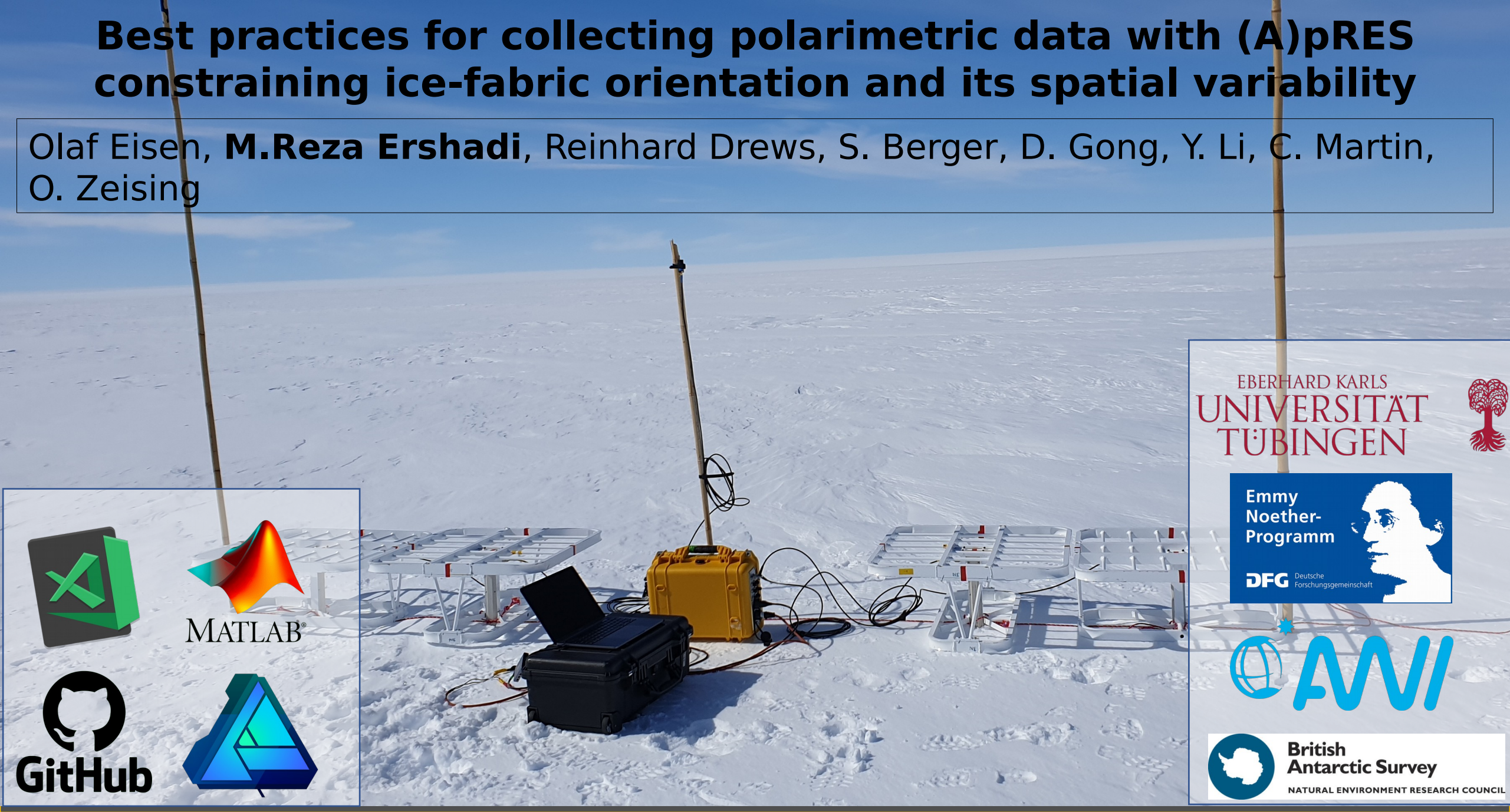
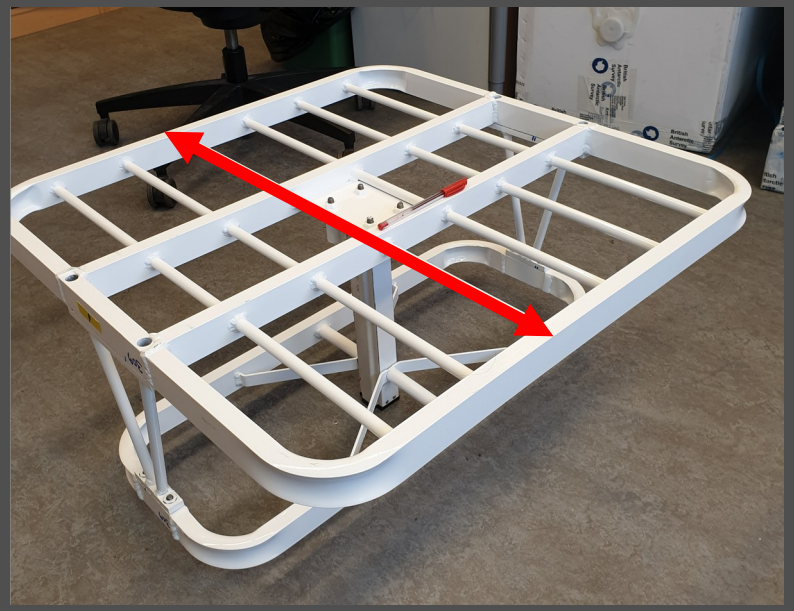
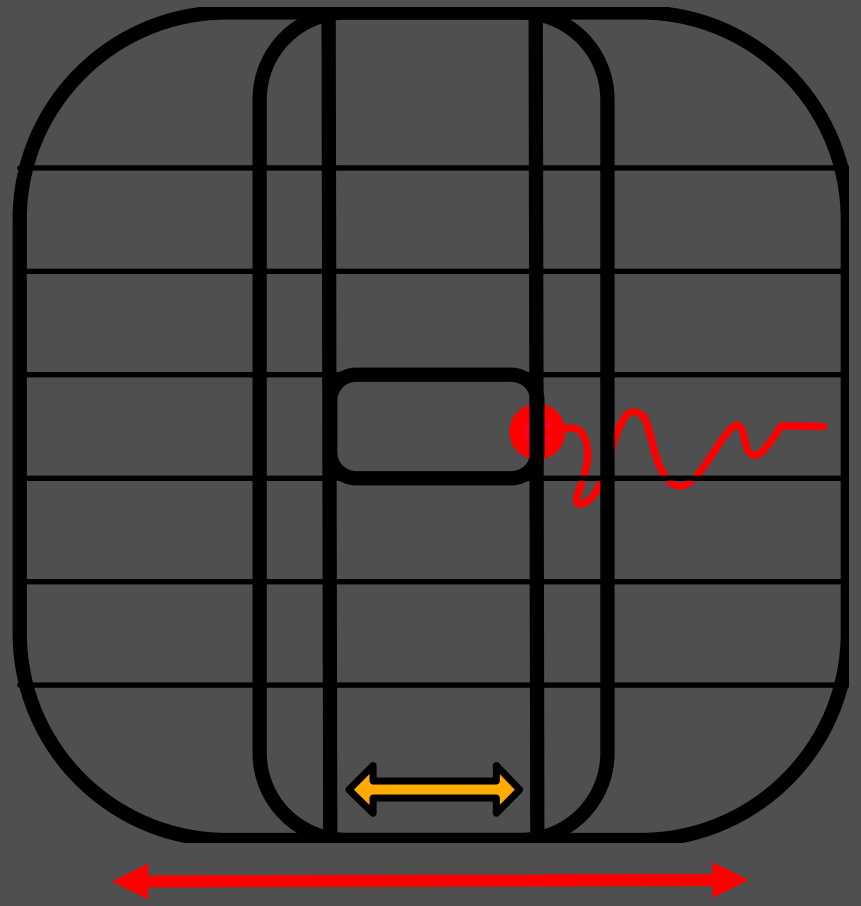
Best practices for collecting polarimetric data with (A)pRES constraining ice-fabric orientation and its spatial variability

Olaf Eisen, **M.Reza Ershadi**, Reinhard Drews, S. Berger, D. Gong, Y. Li, C. Martin, O. Zeising



(A)pRES





Literatures about (A)pRES infereing ice fabric anisotropy

A Polarimetric Coherence Method to Determine Ice Crystal Orientation Fabric From Radar Sounding: Application to the NEEM Ice Core Region

Thomas M. Jordan, Dustin M. Schroeder, *Senior Member, IEEE*, Davide Castelletti, *Member, IEEE*, Jilu Li, *Senior Member, IEEE*, and Jørgen Dall, *Member, IEEE*

Jordan et al. 2019

Rapid and accurate polarimetric radar measurements of ice crystal fabric orientation at the Western Antarctic Ice Sheet (WAIS) Divide deep ice core site

Tun Jan Young[1], Carlos Martín[2], Poul Christoffersen[1], Dustin M. Schroeder[3,4], Slawek M. Tulaczyk[5], and Eliza J. Dawson[3]

Young et al. 2020

On the Limitations of Using Polarimetric Radar Sounding to Infer the Crystal Orientation Fabric of Ice Masses

Nicholas M. Rathmann[1], David A. Lilien[1,2], Aslak Grinsted[1], Tamara A. Gerber[1], Tun Jan Young[3], and Dorthe Dahl-Jensen[1,2]

Rathmann et al. 2022

Estimation of ice fabric within Whillans Ice Stream using polarimetric phase-sensitive radar sounding

Thomas M. Jordan[1,2], Dustin M. Schroeder[1,3], Cooper W. Elsworth[1] and Matthew R. Siegfried[1,4]

