CPS/SPS MD with 50 ns beam of 2011-05-11

T. Bohl

2011-06-16

Contents

MD set-up

Participants

T. Argyropoulos, H. Damerau, J.F. Esteban Muller, G. Rumolo, E. Shaposhnikova, SPS OP Crew, ...

Special contributions:

- CPS RF control: H. Damerau
- bunch profile acquisition: T. Argyropoulos, J.F. Esteban Muller
- bunch profile analysis: J.F. Esteban Muller

MD set-up

Aim and procedures

Aim:

- vary longitudinal parameters of injected and observe consequences in SPS

Observe:

- BCT: LARGER data of injected intensity, capture loss, transmission, intensity at flat top
- bunch profile data (APWL via FO link): bunch length at various times in cycle; stability at flat top only
- IF Out: individual bunch phase data at flat bottom/end of ramp/flat top (stability)

Issues:

- uncoordinated changes of beam and machine parameters
- incremental approach: miss parameter combinations

Chronology

Bunch length and bunch phase

Case	Time	Conditions					Bunch Length	Bunch Phase
		ε[eVs]	n_{80}	BUP	Q'_{H}	G	$\Delta 4\sigma$[ns]	Stability
0	20:33H	0.35	2	on	I	10.0	0.99 ± 0.10	
1	21:35H	0.41	3	on	I	10.0	0.83 ± 0.08	not good
2	21:50H	0.41	2	on	I	10.0	0.40 ± 0.19	rel. good
3a	22:02H	0.35	2	on	I	10.0	$1,00 \pm 0.10$	bad
3b	22:24H	0.35	2	on^{as}	I	10.0	0.75 ± 0.15	
4	22:31H	0.38	2	on	I	10.0		
4a	22:36H	0.38	2	on^{a}	I	10.0	0.95 ± 0.15	
4a'	22:45H	0.38	2	on	II	10.0	0.77	good
4b	22:47H	0.38	2	on^{a}	II	10.0	0.80 ± 0.12	
4c	22:58H	0.38	2	off	II	10.0	0.84 ± 0.18	bad
4d	23:21H	0.38	2	off	III	10.0	0.72 ± 0.11	bad
5	23:36H	0.41	2	off	III	10.0		
5a	23:38H	0.41	2	off	III	10.0	0.53 ± 0.26	
5b	23:42H	0.41	2	off	III	3.0	0.23 ± 0.18	
6	23:51H	0.40	3	off	III	10.0		
6a	23:55H	0.40	3	off	III	10.0	0.35 ± 0.22	good
6b	00:02H	0.40	3	off	III	4.0	0.18 ± 0.08	

Chronology

Intensity data

Case	Time	Conditions					$N_{Q,1}$ [10^{11}]	L	$N_{Q,2}$ [10^{11}]	T
		ε[eVs]	n_{80}	BUP	Q'_H	G				
0	20:33H	0.35	2	on	I	10.0	1.4	3%	1.3	97%
1	21:35H	0.41	3	on	I	10.0	1.4	3%	1.3	96%
2	21:50H	0.41	2	on	I	10.0	1.4	4%	1.3	95%
3a	22:02H	0.35	2	on	I	10.0	1.4	2%	1.3	97%
3b	22:24H	0.35	2	on^{as}	I	10.0	1.6	7%	1.5	91%
4	22:31H	0.38	2	on	I	10.0				
4a	22:36H	0.38	2	on^{a}	I	10.0	1.7	7%	1.5	91%
4a'	22:45H	0.38	2	on	II	10.0	1.7	3%	1.6	95%
4b	22:47H	0.38	2	on^{a}	II	10.0	1.7	3%	1.6	95%
4c	23:14H	0.38	2	off	II	10.0	1.7	3%	1.6	95%
4d	23:21H	0.38	2	off	III	10.0	1.7	3%	1.6	95%
5	23:36H	0.41	2	off	III	10.0				
5a	23:38H	0.41	2	off	III	10.0	1.7	4%	1.6	95%
5b	23:42H	0.41	2	off	III	3.0	1.7	6%	1.6	93%
6	23:51H	0.40	3	off	III	10.0				
6a	23:55H	0.40	3	off	III	10.0	1.7	3%	1.6	96%
6b	00:02H	0.40	3	off	III	4.0	1.7	4%	1.6	96%

