Simulating Reflectometry in Plasma

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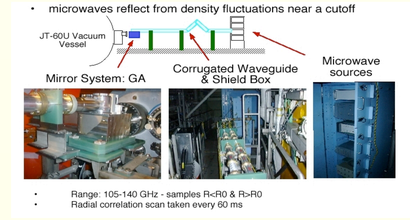
Actual Reflectometer on Fusion Experiment

Emit radio frequency waves, measure reflected waves. Locate turbulence in plasma by correlating reflections.



Expensive, custom-made diagnostic instrument. Limited opportunities for acquiring data from tokamaks motivates need for simulations.

Visualization Client

Web Interface

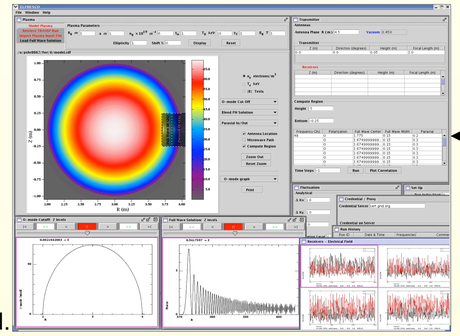
Prepare input, submit run & monitor results.

Display simulated waves downloaded from URL.

Added interactive graphics & visualization without changing existing Fortran simulation programs.

Java applet, runs in browser.

Portable, no software installed.



HTTP

Portal Server

Manage:

- Sessions
- Input Plasmas
- Simulations
- Run History
- Credentials from myProxy server

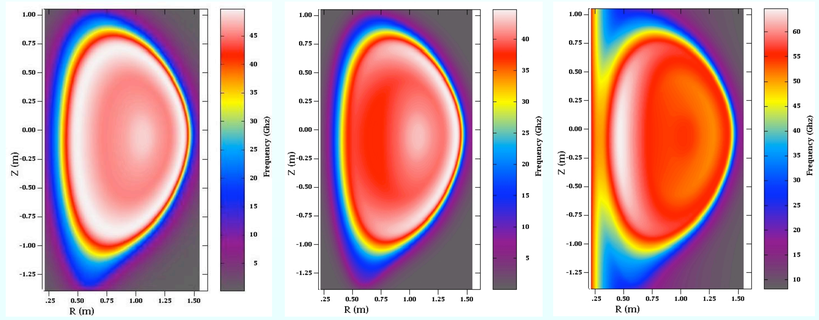
Visualization Servlet

Credentials

Globus job-submit

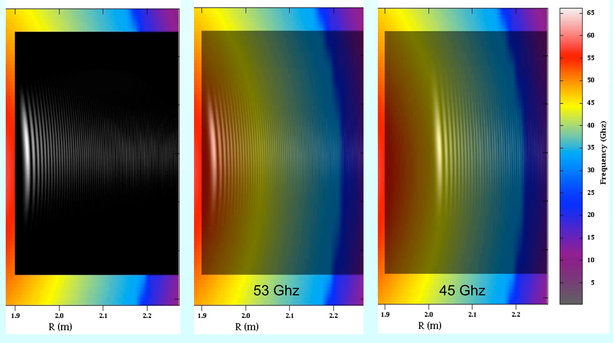
Compute Services

Wave Reflection Layer (Cut-off Location)



O-mode *LX-mode* *RX-mode*

Visualize Solution



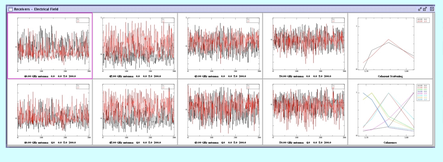
Blending simulated reflection + predicted reflection locations.

Emitted 53 Ghz wave propagates farther than 45 Ghz wave for O-mode cut-off:

$$f_o = \sqrt{\frac{n_e}{1.24x10^{16}}}$$

n_e = electrons / m^3

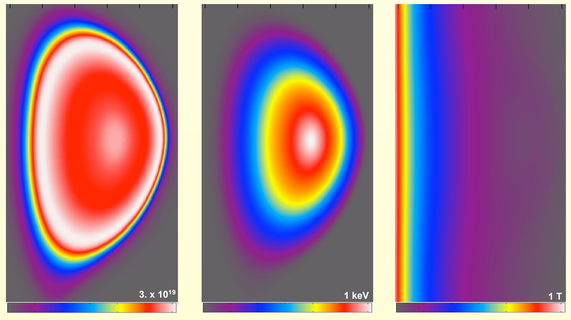
Correlation Graphs



Correlation of 4 frequencies at 2 receivers.
Decreasing correlation indicates fluctuation and turbulence areas in the plasma.
Graph is Java object, serialized to applet.
Encapsulated methods for exploring data.

Multi-Tier Architecture

Visualize Input Plasma Cross Sections



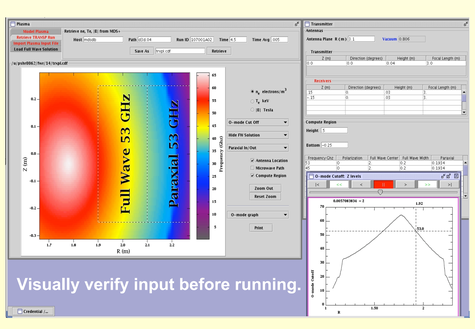
Electron Density **Temperature** **Magnetic Field**

Graphical Input

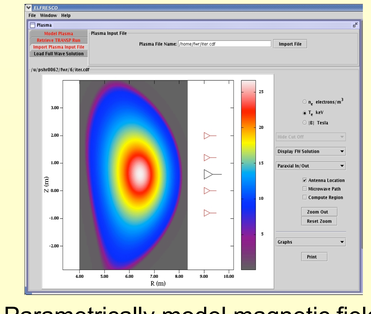
User positions transmitter & receivers outside of plasma.

Interactive crosshair to find reflection layer predicted in O-mode cut-off graph.

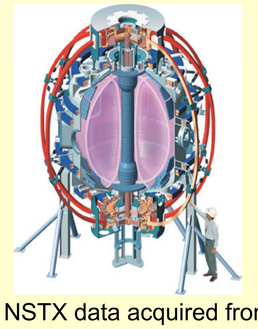
Guides user in specifying frequency to simulate.



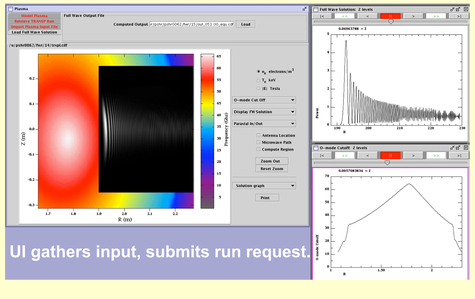
Input Plasma Data Sources



Parametrically model magnetic field geometry, density, & temperature. Or programmatically simulate new designs, such as ITER.



NSTX data acquired from experimental shots, processed & stored in MDSplus database.



Simulation

Compute amplitude of reflected waves.

High resolution output image compressed on server, downloaded from URL.

Elfresco – **The Full Wave Reflectometer Simulation Code** `w3.pppl.gov/fwr`