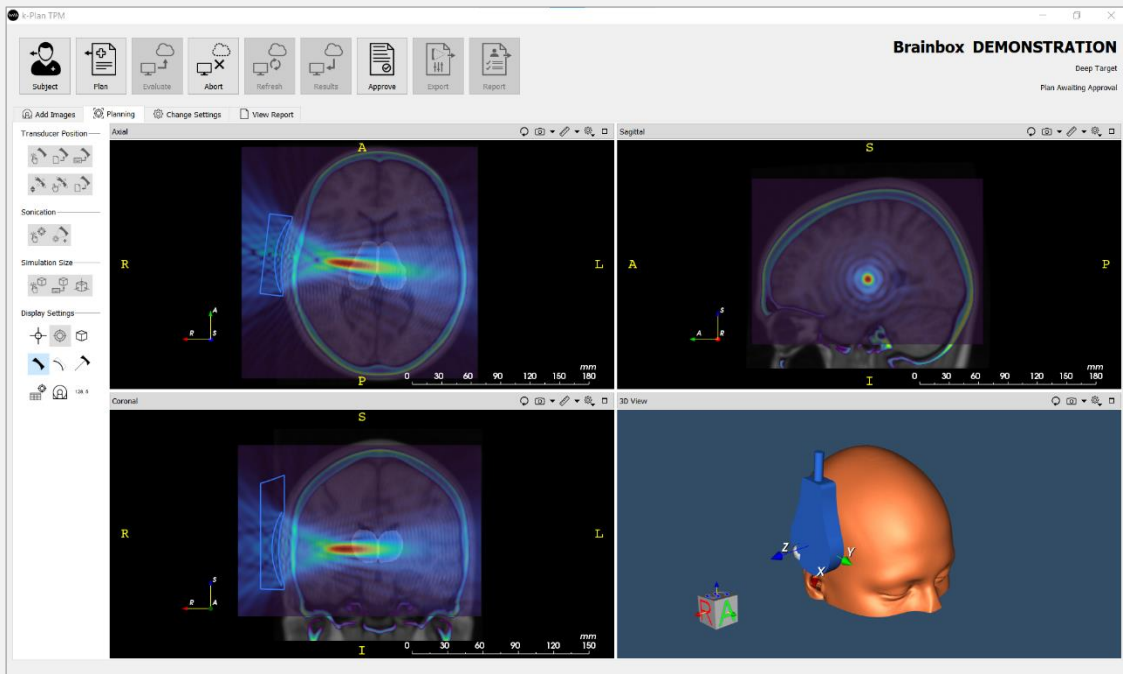




# k-Plan

Ultrasound therapy planning



Available in partnership with

# BRAINBOX

## ADVANCED PLANNING, SIMPLIFIED

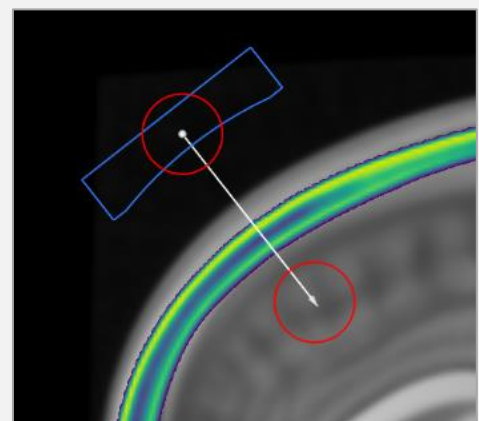
k-Plan is an advanced modelling tool for precision planning of transcranial ultrasound procedures. It uses a streamlined and intuitive workflow that allows users to select an ultrasound device, position the device using a template or medical image, and specify the sonication parameters. High-resolution calculations of the ultrasound field and temperature inside the skull and brain are then automatically calculated in the cloud with a single click. No knowledge of numerical modelling or high-performance computing is required.

The screenshot displays the k-Plan TPM software interface. At the top, there is a navigation bar with icons for Subject, Plan, Evaluate, Abort, Refresh, Results, Approve, Export, and Report. The main workspace is divided into several panels: Transducer Position (Axial and Sagittal views), Sonication (Coronal and 3D View), Simulation Size, and Display Settings. A right-hand panel titled 'Brainbox DEMONSTRATION' shows a list of simulation parameters with checkboxes for 2D and 3D views and labels. Below this, a 'Cursor Position and Voxel Information' box displays World Coordinates, MNI Template T1 MR, and MNI Template CT. At the bottom, a table lists simulation parameters for five different focal distances.