Chronology

Analysis

- for $\varepsilon = 0.41$ eVs reducing the 80 MHz RF voltage improved the quadrupole stability at flat top (Case 1 to Case 2) at the expense of a slightly worse transmission
- going from the low to the high intensity case, the quadrupole instability at flat top grew worse, $\Delta 4\sigma = 0.4$ ns increased to $\Delta 4\sigma = 1.0$ ns (Case 2 to Case 3a)
- for the high intensity case, it was the change of Q'_{H} which improved the transmission such that it was close to the one for the low intensity case (Case 4a to Case 4a'); this did, however, not affect the quadrupole instability at flat top (Case 4a to Case 4a')
- next significant improvement of the quadrupole stability at flat top came with the increase of longitudinal emittance (Case 4d to Case 5a) and a further improvement by lowering the Phase Loop Amp lifer Gain setting (Case 5a to Case 5b)

Chronology

Analysis, cont'd

- with the same longitudinal emittance but a higher 80 MHz RF voltage another step in improvement was made (compare Case 5a with Case 6a) and again with a lower Phase Loop Amplifier Gain setting (Case 6a to Case 6b)
- whereas the lower Phase Loop Amplifier Gain setting for the Case 5b led to a larger capture loss this was not anymore the case when using the higher 80 MHz RF voltage in the CPS, Case 6b

Performance ranking

Bunch length and bunch phase

Case	Time	Conditions					Bunch Length	Bunch Phase
		ε[eVs]	n_{80}	BUP	Q'_{H}	G	$\Delta 4\sigma$[ns]	Stability
6b	00:02H	0.40	3	off	III	4.0	0.18 ± 0.08	
5b	23:42H	0.41	2	off	III	3.0	0.23 ± 0.18	
6a	23:55H	0.40	3	off	III	10.0	0.35 ± 0.22	good
2	21:50H	0.41	2	on	I	10.0	0.40 ± 0.19	rel. good
5a	23:38H	0.41	2	off	III	10.0	0.53 ± 0.26	
4d	23:21H	0.38	2	off	III	10.0	0.72 ± 0.11	bad
3b	22:24H	0.35	2	on^{as}	I	10.0	0.75 ± 0.15	
4a'	22:45H	0.38	2	on	II	10.0	0.77	good
4b	22:47H	0.38	2	on^{a}	II	10.0	0.80 ± 0.12	
1	21:35H	0.41	3	on	I	10.0	0.83 ± 0.08	not good
4c	22:58H	0.38	2	off	II	10.0	0.84 ± 0.18	bad
4a	22:36H	0.38	2	on^{a}	I	10.0	0.95 ± 0.15	
0	20:33H	0.35	2	on	I	10.0	0.99 ± 0.10	
3a	22:02H	0.35	2	on	I	10.0	$1,00 \pm 0.10$	bad

Performance ranking

Intensity data

Case	Time	Conditions					$N_{Q,1}$ [10^{11}]	L	$N_{Q,2}$ [10^{11}]	T
		ε[eVs]	n_{80}	BUP	Q'_H	G				
3a	22:02H	0.35	2	on	I	10.0	1.4	2%	1.3	97%
0	20:33H	0.35	2	on	I	10.0	1.4	3%	1.3	97%
1	21:35H	0.41	3	on	I	10.0	1.4	3%	1.3	96%
2	21:50H	0.41	2	on	I	10.0	1.4	4%	1.3	95%
4a'	22:45H	0.38	2	on	II	10.0	1.7	3%	1.6	95%
4b	22:47H	0.38	2	on[a]	II	10.0	1.7	3%	1.6	95%
4c	22:58H	0.38	2	off	II	10.0	1.7	3%	1.6	95%
6a	23:55H	0.40	3	off	III	10.0	1.7	3%	1.6	96%
6b	00:02H	0.40	3	off	III	4.0	1.7	4%	1.6	96%
4d	23:21H	0.38	2	off	III	10.0	1.7	3%	1.6	95%
5a	23:38H	0.41	2	off	III	10.0	1.7	4%	1.6	95%
5b	23:42H	0.41	2	off	III	3.0	1.7	6%	1.6	93%
3b	22:24H	0.35	2	on[as]	I	10.0	1.6	7%	1.5	91%
4a	22:36H	0.38	2	on[a]	I	10.0	1.7	7%	1.5	91%

Performance summary

Low intensity

Optimal transmission AND optimal stability: not seen.

