EBPMs and Orbit Feedback Electronics for Diamond

IWBS 2004

Guenther Rehm

Outline

- BPM locations and cross sections
- BPM response calculations
- EBPM performance examples
- SOFB plans
- FOFB plans

Number of BPMs

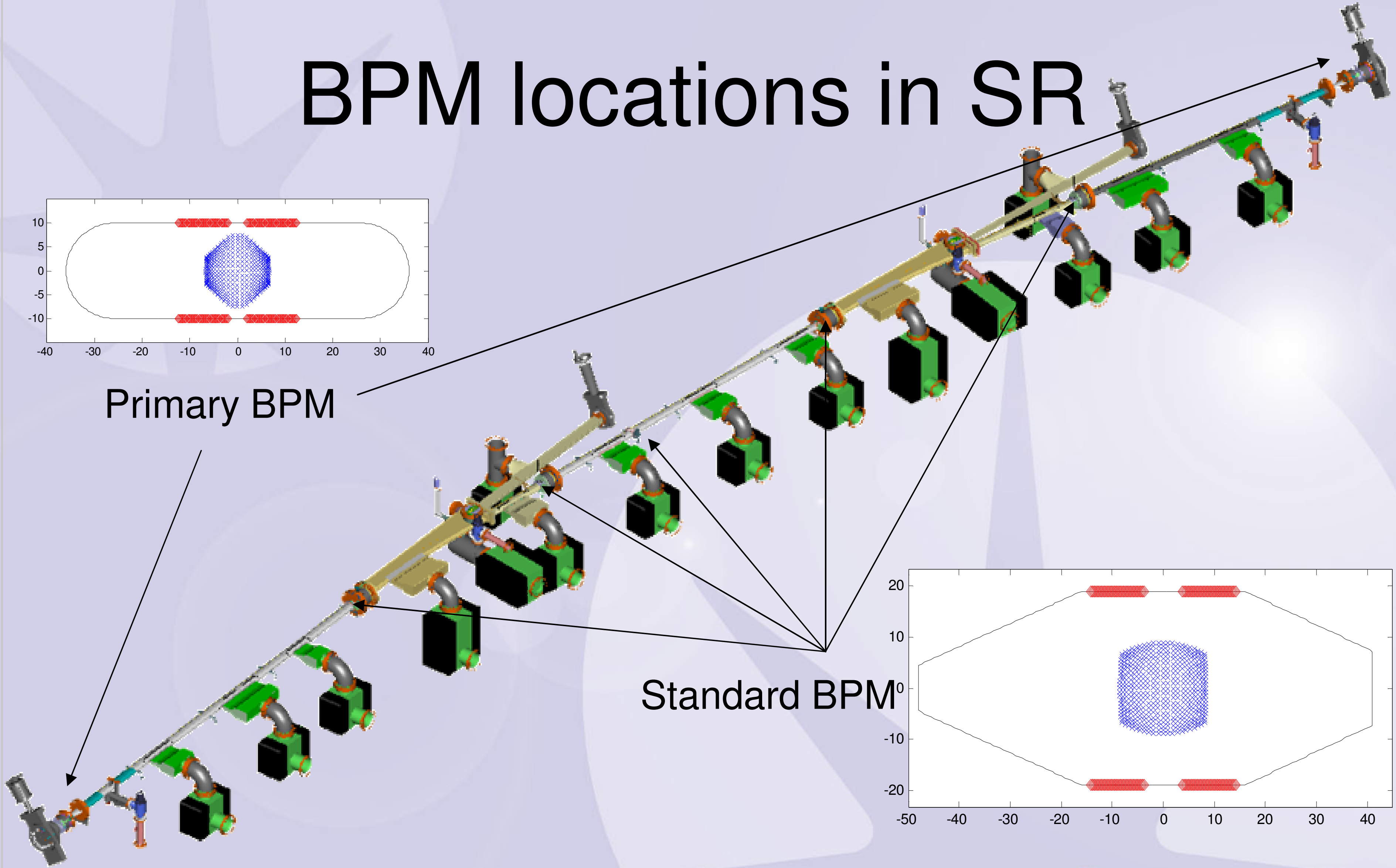
Location	Count	Type / cross section
LINAC	0	-
LTB	7	Stripline / circular
Booster	22	Button / elliptical
BTS	7	Stripline / circular
SR	120+48	Button / octagonal+oval
Sum	204	

All with Libera EBPM electronics

Storage ring BPMs

- Primary BPMs:
  - Increased sensitivity through smaller aperture
  - Mechanically decoupled through bellows
  - Position monitored relative to reference pillar
- Standard BPMs:
  - BPM blocks welded into vacuum vessel
  - Mounted on “anchor” stands
  - Position monitored relative to quad centre

