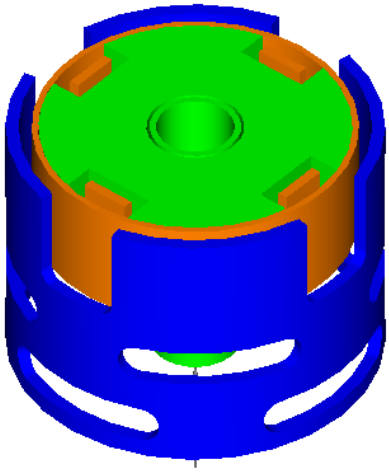
Realize the Beauty of Waves in Life
Apply the Power of Waves for Better

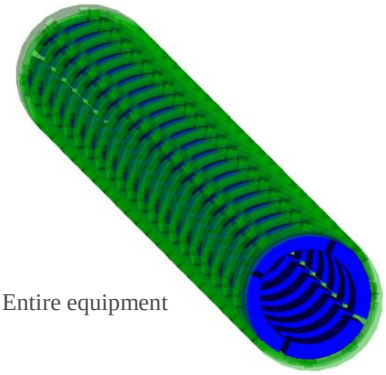
Wavenology EL

Three-Dimensional Transient Elastic Wave Simulator

Advanced 3D Elastic Wave Simulator

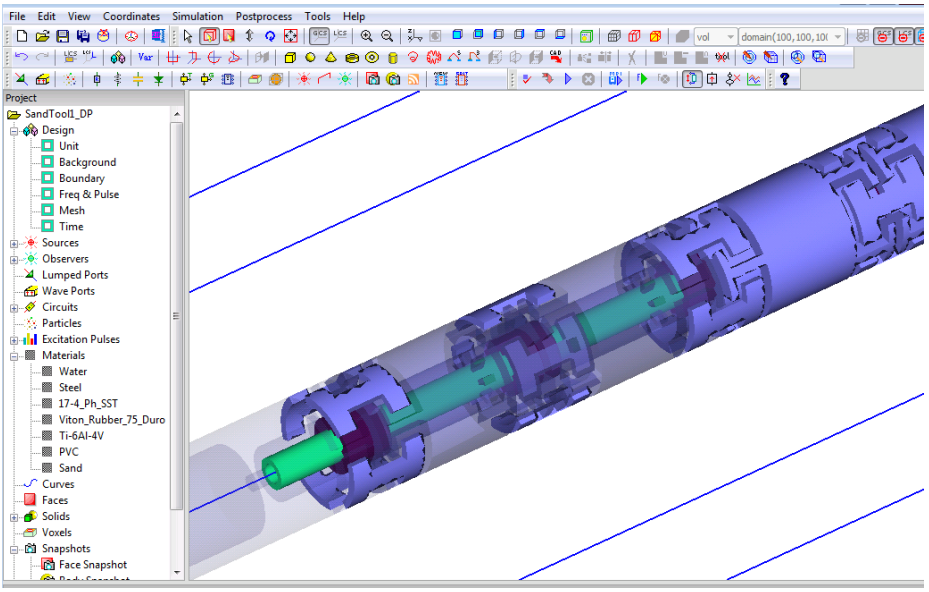


Device unit



Entire equipment

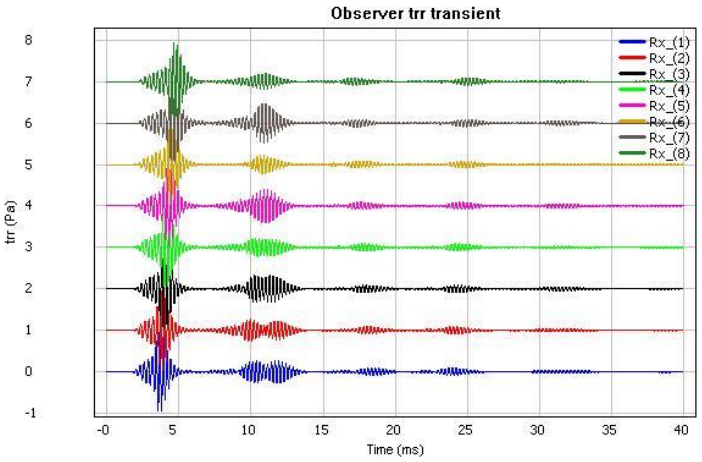
Wavenology EL is one of the major software products of Wave Computation Technologies, Inc. (WCT). It is an advanced, general-purpose, 3D transient elastic wave simulator. It focuses on oil exploration with seismic, sonic, and ultrasonic waves, with major oil services companies as our clients. The software contains a full graphic user interface and integrates a robust transient elastic wave simulator and post-processing capabilities. With Wavenology EL, engineers can analyze complex geophysical problems such as sonic logging tool design, formation evaluation, logging while drilling equipment prototyping, casing and cement bond channel detection and many other borehole acoustic related applications.



