

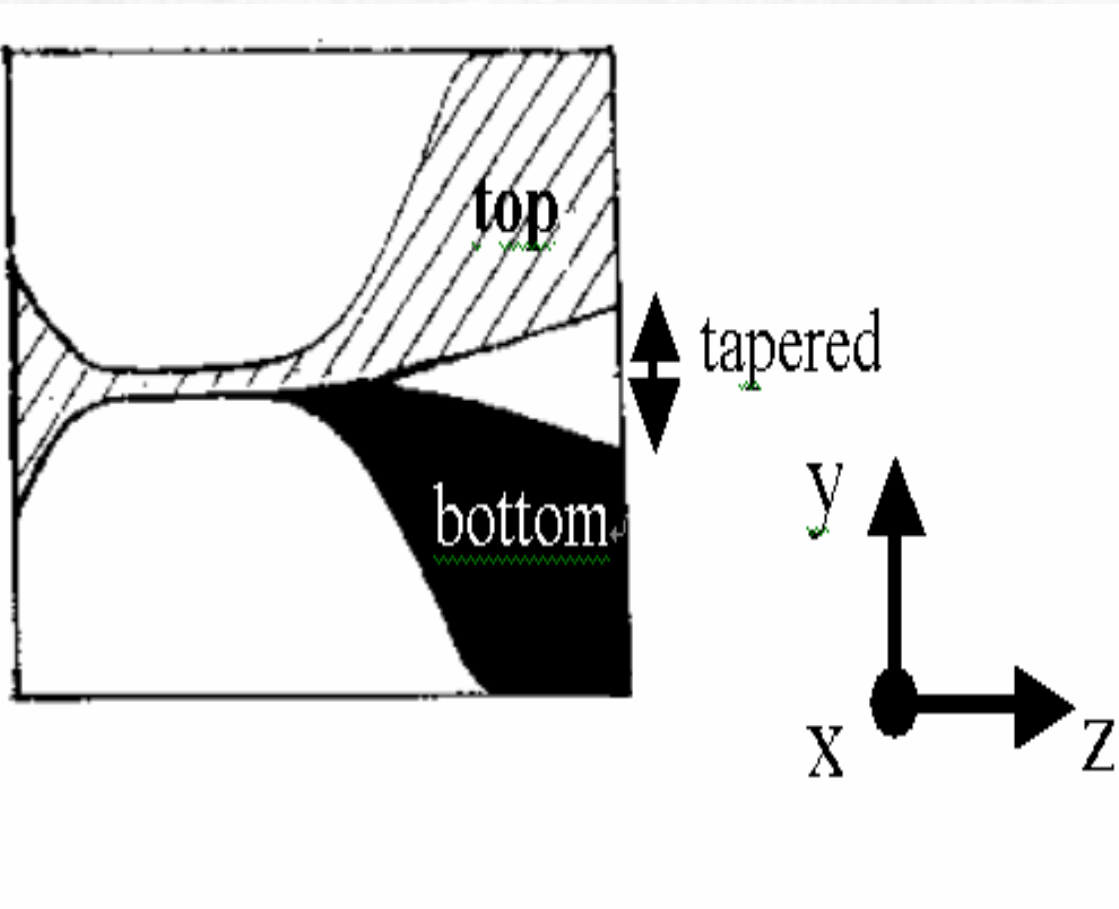
地雷検知用SAR-GPRの開発

東北大学東北アジア研究センター 佐藤 源之

概要

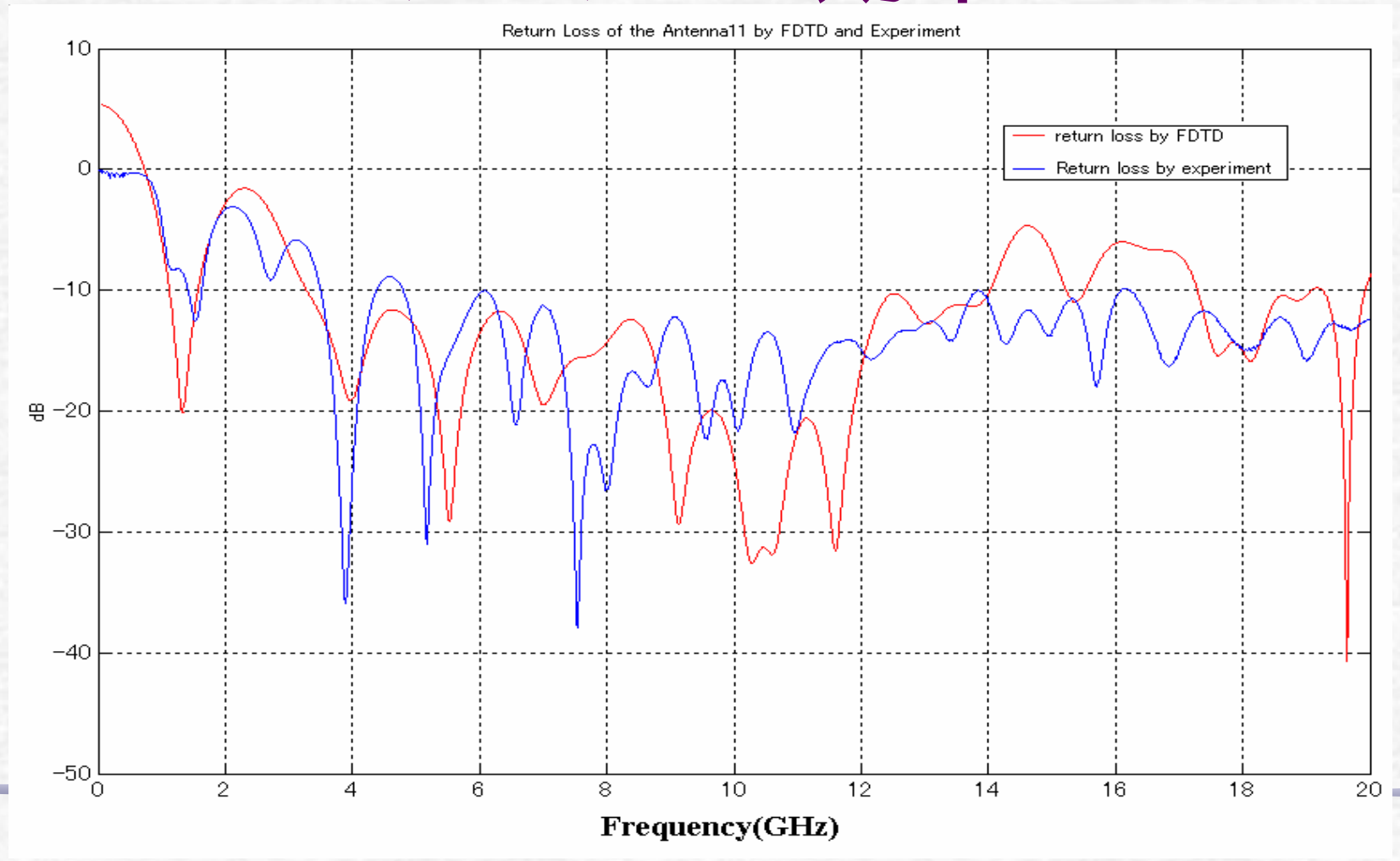
1. イントロダクション
2. GPR用アンテナ設計
3. 簡易なモデルでの実験
4. 信号処理
5. 現実的なモデルでの実験
6. 結論

