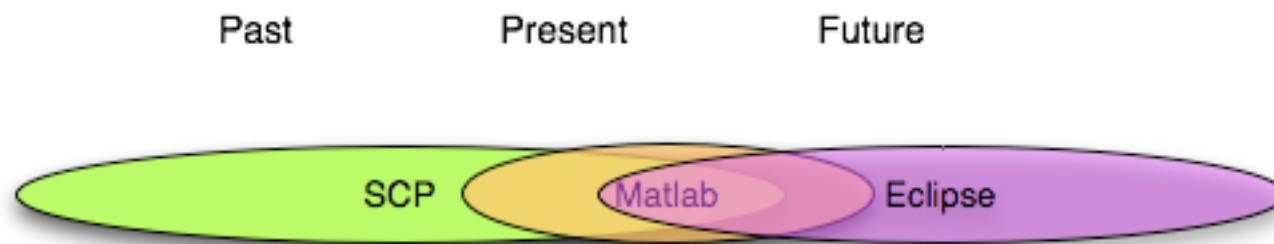


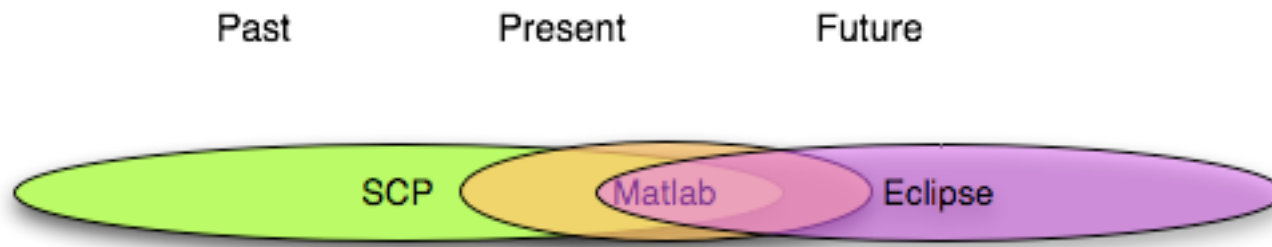
Operational Tools at the Stanford Linear Accelerator Center

Greg White, for many, many, great programmers, scientists
and engineers from the SLAC Controls Department,
operations and physics groups.

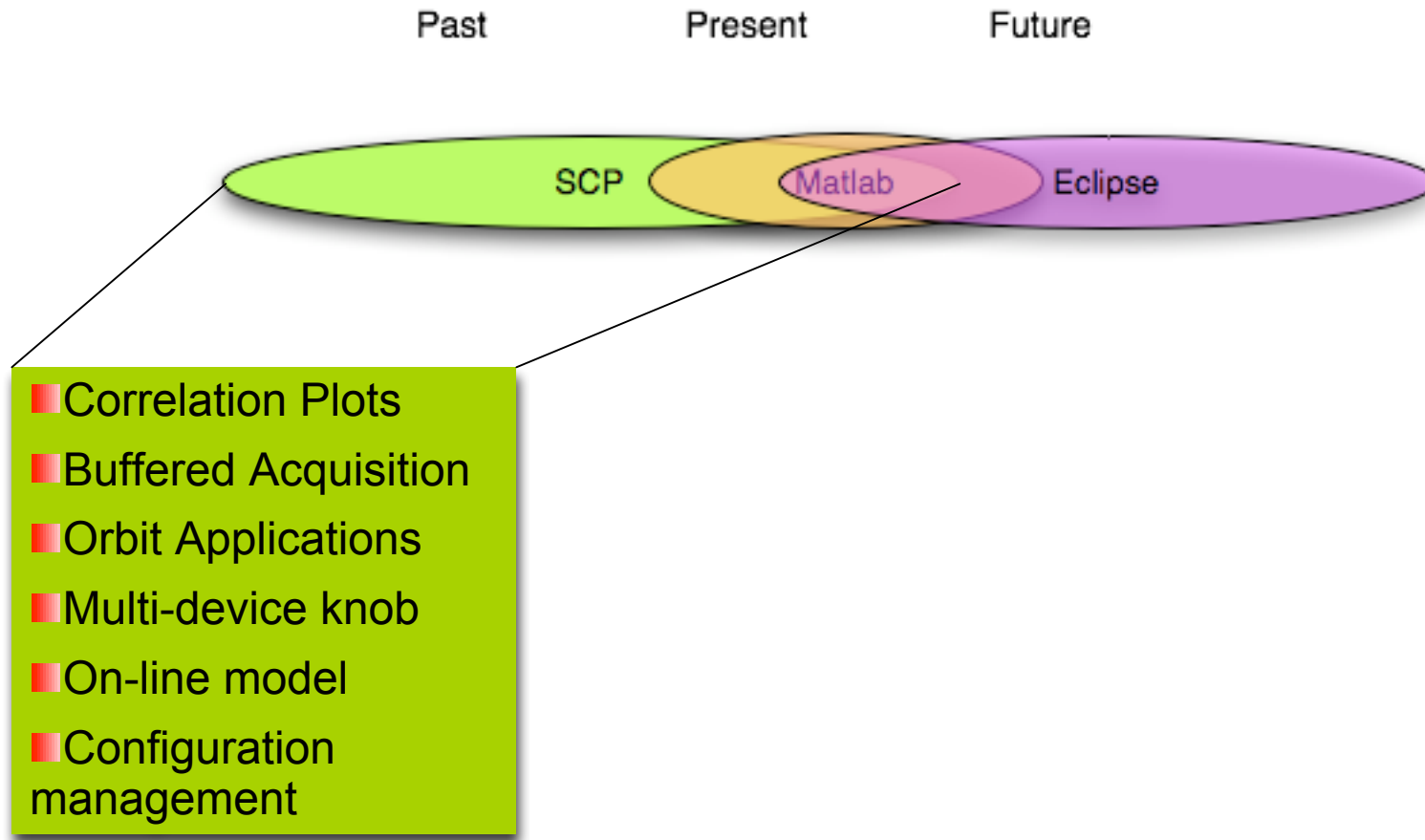
SLAC Tools Technology Timeline



SLAC Tools Technology Timeline

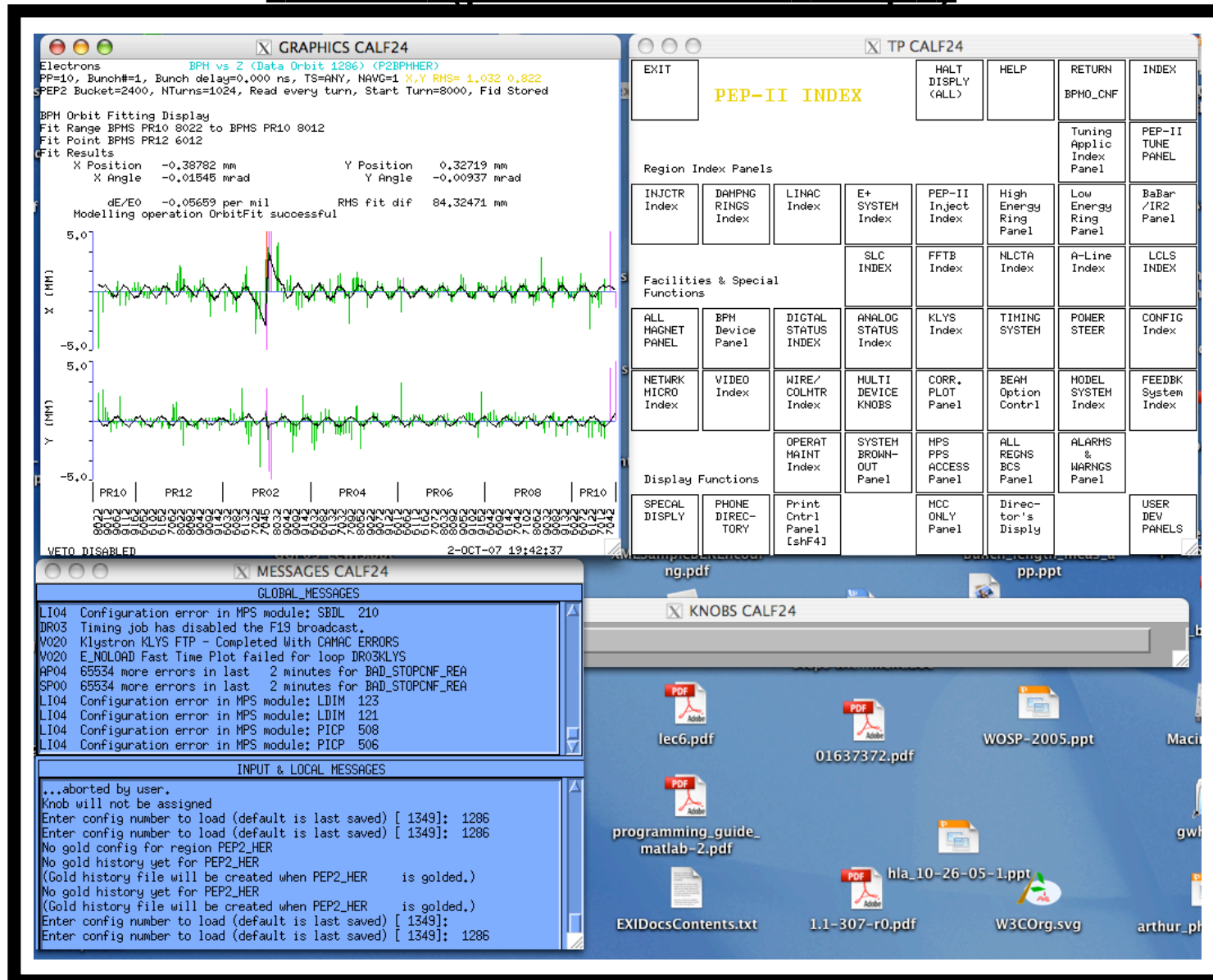


SLAC Tools Technology Timeline

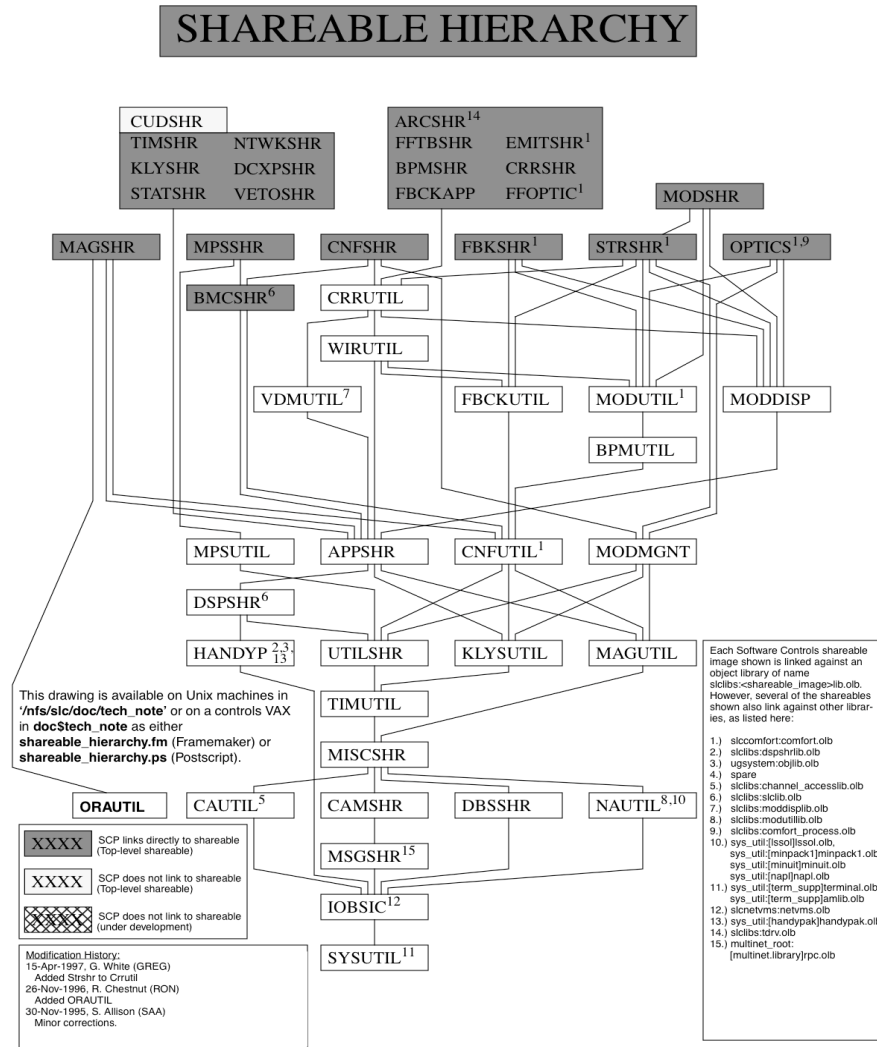


Past 20 years! - The SLAC Control Program

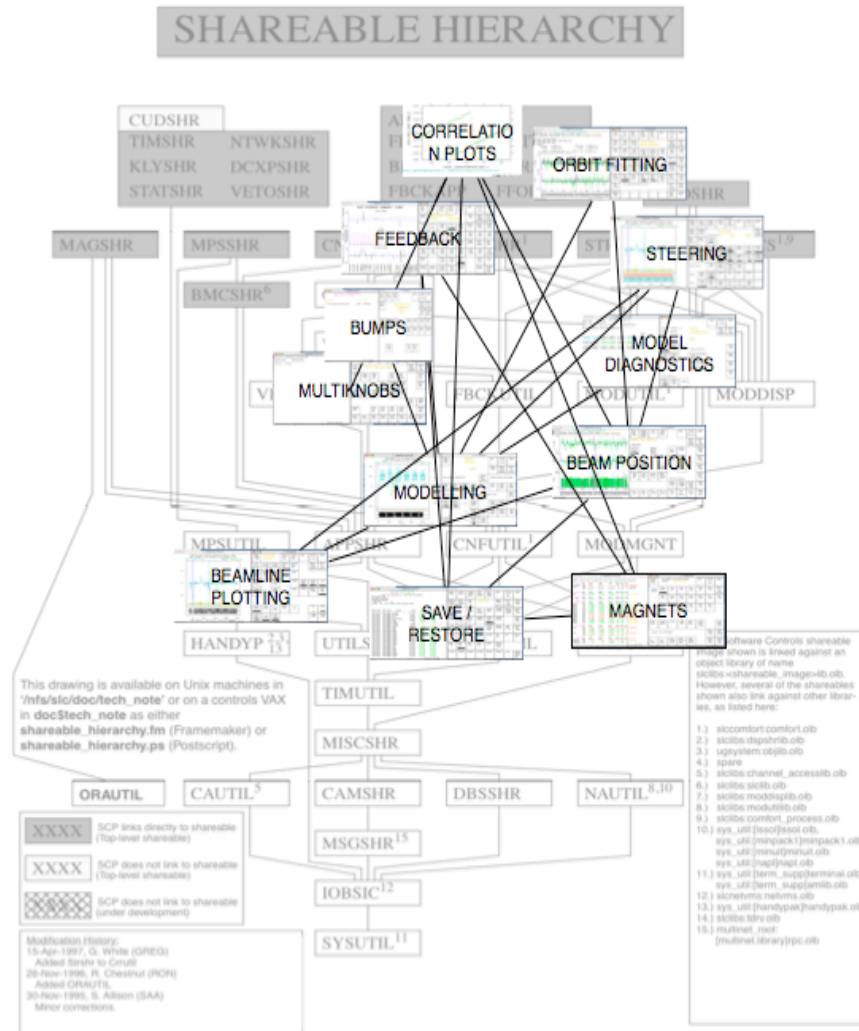
“SCP” (pronounced “skip”)



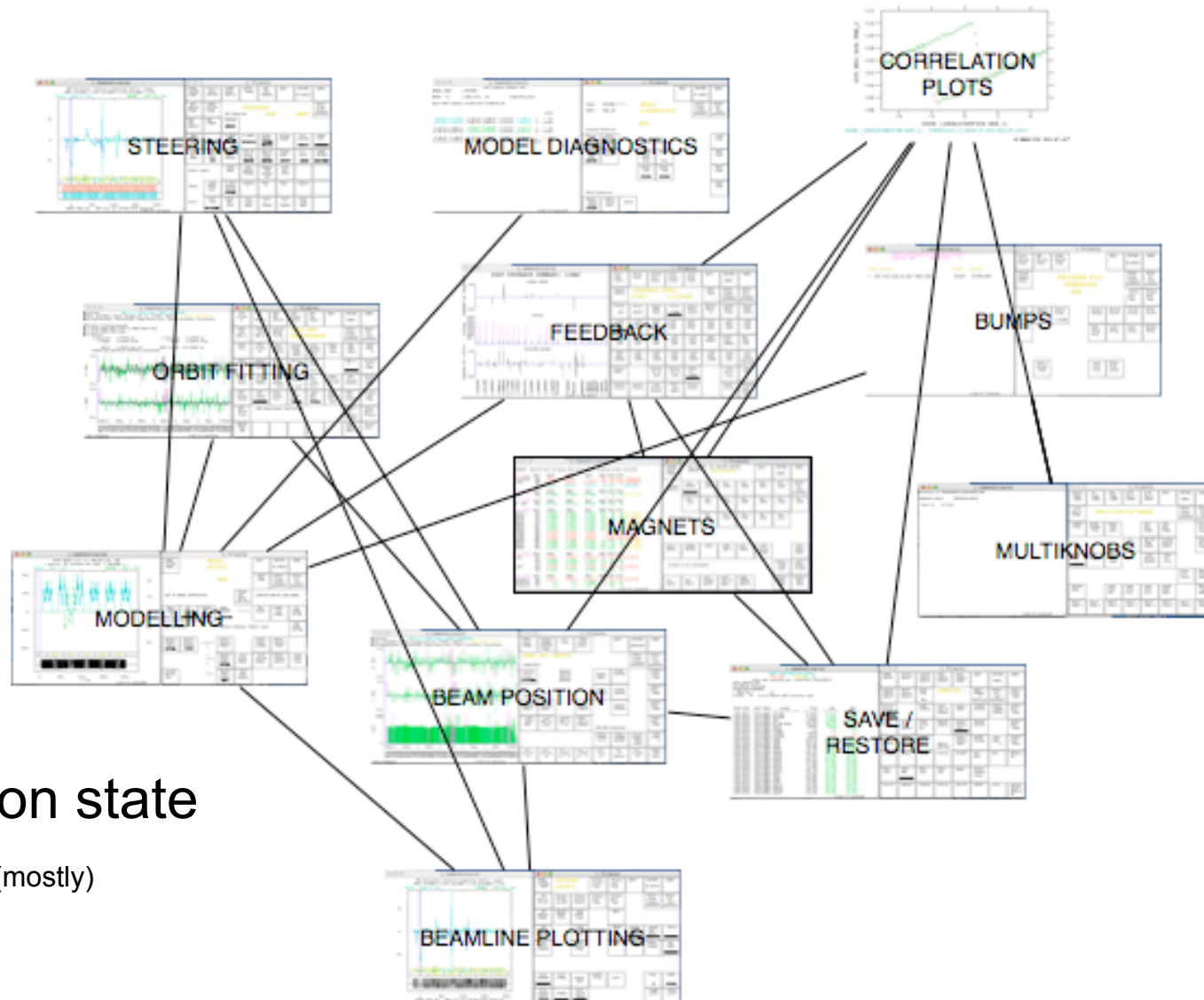
Hierarchy of Applications Dynamically Linked Libraries



