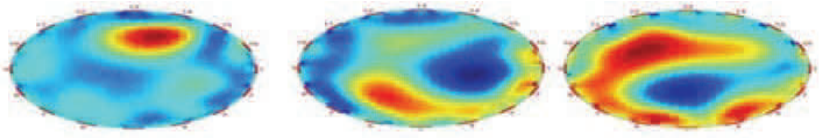


Frequently Asked Questions (FAQs)

Process Tomography

What is ERT?

ERT stands for electrical resistance tomography. This measurement technique measures the distribution of electrical resistance (or conductivity) in a 2D cross-sectional plane of a volume, be it in a pipe or vessel. Measurements can be taken rapidly allowing real time viewing of data. The information is shown on a tomogram which is essentially a map of low conductivity (blue) to high conductivity (red). Conductivity measurements are useful as the different phases of a multi-phase process have very different values. This makes ERT a powerful technique for observing processes such as mixing, flow and separation. It is also useful for reactions where the reactants or products have different conductivities, or where reactions change overall conductivities such as crystallisation.

What is ECT?

ECT stands for Electrical Capacitance Tomography. ECT is used where the bulk medium does not conduct electricity. In ECT the tomogram has red for high dielectric (eg oil) and blue for low dielectric (eg air).

What is EIT?

ERT and EIT are often confused and used interchangeably. EIT stands for Electrical Impedance Tomography and measures both resistive and capacitive components of materials. This allows discrimination of conducting materials to be differentiated based on their properties. For example organic material in suspension has a significant capacitive component and can be differentiated from ionic nutrients.

It should be noted that EIT still requires a conductive medium.

Should I use ERT or ECT for my process?

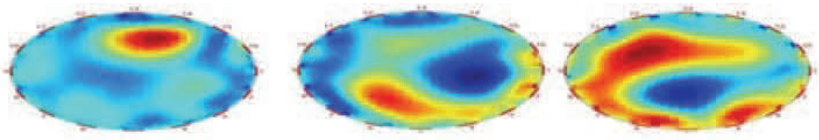
ERT should be used where the continuous material is electrically conducting (eg water, acids, bases and ionic solutions). ECT should be used where the continuous material does not conduct electricity eg. air/oil. If the process changes between conducting and non-conducting, then a combined ECT/ERT system is recommended. An example of this might be polymerization, drying or multiphase flow.

What is a tomogram?

A tomogram is a 2-dimensional conductivity map of a cross-section through a pipe or vessel. It is derived from the Greek "tomos" – slice and "graph" – picture.

In electrical tomography, tomograms are shown using a colour spectrum for values of conductivity (ERT), capacitance (ECT) where red is high conductivity / dielectric and blue is low.

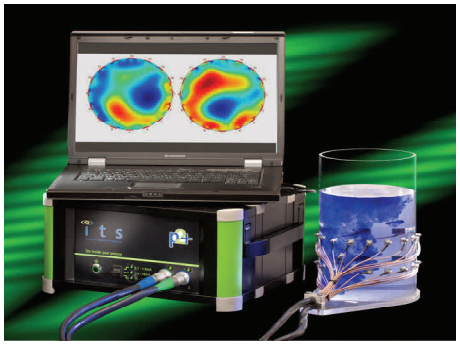
Tomograms can also be used to show concentrations (again with red = high and blue = low).



Frequently Asked Questions (FAQs)

What does a tomography system consist of?

A tomography system consists of a sensor (associated with the process), a data acquisition system (such as p2+, m3c or z8000) and software to reconstruct the acquired data.



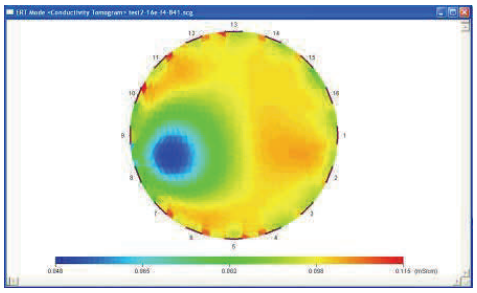
Electrical Resistance Tomography System (Laptop not included)

What information do the measurements provide?

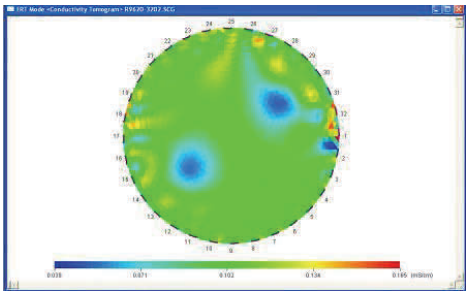
The key to applying tomography is to relate the instrument's measurements to process conditions.