ビバルディ アンテナ



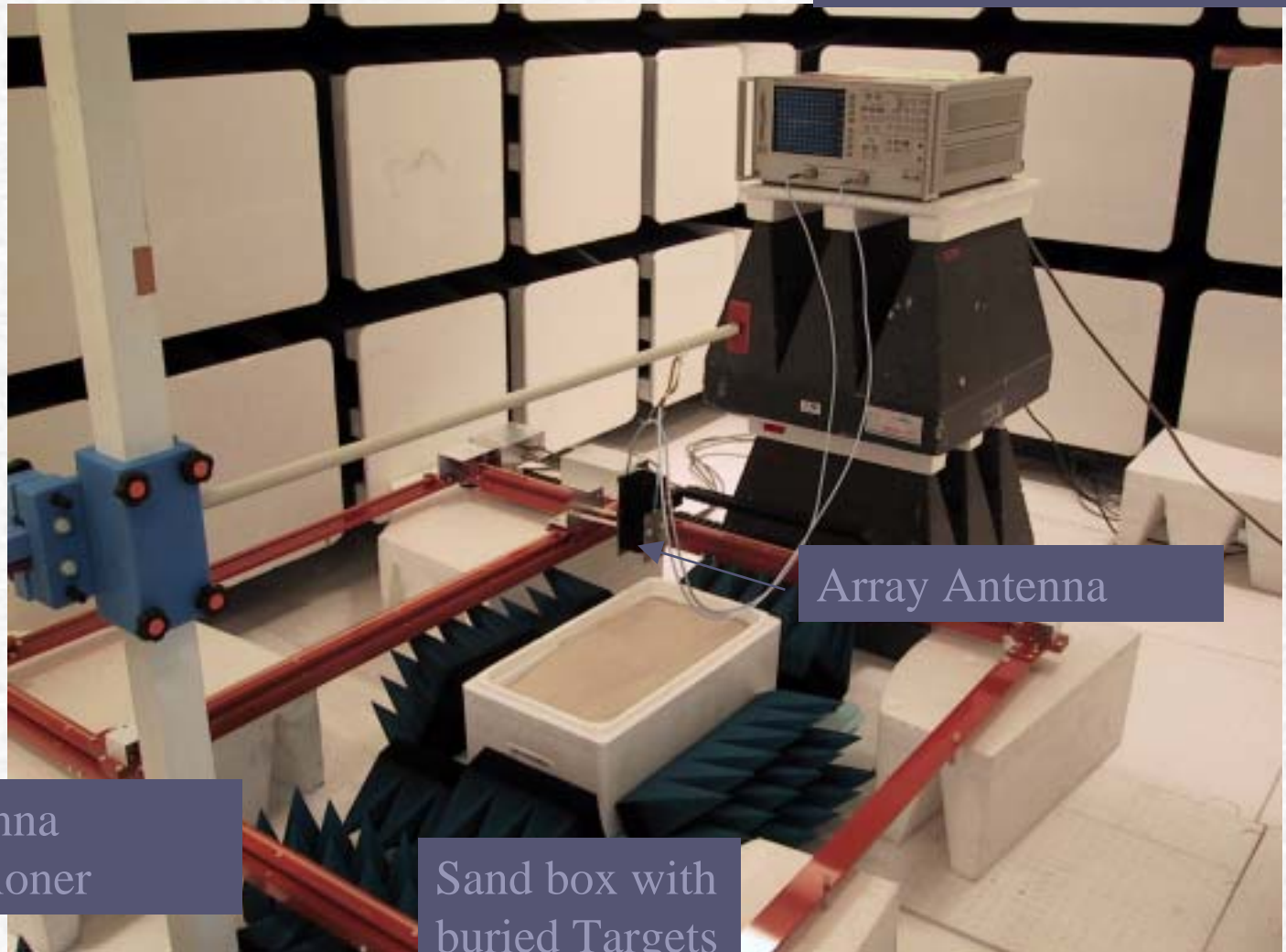
- Broadband
- Small Size
- Endfire Radiation Easy to manufacture

