RAMP: EXPERIENCE AND ISSUES

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Acknowledgment

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CONTENTS

- Historic of the energy ramps during the 2009 run
- Losses and transmission
- Evolution of orbit, tune and chromaticity
- Feed forward and feed back
- Settings incorporation for various systems
- Software tools
- Conclusions and outlook

HISTORICAL OF RAMPS

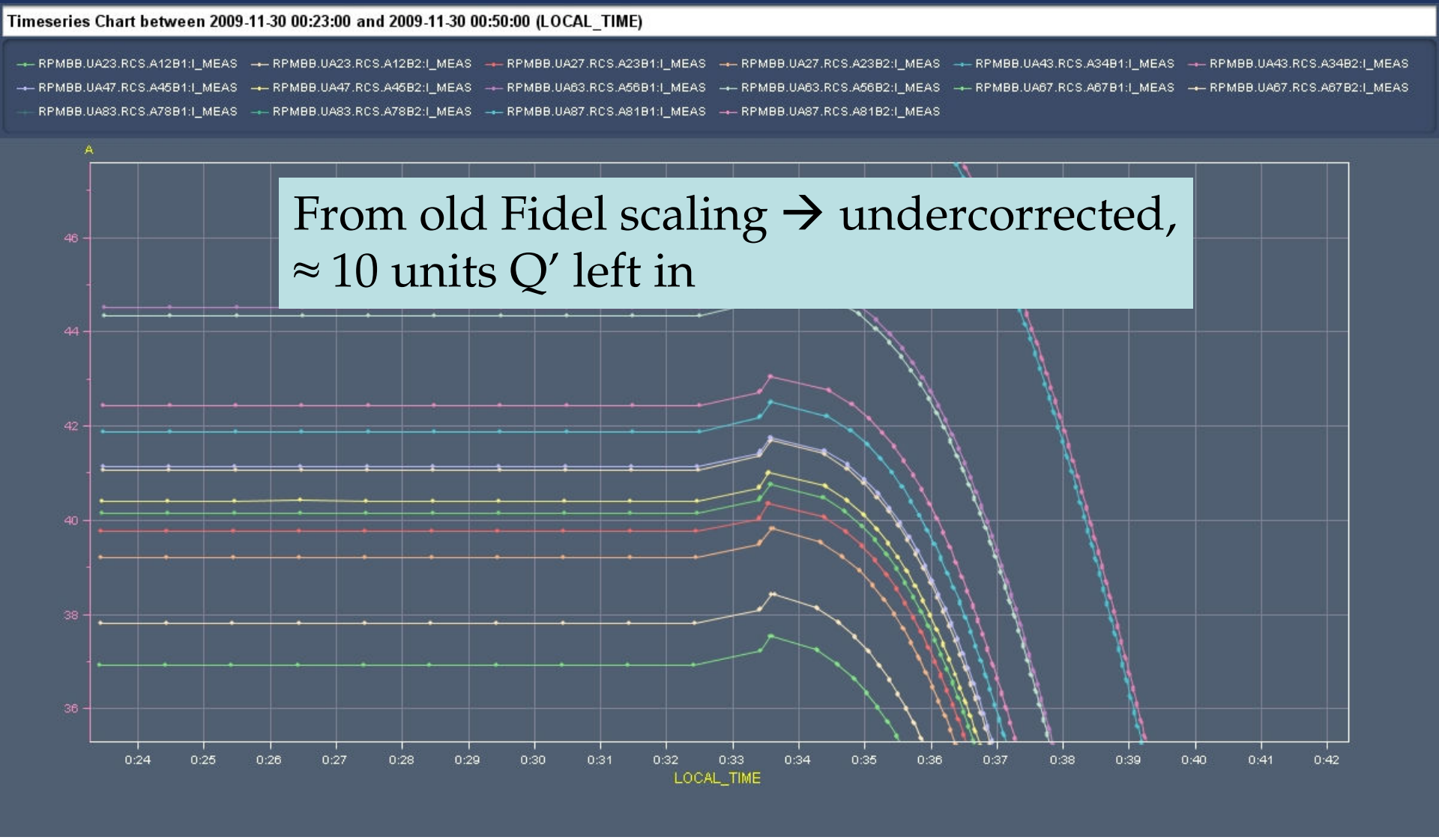
#	Timestamp	Pre cycle	B1 in, protons	B2 in, protons	Q FB, B1	Q FB, B2	B1 out protons	B2 out protons
1		bad	2.6E9	-	no	-	≈ 5E7	-
2								-
3								1.9E8
4								*got to top, no BI data*
5								≈ 5E7 (noise level)
6	2009-12-14 02:31:30.575							1.1E10
7	2009-12-15 21:12:33.680	ok	1.52E10	1.62E10	yes	yes	1.52E10	1.58E10
8	2009-12-16 00:49:06.019	ok	1.15E10	1.9E10	yes	yes	1.15E10	1.89E10

General conditions:
No separation,
No orbit FB,
No Q' continuous measurement,
"constant" incorporation of injection trims,
Ramp with masked BPM interlocks in P6,
Collimators at injection settings,
RF: synch. and phase loops on, constant voltage,
no attempt to blow up emittance

SOFTWARE TOOLS

- Feed forward tool by Mario/Mike
- Generation (to incorporate injection trims)
  - In general, incorporation was done manually by the specialist. In future could it be sequencer task?
- Sequencer/Equip State to load functions and drive the systems
- Tune meter
- Fixed displays for energy, FBCT, bunch profiles, BLM…

SNAPBACK CORRECTION



From old Fidel scaling → undercorrected,
≈ 10 units Q' left in

FEED FORWARD

Used to tackle the tune evolution. A specific application exists, which computes and applies the trims taking input from logging of previous ramps (Mario)

Q_{ref} (LSA) – Q_{meas}(MDB) = Q_{trim} → LSA Q trim knobs for the next ramp

When the FB was on, the feedback contribution was isolated:

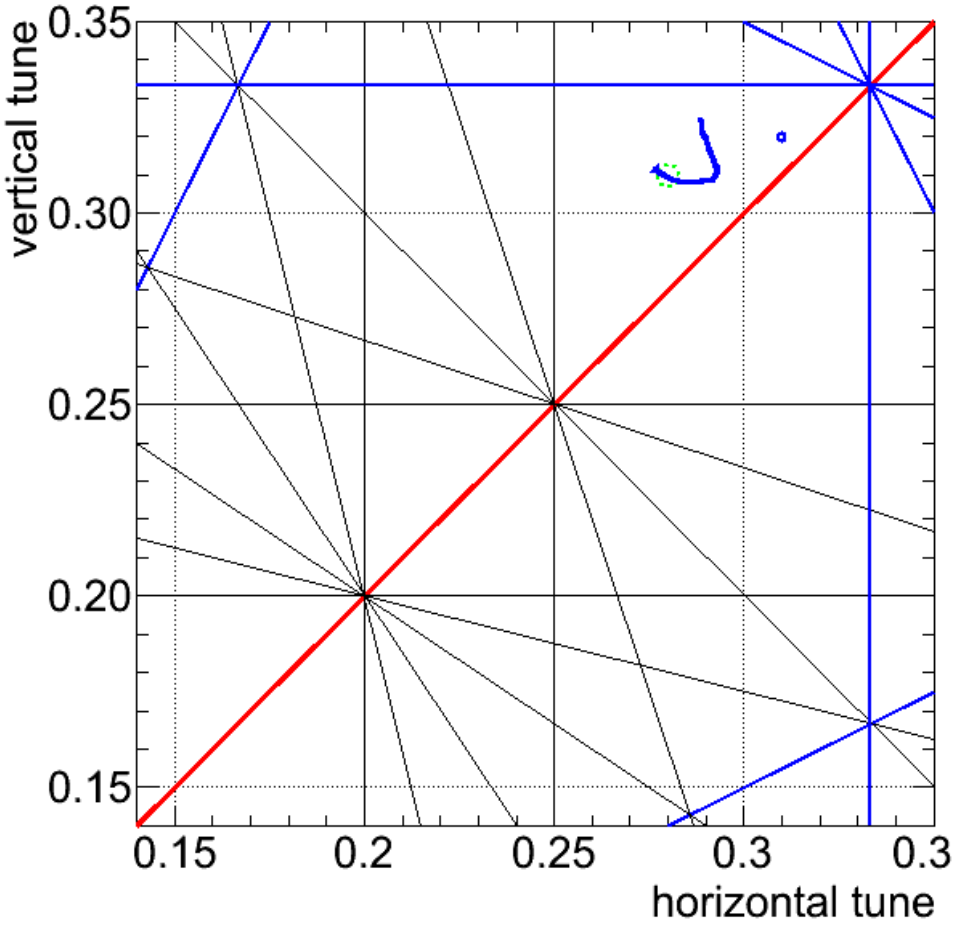
$I_{RQTF\text{-}RQTD}$(MDB) - $I_{RQTF\text{-}RQTD}$ (FF) = $I_{RQTF\text{-}RQTD}$(FB)

