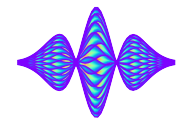


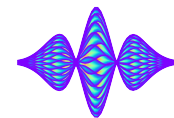


BBU instability in the collider ring



E. Métral

- ◆ Follow-up / update by MauroM with **his code MILES** (Modeling Instabilities in Linacs with Ellipsoidal Space charge)
 - Paper to be presented at IPAC2021 in 2 weeks
 - This is a code for Linacs that they are adapting for a circular machine as far as synchrotron motion can be ignored
- ◆ Next steps



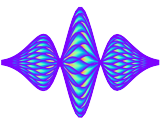
Muon Collider Rings

Speed of light	c	[m/s]	299792458	
Electron charge	e	[10 ⁻¹⁹ C]	1.602176634	
Muon rest mass	mmu	[MeV]	105.6583755	
Muon lifetime (at rest)	taumu	[μs]	2.196981122	
Parameter	Symbol	Unit	3 TeV c.m.	14 TeV c.m.
Energy	E	[TeV]	1.5	7
Gamma			14197	66251
Muon lifetime		[ms]	31	146
Circumference	C	[km]	4.5	14
Average Beta function		[m]	50	50
Beta function at the IP	betaIP	[mm]	5	1.07
Rms bunch length	sigmaz	[mm]	5	1.07
Norm. transverse emittance	epsNorm	[microm]	25	25
Un-norm. transverse emittance	eps	[microm]	0.00176	0.00038
Average rms transv. bunch size	sigmatAvg	[microm]	296.7	137.4
Rms transv. bunch size at the IP	sigmatIP	[microm]	3.0	0.6

Tentative target parameters
Scaled from MAP parameters

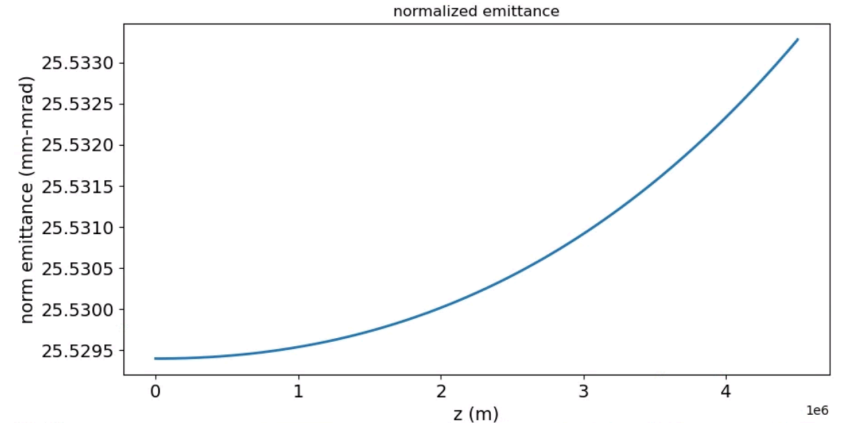
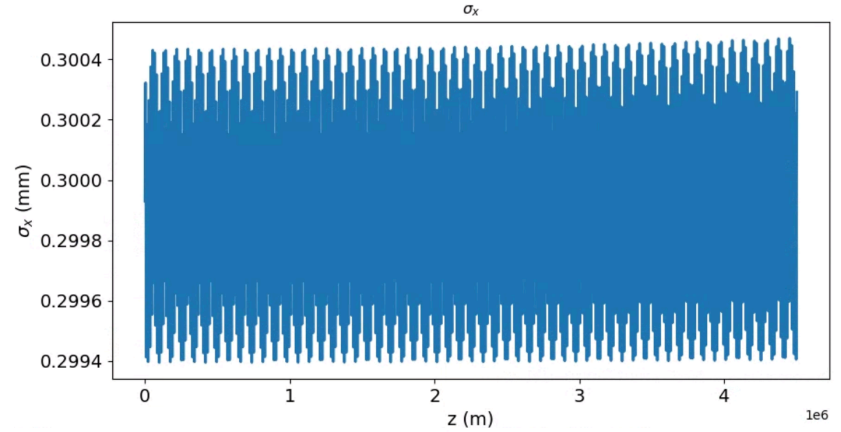
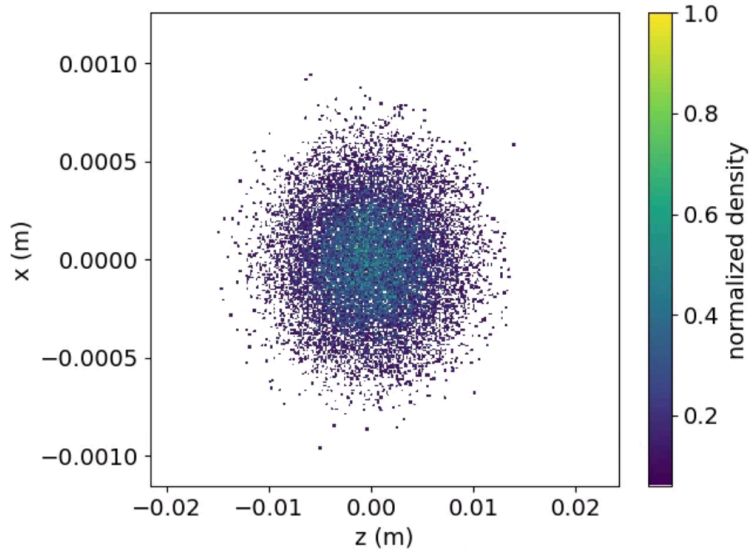
Comparison:
CLIC at 3 TeV: 28 MW

