

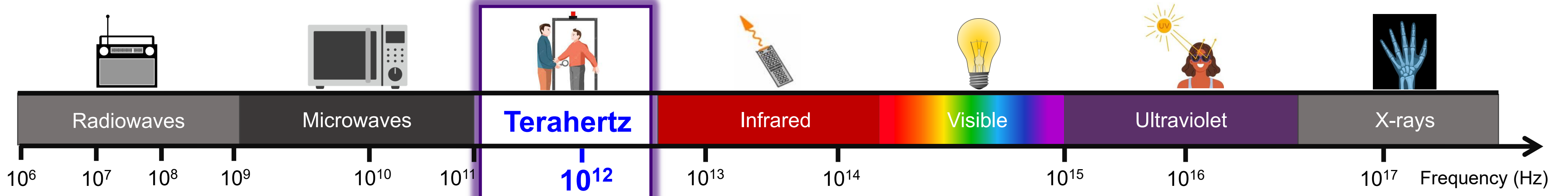
Machine learning based classification of dermatologic conditions using Terahertz measurements

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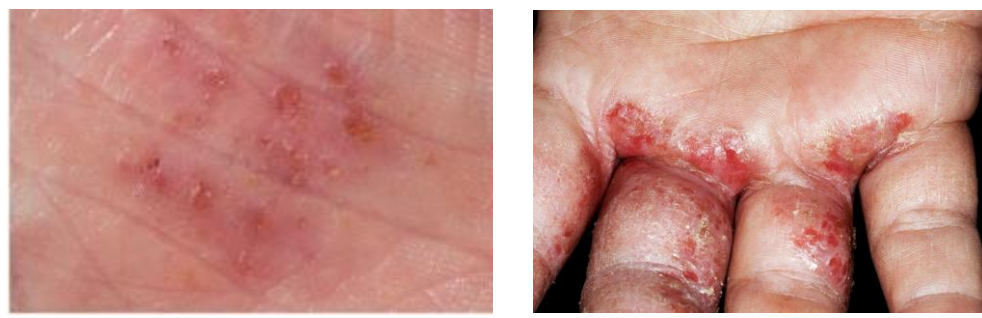
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Motivation

Eczema



~20% of UK children
10% of adults

- Chronic inflammatory disease
- High quality of life burden
- Clinical history + visual exam