Label	Focal Distance	Driving Frequency	Target Amplitude	Target Intensity	Driving Pattern	Duty Cycle	Repeats	Cooling Time
1 30 mm	30.0 mm	500.0 kHz	547.7 kPa	10.00 W/cm <sup>2</sup>	1x On/Off patterns set	1	15	0.000 s
2 40 mm	40.0 mm	500.0 kHz	547.7 kPa	10.00 W/cm <sup>2</sup>	1x On/Off patterns set	1	15	0.000 s
3 50 mm	50.0 mm	500.0 kHz	547.7 kPa	10.00 W/cm <sup>2</sup>	1x On/Off patterns set	1	15	0.000 s
4 60 mm	60.0 mm	500.0 kHz	547.7 kPa	10.00 W/cm <sup>2</sup>	1x On/Off patterns set	1	15	0.000 s
5 70 mm	70.0 mm	500.0 kHz	547.7 kPa	10.00 W/cm <sup>2</sup>	1x On/Off patterns set	1	15	0.000 s

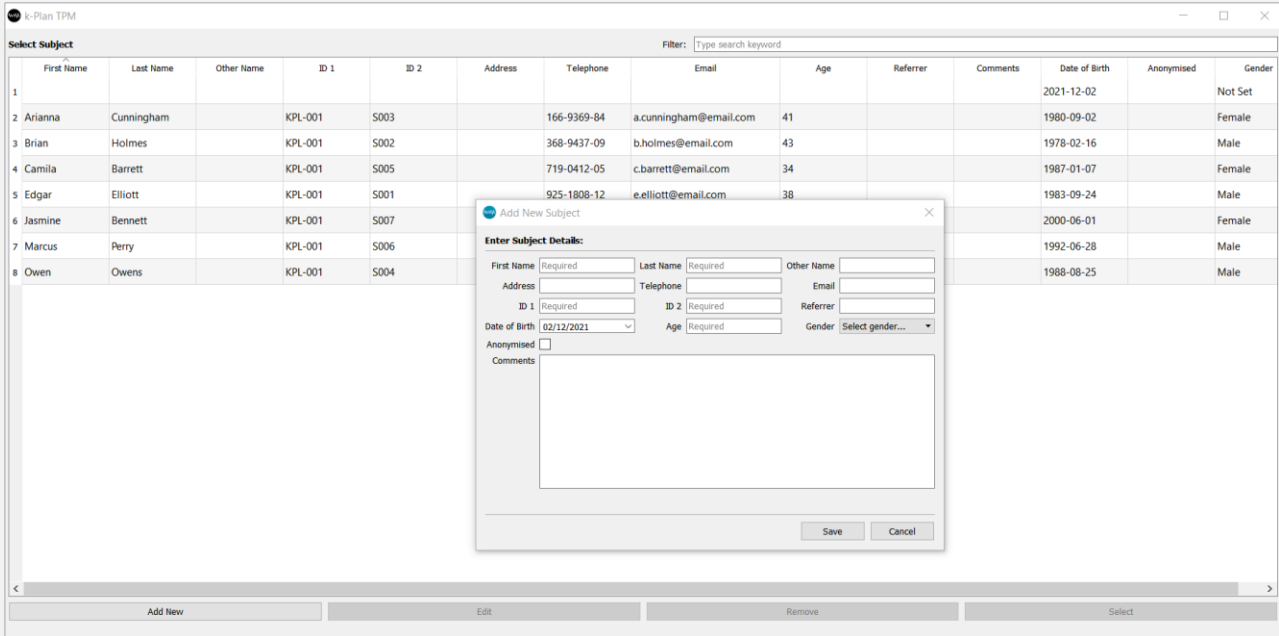
## USER DRIVEN, RESEARCH BUILT

k-Plan is developed by researchers at *University College London* and the *Brno University of Technology* based on more than a decade of cutting-edge research into ultrasound modelling and planning for transcranial ultrasound therapy. More than just a research tool, k-Plan features a refined UI/UX shaped by extensive formative user testing. Features like transducer click-to-place, configurable image overlays, and traceable reporting reduce setup time and increase productivity when running simulations.