アンテナ 効率



実験装置

Vector Network Analyzer

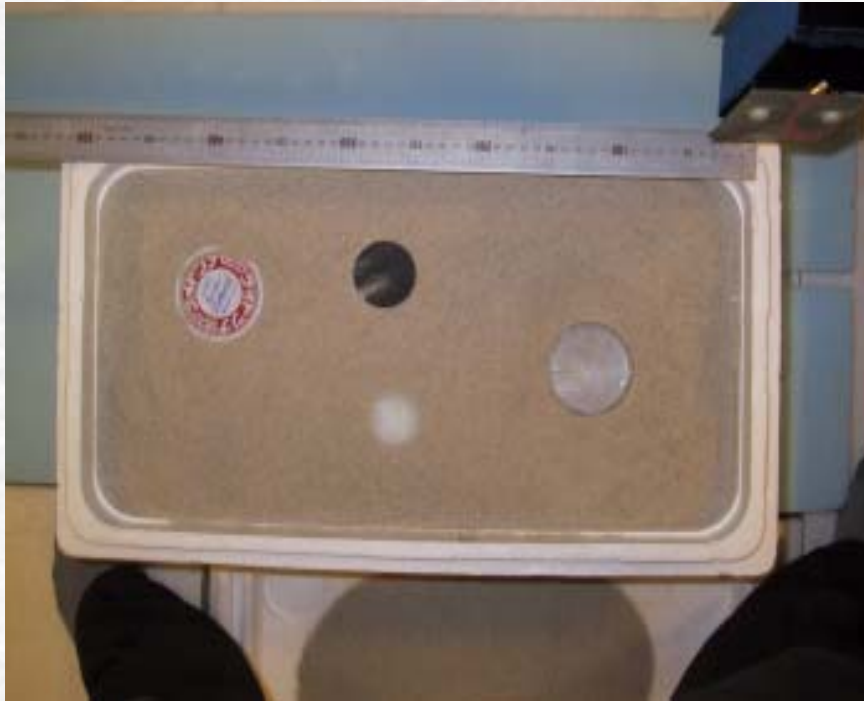


Array Antenna

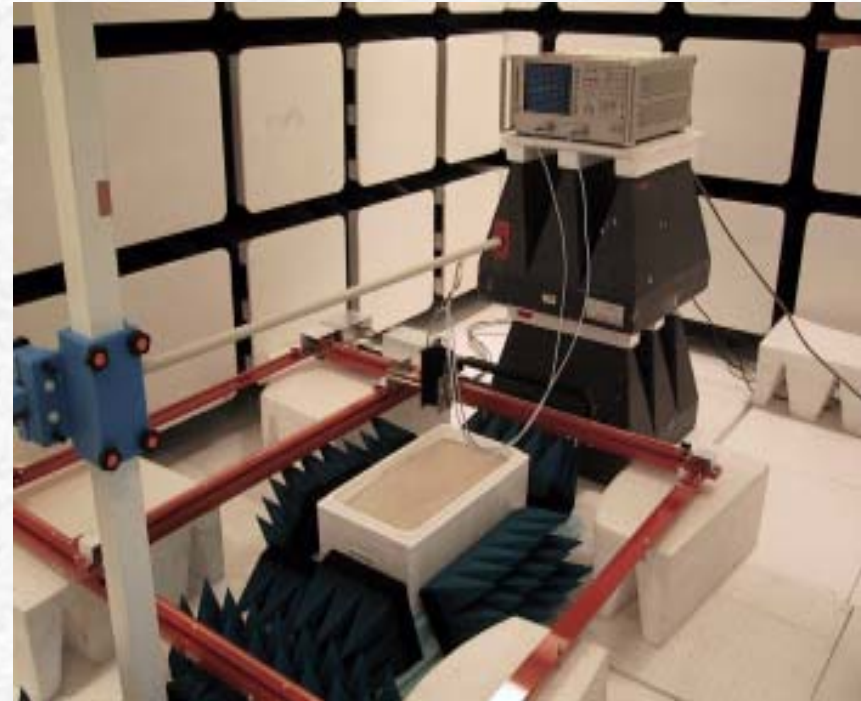
Antenna
Positioner

Sand box with
buried Targets

基礎実験



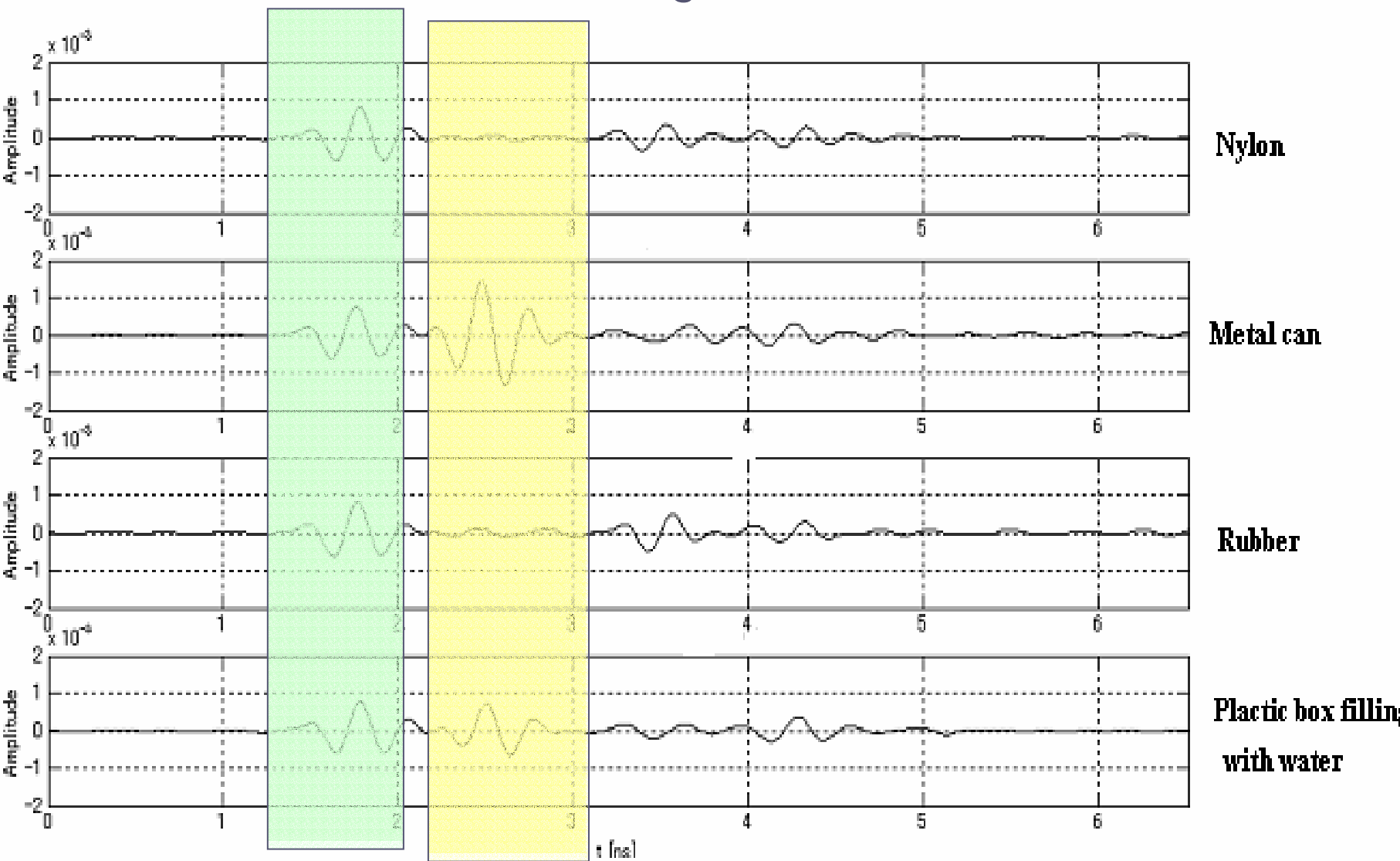
