Application Programming

DOE Semi-Annual Review

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Outline

- XAL
  - Infrastructure progress
    - Database initialization
    - Online model
    - Application Framework
- Applications

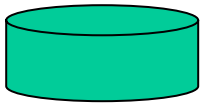
Emphasis on Commissioning Experience

XML Application Initialization

(P. Chu)

- All XAL applications are initialized from a master XML file
- Master file includes database generated xml file + an over-ride file (dead BPMs, calibration factors, …)
  - Was easy to change to override file
  - Need some configuration management on this file

Database ⟶ XML master configuration file



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  </attributes>-
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    <channel handle="fieldSet" signal="MEBT_Mag:QH01:fieldSet“ …/>
   </channelsuite>
 </node>
```

The Online Model Structure

(C.K. Allen , C. McChesney)

- "Model" consists of 3 main parts (based on Malitsky design)
  - Probe: the type of beam model, needs initial conditions.
    - ParticleProbe (Working: for centroids, single-particle, etc.)
    - EnvelopeProbe (Working: for Trace3D-type simulations)
  - Elements: the usual set of lattice elements used in lattice transport codes
    - Have drifts, thin lens, quads, dipoles, + rf gaps implemented
  - Algorithms: We have 1st order transfer matrix + envelope space charge
- The results (I.e. twiss parameters + particle coordinates) are stored in the probe as a function of longitudinal position along the elements