- Cases 3a, 0, 1: intensity ranking vs stability ranking: not compatible
- BUP not optimal?
- Case 2: compromise

Performance summary

High intensity

Main

- bunch phase stability at flat top correlates with $\Delta 4\sigma$
- optimal in terms of $\Delta 4\sigma$: Cases 6b, 5b, 6a (Case 2: low intensity)
- BUP not optimal?
- transmission worse than for low intensity case
- individual bunches dipole unstable at flat bottom (quadrupole: no data)

Aux

- BUP off: less stability at flat top (nevertheless it was kept off)

Examples

Low intensity

- best stability at flat top: Case 2

High intensity

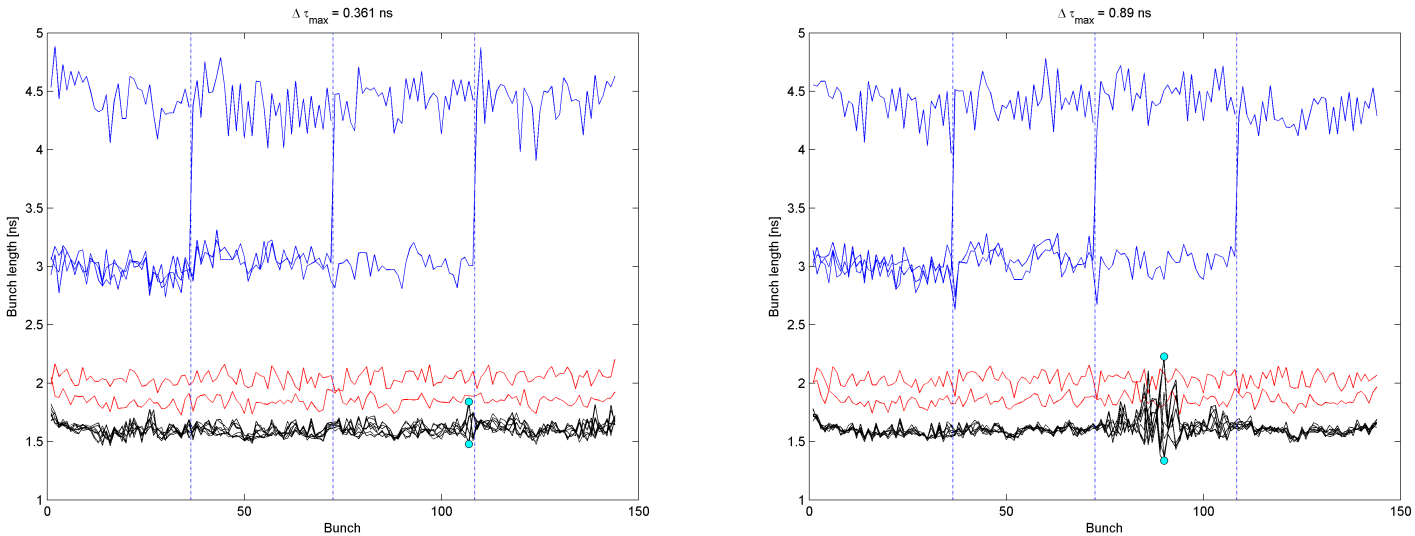
- worst stability at flat top: Case 3a
- best stability at flat top: Case 5 and Case 6
- comparison of Phase Loop Gain settings
  - Case 5a/5b
  - Case 6a/6b

More examples in Note-2011-20.

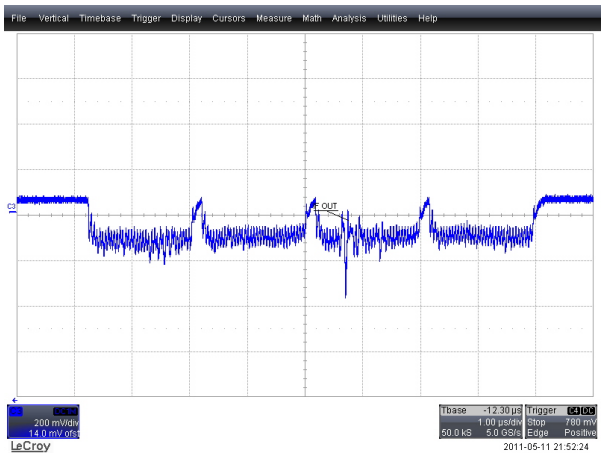
Examples

Case 2

Bunch length data. Best and worst case. Courtesy J.F. Esteban Muller:



