



Initial Optics Checks

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LHC Optics Measurement and Correction Review, 2013-06-18

Many Thanks to:

T. Baer, C. Bracco, M. Lamont, R. Tomas, J. Wenninger

Sector Test

Circulating Beam

Tools & More

Sector Test

Circulating Beam

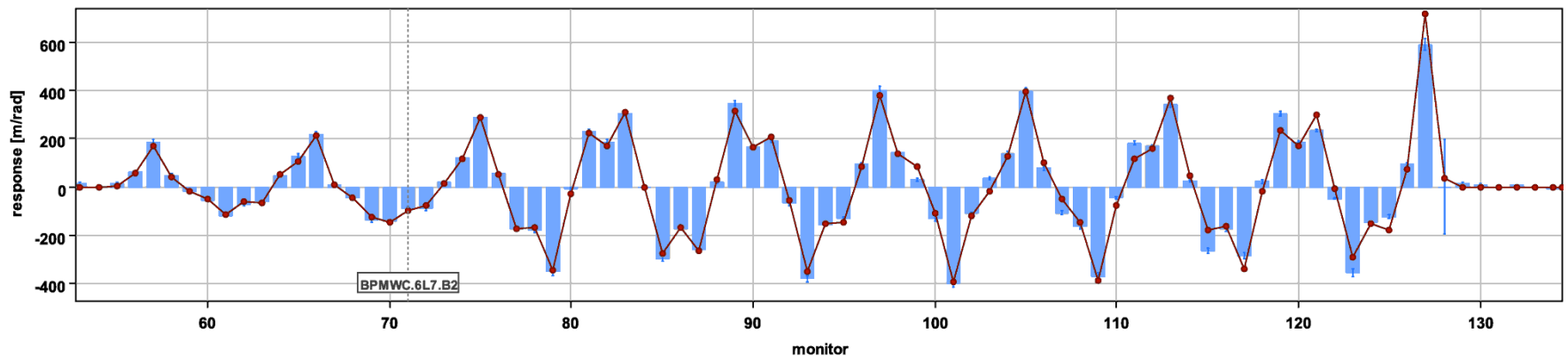
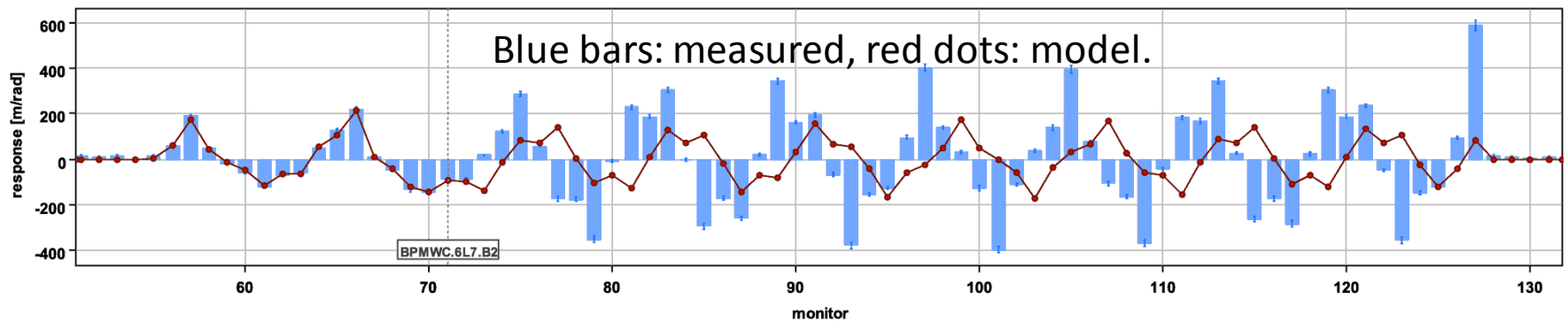
Tools & More

Sector Tests

- Proved to be essential for the LHC startup in 2008/2009.
- Planned again for November 2014:
 - Beam 2: Point 8 to Point 6
 - See Verenas Presentation
- Main tools without circulating beam:
 - Kick Response
 - Dispersion
 - → Following slides: Some examples from 2008/09. Similar measurements will have to be done this time to ensure proper configuration.

