

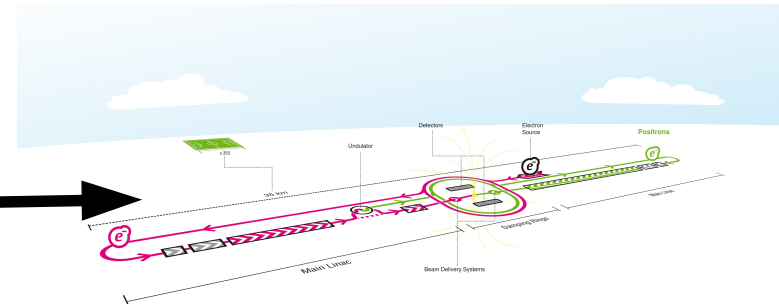
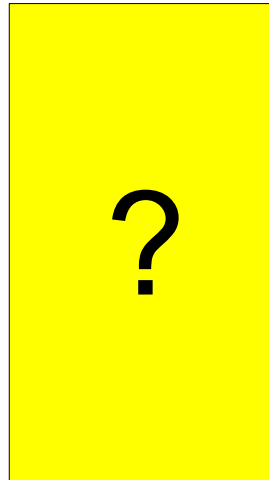
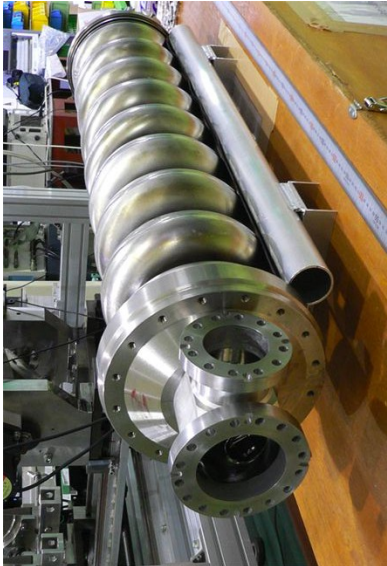


Realistic Maps of Wakefields in RF Cavities

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Presently, the HEP community lacks a tool to link detailed EM codes with particle tracking codes