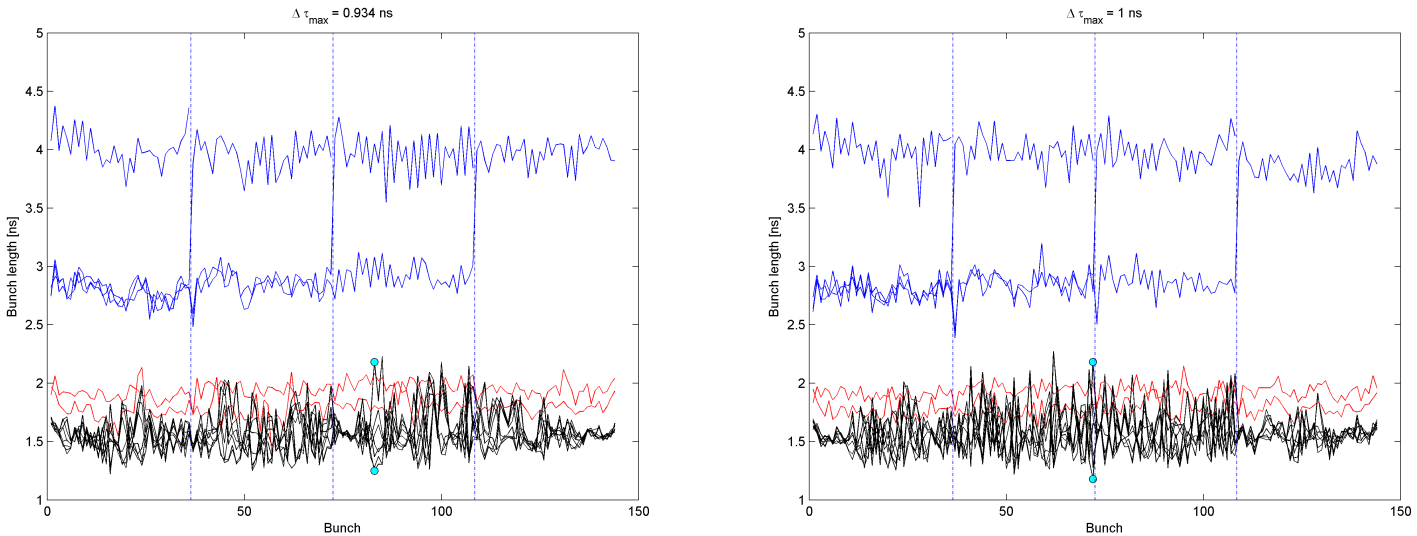
IF OUT at 21:52H. 100 $\mathrm{ps}/100\ \mathrm{mV}$. Vertical scale 200 mV/div:



