DP: Dielectric Properties and its Character of Red Soil from 10MHz to 2GHz

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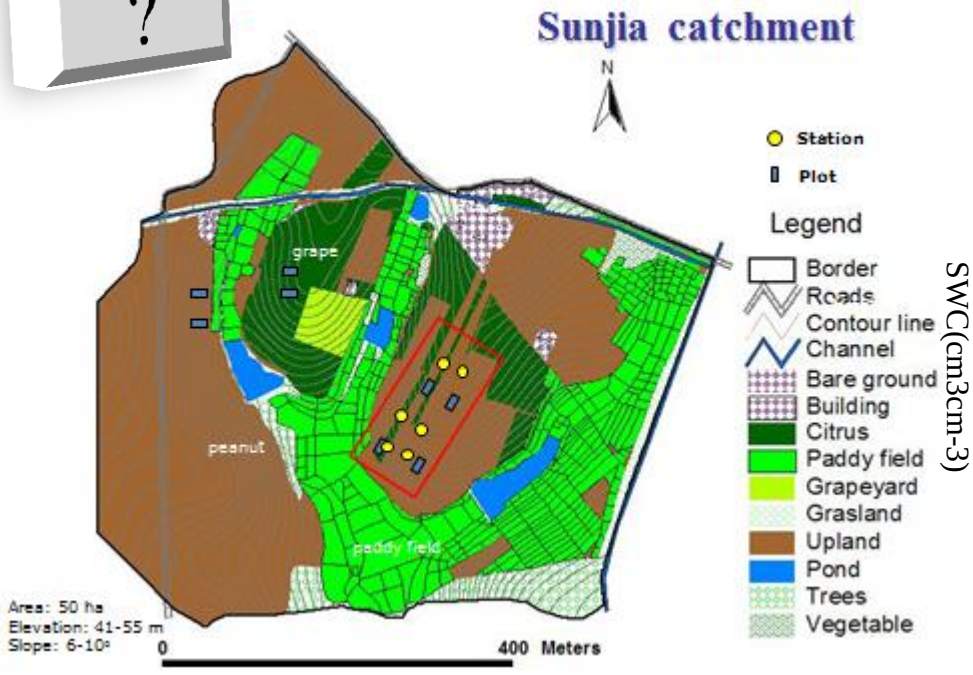
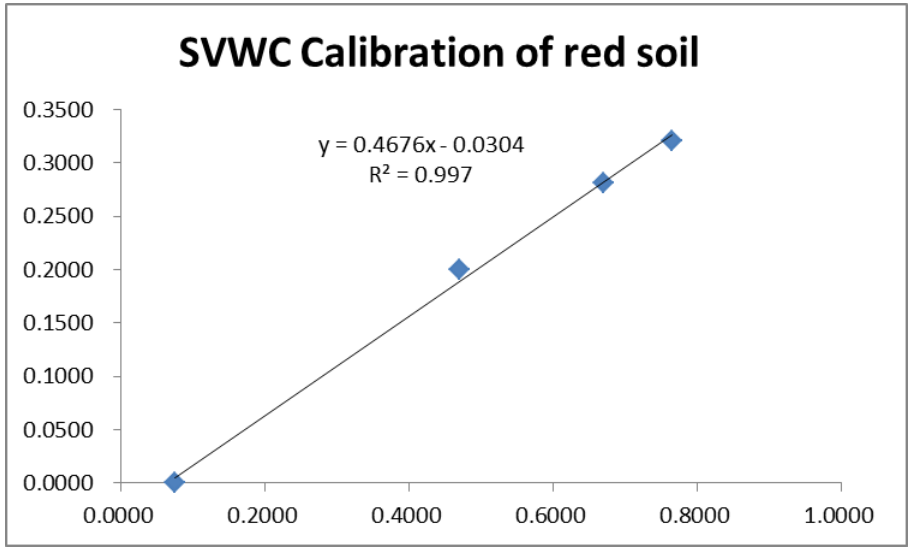
1. **Introduction**
2. **Methods**
3. **Results**

Introduction

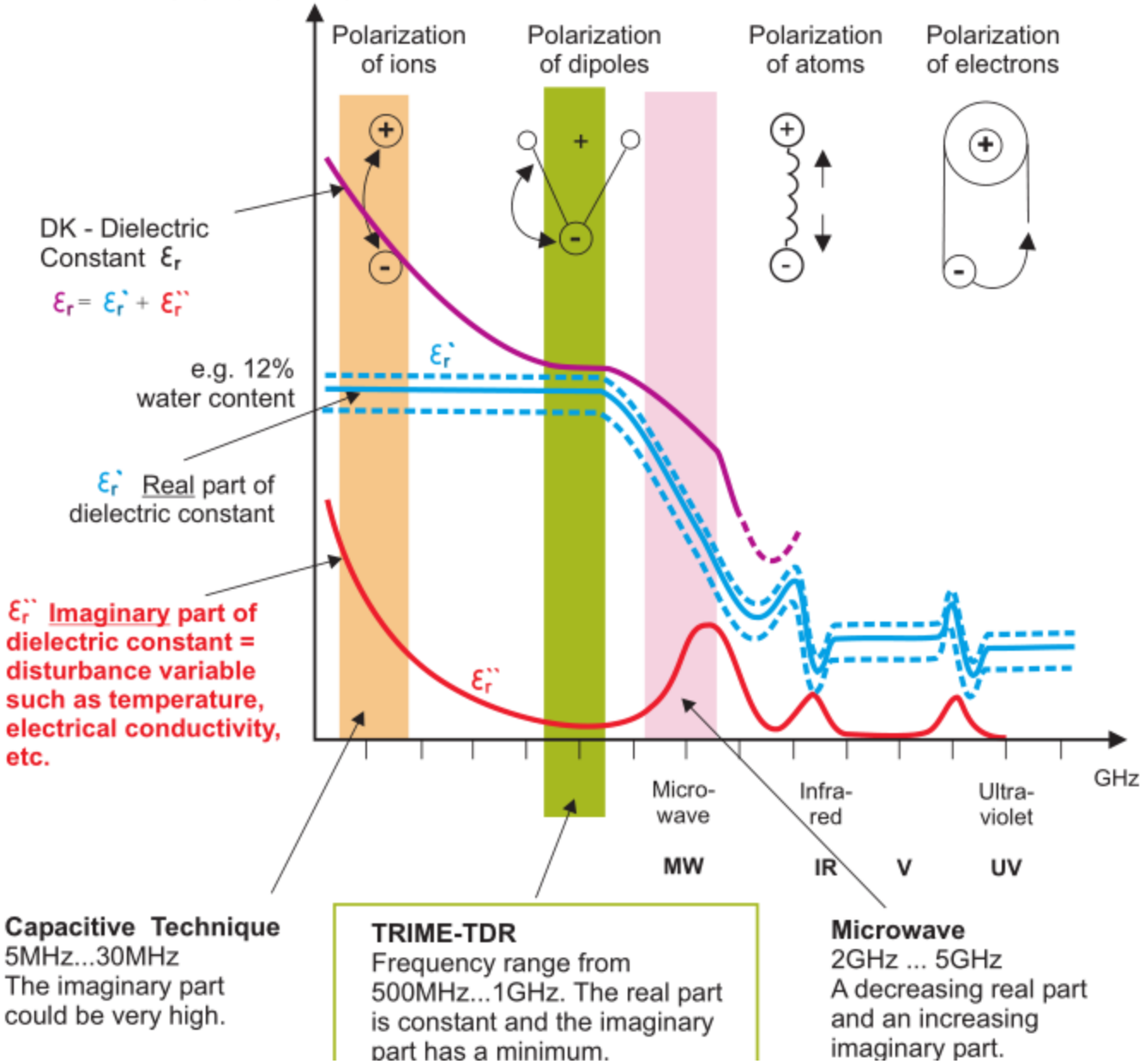
*Most data of **HP** is converted from calibration!*
Some paper said that bad Accuracy for measuring red soil by TDR and Topp said that maybe Magnetic permeability of red soil (Fe) is different with other soils. Is that correct?