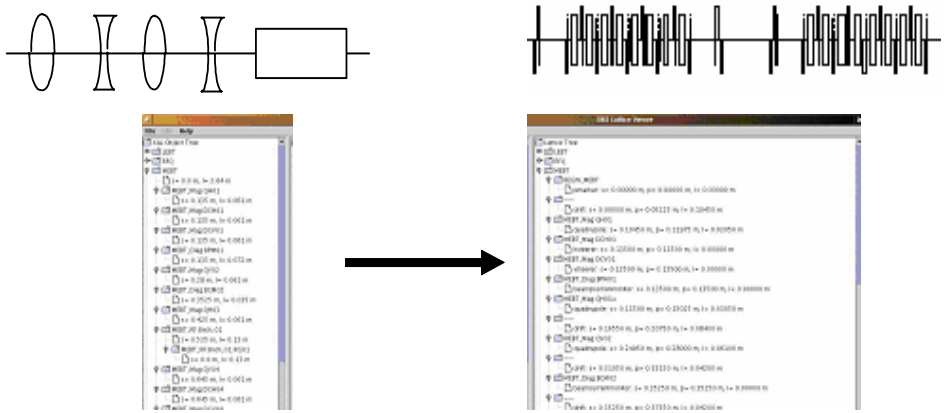
The Online Model Lattice Generation

(W.-D. Klotz)

- A lattice view of the machine is constructed from the “device” structure (via a set of rules)
  - Drifts are added, elements are split
- Lattice element values can be updated from the machine, user defined values or design values
- Mostly use an envelope model for linac tracking at present

Device View
(Stored in XAL)

Lattice View
(used in modeling)



- Single entry per element

- Only physical devices

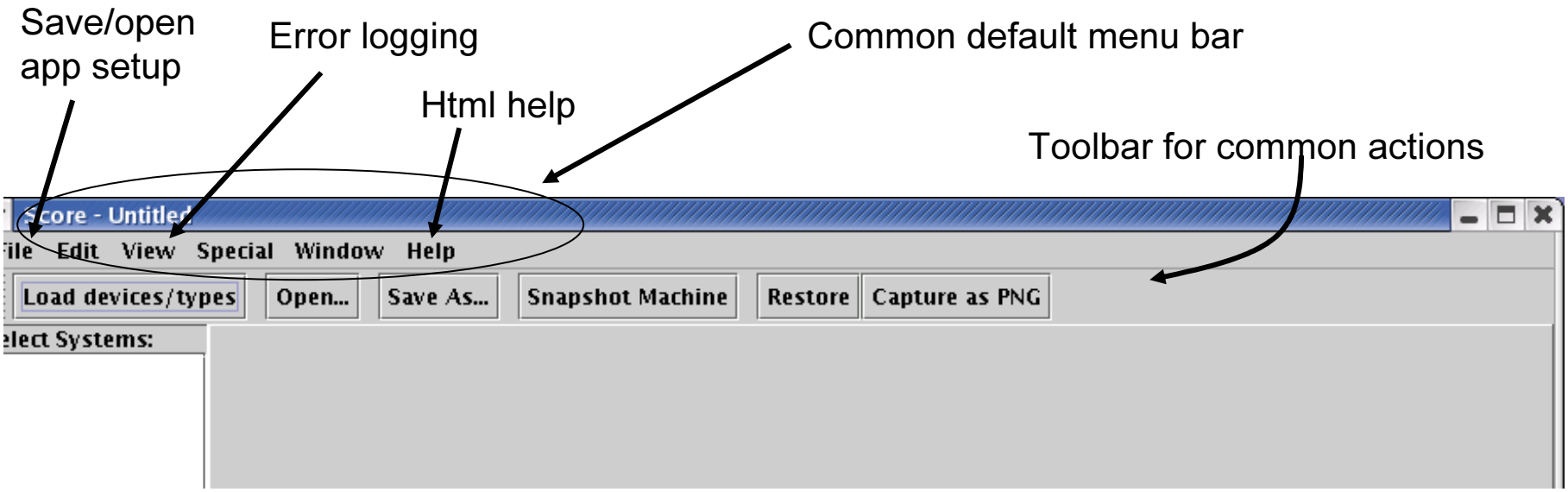
- Elements may be split

-Includes drifts

Application Programming Framework

(T. Pelaia)

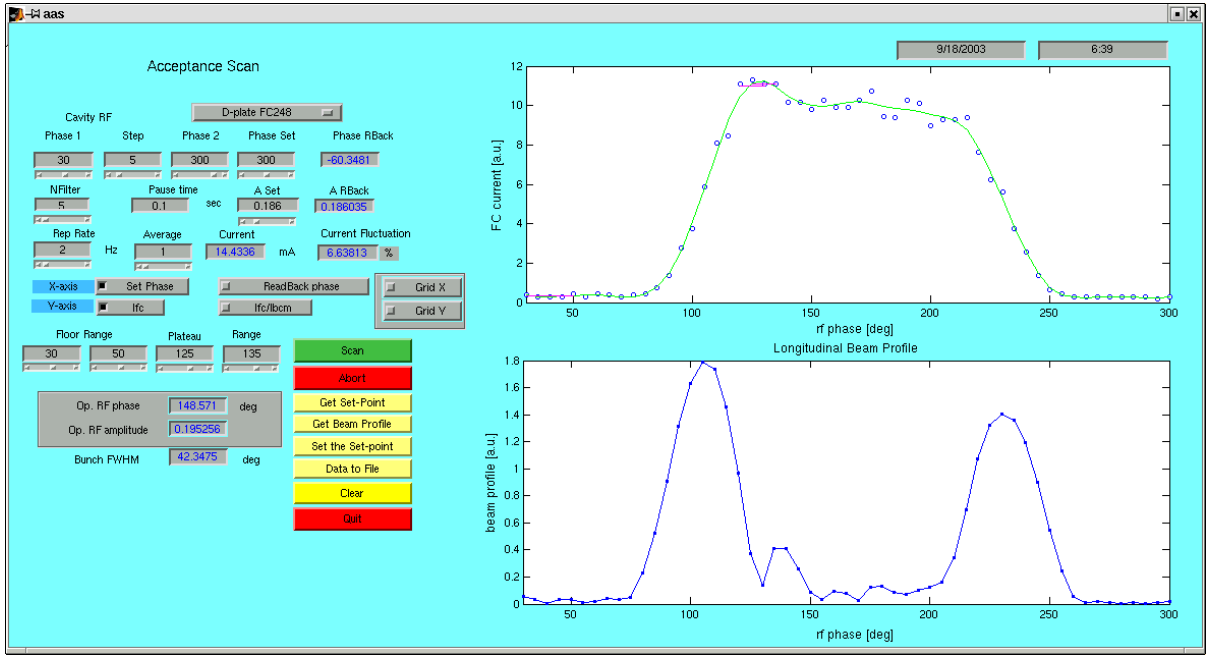
- An Application Framework is developed and used as a common starting point for application programs
  - Provides a common look feel for all apps
  - Quick jump-start for application development
  - Easy retro-fixes across many apps
  - Uses familiar “windows” look feel paradigm
  - Incorporates a document architecture



DTL Tank-1 Acceptance Scan Application

(D. Jeon)

- Matlab program used to set the DTL phase. The algorithms were tuned during commissioning.
- Worked well
- Will migrate to XAL

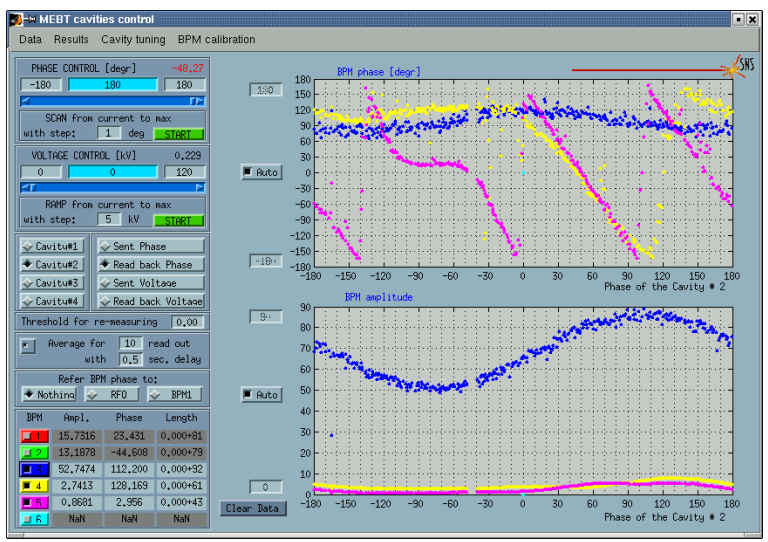


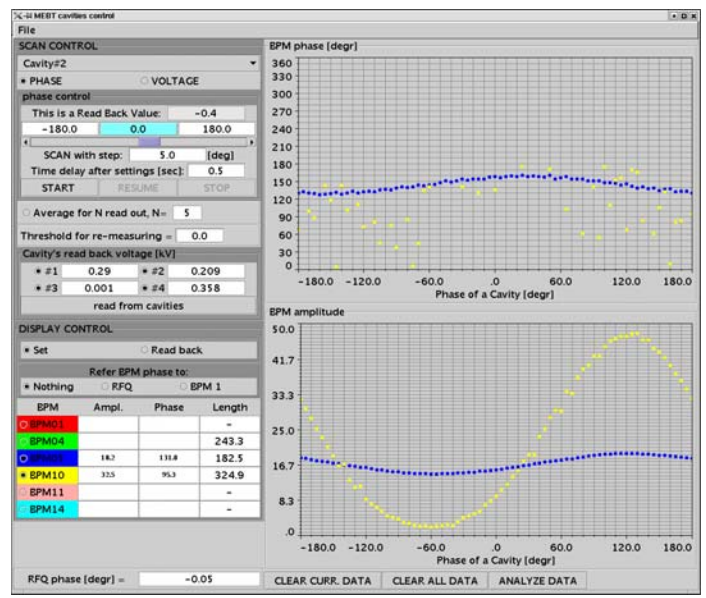
MEBT Cavity Setting Application

(*A. Shishlo, S. Aleksandrov)*

- Initial MEBT commissioning done with Matlab code
- Rewritten in XAL for more permanent maintenance, used for phase settings.
