

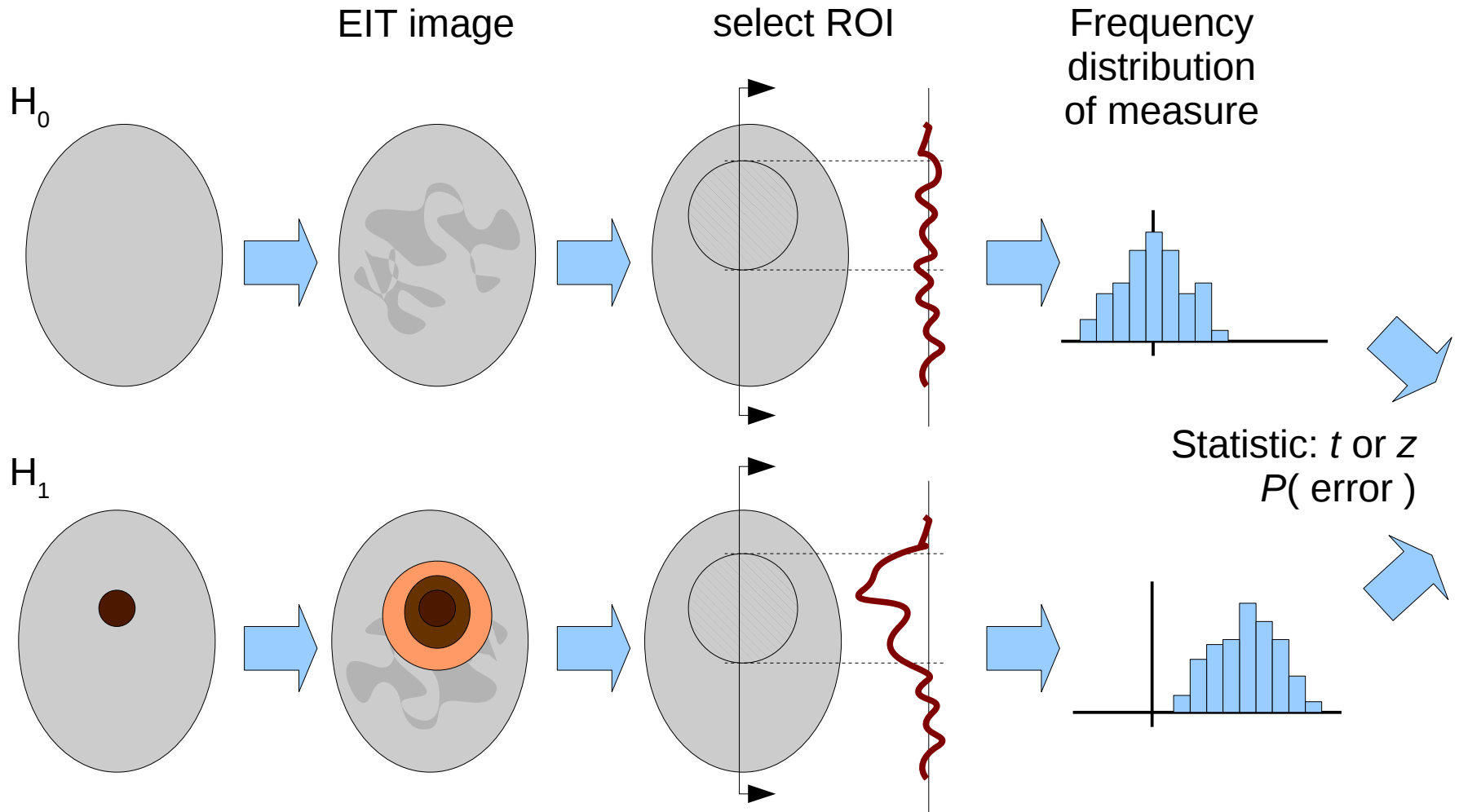
Electrode positions and current patterns for 3D EIT