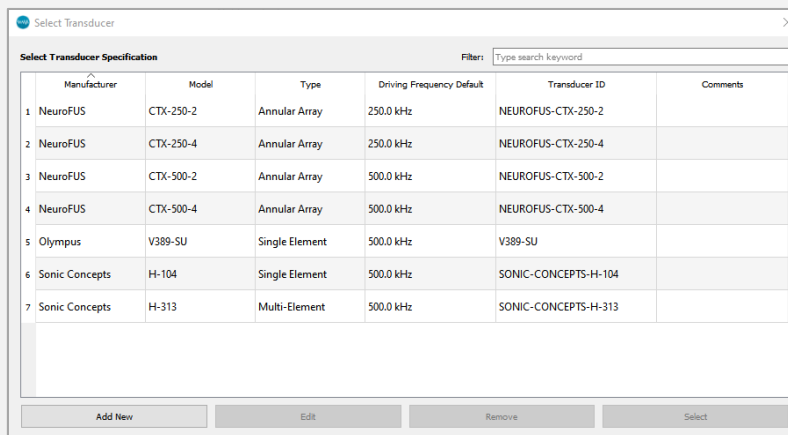
## STUDY MANAGEMENT

k-Plan integrates a complete study management system. Users can capture study information, subject details, and study IDs according to study requirements, and then later de-identify or anonymise planning simulations with a single click.



## EXPANDABLE TRANSDUCER LIBRARY

k-Plan can model single element, annular array, and multi-element transducers. The transducer library is user-extendable to model transducers from a wide range of manufacturers or custom transducer designs.

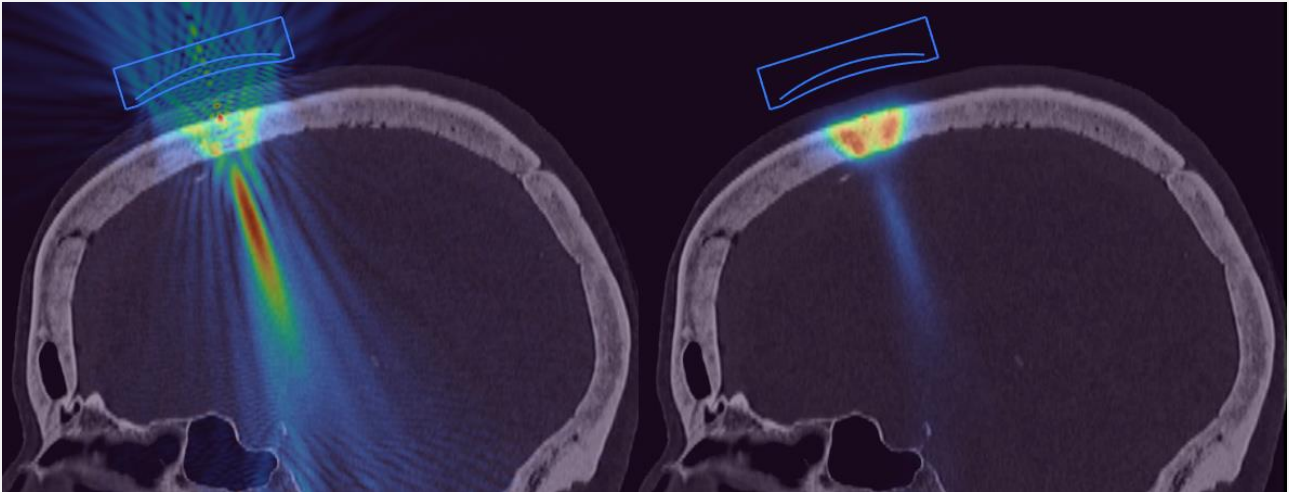


## INTELLIGENT COMPUTE ENGINE

k-Plan’s intelligent compute engine completely automates the process of running a planning simulation for transcranial ultrasound therapy. It automatically maps from skull images to material properties, generates an accurate model of the transducer based on geometric and calibration information, and then sets appropriate numerical and computational parameters. Simulation outputs are automatically processed to display the ultrasound field and temperature inside the brain, and to calculate exposure and dose parameters.

