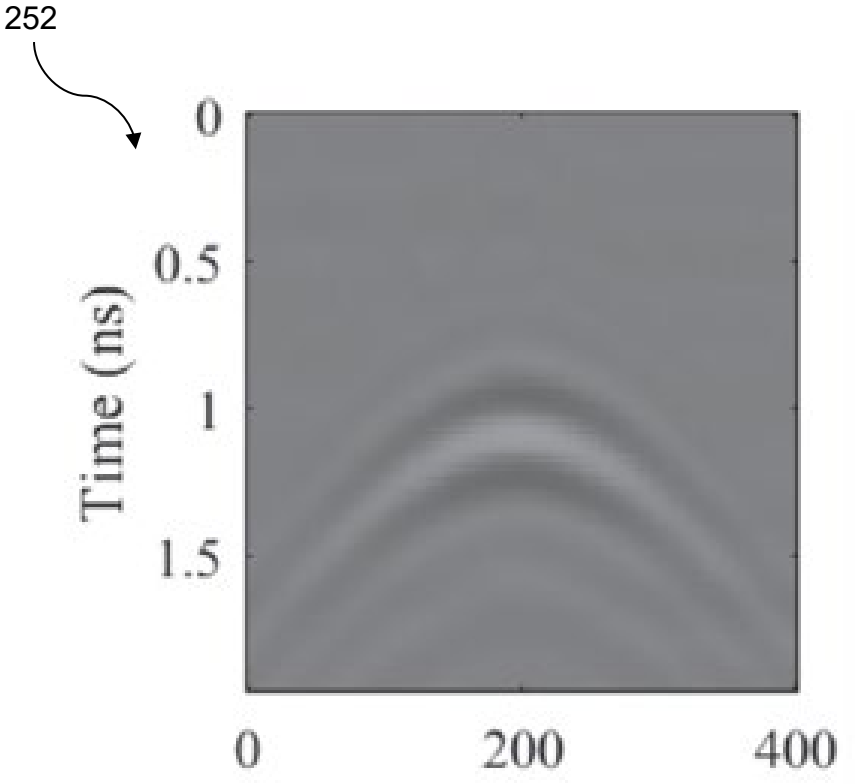


Figure 3A

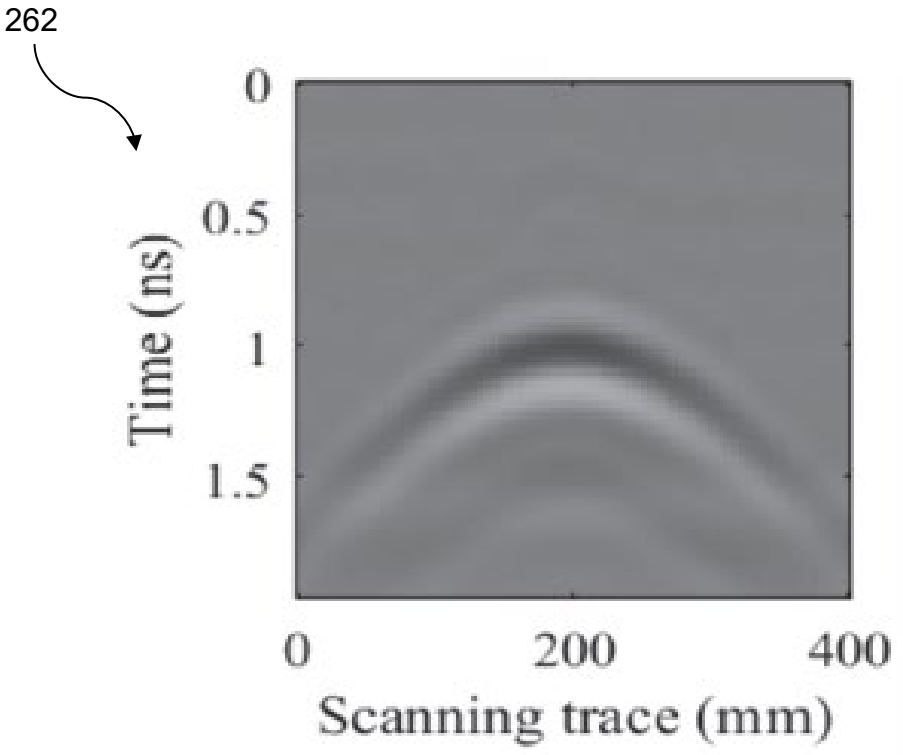


Figure 3B

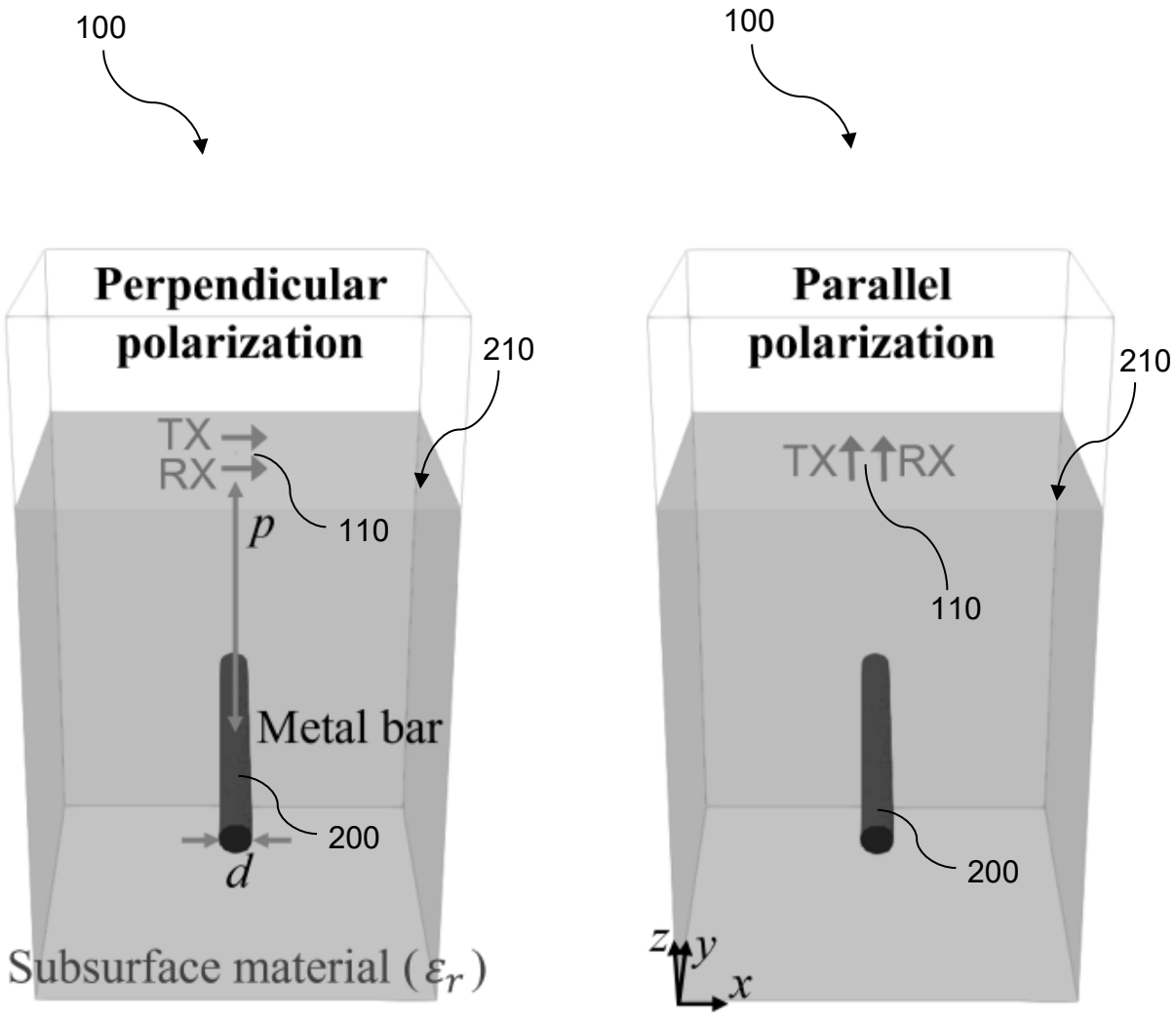

100
100
Perpendicular polarization
210
TX
RX
p
110
Metal bar
200
d
Subsurface material (ε_r)
Parallel polarization
210
TX
RX
110
200
z
y
x