Y. Mamatjan¹, D. Gürsoy² and A. Adler¹

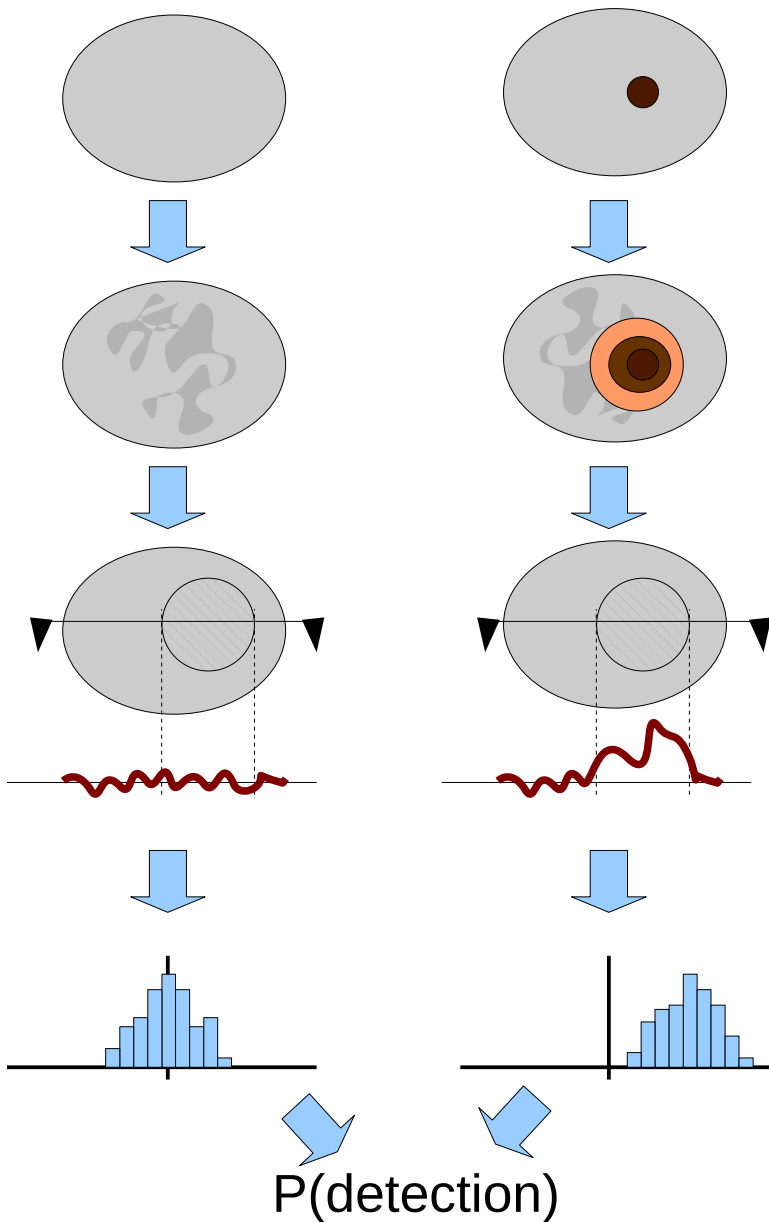
¹Systems and Computer Engineering, Carleton University, Ottawa, Canada