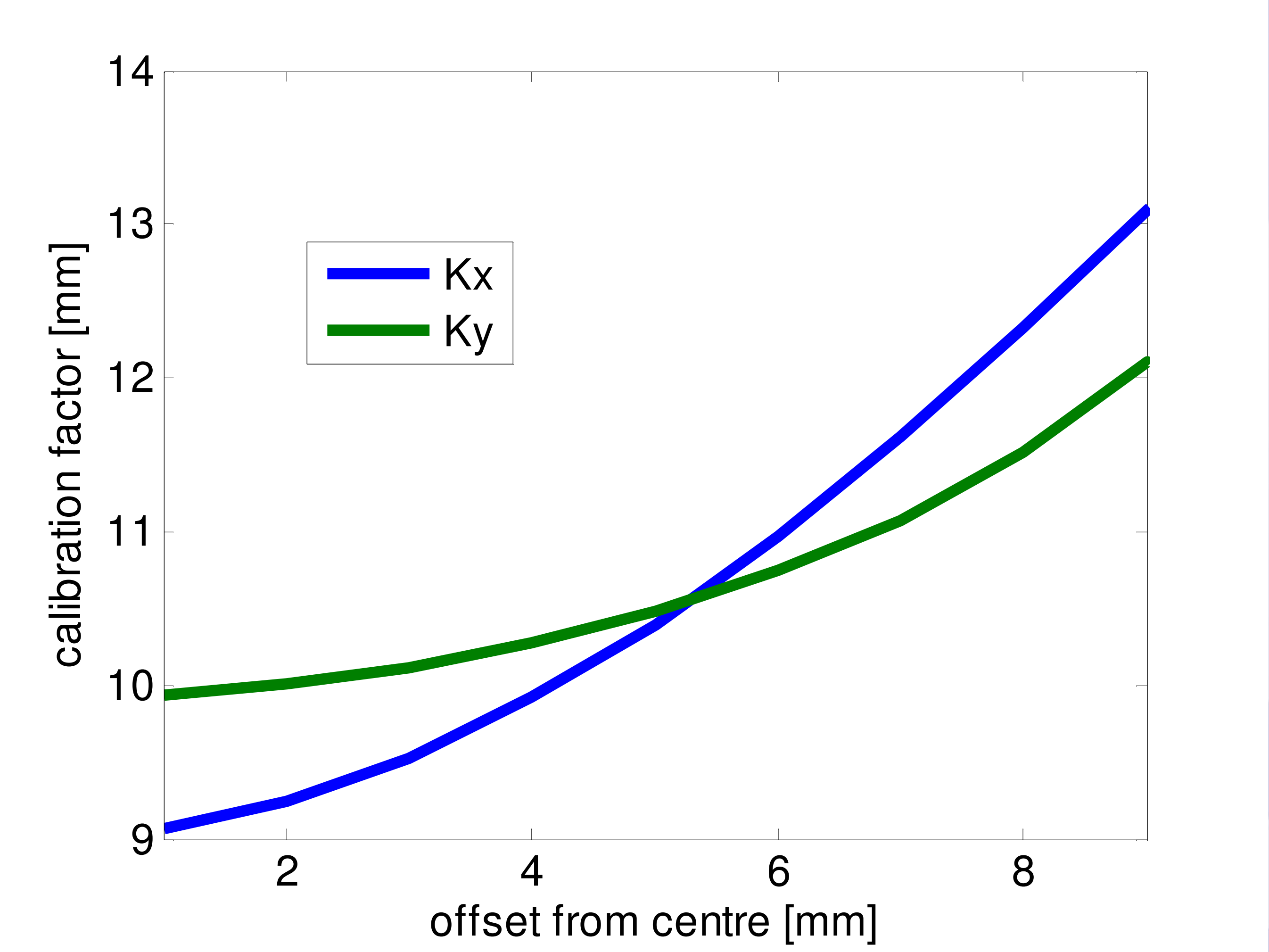
BPM locations in SR



BPM response calculation

- MATLAB based boundary element solver
  - Fast: 5.5 sec on P4/1700 for 722 boundary elements and 441 beam positions
  - Precise: results checked with finite element solver (Vector Fields OPERA)