Jordan et al. 2020

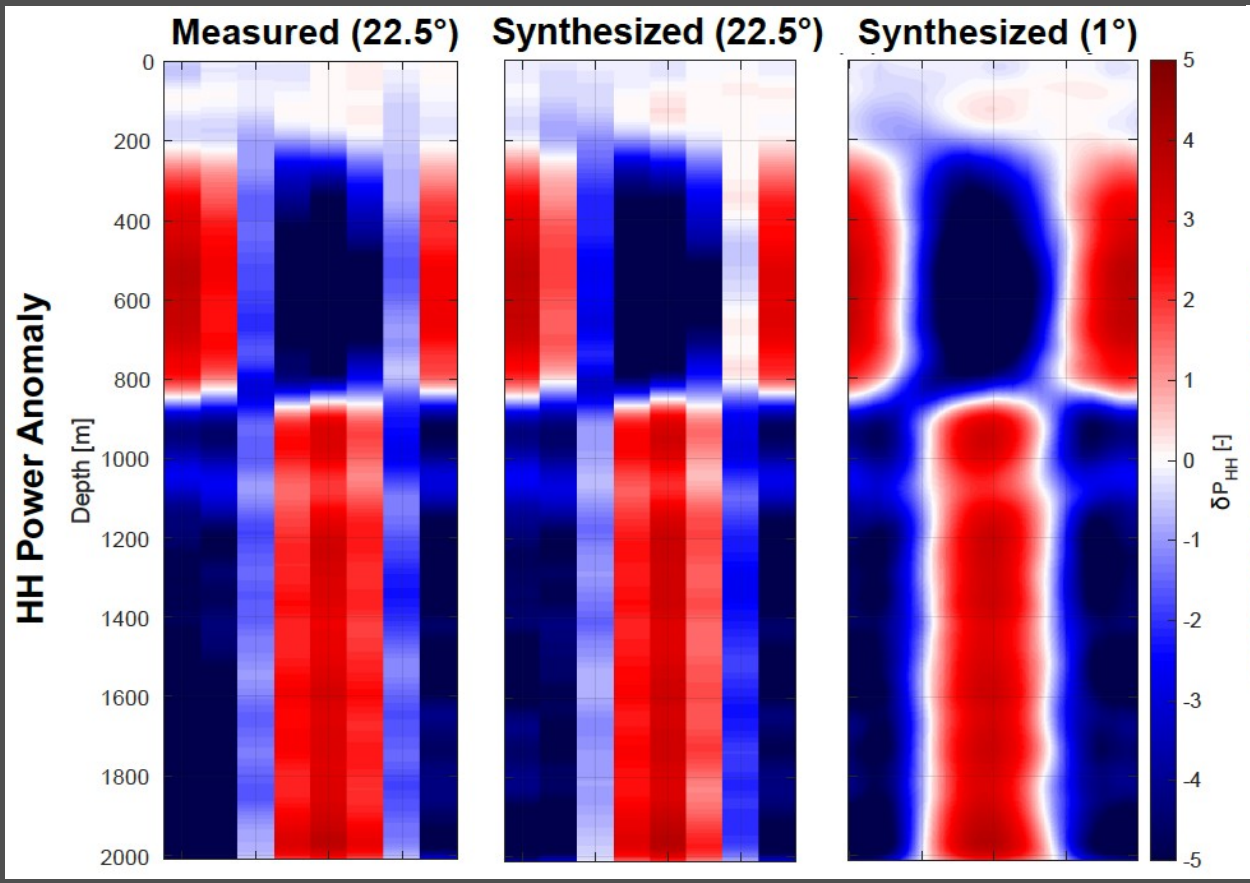
Polarimetric radar reveals the spatial distribution of ice fabric at domes and divides in East Antarctica

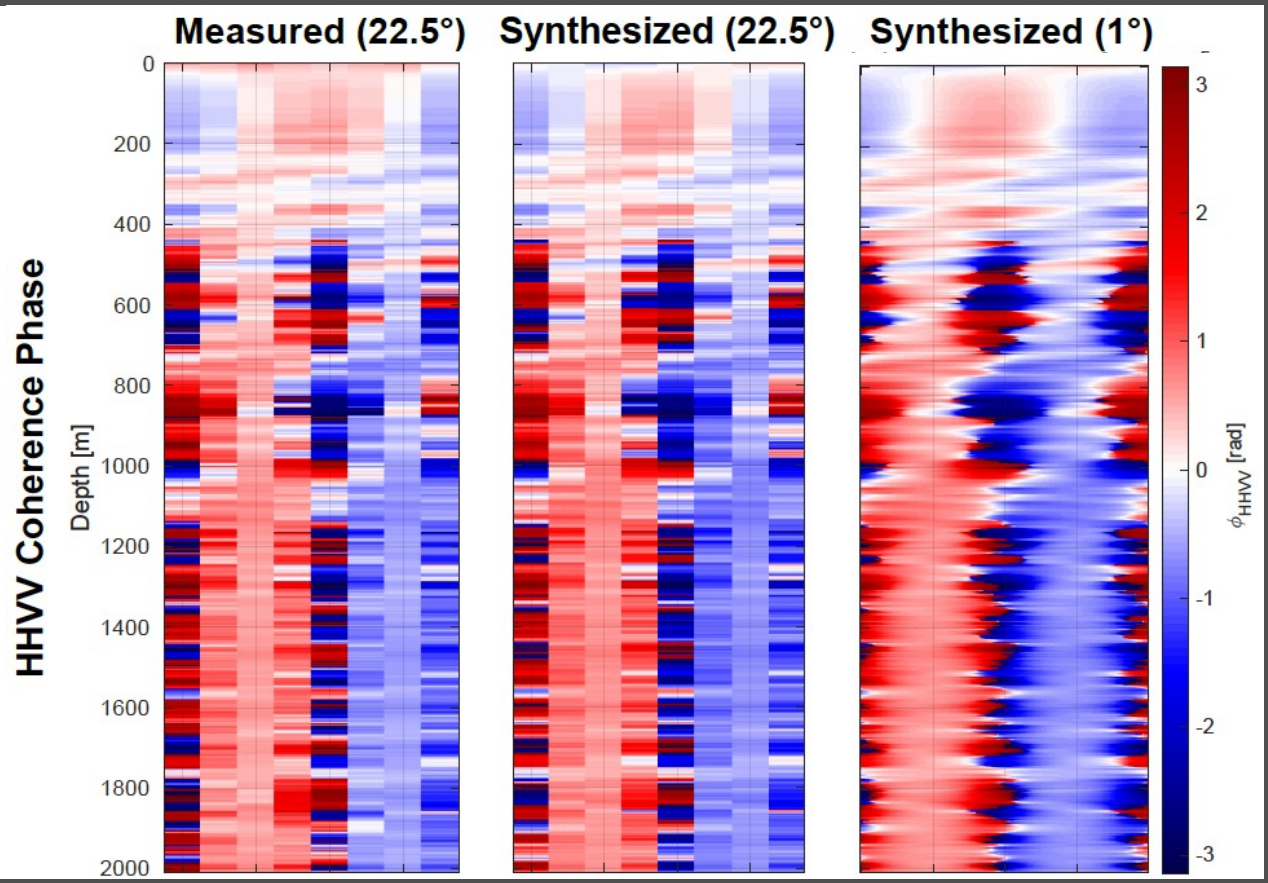
M. Reza Ershadi[1], Reinhard Drews[1], Carlos Martín[2], Olaf Eisen[3,5], Catherine Ritz[4], Hugh Corr[2], Julia Christmann[3,6], Ole Zeising[3,5], Angelika Humbert[3,5], and Robert Mulvaney[2]

Ershadi et al. 2022

Quad-pole synthesization

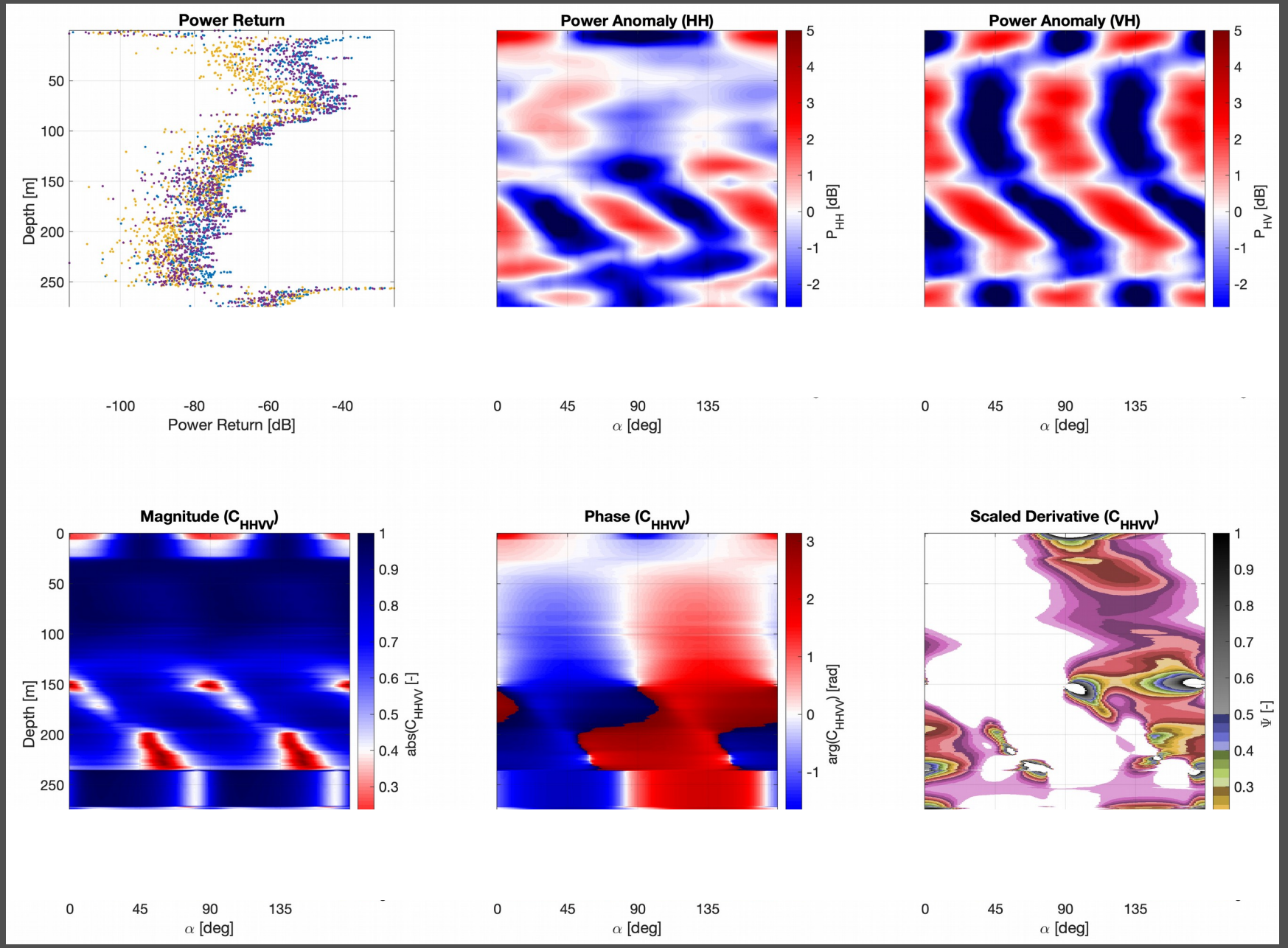
$$\begin{pmatrix} s_{HH}(\theta \pm \gamma) & s_{VH}(\theta \pm \gamma) \\ s_{HV}(\theta \pm \gamma) & s_{VV}(\theta \pm \gamma) \end{pmatrix} = \begin{pmatrix} \cos(\theta \pm \gamma) & -\sin(\theta \pm \gamma) \\ \sin(\theta \pm \gamma) & \cos(\theta \pm \gamma) \end{pmatrix} \begin{pmatrix} s_{HH}(\theta) & s_{VH}(\theta) \\ s_{HV}(\theta) & s_{VV}(\theta) \end{pmatrix} \begin{pmatrix} \cos(\theta \pm \gamma) & \sin(\theta \pm \gamma) \\ -\sin(\theta \pm \gamma) & \cos(\theta \pm \gamma) \end{pmatrix}$$