Electrical process tomography measurements are taken from a sensor using an array of electrodes mounted on a sub-strate (the "sensor"). The measurements are taken as raw voltages. These raw voltages can be used in their own right for bulk trend data, exporting for research into different tomography algorithms, direct input into MVSP (multivariate statistical processing) packages, or for analysis alongside other process measurements etc.

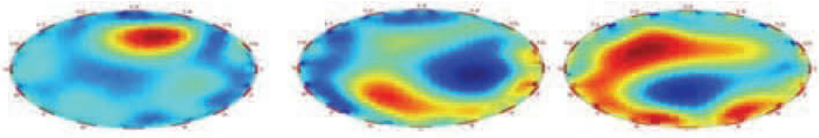
Typically the voltage measurements are converted into conductivity data for ERT (or capacitance data for ECT). [In the case of EIT, data is also available on phase angle and reactance which is of more specialised interest.] Both ERT and ECT data are then displayed as tomograms.



16 Electrodes



32 Electrodes



Frequently Asked Questions (FAQs)

Applications

Mixing

- mixing statistics at start of process
- mixing statistics at end of process
- mixing time
- level of homogeneity
- determine mixing efficiency

Flow

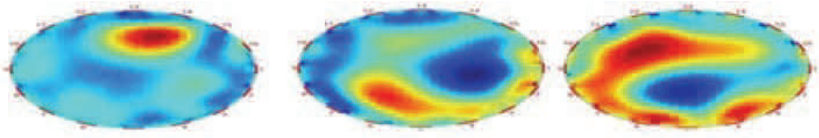
- flow pattern/regime visualisation : real time, online, high speed
- cross correlation , velocity profiles
- phase distribution / volume fraction
- visualisation of solids transportation : speed, settlement, understanding of potential corrosion effects

Separation

- start and end point
- interface detection
- quality of separation - validation of equipment such as separator for example
- volume fraction
- phase inversion

Reaction Engineering

- start and end point
- visualisation of additions
- crystallisation - information from nucleation stage, start of crystal formation, crystal homogeneity and dispersion = quality status



Frequently Asked Questions (FAQs)

Will it work with my process?

Scale:

Sensors can be made with diameters from 5mm up to 2m and lengths from 5cm to 4m.

Materials:

Electrical tomography systems can work with a very wide range of materials ranging from air and non-conducting fluids (using capacitance techniques) to water and polar organic solvents (using resistance techniques). The most common materials which present significant challenges to the current technology are very highly conducting systems (such as molten steel). Resistance tomography systems for use in food and pharmaceutical environments are available and intrinsically safe (IS, EX-rated, ATEX-certified) systems are also available.

Operating Conditions:

Tomography systems can be used in a wider range of temperatures, atmospheres and processes. Although based on electrical resistance, Electrical Resistance Tomography can be used in metal-walled pipes and vessels with metal internals (such as down pipes and impeller shafts). However a substantial quantity of metal internals (such as metallic packing) or highly conducting systems (such as concentrated acids and molten metals) can present a challenge.

Is the system an AC or charge / discharge principal?

Our electrical tomography systems are based on AC.

Sensors

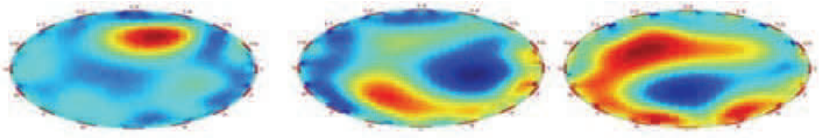
Which sensor is right for my application?

In considering the best sensor for your application the first thing to establish is whether to use ERT or ECT. As above, you would use ERT for processes where the background material is conductive, ECT if the background material is not a conductor, and dual modality (combined ERT and ECT) where the process moves between the two, or for 3-phase systems.

ERT electrodes need to be in contact with the process fluid and can be made out of a wide range of materials (stainless steel etc). The substrate is typically an engineering plastic (eg PVDF) or ceramics, although conductive materials such as metals can also be used providing they can be insulated from the electrodes.

Can sensors be removed from the process?

Sensors can easily be fitted on a temporary or permanent basis.



Frequently Asked Questions (FAQs)

Do the electrodes get dirty?

Electrodes can get dirty. There is an electrode check function built into ITS's software which allow users to determine if there has been any significant signal deterioration.

How often do sensors need to be replaced/cleaned?

Sensors are manufactured from metal (electrodes) and a supporting substrate and are typically as robust as the pipes / process vessels they are fitted into.