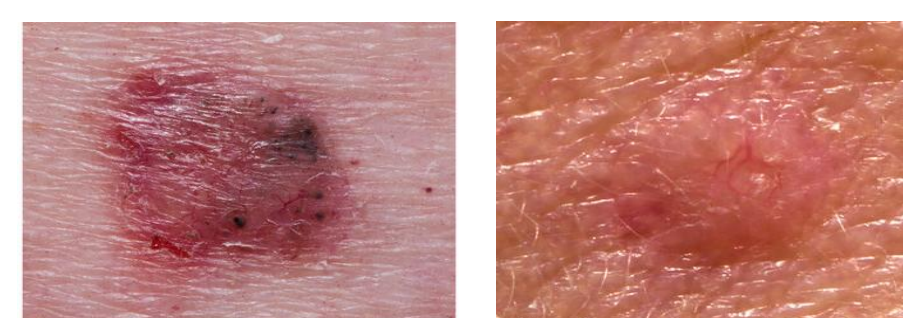
Psoriasis



1.1 million people in UK
~2.8% prevalence

- Immune mediated disease
- Often underdiagnosed
- Visual inspection

Skin cancer



156,000 new cases / year
~ 920 deaths annually

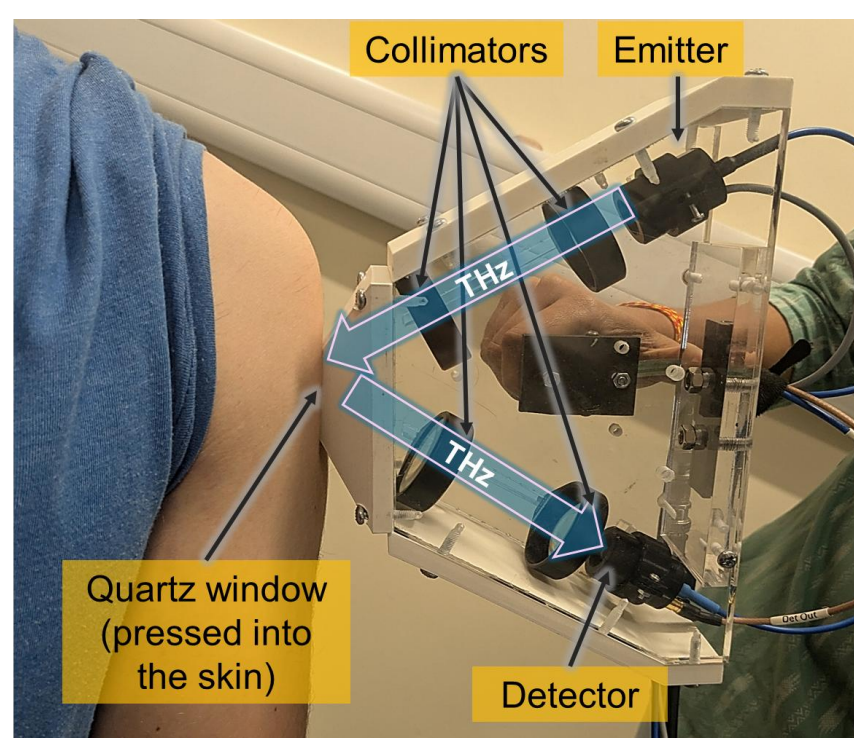
- Most common cancer in the UK
- Early detection is critical
- Visual screening → biopsy

Why Terahertz?

- ✓ Non-ionizing (safe)
- ✓ Non-invasive
- ✓ Highly sensitive to water content
- ✓ Sensitive to structural & inflammatory changes

THz offers a non-invasive, objective alternative to visual diagnosis and biopsy.

Clinical study



THz in vivo skin scanner



THz measurements of skin

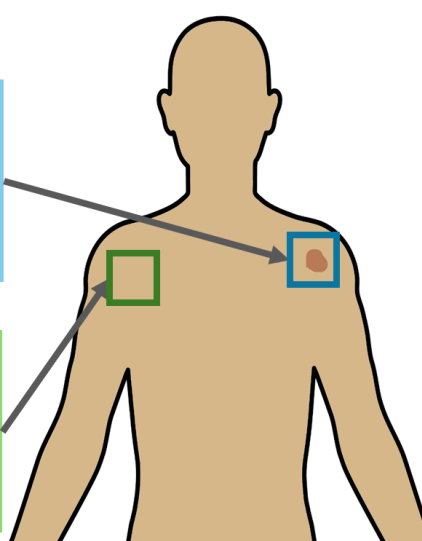
Region Of Interest (ROI)

1. No moisturizer
2. 10 minutes post moisturizer
3. 20 minutes post moisturizer

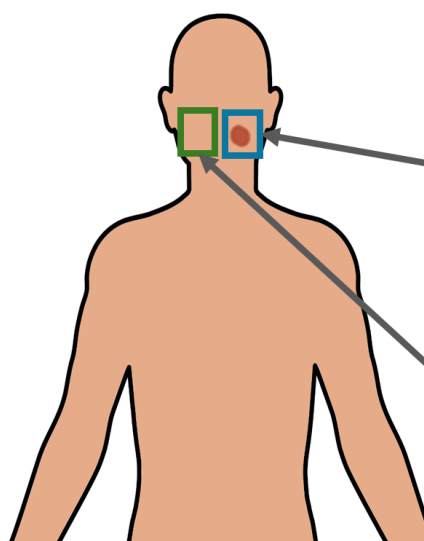
Control

1. No moisturizer
2. 10 minutes post moisturizer
3. 20 minutes post moisturizer

Dry skin patient



Skin cancer patient



THz measurements of skin

Region Of Interest (ROI)