- Will follow this pattern for other applications in the linac

Matlab version → XAL version running with live data

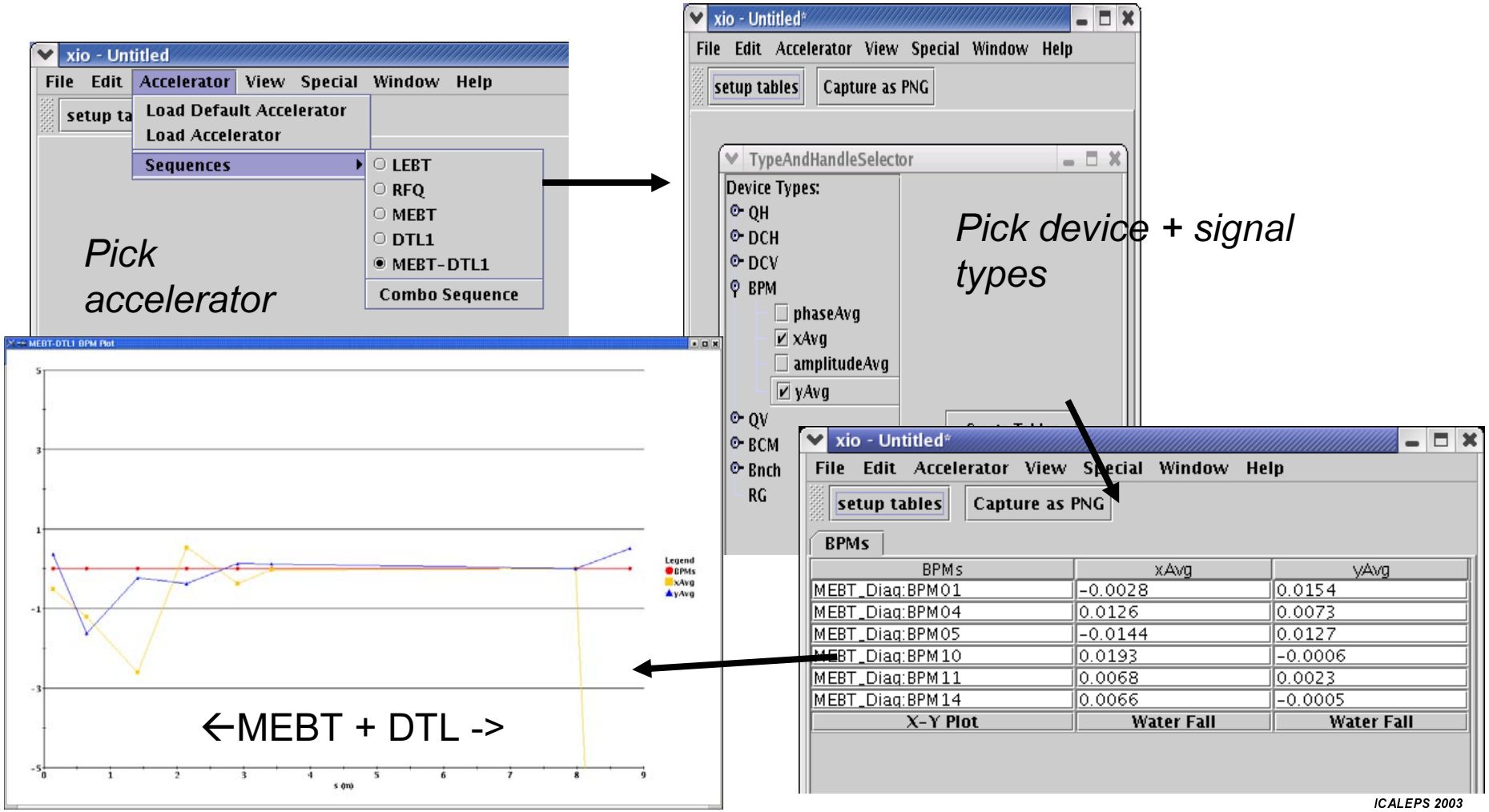




Xio Application

(P. Chu)

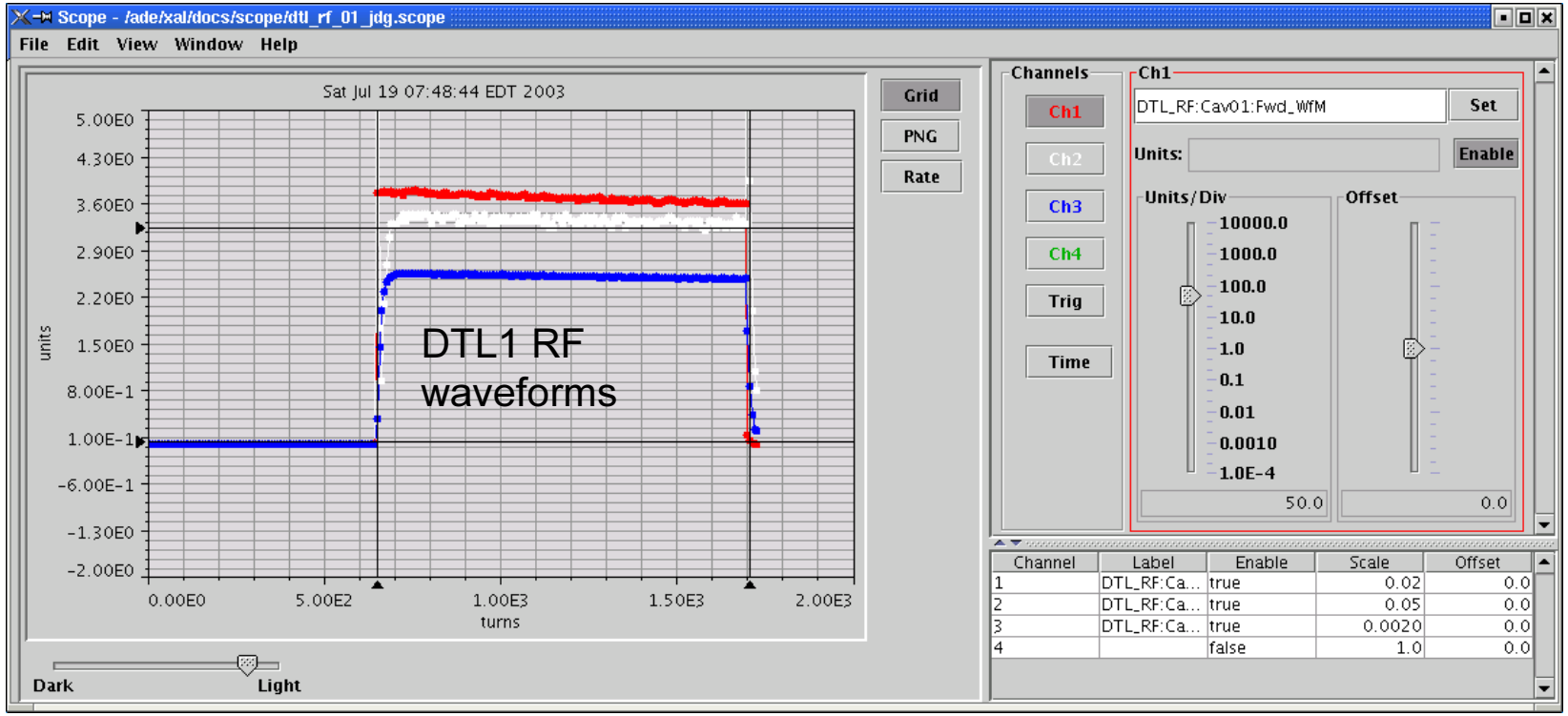
- General purpose value displayer (tables, and or plots)
- Added to application framework, works for MEBT + DTL



Scope Application

(T. Pelaia)

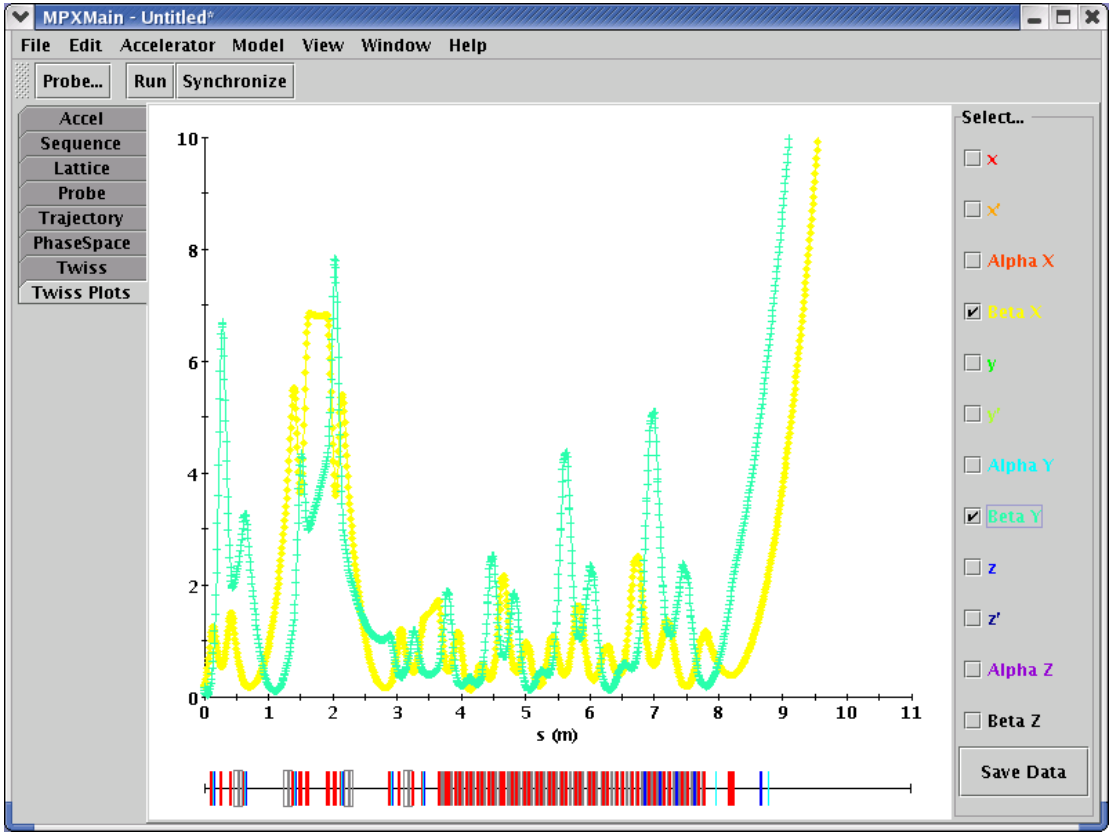
- A Digital Oscilloscope – with a similar user interface as analog scopes
- Displays array waveforms vs. time (NOT vs arbitrary units)
- Uses the time correlator, has built-in math capability, FFT, triggered data acquisition