Figure 4A

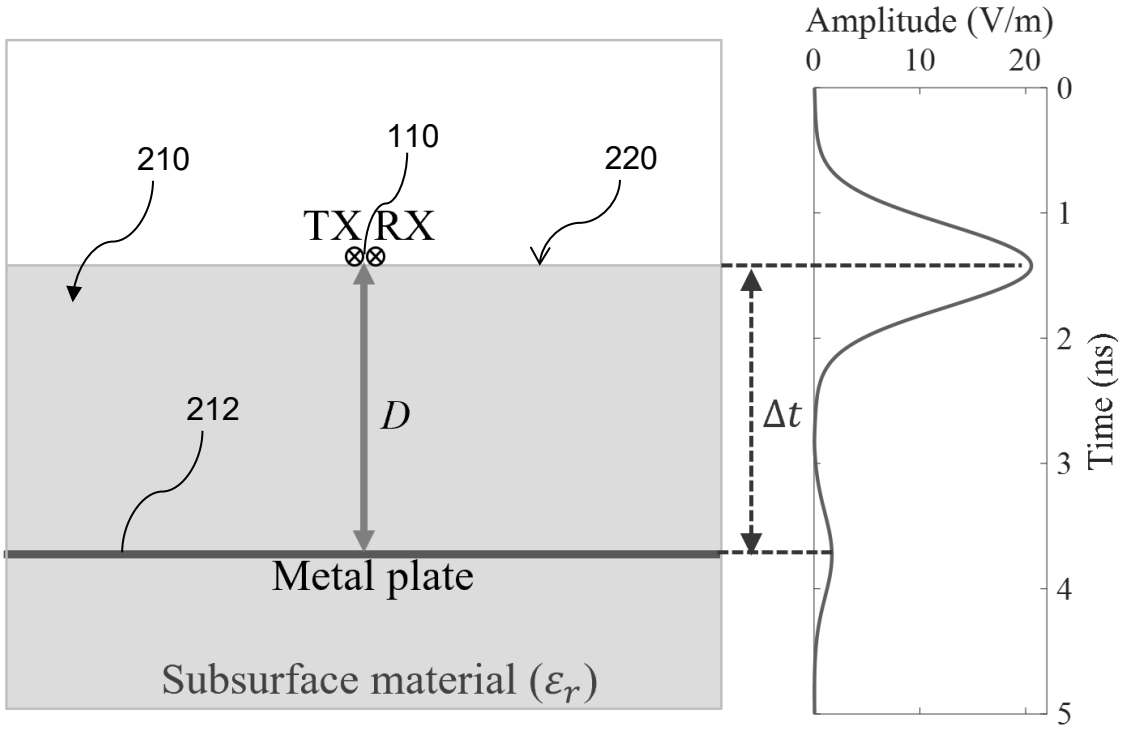


Figure 4B

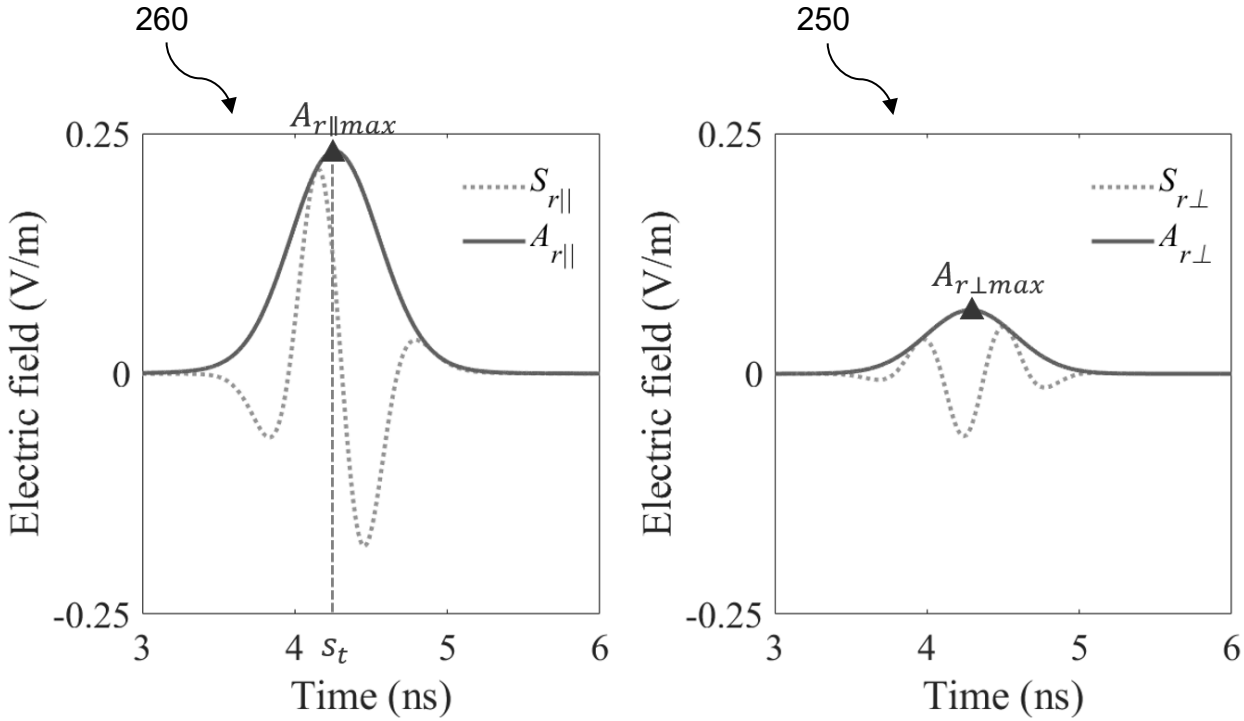


Figure 4C

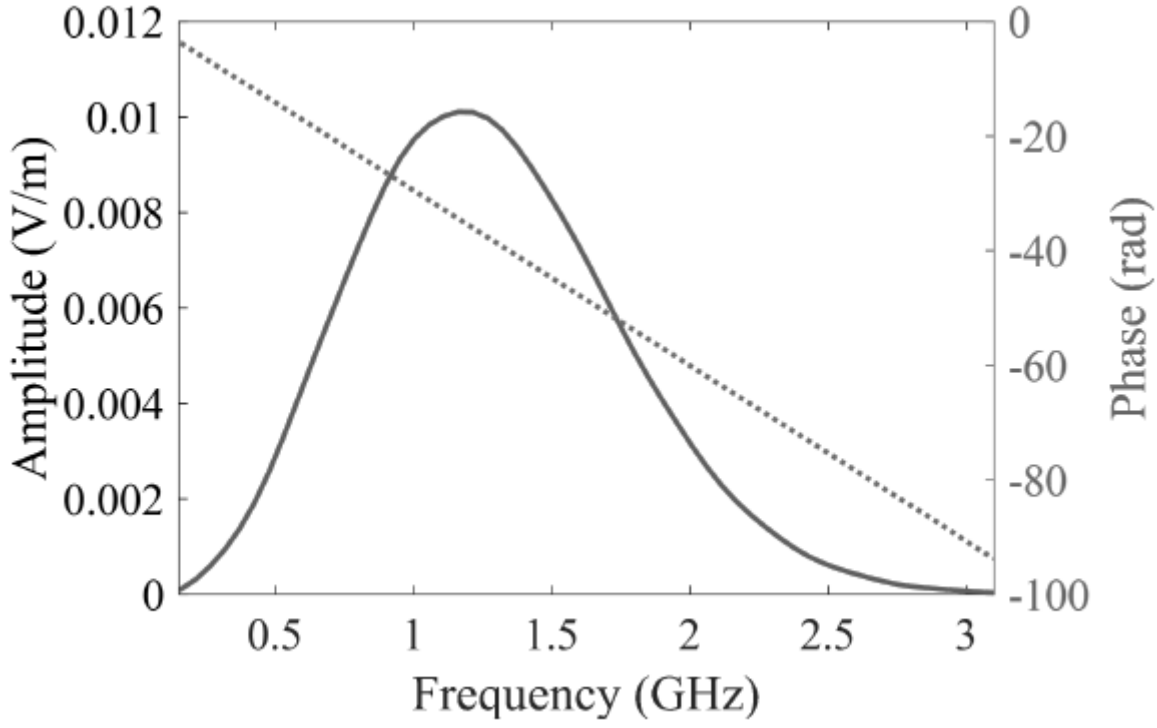


Figure 4D