- Geometrical manufacturing uncertainties have been modelled using Monte Carlo simulation

Calibration Factor for Primary BPM



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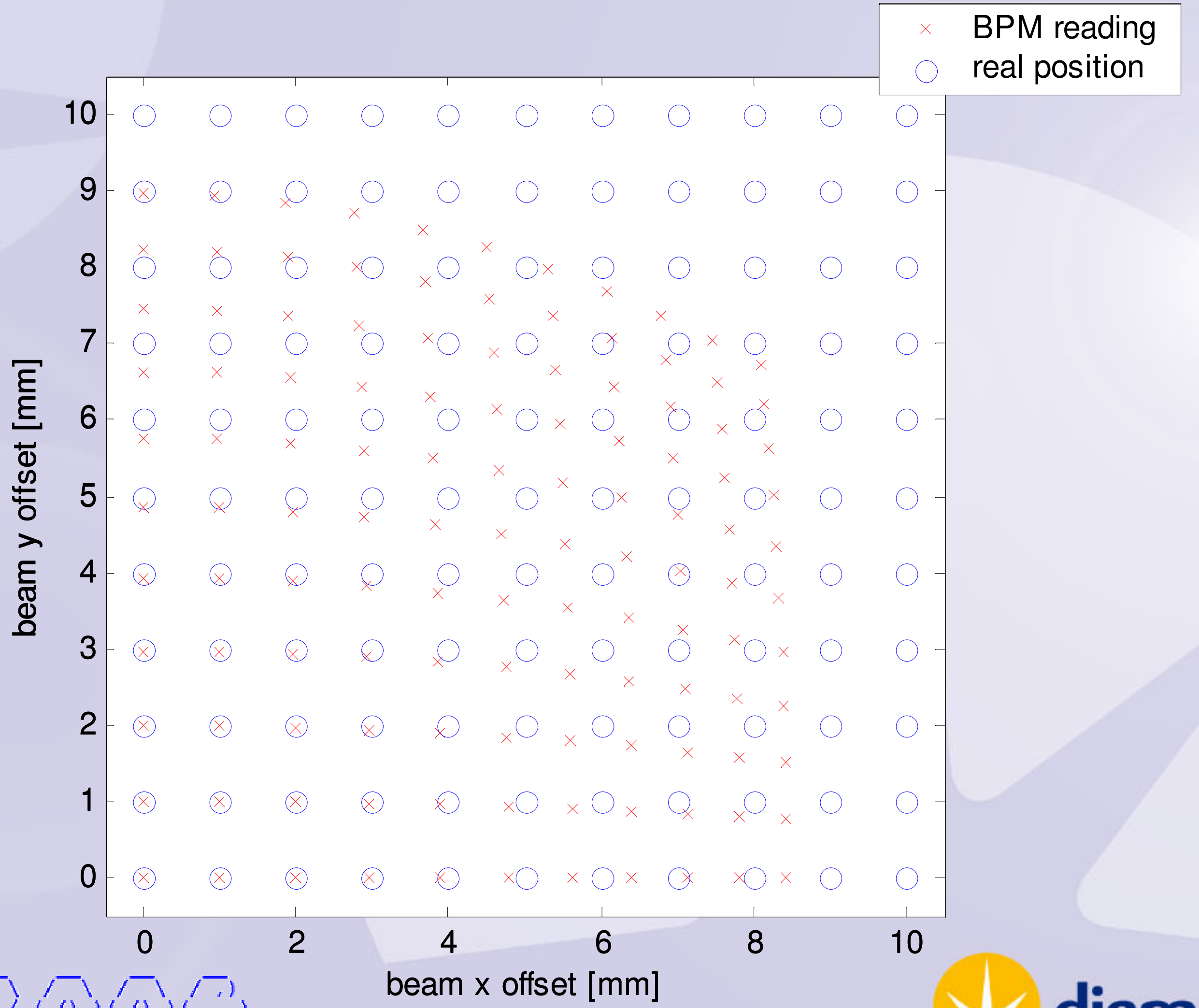
Nonlinear 2D BPM response