- Will use this for comparing waveforms from RF, diagnostics, etc.
- Requires input from signal providers describing how the array information is packaged, and offset from the cycle start + accurate timestamps on signals



Online Model Application

(W.-D. Klotz)

- An online model is now available within the XAL framework
- Online model can be run for 1) live values, 2) design values and 3) user defined what-if changes
- Can display or dump beam Twiss output

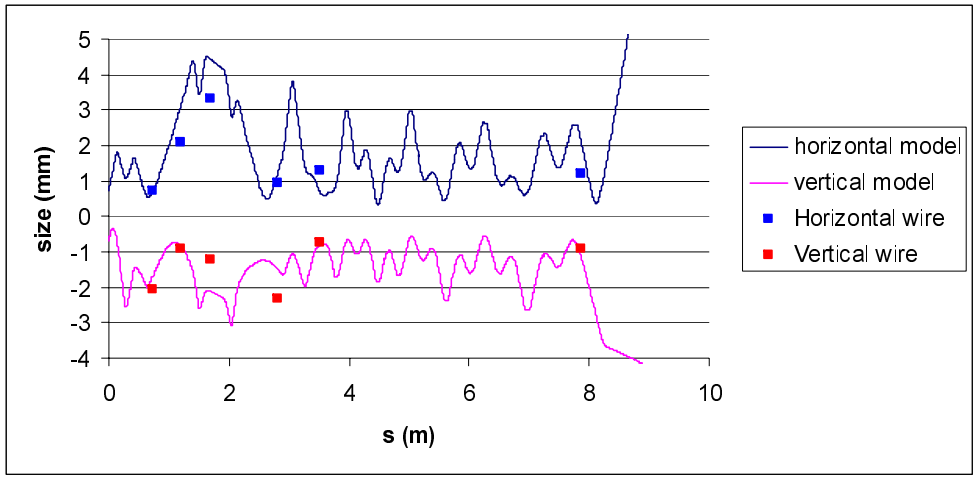


•Vertical and horizontal beta functions through the MEBT, DTL + D-plate for design values

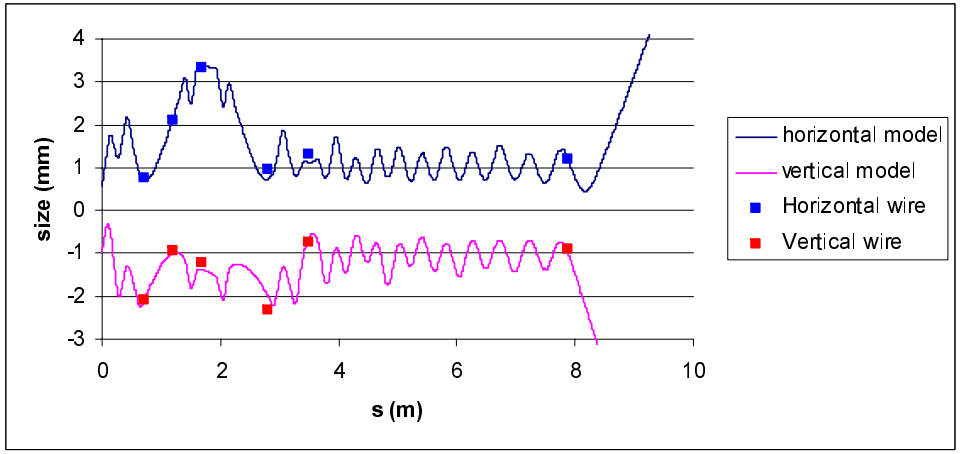
