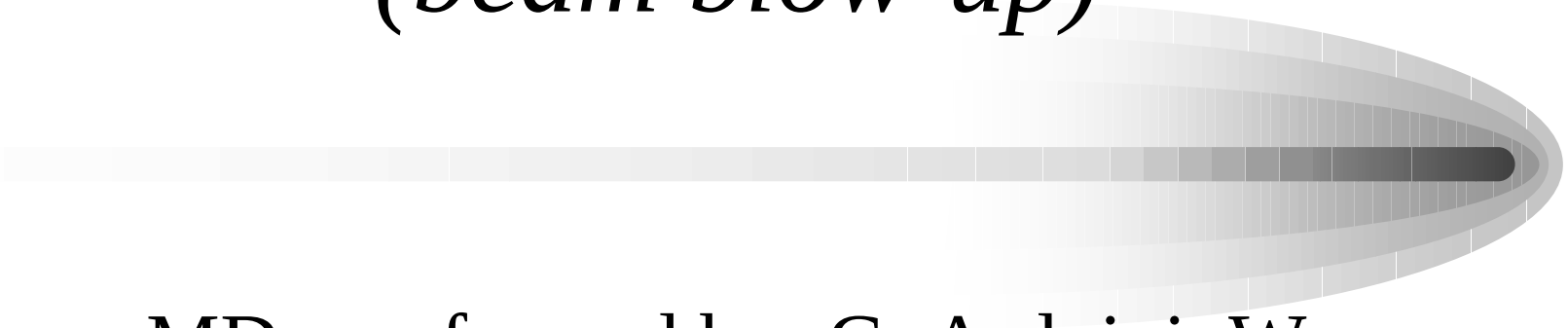
LHC beam transverse stability (beam blow-up)

