Trajectory and orbit corrections in CTF3

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Topic of the presentation

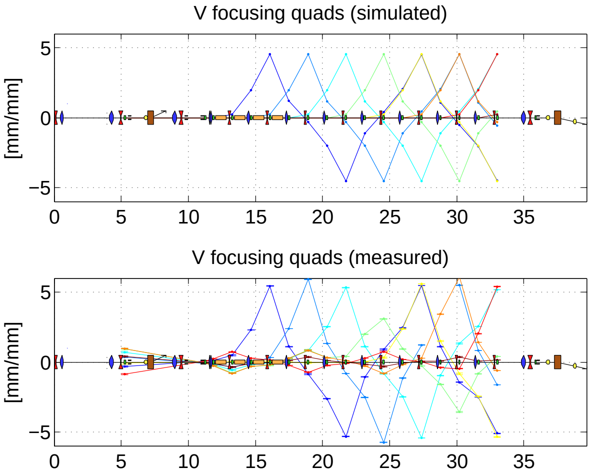
Last year several activities of automatic steering were performed in CTF3. I will rapidly summarize the

- Test Beam Line,
- and Combiner Ring results.

The algorithm used are different flavor of a 1-to-1 steering (we try to reach the target orbit in the BPMs), in opposition to Dispersion Free Steering algorithm (target dispersion, to be discussed). I will NOT discuss the details of the algorithms.

Regarding the 1-to-1 steering we have reached at best 250 μm rms residual error in the orbits (in TBL, yet far above the BPMs resolution). In absolute I think is a good result but I think can be improved.

In TBL we have 16 movers for 16 BPMs in a FODO lattice. Quite “good” agreement between optics models and the measured responses of the system.



TBL results

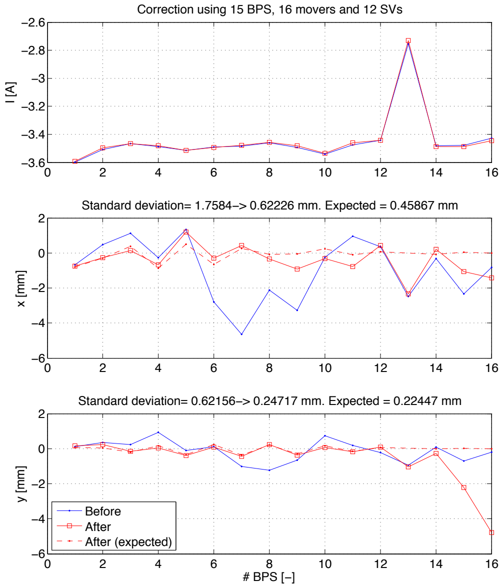
After having

- weighted BPMs
- weighted movers

We reached 600-250 μm rms improving of a factor 2-3 the Steffen's steering. ELOG 28-10-11

Why "poor" result? Some HPs.

1. movers have to be gently handled and beam after one reading-correction-checking cycle incoming orbit has changed.
2. we are still using a non-iterative algorithm...

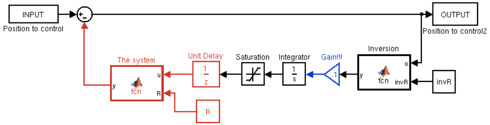


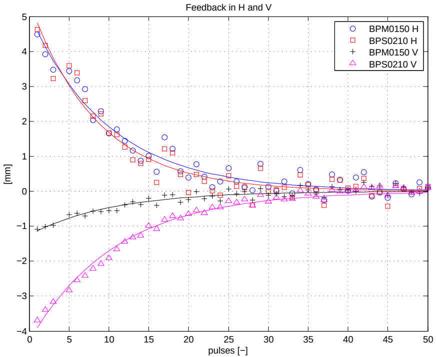
FB at TBL entrance

2 birds with 1 stone

We implement an iterative correction sys (a feedback with low gain) to control the incoming orbit: fully automatic steering.

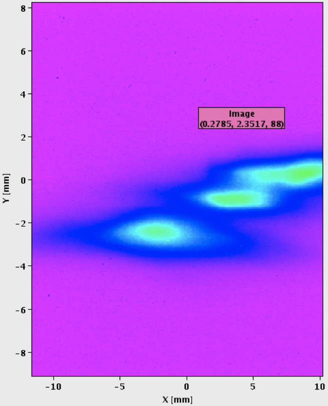
We think that applying this FB during the TBL steering AND apply the same iterative template to the movers correction, we can gain a lot (rms $< 100\ \mu$m?).