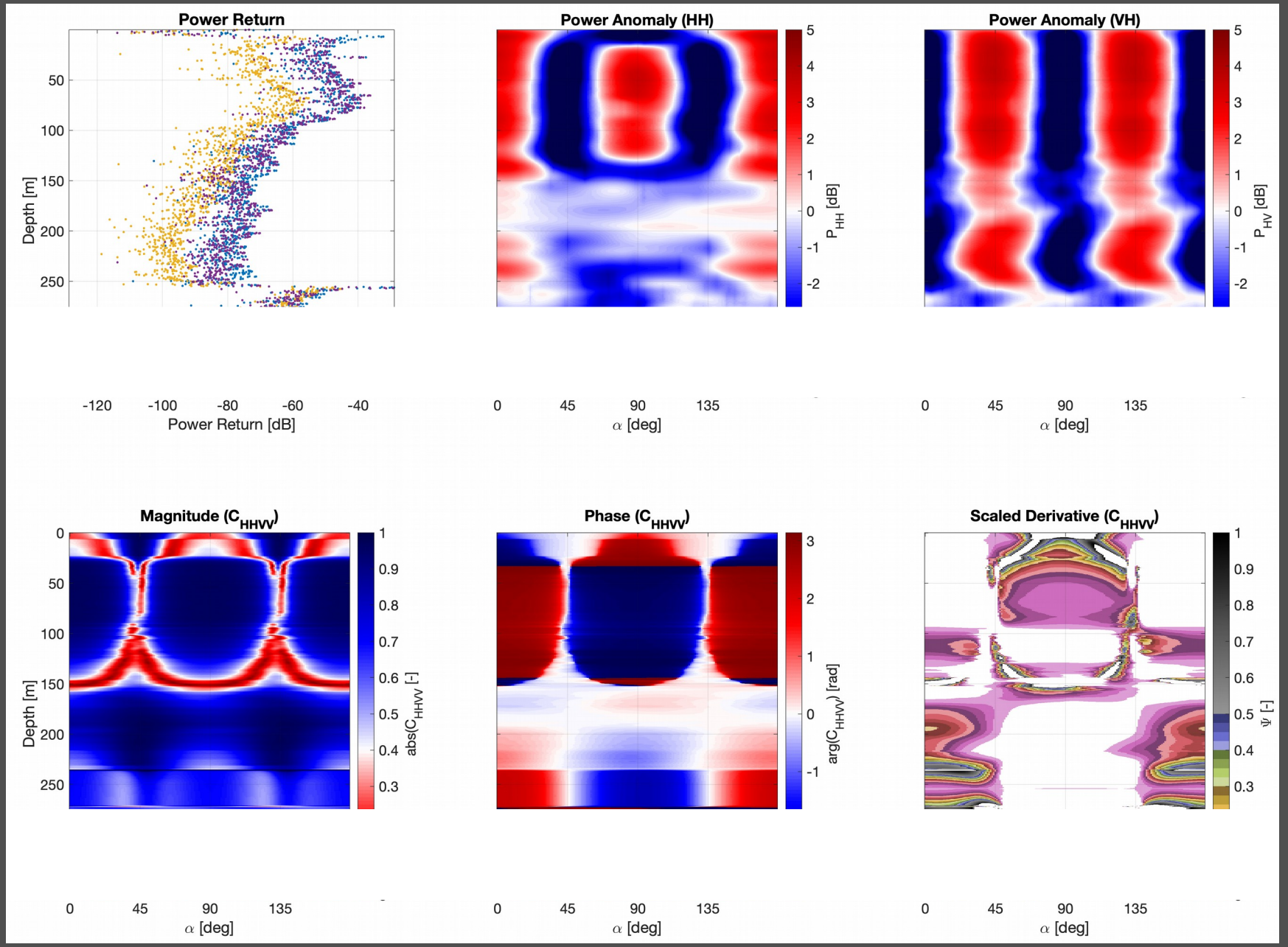


Ershadi et al. 2022

Good synthesization

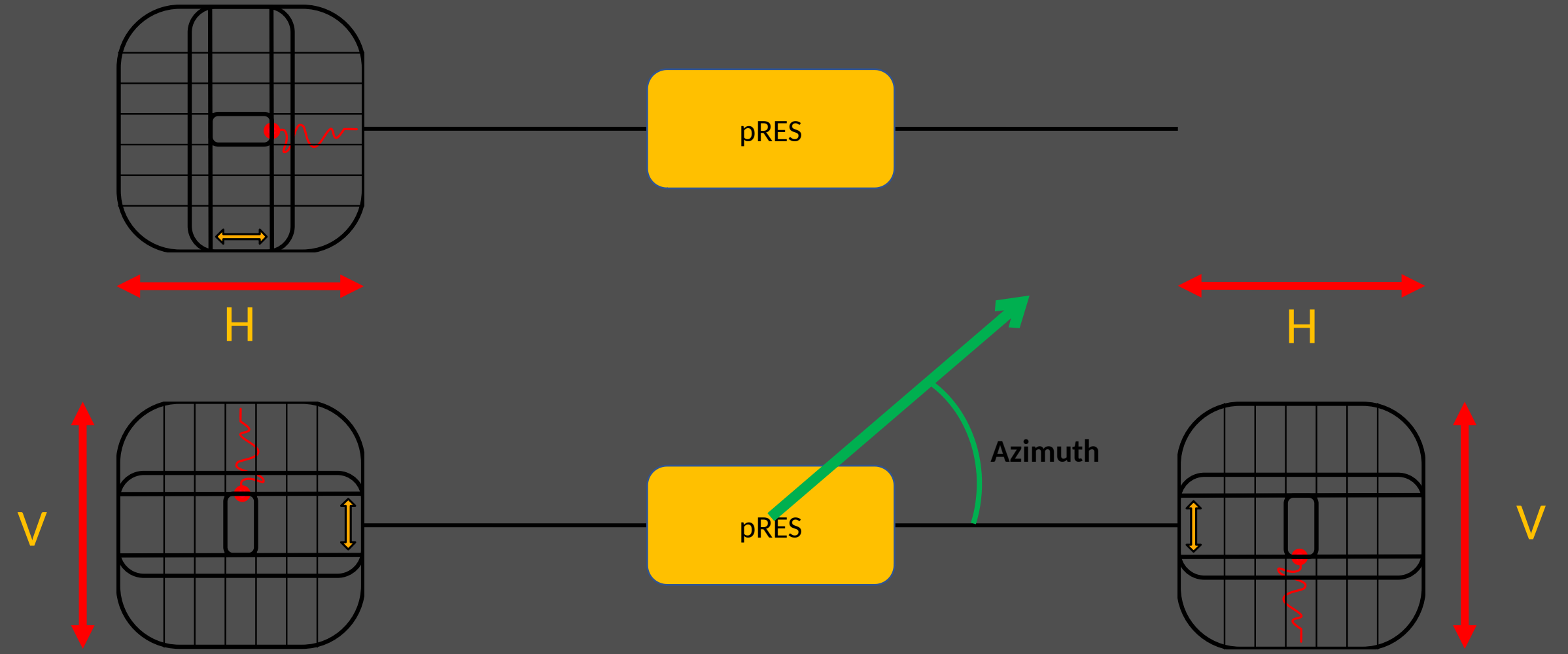


Bad synthesization

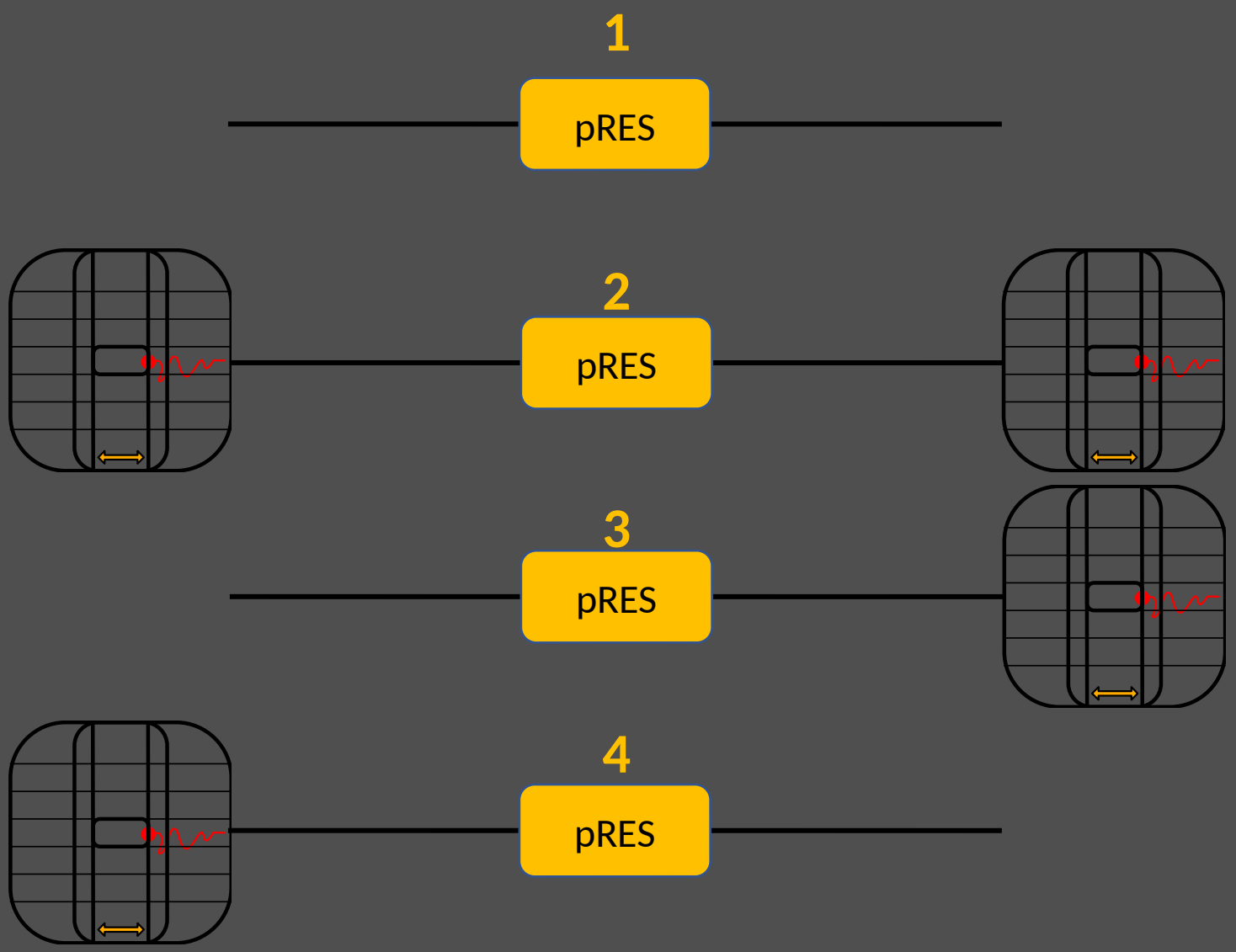


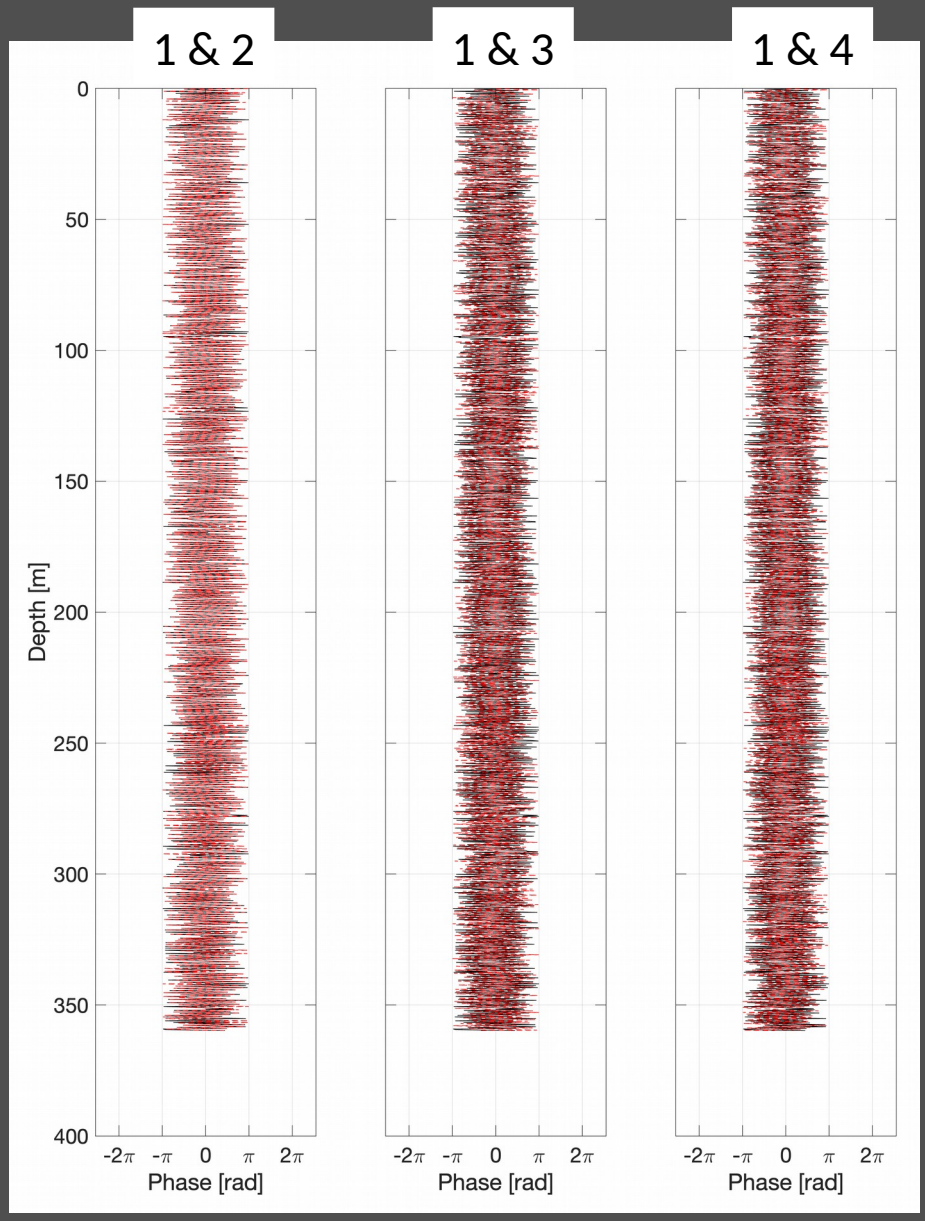
Quad-pole synthesization

$$\begin{pmatrix} s_{HH}(\theta \pm \gamma) & s_{VH}(\theta \pm \gamma) \\ s_{HV}(\theta \pm \gamma) & s_{VV}(\theta \pm \gamma) \end{pmatrix} = \begin{pmatrix} \cos(\theta \pm \gamma) & -\sin(\theta \pm \gamma) \\ \sin(\theta \pm \gamma) & \cos(\theta \pm \gamma) \end{pmatrix} \begin{pmatrix} s_{HH}(\theta) & s_{VH}(\theta) \\ s_{HV}(\theta) & s_{VV}(\theta) \end{pmatrix} \begin{pmatrix} \cos(\theta \pm \gamma) & \sin(\theta \pm \gamma) \\ -\sin(\theta \pm \gamma) & \cos(\theta \pm \gamma) \end{pmatrix}$$