?





Introduction



1. TDR measures DK (apparent dielectric constant)。

2. Assumptions: DK is determined by the real part, the imaginary part (loss) is ignored.

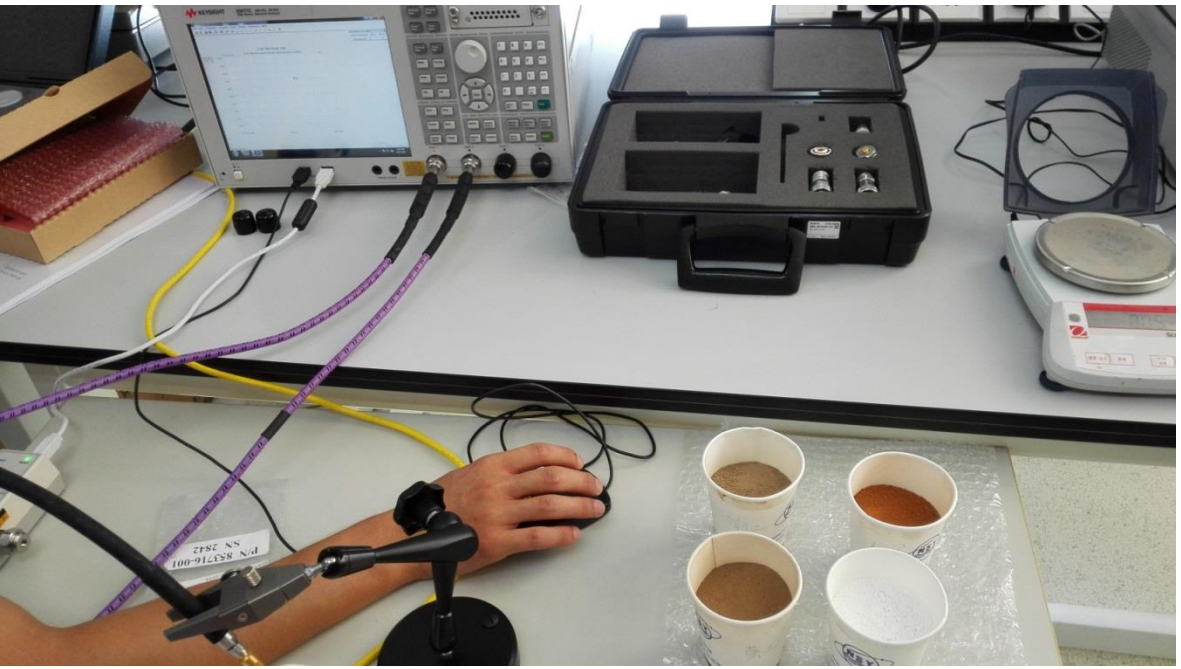
From IMKO

Scientific issues:

1. IMKO published that real part of wet soil (12%)dielectric constant is insensitive with frequency(5MHz-1GHz). And imagination part of that soil could be very high(5MHz-30MHz). Is that conclusion correct? and is high imagination part value as a result of low frequency?
2. What is the real Dielectric Properties of red soil and wet red soil?
3. TDR applies high frequency(normally up to 1GHz) to get the appearance dielectric constant. Can we apply low frequency to measure soil water content accurately?

Methods

VNA:N5071, Probe:N1501A kit



COAXIAL PROBE METHOD

Three calibration points:
(i) the shorted sensor at the place where the rods are connected with the epoxy
resin enclosure (Z = 0 + j0),
(ii) the sensor in air (Z = 1 + j0),
(iii)the sensor fully inserted in water from the Debye model.

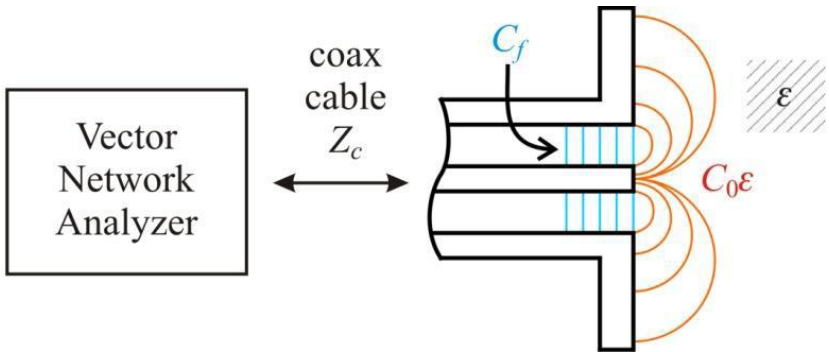
Debye model:

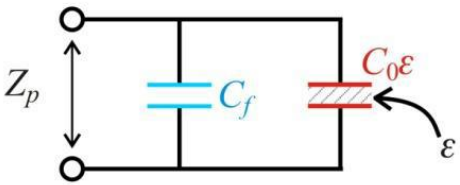
$\varepsilon_r(\omega)=\varepsilon_\infty+[\,\varepsilon(0)-\varepsilon_\infty]\,/(1+i\,\omega\tau)$

$\varepsilon_r' = \varepsilon_\infty+[\,\varepsilon(0)-\varepsilon_\infty]\,/(1+\omega^2\tau^2)$

$\varepsilon_r'' = [\,\varepsilon(0)-\varepsilon_\infty]\,\omega\tau\,/(1+\omega^2\tau^2)$

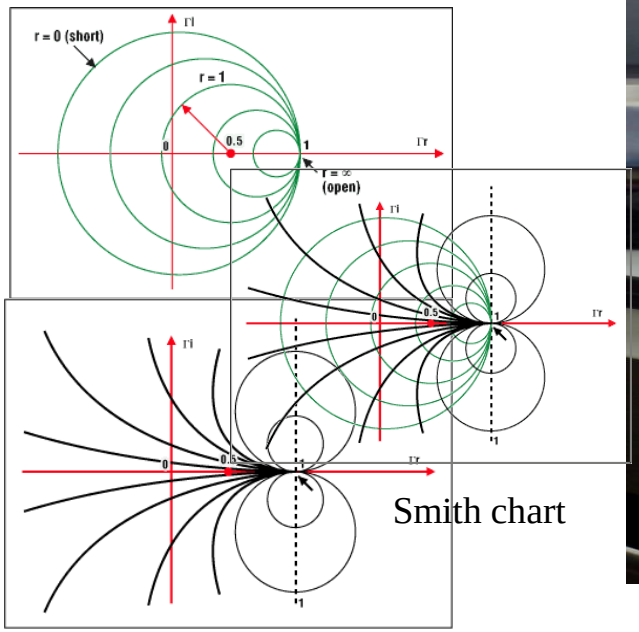
$tg\delta=\varepsilon_r''/\varepsilon_r'$



