Example Application

Separation Process Monitoring and Control

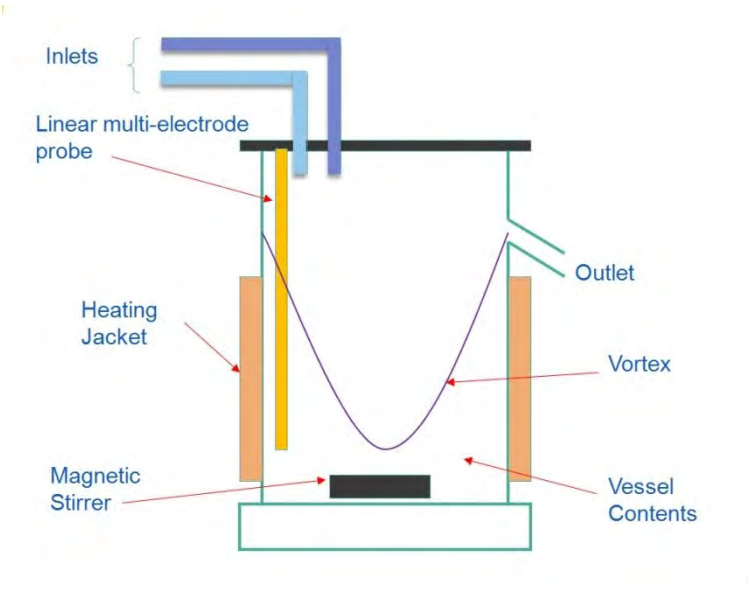
Requirement: Ensure vortex state in certified separation process

Nuclear power, using a controlled fission reaction, is claimed to be our cleanest major form of energy production; the example shown has no chimneys emitting pollutants or CO_2. Once loaded with nuclear fuel a reactor operates for long periods producing heat energy, used to generate steam, in turn powering turbines driving electricity generators.

Nuclear fission transforms one form of uranium to several radioactive by-products which require reprocessing, for reuse or long term storage. This includes separation of materials to provide appropriate treatments.

This set of processes is tightly regulated; each process is monitored continuously to ensure compliance with certified operating conditions.

A certified precipitation process in the diagram is heated using an external jacket. It has two feeds: a metal salt dissolved in nitric acid, and an organic acid.

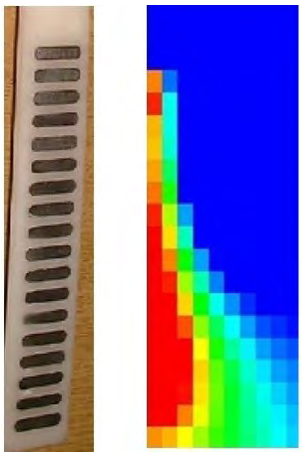


Mixing and reaction is stimulated by a rotating magnetic stirrer bar which creates a vortex whose size/shape depends upon speed and material composition. The process is designed so that the reaction product is forced to the top to leave via the side outlet.

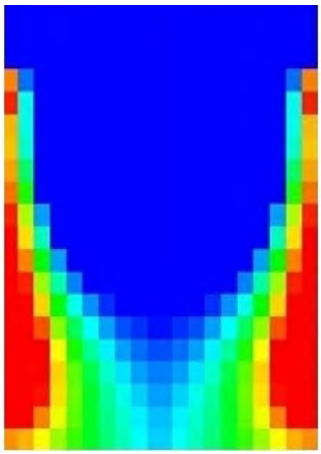
Continuous monitoring must be used to confirm the presence of at stable vortex. The linear probe is deployed to sense the state of a vertical cross-section to *see inside* this shielded and protected process that is also hidden by its heating jacket.

The structure of the probe is seen more clearly in close-up – showing its 18 electrodes.

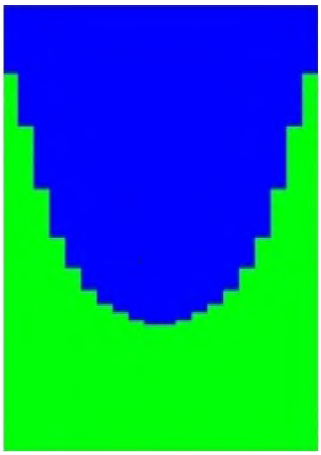
This is connected to an *Industrial Tomography Systems* **P2000** Processing System which computes instantaneous radial section views and estimates the vortex boundary..