Hierarchy of Applications Dynamically Linked Libraries



SCP Application “Integration”



Application state
persists (mostly)

The SCP's Characteristics

Advantages

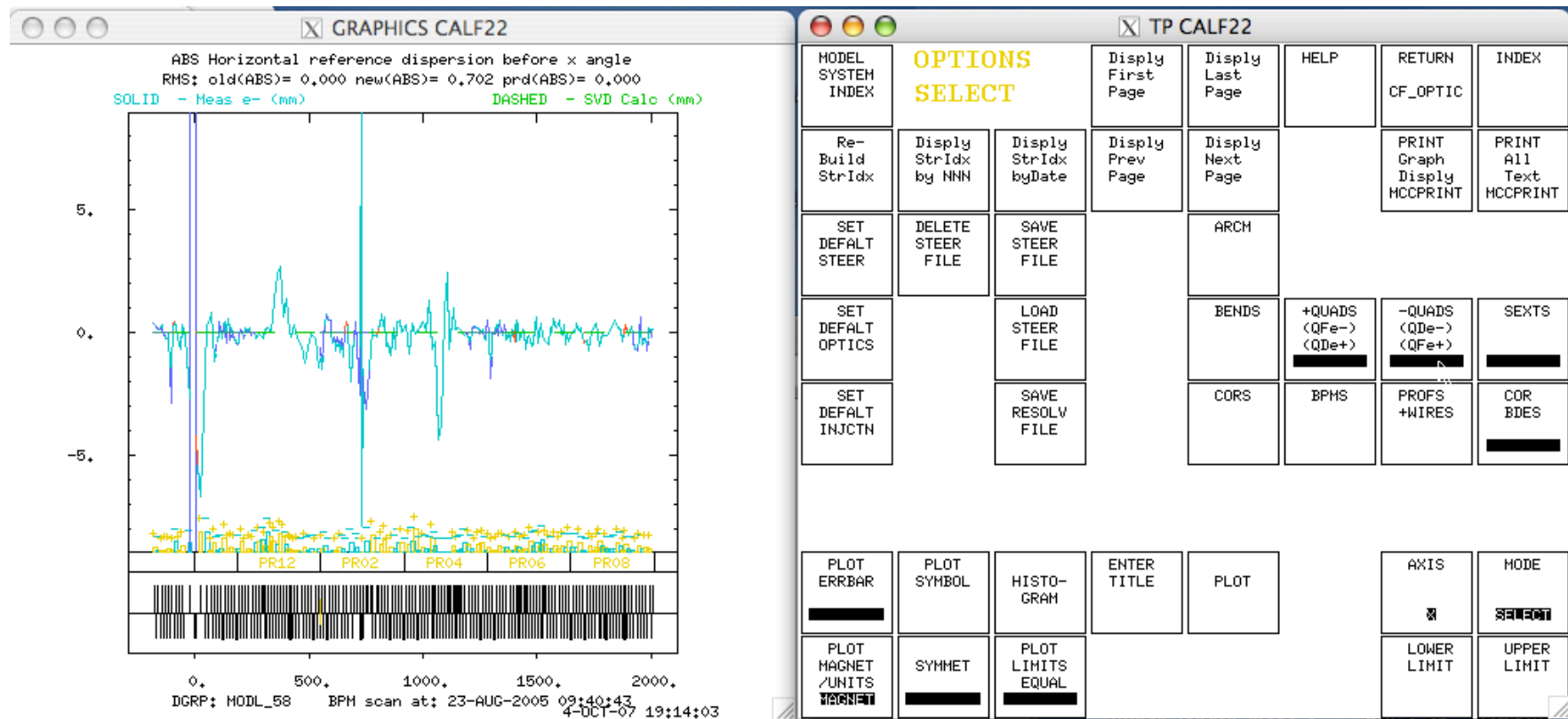
Integrated Applications, tools and science

Rocket **Fast**

Seamless User Interface

One executable, giving **macros**

Beamline “z” plots



TP CALF22

MODEL SYSTEM INDEX	OPTIONS SELECT	Disply First Page	Disply Last Page	HELP	RETURN CF_OPTIC	INDEX
Re- Build StrIdx	Disply StrIdx by NNN	Disply StrIdx by Date	Disply Prev Page	Disply Next Page	PRINT Graph Disply MCCPRINT	PRINT All Text MCCPRINT
SET DEFAULT STEER	DELETE STEER FILE	SAVE STEER FILE		ARCH		
SET DEFAULT OPTICS		LOAD STEER FILE		BENDS	+QUADS (QFe-) (QFe+)	-QUADS (QFe-) (QFe+)
SET DEFAULT INJCTN		SAVE RESOLV FILE		CORS	BPMS	PROFS +WIRES
						SEXTS
						COR BDES
PLOT ERRBAR	PLOT SYMBOL	HISTO- GRAM	ENTER TITLE	PLOT	AXIS	MODE
PLOT MAGNET /UNITS MAGNET	SYMMET	PLOT LIMITS EQUAL			LOWER LIMIT	UPPER LIMIT

Save/Restore (aka “configs”)

GRAPHICS CALF22

SAVED CONFIGURATION DISPLAY

PEP2_HER THPORAR# 39

Data last acquired at: 4-OCT-2007 19:04:56.5

!PEP2_HER#39.CNF

!23-JAN-06 02:47:44

!DIRECTORY=THPORARY

! BEAM NO.= 10

!TITLE= 0* 0:0.00 Before ORH corrector test

!

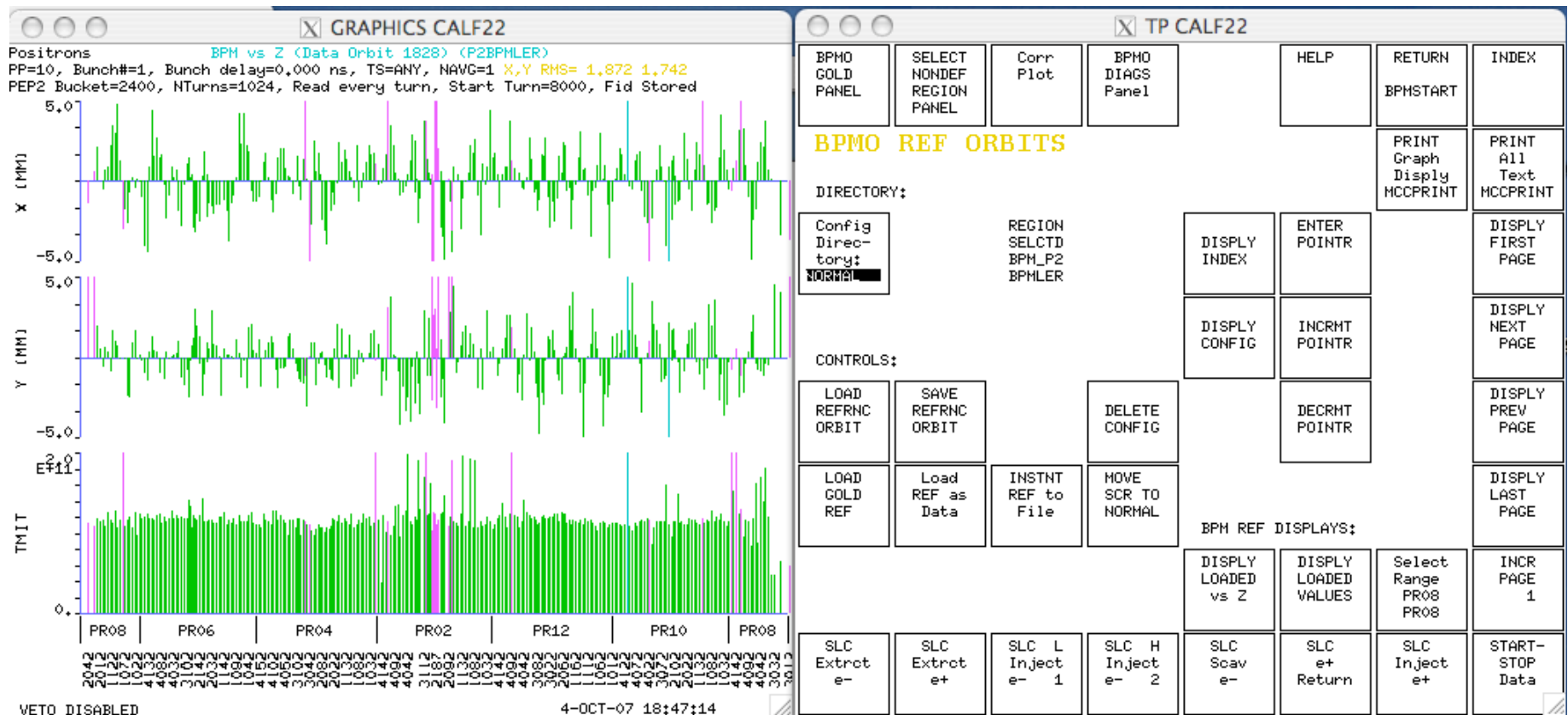
PRIM MICR	UNIT SECN	ALIAS	FILE	CON	DES
LGPS,PR02,	5002,BDES,,B2,B2M		2,0407	2,0406	2,0406
LGPS,PR02,	5003,BDES,,B3,B3M		3,0213	3,0212	3,0212
LGPS,PR02,	5004,BDES,,BLF		-,90593	-,90588	-,90588
LGPS,PR02,	5005,BDES,,BL,BR Bleg		25,337	25,337	25,337
LGPS,PR02,	5006,BDES,,BLFM		,90593	,90588	,90588
LGPS,PR02,	5007,BDES,,SPARE		0,0	0,0	0,0
LGPS,PR02,	5008,BDES,,VCOR1L		,16039	0,0	0,0
LGPS,PR02,	5009,BDES,,VCOR1R		,02149	0,0	0,0
LGPS,PR02,	5104,BDES,,QD4L		-119,16	-119,16	-119,16
LGPS,PR02,	5105,BDES,,QD4R		-119,16	-119,16	-119,16
LGPS,PR02,	5106,BDES,,QF5L		94,296	94,529	94,529
LGPS,PR02,	5107,BDES,,QF5R		94,476	94,558	94,558
LGPS,PR02,	5111,BDES,,QDS3L		-42,707	-42,706	-42,706
LGPS,PR02,	5112,BDES,,QFS3L		41,587	41,586	41,587
LGPS,PR02,	5113,BDES,,QDS2L		-24,130	-24,129	-24,129
LGPS,PR02,	5114,BDES,,QFS2L		50,663	50,662	50,662
LGPS,PR02,	5115,BDES,,QDS1L		-40,868	-40,866	-40,866
LGPS,PR02,	5116,BDES,,QFS1L		41,087	41,085	41,086
LGPS,PR02,	5117,BDES,,QDS0L		-36,009	-36,008	-36,008
LGPS,PR02,	5118,BDES,,QF7L		60,297	60,296	60,296
LGPS,PR02,	5119,BDES,,QD6L		-81,845	-81,841	-81,841
LGPS,PR02,	5120,BDES,,QD6R		-79,986	-79,982	-79,982
LGPS,PR02,	5121,BDES,,QF7R		57,621	57,618	57,618
LGPS,PR02,	5122,BDES,,QDS0R		-35,005	-35,003	-35,004
LGPS,PR02,	5123,BDES,,QFS1R		43,472	43,469	43,469
LGPS,PR02,	5124,BDES,,QDS1R		-42,932	-42,931	-42,931

4-OCT-07 19:04:56

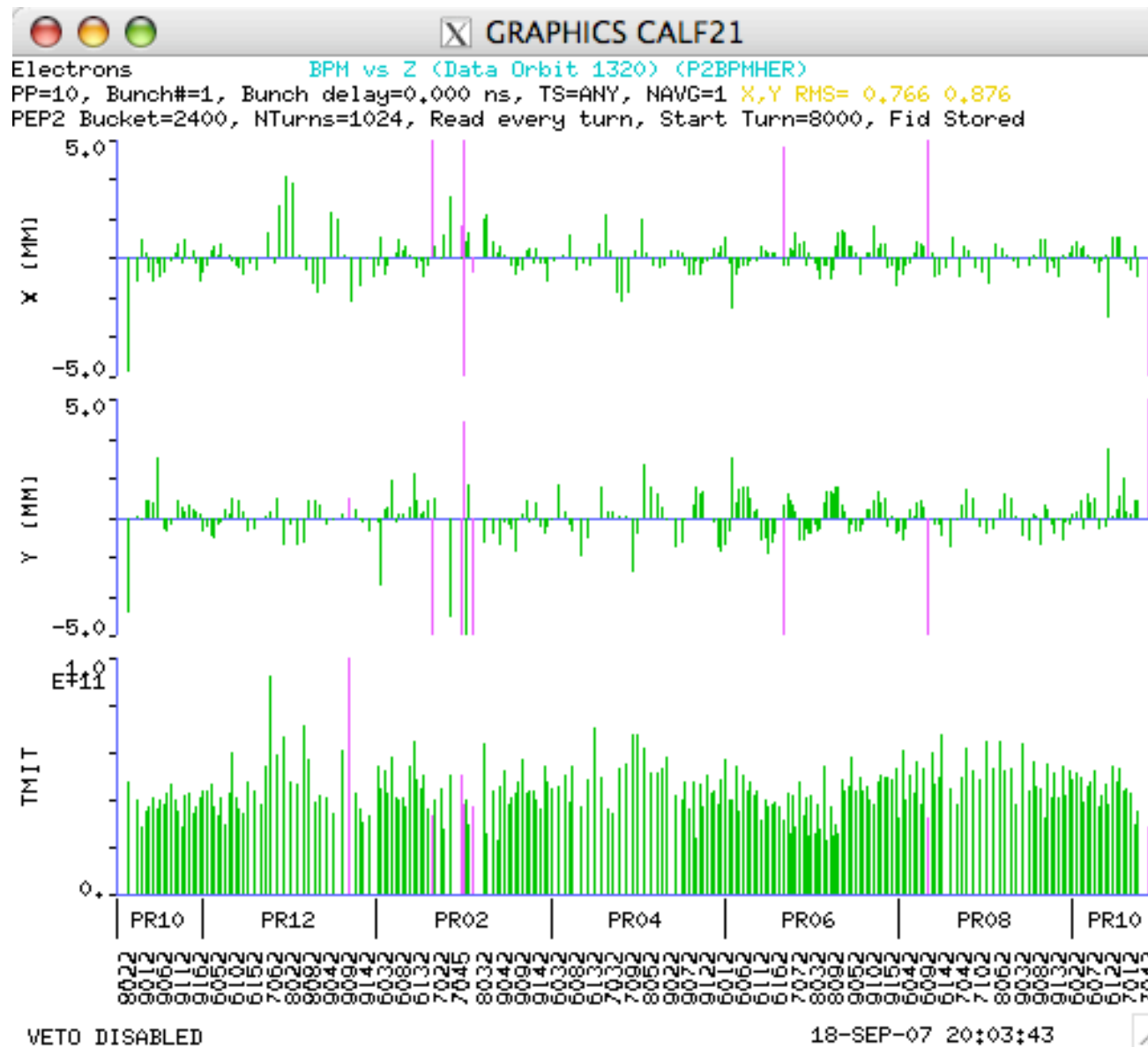
TP CALF22

MODEL SELECT	INJCTN SELECT	TIMING CONFIG SELECT	MISC CONFIG SELECT	GOLD CONFIG INDEX	HELP	RETURN INDEX	INDEX
ANALOG CONFIG SELECT	SETPT CONFIG SELECT	SAVE TYPE DES	CONFIGS		BEAM PROMPT 8 PEP2injH	PRINT All Text MCCPRINT	DISPLY FIRST PAGE
Config Directory: THPORARY		SAVE CONFIG	MOVE SCR TO NORMAL	DISPLY INDEX	INCRMT POINTR	DISPLY LOADED CONFGS	DISPLY NEXT PAGE
LOAD CONFIG	ACTI-VATE CONFIG	KNOB ACTVT ALL	DELETE CONFIG	DISPLY CONFIG (ALL)	DECRMT POINTR		DISPLY PREV PAGE
LOAD PARTIL CONFIG	ACTIVT PARTIL CONFIG	KNOB ACTVT PARTL	SELECT REGION:	DISPLY CONFIG (RED)	ENTER POINTR	INCR PAGE 1	DISPLY LAST PAGE
CID-01	NRING	SRING	L02-20	21-BSY	BSY_ESA	EXT	EPOS LI NE
PEP2 INJH	PEP2 HER	PEP2 INJL	PEP2 LER	BaBar	EPICS CONFGS Panel		
K00-01	KNRING	KSRING	K02-20	K21-30	KEPOS	FFTB	REGION SELECT PEP2_H ER

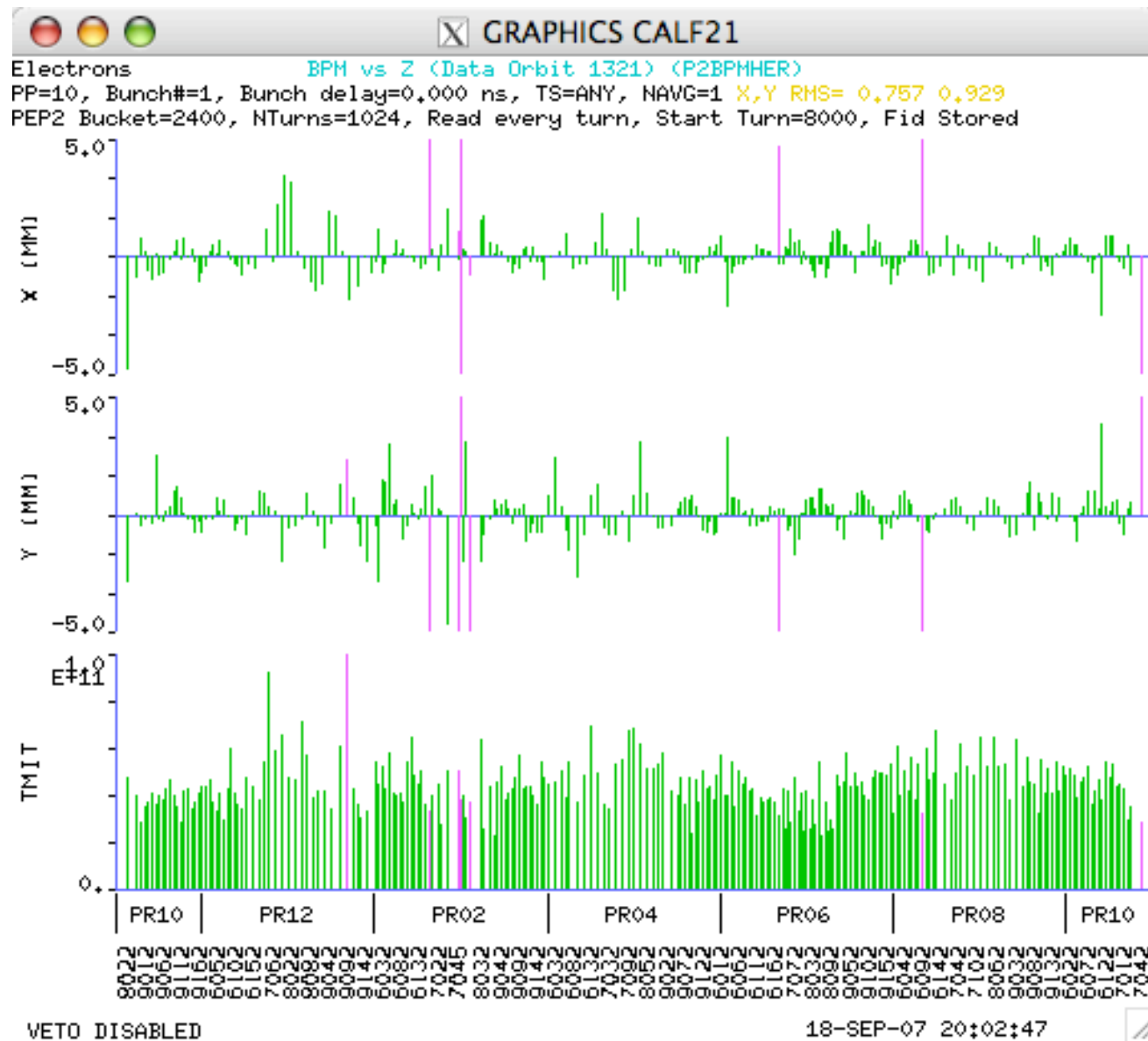
Beam Position Monitors (BPM)