Online Model Matching

- Vary the initial beam transverse twiss parameters (RFQ exit)
- Fit to the measured beam sizes
- Use the online model + the XAL solver
- Done with a script, piecing together existing components

Before matching



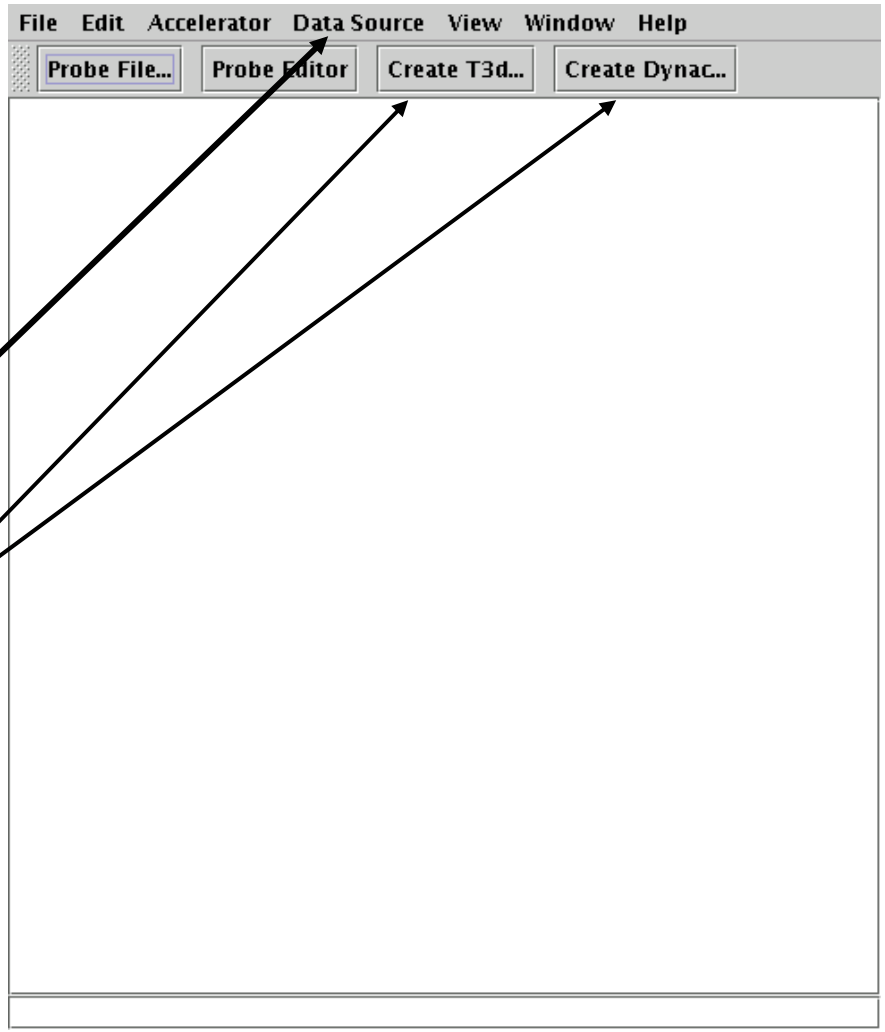
After matching



External Lattice Generator

(P. Chu)

- Generate an external lattice file for selected part of the accelerator
- Uses the online model lattice generation
- Tested though DTL (+ HEBT)
- Can use live or design values
- Trace3D or Dynac input files can be created.
- May be incorporated into the online model application.