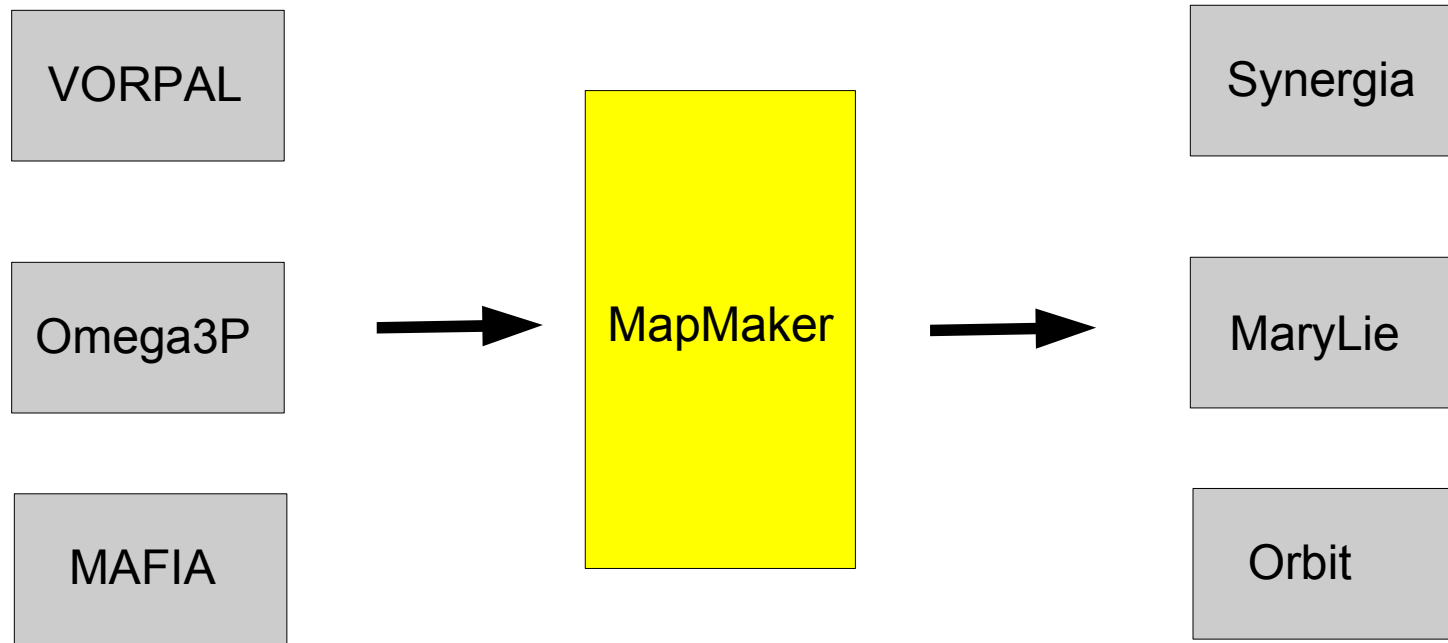
~10s cm

Finite element,
finite difference

~10s km

Maps, particle
tracking

A paper by D Abell gives an analytic method for generating maps from detailed EM simulations



Our work to develop MapMaker is funded by a Phase II SBIR project from DoE HEP

This technique reduces noise inherent in differentiating numerical results



- Maps require expanding (for example in a Taylor Series), and this requires derivatives
 - Calculating derivatives from numerical results is prone to noise
 - Abell's technique replaces on-axis derivatives with approximations from off-axis Fourier terms
 - The technique is low noise, but requires knowing mode structure
-

Test: single cell srf cavity in accelerating mode

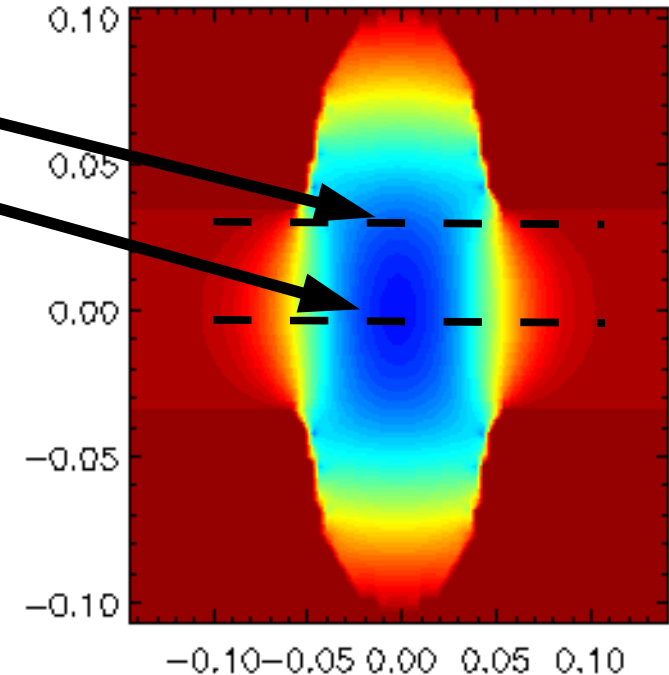


- Goal of the example:
 - Take an off-axis field slice as input
 - Try to reproduce the on-axis field
- This requires two steps:
 - Calculate Fourier terms using E_z off-axis:

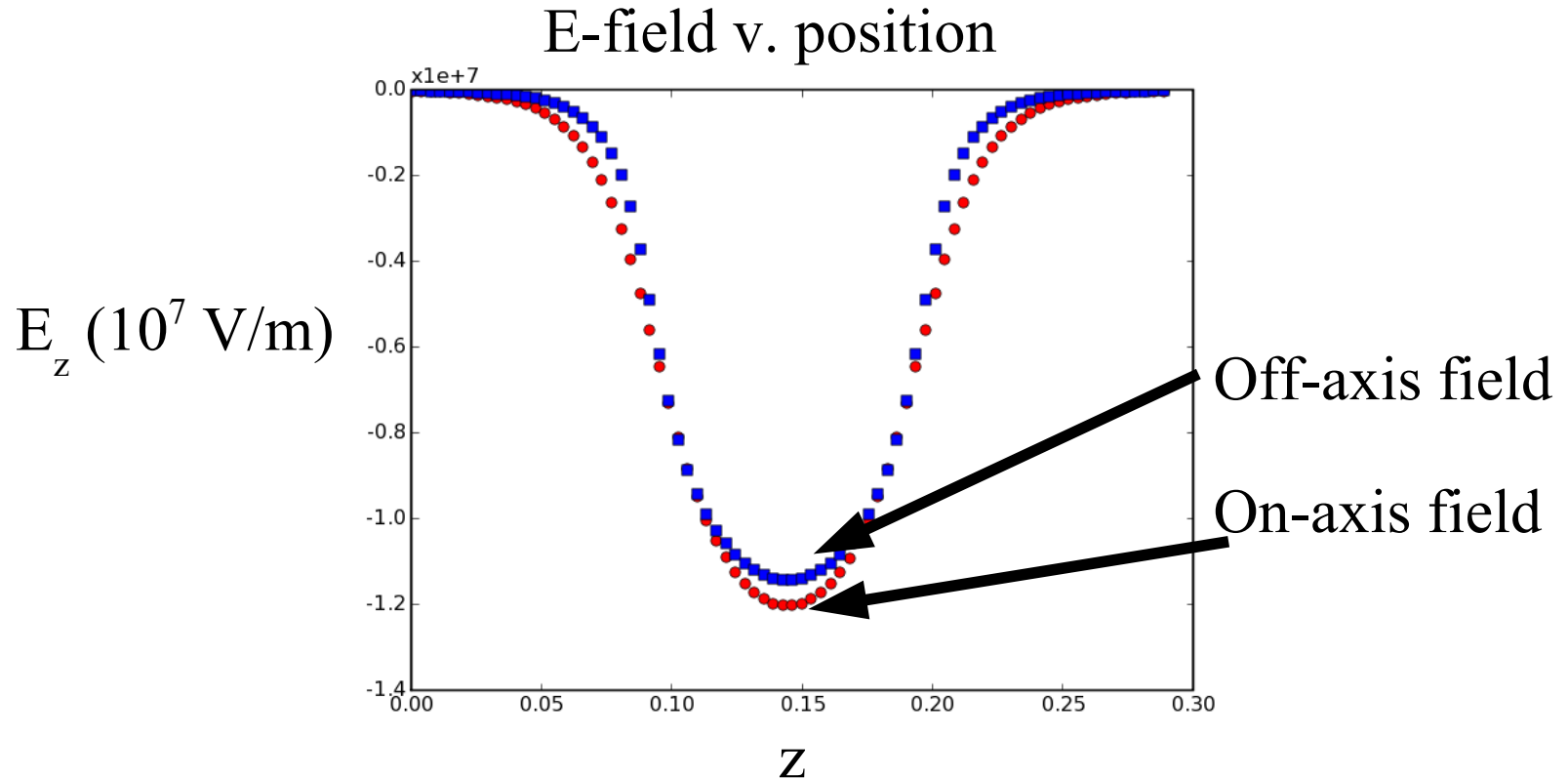
$$\tilde{e}_m(k) = \frac{1}{R_m(k, R)} \int_{-\infty}^{\infty} \frac{dz}{\sqrt{2\pi}} e^{-ikz} E_{zcm}(R, z)$$

- Use those to get derivatives on-axis:

$$\frac{d^n}{dz^n} E_z(0, z) = \int_{-\infty}^{\infty} \frac{dk}{\sqrt{2\pi}} e^{ikz} (ik)^n \tilde{e}_0(k)$$



Goal: to see how well Abell technique reproduces on-axis fields using off-axis values