Targets Location



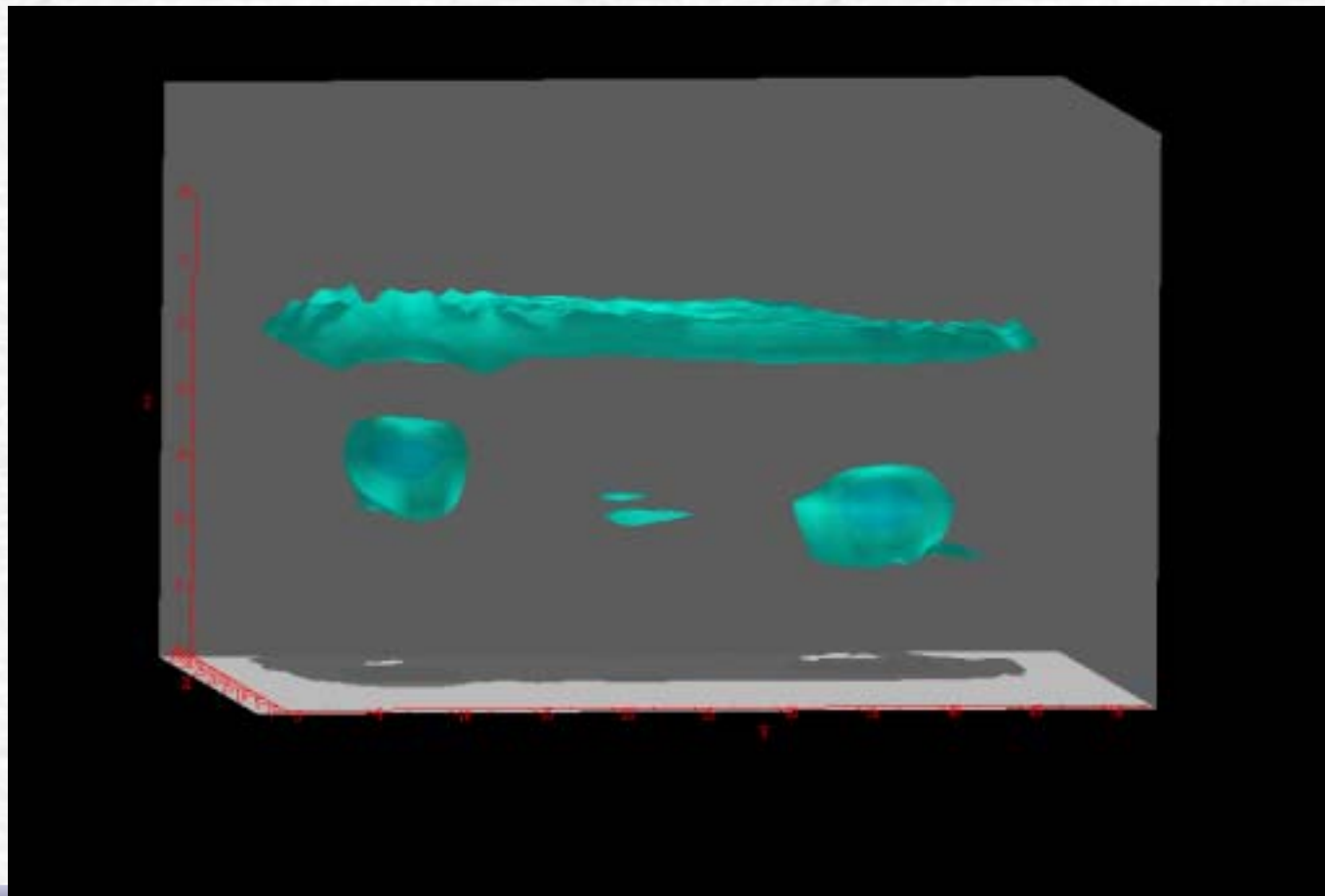
Experiment Configuration

Ground Surface

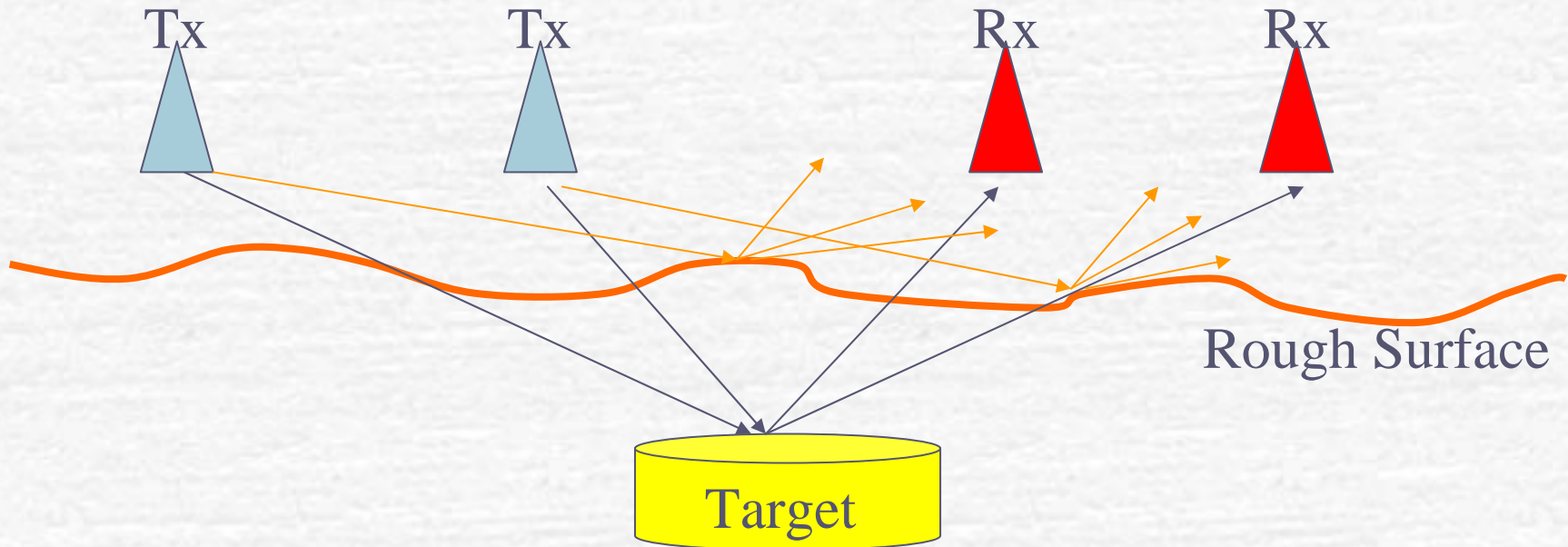
Buried Target

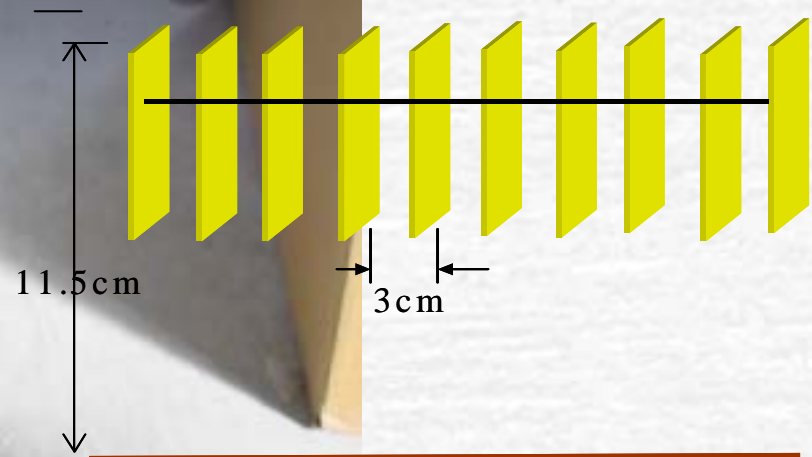
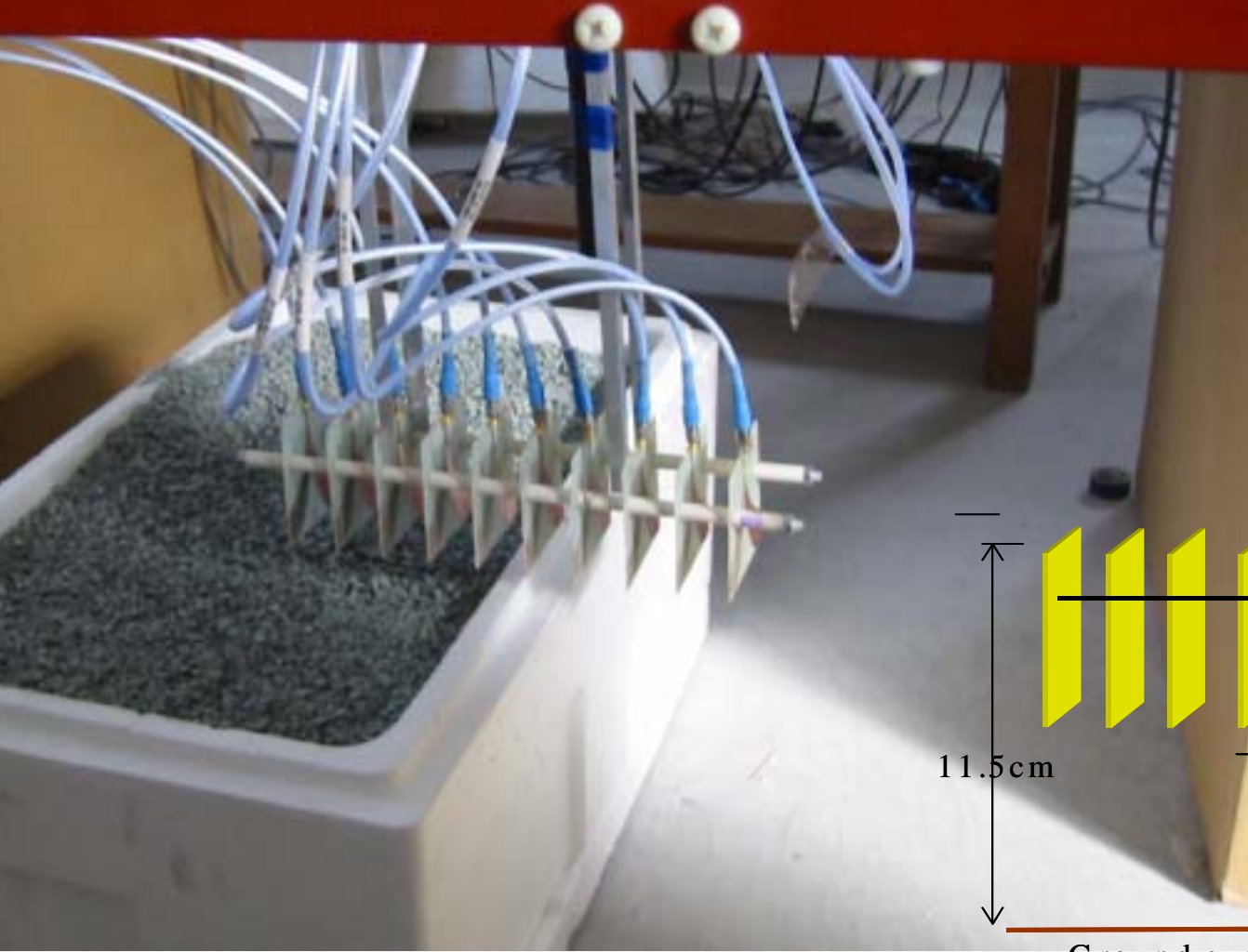