Integrated design environment with robust 3D modeler, simulation manager and result explorer

Background

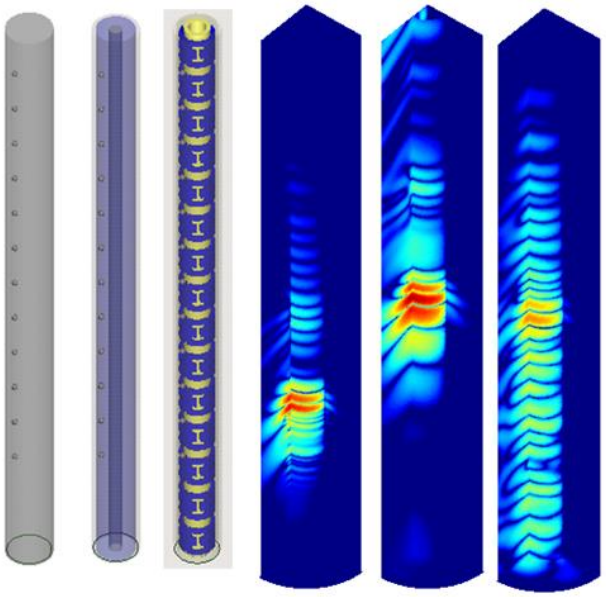
Sonic logging is one of the most widely used geophysical methods in borehole environments. A typical sonic logging tool includes one or more transmitters and several receivers in addition to its electronic circuits. A slotted sleeve housing is generally used to hold the sonde components and support other logging tools in combination. The slotted sleeve, as a major part of the sonic tool, is made of a steel pipe with many slots on it. Very finely-structured slots are designed to attenuate and delay the pipe waves traveling along the tool housing so that the existence of the steel pipe does not have a large effect on the elastic wave fields. In order to optimize the design of sonic tools, researchers and engineers have performed many numerical and experimental studies related to the transducers. For slotted sleeves, however, only experimental studies have been conducted. Due to the restrictions of cost and time, past experimental studies performed on the slotted sleeve are quite limited.



Value Added Software Solution

Due to the usual nonaxisymmetric property of acoustic well logging tools and borehole structures, a full 3-D cylindrical finite difference time domain (FDTD) program is important not only in designing and analyzing the tools, but also in understanding the elastic wave propagation in the presence of the tool and in interpreting the measured data.

Wavenology EL is the first commercialized software to simulate real engineering sonic logging problems. It integrates a powerful FDTD engine which can simulate the whole slotted sleeve for sonic logging tools. It has a complete absorbing boundary condition to handle the unbounded problems, and can simulate very fine structures efficiently.