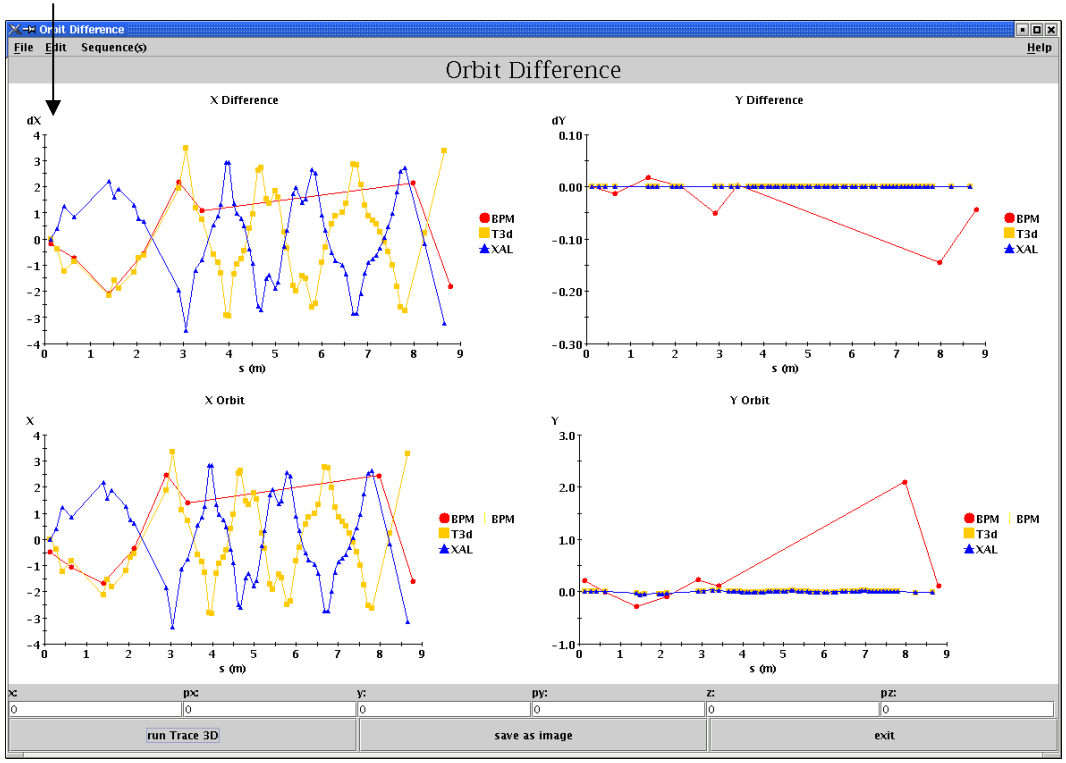


Orbit-Difference Application

(P. Chu)

- Compares differences in beam orbits, for both BPMs and calculated
- Online model is also used in the Orbit Difference Application, in addition to running Trace 3D (external fortran code)

Kick applied here

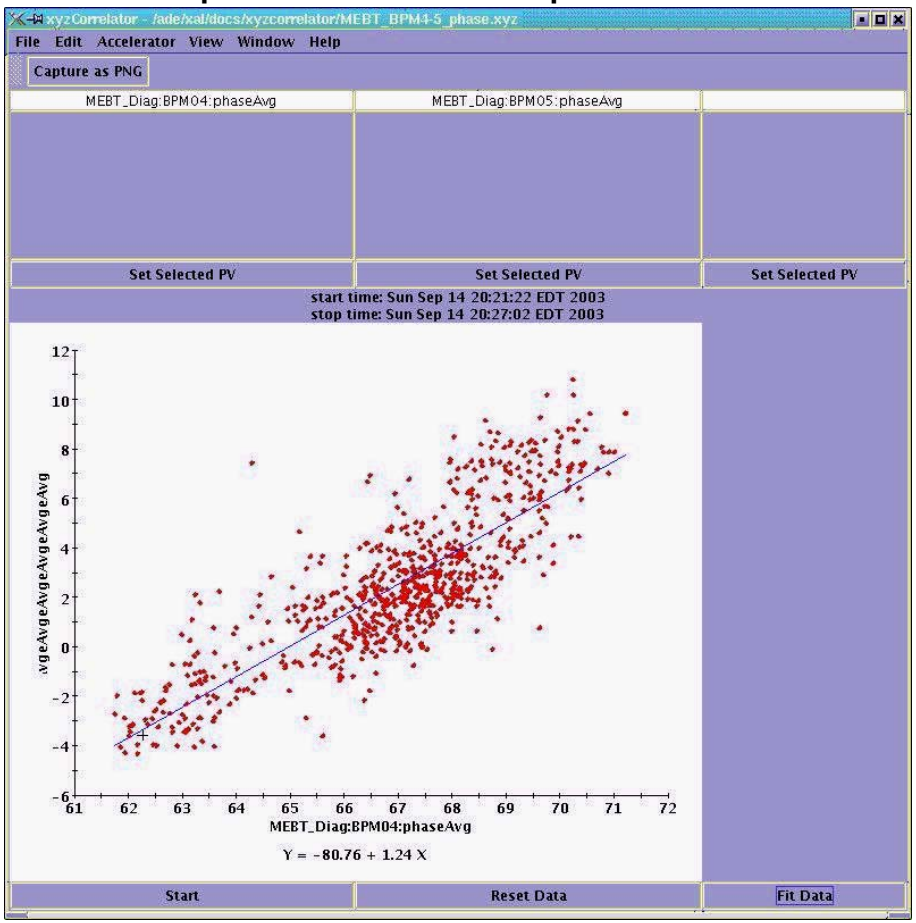


- Orbit difference example using the online model
- Used to observe orbit difference in the horizontal direction
- Helped resolve sign issue in BPMs

XYZ Correlator Application

(*P. Chu*)

- Pick 2 (or three) signals and monitor them together
- Can use the time correlator to ensure signals are from the same pulse
- Added customization features + added to the framework
- Can export or fit the acquired data



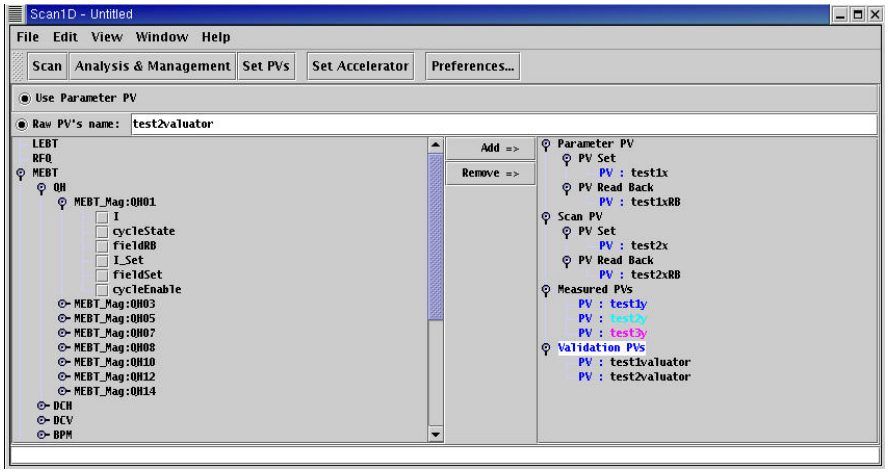
Correlation between phase measurements of 2 BPMs

1-D Scan Application

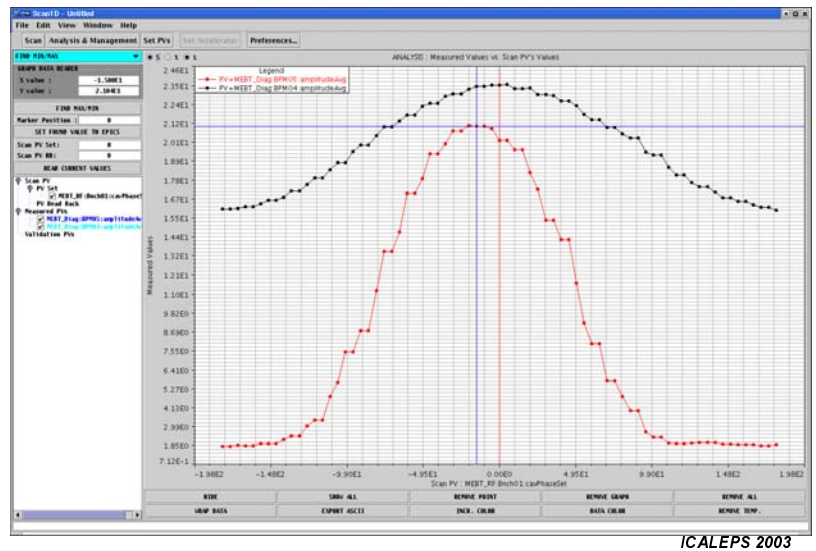
(A. Shishlo)

- Provides an easy way to scan one quantity and monitor others
- Can average over pulses, scan multiple times, pause
- Analysis includes fitting, intersection finding, min/max, etc.