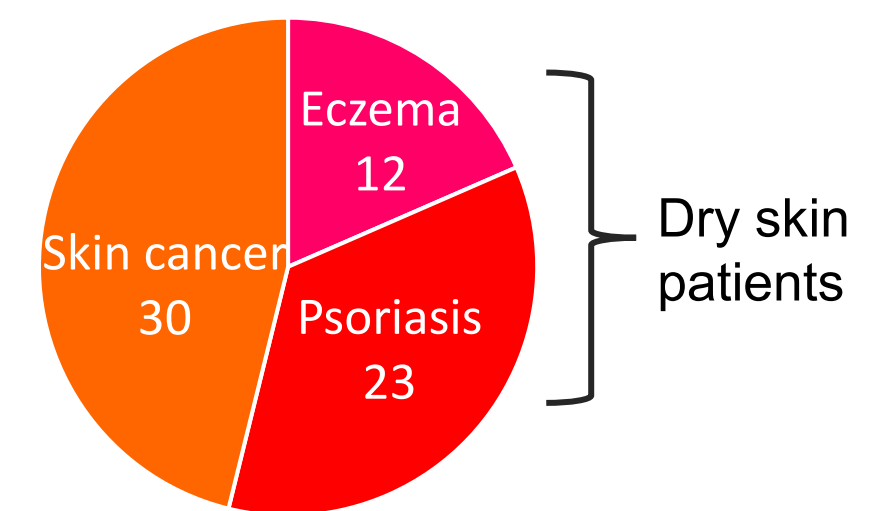
1. No moisturizer

Control

1. No moisturizer

Skin measurement protocol for different patient types

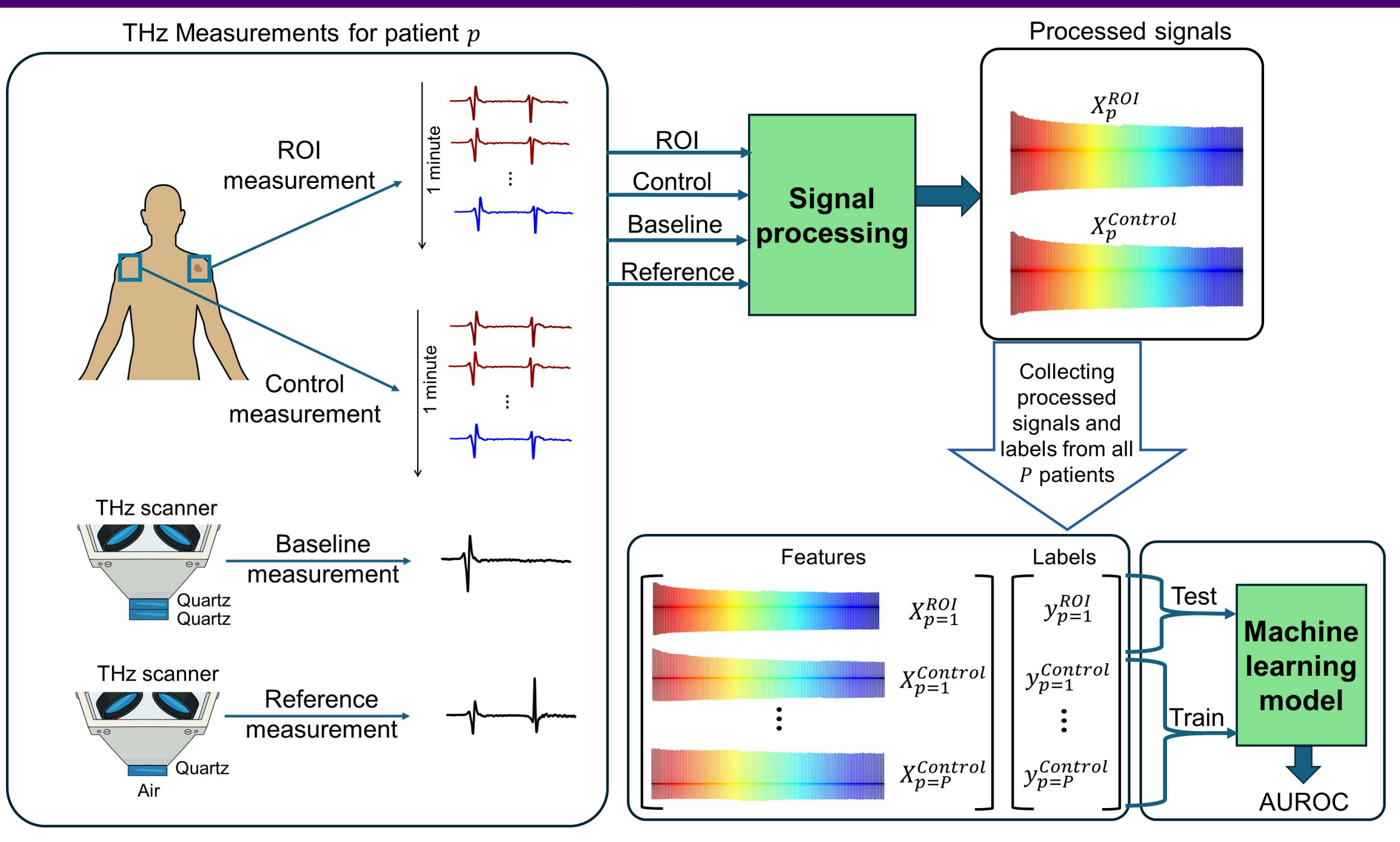
Conducted at University Hospitals Coventry and Warwickshire