Sep 2008, first injection B2 to Point 7

Example: Kick Response of MCBH.14R7.B2

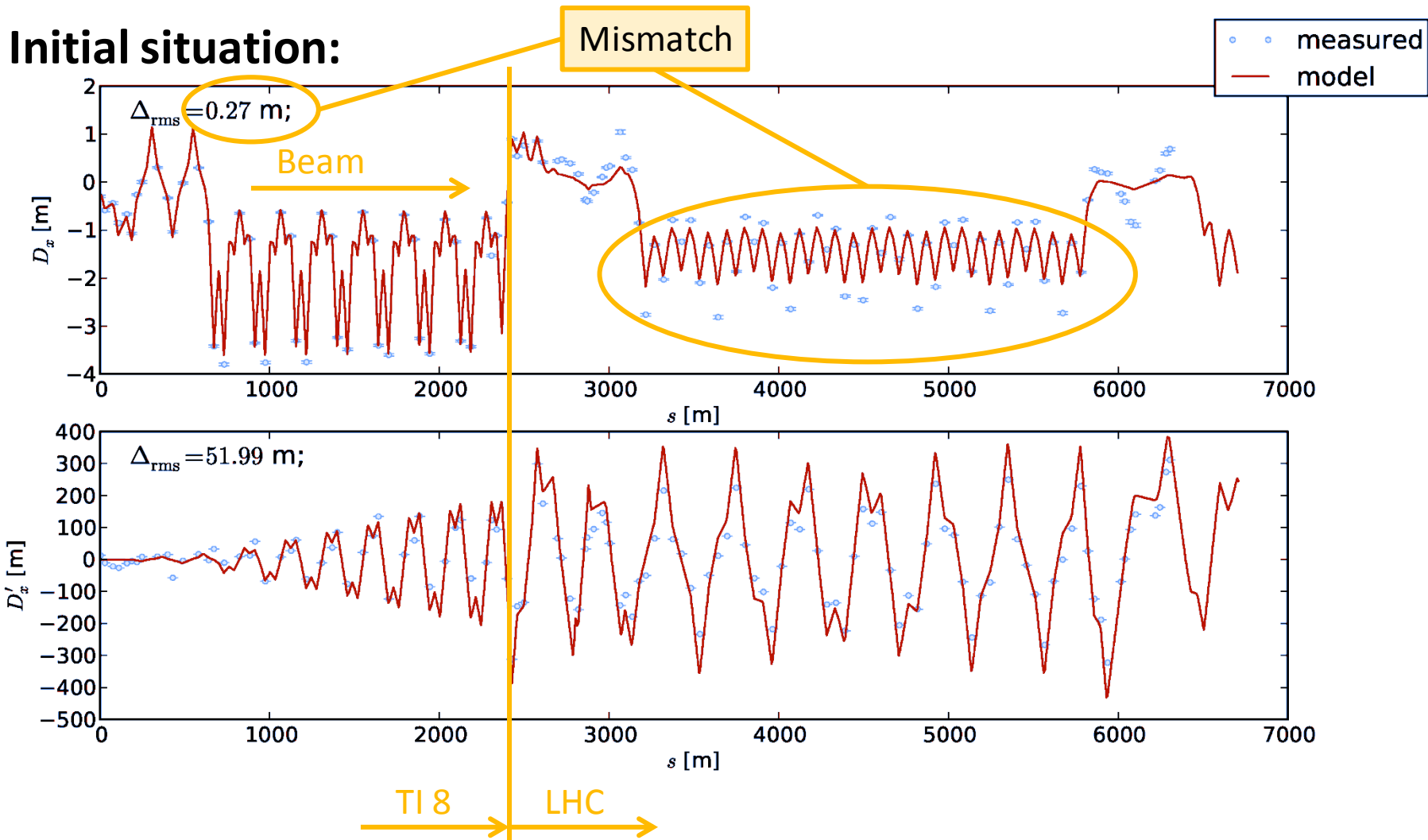


→ Clear result: Inversion of Q6.L7B2

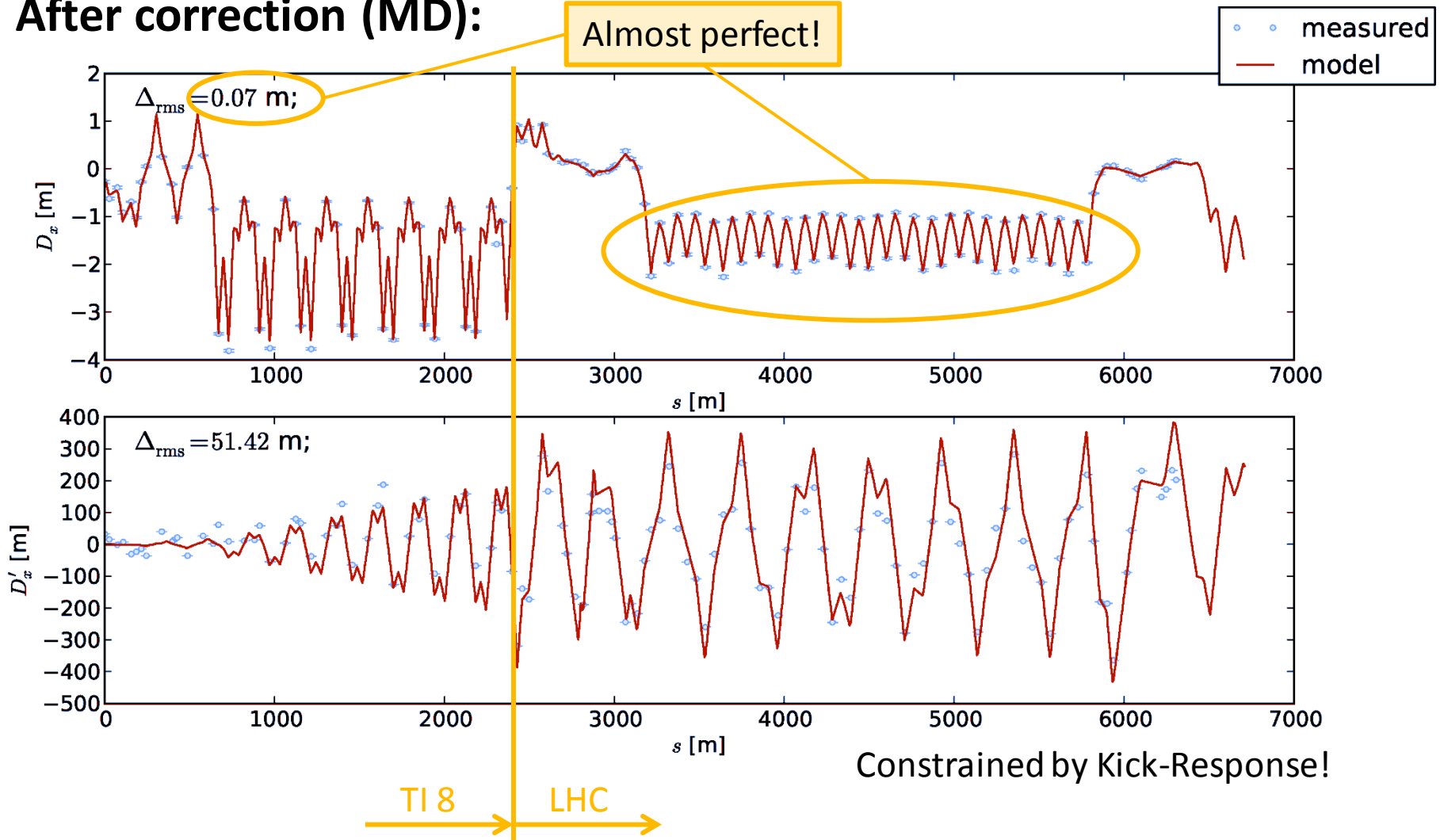
TI8-LHC dispersion matching

Initial situation:

Mismatch



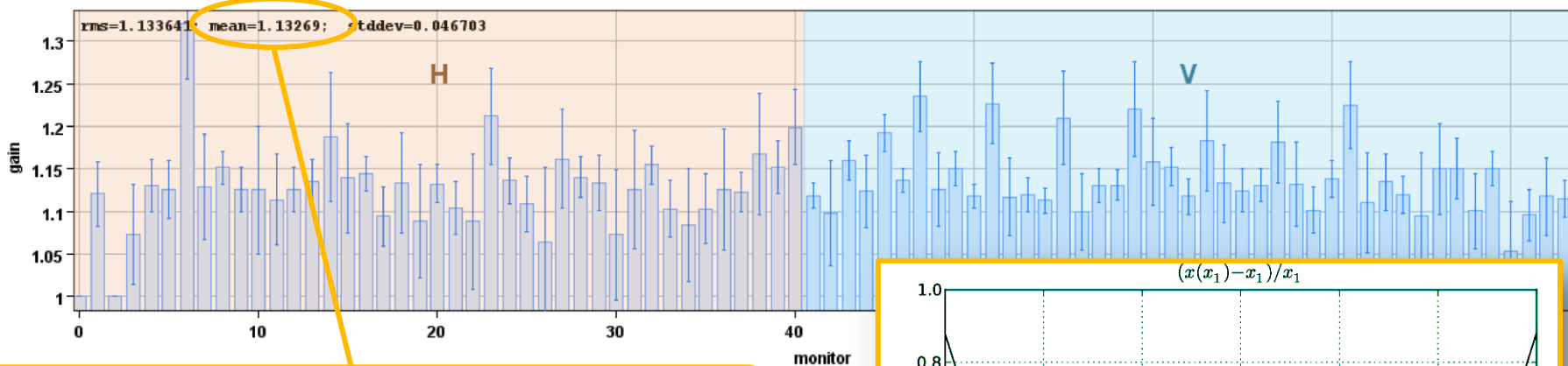
After correction (MD):



→ Correction finally never applied; should be redone.