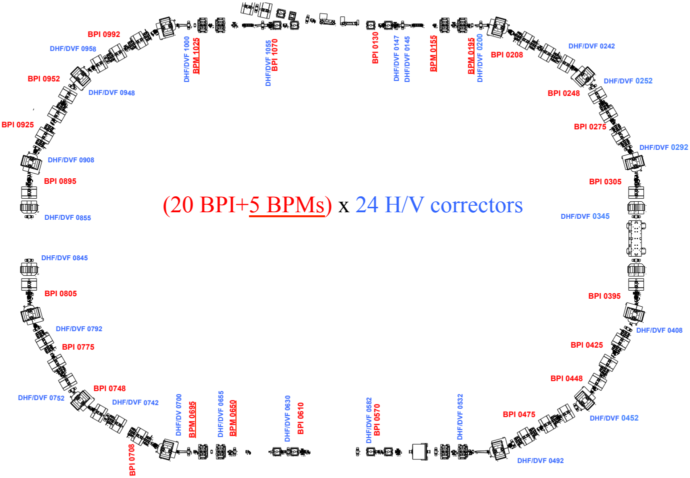


The problem

- closure of the orbit in order to preserve the combined beam emittance for the downstream transport (TL2, TBL and TBTS).
- minimize the rms closed orbit and dispersion to optimize the beam transport and allows sextupoles.

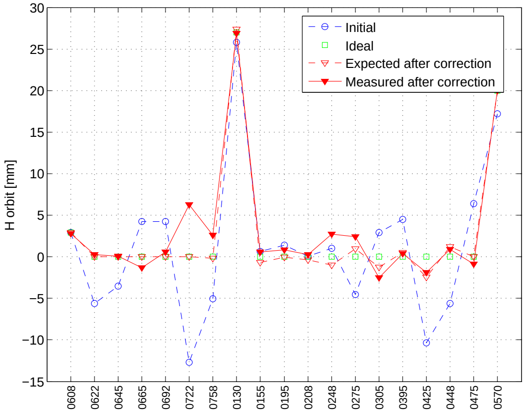


Automatic steering in the CR is less mature than in TBL.



Two possibles approaches: (1) trajectory and (2) orbit correction.

First rudimental attempt to correct the CR trajectory.



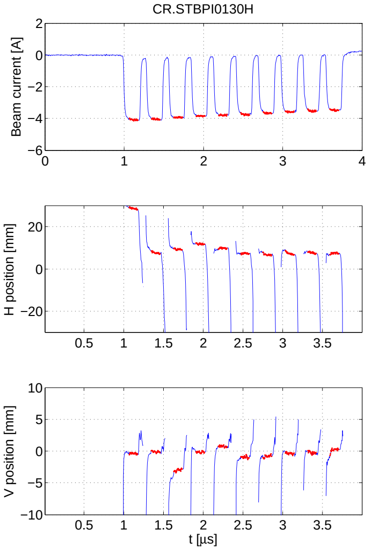
The correction on the half-turn is working reasonably well but it turned out that the injection TL1/CR is too delicate to be dealt as a line: it is better disentangle the injection form the orbit.

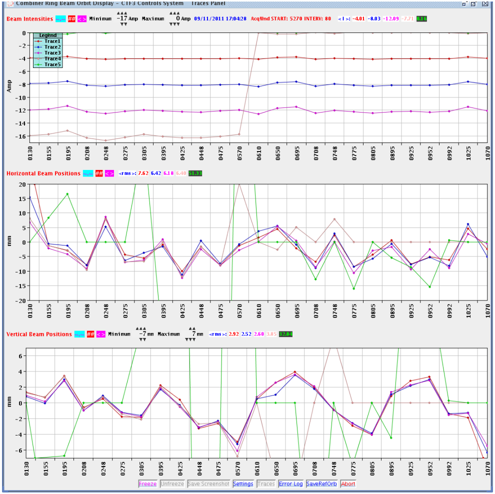
Not transparent for operation...

We use an incoming beam of $\approx$ 250 ns and after injection the RF kickers are switched off. The beam is kept in the ring for 10 turns.

BPI signals (see Ben's talk)...

Charging effect of the BPI is neglected in the analysis.





