e-Cloud Simulations for LHC LPA upgrade scheme

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e-cloud simulation meeting

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Motivation

- Recent studies in the LHC showed that
  - LHC beam-beam tune shift can be > 0.015/IP (LHC design limit <0.015/2IPs)
  - Acceptable pileup events at IP <200 (from experimenters)

  In view of these the LHC LPA parameter list is revised ← **Next Table**

  Here we address the e-cloud issues for new parameters using realistic bunch profiles
  - Longitudinal bunch profiles are derived from ESME simulations
    - HP distribution ← Initial distribution
    - LE(4σ)= 2- 2.5 eVs
    - Various bunch profiles are generated with h=1(400MHz rf) and h=2 rf (800MHz rf) systems
    - BSM and BLM ; V2/V1= 0.25, and 0.5
  - Bunch Intensity 1E11-4E11ppb, Simulations for Dipoles and Drift sections
  - Bunch Spacing 25 nsec and 50 nsec
  - Assuming
    - SEY =2.3 -1.5 (← Only the 1.5 results will be presented)
    - R = 0.25

New Parameter List for LPA scheme

LHC at 7 TeV: "BLMpt5" and "BSMpt5" represent the rf voltage ratio of 0.5 with 180 deg phase apart for 1st and 2nd harmonic rf cavities. (IPAC2011)

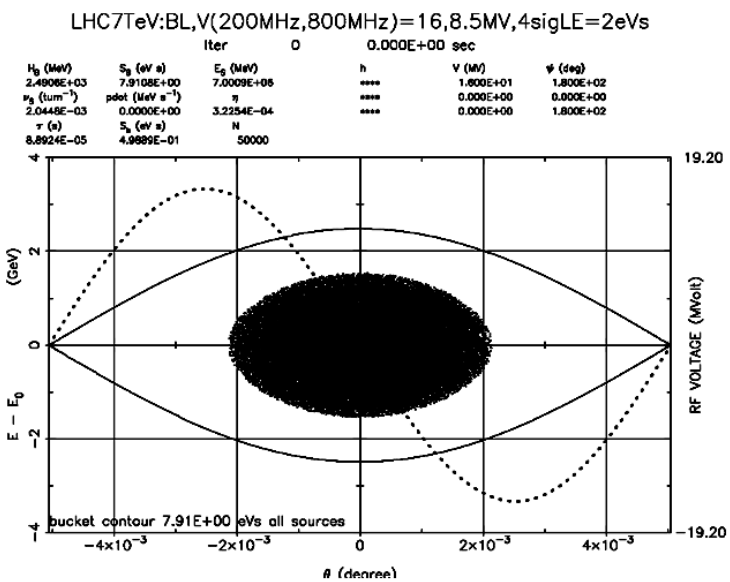
Parameters		Nominal	Ultimate	LPA (200MHz+400MHz RF) BLMpt5 (A)	LPA (200MHz+400MHz RF) BSMpt5 (B)	LPA (400MHz+800MHz RF) BLMpt5 (C)	LPA (400MHz+800MHz RF) BSMpt5 (D)
Number of Bunches		2808	2808	1404	1404	1404	1404
Protons/bunch	$N_b(10^{11})$	1.15	1.7	3.9	3.3	3.5	3.1
Beam Current [A]		0.58	0.86	1	0.84	0.88	0.78
Norm. Transv. Emit	μm	3.75	3.75	3.0-3.75	3.0-3.75	3.0-3.75	3.0-3.75
σz	cm	7.55	7.55	16	11	9	6
Bunch Spacing	nsec	25	25	50	50	50	50
β^* at IP1 and IP5	m	0.55	0.5	0.25	0.25	0.36	0.36
θ_c	μrad	285	315	380	380	380	380
Piwinski Angle		0.64	0.75	3.03-2.71	2.08-1.86	1.42-1.22	0.963-0.862
$\Delta Qbb/2IPs$		0.006	0.009	0.01-0.009	0.012-0.01	0.016-0.014	0.018-0.015
Peak and Average Lum. (10 hr turn around)	$10^{34}cm^{-2}s^{-1}$	1 0.46	2.3 0.91	6-5.3 1.68-1.6	5.9-5.2 1.5-1.4	6.1-5.3 1.6 - 1.5	6.0-5.0 1.5 -1.4
Event Pileup		19	44	201-227	224-196	232-200	227-192

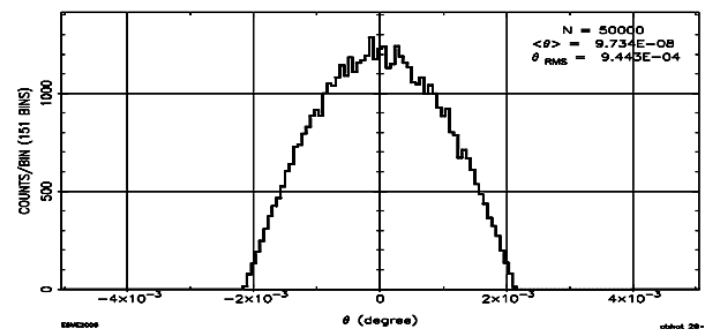
LHC Bunch Profiles for 2 eVs beam with V2/V1=0.5, BLM (400MHz ⊕ 800MHz rf)

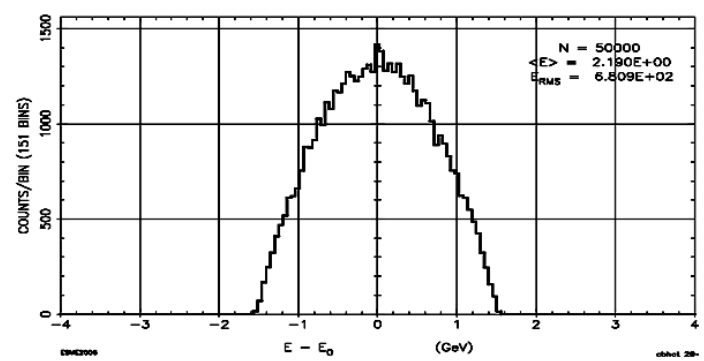
Hoffmann-Pedersen Dists.