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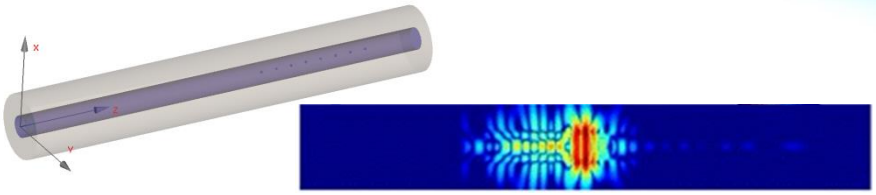
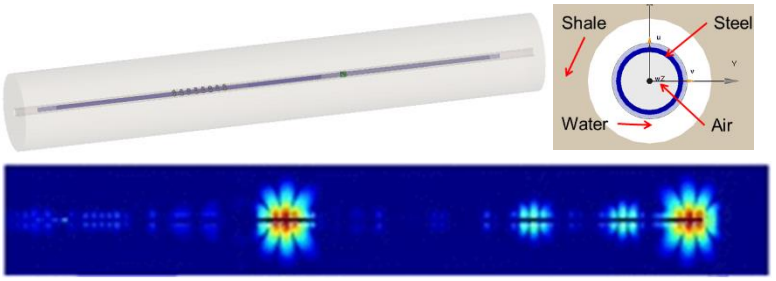
Applications

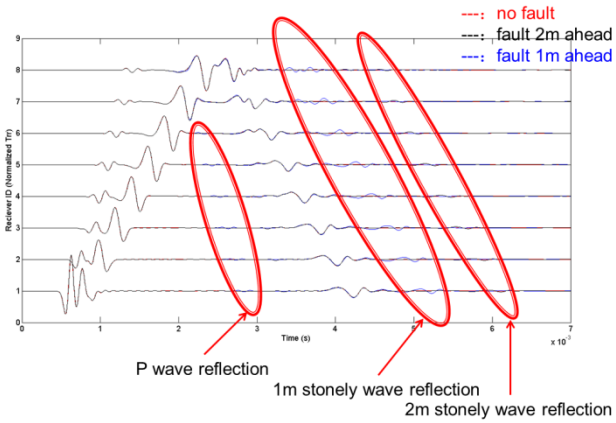
- Borehole acoustics study
- Formation evaluation
- Sonic oil well logging tool design and optimization
- Logging while drilling analysis
- Fault detection
- Casing and cement bond channel detection
- Measurement of pipeline blockade level
- Transducer modeling



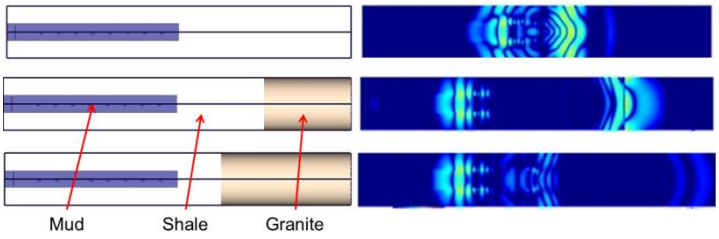
Acoustic wave propagation in open hole



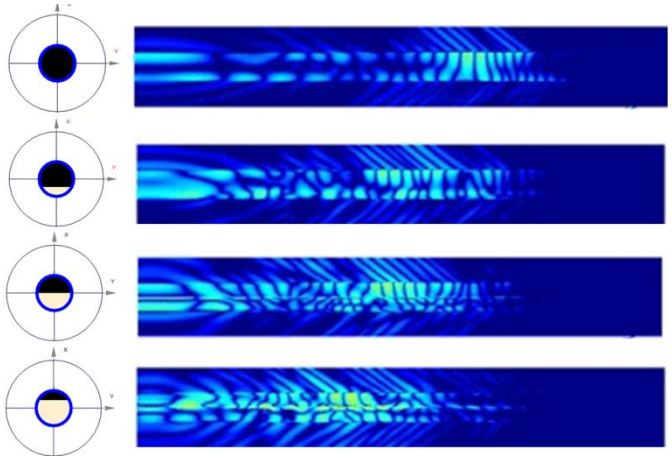
Finite length sonic logging tool characterization