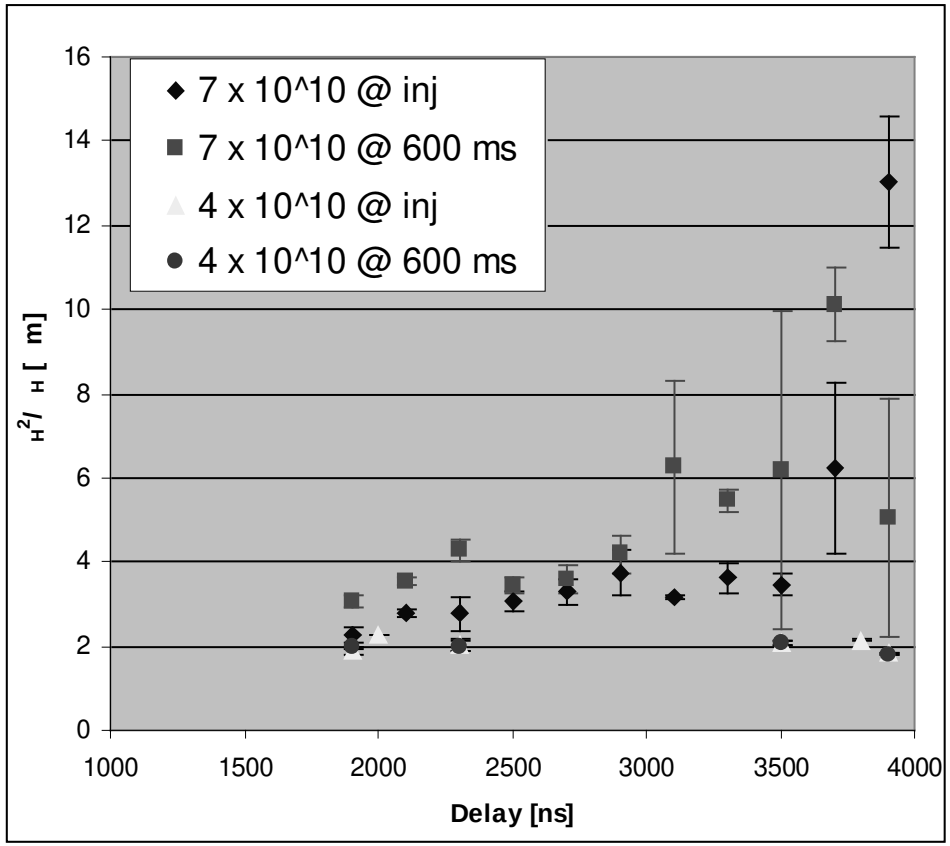


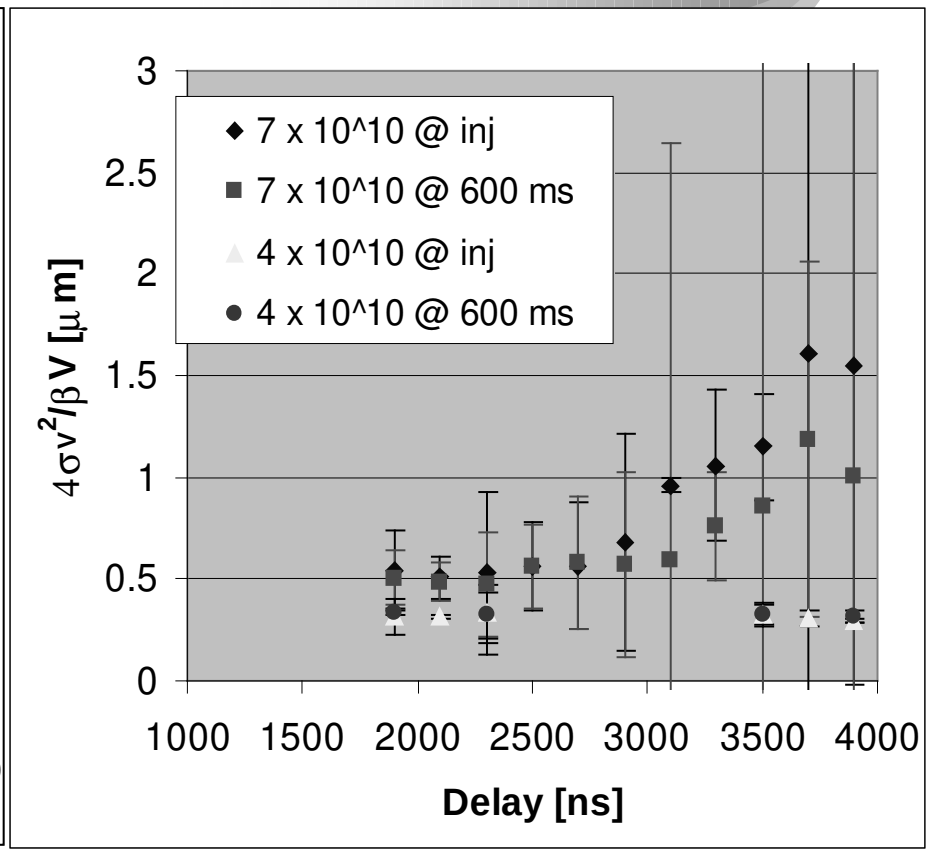
MDs performed by: G. Arduini, W. Höfle, G. Rumolo, F. Zimmermann

TSTLHC on MD cycle (05/05/2000)

- 84 bunches (τ_{bunch} ~ 5 ns)
- Horizontal damper 1 ON - dampers 2,3,4 OFF
- Standard tunes
- Q'_H ~ 0.0 / Q'_V ~ 0.03
- No octupolar component (-0.8/-0.8)
- Horizontal damper 1 ON - dampers 2,3,4 OFF
- Tiny losses (5 %)