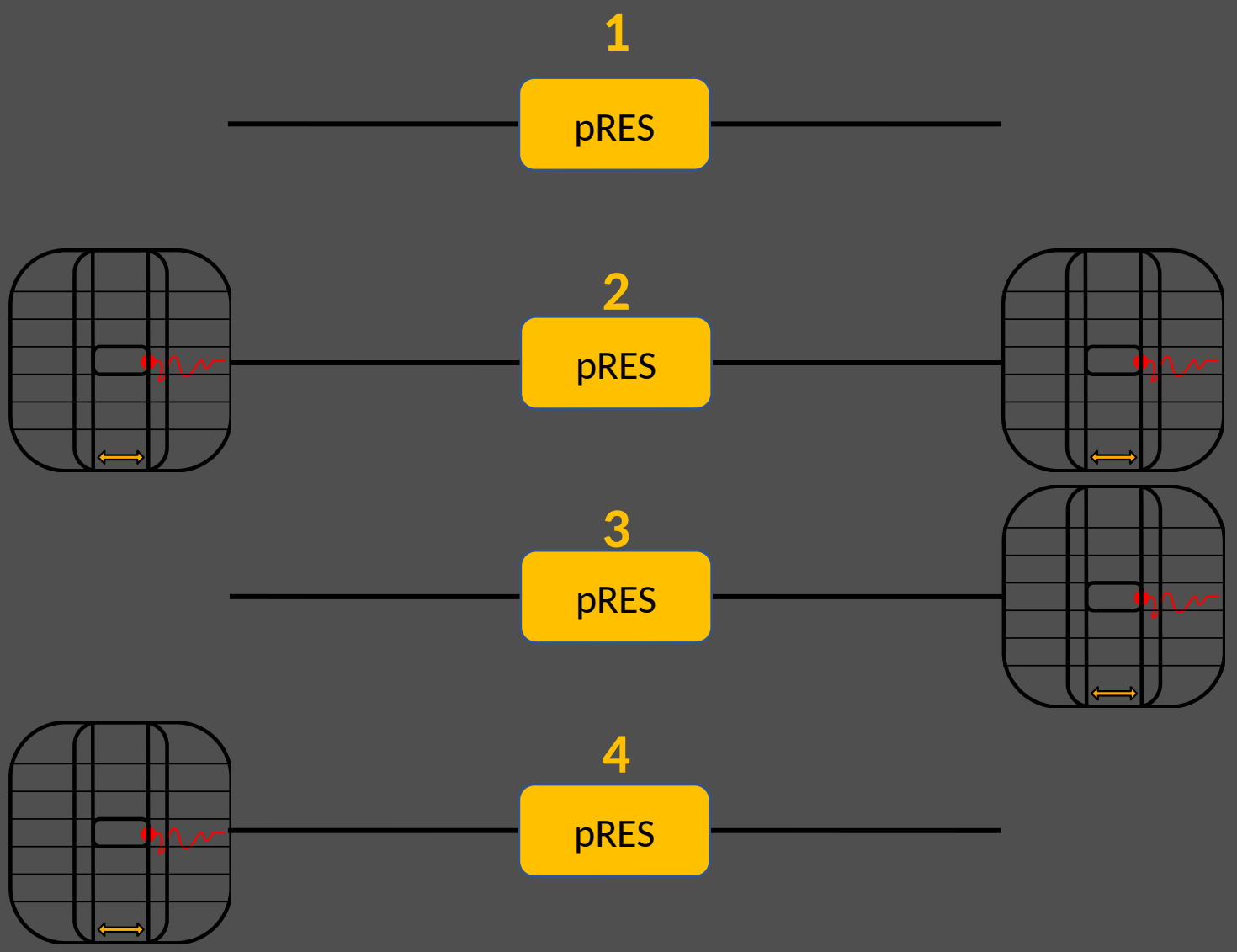


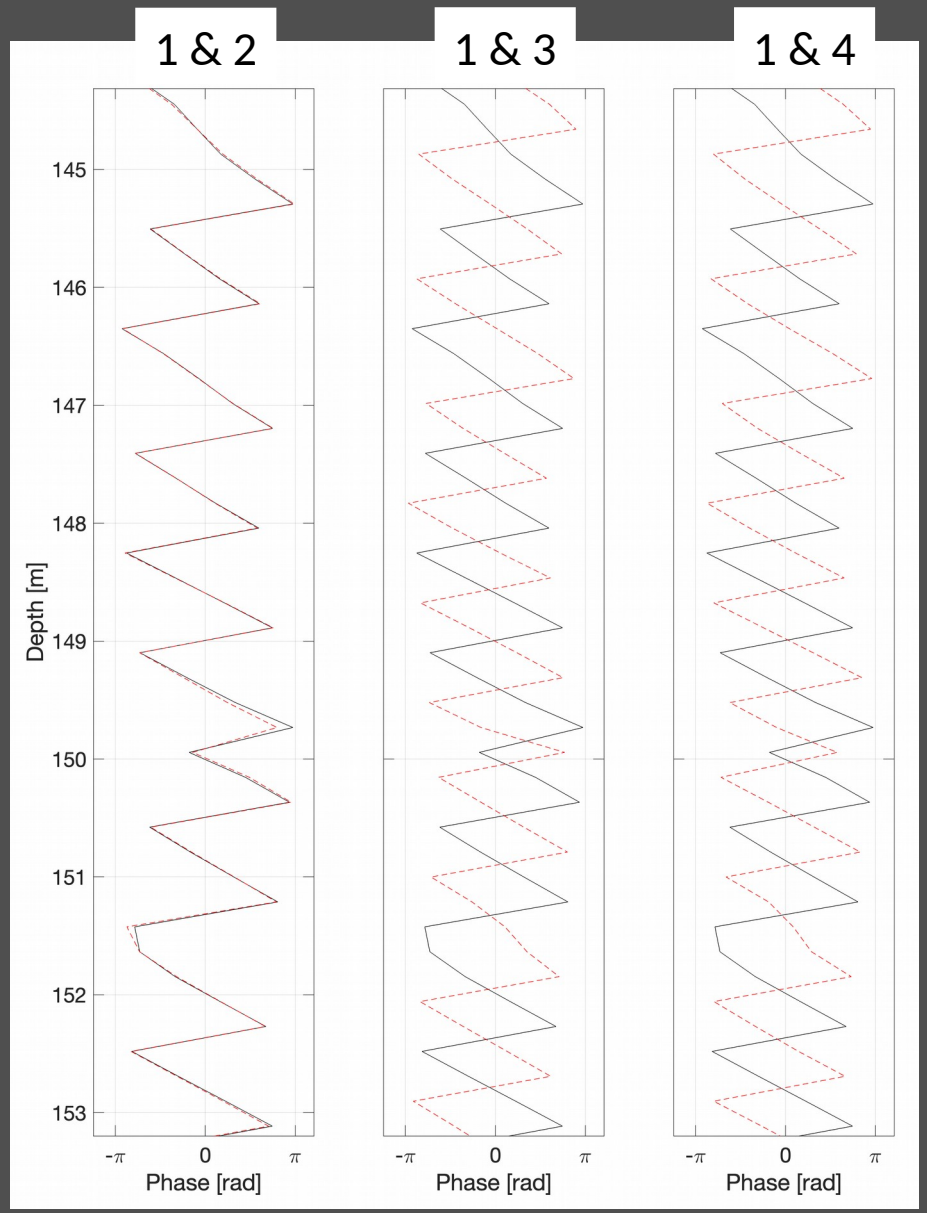
Phase Comparison



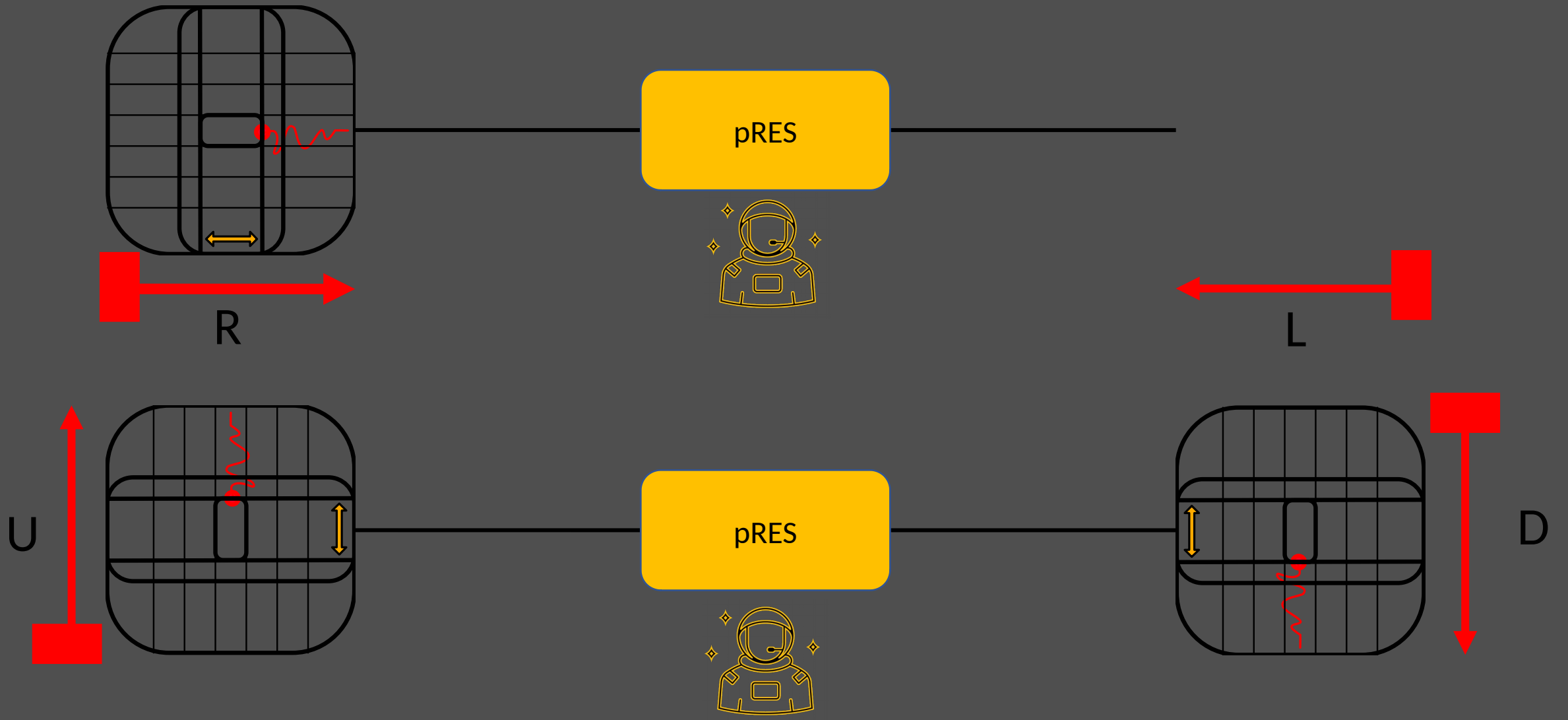


Phase Comparison

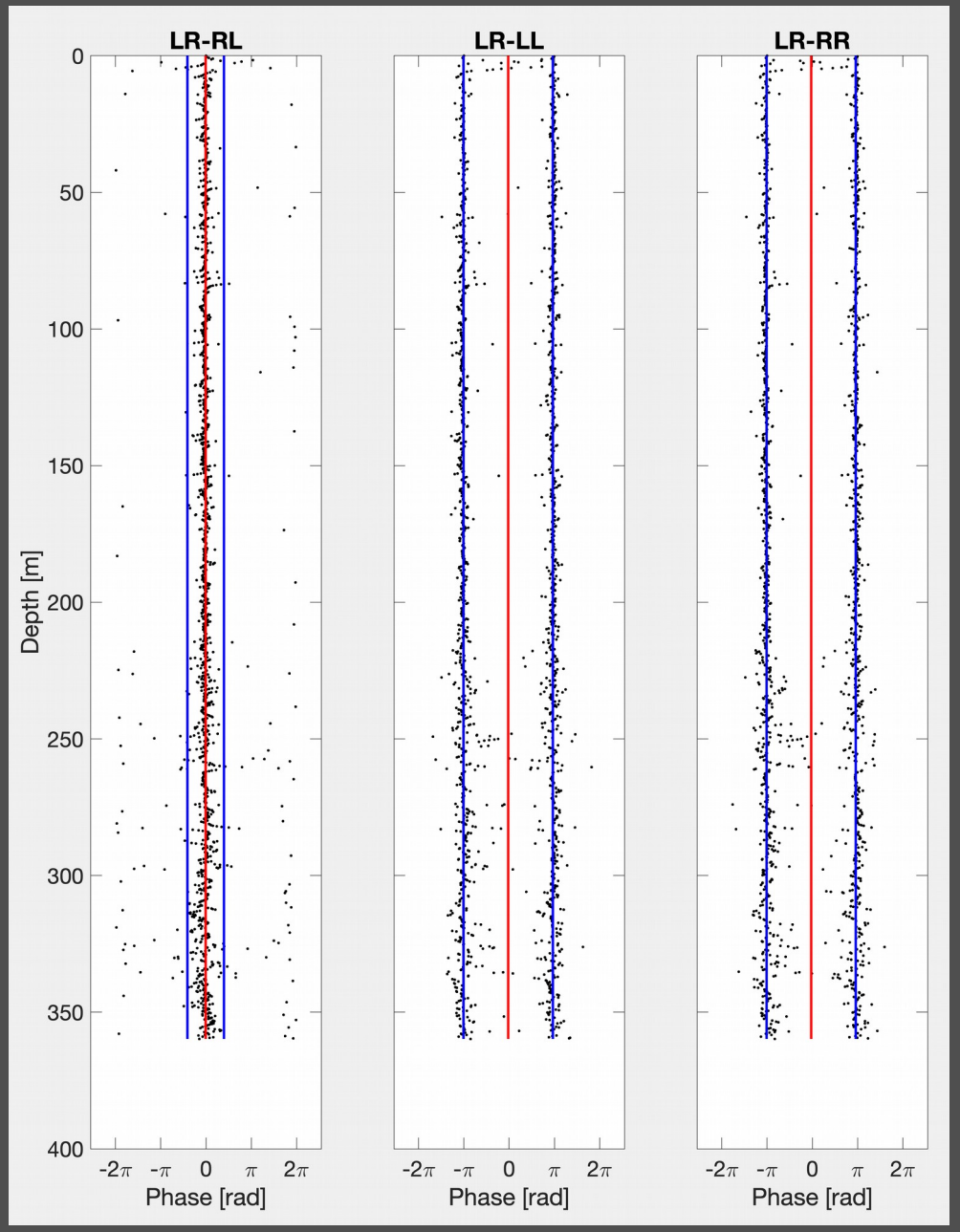


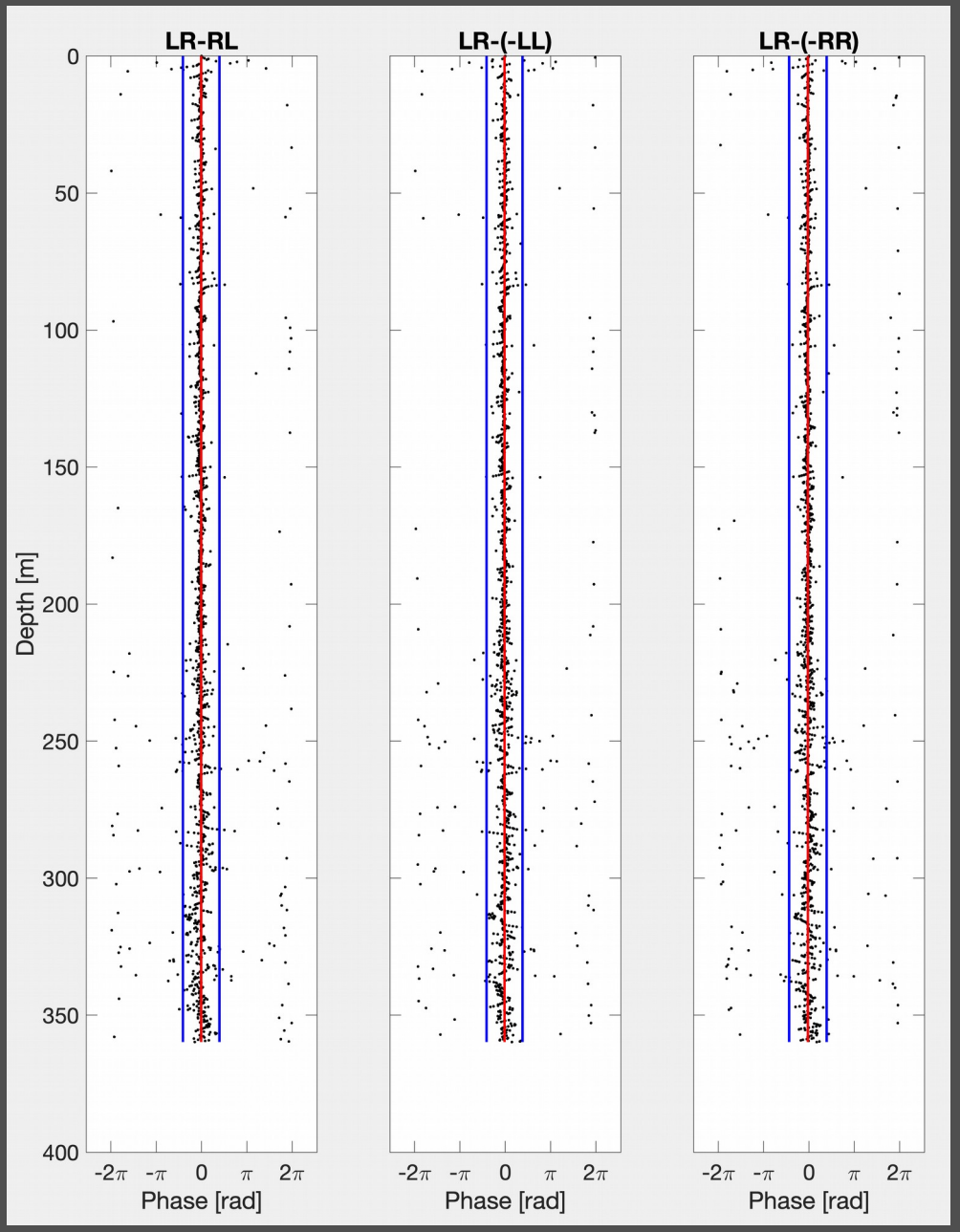


Antenna orientation



Magic minus

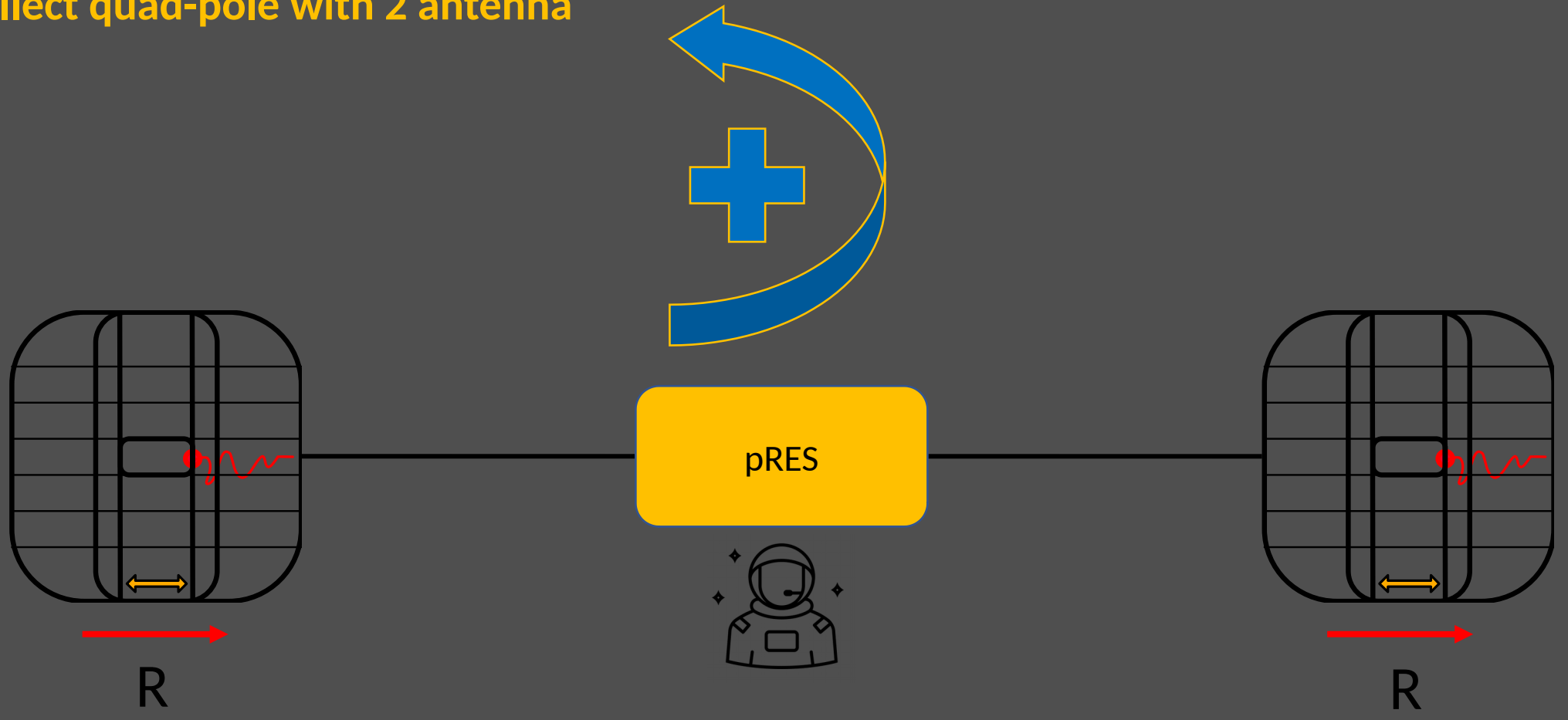

LR-RL
LR-LL
LR-RR