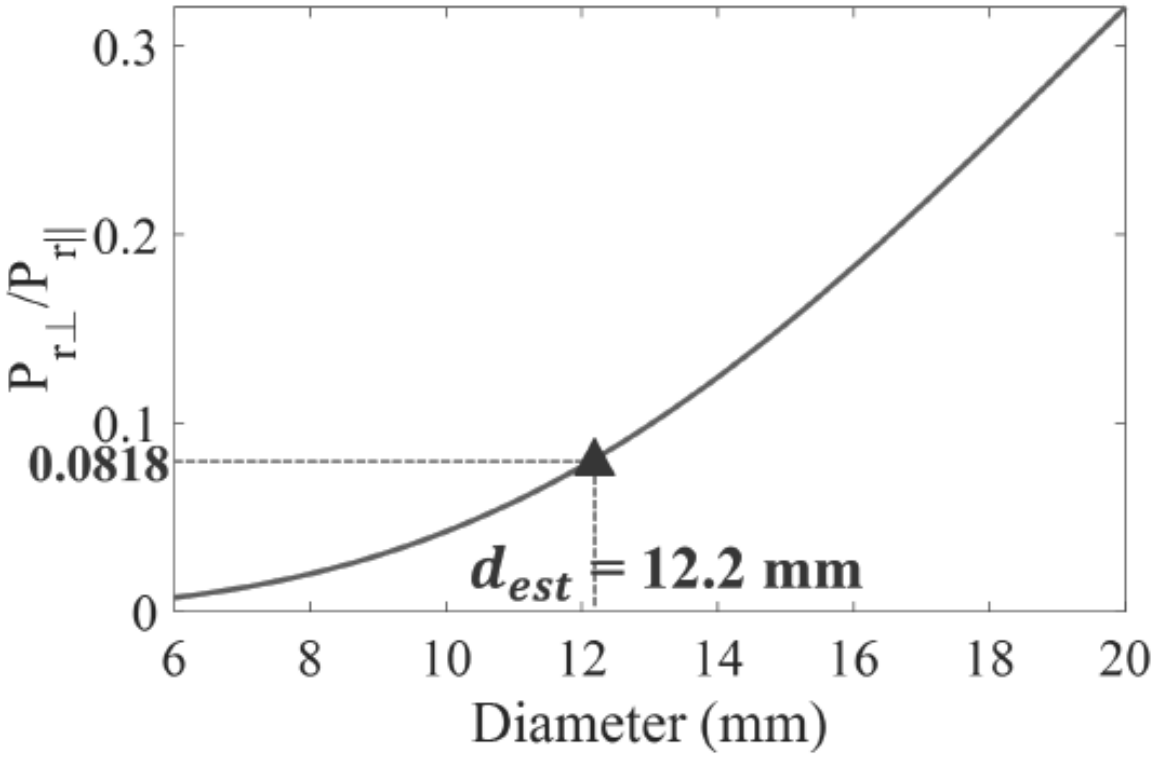


Figure 4E

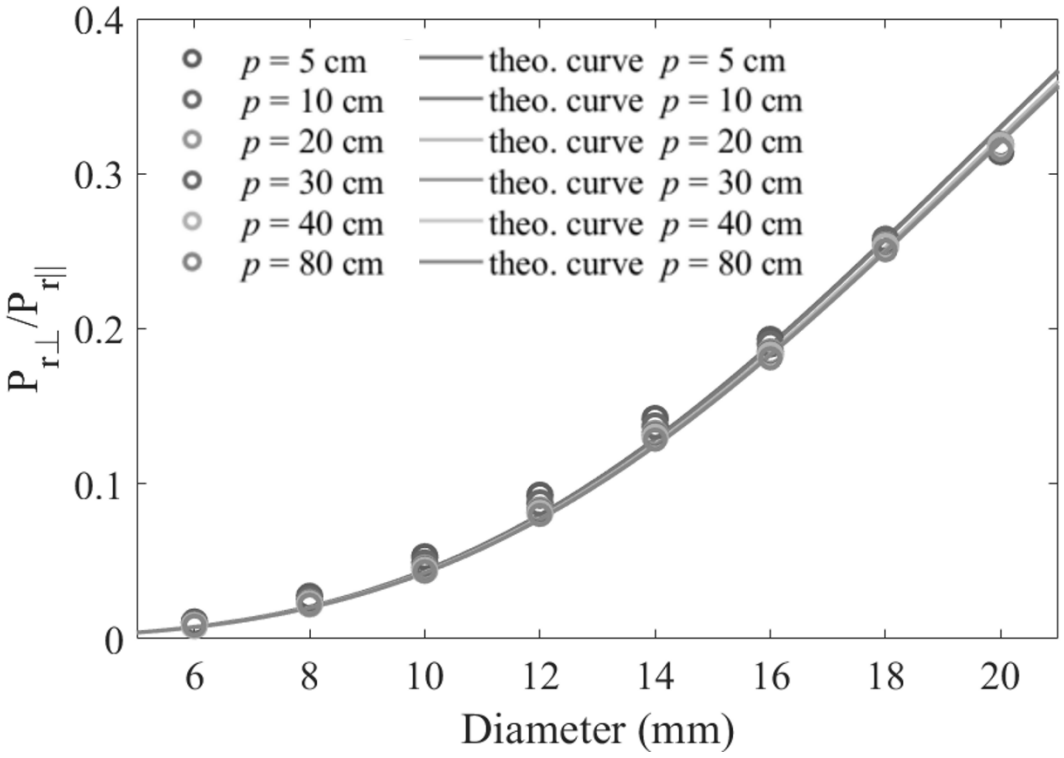


Figure 5A

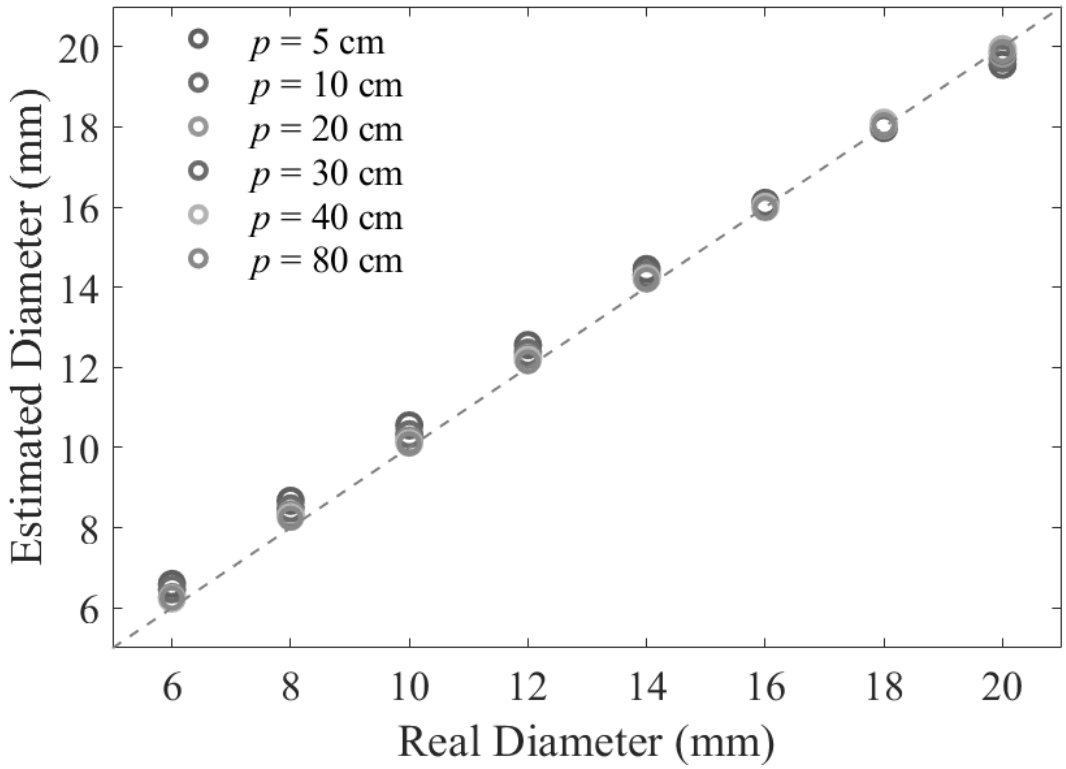


Figure 5B