TSTLHC on MD cycle

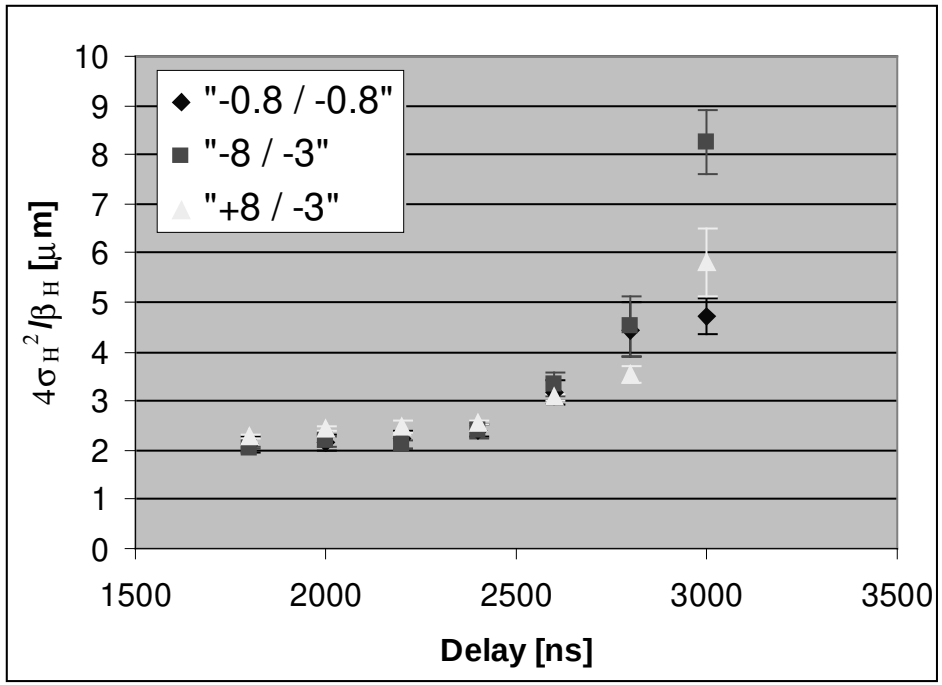


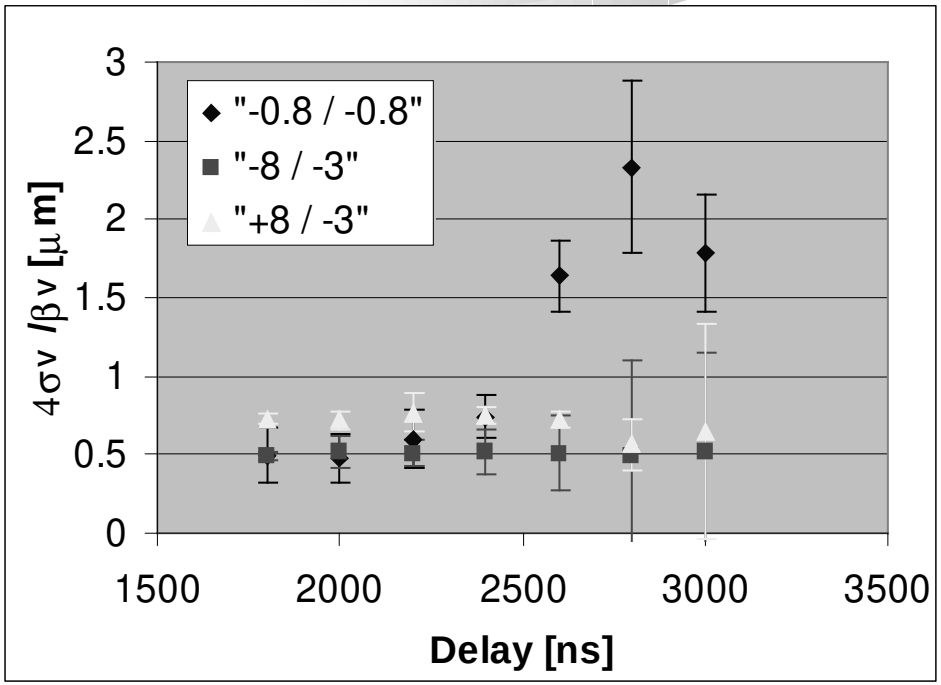


MDRF on MD cycle ($8.3x10^{10}$p/b) (22/08/2000)

- 48 bunches (τ_{bunch} ~ 4 ns)
- Q_H=0.635 / Q_V=0.567 - QH' ~ 0.03 Qv' ~ 0.03
- All dampers OFF
- SC beam dumps (cav. 4) ➔ beam for 50 ms.
- Going from the head to the tail of the batch tails develop and then also the core of the beam is blown-up

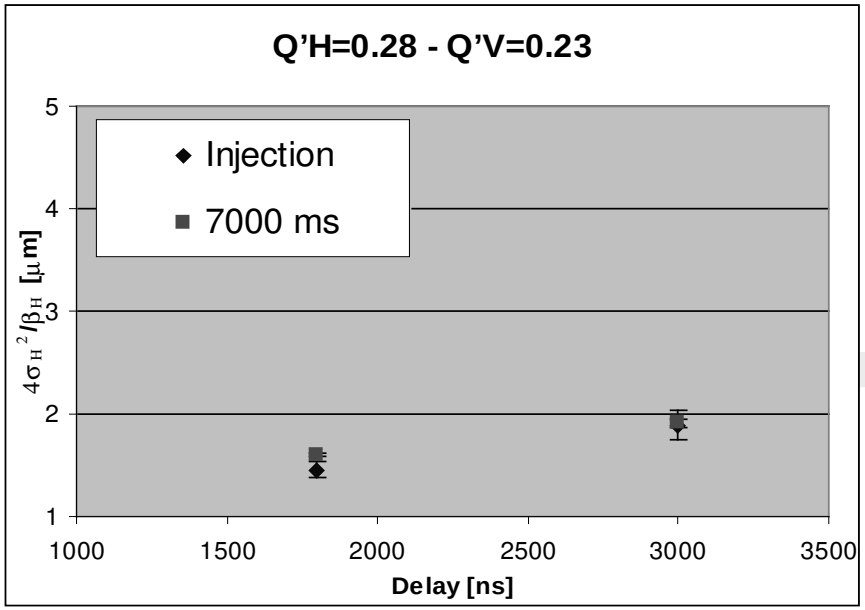
MDRF on MD cycle ($8.3x10^{10}$p/b) (22/08/2000)