Needs to be corrected before nonlinear beam dynamics studies!

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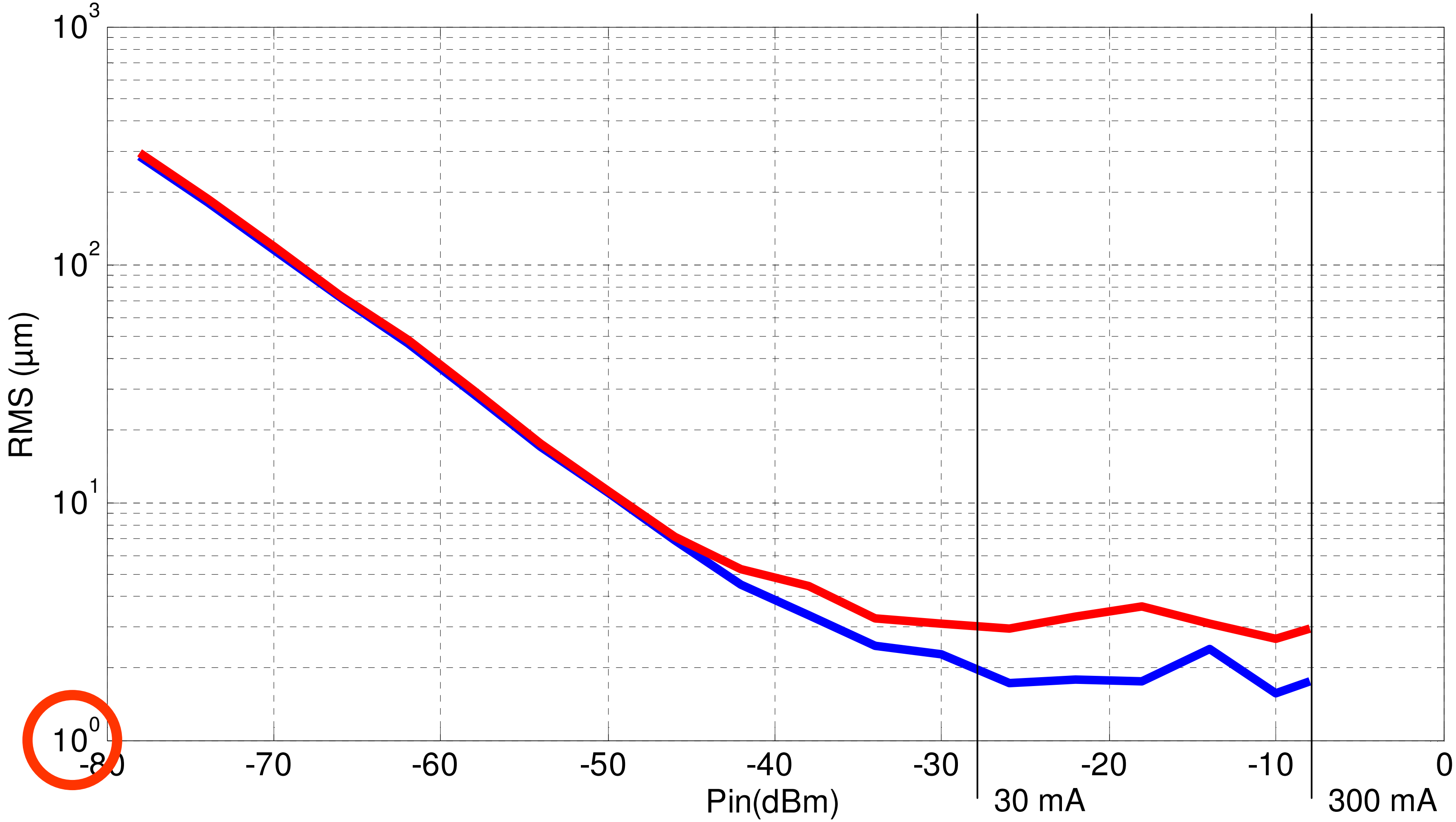
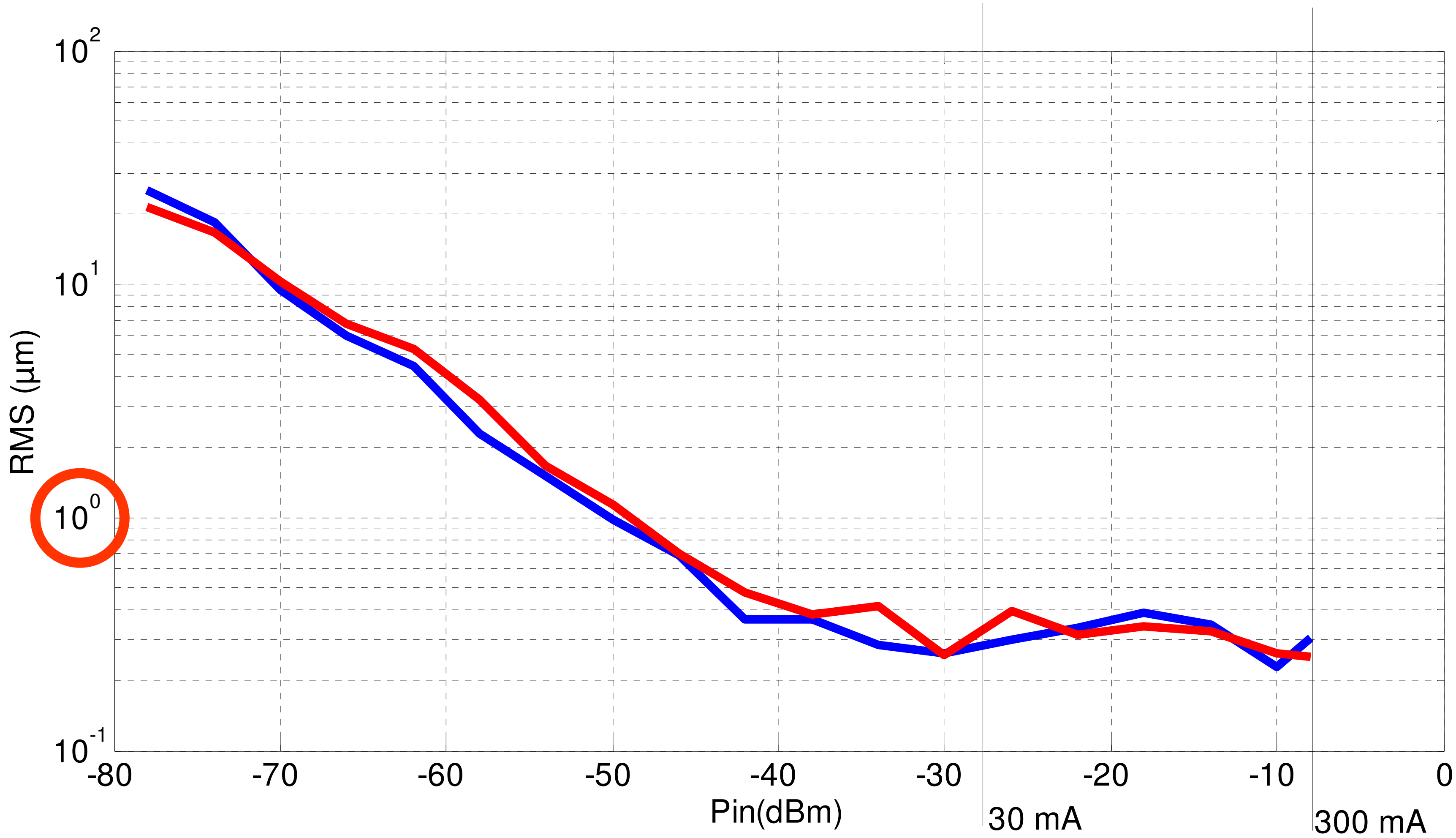
RMS noise @ TBT



