# Improving cancer theranostics with photoacoustic imaging

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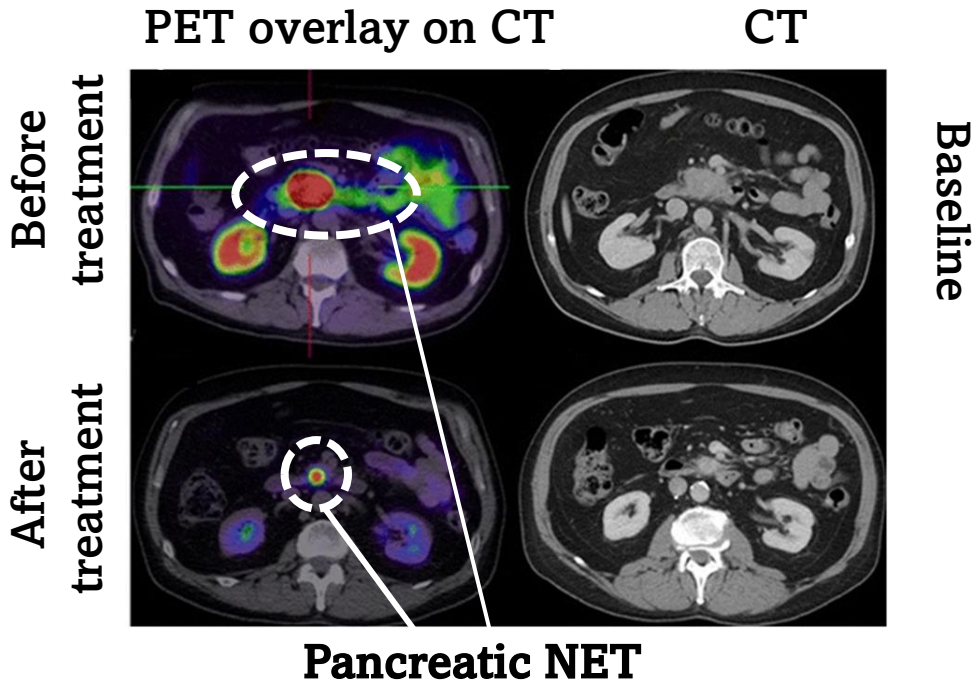
# Modern theranostics for precision healthcare

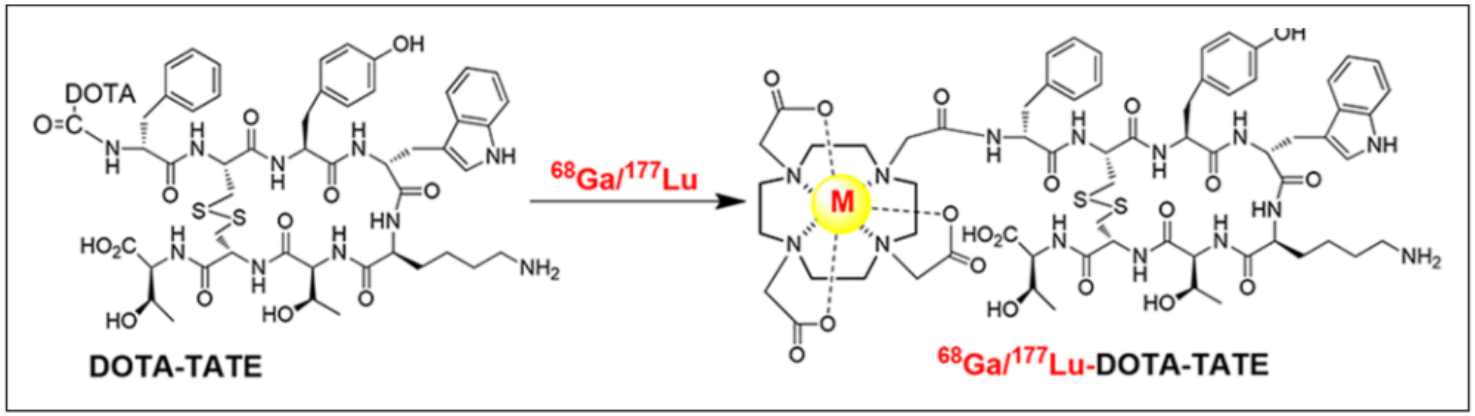
63 y-old male patient with locally advanced pancreatic neuroendocrine tumour




- At baseline, tumour is visible but surgically difficult to remove, but has overexpression of a particular receptor (Somatostatin 2, SSTR2)

- Diagnostic modality: PET
- Molecule (PET tracer) used: 68-Ga-DOTATATE, with *peptide specific for SSTR2 binding*, therefore can specifically light up in the tumour tissue
- For Therapy: 177-Lu-DOTATATE

- Efficacy of therapeutic drugs can be followed with diagnostics as seen, after treatment, tumour regressed and now surgically removable!