Results

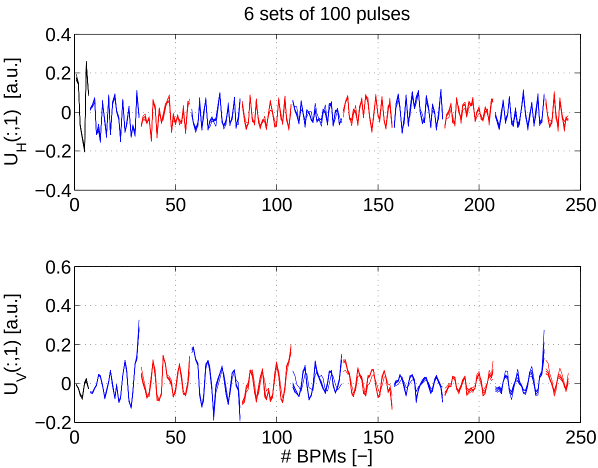
The procedure is semi-automatic. Piotr readjusted manually the injection to the new closed orbit. The rms orbit needs to be improved.

Try to measure dispersion 'parasitically'

In the uncombined storage mode of the CR we can observe significant jitter of the orbit. Due to several studies on the machine (Tobias' talk) we have reasons to think that are mainly due to the energy jitter and dispersion.
Under these assumptions, using SVD for measuring dispersion appears natural and we expect that the fundamental mode of the SVD is proportional to the dispersion.

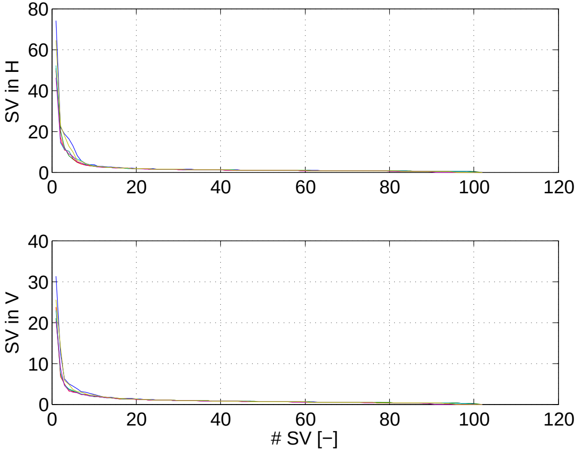
- M(244 bpm$\times$600 pulses)= U$\times$ S$\times$ V^T
- Dispersion(bpms) $\propto$ U(:,1) and Δp/p $\propto$ V(:,1)

Dispersion studies



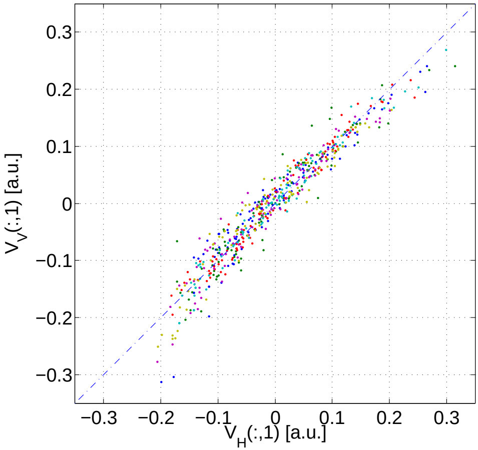
We consider 6 subsets of 100 pulses: results are reproducible.

Dispersion studies



We consider 6 subsets of 100 pulses: results are reproducible.

Dispersion studies



We consider 6 subsets of 100 pulses: results are reproducible.

Conclusions/Plans/Discussion for TBL

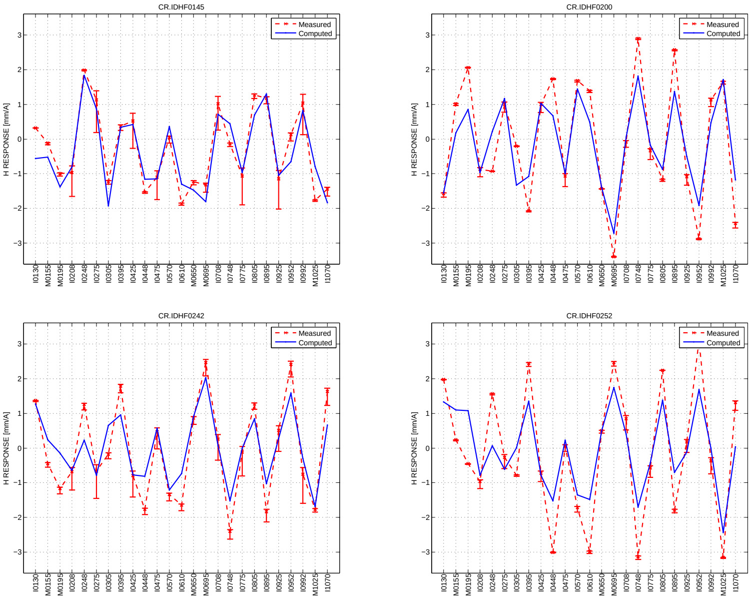
- Can we aim to have 100 um rms with uncombined beam operating in a loop with very low gain?
- Known limit: its difficult to control in parallel all the movers...the last one usually got stuck.
- Can we dare to do DFS in TBL? Problem of dispersion leackage from TL2.