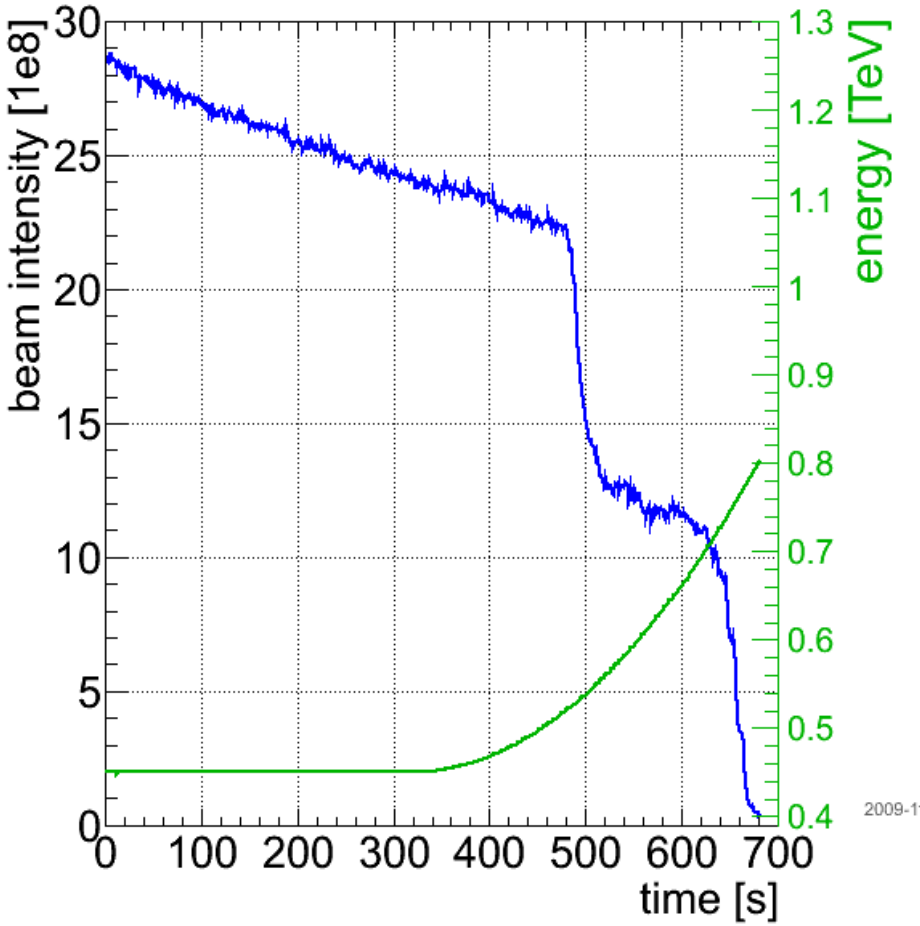
… then translated in an incremental Q trim for the next ramp. A little more cumbersome (working with currents)

- In one case (4th ramp) sign was wrong, error was taken care of by FB
- FF would be possible for orbit and coupling as well
- Not logged (enough), filtered from MDB to LDB
- Completely empirical, corrects the resultant: need a mechanism to interact with TF improvements