### STATE-OF-THE-ART SIMULATION TOOL

Behind the scenes, k-Plan runs simulations using k-Wave, a state-of-the-art simulation tool that is widely used across academia and industry to study acoustic wave propagation. It uses an experimentally validated full-wave acoustic model to accurately calculate how ultrasound waves travel from a therapy device through the skull and into the brain. This is coupled with a model of heat diffusion and perfusion to calculate temperature rise and thermal dose.



### CLOUD-BASED PLANNING SIMULATIONS

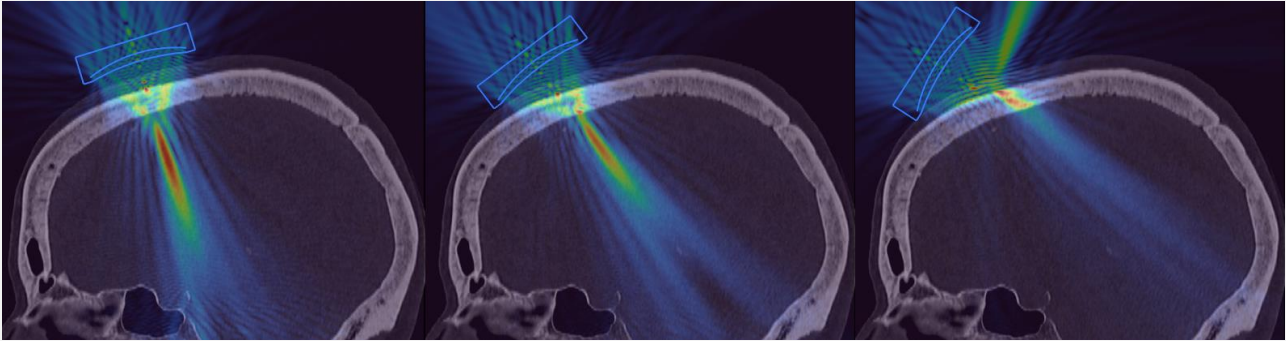
k-Plan allows access to high-performance computing resources in the cloud to run high-resolution planning simulations with a single click. The simple installation procedure and intuitive workflow means users can be running simulations within minutes, with no additional resources or accounts required. k-Plan’s automated dispatch server optimises the computing resources needed for every simulation, minimising the time between planning and results. The status of running simulations is automatically refreshed and displayed in the plan browser.

Select Plan		Filter: <input type="text" value="Type search keyword"/>		
	Label	Transducer	Comments	Status
1	FSL-Extracted Skull	CTX-500-4 (NeuroFUS)	Demonstration of using an FSL extracted h...	Server Running Simulation
2	Focal Length	CTX-500-4 (NeuroFUS)	Demonstration of changing the focal lengt...	Simulation Complete, Ready For Download
3	Skull Variation	CTX-500-2 (NeuroFUS)	Demonstration of the variability in skull att...	Simulation Complete, Ready For Download
4	Incidence Angle	CTX-500-2 (NeuroFUS)	Demonstration of changing the incidence ...	Downloading Plan Results
5	Deep Target	CTX-250-4 (NeuroFUS)	Demonstration of targeting a deep structur...	Plan Awaiting Approval
6	Skull Heating	CTX-500-2 (NeuroFUS)	Demonstration of how the sonication para...	Plan Awaiting Approval
7	Frequency Variation	CTX-250-2 (NeuroFUS)	Demonstration of how the transmit freque...	Awaiting Transducer Placement

Add New
Edit
Remove
Duplicate
Refresh Status
Select

### OPTIMISED TARGETTING

Alignment of the ultrasound beam with the brain target can be iteratively optimised by adjusting the transducer position and sonication parameters and comparing the calculated exposure and dose parameters. For multi-element transducers, automated correction for skull aberrations can also be performed to precisely target the desired brain area.