Conclusions/Plans/Discussion for CR

- We have tried different apprach/flavors: the initial results are good.
- Closure of the CR is good but rms still high for the chromatic correction.
- (I think that) iterative correction would help a lot in that respect like in TBL style because we are (within limit) not sensitive to the errors of the response matrix.
- Would be good to include arc dipole current as a corrector knob for the algorithm.

Thank you!

Backup Slides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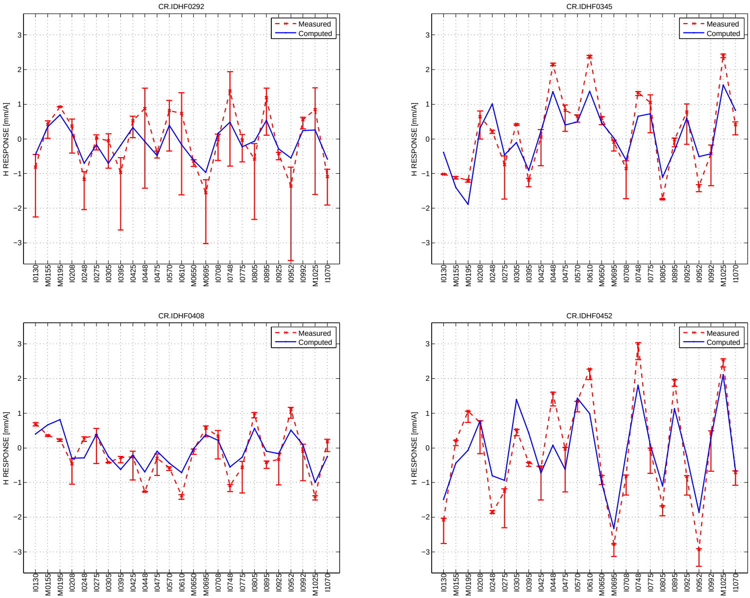
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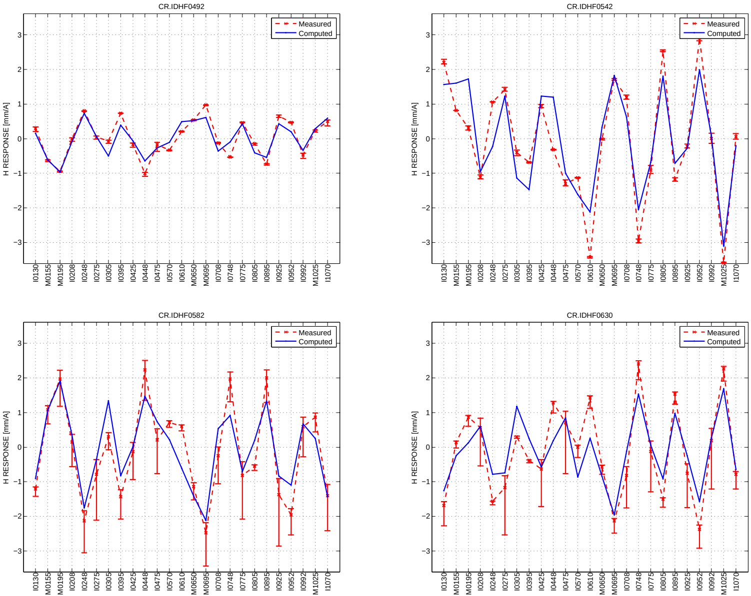
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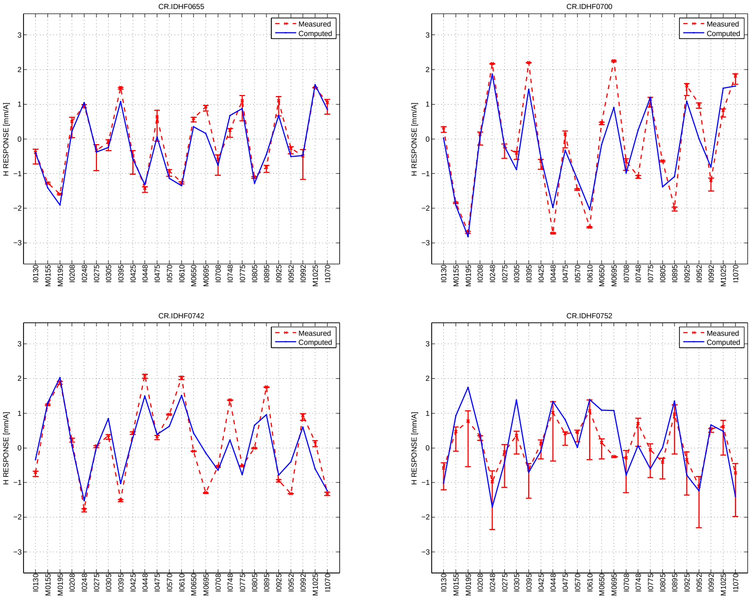
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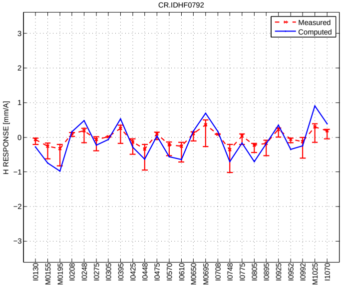
