Comb shaping with X band cavity

Barbara Marchetti

M. Ferrario, C. Ronsivalle, E. Chiadroni, M. Boscolo,

C. Vaccarezza, M. Castellano, A. Cianchi, B. Spataro.

S2E COMB Simulations Meeting , 4-5 October 2011

Outlook

- *Consequences of RF-compression non linearities*
- *Introduction of an higher harmonic cavity in the SPARC layout.*
- *Comb compression including the X band cavity*
- *Advantages of this scheme and conclusion.*

Consequences of RF-compression's non-linearities

- *Let's consider the compression of a 4 pulses train with 360 pC total charge;*
- *The shape of the laser illuminating the cathode is a 4 pulses train with 100 fs RMS-pulse-length and 2.135 ps spacing .between pulses.*

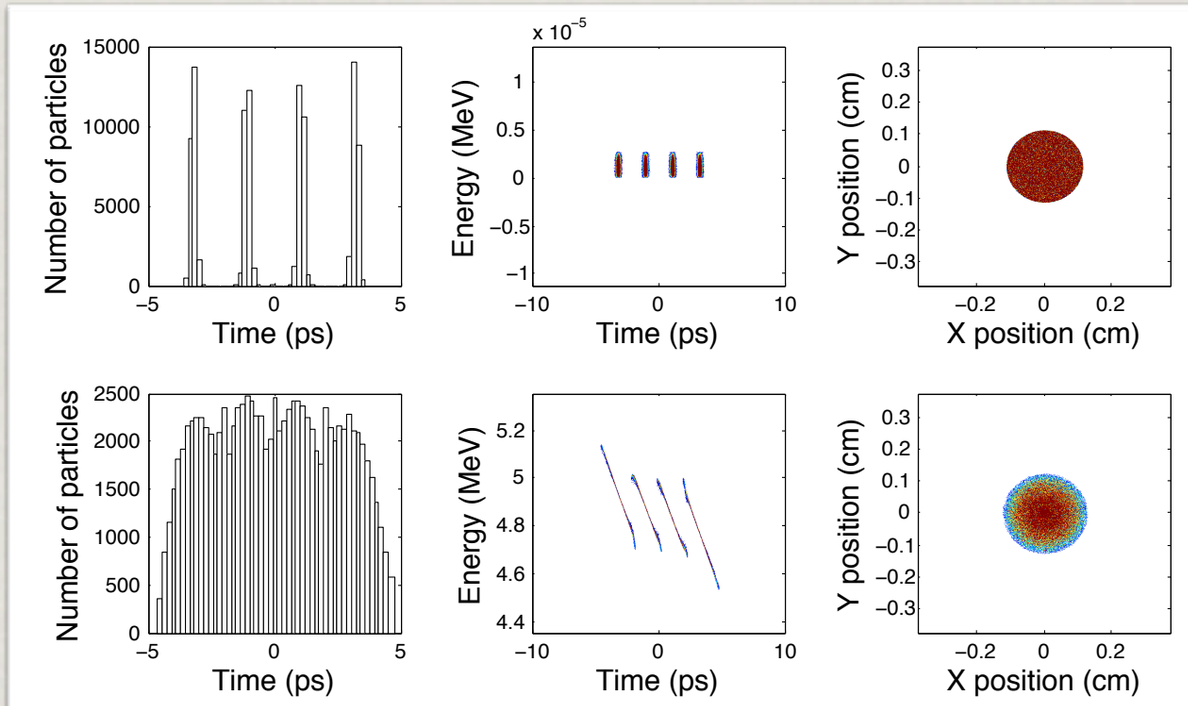


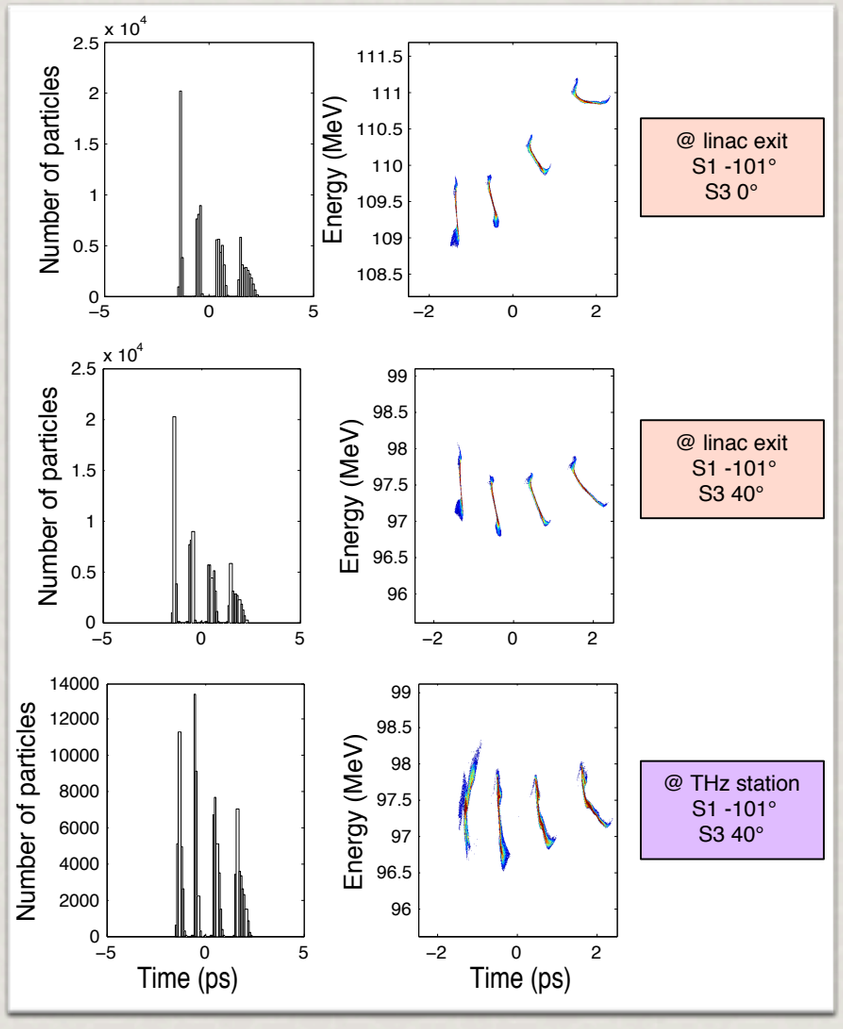
Figure 2.4: *On top*: longitudinal profile, longitudinal phase space and transverse spot of the comb made by four pulses at the cathode. *On bottom*: longitudinal profile, longitudinal phase space and transverse spot of the comb at exit of the gun.

Consequences of RF-compression's non-linearities

- *After the RF-compression, each sub-bunch has, in general, a different length.*

- *The spacing between the bunches is different.*

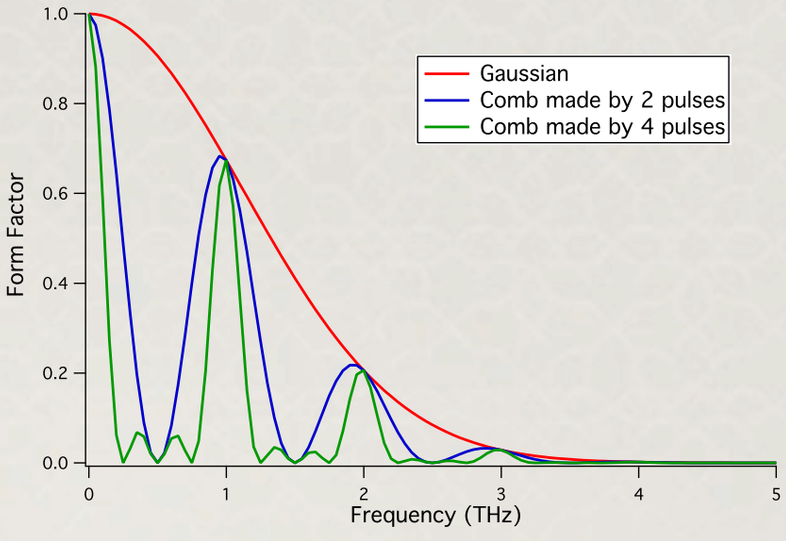
- *The energy of each bunch is different. This energy difference can be compensated by moving S3 off crest. This step is opportune if the comb has to be transport along the dogleg.*