LE(4σ)=2 eVs

(ΔE,Δt) Distributions

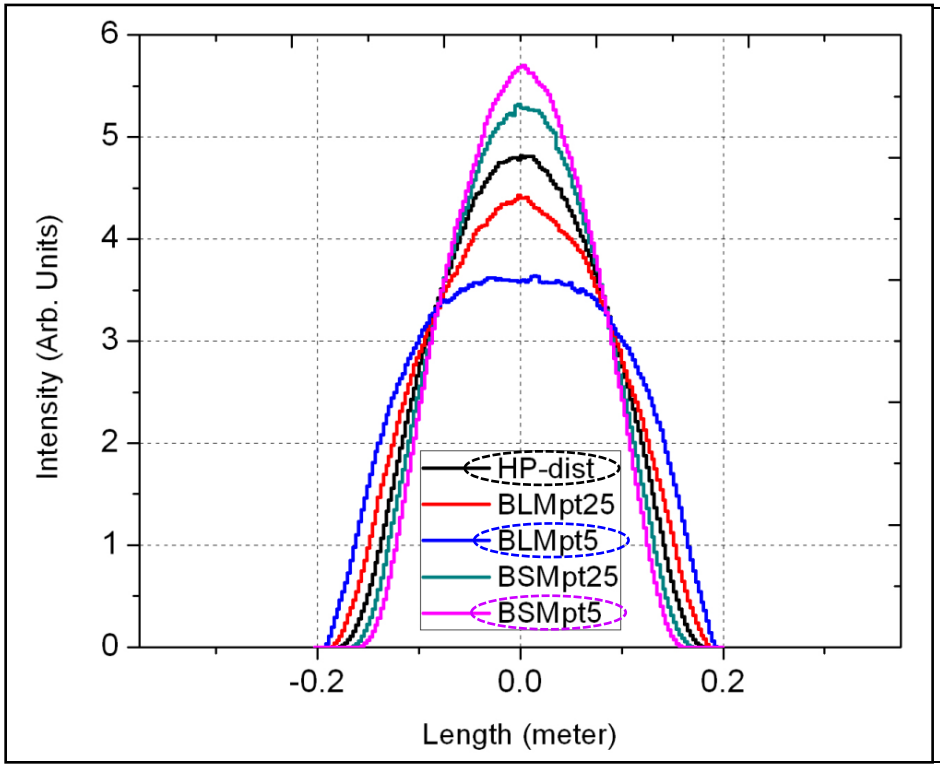




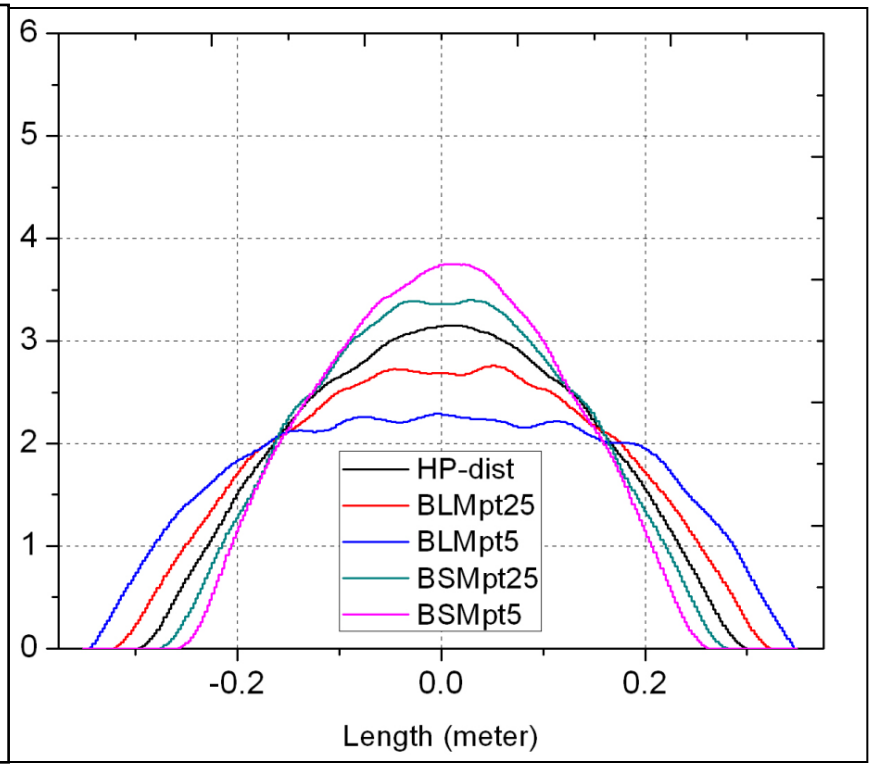


Longitudinal Profiles of the LHC Bunches from ESME 2eVs