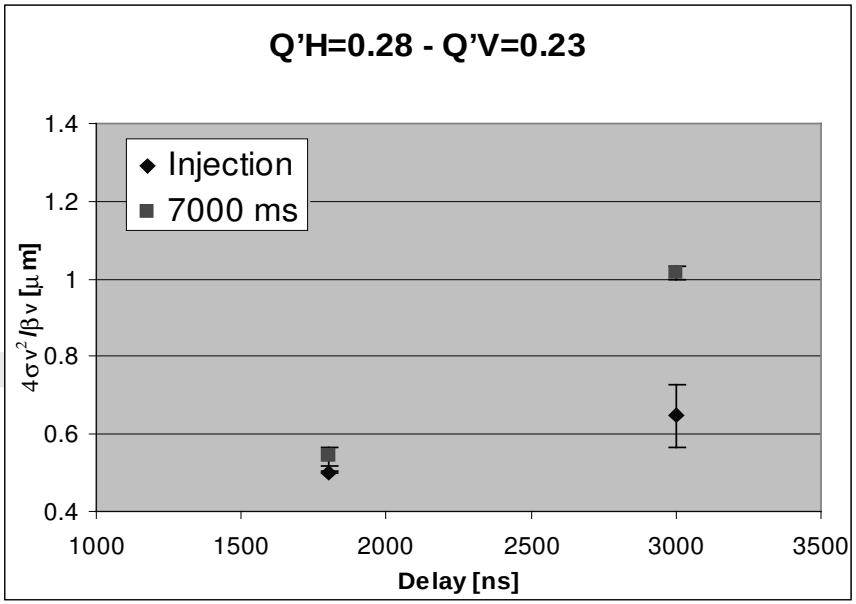


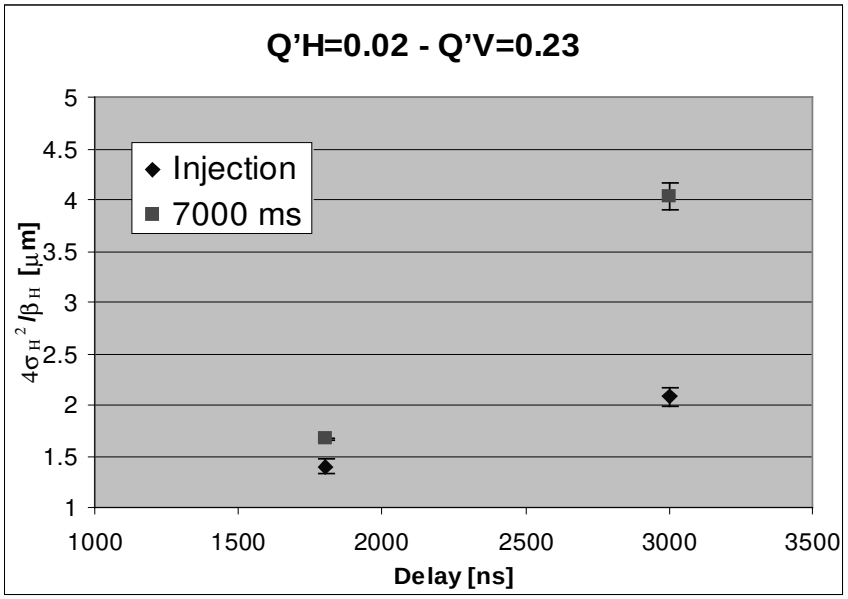


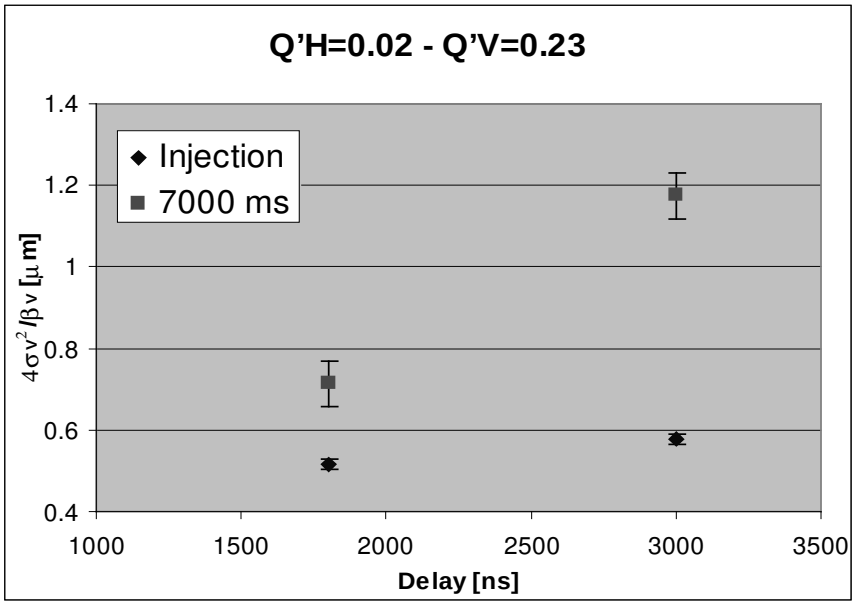
MDRF during long MD - 8.3×10^{10} p/b - (10/09/2000)

- 48 bunches (τ_{bunch} ~ 4 ns)
- Q_H=0.615 / Q_V=0.575
- It was not possible to get decent lifetime in the flat-bottom with high octupoles
- Chromaticity scan with no octupolar component (-0.8/-0.8).


Q'H=0.28 - Q'V=0.23
Injection
7000 ms
$4\sigma_H^2/\beta_H$ [μm]
Delay [ns]
1
2
3
4
5
1000
1500
2000
2500
3000
3500

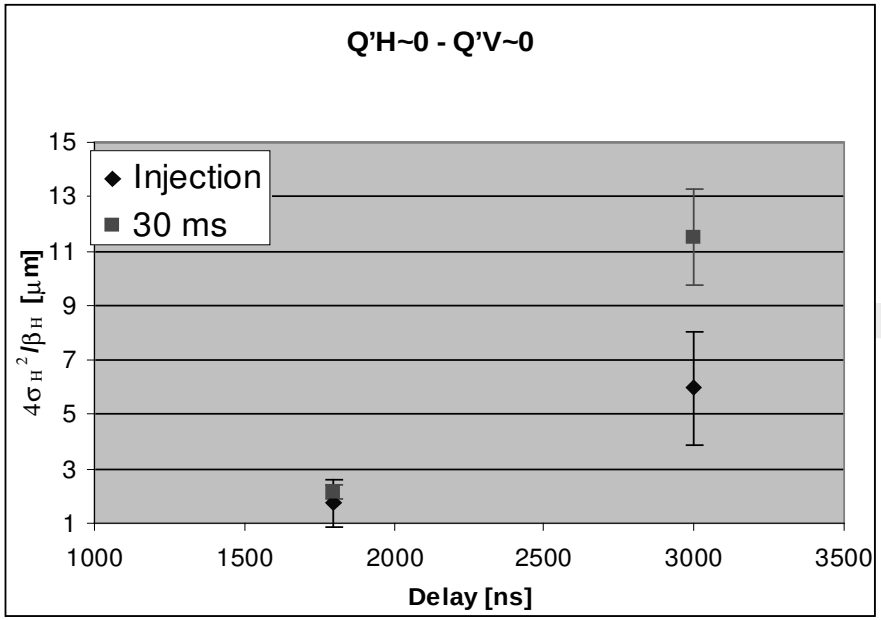

Q'H=0.28 - Q'V=0.23
Injection
7000 ms
$4\sigma v^2/\beta v$ [μm]
Delay [ns]
0.4
0.6
0.8
1
1.2
1.4
1000
1500
2000
2500
3000
3500

