Short talks:

I. Common preparation for quadrangular prism samples for Physical property measurements and CFA

II. Preliminary data for Dielectric Tensor Measurement (DTM) for the EGRIP deep ice core (DO events 9-13)

Shuji Fujita and Tomotaka Saruya (NIPR, Japan)

Purpose of this short talk

- Ice core studies often have exercises as to how we can obtain high-quality data from limited amount of sample, *efficiently, rapidly, continuously with high spatial resolution measurements*.

To address the issue,

- we propose a procedure of sample analyses to improve our efficiency for core analyses.

Items of PP measurements and modern method

- Density change & changes in strain rate

Bulk density
X-ray CT
X ray & γ ray transmission method,
Dielectric Tensor Method (DTM)

- Changes in 3D shapes of firn

Observation for thin- and thick-sections
X-ray CT
Dielectric Tensor Method (DTM), NIR reflectivity method
Macroscope Scanning and Air permeability measurement

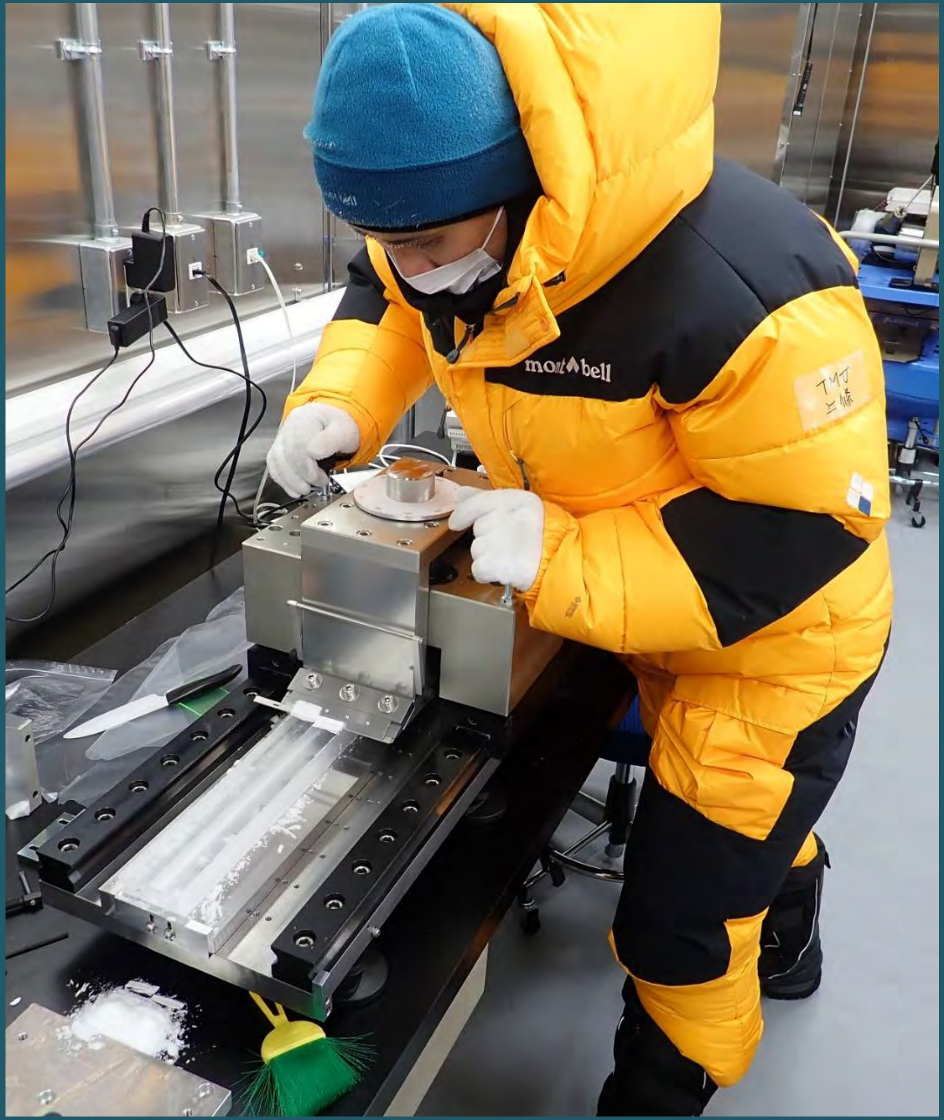
- Ice grains, their connectivity and grain boundary