400MHz ⊕800MHz rf

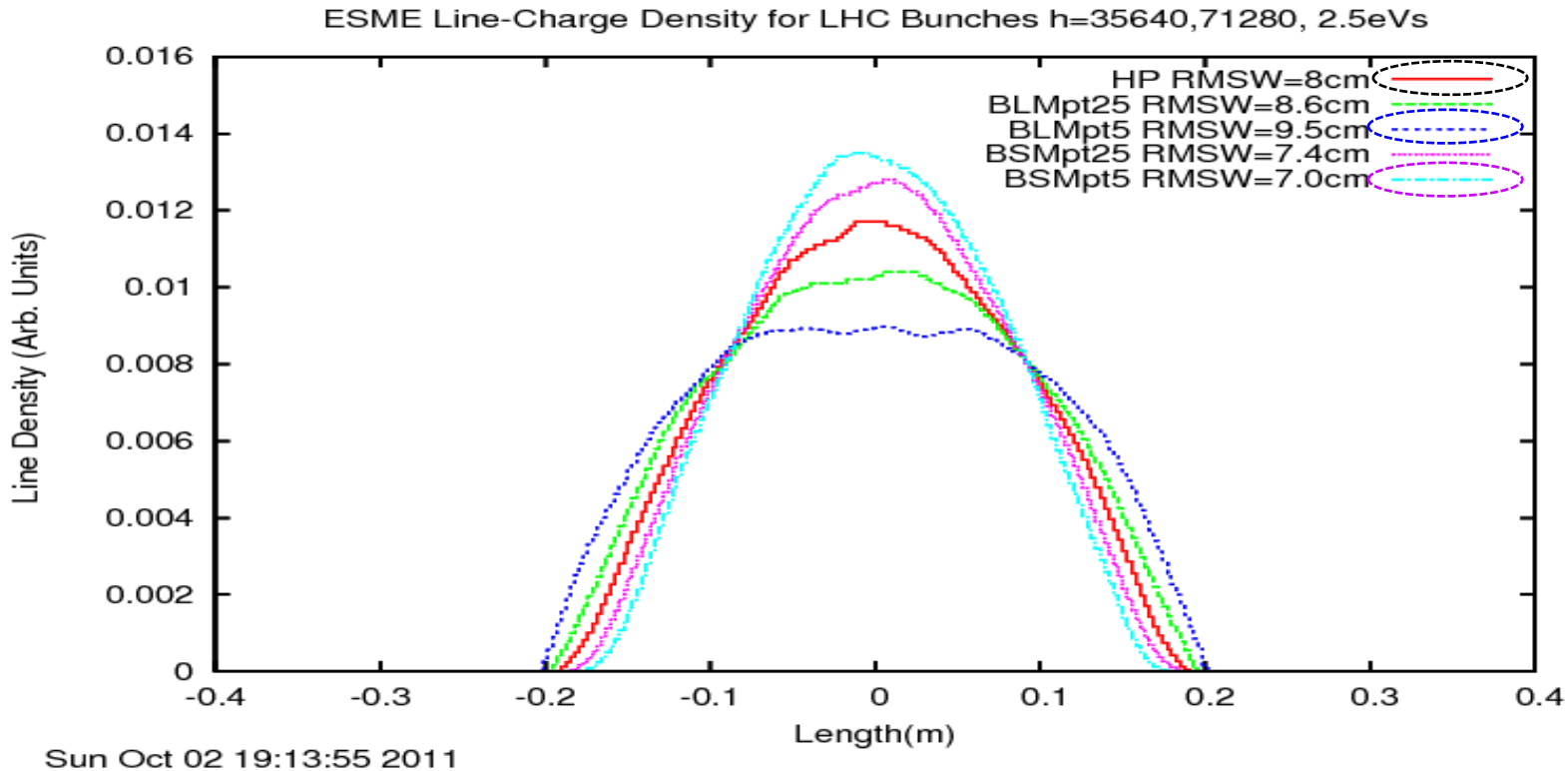


200MHz ⊕ 400MHz rf



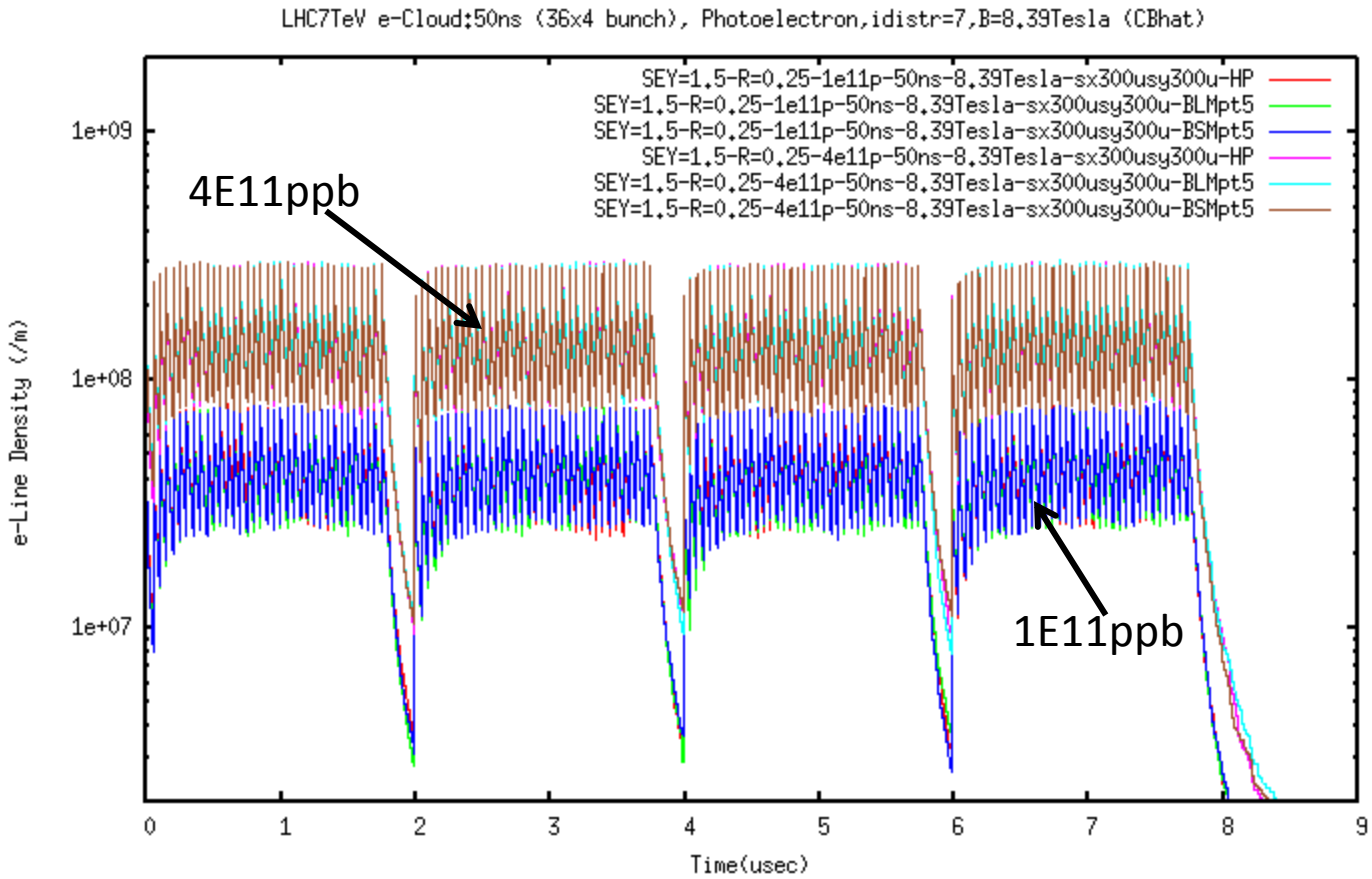
Longitudinal Profiles of the LHC Bunches from ESME 2.5eVs