3-D 再合成画像



アレイアンテナ利用と空間相関性





Ground surface

System Setup



Array Antenna and Switch



MATLAB GUI

GPR Processing System

File Processing Analysis Show \へ?*

BackGround at trace **Figure 1**
 Signal at a point at X and Y (point)
 Vertical profile along x from to (point)
 at trace and Y (point)
 Vertical profile along y from to (point)
 at trace and X (point)

Surf horizontal image Contourf horizontal image
 at trace and z or t or f (point)

BackGround at trace **Figure 2**
 Signal at a point at X and Y (point)
 Vertical profile along x from to (point)
 at trace and Y (point)
 Vertical profile along y from to (point)
 at trace and X (point)

Surf Horizontal image Contourf horizontal image
 at trace and z or t or f (point)

パラメータ

dx: <input type="text" value="0.01"/> (m)	NX: <input type="text" value="32"/> (point)
dy: <input type="text" value="0.01"/> (m)	NY: <input type="text" value="55"/> (point)
dz: <input type="text" value="-999"/> (m)	NZ: <input type="text" value="-999"/> (point)
dt: <input type="text" value="0.0081384"/> (ns)	NT: <input type="text" value="349"/> (point)
SF: <input type="text" value="0.3"/> (e+6 Hz)	EF: <input type="text" value="6000"/> (e+6 Hz)
df: <input type="text" value="14.9993"/> (e+6 Hz)	NF: <input type="text" value="401"/> (point)
Distance between Antenna: <input type="text" value="0.03"/> (m)	
Number of Trace: <input type="text" value="1"/> (trace)	
Constant Velocity: <input type="text" value="0.17"/> (m/ns)	

Data Style CMP Data Common Offset

Processing

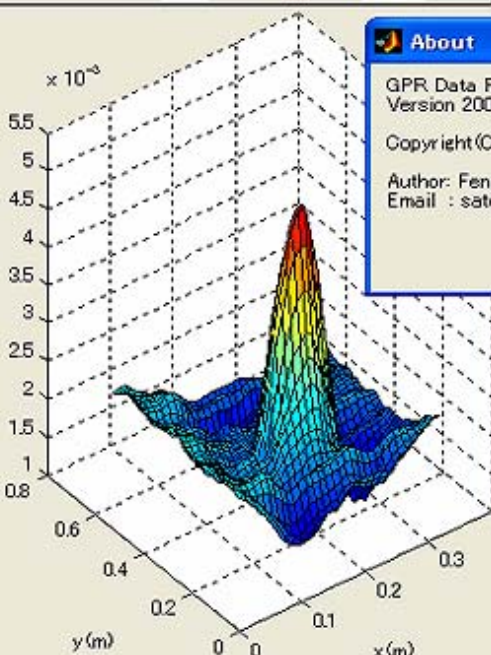
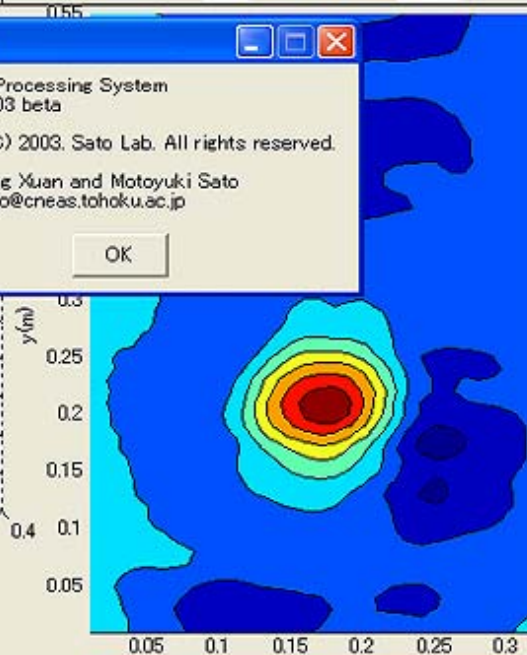
<input type="button" value="1.Subtract Background"/>	<input type="button" value="2.CMP Sorting"/>
<input type="button" value="3.Band Pass (1)"/>	<input type="button" value="4.IFFT"/>
<input type="button" value="5.Velocity Spectrum"/>	<input type="button" value="6.Amplitude Recover"/>
<input type="button" value="7.Trace Energy Balance"/>	<input type="button" value="8.NMO"/>
	<input type="button" value="9.Stacking"/>
<input type="button" value="10.Band Pass (2)"/>	<input type="button" value="11.Migration"/>

About

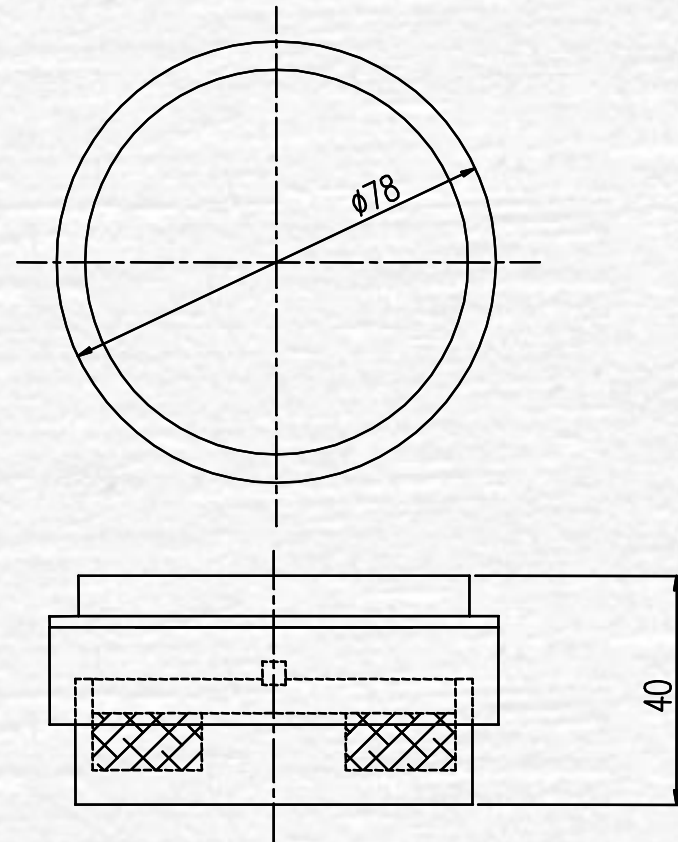
GPR Data Processing System
Version 2003 beta