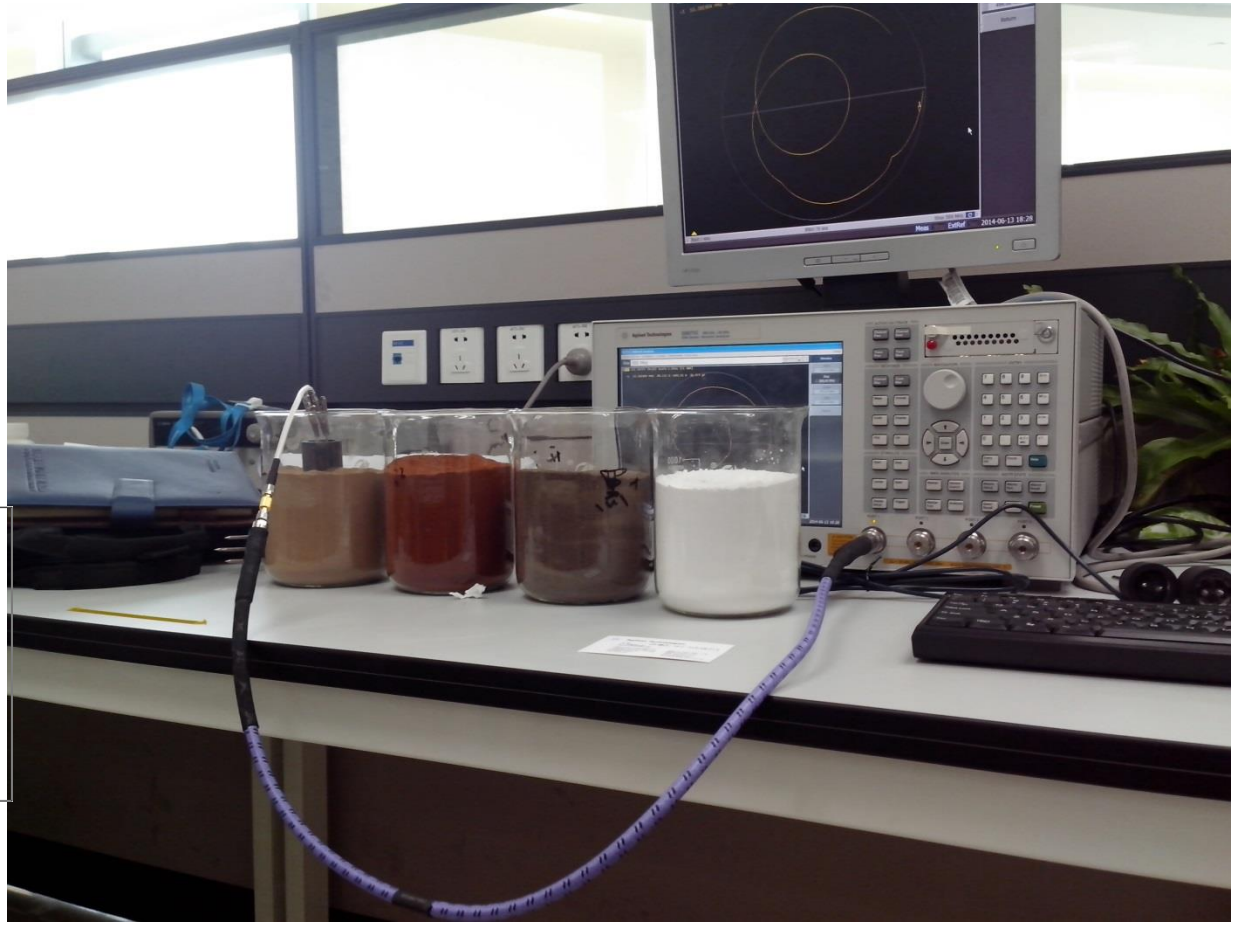


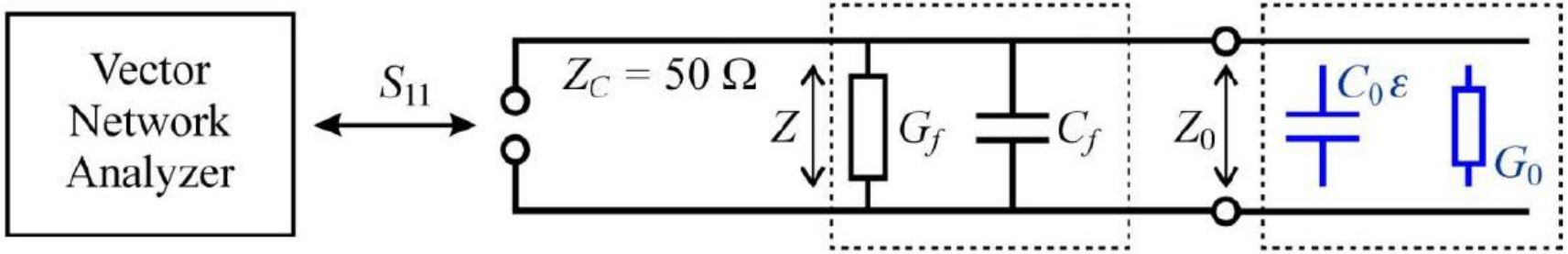
Methods

VNA:N5071,
Probe: Homemade

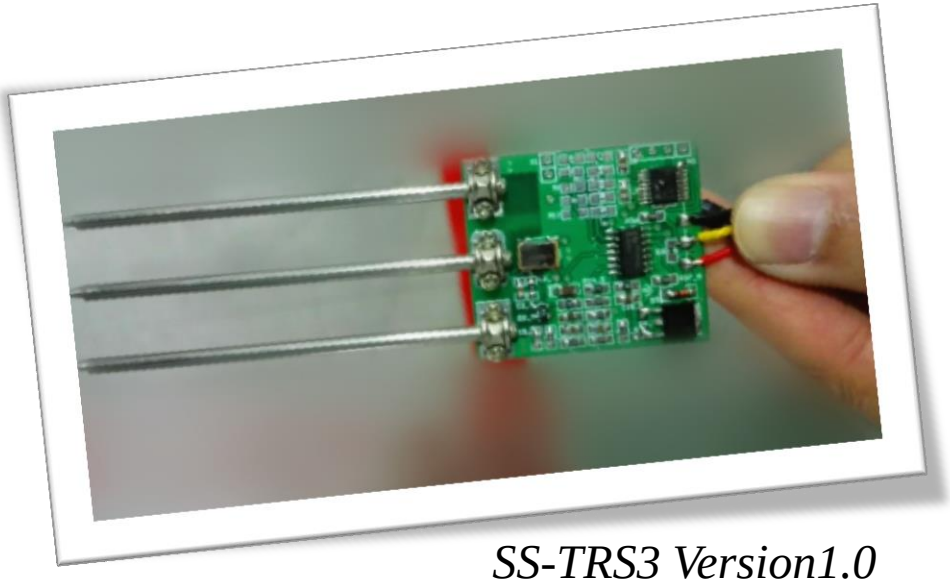


Smith chart

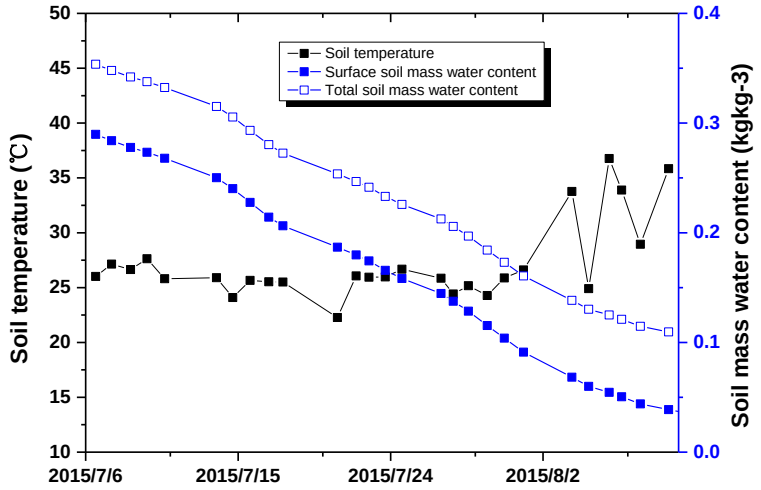




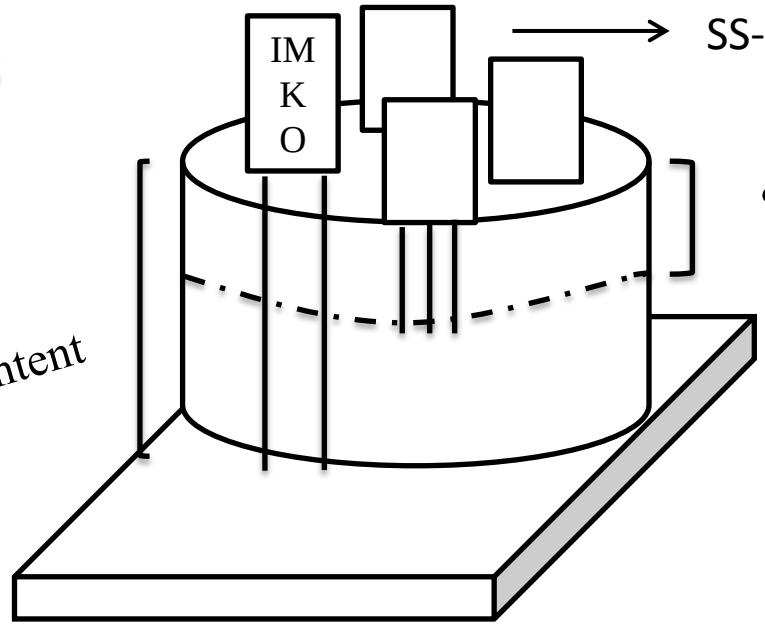
Methods



SS-TRS3 Version1.0



Methods