400MHz ⊕800MHz rf

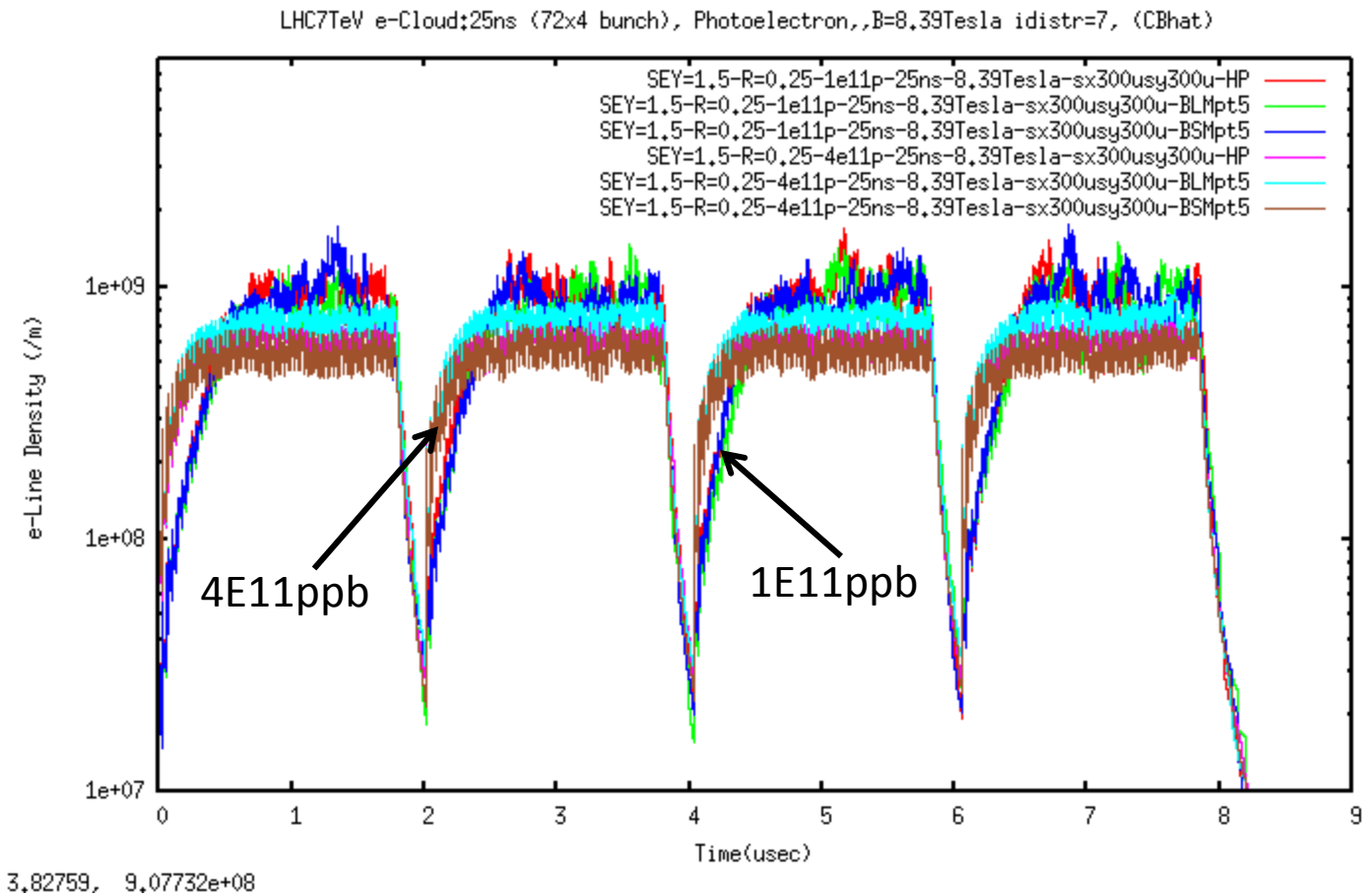


The presented simulations are for 2.5 eVs

Linear e-Density from ECLOUD: Dipole Section (50 nsec)

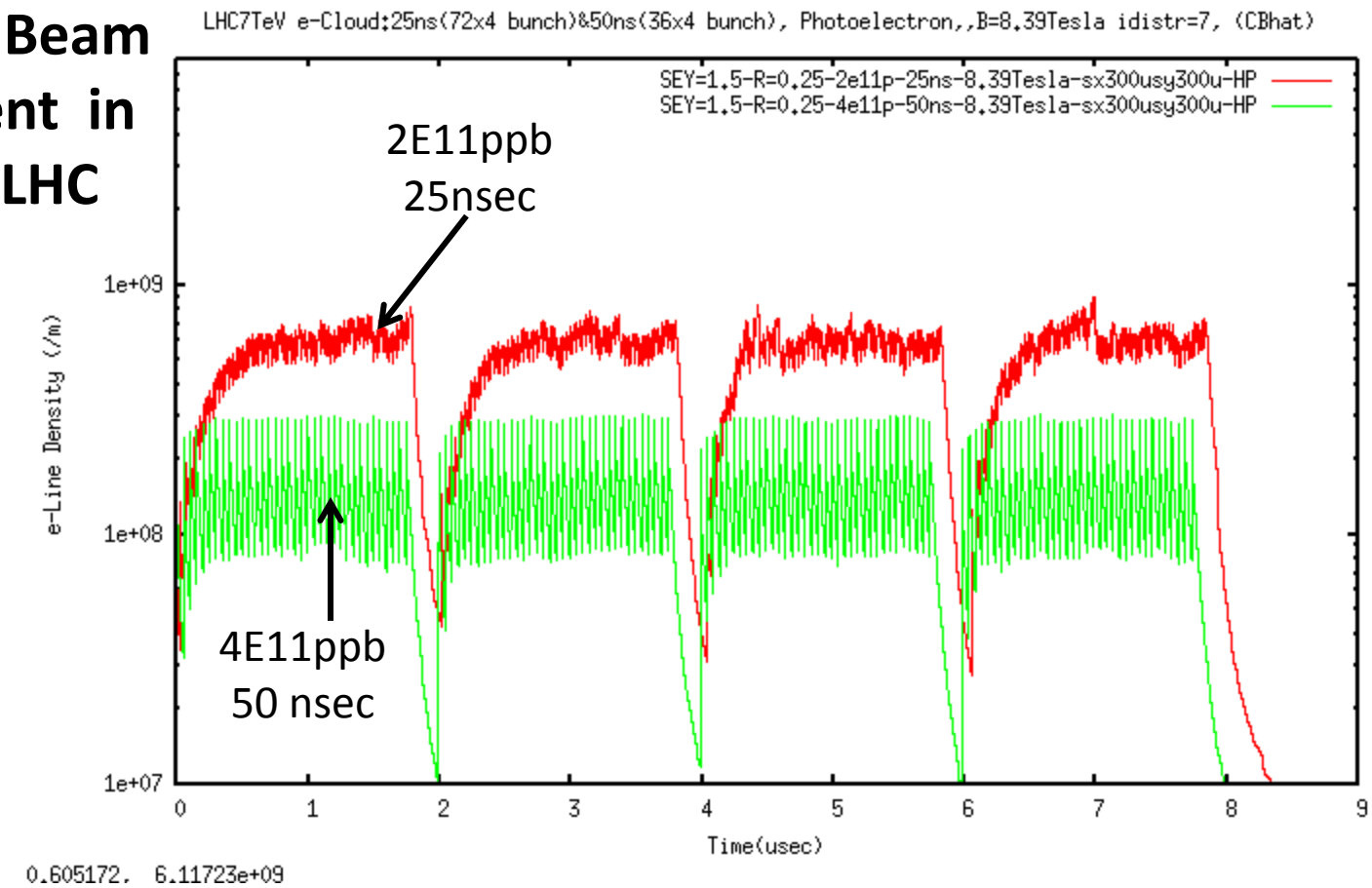


Linear e-Density from ECLOUD: Dipole Section (25 nsec)