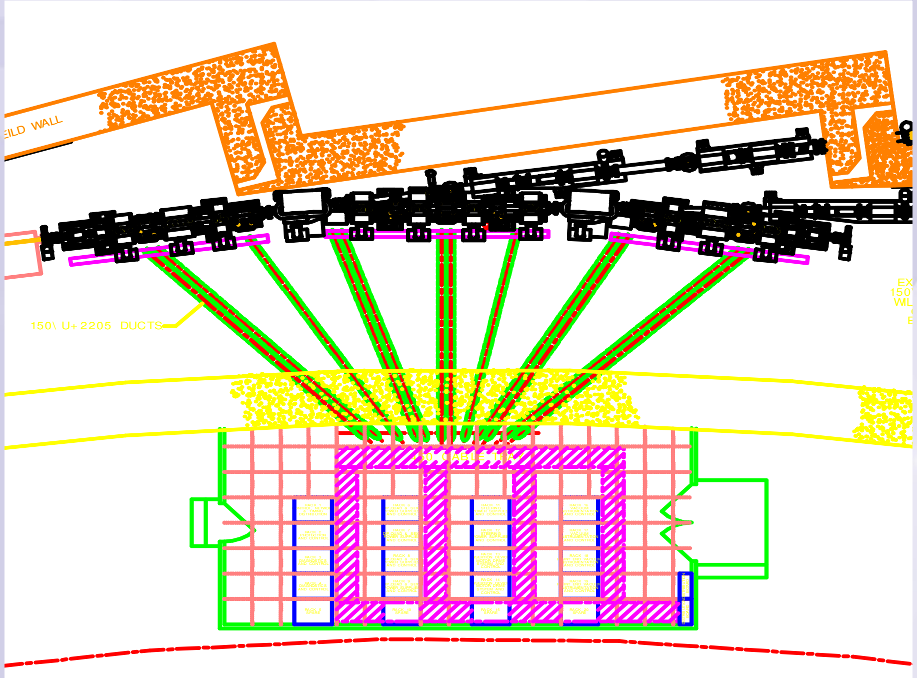
Resolution with 1 kHz BW



RMS noise with 1 kHz Bandwidth

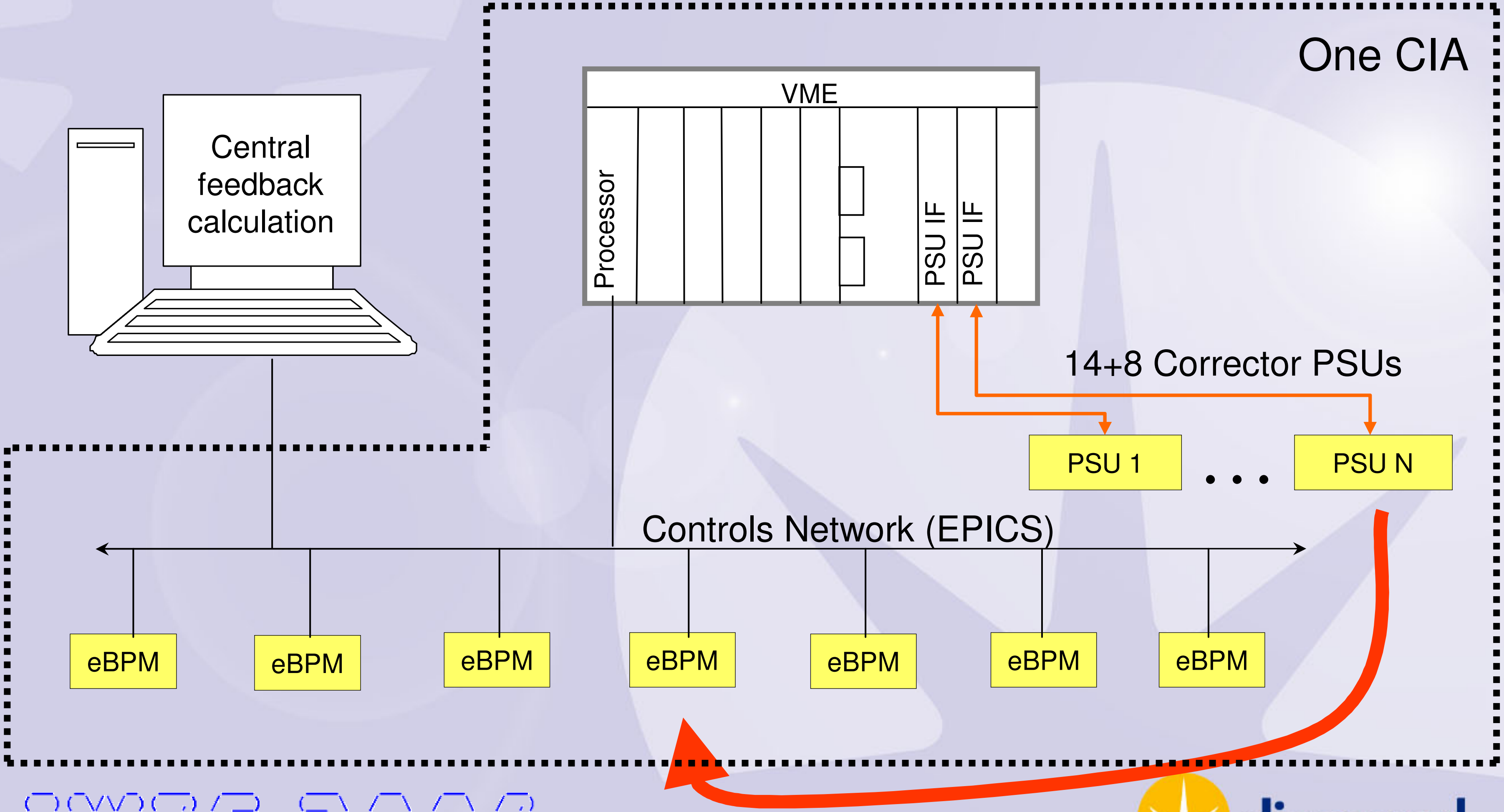
Beam current	Primary x/y in µm	Standard x/y in µm
60-300 mA	0.27/**0.3**	0.65/0.45
10-60 mA	0.54/**0.6**	1.3/0.9
1-10 mA	1.35/**1.5**	3.3/2.2

Control and Instrumentation Areas (CIAs)