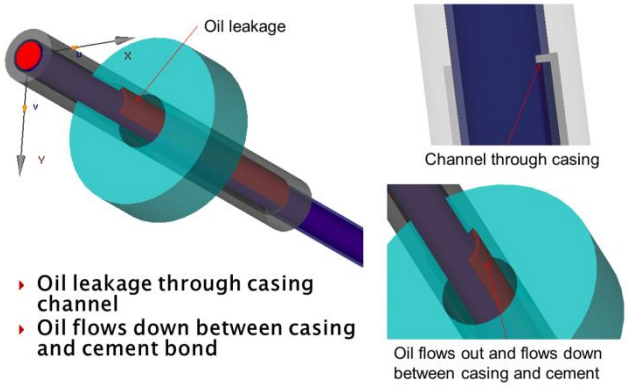
Logging data interpretation

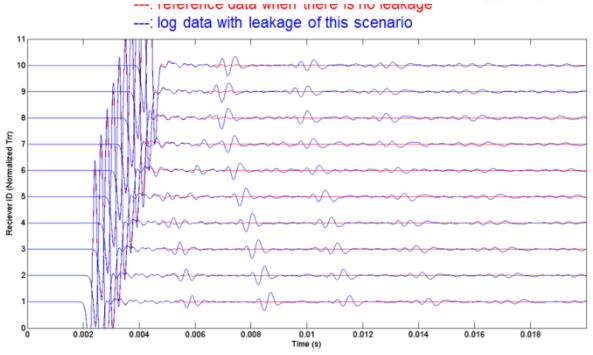


Logging while drilling analysis, fault detection



Acoustic wave propagation in pipeline with various sediments level

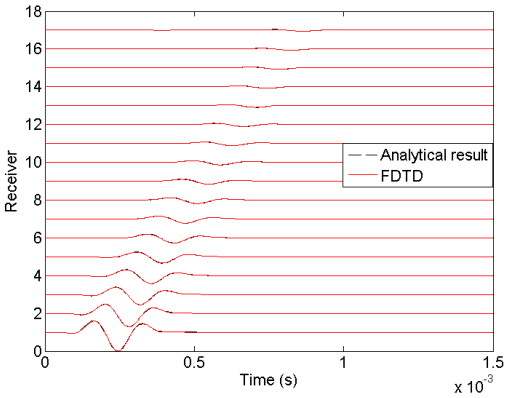




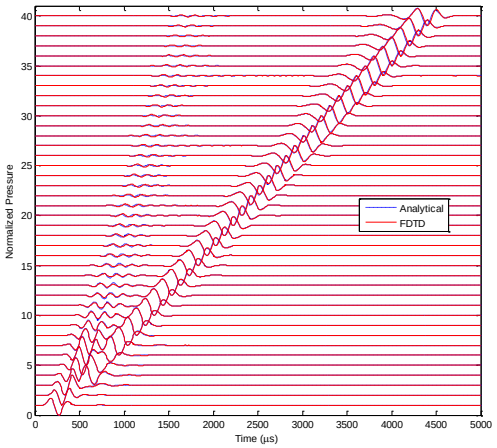
Casing channel detection

Accurate and Trustable Solver

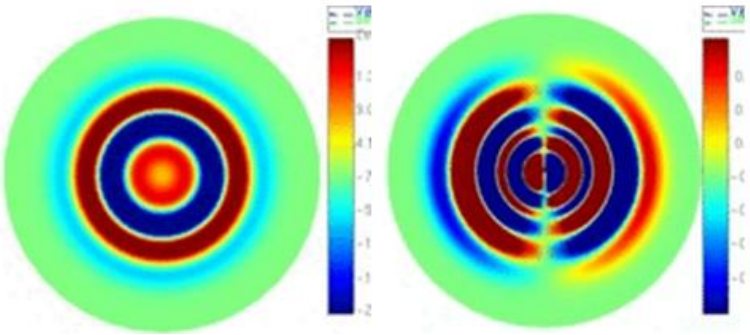
- 3D cylindrical FDTD engine
- Cross-platform computation engine, Windows/Linux single workstation and supercomputing clusters
- Various material type support including mud, water, steel, clay, sand, limestone, granite, saturated shale, etc.
- Support special materials with Q-factor
- Point monopole, point dipole and high-order ring source types
- Support various transient pulse signals, including Gaussian, Ricker, Blackman-Harris Window function, Delta, Rectangle, Sinusoid and arbitrarily user-defined signals
- Soft, hard, periodic, symmetric, anti-symmetric boundary conditions.
- Robust perfect matched layer technology