Observation for thin & thick-sections
X-ray CT
NIR reflectivity method
Macroscope Scanning

- Crystal Orientation fabric

Fabric analyzers
Dielectric Tensor Method (DTM)

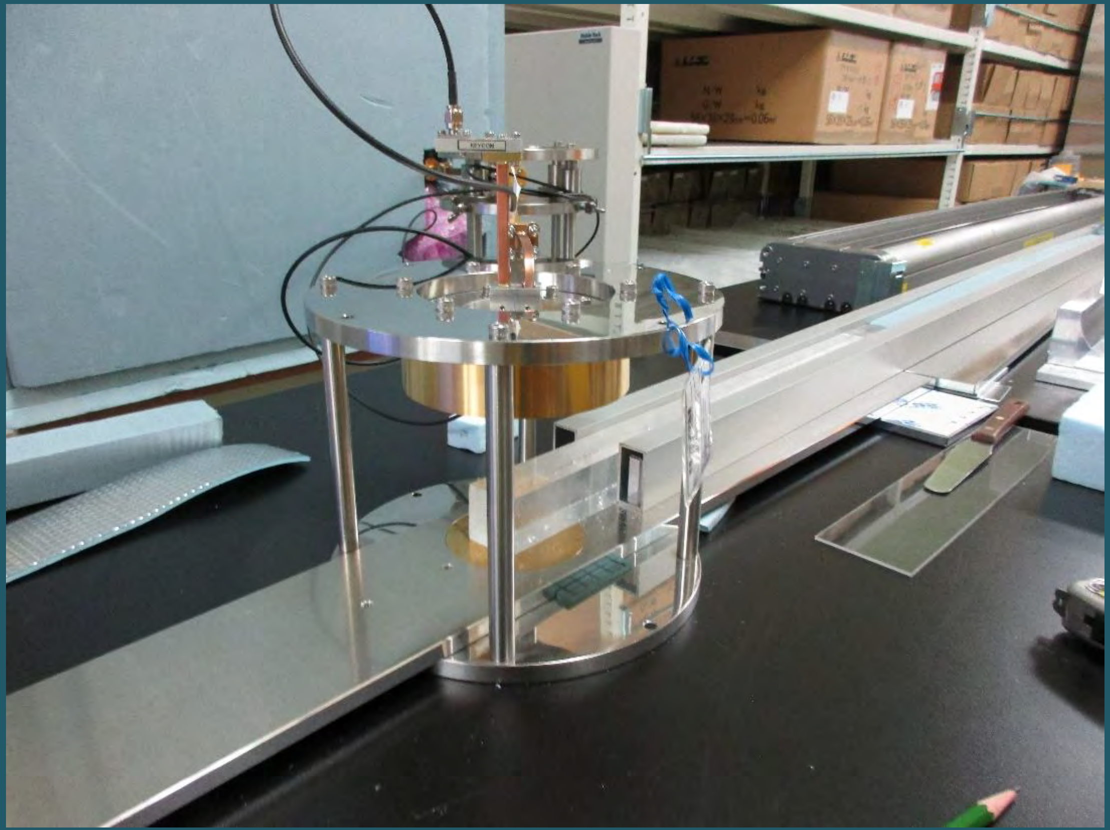
Prerequisite for efficiency: Long stroke microtoming