24 temperature stabilized CIAs for 19” racks

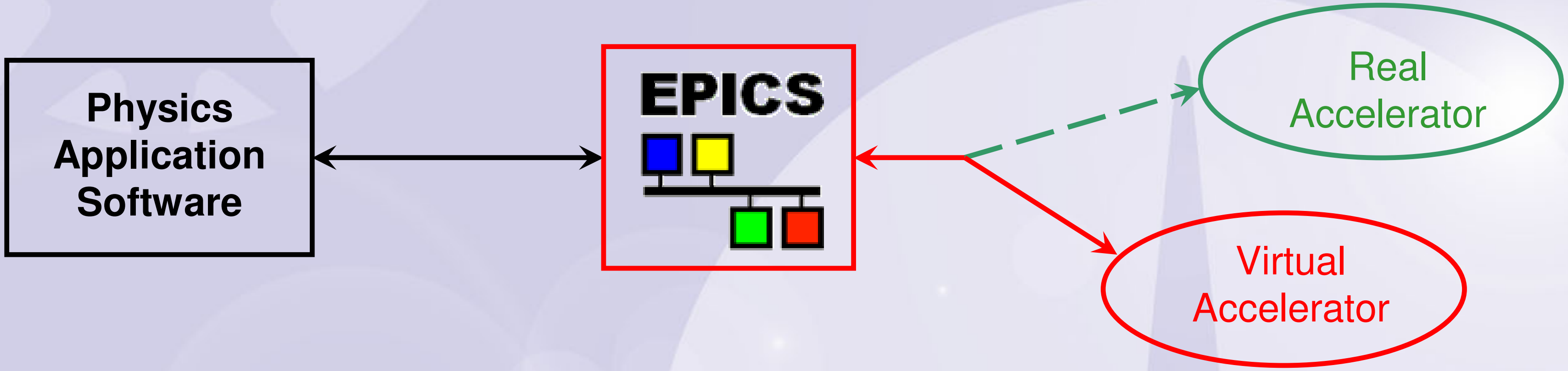
SOFB Setup


One CIA
Central feedback calculation
VME
Processor
PSU IF
PSU IF
14+8 Corrector PSUs
PSU 1
. . .
PSU N
Controls Network (EPICS)
eBPM
eBPM
eBPM
eBPM
eBPM
eBPM
eBPM

SOFB Details

- EPICS IOCs run inside LIBERA
- EPICS interface to PSU already available
- MatLab channel access makes application development easy
- Can be tested with “virtual accelerator”
- Expected to run at 10 Hz sampling, 0.5 Hz closed loop BW
- Will be available on day 1

Virtual Accelerator and Software Commissioning



The **Virtual Accelerator** is used

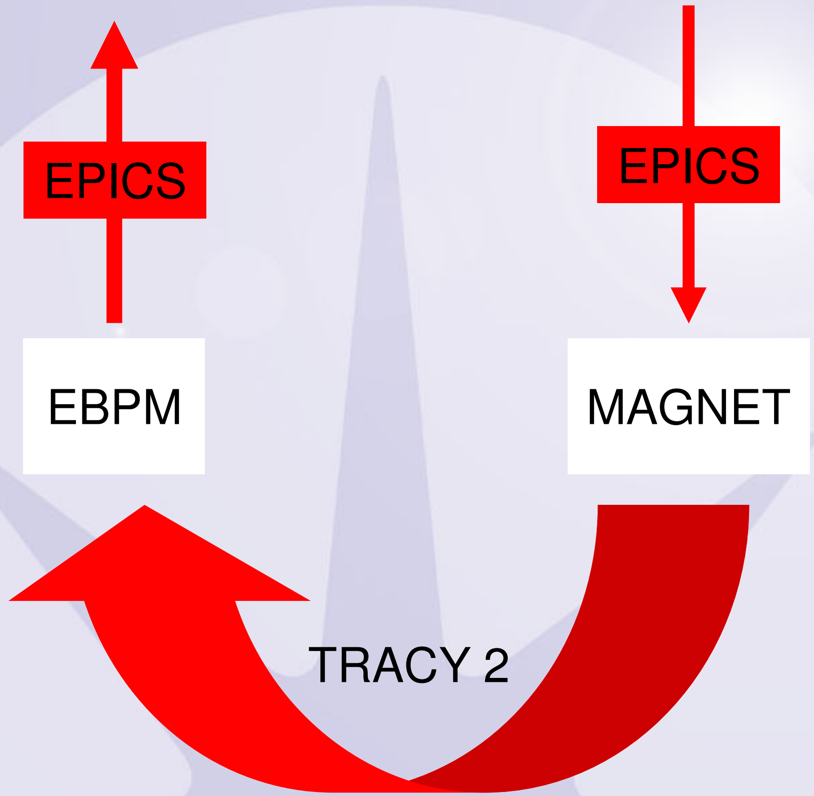
1) to simulate the control system environment as seen by the users