Consequences of RF-compression's non-linearities

- *The Form Factor highlights the periodicity of the comb:*

$$F(\omega) = \left| \int_{-\infty}^{\infty} g(z) e^{-i\frac{\omega}{c}z} dz \right|^2$$



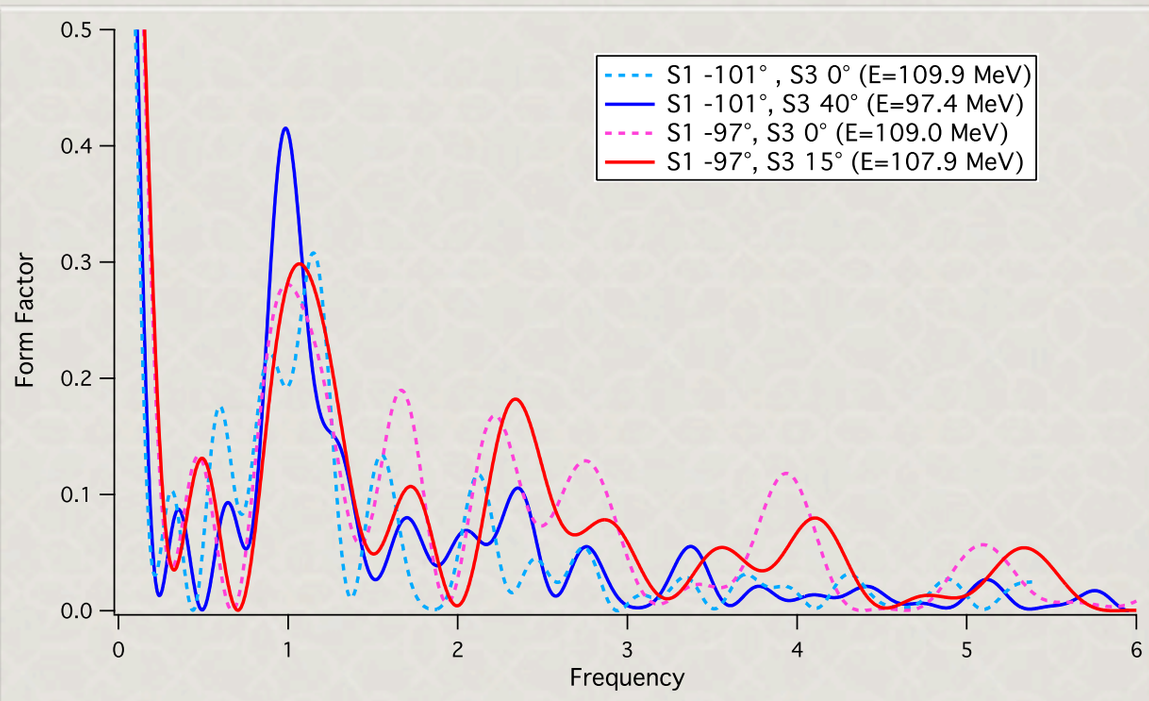
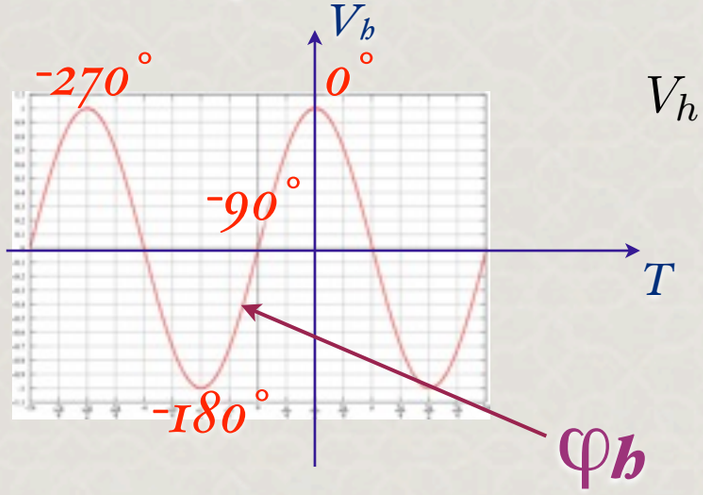