Parameter	Unit	3 TeV	10 TeV	14 TeV
L	10 ³⁴ cm ⁻² s ⁻¹	1.8	20	40
N	10 ¹²	2.2	1.8	1.8
f _r	Hz	5	5	5
P _{beam}	MW	5.3	14.4	20
C	km	4.5	10	14
	T	7	10.5	10.5
ε _L	MeV m	7.5	7.5	7.5
σ _E / E	%	0.1	0.1	0.1
σ _z	mm	5	1.5	1.07
β	mm	5	1.5	1.07
ε	μm	25	25	25
σ _{x,y}	μm	3.0	0.9	0.63

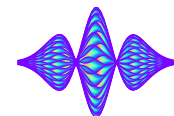


1.5 TeV, BBR: $R_s = 10^6 \text{ Ohm/m}$, $f_r = 1 \text{ GHz}$, $Q = 1$, $Q = 3.52e-7$

Final distribution, no offset

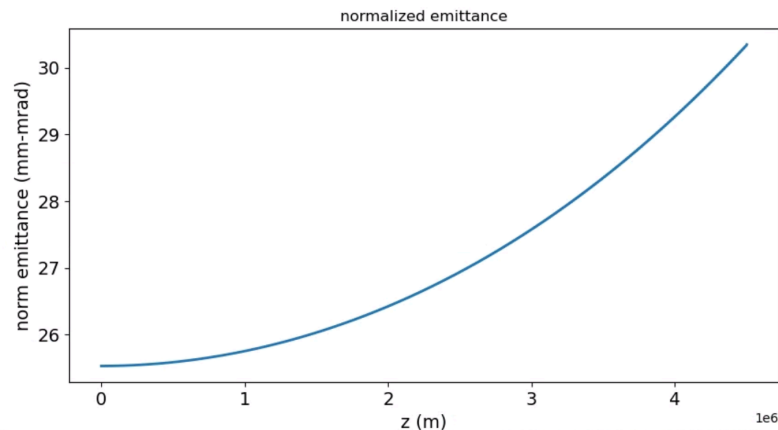
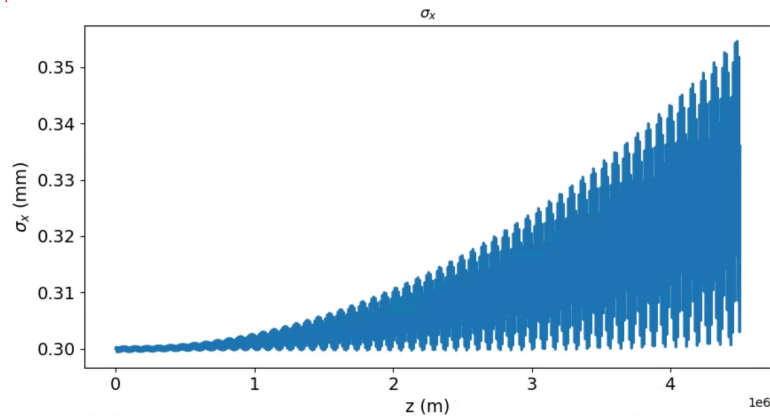
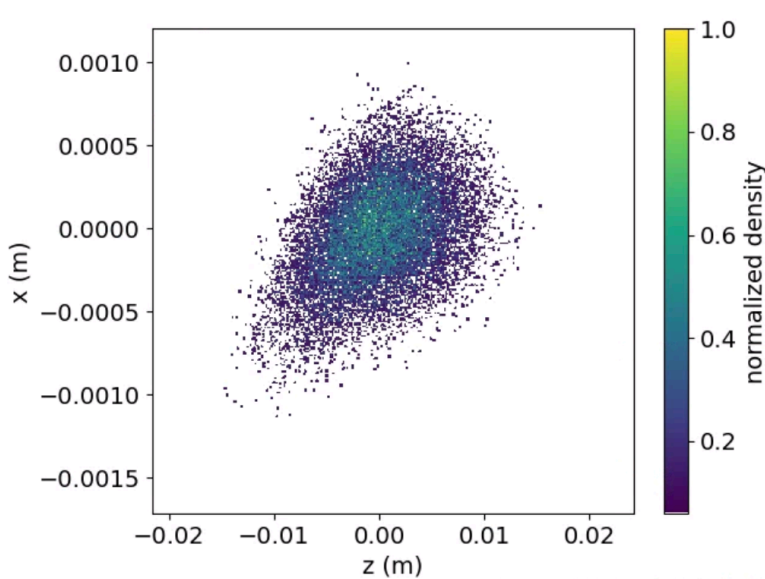


