

Flight Simulator for ATF2

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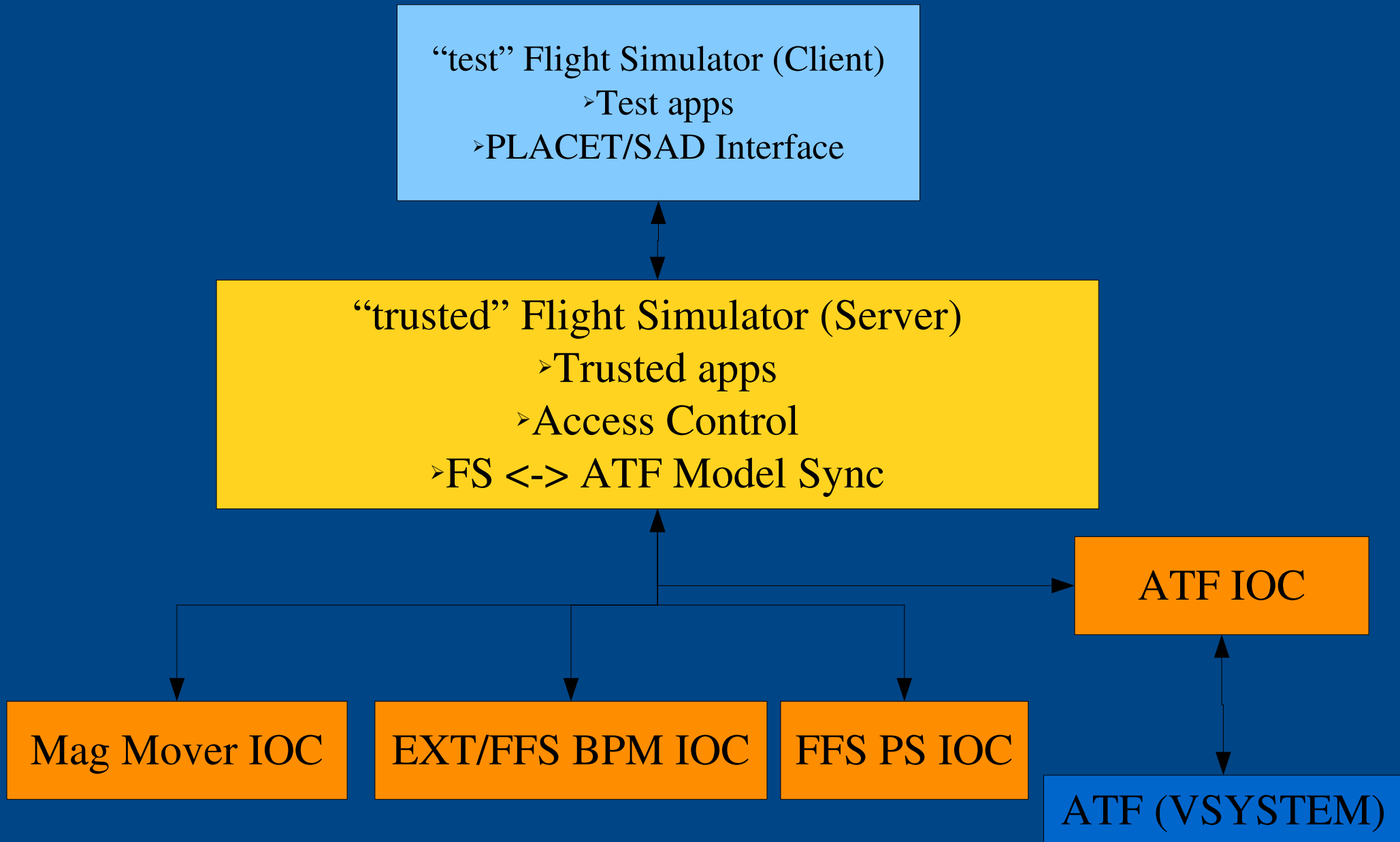
Steve Molloy (SLAC)

- Project goals.
- Implementation plans for ATF2
- Tests at ATF

Flight Simulator Goals

- Provide simple to use, beam dynamics oriented, portable control access framework for ATF2 tuning tasks.
- Simple and reversible transition from beam dynamics simulation to accelerator-ready code.
- Ability for international collaborators to develop beam tuning tools without need for expert-level knowledge of control systems.
- Flight simulator operates in simulation mode at external location in the same way as the production system deployed at ATF2.