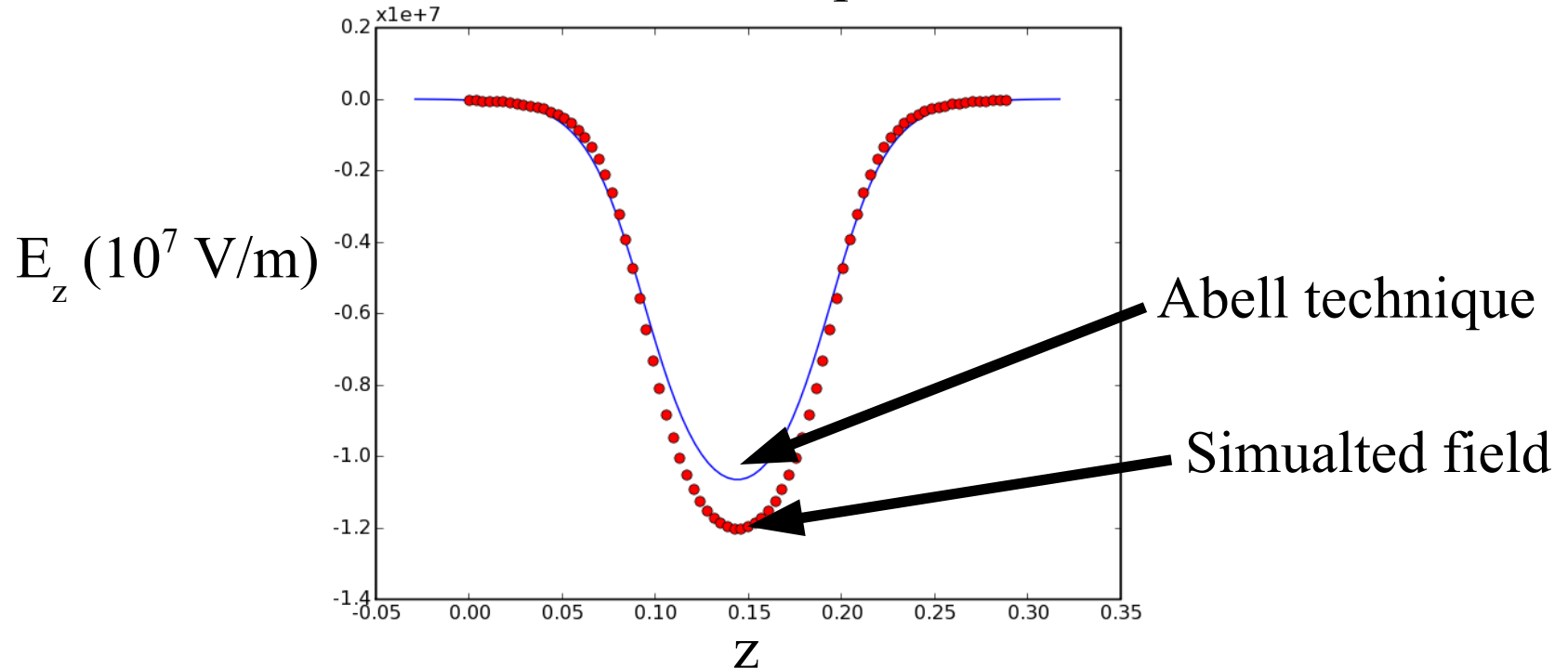


As a benchmark, we will attempt to use off-axis values (blue) from VORPAL simulation to reproduce on-axis values (red)

Abell technique gives good agreement with field profile, but 10-20% error in peak field strength