Dielectric Tensor Method: DTM

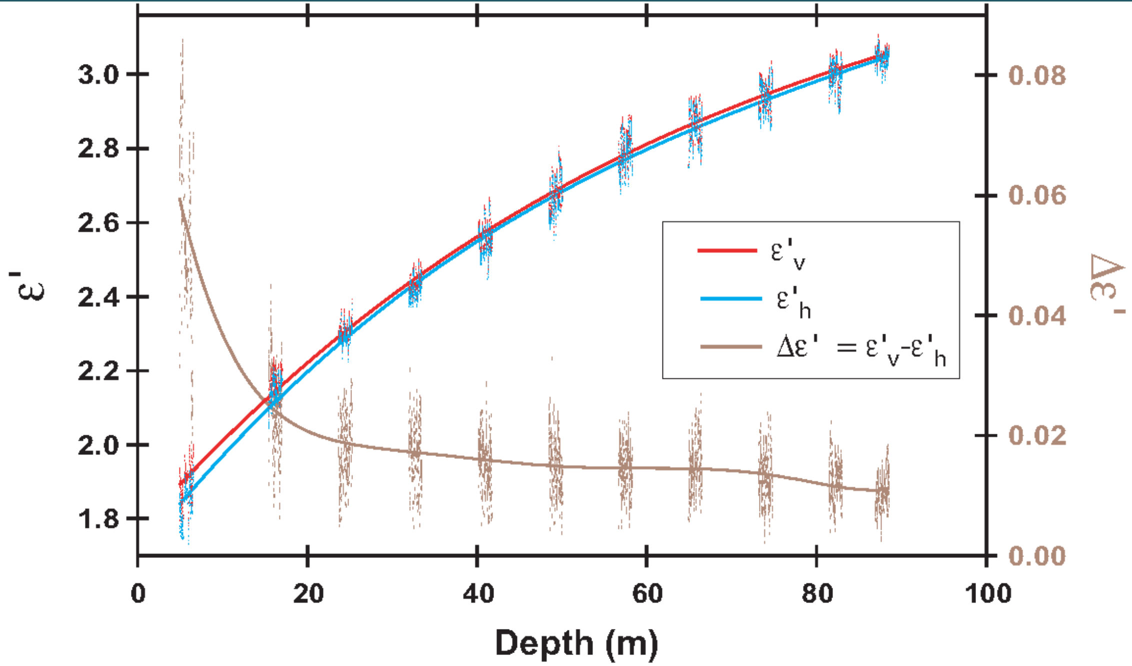
Open resonator system to measure complex and tensorial permittivity of thick specimens.

Frequency: 26.5 GHz- 40 GHz
Beam radius: 16mm
Sample thickness up to 80mm

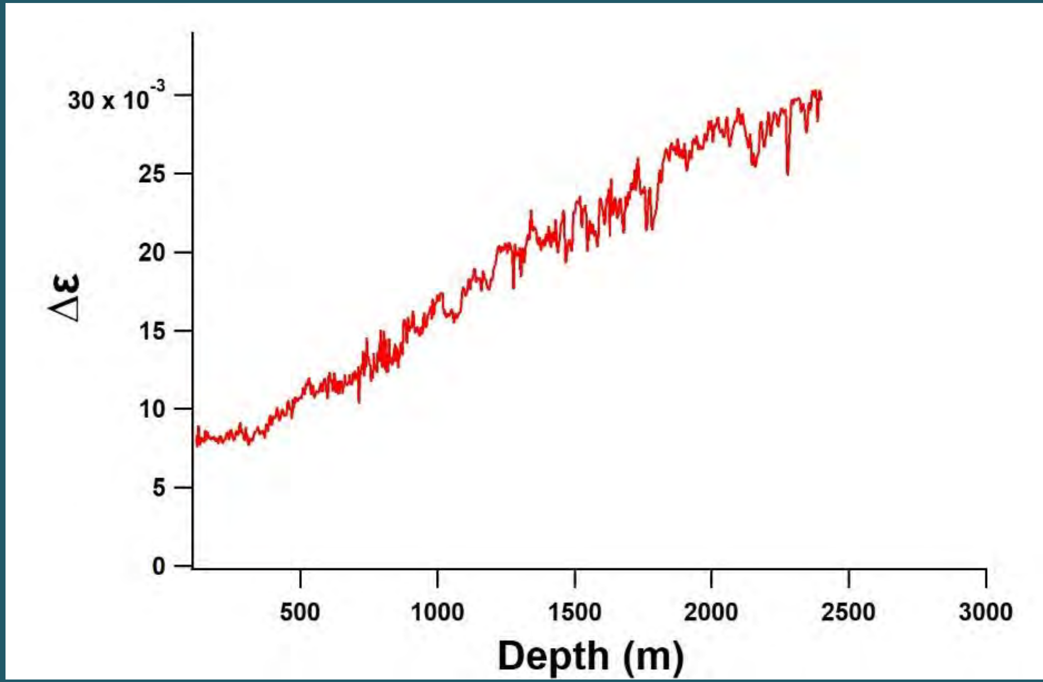


Example of typical data

Evolution of permittivity and the anisotropy with increasing depth.