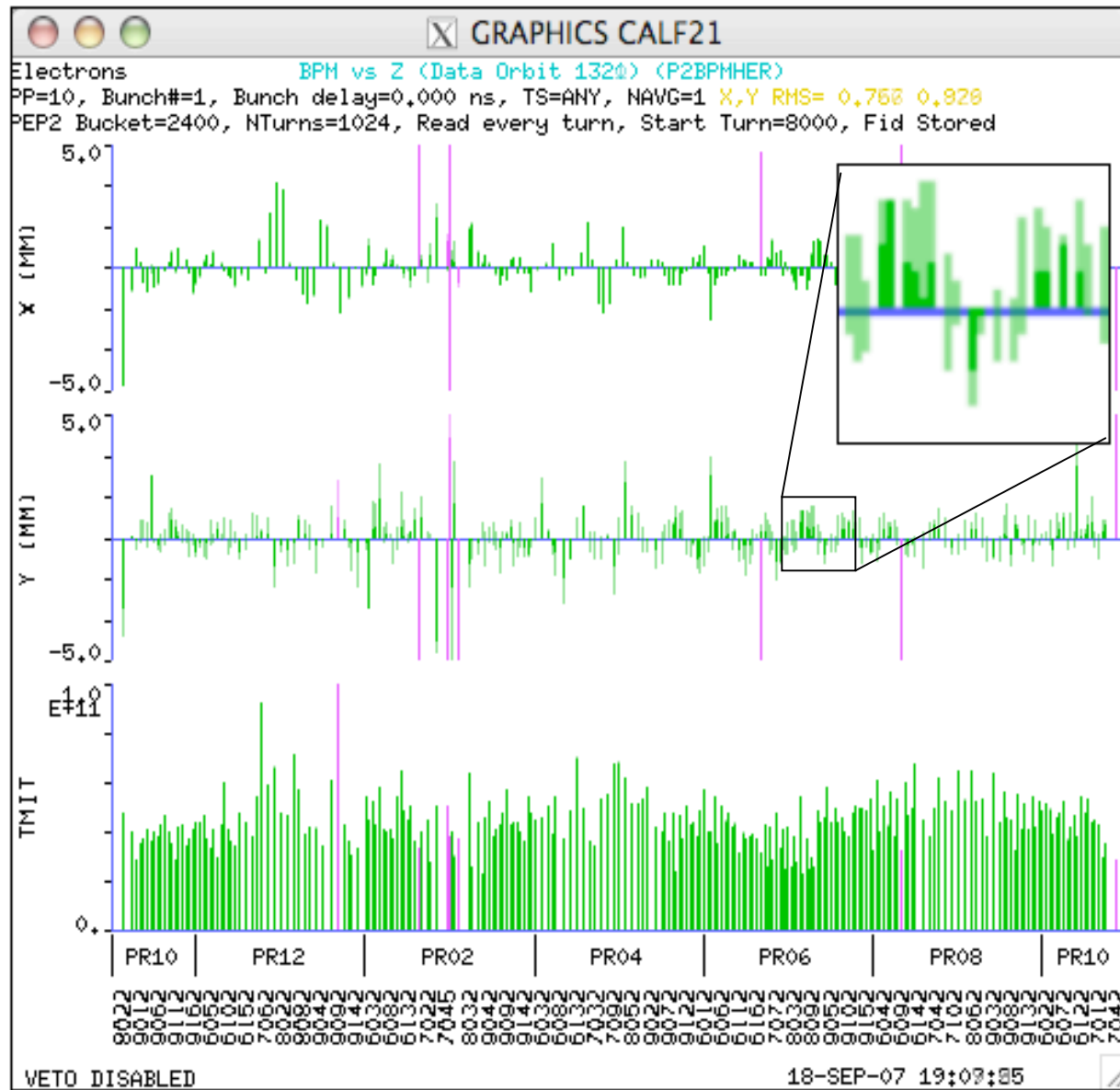
Reference BPM Orbit



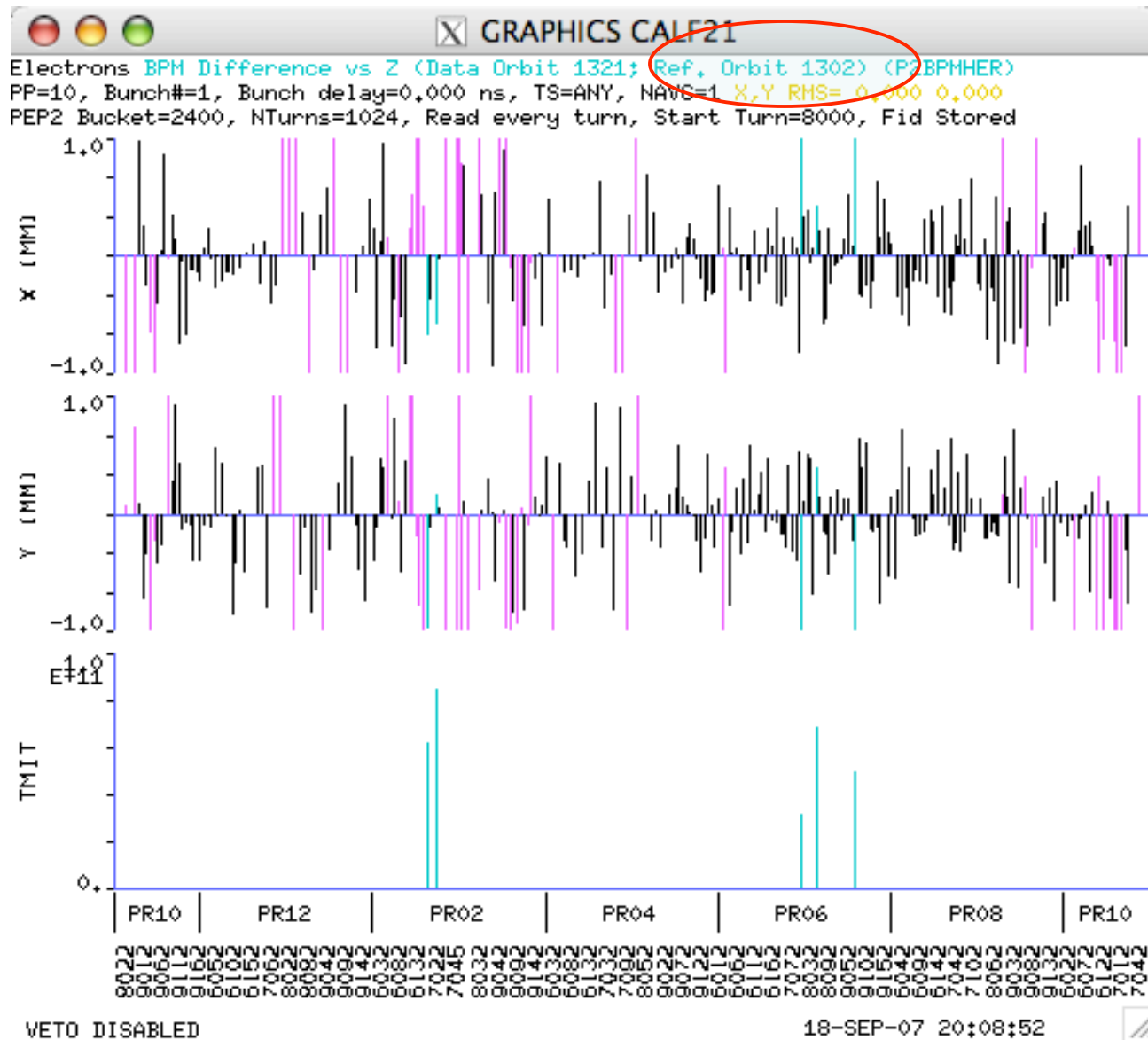
Extant BPM Orbit



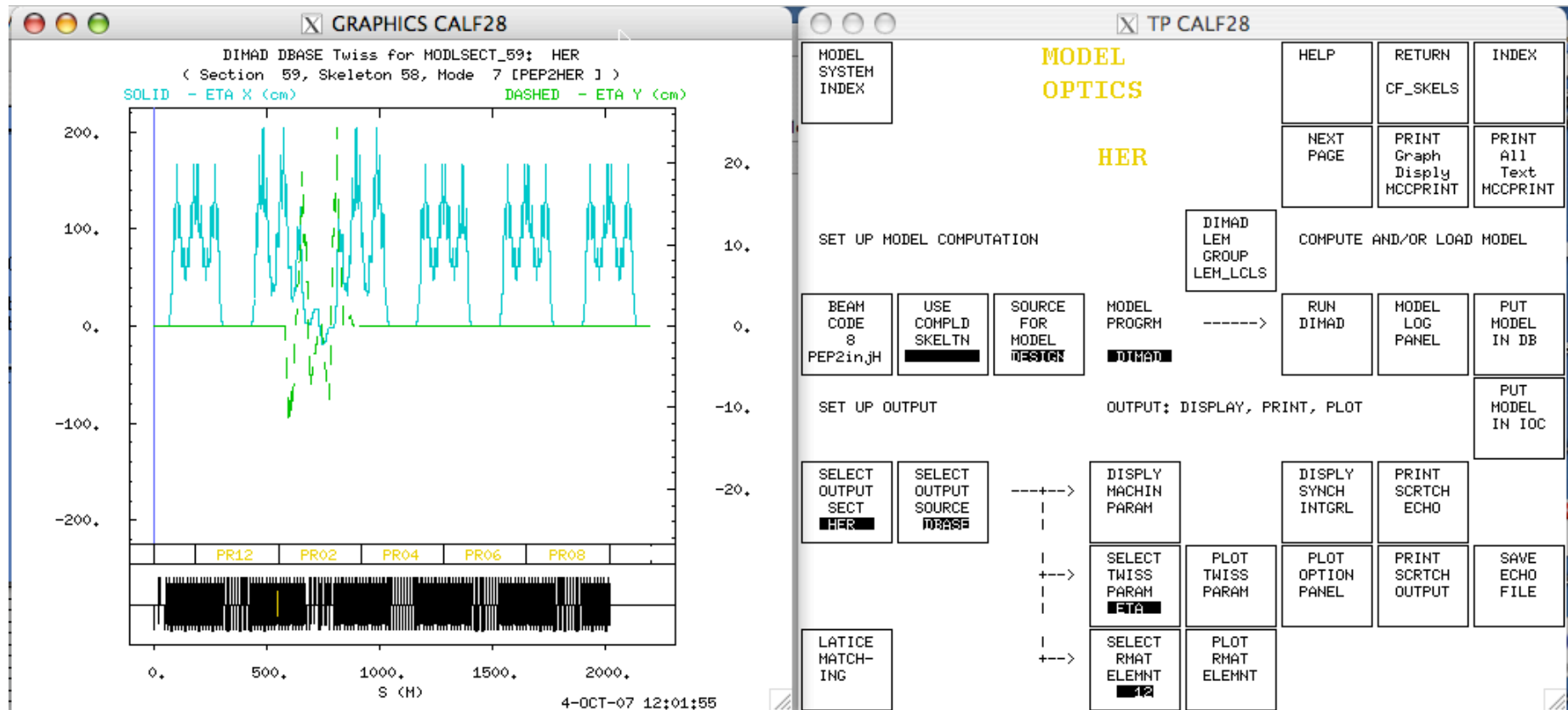
Beam Position Difference Orbits



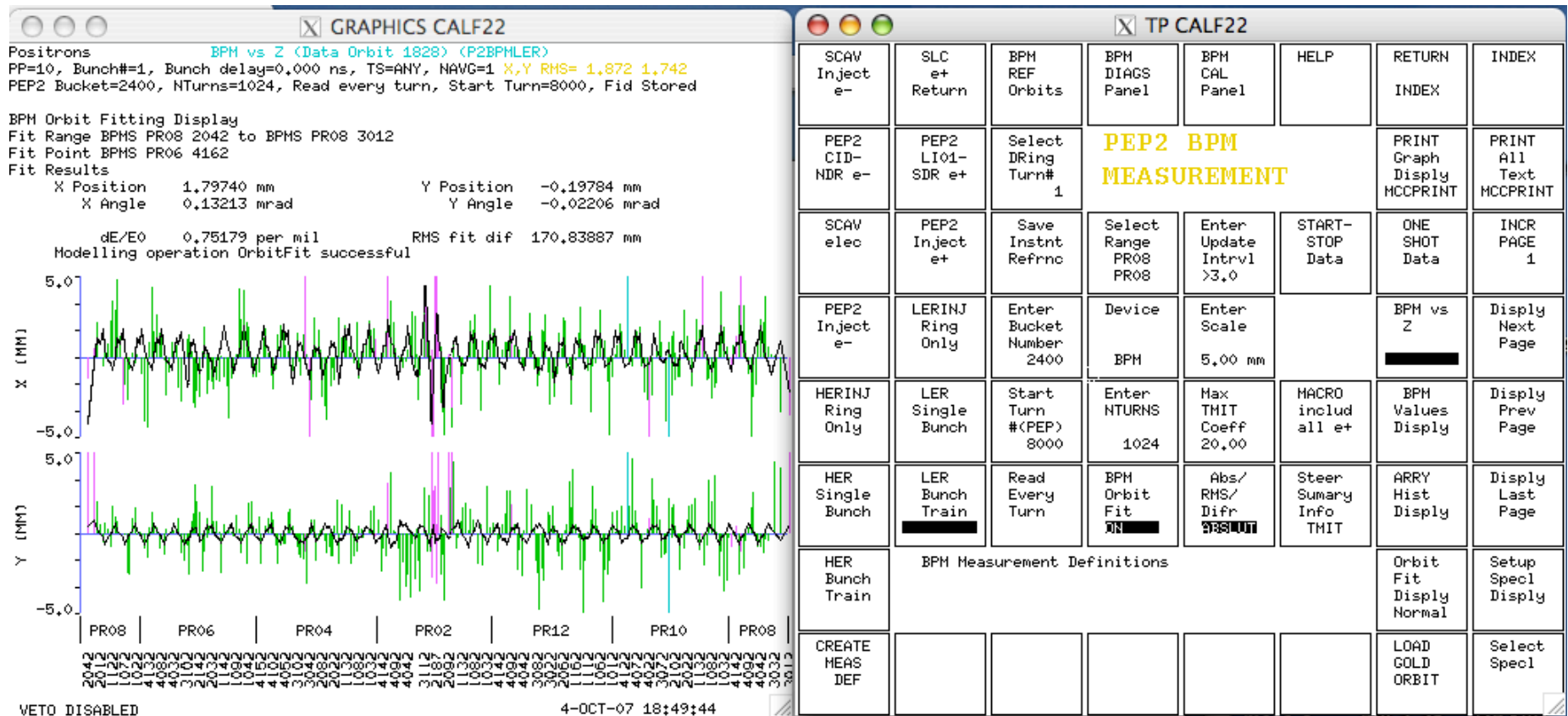
Difference (Actual Orbit minus Reference Orbit)



Modelling



Orbit fitting

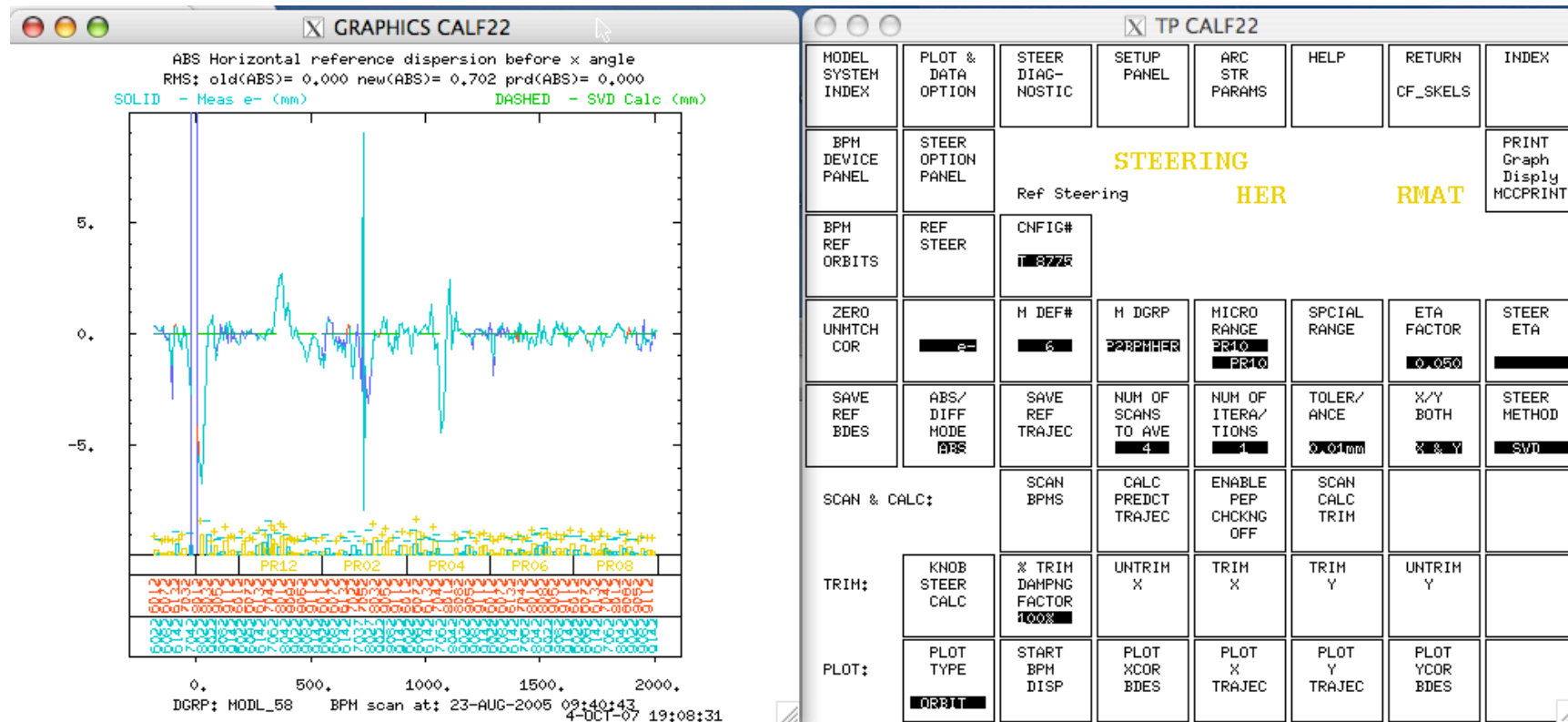


“Correlation Plots”