Courtesy of M. Migliorati

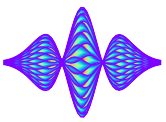


1.5 TeV, BBR: $R_s = 10^6$ Ohm/m, $f_r = 1$ GHz, $Q = 1$, $Q = 3.52e-7$

Final distribution, 0.1 mm offset

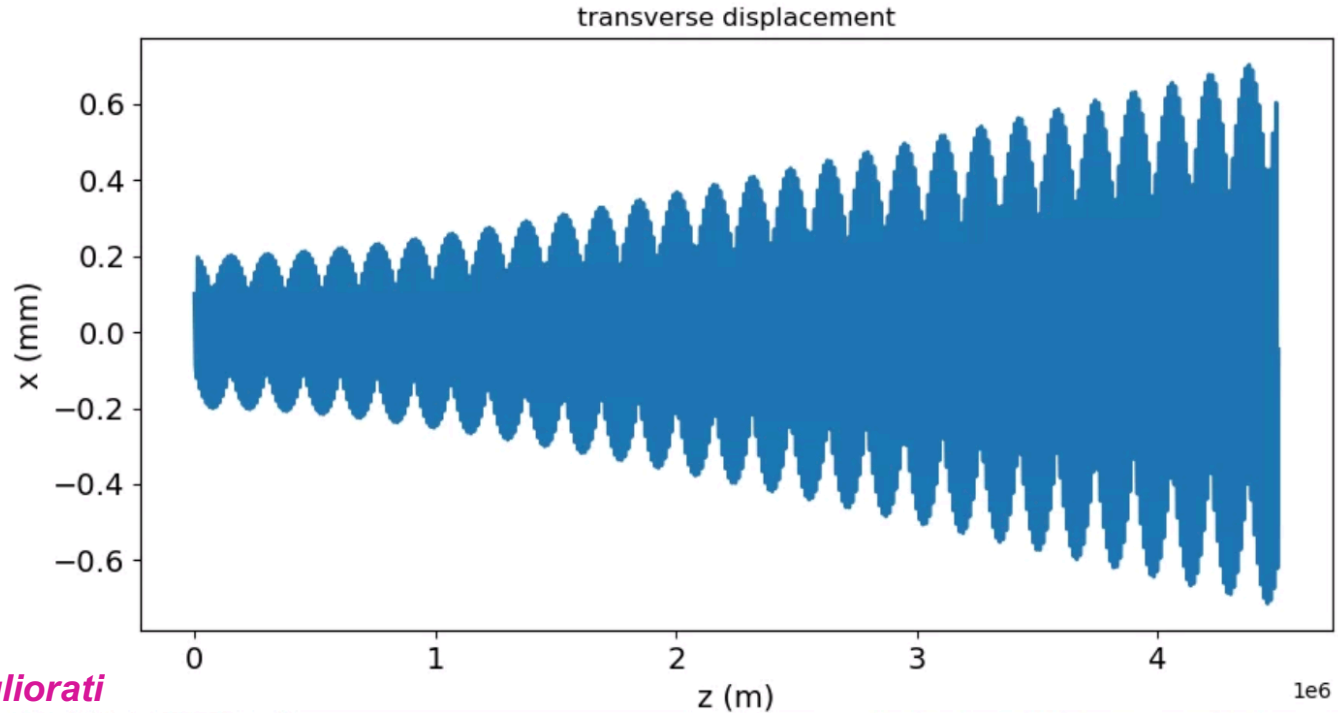


Courtesy of M. Migliorati

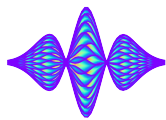