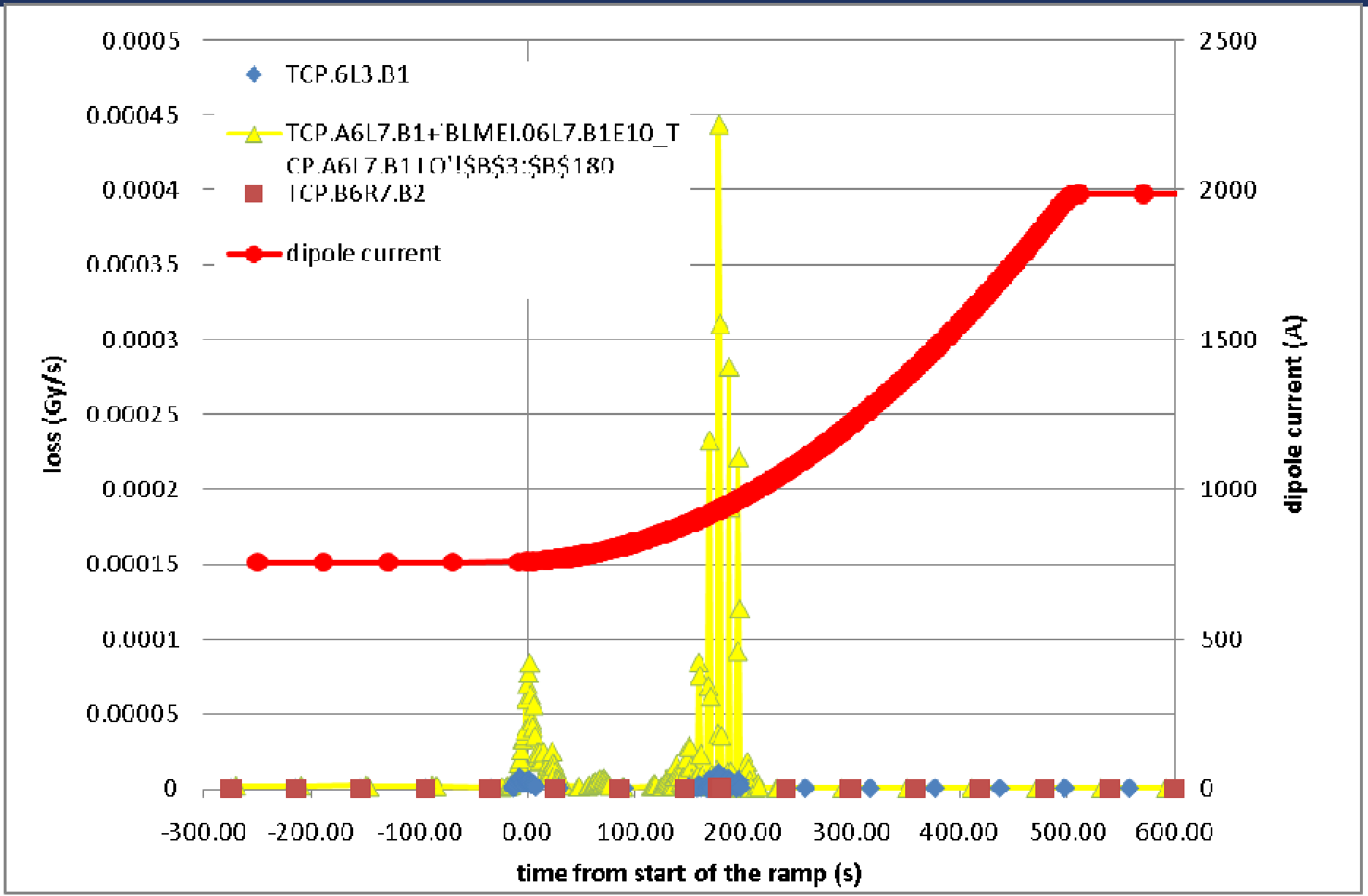
RAMP 1

B1 reached 560 GeV, lost on 3rd order resonance



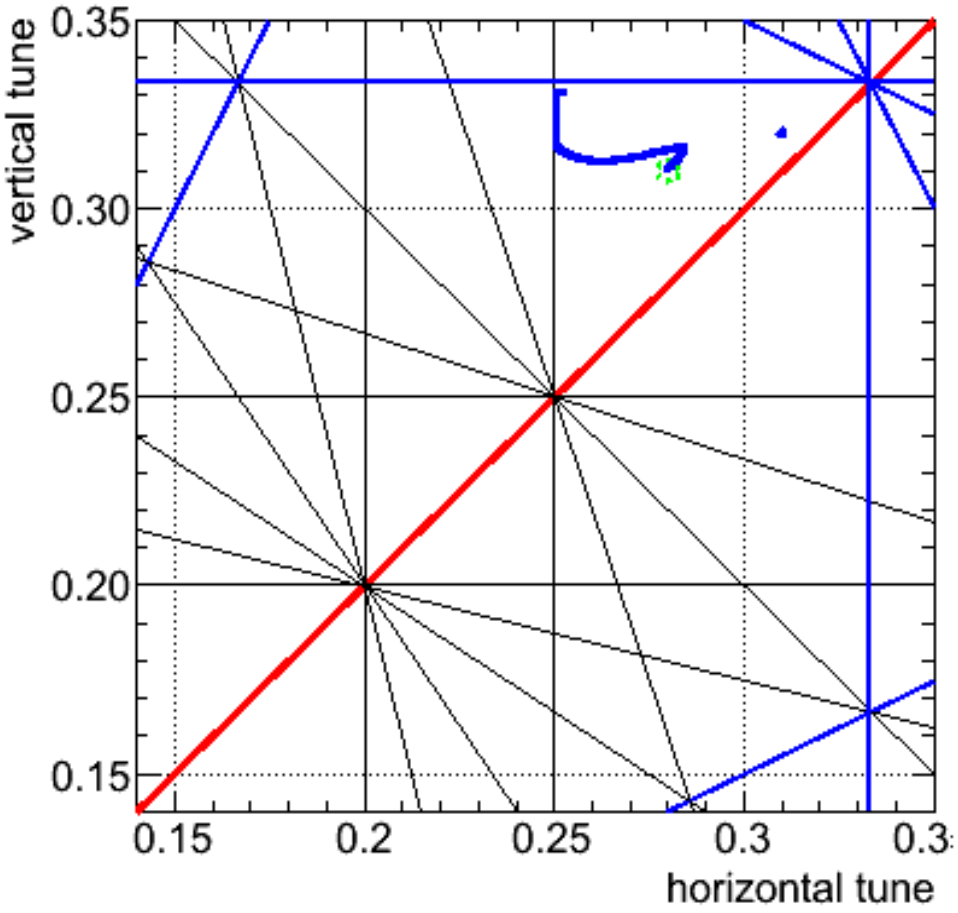


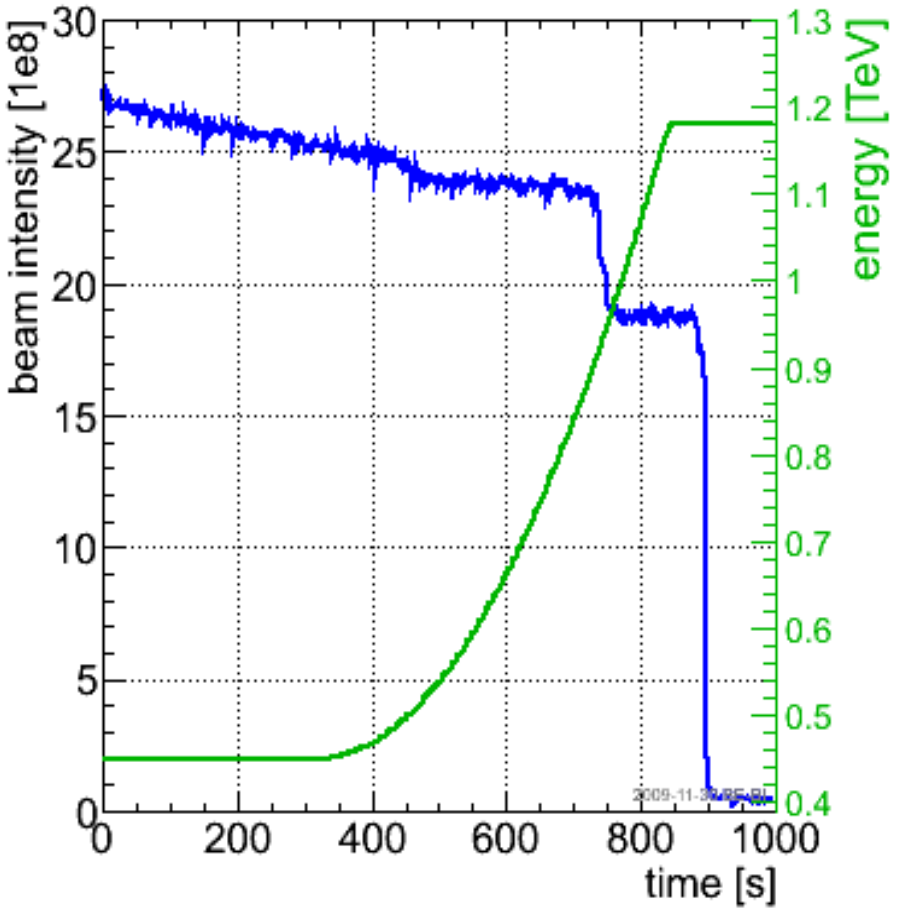
"PRIMARY" LOSS 1ST RAMP



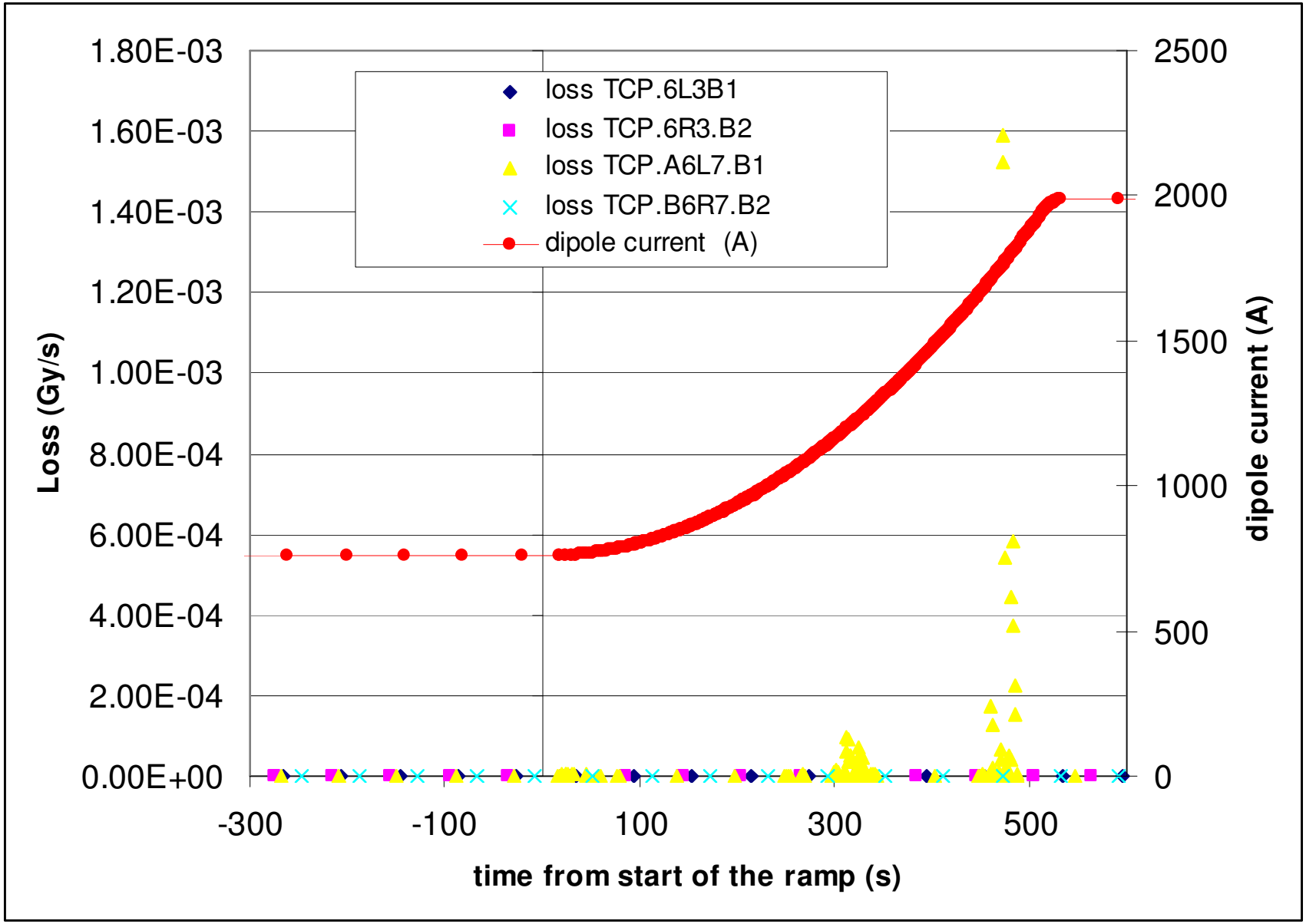
RAMP 2