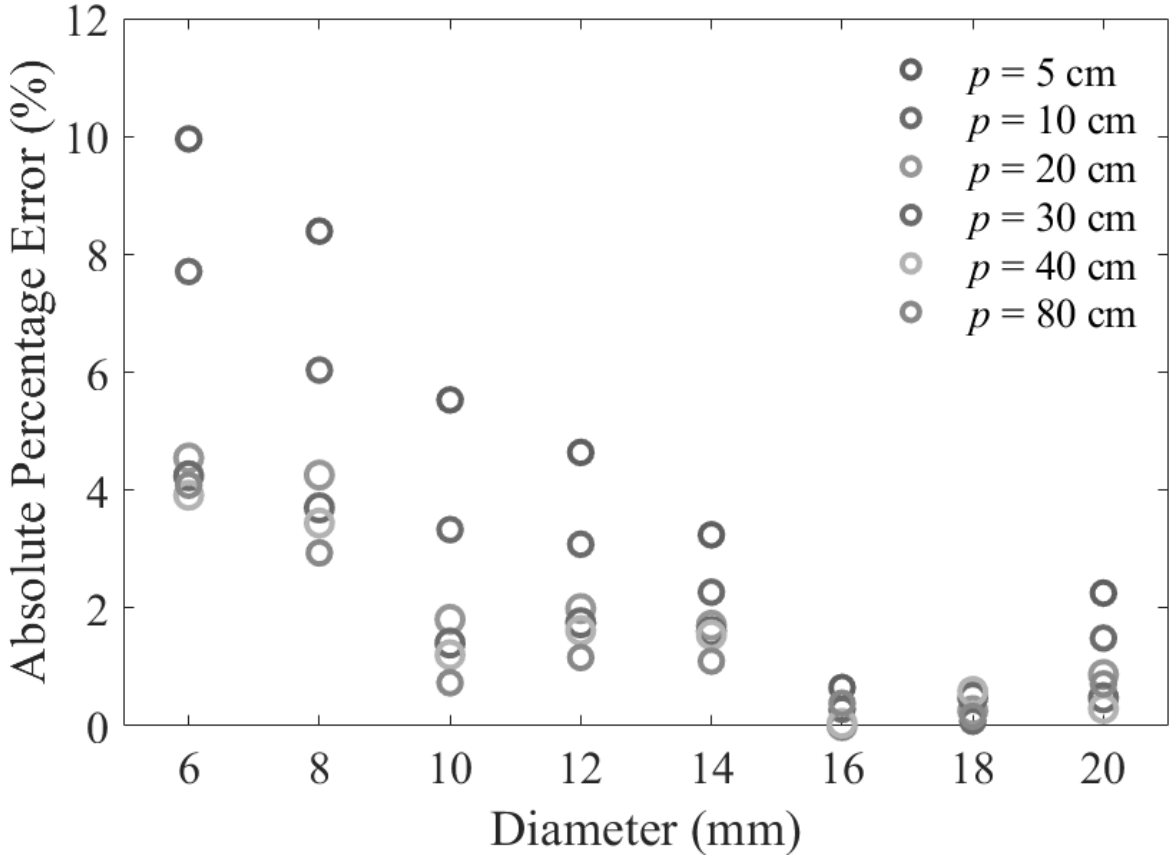

Absolute Percentage Error (%)
Diameter (mm)
p = 5 cm
p = 10 cm
p = 20 cm
p = 30 cm
p = 40 cm
p = 80 cm
0
2
4
6
8
10
12
6
8
10
12
14
16
18
20