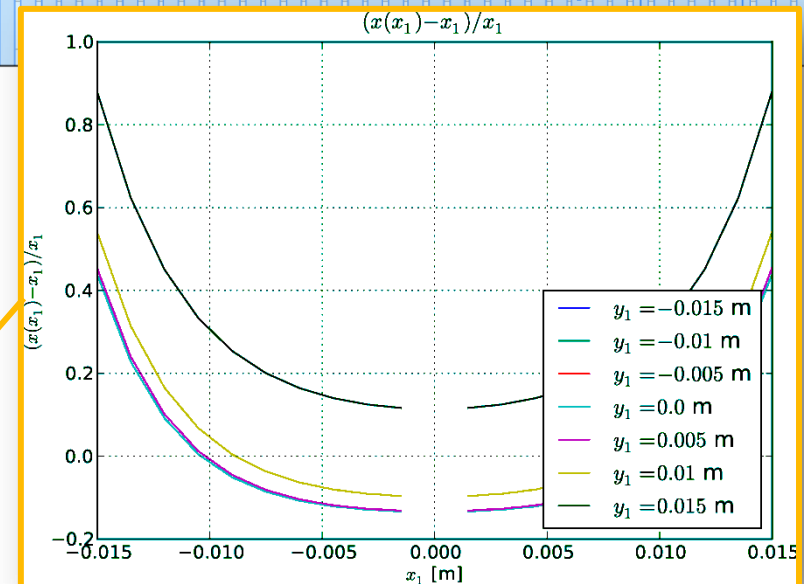
BPM Gains

➔ Fits to Kick Response Data

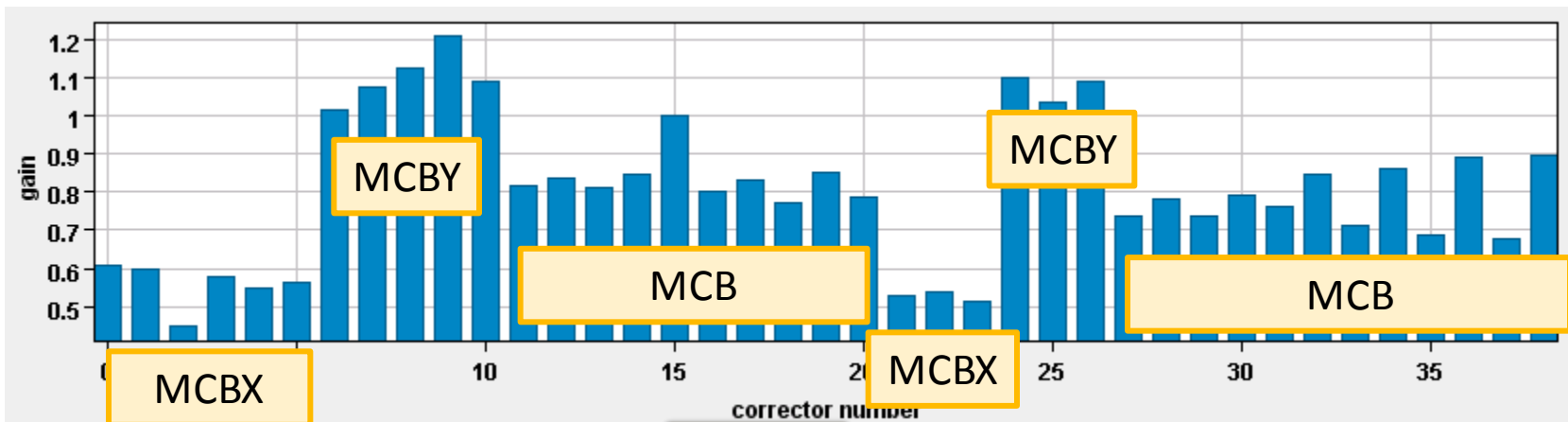


Average Gain: 1.13

➔ **Uncorrected Electronics.**
(Corrected in July (TL) and October (LHC) 2009)



COD Gains



Corrector Type	l_{mag}	gain factor (aloha)		
MCBX H/V	0.450	0.45	...	0.61
MCBY H/V	0.899	1.02	...	1.10
MCBC H/V	0.904	1.04	...	1.21
MCB H/V	0.6470	0.68	...	1.00

→ Misunderstanding between LSA and YASP

Sector Test

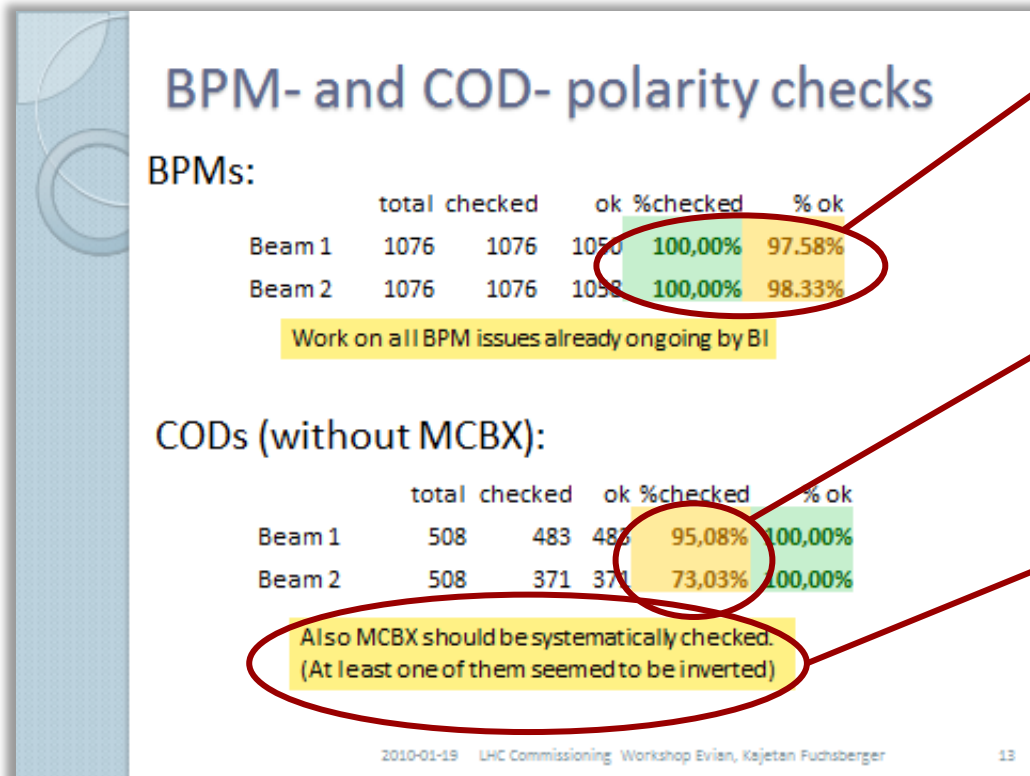
Circulating Beam

Tools & More

BPM & COD Checks

➤ Best done with circulating beam

From Evian Workshop, Jan 2010:



In 2009, we checked systematically all BPMs at least once.