²Institute of Medical Engineering, Graz University of Technology, Austria

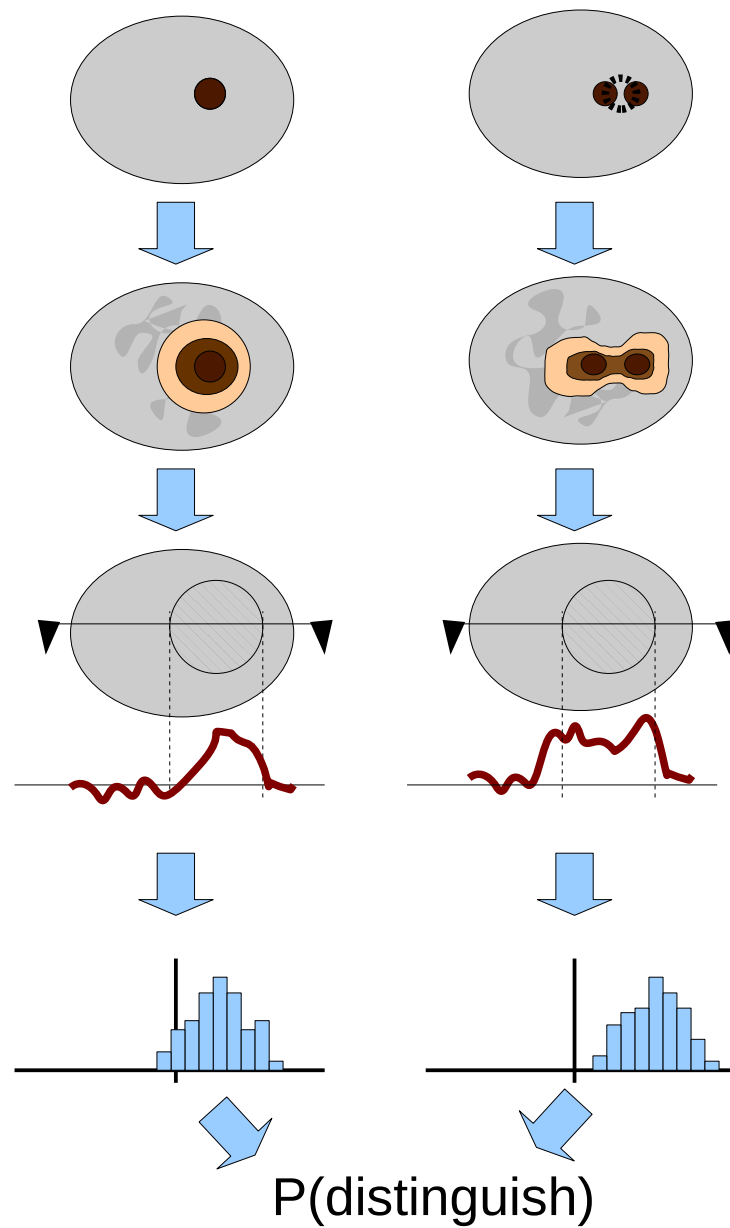
Goal: detect targets



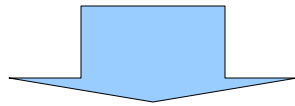
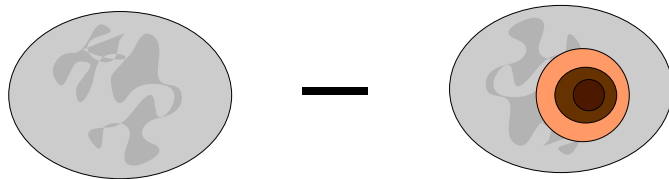
Detect



vs. Distinguish



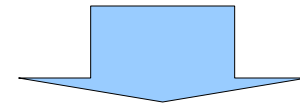
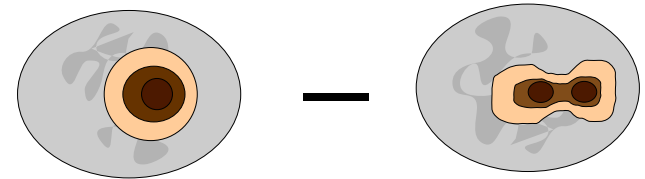
Detect vs. Distinguish