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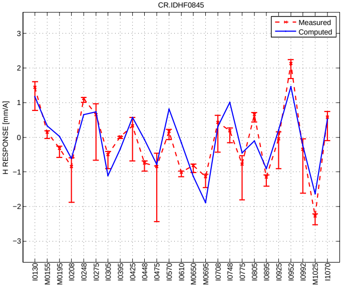
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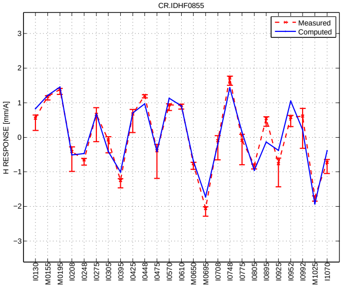
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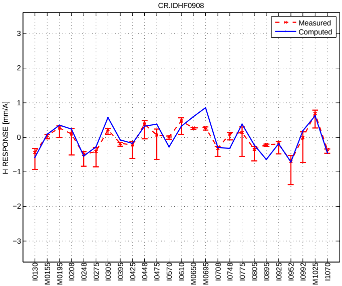
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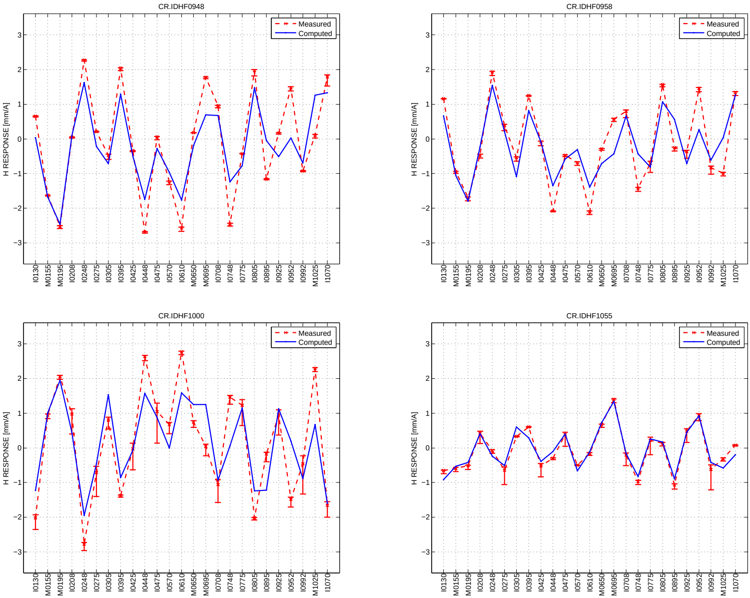
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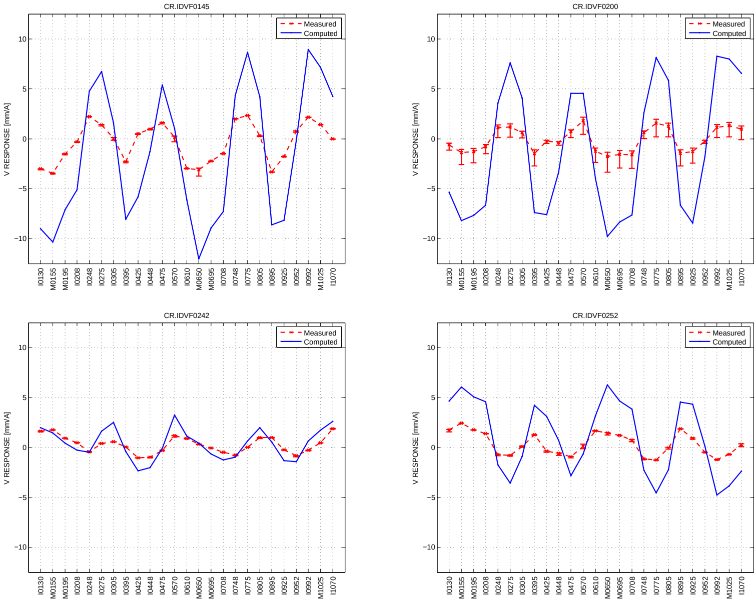
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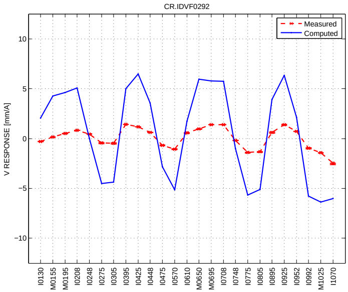
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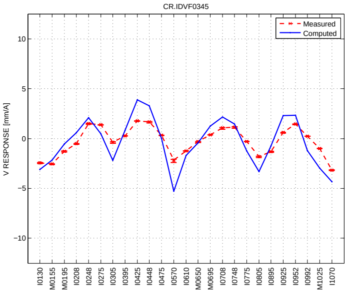
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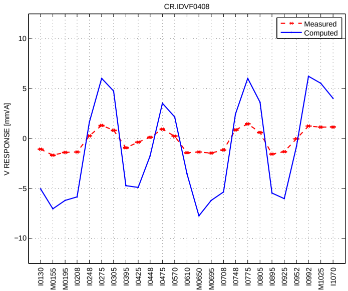
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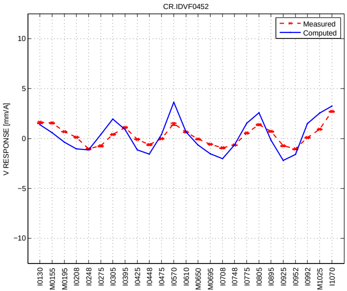
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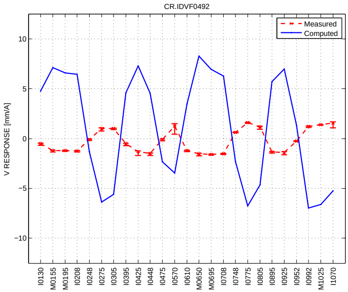