2) to provide a realistic test for AP applications

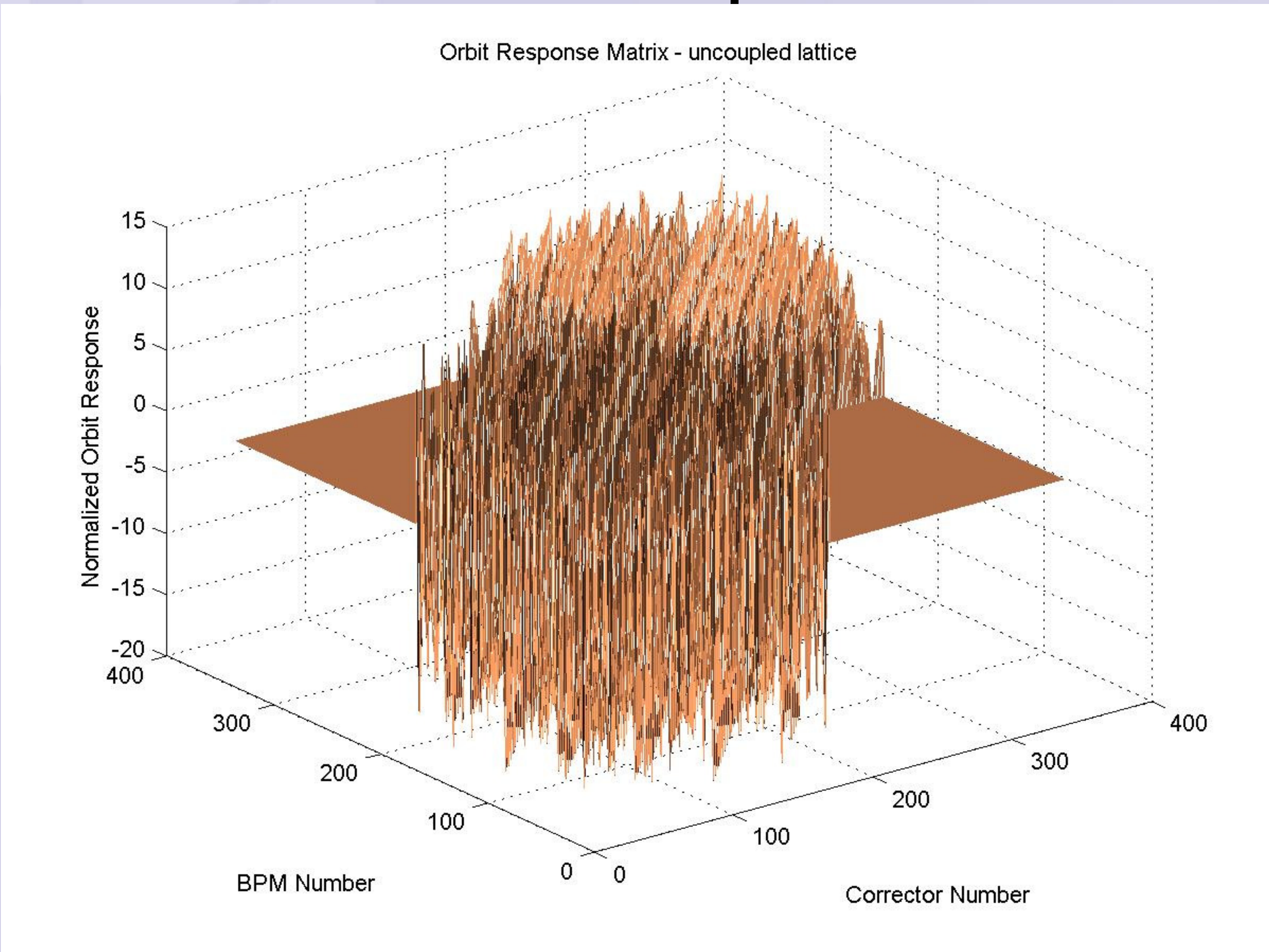
The Virtual Accelerator uses the **Tracy–II** code to simulate the physical behaviour of the ring

Basic Virtual Accelerator Functionality

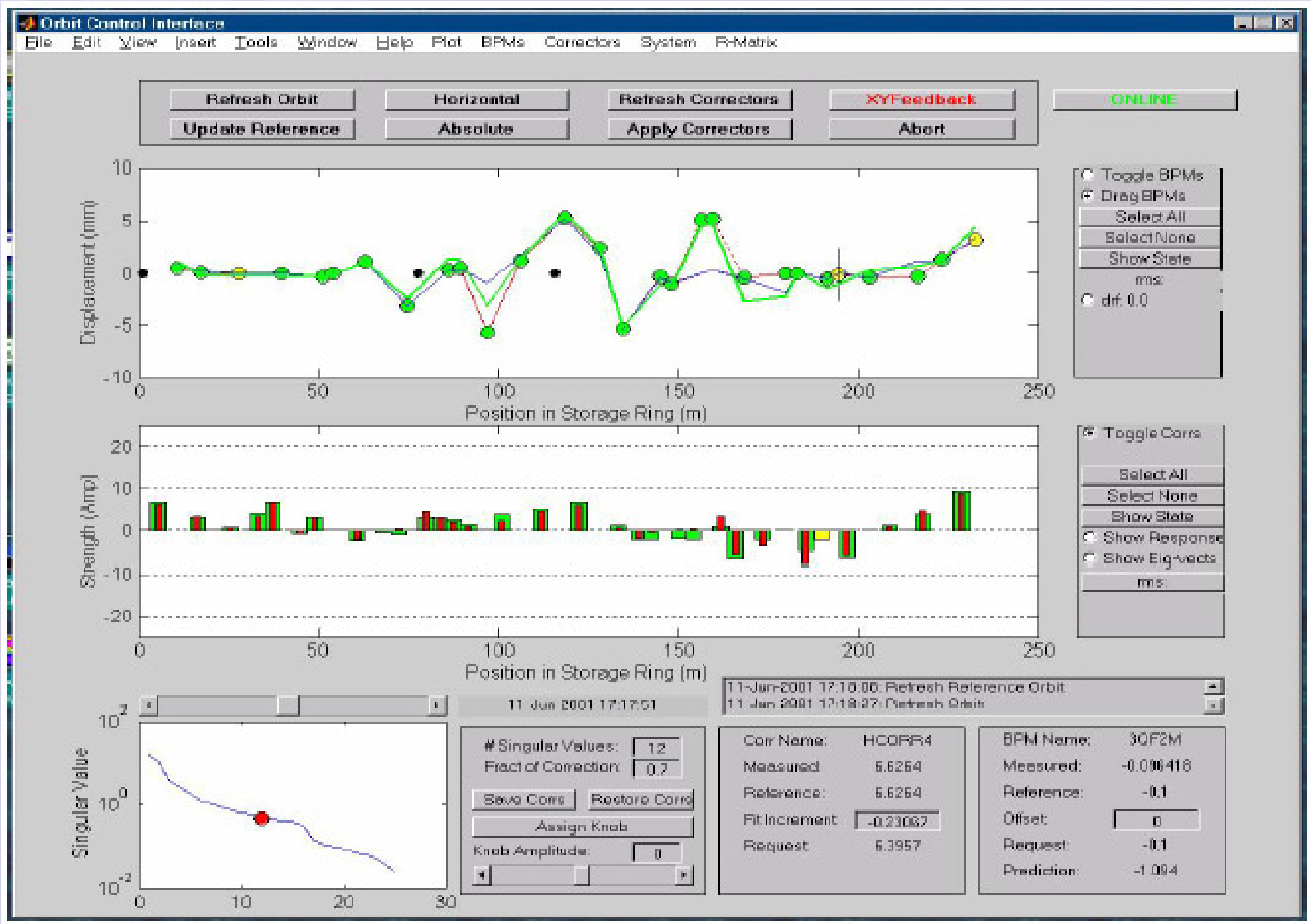
- Set magnet currents
- Read EBPM x/y average calculated using Tracy2 closed orbit
- Read EBPM x/y turn-by-turn buffer using Tracy2 particle tracking