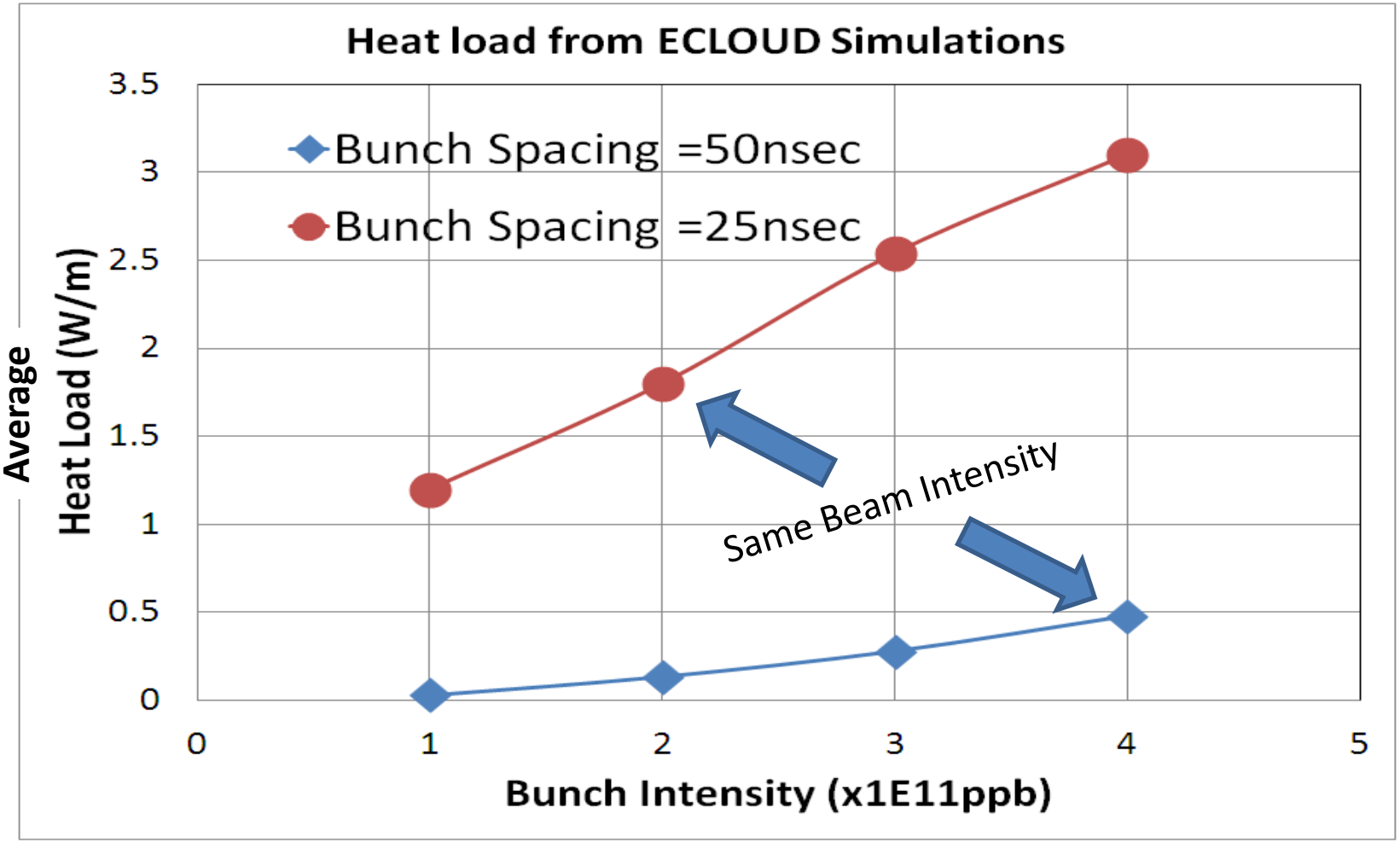


Linear e-Density from ECLOUD: Dipole Section (25ns & 50 ns)