- Easy way to do a quick unanticipated experiment

•Can select scan or readback signals from pull down Accelerator hierarchy

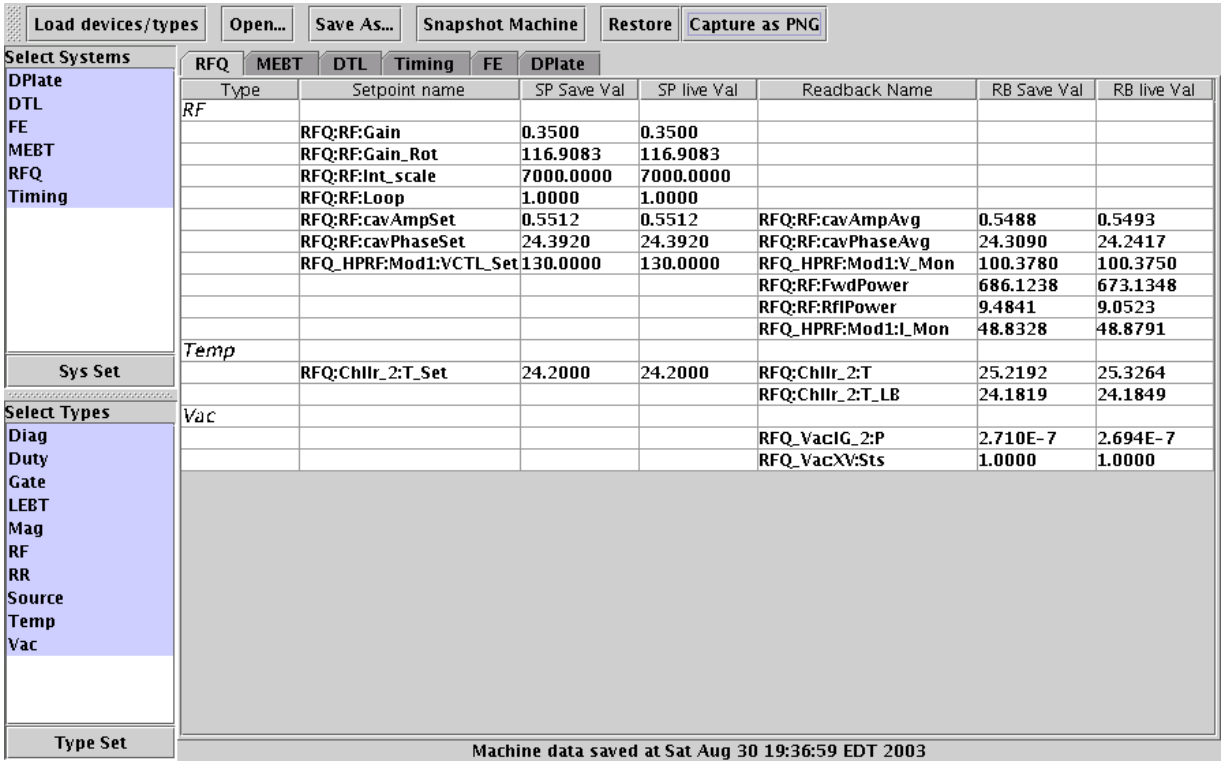


•BPM amplitudes vs. MEBT RF phase setting



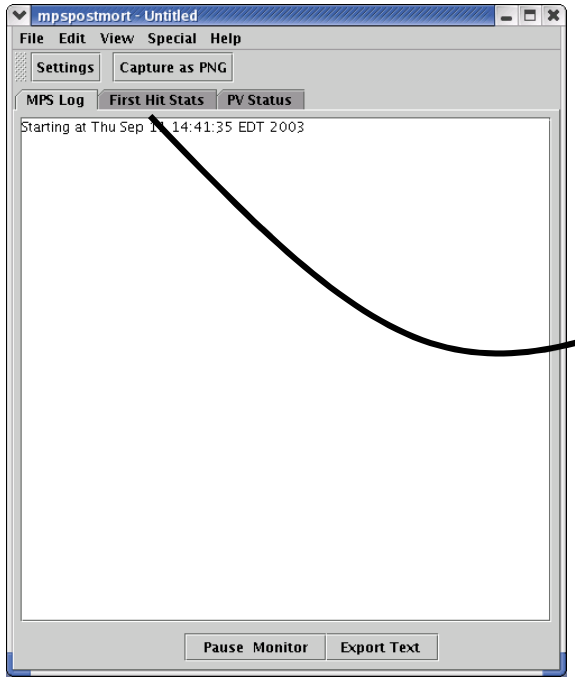
Save-Compare-Restore (Score) Application

- Provides a means to capture machine setup, compare live values to a saved set, and to restore values to a saved set
  - Grabs settable + readback signals
- Can sort by system and device type
  - Uses DataTable classes for querying
- This is the primary means to snap-shot machine data



Machine Protection System (MPS) Post-Mortem Application

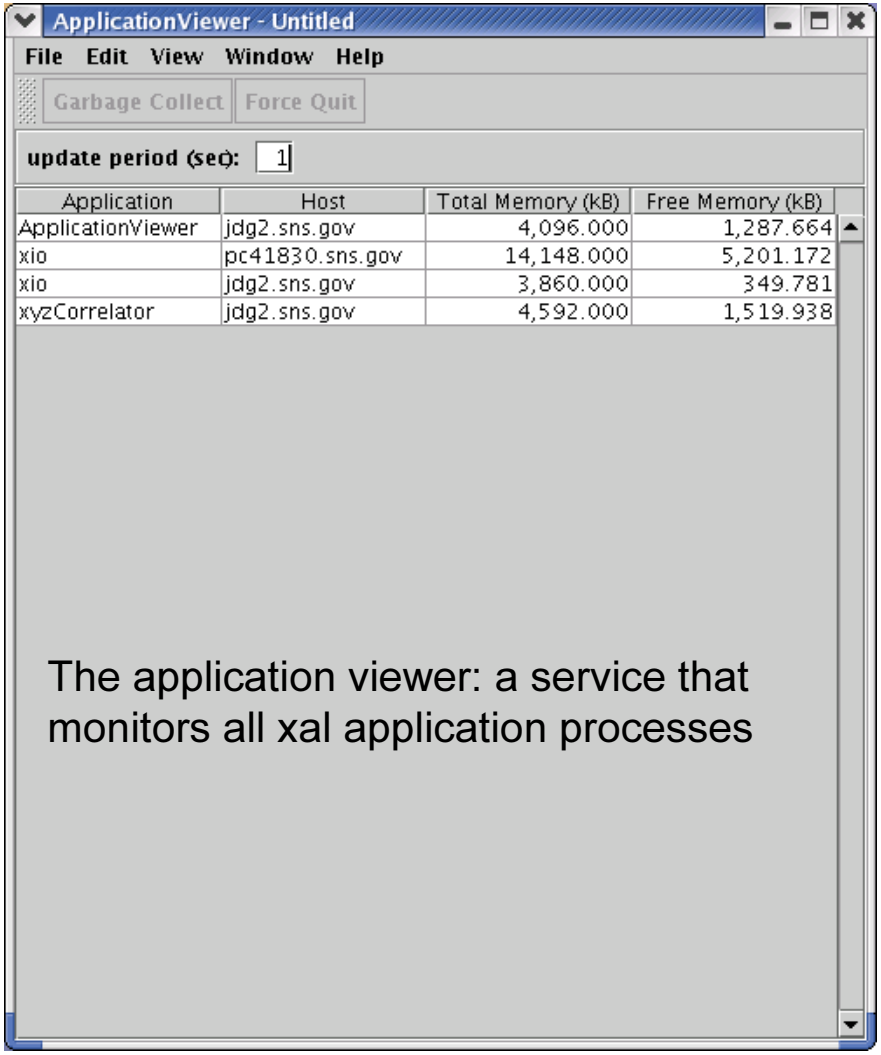
- Captures MPS events, and sorts the signals in order of occurrence – i.e. determines the root cause of a trip (uses correlator)
- Logs mps events, provides statistics
- Used mostly by the MPS team
- Are moving to a client/server architecture



Client Server Architecture

(T. Pelaia, C. McChesney)

- Presently most applications are stand-alone