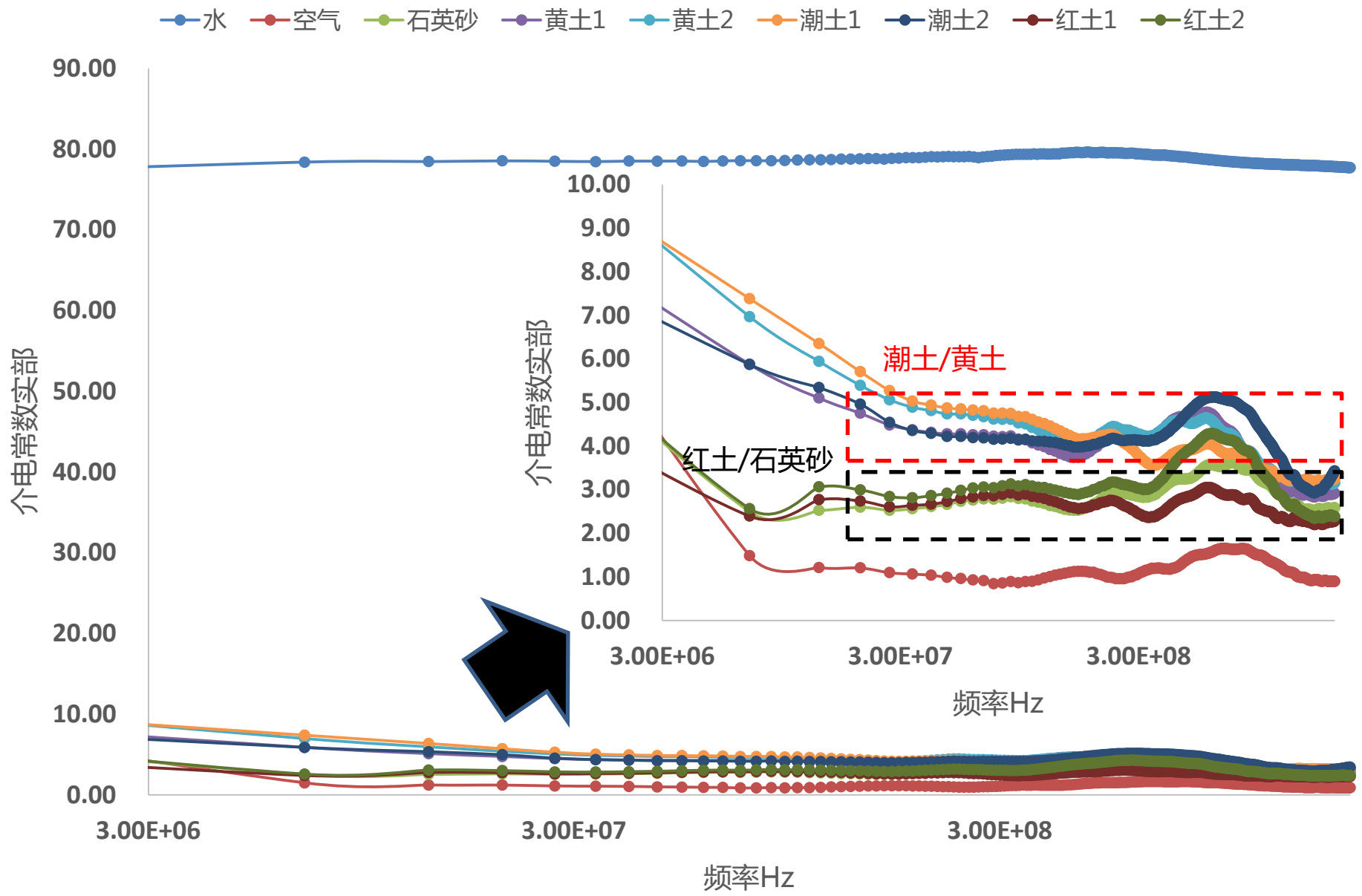
$$\theta_{Total\_volumetric\_soilwater} = \frac{m_{Total\_water\_added} - \Delta m_{water}}{V_{soilcontainer}} + \theta_{airdry\_volumetric\_soilwater}$$

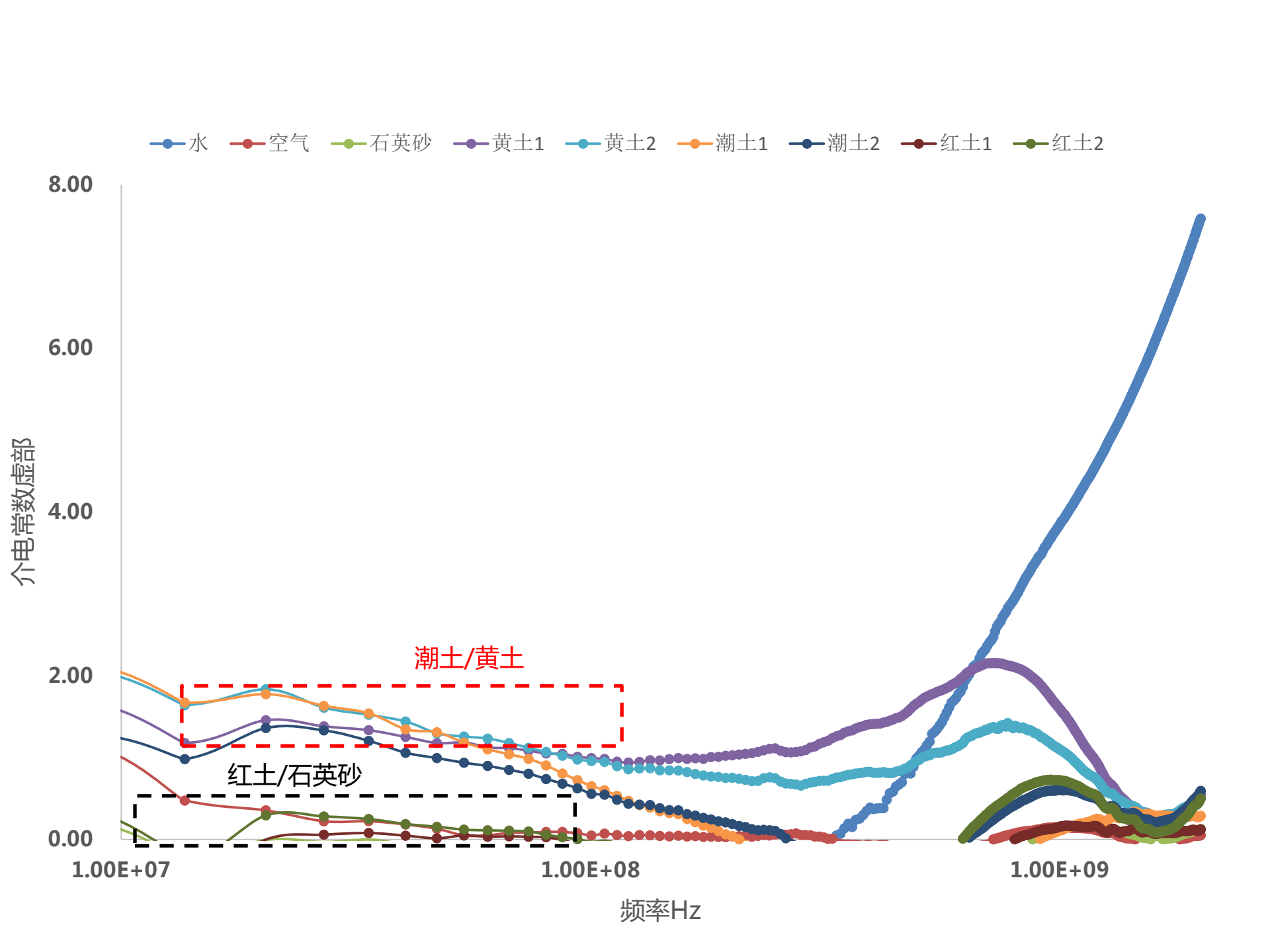
$$\theta_{Total\_mass\_soilwater} = \theta_{Total\_volumetric\_soilwater} / BD$$