Firn core at NEEM
Fujita et al. J.Glaciol. 2014

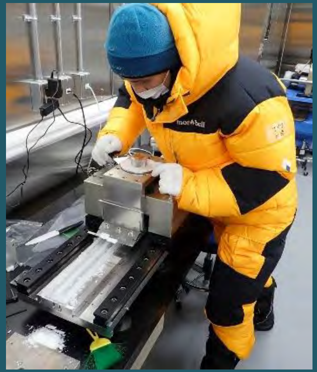


Deep core at DF
Saruya et al. The Cryosphere, 2022

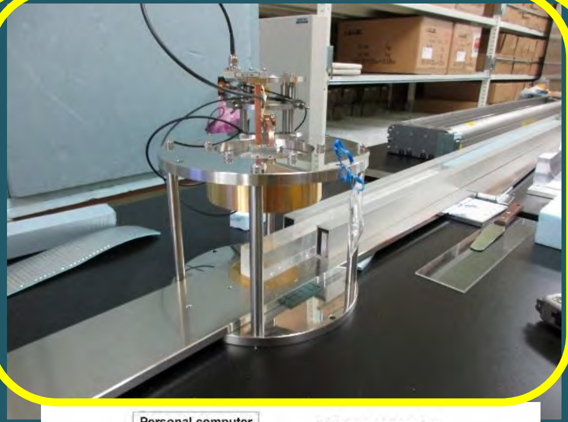
Efficient analytical procedure for ice cores

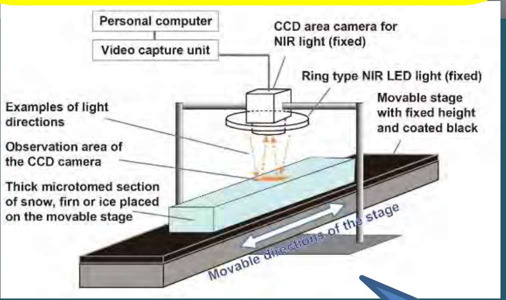
Initial processing

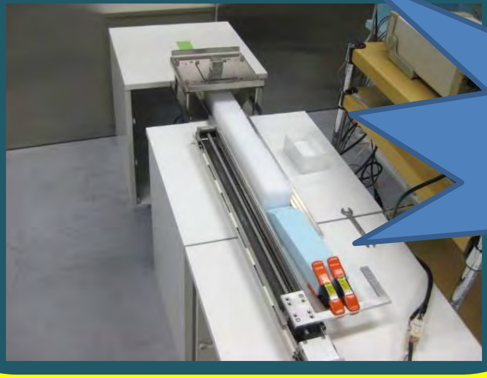
DEP
Cutting
Microtoming



Physical properties



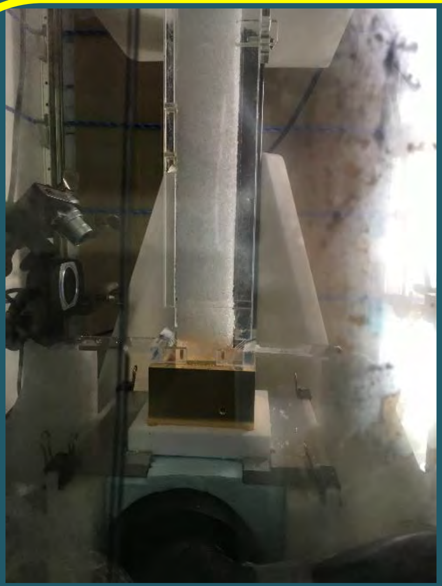




Precise density
3D firn nature
Ice Fabric
Grain size
Bubble features
etc.

More collaborations among consortia

CFA



Water isotopes
Major elements
Dust
Gas
etc.

Key takeaways

- **Once we drill long ice cores at a site, we first measure DEP using cylinder shape of the cores.**

→*Volcanic synchronization can be done for precise dating.*

- **Using quadrangular prism ice (30 mm x 30 mm x 500 mm) we can perform continuous and high-resolution measurement as follows.**

Permittivity、density、dielectric anisotropy、Specific surface area(SSA)、distribution of grain boundaries and bubbles, and components measurable with CFA（water isotopes, elements, dust, gas and others）

This can be one of standard procedures for ice core processing.