1.5 TeV, BBR: $R_s = 10^6 \text{ Ohm/m}$, $f_r = 1 \text{ GHz}$, $Q = 1$, $Q = 3.52e-7$

two-particle model: particle at the tail ($-\sigma_z$)

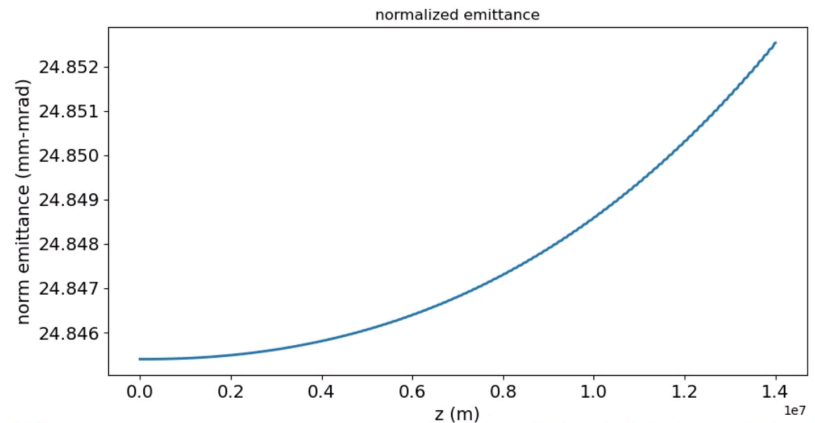
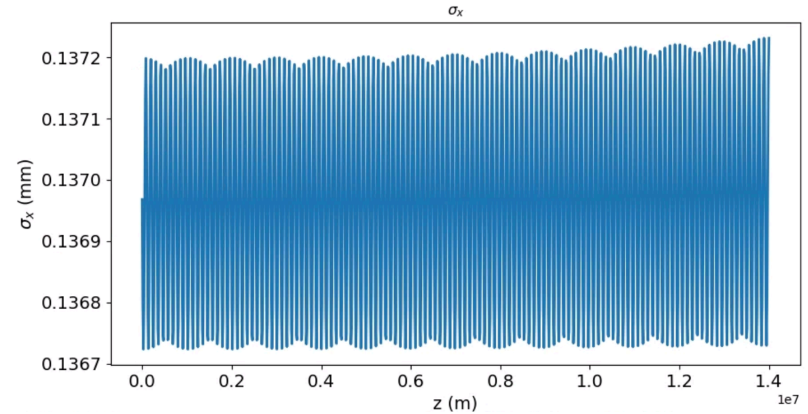
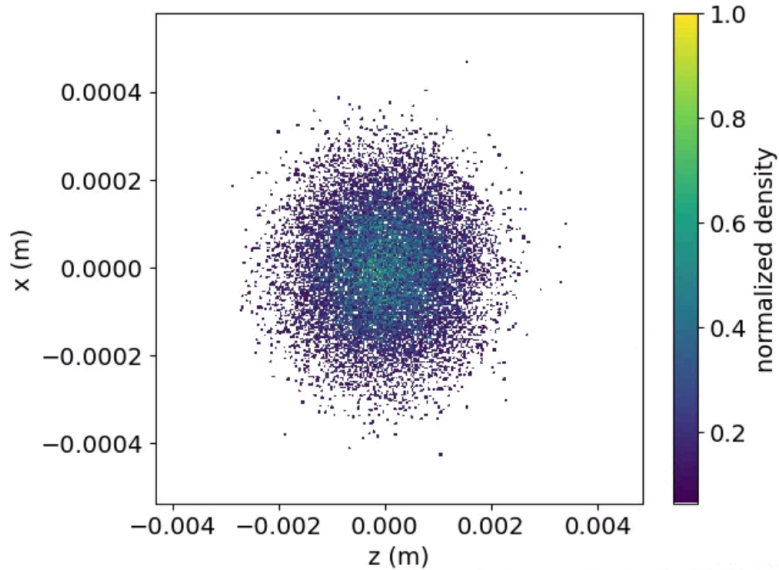