Depth [m]
0
50
100
150
200
250
300
350
400
-2π
-π
0
π
2π
Phase [rad]


LR-RL
LR-(-LL)
LR-(-RR)
Depth [m]
0
50
100
150
200
250
300
350
400
-2π
-π
0
π
2π
Phase [rad]

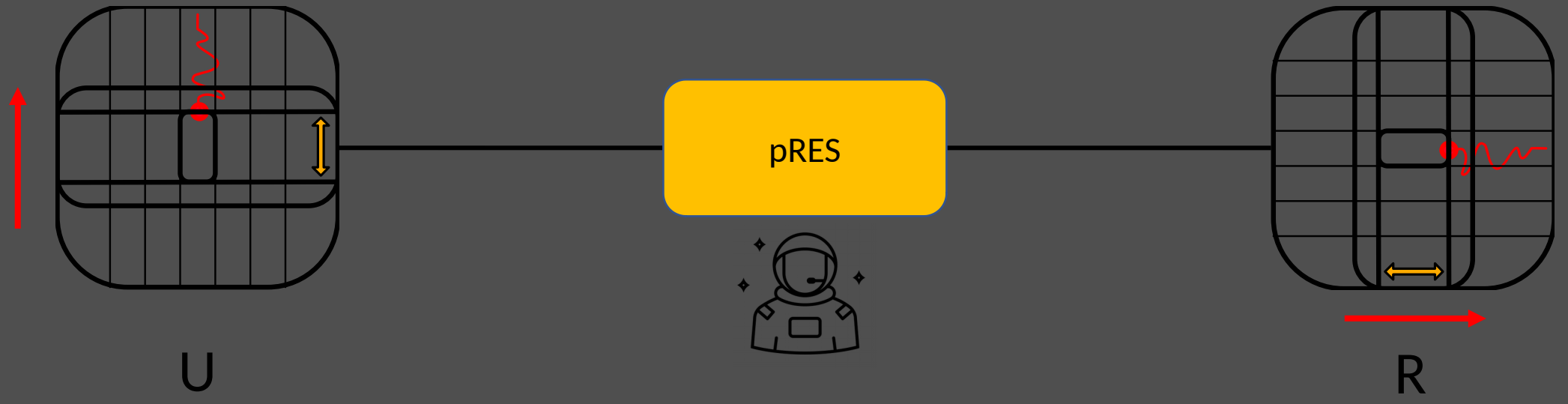
Quad-pole is the most convenient method

	22.5°	10°
1x HH	9x HH	19x HH
1x VH	9x VH	19x VH
1x VV	9x VV	19x VV
1x HV	9x HV	19x HV
4	36	76