- We have created an agent (i.e. client-server) architecture
- Uses open source, supported standards for communication (Rendezvous for network details, and xml-rpc for object passing) – provides simple interface.

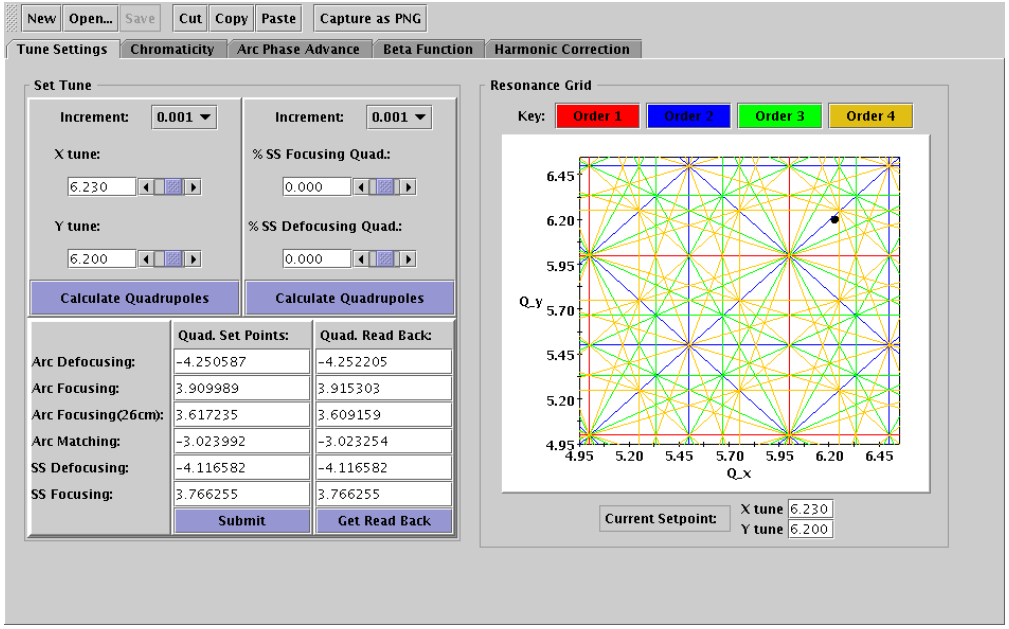


The application viewer: a service that monitors all xal application processes

Planning / future directions

- Application needs re-evaluated
  - Linac + Ring physicists provided input
  - Group feedback from commissioning for automation of tedious procedures (ongoing)
- Application list updated, with names
  - Typically have a physicist + application writer pair
- Additional help from the physics group, + Cosylab

- Started ring applications, e.g. Optics Control (Sarah Cousineau):



Summary

- XAL infrastructure is in place, moving move towards application production (~ 12 apps written)
  - Infrastructure is in place for rapid deployment

- Lots of work to do
  - Many applications to write
  - Planning to do more training