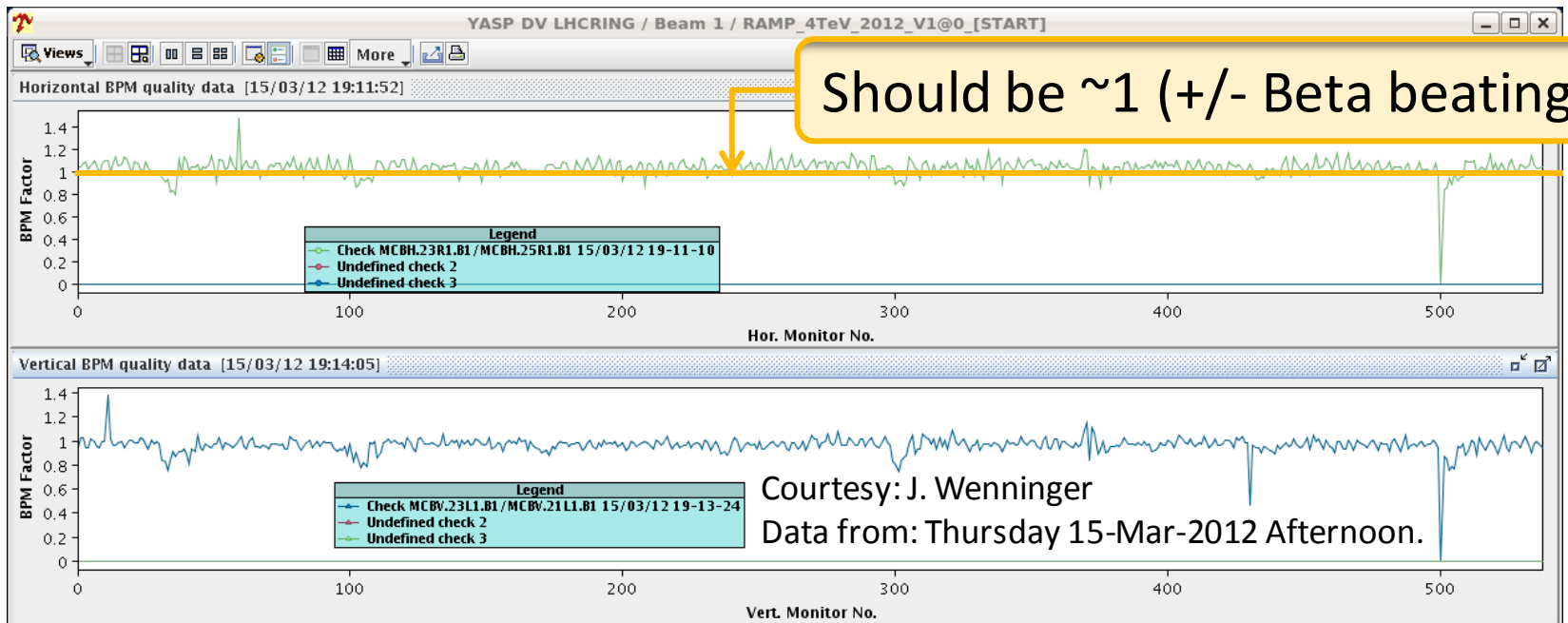
We tested also ~80% of the CODs ...

... and missed the one, which was wrong ☹

➔ More Systematically!

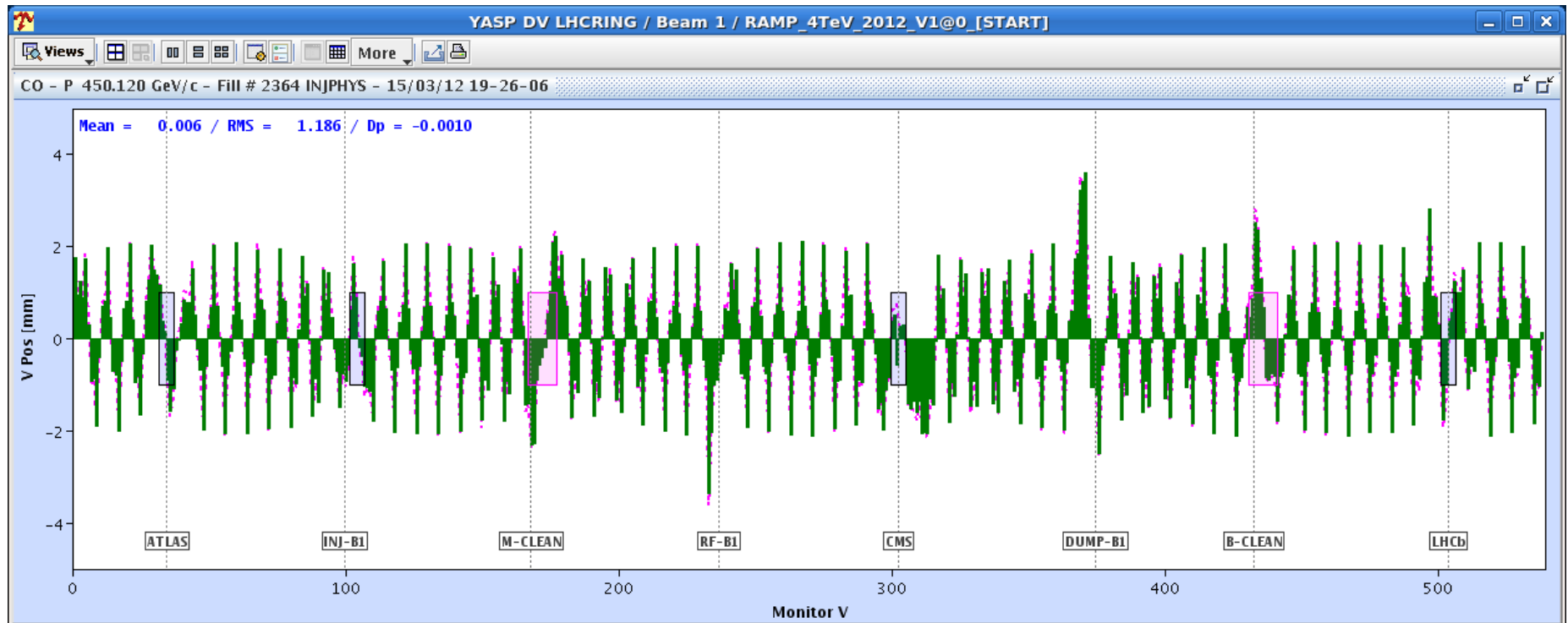
Systematic Checks of BPM gains

- New utility in YASP (since 2012):
 - 2 CODs (90 degree phase advance)
 - Kick ($\delta_i = \frac{\delta}{\sqrt{\beta_i}}$) on each (separately) → Two readings per BPM (u_i)
 - Gain of each BPM is then: $g = \frac{u_1^2 + u_2^2}{\beta_0 \cdot \delta}$ (Sign insensitive!)