Figure 5C

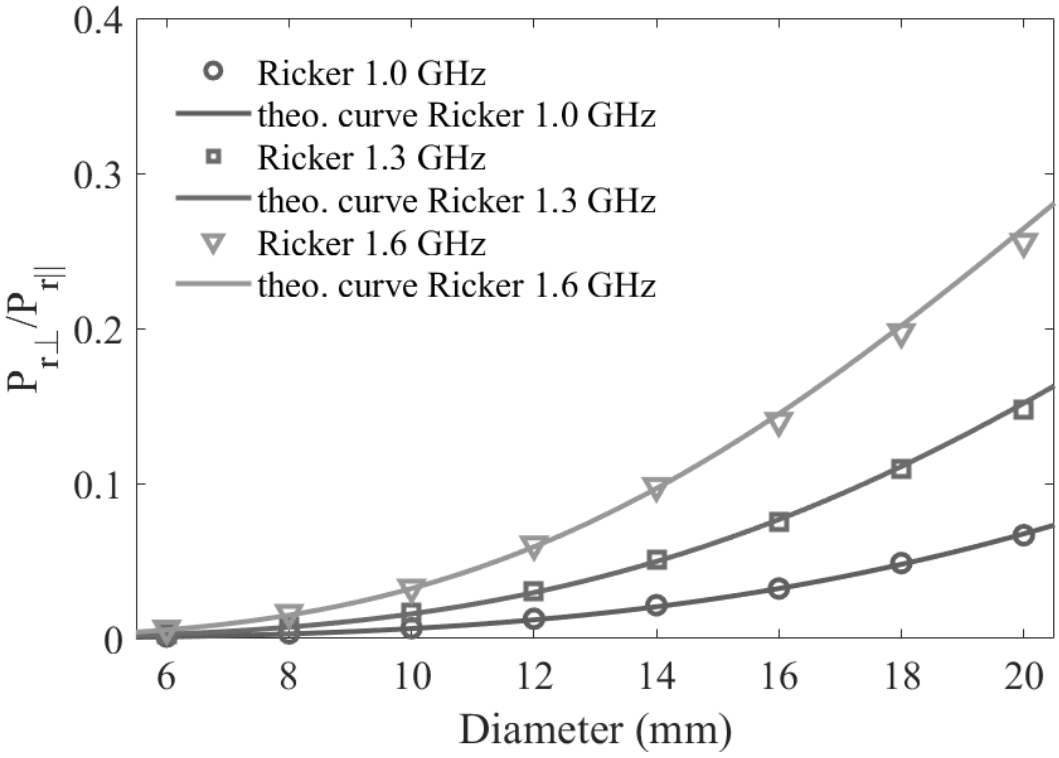


Figure 6A

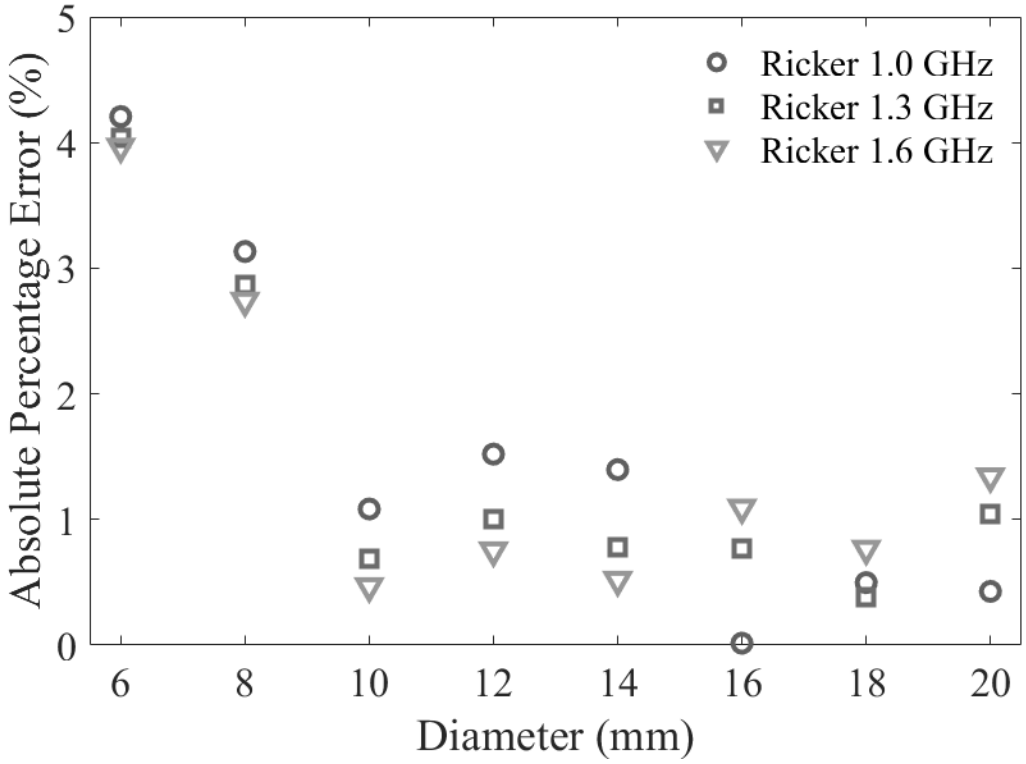


Figure 6B

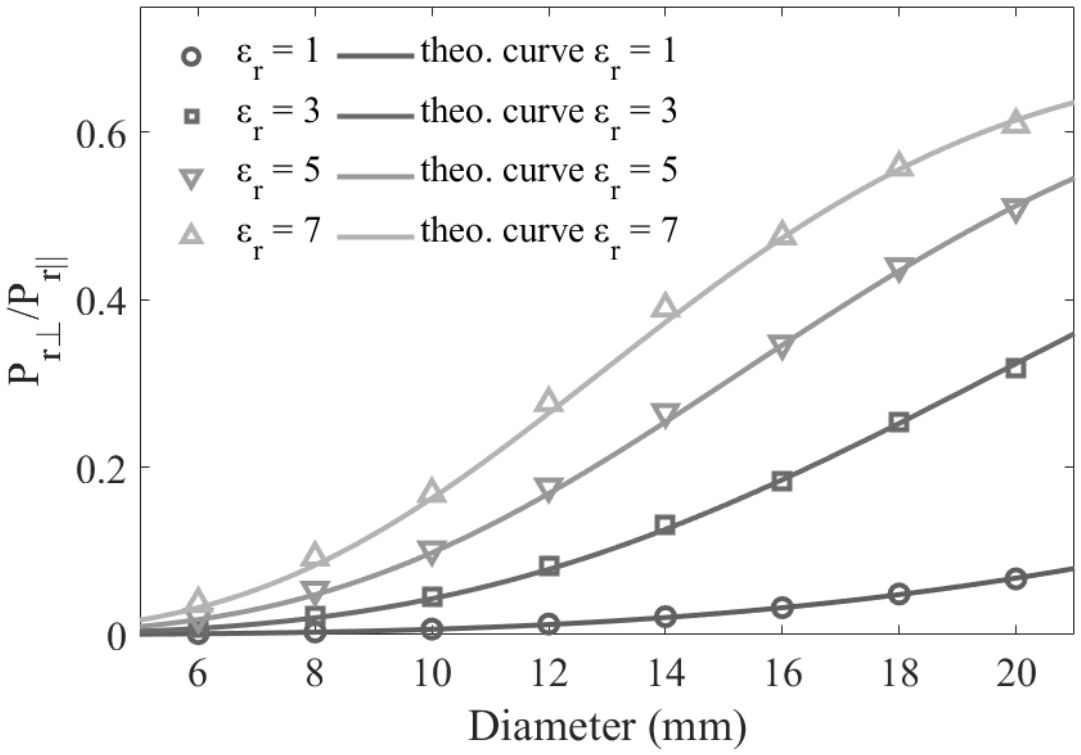


Figure 7A

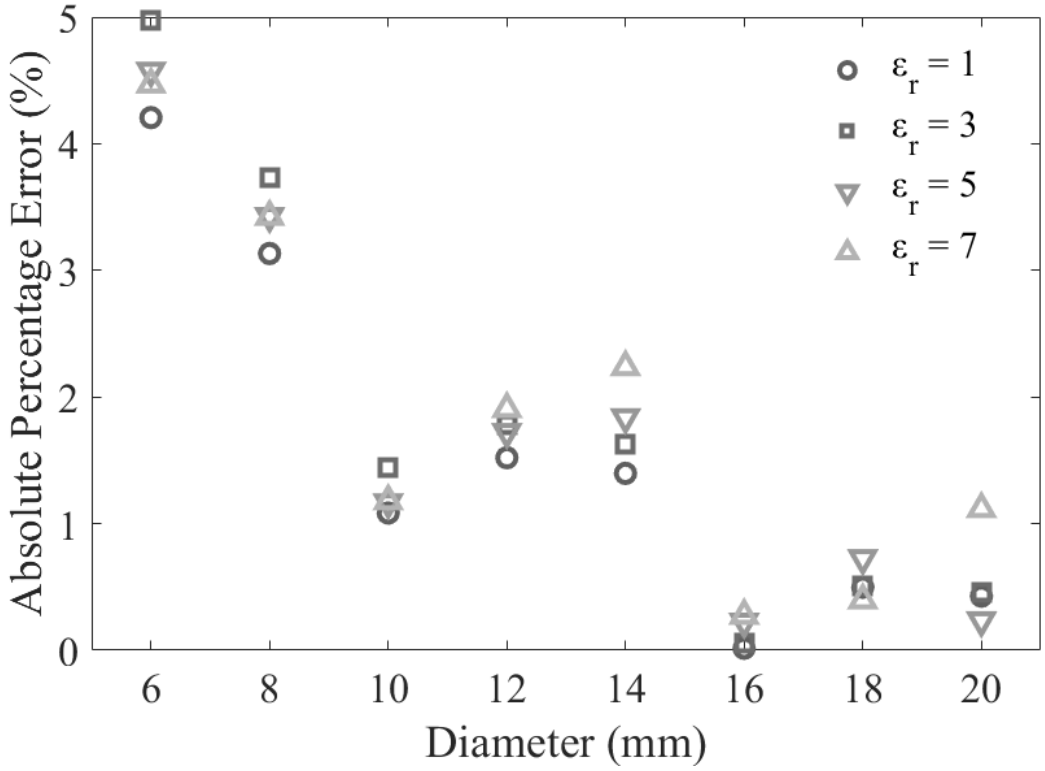


Figure 7B

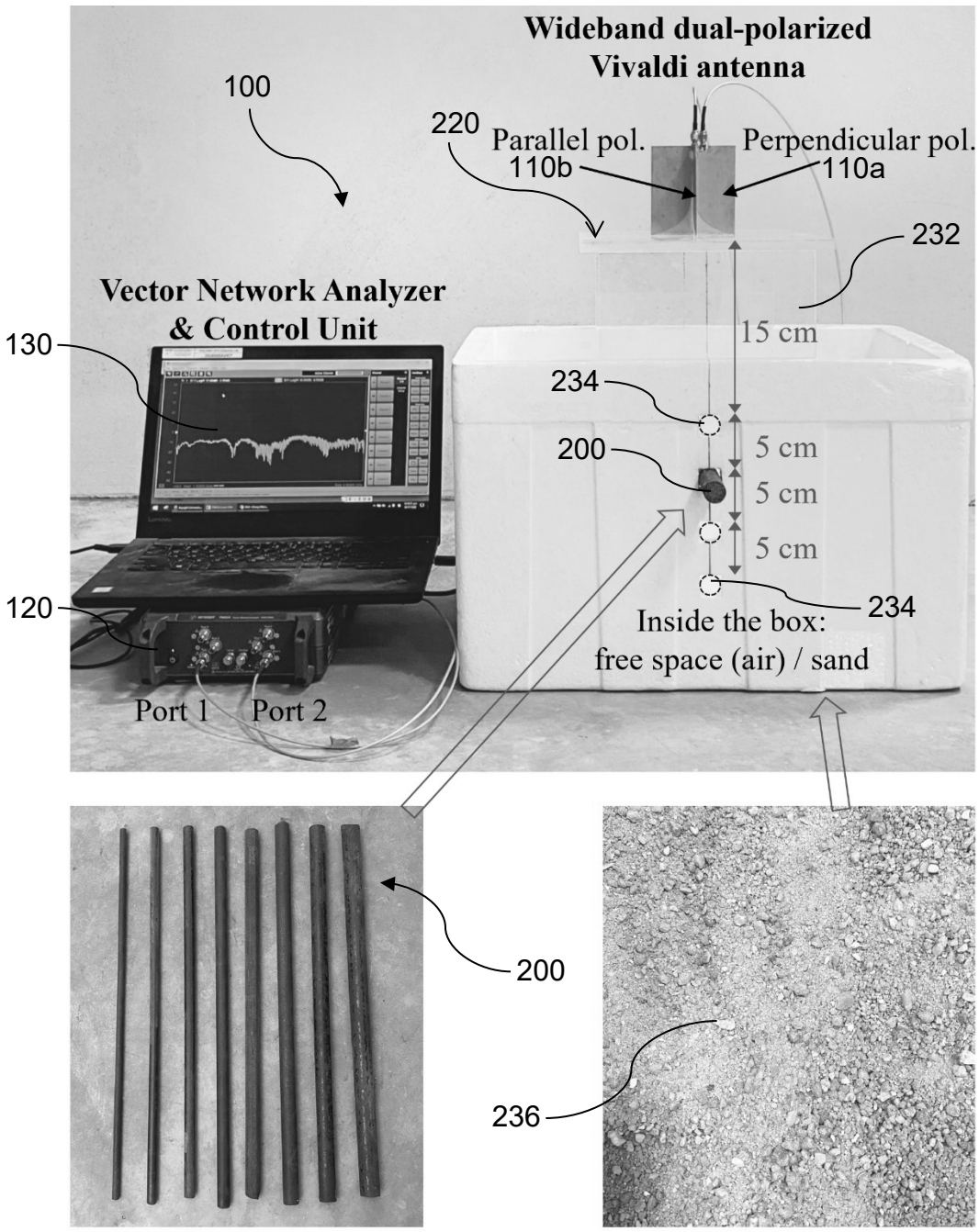

Wideband dual-polarized
Vivaldi antenna
100
220
Parallel pol.
110b
Perpendicular pol.
110a
232
Vector Network Analyzer
& Control Unit
130
15 cm
234
200
5 cm
5 cm
5 cm
120
234
Inside the box:
free space (air) / sand
Port 1
Port 2
200
236