Figure 2.21: Form Factors at the THz station correspondent to the cases in figures 2.19 and 2.20. Because of the periodicity of its longitudinal charge profile, the deeply over-compressed case (continuous blue curve) has the highest amplitude at the comb charge repetition frequency.

Introduction of an higher harmonic cavity in the SPARC layout

- *Why?*



$$V = V_0 sin(\phi_0) + \Delta\phi V_0 cos(\phi_0) - \frac{1}{2}\Delta\phi^2 V_0 sin(\phi_0) + ...$$

$$V_h = V_h sin(\phi_h) + h\Delta\phi V_h cos(\phi_h) - \frac{1}{2}(h\Delta\phi)^2 V_h sin(\phi_h) + ...$$

Which harmonic? f_{rf}=2.856 GHz, f_h= 11.424 GHz (h=4)

Which cavity? 5 MeV energy gain, SW, 9 cells π-mode linac, Ra=4 mm

Barbara Marchetti - barbara.marchetti@roma2.infn.it

Introduction of an higher harmonic cavity in the SPARC layout

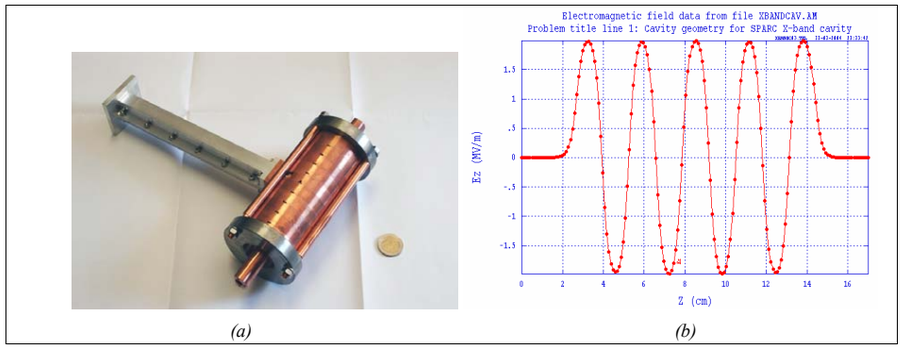


Figure 2.22: (a) Prototype of the SW X-band linac, (b) Electric field distribution on the axis computed by SUPERFISH, (c) Sketch of SPARC layout with X-band structure included

Proceedings of 2005 Particle Accelerator Conference, Knoxville, Tennessee

OPTIMIZATION OF RF COMPRESSOR IN THE SPARX INJECTOR

M. Boscolo, M. Ferrario, B. Spataro, INFN-LNF Frascati (Rome); C. Ronsivalle, ENEA-Frascati (Rome); L. Serafini,INFN-MI, Milan

SPARC-BD-05 /01
May 2005

RF COMPRESSOR OPTIMIZATION STUDY FOR SPARCII/SPARXINO

C. Ronsivalle *(ENEA/FIS)*, M. Ferrario, B. Spataro (*INFN-LNF*), L. Serafini *(INFN-Milan)*

SPARC-RF-03/001
LNF-03/008(R)
6 May 2003

AN X-BAND STRUCTURE FOR A LONGITUDINAL EMITTANCE CORRECTION AT SPARC

A.Bacci[1], M.Migliorati[2], L.Palumbo[2] and B.Spataro[3]

(1) INFN-LASA di Milano – Via Fratelli Cervi 201- 20090 Segrate (MI)
(2) INFN-LNF and Universita' di Roma"La Sapienza", Dip. Energetica-Via A. Scarpa 14,00161 Roma
(3) INFN-LNF,Via E.Fermi 40,00044 Frascati (RM)