How to collect quad-pole with 2 antenna



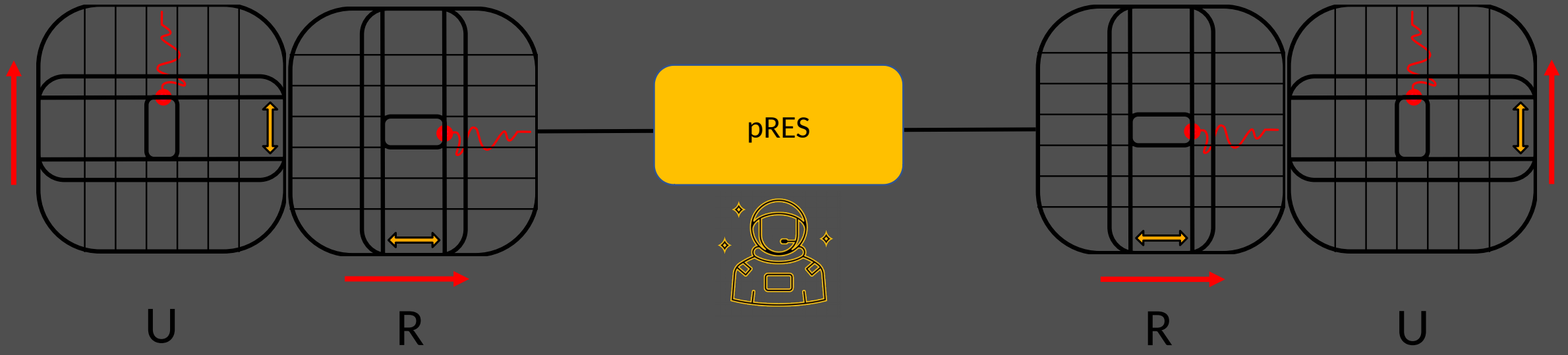
How to collect quad-pole with 2 antenna



How to collect quad-pole with 2 antenna

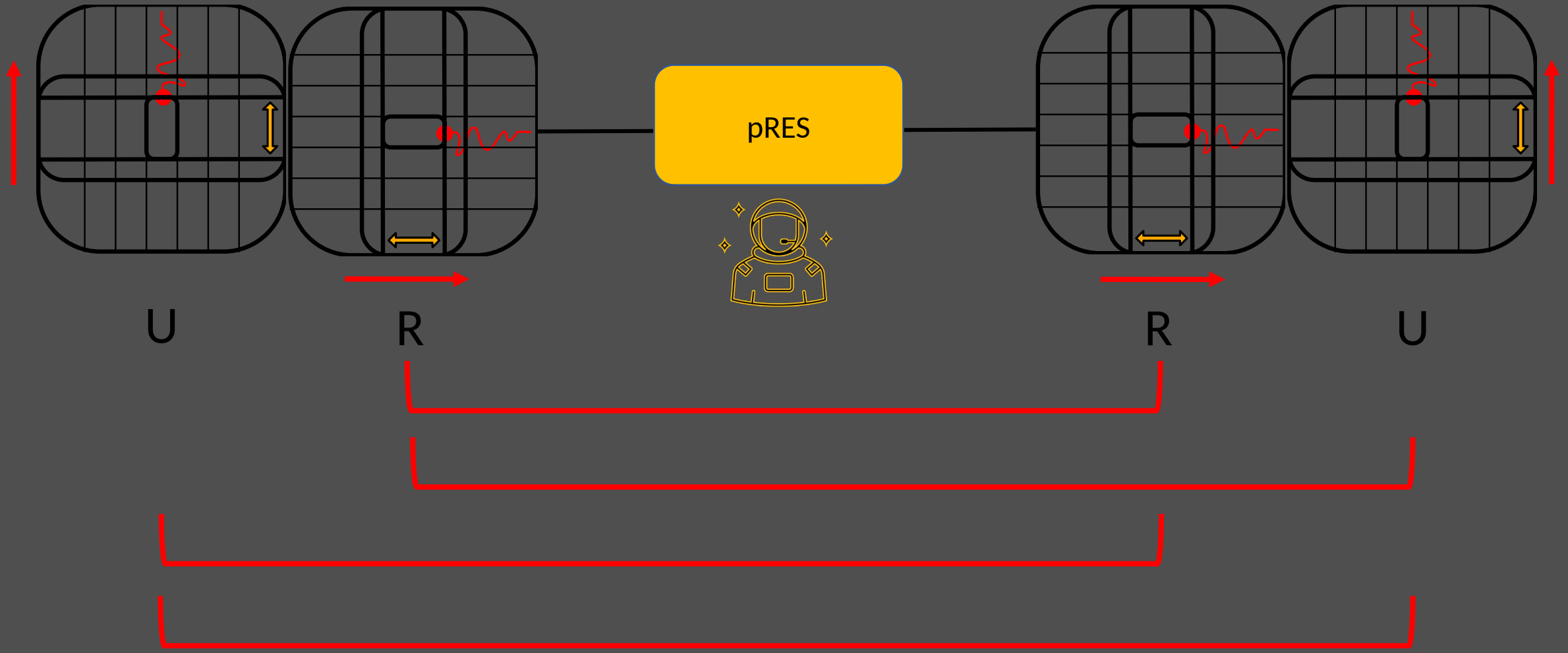
How to collect quad-pole with 2 antenna

How to collect quad-pole with 4 antenna



Autonomous quad-pole data collection

How to collect quad-pole with 4 antenna



In case you wanna take something home (and you use pRES)

Always collect your pRES data in quad-polarimetric

Name the orientations based on the cable direction

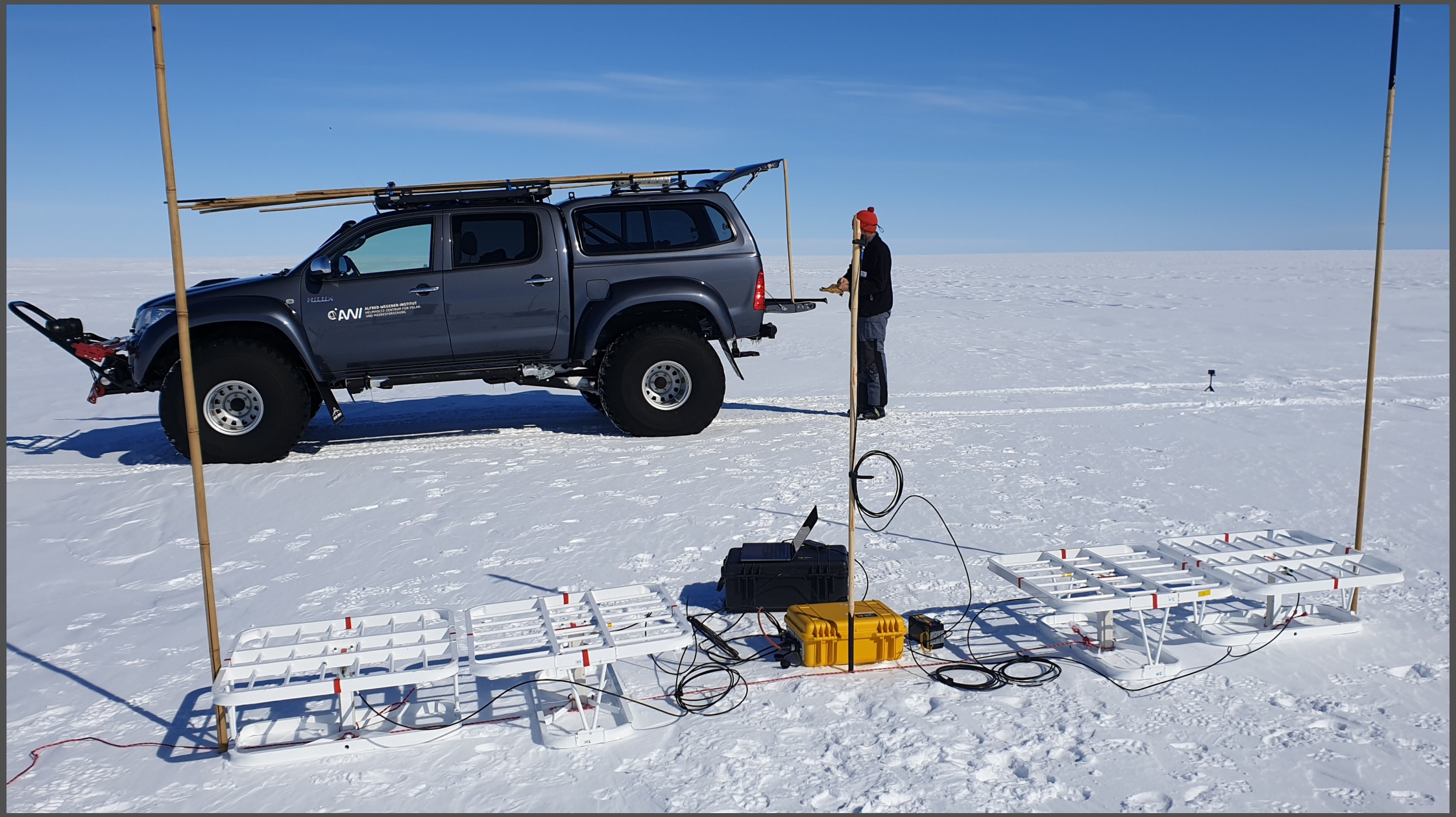
Don’t forget the azimuth

Rotating the antenna 180° will reverse the phase in pRES signal (no effect on amplitude)