$$\theta_{Surface\_mass\_soilwater} = \Delta\theta_{total\_mass\_soilwater} + \theta_{final\_mass\_soilwater}$$

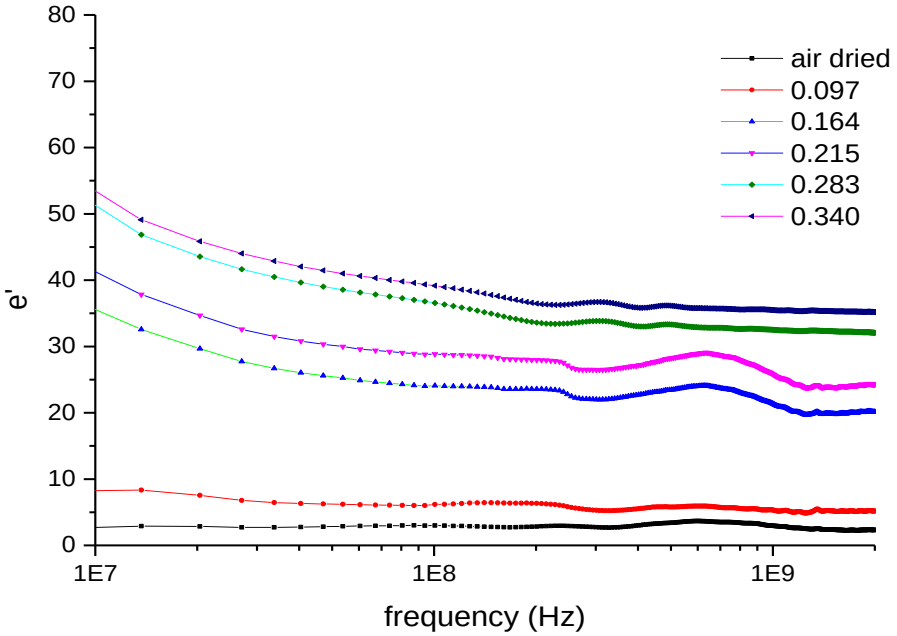
$$\theta_{Surface\_volumetric\_soilwater} = \theta_{Surface\_mass\_soilwater} \times BD$$

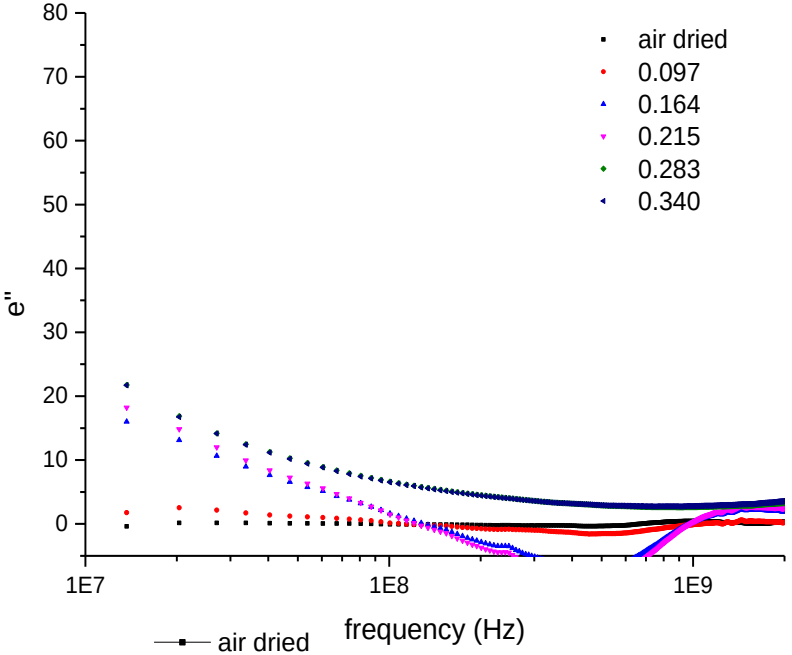
R1:Dielectric Properties of red soil & wet red soil

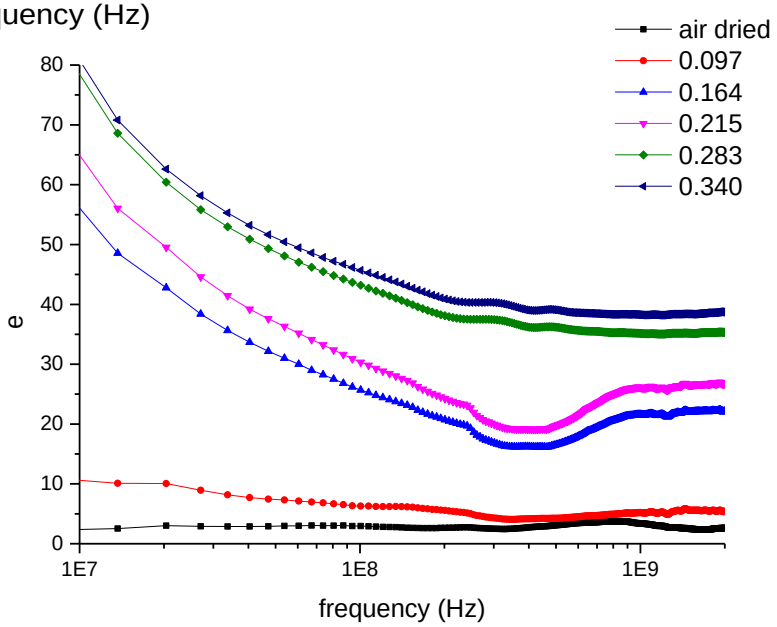



水
空气
石英砂
黄土1
黄土2
潮土1
潮土2
红土1
红土2
8.00
6.00
4.00
2.00
0.00
介电常数虚部
潮土/黄土
红土/石英砂
1.00E+07
1.00E+08
1.00E+09
频率Hz