Proper pre cycle, B1 to 1.18 TeV, “golden orbit”,
beam finally lost on Qv=0.3333



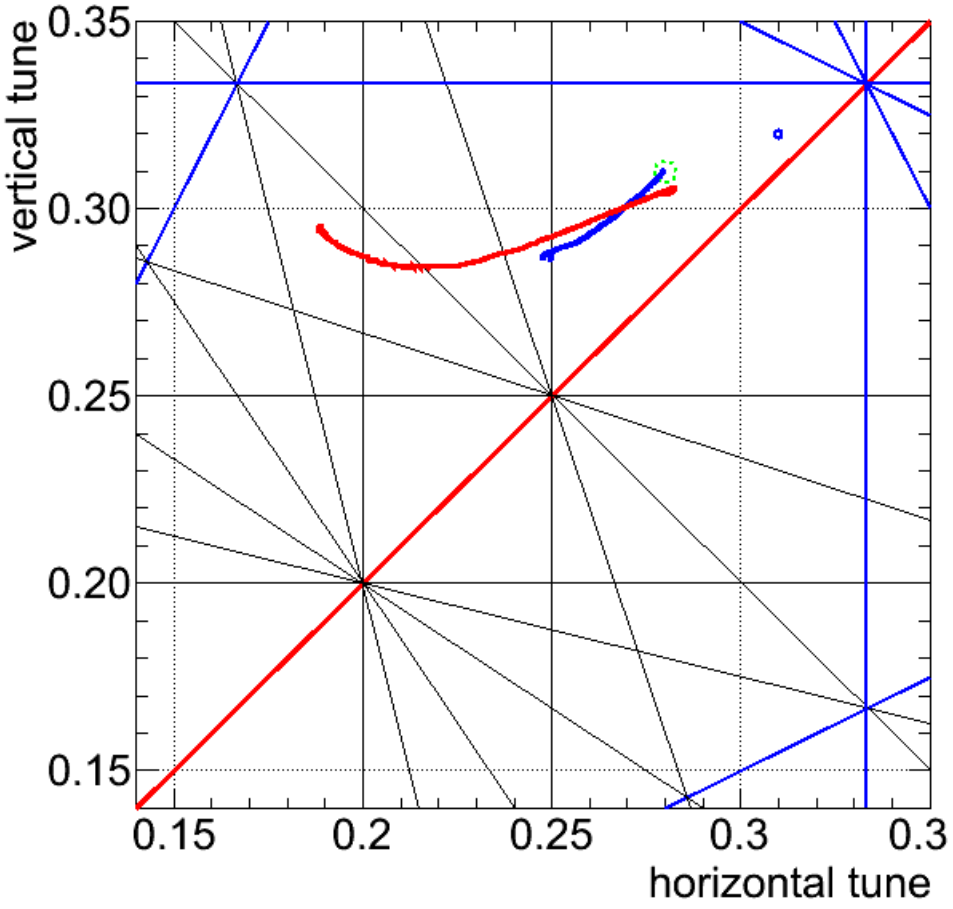


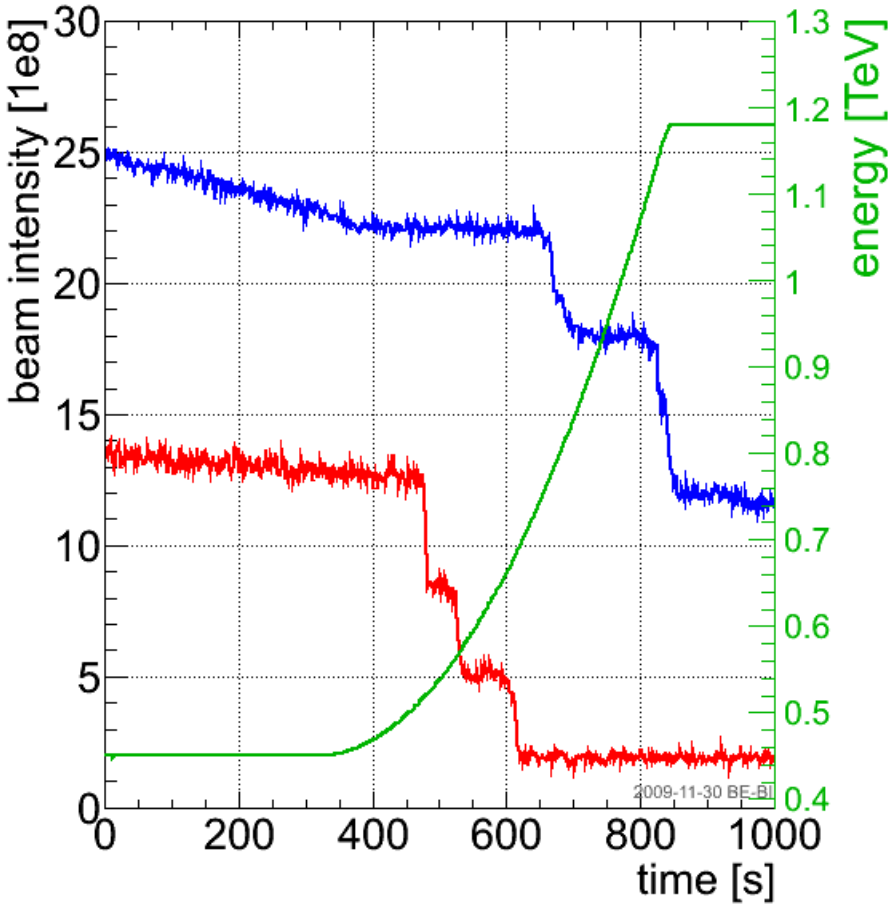
"PRIMARY" LOSS 2ND RAMP



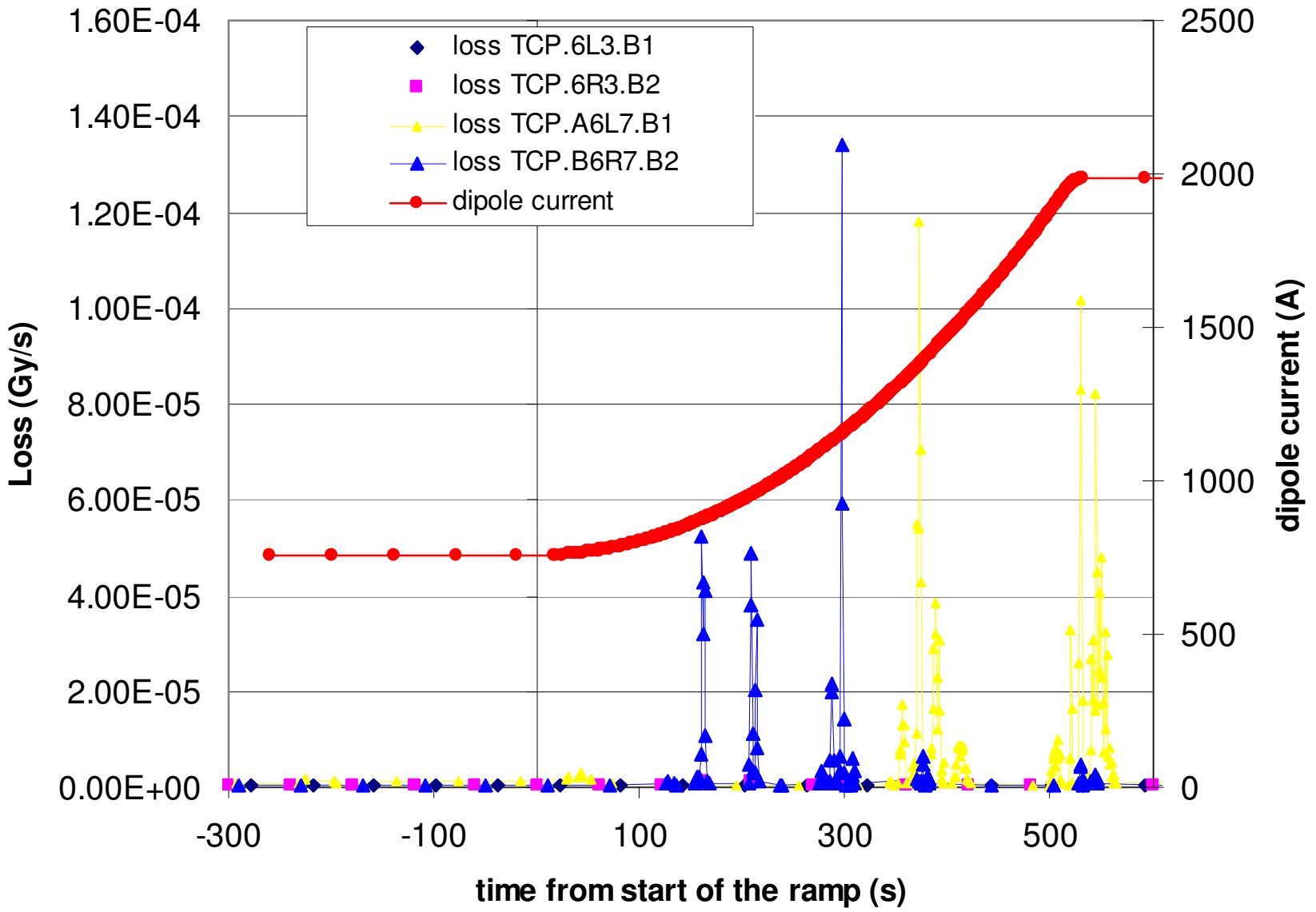
RAMP 3

- 2 beams up to 1.18 TeV, no FB, FF from ramp 2