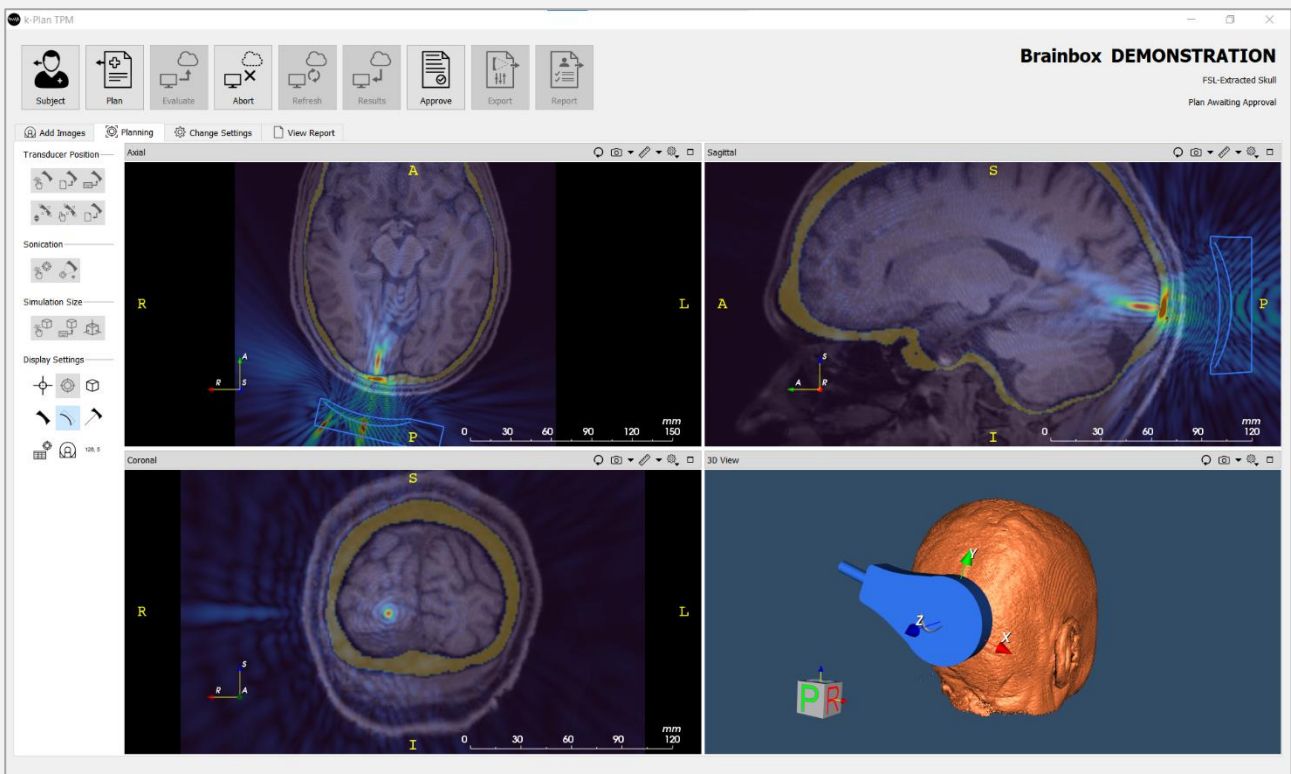


### WORKFLOW INTEGRATION

k-Plan easily integrates into standard neurostimulation workflows, including importing and exporting transducer positions for use with neuronavigation systems, exporting sonication parameters to therapy devices, and exporting traceable plan reports.

### FLEXIBLE SKULL MAPPING

k-Plan relies on a skull image to compute the ultrasound and temperature fields inside the brain. While x-ray computed tomography (CT) images currently provide the gold standard, k-Plan is also configured to work with MR-based skull segmentations and MR skull imaging techniques such as zero-echo time (ZTE) imaging.



## **SECURE BY DESIGN**

Subject data is stored in a password protected AES-256 encrypted database stored locally with each installation. Only anonymised data is transferred to the cloud using industry-standard encrypted communication protocols along with advanced data security and integrity measures. To accommodate data privacy laws in different jurisdictions, the cloud computing resources used by k-Plan can also be restricted to geographical regions.

## **ADVANCED WEB PORTAL**

k-Plan's advanced web portal provides a complete snapshot of your account, including current cloud computing allocations, and a complete usage history. Self-service options allow administrative users to add or remove accounts associated with the same software license and modify user privileges.

## **FURTHER DETAILS**

k-Plan is developed by researchers at *University College London* and the *Brno University of Technology* and is being brought to market by *UCL Business* in collaboration with *Brainbox, Ltd.* Brainbox brings several decades of experience in developing, integrating, and distributing cutting-edge neurotechnologies for neuromodulation and brain mapping to end user scientists, engineers, and physicians conducting neuroscience R&D.

For product and pricing enquiries, please contact [info@brainbox-neuro.com](mailto:info@brainbox-neuro.com).