Dry skin patients

Each region on the skin is scanned for 1 minute: dynamic response

Machine learning based classification

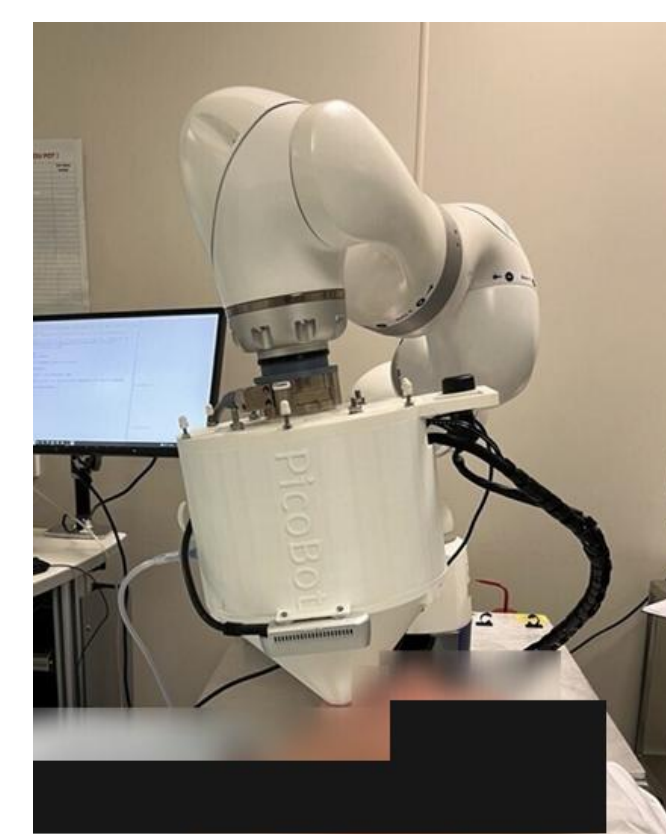


Results

- For each classification, 10 different machine learning models were trained.
- AUCROC was used to find to determine the best performing model for the classification. Closer it is to 1, better the classifier.
- 50 bootstrap repeats were performed to find the error on AUCROC.

Classification task	Dry vs Healthy			Eczema vs Psoriasis	Cancer vs healthy
	No moisturiser	10 min post moisturiser	20 min post moisturiser		
Best model	4 layer 1D CNN	Principal Component 1	Principal Component 1	4 layer 1D CNN	Random forest
AUCROC	0.82 ± 0.05	0.79 ± 0.06	0.72 ± 0.1	0.86 ± 0.1	0.65 ± 0.01

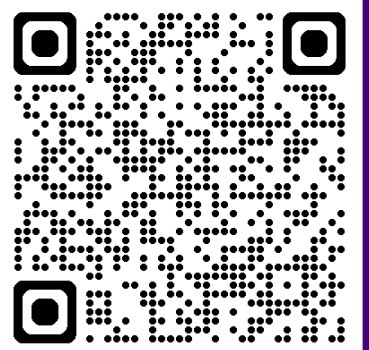
Ongoing study



PicoBot: Robotically controlled THz imaging system

- Scans an area of skin instead of a point.
- Autonomous robotic scanner.
- ~80 skin cancer patients scanned at University Hospitals Coventry and Warwickshire.
- Data analysis in progress.
- **First of its kind and largest number of skin cancer patient scanned with THz.**

Scan to read the research article



Conclusion

- Machine learning based models can differentiate between healthy and diseased skin using skin's THz scans.
- While it is possible to distinguish between skin conditions, there are significant impact of confounding factors like moisturiser, which need to be handled.
- More data taken on a diverse set of patients is needed to train a classifier that is robust to age, sex, skin type, etc.