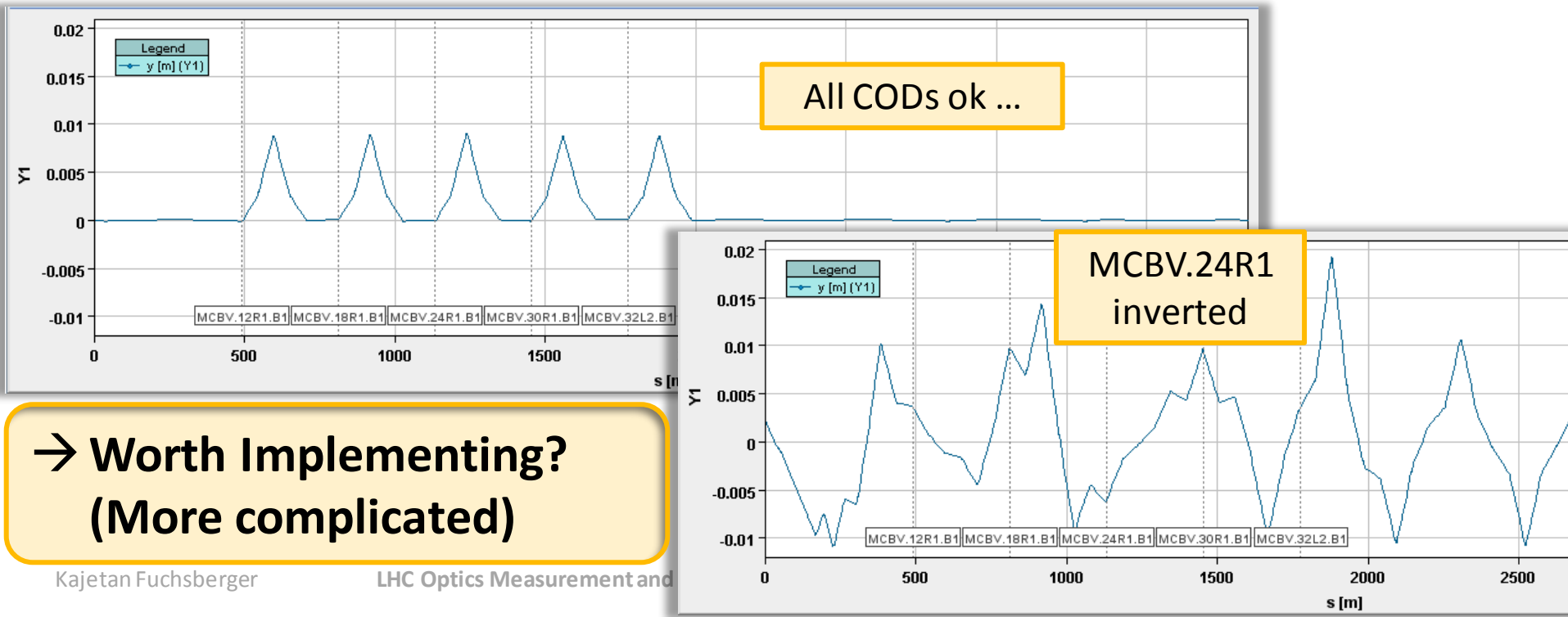
COD Gains & Polarities

➔ Currently Done by Fits to Kick response data or ,by eye‘



Systematic COD Checks – New edition?

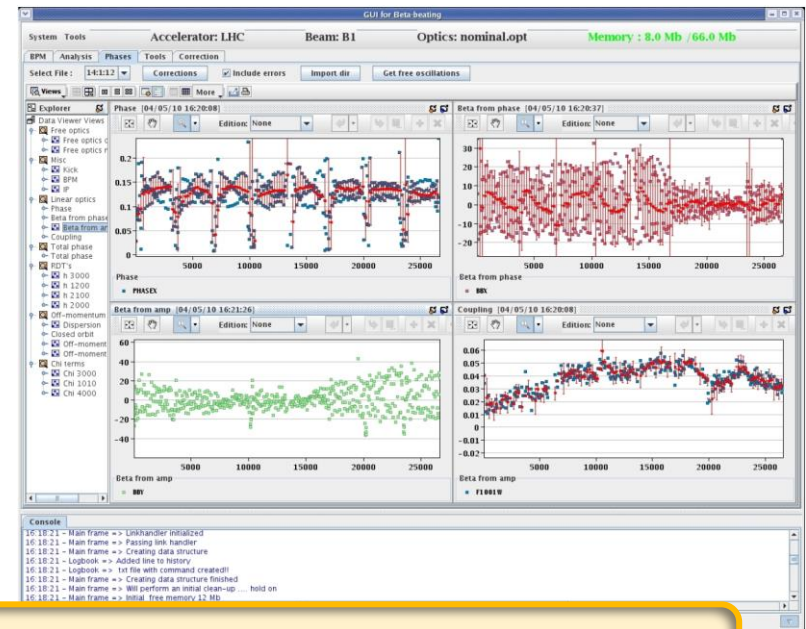
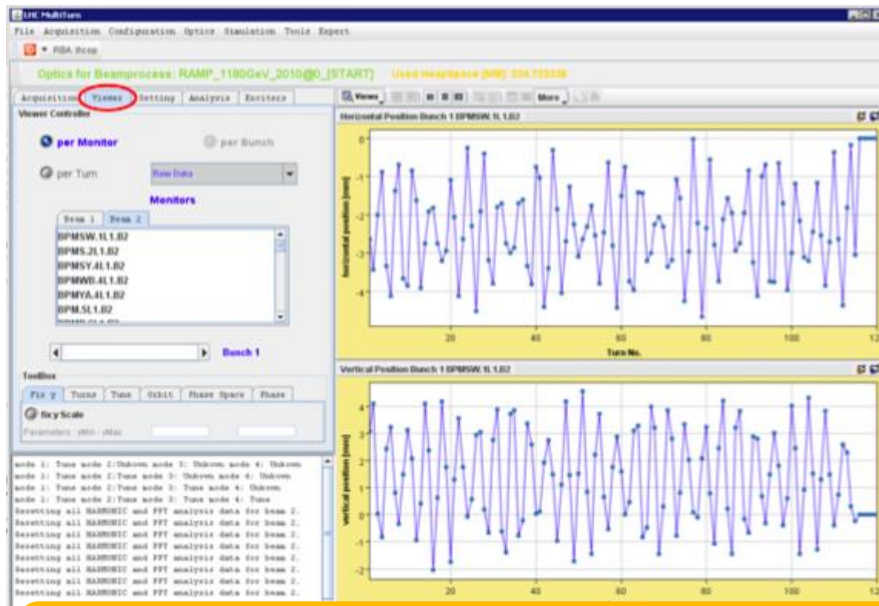
- Proposal (J. Wenninger):
 - We expect rare failures
 - Multiple 3-Corr-Bumps in Arcs: Should be closed with small leakage.
 - If single problem: Easy to find (MICADO)



➔ Worth Implementing?
(More complicated)

As soon as beam is circulating...