$z \Rightarrow P(\text{detect})$

$z = \text{SNR}(\text{target})$

$z \propto \text{Sensitivity}$



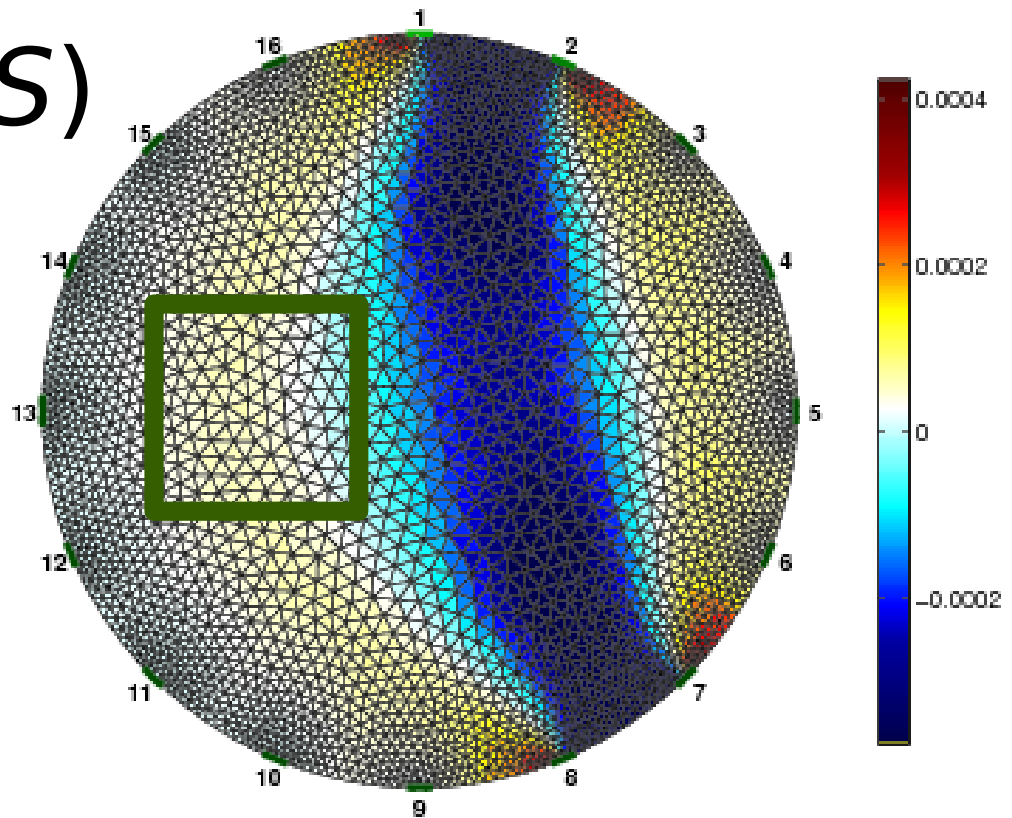
$z \Rightarrow P(\text{distinguish})$

$z = \text{SNR}(\Delta\text{target})$

$z \propto \Delta\text{Sensitivity}$

Sensitivity (S)

ROI



Detect vs.

$$Z^2 =$$

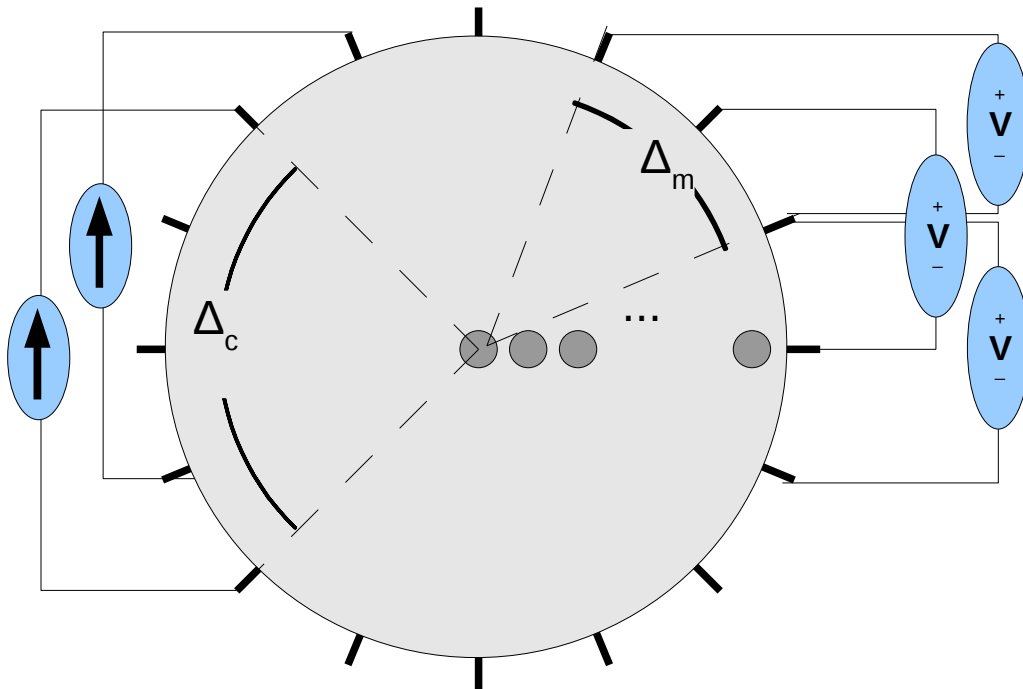
Distinguish

$$\left\{ \begin{array}{l} \sum_{v \in \text{stim pats}} S^2(v) \\ \sum_{v \in \text{stim pats}} \Delta S^2(v) \end{array} \right.$$

Stimulation patterns

Distinguishability is determined by:

- current stimulation amplitude,
- the accuracy of voltage measurement,
- **stimulation and measurement patterns,**
- the number and **placement of electrodes.**