TP CALF21							
CRR Application	Step Setup Panel	21-40 ACQ. PANEL	01-20 DISPLY PANEL	BEAM CODE 8 PEP2injH	HELP	RETURN INDEX	INDEX
ENTER STEP MKNBS	Primary file: Secondary file:		CORRELATION PLOT DATA ACQ 01-20				TRIM / PTRB Toggle TRIM
TIME	RANGE 120 .50000	PRIMARY STEP VARIABLE (SLOW)	START AUTO ACQ.	SETTLE TIME 0.0000 0.0000	EXTRA SETTLE 0.0000 0.0000	BPM / TOROID AVRG 1	VDEM MEAS AVRG 1
ZERO	RANGE	SECONDARY STEP VARIABLE (FAST)	MANUAL ACQ. -- OFF	ADD MANUAL SAMPLE	RETAKE MANUAL SAMPLE	DISPLY SAMPLE VAR. -- OFF	Feedbk 1-Shot 0
Optional Range Entry PRIMARY	HB60:DCC T;SUMY	HB60:DCC T;LIFETI ME	HB60:SAVE;NUMBUCK		SET ALL Y	BUTTON FILE DIR	Disply Next Page
Start Stop #Steps	LB60:DCC T;SUMY	LB60:DCC T;LIFETI ME	LB60:SAVE;NUMBUCK	ReInit All of CRR	SET ALL X	SAVE BUTTON FILE	RESTOR BUTTON FILE
Optional Range Entry SECNDRY	PHYS ORBT YPOS	TIME	ilpb=a2/c2	ASTS PR02 DATA CH117	ASTS PR02 DATA CH130	ASTS PR02 DATA CH131	ASTS PR02 DATA CH129
Start Stop #Steps	ATIM	ZERO	ihpb=a1/c1	ilpbihpb=c3*c4	ln130=e3/(c1*d4)	ln131=f3/(c1*d4)	ln117=d3/(c1*d4)

- * Steps **any** controllable thing, reads **any**, up to 160, readable values
- * **Beam Synchronous** - knows what to do
- * **Total integration** - eg step ring frequency, do orbit fit, read fit params
- * Includes plotting, fitting, optimization (eg implements quad scan)

Steering (Orbit Correction)



Orbit Correction

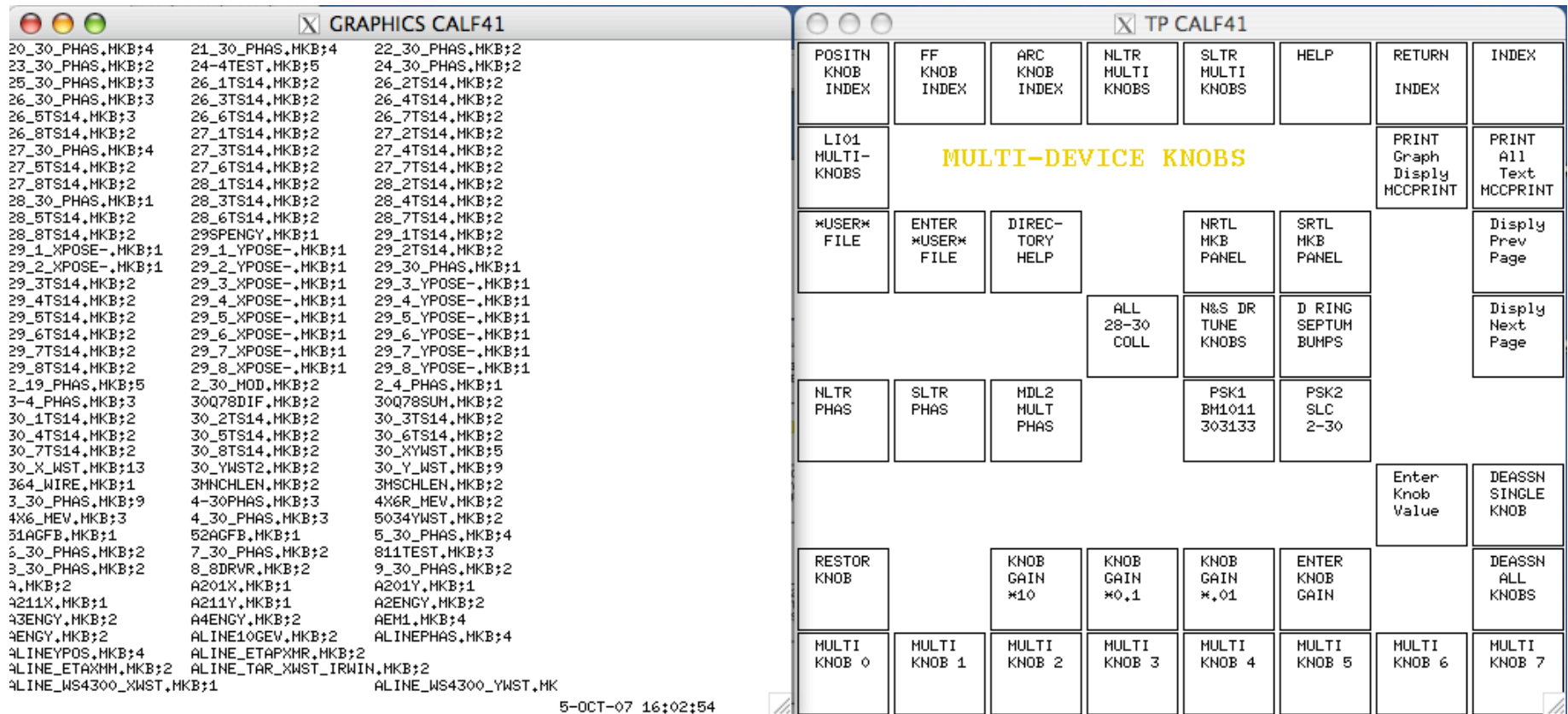
$$\min || Ax - b ||_2$$

subject to $x_j \leq x_{jmax}$

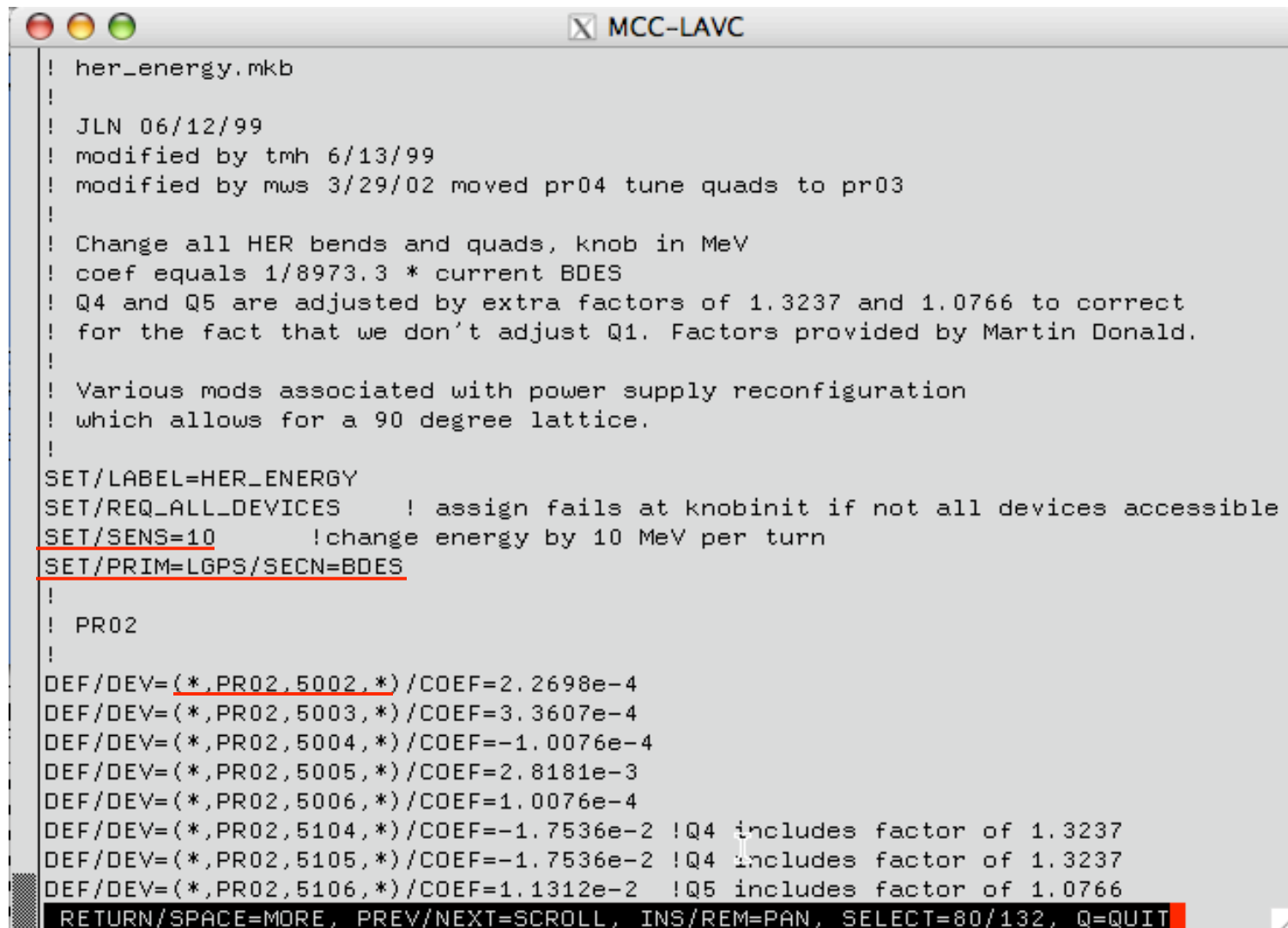
- Correction “methods”:
 - Robust Chi Sq
 - Paired correctors to bpms
 - Micado
 - SVD
 - others now seldom used
- Simultaneous Orbit and Dispersion Correction
- Transport or closed orbit
- Optional Boundary conditions (eg constant injector region)
- If underconstrained, finds soln with smallest corrs
- Iteratively removes BPMs with poor fit (liars)
- Handles degenerate system matrix (by SVD) but includes peak amplitude constraints (corrector Bmax)

<http://www.slac.stanford.edu/pubs/slacpubs/7000/slac-pub-7653.html>

Multi-knobs



Example MKB file



```
! her_energy.mkb
!
! JLN 06/12/99
! modified by tmh 6/13/99
! modified by mws 3/29/02 moved pr04 tune quads to pr03
!
! Change all HER bends and quads, knob in MeV
! coef equals 1/8973.3 * current BDES
! Q4 and Q5 are adjusted by extra factors of 1.3237 and 1.0766 to correct
! for the fact that we don't adjust Q1. Factors provided by Martin Donald.
!
! Various mods associated with power supply reconfiguration
! which allows for a 90 degree lattice.
!
SET/LABEL=HER_ENERGY
SET/REQ_ALL_DEVICES      ! assign fails at knobinit if not all devices accessible
SET/SENS=10              !change energy by 10 MeV per turn
SET/PRIM=LGPS/SECN=BDES
!
! PR02
!
DEF/DEV=(*,PR02,5002,*)/COEF=2.2698e-4
DEF/DEV=(*,PR02,5003,*)/COEF=3.3607e-4
DEF/DEV=(*,PR02,5004,*)/COEF=-1.0076e-4
DEF/DEV=(*,PR02,5005,*)/COEF=2.8181e-3
DEF/DEV=(*,PR02,5006,*)/COEF=1.0076e-4
DEF/DEV=(*,PR02,5104,*)/COEF=-1.7536e-2 !Q4 includes factor of 1.3237
DEF/DEV=(*,PR02,5105,*)/COEF=-1.7536e-2 !Q4 includes factor of 1.3237
DEF/DEV=(*,PR02,5106,*)/COEF=1.1312e-2  !Q5 includes factor of 1.0766
RETURN/SPACE=MORE, PREV/NEXT=SCROLL, INS/REM=PAN, SELECT=80/132, Q=QUIT
```

Bumps

GRAPHICS CALF22

Setup File Display for Subsystem: 3CorPos
Keyword: HER Version No: 1

Index	Comment	UserID	Created
-> 165	x-pos bump at sq61 =bpms 6052	MCCSCP	13-FEB-1999

4-OCT-07 19:17:52

TP CALF22

MULTIKNOB FILE GENERATION HER

Buttons in TP CALF22 window:

- Multi Device Knobs
- BPM Device Panel
- Model System Index
- HELP
- RETURN
- INDEX
- CF_SKELS
- PRINT Graph
- PRINT All
- PRINT Disply
- PRINT Text
- PRINT MCCPRINT
- PRINT MCCPRINT
- Disply Prev Page
- Disply Next Page
- Knob Type
- Magnet Select
- Select Plane
- 3CorPos
- AUTO
- X PLANE
- Disply Setups
- Decrmt Pointr
- Incrmt Pointr
- Enter Pointr
- Locatn BPMS PR10 8042
- Z = 53,53
- Make Setup Gold
- Load Setup
- Save Setup
- Delete Setup
- Comp & Assign Knob
- Save Knob File
- Enter Knob Value

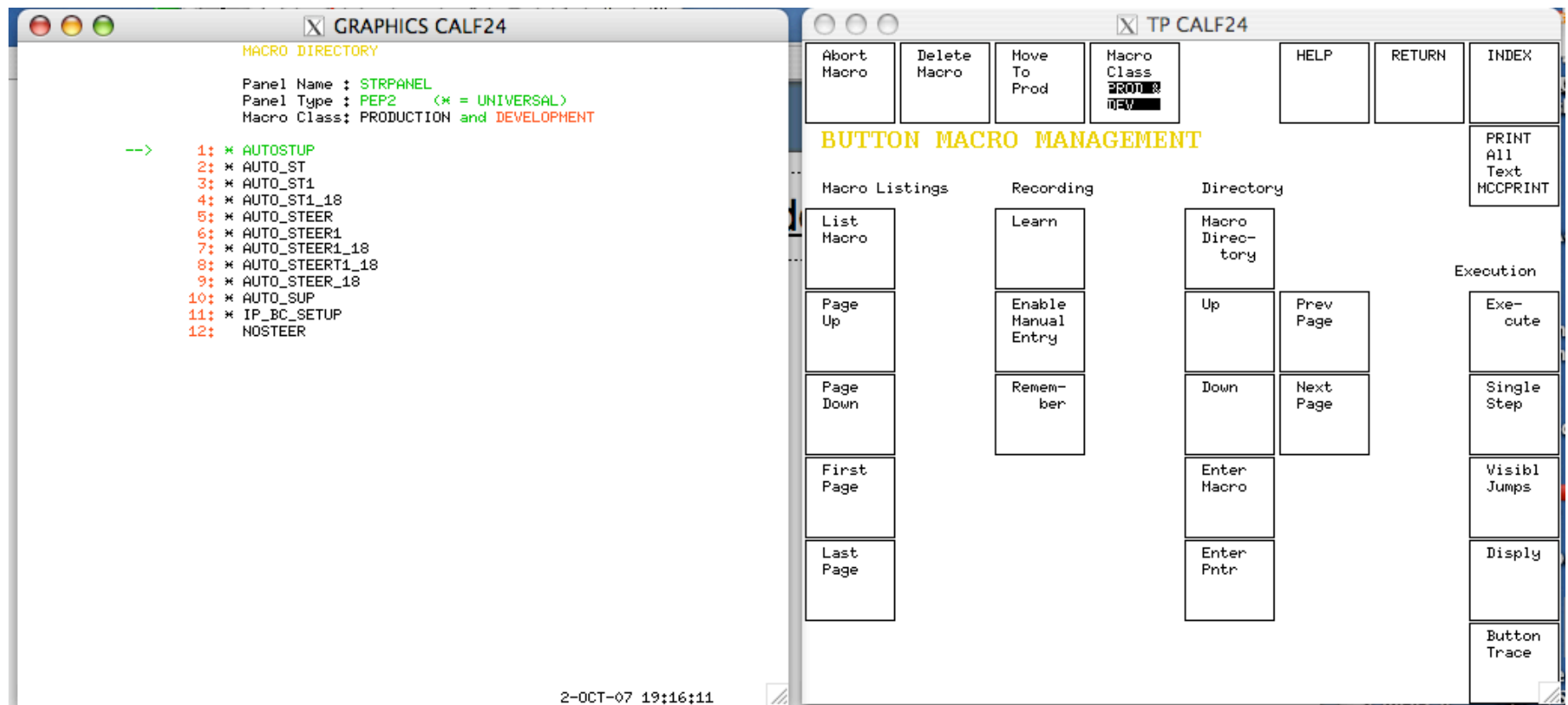
MESSAGES CALF22

GLOBAL_MESSAGES

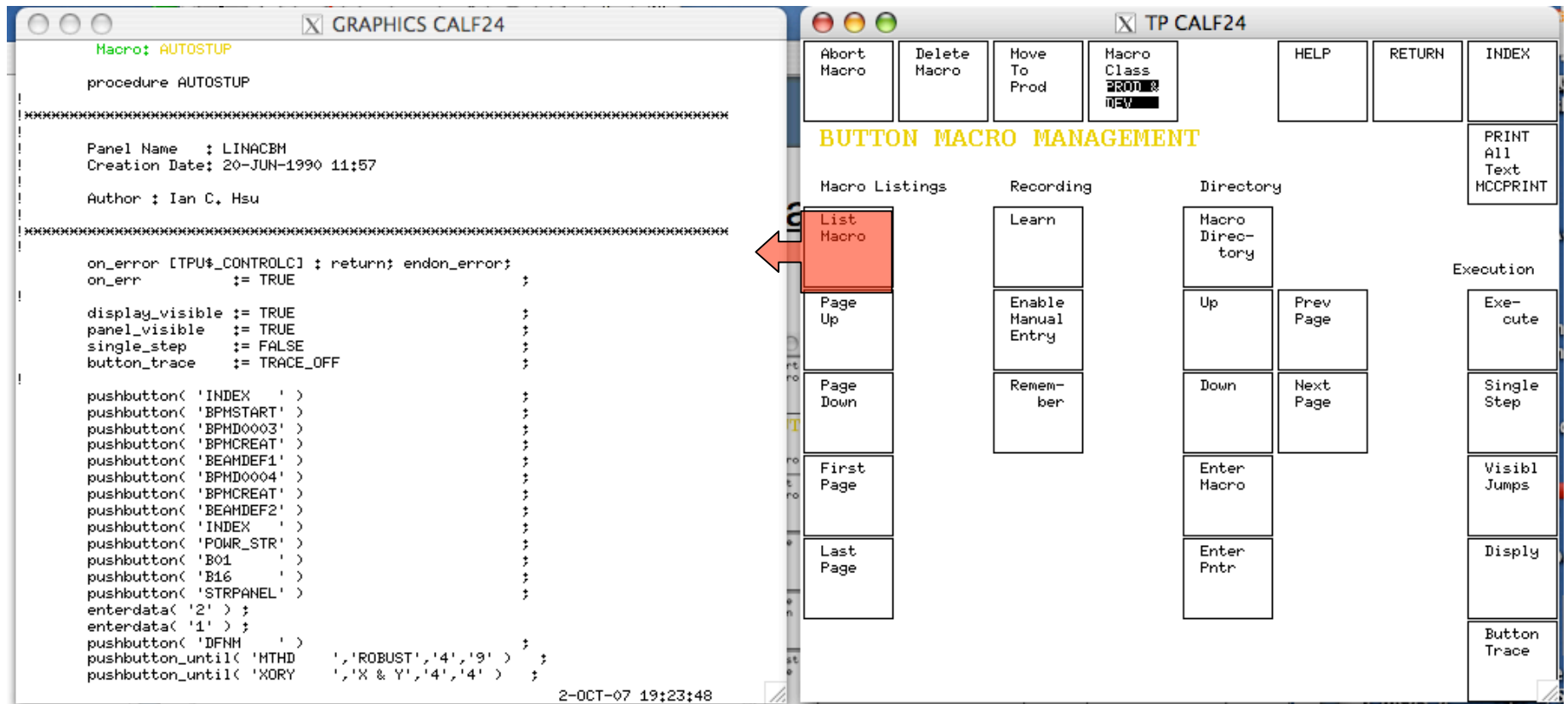
AP20 Bypass data crc doesnt match vax
AP20 Alg data crc doesnt match vax
TA01 21 more errors in last 21 minutes for FID_NONE
LI01 21 more errors in last 21 minutes for FID_NONE
SP00 65534 more errors in last 2 minutes for BAD_STOPCNF_REA
LI12 No more errors for PIOP unit 11 in last 5 minutes, but 4 in pre
ing 1 minutes.
AP20 Previous failure necessitates a coldstart now
AP20 Bypass data crc doesnt match vax
AP20 Alg data crc doesnt match vax
LI23 Starting to count & drop error messages for PIOP unit 71.