Implementation at ATF(2)



Software Overview

- Core Flight Simulator software written in Matlab, based on Lucretia accelerator toolbox.
- Floodland module provides flight simulator functionality:
 - Server-client communications.
 - Access control to client installations.
 - Server-based data services (bpm averaging etc).
 - Sync epics ioc db entries with Lucretia model.
 - Maintain updated AML and Lucretia models.
 - Provide PS setting, magnet move functionality through native Lucretia functions (PSTrim, MoverTrim).

Software Overview

- Lucretia2AML
 - Synchronises Lucretia model with AML
 - Entry-point for non-Lucretia tracking code support
- Client-side runs server for non-Lucretia based support through socket communications
 - Currently tested with PLACET (running with tcl/tk & octave)
- EPICS (hardware IOC's + simulation)
 - Movers, bpms, power supplies
 - ATF interface (Vsystem –ring mags + bpms, ATF controls)
- Documentation effort starting
 - <https://confluence.slac.stanford.edu/display/ATF/ATF2>

Security

- The computer which hosts the trusted server on control system sub-net has read/write privs on all EPICS databases.
- Users test their code on client which must request access privs from trusted server.
 - When tested, code can be migrated easily from client to server which then sits on main control console.
- Security provided by ATF network infrastructure and by EPICS access control which only allows write access through trusted server.

Sim. Implementation

“test” Flight Simulator (Client)
‣Runs as in production mode

“trusted” Flight Simulator (Server)
‣Runs simulation of ATF2
‣Added panel to control error application etc

Sim Mode

ATF IOC

Mag Mover IOC

EXT/FFS BPM IOC

FFS PS

Simulated Functionality

- Make as similar to production system at ATF as possible.
- Runs all on single pc (or more if desired).
- Enables simulation of real machine, enabling realistic testing of accelerator-ready beam dynamics code without need of access to KEK systems.
- EPICS IOCs are also running in the simulated environment providing the ability to build and test custom hardware interface with a simulated version of the complete set of in-production IOC's, control software and tuning routines etc.

External Interface

- Client Flight Simulator installation runs a socket server to provide Lucretia and Floodland commands to external beam dynamics software
 - PLACET, SAD etc...
- Only requirement is that the external software package implements read/write access to a tcp socket.
- Example generic c++ implementation included in flight simulator software package.
- Read/write interface done using AML-like commands.

Example Server Commands (external interface)

- Get/set power supply settings for magnets
 - *fl_socket* << *"amlget('PS1:design:num','PS2:design:num','PS5:design:num');"*;
 - *fl_socket* << *"amlset('PS1:design:num',1.2,'PS2:design:num',0.96,'PS5:design:num',0.5e-3);"*;
- Get average orbit from last 20 bpm pulses, applying default quality cuts
 - *fl_socket* << *"bpmave(20,1);"*;
- Request control access
 - *fl_socket* << *"access-request PS39 PS40;"*;

Test Implementation at ATF during May run

- Same basic software setup as for ATF2.
- Only ATF IOC used (access to ATF magnet power supplies and bpms).
- Write and run some test applications
 - EXT steering (PLACET)
 - EXT bumps (PLACET)
 - Online EXT dispersion measurement.