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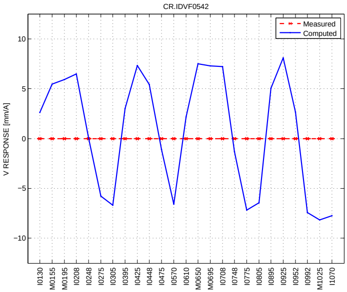
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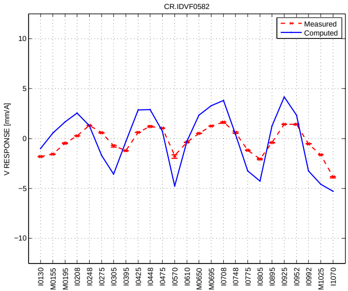
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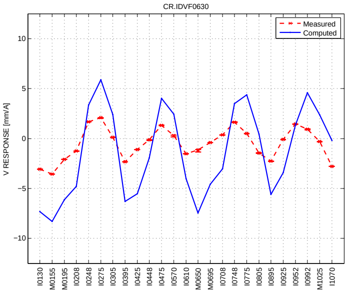
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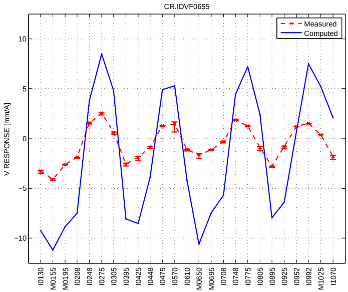
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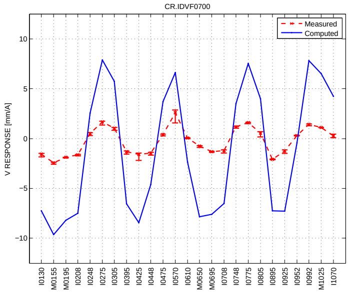
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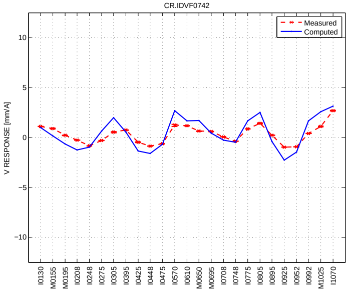
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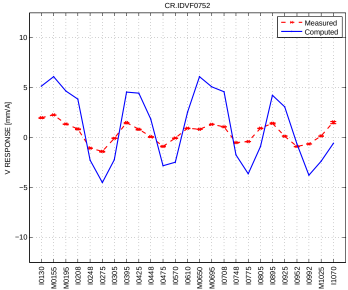
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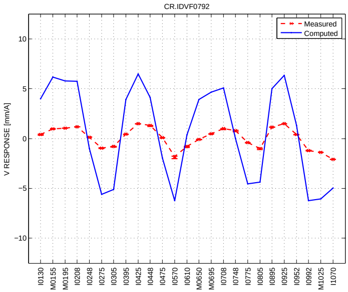
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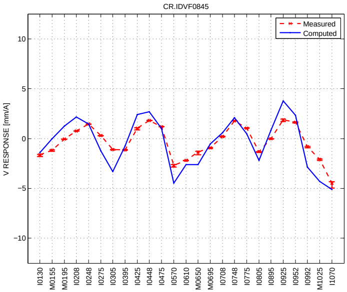