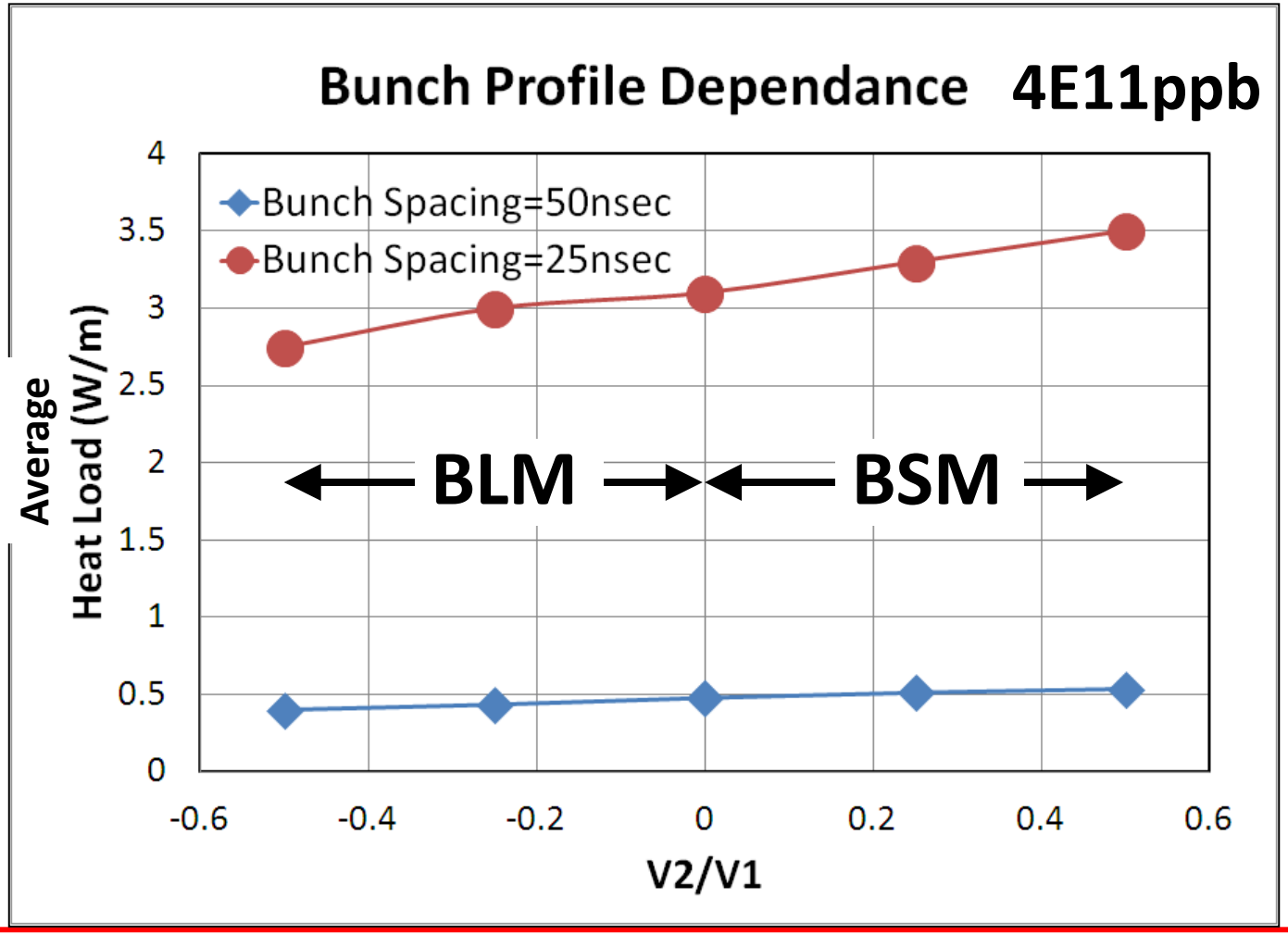
Same Beam Current in the LHC



Heat load: Bunch Intensity Dependence (dipole section)



Heat load: Profile Dependence (dipole section)

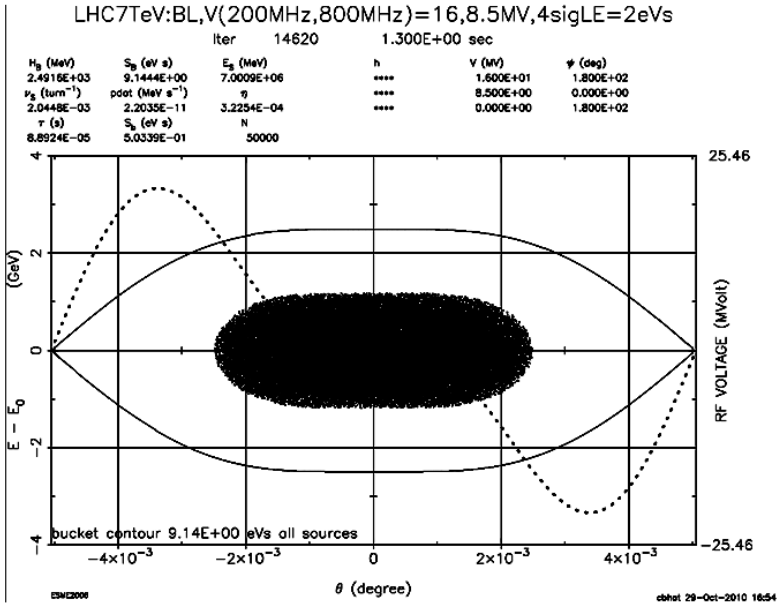


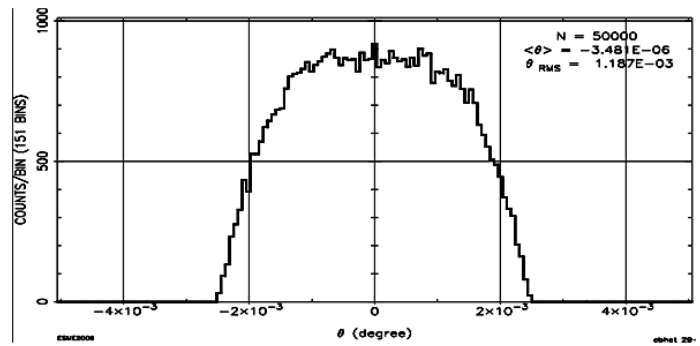
Summary

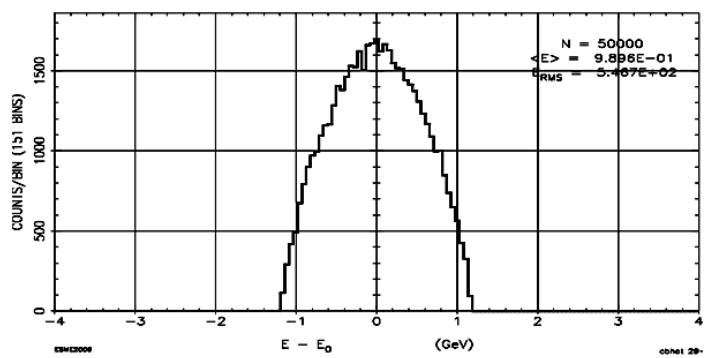
- e-Cloud simulations have been carried out for LHC LPA upgrade beam parameters using realistic bunch profiles.
- The heat load for 25 nsec bunch filling pattern is about six times larger than that for 50 nsec filling in the range of 1E11 to 4E11ppb for Dipole section.
- From e-cloud point of view, 50 ns filling pattern is 3.5 times better than 25 ns filling pattern for the same beam current (dipole section).
- For a given intensity the BSM has about 30% larger heat load as compared to BLM profiles.

LHC Bunch Profiles for 2 eVs beam with V2/V1=0.5, BLM (400MHz ⊕ 800MHz rf)