SPARC-RF-03/002
LNF-03/013(R)
25 August 2003

STUDIES ON A BI-PERIODIC X-BAND STRUCTURE FOR SPARC

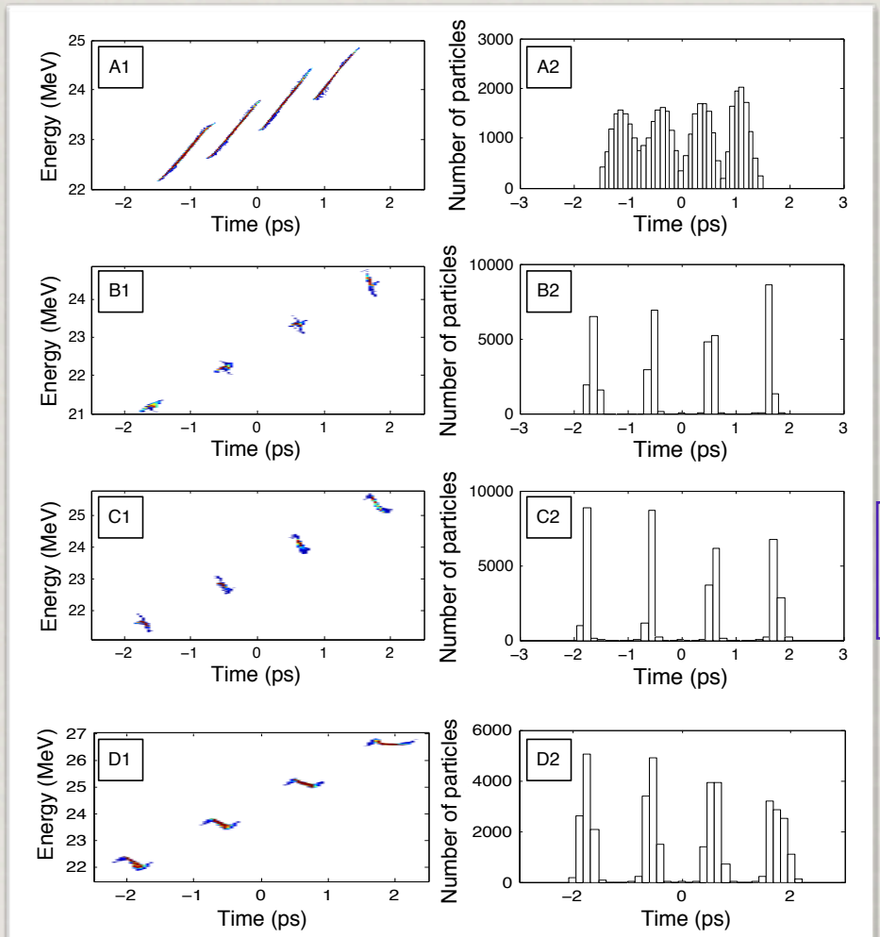
D. Alesini [1], A.Bacci[2], M.Migliorati[3], A.Mostacci[3], L.Palumbo[3] and B.Spataro[1]

[1)] INFN-LNF,Via E.Fermi 40, I-00044 Frascati (RM).
[2)] INFN-LASA di Milano – Via Fratelli Cervi 201, I-20090 Segrate (MI).
[3)] INFN-LNF and Università di Roma"La Sapienza", Dip. Energetica-Via A. Scarpa 14, I-00161 Roma.

Comb compression including the X band cavity

gun sol 185A
linac sol 44 A

All over-compression phases!