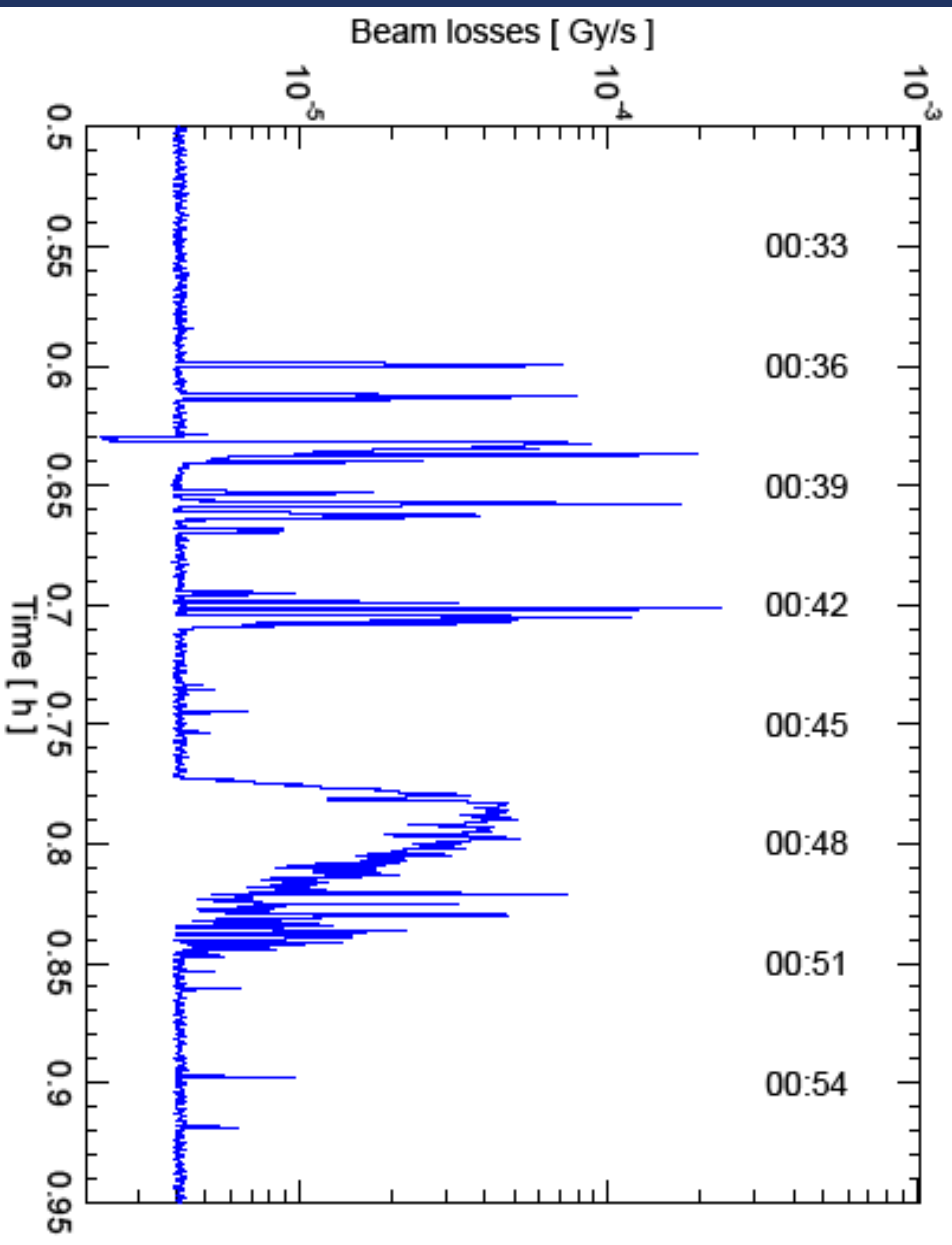


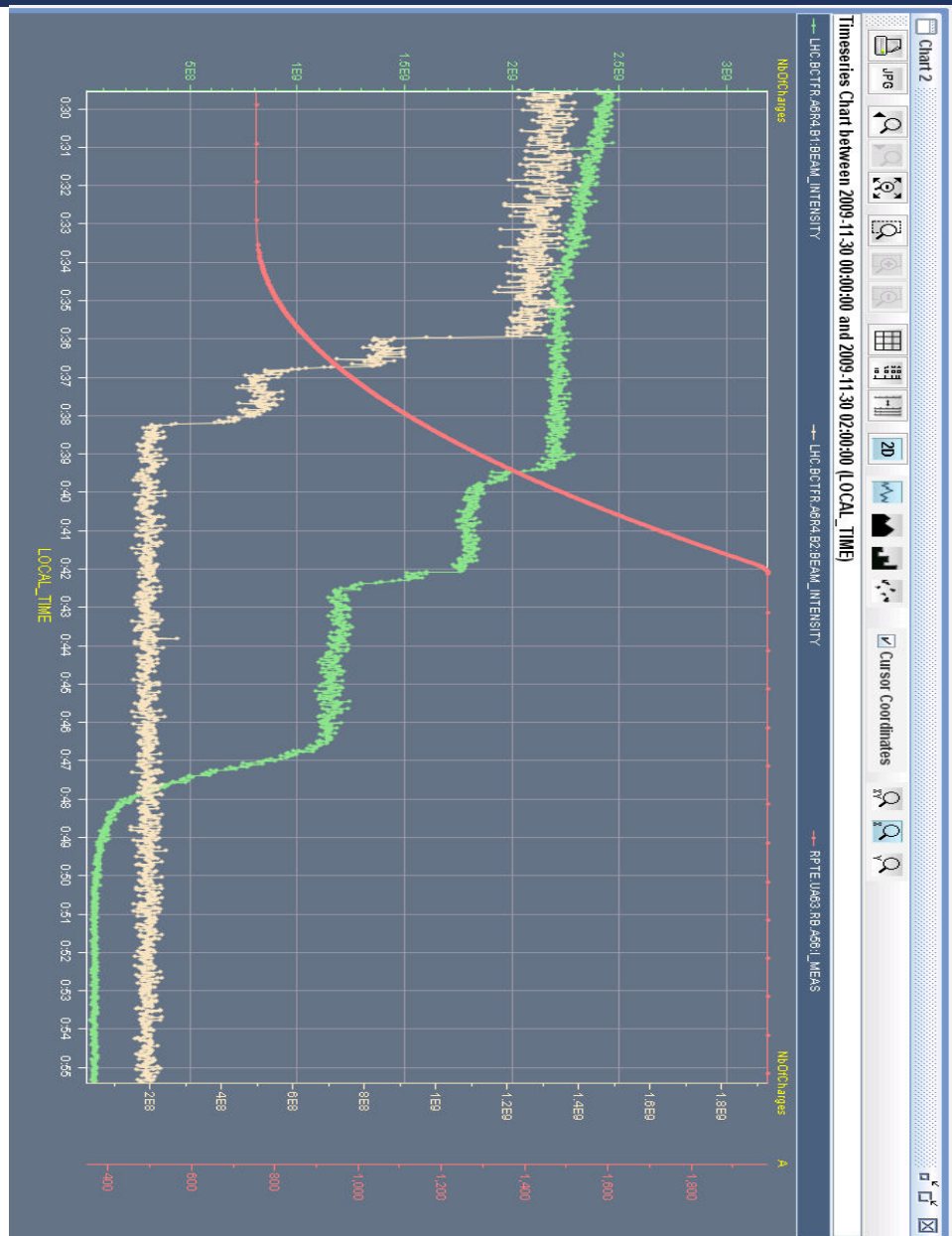


"PRIMARY" LOSS 3RD RAMP



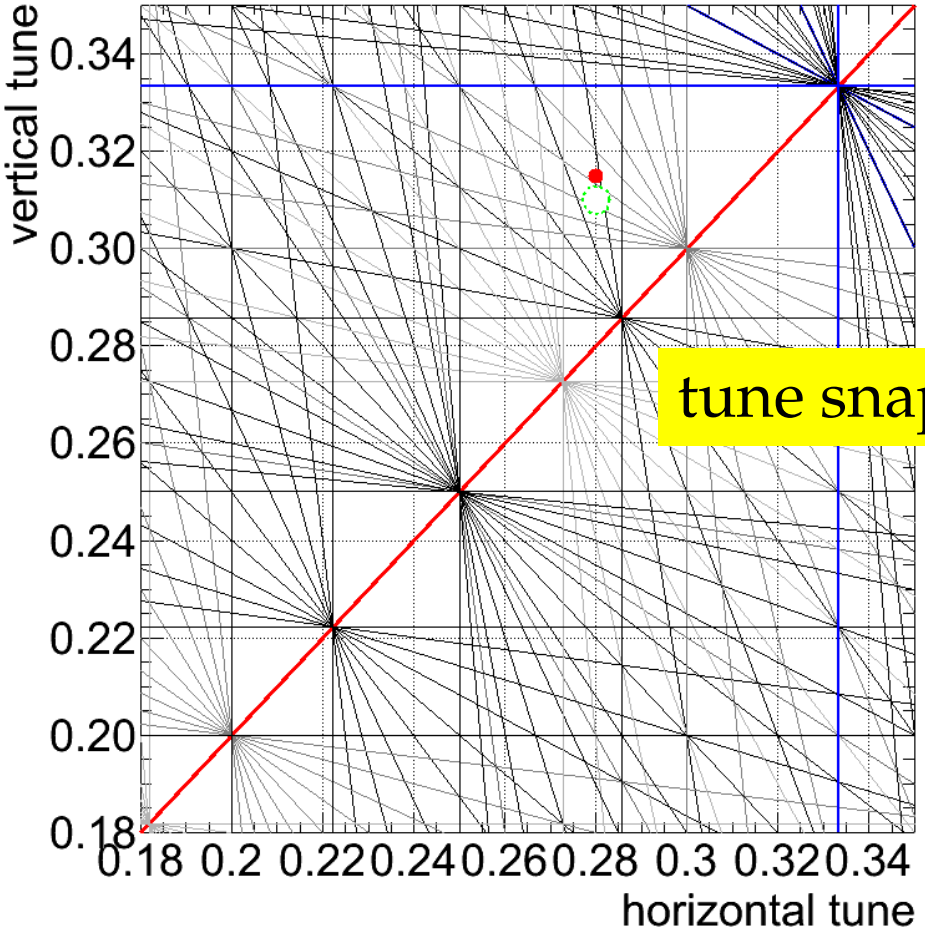
MAX LOSSES / BCT (3RD RAMP)



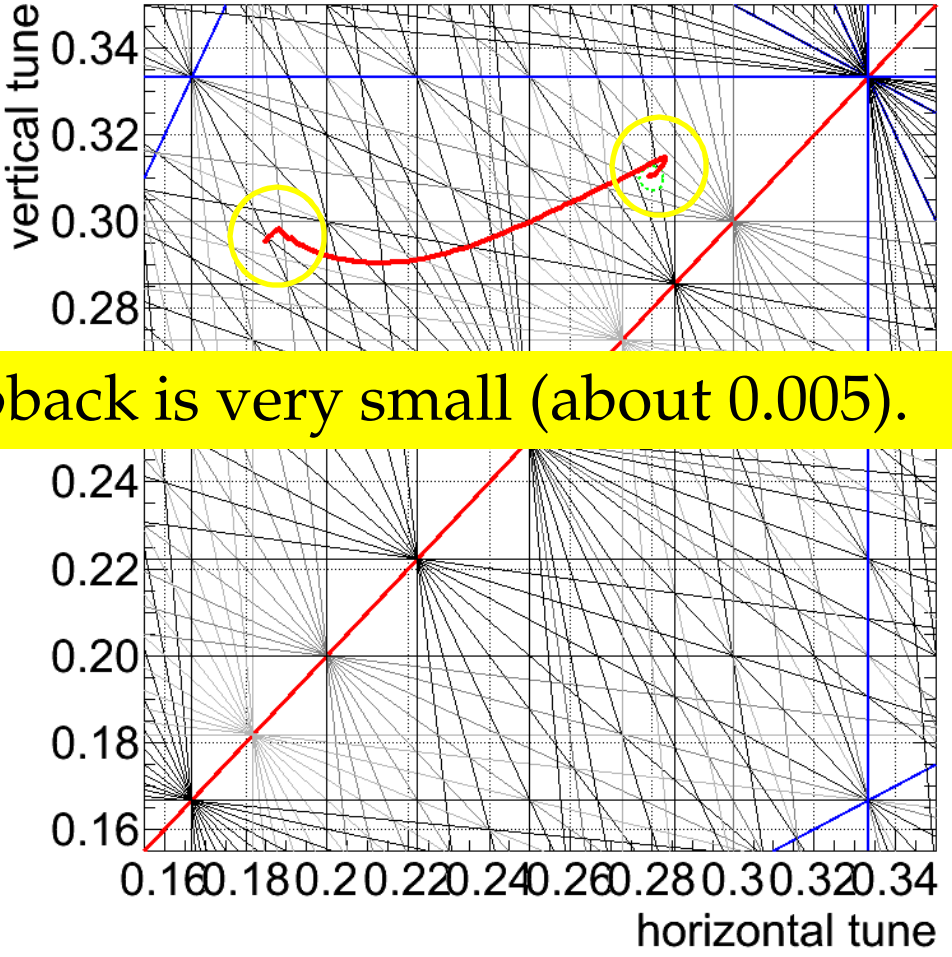


4TH RAMP (B2 WITH FF+FB)