Courtesy of M. Migliorati

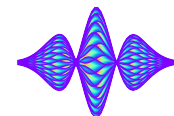


7 TeV, BBR: $R_s = 3.5 \times 10^7 \text{ Ohm/m}$, $f_r = 1\text{GHz}$, $Q = 1$, $Q = 2.88 \times 10^{-7}$

Final distribution, no offset

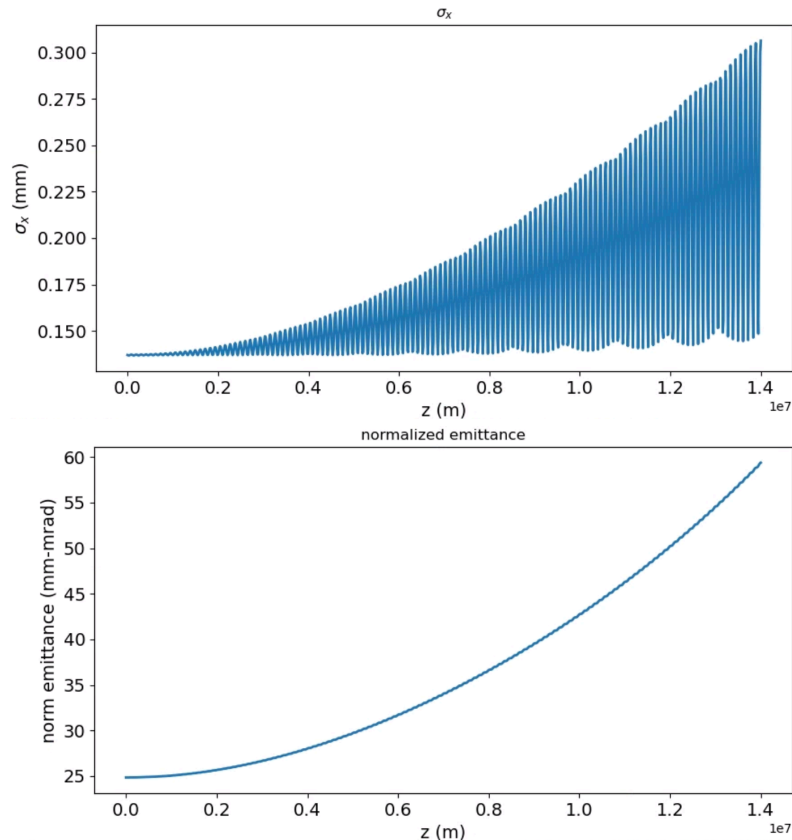
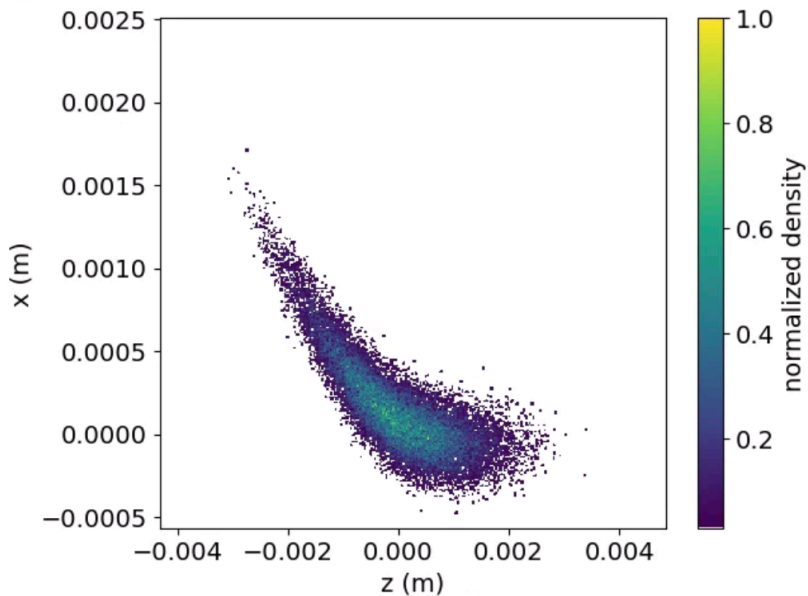