- Beta beat measurements through phase Advance measurements.
- SW Tools: ‚Multiturn application‘ + ‚Beta Beat GUI‘



+ Many more Advanced techniques (see previous talks)

Sector Test

Circulating Beam

Tools & More

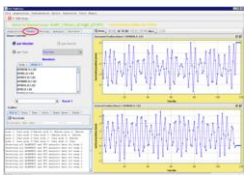
Tools Summary



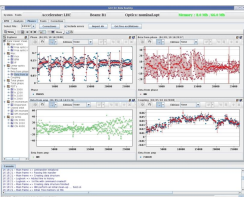
- YASP: Threading, Orbit, Dispersion, Kick Response acq., BPM checks,...
→ Jorg



- Aloha + JMAD: Model to KR and Disp. Fits
→ Unclear Future
(partly to online model → Ghislain's talk)

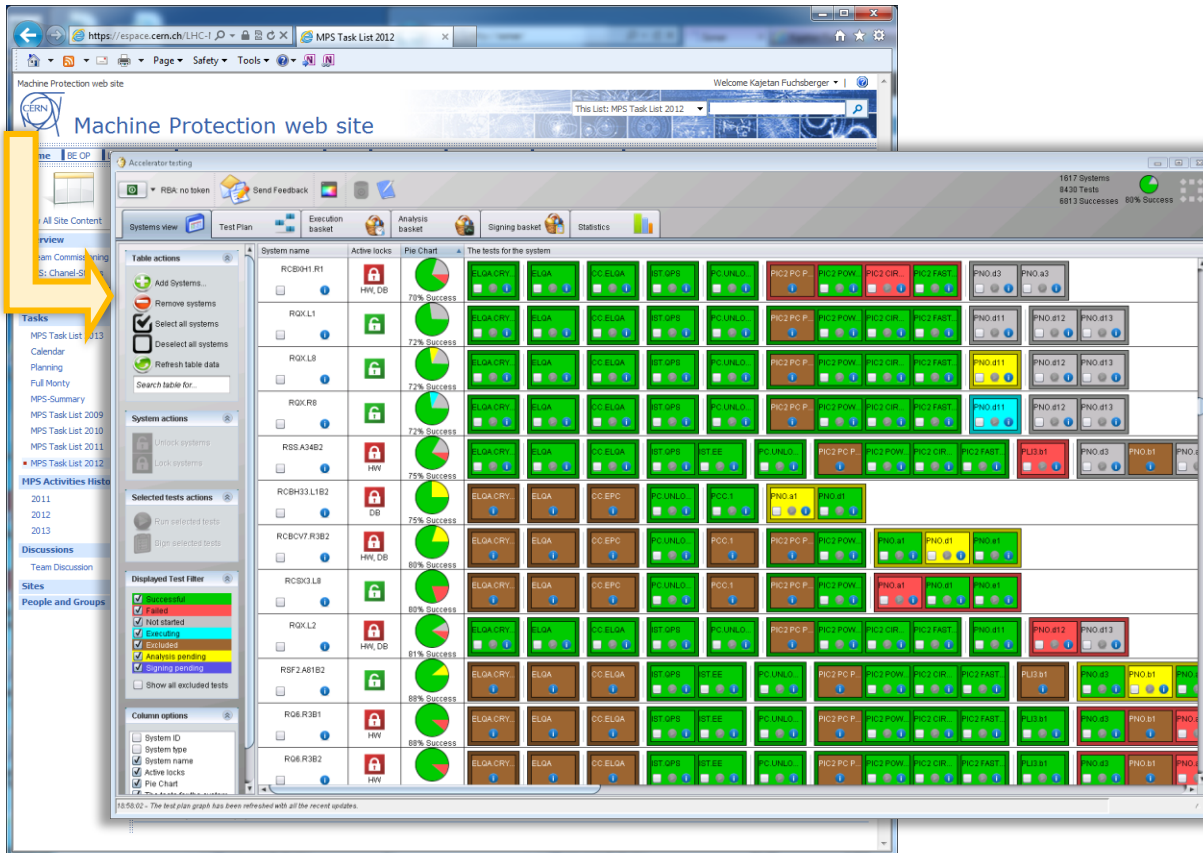


- 'Multiturn' Application: Acq. For Phase advance measurements → Verena



- 'Beta Beat GUI': Analysis of Phase advance measurements → Beta Beat team

If we want to do things systematically ...



- Plan: Put more and more Commissioning Steps into the Framework.
- ~ End 2013: Convenient Testplan Editing → Ready for Preparation.

... Polarity checks as an example ...

	Ready for Powering			Ready for Injection		
QPS	IST1					
BLM	IST2	IST3	IST4			INJ1 INJ2
BIS	IST5	IST6	IST7			INJ3
LBDS	IST8					INJ4
MCBH..	IST10	IST11		POW1	POW2	POL



- Why Not Adding Polarity checks to the Commissioning TestPlan?
- Other checks that could/should be added?

Even further ?

- Automation! (Possible for many things, not for all)
- Test Execution: e.g. YASP (as now).
- Analysis: Using Analysis Language.
(Java embedded DSL, currently under development in TE-MPE)

```
public class MagnetPolarityCheck extends AnalysisModule {{  
  
    Orbit response = calculate(MEASURED_ORBIT).minus(REFERENCE_ORBIT);  
    assertThat(response).isEqualTo(SIMULATED_RESPONSE).withinAbs(500, MICRO(METER));  
  
}}
```

Not limited to orbit correctors... 😊

Summary and Outlook

- Most of the checks from 2008/2009 will have to be redone in 2014/15.
- The tools are available and working.
- Will the people be available to ...
 - Maintain the tools?
 - Use the tools? (Some need special knowledge to be used; e.g. Aloha, Beta – Beat GUI)
- All commissioning steps could/should be tracked in a common tool (AccTesting).

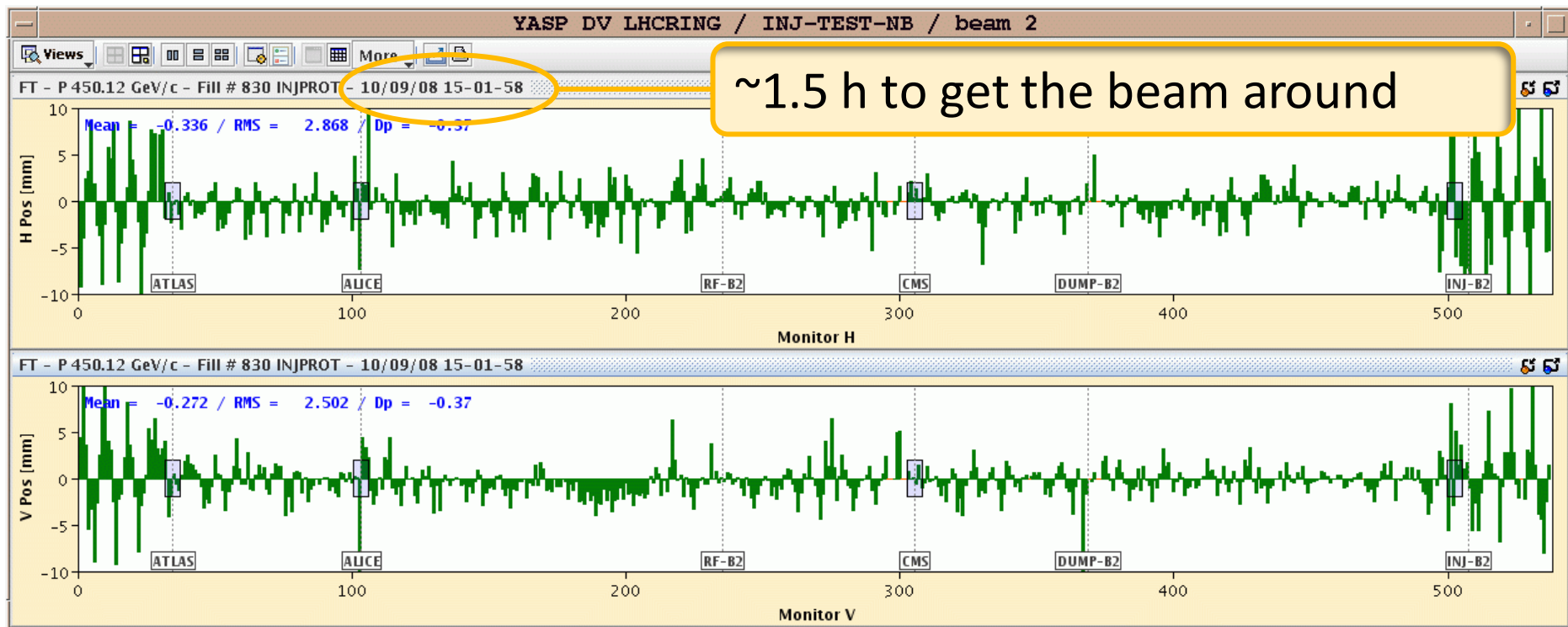
Thank you for your Attention!