“trusted” FS (server) runs on *atfsad.atf-local*

The screenshot shows the FIGui_trusted application window. At the top, it displays "Lucretia - Floodland TRUSTED (SIM-MODE)" with a red "EXIT" button. Below this is a green "EPICS CA-Access Server" button and a blue "Simulation Settings" button. The "BPM Buffer Size" is set to 1000. The "Floodland Memory Usage" is shown as 8.2 MB. The "Measured Update Rate (Hz)" is 1.1 Hz. There are two dropdown menus for "HW Update / File Save Rates (Hz)" with values 1.56 and 0.01. An "Auto - Save Files" checkbox is present and unchecked. At the bottom is a blue "Apps Panel" button.

The screenshot shows the FAS_main application window, titled "Floodland Access Control". It features three main sections: "Current Allowed List" (empty), "Examine Access Request List" (empty), and "New Requests" (empty). The "Current Allowed List" section has buttons for "Clear Item(s)", "Clear All", "Examine", and "Server Running". The "New Requests" section has buttons for "Allow", "Deny", "Examine", "Auto Response", and "Apply Timeout". Below these are "Allow All", "Deny All", and "Examine" buttons. The "Auto Response" dropdown is set to "Allow", and the "Apply Timeout" is set to "0 Hr.".

“test” FS (client) runs on user laptop (@atf-local)

FIGui_test

Lucretia - Floodland
TEST

EXIT

Run User App **Server**

ATF-steering_correction-Placet

Auto Update Lattice **HW Update Rate (Hz)** 2.0

Update **Floodland Update Rate (Hz)** 10.0 Hz

Write Lucretia+AML file

Clear All Access Requests



Live vs. Simulation Model Comparison

The screenshot displays a Linux desktop environment with several windows open:

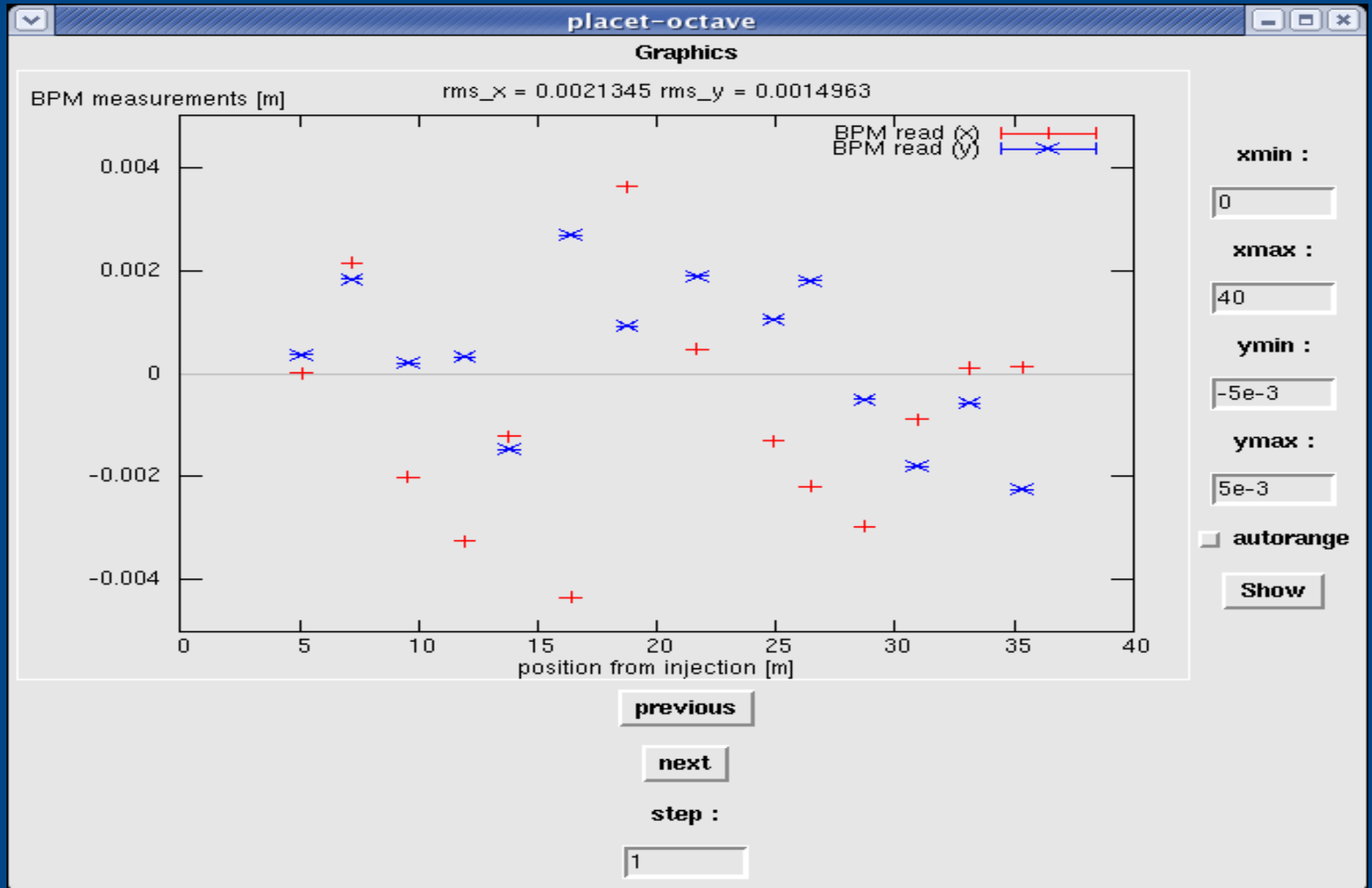
- FIGui trusted:** A control panel for the Lucretia - Floodland EPICS CA-Access Server. It shows a BPM Buffer Size of 1000, Floodland Memory Usage of 9.2 MB, and a Measured Update Rate of 1.7 Hz. It also includes HW Update / File Save Rates (Hz) of 1.56 and 0.01, and an Auto-Save Files checkbox.
- Figure 1:** A plot window showing a green line graph of data over time. The x-axis ranges from 0 to 180, and the y-axis ranges from -3 to 5. The plot shows a complex, oscillating signal.
- ATF2 FS (Trusted):** A terminal window displaying a series of log messages, including "Warning: Setting the 'KeyPressFcn' property is not permitted while this mode is active." and "ans = [1]".
- Background Interface:** A partially visible window titled "Floodland" showing a "Current Allowed List" with multiple entries of "0.0.0.0/0.0.0.0 : ATF:XCOP" and a "Clear Item(s)" button.

The desktop environment includes a taskbar at the bottom with icons for "whitegr@localhost:~...", "ATF2 FS (Trusted)", "FIGui_trusted", "FAS_main", and "Figure 1". The system tray shows the user "Glen White" and the date "Tue May 13, 11:14 PM".