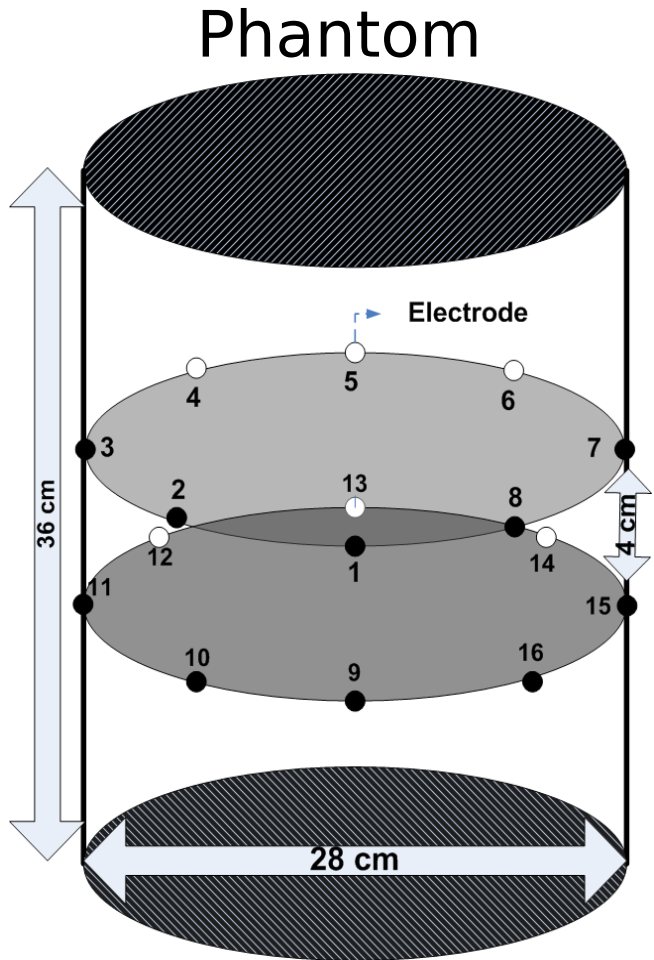


Δ_{sm} : Adjacent (Δ_{11})
Opposite (Δ_{88})

How about 3D 2-ring electrodes?

- **Some issues** on 3D EIT and total lung volume estimation.
- **Goal:** to investigate electrode geometries and stimulation and measurement patterns in to improve distinguishability.
- **Questions:**
 - Does the 2-ring electrode system provides any benefit over 1-ring electrode system?
 - Is there any particular electrode geometry?
 - What is the proper distances of 2-ring electrode separation?

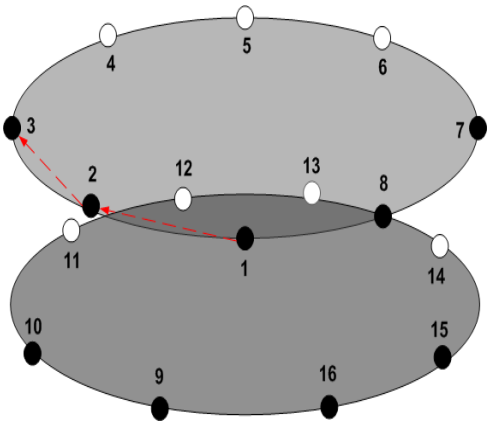
Test design



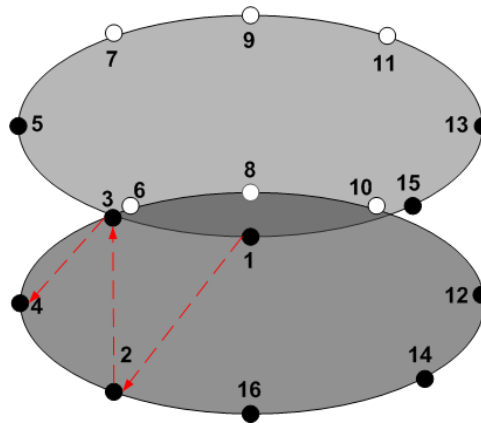
- Simulation Eiders / Netgen.
- Homogenous tank with non-conductive objects.
 - **Volume:** cylindrical tank of 28cm of diameter and 30cm of height.
 - **Target objects:** 1 and two objects