Figure 8

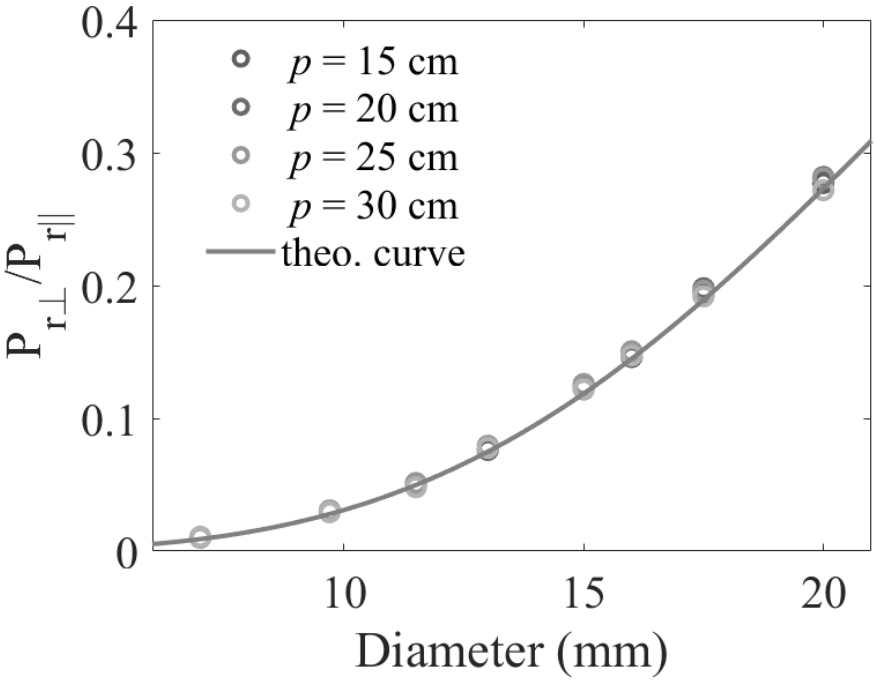


Figure 9A

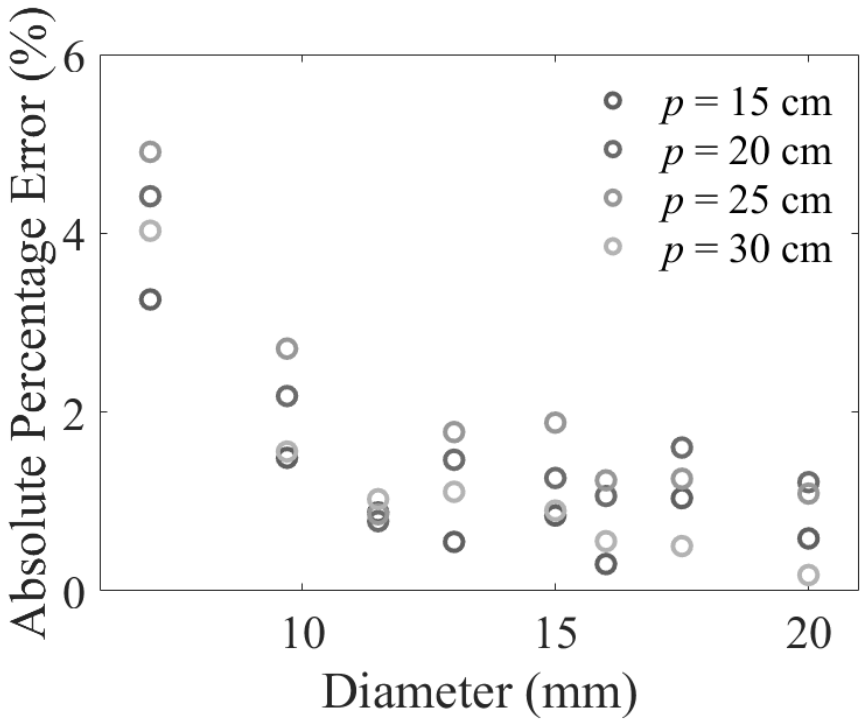


Figure 9B

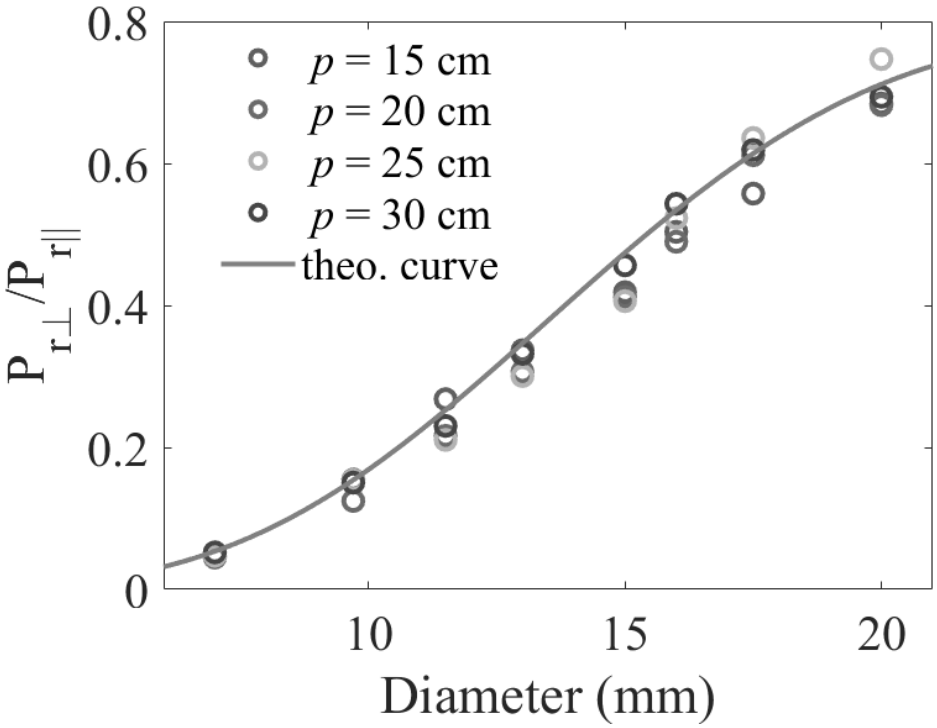


Figure 10A

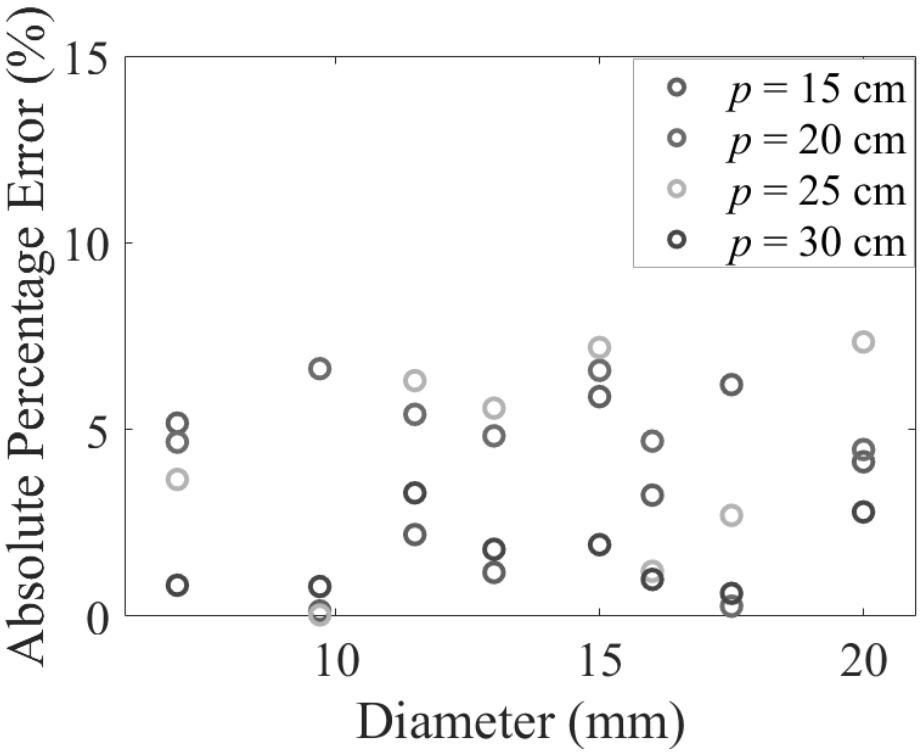


Figure 10B

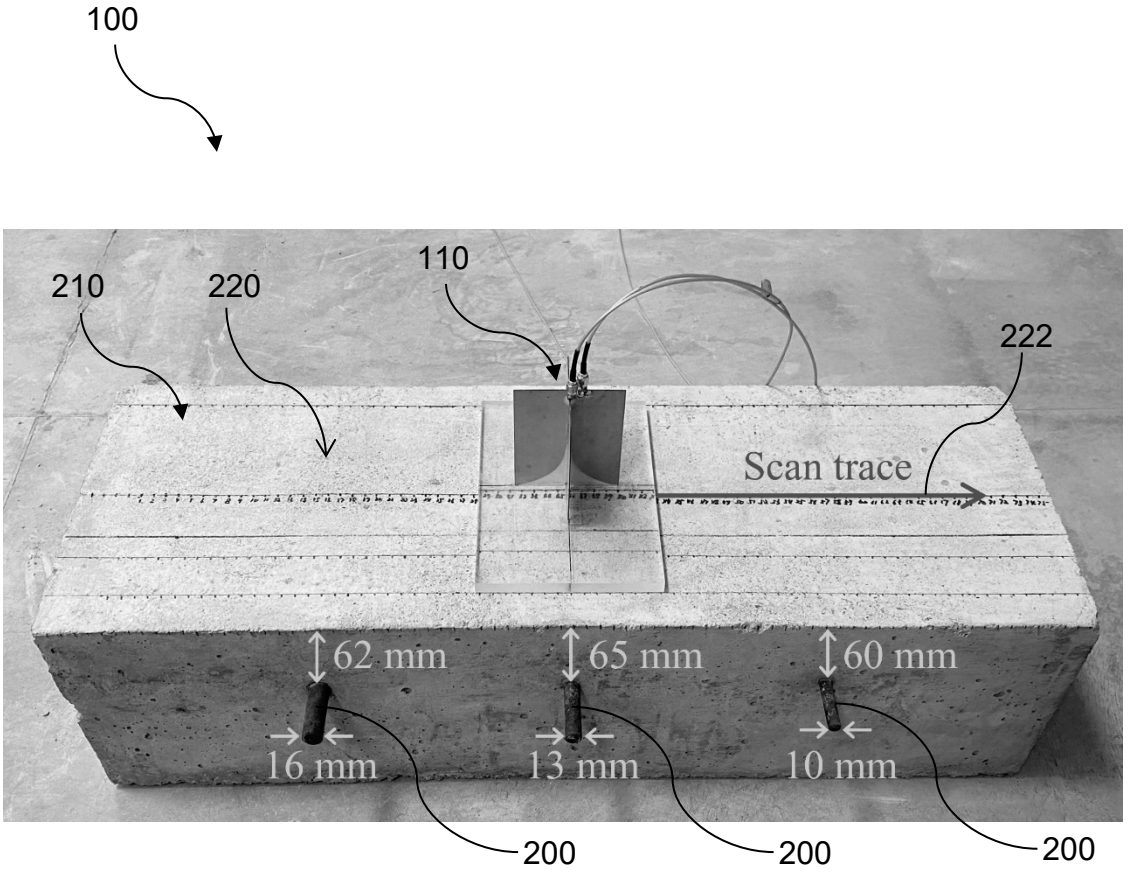

100
210
220
110
222
Scan trace
62 mm
65 mm
60 mm