Questions?

Threading

You Remember (2008) ?

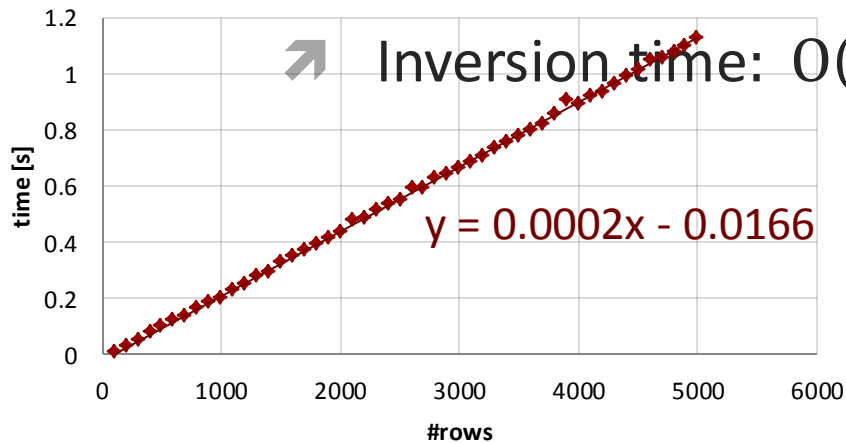


→ Is it really an Issue? (I'd say 'no' ;-)

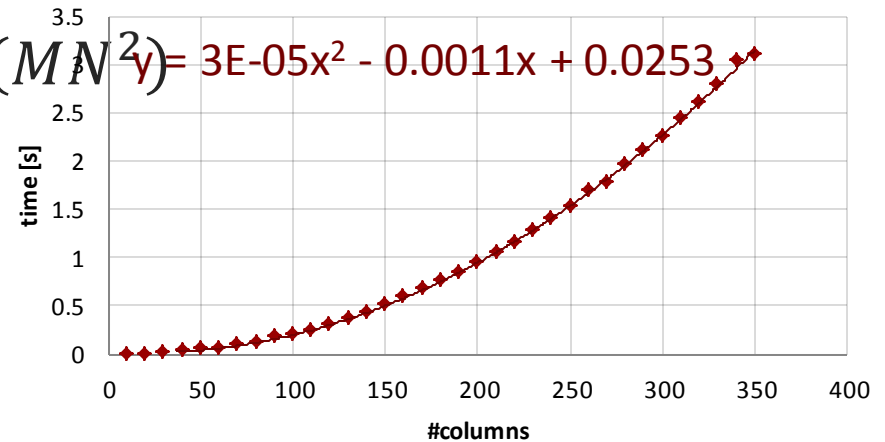
SVD inversion time

$M \dots \#rows; N \dots \#cols$

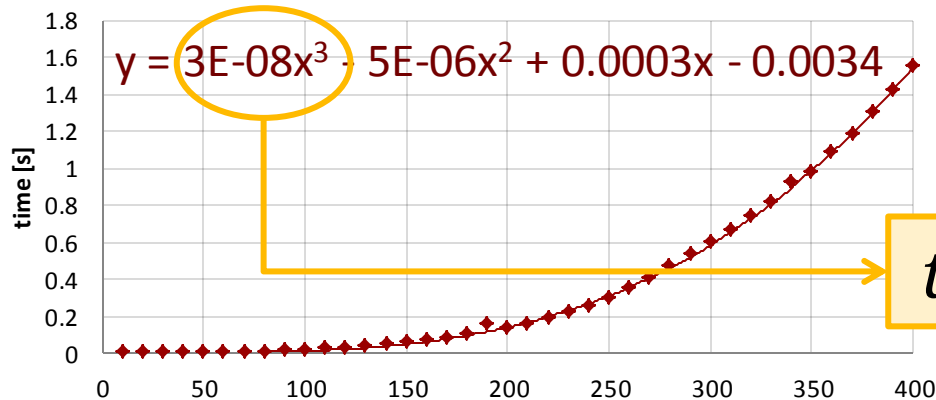
time vs #rows (100 cols)



time vs #cols (1000 rows)