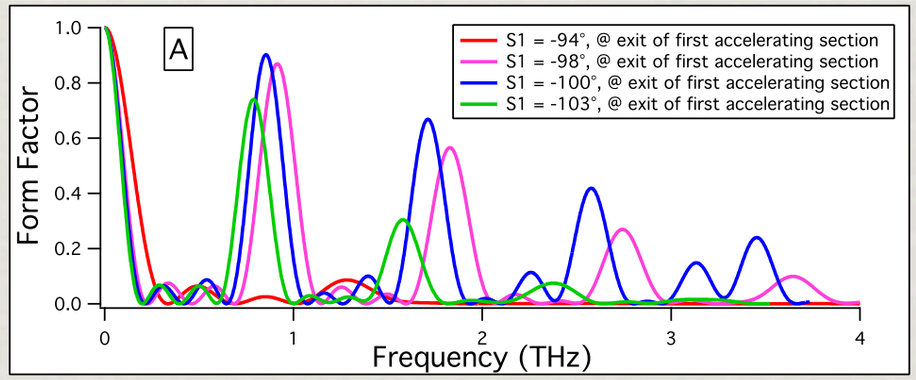
S1= -94°
Sx= -156°

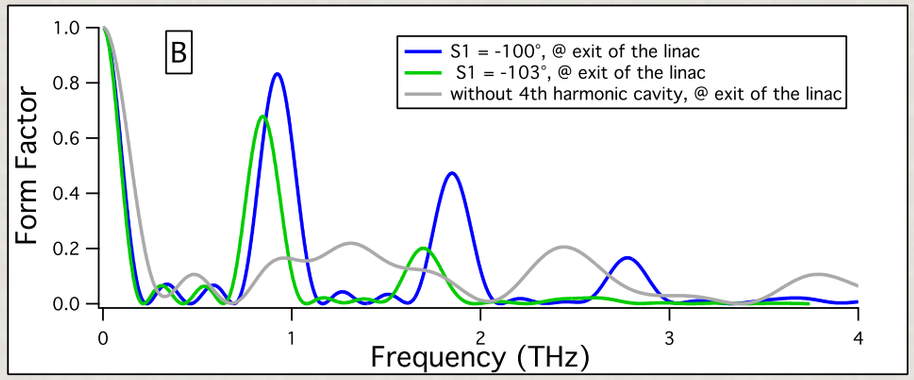
S1= -98°
Sx=-149°

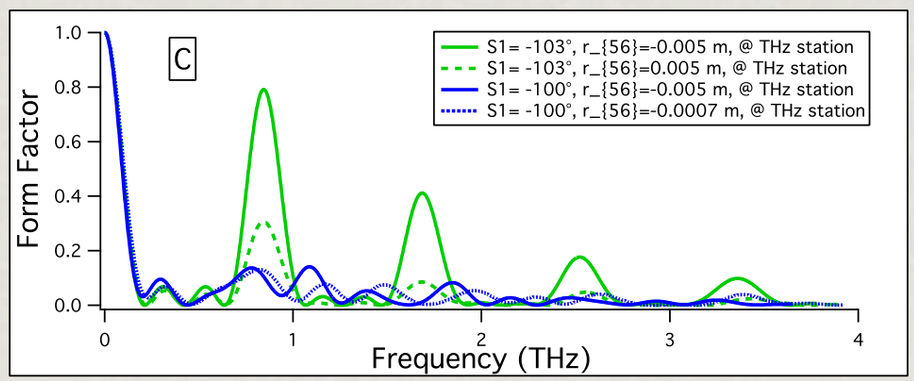
S1= -100°
Sx= -147°

S1= -103°
Sx= -144°

Figure 2.23: Longitudinal phase space and charge distribution of a 4 sub-pulses comb for different over-compression phases and correction of non-linearities by the fourth harmonic cavity discussed in the text. A: $S1 = -94°$; B: $S1 = -98°$; C: $S1 = -100°$; D: $S1 = -103°$.