R1:Dielectric Properties of red soil & wet red soil

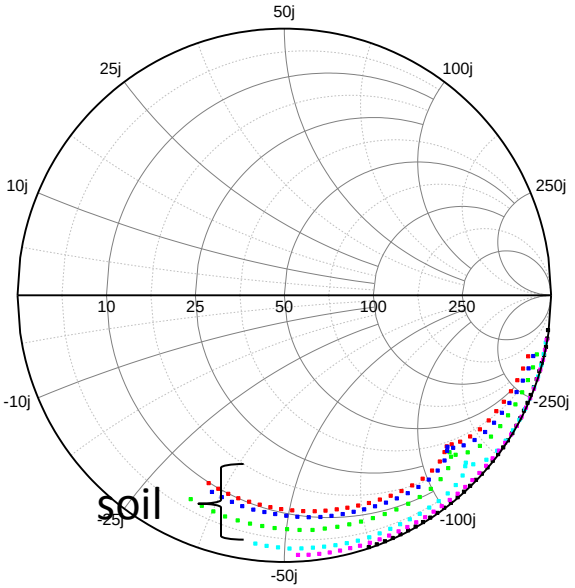




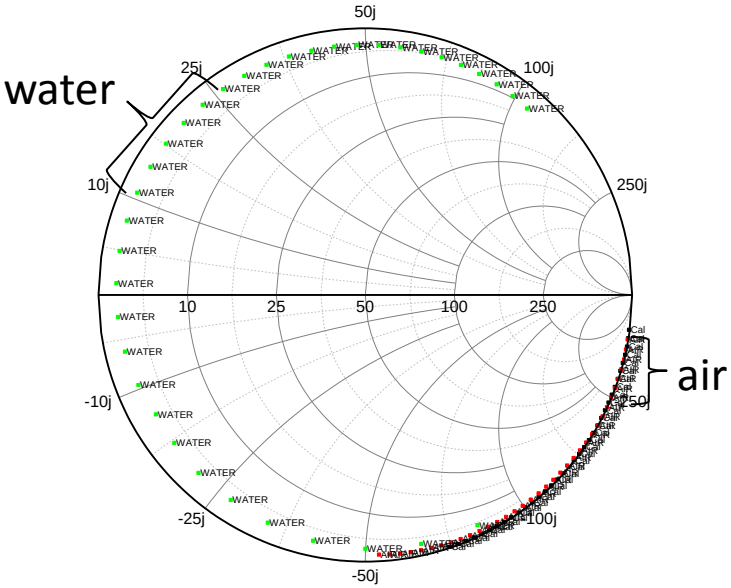


R2:Impedance characteristic of air, soil, water etc.

(10MHz-100MHz)



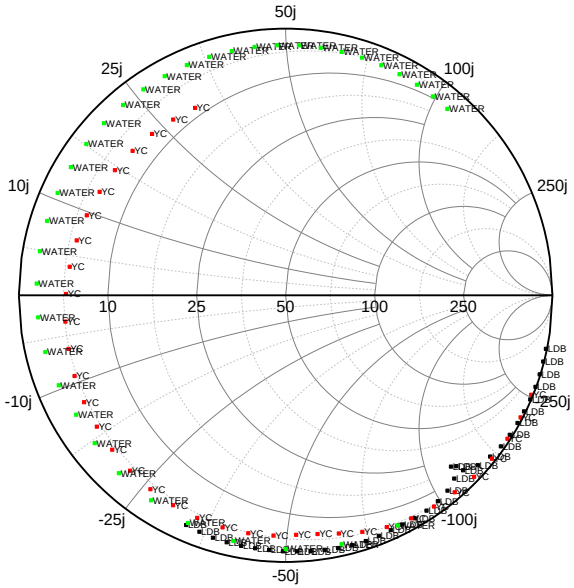
Air / Soil



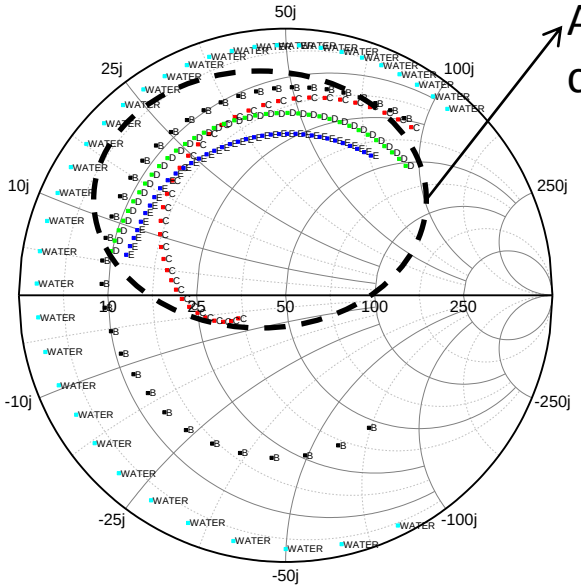
Air / Water

R2:Impedance characteristic of air, soil, water etc.

(10MHz-100MHz)



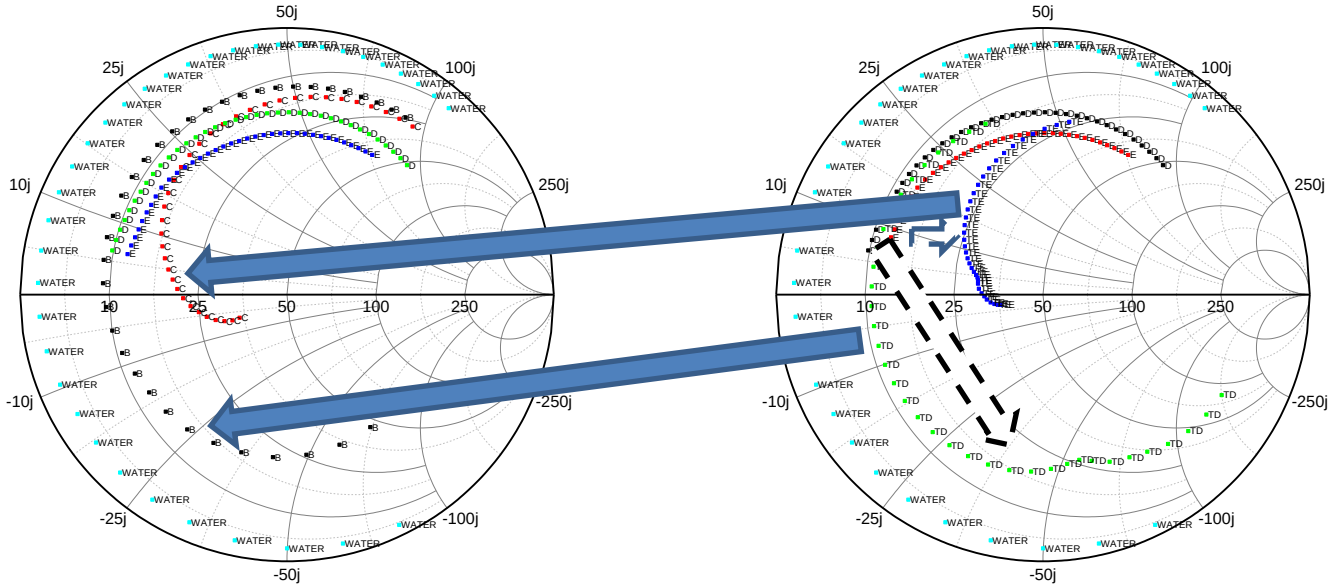
Deionized water
/other Solvent



Deionized water
/Potassium chloride solution

R2:Impedance characteristic of air, soil, water etc.