Q-factor validation with analytical solution

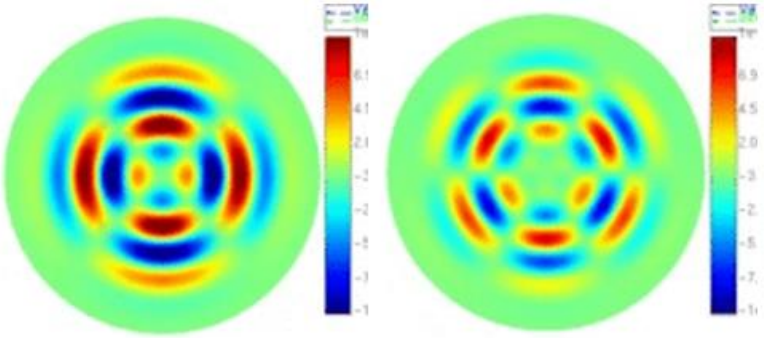


Supercomputing engine validation



Point monopole

Point dipole



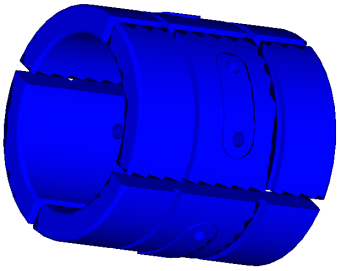
4th order ring source

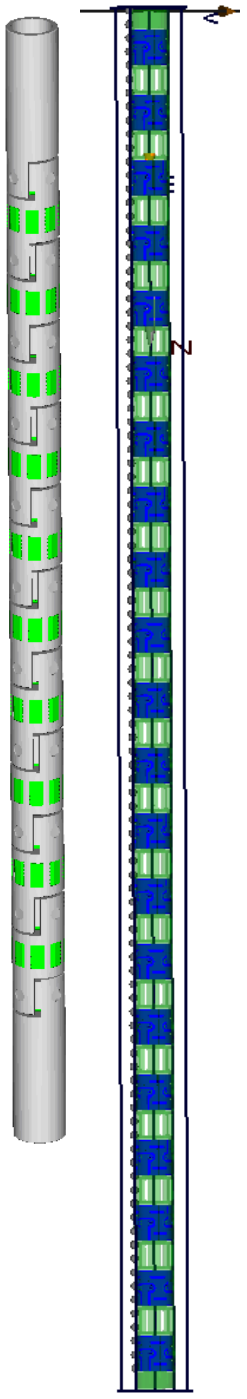
6th order ring source

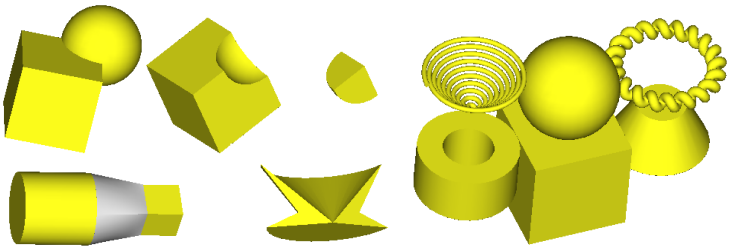
Wave Computation Technologies

3D Solid Modeling System

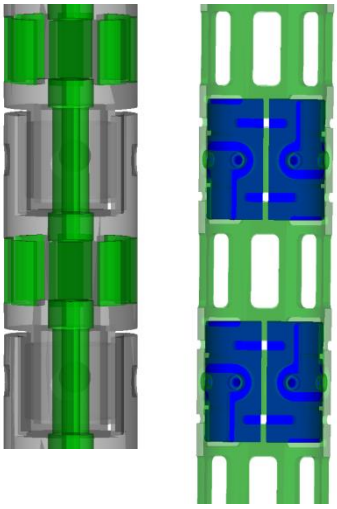
- Boolean operation on solids
- Various 3D operations include translation, mirror, rotation, scale, intersection, union, etc.
- 2D and 3D lines and curves
- Support covering coplanar and closed lines and curves as faces
- Sweeping faces along 2D or 3D lines and curves
- Sphere/Ellipsoid, Box (Brick), Ring (Circular/Elliptical), Torus, Cone, Polygon, Cylinder Archimedean, Toroidal, Spiral, Spline, Bondwire
- CAD solid Import/Export