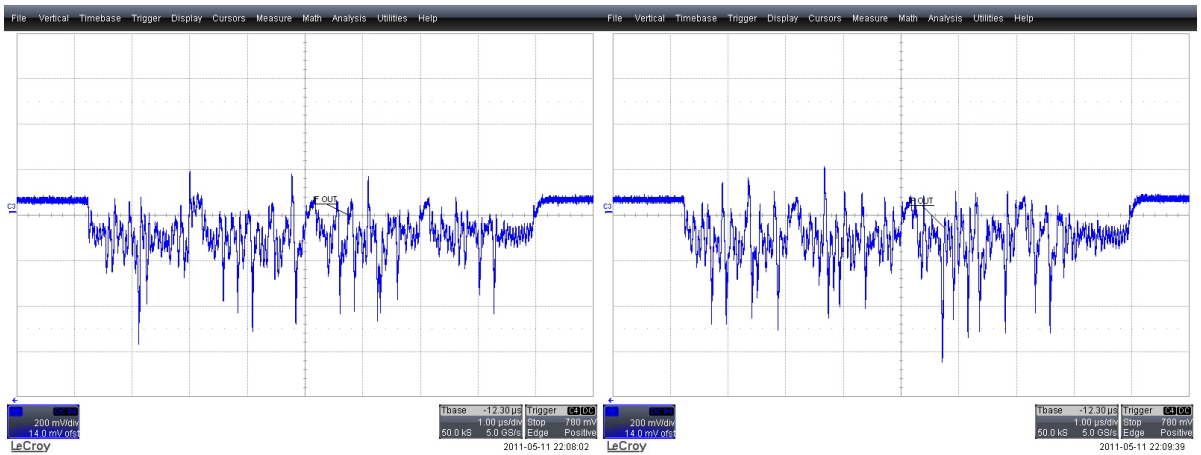
Examples

Case 3a

Bunch length data. Typical examples. Courtesy J.F. Esteban Muller:



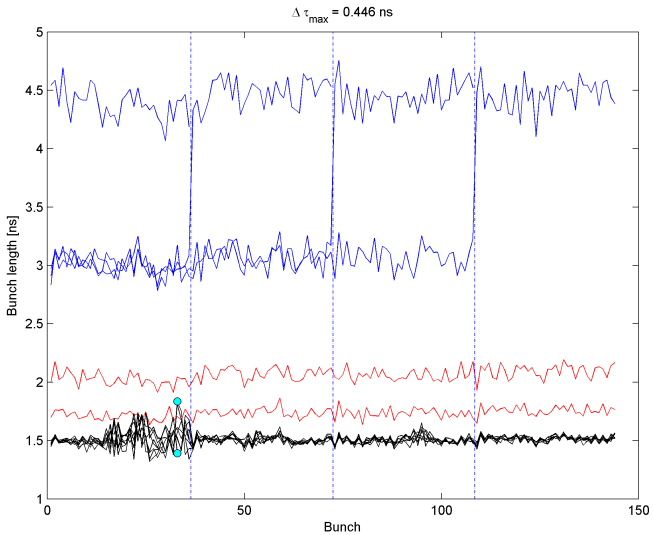
IF OUT at 22:08H, 22:09H. 100 $\mathrm{ps}/100\ \mathrm{mV}$. Vertical scale 200 mV/div:

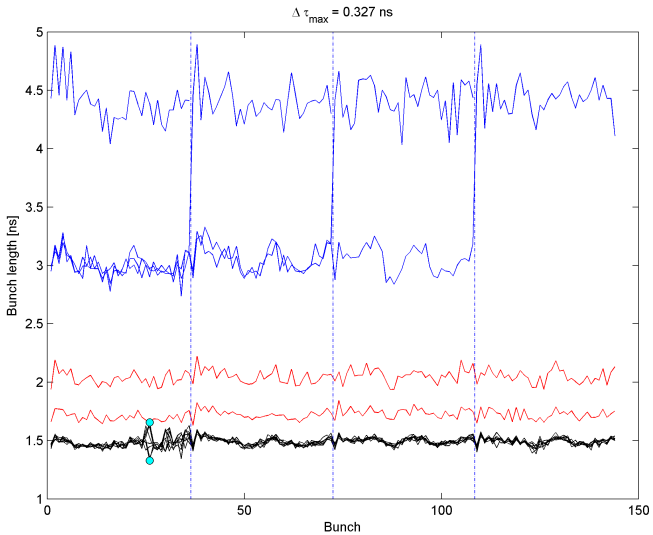


Examples

Case 5a/5b

Bunch length data for two Phase Loop Amplifier Gain settings. Case 5a, $G = 10.0$, left and Case 5b, $G = 3.0$, right. 23:43H (left), 23:40H (right), 2011-05-11. Courtesy J.F. Esteban Muller.