Courtesy of M. Migliorati

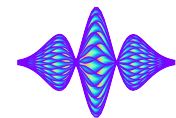


7 TeV, BBR: $R_s = 3.5 \times 10^7 \text{ Ohm/m}$, $f_r = 1 \text{ GHz}$, $Q = 1$, $Q = 2.88 \times 10^{-7}$

Final distribution, 0.1 mm offset

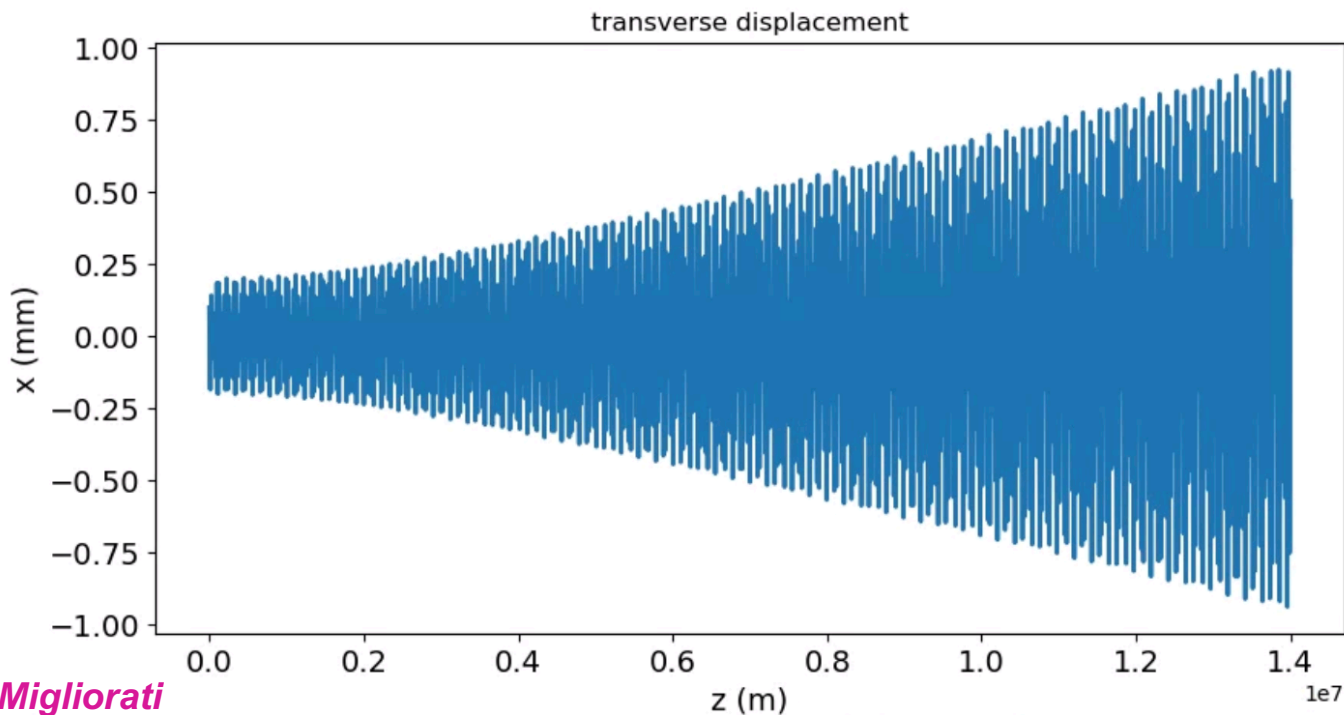


Courtesy of M. Migliorati

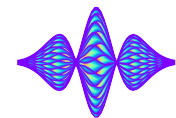


7 TeV, BBR: $R_s = 3.5 \times 10^7 \text{ Ohm/m}$, $f_r = 1 \text{ GHz}$, $Q = 1$, $Q = 2.88 \times 10^{-7}$

two-particle model: particle at the tail ($-\sigma_z$)



Courtesy of M. Migliorati



- ◆ Resistive-wall
 - Results should be presented next week
- ◆ Transverse damper
 - Should be possible to add it => To be looked at in the future
- ◆ Space charge (for the low-energy machines)
 - It can be included with a simple model (a uniformly charged ellipsoid having a linear field, also in z) => It is very fast
 - Do we know other codes which simulate, at the same time, wakefields and space charge for linacs?
 - ELEGANT (had only wakefields)?
 - GPT (had only space charge)?
 - ASTRA?
 - Others?