Electrode geometries

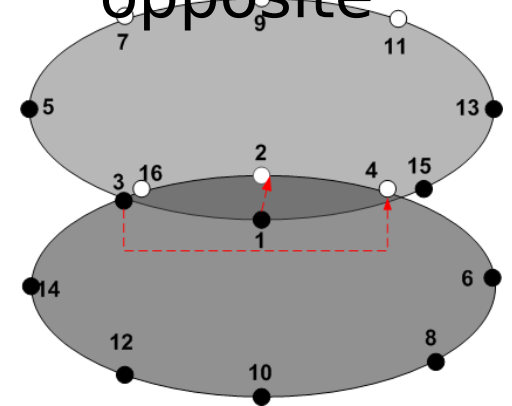
Planar-offset



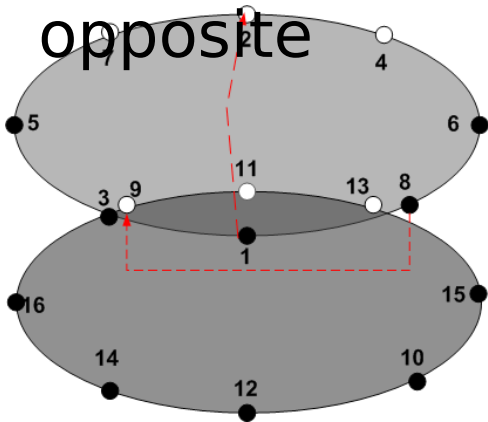
Zigzag



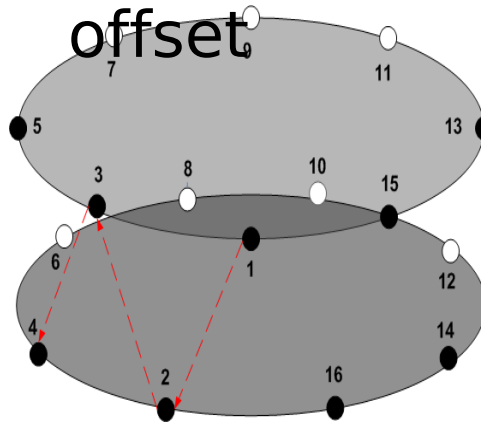
Zigzag-opposite



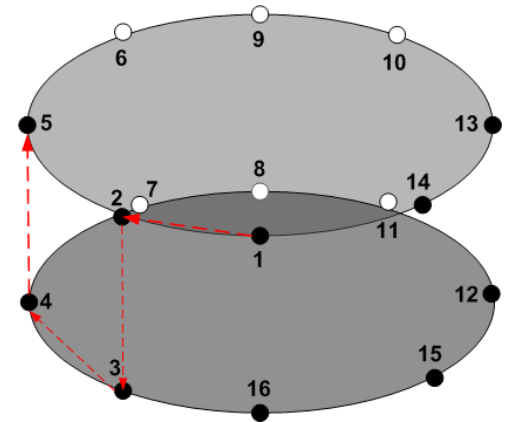
Planar-opposite



Zigzag-offset