Is the technology intrusive?

ECT and ERT sensors can be designed so that there are not intrusive to process conditions. Where surface effects are important (such as chromatography) or if there are significant constraints for retrofitting sensors into an established vessel, this can be challenging.

Is the technology invasive?

ECT sensors can be mounted on the outside of pipes and process vessels so do not intrude in the flow of materials. To do this, the pipe / process vessel needs to be made of Perspex, glass, plastic, ceramic or other non-conducting material. For metal vessels, ECT sensors need to be in contact with the process (similar to ERT described below).

ERT sensors need to make contact with the process and so can intrude into the process vessel, though sometimes they can be made flush with the pipe/vessel wall. ITS has had many years experience in engineering sensors so that any affect is minimised and that the integrity of seals etc are maintained.

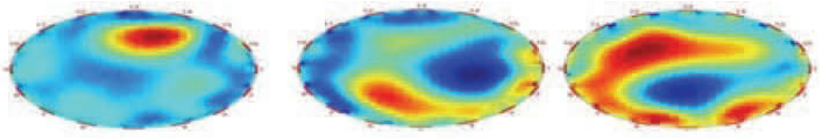
Resolution

What is the temporal resolution?

The most rapid tomography system supplied by ITS is the z8000 which takes a complete set of measurements from 2 x 16-electrode planes in less than 1 millisecond. These rapid frame rates are important for fast processes or getting a statistically significant number of measurements for flow velocity analysis. More typically the m3000 and p2+ have frame rates of around 30 frames per plane per second.

What is the spatial resolution?

Typical on-line resolution is approx 5% of the diameter of a circular sensor around the edge of a pipe or vessel.



Frequently Asked Questions (FAQs)

How can I improve the resolution?

Resolution can be improved by using off-line reconstruction techniques. Examples of such techniques are SCG (sensitivity conjugate gradient, see below) or parametric (model-based) techniques. On a practical level, resolution can be also be improved by taking a good reference (stable measurements at values close to those of the process under observation). It should be noted that on and off line references can be used.

What is LBP?

LBP stands for "linear back projection" which is a single step reconstruction technique. It is computationally simpler than SCG and other iterative techniques and can be operated in real time when tomography data is acquired. LBP tends to smooth boundaries and hence is good where there is a concentration gradient (such as liquid-liquid mixing).

What is SCG?

SCG stands for "sensitivity conjugate gradient" which is an iterative reconstruction technique. It uses different field modelling (for example taking account of electrode size and shape) and repeatedly runs until an optimum value is reached. It is particularly strong for resolving sharp boundaries (such as gas / liquid interfaces).

What is parametric reconstruction?

Parametric reconstruction is based on rules (parameters) that are known about a process. The process is modelled using these rules and raw tomography data is processed to provide the best fit of the data to possible process conditions.

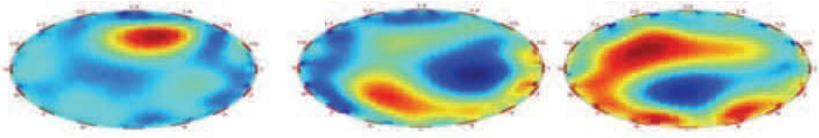
Find out more

How can I see a demonstration?

Our application engineers are able to carry live demonstrations of our p2+ ERT, m3000c ECT and m3000 Dual Modality ERT/ECT instruments. The lab is equipped with various circular and linear sensors, a lab-scale bubble column as well as an integrated tomography test rig. An ERT/ECT Dual Modality sensor is also available for 3-phase flow air-oil-water demonstrations. Our application engineers are also available for demonstrations at your site. Please contact us to arrange an appointment.

Is equipment available for rental/trials?

ITS equipment is available for rental on a short term basis to best suit your research needs - this includes instruments and sensors. ITS also offers trials and feasibility studies which can last from a few days to a few months using our in-house laboratory. Alternatively, on-site trials can also be run.



Frequently Asked Questions (FAQs)

How do I get in contact?

The simplest way to get in contact is via our website using our online contact form

Alternatively, our full contact details are as follows:

Industrial Tomography Systems Plc | Sunlight House | Quay Street | Manchester | M3 3JZ | UK

tel: +44 (0) 161 832 9297 | fax: +44 (0) 161 839 5195 e: sales.support@itoms.com

Do you have representatives where I am?

ITS has representatives around the world, full details can be found here:

http://www.itoms.com/distributors

If there is no representative in your region, then please direct your enquiry to Industrial Tomography Systems