What we saw in the CCC

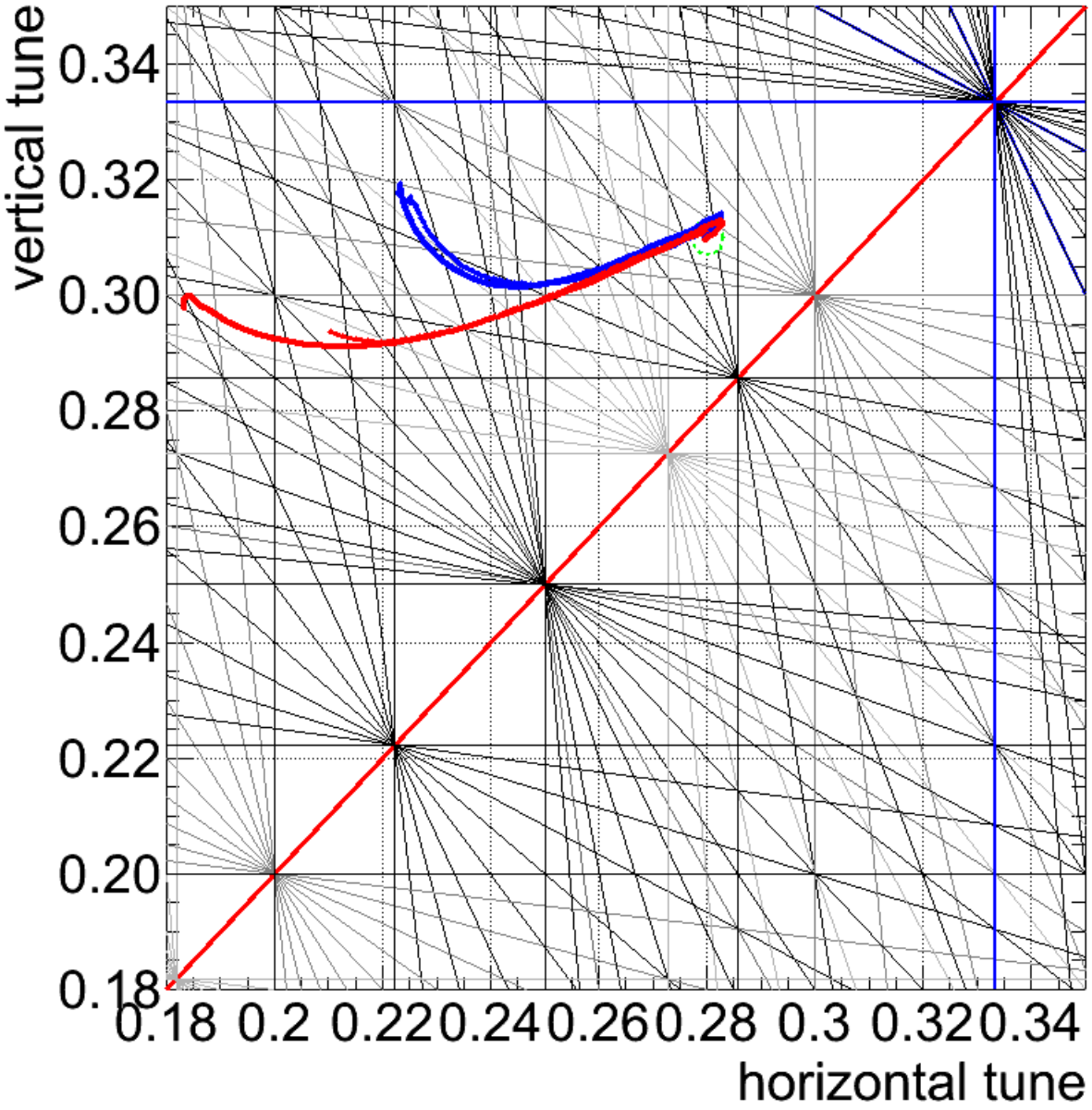


Reconstructed bare tunes B2

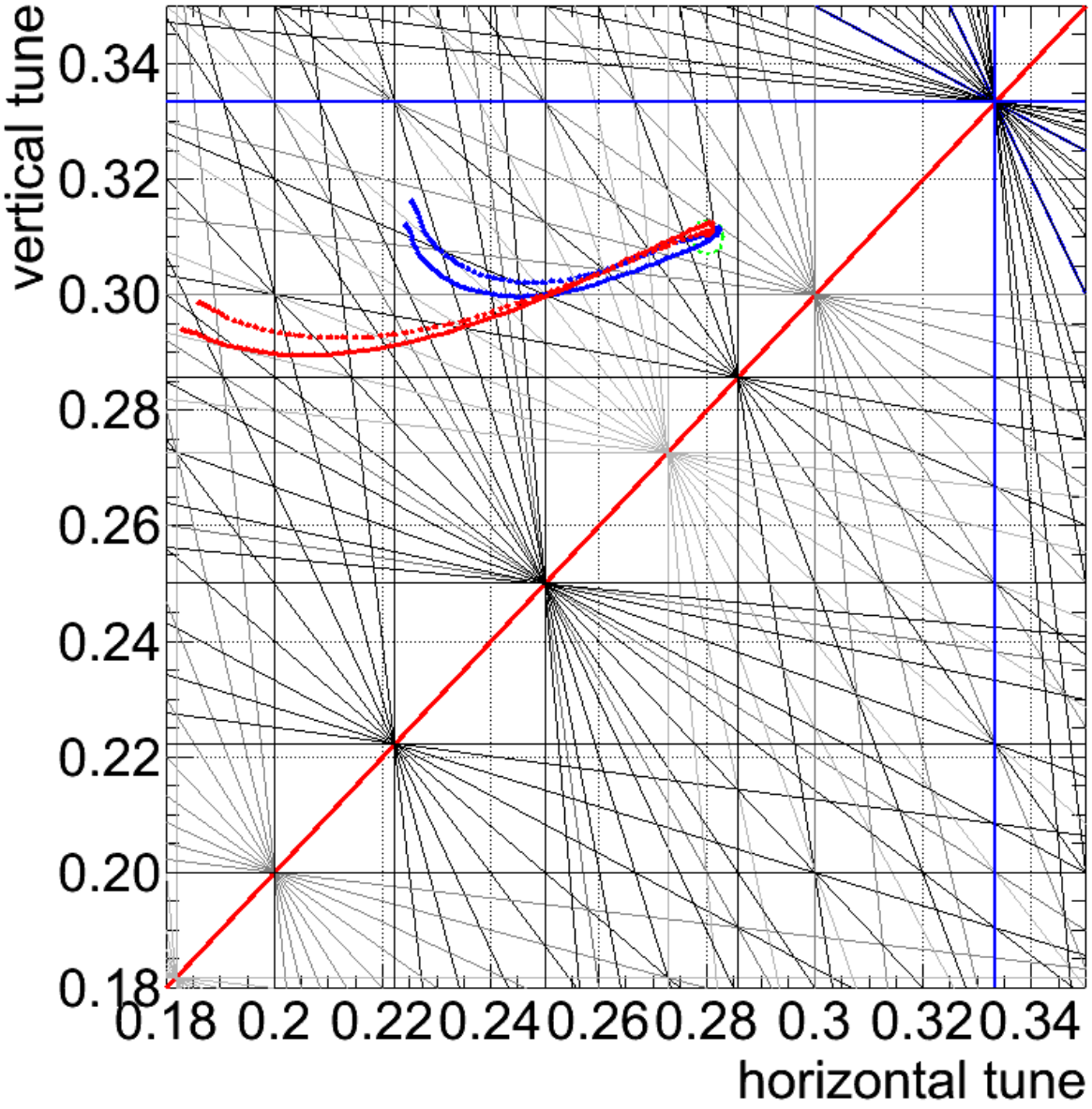


tune snapback is very small (about 0.005).

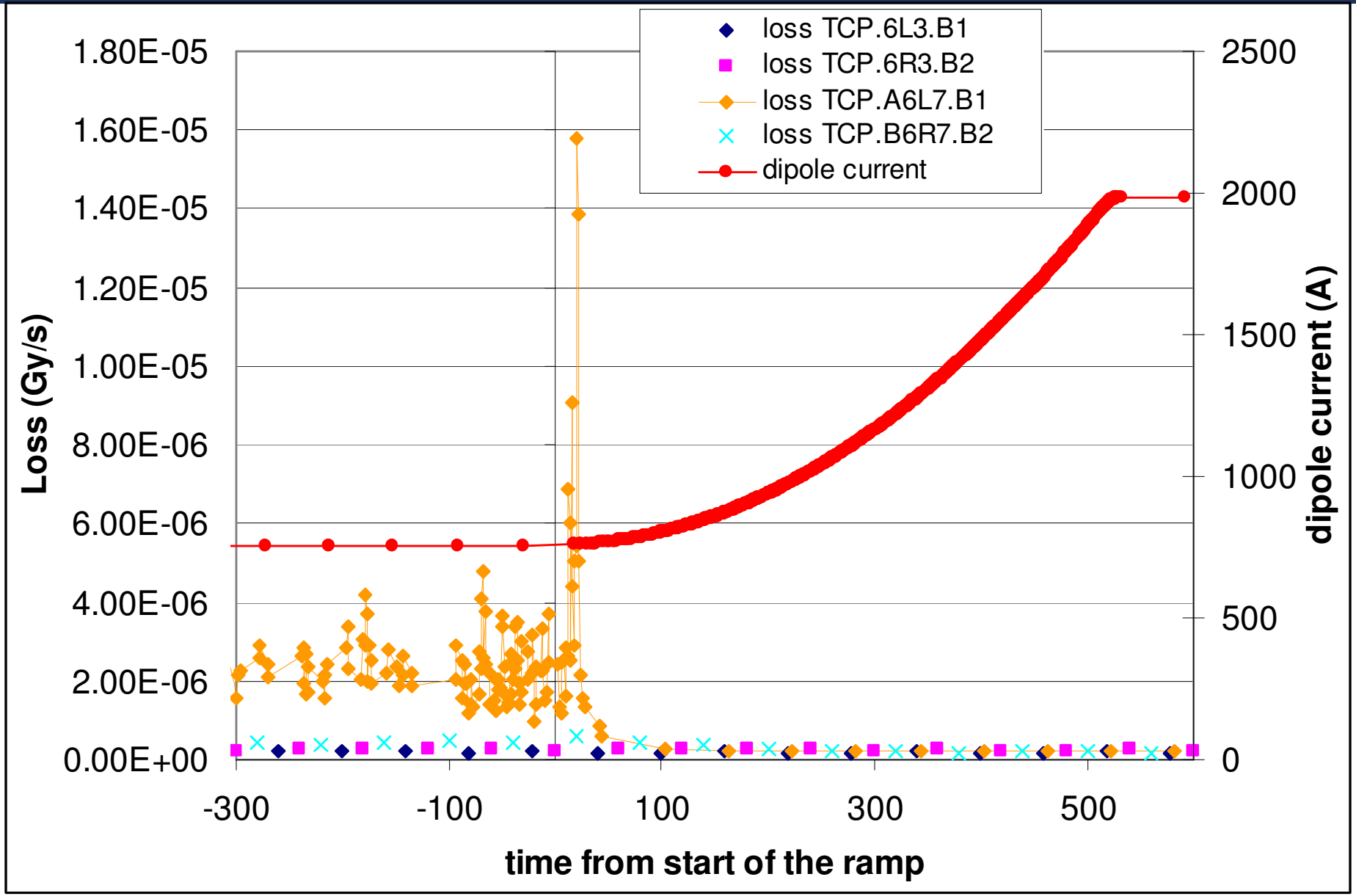
RAMPS 5 AND 6


vertical tune
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.18 0.2 0.22 0.24 0.26 0.28 0.3 0.32 0.34
horizontal tune