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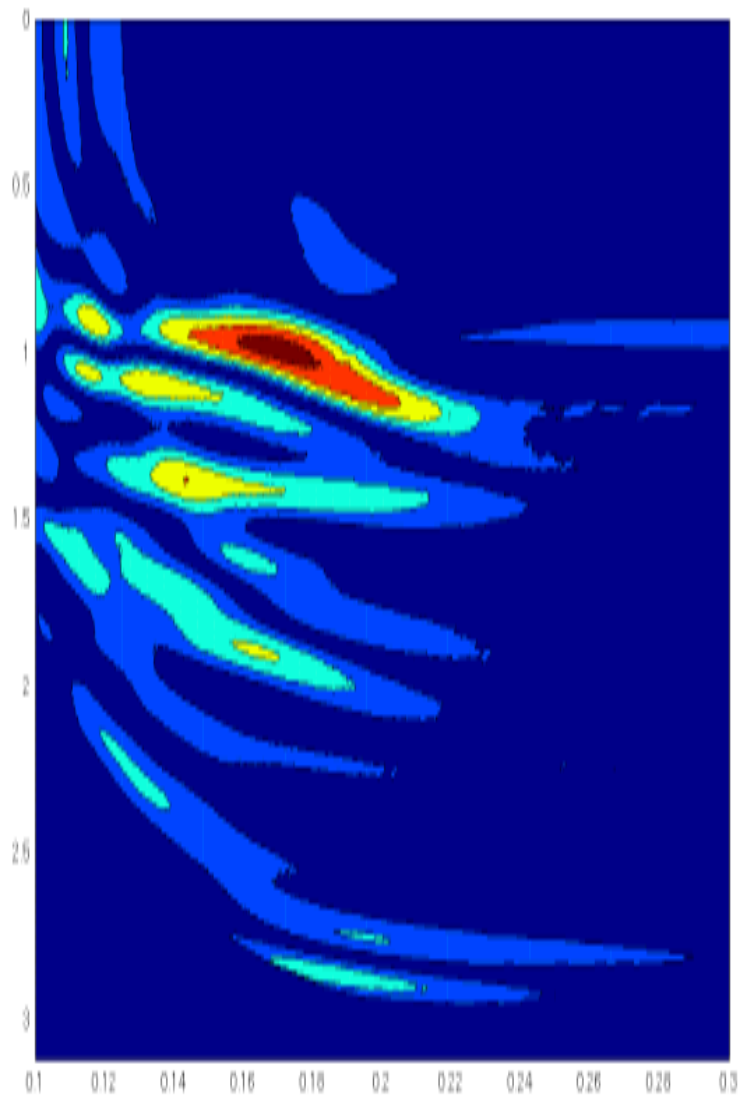



Type72 Landmine Model



平滑表面モデル





Velocity
spectrum

Horizontal image (flat ground)

Common offset

CMP

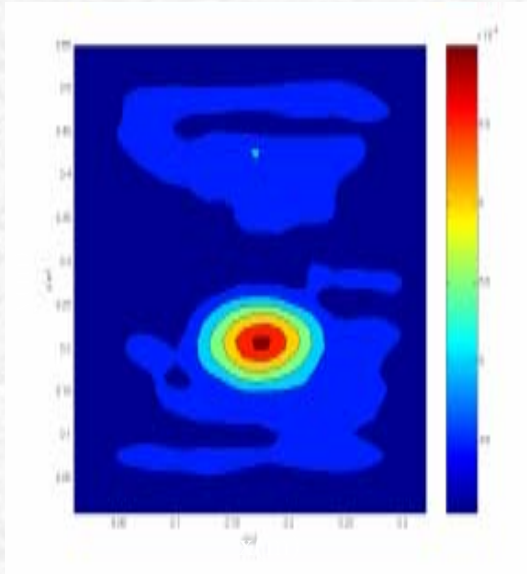


Image at the Z=0.1244m

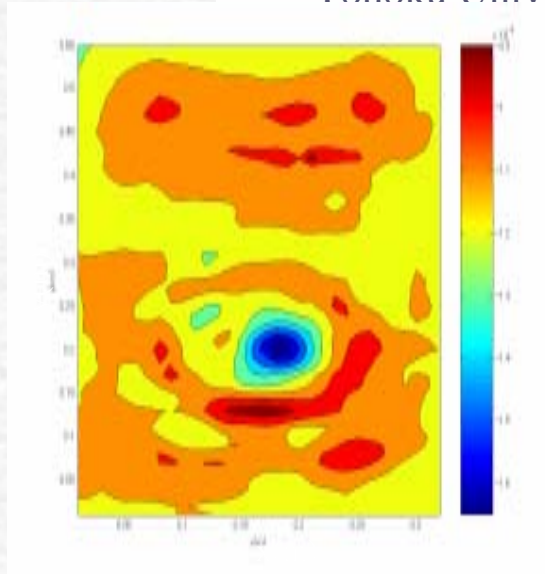
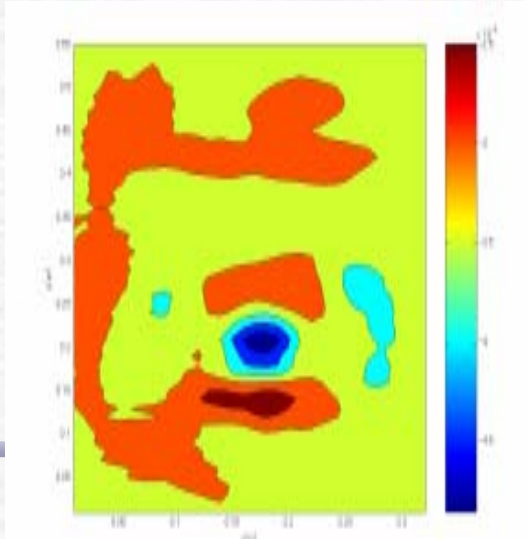
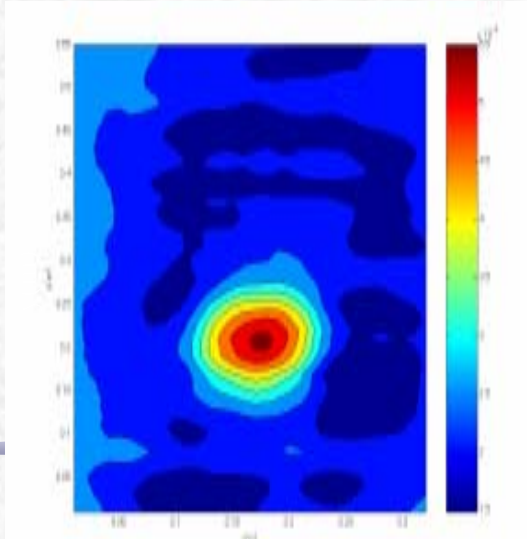
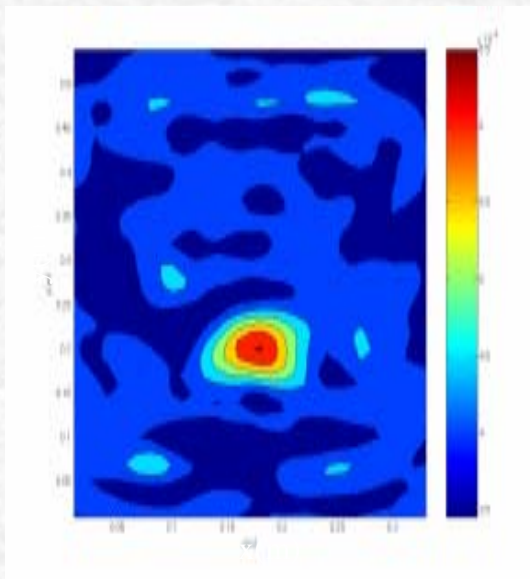