16 mm
13 mm
10 mm
200
200
200

Figure 11A

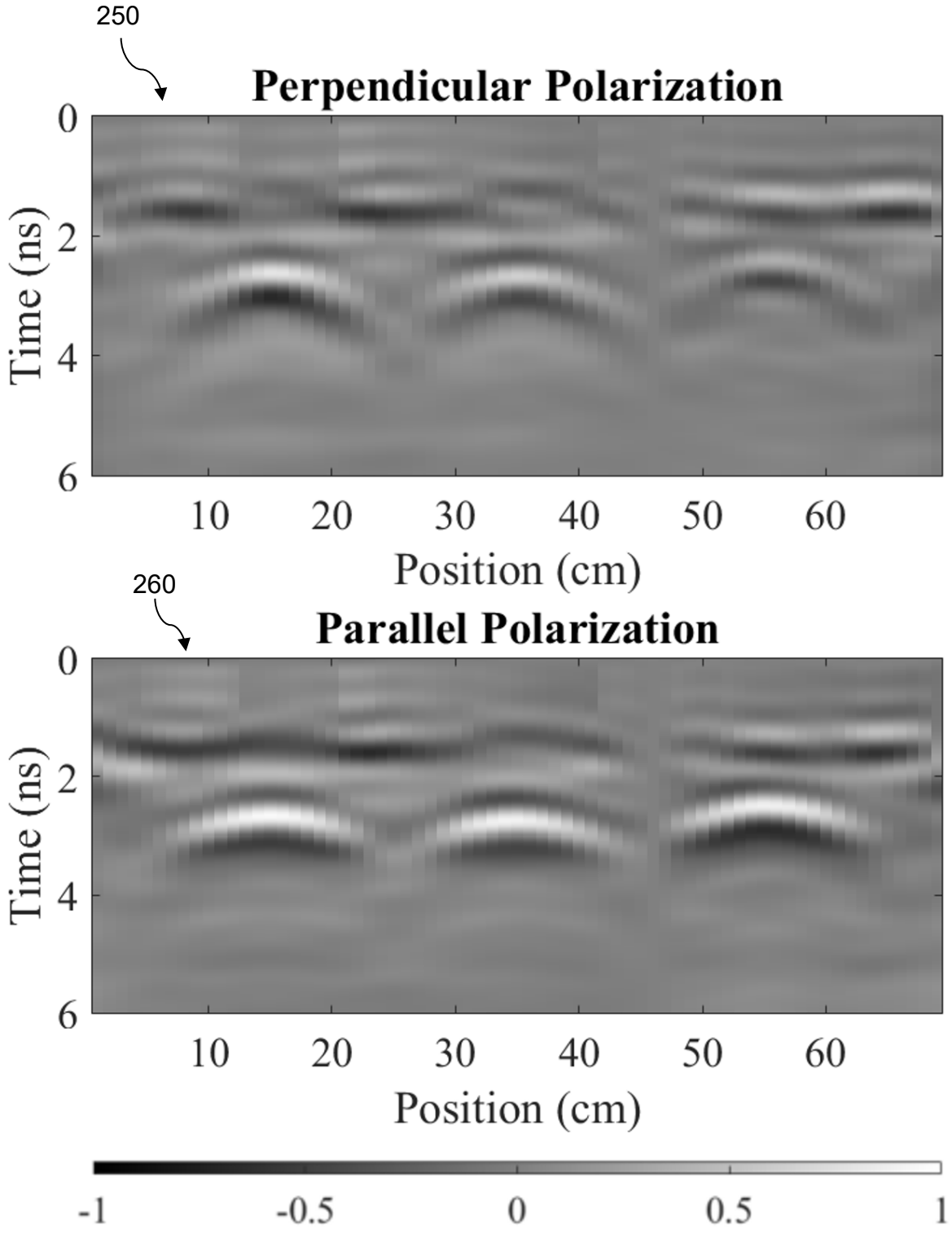

250
Perpendicular Polarization
Time (ns)
0
2
4
6
10
20
30
40
50
60
Position (cm)
260
Parallel Polarization
Time (ns)
0
2
4
6
10
20
30
40
50
60
Position (cm)
-1
-0.5
0
0.5
1

Figure 11B

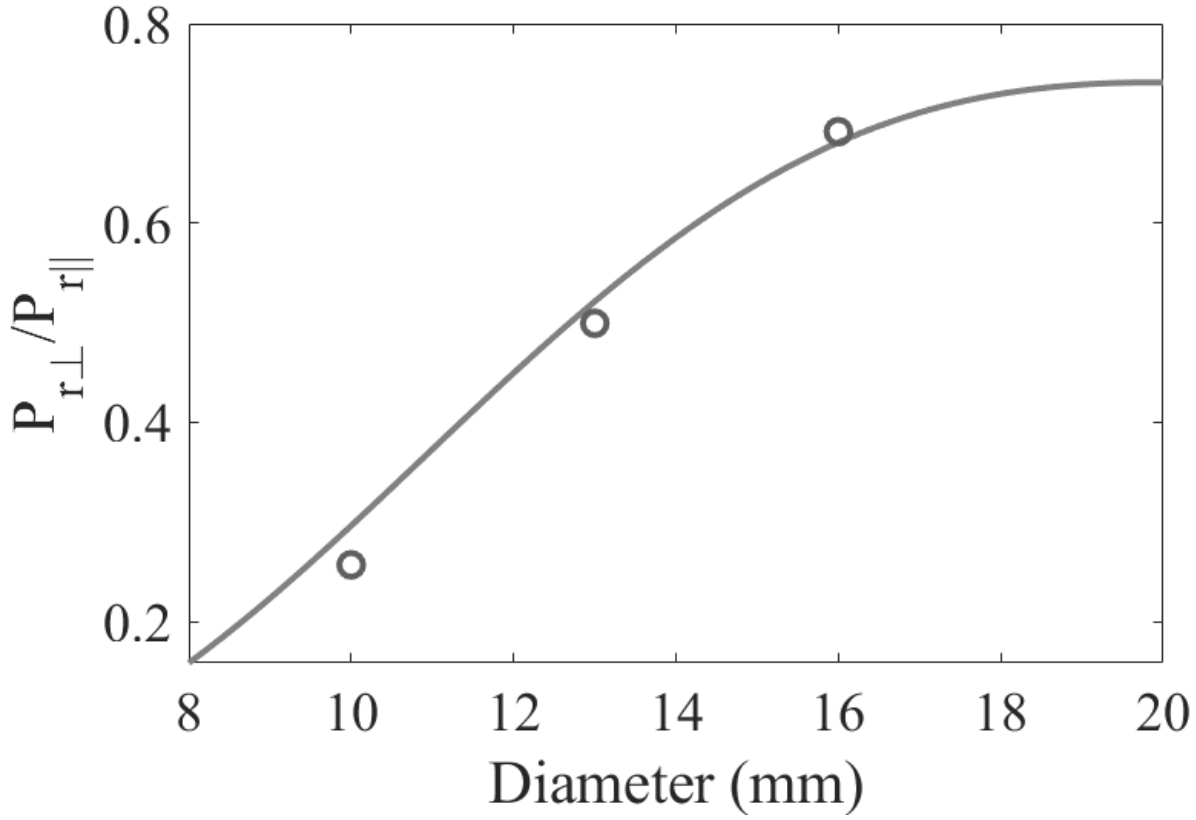


Figure 11C