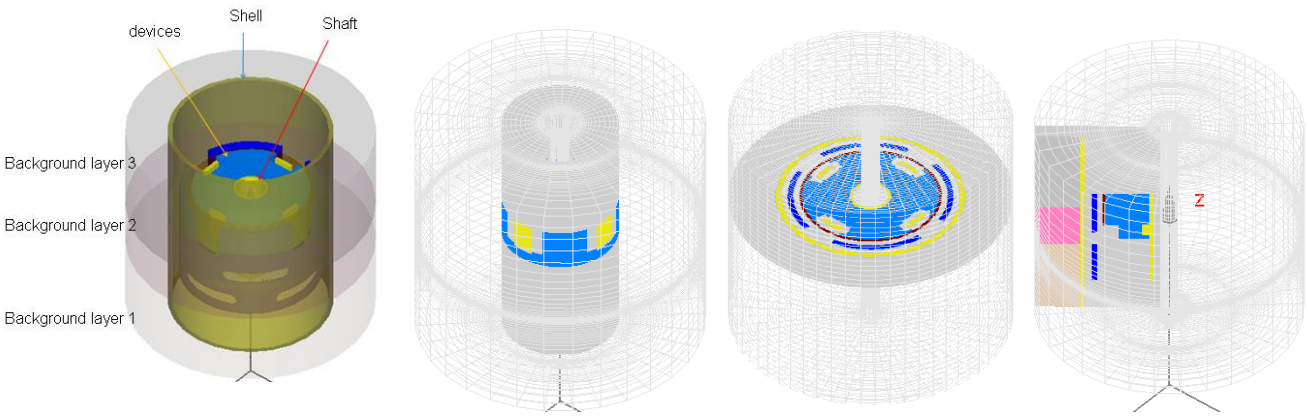


Robust model construction and geometry operations



Robust 3D Cylindrical Mesher

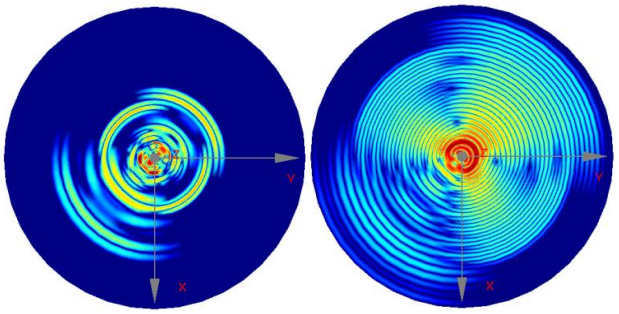
- Flexible controls of R, Phi and Z mesh densities
- Independent sampling density for customized mesh requirements
- Mesh file import / export
- Arbitrary view of mesh on components