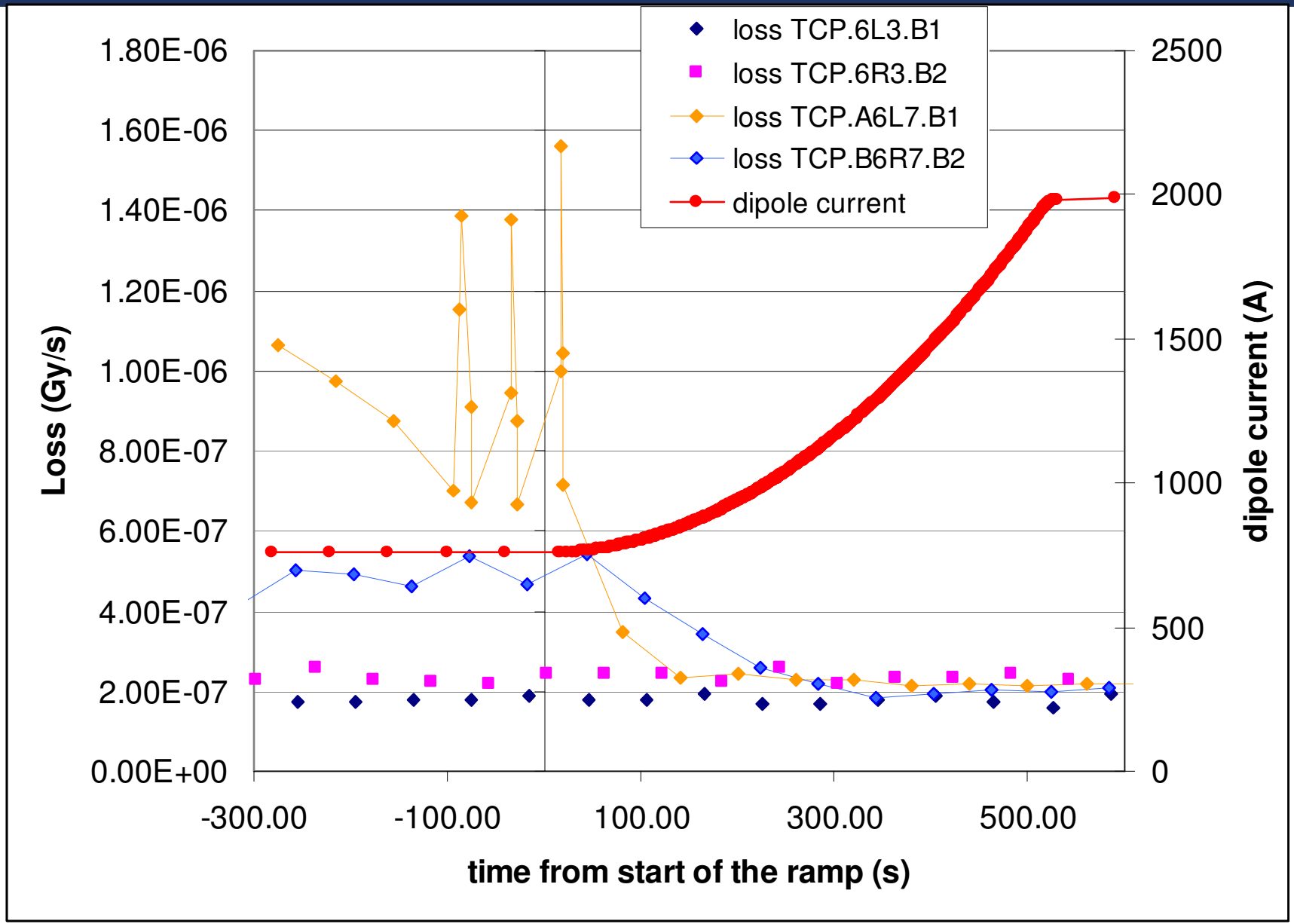
RAMPS 7 AND 8


vertical tune
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.18 0.2 0.22 0.24 0.26 0.28 0.3 0.32 0.34
horizontal tune