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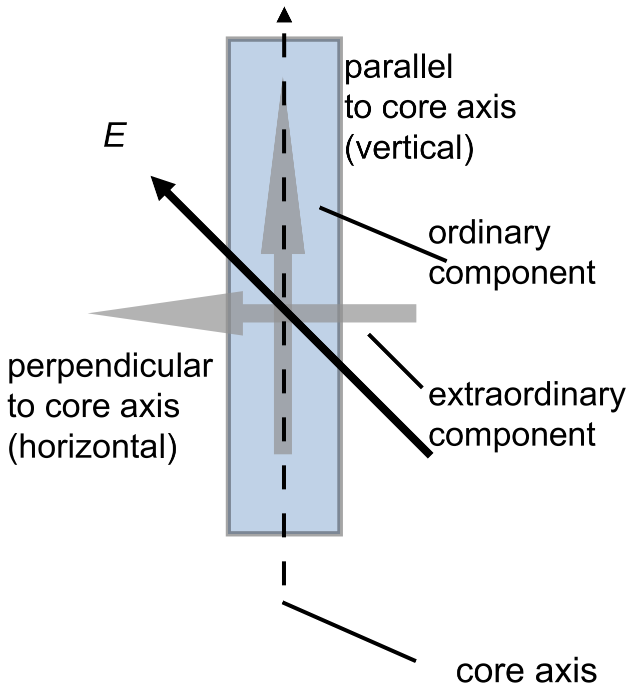
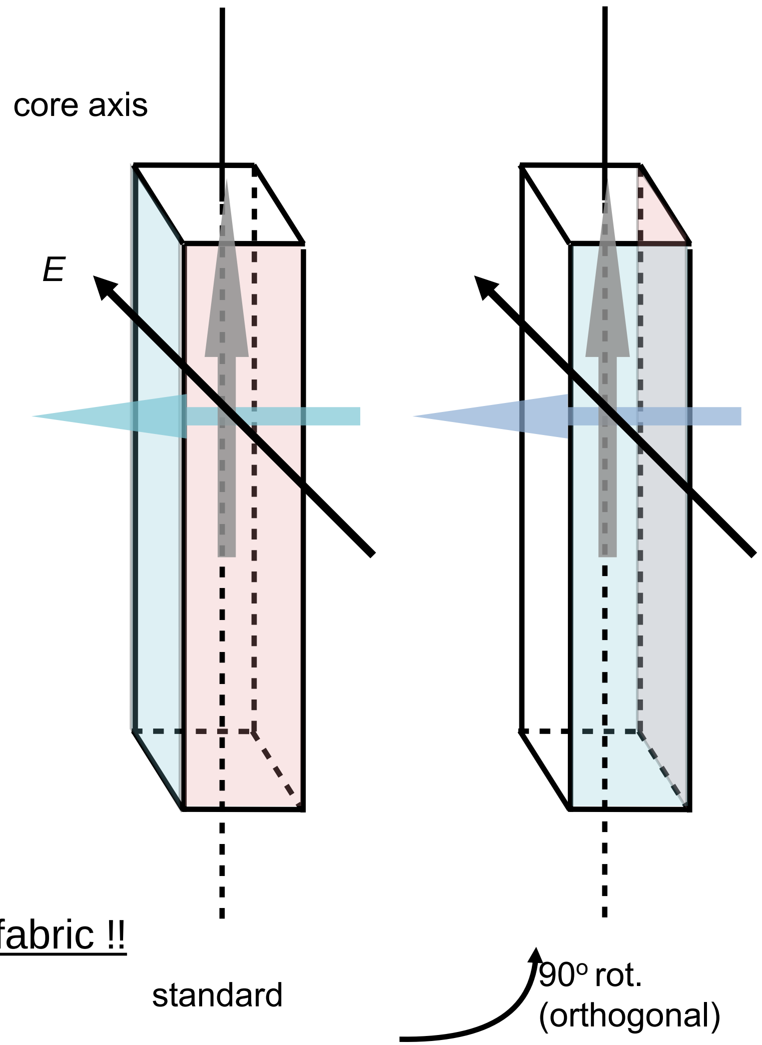
Dielectric measurements
EGRIP core bag#3472-3788 (1909.05-2082.85m)



Relative permittivity of single crystal ice:
3.136 (along a-axis) - 3.170 (along c-axis)