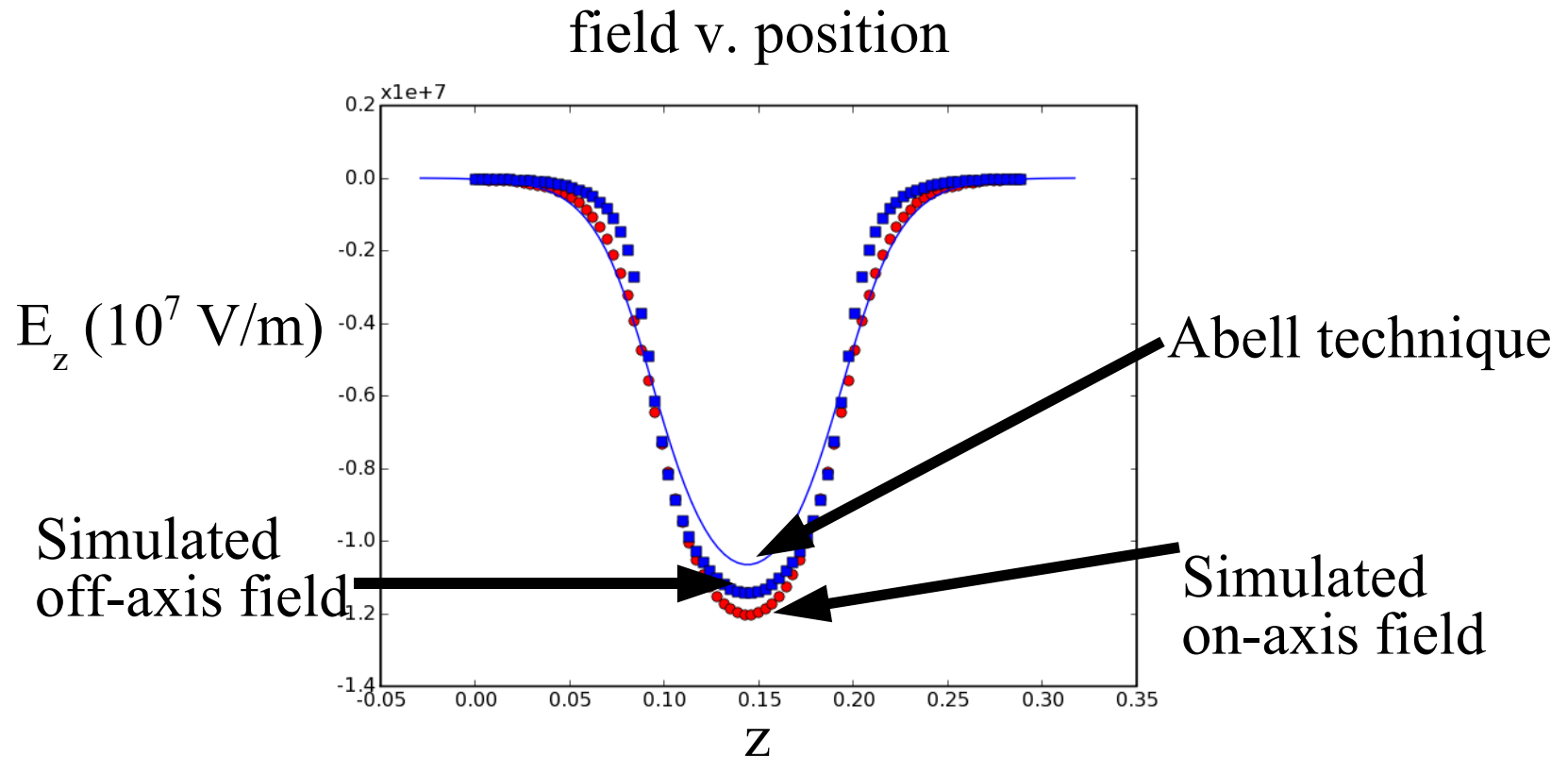


On-axis field v. position



Keeping roughly 100 Fourier terms gives the right shape, but wrong peak field strength

Value from Abell technique is lower than off-axis value (not a pure mode?...or just pilot error!)



Field strength from Abell technique is lower than off-axis value (indicating another mode present or maybe a bug in my implementation?)

Before MapMaker can create a wakefield map, we need eigenmodes and frequencies and TPS library