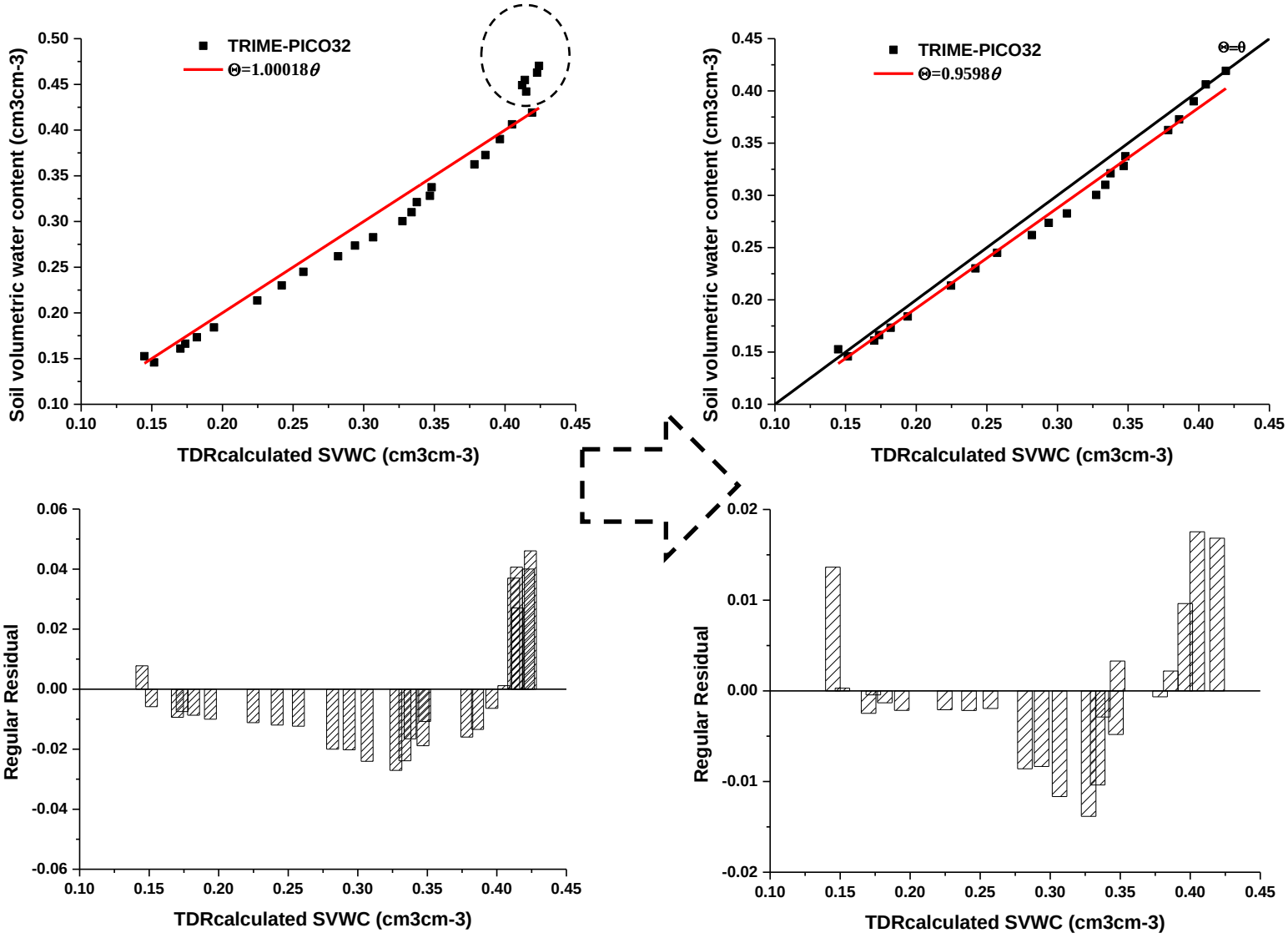
(10MHz-100MHz)



Deionized water
/Potassium chloride solution

Potassium chloride solution
/Coating isolation technology

R3:Verification results of TRIME-PICO32&SS-TRS3



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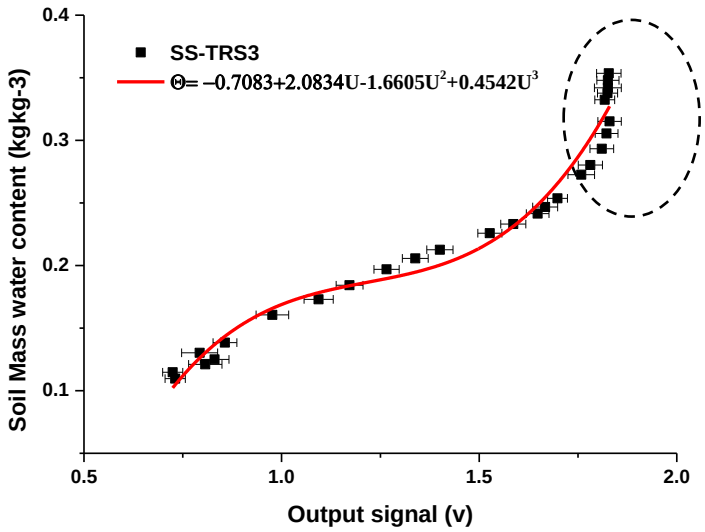