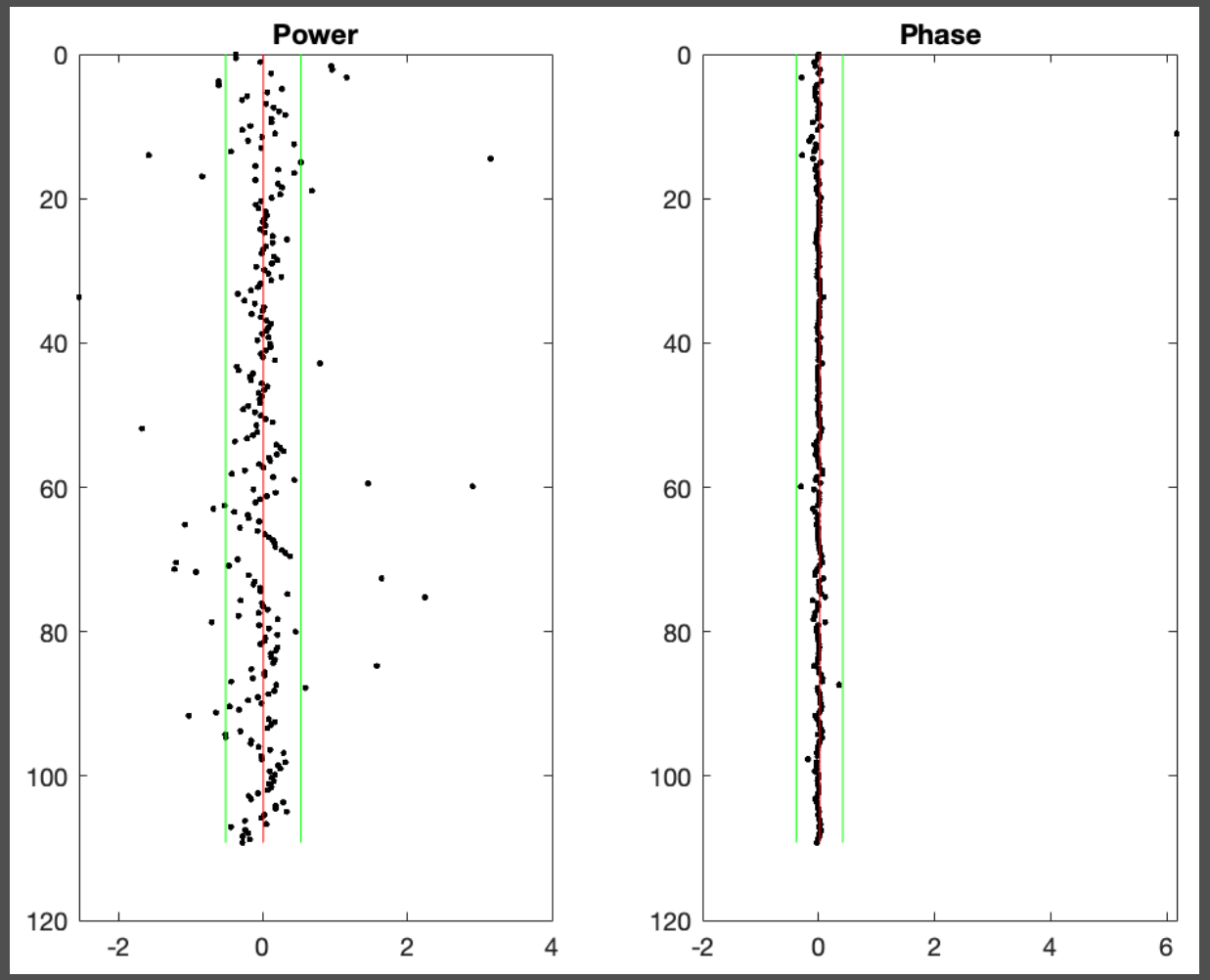
Rotate the antenna counterclockwise

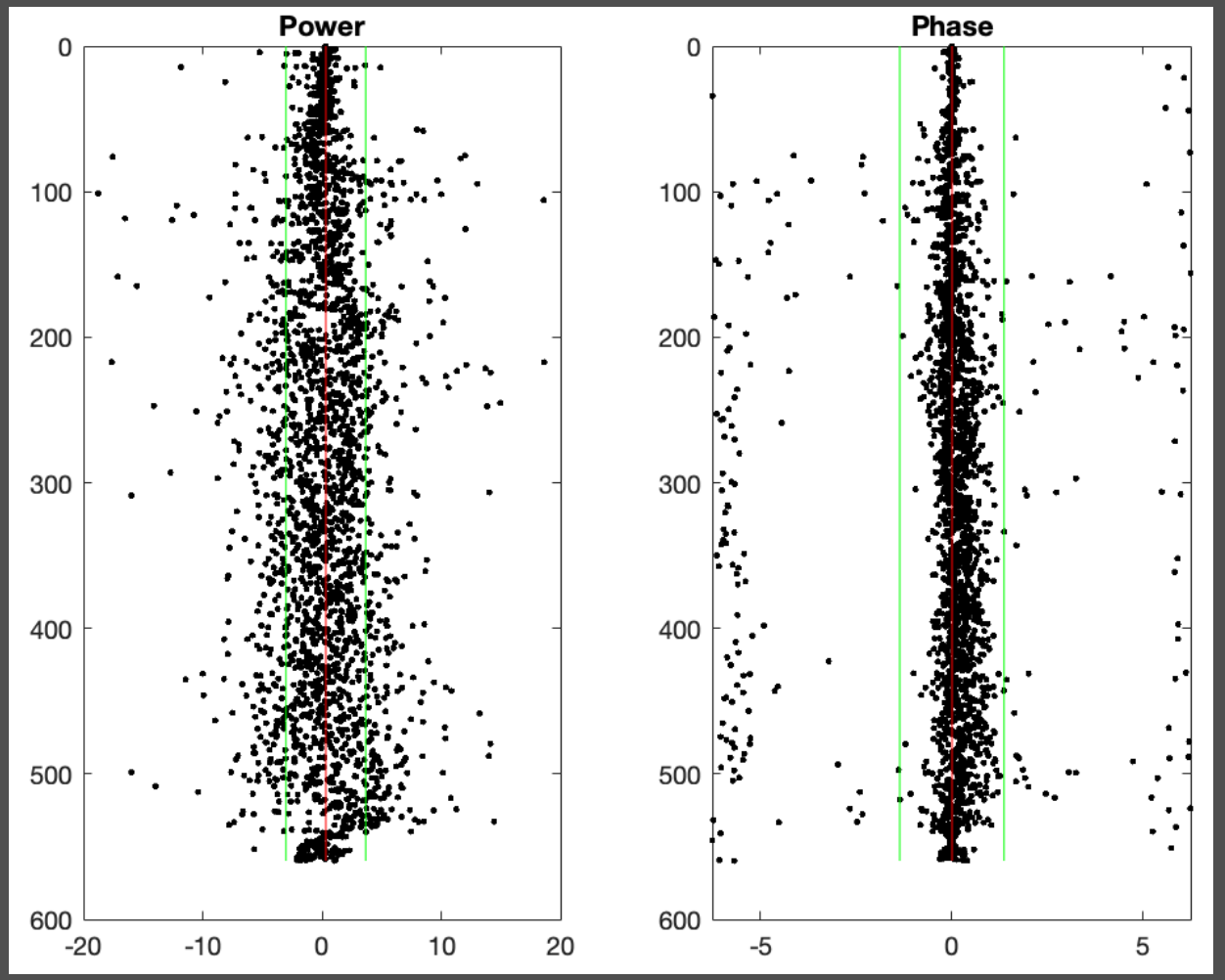
Try to avoid collecting data close to big metal reflectors

Effect of metal reflector on power and phase



Effect of metal reflector on power and phase



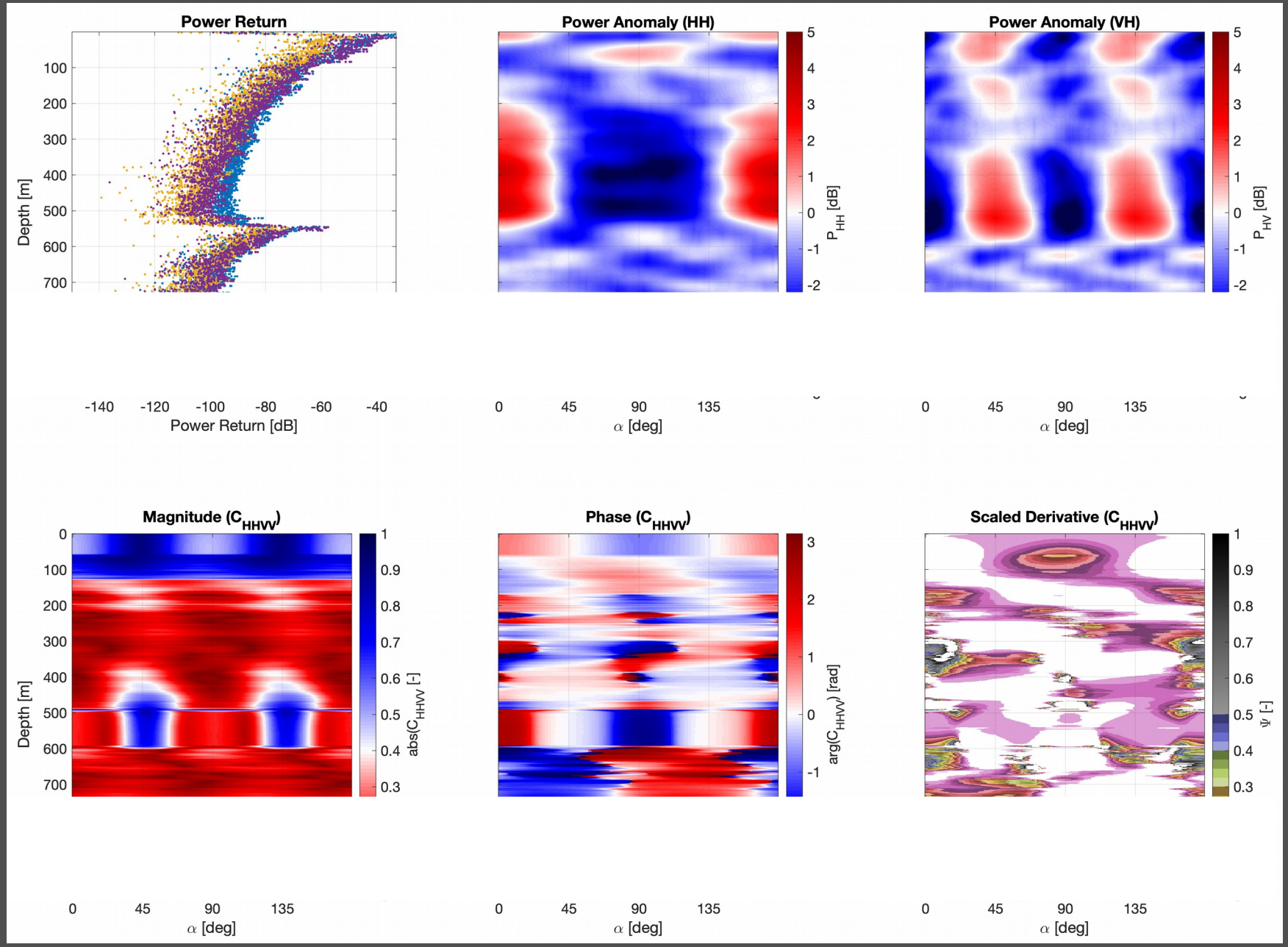


100 m
0.49 dB
0.46 rad

100 m
2.72 dB
0.96 rad

550
3.39 dB
1.36 rad

Effect of metal reflector on synthesization



Effect of metal reflector on synthesization