Processing gives radial view to vertical centreline

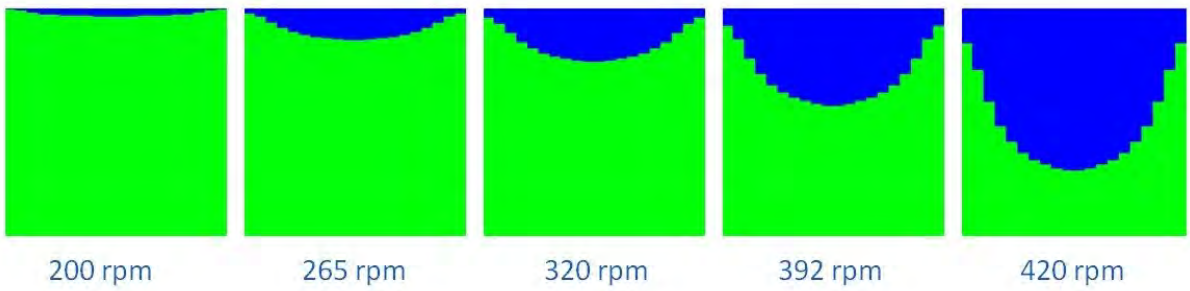


Assuming radial symmetry provides diameter view



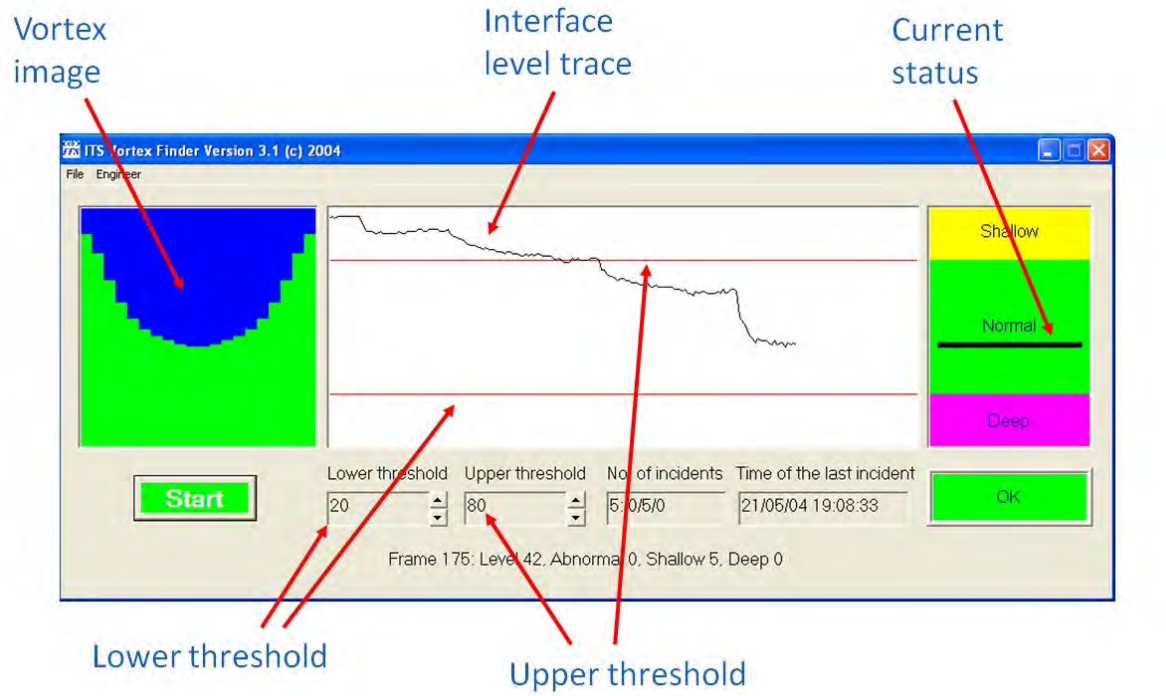
Boundary estimate gives final vortex view

Trials show clear identification of shallow to deep vortex states over the speed range (the vortex state is also dependent upon composition). Here we see a test range of results..



The requirement specification includes the estimation of the vortex depth (for control action) and identification of shallow and deep vortex alarm states.

The purpose-designed display shows the various specification requirements..



In <u>conclusion</u>

S*eeing inside* this process..

enables reliable monitoring and control,

delivers consistent safe process performance,

ensures clear process certification compliance.

Acknowledgement: we are grateful to Industrial Tomography Systems plc for data and images used in this case study.