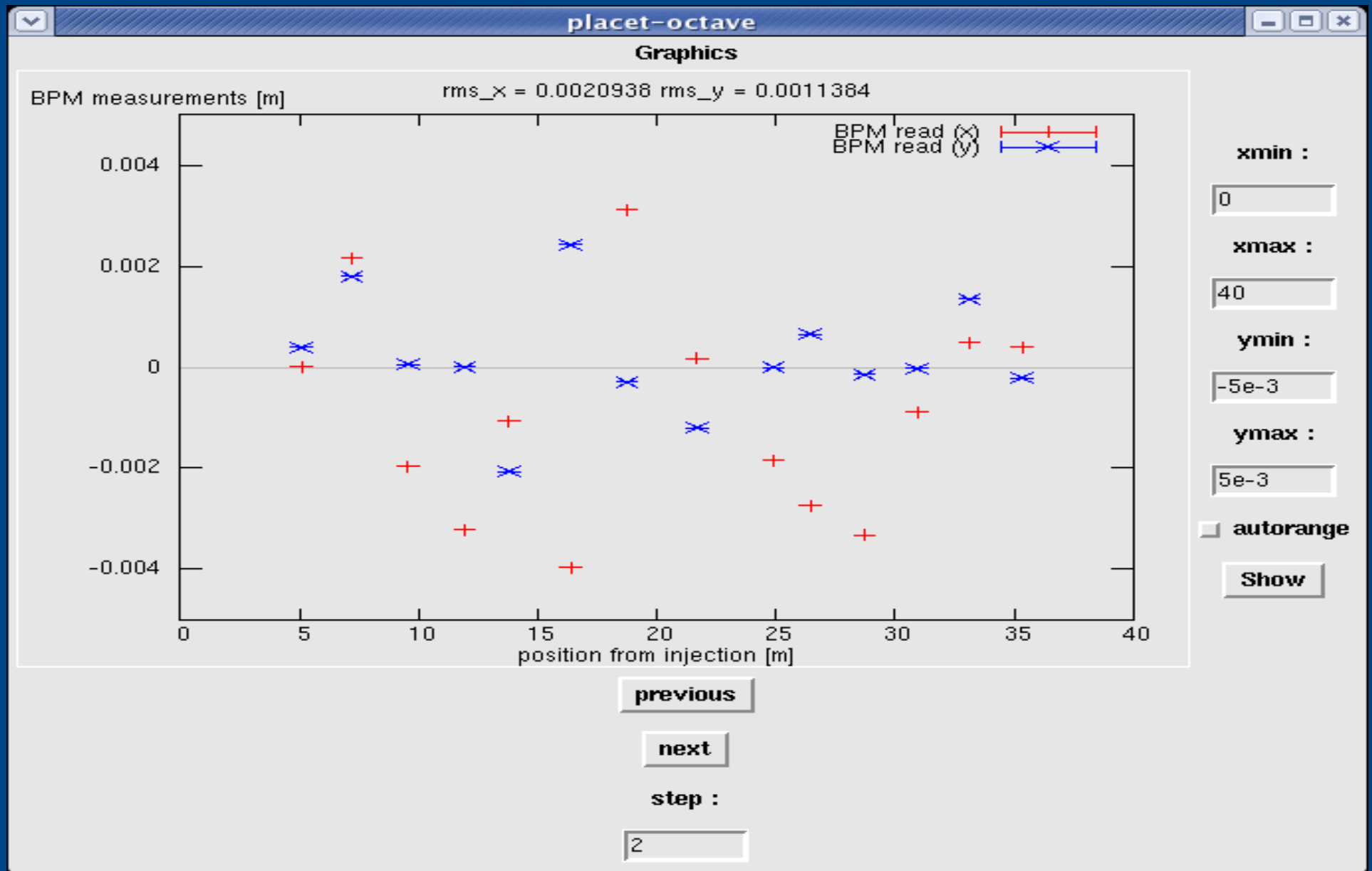
PLACET Steering/Bump Tests

- Using PLACET interface on “test” flight simulator software installation.
- Measure R12 and R34 elements between correctors and BPMs in EXT.
- Use Yves' “1-all” correction scheme to try to improve EXT orbit in x and y.
- Use bump calculator to insert orbit bump in 2 bpms for test.