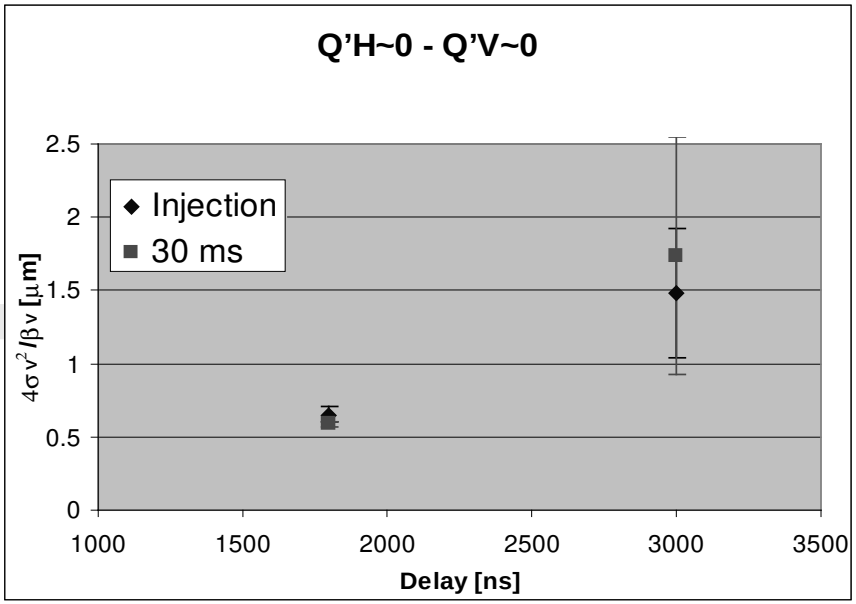

Q'H=0.02 - Q'V=0.23
Injection
7000 ms
$4\sigma_H^2/\beta_H$ [μm]
Delay [ns]
1
1.5
2
2.5
3
3.5
4
4.5
5
1000
1500
2000
2500
3000
3500

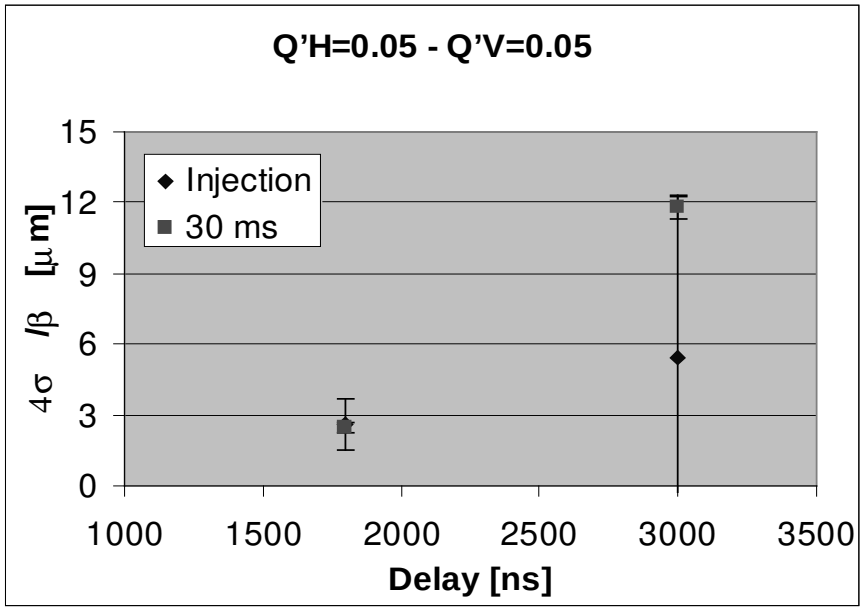

Q'H=0.02 - Q'V=0.23
Injection
7000 ms
$4\sigma v^2/\beta v$ [μm]
Delay [ns]
0.4
0.6
0.8
1
1.2
1.4
1000
1500
2000
2500
3000
3500

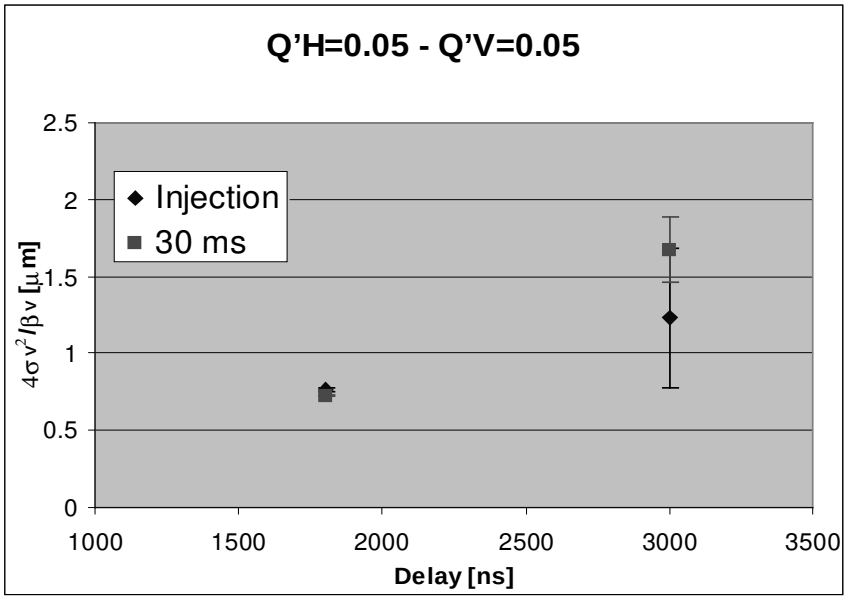
MDRF on MD cycle ($8.3x10^{10}$p/b) (24/10/2000)