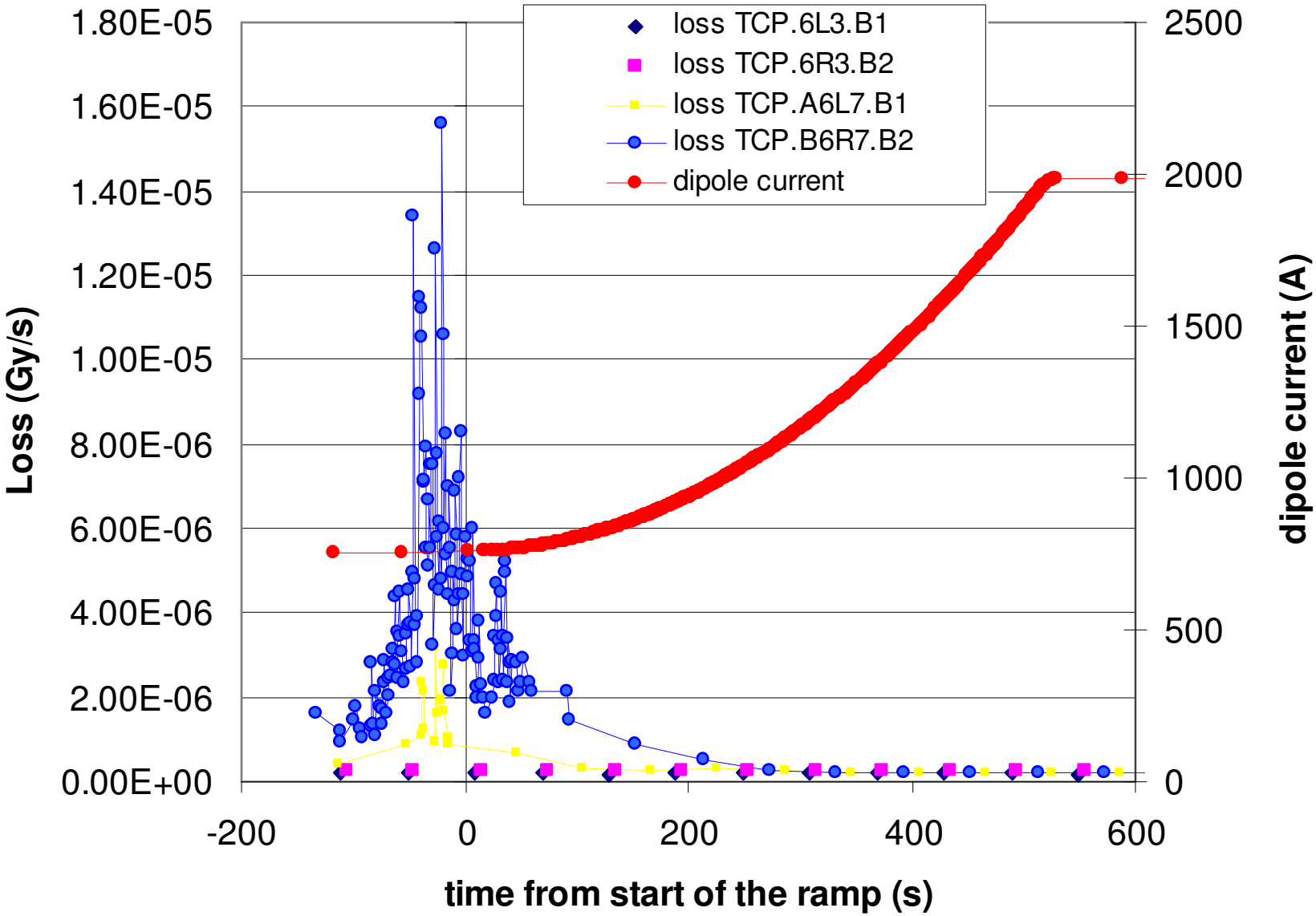
"PRIMARY" LOSS 5TH RAMP



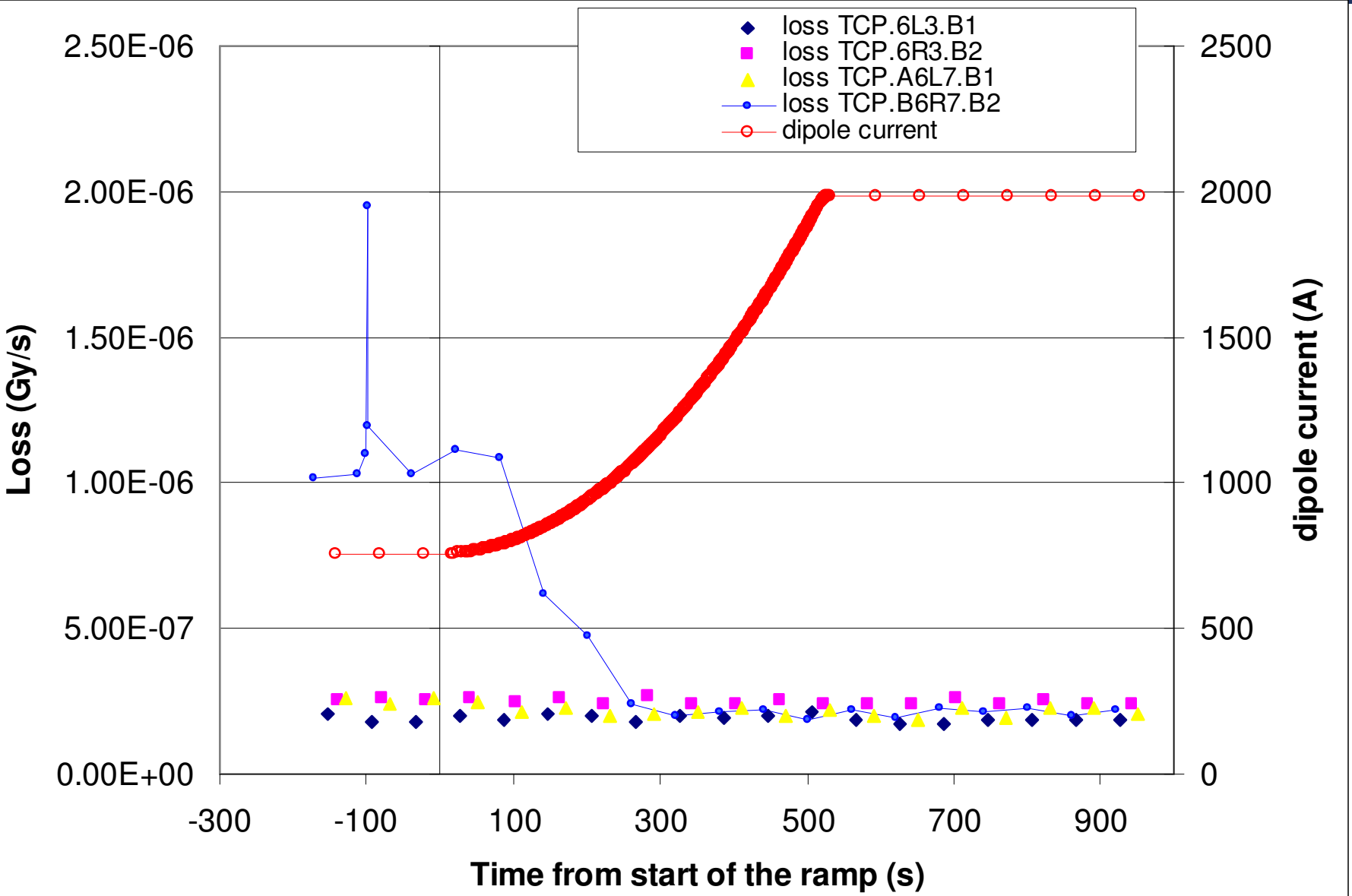
"PRIMARY" LOSS 6TH RAMP



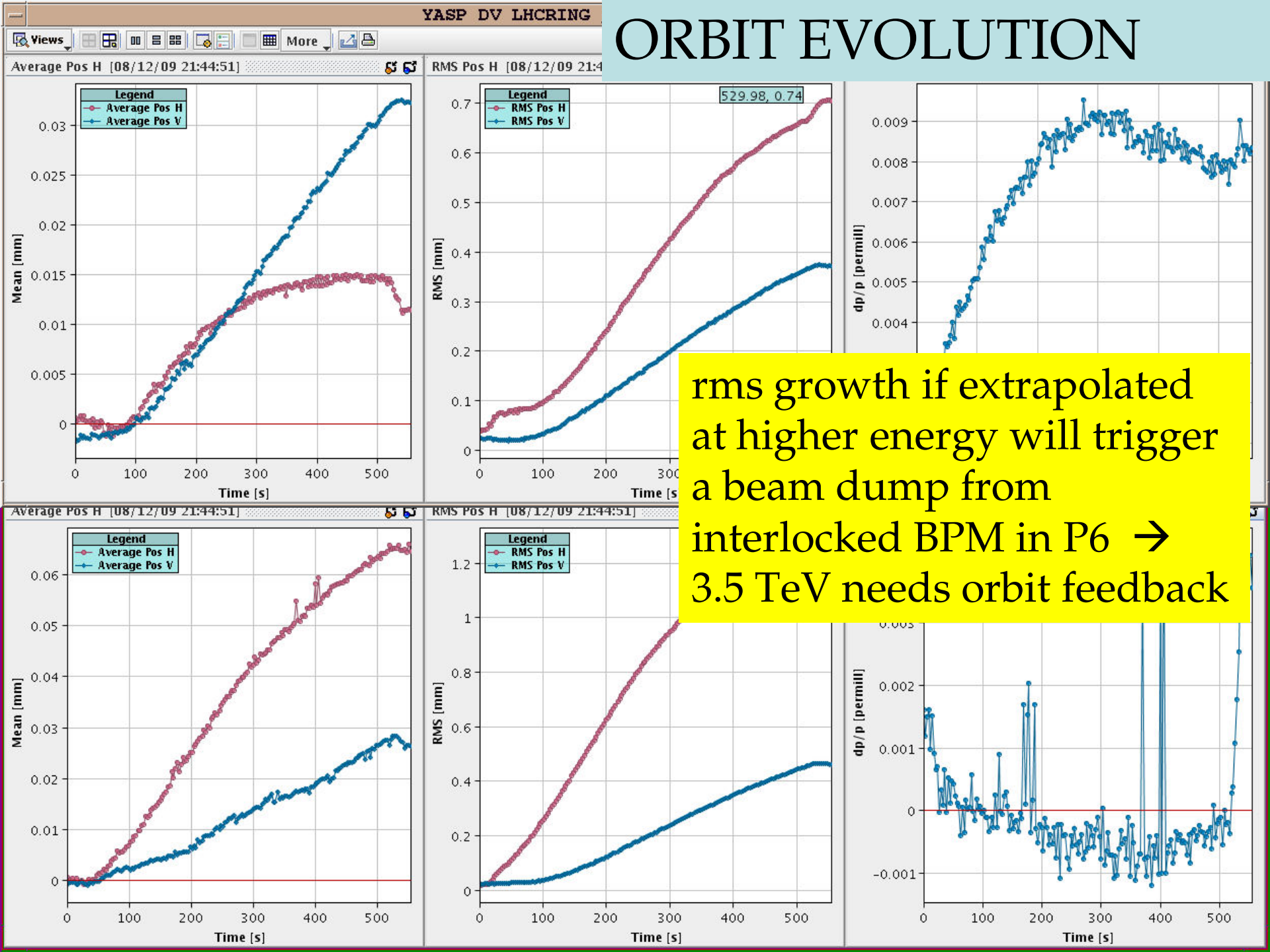
"PRIMARY" LOSS 7TH RAMP



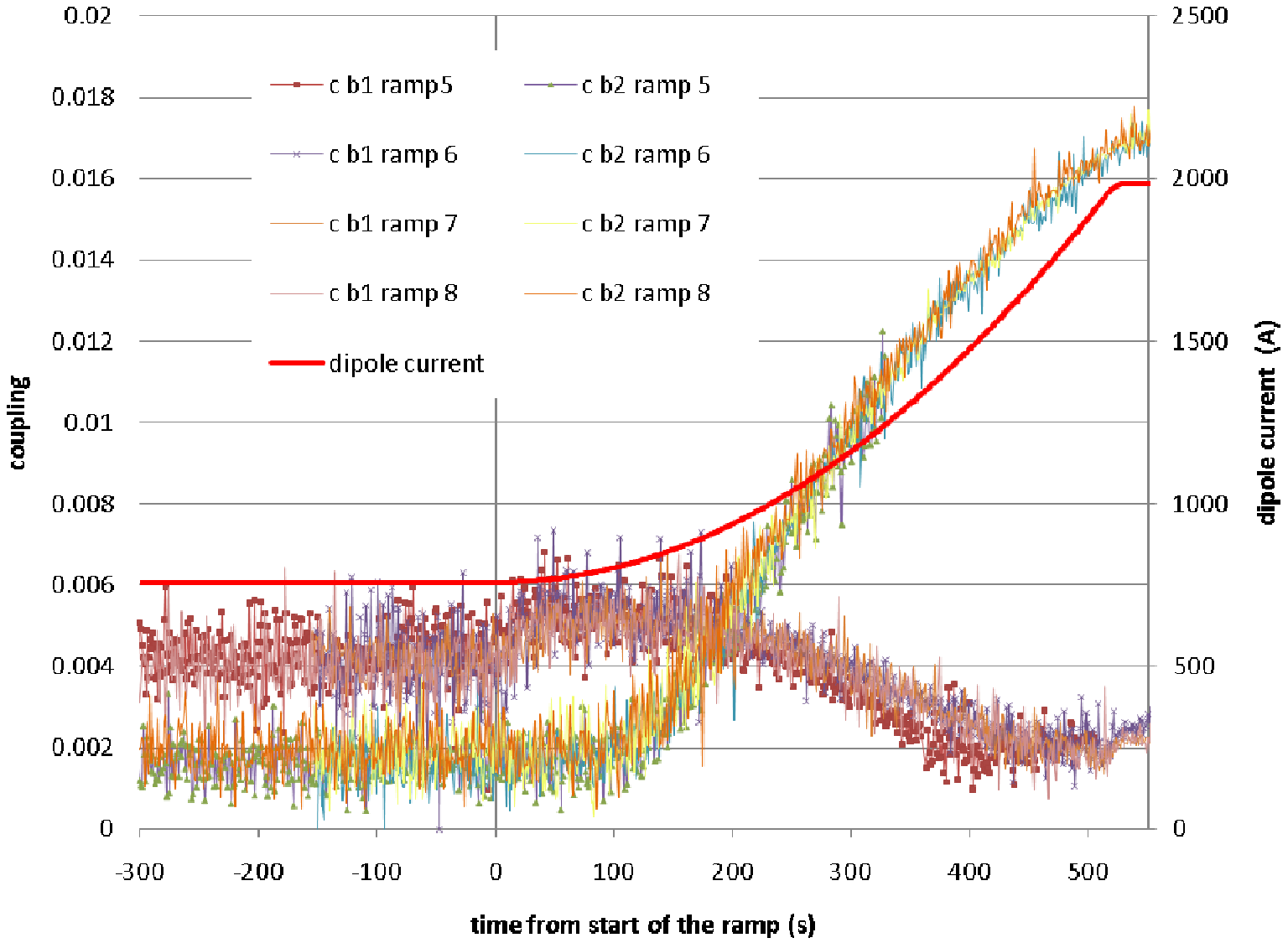
"PRIMARY" LOSS (8TH RAMP)



ORBIT EVOLUTION



COUPLING EVOLUTION



CHROMATICITY EVOLUTION

- Not measured continuously (problem of tune "noise")

- Q' measurements before and after the last ramps:
  - Ramp #4 → beam 1 $\Delta Q'_H \approx -6.3$, $\Delta Q'_V \approx -14.7$
  - Ramp #5 → beam 1 $\Delta Q'_H \approx -2.7$, $\Delta Q'_V \approx -13.2$
  - Ramp #6 → beam 1 $\Delta Q'_H \approx -3.0$, $\Delta Q'_V \approx -10.8$
  - Ramp #6 → beam 2 $\Delta Q'_H \approx -9.2$, $\Delta Q'_V \approx -8.1$

- Possible sources: imperfect b_3 corrections for snapback and magnetization components, hysteresis of MS, …

DISCUSSION

- Possible sources of Q evolution during the ramp:
  - B_2/B_1 tracking error (visible during decay and snapback)
  - Feed down from CO in the main sextupoles (was checked with measured orbit and betas, effect is small, $\approx 10^{-4}$).
  - Feed down from CO in random (uncorrected) b_3 of dipoles (also checked with measured orbit and found small $\approx 10^{-3}$)
  - MCS misalignments and powering. From preliminary calculations this appears to be a good candidate to explain the tune drift.
  - Tracking error MCS-b_3 also gives a contribution
- The effect is bigger for beam 2, as it is the case for orbit and coupling (…?)

CONCLUSIONS AND ISSUES

- Ramping was easier than anticipated, however several issues are still on the table:
  - Beam parameters evolution not fully understood (in particular the differences between beams)
  - Fidel corrections to be updated with best estimate for snapback correction
  - Disentangle feed forward and TF updates
  - Orbit feedback at least in the dump and collimation regions
  - Chromaticity measurement on line
  - Incorporate incorporation (in the sequence)
  - RF: commissioning of emittance blow up, global orbit FB
  - Link logging of BI to beam operation through mode
  - Ramp with separation bumps