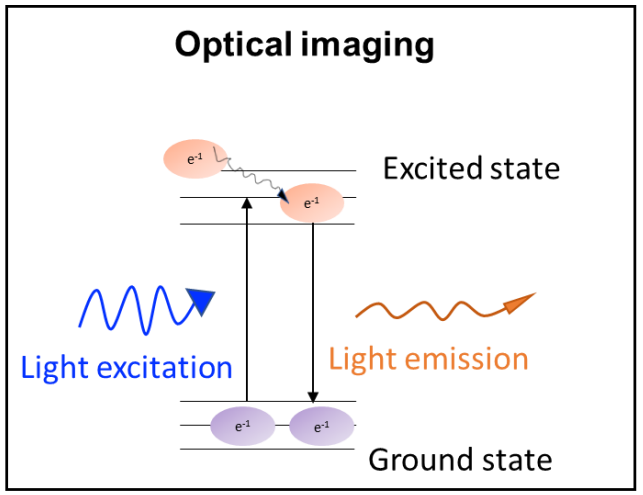

PET: Positron emission tomography, a commonly used diagnostic imaging modality in clinic

# Diagnostic modalities used in the clinic tailored for theranostic applications:

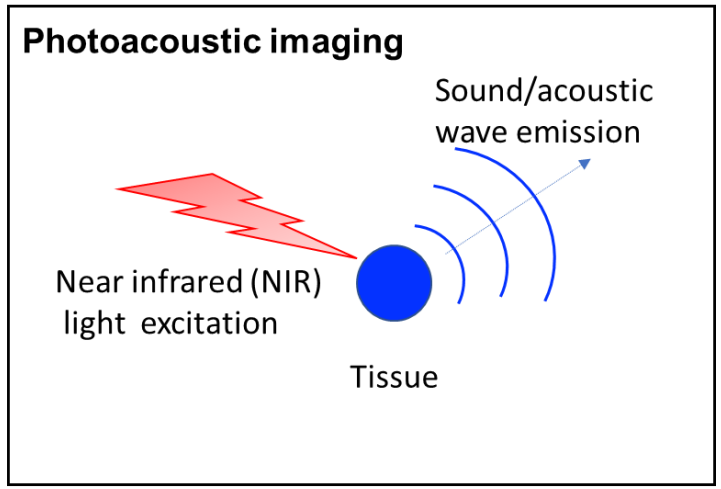
- Positron emission tomography (PET)
- Magnetic resonance Imaging (MRI)
- Ultrasound

- Optical imaging (limited applications in the clinical setting)

- Photoacoustic imaging (PAI): relatively new imaging technology and has great potential for ***clinical translation***




Principle of PAI



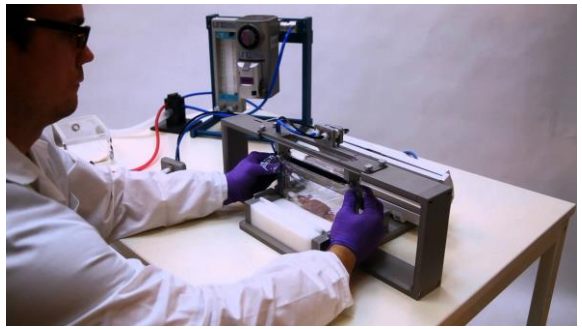

Sound waves travel farther without getting scattered, hence **photoacoustic imaging** can be used for imaging tumour tissues beyond the surface!

Advantages of multispectral Photoacoustic imaging:
- ≤ 1 sec/image (advantage over MRI and PET)
- ~150 µm spatial res (advantage over PET)
- No ionizaing radiation (advantage over PET)
- ~ 100 nM detection (advantage over MRI)
- ~3 cm depth of view (advantage over optical imaging)

# Project: Design and translation of photoacoustic imaging based theranostic probes for solid tumours.

**Major techniques/skills students will learn**

- Design and chemical synthesis of small molecule scaffolds as photoacoustic imaging (PAI) contrast agents
- Engineering PAI scaffolds for therapeutic applications
- Tissue culture experiments for *in vitro* validation of developed probes including studies such as specificity, toxicity and cellular uptake assays.
- Animal handling, and real time *in vivo* photoacoustic imaging on the MSOT
- Image data analysis using spectral unmixing, fluence correction etc.
- Scientific interpretation of data sets from multiple disciplines including chemistry, biology and engineering principles and effective communication of the same.




**Multispectral photoacoustic imaging scanner (MSOT)**

## Further reading


1. Weber J. et al. Contrast agents for molecular photoacoustic imaging. Nature Methods, 2016, Vol 13, 639-650.

2. Attia ABE. et al. Phthalocyanine photosensitizers as contrast agents for in vivo photoacoustic tumor imaging. Biomedical optics express, 2015, Vol 6, 591-598.

3. Luke GP. et al. Biomedical applications of photoacoustic imaging with exogenous contrast agents. Annals of Biomedical Engineering, 2012, Vol 40, 422-437..