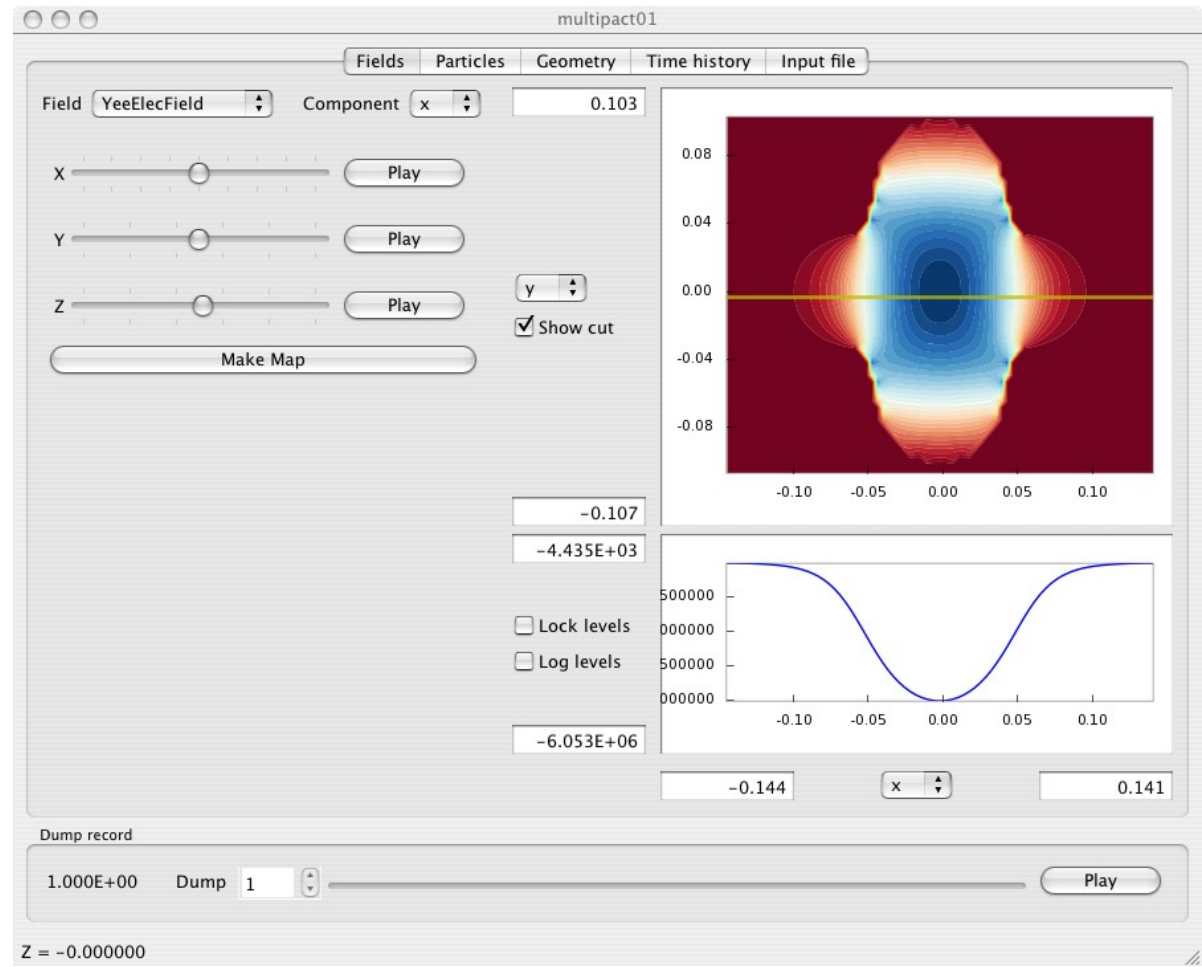


- Need a 3D implementation (Fourier in azimuth)
 - Need ability to extract individual modes from a simulation (would be easy with frequency-domain code like Omega-3P, for time-domain codes, see talk tomorrow by S. Ovtchinnikov)
 - Need a truncated power series library to convert numerically calculated derivatives into terms in a map
-

We are working on a cross-platform, code-independent GUI as well



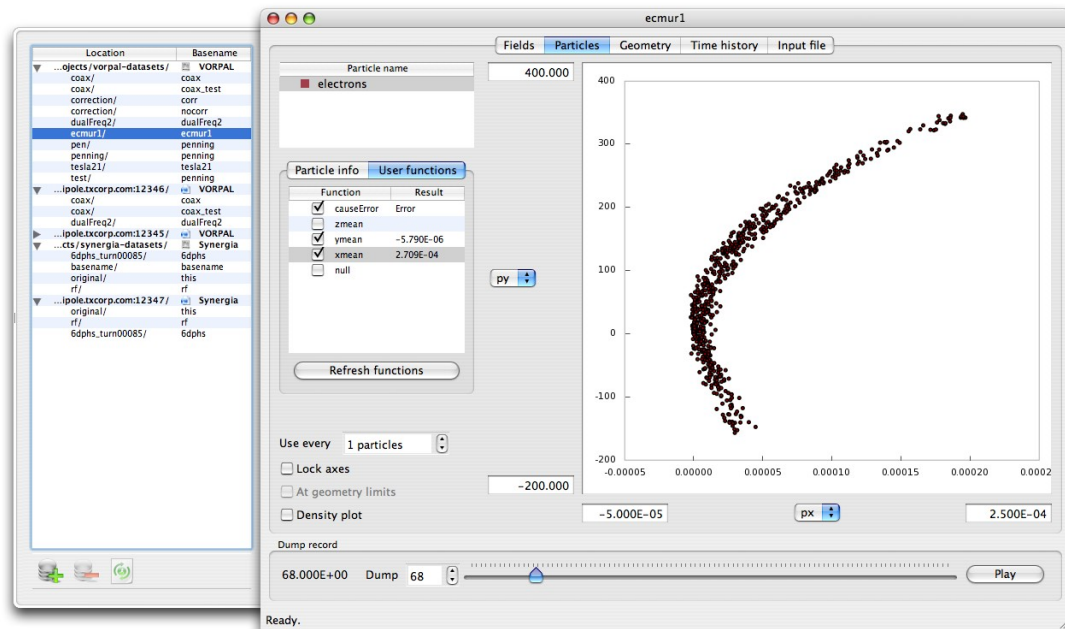
- Qt-based (so should work on any platform)
- Data reader is decoupled from GUI (so should work with any code)