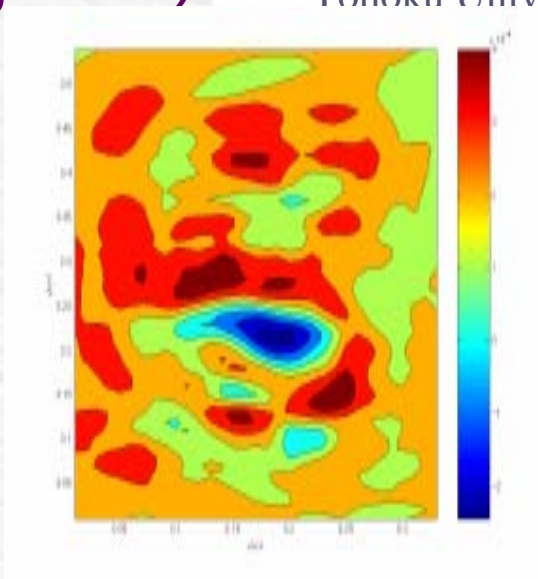
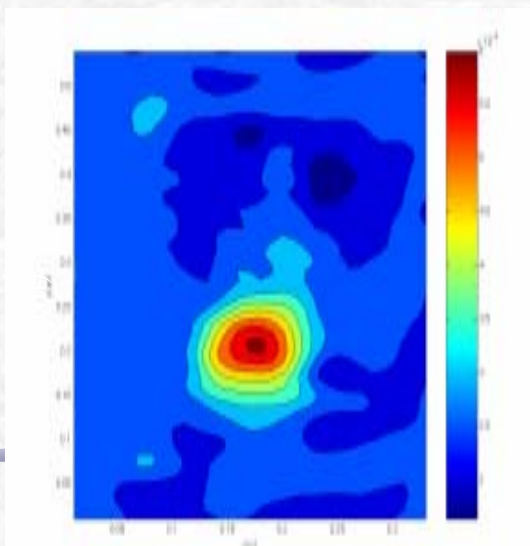
Image at the Z=0.1675m



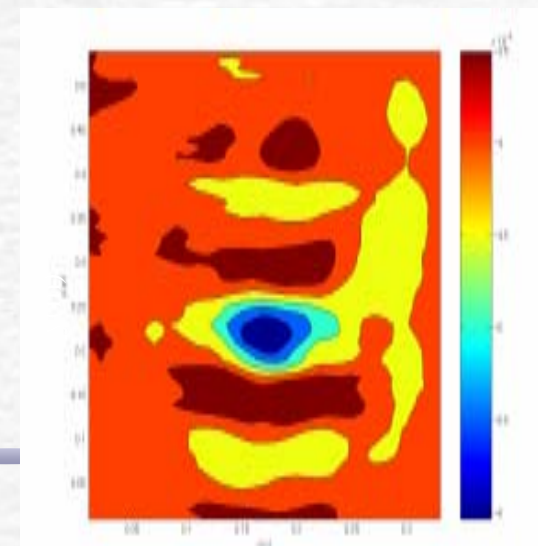
Horizontal Image (rough ground)

Image at the $Z=0.1194\text{m}$ 

Common offset

Image at the $Z=0.1634\text{m}$ 

CMP



粗い表面モデル



Rough Surface and Landmine Model



tal image (covered

Common offset

CMP

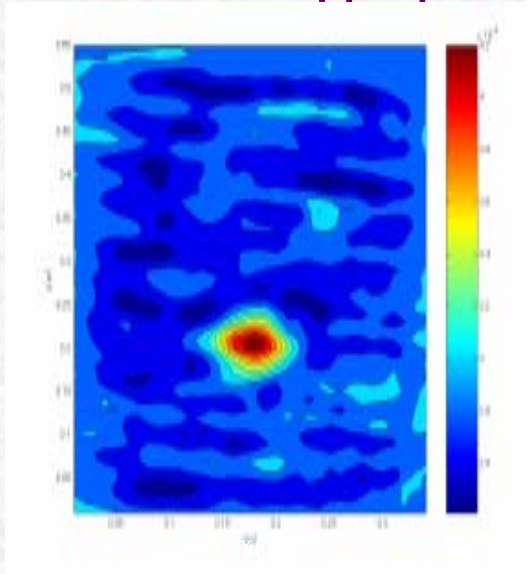


Image at the Z=0.1208m

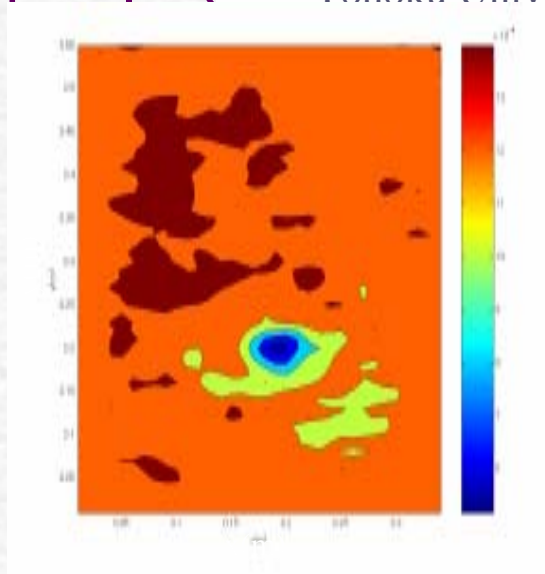
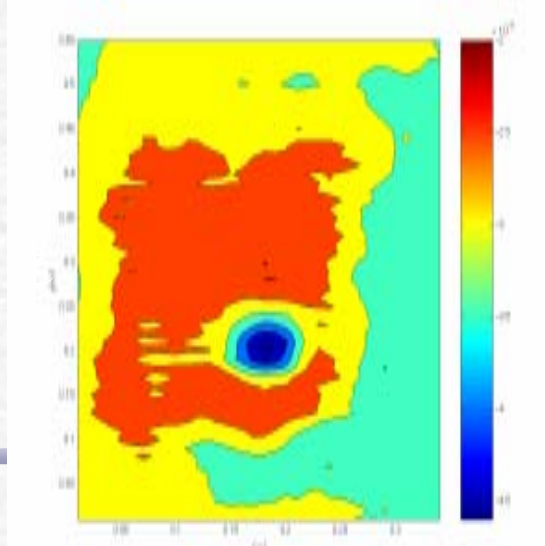
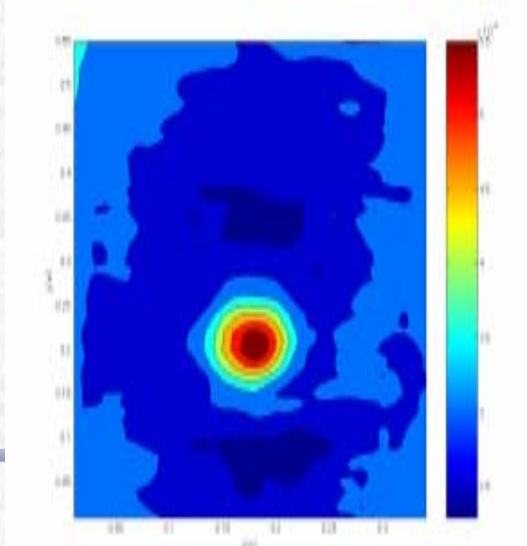
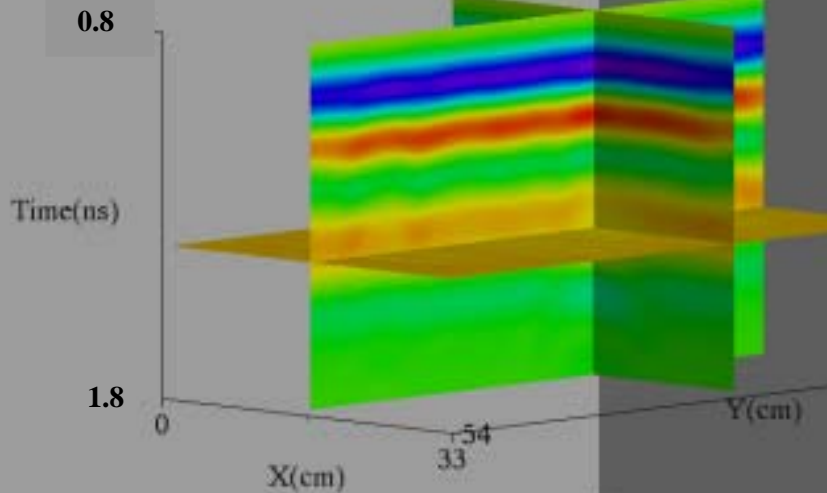