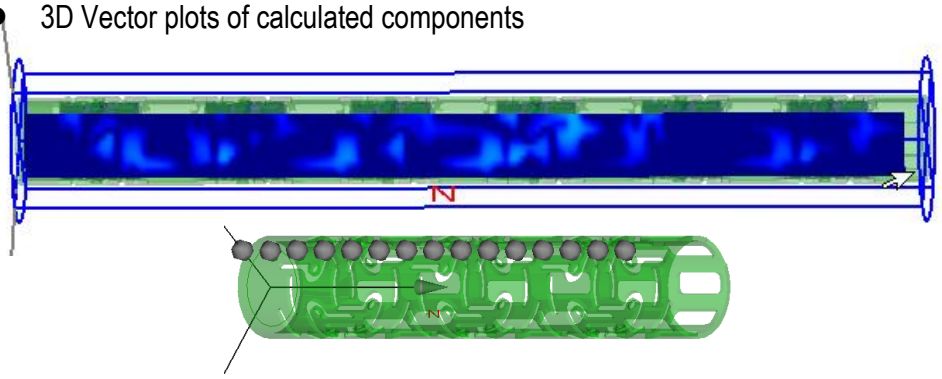
Automatic structured meshing system

3D Elastic Wave Output

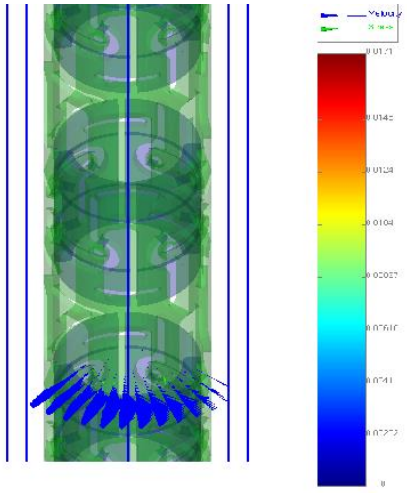
- Full 3D output of speed components and forces at any location
- Array definition of observers
- Both transient and frequency-domain snapshots in volumes and surfaces
- Transient waveforms and frequency-domain impulse responses at observation points
- Output files compatible with Matlab
- 3D Vector plots of calculated components



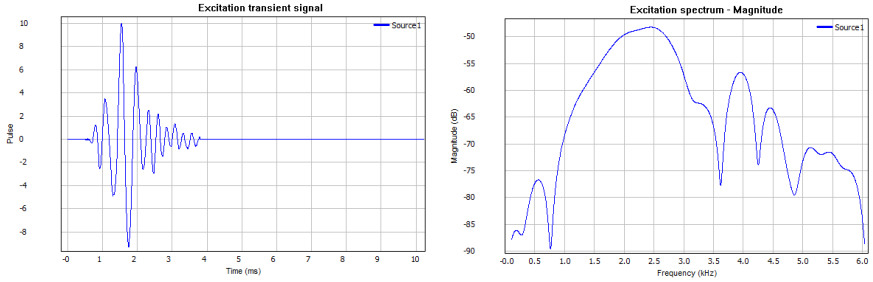
Snapshots acoustic waves. Left: time domain; Right: frequency domain



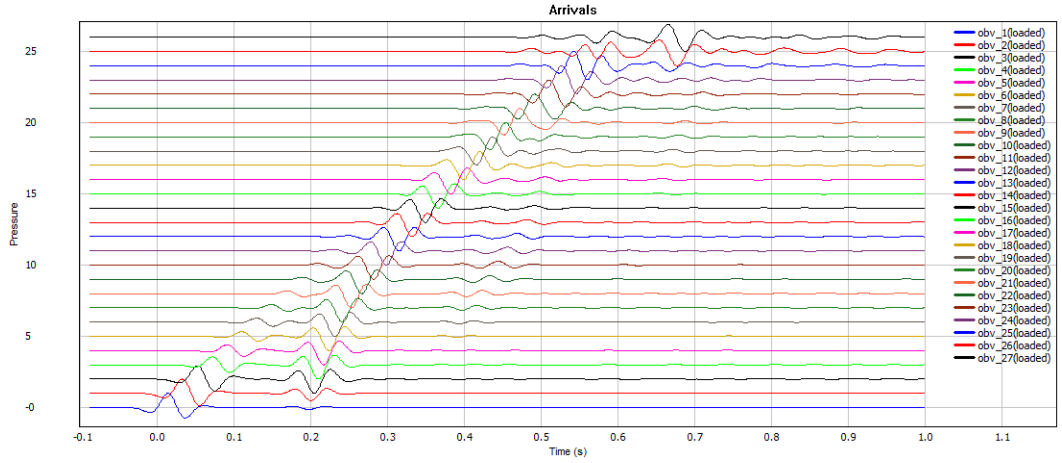
Observer and snapshot definition in complex geometries



Vector snapshot



User-defined signal analysis. Left: transient; Right: spectrum



Waterfall display

Wave Computation Technologies

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Wavenology aims to provide customers with the best computation technologies available for waves in electronic, photonic, medical, and geophysical industries. Our research team applies and develops state-of-the-art algorithms to solve wave equations. The software packages are general-purpose tools for design optimization and for understanding the physics of wave phenomena.