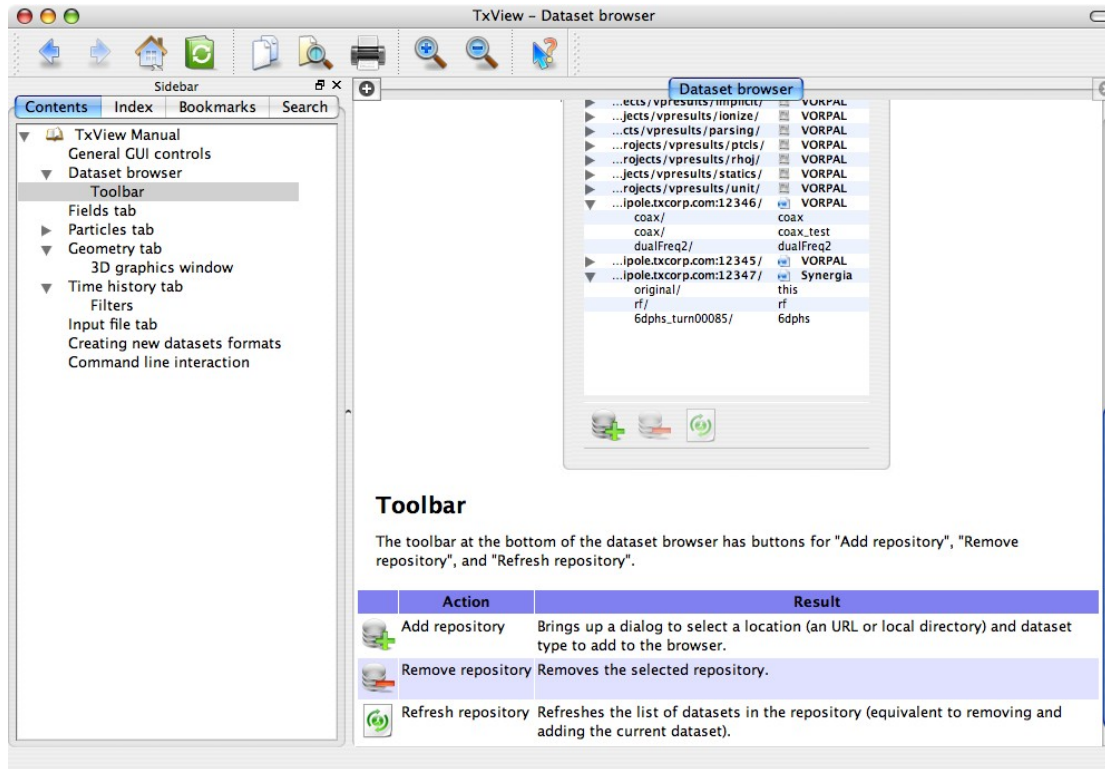
Some features of the GUI are (i) remote data access, and (ii) user-defined functions



- Data Access Protocol (developed by NASA) gives users access to remote data sets as though they were local
- Users can write their own functions and have the GUI display the results



We have even written documentation!

A screenshot of the 'TxView - Dataset browser' application window. The window has a title bar with standard OS controls. Below the title bar is a toolbar with icons for navigation and search. On the left is a 'Sidebar' with tabs for 'Contents', 'Index', 'Bookmarks', and 'Search'. The 'Contents' tab is active, showing a tree view of the application's structure, including 'TxView Manual', 'General GUI controls', 'Dataset browser', 'Toolbar', 'Fields tab', 'Particles tab', 'Geometry tab', '3D graphics window', 'Time history tab', 'Filters', 'Input file tab', 'Creating new datasets formats', and 'Command line interaction'. The 'Dataset browser' is expanded. The main area of the window displays a list of datasets. At the bottom of the window is a 'Toolbar' with three buttons: 'Add repository', 'Remove repository', and 'Refresh repository'.