I0130 M0155 M0195 I0208 I0248 I0275 I0305 I0395 I0425 I0448 I0475 I0570 I0610 M0650 M0695 I0708 I0748 I0775 I0805 I0895 I0925 I0952 I0992 M1025 I1070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Measured
Computed
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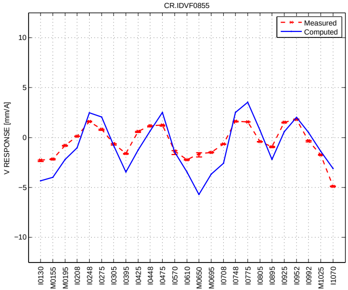
10
5
0
−5
−10
I0130 M0155 M0195 I0208 I0248 I0275 I0305 I0395 I0425 I0448 I0475 I0570 I0610 M0650 M0695 I0708 I0748 I0775 I0805 I0895 I0925 I0952 I0992 M1025 I1070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Computed
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5
0
−5
−10
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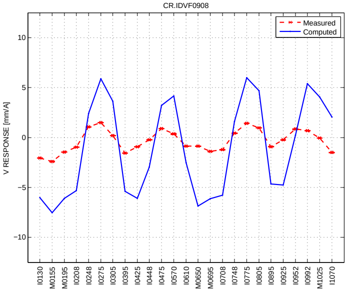
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Computed
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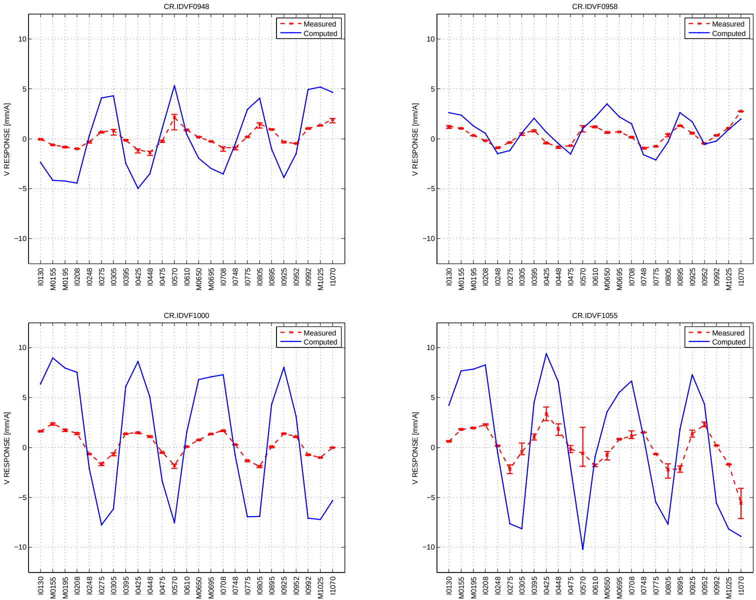
5
0
−5
−10