<u>Relative permittivity = indicator of crystal orientation fabric !!</u>

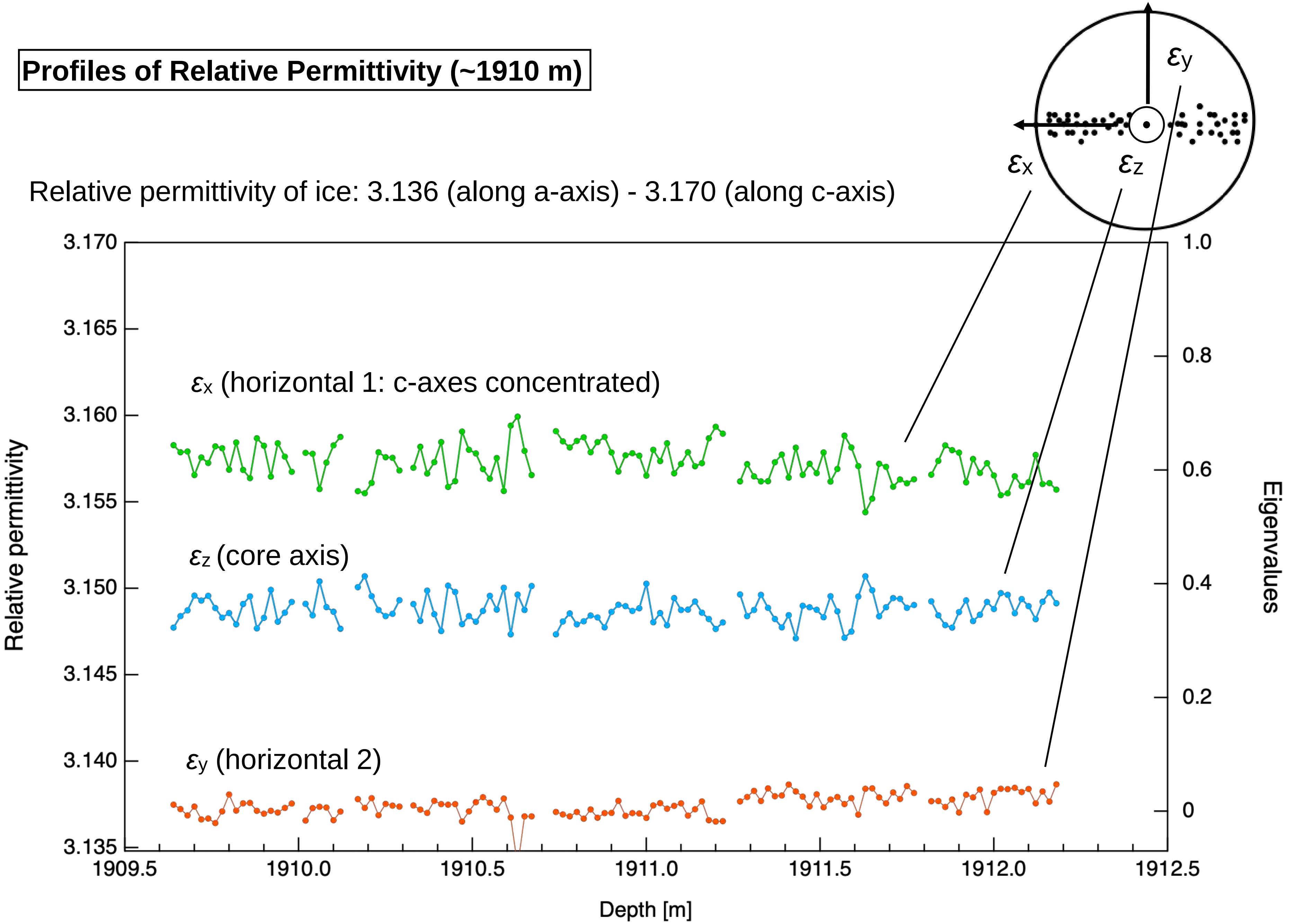
Two direction measurements



By rotating the ice core samples:
we can obtain three components of relative permittivity (1 core-axis + 2 horizontal directions)

Profiles of Relative Permittivity (~1910 m)

Relative permittivity of ice: 3.136 (along a-axis) - 3.170 (along c-axis)



*larger permittivity = c-axes are more concentrated

Thanks for your attention!