Data were read from: SLCHMODLBPB;MODL_58_111.BPM
Enter primary [] : XCOR.PR08 8042
Pausing for initial Oracle database connection
Enter bump location Primary BPMS PR10 8042
Coefficient for XCOR PR10 8022 = 0,00653891
Coefficient for XCOR PR10 8042 = -0,0108642
Coefficient for XCOR PR10 9022 = 0,0144292
Enter a knob number where this knob will be attached (min = 0) (max = 7)
...aborted by user.
Knob will not be assigned

“Button Macros”



“Button Macros”



History/Archive Data

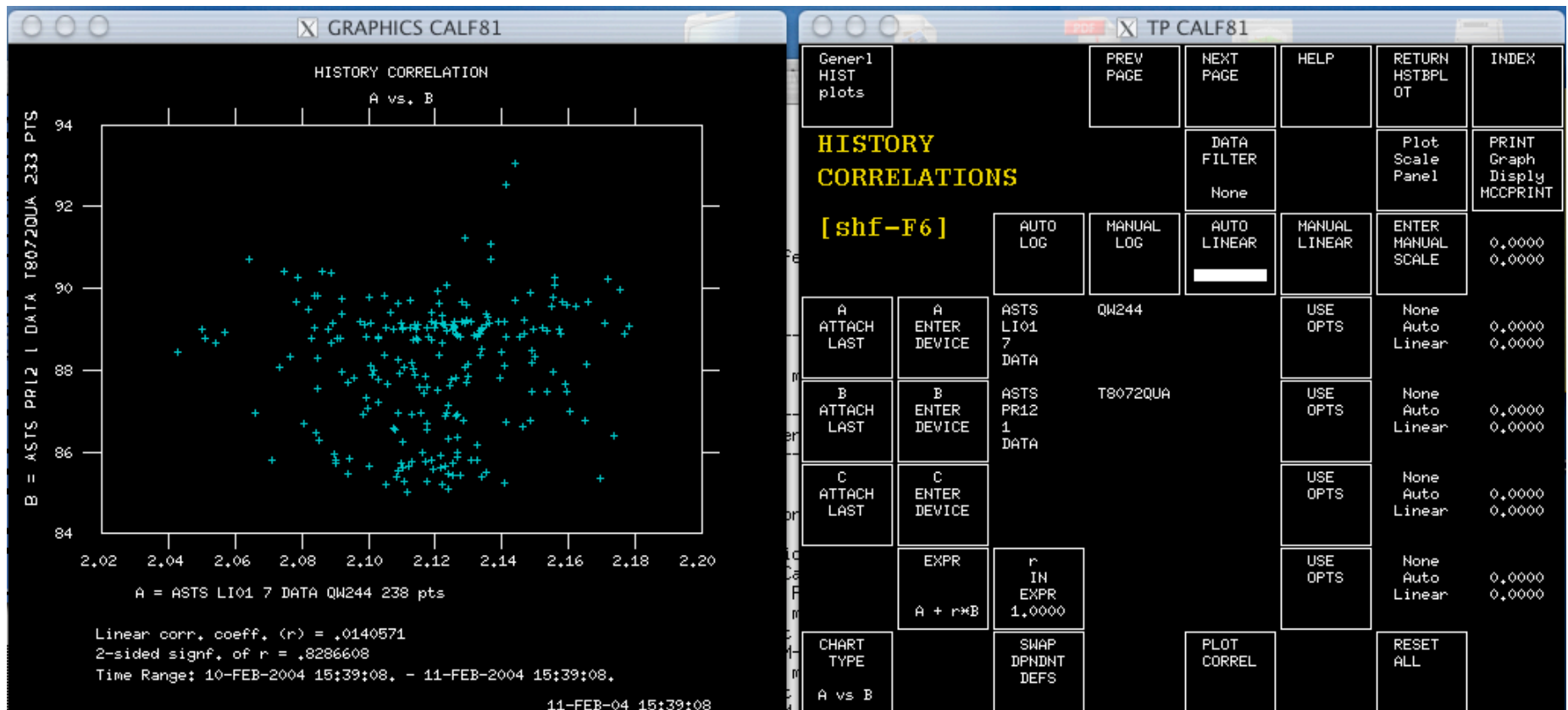


Chart Types: stripchart, Overlay, A vs B (interpolated), expressions in A, B and C
 Linear and Log axes
 Auto or manual scaling axes

The SCP's Characteristics

Advantages

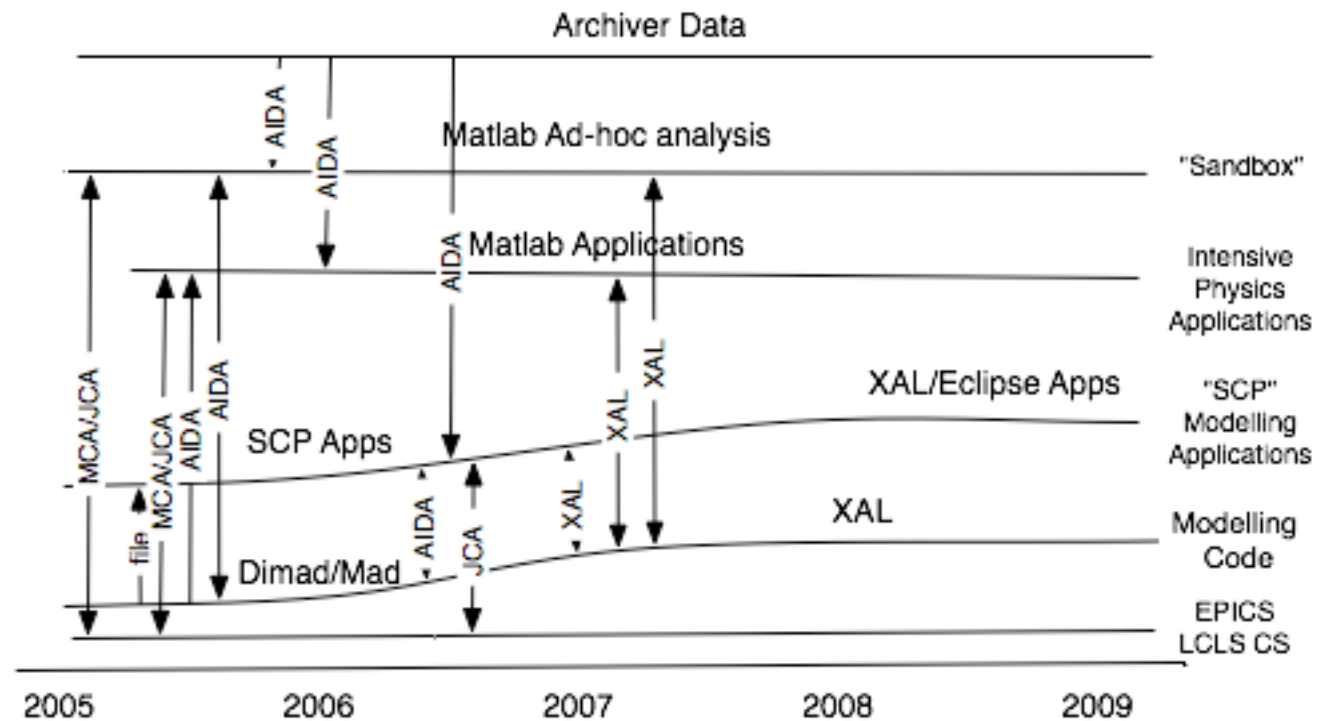
Integrated Applications, tools and science
Rocket Fast
Seamless User Interface
One executable, giving macros

Disadvantages

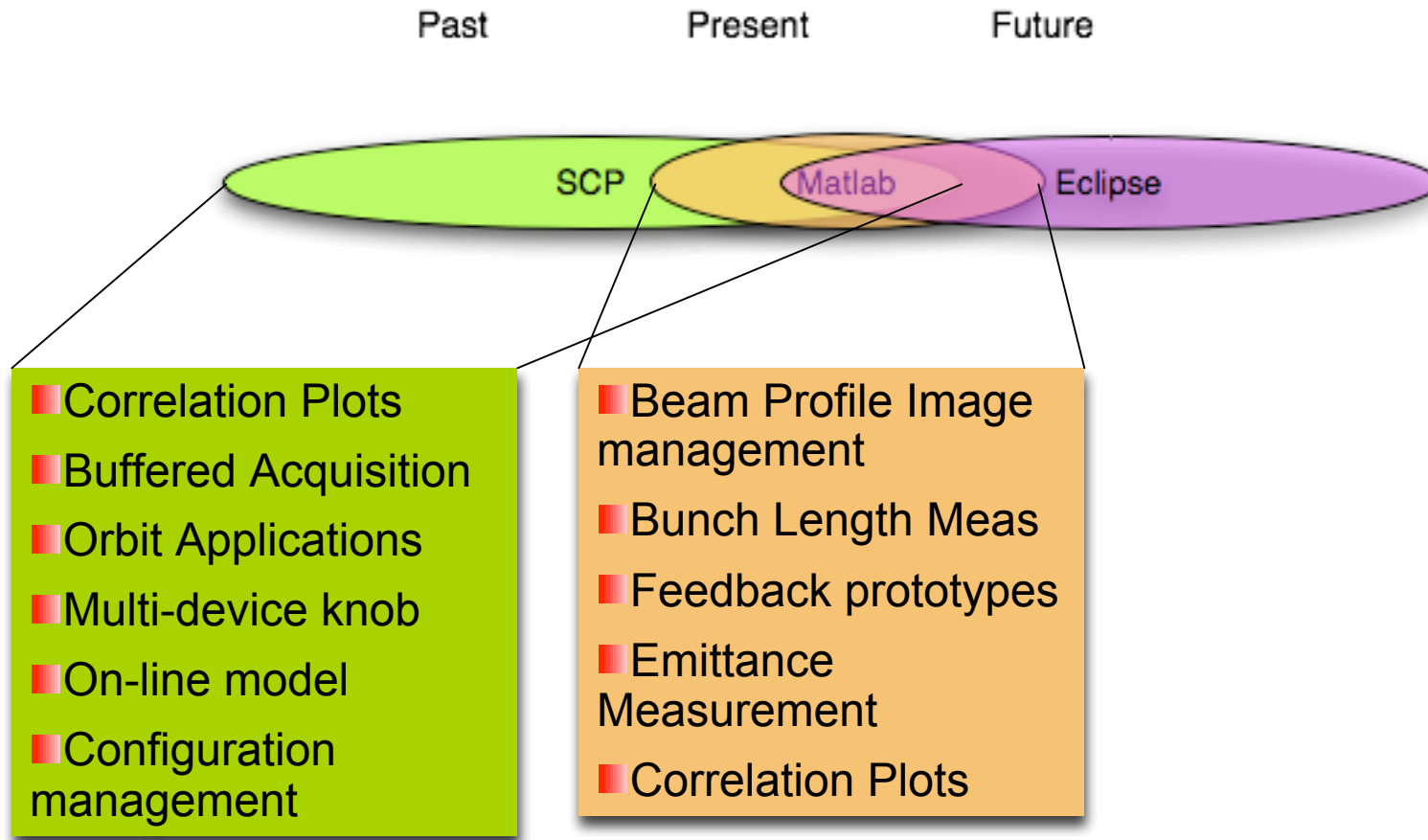
Very difficult to **upgrade** basis technology
Single threaded, **one thing at a time**
Impossible to **collaborate**
VMS based

SCP - Matlab - XAL - Eclipse - CA integration

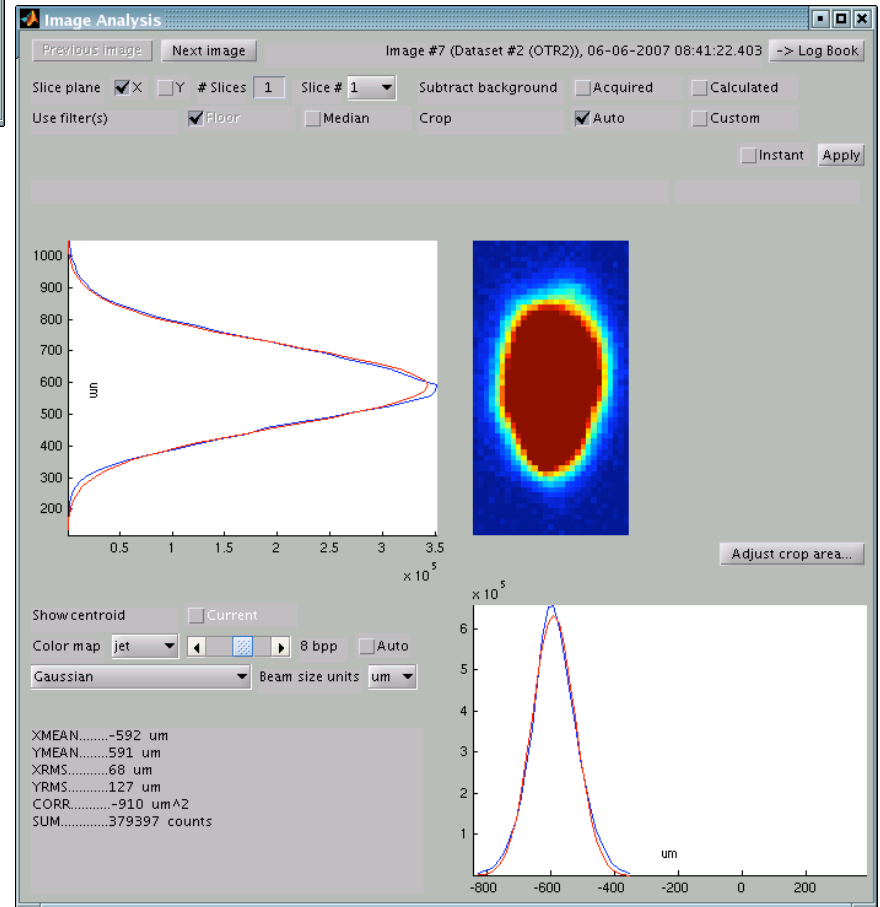
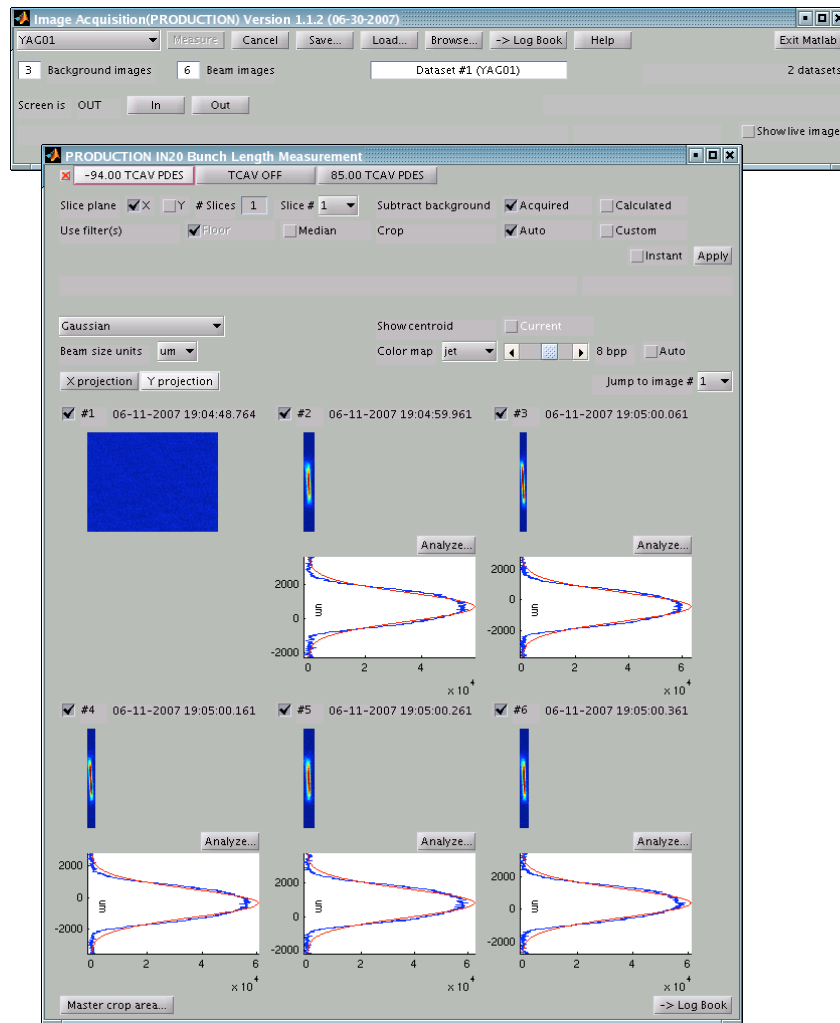
Timeline