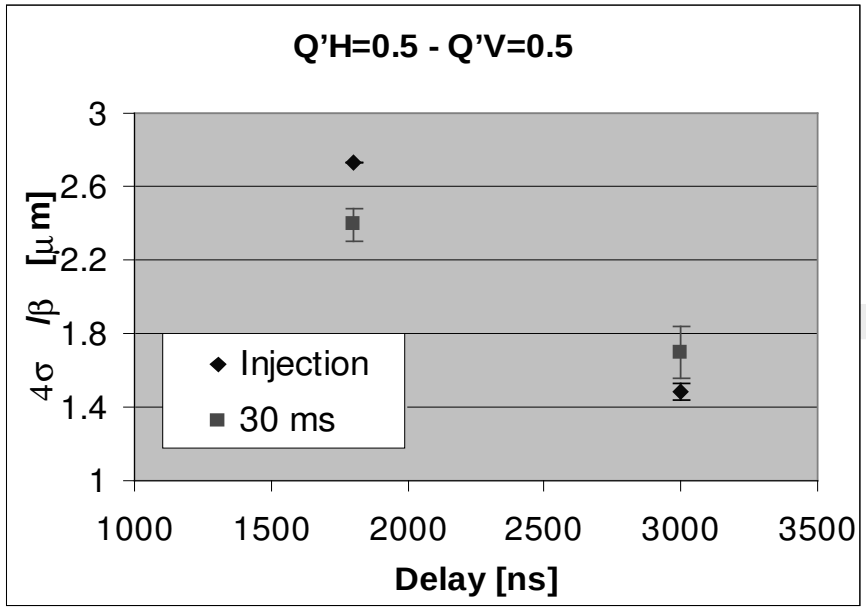
- 48 bunches (τ_{bunch} ~ 4 ns)
- Q_H=0.615 / Q_V=0.575
- No octupolar component (2.71/1.16)
- Coupling corrected (F. Schmidt - 0.00135)
- Damper 2(H) and 4(V) were ON
- SC beam dumps (cav. 4) ➔ beam for 50 ms
- TWC 1 not powered
- Qs oscillations at injection?

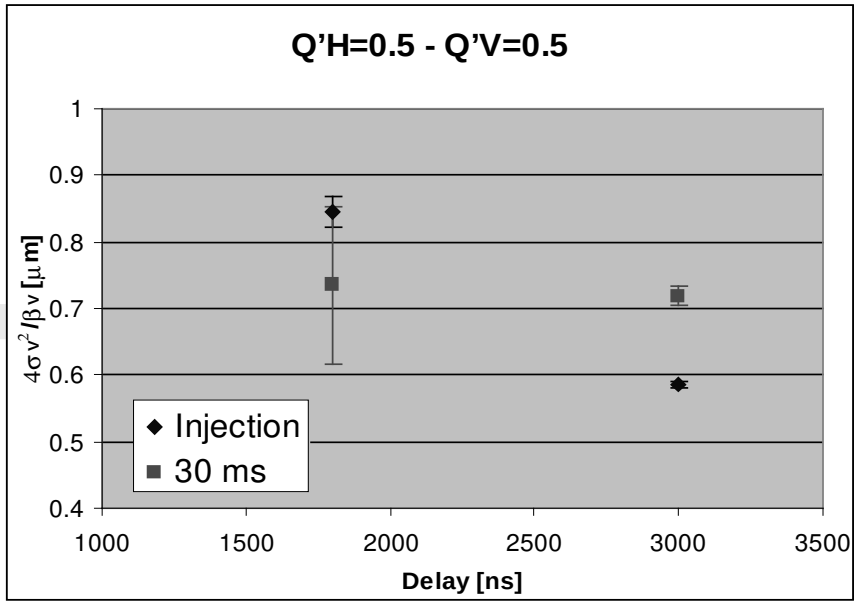

Q'H~0 - Q'V~0
Injection
30 ms
$4\sigma_H^2/\beta_H$ [μm]
Delay [ns]
15
13
11
9
7
5
3
1
1000
1500
2000
2500
3000
3500