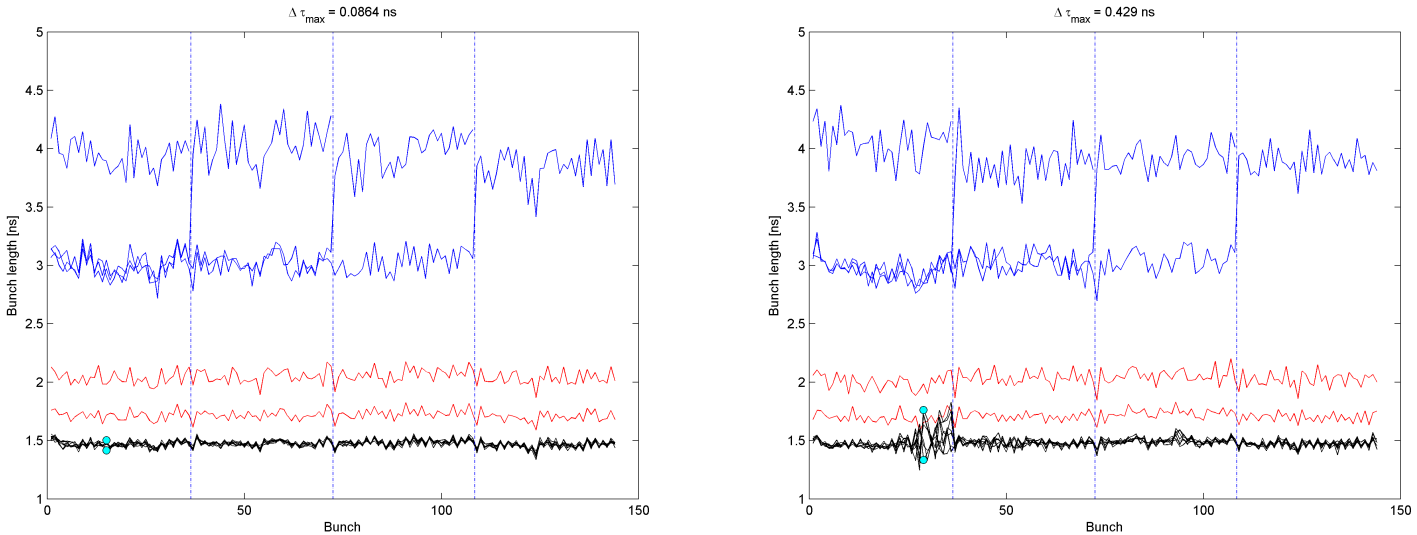




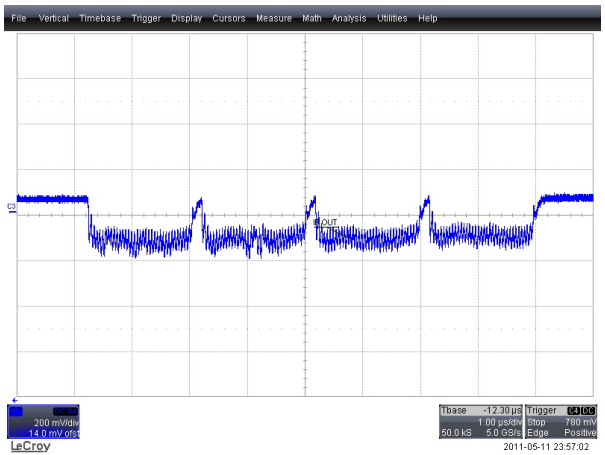
Examples

Case 6a

Bunch length data. Best and worst case. Courtesy J.F. Esteban Muller:



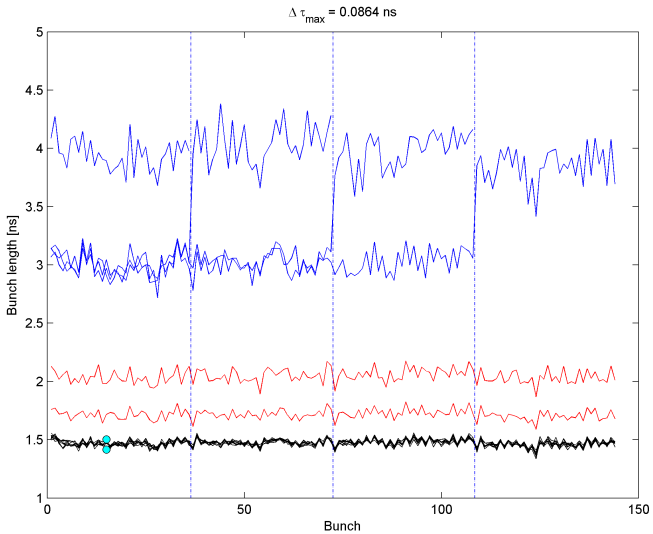
IF OUT at 23:57H. 100 $\mathrm{ps}/100\ \mathrm{mV}$. Vertical scale 200 mV/div:

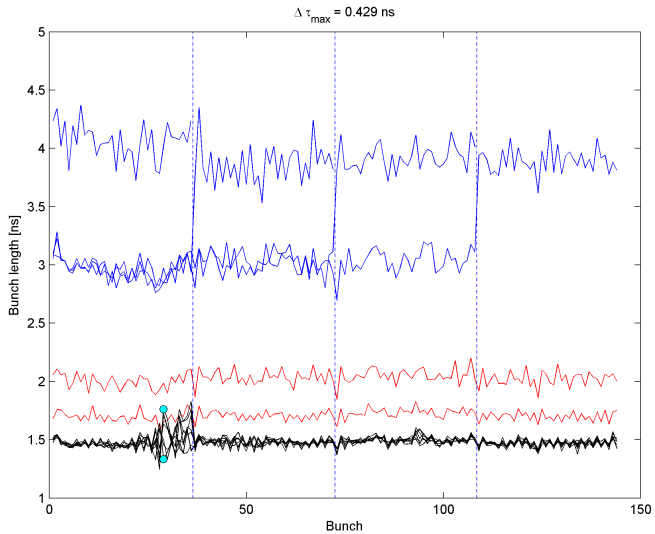


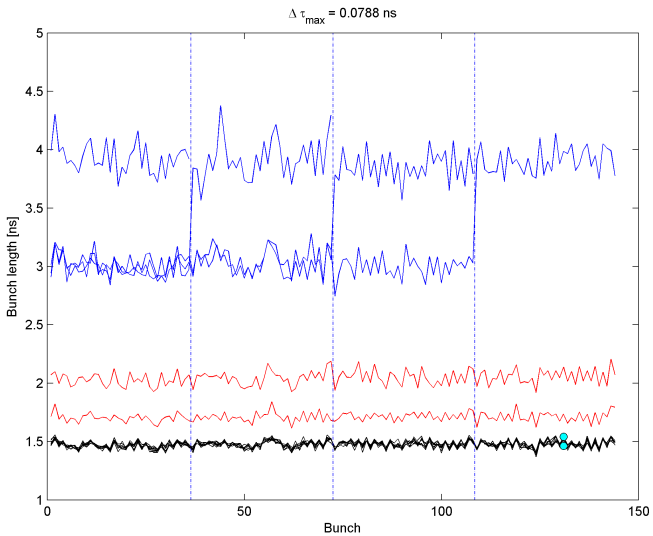
Examples

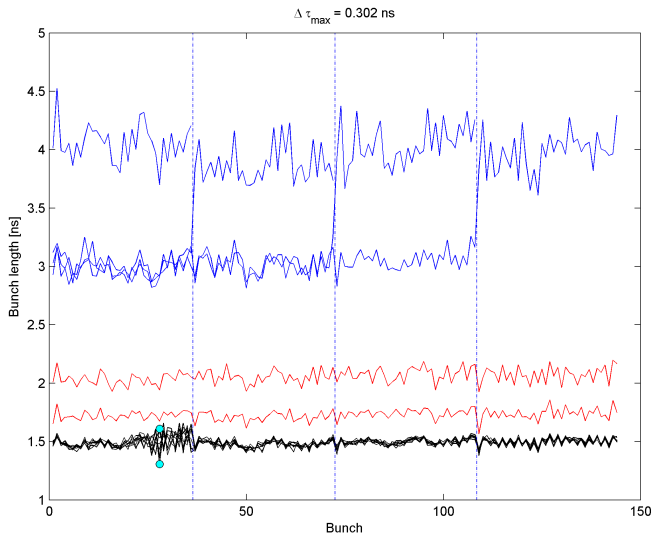
Case 6a/6b: Two Phase Loop Amplifier Gain settings

Bunch length data. Top: Case 6a, $G = 10.0$. Bottom: Case 6b, $G = 4.0$. Best and worst example for each case shown. Courtesy J.F. Esteban Muller.









Conclusions

Low intensity

- optimal transmission AND optimal stability: no
- optimal $\Delta 4\sigma$ worse than for high intensity case
- BUP not optimal, Phase Loop Gain setting not optimal?

High intensity

- optimal $\Delta 4\sigma$ with $\varepsilon = 0.4$ eVs (larger than nominal) and $n_{80} = 3$ (larger than nominal)