Transitional Phase - Present

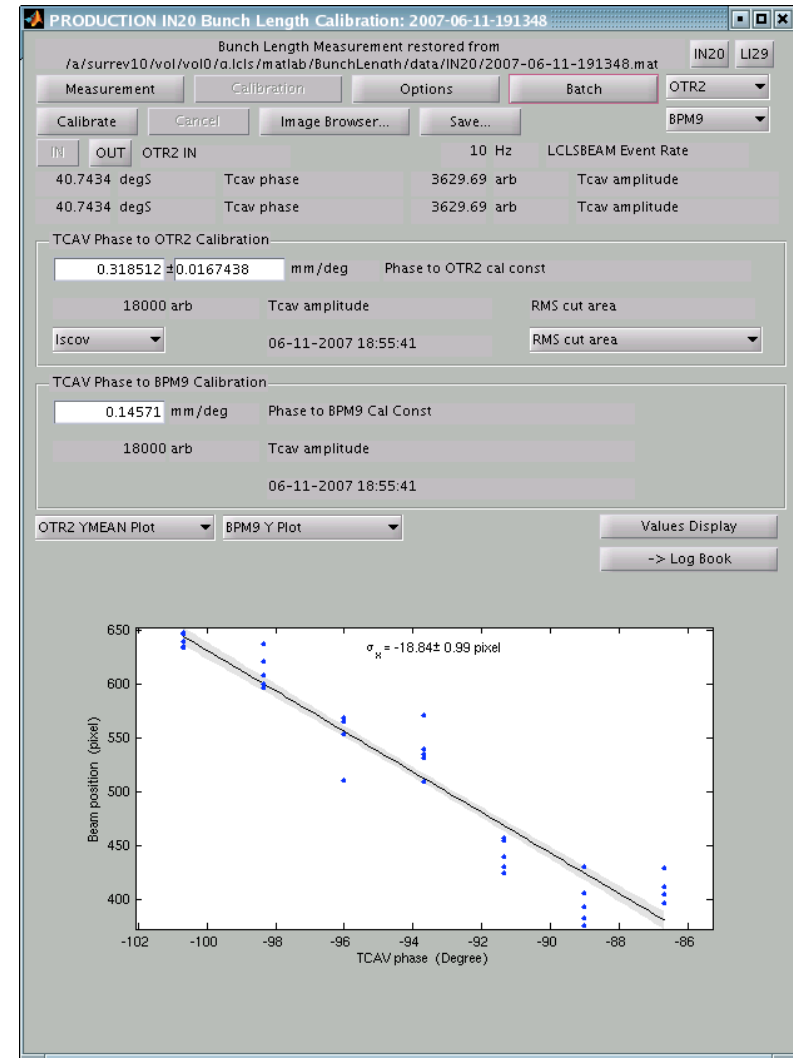
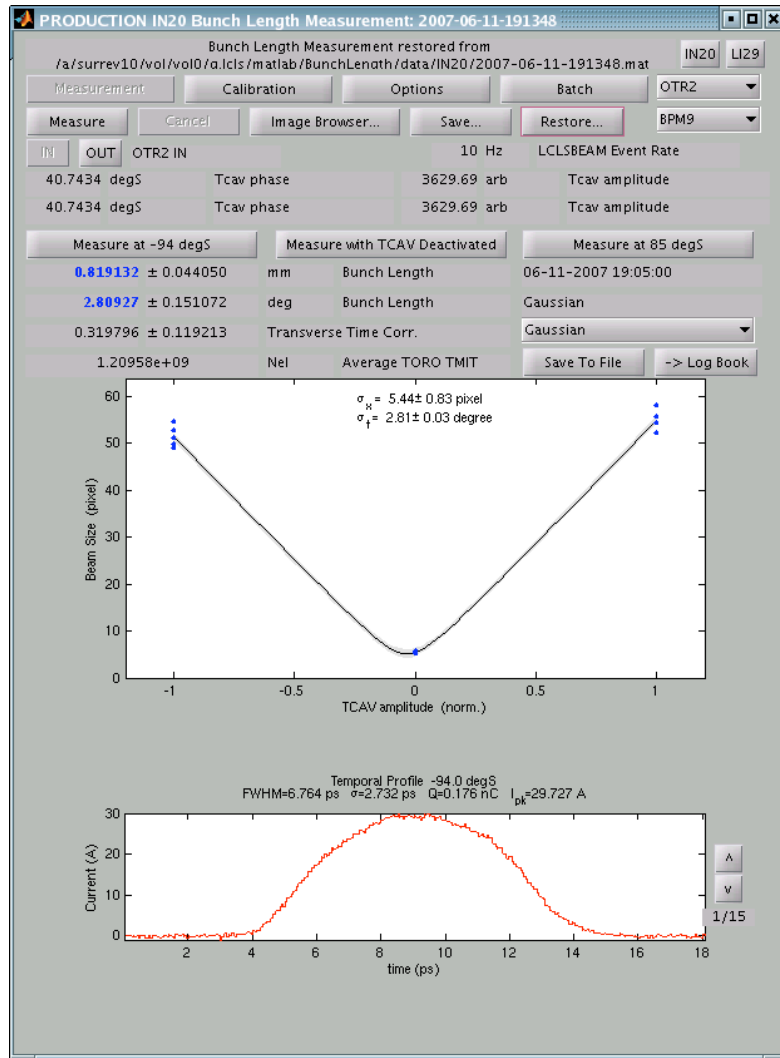


Beam Profile Image Management in Matlab



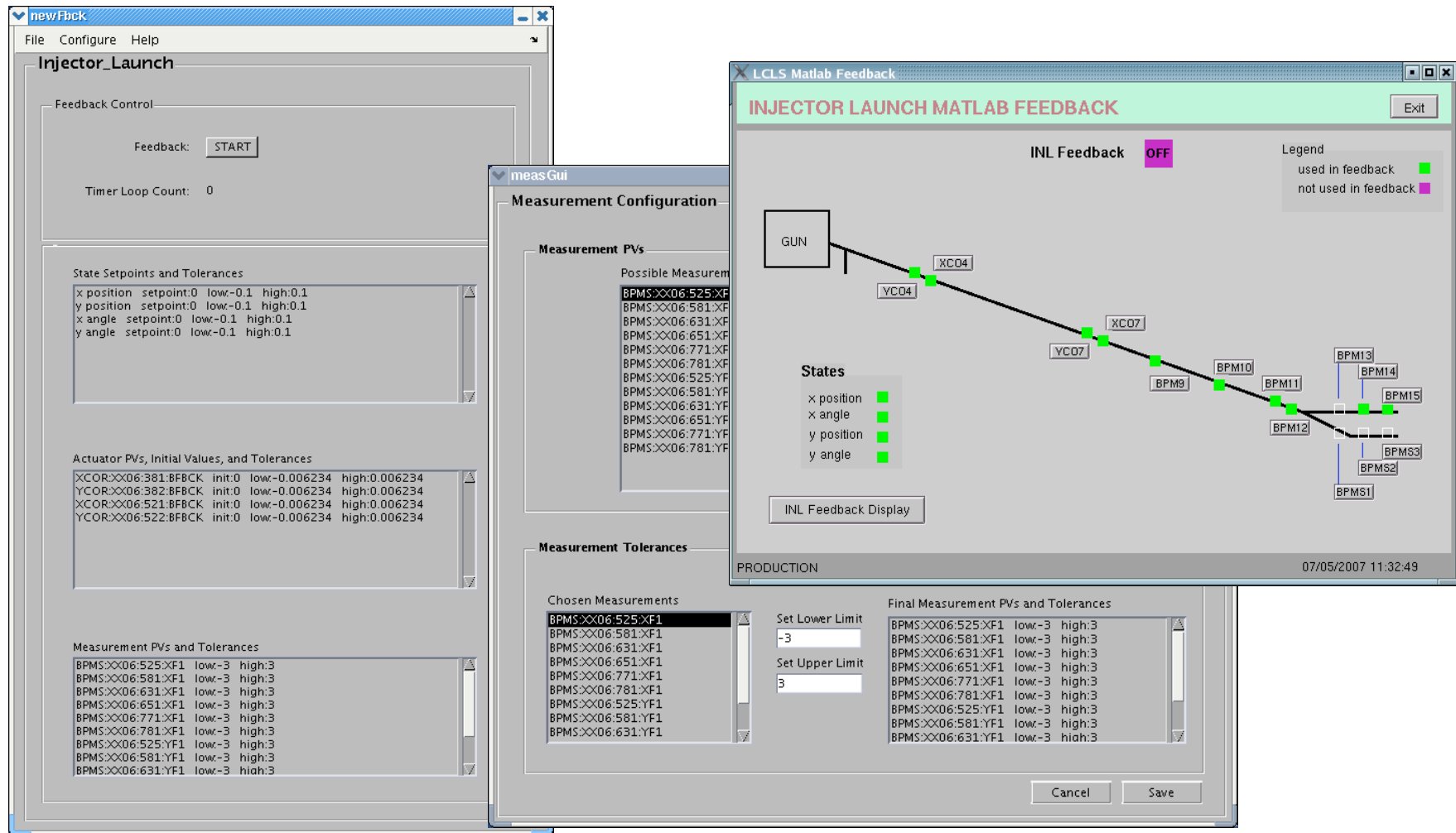
Thanks to Sergei Chevtsov

Bunch Length Measurement



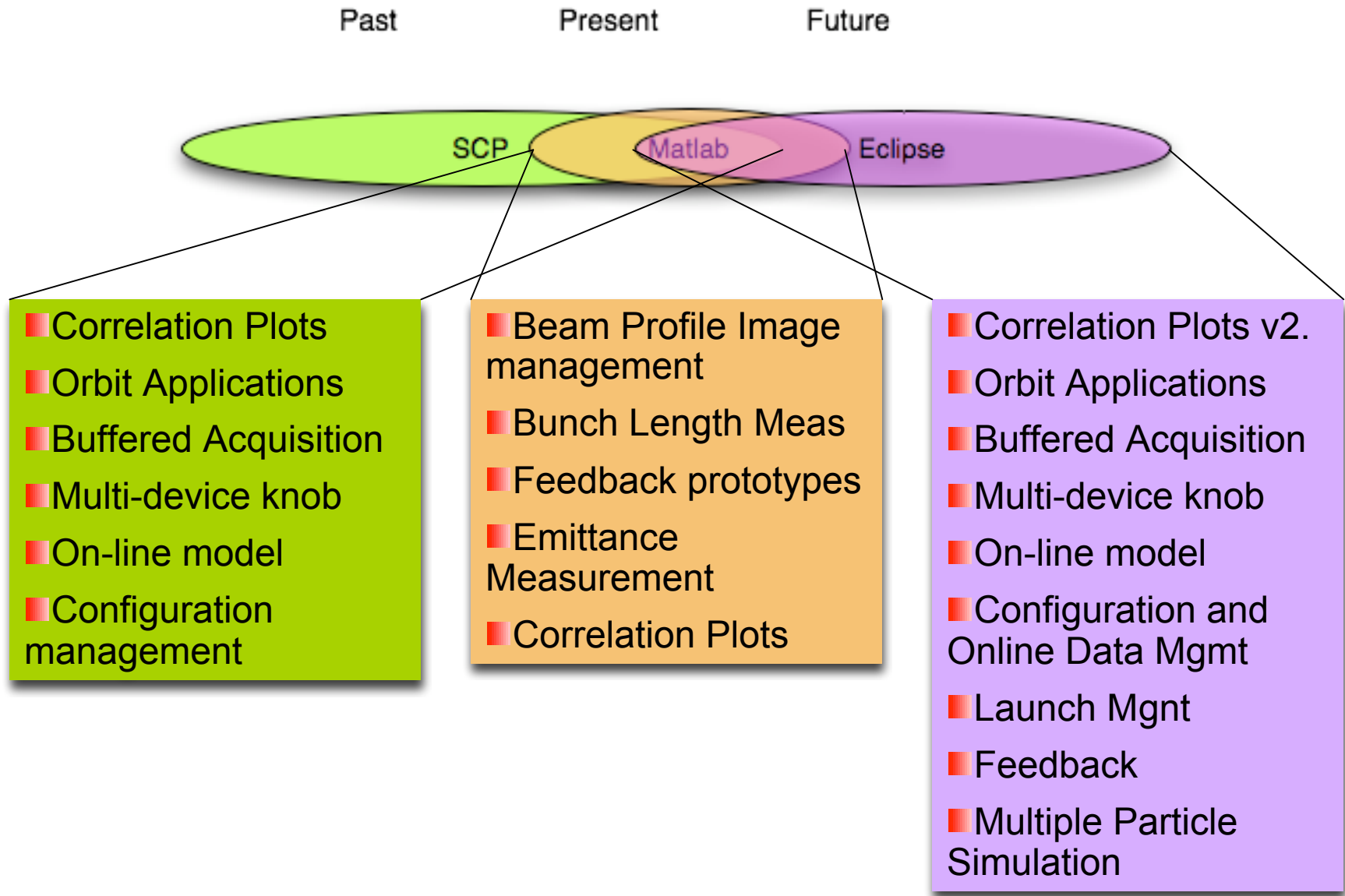
Thanks to Mike Zelazny

Matlab based feedback!

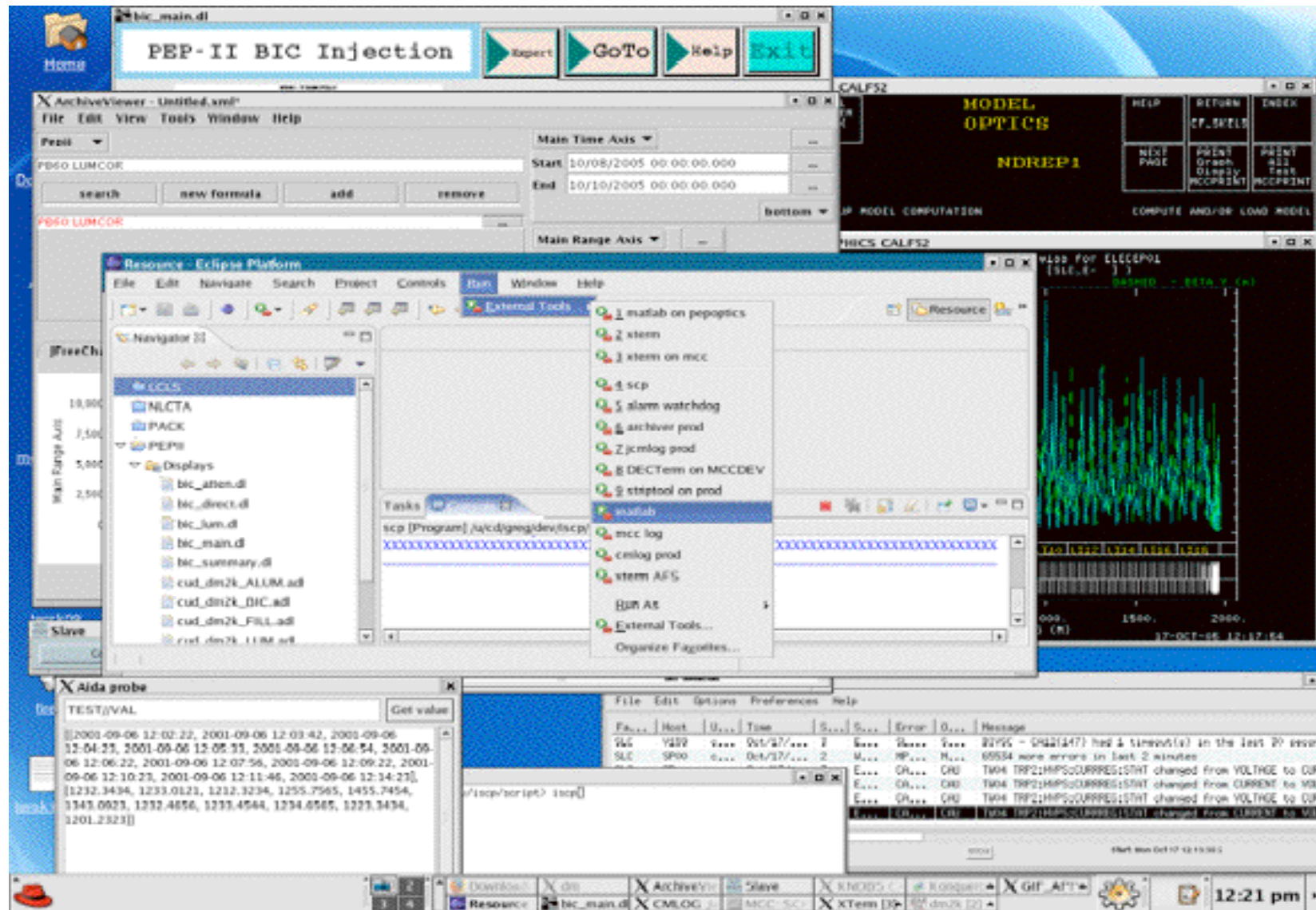


Thanks to Diane Fairley

Transitional Phase - Future (immediate)

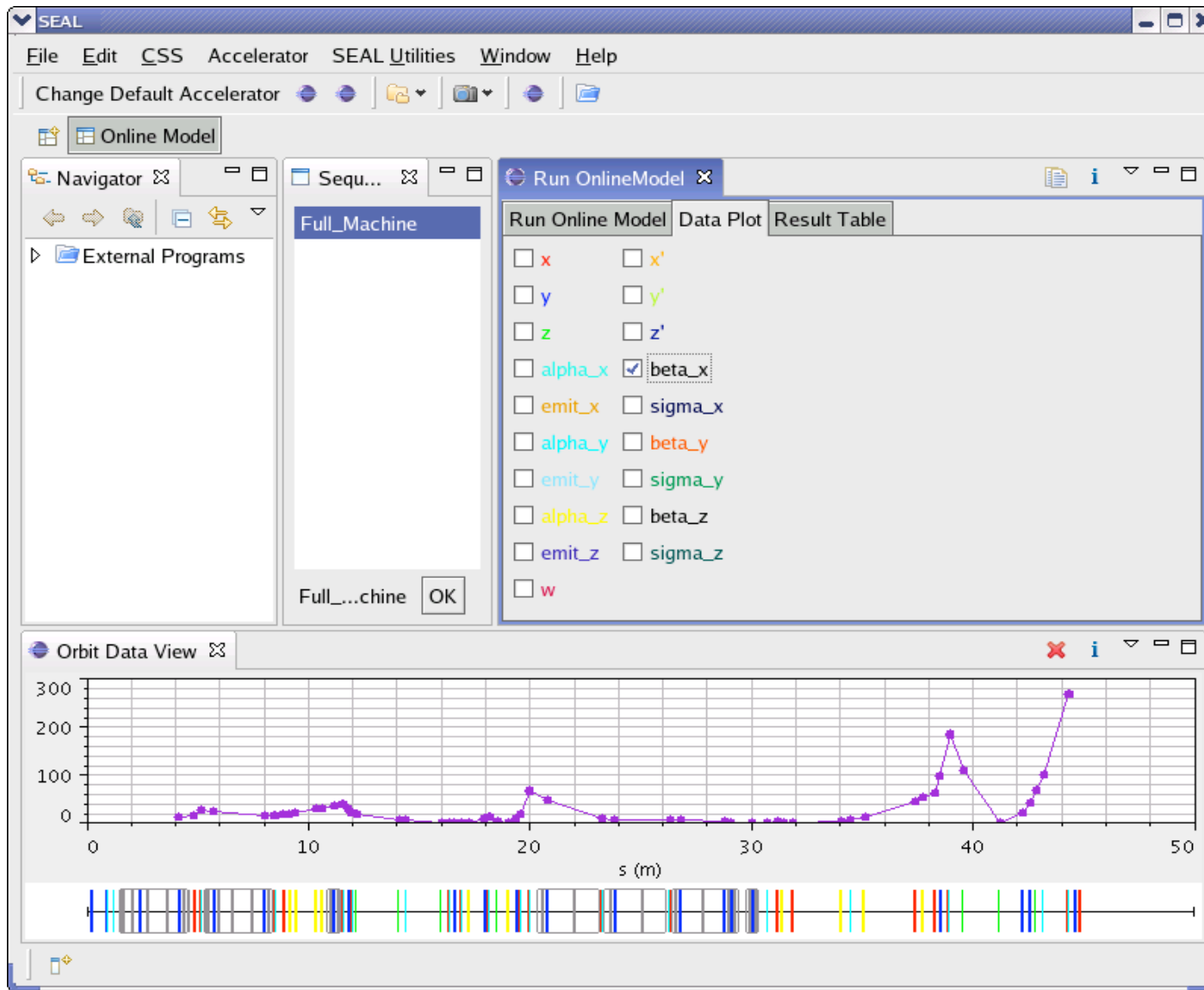


Hybrid environment for applications (now in dev.)