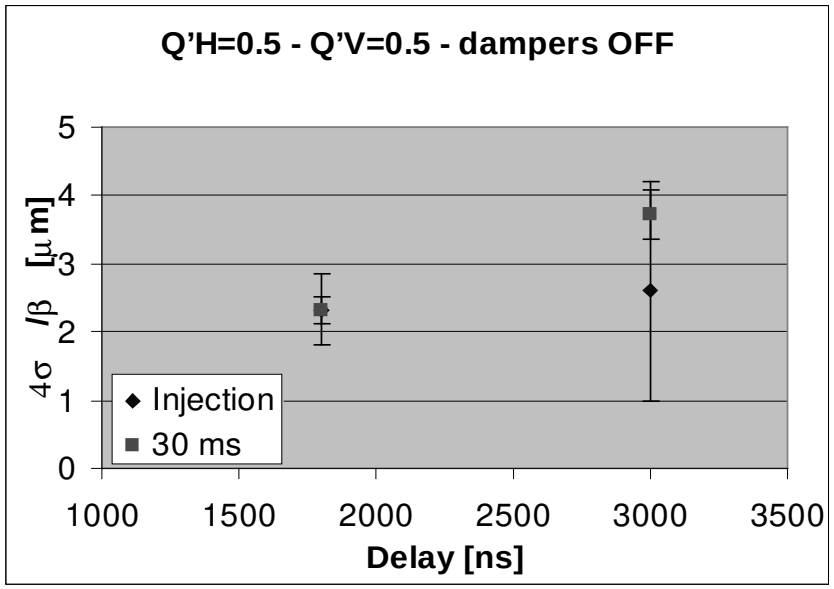

Q'H~0 - Q'V~0
Injection
30 ms
$4\sigma v^2/\beta v$ [μm]
Delay [ns]
2.5
2
1.5
1
0.5
0
1000
1500
2000
2500
3000
3500

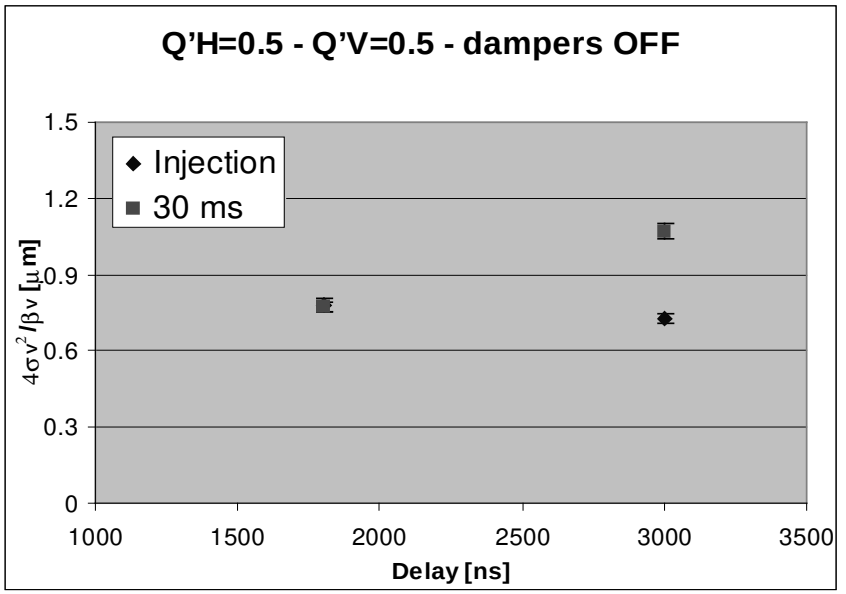

Q'H=0.05 - Q'V=0.05
Injection
30 ms
$4\sigma/\beta$ [μm]
Delay [ns]
15
12
9
6
3
0
1000
1500
2000
2500
3000
3500


Q'H=0.05 - Q'V=0.05
Injection
30 ms
$4\sigma v^2/\beta v$ [μm]
Delay [ns]
2.5
2
1.5
1
0.5
0
1000
1500
2000
2500
3000
3500


Q'H=0.5 - Q'V=0.5
3
2.6
2.2
1.8
1.4
1
4σ /β [μm]
Injection
30 ms
1000
1500
2000
2500
3000
3500
Delay [ns]


Q'H=0.5 - Q'V=0.5
1
0.9
0.8
0.7
0.6
0.5
0.4
4σv²/βv [μm]
Injection
30 ms
1000
1500
2000
2500
3000
3500
Delay [ns]

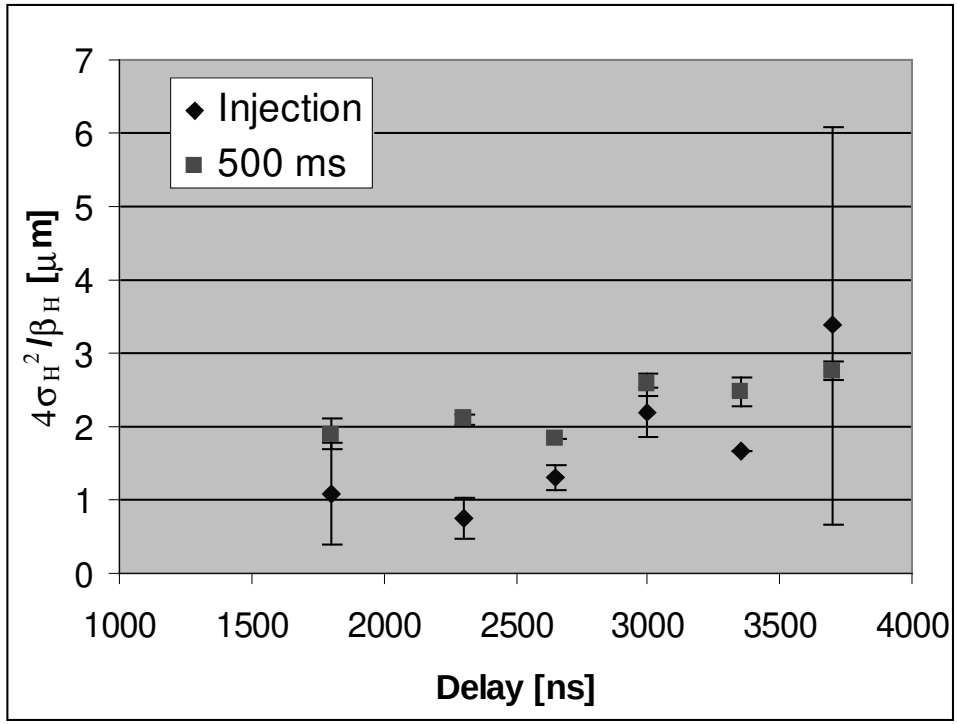

Q'H=0.5 - Q'V=0.5 - dampers OFF
5
4
3
2
1
0
4σ /β [μm]
Injection
30 ms
1000
1500
2000
2500
3000
3500
Delay [ns]