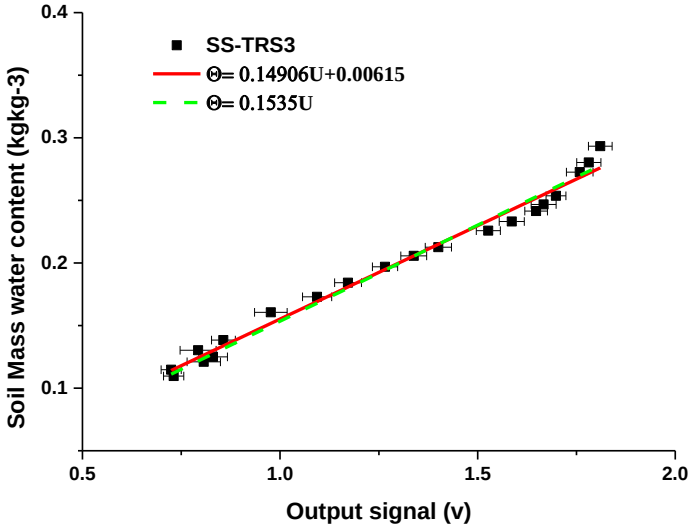

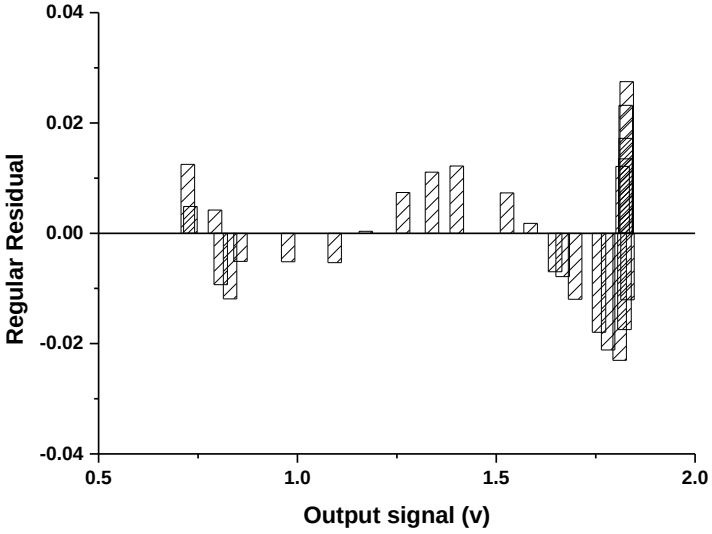

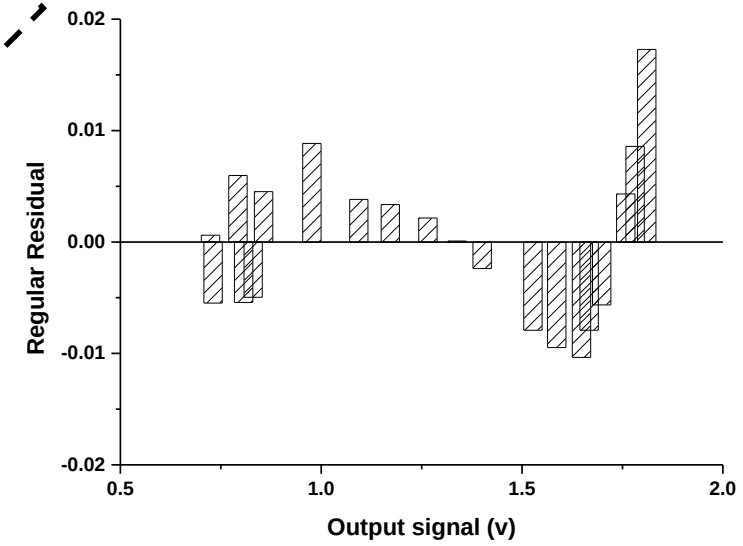

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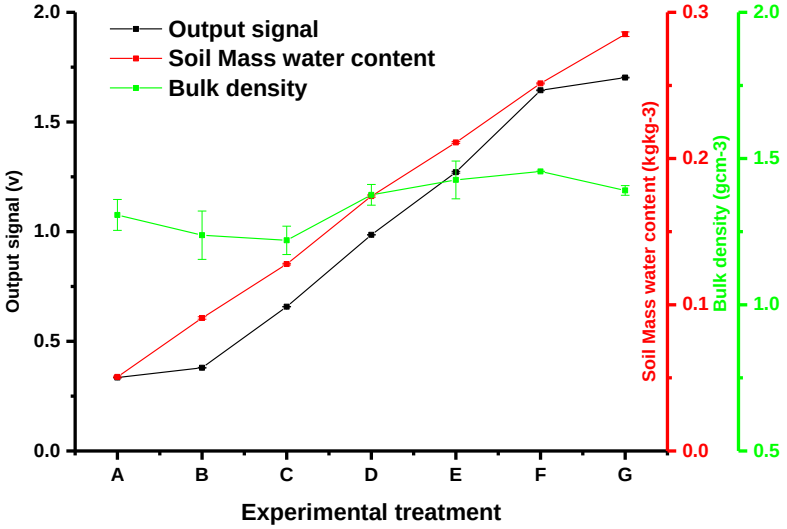
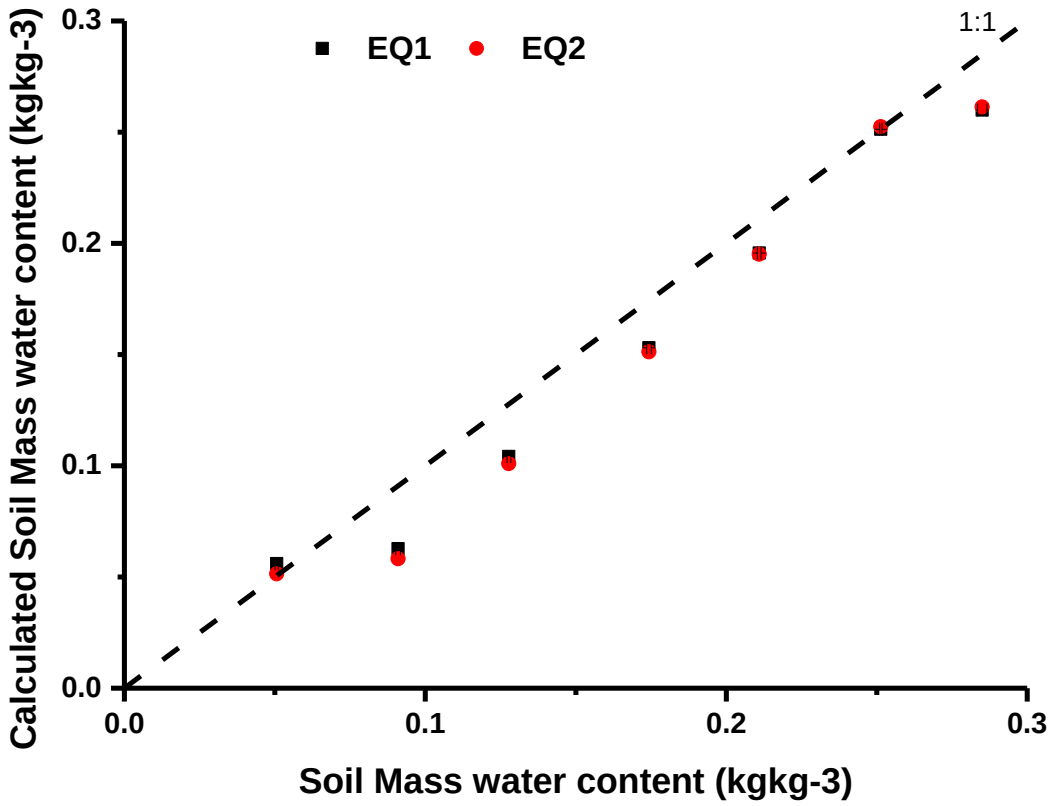


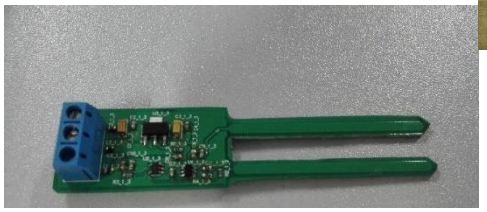
R3:Verification results of TRIME-PICO32&SS-TRS3



EQ1: Θ= 0.14906U+0.00615
EQ2: Θ= 0.1535U

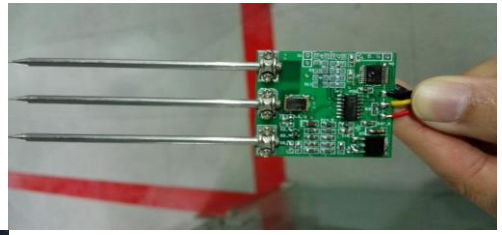
while Θ is from 0 to 0.3kgkg-1(0-0.4cm3cm-3)

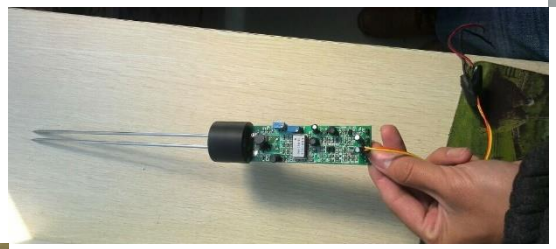
SoilSensor-SW40X-series

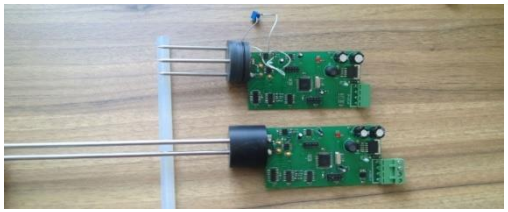


Type	Soil Temperature Range ℃	Soil Volume content Range m^3m^{-3}	Output signal	Release Date as Plan
SW401	-	0-50% Saturation	500-1200mV	2015.12
SW402	-10 to 85	0-50% Saturation	SDI-12	2016.12
SW403	-10 to 85	0-50% Saturation	ModbusRTU（485）	2016.12

SoilSensor-SM30X-series

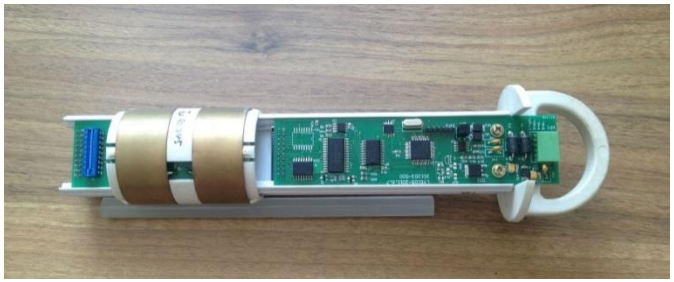


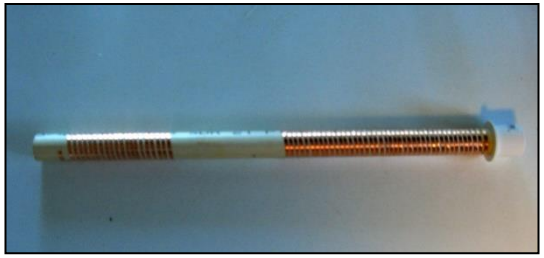




Type	Soil Temperature Range ℃	Soil Volume content Range m^3m^{-3}	Output signal	Release Date as Plan
SM301	-10 to 85	0-50% Saturation	ModbusRTU（485）	2016.12
SM302	-10 to 85	0-50% Saturation	SDI-12	2017.06

SoilSensor-HRC-series





Acknowledgements & Invitations

Supported by


Partners include

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Henry Lin team in PSU

Kailou Liu team in red soil institute

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