SVD inversion time for NxN matrices

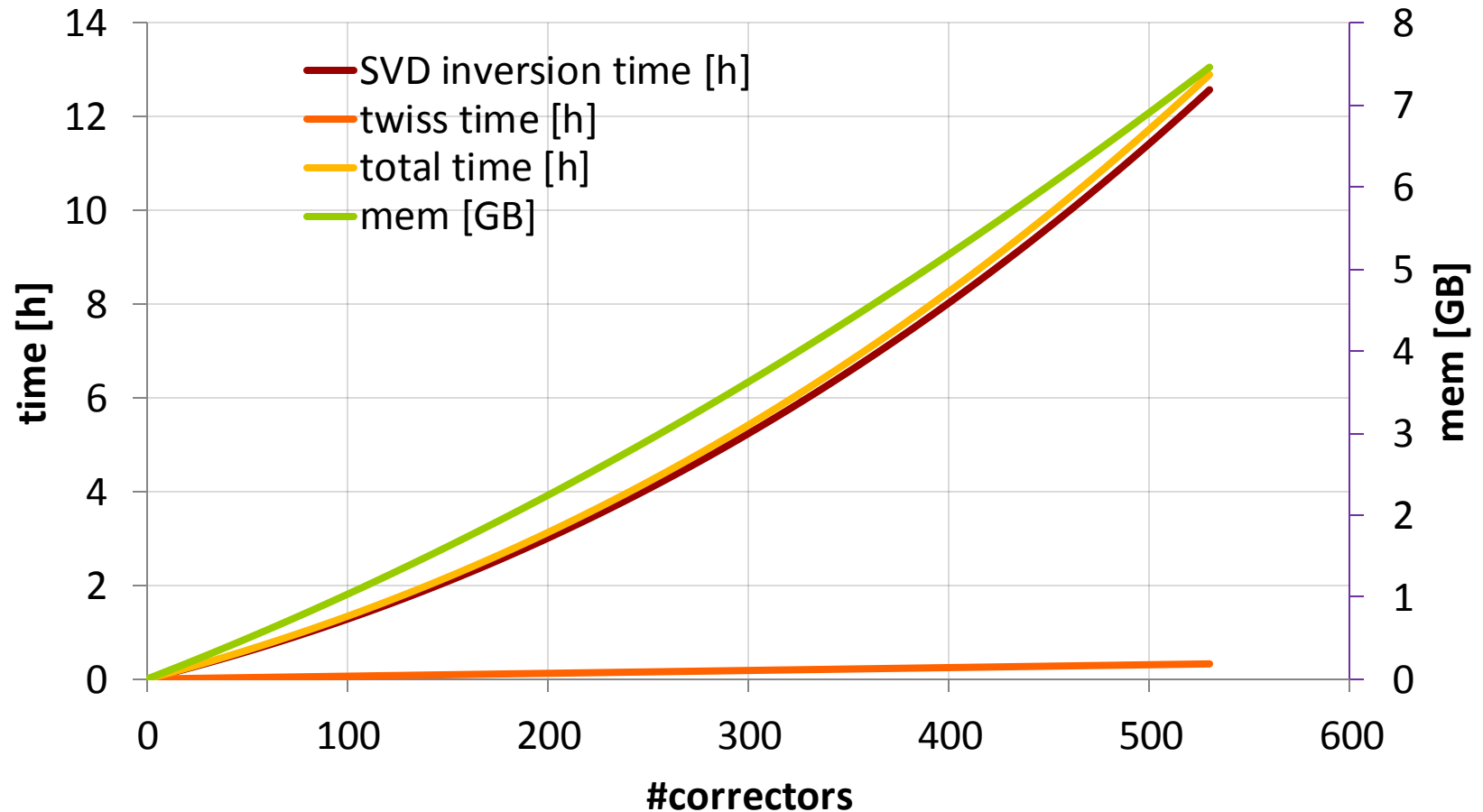


Estimation on Intel Desktop PC (3.17 GHz):

$$t \sim 3 \times 10^{-8} \times M \times N^2 \text{ [s]}$$

Monitor/COD Gain fits II

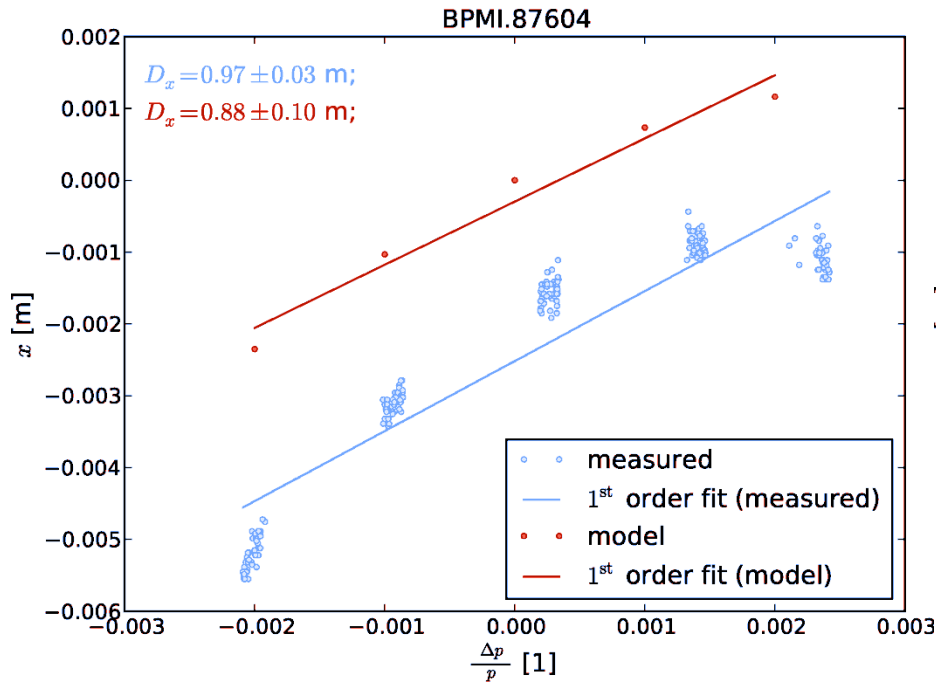
required time for gain fits (1088 mon)



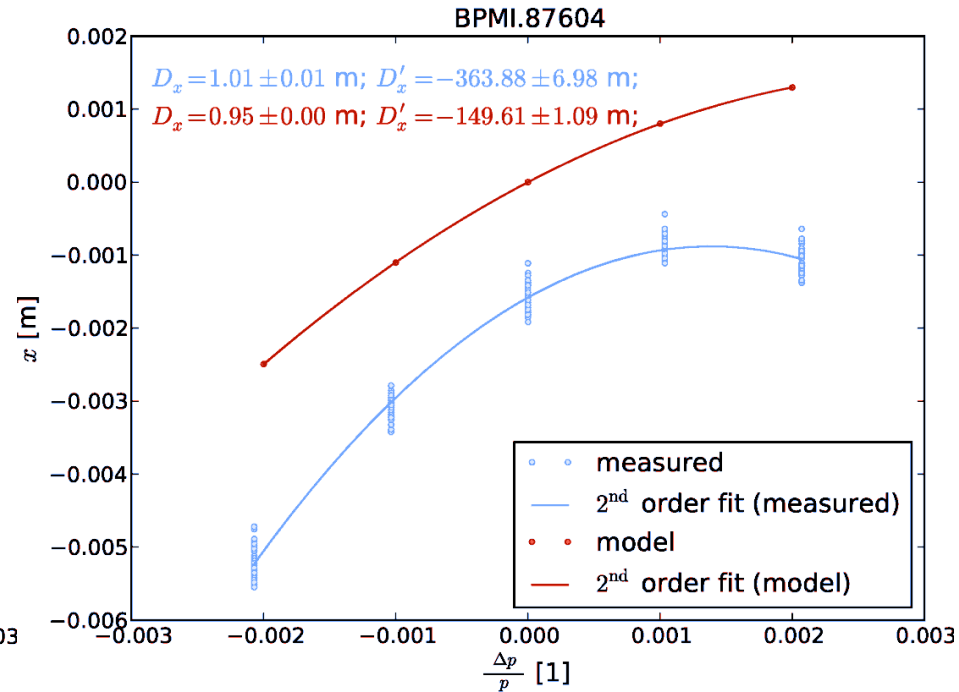
$$u = u_\beta + D_u \frac{\Delta p}{p} + D'_u \left(\frac{\Delta p}{p} \right)^2$$

ersion...

Standard:



Verbessert:



... BPM praezision wird immer wichtiger ...

Backup