LE(4σ)=2 eVs
(ΔE,Δt) Distributions

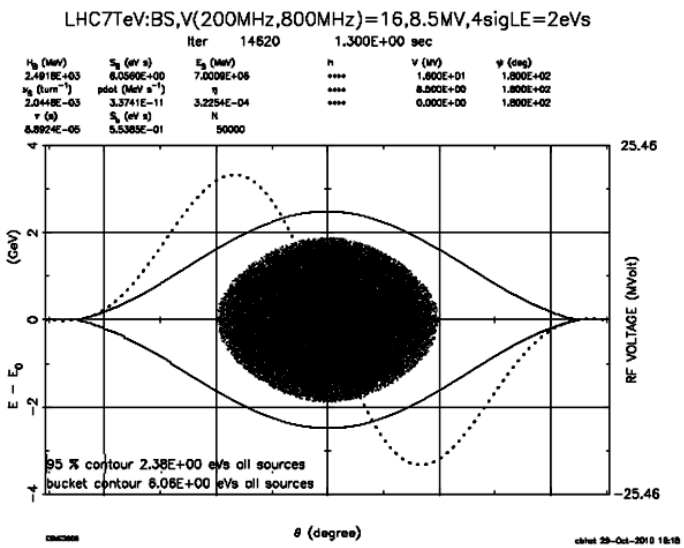


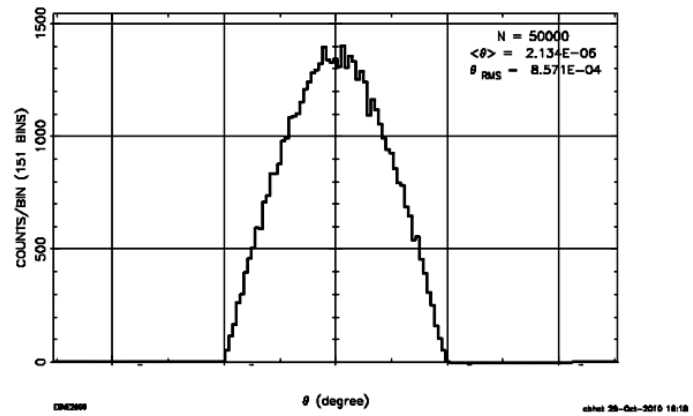


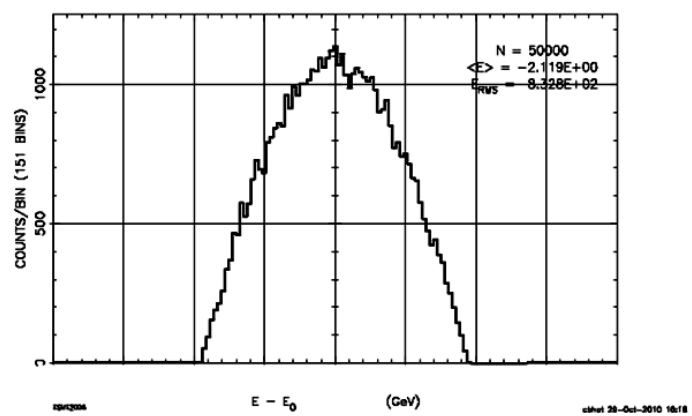


LHC Bunch Profiles for 2 eVs beam with V2/V1=-0.5, BSM (400MHz ⊕ 800MHz rf)