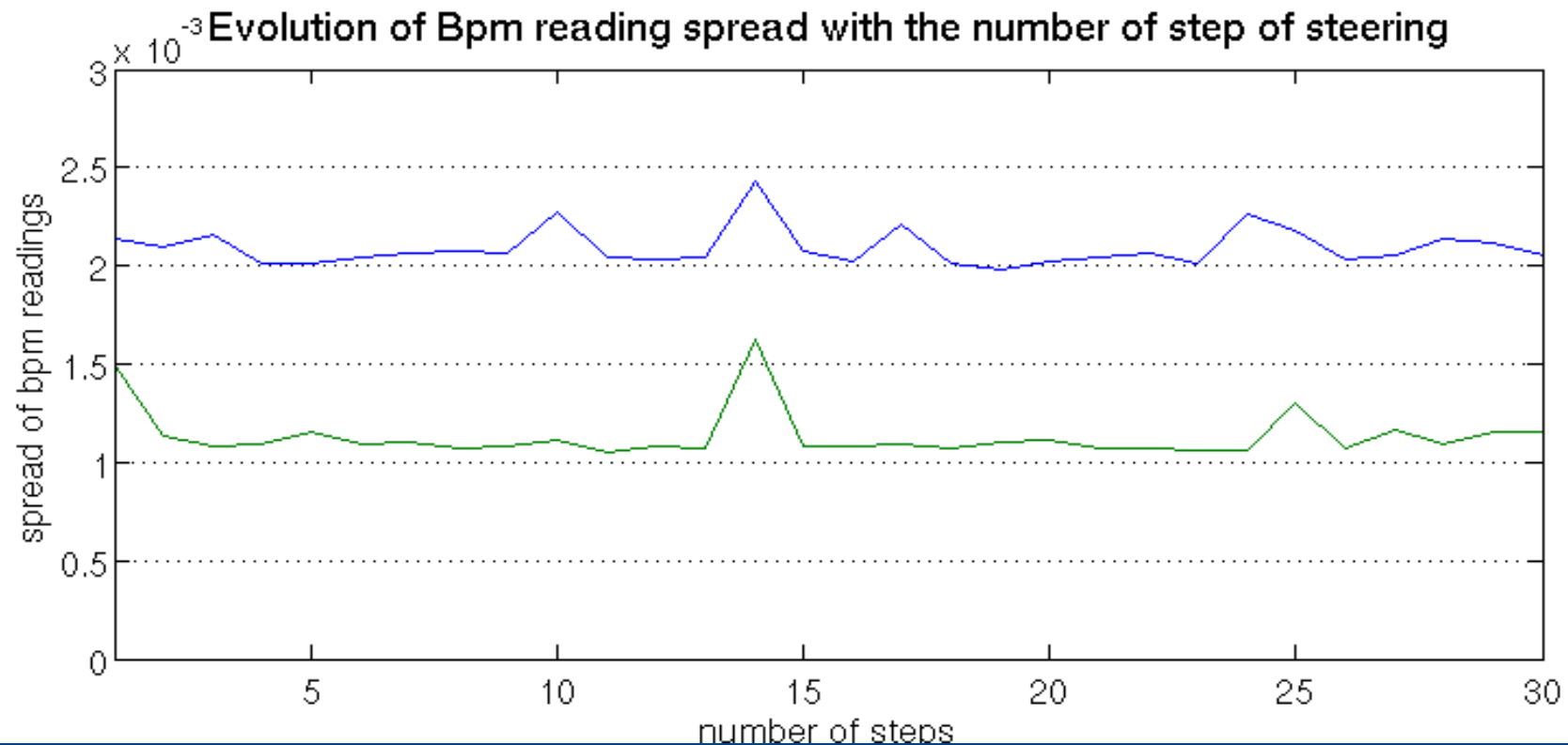
Orbit Before Correction



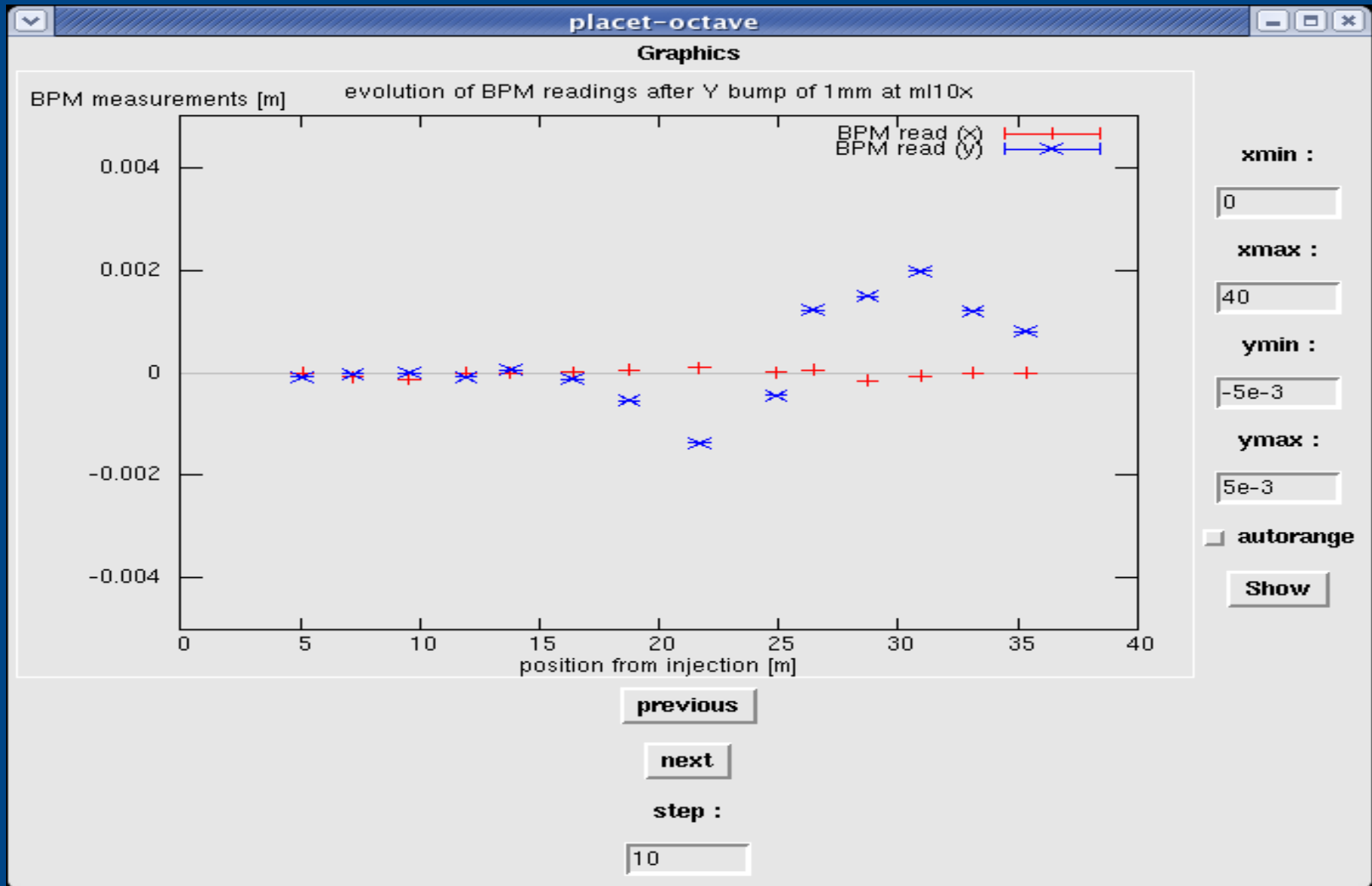
Orbit After 1 Correction



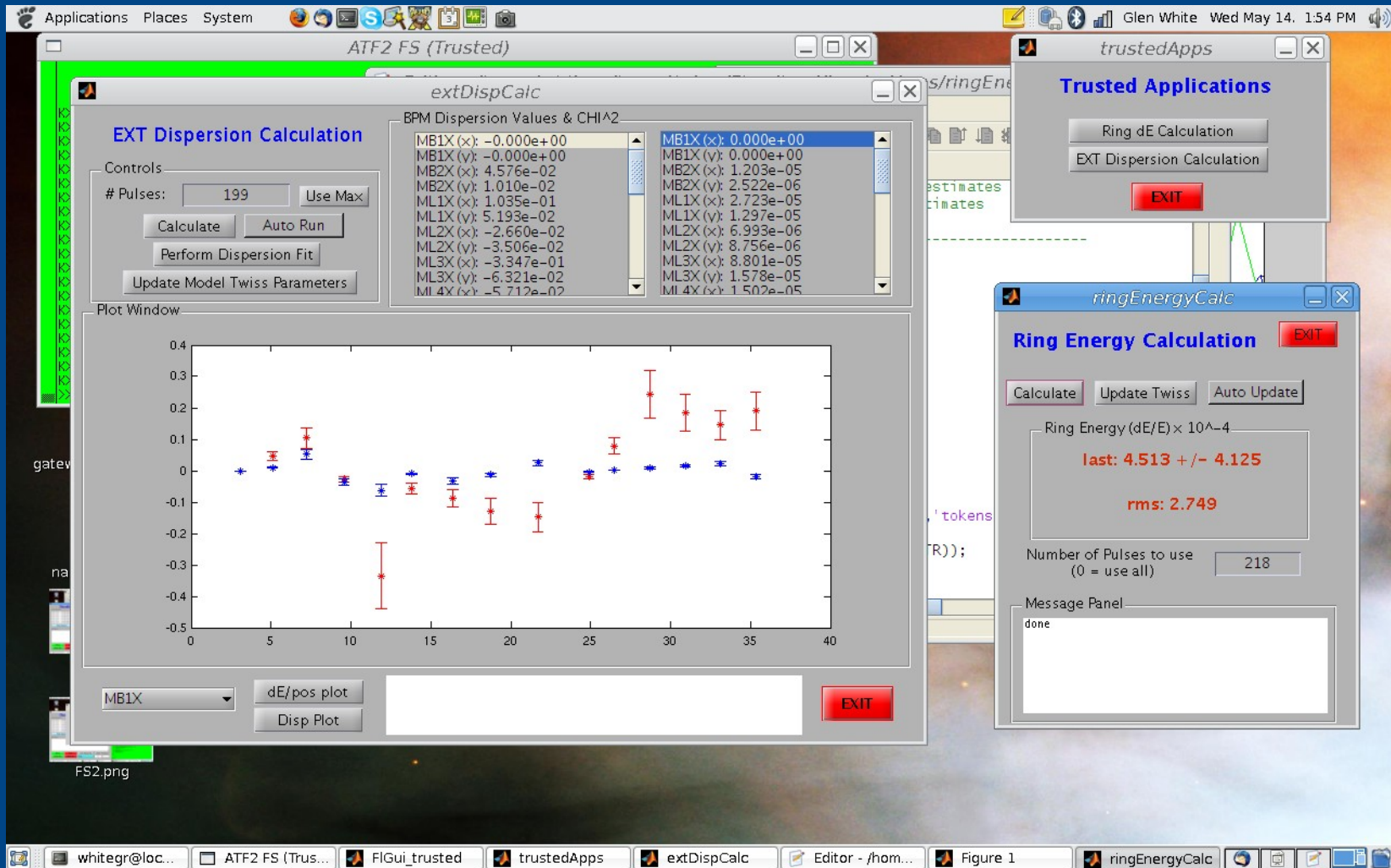
RMS Orbit During Corrections



1mm Bump @ ML10X



Disp Meas Tests



Summary

- Test implementation at ATF went well.
- Core installation and PLACET interface tested in simulation and production modes.
- Much more work can be done
 - Detailed documentation.
 - Installation improvements.
 - FS Software development (error handling, general robustness improvements, speed improvements).
 - Development of software tuning tools for ATF2.

Summary (2)

- Discussion needed on work list for utilities to help with ATF2 beam tuning.
 - Mini-workshop LAL June 18-20 for discussing international co-ordination of software development for ATF2
 - Please participate in person or via webex.
- **Many thanks to colleagues at ATF, especially Terunuma-san, for their help and advice.**