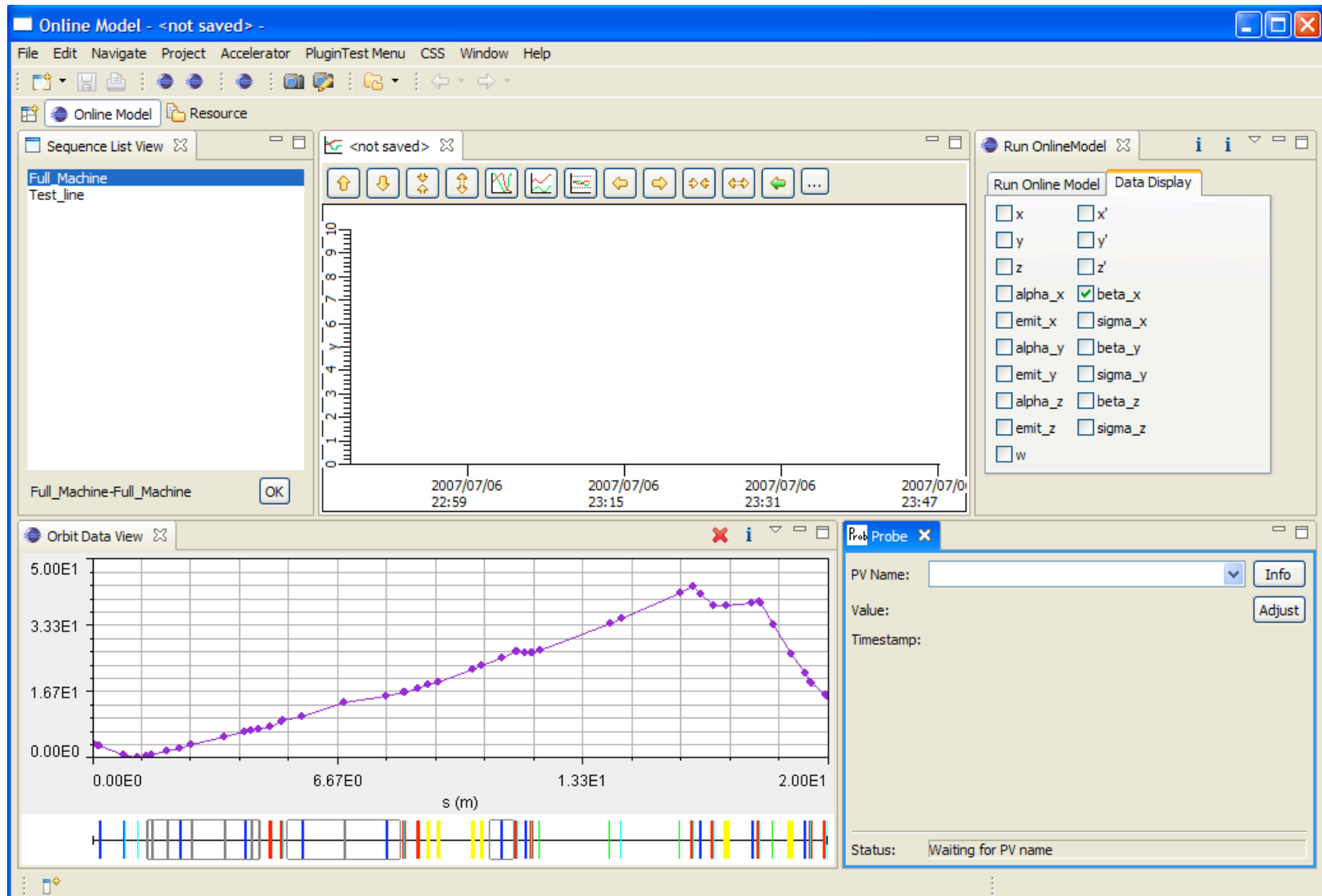


From "LCLS Apps from 20000ft" (G. White)
<http://confluence.slac.stanford.edu/x/IBk>

SLAC Eclipse Accelerator Lab (SEAL) Modelling



SEAL including Control System Studio (CSS)



Thanks P.Chu, K.Kasemir, S.Chevtsov

SEAL Formatted Displays (ready to print, logbook)

The screenshot shows the SEAL software interface. The main window has a menu bar (File, Edit, CSS, Accelerator, SEAL Utilities, Window, Help) and a toolbar. Below the toolbar is a tabbed interface with 'Data Browser', 'SNS Control System Studio', and 'Online Model'. The 'Data Browser' tab is active, showing a list of data sources: 'Films' (selected) and 'Fifa World Cup Rankings'. Below this is a table of film data:

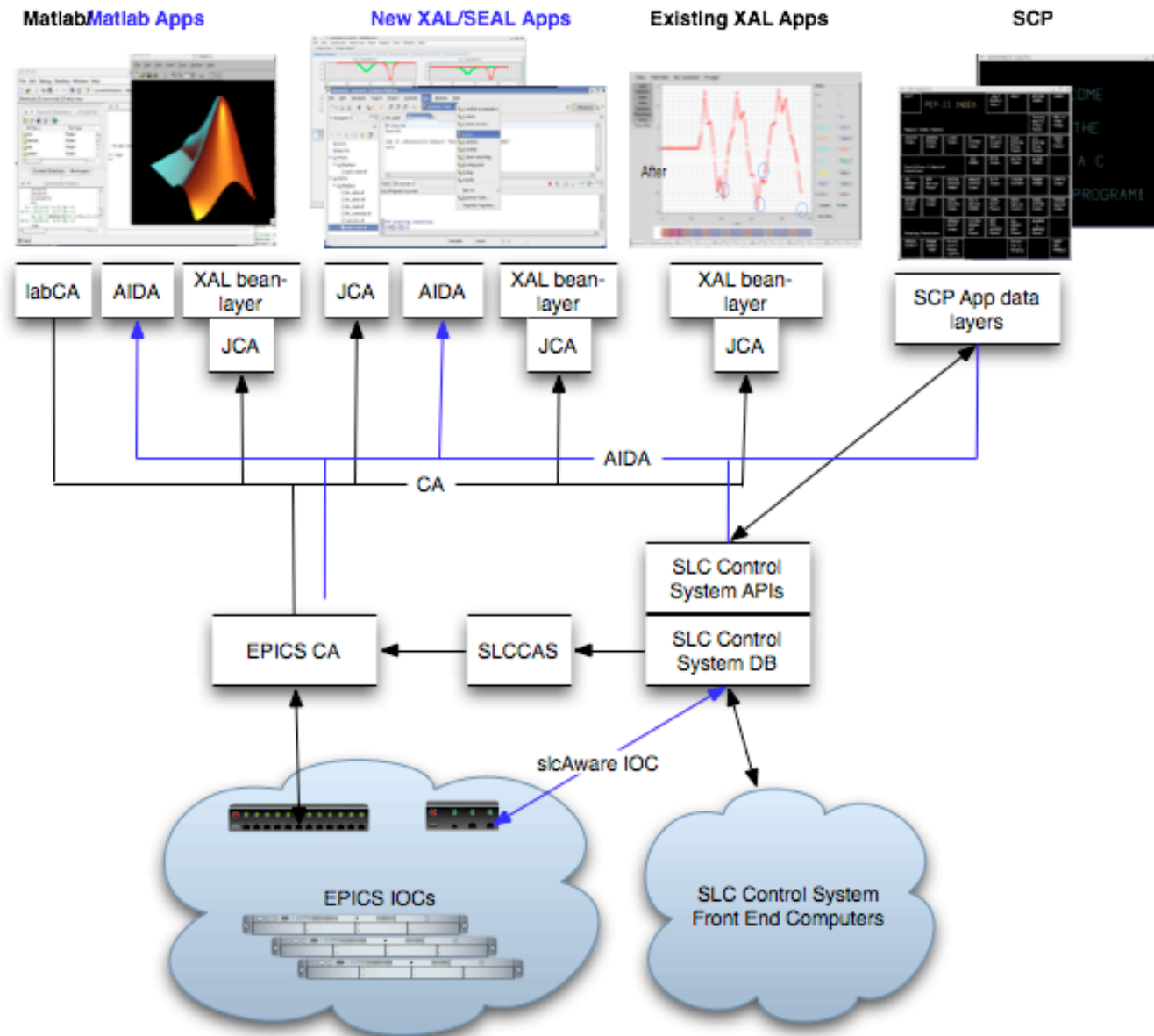
Name	Country	Year	Grade
The Godfather	USA	1972	A+
From Russia With Love	UK	1963	A
Diabolique	FRA	1955	A
Amores Perros	MEX	2000	A

At the bottom of the 'Data Browser' tab is an 'Export to Textual Display' button. The 'Textual Display' tab is also open, showing a formatted view of the same data. It has a title 'My favorite films' in red. Below the title is a table with the same data as the 'Data Browser' tab. Below this table is a title 'Some of the FIFA World Cup Finals' in blue. Below this title is a table with the following data:

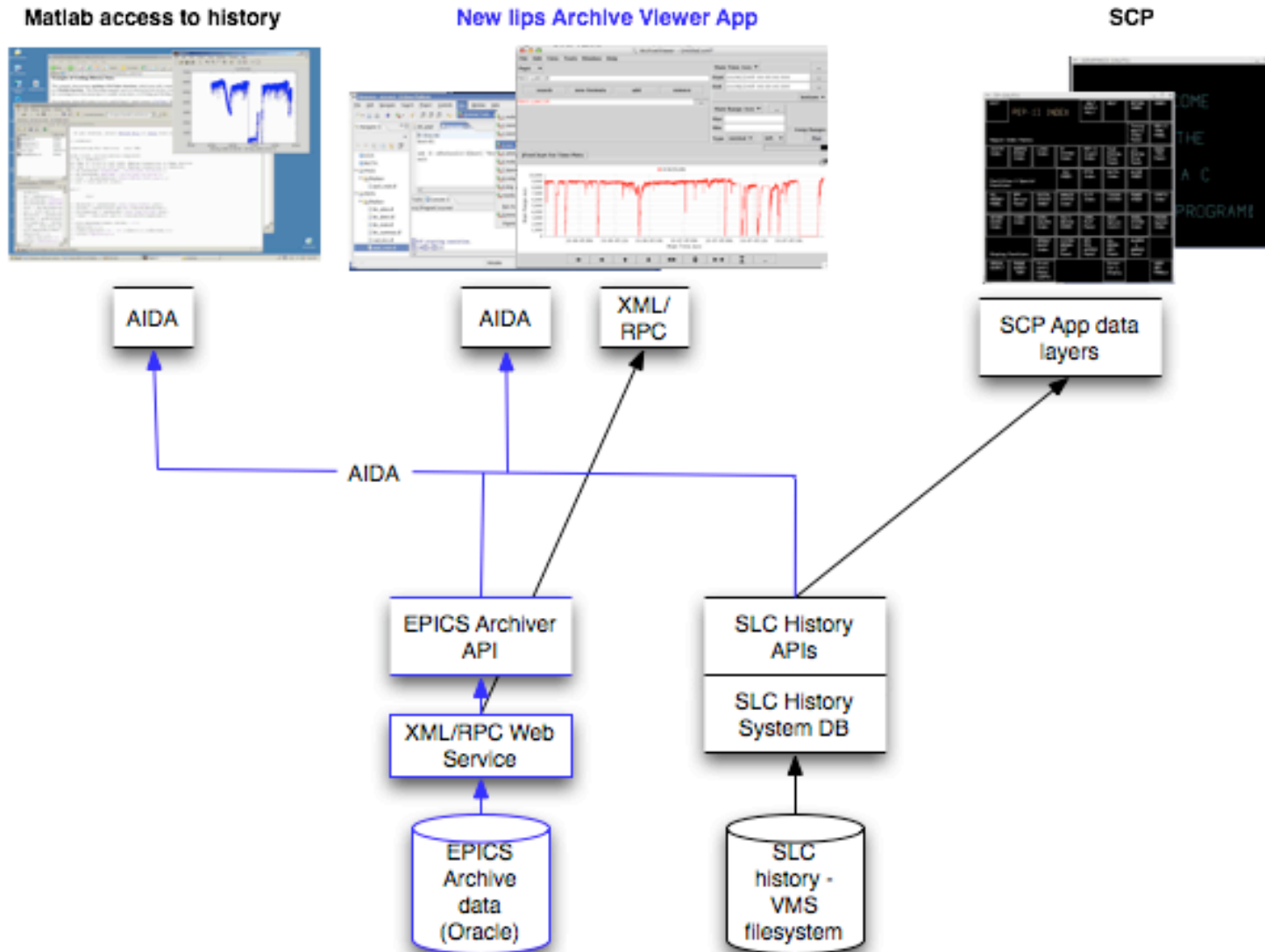
Year	Winner	Runner Up	Score	Host
2006	ITA	FRA	6-5	GER

At the bottom of the 'Textual Display' tab are 'Styled' and 'Raw' buttons.

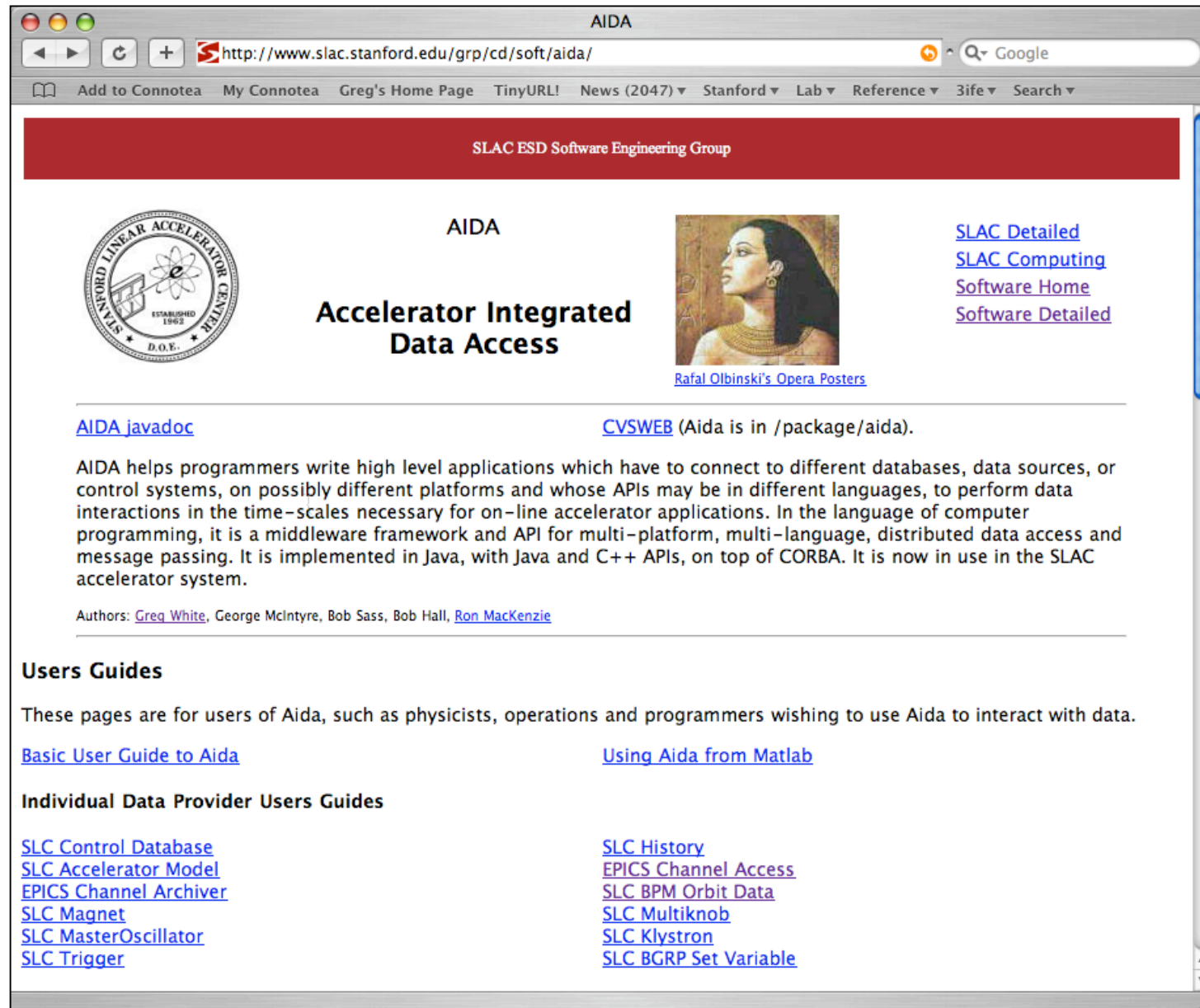
Control Data Flow for Scientific Applications



Access to Archive/History Data



Middleware, connecting legacy to modern software



Command Line Aida

CA

```
[tersk09]:u/cd/greg> aidaget XCOR:LM21:101//BDES  
-6.954E-4
```

Model

```
[tersk09]:u/cd/greg> aidaget XCOR:IM20:121//twiss -DMODE=5  
0.00575  
6.350345  
1.2448077  
6.693392  
0.0  
0.0  
6.350699  
1.2381707  
6.542251  
0.0  
0.0
```

BPM

```
[tersk09]:u/cd/greg> aidaget P2BPMHER//BPMS -DBPMD=38 -DN=1024 -DCNFNUM=712  
BPMS:PR10:8022    0.07417996    -0.07417996    3333.5989    0.0        17    0  
BPMS:PR10:8032    1.0195395     -1.0195395     3356.7275    0.0        17    0  
BPMS:PR10:8042    0.080591545   -0.080591545   3364.437     0.0        17    0  
BPMS:PR10:9012    -0.9720128     0.9720128     3373.0083    0.0        17    0  
BPMS:PR10:9022    0.09097895    -0.09097895    3380.6082    0.0        17    0  
BPMS:PR10:9032    1.099201      -1.099201      3388.2083    0.0        17    0  
. . .
```

AidaWeb: Web -> Excel, Scripts (by wget), Web Browser, Web Apps

ex.jsp?target=P2BPMHER%2F%2FBPMS+-DBPMD%3D38&aidaGet=Get+Data



P2BPMHER//BPMS BPMD=38

[Advanced Search](#)
[Preferences](#)