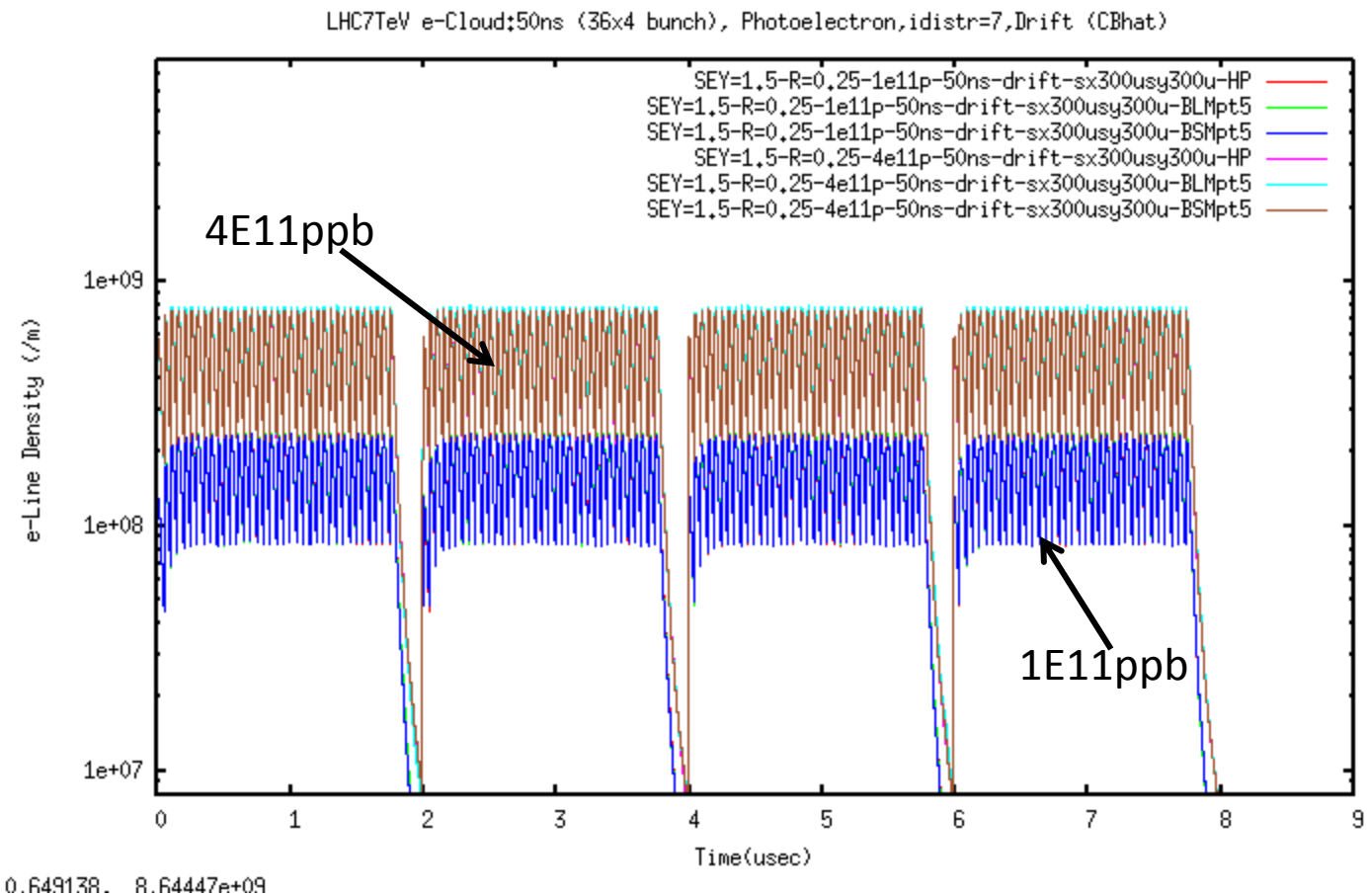
LE(4σ)=2 eVs
(ΔE,Δt) Distributions



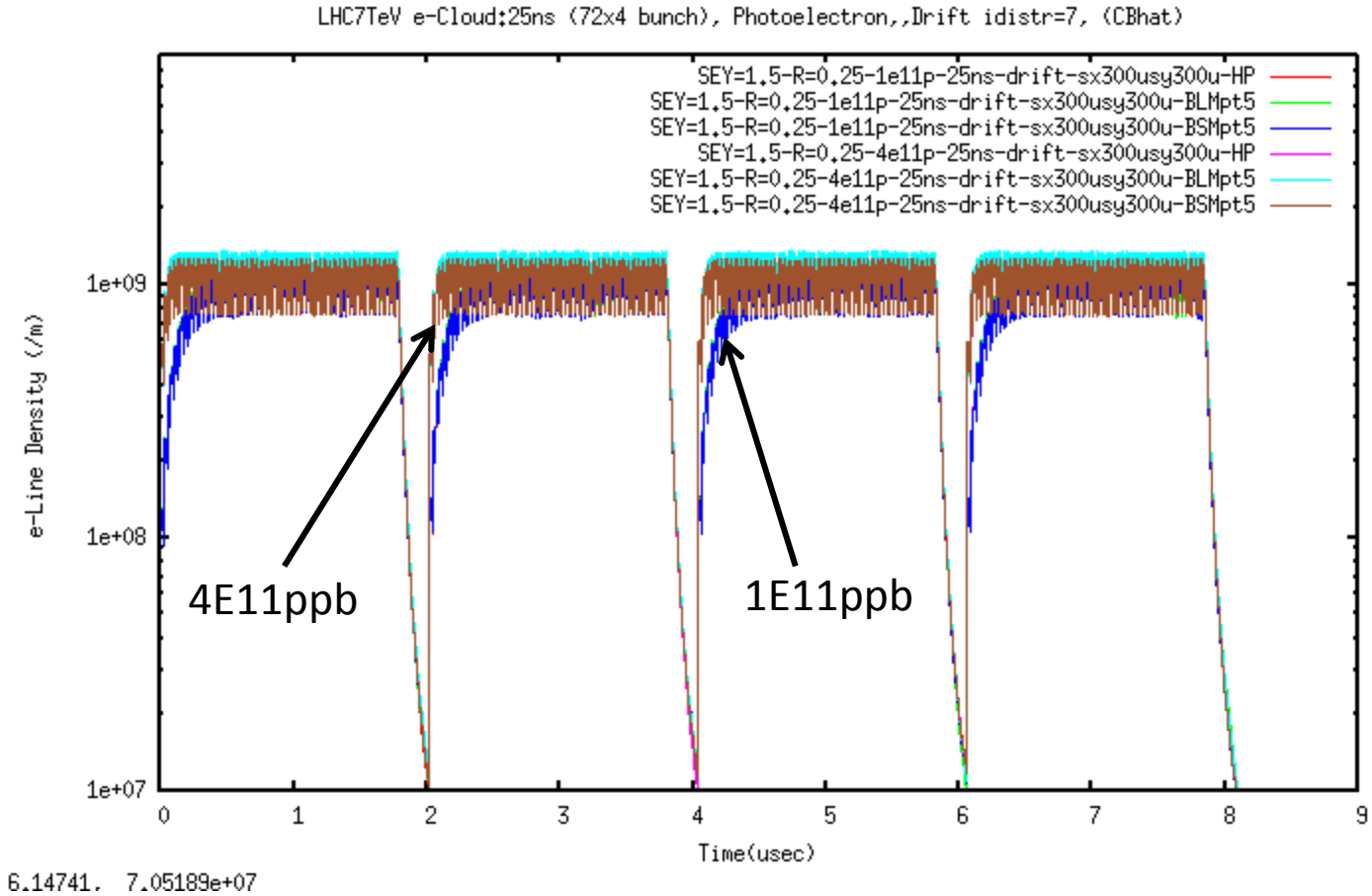


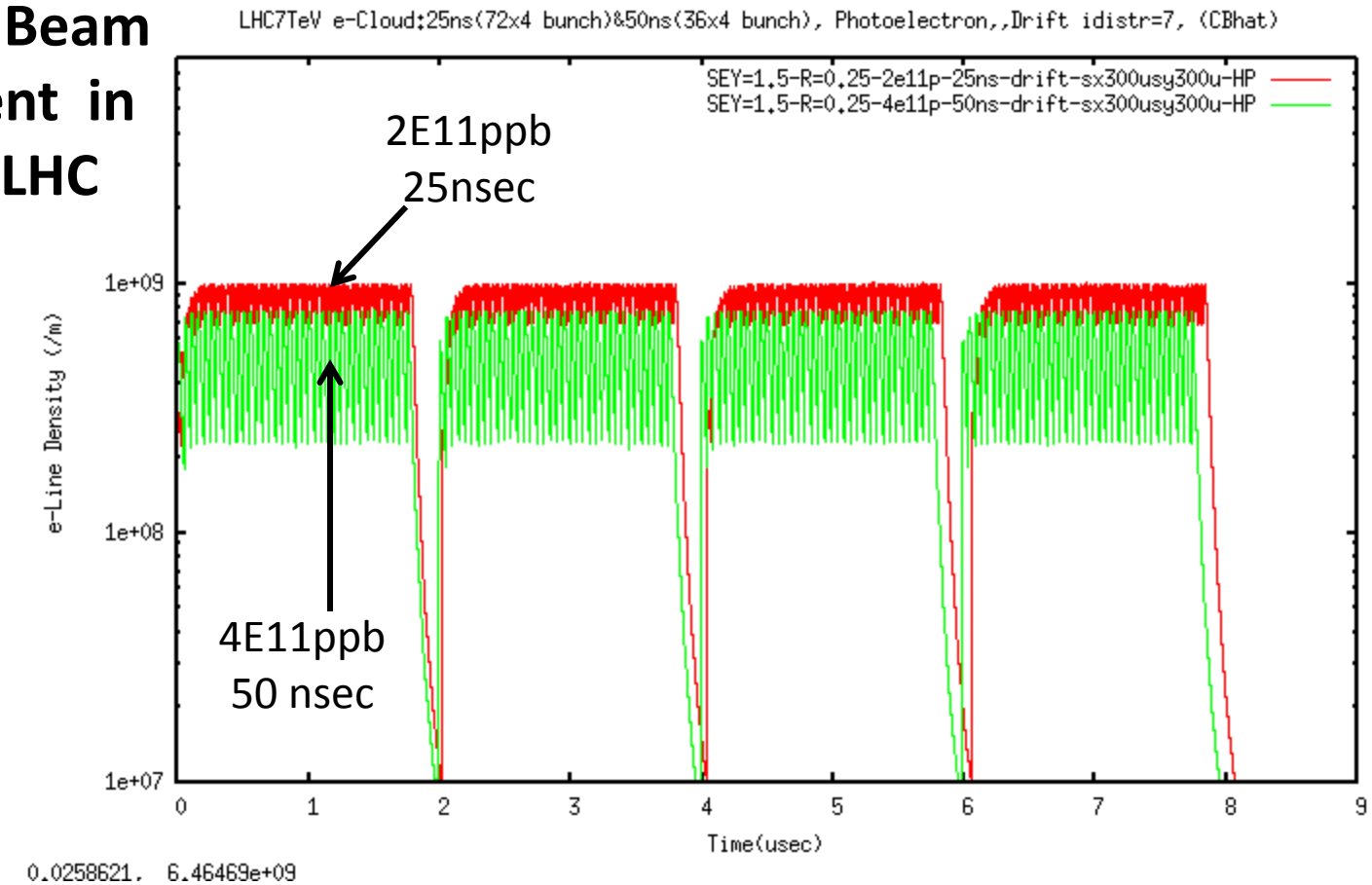


Linear Density from ECLOUD: Drift Section (50 nsec)



Linear Density from ECLOUD: Drift Section (25 nsec)



Linear Density from ECLOUD: Drift Section (25ns & 50 nsec)

Same Beam Current in the LHC