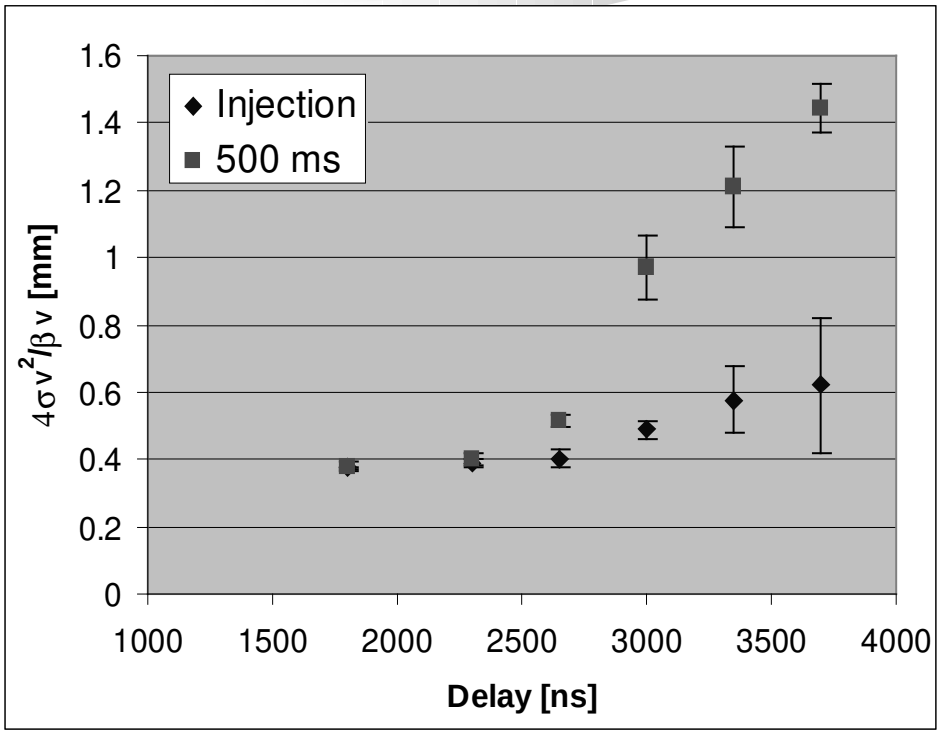

Q'H=0.5 - Q'V=0.5 - dampers OFF
1.5
1.2
0.9
0.6
0.3
0
4σv²/βv [μm]
Injection
30 ms
1000
1500
2000
2500
3000
3500
Delay [ns]

LHC beam on MD cycle - $8.2x10^{10}$p/b - (03/11/2000)

- 72 bunches (τ_{bunch} ~ 4 ns)
- Q_H=0.62 / Q_V=0.567 – Q'_H=0.5 / Q'_V=0.5
- No octupolar component (2.71/1.16)
- Coupling corrected (F. Schmidt - 0.00135)
- Damper 2(H) and 4(V) were ON
- TWC 1 not powered
- Qs oscillations at injection?
- ε_V was smaller as compared to MDRF

LHC beam on MD cycle - 8.2x10^{10}p/b - (03/11/2000)





LHC beam on MD cycle - $8.2x10^{10}$p/b - (03/11/2000)

				Tail measurements				Comments
				Hor		Ver		
Qh	Qv	Q'h	Q'v	Inj.	500 ms	Inj.	500 ms	
0.590	0.590	0.500	0.500	1.829	2.055	0.502	1.056	
0.590	0.590	0.300	0.500	7.060	3.195	0.521	1.487	
0.590	0.590	0.700	0.500	1.480	1.567	0.338	0.385	
0.710	0.599	0.700	0.500	1.455	1.801	0.342	0.374	
0.710	0.599	0.700	0.300	1.372	1.767	0.346	0.450	
0.800	0.599	0.900	0.500	1.686	2.144	0.312	0.329	
0.747	0.599	0.900	0.500	1.248	1.942	0.454	0.449	
0.747	0.599	0.050	0.050	-	-	1.396	1.314	
0.747	0.599	0.900	0.500	1.281	1.545	0.344	0.321	4th PSB ring missing
0.747	0.599	0.050	0.050	-	-	0.550	0.583	4th PSB ring missing
0.747	0.599	0.900	0.500	1.469	1.662	0.354	0.337	3rd PSB ring missing
0.747	0.599	0.900	0.500	1.197	1.380	0.250	0.249	5 x10^{10} p/b
0.747	0.599	0.900	0.500	1.123	1.221	0.231	0.210	5 x10^{10} p/b - 50 ns spacing

Summary (preliminary)

- Chromaticity seems (for the moment) the best tool to fight the blow-up but to which extent? ….and up to which intensity? … and for which plateau length
- High tune?
- Horizontal blow-up (is it always transverse?)
- Hole in the batch seem to help
- 50 ns: some improvement
- What about the ramp?