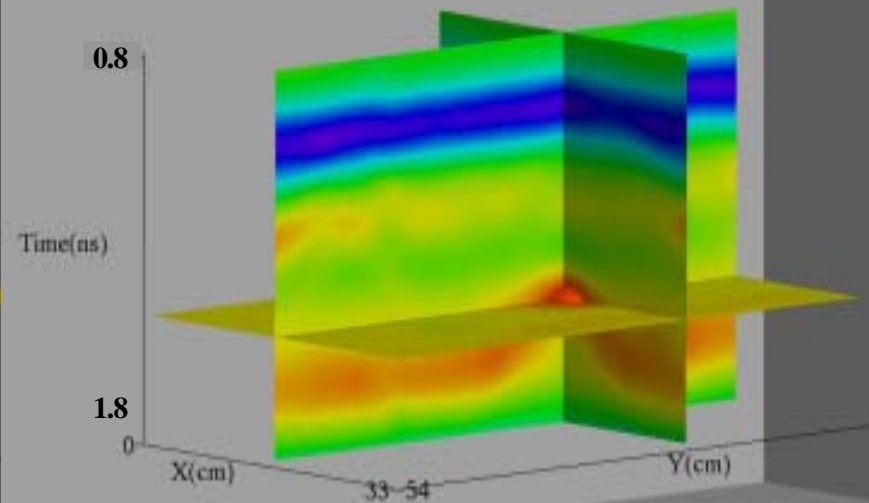
Image at the Z=0.1672m



3D Image of GPR under a rough ground surface



Single trace

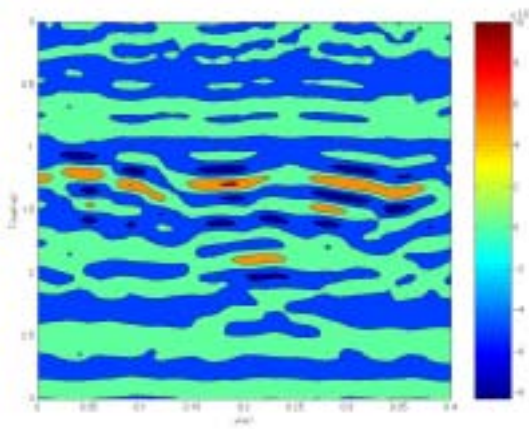


CMP Stacked trace

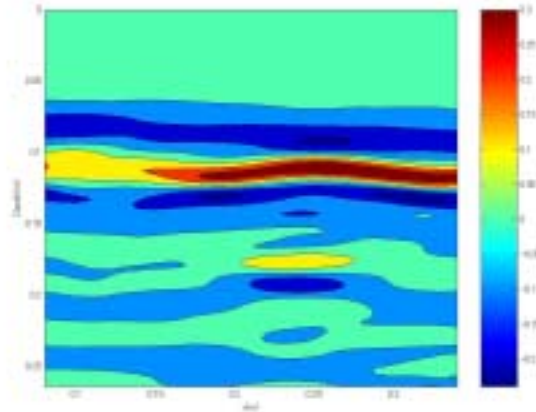
非常に粗い表面モデル



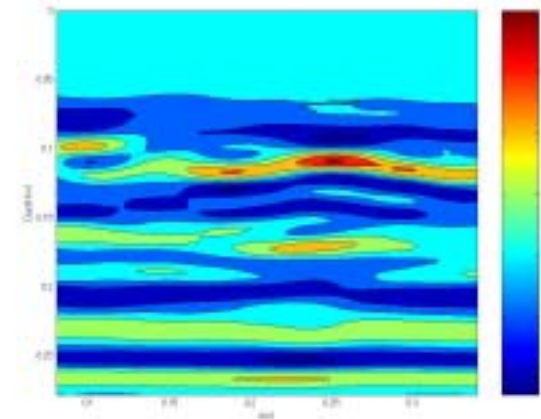
Vertical Slice



Common Offset

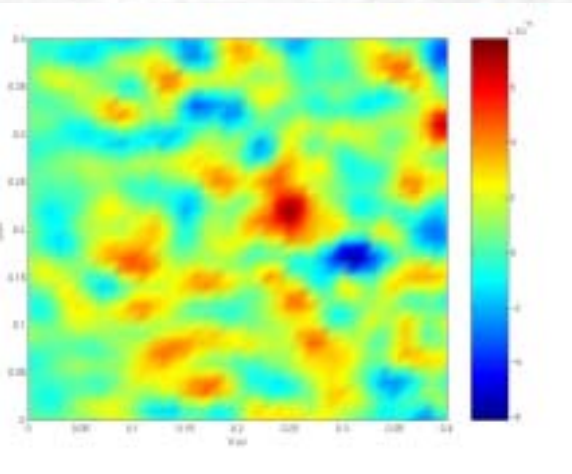


Common Offset +SAR

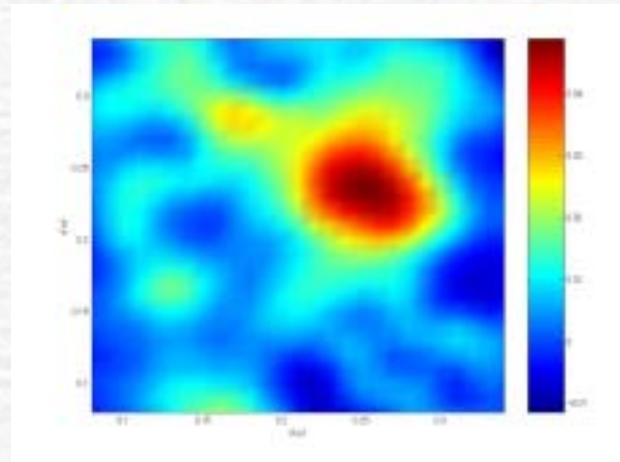


CMP+SAR

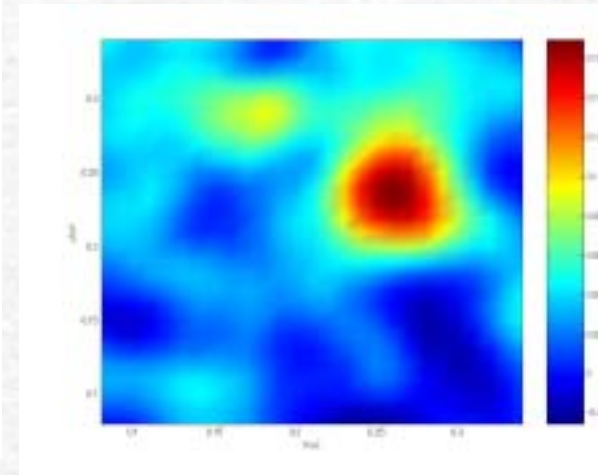
Horizontal Slice



Common Offset



Common Offset +SAR



CMP+SAR

結論

- アレイアンテナの有効性
- 最適周波数：2-10GHz
- CMP と合成開口処理の有効性確認