Dataset browser

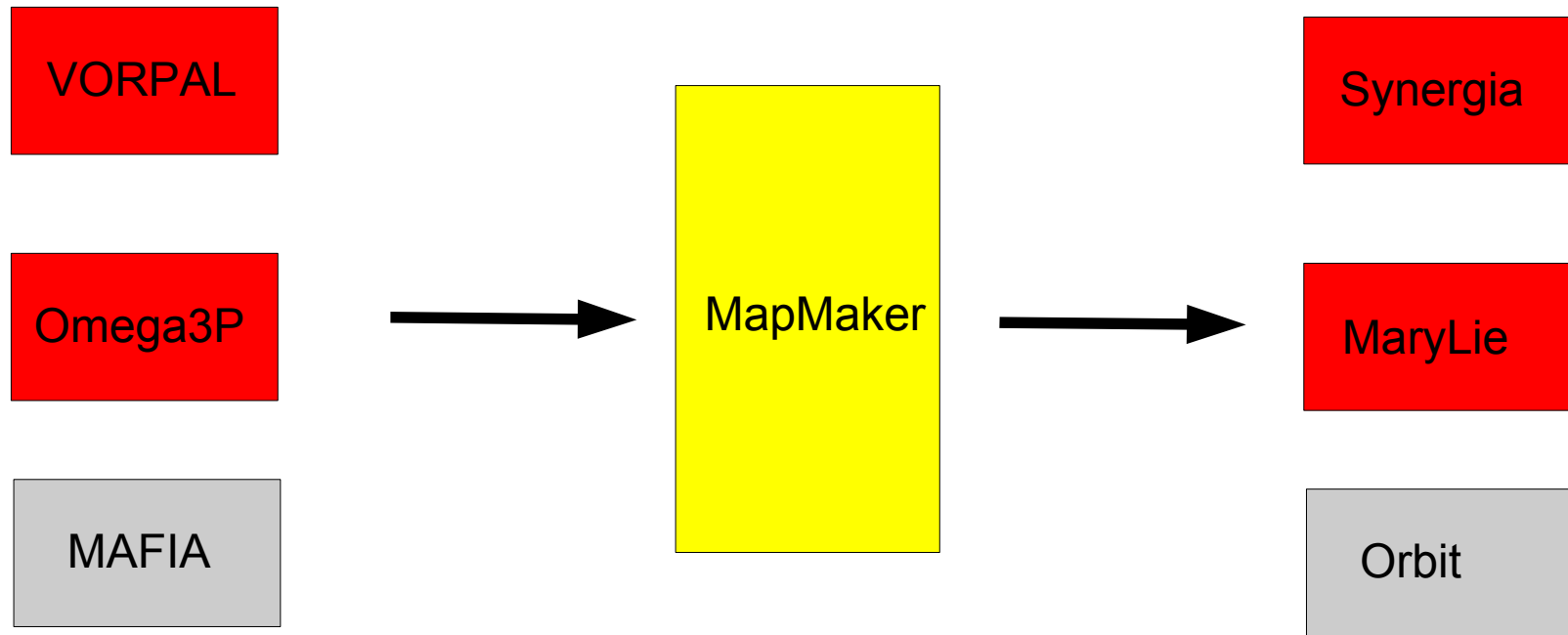
Path	Dataset Name
...ects/vpresults/implicit/	VORPAL
...jects/vpresults/ionize/	VORPAL
...cts/vpresults/parsing/	VORPAL
...rojects/vpresults/ptcls/	VORPAL
...rojects/vpresults/rhoj/	VORPAL
...jects/vpresults/statics/	VORPAL
...rojects/vpresults/unit/	VORPAL
...ipole.txcorp.com:12346/	VORPAL
coax/	coax
coax/	coax_test
dualFreq2/	dualFreq2
...ipole.txcorp.com:12345/	VORPAL
...ipole.txcorp.com:12347/	Synergia
original/	this
rf/	rf
6dphs_turn00085/	6dphs

Toolbar

The toolbar at the bottom of the dataset browser has buttons for "Add repository", "Remove repository", and "Refresh repository".

Action	Result
Add repository	Brings up a dialog to select a location (an URL or local directory) and dataset type to add to the browser.
Remove repository	Removes the selected repository.
Refresh repository	Refreshes the list of datasets in the repository (equivalent to removing and adding the current dataset).

This work benefits from the already-established collaborations of the COMPASS SciDAC



COMPASS SciDAC codes are listed in red. This work benefits from the already established collaboration there.

The reason this project is not further along...