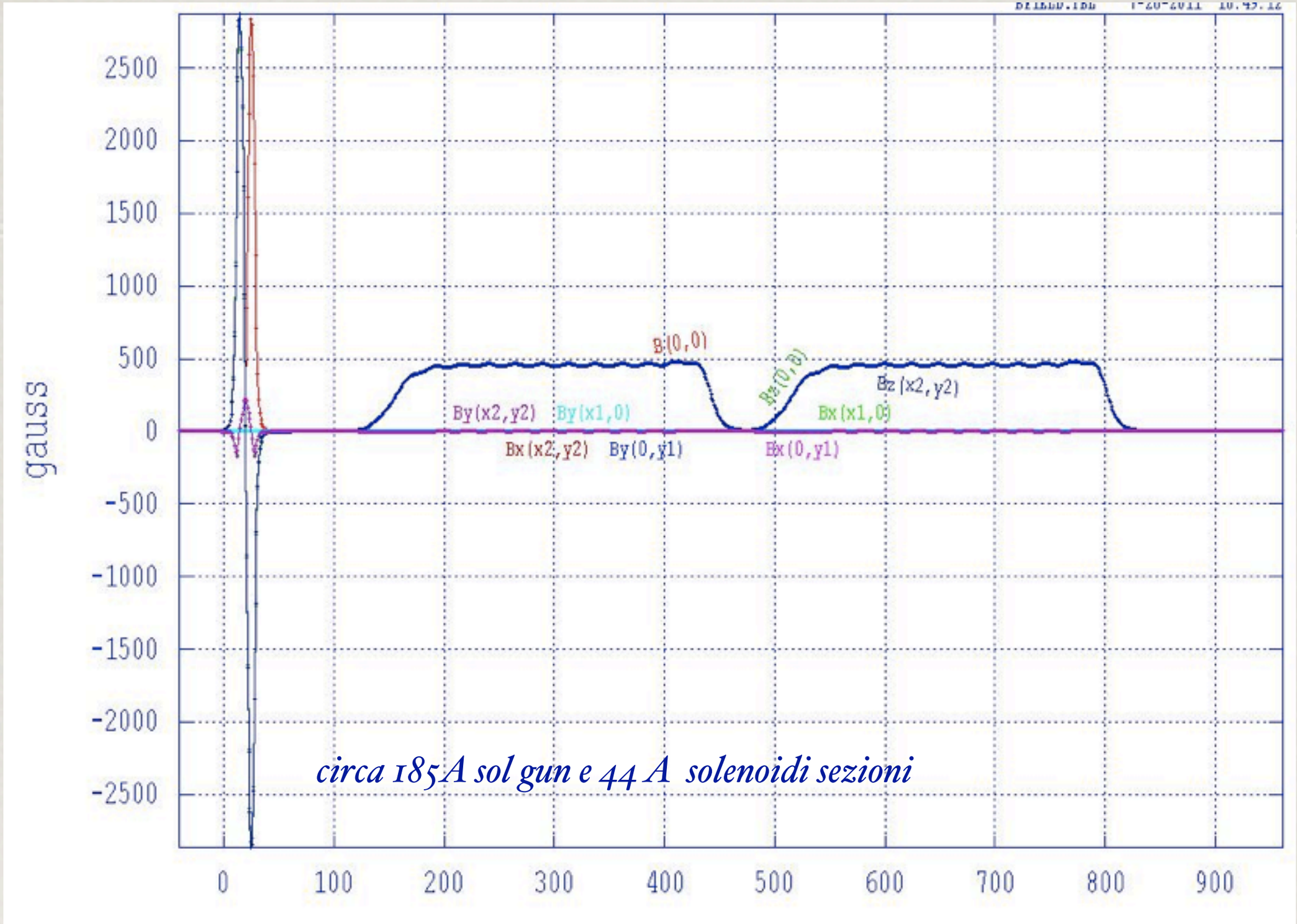


Barbara Marchetti - barbara.marchetti@roma2.infn.it

S2E COMB simulations meeting , 4-5 October 2011

Conclusion: Advantages of this scheme

- *All the pulses have almost the same length.*
- *The distance between the pulses is the same.*


gauss
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
0
100
200
300
400
500
600
700
800
900
By(0,0)
Bz(0,0)
Bz(x2,y2)
By(x2,y2)
By(x1,0)
Bx(x1,0)
Bx(x2,y2)
By(0,y1)
Bx(0,y1)
circa 185A sol gun e 44 A solenoidi sezioni