I0130 M0155 M0195 I0208 I0248 I0275 I0305 I0395 I0425 I0448 I0475 I0570 I0610 M0650 M0695 I0708 I0748 I0775 I0805 I0895 I0925 I0952 I0992 M1025 I1070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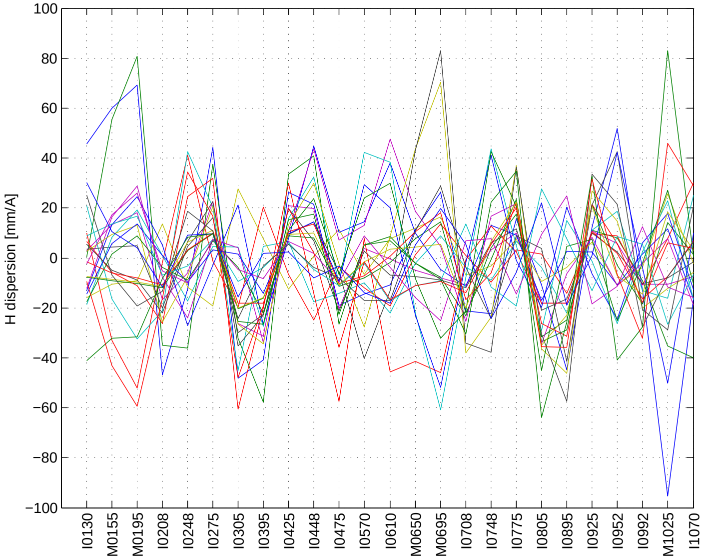
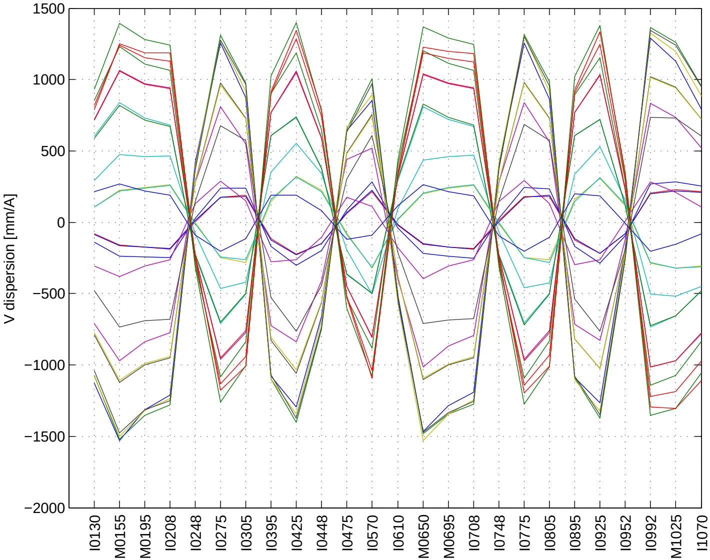
CR.IDVF1055
Measured
Computed
V RESPONSE [mm/A]
10
5
0
−5
−10
I0130 M0155 M0195 I0208 I0248 I0275 I0305 I0395 I0425 I0448 I0475 I0570 I0610 M0650 M0695 I0708 I0748 I0775 I0805 I0895 I0925 I0952 I0992 M1025 I1070


H dispersion [mm/A]
100
80
60
40
20
0
−20
−40
−60
−80
−100
I0130
M0155
M0195
I0208
I0248
I0275
I0305
I0395
I0425
I0448
I0475
I0570
I0610
M0650
M0695
I0708
I0748
I0775
I0805
I0895
I0925
I0952
I0992
M1025
I1070


1500
1000
500
0
−500
−1000
−1500
−2000
V dispersion [mm/A]
I0130
M0155
M0195
I0208
I0248
I0275
I0305
I0395
I0425
I0448
I0475
I0570
I0610
M0650
M0695
I0708
I0748
I0775
I0805
I0895
I0925
I0952
I0992
M1025
I1070