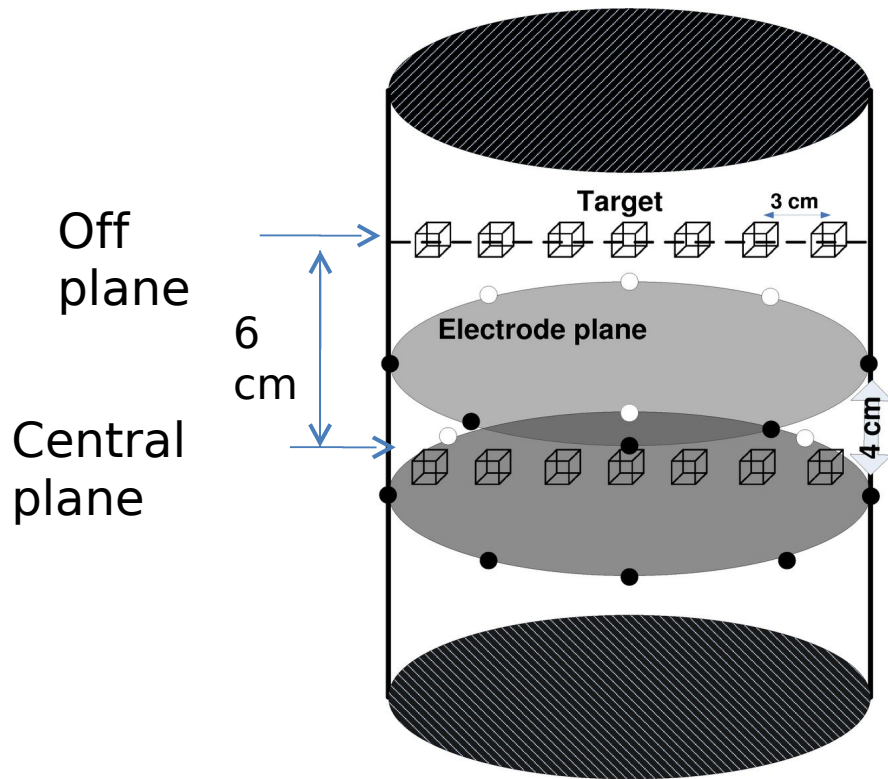


Square



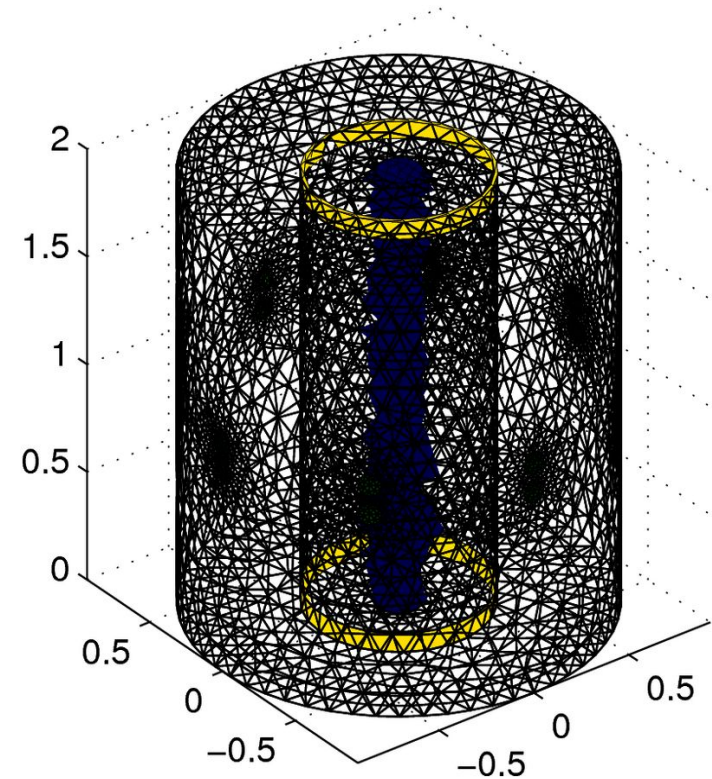
Test protocols

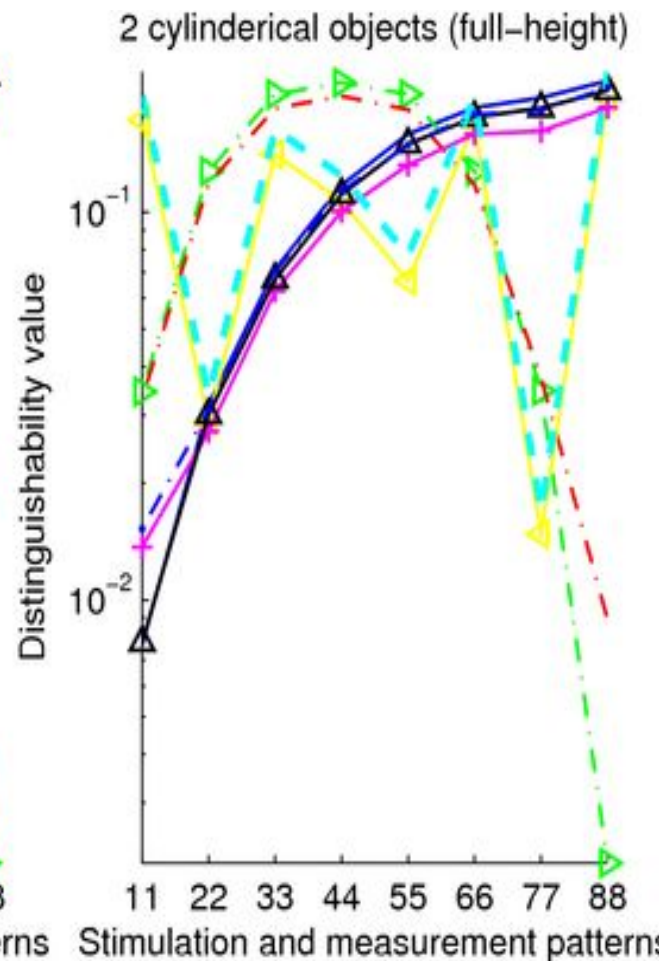
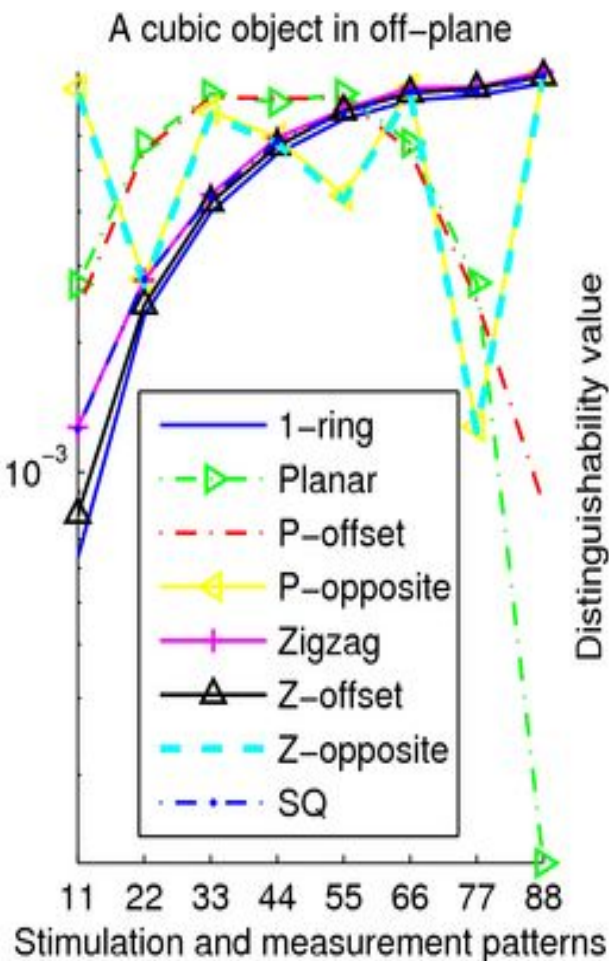
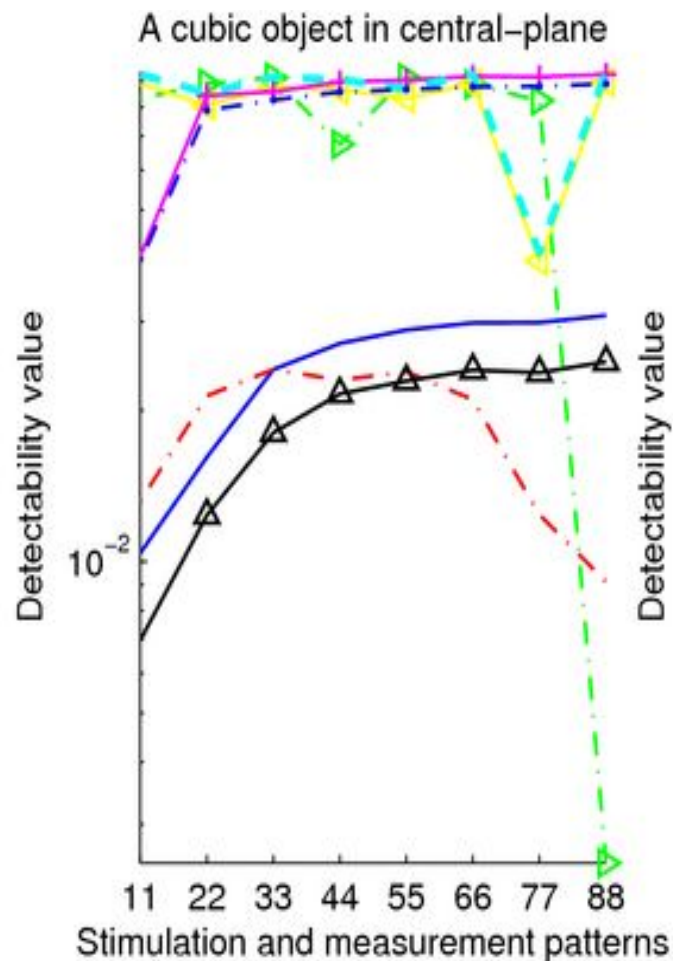
Tank



Off-plane is 6 cm above the central-plane

Simulations





Discussion

- 2-rings are better than 1-ring.
- Adjacent (Δ_{11}) gives large off-plane effect .
- Patterns near opposite better.
- Proper layer spacing is required.
- Limitation: we need to test this on humans.

Warning: FEM simulations of sensitivity can be horrible