	Get Data		Name Search			
BPMS:PR10:8022	0.0	0.0	3333.5989	0.0	17	0
BPMS:PR10:8032	0.0	0.0	3356.7275	0.0	17	0
BPMS:PR10:8042	0.0	0.0	3364.437	0.0	17	0
BPMS:PR10:9012	0.0	0.0	3373.0083	0.0	17	0
BPMS:PR10:9022	0.0	0.0	3380.6082	0.0	17	0
BPMS:PR10:9032	0.0	0.0	3388.2083	0.0	17	0
BPMS:PR10:9042	0.0	0.0	3395.808	0.0	17	0
BPMS:PR10:9052	0.0	0.0	3403.4082	0.0	17	0
BPMS:PR10:9062	0.0	0.0	3411.0083	0.0	17	0
BPMS:PR10:9072	0.0	0.0	3418.6082	0.0	17	0
BPMS:PR10:9082	0.0	0.0	3426.2083	0.0	17	0

Aida (pure java API) in matlab History/Archiver

access and plot

```
function [values, times ] = histDemo(name, starttime, endtime)
```

```
% Example >> histDemo('PB60:LUMCOR//HIST.pepii','05/06/2005 00:00:00',...  
% '05/07/2005 00:00:00');
```

```
aidainit;
```

```
err=Err.getInstance();  
da = DaObject();
```

```
disp 'Acquiring Data'
```

```
da.setParam('STARTTIME',starttime);  
da.setParam('ENDTIME',endtime);  
hist = da.getDaValue(name);
```

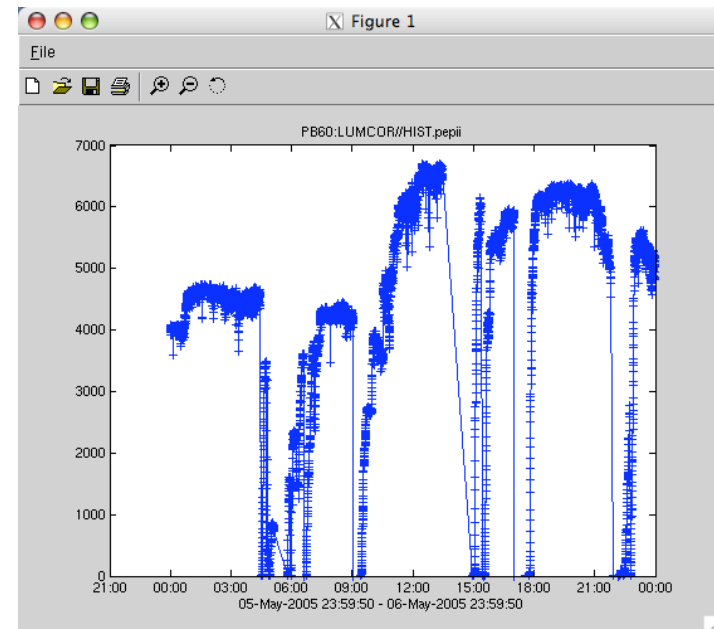
```
% Extract data from pure java to matlab
```

```
pts = hist.get(0).size();  
dblArray = javaArray('java.lang.Double',pts);  
values = double(hist.get(0).toArray(dblArray));  
StringArray = javaArray('java.lang.String',pts);  
times = char(hist.get(1).toArray(StringArray));
```

```
disp 'Plotting...'
```

```
plot(datenum(times),values,'-+');  
datetick('x');  
xlabel(sprintf('%s - %s',times(1,:),times(end,:)))  
title(name);
```

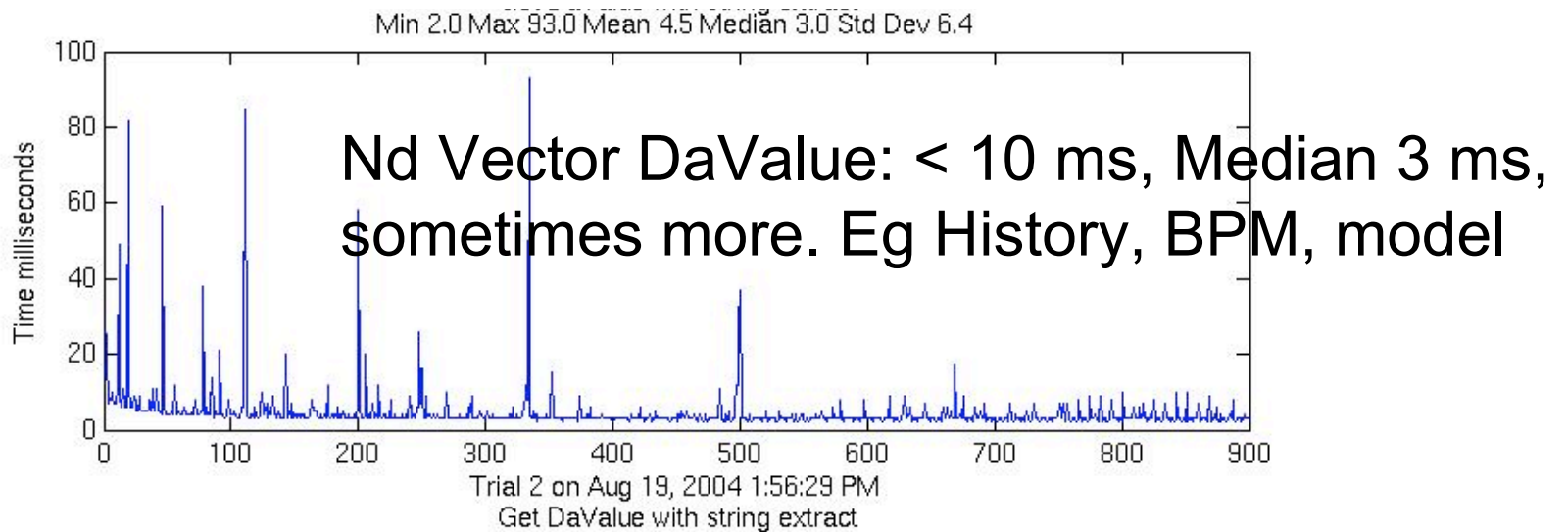
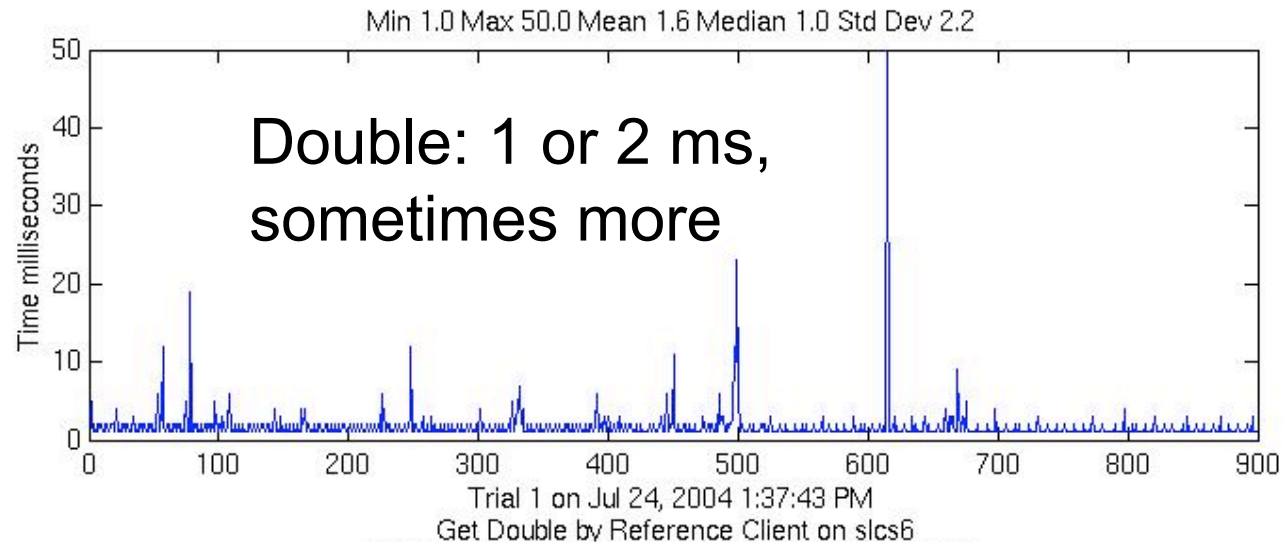
```
return;
```



Matlab java lessons

- `datenum()` converts time format data to plotable floats
- `datetick` tells current `plot()` to scribe axis with date/time
- textual date/time to float conversion is very costly
(soln. use say unix time rather than text)
- Put java VM options in Matlab secret file `java.opt.`

Aida CORBA Performance



Linear up to tested 4MBytes

Future XML Performance -> SOAP -> Web Services -> GRID Performance (Globus OGSA)



Efficient XML Interchange (EXI) Format 1.0

W3C Working Draft 16 July 2007

This version:

<http://www.w3.org/TR/2007/WD-exi-20070716/>

Latest version:

<http://www.w3.org/TR/exi/>

Previous version:

None (First Public Working Draft)

Editors:

John Schneider, AgileDelta, Inc.

Takuki Kamiya, Fujitsu Laboratories of America, Inc.

This document is also available in these non-normative formats: [XML](#).

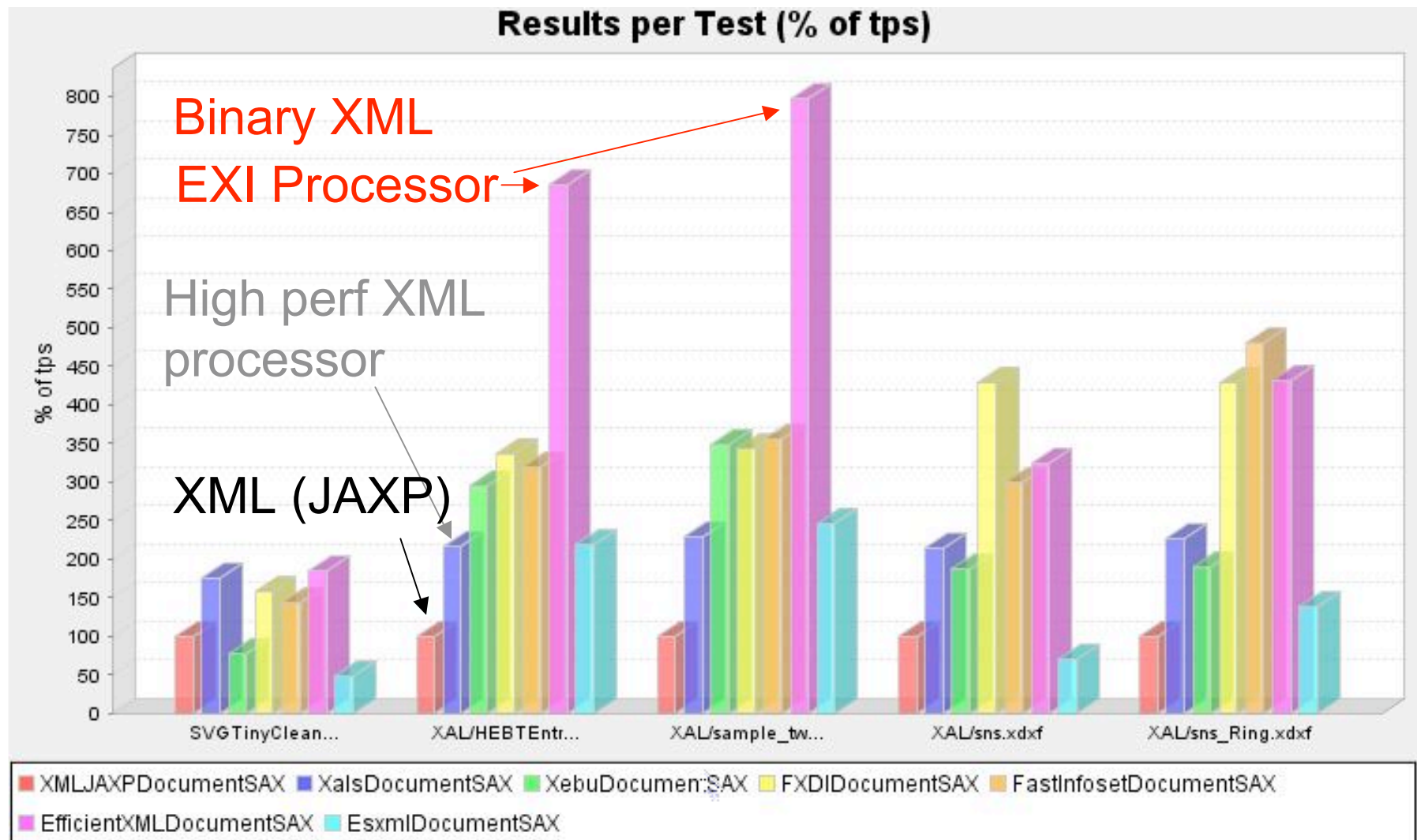
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Abstract

This document is the specification of the Efficient XML Interchange (EXI) format. EXI is a very compact representation for the eXtensible Markup Language (XML) Information Set that is intended to simultaneously optimize performance and the utilization of computational resources. The EXI format uses a hybrid approach drawn from the information and formal language theories, plus practical techniques verified by measurements, for entropy encoding XML information. Using a relatively simple algorithm, which is amenable to fast and compact implementation, and a small set of data types, it reliably produces efficient encodings of XML event streams. The event production system and format definition of EXI are presented.

Efficient XML Interchange Working Group of W3C

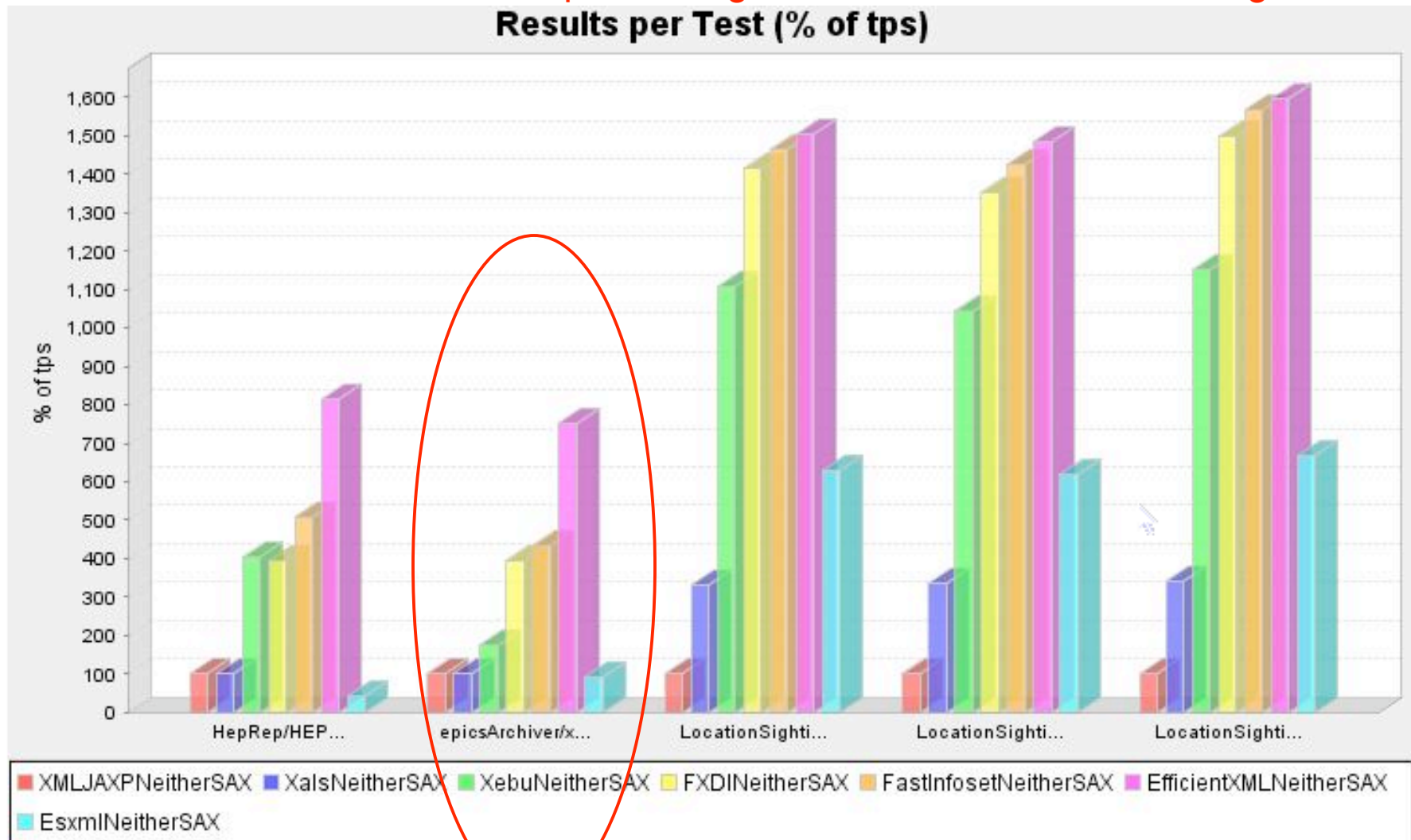
Performance of EXI candidates on XAL with lossless compression (no XML Schema)



EXI (Binary XML) on EPICS Archiver XML-RPC data

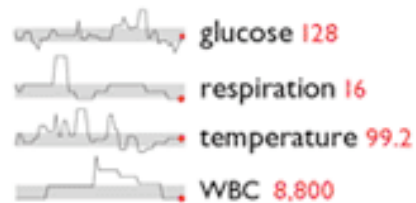
EXI candidates on EPICS Archiver without compression (no XML Schema)

Now > 7 X faster in network and processing time. More efficient float being added.



Sparklines

Edward Tufte



These little data lines, because of their active quality over time, are called *sparklines*: small, high-resolution graphics embedded in a context of words, numbers, images. Sparklines are data-intense, design-simple, word-sized graphics.



<http://www.edwardtufte.com>

<http://sparkline.org/>

What Did we Do Wrong - Bob Dalesio's Slide

- Underestimated XAL integration (modelled elements, SMF layer, database integration)
- Underestimated db persistence
- Underestimated Eclipse questions
 - IDE RCP or our own Product
 - Building in a production environment
 - Distribution
- SWT <> Swing : Eclipse <> XAL
- Matlab pragmatism not accepted by everyone.

Questions - please talk to us!

- **Macros** (automatic script recording) over different hosts, OS? X11 only common factor!
- **Headless**, production, build of Eclipse?
- **3D visualization** for accelerator physics?
- Impact/Parmela -> Elegant -> Genesis/Ginger

Selected References

- These Proceedings
 - High-level Application Framework for LCLS, Paul Chu
 - Electron Bunch Length Measurement for LCLS at SLAC, Mike Zelazny
 - Scripting vs Programming: An Application Developer's Perspective, Sergei Chevtsov
- Aida CORBA Performance Report <http://www.slac.stanford.edu/grp/cd/soft/aida/perf/Report.html>
- A Hybrid Numerical Method for Orbit Correction
<http://www.slac.stanford.edu/pubs/slacpubs/7000/slac-pub-7653.html>
- W3C Efficient XML Interchange Working Group <http://www.w3.org/XML/EXI/>
- Globus Open Services Grid Architecture (OGSA), <http://www.globus.org/ogsa/>
- Visual Display of Quantitative Information. E. tufte.
 - cf. Sparklines. http://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0001OR&topic_id=1&topic=Ask+E.T.
 - <http://sparklines.org>

to add

cmlog
crr plots