“measured” Response Matrix



MatLab AT Based Feedback

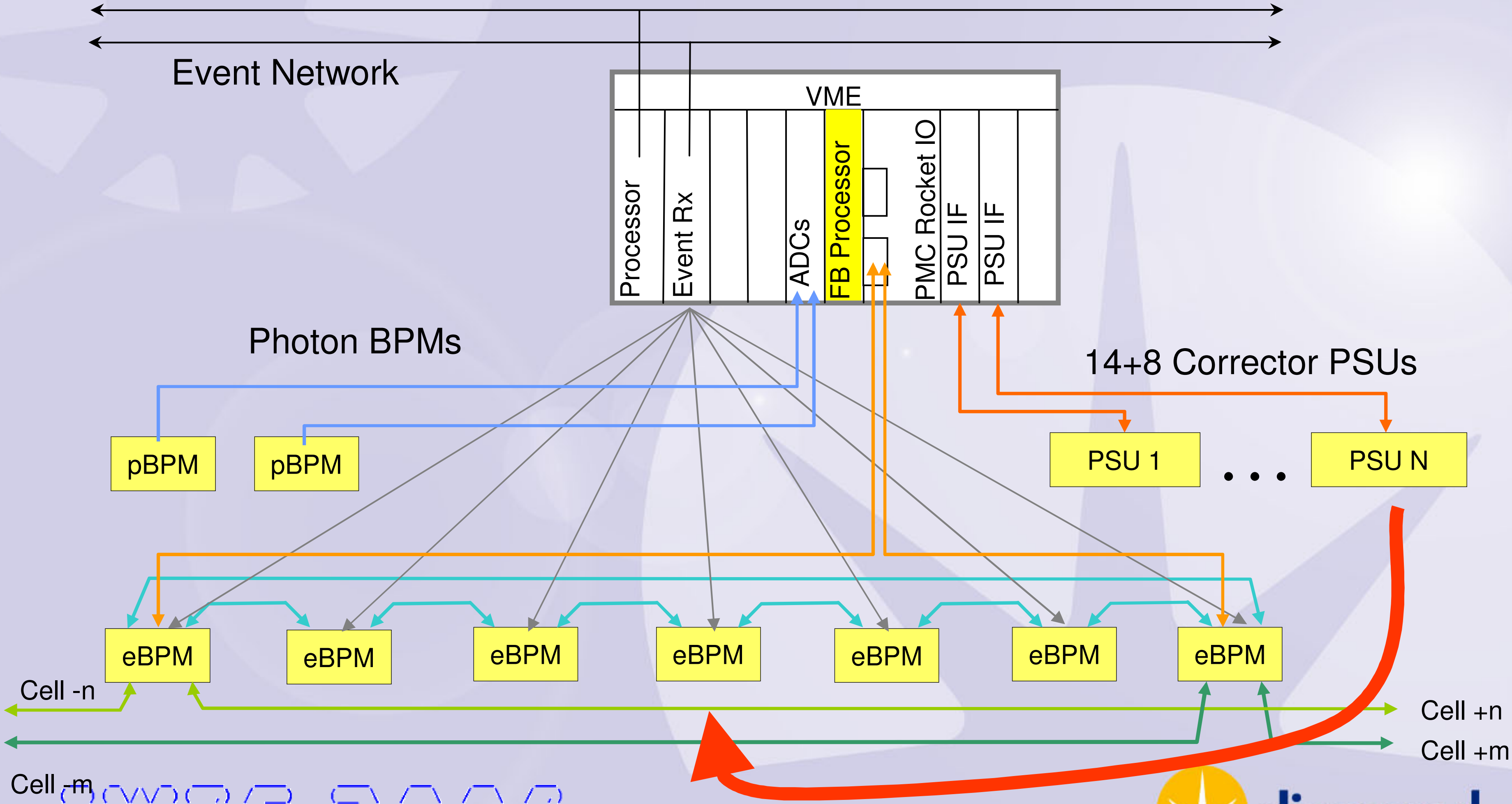


Orbit Correct implemented using AT for Spear 3

Design constraints for FOFB

- Global system, all data should be available everywhere
- Low latency from hardware, main delay should result from LP filter
- FB algorithm should be easily serviceable
- Corrector PSU interface is VME
- Robust system which continues to perform with partial faults

FOFB Setup (one CIA)



FOFB Details

- FB data produced at 4-20 kSamples/s
- Dedicated FB CPU board MVME5500 running vxWorks, but no EPICS IOC, no network.
- RocketIO in Virtex2Pro to run at 2.5 Gbit/s
- PMC card with RocketIO will be board developed for timing system
- Connections inside rack can be galvanic, longer distance will be single mode fibre
- All connections between CIAs will be patched centrally
- Communication is broadcast, no routing or location information is required for any node.

FOFB Delays (simulated/estimated)

- Distribution of 168 sets of data to 168+24 locations: 30 µs
- Transfer to CPU: 10 µs
- Matrix multiplication: 30 µs (worst case)
- Write into PSU: 50 µs
- 200-400 µs delay for LP filter
  - > feedback BW >>100 Hz should be feasible
- **Detailed simulation is required!**

Acknowledgements

- DLS: Mark Heron, Ian Martin, Riccardo Bartolini, Tony Dobbing
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